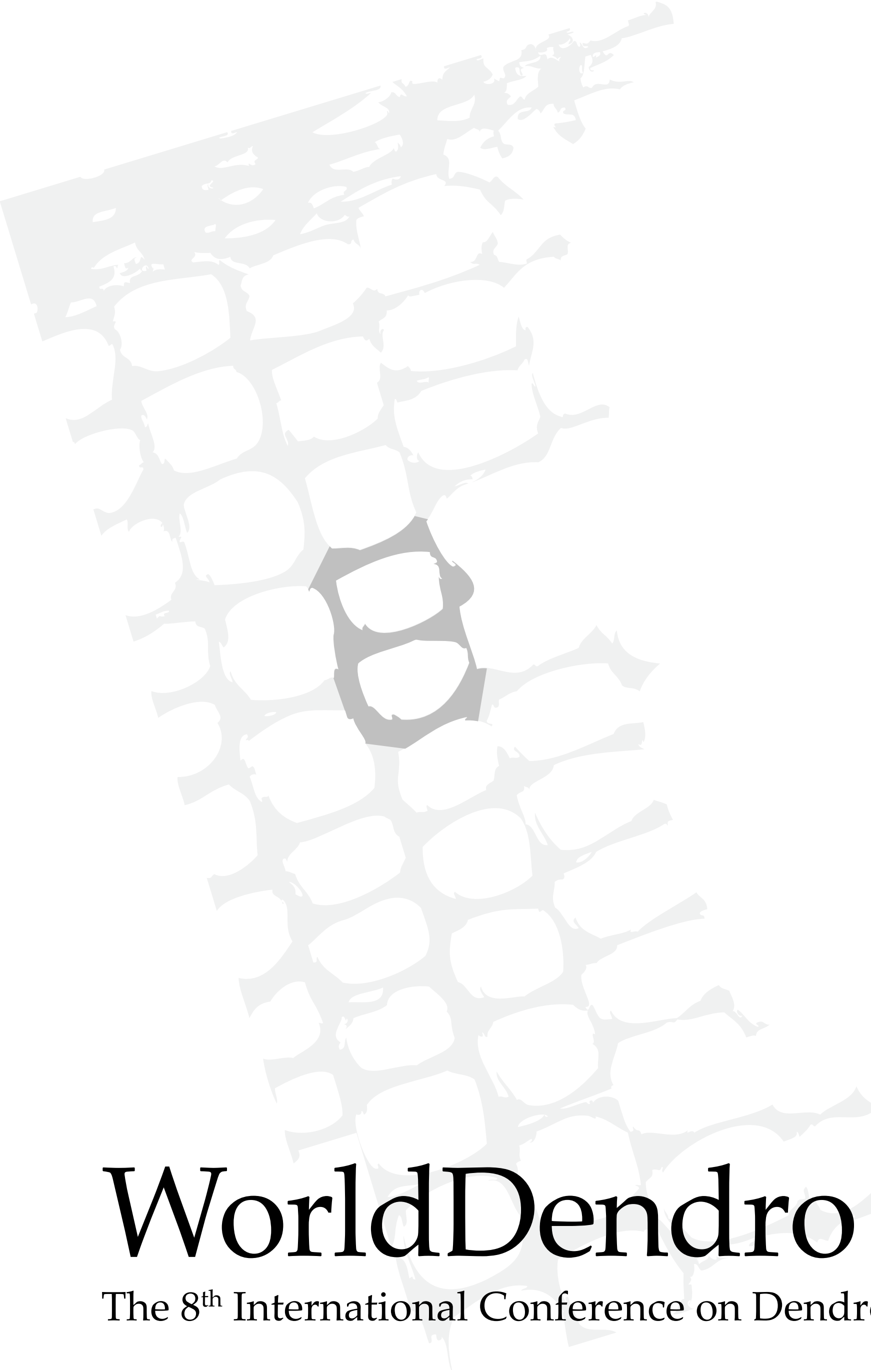
WorldDendro 2010

The 8th International Conference on Dendrochronology

Abstracts

Editors: Kari Mielikäinen, Harri Mäkinen and Mauri Timonen

June 13 – 18, 2010, Rovaniemi, Finland



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Foreword

Climate change is considered one of the greatest environmental, social and economic challenges of our time. Scientists across the world are looking for evidence on past and present climatic changes in order to make predictions about our future environment. Dendrochronology – tree ring research – has attained an eminent position in these studies, primarily because it not only provides annually resolved records, but also deals with decadal to millennial time scales highly useful in global climate change studies. Combining tree rings with additional proxy data from soils, waters and the atmosphere in global networks enhances our understanding on the complex behavior of Planet Earth.

The Eighth International Conference on Dendrochronology – WorldDendro 2010 – is intended for academics, scientists, students, and managers interested in using applications of dendrochronology in climatology, environmental sciences, archaeology, geology, resource management, conservation, policy making, and society. The main goal of the conference is to gather researchers working on the reconstruction and modeling of past, present and future tree growth and analyzing the natural and human induced variation patterns in tree rings.

The conference is the foremost international gathering and prestige platform for researchers to share the latest research findings and novel ideas on dendrochronology and related issues with other scientists. Our conference will facilitate contacts, enhance new collaboration, and stimulate intellectual exchanges amongst more than 300 researchers throughout the world.

The WorldDendro 2010 Conference will be arranged by the Finnish Forest Research Institute (Metla) and the University of Lapland, and it is sponsored by several Finnish and International organizations. The support and ideas of the Scientific and Advisory Committees have been of supreme importance. The Conference will be preceded by International Fieldweek and followed by Post-Conference excursions in Finland, Norway, Sweden and Russia.

We are very happy to see all of You here at the Arctic Circle under the Midnight Sun. On behalf of the Organizing Committee I wish You a nice stay and extremely exciting talks and discussions in a relaxed atmosphere of Finnish Lapland.

Rovaniemi 13.06.2010

Kari Mielikäinen

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Programme

Tree-Ring Science under the Midnight Sun

University of Lapland, Rovaniemi, Finland

Fieldweek, June 6. – 12, 2010, *Mekrijärvi, North Karelia*

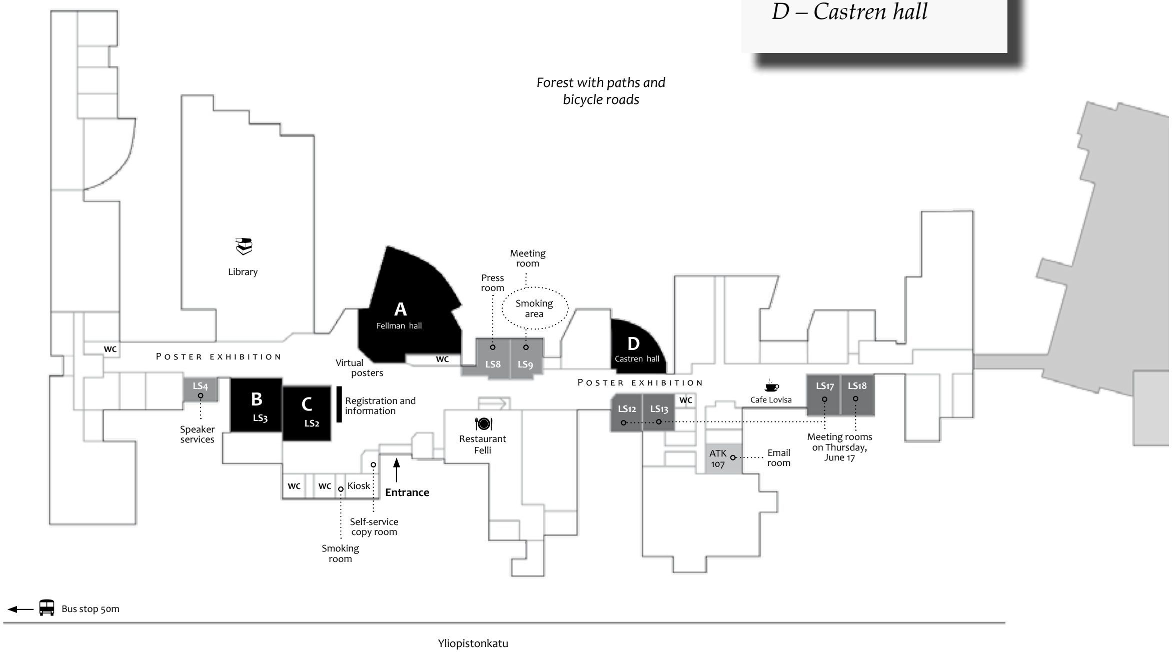
Sunday, June 13, 2010, *Arktikum, Rovaniemi*

15:00–(18:00)	Registration, visit to Arktikum exhibitions: - The Arctic in Change (Arctic Centre) - Northern ways (The Provincial Museum of Lapland)
18:00–20:00	Icebreaker

Monday, June 14, 2010

08:00–09:00	Registration	
09:00–09:30	Opening of the conference *Prof. Pasi Puttonen,*	
09:30–09:35	Technical announcements *Dr. Harri Mäkinen*	
09:35–10:00	Dendrochronology in Finland: Historical milestones and current activities *Prof. Kari Mielikäinen*	
10:00–10:30	Climate history of Eurasia; from greenhouses to Ice Ages *Prof. Juha-Pekka Lunkka*	
10:30–11:00	*Coffee break*	
11:00–11:30	State of dendrochronology; Introspective science from retrospective records *Prof. Peter M. Brown*	
11:30–12:00	Climate change and management of forest ecosystems *Prof. Heinrich Spiecker*	
12:00–13:30	*Lunch*	
	A.1 Divergence phenomenon Session chair: *Achim Bräuning*	B.1 New techniques and statistical approaches Session chair: *Samuli Helama* Co-chair: *Kevin T. Smith*
13:30–14:00	**1** The Challenges Posed by "Divergence", *K. Briffa*	**1** Singular spectrum analysis as a tool to identify dendroclimatic relationships in *Acer saccharum*, *Betula alleghaniensis*, and *Picea rubens* in the northeastern United States, *K. T. Smith*
14:00–14:20	**2** Are temperature reconstructions from northern treeline still possible? *M. Pisaric*	**2** A digital collaboratory for cultural dendrochronology (DCCD) in the Low Countries, *E. Jansma*
14:20–14:40	**3** Forest fire and stand dynamics in West Khentey Mountains, Mongolia *O. Byambamurem*	**3** Application of Monte-Carlo methods to estimate the significance of paleoclimatic and dendroclimatic calibration-verification statistics from autocorrelated time-series, *M. M. Fauria*
14:40–15:00	**4** Nonlinear growth responses of Douglas-fir in the Pacific Northwest to summer temperatures in the past decade, *E. H. Lee*	**4** Process based standardisation and a comparison with a tree-growth model, *T. Melvin*
15:00–15:30	*Coffee break*	
15:30–15:50	**5** A circa 9,000-year summer temperature reconstruction for the Eastern Alps: data, challenges and preliminary results, *K. Nicolussi*	**5** It's all in the mix – Dendroecological archetypes provide a new perspective on inherent growth patterns, *C. Zang*
15:50–16:10	**6** Assessing "divergence" in Swedish tree rings using data from the National Forest Inventory, *H. Grudd*	**6** A new approach to select the best trees for dendroclimatic analyses, *M. Carrer*
16:10–16:30	**7** A mid-20th century shift of Scots pine climate-response in North Norway, *A. J Kirchhefer*	**7** RCS modelling problemacy, *M. Timonen*
16:30–18:00	Poster session I, we ask the authors of the posters PA1–PA2, PB1–PB2, PC1–PC2, PD1–PD2 to be at their posters.	
17:00–18:00	R demo / Franco Biondi	

A – Fellman hall
B – Lecture hall LS 3
C – Lecture hall LS 2
D – Castren hall



	C.1 Treeline and northern tree rings Session chair: *Michael Grabner*	D.1 Dendroarchaeology Session chair: *Kristof Haneca* Co-chair: *Tomasz Wazny*
13:30–14:00	**1** A Tale of 10,000 trees – The Northwestern North American Tree Ring Synthesis, *M. Wilmking*	**1** Trade, earthquakes and tsunami – tree-ring study on Yenikapi harbor in Istanbul, *T. Wazny*
14:00–14:20	**2** Linking cambial phenology with climate growth analysis to understand how climate influences tracheid production in *Picea mariana, B. Dufour*	**2** Differentiation of wood provenances of Norway spruce and Silver fir in Southern Germany by dendroecological and statistical methods, *C. Dittmar*
14:20–14:40	**3** The peculiarities of larch growth in the northern timberline, *A. Shashkin*	**3** Lessons Learned from Irish Dendrochronology, *D. Brown*
14:40–15:00	**4** Potential target season-changes for different subarctic tree-species from 1913–2009, *J. Björklund*	**4** Filling in the blanks in European dendrochronology: building a multidisciplinary research network to assess Iberian wooden cultural heritage worldwide, *M. Domínguez Delmás*
15:00–15:30	*Coffee break*	
15:30–15:50	**5** Tree-line dynamics, radial growth of timberline trees and alpine shrubs on the southeastern Tibetan Plateau, *E. Liang*	**5** Dendrochronological investigations of medieval and post-medieval buildings in south-west England, *M. Hurford*
15:50–16:10	**6** Spruce growth and climate sensitivity along glacial rivers of Alaska, *G. Juday*	**6** Results of Research into Subfossil Oak Trunks from the Morava Basin, *T. Kolar*
16:10–16:30	**7** Environmental drivers and spruce growth along elevation gradient in Finnish Lapland, *R. Sutinen*	**7** Prehistoric dating of the salt mine Hallstatt – Austria: A problem of inter-species synchronisation, *M. Grabner*

Tuesday, June 15, 2010

	A.2 Reconstruction of past climate variations Session chair: *Frank Berninger* Co-chair: *Kerstin Treydte*	B.2 Tree rings and natural hazards Session chair: *Markus Stoffel* Co-chair: *Brian Luckman*
09:00–09:30	**1** Climate reconstruction from tree-rings: Advances, Developments, Challenges, *K. Treydte*	**1** Dendrochronology in natural hazards research, *B. Luckman*
09:30–09:50	**2** Combining tree-ring proxies and model simulations to reconstruct European climate, *J. Franke*	**2** Magnitude-frequency relationships of debris flows – a case study based on field surveys and tree-ring records, *M. Stoffel*
09:50–10:10	**3** Pan-European climate signals in population dynamics of subfossil oak and pine trees from mire lowlands, rivers and lakes, *H. H. Leuschner*	**3** Tree-ring reconstruction of past lahar activity at Popocatépetl volcano, Mexico, *M. Bollschweiler*
10:10–10:30	**4** Scandinavian temperature swings offset global warming, *U. Büntgen*	**4** Dendrochronological reconstruction of snow avalanche activity in the southern Wasatch Mountains, Utah, USA, *M. Bekker*
10:30–11:00	*Coffee break*	
11:00–11:20	**5** 1200 years of summer temperatures from height increment of Scots pine at the northern timberline in Fennoscandia, *M. Lindholm*	**5** Recent snow-avalanche activity determined by dendromorphology and dendrochronology in Northern and Northwestern Iceland, *A. Decaulne*
11:20–11:40	**6** A 3500 years-long density chronology in Dachstein mountains, Austria – preliminary results, *M. Klusek*	**6** Separating debris-flow and snow avalanche events in a steep watershed of the Swiss Alps using injured broad-leaved and conifer trees, *S. Szymczak*
11:40–12:00	**7** Reconstruction of extremely short or cold summers in the Siberian Subarctic over the last 500 years – the story of anomalous tree ring structures, *M. Gurskaya*	**7** Frequency and spread of hyperconcentrated flows on fans: a dendrogeomorphic case-study from a dolomite catchment in the Austrian Alps, *B. Mayer*
12:00–12:20	**8** Floating millenial chronologies of *Pinus* in the Sierra de Gredos (Spain), *M. Génova*	**8** Reconstruction of debris-flow activity in the Mont Dore Valley, Sancy Massif (French Central Massif), *O. Traian Pop*
12:20–13:50	*Lunch*	
	A.2 continues	B.2 continues
13:50–14:10	**9** A multiproxy assessment of the growth response to climatic variability of old living trees in the Pyrenees, *J. J. Camarero*	**9** An improved statistical method in dendrogeomorphology: case study from snow avalanches in the Chic-Chocs Range, eastern Canada, *D. Germain*
14:10–14:30	**10** Climate and streamflow variability in the sub-Antarctic region of South America (45º – 56º S) during the last 500 years: integrating tree-rings, instrumental records and hydro-climatic modeling., *A. Lara*	**10** Use of resistograph for dendrogeomorphological analysis of avalanche impacts, *J. Lopez Saez*
14:30–14:50	**11** Holocenic glacial fluctuations at the Mount San Lorenzo, Aysen Chile, *J.-C. Aravena*	**11** Spatial reconstructions of snow avalanche frequency and extent using tree rings in Parc National des Ecrins, French Alps, *C. Corona*
14:50–15:10	**12** Spatial drought variability over Northwest China inferred from tree rings, *K. Fang*	**12** The dendrochronological age of ancient timbers of Casa de la Moneda (Segovia, Spain) and its relationship with historic flood events *M. Génova*
15:10–15:40	*Coffee break*	
15:40–16:00	**13** Annual temperatures during the last 2485 years in the mid-eastern Tibetan Plateau inferred from tree rings, *Y. Liu*	**13** Snow avalanche records in the central Pyrenees, *E. Muntán*
16:00–16:20	**14** The New Zealand kauri chronology: recent advancements in updating and improving the record, *G. Boswijk*	**14** Dendroecological study of disturbances in the natural Picea abies forest “Paranglitsa” in Bulgaria, *M. Panayotov*
16:20–16:40	**15** Following the flow: recent progress towards a multi-centennial reconstruction from Eucalyptus pauciflora, *M. Brookhouse*	**15** Dendrochronological study in the Terekhol Basin, Southern Siberia, Russia, *E. Kuznetsova*
16:40–17:00	**16** 500 years of *Pinus heldreichii* growth variability for the Pirin Mountains in Bulgaria, *M. Panayotov*	**16** External factors influence on tree growth at the northern timberline at Kola Peninsula and Northern Lapland, *E. Kasatkina*
19:00–20:30	Rovaniemi City Reception	

	C.2 Wood anatomy Session chair: *Patrick Fonti*	D.1 Dendroarchaeology, continues Session chair: *Kristof Haneca* Co-chair: *Tomasz Wazny*
09:00–09:30	**1** Wood anatomy and different data to study the environmental signals registered in tree-rings – overview and example of beech (*Fagus sylvatica*), *K. Cufar*	**8** (-10 min) Medieval roof constructions in Flanders: built with local timber or not? *K. Haneca*
09:30–09:50	**2** Effect of experimental flooding on vessel area of pedunculate oak and common ash – a matter of timing, *U. Sass-Klaassen*	**9** Reconstructing Al-Aqsa: dendrochronological analysis and absolute dating of timbers from Jerusalem's most sacred mosque, *B. Lorentzen*
09:50–10:10	**3** Maximum latewood density derived from wood anatomical time series analysis, *H. Gärtner*	**10** Timber trade in the Baltic area during the 13th century, *S. Wrobel*
10:10–10:30	**4** Twenty years of Needle Trace Method, NTM, *R. Jalkanen*	**11** Identification of Iranian archeological woods by vessel shape, *V. Safdari*
10:30–11:00	*Coffee break*	
		D.2 Hydroclimatic changes Session chair: *Ute Sass-Klaassen* Co-chair: *Jaques Tardif*
11:00–11:20	**5** Intra-annual variation of cell parameters of Scots pine and its association with climate throughout Finland, *J.-W. Seo*	**1** (+10 min) Spring water levels reconstructed from ice-scarred trees and cross-sectional area of the earlywood vessels in tree-rings from eastern boreal Canada, *J. Tardif*
11:20–11:40	**6** Wood anatomy and microcharcoal used as markers of paleoenvironmental reconstruction and indicators of prehistoric fire regimes. The case of the Ambato valley at the end of the 1st Millennium, *H. B. Lindskoug*	**2** An Ensemble-Based Approach To Reconstructing Gridded Drought From Tree Rings Over Monsoon Asia, *E. Cook*
11:40–12:00	**7** Evaluation of water deficit tolerance of young aspen (*Populus tremula* L.) using wood characteristics of juvenile tree rings, *M. Meyer*	**3** A 1000+ year summer PDSI reconstruction for southern-central England, *R. Wilson*
12:00–12:20	**8** Erosional processes in the upper part of the mountain catchments recorded in exposed roots, *D. Wrońska-Wałach*	**4** Dendrohydrology: a tool for decision making in the face of climate uncertainty, *C. Woodhouse*
12:20–13:50	*Lunch*	
	C.2 continues	D.2 continues
13:50–14:10	**9** Wood anatomical analysis of broad-leaved trees injured by debris-flow events, *E. Arbellay*	**5** A Central European oak network reveals inter-annual to multi-centennial hydroclimatic variability over the past 2500 years, *W. Tegel*
14:10–14:30	**10** Investigating relationships between ring width, density and cell properties for two long-lived Southern Hemisphere conifers, *K. Allen*	**6** Reconstructions of regional scale hydroclimatic variability in California using a network of high-quality blue oak (Quercus douglasii) tree-ring chronologies, *D. Griffin*
14:30–14:50	**11** Tree rings used to assess effects of gypsy moth (*Lymantria dispar* L.) defoliation on wood volume growth of oaks (*Quercus* spp.) in Pennsylvania, USA, *M. A. Fajvan*	**7** Applying the tree-ring record to critical problems in water resource management, *S. Gray*
14:50–15:10	**12** The ecological success of the mangrove Avicennia: the perfect combination of well-adapted wood anatomical characteristics and special radial growth? *E. Robert*	**8** Development of south Swedish bog-pine chronologies – assessment of palaeoclimatic potential on local to regional scale, *J. Edvardsson*
15:10–15:40	*Coffee break*	
15:40–16:00	**13** Microstructure and chemical composition of tree-rings: new opportunities for multiparameter analysis, *P. Silkin*	**9** Multi-century tree-ring reconstruction of annual streamflow for the Maule watershed, South-Central Chile, *R. Urrutia*
16:00–16:20	**14** Impact of three silvicultural regimes on radial growth and wood quality of black spruce, a study case in the boreal forest, *É. Pamerleau-Couture*	**10** A tree-ring perspective on recent and future Rocky Mountain runoff, *D. Sauchyn*
16:20–16:40	**15** Spatio-temporal variation of earlywood vessel features of Quercus robur L. along a climatic gradient in the Northwestern Iberian Peninsula, *I. García-González*	**11** The hydroclimatic signal in tree-ring chronologies and recent streamflow trends in the western boreal region, Canada, *J.-M. St. Jacques*
16:40–17:00	**16** Disturbance history of mountain spruce forests in the Carpathian Mts. derived from tree-rings, *T. Zielonka*	**12** Spring flood reconstruction from ice scar chronologies: the example of lake Montausier, northeastern Canada, *E. Boucher*

Wednesday, June 16, 2010

	A.3 Tree rings and insects, diseases and anthropogenic factors Session chair: *Risto Jalkanen*	B.1 New techniques and statistical approaches, continues Session chair: *Samuli Helama* Co-chair: *Kevin T. Smith*
09:00–09:30	**1** Spruce budworm outbreaks and the dynamics of boreal old growth forest of Eastern North America, *H. Morin*	**8** continues (-10 min) DIRECT: a new approach to dendroclimatic reconstructions, *V. Matskovsky*
09:30–09:50	**2** Testing for a CO_2 fertilization effect on growth of Canadian boreal forests, *M. Girardin*	**9** Use of mixed models in dendroecology, *F. Berninge*
09:50–10:10	**3** Coring as a contributing factor to tree mortality?, *J. Wunder*	**10** Analysis of non-linear relationships between climate and tree rings using non metric multidimensional scaling, *D. Patón*
10:10–10:30	**4** Silver fir (*Abies alba* Mill.) decline and dieback: comparison of growth patterns between sites and improvement of tree mortality models, *M. Cailleret*	**11** Dendroclimatic instability in Aleppo pine across the Mediterranean basin, *M. de Luis*
10:30–11:00	*Coffee break*	
11:00–11:20	**5** The contribution of the root system to the success of sylvicultural treatments, *C. Krause*	**12** The interior of tree roots – a fusion of 3D laser scanning and 2D tree ring data, *B. Wagner*
11:20–11:40	**6** Changes in growth and dendroclimatic response of trees growing along an artificial lake, *C. Copenheaver*	**13** Defining temperature and soil moisture thresholds for positive radial increment of cork oak (*Quercus suber* L.) in a mediterranean environment: an approach based on generalized semiparametric linear mixed models, *J. Vázquez-Piqué*
11:40–12:00	**7** Air pollution recorded in Scots pine and disease rises in local population due to harmful emissions in Upper Silesia (southern Poland), *I. Malik*	**14** Does acorn production influence the diametric stem growth of holm oak? *D. Martin*
12:00–12:20	**8** Dendroclimatological analysis of declining Norway spruce forests (*Picea abies* (L.) Karst) in West Carpatians, *R. Marusak*	**15** Analyzing subjective expert opinions about standardization of tree-ring series, *J. Hollmen*
12:20–13:50	*Lunch*	
13:50–20:00	In-conference tour	

Hosts of the in-conference-tour

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	C.3 Dendroecology of shrubs Session chair: *Eryuan Liang*
09:00–09:30	**1** Ecological significance of annual rings in trees, shrubs and herbs, *F. Schweingruber*
09:30–09:50	**2** Scaling the mountains and roaming the tundra – expanding shrubs in North-Scandinavia and Northwest-America, *M. Hallinger*
09:50–10:10	**3** Deciduous shrub growth and the greening of the Arctic in Western Siberia, *B. C. Forbes*
10:10–10:30	**4** Annual shoot length growth of the Arctic dwarf shrub Cassiope tetragona as monitor of present-day and past climate change, *S. Weijers*
10:30–11:00	*Coffee break*
11:00–11:20	**5** Comparison of tree ring patterns of dwarf shrubs and trees of the genus Betula at the upper timber-line in Norway, *I. Burchardt*
11:20–11:40	**6** Are shrubs climbing mountains faster in warmer microclimates? *I. H. Myers-Smith*
11:40–12:00	**7** Interaction of geomorphic features and dendro-chronological potential of polar dwarf shrubs (Salix polaris, Svalbard), *A. Buchwal*
12:00–12:20	**8** Advances of shrub in dendrochronology study in China, *X. Shengchun*
12:20–13:50	*Lunch*

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Thursday, June 17, 2010

	A.4 Climate-growth relationship of different tree species Session chair: *Jan Esper* Co-chair: *David Frank*	B.3 Stable isotopes Session chair: *Gerd Helle*
09:00–09:30	**1** Qinghai-Tibetan Plateau tree-ring network reveals large-scale spring moisture variation, *Q.-B. Zhang*	**1** Stable isotopes of tree rings as a tool to pinpoint the geographic origin of timber, *A. Kagawa*
09:30–09:50	**2** Summer temperature reconstruction for SE European Alps based on European larch (*Larix decidua* Mill.) treering proxies, *T. Levanic*	**2** Laser microdissection-flash-pyrolysis-GC-IRMS: a new method for rapid analysis of intra-and interannual variations of ^{13}C and ^{18}O in tree rings, *G. Helle*
09:50–10:10	**3** Assessment of long-term interannual tree NPP varia tions in response to climate, *F. Babst*	**3** The influence of atmospheric circulation patterns on the oxygen isotope ratio in precipitation and tree rings, *M. Saurer*
10:10–10:30	**4** Climate and stand dynamics in the *Pinus pinaster* forest stands in northern Portugal, *M. L. R. Liberato*	**4** Biases and trends in long-term isotope data from the Spanish Pyrenees, *J. Esper*
10:30–11:00	*Coffee break*	
11:00–11:20	**5** The value of *Pinus heldreichii* as climate archive in South-eastern Europe, *K. Grunewald*	**5** Stable C and O isotopes in tree physiology for the interpretation of tree ring data, *R. Siegwolf*
11:20–11:40	**6** Climate impact on the radial increment of Norway spruce (*Picea abies* (L.) Karst.) in Belarus, *M. Yermokhin*	**6** A Millennial length Stable Isotope Chronology for Arctic Sweden (Torneträsk), *N.J. Loader*
11:40–12:00	**7** The first quantative warm period temperature reconstruction in the Caucasus mountains derived from tree-ring data, *E. Dolgova*	**7** Reconstructing the climate of Scotland using stable carbon and oxygen isotopes in *Pinus sylvestris* L. (Scots pine), *E. Woodley*
12:00–12:20	**8** Opposite migration of beech and spruce in Southern Sweden – A dendroclimatological analysis, *B. Grundmann*	**8** Age related growth trends in the tree-ring archive: A case study from Pinus sylvestris L. in northwestern Norway, *G. Young*
12:20–13:50	*Lunch*	
	A.4 continues	B.3 continues
13:50–14:10	**9** A preliminary analysis of regional moisture in the Northwestern China during the past 150 years, *Y. Zhang*	**9** Long-Term Changes in Water Use Efficiency Across Europe, *D. Frank*
14:10–14:30	**10** Tree-ring-based reconstruction of the April to September mean temperature since 1826 AD for north-central Shaanxi Province, China, *Q. Cai*	**10** Climate signals in stable isotopes of *Juniperus excelsa* from Turkey back to 1025, *I. Heinrich*
14:30–14:50	**11** Responsive variations of *Qilian Juniper* to climate at different elevations in Wulan, Qinghai Province, China, *Y. Xu*	**11** The use of carbon and oxygen stable isotope data in tree-rings for dendroecological studies in Siberia (Russia), *A. V. Kirdyanov*
14:50–15:10	**12** Tree-ring based winter temperature reconstruction for the lower reaches of the Yangtze River in southeast China, *J. Shi*	**12** Stable isotopes in tree rings as indicator of climatic and environmental changes in high – latitude and -altitude regions, *O. Sidorova*
15:10–15:40	*Coffee break*	
15:40–16:00	**13** Three spruce chronologies of tree-ring maximum density from upper tree line in the western Tianshan Mountains of Xinjiang, *Y. Yujiang*	**13** Dendrochronology and metal deposition in tree rings of baldcypress (*Taxodium distichum*) growing in wetlands in south Louisiana, USA, *M. S. Devall*
16:00–16:20	**14** History of *Abies spectabilis* population recruitment along an altitudinal gradient in Mt. Everest region, *L. Lv*	**14** Reconstructing hydro-climate during the last two centuries in the northeastern Canadian boreal forest using carbon and oxygen dendroisotopes, *C. Bégin*
16:20–16:40	**15** The palaeoclimatic potential of conifer species in the Himalayan region of Pakistan, *M. Ahmed*	**15** Evaluating the integrity of isotopic series in fossil wood deposited in Northeastern Canadian lakes – Preliminary work for reconstructing millennium climatic series, *M. M. Savard*
16:40–18:30	Poster session II, we ask the authors of the posters PA3–PA5, PB3–PB4, PC3–PC5, PD3–PD4 to be at their posters	
17:00–17:30	Meeting of the Nordic Association	
17:30–18:30	Meetings of the continental associations (ATR, TRS, Asian, Nordic)	

	C.4 Intra-annual cambium dynamics Session chair: *Annie Deslauriers* Co-chair: *Jožica Gričar*	D.3 Stand dynamics and sustainable forest management Session chair: *Pascale Weber* Co-chair: *Christof Bigler*
09:00–09:30	**1** Application of controlled experiments for studies of radial growth of trees, *J. Gricar*	**1** Use and misuse of tree rings in long-term forestecosystem research: Swiss experiences, *P. Cherubini*
09:30–09:50	**2** Intra-annual cambial activity and carbon availabilty in stem of poplar, *A. Deslauriers*	**2** Climate impacts on tree growth, mortality and lifespan of conifers in forests of the European Alps and the Rocky Mountains, *C. Bigler*
09:50–10:10	**3** Predicting timings of xylogenesis in black spruce under climatic warming, *S. Rossi*	**3** Growth and sensitivity of beech at the dry distribu tion limit, *P. Weber*
10:10–10:30	**4** Intra-annual radial growth in Scots pine (*Pinus sylvestris* L.) exposed to drought, *W. Oberhuber*	**4** Tree response to severe drought in the Republic of Ireland: the case of Avoca, Co. Wicklow, *A. Tene*
10:30–11:00		
11:00–11:20	**5** Temperature-induced differences in timing of intra-annual growth of subalpine Larix decidua and Picea abies, *P. Fonti*	**5** Spatial and age structure, tree-ring growth dynamics and climate sensitivity in treeline beech forests in Central Italy, *C. Urbinati*
11:20–11:40	**6** Circadian stem size dynamics in larch and spruce along a 900-meter elevational gradient, *G. M. King*	**6** Climate signal and sensitivity of Turkey oak (*Quercus cerris*) in central-southern Italy, *V. Gallucci*
11:40–12:00	**7** What a dendrochronologist can learn from cambium phenology and intra-annual dynamics of tree-ring formation? *C. Rathgeber*	**7** Norwey spruce of different provenances grown in dry regions of Austria – influences on ring width and wood density, *S. Karanitsch-Ackerl*
12:00–12:20	**8** Seasonal growth of tree-rings in larch (*Larix gmelinii* Rupr.) on permafrost soils in Siberia, *M. Bryukhanova*	**8** Comparison in radial growth patterns of Picea abies in Bulgarian and Swiss mountains, F. Krumm
12:20–13:50	*Lunch*	
	C.4 continues	D.3 continues
13:50–14:10	**9** Phloem ring formation and secondary changes in beech (*Fagus sylvatica*) bark, *P. Prislan*	**9** Studying the effect of seasonal temperature and precipitation on annual diameter growth of Scots pine on drained peatlands, *H. Hökkä*
14:10–14:30	**10** Re-activation of xylem and phloem flow in young oaks during spring, *P. Copin*	**10** Effects on dry matter production and intra-annual growth ring density characteristics of genetically improved Norway spruce in northern Sweden, *T. Mörling*
14:30–14:50	**11** Xylem formation and seasonal growth of Agathis aus tralis (kauri) – an examination of intra-annual tree-ring patterns, *S. P. J. McCloskey*	**11** Dynamics of Pinus banksiana mortality in the eastern Canadian boreal forest, *A. Genries*
14:50–15:10	**12** Compression wood formation as an indicator of ice storm damage in the southern Appalachian Mountains, USA, *B. Hook*	**12** Would *Quercus canariensis* Willd. populations from low elevations be particularly threatened by drought increase? *G. Gea-Izquierdo*
15:10–15:40		
15:40–16:00	**13** A physiological model of wood formation, *T. Hölttä*	**13** Interactive effects of climate and groundwater depth on semiarid woodlands: a dendrochronological analysis in central Argentina, *S. Marys Bogino*
16:00–16:20	**14** Increment cores from the Finnish National Forest Inventory as a source of information for studying radial increment during a growing season, *H. Mäkinen*	**14** *Nothofagus dombeyi* and *Austrocedrus chilensis* establishment in declining forests, *M. Amoroso*
16:20–16:40		**15** Impact of future climate on radial growth of four dominant boreal tree species along a latitudinal gradi ent in the eastern Canadian boreal forest, *J.-G. Huang*

Friday, June 18, 2010

	A.5 Teleconnections Session chair: *Yu Liu*	B.3 Stable isotopes Session chair: *Gerd Helle*
09:00–09:30	**1** Teleconnections in the climate system from a dendrochronological perspective, *H. W Linderholm*	**16** (-10 min) A comparison of stable carbon and oxygen isotopes in tree rings and Sphagnum mosses from the Canadian Arctic, *S. Holzkämper*
09:30–09:50	**2** Low frequency variation in tree-ring chronologies: evidence of the Pacific North American pattern (PNA) in the Southern Appalachian and Northern Rocky Mountains, USA, C. Crawfor	**17** Hydroclimate variations and $\delta^{18}O$ of precipitation recorded by tree-ring cellulose $\delta^{18}O$ of different tree species from different environment in semi-arid Northern China, *Q. Li*
09:50–10:10	**3** Climate/tree-ring and teleconnection relationships for a millennial-length chronology of Chamaecyparis obtusa var. formosana from northern Taiwan, *W. Wright*	**18** High-frequency signals in millennial stable isotope series from the Tibetan plateau, *J. Griessinger*
10:10–10:30	**4** Climate reconstruction from tree ring data of western Himalaya and its tele-connection with global sea surface temperature and sea level pressure, *A. Bhattacharyya*	**19** The potential of tree rings and stable isotopes from East to West Africa, *A. Gebrekirstos*
10:30–11:00	*Coffee break*	
		B.4 Forest fires in changing climate Session chair: *Connie Woodhouse*
11:00–11:20	**5** Basis and application of superposed epoch analysis to fire/climate relationships, *E. K. Sutherland*	**1** (+10 min) Fire history of the Giant Forest, Sequoia National Park, *T. Swetnam*
11:20–11:40	**6** Expanding the tree-ring chronology network in SW Spain, *D. Patón*	**2** Fire-climate interactions in the American West since 1400 CE, *V. Trouet*
11:40–12:00	**7** Changes in teleconnection pattern between Japanese summer monsoon (Baiu) and ENSO during last three centuries: Evidences from oxygen isotopic ratios of tree-ring cellulose in northern, central and southern Japan, *T. Nakatsuka*	**3** Testing the pyroclimatic hypothesis for Mt.Irish, Nevada, USA, *F. Biondi*
12:00–12:20	**8** Annual Precipitation since A.D. 1460 reconstructed from the juniper ring width of Qilian Mountains, *Q. Tian*	**4** Fire activity in Scandinavia during 1500–1900, *M. Niklasson*
12:20–13:40	*Lunch*	
	Plenary session: Chair: *Prof. James H. Speer*	
13:40–14:00	Asian Dendrochronology – past and present experiences and future challenges *Prof. Nathsuda Pumijumnong*	
14:00–14:20	The multi-millennial-length tree-ring records in the Southern Hemisphere: current development and perspectives *Prof. Fidel Roig*	
14:20–14:40	Atomization of a discipline? Forward thinking for a retrospective science *Prof. Achim Bräuning*	
14:40–15:00	Dendrochronology and IUFRO: history, recent activities and the future *Dr. Margaret Devall*	
15:00–15:30	*Coffee break*	
15:30–15:50	Lessons learned on potentials and future directions of dendrochronology *Prof. Dieter Eckstein*	
15:50–16:10	Concluding remarks *Prof. James H. Speer*	
16:10–16:45	Announcement of the host for the 9th conference	
	Prof. Kari Mielikäinen: WorldDendro2010 adjourns	
20:00–00:30	WorldDendro2010 Farewell Dinner	

Saturday, June 19, 2010

Post-conference excursions

	C.5 Landscape dynamics Session chair: *Rob Wilson*	D.4 Tropical dendrochronology Session chair: *Fidel Roig*
09:00–09:30	**1** Rate of post-fire rise of permafrost under larch stands in Siberia estimated by dendrochronological methods, *A. Knorre*	**1** Long Montezuma Baldcypress tree-ring chronologies in Mesoamerica, *D. Stahle*
09:30–09:50	**2** Tree-ring evidence of glacier dynamics in Monsoon Asia during the Late Holocene, *A. Bräuning*	**2** Plastic wood anatomical responses of tropical species to dry and moist conditions, *E. Fichtler*
09:50–10:10	**3** Tree species portfolio in a drier future – a case study from Valais, *B. Eilmann*	**3** Dendrochronology and isotope chronology of Juglans neotropica and its response to ENSO events in tropical highland areas of Piura, northern Peru, *T. M. Ektvedt*
10:10–10:30	**4** Climate reconstruction from tree ring data of western Himalaya and its tele-connection with global sea surface temperature and sea level pressure, *A. Bhattacharyya*	**4** From darkness to light, evaluating the gap dependence of Bolivian rainforest tree species, *C. C. Soliz-Gamboa*
10:30–11:00	*Coffee break*	
11:00–11:20	**5** Historical fire regimes and stand development patterns in Australian Eucalypt forests – integrating tree-ring, pollen and charcoal analysis, *R. Simkin*	
11:20–11:40	**6** Asymmetric variability between maximum and minimum temperature in Northeastern Tibetan Plateau: Evidence from tree rings, *X. Gou*	
11:40–12:00	**7** Dendroclimatological analysis of summer temperatures in the Irik Valley, Elbrus Region (Russia), *I. H. Holobaca*	
12:00–12:20	**8** Age of the *Pinus sylvestris* trees and forests in northeastern Finnish Lapland, *T. Wallenius*	
12:20–13:40	*Lunch*	

Sessions

Oral/Poster

A1/PA1	Divergence phenomenon in dendroclimatology	
	Session chair:	*Achim Bräuning*
	Invited speaker:	*Keith Briffa*
A2/PA2	Reconstruction of past climate variations: a challenge for the present and future	
	Session chair:	*Frank Berninger*
	Co-chair:	*Kerstin Treydte*
	Invited speaker:	*Kerstin Treydte*
A3/PA3	Tree rings and insects, diseases and anthropogenic factors	
	Session chair:	*Risto Jalkanen*
	Invited speaker:	*Hubert Morin*
A4/PA4	Climate-growth relationship of different tree species	
	Session chair:	*Jan Esper*
	Co-chair:	*David Frank*
	Invited speaker:	*Qi-Bin Zhang*
A5/PA5	Teleconnections in the climate system from tree-rings and multiproxy records	
	Session chair:	*Yu Liu*
	Invited speaker:	*Hans Linderholm*
B1/PB1	New techniques and statistical approaches for detecting environmental signals and predicting forest growth	
	Session chair:	*Samuli Helama*
	Co-chair:	*Kevin T. Smith*
	Invited speaker:	*Kevin T. Smith*
B2/PB2	Tree rings and natural hazards in a changing climate	
	Session chair:	*Markus Stoffel*
	Co-chair:	*Brian Luckman*
	Invited speaker:	*Brian Luckman*
B3/PB3	Stable isotopes and dendrochemistry in trees as indicators of environmental change	
	Session chair:	*Gerd Helle*
	Invited speaker:	*Akira Kagawa*
B4/PB4	Forest fires in changing climate	
	Session chair:	*Connie Woodhouse*
	Invited speaker:	*Thomas Swetnam*
C1/PC1	Treeline and northern tree rings in climate change research	
	Session chair:	*Michael Grabner*
	Invited speaker:	*Martin Wilmking*
C2/PC2	Wood anatomy as an indicator of environmental factors	
	Session chair:	*Patrick Fonti*
	Invited speaker:	*Katarina Cufar*
C3/PC3	Dendroecology of shrubs	
	Session chair:	*Eryuan Liang*
	Invited speaker:	*Fritz Hans Schweingruber*
C4/PC4	Intra-annual cambium dynamics and wood formation	
	Session chair:	*Annie Deslauriers*
	Co-chair:	*Jožica Gričar*
	Invited speaker:	*Jožica Gričar*
C5/PC5	Landscape dynamics and climate change	
	Session chair:	*Rob Wilson*
	Invited speaker:	*Anastasia Knorre*

Oral/Poster

D1/PD1	Past and contemporary environment- human interactions	
	Session chair:	*Kristof Haneca*
	Co-chair:	*Tomasz Wazny*
	Invited speaker:	*Tomasz Wazny*
D2/PD2	Hydroclimatic changes in tree-ring chronologies	
	Session chair:	*Ute Sass-Klaassen*
	Co-chair:	*Jaques Tardif*
	Invited speaker:	*Jaques Tardif*
D3/PD3	Impact of climate variability on stand dynamics and forest management	
	Session chair:	*Pascale Weber*
	Co-chair:	*Christof Bigler*
	Invited speaker:	*Paolo Cherubini*
D4/PD4	Tropical dendrochronology	
	Session chair:	*Fidel Roig*
	Invited speaker:	*David Stahle* (USA)

Contents

A2 Reconstruction of past climate variations: a challenge for the present and future

A3 Tree rings and insects, diseases and anthropogenic factors

B3 Stable isotopes and dendrochemistry in trees as indicators of environmental change

C3 Dendroecology of shrubs

C4 Intra-annual cambium dynamics and wood formation

D2 Hydroclimatic changes in tree-ring chronologies

D3 Impact of climate variability on stand dynamics and forest management

D4 Tropical dendrochronology

PB3 Stable isotopes and dendrochemistry in trees as indicators of environmental change

Keynote presentations

PL1.1 Keynote

Dendrochronology in Finland: Historical milestones and current activities

Kari Mielikäinen
Finnish Forest Research Institute, Vantaa, Finland

The roots of Finnish dendrochronology lie in forest sciences. In the beginning of the 1920's the first national forest inventory in the world, based on statistical sampling, started the continuous collecting of of tree-ring data all over the country. This data has been used for compiling yield tables, but also for correcting measured growth records to correspond "normal" climate. Further on forest scientists have developed growth and yield models in order to forecast the reactions of trees and forests to environmental changes caused by man and nature in an interannual scale. The models have been used for long-term forecasts of the development of forest resources under different management regimes and changing environments.

Dendroclimatology was introduced in Finland first time in the 1910´s in a study dealing with cyclicity in tree-ring chronologies. In the following decades articles on the impacts of climate and the autocorrelation on tree growth were published. The results showed the importance of temperature in the growth process of Scots pine in the North. The impact of precipitation was more pronounced in southern Finland. In the 1980´s the first works dealing with autoregressive modelling in dendrochronology were published. Studies on the impacts of solar activity, gravity of the moon, atmospheric circulations and climate on pine growth in Lapland are also from the same decade.

In the 1970´s the building of the supra-long pine chronology of 7640 years was started in Finnish Lapland. The continuous chronology was in its full length more than two decades after the start. The chronology has been utilised in several studies. The warm period about 5000 years ago was revealed by the absolute location of megafossile pines lying in lake bottoms north of the present tree line. The Medieval Warm Period (MWP) and the Little Ice age are also present in the chronology. The impacts of thermohaline circulation, solar forcing, ENSO and NAO on Nordic climate have been studied recently. A 2000 years long chronology from South-Eastern Finland has supported the hypothesis of large-scale Megadrought during the MWP at northern latitudes.

In the 1990's the European-wide project about long-term trends of tree growth in forests outside the influence of forest management offered the chance to study the role of natural and human impacts on the trends. Nitrogen and sulphur depositions, acid rain, increased CO_2 and climatic factors were analysed in this study. At the same time a comprehensive Finnish-Russion research program was launched for studying the size of the impact zone around a big polluter (nickel smelters) in Russian Kola peninsula, using tree-ring data along transects starting at the smelters. In air pollution studies, the new NMT-method (Needle Trace Method) offered an excellent tool to estimate the variation of needle-years in the past using dendrochronological methods.

Intra-annual monitoring and destructive data collecting (pinning and microcoring), combined with climate data, long-term phenological monitoring and the on-site comparison of tree-provenances from different parts of Europe, will give us information on the resistance of our forests in changing climate.

PL1.2 Keynote

Climate history of Eurasia – From Greenhouse to Ice Ages

Juha Pekka Lunkka
Institute of Geosciences, University of Oulu, Oulu, Finland

Geological proxy data on climate shows that after the Carboniferous-Permian "icehouse world" (ca. 320–260 million years ago) the Earth's climate became warmer towards the Cretaceous Period (ca. 142–65 Ma ago). During this "greenhouse world" mean global temperatures are thought to have reached their maximum in the Late Cretaceous ca. 100 Ma ago when the global sea level was over 200 metres above the present sea level, and ice was entirely absent at sea level. Since the climatic maximum in the Cretaceous, relatively warm climatic conditions existed for 50 Ma to the end of Early Eocene Climatic Optimum (ca. 52 Ma ago). After this climatic event the Earth's climate has been on a general cooling trend for the past 50 Ma.

Although the data on the evolution of Eurasian climate for the past 100 million years is incomplete, general trends of the climatic evolution can be compiled from marine and terrestrial archives. During Late Cretaceous, Palaeocene and Early Eocene climate became gradually warmer. After the Early Eocene Climatic Optimum (ca. 52 Ma ago) climate became gradually cooler and a marked cooling took place at around 34 Ma ago when the first large glaciers formed on Antarctica. Climate became warmer again at ca. 27 Ma ago but after the Middle Miocene Climatic Optimum at around 15 Ma climate has been on a cooling trend. At around 8–7 Ma ago, roughly at the same time when the summer monsoon started to operate in Asia, climate deteriorated even more rapidly. This long term cooling eventually led to the formation of the first ice sheets in Eurasian north during the Quaternary.

The climate variations and environmental changes in Eurasia during the past 100 million years were caused by external forcing mechanisms i. e. plate tectonics, orbital factors and solar activity. While quasicyclic orbital and solar activity changes operate in semi-short and short intervals, the long term climate evolution is dictated mainly by tectonics. It is generally accepted that plate tectonism is the most important external forcing factor behind the global climate cooling during the past 50 million years and this is also the case when considering the long-term climate history of Eurasia. Plate tectonic movements have caused for example, profound changes in the distribution of ocean heat transfer and precipitation patterns, glacier ice build-up, and the weathering intensity which is linked to the atmospheric CO_2 concentration. The major tectonic events that took place during this time period and affected Eurasian climate were: 1) collision of India to Eurasia (past 70 Ma), 2) closure of the Tethys Sea (ca. 25–30 Ma), 3) opening of the North Atlantic (past 50 Ma), 4) separation of Australia from Antarctica (ca. 34 Ma) and 5) formation of the Isthmus of Panama (ca. 4 Ma).

PL1.3 Keynote

A perspective on our retrospective science: Dendrochronology early in the 21st century

Peter M. Brown
Rocky Mountain Tree-Ring Research, Fort Collins, Colorado, United States

Dendrochronology provides both highly unique and certainly compelling insights in its many scientific applications and in the public imagination, as well as strong evidence of often unprecedented climate and environmental changes that in many cases require immediate attention in local to global policy decisions. Our discipline encompasses a wealth of research topics, techniques, species, and regions – as the incredible diversity of talks and posters in this 8th WorldDendro Conference proves – that provide unique information on the functioning of our planet. Although our data are retrospective, much of our research is focused on the future as dendrochronology provides basic process understanding of longer-term and broader-scale dynamics not encompassed by more typical scientific studies based on short-term or local observations or experiments. This type of process understanding is especially critical considering potential future climate change and forecasting its effects on ecosystems, other natural processes, and human societies.

This talk is both a personal reflection of how far dendrochronology has come and where it stands in the first decade of the 21st century, and a call for an integrated global research agenda to continue to bring dendrochronology forward in the future. Certainly in the last two decades – since I have been in the business – we have seen tremendous progress in new applications, new statistical and analytical tools, new regions and new species, and a wealth of new talent and new students in tree-ring research. But we must never loose sight of the basic methods of crossdating, – which defines dendrochronology – and the eco-physiological processes of how trees respond to environmental changes. As for future directions, I want to specifically call on our discipline as a whole to concentrate on additional tools and methods to better incorporate monitoring and experiments, to enlarge upon our mechanistic understanding of climate-environment-growth relationships, to develop refined simulation models of growth processes, and to develop improved multi-proxy approaches that make use of integrated variables from the same data sets to explore especially non-linear dynamics in growth and to improve long-term climate and ecological reconstructions from tree-ring data.

PL1.4 Keynote

Climate change and management of forest ecosystems

Heinrich Spiecker
Institute for Forest Growth, University of Freiburg, Freiburg, Germany

Since forests exist they have been exposed to climate change. Today, the climate is not only changing naturally but it is affected by human activities as well. Moreover, changes in land use and atmospheric deposition alter site conditions. Most drastic changes of the forests such as changes in tree species, forest structure and tree age composition are the result of forest management. We have to acknowledge that forests and their environments have drastically changed over time and most likely will continue to change in the future.

In order to secure the ecosystem services for future generations forest managers already today have to think about how forest of the future should look like. In order to do so the managers have to know:

- How will the future climate look like?
- What is the impact of climate changes on forest ecosystems?
- What are the demands of future generations in respect to ecosystem services?

Today, we do not know the answers to these three questions! So what should we recommend the forest manager to do? We have to admit that we have to live with substantial uncertainty! This uncertainty is especially problematic not only because changes in forest ecosystems may last several decades but as well because today's management activities may have long-term impacts. The forest manager should aim for a forest ecosystem that has a high potential to adapt to future environmental conditions as well as to future human needs what so ever they will be! What information is needed to do so? Climatologist are expected to improve the prediction of climate changes, dendroecologists are expected to better understand the climate – tree interactions, and experts in social sciences have to predict the future needs of people!

As dendroecologists we need to understand impacts of changes in the average climatic conditions as well as impacts of changes in frequency and intensity of extreme events on trees. Three approaches will help to get a better insight: (I) Controlled experiments, (II) current analysis of the tree-climate interaction, and (III) historical analysis based on tree rings. New analytical methods in extracting information from tree rings and improved methods of statistical analysis and modeling may help to improve our understanding in tree-climate interactions and contribute to an appropriate management of our forests.

PL2.1 Keynote

Asian dendrochronology – Past and present experiences and future challenges

Nathsuda Pumijumnong
Faculty of Environment and Resource Studies, Mahidol University, Nakhon Pathom, Thailand

Asia is a region covering large areas and facing climate variability. Monsoon climate that interacts between land and ocean plays an importance role in this region. An El-Nino-Southern Oscillation index (ENSO) phenomenon which originates in the tropical Indo-Pacific region has direct influence on global climate variation, particular in Asian. Drought and flood are harmful for human being in this region where agriculture mainly depends on climate. Climate change is another challenge for most living things and natural resources. To cope with climate variability both current and past climate should be well understood. Palaeoclimate in Asian has been successful in some countries such as Japan and China. Nevertheless, Palaeoclimate is still complicated in South East Asia where climate influence is much more complex. Short climate instrument record is not enough for understanding climate in the future. One proxy record that helps us for a better understanding of palaeoclimate is Tree. However, trees in South East Asia that show annual rings clearly and mainly have been focusing on are only Teak and Pine. Regrettable, a large amount of those tree species were exported in the past. A small amount of teak wood has been found at some remained archeological material such as teak log coffins. This finding has some promises for further research. However, the reconstruction palaeoclimate in South East Asia is currently limited. Applications of other techniques such as cambial activity and isotopic analysis are needed to examine other potential tree species and also to extend past climate for a good understanding about climate variability in South East Asia.

PL2.2 Keynote

The multi-millennial-length tree-ring record development in the Southern Hemisphere: Current situation and perspectives

Fidel A. Roig
Laboratory of Dendrochronology, IANIGLA, CCT-CONICET, Mendoza, Argentina

Available climate recorded since the 19th century considerably limits comparisons between past and present climates. To overcome these difficulties, longer records derived from tree rings can help to put into perspective the modern climatic variability. This paper reviews progress in the development of millennia-long tree-ring chronologies from the Southern Hemisphere (focused on southern Argentina and Chile, New Zealand and Tasmania), examining the potential and limitations of these studies with specific examples from ongoing research. Although relatively few very long records have been developed for the Southern Hemisphere, a suit of selected tree species and areas show great potential in this field: 70% of the modern chronologies have records that extend the past 500 years, 20% up to 1000 years and 10% covers variable periods during the past 4000 years. However, the endemic nature of older trees, the disparity of the available sub-fossil wood and the shortage of archaeological wood are reasons for the slowness in the development of an extended long tree-ring chronology network for the Southern Hemisphere. The current state of the art and future opportunities for the development of long tree-ring, climate-sensitive records in the Southern Hemisphere is here discussed.

PL2.3 Keynote

Atomization of a discipline? Forward thinking for a retrospective science

Achim Bräuning
Institute of Geography, University of Erlangen-Nuremberg, Erlangen, Germany

Dendroecology is a widely applied field in many historical sciences, be it in the reconstruction of former environmental conditions or of former settlement structures and archaeological objects. During the past years, a rapid development of innovative measurement techniques occurred that allowed the quantitative detection of additional wood parameters, for example of wood anatomical properties or of stable isotope variations in an intra-annual resolution or the development of statistical or physical models of wood formation and forest dynamics. These tools allow the analysis of an increasing number of special tree-ring features; however they may also lead to an increased specialization that makes a strong cooperation between different laboratories necessary. While technical developments are pushing research frontiers forward in various fields of data generation and treatment, other applications may increase our knowledge of historic processes by combining various new techniques or by combining dendroecological techniques with other methods from neighbouring sciences. The presentation focuses on examples for tree-ring studies that combine dendroecological research in the fields of archaeology, forestry and climatology with other disciplines in innovative ways that may open new applications and research topics for tree-ring sciences. In addition, some ideas are presented that may reveal possible future links between tree-ring applications in newly developing working fields. To improve the awareness of new developments in measurement technology and statistical data processing and their potential bandwidth of applications in various fields, a new communication platform is suggested.

PL2.4 Keynote

Dendrochronology and IUFRO: History, recent activities and the future

Margaret Devall
Center for Bottomland Hardwoods Research, Stoneville, United States

The International Union of Forest Research Organizations (IUFRO) is an international network of forest scientists which promotes global cooperation in forest research and encourages understanding of the ecological, economic and social aspects of forests and trees. IUFRO's scientific activity is organized into eight divisions, each of which includes several units. Tree Ring Analysis, Unit 5.01.07, is part of Division 5, Forest Products, which has as one of its strong themes the efficient and sustainable use of forests for the good of mankind. The Tree Ring Analysis Unit was established as a group in 1989 during an All Division 5 Conference in Sao Paolo, Brazil, with Dr. Gordon Jacoby as its first chair. The mission of the unit is to increase the visibility of tree ring research in the forest science community and to connect people interested in tree rings worldwide by exchanging knowledge and ideas. After the first years, Dr. Fritz Schweingruber led the group, followed by Drs. Rupert Wimmer, Roland Vetter and Martin Worbes. The current coordinator and deputy coordinator of Unit 5.01.07 are Dr. Margaret Devall and Dr. Paolo Cherubini. During the years since its founding, the unit has held sessions and business meetings at Conferences and Congresses around the world, and IUFRO Group 5.01.07 is one of the sponsors of WorldDendro 2010. Because tree rings can provide a retrospective record of the effects of past climate on forests and indicate disturbances in the environment, dendrochronologists are in a unique position to predict the effects of future climate change on the world's forests, and to assist in understanding the additional challenges that forests face. Climate has not been stable in the past; it has fluctuated with periods of cooler, warmer, wetter and drier weather than at present, and large alterations in forest distribution and composition have occurred. Knowledge of past trends can provide important clues to allow researchers to assess future impacts of global climate change and to make helpful suggestions to begin preparing for this challenge at a time when the future of forests around the world is uncertain. IUFRO Group 5.01.07 can provide exceptional networking opportunities for tree ring researchers. It is prepared to assist scientists in interacting and to provide a link in order to improve information exchange and collaborative work. The Tree Ring Analysis Unit will welcome the participation of researchers interested in the group and its work.

PL2.5 Keynote

Lessons learned on potentials and future directions of dendrochronology

Dieter Eckstein
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During the past decades, dendrochronology has developed into a highly diversified field of research. A world conference is able to impart an overview of the current activities showing the various ways of interlinking between the topics and between the people involved. This kind of a cross section through the accumulated actual knowledge is a snap-shot, even though a necessary one, but it does not sufficiently consider that we owe the existence of our today's impressively high level of knowledge to former generations of scholars. From the various lines of development, few examples will illustrate that our actual achievements did not appear from nowhere but had their "headwaters" somewhere in the past. Moreover, it will be illustrated how difficult, if not impossible, it is to forecast how the state-of-the-art of tree-ring research may be in the medium-term future. Nevertheless, few directions will be outlined based on the achievements presented during the world conference.

Oral presentations

Sessions

A1 Divergence phenomenon in dendroclimatology

A2 Reconstruction of past climate variations: a challenge for the present and future

A3 Tree rings and insects, diseases and anthropogenic factors

A4 Climate-growth relationship of different tree species

A5 Teleconnections in the climate system from tree-rings and multiproxy records

B1 New techniques and statistical approaches for detecting environmental signals and predicting forest growth

B2 Tree rings and natural hazards in a changing climate

B3 Stable isotopes and dendrochemistry in trees as indicators of environmental change

B4 Forest fires in changing climate

C1 Treeline and northern tree rings in climate change research

C2 Wood anatomy as an indicator of environmental factors

C3 Dendroecology of shrubs

C4 Intra-annual cambium dynamics and wood formation

C5 Landscape dynamics and climate change

D1 Past and contemporary environment- human interactions

D2 Hydroclimatic changes in tree-ring chronologies

D3 Impact of climate variability on stand dynamics and forest management

D4 Tropical dendrochronology

A1.01

A1.01 Invited

The challenges posed by “divergence”

Keith Briffa[1], Rosanne D’Arrigo[2], Kevin Anchukaitis[2], Thomas Melvin[1]
[1]University of East Anglia, Norwich, United Kingdom, [2]Lamont-Doherty Earth Observatory, New York, United States

In various geographical and ecological contexts the statistically-defined relationships between observed climate and tree-growth chronologies are becoming increasingly unstable in recent decades, referred to as “divergence”. No one solution has been found to explain the numerous cited examples of divergence because the ‘phenomenon’ may well incorporate multiple mechanisms and a variety of possible causes. An important hypothesis of the cause, where divergence is recognised as a loss of temperature sensitivity, has been increasing moisture stress. A range of potential data-processing factors must be considered before invoking specific causes:

- The curve-fitting problem (e.g. using Hugershoff functions) described as trend distortion.
- The problem created by mixing sloping and horizontal curves (e.g. conservative standardisation of ARSTAN).
- The problem comparing tree-growth indices, exhibiting no overall slope with climate records which have an overall trend.
- The RCS method has end-effect biases, particularly problems associated with sample composition in modem times and also in the absence of sub-fossil material.
- When chronologies are updated inhomogenities between old and new samples can introduce a problem.
- Normal transience in the climate/tree-growth relationship (e.g. crown dieback) caused by problems such as spring frosts or insect defoliation, that potentially reduce ring widths for a decade or two.

Identifying and allowing for these confounding influences may enable us to evaluate the residual chronology variance for “real divergence” and lead to the attribution of causes from among known changes to the tree-growth environment, e.g. drought stress, carbon dioxide increase, nitrogen fertilisation, global dimming or changed UV light levels.

A1.02 Oral

Are temperature reconstructions from northern treeline still possible?

Michael Pisaric, Trevor Porter, Peter deMontigny
Carleton University, Ottawa, Canada

Mean annual temperature has increased >2°C since 1950 in northwest Canada. This rapid warming has led to significant environmental change and ecosystem response. Previous dendrochronological research in northwest Canada during the 1980–90s, suggested temperature increases since the 1950s are largely unprecedented during the past several centuries. However, recent dendrochronological studies from the same region have identified weaker relationships between climate and tree growth during the past few decades. Due to these diverging growth trends, a number of recent studies have not reconstructed past climatic conditions. Here we present results from our research in northwest Canada (Inuvik, Northwest Territories and Old Crow, Yukon Territory). In both regions, divergence is present; however, its expression is at the population level in Old Crow and the individual tree level in Inuvik. Regardless, shared patterns of ring width variability exist between the two regions as indicated by the occurrence of common light rings and traditional marker rings. Our reconstructions of summer temperature from the two regions are remarkably similar to previous reconstructions of northern hemisphere temperature trends, confirming our belief that climatic reconstructions are still feasible, but require the identification of divergent growth trends that otherwise could weaken climatic reconstructions.

A1.03

A1.03 Oral

Forest fire and stand dynamics in West Khentey Mountains, Mongolia

Oyunsanaa Byambasuren[1], Michael Muehlenberg[1], Martin Worbes[2], Baatarbileg Nachin[3]
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[3]National University of Mongolia, Faculty of Biology, Department of Forestry, Ulan Bator, Mongolia

The knowledge about fire ecology and history of Mongolian forest-stands is poorly developed but necessary for an effective fire management. In order to reconstruct historical conditions of fire regime and forest structure in the West Khentey Mountain in Northern Mongolia on the base of forest inventories and tree ring studies, we stratified the forests into four types (*Larix sibirica-Betula platyphylla*, *Pinus sylvestris-Larix sibirica*, *Pinus sibirica-Abies sibirica*, *Picea obovata-Abies sibirica*) according to the dominant tree species. The hyphothesis is that forests are no different fire regime between the forest types. We sampled ten plots in each of the four types of forest. A total of 650 tree cores and 260 disks were collected. In this presentation, we summarize preliminary results derived from individual plot and site chronologies of fire and tree recruitment, such as time-averaged fire regime parameters (mean fire interval and fire seasonality) and changes in forest composition and structure, within light and dark taiga forests. Fire-scar analysis of Scots pine forest showed recurring fires at mean fire intervals (1821–2008) of 19 years (Weibull median interval = 14.51 years). The Siberian larch forest showed at mean fire intervals (1810–2008) of 21.12 years (Weibull median interval = 16.79 years).

The results contribute to a growing global-scale network of absolutely dated fire chronologies.

A1.04 Oral

Nonlinear growth responses of Douglas-fir in the Pacific Northwest to summer temperatures in the past decade

E. Henry Lee, Peter A. Beedlow, David T. Tingey, Ron Waschmann
U.S. Environmental Protection Agency, National Health and Environmental Effects Laboratory, Western Ecology Division, Corvallis, United States

Altered seasonal climate patterns resulting from global climate change could affect the productivity of coniferous forests in the Pacific Northwest region of North America. This study examined seasonal patterns of temperature, precipitation, relative humidity and plant available soil moisture in relation to Douglas-fir growth. Basal area increment (BAI) was measured from 1998 through 2008 in five naturally regenerated forest stands along an elevation gradient from the Pacific coast to 1100 m on the west slope of the Cascade Mountains. Circumference from manually read band dendrometers was used to calculate basal area increment (BAI) at approximately four-week intervals. Regression analysis and time series analysis were performed to relate BAI with plant available soil moisture (ASW), air temperature, precipitation and relative humidity.

Douglas-fir BAI exhibited a curvilinear (quadratic) response to air temperature with an optimum of approximately 20 °C at all sites. BAI increased rapidly in spring with increasing air temperature, rising to a peak in either May or June, followed by a decline in July when air temperatures exceeded the temperature optimum and soil moisture was declining. At the coastal and wet sites, the decline in BAI in July was likely due to limitations in air temperatures above the optimum because soil moisture was adequate for normal growth. BAI continued to decline in late summer at all sites with high temperatures and low soil moisture availability. Summer temperatures in the past decade were the warmest in the western U.S. since measurements have been recorded. During the past decade growth rates of Douglas-fir were significantly reduced in years with aberrantly high summer temperatures in comparison to cooler years.

Growth response of Douglas-fir in the Pacific Northwest can be modeled as an upside-down quadratic growth response to temperature, which was also observed for white fir (D'Arrigo et al, 2004). Our findings suggest that the divergence problem in dendroclimatology observed in 20th century reconstructions is due to a nonlinear growth response, as postulated by Loehle (2009). Because summer temperatures in recent decades have reached and exceeded the temperature optimum for tree growth, tree ring chronologies that showed a positive response to temperature in the early part of the century have a less positive or even negative response to warming in the latter part of the century. Tree ring-based temperature reconstructions based on a linear approximation are likely to worsen in the future as temperatures increase.

A1.05

A1.05 Oral

A circa 9,000-year summer temperature reconstruction for the Eastern Alps: Data, challenges and preliminary results

Kurt Nicolussi[1], Keith R. Briffa[2], Thomas M. Melvin[2], Andrea Thurner[1]
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Multi-millennial dendroclimatic reconstructions, of necessity involve the construction and interpretation of composite records, potentially incorporating data from hundreds, if not thousands, of samples. The material used can be sub-divided into sub-groups of samples categorised according to their source, e.g. cores from living trees, historical/archaeological and dry-dead/subfossil samples. However, site conditions for these various sample types can vary, producing trees that exhibit different growth rates and consequently, varying behaviour in the tree-ring series of modern and "old" data. In using the RCS approach a critical section of the composite chronology are the modern end and the overlap period(s) between the modern data from living trees and the older data from historic, dry-dead or subfossil samples. Avoiding inhomogeneity in the composition of long chronologies represents a major challenge. In particular, consideration must be given to avoiding or reducing the appearance of modern divergence between chronology and forcing climate variability, attributable to the sample composition of the chronology in recent times. However, it is also important to recognise the potential for what would, in effect, be artificial "divergence" in terms of the representation of 'true' climate signal in specific periods in the past when other sample inhomogeneities might occur.

The recently established Eastern Alpine Conifer Chronology (EACC) constitutes the basis for a near-Holocene-length summer temperature reconstruction. Using the EACC tree-ring width data, this paper discusses some of the challenges and presents a preliminary dendroclimatic record of the Holocene history of the summer temperature variability in the Alps.

A1.06 Oral

Assessing "divergence" in Swedish tree rings using data from the National Forest Inventory

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A change in the sensitivity of forest growth to temperature has been detected at a number of circumpolar northern latitude sites. The phenomenon is expressed as an offset between instrumental temperatures and their estimation in reconstruction models based on tree rings. The phenomenon is yet poorly understood and the diverging trends are not consistent throughout the widely-distributed circumpolar sites. It is clear though that the "divergence problem" has significant implications for the development of paleoclimatic reconstructions based on tree-ring records from northern forests. To understand the mechanisms behind the phenomenon it will be necessary to work with large networks of tree-ring and climate data, ideally from a wide geographical/climatological range. In this paper we use tree-ring data from the Swedish National Forest Inventory. Together with instrumental climate data from the Swedish Meteorological and Hydrological Institute we model site specific and regional response to temperature and precipitation.

A1.07

A1.07 Oral

A mid-20th century shift of Scots pine climate-response in North Norway

Andreas J Kirchhefer
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According to principal component analysis of 16 pre-whitened ring-width chronologies 1850–1992, Scots pine (*Pinus sylvestris* L.) shares 71% growth variability across North Norway 69°N. Nearly 50% of this common variability can be explained by July temperatures 1875–1992. However, moving correlations indicate that there is a significant difference between the climate-response before and after 1960 (last year of 30-year period): The secondary temperature response in August (r >0.4) is replaced by June (r >0.3). Also the positive correlation to spring temperature moves by one month from April (r ≈ 0.4) to March (r >0.4), and the negative effect of July precipitation (r <-0.6) is no longer significant (r ≈ -0.2). These changes in the climate-growth response around 1960 seem to be triggered by changes in atmospheric circulation, here represented by the Arctic Oscillation Index (AOI): A correlation between May–June AOI and pine growth (r >0.4) disappears, and the negative correlation moves from July to August (both r <-0.3). Furthermore, the W-E growth difference (c. 10% of the regional growth variability) now is negatively correlated with the July AOI (r <-0.4). An eastward extension of the low pressure field from Greenland into the Barents Sea during years with a strong AOI after 1960 offers an explanation for these response patterns. These observations might contribute to understanding climate-growth divergences in the second half of the 20th century.

A2.01 Invited

Climate reconstruction from tree-rings: Advances, developments, challenges

Kerstin Treydte
Swiss Federal Research Institute WSL, Birmensdorf, Switzerland

Knowledge of past climate variations is essential for disentangling natural and man-made climate variability of the 21st century. In this context tree-rings are seen to be one of the most important high-resolution climate proxies for large terrestrial areas in high- and mid-latitude regions around the globe. The talk will give an overview about what has recently been learned, using tree-rings, about natural climate variability and its environmental and social impacts, and about the most important strengths and weaknesses of dendro-climatology. Selected advances, developments and challenges of dendro-climatologic research are discussed, with a focus on tree-ring based climate reconstructions. Topics include (i) estimation of the absolute temperature amplitude over the past millennium, (ii) the increased need for reconstructions of hydro-climatic conditions and atmospheric circulation patterns, (iii) development of supra-long chronologies, (iv) new techniques and (v) novel tree-ring parameters and multi-proxy approaches. Finally the needs and opportunities for future work will be summarized.

A2.02 Oral

Combining tree-ring proxies and model simulations to reconstruct European climate

Jörg Franke[1], J. Fidel González Rouco[2], David Frank[1]
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In the pre-instrumental period, climate variability can be assessed using proxy records and climate models, both having advantages and limitations. Proxy data exists only at selected locations which are non-uniformly distributed in space. In addition, reconstructions are generally limited to temperature or precipitation, and rarely provide direct insights of important climate parameters such as pressure. Climate models simulate comprehensive and physically consistent climate states, though the simulations produced with them cannot be regarded as a detailed representation of the real past climate trajectory, particularly at higher frequency ranges where natural internal variability dominates. Based on the PSR (Proxy Surrogate Reconstruction) method, we present new results that simultaneously capitalize on the individual strengths of proxy data and model simulations. This is achieved by selecting the model states (analogs) that are most similar with arrays of proxy data available for specific moments of time. We will discuss methodological tests and the development of a model based European climate field reconstruction using tree-ring proxy data.

A2.03 Oral

Pan-European climate signals in population dynamics of subfossil oak and pine trees from mire lowlands, rivers and lakes

Hannes Hubert Leuschner[1], Björn Gunnarson[2], Jonathan G. A. Lageard[3], Johannes Evardsson[4], David M. Brown[5], Mike Baillie[5], Samuli Helama[6], Michaek Friedrich[7]
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The bog pine chronology for the NW German Lowlands is currently covering most of the period from 7.000 BC to 1100 BC. This dataset clearly reveals periods of rapidly changing environmental conditions. These are seen as a number of stress periods causing common germination and dying off events, as well as in at least two general shifts at c.3000 BC and 2.000 BC. These periods and events are in tune with events found in datasets from Northern Ireland, England, Central Sweden, Finland and the South German River Main. As the material originates from wet sites or sites influenced by river dynamics we consider mayor hydrological changes as a trigger of the common signal. The leading role of the NW German bog pine material as a link is probably caused by the distinct and small ecological range of pine growth on mires within this region. In most cases the material was retrieved from the fen-bog transition. This particular ecological niche makes the tree in this habitat very sensitive to mirror hydrological changes in this region.

A2.04 Oral

Scandinavian temperature swings offset global warming

Ulf Büntgen[1], Jan Esper[2], David Frank[1], Laura Cunningham[3], Christoph Raible[4], Daniel Nievergelt[1], Anne Verstege[1]
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Climate across the North Atlantic sector exhibits decadal-scale oscillations of internal variability. Related effects of the Atlantic meridional overturning circulation on sea-surface temperature not only drive northern European marine and terrestrial biomass productivity and ecosystem functioning, but also have large societal consequences emerging from subtropical hurricane activity and rainfall distribution. Validation of the hind cast skill of ocean and coupled model simulations that operate under imposed anthropogenic forcing necessitates long-term understanding of natural Atlantic multi-decadal variability. Here we compile ~190`000 annual measurements of 1179 maximum latewood density series from 25 conifer sites in northern Scandinavia. Probabilistic uncertainty estimates including effects of site location, species response, shore position, tree age, sampling design, growth standardization, and model calibration cover the 1483–2007 period. The empirical model explains 70 and 40% of June–August land and sea surface temperature back to 1860. High-latitude cooling during the early 17th century and peak warming ~1760 and in the 1930s translates into a long-term amplitude of 4.3(±2.1)°C (1609 to 1937). Correlations with existing Scandinavian tree-ring records, which in turn explain ~27–62% of temperature variations (1860-present) and correlate at 0.48 with each other, range from 0.41–0.78 (1483–1980). Mid-frequency coherency amongst this study, marine shelf sediments from coastal Norway, and atmospheric general circulation model output reinforces Atlantic multi-decadal fluctuations, overriding potential solar, volcanic and greenhouse forcing over the past five centuries. Since ocean-atmosphere interactions diminish recent warming, it is likely that large-scale reconstructions predominated by millennium-long Scandinavian proxies also underestimate medieval temperatures.

A2.05 Oral

1200 years of summer temperatures from height increment of Scots pine at the northern timberline in Fennoscandia

Markus Lindholm, Risto Jalkanen, Hannu Salminen
Metla, Rovaniemi, Finland

Annual height increments of 152 Scots pine (*Pinus sylvestris* L.) trees from the northern timberline (68° 30' N, 27° 30' E, 220 m a.s.l., North Finland) and monthly climate data from Sodankylä meteorological station were used in climate and growth calibrations. A comparison of different standardization methods proved that the 33% spline indexing has the most consistent and time-stable relationship with summer temperature. Among the monthly precipitation and temperature variables previous July shows the highest correlation with height growth. In addition, both previous June and previous August have significant positive correlations.

Fourier analysis showed that climatic influence on growth is mostly evident at high-to-medium frequencies. The height-growth chronology and mean June–August temperature are very similar in appearance, both series having peaks at 2.7–3.2 years, 6.7 years and 15.7 years. Thus the reconstruction is limited to relatively high frequencies. Our final transfer model accounts for 31% of the dependent instrumental temperature variance between 1908 and 2007. During split periods in verification RE ranges from 0.22 to 0.33, while CE varies between 0.32 and 0.21. RBar and EPS indicate that the proxy has a strong signal and it is reliable since AD 745.

In this millennial record the most severe growing conditions prevailed in 1601, 1790 and 782. The summer 1903 is the 6th coldest.

A2.06 Oral

A 3500 years-long density chronology in Dachstein mountains, Austria – Preliminary results

Marzena Klusek, Michael Grabner
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In 1999 it was possible to sample more than 200 sub-fossil tree trunks in an alpine lake Schwarzer See, in Dachstein mountains. The cores of about 70 living trees, which showed an age up to more than 500 years, were added to the sample set. It was possible to set up a mixed spruce and larch chronology, back to 1475 BC.

All samples were located within a single micro-site. Thus small variability in sensitivity and climate-growth relationship across the trees was expected. The first attempts showed good relationship to summer temperature.

Conducted densitometric measurements allowed to prepare the chronologies of mean ring density, mean latewood density and maximal density of wood. These chronologies were then correlated with climatic data of different meteorological stations (high elevation: Sonnblick, and long term: Kremsmünster). Preliminary results confirmed the high dendroclimatic potential of the trees from the Schwarzer See. The reconstruction of summer temperature is promising to bring new insights in past climate variability in the Eastern Alpine Region.

This research is financed by the Austrian Science Fund (Grant M 1127–B16).

A2.07

A2.07 Oral

Reconstruction of extremely short or cold summers in the Siberian Subarctic over the last 500 years – the story of anomalous tree ring structures

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Traditionally, ring width, density or isotopic content has been used in dendroclimatic reconstructions. Here we use anomalous tree ring structures as an independent climate proxy. The high latitudes of Siberia have climatic conditions with a high frequency of short or cold vegetation seasons, late spring, summer and early autumn frosts, which lead to the formation of light and frost rings in coniferous trees. We thus present an analysis of the frequency and intensity of frost and light rings over the last 500 years in a large tree ring network from West, Middle and East Siberia (>1500 trees). Light rings form permanently on all sites and in many species (*Larix sibirica* Ledeb., L. *kajanderi* Mayr, *L.gmelini* Rupr., *Picea obovata* Ledeb., *Pinus sylvestris* L, *P. sibirica* Du Tour), but their frequency decreases in the 20th century. Mass formation of light rings in Siberia occurred in 1721, 1772, 1783 and 1885 most likely connected to volcanic eruptions. In addition, simultaneous formation of light rings was observed within each of the three study areas, but different pattern of years with light rings occur between the three study areas. We then used linear regression to reconstruct cold and short vegetation seasons based on light rings for each of the study areas. Frost rings form mostly in mountainous parts and seem affected by microclimatic conditions. Years with simultaneous formation of light and frost rings seem to be associated with the shortest and coldest condition in the Siberian Subarctic.

This work is supported by RFBR No 08-04-00964-a.

A2.08 Oral

Floating millenial chronologies of *Pinus* in the Sierra de Gredos (Spain)

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Technical University, Madrid, Spain

A number of dendroecological studies of pinewoods of *Pinus sylvestris* and *Pinus nigra* in the Gredos mountain range have been carried out over the last several decades, with the aim of increasing the knowledge of the longevity of individuals, their patterns of growth as well as their forest dynamics, structure and origin.

More recently, some samples from tree megafossils (stumps and logs, known locally as troncas) have been analyzed and dated with radiocarbon. The available chronologies span a long period, from the mid-7th century BC to mid 11th century AD, revealing that, at least during the period 800 BC to 1200 AD, ecological conditions limiting the growth of mountain pinewoods in Gredos were similar to today's. However, no living trees or fossil remains have been found from the following 500 years, perhaps due to climatic influences and/or the increase of anthropogenic activities.

A2.09 Oral

A multiproxy assessment of the growth response to climatic variability of old living trees in the Pyrenees

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Theoretically, climatic warming should enhance radial growth and increase maximum wood density of isolated trees in high-elevation sites where temperature is assumed to be the main constrain of xylem formation and drought stress or competition are supposed to be of minor relevance. We assess the effects of temperature variability on wood formation of isolated and old (400–600 years) living *Pinus uncinata* trees growing at high-elevation (2100–2500 m) sites above the forest limit in the Spanish Pyrenees. We used a multiproxy dendrochronological approach based on the measurement of tree-ring width (TRW) and densitometry variables such as maximum density (MXD). Several subalpine forests were explored and sampled in two national parks (Ordesa y Monte Perdido; Aigüestortes i Estany de Sant Maurici). Site chronologies for each park were developed after visual cross-dating and measurement of individual series (at least 20 old trees per site). We discuss our results considering the climatic variables most highly related to TRW and MXD in both study sites and taking into account tree-to-tree variability. Finally, we performed dendroclimatic reconstructions based on individual and mean site chronologies and compared them with published studies for the Pyrenees.

A2.10

A2.10 Oral

Climate and streamflow variability in the sub-Antarctic region of South America (45º–56º S) during the last 500 years: integrating tree-rings, instrumental records and hydro-climatic modeling.

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The sub-Antarctic region of South America is the only continental area where trees grow south of 47° S worldwide, providing proxy climatic records for the last centuries. This emphasizes the uniqueness of the sub-Antarctic region and its relevance to improve our understanding of global climate change. Limitations in the available instrumental climatic records in this region regarding their length, quality and geographic distribution, severely hampers progress in the understanding of climate and its relationship to ocean-atmospheric forcings.

This work presents the results up to date of a research grant in progress that looks for the understanding of climate change and streamflow variability in the Sub-Antarctic region. The main objectives of this research are: 1) To enhance the network of precipitation and/or temperature sensitive tree-ring chronologies in the sub-Antarctic region of Chile. 2) To reconstruct precipitation, streamflow, temperature, and climatic indices such as the Antarctic Oscillation Index (AAO), using the new tree-ring chronologies and the more than 200 available tree-ring records in Chile and Argentina. 3) To develop streamflow annual or seasonal estimations for the last 200 years using innovative hydrological models, largely depending on tree-ring records.

The new knowledge about climate change provided by this study is highly relevant from a global perspective and for long-term planning and decision-making regarding productive activities as well as the provision of ecosystem services in these territories that have remained for the most part pristine.

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A2.11 Oral

Holocenic glacial fluctuations at the Mount San Lorenzo, Aysen Chile.

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We collected wood samples of the oldest trees growing on morraines at Mount San Lorenzo area (47º30'S, 72º30'W), in the Calluqueo, Rio Tranquilo and Arroyo San Lorenzo valleys. We also examined the stratigraphic evidences associated with these moraines, identifying layers of volcanic ash (tephra), buried soils, and lacustrine phases . A detailed analysis of the glacial geomorphology of the valleys permitted us to compare similarities and differences on their Holocenic histories. Preliminary radiocarbon dating of organic samples associated with moraine deposits in Rio Tranquilo valley gave us the following results: sample RTQO-09/01–13 basal organic layer, upper part, 6,610±60 ^{14}C years BP; sample RTQO-09/01–12 basal organic layer, lower part, 6,530±50 ^{14}C years BP; sample RTQO-09/02–003 basal organic layer, 4,350±40 ^{14}C years BP. These results confirm the Neoglacial character of the glacial processes studied there. Additionally, we selected a small lake distally located to the more external moraine at the Rio Tranquilo valley (Lago Corazón, 18G, 697058E, 4740940S). Preliminary batimetric analysis gave a maximum depth of 15 m. The study of the lake sediments will provide a chronological reference for the glacial fluctuations of the Mount San Lorenzo Glaciers.

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A2.12 Oral

Spatial drought variability over Northwest China inferred from tree rings

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A preliminary study for a point-by-point spatial precipitation reconstruction for northwestern (NW) China is explored based on a tree-ring network of 132 chronologies. Precipitation variations during the past ~200–400 years are reconstructed for 26 stations in NW China that are derived from nationwide 160-stations dataset. We herein introduce a "search spatial correlation contour" to locate the candidate tree-ring predictors. The reconstructed data were verified by independent historical or interpolated data. The spatial and temporal patterns of calibration and verification results were used to evaluate the reliabilities of these reconstructions. Additional spatial comparisons between the actual and estimated data were conducted by using rotated principal component analysis. Drought histories for different classified regions were discussed during the common period 1802–1990.

A2.13

A2.13 Oral

Annual temperatures during the last 2485 years in the mid-eastern Tibetan Plateau inferred from tree rings

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By combining living trees and archaeological wood, the annual mean temperatures were reconstructed based on ring-width indices of the mid-eastern Tibetan Plateau for the past 2485 years. The climate variations revealed by the reconstruction indicate that there were four periods to have average tem-peratures similar to or even higher than that mean of 1970 to 2000 AD. A particularly notable rapid shift from cold to warm, we call it the "Eastern Jin Event", occurred from 348 AD to 413 AD. Calculation re-sults show that the temperature variations over the mid-eastern Tibetan Plateau are not only repre-sentative for large parts of north-central China, but also closely correspond to those of the entire Northern Hemisphere over long time scales. During the last 2485 years, the downfall of most major dynasties in China coincides with intervals of low temperature. Compared with the temperature records in other regions of China during the last 1000 years, this reconstruction from the Tibetan Plateau shows a significant warming trend after the 1950s.

A2.14 Oral

The New Zealand kauri chronology: Recent advancements in updating and improving the record

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The late-Holocene, New Zealand kauri (*Agathis australis*) chronology spans over 3700 years and is one of only a few multi-millennial chronologies in the Southern Hemisphere. It is a composite chronology, built from series derived from modern (living) trees, archaeological timbers and sub-fossil wood from 29 sites in the upper North Island. The main purpose underpinning development of the long kauri chronology was reconstruction of past variability of the El Niño – Southern Oscillation (ENSO) phenomenon. Since 2006, the capabilities and limitations of kauri as an ENSO proxy have been established and a ca. 400 year reconstruction of ENSO activity has been presented. However, reconstruction of ENSO over longer timescales using the composite kauri chronology requires an improvement in sample depth to enhance signal strength. Currently there is a rapid decline in sample numbers prior to AD 1500, when the composition of the chronology changes from modern (living) trees to archaeological and sub-fossil series. We outline the state of the long chronology as it was in 2006, and provide an overview of recent research undertaken to update the record to the early 2000s and improve the quality of the late-Holocene kauri chronology in the period prior to AD 1500, facilitating millennial ENSO reconstructions.

A2.15 Oral

Following the flow: Recent progress towards a multi-centennial reconstruction from *Eucalyptus pauciflora*

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In recent years, water levels have fallen in reservoirs throughout south-east Australia because of prolonged drought. Consequently, chronic water shortages are being experienced throughout the region. Chronically low inflow to reservoirs has led to the introduction of water restrictions in many towns and cities. A significant proportion of the water flowing into the major catchments in southeast Australia originates in the Australian Alps. Flow records for catchments within the Australian Alps rarely exceed 100 years in length and are inadequate for assessing the return frequency of drought, discriminating the impact of climate change from natural climate variability or for developing long-term water supply plans. However, recent studies have demonstrated that climate and river flow records may be extracted tree-ring data from *Eucalyptus pauciflora*. Long regarded as, of limited potential, *E. pauciflora* is now attracting interest as a source of hydrological data. This presentation will present an outline and highlight recent results from research conducted on the Baw Baw Plateau at the southern limit of the Australian Alps. This research is aimed at developing a hydrological reconstruction spanning 200 years for the Thomson Reservoir – the largest water storage for Australia's second largest city – using tree-ring data from *E. pauciflora*.

A2.16

A2.16 Oral

500 years of *Pinus heldreichii* growth variability for the Pirin Mountains in Bulgaria

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The Mediterranean Basin, with its summer-dry climate, has been identified as a climatic change hotspot: general circulation models predict high rates of future warming and of decrease in precipitation. Climatic variability in the Mediterranean area is strongly linked to synoptic-scale atmospheric circulation patterns, while thermal and orographic forcing further complicate the climatic system. Therefore, there is a need for local-to-regional scale studies of long-term climate variability in the Mediterranean Basin. Tree-ring records have been used to reconstruct century-scale natural climate variability in the Mediterranean Basin on basin-wide and more regional scales (Pyrenees, Morocco, southeastern Mediterranean). For other areas, particularly the Balkan region, reliable proxy records are lacking.

Here, we aim to fill this gap by developing well-replicated, climate sensitive tree-ring chronologies for the Pirin Mountains in Southwestern Bulgaria. For this purpose, we sampled more than 50 *Pinus heldreichii* (PIHE) trees from three high-elevation sites and developed three tree-ring width chronologies, spanning approximately the last 500 to 800 years. Despite the strong correlation between tree ring series per site (Rbar= 0.58–0.65), comparison with instrumental climatic data has shown that the climatic signal in the tree ring width records is mixed. PIHE is most sensitive to previous winter temperature and current summer drought conditions.

Reliable tree ring records for the Pirin Mountains can not only contribute to long-term understanding of regional-scale natural climate variability, but can also help to unravel the synoptic-scale patterns that modulate the complicated Mediterranean climate system.

A3.01 Invited

Spruce budworm outbreaks and the dynamics of boreal old growth forest of Eastern North America

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Due to their complex structure and high biodiversity potential, natural old growth forests of the boreal zone are recognized as having high ecological value. In North Eastern North America, forest older than 100 years represent more than 50% of pristine forest composition. Because of their maturity, they are the focus of an intensive logging activity. In the context of ecological management, the understanding of the natural dynamics of these pristine forests is of prime importance. Dendroecological analysis of the natural dynamics of old growth forests from the closed boreal forest of Eastern North America, ranging from the balsam fir-white birch zone to the northern closed black spruce forest, shows that recurrent spruce budworm outbreaks that occurred over the past 200 years had a tremendous impact on the structure of the forest. They would be the principal cause of the high vertical and horizontal structural diversity of the stands, typical of old growth. Dendrochronological analysis of spruce budworm outbreaks recurrence and impact on the forest show that, if the cyclic nature of outbreaks has not changed over the past 200–300 years, their impact on the forest has changed a lot. Results show that before the 20th century, outbreaks are more difficult to identify and would have had very low impact locally. These results are supported by independent paleoecological analysis of insect remains during the entire Holocene. The complex structure of the old growth forest of these regions would not be the norm in their 10 000 years of history.

A3.02

A3.02 Oral

Testing for a CO_2 fertilization effect on growth of Canadian boreal forests

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The CO_2 fertilization hypothesis stipulates that rising atmospheric [CO_2] has a positive effect on net primary productivity (NPP) due to increasing availability of carbon. Here, we test this hypothesis by comparing a bioclimatic model simulation of forest productivity over the twentieth century against tree growth increment (TGI) data of 192 *Pinus banksiana* trees from the Duck Mountain forest of Manitoba, Canada. We postulate that, in the event that a CO_2 fertilization effect has occurred, climatically-driven simulations of NPP and TGI will show increasing divergence with increasing [CO_2]. We use a two-level scaling approach to achieve estimates of NPP. At the finest scale, a leaf-level model of photosynthesis is used to simulate canopy properties and their interaction with the variability in radiation, temperature and vapour pressure deficit. Then, the StandLEAP model is used to simulate landscape-level productivity by capturing variability in forest cover. Neither levels account for CO_2 fertilisation. The strength of the modelling approach resides in the finding that the StandLEAP model performed well in a comparison with observations of forest productivity measured by eddy-flux towers in Saskatchewan, Canada. Results show that year-to-year variation in TGI over 1912–2000 is adequately simulated by the bioclimatic model, with 47.2% of the variance in TGI reproduced by the climatically-driven simulations of NPP. As well, a long-term trend detected in TGI ($P < 0.05$) is coherent (no divergence) with the NPP simulation. This study suggests an absence or a limited impact of CO_2 fertilisation on the growth of boreal forests in Central Canada.

A3.03 Oral

Coring as a contributing factor to tree mortality?

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Increment coring of living trees is a standard method in dendrochronology, forest ecology, and forestry. However, increment coring is an invasive method that leads to an injury in the cored tree. This injury may result in tree decay, decreased physical stability, and the distraction of chemical defenses during the compartmentalization process. These effects on tree vitality may vary highly with the cored tree species, condition of the tree, time of coring (within the season), borer type and treatment of the drilling hole. However, the long-term effects of coring on tree mortality are poorly understood for any tree species because long-term data sets are rare. We present results from a long-term study on the effects of coring on tree mortality in a near-primary Norway spruce (*Picea abies*) forest in the Swiss Alps (forest reserve Scatlè). In 1965, all individual trees of the newly established forest reserve were measured in a 5.9 ha-plot; out of this population sample of 2376 living trees, a subset of 551 trees were cored in the same year. A re-assessment of both cored and uncored trees in 2006, more than 40 years after the coring, revealed no significant difference of the mortality patterns between the two groups. Our results suggest that Norway spruce in the study region is insensitive to increment coring. However, additional studies in different environments and on different tree species are needed to evaluate the generality of our finding.

A3.04

A3.04 Oral

Silver fir (*Abies alba* Mill.) decline and dieback: Comparison of growth patterns between sites and improvement of tree mortality models

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Since the beginning of the 21st century, increasing in mortality rates in the Mediterranean area can be connected with the increase in frequency, intensity and duration of summer drought (due to rainfalls decrease and rising temperatures). Diebacks were all the more important as species were more sensitive to drought, and populations located at their xeric range of distribution. We conducted a spatio-temporal analysis of these processes on silver fir (*Abies alba* Mill.) population located in three French Mediterranean mountains, and which showed severe risks face to climate change.

Dead trees were found to have the best growth during the 40 first years of their life. They were also more sensitive to inter-annual climatic variations, especially to current summer drought, than healthy trees. These differences were essentially explained by 3D soil heterogeneity and tree functioning. For example, when the soil water content is higher in surface than in depth (under 3m), trees are not acclimated to water stress due to low roots area / leaf area ratio, low latewood density and proportion... This induce a higher growth but also a higher sensitivity to drought.

As tree mortality does not only depend on recent growth trends, dendrochronological models used to predict dieback need to be improved taking into account the trade-off between growth and resistance to drought. Growth patterns of entire tree lifespan, tree sensitivity to climate and ring autocorrelation values were incorporated to determine the resistance level of each tree, their resilience capacities, and their vulnerability to intense stress.

A3.05 Oral

The contribution of the root system to the success of sylvicultural treatments

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The use of sylvicultural treatments is increasingly widespread worldwide. In the current forest ecosystem based management context, thinning could be a sound choice to attain sustainable development in global market constraints while still achieving maximum value. Through stand density regulation, thinning aims at increasing tree growth and enhancing stand productivity, but mechanisms of treatment successful are still unknown. Our research which analysed several sylvicultural treatments reveals for example, that commercial thinning leads to an increase in the radial growth of stems and roots. The response lasted over several years after the treatment. We found in this case, the ten-year post-treatment radial growth stem increment ranged from 20 to 100 percent higher in comparison with the 10-year mean growth prior to the treatment. The response of individual trees is very variable with stems exhibiting a radial growth decrease whereas others produced annual rings twice wider in comparison to the level before the treatment. Response depends upon tree diameter and competition. Indeed, the biggest trees exhibit the lowest response to the treatment. Nevertheless, those variables explain a fraction of the response ($R^2 = 0.0511$), suggesting that much of the variation observed may be due to variability between the stands and between trees within a stand. Moreover, stem growth response seems to be induced and correlated with root growth response. Radial growth increase occurs first in roots then in the stem.

A3.06

A3.06 Oral

Changes in growth and dendroclimatic response of trees growing along an artificial lake

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The objective of this study was to track changes in growth and dendroclimatic response of white oak (*Quercus alba*) trees that established in the forest interior and, following the creation of an artificial lake, continued living along the lake edge. Twenty-one white oaks from the lake edge were cored and 91% of the trees exhibited a growth response to the creation of the lake – most commonly a suppression. Two 32-year segments (pre-lake and post-lake) were compared for differences in dendroclimatic response. The tree-ring chronology from the pre-lake time period had significant negative correlations between ring width index (RWI) and temperature in June; significant positive correlations between RWI and precipitation from June of the previous year; significant positive correlations between RWI and precipitation in March of the current year; and significant positive correlations between RWI and Palmer Drought Severity Index (PDSI) in July. After lake construction, the same trees exhibited significant positive correlations between RWI and July temperature from the previous year; significant negative correlations between RWI and temperature in February and May; significant positive correlations between RWI and precipitation in September; and significant positive correlations between RWI and PDSI in June, July, August, and September. Most trees that experienced transitions from interior to edge positions responded with a decline in growth rate and a moderate change in dendroclimatic responsiveness.

A3.07 Oral

Air pollution recorded in Scots pine and disease rises in local population due to harmful emissions in Upper Silesia (southern Poland)

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Southern Poland is among the areas suffering the heaviest air pollution in Central Europe. The industry of Upper Silesia has a very great impact on this and high emission levels from this area have caused the progressive degradation of tree stands over large areas. We found a close relationship between the width of the annual growth rings of pines growing in the vicinity of industrial plants in the Upper Silesia and those plants' emissions. Most of the periods during which there was a suppression of annual tree ring growth in pines occurred during the years 1950–1980. The first period during which suppression of tree ring growth become more marked occurred in the mid-1950s. The second period where there was a clear increase in the number of trees indicating suppression occurred during the years 1960–1965. The largest number of trees with ring suppression and many missing rings was found over the period 1960–1975. We found relatively close relationship between harmful emissions and disease rises in local population. Infant mortality and lung cancer rates in Silesia increased along with the air pollution recorded in the annual growth rings of the pines growing in the northern part of the region. It appears that increases in atmospheric emissions of harmful substances recorded in annual tree growth rings led to increases in infant deaths in the two – three years later. Probably cancer incidence in Silesia grew after a six – seven years lag compared with the pollution recorded in the annual growth rings.

A3.08

A3.08 Oral

Dendroclimatological analysis of declining Norway spruce forests (*Picea abies* (L.) Karst) in West Carpatians

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Dendroclimatological analysis of 336 Norway spruce trees was performed in order to contribute for explanation of current massive spruce dieback in the Orava region (Northern Slovakia). Sample trees were selected as the pairs including one vital, visually undamaged and one declining dominant spruce tree along transects allocated across the territory of interest. Increment cores from all trees were sampled in 2008 at breast height (1.3 m) and classical tree-ring analyses were made (measurements with digital positiometer to the nearest 0.01 mm and synchronisation of the tree-ring diagrams). For each pair of trees, climatic data were derived from 7 nearest weather stations by interpolation and regression with altitude. Results indicate that radial increment increased continually during period 1972–2002 in accordance with general growth trends observed in the Central Europe. The highest increase was observed for the youngest trees, with rising age the increase significantly lowered. It was stated that there is no evidence for long-term predisposition of spruce trees for dieback by climatic factors. In year 2002, just when massive dieback started, a breakpoint in radial increment trends appeared, when increase changed to stagnation or decrease in average. Circumstances of this phenomenon are discussed emphasizing possible role of meteorological extremes in decline.

A4.01 Invited

Qinghai–Tibetan Plateau tree-ring network reveals large-scale spring moisture variation

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Located in central Asia and having an area nearly 2.5 million km^2 with an average elevation greater than 4000 m above sea level, the Qinghai–Tibetan Plateau (QTP) is in a critical position to respond to global climate changes. However the exact mechanism by which the QTP responds and modulates the climate variation is not clear because of the complexity of the climate system and the shortage of long-term climatic data. Here we report a study of tree-ring network on the QTP to investigate what climatic signals and what spatial and temporal patterns can be revealed from the tree-ring network. Among the 31 Sabina tree-ring width chronologies we have developed, 22 chronologies are found to be correlated with spring (May–June) Palmer Drought Severity Indices (PDSI) in the period 1953–2000. Empirical Orthogonal Function (EOF) analysis of the 22 tree-ring chronologies showed that the EOF #1 reflects coherent variation mainly in the central QTP and also a relatively less coherence with northeastern QTP. The second EOF of the tree-ring chronologies showed a seesaw structure in the northeastern and the central plateau. The top two leading principal components of the tree-ring chronologies are strongly correlated to those of the PDSI data. Examination of the relationships between QTP tree rings and global climate systems showed the linkages are not stable through time. Our results imply that QTP tree rings capture large-scale climate signals and assessment of QTP climate requires examination of the spatial structure and temporal stability of climate linkages.

A4.02 Oral

Summer temperature reconstruction for SE European Alps based on European larch (*Larix decidua* Mill.) tree-ring proxies

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The presented climate reconstruction is the first multi-proxy temperature reconstruction for the SE European Alps, where the alpine strain of the European larch reaches its south-eastern corner of the areal. The analysis is focused on temperature reconstruction as it is known that trees towards the upper tree line primarily reflect the temperature variations and do not react so sensitively to other environmental factors. The advantage of combining different tree-ring proxies is in covering wider temporal window within the growing period as some of the proxies better correlate with temperatures of early summer months and the others with late summer temperatures. Our sampling sites were located on Veža (46°21'N, 14°42'E) and Vršič (46°26'N, 13°44'E). From each tree we took two 5 mm cores for tree-ring widths (TRW) measurements and two 12 mm cores for stable carbon isotopes (ISO) and maximum latewood density (MxD) analysis. Standardized chronologies were compared with calibrated local meteorological data set which spans over the last 100 years. Stability of all three models (TRW, ISO, MxD) was verified using a split-sample procedure that divided the full period (1900–2007) into two subsets of equal length for calibration and verification purposes. Measures used to assess the accuracy of statistical predictions were the mean squared error (MSE), reduction of error (RE) and coefficient of efficiency (CE). Transfer function was applied to the chronologies (TRW, ISO and MXD) to produce reconstructed time-series of the summer temperature on the upper tree line.

A4.03 Oral

Assessment of long-term interannual tree NPP variations in response to climate

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Within the framework of the European CARBO-Extreme project, we use tree-ring data collected from several sites to assess climate-driven variations in above-ground tree NPP (net primary production). Sampling sites correspond with the location of flux towers that measure CO_2 balance (eddy-covariance method based on wind speed and CO_2 concentration measurements at different elevations) in the exchange layer between vegetation cover and atmosphere. Stem data (ring-width / maximum latewood density of pine, spruce and beech) is used to approximate biomass increment in different ecological and climatic environments. Furthermore, it is used to assess extreme growing season conditions (i.e. drought) and their effects on above-ground NPP with regard to a changing climate. The resulting data along with analysis contribute to the CARBO-Extreme database on the European carbon cycle components. This multi-source database will be used to improve predictions of the European carbon cycle based on different climate scenarios.

A4.04 Oral

Climate and stand dynamics in the *Pinus pinaster* forest stands in northern Portugal

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Tree rings are natural archives of climate variability and here we explore the patterns of common year-to-year tree-ring variability in the northern Portugal using short-term tree-ring chronologies. Exactly-dated ring-width chronologies were derived from *Pinus pinaster* trees growing in pure stands in northern Portugal, one of the most important ecosystems in Portugal. An analysis is then performed to evaluate how climate variability is captured, by means of specific seasonal and monthly climate variables and North Atlantic Oscillation index. Our results suggest that mid-winter and spring temperature on the one hand and summer precipitation on the other are the major factors affecting tree growth at inter-annual timescales. Finally results are used to assess how climate variability and extreme climatic events influence forest vegetation dynamics and affects stands' productivity in the study region.

A4.05 Oral

The value of *Pinus heldreichii* as climate archive in South-eastern Europe

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We compared *Pinus heldreichii* from ecologically different sites located close to each other in the Bulgarian Pirin Mountains. The spectrum of parameters comprises tree ring width (total, early and late wood), wood density (minimum and mean early wood density, mean and maximum late wood density) as well as stable isotopes (^{13}C, δ^{18}O). The different parameter chronologies were correlated with time series of various climate quantities from local stations as well as CRU 2.1 grid point data. The objective was to find relevant relationships and test their stability over time. We will discuss the significance of each tree ring parameter with respect to climate reconstruction at different frequencies.

Pinus heldreichii demonstrate a mixed climate signal, influenced by both high summer temperatures and periods with low precipitation. Mild winters have a positive growth effect. So it is possible to obtain precise data for the past periods with both, extremely dry or cold years.

Tree rings of *Pinus heldreichii* at extreme sites have proven to be reliable and valuable archives for climate signals, especially for regions where data records are short in time or fragmentary. Furthermore, due to the recent climate change *Pinus heldreichii* could be a "winner" at the treeline. We established a monitoring of *Pinus heldreichii* and climate parameters at the timberline (ring width, air and soil temperature and moisture).

A4.06 Oral

Climate impact on the radial increment of Norway spruce (*Picea abies* (L.) Karst.) in Belarus

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The southern border of boreal habitat of Norway spruce crosses the territory of Belarus. Near the habitat border climate factors have especially strong influence on spruce growth. Therefore it is interesting to study climate impact on the spruce trees radial increment in different regions of Belarus.

We have created 29 spruce chronologies for Norway spruce in different regions of Belarus. The high similarity of chronologies depends on precipitation of June–July and air temperatures of winter and early spring, which are analogous in the region. The positive correlation of growth with air temperature strengthens from South-Western to North-Eastern Belarus. We used results of atmosphere-ocean general circulation model HadCM2 to predict changes in radial growth of spruce on the territory of Belarus in 2025 and 2050. If the real climate changes will correspond to the climate change model, the spruce radial growth may decrease 20% by 2050 compared to the base period 1961–1990 in the south regions of the country. In the north regions spruce radial growth is expected to increase 10%. In the south, according to the climate forecast, the number and intensity of draughts will significantly increase, and this may weaken and cause death of spruce stands. In the northern part of the country the duration of the vegetation period is more important factor determining radial growth, and the duration will increase according to forecasted climate changes. Thus it will cause increase in radial Spruce growth.

A4.07 Oral

The first quantative warm period temperature reconstruction in the Caucasus mountains derived from tree-ring data

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The southern part of European Russia is poor in high-resolution paleoclimate data. Here we present the first temperature reconstruction of vegetation period (March-September) in the Caucasus Mountains derived from tree-ring data. The material (*Pinus sylvestris* (L.) was collected from upper-tree limit (2 200–2 400 m a.s.l.) in the Teberda river valley. Optical density measurements of resin-extracted samples were obtained by using flat-bed scanner and commercially available software. Final maximum density (MXD) chronology covers the period AD1759–2005 and includes 43 tree-ring series. The EPS (>0.85) indicates that the chronology is reliable and can be used for the reconstruction from AD1800. The nearest meteorological station Severny Kluhor is located at the altitude of 2042 m a.s.l. and represents climatic conditions close to the tree-line. The MXD chronology indices show a positive correlation ($r=0.8$; $p<0.05$) with March-September mean temperature. The calibration model explains 63% of variance in the instrumental climate records (1957–2005). According to our reconstruction the coolest summer in the Caucasus occurred in the year AD1817 (2-years lag response to Tambora eruption). The reconstructed temperature correlates with the Piatigorsk met.station records (1891–1997) which is located at the altitude of 500 m a.s.l., more than 200 km away from our site. This correlation means that the reconstruction verifies well for a century long period and is valid to assess not only the local but also the regional warm period temperature variations.

A4.08

A4.08 Oral

Opposite migration of beech and spruce in Southern Sweden – A dendroclimatological analysis

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Shifts of the distribution areas of tree species can already be observed, in altitude as in latitude. Interesting is this in regions where two major forest types converge, as the semi-boreal spruce forests and the nemoral beech forests in Southern Sweden. Growth of Common beech and Norway spruce was investigated in naturally grown mixed forests in Southern Sweden and as reference in Germany.

Dendroclimatological analyses showed a temporal variability in the main influencing climate variables. The growth of beech is mainly affected by drought in the previous summer. This influence increased since the 1950s and even strengthened since the 1990s. Main factor for spruce growth is precipitation in June. But this influence nearly vanished since the 1950s and was substituted by the same sensitivity to drought in the previous summer.

The future challenge will be the increased frequency of extreme conditions without phases of recovery. In the past decades secondary impacts of drought and their influences could already be observed. This affects both species similarly. Spruce trees (Sweden) suffered heavily from a succession of extreme events (hurricane, drought, pest) similar to beech trees (Germany) (drougth, pest, drought).

As result this study shows, that the competitive situation between beech and spruce has started to change. On exposed extreme sites in Germany beech trees might reach their physiological limits. In Sweden, however, beech trees could benefit from warm summers and prolonged vegetation periods and continue their migration northwards. In contrast, spruce probably has reached its southern, climatically determined distribution limit in Sweden.

A4.09 Oral

A preliminary analysis of regional moisture in the Northwestern China during the past 150 years

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Drought is one of great recurring nature disasters in China, especially in the dry Northwestern China (NC). A network of annual moisture-related tree-ring chronologies was employed to show the extents, severity and time of severe drought since A.D.1850. The results indicated that several severe regional drought events happened in the past, for example in the 1920–30s and 1880s. Employing the principal component analysis of tree-ring chronologies, we obtained the temporal and spatial characteristics of moisture variation in the NC. The results indicated that the first two principal components (PC1 and PC2) mainly represented the spatial structures of moisture variation in the eastern and western of NC, explaining 26.5% and 14.7% of the variance respectively. The series of PC1 and PC2 showed that the moisture variations in the eastern and western of NC were different. Correlation results with sea surface temperature suggest these differences may have associations with ENSO and NAO. However, more moisture-related tree-ring chronologies in the NC need to be collected and more work need to be carried out.

A4.10 Oral

Tree-ring-based reconstruction of the April to September mean temperature since 1826 AD for north-central Shaanxi Province, China

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Long-time series of high-resolution temperature record from Chinese Loess Plateau is rare. An April–September mean temperature reconstruction (1826–2004) has been developed for the north-central Shaanxi Province, China, based on tree-ring width analysis. The reconstruction captures 39.3% ($p<0.001$) of the variance in the instrumental data over the calibration period from 1951 to 2002. The reconstruction shows a high temperature period of 1928–1933, which coincides with the timing of the extreme drought event in 1920s in the entire northern China. The two low temperature periods in reconstruction are 1883–1888 and 1938–1942. With the global warming, the April–September mean temperature in study area has also increased since the 1970s, but has not exceeded the temperature in 1928–1933. Besides the statistical analysis, the reconstruction is also verified by the local dryness/wetness index and other dendroclimatological results.

A4.11

A4.11 Oral

Responsive variations of Qilian Juniper to climate at different elevations in Wulan, Qinghai Province, China

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Qilian Juniper (*Sabina przewalskii* Kom.) has been widely used for tree-ring research in the northeaster Qinghai-Tibetan Plateau since the 1990s. Most investigations showed close relationships between ring-width data and moisture conditions. Therefore, these ring-width data have been used to reconstruct long-term precipitation variations in the northeast of the Qinghai-Tibetan Plateau. However, a few studies have indicated that the growth of trees at the upper limit at some sites is more correlated to temperature than to precipitation in the study region. For ascertaining the response of Qilian Juniper to climate elements, we took tree-ring samples along a slope on the Shalike Mountains in Wulan, Qinghai Province, China. Eleven stands were sampled at every thirty meters of elevation, from 3644 to 3964 m above mean sea level, including the upper and lower treelines. By examining the correlations between ring-widths and climate factors, we found that the chronologies of the upper treeline and three other stands near the upper treeline are correlated more strongly with temperature than with precipitation for most months from the previous year's September to the current year's October, except for January, and that the correlations between ring-widths and temperature were mostly positive. Meanwhile, the stands at the mid slope and near the lower treelimit had the opposite results. These results imply that temperature variations can be reconstructed using trees growing at and near the upper treeline in this area, while trees growing at lower elevations and especially those near the lower treelimit can be used to reconstruct precipitation variations.

A4.12 Oral

Tree-ring based winter temperature reconstruction for the lower reaches of the Yangtze River in southeast China

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Two robust tree-ring width chronologies were developed for the eastern Tianmu Mountains and the Xianyu Mountains, southeast China. Both chronologies are significantly correlated with each other and were arithmetically averaged to form a regional chronology (RC). The RC correlates significantly with temperature from January to March of the growth year at the 95% confidence level. Based on this relationship, temperatures of previous December to current March were reconstructed using the RC chronology for the period of 1852–2006. The temperature reconstruction is significantly correlated with the winter-half year temperature in the eastern Qinling Mountains, central China, 720 kilometers west to this study region, suggesting large-scale coherence of winter temperature variability. The reconstruction corresponds well with an East Asian Winter Monsoon (EAWM) index in extreme years and reflects the strong influences of EAWM on this study region. Thus, tree-ring width chronologies have a great potential to reconstruct past climate in southeast China with less dendroclimatic work having been done until now.

A4.13

A4.13 Oral

Three spruce chronologies of tree-ring maximum density from upper tree line in the western Tianshan Mountains of Xinjiang

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Based on the tree-ring maximum density data of spruce from the upper tree lines on north slope of three mountains of the western Tianshan Mountains in Yili and Bozhou region of Xinjiang, using three different detrending methods (i.e. regional curves, negative exponential curves (no positive slope) and 300-year fixed spline), the paper develops the chronologies of tree-ring maximum density. After analyzing the effects of different sampling sites and different detrending methods on correlations of tree-ring maximum density chronologies in the different frequency domains, the paper finds that: There are better similarly in the higher frequency domain and greater different in the lower frequency in the changes of tree-ring maximum density on the three different sampling sites; The tree-ring maximum density chronologies are not sensitive to the different detrending methods in development chronology at the upper tree lines of spruce on the north slop of western Tianshan Mountains, but that distance between two sampling sites and whether they are in the same climate area are import factors that influent the correlation between two chronologies of tree-ring maximum density of the upper tree line of spruce; There are significant correlation between the tree-ring maximum chronology at the upper tree line and mean temperature in the current year, the more precipitation in mountainous area is, the better correlation between tree-ring maximum chronologies and mean temperature in the current year at upper tree line of spruce and the number of months increase on which tree-ring maximum chronology correlate well with mean temperature.

A4.14 Oral

History of *Abies spectabilis* population recruitment along an altitudinal gradient in Mt. Everest region

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In high elevation mountains, forest recruitment was expected to respond to climate warming sensitively. Previous studies of timberline dynamics showed that the pattern of response, however, differed from one area to the other, indicating a need to expand our observation both in space and in time. Here we report a study of the history of forest recruitment along an altitudinal gradient in Mt. Everest region of Tibet, China. Four plots, each 30 m x 60 m in size, were established from the eastern Himalayan fir forest's lower to upper limit (3378–3918 m.a.s.l.). Age of each tree was obtained by counting the number of annual growth rings for adult trees, counting the branch whorls for saplings, and estimating from DBH-age models. The population age structure was analyzed to investigate the recruitment history. The results showed that the timberline plot was characterized by sporadic recruitment in the past 250 years with significant pulse occurring during the recent three decades. The other three plots showed episodic recruitment which occurred during 1880s-1910s in the second high plot, during 1870s-1880s and 1920s-1930s in the third high plot, and during 1900s-1940s and 1990s-present in the bottom plot. Our study suggested that the recruitment of fir trees is sensitive to climate in timberline but are additionally controlled by local conditions in the lower altitudinal sites.

A4.15

A4.15 Oral

The palaeoclimatic potential of conifer species in the Himalayan region of Pakistan

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A collection of core samples was obtained from 11 different locations in the northern area of Pakistan. The sites ranged from moist temperate to dry temperate forest regions at elevations extending from 2500 to 3450m above sea-level. More than one species was sampled at four locations giving a total of 15 chronologies from five species (4 genera) – *Abies pindrow, Cedrus deodara, Picea smithiana, Pinus gerardiana* and *P. wallichiana*.

The oldest group is shared between *Cedrus deodara* and *Pinus gerardiana* with individual trees reaching ages over 700 years but this was closely followed by P. *wallichiana* and *Picea smithiana*. Growth rates ranged widely, from 1.66±0.97 to 0.52±0.24 mm per year and reflects the general moisture difference between moist and dry temperate regions. Cross-correlations highlighted the similarity between *Cedrus deodara* and *Pinus gerardiana* ring-width patterns and their potential to be combined. However, the strength of the correlations declined with increasing separation distances.

Response functions using 0.5° grid climate data (www.cru.uea.ac.uk/) were generated to assess the relative regional climate signal strength of the different sites/species and inter-species comparisons. A common feature was the strong negative response to warm May temperatures and positive response to winter/spring rainfall(snowfall) common to several species. Between 37–58% variance was explained and the results emphasise the strong gradients of climate in this mountainous region. Understandably, the limitation appears to be the sensitivity of the grid climate not the tree-ring chronologies.

A5.01 Invited

Teleconnections in the climate system from a dendrochronological perspective

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In climatology, teleconnections refer to the association of climate anomalies over large distances. In the atmosphere, climate signals can be transferred to regions far from the physical source of the variability, while in the oceans teleconnections are associated with the global thermohaline circulation. Teleconnections were first noted by the British meteorologist Sir Gilbert Walker in the late 19th century. One typical example is the El Niño-Southern Oscillation (ENSO), where the ocean and atmosphere over the tropical Pacific interact to produce climate anomalies over the region, but also elsewhere, e.g. over North America and Africa. Moreover, sea surface temperatures (SST) and the atmospheric circulation over the North Atlantic Region have been suggested to influence climate features well beyond the region, e.g. the East Asian Monsoon and drought in the Sahel region in Africa. In general, teleconnections are established using observational-data, which makes the temporal stability difficult to assess. Thus, climate proxies are highly useful for evaluating the stability, but also to better understand the mechanisms behind the teleconnections.

Tree rings, with their large spatial coverage and high resolution, are highly useful proxies for studying the spatiotemporal stability of teleconnections, at least in high-latitudes. Indeed, the Swedish geologist Gerhard de Geer allegedly coined the term teleconnection, where the basis was global climate change, and in the 1930s, his wife, Ebba Hult de Geer, attempted to teleconnect tree-rings from Sweden to Andrew Ellicott Douglass' American Sequoiadendron giganteum tree ring curve. At that time the idea of large-scale teleconnections was not really accepted, and it took several decades, and improved observations and models, before it was. In recent years, many dendroclimatological studies have related weather and climate variations (but also ecological processes) to ENSO and the North Atlantic Oscillation (NAO), but there exist a number of other large-scale patterns which influence regional climate. Also, long tree-ring records have been used to link regional climate to SST variability.

This presentation gives an overview of climate teleconnections from a dendroclimatological perspective, with focus on the large-scale circulation over the North Atlantic Region and its influence on Northern Hemisphere climate. In addition to a brief discussion of past accomplishments within the research field, a new reconstruction of the Atlantic Multidecadal Oscillation (AMO) covering the last 1200 years will be presented. The AMO, which is related to the thermohaline circulation, describes multidecadal fluctuations in North Atlantic SSTs s, and has been related to the variability of a wide range of regional climate parameters e.g. temperatures, precipitation, drought and hurricanes. Moreover, the AMO seems to influence the Asian summer monsoon, and South American precipitation. Using tree-ring data from the Northern Hemisphere, a reconstruction of the AMO spanning AD 800 to 2000 was constructed. The evolution of the reconstruction, as well as its relation to regional climate patterns and global temperatures, are discussed.

A5.02

A5.02 Oral

Low frequency variation in tree-ring chronologies: Evidence of the Pacific North American pattern (PNA) in the Southern Appalachian and Northern Rocky Mountains, USA.

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The Pacific North American Pattern (PNA) is a prominent mode of atmospheric circulation over the continental United States that creates inverse temperature and precipitation regimes between the Southern Appalachian and Northern Rocky Mountains. However, temporal limitations of the PNA index prevent the identification of low frequency expressions within the available data. Alternatively, tree-ring analysis provides one way of elucidating a PNA forcing on longer timescales, particularly where tree rings from regions with opposing climatic responses are employed. Climatic investigations between ocean-atmosphere teleconnections and tree-ring chronologies have become increasingly common with the availability data, and application of dendroclimatic calibration. This paper summarizes the current efforts to document low frequency variability in PNA through two regional tree-ring networks from Southeastern and Interior Northwestern United States. So far, 400 and 700 year regional chronologies have been constructed for the Southern Appalachian and Northern Rocky Mountains, respectively. Both regional tree ring networks show an interesting correspondence with the mechanistic climatology of PNA over the period 1950–2005, but exhibit different seasonal responses. Low elevation Douglas-fir is correlated at 0.50–0.60 with winter and early spring PNA (Jan.–Apr.). This is likely related to winter moisture availability, which predominantly impacts earlywood development in Douglas-fir. High elevation red oak is correlated at 0.40–0.50 with late spring PNA (May–Jun.). This response is related to a total ring-width mixed temperature- precipitation signal. Together, with proper attention towards preservation of low frequency variations at a regional scale, it may be possible to reconstruct PNA patterns and processes for previous time periods.

A5.03 Oral

Climate/tree-ring and teleconnection relationships for a millennial-length chronology of *Chamaecyparis obtusa* var. *formosana* from northern Taiwan

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We have recently developed a millennial length chronology from tree rings of *Chamaecyparis obtusa* var. *formosana* from northern Taiwan. These trees grow between about 1,800 and 2,200 meters in a closed-canopy cloud forest environment. A subset of the original tree ring dataset was used for the subsequent analyses, to enhance the tree-ring/climate relationships. This subset was based on the annual ranking of detrended tree-ring time series, with the upper 25% of the ranked distribution being used to produce a chronology. This chronology is significantly correlated with many environmental variables during the late winter and early spring, including surface wind components (meridional and zonal), vertical velocity, and outgoing longwave radiation, and mean temperature at 850hPa. The position, timing and parameters involved indicate links to fluctuations in the Siberian High and the Northeast monsoon. Significant teleconnections with Eastern Tropical Pacific sea surface temperatures were also identified with the highest correlations being during the summer monsoon season. But this relationship exists only after the mid-twentieth century. From 1900 to 1950 a weak tropical SST teleconnection was identified, but the dominant correlation field during this time was in February–March in the northern Pacific, apparently linked to fluctuations in the Aleutian Low, with an additional feature in the Indian Ocean. Climate reconstructions are currently being investigated.

A5.04

A5.04 Oral

Climate reconstruction from tree ring data of western Himalaya and its tele-connection with global sea surface temperature and sea level pressure

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Tree-ring data of Cedrus deodara and Pinus roxburghii analysed from several sites of the western Himalayan region have been found suitable for high-resolution past climate reconstruction. The tree-ring data of both the trees exhibit common growth pattern and have good correlation with spring (March–May) temperature and winter–spring (October–May) precipitation. Based on tree-ring data climate of these months has been reconstructed which extends from AD 1368–1988.

The reconstructed climate have been compared with both Kaplan sea surface temperatures (SST) and Hadley centre sea level pressure (SLP) datasets by shifting the correlations through different seasonal averages: two seasons preceding the monsoon [December–February (DJF) and March–May (MAM)], the monsoon season itself [June–September (JJAS)] and post monsoon [October-November (ON)]; for the whole year (JD) and for the same season of reconstructed climate. The results show strong correlation with tropical Indian and Pacific Ocean bands. The reconstructed March-May temperature shows a negative correlation at equatorial Pacific Ocean bands with SST in all the seasons. The link is recorded stronger with DJF, JJAS and JD in comparison to MAM and ND at Indian Ocean bands except MAM there is a negative correlation. With SLP, a strong negative correlation at Indian Ocean bands, west Pacific Ocean bands, Indian subcontinent, Tibetan Plateau and China is recorded. The linked is stronger with seasons DJF, MAM and JD in comparison to other seasons i.e., JJAS and ON. For October-May precipitation a positive correlation with SST of Indian and Pacific Ocean bands has been observed for seasons DJF, MAM, JJAS, ON, JD and October–May. The correlation pattern with DJF and October-May is stronger among all the seasons compared. Similarly, The results of with global SLP shows a strong positive correlation at Indian Ocean bands, west Pacific Ocean bands, Indian subcontinent, Tibetan Plateau and China. The linked is stronger with seasons DJF, MAM, JD and October-May in comparison to other seasons i.e., JJAS and ON.

A5.05 Oral

Basis and application of superposed epoch analysis to fire/climate relationships

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Superposed epoch analysis (SEA) is a non-parametric statistical method for examining the influence of an independent variable on a series of events. For example, in fire history studies, SEA is used to evaluate the influence of climate on fire occurrence. Climate data from a window of years preceding, during, and following the fire years are included to evaluate the influence of climate patterns on fire patterns. Climate data might include observed or reconstructed Palmer Drought Severity Indices (PDSI) or hemispheric indices such as the El Nino/Southern Oscillation Index (ENSO). Here we describe and critique SEA using fire history data from regions in the western United States that differ in regards to climate patterns and fire limitations (fuel versus moisture or ignition limitations). We use fire scar data from the International Multiproxy Paleofire Database (IMPD) to introduce and evaluate the SEA approach and investigate specific questions related to the random number generator used, spectral properties of the independent (climate) series, the sample size (of key events), and reliability of and confidence in the SEA results.

A5.06

A5.06 Oral

Expanding the tree-ring chronology network in SW Spain

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The SW Spain show a strong seasonal and inter-annual variability of the precipitation regime. The North Atlantic Oscillation (NAO) is the main cause of this variability due to latitudinal shifts in the wintertime North Atlantic storm tracks. Thus, the recent extended period of dry winters recorded in Mediterranean areas is strongly related to the persistence of positive NAO index. Trees in the SW Spain should record these climatic anomalies in their tree rings. We present here a set of new chronologies developed for the SW Spain: four Castanea sativa records covering the period between 1843 and 2007, a 2-century Juniperus oxycedrus chronology, two records obtained from *Pinus nigra* (1814–2008) and *Pinus pinea* (1745–2007), and a *Quercus ilex* chronology that cover a period between 1806 and 2006. Most of these woods are well represented in buildings from Middle Ages to recent times, giving opportunities to expand the chronologies several centuries in the past. The obtained chronologies show a regional common signal accounting for by the 75% of variance in a PCA analysis. Correlations between these chronologies with climate indicate a direct and significant relationship with precipitation variability during late spring and summer months. Moreover, the tree-ring chronologies reflected the influence of the NAO on the regional climate, in terms of inverse and significant correlations observed between the tree-ring records and the NAO index. The results highlight the importance to expand tree-ring studies to other sites and species in order to increase the paleoclimatic and ecological information of the SW Spain.

A5.07 Oral

Changes in teleconnection pattern between Japanese summer monsoon (Baiu) and ENSO during last three centuries: Evidences from oxygen isotopic ratios of tree-ring cellulose in northern, central and southern Japan

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Baiu/Meiyu/Changma is one of the most predominant features of East Asian Summer Monsoon. Climatologists have revealed that Baiu is tightly related to ENSO, but it is also noticed that the teleconnection is variable in multi-decadal time scales. In order to improve predictability of Baiu, it is useful to clarify historical change in Baiu-ENSO teleconnection during pre-instrumental periods. Here, we measured oxygen isotopic ratio ($d^{18}O$) of tree-ring cellulose at three sites in northern, central and southern Japan to reconstruct spatial-temporal variations in Japanese summer hydroclimate during last three centuries. Historical variations in $d^{18}O$ of tree-ring cellulose showed the highest (negative) correlation with local relative humidity and precipitation in June, indicating that the tree-ring $d^{18}O$ can be a proxy of summer monsoon, especially Baiu front activity there. In order to investigate long-term changes in Baiu-ENSO teleconnection, slide correlation analyses were conducted between the tree-ring $d^{18}O$ time series and the observed and reconstructed ENSO indices. During last three centuries, the correlations between Baiu ($d^{18}O$) and ENSO have been reversed cyclically at about 40 years intervals by different modes at three sites. The latest reversal corresponds to the regime shift occurred in 1970's, indicating that the instrumentally observed non-stationariness of teleconnection is part of a longer-term climatic phenomenon. The cyclic change in Baiu-ENSO correlation is coincident with the long-term change in Pacific Decadal Oscillation, suggesting that the predictability of Baiu can be improved by considering other indices of atmospheric circulation together with ENSO.

A5.08

A5.08 Oral

Annual Precipitation since A.D. 1460 reconstructed from the juniper ring width of Qilian Mountains

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We present a century-scale annual precipitation reconstruction from previous August to current July over the past 540 years based on a tree ring-width chronology developed from juniper (*Juniperus przewalskii* Kom) on the Qilian Mountains. The reconstruction is verified with dependent data, and accounts for 41% of the instrument data variance during their common period (1960–2000). The full reconstruction indicates that the regional precipitation variability is relative stable except for the significant wetter epoch (1680–1760 A.D.) and an extreme drought event in the late 1920 over a large geographic area in northwestern China, which is corroborated by other paleoclimatic indicators. The wavelet analysis reveals the strong low frequency cycles (2.8, 2.1–2.6, 4.5, 5.5–6.1 yr) on the whole reconstructed period. The cycle of 16 yr is also examined, but it is discontinuous for the whole period. Overall, our reconstruction not only extends the regional precipitation history, and provides the valuable information to understand some proposed climate forcing.

B1.01

B1.01 Invited

Singular spectrum analysis as a tool to identify dendroclimatic relationships in *Acer saccharum*, *Betula alleghaniensis*, and *Picea rubens* in the northeastern United States

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Singular spectrum analysis (SSA) and reconstruction (RC) can improve the detection of the high-frequency climatic signal in index chronologies built from short, noisy ring-width series. Weak but authentic responses of growth to monthly mean temperature, total precipitation, and to regional processes such as the North Atlantic Oscillation (NAO) can be resolved in complacent series from temperate environments. Although sharing with Fourier analysis (FA) and the multi-taper method (MTM) the capacity to decompose and identify the periodic components of complex time series, SSA has several advantages: (1) quasi-periodic as well as strictly periodic processes can be identified, (2) the statistical significance of the identified cyclic process can be readily tested, and (3) the chronologies can be reconstructed using the periodic components. In these tests, index chronologies for 1897–2006 were constructed from cross-dated ring-width measurements using ARSTAN software. The significant periodic components of the ARS chronologies were identified and reconstructed using the SAS-MTM Toolkit. Bootstrapped response functions were calculated from the ARS and RC chronologies and monthly weather and NAO indexes using Dendroclim2002 software. As with other spectral analysis techniques, the minimum frequency (maximum periodicity) that can be detected is only a fraction of the length of the original index chronology.

B1.02 Oral

A digital collaboratory for cultural dendrochronology (DCCD) in the Low Countries

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Tree-ring research of palaeo-vegetations and wood from the cultural heritage in Europe has resulted in large amounts of tree-ring data for the Holocene. These data contain essential and unique information about, among others, past environmental change, the historical landscape and its uses, social-economic processes and wood technology. To improve research within these domains international research agendas need to be developed, data need to be made exchangeable and upgraded with metadata that fit the research agendas, and data collections need to be digitally linked or combined. This is happening in the international project "Digital Collaboratory for Cultural Dendrochronology (DCCD) in the Low Countries" (2008–2010). Laboratories in Belgium, France, Germany, the Netherlands and Poland have formulated the outlines of a shared research agenda for tree-ring studies within the Humanities and Geosciences. They have contributed to the development of a new international data-exchange and archiving standard, TRiDaS, which fits these outlines (see the abstract by Brewer, Jansma & Zandhuis for more information about this model). The DCCD is a trusted digital repository and its content is managed according to public regulations (NL, EU). Data access is controlled by the data owners and new members can join at any time. All are welcome to use the stand-alone TRiDaS database available through www.dendrochronology.eu for metadata registration according to TRiDaS and for exporting content to TRiDaS XML, the required format for uploading metadata to the DCCD. The architecture of the DCCD allows linkage to other digital archives and web applications, such as Corina (Cornell) and the ITRDB.

B1.03

B1.03 Oral

Application of Monte-Carlo methods to estimate the significance of paleoclimatic and dendroclimatic calibration-verification statistics from autocorrelated time-series

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Temporal lengthening of instrumental climatic and environmental time series is often performed using indirect paleoclimatic estimates (proxy series) such as tree-rings. These records are natural time-series that may contain a significant portion of temporal autocorrelation. Consequently, conventional statistical methods may be analytically intractable due to a lack of the appropriate assumptions being satisfied. We demonstrate the usability of the flexible Monte-Carlo method to estimate the significance of calibration and verification statistics normally used in paleoclimatic reconstructions, that is, Coefficient of Determination (R^2), Coefficient of Correlation (r^2), Reduction of Error (RE) and Coefficient of Error (CE). Moreover, such methods are subsequently applied to estimate confidence intervals for regression-based climate and environmental reconstructions, computed from the temporal structure of the regression residuals. Examples are provided for both naturally and artificially autocorrelated time-series in the context of late Holocene paleoclimatology. A Matlab package and a Windows executable file for non-Matlab users are presented which perform the described analyses.

B1.04

B1.04 Oral

Process based standardisation and a comparison with a tree-growth model

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Dendroclimatologists derive indices of tree growth from tree-ring measurements while tree-growth modellers simulate tree-growth from climate and environmental variables. Both should produce the same output from "independent" input data and enable cross validation, where dendroclimatically derived tree-growth can constrain some of the processes within tree-growth modelling and a tree-growth model can validate or fine tune dendroclimatic methods. The main control of climate on tree growth is via photosynthesis which is used by tree-growth models to calculate the mass of carbon (growth material) produced in foliage by photosynthesis and processes and parameters are used to allocate this carbon to the growth of new tree structure, resulting in annual stem increments. The age-related trend can be removed from series of ring-width measures using process-based allocation rules and in doing so will perform dendroclimatic standardisation.

The name "process-based standardization" (PBS) is coined to describe this novel method. PBS uses pith-offset and ring-width data to develop indices of carbon per unit foliage for each year using allocation rules and parameters either derived directly from process models or developed from empirical tree-growth data. A description of the PBS model will be presented along with results from comparisons of the outputs of PBS and the tree-growth model (GUESS), made at northern Scandinavia and the Austrian Alps. GUESS has been adjusted to output carbon/unit foliage for each year of simulation; with each simulation represented by a period of initialisation followed by a period of tree growth derived from sequences of measurements of temperature, precipitation and sunshine.

B1.05 Oral

It's all in the mix – Dendroecological archetypes provide a new perspective on inherent growth patterns

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Archetypal analysis is based on the assumption that each point in a multivariate dataset can be represented by a convex combination of a few equally dimensioned archetypes not necessarily observed in reality. By applying archetypal analysis on a dataset of 30 Norway spruce and 22 common oak tree-ring chronologies from Southern Germany, we derived two growth patterns representing archetypes of growth dynamics. These patterns are designated to a hypothetical ideal oak or spruce, respectively.

As common oak and Norway spruce are associated with different strategies of coping with climatic constraints, the derived archetypes can be interpreted in terms of drought tolerance (oak) and drought intolerance (spruce). We found the oak archetype to be characterized by a lower mean sensitivity and a weaker dependence on both temperature and precipitation, whereas the spruce archetype shows a higher mean sensitivity and a stronger growth limitation by summer and autumn temperatures and summer precipitation.

The mixing ratio of the derived archetypes in each chronology provides a comprehensible measure of drought tolerance. We prove archetypal analysis to be more efficient in terms of species separation than more established grouping approaches like fuzzy k-means clustering. Furthermore, the derived archetypes are hypothetical chronologies and can be interpreted as such. This is an advantage over PCA, where the interpretation of principal components of higher order is generally not intuitive. In a spatially explicit approach we show that archetypal analysis can be used to derive site specific species rankings with respect to drought tolerance.

B1.06

B1.06 Oral

A new approach to select the best trees for dendroclimatic analyses

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The development of dendrochronological time series in order to analyze or reconstruct climate conditions usually involves a two-step selection: during field sampling, and during the precise checking of samples dating. This study suggests a change in perspective, passing from an analysis of growth-climate relationships that typically focuses on the mean response of a species, to investigating the range of responses among sample trees. Based on individual response, an additional selection step is introduced, which follows series standardization but precedes chronology computation. The application of this approach is compared with the classical protocol using tree-ring records from conifer species collected in the Alps. Results highlighted that this new approach outperforms the classical one and that the strength of climate correlation can be applied as a valuable metric in the tree-selection phase. Moreover, the best-responder trees at any one time may not always have been the best-responders and may not continue to be so. Finally, this approach also seems to be efficient for disentangling multiple climatic signals coexisting within the same site and species. With minor adjustments to current dendroclimatological protocol, we can reduce possible bias and improve the quality and reliability of the climate/growth relationship. The transfer of climate-growth functions for reconstructions of past conditions could be similarly improved.

B1.07 Oral

RCS modelling problemacy

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A common task in dendroclimatology is to identify climatic events from tree-rings. The many environmental factors affecting simultaneously to tree growth may, however, may make the task difficult. To minimise the problem, a good plan for the whole process of investigation is necessary. Cook's conceptual aggregate growth model provides a framework model for planning. We just need to arm the model with the proper data and methodology and, finally, be careful in drawing the proper conclusions. "Proper" here means a high correlation in terms of validity and reliability (V&V).

Proper Data. Maximising V&V presupposes careful preparing of data. This concerns especially the data sensitive methods like RCS (Regional Curve Standardisation). Applying pre-qualification criteria in sampling grants a smaller sample size and better data quality. Proper sample size depends on the desired accuracy level and the investigated topic. The coefficient of variation (CV) of tree-ring indices at the northern timberline area is 40–50%. Requesting a ± 10% accuracy in the index at 5% risk, counts at least 50 observations per year. A data preparation tool called "the Box Filling Method" (BFM), introduced by the author, provides some criteria for producing evenly distributed datasets defined by calendar year and cambium age. BFM can also generate several independent or dependent subdatas from a larger dataset.

Proper Methodology. There are two methods of exposing climatic signals: Single Tree Standardisation (STS) and Regional Curve Standardization (RCS). STS fits well for identifying annual and decadal variation whilst RCS is used for exposing long trends. In order to gain maximum V&V, RCS should always fulfil both the pre-qualified and the BFM criteria. If not possible, RCS should not be applied to dendroclimatic analyses.

Proper conclusions. How to generalize the results? Small datasets often represent only the local climatic conditions. But the conclusions would even in this case be biased if failing in V&V.

B1.08

B1.08 Oral

DIRECT: A new approach to dendroclimatic reconstructions

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Here we introduce a new method of the past climate reconstruction from raw tree ring measurements and (possibly) other proxy data. DIRECT (which stands for Direct Reconstruction Technique) takes advantage of both response surfaces and Regional Curve Standardization (RCS) concepts to make climatic reconstructions on the basis of available instrumental records and different proxy data, while it was constructed mostly for tree ring proxies. The main feature of this method is direct (i.e. without standardization) transformation of raw measurements into values of climatic parameter being reconstructed. This approach eliminates some common standardization problems like loss of low-frequency variability or potential bias on the ends of chronology

For all the years we have instrumental data that we want to extend in the past we put our raw tree ring measurements against three parameters (climatic parameter value, cambial age and the mean measurement for the first 100–150 years of the sample) in 4D response space, one point for each measurement that falls within instrumental period. Smoothing (approximating) hypersurface for these points can be either plotted for visual analysis or used for transforming raw measurements into climatic parameter values. For each year of reconstruction period these values can be averaged with each other and other proxies (with different weights) to get final reconstruction. As a particular case this method supports nonlinear response models with ambiguous solutions.

In this study we apply DIRECT to tree ring data collected in Central Caucasus Mountains in order to reconstruct mean summer temperature back to 1797.

B1.09 Oral

Use of mixed models in dendroecology

B1.09

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In this presentation we briefly explain the theory behind mixed models and present a few applications of these to dendrochronology. Mixed models have been little used in dendrochronology and have not made their way into the standard dendrochronological resource libraries. The reason is probably that they are computationally intensive and they would not run on most computers in the 1980's when computers made their entry intro tree ring research. Nowadays, memory and processor speed are seldom an issue.

Dendrochronology uses normally a hierarchical sampling scheme, where several single trees are selected from sample stands. Prior to the actual analysis the trees are averaged into a chronology and the actual analysis is usually based on a comparison of these site averages. Mixed models keep and take all individual tree measurements into account and assume that the trees are sampled from a hierarchically structured population, where trees from the same stand my by more similar to each other than to trees from other stands.

We use three examples to describe the possible advantages of the approach, where mixed models are applied along gradients and or sample plots. We show that mixed models can help to make more general climate growth functions and that they, by relaxing the assumption of a common climatic signal, may help to understand how ecological factors interact on tree growth.

B1.10

B1.10 Oral

Analysis of non-linear relationships between climate and tree rings using non metric multidimensional scaling

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Principal Component Analysis (PCA) has been widely used in tree ring research to separate the climate factors that affect to forest growth. However PCA present a serious inconvenient, that is the assumption of linearity in data structure. In Mediterranean environments, the tree growth response to climate is usually not lineal. Also, in many areas climate records do not surpass the 40 years. For these type of situations other mathematical procedures are necessaries. Artificial Neural Networks (ANN) present as problem the overfitting when the climatic records are not enough long and spurious climatic information is introduced in the model. Statistical methods can be more useful in these situations. In the present research, we show an application of Non Metric Multidimensional Scaling (NMMS) to tree ring research. This multivariate method is based in the minimization of statistical stress, defined as the quadratic difference between data and distance based matrix. The method can be tested with different number of axis and distance algorithm. In consequence, NMMS permit to research explore dimensionality and non-linear information based in distances. The application to long data sets in SW Iberia demonstrate its superiority to PCA in Mediterranean Areas. Probably in areas with less interannual and seasonal climatic variability the differences with ACP are irrelevant.

B1.11 Oral

Dendroclimatic instability in Aleppo pine across the Mediterranean basin

Martin de Luis[1], Katarina Cufar[2], Alfredo di Filippo[3], Andreas Papadopoulos[4], Gianluca Piovesan[3], Cyrille B.K. Rathgeber[5], José Raventós[6], Kevin T. Smith[7]
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Aleppo pine (*Pinus halepensis*) is the most common tree species in the Mediterranean basin. In this respect, a detailed knowledge of how the relationship between climate and growth is behaving today, and how this may be modified in the future, is of critical importance. To do that, extensive dendroclimatological research designed to identify variability in climate-growth relationships across the climatic distribution of critical tree species is required to produce meaningful dendroclimatic models and predictions of forest growth in future climates. We present a dendroclimatic study based on a network of 49 tree-ring chronologies in the Mediterranean basin. The results indicate that rather than being uniform, the dendroclimatic relationships are intrinsically instable. This finding implies an unequivocal deviation from the uniformitarian principle that may severely bias interpretations of climate change research. However, our findings also highlight that the variation in the dendroclimatic relationship can be quantified which may result in more reliable projections of future forest growth during climate change.

B1.12 Oral

The interior of tree roots – A fusion of 3D laser scanning and 2D tree ring data

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Forests are huge carbon sinks that play a crucial role in the global carbon budget. Unfortunately, existing biomass calculations and tree growth models concentrate on the aboveground part of trees. This is surprising in light of the fact that up to 40% of tree biomass is belowground. Tree ring-research also frequently ignores the below-ground parts of trees. Most studies are based on ring data of stems or single roots rather than on an entire root system. Root systems are quite heterogeneous and contain important information about root development and anchorage. The objective of this study is to design an annually resolved 3D growth model for tree roots that allows for reliable biomass calculations and that will shed light on root growth and ring-width variations within an entire root system. A FARO scan arm is used to acquire 3D laser scans of root architecture. Root ring-width data are measured using standard dendrochronological techniques. These data sets are then fused using MATLAB. This presentation focuses on the generation of representative root surface models for biomass calculations. These 3D structural models are then fused with 2D ring-width data. Depending on the complexity of the root structure, an offset in volume up to 7% occurs. This error is within the predicted range of error for biomass. In addition, we will present the first successful integration of tree-ring boundaries as coordinates into the model. The integration of ring-width data and structural data provides novel information about the spatial allocation of ring-width ages and variations.

B1.13

B1.13 Oral

Defining temperature and soil moisture tresholds for positive radial increment of cork oak (*Quercus suber* L.) in a mediterranean environment: An approach based on generalized semiparametric linear mixed models

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The definition of treshold levels of limiting factors for assessing stem growth of forest species is of major importance for improving the knowledge about growth processes and to analyse the influence of a changing environment on the length of the vegetative period. In this work, we present a methodology to define temperature and soil moisture tresholds for radial increment of cork oak (*Quercus suber* L.). The dataset is based on continuous measurements by automatic dendrometers performed from 2004 to 2007 on 8 trees in two contrasting sites in Southern Spain. A mixed model considering the positive and negative daily values of radial increment as a binary variable and analysing the influence of the site, year, tree, soil moisture and temperature on the probability of radial expansion is applied. Trend in the probability of radial expansion during the year and in the bivariate soil moisture-temperature distribution are absorbed through low rank radial smoothers incorporated in the mixed model. Mean air temperature lower than 12–14ºC and soil moisture lower than 5% of the field capacity are indicated as limiting the positive radial increment, while no significant effect is shown between sites, years and trees. Because of its flexible application, this mixed and bivariate approach can be suitably used to investigate the influence of the climatic factors on tree growth at very short time scale.

B1.14 Oral

Does acorn production influence the diametric stem growth of holm oak?

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Quercus ilex ssp. *ballota* (Desf.) Samp. is a widely distributed species in the Mediterranean basin and Middle East. In the Iberian penisula holm oak is also a very abundant species and covers a total area of about 2.5 million ha. This species is the dominant in Mediterranean pasturelands known locally as dehesa. Scarce studies have been conducted on the vegetative growth of the stem diameter of holm oaks, but a better knowledge of the growth dynamics is also very important to characterize these systems as atmospheric carbon sinks.

Allocating resources to current reproduction deprives vegetative growth of these resources and so reduces plant size and resource storage (Reekie & Avilà-Sakar, 2005), but since there is a general agreement that there is a trade-off between reproduction and growth, there is very little empirical data available (Reekie & Avilà-Sakar, 2005), and there aren't any for holm oak. In this study we try to advance in the knowledge of the processes that affect growth in holm oak, analyzing the "trade-off" between growth and reproduction. To this end, two plots have been laid out in the province of Huelva, where stem diametric growth (using band dendrometers) and acorn production (containers method) have been assessed in 34 trees throughout 2004–2008. Data have been analyzed using a mixed linear model , the dependent variable being annual acorn production per tree.

B1.15

B1.15 Oral

Analyzing subjective expert opinions about standardization of tree-ring series

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Various methods are available for removing age trend and other disturbing signals from tree-ring series. The smoothing splines with an user defined frequency-response cutoff, i.e. degree of smoothness, have been widely used. However, there is generally little theoretical basis or a priori information for selecting the proper flexibility of the smoothing curve. Thus, the choice of flexibility remains largely problem-dependent and a subjective decision is involved.

The chosen flexibility should be based on the intended use of the tree-ring data, i.e. based on the studied signal. We approach the problem of standardization by presenting the experts two smoothing spline solutions to a single tree-ring series normalization problem and asking them to choose a better one of two normalization solutions in a two-alternatives forced choice setting (2AFC). The presented pairs were randomly selected from a database of tree-ring series. Data were collected from a number of experts using a Web-based tool.

In the analysis part, we merged the preferences of the panel of experts to estimate their common preferences based on a statistical model consisting all preferential relations between the presented complexities. The solution is based on a probabilistic model, a first-order Markov chain, that models the empirically estimated probabilities based on the partial ranks of a number of pre-defined model scales. We were able to define a consensus opinion of all the experts together, and to estimate individual parameters for the standardization problem.

B2.01 Invited

Dendrochronology in natural hazards research

B2.01

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Following its initial employment as a simple dating tool dendrochronology has developed ever expanding applications in the study of Natural Hazards. These range from exploratory studies dating or demonstrating the effects of single events such as a landslide, to dating of multiple events at the same site in order to develop magnitude-frequency relationships of, for example, rockfalls, debris flows or snow avalanches. As the wider geographical application of these techniques continues, their demonstrated utility underscores the need to develop standardized approaches and sampling strategies for particular sites and/or process combinations that can be generally applied across a range of applied studies – whilst always recognizing that any specific site or process combination may contain unique elements that constitute a challenge to routine applications. Although measures of scar dating, documentation of reaction wood series, measures of growth asymmetry and abrupt growth changes are most commonly used there is increasing evidence that other techniques based on e.g. wood anatomy, isotopes or wood chemistry will increase in importance in the future. In addition, new studies have increasingly focused on the potential of developing records from ring-porous species rather than the coniferous species that were the basis for many early studies. This paper will present a series of examples of more traditional and innovative approaches that illustrate the great potential of tree-ring studies to yield important data for natural hazard analyses. In addition to developing an increased understanding of the processes involved, these studies may also assist in the development and calibration of models of process activity that can improve the development of defence and mitigation strategies for dealing with many natural hazard problems.

B2.02 Oral

B2.02

Magnitude-frequency relationships of debris flows – A case study based on field surveys and tree-ring records

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Debris-flow activity in a watershed is defined in terms of magnitude and frequency. While magnitude-frequency (M–F) relationships have long formed the basis for risk assessment and engineering design in hydrology, only fragmentary and insufficiently specified data for debris flows exists. M–F relationships of 62 debris flows are reconstructed for a small watershed in the Swiss Alps since A.D. 1863. The frequency of debris flows is obtained from tree-ring records and the magnitude of individual events is given as S, M, L, XL, and derived from volumetric data of deposits, grain size distributions of boulders, and a series of surrogates (snout elevations, tree survival, lateral spread of surges). A comparison of results with hydrometeorological records shows that class L and XL events are typically triggered by advective storms (rainfall >50 mm) in August and September, when the active layer of the rock glacier in the source area of debris flows is largest. Over the past 150 years, climate has exerted control on material released from the source area and prevented triggering of class XL events before 1922. With the projected climatic change, permafrost degradation and the potential increase in storm intensity are likely to produce "class XXL" events. The dataset clearly demonstrates that the non-stationarity of climatic variables chiefly influences the frequency of debris flows and that the magnitude of events at this site subsequently undergoes changes with time.

B2.03 Oral

Tree-ring reconstruction of past lahar activity at Popocatépetl volcano, Mexico

B2.03

Michelle Bollschweiler[1], Markus Stoffel[2], Lorenzo Vázquez-Selem[3], David Palacios[4]
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Lahars represent a major threat on the slopes of volcanoes all over the world. In order to realistically assess hazards, knowledge on the occurrence and timing of past lahar activity is of crucial importance. However, archival data on past events is usually scarce or completely missing. Tree-ring records have repeatedly proved to be a reliable data source for the reconstruction of past geomorphic events. However, tree rings have seldom been applied for the identification of past lahars. Therefore, it was the aim of this study (i) to identify and describe disturbances in tree growth induced by well-documented lahar events and on this basis (ii) to recognize older, unknown lahar events with tree-ring analyses. Based on these goals, we collected 140 tree-ring series from 62 trees (A*bies religiosa, Pinus hartwegii, Pinus ayacahuite*) standing inside or adjacent to the lahar channel in the Huiloac gorge at Popocatépetl volcano, central Mexico. Most commonly, the known lahar events of 1997 and 2001 resulted in abrupt changes in tree-ring width as well as injuries. The same growth disturbances could be identified in the tree-ring series, indicating that five previously unknown lahar events would have occurred during the 20th century. As most of these unknown events occurred during periods with no volcanic activity, we believe that they were rainfall-induced rather than related to volcanic activity. In general, the investigated tree species proved to be highly suitable for the reconstruction of mass-movement processes.

B2.04

B2.04 Oral

Dendrochronological reconstruction of snow avalanche activity in the southern Wasatch Mountains, Utah, USA

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This contribution is for the suggested session on Tree Rings and Natural Hazards.

Snow avalanches are a common natural hazard in the Wasatch Mountains of Utah. Housing developments along the heavily urbanized Wasatch Front continue to creep closer to the runout zones of avalanche paths. Dendrochronology can help determine the frequency and magnitude of previous avalanches and provide planners and city administrators with data to guide development policies, and reduce the risk of loss of life or property due to avalanches. In March 2005 an avalanche occurred on Loafer Mountain in the southern Wasatch Range. The slide reached a planned subdivision at the base of the mountain, completely covering one lot in about 5 meters of snow and debris. Dozens of Douglas-fir and white fir trees were broken or uprooted and deposited at the base of the mountain, providing an opportunity to remove cross sections with a chainsaw to build a chronology of avalanche occurrence from evidence recorded in tree rings. We sanded samples to a high polish, crossdated them, and analyzed them for corrasion scars, reaction wood, and growth suppressions that could indicate avalanche damage. Preliminary results, primarily from corrasion scars and reaction wood, indicate several events, including many that were common to several samples. In future work we will analyze additional samples to strengthen the chronology, and search US Forest Service records and newspaper articles to corroborate the events.

B2.05 Oral

Recent snow-avalanche activity determined by dendromorphology and dendrochronology in Northern and Northwestern Iceland

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The Fnjóskadalur, Ljósavatnskarð, Dalsmynni and Botn í Dýrafjörður valleys, in Northern and Northwestern Iceland, are characterised by an important snow-avalanche activity impacting large colluvial cones. All valleys expose stands of deciduous trees, which cover an extensive wooded part along the flanks. The main represented species are *Betula pubescens* trees and shrubs. The objective of the research is to determine past snow-avalanche activity to improve historical record for the last century by applying dendrochronological and vegetative analysis. Trees and shrubs experience damages resulting from the impact of snow and debris, to which they respond in a variety of ways. The dendrochronological approach compares tree rings growth from a reference area beside the snow-avalanche path with the ones from within the snow-avalanche path. For this purpose, increment cores are taken from the up-down axis of the trunks and analysed on a LINTAB measuring table. The dendromorphological analysis maps changes in trunk posture such as tilted or topped trunks, and the position of wounds on the trunks. The combination of these two approaches provides a temporal catalogue of snow-avalanche events and also determines the directions of main fluxes. Therefore, it helps to locate the lateral dispersion of snow avalanches over the cones through time. The results obtained from comparison between the reference growth curve and the snow-avalanche impacted one show a clear difference between impeded tree-ring growth due to climatic factors and snow-avalanche occurrence. Several snow avalanche events are unravelled on the investigated cone during the last century.

B2.06

B2.06 Oral

Separating debris-flow and snow avalanche events in a steep watershed of the Swiss Alps using injured broad-leaved and conifer trees

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Debris flows and snow avalanches are common processes in the headwaters of steep watersheds worldwide. In forested areas, dendrogeomorphic analyses of trees affected by debris flows and snow avalanches have regularly been used to date past events. Previous studies have, however, almost never focused on both processes at once, as snow avalanche impacts cannot easily be distinguished from debris-flow scars. Through the determination of the exact position of characteristic growth disturbances within a tree ring, it is not only possible to date a geomorphic process to the year, but sometimes even with intra-seasonal resolution, thus allowing the seperation of the two processes. It is the purpose of this study to report on results obtained from the headwaters of a steep watershed in the Rhone valley (Valais, Switzerland), where past debris-flow and snow avalanche activity was dated based on the location of tangential rows of traumatic resin ducts and scars within the tree rings of different broad-leaved (mainly *Alnus incana* and *Sorbus aucuparia*) and conifer trees (mainly *Picea abies*). In total, the analysis of 171 cores, 34 wedges and 11 cross-sections from 93 trees provided information on 20 debris-flow and 3 snow avalanche events between AD 1930 and 2008. Debris flows were repeatedly triggered between May and mid-July while snow avalanches occurred sometimes between November and April. The intra-seasonal dating of events not only allowed for a separation of the two processes, but also for the detection of different debris-flow events within the same year.

B2.07 Oral

Frequency and spread of hyperconcentrated flows on fans: A dendrogeomorphic case-study from a dolomite catchment in the Austrian Alps

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Growth disturbances in tree-ring series have been regularly used to date debris-flow events in mountain environments. In contrast, there are no studies available to date who have reconstructed hyperconcentrated flows by means of dendrogeomorphology. It was therefore the aim of this study to determine the event frequency and the spread of hyperconcentrated flows in the Gratzental (Tyrol, Austria). The analysis of growth disturbances in the tree-ring series of 227 *Picea abies* (L.) Karst. and *Larix decidua* Mill. allowed the reconstruction of 37 events for the last 200 years. The lateral spread and preferable breakout locations of reconstructed hyperconcentrated flow events were assessed based on the dating of the events and the spatial position of trees affected by an event on the fan. Results show that the Gratzentalbach preferentially left the channel to the east, but affected trees were evenly spread over the fan. Reconstructed data illustrates the high potential of dendrogeomorphology for hazard assessment of hyperconcentrated flows events.

B2.08 Oral

Reconstruction of debris-flow activity in the Mont Dore Valley, Sancy Massif (French Central Massif)

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Debris-flows are one of the dominant geomorphic processes in mountain regions, where they repeatedly cause economic losses and even fatalities. Infrastructural elements often cross debris-flow paths without necessarily considering the frequency of past phenomena. In addition, little is known about the magnitude of past debris flows in mountain regions and this is due to the fact that there are only few archival records.

The purpose of our study was to reconstruct past debris-flow activity affecting the Mont Dore resort in the Sancy Massif, one of the medium-high mountain ranges of the French Central Massif. A forested debris-flow cone has been chosen for study in the Mont Dore Valley, where debris flows originate from unconsolidated volcaniclastic material. A detailed geomorphic map was realized and served as a basis for the selection of affected trees colonizing the debris-flow cone. A total of 43 Silver fir trees (*Abies alba* Mill.) were sampled with 105 increment cores. In parallel, 34 increment cores were extracted from 17 non-affected Silver fir trees for the realization of a reference growth curve. In the laboratory, we determined years with evidence of debris-flow activity by identifying growth disturbances in the tree-ring series. Results indicate that from 1900 to 2008, more than 35 debris-flow events occurred in the Mont Dore Valley. The new knowledge on debris-flow activity needs to be integrated into the planning of the area's future tourism infrastructure projects.

B2.09

B2.09 Oral

An improved statistical method in dendrogeomorphology: Case study from snow avalanches in the Chic-Chocs Range, eastern Canada

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Tree-ring analysis has been used for the study of several geomorphic and geological phenomena, but its accuracy has yet to be investigated, with regard to methodological issues. In that respect, ~10 years ago we started a long-term research program on snow avalanches in the Chic-Chocs Mountains (eastern Canada), with many efforts devoted to the minimum number of samples required for the recognition of past avalanche events. Our approach was based on the process-event-response developed by Shroder and it clearly appears that the larger the sample size, the higher the probability to record past avalanche events. However, because the avalanche activity index is based on the percentage of responses in relation to the number of trees alive for a given year, a very large sample size may increase the noise and make deciphering past avalanche events even more difficult. Indeed, the cumulative distribution function of avalanche chronologies, which describes the probability distribution of avalanche chronologies for variable sample sizes, follows a logarithmic law. Moreover, we statistically distinguish high-magnitude avalanches from other types of disturbances and small avalanche events. This quantitative approach takes into account the statistical distribution of tree ring responses, which usually follow a general extreme value distribution. In this respect, the use of this statistical technique to establish a threshold value should allow us to go one step further in spatiotemporal modeling, particularly for the estimation of return intervals and annual probability.

B2.10 Oral

Use of resistograph for dendrogeomorphological analysis of avalanche impacts

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The resistograph device measures the drill resistance of a fine needle as it penetrates wood. The tool is normally used for detecting wood cavity in phytosanitary. In an attempt to rapid identify and assess the relative wood density of particular tree rings and growth anomalies in tree rings, we have tested the utility of the resistograph for dendrogeomorphic purposes. Ring widths and resistograph measurements were performed on 15 cross-sections of European larch (*Larix decidua* Mill.) trees from an avalanche talus. Eleven of the samples showed visible signs of past snow avalanche impacts, the four other samples did not, in contrast, exhibit obvious signs of avalanche damage. Resistograph profiles were processed to determine width and density parameters of the 613 tree rings in the samples. A first analysis of the dataset, simplified using a Principal Component Analysis (PCA), clearly highlights the abnormally high density of compression wood and overgrowing callus tissue as compared to undisturbed growth rings. Based on the simplified assessment grid originating from the PCA, probability benchmarks were defined to identify disturbances in the densitometric signal. Further research is needed, but first analysis show that the combined use of grid and resistograph data offers good prospects for a realistic spatialization and cartography of snow avalanche hazards

B2.11

B2.11 Oral

Spatial reconstructions of snow avalanche frequency and extent using tree rings in Parc National des Ecrins, French Alps

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Snow avalanches periodically damage infrastructure, disrupt transportation corridors or even cause loss of life in many part of the Alps. Nonetheless, the spatial behavior of past avalanche activity and the analysis of areas affected during particular events remain often imprecise. It was therefore the purpose of this study to reconstruct spatio-temporal patterns of past avalanche activity on a forested avalanche talus in the French Alps. 232 larches with clear signs of snow wasting events were analyzed and growth disturbances (GD) related to avalanche activity assessed, such as tangential rows of traumatic resin ducts, the onset of reaction wood or abrupt growth suppression or release. In total, 901 GD were identified in the tree-ring samples, indicating that 20 different high-magnitude avalanches occurred between 1919 and 1994. The mean return period was ~3 years with a ~34% probability that an avalanche occurs in any particular year. Interpolated maps allowed for explicit spatial estimates of return periods throughout the talus, showing a rapid increase of return frequency from 2.5 to 50 years with increasing distance from the talus apex. The distribution of avalanche years seems to be quite homogeneous in time with a gap between 1951 and 1961 and since 1994. Snowfall from a nearby meteorological station indicated that the five most recent high-magnitude events on record resulted from above-average snowfall anomalies associated with abnormally low air temperatures. Findings suggest that a strong temperature-gradient metamorphosis could explain the occurrence of high-magnitude snow avalanches.

B2.12 Oral

B2.12

The dendrochronological age of ancient timbers of Casa de la Moneda (Segovia, Spain) and its relationship with historic flood events

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In the course of restoration work on the Casa de la Moneda in Segovia (Spain), considered to be the world's oldest industrial building still standing, floorboards were discovered between the old channel of the late sixteenth century, and the most recent, built in the last third of the eighteenth century. Using dendrochronological techniques, we have studied numerous samples of beams and planks, which constitute the platform.

Precise dating of these materials has been possible thanks to the survival of ancient trees over a period of more than 400 years, in the upper mountain forest near the city. The tree-ring sequences of these trees, previously studied and published in other works, have enabled the use of cross-dating techniques with the nearest master chronologies, achieving great success in estimating the age and date of felled trees used in platform. Moreover, documentation from those times indicates that this floorboard wood has been replaced on a number of occasions, generally because of damage caused by single events of flooding. Furthermore, the age distribution of beams and planks provides novel data on the record of the most destructive flood events in the region, a subject very little explored until now in Spain.

B2.13

B2.13 Oral

Snow avalanche records in the central Pyrenees

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A series of major snow avalanche winters in the recent past is causing a growing interest in expanding the knowledge on return periods of high magnitude avalanches in the Pyrenees. A previous study confirmed the occurrence of three major avalanche seasons in the southeastern sector of this mountain range during the last four decades. In other sectors of the Pyrenees, information is still scarce. For this reason, a multiple approach investigation to date, map and describe past avalanche events has been carried out in the central sector (project AVDENPYR 2007–2010, Spanish Ministry of Science and Innovation, CGL2007–62614: Snow avalanche reconstruction using dendrochronological analysis in the Pyrenees). Four selected avalanche paths were studied in the Aragonese Pyrenees (central Pyrenees) using the dendrogeomorphological method developed in a preceding project. Evidence from past snow avalanche events was provided by means of the dendrochronological dating. At the same time, interviews with local people and a systematic research in historical documents were carried out. Also, by combining terrain inspection, comparison of aerial phototographs taken in different years, and dendrogeomorphological mapping, detail maps of these avalanche paths were delivered. This integrated research allowed to date past avalanche winter seasons and to compare them with previously known avalanche years in other sectors of the Pyrenees.

B2.14 Oral

Dendroecological study of disturbances in the natural *Picea abies* forest “Paranglitsa” in Bulgaria

B2.14

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We present results from a disturbance history study of the pristine Norway spruce forest “Parangalitsa” in Rila Mountains, Bulgaria. The 240 ha forested territory was declared a strict nature reserve in 1933. Before that, it was protected from cuttings and therefore presents a unique opportunity to study natural dynamics in a European mountain *Picea* - dominated ecosystem. We mapped the study area by delineating windthrows and other internally homogenous forest patches using aerial photographs from 1966 and 1997. In each patch, we reconstructed disturbance history using dendrochronological methods. We collected above 600 cores with increment borers from trees on borders between patches and from the largest trees within them. We prepared, measured and processed the cores following standard procedures, recorded two categories of growth releases or decreases and the patch origin years. After windthrows, we found species-specific reactions in the tree-ring growth patterns related to the social status of the trees. While suppressed *Picea* and *Abies* trees displayed clear releases, survival dominants and *Pinus sylvestris* individuals were often suppressed due to crown damages. Windthrows that led to the creation of single-cohort forest patches happened in the 1840-s, 1863, 1873, 1883, 1895, 1898, 1902 and 1911. More recent windthrows occurred in 1962, 1971 and 1983. These events also triggered endemic tree falls and bark-beetle attacks and contributed to numerous small-medium scaled gaps in the following decades. These various disturbances on different scales have formed a complex mosaic of forest patches with different ages and heterogeneous forest structure.

B2.15

B2.15 Oral

Dendrochronological study in the Terekhol Basin, Southern Siberia, Russia

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The Por-Bajin fortress is an Early Medieval (middle 8th century AD) archaeological monument located on a small 6-ha island in the Tere-Khol Lake (1300 m above the sea level), the Terekhol Basin, Southern Siberia (50°36'54" N, 97°23'07"E). The island is characterized by permafrost conditions and is subjected to thermal denudation now, which makes a potential threat to the monument. Evaluation of island bank destruction reasons and rates is necessary to elaborate protection measures. In this study we used the dendrochronological method to inquire into the two important problems: 1) reconstruction of climatic and hydrological conditions in the lake catchment in the last 200–250 years as a background of the island destruction; 2) evaluation of major natural drivers of tree-ring growth necessary for landscape dynamics study in the area around the lake. High variability of tree-ring growth in the Terekhol Basin results from variable local landscapes that transform regional climatic signal. Tree-ring growth in watersheds is sensitive to temperature and permafrost conditions. Decrease of precipitation results in decline of tree-ring growth in the lake area. In the last 100 years precipitation demonstrated decadal-scale cyclicity: increased humidity in the middle 20th century with the highest lake levels during 1947–1954, and sharp drop of moistening since 1970. To understand landscape dynamics we have studied tree-ring growth in various geomorphic positions against regional (climate) and local (permafrost, etc.) driving factors and competition in the ecosystem. The research was supported by the Russian Foundation for Basic Research (projects 09-05-00351-, 08-05-00152-a).

B2.16 Oral

External factors influence on tree growth at the northern timberlines at Kola Peninsula and Northern Lapland

B2.16

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The paper deals with an analysis of the external factor (solar activity, volcanic eruptions) influence on tree growth at high latitudes. We analysed a 461-year record of *Pinus sylvestris* L. (Scots pine) collected nearby the northern timberline (68.63 N; 33.25 E) at the Kola Peninsula, northwestern Russia. As well known the climatic impacts of solar and volcanic activity vary regionally, and major volcanic eruptions do not always result in regional cooling. A response of tree growth at the Kola Peninsula to climatic changes due to solar variability and volcanic eruptions was revealed. For example, Dalton minimum of solar activity (1801–1816 AD) and Laki (1783 AD) and Tambora (1815 AD) volcanic eruptions appeared to cause the greatest ring-width reduction and cooling. Intervals with an absence of significant volcanic eruptions correspond to intervals of increased ring-width values. A superposed epoch analysis of 19 large (Volcanic Explosivity Index, VEI>5) volcanic events revealed a significant suppression of tree growth for up to 8 years following volcanic eruptions. The similar effect (supression of tree growth after powerful volcanic eruptions) was obtained under analysis of Finnish supralong chronology (~7,500 years) at the same latitude in Finnish Lapland. Our results documenting the regional climatic impacts of solar and volcanic activity permit us to understand the dynamics of the climate system and its response to external forcing.

This work is financially supported by grant from Russian Foundation for Basic Research (grant No. 09-04-98801), by the Program of the Russian Academy and by the Regional Scientific Program of Murmansk region.

B3.01

B3.01 Invited

Stable isotopes of tree rings as a tool to pinpoint the geographic origin of timber

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Deforestation and forest degradation account for about 20% of world's greenhouse gas emission. Illegal logging is a major cause of worldwide deforestation, and demands for scientific methods to identify the geographic origin of timber are increasing. "Dendro-provenancing" is one such method, in which the origin of unknown wood is estimated by calculating correlations of the ring-width series of the unknown wood with reference trees of known geographic origins. We applied the dendroprovenancing method to carbon isotope network data of pinyon pines (*Pinus edulis* and *Pinus monophylla*) from the Southwestern United States to test the efficiency of using stable isotope time series for provenancing wood. First, we calculated correlations (*t* values) between test trees temporarily assumed to be of unknown origin and reference trees from 13 surrounding sites. Then we plotted the *t* values on a map. When provenancing was successful, the tested trees showed the strongest correlation with reference trees from sites close to the actual origins of the test trees, and the correlations decreased with the distance between the original sites of test and reference trees. This conical distribution of *t* values enabled provenancing of wood with 114–304 km precision. Although isotope measurement is more expensive and laborious than ring-width measurement, our tests of provenancing pinyon pines in the Southwestern United States showed higher success rate with carbon isotopes (Kagawa & Leavitt 2010, Journal of Wood Science *in press*). Preliminary results of teak (*Tectona grandis*) provenancing from Southeast Asia using the "isotope dendroprovenancing" method will be also presented.

B3.02

B3.02 Oral

Laser microdissection-flash-pyrolysis-GC-IRMS: A new method for rapid analysis of intra- and interannual variations of ^{13}C and ^{18}O in tree rings

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We present a rapid technique for high precision sampling and determination of $\delta^{13}C$ and $\delta^{18}O$ in tree-rings, combining laser microdissection (LMD), flash pyrolysis (FP), gas chromatography (GC) and isotope ratio mass spectrometry (IRMS) (LMD-FP-GC-IRMS). The LMD-FP-GC-IRMS method is based on a two step process. The first step comprises precise laser microdissection of whole tree-rings or parts thereof from cross sections of 180 to 600µm thickness. The use of a LMD microscope (LMD 7000, Leica Microsystems, Wetzlar, Germany) makes it possible to distinguish between relevant (e.g. earlywood, latewood) and non-relevant cells or tissues (i.e. woody rays, resin ducts). Areas of interest are selected by software, excised from the surrounding tissue by a thin UV-laser beam, and collected by gravity into series of specialized crucibles placed on an automatically movable tray for further stable isotope analysis. In the second step sample containing crucibles are placed into seperate reaction vessels that are sealed with caps with septum allowing the injection of helium for purging and transfer of sample gas into the GC-IRMS. Up to 200 samples/reaction vessels can be placed onto a user-programmable autosampler coupled online to a GC-IRMS. Sample gas (CO) is produced by flash pyrolysis at 1600–1700°C utilizing an inductive heating system. $\delta^{13}C$ and $\delta^{18}O$ can be measured on the same sample, since all samples are pyrolyzed individually and no memory effects or contamination from preceeding samples can occur as it is common using conventional EA or TC/EA techniques. The new method is more precise, faster and also cheaper since consumables, like tin or silver capsules are no longer necessary.

B3.03

B3.03 Oral

The influence of atmospheric circulation patterns on the oxygen isotope ratio in precipitation and tree rings

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The oxygen isotopic composition of precipitation as recorded in ice cores and cellulose of tree rings is often used as indicator of past temperatures. Such records have greatly improved our knowledge about the temperature history of our planet on various spatial and temporal scales. However, $\delta^{18}O$ of precipitation is a complex proxy, determined by multiple processes in the hydrological cycle, governed by atmospheric circulation. Even many more additional isotope fractionations processes in the trees determine the tree-ring cellulose archive, making a straightforward climate interpretation difficult. In this study, we assessed statistical relationships between the frequency of different synoptic weather situations and the oxygen isotopic variability in time series of precipitation and tree rings for several sites in Switzerland. The frequency of cyclonic conditions (i.e. low pressure situations) during July and August proved to be a strong predictor of the isotopic composition. By creating an index that combines the influence of temperature and the occurrence of cyclonic conditions, we estimated $\delta^{18}O$ of precipitation and fed this information into a Craig-Gordon type enrichment model to calculate tree-ring $\delta^{18}O$. While the model to data agreement is encouraging (R^2=0.41), the perspectives for reconstructing temperature from $\delta^{18}O$ of tree rings still are limited, because this parameter integrates the combined influence of temperature, air pressure and relative humidity.

B3.04 Oral

Biases and trends in long-term isotope data from the Spanish Pyrenees

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Tree-ring stable isotopes became important estimators of environmental change. Potential biases inherent to these parameters, including age-trend and level offset, are, however, not well understood, but might alter the long-term behavior of derived timeseries. We here address these biases by introducing a dataset of decadally resolved $\delta^{18}O$ and $\delta^{13}C$ measurements from 25 pine trees in the Spanish Pyrenees spanning the past millennium. The analytical design – decadal resolution but single-tree-measurements – of this dataset enables analyses of age-related noise largely independent of climatic influences, as trees germinated throughout the past 11 centuries. Alignment of these data by biological age reveals age-trends over the first one to four centuries after germination. On average, isotope values change by -0.089‰ $\delta^{18}O$ and +0.064‰ $\delta^{13}C$ per decade over the first 100 years. This trend persists into the forth century after germination for $\delta^{18}O$, but diminished to ~0‰ over the 100–390 year period for $\delta^{13}C$. We also find substantial level offsets up to 7‰ $\delta^{18}O$ and 3‰ $\delta^{13}C$ between single trees, which together with the identified age-related noise necessitate detrending of isotope data for climate reconstruction purposes.

B3.05

B3.05 Oral

Stable C and O isotopes in tree physiology for the interpretation of tree ring data

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In dendrochronology the use of stable C and O isotopes is established as a complementary tool to reconstruct past climate courses. As trees are living organisms their physiology responds to changes in the environment, which his reflected in the isotopic composition of the biomass. During photosynthetic carbon uptake (P_N) ^{13}C is discriminated against ^{12}C leaving the biomass depleted in ^{13}C relative to the atmospheric CO_2, while the oxygen isotope (^{18}O) is enriched relative to the source water. Environmental impacts modify the ^{13}C depletion and ^{18}O enrichment in the organic matter, depending on P_N and the stomatal conductance (g_l). Both variables are strongly influenced by ambient humidity, CO_2 concentration, water and nutrient availability, and indirectly by temperature (via vapor pressure Deficit (VPD)). The combined use of the two isotopes along with tree ring width allows the identification of the coherence between the physiological mechanisms and the environmental parameters, which cause the modifications of the isotope ratios and tree ring width. In this presentation we demonstrate the use of the leaf water enrichment models (Craig & Gordon and Peclet effect) and a conceptual model, where the combination of the C and O isotope ratios and tree ring width allow the distinction whether photosynthesis or stomatal conductance dominate the isotopic variation. The evaluation of environmental impacts will be discussed with the focus on increasing CO_2, using measured data.

B3.06 Oral

A millennial length stable isotope chronology for arctic Sweden (Torneträsk)

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Trees growing close to the boreal tree line in northern Sweden have been shown to record inter-annual variations in growing season conditions within the physical properties (width and relative density) of their annual growth rings. Until recently, the nature of the isotopic response of these trees had yet to be investigated.

A replicated stable isotope based reconstruction for the last 1,000 years is presented for Arctic Sweden and compared in relation to recent (20th Century trends) and other proxy-based reconstructions for this region. Issues of chronology development, signal preservation and the potential for "age" trends in tree-ring stable isotope data are also considered.

B3.07 Oral

Reconstructing the climate of Scotland using stable carbon and oxygen isotopes in *Pinus sylvestris* L. (Scots pine)

B3.07

Ewan Woodley[1], Neil Loader[1], Iain Robertson[1], Danny McCarroll[1], Timothy Heaton[2]
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In order to better constrain future climate predictions, it is essential to minimise error in palaeoclimate reconstructions and understand how climate behaves at different temporal frequencies. Recent decades have witnessed a large expansion in the number and spatial distribution of dendroclimatic reconstructions across Europe, particularly in high altitude and high latitude regions. Nonetheless, there remain areas (such as Scotland) where high-resolution palaeoclimatic coverage is comparatively weak. The less extreme, temperate maritime climate of Britain results in a complex combination of factors determining tree-ring width. However, stable carbon and oxygen isotopes from Scots pine may provide additional climate information in such regions. Annually-resolved stable carbon and oxygen isotope chronologies have been constructed for Southern Glens (Western Scotland), spanning the period AD 1650–2007. Results suggest that a significant relationship exists between stable carbon isotopes (Southern Glens) and both mean temperature (Tiree, Western Scotland) ($r = 0.65$; $P<0.01$) and total sunshine hours (Scotland composite) ($r = 0.58$; $P<0.01$) for July–August (AD 1950–2000). This research will extend palaeoclimate coverage in Scotland, as well as providing comprehensive information on the mechanistic controls on both stable carbon and oxygen isotopes within Scots pine trees growing at less climatically extreme sites.

B3.08

B3.08 Oral

Age related growth trends in the tree-ring archive: A case study from *Pinus sylvestris* L. in north-western Norway

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Swansea Univeristy, Swansea, United Kingdom

The measurement and interpretation of stable isotopes in natural plant-based archives such is an increasingly important and rapidly developing branch of palaeoecology. The measurement of stable carbon ($\delta^{13}C$), oxygen ($\delta^{18}O$) and non-exchangeable hydrogen ($\delta^{2}H$) isotope ratios have all been used successfully for palaeoclimatic research, and such studies have informed our understanding of past environmental variability and plant response to environmental change. The need to develop more rapid methods for reliable stable isotope analysis have led researchers to investigate the potential for simultaneous determination of stable carbon and oxygen isotopes from cellulose pyrolised on-line to carbon monoxide (CO). Several small-scale studies have demonstrated that this may indeed be possible and where reliable values for both $\delta^{13}C$ and $\delta^{18}O$ are attainable through simultaneous measurement, sample throughput would improve by ca. 100%. We expand upon studies by comparing >2500 $\delta^{13}C$ results from the cellulose of individual annual tree-rings, produced by both pyrolysis and combustion in combination with discrete test results. We find that $?^{13}C$ values produced simultaneously with $?^{18}O$ by pyrolysis are numerically similar enough to those produced from combustion to be used with confidence for reconstructing palaeoclimatic variables. Care should, however, be taken with the choice of standard materials and scaling may be required, especially when results from low (ca. 1100°C) and high (ca. 1400°C) temperature setups are compared. It is also advisable to run a test set with both combustion and pyrolysis where new materials are analysed or hardware setups are employed.

B3.09 Oral

Long-Term Changes in Water Use Efficiency Across Europe

David Frank
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Numerous free-air CO_2 enrichment and laboratory experiments have been performed to reveal plant reaction to anthropogenic CO_2 emissions, including possible increases in productivity and water use efficiency (WUE). These experiments however tell little about how natural forests have responded to the ongoing CO_2 increase from 280–390 ppmv over the past 150 years. To do this, we employ annually resolved $\delta^{13}C$ measurements from a continental network of more than 20 evergreen and broadleaf forest sites covering Europe to reconstruct changes in intercellular CO_2 concentrations over the past centuries driven by (i) climatic variation and (ii) the long term increase in atmospheric CO_2. We detect a mean discrimination response to increasing CO_2 concentrations of 0.0085 ± 0.0033 $\delta^{13}C/\Delta$ CO_2 (in ppmv). However, the physiological response is stronger in coniferous than broad-leaf species, and correspondingly suggest greater increases of WUE in the evergreens. Our differentiation of isotopic variation due to CO_2 increase as well as climatic variation suggests that conventional approaches that do not consider climate variation tend to over estimate past WUE increases. Results offer widespread empirical support for changes in the terrestrial evapotranspiration regimes, but cannot yet contribute to the discussion of increases in productivity.

B3.10

B3.10 Oral

Climate signals in stable isotopes of *Juniperus excelsa* from Turkey back to 1025

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Turkey is located in the eastern Mediterranean which experiences repeatedly extreme and persistent droughts, heat episodes and limited water resources. Water availability is an increasingly sensitive topic in a region which faces growing human populations and limited water supplies at the same time. A better comprehension of the natural hydrological variability is of great importance as it will help to better predict the regional climate variability and to find a sustainable management of regional water resources. Dendroclimatological studies making use of the stable isotope ratios in tree rings have not been conducted in Turkey yet. We present the first multicentennial carbon and oxygen stable isotope series from Turkey, measured in tree rings of *Juniperus excelsa* M. Bieb. from the hinterland mountain area near Antalya.

We show that $\delta^{13}C$ and $\delta^{18}O$ in tree rings are useful proxies to reconstruct climate in Turkey and that they have good potential for further palaeoclimatological investigations. Different tree-ring parameters contain separate climatic signals. While $\delta^{13}C$ correlates best with Jan-May temperatures, $\delta^{18}O$ correlates well with scPDSI which leads to the assumptions of a distinct summer drought signal.

The reconstructions of the drought index (scPDSI) and the winter/spring temperatures (Jan-May) suggest that during the last 100 years Southwest-Turkey has experienced wetter summers and also that there is a long-term trend towards lower spring temperatures. Effects of the MWP and LIA can be found in the temperature reconstruction.

B3.11 Oral

The use of carbon and oxygen stable isotope data in tree-rings for dendroecological studies in Siberia (Russia)

B3.11

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As a complementary field of dendroecology and dendroclimatology, stable isotope analysis in tree rings has a large potential. However, in Siberia tree-ring isotope studies were initiated quite recently and only a few data are available for this vast territory. To understand advantages of using the isotope data in Siberia, we analyzed tree-ring width, density and ratio of stable isotopes ($^{13}C/^{12}C$, $^{18}O/^{16}O$) in larch trees growing in different vegetation zones in Siberia. The data were obtained for four sites located along the regional temperature gradient to cover the territory of natural distribution of larch at low elevations from the northern (72°N) to southern boundaries (54°N): further to the south larch can be found only in mountains.

Dendroclimatic analysis of the chronologies indicates carbon isotope data to be the only parameter providing information on July and/or summer precipitation at all the sites. In the south where the role of precipitation becomes especially significant for tree-ring growth and isotope fixation, $\delta^{13}C$ and $\delta^{18}O$ show the highest relations to summer precipitation. Moreover, the combination of isotope data provides additional information on environmental changes. Thus, an increasing trend in $\delta^{13}C$ and decreasing one in $\delta^{18}O$ chronologies observed in the southern Taiga indicate an increase of anthropogenic impact on tree growth since 1850. In the northern Taiga, changes in correlations between C and O isotope ratios testify a possible water shortage for the last half century. Our study shows that combining different tree-ring parameters obtained for the same sites/trees can provide more information than simple correlations with climatic variables.

B3.12

B3.12 Oral

Stable isotopes in tree rings as indicator of climatic and environmental changes in high-latitude and -altitude regions

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Trees growing at treeline sites are very sensitive to climatic and environmental changes due to limiting temperature regimes. Tree-ring width and tree-ring density provide summer temperature information, but no significant relationship with precipitation could be identified. The application of stable isotope analysis in combination with classical dendrochronology provides complementary information about climatic variability.

A spatial description of climatic changes along high latitude northeastern Yakutia (70N, 148E), eastern Taimyr (70N, 103E), Central Evenkiya (64N, 100E), and high altitude Siberian Altai (49N, 86E), and the Alps, Loetschental (46N, 8E) is presented based on a larch tree ring width index, latewood density, $\delta^{13}C$, $\delta^{18}O$ of cellulose chronologies for the period 1900–2006 and selected extreme periods of the last 1500 years. The climatological analysis revealed that the stable isotope data (C, O) shows a significant relationship with July and August precipitation, which is not observed in tree ring parameters for all studied sites.

To investigate common large-scale climatic patterns along the high-latitude and high-altitude gradients we used available stable isotope chronologies from northern Scandinavia and $\delta^{18}O$ ice core chronologies from Greenland (GISP2) and from Siberian Altai (Belukha glacier).

For extreme periods, characterized by major stratospheric volcanic eruptions, we observed strongly decreasing tree-ring widths, latewood densities and stable isotope values after each event. This might be caused by an increase of relative humidity, which resulted in higher stomatal conductance and lower photosynthetic capacity due to reduction of solar radiation and temperature and increased cloudiness.

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B3.13 Oral

Dendrochronology and metal deposition in tree rings of baldcypress (*Taxodium distichum*) growing in wetlands in south Louisiana, USA

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Baldcypress (*Taxodium distichum*) is a deciduous conifer that grows in wetlands in the southeastern United States. The species has been shown to be useful as a bioindicator of metal contamination of wetlands. We cored baldcypress trees, crossdated, measured annual rings and constructed a baldcypress tree-ring chronology from trees growing in a swamp bordering the Mississippi River in southern Louisiana. The swamp had been polluted by a nearby hazardous waste facility and other industries. Birds nesting nearby had been found to have higher levels of metals compared to those living near a reference area, but various fish species had not.

Stinking Bayou, a waterway on the northwest shore of Lake Pontchartrain, served as a reference area to provide background levels of metals in baldcypress trees in the region. We analyzed the levels of nickel (Ni), copper (Cu), chromium (Cr), manganese (Mn), and iron (Fe) in the tree rings from both swamps using x-ray fluorescent spectrometry and compared the levels of metals in tree rings from the contaminated and uncontaminated swamps.

B3.14

B3.14 Oral

Reconstructing hydro-climate during the last two centuries in the northeastern Canadian boreal forest using carbon and oxygen dendroisotopes

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In this research project, dendroisotopes are studied to support the sustainable management of the La Grande river basin, in the context of hydropower production. Our objective is to reconstruct quantitatively over the last 200 years, the main variables involved in hydrologic forecast models. Four to five individual $\delta^{13}C$ and $\delta^{18}O$ series, covering the period of 1800–2004, were produced for three old-growth black spruce stands. The $\delta^{18}O$ results show a strong co-variation between all sites indicating that oxygen isotopes express an important regional component. For the $\delta^{13}C$ series, slight inter-tree and inter-site differences suggest the influence of local conditions. However, the good correspondence of the long-term trends indicates that regional conditions also play an important role. Statistical tests show that $\delta^{18}O$ values directly reflect summer temperatures (r=0.65) but also correlate inversely with water inflow during the July–November period (r=-0.63). $\delta^{13}C$ values correlate with late summer maximum temperatures (r=0.61) and with a summer climatic index integrating temperature and precipitation effects (r=-0.61). Because $\delta^{18}O$ and $\delta^{13}C$ values are sensitive to climatic variables that are linked and commonly associated in typical subarctic climate ambiances (warm-dry, cold-wet), the patterns of their joint response show a higher sensitivity to climatic parameters. The reconstructed series indicate that the first half of the 19th century was the coldest and the wettest period in the past 200 years and that a steadily change throughout milder and dryer conditions started in the early 1940's. These trends are consistent with other reconstructed values from independent proxies available for the same region.

B3.15 Oral

Evaluating the integrity of isotopic series in fossil wood deposited in Northeastern Canadian lakes – Preliminary work for reconstructing millennium climatic series

B3.15

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Extending climatic series back to the first millennium using isotopic tree-ring chronologies represents a challenge because trees in northern regions seldom reach the adequate age. Fossil trees imprisoned in lake sediments could serve such an endeavour provided that dating the tree-ring series is possible and that the isotopic ratios of fossil wood are preserved. We collected segments of *Picea mariana* specimens covering the 800–2000 period A.D. from a lake located in the north-central boreal forest of Quebec, with the ultimate objective of reconstructing a millennium-long climatic series for that region. Here we propose to validate the fossil series by comparing carbon and oxygen isotope of cellulose and lignin with the isotopes of a living tree. We consider a systematic difference of the ratios ($\Delta\delta^{13}C_{cel\text{-}lig}$, $\Delta\delta^{18}O_{cel\text{-}lig}$) as indicative of isotopic integrity of the fossil specimens.

The results obtained for 23 tree-ring pairs from the living tree and compared with those of 24 pairs from a single sub-fossil stem of the 19th century indicate well preserved isotopic signals. The $\Delta\delta^{13}C_{cel\text{-}lig}$ values of the living (3.7±0.3‰) and sub-fossil trees (3.5±0.3‰) are systematic and matching. The $\Delta\delta^{18}O_{cel\text{-}lig}$ measurements in the living tree are not as coherent as the one obtained for carbon, and show much broader variations (13±1‰). However, the measurements in the sub-fossil stem fall in the same range (12.9±0.9‰) and therefore express a high degree of oxygen isotope ratio preservation. These results are promising and our study now involves evaluating the isotopic integrity of fossil trees from the 14th and 11th centuries.

B3.16

B3.16 Oral

A comparison of stable carbon and oxygen isotopes in tree rings and Sphagnum mosses from the Canadian Arctic

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In this study we compare the ring width of white spruce (*Picea glauca*) with the stable carbon and oxygen isotopes in the tree ring cellulose as well as in Sphagnum fuscum mosses growing in hummocks in the discontinuous permafrost zone in west central Canada. Observed meteorological data from surrounding weather stations are used to determine the controlling climate parameters. As there is a large number of climatic and environmental factors influencing the stable isotopic composition of tree ring and peat cellulose, this multi-proxy study was initiated to shed light on the underlying mechanisms controlling the fractionation processes and with that, to enable us to improve climate reconstructions that are based on stable isotopes in tree rings and peat. Carbon isotopes in the analyzed Sphagnum fuscum plants show high correlation with summer temperatures over the past c. 20 years, whereas the oxygen isotopes are related to both summer temperatures and precipitation and are probably indicative for changes of the source regions of the moisture as well (Kaislahti Tillman et al., 2010). The analysis of tree ring isotopes is ongoing and will be extended further into the past, back to c. AD 1850. Similar studies from subarctic Canada and Russia show that influencing factors for the isotopic fractionation are mainly summer temperature and winter precipitation (Holzkämper et al., 2008).

References

Holzkämper, S, Kuhry, P, Kultti, S, Gunnarson, B E and Sonninen, E, 2008. Stable isotopes in tree rings as proxies for winter precipitation changes in the Russian Arctic over the past 150 years. Geochronometria 32: 37–46.

Kaislahti Tillman, P, Holzkämper, S, Kuhry, P, Sannel, B, Loader, N J and Robertson, I, 2010. Stable carbon and oxygen isotopes in Sphagnum fuscum peatfrom subarctic Canada: implications for palaeoclimate studies. Chem. Geol. 270: 216–226.

B3.17 Oral

B3.17

Hydroclimate variations and $\delta^{18}O$ of precipitation recorded by tree-ring cellulose $\delta^{18}O$ of different tree species from different environment in semi-arid Northern China

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Tree-ring cellulose oxygen isotopic ratios ($\delta^{18}O$) in different three species from different two stand environment were determined in semi-arid Northern China from 1954 to 2003. They present the common inter-annual variability, irrespective of the tree species or stand environment, which is highly correlated positively with temperature and negatively with precipitation and relative humidity in growing season, although there is a significant change in temperature correlation between 1954–1978 and 1979–2003. This suggests that the past summer hydroclimate can be consistently reconstructed by tree-ring cellulose $\delta^{18}O$ from various kinds of trees growing in the semi-arid Northern China. In addition, we evaluated past changes in $\delta^{18}O$ of precipitation from the obtained parameters using the mechanical model for tree-ring cellulose $\delta^{18}O$ in Roden et al. (2000). By setting the species-dependent exchange rate (fo) between carbohydrate and xylem water oxygen as 0.59 and 0.47 for Larix principis-rupprechtii Mayr and Picea koraiensis, we could re-construct the variations of precipitation $\delta^{18}O$ consistently from the different tree species, which are similar with observed $\delta^{18}O$ of precipitation during 1985–2002, too. Although the reconstructed $\delta^{18}O$ of precipitation does not have any significant relationships with local temperature or precipitation during 1954–2003, its long-term variation pattern is similar with the East Asian Summer Monsoon (EASM) index and $\delta^{18}O$ of stalagmites, suggesting that $\delta^{18}O$ of precipitation is not controlled by local meteorology but influenced by large scale atmospheric circulations.

B3.18

B3.18 Oral

High-frequency signals in millennial stable isotope series from the Tibetan plateau

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Although long-term trends of temperature and precipitation are of concern for human society, changes in the frequency and intensity of extreme climatic events are of greater relevance to cope with changing in regional environmental conditions. In this study, we present multi-centennial to millennial stable carbon and oxygen isotope series from juniper (*Juniperus tibetica*) and spruce trees (*Picea balfouriana*) from the south-eastern part of the Tibetan plateau. The region is of high climatic sensitivity and plays an important role in the control of the South Asian monsoon circulation system. The three study sites are located near the upper timber line and are aligned along a 800 km long transect along a moisture gradient from cool and moist conditions in the river gorge region to the dry and warm climate of the steppe forests in southern Tibet. The easternmost site is mainly dominated by the East Asian branch of the summer monsoon circulation whereas the westernmost site is controlled by the Southwestern branch of the summer monsoon. Thus, both monsoons cause a characteristic seasonal change in the regional climate, which should manifest itself in the stable isotope ratios of wood cellulose. After identification of high-frequency signals implemented in the isotope series, spectral analyses and cross-wavelet analyses were performed to detect changes of the influence of ENSO, severe droughts or volcanic eruptions. Finally, our results were verified by a comparison with regional historical documents of extreme events.

B3.19 Oral

The potential of tree rings and stable isotopes from East to West Africa

B3.19

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There is a growing need to develop long-term regional climate data for proactive adaptation management of climate change risk. However, in Africa, long term climate information are still sorely lacking today. Tree rings and stable carbon isotopes ($\delta^{13}C$) have the potential to provide empirical data of past climatic events. Our results from Acacia savannah woodlands in Ethiopia demonstrated the potential of tree ring width and $\delta^{13}C$ in tree rings to reflect physiological responses to environmental changes and drought years as a tool for paleoclimatic reconstructions. High correlations (up to $r = -0.82$) were found between the $\delta^{13}C$ chronologies and precipitation data, which demonstrates their potential to reconstruct precipitation in the semi-arid tropics. In this context, we extend the study to East Africa in Tanzania (Miombo woodland) and West Africa in Burkina Faso (Sahel region). Samples from common co-occurring agro forestry species, *Sclerocarya* birrea and *Pterocarpus angolensis* were collected from both sites. First results indicate formation of tree rings in both species characterized by parenchyma bands and density variation, respectively. The main purpose of the study is to establish large-scale correlation patterns between tree growth, precipitation and temperatures in order to explore regional processes. These findings could help in the identification and interpretation of extreme environmental and climatological events and the way societies and ecosystems respond to them in longer term records, for which no historical/meteorological records are available.

B4.01 Invited

Fire history of the Giant Forest, Sequoia National Park

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Giant sequoias of the Sierra Nevada California, USA preserve an extraordinarily detailed and lengthy record of forest fires within their tree rings. From the late 1980s to the early 1990s we collected partial cross section samples from about 150 giant sequoia stumps, logs, and snags. Crossdating of the tree-rings and fire scars resulted in fire histories from 6 extant sequoia groves extending back more than 2,000 years before the present. We reported regional fire occurrence patterns and associations with climate in earlier papers. In this presentation we will describe a detailed study of the largest collection from a single grove – the Giant Forest of Sequoia National Park. This record extends back more than 3,000 years, and to the best of our knowledge is the longest continuous tree-ring based fire history in the world. Both profound and subtle changes in fire frequency, seasonality, and extent are evident in the Giant Forest fire chronology. Drought and temperature variations explain substantial portions of the fire regime variations. Fire frequency minima occur in the early first millennium and after AD 1850, and strong maxima are evident during the height of Medieval Warm (Drought) Period of the 10th through 13th centuries. We will evaluate and discuss the implications of these spatial and temporal patterns of fire and climate in the context of today's changing climates.

B4.02 Oral

Fire-climate interactions in the American West since 1400 CE

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Despite a strong anthropogenic fingerprint on 20th century wildland fire activity in the American West, climate remains a main driver. A better understanding of the spatio-temporal variability in fire-climate interactions is therefore crucial for fire management. Here, we present annually resolved, tree-ring based fire records for four regions in the American West that extend back to 1400 CE. For this purpose, we selected for each region fire-scar records from individual trees that were recording fire prior to the year 1500. Fire years in all regions were characterized by widespread yet spatially explicit summer droughts. Moreover, fire years in the Interior West and Southwest (SW) were affected by the El Niño Southern Oscillation (ENSO) pattern, with 76% of the largest fire years in SW occurring in La Niña years (1400–1850). Overall fire activity was high in late Medieval times, when much of the American West was affected by mega-droughts. A distinct decline in fire activity in the late 16th century corresponds with anomalously low temperatures during the Little Ice Age and a decline in Native American fire use. The high spatiotemporal resolution of our fire record discloses a frequency-dependent climatic influence on wildfire regimes in the American West that needs to be accounted for in fire models.

B4.03 Oral

Testing the pyroclimatic hypothesis for Mt.Irish, Nevada, USA

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One of the most controversial issues in studies of past environmental changes is the lack of a true hypothesis-testing approach. Records are derived from paleoarchives without explicit expectations, making most analyses ad-hoc and a-posteriori. In this talk, I attempt to describe a possible way to address this conundrum with regard to fire-climate interactions derived from tree-ring records. In the Great Basin region of western North America, records of past climate and wildfire variability are needed not only for fire use, but also for understanding the mechanisms behind the century-long expansion of piñon-juniper woodlands. The Mt. Irish area (Lincoln County, south-eastern Nevada) is a remote ecosystem on the hydrographic boundary between the central Great Basin and the Colorado River Basin, but well within the floristic Great Basin. Ponderosa pines and single-leaf piñons are present at the area, and non-scarred dominant trees were used to develop a tree-ring reconstruction of drought (mean PDSI for May–July, NV Clim. Div. 3) from 1396 to 2003. A hypothetitical fire regime obtained from the PDSI reconstruction and from some assumed relationships between climate and fire was developed and presented prior to obtaining any fire-scarred samples. Fire-scarred ponderosas found at the area were then sampled to determine wildfire history. The actual fire record was developed solely based on crossdated fire-scar samples, independently of the pre-existing pyroclimatic model. By comparing the "expected" to the "observed" record of fire history, further insight can be obtained on climate-wildfire relationships.

B4.04

B4.04 Oral

Fire activity in Scandinavia during 1500–1900

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Separating the natural, climate-related signals from the human activity related signals in fire chronologies presents one of the major problems in the interpretation of site disturbance histories. In the boreal zone, fire was common both as the main factor driving forest dynamics and as an agricultural tool used to clear the land and grow food for people and their domesticated animals. As a result, fire chronologies contain a mix of information that reflects both climate variation and differing land-use regimes, complicating their interpretation. In this study we use a network of sites with spatial reconstruction of past fire histories to separate climatically controlled (temporally synchronous within a study area) fires vs. non-climatic (non-synchronous and typically small) fires. By using this simple conceptual model, we discuss long-term trends and within-regional variation in historical fire activity over Scandinavia.

C1.01 Invited

A Tale of 10,000 trees – The Northwestern North American Tree Ring Synthesis

Martin Wilmking[1], Glenn Patrick Juday[2], Yongxiang Zhang[1], Alix Claire[3], Anchukaitis Kevin[4], Barber Valerie[2], Edward Berg[5], Buckley Brendan[4], Bunn Andrew[7], Danby Ryan[8], D'Arrigo Rosanne[4], Hogg Ted[9], King Greg[6], Laxton Sarah[10], Lloyd Andrea[11], Luckman Brian[12], Pisaric Michael[6], Porter Trevor[6], Roland Carl[13], Sherriff Rosemary[14], Greg Wiles[15], Rob Wilson[16], Steve Winslow[2]

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The boreal regions of Northwestern North America have experienced rapid warming in recent decades and this trend is projected into the future. Several findings from this region suggest an ecosystem undergoing fundamental changes in the face of rapid climate and associated environmental change, including (1) increasing tree growth due to warming in some areas, (2) declining tree growth most likely due to increasing drought stress in other areas, (3) divergent growth trends within sites, and (4) wide-spread changing relationships between climate and tree growth in several species. To gain a better understanding of the mechanisms underlying divergent growth responses in boreal trees, we compiled a massive amount of tree ring width data from Alaska, British Columbia, and the Yukon and Northwest Territories of Canada. The data-base totals >10 000 tree ring series from all major boreal forest species of the region. These data represent >250 sites covering most landscape types and each site contributes data to at least the year 2000. Preliminary results suggest that in the recent past optimal conditions (temperatures and moisture) for tree growth for many species in many landscape types have been exceeded more frequently. This suggests future wide-spread change in growth performance of existing trees and possibly questions the survival of certain genotypes if rapid warming continues as projected.

C1.02

C1.02 Oral

Linking cambial phenology with climate growth analysis to understand how climate influences tracheid production in *Picea mariana*

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Tree ring width in conifers is the integration of two fluctuating anatomical components: tracheid radial number and tracheid radial width. To study the climatic influence on boreal black spruce tracheid production, four independent measurement plots were established. Intra-annually repeated micro-coring of 5 representative trees per plot has been carried out for 5 years to assess for cambial phenology and tracheid production. Each plot incorporated the monitoring of air temperature and humidity, soil temperature and water content, light intensity and snow depth. Initiation of tracheid production revealed to be influenced by climatic factors between the end of March and the initiation itself, mean daily air temperature being the most influent one. An earlier initiation has been revealed to influence positively the number of tracheid produced. However, stronger influence come from photosynthesis-related daily factors (positive influence of light intensity and daytime vapor pressure, negative influence of maximum temperature) occurring from the mid-July until cessation of tracheid production in mid-August. The high sensitivity during this period is due to a combined effect: when climatic conditions promote photosynthesis, a higher latewood tracheid production rate concomitant with an extended latewood production occurs. Furthermore, late summer temperatures (soil and air) of the previous year showed a positive influence on tracheid production duration. These results suggest that a uniform climate warming has a conflicting effect on tracheid production. While higher temperature helps to extend tracheid production, it also inhibits this production during latewood formation, the second being the most influent on the number of tracheid.

C1.03 Oral

The peculiarities of larch growth in the northern timberline

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V/N/ Sukachev Institute of Forest SB RAS, Krasnoyarsk, Russian Federation

C1.03

In this paper the peculiarities of Gmelin larch (*Larix gmelinii* (Rupr.) Rupr.) radial growth in the northern timberline (Taymir peninsular, 72^0 00' N, 102^o 10' E). Two experimental sites (PP1 and PP2) situated along elevation transect were taken into consideration. The distance between them was 1700 m; the difference of its elevation was 216 m. Larch trees growing in the site pp1 formed the elevation timberline. Climate factors influencing on tree ring growth have been revealed by an ingenious method of "sliding response function". Correlation between tree ring series and series of mean 20- 30- and 40-day- temperatures (when these periods are shifted in 10 days forward) has been calculated from April (growth season start) towards October. This method of "sliding response function" allowed revealing time periods within growth season with the most effective influence of climate factors in tree growth.

It has been shown that in the elevation timberline pp1 the temperature factor is beginning to affect tree growth later and during shorter time period as compared with PP3. Correlation between a sum of October–April– precipitation and a corresponding tree-ring series for the period of 1948–1999 is negative (-0.61) in PP1 and positive in PP3. The latter result is in agreement with "temperature response function". So that, temperature effect in PP3 before the beginning of vegetation (in May) is the mediated one and reflects the influence of data of snow cover left.

C1.04

C1.04 Oral

Potential target season-changes for different sub-arctic tree-species from 1913–2009

Jesper Björklund, Hans Linderholm, Petter Stridbeck, Dave Rayner
Department of Earth Sciences, Gothenburg, Sweden

The use of tree-ring width (TRW) as a proxy for past climate variability, rely on stable temporal association between the annual growth and a specific climate variable. In a simple regression-based climate reconstruction, this relationship is assumed to be linear. As an example, for TRW of *Pinus sylvestris* in Northern Fennoscandia, July mean temperature is often used as target season, and reconstructed back in time. Preliminary results from a target season-analysis of pines west of Jokkmokk, Sweden (67°N, 19°E) show that July as target season is valid for the first half of the 20th century. However, in the latter half of the century, a target season of half of June and half of July appears to be more valid. This result is in agreement with the trend seen in the growing season, where the start has moved forward by around 2 weeks in the area in the 20th century. Furthermore, the target season of pine has potentially changed to such a degree, that the late 20th century target-season temperatures were colder than the July target season in the beginning of the 20th century. This could account for some of the unexplained divergence between TRW and July temperatures, seen in Fennoscandian pines during this time. In addition to pine, target-season analyses of other temperature-sensitive tree-species; *Betula Pubescens*, *Picea Abies* and *Juniperus Communis*, from the same site are presented.

C1.05 Oral

Tree-line dynamics, radial growth of timberline trees and alpine shrubs on the southeastern Tibetan Plateau

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For the southeast Tibetan Plateau, instrumental climatic records show a clear warming trend. However, little is known about its effect on high-elevation forest ecosystems that has been less disturbed by human activity. A network of nine Smith fir (*Abies georgei* var. *smithii*) ring-width chronologies was constructed from sites ranging in elevation from 3550 to 4390 m above sea level (a.s.l.) in the Sygera Mountains, southeastern Tibetan Plateau. The initiation of tree-ring growth of Smith fir is controlled by common climatic signals, such as July minimum temperature, across a broad altitudinal range. Precipitation is not a growth-limiting factor across stands. A regionally well-replicated ring-width composite chronology (RC) from four timberline sites showed a significantly positive correlation with mean summer (June–August) temperature. Therefore, mean summer temperature was reconstructed for southeast Tibet back to A.D. 1765 based on RC. This reconstruction successfully captures the recent warming observed in the instrumental record since 1961 with the last decade being the warmest period during the past 242 years. The reconstructed cold period from 1808–1827 may be linked to an unknown volcanic eruption in 1808 and the Tambora eruption in 1815. Smith fir density increased rapidly and tree line moved upslope in the recent 50 years. The alpine shrub *Rhododendron nivale* growth in the Ranwu region, southeast Tibet, is highly correlated with the above timberline fir chronology, about 200 km apart, displaying an increasing growth trend in the recent decades. This indicates an effect of recent global warming on high-elevation forest and alpine shrub ecosystems.

C1.06 Oral

Spruce growth and climate sensitivity along glacial rivers of Alaska

C1.06

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We are examining the growth, growth history and climate sensitivity of white and black spruce trees on the floodplains of the major rivers fed by glacial meltwater in Interior Alaska. To date we have collected samples from 624 trees on 41 sites distributed across a total of 2,528 km of the Yukon River, Tanana River, and Kuskokwim River. We have analyzed the climatic control of radial growth in 146 large, dominant white spruce trees from 7 sites on the floodplain of the Yukon River, two stands on the Tanana River in BNZ LTER, and 188 white spruce and 77 black spruce trees along the Kuskokwim River. Our sampled trees represent the population that enters rivers from bank erosion and are transported into the Bering Sea and Arctic Ocean to become driftwood accumulations. The growth of Interior Alaska spruce trees is negatively sensitive to temperature and weakly positive to precipitation, a pattern that is consistent for at least 150 years. Recent years have been the least climatically favorable for the past two centuries at least because of sustained warmth. Spruce populations in cooler maritime climate regions of western Alaska predominately include trees whose growth responds positively to warmth, with a transition zone between the Interior and maritime regions. Our results indicate that recent warming has strong stressed spruce in many Interior locations and has already created an optimum climate region in western Alaska with smaller trees or only young trees.

C1.07 Oral

Environmental drivers and spruce growth along elevation gradient in Finnish Lapland

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Forest lines have fluctuated throughout the Holocene time period, yet the rate and vigor of the ongoing change in the alpine forest-tundra is not well understood. We investigated recent shifts of the forest lines with regard of snowpack, soil physical-chemical properties as well as tree species canopy coverage and the age chronology along the elevation gradient (380–557 m a.s.l.) of the Lommoltunturi fell (mountain shaped by the Pleistocene glaciations) in Finnish Lapland. The forest is young (<165 years) and the age structure of Norway spruce (*Picea abies* (L.) Karst.) evidences marked altitudinal shifts to higher elevations. Norway spruce established in 1842–1863 at 420 m a.s.l. elevation. In the 1920's spruce shifted to the elevation of 475 m a.s.l, and it took 60 years to expand the forest by 55 m in elevation. On tundra safe sites for seedlings/saplings are restrict, establishment being challenged by cryoturbation, solifluction as well as low soil Ca-to-Al. Radar evidence indicated that snowpack thickness is spatially variable in tundra. Summer soil temperature was higher on tundra than in forest, hence being not a growth limiting factor. We did not found evidence to show fire disturbances, nor evidence of old stumps/logs, hence we conclude that the forest has expanded onto formerly tree-free tundra. Based on tree-ring indices the growth of spruce positively correlated with June–July temperature, yet the data demonstrated climatic periodicity suggesting that the 30–33-year (Bruckner) solar forcing has impacted on the alpine forest-tundra in Lapland.

C2.01 Invited

Wood anatomy and different data to study the environmental signals registered in tree-rings – Overview and example of beech (*Fagus sylvatica*)

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The extended talk will present some recent advances in using wood anatomy to identify records of environmental factors in the wood of conifers and broadleaved species from different ecosystems.

In the second part will be presented results of our own research using combination of long-term (tree-ring width and phenology) and short-term (intra-annual xylem and phloem formation and cambial activity at a cellular level) data to understand better the environmental signals registered by a tree during growth.

We performed tree-ring and response function analyses and studied the dynamics of cambium activity and wood and phloem formation on cellular level in European beech (*Fagus sylvatica*) from different sites in Slovenia, SE central Europe. Climate and leaf phenology (leaf unfolding and leaf yellowing) data were collected by the Environmental Agency of the Republic of Slovenia.

The combined information of tree-ring width and phenology series, and seasonal dynamics of wood formation and their relation to climate, enabled us to define some milestones of wood formation, as well as to define climatic parameters that affect year to year tree-ring variation and phenology.

There exist differences in tree-ring response to climate in beech from different altitudes and different biogeographical units. Tree ring indices, leaf unfolding, leaf yellowing and days with leaves all depend on climate but there are differences in the climatic parameters and the periods affecting them. The closest correspondence can be found between leaf unfolding and reactivation of the cambium, therefore leaf unfolding can be used for a rough estimation of the onset of cambial divisions in beech. There are differences between lower and higher elevated sites in regard to onset and cessation of cambial activity and dynamics of wood and phloem formation.

C2.02 Oral

Effect of experimental flooding on vessel area of pedunculate oak and common ash – A matter of timing

Ute Sass-Klaassen, Clifton Sabajo, Evelijn Belien, Jan den Ouden
Wageningen University, Forest Ecology and Forest Management Group, Wageningen, Netherlands

Early-wood vessel area may record flooding events with high temporal resolution. For interpretation of these anatomical 'flood markers', the relation between timing and length of flooding and the dynamics of early-wood vessel formation was studied in two ring-porous tree species.

In 2005, a flooding experiment was conducted on 30-year old oaks (*Quercus robur*) and ashes (*Fraxinus excelsior*). The trees were flooded for 20 days, starting on the 13th of April. The flooding treatment resulted in the formation of extremely small early-wood vessels – a flood marker – in oak but not in ash. We hypothesize that this species-specific difference in response to the flooding treatment was due to a difference in the dynamics of vessel enlargement between oak and ash at our study site.

In 2008 a further study was conducted to trace early-wood vessel enlargement in oak and ash at the experimental site by taking microsamples in weekly intervals from the end of March to the end of May. In addition leaf phenology was recorded throughout the same period. A phenological model was used to relate dynamics in vessel enlargement and phenology as recorded in 2008 to the experimental year 2005.

The results indicated striking differences in dynamics of vessel enlargement and in the relation to leaf phenology for oak and ash. These differences can largely explain the observed difference in response to the experimental flooding.

C2.03

C2.03 Oral

Maximum latewood density derived from wood anatomical time series analysis

Holger Gärtner
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Wood anatomical features such as vessel or tracheid size and cell wall thickness bear ecologically relevant information. However, long term variations of these features have only sporadically been used to reconstruct climatic changes. These attempts mostly concentrate on the analysis of vessel sizes in ring-porous species to reconstruct temperature changes over longer periods. The relatively big dimension of the vessels enables measuring their size by preparing plain surfaces on cores without preparing microsections. Conversely, continuous measurements of coniferous tracheid dimensions have rarely been done because of their relatively small sizes compared to the much larger vessels in angiosperm wood. For this, anatomically based time series analysis focussing on centennial variations of tracheid structures do not exist. While radiodensitometric studies have been very successful in reconstructing temperature, wood anatomical studies of tracheid features such as cell size and cell wall thickness are rare. This is due to the fact that microsections, especially those taken from cores, are relatively small (length approx. 1–2 cm). Hence, the amount of work needed to prepare an entire core for a detailed wood anatomical analysis is not appropriate. The development of a new microtome and a special core holder enabled preparing microsections of cores up to a length of 7 cm. Based on this, the measurement of intra ring wood density profiles of *Larix decidua* cores was done and a maximum latewood density chronology spanning more than 100 years was established, which is compared to “traditional” x-ray densitometry measurements.

C2.04 Oral

Twenty years of Needle Trace Method, NTM

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Metla, Rovaniemi, Finland

At the time of the strong debate about the role of air pollution in forest health in the 1980s, there was a need to have reliable knowledge also about needle retention, needle longevity and crown thinning in the past. A common opinion was that needle age shortens; defoliation increases and trees finally die due to air pollution. A social need was born to produce exact data on needle longevity in the past: The highly sophisticated Needle Trace Method, NTM, was published in 1990 to produce information on crown and needle dynamics retrospectively. In this destructive method trees are cut to obtain long-term, annually based NTM proxies. Needle retention, needle age, needle loss and needle density revealed in early 1990s that they, similarly to crown thinning, change temporally and that forests were not about to die. In the late 1990s new proxies were developed when measurements of annual shoots of the entire stem started. This brought into hand several new proxies, including height increment, which has a strong temperature signal at high northern latitudes. Currently, summer temperature based on height increment has been reconstructed back to the 8th century; needle retention and needle age series stretch back to the 16th century. Needle production, needle pool and many others among a total of about 15 NTM proxies and their use in forest health, air pollution, dendroecological, dendroclimatological etc. studies are demonstrated.

C2.05 Oral

Intra-annual variation of cell parameters of Scots pine and its association with climate throughout Finland

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Tree-ring widths are, more or less, strongly determined by the environmental conditions during the growing season. It is also suggested that each tracheid parameter, e.g. diameter and wall thickness, within a tree ring keep different climate information as the consequence of the environmental conditions at the time of its formation. In our present study, we aspire at a higher time resolution by measuring some parameters of tracheids across the tree rings and screening them for their climatic signals. Our study trees are Scots pine (*Pinus sylvestris* L.) along a south-north transect through Finland up to their northern distribution limit. 10 trees, approximately 100 years old, were selected at six sites to extract cores in spring 2009. In order to precisely measure tracheid parameters by image analysis, thin transverse sections were prepared with a sliding microtome from all cores. The measured tracheid parameters are tree-ring width, early- and late-wood width, cell-wall thickness, as well as lumen diameter and lumen area. We assume to obtain precise climate information and thus improve our models on tree growth.

C2.06

C2.06 Oral

Wood anatomy and microcharcoal used as markers of paleoenvironmental reconstruction and indicators of prehistoric fire regimes. The case of the Ambato valley at the end of the 1st Millennium

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Macro and micro charcoal recovered in the Ambato Valley, Catamarca in the NW Argentina have been used as a proxy in paleo-environmental reconstruction.

The charcoal macro remains are associated to cultural practices and comes from archaeological contexts.Anatomical features related to water deficiency were analyzed in archaeological plant charcoal of Geoffroea decorticans These analyses have been proven to give indications of arid periods dated to the end of the first millennium when the valley was occupied by settlements associated to the Aguada culture.

While the micro charcoal are extracted from geological profiles sampled in the vicinity of the prehistoric settlements. Through the counting of these micro remains we can obtain information about fire regimes, probably associated to the abandonment of the Aguada sites in the Ambato valley.

The connection between droughts and wild fires has been extensively mentioned in the literature and is a possibility that the processes of abandonment of the Aguada sites in the Ambato valley in the end of the 1st millennium have been related to this scenario.

C2.07 Oral

Evaluation of water deficit tolerance of young aspen (*Populus tremula* L.) using wood characteristics of juvenile tree rings

Matthias Meyer[1], Gerhard Helle[2], Björn Günther[1], Dirk Landgraf[3], Doris Krabel[1]
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Wood production under water deficits is one of the most challenging tasks for forestry and short rotation coppice management. An increasing demand for tree breeding concerning water deficit tolerance and water use efficiency may also result from future climate conditions.

Unfortunately, water deficit tolerance is not a directly measurable trait. It has to be evaluated using proxy traits that either reflect water deficit reactions or are a part of an adaptation itself. The tree ring archive is one option to obtain information on trees water deficit reaction in a retrospective way without permanent data acquisition over a several years period. We discuss examples of our research results at the interface of wood anatomy and poplar (*Populus* spp.) molecular genetics and possible implementation into future tree breeding. Our special interest is devoted to the first tree rings that are normally not suitable for dendrochronological research due to the juvenile trends of wood traits in developing trees. However, tree breeders may gather more information about the trees' water deficit reaction from the shape of their wood anatomical juvenile trend. Radial increment, vessel lumen cross sectional area, fibre and vessel element length, and wood density (X-ray densitometrical) were investigated in the first six tree rings of a F1-crossbred tree population (planted in a tree nursery in the same year). The results show variations in the sensitivity of these traits to dry vegetation periods.

C2.08

C2.08 Oral

Erosional processes in the upper part of the mountain catchments recorded in exposed roots

Dominika Wrońska-Wałach
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There are a number of steep forest-covered headwater catchments in the Gorce Mountains – a flysch-type range that is part of the Polish Carpathian Mountains. Five headwater areas in Gorce Mountain which exhibits fresh signs of contemporary geomorphic activity were selected for detailed dendrogeomorphological mapping.

Select landforms such as ravines, torrential channels, rills, small landslides and rock veneers were inspected for the presence of exposed roots with particular attention paid to scarred exposed roots.

The main aim of the research was to use the exposed roots to determine the spatial and temporal variation of erosional processes. In addition root's data were employed to determine the rainfall thresholds for different geomorphic processes.

Microanalysis of 112 exposed Spruce roots was performed based on the procedure by (Schweingruber 1990, Gärtner et al. 2001). WinCell (Regent) analysis contained the measurements of earlywood cell size and the first appearance of higher amount of latewood was performed.

Analytical data were compared to available rainfall data collected by meteorological stations located in close proximity to the study area.

It has been determined that the roots had become exposed at different times ranging anywhere from 1944 to 2006. The roots had become exposed by a variety of geomorphic processes.

The main differences between the roots collected from a range of landforms from the upper part of mountain catchments will be discussed. Furthermore, some correlations between the precipitation and the temporal and spatial variation of roots exposition will be presented.

C2.09 Oral

Wood anatomical analysis of broad-leaved trees injured by debris-flow events

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Geomorphic events may cause changes in wood anatomy, including the reduction of cell dimensions and the formation of callus tissue and tangential rows of traumatic resin ducts. Such changes in wood anatomy provide a proxy record of geomorphic events. Wood anatomical analyses have successfully been used in dendrogeomorphic studies on conifers disturbed by debris flows, rockfalls and snow avalanches. They have more rarely been applied on broad-leaved trees. Consequently, we aim at characterizing the wood anatomical response of broad-leaved trees to debris-flow injuries. Specifically, this study was undertaken to quantify the anatomical differences between the injured rings corresponding to debris-flow event years and the pre-injury rings formed in the year before the impact. Cross-sections from 7 Gray alder (*Alnus incana* (L.) Moench) and 7 Silver birch (*Betula pendula* Roth) trees were dated. Micro-sections were prepared from samples at two different radii, namely immediately adjacent to the injury and opposite to the injury, and the WinCell Pro image analysis program was used. Preliminary results from the comparison of the 14 injured rings and pre-injury rings show a reduction of vessel dimensions in injured rings. These first results are encouraging for dendrogeomorphic research to develop other dating methods to reconstruct geomorphic events.

C2.10 Oral

Investigating relationships between ring width, density and cell properties for two long-lived Southern Hemisphere conifers

Kathryn Allen[1], David Drew[1], Geoff Downes[1], Rob Evans[1], Patrick Baker[1], Rohan Simkin[1]
[1]Monash University, Clayton, Australia, [2]CSIRO, Sandy Bay, Australia, [3]CSIRO, Clayton, Australia

We have applied rapid-assessment, high-resolution wood property technology (SilviscanÒ, developed by CSIRO Australia) to measure density and cell properties of two long-lived coniferous species in Tasmania: *Athrotaxis cupressoides* and *Phyllocladus aspleniifolius*. Because existing Tasmanian tree ring chronologies are all ring-width based, the use of this technology provides important potential to not only develop chronologies based on different growth parameters, but to also improve our understanding of climate-growth relationships thereby augmenting centennial- to millennial-scale chronologies from these species. At an individual tree level, and for both species, we show that relationships between ring width and density parameters vary over time, indicating that density parameters may provide climatic information additional to that contained in ring widths. For the two sites examined, density profiles for *Athrotaxis cupressoides* diverge from ~AD1950, while those of *Phyllocladus aspleniifolius* do not. We discuss the cross-dating of the different density profiles for each species, both in terms of the potential for augmenting and better interpreting information available from ring widths and for creating density-based chronologies. We also consider the cell property data and its relationship with other growth parameters.

C2.11

C2.11 Oral

Tree rings used to assess effects of gypsy moth (*Lymantria dispar* L.) defoliation on wood volume growth of oaks (*Quercus* spp.) in Pennsylvania, USA

Mary Ann Fajvan, Kurt Gottschalk
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Stem dissection and dendroecological techniques were used to model the effects of gypsy moth (*Lymantria dispar* L.) defoliation on radial volume increment of *Quercus* spp. Sixty-five trees were sampled from three different stands and had been defoliated for 2 consecutive years. Annual volume increment was calculated for individual stem sections and then summed for the entire stem. The annual volume increments determined for each tree were used in the construction of a polynomial model to estimate annual cumulative volume (m^3) increment as a function of dbh for each stand. Volume loss was greater during the second year of defoliation with complete recovery taking 2 to 4 years. Annual volume increment demonstrated a decreasing trend from stump to the base of the live crown and volume increment of the lowest log (from stump height to 1.37 m) was always higher than upper log sections. During defoliation the magnitude of the decrease for the lowest logs was much greater than for the upper logs. Defoliation caused reductions in both earlywood and latewood increments; latewood reductions were distributed along entire stems while earlywood reductions were greater on upper stem sections within the crown. New data will also be presented on estimates of the total wood production lost from defoliation for each stand. Growth rings from increment cores collected at 1.37 m above the ground (dbh) on the remaining 150 *Quercus* spp. trees will be used in the polynomial models to predict volume changes before, during and after defoliation.

C2.12

C2.12 Oral

The ecological success of the mangrove Avicennia: The perfect combination of well-adapted wood anatomical characteristics and special radial growth?

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The mangrove Avicennia, the only mangrove genus with successive cambia, has the broadest distribution of all mangroves genera. This pattern is repeated at local scale where Avicennia trees can grow more landinward and at places with more stressful environmental conditions if compared to other mangroves. This study wants to address the questions: "Why is Avicennia able to survive at locations where other mangrove genera are not able to grow?" and "What makes Avicennia so well adapted to highly stressful conditions?". Herefore we (i) made a wood anatomical comparison between Avicennia and Rhizophora, another important mangrove genus, and (ii) investigate the three-dimensional structure of Avicennia's transport structure through (micro) CT-scanning. We furthermore analysed the link between successive cambia and stressful environmental conditions through a database analysis. We can conclude that the water transport system of Avicennia is, more than in other mangrove genera, adapted to extreme environmental conditions and that (ii) Avicennia's highly complex three-dimensional structure of the xylem and phloem tissue most probably offers advantages in stressful environments as was proven by a clear link between species with successive cambia and dry or salty habitats. Overall, the vessel characteristics, the structure of the transport tissues as well as the special way of radial growth seems to offer Avicennia the necessary characteristics to survive in extreme conditions. These insights are of special importance in the understanding of the mangrove ecosystem but also bring understanding in the survival strategies and mechanisms of radial growth of trees in general.

C2.13

C2.13 Oral

Microstructure and chemical composition of tree-rings: New opportunities for multiparameter analysis

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The author has developed the method and software used in multiparameter analysis of microstructure and chemical composition of conifers' tree-rings. The key idea of this method is to obtain and analyze a set of cell parameters for the same tree-rings with spatial resolution on the level of a tracheid radial size. For the first time the method of multiparameter analysis was used in studying the microstructure and chemical composition of conifers' tree-rings. The tree-rings of woody plants' four species of the genus *Picea*, *Abies, Pinus, Larix,* which grow in different climatic conditions, were used as subjects of research. For the same tree-rings the cell sizes, densitometric and radiographic parameters, and also the concentration of elements falling within the range of Cl-Sr were measured. The measurement results processing with the help of the developed method and the software made it possible to get a set of cell parameters for tree-rings tracheids, which have different physical and biological sense. The analysis of the investigation results made it possible to discover significant influence of cell walls chemical composition on the results of X-ray densitometry. The equation of connection of cell wall's radiographic density and its thickness was obtained, which made it possible to solve the problem of density profile recovery according to the results of histometric measurements.

It was shown by experiments, that there is the existence of connection the elements concentrations in cell walls among themselves and with tree-rings' structural parameters.

The discovered types of connections between the histometric, radiographic data and chemical composition data are observed for all the tested woody plants samples, and this made it possible to draw a conclusion about their generality and independence from the kind of a woody plant species and its habitat. The perspective of the tree-rings multiparameter analysis is shown in the issues of dendrochronology, dendroecology and dendroclimatology.

C2.14 Oral

Impact of three silvicultural regimes on radial growth and wood quality of black spruce, a study case in the boreal forest

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Silvicultural regimes enhance the productivity of stands by increasing the growth of residual stems. However, a strong increase of radial growth can lead to a decrease of wood quality in terms of both density and anatomy. Our research aims to evaluate black spruce growth and wood quality within three different but very common silvicultural systems. The study has analyzed the effects of these forest management practices by evaluating the variability of the radial growth and the wood quality in regard of tree-ring density and anatomical features such as tracheid radial diameter and cell wall thickness. Preliminary results reveal a radial growth increase after thinning and careful logging practices; stems within juvenile stands exhibited the most important increase compared to the other treated stands. The growth response after treatment was highly variable with ring-width decrease and sometimes double increase. It is well known that a growth increase can lead to a wood density decrease which can influence the mechanical resistance. Indeed, latewood proportion is inversely proportional to tree-ring width. Furthermore, the relation between the cell wall diameter and lumen radial diameter decrease after the treatment. Considering that cell wall thickness provide mechanical stability, it is possible that this change could decrease the wood properties. These results allow us to combine the growth response and wood quality in order to classify the benefits of these silvicultural regimes.

C2.15

C2.15 Oral

Spatio-temporal variation of earlywood vessel features of *Quercus robur* L. along a climatic gradient in the Northwestern Iberian Peninsula

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Common European oak (*Quercus robur* L.) reaches its southwestern distribution limit in Europe close to the Northwestern Iberian Peninsula, where the transition to Mediterranean vegetation results in a progressive substitution of this species as xeric conditions increase. For this reason, xylem adaptations to drought conditions are relevant for the survival of these oaks, while their analysis by means of dendrochronological techniques can be useful to study their behavior in changing environments.

For this work, we selected a network of 12 sites distributed all along Galicia (NW Spain), trying to characterize the transition to the Mediterranean climate within the region. Earlywood vessels were measured for 10 trees per site for a common period of 20 years, and combined into several growth variables combining vessel size and numbers (mean and maximum vessel area, number of vessels, total conductive area and conductivity), also considering the position within the ring. We used these data to build chronologies for each growth variable and site, which were compared by multivariate techniques.

The results showed that vessel characteristics varied among sites according to the prevailing conditions along the gradient. Similarly, the comparison of time series provided a more detailed picture of the influence of climate on the adaptations of xylem anatomy. In summary, this works constitutes one of the first attempts to apply quantitative tree-ring anatomy to a network of site chronologies, and can be of relevance to the study of global change.

C2.16 Oral

Disturbance history of mountain spruce forests in the Carpathian Mts. derived from tree-rings

Tomasz Zielonka
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C2.16

Spruce forests in central Europe are affected by different types of natural disturbances. Disturbance events of varied severity occur in the different spatial scale with different interval. In this study we reconstructed a disturbance history of spruce stands located in the Carpathian Mts. Cliff forests, subalpine spruce stands and spruce – larch mixed forest were studied. Past disturbance events were detected using the growth release signal in tree-ring series. Synchronized and strong release signals in the mixed spruce-larch stands showed severe, large-scale and infrequent disturbance events. Dynamics of the other spruce subalpine and cliff stands appeared to be driven by small scale and asynchronous disturbances of low severity. Sudden and synchronous production of compression wood and resin pockets overlapped in time with growth releases. It confirmed a significant changes in environment in the past probably due to wind disturbances.

We conclude that forest stands located across Carpathian Mts. have different disturbance history. Natural disturbances which occurred with different frequency and severity influenced on structure and composition of these mountain forests.

C3.01

C3.01 Invited

Ecological significance of annual rings in trees, shrubs and herbs

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Secondary growth is responsible for the formation of annual rings in 98% of 2500 analyzed dicotyledonous trees, shrubs perennial and annual herbs in arid, subtropical, temperate, boreal and arctic vegetation zones of the northern hemisphere.

Ring distinctness, ring width and plant age and intra annual ring formation time is related to taxonomy, plant size, life form and climate.

Maximum plant ages of the European temperate zone reach 1000 years in trees, 200 years in dwarf shrubs and 40 years in herbaceous cushion plants of the alpine zone.

Ring formation varies from year to year and from species to species. In general it starts in April in the hill-zone and in July of the subalpine zone and ends approximately in early September of the temperate zone.

The analysis of plant ages in all life forms allows the reconstruction of:

- population age structure in all vegetation types in an outside forests from the temperate to the arctic zone in natural and man made plant units,
- landscape history in river beds, glacier fore fields, landslides etc.
- annual biomass production,
- management influences, and the determination of restoration practices,

The analysis of plant ages open a wide research field in relation to ecology, anatomy physiology and molecular biology.

C3.02 Oral

Scaling the mountains and roaming the tundra – expanding shrubs in North-Scandinavia and Northwest-America

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Evidence from remote sensing and repeat aerial photography suggest a recent increase of shrub cover in northern Alaska and a circumpolar greening of the arctic tundra, possibly related to expanding shrub patches. In this study, we investigate and compare shrub dynamics over elevational and latitudinal gradients in North-Scandinavia and Northwest-America. At all study sites, shrub main stems were dissected continuously in regular intervals applying the method of serial sectioning. Sampled species include *Juniperus nana*, *Betula nana*, *Alnus crispa* and various *Salix* species. Age class distributions were used to reconstruct elevational movement of the shrubline on south and north slopes. To assess a possible latitudinal shrub expansion, shrub patches that had been identified as increasing or stagnant via repeat photography were sampled to determine exact radial and vertical growth rates. Our preliminary results suggest a prevailing uniform positive growth response of shrubs on the elevational as well as the latitudinal range margins. Shrubs growing on south slopes exhibit signs of increased growth and increasing range margins (indicated by age class distributions) with weaker responses for north slopes. We expect to confirm expansion or stagnancy status of (latitudinal) tundra shrub patches and increasing shrub growth rates, as well, with warming temperatures as the main cause for shrub expansions.

C3.03

C3.03 Oral

Deciduous shrub growth and the greening of the Arctic in Western Siberia

Bruce C. Forbes[1], Marc Macias Fauria[2], Pentti Zetterberg[3]
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Salix lanata and Alnus fruticosa are abundant shrubs in the tundra zone of West Siberia. They occur in similar habitats with the live portions of genets up to 100 years old. We have established that growth rings of *S. lanata* provide an excellent proxy for summer temperature, as well as for the Normalized Difference Vegetation Index (NDVI), a satellite measurement strongly correlated with the photosynthetic capacity of the canopy. Such findings strongly suggest that *S. lanata* is behind the observed ‘greening’ of large portions of the Arctic since the 1980s. In that study our data were derived from shrubs growing near the arctic coast of the Nenets Autonomous Okrug. By sampling two different species side by side on the Yamal Peninsula in West Siberia, we aim to shed light on the relationship between deciduous shrubs and growing season temperatures in the last half century, a period of pronounced regional warming. We further aim to discern if there are regional differences in the climate signal within a single species (*S. lanata*), as well as between it and a neighbouring species with a strongly overlapping ecological amplitude (A. fruticosa). Preliminary results indicate a more complex signal in A. fruticosa than the strong temperature correlation seen in *S. lanata*. Finally, we aim to see if the relationship between stem growth and NDVI detected west of the Urals holds in the Yamal Peninsula and thus offers increased regional support for the thesis that deciduous tundra shrubs are responsible for the ‘greening’ of the Arctic.

C3.04 Oral

Annual shoot length growth of the Arctic dwarf shrub *Cassiope tetragona* as monitor of present-day and past climate change

C3.04

Stef Weijers, Jelte Rozema
VU University, Amsterdam, Netherlands

The instrumental arctic climate record is both temporally and spatially limited. Thus, there is a need for reliable climate proxies to increase knowledge of past and future Arctic climate change. We measured annual shoot length increase for the circumarctic dwarf shrub species *Cassiope tetragona* using the presence of wintermarksepta within its stems. Wintermarksepta consist of bands of dark dense tissue within the pith of *C. tetragona* stems, which are clearly visible in longitudinal sections of stems and which are associated with "lows" in leaf lengths and distances between leaf scars, thereby demarking annual growth.

This way in a 169 year long growth chronology for a high arctic site on Svalbard was created. We found that July average air temperature was the most important factor determining growth, allowing for July temperature reconstruction.

Reliable mean July temperature estimates based on time stable linear growth-temperature transfer function models reveal a significant positive trend on Svalbard between 1876 and 2007 of 0.09 oC decade-1 on average.

This study shows that the strong climate-growth interactions in *C. tetragona*, its longevity, the availability of (sub)fossil fragments in tundra soil cores and its circumartic distribution make *C. tetragona* a very valuable tool for climate reconstructions beyond the instrumental record throughout the Arctic.

Next to the construction of growth chronologies we perform field experiments on Svalbard in which temperature, precipitation and PAR are manipulated, in order to validate the use of shoot length growth of *C. tetragona* as a climate proxy.

C3.05

C3.05 Oral

Comparison of tree ring patterns of dwarf shrubs and trees of the genus Betula at the upper timberline in Norway

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To extend the reach of tree ring data into alpine ecozones, we analyzed *Betula nana* dwarf shrubs from above and *Betula pubescens* spp. *czerepanóvii* trees from below the upper timberline in Filefjell in the Norwegian Scandes. *Betula nana* individuals were sampled along a micro-topographic gradient. Different ecological conditions along the gradient were confirmed by a vegetation survey. To establish a chronology for the dwarf shrubs, thin sections were prepared and a variant of serial sectioning was used. An overreaching common signal in both chronologies was found, which allows for crossdating between the chronologies of the two growth forms / species. Growth of the dwarf shrubs, as well as growth of the birch trees, is positively correlated with summer temperature, while different growth trends in individual dwarf shrubs and their age structure can generally be attributed to the duration of snow cover as inferred from the topographic position at the ridge or at the bottom of the micro-catchment. No significant correlations with precipitation data were found. For a better comparison of the tree and dwarf-shrub chronologies, pointer year analysis was implemented.

C3.06 Oral

Are shrubs climbing mountains faster in warmer microclimates?

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With a warming climate, the arctic will experience shifting vegetation boundaries such as the spread of tall shrubs into tundra ecosystems. Rapid shrub expansion has been documented in arctic Alaska and north-western Canada using repeat aerial photography and satellite imagery. To test whether willow shrubs have responded to changing climate conditions in alpine tundra, we surveyed shrub abundance and shrub-line patterns in the Ruby Range Mountains and Kluane Foothills of the Yukon Territory, Canada. We collected stem sections from willow shrubs at shrub line (the maximum elevation at which erect shrubs grow) and below shrub line (at approximately 50% shrub cover) in 12 valleys and counted and measured growth rings. Shrub stems were thin-sectioned using a microtome, images of the sections were taken under a microscope and ringwidths were measured from the digital images. The ringwidths were processed following standard treering methodology. We compared age distributions of willows at and below shrubline and found younger populations at higher elevations, particularly on warm, south-facing aspects. Younger willows at shrubline and lack of significant mortality provide evidence that shrubs are advancing up slope. We compared growth ring chronologies to regional weather and modelled site specific temperature data corrected for elevation and aspect. Our results indicate that willows grew most in years with a warm June and July. This evidence of a direct response of shrub growth to higher temperatures suggests that shrubline expansion will continue with projected warming in arctic and alpine ecosystems.

C3.07 Oral

Interaction of geomorphic features and dendrochronological potential of polar dwarf shrubs (*Salix polaris*, Svalbard)

Agata Buchwal
Adam Mickiewicz University, Poznan, Poland

Permafrost melting and tundra expansion in the polar regions give us a unique chance to study significant environmental changes, which are induced by global climate change and result in activations of various geomorphic processes, like solifluction or debris flows.

Dendrochronological techniques were used to study growth of polar dwarf shrub *Salix polaris* from Central Spitsbergen, Svalbard. Wood anatomical features of shrub growing were analyzed in comparison to different slope stability and geomorphic process occurrences. Samples were taken both from active and rather stable parts of periglacial valley system.

Currently, not so many studies exist on dendrochronological potential of polar shrubs. The problem is still insufficient recognized and detailed studies need to be conducted in different polar and subpolar zones.

C3.08

C3.08 Oral

Advances of shrub in dendrochronology study in China

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Using the tree-ring series to reconstruct the high resolution proxies of environmental process in the area of climate, ecology and hydrology have been as an important tool in the world. However, dendrochronology has been mainly confined to the use of trees, and the majority of shrubs and dwarf shrubs have generally been overlooked. Arctic, alpine and desert regions are often devoid of trees and therefore, tree-ring chronologies cannot be developed. Instead, shrubs producing a small amount of growth every year are often found in these extreme environments, and many studies have described dwarf shrubs as having good potential for dendroclimatological work. Comparing to the trees, the shrub tree ring would not supply the longer time series of ecological and environmental information. While shrub tree-ring contained more sensitive information due to it distributed in the harsh conditions. Thus, the local environmental information which abstracted from the shrub tree-ring will be more credible than extrapolated from the far way mountain forest. The shrub will be the powerful and potential material on the study of environmental history in the area where no trees distributes. At the same time, the short instrumental records of the meteorology and hydrology as an obstacle to understand the eco-environment changes in the desolate and remote area. The zonal vegetation was the scrubs and shrubs in the arid and desert regions in northwest china, which played an important role in the environment conservation and ecosystem rehabilitation. Understanding deeply to the interrelations between the climate changes and plant growth will promote the vegetation recovery process and ecosystem management in the degenerated and fragile arid regions.

C4.01 Invited

Application of controlled experiments for studies of radial growth of trees

Jozica Gricar
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C4.01

The signals that determine the beginning, cessation and the rate of individual processes of wood and phloem formation derive from environment. Controlled experiments of heating and cooling of tree portions and their significance for studies of radial growth of trees will be presented. Such experiments performed on different tree species (*Picea abies*, *Quercus sessiliflora* and *Acer pseudoplatanus*) during vegetation period have demonstrated that it is possible to affect cambial activity and processes of wood and phloem formation and by that their anatomical structure; however, the response of cambium to locally elevated or decreased temperatures differed in various evergreen and deciduous tree species. Our most recent findings indicate that tree age and thickness off bark (i.e. dead bark) appears to influence the extent of such experiments on cambial activity and cell development. Thick dead bark acts as a very good insulation layer for the internal, living and sensitive tissues of living bark and cambium and therefore protects them against external abiotic and biotic factors.

C4.02 Oral

Intra-annual cambial activity and carbon availabilty in stem of poplar

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Cambial activity is influenced by many environmental and physiological factors and among them, carbon acts as a source of energy for the growing meristems. This work focussed on the intra-annual stem growth of poplar compared with the carbon available for xylogenesis processes in cambium and outer wood. The major stages of xylem production and differentiation in two poplar genotypes with different growth performances were considered. monitoring of stem growth and leaf phenology combined with starch, non-structural soluble sugars and water content in the stem was conducted from February to November 2006 in *Populus* × *canadensis* and *P. deltoides*. Anatomical analyses of wood formation were performed by measuring the width of the zones with differentiating and mature xylem. Xylem differentiation at the top of the tree started at the beginning of April for both genotypes and proceeded down the stem at about 0.5 m day^{-1}, occurring almost at the same time as leaf opening. The rate of growth and wood density was superior in Dvina but this higher productivity could not be explained by differences in number of cambial initials and duration of xylogenesis. However, the most productive poplar genotype showed higher glucose, fructose and sucrose contents in the outer wood. The non-structural soluble sugars available in the cambial zone followed the intra-annual pattern of xylem formation, with higher concentration when growth rate was maximum. The accumulations of non-structural soluble sugars at a certain time during stem growth corresponded with higher carbon availability to the actively growing meristems in the stem.

C4.03

C4.03 Oral

Predicting timings of xylogenesis in black spruce under climatic warming

Sergio Rossi, Annie Deslauriers, Hubert Morin, Cornelia Krause
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In the next century, the boreal ecosystems are projected to experience the greatest rates of warming than most other regions of the world. As the boreal forest constitutes a reservoir of trees of huge ecological importance and only partially-known economic potential, any potential climate-related change in plant growth and dynamics has to be promptly predicted and evaluated. A model for assessing the timings of xylogenesis in black spruce [*Picea mariana* (Mill.) B.S.P.] using daily temperatures and thermal thresholds was defined and applied to predict changes in onset, ending and duration of xylogenesis under different warming scenarios with temperatures arising up to 3°C. This aim was realized by collecting and analysing a dataset obtained from a seven-year-long monitoring of cambium phenology and wood formation on a weekly time-scale in trees growing in four sites at different latitudes and altitudes in the Saguenay-Lac-Saint-Jean region (Quebec, Canada). In the region, the onset of xylogenesis occurred between mid-May and the beginning of June while the end of xylogenesis ranged between mid-September and the beginning of October, resulting in a growing season of 101–141 days. The model predicted longer duration of xylogenesis at higher temperatures, with an increase of 7.7–11 days/°C, because of an earlier onset and a later ending of growth. With an increase of 3 °C in the mean temperature during the year, the duration of xylogenesis changed in average from 125 to 160 days. The predicted changes in cambial phenology could significantly affect wood production of the boreal ecosystems.

C4.04 Oral

Intra-annual radial growth in Scots pine (*Pinus sylvestris* L.) exposed to drought

Walter Oberhuber, Andreas Gruber
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C4.04

Temporal dynamic of wood formation in *Pinus sylvestris* in a dry inner-Alpine environment (750 m a.s.l., Tyrol, Austria) was studied during two contrasting years by comparing dendrometer traces with xylem cell development (micro-coring) at two sites differing in water availability (xeric and dry-moist). Whereas climate at the beginning of the growing season in April 2007 was characterized by exceptionally warm and dry conditions, climate in 2008 corresponded to long-term mean.

Results revealed that xylogenesis was characterized by almost 3 wk earlier onset of wood formation in 2007 compared to 2008, an early culmination of maximum growth in May and a *c*. 4 wk shorter growing season length at the xeric compared to dry-mesic site. On the other hand, daily and seasonal fluctuations of the stem radius primarily reflected changes in tree water status and masked radial growth especially during drought periods in spring. Unexpectedly, radial increment showed closest relationship with precipitation, while soil water content was not significantly correlated to radial growth.

Based on our findings we conclude that start of wood formation is triggered by temperature in early spring, whereas temporal dynamics of xylem development is controlled by tree water status throughout the growing season. Furthermore, we suggest that early culmination of maximum growth in spring prior to occurrence of more favourable growing conditions during summer is caused by a shift in carbon allocation to belowground organs to cope with extreme environmental conditions (i.e., frequent drought periods and nutrient deficiency of the substrate), which prevail within the study area.

C4.05

C4.05 Oral

Temperature-induced differences in timing of intra-annual growth of subalpine *Larix decidua* and *Picea abies*

Patrick Fonti, Julia Franzen, Gregory King, David Frank
Swiss Federal Research Institute WSL, Birmensdorf, Switzerland

Insight into the timing and processes of intra-annual growth is essential to understand the physiology of tree-ring formation as well as to correctly interpret the signal of anatomical or isotopic wood structures. Recent research has significantly improved the tools and methods used to monitor tree growth and through its use fundamental knowledge about timing of ring formation in specific environments have already been collected. In my talk I will present results about differences in timing of tree-ring formation and cell sizes between two phenologically different species (deciduous *Larix decidua* versus evergreen *Picea abies*) growing along a 4 degree Celsius natural temperature gradient in the subalpine forest of the Lötchen valley, in the central Swiss Alps. Growth observations are based on weekly micro-coring of 48 trees distributed along a 900 m elevation gradient sampled during the 2007 and 2008 growing seasons. Observed differences between the species will be the focus of discussion and will relate to possible species-specific growth response to projected climate warming in alpine environments.

C4.06 Oral

Circadian stem size dynamics in larch and spruce along a 900-meter elevational gradient

Gregory M. King, Patrick Fonti, David C. Frank
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Trees respond to environmental variations from sub-hourly to multi-centennial time-scales. Dendrometers record both reversible daily fluctuations in stem radius and irreversible radial growth with high temporal precision, providing insights into intra-seasonal dynamics and thus basic growth processes. We installed automatic point and band dendrometers on a total of 48 trees at seven mixed larch (*Larix decidua*) and spruce (*Picea abies*) sites along a 900 m elevational gradient across two slopes in the Lötschen Valley located in the Central Swiss Alps. This transect has a natural growing season temperature gradient of approximately 4°C, making it ideal for investigating possible impacts of projected future temperature increases on alpine tree growth. In my talk, I will present three years (2007–2009) of hourly dendrometer data providing insight into the physiological response of trees to short-term environmental changes, including temperature, precipitation, soil moisture and solar radiation (collected in-situ). A major focus will be comparisons between two tree species (larch and spruce) with very different physiological characteristics (deciduous vs. evergreen; shallow vs. deep root system, timing of phenology, etc.). I will also describe differences in circadian growth dynamics between the growing and dormant season (supported with results from weekly microcores collected at the same sites), as well as between the different site elevations and aspects. These data contribute to a greater understanding of tree growth and future response of forests to climatic conditions in alpine environments.

C4.07 Oral

What a dendrochronologist can learn from cambium phenology and intra-annual dynamics of tree-ring formation?

C4.07

Cyrille Rathgeber[1], Sergio Rossi[2], Annie Deslauriers[2], Jozica Gricar[3], Patrick Fonti[4]
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Context. Since Leonardo da Vinci, scientists have been seeing tree-rings as a source of information on past environmental conditions. The relationships between tree-ring characteristics and recorded environmental conditions are classically portrayed using relational statistical models that could also be used to simulate future tree radial growth. However, despite these evident relationships, little is known about the detailed mechanisms responsible for the environmental signatures found into annual tree-ring features. Analysis of cambium activity and xylem development during the growing season can lead to a functional understanding of the mechanisms involved in wood formation.

Aim. To explore the relationships between (1) cambium phenology and tree-ring properties, and (2) cambium phenology and climatic factors, in order to (3) better understand the influence of climate on tree radial growth.

Location. This study is based on a worldwide dataset comprising Alpine, Boreal and Temperate forests from Europe and North America.

Methods. Microcoring or pining technics were used for monitoring cambial activity and xylem development at a weekly time step.

Results. The onset and cessation of cambium activity are independent and both contribute to the total duration of cambium activity. The duration of cambium activity is the best predictor of tree-ring width but considering only cambium phenology is not enough to model tree-ring formation accurately, the rate of cell production should also be taken into account. Cambial activity is constrained by critical temperatures, which are relatively stable for all the studied species.

C4.08

C4.08 Oral

Seasonal growth of tree-rings in larch (*Larix gmelinii* Rupr.) on permafrost soils in Siberia

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Analysis of seasonal growth of tree-ring formation is a key to understand the possible shifts in stem wood productivity under changing climate. It becomes especially important in permafrost zone due to predicted degradation of permafrost and consecutive changes in forest phytomass production. Here we analyze the influence of environmental factors (air temperature, precipitation, soil moisture) on tree-ring formation in larch growing at three sites in the north of central Siberia characterized by different thermo-hydrological regime of soil. Seasonal samples were collected from three trees per site, seven times from late May till September in 2008 with the increment bore. Cross sections of 15 μm thickness were cut with a microtome and colored to identify lignified and developing tracheids. The size of each tree-ring zone (cambium, enlarging and mature xylem) as well as the number of cells in each zone was determined using an Image Analysis System (Carl Zeiss, Jena).

It was found, soil temperature in the early growing season is the most crucial factor for the start of tree-ring formation. Thus, first cell divisions in cambium in trees have been observed depending on the site between late May and mid-June. Later in the season, different growth rates were observed for different sites with the highest number of tracheids and earlier cessation of radial growth at the site characterized by the shallowest active layer.

The data obtained are important for improving tree ring growth models and estimating future tree-growth under climate change.

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C4.09 Oral

Phloem ring formation and secondary changes in beech (*Fagus sylvatica*) bark

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We present the dynamics of phloem ring formation and secondary changes in older phloem rings of European beech (*Fagus sylvatica*) from two sites in Slovenia. The investigations were made on sections of tissue samples taken from mature trees at weekly intervals in 2006, 2008, and 2009 and examined with light microscope, UV-microspectrophotometer (UMSP), and transmission electron microscope (TEM).

The results can be summarized as follows. The divisions in the cambium start at the same time on phloem and xylem side but the differentiation of first phloem cells occurs approximately one month earlier then on the xylem side. The formation of early-phloem containing sieve tubes with larger lumina is followed by the formation of tangential bands of axial parenchyma. After that, late phloem with smaller sieve tubes and finally a band of terminal axial parenchyma are formed. The trees with wider phloem rings as a rule have also wider xylem rings. The collapse of the sieve tubes seems to occur either in the year of their formation, or in the following year. The first sclereids occur after few years. Their formation is connected to secondary changes in phloem parenchyma. TEM demonstrated the development of their polylamellated cell walls. Additional cellular UMSP measurements revealed changes in lignin composition and distribution during different stages of sclereid development. The increasing frequency of sclereids and progressive collapse of the tissue in older phloem are among the main reasons why older phloem rings cannot be clearly recognized.

C4.10

C4.10 Oral

Re-activation of xylem and phloem flow in young oaks during spring

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Nuclear Magnetic Resonance (NMR) imaging was combined with wood-anatomical analyses to investigate the re-activation of cambial activity and xylem and phloem flow in three-year-old pedunculate oaks (*Quercus robur* L.). Cambial activity and early-wood vessel formation were followed along the stem throughout five consecutive phases of leaf phenology – from dormant buds to full leaf expansion. NMR imaging was used to non-invasively determine water content as well as xylem and phloem flow (velocity, conducting area and volume flow) at 50 cm stem height. Results indicate that the start of cell division is closely related with the increase in water content around the cambial layer. The formation of new early-wood vessel is very irregular around the stem circumference and the same holds true for xylem and phloem flow initiation. Xylem flow was mainly related to the vessels of the current season – only during bud swelling water transport takes place in adjacent latewood vessels of the previous season as well. NMR imaging has shown to be a powerful and non-invasive tool to study water relations in small trees – it enables to study changes in water content and transport over time both spatially and quantitatively and in relation to changing environmental conditions.

C4.11 Oral

Xylem formation and seasonal growth of *Agathis australis* (kauri) – An examination of intra-annual tree-ring patterns

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The annual tree-rings of New Zealand's *Agathis australis* (kauri) have been extensively studied due to their strong association with the El Niño – Southern Oscillation (ENSO) phenomenon. A potential source of sub-annual climate information lies in the intra-ring cellular features, since tracheid cells are exposed to external forcing factors for a much shorter time period during their lives. Thus, more temporally-precise record of the timing of ENSO events may be possible through the examination of intra-ring cellular features of kauri tree rings.

Kauri trees within the Huapai Scientific Reserve in the Waitakere Ranges north-west of Auckland, New Zealand were micropunched or cored at monthly or bimonthly intervals throughout a complete growing season to determine the pattern of seasonal xylem growth. Following the growing season, automated image analysis software was used to measure individual tracheids from the completed year's tree rings (lumen diameter and cell wall thickness) to produce 'tracheidograms' of seasonal growth that show the variations in cell parameters as a function of cell position within an annual ring. These data allow the relationships between intra-ring features and environmental forcing to be hypothesized and transfer functions relating intra-ring features to climate variables to be derived for use in reconstruction of climate history.

C4.12

C4.12 Oral

Compression wood formation as an indicator of ice storm damage in the southern Appalachian Mountains, USA

Benjamin Hook, Carolyn Copenheaver
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Winter storms are the most common climatic disturbances in the eastern United States, and their influence on forests depend upon type and amount of precipitation, tree species, stem size, and topographic position. In 1994, an ice storm deposited 3 to 8 cm of glaze across the Appalachian Mountains. In 2007, disks were cut from 77 *Pinus strobus* (L.) trees on a northeast-facing ridge. Areas of compression wood as a percentage of basal area increment and total disk area were quantified. Samples <10 cm in diameter contained more compression wood than larger diameter trees. Pre-storm, the 2 to 5 cm diameter class formed more compression wood than the 6 to 9 cm class; but, after the storm the 6 to 9 cm class formed more compression wood than any other diameter class. Suggesting that trees in the 6 to 9 cm class required more compressive force than the 2 to 5 cm class to right themselves. Large trees did not form as much compression wood, but they experienced a reduction in annual ring width following ice damage – possibly due to branch breakage. 30μm-thick wood sections were sampled from the three years before and after the ice storm to compare pre- and post- storm cell structure. Compression wood cells were more circular than normal tracheids, with thicker cell walls; characteristics designed to straighten trees after external displacement. These results imply that trees make the best "recorders" for ice storm events when they are <10 cm in diameter.

C4.13 Oral

A physiological model of wood formation

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Wood formation was modelled based on detailed physiological processes for water and sugar transport to cambium. Wood formation was described at the cell level, where local sugar concentration and turgor pressure induce irreversible cell expansion and cell wall synthesis. We showed how the environmental conditions, metabolic and physiological processes and structural features of a tree mediate their effects directly on the local water and sugar concentration and influence wood formation. The radial short-distance transport of water and sugars were used as control signals determining cell division, cell enlargement and cell wall synthesis. The model was able to produce qualitatively logical predictions on cell size distribution. Furthermore, large trees were predicted to be less sensitive to changes in environmental conditions compared to smaller ones as they have more storages and were therefore less coupled to short-term changes in the environment compared to smaller trees. However, the dynamics of cambial activity turned out to be a complex phenomena. Mechanistic modelling of the cambial dynamics still requires knowledge on the physiological basis of wood formation.

C4.14

C4.14 Oral

Increment cores from the Finnish National Forest Inventory as a source of information for studying radial increment during a growing season

Harri Mäkinen, Helena Henttonen, Pekka Nöjd
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In the Finnish National Forest Inventory (NFI) thousands of trees are cored every year. As the inventory design is based on systematic cluster sampling, the results are representative, for example, geographically or climatically defined areas. In the inventory data, one only has a single-time observation for each tree. However, observations from individual trees can be combined to describe the average development of intra-annual growth.

First, we tested, whether increment cores, routinely measured as a part of the NFI, could be used for studying the progress of radial increment during growing season. Widths of incomplete current-year annual rings of the NFI cores were compared to measurements from cellular analysis (microcores). The results showed that the NFI cores produced similar current year ring-widths as the microcores in the majority of cases.

Second, we assessed the progress of radial increment in Scots pine and Norway spruce during a growing season, and evaluated how much the length of radial increment period differed between years. We also compared the timing of radial increment between the southern and middle boreal zone in Finland. We also compared the timing of different radial increment phases (initiation, midpoint, cessation, duration) with the annual radial increment indices to identify the most important factors related to the annual variations in wood formation.

Third, we related the different phases of radial increment to environmental variables. The aim was to increase our understanding of the dynamic interplay between environmental factors as they affect wood formation during the growing season.

C5.01

C5.01 Invited

Rate of post-fire rise of permafrost under larch stands in Siberia estimated by dendrochronological methods

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Forest fire is among the main environmental factors which determine structure and functioning of boreal ecosystems. In permafrost zone of Siberia (Russia), seasonal thawing depth after fires increases considerably. Then, tree regeneration and ground vegetation recovery lead to increasing thermal insulation of soil surface and, consequently rise of permafrost table. In this study, we estimated the rate of permafrost rise for a larch (*Larix gmelinii*, Rupr.) stand formed after fire in 1898 and further invaded by Sphagnum mosses. We cross-dated tree-ring width chronologies obtained for tree disks taken at different depth along the larch stem and axial root in peat (further "root") to define calendar years of formation for the inner (first) and outer (last) tree-rings. There is a good agreement of tree ring growth along the root of each tree: r=0.38–0.98 (81–103 years, $p<0.05$). A gradual cessation of cambial activity is observed along each larch root with earlier extinction of cambium at deeper levels. The earliest cessations of root radial growth were observed for the period of 1940–1950 which corresponds to the present depth of peat layer of 30–40 cm. Since during the first approximately 20 years Sphagnum grew mostly horizontally to form continuous cover, peat depth in 1940–1950 has reached 10–15 cm. Similarly, recent cessation of root cambial activity in larch occurs also at the depth of 10–15 cm. In general, the rates of permafrost rise and moss layer growth were shown to be similar and equalled to 0.48 ± 0.01 cm year^{-1}.

C5.02

C5.02 Oral

Tree-ring evidence of glacier dynamics in Monsoon Asia during the Late Holocene

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Glaciers in the summer monsoon influenced region of southern and eastern Asia provide important hydrological resources for the population living in the mountain regions and the surrounding lowlands. During the past decades, temperate monsoonal glaciers experienced dramatic shrinking as a result of regional warming and changes in the hydrological cycle. So far, it is not known how monsoonal glaciers might respond to an intensification of the Asian summer monsoon that is expected in the near future. We reconstructed glacier variations during the Little Ice Age (LIA) by dating moraine deposits and we were able to date maximum glacier advances and re-advance stages during the past centuries. We compare glacier history with reconstructions of regional temperature and rainfall during the past millennium derived from a dense spatial dendroecological network including chronologies from tree-ring width (TRW), maximum latewood density (MXD) and stable oxygen isotopes of long-living trees. Periods of glacier advances during the LIA generally occurred during cooler periods of the last millennium. However, they also correspond to periods of increased moisture input related to an intensification of the Asian summer monsoon. Extremely positive growth years correspond to years with enhanced meltwater pulses and can be used to reconstruct glacier mass balance and past hydrological conditions. The study sheds new light on the dynamic behaviour of monsoonal glaciers in southern Asia and their relation to the Asian summer monsoon circulation

C5.03

C5.03 Oral

Tree species portfolio in a drier future – A case study from Valais

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Scots pine decline in the dry valley of the inner Alps was caused by multiple stress factors especially by increasing drought. To warrant that the dry forests can provide ecosystem goods and services in future, Scots pine and possible substitute species were tested for their drought tolerance. Firstly, we focused on the endemic species Scots pine and pubescent oak growing under contrasting water supply. Secondly, we compared the growth response to and the growth recovery after drought years in endemic (Scots pine and European larch) and non-endemic (Douglas fir and black pine) species. The growth response of Scots pine to drought culminates in a cavitation-vulnerable water conducting system or a complete loss of tree rings. Oak might have gradual advantages over pine as it was less sensitive do drought. However, latewood, the emergency system for the water transport in oak, was often missing. Thus, both species might reach their limits of physiological capacity under a drier future climate. All species responded to drought years with a drop in increment, however, black pine and Douglas fir recovered best. This picture was supported by the results of mortality analysis showing no mortality in black pine and Douglas fir, but high rates of crown-dieback and mortality in Scots pine and larch. Thus black pine and Douglas fir seemed to have a higher potential to resist drier conditions and hence might be an alternative in future protection forests. To verify this ranking the study will be expanded to sites all over the alpine arc.

C5.04 Oral

Effects of high latitude climate change and permafrost dynamics on forest growth in the Mackenzie river basin in northern Canada.

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Growing evidence indicates that the northern latitudes of Canada are warming more rapidly than the mid latitudes. The Mackenzie valley region of northwestern Canada has undergone the most warming (1.7^{o} C) over the last century in Canada. If this warming trend continues, it is expected that permafrost will partially or completely disappear over large areas in the Mackenzie valley. Climate change effects on forest growth could be both positive (e.g., increased rates of photosynthesis and increased water use efficiency) or negative (decreased water availability, higher rates of respiration) depending upon a number of parameters such as latitude, species, soils and topography along the valley.

This study was designed to improve our understanding of the effects of recent climate change on forest growth in the Mackenzie valley. Tree rings were used to quantify historical forest productivity in sites along a 1 400 km transect in northern Canada. It was found that productivity has been increasing significantly in the northernmost sites, particularly those dominated by permafrost. In the south, where permafrost is less prevalent, the results were variable. Both responses appear related to changes in water availability. In the north, increasing temperatures appear to change the depth of thaw, increasing the depth of the active layer, resulting in increased soil water mobility and resultant tree productivity. However, in the south, the same increase in temperature has resulted in more frequent water stress, resulting in both increases and decreases in productivity depending on the hydrology of the site.

C5.05 Oral

Historical fire regimes and stand development patterns in Australian Eucalypt forests – Integrating tree-ring, pollen and charcoal analysis

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Dendroecological studies play an important role in describing the history of fire and forest stand development. Such studies focus on the relatively recent history of the forest, typically over time scales of centuries. Reconstructions of stand development patterns provide unique insights into processes of regeneration, stand development and disturbance regimes, which can inform forest management prescriptions such as prescribed burning or harvesting schedules. To develop a deeper understanding of the influence of fire on the landscape, and the changes in vegetation assemblages over longer time scales, the integration of other historical reconstructions can be beneficial. Palaeoecological techniques such as pollen and charcoal analysis can provide a broader historical context for observations drawn from dendroecological studies and can provide information that will put management decisions into the context of variation at much longer time-scales. Here, we integrate results from a dendroecological reconstruction of the fire history and stand development patterns of tall open Eucalypt forest in South-eastern Australia. We then integrate these results into the broader context afforded by recent studies from pollen and charcoal analysis from the same area as an example of the way in which information from such studies can be integrated to provide a deeper understanding of the long-term ecology of forest ecosystems.

C5.06 Oral

Asymmetric variability between maximum and minimum temperature in Northeastern Tibetan Plateau: Evidence from tree rings

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Ecological systems in the headwaters of the Yellow River, characterized by hash natural environmental conditions, are very vulnerable to climatic change. In the most recent decades, this area greatly attracted the public's attention for its more and more deteriorating environmental conditions. Based on tree-ring samples from the Xiqin Mountain and Animaqin Mountains at the headwaters of the Yellow River in the Northeastern Tibetan Plateau, we reconstructed the minimum temperatures in the winter half year over the last 425 years and the maximum temperatures in the summer half year over the past 700 years in this region. The variation of minimum temperature in the winter half year during the time span of 1578–1940 was a relatively stable trend, which was followed by an abrupt warming trend since 1941. However, there is no significant warming trend for the maximum temperature in the summer half year over the 20th century. The asymmetric variation patterns between the minimum and maximum temperatures were observed in this study over the past 425 years. During the past 425 years, there are similar variation patterns between the minimum and maximum temperatures; however, the minimum temperatures vary about 25 years earlier compared to the maximum temperatures. If such a trend of variation patterns between the minimum and maximum temperatures over the past 425 years continues in the future 30 years, the maximum temperature in this region will increase significantly.

C5.07

C5.07 Oral

Dendroclimatological analysis of summer temperatures in the Irik Valley, Elbrus Region (Russia)

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Various studies show that mountain glaciers are subject to a more or less rapid retreat, which is often correlated with changing climatic conditions. In high mountains, direct meteorological measurements do not normally exist. Therefore, the reconstruction of paleoclimatic conditions has to be based on proxies such as historical records, gas concentration in ice cores or tree-ring records. The first two methods are relatively difficult to use due to the lack of quantitative records of meteorological parameters or because of the elevated costs related to the use of instruments. On the other hand, dendroclimatology has proven to be a reliable tool for the reconstruction of e.g., summer temperatures in high-elevation environments. We have therefore used dendroclimatology to reconstruct climatic changes of the past two centuries in the Irik Valley (southeastern Elbrus Massif, Central Caucasus). For this purpose, 60 increment cores have been extracted from 30 pine trees (*Pinus sylvestris*) situated at the trimline. The samples were then prepared and analyzed following the classical steps in dendroclimatology. First results show an increase of summer temperatures starting in the first half of the 20th century. These changes seem to be in concert with the retreat of most of the valley glaciers in the Elbrus region. This obvious retreat may vary between tens and hundreds of meters as in the case of Kaskatas and Irik glaciers.

C5.08 Oral

Age of the *Pinus sylvestris* trees and forests in northeastern Finnish Lapland

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Forest age, i.e. age of the oldest trees in a forest, is one of the most important factors that affect the tree size distribution, forest carbon pool and species composition. In this study, a total of 1030 living and dead trees were sampled on 256 systematically located study plots in three landscapes in north-eastern Finland dominated by *Pinus sylvestris*. Two of the landscapes were located in commercially cut forests and one in Urho Kekkonen National Park. The sampled trees were primarily selected for reconstructing fire history of the region but can be used to estimate the age of the forests as well. Sawn disks and partial cross sections of trees were dendrochronologically dated to the correct years. The oldest living *Pinus sylvestris* in the sample had a pith year of AD 1244 and thus it was about 780 years old. On average the samples from living trees included nearly 300 annual rings. The ages of the dead trees were similar. Moreover, it appeared that the dead trees preserve extremely well; the oldest snags, stumps and logs have been dead for more than 500 years. The average age of the forests was more than 340 years. Forests of the commercially cut areas were not any younger than in the national park. The results demonstrate the unexpectedly slow dynamics of northern *Pinus sylvestris* forests; if the forest is destroyed by a clear cut, it takes half a millennium to have it back.

D1.01 Invited

Trade, earthquakes and tsunami – Tree-ring study on Yenikapi harbor in Istanbul

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The Yenikapi harbor area in Istanbul has been under construction since 2004 to build a tunnel under the Bosphorus that will eventually ease traffic congestion between the European and Asian parts of the city. Archaeological excavations were initiated by the Istanbul Archaeological Museum soon after the project began, and over the past five years

the earliest known city wall of Constantinople, its 5th–10th c. commercial harbor, and at least 33 shipwrecks of varying size have been uncovered. It may well be "the greatest nautical archaeological site of all time" (Rose and Aydingün, p.34, Archaeology July/August 2007). The construction of the tunnel has been postponed until completion of the excavation and preservation of archaeological materials. Their range includes everything from Late Neolithic wattle-and-daub structures to thousands of Byzantine artifacts and late-Ottoman wind mills.

Around the 6th century AD, a catastrophic event destroyed the harbor. The 6th century destruction level could be interpreted as a tsunami deposit, based on the stratigraphy and debris (intermixed pottery sherds, gravel, wood fragments, shells, bones, and complete skeletons of five horses and a camel). Next, the tsunami may be related to one of the earthquakes in AD 553, 557, and 558 which caused the dome of Hg. Sophia to crack and collapse. Part of the dock constructions was covered by these deposits. Dendrochronological study of wood samples from the docks of this ancient harbor provide invaluable insight into the establishment and renovation dates of this major harbor and the potential climate and non-climate related events that affected the harbor throughout its history.

The case of Yenikapi will be used to highlight the recent advances of dendroarchaeology – a discipline standing at the intersection of science and humanities.

D1.02 Oral

Differentiation of wood provenances of Norway spruce and Silver fir in Southern Germany by dendroecological and statistical methods

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D1.02

The synchronisation and age determination of historical tree-ring samples require long and statistical verified chronologies. The different regions in Southern Germany are characterized by various climatic regimes, representing growth conditions at low elevation sites around 300m a.s.l. up to the sub alpine timberline around 1800m a.s.l. In Southern Germany, historical logging by rafts and timber storage at water based towns since the mediaeval times caused a strong mixture and segregation of wood between the location of its extraction and the location of its usage. Thus, over-regional chronologies are not suitable for synchronisation and dating of wood samples from different provenances.

The aim of the presented study was the development, test and application of different methods in order to establish regional and altitudinal specific chronologies for the determination of wood provenances and the dating of historical wood samples. Recent tree-ring data of Norway spruce (*Picea abies* (L.) [Karst.]) and Silver fir (*Abies alba* Mill.) of around 40 sites along elevation profiles in Southern Germany were used to evolve a model which can display provenance specific differences in tree-ring series. The derived model is presented as base for the differentiation and integration of regional and altitudinal specific chronologies.

D1.03 Oral

Lessons Learned from Irish Dendrochronology

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This paper will look in a little detail at the dating process and at how even dendrochronological dating has to be interpreted depending on the completeness of the samples. It will review issues concerning the importance of sapwood and how it is a limiting factor when its comes to answering questions about cause and effect in the past. It will draw the distinction between the issue of dating an indivdual site and the patterns of dates observed when many site dates are combined. Alongside a picture of human activity in the past Irish landscape it will help to understand enivironmental information contained in the tree-rings records. These different lines of enquiry will show the first clear glimpse of what may have been going on in the Irish past, at high chronological resolution.

D1.04 Oral

Filling in the blanks in European dendrochronology: Building a multidisciplinary research network to assess Iberian wooden cultural heritage worldwide

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Dendrochronology is used in most of Europe to answer questions about the age and origin of wooden artefacts and related topics such as trade or the technological aspects of craftsmanship. In the Iberian Peninsula, such studies are hampered by two main factors: first, the lack of awareness about the method and its possibilities on the part of potential users (e.g. archaeologists, conservators, historians); second, existing tree-ring chronologies from the Iberian Peninsula are too short and few to allow such studies regarding indigenous wood. The occurrence of either or both of these factors results in inadequate assessments of wooden heritage in and originating from Spain and Portugal. This is illustrated by the unknown origin of the so-called "Flemish" oak used in 16th-century Spanish altarpieces and by our inability to date and confirm the Iberian origin of certain shipwrecks found in the North Sea. Equally, 15th- and 16th-century wrecks of ocean-going Spanish vessels found in the New World remain unidentified and undated, as well as Armada and earlier wrecks of supposed Iberian origin found along the British and Irish coast.

The Dutch Organization for Scientific Research has funded a project to set up an international, multidisciplinary research network of historians, archaeologists, conservators and dendrochronologists interested in improving the assessment of wooden heritage in and from the Iberian Peninsula. This group will pursue the following objectives: i) cataloguing existing dendrochronological data from Spain and Portugal, ii) developing a research agenda regarding Iberian wooden heritage and iii) designing strategies for further chronology compilation.

D1.05 Oral

Dendrochronological investigations of medieval and post-medieval buildings in south-west England

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Extensive dendrochronological investigations have been carried out over a number of years on oak (*Quercus* spp) timbers in standing historic buildings in south-west England. These investigations have been partly research driven but also provide valuable information for English Heritage, the government advisory body, in its role of protecting and promoting England's historic environment. The problematic nature of the material in this region has been previously highlighted but the extensive investigations undertaken have gone someway to addressing these difficulties. The results obtained provide a greater understanding of the historic development of each individual building but, perhaps more importantly, also allow a much more detailed understanding of building typologies that can be applied more widely. The increasing amounts of data, combined with the information derived from buildings considered unsuitable for dendrochronological analysis, are also revealing insights into the changing nature of the woodland resources available and their exploitation over several centuries. This paper aims to investigate and discuss the material investigated to date with a view to highlighting the potential within this increasingly extensive data set.

D1.06

D1.06 Oral

Results of research into subfossil oak trunks from the Morava Basin

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The paper presents the results of the research into subfossil oak trunks obtained in the last 3 years. The research commenced in the second half of 2007 with the aim to extend the oak standard chronology for the Czech Republic towards the past. As archaeological finds of such age are rare, it was necessary to start using subfossil wood. The samples from selected locations underwent dendrochronological analysis. The available and sufficiently long standard chronologies from Germany, Austria and Poland were used for the process of dating. When the dendrochronological dating was unsuccessful, the samples were sent out for radiocarbon dating. In total, more than 120 samples were taken and floating average tree ring curves were created. It was not possible to directly connect any of these curves to the Czech oak standard chronology. To utilize the rare material in its full potential, the research also included the testing of selected physical and mechanical properties of subfossil oak. The samples were tested in compliance with valid Czech technical norms. Mechanical properties of subfossil oak correspond to about 70–80% of the values of recent oak; on the other hand, shrinking and swelling are twofold. In the following years, the sampling and sample processing of subfossil oak trunks is supposed to continue with the priority to interconnect the floating curves with the Czech standard chronology.

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D1.07 Oral

Prehistoric dating of the salt mine Hallstatt – Austria: A problem of inter-species synchronisation

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D1.07

The prehistoric salt mine Hallstatt together with its burial ground is the most prominent archaeological site in Austria – the name also standing for the Hallstatt period (800 to 400 BC). Due to the perfect conservation with rock salt many objects of organic material, primarily wooden artefacts, have been found.

As just narrow pathways were reaching the area of salt mining, a local wood utilization can be hypothesized. The forest sites to utilize the mining timber are located between 900 m asl and 1500 m asl. The spectrum of wood species utilized in the Bronze Age comprises 47% Norway spruce, 43% Silver fir, 8% beech and 1% for European larch and maple each. Sampling activities have yielded in hundreds of wooden artefacts so far, including the discovery of the oldest wooden staircase.

Most Bronze Age and Iron Age chronologies currently existing are established either at lower elevations, e.g. at lake settlements; or at much higher elevations, e.g. tree-line chronologies. The most promising reference chronology already available, including spruce and larch, originates from the Dachstein plateau, close to Hallstatt.

Inter-species synchronisation of living trees at Hallstatt showed, that it is possible to synchronize different species. As the site altitude ranges from 900 to 1500 m asl. The synchronisation of sites at different elevations was checked too. It was still possible to synchronise against different species. Comparison with existing chronologies showed the strong linkage to the alpine region as well to the northern alpine foreland.

D1.08

D1.08 Oral

Medieval roof constructions in Flanders: Built with local timber or not?

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Building activities during the middle ages required massive amounts of lumber. To date, we encounter these medieval timbers in roof structures of historical buildings, churches and belfries. In Flanders (northern part of Belgium) a lot of construction wood was imported from remote regions during the middle ages. Especially forests along the rivers Meuse and Rhine were sources of high-quality timber.

For instance, in Damme (near Bruges) several building phases can be identified by tree-ring dating on beams from the roof of the Church of Our Lady. The oldest (~1240 AD) and most recent roof (~1330) of that church were erected during different construction phases, separated by up to 100 years. Despite this relatively long interval, imported wood from the same geographical region was used, as demonstrated by dendro-provenancing. In contrast, the dendrochronological analyses on the roof of the parish church of Belsele, which consists of at least 3 building phases, shows that the oldest part (~1280) was constructed with imported wood from the Meuse valley, where the youngest constructions were made with local wood (~1425/~1500). In practice, the local wood can easily be distinguished from the imported variant by the notable wider tree-rings and more irregular growth pattern.

The regained interest in local wood for construction purposes towards the 15th century proves to be a more general phenomenon in Flanders. Whether this is related to forest recovery or to a changing political situation remains unclear so far.

D1.09 Oral

Reconstructing Al-Aqsa: Dendrochronological analysis and absolute dating of timbers from Jerusalem's most sacred mosque

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Al-Aqsa Mosque, which lies on Jerusalem's Temple Mount, is the third most holy site in Islam and has been an important part of Jerusalem's landscape from its construction in the early 8th century CE to the present. The mosque has undergone several renovations since its construction, and previous studies indicate that some of its primary timbers may themselves have been re-uses of earlier material (Lipschitz et al. 1997; Lev-Yadun et al. 1984). Obtaining absolute dates for the mosque's timbers provides valuable data in reconstructing the building's history, particularly in identifying periods of reconstruction and timber reuse

In 2008 and 2009, members of the Malcolm and Carolyn Wiener Laboratory for Aegean and Near Eastern Dendrochronology at Cornell and the Weizmann Institute of Science sampled a collection of timbers that had been removed from the southeastern corner of al-Aqsa during the mosque's 1969 renovations. The timbers studied were identified as Cedrus libani and deciduous *Quercus* species, all likely non-native to Israel (as was also noted in previous work by Lev-Yadun 1992). We present here the tree-ring chronologies obtained from these timbers and their preliminary dating, and discuss how these correspond with the historical record and with previous published studies. We also discuss the tree-ring growth patterns and anatomical features observed in the samples and how these may give insights into where the materials were procured and the environmental conditions under which they grew.

D1.10

D1.10 Oral

Timber trade in the Baltic area during the 13th century

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A quite dense network of regional and supra-regional tree-ring chronologies has meanwhile evolved throughout most of Europe. They were primarily established as dating tools. For at least 40 years, it is known that timber in the past was transported over long distances; obviously not only timber of high quality for art-historical objects, but also building timber. This may quite often have led to the fact, that 'foreign' samples were included in such composite dating chronologies. Therefore, a risk for circular reasoning is grounded if such a dating chronology is used to prove the origin of timbers. Furthermore, it is problematic to use these chronologies as climatic archive. As a consequence,

Many such chronologies will have to be dismantled and re-assembled on the basis of new criteria.

The case study deals with oak beams from the Holy Ghost-Hospital in Lübeck/Northern Germany. Thirty years ago the roofs were dated to 1286–89 AD. Beside the conventional similarity measures such as W- and t-values, a cluster analyse was applied to approach the question of the origin of timbers.

D1.11 Oral

Identification of Iranian archeological woods by vessel shape

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Iran has a history of civilization going back over 5000 years. A simple technique for wood identification would be valuable at many of its historical sites. Wood Anatomists rarely uses the wood maceration in wood identification. However, in the identification of woods, sawdust, wood chips, decayed woods, archeological woods, the use of vessel elements may be very useful. In this research, vessel elements and other important indicators characteristics of 20 most important hardwoods species of Iran have been recorded. Prior to archeological wood identification the important of Iranian wood has been gathered by using of increments borer and placed in equal parts of glacial acetic acid and hydrogen peroxide in oven at 60°C for 48 hours. The wood samples were then washed, placed in small flasks with 25ml distilled water and the fiber bundles were separated into individual fibers using mixer with a plastic. The macerated fiber suspension was finally placed on a slide and dyed with small drop of safranin. In hardwoods, vessel characteristics, including shape, spiral thickening, perforation plate, and pits, especially ray- vessels pits and also vasicentric and vascular tracheid are most crucial features for identification. This study proved that the identification of Iranian archeological wood via vessel shape is feasible and the identification of hardwoods is easier than softwood due to the structural diversity in hardwoods.

D2.01 Invited

Spring water levels reconstructed from ice-scarred trees and cross-sectional area of the earlywood vessels in tree-rings from eastern boreal Canada

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D2.01

Flood levels occurring at the time of spring break-up were reconstructed for Lake Duparquet, a large unregulated water body located at the southern fringe of the boreal forest in north-western Quebec. In 1997, the frequency and magnitude of spring floods associated with ice break-up was successfully achieved using cross-dating of ice-scars occurring along the trunk of northern white-cedar (*Thuja occidentalis* L.) trees exposed to drifting ice and debris during ice break-up. This reconstruction was recently compared with early-wood vessel anomalies occurring in tree rings from black ash (*Fraxinus nigra* Marsh.) trees growing on the lake flood-plain. It was hypothesized that earlywood vessel development would be affected in F. nigra trees exposed to floods lasting into the early growing season thus re-sulting in reduced cross-sectional area of the earlywood vessels. The years with lowest cross-sectional area of the earlywood vessels were 1890, 1907, 1909, 1917, 1922, 1928, 1947, 1950, 1960, 1967, 1979, and 1989. Many of these years also corresponded with years of maximum ice-scar frequency and/or ice-scar height. Interestingly, the earlywood vessel chronology was negatively associated with both ice-scar frequency and maximum height (Spearman rho $r=-0.573$, $p<0.001$ and -0.329, $p=0.001$, respectively). The strong association between the ice-scar derived chronologies and the independently derived earlywood vessel chronology suggests that during major ice-flood years, the high water level on Lake Duparquet may persist long enough so that the earlywood vessel production of floodplain F. nigra trees is affected.

D2.02

D2.02 Oral

An ensemble-based approach to reconstructing gridded drought from tree rings over monsoon Asia

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Long-term spatiotemporal reconstructions of the Asian monsoon system are needed to better understand its complex variability and causes over time. This has been accomplished now through the development of a Monsoon Asia Drought Atlas (MADA), a gridded set of Palmer Drought Severity Indices (PDSI) for the summer monsoon season. The MADA was developed using a ensemble-based generalization of point-by-point regression (PPR) used to reconstruct gridded PDSI over North America. The original PPR method was not as successful here because of the relatively high level of noise in both the instrumental PDSI grid and the tree-ring network used for reconstruction. In addition there was a significant geographic mismatch between the irregular tree-ring network and the regular PDSI grid being reconstructed. To reduce the effects of noise on the grid point calibration models, an ensemble-based modification of the PPR method was implemented in which the covariance matrix of tree-ring predictors used for reconstruction at each grid point was perturbed to produce an ensemble of six reconstructions. This was also done for four different search radii used for locating candidate tree-ring predictors around each grid point to take into account the spatial mismatch between the regular PDSI grid and irregular tree-ring network. The net result was the development of a 24-member ensemble of reconstructions at each grid point. By robustly averaging those reconstructions, it was possible to produce better-calibrated and verified reconstructions of PDSI. The general utility of this approach to low signal-to-noise climate reconstruction problems in dendroclimatology should be investigated.

D2.03 Oral

A 1000+ year summer PDSI reconstruction for southern-central England

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We present a millennial long dendroclimatic reconstruction of summer PDSI for southern-central England. Earlier work by Keith Briffa identified a significant moisture stress signal in ring-width data measured from Oak trees growing in the south of England. In this study, we build upon this earlier research, specifically targeting south-central England, and have derived a highly replicated Oak ring-width composite chronology using both living and historical material. At the time of writing this abstract, the data-set includes 258 living trees (1725–2006) and 1313 individual historical series (827–1913). The period expressed by at least 30 trees is 980–2001. Calibration experiments identify optimal seasonal predictand targets for March-July precipitation ($R^2 = 0.31$) and July–August PDSI ($R^2 = 0.32$) with the latter parameter being temporally more stable. Detrending of the ring-width data, using the Regional Curve Standardisation method to capture lower frequency information, results in a series showing wetter conditions in the medieval period until ~1300AD, dry conditions until the mid 19th century and wetter conditions leading into the late 20th century. These pluvial conditions are in broad agreement with historical and peat water level proxy records for England.

D2.04

D2.04 Oral

Dendrohydrology: A tool for decision making in the face of climate uncertainty

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Increasing water demands, persistent drought, and projections for a warmer and possibly drier future have forced water managers in the southwestern U.S. to adopt new tools and sources of information for water resources planning. Five years after the first workshop on dendrohydrology for water managers was held in Arizona, tree rings reconstructions of annual streamflow have become widely accepted as a tool for planning in the face of climate uncertainty. The primary renewable source of water in the southwestern U.S. is runoff from mountain snowpacks. The high sensitivity of tree-growth to winter precipitation has made it possible to reconstruct past streamflow for many rivers in this region. These reconstructions and the broad range of hydrologic variability they document have become an important source of information for planning. Workshops, collaborations, and the development of TreeFlow – a web-based resource – have all contributed to the wide acceptance and use of tree-ring data by water resource managers. An independent evaluation indicates that water professionals are using tree-ring data in a number of ways, ranging from educating the public and to providing input for water system models. New applications are combining past climate variability from tree-ring data with projections of future climate change. The application of these data to resource management in the Southwest may provide useful examples for water managers elsewhere. Tree-ring data are increasingly being adopted as a planning tool in other regions as well.

D2.05 Oral

A Central European oak network reveals inter-annual to multi-centennial hydroclimatic variability over the past 2500 years

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Past natural and future anthropogenic drought dynamics have and will impact terrestrial ecology, agricultural productivity, socio-economic stability, and public health on various time-scales. On the European-scale, annually resolved estimates of past hydroclimatic conditions are primarily based on tree-ring chronologies, but rarely extend into medieval times and no such evidence is currently available for the Roman era. There is no lack of historical and archaeological oak (*Quercus* sp.) wood that dates back to this period and oak growth has been proven to be precipitation sensitive. Yet, the dendroclimatological potential of this material depends on an explicit separation of climatologically and non-climatologically induced signals on longer than annual time-scales. Here we address this issues by compiling Central European ring width measurements from >7200 living, historical, archaeological, and sub-fossil oaks. This unique network covers Northeast France, Southeast Germany, and Northeast Germany over the past 2500 years. We applied extreme year analyses, calibration/verification trials, and standardization techniques to preserve low-frequency information, which allowed us to detect hydroclimatic fingerprints on inter-annual to multi-centennial time-scales. A multi-proxy comparison, for the first time, allows different climatic parameters to be distinguished for the Roman period. We discuss the potential of low-elevation oak data to estimate synoptic-scale variability in summer precipitation back to pre-historic times, taking temporal changes in wood provenance, forest utilization, and stand dynamics still complicate interpretation of particularly longer-term fluctuations into account.

D2.06

D2.06 Oral

Reconstructions of regional scale hydroclimatic variability in California using a network of high-quality blue oak (*Quercus douglasii*) tree-ring chronologies

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California's endemic *Quercus douglasii* woodlands are found at the lower forest border throughout the foothills of the Coast Ranges and the Sierra Nevada, encircling the great Central Valley. The species was never systematically logged and old-growth blue oak woodlands still survive in many places. We have developed a new network of 35 tree-ring chronologies that are 400–700 years long and are well distributed across the species' native range. These records, comprised of samples from living trees and well-preserved dead wood, are among the most moisture sensitive tree-ring chronologies ever developed in North America. The chronology network has been used to reconstruct a host of hydroclimatic variables across California, including precipitation, streamflow, estuary inflow, and San Francisco Bay salinity. The reconstructions exhibit outstanding regression statistics and reveal a dramatic history of regional scale moisture variability. We are currently working with state- and regional-level water managers to determine how these data can be best applied in the context of long-term drought planning.

D2.07 Oral

Applying the tree-ring record to critical problems in water resource management

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D2.07

Many watersheds in western North America are undergoing rapid, fundamental transformations due to interactions among climate change, widespread fire and pathogen outbreaks, species invasions, and altered patterns of human land-use. In turn, regional water managers face great challenges in identifying and implementing effective adaptation and mitigation strategies, challenges that are amplified by uncertainties in predicting local to regional-scale climate change. Dendroclimatology, dendrohydrology, and dendroecology can provide valuable insights by revealing the range of natural hydroclimatic variability in the region, and by showing how runoff producing areas have responded to past changes in climate of various types, magnitudes, and rates. Here we describe four different applications of dendroenvironmental records to problems in water management from a region that encompasses key source areas for the Colorado, Columbia and Missouri River systems. Rather than simply providing cautionary tales about the potential for extended droughts or other types of change, dendroenvironmental records can be used as direct inputs to hydrologic simulation models, and provide a foundation for exploring water-system vulnerabilities within a robust, probabilistic framework. When combined with forecasts of future climatic change, dendroenvironmental records offer detailed, realistic scenarios that can reveal water-system vulnerabilities, and help managers identify "win-win" strategies for responding to a broad range of potential futures. Most importantly, these studies show that tree-ring records are an excellent tool for engaging diverse groups in discussions of environmental change, and for promoting concrete management actions in the face of significant uncertainty about future climates.

D2.08

D2.08 Oral

Development of south Swedish bog-pine chronologies – assessment of palaeoclimatic potential on local to regional scale

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The aim of this project is to reconstruct humidity variations during specific periods of the Holocene with high temporal precision based on dendroclimatic analysis of subfossil Scots pine (*Pinus sylvestris*) together with peat stratigraphy from raised bogs in southern Sweden. Periods of relatively dry climatic conditions and lowered groundwater levels allow pine forest to establish and spread across peat bogs. As a consequence of inhibited root respiration periods of persistently elevated groundwater tables are a major stress factor for peatland trees and may in some cases result in synchronous degeneration events. More than 500 samples from five peat bogs used for peat mining have been collected. Chronologies covering almost 2500 yrs have been developed based on pine samples from three of these bogs. The dated chronologies cover the periods of 5219–3728 BC and 2172–1204 BC. The chronologies are of importance as they provide detailed regional palaeoclimate records for two different climate modes in southern Sweden. Tree growth variability, shifts in population dynamics and specific locations of individual trees, together with peat stratigraphic studies, enable reconstruction of local environmental conditions and regional climate changes that affected the surface wetness of the bogs. The establishment of pine settlements on the investigated peat bogs correlates with known dry periods when lake-levels were low in southern Sweden.

D2.09 Oral

Multi-century tree-ring reconstruction of annual streamflow for the Maule watershed, South-Central Chile

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Given the increasing importance of water availability as a restriction for future development, the reported decreasing trends in precipitation in South-Central Chile, and the high priority conservation of the Valdivian rainforest eco-region, it is essential to understand changes in water availability in a long term perspective in this area. Thus, the present study assesses a 450-year annual streamflow reconstruction in the northern part of the eco-region for the Maule river watershed (35º–36º 30`S). This reconstruction uses *Austrocedrus chilensis* tree-ring chronologies and goes back until 1550. A singular spectral analysis shows two main oscillation modes, a 17.5-year cycle and a 47-year cycle that explain almost 40% of the temporal variance.

Temporal correlations between the observed streamflow and climatic forcings such as ENSO (expressed as the Southern Oscillation Index, SOI) and the Antarctic Oscillation (AAO) demonstrate a significant correlation with both of them (winter-spring and summer, respectively and negative in both cases), showing that the precipitation regime is influenced by these two forcings in this area. A better correlation with SOI compared to AAO, shows a major influence of this phenomenon on streamflows in this region. A hydrological analysis of the reconstructed series shows that there is a higher interannual variability after 1900 compared to the period before (1550–1899). This higher variability implies more frequent and severe low and high streamflow conditions in the 20th century affected by climate change, compared to the previous period.

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D2.10

D2.10 Oral

A tree-ring perspective on recent and future Rocky Mountain runoff

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Various studies have detected and projected declining streamflow from the Rocky Mountains of western North America. Decreasing streamflow is consistent with climate model projections of higher winter temperatures with associated impacts on the depth and duration of mountain snowpacks. However, most of the analyses of recent trends are problematic because they do not account for a) water consumption and diversion, b) residual autocorrelation, and /or c) the length and timing of instrumental records relative to low-frequency variability in the regional hydrology, which is evident in multi-century proxy hydrometric records. We have established a network of moisture sensitive tree-ring chronologies for the reconstruction of streamflow from the eastern slopes of the Rocky Mountains in Alberta, Canada. These proxy records, commencing in A.D. 1200, display strong interdecadal variability, particularly at the 65-year frequency associated with the Pacific Decadal Oscillation (PDO). The combined analysis of gauge and tree-ring inferred stream hydrology suggests that the availability of future water supplies will depend as much on the future intensity and tempo of internal low-frequency hydroclimatic variability as on the effects of global warming. Our approach to the analysis of the gauge data explicitly models the influence of the PDO and autocorrelation of residual values on the variability of natural and naturalized streamflow.

D2.11

D2.11 Oral

The hydroclimatic signal in tree-ring chronologies and recent streamflow trends in the western boreal region, Canada

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Under global warming scenarios the Canadian western boreal region is projected to undergo early and major warming, accompanied by increasing streamflow due to glacial and permafrost melting and hydrological cycle intensification. Increasing streamflow trends have already been detected in the instrumental hydrometric records for the Northwest and Yukon Territories, and attributed to permafrost decay. Similar trends have been projected for and found in northern Eurasia. However, unlike the Eurasian hydrometric records, which commenced in ~1936, the Canadian records in this region are shorter in duration (only ~30–45 years) and longer-term trends, variability, and linkages to atmosphere-ocean oscillations (i.e., the Arctic Oscillation, Pacific Decadal Oscillation, ENSO) are relatively unknown. In order to extend the hydroclimatic record, we constructed a tree-ring network of 27 chronologies, primarily from *Picea glauca* (white spruce), spanning the Northwest Territories from its southern border at 60oN to tree-line. Fire-vulnerable sites were avoided; hence a relatively long boreal forest record was obtained that commenced in AD 1492. Correlations between the tree-ring indices and streamflows were significant and stronger than those between the indices and climatic variables (i.e., temperature and precipitation); hence the tree-ring data were most suitable for hydrometric inferences. Chronologies were developed using both standard techniques and Regional Curve Standardization in order to assess low frequency variation. A strong positive correlation exists between the tree-ring data and the North Atlantic Oscillation (used as a proxy for the shorter duration Arctic Oscillation). Tree-ring inferred hydrometric data provides a long-term context for the predicted global warming-induced increase in streamflows.

D2.12

D2.12 Oral

Spring flood reconstruction from ice scar chronologies: The example of lake Montausier, northeastern Canada

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Spring flood is a dominant component of the hydrological cycle in northern environments. This study aims at reconstructing the spring flood variability since AD 1850 for the upstream section of the LaGrande hydroelectric complex in northern Québec, Canada. We used discrete dendrogeomorphological indicators such as the proportion (It) and maximal heights (Ht) of ice-scarred trees sampled around Lake Montausier, a small water body whose yearly (spring) hydrological fluctuations are hypothesized to be of "regional significance". We developed a novel reconstruction model to take into account the various sources of uncertainties involved throughout the modeling process. Such uncertainties are: (1) a possible error in the estimation of It and Ht from field data, (2) error of generalizations (e.g. applying data to an independent dataset). We also introduced a new regression technique, namely Generalized Additive Models (GAMs), that enable the modeling of the non-linear relationships that naturally occur in such environments. All these techniques are implemented in a new algorithm called GLAMODEL (programmed in R). Discharge reconstructions performed from GLAMODEL suggest that, since the 1930s, spring floods became more intense and also more variable. Periods of high spring discharge were documented for the 1880s, 1930–1940s and 1960–1970s periods. These results support the past trends documented from other proxys (tree-rings) and in similar studies using ice scars in nearby environments. The novel aspect, however, is that variations in It and Ht are directly translated in terms of past discharges which makes them readily available for water resources managers.

D3.01 Invited

Use and misuse of tree rings in long-term forestecosystem research: Swiss experiences

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Tree rings have a tremendous power for reconstructing past environmental conditions, and have consequently been used in many forest monitoring programmes to extend the time range of specific attributes. Tree-ring width is influenced by many environmental factors, and tree rings can therefore be used as surrogates for assessing past environmental conditions at a site. However, disentangling these different factors is difficult, and tree rings lose their diagnostic power if incorrectly used or the experimental design is inadequate. Selecting trees according to the site characteristics where they grow, for example, can provide useful information on the different factors that affect growth at different sites. If all environmental factors bar one can be kept constant, it may be possible to determine the influence of that single factor on tree growth. However, establishing the required experimental design in long-term forest ecosystem research plot is difficult, as the plots have been purposively selected to meet a range of criteria that may or may not address the environmental factors of concern today.

It is difficult to use tree rings to assess forest stand biomass. Some attempts have been made, but such studies usually select dominant trees rather than suppressed ones, creating a sampling bias. Using tree rings as indicators of tree biomass accumulation through time is possible but all these sources of error should be accounted for. A sampling design that deals with all these issues adequately has yet to be developed, and represents a major challenge for dendroecology.

D3.02

D3.02 Oral

Climate impacts on tree growth, mortality and lifespan of conifers in forests of the European Alps and the Rocky Mountains

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Short- to long-term variability of climate affects forest ecosystems at different spatial and temporal scales. Annual climate variability results in distinct growth patterns, which are synchronous for many trees in a region. Infrequent, extreme climatic events may induce rapid and widespread changes in processes of population demography such as tree mortality. Consequently, changes in the mean and variability of climate parameters may have persistent effects on the structure and species composition of forest stands. I will present results on different tree-ring studies from several forest stands of the European Alps (Switzerland and Slovenia) and the Rocky Mountains (Colorado, USA). Investigated species include shade-intolerant pine species (*Pinus silvestris*, *Pinus montana*, *Pinus contorta*) as well as shade-tolerant spruce and fir species (*Picea abies*, *Picea engelmannii*, *Abies alba*, *Abies lasiocarpa*). I will link climatic and topographic variability with tree growth and mortality. First, the trade-off between growth, mortality risk and lifespan of trees is demonstrated. The apparent paradox of reduced growth rates resulting in both increased mortality risk and increased lifespan will be resolved. Second, drought decreases growth rates which in turn increases the risk of drought-induced mortality. Tree mortality may occur during drought years, but also lagged over several years following drought. At last, potential effects of global warming and more frequent droughts on the relationship between tree growth, mortality risk and maximum lifespan are discussed.

D3.03 Oral

Growth and sensitivity of beech at the dry distribution limit

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Beech (*Fagus sylvatica* L.) covers a large area mainly in the colline and montane ranges of Europe, and a drier and warmer climate, as expected for the coming decades, is likely to alter its distribution. So far, an altitudinal shift has been projected using a variety of modelling approaches. However, we lack knowledge about the climatic and edaphic factors that control the growth and competitive behaviour of beech at its dry distribution limit. In this project, we applied and further developed dendroecological methods to study the drought response and sensitivity pattern of beech at sites with different moisture regimes. Specifically, we compared three pairs of sites from different geographical regions at the climatic dry distribution limit of beech in Switzerland, including one site on a dry and one on a mesic soil each. The adaptation of radial growth to water availability was found to differ between moderate and dry sites, in that average ring-width at moderate sites was around double the width at dry sites. For the whole study period between 1930 and 2006, the sites with lowest available water capacity (AWC) were found to respond most sensitively to drought. However, in recent years, sites with higher AWC showed increasing drought sensitivity, i.e. responded even more strongly to drought than the dry sites. This change in sensitivity was found to run parallel to a seasonal shift in drought response at moderate sites, with different months getting more important for drought response in the three studied regions. Whereas dry sites generally showed more negative pointer years than moderate sites, it appears that the frequency of pointer years has increased at moderate sites, i.e. that moderate sites have become particularly more sensitive in the last quarter of the 20th century. Yet, the frequency of pointer years at the dry sites has remained fairly constant. These results indicate that dry forests at the limit are probably already adapted to extreme conditions, while changes in the growth patterns of moderate forests have to be expected.

D3.04 Oral

Tree response to severe drought in the Republic of Ireland: The case of Avoca, Co. Wicklow

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D3.04

Tree-ring chronology from forest stands growing on brown earth soils in the British Isles would enable us to ascertain a discernible trend in response to climatic conditions. As part of the COFORD/Forest Research UK funded project CLIMADAPT, an assessment of growth across a climatic gradient (moist to dry) will be completed from the eastern coast of Ireland to eastern England.

Radial increments, height distribution, crown ratio, basal area and dbh were used to characterize tree growth and stand dynamics. Carbon and oxygen stable isotope values were measured around two periods of localised drought, covering a year before and three years after each drought, for a preliminary study at Avoca, Ballinvalley on the east coast of the Republic of Ireland.

The aim of this assessment was to develop a methodology to understand and explain using dendrochonological procedures and stand dynamics, tree adaptability to severe climatic conditions; particularly moisture deficit and temperature. Using data from tree ring series and stable isotope analysis, meteorological records were analysed to understand tree responses to adverse conditions and eventually will be used to model their future adaptability to changes in our environment following IPCC scenario predictions. This short communication outlines some preliminary results from the study.

The methodology developed and tested throughout this phase conducted in a Sitka spruce stand in Avoca Co. Wicklow, will later be extended to Douglas fir and Scots pine, growing on a similar soil type and broaden the study across a transect of similar accumulated temperature but varying in moisture deficit.

D3.05 Oral

Spatial and age structure, tree-ring growth dynamics and climate sensitivity in treeline beech forests in Central Italy

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We assessed the spatial and chronological structure of abandoned coppiced beech forests at the treeline in central Apennines (1700–1800 m asl) included since 15 years in the Gran Sasso-Laga Mountains National Park. The aims were to to model their dynamics in relation to natural and anthropogenic disuturbances, in a sustainable management perspective. In two permanent plots (of 1.6 and 0,5 hectare) we have mapped and censed all living (shoots in stumps and releases) and dead (log and snags) tree elements (around 6000 individuals). In each stump we recorded d.b.h. of all present shoots, total height and crown features of each dominant shoots and in most of them we extracted one core at dbh (more than 600 samples). Tridimensional layout of the two forest plots was carried out using existing dedicated packages (SVS and En-Vision); spatial distribution analysis of the main structural parameters (crown area, dominant diameter, dominant age, etc.) was geostatistically assessed (Ripley's K, Moran's index, Local Getis) and dendrochronological and dendroclimatic analysis performed according to standard methods (COFECHA for crossdating, ARSTAN for standardization, DENDROCLIM2000 for climate-growth relationships). We have found similar original age structure, but different growth dynamics in the two study plots and we believe that the prevalence of vegetative reproductive systems cause: i) a standardizing effect due to lower genetic diversity of the coppice forests, ii) an inertial effect where each stump (with shoots) carries the influence of former management and site history affecting the growth and the adaptive efficiency of its regeneration system.

D3.06

D3.06 Oral

Climate signal and sensitivity of Turkey oak (*Quercus cerris*) in central-southern Italy

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Turkey oak (*Quercus cerris)* is a north-mediterranean tree species widespread especially in the sub-montane zones of southern-eastern Europe. This study was aimed to assess climate-growth responses in managed forests of the central Apennines. We sampled 550 cores and 20 discs from 14 turkey oak high forest in order: a) to build site ring-width and BAI (Basal Area Increment) chronologies; b) to calculate growth-climate correlation function (CF) using climatic time series from CRU 3.0 grid (1901–2006); c) to assess CF stationarity and consistency through time (moving correlations) and for different age classes (50, 100, 150 year). We used standard procedures for core extraction (two cores per tree at 1.30 m above ground level), preparation and tree-ring width measurement and crossdating. Tree age span from 60 to 140 year. Single chronologies were standardized using software ARSTAN applying a double detrending (negative exponential function and 10-year smoothing spline) to maximize the high frequency variability due to climatic signal. Standardized series were related to temperature and precipitation series using a bootstrap procedure with DENDROCLIM2002 software. A common climatic signal appears from a good inter-series synchronization, even in presence of different management regimes. The CF profiles show that radial growth is positively correlated with summer precipitations and negatively correlated with summer temperature. Younger age classes (<50 years) are less sensitive than the older ones to limiting factors (temperature in particular). The greater sensitivity of older trees may suggest a possible adaptation of *Quercus cerris* to new climatic conditions.

D3.07 Oral

Norway spruce of different provenances grown in dry regions of Austria – Influences on ring width and wood density

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In lowland forests of eastern Austria higher temperatures, limited precipitation (e.g. in Vienna: precipitation sum May to August is 278 mm, mean air temperature from May to August is 17.8 °C), and the occurrence of droughts limit tree growth, in particular of Norway spruce. The increase of the frequency of temperature-induced droughts, which is expected due to global warming, seems to worsen this situation. For a better understanding of climate-growth relationships, we analysed tree cores from three different sites in eastern Austria.

In previous studies x-ray densitometry has often been used to investigate the relationship between maximum density and summer temperature at temperature-limited sites (i.e. northern and elevation timberline). In this study, we applied x-ray densitometry on 1000 about 35 years old spruce trees originating from a national provenance trial. The influence of drought on the ring width as well as on different wood density parameters was analysed.

It was possible to describe the tremendous impact of drought on growth of the trees. Mean wood density was mainly following these trends in an inverse way – due to the increased amount of latewood. The small effect of provenance on the wood formation under drought conditions was shown.

D3.08 Oral

Comparison in radial growth patterns of *Picea abies* in Bulgarian and Swiss mountains

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D3.08

Picea abies (Karst) is a widely distributed and economically very important species in the subalpine zones of European Mountains. This enables the comparison of growth reactions and patterns of Norway spruce from regions with generally similar environmental and climatic conditions, but differing climate situations in extreme years and differing land-use history and disturbance regimes.

We developed highly replicated *Picea abies* tree-ring datasets from Bulgarian and Swiss subalpine locations and analysed them concerning growth dynamics as a result of different influencing factors, such as extreme climatic events, intraspecific tree competition and external disturbances. We further investigated differences in growth patterns based on tree ring width.

The tree ring chronologies from both regions often display differences in ring width patterns which reflect dissimilarities in climate situations in extreme years. The high spatial resolution of our field sampling strategies is a basis for analysing intraspecific competition within the forest sites, which allows conclusions about the disturbance regimes. We demonstrate that although tree-ring growth is responding in both regions in similar way to the hydro-thermal regime, differences in disturbance regimes, land-use history and microclimate strongly influence the growth of *Picea abies*.

D3.09 Oral

Studying the effect of seasonal temperature and precipitation on annual diameter growth of Scots pine on drained peatlands

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The weather conditions of the present and previous growing seasons have been shown to influence growth of coniferous trees in mineral soils sites. In the Nordic and Baltic countries, altogether millions of hectares of peatlands and wetlands have been drained in order to enhance forest production. The drainage network does not guarantee stable soil water conditions for the whole rotation. It is thus likely that especially growing season precipitation may have different influence on annual growth in peatland than in mineral soil sites. We studied the effect of growing season precipitation and temperature on annual diameter growth of Scots pine (*Pinus sylvestris* L.) in Finland in experimental peatland forests that had been drained for forestry. The diameter growth data were limited to periods when growth response to drainage had levelled out. For comparison, growth data were collected from adjacent mineral soil trees. The meteorological variables were monthly mean temperature and precipitation in a given location estimated from observations of the three nearest weather stations by means of spatial smoothing. We used the mixed linear models in describing annual growth of individual trees as a function of tree size and site properties. The peatland and mineral soil growth indices were not similar. Different weather parameters tried in the model indicated that summer time precipitation was negatively correlated to diameter growth of peatland trees but there was virtually no correlation with temperature. Trees in mineral soils showed positive correlations with summer month temperatures.

D3.10

D3.10 Oral

Effects on dry matter production and intra-annual growth ring density characteristics of genetically improved Norway spruce in northern Sweden

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The long term tree breeding programme in Sweden is mainly focused on increased volume production and improved stem properties such as straightness and branch properties. The aim with the present study was to evaluate how accumulated dry matter production of stem wood and wood density characteristics is affected by north transfer of seed origin and selection for increased growth of genetically improved Norway spruce in northern Sweden. One younger, about 25 years old, and four older, about 60 years old, genetic field experiments were inventoried in 2005 and 2006. About 1300 5 mm increment cores were sampled from 1.3 m and analysed using direct scanning x-ray microdensitometry.

The results showed that for growth conditions in northern Sweden north transfer of Norway spruce may result in increased growth ring density by decreased early wood width and increased proportion of late wood. Genetic selection for improved growth at the age of about 25 years was positively correlated with accumulated dry matter production and was also positively correlated to increased earlywood width and slightly decreased ring density. The results also points to need for investigating the relation between shoot phenology and stem wood formation and hence the timing of earlywood and latewood formation and proportions. Since forest tree breeding is made on long term basis, possible changes in growth conditions such as climate change must taken in to account and analysed in terms of possible changes in growth phenology.

D3.11 Oral

Dynamics of *Pinus banksiana* mortality in the eastern Canadian boreal forest

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In the Canadian boreal forest, fire is the main natural disturbance and initiates the succession of jack pine (*Pinus banksiana*) and black spruce (*Picea mariana*), two ecological and economical important species. By modifying the fire regime or increasing the occurrence of extreme climatic events, the present climate change could deeply affect the equilibrium of those species.

The objectives of this study are 1) to analyze the structure of jack pine-black spruce stands in function of time since the last fire, and 2) to determine the mechanisms of death of jack pine and its replacement by black spruce.

The time since the last fire was reconstructed in 19 sites of northwestern Québec with dendroecological and paleoecological methods, then dendrochronology was used to evaluate the age of living and dead trees.

Our preliminary results show 1) two death-age periods for jack pine, the first occurring when trees are around 50 years old, and the second when they are older than 130 years, 2) that jack pines of a single stand randomly die, but that once stands grouped together, particular years of death seem to prevail. This indicates that black spruces mainly develop in the stand when jack pines die of senescence, but suggests that years of extreme climatic events can lead to premature deaths of jack pines, then favoring the growth of black spruces.

The forecast increase of extreme climatic events could thus lead to a more important of black spruce in the eastern Canadian boreal forest.

D3.12

D3.12 Oral

Would *Quercus canariensis* **Willd. populations from low elevations be particularly threatened by drought increase?**

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In the Mediterranean Region, trees located in water limited sites are more likely to suffer from climate warming through increased drought stress compared to trees from the same species located in more humid sites. These water limited ecosystems are also more likely to coincide with lower elevations and latitudes, within the range where species are found. In this study we compare the response to drought of the Mediterranean deciduous oak *Quercus canariensis* sampled at three different altitudes from the range where the species is encountered in Southern Spain (from circa 300 m to 900 m). This species only occupies the most humid and warmest variants of the Mediterranean climate in Iberia and Northern Africa, thus we expect it to be particularly sensitive to increases in aridity. To study the species response to last decade's climate warming, we analyzed the tree-ring trends from these three chronologies, and also the vessel characteristics during the last 25 years from a subsample of five trees/altitude. Likewise other species in the same area, we expect this population to show a response to warming since the 1960s. The stands were of similar density, and we expect the stand coming from the lowest elevation to be more water stressed. This maximum stress might result on non-linearities in the climate-growth response. Under future climate predictions, proper management and understanding of populations at drier locations (here represented by low altitude) is very likely to be crucial for their preservation, particularly in the distribution limit of species.

D3.13 Oral

Interactive effects of climate and groundwater depth on semiarid woodlands: A dendrochronological analysis in central Argentina

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D3.13

Some calden (*Prosopis caldenia* Burkart) woodlands, a dominant vegetation type of the temperate semiarid belt of central Argentina, have experienced raising groundwater levels causing extensive tree die-off in the last decades. Although recent precipitation increases and forest replacement by crops are likely causes of this hydrological change, their relative importance driving this process is not understood. Here we explore (a) the association of calden growth to climate and groundwater depth and (b) the potential use of tree rings as a tool to reconstruct past water table depth changes. Standard dendrochronological techniques were applied to construct two chronologies, one in a high altitudinal position were water table are currently >8 m deep and the other on a low position were water tables are currently at the surface and trees have died. A higher variability relate to climate variables was found in trees located in the highest analysed place ($R^2 = 0.59$) than in the lowest place ($R^2 = 0.50$). Temperature in the growing season at the lowest place and rainfall in winter in the highest place are the significant climate variables that affect growth. In spite of the effect of water table, calden is vulnerable to climate effect. Tree die-off in the lowland site peaked in the nineties. According to these results we can now anticipate the vulnerability of these woodlands to further hydrological changes. This information will also help to understand past water table level shifts and their relative response to precipitation changes and forest replacement by crops.

D3.14 Oral

Nothofagus dombeyi **and** *Austrocedrus chilensis* **establishment in declining forests**

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D3.14

In mixed Nothofagus dombeyi – *Austrocedrus chilensis* forests successful establishment of both species occurs as a consequence of large natural disturbances in wet conditions. However, little is known about regeneration of these species at the eastern drier limit of *N. dombeyi* distribution near the pure *A. chilensis* forests. The mortality process in *A. chilensis* forests known as ‘‘mal del ciprés” generates conditions (i.e. gaps) for the recruitment of new individuals. The objective of this study was to examine the population dynamics of both species in these conditions. We sampled and described the structure of 6 symptomatic stands and used dendrochronological techniques to reconstruct basal area development and regeneration establishment over time. Bivariate event analysis was performed to examine the temporal relationships between mortality events, climate and forest establishment patterns. While the diameter class distributions show similar ranges of sizes for both species, basal area development over time indicates that *N. dombeyi* established gradually after most the *A. chilensis* trees did. Likewise, we observed that the recruitment of new individuals over the past 2 decades correspond primarily to *N. dombeyi* individuals. The result of this study shows that *N. dombeyi* has the ability for establishing in postfire pure *A. chilensis* forests resulting in mixed unevenaged forests. Although there is not enough evidence at the moment to indicate a replacement of one species by the other, it is clear that after 100 years since establishment there is an important shift in the composition of these stands.

D3.15 **Oral**

Impact of future climate on radial growth of four dominant boreal tree species along a latitudinal gradient in the eastern Canadian boreal forest

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D3.15

Future tree growth conditions would be changing with climate warming over time, thereby resulting in large uncertainty in growth prediction during the 21st century. In this paper, the phenotypically determined model and the genetically determined model was, respectively, constructed according to the following assumptions: (1) Future growth of trees at northern latitude may be forecasted by the growth-climate equations established for trees currently growing at southern latitudes, given that tree growth conditions would be changing with climate warming over time; (2) Future tree growth might be maximally predicted by the growth-climate equations obtained from the given local site, when considering the genetic constraints effect or the lagged effect of genetic response to climate on growth. The constructed two types of models were employed to predict radial growth change of four dominant boreal tree species *Populus tremuloides*, *Betula papyrifera*, *Picea mariana*, and *Pinus banksiana* from 2010 to 2099 based on several climate change scenarios data generated from GCMs and CRCM. The northern stands were predicted to show large growth increase due to future favourable growing season climate conditions, whereas the southern stands would show minor growth change or growth decline because of increased drought stress. Of the four species, *P. banksiana* would be the most beneficial species from climate warming to enhance growth over the gradient during the 21st century. These two types of models-based growth simulations may constitute two theoretical baselines for future radial growth change of these species in the eastern Canadian boreal forest over the 21st century.

D4.01 Invited

Long Montezuma Baldcypress tree-ring chronologies in Mesoamerica

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D4.01

Mesoamerica is located at the intersection of several major ocean-atmospheric circulation systems that govern seasonal to long-term climate variability over North America, including the El Nino/Southern Oscillation (ENSO), the northeast trade winds, the Inter-Tropical Convergence Zone (ITCZ), and the North American Monsoon System (NAMS). Mesoamerica (Mexico and Central America) also has a fabulous pre-Conquest archaeological record of cultural development and decline, including calendrical systems and hieroglyphic writing that are believed to provide an accurate and precise cultural chronology for some of the major pre-Hispanic occupation centers. The post-Conquest colonial and modern record for this region is rich in detail on socioeconomic extremes, including famines, epidemics of infectious diseases, and warfare. Mesoamerica does not have a long, well distributed, high-resolution paleoclimatic record with which to test hypotheses concerning climate change, internal and external forcing of climate variability over the region, or the possible role of multi-decadal climate anomalies in the rise and fall of pre-Hispanic city states, including the possible role of "megadroughts" during Classic Period decline in the 9th and 10th centuries. We have discovered ancient Montezuma baldcypress (Taxodium mucronatum) trees well over 1000-years old at two locations in central Mexico, and are developing an exactly dated ring width chronology that currently extends from AD 842 to 2009 at Barranca de Amealco, Queretaro. These trees are correlated with growing season precipitation totals over central Mexico, and will provide a valuable high-resolution counterpart to the lake sediment and speleothem records of environmental variability during the evolution of Mesoamerican civilizations.

D4.02 Oral

Plastic wood anatomical responses of tropical species to dry and moist conditions

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Tree species can largely differ in wood-anatomical properties, but yet it is unclear whether this anatomical differentiation reflects specialisation for different niches. In xylem, vessels, fibres and parenchyma accommodate hydraulic conductivity, stability and storage, respectively. Within dry and moist forests, large variation occurs in the size and density of vessels but also the share of parenchyma and fibres. This suggests large variation in water-transport capacity but also storage capacity of water and/or carbohydrates that may help trees to survive periods of low resource levels, as well as variation in the mechanical stability. In line with this, trees may face trade-offs between (1) conductivity and safety margins for cavitations in the dry forest (2) mechanical stability and storage, both within and between forests (3) mechanical stability and pace of reaching adult stature, given that fibre cell walls are the major cost of making xylem. In this study, the variation in wood anatomy (vessel size and density, tissue percentages) of 10 tree species growing both in a dry and a wet tropical forest in Bolivia was investigated. Wood-anatomical variables were measured in the outermost growth rings from digital pictures of micro-thin sections by using image-analyses techniques. Relationships between wood-anatomical properties and growth at various resource levels (light and water) were analyzed. The results provide information on the plasticity of different wood-anatomical variables and the ability of species to adapt to different ecological niches.

D4.03

D4.03 Oral

Dendrochronology and isotope chronology of *Juglans neotropica* and its response to ENSO events in tropical highland areas of Piura, northern Peru

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To carry out tree ring studies in tropical areas are challenging. Few chronologies exist, and hardly any tree ring chronologies in areas where El Niño Southern Oscillation-events are strong, such as north Peru, exist. We investigated the dendroclimatological potential of *Juglans neotropica* Diels (Juglandaceae), a tree species found in tropical and subtropical regions of Mexico, Central and South America. 225 radii from 57 trees were collected in Piura (04° 56’ S, 79° 51’ W), northern Peru, of these 112 radii from 40 trees passed quality control and are included in the first dendrochronological chronology for this species. We carried out anatomical work by taking microtone slices and doing microscopic investigations. We used standard dendrochronological methods to develop a chronology. The latter shows that ring width growth of *J. neotropica* are related to amount of precipitation. *J. neotropica* has demonstrably annual rings. In addition we measured oxygen isotopic composition from two radii from two trees and collected radiocarbon dates as independent chronological control to more firmly establish the annual nature of rings identified from growth measurements. Isotopic analyses confirm the growth pattern seen in the ring-width chronology. The age distribution of the sample collection is young and invariant, and suggests that the species is used extensively in northern Peru and protection of this important species should be assessed. Combining isotopic analysis and radiocarbon dating with dendrochronological investigations have proved useful for the investigation of *J. neotropica*, and can serve as an example for further investigation of tropical tree species.

D4.04 Oral

From darkness to light, evaluating the gap dependence of Bolivian rainforest tree species

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Light is a scarce resource in the understory of tropical forests and presents a challenge to newly established trees. Low light levels may result in sustained low growth rates over numerous years (suppressed growth). Shade-tolerant species can survive for several years in a suppressed state and it is believed that they will increase their growth rates when a gap in the canopy occurs. It is also expected that juvenile suppressed trees will react stronger than their mature conspecifics. We evaluated the diameter growth response of two shade-tolerant and one long-lived pioneer rainforest tree species to logging openings in northeast Bolivia. Logging disturbance took place seven years before the sampling date. The samples were collected considering their diameter class (5–10, 10–20 and 20–25 cm diameter at breast height) and its distance to the stump (<10m, 10–40 m and >40 m). Tree-ring widths were measured in three radii and then converted into an average diameter growth. A boundary line for each species was developed to allow releases identification. We scored the absence or presence of releases for all the trees and then we focused in the last 7 years. Results showed inter and intra specific differences in the intensity of response in respect to the diameter class and distance to the stump. Our findings suggest that for certain diameter categories the gap dependence could be overestimated, which may have implications in our understanding of forest dynamics.

Poster presentations

Sessions

PA1	Divergence phenomenon in dendroclimatology
PA2	Reconstruction of past climate variations: a challenge for the present and future
PA3	Tree rings and insects, diseases and anthropogenic factors
PA4	Climate-growth relationship of different tree species
PA5	Teleconnections in the climate system from tree-rings and multiproxy records
PB1	New techniques and statistical approaches for detecting environmental signals and predicting forest growth
PB2	Tree rings and natural hazards in a changing climate
PB3	Stable isotopes and dendrochemistry in trees as indicators of environmental change
PB4	Forest fires in changing climate
PC1	Treeline and northern tree rings in climate change research
PC2	Wood anatomy as an indicator of environmental factors
PC3	Dendroecology of shrubs
PC4	Intra-annual cambium dynamics and wood formation
PC5	Landscape dynamics and climate change
PD1	Past and contemporary environment- human interactions
PD2	Hydroclimatic changes in tree-ring chronologies
PD3	Impact of climate variability on stand dynamics and forest management
PD4	Tropical dendrochronology

PA1.01 Poster

Do biochemical and geochemical influences of acidic deposition affect dendroclimatic stability?

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Tree rings integrate tree condition and climate within the context of genetic potential and biogeochemical flow. The serial consistency in the response of ring growth to seasonal weather may have obscured the importance of other factors that affect growth on a regional scale. Coincident in time with the divergence of measured tree rings from modeled growth have been shifts in forest biogeochemistry attributable to acidic deposition. Previously published comparisons of archived soil samples in the St. Petersburg region of western Russia suggested that decreased amounts of essential calcium were the basis for changes in the dendroclimatic response of *Picea abies*. New research on tree-ring width series of *Acer saccharum* in the Catskill Mountains of the northeastern United States shows a negative relationship of growth and March temperature (late in the dormant winter season) since 1950. This relationship may be interpreted as the effect of premature dehardening of dormant tissues followed by a return to normal, cold weather. In this scenario, the seasonally cold weather late in the dormant season damages tree tissue because the preceding period of premature warming dehardens tissues and increases the risk of freezing damage. The timing of the sensitivity to March temperature may be linked to a mid-20th century mobilization and depletion of calcium consistent with the hypothesized effect of acidic deposition on these forests. Calcium regulates and supports cold tolerance. Consequently, the divergence in the dendroclimatic relationship at some locations may reflect broader biochemical factors.

PA1.02

PA1.02 Poster

Does age matter? A case study from the Iberian Peninsula

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In dendroclimatology, it is under debate whether climate-growth relationships are age-controlled and how changes in physiological processes associated with tree ageing may affect this relation. Generally, ageing in trees implies a reduction in growth rate and it is well established that photosynthesis rates and related physiological attributes differ between juvenile and mature plants (Yoder et al 1994). However, changes in morphological and physiological trends that characterize the transition from juvenility to reproductive maturity do not seem to remain constant once the reproductive maturation is completely achieved and continue as trees progress to the old-growth life stage (Bond et al. 2000, Day et al. 2002). In general, increased age and size may have effects on ecophysiological processes such as photosynthesis and carbon allocation (Mencuccini 2003) that are reflected in tree-ring properties like growth increment, density or stable isotopes. Because of the implication that these changes can have for the tree response to climate and consequently, for tree-ring proxy based climate reconstructions, we tested whether these age and size related differences can lead to different climate-responses. We studied possible age-related trends in time series of several tree-ring parameters (ring width, wood density, and stable carbon and oxygen isotopes) in relation to climate. The study focused on mature individuals from different age classes of *P. uncinata* and *P. nigra* from two locations on the Iberian Peninsula. The results show that differences in climate response between adult (200–300 yrs) and old trees (more than 500 years old) are generally minimized when more restrictive climatic conditions occur.

PA2.01 Poster

Summer temperature fluctuations in the French Alps, AD 751–2008

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On the basis of a dense tree-ring width network (34 unpublished multi centennial larch chronologies), this study attempts, for the first time, a reconstruction of the summer temperatures over the French Alps (44–45.30◦ N, 6.30◦–7.45◦ E), influenced by Mediterranean and Atlantic climatic systems, during the last millennium. The Adaptative Regional Growth Curve standardization method was applied to preserve interannual to multicentennial variations in this high-elevation proxy dataset. The proxies are calibrated using the June to August mean temperatures from the last revised version of the HISTALP database spanning the 1760–2003 and adjusted to take into account warm bias before 1850. About 45% of the temperature variance is reconstructed. Despite the use of the newly updated meteorological dataset, the reconstruction remains colder than early instrumental measurements between 1760 and 1840. The proxy record evidences a prolonged Medieval Warm Period persisting until 1500 with warm periods that resemble twentieth century conditions but also cold phases before 1000 synchronous to the Swiss glacier advances. The Little Ice Age is rather mild until 1660 if compared to other alpine reconstructions. Then, summers are 0.7°C cooler than the 1961–1990 mean until 1920. Maximum temperature amplitude over the past 1250 years is estimated to be 3°C between the warmest (810s, 1990s) and coldest (1810s) decades. Colder summers coincide with periods of high solar activity amplified by volcanic activity and warm summers vice versa. Most of the 20th century is comparable to the MWP but the last decade clearly overshot it.

PA2.02

PA2.02 Poster

A long oak chronology from Northwest Portugal: A work in progress

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Tree-ring width chronologies of *Quercus robur* L. from Northwest Portugal will be evaluated for their potential as proxies for regional temperature, precipitation and North Atlantic Oscillation variability. Ring-width series often show a non-climatic, age-related trend that must be removed prior to chronology development and dendroclimatic analyses. Traditional detrending methods do not distinguish between biologically and climatically controlled trends, thus this process may remove low-frequency climate signals on time scales that roughly equate to the mean length of the samples – the so-called ‘segment length curse’. Two standardization strategies will employed: the cubic smoothing spline (SPL) chronology, standardized with a fixed 80 year spline function, which retains decadal and higher frequency variation; and the regional curve standardization (RCS) chronology uses regional curve standardization which retains additional lower frequency variation from the same data. These chronologies will be calibrated against the instrumental data records of temperature and precipitation. Calibration trials will be undertaken using both chronologies to identify the optimal season for reconstruction. We hypothesize that the chronologies of Q. robur growing on the Northwest of Portugal, under both Atlantic and Mediterranean climate influences will have a strong NAO signal.

PA2.03 Poster

Tree-ring based climate reconstruction in western Mediterranean mountain regions (Corsica) in the Late Holocene

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Corsican Pine (*Pinus nigra* ssp. laricio) forms the subalpine forest belt in the mountain regions of Corsica. Reaching tree ages of up to 900 years, this species can be used as an archive for past climate variations in the western Mediterranean region since the Medieval Warm Period. In the study region, the complex mountain topography remarkably alters the winter precipitation brought by westerly winds. Thus, local site conditions vary considerably in their climatic conditions and tree growth patterns. Furthermore, local fire history, insect infestations and stand dynamics further contribute to a high spatial variability of local site conditions. We present first results from a sampling network comprising tree-ring width, wood density and wood anatomical data. We discuss the spatial heterogeneity of climate-growth relationships and relate them to local topography and site history. To test the representativeness of Corsican Pine chronologies as a climate proxy for the western Mediterranean region, we examine teleconnections with other tree-ring chronologies from the region. Finally, we give an outlook on the suitability of Corsican Pine chronologies to reconstruct past circulation dynamics and variations of the North Atlantic Oscillation.

PA2.04 Poster

Dendroclimatic reconstructions of summer precipitation from oak growth series in the Basque country

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The main aim of this research was the dendroclimatic reconstruction of those climate variables of precipitation and temperature limiting *Quercus* spp. annual ring width. The study was conducted in The Basque Country, located at the north of the Iberian Peninsula (south-west of Europe). Its interest is due to its condition of transition zone between the Atlantic and the Mediterranean climate. Important forests still remain in this region, and *Quercus* sp and Fagus sp are the predominant genera.

Three well-replicated chronologies of *Quercus faginea* were established from different sites. These sites were selected because of its geographic location and the presence of forests with old living trees. Climate – tree-ring width relationships were carried out and the most limiting climatic variables were reconstructed for each site. The obtained results are the annual variation of the reconstructed summer precipitations covering the last 400 years to the present.

PA2.05

PA2.05 Poster

Pointer years in the northern Fennoscandian climate proxies

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During the EU project Millennium an extensive dataset of annually resolved tree-growth based climate proxies for the last 1000 years were collected from different sites across northern Fennoscandia and NW Russia. These include time series of ring width, maximum tree-ring density, height increment and stable isotopes in tree rings. These proxies reflect the complex forcing of climate on tree growth in slightly different ways, and thus new information can be obtained by combining them. We analyzed these time series for pointer years. The pointer year is defined as a year or a small number of successive years exhibiting extremely low or high values, and it is used as an indicator of local or regional factors and events that influence tree growth or isotopic composition. We study the spatial pattern and temporal frequency of these years. Synchronous occurrence of the same pointer year at several sites is interpreted as an indication of larger scale climatic event. The proxies in which that pointer year is expressed provide information of the nature of the climatic event. The absolute dating provided by dendrochronology is allowing the comparison of the results to documentary proxy evidence. And thus, whenever possible, we attribute the pointer years to more widely known climatic events.

PA2.06 Poster

North Fennoscandian summer temperatures for the last millennium reconstructed from Scots pine maximum density

Håkan Grudd[1], Björn Gunnarson[1], Paul Krusic[1], Anders Moberg[1], Risto Jalkanen[2], Andreas Kirchhefer[3], Hans Linderholm[4]
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This paper explores novel techniques of calibration and climate reconstruction using new tree-ring maximum density data (MXD) from four sites in northern Norway, Sweden, and Finland. Site specific MXD chronologies are constructed using regional curve standardization (RCS) and the climatic sensitivity is assessed by correlation to local mean monthly temperatures and to corresponding 5°x5° CRUTEM3 grid boxes. Two fundamentally different approaches to regression are tested: Ordinary least square (OLS) and data least square (DLS). Statistical confidence is estimated by allowing sliding and cascading time windows for the calibration period to produce ensembles of reconstructions. Finally, a grand ensemble of summer temperatures for the last millennium in northern Fennoscandia is presented using maximum entropy bootstrapping.

PA2.07 Poster

Tree-growth and climate relations in the Tronador volcano, southern south America-Chile

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A great amount of studies guarantee the dendrocronological potential of *Fitzroya cupressoides*, *Pilgerodendron uviferum* and *Nothofagus pumilio*. These species are endemic from southern Chile and Argentina. *F. cupressoides* and *P. uviferum* are long-live conifers that can reach 4000 and 850 years respectively, while *N. pumilio* is a deciduous angiosperm that grows at the upper tree line of the southern Andes. This study was developed in southern Chile, in the south-west slope of the Tronador volcano (41°09´S–71°53´O). The top of this volcano reaches 3554 m asl and it is covered by a thick cap of ice from where more than nine glaciers descend. The main objetive of this study was to develop chronologies of F. cupressides, *P. uviferum* and *N. pumilio* in order to correlate the anual growth of these species with regional climatic factors (precipitation, temperature and PDSI), and large-scale climatic forcings (ENSO and AAO). The longest series was from *F. cupressoides* reaching 1636 yr. The results indicates that the growth from both conifers respond negatively to temperature whereas *N. pumilio* show a positive relation with this parameter. The use of this registries would help to understand the differential role of local and regional climate on tree growth at community level.

PA2.08 Poster

Subfossil Pilgerodendron wood at southern Chile, South America

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Pilgerodendron uviferum (D. Don) Florin is the southernmost conifer tree species in South America. Its geographic range extends over 1,600 km north to south, until 55ºS, and it has been succesufully used to reconstruct climate variations for the last 500 years in southern South America. The purpose of this study is to span the present tree ring-width chronologies from buried subfossil wood of Pilgerodendron. Most of the analized wood material came from stumps buried around 100 cm depth associated with a very clear layer of fluvioglacial sand and gravel extended along the entire study area. This layer has an age of 980 ± 90 C^{14} years BP. Below the Pilgerodendron level at around 170 cm depth a buried forest of angiosperm trees have ages of 2640 ± 130, 2810 ± 130 y 3150 ± 130 C^{14} years BP. These results show an interesting possibility to produce a chronology of highly resolved millennial climatic reconstruction, to interpretate the past vegetation dynamics and natural catastrophic events.

PA2.09 Poster

A tree-ring based reconstruction of the Southern Bolivian Altiplano precipitation since A.D. 1300

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Instrumental records of climate in the tropics are short, fragmentary and heterogeneous. Longer records are needed to understand the nature of climate variations, and how the interannual modes of tropical climate variability (such as ENSO) have evolved under changes in long-term background conditions. *Polylepis tarapacana* (Rosaceae) is a small- to medium-size tree growing on the slopes of the Andean tropical volcanoes in Bolivia and adjacent areas of Peru, Chile and Argentina (17–23°S) between 3900 and 5200 m elevation. Previous dendrochronological studies indicate that the radial growth of *P. tarapacana* is influenced by precipitation during the summer preceding the ring formation. Based on extensive collections of *Polylepis* samples across its range of distribution, more than 15 ring width chronologies have recently been developed. Some of these records extend for more than 700 years. Ring-width variations from *Polylepis* were used as predictors of regional records of summer precipitation across the Southern Altiplano. The model used for the reconstruction captures c.a. 46% of the total summer precipitation variance. The reconstruction covers the past 700 years and captures interannual to decadal scales of variability in summer precipitation. Several persistent droughts were observed throughout the last 700 years, as well as a negative trend in precipitation during the last 150 years.

This record represents the first precipitation reconstruction for the outer tropics in South America and demonstrates the highly significant skill of *P. tarapacana* as a precipitation proxy.

PA2.10

PA2.10 Poster

Dendrochronological analysis of selected spruce stands in the Drahany highlands

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The research was carried out in spruce stands more than 80 years old in the Drahany Highlands. Nine testing locations were chosen at altitudes from 490 m ASL to 576 m ASL. 30 samples for tree-ring analysis were taken in each of the locations. The sampling and the sample processing were carried out in compliance with standard dendrochronological methodology. The PAST4 application was used to measure tree-ring width and synchronize the individual tree-ring curves. The age trend was removed using the ARSTAN application and climatic influences were modelled in Dendroclim. Moreover, the work contains the determination of the basic density of the analysed trees. Wood density is the determining factor for the evaluation of the physical, mechanical and technological properties of wood which are of fundamental importance for forestry and wood industry.

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PA2.11 Poster

Temperature reconstruction based on tree ring data in Yulin, Shandong

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Dendroecological techniques have been employed to investigate the relationship between *Pinus bungeana* (*Pinus bungeana* Zucc.ex Endl) growth and climatic variability in Yulin of Shandong Province, China over the past 314 years. Statistical analysis of the tree-ring data showed an absent rate of 0.121%, a mean series intercorrelation of 0.735, a signal-to-noise ratio of 32.089, and a mean sensitivity of 0.360, indicating suitability for climatic analysis.

Correlation analyses indicate that the mean lowest temperatures are the principal factors limiting the growth of trees in the eastern low-elevation distributional areas. Radial growth was positively correlated with temperatures from prior October to current September, and prior December to current April. By regression analysis, the annual and winter mean lowest temperatures were reconstructed based on ring-width indices of Yulin for the past 314 years. The predictor variables account for 55.6% and 53.0% of the variance, respectively. And the 2.28–3.44-year periodicities detected in the temperature series are considered to be influenced by QBO (Quasi-Biennial-Oscillation).

In addition, the reconstructed series display a significant rising trend after 1970AD, indicating remarkable warming trend, especially winter warming. This winter warming trend also exhibits in the dendrochronology of Qingdao in Shandong, showing prevalent winter warming in Shandong province. Besides, the rate of winter warming in Shandong is higher than that of the whole country, reflecting a more obvious warming evidence in eastern areas of the whole country.

PA2.12

PA2.12 Poster

Temperature variations recorded in *Pinus tabulaeformis* tree rings from the southern and northern slopes of the central Qinling Mountains, central China

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The Qinling Mountains constitutes a critical boundary for climate and vegetation distribution in eastern central mainland China due to its importance as a geographical demarcation line. Cores from 88 Chinese pine (*Pinus tabulaeformis*) from the southern (MW site) and northern (NWT site) slopes of the Qinling Mountains were used to reconstruct seasonal temperature variations. During the calibration period, significant correlations were found between ring width and the mean temperature from prior September to current April of 0.76 at the southern slope, and between ring width and the mean May–July temperature of 0.67 at the northern slope. The subsequent temperature reconstructions span 1760–2005 for the northern site, and 1837–2006 for the southern site. Prior to the mid-twentieth century, low September–April temperatures were, in general, followed by high May–July temperatures, likely reflecting variations in the winter and summer monsoon. However, since the mid-twentieth century, both records show increasing trends where the increase in September–April temperature on the southern slope is more pronounced. The results provide independent supports for the interpretation that recent warming is unusual in nature, coinciding with the observed record.

PA2.13 Poster

Variation of solar activity during AD 1250–1750 indicated by radiocarbon content in tree rings of Korean conifers

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This paper presents the results of our yearly measurements of radiocarbon in Japanese red pine (*Pinus densiflora*) woods, which were obtained from historical buildings in South Korea, for 500 years 1250–1750. We first measured the radiocarbon content around the Spoerer and the Maunder minima, in order to clarify the solar cycle during prolonged sunspot minima. The radiocarbon data was also compared with the solar activity reconstructed from historical documents in Korea. We will also discuss about offsets in radiocarbon data.

PA2.14 Poster

Studies with the Finnish 7644-year pine chronology

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The growth of Scots pine at the Finnish pine timberline is highly sensitive to June–July temperatures. Exceptional preservation of wood and its accumulation in non-oxygen muddy bottoms of ice-cold lakes made it possible to build a 7644 years long continuous tree-ring chronology. The characteristics of this chronology and the distribution of the samples on the both sides of the present timberline provide an exceptional data for dendroclimatic reconstructions. Based on megafossil locations, tree-ring and climate data, we built separate models for estimating past and future June–July temperatures. Spectral analysis was used for identifying cycles and FFT smoothing for removing high-frequency variation from the chronology. Cycle pattern analysis and extrapolation techniques were used for expanding the cycle history of the past 500 years over the next 100 years. Our models clearly suggest that climate 6000 years ago was circa 2.6 degrees warmer than today. The most significant cycles in the chronology range from 30 to 95 years. We hypothesize that climate during the last 500 years has had a varying cyclic pattern of 60–95 years. The last cycle maximums occurred around 1540, 1660, 1760, 1855 and 1925 and the minimums around 1610, 1710, 1795, 1895 and 1970. Fitting these data in the prediction model, we conclude that the next warm cycle should peak some 2005–2020 and the next cool one some 2050–2065. One should, however, note that our model takes only natural variation into consideration.

PA2.15

PA2.15 Poster

Variability of the air temperature in the north of Eurasia inferred from millennial tree-ring chronologies

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An integral estimation of tree-ring growth spatial-temporal conjugation was carried out based on tree-ring chronology network of subarctic zone of Siberia, Ural and Sca ndinavia for the last 2000 years. Phase and amplitude disagreements of the annual growth and its decadal fluctuation in different subarctic sectors of Eurasia are changed by synchronous fluctuation when century and longer growth cycles are considered. Long-term changes of radial growth indicate common character of global climatic changes in subarctic zone of Eurasia. Medieval warming occurred from 10 to 12 centuries and 15-century warming are changed by Little Ice Age with the cooling culmination taking place in the 17 century. Current warming started at the beginning of the 19 -century for the moment does not exceed the amplitude of the medieval warming. The tree-ring chronologies do not indicate unusually abrupt temperature rise during the last century, which could be reliably associated with greenhouse gas increasing in the atmosphere of our planet. Modern period is characterized by heterogeneity of warming effect in subarctic regions of Eurasia. Integral tree-ring chronology of the Northern Eurasia shows well agreement with ^{18}O fluctuations in the ice core obtained for Greenland (GISP2).

PA3.01 Poster

An insect outbreak network for Pandora moths across its entire range in the Western United States

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Researchers have been collecting samples from ponderosa pine (*Pinus ponderosa*) trees throughout the western United States during much of the history of dendrochronology. These chronologies are often collected for climate reconstructions and some researchers submit their chronologies to the International Tree-Ring Data Bank (ITRDB) for permanent archiving of the digital files and for further analysis. I have downloaded and reanalyzed all 200 ponderosa pine chronologies posted on the ITRDB to determine if they have recorded pandora moth (*Coloradia pandora*) outbreaks in the past. Most researchers working in ponderosa pine where not aware of the potential for these trees to record pandora moth outbreaks until tree-ring work with this insect in 1997. I have used this data set of ponderosa pine chronologies to determine if researchers had inadvertently collected data on pandora moth outbreaks and found that 82% of the chronologies showed two or more suppressions consistent with the pandora moth signature. This is the first stage to building a network of insect outbreak records for the entire range of an insect for better examination of its outbreak dynamics across the entire species and to examine diversification in the insect and its host tree species.

PA3.02 Poster

Long-term spruce budworm outbreak dynamics in the North American boreal forest inferred from subfossil trees

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To better assess the natural variability of spruce budworm (*Choristoneura fumiferana* Clem.) outbreaks in the eastern part of the North American boreal forest and portray the long-term dynamics, reconstruction based on subfossil trees buried in mires was achieved. Although most of the excavated wood belonged to the gender *Picea*, a host species that could reveal the past defoliating activity of the insect through tree-rings, very few trees could be crossdated. Marker rings such as narrow ones produced during outbreak events were generally absent. The crossdated trees were found within a similar depth in the mire and the floating chronology thus built was radiocarbon dated to approximately 5.1 ka cal. BP, a period of low fire frequency. The results obtained in this research are in agreement with previously published researches that showed a continuous presence of the budworm during the Holocene with scarce outburst of insect remains comparable to that observed during the 20th century. The hypothesis linking fire frequency and spruce budworm outbreaks through its impact on the forest composition could help explain the results, low fire frequencies leading to vulnerable forest stands in regards with the spruce budworm. The results obtained in this research raise some fundamental questions and have serious implications on the actual management practices.

PA3.03

PA3.03 Poster

Accelerated insect disturbance of forests in Alaska and dendrochronology

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The two main sources of information about insects that affect Alaska forests are the Bonanza Creek (BNZ) Long Term Ecological Research (LTER) site record of insect density since 1975, and the statewide Alaska Forest Health survey of area visibly affected by insects, which began in 1974. The BNZ insect record varies in a way generally similar to the statewide survey data, although there are a few differences of outbreak timing. The BNZ and statewide records show tree-damaging insect population outbreaks with increasing frequency and in the most recent portion of the record, simultaneous outbreaks of several species. The principal outbreaks have involved Ips (engraver beetles), larch sawfly, aspen leaf miner, and spruce budworm (SBW). SBW probably did not occur or at least persist in Interior Alaska because of insufficient heat sums to complete development until the 1970s. SBW has occurred at outbreak levels in 1989–90, 1993–95, and 2005–2007. SBW presence and density at BNZ is well modeled by an index made up of August temperature and date of accumulation of a threshold of 454 GDD (8 °C threshold) at Fairbanks. Since 1989, years with peak SBW populations are the principal years of negative growth anomalies in climatically based predictions of white spruce growth, consistent with a non-climatic effect of defoliation. Such growth anomalies are not obvious in the previous period of climate record, 1905 to 1989. A number of invasive insects and pathogens have become established or have high potential to in the boreal forest of Alaska.

PA3.04 Poster

Influence of bamboo Guadua aff. paraguayana Doll (*Poaceae*) on the radial increment of *Sebastiana commersoniana* trees in remnant of a Mixed Ombrophilous Alluvial forests in southern Brazil

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Sebastiania commersoniana (Baillon) Smith & Downs (*Euphorbiaceae*) is a typical tree species almost exclusively growing in the floodplains of the second plateau of Parana State and one of the most important tree species that best characterizes the stratum of these riparian forests. This study aims to assess the influence of Guadua aff. paraguayana bamboo species on the trunk increment of this tree species in remnant of a Mixed Ombrophilous Alluvial forests strongly altered by anthropogenic action, using tree rings analysis for age determination and as indicators of this forest formation health. The study was carried out in a riverside forest severely degraded by sand extraction in the Tibagi River. Through non-destructive small wood sampling methods, two radial wood strips (core diameter 5,15 mm) oriented from pith to bark at DBH level were collected for each selected tree, totalizing twenty two representative trees, twelve of them growing in areas strongly occupied by Guadua bamboo and ten of them in its absence. Distinct tree rings can be recognized by flattened radial fibers wall and a slightly decrease of vessel diameter. Data of average annual diameter increment and age estimates for this tree species are presented. Differences in growth rate and dynamics were observed in both growth conditions, allowing identifying the probable period of more intensive anthropogenic action. The influence of Guadua bamboo on tree growth seems probably be related to competition for light and nutrients. Tree rings analysis can provide important information for the management and conservation of these endangered forest fragments.

PA3.05

PA3.05 Poster

Stand development patterns in declining *Austrocedrus chilensis* forests

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The forests of *Austrocedrus chilensis* in Argentina suffer mortality from what is locally known as ‘‘mal del ciprés”. This process of overstory decline and mortality was identified about 60 years ago. At the stand level, it usually appears as aggregated or randomly dispersed dead trees. Symptoms at the tree level often include loss of foliage and vigour followed by death. While this disturbance has been subject of detailed study, aspects such as the forest dynamics and how these stands will develop remain unknown. This research is the first to study and describe forest stand dynamics in *A. chilensis* forests affected by ‘‘mal del ciprés”. We used dendrochronological techniques to reconstruct overstory and regeneration establishment, mortality events, and past radial growth in twelve stands. Overstory and regeneration age structures at all stands exhibited a bimodal distribution. We found that after the overstory establishment, new individuals have been successfully establishing. These periods of regeneration recruitment coincided with the variable death of overstory trees. Tree death dated from as early as 1940 and 1950 but most began in 1960 and early 1970’s. Mortality events were either sporadic or concentrated. Mortality in most cases was preceded by a decline in radial growth. Furthermore, we found that the majority of the symptomatic trees and about a third of the healthy trees exhibited radial growth decline. Mortality in *A. chilensis* forests appeared to be unpredictable and variable resulting in unevenage forests. In absence of other disturbances, regeneration establishes successfully after radial growth decline and tree death.

PA3.06

PA3.06 Poster

Effect of the oak leafroller moth, *Tortrix viridana* L. on tree ring width of oak species, a case study: Iran's northwest forest

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The oak leafroller moth , *Tortrix viridana* L. is a destructive pest which has invaded recently to oak species, especially in west and northwest forests of Iran. Some parts of this area which are located in Piranshahr and Sardasht have been affected by the pest since 1989 that oak trees vigor and survival have been gone down resulting the pest outbrake anually. In this study, 2 forest sites were chosen primairly which the first one was located in infested and the second one was in unfested area (as a control). In each site, 10 trees from each two oak species including gall oak (*Quercus infectoria* Oliv.) and Lebanon oak (*Q. libani* Oliv.) were selected using transect method and a core was brought out from each tree employing increment borer. After preparing the cores, tree ring width was measured and comparing of the mean tree ring width between two sites and correlation between them and climatic data were conducted. The results showed that the mean tree ring width of both gall oak and lebanon oak in the infested site were decreased significantly after outbrake while this significant reduction was not seen in the control. Also the pest outbrake caused tree ring width reduction of gall oak and lebanon oak 27% and 35% respectively as compared with the period before outbrake. Nonexistence of any correlation between tree ring width and climatic data showed that the oak leafroller could be a reason for tree ring width reduction in both oak species

PA3.07 Poster

Variation of diameter growth of beech (*Fagus orientalis* L.) and hornbeam (*Carpinus betulus* L.) after forest fire in Caspian forests (Iran)

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Iran has a total area of 1.2 million ha temperate forest in the north where fires occur annually. The study area is located in research and educational Kheyroud forest (northern Iran) which was burned in 1998. This study was carried out to evaluate forest fire effect on diameter growth of beech (*Fagus orientalis* L.) and hornbeam (*Carpinus betulus* L.) after passing 7 years from the event. After surveying whole burned and control area, 60 cores using increment borer were provided from both beech and hornbeam (15 cores were provided for each species in each area) and each sample's ring growth width was measured. Statistical analysis was conducted for the obtained data which classified in years before and after fire occurring. Detrended correspondence analysis (DCA) was used to reveal the variation of diameter growth induced by forest fire. The results showed that the variation of diameter growth totally altered after fire. And also the surface fire didn't affect on beech but hornbeam ring growth was increased significantly.

PA3.08 Poster

Depression and recovery in growth of Scots pine (*Pinus sylvestris*) due to intensity of the local air pollution

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The study was conducted in the Olkusz Ore-bearing Region in the southern Poland. This is an area of long history of zinc and led mining as well as metallurgic industry. In this study we analyzed growth dynamics of pine trees using tree-ring series collected from 21 sites located near the Boleslaw Metallurgical Works. Tree-rings indicated a strong growth depression in the 60's and 70's of the 20th century. In this time the average ring width was significantly lower then in the preceding time. In the beginning of 80's of the 20th century a strong growth release was observed in the most of plots. Periods of depression and release of pine growth overlaps in time with the intensity of air pollution produced by local metallurgic industry. Tree-ring information might be a valuable indicator of the scale of industrial impact on the natural environment. The study was supported through the Financial Mechanism of the European Economic Area (project MF EOG PL0265).

PA3.09 Poster

Radial growth of *Larix gmelinii* and the cyclicity of the Siberian moth (*Dendrolimus superans*)

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More than 98% of the forested area of northern China have been attacked by the Siberian moth, *Dendrolimus superans* Butler (Lepidoptera: Lasiocampidae) which is one of the most destructive native defoliators of Larix spp. in China. The outbreaks of the pest have occurred in Inner Mongolia at least since 1935 but the outbreak dynamics, i.e. their occurrence or cyclicity are poorly known. Dendroecological methods can be used when studying defoliator outbreak cycles. The timing of historical outbreaks can be dated based on the negative effects of insect damage on the radial growth of the host trees. To separate the possible influence of climatic factors in the growth reductions, we will relate regional climatic data with the radial growth of *Larix gmelinii*. We use control chronologies derived from trees in semi-natural forests in the region that have apparently avoided the severe impact of previous defoliator outbreaks. The study material consists of 300 core samples from 150 larch trees, with tree-ring series lengths ranging from 20 years in man-made forests to over 100 years in natural forests. The aim is to document the past *D. superans* outbreaks in our study area and to assess whether they occur at regular or irregular intervals. This information would aid in predicting future outbreaks. Preliminary results concerning the relationship between tree radial growth reduction and *D. superans* occurrence will be presented.

PA3.10

PA3.10 Poster

Decline of pedunculate oak (*Quercus robur* L.) in Tammisto Park in southern Finland

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A decline of pedunculate oak (*Quercus robur* L.) has reported in a large number of countries in central and northern Europe including Finland. The decline is associated with several abiotic and biotic factors. For example, the pattern of tree-rings was used to describe the pre-mortem growth of oaks in Annala Park, Helsinki. The dendroclimatological analysis showed a positive influence of summer precipitation on the radial growth of oaks in all vigour classes and a negative influence of mid-winter temperatures for dead oaks. These were situated on the shallowest soils, which is the most likely reason for a higher risk of frost damage to their roots. To analyse whether these characteristics are similar in other oak habitats of southern Finland, the same kind of study is going to be carry out. In the following work, a total of 30 oak samples from Tammisto Park in southern Finland are going to be investigated. The data include ten healthy oaks, ten declining oaks and ten dead oaks sampled in summer 2008. The thickness of soil on the bedrock of the growing site of each sampled oak has been measured and is going to be included in the analysis alongside the closest monthly meteorological data.

PA3.11 Poster

Tree-rings reflecting environmental impacts of talc emission

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Tree-ring based growth modelling provides a sophisticated tool for estimating one-time short-term (5–30 years) growth responses. The method we tested works best in cases where the forcing event has a clear start and end. Our case study, taking place in a former mining area in Vuokatti, deals with talc emissions affecting the growth of Scots pine in 1961–1975. In order to be able to estimate the annual forcings, we first built a basic model describing the tree-growth in average climatic conditions. The talc-polluted trees provided, around the forcing period (before 1961 and after 1975), an ideal data for estimating the undisturbed ring-width development. We limited the model estimation period to the years 1931–60 and 1976–2000. Before modeling, year-to-year changing climate was calibrated by regional climate indices. The estimated standard climate model was applied to the event period and climate-corrected for providing modeled real-climate growths. The annual talc forcings show nicely up as a difference of the observed and estimated growths. Some results of the case study. The trees of the nearest locations (distance <1 km) suffered from mining activities in the 1960s and 1970s. The trees at 1–3 km distance were growing rather normally. Trees in the next location, from 3 to 6 km, had significant growth response the 1970s. At longer distances tree growth seemed to be normal.

PA3.12 Poster

Dendrochronological study of conifer trees (*Larix*) artificially planted inside and outside of several cities at the Northern Europe

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The aim of the paper was to investigate growth of larches being planted at several cities of Northern Europe: St. Petersburg (59°57'N, 30°19'E), Rovaniemi (66°30'N, 25°44'E), Apatity (67°34'N, 33°23'E). The data were collected at several sites inside of each city, and at one site in the rural area outside of each cities (about 50 km apart). Totally we studied 10 series. The longest chronology was about 190 years (in St. Petersburg). However, the most others were not very long (about 50–70 years). The main preliminary results are:

- Tree-rings of planted (not typical) larch trees don't reflect the influence of external (solar) factors in contrast with natural species. That is it could not be possible to detect some warming for the 1930–1960 period and some cooling later on. This effect was observed for both series inside the cities and outside of them.
- For both northern cities (Apatity and Rovaniemi) variability of tree-ring indexes was more pronounced in series collected inside of them. Another situation was found for St. Petersburg. Growth of larch trees was stable inside of this megapolis.

The preliminary interpretation of the results obtained seems to be connected to different influence of "urban heat island" effect on planted trees inside and outside of the cities for megapolis and relatively small towns.

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PA4.01

PA4.01 Poster

Climatic signals and radial increment variation of Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.) in Estonia

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In growth variation studies main attention has been paid to the radial increment of trees. Radial growth variation of coniferous trees could be related to current summer temperature or with precipitation. However, the growth response to weather variation differs between geographical regions. There are limiting as well as favorable factors for tree growth that are common for entire area.

Our starting hypothesis could be that high- and medium-frequency changes in tree growth are connected to changes in precipitation and air temperature. The specific objectives could be determined as which climate variables affect the variation in Scots pine and Norway spruce growth in regions.

The data analyzed in this study are 100–200 years long time series of annual growth variation of Scots pine and Norway spruce. In each stand, dominant trees without visible signs of damage were selected as sample trees. Increment cores were taken at 1.3 m height from each tree. Standardization of the individual ring-width series is carried out in order to remove variation due to tree maturation and stand dynamics. The chronologies are constructed by using procedures in the ARSTAN software. Principal component analysis is used to identify common patterns of growth variation between chronologies representing the different regions in Estonia.

PA4.02 Poster

Climatic factor influence on Scots pine (*Pinus sylvestris* L.) radial and height growth in Järvselja: An Estonian case study

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Estonia covers a relatively small area, but due to its location, the weather conditions vary from maritime climate in the West to continental one in the East, which makes it sensitive to expected climate change. Following the results of earlier studies, tree growth responds to altered climate conditions with changes in growth rates. The aim of this study is to indentify the climatic factor that has exerted the greatest influence on height and diameter growth of Scots pine (*Pinus sylvestris* L.) in the past in the eastern part of Estonia. Based on the results of climate factor influence analysis, the growth responses for the future can be modeled. We hypothesize that influence of particular climate factor to height growth and diameter growth differs. Stem analysis was used to reconstruct past height and radial growth of individual Scots pine trees. The cross-section disks, taken at every 2.5 m along the tree stem were used for measuring of annual ring-widths. Annual height increments were measured as the distance between adjacent nodes indentified by the branch whorls, on the split stem surface. The weather conditions were described by monthly temperatures and precipitation.

PA4.03 Poster

The influence of climate on Scots pine growth on mires in Latvia

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The climatic signal for the past centuries recorded on tree rings is well known in European regions for pines growing in dry conditions, but little knowledge has accrued regarding peatland pines. The aim was to determine the effect of climatic factors on the radial growth of Scots pine on mires in Latvia.

Trees were sampled from six mires in Latvia. Residual chronologies were compared with mean monthly temperature and total monthly precipitation for 12-monthly periods extending from October of the prior year to September of the growth year.

Previous studies have shown that there are difficulties with measurement and cross-dating of trees growing on mires not only among trees but also between radii from a single tree. The climatic influence on the yearly growth of mire pines is weak. The water table level has a direct and stronger influence on the growth of pine. The climate influence on the growth of trees is clearer when the data series is divided into 30-year subperiods. Temperature is the most important factor for Scots pine growth in comparison with precipitation. It can be argued that the precipitation data may not truly represent actual conditions at the all study sites because data used for analysis were obtained from the Riga Meteorological Station (longest series), which was quite far from some sites. The few observed common reactions to climatic factors among sampling sites suggests that tree-ring width is mainly determined by local factors – local climatic conditions, hydrology, peat thickness, geology and geomorphology of site.

PA4.04

PA4.04 Poster

Growth trends in Finland – New results?

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A European wide project called "Growth Trends in European Forests" was carried out in the mid-1990s. The main question in the project was whether there, in addition to changes in silviculture, would exist some external forcing factors like long-term climatic variations, global warming, increased CO_2 in the atmosphere or new fertilizing pollutant(s). Unexpected growth of trees over the whole 1900s was found in natural stands in Central Europe, but not in Scandinavia and Russian Carelia. A detailed analysis revealed that much higher nitrogen deposition rate in Middle Europe (25 <-->5kg ha^{-1} $a^{-1)}$ explained the difference. Today, 15 years later, it is a good time to investigate, what's going on in the Finnish forests. Our project provides a wider perspective for detecting not only growth trends but also climatic variations: 1) Growth trends for Northern and Southern Finland, 2) Growth comparison of trees in the same age classes now and 100 years ago. 3) Growth trends on high elevations. 4) Transect studies from tree-rings 5) Abrupt and cyclic climate changes from tree-rings during the last 7500 years and 6) Studies based on the amplified climate signal of tree-rings. Here we refer only to the tasks 1 and 2. A countrywide tree-ring dataset for Scots pine was collected in 2007 and 2008. Pre-defined criteria was applied for minimising noise and maximising the common signal. The new dataset composes of over 700 cores in 25 regions in northern Finland and over 400 cores in 11 regions in southern Finland. We apply the RCS modeling technique boosted by our new BFM data selection method that randomizes from a larger dataset distribution controlled subdatas based on a chosen criteria. Residual RCS variation plotted against calendar year (tree-ring index) provides a measure for conclusions. Our analyses, in general, show no trends, just natural variation and cyclicity, which both connect to macroclimate patterns.

PA4.05 Poster

Daily temperature and daily photosynthetic production vs. Scots pine growth

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During the early days of dendrochronology, the growth of Scots pine near the northern timber line in Scandinavia has been shown to correlate strongly with summer temperature. We aimed to add a new aspect to the studies by analysing the relationship between daily rather than monthly mean temperatures and ring-widths of the species. Correlations between temperature sums for all time periods between 1.5. and 31.8. and ring-widths were calculated. In addition, modelled daily photosynthetic production was used in the analysis. The tree-ring data was collected from the Värriö natural park in northern Finland. Highest correlations between ring-width and daily temperatures were obtained for periods starting around the summer solstice (21.6.) and ending in late July. These periods are – incidentally – rather close to the month of July, traditionally identified as a strong regressor in this type of studies. The result was rather similar when estimated daily photosynthetic production of the species was used. The period yielding the highest correlation started slightly later, the beginning of July, and correlations were slightly weaker.

PA4.06

PA4.06 Poster

Reactions of *Fagus sylvatica* and *Quercus* spp. to past climate extremes in Northeastern Germany and conclusions for their future performance

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Forestry-management in Northeastern Germany intends to reduce the large proportion (52%) of coniferous plantations in favor of more natural mixed deciduous stands. Beech (*Fagus sylvatica*) and Oak (*Quercus* spp.) are the economically and ecologically most important deciduous tree species at present. Regional climate models project a moderate overall decline in precipitation combined with a shift from summer to winter until 2100. Together with rising temperatures this will lead to an increased frequency of summer droughts and winter inundations. We hypothesized that these changes will negatively affect the competitive ability of beech compared to more drought or inundation tolerant species like sessile or pedunculate oak. Our study thus focused on the effects of past climate extremes on the growth of these species. Along a precipitation gradient (700mm to <500mm /year) we studied three mixed stands of oak and beech on sandy soils, highly susceptible to drought. In addition we selected one stand on gleyic soil with periodical stagnating wetness. At each site we took increment cores from 25 beeches and 25 oaks and then built chronologies using common dendrochronological methods. Correlations will be calculated with climatic data from the nearest climate stations together with data from soil water balance models. Preliminary results show an increased frequency of pointer years for the last two decades, possibly concurrent with a shift of climate as projected.

PA4.07 Poster

The manifestation of extreme ecological events in tree rings of beech and oaks in northern Bavaria (Germany)

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The frequency and intensity of climatic extreme events is expected to increase in the near future in central Europe as a consequence of climate change. The manifestation of some climatic events leaves specific and characteristic features in the form of frost rings, light rings, false rings and reaction wood. Droughts or severe storms are expressed by abrupt growth reductions which might be compensated in the following growing season or which might alter growth for a number of years. Other extreme events may only be reflected by variations of stable isotopes and are thus hard to decipher by visual inspection. The poster presents first results of a project studying extreme climatic events in trees of edaphically dry forest sites in northern Bavaria, Germany. Special emphasis is laid on the analyses of drought events of the 20th century and the recreation time of different tree species needed to recover from droughts. We investigate drought reactions in beech (*Fagus sylvatica*) and oak (*Quercus petraea*) by applying a multi-parameter approach including quantitative wood anatomy, wood density and intra-annual carbon isotope variations. The final goal of the study is to create a model if these tree species are still adapted if frequency and intensity of drought events will increase in the near future or if forest management actions have to be taken to modify the forest structure on drought-prone sites as an adaptation to future climate change.

PA4.08

PA4.08 Poster

Austrian pine (*Pinus nigra* Arnold) tree-ring width chronologies from Albania

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We analyze growth of Austrian pine (*Pinus nigra*) on extreme sites in Albania. Our study sites were located on a southern exposition and a relatively steep, rocky slope in Qaf-Sthame (QS site) mountains (NE Albania) and in Llogara mountains (LL site) (SW Albania). Elevation of the first site was between 1050 and 1500 m a.s.l. and the second was between 1700 and 1900 m a.s.l. On QS site we cored 36 trees and on LL site 25 trees. Each core was mounted and sanded to a high polish following standard dendrochronological procedures. The cores were then digitized using ATRICS® system and annual radial growth was measured to the nearest 0.01 mm using WinDENDROÔ software. Each tree ring series was then visually crossdated using PAST-4. We used the ARSTAN program to detrend individual tree ring series with a negative exponential function to preserve low frequency. The detrended series from each tree were then averaged to form a site chronology and residuals were compared to gridded climatic data CRU TS 1.2 (period 1901–2000). We compiled two chronologies. QS site chronology is 238 years long with a good replication (>8 trees; EPS>0.85) from 1797 on. LL site chronology is much longer – 426 years. Some trees included into this chronology are more than 450 years old. The oldest tree is 540 years old. Preliminary analysis of climatic signal shows a clear summer drought signal. Considering that it would probably make sense to produce a PDSI reconstruction rather than just a temperature or precipitation reconstruction.

PA4.09 Poster

Contrasting sensitivity of *Pinus canariensis* tree rings to local climate on north- and south-facing slopes on Tenerife, Canary Islands, Spain

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Pinus canariensis extends at elevations of 600–2,200 m in the Canary Islands. Its upper range limit, as in other tropical and subtropical mountains, is supposed to be determined by water availability. Our objective is to assess the influence of limiting climatic conditions on P. canariensis tree rings at the north- and south-facing slopes on Tenerife Island. We sampled two cores per tree from at least 40 trees in both the north- and south-facing slopes, at elevations of 1,400–1,600 m. After tree-ring series were measured and cross-dated, we standardized ring widths using a 32-yr spline function. A mean chronology for each exposition was obtained as the robust mean of the growth indices. The correlation between both chronologies for the common period 1963–2006 was $r = 0.018$ ($P = 0.907$), suggesting a divergent growth behaviour according to the exposition. We used monthly gridded data (0.5º × 0.5º) for maximum, mean and minimum temperature, total precipitation, Palmer Drought Severity Index, vapour pressure, and sea level pressure (SLP) taken from the CRUTS3 model at http://climexp.knmi.nl/. The south-facing site showed a higher sensitivity due to its xeric features. Radial growth at this site was strongly influenced by SLP during the previous winter. By contrast, climate sensitivity was lower at the north-facing site while temperature was the most significant climatic parameter. Contrary to studies performed at their upper range limit on Tenerife, the growth of *P. canariensis* at intermediate elevations is noticeably dependent on the exposition and not limited by water availability.

PA4.10

PA4.10 Poster

Cool summers in Interior North America inferred from light rings in jack pine trees growing along the Manitoba Escarpment, Canada

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Climatic light rings in conifers have mainly been described for treeline sites. Work conducted in the Duck Mountain region (51°40′N; 100°55′W) of Interior North America has revealed that years in which jack pine (*Pinus banksiana* Lamb.) trees produced frequent light-rings are characterized by significantly cooler summers than in other years. Such a cool summer was recently observed in 2004, the coldest summer on records for Winnipeg with meteorological data covering the period 1873 to 2008. Exceptionally, the summer of 2009 may also turn out to be a frequent light ring year with August 2009 being the 9^{th} consecutive month with temperatures below the climate normals. In this study, we extended our tree-ring network to cover the distribution of jack pine along the entire Manitoba Escarpment including Riding Mountain National Park and Porcupine Mountain Provincial Forest. Light ring chronologies are being developed for these new areas. Preliminary results indicate a strong coherency between the three regions. They also indicate that enhanced cyclonic activity from April to September over much of central North America, along with advecting moist polar air masses, tended to favor the occurrence of these years. The temporal occurrence of light rings in jack pine provided little evidence that daytime temperatures during the summer (i.e., growing season) have become warmer in Interior North America following the Little Ice Age episode. The strong coherency among the three regions suggests that light rings could be useful to develop a robust reconstruction of temperatures for the Interior North America.

PA4.11 Poster

Solar-climatic cycles studied by tree growth rings in conifers from Holocene and Triassic

Alan Prestes[1], Nivaor Rodolfo Rigozo[2], Mario Tomazello Filho[3], Claudio Sergio Lisi[4], Daniel Jean Roger Nordemann[2], Cristiano Max Wrasse[1], Mariza Pereira de Souza Echer[5], Ezequiel Echer[2]
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In this work a study of Sun-Earth relationships was developed using tree growth rings of araucarias (*Araucaria angustifolia*) in the present time and in silicified Mesozoic wood, both collected in the Rio Grande do Sul State, Brazil. From the *Araucaria angustifolia* were obtained chronology average for 264 years. The petrified samples, lead to 15 time series, with 28 to 159 tree growth rings. The method of classical spectral analysis, iterative regression, was used to search the periodicities and trends contained in tree growth. The wavelet method was also used to verify the periodicities and amplitudes found as a function on time. The analysis of the time series of the tree growth rings thicknesses, indicates representative periods of the solar activity of 11, 22, 52 and 80 years, with a significance statistics of 95%. This may show a possible influence of the solar activity in the growth of the trees in the recent past, in the last 250 years and in the distant past, around 200 million years ago. Low periods of 2 to 7 years were also found, and can represent a response of the trees to the local climatic conditions at their respective epochs of life. The wavelet analysis showed a good agreement between the time series of tree growth rings with the 11 year solar cycle, during Solar Minimum and Maximum, such as the Minimum of Dalton and the Modern Maximum.

PA4.12 Poster

Sol-Climate Relationship in tree-ring from Brazil

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The tree-ring width date from Brazil, were studied by cross-wavelet analysis technique, which permits the identification of non-steady features in the tree ring data, southern hemisphere temperature and sunspot number. It was found that evidences of the 11 and 22-yr. solar cycle. The 11 yr solar cycle in the tree-ring width data is present only during the epochs the maximum solar activity, to 1940–1970 interval time. The Hale solar cycle in the tree-ring width data is present only to 1890–1915 and 1940–1970 interval time. The cross-wavelet map between tree-ring width and sunspot number show the results identical for the 11 and 22-yr. solar cycle, found in tree-ring width wavelet map.

PA4.13 Poster

Paleoclimate from tree-ring widths of *Picea morrisonicola* in Central Taiwan

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This study reports on dendroclimatological efforts using *Picea morrisonicola* (Taiwan Spruce), the southernmost member of the *Picea* genus with a distribution that just crosses the Tropic of Cancer at at 23°N. This high-elevation species often reaches ages in excess of 300 years. Though Taiwan has tree species which are appropriate for dendrochronology, almost no chronologies have been reported internationally. Our site is part of a Taiwan National Forest Service permanent plot that has been monitored for over 50 years. We produced whole ring, earlywood, and latewood chronologies from our cores for comparison with local climate data and to investigate potential teleconnections. The crossdating was consistently high for a humid subtropical site, but locally absent rings were fairly common during periods of suppressed growth. Our results indicates that the ring widths are influenced mainly by the maximum temperature during the early growing season (March–June).

PA4.14 Poster

Pseudotsuga wilsoniana ring formation and climate in Taiwan

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Dendroclimatology is relatively new to Taiwan. Despite the large number of tree species native to Taiwan, only a few scientific studies have applied dendroclimatological methods. This study considers the relationship between tree-ring widths and climate using *Pseudotsuga wilsoniana* Hayata growing in Wulin, Shei-Pa National Park, northern Taiwan. We analyzed the tree-ring widths in cores as total ring width, earlywood and latewood. Comparisons of the climate data with the earlywood chronology revealed a negative correlation between early growing season temperatures in April through June and earlywood formation. Latewood formation is also influenced by early growing season temperatures in May and June, but with the opposite sign. The latewood width also covaries negatively with June relative humidity, so wide (narrow) latewood occurs when the May–June temperature is warm (cool) and the humidity is low (high). Significant teleconnections were also found, though they appear to shift in the mid-twentieth century. Positive correlations with eastern tropical Pacific Ocean SSTs were noted for the late twenty century both in earlywood and latewood, but the early twenty century ring widths showed almost no correlation with the tropical SSTs. Instead, a positive correlation was found with north Pacific Ocean SSTs in an arc around the Aleutian Low and along a swath southwest to the Philippine Sea. The apparent shift in the teleconnections was also found during tree ring research using other Taiwanese tree species, research also being presented at this conference.

PA4.15 Poster

Precipitation variations since 1857 A.D. inferred from tree-ring recorder of changling region in Gansu province

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The sampling site locates in Changling Mountain (37°26.67′N□103°41.62′E) in the middle of Gansu province. In the paper, 88 cores from 46 trees were collected and measured and quality control was carried out by the COFECHA program. Then using the ARSTAN program obtained the SSS chronologies from 1857. By analyzed the correlation, we found more obvious relationship between precipitation and tree-ring width than the temperature.

The correlation coefficient between the STD and the precipitation recorders from the Gulang meteorological observation station is 0.623. Then using current STD standard chronology and climate date, through simple linear regression method, we built a transfer function to reconstruct precipitation from last September to current July since 1857A.D.

In the series, we found that the precipitation in 1865–1876 and 1933–1939 was especially abundant, but in the 1920'Th was very little. Several serious droughts occurred from 1923 to 1932. The 1920'Th drought can bee seen in many published thesis. We also compared the precipitation to other area and found that in the reconstruction series, some dry periods are conference well with the dry periods of Hohhot, Inner Mongolia in historical documents. In the recent years, from the curve, we can see that the rainfall is increasing slowly but the rainfall variability is much smaller than the years before 1960.

Power spectrum analysis detected 2 to 3 years periodicities in the reconstruction precipitation series. It may be influenced by "QBO" events.

PA4.16

PA4.16 Poster

The stem growth of *Quercus ilex* subs. *ballota* (Desf.) Samp. and *Quercus suber* L. in the province of Huelva. Influence of clima, soil, silvicultural and spatial parameters

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UNIVERSITY OF HUELVA, Huelva, Spain

Quercus ilex and *Quercus suber* are two widely distributed species in the Mediterranean basin and are also the species with a bigger area in the Iberian Peninsula. In Southwestern these oaks are managed as a traditional agroforestry system called “dehesa”, created and maintained by humans, but with a high ecological and socioeconomical value. The objective of this study is to describe the pattern of stem growth of *Quercus ilex* subs. *ballota* (Desf.) Samp. and *Quercus suber* L. among and within years and to define the climatic, edaphic, spatial and silvicultural (soil and pruning treatments) that influence this model. In order to achieve this objective, we have established three experimental plots in different locations of the province of Huelva (SW Spain), where pruning and soil treatments have been applied.

The monthly growth of oaks for the period 2004–2008 has been measured in the plots, using band dendrometers; climatic parameters have been obtained from weather stations; continuous soil moisture has been measured with buried sensors and spatial data have been taken from a Digital Elevation Model.

PA5.01 Poster

Developing a multi-species dendrochronological network of long-lived species in Tasmania, Australia: Athrotaxis and the potential to reconstruct broadscale climate indices

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In Tasmania, southeast Australia, dendrochronology offers the possibility of annually resolved proxy climate records extending back over much of the past millennium. However, to date, reconstructions rely almost solely on the west coast Mt Read *Lagarostrobos franklinii* (Huon Pine). Although Tasmania is a small island, influences on Tasmania's climate are complex. Variations in the southern annular mode (SAM) have a greater impact on the west coast while ENSO and the IPO/PDO are more significant in the east and far north of the state. Atmospheric blocking can have different impacts on the southwest and the north east of the state. If we are to better understand the complicated climate history and the occurrence of historical droughts in southeastern Australia, it is important to investigate the dendroclimatic potential of species with relatively broad distributions across Tasmania. Two species of Athrotaxis (*A. selaginoides* and *A. cupressoides*) in Tasmania can live up to 1000 years, have wider geographic distributions than Huon Pine, extending further into the drier eastern part of Tasmania which is affected by ENSO. We examine the climate-growth relationships derived for ring-width chronologies from these two species and the potential for examining and reconstructing broad-scale indices representing ENSO, the IPO/PDO and SAM. We also investigate the relationships between the first principal component of the chronologies with sea surface temperatures (SSTs) and with sea level pressure (SLP) in the temporal and frequency domains. We highlight some of the issues requiring careful consideration before any attempt at climate reconstruction can be made.

PA5.02

PA5.02 Poster

A possible teleconnection between the summer North Atlantic Oscillation (SNAO) and climate in East Asia over the last 500 years

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Summer climate in the North Atlantic-European sector possesses a principal pattern of year-to-year variability similar to the North Atlantic Oscillation in winter. This ‘Summer North Atlantic Oscillation’ (SNAO) is defined as the first EOF of July–August extratropical North Atlantic pressure at mean sea level. The SNAO exerts a strong influence on European climate, e.g. rainfall, temperature and cloudiness, but is also associated to climate variability elsewhere, e.g. eastern North America and northern Africa. Modelling and observational results indicate that SNAO variations are partly related to the Atlantic Multidecadal Oscillation (AMO) on interdecadal time scales.

A possible teleconnection between the SNAO and summer climate over China in the latter half of the twentieth century, and it possible mechanism has previously been shown. Here we utilize a tree-ring based reconstruction of the SNAO spanning over the last 500 years as well as a number of tree-ring, ice core etc. proxies of Chinese climate (e.g. temperature and the summer monsoon) to investigate the temporal stability of this proposed teleconnection. The results tentatively suggests that a relationship between SNAO and Chinese summer climate exist back in time, especially on multidecadal timescales. This association may result of common responses to changes in the large-scale ocean circulation associated with the AMO.

PA5.03 Poster

Dendrochronology in Israel: Preliminary results and future prospects

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Israel's location at the juncture between the Mediterranean and desert climate zones on the eastern Mediterranean coast (the Levant) creates several diverse climate and ecological zones within a small geographic space that may be significantly altered by climate change. Understanding the area's history of ecological response to climate variation is critical, and the tree-ring record provides a valuable, precise source of environmental information

Since 2008, the Malcolm and Carolyn Wiener Laboratory for Aegean and Near Eastern Dendrochronology at Cornell has been systematically sampling forest sites in Israel along the country's environmental/climatological gradients, in order to examine variability in the dendrochronological record both within Israel and the eastern Mediterranean. We present here preliminary results from century-plus site chronologies built from three native Pinus halepensis forests located along a north-south transect in Israel–Rosh HaNiqra, near the Israeli-Lebanese coastal border; Mt. Carmel; and the Masreq Nature Reserve near Jerusalem. We examine correlations between the tree-ring and climatic records (particularly precipitation) and variability among the Israeli site chronologies. We also compare the Israeli chronologies with a Pinus halepensis chronology from Jordan (Touchan and Hughes 1999) and Pinus brutia chronologies from Syria, Turkey (Touchan et al. 2005), and Cyprus, in order to highlight teleconnections between sites in the northern and southern Levant.

The project's future goals–including expanding the Cornell Lab's tree-ring database in Israel and utilizing this information for dating and provenancing historical and archaeological timbers–are also discussed.

PB1.01

PB1.01 Poster

Dendrochronology in R with the dplR library

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We demonstrate the utility of the dendrochronology program library in R (dplR) in performing standard tree-ring analyses including detrending and chronology building. R is a well-regarded open-source statistical computing environment where users can contribute packages that are freely available. The detrending options dplR have been updated and now include regional curve and c-method standardization which we compare to traditional approaches. We also demonstrate crossdating in dplR via moving correlation analyses, cross correlation, and automatically generated skeleton plots. The expansion of dplR is due in large part to code contributed, in part or in whole, by the user community. The increased functionality of dplR makes it easier for dendrochronologists to use R as their primary analytic environment.

PB1.02 Poster

Interactive technologies in dendroclimatic researches

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In the paper an Interactive Dendroclimatic System (IDS) is described (Shishov et al., 2009). The system includes 2 principal components: dendroclimatic database and software package using for proxy data analysis.

Dendroclimatic database includes proxy data from 300 spatially distributed dendrochronological sites and more than 400 instrumental climatic records for Russian Federation (Vaganov et al., 1996; 1998; 2000; Vaganov, Shiyatov, 2005; Shishov et al., 2002; 2007). In the IDS a TCL-SQL project is using which provides common TCL-interface to database by PostgreSQL technologies.

To integrate inherited special applications (dendroclimatical software) to the system Expect technology is used as instrument for automation and testing in UNIX/Windows XP OS. The Expect is an addition to Tool Command Language (TCL) for using of non-graphical interactive inherited applications.

On the current stage the developing interactive provides an automating standard analysis of dendroclimatic data, i.e.:

1. To carry out different inquiries concerning coordinate searching of dendrochronological and climatical data;
2. To obtain standard tree-ring chronologies (Cook, Kairiukstis, 1989);
3. To provide transformations of daily climatic data;
4. To obtain and analyze response functions (Fritts, 1976);
5. To simulate a tree-ring growth by VS-model (Vaganov et al., 2006);

PB1.03 Poster

A three-step procedure in SAS to analyze the time series from automatic dendrometers

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Continuous measurements of stem radius variation in trees are obtained with automatic dendrometers that provide time series composed of seasonal tree growth and circadian rhythms of water storage and depletion. Several variables can be extracted from the raw data, such as amplitude and duration of radius increase and contraction, which are useful for understanding intra-annual tree growth, tree physiology and for performing growth-climate relationships. These measurements constitute a huge dataset whose manipulation needs numerous algorithms and automatic procedures to efficiently and rapidly extract the information. This paper presents a three-step procedure using two SAS routines to extract the time series describing radius variation and associate them with environmental parameters. The first routine organizes and corrects data and generates outputs in the form of files and plots to visualize the results and improve data correction (first step). The second step consists of a reclassification of the hours of contraction or expansion that have been misclassified by the automatic process. The second routine classifies the daily patterns of stem variation into the three phases of contraction, expansion and radius increment and associates the environmental parameters (third step). An example of the procedure is given, with an explanation of the outputs generated. The advantages and shortcomings of the procedure and its importance for the intra-annual analyses of tree growth are discussed.

PB1.04

PB1.04 Poster

Method comparison and reconstruction of canopy-disturbance histories in the Big Woods of Minnesota, USA

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The Big Woods of south-central Minnesota, USA, was a maple-basswood forest that developed over the past 650 years. Scattered remnants of this formerly extensive forest may help us understand whether the Big Woods established during moister or drier periods. Our objectives were to (1) compare several methods of reconstructing the canopy disturbance history from tree-rings, including the percent-increase, absolute-increase, visual inspection, sequential t-test (regime shift detection), and time-series analysis with intervention detection methods; (2) reconstruct the canopy-disturbance history of eight old-growth forests; and (3) determine whether peaks of tree establishment were correlated with wet or with dry conditions. First we determined that the starting date of disturbances as determined by the different methods can vary appreciably; the percent-increase and absolute-increase methods usually underestimated the release date, and the sequential t-test and time-series methods usually overestimated the release date. The sequential t-test (regime shift) method was best at identifying sudden releases and suppressions so we used that approach to reconstruct the disturbance histories. We analyzed climate-disturbance relationships at decadal scales. The average percent of canopy disturbed in all eight plots is 6.1%, which is similar to this measure in other studies of similar and different forest types in the eastern United States. Palmer Drought Severity Index and the local canopy-disturbance history were significantly related at only three of eight sites. Studies in other forest types identified a drought-disturbance relationship, but disturbances in the Big Woods forests apparently are related to other factors.

PB1.05 Poster

Determination of density profiles in wood tissue from radiography

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Tree-ring density has become increasingly important as a source for paleoclimatic information. Various analytical methods for determining tree-ring density have been developed over the past, including radiography, reflective light, and image analysis of cell wall area. The most commonly used systems are based on x-ray radiography where samples are placed on an x-ray sensitive film and exposed to radiation. The system setup and sample preparation is usually designed to have x-rays parallel to the orientation of the wood fibers. This "conventional" method has proven very successful, and its major advantage is the nearly infinite image resolution provided by the film and hence the capability of identifying very fine structures in the wood. With the introduction of the flat-beam scanning technology and digital recording technique, new analytical features have become available. In this paper we compare density profiles obtained from both conventional and flat-beam type radiographic analysis systems. The deviations observed are discussed in terms of instrumental design and calibration procedures. The limitation of the methodology is also discussed in terms of sample heterogeneity.

PB1.06

PB1.06 Poster

Comparisons of subseries trend-changes in Tree-ring index for 7630 years in Finland with those in southwest of USA

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Joint global wide climatic signals and trend changes were investigated from two tree-ring chronologies for the period of 7630 years. The compared series were the 7642-yr supralong timberline chronology of Scots pine from Northern Finland and the tree-ring reconstruction for precipitation from Nevada, USA. A normalization algorithm of the Quantile techniques were applied in order to produce two normalized series with consistent probability distribution. Maximum Entropy Spectrum analysis was applied for periodicity detecting. The Finnish series showed the cycles of 84.78 and 31.27 years, and the U.S. series a cycle of 162.34 respectively. The periodic oscillations of the normalized chronologies were smoothed by a low pass Gaussian filter of 165 points. Finally, a scanning F-test on a multi-time scales was applied to identify the significant trend changes in the series.

The Finnish tree-ring index features a comparatively steady pattern with only a 0.004σ standard deviation with the minimum value of -0.117σ and the maximum value of 0.208σ. The series included 16 change-points. The precipitation construction has standard deviation 0.114σ with the minimum value of -0.240σ and the maximum value of 0.293σ. The number of change points was 14. There were 14 of 17 episodes had same signal in the regression coefficient b. Good positive coherencies were detected in the last 2000 years between the two series. The trends, however, may be regarded only symbolic, because the regressions are not statistically significant. This is a common problem in the majority of the previous trend detection analyses.

PB1.07

PB1.07 Poster

Internet Virtual Database Lab (MELTIH) project

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In the long process of developing the Finnish dendrochronology analysis system, we are proud to introduce our Internet Virtual Database Lab (MELTIH) project. This approach uses the newest facilities provided by the Microsoft MS Visual Studio. We are dedicated to develop a world-wide virtual platform for flawless exchange of tree-ring data and other related resources. The system is not intended to replace any of the existing tree-ring databases, just connecting to them and downloading datasets to be processed in the MELTIH environment.

Just some technical details to be mentioned here: 1) The MELTIH system uses clearly accepted standards of today, which promises a long life span for the application. 2) The techniques are based on object-oriented programming, which shows up to an end-user as simplicity, user-friendliness and overwhelming applications. 3) Data and the user interface information are saved in a SQL Server database. 4) The user interface is based on a Silverlight/XHTML standard. 5) C# is the programming language. 6) The class library of the Microsoft.NET Framework runs in the background. 7) The control structure of the MELTIH system is totally XML-based. No matter from where input data comes, because all the activity always uses the same XML structure. 8) The body of the MELTIH system is not attached to any specific data, which makes the system highly adjustable.

We hope the services of MELTIH offer to dendrochronologists a pleasing environment for exchanging, manipulating and utilizing tree-ring data, metadata and all the related material.

PB1.08

PB1.08 Poster

Tree-Ring Data Standard (TRiDaS)

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Tree-ring research and collaboration are currently being hampered by the lack of a suitable data-transfer standard for both data and metadata. This paper describes the new universal Tree-Ring Data Standard (TRiDaS) and how institutions and software developers around the world are adopting it. TRiDaS is a data model for dendrochronological data and metadata and an eXtensible Markup Language (XML) schema that is enabling the exchange of data and metadata between laboratories around the world. It enables users in different laboratories, working in different fields, and using different compatible software and databases to seamlessly share data with no loss of information. More than 80 dendrochronologists, users of dendrochronology and computer scientists from 13 countries, have contributed to the standard so far. The extensible nature of XML means that the standard can evolve over time to meet the changing requirements of our diverse community. It is also an open standard so new users and developers are encouraged to join and help shape the initiative.

PB2.01 Poster

Dendrogeomorphology and dendrochronology revealing recent snow-avalanche activity in Upper Nordfjord, western Norway

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Two study sites are investigated in Western Norway, in the Upper Nordfjord valleys Erdalen and Bødalen, with regard to snow avalanche activity. Both valleys are characterised by recurrent activity impacting colluvial slope accumulations. Also, both valleys expose stands of deciduous trees, mainly *Betula pubescens*, covering an extensive part of the valley bottoms and along the flanks. The objective of the research is to determine past snow-avalanche activity to improve historical record for the last century. The geomorphological impact of snow avalanches is obvious through visible damages on trees and shrubs, such as fallen trees, tilted trunks, topped trees and more or less extensive scars. The dendrochronological approach compares tree rings growth from a reference area beside the snow-avalanche path with the ones from within the snow-avalanche path. For this purpose, discs and increment cores taken from the up-down axis of the trunks are analysed on a LINTAB measuring table. The dendromorphological analysis maps changes in trunk posture. The combination of these two approaches provides a temporal catalogue of snow-avalanche events, revealing a recent increasing activity, since 2000, that can be correlated with a change in snow accumulation in the source-area.

PB2.02

PB2.02 Poster

The Euro-Dendro project – Snow-avalanche and debris-flow frequency in European Middle Mountain unravelled by dendrogeomorphological analyses

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The Euro-Dendro project (2009–2010) associates French, Icelandic, Norwegian and Romanian researchers to analyse the recurrence of geomorphic dynamics occurring on slopes with a dendrogeomorphological approach. Study sites are located in France (Auvergne), Iceland (Northwestern and Northern Iceland), Norway (Nordfjord) and Romania (South Carpaths Mountains), enabling to investigate various European middle mountain environments and different tree species impacted by similar processes. The aim of the study is to highlight the different responses of conifers and broadleaf trees subjected to recurrent snow avalanches and debris flows in similar cold environments. In a longer perspective, the Euro-dendro project aims to analyse natural hazard for local populations in areas with a lack of historical records. The study sites are voluntarily selected outside the Alpine area to represent areas that are scarcely present in the international literature, whereas such territories offer great potentialities in a global change context.

PB2.03 Poster

The influence of volcanic eruptions on tree growth in Central and Southern Europe during the last 1000 years

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Large volcanic eruptions have strong impacts on the global climate, lowering the global temperature and increasing the diffuse light fraction for one to several years after the eruptions. It has been argued that due to scattering by volcanic sulfur aerosol the more diffuse light fraction can be used more efficiently by forests. However, other observations suggest a growth decrease because of the cooler conditions following large eruption. Trees growing to the north of the temperate zone are mainly temperature-limited and therefore a reduction in ring width after large volcanic eruptions seems inevitable. Since tree growth in the temperate and Mediterranean zones is less limited by temperature than by other climate parameters such as precipitation, we hypothesise that tree growth may not suffer from lower temperatures so much but profit from increased diffuse light and reduced water stress. Therefore, we used a database of long tree-ring chronologies originating from sites in Central and Southern Europe to test whether tree growth suffered or profited from the globally changed conditions after large eruptions. The timing and magnitude of the 23 biggest eruptions during the second millennium were identified using ice core records of sulfur deposition by Crowley (2000). This data set was compared with our tree ring data from Central to Southern Europe. First results will be presented in poster format.

PB2.04 Poster

Multi-proxy analysis in reassessment of the 1902 event in northern Fennoscandia

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Tree-ring width series of Scots pine (*Pinus sylvestris* L.) from northern Fennoscandia exhibit a rapid decline in the year 1902, followed first by a low and then gradually recovering growth of about two decades to the 1920s. In dendroclimatology this period of low growth is considered due to low temperature only. On contrary ecologists are underlining also the role of the combination of the warm and cold summers of 1901 and 1902, respectively, resulted in a severe shoot dieback of Scots pine in autumn 1902. To evaluate the nature of the 1902 phenomenon and the period in 1880–1940 we applied multi-proxy analysis to pine trees from Laanila, northern Finland. The applied proxies consist of numerous time series derived from tree rings (tree-ring width, tree-ring density and stable isotopes), height increments and parameters produced by the Needle Trace Method, NTM (needle production, needle density etc.). Tornedalen and Sodankylä temperature records were used to demonstrate climatic variations.

PB2.05

PB2.05

Dendrogeomorphic reconstruction of spring floods using injured broad-leaved trees

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Dendrogeomorphic studies have successfully been used to reconstruct geomorphic events over the last few decades. They have been predominantly conducted with conifers despite the high potential of broad-leaved trees for dendrogeomorphic research. Consequently, this study aims at dating the occurrence of recent spring floods from growth series of broad-leaved trees and at determining their suitability for dendrogeomorphic research. A total of 47 i*njured broad-leaved trees were sampled along the channels of two torrents in the region of El Chaltén, in southern Patagonia (Argentina). Tree species include Nothofagus pumilio* (Poepp. et Endl.) Krasser, Nothofagus antarctica (G. Forst.) Oerst., Berberis microphylla G. Forst. and Ribes magellanicum Poir. Tree-ring analysis of 53 cross-sections allowed the reconstruction of 10 flood events in early spring between AD 1992 and 2008. Dated injuries exclusively resulted from events occurring during the dormancy of trees. It also appears that flood event years differ between the two investigated torrents and that events seem to be produced by snowmelt. Reconstructed events were compared to precipitation records from a nearby meteorological station so as to better define the triggers of spring floods in this region.

PB2.06 Poster

Dendrogeomorphic reconstruction of past debris-flow activity using injured broad-leaved trees

PB2.06

Estelle Arbellay[1], Markus Stoffel[1], Michelle Bollschweiler[1]
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Tree-ring records from conifers have been regularly used over the last few decades to date debris-flow events. The reconstruction of past debris-flow activity was, in contrast, only very rarely based on growth anomalies in broad-leaved trees. Consequently, this study aimed at dating the occurrence of former debris flows from growth series of broad-leaved trees and at determining their suitability for dendrogeomorphic research. Results were obtained from Gray alder (*Alnus incana* (L.) Moench), Silver birch and Pubescent birch (*Betula pendula* Roth and *Betula pubescens* Ehrh.), Aspen (*Populus tremula* L.), White poplar, Black poplar and Gray poplar (*Populus alba* L., *Populus nigra* L. and *Populus x canescens* (Ait.) Sm.), Goat willow (*Salix caprea* L.) and Black elder (*Sambucus nigra* L.) injured by debris-flow activity at Illgraben (Valais, Swiss Alps). Tree-ring analysis of 104 increment cores, 118 wedges and 93 cross-sections from 154 injured broad-leaved trees allowed the reconstruction of 14 debris-flow events between AD 1965 and 2007. These events were compared to archival records on debris-flow activity at Illgraben. It appears that debris flows are very common at Illgraben, but only very rarely left the channel over the period AD 1965–2007. Furthermore, analysis of the spatial distribution of disturbed trees contributed to the identification of 6 patterns of debris-flow routing and led to the determination of preferential breakout locations of events. The results of this study demonstrate the high potential of broad-leaved trees for dendrogeomorphic research.

PB2.07

PB2.07 Poster

Forest cover – A spatio-temporal marker of landslide activity

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Unlike snow avalanches or floods, it seems much more complex to identify and record historical landslide activity.

Trees record, from a certain threshold of intensity, duration or recurrence, the geomorphological and hydrological processes that lead to disturbances in their natural habitat or direct mechanical damage to their trunks. Any significant disturbance will leave characteristic signs in the annual growth rings or visible morphological anomalies. The identification of these reactions can be used as markers of previous disturbance and for the reconstruction of geomorphological and hydrological events in time, space and intensity.

The dating of mass movements, is primarily based on the identification of reaction wood as well as asymmetric growth rings. The combined use of trees as bio-markers or indicators of unstable terrain with dendrogeomorphic methods represents an effective and innovative technological advance and offers perspective for a better understanding and prevention of natural hazards.

As part of our presentation, we reconstructed the activity of a landslide in the region of Barcelonnette (Alpes de Haute Provence, France) using the forest growing on the landslide body as a silent witness of the past. A total of 75 *Pinus uncinata*, which were damaged during mass movement events, were analysed and growth disturbances related to landslide activity were assessed. We identified 174 growth disturbances in the samples, indicating that 6 different periods with landslide activity occurred between 1947 and 2004 although only one event was clearly identified by historical records in April 1993.

PB2.08 Poster

Reconstruction of the debris-flow history of a small alpine torrent of the French Prealps using dendrogeomorphic methods

PB2.08

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The assessment of debris-flow risks in mountainous terrains requires a compilation and realistic characterization of the frequency and the propagation area of former and potential future debris-flow events at the site. Such a characterization is generally based on the analysis of historical records, which are more or less incomplete and sometimes inexistent for small pristine catchments. In order to complete and enhance the historical record analysis, dendrogeomorphic surveys of alluvial fans have proved to be an efficient and attractive tool. The objectives of this study conducted on a small torrent of the Northern French Prealps (Manival Torrent, drainage area: 7 km²) therefore were : (1) to map geomorphic evidence of debris-flow events by means of a high resolution DEM obtained from an airborne LiDAR survey, (2) to date past debris-flow activity based on dendrogeomorphic evidence in the records of trees growing on the alluvial fan, and (3) to analyze the evolution of debris-flow activity with time via a coupling of historical data and dendrogeomorphic reconstructions. Through the study of growth disturbances in 250 Scots pine trees (*Pinus sylvestris* L.) located in abandoned channels and associated banks, we were able to reconstruct the geomorphic activity of old debris-flow channels of the Manival torrent. Ten events were identified in the tree-ring series, of which only three were known from historical records.

PB2.09

PB2.09 Poster

An assessment of deep landslide activity in the Transylvanian Depression (Romania) with tree rings

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In Transylvanian landscape morphology, so-called "glimee" represent the largest landslides as to their surface (up to hundreds of hectares), volume, and depth (up to hundreds of meters). Studies referring to the spatial distribution, morphometry, genesis and age of these landslides are scarce. Their age dating was mainly based on palynological methods, which are rather uncertain and indicate the genesis of these landforms in the humid periods at the beginning of the Holocene. In some cases, there is clear evidence for them being much more recent. In an attempt to improve our understanding of "glimee" processes, we aim at identifying partial or total present-day activity of these large features. For this purpose, 3 forested landslides have been chosen as initial study areas. Based on detailed geomorphic maps of each landslide, broadleaved trees (*Quercus* sp., *Fagus sylvatica*, *Populus* sp.) affected by mechanical stress (tilted or curved trees, buried roots, etc.) have been selected for sampling. In parallel, increment cores from nearby unaffected trees have been extracted in order to realize reference curves for each tree species. Preliminary results indicate that some of the deep landslide sectors can be considered still active. The project's results should be integrated in future infrastructure planning policies in the areas affected by these landslides.

PB2.10 Poster

Quantifying erosion on steep marly hillslopes (Draix, Haute-Provence, France) by means of anatomical changes in exposed tree roots

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Extensive areas in the French Alps are underlain by Jurassic black marls. Wherever these so called ‘terres noires’ crop out they are subject to intense erosion, causing major problems with sedimentation in regional reservoirs and river system. In the Badlands near Draix (Alpes de Haute-Provence, France), measured sediment yields obtained by surface elevation change-based methods, indicate denudation rates of more than 10 to 20 mm yr^{-1}. In this study, these measurements, relying on continuous field monitoring of 35 profilometers during 5 years, are compared to an alternative method, based on dendrochronology. A total of 78 exposed and buried roots of *Pinus sylvestris* was sampled in the badlands and the variations in annual growth rings due to exposure caused by denudation were analyzed. The changes in the characteristics of latewood tracheids in roots were used as a sign for surface lowering, whereas the first year of exposure was determined by a peculiar reduction in size of earlywood tracheids. The medium-term erosion rates are slightly underestimated (3 to 7 mm yr^{-1}) if compared to traditional methods. This discrepancy is mainly related to the protective action of roots during the few years following exposure. However, the detailed knowledge of anatomical changes in roots provides is demonstrated a powerful tool for geoscientists to quantify minimal rates of soil erosion in areas where no measurements of past processes are available.

PB2.11

PB2.11 Poster

Applied debris-flow modeling using dendrogeomorphic data: A case study from the Swiss Alps

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Debris flows constitute a significant and increasing hazard in mountain regions. New numerical tools allow a detailed delineation of potentially endangered zones. Applied modeling requires well-defined input parameter sets. Depending on the model used, a series of parameters needs to be defined before model running. Normally, the data base describing known events in a certain torrent is very limited and data sets delivering information on the spatial and temporal distribution of former flow paths and deposition zones are very scarce. Tree-ring records in combination with detailed geomorphic mapping for instance provide such data sets over a relatively long time span. Considering the significant loss potential associated with debris-flow disasters, it is crucial that decisions made in regard to hazard mitigation are based on a consistent assessment of the risks. This in turn necessitates a proper assessment of uncertainties involved in the modeling of the debris-flow frequencies and intensities, the possible run out extent, as well as estimations of damage potential. Because uncertainties in run-out areas cause large changes in risk estimations, we use the data of flow path and deposition zone information of reconstructed debris-flow events derived from dendrogeomorphic analysis covering more than 400 years linked to a Bayesian network to update the input parameters of the three-dimensional RAMMS (Rapid Mass Movements) model. The probabilistic model, which consistently incorporates this available information, can serve as a basis for spatial risk assessment.

PB2.12 Poster

Trends and changes in debris-flow occurrence – A regional reconstruction based on tree rings

PB2.12

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Tree rings have regularly been used for the reconstruction of past debris-flow occurrence in numerous torrents and channels all over the world. However, most of these studies remained rather isolated reconstructions on single torrents. It is therefore the aim of this study to provide a regional chronology of past events in the Zermatt Valley, Swiss Alps and to go beyond the simple dating of events. Based on tree-ring reconstruction of past debris-flow activity in eight torrents, we shed light on trends and changes in debris-flow occurrence, on past climate conditions during events and on possible future evolution under a changing climate. Based on 2467 trees (mainly *Larix decidua* Mill. and *Picea abies* (L.) Karst.), 417 events between AD 1600 and 2008 were assessed. Decadal frequencies suggest a maximum of debris-flow activity after the end of the Little Ice Age and especially during the period 1919 to 1928. In contrast, activity was rather low in the last decade (1999–2008) which is in accordance with an observed decrease in the number of triggering rainfall events. In order to identify long-term trends in debris-flow occurrence, the period 1850–2008 was divided into three time intervals and student's t-tests were performed to test whether changes between these intervals were significant. For the debris-flow occurrence in the entire valley, no significant trends were observed. Meteorological data will be analyzed so as to determine climatic conditions responsible for the triggering of past events.

PB2.13

PB2.13 Poster

Dendrogeomorphic investigation of debris-flow activity in the Patagonian Andes

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Debris flows are pervasive disturbances in the Patagonian Andes that increasingly affect settlements expanding into the upper Andean valleys. However, written documents of this rapid mass-movement process are scarce, fragmented and limited in time. In this study, we used tree-rings to reconstruct temporal patterns of debris-flow activity. The study site 'Brazo Huemul' is adjacent to Lago Nahuel Huapí, Neuquén, Argentina (40°56'01''S, 71°24'43''W). We sampled 43 trees that all showed external evidence of past debris-flow activity. The sampled species are *Austrocedrus chilensis*, a native conifer from northern Patagonia, and *Pseudotsuga menziesii*, a conifer introduced from North America. We collected cross-sections and/or increment cores from the stems of both species, as well as exposed roots from selected trees. We dated and analyzed scars, tangential rows of traumatic resin ducts, eccentricity variations, reaction wood and abrupt growth changes on all samples. Preliminary results indicate abundant evidence of debris flow activity in 1895, 1949, 1975, 1993, 1999 and 2004. Although most events occurred during the dormant season of trees, damage during the vegetation period was also recorded. Regional temperature and precipitation records were analyzed to examine potential climatic conditions that triggered these events.

PB2.14 Poster

Rockfall activity at the base of a rockfall talus slope in the El Chaltén region, southern Patagonia, Argentina

PB2.14

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Rockfall is the free or bounding fall of rock debris down steep slopes and is one of the most intensely studied geomorphic processes of the cliff zone in alpine and periglacial environments. Where the runout fringe of boulders beyond the talus foot is forested, individual rockfall fragments may damage or even destroy trees along their trajectory. Woody vegetation physically damaged by rockfall or growing on talus therefore provides a valuable means to date and investigate past rockfall activity with high accuracy over long periods. Tree-ring based rockfall research remains in its infancy and has been mainly limited to studies on talus slopes in European mountains using a limited number of species. To test the wider applicability of these techniques we investigated the spatio-temporal patterns of rockfall activity at the base of the Rio Toro talus slope in the El Chaltén region (southern Patagonia, Argentina). Analyses were performed using Lenga (*Nothofagus pumilio* (Poepp. Et Endl.) Krasser, a "southern beech") which has not previously been used in rockfall research. We report the chronology of rockfall events observed in the tree-ring series of 20 trees (63 cross-sections) since AD 1899. Our results demonstrate that rockfall activity is most frequent during southern hemisphere winter and that there is an influence of tree diameter on the calculation of impact probabilities and the potential bias introduced to measures of reconstructed rockfall frequencies.

PB2.15

PB2.15 Poster

Use of dendrochronological and radiocarbon methods for dating a volcanic event in the Lake District, northern Patagonian Andes

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Volcanic activity is a common feature that modifies the landscape and eventually puts at risk settlements and roads in the Lake District of the Patagonian Andes. Although some volcanoes from this region are presently extinct, most have records of past activity during the Holocene, including eruptions in the past centuries. According to estimations from different sources, the volcano 'Ayen Niyeu', located in the Parque Nacional Lanín, Neuquén, Argentina (39°50'02"S, 71°31'40"W) produced a large lava-flow event ca. 470 years BP. The large basaltic flow dammed a transversal valley to the water flow creating 'Lago Verde' lake. As a result, a large portion of a Nothofagus dombeyii- dominated forest was flooded. In February 2009 we sampled 27 cross-sections of *N. dombeyi*i trees flooded by the volcanic event. The upper parts of these trees had recently been exposed due to drought conditions prevailing over the past few years in the region. In addition, 15 living *N. dombeyi*i trees not flooded by the event were sampled at a near location, in order to attempt dating the floating tree-ring chronologies with this reference tree-ring chronology. Radiocarbon dating techniques are presently being conducted on pieces of six flooded trees; the first dating indicates an age of 475±35 radiocarbon years BP.

PB2.16

PB2.16 Poster

Wood anatomical features of *Austrocedrus chilensis* and *Pseudotsuga menziesii* related to debris-flow activity: A case study near San Carlos de Bariloche, Argentina

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Debris flows regularly affect infrastructure and transportation corridors in the Patagonian Andes. However, the disturbed areas and return periods of this mass-movement process have been poorly documented. Trees affected by debris-flow activity enclose hidden archives of past disturbances. These archives have seasonal resolution and can extend over several centuries. Although related studies have reported specific morphological responses of trees to debris-flow activity, few of them have assessed specific wood anatomical responses to this disturbance. Our study site is named 'Brazo Huemul' and is adjacent to Lago Nahuel Huapí, Neuquén, Argentina (40°56'01''S, 71°24'43''W). We sampled 43 trees showing external evidence of past debris-flow activity. The sampling included two conifer species: *Austrocedrus chilensis*, a native species, and *Pseudotsuga menziesii*, recently introduced in northern Patagonia. We collected cross-sections and/or increment cores from the 43 tree stems and exposed roots from selected trees located at the border of the channel. Changes in wood anatomy were analyzed to identify distinct features in both species that can be used for reconstructing spatial and temporal patterns of past debris-flow activity. In particular, callous tissue, tangential rows of traumatic resin ducts and compression wood show the largest potential for reconstructing past debris-flow activity. Future dendrogeomorphic studies can take into account these wood anatomical features in order to obtain increment cores from specific sectors of stems and roots, thus avoiding destructive sampling using cross-sections.

PB3.01

PB3.01 Poster

Processes of carbon isotope signal transfer from leaves to tree rings

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The stable carbon isotope ratio of leaf photosynthates reflects environmental conditions at the time of carbon fixation, and the fractionation process at the leaf level is explained rather successfully by conventional models. However, we still do not have a reliable model to explain how the carbon isotope signal at the leaf level is then transferred to tree rings. Understanding these key processes is indispensable for improving the quality of climate reconstruction.

The first topic in this presentation is these signal transfer processes. $^{13}CO_2$ pulse-labeling used in combination with high-resolution analysis of tree-ring isotopes is an effective tool to elucidate the processes of signal transfer. By pulse-labeling trees and analyzing the resulting distribution of the ^{13}C label in the tree rings, we can visualize the deposition pattern of photosynthetic isotope signal to tree rings. In our studies on *Larix gmelinii* from Siberia, we have found that a significant portion of summer and autumn photosynthate is stored and used for earlywood formation in the following year. Based on the results from recent pulse-labeling experiments, we have developed a preliminary model that takes storage processes into consideration to explain the isotope signal transfer processes.

The second topic is the optimal sample sectioning methods for tree ring samples using rotary microtome and diamond saw microtome, which enables extraction of intra-annual information from tree rings at the finest resolution possible.

PB3.02

PB3.02 Poster

An inter-site comparison of stable isotopes ($\delta^{13}C$, $\delta^{18}O$) in tree-ring series of *P. heldreichii* and *P. heldreichii* var. *leucodermis* from Mount Vihren, Bulgaria and Monte Pollino, Italy

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Pinus heldreichii (var. leucodermis) is widespread in the Balkan peninsula and has some scattered and isolated populations in Southern Italy (Todaro et al. 2007). We selected two sites at the western (Italy) and the eastern (Bulgaria) limit of its geographical range distribution, respectively. The Italian site (39°56`N, 16°12`E) is located at the timberline (2054m a.s.l.) of Monte Pollino in the Serra di Crispo mountain range. The Bulgarian study site (41°46`N, 23°25`E) is situated slightly below the timberline (1900m a.s.l.) of the northern Pirin mountain range, near Mount Vihren. Both sites are characterized by shallow rocky soil and carbonate bedrock (limestone and marble). The Italian site is influenced by humid Mediterranean climate with mean annual temperature at 4°C and 1500mm mean annual precipitation. In contrast, the Bulgarian site is located at in the transition zone between Mediterranean and temperate climate with a mean annual temperature of 1°C and mean annual precipitation of ca. 800mm. We have compared the site chronologies of $\delta^{13}C$ and $\delta^{18}O$ between AD1600 and AD2003. We will present and discuss common variance in year-to-year variations and long-term variations, as well as response to increasing atmospheric CO_2 concentration and climate.

References

Todaro, L. et al. 2007, Biological Conservation, 137:507–519

PB3.03

PB3.03 Poster

A novel device for batch isolation of cellulose from tree-rings

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Most environmental studies based upon the analysis of stable isotope ratios of carbon and oxygen in tree rings use a single wood compound, namely cellulose. Extracting this particular wood ingredient without alteration of its original isotope composition affords the application of a time-consuming chemical isolation process. If annual or even sub-annual resolution and high numbers of replicate samples are desired, a system is needed that does not change well-adopted chemical procedures (e.g. Green 1964), but allows for treating several large sample batches in one go. In order to meet these requirements a novel device was developed at the Potsdam Dendro Lab. It allows for simultaneous processing of 40*n wood samples within sintered disc filter funnels placed in our device. n being the number of devices that can be coupled and depends on the size of the flue-gas cabinet in the lab. The key feature of this new device is that any chemical solution can be sucked off automatically from all funnels at a time. This saves about 70% of the time. Since the device is made of PTFE and filter funnels are from glass all parts of the system can be used repeatedly over several years. Hence, running costs are confined to the replacement of broken filter funnels. This is an important advantage over the cellulose isolation using one-way PTFE bags. Furthermore, each funnel position on the device is permanently marked with a code. This ensures simple assignment and identification of samples.

References

Green, J.W., 1963. Wood cellulose. In: Whistler, R.L. (Ed.), Methods in Carbohydrate Chemistry III., New York.

PB3.04 Poster

Isotope pathway from the atmosphere to the tree ring along a humidity gradient in Switzerland

PB3.04

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The increasing number of tree-ring isotope records highlights the need for an improved understanding of the mechanisms leading to variations in the tree's internal carbon and water cycle in relation to climate, soil moisture conditions, transpiration and root system. We will decipher the environmental and physiological information encoded in the isotopic signature of *Larix decidua* tree-rings. Weekly resolved carbon and oxygen isotope records of xylem and needle water, needle sugars, phloem sugars and stem cellulose are developed. We act (i) on a spatial scale by following the pathway of stable isotopes from the atmosphere into the tree-ring under varying environmental conditions and (ii) on a temporal scale by studying seasonal cycles of the isotope signals in all these different components, covering two growth seasons. Tree-ring $\delta^{18}O$ seems to be dominated by the source water signal, including recent precipitation and further water pools within the soil. Although variations in needle water enrichment are controlled by weather conditions, they are of minor relevance for the signal recorded in the tree-ring. The impact of physiological parameters seems to be independent of altitude and moisture conditions. Cool conditions, however, cause a more diffuse short-term pattern of the tree's oxygen cycle, due to lower metabolism rate and time lags in the response to meteorological and physiological impacts. Carbon isotope measurements are in progress and will also be presented. Our unique dataset will be finally used to test and improve advanced models for isotope fractionation at the leaf level and in the tree-ring.

PB3.05

PB3.05 Poster

Does CO_2 degassing from mofettes influence growth and isotopic composition of tree rings?

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The Eger rift system on both sides of the Czech-German border is characterised by the occurrence of Cenozoic volcanism. It is known as one of the most interesting European earthquake swarm regions, characterized by the repeated occurrence of seismically active periods with thousands of small and intermediate magnitude earthquakes. In addition to earthquake swarms, numerous CO_2-rich mineral springs and mofettes occur. These degassing zones are characterised by high gas fluxes with CO_2 concentrations of more than 99 vol. % and $\delta^{13}C$ values between -2 and -4 ‰, that is, the geogenic CO_2 is less depleted in ^{13}C than the atmospheric CO_2. Natural degassing zones of CO_2 strongly affect the surrounding biosphere and investigation of this impact can reveal recent and past interactions between the geo- and biosphere (Bräuer et al. 2008).

We analysed ^{13}C isotope variations over an 80-year period in tree rings of *Quercus robur* and *Fraxinus excelsior* trees growing at a mofettes. We compared the trees from the degassing site with the reference trees from a site nearby experiencing normal atmospheric CO_2 levels in order to test if the isotopic ratios were affected by the geogenic CO_2. First results will be presented in poster format.

PB3.06 Poster

The influence of climate on the $^{13}C/^{12}C$ and $^{18}O/^{16}O$ ratios in tree ring cellulose of *Pinus sylvestris* growing in central Scandinavian Mountains

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Tree ring stable isotope composition is known to contain information of past climatic and environmental changes, and may be used as a complement to TRW and MXD in climatic reconstructions. In this study we examine the nature and strength of the climate signal captured in the $\delta^{18}O$ and $\delta^{13}C$ values of Scots pine trees (*Pinus sylvestris* L.) growing at a tree-line site in the central Scandinavian Mountains. Between 4 and 14 pine trees were pooled to produce records of carbon and oxygen isotope ratios of annual tree-ring cellulose spanning the period AD 1736–2006. Comparison of $\delta^{18}O$ with local meteorological data showed a positive correlation with summer temperature (JJAS; $r=0.47$, $p<0.01$) of the current year, which is likely a reflection of the evaporative fractionation within the tree. Moreover, a relationship between the $\delta^{18}O$ data and the $\delta^{18}O$ values of late winter precipitation (February; $r = 0.58$, $p <0.05$), and the precipitation over the summer season (JJA; $r=-0.41$, $p<0.01$) was observed. After correcting the $\delta^{13}C$ values for anthropogenic changes in the atmospheric CO_2 isotope composition and for physiological responses to increasing concentrations of atmospheric CO_2, the $\delta^{13}C$ values showed a strong summer temperature (JJA; $r=0.73$, $p<0.01$) and light (July; $r=70$, $p<0.01$) dependence, and a moderate relationship with summer relative humidity (JJA; $r=0.39$; $p<0.01$). This suggests a greater importance of photosynthetic rate rather than stomatal conductance on the $\delta^{13}C$ variability in pine trees growing at the site.

PB3.07

PB3.07 Poster

Larix decidua tree rings as indicators of vehicular traffic through the Mont Blanc Tunnel

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Stable isotopes composition ($\delta^{13}C$,$\delta^{18}O$,$\delta^{15}N$), heavy metals and ring width of *Larix decidua* have been analyzed at three sites along the Mt. Blanc Motorway, Italy, with the aim to check how trees recorded some significant air-pollution changes occurred over time. The Mt.Blanc Tunnel is one of the major trans-Alpine transport routes, well suited for the study of pollution effects because there was a steady increase in the vehicular traffic after the opening of the tunnel(1965) up to 2-million vehicles per year(1998), followed by a three-year period of closure(1999–2002) after the car accident occurred in the tunnel and by the definitive ban of fossil fuels(2000–2002). Preliminary results from three sites at about 1400m (C: close to the tunnel-360m-; H: at higher altitude; F: far away-1km-) don't indicate any clear relationships between ring width and climate factors, probably because of disturbances occurred over time within the. First results from stable isotope analyses ($\delta^{13}C$ and $\delta^{18}O$) show interestingly an enrichment in $\delta^{13}C$ at Site C in the year 1999 probably related to higher photosynthetic activity. Similar values for $\delta^{13}C$ and $\delta^{18}O$ were found at sites H and F for the period 1950–1970. However, for the period 1985–2008 at site H we found higher values of $\delta^{18}O$ than site F; highest values were found for Site C, probably related to a lower stomatal conductance. The Mt. Blanc Tunnel can be used as an experimental facility for studying the responses of trees to long-term air pollution and for assessing the reliability of trees as yearly-scale air-pollution biomonitors.

PB3.08 Poster

Pooling vs. individual measurements in stable isotope (δ^{13}C and δ^{18}O) chronologies

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The isotopic compositions of carbon, oxygen and hydrogen of annually dated tree rings contain time integrated information about the environmental conditions weighted by seasonal growth dynamics. Today, δ^{13}C and δ^{18}O of tree-rings are well established as sources of palaeoclimatic and ecophysiological information (Helle and Schleser 2004). Since Leavitt and Long (1984), isotope measurements are frequently carried out by pooling dated growth rings from several trees prior to the isotopic analyses. This procedure has the advantage of saving time and resources but prevents from defining the isotopic error or certainty associated with inter-tree variability of each year's isotopic composition. However, if the contributions in mass of each tree ring to the pool are not equal, the results are biased towards the tree rings with the highest mass contribution. Up to now only a few studies have compared isotope series from pooled tree-rings with measurements for individual trees (e.g. Treydte et al. 2001) to assess advantages and constraints. We tested whether site chronologies derived from pooling and individual measurements display significant differences in both the inter-annual and the low frequency domain for δ^{13}C and δ^{18}O chronologies at two different locations from the Iberian Peninsula.

PB3.09 Poster

Stable carbon isotope ratios of α-cellulose in *Pinus tabulaeformis* carr. from Qinling Mountains: Variability and signal-strength

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Three individual *Pinus tabulaeformis* Carr. samples (D1,D2,D3) and one pooled sample(MD) were sampled in NanWutai (NWT) on the northern slope of the Qinling Mountains and their stable carbon isotope ratios were measured from their α-cellulose after cross-dating. δ^{13}C values were corrected for changes in the δ^{13}C of CO_2 in the atmosphere and de-trended to remove the effects of tree age. Simple linear regression was used to determine the natural and strength of any climatic signal. The isotope record of NanWutai *Pinus tabulaeformis* Carr. spans the period 1952–2002. Comparing the □^{13}C from the three individual samples (D1,D2,D3) and the pooled sample(MD),the data shows that there exists a high correlativity□r=0.495□0.590□P<0.001□. Our preliminary results suggest that the individual samples can yield results similar to those obtained from preparation and combination of the pooled sample.

PB3.10

PB3.10 Poster

Isotopic signatures of global change and Little ice age in the South Iberian peninsula using tree growth rings of *Pinus nigra*

Sonia Granados Paez, Antonio Delgado Huertas
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The isotopic composition of carbon ($^{13}C/^{12}C$) in tree growth rings of *Pinus nigra* from Cazorla, Segura and Villas Natural Park in the south-eastern Iberian Peninsula has been analysed with the objective of studying recent climate events such as the Little Ice Age and to quantify the global climate change effects in the Mediterranean region. Most existing dendroisotopic studies focus on sites in Northern Europe and as a result, isotopic values from south of Europe are of particular interest to the scientific community in considering the effects of global change in semiarid Mediterranean ecosystems.

The results show that the most negative isotopic values of $\delta^{13}C$ are in the range of -23‰ to -24‰ (V-PDB) and correspond to the period from 1645–1715 known as the "Maunder minimum" which was characterized by intense cold in Europe and an increase in rainy periods in the south Iberian Peninsula. At the end of 19th century, a change toward more positive isotopic values of $\delta^{13}C$ is observed. These values are around -21‰ to -22‰ (V-PDB) and correspond to the end of the Little Ice Age. This period was characterized by warmer conditions.

In accordance with our results we believe that the use of stable isotopes in tree rings can be a useful tool for global climate change research in Mediterranean semiarid areas such as the south Iberian Peninsula.

PB3.11 Poster

Isotopic dendroclimatology in the national park of doñana: Effects of global change

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The isotopic composition of carbon ($^{13}C/^{12}C$) in tree growth rings of two pine tree specimens of *Pinus pinea* from the Doñana National Park has been analysed with the objective of validating their potential in the reconstruction of palaeoclimates and palaeohydrologies of the Southern Iberian Peninsula and, in addition, to evaluate the effects of Global change on the stress conditions of this ecosystem. The isotopic values of the specimens studied have been compared with the climate data of the study zone (mean monthly temperatures, monthly and annual rainfall). The isotopic data of both specimens shows similar tendencies along with some differences which probably result from the specific site context of each individual (distance to water table, proximity of competitive specimens etc.). The values of $\delta^{13}C$ are in the range -23,6‰ to -27,9‰ (V-PDB). The observed data indicates that in high rainfall periods, especially in rainy months of May, the isotopic values indicate impoverishment in ^{13}C while in drought years and in the annual period May–July, when the temperatures are rising, an enrichment of ^{13}C is seen. From 1950 starts a progressive deterioration (more stress) until 1995. This period is characterized by a reduction in the isotopic discrimination ($\Delta^{13}C$) by the plant which concords with the generalized increase in temperatures associated with Global Climate Change during these years.

PB3.12

PB3.12 Poster

D/H in tree growth rings: A potential tool for paleoclimatic reconstructions in the Iberian peninsula

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The isotopic ratio of D/H in cellulose extracted from tree growth rings of three pine tree specimens of *Pinus pinea* from the Doñana National Park has been studied with the objective of quantifying and verifying the behaviour of the hydrogen isotopic signal in environments with irregular rainfall, such as the south Iberian Peninsula, with the aim of establishing its potential for longer chronological studies that include periods for which climate data is non-existent. We have compared the D/H isotopic values of the specimens studied with rainfall date for the study zone. The results show an inverse relation between the Hydrogen isotopic signal and the amount of rainfall. The values for δD are in the range -5‰ to -61‰ (V-SMOW). The years of highest rainfall correspond with the more negative values in each of the three cases studied. 1996 stands out as the rainiest year of the last few decades and is characterized by the most negative isotopic value -61‰ (V-SMOW).

Given the significant correlation between the isotopic data and the climate data (in this case, the amount of rainfall), we believe that it would be possible to apply this technique to time-series of greater duration to assist in palaeoclimatic reconstruction in the South Iberian Peninsula

PB3.13 Poster

Comparison of stable isotopes of carbon in cellulose and total wood in tree growth rings of *Eucalyptus globulus*

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The carbon isotopic composition ($\delta^{13}C$) of total wood and of cellulose from tree growth rings of *Eucalyptus globulus* in Doñana national park has been studied with the objective of establishing if the extraction of cellulose is necessary for palaeoclimate studies. The results demonstrate a good correlation between the isotopic data of total wood and of cellulose, the latter of which is approximately 1,36‰ more enriched in ^{13}C than the total wood. The correlation of isotopic data with climate date from the zone is ambiguous. No strong correlation with the temperature was found except for a positive correlation with the temperature in September and the isotopic values of both wood and cellulose. However when the comparison is made against monthly rainfall data a negative correlation between $\delta^{13}C$ of cellulose and wood is seen for the months of January, February, September and October. This correlation is stronger in the cellulose. According to the results obtained we believe that it is possible to analyze ^{13}C in total wood of *Eucalyptus globulus* in place of cellulose as a tool for palaeoclimatic studies, however, the data needs to be interpreted with caution and further studies are necessary to explain possible ambiguities in the data owing to the influence of non-climatic factors that could influence the isotopic signal of wood.

PB4.01 Poster

Climate and fire history in Mongolia

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The impact of increasing temperatures and changing hydroclimatic regimes on ecosystems is expected to be most pronounced and occur earliest in northern latitudes, such as in Mongolia in central Asia. Based on fire atlas data sets, the frequency and aerial extent of forest and steppe fires in Mongolia have significantly increased over the last c. 50 years. However, there is a need to place these recent changes into a longer-term perspective to more fully understand fire-climate dynamics in Mongolian forests. To this end, we are developing a new, broad-scale and multi-centennial network of absolutely dated fire chronologies based on crossdated fire scars and stand ages from across Mongolia. Fire-scar records are common and ubiquitous in Mongolian Scots pine forests with centuries-long records that come up to the present (several sampled stands have recently burned within the past 1 to 10 years, with fire scars recorded from these burns). Results from the first field season in 2009 will be presented, along with observations about the climatic effects on fire regimes both currently and over the past few centuries.

PB4.02 Poster

Fire and forest history across forest gradients in the western US

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I describe a systematic sampling approach that has been used to reconstruct forest and fire histories across gradients in elevation and forest types at numerous sites in the western US. Data developed by these studies have been used to determine spatial and temporal variation in historical fire regimes and forest structure and composition. Trees for dendroecological analysis are collected using an n-tree density adapted sampling design in plots located at grid points placed across each site. I summarize from several sites the overall results derived from individual plot and polygon chronologies of fire and tree recruitment, such as time-averaged fire regime parameters (mean fire interval and fire severity) and changes in forest composition and structure, across historical ecosystem types ranging from low-elevation shrublands and woodlands to montane and subalpine forests. Data derived by these studies also are used to reconstruct climate forcing of local to regional fire synchrony using both these and additional targeted fire-scar datasets.

PB4.03

PB4.03 Poster

A Fire and Climate Synthesis (FACS) for Western North America Using Tree Rings and Documentary Sources

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Fire climatology is rapidly developing due to increasing understanding of broad-scale ocean-atmosphere climate forcings (such as ENSO) and their teleconnections to regional and local patterns of droughts and wildfires, and recent global warming trends and concurrent increases in areas burned and lengthened fire seasons. The authors are collaborating on the Fire and Climate Synthesis (FACS) project to describe temporal and spatial patterns of fire and climate in the western USA and adjacent parts of Mexico and Canada. We can accomplish this by using a large, public database of tree-ring based fire histories (the International Multi-Proxy PaleoFire Database or IMPD, see www.ncdc.noaa.gov/paleo/impd/), wildland fire records, climate records, and tree-ring based climate reconstructions. Our goal is to develop new approaches for spatio-temporal analyses on sub-continental scales of climate/fire dynamics, and to translate that new science into improved information and communication to fire managers, planning staffs in resource and fire management, fire predictive services, and wildfire decision-makers, and to better inform policy development. We are (1) reviewing and synthesizing existing literature, and performing spatial-temporal analyses of tree-ring and documentary based fire and climate time series to define a "geography of fire climatology" of the western USA and beyond; (2) incorporating these fire-climate synthesis results into a set of existing online management decision support tools recently developed as part of the IMPD; and (3) working with end users, evaluating and interpreting how a better understanding of fire climatology can help shape fire and fuel management decisions.

PB4.04 Poster

Historical fires regimes in red pine forests of Eastern North America

PB4.04

Igor Drobyshev, Yves Bergeron
Université du Québec en Abitibi-Témiscamingue, Rouyn-Noranda, QC, Canada

Red pine (*Pinus resinosa* Ait.) is one of the few fire-resistant tree species in the eastern North America, with a range confined to the North American Northern Forest region and the southern fringe of the North American Boreal Forest region. Natural fires have been recognized as the driving factor in the historic development of red pine forests, with surface fires being the most typical disturbance events. Ability of this species to survive in low and moderate intensity fires makes it a valuable research object for analysis of past disturbance histories in this part of the boreal North America. In the project we present fire history reconstructions for mixed pine forests across a network of sites in Eastern US and Canada over the period of 200–400 years. We link this dynamics to both past climatic variation and history of human colonization of the region and discuss long-term dynamics of climatic forcing upon regional fire regimes.

PB4.05

PB4.05 Poster

Snow gum (*Eucalyptus pauciflora*) stand dynamics: The use of modern crossdating methods to reconstruct historical relationships between climate and fire

Jessica Davies, Patrick Baker, Rohan Simkin
Monash University, Melbourne, Australia

We investigated the influence of regional factors, namely drought, on the reconstructed fire history of Snow gum (*Eucalyptus pauciflora*) dominated communities in Tallaganda National Park (TNP), Eastern Australia. We analysed 56 fires scars collected from 32 Snow gum trees, and crossdated 126 cores to establish the age structure of four discontinuous Snow gum stands. We produced a standardized master ring-width chronology to determine growth responses of Snow gum to climate. Fire frequency thresholds were utilised to increase the confidence of fire occurrence predictions from fire scar analysis, which indicated that there had been 34 fire years since 1890. We used the master fire chronology to determine correlations between fire occurrence and Palmer Drought Severity Index, Forest Fire Danger Index (FFDI), mean maximum temperature, mean minimum temperature and total monthly and seasonal rainfall. These predictor variables were also correlated with our standardized ring-width chronology. We confidently determined low—moderate intensity fire occurrence during 1959, the mid-1960s, and in 1976, and correlated these events to significantly low FFDI in the early summer, and mean maximum temperature in the late summer, both in the year prior to fire occurrence. A further 15 fire events were observed to have significantly negative PDSI in the 5 years prior to fire. Limitations upon the dating of fire scars, determination of recruitment pulses, and upon the relationship with fire occurrence and radial growth patterns meant that indicators of fire must not be used alone, but together to accurately reconstruct fire history.

PB4.06 Poster

Impacts of wildfire intensity on *Pinus canariensis* tree-ring growth on Tenerife Island, Canary Islands, Spain

PB4.06

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We studied the impacts of a wildfire occurred on Tenerife in summer 1995 upon the radial growth of *Pinus canariensis*, an endemic species from the western Canary Islands adapted to fire dynamics. The main objective of this study was to quantify the effects of a fire of known date on radial growth patterns. Moreover, we tested the applicability of several dendroecological methods for the analysis of abrupt growth changes for disturbance dating, which may complement the classical techniques based of fire scars dating. We sampled two cores per tree in at least 22 trees per stand, at two stands of each fire treatment (control without fire, surface fire and crown fire) and on two expositions (north- and south-facing slopes), yielding a total of 266 trees sampled in 12 stands. After tree-ring series were dated and measured, we identified the numerous absent rings. Mean growth rates were compared by treatment and exposition with two-way ANOVA and growth suppression filters were applied to the tree-ring series. Our results suggested that the high-intensity crown fire caused a significant reduction in tree-ring width, but no differences between low-intensity surface fire and control treatment were found. Likewise, wildfire effects were sharper at the north-facing sites. Canary pine is a very complex species for applying dendrochronological techniques, given its abundance of absent rings especially after crown fires occurrence. Although only the influence of crown fire was detected, this method showed to be suitable to study wildfire dynamics of Canary pine.

PB4.08

PB4.07 Poster

Forest fire occurrence connected to meteorological and solar activity in 1958–2007 at Kola Peninsula

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We investigated the cyclicity of forest fire number for the period 1958–2007 at Kola Peninsula. We used the data of regular aerial surveying. The frequency of forest fires was compared with regional meteorological and dendrochronological records. Spectral analysis with help of MEM and wavelet revealed a clear cyclic character of fire occurrence with two main maxima. The main one occurred at frequencies around 18–20 years and the other in the band 2.8–4 year. Detailed analysis showed that fire occurrence at Kola Peninsula was a result of a complicated mixture of both anthropogenic and climatic forcings (temperature and precipitation). Climatic forcing is influenced by variations of solar activity (solar radiation, cosmic rays, cosmic dust etc.). Two maxima in the fire occurrence spectrum seem to be connected to one of the main cycles of solar activity (22 y) and NAO oscillation (3–4 y). As it is well known the NAO variations are rather tightly connected to cyclonic activity in the North Atlantic region. The enhanced numbers of fires were observed close to minima of solar activity. These results may be applied for fire forecasting at Kola Peninsula.

This work is financially supported by the Russian Foundation for Basic Research (grant No. 09-04-98801), by the Program of the Russian Academy and by the Regional Scientific Program of Murmansk region.

PC1.01 Poster

Building of long tree-ring chronologies for reconstruction of a climate of Altai-Sayan region for two last millennia

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PC1.01

During 2007–2009 five tree-ring chronologies (from 1200 to 2360 years) were built for Altai-Sayan region. The living trees and rest of stem wood of Siberian larch (*Larix sibirica* Ldb) were used for upper tree line (2300–2500 m). This chronologies are coincidence with paleoclimatic data and reflects basic climatic changes in the northern hemisphere for the last two millennia. We revealed extraordinary decreasing of tree radial growth after AD 536, “Medieval warming”, “Little Ice Age”, and current warming were revealed. Tree ring chronologies had shown a high correlation between each other and good response function of June–July air temperature (R=0,69). Such a long term chronology gives the possibility for dating of archeological wood to define the date of construction of archeological monuments.

PC1.02 Poster

Spontaneous recruitment of *Pinus nigra* at high elevation in central Italian Apennines: A climate- or anthropogenic new treeline?

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Marche Polytechnical University, Ancona, Italy

A synergy of long term anthropogenic and natural disturbances altered forest cover, structure and functions in most areas of the Apennines in central Italy. Recent abandonment and climate variability seemed to have induced secondary succession processes at treeline ecotones. In several locations, above the closed forest line (located between 1600–1800 m asl), in the absence of other woody species, we have unexpectedly found scattered young cohorts (8–30 years) of *Pinus nigra*. This pioneer species was widely used in previous forest plantations for slope protection purposes at lower elevation (1000–1500 m asl). We have investigated different sites in the central Apennines to test the role of climate change as the main driving force of the pine expansion.. Tree-ring and annual height increment time series analysis performed on about 250 individuals assessed the progressive establishment process and the climatic control especially on the height growth dynamics. The trees have low stature and sometimes a shrub-like physiognomy, frequent stem mechanical damages, but vitality seems not compromised, however only a few of them have reached maturity. Local and regional climate data show a clear warming trend and a change of the precipitation regimes in the last 20–30 years that could have triggered the pine recruitment process at high elevation. We believe that a complex process is occurring determined by the availability of seeds, their altitudinal dispersion efficiency, the selection of safe sites, the changes of pastoral management and the maintenance of suitable climatic conditions.

PC1.03

PC1.03 Poster

The soggy road to an 8000-year Scottish pine chronology

Rob Wilson[1], Neil Loader[2], Anne Crone[3], Coralie Mills[4], Colin Edwards[5], Miloš Rydval[1]
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Despite promising work in the 1980s by Malcolm Hughes showing the potential of Scots pine for the reconstruction of past summer temperatures in the Scottish Highlands, little dendroclimatic work has been attempted since. This situation is partly a result of the sparse number of remaining patches of semi-natural pine woodland in the Scottish Highlands and the difficulty of extending, significantly, the living chronologies which generally only go back to the early 18th century. In this presentation, we present the first results of recent efforts to acquire preserved sub-fossil pine material from lake sediments in the Highlands. Carbon dating results indicate that preserved pine material cover the last 8000 years with initial clusters focused on the medieval period and ~7900 years BP. No samples were dated to the 3000–6000 year BP period. Although we are under no illusions that it may taken many years to develop a continuous pine record for much of the mid-to-late Holocene, we highlight the importance of such a record to not only place recent climate change in a very long temporal context, but also allow the dendro-dating of multiple historical structures built from local pine material.

PC1.04 Poster

Are shrubs paving the way for trees? – Growth responses of *Picea glauca* to climate change might be influenced by shrubby vegetation

PC1.04

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Trees at northern treelines were long assumed to grow better with warmer temperatures. However, in recent years, treeline trees in Alaska react to climate warming with either increased growth, decreased growth, or no significant change in growth. Due to differences in precipitation patterns (regional scale), and to different stand densities (local scale), drought stress might be increasing, leading to different proportions of positive, negative, and non-responders within sites. Also, shrub densities in tundra and boreal forest areas have been increasing recently most likely as a result of warming temperatures. Our goal was to test whether differences in shrub cover reflecting different microsite conditions influence tree-to-tree growth variability. In a 3m radius around each cored white spruce (*Picea glauca*) tree, we investigated shrub species, height, and coverage of shrubs. Sampling was done at and below treeline at five sites across Alaska. Preliminary results suggest, that at most sites high cover of small shrubs (<70cm) influences tree growth positively, whereas cover of high shrubs (>70cm) does not significantly influence tree growth. However, this pattern is more evident for trees below treeline than for trees at treeline. Furthermore, alder shrubs (*Alnus* spec.) seem to enhance tree growth, which might be due to improved nutrient supply as a result of the species' nitrogen fixation. It is still to be investigated which of the shrub-indicated microsite conditions, such as differences in organic matter input, snow accumulation, and soil thermal conditions, might be responsible for the diverging tree growth at some sites.

PC1.05

PC1.05 Poster

Scots pine (*Pinus sylvestris* L.) has advanced 35 km since 1920's in Western Finnish Lapland

Mari Kuoppamaa[1], Vesa Juntunen[1], Seppo Neuvonen[3], Mauri Timonen[4], Marja-Liisa Sutinen[4], Samuli Helama[5], Raimo Sutinen[6]

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The ages of 2489 Scots pine individuals on transects totaling in length of 275 km and located 20–35 km north of the present coniferous forest line in western Finish Lapland were determined. Each individual was GPS-positioned. The oldest pine was dated to the year 1637, only 41 surveyed pines germinated before the 1800s, and 111 pines before the 1900s. Between 1788 and 1973, the pine treeline advanced 140 m per year. In the 17th and 18th centuries no pines were established beyond 10 km from the current pine timberline but an average of 5 pines per century and per square-km were established in the zone 0–5 km from it. During the second half of the 20th century 0.08 and over 7 pines were established on average annually per square-km in the zones >20 and 0–5 km, respectively, from the present timberline. The age structure of the pines increased nearly exponentially during the 20th century within 5 km of the present pine timberline while at >5 km from the timberline, the age distribution was smoothly multi-modal. Between 1894 and 1994 there was a large increase in the number of pines germinated as time proceeded, year explaining 44 to 82% of the variation in the dependent variable, log((number of pines)+1). Climatic variables did not enter the model as significant factors at <5 km from the timberline, but farther from it both winter and summer temperatures (5 year averages) increased significantly the fit of the model.

PC1.06 Poster

Macrofossils challenge ubiquitous birch-pine-spruce succession in Finnish Lapland

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PC1.06

Reconstruction of post-glacial migration of Norway spruce (*Picea abies* (L.) Karst.) into northern Fennoscandia is based on pollen records and radiocarbon (^{14}C) ages from organic deposits, no macrofossil evidence has been shown to indicate distribution of spruce beyond its present timberline-treeline ecotone. We applied total sampling to study Holocene succession of tree species at two sites: Pousujärvi peat bog (68°51'N, 21°10'E), beyond the present tree limits of spruce and Scots pine (*Pinus silvestris* L.) and the lake Kompsiotievanlammit (68°30'N, 22°30'E) at the present pine treeline in western Finnish Lapland. Subfossil pine logs at Pousujärvi site yielded ^{14}C-ages from 5,000±40 to 5,110±60 yr BP (5,730 to 5,900 cal. BP). Pioneer species was found to be birch (*Betula pubescens* ssp.) yielding ^{14}C-age of 7,980±60 yr BP (8,810 cal. yr BP). No spruce was present. All subfossil trunks sampled from lake Kompsiotievanlammit were pines, and yielded ages less than 3500 yr BP. No spruce was present. Our results imply that Holocene tree species succession is incomplete such that spruce is absent in the chrono-stratigraphic sequences in regions where an edaphic dispersal barrier for spruce is comprised by tills derived from felsic rocks, particularly granulites.

PC1.07

PC1.07 Poster

Altitudinal forest expansion through change detection of historical aerial photographs

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The twentieth-century migration of alpine treelines to higher elevations is attributed to the ongoing global change in Fennoscandia. Although this phenomena is well acknowledged the spatial pattern and dynamics of the timberline advance to higher altitudinal elevations is not yet quantified and the relation of tree migration to soil quality and snow pack properties is rather unknown. In this paper, an automated pattern recognition technique called object based image analysis is applied to tree crown delineation from digitized historical panchromatic aerial photographs from 1940' and 1960's and from present false colour aerial photographs from the 2000's on two altitudinal forest-tundra fell ecotones in Finnish Lapland. The change in the resulted relative crown areas of Norway spruce (*Picea abies*) and downy birch (*Betula pubenscens*) were then assessed in change detection analysis, and verified with forest inventory and tree age data of saplings and tree-rings. Within the last 60 years, Norway spruce has expanded uphill, in terms of distance, approximately 100 m and birch 50 m. In accordance with the birch-pine-spruce succession concept, the downy birch dominated forest-tundra ecotone stands are now replaced by Norway spruce. We did not find water availability, soil temperature nor nitrogen to be limiting factors in expansion of spruce-birch forest but a surplus of aluminium relative to base cations may disfavour spruce on some sites in the tundra. Primarily, the harsh winter wind-climate and spatial variability in thickness of snow cover are presently restricting the regeneration of trees on the open tundra.

PC2.01 Poster

Needle retention and needle longevity dynamics of Scots pine since 1560 revealed by the Needle Trace Method

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Conifer foliage consists of several needle age classes. As a part of needle dynamics, new needle cohort appears in the developing long shoots; oldest needles become senescent and shed down, and mean needle age varies temporally. Needle longevity and annual needle loss determine how many needle sets are attached in the shoots, i.e. how long the needles are retained. Needle retention among species is strongly genotypic but within species, environmental factors such as nutrition, weather and climate affect it markedly, too. Needle longevity is also dependent on tree's growth: the faster a pine tree grows, the shorter is needle age. This relationship was used to indirectly study past climatic variation. To produce 450-year-long series on needle proxies we applied the Needle Trace Method, NTM, to the main stem of 65 Scots pine (*Pinus sylvestris*) trees in Laanila, northern Finland. In the unique needle longevity series, needles lived on average much longer in the 19th than 18th or 20th century. Needle age was extremely short in 1790 and clearly shortened in 1601, 1892 and 1903. Needle retention varied between 4.5 and 6.5 in the early 18th and late 20th, and in the late 19th century, respectively. It is suggested needle proxies to be used in studies on past climate dynamics.

PC2.02

PC2.02 Poster

Climatic signals in English oak *Quercus robur* in tree-rings and earlywood vessels in Latvia

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University of Latvia, Riga, Latvia

Tree-rings contain information about tree condition, environmental factors and their coactions, and are widely used for climate analysis. Tree-rings from a single species usually have significant climatic signals that are also site specific. Wood anatomy structure (vessel size) analysis has been shown to portray more specific climatic information. In Latvia English oak *Quercus robur* a ring porous species, is situated close to its northern distribution limit, which suggests that temperature is a limiting factor. Oak stands on dry and moist habitats were investigated and cores were taken from dominant trees. Tree-ring widths and annual early wood vessel cross-section areas were measured. Climatic signals from tree-ring widths and early wood vessels were obtained by correlation analysis with precipitation and temperature variables. Analysis showed that temperature had more influence than precipitation on tree-ring and vessel formation. The temperature effect was more significant in late winter and spring when oak is preparing for vegetation season and in the beginning of summer. Climatic signals obtained from tree-ring widths differed among sites even in similar habitat conditions at short geographic distances, while climatic signals from vessel areas were more similar (but still showing differences). There was hardly any monthly temperature or precipitation variable characteristic for all investigated sites, but seasonal variables showed more similar tendencies, especially in early wood vessel cross-section fluctuations. Overall, earlywood vessel area showed higher correlation with climatic variables than tree-ring widths.

PC2.03 Poster

Experimental exposure and recovery of Spruce roots

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PC2.03

A preliminary analysis of exposed roots found in a headwater area along rock veneers and on slopes revealed many uncertainties with respect to observed changes in wood anatomy.

According to H. Gartner et al. (2001), the exposure of roots is the main cause of a 50–60% decrease in early wood (EW) lumen size. In addition, roots growing under soil of variable depth exhibit various types of modifications in wood anatomy (Gartner 2003).

This is also true of the roots under consideration herein, but in some cases, the response of roots found at the same site was found to be shifted by one or two years. Furthermore, initial changes in early wood and latewood structure were followed by two further changes.

Therefore, our project is aimed at monitoring the actual behavior of roots exposed at different times during the growing season and in different soil conditions. We have selected two sites in the Gorce Mountains which are located in the southern part of Poland, near the city of Krakow. Experimental work began during the 2009 growing season and will continue until the end of the 2012 dormant season.

The experimental sites were selected in two upper sections of mountain catchments

The roots were splitted into:

1. Exposed or covered one times at the beginning of growing season
2. Exposing and recovering during the same growing season

Anatomical changes in the structure of roots collected from rock veneers and slopes both with preliminary results from triggered roots will be discussed.

PC2.04

PC2.04 Poster

Tangential rows of traumatic resin ducts in dendrogeomorphic research

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Trees respond to mechanical disturbance with the formation of callus tissue, abrupt growth changes, or reaction wood. Different conifer species react to mechanical stress with the formation of resin ducts. Following disturbance, traumatic resin ducts (TRD) appear in tangential rows close to the wound, where the cambium has been destroyed through impact. So far, studies on tree reaction were based on artificial wounding or chemical treatment. The analysis of 1707 cross-sections taken from trees wounded by debris flows, rockfall and snow avalanches, allows, for the first time, insights into the anatomical response, type, temporal appearance, and spatial extent of tree response of *Abies alba*, *Larix decidua* and *Picea abies* injured under natural conditions. TRD production was largest at wound height, and TRD occurred more commonly above than below wounds. For all species, an intra-annual radial shift of TRD was observed with increasing axial and radial distance from wounds. We illustrate that the external appearance of wounds does not reflect internal response intensity. Disturbance induced under natural conditions triggers more intense and more widespread anatomical responses than that induced under artificial stimuli, and experimental tests considerably underestimate tree response. Analysis of the dimension of earlywood tracheids and the arrangement of TRD bordering wounds does not only allow identification of geomorphic processes, but also enables a differentiation of snow avalanche from rockfall impacts induced at the same time during the dormant season. TRD therefore represent a valuable and reliable signature of geomorphic disturbance and allow for an accurate dating of events.

PC2.05 Poster

Cambial resistance to water stress and defoliation

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Tree rings originate from the differentiation of cells produced in the cambium. Their formation is similar across tree species and environments. To what extent does the resistance of the cambium dynamics hold facing environmental stresses? We tested the cambial resistance of balsam fir (*Abies balsamea* Mill.) to water stress and defoliation. Meristem growth was studied on a weekly basis from May to October 2005 on 7-year-old seedlings submitted to either a 20-day-long dry period in June–July or two-thirds of needle defoliation. The radial number of cambial, enlarging, cell-wall thickening, and mature cells were counted. Anatomical features of the developed xylem were also measured along the tree rings. Cell production rate was estimated at about one xylem cell per day, achieving in 100 days 108 tracheids and a ring width of 2 mm. Although thinner rings were observed in non-irrigated plants, irrigated and non-irrigated trees showed the same trend of xylem formation and timings of cell differentiation. A reduction of up to 50% in lumen area and cell diameter was observed for the tracheids produced during the dry period. Conversely, no effect on the cambial phenology, differentiation and anatomical features was observed in trees subjected to defoliation. Responses of balsam fir seedlings consisted of good resistance of the cambial meristems to water stress and defoliation and high sensitivity and rapid recovery of cell sizes during and after water depletion. The results demonstrated that plants were able to produce all resources required to maintain vigorous stem growth at these levels of defoliation.

PC2.06

PC2.06 Poster

Vessel characteristics of Oriental beech (*Fagus orientalis*) in the Alborz Mts., north Iran, and their ecophysiological evidence – An explorative study

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Iran is forested to only 7.4% whereby Oriental beech accounts for 17.6% of the total forest area. Its altitudinal range extends from 500 to 2200 m a.s.l. and thus spanning different climatic zones. Trees have to adapt to such differences prevailing in the long-run but at the same time also to the annually changing environment in the short-run. The short-term responses are permanently archived in the annually formed growth which therefore is a high-valued source of information for foresters, ecologists and climatologists.

Our project is aimed at constructing 50-year long vessel chronologies along an east-west transect through the Elborz Mts. and along an altitudinal transect. The oldest beech stands are up to 250 years old; their mean tree-ring width is 1.03+/-0.53 mm. At first glance, Oriental beech in the Elborz Mts. is well suited for dendroecology and -climatology as regards tree-ring widths. However, neither large-scale studies have been made on the inter- and intra-annual variability of the vessel size nor on the cambium dynamics of Oriental beech in the Elborz Mts. Whatever climatic signal the vessel characteristics reflect, it is envisaged to reconstruct it back over approx. 250 years.

PC2.07 Poster

Frequent intra-annual wood anatomical features in *Larix sibirica* growing in the drought-stressed forest-steppe ecotone of northern Mongolia

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Albreht von Haller Institute, Goettingen,, Germany

Wood cores of Siberian larch (*Larix sibirica* Ledeb.) were collected on each five plots in two regions of northern Mongolia (Bogd-Khan, eastern Khentey Mountains). In these areas, Siberian larch occurs at the southernmost distribution limit of the Siberian taiga to the Central Asian steppe. At their drought limit, Siberian larch shows conspicuous intra-annual tissue and cell structures indicating special weather conditions or insect calamities, in addition to climate-related inter-annual variation of tree-ring widths. Relevant features include frost rings, extremely narrow or missing annual rings as well as rings with small springwood vessels, narrow and light latewood, reaction wood, traumatic cells, intra-annual density variations or rings containing much resin. Tree rings with narrow and light latewood, but well developed earlywood probably result from insect calamities, whereas drought years mostly produce both narrow earlywood and latewood.

Differences occurred both between the two study areas and different sites within a study area. Wood-anatomical traits only found in individual replicate plots of a given study area probably reflect non-climatic influences, whereas traits found in all plots are more likely attributable to weather conditions. Attribution of the anatomical traits observed in the L. sibirica wood to individual climatic and non-climatic factors is an ongoing challenge which we aim at solving in our future work. Evaluation of visually detectable wood anatomical anomalies, including frost rings and density variations in relation to extreme climate events and insect calamities, will be analyzed with an automated image-analysis system (Leica DM 6000 Digital-Microscope and Leica image analysis software).

PC2.08

PC2.08 Poster

Raulinoa echinata R. S. Cowan (Rutaceae): Ecological wood anatomy of root and stem in Santa Catarina, Brazil

Greice Campos-Moresco, Tiana Mara Custódio, Morilo José Rigon Júnior, Karin Esemann-Quadros
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Raulinoa echinata is a reophytic specie, threatened of extinction, that live near swift-running Itajaí-açu river, subject to periodical floods. The wood anatomy of root and stem was investigated to indentify characteristics that allow adaptation and survival on rocky and sandy substrates. The studies were conducted in Ibirama and Apiuna, Santa Catarina, Brazil (S 27º 05´07´´/ W 49º 30´59´´). There were collected samples deriving from ten individuals, by wood root and stem from 20 cm of base. Transverse, tangential and radial 20 micrometer thick sections of the pre-softened wood are made, dehydrated, double stained and fixed to slides for light microscopy. Average values of 30 measurements of each characteristic were used in the evaluation. The dissociated cellular elements were prepared according to the modified Franklin method. All data were analyzed with statistical programme. The root is tetrarch, the root and stem wood show little distinct growth rings, diffuse porous, vessels solitaries and multiples from 2–3 in radial arrangement, simple perforation plates, absent tylosis, axial parenchyma in marginal and paratracheal lines scanty. Vessel elements length range from 180–460µm in root and 125–450µm in stem and tangential diameter from 18,5–65µm in root and 17,5–57,5µm in stem. Fibers length range from 490–1100µm in root and 632–977µm in stem. The height of rays was 240–630µm in root and 195–270µm in stem. Wood displays xeromorphic characteristics, been confirmed by the vulnerability index in average (0,42) and mesomorphy (126). The root vascular cylinder is modified for the efficiency in transport, with eccentric growth and reaction wood.

PC2.09 Poster

Anatomical characteristics and wood density components of sessile oak (*Quercus petrea* Liebl.) in East Germany

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The basis for many dendroecological investigations of conifers lies in the measurement of tree-ring components in high resolution by the help of X-ray microdensitometry. The possibility to use X-ray microdensitometry for the measurement of wood density components in addition to ring width seems to be especially interesting for the long-lived sessile oak.

Compared to coniferous wood the anatomical structure of dicotyledonous wood is even more complex which causes difficulties in measuring and interpreting intraannual density values. This is one reason for the often disappointing results of X-ray microdensitometry investigations on dicotyledonous wood.

Our objective was to clarify how anatomical characteristics of different structured tree-rings of oak are reflected in the structure of microdensitometric profiles. Based on these results the X-ray method was intended to be optimized for the wood of sessile oak. The investigation included four radial sections of two 130 and 70 years old trees on which microdensitometric profile and ring width were measured.

The anatomical properties of every annual tree-ring were quantified and described by the help of digital image analysis. Special attention was given to vessel dimensions in the early- and latewood as well as their distribution and ratio. The assembly, distribution and ratio of axial and tangential parenchyma, fibers and rays were measured and calculated.

As a result of this investigation it was possible to create repetitious density components which are verifiable by wood anatomy for the climate sensitive latewood portion of sessile oak.

PC3.01

PC3.01 Poster

‘Small trees’ from Northeast Greenland

Claudia Baittinger[1], Mads C. Forchhammer[2], Johannes Kollmann[3], Niels M. Schmidt[2]
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In the High Arctic, climate change is expected to strike first and to be most pronounced.

Dwarfshrubs from the Arctic do have the potential for dendroclimatological studies, but have been used very little due to methodological problems (very low growth-rates, eccentric pith and missing and discontinuous rings). A basic investigation of the annual growth of individuals is necessary to define and verify the method and will make it possible to produce proxy data that can be used to describe past climate.

Samples of Arctic Willow (*Salix arctica* Pall.) have been collected on three sites in Northeast Greenland – in the Zackenberg Valley, on Clavering Island and at a location on the mainland close to this island.

The research in progress is not only throwing light on changes in snowcover and temperature around Zackenberg, but will also contribute to the use of dendroclimatology on other woody species from the High Arctic.

PC3.02 Poster

Tree-ring growth and wood anatomy of Mediterranean sub-shrubs

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The seasonal cambial dynamics of most Mediterranean sub-shrub species are virtually unknown. However, the detailed description of their cambial phenology (xylogenesis) should be the first step for evaluating their potential dendrochronological use. We selected four species of Mediterranean sub-shrubs that grow along a climatic gradient in NE Spain ranging from continental to semi-arid Mediterranean climate types. These species include the seasonally dimorphics *Lepidium subulatum, Linum suffruticosum, Salvia lavandulifolia* and *Satureja montana*. Wood formation and anatomy (vessel area and density) were investigated taking monthly samples during one year of 1-, 2- and 3-years old branches from 5 individuals per species. Tree-ring width was measured in two opposite radii every sampling period and wood anatomy was studied in selected individuals every month. Wood sections (20–40 μm) were cut with a sliding microtome, fixed and stained with methylene blue and safranin and examined under a light microscope at ×40–100 magnification. To estimate total vessel area selected photographs were analysed with the ImageJ software. All species formed distinct rings and semi-ring-porous wood excepting *L. subulatum* which presented diffuse-porous wood, and frequently ring shake. Wood formation started in March in all species whereas the maximum rate of tree-ring growth was observed in May. Most of the annual theoretical hydraulic conductivity provided by the widest vessels was reached between April and May in the species with semi-ring-porous wood. We discuss our results considering the relationships between cambial dynamics, phenology, primary growth and carbohydrates accumulation in the four studied species.

PC3.03 Poster

The fine lines of pleasure and pain – Unravelling the tree ring record of *Podocarpus lawrencei*

Matthew Brookhouse
The Australian National University, Canberra, Australia

Despite potentially exceeding 400 years in age, Australia's *Podocarpus lawrencei* has long remained off the list of potential species for dendrochronological study. Normally existing as a shrub above the eucalypt treeline, fire-sensitive *P. lawrencei* is an important part Australia's alpine environment. However, frequent ring wedging and high conservation value, have long prevented dendrochronological study of the species. Following widespread fire throughout the Australian Alps in January 2003, unprecedented access was gained to sample material from the species. This sample material now forms the basis of research to examine long-term stand dynamics and climatology. This poster introduces this hitherto untested conifer and highlights recent advances in chronology development and climatological analysis

PC3.04

PC3.04 Poster

Growth rings and age in *Vella pseudocytisus* subsp. *paui*

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The correct identification of age classes plays a key role in demographic studies. Age characterizes the population structure and determines its dynamics. The most accurate age estimation of woody plants can be reached through dendrochronological techniques when the rings are well marked and constitute a reliable record of each annual growing season. Our work has focused on *Vella pseudocytisus* subsp. *paui* Gómez Campo (Brassicaceae), an endemic shrub which grows in an extreme climate region in the center of the Iberian Peninsula (Community of Aragón), with only two extant populations which have been recently enlisted as Endangered in the Spanish Red Data List. Our objective was to support with dendrochronological data the demographic monitoring performed over the last ten years, in order to assess vital rates, calculate population dynamics and determine survival trends. Its jeopardized status imposed some restrictions on their work, and in fact it has not been possible to carry out a sufficiently representative dendrochronological study. Any individual known to be dead or removed by agricultural practices was collected from both populations over the last ten years. After checking the existence of defined boundaries between rings, we have measured them in 126 trunk sections corresponding to 61 individuals. Data proved that *Vella pseudocytisus* subsp. *paui* is a relatively long-lived taxon, exceeding forty years in some cases. Such remarkable longevity of adult specimens calls attention to the need for managing populations with individuals that can performe many years and withstand adverse periods while awaiting suitable conditions.

PC3.05 Poster

Dendroclimatology of two mediterranean shrubs species: *Cistus ladanifer* L. and *Retama sphaerocarpa* L. (Boiss)

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PC3.05

Cistus ladanifer L. and *Retama sphaerocarpa* L. (Boiss) are two Mediterranean shrubs widely distributed in SW Spain (Extremadura region). The first species colonizes areas burnt by forest fires while the second is more frequent in overgrazed pastures. A total of 307 shrubs from 14 populations of *Cistus ladanifer* and 227 shrubs from 20 populations of *Retama sphaerocarpa* were sampled. Each individual was age dated and their maximum and minimum diameters were recorded. Log-log regression analysis between the average diameter and age prove that a global model of age determination is possible for each species (R^2= 0.956; p <0.001 and R^2= 0.986; p <0.001). Hierarchical Partition testing shows interactions between radial growth and climatic regions. Very rainy areas (>1000 mm) with *Cistus ladanifer* present a radial growth 1.47 times (2.2 mm/year) faster than the rest of the region (1.5 mm/year). In contrast, *Retama sphaerocarpa* present a radial growth 1.05 times lower in semiarid areas (<500 mm) with a radial growth of 2.1 mm/year. In consequence, combining the growth pattern of both species we define three climatic areas in the Extremadura region: semiarid (<500 mm), mesomediterranean (between 500 and 1000 mm) and humid areas (>1000 mm). This division is useful for choosing appropriate sampling areas for a regional strategy in tree ring research with long lived woody species.

PC3.06 Poster

Salix reticulata (L.) – Wood anatomy and application for the High Arctic environmental research

PC3.06

Piotr Owczarek
Institute of Geography and Regional Development, University of Wroclaw, Wroclaw, Poland

An extremely short growing season, long, dark winters and low precipitation influence the development of the tundra vegetation cover specific to the Arctic area. This biome, which is dominated by low creeping shrubs and different species of mosses, herbs and lichens is very sensitive for climatic changes. Only a few species of the Arctic dwarf shrubs has well-defined growth rings according of these we can reconstruct natural environment changes. One of these species is net-leaved willow (*Salix reticulata*, L.), which is 3–10 cm in high and forming colonies by layering in dry, sunny, gravel slopes. The main stem, ranged from 0.5 to 1.1 cm, is located just under the soil surface. Wood anatomy of S. reticulata was analysed as a source of dendroecological information from the High Arctic area.

Samples were collected on the West Spitsbergen Island in the Svalbard Archipelago and sectioned with GSL 1 sledge microtome, taking 15–20μm cross-sections from 4 to 6 different locations along the length of the individuals. S. reticulata from the Spitsbergen Island has clearly visible and countable annual growth rings, which boundaries are delimited by 2–5 rows of flattened latewood cells. Growth rings in the individuals ranged from 0.8 mm, to extremely narrow rings less than 0.01 mm in width. The oldest individual sallow tree collected was 78 yrs old. The pores in S. reticulata wood are solitary or are joined in radial groups of 2–4 pores.

Visible annual tree-rings and other wood anatomical features such as compression wood and scars are giving great possibilities of using them in different field of natural sciences, like geomorphology, climatology and ecology.

PC4.01 Poster

Age-dependent xylogenesis in timberline conifers

Sergio Rossi[1], Annie Deslauriers[1], Tommaso Anfodillo[2], Marco Carrer[2]
[1]University of Quebec in Chicoutimi, Chicoutimi, Quebec, Canada, [2]Università degli Studi di Padova, Padova, Italy

Neither anatomical change nor physiological abnormalities have been observed in the cambia of older trees. However, different sensitivity and period of significant responses to climate suggest the existence of some age-related change in the patterns of cambial activity and/or wood cell formation. we compared weekly cambial activity and xylem formation in adult (50–80 years) and old (200–350 years) conifers at the Italian Alpine timberline during 2004 and 2005. Timings and durations of xylogenesis differed between adult and old trees, with 2–3 weeks shorter cambial activity found in the latter. the delayed onset of cambium division and lower cell production in old trees, with respect to adult trees, led to reductions of 15–20% in the overall duration of xylem differentiation. These results demonstrate that cambial dynamics change during the tree lifespan and that the time window of tree-ring production shortens with age.

PC4.02 Poster

Xylogenesis in black spruce on two sites in the boreal forest of Quebec: The importance of temperature for the onset and duration of cell differentiation

Carlo Lupi, Hubert Morin, Annie Deslauriers, Sergio Rossi
Université du Québec à Chicoutimi, Chicoutimi, Québec, Canada

Climate warming is expected to influence the timing of cambial reactivation in the boreal forest, and thus cell differentiation and growth. The aim of this study was to compare the growth patterns of cambium and xylem in two sites of the boreal forest, in order to understand how temperature affects wood formation. The study compared cambial activity and cell differentiation in two sites characterized by different mean annual temperatures in the boreal forest of Quebec (Canada). Xylem growth had been studied from April to October, from 2006 to 2009, collecting weekly wood samples on the stem in 6 black spruces (*Picea mariana*, (Mill.) BSP). The threshold temperatures at which xylogenesis had a 0.5 probability of being active were calculated by logistic regressions. The onset of cell differentiation differed significantly between the two sites. The warmer site showed an earlier onset of cambial activity and cell differentiation, of 16 days. Xylogenesis was active when the minimum, mean and maximum daily air temperatures were about 4°C, 10°C and 16°C. Thresholds for the onset of cell differentiation were similar between sites and years, but were reached at different times in spring (two weeks later in the colder site). The major finding of this study was the existence of a relationship between the onset and duration of cell differentiation. Trees having a longer growing season showed an earlier onset of cell differentiation, but not different ending. So the factors that determined the onset of cell differentiation indirectly affected the overall duration of wood formation.

PC4.03

PC4.03 Poster

Tree growth dynamics in tropical forests in Southern Ecuador derived from high-resolution dendrometer measurements

Franziska Volland-Voigt, Achim Bräuning
Friedrich-Alexander-University of Erlangen-Nuremberg Institut of Geography, Erlangen, Bavaria, Germany

Tropical forests grow under a wide variety of environmental conditions, especially in mountain regions where climate is strongly altered by topography. Despite of the lack of palaeoclimatic information from tropical regions, tree growth dynamics first needs to be well understood before climate reconstructions can be derived from tropical trees. Since April 2006 we measure tree growth dynamics in two different forest ecosystems in Southern Ecuador: a dry forest and a mountain rainforest. Cambial dynamics is studied with high-resolution point dendrometers that collect measurements of stem diameter variations in 30 min. intervals. Cumulative growth curves indicate a great difference in the seasonal growth dynamics at the two study sites. In the mountain rainforest, trees grow more or less continuously. However, cambial activity is occasionally interrupted during short dry periods which provoke a synchronous shrinkage of the stems, irrespective of tree species and life form. Daily stem diameter amplitudes correlate with the length of the dry period and with daily maximum vapour pressure deficit. In the dry forest, trees show cambial dormancy during the dry season. Cambial growth is restricted to the rainy period during January to April. At the beginning of the rainy period, tree diameters increase as a consequence of stem rehydration. After middle of May, stem diameters are decreasing as a consequence of water loss during the day which is not compensated by water uptake during the night. The study demonstrates the great variety of tree growth behaviour as a result of local climate conditions in tropical mountain environments.

PC4.04 Poster

Wood formation, girth trunk increment and phenology of two tree species from Atlantic rain forest in southern Brazil growing in two different soil conditions

PC4.04

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The tree growth and regulation of reproductive and vegetative activities of the plants over time depends on factors such as climate, day length, water availability and nutritional characteristics of the soil. Phenological observations and girth trunk increment data were performed every 15 days over one year for 61 adult trees of *Senna multijuga* (Caesalpinioideae) and 61 *Citharexylum myrianthum* trees (Verbenaceae) growing in the Atlantic rainforest (25º19´15" S; 45º42´24" W) with a well-balanced rainfall distribution all year round, high and nearly constant humidity, no dry season and low annual thermal oscillation. The increment of trunk and timing of growth for all trees were recorded at DBH by using steel permanent dendrometer bands, aiming to investigate the phenological and growth patterns of these species growing in two different soil conditions (Gleisol and Cambisol). Phenophases were strongly correlated with climate variables and day length, but they were weaker in relation to water table depth. Diameter growth and wood formation was significantly correlated with flushing and fruiting. Mean cumulative growth for *C. myrianthum* trees was lower in the Gleisol area than in Cambisol, while there was no difference in growth between soils for *Senna multijuga* trees. There were strong correlations between diameter growth and all the climatic variables, but they were stronger with day length, rainfall and mean temperature. Simultaneously exploring relationships among phenology, cambial activity and growth conditions, it was possible better understand the particular growth behavior, including the rhythm of cambial activity and the wood formation of these species.

PC4.05

PC4.05 Poster

Does tree size matter? Evaluating the climate-growth relationship of *Agathis australis* (kauri) using high-resolution dendrometer bands

Jan Wunder[1], Jan Wunder[2], Anthony M. Fowler[1], Shane P. J. McCloskey[1], Shane P. J. McCloskey[3]
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Tree rings of *Agathis australis* (kauri) from New Zealand have been successfully used to reconstruct the El Niño-Southern Oscillation (ENSO), a climate phenomenon that is the most important source of the inter-annual climatic variability of the Earth's climate. The kauri-based ENSO reconstruction is currently being extended from the last ca. 400 years to the last Millennium – using tree-ring information from increasingly younger trees. However, the growth responses of different sized trees to different environmental conditions are still not well known. For kauri, the effect of tree size is related to a change in tree architecture between the monopodial growth of young trees to sympodial growth of large, canopy emergent trees. But how similar – or how different – are those different sized trees with different architecture in their ability to store climate information? We present results from a field study (2008–2010) where we measured kauri growth and climate variables with high temporal resolution (every 30 minutes) using automatic dendrometer bands. Preliminary results suggest different growth responses between large and small trees (threshold: diameter at breast height ca. 20 cm). The tree-ring formation of the latter may be largely driven by endogenous processes of forest dynamics, i.e. tree competition during the self-thinning phase, and less by exogenous climate phenomena. We will identify the scale of this tree-size effect and demonstrate its significance for millennial ENSO reconstructions.

PC4.06 Poster

Factors regulating cambial reactivation and re-initiation of xylem differentiation

Yuichiro Oribe[1], Yoshio Kijidani[2], Shahanara Begum[3], Takafumi Kubo[3], Ryo Funada[3]
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In trees growing in temperate zone in the Northern hemisphere, the vascular cambium usually has annual periods of activity and winter dormancy. The periodicity of cambial growth is responsible for annual-ring formation. The heating of limited regions of the stems of trees appears to provide a useful experimental model system for studies of cambial reactivation, i.e. resumption of cell division in the cambium, and re-initiation of xylem differentiation of cambial derivatives, which concern with initiation of annual-ring formation, intact trees. In order to identify the factors that regulate cambial reactivation and re-initiation of xylem differentiation, we have monitored the extent of cell division in the cambium and the extent of differentiation of cambial derivatives in locally heated stems of some conifers and broad-leaved trees during winter cambial dormancy. We will present an overview of the results that have been obtained in our experiments using the model system.

PC4.07 Poster

Relationship between intra-annual changes in tree-ring structure and leaf phenology of ring-porous species (*Quercus serrata* and *Robinia pseudacacia*)

Kayo Kudo, Yoshihiro Hosoo, Koh Yasue
Shinshu University, Nagano, Japan

The relationship between seasonal annual ring formation and leaf phenology was investigated using two ring-porous species, *Quercus serrata* and *Robinia pseudacacia*. Leaf phenology of *Q. serrata* and *R. pseudacacia* trees was observed in every 3–14days. The trees were cut down and disks were taken from the trunk every 2m from the base to stem apex. Samples of wood tissue containing differentiating xylem were collected from each disk, and then the process of xylem formation was observed by light microscopy. The cambial reactivation was observed just before bud break at the end of March in both species. When leaf expansion was seen, first vessel formation was completed from the end of April to the beginning of May. The time of transition from earlywood vessel formation to latewood vessel formation was almost same as the time of maturation of leaves in both species; at the middle of May for *Q. serrata* and at the beginning of July for *R. pseudacacia*. Although the timing of leaf phenology such as leaf expansion and leaf maturation between two species differed, xylem formation corresponded to the process of shoot development in both species. These results indicate that intra-annual changes in tree-ring structure are associated with leaf phenology in *Q. serrata* and *R. pseudacacia*.

PC4.08

PC4.08 Poster

The comparison of four different tree species in Munessa Forest (Ethiopia): Seasonal growth dynamics and their climatic control

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University of Erlangen-Nuremberg, Institute of Geography, Erlangen, Germany

Munessa Forest is a dry tropical mountain forest in the south-eastern part of Ethiopia. The local seasonality of rainfall induces cambial dormancy of variable length in different tree species. To investigate species-specific periods of seasonal cambial activity and dormancy, we studied wood increments of four different tree species belonging to varying life forms with the help of high-resolution electronic dendrometers. Studied tree species include evergreen native and introduced conifers (*Podocarpus falcatus* and *Pinus patula*), evergreen broadleaved trees (*Prunus africana*) and the deciduous broadleaved Celtis africana. Measurements of radial stem diameters were registered in 30 min intervals. In addition to daily amplitudes of stem diameter variations and net growth rates, the daily length of each separate phase during a diurnal cycle (shrinkage, recreation and increase of stem diameter) was determined and related to climatic variables measured at local climate stations. Seasonal patterns of growth dynamics derived from dendrometer measurements are compared with occasionally collected wood anatomical samples that allow a visual control of newly formed wood cells during certain time intervals. Irrespective of life form, cambial growth started quite synchronously among the studied species with a considerable delay of stem diameter increase as indicated by the dendrometer curves. Thus, a combination of stem diameter measurements and study of wood anatomy derived from micro sections provide the bases for delineating the species-specific cambial growing season.

PC4.09 Poster

Intra and interregional variability in the diametric growth of Holm oak (*Quercus ilex* subs. *ballota* (Desf.) Samp.): Influence of climate and soil factors through the combination of continuous and monthly measurements

PC4.09

Javier Vázquez-Piqué[1], Sonia Roig[2], Reyes Alejano[1], Raquel Benavides[2], Daniel Martín[1], Aranzazu González-Pérez[1]
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The quantification of growth of forest species is of major importance to develop a silviculture based on technical and scientific criteria. Moreover, the analysis of the influence climatic and soil factors on growth allow to transform empirical growth models to models with a greater ecophysiological component and to gain a better knowledge of the soil-climate-plant relationships.

We analysed the influence of soil and climate variables on diametric growth of Holm oak on 3 sites with contrasting climate and soil conditions in central and southwest of Spain. Growth data is obtained at two levels: (a) with electronic point dendrometer at 15 min. interval in 6–9 trees per plot and (b) with band dendrometers in 60–100 trees per plot with monthly measurements. Climatic variables and soil moisture and soil temperature are measured in continuous at each plot.

With band dendrometers data we elaborated a mixed linear growth model that takes into account the influence of site, tree, month and site x month interaction on tree growth. All the effects considered were significant. The model shows a growth pattern with maximum spring growth, summer and winter vegetative stops and an autumn growth or hidratation. Data from electronic dendrometers allowed us to add more detail to the analysis and improve the interpretation of the monthly data analysis.

PC4.10

PC4.10 Poster

Age-dependent xylogenesis of *Pinus pinaster* in a drought limited environment

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In the last century, temperatures have rose ca. 1ºC and a significant decline in precipitations has been observed in the Mediterranean Basin. Moreover, predictions expect climate to become warmer and drier in the next decades. Thus it is extremely relevant to understand how forests will cope with such changes. One of the most recently-used and intriguing approach is to analyze the formation of xylem cells at short-timescale and comparing xylogenesis with the environmental parameters such as precipitation, temperature or photoperiod. This information is being used to improve the growth models under Mediterranean climate. We will investigate wood growth in *Pinus pinaster* Ait. belonging to two age classes, young (30 years-old) and mature (50 years-old), growing in the West Mediterranean coast of Portugal. We will collect microcores to follow the development and formation of tree rings 'cell-by-cell', and the results will be compared with those obtained from dendrometer bands. Within a frame of climate variables, we will construct tree growth curves, will estimate the dynamics of cambial activity and will determine the time spent by the xylem cells in each developing stage. We hypothesize that the onset and duration of the cambial activity is different between young and mature trees, and this will have implications in the reaction to climate changes of the forest stands of different age.

PC4.11 Poster

Phenology of cambial activity and wood formation of cork oak (*Quercus suber* L.) in the south of Spain

Arantzazu González-Pérez, Javier Vázquez-Piqué
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We studied the phenology of cambial activity and wood formation in six cork oak trees situated in an experimental plot in Hinojos (Huelva, southwest of Spain) under a typical mediterranean climate for one vegetative period. Microcores were extracted monthly since February until November and histological samples of the phloem-cambium-xylem tissues were obtained after inclusion in paraffin. The standard protocol of inclusion in paraffin had to be modified and adapted to deal with an species with very hard xylem and contrasting hardiness of cambium and xylem tissues. In most of the trees the cambial activation occurred in mid-march, with samples obtained the 23rd of March showing enlarging xylem cells and vessels in formation. Lignification process is very fast and samples of may present already a high proportion of mature cells. In mid-june the cambial activity in all samples was very reduced presenting only mature cells and cells in lignification and no cells in enlarging status. Results are discussed according to the climate of the vegetative period and with data from electronic point dendrometers collected in the same plot.

PC4.12 Poster

A new experimental system for elucidating increased temperature effects on cambium phenology

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It has been shown that wood formation is influenced by environmental factors such as photoperiod and temperature. Environmental factors interact in a complex way under natural conditions, which limit the comprehension of the effects of selected factors on xylogenesis. However, the effect of individual factors on wood formation has been successfully elucidated in experiments carried out under controlled conditions. In particular stem heating can alter cambial activity, especially on quiescent cambium causing an early re-activation of initial cells division.

To study the effects of increased temperature on cambial activity an experimental system to perform local stem heating was developed.

The system is able to maintain a user defined differential temperature (Δt) on the surface of bark of heated trees. The Δt is maintained (with a ± 0.3 °C error) through a datalogger controlled system recording reference temperatures and activating flexible heating cable wrapped around treated stems. The system is implemented to control simultaneously 14 plants using 21 thermal probes. The actual heat penetration from the bark to the cambial region (0.5 °C lower as an average compared to the bark surface temperature) as well as the heat propagation along the stem was assessed by recording stem internal and external temperature analyzing different species in order to test the system on differences in wood thermal inertia. The system developed has been tested in an experiment on Norway spruce xylogenesis whose results are being analyzed with anatomical, biochemical and molecular biology approaches.

PC4.13

PC4.13 Poster

Effects of extended growing season in 2007 on intra-annual growth dynamics of *Pinus sylvestris* and *Pinus cembra* at their climatic limits in the Alps

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It has frequently been stressed that at boundaries of tree existence, e.g. at the Alpine timberline and within dry inner Alpine valleys, tree growth will be affected first by extreme climate conditions. Hence, we compared temporal dynamics of xylem development among mature *Pinus sylvestris* and *Pinus cembra* at a xeric inner Alpine environment (750 m a.s.l.) and at the Alpine timberline (1950 m a.s.l.), respectively, in response to exceptionally warm-dry conditions prevailing in spring 2007. Xylem cell development was determined by repeated cellular analyses of microcores (5 trees/site) and radial stem increments were extracted from dendrometer traces (3 trees/site).

First enlarging tracheids were detected in *P. sylvestris* on 12th April and in *P. cembra* on 27th April, i.e. about 3 weeks earlier than in years when average climate conditions prevailed. Maximum daily growth rates already peaked on 6th May at the valley site and 23rd June at timberline. Rather unexpectedly, strikingly higher cell numbers were found at timberline (61 ± 11 cells) compared to the valley site (17 ± 2 cells). Daily radial increments extracted from dendrometer records showed closest relationships with precipitation and temperature at the valley site and at timberline, respectively.

Results suggest that at both sites onset of wood formation is temperature controlled. Furthermore, we hypothesise that the early culmination of radial growth prior to occurrence of more favourable conditions during summer is due to high demand of carbohydrates by the root system and associated mycorrhiza, to ensure adequate resource acquisition at climatic limits of tree growth.

PC4.14 Poster

Seasonal dynamics of phloem formation in *Larix decidua* and *Picea abies* growing along an altitudinal gradient in Switzerland

PC4.14

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Unlike the well studied xylem, phloem has been broadly neglected in dendrochronological and dendro-physiological studies. This research absence stems in part due to difficulty in distinguishing older phloem growth rings and determining their year of their formation, but is particularly noteworthy as phloem is responsible for the transport of photosynthates and thus essential for the growth activities in the cambial zone. A similar situation exists concerning the seasonal dynamics of cambial activity and wood formation in various tree species. However, studies on intra-annual phloem formation are still scarce and consequently very little is known about the interplay between the processes of phloem and xylem formation. The aim of the present work was to study the dynamics of phloem formation. We followed the development of 2008 phloem ring in larch (*Larix decidua*) and spruce (*Picea abies*) growing along a 900 m altitudinal gradient in the subalpine forest of the Swiss Loetschental. Tissues microsections (phloem, cambial zone, wood) sampled from living trees by micro-coring at weekly intervals were studied under a light microscope. The poster describes the dynamics of phloem formation and gives possible physiological interpretations on observed species-specific and altitudinal differences in timing and rate of phloem formation.

PC4.15

PC4.15 Poster

Intra-annual dynamics of wood formation for three conifer species (Norway spruce, Scots pine and silver fir) in the northeast of France

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We investigated the intra-annual dynamics of cambial activity and xylogenesis for three conifer species in the Vosges Mountains (northeast of France) using weekly samples of wood, taken around the stem during 2007. Anatomical sections were prepared from the collected microcores for observations with an optical microscope. Four zones of cell differentiation were distinguished, each corresponding to a phase of the cellular development process, which brings to the mature tracheids. For each sampling dates, we count the number of cells in each cellular differentiation zone. Needle's phenology of the studied trees is also recorded weekly. Initiation of wood formation occurred at the middle of April and was synchronized with bud burst for the 3 species, which is in agreement with the theory of a cambial reactivation by foliar hormonal messengers. The end of the cellular divisions in the cambial zone occurred between the beginning of August and the middle of September, depending on the species, while the end of needle formation occurred in June for the three species. The long lapse of time between these two phenomena indicates that cambial activity cessation is not under leave hormon control. Wood formation finished at the middle of September, beginning of October and beginning of November for Norway spruce, Silver fir and Scot pine. Extension of these analyses along an altitudinal gradient and over several years will allow us to better understand the influence of the climatic factors on wood formation in general and on the behaviour of the studied species in particular.

PC4.16

PC4.16 Poster

What is triggering the activities of meristematic tissues of Scots pine (*Pinus sylvestris* L.) during the recent past?

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Trees in boreal forests provide attractive proxy data on environmental changes due to the fact that their meristematic tissues are highly responsive to external impacts. But despite intense studies since more than 50 years, our knowledge on the climate/growth association is still incomplete. In our project, we, therefore, investigated Scots pine trees in northern Finland during up to five consecutive growing seasons for their intra-annual dynamics of height growth and radial growth. Height growth started in the second half of May whereas radial growth followed between the end of May and the beginning of June when the heat-sum values, computed according to Sarvas (1972), had accumulated to approx. 12.5% of the long-term average (1961–1999) of the heat-sum total. The highest rate of cell production occurred during the time of maximum day length, i.e. in the first half of June. Height growth ended when the heat sum had reached approx. 41% of the long-term average of the heat-sum total. Soon after, latewood formation started. Cell production came to an end between end of July and end of August. Scots pine trees located 280 km south of the tree line were positively influenced by temperature, whereas trees close to the tree line were negatively influenced. Trees near their northern distribution border do possibly not profit from the recent warming trend but start to get impaired from an increasing moisture deficit.

PC4.17

PC4.17 Poster

Predicting day-to-day stem diameter variations and annual growth of balsam fir (*Abies balsamea* (L.) Mill.) from daily climatic variables

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In the present context of global changes, it is important to develop a better understanding of the climatic factors controlling the growth of boreal forests. In this study, we report the results of a five years field research within which day-to-day variations of stem diameter of balsam fir (*Abies balsamea* (L.) Mill.) measured with dendrometers were related to daily climatic variables. A model built with the data of three growing seasons that included solar radiation, relative humidity, temperature and precipitation explained 84% of the variance in day-to-day stem diameter variations from June to September. The model was successful when validated with independent daily data over two other growing seasons. In general, rainy days during which relative humidity was high and solar radiation was low favored stem diameter expansion (growth and swelling) while stem shrinked during periods of low relative humidity and high solar radiation. The model captured both, the variation associated with the irreversible growth and the high frequency variation of day to day fluctuations associated to changes in the stem water content. Cumulative growth of the year computed from the modeled day-to-day variations in stem diameters was in good agreement with total annual growth determined from tree core measurements over a ten years period. Results suggest that it is possible to estimate the future potential growth response of balsam fir trees and to identify the changes in frequencies of climatic events associated with high tree vulnerabilities using daily variable from climate scenarios.

PC5.01 Poster

Dendrochronological study on sub-fossil pine and oak from a bog near Hannover

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Distinct layers of pine roots and trunks are commonly found in Northwest German raised bogs, often near the base of sphagnum peat.

In the large raised bog complex 'Totes Moor' sub-fossil remains of pine and oak trees dating to several millennia are uncovered. The focus of this study is on the finds from the bog 'Totes Moor' dating to the fifth millennium BC, which can be paralleled to finds from other bogy over a wide geographic area.

While the oak remains cluster in the northern part of the investigated area, pines are found in the southern part during the same time. Dendrochronological, peat-stratigraphical, palynological and root morphological investigations were conducted in order to try to understand the different species distribution and population dynamics at that time. The drainage direction in the area is north south and thus the species differentiation may be explained by a higher proximity of the oak woodland to nutrients delivered by overland flow and ground water. The detailed investigations at 'Totes Moor' deliver new evidence for a better understanding of the spacial-temporal dynamics of woodland formation in context with the related bog development.

PC5.02

PC5.02 Poster

Tree layer structure in ecotones forest-tundra at the Kola peninsula

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The forest belt of Khibiny mountains mainly formed by spruce (*Picea obovata*), pine (*Pinus sylvestris*) often forms secondary stands originated from fires and cuttings. Both species representatives could be found at tree line. Climate changes due to warming and wetting effects could result in an upward expansion of trees.

The main goal of this study was to characterize the contribution of different tree species into tree layer within forest-tundra ecotones in Khibiny mountains.

This study was carried out for 5 strips of 10 x 50 m at Umechorr. Number, diameter and height of trees, saplings and seedlings were measured on plots with areas of 500 m^2.

Field mapping of vegetation micro-mosaic structures has been carried out for 5 strips of 10 x 50 m at the scale of 1:20 in three key areas: Umechorr in Khibiny mountains and Kanentiavr to the east and west of Lake Kanentiavr in northern Kola Peninsula. The strips were divided on squares 1 x 1 m, and plant micro-groups were drawn on millimetre paper. The borders of micro-groups were identified accordingly the distribution of the predominant plant species.

About 50 microgroups below and between the crowns of different trees have been identified in forest-tundra ecotones at three sites under investigation. The calculation of area of micro-groups is in progress.

PC5.03 Poster

Impact of recent warming on Arctic willow (*Salix arctica* Pall.) in the High Arctic: Comparison of sites in Greenland and Canada

PC5.03

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Modification of plant abundance and distribution, especially shrubs, has been predicted by warming experiments using open-top chambers and confirmed by aerial photography analyses and land based observations in the Low Arctic. In the High Arctic, even though warming experiments have a positive effect on shrub cover, little is known about natural systems responses. Arctic willow (*Salix arctica* Pall.) is a structuring species in this harsh environment that could induce noticeable vegetation cover changes, either by increased growth of established individuals and/or by colonization of new sites. While the potential of dendrochronological analyses on arctic willow was recognized several years ago, little research has been conducted since 1994. Recently, using novel techniques, a negative trend in individual growth related to an increase in early spring snow cover was detected in Zackenberg, Greenland (74°N, 20°W). However, no correlations have been found between growth ring width and temperature. In Canada, current analyses on samples collected at four locations on Ellesmere and Cornwallis Islands (from 74°N 94°W to 83°N 75°W) have given us the opportunity to compare growth patterns and age structure with those from Greenland. We expect a lesser influence of snow cover in the Canadian High Arctic due to the dryer climatic conditions, however recent warming may have increased growing season length, which could promote arctic willow growth.

PD1.01 Poster

Dendrochronological and sedimentological cross-dating – Making use of talkative timber and communicative clay

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Tree-ring research becomes dendrochronology by means of cross-dating. It is widely acknowledged that the persistent and extensive use of tree-rings by means of cross-dating was started by Andrew Ellicott Douglass during the early decades of the 20th century. However, it is notable that dendrochronology is not the only discipline where the application of cross-dating is useful or even prerequisite. Another discipline that extensively uses cross-dating is sedimentology of annually laminated clays (varves). Varves are produced in pro-glacial basins where the annual cycle of melt-water streams from retreating glacier deposit distinct layers of clayey silt and silty clay within a calendar year. Similarly to tree-rings, the variation of relative varves thicknesses have been used to cross-date the varves records from adjoining outcrops to produce chronologies comprising tens or hundreds of individual varve records. This method of making accurate varve calendars was initiated by Gerard De Geer in Sweden and dates back to 1880s. Here, a comparison of the history, the methods and the records used in the two disciplines is performed. It is noted that the initial studies by De Geer predate the investigations of Douglass. Detrending and autoregressive-moving average modelling are found to improve the cross-dating results in both disciplines. Yet, it is shown that statistical cross-dating of varves provides results similar to those often found in dendrochronological investigations. Although dendrochronologists often tend to "monopolize" cross-dating, it is notable that cross-dating has its own historic development in sedimentology which was likely not influenced by the contemporaneous ideas of early dendochronologists.

PD1.02 Poster

Coherence of pine chronologies in the Baltic region through the last eight centuries

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Ring-width chronologies of pine (*Pinus sylvestris* L.) of the Baltic region were correlated between themselves using appropriate time windows (e.g. 100 years). It appeared that coherence of the chronologies was fluctuating in great amplitude during the centuries. In certain periods the chronologies were much more similar to each other (correlation coefficient up to 0.76) than in other periods. The period-dependent similarity of the chronologies is assumedly related to long-term changes in atmospheric circulation patterns. Some evidences of the changing climate in northern Europe are brought to support this hypothesis. Besides, possible influence of historical timber trade in certain periods across the Baltic Sea cannot be excluded.

PD1.03 Poster

A millennium history of pine growth fluctuations in the surroundings of Vilnius (Lithuania): Natural forcing versus human impact

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During dendrochronological investigation of wooden constructions from the Vilnius Lower Castle archaeological site as well as wood from historical houses located in the territory of the Castle and in Vilnius old town a millennium – length pine chronology ZPMLPSC8 has been constructed. The chronology covers 1010–2009 period. Dendrochronological series from waterlogged archaeological wood cover the 11th–16th centuries. Series from historical houses represent the 17th–20th centuries. Tree ring width information of the 19–21 centuries. comes also from living pine trees.

The chronology has been constructed using 336 sample series. The best replication of the chronology is in the 13–14th centuries: up to 142 samples. Lower replication is in the 17th– 9th centuries part. In this period the chronology sample depth fluctuates mostly between 10 and 20.

Despite the heterogeneity of the replication it is evident that age curves of the trees and mean increment rates vary in different periods of the second millennium AD. Major shift to higher increment rates happens in the second half of the 15th–16th centuries. This is coincident with changes in forest use and intensified timber export. Two signals are obvious in the long-term dynamics of pine tree growth: the climatic signal and increment rate changes because of forest exploitation dynamics in the timber supply region. These signals should be separated when using chronology for long-term climatic reconstructions. The human impact signal would be of interest for economic history studies.

PD1.04 Poster

Tree-ring chronology of Scots pine (*Pinus sylvestris* L.) from Nesvizh castle XVI-XIX cc.

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PD1.04

The Nesvizh castle is situated in the centre of Belarus. It was a residence of Radzivils, one of the most famous family in Grand Duchy of Lithuania and Kingdom of Poland during XVI–XIX cc. The castle was significantly destroyed during Great Northern War (1706) and acquired the current look during reconstructions in XVIII–XIX cc.

We developed Scots pine tree-ring chronology from historical timber of the Nesvizh castle. The wood samples were taken from different castle construction elements (roofs of towers and building, ceilings of building) in 2009 year. In spite of repeated fires and reconstructions during XX c. (the castle was a health resort in Soviet Union time) authentic wood of XVII–XVIII c. has remained.

The chronology includes 59 dated tree-ring series and covers 222 years between 1608 and 1829. All of the researched samples are historical wood and they clearly show the different stages of the castle reconstruction in XVIII–XIX cc.

The chronology was dated with the help of the closest chronology (150–200 km) from Lithuania Litpinus-1 (Vitas, 2008). The developed chronology is the first Scots pine chronology for XVII–XIX cc. in Belarus.

PD1.05 Poster

Monitoring the Bunker Cave in the Sauerland (Germany): Implications for speleothems as climate archives

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PD1.05

Bunker Cave is located in the massive Devonian limestone of the Rhenish Slate Mountains. The cave is monitored with respect to its air composition, drip rate, stable isotopic composition and chemical parameters of the drip water.

Cave air temperature represents the annual mean outside temperature, relative humidity is constantly in excess of 90%. Bunker Cave is well ventilated due to its two entrances. This ventilation results in relatively low CO_2 content. CO_2 is seasonally fluctuating because it origins from the soil above the cave and is produced by the vegetation and the microorganisms. The drip sites do not show a direct response to precipitation events but increase several months after the main yearly infiltration phase. Tritium analyses suggest a mean drip water age of about three years. Chemical water analyses show that the pH-value and the saturation index of calcite are dependent on the pCO_2 of the cave atmosphere. Cation and anion analyses allow to differentiate the different parts of the cave. The oxygen isotopic composition of the drip water shows a constant signal over the three year monitoring period and is associated with mean surface temperature over this period. The carbon isotopic composition of the drip water shows kinetic influence due to CO_2 outgassing.

The monitoring shows that some parameters are constant for the entire cave, whereas others are seasonally fluctuating at individual drip sites. This information is helpful for the interpretation of environmental signal from speleothems.

PD1.06

PD1.06 Poster

A network of 225 medieval to baroque roof constructions of churches in Austria – Basic knowledge for the conservation of Wooden Cultural Heritage

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Wooden roof constructions are very often a resource of dendrochronological dating. In combination with the analyses of archives, of wall construction details, plaster and so on, statements about building phases can be made.

The relevance of old wooden constructions (like roofs constructions) is sometimes neglected in Austria. Special interest and care is given on the building itself (for examples arches), frescoes or interior art work. The intention of this study was also to promote the interest in wooden constructions in the scientific community as well as in public and society.

225 medieval to baroque roof constructions were analysed in middle and eastern Austria. In total 3428 samples were taken. It was possible to date 1978.

The roof constructions were mapped and the static system described. Signs, made by handicrafts to set up the roof constructions were observed. It was possible to correlate the building time with the static system and the handicraft signs.

PD1.07 Poster

Dendrochronological and dendrological studies of wood from archaeological excavations at the Szczepanski Square in Krakow (S Poland)

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During constructions connected with revitalization of Szczepanski Square in Old Town of Krakow in spring of 2009 year, the archaeological rescue works were conducted. The area of two hundred square meters were exposed. At the early stage of archeological excavations it was expected that all older wooden structures were destroyed by later Renaissance and Baroque buildings of the Jesuit collegium existed here since the sixteenth to the early nineteenth century. However, during further research, fragments of medieval buildings were discovered. Finally five phases of wooden structures were exposed. More than 160 samples were taken to dendrological and dendrochronological analysis. Most of them were wooden elements of buildings, wells and road. Among them wood of fir, oak and pine was the most popular. In addition, two of the samples of plait, composed mainly of willow twigs, were taken to radiocarbon dating. Studies revealed a unique sequence of stratigraphic layers dated to the entire fourteenth and the beginning of the fifteenth century. The oldest excavated wooden structures (including fragments of the road paved with wood) were dated to the second half of the thirteenth century, shortly after the location of the city.

PD1.08 Poster

Forest exploitation history: The case of the Gallo-roman agglomeration Oedenburg (Alsace, France) between 10 and 180 AD

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Although there are abundant archaeological tree-ring dates, these data are used much more rarely in past environment-human interactions fields. Our study of the Gallo-roman settlement of Oedenburg, established on the Rhine Limes, was conducted with a dendroarchaelogical framework. The series dated provide description of some of the structural aspects of oak-stands that were exploited for construction. In this aim, the analytic tools employed are the "age trend form" and series pattern classification, dendrotypology. Archaeological series were also compared to modern forest characteristics. Throughout the chronology, woodland development appears dominated by two stages. The first is oak tree harvest. We observe that (1) series patterns from a single archaeological structure are more similar than between structures and (2) large tree-rings are present during the juvenile phase. These rings are larger than those observed consecutively to modern logging. The effect of oak tree harvesting is local high-forest clearing. During the second stage, the high forest is in the process of recovery. After a few years aging, Gallo-roman oak ring width becomes sharply inferior to that observed in the actual forest. This can be explained by the high degree of competition between trees due to a poor thinning grade during recovery. Within the chronology, stands were first exploited using harvest and recovery system; second, supply may have focused on preserved trees; and third, the regeneration rate was respected, but harvest age was lowered, resulting in greater thinning of a stand, although they seems denser than today's managed high forest.

PD1.09

PD1.09 Poster

Tree-ring dating and AMS wiggle matching of Korean wooden statues

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Buddhist statues have been often dated by the historical records and their styles by art historians. When these dates are controversial, it is necessary to obtain scientifically and objectively measured dates. Dendrochronological dates obtained by tree-ring dating can provide absolute dates of the wood materials used for the statues. However, tree-ring dating can not apply to all objects. Radiocarbon dating may compliment the dendrochronological dating. Specially, wiggle matching of radiocarbon dates, which provide highly precise dates as much as 15 to 30 years (2σ), would be very useful to date the objects which can not be dated dendrochronologically. We will compare the AMS wiggle matching data with tree-ring dates of several Korean Buddhist statues whose dates have already been known from historical records. Among 23 statues in a temple, ten were successfully dated by tree rings. The cutting date of logs used for the statues was determined on some time between late fall 1684 and early spring 1685 because the bark ring (AD 1684) completed the latewood formation. The 95.4% confidence interval of radiocarbon date (2σ: cal AD 1688–1713), which was obtained by wiggle matching of 7 samples in a statue, included almost its dendro date (AD 1684). The dendro date and written record indicated that the statues were made within 3–8 months after log cutting. It is rather short if we consider the period required for natural drying in order to avoid defects such as cracking and crooking.

PD1.10 Poster

'Woodville', Kauri and Dendroarchaeology in New Zealand

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PD1.10

The ability to develop an accurate chronology of events is important to understanding and interpreting archaeological sites, including those involving standing structures. In the Northern Hemisphere, dendrochronology is widely applied to provide independent dates for wooden structures in above- or below-ground contexts. In New Zealand, dendroarchaeology is a new area of research. Although the potential of dendrochronology to contribute absolute dates for the prehistoric period has been discussed since the 1950s, very little research has been undertaken in this area, and the application of dendrochronology to study 19th and early 20th century structures has not previously been considered.

Kauri (*Agathis australis*) was widely used for the construction of buildings and other structures in New Zealand in the 19th century. This is a species for which we now have a robust network of modern and sub-fossil tree ring chronologies from the upper North Island. In 2004 a project was established to assess the potential and limitations of dendrochronology as an aid to the archaeological investigation of standing structures, specifically regarding the provision of felling dates and interpretation of construction phases. The project focused on colonial era (1840–1907) buildings which contained kauri timbers, and fits within institutional moves to encourage archaeological approaches to the examination and recording of buildings. Using the example of 'Woodville', a large, mid-19th century house in Auckland City, this paper outlines how dendrochronology can usefully contribute to interpreting the construction history of 19th and early 20th century structures in New Zealand.

PD1.11

PD1.11 Poster

Cedrela fissilis Vell. (Meliaceae): Dendrochronology and dendroclimatology in Blumenau, Santa Catarina, Brazil

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Cedrela fissilis Vell. (Meliaceae) presents a large ecological distribution on the Brazilian landscape and previous research has indicated that this species has potential for dendrochronological approaches due to its semi-ring porous wood anatomy and formation of annual rings reasonably well demarcated in the juvenile and adult wood in other tropical forests. The present work aimed at developing an exactly dated tree-ring chronology of *C. fissilis* and model the climatic response of its tree-ring chronology. The site studied was a partially disturbed fragment of dense ombrofila forest in Blumenau, Santa Catarina State, Brazil (26º54'S e 49º06'W). Increment cores were taken from the lower bole from thirteen remnant trees using the Presler´s increment borer of 5 mm diameter. For each host tree, four radii were bored. Skeleton plots were prepared within and between trees to allow recognition of patterns and problems in ring series. The crossdated tree-ring widths were then measured interfaced with a microcomputer. Crossdating was confirmed with the COFECHA computer program. The age of each tree, correlations and response function analyses were computed between the chronology and monthly total precipitation and average temperature from a location some 30 km distant from the collection site with the test of Pearson. The results indicated that the age of trees ranged from 34 to 87 years and that showed average increase of 3,026mm, highlighting the good state of conservation of the forest, that phenological events are related to precipitation, which also has direct relationship with the tree growth of *C. fissilis* analyzed.

PD1.12 Poster

Radiocarbon dating of cross-dated *Fitzroya cupressoides* tree-rings from southern Chile

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Fitzroya cupressoides is a long-lived conifer that can live more than 4,000 years. It occurs in southern Chile and adjacent areas of Argentina under an oceanic temperate climate with an annual rainfall of 3,000–4,100 mm. The longest *Fitzroya* tree-ring chronology covers the last 5,600 years and was developed from living trees, stumps, snags and dead logs buried by tephra. There were also ^{14}C-dated tephra layers and lake sediments in the studied dendrochronological sites. This context provided the opportunity to compare the results of radiocarbon dating with cross-dated tree-rings. This work presents up to date results of a research in progress. Wood samples containing 15–30 cross-dated tree-rings included in the 5,600 year-chronology from a site located in the Andean Range (41º 33´ S and 72º 36´ W and 860–900 m of elevation) were ^{14}C-dated in two different laboratories. Results so far are contrasting. Small differences (±110–218 years) between radiocarbon dates compared to cross-dated samples at 1959, 2053 and 4032 BP were found. Conversely, large differences were found for cross-dated samples at 1717, 2053 and 4115 BP with Radiocarbon dates that were 1251 (younger), 1723 (older) and 701 (younger), respectively. Some of these differences were maintained when analysis were repeated. More results will be presented at the conference.

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PD2.01 Poster

Influence of river water-level and climatic factors changes on the radial growth of black alder (*Alnus glutinosa* (L.) Gaertn.) in Latvia

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PD2.01

Black alder *Alnus glutinosa* (L.) Gaertn. stands are important habitats in Latvia and Europe. Growth of alders is limited by periodically flooding areas or wetlands where hydrological regime is not significantly affected by human.

The aim of the study is to determine the climatic factors and the water level changes of the river influencing the radial growth of black alder in Western Latvia.

Tree ring samples for the study were collected in two sampling plots in Ziemelkurzeme (Northwestern Latvia), on the shores of the Rakupe River and the Dursupe River. Data of monthly mean, maximum and minimum river water level, monthly mean air temperature and monthly precipitation sum, as well as seasonal and previous year data of water level, temperature and precipitation sum were used for the analysis.

Tree-ring series were measured and cross-dated. From cross-dated tree-ring series a chronology was developed for each sampling site. Chronologies were used to perform correlation analysis to determine their relationship with climatic factors and fluctuations of water level.

It was found that radial increment of black alder was significantly affected by water level of the previous year. The influence of water level was stronger on the trees growing on wetter soils. Monthly and seasonal temperature had significant impact on radial increment of black alder at the end of summer and autumn of the previous year. Black alder stands on different types of soil and at different humidity regimes reacted differently to climatic factors and water level.

PD2.02 Poster

The water level of a shallow steppe lake in Austria reconstructed with the help of tree rings

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PD2.02

Lake Neusiedl, a shallow steppe lake, is located in the east of Austria between the eastern foothills of the Alps and the Little Hungarian Plain. Its water balance is primarily determined by precipitation, which is less than 600 mm per year with mean annual air temperatures of around 10 °C. Records back to 1600 AD show that the lake level is subject to great fluctuations – floods as well as periods where the basin was completely dry occurred in the past.

Nine sites expecting the oldest trees of the lake's catchment area were chosen. Field work consisted of taking 254 cores of 67 pines (*Pinus nigra* ssp. *nigra*) and 60 oaks (*Quercus petrea* and *Quercus robur*).

Best correlation results were achieved with latewood of pine at dry sites and precipitation of June, July and August as well as with monthly lake-level-data of August and September.

Due to the limited age of the trees (the longest pine-site-chronology reaches only back to 1882 AD), the relationships to older living Black Pine trees (1237 to 2003) south of Vienna were checked. These trees are around 30 km west of the lake. It was possible to crossdate the trees of the catchment area and the old Black Pine trees. Therefore a reconstruction of the water level of the lake was possible.

PD2.03

PD2.03 Poster

Tree rings and North American monsoon variability in the southwestern United States

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The North American Monsoon (NAM) is a summer precipitation regime that is centered over northwestern Mexico. The southwestern United States is on the fringe of NAM influence, and as a result NAM rainfall over the region is highly variable across space and through time. This rainfall regime and its variability have important impacts on desert ecosystems, agricultural economy, water resources management, and public health. The NAM has been the topic of much research in recent years and a great deal of progress has been made in improving our understanding of the NAM. However, questions remain about the long-term behavior of the monsoon, as well as its relationship to cool season precipitation and to large-scale circulation. Here we report preliminary results from research that is investigating the long-term variability of the NAM using instrumental data and an updated network of reanalyzed tree-ring collections from across the southwestern United States. These results focus on three specific areas: 1) strategies for extracting and enhancing NAM precipitation information from tree rings using earlywood and latewood measurements and isotope analysis, 2) the tree-ring collection network and preliminary results, and 3) the definition of dominant patterns of NAM variability as determined with principal components analysis of standardized precipitation index data.

PD2.04 Poster

Black-spruce dendroclimatic potential and hydro-climate reconstruction in James Bay area, Northern Québec

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Gathering information on long-term climatic and hydrological variability is crucial to effective management and forecast of surface water resources. To retrieve past hydrological regimes, we reconstructed some key hydro-climatic variables by means of dendrochronology over the past 200 years. The study was conducted in the La Grande hydroelectric complex (James Bay area, Québec) where we established a tree-ring network within an area of 320,000km^2. Chronologies were developed for nearly one hundred old Black spruce stands. The dendrochronological network included various tree-ring proxies such as tree-ring width, tree-ring maximum density and oxygen and carbon stable isotope ratios.

First, the dendroclimatic potential of northern Québec black spruce was evaluated. We analysed the spatial behaviour of the tree-ring network, and calculated response functions to characterise the climate to tree-ring relationships. Then we reconstructed some hydrological variables (annual water supply, summer run-off) at the local scale (Caniapiscau, LG4, LG2 reservoirs). We also reconstructed climatic variables on a 45km x 45km grid over the La Grande complex to analyse hydrological variations in terms of climate and atmospheric circulation.

Our reconstruction method combines an analogue technique for the estimation of missing tree-ring data with an artificial neural network for optimal nonlinear calibration, including a bootstrap error assessment. Transfer functions were calibrated with water supply and meteorological data provided by Hydro-Québec, and with Climate Research Unit (CRU) gridded climate data. The reconstructed series were validated using RE and RMSV coefficients, standard cross-validation tests and verified with instrumental or modelled independent data.

PD2.05

PD2.05 Poster

ARCHIVES: A multidisciplinary project on the analysis of past climatic and hydrological variability in Northern Boreal Quebec

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The ARCHIVES project is a university research initiative in partnership with the hydropower industry. The main objective of this multidisciplinary initiative is to study the hydrological and climatic variations of the last millennium in northern Quebec. The study is based on the use of several natural indicators such as tree rings (living and fossil trees) which offer the best temporal resolution and a great potential for spatial interpretation, proportion and maximal heights of ice-scarred trees which are directly linked with spring flood variability, and finally, lake sediments, which are good indicators of watershed hydrology.

ARCHIVES is articulated around three sub-objectives. The first one is to analyse climate and hydrology spatiotemporal variability of the past 200 years. This retrospective climate analysis will be done on grids (0.5º by 0.5º), which cover the climate spatial variability of the northern half of Quebec. The second one deals with the hydroclimatic exploration of the last millennium. It is based on the construction and analyses of long tree ring series obtained from fossil tree trunks found on the floor of boreal lakes, and of long sedimentary sequences from lakes. The third sub-objective is to compare spatio-temporal climate reconstructions with climatic simulations of the Canadian Regional Climate Model (CRCM) over a 150 years period. The general aim of the comparison is a cross-validation and interpretation of the climatic variables in terms of atmospheric circulation. This poster presents the aims and the organisation of ARCHIVES and the main results obtained up to date on each sub-objective.

PD2.06 Poster

Tree-ring hydrological research for the Heihe River watershed, western China since 1430AD

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In terms of the tree-ring width indices, total precipitation from previous July to current June of Mt. Qilian from 1634 to 2000 AD, and the average runoff from previous September to current June in the middle section of the Heihe river from 1430 to 2007 have been reconstructed. The hydrological variation history thus has been analyzed for the watershed of Heihe river basin in western China. It has been found that the precipitation, runoff and ground water level are significantly correlated with each other on the decadal scale. Three curves display quite synchronous variation trends before 1940 AD, and they present the natural variations without any man-made disturbances. A remarkable period is 1925–1940, when precipitation is low in the upper section, the runoff is low in the middle section, and the ground water level is very deep in the downstream section. After 1940, the ground water shows a lag effect, which may be a resultant result of great water consumption in the middle and downstream sections.

PD2.07 Poster

Summer monsoon droughts in the Nepal Himalaya reconstructed from a 223-year tree-ring $\delta^{18}O$ chronology

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The Palmer Drought Severity Index (PDSI) for the Nepal Himalaya since AD 1778 was reconstructed using oxygen isotope ratios of tree-ring cellulose. A total of 46 cores were collected from 23 individual trees growing in an open A. spectabilis stand near the tree line of 3850 masl in Humla District, western Nepal. Cross-dating was performed by matching ring-width variations for all cores to determine the absolute year of each ring. Of the 40 cores precisely dated, 10 cores from 5 trees were pooled for each year to obtain representative stable isotope records at the site. Response analysis with ambient climatic records revealed that tree-ring $\delta^{18}O$ was primarily governed by the amount of rainfall during the monsoon season (June–September). Extreme dry years identified in instrumental weather data were detected in the $\delta^{18}O$ chronology. Since the tree-ring $\delta^{18}O$ chronology was simultaneously correlated with temperature, drought history in the monsoon season was reconstructed by calibrating against the PDSI. Our reconstruction that accounts for 33.7% of the actual PDSI variance shows a decreasing trend of moisture over the past two centuries. The moisture decrease appearing in our reconstruction is consistent with reduction in rainfall recorded in Himalayan ice-core records, whereas other proxy records from lower altitudes indicate a strengthening of the monsoon winds and rain.

PD2.08

PD2.08 Poster

Three centuries of drought variability for east-central Sweden reconstructed from tree-rings

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While most proxy-based studies from northern latitudes have focused on temperature reconstructions, comparatively few efforts have been made to examine past precipitation variability and climatic extremes such as drought. Consequently, there is a strong need for high-resolution precipitation reconstructions for this region.

The project "*Multi-proxy reconstruction of drought and its relationship with forest fire activity in southern and central Fennoscandia since AD 1500*", founded by The Swedish Research Council Formas, is one of few research efforts which aims to develop reconstructions for summer precipitation extremes, and to evaluate spatial and temporal extents, durations, and frequencies of past drought in southern and central Fennoscandia for the last 500 years. Here we present the first regional high-resolution reconstruction of drought for east-central Sweden, which has been conducted within the frames of the project. May–June Standardized Precipitation Index (SPI) was reconstructed for the region over the 1731–1995 time period based on *P. sylvestris* ring-width data. Approximately 45% of the variance in the instrumental precipitation record was captured in our reconstruction, showing that tree-ring data from xeric environments in central Sweden contain valuable hydro-climatic information which may be used to assess past summer moisture conditions. A total number of 11 single-year wet and dry episodes, respectively, were identified relatively evenly distributed throughout the last three centuries, where the summer of 1818 was the driest and the summer 1894 was the wettest in the record. The most prolonged and outstanding drought spell was recorded in the early eighteenth century and lasted for approximately three decades.

PD3.01 Poster

Adaptability of fir, spruce and larch to climate change outside their natural range in Poland

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Today, the species composition of forest trees is often more heavily influenced by Man than nature, with forest management limiting the natural extend of trees. Poland has a transitional climate, between Atlantic and continental air masses; because of this there are few natural species boundaries. However, recently it has been argued that some forest trees could have migrated beyond their natural areas. Nevertheless, in some regions many tree species were introduced and the presence of surviving 150-year-old trees is witness to this.

The aim of this work was to build chronologies for fir, larch and spruce species outside their natural range; to investigate climate-growth relationships and compare results with prevailing ecological knowledge. Preliminary results from three sites in north and northeastern Poland are presented. The results showed that, for fir, temperature plays the dominant role on growth during the previous September (negative dependence) and the current March. Larch is, however, sensitive to previous July temperatures (negative dependence) and current January and May temperatures. Precipitation is the dominant influence on spruce during the vegetation period in both the previous and the current year, while high May temperatures during the previous year can have a negative influence on growth.

PD3.02 Poster

Dendroclimatological study of larch (*Larix decidua* Mill.) in southern Poland

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Southern part of Poland is an area with diversified landscape: upland and dale in the northern part of the region, foothills of Carpathian mountains in the middle and Carpathian mountains in the most southern part. Larch trees, which can be found on all those areas, create mixed stands with various deciduous species (mostly in the upland and foothills) or with fir and spruce (in the mountain areas). Most of them are relatively young, with maximum tree age up to 145 years. Nine sites were chosen for detailed investigations. They were localized in all areas mentioned above. Additionally, in mountain areas, sites were localized on slopes with different expositions. Site chronologies were created and then correlated with climatic data using classic methods of dendroclimatological studies. Besides, in some cases, when classic approach was insufficient, selected methods of robust statistics were applied. High correlation between tree ring growth and climatic conditions during vegetation period was found in all chronologies from upland and foothills. Correlation with precipitation in vegetation period are in agreement with high water requirements of larch. Analysis of pointer years, which was also performed, seems to confirm this fact. In the mountain sites the response to climatic conditions is less clear, probably because of influence of other factors like slope exposition and local conditions.

PD3.03

PD3.03 Poster

Exploring for senescence signals in native Scots pine (*Pinus sylvestris* l.) in the Scottish Highlands

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The main aim of this project was to explore whether the pine trees in Glen Affric (GA), one of the more extensive pine woodlands in the northern Highlands, were, on average, reaching a senescent stage which could ultimately be detrimental to the sustainability of the pine woodland in this region under present management conditions. This aim was realized by (1) comparing the mean stand age of the GA trees to other pine woodlands around Scotland, (2) exploring whether there was a significant pre-death trend in ring-width series from naturally dead trees and (3) assessing whether a notable change in response of tree-growth to climate was noted as a function of age which could indicate that trees were entering a state of senescence.

The average age of the GA trees is 236 (±36) years compared to 225 (±55) years for Scotland as a whole and comparing the GA data to older pine trees around Scotland suggests that the current forest system should remain healthy for at least the next century. We also note no obvious pre-death trend in ring-width time-series measured from recently dead standing trees. Intriguingly however, there is a consistent weakening in the response of the pine trees to temperatures through the 20th century. Despite younger trees showing, on average, a stronger response to temperatures, they show the greatest temporal instability in response. This response change is not related to tree senescence and ongoing research is exploring this phenomenon in more detail.

PD3.04 Poster

Dendrochronological approach to explain the impact of the drought on the dieback of *Cedrus atlantica* in the Aurès Montain (Algeria)

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PD3.04

In order to explain the impact of the drought on the phenomenon of dieback in the cedar forests in Aurès Mountain, the dendrochronology is one of many other approches that we have used.

Limiting our analysis with an EPS of at least 0,80, a single chronology of 508 years (1501–2008) was developped from cores of living trees of *Cedrus atlantica*.

The climate seems more limiting for the growth in the 20th century ; the average segment correlation between trees and the master, obtained from COFECHA, varies from 0,7 in the beginning of the century to 0,9 in the end.

The instrumental climate data were used to reconstruct the seasonal precipitation (Mars–June) for the period AD 1501–2008. The recnstruction of the drought periods confirm that the 20th century is the worst since 5 centuries with 14 dry years. The number of dry years tends to increase in the later half of the 20th century with 11 years. The recent period of drought (1999, 2001, 2002) appears to have a great responsability in the dieback observed from 2002.

PD3.05 Poster

Effect of aspects on tree ring width in Cornus mas, a case study: Arasbaran forest, NW Iran

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Urmia university, Urmia, west Azarbayjan, Iran, Islamic Republic of

The Arasbaran forest is a valuable forest in NW Iran which has been preserved for many decades. The vegetation type is similar to hyrcanian forest in N Iran which containing hornbeam, common yew, oak, etc. Cornus mas (european cornel) is growing understory in cardinla points and villagers get some benefits of it. For tree growth's determining, 4 common yew stands at cardinal points were selected using selective stratification method. In each direction (aspect) 10 individuals were cut and a disk with 1.5 cm thickness was obtaind from each tree. After preparing the disks, ring width was measured using image tools ver. 2 and comparing between directions were applied using Anova and duncan test. Results showed that the highest amount of anually mean ring width was observed in the north (1.06 mm) due to better condition of humidity and the others were ranked as south (0.96 mm), east (0.92 mm) and west (0.77 mm) respectively. Statistical analysis showed no significant difference between south and east but between the others there was significant difference. Finally, this study recommend if Cornus mas is selected for cultivating in farms or forests, it would better planting in north, south and east respectively rather than west direction.

PD3.06

PD3.06 Poster

Dendroecological study on *Fagus orientalis* along climatic and altitudinal gradients in the Alborz Mountains, Iran

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F. orientalis is an important constituent of the Hyrcanian Forest or Caspian Forest which covers the northern slope of the Alborz Mountains between the Caspian Sea and the interior dry areas of central Iran. Climate on the northern slopes of the Alborz Mountains is generally humid with decreasing annual precipitation from 1853 mm in the west to 601 mm in the east. In contrast, annual mean temperatures increase from west to east from 16°C to 18°C, respectively.

According to the differences of the precipitation and temperature regime along the longitudinal and altitudinal gradients in the study area, this study was carried out to know how growth of Oriental beech reacts under these different climatic situations.

Two study regions in the central and eastern parts of the Alborz Mountains were selected along a climatic gradient. Wood samples were collected with a Swedish increment borer. Only dominant trees were selected. Ring widths were measured to the nearest 0.01 mm with a LNTAB II system. To remove age-related growth trends, the raw measurement values were detrended by a cubic smoothing spline that kept 50% of the variance at a flexible wavelength of 2/3 of each individual series. The final standard chronologies were calculated as a biwight robust mean of all single series of a site. A Hierarchical Cluster Analysis (HCA) was carried out to group beech sites with high similarities of interannual growth variations. The similarity was calculated according to the Euclidean distance and the hierarchy was computed using the Ward's method.

PD3.07 Poster

Age and radial growth pattern of four tree species in a subtropical forest of China

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Subtropical forests are usually composed of many tree species. Knowledge of the age and radial growth variation of the dominant tree species is useful understanding the ecological growth characteristics and the community structure and function. The aims of this study are to explore whether there are identifiable annual growth rings in the main tree species and to examine the growth characteristics within and among the species in Mount Gutian subtropical forest of China. The results showed that four out of eight species that samples were collected had visible and crossdatable rings. There were no stable relationships between the age and diameter for these subtropical trees. Significant differences exist in radial growth rate within and among the four species. It is interesting to note that the growth rate at the same age classes was different for trees at 0–40 years of age and >40 years of age, suggesting a change in climate in the two time period. The results obtained from this study help understanding growth dynamics in other subtropical forests having these tree species.

PD3.08

PD3.08 Poster

Dendrochronological investigation of the high Andean tree species *Polylepis* besseri

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High-altitude *Polylepis* besseri woodlands in Bolivia are under increasing threat from human use and disturbance. Currently, there is no information regarding P. besseri growth rates, age structures or the relationship between environmental variables and growth. Such information would be useful for effective management and conservation of the remaining woodlands. We used standard dendrochronological techniques to determine the age and radial growth rates for 23 trees from two *Polylepis* besseri populations in Sacha Loma (mountains Uypa and Chutu Senega), and investigated the relationship between climate and radial growth. Wood samples exhibited semicircular porosity and visible tree-ring boundaries, providing evidence that this species produces growth rings that can be crossdated. The sample trees were young (mean age 40y, max age 63y) and growing slowly (<1mm/y). Trees at Chutu Senega were older and growing more slowly than those at Uypa. The strong linearity of cumulated radial increments suggests P. besseri may maintain consistent growth rates beyond 60 years. Our results indicate that radial growth is limited by the accumulation of reserves the year before ring formation, and that a warm period before the growing season (humid period) can increase P. besseri's growth in the Peruvian Puna Province. It seems local factors are more important than regional factors in these high Andean woodlands. This study improves our understanding of the biology of *Polylepis* and demonstrates the usefulness of dendrochronology for investigating the biotic, abiotic and anthropogenic effects on woodlands in areas lacking long term historical data.

PD3.09 Poster

Climate influences on the radial growth of Centrolobium microchaete, a valuable timber species in the tropical dry forests of Bolivia

Lidio Lopez Callejas, Ricardo Villalba
IANIGLA-CONICET, Mendoza, Argentina

The lack and shortness of instrumental records in the tropical forests of Bolivia limit our understanding on regional climate variability. Therefore, it is necessary to use proxy-climatic records to reconstruct past environmental changes. Tree rings provide continuous series with annual resolution which can be modeled to accurately reconstruct annual variations of temperature, precipitation and, atmospheric pressure during the past centuries. Our goal was to develop chronologies with Centrolobium microchaete (Tarara amarilla) and determine the relationships between the radial growth of this species and the climatic variations during the 20th century in different eco-regions of the tropical Cerrado Boliviano.

PD3.10 Poster

Impacts of soil organic layer thickness on sensitivity to climate change of black spruce and trembling aspen in western Quebec, Canada

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Growth and distribution of trembling aspen and black spruce, the dominant species of the eastern Canadian boreal forest, may be modified by climate change. In the Quebec Clay Belt, the accumulation of the soil's organic layer could affect climate-growth relationships for these species. We conducted dendroclimatological analyses to identify critical climatic variables responsible for radial growth of these 2 species. Effects of the organic layer depth on climate responses were then assessed. The following hypotheses were tested: (1) tree growth diminishes with a thicker organic layer, (2) aspen is more sensitive and has different growth-responses to climate than black spruce, and (3) trees growing on a thick organic layer have a strong positive response to warmer temperatures and are less sensitive to precipitation, whereas trees growing on mesic to xeric sites are disadvantaged by warm and dry growing seasons. First results show that an organic layer thicker than 20cm limits the distribution of aspen, but not the distribution of black spruce. The absolute growth of aspen and black spruce is diminishing with a thicker organic layer. The major monthly climatic variables controlling black spruce growth seem to be late-winter and early-spring temperatures and temperatures at the end of the previous year's growing season. For black spruce, there is an increasingly positive relationship between growth and current year summer temperatures with a thicker organic layer. Results suggest that the response of black spruce and trembling aspen to climate change will be mediated locally by the importance of organic layer accumulation.

PD3.11

PD3.11 Poster

Climate influence on tree growth in the northern portion of the black spruce-moss domain of western Quebec from tree-ring data

Giancarlo Marino[1], Martin P. Girardin[2], Fréderic Raulier[3], Pierre Y. Bernier[2], Yves Bergeron[4]
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Climate change is generally associated with increased growth of northern boreal forests. Here we present a reconstruction of black spruce (*Picea mariana*) forest growth in the northern portion of the black spruce-moss domain of western Quebec, Canada, inferred from tree-ring data and verified against a simulation from the bioclimatic model of forest stand productivity StandLEAP. First, a tree growth index (TGI) spanning 1707–2006 was built from 114 disks of mature black spruce trees. Second, a leaf-level model of photosynthesis was used to simulate canopy properties per species and their interaction with the variability in radiation, temperature and vapour pressure deficit. Landscape-level productivity over the period 1930–2005 was simulated using a top-down plot-level model of forest productivity that captured the between-stand variability in forest cover. The simulation approach did not use an error reduction technique against the TGI data. Results showed that net ecosystem productivity (NEP) computed as the difference between annual Gross Primary Productivity (GPP) and previous year annual total ecosystem respiration (Re) explained approximately 21% of the variance in the observed TGI over the period 1930–2005. The model-data comparison suggested some evidence of noise in TGI data arising from insect herbivory, which may have weaken or altered the climate signal in TGI data. Neither the tree growth index nor the NEP simulations indicated evidence ($P>0.05$) for increasing growth at the end of the 20th century for this particular region. This region has perhaps not yet responded to anthropogenic climate change. However, the interest of forest industry in this area pushes governmental institution to plan new adaptation strategies for sustainable management.

PD4.01 Poster

Teak Tree Ring dendroecology an climatology Research in Northwest Thailand

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Due to there being only a few tree species in tropical zones that show the potential for carrying out dendrochronology, and since tropical zones have been the target of logging concessions for a long time, there are thus obstacles to the study of tree rings in such areas where full-grown trees with a significant tree ring width are preferable.

Nevertheless, this study attempts to select living teak trees from difference elevation at 400–1000 m. a.s.l from Maehongson province, Northwest Thailand. The studies sites are isolated and discovered that were leave during the intensive logging concessions in Thailand. Our research aims to investigate growth, synchronize data between sites, and understand how teak tree ring width responds to ecological site and climate. In this study, we will divide study site in 3 parts, the elevation from 300–500 m, 500–700 m and 700–1000 m. a.s.l. In each study site, at least 30 trees, 60 cores will be samples. The routine dendrochronology technique will perform. The individual index from each site will be construct and analysis with climate data. The results of recent research will be compare and discussion with the previous researches results.

PD4.02

PD4.02 Poster

Dendroecological potential of *Cedrela odorata* and *Cedrela fissilis* trees from the semideciduous and Atlantic forests of Brazil

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Tree ring analysis from tropical tree-species is a relevant task in order to properly understand related biotic and physical consequences produced by environmental perturbations from present times to past decades and centuries in the tropical South America. The high biodiversity and seasonal climates of many tropical forest ecosystems increase the possibility to find tree species with distinct tree-rings. Among these species, *Cedrela odorata* and *C. fissilis* trees are increasingly used to develop a tree-ring network chronology through the rain forest of Mata Atlantica and neighboring semideciduous forests in Brazil and Argentina.

Cedrela odorata and *C. fissilis* trees occurring in the São Paulo region were cored by non-destructive methods and their tree-ring widths were successfully cross-dated due to their clear annually defined growth rings and their common tree growth variability among trees ($r = 0.60–0.70$ among trees). Some of the tree-ring chronologies were around 200-yrs length and they showed statistically significant links with precipitation. Although results obtained with these species are highly preliminary, they constitute a promising field of dendroclimatic research in the tropics of the New World. We discuss our findings in terms of the contribution of these species to the paleoclimatic, ecological and management field research.

PD4.03 Poster

Tree rings evaluation of mahogany trees, *Swietenia macrophylla*, and the relationship to environmental conditions of the tropical rainforest of Peru

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The conditions of the site, including the seasonality of the climate, influence the trees growth inducing the formation of tree rings in the wood. The growth can be correlated with climatic variation and thus enable the reconstruction climate. For this study were selected 27 mahogany trees in 2 forest populations in the departments of Madre de Dios and Ucayali, in Peruvian Amazon, and extracted 55 samples of wood with radial probe Pressler. The wood anatomical structure, tree rings and radial variation of density inter-and intra-annual rings by X-ray densitometry were analyzed. The tree rings are distinct, with characteristic anatomical structure (demarcation of parenchyma rings and semi-porous) and the average wood density, as the minimum and maximum were significantly different in the 2 forest communities. The demarcation width of the tree rings by 2 methods (table of measurement and density profiles of wood) showed significant correlation (r^2 = 0.8628) and allowed to estimate the age of trees (32–122 years). The correlation index of Pearson confirmed the correlation between the annual growth the trunk of mahogany trees with temperature and precipitation. The growth of the mahogany trunks trees occurring in the 2 populations showed a sensitivity to rainfall (late dry season: Jul–Aug; beginning of the season: December) with common signal response to climate, influenced by the conditions of the site.

PD4.04 Poster

Management Strategy in Central Amazon floodplains based on Growth-Oriented Logging (GOL)

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The Amazon forest is an important reservoir of carbon which can be released to the atmosphere through deforestation and fires. This represent about 75% of the global emissions In countries like Brazil, nevertheless projects aimed reduction of forest degradation are not included as targets to reduce emissions (Kyoto Protocol, 1997). Studies have shown the benefits of reduce ecological damage to the forest by selective logging of timbers and the RIL (Reduced-Impact Logging). However, the success of the management of forest resources depends on the ecological sustainability of timber production, which requires information about growth rates of commercial species to determining harvest volumes and cutting cycles. The tree-ring analysis of wood (dendrochronology) is an important tool to the modeling of tree growth and age of tropical trees. The present study aims to model patterns of tree growth of timber species in Central Amazonian várzea floodplain, based on species-specific management criteria (Growth-Oriented Logging -GOL), where MDL (Minimum Diameter Logging) and cutting cycles that were determined and discussed in the context of current standards of forest management in the Amazon by Brazilian legislation. Considering the differences in growth patterns of tree species, it is concluded that polycyclic systems establishing only one felling diameter and only one cutting cycle for these species did not guarantee the stock maintenance of wood in the forest and therefore are not sustainable and do not contribute to reducing forest degradation.

PD4.05 **Poster**

On the dendroclimatological potential of $\delta^{13}C$ and $\delta^{18}O$ from tropical tree-rings – A case study on *Tectona grandis* from Java, Indonesia

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The present study tries to develop stable isotope chronologies from Indonesian teak (*Tectona grandis*). *Tectona* is one of the few species showing visible density variations, and annual growths boundaries enable the development of precisely dated chronologies to reconstruct climatic or environmental changes. Ring width chronologies from Indonesian teak have been successfully used for climate reconstructions (e.g. D`Arrigo et al. 2006, 2008). However, at present, stable isotope ($\delta^{13}C$, $\delta^{18}O$) chronologies from tropical trees are scarce and the influence of climatic or environmental factors has not been studied in detail yet. For testing the relevance of changes in temperature and precipitation dynamics we performed inter- and intra-annual isotope investigations on tree-rings of Teak from an Indonesian site (Donoloyo, Central Java, 111°11‘ E / 7°52‘ S, 380m asl) that revealed rather low correlations between Indionesian warm pool SSTs and ring width (r = 0.28, D`Arrigo et al. 2006). The presentation will give an answer to the questions: Do tree ring stable isotopes have an additional value to ring width studies? Are tree ring stable isotopes the better climate proxies?

References

D’Arrigo, R., Wilson,R., Palmer,J., Krusic,P., Curtis, A., Sakulich, J., Bijaksana,S., Zulaikah,S., Ngkoimani, L.O. and Tudhop, A. (2006) The reconstructed Indonesian warm pool sea surface temperatures from tree rings and corals: Linkages to Asian monsoon drought and El Nin˜o-Southern Oscillation. Paleoceanography, 21, PA3005, Doi:10.1029/2005PA001256

D’Arrigo, R and Wilson, R. (2008). El Niño and Indian Ocean Influences on Indonesian Drought: Implications for Forecasting Rainfall and Crop Productivity. International Journal of Climatology. 28: 611–616

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