Second American Dendrochronology Conference

Monday May 13 – Friday May 17, 2013,
Tucson, Arizona.

Welcome

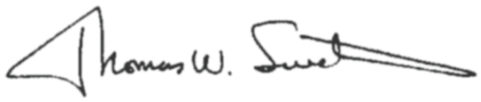
Welcome to the 2nd American Dendrochronology Conference!

We are pleased to host the 2nd meeting of AmeriDendro, and to welcome all presenters and attendees from the Americas and elsewhere around the planet. The 1st AmeriDendro Conference in Vancouver British Columbia in 2008, hosted by the University of British Colombia, was a great success. We hope to emulate their precedent with an engaging and stimulating set of oral and poster presentations, workshops and fieldtrips. At this time we have more than 240 submitted abstracts for oral and poster presentations that are included in the following program, as well as 3 workshops, and four mid-week field trips. We also welcome all participants to an evening banquet to be held on the University of Arizona campus in combination with an "open house" and tours of our new Bryant Bannister Tree-Ring Building. We hope you will agree that this diverse mix of scientific presentations and interesting events will be well worth your time over the course of our meeting week, May 13 to 17, 2013.

Tucson, Arizona is an interesting city to visit, especially for dendrochronologists. The founder of the Laboratory of Tree-Ring research, Andrew Ellicott Douglass, arrived in Tucson in 1906. His systematic development of many of the basic methods and concepts of dendrochronology ultimately led to a breakthrough in archaeological chronology of the Southwest in 1929 and the formal establishment of the Laboratory of Tree-Ring Research in 1937. The whole field of dendrochronology is now a worldwide endeavor, with many centers of excellence, and individual scientists and their students making new discoveries every year. Our AmeriDendro meeting is a terrific opportunity to learn about new research, very recent findings, new methods and, of course, to meet other dendrochronologists and researchers with common and diverse interests.

The Conference would not have been possible without the generous contributions of support from the Tree-Ring Society, The Institute for the Environment at University of Arizona, and other sponsors (the full list with acknowledgements will be included in our final printed program and on the conference web page). We are grateful for this support and we thank our sponsors.

On behalf of the Program Co-Chairs, Dr. Ron Towner and Dr. Valerie Trouet, our local planning and organizing committees, and the external advisory committee chaired by the Tree-Ring Society President Elaine Sutherland, I welcome all participants to Tucson!



Thomas W. Swetnam, Conference Chair

Laboratory of Tree-Ring Research

Committee and Sponsors

AmeriDendro 2013 is sponsored, in part, by the Tree-Ring Society, and hosted by the Laboratory of Tree-Ring Research (LTRR), University of Arizona. An Organizing Committee includes faculty, staff and students at LTRR. An Advisory Committee is chaired by Dr. Elaine Kennedy Sutherland (President of Tree-Ring Society), with Lori Daniels, Patrick Baker, Henri Grissino-Mayer, David Stahle, Antonio Lara, Thomas Kitzberger, Jacques Tardif and Markus Stoffel. The committees are grateful for the support of several addtional organizations:

Monday, May 13.

1:00 PM	Salon A–C — FHAES Workshop	1:00 PM	Salon D — dplR and Signal-Free Detrending Workshops
3:00 PM	Foyer — Break		
3:30 PM	Salon A–C — FHAES Workshop	3:30 PM	Salon D — Tellervo and TRiDaS Workshops
5:00 PM	(workshops end)		
5:30 PM	Foyer — Registration		
6:00 PM	Foyer — Reception		
7:00 PM	(registration closes for the day)		
8:30 PM	(reception ends)		

Tuesday, May 14.

7:00 AM	Foyer — Continental Breakfast	
8:00 AM	Foyer — Registration opens	
	Salon A–D—Welcome + Plenary Session (Ecology)	
8:30 AM	Welcome Remarks	University of Arizona Provost
8:55 AM	Dendroecology as Multi-disciplinary Dendrochronology	Swetnam, Thomas
9:15 AM	Foyer — Break	

Salon A–C—Climate Growth Relations I
chaired: David W. Peterson

9:30 AM	Examining Variability in Douglas-fir Growth at a Continental Scale	Restaino, Christina
9:50 AM	Why Distribution Location Matters for the Climatic Response of Broadleaf Species in the Eastern Deciduous Forest	Martin-Benito, Dario
10:10 AM	Observed and simulated climate sensitivity of large-scale forest productivity	Babst, Flurin

Salon D—Fire Ecology I
chaired: Thomas Swetnam

9:30 AM	Fire history, Stand Structure and Ecological Type Conversions in Mixed Conifer Forests, Northern Colorado Front Range	Huckaby, Laurie
9:50 AM	Historical high-severity fire in mixed-conifer forest, Grand Canyon North Rim	Yocom, Larissa
10:10 AM	Collapse of frequent fire regime linked to increased tree density in a piñon-juniper landscape, New Mexico, USA	Margolis, Ellis

10:30 AM	Foyer — Break	

Salon A–C—Climate Growth Relations II
chaired: Flurin Babst & Christina Restaino

10:55 AM	A mixed-effects modeling approach for describing climate-growth relationships with applications to climate change research	Peterson, David W.
11:15 AM	Application of a simple soil moisture model for assessing drought effects on the growth of boreal aspen (Populus tremuloides) forests in western Canada	Hogg, E.H. (Ted)

Salon D—Dendroecology I
chaired: Kurt Kipfmueller & Lori Daniels

10:55 AM	Relationships between root and stem growth	Krause, Cornelia
11:15 AM	A Modified Negative Exponential Curve For Estimating Growth Trends in Closed-Canopy Forests	Druckenbrod, Daniel

Tuesday, May 14.

Salon A–C—Climate Growth Relations II chaired: Flurin Babst & Christina Restaino			Salon D—Dendroecology I chaired: Kurt Kipfmueller & Lori Daniels		
11:35 AM	New multi-century earlywood and latewood tree-ring chronologies refine understanding of climate-growth relationships at the southern range margin of longleaf pine (Pinus palustris R. Mills)	Flinner, Nicholas	11:35 AM	Spatial and temporal interactions between Spruce beetle outbreaks, fire, and climate in a remnant isolated spruce-fir forest	O'Connor, Christopher
11:55 AM	Growth climatic response of two species from Hunza Valley of Karakorum Range, Northern Pakistan	Ahmed, Moinuddin	11:55 AM	Climatic Drivers of Western Spruce Budworm Outbreak Dynamics in the Interior Pacific Northwest	Flower, Aquila
12:15 PM	Foyer — Buffet Lunch				
1:45 PM	Salon A–D — Panel Discussion (Plenary Session)				
2:15 PM	Foyer — Break				
Salon A–C—Climate of Recent Millennia I chaired: Malcolm Hughes & Erika Wise			Salon D—Dendroecology II chaired: Neil Pederson & Grant Harley		
2:30 PM	On the Turquoise Road: Millennium-Long Seasonal Moisture Proxies from the Aztec to Anasazi Areas	Stahle, David	2:30 PM	Multi-proxy Land Use History Reconstruction at Zena Forest, Oregon	Copes-Gerbitz, Kelsey
2:50 PM	A 1500-Year Reconstruction of Annual Mean Temperature for Temperate North America on Decadal-to-Multidecadal Time Scales	Trouet, Valerie	2:50 PM	Differences in Nothofagus pumilio forest structure and tree-ring growth along altitudinal gradients at different aspect in Southern Patagonia	Srur, Ana
3:10 PM	Late Holocene paleotemperatures from bristlecone pine tree rings and treeline elevation change	Salzer, Matthew	3:10 PM	Dendroecological Insights from Industrial Dendro: Missing Rings and the Importance of Seed Source in 36-year old Pinus rigida	Leland, Caroline
3:30 PM	Frost-ring formation in Douglas fir at the lower forest border in central Idaho	Crawford, Christopher J.	3:30 PM	Scots Pine (Pinus sylvestris L.) Growth Suppression and Adverse Effects on Human Health Due to Air Pollution in the Upper Silesian Industrial District (USID), Poland	Malik, Ireneusz
3:50 PM	Foyer — Break (registration closed at 3:15 PM)				

Tuesday, May 14.

Salon A–C—Climate of Recent Millennia II chaired: Kevin Anchukaitis & David Frank			Salon D—Network Analysis chaired: Jose Villanueva-Diaz & Scott St. George		
4:10 PM	The Scottish Pine Project: Trees, Lakes and Climate	Wilson, Rob	4:10 PM	Climatic response of the mexican mountain pine (Pinus hartwegii Lindl.) in northeastern and central Mexico	Villanueva-Diaz, Jose
4:30 PM	North American monsoon precipitation reconstructed from tree-ring late wood	Griffin, Daniel	4:30 PM	Feasibility of climate reconstruction using Forest Inventory and Analysis data	DeRose, R. Justin
4:50 PM	Multi-century Variability in Synoptic Circulation Patterns over Western North America and the North Pacific	Wise, Erika	4:50 PM	Dendroclimatological insights from a high-elevation multispecies tree-ring width and density network spanning the British Columbia Coast Mountains, Canada.	Coulthard, Bethany
5:10 PM	Mixed signals, mixed messages and lessons from bristlecone pine	Hughes, Malcolm	5:10 PM	A new North American fire scar network for reconstructing historical pyrogeography, 1600-1900 AD	Falk, Donald
5:30 PM	(talks end)				
6:00 PM	Foyer, Salon E–H — Poster Session & Reception				
9:00 PM	(reception ends)				

Wednesday, May 15.

7:00 AM Foyer — Continental Breakfast

8:00 AM Foyer — Registration opens

Salon A–D—Invited Speaker + Plenary Session (Decison Making)

chaired: Peter Brown & Connie Woodhouse

8:00 AM	A South American Perspective on Dendroclimatology	Villalba, Ricardo
8:20 AM	Pyrodendroecology in fire-adapted Pinus species: Linking evolutionary ecology and ecosystem management	Brown, Peter
8:40 AM	Linking Tree-Ring Research and Resource Management through Collaboration	Woodhouse, Connie
9:00 AM	The consequences of under-representing uncertainty in tree-ring-based risk analyses	Lukas, Jeffrey
9:20 AM	Application of dendrohydrology to drought preparedness planning in western Canada	Sauchyn, Dave

9:40 AM Foyer — Break

Salon A–C—Dendroclimatology I

chaired: Mary Gagen & Dario Martin-Benito

10:00 AM	A comparison of tree-ring inferred climate reconstructions from central Minnesota, USA, to 19th century US military fort climate data and high-resolution pollen-inferred climate data	St. Jacques, Jeannine-Marie
10:20 AM	A tree-ring based reconstruction of early summer precipitation in southwestern Virginia (1750-1981)	Dawson, Andria
10:40 AM	The Influence of the Atlantic Multidecadal Oscillation on Tupelo Honey Production since AD 1800	Maxwell, Justin
11:00 AM	Spatial Structure of Eastern Mediterranean Tree-Ring Network	Touchan, Ramzi
11:20 AM	Sensitivity of tree growth to temperature in the southeastern China and the potential for spatial temperature reconstruction	Shi, Jiangfeng

Salon D—Wood Anatomy

chaired: Jodi Axelson & Jacques Tardif

10:00 AM	White Earlywood Rings and Frost Rings in Black Spruce Trees from Manitoba, central Canada.	Tardif, Jacques
10:20 AM	Impact of various partial cutting treatments on radial growth and wood quality of black spruce: a study case in the boreal forest	Pamerleau-Couture, Émilie
10:40 AM	Earlywood vessels of Quercus robur and Fraxinus excelsior as climate indicators	Elferts, Didzis
11:00 AM	Exploring the effects of western spruce budworm outbreaks on the wood anatomy of Douglas-fir	Axelson, Jodi
11:20 AM	Acoustic Illustration in Dendrochronology	Guyette, Richard

11:40 AM Foyer — Buffet Lunch

12:00 PM (registration closes)

Wednesday, May 15.

12:45 PM	Meet for field trips				
	Half-Day Field Trips Depart				
1:00 PM	Lemmon Highway Excursion	Biosphere II and Hohokam Archaeology Excursion	Sonoran Desert and Rock Art Excursion	San Xavier Mission and Madrean Woodland Excursion	
8:00 PM	(field trips return)				

Thursday, May 16.

7:00 AM Foyer — Continental Breakfast

8:00 AM Foyer — Registration opens

Salon A–D—Invited Speaker + Plenary Session (Dendroecology)

chaired: Martin Wilmking & Stockton Maxwell

8:00 AM	Cambial matter: what does 10 years of cell counting teach?	Deslauriers, Annie
8:20 AM	Regional-scale dynamics in humid, broadleaf forests	Pederson, Neil
8:40 AM	Invasive Earthworms Alter Climate-Tree Growth Relationships	Larson, Evan
9:00 AM	Modern fire regime approximates historical fire regime in a forest on tribal lands	Stan, Amanda
9:20 AM	Fire history along a historic travel corridor in Minnesota's Boundary Waters Canoe Area Wilderness	Kipfmueller, Kurt

9:40 AM Foyer — Break

Salon A–C—Dendroclimatology II

chaired: Annie Deslauriers & Daniel Griffin

10:00 AM	Elevational gradients reveal tree growth response to a warming climate	King, Gregory
10:20 AM	Evidence for cambial activity in Great Basin subalpine conifers under heavy snow	Dufour, Boris
10:40 AM	Widespread absent rings have not occurred in boreal and temperate trees outside the American Southwest	St. George, Scott
11:00 AM	False Rings in the Southwest: An Update of "The Time of Year of Ring Formation"	Morino, Kiyomi
11:20 AM	Paleoclimatology of Early Paleogene Mummified Wood from the Canadian Arctic	Hook, Benjamin

Salon D—Fire Ecology II

chaired: Ellis Margolis & Jim Speer

10:00 AM	Multi-century forest fire history in Scandinavia	Drobyshev, Igor
10:20 AM	Fire-induced wounding elicits changes in the wood anatomy of North American conifers	Arbellay, Estelle
10:40 AM	Climate Variability and Altered Fire Regimes in the Mountain Forests of British Columbia, Canada	Daniels, Lori
11:00 AM	Interaction of fire, climate, and human history of northern Mongolia	Suran, Byambagerel
11:20 AM	Fire History of Boreal Forests in the Sakha Republic of eastern Siberia	Guiterman, Christopher

11:40 AM Foyer — Buffet Lunch

12:00 PM (registration closes)

Thursday, May 16.

Salon A–C—New World Dendroarchaeology

chaired: Stephen Nash & Ronald Towner

1:00 PM	The Historical Analysis of, and Systematic Bias in, Large, Regional Tree-Ring Date Distributions from the American Southwest	Nash, Stephen
1:20 PM	Culturally Peeled Trees in Northern Colorado	Reiser, Marcy
1:40 PM	Dating First Nation "Brush Structures" in Kluane National Park and Reserve	Luckman, Brian
2:00 PM	Dendrochronological dating of the Puerto Madero vessel, Buenos Aires, Argentina	Mundo, Ignacio
2:20 PM	Dendroarchaeological dates of prehistoric contexts in the Bolivian Altiplano	Morales, Mariano

Salon D—Fire Ecology III

chaired: Donald Falk & Laurie Huckaby

1:00 PM	A spatial analysis of fire history across adjacent watersheds	Marshall, Laura
1:20 PM	Dendrochronology-based fire history of the western San Juan Mountains: The influence of aspect and forest composition	Bigio, Erica
1:40 PM	The relative influence of climate and fire on subalpine forest productivity in the Wallowa Mountains, northeast Oregon	Allen, Sara
2:00 PM	The Effect of Fire on Multiple Arboreal Species in the Eastern Deciduous Forest	Speer, Jim
2:20 PM	External charring and fire scarring in three western conifers	Sutherland, E.K.

2:40 AM Foyer — Break

Salon A–C—Old World Dendroarchaeology

chaired: Pearce Paul Creasman & Tomasz Wazny

3:00 PM	Pluvials, Droughts, Energetics, and the Mongol Empire	Hessl, Amy
3:20 PM	Wood, mud and dating a flood: Dendroarchaeology of the Theodocian Harbour, Yenikapı, Istanbul	Pearson, Charlotte
3:40 PM	Ships of the Early Modern Age – innovative tree-ring approaches to the Atlantic challenge	Dominguez-Delmas, Marta
4:00 PM	Early Neolithic water wells reveal the world's oldest wood architecture	Tegel, Willy

Salon D—Recent Growth Trends and Tree Mortality

chaired: Alison Macalady & Rob Wilson

3:00 PM	Radial growth decline and mortality in Austrocedrus chilensis forests: climate and competition as triggering factors	Amoroso, Mariano
3:20 PM	Variability in tree-level bark beetle induced tree mortality and its relationship to climate and forest dynamics	Hart, Sarah
3:40 PM	Deciphering forest response to drought and air pollution in the southern Sierra Nevada	Cousins, Stella
4:00 PM	Examining recent growth rebounds of red spruce trees in the northeastern forest	Kosiba, Alexandra

Thursday, May 16.

Salon A–C—Old World Dendroarchaeology chaired: Pearce Paul Creasman & Tomasz Wazny			Salon D—Recent Growth Trends and Tree Mortality chaired: Alison Macalady & Rob Wilson		
4:20 PM	Dendrochronological investigations of Bronze Age to Early Iron Age mining on copper in the Austrian Alps	Nicolussi, Kurt	4:20 PM	Vertical resin ducts in tree-rings and predisposition to mortality during drought	Macalady, Alison
4:40 PM	(talks end)				
5:40 PM	Transportation leaves for the University of Arizona				
6:00 PM	Banquet & Tour of the Bryant Bannister Tree-Ring Building				
9:30 PM	Transportation returns to the hotel.				
9:45 PM	Final vans return to the hotel.				

Friday, May 17.

7:00 AM Foyer — Continental Breakfast

8:00 AM Foyer — Registration opens

Salon A–C—Tropical Dendrochronology

chaired: Valerie Trouet & Matthew Therrell

8:30 AM	Tree-Ring Chronologies from Mozambique	Therrell, Matthew
8:50 AM	Reconstruction of humidity in a dry forest and a humid forest in southern Ecuador	Pucha Cofrep, Darwin Alexander
9:10 AM	High elevation dendrochronology in Guatemala	Anchukaitis, Kevin
9:30 AM	Growth responses to climate across environmental gradients in subtropical forests from South America	Ferrero, María Eugenia

Salon D—Isotopes in Dendrochronolgy

chaired: Adam Csank & Soumaya Belmecheri

8:30 AM	Response of tree growth and water use efficiency to climate change and nitrogen deposition in a temperate deciduous forest in the northeastern U.S.	Jennings, Katie
8:50 AM	Tree-ring δ13C as a proxy of gross primary productivity in a North American forest	Belmecheri, Soumaya
9:10 AM	Carbon dioxide reconstruction from Tree-ring cellulose	Bose, Trina
9:30 AM	The Teflon-container method for extracting alpha-cellulose directly from tree-ring laths.	Kagawa, Akira
9:50 AM	Reconstructing past climate variability in the Iberian Peninsula using carbon and oxygen stable isotopes in tree rings	Andreu-Hayles, Laia

10:10 AM Foyer — Break (registration closes at 10:00 AM)

Salon A–C—Dendrohydrology

chaired: Dave Meko & Ryszard Jerzy Kaczka

10:30 AM	Streamflow Signal in Annual Ring Widths of Cottonwood Trees along Little Missouri River, North Dakota	Meko, David
10:50 AM	Multi-century reconstruction of Pacific salmon abundance and river discharge in west central British Columbia, Canada	Smith, Dan

Salon D—Isotopes in Dendrochronology II

chaired: Steven Leavitt & Shelly Rayback

10:30 AM	Using δ13C and δ18O measurements to assess climate controls on insect-related tree mortality in south-central Alaska	Csank, Adam
10:50 AM	Stable carbon isotopes from eastern hemlock trees in northern New England and their potential for mid-latitude climate reconstruction.	Rayback, Shelly

Friday, May 17.

Salon A–C—Dendrohydrology

chaired: Dave Meko & Ryszard Jerzy Kaczka

11:10 AM	Dendrogeomorphic reconstruction of recent flood events in small streams in the Polish Tatra Mountains	Kaczka, Ryszard Jerzy
11:30 AM	Flash floods in the Patagonian Andes: A dendrogeomorphological approach	Casteller, Alejandro
11:50 AM	Can tilted trees be used for flood discharge estimaton?	Ballesteros Cánovas, Juan Antonio

Salon D—Isotopes in Dendrochronology II

chaired: Steven Leavitt & Shelly Rayback

11:10 AM	Monsoon Rainfall from Annual δ13C Chronologies of Pseudotsuga menziesii and Pinus ponderosa in Southern Arizona, USA	Leavitt, Steven
11:30 AM	Spatial Changes in the Seasonal Mixing Proportions of Available Soil Moisture in the High Elevations of Arizona and New Mexico	Wright, William
11:50 AM	Drought history inferred from tree-ring δ13C and δ18O in the Middle of the Tianshan Mountains of China, and linkage with the North Atlantic Oscillation	Xu, Guobao

12:10 PM Foyer — Buffet Lunch

Salon A–D—Dendrogeomorphology

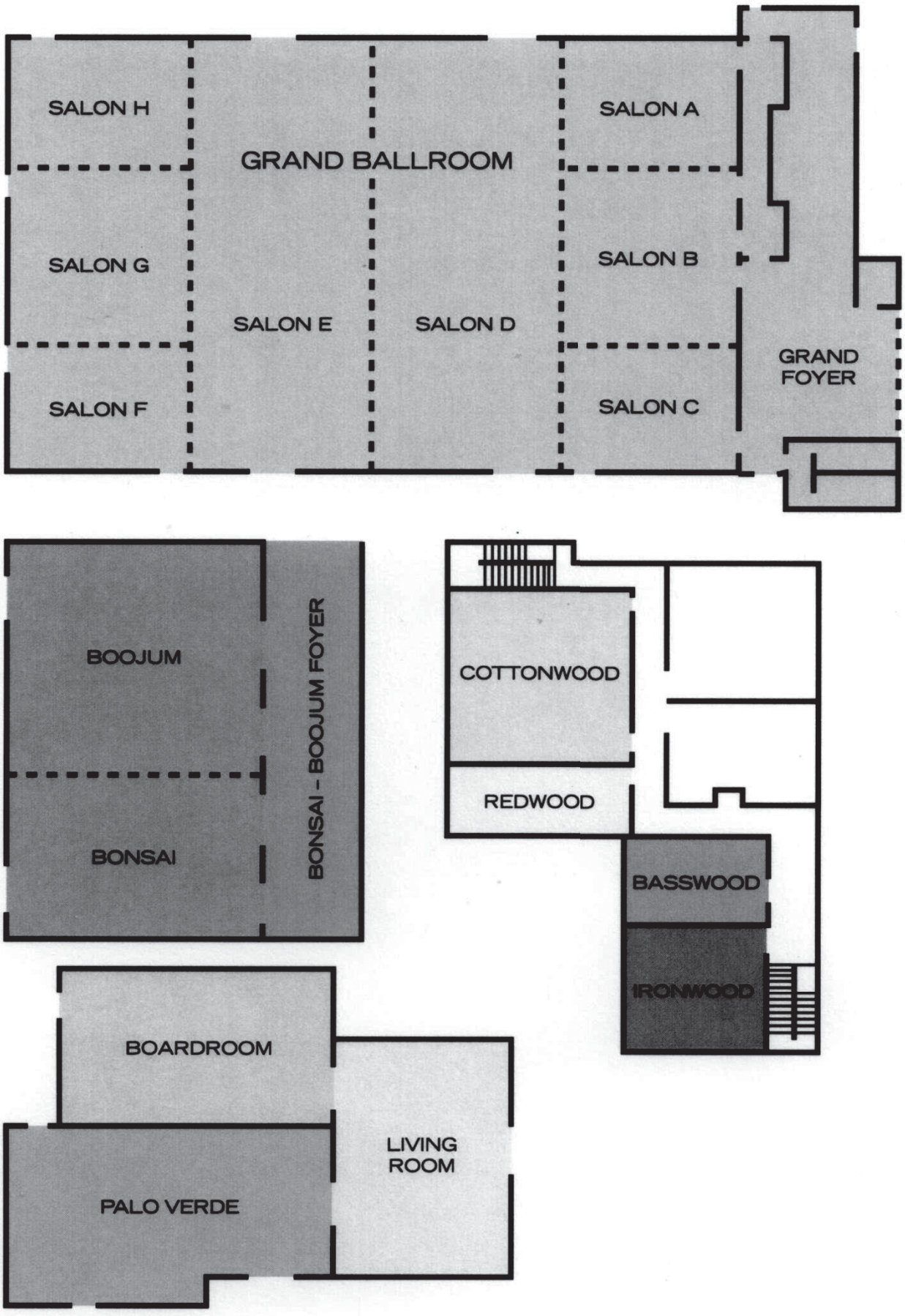
chaired: Christophe Corona & Markus Stoffel

1:30 PM	Shrubs – Expanding opportunities for dendrochronologists	Wilmking, Martin
1:50 PM	Four-dimensional reconstruction of gullying processes in a sandy badland of the Spanish Central System	Stoffel, Markus
2:10 PM	Dendroglaciological investigations at Jacobsen Glacier, central British Columbia Coast Mountains	Harvey, Jill
2:30 PM	Lessons learnt from a unique 700-yr snow-avalanche chronology from the French Alps.	Corona, Christophe
2:50 PM	Visual dating of scars based on their appearance on the stem surface	Trappmann, Daniel

3:10 PM Salon A–D — Closing Remarks

3:40 PM (conference ends)

HOTEL MAP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BONSAI
COTTONWOOD
REDWOOD
BASSWOOD
IRONWOOD
BOARDROOM
LIVING ROOM
PALO VERDE

Oral Presentations

Growth climatic response of two species from Hunza Valley of Karakorum Range, Northern Pakistan

Ahmed, Moinuddin*# (*Federal Urdu University of Arts, Science and Technology Gulshan Iqbal Campus Karachi-Pakistan*)

11:55 am Tuesday May 14 Salon A–C Climate Growth Relations II

Juniperus excelsa and Picea smithiana from three sites of Hunza valley were sampled to develop chronologies. Juniperus excelsa from Morkhun showed extremely narrow rings. Ring-width measurements were detrended using the standardization method to preserve as much climatic signals as possible. EPS, SNR, and Rbar values were higher in Juniperus excelsa. To determine whether climate was the main factor to control the growth of these species of Hunza, Correlation and Response Functions Analysis were used. Picea smithiana from Chaprot did not show any correlation with temperature while Juniperus excelsa from the same site correlated negatively with May to July temperature. Picea smithiana from Chaprot showed positive correlation with precipitation in May-April whereas Juniperus excelsa have positive correlation in April. Climate correlation modeling showed that temperature and precipitation explained 39-59% variance, hence chronologies may be used for climatic reconstruction.

The relative influence of climate and fire on subalpine forest productivity in the Wallowa Mountains, northeast Oregon

Allen, Sara*# (*Tree-Ring, Earth, and Environmental Science Laboratory, University of Wisconsin-Platteville*)
Larson, Evan (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)

1:40 pm Thursday May 16 Salon D Fire Ecology III

We estimated subalpine forest productivity over the past 300 years in the Wallowa Mountains of northeastern Oregon using basal area increment (BAI) data from 462 trees across 13 stands of varying age, setting, and successional status. We examined this record in the context of climate variability and disturbance. Landscape-scale BAI was significantly correlated with annual temperatures over the instrumental record ($r = 0.64$, $p < 0.0001$) and increased monotonically with stand age, resulting in older forests being more productive than younger forests. Taken together, these data suggest that climate change projections of warmer temperatures will likely increase forest productivity, but that predicted increases in fire activity will reduce mean forest age on the landscape and reduce overall forest productivity. Modeling the forests of this landscape based on our data suggest that the size of fires in the future will have more influence on landscape-scale productivity than the frequency of fires.

Radial growth decline and mortality in Austrocedrus chilensis forests: climate and competition as triggering factors

Amoroso, Mariano*# (*IANIGLA - CONICET*)
Villalba, Ricardo (*IANIGLA - CONICET*)
Daniels, Lori (*Tree-Ring Lab, Department of Forest Sciences, University of British Columbia*)

3:00 pm Thursday May 16 Salon D Recent Growth Trends and Tree Mortality

Austrocedrus chilensis forests in northern Patagonia experience stand-level growth decline and mortality. While this disturbance has been subject of detailed study, the role of contributing factors such as climate variation and processes associated with stand development has just begun to be understood. We studied the influence of climatic variation and stand development on the radial growth decline and death of trees to distinguish between the possible causes and the interactions of allogenic (abiotic and biotic factors) and autogenic processes. Radial growth decline onset in overstory trees was strongly related to the occurrence of droughts, while decline in understory trees could be explained by competition. Mortality dates were concentrated in periods of unfavorable conditions but did not exhibit a clear relationship with climate variation; mortality at early stages resulted from competition. Our results emphasize the complexity of this disturbance, and the important role climate and stand development play on it.

High elevation dendrochronology in Guatemala

Anchukaitis, Kevin*# (*Woods Hole Oceanographic Institution*)
Taylor, Matthew (*University of Denver*)
Martin Fernandez, Javier (*Lamont Doherty Earth Observatory of Columbia University*)
Pons, Diego (*Universidad del Valle, Guatemala*)
Leland, Caroline (*Lamont Doherty Earth Observatory of Columbia University*)
Griffin, Daniel (*University of Arizona*)
Castellanos, Edwin (*Universidad del Valle, Guate-*

mala)

9:10 am Friday May 17 Salon A–C Tropical Dendrochronology

Central America sits at the center of a virtual crosshairs of predicted declines in precipitation due to anthropogenic climate change. Understanding patterns of past, present, and future rainfall variability in the region is not simply a question of climatology, but of the potential human consequences of climate change. Here, we demonstrate crossdating and identify a climate signal in high-elevation populations of Abies guatemalensis and Pinus hartwegii in Guatemala. Both species reflect precipitation in boreal winter and spring, and can therefore be used to reconstruct and characterize the intensity of the annual dry season. Our reconstruction reveals the importance of interannual and decadal precipitation variability, but doesn't suggest that recent trends in rainfall are exceptional in the context of the last 3 centuries. We compare our reconstruction to climate model simulations for the region, and we also describe recent findings from other species and additional sites along Guatemala's 'Dry Corridor'.

Reconstructing past climate variability in the Iberian Peninsula using carbon and oxygen stable isotopes in tree rings

Andreu-Hayles, Laia*# (*Tree-Ring Laboratory, Lamont-Doherty Earth Observatory of Columbia University*)

Helle, Gerd (*Climate Dynamics and Landscape Evolution, Potsdam Dendro Laboratory*)

Schleser, Gerhard H. (*Climate Dynamics and Landscape Evolution, Potsdam Dendro Laboratory*)

Gutiérrez, Emilia (*University of Barcelona*)

Barriendos, Mariano (*University of Barcelona*)

Cook, Edward R. (*Tree-Ring Laboratory, Lamont-Doherty Earth Observatory of Columbia University*)

9:50 am Friday May 17 Salon D Isotopes in Dendrochronolgy

Improving the understanding of past climate in the Mediterranean basin is still a challenge due to the very distinct seasonality and high climatic variability inherent to this region. Studying the climate of the Iberian Peninsula is particularly complicated because of the complex orography and the atmospheric circulation patterns composed by the influence of three climatic regimes: Atlantic, continental and Mediterranean. We found that stable carbon (δ13C) and oxygen (δ18O) isotope ratios measured in tree rings from Iberian pine forests are very sensitive proxies to moisture variations during the summer period. The isotopic signatures seem to be mainly dominated by variations in stomatal conductance driven by changes in air relative humidity. While the ring-width series were more dependent on local site conditions, the isotopic series captured a large-scale climatic signal of summer aridity. Paleoclimatic records were produced by a point-by-point regression based on these tree-ring chronologies for the last 400 years.

Fire-induced wounding elicits changes in the wood anatomy of North American conifers

Arbellay, Estelle*# (*Laboratory of Dendrogeomorphology, University of Berne*)

Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)

Sutherland, Elaine K. (*USDA Forest Service, Forestry Sciences Laboratory, Missoula, USA*)

Smith, Kevin T. (*USDA Forest Service, Northern Research Station, Durham, USA*)

Falk, Donald A. (*Laboratory of Tree-Ring Research, University of Arizona, Tucson, USA*)

10:20 am Thursday May 16 Salon D Fire Ecology II

Fire is a major disturbance agent in North American forests. Fires injure trees when heat transfer through the bark partially kills the cambium and the compartmentalization process results in a fire scar. Dendrochronologists use these scars in the xylem to reconstruct fire regimes. However, little information exists on the wood anatomy of fire scars. Consequently, this study quantifies changes in xylem (tracheid and ray traits) caused by fire-induced wounding in 2 individuals each of Larix occidentalis, Pseudotsuga menziesii and Pinus ponderosa. Transverse and tangential microsections were cut from samples for light microscopy. Using image analysis, anatomical measurements of cells are being performed three-dimensionally: at 4 heights along the tree axis, within 4 cm from the wound margin and in 5 different rings; 1 control ring and 4 rings after the injury. These results will contribute to understanding the effects of fire on wood formation and improve fire histories in conifers.

Exploring the effects of western spruce budworm outbreaks on the wood anatomy of Douglas-fir

Axelson, Jodi*# (*Universit of Victoria*)

Gärtner, Holger (*Swiss Federal Research Institute WSL*)

Alfaro, René (*Canadian Forest Service - Pacific Forestry Centre*)

Smith, Dan (*University of Victoria*)

11:00 am Wednesday May 15 Salon D Wood Anatomy

The western spruce budworm (WSB) is the most destructive defoliator of coniferous forests in western North America. Although numerous studies have reconstructed WSB outbreaks, there has been no prior research on how outbreaks affect the anatomical structure of the stem. In this study we examine the response of Douglas-fir to sustained WSB out-

breaks, hypothesizing that anatomical characteristics, e.g., cell wall thickness, cell size, and/or lumen area, change during WSB outbreaks. To test this we sampled four stands with annual defoliation data, produced micro sections, and measured a number of cell parameters in each ring. Preliminary results indicate that earlywood parameters remain quite stable during WSB outbreaks, while latewood parameters such as secondary cell wall thickness and cell length undergo step-shifts at the beginning and end of outbreaks. These parameters, tree-level data, and annual defoliation data will further be tested to determine if changes in stem wood anatomy during WSB outbreaks are statistically significant.

Observed and simulated climate sensitivity of large-scale forest productivity

Babst, Flurin*# (*Swiss Federal Research Institute WSL*)

Frank, David* (*Swiss Federal Research Institute WSL*)

10:10 am Tuesday May 14 Salon A–C Climate Growth Relations I

Limited understanding of forests' climate sensitivity contributes to widely divergent estimates of their past and future carbon sink capacity in current vegetation models. Hence, extensive empirical archives are needed to link forest growth to climate variability at large spatiotemporal scales. Here, we compile and classify close to 1000 tree-ring records for all major European tree species and quantify growth changes as a function of historical climatic variation. The resulting empirical climate responses are used to benchmark the respective sensitivities of forest productivity estimates from two vegetation models. Results show that both models underestimate the temperature sensitivity in the boreal zone and overestimate the precipitation sensitivity towards the mid-latitudes. Additionally, our results emphasize the importance of i) species-specific growth characteristics and ii) carry-over effects from the previous year. Both aspects are insufficiently considered in most vegetation models. These biases will need resolution to accurately quantify carbon-cycle climate feedbacks from model simulations.

Can tilted trees be used for flood discharge estimaton?

Ballesteros Cánovas, Juan Antonio*# (*Department of Research and Geoscientific Prospective, Geological Survey of Spain (IGME), Ríos Rosas 23, Madrid E-28003, Spain,*)

Ruiz-Villanueva, Virginia (*Laboratory of Dendrogeomorphology, Institut of Geological Sciences, University of Berne, Baltzerstrasse 1+3, Berne, Switzerland*)

Stoffel, Markus (*Laboratory of Dendrogeomorphology, Institut of Geological Sciences, University of Berne, Baltzerstrasse 1+3, Berne, Switzerland; Climatic Change and Climate Impacts, Institute for Environmental Sciences, University of Geneva, 7, chemin de Drize, CH-1227 Carouge-Geneva, Switzerland.*)

Eguibar, Miguel Angel (*Department of Hydraulic Engineering and Environment, Institute for Water and Environmental Engineering (IIA-MA), Technical University of Valencia, Camino de Vera s/n, Valencia, E-46022, Spain*)

Sánchez-Silva, Mauricio (*ssociate Professor, Department of Civil and Environmental Engineering, Universidad de Los Andes, Bogotá Colombia*)

Bodoque, Jose María (*Mining and Geological Engineering Department, University of Castilla-La Mancha, Campus Fábrica de Armas, Avda. Carlos III, Toledo E-45071, Spain*)

Díez-Herrero, Andrés (*Department of Research and Geoscientific Prospective, Geological Survey of Spain (IGME), Ríos Rosas 23, Madrid E-28003, Spain*)

11:50 am Friday May 17 Salon A–C Dendrohydrology

Tilted trees have been widely used to date past hydrogeomorphic events. However, their usefulness to derive flood discharge has never been explored. We present a mechanical tree deformation–flood depth model to reconstruct flood peak discharge based on the rotational stem deformation. We combined dendrogeomorphic techniques, mechanic-structural and hydraulic approaches for this purpose. In addition, 3D georadar work has been carried out to define root-plate architecture. This model has been applied in trees tilted by floods and located in riverbanks next to gauge station. Results indicate that there is agreement between deformation and flood depth. Variability in results is related to tree age at the time of tilting and to signal-noise in deformation due to subsequent events. The added value of the censored data is still considerable since it helps the reconstruction of flood frequency in ungauged or poorly gauged catchment.

Tree-ring δ13C as a proxy of gross primary productivity in a North American forest

Belmecheri, Soumaya*# (*The pennsylvania State University*)

Maxwell, Stockton (*Radford University*)

Davis, J. Kenneth (*The pennsylvania State University*)

Taylor, H. Alan (*The pennsylvania State University*)

8:50 am Friday May 17 Salon D Isotopes in Dendrochronolgy

Here we present results from a study conducted at Harvard Forest (Petersham, Massachusetts) to examine the poten-

tial relationship between δ13C in dominant trees and GPP measured by the Harvard Forest flux tower (1992-2010). The δ13C analysed from Tsuga canadensis and Quercus rubra trees growing in the flux tower footprint and corrected for the declining trend of atmospheric δ13C show a decreasing trend from 1992 to 2010 and a significant increase in discrimination (D). The inter-cellular CO2 (Ci) shows a significant increase for both tree species and follows the rate of atmospheric CO2 (Ca) increase. The net Ci and Δ increase observed for both species did not result in an increase in the intrinsic Water Use Efficiency (iWUE). Ci/Ca is strongly related to the growing season Palmer Drought severity Index (PDSI). The Ci trend is interpreted as a result of higher CO2 assimilation in response to increasing soil moisture allowing a longer stomata opening and therefore stimulating tree growth.

Dendrochronology-based fire history of the western San Juan Mountains: The influence of aspect and forest composition

Bigio, Erica*# (*Laboratory of Tree-Ring Research*)
Swetnam, Thomas (*Laboratory of Tree-Ring Research*)
Baisan, Christopher (*Laboratory of Tree-Ring Research*)

1:20 pm Thursday May 16 Salon D Fire Ecology III

We reconstructed the fire history in three tributary basins of the San Juan Mountains in Colorado. Fire-scarred trees and age-structure data yielded a chronology of surface fire years, along with estimates of high-severity burned area for the past ~ 400 years. In each basin, fire history and forest composition were strongly influenced by aspect. The south-facing slopes were dominated by ponderosa pine and surface fire at about 25 year intervals. The north-facing slopes were composed of mostly white fir with few fire-scarred trees. The age-structure data suggested that patches of high-severity burned on the north-facing slopes, following a widespread surface fire on the south-facing slopes in 1818. This record suggests that a recent wildfire in the study area had a larger proportion of high-severity fire within our sampled areas(killing many 700+ year living trees) than historical fires observed in the tree-ring record.

Carbon dioxide reconstruction from Tree-ring cellulose

Bose, Trina*# (*Indian Institute of Tropical Meteorology*)
Chakraborty, Supriyo (*Indian Institute of Tropical Meteorology*)
Borgaonkar, Hemant (*Indian Institute of Tropical Meteorology*)

9:10 am Friday May 17 Salon D Isotopes in Dendrochronolgy

A geochemical model involving meteorological parameters that govern physiochemical fractionation of carbon isotopes during cellulose production in tree rings has been developed. This model is able to extend the atmospheric partial pressure of carbon dioxide (Ca) data in the tropics and northern sub-tropics at 10 sites to the first decade of the last century where no Ca data were available before 1958. Comparison with the ice core Ca from Law Dome, Antarctica shows that, the difference (Ice-core – Tree-ring) remains low till 1960's; afterwards it rises until 1931-40 with different amplitudes for different sites. This amplitude correlates well with latitude implying its dependence on the distance from Antarctica. Going backwards from 1930's this difference decreases continuously passing the uncertainty limit and going negative for a few sites.

Pyrodendroecology in fire-adapted Pinus species: Linking evolutionary ecology and ecosystem management

Brown, Peter*# (*Rocky Mountain Tree-Ring Research*)

8:20 am Wednesday May 15Salon A–DInvited Speaker + Plenary Session (Decison Making)

Pinus species from around the world exhibit various adaptations to fire as an evolutionary force. Adaptations such as cone serotiny or thick bark are widespread in Pinus, such that Mirov in his classic volume The Genus Pinus (1967) devoted more attention to fire than on any other physiological or ecological factor affecting various species of the genus. In this talk, I focus on how dendroecological analyses of fire scars and other components of fire regimes (pyrodendroecology) can inform both the evolutionary ecology and current and future management of Pinus species and Pinus-dominated ecosystems. I first examine commonalities in fire adaptations in Pinus species from North America, Asia, and the tropics. I then discuss how insights into the adaptive capabilities of these species can contribute to ecosystem restoration efforts that are intended to increase resilient to future disturbances such as uncharacteristic wildfires, widespread insect outbreaks, and climate change.

Flash floods in the Patagonian Andes: A dendrogeomorphological approach

Casteller, Alejandro*# (*Argentine Institute for Snow, Ice and Environmental Research - CONICET*)
Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)
Villalba, Ricardo (*IANIGLA-CONICET*)
Crespo, Sebastián (*IANIGLA-CONICET*)

Corona, Christophe (*CNRS GEOLAB*)

11:30 am Friday May 17 Salon A–C Dendrohydrology

Flash floods represent significant natural hazards in the Patagonian Andes causing destruction of buildings and infrastructure. In this region, historical records of past events tend to be short, scarce and fragmentary. This lack of information results in a higher regional vulnerability against flash floods. Dendrogeomorphology is an accurate method for spatially and temporally reconstructing torrential processes. Through the analyses of 58 samples collected from Austrocedrus chilensis, Nothofagus dombeyi, and Pseudotsuga menziesii trees, we reconstructed spatio-temporal patterns of flash floods in a torrent located in the province of Neuquén, Patagonian Andes. The tree-ring based chronology of events was then utilized to determine potential triggers of flash floods in the torrent through the analysis of regional climatic data. Since most precipitation typically occurs in the region during the cold season, the altitudinal gradient between the meteorological station and the watershed was considered to infer the type of the precipitation (snow/rainfall) and thus the possibility of occurrence of events.

Multi-proxy Land Use History Reconstruction at Zena Forest, Oregon

Copes-Gerbitz, Kelsey*# (*Willamette University*)
Gildehaus, Stevie (*Department of Environmental and Earth Sciences, Willamette University*)
Arabas, Karen (*Department of Environmental and Earth Sciences, Willamette University*)

2:30 pm Tuesday May 14 Salon D Dendroecology II

Landscapes are dynamic and complex, shaped by natural and anthropogenic processes operating on a variety of spatial and temporal scales. This study employs a multi-scale, multisource, cross-referential analysis to better understand the complex ecological landscape history at Zena Forest, Willamette Valley, Oregon between 1850 and 1935, prior to the availability of aerial imagery. We used the historic written record and Oregon white oak (Quercus garryana) tree ring proxy data to investigate forest patterns and processes at the individual, stand, and landscape scale. Our results suggest that forest patterns and processes are directly related to a number of disturbances operating at a variety of scales including climate, anthropogenic activities (agriculture, silviculture and fire suppression), and intra-stand competition. The use of multiple proxy records provides a more comprehensive understanding of historic landscape conditions and is thus useful for informing land managers interested in conserving these landscapes.

Lessons learnt from a unique 700-yr snow-avalanche chronology from the French Alps.

Corona, Christophe*# (*MSH - GEOLAB UMR 6042 - 4 rue Ledru 63057 Clermont-Ferrand cedex 1, France*)
Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)
Lopez Saez, Jérôme (*IRSTEA, UR EMGR, 2 rue de la Papeterie, BP 76, F 38402 St-Martin-d'Hères cedex, France*)

2:30 pm Friday May 17 Salon A–D Dendrogeomorphology

This study focuses on the reconstruction of spatio-temporal patterns of past snow avalanche events in forested paths of the Queyras massif (southeast French Alps). Analysis based on tree-ring series from 163 heavily affected multi-centennial Larix decidua Mill. trees growing near or next to the avalanche path. A total of 514 growth disturbances were identified pointing to 38 destructive snow avalanches between 1338 and 2010. On a temporal plan, three maxima in snow avalanche activity were reconstructed at the beginning of the 16th and 19th centuries as well as around 1850, matching well with periods of below-average winter temperatures and glacier advances. Analysis of the spatial distribution of disturbed trees also contributed to the determination of four preferential patterns of avalanche events. The comparison of dendrogeomorphic data with historical records demonstrates that at least 18 events – six of which were undocumented – reached the hamlet of Echalp during the past seven centuries.

Dendroclimatological insights from a high-elevation multispecies tree-ring width and density network spanning the British Columbia Coast Mountains, Canada.

Coulthard, Bethany*# (*University of Victoria*)
Smith, Dan (*University of Victoria*)

4:50 pm Tuesday May 14 Salon D Network Analysis

Dendroclimatic analyses are being conducted on over 200 tree-ring width and density chronologies collected from subalpine fir (Abies lasiocarpa), mountain hemlock (Tsuga mertensiana), and white spruce (Picea glauca) trees from high elevation sites located throughout the Coast Mountains of British Columbia, Canada. The data are assessed to evaluate spatiotemporal variability in the strength and nature of radial tree growth/climate relationships, and to reconstruct paleoclimatic and other environmental variability at various spatial scales. The utility of multiproxy (ring width and density) models is explored.

Deciphering forest response to drought and air pollution in the southern Sierra Nevada

Cousins, Stella*# (*University of California Berkeley*)

Larson, Debra (*University of California Berkeley*)

3:40 pm Thursday May 16 Salon D Recent Growth Trends and Tree Mortality

In California's southern Sierra Nevada, air pollution in the form of ozone is a major ecosystem stressor. Additionally, climatic shifts are expected to exacerbate drought in the region, including in forests throughout Sequoia/Kings Canyon National Parks. In order to describe response to these compound stressors, our study asks: is the growth signature of drought in pine forests detectable, consistent, and quantifiable? Do the responses of otherwise comparable trees vary in ways related to pollutant exposure? To address these questions we couple intervention analysis of drought response with long term monitoring in a network of polluted and unpolluted sites. More than twenty years of climate, ozone, and foliar injury data will be combined with ring series to develop a model of growth in the presence of these potentially interacting stressors. Understanding of these patterns will improve capacity to describe ecosystem processes and anticipate environmental and management challenges.

Frost-ring formation in Douglas fir at the lower forest border in central Idaho

Crawford, Christopher J.*# (*Center for Dendrochronology, University of Minnesota*)
Kipfmueller, Kurt (*Center for Dendrochronology, University of Minnesota*)
Salzer, Matt (*Laboratory of Tree-Ring Research*)
Torbenson, Max (*Center for Dendrochronology, University of Minnesota*)
St. George, Scott (*Center for Dendrochronology, University of Minnesota*)

3:30 pm Tuesday May 14 Salon A–C Climate of Recent Millennia I

We developed earlywood and latewood chronologies of frost-damaged rings (frost rings) from three lower forest border Douglas fir (Pseudotsuga menzeisii Mirb. Franco) sites in central Idaho, USA spanning AD 1281-2009. In these records, frost rings occur more frequently in earlywood than in latewood, tree age does not significantly affect whether or not a tree records a frost event, and some weak tree-to-tree agreement is apparent. Earlywood and latewood composites were constructed and the temporal pattern of frost-ring occurrence shows infrequent events before AD 1550, with more frequent frost rings occurring during the Little Ice Age (AD 1550-1850). Over the last 150 years, frost-ring events have been less common, especially during the 20th century. The frost rings identified in the Douglas fir trees at these sites likely result from valley cold air pooling rather than from short-term cooling associated with aerosols from large volcanic eruptions as reported elsewhere.

Using δ13C and δ18O measurements to assess climate controls on insect-related tree mortality in south-central Alaska

Csank, Adam*# (*Nipissing University*)
Miller, Amy (*National Park Service, Anchorage*)
Sherriff, Rosemary (*Humboldt State University*)
Berg, Edward (*US Fish and Wildlife Service (retired)*)
Welker, Jeffrey (*University of Alaska Anchorage*)

10:30 am Friday May 17 Salon D Isotopes in Dendrochronology II

Here we test whether trees killed by spruce beetles show a water stress response prior to death using tree-ring chronologies and isotopic measurements from live and dead trees. Growth and δ13C in surviving trees was only weakly correlated with spring-summer temperatures until roughly 10 years before the beetle outbreak, both growth and δ13C in the dead trees was correlated with temperatures for several decades. Approximately 10 years prior to death, growth in the dead trees became decoupled from temperature. This is in contrast to δ13C values, which show a stronger temperature response 10 years prior to death. At sites where δ18O was more sensitive to precipitation surviving trees showed a more clear climate- δ18O response. Water stress response explains both the isotopic values and the decoupling of temperature and growth in trees that were killed during the outbreak and also indicate that certain trees may be physiologically pre-disposed to mortality events by nature of their environmental response.

Climate Variability and Altered Fire Regimes in the Mountain Forests of British Columbia, Canada

Daniels, Lori*# (*University of British Columbia*)
Greene, Gregory (*University of British Columbia*)
Cochrane, Jed (*Parks Canada Agency*)
Marcoux, Helene (*University of British Columbia*)
Nesbitt, John (*University of British Columbia*)
Gergel, Sarah (*University of British Columbia*)
Gedalof, Ze'ev (*University of Guelph*)
DaSilva, Eric (*University of Guelph*)
Pisaric, Michael (*Brock University*)
Mustaphi, Colin (*Carleton University*)

10:40 am Thursday May 16 Salon D Fire Ecology II

We have compared fire history and forest dynamics in the East versus West Kootenay areas of southeastern British Columbia. In both areas, fire regimes varied significantly with steep elevational gradients. At high elevations, stand-replacing fires burned every 150-300 years according to our fire scar, forest age structure and lake sediment records. In the lower-elevation forests, low-severity fires burned and scarred trees once every 25 to 50 years, on average. Fires burned in late summer of drought years, often during the warm phase

of the Pacific Decadal Oscillation, associated with warm, dry conditions in the Kootenay region. Despite the historic frequency of fires and recent periods of suitable climate, these forests last burned 56 to 159 years ago, providing evidence of altered fire regimes. The lack of recent fires was reflected in the composition and density of low-elevation forests in both study areas, posing a risk of higher fire severity, especially given anticipated regional warming.

A tree-ring based reconstruction of early summer precipitation in southwestern Virginia (1750-1981)

Dawson, Andria*# (*University of Alberta*)
Trouet, Valerie (*Laboratory of Tree-Ring Research, University of Arizona*)
Walker, David (*Virginia Tech*)
Austin, David (*Appalachian State University*)

10:20 am Wednesday May 15Salon A–C Dendroclimatology I

In a closed-canopy forest, stand dynamics play an important role in shaping the forest, and it has been hypothesized that dense forests are not sufficiently limited by climate to warrant climate reconstruction. We sample Quercus prinus ring-widths from a dense forest in the Appalachians, and after removal of stand dynamics and age trends we find strong correlations between the developed chronology and early summer precipitation. To strengthen the climate signal, we include additional southeastern US Quercus chronologies in a nested principal component analysis (PCA). Correlation between the growth proxy and early summer precipitation was increased through PCA, and assessment of reconstruction skill was favorable. The reconstruction was modeled using a Bayesian regression model, which allowed uncertainty to be quantified. The reconstruction covered the period 1750-1981, and extended the instrumental record by 150 years. The reconstruction showed key drought years identified by others, as well as 11-year periodicity.

Feasibility of climate reconstruction using Forest Inventory and Analysis data

DeRose, R. Justin*# (*USDA Forest Service*)
Wang, Shih-Yu (*Utah State University*)
Shaw, John D (*USDA Forest Service*)

4:30 pm Tuesday May 14 Salon D Network Analysis

We introduce a novel data set, with unparalleled spatial density, for use as climate proxy data. A subset of ~500 Douglas-fir and pinyon pine tree-ring series collected on a systematic sampling grid by the Forest Inventory and Analysis Program (FIA data) were tested to determine their feasibility as climate proxies. First, we found strong temporal coherence between the FIA data and previously published tree-ring chronologies (>0.82). Second, spatial and temporal coherence between the FIA data and water year precipitation was strong (oftentimes $r > 0.8$). Third, the El Niño-Southern Oscillation dipole was captured by the FIA data and revealed considerable latitudinal fluctuation over the past three centuries. Finally, the FIA data confirmed the quadrature-phase coupling between wet/dry cycles and Pacific decadal variability known to exist for the Intermountain West. The results highlight the potential to further develop high spatial resolution climate proxy data sets for the western U.S.

Cambial matter: what does 10 years of cell counting teach?

Deslauriers, Annie*# (*Departement des Sciences Fondamentale, Université du Québec à Chicoutimi, Canada*)

8:00 am Thursday May 16 Salon A–D Invited Speaker + Plenary Session (Dendroecology)

Xylogenesis can provide valuable insight into the causal link between wood production, phenological traits of trees, and environment by gathering specific and detailed information like (1) the onset or (2) ending of cambial activity and xylem cell differentiation, (3) changes in cell number, size and shape, and (4) rates of change of the processes. The variability in the growth timings and dynamics as well as the characteristics of the cells represents a very sensitive bio-indicator of plant responses. All components of the growth process, from the how (physiology), to the when (phenology), and to the characteristics of the final product (tree-ring and anatomy) are encoding important indications of the way plants respond to the changing environmental conditions. Examples of how investigations on wood formation have evolved during the last 10 years are supplied by using different cases of study and applications in dendrochronology. From climate change to insect infestation, integration of metabolic and genetic processes linked with cambial activity and wood formation provided a better understanding of whole plant response.

Ships of the Early Modern Age – innovative tree-ring approaches to the Atlantic challenge

Dominguez-Delmas, Marta*# (*Ring Foundation – Netherlands Centre for Dendrochronology, The Netherlands, and University of Huelva, Spain*)
Sass-Klaassen, Ute (*Forest Ecology and Forest Management Group, Wageningen University, The Netherlands*)
Wazny, Tomasz (*Laboratory of Tree-Ring Research, University of Arizona, USA, and Institute for the Study, Conservation and Restoration of Cultural Heritage, Nicolaus Copernicus University, Poland*)
Nayling, Nigel (*School of Archaeology History and Anthropology, University of Wales Trinity Saint*

David, United Kingdom)

3:40 pm Thursday May 16 Salon A–C Old World Dendroarchaeology

In the Early Modern Age (1400-1800) the construction of ocean-going ships was a crucial element of European expansion in what has become known as the Age of Discovery. The shipbuilding industries in the Old World placed unprecedented demands on forests for the supply of timber, while wood resources from the New World served to enlarge European fleets overseas to facilitate domestic transport and connections, as well as trans-Atlantic and global trade. Forestry and sea power became inextricably linked.

Through review of recently researched case studies, this paper explores the potential of tree-ring investigations on shipwreck assemblages to provide an insight into the relationships between forests and forestry, timber supply and the evolution of shipbuilding in the Early Modern Age. We discuss the adequacy of the approaches employed so far and propose a multi-disciplinary approach for future research, combining dendrochronology with other disciplines from the Life Sciences and the Humanities.

Multi-century forest fire history in Scandinavia

Drobyshev, Igor*# (*UQAT / Swedish University of Agricultural Sciences*)
Niklasson, Mats (*Swedish University of Agricultural Sciences*)
Linderholm, Hans W. (*University of Gothenburg*)
Granström, Anders (*Swedish University of Agricultural Sciences*)
Hellberg, Erik (*Naturvardsverket*)
Bergeron, Yves (*UQAT / UQAM*)

10:00 am Thursday May 16 Salon D Fire Ecology II

Forest fires are one of the main disturbance agents in boreal and temperate ecosystems. To decipher large-scale temporal and spatial patterns of past fire activity in Scandinavia, we analyzed the synchronicity of dendrochoronologically reconstructed fire events in a large network of sites covering a wide geographical gradient (56.5 - 67.0 º N and 9.3 - 20.5 º E) over AD 1400-1900. We identified large fire years (LFY) as years with regionally increased forest fire activity and located the geographical centers of climatic anomalies associated with synchronous LFY occurrence across the region, termed LFY centroids. By analyzing the spatial pattern of LFY centroids, we identified two regions with climatically-mediated synchronicity of fire occurrence, located south and north from 60º N. Northern LFYs showed much stronger association with Europe-wide periods with reduced summer precipitation. We speculate that the northern and mid-boreal forests might be more sensitive to past summer climate, as compared to the southern boreal forests.

A Modified Negative Exponential Curve For Estimating Growth Trends in Closed-Canopy Forests

Druckenbrod, Daniel*# (*Rider University*)
Pederson, Neil (*Tree Ring Laboratory*)

11:15 am Tuesday May 14 Salon D Dendroecology I

A persistent challenge in tree-ring analysis is the extraction of a specific signal in the presence of other embedded signals. Overcoming this challenge is particularly important in closed-canopy forests where a substantial change in light availability between understory and overstory environments, in addition to growth and climate signals, affects tree growth rates. This presentation introduces a modification to the negative exponential curve commonly used to represent the growth trend. This modification allows the negative exponential curve to fit just an initial subset of ring-width measurements, enabling it to better isolate a decreasing growth trend by minimizing the effect of a subsequent release episode, which is often present in closed-canopy forests. This approach to growth trend estimation can also be combined with intervention detection to isolate canopy disturbance episodes to potentially disentangle growth, disturbance, and climate signals in these forests. Example applications of the modified negative exponential curve are shown for various closed-canopy forest types.

Evidence for cambial activity in Great Basin subalpine conifers under heavy snow

Dufour, Boris*# (*Université du Québec à Chicoutimi*)
Biondi, Franco # (*DendroLab, University of Nevada, Reno*)
Morin, Hubert (*Département des Sciences Fondamentales, Université du Québec à Chicoutimi, Canada*)

10:20 am Thursday May 16 Salon A–C Dendroclimatology II

In order to correctly integrate tree growth parameters at multiple temporal scales in arid and semi-arid mountains, there is now a renewed demand for clearly understanding the physiological mechanisms that control the climatic response of high-elevation conifers. Cellular-level dendroclimatology has already shown great promise, but studies of wood formation are still lacking in the Great Basin. The Nevada Climate-ecohydrological Assessment Network (NevCAN) was recently established as a network of valley-to-mountaintop instrumented transects in the Snake and Sheep Ranges. State-of-the art automated sensors record meteorological, soil, and vegetational variables at these sites, providing unique opportunities for tree-ring science. We present here a preliminary study based on micro-cores collected at the end of May 2011 from subalpine conifers (including Pinus longaeva) growing at 3355 m elevation. Results show that cambial activity had

already resumed in many trees despite the presence of a 2-m deep snow pack.

Earlywood vessels of Quercus robur and Fraxinus excelsior as climate indicators

Elferts, Didzis*# (*University of Latvia, Faculty of Biology*)
Putnina, Sintija (*University of Latvia, Faculty of Biology*)
Sprudzane-Cakula, Anda (*University of Latvia, Faculty of Biology*)
Matisons, Roberts (*University of Latvia, Faculty of Biology*)

10:40 am Wednesday May 15 Salon D Wood Anatomy

Previously, mean earlywood vessels lumen area (VLA) in ring-porous species has been shown to contain strong environmental signals. The aim of this study was to determine the response of VLA and tree-ring width (TRW) to climate in two ring-porous species in in Latvia (Europe). VLA was measured from core images (2400 dpi) using WinCELL 2007a program. Monthly precipitation sum and mean monthly temperature was used as climatic factors. Climatic signals were determined by response function. There was a weak connection between TRW and VLA that implies different sources of variation. Effect of climatic factors on TRW was habitat specific, while VLA showed clear limitation by temperature. Thus VLA is a valuable tree-ring proxy for climate reconstructions from ring-porous species growing near their northern distribution limits.

The presentation was supported by ERAF Project 2010/0202/2DP/2.1.1.2.0/10/APIA/VIAA/013

A new North American fire scar network for reconstructing historical pyrogeography, 1600-1900 AD

Falk, Donald*# (*University of Arizona*)
Swetnam, Thomas (*Laboratory of Tree-Ring Research, University of Arizona*)
Kitzberger, Thomas (*Universidad Nacional del Comahue, Argentina*)
Sutherland, Elaine (*US Forest Service, Rocky Mountain Research Station*)
Brown, Peter (*Rocky Mountain Tree-Ring Research*)
Bigio, Erica (*Laboratory of Tree-Ring Research*)
Hall, Matthew (*School for Information Science and Technology, University of Arizona*)

5:10 pm Tuesday May 14 Salon D Network Analysis

The Fire and Climate Synthesis (FACS) project is a collaboration of about 50 fire ecologists to compile and synthesize fire and climate data for western North America. We have compiled nearly 900 multi-century fire-scar based fire histories from the western United States, Canada, and Mexico. The resulting tree-ring based fire history is the largest and most spatially extensive in the world, consisting of annually crossdated fire records for more than 3,000 years (1248 BC – 2011 AD) and representing more than 15,000 site-year fire records. State space analysis indicates that the fire history network represents the full climatic range of annual temperature and precipitation conditions in seven widespread forest types in western North America. Large-scale fire occurrence patterns indicate years in which teleconnections of the El Niño-Southern Oscillation (ENSO) and other climate oscillatory modes regulate regionally synchronous high and low fire occurrence years through expression of regional drought (wet) conditions.

Growth responses to climate across environmental gradients in subtropical forests from South America

Ferrero, María Eugenia*# (*IANIGLA, CCT-CONICET-Mendoza*)
Villalba, Ricardo (*IANIGLA, CCT-CONICET-Mendoza*)
De Membiela, Mónica (*Universidad Politécnica de Madrid*)
Ripalta, Alberto (*IANIGLA, CCT-CONICET-Mendoza*)

9:30 am Friday May 17 Salon A–C Tropical Dendrochronology

In subtropical northwestern Argentina (22-20°S; 64-66°W), changes in forest composition reflect the large diversity of environmental conditions resulting from interactions between topography and regional climate.

The dominant patterns of interannual variations in 15 tree-ring chronologies (including four subtropical species: Juglans australis, Cedrela lilloi, Alnus acuminata and Schinopsis lorentzii) developed along an elevation gradient from the dry-warm Chaco lowlands to the wet-cool montane Yungas were determined using principal component analysis (PCA).

At a large, regional scale tree growth is largely modulated by climate. However, different species may respond differentially according to climatic conditions along the elevation gradient. At the most climatically severe sites, species response to climate variations are similar. In contrast, mild environments display a large diversity in tree-growth responses to climate reflecting differences in both local environmental conditions and physiology of the species.

Climatic Drivers of Western Spruce Budworm Outbreak Dynamics in the Interior Pacific Northwest

Flower, Aquila*# (*University of Oregon*)

Gavin, Daniel (*University of Oregon*)

11:55 am Tuesday May 14 Salon D Dendroecology I

Outbreaks of the western spruce budworm (WSB) often occur synchronously over broad regions of western North America. In spite of the ecological and economic significance of this species, the mechanisms controlling its population dynamics are still not fully understood. In this study, dendrochronological methods were used to reconstruct multi-century records of WSB outbreaks at thirteen sites along a transect running from central Oregon to western Montana. The reconstructions show that all thirteen sites experienced multiple WSB outbreaks over the last three centuries. Outbreaks were often synchronous across the entire transect. Comparison of the outbreak records with climate records revealed consistent relationships between moisture availability and outbreak dynamics. Climatic variability at broad spatial scales was also shown to be associated with the regional synchronicity of WSB outbreaks. Outbreak initiation at individual sites and the initiation of regionally synchronous outbreaks both tended to occur near the end of moderate droughts.

North American monsoon precipitation reconstructed from tree-ring late wood

Griffin, Daniel*# (*University of Arizona*)
Woodhouse, Connie (*University of Arizona*)
Meko, Dave (*University of Arizona*)
Stahle, David (*University of Arkansas*)
Faulstich, Holly (*University of Arizona*)
Carrillo, Carlos (*University of Arizona*)
Touchan, Ramzi (*LTRR*)
Castro, Christopher (*University of Arizona*)
Leavitt, Steven (*University of Arizona*)

4:30 pm Tuesday May 14 Salon A–C Climate of Recent Millennia II

The North American monsoon is a major focus of modern and paleoclimate research, but relatively little is known about interannual- to decadal-scale monsoon moisture variability in the pre-instrumental era. This study draws from a new network of sub-annual tree-ring latewood width chronologies and presents a 470-year reconstruction of monsoon (June-August) standardized precipitation for southwestern North America. Comparison with an independent reconstruction of cool-season (October-April) standardized precipitation indicates that southwestern decadal droughts of the last five centuries were characterized not just by cool-season precipitation deficits, but also by concurrent failure of the summer monsoon. Monsoon drought events identified in the past were more severe and persistent than any of the instrumental era. The relationship between winter and summer precipitation is weak, at best, and not time stable. Years with opposing-sign seasonal precipitation anomalies, as noted by other studies, were anomalously frequent during the mid- to late-20th century.

Fire History of Boreal Forests in the Sakha Republic of eastern Siberia

Guiterman, Christopher*# (*Laboratory of Tree-Ring Research, University of Arizona*)
Swetnam, Thomas (*Laboratory of Tree-Ring Research, University of Arizona*)
Baisan, Christopher (*Laboratory of Tree-Ring Research, University of Arizona*)

11:20 am Thursday May 16 Salon D Fire Ecology II

Wildfires in the boreal forests of Siberia may significantly contribute to global warming through feedbacks related to greenhouse gas emissions. How future warming will affect boreal fire regimes remains uncertain due to a lack of knowledge on the climatic controls of fire. Here we present fire-climate relationships derived from a new set of tree-ring reconstructions of fire history for the Sakha Republic (Yakutia) in eastern Siberia. We sampled 32 sites in both pine and larch dominated forests that yielded chronologies 300-700 years in length. Decadal scale temperature variability appears to be important in regulating fire synchrony across multiple sites. We note a decline in fire activity during the 20th century, which is possibly related to changing cultural practices, fire suppression efforts, or landscape fragmentation. Therefore, recent wildfire sizes and frequencies in our study area may have been more influenced by human land-use than increased global temperatures.

Acoustic Illustration in Dendrochronology

Guyette, Richard*# (*University of Missouri*)

11:20 am Wednesday May 15 Salon D Wood Anatomy

Human auditory perception can be used to exploit and understand natural time series with sound. Dendrochronology is uniquely equipped with methods and abundant time sensitive data for translating science with acoustic illustrations. The neurology of human hearing offers distinct advantages in perceiving scientific data and analyses when compared to graphic illustration. Perceiving time series of tree growth as real time acoustic series is a method with powerful new pathways between scientific data and human awareness. The objectives of this presentation are to: 1) demonstrate the basic concepts, methods, and probable requirements used for acoustic illustrations in dendrochronology (Figure 1, 2; click on speaker), 2) show that acoustic illustrations are a different and legitimate method for the expressing scientific results and, 3) argue that auditory presentations of tree-ring sequences have important implications for bringing dendrochronology into society. Digital sound technologies and

online publishing now allow for auditory communication of dendrochronology.

Variability in tree-level bark beetle induced tree mortality and its relationship to climate and forest dynamics

Hart, Sarah*# (*University of Colorado*)
Veblen, Thomas (*University of Colorado*)

3:20 pm Thursday May 16 Salon D Recent Growth Trends and Tree Mortality

Across western North America, changes in climate during the late 20th and early 21st centuries have manifested in dramatic periods of tree mortality, such as those driven by wildfire, bark beetle outbreaks, and increased background mortality. This broad-scale mortality is understood to have important impacts on carbon cycling, with feedbacks to global climate change. Despite the importance of tree mortality, the mechanisms driving mortality remain poorly understood. Here we present the results from an empirical study on the factors that predispose trees to spruce bark beetle (Dendroctonus rufipennis) induced tree mortality. We show that tree-level traits, (size, canopy dominance, spatial arrangement) are important in dictating survivorship during bark beetle outbreaks. We also examine the role of climate and forest dynamics in predisposing trees to bark beetle mortality through an analysis of radial growth patterns.

Dendroglaciological investigations at Jacobsen Glacier, central British Columbia Coast Mountains

Harvey, Jill*# (*University of Victoria Tree Ring Laboratory*)
Smith, Dan (*University of Victoria Tree Ring Laboratory*)

2:10 pm Friday May 17 Salon A–D Dendrogeomorphology

Historical ice front recession and downwasting of glaciers in the in the Monarch Icefield area has exposed landforms covered until recently by glaciers. Jacobsen Glacier is a large northeast flowing outlet glacier that has retreated over 6 km since 1915. In July 2010 the remnants of standing forests overwhelmed and buried by the mid-Holocene expansion of Jacobsen Glacier were located close to ice level within the northern lateral moraine. Twenty-three subalpine fir (Abies lasiocarpa) samples, including an in-situ stump, ice pressed logs, and detrital wood, were collected at four sites. Nine of the samples crossdate to form a 177 year-long floating tree-ring chronology (r= 0.403). Radiocarbon dating of the crossdated remains suggest Jacobsen Glacier is morphologically similar in size and shape today as it was during this mid-Holocene event. These findings provide opportunities to develop and expand longer Holocene tree ring chronologies.

Pluvials, Droughts, Energetics, and the Mongol Empire

Hessl, Amy*# (*West Virginia University*)
Pederson, Neil (*Tree Ring Laboratory*)
Nachin, Baatarbileg (*National University of Mongolia*)
DeGraauw, Kristen (*West Virginia University*)
Leland, Caroline (*Columbia University*)

3:00 pm Thursday May 16 Salon A–C Old World Dendroarchaeology

We use tree-ring records of temperature and water to illuminate the role of energy and water in the evolution of the Mongol Empire. Because water and energy are tightly linked in human and natural systems, studying their synergies and interactions make it possible to integrate knowledge across disciplines and human history, yielding important lessons for modern societies. We focus on the role of energy and water in the trajectory of an empire, including its rise, development, and demise. Our research is focused on the Orkhon Valley, seat of the Mongol Empire, where recent paleoenvironmental and archeological discoveries allow high resolution reconstructions of past human and environmental conditions for the first time. Our tree ring records indicate that the period 1210-1230 CE, the height of Chinggis Khan's reign is one of the longest and most consistent pluvials in our millennium-long tree ring reconstructions of interannual drought derived from two species.

Application of a simple soil moisture model for assessing drought effects on the growth of boreal aspen (Populus tremuloides) forests in western Canada

Hogg, E.H. (Ted)*# (*Natural Resources Canada - Canadian Forest Service*)
Barr, Alan G. (*Environment Canada*)
Black, T. Andrew (*University of British Columbia*)

11:15 am Tuesday May 14 Salon A–C Climate Growth Relations II

Previous research shows that droughts lead to multi-year decreases in the growth of western Canadian aspen forests. We postulated that this is partly a consequence of aspen responding directly to slow variation in the water content of deep soils in this dry region. To address this hypothesis, a soil moisture (SM) model was developed that requires only basic climatic inputs. The model successfully simulated variation in SM at an intensively instrumented aspen stand over a 9-year period. This model was then used in tree-ring analyses of aspen growth responses to climatic variation in similar stands across western Canada. Results showed that aspen growth was significantly related to modelled SM in the current growing season, and indicated that hydrological lags contribute to the delay in aspen growth responses to drought events. Future tree-ring studies may benefit from using

modelled SM as an alternative indicator of drought effects on forest productivity.

Paleoclimatology of Early Paleogene Mummified Wood from the Canadian Arctic

Hook, Benjamin*# (*University of Toronto*)
Halfar, Jochen (*University of Toronto*)
Bollmann, Joerg (*University of Toronto*)
Gedalof, Ze'ev (*University of Guelph*)

11:20 am Thursday May 16 Salon A–C Dendroclimatology II

The discovery of non-permineralized (mummified) wood fossils within Canadian Arctic kimberlites (62°N paleolatitude) has invited a paleoclimatic study of the Paleocene-Eocene transition, a time of extreme global warmth (12 – 15°C above modern temperatures). Kimberlite eruptions (dated at 55.5 and 53.3 ±0.7 Ma) buried wood in pyroclastic debris, thus entombing them within an anaerobic environment that protected them from decay or petrifaction. Pre-eruption tree growth was prodigious (mean tree-ring width 2.98 mm) suggesting equable polar climates despite a short growth season. Numerous traumatic resin ducts and Coleopteran larvae galleries signify forest disturbance regimes similar to modern forests. The mummified wood contains the oldest-known alpha-cellulose yet found, making annual and sub-annual stable-isotope studies possible. This is important because high-resolution proxy records from the Early Paleogene are scarce. A detailed portrait of an Early Paleogene Arctic temperate rainforest is emerging by combining dendrochronologic, wood-anatomical, and geochemical analyses.

Fire history, Stand Structure and Ecological Type Conversions in Mixed Conifer Forests, Northern Colorado Front Range

Huckaby, Laurie*# (*US Forest Service Rocky Mountain Research Station*)
Kaufmann, Merrill (*US Forest Service Rocky Mountain Research Station, emeritus*)
Kent, Brian (*US Forest Service Rocky Mountain Research Station, emeritus*)
Negron, Jose (*US Forest Service Rocky Mountain Research Station*)

9:30 am Tuesday May 14 Salon D Fire Ecology I

We reconstructed historical stand structures and fire regimes in mixed conifer forests between 2300 m and 2800 m elevation, spanning the last 1000 years. A mixed-severity disturbance regime maintained a spatial and temporal landscape mosaic. Dominance fluctuated between ponderosa pine and lodgepole pine. Before ~1350 C.E., higher elevations were dominated by ponderosa pine and surface fire regimes. These stands shifted to the present lodgepole pine and less frequent stand-replacing fire regimes during the Little Ice Age, though with a lag between climate change and stand-replacing disturbance precipitating the shift. Distribution of remnant wood pre-dating 1400 C.E. suggests that the lower elevation extent of forest occurred around 2500 m elevation, some 800 m higher than at present. Trees migrated downslope during climate-mediated episodes of establishment continuing into the 20th century. Similar dramatic shifts in species distributions and fire regimes may be expected in the near future as climate becomes warmer and drier.

Culturally Peeled Trees in Northern Colorado

Huckaby, Laurie* (*US Forest Service Rocky Mountain Research Station*)
Reiser, Marcy # (*US Forest Service, University of Arizona*)

1:20 pm Thursday May 16 Salon A–C New World Dendroarchaeology

The indigenous use of trees has been well-documented in western North America, but not in northern Colorado. We present data from 37 trees likely peeled by Native Americans between 1605 and 1812 CE, based on dendrochronological analysis of scars. All trees were ponderosa pines between 1740 and 2788 m elevation and were located serendipitously during the course of fire history studies. They occured in groups, with the greatest concentration (19 trees) at Red Mountain Open Space in Larimer County. The Red Mountain area also features a 1000-year history of fire and a rich archaeological record of human activity. We also present data for six trees with similar modifications that date to the settlement era, and seem likely to have been scarred by Euro-Americans. Culturally modified trees are a swiftly vanishing resource due to changing climate, fire, bark beetle attacks and intensifying land use. Further study and more extensive searches for peeled trees is needed urgently.

Mixed signals, mixed messages and lessons from bristlecone pine

Hughes, Malcolm*# (*Laboratory of Tree-Ring Research, University of Arizona*)
Salzer, Matthew (*Laboratory of Tree-Ring Research, University of Arizona*)
Bunn, Andrew (*Dept of Env. Sciences, Western Washington University*)

5:10 pm Tuesday May 14 Salon A–C Climate of Recent Millennia II

The dendroclimatology of Pinus longaeva tree rings has six decades of history. The attractions are clear: the longevity of the trees (~5000 years), the persistence of relict wood (~10,000 years), and their strong cross-dating. The work is complex however, as the high, cold, dry growth conditions can make it hard to disentangle temperature and moisture signals. Further, confusion has been unwittingly added by traditional dendroclimatological methods. Customary stan-

dardization led to mistaken emphasis on the stripbark growth form. The site chronology concept obscured the temperature signal near the species' upper elevation limits, as well as diverting attention to a likely incorrect hypothesis of carbon dioxide fertilization. Here we show how these obstacles have been overcome by going back to first principles, resulting in much new and unexpected information on the climate of the Great Basin (hydroclimate as well as temperature) in a global context for the mid-and late Holocene.

Response of tree growth and water use efficiency to climate change and nitrogen deposition in a temperate deciduous forest in the northeastern U.S.

Jennings, Katie*# (*University of New Hampshire*)
Eggemeyer, Kathlene (*University of New Hampshire*)
Asbjornsen, Heidi (*University of New Hampshire*)

8:30 am Friday May 17 Salon D Isotopes in Dendrochronolgy

Rising atmospheric CO2, nitrogen (N) deposition and changing precipitation patterns in the northeastern U.S. can influence tree growth and water use efficiency (WUE) through effects on plant water and nutrient relations, productivity, and photosynthetic capacity. To assess these impacts, we collected increment cores from the dominant tree species Quercus velutina from the Chronic Nitrogen Amendment Plots at the Harvard Forest simulating a steep N deposition gradient. We hypothesized that trees would exhibit a pronounced yet transient increase in increment growth and WUE with the onset of N fertilization, but demonstrate a more gradual, weaker enhancement of WUE in response to rising CO2. Tree rings were analyzed using dendrochronology and stable isotope (13C, 18O) techniques to evaluate the historical effects of climate and N deposition on tree growth and WUE. Preliminary results suggest that tree productivity was strongly influenced by N fertilization, while correlations to climate variability were relatively weak.

Dendrogeomorphic reconstruction of recent flood events in small streams in the Polish Tatra Mountains

Kaczka, Ryszard Jerzy*# (*University of Silesia*)
Stofel, Markus (*University of Bern*)
Rzepecka, Aneta (*University of Silesia*)
Czajka, Barbara (*University of Silesia*)
Janecka, Karolina (*University of Silesia*)

11:10 am Friday May 17 Salon A–C Dendrohydrology

The northern foothills of the Tatra Mountains are among the most densely populated regions in Poland, but also the source area of the large floods of the recent past. In this contribution, we reconstruct a detailed database on the history, magnitude and triggers of floods. The dendrogeomorphic work presented focuses on four streams, in which six sectors have been sampled with more than 1100 increment cores. We present data on the temporal frequency, magnitude and spatial patterns of floods and use the results as input data for the 2-D modelling of hydrologic and hydraulic processes in these catchments.

The Teflon-container method for extracting alpha-cellulose directly from tree-ring laths.

Kagawa, Akira*# (*Forestry and Forest Products Res. Inst.*)
Nakatsuka, Takeshi (*Nagoya University*)

9:30 am Friday May 17 Salon D Isotopes in Dendrochronolgy

We present a new cellulose extraction, where alpha cellulose is extracted directly from 1mm-thick laths. We prepared 1mm-thick cross sections using diamond saws (Leica SP1600) from wood of teak, fir, beech etc. The laths were enclosed in custom designed cases made of Teflon (Teflon punching sheets, thickness 0.5mm, hole size 1.5mm, pitch 3mm, TIC Corporation, Tokyo, Japan). The small holes of the Teflon sheets enable solutions such as sodium chlorite or sodium hydroxide to pass through the sheets. Alpha-cellulose was extracted using the Jayme-Wise method. The resultant alpha cellulose laths were either freeze-dried or air dried overnight before placing them onto album sheets (a-LDR-5, NAKABAYASHI, Tokyo Japan), then dissected under stereomicroscope. The cellulose laths maintain clear ring boundaries with little disintegration. We compared tree-ring oxygen and carbon isotope trends, between those obtained using the new and conventional method and found no statistically significant difference between the two.

Elevational gradients reveal tree growth response to a warming climate

King, Gregory*# (*Swiss Federal Research Institute WSL; Oeschger Centre for Climate Change Research, University of Bern*)
Fonti, Patrick (*Swiss Federal Research Institute WSL*)
Gugerli, Felix (*Swiss Federal Research Institute WSL*)
Simard, Sonia (*Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences*)
David, Frank (*Swiss Federal Research Institute WSL; Oeschger Centre for Climate Change Research, University of Bern*)

10:00 am Thursday May 16 Salon A–C Dendroclimatology II

The environment influences tree growth on sub-hourly to multi-centennial scales, making mechanistic knowledge of tree-ring formation across this spectrum essential to accu-

rately evaluate response to environmental change. We established a network to observe physiological responses of two conifer species along a 6°C natural warming gradient through weekly assessment of bud phenology and cellular development, sub-hourly measurements of stem radial fluctuations and environmental parameters, an evaluation of the genetic landscape and classic dendroclimatology analysis. Because we found high gene flow, which likely counteracts local adaptation, we attribute variation in tree growth principally to climate. Dendrometers provide insights into how daily cycles of water uptake and loss are coupled with atmospheric conditions, while concurrent phenology and xylem development data allow us to assess shifts in the timing and length of growth. Here we highlight significant results and discuss the elevational transects as exceptional platforms for understanding climate-driven changes over time.

Fire history along a historic travel corridor in Minnesota's Boundary Waters Canoe Area Wilderness

Kipfmueller, Kurt*# (*University of Minnesota*)
Johnson, Lane (*University of Minnesota*)

9:20 am Thursday May 16 Salon A–D Invited Speaker + Plenary Session (Dendroecology)

We developed a fire history of a portion of the Boundary Waters Cane Area Wilderness in northern Minnesota, USA using more than 70 remnant Pinus resinosa stumps collected within an historic canoe travel corridor in Lac La Croix. Our search builds on the efforts of Heinselman to better understand the relative influence of climate and Ojibwe occupancy patterns on the area's fire regime. Crossdated fire years derived from the samples were analyzed to determine the synchrony of fire events across space and time and to test the relationship between fires and drought. In addition, fire frequency is being examined within the context of Ojibwe occupancy and French Voyageur trade patterns to assess the impact of human activities on Lac La Croix's Pinus resinosa fire regimes prior to extensive Euro-American land use.

Examining recent growth rebounds of red spruce trees in the northeastern forest

Kosiba, Alexandra*# (*University of Vermont*)
Schaberg, Paul (*Forest Service, U.S. Department of Agriculture, Northern Research Station*)
Rayback, Shelly (*University of Vermont*)

4:00 pm Thursday May 16 Salon D Recent Growth Trends and Tree Mortality

Red spruce (Picea rubens Sarg.) diameter growth in the northeastern United States has decreased since the 1960s due to a combination of factors, including foliar winter injury predisposed by acidic deposition-induced calcium depletion. We assessed the influence of a severe region-wide winter injury event in 2003 on radial growth decline and the subsequent rebound of red spruce growth in stands in Vermont, New Hampshire, and Massachusetts, USA. We found that growth declines relative to pre-injury growth persisted for three years following the winter injury event. We also found that, 1) growth declines were followed by an unprecedented rebound in growth, and 2) stands did not rebound uniformly when grouped by elevation (mid-elevation plots rebounded most robustly). We evaluated the relationship between climate and other parameters to growth in order to examine possible reasons for the recent growth rebound following decades of regional species decline.

Relationships between root and stem growth

Krause, Cornelia*# (*Université du Québec à Chicoutimi*)
Tremblay, Maxime (*Université du Québec à Chicoutimi*)

10:55 am Tuesday May 14 Salon D Dendroecology I

Dendrochronological studies are mainly focused on stem, but rarely includes roots. It is well known that the root system achieves essential tasks such as tree anchorage, water and mineral absorbtion. This study focused on growth response in roots and stem after commercial thinning for black spruce exhibiting root grafting. The study site was located in the boreal forest of Canada. Radial growth was measured in five mature stems with their whole root system. Growth pattern varied between different roots within a tree. Radial increase started in the roots before being registered afterwards in the stem. Two distinct mecanisms seem to explain these results : a) carbon exchange with the help of root grafting and b) the need of tree stabilisation by increasing the radial growth in the root system.

Invasive Earthworms Alter Climate-Tree Growth Relationships

Larson, Evan*# (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)
Wilding, Thomas (*Tree-Ring, Earth, and Environmental Science Laboratory*)
Kipfmueller, Kurt (*Department of Geography, University of Minnesota*)
Hueffmeier, Ryan (*Great Lakes Worm Watch, Natural Resources Research Institute, University of Minnesota - Duluth*)
Hale, Cindy (*Natural Resources Research Institute, University of Minnesota - Duluth*)
Frelich, Lee (*Center for Hardwood Ecology, University of Minnesota*)
Reich, Peter (*Department of Forest Resources, Uni-*

versity of Minnesota)

8:40 am Thursday May 16 Salon A–D Invited Speaker + Plenary Session (Dendroecology)

The invasion of European earthworms into North American temperate forests is profoundly and fundamentally changing the dynamics of these ecosystems. Immediately upon invasion, forest soils are compacted, native plant communities are reduced in diversity and abundance, the fine root systems of trees and their associated mycorrhizal communities are disrupted, carbon fluxes increase, nitrogen is mineralized and leached from the system, and the O horizon, a layer of accumulated organic debris from decades of litter-fall, is completely eliminated and mixed into upper forest soils. These changes have been documented in numerous locations throughout the Great Lakes Region and the Upper Midwest. In this talk we will present the first analyses of how the environmental changes initiated by earthworm invasions altered the climate-tree growth relationships in three different sugar maple forests and illustrate the profound implications of these changes for dendroclimatology in the hardwood forests of eastern North America.

Monsoon Rainfall from Annual δ13C Chronologies of Pseudotsuga menziesii and Pinus ponderosa in Southern Arizona, USA

Leavitt, Steven*# (*U. of Arizona*)
Woodhouse, Connie (*University of Arizona*)
Griffin, Daniel (*University of Arizona*)
Touchan, Ramzi (*LTRR*)
Carrillo, Carlos (*University of Arizona*)
Castro, Chris (*University of Arizona*)
Meko, Dave (*University of Arizona*)

11:10 am Friday May 17 Salon D Isotopes in Dendrochronology II

Approximately half of the annual precipitation in Southern Arizona comes from the summer monsoon season in July-September. Natural and human systems in the U.S. Southwest profoundly benefit from delivery of this summer moisture, and knowledge of the variability in precipitation through time provides a baseline for water planning and assessing climate changes. Established linkage between stable-carbon isotope composition of tree rings and moisture, particularly in semi-arid environments, forms the basis for analyzing latewood cellulose of Douglas-fir at sites in three mountain ranges (and co-occurring ponderosa pine at two of them) to determine its ability to accurately track summer monsoon precipitation. In addition to assessing relationships with moisture, comparisons with other climate parameters and with latewood width measurements (also a proxy for summer precipitation) are made. These relationships are described and the role of the isotope measurements as supplementary to or independent of width proxies is evaluated.

Dendroecological Insights from Industrial Dendro: Missing Rings and the Importance of Seed Source in 36-year old Pinus rigida

Leland, Caroline*# (*LDEO, Columbia University*)
Pederson, Neil (*LDEO Tree Ring Laboratory*)
Hom, John (*USDA Forest Service*)
Skowronski, Nicholas (*USDA Forest Service*)
Ledig, Thomas (*USDA Forest Service*)
Cook, Edward (*LDEO, Columbia University*)
Krusic, Paul (*LDEO, Columbia University*)

3:10 pm Tuesday May 14 Salon D Dendroecology II

Despite decades of tree-ring research, it is not evident how anthropogenic climate change will impact the growth of most species. We cored 953 Pinus rigida trees from 27 seed sources planted in New Jersey as a part of a long-term provenance study. Dendroecological analyses of these sources, derived from Maine to Georgia, are being used to help develop tools for the selection and management of future forests. Surprisingly, we found that even widely-spaced plantation trees have locally-absent rings. Many individual trees are missing four of the expected 35 rings (11% of their annual increment) with some seed sources missing the 1992 ring in 56-96% of all trees. Local seed sources were less apt to miss this ring. Subsequent analysis of native Pinus rigida indicated missing rings decreased with stem height. Preliminary analysis uncovers differences in latewood and ring width production with some northern populations producing less than southern populations.

Dating First Nation "Brush Structures" in Kluane National Park and Reserve

Luckman, Brian*# (*Geography, Western University*)
Reid, Emma (*Western University*)
Dueck, Lori (*Western & Northern Service Centre, Parks Canada, 145 McDermot Avenue*)
Luckman, Helen (*Western University*)

1:40 pm Thursday May 16 Salon A–C New World Dendroarchaeology

Brush structures are the remains of traditional housing used by the Southern Tutchone people in the forests of the South West Yukon. They are frameworks of wooden poles, usually ca. 10-25cm diameter cut from the trunks of local spruce trees and provided temporary shelter for families or small itinerant groups. Five groups of structures were examined on the alluvial fan of Vulcan Creek, a tributary of Slims River (A'ay Chu) in Kluane National Park. The project goals were to determine the feasibility of dating these structures using local reference spruce chronologies. Outer ring dates from poles, cut stumps and a culturally modified tree indicate the structures dated between 1862 and 1887, slightly predating the arrival of the first Europeans. Several structures used a surprising amount of older wood with outer dates extending

back into the 1600s and 1700s, suggesting either re-use of materials or selective use of deadwood in construction.

The consequences of under-representing uncertainty in tree-ring-based risk analyses

Lukas, Jeffrey*# (*Western Water Assessment, University of Colorado*)

9:00 am Wednesday May 15Salon A–DInvited Speaker + Plenary Session (Decison Making)

Tree-ring reconstructions of hydroclimate variables such as streamflow, precipitation, and drought indices are increasingly used by water managers and others in risk analyses intended to capture their system's behavior under paleo-variability. While these users are generally informed about the uncertainty around the reconstructed values—which implies multiple plausible realizations of past variability—in most cases these risk analyses have been driven by a single realization. This practice appears to result from both practical constraints and issues of communication and perception. Using selected case studies from water resource planning, I explore the consequences of using a single paleo-realization in risk analyses. Different paths that are within the uncertainty bounds of that one realization can lead to very different simulated system outcomes. This finding points to the need for more explicit treatment of uncertainty in communications to users, and the use of multiple realizations in user applications.

Vertical resin ducts in tree-rings and predisposition to mortality during drought

Macalady, Alison*# (*University of Arizona*)
Klaey, Matthias (*Swiss Federal Institute of Technology (ETH), Department of Environmental Systems Science, Forest Ecology*)
Bugmann, Harald (*Swiss Federal Institute of Technology (ETH), Department of Environmental Systems Science, Forest Ecology*)
Gaylord, Monica (*Northern Arizona University, School of Forestry*)
English, Nathan (*School of Earth and Environmental Sciences, James Cook University*)
Allen, Craig D. (*United States Geological Survey, Jemez Mountain Field Station*)
Swetnam, Thomas (*University of Arizona, Laboratory of Tree-Ring Research*)
McDowell, Nate (*Los Alamos National Laboratory, Earth and Environmental Sciences*)

4:20 pm Thursday May 16 Salon D Recent Growth Trends and Tree Mortality

Drought and insect infestations can lead to widespread tree mortality in forest ecosystems. However, models of forest dynamics are limited in their ability to simulate mortality during drought because the processes underlying tree death are poorly constrained. Tree allocation to defense is hypothesized to be a key element in tree avoidance of mortality, but there are few empirical tests of its importance in predisposing trees to die during drought. Here we characterize the properties of vertical resin ducts in piñon pine (P. edulis) tree-rings, and investigate the relationship between defensive anatomy and piñon mortality. We generated resin duct timeseries for 102 pairs of trees that died and survived the 2000s and 1950s droughts in New Mexico, USA. Statistical models of mortality risk based on resin duct and radial growth metrics correctly classify 85% of live and dead trees, with consistently high validation statistics across sites. This represents a major improvement over models calibrated using growth metrics alone.

Scots Pine (Pinus sylvestris L.) Growth Suppression and Adverse Effects on Human Health Due to Air Pollution in the Upper Silesian Industrial District (USID), Poland

Malik, Ireneusz*# (*University of Silesia*)

3:30 pm Tuesday May 14 Salon D Dendroecology II

Air pollution emissions were not continually monitored in the Upper Silesian Industrial District (USID), Poland, and data is only available for the last 20 years. Long-lasting and severe tree ring reductions in pines growing 5–20 km north of the USID area recorded particularly high levels of air pollution emissions from 1950 to 1990. Especially high amounts of reductions and many missing rings were found from 1964 to 1981. At the same time, pines growing 60 km west of the USID do not record deep ring reductions; this proves that the phenomenon is of a regional nature. Increases in infant mortality and lung cancer morbidity rates among males were also recorded in the USID during periods of high air pollution. Infant mortality rates increased several years after the tree ring reductions. Therefore, it may be possible to use tree ring reductions as an early indicator of the occurrence of adverse effects on human health.

Collapse of frequent fire regime linked to increased tree density in a piñon-juniper landscape, New Mexico, USA

Margolis, Ellis*# (*University of Arizona Laboratory of Tree-Ring Research*)

10:10 am Tuesday May 14 Salon D Fire Ecology I

Piñon-juniper (PJ) fire regimes are described as infrequent and high severity, but data for PJ savannas are lacking. The goal of my research was to reconstruct the history of fire and forest structure on a 30,000 ha PJ-dominated, savanna landscape. I crossdated 112 fire-scarred trees (8% Junipe-

rus scopulorum, 17% Pinus edulis, and 74% P. ponderosa) containing 630 fire scars that burned during 87 unique fire years (1547-1899). Mean fire interval was 7.8 years for fires recorded at > 2 sites (separated by 7 km), and 23.7 years for fires recorded at over half of the sites. Evidence of high severity fire (e.g., even-aged stands or fire-killed snags or logs) was not observed. Frequent, low-severity fires historically maintained low tree densities across what was a PJ–PIPO savanna landscape and late 19th century fire cessation, initiated by overgrazing, was the primary driver of current high tree densities (> 880 trees/ha).

A spatial analysis of fire history across adjacent watersheds

Marshall, Laura*# (*University of Arizona*)
Falk, Donald (*University of Arizona*)
Margolis, Ellis (*University of Arizona*)

1:00 pm Thursday May 16 Salon D Fire Ecology III

Recent extreme wildfires have grown larger and burned more severely in forests adapted to frequent, low-severity fire. To investigate the spatial fuel-topography linkages which may influence extreme wildfire size, we reconstructed fire history using fire-scarred trees in a ponderosa pine forest in Black Canyon/Little Tesuque Watershed, Sangre de Cristo Mountains, New Mexico. We compared fire intervals, spatial patterns of major and minor fire years, and past climate to fire history from the adjacent Santa Fe Watershed. The Santa Fe Watershed, a major source of drinking water for the city of Santa Fe, NM, has been managed extensively to reduce fire risk, while less treatment has occurred in surrounding areas. We examined the fire history of the two watersheds and found similar fire intervals in each. Synchronous fire across watersheds is common in widespread fire years, potentially indicating the need for management at larger scales to reduce fire risk to natural resources.

Why Distribution Location Matters for the Climatic Response of Broadleaf Species in the Eastern Deciduous Forest

Martin-Benito, Dario*# (*Tree-ring lab, Lamont-Doherty Earth Observatory. Columbia University*)
Pederson, Neil* (*Tree Ring Laboratory*)

9:50 am Tuesday May 14 Salon A–C Climate Growth Relations I

We conducted a dendroclimatic study of broadleaved tree species in the humid deciduous forests of the eastern United States to understand their response to precipitation, temperature, and drought in a large biogeographical context. We analyzed a network of 86 tree-ring width chronologies composed of eight species along a 1700 km latitudinal transect. All species were sensitive to summer drought, as driven by precipitation and temperatures during the growing season. However, the causes of this drought response revealed a strong latitudinal gradient: the influence of precipitation on tree growth decreased from north to south while temperature effects followed the opposite trend. Warmer winter temperatures enhanced growth of some species like tulip poplar and at certain sites, particularly along the Hudson River Valley. Results from these analyses might prove useful for future dendroclimatic reconstruction and for the accurate prediction of the response of these forests to future climate changes.

The Influence of the Atlantic Multidecadal Oscillation on Tupelo Honey Production since AD 1800

Maxwell, Justin*# (*Indiana University*)
Knapp, Paul (*University of North Carolina at Greensboro*)
Ortegren, Jason (*University of West Florida*)

10:40 am Wednesday May 15Salon A–C Dendroclimatology I

We reconstructed tupelo honey yield-per-hive from 1800–2010 using tree-ring data from the nectar-source species, Nyssa ogeche. The composite N. ogeche radial growth chronology and honey yield-per-hive were significantly correlated, suggesting optimal growth conditions are coincident with increased nectar production and that tree-ring data can be used to reconstruct crop history. Tupelo honey yield-per-hive has oscillated between multidecadal-length periods of low and high yields during the past 211 years and is associated with the Atlantic Multidecadal Oscillation (AMO). The expansion of the honey record suggests that the current decline is within the natural range of variability prior to record-keeping. Multidecadal-length variations in tupelo honey yield illustrate how naturally occurring climatic cycles affect crop productivity beyond the length of recorded high-quality agriculture records and may offer additional information to better understand interactions between oceanic-atmospheric climate drivers, non-climatic anthropogenic impacts, and yield variability.

Streamflow Signal in Annual Ring Widths of Cottonwood Trees along Little Missouri River, North Dakota

Meko, David*# (*University of Arizona*)
Touchan, Ramzi (*University of Arizona*)
Friedman, Jonathan (*U. S. Geological Survey*)
Edmondson, Jesse (*Alabama Graphite Co.*)
Scott, Julian (*Consulting Hydrologist*)
Griffin, Eleanor (*U. S. Geological Survey*)

10:30 am Friday May 17 Salon A–C Dendrohydrology

Ring widths of 394 Populus deltoides, ssp. monilifera trees from a relatively undisturbed setting in the North Unit of Theodore Roosevelt National Park, North Dakota, are ana-

lyzed for potential use in reconstructing the flow of the Little Missouri River. Results indicate that a single well-replicated age-curve-standardized (ACS) (similar to regional-curve standardization) cottonwood chronology explains 46% of the variance of log-transformed seasonal-total (April-July) flow of this river over a 1935-1999 calibration period. The signal is relatively strong in young-age rings (ages 5-35), presumably because of the proximity of young trees to the migrating river course, and can be enhanced by including chronologies of other species from non-riparian sites in the reconstruction model. Results could lead to improved streamflow reconstruction modeling with better retention of low-frequency climate signal.

Dendroarchaeological dates of prehistoric contexts in the Bolivian Altiplano

Morales, Mariano*# (*Dep. Dendrocronología e Historia Ambiental. IANIGLA CCT CONICET, Mendoza*)
Nielsen, Axel (*Instituto Nacional de Antropología y Pensamiento Latinoamericano. CONICET. Buenos Aires*)
Villalba, Ricardo (*Dep. Dendrocronología e Historia Ambiental. IANIGLA CCT CONICET, Mendoza.*)

2:20 pm Thursday May 16 Salon A–C New World Dendroarchaeology

Recent research in the Bolivian Altiplano of the Central Andes has yielded a network of Polylepis tarapacana chronologies that go back to the 13th century. This wood was regularly used by local populations in pre-Columbian times as raw material for beams, lintels, hooks and other architectural features in houses, chambers, and sepulchers. This study evaluated the potential of P. tarapacana samples to provide high resolution dates of significant archaeological features and/or events during the pre-Columbian era. This trial study was based on a chronology of chullpas (burial towers and storage chambers) in the southern Andean Altiplano. Using the 786-yr. long regional reference chronology of P. tarapacana, calendar years were assigned to woody pieces from pre-Hispanic chullpas. The dendroarchaeological results are consistent with contextual evidence and radiocarbon dates from other woody samples, suggesting that P. tarapacana has a high potential for providing annually-resolved tree-ring dates for archaeological contexts in the Altiplano.

False Rings in the Southwest: An Update of "The Time of Year of Ring Formation"

Morino, Kiyomi*# (*The University of Arizona, LTRR*)
Woodhouse, Connie (*The University of Arizona, LTRR&GRD*)
Griffin, Dan (*The University of Arizona, LTRR&GRD*)
Meko, Dave (*The University of Arizona, LTRR*)

11:00 am Thursday May 16 Salon A–C Dendroclimatology II

False rings are commonly encountered in conifer species throughout the Southwest and have played an integral part in Southwestern dendrochronology. Indeed, crossdating was developed, in part, to ensure the correct dating of tree-ring samples in the presence of false rings. However, an extensive analysis of potential climate drivers of false-ring formation in Southwest has not yet been conducted. In general, false rings are the product of a two-part process: prolonged drought stress followed by readily available moisture. The particular combinations of climate conditions that induce the increase and relief of drought stress, however, may vary over space and may be mediated by tree age. In this study, we used generalized linear modeling to explore and characterize potential differences in the suites of climate variables that drive false-ring formation at three sites in the Southwest. We also investigated the extent to which climate drivers varied between young and old trees.

Dendrochronological dating of the Puerto Madero vessel, Buenos Aires, Argentina

Mundo, Ignacio*# (*IANIGLA-CONICET*)
Girardclos, Olivier (*Laboratoire Chrono-environnement, Université de Franche-Comté*)

2:00 pm Thursday May 16 Salon A–C New World Dendroarchaeology

Although dendrochronology has been used to date ships throughout the world, it has not yet been used in South American nautical archaeology. In 2008, workers digging foundations of an apartment complex in Puerto Madero, Buenos Aires, uncovered the remains of a wooden-hulled vessel. Archaeological evidence indicated that this vessel might be an 18th century Spanish ship. Dendrochronology was used to provide an accurate date of construction based on a reference oak chronology from France developed by Principal Component Analysis. We estimate the vessel timbers were probably cut between 1776 and 1793. Although the correlation statistics between the vessel chronology and the reference chronology ($r = 0.44$ and t-value = 3.92, $n = 66$ years) do not provide a strong, conclusive match, this dating is consistent with other archaeological evidence. This study is a promising prelude to future dendrochronological studies that could be carried out on many ship remains along the Argentinean coasts.

The Historical Analysis of, and Systematic Bias in, Large, Regional Tree-Ring Date Distributions from the American Southwest

Nash, Stephen*# (*Denver Museum of Nature & Science*)

1:00 pm Thursday May 16 Salon A–C New World Dendroarchaeology

Archaeological sites in the American Southwest are some of the best dated in the world because of the widespread availability and applicability of dendrochronology, and the fact that the science has been successfully applied in the region since 1929. Even in reasonably well-dated regions, however, systematic bias is present in very large, regional databases of archaeological tree-ring dates. This paper offers an historical analysis of 19,281 tree-ring dates from the Four Corners and Rio Grande regions of the American Southwest to demonstrate that the non-random and contingent history of research in the region creates patterns (i.e. bias) in the data that cannot be addressed simply through the use of ever larger sample sizes. This finding has significant implications for scholars who want to read too much into archaeological tree-ring date distributions.

Dendrochronological investigations of Bronze Age to Early Iron Age mining on copper in the Austrian Alps

Nicolussi, Kurt*# (*University of Innsbruck, Institute of Geography*)

Pichler, Thomas (*University of Innsbruck, Institute of Geography*)

Goldenberg, Gert (*University of Innsbruck, Institute of Archaeology*)

Thurner, Andrea (*University of Innsbruck, Institute of Geography*)

Stöllner, Thomas (*University of Bochum, Institute of Archaeological Science*)

4:20 pm Thursday May 16 Salon A–C Old World Dendroarchaeology

Mining on copper ore in the Northern Alps of Austria has been well known for a long time. Trace element analyses on metallic artefacts prove that copper from this region was important for whole central Europe during Bronze Age. However, accurate dating of the mining activities was poor both regarding absolute age determination and duration of mining at a certain place, i.e. dating was based on find typology and radiocarbon analyses.

In recent years, we established tree-ring dates for several mining sites in the Austrian Alps based on the analysis of some 500 wooden samples from different types of mining sites, e.g. charcoals from fire-setting activities (mining pit) or boards of an ore washing box (ore processing site). The tree-ring dates established spread over the time period of the 14th to 8th century BC.

Spatial and temporal interactions between Spruce beetle outbreaks, fire, and climate in a remnant isolated spruce-fir forest

O'Connor, Christopher*# (*University of Arizona*)

Lynch, Ann (*USFS RMRS and UA LTRR*)

Falk, Donald (*University of Arizona SNRE*)

Swetnam, Thomas (*University of Arizona LTRR*)

11:35 am Tuesday May 14 Salon D Dendroecology I

The Pinaleño Mountains of southeastern Arizona contain the southernmost spruce-fir forest in North America. Contemporary disturbance events in this forest include bark beetle outbreaks in the 1950s and late 1990s, endemic defoliator and exotic aphid outbreaks in the mid-1990s, and a stand-replacing fire in 2004. Using dendrochronology, we reconstructed the disturbance events and stand dynamics that followed the last stand replacing fire in 1685, and examined relationships among stand composition, climate, fire and insect outbreaks. Spruce beetle outbreaks tended to lag spruce establishment by ~40 years and were significantly correlated with persistent drought events. The area occupied by Engelmann spruce and corkbark fir nearly doubled in size from 1880 to 1950, coinciding with the first wide-spread outbreak events. Increasing size and severity of outbreaks appears to have been influenced by host range expansion due to fire suppression and host water stress during persistent 20th century droughts.

Impact of various partial cutting treatments on radial growth and wood quality of black spruce: a study case in the boreal forest

Pamerleau-Couture, Émilie*# (*Université du Québec à Chicoutimi*)

Krause, Cornelia (*Université du Québec à Chicoutimi*)

Pothier, David (*Université Laval*)

10:20 am Wednesday May 15 Salon D Wood Anatomy

Partial cutting is known to enhance the growth of residual stems. However, a significant radial increase can lead to a lesser wood quality in regard of anatomy and density parameters. Our research aims to evaluate black spruce growth and wood quality within various partial cutting treatments in Quebec. We evaluated the annual yield and the wood quality by examining tree-ring density and anatomical features such as tracheid length, radial diameter and cell wall thickness. Results revealed a general increase of radial growth after partial cutting. A significant increase altered the anatomical properties as expressed by a decrease in cell wall thickness. Latewood proportion is also negatively proportional to tree-ring width. When both observations are combined, it impacts the wood density which can modify the mechanical properties. The intensity of partial cutting determines the magnitude of changes observed in wood growth and quality.

Wood, mud and dating a flood: Dendroarchaeol-

ogy of the Theodocian Harbour, Yenikapı, Istanbul

Pearson, Charlotte*# (*University of Arizona*)
Wazny, Tomasz (*University of Arizona*)
Kuniholm, Peter I. (*University of Arizona*)

3:20 pm Thursday May 16 Salon A–C Old World Dendroarchaeology

In 2004, excavations for a new metro line under the city of Istanbul, Turkey, uncovered the remains of an extensive Byzantine harbour. Still under excavation, this site at Yenikapı has grown into the largest archaeological excavation ever conducted in Turkey. The richness and quantity of recovered artefacts (including numerous shipwrecks with intact cargo) is extraordinary, as is the complete geoarchaeological record from this site which now extends back over 8000 years. Here we report on the latest dendroarchaeological analysis of over 3000 oak samples taken primarily from wooden docks and other structures at Yenikapı and further metro excavations at nearby Sirkeci. We demonstrate examples of how the chronologies from various docks can be used to bring dendrochronological precision to stratigraphic horizons, how docks from different time phases group together and how this material is continuously strengthening an oak master chronology for the first millennium AD.

Regional-scale dynamics in humid, broadleaf forests

Pederson, Neil*# (*Tree Ring Laboratory*)
McEwan, Ryan (*University of Dayton*)
Hessl, Amy (*West Virginia University*)
Mock, Cary (*University of South Carolina*)
Orwig, David (*Harvard Forest*)
Rieder, Harald (*Lamont-Doherty Earth Observatory and Department of Applied Physics and Applied Mathematics of Columbia University*)
Cook, Benjamin (*NASA Goddard Institute for Space Studies*)
Dyer, James (*Ohio University*)

8:20 am Thursday May 16 Salon A–D Invited Speaker + Plenary Session (Dendroecology)

In humid, broadleaf forests, gap-dynamics are thought to be the prevailing disturbance regime. Paleoecology, however, shows regional-scale changes forest alteration with climatic change. We used 76 tree-ring collections and 5.3k tree recruitment dates to investigate the potential for regional-scale disturbance in a temperate, humid forest. Growth-release analysis indicates coherent and intense canopy disturbance from 1775-1780 across 42,800 km2. The resulting time-series is poorly described by a Gaussian distribution and indicates that the 1775-1780 event is a rare event that can alter ecosystem trajectory. Superposed-epoch analysis suggests that drought triggered elevated disturbance. Age data documents a pulse of tree recruitment during the late-1600s over much of 1.4 million km2. These results provide evidence of rare, episodic climatic events that shape broadleaf forests for centuries and reveal the potential for rapid, regional-scale forest alteration over future decades.

A mixed-effects modeling approach for describing climate-growth relationships with applications to climate change research

Peterson, David W.*# (*U.S. Forest Service, Pacific Northwest Research Station*)

10:55 am Tuesday May 14 Salon A–C Climate Growth Relations II

Climate-growth relationships have typically been described for mean chronologies at the stand or larger spatial scales, either as a basis for subsequent reconstruction of past climatic variability, or to better understand environmental controls on tree growth. However, accurately forecasting forest responses to future climate change may require a better understanding of variability in tree growth responses to climatic variability within stands, among species, and across environmental gradients than can be obtained from mean growth chronologies. I demonstrate an approach to describing and testing hypotheses about climate-growth relationships based on individual trees as the basic sampling unit that uses mixed effects statistical models to model variability in responses to climate within and among populations. Using previously published data from subalpine conifers in the Pacific Northwest, I show that climate-growth relationships can vary significantly within and among stands and that this variability can be partially attributed to tree and site characteristics.

Reconstruction of humidity in a dry forest and a humid forest in southern Ecuador

Pucha Cofrep, Darwin Alexander*# (*University of Erlangen-Nuremberg, Institute of Geography, Erlangen, Germany and National University of Loja, School of Forestry, Loja, Ecuador*)
Bräuning, Achim* (*University of Erlangen-Nuremberg, Institute of Geography, Erlangen, Germany.*)
Valarezo Manosalvas, Carlos* (*National University of Loja*)

8:50 am Friday May 17 Salon A–C Tropical Dendrochronology

Dendrochronological studies are an important tool to provide important paleoclimatic data. In the tropics, however, dendroecology is still a rather young science and little is known about how climate affects the development of these sensitive ecosystems. We present the first tree-ring chronology of a dry forest and a humid forest in southern Ecuador and compare it with the ENSO index.

Therefore, we combine measurements of individual annual growth rings with the variations of stable carbon iso-

tope (δ13C and δ18O) variations to obtain information about how different climatic conditions influence the short-term and the long-term growth of the trees. A reconstruction of the variations of humidity conditions during the past decades was prepared using stable carbon isotopes and ring width measurements. Consequently, we verify our hypothesis that the stable carbon isotopes in the wood reflect variations of moisture variability during the past decades.

Stable carbon isotopes from eastern hemlock trees in northern New England and their potential for mid-latitude climate reconstruction.

Rayback, Shelly*# (*University of Vermont*)
Lini, Andrea (*University of Vermont*)
Gagen, Mary (*Swansea University*)
Cogbill, Charles (*Harvard Forest*)
Gregory, Rachel (*Cardiff University*)
Jenkins, Catherine (*Cardiff University*)

10:50 am Friday May 17 Salon D Isotopes in Dendrochronology II

Little is known of past climate in northern New England (USA) from tree-ring proxies aside from drought. A preliminary stable carbon isotope ratio chronology (1849-2010) from eastern hemlock (Tsuga canadensis) trees was developed to explore other climate relationships at a moist mid-latitude site. Significant correlations with maximum growing season temperature ($r=0.53$, $P<0.01$) and spring cloud cover ($r=0.45$, $P<0.05$) suggest that photosynthetic assimilation rate is the (indirect) dominant control over the internal concentration of CO_2 (ci) for eastern hemlock in northern New England. EPS values of 0.86 derived from five trees indicate the species' paleoclimatic potential. Several reconstructions of past climate are explored and compared with other proxies and historical data from the region. In addition, we note the passive response of eastern hemlock since the early 1980s to rising CO_2.

Examining Variability in Douglas-fir Growth at a Continental Scale

Restaino, Christina*# (*University of Washington*)
Peterson, David (*Pacific Wildland Fire Sciences Laboratory*)

9:30 am Tuesday May 14 Salon A–C Climate Growth Relations I

Tree life-history processes like establishment, growth, and mortality are partially controlled by climate. Even relatively small shifts in climate can influence these processes and may result in shifts of species distributions. Climate change models that address ecosystem impacts simulate these distribution shifts at coarse spatial scales. However, this information lacks utility for resource managers who operate at finer resolutions. Tree growth rates serve as an alternative method of predicting climate effects on trees. Coniferous trees, for example Douglas-fir, can record changes in growth that relate to climate. These Douglas-firs have radial growth rings that express the spatial and temporal variability in tree growth and climate sensitivity. Past growth fluxes can provide early indications of climate change effects on trees. We are investigating the climate-growth interaction of Douglas-fir across its entire range in the United States to better understand how water and energy influence growth from stand to regional to continental scales.

Late Holocene paleotemperatures from bristlecone pine tree rings and treeline elevation change

Salzer, Matthew*# (*Laboratory of Tree-Ring Research, University of Arizona*)
Bunn, Andrew (*Department of Environmental Sciences, Western Washington University*)
Graham, Nicholas (*Hydrologic Research Center, San Diego, CA*)
Hughes, Malcolm (*Laboratory of Tree-Ring Research, University of Arizona*)

3:10 pm Tuesday May 14 Salon A–C Climate of Recent Millennia I

High elevation tree-ring widths from Great Basin bristlecone pine (Pinus longaeva) are a particularly useful proxy to infer temperatures prior to the instrumental record in that the tree-rings are annually dated and extend for millennia. We have created a very long (4500+ years) annually resolved record of ring width, and an estimate of past treeline elevation for the Great Basin, USA. These records are integrated and used to infer decadal- to millennial-scale regional temperature variability over the past 4,500 years. We find that late 20th century treeline advances are probably greater than in at least 4,000 years. There is also considerable covariation between a regional high elevation tree-ring chronology and regional temperature estimates from an atmosphere-ocean general circulation model (GCM) over much of the last millennium. A long-term temperature decline of ~ -1.1° C since the mid-Holocene underlies substantial volcanic forcing of climate in the preindustrial record.

Application of dendrohydrology to drought preparedness planning in western Canada

Sauchyn, Dave*# (*Prairie Adaptation Research Collaborative, University of Regina*)
Lapp, Suzan (*FORREX, Kelowna, British Columbia*)
St. Jacques, Jeannine (*Prairie Adaptation Research Collaborative, University of Regina*)
Vanstone, Jessica (*Prairie Adaptation Research Collaborative, University of Regina*)

9:20 am Wednesday May 15Salon A–DInvited Speaker + Plenary Session (Decison Making)

Our network of 170 moisture-sensitive tree-ring chronologies is the basis for millennial reconstructions of surface water levels across Canada's western interior, where water is limiting ecologically and economically. This paleohydrology undermines fundamental assumptions about the reliability and stationarity of water supplies, by revealing scales and extremes of hydroclimatic variability outside the scope of instrumental records. It also has various applications to regional climate adaptation, and specifically drought preparedness planning. Whereas recent temperature trends, notably higher winter temperatures, are mostly favorable circumstances in the region, less favorable and more challenging consequences of regional climate change are shifts in precipitation and surface water supplies among seasons, years and decades. Generally, professional planners and hydrological engineers regard the tangible evidence from climate proxies with less skepticism than model projections and thus paleoclimate reconstructions are a point of entry for introducing practitioners to concepts of climate variability and change.

Sensitivity of tree growth to temperature in the southeastern China and the potential for spatial temperature reconstruction

Shi, Jiangfeng*# (*School of Geographic and Oceanographic Sciences, Institute for Climate and Global Change Research, Nanjing University, Nanjing 210093, China; Nanjing Institute of Geography & Limnology, Chinese Academy of Sciences, Nanjing 210008, China; Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York 10964, USA*)

Li, Jinbao (*International Pacific Research Center, University of Hawaii at Manoa, Honolulu, Hawaii 96815, USA*)

Lu, Huayu (*School of Geographic and Oceanographic Sciences, Institute for Climate and Global Change Research, Nanjing University, Nanjing 210093, China*)

Li, Lingling (*School of Geographic and Oceanographic Sciences, Institute for Climate and Global Change Research, Nanjing University, Nanjing 210093, China*)

Hou, Xinyuan (*School of Geographic and Oceanographic Sciences, Institute for Climate and Global Change Research, Nanjing University, Nanjing 210093, China*)

Edward R. Cook, Edward R. (*Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York 10964, USA*)

11:20 am Wednesday May 15 Salon A–C Dendroclimatology I

Tree-rings play an important role in reconstructing past temperature in high-latitude and high-elevation regions. However, little tree-ring research has been done in the subtropical southeastern China. Recent studies show that coniferous tree growth there is limited by temperatures in prior winter and the current growing season. Higher temperature in the dormant season means less damage to leaves and roots, and less consumption of previously stored carbohydrates and starches. The new temperature reconstructions match each other very well at decadal to multi-decadal scales during the past 150 years at a large spatial scale, that is, of 700 km, even though there are some discrepancies in the early part of the comparisons. Possible reasons for the discrepancies include local temperature differences, small sample depth in the early part of the reconstructions, and/or juvenile effects. Regardless, the agreements among reconstructions indicate the potential to develop a large tree-ring network to reconstruct temperature over the southeastern China.

The Effect of Fire on Multiple Arboreal Species in the Eastern Deciduous Forest

Speer, Jim*# (*Indiana State University*)

Rubino, Darrin (*Hanover College*)

Robb, Joe (*Big Oaks National Wildlife Refuge*)

Alexander, M. Ross (*University of Arizona*)

2:00 pm Thursday May 16 Salon D Fire Ecology III

Fire is starting to be recognized as a major disturbance that helps to maintain the diverse mosaic of vegetation in the Eastern Deciduous Forest, although the ability to reconstruct fire occurrence in hardwood trees still lags far behind our expertise in reconstructing fire from conifers. This study examines the fidelity of fire scaring in multiple tree species in the Central Hardwood Region of the Eastern Deciduous Forest. All thirteen species sampled showed evidence of past fires and most samples recorded multiple fire events. Establishment pulses were documented in association with fires events in 1981 and 1995 suggesting that fire may benefit the establishment of some Eastern Deciduous Forest tree species. Every species that was sampled preserved fire scars suggesting that all of the trees in the Eastern Deciduous Forest can be examined for fire history in this hardwood forest type.

Differences in Nothofagus pumilio forest structure and tree-ring growth along altitudinal gradients at different aspect in Southern Patagonia

Srur, Ana*# (*IANIGLA-CONICET-CCT Mendoza*)

Villalba, Ricardo (*IANIGLA-CONICET-CCT Mendoza*)

Lavergne, Aliénor (*IANIGLA-LSCE*)

Rodríguez Catón, Milagros (*IANIGLA-CONICET-CCT Mendoza*)

Amoroso, Mariano (*IANIGLA - CONICET*)
Morales, Mariano (*Departamento de Dendrocronología e Historia Ambiental. IANIGLA CCT CONICET, Mendoza*)
Mundo, Ignacio (*IANIGLA-CONICET*)
Ripalta, Alberto (*IANIGLA-CONICET-CCT Mendoza*)

2:50 pm Tuesday May 14 Salon D Dendroecology II

To estimate the potential changes global warming will impose on the structure and growth of Nothofagus pumilio forests along elevational gradients and different aspect. Structural traits and tree-ring growth patterns were analyzed at three elevational points with different exposures. Along gradient, height and diameter decreased. Tree growth trends over the past 120 years show that low-elevation forests present a significant reduction in growth at sites facing north. Negative growth trends at low elevations are related to increasing summer temperature. Mid- and high elevation stands also showed decreasing trends in growth patterns, though the south facing in both altitudinal strips evidenced an opposite pattern linked to summer temperatures over the 20th century. The establishment of new individuals above treeline is more frequently at south forests. Whereas variations in regional climate influences both the structure and rate of growth of Nothofagus pumilio forests along elevational gradients, differences related to site conditions influences the patterns of tree growth and establishment.

Widespread absent rings have not occurred in boreal and temperate trees outside the American Southwest

St. George, Scott*# (*University of Minnesota*)
Ault, Toby (*National Center for Atmospheric Research*)
Torbenson, Max (*University of Minnesota*)

10:40 am Thursday May 16 Salon A–C Dendroclimatology II

Locally-absent (or "missing") growth rings can potentially cause errors in tree-ring dates and dendroclimatic reconstructions but the frequency, distribution and controls of these features are not well understood at large spatial scales. Here we present a synthesis of locally-absent rings across the Northern Hemisphere during the last millennium based on 2,359 publicly-available tree ring-width records. Because these features have occurred so rarely in high-latitude and high-elevation tree ring-width records, it is not likely that paleotemperature estimates based on these data contain chronological errors due to unrecognized absent rings. If the rate of absent-ring formation were to increase in forests outside of the American Southwest, that behavior would represent a response to environmental stress that is without precedent over the last millennium.

A comparison of tree-ring inferred climate reconstructions from central Minnesota, USA, to 19th century US military fort climate data and high-resolution pollen-inferred climate data

St. Jacques, Jeannine-Marie*# (*Prairie Adaptation Research Collaborative*)
Sauchyn, David (*PARC*)
Vanstone, Jessica (*PARC*)
Cumming, Brian (*Queen's University*)
Smol, John (*Queen's University*)

10:00 am Wednesday May 15Salon A–C Dendroclimatology I

A vital component of dendroclimatology is the validation of reconstructions. Given the scant instrumental data prior to the 20th century, the validation of dendroclimatological reconstructions largely depends on other proxy-inferred climate reconstructions. Here we compare a three-century tree-ring inferred central Minnesota moisture reconstruction based upon sites in Minnesota (e.g. Itasca Park) and adjacent North Dakota to 19th century climate data from nearby Fort Snelling, Minnesota. We also compare our tree-ring based reconstruction and those of other researchers to longer high-resolution pollen-inferred climate data from Lake Mina, Minnesota. The Lake Mina pollen record is dated by a varved-sediment chronology and sampled at a four-year resolution. The pollen-based climate reconstructions are based upon an early-European settlement period pollen-climate calibration set in order to minimize signal distortion and bias from the severe anthropogenic disturbance that has impacted the Midwest: selective logging, fire suppression, deforestation and agriculture.

On the Turquoise Road: Millennium-Long Seasonal Moisture Proxies from the Aztec to Anasazi Areas

Stahle, David*# (*University of Arkansas*)
Villanueva, Jose (*INIFAP Mexico*)

2:30 pm Tuesday May 14 Salon A–C Climate of Recent Millennia I

Turquoise, parrots, and other goods appear to have been exchanged between the ancient Southwest and central Mexico during the Classic and Post-Classic Eras. Exchange along the 'Turquoise Road' brought at least some Mesoamerican ideas into the Southwest, notably at Casas Grandes, Chihuahua (Paquime), and Chaco Canyon, New Mexico. Major questions remain about the importance, timing, and climate dynamics of these connections, but dendrochronology has helped to constrain the chronology of this long-distance exchange. New seasonal moisture proxies have been developed from ancient trees in Mesoamerica and from old trees augmented with archaeological wood and charcoal in northern Mexico and the Southwest. Moisture reconstructions for the past 1,200-years indicate an unusual sequence of large-scale

multidecadal droughts impacting both Mesoamerica and the Southwest during the mid-12th and early 13th Centuries. These simultaneous megadroughts may have contributed to cultural changes and perhaps to decline of long-distance trade along the Turquoise Road.

Modern fire regime approximates historical fire regime in a forest on tribal lands

Stan, Amanda*# (*Northern Arizona University*)
Fulé, Peter (*Northern Arizona University*)
Ireland, Kathryn (*Northern Arizona University*)
Sanderlin, Jamie (*USDA Forest Service*)

9:00 am Thursday May 16 Salon A–D Invited Speaker + Plenary Session (Dendroecology)

We examined the surface fire regime in a ponderosa pine-dominated forest on the Hualapai tribal lands in Arizona. Using 113 fire-scarred trees from five 25-ha sites, we inferred spatio-temporal attributes and regulators of the fire regime over three land-use periods (historical, suppression, modern) between 1702 and 2007. Fire frequency and synchroneity patterns were similar, but fire seasonality was dissimilar, between the historical and modern periods. Statistical models identified a suite of variables representing climate, fuels, and human land uses that were associated with the probability of a site burning over time. Results suggest that the current fire regime in our study area, which predominately consists of prescribed fires implemented since the 1960s, approximates the past frequent surface fire regime that occurred here and in similar forest types on non-tribal lands in the southwestern United States. These results may be useful for informing management in the region as climate warms.

Multi-century reconstruction of Pacific salmon abundance and river discharge in west central British Columbia, Canada

Starheim, Colette* (*University of Victoria Tree-Ring Laboratory*)
Smith, Dan # (*University of Victoria Tree-Ring Laboratory*)
Prowse, Terry (*University of Victoria*)

10:50 am Friday May 17 Salon A–C Dendrohydrology

A multi-species network of tree ring-width and ring-density measurements from new and archived tree-ring chronologies collected in west central British Columbia. Using this network, models were constructed allowing for reconstructions of Pacific salmon abundance and July-August mean runoff for the Skeena and Atnarko rivers. Our models describe intervals of below-average runoff during the early to mid-1700s and parts of the early, mid- and late 1900s, with above-average discharge during the late 1600s, the early 1700s and 1800s, and parts of the early and mid-1900s. Our reconstructions of salmon abundance extend from 1400 AD, 1536 AD and 1638 AD to present. Similar to the long-term discharge records, salmon abundance varied throughout the past six centuries. Significant collapses in the proxy records of Pacific salmon stocks were noted during the early 1400s, the late 1500s, the mid-late 1600s, the early 1700s, the early-mid-1800s and parts of the 1900s.

Four-dimensional reconstruction of gullying processes in a sandy badland of the Spanish Central System

Stoffel, Markus*# (*Laboratory of Dendrogeomorphology, University of Berne*)
Ballesteros Canovas, Juan Antonio (*Geological Survey of Spain*)
Corona, Christophe (*CNRS Geolab Clermont ferrand*)
Lucia, Ana (*Faculty of Science and Technology, Free University of Bolzano*)
Martin Duque, José Francisco (*Complutense University of Madrid*)
Bodoque, José Maria (*University of Castilla-La Mancha*)

1:50 pm Friday May 17 Salon A–D Dendrogeomorphology

The evolution of gully retreat has often been addressed through short-term field monitoring of headcuts or the interpretation of aerial photographs, but rarely studied with dendrogeomorphology. Pinus pinaster roots spanning incised gullies are found in sandy badlands in Spain, where retreat rates of 0.53 m yr–1 have been observed through repeat surveying. The advantage of this case-study site lies in the arrangement of roots with respect to the gully, since they allow determination of gully-head retreat and sidewall erosion, and also permit reconstruction of vertical incision and channel widening within the gully. The site is characterized by abundant exposed roots in a ~100-m long gully segments, thus allowing analysis of temporal changes and identification of extreme erosion events. Based on anatomical changes identified in 120 roots and TLS data, we document, quantify and map changes within the gully with high spatial resolution, over 40 years and in 4D.

Interaction of fire, climate, and human history of northern Mongolia

Suran, Byambagerel*# (*Colorado State University*)
Brown, Peter (*Rocky Mountain Tree-Ring Research*)
Nachin, Baatarbileg (*National University of Mongolia*)
Hessl, Amy (*West Virginia University*)
Pederson, Neil (*Tree Ring Laboratory*)

11:00 am Thursday May 16 Salon D Fire Ecology II

In Mongolia, mean annual temperature has increased by 2OC and forest and steppe fires have increased in temporal and spatial scales in recent decades. We developed a network of fire-scar chronologies across forests in northern Mongolia to place this recent fire history and associated fire climatology into their longer term historical context, and to assess relationships between historical fires and climate and human influences. Trees sampled include both Scots pine (Pinus sylvestris) and Siberian larch (Larix siberica). Cross sections from 10-20 fire-scarred trees were collected from each site using a targeted sampling approach. All sites had fire histories that ranged from 250-450 years, and fire scars were frequent in all stands. Regional fire dates have been identified from local fires, and used to disentangle longer term patterns of top-down climate forcing of fires from bottom-up human factors across this region of the world.

External charring and fire scarring in three western conifers

Sutherland, E.K.*# (*USFS Rocky Mountain Research Station*)

Farella, Josh* (*Laboratory of Tree-Ring Research, University of Arizona, Tucson*)

Wright, David K* (*USFS Rocky Mountain Research Station*)

Hyp, Ian* (*School of Forestry and Conservation, University of Montana, Missoula*)

Smith, K.T.* (*USFS Northern Research Station*)

Falk, Donald A.* (*5School of Natural Resources and the Environment / Laboratory of Tree-Ring Research, University of Arizona,*)

Arbellay, Estelle (*Laboratory of Dendrogeomorphology, Institute of Geological Sciences, University of Berne, Switzerland*)

Stoffel, Markus (*Laboratory of Dendrogeomorphology, Institute of Geological Sciences, University of Berne, Switzerland*)

2:20 pm Thursday May 16 Salon D Fire Ecology III

Fires that injure but do not kill trees cause scars used as proxies for the reconstruction of wildfire history. Understanding about these wildfires – and their relationship to vegetation dynamics and climate –has profoundly affected wildfire and land management policy globally. To better understand scarring in the context of wildfire behavior, landscape and biological processes, and tree species differences, we established a study on forests burned in 2003 near Missoula, Montana. We cut down small trees with visibly charred bark of species Larix occidentalis, Pseudotsuga menziesii, and Pinus ponderosa, and cut cross-sections as high as bark charring occurred. We evaluated tree diameter and age, previous injuries, the number and size of new injuries, their relationship to bark charring and furrows and to topography, and whether the injuries closed over after 9 years recovery. We will discuss the probability of injury given external charring and the variability of scar characteristics among species.

Dendroecology as Multi-disciplinary Dendrochronology

Swetnam, Thomas*# (*Laboratory of Tree-Ring Research University of Arizona*)

8:55 am Tuesday May 14 Salon A–D Welcome + Plenary Session (Ecology)

The roots of dendrochronology reflect the essential nature of our field. In 1929 an astronomer interested in solar variability and its influence on terrestrial processes (A.E. Douglass) made a great breakthrough in archaeological dating, and thereby established a method subsequently applied worldwide in archaeology, climatology, geology, and ecology. The relevance and need for multi-disciplinary applications and perspectives of dendrochronology have never been greater. Climatic changes are underway now in many regions, and combined with increased vulnerability of ecological and human systems, we are increasingly at risk of catastrophic impacts. These risks call for broad-scale perspectives and investigations with direct relevance to understanding coupled-human-environment systems. The expansion of broad-scale networks of tree-ring chronologies has now enabled us to evaluate these systems, including the inter-connections of environmental and human history on regional to global scales. With these perspectives we can provide insights on past and future dynamical behaviors that are un-obtainable by other means. In my presentation I will describe new examples of multi-disciplinary tree-ring studies, focusing on climate, ecosystems and humans.

White Earlywood Rings and Frost Rings in Black Spruce Trees from Manitoba, central Canada.

Tardif, Jacques*# (*Centre for Forest Interdisciplinary Research (C-FIR), University of Winnipeg*)

Waito, Justin (*Centre for Forest Interdisciplinary Research (C-FIR), University of Winnipeg*)

Conciatori, France (*Centre for Forest Interdisciplinary Research (C-FIR), University of Winnipeg*)

10:00 am Wednesday May 15 Salon D Wood Anatomy

Tree-ring anomalies are increasingly used to better understanding of how environmental conditions influence tree-ring formation. Frost rings (FR) constitute a well described anomaly though little is known about their distribution in tree stems. In contrast, white earlywood rings (WER) constitute an un-described anomaly. These rings present a whitish coloured earlywood and they have been observed in numer-

ous coniferous species such as black spruce and jack pine. Our objectives were i) to examine the distribution of FR and WER in black spruce stems, ii) to characterize tracheid dimensions in WER and iii) to investigate potential causes associated with WER formation. Results indicated that FRs were unexpectedly present in almost every year of the chronology. In contrast, WER were rare and were characterized by earlywood with reduced cell wall thickness. The potential linkage between WER and frost damage to the crown prior to ring formation merits further investigation.

Early Neolithic water wells reveal the world's oldest wood architecture

Tegel, Willy*# (*Institute for Forest Growth IWW, University of Freiburg, Germany*)
Hackelberg, Dietrich (*Institute for Forest Growth IWW, University of Freiburg, Freiburg, Germany*)
Büntgen, Ulf (*Swiss Federal Research Institute WSL, Birmensdorf, Switzerland*)
Elburg, Rengert (*Archaeological Heritage Office Saxony, Dresden, Germany*)

4:00 pm Thursday May 16 Salon A–C Old World Dendroarchaeology

We present the first annually resolved and absolutely dated dendroarchaeological findings of four water well constructions from East Germany that survived in a waterlogged environment for 7200 years. The completely excavated well linings reveal an unexpectedly high caliber of carpentry skill.

Our results, based on a total of 151 oak timbers that represent the oldest man-made wooden constructions worldwide, question the principle of continuous evolutionary development in prehistoric technology. We argue that wood technology was essential for the success of the first agricultural societies and postulate that the early Neolithic farmers were also the first carpenters.

Our results emphasize that water wells constitute a unique palaeoenvironmental archive for the overall data-sparse period of the early to mid Holocene. The archaeologically excavated and dendrochronologically dated wooden well constructions offer a holistic perspective on woodland use, resource utilization and woodworking techniques in addition to vegetation and the climate conditions during the Central European Early Neolithic.

Tree-Ring Chronologies from Mozambique

Therrell, Matthew*# (*Southern Illinois University*)
Remane, Ivan (*Southern Illinois University*)

8:30 am Friday May 17 Salon A–C Tropical Dendrochronology

We present results of recently conducted tree ring research on tropical tree species from Mozambique. We have developed new ring-width chronologies of two tropical hardwood species (Millettiia stuhlmannii, Panga panga and Vitex payos, Chocolate berry) from central Mozambique and use these chronologies to investigate the history of climate variability (principally seasonal drought) in the region. Initial analyses of the chronologies indicate that these species are strongly responsive to seasonal rainfall and should be useful for the development of long reconstructions of wet-season climate and linkages to large-scale ocean atmosphere forcing mechanisms. These species and other closely related species are widely distributed in Mozambique and adjacent areas in southern and eastern Africa, which suggests that a wider network of chronologies can be developed in this region.

Spatial Structure of Eastern Mediterranean Tree-Ring Network

Touchan, Ramzi*# (*LTRR*)
Sivrikaya, Fatih (*Kahramanmaras Sütçü İmam University, Kahramanmaras, Turkey*)
Attieh, Jihad (*University of Balamand, Lebanon*)
Stephan, Jean (*Ministry of Agriculture, Lebanon*)
Ketmen, Muzaffer (*Forestry Department, Kahramanmaraş,Turkey*)
Mitsopoulos, Ioannis (*The Global Fire Monitoring Center (GFMC), Germany*)
Christou, Andreas (*Department of Forests, Cyprus*)
Meko, David (*LTRR*)

11:00 am Wednesday May 15Salon A–C Dendroclimatology I

Spatial modes of tree-growth in a newly developed network of 78 chronologies are summarized by S-mode principal components analysis (PCA), using varimax rotation of components. The network, representing eleven species and five countries, is intended for climatic reconstruction. Runs of PCA on two periods are described: 1) 1923-2000 CE (common period for all 78 chronologies), 2) 1251-2000 CE (time coverage by 6 chronologies). Unrotated and rotated PCA loadings are mapped to summarize modes of growth. Scree plots highlight the overwhelming importance of the first PC, presumably representing a broad regional climate signal. PC1 accounts for 29.3% of the tree-ring variance for 1923-2000 and for 49.2% of the variance for 1251-2000. The percentage of explained variance drops sharply after PC1 for both analysis periods. Maps of loadings suggest that both climate and species are important for the spatial structure of the chronologies.

Visual dating of scars based on their appearance on the stem surface

Trappmann, Daniel*# (*Laboratory of Dendrogeomorphology (dendrolab.ch), University of Bern*)
Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)

2:50 pm Friday May 17 Salon A–D Dendrogeomorphology

Gravitational processes frequently threaten settlements and transportation corridors in mountain environments. On forested slopes, injuries in trees form an archive of past events which has been used extensively for hazard and risk assessment in the past. However, dendrogeomorphic dating of events often represents a time-consuming and expensive approach, and is not therefore widely used in practical applications. Here we present a dating approach for scars inflicted to Larix decidua Mill. which solely considers their external appearance. The dating tool is based on age-dependant characteristics of rockfall scars, such as the appearance of resin or the color of the overgrowing tissue. Extensive tests on a rockfall slope in the Swiss Alps demonstrate quite clearly that differences in reconstructed spatio-temporal patterns of rockfall activity are negligible between visual dating and dendrogeomorphic approaches, and therefore point to the potential of this new and efficient tool.

A 1500-Year Reconstruction of Annual Mean Temperature for Temperate North America on Decadal-to-Multidecadal Time Scales

Trouet, Valerie*# (*Laboratory of Tree-Ring Research, University of Arizona*)
Diaz, Henry (*NOAA/CIRES/PSD1*)
Wahl, Eugene (*NOAA/NCDC/Paleoclimatology*)
Viau, Andre (*University of Ottawa*)
Graham, Rochelle (*Hydrologic Research Center, San Diego*)
Graham, Nicholas (*Hydrological Research Center, San Diego*)
Cook, Edward (*Tree Ring Lab, Lamont-Doherty Earth Observatory*)

2:50 pm Tuesday May 14 Salon A–C Climate of Recent Millennia I

We present two reconstructions of annual average temperature over temperate North America: a tree-ring based reconstruction at decadal resolution (1200–1980 CE) and a pollen-based reconstruction at 30-year resolution that extends back to 480 CE. The tree-ring based reconstruction was calibrated against instrumental temperatures, was then reduced to a lower resolution and used as a calibration target for the pollen-based reconstruction.

There are three prominent pre-industrial low-frequency periods in our extended reconstruction: the Dark Ages cool period (500–700 CE), Little Ice Age (1300–1850 CE), and the Medieval Climate Anomaly (MCA; 800–1200 CE). The 9th and the 11th Century are the warmest centuries and they constitute the core of the MCA in our reconstruction. These two warm peaks are slightly warmer than the baseline period, but nevertheless much cooler than North American temperatures during the early 21st Century.

A South American Perspective on Dendroclimatology

Villalba, Ricardo*# (*IANIGLA, CCT-CONICET, Mendoza, Argentina*)

8:00 am Wednesday May 15 Salon A–D Invited Speaker + Plenary Session (Decison Making)

South America is the only landmass in the Southern Hemisphere that extends from the tropics through the mid-latitude Westerlies to the subantarctic domains at ~55˚S. Stretching N-S over a 65° latitudinal transect, dendrochronological records in South American offer unique opportunities to study the interlinked low- and high-latitude processes influencing climate in the Southern Hemisphere and their teleconnections with other regions in the world, particularly the North American continent. The proven potential for long tree-ring records in South America also allows extended analysis of these teleconnections well beyond the short period provided by instrumental data sets. In this presentation we review the state-of-the-art of dendroclimatology across South America with emphasis on the expansion and strengthening of previous chronology networks; the development of new tropical-subtropical tree-ring records for dendroclimatology; the reconstructions of local to sub continental-scale variations in climate and hydrology; the use of South American tree-ring records to reconstruct past variations in the large-scale circulation indices such as ENSO, PDO and SAM; and the contribution of tree rings to the first continental- scale multi-proxy reconstructions of temperature and precipitation across southern South America for the last ca. 400 years. The limitations imposed by the large variations in quality and uneven distribution of the available tree-ring records are also discussed, noting that many South American tree-ring series remain poorly exploited and contain great potential for future dendroclimatic research.

Climatic response of the mexican mountain pine (Pinus hartwegii Lindl.) in northeastern and central Mexico

Villanueva-Diaz, Jose*# (*INIFAP*)
Cerano-Paredes, Julian (*INIFAP*)
Vazquez-Selem, Lorenzo (*UNAM*)
Stahle, D.W. (*University of Arkansas*)
Fulé, Peter Z. (*Northern Arizona University*)

4:10 pm Tuesday May 14 Salon D Network Analysis

A network of ten ring-width chronologies of Pinus hartwegii a treeline species was developed from conifer stands at the Eastern Sierra Madre (ESM) and the Trans-Mexican Volcanic Belt (TVB) in the Valley of Mexico where the species was present. The PCA grouped the chronologies into two main components, PC1 for TVB and PC2 for ESM chronologies. ENSO in its warm phase (El Niño) and cold phase (La Niña)

had significant impacts in the chronology index values. The La Niña phase produced dry conditions for the northeastern region and wet conditions for the Valley of Mexico, whereas dry conditions dominated both regions during intense warm ENSO events. The ENSO dipole apparently divided by the Tropic of Cancer may have significant implications to understand the historical impact of this circulatory pattern in the hydroclimatic variability of Mexico for the last 600 years.

New multi-century earlywood and latewood tree-ring chronologies refine understanding of climate-growth relationships at the southern range margin of longleaf pine (Pinus palustris R. Mills)

Wilding, Thomas* (*Tree-Ring, Earth, and Environmental Science Laboratory*)

Flinner, Nicholas # (*Department of Earth and Environmental Systems - Indiana State University*)

Mirti, Thomas (*St. Johns River Water Management District*)

Larson, Evan (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)

11:35 am Tuesday May 14 Salon A–C Climate Growth Relations II

We developed new longleaf pine (Pinus palustris R. Mills) chronologies from living trees and remnant stumps from two sites in central Florida to determine the relationship between tree-growth and climate near its southern range margin and to determine the potential to inform water resource managers through hydrologic reconstructions. The chronologies extended from 1551–2006 and 1536–2006 with inter-series correlations of 0.46 and 0.40 and mean sensitivities of 0.37 and 0.43, respectively. Total ring-width, earlywood, and latewood measurements exhibited several significant correlations with climate variables, including an inverse relationship between earlywood widths and winter temperature and positive relationship with latewood widths and summer precipitation. Previous research indicates cold winter temperatures may limit the northern range of longleaf pine; our results suggest that winter temperature may also play an important role in determining the species southern range boundary as well, with implications for how the species may respond to climate change.

Shrubs – Expanding opportunities for dendrochronologists

Wilmking, Martin*# (*University Greifswald*)

Hallinger, Martin (*University Greifswald*)

Myers-Smith, Isla H. (*Université de Sherbrooke, Canada*)

Baittinger, Claudia (*National Museum of Denmark*)

Beck, Pieter (*Woods Hole Research Center, USA*)

Beil, Ilka (*University of Greifswald, Germany*)

Blok, Daan (*University of Copenhagen, Denmark*)

Boulanger-Lapointe, Noémie (*Université du Québec à Trois-Rivières, Canada*)

Buchwal, Agata (*Adam Mickiewicz University, Poznan*)

Buras, Allan (*University of Greifswald, Germany*)

Dawes, Melissa (*WSL Institute for Snow and Avalanche Research SLF, Switzerland*)

Forbes, Bruce C. (*University of Lapland, Finland*)

Hik, David (*University of Alberta, Canada*)

de Jong, Rogier (*University of Zurich, Switzerland*)

Jørgensen, Rasmus Halfdan (*University of Copenhagen, Denmark*)

Lantz, Trevor (*University of Victoria, Canada*)

Lévesque, Esther (*Université du Québec à Trois-Rivières, Canada*)

Macias-Fauria, Marc (*University of Oxford, UK*)

Naito, Adam T. (*Texas A&M University, USA*)

Ravolainen, Virve (*University of Tromsø, Norway*)

Rayback, Shelly A. (*University of Vermont, USA*)

Rixen, Christian (*WSL Institute for Snow and Avalanche Research SLF, Switzerland*)

Schaepman-Strub, Gabriela (*University of Zurich, Switzerland*)

Schmidt, Niels Martin (*Aarhus University, Denmark*)

Speed, James (*Norwegian University of Science and Technology*)

Tape, Ken D. (*University of Alaska Fairbanks, USA*)

Trant, Andrew (*University of Victoria, Canada*)

Vellend, Mark (*Université de Sherbrooke, Canada*)

Weijers, Stef (*University of Bonn, Germany*)

Wheeler, Julia (*WSL Institute for Snow and Avalanche Research SLF, Switzerland*)

Wipf, Sonja (*WSL Institute for Snow and Avalanche Research SLF, Switzerland*)

Zimowski, Matheusz (*University of Greifswald, Germany*)

1:30 pm Friday May 17 Salon A–D Dendrogeomorphology

Trees have long been the dominant life-form used in dendrochronology. In the last few years, however, dendroecology of shrubs comprises a rapidly expanding and vigorous field, especially in arctic, subarctic and alpine regions. But shrubs are not simply small trees, rather a different life strategy to cope with strong environmental variations. For example, issues of crown architecture, resource allocation and clonal growth pose new challenges to the application of traditional dendrochronological methods. Here we review the current field of shrub dendro-sciences and outline the new opportu-

nities, main challenges and recent methodological advances. As an example, we will present initial results of a circumpolar shrub synthesis effort drawing on data from 34 locations and 25 shrub species. Climate sensitivity did not seem to vary significantly by genus or potential canopy height, but seemed highest at the centre of the sampled climate gradient rather than at the edge as expected.

The Scottish Pine Project: Trees, Lakes and Climate

Wilson, Rob*# (*University of St Andrews*)
Rydval, Miloš (*University of St Andrews*)
Cunningham, Laura (*University of St Andrews*)
Anchukaitis, Kevin (*Woods Hole Oceanographic Institution*)
Davies, Siwan (*Swansea University*)
Loader, Neil (*Swansea University*)
Edwards, Kevin (*University of Aberdeen*)
Twiddle, Claire (*University of Aberdeen*)
Gunnarson, Björn (*Stockholm University*)

4:10 pm Tuesday May 14 Salon A–C Climate of Recent Millennia II

The living pine network across the Scottish Highlands is now numbered at ~50 sites with almost complete representation of all remnant semi-natural pine woodlands. Due to human impact in the 18th/19th centuries most of the sites are only well replicated back for ~200-250 years. Extension of these chronologies is only possible using both historical and/or sub-fossil material. Sub-fossil samples have been extracted from several lakes in the Northern Cairngorms and radiocarbon dating identifies material from multiple periods over the last 8000 years. We have also collected sediment cores from two lakes and undertaken a range of palynological and paleolimnological analyses. Results of this multi-proxy comparison will be presented. Despite tree-ring calibration explaining >50% of the summer temperature variance, problems exist. Detrending biases related to the human disturbance and temporally unstable response in ring-width data first need to be overcome before any new dendroclimatic reconstruction is published for this region.

Multi-century Variability in Synoptic Circulation Patterns over Western North America and the North Pacific

Wise, Erika*# (*Department of Geography, University of North Carolina at Chapel Hill*)
Dannenberg, Matthew (*Department of Geography, University of North Carolina at Chapel Hill*)

4:50 pm Tuesday May 14 Salon A–C Climate of Recent Millennia II

Long-term records of atmospheric pressure and circulation patterns are needed to understand the drivers of past droughts and to evaluate how future climate changes may impact hydroclimatic systems. We utilized 500hPa geopotential height (GPH) data from the Twentieth Century Reanalysis (V2) project and existing tree-ring chronologies from the International Tree-Ring Data Bank to reconstruct a multi-century record of year-to-year variation in synoptic circulation patterns. We tested four Climate Field Reconstruction methods: CCA, RegEM-ridge, RegEM-TTLS, and PPR. The RegEM-ridge method, which produced the most robust calibration and validation statistics, was used to produce a 2° x 2° gridded reconstruction of atmospheric pressure over western North America and the northeastern Pacific Ocean. This GPH reconstruction, which rivals the strength of tree-ring based temperature and precipitation reconstructions, ties tree growth to climate-delivery processes and allows dominant synoptic features of the past century to be compared with earlier time periods.

Linking Tree-Ring Research and Resource Management through Collaboration

Woodhouse, Connie*# (*University of Arizona*)
Ferguson, Daniel (*University of Arizona*)
Rice, Jennifer (*University of Georgia*)
Lukas, Jeffrey (*University of Colorado*)

8:40 am Wednesday May 15Salon A–DInvited Speaker + Plenary Session (Decison Making)

The need for science to inform decision making, particularly in the light of the need to adapt to a changing environment, has provided opportunities for scientists to engage with resource managers. Tree-ring scientists are well-positioned to respond to these needs. Planning requires some knowledge of what may occur in the future, and somewhat ironically, looking into the past is a key source of this knowledge. In the absence of reliable, long-term forecasts of future hydrology, tree-ring reconstructions of past streamflow have become credible, relevant, and acceptable tools for water resource planning in the western US. While the confluence of prolonged drought, increasing demand, and anticipated changes in climate have all motivated the adoption of tree-ring information, other factors have also been influential in this shift. We provide an overview of the suite of factors that have led to acceptance and use of tree-ring information in water planning and management.

Spatial Changes in the Seasonal Mixing Proportions of Available Soil Moisture in the High Elevations of Arizona and New Mexico

Wright, William*# (*Laboratory of Tree-Ring research, The University of Arizona, Tucson, AZ 85721*)
Leavitt, Steven (*Laboratory of Tree-Ring Research, The University of Arizona, Tucson, AZ 85721*)

Woodhouse, Connie (*School of Geography and Development, The University of Arizona, Tucson, AZ 85721*)
Monson, Russell (*School of Natural Resources and Environment Biological Sciences East, The University of Arizona, Tuscon, AZ 85721*)

11:30 am Friday May 17 Salon D Isotopes in Dendrochronology II

The North American Monsoon dominates climate in the U. S. Southwest, with discrete cool season and warm season phases. North American Monsoon forcings influence ecosystem synchronization in the U.S. southwest, yet spatial information is almost nonexistent about shifts in the proportions of cool season and warm season precipitation in soil moisture available for plant growth. The influence of the warm season phase of the monsoon weakens from south to north, with little warm season precipitation occurring in many years in the north, but with enhanced persistence of cool season-derived soil moisture later into the year. Similar changes are noted with elevation increase. Analyses of the presence and intensity of false latewood bands and subannual analyses of the δ18O in the tree cellulose along latitudinal and elevational transects potentially can indicate spatial and temporal patterns in seasonal moisture availability. Here we present preliminary results from these analyses.

Drought history inferred from tree-ring δ13C and δ18O in the Middle of the Tianshan Mountains of China, and linkage with the North Atlantic Oscillation

Xu, Guobao*# (*State Key Laboratory of Cryospheric Sciences, Cold and Arid Regions Environmental and Engineering Research Institute*)
Liu, Xiaohong* (*State Key Laboratory of Cryospheric Sciences, Cold and Arid Regions Environmental and Engineering Research Institute*)
Qin, Dahe* (*State Key Laboratory of Cryospheric Sciences, Cold and Arid Regions Environmental and Engineering Research Institute*)
Chen, Tuo* (*State Key Laboratory of Cryospheric Sciences, Cold and Arid Regions Environmental and Engineering Research Institute*)

11:50 am Friday May 17 Salon D Isotopes in Dendrochronology II

We established annual tree-ring δ18O and δ13C chronologies using Tianshan spruce (Picea schrenkiana) in the central Tianshan Mountains of China. Temperature has positive effect on tree-ring δ18O and δ13C in study area, while precipitation and relative humidity have negative effects. The standardized precipitation-evapotranspiration index (SPEI) considered all of these effects and was significantly negatively correlated with tree-ring δ18O and δ13C. We combined the tree-ring δ18O and δ13C series to reconstruct the past 192 years of SPEI, which accounted for about 46% of the total variance. Our reconstruction reveals several wet and dry periods and has good agreement with other records. Wavelet analysis showed quasi-periodic 10-, 20-, 30- and 70-year fluctuations. The 10- and 30- may reflect the potential influence of the solar activities and North Atlantic Oscillation (NAO). Overall, this study indicates that the SPEI is a potential drought index, and the NAO affects the regional moisture conditions in the long term.

Historical high-severity fire in mixed-conifer forest, Grand Canyon North Rim

Yocom, Larissa*# (*Northern Arizona University*)
Fulé, Peter (*Northern Arizona University*)
Bunn, Windy (*National Park Service*)
Gdula, Eric (*National Park Service*)

9:50 am Tuesday May 14 Salon D Fire Ecology I

The high-elevation forests of Grand Canyon´s North Rim have supported the most severe fires in the Park´s recorded history. Since 2000, 11,650 acres have burned with high severity, occasionally in patches exceeding 1,000 acres. Information about the historical arrangement in time and space of severely burned forests is valuable for comparison to the modern fire regime, allowing managers to confirm the ecological basis of current fire management or make adjustments if appropriate. Our question was: what is the best estimate of historic high-severity patch sizes, spatial arrangement, and temporal arrangement of fire dates in high elevation forests on the North Rim? We collected cores from 911 trees in 72 plots, stratified by dominant tree species. We analyzed tree pith dates to determine whether each plot represented an even-aged cohort, possibly resulting from high-severity fire. Preliminary results suggest evidence of historical high-severity fire, although tree ages varied widely across the landscape.

Poster Presentations

A study of dendrochronological and dendroclimatological potential of Taxus baccata in different habitats during the last millennium in the UK

Agin, Beheshteh*# (*Brunel University, London*)
Leroy, Suzanne (*Brunel University, London*)
Moir, Andy (*Brunel University, London*)

Recently yew (Taxus baccata) has shown promising potential to be used in dendrochronological and dendroclimatological analysis in Ireland, western Himalaya and England. So far however, few studies on yew dendrochronology and dendroclimatology exist. The potential for obtaining long yew chronology with strong response to climatic variables are the main reasons of this research. Yew is native to Europe and can be found wild from Asia to North America in woodlands, and planted in churchyards, etc. and is well suited to mild oceanic climate (abundant rainfall and high humidity) occurring widely on chalk and limestone. It is one of the best conifers for dendrochronological and dendroclimatological analysis: i.e. longevity, slow-growth, salt-tolerance. The aim of this research is to explore yew's potential to be used as an alternative species for dendrochronological and dendroclimatological analysis in future and filling the data gaps, especially over the last millennium.

Informing carbon balance models with tree-ring data from a high-elevation Pinus ponderosa site in New Mexico

Alexander, M Ross*# (*University of Arizona, LTRR*)
Moore, David J.P. (*University of Arizona*)
Trouet, Valerie (*Laboratory of Tree-Ring Research, University of Arizona*)

Modeling carbon uptake by terrestrial ecosystems (Gross Primary Production (GPP)) is important because plants transfer approximately 120Gt of Carbon, annually, from the atmosphere to the biosphere. This sequesters a portion of the anthropogenic carbon being released to the atmosphere. However, GPP models are inaccurate due to the difficulty of measuring all carbon within the system. Here, we investigate whether combining fluxtower-based GPP estimates with tree-ring based biomass measurements can improve model constraints, resulting in more accurate projections. We collected tree-ring samples from two sites in the Jemez mountains, NM. The pilot data show that ponderosa pine trees of similar age (~60-65 yrs.) showed significant differences in growth rate. For 2011, we calculated a tree-level biomass range of 6-206 kg and stand-level annual net primary production of 32.8 kg/m2. Climate data shows a significant negative correlation with springtime temperatures, showing almost zero annual net primary productivity during warm years.

Climate influences on radial growth of Nothofagus pumilio near treeline on Choshuenco Volcano, Northern Patagonia, Chile

Alvarez, Claudio*# (*Biogeography Lab University of Colorado Boulder*)
Veblen, Thomas* (*Biogeography Lab University of Colorado Boulder*)
Christie, Duncan* (*Laboratorio Dendrocronologia y Cambio Global Universidad Austral de Chile*)
Gonzalez-Reyes, Alvaro* (*Laboratorio de Dendrocronologia y Cambio Global Universidad Austral de Chile, Departamento de Geología, Facultad de Ciencias físicas y Matemáticas, Universidad de Chile*)
Iglesias, Waldo* (*Laboratorio de Dendrocronologia y Cambio Global Universidad Austral de Chile*)
Rojas, Moises* (*Laboratorio Dendrocronologia y Cambio Global Universidad Austral de Chile*)

Given the expected sensitivity of radial growth of trees near altitudinal treeline to global warming, we examined recent variability in growth of Nothofagus pumilio in monospecific stands near altitudinal treeline on Choshuenco Volcano (40oS latitude) in Chile. Preliminary results based on a chronology of 99 tree-ring series for the period from 1768 to 2010 yielded a mean series intercorrelation of 0.480. Focusing on the period after 1877 when the sample size exceeds 40 series, we produced standard and residual chronologies for analysis of relationships with local instrumental climate records as well as broad-scale climate drivers such as the Southern Annular Mode. Preliminary results show a sharp but short-lived decline in tree growth from 1960 to 1970 and a second long-lasting decline after approximately 1981 which are consistent with the positive trend in SAM during these time periods.

Wave regeneration after wind blowdowns in Nothofagus forests in southern Patagonia

Amoroso, Mariano*# (*IANIGLA - CONICET*)
Ruiz, Matias (*Universidad Nacional de Cuyo*)
Villalba, Ricardo (*IANIGLA - CONICET*)

Wave regeneration describes a process involving the death of trees along a narrow moving front perpendicular to the direction of the prevailing winds. For southern Patagonia, regenerating waves are known for the southern island of Tierra del Fuego but have not been reported for the continental forests yet. We reconstructed the history of wave mortality and regeneration patches in Nothofagus pumilio forests in Santa Cruz, Argentina. We used vegetation transects along the regeneration patches and adjacent undisturbed forests to reconstruct mortality and establishment patterns. With this information we determined the occurrence, intensity and synchrony of windstorms along patches. Intense sampling along the edge allowed us to describe mortality and growth patterns in the residual trees after the windstorms. Furthermore, we identified disturbance interaction with avalanches at the highest patches. This study represents the first report of wave regeneration for the continental and mountain forests in southern Patagonia.

Forward modeling the dendroclimatology of Common Era volcanic eruptions

Anchukaitis, Kevin*# (*Woods Hole Oceanographic Institution*)

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Vaganov, Eugene (*Siberian Federal University, Krasnoyarsk, Russia*)

Wilson, Rob (*University of St Andrews*)

Buchwal, Agata (*Institute of Geoecology and Geoinformation, Adam Mickiewicz University, Poznan, Poland*)

Büntgen, Ulf (*Swiss Federal Research Institute WSL, Switzerland*)

Cook, Edward (*Lamont Doherty Earth Observatory of Columbia University*)

D'Arrigo, Rosanne (*Lamont Doherty Earth Observatory of Columbia University*)

Esper, Jan (*Department of Geography, Johannes Gutenberg University, Mainz, Germany*)

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Frank, David (*Swiss Federal Research Institute WSL, Switzerland*)

Nearly all reconstructions of the large-scale temperature history of the Common Era rely on tree-ring proxies. Estimates of past climate variability and the sensitivity of the ocean-atmosphere system to changes in solar and volcanic forcing are likewise informed by these reconstructions. In concert with ice cores proxies tree-rings provide one of the primary means for identifying the timing of (often poorly observed) volcanic eruptions and the ensuing climate response. Here, we use a previously-validated and properly parameterized forward model of tree-ring formation to simulate suites of actual tree-ring observations and to explore the sensitivity of the data-model intercomparison to the amplitude of the environmental forcing, the spatiotemporal covariance of the climate response and the proxy network, the seasonality of forcing and response, and to investigate the likelihood of systematic, large-scale amplitude and chronological bias in the tree-ring proxies.

Proxy and model evidence for ENSO-mediated coupled Pan-Pacific Drought and Pluvial Modes in North America and Asia

Anchukaitis, Kevin*# (*Woods Hole Oceanographic Institution*)

Cook, Edward (*Lamont Doherty Earth Observatory*

of Columbia University)

A network of more than a thousand tree-ring chronologies across the Northern Hemisphere provides precisely dated annual resolution data on past droughts and pluvials spanning the last two thousand years (the Common Era). Hydroclimate reconstructions using these proxies consistently reveal epochs of anomalously dry and wet conditions of substantially greater magnitude and duration than those recorded over the last century of direct observations. Using networks of tree-ring chronologies from North America and Asia, we identify the extent and duration of these events, and link their spatiotemporal fingerprint to large-scale modes of ocean-atmosphere variability. In particular, Pan-Pacific drought and pluvial patterns are linked to interannual and decadal variability in the El Nino-Southern Oscillation, while proxy and climate model evidence show that periods of weak interannual variability in the tropical Pacific coincide with rare but severe periods of synchronous North American and Monsoon Asian 'megadrought' and reveal additional influences.

Dating the Mid-Holocene History and Glacial Stratigraphy of Wachusett Inlet, Glacier Bay National Park and Preserve, Southeast Alaska

Appleton, Sarah*# (*The College of Wooster/The University of Minnesota*)
Wiles, Gregory (*The College of Wooster*)
Lawson, Daniel (*Cold Regions Research and Engineering Lab*)
Wiesenberg, Nicholas (*The College of Wooster*)
Wilch, Joseph (*The College of Wooster*)

A 570-year floating tree-ring-width chronology was built from samples of in situ forests and detrital logs of 27 trees from a tributary valley of Wachusett Inlet in Glacier Bay National Park and Preserve. Calibrated radiocarbon dates provide absolute ages for the ring-width series and stratigraphic analyses show that the trees were killed by a series of ice advance-related sedimentation events at approximately 3,000 yr. BP. The ring-width chronology strongly crossdates with a ring-width series from Geikie Inlet, 30 km to the southwest, suggesting the ice expansion covered much of the mid-to-upper watershed at 3,000 yr. BP. The ice advance in Geikie Inlet occurred between 3,400-3,000 yr. BP after the advance in the tributary valley, which dates to 3,000-2,800 yr. BP. The coupled use of radiocarbon dating with tree-ring-width chronologies adds decadal resolution to the glacial chronology within Glacier Bay.

Resin duct characteristics in the wood of fire-scarred North American conifers

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Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)
Sutherland, Elaine K. (*USDA Forest Service, Forestry Sciences Laboratory, Missoula, USA*)
Smith, Kevin T. (*USDA Forest Service, Northern Research Station, Durham, USA*)
Falk, Donald A. (*Laboratory of Tree-Ring Research, University of Arizona, Tucson, USA*)

Traumatic resin ducts form in xylem and phloem tissue of conifers in response to abiotic wounding, fungal invasion, and insect attack. Little is known about resin duct characteristics in the wood of fire-scarred trees. The aim of this study is to quantify changes in traits of both axial and radial resin ducts, along with those of associated epithelial cells and fusiform rays, in 2 individuals each of Larix occidentalis and Pseudotsuga menziesii. Transverse and tangential microsections were cut from samples for light microscopy. Using image analysis, anatomical measurements of cells are being performed three-dimensionally: at 4 heights along the tree axis, within 4 cm from the wound margin and in different rings, including 2 rings from the wound xylem. The forthcoming results will provide new insights into one of the most important defense mechanisms of trees.

Fire History in Madrean Sky Islands

Arizpe, Alexis*# (*University of Arizona*)

Pine forests of the Southwestern United States were characterized historically by high-frequency low-severity surface fire events evident in the tree-ring record. Twentieth century fire suppression has disrupted these fire regimes in US forests leading to recent unprecedented fire severity and behavior across the Western US. Forests of Northwestern Mexico are similar in both species composition and climate to Southwestern US forests, however land management and historical practices are different. We have characterized fire regimes across five sites ranging from the northern extent of the Sierra Madre in Eastern Sonora, to the Madrean Archipelago of sky islands across the US-Mexico border. Presence of frequent 20th century fire provides a unique opportunity to characterize modern fire regimes in context with climate change. These sites provide a needed proxy for understanding fire regimes, forest resilience and climate change across the western US in forests analogous to historic ecosystems.

Using exposed roots and terrestrial laser scanner for high-accuracy erosion rate estimation in bad-

lands

Ballesteros Canovas, Juan Antonio*# (*Spanish Geological Survey*)
CORONA, Christophe (*CNRS GEOLAB*)
Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)
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Bodoque, Jose María (*Mining and Geological Engineering Department, University of Castilla-La Mancha, Campus Fábrica de Armas, Avda.*)
Martin-Duque, Jose Francisco (*Department of Geodynamics, Complutense University of Madrid, C/ José Antonio Novais 2, E-28040Madrid, Spain*)

Badlands are one of the most significant features of erosion and cause huge environmental and economic impacts to society, especially in semi-arid areas with strongly marked seasonal climatic contrasts. In this study, we present a methodology based on the analysis of exposed roots from Pinus pinaster Ait. and terrestrial laser scanning (TLS) to estimate medium-term erosion rates in a badland of the Guadarrama Range (Central System, Spain). Exposed roots orientated in perpendicular and parallel positions with respect to flow direction were sampled on three slopes with different hydrologic response unites. Anatomical changes in root rings have been used to identify the year of exposure. In addition, micro-topographic analyses from TLS data has been carried out to define the erode soil and to quantify the uncertainty related to micro-roughness. Finally results are compared with short-term observed erosion rates data.

Assessment of wood density structures of flood-damages trees with X-ray computed tomography and variogram analyses

Ballesteros Canovas, Juan Antonio*# (*Spanish Geological Survey*)
Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)
Guardiala-Albert, Carolina (*Spanish Geological Survey, C/ Ríos Rosas, 23, 28003 Madrid, Spain*)
Díez-Herrero, Andres (*Spanish Geological Survey, C/ Ríos Rosas, 23, 28003 Madrid, Spain*)

Dendrogeomorphology has been demonstrated to be a valuable tool for studying hydrogeomorphic processes in ungauged or poorly catchment. However, an appropriate knowledge of the response of trees to these processes is crucial for proper interpretation of dendrochronological signal. In this communication, we present results from the study of damages riparian trees (Alnus glutinosa, Fraxinus angustifolia and Salix atrocinerea) by floods from the Spanish Central System by mean of X-ray computed tomography (XRCT). Analyses are focused on macroscopical features as well as on the characterization of internal density variations using a novel geostatistical application. The objective is to understand the eco-physiological impact of floods in three common Mediterranean riparian trees species and, therefore to improve the tree sampling efficacy for futures dendrogeomorphological studies.

Including tree ring data in a flood risk analysis: the case of Navaluenga (Centra Spain)

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Sánchez-Silva, Mauricio (*Associate Professor, Department of Civil and Environmental Engineering, Universidad de Los Andes, Bogotá Colombia*)
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Díez-Herrero, Andrés (*Department of Research and Geoscientific Prospective, Geological Survey of Spain (IGME), Ríos Rosas 23, Madrid E-28003, Spain*)

Flood risk management decisions require the rational assessment of mitigation strategies. Here, we present a study case where tree-rings have been used for including past flood dating into a cost-benefit methodology to compare structural alternatives for flood-risk mitigation in Navaluenga (Ávila, Spain). Uncertainties have been assessed by comparing the flood frequency obtained with a hydrological model with those obtained by extending the existing flow record from dendrogeomorphological analysis of riparian trees. Flood damages have been assessed by means of depth-damage functions, whereas the flooded urban areas were obtained running the hydraulic model. We also have taken into account observed uncertainties derived from differences in the results of roughness calibration using the flow gauge and those obtained using scars on trees. Results shows that the improvements on knowledge of the flood process derived from the incorporation of non-systematic data (i.e. Tree-ring data) can be used into decision making procedures.

Documenting Traumatic Resin Ducts from Avalanche Injury in Abies concolor and Pseudotsuga

menziesii in Northern Utah

Bekker, Matthew*# (*Brigham Young University*)
Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)

Tangential rows of traumatic resin ducts (TRDs) are reliable indicators of injury from geomorphic disturbance in conifer species such as Pseudotsuga, Picea and Larix, but very limited research on Abies species suggests that they produce TRDs only rarely and very close to the wound. We documented the strength, tangential (%) and radial (years) extent, and position within the growth ring of TRDs in cross sections from 10 Abies concolor (white fir) and 7 Pseudotsuga menziesii (Douglas-fir) injured by avalanche activity in the Wasatch Mountains of Utah. All samples from both species contained moderate-strong TRDs in the year of the injury that weakened tangentially and radially. Mean tangential extent in white fir was 13% compared to 20% for Douglas-fir. These results suggest that TRDs in white fir are sufficiently strong and extensive to be identified using an increment borer, providing to-the-year dating of geomorphic events without necessitating cross sections or wedges.

Reconstructing Forest Structure, Fire History, and Stand Spatial Patterns in Colorado Front Range Montane Forests to Inform Forest Restoration: The Front Range Forest Reconstruction Network

Brown, Peter*# (*Rocky Mountain Tree-Ring Research*)
Cheng, Antony S. (*Colorado Forest Restoration Institute, Colorado State University*)
Huckaby, Laurie (*US Forest Service Rocky Mountain Research Station*)
Battaglia, Michael (*Rocky Mountain Research Station*)
Fornwalt, Paula (*Rocky Mountain Research Station*)

Quantitative data on historical forest structure (tree composition, densities, basal areas, size distributions, and spatial arrangements) are rare for Colorado Front Range forests dominated by ponderosa pine. The Front Range Forest Reconstruction Network was initiated in spring, 2012, to develop these metrics to better inform ecological restoration efforts, and to examine changes in forests and fire regimes across spatial environmental gradients and temporal climatic variation. We are using a consistent sampling protocol to map all pre-settlement tree evidence in randomly selected 0.5-ha plots, to age subsamples of pre- and post-settlement trees, and to collect fire-scar evidence. To date we have sampled 73 plots collected across 13 landscape units. We present results from those plots in this talk. An additional field season in 2013 is planned, with a final goal of ~150 total plots across the region.

Mammoths, mastodons, and tree rings: Dendrochronology of wood found during the Snowmastedon Project, Colorado

Brown, Peter*# (*Rocky Mountain Tree-Ring Research*)
Nash, Stephen (*Denver Museum of Nature & Science*)
Kline, Douglas (*Denver Museum of Nature and Science*)

A phenomenal late Pliestocene (interglacial or interstadial) faunal assemblage has been collected from the Snowmastedon site (2270 m) in central Colorado. The assemblage contains several thousand bones from dozens of species, including many individual mammoths and mastodons. An equally impressive number of wood fossils have been collected. Many of the fossils, especially the largest logs (~40-60 cm diameter), were collected from the "beach", where they appear to have been washed up on the side of the interglacial lake and buried. Most of the wood is Abies sp. or Pseudotsuga menziesii. Dendrochronological analyses have compared the fossil growth patterns to modern trees, and intriguing crossdating results suggest that at least some of the trees from the beach may have died at the same time. The dendrochronological evidence supports a prevailing hypothesis that an abrupt liquefaction event in the sediments surrounding the lake may have trapped many of the Snowmastedon animals.

Updating the Presque River Isle Hemlock Chronology, Porcupine Mountains Wilderness State Park

Brownell, Gabriel*# (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)
Waupoose, Brennan (*College of Menominee Nation*)
Varrientos, Giselle (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)
Duquain, McKaylee (*University of Wisconsin - Madison*)
Larson, Evan (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)

We updated and examined the stability of the climate response exhibited by the Presque Isle River eastern hemlock chronology developed by Dr. Ed Cook in 1983 along the shores of Lake Superior in northern Michigan. The original

and new chronologies were significantly correlated (r2 = 0.9), indicating we successfully updated the original chronology. The updated chronology spanned the period AD 1444–2011 with EPS>0.9 from 1700–2011, and exhibited a significant inverse relationship with previous summer temperature and a significant positive relationship with current spring temperature. Every ancient tree we cored was rotten and we observed numerous recently dead and down trees at the site. This underscores the importance of updating chronologies as trees begin to reach and exceed their maximum lifespans.

Mean sensitivity isn't! A description of mean sensitivity as a useful statistic in dendrochronology

Bunn, Andrew*# (*Dept of Env. Sciences, Western Washington University*)
Jansma, Esther (*Utrecht University*)
Korpela, Mikko (*Aalto University and University of Helsinki*)
Westfall, Robert (*USDA Forest Service, Pacific Southwest Research Station, Albany, CA, USA*)
Baldwin, James (*USDA Forest Service, Pacific Southwest Research Station, Albany, CA, USA*)

Abstract There is a small but substantial literature showing mean sensitivity to be a poor statistic for describing the properties of tree-ring data. Yet, it continues to be widely used. We show in a logical and straightforward way that mean sensitivity is an inefficient estimator of the coefficient of variation and that mean sensitivity can be expressed as a function of the variance and first-order autocorrelation of a time series. Mean sensitivity is proportional to variance in cases without high autocorrelation but is harder to interpret than either variance or autocorrelation. Thus, it is hard to justify the use of mean sensitivity in many, or any, circumstances. We suggest that is is more worthwhile to describe tree-ring data in terms of a few simple time series properties familiar to most dendrochronologists and give examples of how to do so.

History of Dendrochronology: Retrospect and Prospect

Capshew, James*# (*Indiana University*)

The scientific study of tree rings – the modern field of dendrochronology – dates to the early 20th century with the pioneering research of Douglass at Arizona. Since that time, it has become a respected field, with training and research laboratories, specialized journals, diverse applications to other areas of science, scientific societies, and a worldwide network of researchers. Even though dendrochronology has contributed valuable research methods and findings to climatology, ecology, and archaeology, among others, and was responsible for the identification of the oldest non-clonal living organism (bristlecone pine), its historical trajectory has been studied by few (e.g., Cohen; McGraw; Nash; Webb). Review of existing historical literature identifies analytical themes, patterns of interpretation, and scholarly lacunae. With this background, potentially fruitful historical questions are sketched and possible research avenues are explored, including academic genealogy, oral history, ethnography, and public history. Historical study can contribute to public understanding of dendrochronology as well as to foster appreciation of heritage among dendrochronologists.

Dendrochronology and Ancient Egypt: A Survey of Commonly Used Species

Caroli, Rebecca*# (*University of Arizona*)

As a result of a favorable preservation and the ancient Egyptian practice of ritually provisioning individuals for the afterlife, hundreds of tons of wood have been recovered from archaeological excavations in Egypt. Ancient ships, coffins, furniture and architectural timbers provide a potentially robust source of material for dendrochronological investigations. As early as 1932, A.E. Douglass was in contact with prominent Egyptologists exploring the possibility of constructing a dendrochronology for Egypt, concluding that a sufficient volume of material existed even then to make substantial progress. This poster surveys the most common species of wood that were exploited in sufficient quantities from the Predynastic to the Late Period (c. 3100-664 BC) to be dendrochronologically useful. An evaluation of the commonly used species is provided (e.g, Cedrus libani, Ficus sycomoros, Hyphaene thebaica) with summary statements about each species' potential utility in building a chronology for ancient Egypt.

Controlling for modern sampling bias through tree-level effects

Cecile, Jacob*# (*University of Guelph*)
Anand, Madhur (*University of Guelph*)

Non-random sampling protocols and differences in mortality between trees of different growth rates has been suggested to cause widespread, systematic bias in dendrochronological reconstructions of tree growth, a phenomenon known as modern sample bias. By making explicit the model of tree growth used in regional curve standardization, it becomes evident that tree ring data can be stored and manipulated in arrays, while the regional curve and standardized chronology (forcing) can be thought of as vectors. In this framework, we describe the origin of trend-in-signal bias in re-

gional curve standardization and the improvements shown by using signal-free standardization. We then extend signal-free standardization and show its equivalence to a new standardization technique, factor regression standardization. A tree-specific effect can be added to the model to account for differing-contemporaneous-growth rate bias, eliminating modern sample bias and providing a novel tree-level index of productivity.

Climatic response of Pinus cooperi radial growth in Durango, Mexico

Cerano-Paredes, Julián*# (*INIFAP*)
Villanueva-Díaz, José (*INIFAP*)
Cervantes-Martínez, Rosalinda (*INIFAP*)
Duran-Guerra, Omar (*INIFAP*)

With the objective to increase the network of climate-sensitive chronologies in Mexico, the dendroclimatic potential of Pinus cooperi a conifer species distributed in the western section of Durango, Mexico was analyzed. Increment cores were taken from selected trees along an altitudinal gradient (2300 to 2900 m). Increment core samples were successfully dated by standard dendrochronological techniques and six rign-width chronologies were developed. The PCA grouped the 2700-2910 m elevation chronologies into PC2 and those from 2350 to 2450 m into PC1. The PC2 chronologies were used to develop a representative chronology for the upper elevation and PC1 for the lower elevation. Representative upper elevation chronology responded to average monthly temperature for the winter season ($r= 0.75$, $p<0.001$, $n= 37$) and lower elevation chronology was related to total winter-spring precipitation ($r= 0.704$, $p<0.001$, 1966-1998, $n= 33$). The species has the potential to reconstruct either temperature or precipitation depending on elevation.

Historical Fire Regimes in Montane Forests of Jasper National Park, Canada

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Daniels, Lori D (*Department of Forest Sciences, University of British Columbia*)
Andison, Dave W (*Healthy Landscapes Program, Foothills Research Institute, Hinton, Alberta*)

In montane forests of Jasper National Park, Canada, 20th century land use altered fire frequency and resulted in changes to forest structure and composition that render low and high elevation forests more similar. We tested whether historical fires in Jasper included high and moderate severity fires comprising a mixed-severity fire regime. Cross-dated, annually-resolved fire-scar records were combined with stand age structure for a network of sites in the montane forests to estimate past fire frequency and severity. Effects of historic fires on contemporary forest dynamics were inferred from stand density, structure and composition. At 19 of the 29 sites, the presence of fire scars and cohorts indicate mixed-severity fires. Moreover, many sites include shade-tolerant white spruce in the understory even at lower elevations. Our research results improve understanding of fire severity and frequency, enabling ecosystem management based on historic range of variation to increase forest resilience to climate change.

Application of exposed Pinus halpensis roots to quantify the evolution of cliff profiles (Porquerolles Island, France)

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Lopez Saez, Jérôme (*IRSTEA, UR EMGR, 2 rue de la Papeterie, BP 76, F 38402 St-Martin-d'Hères cedex, France*)
Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)

Studies on long-term sea cliff morphology typically use historical maps, aerial photographs or Lidar data to determine cliff retreat. In this study, anatomical changes in 58 exposed roots of Pinus halpensis were used to quantify retreat of decametric sandstone cliffs on Porquerolles Island (France). At the plot scale, average medium-term soil erosion rates derived from exposed roots was 20 mm yr−1. The dendrogeomorphic record of point-scale soil erosion rates matches very well with cliff retreat measured with aerial photographs and topographic maps. These rates in detritic cliffs are significantly lower than those observed at nearby pocket sand beaches (200 mm yr−1) for which analysis was based on diachronic aerial photographs. The study also reveals that the selection of oblique roots allowed a coupled reconstruction of cliff erosion rates and temporal changes in cliff profiles.

Toward a Dendrochronology for Ancient Egypt

Creasman, Pearce Paul*# (*University of Arizona*)

For ancient Egypt, a fundamental concept remains unresolved: time. Despite being the focus of nearly 200 years of research, thousands of archaeological excavations, and despite survival of an extensive written record, the chronology of Egypt has been based on a fragmented copy of a 3rd century BC historian's chronicle of the pharaonic period. To refine this framework, Egyptologists have relied on a variety of insufficiently precise methodologies. Many pharaohs ruled for short periods, often less than five years, so precision dating is essential. If annual resolution could be offered for

ancient Egypt, the impact would be similar in scope to that of tree-ring dating in the American Southwest and would have broad implications. The need for such precision has been recognized for a century, as has the potential solution: dendrochronology. This paper presents the history of such efforts and a case for further progress toward the construction of a tree-ring chronology for ancient Egypt.

CSI: Cedar Science Investigations Using Tree Rings

Daniels, Lori* (*University of British Columbia*)
Dobko, Ashley # (*University of British Columbia*)
Baylis, Andrew (*University of British Columbia*)
Stan, Amanda (*Northern Arizona University*)
Thorpe, Hilary (*Parks Canada Agency*)
Point, Wayne (*Musqueam Nation*)

Large, old western redcedar trees provide a wide range of ecological functions and are an integral part of coastal First Nations' culture in British Columbia. Redcedar bark is commonly removed from tree trunks and used in baskets, hats and clothing. The surviving tree forms a permanent scar that can be crossdated to determine the year of past cultural modifications. We have developed multi-century chronologies for western redcedar and used them to crossdate scars on culturally modified trees and stumps of trees cut before European settlement. We have dated up to 4 or 5 modifications on a single tree, dating back to the year 1541 AD. We demonstrate how we include our research results in "CSI: Cedar Science Investigations", tree-ring workshops presented to school children and youth groups in British Columbia.

Dendroarchaeology in the Valles Caldera: The Salt Barn and Commissary Cabin

de Graauw, Kristen*# (*West Virginia University*)
Grissino-Mayer, Henri* (*University of Tennessee Knoxville*)
Towner, Ronald* (*Univesity of Arizona*)
Kessler, Nick (*R.C. Goodwin and Associates Inc.*)
Knighton-Wisor, Johnathan (*Valles Caldera Trust*)
Doerner, James (*University of Northern Colorado*)

Dendroarchaeology was used to interpret the history of two historic structures in the Valles Caldera National Preserve of New Mexico. Historical documents date some structures in the preserve, but a commissary cabin and a salt barn were lacking conclusive construction dates. Two tree species, Abies concolor (white fir) and Pseudotsuga menziesii (Douglas-fir), were represented by the cores extracted from the logs. Twenty cores were confidently crossdated both graphically and statistically, and provided cutting dates of 1940 and 1941. Additional dendroarchaeological data indicate simultaneous procurement of beams for each structure, probably from higher elevation sources, little reuse of beams from other structures, no deadwood use, and beam modification using locally available tools. Walls of the structures were apparently constructed in single building episodes and not remodeled or repaired. Dendroarchaeological and historical data indicate that the two structures were associated with the transition from sheep ranching to more modern cattle grazing.

An Attempt to Determine the Age of Timbers from Fort Edmonton, Alberta, Canada

Dickenson, James*# (*Prairie Adaptation Research Collaborative, University of Regina*)
Sauchyn, Dave (*Prairie Adaptation Research Collaborative, University of Regina*)

A historic barn near Edmonton, Alberta, is thought to have contained extant timbers from Fort Edmonton, the Hudson Bay Trading Post constructed in 1795 and dismantled in 1915. When the barn was demolished a few years ago, the Alberta Royal Museum salvaged and archived these timbers. In 2012, they contracted the University of Regina Tree-Ring Lab to determine the age of the timbers, as further evidence that they were derived from Fort Edmonton. This poster describes the results of this project, our approach, and the constraints on our use of standard crossdating methods, including some short and complacent undated ring-width series and the absence of an existing tree-ring chronology from the immediate vicinity. Despite these constraints, we were able to confirm the antiquity of the timbers; crossdating with 11 chronologies from west-central Alberta gave dates in the 18th and 19th centuries, during which the Fort was constructed and rebuilt.

Species specific growth responses of black spruce and trembling aspen may enhance resilience of boreal forest to climate change

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Bergeron, Yves (*UQAT - UQAM*)
Gewehr, Sylvie (*UQAT*)
Berninger, Frank (*University of Helsinki*)

To understand how the future climate will affect the boreal forest, we studied growth responses to climate variability in black spruce (Picea mariana) and trembling aspen (Populus tremuloides) two major co-occurring boreal tree species of the eastern Canadian boreal forest. We analysed climate growth interaction during (i) periods of non-anomalous

growth and (ii) in years with strong growth anomalies. We utilized paired tree level data for both growth and soil variables, which helped ensure that the studied growth variability was a function of species specific biology, and not of within stand variation in soil conditions. Black spruce and trembling aspen showed an inverse pattern in respect to expression of growth anomalies (pointer years) and during the periods of non-anomalous growth. Species specific responses to environmental variability imply that tree responses to future climate will likely be not synchronized among species, which may translate into changes in structure and composition of future forest communities.

Invasive Earthworms effect on Northern Hardwood Forest Productivity

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Varrientos, Giselle (*Tree-Ring, Earth, and Environmental Science Laboratory, University of Wisconsin-Platteville*)

Waupoose, Brennan (*College of Menominee Nation*)

Brownell, Gabriel (*Tree-Ring, Earth, and Environmental Science Laboratory, University of Wisconsin - Platteville*)

Allen, Sara (*Tree-Ring, Earth, and Environmental Science Laboratory, University of Wisconsin - Platteville*)

Wilding, Thomas (*Tree-Ring, Earth, and Environmental Science Laboratory, University of Wisconsin - Platteville*)

Larson, Evan (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)

During the last Ice Age earthworms were eradicated from the Great Lakes Region. Earthworms present today are invasive, were introduced by European settlers, and have since spread via migration widespread dispersal by people. Earthworms alter the structure, composition, and nutrient cycling of forest communities. We examined how earthworm invasion effects tree growth and productivity. We sampled earthworm populations along a 400m transect that crossed an active earthworm invasion front using mustard extraction techniques and collected tree-ring samples from 10 sugar maple trees at each earthworm sampling location. Tree-ring samples were compared with other chronologies and climate data. Earthworm biomass increased with distance along the transect. Ring widths were significantly wider in earthworm-free conditions. Correlations among the chronologies for each sampling over the last 40 years were higher during wet years (r=0.83, n=20) than the dry years (r=0.52). This illustrates the influence of earthworms on forest productivity and climate-tree growth relationships.

Using dendroecology to date mountain pine beetle outbreaks in northwestern Colorado

Dynes, Emily*# (*University of Arizona*)

Trouet, Valerie (*Laboratory of Tree-Ring Research, University of Arizona*)

Alexander, M Ross (*University of Arizona, LTRR*)

Moore, David (*University of Arizona*)

Trahan, Nicole (*University of Boulder*)

Mountain pine beetles are major disturbance agents that have affected millions of hectares of forest in North America. They cause vast tree mortality, reducing forest productivity and altering regional carbon dynamics. Consequently, developing techniques to accurately date tree mortality is of increasing relevance. To estimate the date of tree mortality, many studies have used the 'red phase/grey phase' technique, which is based on the colour and amount of needles remaining on the trees. However, it is only possible to narrow tree mortality down to within a couple of years using this method, which is unsatisfactory for understanding short-term processes and interactions. To improve estimates of tree mortality, this study dates mountain pine beetle killed lodgepole pines from northwestern Colorado. We found that dendroecological techniques provide a more robust mortality date than the red phase/grey phase method. This enabled improved estimates of changes in forest properties and processes, such as carbon cycling, as a result of beetle infestation.

Climate, fire, and demography central Oregon 1560-1900 AD

Falk, Donald*# (*University of Arizona*)

Heyerdahl, Emily (*US Forest Service, Fire Sciences Laboratory*)

Loehman, Rachel (*US Forest Service, Fire Sciences Laboratory*)

Documenting historical fire regimes provides an unparalleled view of ecosystem function across spatiotemporal scales. We analyzed fire-scars and tree demography in a multiscale dendrochronological study from a network of sites in central and eastern Oregon. We sampled over 6000 trees for tree-establishment dates in ponderosa pine, dry and mesic mixed conifer, and lodgepole-ponderosa pine communities. Fire history was based on 12 new collections and 7 existing records. Fire-scar chronologies indicate 22 years in the period 1560-1900 with more than 10 sites recording fire, representing regionally widespread fire years on average every 16 years. Demography analysis revealed complex

patterns of mixed-severity fire as expressed in tree regeneration patterns. Regional fire years occurred primarily in years of negative PDSI and above-average spring-summer temperature, whereas local and non-fire years were not different from mean conditions for the period of record, indicating a contingent relationship of seasonal climate to the extent of regional fire years.

Adapting dendroecology for the secondary classroom - collaborative education development in New Mexico and Arizona

Farella, Joshua*# (*University of Arizona, LTRR*)
Chavarria, Sara (*University of Arizona College of Education*)
Swetnam, Thomas (*Laboratory of Tree-Ring Research University of Arizona*)

Successful dissemination of scientific knowledge in a format accessible to the general public is a major contemporary concern, especially concerning issues that impact all people such as wildfire and climate change. This knowledge gap creates a divide between scientific communities and educational systems, limiting dialogue concerning viable environmental solutions. In 2012, LTRR initiated collaborative relationships with 5 teachers from grades 7th to 12th representing 4 schools in an effort to incorporate local and regional ecological knowledge into their school curriculums. Our research project has focused on addressing two important issues - understanding of human-natural coupled ecosystems and exploring different ways to communicate scientific findings and ecological knowledge into schools via lesson design resulting from collaborative relationships between the teachers and researchers. Initial efforts have involved teachers from Tucson, Arizona and the Jemez region of northern New Mexico. Together, we have developed teaching tools designed to promote ecological understanding at a variety of grade levels and cultural backgrounds.

Terminus ante quem Dating of Wabakwa and the Return of Fire to an ancient WUI, Jemez Mountains, New Mexico.

Farella, Joshua*# (*University of Arizona Laboratory of Tree Ring Research*)
Swetnam, Thomas (*University of Arizona Laboratory of Tree Ring Research*)

Effects of recent warming and fire suppression have created unprecedented changes in fire behavior and severity of wildland fires in some forests of the Western US. Wildland urban interfaces (WUIs) are particularly vulnerable in the context of these changes. One of the best resources we have for informing future fire management and understanding the interactions of climate, humans and wildfires are historical-ecological records. Abundant archaeological and tree-ring records present on the Jemez Plateau provide a unique opportunity to learn about coupled human-natural ecosystems over the past 500 years. We have completed a terminus ante quem tree-ring analysis at the Pueblo ruin site of Wabakwa that provides specific insight into the duration of human occupation of a village within an ancient WUI, and the nature of fire regimes post-occupation.

Stable isotope palaeoclimatic potential of Acacia tortilis populations in the Eastern Sahara.

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Young, Giles (*Department of Geography, Swansea University, Swansea, SA2 8PP, UK*)
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Goslar, Tomasz (*Faculty of Physics, A. Mickiewicz University, Umultowska 85, 61-614 Poznan, Poland and Poznań Radiocarbon Laboratory, Rubież 46, 61-612 Poznan, Poland.*)
Czernik, Justyna (*Poznań Radiocarbon Laboratory, Rubież 46, 61-612 Poznan, Poland*)

Stable carbon and oxygen isotopic analyses are presented from 14C dated living Acacia tortilis (Forssk.) Hayne trees sampled with the aim of exploring the stable isotope palaeoclimatic potential of this species in xeric regions of northern Africa. Trees were sampled at Gebeit (Red Sea State, Sudan) under the auspices of the ACACIA Project. Stable carbon isotopic ratios were assigned calendar dates based on high-density radiocarbon results and are presented at near-annual resolution. Water use changes were calculated over the industrial period. These data suggest that the acacia are doing little to conserve water or improve their water use efficiency. This is an unexpected finding for trees growing in such an arid environment but may be consistent with very deep-rooting trees. The variability in the mean isotope series suggests that there are common environmental factors effecting both carbon and oxygen isotope ratios which may hold significant palaeoclimatic potential.

The Stable Isotope Record of Tropical Hurricanes in Southwestern Ontario – A Test Of Concept

Gedalof, Ze'ev*# (*CEDaR Lab, University of Guelph*)
Clark, M. Graham (*CEDaR Lab, University of*

Guelph)
Schutten, Kerry (*CEDaR Lab, University of Guelph*)
Evans, Michael N. (*Department of Geology and Earth System Science Interdisciplinary Center, University of Maryland, College Park*)

Cedars (Thuja occidentalis) that grow on the Niagara Escarpment cliff face provide a unique opportunity to examine the paleoclimate of eastern North America: they are the oldest trees east of the Rockies, they bisect Canada's population centre, and transect the northwestern limit of tropically originating hurricane tracks – which reach southwestern Ontario approximately once per decade. These storms bring anomalously isotopically-depleted precipitation. We test the hypothesis that the oxygen isotopic composition of alpha-cellulose of cliff cedar rings formed in the year following severe tropical storms is also anomalously low. We present an annually resolved record of cellulose d18O derived from trees from three sites in Southwestern Ontario, for the period 1900–1996. If we detect a tropical storm signal in this record, we will evaluate whether these storms were more common during the Medieval Warm Period, or less common during the Little Ice Age, questions of key importance to predicting important consequences of global climatic change.

The Value of Willamette Valley Oregon White Oaks for Establishing Climate Growth Interactions

Gildehaus, Stevie* (*Department of Environmental and Earth Sciences, Willamette University*)
Copes-Gerbitz, Kelsey (*Willamette University*)
Arabas, Karen # (*Department of Environmental and Earth Sciences, Willamette University*)

Oregon white oak (Quercus garryana) is an integral part of the ecosystem in the Willamette Valley, Oregon. Human activities including fire suppression and land use change have resulted in the dominance of Douglas fir, making native oak habitat in the region rare. Understanding the relative importance of human vs. climate impacts on Quercus garryana growth will inform conservation techniques for land managers. This study is an extension of previous research which suggests that the growth of Quercus garryana at Zena Forest, Willamette Valley can be correlated with the Palmer Drought Severity Index. Although climate signals often appear more clearly in populations at the edges of their range, the Zena Forest population suggests that Quercus garryana in the Willamette Valley may be responding to climatic stresses. Therefore, this Quercus garryana tree ring record may be useful for separating growth trends into climate and other disturbance signals.

Tree Ring Dating of Castor Canadensis Invasion in Southern South America.

Graells, Giorgia*# (*Universidad de Magallanes*)
Corcoran, Derek (*WCS Chile*)
Aravena, Juan (*CEQUA*)

In 1946, 25 Castor canadensis pairs were introduced in Tierra del Fuego Island. Today more than 100,000 individuals of this species are distributed in several islands in the southern Patagonia archipielagos and even in the South American continent. The advances of the beaver populations were not systematically registered.

We collected 200 dendrochronological samples in seven sites in the continent using increment Haglof borers for living trees and manual saws in stumps left by beaver activities. All samples were dated using standard tree-ring methods.

The dates estimated by tree-ring methods were found to be earlier than the previous estimations based on polls data. Results also show that beavers arrived first to the continent in places not detected previously, suggesting multiple invasions to the continent at different places. We also present an insight to the dynamics of the colonization and abandonment of a beaver occupation site in the continent.

Fire-Scarred Edges and Pie-Slice Wedges: Examining the Success of the Partial Cross-Section Method in Obtaining Fire Scar Information

Greene, Gregory*# (*University of British Columbia*)
Daniels, Lori (*University of British Columbia*)

The partial cross-section (PCS) method is a proven technique to obtain fire-scar samples while ensuring the trees survive, as long as specific perimeter and cross-sectional area thresholds are not exceeded. In this study, we examine the success of the PCS method in obtaining fire scar information from trees. Using a GIS, we digitized 230 images of full cross-sections from fire scarred western larch, Douglas-fir and lodgepole pine trees, and compared results of three "virtual" PCS arrangements. PCS success was variable, depending on within-tree scar position, tree shape and catface morphology. From 561 total scars, PCS arrangements captured between 82-93% of visible scars, 70-82% of all scars, and 10-23% of piths. Results suggest placing cuts based on tree perimeter, rather than cross-sectional area, to reduce the potential of exceeding critical thresholds. This research improves our understanding of the limitations of the PCS method in obtaining fire-scar information.

A climate regime around Lake Ontario – a seesaw between freeze and melt at the end of the Younger

Dryas

Griggs, Carol*# (*Cornell Tree Ring Laboratory, Cornell University*)

In central New York State, southeast of Lake Ontario, the relationship between summer temperature and relative humidity recorded in tree rings and their 13C isotope content indicate oscillations between a dry-cold regime and a wet-cool regime at the end of the Younger Dryas. This record corroborates with that found in boreal environments today, with the exception of frequency - the seesaw in the YD appears to have occurred much less frequently over time. New del-18O data indicate that while the 13C levels changed significantly over the 284-year represented period, the source of humidity remains the same. The variability in the three data sets suggest a steady anticyclonic pressure system from the North Atlantic region with ground-level temperature affected by the re-advance and recession of the ice sheet margin, adiabiatic winds, and the melting / freezing cycles caused by meltwater transport from the ice sheet at the end of the Younger Dryas.

Establishment and mortality of the Patagonian forest in response to episodic glacier-induced floods

Guerrido, Claudia Marcela*# (*Univerdad Nacional de la Patagonia Austral*)
Villalba, Ricardo (*IANIGLA - CCT - Conicet*)

Since early 20th century, Glaciar Moreno's experienced successive advances and retreats. During advances it closes the drainage of southern arms of Lago Argentino. Increases in water levels flood Nothofagus forests' coast and subsequently kills the submerged trees. During ruptures of ice front, the stored water flows rapidly, exposing vast areas to re-colonization. Tree-rings from standing dead trees and living saplings colonizing the flooded plains contain information on past fluctuations of the glacier and on the impact of floods on Nothofagus forest. Using dendrochronology, we established maximum ages of standing dead trees, dates of death of trees devastated by floods, and dates of trees established after breakups of the ice front. Dendrochronological dating matches the available history on ruptures' events. Standing death trees reached ages over 200 years suggesting a long-term period without floods before the 20th century. Colonization by seedlings shows ages related to post flood events associated with 1988, 2004, 2006 glacier-front ruptures.

Sourcing the Plaza Tree of Pueblo Bonito Using New Documentary and Tree-Ring Evidence

Guiterman, Christopher*# (*Laboratory of Tree-Ring Research, University of Arizona*)
Swetnam, Thomas (*Laboratory of Tree-Ring Research, University of Arizona*)
Baisan, Christopher (*Laboratory of Tree-Ring Research, University of Arizona*)
Dean, Jeffrey (*Laboratory of Tree-Ring Research, University of Arizona*)

Since its discovery in the west courtyard of the Chacoan great house of Pueblo Bonito, the "rooted tree" labeled JPB-99 has captivated the imaginations of archaeologists and the public alike. It stands alone in the archaeological record of the Southwest as the only non-architectural timber unearthed within a ruin. Ideas abound regarding its relevance to the design, location, and ritual practices of Pueblo Bonito, but few have tried to determine if it did, in fact, grow within the walls of the great house, as inferred by the excavators. We examine the history of the plaza tree, and present new documentary and dendrochronological evidence that support an alternative explanation for the tree's source. Our results suggest that the tree may have grown in Chaco Canyon, but not within Pueblo Bonito, and that the tree bole with some primary roots attached was likely carried to the great house from its original location.

Updating the Eastern White Pine Chronology from Devil's Lake State Park, Wisconsin

Gultch, Ben*# (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin-Platteville*)
Wilding, Thomas (*Tree-Ring, Earth, and Environmental Science Laboratory*)
Larson, Evan (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)

We updated the eastern white pine chronology developed by Dr. Ed Cook at Devil's Lake State Park, Wisconsin for an introduction to dendrochronology class project. The original chronology spanned 1642–1982, with a series intercorrelation of 0.664 and mean sensitivity of 0.25. We cored white pines growing on exposed talus slopes overlooking Devil's Lake and although we encountered rot in nearly every tree, developed a chronology that spanned 1802–2011 with a series intercorrelation of 0.634 and mean sensitivity of 0.24. Standard chronologies developed from the original and new ring-width data are significantly correlated ($r = 0.84$) for the periods of overlap and show similar means and variability. The expressed population signal of the updated chronology is >0.9 from 1700–2011 when the data sets are combined. The chronology is inversely correlated with summer temperature during the early instrumental period but exhibits a positive trend and shifting response over more recent decades.

Frost rings records in Araucaria araucana forests from northern Patagonia since AD 1256

Hadad, Martín*# (*IANIGLA*)
Amoroso, Mariano Martín (*IANIGLA*)
Arco Molina, Julieta (*IANIGLA*)
Mundo, Ignacio (*IANIGLA*)
Roig Juñent, Fidel Alejandro (*IANIGLA*)

Tree rings are a reliable source of information for studying past climate variability. In this sense, frost events can be recorded in the annual rings of tree as frost rings. We analysed samples from five Araucaria araucana forests in northern Patagonia, Argentina and classified the position of frost damage within tree rings. A regional frost ring chronology of 700 years was developed. The most geographical-extended freezing events in the region took place in AD 1569, 1589, 1714, 1842, 1863, 1889, 1902, 1916, 1941, 1942 and 1948. Frost damage was primarily restricted to the middle section of the rings. The large frost rings events were detected at the juvenile wood portions, that is trees at biological ages of ≤100 years and about 6 cm of stem diameter. The regional frost ring record from A. araucana may be used as an extreme temperature event record for paleoclimate reconstruction.

Pacific climate forcing of historical wildfire in an endangered subtropical ecosystem of the Florida Keys, U.S.A.

Harley, Grant*# (*University of Southern Mississippi*)
Grissino-Mayer, Henri (*University of Tennessee*)
Horn, Sally (*University of Tennessee*)
Bergh, Chris (*The Nature Conservancy*)

We investigated relationships between climatic variability and historical wildfires in Florida Keys pine rocklands using tree-ring samples from the canopy dominant Pinus elliottii var densa (South Florida slash pine). We compared a new set of crossdated fire-scar chronologies spanning the period 1707–2010 CE to measured values of ENSO (NIÑO3.4), PDO, and regional temperature and precipitation. Wildfires occurred during years that were drier than average, and NIÑO3.4 values were significantly lower than average one year prior to these fires (La Niñas; $P < 0.01$). We found evidence that suggests linkages between the El Niño Decadal Modulation (ENDM) and wildfire, with antecedent years wetter than average combining with the effects of El Niño and PDO (warm phase) to precondition widespread fires by likely increasing the amount and continuity of fine fuels. This study is a first step in elucidating broader and longer-term fire-climate relationships across islands in the region.

A Prioria copaifera tree-ring chronology from the Colombian Tropical Pacific

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del Valle, Jorge Ignacio (*Forest and Climatic Change Group, National University of Colombia*)
Andreu-Hayles, Laia # (*Tree-Ring Laboratory, Lamont-Doherty Earth Observatory of Columbia University*)

The Tropical Pacific region in Colombia is the rainiest in America. Short and scarce instrumental meteorological data are a frequent drawback in South America. Tropical dendrochronology can potentially provide long-term climatic records extremely needed considering first, the lack of climatic data for feeding the global climate models for this region, and second, the high ecosystem and population vulnerability to the ongoing climatic change. Prioria copaifera, known as cativo, is a tropical tree-legume species growing in the floodplains of the low Atrato River that cross the Colombian Pacific through the north, close to the Pacific Ocean. Here, we demonstrated that P. copaifera forms annual rings with the generation of reliable tree-ring chronology with significant correlation with climatic variables. This annuity was also confirmed by several 14C dates and a reconstruction of the water level for the Atrato river was performed for the last 150 years. Our reconstruction was strongly related with the ENSO phenomenon.

Floods events in tree-ring streamflow reconstructions – Can they be sorted out?

Hirschboeck, Katherine*# (*Univ Arizona*)

Riverine floods have been analyzed using a variety of floodplain-based and dendrogeopmorphic approaches. This study takes a "mechanistic" weather-based approach to explore the degree to which flood events are detectable in time series of observed and reconstructed mean annual streamflow in the Salt and Verde watersheds of the Lower Colorado River Basin. Results indicate that the detectable contribution of flood events to reconstructed streamflow varies based on the atmospheric cause of the flood. Floods produced by persistent or anomalous synoptic atmospheric circulation features such as persistent storm tracks, blocking, cutoff lows and atmospheric rivers are more likely to be associated with reconstructed high flow years than floods produced by other mechanisms. Decadal variability in tree ring series and streamflow can also be seen in floods, and just as wide rings can occur in otherwise narrow-ring sequences, large floods

can occur during periods of low flows under certain synoptic situations.

Xylogenesis and Dendroclimatology of Douglas fir (Pseudotsuga menziesii (Mirb.) Franco) in Southern Alberta

Hozová, Jana*# (*Mendel University in Brno*)
Hacura, Jakub*# (*Mendel University in Brno*)
Vetter, Mary (*University of Regina*)
Sauchyn, David (*Prairie Adaptation Research Collaborative*)

Xylogenesis is the method of monitoring cell formation allowing the description of cambial activity and every new xylem cell during the growing season. Cell formation and cell characteristics can be compared with many biotic and abiotic factors.

We are conducting research on Douglas fir at three locations in the montane forest of southern Alberta (Canada) during the vegetation season 2013. Chosen locations are similar in growing conditions but different in elevation. At each site we are monitoring 6 "young" and 6 "old" trees. Micro samples are taken at weekly intervals from each tree and mounted in paraffin to produce permanent slides. We also are using band dendrometers to measure radial growth increments to compare xylogenesis and dendrometer methods of analyzing radial growth.

This research will inform our understanding of the effects of tree age, elevation, and growing-season weather conditions on radial growth, and will enhance our interpretation of climate-growth relationships and the dendrochronologic records in this montane forest.

Holocene wildfire history and climatic change over the middle part of the Loess Plateau in North China

Huang, Chunchang*# (*Shaanxi Normal University*)
Zhang, Fuping (*Shaanxi Normal University*)

Wildfire history and climate change were investigated over the middle part of the Chinese Loess Plateau. High-resolution analysis of charcoal and sediment in combination with OSL dating were carried out in a complete eolian loess-soil profile. The results indicate that wildfires occurred frequently during the last glacial through to the early Holocene under the dry climate. Wildfires were reduced largely during the mid-Holocene climatic optimum (8500-3100a BP) during which Chernozem soil developed widespreadly under a relatively humid-warm monsoonal climate. An unprecedented increase in biomass burning during the late Holocene (3100a BP to the present) is shown by a distinct increase in charcoal concentration. This is attributable to the intensified land reclamation for cereal cultivation since the Bronze-age when climate became more arid over the region. This result is of importance in understanding the relations between wildfire history and climate change and human land-use change over the arid and semi-arid regions.

Reconstructing Past Mountain Pine Beetle Activity Above 3077 m in Northern Colorado

Huckaby, Laurie*# (*US Forest Service Rocky Mountain Research Station*)
Negron, Jose (*US Forest Service Rocky Mountain Research Station*)

The current mountain pine beetle (mpb) epidemic has killed lodgepole pines throughout their range in Colorado, including above 3077 m. Prevailing opinion suggests that mpb activity at such high elevation is unprecedented. We selected old stands above 3077 m and examined remnant wood for signs of mpb attack: visible galleries, exit holes, frass, larval galleries and pupal chambers; stems broken 13 to 78 cm above the roots; and blue stain fungi in the sapwood. We collected cross-sections from remnant wood with multiple mpb indicators to obtain death dates, as well as cores from adjacent trees for growth releases coinciding with death dates. At three sites, lodgepole pine stands showed signs of past mpb outbreaks, most recently in the 1940s. These stands have not experienced stand-replacing disturbance in centuries, but have been shaped by patch dynamics, including mpb activity. The resulting stand structures are important to overall landscape heterogeneity, which influences the course of large-scale disturbances.

Biological Harvesting Rotation (BHR) of Juglans neotropica Diels (Juglandaceae) from the analysis of growth rings in Central Rainforest of Perú

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Srur, Ana Marina (*Departamento de Dendrocronología e Historia Ambiental, Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales, Centro Regional de Investigaciones Científicas y Tecnológicas, Mendoza,Argentina*)
Rodriguez Arismendiz, Rodolfo (*Facultad de Ingeniería de la Universidad de Piura,Perú*)
Pereyra Espinoza, Manuel (*Universidad Agraria La Molina - Perú*)

In the central rainforest of Peru, the tree rings have not been used to obtain data from tree growth, although their application may be useful for forest management. The objective of

this study was to determine the Biological Harvesting Rotation of Juglans neotropica from the analysis of tree-rings growth. For this purpose samples were collected from 64 trees from the forests of the Native Community "Tres Unidos de Matereni" Satipo Province. These samples were processed and measured according to standard techniques in dendrochronology. The current annual increment in diameter is 0.22cm/year and mean annual increment in diameter is 0.31cm/year. The projection of the curve of current annual increment in basal area is intercepted by the curve of mean annual increment in basal area indicating the biological harvesting rotation at about 128 years. These results indicate the applicability of dendrochronology for species in forests of the Central Rainforest of Peru.

The DCCD: a digital infrastructure for cultural tree-ring studies

Jansma, Esther* (*Utrecht University*)
Brewer, Peter # (*LTRR*)
Van Lanen, Rowin (*Utrecht University*)

The DCCD is a dendrochronological data repository for Humanities-based research (http://dendro.dans.knaw.nl). It uses the International Tree-Ring Data Standard (TRiDaS), software library TRiCYCLE for ingesting/exporting data in many digital formats, and Access (MS) system TRiDaBASE for exporting/ingesting metadata. The repository contains all heritage-related tree-ring research performed in the Netherlands from the 1960's onwards and many projects from Belgium, France, the UK (Ireland) and other European countries, bringing the content to > 5000 projects and the chronological range to 6000 BC-present. The repository can be searched in Dutch, English, French and German, and besides tree-ring series also contains extensive metadata and associated files (e.g. research reports). Participants manage the access levels to their projects on line. The new infrastructure has proven a valuable tool for international interdisciplinary research and for generating research funding. Products of the DCCD project are open source and can be downloaded at www.tridas.org.

Multi-species analyses of the blue reflectance as a climate proxy

Kaczka, Ryszard Jerzy*# (*University of Silesia*)
Czajka, Barbara # (*University of Silesia*)

One of the latest applications of proxies related to tree-ring is the use of the image analysis of blue reflectance (BR). This study presents the analysis of BR for sixe coniferous spices which grow in Tatra Mountains, Carpathians within subalpine (Larix decidua Mill., Picea abies (L.) Karst., Pinus Cembra (L.), Pinus mugo Turra) and montane (Abies alba (L.) Karst., Pinus sylvestris (L.)) zones, complete set of coniferous spices that grow in Tatras and throughout entire Carpathians.. We aimed at testing the potential of BR as climate proxy comparing to tree-ring width (TRW) and in two cases to maximum wood density (MXD) records (spruce and larch). Growth response to climate analysis of the BR and TRW chronologies shows rather consistent response to current-year spring-summer (April-August) and high summer (June- July) temperature (calculated for 1901 – 2006 period) respectively. The BR chronologies of all species show the higher response to climate than TRW and comparable with MXD.

Tree rings and sunspots, chasing the old dream

Kaczka, Ryszard Jerzy* (*University of Silesia*)
Rzepecka, Aneta # (*University of Silesia, Poland*)
Janecka, Karolina # (*University of Silesia, Poland*)

Assessing the effects of sunspots on the tree growth was the very first application for which dendrochronology was used. The founder of the scientific use of tree rings, A. E. Douglass began the long development of this method by posing the question of relationship between the Sun activity and the tree growth. The first conclusions drawn from the analysis have not been decisive due to an early stage of sunspot and tree ring data pile development. Here we propose a global approach to sunspots effects on climate and tree growth during the period of 1849 – 1990. A unique set of more that 500 chronologies were compiled in a multi-species worldwide net using data available from ITRDB compared with data outlining Sun activity expressed by International Sunspot Numbers and The NOAA Group Sunspot Number. The results suggest a very strong regional and global variation of Sun activity influence on climate and the tree growth

Climatologic and hydrologic influences on the oxygen isotopic composition of tree-ring cellulose in southern California over the 20th century

Kanner, Lisa*# (*University of Southern California*)
Stott, Lowell (*University of Southern California*)
Buenning, Nikolaus (*University of Southern California*)
Stahle, David (*University of Arkansas*)

Quercus douglasii (blue Oak) tree-ring cellulose δ18O in southern California contains a memory of the interannual variability in precipitation δ18O via soil water δ18O. Combined, soil water δ18O and cellulose δ18O provide insights into regional hydrologic variability that may be caused by distinct atmospheric dynamics. In the late 20th century,

years with uniquely low cellulose δ18O are associated with known El Niño events, high relative humidity, and high precipitation in the region. High relative humidity decreases evaporative enrichment in the soil and leaf water, driving cellulose δ18O to lower values. Dynamically, during these isotopically low years, Reanalysis-derived atmospheric wind patterns suggest anomalously high upper level divergence, which favors condensation higher in the atmosphere, also lowering precipitation δ18O. At the transition into the 20th century, Q. douglasii cellulose δ18O exhibits a mean-state shift of about -2‰. This shift potentially implies a change in relative humidity, temperature, or moisture source region.

Pre-instrumental reconstruction of three Canadian Prairie streams using tree-ring chronologies from the Bears Paw Mountains (Montana, USA), Sweet Grass Hills (Montana, USA) and Cypress Hills (Saskatchewan, Canada)

Kerr, Samantha*# (*Prairie Adaptation Research Collaborative, University of Regina*)
Sauchyn, Dave (*Prairie Adaptation Research Collaborative, University of Regina*)

Water resources of the southwestern Canadian Prairies are limited and sensitive to changes in climate and land cover. An increasing demand for water resources has increased vulnerability to hydrological drought. Because few instrumental records exceed 100 years, climate proxies are used to extend the historical record of natural variability. Fifteen moisture sensitive tree-ring chronologies (Pinus albicaulis, Pinus ponderosa, Pinus contorta, Picea glauca, and Pseudotsuga menziesii) from Montana and Saskatchewan are used to extend mean spring and summer streamflow records of the Frenchman River, Battle Creek, and Swift Current Creek in southwestern Saskatchewan, Canada, back to the mid 1600s. Spectral analyses (Multi-taper and Wavelet) of the reconstructed streamflow reveal common cycles of variability at interannual and multidecadal scales. Results show the large natural variability of prairie water levels, with cycles of decades with high flow followed by decades of low flow, and more extreme flows than in the instrumental records.

A tree-ring based drought reconstruction for the Miombo region in Tanzania

Khamisi, Zakia Hassan*# (*Laboratory for Tree-Ring Research, University of Arizona, Tucson, Arizona, United States of America*)
Trouet, Valerie (*Laboratory for Tree-Ring Research, University of Arizona, Tucson, Arizona, United States of America*)

Drought has significant impacts on domestic use, agriculture, and ecosystems in Tanzania and is a major seasonally occurring stress factor in water resources management. Water shortage is projected to increase with globally rising temperatures and this will likely be one of the major limitations for future development in Tanzania. Instrumental records of drought variability are sparse in Tanzania and cover only a short period of time, but regional tree-ring records can provide reliable information about longer-term water availability. We here present a drought-sensitive tree-ring chronology based on 58 Brachystegia spiciformis trees from two sites in the Miombo woodland of southern and western Tanzania. The chronologies were compared to monthly and seasonal instrumental climate data (Tabora and Morogoro stations; 1892-2011).Annual growth rings in Brachystegia spiciformis reflect rainy season (December-February) precipitation variability.Our tree-ring chronologies extended back to the 19th Century and can thus provide an improved benchmark for sustainable water use in Tanzania

Bristlecone Fire History and Stand Dynamics at Mount Washington, Nevada.

Kilpatrick, Mackenzie*# (*University of Nevada, Reno*)
Biondi, Franco (*University of Nevada, Reno*)

This poster shows the study design and preliminary results of a fire history and stand dynamics study in a Great Basin bristlecone pine forest at Mount Washington, Nevada. This forest has experienced a recent high severity fire enables us to directly examine fire effects in bristlecone pine. The research plan includes mapping fire boundaries via ground mapping and remote sensing, measuring vegetation at randomly located plots, extracting increment cores from trees at the plots, and sampling fire scars from bristlecone pine. Preliminary results include the completion of fire boundary mapping, locating 40 bristlecone pine containing fire scars, and the completion of vegetation measurements at twenty vegetation plots which has shown regeneration in areas affected by the high severity fire. The preliminary results indicate that it may be possible to conduct a fire history study in bristlecone pine and that severe fires could potentially facilitate regeneration.

Colorado pinyon (Pinus edulis) population dynamics and climate variability in an old growth woodland over the last 1500 years on the Tavaputs Plateau, northeastern Utah

Knight, Troy*# (*College of St. Benedict/St. John's University*)
Baisan, Chris (*University of Arizona*)

Swetnam, Thomas (*University of Arizona*)

Long-term demographic datasets of tree populations improve our understanding of forest response to climatic fluctuation and change. Excellent preservation of remnant wood on the Tavaputs Plateau in northeastern Utah provides the opportunity to investigate population dynamics of Colorado pinyon (Pinus edulis), and its relation to climate variability over multiple centuries. From a sample of 597 pinyon trees, we found estimated establishment dates extending back to the 7th century BC. Significant numbers of samples are not available until the 5th century AD. Preservation is nearly matched by extreme longevity as several trees exceed 1000 years in age. Low frequency patterns of tree establishment and mortality suggest multi-centennial scale cycles in population densification and subsequent thinning and die-back. While this may result from the rise and decline of dominant cohorts of long lived trees, decadal scale demographic patterns within these broad swings are related to drought and subsequent climatic recovery.

Environmental change in the subalpine environment of the southern Coast Mountains, British Columbia, during the past millennium

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Glacier and treeline fluctuations in the subalpine region of the southern Coast Mountains have been reconstructed using dendroecologic methods. Glaciers in Garibaldi Provincial Park and the Pemberton Icefield allow detailed reconstructions of fluctuations during the past millennium. Glaciers advanced as early as the 11th, reached maxima in the 12th, and retreated in the 13th century. Glaciers reached maxima again in the 14thcentury, fluctuated around these advanced positions until the early 20th century, and since then have retreated significantly. This data is supplemented with studies at treeline and in subalpine meadows in Garibaldi Park covering nearly the last 500 years. The combined record shows synchronous albeit opposite behaviour of subalpine vegetation and glaciers: when glaciers advance, subalpine tree establishment ceases, but when glaciers retreat, tree establishment succeeds. Both records correspond with changes in the Pacific Decadal Oscillation, but also with global glacier and treeline fluctuations, and with changes in sunspot numbers.

Seeking the Natural: Shifting Climate and Human Influences on the Fire Regimes of Mid Sweden

Larson, Evan*# (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)
Rauchfuss, Julia (*Mid Sweden University*)
Jonsson, Bengt-Gunnar (*Mid Sweden University*)

We developed a 700-yr, spatially-explicit fire history from 344 crossdated samples and a 1,100-yr estimation of summer precipitation from Pinus sylvestris trees growing across two nature reserves in mid Sweden to examine patterns of fire activity and fire-climate relationships in the context of varying land use. Shifts in the frequency, area, and variance of fire events occurred synchronously in the early 1700s and the late 1800s, indicating pre-settlement era, the pre-industrial era, and the fire-suppression era. Fires were less frequent but larger early in the record, more frequent and smaller during the pre-industrial era, and nearly absent during the fire-suppression era. Widespread fires consistently burned during dry years throughout the record, while smaller fires during the logging era showed no relationship with summer drought. Our results illustrate a shifting fire regime and raise important questions about what restoration targets should be in mid Sweden.

Tree-ring based reconstruction of the southern Patagonian Andes precipitation since AD 1735

Lavergne, Aliénor*# (*IANIGLA-LSCE*)
Villalba, Ricardo (*IANIGLA*)
Srur, Ana Marina (*IANIGLA*)

Tree-rings provide high-resolution records of past climate variations. Five regional tree-ring chronologies from Nothofagus pumilio, the dominant subalpine species in Southern Patagonia, were developed in Santa Cruz, Argentina. Sampling sites were located between 47° and 53°S along both elevation (600-1200 m) and precipitation gradients (west-to-east; 4000 to 1000 mm). In this study, we focus on determining the influence of precipitation on tree growth as a tool for potentially extending the limited instrumental precipitation records in the region. Rainfall records were used to develop a regional precipitation record. The relationships between Nothofagus pumilio growth and monthly precipitation were determined over the period 1945-2001 (56 years). Based on these relationships, a transfer function was used to reconstruct seasonal precipitation variations (October to January) over the last 275 years (AD 1735-2000). The precipitation reconstruction is dominated by interannual variability with a dry interval centered at 1920, 1950 and the end of the 20th century.

Growth – Climate Relationships for Oak Species in Eastern North America

LeBlanc, David*# (*Dept of Biology, Ball State University*)

Research has shown growth-climate associations for Quercus alba and Q. rubra are similar and consistent across their geographic range. Correlations between growth and early growing season water balance variables were spatially replicated, evidence for cause-effect relationships. This analysis was expanded to Q. prinus, Q. velutina, Q. macrocarpa, and Q. stellata and includes 116 sites. Correlations were computed between ring width indices and monthly and seasonal temperature and precipitation variables for the period 1930 – 1980. Results were similar to those for white oak and northern red oak. Correlations with dormant season precipitation were more prevalent at Great Plains sites than eastern deciduous forest sites, similar to findings for white oak. Differences among species are more likely due to site differences in soil water storage than physiological differences. This study supports the hypothesis that ring-porous oak species form a functional group with similar responses to climate resulting from similar phenology and ecology.

Spatially Unique Hydroclimatic Regimes and its Potential Impact on Agriculture in the Mongolian Breadbasket

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Pederson, Neil (*Tree Ring Laboratory*)
Nachin, Baatarbileg (*National University of Mongolia*)
Hessl, Amy (*West Virginia University*)
Davi, Nicole (*LDEO, Columbia University*)
Bell, Andrew (*International Food Policy Research Institute*)
Martin-Benito, Dario (*Tree-ring lab, Lamont-Doherty Earth Observatory. Columbia University*)
Saladyga, Tom (*Concord University*)
Brown, Peter (*Rocky Mountain Tree-Ring Research*)
Suran, Byambagerel (*Colorado State University*)

Mongolia has recently focused on agricultural initiatives to improve food security under the uncertainty of climate change. We used a network of tree-ring chronologies to reconstruct May-September Yeruu River streamflow (1680-2001) to better understand historical climate variability in the 'eastern' part of the Mongolian Breadbasket. Model calibration from 1959-1987 captured 60.8% of the instrumental variability during that period; it verified with an r^2 of 74.1% from 1988-2001. The Yeruu reconstruction was compared with a previously-published reconstruction of the Selenge River, which represents the 'western' portion of the Breadbasket. Both reconstructions yield similar hydroclimatic variability in the past, with the 20th century being relatively wet, and with severe droughts during the 18th century. However, the Selenge River reconstruction experiences a more drastic 'pendulum' of historical hydroclimate in comparison to the Yeruu River. This difference suggests that an understanding of regional hydroclimatic variability is necessary for managing agricultural and water resources.

Black spruce stem and root growth after commercial thinning

Lemay, Audrey*# (*Université du Québec à Chicoutimi*)
Krause, Cornelia (*Université du Québec à Chicoutimi*)

The root system is often neglected in the study of the effect of commercial thinning, even though it plays a great part in the success of the treatment. The research aims to compare the growth response in the stem and roots after commercial thinning. Six black spruce (Picea mariana) stems and their root system were sampled within three commercial thinning stands in the boreal forest. Thinning occurred ten to twelve years prior to sampling. A decreasing radial growth pattern in the stem and the root system was observed in the thirty years prior to thinning. After thinning, radial growth increased in both tree parts but the increase was faster and larger in the roots. The growth increase in the roots was also more important further away than closer to the stump. This observation can be interpreted as the trees allocating more resources to roots for stability and better water transport.

High Resolution Hydroclimate Variability in the Central Andes of Chile and Argentina reconstructed by ancient Austrocedrus chilensis

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Christie, Duncan (*Laboratorio de Dencrocronología y Cambio Global, Universidad Austral de Chile*)
Falvey, Mark (*Departamento de Geofísica, Universidad de Chile*)
Masiokas, Mariano (*IANIGLA, Argentina*)

The highly waterdependent semiarid Andes of Chile and Argentina (CChA) are characterized by extremely variable annual precipitation regimes. The existing hydroclimate instrumental records from CChA provide a spatially dense network but only for the last 40-80 years. During recent decades our tree-ring studies in Austrocedrus chilensis have demonstrated the usefulness of this conifer to reconstruct hidroclimate variability in the CChA over several centuries.

We will present a starting project were we propose to develop a millennium-long reconstructions of combined hydroclimate variables for the CChA. Our goals are to characterize the main temporal patterns of these reconstructions at different time-scales, and investigate the hindcast skill of downscaled climate products based on the current generation of General Circulation Models by comparing tree-ring based hydroclimatic reconstructions with simulated regional climates of the past millennium.

Growth rings in tropical trees from the Bolivian Cerrado phytogeographical province: Applications to forest management

Lidio, Lopez Callejas*# (*IANIGLA/CONICET, Mendoza*)
Ricardo, Villalba # (*IANIGLA/CONICET, Mendoza*)

This study describes the most prominent anatomical features associated with the presence of annual growth bands in eight species from the tropical Bolivian Cerrado forest: Amburana cearensis, Cedrela fissilis, Platimiscium ulei, Centrolobium microchaete, Hymenaea courbaril, Anadenanthera colubrina and Ficus boliviana. In six from the eight species, marginal parenchyma is the most common pattern delimiting annual growth bands. Growth lenses and false rings were recorded in some species. Based on these observations, the determination of the growth rings along two opposite radii in each cross-section allowed achieving a reliable representation of the radial growth of selected species. Dendrochronological methods were effective to estimate the age of the trees and their growth rates, expanding the use of tree-ring methods to tropical dry forests in South America. The information resulting from the application of dendrochronological methods in the dry forests of the Cerrado is crucial for the definition of precise management practices in tropical regions.

Use of tree-rings to derive the impacts of predicted climate change on landslide reactivations in the French Alps

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Past activity on seven landslides of the Barcelonnette valley (French Alps) was reconstructed from 759 conifers (3036 cores). Based on 1298 growth anomalies, we identify 61 landslide phases since 1890. Logistic regressions using monthly rainfall data and temperature anomalies indicate that landslides used to occur after wet winters with subsequent positive temperature anomalies in spring, and thereby point to the crucial role of snowmelt in landslide triggering. Since 1990, however, landslide activity shows an excessive and unprecedented increase in activity which is favoured by positive spring temperature anomalies. This evolution suggests a shift from snowmelt induced landslides to events controlled by spring temperatures. In addition, statistically downscaled climate projections for the study region, based on the SRES A1B scenario, point to a further increase of warm spring anomalies for 2050–2100, and thereby suggest that spring landslides could become even more important toward the end of the 21st century.

Education of dendrochronology through applied research: A case study & chronology creation in New Mexico

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Brice, Becky* (*University of Denver*)
Guiterman, Christopher # (*University of Arizona*)
Macalady, Alison (*University of Arizona*)
Griffin, Daniel (*University of Arizona*)
Benakoun, Laura (*University of Guelph*)
Cutter, Amy (*Boise State University*)
Hart, Megan (*Austin Pea State University*)
Murray, Michael (*BC Forest Service*)
Nash, Steve (*Denver Museum of Nature and Science*)
Shepard, Robert (*Austin Pea State University*)
Stewart, Alexander (*St. Lawrence University*)
Wang, Haitao (*Virginia Tech*)

This study, as part of the 22nd annual North American Dendroecological Fieldweek (NADEF), contributed to a new network of monsoon-sensitive latewood width (LW) chronologies in north-central New Mexico while also providing hands-on experience for NADEF participants to learn the fundamental skills of dendrochronology. Participants developed the first EW/LW chronology for Pinus ponderosa in the Jemez Mountain region. The Cat Mesa master chronology was extended to 2011 and pushed back to 1531, with sample depth improved in the 16th, 17th, and 18th centuries. Preliminary analysis of climatic signals had implications for necessary sample sizes; results suggest larger sample sizes may be needed, with 23 sample trees required to capture the LWa signal at Cat Mesa. Further comparison of LW chronologies is needed in the Southwest to verify the findings of this study.

TreeFlow: A web resource for researchers and us-

ers of dendrohydrology

Lukas, Jeffrey*# (*Western Water Assessment, University of Colorado*)
Woodhouse, Connie* (*University of Arizona*)
Griffin, Daniel* (*University of Arizona*)

TreeFlow (http://treeflow.info) is a web resource for tree-ring reconstructions of streamflow and climate, providing access to data for over 60 reconstructions as well as information about methodology and applications. It was first developed in 2003 for Colorado river basins, and expanded in 2009 to all of the western US. While the primary users of streamflow reconstructions have been water resource managers, researchers and practitioners in many other sectors and disciplines may find TreeFlow to be useful. In the past year, TreeFlow received ~300 visits per month, with about one-third of these visits involving substantive interactions. Universities and federal, state, and local resource management agencies are the principal sources of the visitors whose affiliation can be identified. TreeFlow is intended to be a dynamic resource, and we have recently incorporated new flow reconstructions in the eastern US. We welcome additional contributions and feedback from researchers and resource managers.

Climatic influences on the apical and radial growth of Nothofagus pumilio (Nothofagaceae)

Magnin, Amaru*# (*INIBIOMA, CONICET-UNComahue*)
Puntieri, Javier (*INIBIOMA, CONICET-UNComahue*)
Villalba, Ricardo (*IANIGLA, CCT-CONICET-Mendoza*)

The aim of this study is to evaluate the relationships between apical (primary) and radial (secondary) growth as well as the influences of climate variations on both apical and radial growth in a native forest of Nothofagus pumilio in the north Patagonia Andes. Ring widths and the lengths and number of internodes per annual shoot for the interval 2001-2010, were measured in 40 individuals of N. pumilio at the upper treeline. There are significant relationships between primary and secondary growth, and between these traits with climate over the 10-year interval of comparison. Ring width and the lengths and number of internodes per annual shoot are influenced by climatic variations in both the current and previous year of growth. Our results reveal that temperatures in winter and spring (June-October) preceding the period of shoot extension regulate stem elongation and thickening, whereas rainfalls during summer (December to March) also influence stem elongation.

Tree-ring reconstructed hydroclimate of the Upper Klamath basin

Malevich, Steven*# (*University of Arizona*)
Woodhouse, Connie (*University of Arizona*)
Meko, Dave (*University of Arizona*)

This work presents the first tree-ring reconstructions of hydroclimate for the Upper Klamath River basin, which stretches from northern California into southern Oregon. The extended record provides a centuries-long perspective on the region's hydroclimatic variability and context for water-related political issues that have erupted in recent years. Reconstructions of water year precipitation for Klamath Falls, Oregon (extending 1564 – 2004 and 1000 - 2010 CE) were developed to compare past drought severity with droughts of the instrumental record. The reconstructions suggest that variability exhibited during the instrumental period captures moderate-to-long duration (six-, ten-, and twenty-year average) droughts, but it is likely that short (one- and three-year average) and very long (fifty-year average) dry periods were more severe during the eleventh-through-thirteenth centuries. Cool-season storm tracks appear to be a direct driver of hydroclimatic variability, leading to instances of see-saw like relationships with neighboring regions.

Corroboration of modeled and tree-ring reconstructed burn probability, New Mexico, USA.

Margolis, Ellis*# (*University of Arizona Laboratory of Tree-Ring Research*)

Fire scars in tree rings are commonly used to reconstruct fire frequency, but reconstructing spatial variability of fire regimes can be challenging. Spatially explicit fire models provide a great new opportunity to study fire at landscape scales, but can rarely be tested against real fires. In this study, I corroborate tree-ring reconstructed and modeled conditional burn probability for a 30,000 ha mesa landscape. FlamMap modeled conditional burn probability derived from 1000 simulated fires indicates distinct areas with high and low burn probability, which are primarily a function of prevailing wind direction and topography. Reconstructed historical (1601 – 1899) burn probability derived from 112 fire-scarred trees at 7 gridded sites remarkably reproduced similar spatial patterns of high and low fire occurrence. Point-based estimates of modeled and tree-ring reconstructed burn probability are positively correlated (r = 0.71). The results indicate the potential for fire scars to provide information about spatial variability of fire regimes within large landscapes.

Red and Pitch Pine Fire Histories Illuminate Fire

Regimes in Northeast United States

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Guyette, Richard (*University of Missouri*)
Brose, Patrick (*USDA Forest Service, Northern Research Station*)
Stambaugh, Michael (*University of Missouri*)

Compared to the western United States, there is a relative paucity in the understanding of historic fire regimes in the wet and cool north eastern United States. We investigated historic fire frequencies at three different sites in the Pine Creek valley of north central Pennsylvania. Fire scarred living trees and remnant materials were dated using dendrochronological methods. Considering all sites, 93 samples recorded 75 fire events in 55 years spanning 480 years. Mean fire intervals (MFI) were calculated for different time periods corresponding with changes in land use history. American Indian (1530-1790), European Settlement (1791-1919), and Modern (1920-2010) eras yielded respective MFIs of 14.5, 2.9, and greater than 99 years. Stand dynamics are discussed in regard to regeneration, growth release, and fire events. Our results suggest that in this region human population density and culture drive fire frequency more so than drought.

Tree-ring stable oxygen isotope from southeast Asia reveal monsoon circulation dynamics

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Anchukaitis, Kevin* (*Woods Hole Oceanographic Institution*)
Buckley, Brendan* (*Tree ring laboratory. LDEO*)
Ummenhofer, Caroline (*Woods Hole Oceanographic Institution*)
Nam, Le Canh (*Forest Science Academy, Dalat City, Vietnam*)
Gagen, Mary (*Swansea University*)

Asian monsoon circulation might be better inferred from tree-ring oxygen stable isotope ratios than ring widths alone, which primarily record local pre-monsoon drought conditions. Here, we present new evidences on the effect of climate and circulation dynamics on stable isotope series in tree-rings from Fokienia hodginsii, a long-lived conifer from southeast Asian highlands. Preliminary analysis reveal that oxygen stable isotopes in tree rings are negatively correlated with summer monsoon surface wind speeds over the Bay of Bengal and the adjacent regions, indicating that when strong onshore winds move moisture quickly rain water becomes less enriched in the heavier isotope. Oxygen isotope values appear to be controlled by local and regional metrics reflecting broad-scale monsoon controls on local climate. However, these two proxies are coherent at the multidecadal time scale and their combination might allow for a broader understanding of past precipitation amount and monsoon circulation dynamics

Dendrochronological dating of the World Trade Center ship, Lower Manhattan, New York City

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Andreu-Hayles, Laia (*Tree-ring laboratory. LDEO*)
Martin Fernandez, Javier (*Tree-ring laboratory. LDEO*)
Cook, Edward (*Tree-ring laboratory. LDEO*)

On July 2010, archaeologists encountered the intact remains of a ship's hull in lower Manhattan. Because the date of construction and origin of the timbers were unknown, samples from different parts of the ship were for dendrochronological dating and provenancing. After building a floating chronology from the extracted white oak samples, absolute dating and provenance was evaluated against 21 oak site chronologies. The year 1773 showed the strongest evidence for the tree felling date prior to construction. Higher agreement was found between the ship chronology and two chronologies from Philadelphia and eastern Pennsylvania. Our analysis suggest that the timbers used to build the ship originated from the same specific location, supporting the independent hypothesis that the ship was built in a small shipyard. Few 18th century ships have been found and there is little historical documentation of how vessels of this period were constructed. The hull represents a rare and valuable piece of American shipbuilding history.

Tree-ring δ13C as a proxy for drought in New England

Maxwell, Stockton*# (*Radford University*)
Belmecheri, Soumaya (*Pennsylvania State University*)

In this investigation, we assessed the utility of tree-ring width and δ13C from Tsuga canadensis and Quercus rubra trees growing at Harvard Forest, MA to reconstruct drought in New England. We conducted a correlation analysis between ring width, δ13C, and Palmer Drought Severity Index at varying spatial scales (forest stand to region) with data from 1991-2010. As expected, tree-ring width showed weak to moderate correlation with drought because of the prominence of stand dynamics at the Harvard Forest site. In contrast to ring width, the δ13C of tree rings is likely to have a strong correlation with drought because of the mechanistic link between carbon assimilation, CO2 concentrations, and climate. The most significant correlations were found with PDSI from May to August for T. canadensis and for May, July, and August for Q. rubra. We also investigated the spatial extent of the correlation between δ13C and drought in the KNMI explorer.

Oxygen Isotope Analysis in Tree-Rings of Pterocarpus angolensis in Zimbabwe

McLeran, Kerry*# (*Southern Illinois University*)
Therrell, Matthew (*Southern Illinois University*)
Lefticariu, Liliana (*Southern Illinois University*)

Our study was designed to identify the relationships between climate parameters, such as precipitation, and δ18O values of tree ring α-cellulose extracted from exactly dated tree rings of Pterocarpus angolensis growing in the arid to semiarid Mzola region of western Zimbabwe. We applied the Modified Brendel technique to isolate α-cellulose from raw wood samples extracted from two P. angolensis trees and measured the α-cellulose δ18O values using IRMS. We developed a 30-year (1955-1984) α-cellulose δ18O chronology and correlated it with monthly and seasonal precipitation totals, δ18O of meteoric water, and seasonal mean temperature. The strongest correlations were observed between α-cellulose δ18O values and February total precipitation (r = -0.49, p = 0.006) and wet season precipitation amounts, specifically those seasons with the highest amount of precipitation. Between the years 1955-1984, the ten wettest seasons (Nov-April) were plotted against the corresponding δ18O values, identifying a highly significant correlation (r = -0.79, P = 0.007).

A multi-millennial precipitation reconstruction at Black Mountain in the Upper Arkansas River basin

Miller, Kyle R.*# (*Graduate Student*)
Woodhouse, Connie (*Researcher*)

Reconstruction of past climate using standardized ring measurements enables an examination of the modern climate in the context of the last several hundred, and in some cases, thousand years. We have generated the first precipitation reconstruction for the Upper Arkansas River basin from Pinus aristata (Rocky Mountain Bristlecone Pine) at Black Mountain in central Colorado. The reconstruction, which extends back over 2,000 years, provides information about upper Arkansas River basin droughts, including those of the medieval and Roman periods. This reconstruction adds to the small number of multi-millennial-length records of hydroclimatic variability in Colorado and the US Southwest. It will also be used as part of a multiproxy study with lake sediment data from the San Juan Mountains to investigate the past climate of this region.

Tree-ring evidences of insect outbreaks in Nothofagus pumilio forests in southern Patagonia, Argentina

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Mundo, Ignacio (*IANIGLA-CONICET*)
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Insect outbreaks from Ormiscodes anphimone are easily recognized in the Patagonian landscape due to changes in color of Nothofagus pumilio forests in response to strong tree defoliation. In this study we use 26 N. pumilio tree-ring chronologies along a S-N transect from El Chaltén (49º25'S) to Laguna del Desierto (49º00'S) in southern Patagonia to reconstruct past Ormiscodes outbreaks over the period 1743-2010. In addition, we asses the relationships between outbreaks, climate variability and atmospheric circulation index including the Southern Annular Mode (SAM). Using

dendroecological methods, 47 Ormiscodes outbreaks were identified over the period 1743-2010. Tree-ring chronologies from forests affected by Ormiscodes showed abrupt growth reductions during the years following the insect attacks. No periodicities were detected in the outbreak reconstruction. Although the relationships between outbreaks and climate variations seem to be complex, insect outbreaks appear to be related to drier climatic conditions and the positive phase of the SAM.

Changes in climate-growth relationships for Picea glauca in the Yukon Territory, Canada

Morimoto, David S.*# (*Western University*)
Luckman, Brian H. (*Western University*)

A network of 73 upper elevation white spruce chronologies was developed from treeline sites across the Yukon Territory. PCA of standard ring-width chronologies indicate a strong common growth pattern (50 sites, 57.3% of variance) loading on PC1 during the 1900-1950 period but varied patterns over the 1951-2000 interval when 22, 19 and 14 chronologies load on the first 3 PCs respectively (67.8% cumulative variance). The PC1 chronologies of the 1900-1950 period show strong positive relationships to summer (JJA) minimum temperatures and strong negative relationships with summer maximum temperatures of the previous year. Sixteen of these 50 chronologies show strong negative responses to minimum temperatures of spring and summer (MAMJJA) in the 1951-2000 interval and only 4 retain the strong positive summer signal. The greatest changes and most negative response to summer temperatures occur in the central and north central Yukon. Positive summer temperature sensitivity only remains in the most southerly sites.

Fire history in the Araucaria forests of Argentina: human and climate influences

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Kitzberger, Thomas (*Laboratorio Ecotono - INIBIOMA CONICET*)
Roig Juñent, Fidel (*IANIGLA-CONICET*)
Villalba, Ricardo (*IANIGLA-CONICET*)
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Little is known about drivers and trends of historic fire regimes in the Araucaria araucana forests of southwestern Argentina. Fire history in these forests was reconstructed by the analysis of 246 fire-scarred partial cross-sections collected at 10 sites in northern Patagonia. Fire chronologies showed an increase in fire occurrence during the nineteenth century and a sharp decrease since the early twentieth century. The creation of Lanín National Park in 1937, changes in human activities, and the active suppression of wildfires led to a significant increase in mean fire intervals since 1930. Interannual variability in wildfire activity was associated with ENSO. Years of widespread fire are related to negative departures of both Niño 3.4 and PDO indices, as well as coincident phases of positive Southern Annular Mode and La Niña events. Temporal variations in Araucaria fire history in Argentina show the combined effect of human and climate influences.

Tree-ring based reconstruction of the Río Neuquén streamflow, northern Patagonia, Argentina

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Morales, Mariano (*IANIGLA-CONICET*)
Neukom, Raphael (*Institute of Geography, University of Bern*)
Le Quesne, Carlos (*Laboratorio de Dendrocronología, Universidad Austral de Chile*)
Urrutia, Rocío (*Laboratorio de Dendrocronología, Universidad Austral de Chile*)
Lara, Antonio (*Laboratorio de Dendrocronología, Universidad Austral de Chile*)
Masiokas, Mariano (*IANIGLA-CONICET*)

In most cases, gauged river flow records in southern South America extend for only a few decades, hampering the detection of long-term cycles and trends. In northern Patagonia, Argentina, the Río Neuquén has great importance for local and national socio-economic activities. We reconstructed the October–June mean streamflow for the period 1346–2000 AD based on a network of 43 tree-ring chronologies from Araucaria araucana and Austrocedrus chilensis, grouped in composite series, using a nested principal component regression approach. Analyses of the frequency, intensity, and duration of droughts and pluvial events indicate that the 20th century contains some of the driest and wettest annual to decadal-scale events. Blackman-Tukey and singular spectral analyses identified oscillations from 3.5 to 17.5 yr. A dominant 6.8-yr cycle explains ca. 23.6% of the total variance in the reconstruction. Correlation analyses showed that discharges of this river are related to the Southern Annular Mode.

Streamflow variability in the Chilean Mediterranean-temperate climate transition (35°S-42°S) during the last four hundred years inferred from tree-rings records

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Riquelme, Natalia (*Laboratorio de Dendrocronología y Cambio Global, Universidad Austral de Chile*)
Mundo, Ignacio (*Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA).*)
LeQuesne, Carlos (*Laboratorio de Dendrocronología y Cambio Global, Universidad Austral de Chile*)
Villalba, Ricardo (*Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales, CONICET*)

We developed a streamflow reconstruction of the Biobío River, located on the limit of influence of Mediterranean and wet-temperate climate. We compared it with previous reconstructions from the Temperate (Puelo-River) and Mediterranean (Maule-River) climates.

The present trend of reduced flow in both Biobío and Puelo Rivers seems to be part of a low frequency cycle (>80 years) shared by these rivers. Flows of both of these rivers showed a high correlation with the Antarctic Oscillation. Extreme events for all three rivers showed an increase during the 19th and 20th centuries. Both the most extreme drought and pluvial years in the instrumental record (1943-2000) were found within the five most extreme years in the common period of the last 400-years displayed by the reconstructions.

We conclude that the Biobío reconstructions, allow for greater understanding of the differences in the regime of these rivers, identifying interannual and multi-decadal patterns.

Growth trends and sensitivity to climate of declining Mediterranean open woodlands exhibiting widespread mortality in Southern Spain

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Cañellas, Isabel (*National Institute for Agricultural and Food Research and Technology (Madrid, Spain)*)
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We present two chronologies of dead and weakened Quercus ilex trees from declining open woodlands of Southern Andalusia and discuss climate's implication in the current widespread mortality in these ecosystems. Basal area increments were used to find out periods of growth decline preceding death. Absent rings became frequent since the 1970s, coinciding with increasing drought. Negative pointer years matched dry years and became more pronounced in the last decades. Growth was correlated with the annual Palmer Drought Severity Index and precipitations from previous October to May. Mean sensitivity increased recently, ranging between high values (0.35-0.5). Correlations with spring temperatures turned from positive to negative, positive correlations with current autumn precipitation arose whereas significant positive correlations with summer precipitations were no longer observed. These changes could suggest modifications on tree phenology. Intensively-used Mediterranean open woodlands of Southern Andalusia are vulnerable and the current dying process suggests that they are unlikely to overcome increasing stress climatic conditions.

The 8.2 ka event - Calendar-dated glacier response in the European Alps

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Schlüchter, Christian (*University of Bern, Institute of Geological Sciences*)

The 8.2 ka event has been recognized as one of the most significant cooling periods during the Holocene in the north Atlantic realm. However, clear evidence for an 8.2 ka event-related reaction of Alpine glaciers was missing for a long time. In the light of dendrochronological analyses for more than 30 tree remains found in front of the Mont Miné Glacier, Swiss Alps, we present evidence for such a reaction, i.e. an advance, related to this cooling event. Calendar dates established for these tree remains place this glacier advance ~8175 yr before A.D. 2000. The Mont Miné Glacier reached an extent like the current ice extent at that time. Moreover, this 8.2 ka advance response of the Mont Miné Glacier termi-

nated a nearly millennial-long retreat period with a glacier always shorter than today.

Four centuries of winter temperature variability for Southern Poland reconstructed from tree rings, early instrumental data and documentary sources

Opała, Magdalena*# (*University of Silesia, Faculty of Earth Sciences, Department of Climatology*)

The precise study of the variability of winter temperature in recent centuries is critical, due to the fact that the increase in the prevalence of warm winters is regarded as clear evidence of climate warming in Poland. The study was conducted in the Silesia Region, located at the south of Poland, eastern Europe. The investigated region is particularly favorable for historical climate studies thanks to the existence of potential natural and manmade climate archives. This valuable material, however, remained so far unexploited for reconstructing climate purposes. Different types of data were used for long-term climate variability studies: 1)Tree Rings of Pinus sylvestris from nature reserves, 2)TR of historical/relict wood, 3) early instrumental data series from the eighteenth and nineteenth century German archives, 4)documentary sources. The obtained reconstruction allowed for identification of four phases of thermal trends and duration of climatic fluctuations, well-known in the Euro-Atlantic area: LIA, Maunder and Dalton Minimums, Modern Warming.

Dendrochronological potential of Tajikistan (the example of western part of Pamiro-Alay Ridges): Preliminary results and future prospects

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Parusel, Tomasz (*University of Silesia, Faculty of Earth Sciences, Department of Physical Geography, Poland*)

The presented preliminary studies are a part of interdisciplinary project on recognition of mechanisms and effects of human influence and natural factors on the alpine ecosystems in context of continental arid climate of Central Asia. The study area is located in the Fann Mts, at the contact of the Zarafshan and the Gissar ranges, Western Pamir-Alay. Based on field reconnaissance the following species were selected for studies: Juniperus seravcshanica, J.turcestanica, J.semiglobosa, J.sibirica and Ephedra equesitina. Preliminary investigations indicate the greatest potential of J.seravschanica from Kuli Kalon Basin (~2880masl). The first regional chronology were created and analyzed in terms of its usefulness as climatic archive. Investigated region can be considered as the key area, because there are preserved centuries-old living trees (>500yrs) and the potential of relict wood. Through the use of long-term juniper chronologies it will be possible to study the history of climate and anthropogenic impacts on high-mountain juniper forests ecosystems.

Tree-ring perspectives on short-term climate variability during the transition during Late Pleistocene to Holocene from the Great Lakes Network of buried timbers

Panyushkina, Irina*# (*LTRR*)
Leavitt, Steven (*U. of Arizona*)

We investigate climate interannual variance and decadal variability in tree rings from the periphery of the retreating Laurentide Ice Sheet to understand how the warming atmosphere affected tree growth and how changes in atmospheric circulation altered high-frequency modes of climate variability. The Great Lakes region provides geological circumstances that favored preservation of ancient wood in glacial, alluvial, organic, aeolian, and lacustrine deposits. Currently the U.S. Great Lakes Network of buried wood counts over 50 sampled tree-ring sites spanning 14,000 BP to 2,000 BP, only about 20% of which produced well-dated, highly-replicated chronologies. Post-glacial tree-ring records of spruce (Two Creekan age and Younger Dryas) have a summer temperature signal with significant ENSO-like modes of interannual and decadal variability, which disappear from the tree-ring records after ca. 9,000 BP. Mid to Late Holocene tree-ring records of cedar, larch, pine and deciduous trees provide evidence of short-term hydrological fluctuations.

Is an Epic Pluvial Masking the Water Insecurity of the Greater New York City Region?

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Bell, Andrew (*International Food Policy Research Institute*)
Cook, Edward (*Tree Ring Laboratory of Lamont-Doherty Earth Observatory of Columbia University*)

Lall, Upmanu (*Columbia Water Center of Columbia University*)
Devineni, Naresh (*Columbia Water Center*)
Seager, Richard (*Lamont-Doherty Earth Observatory of Columbia University*)
Eggleston, Keith (*Northeast Regional Climate Center*)
Vranes, Kevin (*Unaffiliated*)

Six water emergencies have occurred since 1981 for the New York City region (NYC) despite: 1) 30 yrs of water conservation policies and 2) meteorological data showing little severe or extreme drought since 1970. We reconstruct 472 years of moisture availability to place these emergencies in long-term context. Thirty-two chronologies comprised of 12 species account for up to 66.2% of the average May-August Palmer Drought Severity Index. The use of multiple tree species seems to aid reconstruction skill. The full record reveals repeated severed droughts during the 16th and 17th centuries and a trend towards more pluvial conditions since ca 1800 that is accentuated by an unprecedented, 43-year pluvial event that continued through 2011. It appears that the water supply system for the greater NYC region could be severely stressed if the current water boom shifts towards hydroclimatic regimes like the 16th and 17th centuries.

Growth response of Douglas-fir to coseismic subsidence in the Red Canyon fault block, Hebgen Lake, Montana

Pendergrass, Kayla*# (*Austin Peay State University*)
Galicki, Stan (*Millsaps College*)
Gentry, Christopher (*Austin Peay State University*)

Various studies have described the application of tree rings to seismological research. While most of these studies have focused on the growth response of species adjacent to the fault, very few have examined the spatial variation of the response at a moderate distance from the disturbance. In this study, Douglas-fir (Pseudotsuga menziesii) cores were examined from four sites at a distance of up to 500m from the Red Canyon Fault, site of the 1959 Hebgen Lake Earthquake (7.5 Ms) in the Gallatin National Forest in southern Montana. With an average interseries correlation of 0.6 and time span from 1843-2010, all sites had numerous trees recording minor suppressions in the three years following the earthquake. While additional sampling will be required, this study demonstrates that seismic damage to trees even at a distance of 500m from the fault can be caused by subsidence from earthquake events.

Potential of Cedrela odorata for dendroclimatological and dendroecological studies in the Selva Central of Perú.

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Rodrígues Arisméndiz, Rodolfo (*Facultad de Ingeniería de la Universidad de Piura, Apartado 353, Piura, Perú*)

Despite the progress made during the past 20 years searching dendrochronological potential in tropical and subtropical tree-species, tropical dendrochronology is still in a development stage. The aim of this research was to determine the potential of Cedrella. odorata for dendrochronological studies in the Selva Central of Peru. The tree-ring anatomical characteristics were carefully examined and we were able to develop a 207 year tree-ring chronology and correlate it with precipitation records. Tree-rings are clearly delimited by larger pore diameters in earlywood and smaller pore diameter in latewood associated with marginal and paratracheal parenchyma. The tree-ring chronology was related to precipitation records from Satipo and significant correlations were found with the previous rainy season and late dry season. The good discrimination of annual rings, strong relationship with precipitation, the wide range and longevity of trees (200 years) makes C. odorata a very promising species for dendrochronological studies in tropical forest of America.

Stand Dynamics in a Small Volcanic Depression in the Valles Caldera National Preserve, New Mexico

Pettit, Joseph*# (*Indiana State University*)
Barrett, Kristen (*USGS*)
Yocom, Larissa (*Northern Arizona University*)
Pendergrass, Kayla (*Austin Peay State University*)
Bragg, Thomas (*University of Nebraska-Omaha*)
Owens, Maria (*University of Tennessee*)
Stan, Amanda (*Northern Arizona University*)
Gentry, Christopher (*Austin Peay State University*)

As part of the 2012 North American Dendroecological Field Week (NADEF), we reconstructed stand dynamics of a depression on a lava flow in the Valles Caldera National Preserve, New Mexico. Our study area presented a unique

opportunity to assess stand dynamics as related to aspect. Within each of five plots (N, S, E, W slopes and depression center) we collected tree-ring data from 10 live or dead trees to assess age, composition, density, and growth rates on different aspects and over time. Tree age, composition, and basal area increment varied with aspect. Ponderosa pine was the dominant species in all but the north-facing plot, which consisted entirely of Douglas-fir. Recruitment was fairly steady until approximately 1880 which was followed by a pulse in recruitment in the 1920s that coincided with a logging event. The ecological patterns found within our study area were representative of broad-scale patterns of the larger region.

A description of roost trees used by Indiana bats on a mitigation site near Plainfield, Indiana.

Pettit, Joseph*# (*Indiana State University*)
James, Speer (*Indiana State University*)
O'Keefe, Joy (*Indiana State University*)

With the goal of better managing land used by the Indiana Bat (Myotis sodalis), we study both tree-level and stand-level characteristics on a mitigation property in Plainfield, Indiana. In this study we explore factors in the life of trees that might affect their quality as a roosting site (e.g. time since mortality, season of mortality, and type of mortality event such as senescence or disturbance). These observations are compared within and among species where sample size allows. We also investigate the time limit that a tree is seen by bats as roost habitat because of environmental factors such as gap phase dynamics and the time a tree stands dead. Finally we explore the characteristics of a tree that differ significantly when comparing trees that are frequently used by bats for multiple years and the trees that are used by few bats infrequently.

Culturally Peeled Engelmann Spruce Trees in the Absaroka Mountains of Northwestern Wyoming

Reiser, Marcy*# (*Laboratory of Tree-Ring Research*)

The indigenous use of bark and cambium harvested from trees has been documented world-wide for centuries, especially in northern latitudes and in western regions of North America, including the Pacific Northwest, the Southwest, and portions of western Montana, Idaho, and Canada. However, there remain substantial portions of western North American where indigenous use of tree resources is largely undocumented. This is especially true in northern Colorado and most of Wyoming. Since 2006, samples have been collected from culturally peeled trees in both Colorado and Wyoming. This study focuses on dendrochronological results from analysis conducted on tree-ring samples collected from peeled trees in northwestern Wyoming.

Linking climate-fire relationships: A fire history of Pinus ponderosa in Valles Caldera National Preserve, New Mexico

Restaino, Christina*# (*University of Washington*)
Farella, Josh (*University of Arizona*)
Swetnam, Tom (*University of Arizona*)

We collected fire scars from Ponderosa pine (Pinus ponderosa) to characterize the fire frequency and severity of a stand in the Valles Caldera National Preserve in New Mexico. We developed a master-tree chronology using Douglas- fir (Pseudotsuga menziesii) cores to cross-date fire scars to detect precise fire years. After identifying fire event years, we qualitatively assessed seasonality of fire based on the position of scar in the sapwood and heartwood. Superposed-epoch analysis (SEA) was used to investigate the relationship between fire years and climate. The period of analysis was limited to 1700-1900 in order to meet a threshold of three recording trees. Most fires in the Jemez Mountains occur during the early part of the growing season, usually May through early July. Results from the SEA suggest that fire years are linked to both current and antecedent year climate, with wet conditions two years prior and dry conditions in the year of the fire.

Nothofagus pumilio dieback in northern Patagonia: Relationships between patterns of radial growth and crown mortality.

Rodriguez Catón, Milagros*# (*IANIGLA, CCT CONICET-Mendoza*)
Villalba, Ricardo (*IANIGLA, CCT Mendoza - CONICET*)

Crown dieback is frequently observed in most Nothofagus pumilio forests located in relatively dry environments of the north Patagonian Andes. Seven stands of N. pumilio showing external evidence of crown decline were sampled to determine the relationships between radial growth patterns and crown dieback. In each stand, Principal Component Analyses were applied to ring width and basal area increments to determine the dominant patterns of tree growth. Crown dieback was recorded for each tree using categorical classes including: severely affected (>75% of crown dead), affected (50-74%), partially affected (25-49%) and healthy (<25%) trees. Trees with advanced crown mortality show declining trends in ring width and basal area increments. Conversely, most healthy trees are associated with patterns of increasing tree-growth during the past decades. A comparison between

patterns based on temporal variations in ring width and basal area increment indicates that the latter is a better predictor of N. pumilio tree health.

Should we have the Blues?

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Larsson, Lars-Åke (*Cybis Elektronik & Data AB, Saltsjöbaden. Sweden*)
Wilson, Rob # (*School of Geography and Geosciences, University of St Andrews, UK*)

Blue Intensity (BI) has the potential to provide information on past summer temperatures of a similar quality to maximum latewood density (MXD) at a substantially lower cost. As part of the Scottish Pine Project, BI chronologies have been generated for 17 woodlands from a wider ~50 site Scots pine network around the Scottish Highlands. Focussing on two sites in the Cairngorms National Park, Scotland, ring-width, MXD and BI were measured on replicate cores from each tree to facilitate a direct comparison between the parameters, evaluating the utility of the BI data. Results indicate that while inter-annual variability of BI was found to be of comparable quality to MXD, potential biases exist at longer timescales in the BI time series. More detailed research is required to better understand and quantify the limitations of this new parameter before it is commonly used for dendroclimatic reconstruction.

Students Monitoring the Decline of Eastern Hemlock (Tsuga canadensis L.) in the Bluestone River Gorge, West Virginia

Saladyga, Tom*# (*Concord University*)

Across much of its native range, eastern hemlock (Tsuga canadensis L.) is threatened by the invasive forest pest, hemlock woolly adelgid (HWA) (Adelges tsugae Annand). In West Virginia, the Wildlife Diversity Unit (WDU) has listed hemlock forest systems as a "very high" conservation priority due to the extrinsic threat of HWA infestation and declining quality of these systems. Eight permanent plots were established at Pipestem Resort State Park as part of a course taught by Saladyga at Concord University. All trees ≥ 10 cm diameter at breast height (DBH) were tagged and measured and distance and bearing from plot center, species, and vigor were recorded. All hemlock trees (DBH ≥ 10 cm) were cored to determine establishment dates. Preliminary results indicate an association between site factors and hemlock decline. Student participation in baseline and future data collection will instill an understanding and appreciation of natural resources in West Virginia and provide training for future scientists and land managers.

Dendrochronology of the "Currey Tree"

Salzer, Matthew*# (*Laboratory of Tree-Ring Research, University of Arizona*)
Baisan, Chris # (*Laboratory of Tree-Ring Research, University of Arizona*)

In August of 1964 a large bristlecone pine (Pinus longaeva) in the Snake Range of Nevada was cut down by Donald Currey, then a graduate student at the University of North Carolina. In the immediate aftermath of this unfortunate incident a counting of rings indicated the tree to be of record setting age: 4,844 years (later revised by D. Graybill to 4,862 years). However, these were estimates based on ring counts rather than on crossdating. The University of Arizona's Laboratory of Tree-Ring Research recently obtained the pith portion of the "Currey Tree" (AKA "Prometheus"; AKA "WPN 114") and have crossdated the inner section against upper treeline sites in both California and Nevada. Dating indicates an inner ring of 2936 BC. The tree lived more than 4900 years. Now, almost 50 years after the tragic cutting event, data from the tree are being used in research.

International Summer School 2012 "Tree Rings, Climate, Natural Resources, and Human Interaction", Valsaín, Spain. ("DendroSpain 2012")

Sanchez-Salguero, Raul* (*INIA-CIFOR*)
Ballesteros Canovas, Juan Antonio*# (*Spanish Geological Survey*)
Touchan, Ramzi # (*LTRR*)
Meko, Dave # (*University of Arizona*)
Camarero, J. Julio (*ARAID-IPE-CSIC (Spain)*)
Alfaro-Sánchez, Raquel (*Universidad de Castilla-La Mancha (Albacete, Spain)*)
Blanco, Juan A. (*Universidad Pública de Navarra (Pamplona, Spain)*)
Garah, Kenza (*University of Batna (Batna, Algeria)*)
Garofano Gómez, Virginia (*Universitat Politècnica de València (Valencia, Spain)*)
Hevia, Andrea (*CETEMAS (Asturias, Spain)*)
Kerchouche, Dalila (*University of Batna (Batna, Algeria)*)

Khabcheche, Madjda (*University of Batna (Batna, Algeria)*)
Madrigal, Jaime (*University of Alcalá (Spain)*)
Martín, Luis A. (*AREVA (Spain)*)
Muntan, Elena (*University of Barcelona (Barcelona, Spain)*)
Rodriguez Morata, Clara (*Spanish Geological Survey*)
Sánchez-Miranda, Ángela (*Junta de Andalucía (Granada, Spain)*)
Shestakova, Tatiana A. (*Siberian Federal Institute (Russia)*)
Tabakova, Maria (*Siberian Federal Institute (Russia)*)

The summer school objectives were to sharpen and broaden the dendrochronology skills of the participants, stimulate ideas for future dendrochronological research, and foster collaboration of tree-ring researchers around the world. The course was hosted by the National Center for Environmental Education at the Valsaín Forest (Spain). The course had 14 participants from three countries (Spain, Algeria, and Russia). Activities included basic training in dendrochronology skills as well as application to projects in dendroclimatology, dendroecology and dendrogeomorphology. Group projects focused on P. sylvestris stands at three locations: a high-elevation (1864 m a.s.l.) site, a lower-elevation (1534 m a.s.l) site, and upper and lower reaches of the flood-influence area of a tributary of the Eresma River. The course demonstrates the potential of tree-ring data for studying various aspects of the climate, ecology, and geomorphology of the Valsaín Forest.

Assessing the potential of Paraná pine (Araucaria angustifolia) for high precision Southern Hemisphere 14C calibration

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Araucaria angustifolia is a native subtropical coniferous species of southern Brazil. Previously published 14C measurements on selected annual growth rings confirmed the overall profile of the Southern Hemisphere (SH) of the "bomb-pulse", suggesting that using an annual resolution of this long-lived species for the construction of a calibration chronology curve was promising. This work reports the first high-precision 14C-AMS dating of holocellulose from 71 rings (from 1927-1997). The tree-rings analyzed here were from a single tree growing at Camamducaia, Minas Gerais. A slight depletion of atmospheric 14C after 1927 was observed, in agreement with the expected Suess effect. Our 14C results also showed the rise and rapid decrease of atmospheric 14C concentrations associated with the detonations of nuclear weapons during the late 50's, and its subsequent uptake by other large C sinks. The agreement between this record and the SH compilation 14C data shows the potential of this tree species for older chronologies.

Site-specific responses to climatic variability in sugar maple (Acer saccharum Marsh.) dominated stands in south-central Ontario, Canada

Schutten, Kerry*# (*University of Guelph Department of Geography*)
Gedalof, Ze'ev (*University of Guelph Department of Geography*)
Gordon, Andrew M. (*University of Guelph Department of Integrative Biology*)

We investigated the sensitivity of sugar maple (Acer saccharum) annual radial growth to climatic variability in Algonquin Provincial Park, south-central Ontario, Canada, using dendroecological techniques. Site chronologies were developed from 19 stands of sugar maple across a range of edaphic conditions and stand properties, but within a small geographical area. Specific sites varied in their responses to increased temperature or decreased precipitation. A cluster analysis of the growth climate associations indicated three main types of sensitivity: Cluster 1 sites were quite strongly limited by previous summer and winter temperatures; Cluster two sites were less sensitive to previous winter conditions, but are still limited by previous and current summer temperatures; and Cluster 3 sites were relatively insensitive to temperature, but showed the greatest positive correlations to precipitation. The results from our study provide evidence that stands growing under the same regional climatic controls can experience very different responses to climatic variability over time.

The fundamental influence of landscape structure

on boreal forest dynamics, northern Sweden

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Underwood, Christopher (*Tree-Ring, Earth, and Environmental Science Laboratory, University of Wisconsin - Platteville*)
Larson, Evan (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)

We examined the influence of landscape structure on disturbance, succession, and the duration of legacies initiated by fire across a naturally fragmented boreal forest in northern Sweden. We inventoried 2,038 trees, of which 1,249 were cored and dated, and collected 128 soil samples on 16 distinct forested islands. Several stand characteristics were significantly correlated with island size, including density ($r = -0.77$), basal area increment ($r = 0.7$), the importance of Betula ($r = -0.63$), and the importance of Picea ($r = 0.69$). Soil charcoal was found in 76 of 128 samples and on all but one island. Charcoal mass showed no consistent relationship with island area, isolation, or any stand variables. Carbon dates are forthcoming. Our findings indicate landscape structure as a fundamentally important driver of forest structure in this landscape and provide a frame for understanding the length of fire's ecological legacy in boreal forests.

Optimizing the reliability of cell-anatomical chronologies of Scots pine by including an increasing number of radial rows of tracheids

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Smiljanic, Marko (*University of Greifswald, Institute of Botany and Landscape Ecology, Germany*)
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Tree rings result from the total number of woody cells formed under various positive and negative environmental influences prevailing prior to and during a growing season. That is why it is assumed that cell-anatomical variables such as lumen area or wall thickness may have 'archived' some environmental information. Most studies up to now were made with deciduous tree species such as oak and beech using their vessel sizes. Only recently, conifers have come into focus. It has been proven that cell-anatomical chronologies of conifers are useful climate proxies providing environmental information other than tree-ring width or density. However, the question of how many radial transects should be taken into account has not unequivocally been answered yet. Here we present an estimation of how many radial transects are necessary to establish reliable cell-anatomical chronologies using examples from three Scandinavia sites.

Preliminary Dendrogeomorphological Results Showing Past Eruptions in the Andes

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Casteller, Alejandro (*Argentine Institute for Snow, Ice and Environmental Research - CONICET*)
Muñoz, Ariel (*Laboratorio de Dendrocronología y Cambio Global, Universidad Austral de Chile*)
Gonzalez, Mauro (*Laboratorio de Dendrocronología y Cambio Global, Universidad Austral de Chile*)
Müller, Wolfgang (*Department of Earth Sciences, Royal Holloway University of London*)

Tree-ring samples were collected from trees growing on the flanks of various volcanoes of the central Andes Volcanic Range, on the border of Argentina and Chile. The species sampled were Araucaria, which appear to be up to 800 years in age, and Austrocedrus, which are about 150 years in age. The Araucaria samples have extremely narrow rings for hundreds of years in a row, and strictly speaking crossdating those samples will be difficult, if not impossible. The Austrocedrus samples have much wider rings, and those samples are crossdatable. The intention is to analyze these tree-ring samples both for ring width and for ring chemistry to ascertain possible eruptions of the past. For example, many Austrocedrus samples show an abrupt increase in ring growth beginning in 1960, which might be evidence of an eruption and ash fall at that time. Salvaging the Araucaria samples with dendrochemistry is proposed.

Additional analysis of dendrochemical data of Fallon, Nevada

Sheppard, Paul R.*# (*Laboratory of Tree-Ring Research*)
Helsel, Dennis (*Highlands Ranch, Colorado*)
Speakman, Robert (*Center for Applied Isotope Studies, University of Georgia*)
Ridenour, Gary (*Physician, Fallon, Nevada*)
Witten, Mark (*Odyssey Research Institute, Tucson, Arizona*)

Previously reported dendrochemical data showed temporal variability in concentration of tungsten (W) and cobalt (Co) in tree rings of Fallon, Nevada, US. Since then, intertree vari-

ability was calculated for each measured element across trees within subsites and time periods. For W and Co, the metals of highest interest in Fallon, inter-tree variability was always higher within versus outside of Fallon. For calibration purposes, this entire analysis was repeated at a different town, Sweet Home, Oregon, which has a known tungsten-powder facility, and inter-tree variability of W in tree rings confirmed the establishment date of that facility. This research adds important new dimensions to dendrochemistry of point-source contamination by adding analysis of inter-tree variability to analysis of central tendency.

Dendrochemistry Shows a Past Insect Defoliation

Sheppard, Paul R.*# (*Laboratory of Tree-Ring Research*)
Lynch, Ann (*Laboratory of Tree-Ring Research*)

In past dendrogeomorphological research on pines growing around the Mexican cinder cone called Parícutin, it was noticed that most of the trees sampled showed reduced ring widths from 1970 to 1974. That tree-ring signal was due not to the volcano but rather to an outbreak of an insect defoliator. Dendrochemistry was tried on selected tree-ring samples to see if the known defoliation caused changes in the environmental availability of important soil nutrient elements. Evidence exists that key cation nutrients increased in rings of these trees just after the time of the defoliation outbreak, perhaps due to recycling of those nutrients from needles to available ionic forms in the soil as a result of the defoliation itself. If this bears out, dendrochemistry could be an additional tool for studying past insect defoliations.

Macroanatomy of compartmentalization in fire scars of three western conifers

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Sutherland, Elaine (*USDA Forest Service*)
Arbellay, Estelle (*University of Berne*)
Stoffel, Markus (*Laboratory of Dendrogeomorphology, University of Berne*)
Falk, Donald (*University of Arizona*)

Fire scars are visible evidence of compartmentalization and closure processes that contribute to tree survival after fire injury. Preliminary observations of dissected fire scars from trees injured within the last decade showed centripetal development of wound-initiated discoloration (WID) through 2-3 decades of former sapwood in Larix occidentalis and Pseudotsuga menziesii. Although the WID reached and was apparently confluent with the visually similar heartwood, WID lacked the decay and insect resistance characteristics of heartwood. In contrast, development of WID in Pinus ponderosa, was limited to fewer than 5 rings of former sapwood with healthy sapwood retained between the WID and heartwood. The healthy sapwood has the potential to actively resist the spread of infection and further loss of wood function. For wound closure, all three species produced wide rings of woundwood from the margin of the killed vascular cambium in the growing season following fire injury.

Dendrogeomorphic reconstruction of lahar events at Klyuchevskoy and Shiveluch volcanoes (Kamtchatka, Russia)

Sorg, Annina*# (*University of Berne / Geneva*)
Salaorni, Elisa (*University of Berne*)
Stoffel, Markus (*University of Berne / Geneva*)
Tutubalina, Olga (*University of Moscow*)
Chernomorets, Sergey (*Univsersity of Moscow*)

Changing climatic conditions and volcanic activity on the Kamchatka Peninsula have triggered a large number of devastating volcanic debris flows (lahars), which have the potential to develop considerable reach and devastate populated areas. While there are complete records of the past decades for volcano eruptions around the village of Klyuchi, lahars have only been recorded when infrastructure was damaged. In order to better understand the spatial and temporal dynamics of lahars, we sampled 60 willows (Salix sp.) and 90 larches (Larix gmelini) growing on the foothills of Klyuchevskoy and Shiveluch volcanoes. All sampled trees show signs of lahar activity, in the form of injuries, burial, tilting or root exposure. Dendrogeomorphic analysis was complemented by information from satellite imagery to reconstruct the frequency and spatial patterns of recorded and unrecorded lahars, which was then set into context with volcanic eruptions and climate data so as to discriminate hot from cold lahars.

Dating of the Bridger Antelope Trap in Wyoming Using Dendrochronology

Speer, Jim*# (*Indiana State University*)
Hansen-Speer, Karla (*Indiana State University*)
Harrell, Lynn (*Bureau of Land Management, Kemmerer Office*)

The Bridger Antelope Trap is an archaeological site in southwestern Wyoming that was used by American Indians while hunting antelope (Antilopcapra americana). The trap is a large corral constructed from Utah juniper (Juniperus osteosperma) covering 110,000 m2. The primary purpose of the project was to provide information about when the trap was built and used. The juniper wood contained numerous micro and locally absent rings, but we successfully built a

chronology back to AD 647 by crossdating with skeleton plots and statistically verifying with COFECHA. Because trap samples exhibited weathering, the actual cutting dates are about 25-50 years after the outermost ring. Outside dates from the antelope trap are continuous (without plateaus of cutting events) from AD 1400 through AD 1725 with a series of samples from the 1100s located along the back wall of the coral, indicating that the trap was continuously remodeled by American Indians long before Euro-American occupation of the land.

Mass movements and tree rings: A guide to dendrogeomorphic field sampling and dating

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Corona, Christophe (*CNRS Geolab Clermont-Ferrand*)

Trees affected by mass movements record the evidence of geomorphic disturbance in their growth-ring series, thereby providing a precise geochronological tool for the reconstruction of past process activity. Identification of activity was typically based on the presence of growth anomalies in affected trees and focused on the presence of scars, tilted or buried trunks as well as on apex decapitation. For the analyses and interpretation of disturbances in tree-ring records, in contrast, clear guidelines have been missing so far and largely differing or no thresholds have been used to distinguish signal from noise. We examine interpretive issues relating to the interpretation and dendrogeomorphic dating of mass movements. Particular attention is drawn to sampling in terms of sample distribution across a study site, the actual selection of trees as well as to sample depth. This contribution wants to set standards for dendrogeomorphic fieldwork, analysis and interpretation and for different mass-movement processes.

Rockfalls triggered from a rock-glacier front as a mirror of multi-centennial permafrost dynamics in the Alps?

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Trees are excellent recorders of rockfall activity in terms of their spatio-temporal activity and possible changes thereof. Rockfall depends, among others, on freeze-thaw cycles and the melting of winter ice in clefts. Its temporal frequency and magnitude will likely be altered at higher elevations due to on-going climatic changes. Here we focus on rockfalls triggered from a rock glacier in the Swiss Alps located above a steep cliff. It is anticipated that changes in rock glacier movement will affect rockfall rates and in turn the frequency of impacts in trees growing below the cliff. Based on 400 time series of century-old Larix decidua Mill., we demonstrate that rockfall activity – and therefore rock glacier movements – have been altered significantly between the end of the Little Ice Age and today, and that such changes can be considered reflective of changing climatic conditions in general and of recent temperature increase in particular.

Watershed-scale Topoclimatic Dendrochronology: Combining tree-ring records, in-situ instrumentation, and baseline ecology in the Walker River Basin, California-Nevada

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Topoclimatic factors can influence seasonal controls on tree growth within local conifer populations, producing differing response signals in measurements of ring properties. Accordingly, microsite chronologies are targeted in a new study design to enhance discrete climatic signals. In semi-arid environments, high resolution palaeohistory of water supply is considered a valuable planning tool for watershed managers. Runoff, infiltration, and recharge in the Walker River Basin are determined primarily by seasonal snowpack conditions. Variability of snowpack (elevation, timing, magnitude) is not well understood outside of the modern instrumental era. By initializing the study with seasonal hydroclimatic variables in mind, our dendrochronological approach seeks to provide reconstruction of parameters useful to water and snowpack modeling. Using multiple species at multiple elevations may also provide insight into stationarity of conditions both spatially and temporally. Establishment of baseline ecological and instrumental observations enhances immediate conclusions as well as provides valuable in-situ data for future analyses.

Multiproxy reconstructions of mixed-severity wildfire dynamics in the Alberta Foothills, Canada

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Wildfire is an important disturbance agent in western Canadian forests, and land management and fire exclusion strategies have made the modern record of fires unrepresentative of the natural disturbance regime resulting in apparent landscape homogenization. This research uses a multiproxy fire history approach to reconstruct wildfire history in the Alberta Foothills, a landscape believed to be characterized by a mixed-severity regime. A pilot study was conducted in the summer of 2012 which involved the establishment of a sampling grid and the collection of fire scar and stand origin data from 16 plots. To date, stand establishment and fire years have been determined. These records will be supplemented by further sampling and extended using the macroscopic sedimentary charcoal record in hopes of understanding the spatial and temporal controls on changes to the wildfire regime in this area, as well as corroborating wildfire proxy records.

False rings of Pinus oocarpa and their relations with climate events in Eastern Guatemala

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We aim to assess the dendrochronological potential of Pinus oocarpa in eastern Guatemala in semiarid areas and investigate the intra-annual meteorological phenomena that might explain the formation of intra-annual rings. These results are based on the hypothesis that P. oocarpa is producing evident annual tree-rings due to climatic seasonality. This study was located at low latitudes 14º35´ N to 15º11´ N, in low elevations 940 to 1500 m asl. These new tree-ring chronologies were successfully dated and positively correlated with monthly rainfall. Tree-rings of P. oocarpa showed intra annual variations called "false rings", finding variations within the early wood and the late wood as well, so we suggest that erratic meteorological events such as the Mid Summer Drought and strong cold fronts might be the cause of the formation of intra annual density variations.

Is drought the main decline factor at the rear edge of southern Iberian pine plantations?

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The current climate change involves an increase in droughts events. We analyze the impact of drought on the radial growth and vigor of two pine species (Pinus sylvestris, Pinus nigra) in a semi-arid mountain at southeastern Spain near of their rear edge limit. We used dendrochronological methods, defoliation records, linear mixed and logistic models for growth and defoliation, respectively, to quantify changes at both species and individual scales. A temperature rise and a decrease in spring precipitation have led to drier conditions during the late century. The defoliation levels and reductions in growth were higher P. sylvestris than in P. nigra. The growth was favored by wet conditions in May and June in both species. The growth of defoliated trees responded more to water deficit and competition than that of less defoliated trees. Our results suggest that pine populations located in sub-optimal Mediterranean will not be viable in the long term if the frequency of extreme droughts increases.

Fire history in marginal jack pine populations at their southern limit of distribution, Riding Mountain National Park, central Canada.

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Cornelsen, Stephen (*Parks Canada Agency, Riding Mountain National Park*)
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In central Canada, information on fire history remains largely anecdotic and long-term reconstructions are rare. In a context where both anthropogenic and climate influences on fire regime have changed (fire suppression remaining the dominant management paradigm) the Canadian National Parks have for mandate to maintain ecological integrity. We present a fire reconstruction derived from jack pine trees growing in Riding Mountain National Park (RMNP). Fire scars and other indicators were used to document fire dynamics. During the mid-19th to early 20th century (period coinciding with European colonization) the fire interval was significantly shorter than during the recent fire-free period of 1930 to 2010 (period coinciding with creation of RMNP, reduced aboriginal presence and increased fire suppression).

In absence of fire, jack pine will slowly become excluded from the study area and prescribed burning may be advocated to allow it to remain a significant component of this landscape.

Traumatic resin ducts in Abies magnifica at interior sites along the central Pacific Coast of the United States

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Traumatic resin ducts (TRDs) in trees are commonly associated with insect of fungal attacks, mechanical injury or fire damage during the growing season. Here we present records of TRDs from Red fir (Abies magnifica var. shastensis) at five sites along the central Pacific Coast of the western United States. The ratio of rings with TRDs to undamaged rings is highest in the south, and more TRDs are observed in the 20th and early 21st centuries. A positive age-dependent relationship was recorded when trees passed 350 years of age. At the southernmost sites, trees across all age classes show fewer rings with TRDs between AD 1800 and AD 1865. Because the width of rings showing TRDs is not significantly different from concurrent undamaged rings, we suggest the growth anomaly does not substantively alter the ring-width pattern in affected trees.

Dendroarchaeology in the Southwest: Past, Present, and Future

Towner, Ronald*# (*LTRR*)

Almost 100 years ago, the astronomer Andrew Ellicott Douglass of the University of Arizona received archaeological tree-ring samples from archaeologists working in northwestern New Mexico. Although it took Douglass—in collaboration with many archaeologists—another 15 years, he ultimately laid the foundation for the most accurate and precise prehistoric cultural chronology in the world. Since Douglass's time, dendroarchaeologists at the LTRR have moved beyond simple tree-ring chronology building and site dating to develop a robust body of dendrarchaeological method and theory while building the most extensive archive of natural and cultural tree-ring samples in the world. This presentation briefly (a) discusses some of this dendroarchaeological history, (b) uses examples to illuminate past human responses to changing physical and social environments, and (c) suggests future research agendas that will expand dendroarchaeology theoretically, methodologically, and geographically while retaining our collective roots in the Southwest.

How to improve results and quantify uncertainties in reconstructed time series of rockfall activity

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Unlike other geomorphic processes, each injury recorded in trees growing on a rockfall slope will typically be considered one rockfall event. Reconstructed rockfall activity and fluctuations thereof will thus heavily depend on sample depth and the spatial distribution of sampled trees. In addition, fewer events will normally be recorded the farther one goes back in time due to decreasing sample depth. Past approaches trying to overcome this drawback are not satisfactory, since results still tend to contain mathematical and statistical biases. Here, we provide a new approach considering impact probability, determined for each year of the reconstruction via mean rock sizes, sample depth and exposed tree diameter to render results comparable over time. In addition, this new approach not only facilitates a realistic comparison of rockfall activity between different sites but also allows quantification of uncertainty in the reconstructed time series and a quantitative estimate of presumably missed events.

Stable carbon isotopes in tree-rings reveal increases in water use efficiency of Fitzroya cupressoides forests from southern Chile

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We present the first annual δ13C analyses from Fitzroya cupressoides, one of the oldest tree species in the world. Preliminary results from four series (since 1900) from trees growing in the Coastal (2) and Andean cordillera (2) indicate a significant increasing trend in intrinsic water use efficiency that is especially strong during the last 50 years. Tree growth data from tree-ring chronologies in both areas show an increasing growth trend in the Andes Cordillera but no trend in the Coastal Range. This can be interpreted as possibly a CO2 fertilization effect in the Andes, likely accompanied by other climatic effects that have not yet been detected. Ad-

ditional analyses from both areas and detailed examination of the climate- isotope relationships will be used to improve understanding of the long term response of this long-lived species to recent environmental changes.

Investigation and reconstructions of the hydroclimatic variability of the Souris River Basin, Saskatchewan, Manitoba, and North Dakota

Vanstone, Jessica*# (*Prairie Adaptation Research Collaborative, University of Regina*)
Sauchyn, David (*Prairie Adaptation Research Collaborative, University of Regina*)

Fourteen moisture sensitive tree-ring sites, (37 chronologies; annual, earlywood, and latewood) were developed to create robust multi-proxy reconstructions of annual water year and summer streamflow for four gauges within the Souris River Basin. Multiple linear regressions were able to account for ~76% and ~67% of the instrumental variance for water-year and summer flows, respectively. Spectral analyses provide evidence that streamflow variability in the Souris River Basin is driven by a combination of interannual, interdecadal, and multidecadal ocean-atmosphere oscillations. Correlation analyses, cross-wavelet transforms and wavelet transform coherence identify significant periods of high common power and coherence of streamflow with ENSO, solar sunspot cycles, and PDO indices. When these sea-surface temperatures and atmospheric oscillations are coupled, and in-phase with each other, it may lead to more prolonged and possibly greater in magnitude extremes than when climate anomalies are out of phase, resulting in a relatively modest influence of streamflow variability.

New at NOAA-Paleoclimatology/WDC for Paleoclimatology

Wahl, Eugene*# (*NOAA Paleoclimatology/WDC for Paleoclimatology*)
Anderson, David (*NOAA Paleoclimatology/WDC for Paleoclimatology*)

Across the Earth Sciences demand is increasing for structured data that can be shared across disciplines and used efficiently in diverse computing environments. NOAA Paleoclimatology has implemented structured templates for data and metadata across eighteen proxy/archive types, from corals to caves. Similar to the iconic ITRDB format but richer in descriptive information, the templates will facilitate multi-proxy compilation and analysis. NOAA Paleoclimatology is eager to explore how we can best work with the dendro community to harmonize our efforts with ITRDB, TRIDAS and other dendro data/metadata structures. A revised description of paleoclimate variables ("what was measured") developed in concert with the PAGES 2K Network project aims to allow precise comparison of measured quantities for the most general and flexible cross-comparison possible. Use of paleoclimate records via data mining and other informatics tools will be strongly facilitated by these advances, and will enhance the use of paleoclimate data beyond the boundaries of science, including decision making.

Fire history in the southern portion of the boreal shield ecozone of central Canada reconstructed from tree-rings and lake sediments

Waito, Justin*# (*University of Winnipeg*)
Tardif, Jacques (*University of Winnipeg, Centre for Forest Interdisciplinary Research (C-FIR)*)

Fire is an important process in the boreal forest. Reconstructing fire history is necessary for development of appropriate management strategies. Two approaches well suited to fire history reconstructions are analysis of tree-rings and of lake sediment-charcoal records. In this study, the fire record stored in these two proxies will be analyzed and calibrated to reconstruct recent to millennial fire history. Lake sediments were collected from 8 lakes with the fire record obtained from charcoal particles where peaks in charcoal deposition represent local fire events. Tree cores and cross sections were also collected and, in addition to archival records, will be used to establish the recent fire history. The tree-ring record will be interpreted from dated fire scars and stand initiation date of pioneer species. Charcoal peaks are expected to coincide with dated fire events and peaks throughout the longitudinal sediment profile are expected to accurately provide long-term fire reconstruction.

Refining Climatic Interpretations of Lower Forest Border Bristlecone Pine Tree-Ring Chronologies Over Recent Millennia

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Larson, Evan (*Tree-Ring, Earth, and Environmental Sciences Laboratory, University of Wisconsin - Platteville*)
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We developed a 750-year tree-ring chronology from Piñon pine trees growing near Grandview Campground (GVP) in the White Mountains to refine the Methuselah Walk bristlecone pine precipitation reconstruction (MWK) which failed to capture five of the ten driest years during its calibration period. GVP was significantly correlated with MWK over

1500–2009 ($r = 0.7$, $p < 0.001$) and tracked precipitation during three of the missed drought years. A period of low correlation between the chronologies from ~1600–1650 corresponds with an increase in autocorrelation in MWK and a decline in growth in bristlecone pine growing at the highest elevations of the White Mountains. This suggests cooler temperatures during that period may have reduced the sensitivity of MWK to precipitation. These results identify an opportunity to utilize piñon pine chronologies to refine precipitation estimates derived from lower-forest border bristlecone chronologies for at least the past millennium using a multi-species approach.

Application of eccentric growth of trees as a tool for landslide analyses (the example of Picea abies Karst. in the Carpathian and Sudeten Mountains - Central Europe)

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A method based on a feature of wood anatomy: tree-ring eccentricity was developed to analyze the spatial and temporal variability of landslide activity. The degree of eccentricity is used as an indicator of the intensity of the mechanical stress affecting a stem in a certain year. The uneven distribution of strains in a stem of Norway spruce tilted by ground instability causes more intensive growth of the compressed, lower part of the stem. Field studies and laboratory experiments proved that eccentricity starts to develop directly after the tilting/landslide event. Thanks to the application of reference results (from stable slopes) as thresholds in dating, an objective mathematical method for detecting landslide activity was developed. The method was used for seven landslide slopes with different sizes and geological settings, located in the Carpathians and Sudetes (central Europe: Poland, Czech Republic). Achieved results suggest that eccentricity can gain a practical application in detecting initial landslide activity and predicting future hazards.

Crossdating of Miocene-aged Permineralized Wood from Oregon, USA

Wright, William*# (*The University of Arizona*)

Permineralized (fossilized or 'petrified') wood from many sites around the world can exhibit an incredible degree of preservation, including intact cell structure and sub-cellular features. Yet previous attempts to use traditional dendrochronology on such material have met with only limited success. Here we present the results of ring width analyses of fossil wood samples from two mid-Miocene locations in the United States northwest. Clear crossdating of measured ring width time series on some samples provides proof of the absolute contemporeneity of the rings in those samples and likely of almost all the fossil wood samples within each site. Crossdating of Stinking Water fossil wood samples supports other evidence indicating that these fossil trees are remnants of a forest that was killed, buried and permineralized in place. Crossdating of the Deschutes fossil wood samples is consistent with rafting from growing locations close enough to produce similar patterns in their ring widths.

Reconstruction of past temperatures from Gilgit valleys Northern Pakistan

Zafar, Muhammad*# (*Federal Urdu University of Arts, Science and Technology Gulshan Iqbal Campus Karachi-Pakistan*)

The present study used three species (Picea smithiana, Juniperus excelsa and Pinus gerardiana) ring-width chronologies to investigate palaeo-temperature history in Gilgit valleys Northern Pakistan. Picea smithiana Jutial chronology was used to reconstruct March-June temperatures back to A.D. 1523. The calibration model explained 38.16% of the variance in temperature. The reconstructed temperature was tested over decadal and century time-scale. The coolest decadal time scale period revealed that 17th century experienced lowest degree of temperature and ensuing the period of "Little Ice Age" (LIA). The temperatures reached their maximum in 19th century over century time-scale. As Pinus gerardiana Chaprot chronology exhibited strongest temperature signal among all chronologies therefore, separate exercise was performed where Jutial chronology reconstruction was compared with Chaprot reconstruction. Two species demonstrated the common pattern in spring temperatures. However, the temperature reconstruction from Chaprot was insufficient to produce a long term proxy temperature.

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