PROGRAM AND ABSTRACTS

PAGES 1ST YOUNG SCIENTISTS MEETING

RETROSPECTIVE VIEWS ON OUR PLANET'S FUTURE

6-7 JULY 2009 • CORVALLIS • USA

The PAGES International Project Office and its publications are supported by the Swiss and US National Science Foundations and NOAA.

PAGES
PAST GLOBAL CHANGES

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1ST YOUNG SCIENTISTS MEETING

Corvallis, USA – 6-7 July 2009

Contents:

Prologue: Welcome to PAGES 1st Young Scientists Meeting

PAGES (Past Global Changes) was founded in 1991 as a core project of the International Geosphere-Biosphere Programme (IGBP). PAGES serves the Global Change community by supporting science aimed at understanding the Earth's past climate and environment, with the ultimate goal of assisting future projections. Having become a mature scientific organization, PAGES has grown to recognize the need to nurture our young scientists to ensure that paleoresearch and Global Change science in general continue to thrive and evolve. We have organized this 1st Young Scientists Meeting in the belief that PAGES has a lot to offer early-career researchers.

This YSM is intended to provide you with a platform for interdisciplinary scientific exchange and discussion of your research. It should also provide you with tips and ideas, which we hope will be helpful in the future. On the input side, you have the chance to provide feedback on the infrastructure of the scientific world, such as organizations like PAGES, publishers, funders, data centers, etc., and hence to actively shape a part of your scientific environment. Perhaps most importantly, we hope that you will make new or strengthen existing contacts with fellow scientists across geographical and scientific borders, and establish ties that last a whole career.

We would like to take this opportunity to thank our hosts from Oregon State University (see page 5) for enabling us to meet here in Corvallis, and the co-sponsors (see page 6) for their generous support that has allowed us to assemble a truly international group of early-career scientists.

We wish everyone a productive and inspiring meeting!

Thorsten Kiefer, Louise Newman and Leah Witton

PAGES IPO

Bette Otto-Bliesner and Heinz Wanner

PAGES Co-Chairs

Acknowledgements: YSM Committees and Organizers

LOCAL ORGANIZING COMMITTEE

Patrick Bartlein
Geography, University of Oregon

Edward Brook
Geosciences, Oregon State University

Peter Clark
Geosciences, Oregon State University

Steven Hostetler
U.S. Geological Survey

Alan Mix
Oceanic and Atmospheric sciences, Oregon State University

Nicklas Pisias (Chair)
Oceanic and Atmospheric Sciences, Oregon State University

Andreas Schmittner
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PAGES INTERNATIONAL PROJECT OFFICE

Thorsten Kiefer
Executive Director

Louise Newman
Science Officer

Leah Witton
Science Communicator

PAGES wishes to thank Oregon State University Conference Services.

Acknowledgements: YSM Sponsors

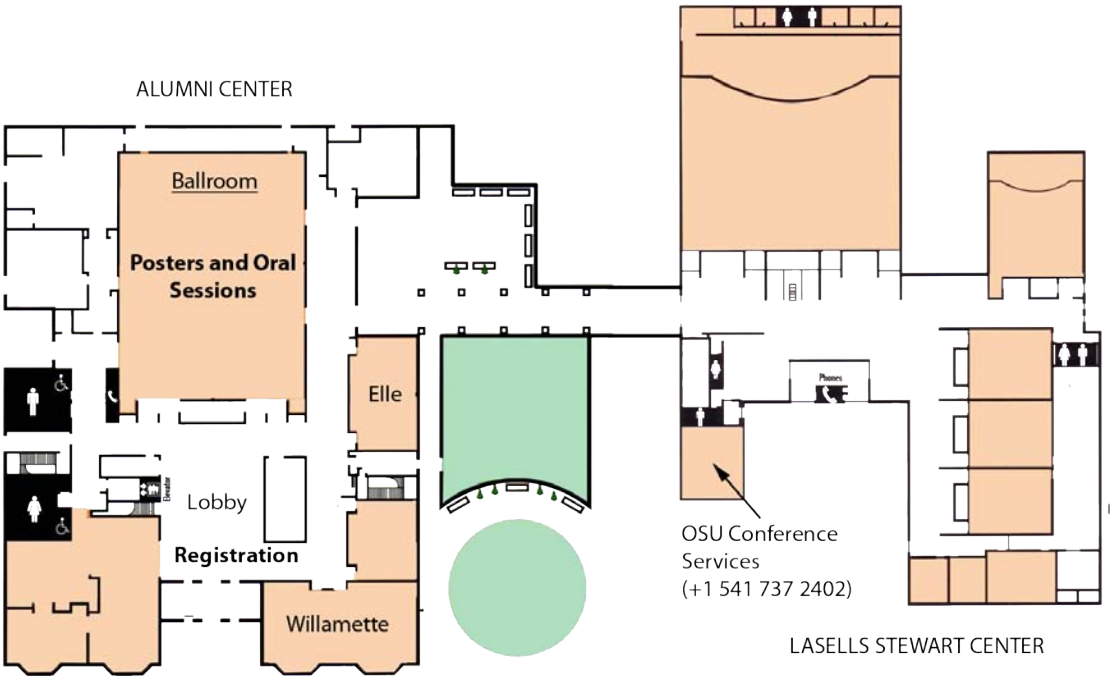
PAGES Sponsors:

- SNF (Swiss National Science Foundation)
- NSF (U.S. National Science Foundation)
- NOAA (National Oceanic and Atmospheric Administration)
- IGBP (International Geosphere-Biosphere Programme)

Meeting Sponsors:

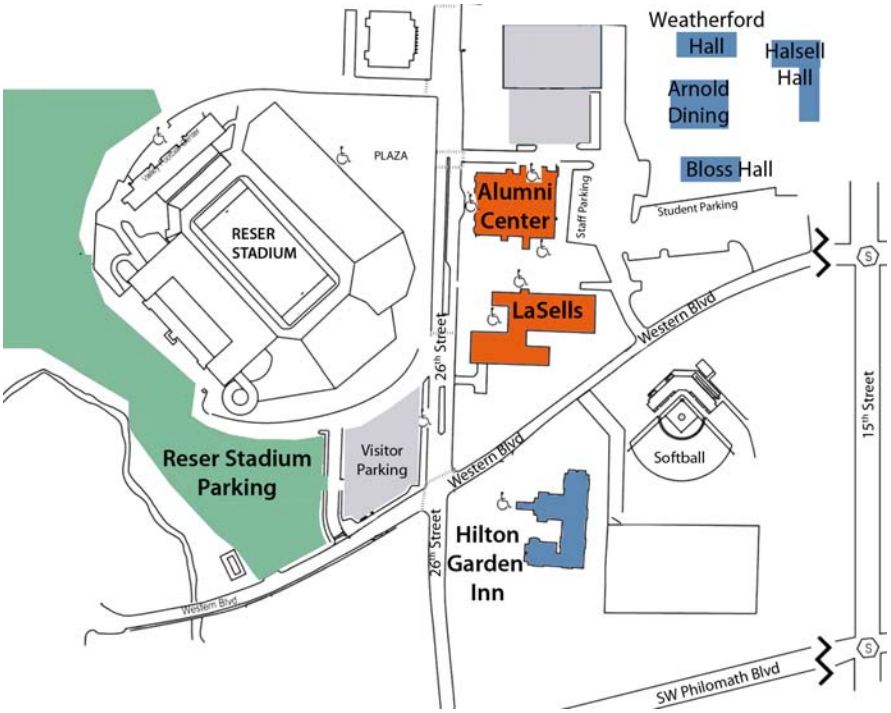
- AQUA (Australasian Quaternary Association)
- ARCNESS (Australian Research Council Network for Earth System Science)
- CHIQUA (Chinese Association for Quaternary Research)
- DFG (German Research Foundation)
- EPRI (Electric Power Research Institute)
- IAI (Intra-American Institute for Global Change Research)
- MoES (Indian Ministry of Earth Sciences)
- QUEST (Quantifying and Understanding the Earth System)
- SNF (Swiss National Science Foundation)
- USNC/INQUA (U.S. National Committee for the International Union for Quaternary Research)
- NSF (U.S. National Science Foundation)

Venue: Oregon State University



Registration for the Young Scientists Meeting is in the lobby of the Alumni Center (map above).

YSM breaks are in the lobby of the Alumni Center. Lunches are in the Arnold Dining Hall (map below).



Parallel Meetings:

IPICS – 6-7 July, held in Willamette rooms.

PAGES 2k Regional Networks Workshop – 7 July, held in Elle rooms.

MEETING PROGRAM

SUNDAY, 5 JULY

19:00	**Welcome Reception and Registration**

MONDAY, 6 JULY Chair: Heinz Wanner (PAGES Co-Chair)

09:00-09:30	**Welcome and Introduction – PAGES Science**
09:30-10:00	**Keynote Talk given by OSU Paleoscientists** Nicklas G. Pisias — What is the relevance of paleoclimate research?
10:00-11:00	**Oral Session A: Reconstructing & Understanding Climate Forcings & Feedbacks (PAGES Focus 1)**
	Chair: Fatima Abrantes — INETI, Portugal
	Catalina González, Germany – Tropical salt-marsh evidence for rapid sea-level changes associated with Heinrich events
	Alberto Reyes, Canada – The response of permafrost to last interglacial warming constrains projections of future thaw
	Jeremy Shakun, USA – Forcing of deglacial climate change and implications for greenhouse warming
	Akitomo Yamamoto, Japan – Modeling of methane bubbles released from sea-floor gas hydrate
11:00-11:30	Morning Break
11:30-12:30	**Oral Session B: Regional Climate Dynamics - Reconstruction & Modeling (PAGES Focus 2)**
	Chair: Mohammed Umer – Addis Ababa University, Ethiopia
	Elizabeth Farmer, UK – Surface and thermocline records of Mg/Ca derived temperatures in the Holocene subpolar North Atlantic
	Yao Liu, USA – Antiquity and turnover of North American terrestrial ecosystems since the Last Glacial Maximum
	Raphael Neukom, Switzerland – Multiproxy climate field reconstructions for southern South America back to AD 1000
	Martin Tingley, USA – A Bayesian approach to reconstructing climate fields from proxy data
12:30-13:30	**Poster Session A & B (PAGES Focus 1 and 2)**
13:30-14:30	Lunch
14:30-14:45	**Oral Session C: Chronology (PAGES CCT 1)**
	Chair: Pierre Francus — University of Quebec, Canada
	Yusuke Suganuma, Japan – Delayed acquisition of paleomagnetic record in marine sediments inferred from offset Be-10 flux anomaly
14:45-15:30	**Oral Session D: Proxy Development, Calibration & Validation (PAGES CCT 2)**
	Chair: Ricardo Villalba — IANIGLA, Argentina
	Duncan Christie, Chile – Aridity changes in the Temperate-Mediterranean transition of the Andes since A.D. 1346 reconstructed from *Austrocedrus chilensis* tree-rings
	Branwen Williams, USA — Proxy records from western tropical Pacific black corals and soft corals
	Julie Ferguson, USA – Glacial seasonal-resolution sea surface temperature records from paired $\partial^{18}O$ and Mg/Ca in limpet shells from Gibraltar
15:30-16:00	**Oral Session E: Modeling Past Changes (PAGES CCT 3)**
	Chair: Michael Schulz — University of Bremen, Germany
	Fanny Adloff, Germany – Modelling changes in eastern Mediterranean ocean climate for the early Holocene
	Steven Phipps, Australia – Understanding ENSO dynamics through the exploration of past climates
16:00-17:00	**Poster Session C - E (Cross Cutting Themes 1 - 4)** including Afternoon Break
17:00-18:30	**Plenary and Breakout Groups: Support for Young Scientists**

MEETING PROGRAM

Tuesday, 7 July Chair: Bette Otto-Bliesner (PAGES Co-Chair)

09:00-10:00	**Reporting from Breakout Groups & Discussion**
10:00-11:00	**Oral Session F: Earth System Dynamics - Global-Scale Processes & Linkages (PAGES Focus 3)**
	Chair: Peter Kershaw — Monash University, Australia
	Jessica Tierney, USA – Coherence between the Asian monsoon and Indonesian hydrology during the past two millennia
	Andreas Born, Norway – The 8k event: abrupt transition of the subpolar gyre towards a modern North Atlantic circulation
	Yanjun Cai, China – An absolute-dated and high-resolution Indian Monsoon record over the past 245 kyr from Xiaobailong Cave, southwest China
	Björn Machalett, Germany – Long term seasonality changes and abrupt climate shifts recorded in highly resolved dust/loess sequences across Eurasia
11:00-11:30	Morning Break
11:30-12:30	**Oral Session G: Past Human-Climate-Ecosystem Interactions (PAGES Focus 4)**
	Chair: John Dearing — University of Southampton, UK
	Megan Walsh, USA – Natural and anthropogenic influences on the Holocene fire and vegetation history of the Willamette Valley, NW Oregon and SW Washington
	Tyhra Carolyn Kumasi, Ghana – Land cover change in the Barekese River Basin of Ghana
	Mariano Morales, Argentina – Seven centuries of precipitation variations in the Bolivian Altiplano inferred from the world's highest-elevation tree-ring records: Environmental and sociocultural implications
	Robert Hatfield, Canada – Sediment sourcing and environmental reconstruction using particle size-specific magnetic fingerprinting: Bassenthwaite Lake, UK
12:30-13:30	**Poster Session F & G (PAGES Focus 3 and 4)**
13:30-14:30	Lunch
14:30-15:15	**Opportunities, Proposals, Grants: Tips from the Funders**
	Paul E. Filmer from the U.S. National Science Foundation
15:15-16:00	**Publishing your Work: Tips from the Editors**
	Alicia Newton from *Nature Geoscience* and Thorsten Kiefer from *Climate of the Past.*
16:00-16:30	Afternoon Break
16:30-17:00	**Data Management** – Speaker: David Anderson – NOAA Paleoclimatology Program, USA
17:00-17:30	**Communicating Scientific Results** – Speaker: Gavin Schmidt (RealClimate.org) — NASA, USA
17:30-18:00	**Talk/Poster Awards and Closing Remarks**
18:30	**OSM Reception and Registration**

All posters will be displayed for the entire length of the YSM.
Note: Participants selected to give talks will not present posters.
www.pages-osm.org/ysm

Welcome and Introduction to PAGES Science

Thorsten Kiefer

Executive Officer, PAGES International Project Office, Switzerland

PAGES is an international program, set up to coordinate and promote past global change research. The ultimate objective underlying all of PAGES efforts is to address past changes in the Earth System in a quantitative and process-oriented way in order to improve projections of future climate, environment and sustainability.

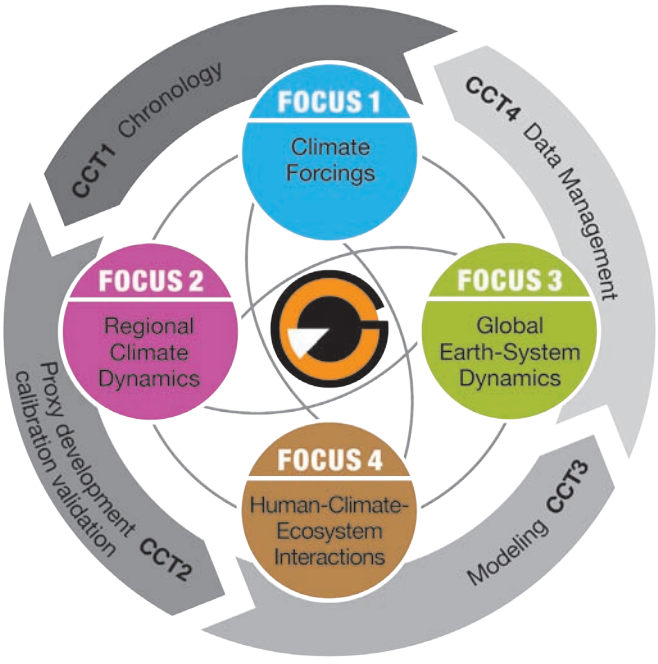
In working towards this objective in the coming years, PAGES will target four sets of key overarching questions, within four Foci, each divided into a number of Themes. The goals of the Foci are addressed by Working Groups that target specific aspects of the scientific scope.

Focus 1: Climate Forcings

This Focus fosters activities that aim to produce improved, extended, and consistent timeseries of climate forcing parameters, both natural and anthropogenic, including solar insolation and irradiance intensity, volcanic activity, land cover, sea ice, and greenhouse gas and aerosol concentrations. Furthermore, Focus 1 aims to quantitatively understand the causes and impacts of variations in climate forcings, including climate sensitivity and the carbon cycle-climate feedback.

Focus 2: Regional Climate Dynamics

This Focus seeks to achieve a better understanding of past regional climatic and environmental dynamics through comparison of reconstructions and model simulations. Activities contribute towards a global coverage of high-resolution, well-dated palaeoclimatic data, reconstructions of past climate-state parameters (e.g., temperature, precipitation, atmospheric pressure fields), a better understanding of past modes of climate variability and their teleconnections, and of rapid and extreme climate events at the regional scale. The Focus hosts activities that promote data-model comparisons and collaborates closely with Cross-Cutting Theme 2 on proxy development and calibration. The timescales covered by this Focus encompass the last 130 ka, in particular the time streams of the last glacial-interglacial cycle, the Holocene and the last 2 ka.



PAGES scientific structure: Four thematic Foci are complemented by four Cross-Cutting Themes that are relevant to all the Foci.

Focus 3: Global Earth-System Dynamics

This Focus looks at large-scale interactions between components of the Earth System (atmosphere, biosphere, cryosphere, hydrosphere) and the links between regional- and global-scale changes. It hosts activities to synthesize records at a global scale, acting as an umbrella for the regional studies of Focus 2 and as a link to the forcings addressed in Focus 1. Working Groups address global-scale abrupt and gradual Earth System changes and their underlying processes, including their response to changes in forcings, internal feedbacks and teleconnections.

Focus 4: Past Human-Climate-Ecosystem Interactions

This Focus addresses the long-term interactions among past climate conditions, ecological processes and human activities during the Holocene. Emphasis lies in comparing regional-scale reconstructions of environmental and climatic processes using natural archives, documentary and instrumental data, with evidence of past human activity obtained from historical, paleoecological and archeological records. The Focus promotes regional integration of records and dynamic modeling to: 1) Understand better the nature of climate-human-ecosystem interactions, 2) Quantify the roles of different natural and anthropogenic drivers in forcing environmental change, 3) Examine the feedbacks between anthropogenic activity and the natural system, and 4) Provide integrated datasets for model development and data-model comparisons.

In addition to the Foci, PAGES scientific structure includes four Cross-Cutting Themes that are of fundamental relevance to all the Foci and to palaeoscience in general:

Cross-Cutting Theme 1: Chronology

Chronology is crucial to paleoresearch and often constrains the strength of conclusions from paleoenvironmental reconstructions. This Theme supports efforts to improve tools for absolute and relative dating, and to enhance the reliability of reference timescales. It also encourages creative new approaches to solving chronology issues.

Cross-Cutting Theme 2: Proxy Development, Calibration and Validation

This Theme supports improvement of the precision and accuracy of paleo-proxies as a basis for high-quality reconstructions of past global change to complement instrumental data. It includes efforts on proxy interpretation and development, analytical innovation, inter-laboratory comparisons, and calibration refinement, with the aim to reduce uncertainty in proxy-based reconstructions.

Cross-Cutting Theme 3: Modeling

Numerical models provide a comprehensive, quantitative and physically coherent framework for exploring couplings and feedbacks between the various components of the Earth System. As such, modeling is a key element of all the PAGES Foci. Some paleo-specific modeling issues are

generally not as relevant to the communities developing Earth System models for future projections. Accordingly, this Theme supports efforts to improve model components specific for paleoresearch requirements.

Cross-Cutting Theme 4: Data Management

This Theme provides an umbrella for activities that support availability and access to palaeoscience data, as well as creative ways for their scientifically fruitful utilization. It aims to mediate between the scientific community and international data centres such as WDC and PANGAEA, as well as the regional, national and thematic databases.

Activities under the PAGES umbrella are carried out by the paleoscience community, PAGES Scientific Steering Committee and the PAGES International Project Office. The PAGES project plays a central role in integrating the themes of the other IGBP core projects and actively engages with the broader Earth System Science community.

The major outcomes that PAGES envisions as a result of these activities include:

- Research results that address the major scientific issues in paleoscience and come closer to answering the key overarching questions that PAGES has posed.

- Closing of critical knowledge gaps described in the Fourth IPCC Assessment Report.

- Support of innovative scientific approaches and new data acquisition in areas that will lead to a better understanding of the Earth System.

- Development of standardized reference datasets, such as on paleoclimate forcings and chronology.

- Further synthesis and dissemination of paleoscience research results.

- Establishment of a more interdisciplinary and internationally inclusive paleoscience research framework.

- Better integration of paleoscience into other global change research agendas.

SESSION A: Climate Forcings

Chair: Fatima Abrantes

Tropical salt-marsh evidence for rapid sea-level changes associated with Heinrich events

Catalina González, Lydie M. Dupont

The role of sea-level as an active mechanism of rapid climate change is still under debate and new records that complement the almost exclusively marine body evidence are needed. The ecological response of intertidal tropical ecosystems can be particularly useful, since they are sensitive to environmental gradients in the sea-continent interface, and might provide valuable information on sea-level variations in the past. Centennial-millennial dynamics of tropical salt marsh vegetation are documented in the pollen record from marine core MD03-2622, Cariaco Basin, which spans the period between 63 and 29 ka. Five rapid and abrupt expansions of salt marsh vegetation are coeval with the north Atlantic Heinrich events (HEs). Within each event, a recurrent pattern—starting with species of Chenopodiaceae, followed by grasses, and subsequently by Cyperaceae species—suggests a successional process that is determined by the relationship between sea-level and community dynamics. Salt tolerant Chenopodiaceae expansions at the base of each sequence indicate hypersaline intertidal environments, which were promoted by extremely dry conditions. Rapid sea-level rise characterizes these intervals, causing erosion of marsh sediments, and continued recruitment of pioneer species. Once as sea-level drops, marsh plants are able to trap and stabilize sediments, favouring the establishment of more competitive species. The increment of marsh height reduces the extent of hypersaline environments, and allows the further establishment of mesohaline species. The Cariaco Basin palynological record is especially informative on the timing of sea-level changes during MIS 3 and their connection with HEs, supporting the idea that sea level fluctuations followed Antarctica climate variability.

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Lydie M. Dupont, MARUM/Department of Geosciences, University of Bremen, Germany

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The response of permafrost to last interglacial warming constrains projections of future thaw

Alberto Reyes, Duane Froese, Britta Jensen

Numerical models predict that 21st century warming will result in thinning and disappearance of permafrost over much of the northern hemisphere, leading to positive warming feedback through decomposition of thawed organic carbon and release of CO_2 and CH_4. However, it is difficult to evaluate projections of permafrost degradation, and the associated release of greenhouse gases, because there is little understanding of the magnitude of permafrost degradation during past warmer-than-present intervals. We document the response of permafrost to warming during the last interglaciation, focusing on the unglaciated region of Yukon Territory and Alaska, where numerous distal tephra provide excellent chronostratigraphic control. Multiple exposures in Alaska and Yukon show consistent stratigraphic relations between Old Crow tephra (131±11 kyr) and prominent deposits of last interglacial organic material, which represent widespread ground thaw and thermokarst development during the last interglaciation. However, thaw was limited to the uppermost several metres of permafrost, and relict pre-last interglacial ice wedges are present in at least three exposures separated by over 700 km. These relict ice wedges indicate that the antiquity and resilience of discontinuous permafrost is regional in nature. However, the ubiquity and magnitude of last interglacial thermokarst suggest that terrain effects associated with current permafrost degradation foreshadow more widespread and severe shallow thaw under modest future warming scenarios. The response of permafrost to last interglacial warming suggests that carbon sequestered in near-surface permafrost is likely highly vulnerable to 21st century warming, but deeper permafrost and its associated carbon reservoirs are probably more stable than previously thought.

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Duane Froese, Department of Earth and Atmospheric Sciences, University of Alberta, Canada
Britta Jensen, Department of Earth and Atmospheric Sciences, University of Alberta, Canada

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Forcing of deglacial climate change and implications for greenhouse warming

Jeremy Shakun

Understanding how the climate system responds to forcings is critical to a complete theory of past changes in the earth's climate as well as predicting the magnitude of future global warming. For example, climate models exhibit a considerable range in climate sensitivity, or the equilibrium response of global temperature to a doubling of atmospheric CO_2 and empirical approaches have so far been unable to significantly reduce this uncertainty. The termination of the most recent ice age provides what is perhaps the best opportunity to address this issue as the climate forcings and response were very large and are relatively well-constrained by geological records. Here, I show that the dominant mode of global temperature variability during the last deglaciation was strongly related to rising greenhouse gas concentrations, while ocean circulation played a secondary role in driving climate change. Quantifying the temperature response to greenhouse forcing during this time suggests climate sensitivity is at or above the upper end of the Intergovernmental Panel on Climate Change's best estimate. Thus, anthropogenic warming may be greater than has been generally expected.

Jeremy Shakun, Department of Geosciences, Oregon State University, 104 Wilkinson Hall, United States, shakunj@geo.oregonstate.edu

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Modeling of methane bubbles released from sea-floor gas hydrate

Akitomo Yamamoto, Yasuhiro Yamanaka, Eiichi Tajika

Massive methane release due to decomposition of methane hydrate in sea-floor sediments might have caused rapid global warming in the past (i.e. the Paleocene/Eocene thermal maximum, ~55 Ma). However, the degree of global warming has not been estimated due to uncertainty over the proportion of methane flux from sea-floor to reach the atmosphere. According to the observation and model results of present methane-bubbling seep site, the methane bubble released from seafloor would not reach the atmosphere directly. Massive methane release would result in methane-saturated seawater, thus some methane bubble would reach the atmosphere.

This study investigated whether the massive methane released from sea-floor could reach the atmosphere or not, focusing on methane saturation in the water column required for methane bubble to reach the atmosphere. Using a one-dimensional numerical model, we calculated the required methane saturation in the water column and methane input from the sea-floor. We compared the required methane input with the amount of methane in the sediment in the form of methane hydrate and free gas. In most cases, our results suggest that the typical amount of methane in the sediment is significantly lower than the required methane input. It is, therefore, suggested that the massive quantity of methane bubbles released from sea-floor would not reach the atmosphere directly but would be dissolved in the seawater.

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Yasuhiro Yamanaka, Graduate School of Environmental Science, Hokkaido University, Japan
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SESSION B: Regional Climate Dynamics

Chair: Mohammed Umer

Surface and thermocline records of Mg/Ca derived temperatures in the Holocene subpolar North Atlantic

Elizabeth Farmer, Mark Chapman, Julian Andrews

Mg/Ca ratios from planktonic and benthic foraminifera are now routinely used as an independent proxy for past ocean temperature. Analysing $d^{18}O$ from the same sample potentially allows the separation of the foraminiferal $d^{18}O$ signal into its salinity/seawater $d^{18}O$ and temperature components. Mg/Ca derived temperature estimates are dependent on the choice of species-specific Mg/Ca-temperature calibrations. The analysis of multiple species of planktonic species may provide insight into changes occurring throughout the upper water column. Other factors, such as changes in depth habitat or a shift in seasonal production patterns, should also be considered when interpreting Mg/Ca records.

Here we present a high resolution record of Mg/Ca ratios measured on two planktonic foraminifers, *Globigerina bulloides* and *Globorotalia inflata*, from the subpolar North Atlantic core MD99-2251 (57°26'N, 27°54'W; 2620 m water depth), extending throughout the Holocene at ~ 20-70 year resolution. Core site oceanography is dominated by the convection of the warm saline waters of the North Atlantic Current. Shell chemistry reflects spring to summer conditions at the near surface (*G. bulloides*) and thermocline (*G. inflata*). Our records indicate variability throughout the Holocene, with ratios ranging from 1.6 to 2.6 mmol/mol for *G. bulloides* and 1.0 to 1.7 mmol/mol for *G. inflata*. Mg/Ca derived temperatures at the surface are typically in the range of ~7-13°C, with both species exhibiting Holocene variability of 3-4°C. A long term warming trend at both the surface and the thermocline is also revealed, particularly over the last 5 ka.

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Mark Chapman, School of Environmental Sciences, University of East Anglia, United Kingdom
Julian Andrews, School of Environmental Sciences, University of East Anglia, United Kingdom

Antiquity and turnover of North American terrestrial ecosystems since the Last Glacial Maximum

Yao Liu, Simon Brewer, Stephen T. Jackson

We assessed i) antiquity existing ecosystems, and ii) patterns of appearance, persistence, and disappearance of ecosystems since the Last Glacial Maximum. These questions are particularly important for understanding environmental controls of ecosystem properties and the persistence of terrestrial plant ecosystems under future global change scenarios. We undertook two complementary approaches, multivariate analysis and receiver operating characteristic (ROC) analysis, to objectively identify plant ecosystem types from fossil pollen assemblages records over the past 21 ka in the Neotoma Paleoecology Database. We identified and mapped the transitions of ecosystem types at individual sites in the database to investigate the spatial and temporal pattern of ecosystem turnover in North America.

Our results show that: i) All ecosystems are sensitive to environmental change of the magnitude experienced since the last glacial period; ii) At time scales of decades to millennia, changes in ecosystems generally correlate with changes in climate. The mean ecosystem turnover rate in North America through time showed the same pattern as the magnitude of climate change through the glacial-interglacial period, including abrupt climatic events such as the Younger Dryas at 11-12 ka BP and the gigadrought at 4.2 ka BP. The timing of origination and duration of different ecosystems at different places shows some systematic pattern. iii) Ecosystems in some areas persist longer than in other areas. These findings from paleoecological records help us assess the historical range of environmental conditions under which ecosystems are maintained, and identify critical environmental conditions beyond which modern ecosystems may not sustain.

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Stephen T. Jackson, Department of Botany, University of Wyoming, United States

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Multiproxy climate field reconstructions for southern South America back to AD 1000

Raphael Neukom, LOTRED-SA Consortium

LOTRED-SA (Long-Term climate REconstruction and Dynamics of southern South America) is a collaborative initiative under the umbrella of PAGES with the objective to perform high resolution multi proxy climate field reconstructions for southern South America (SSA) covering the last millennium. The locations of annually resolved natural climate archives (mainly tree rings, ice cores and varved sediments) in SSA are mostly restricted to the areas in and close to the Andes. In order to enlarge the area with sufficient predictive skill, we combine these data with time series derived from documentary evidence as well as from sites outside of SSA making use of teleconnection patterns such as the El Niño Southern Oscillation (ENSO) or the Antarctic Oscillation (AAO). We present the methods and results of optimizing this predictor network in order to explain a significant portion of SSA cold and warm season climate variability as well as to make optimal use of the low frequency information preserved in the different proxy archives. We applied three methods (PC regression, CPS and RegEM) to calculate SSA temperature and precipitation back to AD 1000 on 0.5° x 0.5° spatial resolution. The results represent the first continental scale field reconstructions of the Southern Hemisphere and provide new insights into its past climate variability and dynamics. We discuss the climatic evolution of different sub regions of SSA and name the areas where further improvements of the proxy network are most needed.

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LOTRED-SA Consortium, Past Global Changes International Project Office, Switzerland

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A Bayesian approach to reconstructing climate fields from proxy data

Martin Tingley, Peter Huybers

We present a Bayesian model to assimilate incomplete (in space and time) instrumental and proxy data sets to estimate, with uncertainties, the time evolution of a climate field. The Bayesian model consists of a process level that describes the evolution of the true climate field as a multivariate AR(1) process with spatially correlated innovations; a data level that specifies the relationships between the measurements (proxies and instrumental) and the true field values; and a prior level that specifies diffuse prior distributions for all unknown parameters. Multiple draws from the posterior produce a spatially and temporally complete ensemble of field evolutions compatible with the data and the model assumptions. Probability distributions for various statistics can be estimated from this ensemble, from simple measures like the time series of spatial means to more exotic quantities like the probability that a given year featured the most extreme value of the climate field during the reconstruction.

We demonstrate the utility of this approach with two applications: 1) a 600-year surface temperature reconstruction for high Northern latitudes based on tree ring, ice core, and lake sediment core data, as well as the Climate Research Unit's compilation of instrumental observations; and 2) a 500 year drought reconstruction for the four corners region of the USA based on tree ring time series and the Palmer drought severity index over the 1990-2003 interval.

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Peter Huybers, Harvard University, United States

SESSION C: Chronology

Chair: Pierre Francus

Delayed acquisition of paleomagnetic record in marine sediments inferred from offset Be-10 flux anomaly

Yusuke Suganuma, Yusuke Yokoyama, Toshitsugu Yamazaki

Fluxes of meteoric cosmogenic radionuclide, Be-10, vary with changes of incoming comic-ray flux modulated by geomagnetic field intensity variations. The variability in Be-10 flux can be used for synchronization between ice cores, as well as other geological archives, such as marine sediments by comparison to relative paleointensity, which is another tracers of geomagnetic filed intensity. This strategy has critical importance for identifying lead-lag relationship of abrupt environmental changes in globe, which is a key for understanding the Earth's climate system. However, the widely accepted process of post-depositional remanent magnetization (PDRM) suggests that palaeomagnetic record is locked in some appreciable depths in marine sediments (paleomagnetic lock-in depth), resulting in an uncertainty of the synchronization. Here, we present clear evidences of downward offset of paleointensity drop relative to Be-10 flux anomaly at the Brunhes-Matuyama geomagnetic polarity transition, which we interpret as a result of ca. 16 cm deep of the paleomagnetic lock-in. This deep paleomagnetic lock-in implies that up to several tens of thousands years of age offset occurs when a paleomagnetic record is used for dating sediments. Therefore we propose that the potential paleomagnetic lock-in depth effect should be corrected for a precise correlation.

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Yusuke Yokoyama, University of Tokyo, Japan
Toshitsugu Yamazaki, AIST, Geological Survey of Japan, Japan

SESSION D: Proxy Development, calibration, validation

Chair: Ricardo Villalba

Aridity changes in the Temperate-Mediterranean transition of the Andes since AD 1346 reconstructed from *Austrocedrus chilensis* tree-rings

Duncan Christie, José Boninsegna, Malcolm Cleaveland, Antonio Lara, Carlos LeQuesne, Mariano Morales, Dave Stahle, Ricardo Villalba

Water availability is one of the main limitations for future socio-economic development in many regions of the world and also has a potentially large impact on ecosystem dynamics. In the temperate-Mediterranean transition of the Andes (36° - 39°S) water supply is currently stressed because of the decreasing trend (up to 30%) observed in the instrumental precipitation records over the twentieth century. This precipitation reduction has occurred in conjunction with a growing demand for water resources as a result of population increase and economic growth in an area that generates >70% of Chilean hydropower. The objective of the present study is to reconstruct drought variability in the temperate-Mediterranean transition of the Andes using tree rings to provide a multi-century perspective of past drought occurrence.

Based in a network of *Austrocedrus chilensis* tree-ring chronologies from both flanks of the Andes we reconstructed late-spring early-summer PDSI since AD 1346. Sea Surface temperatures from the Niño 3.4 region and the AAO appear to be positively and negatively correlated with spring and summer instrumental PDSI, respectively. This study indicates that drought variability in our study area is closely related to blocking activity in the Ross-Amundsen Seas region. The reconstruction also demonstrates that the return time of drought events in all PDSI severity classes has decreased significantly during the last century when compared with the previous reconstructed period.

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Glacial seasonal-resolution sea surface temperature records from paired $\delta^{18}O$ and Mg/Ca in limpet shells from Gibraltar

Julie Ferguson, Gideon Henderson, Darren Fa, Clive Finlayson

Seasonal resolution climate records from higher latitudes are important to allow investigation of the role of seasonality in controlling mean climate on diverse timescales, and of the evolution of climate systems such as the North Atlantic Oscillation. However, outside the range of tropical corals, very few seasonal-resolution sea surface temperature (SST) records exist for the Holocene and none for the last glacial. Paired $\delta^{18}O$ and Mg/Ca analyses of micromilled samples of modern limpet (Patella) shells from Gibraltar allow the reconstruction of average seawater $\delta^{18}O$ and capture over 80% of the weekly range in SST. Glacial-interglacial sea-level changes make long time-series of intertidal molluscs difficult to find. On Gibraltar, Neanderthals and early humans collected molluscs for food and transported them inland to caves such as Gorham's Cave at times throughout the last 110 ka. Applying Mg/Ca and $\delta^{18}O$ to radiocarbon-dated examples of limpet shells from such caves provide the first seasonal-resolution SST and seawater $\delta^{18}O$ records for the last glacial outside the tropics. Results show that SST seasonality is variable through the last glacial but is greater than today by an average of 2°C even at the last glacial maximum when seasonal ranges of local insolation were similar to today. This implies that regional climate feedbacks rather than insolation are controlling SST seasonality and suggests that the presence of Northern Hemisphere ice sheets during the last glacial resulted in greater winter cooling and greater SST seasonality. These results contrast with GCM model estimates of SST values and seasonality during the glacial.

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Proxy records from western tropical Pacific black corals and soft corals

Branwen Williams, Andrea Grottoli

Changes in the chemical and biological oceanography accompanying shifts in ENSO conditions in the western tropical Pacific are not well understood and would be enhanced by high-resolution, century-scale proxy records. Soft corals and black corals are abundant in the western tropical Pacific from the near surface to thousands of meters deep, deposit organic skeleton in concentric bands, and live for hundreds to thousands of years. Geochemical measurements across growth axes serve as proxies for the geochemistry of particulate organic matter. Here, measurements of stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) and trace elements (B, Mn, Zn, Cd, and Pb) from three corals collected from 5 m, 85 m, and 105 m depths offshore of Palau are presented. Records are dated with a radiocarbon (^{14}C)-derived chronology. These data show that while anthropogenic carbon has penetrated below the mixed layer, stratification of the water column

results in differing sources of nitrate to the 5 m coral versus the deeper 85 m and 105 m corals below the mixed layer. The $\delta^{15}N$ and trace element records from 5 m suggest a shift in dominance of the North Equatorial Counter Current to North Equatorial Current bathing Palau on sub-decadal scales. The records from 85 m and 105 m suggest a shoaling of the mean depth of the thermocline over the past several decades. This research is the first to develop soft corals and black corals in the western Pacific as proxy organisms across the euphotic zone. Together, these corals provide paleoceanographic records on annual-to-centennial timescales of changes in organic matter geochemistry.

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SESSION E: Modeling

Chair: Michael Schulz

Modelling changes in eastern Mediterranean ocean climate for the early Holocene

Fanny Adloff, Uwe Mikolajewicz

During the early Holocene, the Mediterranean circulation has undergone big changes. Those changes are reflected in the occurrence of organic-rich marine sediments called sapropels in the eastern Mediterranean, which indicate the presence of oxygen depleted deep waters. A possible explanation is that a precession-induced increase in the amount of freshwater input leads to a reduction of the deep water ventilation and could allow the formation of those organic layers.

The relative isolation of the basin together with a good coverage of available proxy data make this region an ideal testbed for modelling past climate changes. The work presented here is a first step towards elucidating the mechanisms responsible for sapropels formation. We set up a regional version of the general ocean circulation model MPIOM for the Mediterranean. We force the model with atmospheric data derived from equilibrium time slice simulations with the coupled atmosphere/ocean/dynamical vegetation model ECHAM5/MPIOM/LPJ. We focus on the 9 ka BP time slice (500 years integration).

The effect of insolation and fresh water input changes on Mediterranean ocean climate are analyzed. The amplitude of the SST seasonal cycle is stronger, leading to colder winters with a resulting cooling of the deeper layers. The enhanced summer warming is restricted to the very uppermost layers leading to a strong temperature gradient. The enhanced Nile runoff is overcompensated by the missing outflow from the Bosporus. The location of Aegean deep water formation is shifted westward. The model results are compared to available paleoproxy data.

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Understanding ENSO dynamics through the exploration of past climates

Steven Phipps, Jaclyn Brown

Historical reconstructions show that significant changes in ENSO characteristics took place during the Holocene. "Modern" El Niño variability began around 5-7 ka ago, with a gradual strengthening of ENSO thereafter and a possible peak in variability around 1-2 ka ago. Exploring these changes, using both data and models, provides a means of understanding ENSO dynamics.

Modelling studies to date have suggested a mechanism whereby changes in the Earth's orbital geometry explain the strengthening of ENSO over the Holocene. Decreasing summer insolation over the Asian landmass resulted in a weakening of the Asian monsoon system. This led to a weakening of the easterly trade winds in the western Pacific, making it easier for El Niño events to develop. To explore this hypothesised forcing mechanism, we use the CSIRO Mk3L climate system model to conduct a suite of simulations of the climate of the past 8 ka. We find that the model is able to reproduce the historical trends in ENSO variability. In the early Holocene, the easterly trade winds are amplified in the western Pacific during the northern autumn, consistent with an enhanced Asian monsoon. The stronger trade winds represent a barrier to the eastward propagation of westerly wind bursts, therefore inhibiting the onset of El Niño events. We find that the fundamental behaviour of ENSO remains unchanged, with the major change over the Holocene being the influence of the background state of the Pacific on the susceptibility of the ocean to the initiation of El Niño events.

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SESSION F: Global Earth System Dynamics

Chair: Peter Kershaw

The 8k event: Abrupt transition of the subpolar gyre towards a modern N. Atlantic circulation

Andreas Born, Anders Levermann

In the relatively stable conditions of our present interglacial, the 8k event is the largest climatic disruption with a widespread cooling in the North Atlantic region probably associated with a meltwater outburst from North American proglacial lakes. North Atlantic deep-sea sediment cores suggest that abrupt and persistent changes in the oceanic surface circulation, the onset of a modern-like situation, took place at the same time. Here we provide a causal link between these events supported by coupled climate model simulations. We show that an abrupt strengthening of the North Atlantic subpolar gyre establishes a modern flow regime and stabilizes the meridional overturning circulation.

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An absolute-dated and high-resolution Indian Monsoon record over the past 245 ka from Xiaobailong Cave, southwest China

Yanjun Cai, Liangcheng Tan, Hai Cheng, Zhisheng An, R. Lawrence Edwards, Chuan-Chou Shen

An absolute-dated $\delta^{18}O$ record from Xiaobailong Cave, southwest China, completes a Chinese speleothem-based record of the Indian Monsoon (IM) over the past 245 ka. The record is dominated by 23-ka precessional cycles that are synchronous within dating errors with that of East Asian Monsoon (EAM) records from Sanbao Cave. The synchronicity of precessional cycles of both records with summer insolation at 65°N supports the idea that Asian monsoon respond dominantly and directly to changes in N-Hemisphere summer insolation on orbital timescales. The Xiaobailong record, similar to EAM records, demonstrates a remarkable resemblance to $\delta^{18}O$ records from Greenland ice-core, suggesting that IM intensity changed in concert with Greenland temperature as well. This, in turn, suggests that the meridional thermal gradients in N-Hemisphere may be the main driving force behind the millennial-scale oscillations in intensities of both IM and EAM. However, there are also a number of notable differences in detailed features and amplitudes of variations between EAM and IM $\delta^{18}O$ records. This might be mainly because of the different geographical conditions that result in different responses of these two monsoon systems to global climatic change. For example, the "continental-effect" on amplitudes in $\delta^{18}O$ variations could be quite different as the coastline shift during the glacial and interglacial cycles was far more significant in western Pacific Ocean than in northern Indian Ocean. Furthermore, the IM record bears certain features that are likely to be linked to climatic changes in S-Hemisphere where significant amount of moisture of the IM originated from.

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Long term seasonality changes and abrupt climate shifts recorded in highly resolved dust/loess sequences across Eurasia

Björn Machalett

The distribution of Eurasian loess deposits allows interregional palaeoclimatic investigations along a west-east transect across the entire Eurasian loess belt of the Northern Hemisphere, offering the potential to reconstruct Pleistocene atmospheric circulation patterns and aeolian dust dynamics on a wide spatial scale. High resolution proxy data from several loess sequences across Eurasia (Serbia, Romania, Uzbekistan & Kazakhstan) provide a detailed signal of glacial-interglacial atmospheric dynamics and long term, semi-continuous trends in the aeolian dust record since marine isotope stage 10. In consideration of the modern synoptic atmospheric circulation patterns and aeolian dust transport across the Eurasian landmass, we propose that the data reflect oscillations superimposed on a long term signal of seasonality, triggered by changes in duration and permanency of the seasonal shift of the Eurasian polar front during the middle to late Pleistocene.

Unlike the similarities in long term seasonality changes across Eurasia, there are distinct differences in short-term climate variability along the studied transect from SE Europe to Central Asia. While the records in SE Europe seem to reflect short term climate oscillations controlled by regional climate dynamics and local wind systems, the highly resolved Central Asian dust archives suggest a clear pattern of rapid warming and gradual cooling, indicating a teleconnection with D/O events of the last glacial cycle.

This study aims to reconstruct long-term aeolian dust dynamics and climate variability recorded in high-resolution loess records across Eurasia, linking inter-hemispheric climates on time scales ranging from glacial-interglacial to (sub)millennial.

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Coherence between the Asian monsoon and Indonesian hydrology during the past two millennia

Jessica Tierney, Delia Oppo, James Russell, Braddock Linsley, Yair Rosenthal

The West Pacific Warm Pool (WPWP) is the largest zone of deep convection on earth, and thus a major source of heat and water vapor to the global atmosphere. Shifts in the location and intensity of convection in the WPWP dramatically affect local precipitation, and—through modification of Hadley and Walker circulation—global atmospheric heating and circulation. However, mechanisms of hydrologic change in the WPWP are poorly understood, and paleohydrologic variability in this region, especially on decadal-to-millennial scales, is scarcely constrained. To better understand hydrology in this critical tropical region, we use hydrogen isotopic ratios on terrestrial higher plant leaf waxes ($\delta D_{leaf\ wax}$) in marine sediments to infer centennial-scale changes in rainfall amount in Southwest Sulawesi, Indonesia during the last two millennia. Our data indicate drier conditions during the Medieval Warm Period (AD 1000-1300) and the Roman Warm Period (AD 0-400). The Little Ice Age (AD 1400-1850) appears to be the wettest interval during the past two millennia, in agreement with existing $\delta^{18}O$ of seawater ($\delta^{18}O_{sw}$) data from the Makassar Strait. Notably, $\delta D_{leaf\ wax}$ resolves centennial-scale trends in precipitation that are antiphased with a speleothem-based rainfall reconstruction from Southeast Asia. This relationship suggests that migrations of the Inter-tropical Convergence Zone (ITCZ) coupled with changes in Asian monsoon strength were major influences on Indonesian hydrology during the past 2 ka.

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SESSION G: Human-Climate-Ecosystem Interactions

Chair: John Dearing

Sediment sourcing and environmental reconstruction using particle size-specific magnetic fingerprinting: Bassenthwaite Lake, UK

Robert Hatfield, Barbara Maher

Here we use particle size-specific magnetic fingerprinting to better understand sediment sourcing in the Bassenthwaite Lake catchment, UK, which currently suffers issues associated with fine sediment delivery. Ferrimagnetic grain size and magnetic 'hardness' vary significantly between the suspended sediments from the three inflows. The 8-31 μm and 31-63 μm fractions appear most useful for sediment sourcing as they displaying greatest magnetic contrasts between sources, whilst post-depositional formation of bacterial magnetosomes is evident in the <8μm fraction of the lake sediments. Mineral magnetic techniques identify significant variations in sediment source and flux over the last 6 ka. Using a quantitative fuzzy-clustering technique, we show that between 2500 BP and 1700 AD sediment fluxes to the lake were low and dominated by material sourced through the Derwent sub-catchment (presently providing 80% of the hydraulic load). Post-1700 AD, lake sediments became dominantly sourced from Newlands Beck (providing ~10% of the lake's hydraulic load). Three successive, increases in sediment flux appear linked to specific activities; mining in the late 19th century, agricultural intensification in the mid-20th century and, within the last decade, the additional impact of climate change. Despite significant land-use change from 3,500 BP the catchment was able to 'buffer' such pressures up until the last few hundred years. Thus, novel application of magnetic parameters has shown greatest rates of change in the most recent period resulted from exceedance of the catchments natural buffering capacity. These results are important for upland areas as modifications in climate are progressively superimposed upon the effects of previous and/or ongoing anthropogenic catchment disturbance.

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Land cover change in the Barekese River Basin of Ghana

Tyhra Carolyn Kumasi, Kwasi Obiri-Danso, J.H. Ephraim

The Barekese reservoir provides 80% of the total public pipe borne water to the Kumasi metropolis and its environs. However over the past two decades the Barekese river basin has seen persistent degradation through anthropogenic activities along its catchment area which also raises concern on the deteriorating water quality. The study examines the land cove change and assesses its impacts on the reservoir's water quality and quantity. Data employed in estimating land cover change were extracted from two cloud-free LANDSAT Multi-Spectral Scanner (MSS) and one LANDSAT Thematic Mapper (TM) images obtained in 1973, 1986 and 2003. All the three images were registered to the Universal Transverse Mercator (UTM), Zone 31 geographic projection. From 1973 to 1986 the closed forest decreased by 43.54% whereas the open forest increased by 52.91%. From 1986 to 2003, the open forest decreased extensively by 55.25% resulting in more grassland and open area/towns. The projections of the land cover change in Barekese catchment area reveal that vegetation cover will continue to experience a decline in area with a subsequent negative decline in closed forest in the year 2043 resulting in feedbacks in regional climate and weather. Conversely grassland and open area/towns will experience a swift rise in area from 2003 -2043 impacting on water resources. Unsustainable agricultural practices, bushfires, deforestation and encroachment of the Barekese reserve as a result of rural poverty and weak institutional mechanisms are the factors responsible for the degraded land cover impacting on quality and quantity of water in the Barekese basin.

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Seven centuries of precipitation variations in the Bolivian Altiplano inferred from the world's highest-elevation tree-ring records: Environmental and sociocultural implications

Mariano Morales, Axel Nielsen, Ricardo Villalba, Jeanette Pacajes, Jaime Argollo, Duncan Christie

Dry farming and pastoral economies in the Bolivian Altiplano are sensitive to fluctuations in climate, particularly drought. However, it is difficult to examine these relationships because of the scarcity, shortness and inhomogeneity of the available instrumental climate records. The recent development of well-replicated, climate-sensitive tree-ring records from *Polylepis tarapacana* allows the reconstruction of past environmental conditions at various temporal scales and examination of the links between climate and particular events in past human history. *Polylepis tarapacana*, growing between ca. 4500-5000 m, has remarkable dendrochronological potential, and was regularly used by pre-Columbian populations for fuel and construction. We

used a network of *P. tarapacana* chronologies to reconstruct precipitation variability in the Bolivian Altiplano for the past 640 years. This reconstruction has periods of several decades with precipitation below the mean and a negative trend in precipitation during the last 150 years. Archeologists have identified a major shift in settlement patterns in the Altiplano-Puna and adjacent valleys during the 14th and 15th centuries. Low-elevation, vulnerable villages occupied until the 13th century were rapidly abandoned in favor of highly visible, frequently fortified sites with difficult access. This process has traditionally been related to the onset of a state of endemic warfare, possibly triggered by periods of drought resulting in repeated crop failure and high animal mortality that forced dry farmers and pastoralists to fight for the control of marshes and irrigable farmlands on both sides of the Andes. The reconstruction of severe drought in AD 1380-1399 and 1432-1452 provide strong support for this hypothesis.

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Natural and anthropogenic influences on the Holocene fire and vegetation history of the Willamette Valley, northwest Oregon and southwest Washington

Megan Walsh, Cathy Whitlock, Patrick Bartlein

The debate concerning the role of natural versus anthropogenic burning in shaping the prehistoric vegetation patterns of the Willamette Valley of Oregon and Washington remains highly contentious. To address this, pollen and high-resolution charcoal records obtained from lake sediments were analyzed to reconstruct the Holocene fire and vegetation history, in order to assess the relative influence of climate variability and anthropogenic activity on those histories. Two sites provided information on the last 11 ka. At Battle Ground Lake, shifts in fire activity and vegetation compared closely with millennial- and centennial-time scale variations in climate. In contrast, the fire and vegetation history at Beaver Lake (near Corvallis) showed relatively little vegetation change in response to both millennial- and centennial-scale climate variability, but fire activity varied widely in both frequency and severity. A comparison of this reconstruction with archaeological evidence suggests that anthropogenic burning near the site may have influenced middle- to late-Holocene fire regimes. The fire history of the last 1200 years was compared at five sites along a north-south transect through the Willamette Valley. Forested upland sites showed stronger fire-climate linkages and little human influence, whereas lowland sites located in former prairie and savanna showed temporal patterns in fire activity that suggest a significant human impact. The results of this research contribute to our understanding of long-term vegetation dynamics and the role of fire, both natural- and human-ignited, in shaping ecosystems, as well as provide an historical context for evaluating recent shifts in plant communities in the Willamette Valley.

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SESSION A: Climate Forcings

YF1-12

Investigating multi-decadal scale changes in ENSO variability using a coupled A/OGCM

Jay Alder, Steve Hostetler, David Pollard

We simulate multi-decadal and multi-centennial ENSO variability using GENMOM, a non flux-corrected A/OGCM comprised of the GENESIS V3.0 atmospheric model and the MOM2 ocean model. The model produces realistic ENSO variability comparable with similar models used in the 2007 IPCC assessment. Long integrations of the model yield significant changes in the frequency and amplitude of ENSO on decadal and centennial time scales. A suite of equilibrium simulations in which atmospheric CO_2 levels were prescribed at LGM (180 ppmV), 6 ka (280 ppmV with 6 ka solar forcing), present (355 ppmV), doubled and quadrupled values display differing characteristics of ENSO variability. Wavelet analysis of the present simulation shows significances at both 12-30 years multi-decadal range and 70-100 year centennial scale range. Initial results show that only slight changes in ENSO variability and amplitude exist between simulations calculated over the entire length of the runs. However, subsampling at decadal and centennial scales shows large changes, indicating a low frequency pattern in the ENSO signal.

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YF1-15

A high-resolution reconstruction of late Quaternary sea-ice history in the Atlantic sector of the Southern Ocean

Lewis Collins, Claire Allen, Jenny Pike, Dominic Hodgson

Sea-ice represents one of the most important components of the Earth's climate system. Seasonal expansion of sea ice doubles the continental size of Antarctica and impacts a variety of climate amplifiers (e.g. albedo, ocean ventilation, primary productivity etc.) Many authors advocate that sea-ice expansion is responsible for the glacial – interglacial variations in atmospheric CO_2, providing a potential trigger for interhemispheric climate change.

Here, we present sea-ice reconstructions based on two marine cores recovered from north and south of the modern winter sea-ice limit in the Scotia Sea, SW Atlantic. We employ Relative Paleointensity data to construct an independent and accurate chronology for the late glacial sequences and use lithology, biomarker pigments and diatom assemblages to reconstruct the migration of summer and winter sea-ice during the late glacial. Prior to 29.5 ka, permanent sea ice was mostly confined to the Weddell Sea Basin and winter sea-ice cover was not much greater than at present. The southern site (61°47.3'S, 40°08.3'W) documents a pre-LGM summer sea-ice maximum between 34 and 22 ka, well in advance of northern hemisphere deglaciation. By comparison, our northern site (53°56.0'S, 48°02.6'W) suggests a gradual northwards shift of the winter sea-ice edge towards a maximum at 24.1 ka. In contrast to its steady expansion, the sea-ice field retreats rapidly, indicating an almost synchronous termination of both winter and summer sea-ice around 22.9 ka. We help address the paucity of data concerning glacial variability of sea ice cover with a thought-provoking reconstruction and challenge modellers to replicate this variability.

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YF1-3

Changes in plant water use efficiency over the recent past reconstructed using palaeo plant records from the boreal forest

Mary Gagen, Walter Finsinger, Friederike Wagner, Danny McCarroll, Risto Jalkanen

Physiological forcing is a positive feedback associated with the effects of rising carbon dioxide on evapotranspiration. Higher atmospheric carbon dioxide reduces evapotraspiration because tree stomata tend to close under elevated carbon dioxide. The warming associated with reduced evapotranspiration is not well constrained. Here we suggest that future predictions of evapotranspiration flux within the Boreal forest zone might be more accurately gauged by taking account of palaeo evidence of changing plant water use efficiency and stomatal density in the two most important Boreal plant species: *Pinus sylvestris* and *Betula nana*. Stable carbon isotope ratios in tree ring cellulose and stomatal density measurements, from preserved leaves falling on the forest floor, hold a record of the plant physiological changes associated with adjustment to rising carbon dioxide. We present evidence that, rather than plants simply closing their stomatal apertures under recent elevated carbon dioxide, over the last 150 years reduced evapotranspiration in the northern Boreal forest has been associated with a powerful plastic response including reductions in stomatal conductance via changes in stomatal density and pore length. Furthermore we present evidence that trees may be reaching the limits of their ability to respond plastically to rising carbon dioxide by increasing their water use efficiency.

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YF1-14

Comparison of diatom records of the Heinrich Event 1 in the Western North Atlantic

Isabelle Gil, Lloyd Keigwin, Fatima Abrantes

Heinrich event 1 (H1) is a climate event resulting from the release into the North Atlantic of a huge volume of sea ice and icebergs from the northern hemisphere ice sheets. We present here high-resolution diatom records of it from the Bermuda Rise (Sargasso Sea) and the Laurentian Fan (South of Newfoundland) to assess the surface oceanographic changes induced. At both sites, diatom abundances started to rise at 16.9 ka. This increase is marked by diatom species thriving in sea-ice environments over the Laurentian Fan, while brackish and fresh water diatoms species characterized this increase over the Bermuda Rise. This last record is unexpected in an otherwise oligotrophic setting and suggests icebergs migration and nutrient-rich meltwater to support such diatom productivity. The persistence of lower salinity surface water over the Bermuda Rise suggests continued injection of icebergs and fresh water by cold-core rings. A further comparison of both sites will illustrate the surface oceanographic changes resulting from this major perturbation in North Atlantic climate.

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YF1-9

Evaluating sources and chemistry changes based on the isotopes of atmospheric nitrate in ice cores

Meredith Hastings

A clear negative trend is found in the nitrogen isotopic ratios ($^{15}N/^{14}N$) of nitrate over the industrial period, based on a 100-meter ice core from Summit, Greenland. This record indicates that ice core nitrate reflects changes in nitrogen oxide (NO_x) source emissions and that anthropogenic emissions of NO_x have resulted in a 12‰ (versus air N_2) decline in $\delta^{15}N$ of atmospheric nitrate from pre-industrial values to present. Interestingly, over the last glacial period as recorded in the GISP2 ice core, the $\delta^{15}N$ of nitrate changes by ~20‰ from a mean pre-industrial Holocene value of 9.7‰ to a mean glacial value of 28.4‰, despite the lack of a significant change in nitrate concentration. The more recent ice core record clearly indicates an influence of NOx emission sources, therefore suggesting that the glacial-interglacial change in $\delta^{15}N$ may be a record of significant variations in the contribution of NO_x sources, such as lightning, biomass burning and/or biogenic soil emissions. In contrast to the source changes recorded by the nitrogen isotopes, the oxygen isotopic record of atmospheric nitrate ($^{18}O/^{16}O$, $^{17}O/^{16}O$) has implications for reconstruction of past atmospheric oxidant levels. This is because the oxygen isotopic composition of nitrate reflects oxidation of NO_x to nitrate in the atmosphere by oxidants such as ozone and hydroxy and peroxy radicals. Variations in the isotopic composition of nitrate may affect the interpretation of other records of environmental change, such as tree rings and lake and ocean sediments, which are impacted by atmospheric nitrate.

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YF1-11

The seasonal cycle as template for climate variability on astronomical time scales

Thomas Laepple, Gerrit Lohmann

A concept for insolation-driven temperature variability on orbital timescales is developed. It relies on the observed annual cycle of temperature to estimate the climate's sensitivity to local insolation at different seasons. Based on this concept, the temperature evolution of the last 750 ka related to local insolation forcing is estimated. The seasonal template model largely reproduces the Holocene temperature trends as simulated by a coupled climate model. For the Pleistocene it predicts significant temperature variability in the eccentricity and semipreccession frequency band in the tropics and indicates that the temperature response to insolation is highly spatially dependent. In a second step, to compare the results to proxy data one has to take into account the proxy specific recording mechanism. This is important in particular on orbital timescales as strong changes in seasonal insolation, and hence seasonal climate variability, interact with records sensitive to specific seasons. This problem is discussed on two exemplary cases, the Antarctic ice-core-derived temperature record and SST records based on planktonic foraminifera.

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YF1-8

$\delta^{15}N$ measurements of nitrogen gas trapped in ice cores during Marine Isotopic Stage 3 at Berkner Island, Antarctica

Francis Mani, Robert Mulvaney, William Sturges, Paul Dennis, Jérôme Chappellaz, Jean-Marc Barnola, Daphné Buiron, Amaelle Landais, Emilie Capron

An ice core from Berkner Island, a coastal site on the Weddell Sea facing the Southern Atlantic Ocean, provides a new climate record and further insights into the phasing relationship of Northern/Southern Hemisphere climate changes. Isotopic measurements (δD and $\delta^{18}O$) show two distinct peaks during MIS 3 corresponding to the AIM 8 and AIM 12 climate events. High resolution $\delta^{15}N$ measurements of air occluded in bubbles were carried out across

these two events and changes of ~ +0.07‰ in $\delta^{15}N$ were observed. Attempts to extract the thermal isotopic anomaly for the two climatic events were unsuccessful due to the inability of the firn diffusion model to reproduce the magnitude of this fractionation, while $\delta^{15}N$ excess calculations were hindered by the scatter in the $\delta^{40}Ar$ measurements. The Δdepth of 2 m obtained by matching variations in δD and $\delta^{15}N$ is consistent with the model predictions, hence constraining the chronology of the ice core. Based on the classical δD/temperature spatial relationship a warming of approximately 3°C for the AIM 8 event and 5°C for AIM 12 was obtained. Another $\delta^{15}N$ change of +0.18 ‰ was observed around 33,000 Yrs BP, which does not correlate to any events in the δD profile but correlates with the period where large altitudinal changes occurred in the ice sheet at Berkner Island. An important aspect of this study is the opportunity it provides to phase $\delta^{15}N$ with methane, the latter being considered as a proxy for climate change in the northern hemisphere. Preliminary methane data show that the time lag for climate events between the northern hemisphere and southern hemisphere is on the order of a few hundred years.

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YF1-7

Abrupt climate transitions and the $\delta^{13}CH_4$ record: New measurements and old corrections

Joe Melton, Hinrich Schaefer, Michael Whiticar

We present new $\delta^{13}CH_4$ measurements from interstitial air extracted from ice outcropping at Pakitsoq, Greenland. Our high-resolution gas isotope record spans three different abrupt climate transitions from the Last Glacial Maximum (LGM) into the Preboreal: 1) Oldest Dryas – Bølling (OD-B, climate warming at 14.7 kyr BP), 2) Ållerød –Younger Dryas (A-YD, climate cooling at 12.8 kyr BP), and 3) Younger Dryas – Preboreal (YD-PB, climate warming at 11.5 kyr BP). We note an interesting contrast between a) transitions with no apparent coupling between the methane concentration and its stable carbon isotope ratio (YD-PB) and b) transitions where the methane and its isotope ratio appear to move in concert (OD-B). Our results demonstrate the same general trend of more ^{13}C-enriched methane during colder periods in the climate record as published recently (e.g., Schaefer et al. 2006, Fischer et al. 2008). However, to properly compare our abrupt climate transition results to those recently published we must correct for the processes that can fractionate the methane as it moves from the atmosphere, within the firn and to isolation after bubble close-off. These processes include thermal, gravitational, diffusional, and dilution fractionations. We will pay particular attention to diffusional corrections as these corrections have been neglected in some of the published ice core records. Additionally, this correction is of critical importance to compare stable isotope measurements from ice between different locations and records.

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YF1-6

New high-precision, high-resolution records of atmospheric methane from Greenland and Antarctic ice cores: AD 1000 – present

Logan Mitchell, Ed Brook

Atmospheric methane has caused the second largest increase in radiative forcing from greenhouse gases since the start of the industrial revolution. Here we present a high-precision, high-resolution, 1000 year long record of atmospheric methane from the West Antarctic Ice Sheet Divide 05A (WDC05A) shallow gas core and preliminary results from the Greenland ice core GISP2D. These records have an average temporal resolution of ~9 years and an analytical precision of <3 ppb. Preliminary high resolution data from GISP2D show patterns similar to those in Antarctic records. These records allow us to begin constructing the first high resolution interpolar gradient (IPG) which will enable us to investigate geographical changes in atmospheric methane source regions on a multi-decadal timescale. The Law Dome and WDC05A methane records are highly correlated (r^2 = 0.77) which increases confidence in the accuracy of both records. An offset between the gas age timescales is apparent and the maximum correlation (r^2 = 0.81) is attained when one of the timescales is shifted by 8 years. This demonstrates that high resolution analysis of methane can be used to synchronize gas age timescales between different ice cores during climatically stable periods. We compare these atmospheric methane records with various paleoclimate archives and have identified a possible correlation with a proxy for East Asian monsoon strength.

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YF1-10

Response of terrestrial N_2O and NO_x emissions to abrupt climate change events

Mirjam Pfeiffer, Jed O. Kaplan

Ice core records of atmospheric N_2O concentrations are marked by rapid fluctuations concurrent with abrupt climate change events. The causes of this observed variability are currently poorly understood, as the reactive N trace gases (N_2O, NO_x) have sources in both the oceans and the terrestrial biosphere. In this study we simulate terrestrial nitrogen cycling by implementing the ORCHIDEE-CN nitrogen module into the ARVE-DGVM. This model simulates the fluxes of N_2O and NO_x emitted by the terrestrial biosphere. In order to test the sensitivity of terrestrial N emissions to abrupt climate change, we applied the ARVE-O-CN model to the rapid warming during the Oldest Dryas-B/A transition recorded at the Gerzensee site in Switzerland. The high resolution multi-proxy record of environmental change at Gerzensee contains detailed information on seasonal and annual temperature change from delta ^{18}O, precipitation inferred from lake level reconstructions, and changes in vegetation cover from pollen and macrofossils. Using these data to drive our model, we simulate rapid outgassing of both N_2O and NO_x in response to abrupt warming. Higher temperatures and precipitation combined with an increase in labile carbon from vegetation change lead to accelerated N-cycling over the abrupt climate change event. Our results indicate that terrestrial ecosystems in temperate latitudes are very sensitive to rapid warming. To quantify the potential for terrestrial N-emissions to amplify the climate warming observed during abrupt climate change events, our methodology may be applied at the global scale.

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YF1-1

Solar forcing and climate variability in the North Atlantic during the last millennium: comparison between models and reconstructions

Jérôme Servonnat, Myriam Khodri, Pascal Yiou, Joel Guiot

Studying the climate of the last millennium allows replacing the present climate change in a long term context. Since it is a relatively well-documented period, it provides an interesting base to assess the secular variability of the climate, free of anthropogenic greenhouse gas influence. Considering this, the climate of the last millennium is likely to have been driven by natural forcings, such as major volcanic eruptions or solar variability.

We present here the results of simulations performed with the IPSLCM4v2 climate model for the French ANR ESCARSEL project (reconstruction of the climate of the last millennium). In order to understand the role of the solar variability during this period, we have forced the model with a reconstruction of the Total Solar Irradiance since 1000AD (Crowley, 2000). The results are compared with various reconstructions based on proxy data, from the hemispheric to the continental scale. A new reconstruction of the temperature in Europe since 600AD (annual April to September mean, based on tree rings data) has been achieved within the ESCARSEL project. This dataset provides the possibility to compare the spatial response of the model to the solar forcing with the corresponding temperature patterns recorded in the proxys. As a first step we present the results on the long term variability, before focusing on selected periods to assess the spatial behaviour of the model to different value of the total solar irradiance.

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YF1-13

A high-resolution sea surface temperature record off the southeastern Papua New Guinea, tropical western Pacific of the past 320,000 years

Liang-Jian Shiau, Yin-Chieh Liao, Masanobu Yamamoto, Yusuke Yokoyama, Min-Te Chen

We present a 320-ka high-resolution $U^{k'}_{37}$-sea surface temperature (SST) record from core MD052928 (11°17.26'S, 148°51.60'E, water depth 2250 m) which was located off the southeastern Papua New Guinea, the tropical western Pacific. The age model of the core was constructed by AMS ^{14}C dating of planktic foraminifers and the measured MD052928 benthic foraminifer oxygen isotope curve correlated to a LR04 stack. The $U^{k'}_{37}$-SST ranges from 26.5 to 29°C, showing glacial-interglacial and noticeable millennial variations. The timing of the $U^{k'}_{37}$-SST appears to be similar to the Antarctica temperature changes shown in ice cores. The spectral analysis of the $U^{k'}_{37}$-SST of MD052928 show clear variances on the eccentricity and precession bands, but the variance is not significant in the obliquity band. The muted variance in obliquity band shown in MD052928 spectra is different from what observed from other SST records in the Western Pacific Warm Pool (WPWP) (e.g. ODP 806 and MD972140), in which the obliquity variance is more significant. In the precession band, MD052928 Uk'37-SSTs are in-phase with Northern Hemisphere summer insolation maxima but leads 2~5 ka to other SST records from the WPWP. While comparing the MD052928 $U^{k'}_{37}$-SST to the Antarctica ice core records of CH_4 and CO_2 concentrations, the $U^{k'}_{37}$-SST is in phase with the CH_4 concentration on three major orbital bands, but leads the CO_2 concentration by ~2.6 ka on the precession band. These results imply that the climate dynamics in the south margin of the WPWP on the orbital time scale is dominated by a complex interaction that may involve solar insolations, greenhouse gases, and possibly other low-latitude processes.

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YF1-5

East Asian winter monsoon maxima during the last glacial cycle: Insights from a latitudinal sea-surface temperature gradient across the South China Sea

Jun Tian, Enqing Huang, Dorothy K. Pak

Precisely dated marine sediment proxy records of the East Asian winter monsoon remain sparse. We present high resolution planktonic foraminifer Mg/Ca SST records of IMAGES core 2896 from the southern South China Sea (SCS) for the past 23 ka. We found that the ΔSST (SST gradient) of core 2896 and ODP Site 1145 is an useful marine proxy of the East Asia winter monsoon. Our records suggest that both the East Asian summer and winter monsoons had strengthened in the Holocene relative to the last glacial. The positive anomalies of the SCS ΔSST and the Lake Huguang Maar MS suggest several "East Asia winter monsoon maxima" for the last glacial/interglacial cycle, which are consistent with the Holocene Bond cycles and the Younger Dryas and Heinrich H1 events. These "East Asia winter monsoon maxima" were probably internally triggered by the slowdown of the NADW and externally forced by reductions of the solar output.

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YF1-2

Solar activity: A reason for south westerly wind shift during the late Holocene?

Vidya Varma, Matthias Prange, Frank Lamy, Ute Merkel, Michael Schulz

The Southern Hemisphere westerlies constitute an important zonal circulation system that influence large-scale precipitation patterns and the global ocean circulation. Understanding the variability and forcing of the westerly wind belt on interdecadal–to-millennial timescales is therefore of great importance. A high-accumulation rate marine sediment core from the Chilean continental slope provides a mid-to-late Holocene record of rainfall variability in southern Chile related to the position of the southern westerlies (Lamy et al. 2001). A correlation analysis reveals that shifts in the westerlies are strongly related to changes in solar activity on a multi-centennial timescale during the last 3000 years. Depending on the solar activity reconstruction used, linear correlation coefficients vary between 0.49 and 0.60. To study the influence of solar activity on Southern Hemisphere westerly wind shift in a state-of-the-art global climate model, experiments with the Community Climate System Model CCSM3 were carried out with pre-industrial boundary conditions along with different solar irradiance values (1365 W/m^2 and 1363 W/m^2). The model results support the northward shift of south westerly winds postulated for lower solar activity. Based on these results we infer that enhanced solar activity may have contributed to the observed southward movement of the Southern Hemisphere westerlies during the past decades, albeit to a much lesser degree than global warming and/or the Antarctic ozone hole.

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YF1-4

The significance of northern peatlands in global carbon systems during the Holocene

Yi Wang, Nigel T. Roulet, Steve Frolking, Lawrence A. Mysak

Using an inverse method (Wang et al., 2005c, hereafter, WMR), reconstructed atmospheric carbon (C) contents from Antarctic ice core, and a prescribed slow accumulation of Northern Peatland (NP) C, model simulations with foci in global and terrestrial C cycle dynamics are carried out. The prescribed peatland C growth significantly modifies our previous viewpoints of Holocene C cycle dynamics over the last eight thousand years. We conclude that if the build-up peatland C is considered, the only C source for the terrestrial and atmospheric C increases presumably come from the deep ocean. Future studies need to be conducted to constrain the basal-times and growth-rates of the NP C accumulation in the Holocene. These research endeavors are challenges because they need a dynamically-coupled peatland simulator to be constrained with the initiation time and reconstructed C reservoir of the NP. Nevertheless, our major conclusions are: (1) The NP acts as a C sink over the slow accumulation of peat, (2) This C sink is a necessary to explain the controversial Holocene terrestrial C cycle dynamics, and (3) The overall C source of the NP comes from the deep ocean during the gradual deglaciation as sea surface temperature only increases about 0.2°C. Our results indicate that the huge reservoir of deep ocean C explains the major variability of the glacial-interglacial C cycle, and hence are supported by the previous finding of Broecker et al. (2001). Notice that we do not include the anthropogenic land-use and land-cover changes in our current study.

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SESSION B: Regional Climate Dynamics

YF2-3

Variable oceanic teleconnections to western North American drought over the last 1200 years

Jessica Conroy, Jonathan Overpeck, Julia Cole, Miriam Steinitz-Kannan

Cool La Niña conditions in the tropical Pacific often bring drought to western North America on interannual timescales. Recent syntheses of available paleoclimate records suggest that past intervals of persistent, widespread 'megadrought' may also result from a cool tropical Pacific, but the strength of such conclusions have been limited by a dearth of appropriate sea surface temperature (SST) records. Here we use a new, continuous record of eastern equatorial Pacific (EEP) SST to explore the context of past megadroughts in western North America. Our results indicate that major episodes of drought occurred when EEP SST was below its 20th century mean, but multidecadal variability in the EEP SST record does not correspond with multidecadal variability in the drought record. In particular, droughts from AD 850-1050 and AD 1350-1400 occurred during periods or relatively warm EEP SST. Reconstructions of North Atlantic SST demonstrate that these droughts co-occurred with North Atlantic warmth, highlighting the potential diversity of controls on drought in western North America.

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YF2-11

Mid to Late Holocene seasonal SST records along coastal Peru and their implications for ENSO behavior and climate change

Jennifer Cumpston, Paul Loubere

The El-Niño Southern Oscillation influences climate globally. The variability of ENSO and its relationship to global climate conditions has great importance on regional climate dynamics, marine biological resources, and feedback in the planetary climate system. Key factors in ENSO development are depth of the thermocline, trade wind strength, and temperatures of the waters upwelling along the west coast of South America. These variables are incorporated into the annual cycle providing the stimulus of the switching of ENSO states. Though the sensitivity of the ENSO phase switching in relation to tropical background state is in debate, theories can be tested by examining the SST and seasonal cycles from coastal Peru during times of different ENSO behavior. We are able to supply this information in the form of oxygen isotope records of the surf clam Mesodesma donacium from key Holocene time periods. Over the Holocene, ENSO frequency has been variable, as recorded in Ecuadorian lake deposits. During the archaeological Late Archaic Period (5000 – 3800 YBP) ENSO variability was diminished compared to the present. Our data indicates that this is associated with a reduced annual SST cycle along coastal Peru. The absence of austral summer warming could suppress ENSO switching.

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YF2-10

Is El Niño an appropriate analogue for Tropical Pacific Climate Change?

Pedro DiNezio, Amy Clement, Gabriel Vecchi

El Niño/Southern Oscillation is often been invoked as physical framework for interpreting changes in the tropical Pacific for both future climate change and past climate changes. We argue that this analogy has limitations due to two physical aspects of the long-term climate response that are fundamentally different from either El Niño or La Niña. The Walker circulation weakens (strengthens) in general circulation model (GCM) experiments of warmer (cooler) climates, however the SST response is not necessarily El Niño or La Niña-like. While changes in wind and sea surface temperature (SST) are strongly coupled through changes in the equatorial thermocline during El Niño events, this coupling is much weaker during climate changes, such as Global Warming (GW) or the Last Glacial Maximum (LGM), because the response is slow enough for the thermocline to reach equilibrium with the wind changes. The equilibrium response to weaker (stronger) winds consists of a zonal mean shoaling (deepening) of the thermocline driven by the curl of the wind changes, in addition to a relaxation (increase) of the thermocline tilt. These two dynamical processes oppose in the eastern basin, thereby limiting the coupling between wind and SST changes. Additionally, GCM experiments suggest that a weaker (stronger) Walker circulation could result from changes in the hydrological cycle that are uncoupled to the east-west SST gradient. In general, GCM experiments indicate that can be significant ocean and atmospheric changes without much change in the zonal SST gradient. Implications for reconciling paleoclimatic proxies are discussed.

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YF2-6

Climate variability in the Caribbean area during the last 15.3 ka reconstructed from speleothems from western Cuba

Claudia Fensterer, Denis Scholz, Augusto Mangini, Christoph Spötl, Jesús M. Pajón

Two stalagmites from the Dos Anas cave system in western Cuba were studied by Th/U-dating and high-resolution $\delta^{18}O$ and $\delta^{13}C$ analyses. These measurements are complemented by a cave monitoring program including $\delta^{18}O$ analysis of modern drip waters.

Stalagmite CG is 720 mm long and grew within the last 1.5 ka. Stalagmite CP is 420 mm long and grew between 15.3 and 0.8 ka. Stable isotopes were sampled at a resolution of approximately 2-4 a (CG) and 4-10 a (CP). The growth phases of both stalagmites overlap between ~1.5 ka and 0.8 ka, and based on the comparison of the two $\delta^{18}O$ records within this overlap a continuous record for the last 15.3 ka, COMCUBA, was constructed.

COMCUBA displays high $\delta^{18}O$ values (between -1 and -1.5‰) before 10 ka, continuously decreasing $\delta^{18}O$ values between 10 and 6 ka and lower values (around -3‰) between 6 ka and today. This long term trend on the millennial timescale agrees well with the $\delta^{18}O$ variations observed in Caribbean sea surface waters and is, thus, interpreted as reflecting variations in the $\delta^{18}O$ values of the source of precipitation.

Today, major precipitation events on Cuba occur during summer, and $\delta^{18}O$ values of local precipitation show a significant correlation with rainfall amount, which is attributed to the amount effect. The $\delta^{18}O$ values of the collected cave drip waters are comparable with the $\delta^{18}O$ values of summer rainfall. On decadal to centennial timescales we, thus, interpret the COMCUBA record as reflecting interannual changes in rainfall amount.

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YF2-16

Identifying spatial and temporal variations in tree growth within subtropical montane forests in South America

María Eugenia Ferrero, Ricardo Villalba

Climate modulates tree growth at large spatial scales; however topographic position can locally induces different growth responses. Subtropical montane forests in South America afford the opportunity to study the climatic influences on tree growth and how site location influences growth pattern in the same species.

The subtropical montane forest in NW Argentina occupies a narrow strip (22-28ºS; 66-68ºW) of very diverse environments: from the warm, dry sites of the lower woodland transitional ecotone to the moist, cool sites at upper tree line. Tree-ring chronologies allow us to characterize the relations between woody growth and climatic variations across these diverse environments. We describe differences in temporal patterns of radial growth of *Juglans australis* between sites, and relationships between these growth patterns with temperature and precipitation are also determined.

Based on the similarity in tree-growth response to climate, thirty-four *J. australis* chronologies were merged in composite chronologies to enhance the regional climatic signals present in the tree-ring records. Principal Components Analysis (PCA) was used to identify spatial and temporal patterns of growth. Climatic records of temperature and precipitation from 32 stations distributed across the region were used to examine the relationships between climate and tree-ring growth patterns using correlation analysis.

By identifying the mayor climatic factors controlling the variability of these sensitive tree-ring records, we will be able to develop the first reconstructions of long term climatic variations in the subtropical montane forests in South America.

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YF2-13

Reconstructing pre-20th century temperature, rainfall and pressure for the Australian region using palaeo, documentary and early instrumental data

Joelle Gergis, David J. Karoly, Karl Braganza, Rob J. Allan, Chris SM Turney, Andrew M Lorrey

While the suite of global and hemispheric reconstructions that have emerged during the last decade now form an important basis for the Intergovernmental Panel on Climate Change's future scenario estimates, they still suffer from inadequate estimates of the range of Southern Hemisphere variability.

Reconstructions of Southern Hemisphere climate have suffered from a relative lack of data and research effort in comparison with the Northern Hemisphere. Given the importance of the 'Water Hemisphere' in driving and moderating many aspects of the global climate system, there is a clear need to consolidate palaeoclimate data in the Australian region.

This project directly targets a critical gap in global palaeoscience by assembling a range of pre-20th century palaeo, documentary and early instrumental data suitable for multi proxy temperature, rainfall and pressure reconstructions for the Australian region over the past 500 years. Data issues, methodology and results will be discussed in the

context of an annually resolved, multi proxy pilot study.

Comparing regional climate reconstructions with independent reconstructions of the larger climate system (e.g. ENSO, SAM, IOD, PDO) is helpful for characterising the long-term stability of the dominant drivers of Southern Hemisphere climate variability in the Australian region. Results with our previously developed, annually resolved, ENSO reconstructions back to AD 1525 are presented. Given the large number of extreme climate events the Australian region has been experiencing recently, this research provides a timely context for understanding recently observed changes and an opportunity to constrain regional climate change projections using broader estimates of natural climate variability.

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YF2-5

Temperature and hydrologic variability in the Holocene documented in corals from the Southern Caribbean Sea

Cyril Giry, Thomas Felis, Sander Scheffers, Denis Scholz, Claudia Fensterer

Holocene storm and tsunamis deposits on Bonaire (Netherlands Antilles) provide well-preserved annually-banded corals that we use to reconstruct the climate variability of the Southern Caribbean Sea at sub-seasonal resolution. 19 fossil brain corals (*Diploria strigosa*) ranging in age up to 6000 years old (U-series) were cored. X-radiographs reveal that each core contains several decades of coral growth, up to a maximum of about 100 years with a typical growth rate of 0.75 cm/year ranging from 0.3 to 1.25 cm/year. Diagenetic investigations (powder X-ray diffraction, thin sections, scanning electron microscopy) reveal an excellent preservation of the coral skeletons. Sr/Ca (temperature proxy) and oxygen isotopes (a combined hydrology and temperature proxy) were analysed at monthly resolution increments sampled along the thecal walls. Both proxies exhibit clear seasonality. Using a regional Sr/Ca-sea surface temperature (SST) calibration, the amplitude of reconstructed SST from a 40-year window at 3.8 kyr BP is similar to modern seasonality of about 2-3°C. Decadal to interdecadal variability is present in the Sr/Ca record but not in the corresponding oxygen isotope record. Initial results suggest that lower SSTs on these timescales were associated with fresher sea surface conditions at 3.8 kyr BP. We are currently analysing further corals covering different periods when the nearby Cariaco Basin Titanium record indicates highly variable hydrological conditions over northern South America. Combining sub-seasonal records from several well-dated corals will provide robust estimates of changes in SST and seawater isotopic composition of the Southern Caribbean Sea during the mid to late Holocene.

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YF2-2

Continentality of climate in tree ring chronologies from Western Siberia

Marina Gurskaya, Leonid Agafonov

We have analyzed larch (*Larix sibirca*) and spruce (*Picea obovata*) tree ring chronologies from North-Western Siberia areas with purpose to revealed information about climate continentality and its changes over last 500 years. We used two approaches to analyze climate signal in tree ring width and to reveal differences in frequency of climatic extremes which are recorded as abnormal structures in tree rings (light, frost and missing rings). For that we collected cores from trees, growing in temperate climate condition along the Ob river bank (65°N, 65°E), and from continental climate condition in northern taiga in Siberian plain (65°N, 69°E). Monthly mean temperature data from Salekhard (1883-2000) weather station were used. Analyzed chronologies are characterized high synchronous, but Ob chronologies have strong signal of October of previous year and June-July of current year. Siberian chronologies have strong June-July signals, without October signal. Light rings form mostly in the same years, but their intensity are different. We revealed several years when light rings form plentiful in one climate condition and absent in another. Frost and missing rings have different pattern of distribution. Reasons of difference in climate signal in tree ring chronologies and frequency of abnormal structure formation are discussed.

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YF2-7

Response of tropical African vegetation to periods associated with North Atlantic Heinrich Events

Ines Heßler, Lydie Dupont

Abrupt climate change in the tropics is thought to be related to shifts in the migration pattern of the intertropical convergence zone (ITCZ). Shifts in the ITCZ would have effects running in opposite directions on both sides of the equator. Comparing the southern African vegetation development with that in Northwest Africa should allow us to test the hypothesis that the ITCZ shifted southwards during HE periods.

Palynological investigations at high temporal resolution were performed on marine sediment cores recovered from ODP Site 1078 (11°55'S, 13°24'E) off Angola at 426 m water depth. The distribution of pollen provides information about fluctuations in the dominating vegetation composition on the adjacent continent and the corresponding climate during the last glacial.

Previous work on ODP Site 1078 has shown that the pollen record is very divers and represents large changes in the southern African vegetation, especially during the period associated with HE1. However, a different vegetation response is observed during the HE3 period when, for instance, the Ericaceae record displays higher percentages compared to HE1 and HE4. Nevertheless, the impact of the climate change related to HE 1, 3, and 4 on the tropical African vegetation also show similarities. Particularly, during the HE3 period the tropical vegetation of Angola tends to become more lush with higher percentages of forest and mountain taxa. As expected, dryforest/savannah elements and grasses showing short-term drops in their abundances during these events. This development is in contrast to the situation in West Africa north of the equator.

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YF2-1

Heat wave changes in the Mediterranean Region since 1900

Franz Gunther Kuglitsch, Andrea Toreti, Elena Xoplaki, Jürg Luterbacher

The Greater Mediterranean Area (GMA) is regarded as a "Hot Spot" of climate change that suffers from increasing summer heat wave frequencies, durations and intensities.

Instrumental observations and reconstructions of European temperatures let assume that the summer heat wave 2003 was probably one of the most severe temperature events for the last 500 years and the most devastating natural disaster in Europe in the last 50 years causing financial losses of more than 10 billion Euro.

In order to help predicting the occurrence of future heat wave events and understanding the physical mechanisms and key processes contributing to their evolution it is important to have a dense number of reliable and long daily temperature records.

An adapted version of PENHOM method was applied to homogenize daily maximum and minimum summer temperature series of more than 300 stations across the GMA.

Results from the daily temperature homogeneity analysis suggest that many instrumental measurements in the mid 20th century were warm-biased. Correcting these biases, the length, frequency and intensity of summer heat waves have been increased significantly since the late 1970s in the Western, the early 1980s in the Central and the late 1980s in the Eastern Mediterranean, respectively. In some smaller areas the number of hot days has tripled, the number of hot nights has even quadrupled.

The findings show that the Mediterranean climate has become more extreme than previously thought when analysing raw data and underline the importance of homogenizing climate series also for validating temperature reconstructions.

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YF2-14

520 years of glacier mass balance proxy records in NW Patagonia reconstructed from instrumental climate data and tree-ring width series

Mariano H. Masiokas, Brian H. Luckman, Ricardo Villalba, Antonio Lara, Rocio Urrutia

Very few, short mass balance measurements are available for glaciers in the Patagonian Andes. We have therefore developed proxy glacier mass balance data using instrumental climate and tree-ring records in an attempt to improve understanding of the impacts of inter-annual and inter-decadal climate variations on glacier behavior. Initially, we developed a 1912-2002 climate-based proxy series using homogenized, regionally-averaged temperature and precipitation data that mimicked regional glacier mass balance relationships in NW Patagonia. Subsequently we extended this record back to 1481 using an extensive, multi-species network of tree-ring width chronologies from sites on both sides of the north Patagonian Andes. In both series extended periods of "positive" proxy values are interpreted as periods during which climatic conditions were relatively more favorable for glacier growth and vice versa. This approach can provide useful baseline information to put the 20th-century regional climate and glacier changes in a longer term context. Comparison with the history of glacier fluctuations in NW Patagonia during the last 500 years shows some promising results. However, this approach should only be considered preliminary because of the simplicity of the climate-based indices used, the absence of direct glacier mass balance records for validation, and the lack of detailed information on regional glacier variations in this region. More sophisticated approaches may be developed once more detailed glacier-climate linkages are established

and a larger network of glacier mass balance and tree-ring records become available.

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YF2-9

Coral records of late 20th century warming and freshening in the central tropical Pacific

Intan Nurhati, Kim Cobb, Christopher Charles, Robert Dunbar

Accurate projections of future regional climate changes require an improved understanding of how the tropical Pacific climate evolves in response to global warming. Climate models and analyses of instrumental climate datasets provide a wide range of scenarios including both a weakening and a strengthening of the tropical Pacific zonal SST gradient. Here, we use coral geochemical records from three islands in the central tropical Pacific (2°-6°N, 157°W-162°W) to reconstruct late 20th century SST and salinity trends. The three islands span strong gradients in SST and salinity. At the northern end, Palmyra lies in the core of the North Equatorial Counter Current that delivers warm water from the western Pacific and is heavily influenced by ITCZ variability. At the southern end, Christmas is bathed by the westward South Equatorial Current and dominated by upwelling variability. Located in the middle, Fanning climatological SST and salinity lie in between the two islands. The coral-based SST reconstructions (via Sr/Ca ratios) reveal warming trends that increase towards the equator (0.94°C at Palmyra, to 1.65°C at Christmas), implying a decrease in the equatorial upwelling of cool waters in the last decades. Seawater freshening trends at the southern edge of the ITCZ (-1.19 psu at Palmyra and -0.42 psu at Fanning) reconstructed using seawater oxygen isotopic ratios (d18Osw), suggest an equatorward shift of the convergence zone. Together, the new coral records support a late 20th century trend towards a weakening of the tropical Pacific zonal SST gradient, in line with the majority of global climate models under anthropogenic forcing.

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YF2-15

High resolution record of the Last Glacial Maximum in eastern Australia

Lynda Petherick, Patrick Moss, Hamish McGowan

A continuous, high resolution (ca. 10 – 30 year) record encompassing the LGM has been developed using multiple proxies (aeolian sediment flux, grain size, pollen and charcoal) in lake sediment from Tortoise Lagoon (TOR), North Stradbroke Island, Queensland, Australia. Identification of the bioclimatic envelopes associated with pollen taxa present in the TOR record allowed quantification of past climate variables (viz. temperature and precipitation), providing insight into the rate of environmental response to periods of climate change. The presence of *Asteraceae tubilifloreae* and spineless Asteraceae (common indicators of glacial conditions in Australia) at TOR indicates significantly cooler temperatures (mean annual temperature up to 6°C lower than today). Similarities between the vegetation at TOR during the LGM and that at temperate sites e.g. Caledonia Fen, Victoria (Kershaw et al. 2007), Redhead Lagoon, New South Wales (Williams et al. 2006) and Barrington Tops, New South Wales (Sweller and Martin 2001) suggests that this record reflects regional conditions across southeastern Australia. Vegetation at TOR suggests a more open environment than present during the LGM, which is supported by previous studies indicating large areas of southern Australia were characterised by semi-arid steppe environments (e.g. Hope 1989; Dodson 1998). The TOR record correlates well with that from nearby Native Companion Lagoon (Petherick et al. 2008), which along with other Southern Hemisphere records (Denton et al. 1999; Röthlisberger et al. 2002; Suggate and Almond 2003; EPICA 2006; Alloway et al. 2007; Newnham et al. 2007), suggests the LGM was an extended period characterised by two peaks in aridity, interrupted by a period of climate amelioration.

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YF2-17

An extraordinary diatom deposition event in the Pleistocene subtropical South Atlantic

Nick Rackebrandt, Henning Kuhnert, Jeroen Groeneveld, Torsten Bickert

Up to 1.5 m thick almost monospecific layers of the giant diatom *Ethmodiscus rex* have been reported from Pleistocene sediments below the South Atlantic subtropical gyre. This oligotrophic region is less favorable for diatom growth and the sediments typically constitute of calcareous nannofossil oozes. Since giant diatoms like *E. rex* are known to get concentrated at open ocean fronts, we reconstructed temperatures and salinities from planktonic foraminiferal Mg/Ca and stable oxygen isotopes (*Globigerinoides ruber*

white and *Globorotalia inflata*) to test whether the extraordinary occurrence of an ocean frontal system could have provided the conditions to deposit this layers.

The diatoms were deposited at exceptionally high sedimentation rates of 12 cm/ka during glacial stage 14 (MIS 14). Temperatures and relative changes in salinity show a very high variability during the deposition of the layers. Minimum temperatures are even lower than observed in other glacials. Maxima are close to or exceed those reconstructed from interglacials. We interpret the sudden changes to result from an oceanic front (presumably the Subtropical Front) which has crossed the core location several times between 539 and 550 ka.

But how could an open ocean front have formed within the subtropical gyre? A minimum dust supply during MIS 14 and the warmest glacial temperatures within the last 800 ka as recorded in the EPICA ice cores indicate a weakening of the wind system at the end of the Mid-Pleistocene Transition. These observations hint to a major perturbation of the global climate system, which is yet not understood.

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YF2-4

The progression of precipitation: A scale analysis of controls on oxygen isotope variability in caves of the Southwest

Sarah Truebe, Toby Ault, Julia Cole

Cave records of oxygen isotope variability in arid regions have been interpreted as indicators of both the total precipitation amount and/or its seasonal balance. Here, we compare oxygen isotope modeling experiments with in situ measurements from Cave of the Bells, Southern Arizona. We simulate the flux of moisture from surface to cave as a series of "leaky buckets" modified to accommodate isotopic fractionation. Nearly 7 years of isotope measurements from the site are used for validation. We employ a Monte Carlo method to specify a random but physically realistic range of temperature values, precipitation amounts, and rainwater $\delta^{18}O$ values as input for the model, allowing us to assess the relative importance of different controls on oxygen isotope ratios in the cave.

Precipitation at Cave of the Bells is highly seasonal; summer and winter precipitation have very different isotopic signatures and moisture source regions. However, the long-term average of dripwaters from within the cave most resembles wintertime precipitation. Deviations therein have occurred during exceptionally strong monsoon events. We show that both seasonality and duration of the monsoon may be as important as the amount of precipitation during a given summer. We also demonstrate that the spectrum of our synthetic $\delta^{18}O$ series exhibits a high degree of variance at lower frequencies, despite being driven by "white" (i.e., uncorrelated in time) Monte Carlo data. This finding suggests that additional work may be needed to interpret the low-frequency timescale of cave records as a direct response to low-frequency variability in the climate system.

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YF2-12

Multi-century tree-ring reconstruction of Maule River annual streamflow in South-Central Chile

Rocío Urrutia, Antonio Lara, Ricardo Villalba, Carlos Le Quesne, Augusto Cuq

Given the increasing importance of water availability as a restriction for future development, the decreasing trends in precipitation in South-Central Chile, and the high priority of the Valdivian rainforest eco-region conservation, it is essential to understand changes in water availability in a long term perspective in this area. Thus, the present study assesses a 450-year annual streamflow reconstruction in the northern part of the eco-region (35°-37°S) complementing the only streamflow reconstruction developed in Chile for the Puelo river summer streamflow in its southern part (41°S).

The Maule watershed streamflow reconstruction was developed using Austrocedrus chilensis tree-ring chronologies and goes back until 1550. The adjusted r^2 is 0.44. A singular spectral analysis of the reconstruction shows two main oscillation modes, a 17.5 and a 47-year cycle that explain almost 40% of the temporal variance.

Correlations between the observed streamflow data and climatic forcings such as El Niño Southern Oscillation (ENSO expressed as the Southern Oscillation Index, SOI) and the Antarctic Oscillation (AAO) demonstrate a significant correlation with both of them (winter-spring and summer, respectively and negative in both cases), showing that the precipitation regime is influenced by these two forcings in this area. A better correlation with SOI shows a major influence of this phenomenon on streamflows in this region.

The slight decreasing trend of the streamflow data in the last decades may be explained by the observed positive trend of the AAO, implying that projected atmospheric circulation changes in the midlatitudes might enhance the actual trend of the streamflow.

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YF2-18

Variability of Late Holocene Atlantic Water advection on the West Spitsbergen continental margin

Kirstin Werner, Robert F. Spielhagen, Katarzyna Zamelczyk, Katrine Husum, Morten Hald

Presently the Fram Strait and the Arctic Ocean are responding very rapidly to global warming. The Fram Strait is the only deep-water passage for Atlantic Water masses to enter the Arctic Ocean. The western part of the Fram Strait is today perennially ice-covered, while relatively warm Atlantic waters enter the Arctic Ocean through the eastern part of Fram Strait keeping it ice-free all year. Accumulation of relatively thick Holocene sedimentary sequences is attributed to sediment transport at certain water depths along the margin and deposition of fine-grained sediments at sites of "lee positions" with diminished flow velocities. Sediment cores from the West Spitsbergen continental margin with high resolution of the late Holocene have been studied in order to establish multiproxy data sets with a centennial to decadal time resolution during the last 2000 cal. yr BP. Isotopic, micropaleontological, sedimentological, and geochemical proxies are used to reconstruct variations of Atlantic Water advection to the Arctic, the sea ice extent, and the structure of the water column during the late Holocene. The records of foraminiferal oxygen and carbon isotopes, planktic foraminifer associations, and the amount of ice rafted debris clearly reveal climatically warmer and colder periods such as the Roman Climatic Optimum, the Medieval Warm Period, and the Little Ice Age. In addition, the data reveal a significant variation of Atlantic heat advection to the Arctic during the last 2000 years, including a strong warming event in the present, anthropogenically influenced period.

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YF2-8

Evaluating sea surface temperature variability using replicated *Porites lobata* coral Sr/Ca records from Clipperton Atoll (AD 1994-1894)

Henry Wu, Braddock Linsley, Daniel Schrag

Monthly resolution Sr/Ca record from 3 coral colonies of *Porites lobata* at Clipperton Atoll (10°18'N, 109°13'W) in the eastern Pacific was assessed as a proxy of sea surface temperature (SST). Significant relationships were found between individual cores and instrumental SST for the 20-year calibration period (1994-1974) with a 3-core composite average Sr/Ca increasing the regression (R^2= 0.66, slope = 0.068 mmol/mol/°C, y-intercept = 11.12). Correlations of monthly Sr/Ca data between cores were high with the exception of a 10-year section of growth in one coral, stable isotopes record and SEM images revealed nothing anomalous about this interval. The composite Clipperton Sr/Ca record exhibits interannual fluctuations highly correlated with the El Niño Southern Oscillation (ENSO) that are in phase with observed gridded SST record (Global Ice and Sea Surface Temperature Ver. 2.2 (GISST)) and showed dampened ENSO-band variability in the 1920s-1940s during the well-documented "ENSO quiet period." Examination of boreal spring in the composite Sr/Ca record and estimated $\delta^{18}O_{seawater}$ record (reconstructed from skeletal $\delta^{18}O$ and Sr/Ca data from 1994-1894) indicates reduced interannual spring SST variability and greater interannual $\delta^{18}O_{seawater}$ variability from ~1925 to mid 1940s suggesting anomalous variations in the Intertropical Convergence Zone during the ENSO quite period. An observed warming trend of ~1°C since 1976 may have been related to the 1976 Cold Event and subsequent interdecadal climate shift of the Pacific Ocean. These results highlight replication benefits and the high degree of reproducibility in SST driven Sr/Ca proxy from rapidly growing *Porites* corals at Clipperton.

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SESSION C: Chronology

YC1-1

Extracting moraine ages from statistical distributions of cosmogenic exposure dates

Patrick Applegate, Richard Alley

Moraines are distinctive landforms that mark the past extents of glaciers, which are sensitive to climate change. The ages of these landforms can be determined using cosmogenic exposure dating. However, the statistical distributions of exposure dates from moraines commonly show more scatter than can be explained by the measurement error of the technique. Here, we present models of two geomorphic processes that may influence the statistical distributions of cosmogenic exposure dates on moraines. These processes are moraine degradation and inheritance due to boulder reworking or landsliding onto glacier surfaces. We generate synthetic statistical distributions of exposure dates from these models using Monte Carlo methods. We fit the models to collections of exposure dates from real moraines by matching the cumulative density functions of the modeled and observed distributions. This process yields improved estimates of the ages of the moraines. We present fits of the model to real data sets from moraines whose ages are important in paleoclimate, and discuss the implications of the differences between the ages yielded by our interpretive methods and other possible age estimates.

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YC1-2

A latest Pleistocene and Holocene chronology of alpine glaciation for the western United States

Shaun Marcott, Peter Clark, Jeremy Shakun, Edward Brook, Anthony Novak, Marc Caffee

We are developing a Holocene glacial chronology based on cosmogenic dating of boulders from moraine crests at several sites across the western U.S. This chronology will address spatial and temporal glacier variability in response to postulated Holocene climate forcings (Mayewski et al., 2004). A number of studies have interpreted several Holocene glacial advances in the western U.S. (Burke and Birkeland, 1983; Davis, 1988) but age control is based largely on relative dating techniques or limited radiocarbon dates. Surface exposure dating using cosmogenic nuclides provides a robust method to reevaluate and re-date several of these poorly defined glacial chronologies and develop a high-precision glacial record across the western U.S. for the Holocene epoch. Development of this chronology will provide new constraints on the extent of major Holocene climate forcings and their effects on the mass balance of western North American alpine glaciers as well as providing a better framework for understanding climate forcing during deglaciation. We will be presenting 70-80 new cosmogenic dates from nine mountain ranges in the western U.S. as well as discussing our ongoing and future work. Our initial results indicate that all but one of the sites we have resampled, where Holocene glacial deposits were thought to exist, date to latest Pleistocene in age. These finding will have major implications in how people have interpreted Holocene glacial advance in the western U.S. and their relevance to past climate episodes.

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SESSION D: Proxy Development, Calibration, Validation

YC2-1

Tropical cloud forest dendroclimatology and the demise of the Monteverde Golden Toad

Kevin Anchukaitis, Michael Evans

Recent, widespread amphibian extinctions in the mountains of the American tropics have been blamed on the interaction of anthropogenic climate change and a lethal pathogen. However, the temporal span of limited meteorological records make it impossible to confidently conclude whether current climate conditions at these sites are actually exceptional in the context of natural variability. Here, we use stable oxygen isotopes to reconstruct a century of hydrometeorological conditions in the Monteverde Cloud Forest of Costa Rica from trees without annual rings. Very high-resolution measurements reveal coherent isotope cycles that provide annual chronological control, which we confirm with precision radiocarbon assays. The amplitude of these cycles reflect interannual variability in dry season moisture. Dry years are associated with El Niño events and weaker tradewinds. Lower frequency oscillations appear to be related to multidecadal Pacific and Atlantic climate variability. There is no evidence of a trend in cloud forest hydroclimate associated with rising global mean temperatures. Rather, it appears that the extinction of the Monteverde Golden Toad (*Bufo periglenes*) occurred during an exceptionally dry interval caused by the 1986-7 El Niño event and coincident with a period of increased moisture seasonality.

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YC2-2

Identifying changing climate responses of boreal forest trees in northwestern Canada: An integrated empirical and process-based approach

Jonathan Barichivich, Keith Briffa, Kevin Anchukaitis, David Sauchyn, Tom Melvin

Tree growth at high northern latitudes has provided a detailed history of extra-tropical Northern Hemisphere temperature variability over most of the last millennium. However, recent tree growth in some high-latitude regions does not appear to be tracking the strong warming trend observed in the instrumental record during the past few decades as might be expected. This apparent sensitivity change has been recently described as the "divergence problem" and has important implications for the interpretation of paleoclimatic reconstructions based on tree-rings and for the global carbon cycle. We use an integrated empirical and process-based modeling approach to test the potential influences of tree-ring processing techniques and changes in growth forcing on the apparent divergence of tree growth through the boreal forest in northwestern Canada. This approach allows us to examine the extent to which instances of divergence may be explained in terms of changes in limiting environmental factors or statistical artefacts of the tree-ring standardization methods.

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YC2-9

Evidence for calcification depth change of *G. truncatulinoides* between deglaciation and the Holocene – or why to be careful in transposing modern observations back in time

Caroline Cleroux, Jean Lynch-Stieglitz, Matthew Schmidt, Elsa Cortijo, Jean-Claude Duplessy

Deep-dwelling planktonic foraminifera living in the subsurface ocean can be useful proxy for past thermocline conditions. One species *G. truncatulinoides* is generally accepted as a recorder of the condition around 200 m depth in the North Atlantic and has been used to reconstruct past upper ocean structure.

Recent $\delta^{18}O$ measurements from planktonic and benthic foraminifera in the Florida Straits provide a reconstruction of the entire water column isotopic composition (reflecting the vertical density gradient) over the last 12 ka. We use this reconstruction and $\delta^{18}O$ measurements on *G. truncatulinoides* in a nearby core to track the depth habitat of this species from the last deglaciation to 1.6 ka B.P. Around 9 ka, *G. truncatulinoides* was calcifying in much shallower water than during the later part of the Holocene. We show by analysing several cores that the downward migration toward its modern habitat is a regional phenomenon over the western tropical Atlantic continental slope. The cause is still unclear but we hypothesize that the shallower habitat may be a response to the presence of glacial melt water or to circulation changes. This study emphasizes the needs for better understanding of the ecology, life cycle and controls on calcification depth for *G. truncatulinoides* and other planktonic foraminifera that are used to reconstruct the history of the thermocline and upper water column structure.

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YC2-7

Foraminiferal Mg/Ca as a proxy for deep-sea carbonate ion concentration

Jennifer Fehrenbacher, Pamela Martin

We are developing a proxy for deep-sea carbonate ion (CO_3^{2-}) concentration based on the Mg/Ca ratio of planktonic foraminifera. Reconstructions of past deep-sea CO_3^{2-} can be used to assess changes in ocean circulation and carbonate chemistry. We exploit the 'dissolution effect', the decrease in the Mg/Ca ratio with increased water depth, to reconstruct the paleo-CO_3^{2-} gradient using samples obtained from multiple cores along a depth transect. Mg/Ca measurements were made on *G. ruber* and *N. dutertrei*. The species have different sensitivities to temperature and CO_3^{2-} concentration. Data from the shallow core is used to estimate the temporal change in the Mg/Ca ratio due to temperature. The residual decrease in the ratio with increased water depth is attributed to changes in CO_3^{2-}. We present results for the tropical Atlantic (LGM) and Pacific (LGM and deglaciation). The Pacific reconstructions suggest a more corrosive deep-water mass in the deep Pacific during the LGM and similar or slightly better preservation during the deglaciation in comparison to today. The Pacific results are at odds with the long-held view of better preservation in the Pacific during the LGM, however, they are in agreement with other proxy data. The Atlantic results suggest a steeper CO_3^{2-} gradient during the LGM in comparison to the modern in agreement with the inferred changes in water mass geometry during the LGM (implied by $\delta^{13}C$ reconstructions). We have also generated electron microprobe Mg/Ca image maps from the samples used in the carbonate ion reconstructions to characterize how dissolution alters shell chemistry.

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YC2-3

Exploring climatic signal in pine ring-width chronologies at the high elevation sites in the Northern Caucasus, Russia

Vladimir Matskovsky, Katya Dolgova, Olga Solomina

Since 2004 we have collected samples of pine trees (*Pinus sylvestris*) at 20 high elevation sites in three regions of the Northern Caucasus: in Teberda and Kyzgich valleys, in the Elbrus area, and in the Northern Osetia. In order to extend the living trees chronology back in time we also sampled old houses in the Dunta village (N. Osetia). The purpose of this study was to build sub-regional and regional chronologies in the Northern Caucasus in order to use them for paleoclimatic reconstructions, for dating of moraines, avalanche and debris flows deposits, as well as archeological and architectural wood.

Most samples even from the very remote places cross-date very well. The length of our regional chronology, which includes up to 400 samples, is 456 years. We tentatively cross-dated the floating Dunta conifer chronology from old buildings (AD 1541-1761), although the overlapping portions of the living trees and dead wood chronologies require more samples in order to reinforce our preliminary dating.

We also built principal component chronology to extract common climatic signal from our sub-regional chronologies. It showed the strongest response to climatic variability, correlating negatively with May-July maximum temperature and positively with May-July relative humidity. It's also positively correlated with aggregate duration of 2 atmospheric circulation types which are specific for the winter period and result in precipitation. So we assume that radial growth of pine in these climatic conditions depends rather on moisture content and therefore suffers from high summer temperatures while enforced by aggregate winter snow cover.

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YC2-5

Coral proxy record of reduced groundwater input from Molokai, Hawaii

Nancy Grumet Prouty, Mike Field

New results indicate that the rare earth elements, including yttrium (REYs) can be used as hydrologic tracers of groundwater flow paths through basalt aquifers. The source of the REYs is dissolution of labradorite and olivine. For this study the REYS were analyzed from coral cores and normalized to calcium (Ca) to develop proxies of coastal groundwater input over several decades from sites along the south shore of Molokai, Hawaii. The strongest relationship between calculated base flow and coral REY/Ca is during the rainy seasons. There was also a statistically significant downward trend in monthly resolved REY/Ca ratios over the last century. This is consistent with records of long-term stream discharge from Molokai, which reveal a downward trend in base flow. The coral geochemical records appear to respond to a decrease in base flow since 1913. A decrease in base flow is observed statewide and is consistent with the long-term downward trend in annual rainfall over much of the State.

While interdecadal and interannuall rainfall is largely linked to the Pacific Decadal Oscillation (PDO) and El Niño-Southern Oscillation (ENSO), divergence in Hawaiian air temperatures from the PDO signal in recent decades suggest a potentially greater influence of global warming compared to large-scale modes of climate variability. Despite a trend towards a positive PDO phase (colder/wetter), Hawaiian rainfall has been low since the mid-1970s. The development of a groundwater proxy presented here can supplement long-term observational networks and offer an accessible source of hydrologic and climate information.

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YC2-6

Genomic-level DNA sequence data as a testable proxy for paleo-environmental reconstructions and species responses to historical global change

Amanda Robertson, Matthew Olson, Naoki Takebayashi, Peter Tiffin

New advancements in DNA sequencing technology coupled with increasing computational power make it possible to tease historical signals from DNA sequence data with unprecedented statistical power and resolution. We present an empirical dataset in which multi-locus sequence data (ca. 600 gene regions) from a dominant North-American boreal forest tree, *Populus balsamifera*, (balsam poplar), is used to determine changes in boreal forest demography in response to Late-Pleistocene climate oscillations.

Genomic–scale datasets have the statistical power to test between alternative historical demographic and biogeographic scenarios which can lead to an innovative method of proxy validation. Here, we tested for the best-fit historical demographic scenario for *P. balsamifera* by fitting the data to complex demographic models (previously computationally prohibitive) created in a coalescent framework. Statistical model selection was determined using approximate Bayesian computation (ABC) methods. 594 gene regions were directly sequenced for 15 individuals sampled from across the North American distribution. Data analyses were automated in PERL and C and PERL scripts drove the programs PHASE, SITES, and mlcoalsim; alternative demographic hypotheses were generated from a continuous parameter distribution using PERL scripts.

The statistical power of large-scale DNA-based biome reconstructions along a chronosequence using the methods described herein has wide-ranging implications for genomics as a paleo proxy. Genome science is a relatively unexplored yet powerful approach to gain perspectives on the regional effects of past global change on biota. This analytical framework could be a template for using multi-locus datasets as a proxy for reconstructions of past global change.

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YC2-4

Potential of multiple dendroclimatic proxies for the Prairies?

Jessica Vanstone, Dave Sauchyn

Concern to establish the nature and rate of climatic changes, should serve to reinforce our determination to understand similar details of the 'natural' (i.e. non-anthropogenic) variability of climate. Dendrochronology offers great potential for studying climatic and environmental variability at local and regional levels, because of the wide geographical distribution of suitable sites, high temporal resolution, and environmentally sensitive characteristics of tree rings. Patterns within the annual rings of *Quercus* species, suggest that environmental factors influence the size and density of vessels within the ring, either by acting as a limiting factor for growth or through fine tuning of the wood structure to environmental factors. The purpose of this study is to investigate growth responses (annual, early- and late-wood)

of *Q. macrocarpa* to regional climatic variability affecting the Canadian Prairies. Results indicate that ring width chronologies, from Southeastern Saskatchewan capture regional signals related to moisture and drought conditions. Correlations suggest that late-wood measurements are more strongly representative of annual ring-widths, than are early-wood widths, and can therefore be applied for investigating seasonal fluctuations in climatic data. Correlations with precipitation and PDSI values indicate that annual, early- and latewood chronologies are useful proxies for investigating large scale climatic fluctuations, and present the opportunity for further investigation of the effects of indices that represent major modes of climate variability, i.e. ENSO and PDO, patterns that are thought to influence climate within the Prairie region. This study is novel in terms of sub-annual analysis of tree-rings in a region that previously lacked dendrochronological research.

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SESSION E: Modeling

YC3-5

Modelling isotopic signatures of cryospheric variability

Catherine Brennan, Katrin Meissner, Andrew Weaver, Michael Eby

Oxygen isotopes are a key paleoproxy, informing estimates of past temperature and ice volume. The interpretation of seawater isotopic data rests upon standard assumptions concerning ice-ocean interaction. For example, a melting ice sheet is assumed to contribute meltwater with a constant isotopic value to seawater. A second assumption is that variability in sea ice production rates may be neglected when interpreting seawater isotopic shifts. Although these assumptions may be necessary to extract information using oceanic isotopic data, they also provoke questions about uncertainty and bias in our interpretations of seawater $\delta^{18}O$ reconstructions. The following questions may be addressed using a model that includes oxygen isotopes: (i) Does a melting ice sheet that is contributing a time-evolving isotopic flux to the ocean disconnect the ice volume estimate (based on deepwater isotopic changes) from the actual ice volume? (ii) Can variability in sea ice production rates produce a discernable shift in deepwater isotopic values? We will attempt to examine the effects of variable cryospheric processes on seawater oxygen isotope distributions, with the aim of quantifying potential errors in seawater $\delta^{18}O$ interpretation.

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YC3-2

Simulating transient climate evolution of the last deglaciation with CCSM3

Feng He, Zhengyu Liu, Bette Otto-Bliesner, Peter Clark, Anders Carlson, Esther Brady

The dramatic deglaciation climate evolution provides a key observation for understanding abrupt climate changes and for testing climate models. Here, we present the first transient climate simulation of the deglaciation evolution from the last glacial maximum to the early Holocene in a synchronously coupled general circulation model—CCSM3. Our model simulates the major features of the deglaciation evolution—the deglacial warming trends from Greenland and Antarctic are well captured in the simulation as the response to CO_2 increase, and the warming trend in Greenland was interrupted by the millennial events caused by the variability of the Atlantic Meridional Overturning Circulation (AMOC). In this simulation, the cooling of Heinrich 1 is due to the collapse of the AMOC and the dramatic Bolling Allerod warming is the transient response of the AMOC to the termination of the meltwater discharge under the background CO_2 rise. The cooling of the Younger Dryas is induced by the reduction of methane and the slowdown of AMOC, but the magnitude of the cooling remains as a challenge. In Antarctic, the Cold Reversal (ACR) is the result of the pause of the CO_2 increase after BA.

The abruptness of the BA warming is simulated only if the major meltwater discharge over the North Atlantic is terminated within hundreds of years prior to BA. Our mechanism is in contrast to the previous mechanism of nonlinear bifurcation of the AMOC as proposed in intermediate climate models.

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YC3-4

Tropical precipitation during the Last Glacial Maximum: An analysis of the "amount effect" with a water isotope-enabled General Circulation Model

Jung-Eun Lee, Kathleen Johnson, Inez Fung

Low latitude proxy records, including $\delta^{18}O$ in speleothems, are generally interpreted as variations $\delta^{18}O$ in precipitation ($\delta^{18}O_p$) and as precipitation amounts. These records suggest that Brazil was wetter during glacial periods. Here we explore modern and Last Glacial Maximum (LGM) controls on the $\delta^{18}O_p$ in Brazil, using a water isotope enabled atmo-

spheric general circulation model. The simulation suggests a wetter Brazil and a more southerly position of the intertropical convergence zone (ITCZ) during the LGM, most likely due to the decreased inter-hemispheric temperature gradient that results from increased Northern Hemisphere ice cover at this time. The simulated isotopic changes agree well with the available proxy data. Our analysis indicates that the amount effect, commonly used to infer precipitation rates from $\delta^{18}O_p$ in low latitude regions, may not be generalized. In northeastern Brazil, the isotopic composition of transported vapor ($\delta^{18}O_v$) to the region is relatively constant for the present-day and the LGM whereas the contribution of transported $\delta^{18}O_p$ compared to the local evaporation, which has higher isotopic values, increases. In this case, $\delta^{18}O_p$ changes can be explained by the changes in precipitation amount, most of the difference comes from the changing partitioning of vapor source between transported vapor and local evaporation. If there is a significant change in $\delta^{18}O_p$ to the region, $\delta^{18}O_p$ cannot be explained as the changes in precipitation amount. This is the case for southeastern Brazil, where the decrease in $\delta^{18}O_p$ cannot be explained by the changes in precipitation amount, but by the contribution of Amazon moisture that has been more depleted by distillation effects.

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YC3-6

Sensitivity of East African lakes to climate change: Modeling results

Lydia Olaka, Martin H. Trauth

Reconstructing climate from sediments can be very challenging when translating local responses of individual lakes to regional scale, mainly because response of lakes and various components of lakes to climate are regulated by non climatic factors such as geomorphology and the hydrologic setting. In this study we introduce an interpretational key to understanding and interpreting paleoclimate proxies from lakes based on the experiences from the tectonically/ volcano-tectonically formed East African Rift Lakes. Lakes typically respond by changes in area and or depth depending on their form. To illustrate this, we develop a physically-based model in MATLAB based on mechanistic principles for three classical lake form; the graben shaped, 'V' shaped and the pan-shaped morphologies. We use a synthetic digital elevation model (DEM) that covers an area of 3000 square kilometers (30 by 100 km), with elevations ranging from 0 to 2000 m and a spatial resolution of 1 km and create the three probable forms. The hydrological setting is defined by the aridity index which is a measure of water availability in a region and vary this from 0.1 (very arid) to 1.5 (humid) for the three lake forms, and test the lakes morphometric (surface area, volume and maximum depth) response to these changes in climate. The trajectory of response for each of these lakes is unique; for the same volume of inflow/outflow, pan-shaped lakes respond by variations in areal extent while, graben and 'V' shaped lakes respond by fluctuations in lake depth and these are the most sensitive to climate. The interpretational key helps to highlight the biotic and abiotic variation in lakes in the same region and hence interpretation of lake sediment proxies.

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YC3-3

Changes in atmospheric variability in a glacial climate and the impacts on proxy data: a model intercomparison

Francesco Salvatore Rocco Pausata

We investigate sea level pressure variability in the North Atlantic in the preindustrial climate and at the Last Glacial Maximum (LGM, 21 kyr BP) using four climate models. In general, the models exhibit a significant reduction in interannual variance of sea level pressure (SLP) during the LGM compared to pre-industrial simulations.

For the preindustrial, all models feature a similar leading mode (EOF) of SLP variability that is also similar to the leading mode of variability in the instrumental record: the North Atlantic Oscillation. In contrast, the leading mode of SLP variability during the LGM is model dependent, but in each model different from that in the preindustrial. In each model, the leading mode of variability explains a smaller fraction of the variance and also less absolute variance in the LGM than in the preindustrial. The leading mode of SLP variability is shifted southward in the LGM relative to the preindustrial.

We correlate the leading mode of SLP variability with surface temperature and precipitation within each model and for the two time periods. In the preindustrial, the leading mode of SLP variability is similar from model to model and the temperature and precipitation correlation patterns are also similar. In contrast, since the models find different dominant modes of SLP variability for the LGM climate, they also disagree on the associated patterns of temperature and precipitation variability. Assuming stationarity of the relationship between surface climate and the leading mode of SLP variability could lead to a misinterpretation of signals recorded in proxy data.

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YC3-1

Spatial patterns of Central Asian glacier advance and retreat during the last glacial cycle

Summer Rupper

Glaciers are found on high topography throughout Central Asia, and in very diverse climates: glaciers in the Himalaya are fed by the intense summer monsoon precipitation and

a wintertime storm track; glaciers nestled along the eastern side of the Karakoram face the extreme dryness of the desert; and glaciers clinging to the peaks of the Mongolian Altai experience seasonal cycles in temperature as large as 40°C. There is a remarkable spatial pattern of glacier advances across Asia during the last glacial cycle (~100,000 years) as well. For example, glacier advances in western Central Asia were largest prior to the LGM with little evidence for large advances during the LGM itself. In contrast, glaciers in the more northern regions of Central Asia advanced at the LGM, roughly synchronous with the high latitude ice sheets.

Together, the regional climate and glacier variability within Central Asia make it an ideal area to test the sensitivity of glacier mass balance changes to climatic setting and climatic forcing. In this study, the Central Asian Holocene and LGM climate histories are reconciled with the glacier histories using two glacier mass-balance models and general circulation model simulations for 0 ka, 9 ka, and 21 ka. The results show that the sensitivity of glacier mass balance to changes in climate depend both on the climate setting (e.g., monsoonal versus continental) and boundary conditions.

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SESSION F: Global Earth System Dynamics

YF3-15

A paleoenvironmental reconstruction of Pingualuit Crater Lake sediments: A long-term record in the terrestrial Canadian arctic spanning more than 200,000 years

Jessica L. Black and 23 other contributors

The sediments of the 1.4 Ma old Pingualuit Crater Lake offer the unique opportunity to study terrestrial climate dynamics not only during the postglacial period, but over several hundreds of thousands of years as its deep sediment infill yields an uninterrupted arctic paleoclimate record covering several interglacial-glacial cycles. The Pingualuit meteoritic crater (Nunavik, Canada; 61°17'N, 73°41'W) is located in the northernmost part of the Ungava Peninsula in northern Quebec - close to the area where the Laurentide Ice Sheet reached maximum thickness during the last (Wisconsinan) glaciation. Here we present results of limnological measurements (PAR, UV light transparency), sedimentological (grain size, MS, ITRAX, ICPMS), micropaleontological (diatom and pollen), and stratigraphic interpretations of Pingualuit Crater Lake sediments. There are two decimetre-thick intervals in addition to the uppermost Holocene sediments composed of laminated, dark grey clayey-silts characterized by a relatively low density and magnetic susceptibility, that contrast sharply with the thicker over- and underlying sections with light grey, denser, sandy sediments. Moreover, these two intervals contain fossil diatoms and chrysophytes, suggesting that these two intervals represent ice-free conditions and thus interglacials, whereas the more extensive light grey and sandy sediments reflect glacial intervals. Initial TL dates indicate the first interglacial after the Holocene corresponds to MIS 5d and the second interglacial corresponds to MIS 7. The timing and magnitude of the interglacial periods have been reconstructed from Pingualuit Crater Lake and will be compared with other records from around the Arctic.

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YF3-9

Precipitation variability over southeastern South America: From orbital- to decadal-scale processes

Cristiano Chiessi, Stefan Mulitza, Jürgen Pätzold, Gerold Wefer

Detrending natural and anthropogenic components of climate variability is arguably an issue of utmost importance to society. To accomplish this issue, one must rely on a comprehensive understanding of the natural variability of the climate system on a regional level. The South American summer monsoon (SASM) controls precipitation over southeastern South America, the most densely populated and agriculturally productive region in the continent. In our presentation we will show how Fe/K ratios measured in bulk sediment samples raised off the La Plata River mouth can be used as a proxy for the SASM activity. The La Plata River basin is the fifth largest river basin in the world, extending over 3.1 million km^2, and draining most of the SASM precipitation. To test our new proxy we will show unpublished Fe/K ratios from a marine sediment core (GeoB6211-2, 32.5°S/50.2°W/657 m water depth) raised off the La Plata River mouth that spans the last 14,000 years. Site specific high sedimentation rates coupled with the high spatial resolution of our analyses provide unprecedented detailed information about rainfall variability in the continent. Our downcore record shows striking orbital- to decadal-scale oscillations and sheds new light on the SASM dynamics.

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YF3-10

Marine observations of deglaciation and the Bølling-Alleröd/Younger Dryas transitions from the SE Alaskan margin

Maureen Davies, Joseph Stoner, Alan Mix, Jason Addison, John Southon, John Jaeger

The marine deglaciation of Alaska following the Last Glacial Maximum (LGM) is poorly constrained. A number of

records illuminate the behavior of alpine glaciers, however the timing of retreat of the northwest Cordilleran ice sheet is complicated by the submarine location of the LGM end morains. This study focuses on core EW0408-85JC (59.56°N, 144.15°W, 682 m depth) collected at the continental shelf break of the Gulf of Alaska margin at a depth shallow enough to avoid carbonate dissolution, close enough to the continent to record the signature of glacial retreat, and yet distal enough to experience oceanic conditions as confirmed by the foraminiferal oxygen isotope record. The chronology of EW0408-85JC is well constrained, with 33 intervals having paired benthic and planktic foraminiferal radiocarbon dates, demonstrating that a continuous ~17 cal ka BP record is preserved. Sedimentation rates vary from an early Holocene low of ~20 cm/ka, to deglacial values of >500 cm/ka, reflecting glaciomarine deposition. Sedimentology, geophysical properties (GRA density and magnetic susceptibility), and biogenic silica records capture distinct changes that reflect regional deglaciation and oceanographic changes associated with the transition into the Bølling/Alleröd, the Younger Dryas climate reversal, and the onset of the Holocene. Periods of warming (cooling) in Greenland correlate closely to decreases (increases) in sediment density apparently driven by an increase (decrease) in the ratio of sedimentary biogenic silica. The apparent temporal synchronicity of this relationship supports an atmospheric teleconnection between North Atlantic climate and Northeast Pacific productivity.

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YF3-5

Postglacial climate evolution of the southern sub-equatorial tropics from speleothems in Flores, Indonesia

Michael Griffiths, Russell Drysdale, Silvia Frisia, Michael Gagan, Jian-xin Zhao, Linda Ayliffe, Yue-xing Feng, John Hellstrom, Wahyoe Hantoro, Bambang Suwargadi

Modern climate in Indonesia is governed by the Australasian Summer Monsoon (ASM), which orchestrates rainfall variability and terrestrial productivity in northern Australia and Indonesian maritime continents. Gaining a clearer understanding of the dominant mechanisms that have influenced its variability since the last deglaciation has proven difficult because, until now, we have lacked precisely dated records of past monsoon behaviour. Radiometrically dated oxygen isotope and trace element data from two stalagmites in Flores (east Indonesia) provide the first high-resolution, terrestrial reconstruction of ASM behaviour covering the period 0 to 12.8 ka. The multi-proxy records are constrained by 41 TIMS and MC-ICP-MS U-series ages.

The isotope and trace element (i.e. Mg/Ca and Sr/Ca) records show that global eustatic sea-level rise was the dominant climate forcing controlling ASM intensity during the early Holocene. Once sea-level had stabilised, Southern Hemisphere summer insolation became the dominant influence, whereby rainfall variability in the tropical west Pacific was driven by changes in convective intensity over the Australian continent associated with the migration of the ITCZ. This pattern of ASM variability is in phase with precipitation records from southern Brazil but anti-phased with East Asian summer monsoon intensity. Shorter-term (multi-decadal to centennial) increases in rainfall occur during periods of strong East Asian winter monsoon activity and match the timing of Northern Hemisphere ice-rafting events. Therefore, changes in ASM circulation over the past 12.8 ka reflect a combination of precession-controlled variations in external radiative forcing as well as internal climate dynamics associated with North Atlantic circulation and sea-level change.

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YF3-6

Millennial-scale vegatation response to the East Asian monsoon for the last 40 ka based on a pollen record of Lake Biwa, central Japan

Ryoma Hayashi, Hikaru Takahara, Akira Hayashida, Keiji Takemura

Understanding vegetation response to the millennial-scale changes in the East Asian monsoon, we present a 250-year resolution pollen record for the last 40 ka from Lake Biwa, the central Japan. Between 40 to 30 ka, *Cryptomeria japonica* was dominant with pinaceous conifers and deciduous broad-leaved trees around Lake Biwa. In this period, fluctuations of *C. japonica* could be correlated with the D-O cycles in the ARM record of same core from Lake Biwa, which represents amount of fine magnetic particles (Hayashida et al. 2007), and the speleothem records from Hulu Cave, China (Wang et al. 2001). The increases of *C. japonica* were likely caused by wetter conditions in summer influenced by the summer East Asian monsoon and/or the snowfall on the Sea of Japan side. Pinaceous conifer forests mainly composed of *Pinus* subgenus *Haploxylon*, *Tsuga* and *Picea* developed in MIS 2. In about 23 ka, *Picea* trees increased with the decrease of the ARM record (Hayashida et al. 2007). The expansion of *Picea* trees could be correlated with the Heinrich event 2 around the North Atlantic. Millenial-scale vegetation changes in MIS 2 were significant in the cold periods around Lake Biwa. It suggest that climate around Lake Biwa was strongly influenced by

the winter East Asian monsoon in this period. In contrast, millennial-scale vegetation responses to the abrupt climate changes in the beginning of MIS 1 such as the D-O 1 and the Younger Dryas were not clear in the pollen record of BIW95-4.

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YF3-13

Modelling climate evolution through the last interglacial

Peter Hopcroft, Paul Valdes

The Eemian interglacial (covering the time from approximately 130-116 ka BP) was the most recent pre-Holocene period of prolonged warmth that is comparable to pre-industrial or modern climate. The orbital configuration which occurred early in the Eemian implied large positive summer insolation anomalies in the Northern Hemisphere relative to the present day, and this is believed to have led to rapid deglaciation there, and partial ablation of the Greenland or West Antarctic ice sheets, or both. Support for this scenario can be derived from sea level reconstructions which show an early high stand above the level at present day, and temperature reconstructions derived from isotope measurements in polar ice which indicate temperatures around 4°C higher than the pre-industrial average. However, there remains uncertainty surrounding the mechanisms of warming at this time, and this is related to the relative paucity of data from sub-polar regions and of climate model simulations appropriate for this time-period. In this work we have employed a coupled atmosphere-ocean general circulation model, FAMOUS (a low resolution version of HadCM3), to simulate a series of snapshots covering the whole interglacial. In order to achieve this, we have configured the model with newly available ice-sheet reconstructions, as well as appropriate trace gas concentrations and orbital parameters. The resulting temporal evolution of the simulated climate is then used to investigate whether the aforementioned scenario is reproduced by the model, and to quantify whether other mechanisms are required to give adequate agreement with inferences derived from ice-core data.

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YF3-4

Water isotopes records of Australian palaeo-monsoon dynamics over the last ~ 30 ka: Integrating speleothem reconstructions and GCM results

Sophie Lewis, Michael Gagan, Linda Ayliffe, Allegra LeGrande, Maxwell Kelley, Gavin Schmidt, Jian-xin Zhao, Michael Griffiths, Russell Drysdale, Wayhoe Hantoro

We present high-resolution, uranium-series dated stable isotope records from multiple speleothems from southern Indonesia (8°S, 120°E) spanning the last ~30 ka. Speleothem $\delta^{18}O$ variability at this site largely reflects changes in precipitation brought about by large-scale shifts in the position of ITCZ.

The speleothem $\delta^{18}O$ record shows pronounced variability over the last ~30 ka and demonstrates distinct differences from late Quaternary speleothem-based climate reconstructions of the Northern Hemisphere (Borneo and China). In addition, fast-growing Indonesian stalagmites are near-annually banded and provide the opportunity for multi-proxy annual- and seasonal-scale rainfall $\delta^{18}O$ reconstructions during MIS3.

Although water isotope records provide some of the most extensive evidence of past climate change, interpreting their variability into climatic change requires applying a relationship between water isotopes and climate, usually inferred from modern variability. We improve this estimate for the relationship between water isotopes and climate through multiple simulations of past and present climate using the GISS ModelE-R, a fully coupled atmosphere-ocean GCM equipped with water isotope tracers. In addition, we tag water isotope variability due to alterations in source through the addition of 144 tracers that allow us to explicitly track the precipitation source distribution for individual sites.

Model results support the interpretation of isotopic variability in tropical speleothem records and allow a greater understanding of late Quaternary changes in precipitation. In southern Indonesia, speleothem $\delta^{18}O$ variability is caused by changes in local precipitation amount and shifts in oceanic source region through time.

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YF3-7

Millennial-scale oscillations in westerly jet path and their linkage with East Asian monsoon

Kana Nagashima, Ryuji Tada, Atsushi Tani, Youbin Sun, Yuko Isozaki, Shin Toyoda

Abrupt changes in the East Asian Summer Monsoon (EASM) intensity in association with Dansgaard-Oeschger (D-O) cycles have been well demonstrated as variations in the oxygen isotope ratio of stalagmites in southern China (Wang et al., 2001; 2008). Recently, an ultra-high-resolution study of a Greenland ice core (Steffensen et al., 2008) has suggested that a decrease in the aeolian dust flux from low-latitude Asian deserts may have preceded the temperature shifts at the onset of the Bølling-Allerød and the termination of the Younger Dryas by approximately 10 years. If true, these findings suggest that millennial-scale climate changes in Asia may have preceded and somehow affected climate changes in Greenland and the North Atlantic region. Thus, it is important to clarify the mechanism that links EASM to North Atlantic climate.

Here we demonstrate that temporal changes in the provenance of eolian dust in Japan Sea sediments, which we interpret to reflect changes in the westerly jet path, exhibit millennial-scale variations in harmony with D-O cycles. Dominance of dust with a Mongolian–North Chinese Gobi Desert provenance during stadials suggests southward shifts of the westerly jet axis, whereas the Taklimakan Desert provenance during interstadials suggests northward shifts of the axis.

N–S oscillations of the westerly jet axis thus seem to play a critical role in linking the East Asian monsoon to the North Atlantic climate on a millennial timescale.

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YF3-16

Deep water circulation changes in the equatorial Indian Ocean during the last ~350 ka BP: The north Atlantic connection

Rajeev Saraswat, Rajiv Nigam, Andreas Mackensen

We infer millennial scale deep water changes from the northern Indian Ocean over the last ~350 ka BP based on the stable oxygen isotopic composition of benthic foraminifera. Since none of the single benthic foraminiferal species was available throughout the core, both *Fontbotia wuellerstorfii* and *Uvigerina peregrina* recovered from a total of 300 samples of a gravity core collected from the equatorial Indian Ocean, were used for the stable isotopic analysis. The *F. wuellerstorfii* oxygen isotopic values were corrected by +0.64‰ to bring it in equilibrium with seawater oxygen isotopic value. The composite oxygen isotopic ratio shows a change of 2.0‰ over the last glacial-interglacial transition. These estimates are comparable with that of the CLIMAP which reported an average benthic oxygen isotopic change of 2.0‰ for the Indian Ocean region, but higher than the global mean of 1.9‰. Based on the benthic foraminiferal $\delta^{18}O$ changes over the last ~350 ka BP, we infer that the glacial-interglacial deep water $\delta^{18}O$ changes in the equatorial Indian Ocean were comparatively more intense than the global average glacial-interglacial $\delta^{18}O$ variations. We further propose that the Indian Deep Water was significantly cooler during glacial periods as compared to present. Based on the modern day composition of the Indian Deep water, we infer that during the glacial periods Southern Ocean water constituted the major component of the Indian Deep Water whereas the contribution of North Atlantic Deep Water to the Indian Deep Water was considerably reduced, in contrast to present.

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YF3-17

Modeling nitrogen isotopes in a global marine ecosystem model: Constraints on the coupling between N fixation and denitrification

Christopher Somes, Andreas Schmittner

Substantial changes in the oceanic fixed nitrogen inventory may significantly affect the ability of marine phytoplankton to sequester atmospheric CO_2 via the biological pump because nitrogen is one of the key limiting nutrients for photosynthesis. The predominant source and sink terms are N_2 fixation and denitrification, respectively, which have their own distinct effects on nitrogen isotopes making $\delta^{15}N$ a useful proxy for interpreting these processes. Nitrogen isotopes are embedded as prognostic tracers within the UVic Earth System Climate model to constrain N_2 fixation and denitrification in the present day climate. An idealized experiment employing an iron limitation on the growth rate of nitrogen fixers simulates a mechanism which removes the tight coupling between N_2 fixation and water column denitrification which also compares much better with $\delta^{15}NO_3$ and N:P observations. This suggests that N_2 fixers may only be able to balance any change in denitrification on a potential multi-centennial time scale of which ocean circulation can transport this low N:P subsurface water to a suitable surface environment with enough iron for them to grow. An imbalance in the nitrogen cycle during the last glacial/interglacial transition may be the reason for observed changes in sedimentary $\delta^{15}N$ and help contribute to atmospheric CO_2 changes via changes in the biological pump.

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YF3-12

Delayed development of fully marine surface water conditions in the Norwegian Sea and Fram Strait during the last interglacial (MIS 5e)

Nicolas Van Nieuwenhove, Henning A. Bauch, Evgeniya Kandiano

Last interglacial (Marine Isotope Stage or MIS 5e) sediments from the Vøring Plateau (Norwegian Sea) and southeastern Fram Strait were studied for their dinoflagellate cyst (dinocyst) and planktic foraminiferal content. The position of the investigated sites along the modern pathway of the North Atlantic/Norwegian Current allows tracing past fluctuations in the northward flow of these warm water masses, for a time interval generally believed to have been warmer than the Holocene.

Iceberg rafted detritus (IRD) and light stable oxygen isotope values reveal that freshwater input from melting ice(bergs) persisted at the Vøring Plateau during the first, post-deglacial ~6000 years of MIS 5e. Quantitative and qualitative analysis of the dinocyst data indicates that this freshwater input created a pronounced stratification and seasonality in the surface waters from the area. The dinocyst and foraminiferal assemblages suggest that optimal, fully marine interglacial conditions with a modern type of surface circulation only developed late in MIS 5e, after the cessation of meltwater input and just prior to glacial inception. Consequently, northward heat transport was strengthened and an interglacial environment also could become manifest in the surface waters of the southeastern Fram Strait, where conditions had remained harsh during the early MIS 5e interval. The development of the last interglacial climate thus seems to have been controlled to a large degree by the long-lasting meltwater input from the Saalian deglaciation, which had hindered the northward protrusion of warm surface waters well into MIS 5e.

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YF3-2

Late glacial-holocene indian monsoon changes: a sediment core record from the southeastern Arabian Sea

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The southeastern Arabian Sea is an important oceanic region to study the past climate changes. Because of high to moderate water column productivity, intense oxygen minimum zone, and relatively a higher accumulation of organic matter but a lower terrigenous input, sedimentary records from this region can be used to resolve late glacial-interglacial climate changes. Here we report sedimentological, geochemical and isotopic data in closely spaced samples (2 cm intervals) in a sediment core SK-215/5 collected during 215th Cruise of ORV Sagar Kanya. The core covers the sedimentation and climate history of Late Glacial-Holocene periods. The geochemical and isotopic data show high concentrations of detrital elements and thus terrigenous input between ~13.5 and 7 kyr BP (calendar thousand years before the present) and low terrigenous input since ~7 kyr BP. This implies a shift from a stronger to weaker Indian summer monsoon from the former to latter interval. The multiproxy approach adopted in this study further revealed an intense summer monsoon during the Late Glacial to early Holocene periodically at ~13.3, 11.9, 10.7, 9.2 and 7.5 kyr BP. Such millennial-scale changes suggest that southwest coast of India was heavily rained during the Late Glacial-Holocene transition than during the mid and late Holocene periods. This study demonstrates the Indian monsoon variability during the past 13.5 kyr and explores its mechanistic physical links with other monsoon and climate forcing.

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YF3-1

Migration of the Mu Us desert and its implications for advance/retreat of the East-Asian summer monsoon rainfall belt during the last two glacial-interglacial cycles: Evidence from particle size of Chinese loess

Shiling Yang, Zhongli Ding

In northern China, desert margin migration can be well documented in the downwind loess deposits, since recent studies have shown that the grain size of Chinese loess is principally controlled by source-to-sink distance rather than wind intensity. In order to investigate the migration of the Mu Us desert during the last two glacial-interglacial cycles, contour maps of grain size from 53 loess sections were constructed for MIS 2, 3, 4, 5, 6 and 7. All the grain-size isolines show a near north-south gradient for both glacials and interglacials, indicating a dominant dust source region in north and an approximately north-south dust transport pathway for dust deposits on the Loess Plateau, at least for the past two glacial-interglacial cycles. Using the grain-size isolines of MIS 2 as a reference, we derive a northerly

desert retreat of ~160 km, ~19 km, ~225 km and ~223 km for MIS 3, 4, 5 and 7, respectively, and a southerly desert advance of ~29 km for MIS 6, that could be preliminarily regarded as the relative migration distance for the East-Asian summer monsoon rainfall belt. In addition, the inferred climate conditions in MIS 3 are cool and humid in northern China, while the driest and coldest interval of the last two glacial periods occurs in MIS 6.

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YF3-3

A comparison of stalagmite records of Asian Monsoon climate changes since 7 ka BP

Xiaoyan Zhu, Meiliang Zhang, Hai Cheng, Hairuo Qing, Jason Cosford

Oxygen isotope records from Chinese cave speleothem have been demonstrated to faithfully reflect the intensity changes of Asian-monsoon, including Indian-monsoon, East-Asian-Monsoon and Asian-Winter-Monsoon subsystems.

Coupled with high-precision dating, we obtained three stalagmite $\delta^{18}O$ records from Lianhua Cave, Hunan, Dongge Cave, Guizhou and Xianren Cave, Yunnan, China, respectively. Their equilibrium oxygen isotope records indicate that the $\delta^{18}O$ variations depend on monsoon changes, in particular, regional rainfall amount and relative ratio of different types of rainfall (frontal rains with heavier $\delta^{18}O$ and cyclonic rains with lighter $\delta^{18}O$). Three records display quite identical tune that the $\delta^{18}O$ values increased gradually, following local insolation change, consistent with other speleothem records such as in Sanbao, Heshang and Qunf Cave. We also observed two dramatic positive shifts of $\delta^{18}O$ superimposed on gradually increasing trend, occurred at ~5-5.7 ka BP and ~3-3.7 ka BP. However, the comparisons between the three records show clear discrepancies in terms of amplitudes of variations and finer structures. The early positive shift (~1.2‰, 1.5‰ and 4‰ in Lianhua, Dongge, and Xianren Caves, respectively) occurred at ~5-5.7 ka BP, and a positive increase in Indian-Monsoon transit route, suggesting a quick withdrawing of Indian Monsoon. The other shift happened sharply at ~3-3.7 ka BP, considering two types of rainfall and rainfall amount effort, associated with intensified winter monsoon circulation. However, obvious oscillations without positive shift were found in the record of Xianren Cave because high Yungui highland blocked cold air attacks greatly.

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SESSION G: Human-Climate-Ecosystem Interactions

YF4-5

The effect of land use and land cover changes on runoff fluxes and soil losses on Mt. Elgon in Uganda

Yazidhi Bamutaze, Clare Nantumbwe

In this poster, we present preliminary results from an ongoing study which is assessing land use and land cover change (LULC) effects on water erosion and sedimentation on Mt. Elgon in Uganda. Whilst the understanding the dynamics of runoff and soil losses are important in designing conservation strategies, there is limited quantitative knowledge and information on the land use and land cover change effects on runoff fluxes and soil loss on Mt. Elgon. These gaps are being addressed through (1) Air photo interpretation and satellite image to determine LULC (2) Runoff plot experimentation to measure runoff and soil losses in major land uses and slope positions (3) flumes and automated devices for stream water discharge and loading patterns (4) isotope for historical reconstruction of sediment patterns. Preliminary results reveal major conversion from forestland to arable land (from 52.4% in 1960 to 7.7% in 2003). The associated runoff amounts for the sites were 450 m^3/ha/yr. On average more runoff (987m^3/ha/yr) was generated in annual land use than in the perennials (643 m^3/ha/yr); similarly the highest (45.8 t/ha/yr) and lowest (25.2 t/ha/yr) soil losses were recorded from the annual and perennial land uses, respectively. The greatest runoff (823.1 t/ha/yr) and soil loss (43.5 t/ha/yr) occurred on the lower slopes. The effects of landscape position on soil loss were not significant ($p<0.05$). Isotopic analysis is being undertaken to quantify the temporal onsite and offsite sediment magnitudes owing to land use and land cover changes.

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YF4-4

Did prehistoric anthropogenic soil erosion cause a shift in Mediterranean biomes over the Holocene?

Pamela Collins, Jed Kaplan

The paleoecological record of the Mediterranean basin shows widespread changes in vegetation cover from the mid-Holocene to the present. While these changes vary from place to place, the overall trend is a transition from temperate forests to xerophytic shrublands. The cause of this transition is generally believed to have been a drying trend in regional climate. However, prehistoric and preindustrial anthropogenically-induced soil degradation could have altered soil characteristics enough to cause a shift in Mediterranean biomes without major changes in climate.

To test this hypothesis, we analyze pollen records from the European Pollen Database for 56 locations in Mediterranean Europe and North Africa that demonstrate the Holocene trend towards more xeric vegetation cover. For each site, we specify a typical soil profile for "undisturbed" and "degraded" soil conditions and simulate the resulting vegetation cover using the ARVE-DGVM. Physical characteristics of the 17-layer soil column used in the ARVE-DGVM include particle size distribution, organic matter content, coarse fragments, and depth to bedrock. By manipulating these parameters in a series of experiments consistent with the effects of human exploitation of the land for agriculture and pasturing, our preliminary results show that a simple change in soil physical characteristics, such as that caused by anthropogenically-induced soil erosion and degradation, could be sufficient to cause the biome shifts observed in the paleorecord without invoking climate change. These findings allow us to quantify early human impact on the terrestrial biosphere and may alter the way pollen records are interpreted for climate reconstruction.

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YF4-10

Fire history in central Japan reconstructed from sedimentary charcoal

Jun Inoue, Hikaru Takahara, Nao Miyake, Naoko Sasaki

Although in East Asia the fire history has barely been addressed, recently in central Japan, fire history has been examined by charcoal analysis of the lake or bog sediments. These studies show that charcoal fragments are the most abundant in early Holocene sediments, indicating fire occurrence (e.g., Inoue et al., 2001). What caused fire occurrence in the early Holocene? Fire frequency generally depend on vegetation type, climate type and, intensity and type of anthropogenic activity. Between terminal Pleistocene and middle Holocene the vegetation changed generally in turn in central Japan, subarctic conifer forest to cool-temperate broadleaf forest or conifer forest to warm-temperate broadleaf forest, indicating warming trend. Although the warming and specific vegetation in early Holocene might have increased fire frequency, the influence of the anthropogenic activity should be considered. In Japan, Jomon Era (corresponding to Neolithic and Mesolithic era) started at terminal Pleistocene, which was characterized by hunting-and-gathering life and using earthenware. Few people are considered to have been in central Japan in the early Holocene, however they might have burnt forest intentionally for hunting or other purposes. While the origin of the early Holocene fire is still unclear, the fire probably disturbed or influenced the vegetation and others.

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YF4-11

Fire and climate variations inferred from *Araucaria araucana* chronologies in northern Patagonia

Ignacio A. Mundo, Kitzberger Thomas, Fidel Roig Juñent, Ricardo Villalba

Fires have been a recurrent disturbance in the *Araucaria araucana* forests from northern Patagonia during the past centuries. However, the influences of climate versus human activity on fire regimes in the *Araucaria* forest still remain poorly known. The objectives of this study were to develop tree-ring and fire chronologies in the *A. araucana* forests from Ñorquinco, Minchén and Rucachoroi (Lanín National Park, northern Patagonia, Argentina) and to determine the influences of climatic variability on tree growth and fire events. Partial cross-sections from scarred trees were collected to develop the fire chronologies. Cores from nearby stands were used to develop the tree-ring chronologies of reference. All samples were processed following the traditional dendrochronological methods. In all the sampling sites, an important concentration of fire events was recorded during the second half of 19th century. In Ñorquinco, fire events were significantly related, based on superposed epoch analysis, to years with extremely low precipitation. This pattern is not clear in the other two sites, suggesting that fire events in the Minchén and Rucachoroi are influenced by a combination of human activity and climate. The establishment of the Lanín National Park in 1937 had a major influence on the regional fire regime, with a significant suppression in all sites. Variations in the tree-ring chronologies are directly associated with changes in the Palmer Drought Severity Index and negatively with the Antarctic Oscillation Index during the current growing season, suggesting large potential of the *Araucaria* records to reconstruct regional variations in water balance and atmospheric circulation.

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YF4-7

Examining the mid-late Holocene environments of west-central Argentina

Diego Navarro, Cathy Whitlock, Marta Paez, Marcelo Zarate

In southern South America, widespread aridity has been postulated during the mid Holocene, followed by wetter conditions in the late Holocene. West-central Argentina experienced a hiatus in the archeological record during the mid Holocene, which has been attributed to scarce resources during dry conditions; however, there is little paleoenvironmental information available from this area to test this hypothesis. New Holocene records from the upper Atuel

River basin (34°47'S,69°52'W; 2000 m asl) provide information on the vegetation, climate, and fire history of the region and offer an important comparison with other published records. Pollen data from Laguna El Sosneado and nearby peat records show a period of shrub steppe between 6400-3200 yr BP, suggesting moderate but wetter-than-present conditions. During this interval, high-resolution charcoal records suggest that fires were frequent. Between 3200-1900 yr BP, an increase in Poaceae, Apiaceae and other shrubs suggests a period of high effective moisture. High fire activity at this time is explained by the greater abundance of fine fuels. Sparse vegetation and dry conditions are inferred between 1900-300 yr BP based on an increase in Chenopodiaceae, Asteraceae, *Ephedra* and *Schinus*. The lack of fuels resulted in extremely low fire activity. The last 300 years mark the development of modern conditions and evidence of intensive land use. Evidence of wet conditions in the Andean foothills during the middle Holocene contrasts with postulated arid conditions, especially in Chile. We suggest that the archeological hiatus implies low dispersed populations, high mobility, or poor site preservation, rather than regional abandonment.

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YF4-1

Diatoms of Ondiri Swamp, Kikuyu, Kenya

Julian Odhiambo, Daniel Olago, Eric Odada

Ondiri Swamp is located at longitude 36°40'S and latitude 1°15'E in Kikuyu Division, Kiambu District, Central Province. It lies at 2,200 m asl and 10 m below the general topography of the area hence exhibits less hiatuses and is a major source of Nairobi River. The present day Swamp has vegetative cover that comprise species of Cyperaceae, reeds (Plagmites), Typha (Cattails) and water grass (Vossia) which are aquatic plants. The major diatoms at Ondiri Swamp were *Amphipleura pellucida*, *Navicula gawaniensis*, *Pinularia tropica, Eunotia tenella, Melosira ambigua, Nitzschia subrostrata, Surirella sp., Eunotia pectinalis, Cyctotella iris, Nitzschia latens* and *Strauroneis phoenicenteron,* which are mainly associated with larger and more open wetland. The younger level was dominated by *Navicula tenella, Navucula el Kab, Nitzschia linearis, Navicula halophila, Gomphonema gracile, Navicula salinicola, Frustulia rhomboides, Eunotia pectinalis* and *Hantzschia amphioxys,* which are associated with smaller wetlands.

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YF4-6

Anthropogenic impacts on ecosystem dynamics in nearshore Chesapeake Bay environments

Cindy Palinkas, Evamaria Koch, Nicole Barth

The decline of submerged aquatic vegetation (SAV) in nearshore Chesapeake Bay environments has been well documented, focusing largely water-quality issues. However, other, sometimes co-varying, factors also can be responsible (e.g., temperature, salinity, waves, sediment type and accumulation) that are susceptible to natural and anthropogenic perturbations. In order to better understand how these changes are incorporated into the stratigraphic record, we examine the radiochemical and textural properties of sediment in the nearshore, modifications to it over relatively small spatial (m-km) and temporal (1-100 y) scales, and resulting potential impacts to SAV communities. We hypothesize that fine and organic material are increasing due to increased supply of sediment and nutrients from the watershed (i.e., eroding shorelines and fluvial inputs). This increase likely contributes to the historical decline of SAV in some areas, even though water-column requirements are satisfied. We also examine perturbations due to coastal structures, which can trap fine and organic material in the protected area. To address these issues, ~3-m long vibracores have been collected in current and historical SAV beds, and inshore of and adjacent to segmented breakwaters. A suite of naturally occurring radioisotopes (^{234}Th, ^{7}Be, ^{137}Cs, and ^{210}Pb) allows the establishment of a geochronology for each core over approximately yearly to decadal time scales. This is then used to relate observed changes in sediment properties (grain size and organic content) to current and historical SAV distributions present in aerial photographs. The insights gained are placed into the broader context of previous paleoecological studies in the region.

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YF4-8

Long-term drought variability in the Central United States: Signal detection and agricultural connection

Michael Stambaugh, Richard Guyette

Long tree-ring chronologies from continental locations (climates) of central and eastern North America are lacking with few chronologies exceeding 500 years and none exceeding 2 ka BP in length. Since 1999 we have collect over 500 subfossil oak trees buried in streams of Missouri and Iowa with the long-term objective of constructing a Holocene length chronology. With over 380 radiocarbon dates we have made significant progress that includes seven floating chronologies during the Holocene and an absolutely dated chronol-

ogy spanning AD 912-2004. The absolute chronology was developed using regional curve standardization and exhibits considerable low-frequency variation with spectral peaks near 22, 49, and 120 year periods. Dendroclimatological analyses show twentieth century tree growth has been most highly correlated with summer season drought (JJA PDSI) and a full period regression model ($r^2 = 0.52$) exhibited reasonable reconstructive skill. The bidecadal drought rhythm, known to be related to drought area across portions of the central and western U.S., persists throughout the past millennium. Understanding the timing and cycles in drought has important implications to understanding continental climate dynamics with critical implications to plant growth and productivity in this highly agricultural region.

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YF4-3

Recent sedimentary processes in a coastal Lake Sarbsko (northern Poland) and their paleoenvironmental implications

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As coastal basins are located at the contact of marine and terrestrial environments, it seems reasonable to assume, that deposits formed therein provide reliable high resolution records of sea level fluctuations as well as paleoecological, paleohydrological and climatic changes in coastal zones. On the other hand, lagoonal sediments are formed under seasonally variable water chemistry and might be resuspended by wave action and bottom currents and, hence, they are supposed to be substantially lithologically and chemically diversified. From that perspective, understanding of local processes that control and modify sediment lithology and geochemistry is of great importance.

The present study is to outline first results of 2-year research programme carried out in Lake Sarbsko, which is a typical coastal lake located on the middle Polish Baltic coast. The main objective of the project is to determine factors controlling recent sedimentation in the basin and, consequently, to evaluate the potential of coastal lake sediments to preserve paleoenvironmental information.

In the project special emphasis was put on: 1) lithological variability of surface deposits as well as spatial changes in the rate of recent sedimentation in Lake Sarbsko and their relation to water circulation in the lake. 2) interrelations between geochemistry of surface sediments (upper 5-cm layer) and chemical composition of ambient water. 3) controls on stable carbon isotope signal in lake water DIC and gaseous emmanations from the lake sediments as reflections of early diagenetic processes. 4) differences between modern and subfossil diatom spectra in the lake water and surface sediments

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YF4-2

Fossil midges (Diptera: Chironomidae) as paleoecological indicators in Chinese lakes

Enlou Zhang, Richard Jones, Alan Bedford, Peter Langdon, Hongqu Tang, Ji Shen

The use of Chironomid (non-biting midges) in Paleoenvironmental research has expanded significantly over the past decade but in China, progress has been slow due to a lack of taxonomical and ecological data. A number of recent studies have highlighted the potential of subfossil chironomds for the study of Chinese lakes, particularly in relation to anthropogenic activities such as eutrophication. Subfossil chironomid assemblages in surface sediments from Chinese lakes have a strong regional character. In Tibet they have been shown to be particularly sensitive to changes in salinity. For example in Sugan Lake, in the north part of Tibetan Plateau they have been used to reconstruct past salinity changes over the last 1000 years. Whilst in the middle and lower reaches of the Yangtze River a strong, statistically significant relationship with nutrient gradient is evident. A new TP inference model has been developed that has led to the production of a quantitative record of past water quality for the last 100 years. The results of these two studies, provides a unique insight into past conditions in these areas, which can prove invaluable for future lake management and ecological restoration programmes.

A range of other studies currently under development across China also reflects a strong regional pattern. With lakes in northern China strongly affected by salinity and anthropogenic activities, whilst midges from southwest China lakes appear to reflect differences in temperature and nutrients.

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MEETING PROGRAM

SUNDAY, 5 JULY	
19:00	**Welcome Reception and Registration**
MONDAY, 6 JULY	
09:00-09:30	**Welcome and Introduction – PAGES Science**
09:30-10:00	**Keynote Talk**
10:00-11:00	**Oral Session A: Reconstructing & Understanding Climate Forcings & Feedbacks**
	Morning Break
11:30-12:30	**Oral Session B: Regional Climate Dynamics - Reconstruction & Modeling**
12:30-13:30	**Poster Session A & B**
	Lunch
14:30-14:45	**Oral Session C: Chronology**
14:45-15:30	**Oral Session D: Proxy Development, Calibration & Validation**
15:30-16:00	**Oral Session E: Modeling Past Changes**
16:00-17:00	**Poster Session C - E** including Afternoon Break
17:00-18:30	**Plenary and Breakout Groups: Support for young scientists**
TUESDAY, 7 JULY	
09:00-10:00	**Reporting from Breakout Groups & Discussion**
10:00-11:00	**Oral Session F: Earth System Dynamics - Global-Scale Processes & Linkages**
	Morning Break
11:30-12:30	**Oral Session G: Past Human-Climate-Ecosystem Interactions**
12:30-13:30	**Poster Session F & G**
	Lunch
14:30-15:15	**Opportunities, Proposals, Grants: Tips from the Funders**
15:15-16:00	**Publishing your Work: Tips from the Editors**
	Afternoon Break
16:30-17:00	**Data Management**
17:00-17:30	**Communicating Scientific Results**
17:30-18:00	**Awards and Closing Remarks**
18:30	**OSM Reception and Registration**

All posters will be displayed for the entire length of the YSM.

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