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MAY 7-8, 2009

CLIMATE CHANGE INSTITUTE

UNIVERSITY OF MAINE

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1 Thursday, May 7, 2009

Coffee and Pastries 7:30 a.m.

1.1 Morning Session

1.1.1 Welcome and Introduction by George Jacobson 8:00 a.m.

1.1.2 Posters introductions by:

- Ann Dieffenbacher-Krall
- Jong-Suk Kim
- Molly Schaufler

1.1.3 Glaciology and Sea Level 8:20 a.m.

8:20 a.m.

RAPID TRANSMISSION OF SUBTROPICAL WARMING TO THE GREENLAND ICE SHEET

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The Greenland Ice Sheet's contribution to sea level rise more than doubled in the last five years, mostly because of increased mass flux rates from large outlets, such as Helheim Glacier in southeast Greenland. These outlet glaciers terminate at tidewater in deep fjords, which provides an intimate connection between the ice sheet and the ocean, and raises the possibility that ocean warming was the trigger for recent changes in ice dynamics. Until recently, there was little observational evidence to show that the warm waters of tropical origin, found offshore along the continental margins of southeastern and western Greenland, could cross the cold, fresh Arctic waters found on the shelf, and penetrate deep into fjords. We tested this hypothesis with a series of oceanographic measurements conducted in the summer of 2008. Our results show that warm offshore waters both penetrate and circulate deep inside Sermilik Fjord, the 100 km long fjord in East Greenland where Helheim Glacier terminates. The depth at which these waters are found, as well as the observed spatial and temporal variability all indicate that the warm waters play an active role in the fjord-glacier estuarine system and suggest that they come into contact with the glacier's terminus. The timing of Helheim Glacier's acceleration is consistent with the variability in warm water properties found offshore, in particular a recent warming in the subtropical basin. Sermilik Fjord and Helheim Glacier are typical of many fjord-glacier systems in coastal Greenland, leading us to argue that glacier-ocean interactions can explain a significant fraction of the observed increase in mass

flux from the Greenland Ice Sheet.

8:32 a.m.

THE OUTLET GLACIERS OF GREENLAND'S LARGEST ICE STREAM

William A. Sneed

Climate Change Institute
University of Maine, Orono

The ~700 km long Northeast Greenland Ice Stream was first observed in the early 1990s using synthetic aperture radar imagery. The ice stream flows from the interior of the ice sheet in a northeasterly direction and enters the Fram Strait between 76.5° and 79.5° North through three large and distinctly different glaciers. Nioghalvfjærdsfjorden Glacier at ~ 79.5° N and Zachariæ Isstrøm ~75 km to the south are the main exit points of the ice stream while a branch of the stream makes an abrupt turn to the south and exits through the surging glacier Storstrømmen, near 76.6° N.

We have begun a study of changes to the ~60 km floating ice tongue of Nioghalvfjærdsfjorden Glacier and the ice shelf of Zachariæ Isstrøm as they might relate to increases in surface melt water.

8:44 a.m.

MAPPING THE GROUNDING LINE OF ANTARCTICA

HALL, Monica L. and HAMILTON, Gordon S.

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Global sea level is directly tied to the mass balance of Antarctica. A complete collapse of the ice sheet would raise sea level about 60 m, but even a partial collapse would have tremendous societal impacts. Clearly, it is very important to monitor the mass balance of Antarctica and its response to climate change. The mass loss component of Antarctica is almost completely dominated by ice flow across the grounding line. This flux term is determined by the product of ice thickness and flow velocity at the grounding line. Velocity can be measured directly, but ice thickness is often the biggest unknown quantity. One way of estimating ice thickness is to use the elevation at the grounding line and the principal of hydrostatic equilibrium. We are contributing to an ongoing project working toward mapping the grounding line around the entire continent in order to produce an updated mass balance estimate. Our primary technique for grounding line mapping is to apply shape-from-shading to optical satellite images to retrieve the surface elevation field. Here we present methodology, early results, and challenges we have had.

8:56 a.m.

ENVIRONMENTAL CONTROLS ON CALVING EVENTS IN GREENLAND

Kristin Schild

The contribution of melting continental ice sheets to sea level rise has doubled in the last decade and the rapid acceleration of Greenland's outlet glaciers has been one of the dominant factors in this contribution. The largest changes in speed have been observed at the tidewater margins of these glaciers, implying a link between terminus position and glacier dynamics. By understanding the controls on terminus position, we will be better able to predict future ice dynamic changes in Greenland. Anecdotal observations point to an interannual and intraseasonal variability in the timing of large calving events at outlet glaciers in Greenland. We are using high-temporal resolution satellite imagery to quantify this variability. The goal of this project is to understand the environmental conditions (e.g. air temperature and ocean temperature) governing the observed variability in the timing of large calving events at major outlet glaciers in Greenland. In determining the environmental factors associated with this variability, we will be better able to understand the causes of large-scale dynamic change in Greenland and predict future behaviour of the ice sheet and its contribution to sea level rise.

9:08 a.m.

EVIDENCE FOR ABRUPT CLIMATE OSCILLATIONS DURING DEGLACIATION IN MAINE

Chase, Brenda

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The deglacial period, lasting from about 14-10 ka C in Maine, was punctuated by abrupt climate oscillations, such as the Bölling warm period and the Younger Dryas cool period. The objective of this project is to identify, quantify, and date precisely abrupt climate oscillations during deglaciation by looking at changes in vegetation. In addition, by obtaining high-resolution data to compare to existing moraine and pollen records from eastern Maine and adjacent Canada, I will provide evidence of how climate oscillations may have affected the retreating edge of the Laurentide Ice Sheet. Sediment cores from Moulton Pond, Dedham, Maine have been collected and stratigraphy analyzed. Further assessments will include pollen counts and LOI burns.

9:20 a.m.

A DROWNED, FORMERLY INHABITED BAY/LAKE SHORELINE OFF MOUNT DESERT ISLAND, MAINE

Joseph T. Kelley¹, Stefan Claesson², Daniel F. Belknap¹

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Recovery of prehistoric tools south off Bass Harbor by scallopers led to a coring/geophysical survey of this area. At 20-30 m depth, we found two gravel ridges separated by a basin. Seismic reflection reveals the ridges as reworked moraines covered with spits extending from moraine margins. Cores through paleo-spits penetrated sandy gravel overlying mud deposits with *Zostera marina*, and muddy sand deposits with *Crassostrea virginica* and *Mya arenaria*. We interpret the deposits to represent lagoon and tidal flat deposits, respectively and dating from 7.8–8.8 ka. This time corresponds to a time when sea level rose very slowly in Maine. This slow rise in sea level permitted spits and estuarine deposits to accumulate, and Early to Mid-Archaic Period Native Americans to inhabit the landscape. Our research suggests that this time/depth interval is the best candidate to preserve sedimentary deposits and associated prehistoric archaeological sites and artifacts along the Maine shelf.

9:32 a.m.

WHAT DO SALT MARSH STRATIGRAPHIC RECORDS REFLECT? LOCAL DYNAMICS OR REGIONAL SEA-LEVEL FLUCTUATIONS?

Wilson, Kristin R.¹, Kelley, Joseph T.², Belknap, Daniel F.², Tanner, Benjamin R.³

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Salt pools are shallow, water-filled depressions that are common features of many north-temperate salt marshes. Previous studies suggest that pool growth may be a precursor of a state change from a largely vegetated marsh surface to an open-water embayment in response to relative sea-level rise. The stratigraphic record of pools is poorly described and often confused as tidal flat or creek environments. Maine pool sediment is characterized by dark gray muddy material of high water content, low C:N ratios (6.79-9.13), high total percent organic carbon (2.21-9.18), and unique macrofossils (e.g., *Ruppia maritima drupes*). In addition, time-series aerial photograph analyses show that pools are dynamic features. Our findings suggest that previous work likely misinterprets salt pool deposits, resulting in false understanding of past salt marsh environments and their relationship to relative sea-level fluctuations. Recognition of

the salt pool signature and better understanding of the dynamic pool cycle warrant a reinterpretation of these reports.

9:44 a.m.

ARE MAINE'S MARSHES DROWNING - OR COULD THEY SOON?

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Global sea-level rise is a concern at present and especially under future scenarios. In Maine, tide gauges demonstrate about 2.0 mm/yr of rise over the past century, while new satellite data suggest 3-4 mm/yr recent global rise (an increase of 3X over long-term trends). The IPCC 2007 conservative projection to 2100 is 6 mm/yr, while some recent studies suggest 10 mm/yr or greater as a more likely trend. New England salt marshes have finely tuned responses to frequency of flooding and upper limit of tide levels. Vegetation communities reach dynamic equilibrium with frequency of flooding. Ultimately, the ability of the marsh to maintain a viable surface with respect to sea-level rise depends on growth of plant material, accumulation of plant detritus, as well as capture (hydrodynamic and adhesive) and settling of inorganic sediments. These vertical additions are balanced against decay, bioerosion, compaction, and deeper subsidence. In Maine, salt marshes receive a large percentage of their total sediment from ice rafting and suspended sediment. Bioerosion by crabs and other animals is small, while compaction is hastened by ice and snow loading. Lateral positions of marsh edges are controlled by colonization of intertidal areas by low marsh, or transgression of the landward edge during sea-level rise. Erosion may occur by waves, tidal currents, and ice at tidal-flat margins and on tidal creeks. Recent studies have focused on salt-marsh pools as a potential indicator of the equilibrium (or lack) on marsh surfaces. Some southern New England localities or disturbed areas show large growth in open-water pools. Our studies demonstrate dynamic growth, draining and recolonization over many decades, but no unidirectional trend. Complex ecological factors affect migration of marsh zones as well. Accretion of the high marsh surface has kept up with tide-gauge trends of 1-2 mm/yr through 17 years of brick-dust horizon monitoring, and longer ²¹⁰Pb and ¹³⁷Cs dating. New accommodation space created during an accelerated sea-level rise would likely provide extra sediment to the marsh, as is shown in pools today, but there is a limit. Salt marshes have accumulated in southern Maine marshes for 6000 years at long-term rates of sea-level rise up to 2 mm/yr (at 5 ka) to 0.5 mm/yr (at 2 ka). However, the oldest known fossil peats in Maine come from fringing marshes 7 ka formerly in a regime of 7.5 mm/yr rise that were ultimately drowned and transgressed. This may provide a cautionary indication of the limit to local salt-marsh stability.

9:56 a.m.

**POCKMARK FIELD NEAR SURFACE SEDIMENT STRENGTH,
A CASE STUDY: BELFAST BAY, ME**

Laura L. Brothers¹, Melissa M. Landon², Joseph T. Kelley¹, Daniel F. Belknap¹

1. Department of Earth Sciences, University of Maine.

2. Department of Civil & Environmental Engineering, University of Maine.

Pockmarks are seafloor craters that occur in a variety of continental shelf settings worldwide. Generally found in proximity to petroleum resources, gas hydrates, or shallow methane deposits, pockmarks are associated with fluid escape. In the Gulf of Maine, the fluid associated with pockmark fields is methane. The driving mechanisms responsible for pockmark formation and maintenance remain uncertain, particularly in previously glaciated estuarine environments such as Belfast Bay, ME. An initial investigation of pockmark maintenance was conducted by assessing the shear strength of the sediments existing in the upper 0.5 m of the seabed. These tests were performed on sub-samples of four box cores (0.25-0.5 m depth) collected in Belfast Bay in 2008. Preliminary analyses indicate that the pockmark field occurs in very soft sediment having an undrained shear strength of less than 20 kPa.

1.1.4 Physical properties of Ice Core Records 10:08 a.m.

10:08 a.m.

**DUST AND DISPLACEMENT: AUTOMATION OF WAIS CORE
DATA COLLECTION**

Breton, Daniel

University of Maine Department of Physics and Astronomy, Climate Change Institute

The development and testing of a microprocessor-based melt monitoring and control system was required to achieve the depth-correlated particle and chemistry analysis goals of the WAIS ice core project at the Climate Change Institute. This new system measures melt displacement with sub-millimeter accuracy and provides automated high-resolution collection of laser particle counter data. The system also allows the user to control sample pump speeds, melt head temperature and fraction collector movements from a single graphical user interface on a PC. Data demonstrating the performance and data collection abilities of the system will be presented.

10:20 a.m.

**CHARACTERIZATION OF SEVEN EAST ANTARCTIC ICE CORES
USING SCANNING ELECTRON MICROSCOPY**

N. Spaulding¹, D. Meese^{1,2}, I. BAKER², P. Mayewski¹, G. Hamilton¹

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A scanning electron microscope (*SEM*), equipped with a liquid nitrogen chilled cold stage, in combination with energy dispersive x-ray microanalysis (*EDS*), and electron back-scattered patterns (*EBSP*), was used to physically and chemically characterize the firn and ice cores collected during the 2006 and 2007 U.S. ITASE traverses. Details of grain size, porosity, crystallographic orientation, chemistry and stratigraphy have revealed new and interesting information about both the core sites examined and our methodology. Synthesis of the parameters listed above could provide a detailed understanding of the interplay between chemistry and physical structure in ice sheets, thereby enhancing our understanding of firn metamorphism and the interpretation of paleoclimate records.

1.1.5 Break 10:32-11:00 a.m.

1.2 Keynote Speech 11:00 a.m.

“What is Causing Temperature Trends Over the Americas?” by **Dr. Martin Hoerling**

Meteorologist, NOAA Earth System Research Laboratory, Boulder, Colorado;

Lead Scientist, NOAA Climate Change Attribution Team;

Chair, U.S. CLIVAR Program.

1.3 Lunch 12:00- 1:00 p.m.

1.4 Poster Session 1:00 p.m.

THE FOUR EPOCHS OF GLACIOLOGY

Hughes, T. J.^{1,2}

1. Department of Earth Sciences
2. Climate Change Institute

Glaciology over the past half century has encompassed four generations of glaciologists, each giving a unique contribution. I call these contributions glaciological epochs because the changes in each generation were epochal.

The first epoch was established by what I call the Founding Generation. It moved glaciology from being a descriptive branch of geology to being an analytical branch of physics. There was a “Big Four” in the Founding Generation, John Nye (UK), Hans Weertman (USA), Petr Shumsky (USSR), and Louis Liboutry (France). More than others, they “founded” glaciology in their countries, laying theoretical foundations during the Cold War years from 1950 to 1970. A burst of field activity during and after the International Geophysical Year in 1957-1958 included tractor-train traverses over the Antarctic Ice Sheet that collected meteorological and seismic data, mechanical drilling through the Greenland and Antarctic Ice Sheets, and analyses of climate records in ice cores.

A Transitional Generation defined the second epoch. Members of this generation were mostly trained by the Founding Generation. In glaciological theory, they moved from analytical solutions for idealized glaciological conditions to numerical solutions for actual glaciological conditions. In field research, they replaced using poles and pits to measure the mass balance, theodolites and tapes to measure ice motion, and seismic sounding to get ice thickness with satellite imagery, aerial photogrammetry, and radar sounding to get these data. Climate records advanced from stable isotopes to a variety of ions, dust, diatoms, and gasses, all in ice cores and all with a unique climate signature. This change was inaugurated for the most part from 1970 to 1990.

The third epoch was dominated by a High Tech Generation of glaciologists, mostly trained by the Transitional Generation. High speed computers produced three-dimensional time-dependent solutions to glaciological processes, notably the Quaternary cycles of glaciation. Field research focused increasingly on satellite imagery in all wavelength bands, each band sensitive to critical data, deep drilling with hot-water replacing mechanical drilling and using instruments developed to sample bed materials, research pioneered by Barclay Kamb and Hermann Engelhardt, and an increasing focus on ice streams as the most dynamic components of ice sheets. These developments mainly took place from 1990 to the present. High technology made possible increasingly accurate records of climate change in ice cores for many more trace chemicals linked to high-resolution radar horizons in ice.

The fourth epoch, just beginning, will be a Holistic Generation that places glaciology in the context of global climate change but with the new perspective that ice sheets, unlike other components of Earth’s climate system, can rapidly self-destruct and thereby remove themselves wholly or in part from the system.

This triggers rapid climate change. Holistic modeling will need to include interactions of all components of the climate system: ice sheets with subglacial hydrology, the atmosphere, the oceans, crustal and mantle dynamics, and ecological changes, including changes linked to human activities. Unmanned surface and airborne vehicles are being developed for collecting field data as part of CReSIS research in hazardous regions of ice sheets undergoing rapid changes. Calving dynamics will be a major part of glaciology because calving causes massive outbursts of ice into the rest of Earth's climate system.

My own glaciological career spans all four epochs. Not many of us remain who have this personal perspective.

1.4.1 Paleoclimate

CLIMATE VARIABILITY IN SOUTH WESTLAND, NEW ZEALAND FROM 30,000-15,000 CAL YR BP

Dieffenbacher-Krall¹ A.C., Vandergoes^{1,2} M.V., Denton¹ G.H., and Newnham³, R.

1. Climate Change Institute, University of Maine.
2. GNS Science, Lower Hutt, New Zealand.
3. School of Geography, University of Plymouth, UK.

Determining the precise structure of climate change in the Southern Hemisphere mid-latitudes is key to understanding the role of the Southern Hemisphere in driving global glacial cycles and identifying interhemispheric leads and lags. Here we use pollen and chironomid analysis from Galway Tarn, south Westland, to outline the complex structure and timing of climate fluctuations between 30 and 15 cal ka. The sequence shows a mostly cold interval interrupted by two milder interstadials. Chironomid-based temperature reconstruction indicates a 3.5-5.5 °C cooling at the site during the LGM and provides preliminary evidence of a minor shift toward less severe temperatures during the pollen-identified interstadials. The same structure of two interstadials within the LGCP (last glacial cold period) is observed in several other proxy records from southern New Zealand.

RECENT CHANGES IN THE STREAM FLOW CALENDAR OF WESTERN UNITED STATES

Jong-Suk Kim¹ and Shaleen Jain^{1,2}

1. Department of Civil and Environmental Engineering, University of Maine, Orono, Maine 04469, USA.
2. Climate Change Institute, University of Maine, Orono, Maine 04469, USA.

Recent evidence of shifts in the timing of stream flow in the western United

States signals a need for mitigation and adaptation measures in the face of hydroclimatic change. The seasonal calendar of stream flow is a strong determinant of the ecological integrity of river and riparian ecosystems. We present a regional assessment of the changes in stream flow seasonality through a broad classification of streams and computation of trends resolved to finer times of days, to weeks and the water year. This analysis affords an efficient research product to examine the diversity of trends across seasons for individual streams. At the same time, the windows of change that can potentially be mapped to decision calendars, thus permitting rapid assessments of the near-term implications of the observed trends to provide usable knowledge for decision-making and policy reassessment efforts.

1.4.2 Climate Change and Policy

INVESTIGATING CLIMATE USING TECHNOLOGY, INQUIRY, AND DATA IN GRADES 6-12

Schauffler, Molly¹, Brickley, Annette², and Mary Jean Jones³

1. University of Maine Climate Change Institute, the Center for Science Mathematics Education Research and Department of Earth Sciences.
2. The Challenger Learning Center of Maine (Brickley).
3. Center for Science and Mathematics Education Research

A perfect storm of need inspires several education projects to help teachers gain technology skills, scientific knowledge, and experience analyzing data to deepen their understanding of local, regional, and global change. This poster will highlight the Climate to Curriculum Math/Science Partnership, the Camden to Katahdin Temperature Study, and a graduate course for teachers (SMT 504, "Understanding climate change through data") in terms of how these efforts address driving needs to increase use of inquiry and science skills in middle and high school science classrooms, as well as deepen public understanding about climate and change

1.5 Afternoon Session 1:30 p.m.

1.5.1 Climate Prediction and Modeling 1:30 p.m.

1:30 p.m.

EVALUATION OF HIGH-RESOLUTION REGIONAL CLIMATE MODEL (WRF) IN ASIA

Grigholm, B; Mayewski, P.A.; Maasch, K.A.; Oglesby, R.J.; Hays, C.J.

The Weather Research and Forecasting (WRF) model was used to reproduce daily weather and monthly climate of Asia for two separate years (1970 and 1986). WRF was designed for high-resolution applications, and is an ideal tool for assessing the value of high-resolution regional climate modeling. High resolution allows for a more precise description of regional topographic forcings due to orography, land-sea contrasts and vegetation characteristics. WRF simulations may be particularly beneficial to the alpine regions of Asia (e.g. Himalayas and the Tibetan Plateau), where topography is very complex and has impacts on monsoonal circulation. Two nested domains were used in the simulations. An outer domain (48 km grid-spacing) covering roughly the Asian continent and an inner domain (12 km grid-spacing) centered on the Tibetan Plateau. WRF is forced by initial boundary conditions from the NCEP-DOE Reanalysis II. It is important to note that higher resolution does not necessarily imply more accurate climate simulation as smaller grid-spacing may overwhelm the sensitivity of physics parameterization distorting any benefits of higher resolution simulation. Preliminary evaluation of the WRF is accomplished by comparison to synoptic weather maps and comparisons between time series of meteorological variables from the higher resolution inner domains with observed station data. This study represents a first step in assessing the quality of a high-resolution regional climate model in Asia.

1:42 p.m.

ASSESSING THE FIDELITY OF CLIMATE DOWNSCALING FOR NORTH AMERICA USING THE WRF MODEL

Kirk Allen Maasch¹ and Robert J. Oglesby²

1. Climate Change Institute and Department of Earth Sciences, University of Maine
2. Department of Geosciences, University of Nebraska Lincoln

The ability of the Weather Research and Forecasting (WRF) model to reproduce daily weather and monthly climate of North America is assessed with a three year simulation (1991-1993) forced by initial and boundary conditions from the NCEP-DOE reanalysis. We used four nested domains for the simulation. An outer domain covers the North American continent and has horizontal resolution of 48 km. In addition there are three inner domains, one centered on the Great Plains, one covering northeastern North America and the other the south-

eastern United States. Horizontal grid spacing of the inner domains is 12 km. The basis for evaluation of WRF is accomplished in two different ways. One is by comparison of our North America domain the North America Regional Reanalysis (NARR). We also evaluate simulated time series of meteorological variables from the higher resolution inner domains by comparing with observed station data from within those domains.

1:54 p.m.

WATERSHEDS IN TRANSITION: HYDROCLIMATIC CHANGE AND THE EMERGENT FLOOD REGIME IN NORTHERN MAINE, USA

Jong-Suk Kim¹ and Shaleen Jain^{1,2}

1. Department of Civil and Environmental Engineering, University of Maine, Orono, Maine 04469, USA.

2. Climate Change Institute, University of Maine, Orono, Maine 04469, USA.

In snowmelt-dominated watersheds are especially vulnerable to hydroclimatic change. Changes, individually or jointly, in temperature and precipitation statistics have the potential to engender dramatic shifts in the magnitude and timing of stream flow. Sensitive linkages between the hydrologic regime, ecosystem function, and societal vulnerability provide another motivation for a careful characterization of changes in flow statistics. We investigate the recent changes in the flood regime for the Saint John River Basin, Maine with a view to understand the large-scale climate precursors and basin-scale hydrologic variables that control the sensitivity of the flood regime. Key wintertime teleconnection patterns in the Pacific North American region that modulate precipitation and temperature variability during the winter and spring season impart structure to the flood statistics. Mechanistic understanding of the role and impact of identified atmospheric circulation and sea surface temperature patterns is a critical step in developing nonstationary flood frequency methodologies.

2:06 p.m.

MODIFIED Morland-MacAyeal MODEL FOR ICE-STREAM FLOW (The work is supported by CReSIS)

Sargent, Aitbala and Fastook, James

Computer Science & Climate Change Institute, University of Maine

Modeling glacier and ice sheet flow is a computationally challenging problem. To solve this problem, modelers use a number of simplifications with respect to the physics of the ice mass. The most popular approaches are reduced shallow-ice approximation (SIA) for interior ice and the Morland Equations[1] for the ice shelf flow. These models reduce the scale of the problem by integrating out the vertical dimension, taking advantage of the fact that the vertical dimension is very different from the two horizontal dimensions.

The Morland Equations apply specifically to ice shelf physics, but they have been successfully applied to the transition zone in ice streams with a modification source term in the Morland formulation [2]. While this approach does yield reasonable results, the fact that the basal drag correction term is not included in the derivation of the equations but added after the fact, violates the assumptions that go into the original integration of the vertical dimension, and hence is not self-consistent.

We present a formulation for the diagnostic equation for conservation of momentum that follows the original Morland derivation closely, but include at the outset an explicit term for the basal drag. Our approach does two things. First, by including the basal drag in the derivation of the equations, it makes the equations self-consistent. Second, since derived equations contain a term that depend on the bed gradient, it gives a formula of dependency of ice stream flow on the bed topography. This self-consistent formulation for the diagnostic equation coupled with a prognostic equation for mass conservation and solved using the Finite Element Method, is tested for a number of simplified geometries where longitudinal stresses are comparable to the basal drag.

References

- [1] L.W. Morland. Unconfined ice-shelf flow. In C.J. van der Veen and J. Oerlemans, editors, Dynamics of the West Antarctic Ice Sheet. D. Reidel, Boston, 1987. [2] D. R. MacAyeal. Large-scale ice flow over a viscous basal sediment: Theory and application to Ice Stream B, Antarctica. Journal of Geophysical Research, 94(B4):4071-4087, 1989.

2:18 p.m.

MODELING NORTHERN MID-LATITUDE GLACIATION WITH GCM-DRIVEN CLIMATE: FOCUS ON DEUTERONILUS-PROTONILUS MENSÆ VALLEY

J L Fastook¹, J W Head², J-B Madeleine³, F Forget³, and D Marchant⁴

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4-Boston University.

Investigations with models of paleo-ice sheets on Mars help identify and interpret glacial deposits observed from orbit [1, 2, 3] as well as aid in explaining the mechanisms that may have been responsible for the formation of the ice-rich mantling seen north of $\sim 50^\circ\text{N}$ latitude by GRS on Mars Odyssey [4] The interesting story of how Mars at high obliquity ($\sim 45^\circ$) transfers water from current polar ice caps to the flanks of the large tropical volcanos [2] continues, except now at lower obliquity ($\sim 35^\circ$) with water sources not at the poles, but instead on the tropical volcanos.

A GCM [5] has produced a map of potential accumulation rates for the Dichotomy Boundary region, which can be used in an ice sheet model to describe a possible ice sheet with associated valley glaciation observed in the glacial geol-

ogy [6, 7]. With peak values of ice accumulation reaching 16 mm/a this pattern of mass balance is clearly capable of producing an icesheet along the Dichotomy Boundary commensurate with the geological observations. As pointed out in [5], the broad region of positive mass balance north of 50° could explain the observed ice mantling [4].

UMISM, as used here, is an adaptation for the Martian environment [8,9,10] of a thermo-mechanically coupled shallow-ice approximation terrestrial ice sheet model used for time-dependent reconstructions of Antarctic, Greenland, and paleo-icesheet evolution in response to changing climate on Earth [11]. We chose to focus attention on the Deuteronilus-Protonilus Mensae valley (DPM) described in [6]. Running the ice sheet model at a resolution sufficient to resolve the valley is prohibitive for such a broad area. We instead utilize the embedded-grid feature of *UMISM*. This feature allows us to run a broad-domain, low-resolution grid with a more limited-domain, higher-resolution grid embedded within it. This embedded grid obtains boundary condition information from a spatial and temporal interpolation of the low-resolution grid.

A scenario is of ice sheet growth and decay that leads to a configuration where only limited patches remain surrounding one of the aretes on the plain outside the mouth of the valley, a configuration similar to the patterns reported by [12].

References: [1] Head and Marchant (2003) *Geology* 31(7), 641- 644. [2] Forget et al. (2006) *Science*, 311, 368-371. [3] Fastook et al. (2008) *Icarus* 198, 305-317. [4] Levard et al. (2004) *Nature* 431, 1072. [5] Madeleine et al. (2008) *Icarus* submitted. [6] Head et al. (2006) *Geophys. Res. Lett.* 33, L08S03. [7] Fastook et al. (2008) LPS XXXIX #1109. [8] Fastook et al. (2004) LPS XXXV #1352. [9] Fastook et al. (2005) LPS XXXVI #1212. [10] Fastook et al. (2006) LPS XXXVII, #1794. [11] Fastook (1993) *Computational Science and Engineering*, 1(1):55-67. [12] Holt et al. (2008) Fall AGU.

2:30 p.m.

IMPLICATIONS OF A NON-NEWTONIAN UPPER MANTLE

Peter O. Koons¹

1. ERS/CCI, University of Maine

There is increasing recognition that the rheological structure of the upper mantle varies spatially and temporally as a non-linear function of temperature, water fugacity, composition and strain rate. One important implication of this non-linear behavior is that the rate of un-loading strongly influences the apparent viscosity of both lower crust and upper mantle. High strain rate regimes associated with rapid unloading due to ice sheet collapse as in the Hudson Dome collapse 9kyr or in the rapid LIA deglaciation of Glacier Bay, southeast Alaska can lower the effective viscosity by several orders of magnitude. One consequence of this behavior is that the very different effective viscosity during the rapid unloading of marine-based instabilities yields quantitatively distinct ver-

tical uplift fields. A further corollary is that a single temporally and radially stationary viscosity structure, will significantly mismatch the dynamic rheology of the upper mantle during rapid strain events.

2:42 p.m.

EARTH'S "HYDROGEN" DEGASSING, OZONOSPHERE, GLOBAL WARMING AND NATURAL HAZARDS

Syvorotkin¹, Vladimir L. and Smorodin², Vladimir Y.

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Man's living space, the biosphere, is placed at the bottom of the air ocean - the atmosphere. The atmosphere, mainly, is the result of Earth's grandiose global degassing process- releasing restored gases from the Earth's interior. Slow accumulation of molecular oxygen, as a result of biotic activity, has led to occurrence of aerobic forms of a life, first in the ocean, and, in the Silurian epoch after the ozone layer formation, on the Earth's surface. Actually, the interaction of the restored deep gases and oxygen of the Earth's upper mantle, hydro- and atmosphere defines all variety of the processes. This set is called the biosphere. Earth's degassing is the leading geo-planetary process penetrating all its spheres, from the core to the surrounding space. The basic planetary stocks of gases (mainly hydrogen) are concentrated in the liquid core of the Earth. The crystallization of the internal firm core proceeds with the liberation of gas and its accumulation in the upper part of the core at the border with the mantle. Overflow of the liquid core by gases leads their excess in the mantle, thereby strengthening Earth's degassing. The major characteristic of the modern process of Earth's degassing is its non-uniformity in time and space. Time variations are defined, first of all, by gravitational interaction in the system Earth - Moon - Sun (Moon phases, the position of the Earth in a circumsolar orbit), and also cumulative interaction of all planets and the Sun. The main spatial law is releasing basic volumes of the restored gases through median-ocean rifts. The "hydrogen" hypothesis of the Earth ozonosphere depletion was proposed earlier (Syvorotkin, 1990). Its essence is the ability of the hydrogen containing gases to produce hydroxyl radicals during photolysis in the stratosphere, which then serve as a catalyst of the hydrogen cycle of ozone depletion. Reactions of this cycle proceed through homogeneous channels (in the air) and through heterogeneous ones (on stratospheric aerosols). The ozone layer in the stratosphere is capable of absorbing solar ultraviolet, and re-emitting this energy as thermal (infra-red) radiation. Due to light absorption, the stratosphere warms by a few tens degrees up to a height of 50 km. During ozone layer depletion, excess sunlight penetrates to the terrestrial surface and heats the lower atmosphere layers and the ocean surface, while the stratosphere cools. The analysis of geographical distribution of planetary regions where *global warming* is most prominent

shows a significant correlation; all such regions are the active centers of Earth's deep degassing over which the ozone layer is strongly depleted. The additional heat coming through ozone anomalies leads to thawing of glaciers of Antarctica and mountain tops of Africa (Kilimanjaro). Ocean waters are heated over the East Pacific rift (a phenomenon of El Niño-Southern Oscillation). Decreasing pressure during heating of the lower troposphere leads to changes of standard air currents and the origin of cyclones and hurricanes. Thus, in the Atlantic area of lowered atmospheric pressure under ozone anomalies, the Azores anticyclone with heated air is "tightened". In summertime it leads to abnormal heat and in winter to sudden thawing of snow in mountains and to flooding. The analysis of the numerous statistical data shows that the majority of regional weather anomalies and natural accidents are correlated with the ozone layer depletion over such given regions. Thus, the perturbation of the ozonosphere caused by the deep "hydrogen" degassing of the Earth essentially defines weather, climate, natural catastrophes and life on our planet. As a matter of fact, this mechanism is the major geo-climatic sub-system, which, up to now, has not been considered. Accounting for it and the subsequent adequate formalization of this geo-climatic concept, should promote improved system analysis and forecasting of weather, climatic and ecological phenomena, and could lead to improved prevention or mitigation of undesirable hazards and crises.

1.5.2 Break 2:54-3:20 p.m.

1.5.3 Paleoecology 3:20 p.m.

3:20 p.m.

EVOLUTION OF CONTROLS ON PHOSPHORUS AVAILABILITY IN AQUATIC ECOSYSTEMS: PERI-GLACIAL TO RECENT TIMES

Stephen A. Norton¹, Jiří Kopáček², Tomáš Navrátil³, Ivan J. Fernandez¹, Aria Amirbahman¹

1) University of Maine

2) Biology Centre ASCR, Institute of Hydrobiology, Ceske Budejovice, Czech Republic

3) Academy of Sciences, Rozvojova, Prague, Czech Republic

We assessed the long-term mobility of P in forest soils and soil solutions, streams, lakes, and stream and lake sediment. (I) After deglaciation, the landscape was rapidly leached of labile minerals, including apatite ($\text{Ca}_5(\text{PO}_4)_3(\text{OH},\text{F},\text{Cl})$). Dissolved P decreased.

(II) Afforestation increased weathering because of elevated soil CO_2 and dissolved organic carbon (DOC), promoting illuviation of $\text{Al}(\text{OH})_3$ and $\text{Fe}(\text{OH})_3$ in soils, and increased P adsorption. Al-DOC and Fe-DOC complexes were ex-

ported to surface waters. Photo-oxidation of the complexes precipitates $\text{Al}(\text{OH})_3$ and $\text{Fe}(\text{OH})_3$. The $\text{Al}(\text{OH})_3$ irreversibly sorbs P from the water. Soil acidification increases the P adsorption capacity of Al and Fe hydroxides, reducing P in runoff.

(III) Anthropogenic acidification reduces lake sediment P concentrations because of increased retention of P by acidifying soils, and reduced internal loading from sediments enriched with $\text{Al}(\text{OH})_3$. Processes I and II caused a transition from eutrophy toward oligotrophy. Process III likely causes lake oligotrophication.

3:32 p.m.

METAL CONTROLS AND ACIDITY CONTROLS ON FOREST FLOOR AND B-HORIZON EXTRACTABLE PHOSPHORUS IN FORESTED WATERSHEDS

SanClements, M.D.¹, Fernandez, I.J.¹, Norton, S.A.¹

1. The University of Maine

We used phosphorus (P) fractionation to study the accumulation, mobilization, and availability of soil P in six watersheds of the eastern United States and Europe, two of which included paired long-term acidification experiments. The P fraction associated with aluminum (Al) in the reference watersheds accounted for 71% of P on a mean basis and consistently dominated P retention. Experimental whole-watershed acidification resulted in significant depletions of Al-P from the upper mineral soil in treated watersheds. Because pH controls Al solubility, it appears to also influence Al:P ratios in the predominant Al-P fraction of these mineral soils. Sites with the lowest mineral subsoil Al:P ratios generally had the lowest pH's and the highest O-horizon available P concentrations. Changes in soil acidity due to management, pollutants, or pedogenesis could shift P availability by altering acidity and the Al:P balance. Here we show evidence that processes affecting soil Al may alter P dynamics.

3:44 p.m.

FOREST ECOSYSTEM RESPONSE TO A CHANGING CLIMATE - WHY NITROGEN MATTERS

Fernandez, I.J.¹

1. The University of Maine

Forest ecosystems respond to the simultaneous and interactive stressors of our changing chemical and physical climate. Nitrogen (N) dynamics in forests represent critical ecosystem processes linking both concerns for "acid rain" and the reality of climate change we face today. Since the Clean Air Act Amendments of 1990, Maine has seen a ~50% decline in sulfur (S) deposition, with little evidence for marked declines in N deposition. Yet, research shows that N remains the most commonly limiting nutrient in Maine forests, with well over 90% of

atmospheric N sequestered. Small changes in ecosystem condition (e.g., temperature, moisture, C/N) can have large effects on N dynamics that influence forest function and N export to surface waters. Models of forest response to climate change are often driven by temperature effects on forest N dynamics. For these reasons we need improved metrics of N dynamics built on an understanding of ecosystem processes

3:56 p.m.

QUANTIFYING THE IMPACT OF INDUSTRIAL COPPER SMELTING ON REGIONAL SOIL CHEMICAL VARIABILITY, SOUTH COASTAL PERU

Laura Labbe¹, Gregory Zaro², Steve Norton³, Bekka Brodie⁴ and Clive Devoy⁴

1. Department of Biological Sciences and Department of Anthropology, UMaine
2. Department of Anthropology and Climate Change Institute, UMaine
3. Department of Earth Sciences and Climate Change Institute, UMaine
4. Sawyer Environmental Chemistry Research Laboratory, UMaine

Agriculture, deforestation, overgrazing, and industry are argued to be the primary human factors involved in desertification. In south coastal Peru, each of these has been present at some point over the past 1000 years and may have played a role in regional scale desertification. While archaeologists are currently examining changes in agriculture and deforestation over the past millennium, the impact of smelting remains uninvestigated. In the 1960s, Southern Peru Copper Corporation established its smelter along the Tambo-Ilo coast of southern Peru. Here, we discuss our method for quantifying the impact of industrial smelting on regional soil chemical variability, specifically the spatial variation of metals post-1960s. This will complement the archaeological data sets in the broader context of understanding human-induced ecological change in this arid region of southern Peru.

4:08 p.m.

ALLOCATING WATER FOR HUMAN AND ECOLOGICAL USE IN THE FACE OF CHANGING NEW ENGLAND STREAMFLOWS
Ricupero, Krista; Jain, Shaleen

University of Maine

Department of Civil and Environmental Engineering

Sustainable Hydrosystems Laboratory

This research identifies and discusses changing streamflow patterns throughout New England, with a focus on Maine. Changes in important hydrologic events, such as the maximum annual flood and summer minimum flows, present challenges for both human water users and ecosystems. Streamflow changes can be quantified in a number of ways and at different scales, some of which

better address the human and ecological dimensions of the issue. This research shows that computing trends in summary statistics such as monthly or seasonal median flows provide one way of cataloguing change in streamflow, but methods like the Indicators of Hydrologic Alteration, which capture changes in ecologically important flow events, may offer more pertinent insight into how alterations in seasonal streamflow patterns effect both human and non-human water users.

4:20 p.m.

A 16.5 ka LEAD ISOTOPE-INFERRED LAKE SEDIMENT RECORD OF POST-GLACIAL CATCHMENT EVOLUTION AT SARGENT MOUNTAIN POND, MAINE

Randall H. Perry¹, Stephen A. Norton^{1,2}, Peter O. Koons^{1,2}, Michael Handley²

1. Department of Earth Sciences, University of Maine, Orono, ME 04469-5790, USA 2. Climate Change Institute, University of Maine, Orono, ME

A 16.5 ka lake sediment record of stable lead (Pb) isotopic ratios and phosphorus (P) flux indicates an approximately 4,000-year period of apatite-dominated chemical weathering in the Sargent Mountain Pond (SMP) catchment in Maine (USA). During depletion of apatite, the Pb isotopic signal shifted to one dominated by slower primary silicate mineral weathering. Early, low $^{207}\text{Pb}/^{206}\text{Pb}$ values ($^{207}\text{Pb}/^{206}\text{Pb}=0.799$) suggest a sedimentation and weathering regime influenced by strongly urogenic accessory minerals (e.g., apatite). Following this period, non-urogenic primary minerals dominate ($^{207}\text{Pb}/^{206}\text{Pb}=0.814$). Core data indicate a shift from high apatite-derived P flux from the catchment to lower values, suggesting a reduction in lake productivity from its early eutrophic status to meso-oligotrophic conditions in the lake's first 4,000 years after deglaciation. Laboratory experiments involving similar parent material to the SMP catchment till seek to verify at the mineral scale the weathering trajectories inferred at the catchment scale from the core.

4:32 p.m.

ARSENIC IN THE WATER: HOW MICROBES AND MINERALS INTERACT TO POLLUTE OUR GROUNDWATER

Jean D. MacRae¹ and Jennifer Weldon²

1. Associate Professor, Civil and Environmental Engineering 2. PhD Candidate, Civil and Environmental Engineering

High arsenic in drinking water causes cancer and other maladies. It affects the health of millions of people worldwide from Bangladesh to Taiwan to Chile and Maine. How does it get into our groundwater? Primarily through the geologic materials that make up our aquifers and the activity of microorganisms that live in the subsurface. Each affected aquifer is unique, but the mobility

of arsenic seems to be closely linked to the fate of iron. In Northport, ME, arsenic concentrations more than 100 times the drinking water limit have been observed in some groundwater samples, while others were much lower. Groundwater arsenic correlated strongly with the population of delta proteobacteria, a group of microorganisms that includes many iron-reducing bacteria. The microbial populations in water and on surfaces deployed in wells with varying arsenic concentrations are different. A conceptual model of the linked arsenic and iron cycles will be presented.

2 Friday, May 8, 2009

Coffee and Pastries 7:30 am

2.1 Morning Session

2.1.1 Day 2 Overview 8:00 a.m.

2.1.2 Day 2 Poster introduction 8:10 a.m.

- Debra Kenneway
- Vladimir Smorodin
- Karl Kreutz
- Andrei Kurbatov

2.1.3 Paleoecology 8:20 a.m.

8:20 a.m.

LATE HOLOCENE PALEOCLIMATE RECORDS FROM LAKE TANGANYIKA, EAST AFRICA

Stager J. Curt

Climate Change Institute, and Natural Sciences, Paul Smith's College, Paul Smiths, NY 12970

New diatom records from Lake Tanganyika, Tanzania, allow the reconstruction of rainfall-driven variations in lake conductivity during the last 3800 years at 15-36 year resolution. Pollen of aquatic plants increased during periods of inferred lake dilution as a result of increased river discharge during rainy episodes, particularly ca. 1700-1400 B.P. Ancient carbon effects on AMS dates were measured by comparing 21 ages of terrestrial and aquatic materials, providing tighter chronological control than that available for most previous studies here. The Tanganyika watershed was drier than usual during much of the Little Ice Age, in opposition to wetter conditions at Victoria and Naivasha and therefore undermining the hypothesis of latitudinal ITCZ displacement 550-350 years ago. A long-term wetting trend at Tanganyika is mirrored by ^{13}C isotope fluctuations in South African stalagmites, but uncertainty about the climatic significance of the ^{13}C signals make it unclear whether this represents regional synchrony or antiphasing.

8:32 a.m.

IMPACTS OF WHITE PERCH INTRODUCTIONS ON FOOD WEB DYNAMICS: PALEOLIMNOLOGICAL RECORD OF ZOOPLANKTON GRAZING AND NUTRIENT CYCLING

Ditzler Kristin, Saros Jasmine, and Simon Kevin

School of Biology & Ecology

Climate Change Institute

Fish introduction to lake ecosystems may result in changes in zooplankton and algal communities via cascading interactions in food webs. Current knowledge of the large-scale and long-term impacts of planktivorous fish introduction, through both size-selective predation and altered nutrient cycling, is limited in Maine lakes and is a necessary requirement for effective management of water quality. We will use paleolimnological analyses to study changes in lake ecosystems before and after known dates of a common food web manipulation, the introduction of white perch. In order to explore the mechanistic links between fish introduction and lake ecosystem response, these paleolimnological analyses will be paired with experimental studies to isolate the impacts to plankton communities through both predation and changes to nutrient cycling. This analysis will provide insight into the long-term development, past conditions, and mechanisms of biological response to fish introduction at the whole lake scale.

8:44 a.m.

USING GLACIALLY-DERIVED NITROGEN PULSES INTO ALPINE LAKE ECOSYSTEMS AS INDICATORS OF CLIMATE CHANGE

Nurse, Andrea¹, Saros, Jasmine^{1,2}, Fulford, Gilbert³

1. Climate Change Institute

2. School of Biology and Ecology, University of Maine

3. Forest Ecosystems and Science, University of Maine

Because nitrogen content of high alpine lakes is at least partially driven by fluctuations in glacial meltwater, lacustrine indicators of nitrogen inputs may provide climate inferences from glacially-fed alpine lakes. Most of the 600 lakes in the Beartooth Mountains of the central Rockies are sustained by snowmelt, but some receive glacial meltwater as well. Rainbow Lake receives inputs from two glaciers, making it ideal for examination of the effects of glacial meltwater on nitrogen loading. A 57 cm surface core from Rainbow Lake allows us to examine whether nitrogen loading to the lake varied during the shift from cooler Little Ice Age temperatures to present-day warming. Core analyses include ²¹⁰Pb dating, loss-on-ignition, charcoal, and diatom and pollen assemblages. Diatom assemblages typically show strong, rapid responses to nitrogen enrichment in alpine lakes. Pollen analyses determine whether changes in lake chemistries relate to changes in catchment vegetation or to changes within the lake basin.

8:56 a.m.

**EFFECTS OF GLACIAL MELT WATER ON THE ECOSYSTEM
STRUCTURE OF ALPINE LAKES**

Saros, Jasmine^{1,2}, Nurse, Andrea¹, Fulford, Gilbert³

1. Climate Change Institute
2. School of Biology and Ecology
3. Forest Ecosystems and Science

Runoff from mountain glaciers can affect several properties of alpine lake ecosystems. In many alpine regions, one of the key effects of increased glacial runoff into lakes is the resulting high minerogenic turbidity. Glaciers can also release large quantities of accumulated organic pollutants into lake ecosystems. We investigated two additional features of alpine lake ecosystems that are potentially associated with runoff from mountain glaciers: water column stability and nitrate concentrations. Two lakes receiving glacial melt water, Rainbow and Crow, were compared to a suite of lakes without glacial inputs. Inlet nitrate concentrations to Rainbow and Crow were $250 \mu\text{g L}^{-1}$, with lake water nitrate concentrations of $150 \mu\text{g L}^{-1}$ in both lakes. In contrast, nitrate concentrations in the suite of lakes without glacial inputs were below detection ($<1 \mu\text{g L}^{-1}$). A water column stability assessment for Rainbow Lake revealed an unusually deep mixing layer in this system compared to the larger suite of lakes. The implications of these physical and chemical features for plankton communities will be discussed.

9:08 a.m.

**QUANTIFYING SURFACE WATER NITRATE CONCENTRATIONS
THAT ELICIT DIATOM COMMUNITY CHANGES IN LAKES
ACROSS THE ROCKY MOUNTAINS**

Arnett, Heather^{1,2} and Saros, Jasmine^{1,2}

1. School of Biology and Ecology
2. Climate Change Institute

In the western United States, rates of atmospheric nitrogen deposition have increased over the past century. This increase is of particular concern for alpine lakes in this area, as nitrogen deposition can cause nutrient enrichment in these systems. Changes in sedimentary diatom profiles from alpine lakes across the Rocky Mountains suggest that nutrient enrichment via nitrogen deposition has occurred during the last 20-50 years across these regions. Our goal in this project is to develop a diatom calibration set across high-elevation lakes of the Rocky Mountains to quantify the surface water nitrate concentrations at which diatom changes occur. Diatom communities in surface sediments from 41 high-elevation lakes in the Rocky Mountains are being examined and will be related to surface water chemistry using multivariate statistical techniques. Preliminary data from the counts for the calibration set will be discussed. Quantifying these

changes will allow the data to be used to set thresholds for future emissions policies.

9:20 a.m.

ECOLOGICAL INTERACTIONS AFFECTING DIATOM CLIMATE RECONSTRUCTIONS IN PRAIRIE SALINE LAKES OF THE NORTHERN GREAT PLAINS (USA)

Salm, Courtney R. and Jasmine E. Saros

Climate Change Institute, University of Maine

Sedimentary diatom assemblages from closed-basin lakes in arid and semi-arid regions are used to reconstruct salinity and infer past moisture balance. However, the response of lake ecosystems to climate change is complex, and the extent to which intrinsic factors complicate these signals is generally unclear. We hypothesize that inconsistencies in existing drought reconstructions are due to differences in ecological interactions across lakes, including zooplankton grazing and macrophyte habitat characteristics. The objective of this project is to improve drought reconstructions in prairie saline lakes of the northern Great Plains by understanding how these ecological interactions may affect diatom sediment records and potentially alter interpretations of paleoclimate records. A combination of laboratory feeding experiments, mesocosm experiments, and multi-proxy analysis of sediment cores will be used to quantify effects of zooplankton grazing and macrophyte habitats on diatom assemblages, and ultimately improve our understanding of patterns of drought frequency in prairie saline lakes.

2.1.4 Break 9:32-10:00 a.m.

2.1.5 Climate Change and Policy 10:00 a.m.

10:00 a.m.

PAST CLIMATE, FUTURE PERSPECTIVE: EXPLORATORY ANALYSIS USING CLIMATE PROXIES TO INFORM WATER ALLOCATION POLICY IN MAINE**Sen Gupta Avirup¹, Jain Shaleen², and Kim Jong-Suk³**

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3. Postdoctoral Research Associate, Department of Civil and Environmental Engineering, University of Maine, Orono, ME 04469 USA

Our work focuses on utilizing the reconstructed record of Palmer Drought Severity Index (PDSI) based on tree ring data, dating back to 1138 A.D. to understand the nature of drought occurrence (severity and duration) for the state of Maine. This work is motivated by the need to provide a strong scientific basis to the recently promulgated water allocation framework in Maine (Department of Environmental Protection, Chapter 587). Through a joint analysis of PDSI reconstruction and streamflow data for twelve streams in the state, we find that the current definition of natural drought in the Chapter 587 may not be representative of the nature and severity of past droughts in this region. Furthermore, new metrics that may be better suited for hydrologic risk assessment, especially in the context of multiyear droughts, are provided. Finally, a statistical framework that allows localized drought-related risk assessment for streams across the state is developed.

10:12 a.m.

HUMAN HEALTH CONCERNS IN MAINE – AN OVERVIEW OF CLIMATIC INFLUENCES ON DISEASE, ALLERGENS, & TOXINS**Guillemette, Ryan**

Bingham Undergraduate Fellow - Climate Change Institute, University of Maine

With the growing global interest on climate change, it is important to recognize potential climatic impacts on local communities, and begin identifying appropriate ways to mitigate these concerns. This presentation attempts to identify potential health concerns in Maine in relation to climate, while offering recommendations on how to address the issues. The state of Maine has shown a warming trend over the past 30 years and temperatures are expected to continue rising over the next century. As a result of temperature increase, Maine should expect to see changes in many ecological cycles, including those involving

insect vectors that harbor disease, increases in allergic pollen production, and air and oceanic current cycles. Scientist and policy makers should be aware of these potential problems and act accordingly through the promotion of scientific research and policy development

10:24 a.m.

DEVELOPING A REGIONAL FORENSIC TAPHONOMY: CLIMATOLOGICAL AND OTHER ENVIRONMENTAL INPUTS

Sorg Marcella H.^{1,2,3}, **Borns Harold W.**¹, **Dieffenbacher-Krall Ann**¹, **Burger John**⁶, **Solouki Touradj**⁵, **Dearborn John**⁵, **Haglung William D.**⁷, **David Edward**⁸, **Palman Deborah**⁹, **Parker William**¹

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7. Physicians for Human Rights,
8. Office of Chief Medical Examiner, State of Maine,
9. Maine Criminal Justice Academy.

Regionally specific taphonomic models are necessary in forensic death investigation to correctly interpret the condition of the body, estimate time since death, and interpret cadaver dog searches. This is particularly true in outdoor settings where weather, climate, and topography affect temperature, moisture, and scavenging, and hence decomposition patterns. In order to refine the forensic taphonomy model for northern New England, this research is using an interdisciplinary approach (anthropology, geology, botany, entomology, chemistry, cadaver K-9 training, wildlife management) with a combined methodology of forensic case series analysis, GIS mapping of environmental variables, and actualistic experimentation using pig cadavers. The new model incorporates a measure of 'accumulated degree days' to characterize cases in the reference series that have a known time since death, and to act as a quantifiable independent variable. Additional refinements include consideration of the impacts of recent climate change on necrophagous insect metamorphosis and on decomposition patterns.

2.1.6 Ice core records 10:36 a.m.

10:36 a.m.

BEHAVIOR OF THE SOUTHERN HEMISPHERE WESTERLIES FROM THE MID HOLOCENE TO THE PRESENT**Dixon¹, Daniel A., Mayewski¹, Paul A., Goodwin², Ian D., Freeman², Rhaelene, Maasch¹, Kirk A., Sneed¹, Sharon B.**

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2. Climate Risk CoRE and Environmental Science, Macquarie University, Sydney, NSW 2109 Australia

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Abstract Greenhouse gas induced warming and ozone depletion are changing the dynamics of high-latitude Southern Hemisphere (SH) climate. To provide long-term perspective for one of the most pervasive features of recent SH climate change, intensification of the Southern Hemisphere circumpolar westerly wind (SHW), we utilize an ice core proxy. Non-sea-salt Ca^{2+} (nssCa) records from eight United States International Trans Antarctic Scientific Expedition (US ITASE) ice cores (AD 1400 - 2002) and the U.S. Siple Dome (SDM-A) deep ice core (the last 10,000 years) reveal that SHW intensification since \sim 1980 is unprecedented for at least the last 5400 years, supporting the proposed role of human activity in this intensification. Our study also demonstrates the abrupt termination of the SHW intensification 5400 years ago, in addition to earlier such events. Ozone hole recovery and continued greenhouse gas warming could trigger yet another abrupt weakening of the SHW, leading to a hastening of Antarctic warming and accelerated changes in SH climate.

10:48 a.m.

DETROIT PLATEAU ICE-CORE**Potocki Mariusz, Mayewski Paul A., Kurbatov Andrei V., Handley Michael, Introne Douglas S., Sneed Sharon B.**

Climate Change Institute and Department of Earth Sciences, University of Maine

The Detroit Plateau (DP) ($64^{\circ}10'S$, $60^{\circ}0'W$) is located in the northern sector of the Antarctic Peninsula where glaciological and meteorological observations reveal a notable warming trend over the last five decades ($+0.56^{\circ}\text{C decade}^{-1}$, Turner et al., 2005). It is also close to the Larsen Ice Shelf where a series of major collapse events demonstrate continuing climate and ice sheet instability (van den Broeke, 2005).

The DP ice coring project is part of *CASA* (Climate of Antarctica and South America) which has as its goal collection of ice core data that will provide sub-seasonal reconstruction of past temperature, precipitation, atmospheric circula-

tion, and air mass chemistry over the Antarctic Peninsula and South America and in so doing perspective for interpreting current and future climate change.

Preliminary results from DP ice core chemical and isotopic analysis demonstrate that the site has a high seasonal accumulation (~ 5 m, over the last 4 years), and that the ~ 133 m long core retrieved in 2007 will provide a highly detailed record covering the last 35 ± 5 years. Deep drilling (~ 500 m) is planned for the future.

11:00 a.m.

EEMIAN INTERGLACIAL AND GLACIAL TRANSITION IN A MOUNT MOULTON (WEST ANTARCTICA) GLACIOCHEMICAL RECORD.

Korotkikh Elena, Mayewski Paul, Handley Michael, Introne Douglas, Sneed Sharon

Climate Change Institute, University of Maine

Soluble major ions, trace elements and water hydrogen isotope ratios have been measured along a ~ 40 -meter horizontal ice core from Mount Moulton blue ice area with a temporal sample resolution of ~ 6.5 -7 years. The melted section covers the period from 107 to 136 ka B.P., based on $^{40}\text{Ar}/^{39}\text{Ar}$ radiometric dates from three englacial tephra layers. The resulting time-series provide a detailed record of the Eemian interglacial and transition to the subsequent glacial period. The Mount Moulton deuterium record matches well with isotope records from four other Antarctic deep ice cores. All Mount Moulton chemical concentrations are higher during the glacial period than during the interglacial, likely due to increased atmospheric circulation, sea ice extent and ocean biogenic activity. According to the Mount Moulton record, the Eemian period began ~ 134.5 ka B.P., reached its warmest phase at ~ 132 ka BP, and ended sometime between 123-124 ka B.P.

11:12 a.m.

DUST AND IRON BIOGEOCHEMISTRY IN WEST ANTARCTICA AT THE WAIS DIVIDE SITE

Bess Koffman^{1,2}, Karl Kreutz^{1,2}, Daniel Breton^{2,3}, Mike Handley², Andrei Kurbatov², Nelia Dunbar⁴, Natalie Mahowald⁵ Paul Mayewski^{1,2}, and Mark Wells⁶

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2. Climate Change Institute, University of Maine.
3. Department of Physics, University of Maine.
4. New Mexico Institute of Mining and Technology.
5. Cornell University, 6School of Marine Sciences, University of Maine.

To better constrain the role of atmospheric dust in climate dynamics, we are analyzing the new WAIS Divide (West Antarctica) deep ice core for trace ele-

ment chemistry and microparticle size and concentration. Initial results show that 9.8% of the Fe is soluble at the site, an inverse relationship exists between percent dissolved Fe and total Fe, and there is significant interannual variability in all Fe fractions. Strong seasonality in Fe flux is predicted by a general circulation model for this site, with peaks in both total and soluble Fe during the summer. Ongoing work measuring particles and Fe in the ice core will let us explore the question of seasonality in greater detail, and resolve some apparent contradictions between the model and the data. Long-term acidification of *WAIS Divide* snow samples reveals that more particulate Fe dissolves with time (i.e., hours vs. months), which has implications for both ice core analysis and interpretations of potential dust impacts on ocean productivity and carbon export. We review our results in the context of other Antarctic work and make preliminary interpretations of climate and dust transport.

2.1.7 Paleoclimate, Part I 11:24 a.m.

11:24 a.m.

GLACIAL HISTORY AND ENVIRONMENTAL CHANGE OF TORRES DEL PAYNE (51°S) REGION IN SOUTHERN SOUTH AMERICA DURING THE LAST ICE AGE

Juan L. García et al.

Glacial mapping of the Torres del Payne Region (51°S, southern South America) shows the existence of at least four ice advances recorded by moraine complexes (TDP I-IV) during the last glacial cycle. Our preliminary surface-exposure ages indicate the earliest advance (TDP I) occurred close to ~40 kyr B.P. The youngest two events (TDP III, IV) occurred during late-glacial time (~13.5 kyr B.P.). The age of the intermediate advance (TDP III) is still unclear, but it may have occurred close to 18-20.0 kcal BP during the last glacial maximum (LGM).

According to the preliminary data, the LGM in this area was underway by ~40.0 kyr BP, well before that in the Northern Hemisphere, and may have lasted close to ~20.0 kyrs. Moreover, our mapping indicates that the Late-glacial readvance at ~13.5 kyr BP was very extensive and reached at least the inner LGM ice position. Deglaciation from the innermost (TDP IV) moraine occurred by ~12.5 kyr B.P.

11:36 a.m.

RAPID ICE RETREAT IN THE CORDILLERA DARWIN DURING THE MYSTERY INTERVAL

Brenda L. Hall

Department of Earth Sciences and the Climate Change Institute

The “Mystery Interval” (14.5-17.5 kyr B.P.) is key for understanding not only the last termination, but also how Earth abruptly shifts climate modes. Here, we show that *Mystery Interval* glacial retreat, well-known from the Swiss Alps, also occurred at the same time in southernmost South America. Our new radiocarbon chronology shows that glaciers in the Cordillera Darwin had collapsed back into the mountains close to their late Holocene limits by 16,000 cal yr B.P. This is scarcely 1000 years after being essentially at their maximum extent in the Straits of Magellan and Bahía Inútil, indicating massive reorganization of local climate and ice dynamics beginning roughly 17,000 cal years B.P. One explanation of the mismatch between rapid glacier retreat in southern South America and elsewhere during the Mystery Interval, and generally cold temperatures shown by North Atlantic proxies during the same period, is that glaciers globally were driven by warming summer temperatures, but cold winter temperatures and severe winter sea ice delayed return of the North Atlantic to its interglacial mode.

11:48 a.m.

RESOLVING THE TIMING OF MOUNTAIN GLACIER ACTIVITY IN THE MIDDLE LATITUDES OF BOTH POLAR HEMISPHERES DURING THE LAST ICE AGE

Aaron Putnam, Joerg Schaefer, George Denton, David Putnam, Sean Birkel, Roseanne Schwartz, Robert C. Finkel, Peter Quesada, Edward Evenson, Peter Huybers, Bjorn Andersen, David Barrell, Sam Kelley, Alice Doughty

Understanding the origins of glacial cycles requires a secure global chronostratigraphic framework. To this end, we are developing ^{10}Be surface-exposure age chronologies from middle-latitude moraine systems deposited during recent glacial maxima by mountain glaciers in both hemispheres. Glacial chronologies developed from New Zealand, located at $\sim 44^\circ\text{S}$, are compared to new preliminary exposure-age datasets being developed from two moraine sequences located at the foot of the Wind River Range, Wyoming, located at $\sim 44^\circ\text{N}$. With these data in mind, we discuss the timing and degree of interhemispheric symmetry expressed in the glacial geologic record, and implications for focusing the ice-age problem.

2.2 Lunch 12:00- 1.00 p.m.

2.3 Poster Session 1:00 p.m.

2.3.1 Climate Prediction and Modeling

BETTER PHYSICS USING FULL MOMENTUM SOLVER IN 2D VERTICAL SLICE DOMAIN, WHERE DOES LONGITUDINAL STRESS REALLY MATTER? APPLICATION TO THE THWAITES GLACIER FLOWLINE

Debra Kenneway, Aitbala Sargent, James Fastook

University of Maine

The shallow-ice approximation neglects all stresses except basal drag, a good assumption for inland ice but poor for fast-flowing, low-surface slope ice streams, where longitudinal stresses are important, even dominant [2]. A higher-order approach couples mass- and momentum-conservation equations and solves with no neglected stresses. In developing such a full-momentum solver for the University of Maine Ice Sheet Model (UMISM) [1], we test a simplification that models a vertical slice through the ice sheet. This allows us to: 1) implement and test complex boundary conditions, and 2) evaluate longitudinal stresses.

There are two types of boundary conditions [4]: 1) Dirichlet, state variable (velocity) specified, and 2) Neumann, conserved flux (force applied on the boundary) specified. With frozen beds, Dirichlet boundary conditions are specified, since velocity is zero. With sliding, the force exerted on the ice by the bed is specified. This resistive force cannot equal or exceed the driving stress. A fraction of the driving stress does produce the characteristic concave profile, but is hard to define. A boundary-layer is a better approach. We preserve Dirichlet-type zero velocity on the boundary, and allow greater deformation within the boundary-layer to simulate sliding. This soft layer can be interpreted as deformable till or slush. Either way its thickness is negligible compared to ice thickness.

We apply this to a flowline along the Thwaites Glacier in the Amundsen Sea sector using excellent new data from the Airborne Geophysical survey of the Amundsen Sea Embayment by University of Texas [3] and British Antarctic Survey [5] teams.

[1] J.L. Fastook. Computational Science and Engineering, 1(1):55–67, 1993.

[2] J.L. Fastook and A. Sargent. 11th Annual WAIS Initiative Workshop, Virginia, 2004.

[3] Holt et al. Geophys. Res. Lett., L09502(doi:10.1029/2005GL025561), 2006.

[4] T.J.R. Hughes. Prentice-Hall, Inc., New Jersey, 1987.

[5] Vaughan et al. Geophys. Res. Lett., doi:10.1029/2005GL025588, 2006.

EARTH'S OZONOSPHERE, WEATHER “ANOMALIES” AND GLOBAL WARMING**Syvorotkin¹, Vladimir L. and Smorodin², Vladimir Y.**

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2. Climate Change Institute, University of Maine, Orono, Maine 04469, USA

vladimir.smorodin@gmail.com

Surprisingly, in the treatment of weather/climate “anomalies”, the extremely important and easily accessible information on the state of the ozonosphere seems to be ignored. Indeed, the atmospheric ozone layer regulates the thermal parameters of the lower atmosphere. First, the stratosphere is heated by tens of degrees from absorbed sunlight and reradiated by ozone molecules. As a result of destruction/thinning of the ozone layer, the heat excess screened earlier with ozone at stratospheric heights, penetrates into the troposphere, heating up the air boundary layer and/or water oceans and seas. Air heating, naturally, reduces its weight and pressure as well. The area of lowered pressure arising from the ozone anomaly causes a corresponding pressure gradient that influences anticyclone motion if those appear nearby. In part, during autumn and winter in Europe, abnormally warm episodes lasting 1-1.5 weeks, have repeatedly occurred in recent years. Both the timing and the location of the thermal anomalies coincided with the area of development of the negative anomalies of the ozone total content, e.g., in November 2004, the beginning of January 2005, October and November 2005, January 2006, etc. Many of them were in 2005. This corresponds completely to the definition of this year as the warmest and most abnormal for all periods of meteorological observations. On October 27-29 2005, over northwestern Russia, an ozone anomaly arose. By November 1, it has expanded and included territory from Britain to western Siberia in longitude and from Scandinavia to Spain and Black Sea in latitude. The decrease of ozone content in the center of this giant anomaly reached 50-60% compared with external regions. The powerful negative ozone anomalies influencing European weather arise more often in the north Atlantic and/or in the center of western Europe. The warming of ocean water and air through ozone anomalies near Iceland leads to decreasing atmospheric pressure in the north Atlantic and to the subsequent displacement of the Azores anticyclone which brings warm air into areas of the north Atlantic, Arctic Ocean and western Europe. This is the origin of the regional atmosphere pressure gradient called the “North Atlantic Oscillation”. Such “pumping out” of warm air in western Europe is correlated with synchronous abnormal decrease in temperatures in other regions of Europe, Africa and Asia, located between 30 - 40 °N. In European Russia, for example, January 2007 was abnormally warm, while during the same time frost in India, snowfall in the Near East, Spain, and also in the Southwest USA was noted. In the beginning of March 2007 reports of unknown cold spells in India and Pakistan again were given. In the middle of March 2007 in European Russia, abnormal warm weather occurred, with daytime temperatures almost breaking long-term records. In this period, western Europe received unusual

snowfall. Synoptic contrast can be caused by the ozone mechanism itself. During daytime, the heat excess goes into the ozone anomaly, while at night, an outflow of thermal radiation from the Earth to space, through the ozone window of transparency at 957 nm occurs. Thus, statistical data demonstrate the interrelationship of the ozonosphere state, weather anomalies, and the Earth's climate system. The advancement of the weather/climate modeling demands an understanding, conceptualization, and relevant formalization of this fact.

2.3.2 Environment and Ice Core Records

IMPACT OF ROSS SEA PRIMARY PRODUCTIVITY ON SNOW CHEMISTRY IN DRY VALLEYS, ANTARCTICA

S.M. Griffin, K.J. Kreutz, S.B. Sneed, and P.A. Mayewski

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Climate Change Institute, Department of Earth Sciences, University of Maine, Orono, Maine 04469, USA

Methanesulfonic acid (MSA), an oxidation product of dimethylsulfide (DMS), is generally used as a proxy record of phytoplankton productivity in ice and snow samples. However, previous work at ice core sites around Antarctica has shown conflicting correlations between sea ice extent and concentration of MSA. To address this problem, we collected meteorological data and concurrent snow samples from weather stations placed on Commonwealth (77.532S, 162.969E, 770 masl) and Clark Glaciers (77.390S, 162.295E, 778 masl), Dry Valleys, Antarctica from November 2004 to November 2005. Clark and Commonwealth Glaciers experienced a snowfall event (10.3 cm and 13 cm respectively) on December 26-28, 2004. This event corresponded with a drop in atmospheric pressure from 924 mb to 891mb, wind direction from 112°, and higher than average concentrations of MSA (559 $\mu\text{g/L}$ and 639 $\mu\text{g/L}$), Na^+ , and SO_4^{2-} (514.5 $\mu\text{g/L}$ and 905.5 $\mu\text{g/L}$ respectively), all suggesting a marine source for precipitation and aerosols. Monthly averaged sea ice records from the National Snow and Ice Data Center (NSIDC) indicate a larger than normal polynya during December 2004 in the Ross Sea, relative to December sea ice record for 1979-2000. Eight-day averaged 9 km resolution SeaWiFS chlorophyll-a concentration data obtained using GIOVANNI (79S-65S, 164E-140W) averaged 4.53 mg/m^3 during the week December 21-29, 2004, the highest in the record from 1998-2009. We conclude that the concentration of MSA, Na^+ and SO_4^{2-} in Dry Valleys, Antarctica ice core records may be a useful proxy records for the past extent of Ross Sea ice and primary productivity.

QUEST for the OLDEST ICE ON EARTH**Andrei V. Kurbatov¹, Michael Bender², Gordon Hamilton¹, Paul A. Mayewski¹**

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Fundamental uncertainties remain in our understanding of natural and human-imposed climate changes, and in the factors controlling climate dynamics over the past several million years. IPICS (International Partnerships in Ice Core Sciences) planned to drill a continuous Antarctic ice core extending to 1.5 Ma.

Preliminary work by B. Spikes on ice flow modeling at Allan Hills Blue Ice Area (BIA) shows that modeled maximum ice ages agree well with age of meteorite radiometrically dated as 2.5 Ma. In our new project we aim to reconstruct details of past climate changes and greenhouse gas concentrations for certain time periods back to 2.5 Ma. Ice ages will be determined by applying emerging methods for absolute and relative dating of trapped air bubbles (based on $^{40}\text{Ar}/^{38}\text{Ar}$, $\delta^{18}\text{O}$ of O_2 , and the O_2/N_2 ratio). Collected ice cores and trench samples will be analyzed for ice chemistry and particles in order to unveil unknown details of atmospheric circulation of past climate change events known from marine sediment records.

2.4 Afternoon Session 1:30 p.m.**2.4.1 Paleoclimate, Part II 1:30 p.m.**

1:30 p.m.

A GLACIOLOGICAL RECONSTRUCTION OF THE WIND RIVER ICE CAP, WIND RIVER MOUNTAINS, WYOMING**Birkel, Sean D.^{1,2}, Putnam, Aaron, E.^{1,2}, Denton, George, H.^{1,2}, Fastook, James L.¹⁻³**

1. Department of Earth Sciences, University of Maine
2. Climate Change Institute, University of Maine
3. Department of Computer Science, University of Maine

A UMaine field project is underway in order to establish ^{10}Be cosmogenic exposure chronology of ice-cap glaciation in the Wind River Mountains, Wyoming. As a component of this research, we are reconstructing the former glacier system using the University of Maine Ice Sheet Model. Preliminary results indicate that the ice cap formed in response to 5-6 °C summer cooling with an annual precipitation regime similar to that of present day. The termini positions of outlet glaciers predicted in the model are consistent with field evidence. It is also noteworthy that thick wet-based ice develops west of the range divide, whereas thin cold-based ice develops to the east; this pattern is consistent with observed extensive and limited aerial scour west and east, respectively.

1:42 p.m.

THE LOCH LOMOND READVANCE IN SCOTLAND - A BØLLING / ALLERØD ADVANCE?**Gordon R. M. Bromley, Aaron Putnam, Harold Borns**

During the late glacial period, following the wasting of the last British ice sheet, glaciers reformed in the Scottish Highlands and advanced down to sea level. This event is termed the Loch Lomond Readvance. While geomorphic evidence for this event is widespread, chronologic control is poor, and so the advance has long been attributed to the Younger Dryas Stade (12.9 – 11.5 ka BP). We present 'new' radiocarbon ages from glacial deposits along the southern margin of the main Loch Lomond Readvance icefield and from the Isle of Mull that, along with the existing data, show that glaciers likely reached their maximum extent shortly after 13.1 ka BP and were in retreat, or had vanished, by 12.4-12.8 ka BP. This chronology hints at the possibility that glacier behaviour in Scotland did not match our understanding of the timing of 'warm' and 'cold' events during the late glacial period. If true, the pattern of pre-Younger Dryas deglaciation of the Loch Lomond Readvance icefield has major implications for our understanding of abrupt climate events in the circum-Atlantic region and for the existing calibration of cosmogenic surface-exposure dating.

1:54 p.m.

¹⁰Be SURFACE EXPOSURE CHRONOLOGY OF MORAINES OF THE FORMER PUKAKI GLACIER LOBE IN THE MACKENZIE BASIN, SOUTH ISLAND, NEW ZEALAND

Kelley, Samuel

Climate Change Institute, University of Maine

Using ¹⁰Be exposure dating of boulders located on moraine crests, a glacial chronology is constructed for the northern segment of the Pukaki glacier left lateral moraines (43°S 170°E). Identified in this chronology are an extensive Marine Isotope Stage 4 advance at 65,000 as well as subsequently less extensive advances occurring at 40,200, 35,700, 26,200, 24,200, 20,200, culminating with a recession to the Termination from 18,700 to 16,700 years ago, with ice exiting the depression occupied by the current lake by 16 ka (Moar, 1980).

This chronology identifies two important features. One is the existence of a long last glacial maximum lasting from 40,200 to 18,700 years ago. The second is a stage four advance more extensive than that of the last glacial maximum. These results have major implications on the Milankovitch theory of glaciations, as the last glacial maxima reported in this study falls during a peak in Southern summer insolation intensity, as well as being in step with the maxima seen in the Northern Hemisphere.

2.4.2 Anthropology I 2:06 p.m.

2:06 p.m.

“THE WATERLESS REALMS OF THE HUMAN SEASCAPE”

V. Constanza Ocampo-Raeder

(Assistant Professor, Department of Anthropology)

Severe environmental changes, industrial fishing, and marginalization from the national policy-making process threaten the livelihoods of traditional fishing communities in Northern Coastal Peru. Maintaining their form of life is about cultural resilience and may be key to designing effective conservation programs. In fact, insights from traditional management regimes have been documented in the common property literature of marine fisheries. However, these works have mainly based their analysis on social activities taking place at sea or in social arenas directly related to fishing activities, often overlooking land-based dynamics. I will present some preliminary ethnographic observations carried out in three fishing communities which indicate that social dynamics at the household and community level (waterless realms of fishing life) form around a different set of cultural norms but strongly influence decisions taking place at sea. Consequently any analysis or planning must explicitly recognize dynamics taking place inland.

2:18 p.m.

DIETARY CHANGE THROUGH TIME: A VIEW FROM HINDS CAVE

Samuel Belknap III

Climate Change Institute & Department of Anthropology

An examination of 64 coprolites from Hinds Cave (Lower Pecos Region of Texas) reveals a great deal of information regarding ancient dietary patterns. The samples in this study are from two distinct areas, and two distinct levels, of Hinds Cave. While the coprolites in this study have yet to be directly dated, their context has been dated to two separate periods of habitation. Some significant differences have been observed between the two sample sets, potentially providing a glimpse into possible changes in food availability/ procurement practices through time.

2.4.3 Archaeology 2:42 p.m.

2:42 p.m.

PINNIPEDS, PEOPLE, AND PETROGLYPHS: ANALYSIS OF THE MACHIAS BAY FAUNAL ASSEMBLAGES**Ingraham, Robert C.**

University of Maine Climate Change Institute

Faunal remains deposited within the shell middens at the archaeological sites along Machias Bay on the Maine coast have been remarkably well preserved, and offer a valuable opportunity for the analysis of human relationships with various prey species. Apart from a traditional research trajectory, analysis models cultural mechanisms of use and disposal, seasonality, and dietary breadth. Ethnographic records from the Northeast detailing hunting practices and various forms of “hunting magic” may be applied to skeletal elements to explain both their presence and absence in the assemblage. Excavations from 1973 and 2008 are being analyzed currently; the results of which will be used to actively modify a model for excavation in the summer of 2009.

2:54 p.m.

THE ARCHAEOLOGY OF ATLANTIC SALMON AND CLIMATE CHANGE**Brian S. Robinson,^{1,2} George L. Jacobson,^{2,3} and Martin G. Yates⁴**

1. Anthropology Department, University of Maine

2. Climate Change Institute and Department of Earth Sciences, University of Maine

3. Botany, University of Maine

4. Earth Sciences, University of Maine

Accounts of archaeological salmon in the Gulf of Maine range from decidedly negative, to reports of nonspecific large salmonid and isolated occurrences of Atlantic salmon vertebra. Recent research has focused on more positive identification of Atlantic salmon based on the morphology of small fragments of burned vertebra and Strontium/Calcium analysis. Atlantic salmon is confidently identified as early as 7000 - 6500 cal BP (2) at the Sharrow site in the upper Penobscot drainage. Although the number of cases remains small, Atlantic salmon appears to be associated with climate periods that are wet but also warmer than the recent past. Future avenues of research are discussed.

3:06 p.m.

**CHRONOLOGY OF LATE PLEISTOCENE/EARLY HOLOCENE
LANDSCAPE DEVELOPMENT IN THE CENTRAL PENOBSCOT
RIVER VALLEY: GEOARCHAEOLOGY AND OSL CHRONOL-
OGY**

Alice Kelley and Roger Hooke

Department of Earth Sciences and Climate Change Institute, University of
Maine

Surficial mapping in the Old Town, Greenbush, and Howland 7.5' quadrangles has revealed a series of eolian dunes adjacent to the modern Penobscot River. These deposits lie on a late Pleistocene/Holocene geological sequence ranging from till and glaciomarine muds (Presumpscot Fm), to glaciofluvial sediments. Within the river valley, terraces underlain by stratified alluvial deposits up to 8 m thick, and document sedimentation and subsequent incision that followed deglaciation and coincided with falling sea level. These terrace gravels were deposited between 11 and 13 ka. Dunes locally fill channels in the terraces. OSL dates on the dune sands range from 9.1 to 11.2 ka. Inset into the terrace sequence are Holocene alluvial sediments, the base of which preserve the region's Early Holocene archaeological record. Radiocarbon dates and diagnostic artifacts from archaeological sites suggest that these sediments postdate ~9 (cal) ka. Thus, a picture of the postglacial landscape evolution is emerging.

2.4.4 Cyberinfrastructure 3:18 p.m.

3:18 p.m.

THE *ice*READER DATA REPOSITORY

**Mark Royer¹, Sudarshan S. Chawathe^{1,2}, Andrei V. Kurbatov², and
Paul A. Mayewski^{2,3}**

1. Computer Science Department
2. Climate Change Institute
3. Earth Sciences Department

*ice*READER is a public Web portal for the sharing of ITASE (International Trans Antarctic Scientific Expedition) data. Most of the data in *ice*READER is marked as public, making it available to all. An interactive map allows visitors to view data sets projected on the Antarctic continent. Users who are interested in contributing data to the *ice*READER repository may register with the system, which allows them to upload field data and download shared data from others. For ITASE members, the system supports email notifications to active group members. Although diverse datasets may be stored in *ice*READER, a few standard meta-data fields are required, allowing uniform access to datasets. The result is that data maintained by *ice*READER can not only be browsed and

queried using the Web interface but can also be easily shared and accessed using applications like the *P301dx* tool, which has a number of additional functions for analyzing climate-change data.

3:30 p.m. ***P301dx*: A TOOLKIT FOR EXPLORING CLIMATE-CHANGE DATA**

Sudarshan S. Chawathe^{1,2}, Andrei V. Kurbatov², Paul A. Mayewski^{2,3}, and Mark Royer¹

1. Computer Science Department

2. Climate Change Institute

3. Earth Sciences Department

P301dx is a data repository coupled with a collection of interactive tools that allow scientists to rapidly explore climate-change data. *P301dx* makes it easy to import and clean data. This data can then be explored using a large and growing collection of tools. A systematic repository facilitates correlation of diverse datasets. *P301dx* is built using a plug-in framework that makes it easy to add additional functions. In contrast to ad hoc data processing, when using *P301dx* there is no need for tediously importing and exporting data to various programs. Instead, the data is maintained in one reliable place, so that the user's view (or perspective) of the data is the only change required. The shift in perspective usually includes the way the data is presented to the user and the array of tools available for inspecting data. Examples of some *P301dx* perspectives include: data maintenance, chart plotting, data re-sampling, and 3d data mapping.

2.4.5 Break 3:42-4:00 p.m.

2.4.6 Anthropology II 4:00 p.m.

4:00 p.m.

**DIETARY INTAKE OF PREBIOTIC INULIN-TYPE FRUCTANS
IN PREHISTORY**

Sobolik Kristin¹ and Leach Jeff²

1. Climate Change Institute and Department of Anthropology, University of Maine,
2. Paleobiotics Lab.

Archaeological evidence from dry cave deposits in the northern Chihuahuan Desert reveal intensive utilization of desert plants that store prebiotic inulin-type fructans as the primary carbohydrate. In this semi-arid region limited rainfall and poor soil conditions prevented the adoption of agriculture and thus provides a unique glimpse into a pure hunter-forager economy spanning over 10,000 years. Ancient cooking features, stable carbon isotope analysis of human skeletons, and well-preserved coprolites and macrobotanical remains reveal a plant-based diet that included a dietary intake of ~135 g/d of prebiotic inulin-type fructans by the average adult male hunter-forager. These data reveal humans were well adapted to daily intakes of prebiotics well above those currently consumed in modern diet or administered in current medical studies.

2.5 Graduate Students Awards Ceremony 4:12 p.m.

2.6 Closing Remarks by Kristin Sobolik 4:20 p.m.