THE UNIVERSITY OF MAINE

CLIMATE CHANGE INSTITUTE

18th Annual Harold W. Borns, Jr.

Symposium

May 6-7, 2010

CLIMATE CHANGE INSTITUTE
UNIVERSITY OF MAINE

DAY 1
2010-05-06
07:30 AM Coffee and Light Refreshments

8:00 AM Summary for the day

Morning Session

(10 minutes talk and 2 minutes questions)

08:12 AM

Pockmarks: Self -Scouring Mud Landforms?

Laura Brothers

Pockmarks, or seafloor craters, occur worldwide in a variety of geologic settings and usually within cohesive fine-grained sediment. Associated with methane release and common among gas hydrate fields, the mechanisms and timescale of pockmark formation are not well constrained and several hypothesis for their formation and maintenance have been proposed. This study combines morphologic analysis, numerical modeling and the results of flume tank experiments to assess the role of nearbed currents in pockmark evolution. From our findings we construct a novel working hypothesis that pockmarks result from initial seafloor perturbations that become modified and grow by vortical flow.

08:24 AM

Antarctic Cold Reversal in the tropical Andes?

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The occurrence of pronounced climate reversals during the last glacial termination has long been recognised in palaeoclimate records from both hemispheres and from high to low latitudes. Accurate constraint of both the timing and magnitude of events, such as the Younger Dryas and Antarctic Cold Reversal, is vital in order to test different hypotheses for the causes and propagation of abrupt climate change. However, in contrast to higher-latitude regions, well-dated records from the tropics are rare and the structure of late-glacial tropical climate remains uncertain. We present an *in-situ* cosmogenic ^{3}He surface-exposure chronology from Nevado Coropuna, southern Peru, documenting an advance during the late-glacial period. Ten tightly clustered ages from a pair of moraines located halfway between the modern glacier and the last glacial maximum terminus range from 11.9 ka to 13.9 ka and give an arithmetic mean age of 12.9 ± 0.7 ka (1σ). These data constitute direct evidence for a major readvance of glaciers in the arid Andes of south-western Peru.

08:36 AM

Ice Core oh' Ice Core, where art thou? Radar and GPS Data from the Upper Kahiltna Glacier of Mount McKinley, Alaska

Seth Campbell, University of Maine/ CRREL
Karl Kreutz, 1Department of Earth Sciences and Climate Change Institute

Cameron Wake, Climate Change Research Center, University of New Hampshire
Erich Osterberg, Department of Earth Sciences, Dartmouth College
Steven Arcone, CRREL
Kevin Volkening, Max Lurie, Department of Earth Sciences and Climate Change Institute

We characterize a portion of the accumulation zone of the upper Kahiltna Glacier on Mount McKinley, Alaska using 100 MHz ground penetrating radar and surface velocity measurements to find a suitable ice core drill site. We found westward dipping, en-glacial stratigraphy that thickened as it flowed from steep high velocity terrain to flat terrain associated with slower velocities. Stratigraphy appear continuous through out the basin, however significant signal attenuation occurs near the steeply dipping layers and some signs of internal deformation are present in these areas. Stratigraphy on the western side is surface conformable with minimal signs of deformation or variation in layer thickness suggesting it the best location as a potential drill site. This said significant upstream extensional and compressional flow dynamics as suggested by surface velocity measurements will require advanced flow modeling to resolve some questions associated with an ice core collected at this site.

08:48 AM

Asian Ice Core Array (AICA): Climate and Environmental Reconstruction of Asia

Bjorn Grigholm, Climate Change Institute
Paul Mayewski, Climate Change Institute
Vladimir Aizen, University of Idaho
Shichang Kang, Institute of Tibetan Plateau Research
Karl Kreutz, Climate Change Institute
Susan Kaspari, Central Washington University
Kirk Maasch, Climate Change Institute

The large landmass and relief of the Asian continent has a substantial influence on global atmospheric circulation and the regional climate that supports ~4 billion people. Variations in climate and environmental conditions may have serious consequences on humans and ecosystems (e.g. water resources). It is therefore necessary to improve the understanding of past climate and environmental change in the region. Instrumental records used to establish climate and environmental variability over the region are sparse and temporally limited. Fortunately, alpine glaciers in Asia can provide high-resolution records of past climate and atmospheric chemistry (e.g. seasonal to millennial scales). The goal of AICA is to enhance the spatial and temporal understanding of physical and chemical climate variability, establish a baseline for assessing modern climate variability in the context of human activity, and contribute to the prediction of climate variability in Asia. Ice core reconstructions of past climate (e.g. atmospheric circulation, precipitation, and atmospheric chemistry) will utilize continuous, co-registered, and multi-parameter measurements of major ions, trace elements and stable isotopes. AICA sites include cores from the Himalayas, Pamir, Tien Shan, Altai, and the Tibetan Plateau.

09:00 AM

Are Maine's salt marshes drowning in response to rising sea level?

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Salt marshes are vulnerable to rising sea level due to climate change. Studies indicate that one response to sea-level rise is an expansion of salt pools (shallow, water-filled depressions) in interior marsh sections, leading to the rapid conversion of once-vegetated surfaces to open water over short time periods. These changes are a concern because they represent an irreversible ecological tipping point (or state change) within these environments. This study examines surficial dynamics of six Maine salt marshes, combining field surveys of pool ecophysical properties with analyses of aerial photographic time-series. Results indicate a moderate increase in the ratio of open water to vegetated marsh over the study period and that new pools form over decadal time periods. Our results suggest that Maine marshes are in dynamic equilibrium, that they are coping with sea-level rise, and that they have not yet reached the tipping point that converts them to open-water systems.

09:12 AM

Quantifying Surface Water Nitrate Concentrations that Elicit Diatom Community Changes in Lakes across the Rocky Mountains

Heather Arnett, SBE & CCI, UMaine
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Nitrogen (N) limited alpine lakes have been receiving enhanced atmospheric N deposition over the last century. This increase has elicited dramatic changes in diatom community structure, but nitrate concentrations that cause this shift remain unclear. We attempted to quantify these concentrations by developing a diatom calibration set using 46 lakes across the U.S. Rocky Mountains. Ordination analysis identified that nitrate, conductivity, total phosphorus, and temperature affect diatom distributions. A nitrate transfer function was developed and applied to diatom profiles across the Rockies. Model validation suggested high potential for reconstructing nitrate concentrations over time. However, comparisons of diatom-inferred nitrate to historical values revealed poor performance, with diatom-inferred values much higher than observed ones. The frequent domination of diatom assemblages by generalist species is likely the key problem with this model. This complication underscores the utility of the indicator species approach in understanding the effects of nitrate enrichment in oligotrophic lake ecosystems.

09:24 AM

Holocene Fluctuations of Istorvet Ice Cap, East Greenland

Amanda Rose Lusas

The Arctic today is experiencing one of the largest reactions to current warming. Has the earth experienced anything like this earlier in the Holocene? If so, what can we expect to be the results of this warming? Our goal is to help answer this question by reconstructing fluctuations of Istorvet ice cap in Liverpool Land in the Scoresby Sund region of East Greenland. This will be done through analysis of sediment cores from proglacial and glacially-fed lakes adjacent to the ice cap.

Characteristics such as stratigraphy, grain size, magnetic susceptibility, and loss on ignition (LOI) can indicate the proximity of the ice margin to the lake and the flow of meltwater. The analysis should provide a reconstruction of Holocene climate and help place the current warming in context.

09:36 AM

Fragments of the Past: Bone histology as a tool for species differentiation

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New England's acidic soils have resulted in poor bone preservation in archaeological contexts throughout the area. Faunal remains recovered by archaeologists have consisted almost exclusively of small burnt or calcined fragments that are largely unidentifiable with commonly used techniques. The ability to identify these fragments would provide valuable insight into a wide range of archaeological questions and a broader understanding of sites of great antiquity where little currently identifiable faunal evidence is available. This paper introduces research into the use of bone histology and histomorphometrics as a method for species differentiation of small fragments of calcined bone with the aim of applying the results to samples from the Bull Brook and Morrill Point Mound sites in Massachusetts. These sites cover a period of dramatic climate change that is likely to be reflected in the species present in the faunal assemblages of each site.

09:48 AM

Release of Reactive Nitrogen by Melting Alpine Glaciers: Effects On Diatom Diversity in Lake Ecosystems Over The Last Century

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Mountain glaciers have receded substantially on a global scale over the last century. Consequently, increases in the volume of glacial runoff have been observed. Changes in glacial meltwater have important implications for nutrient fluctuations into lake ecosystems. Less is known, however, about how this high influx of glacial meltwater, rich in reactive nitrogen (Nr), affects the biota of lakes. We investigated the species richness of sedimentary diatom assemblages in a suite of lakes in the central Rocky Mountains of North America, a region with relatively low Nr deposition (< 3kg N ha-1 yr-1) and rapidly disappearing alpine glaciers. Sediment cores were extracted from glacially-fed and snow-fed lakes and examined for differences in fossil diatom taxa. Taxonomic richness of diatom communities was determined using rarefaction analysis. Preliminary results indicate that glacial-fed lakes have lower diatom diversity compared with snow-fed lakes, and that this difference has persisted over the last century.

10:00 AM Break

10:15 AM

Modeling a floating ice tongue of an outlet glacier in northern Greenland

Bill Sneed

A 3-dimensional model of a floating ice is created using COMSOL, a finite element modeling software. The model is parameterized, whenever possible, by measured data values such as input velocity, thickness, and basal melt rates. No attempt is made to model calving.

10:27 AM

Potential Effects of Climate Change on Two Wetland Bird Species: Sora and Virginia Rail

Ellen Robertson
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Soras and Virginia rails nest near the water surface and are vulnerable to nest flooding from water level fluctuations during the breeding season. The delicate balance of building and maintaining nests at a height that can withstand normal water level fluctuations could easily be upset by changes in storm events due to climate change. This study is examining the effects of flooding and predation on rail nesting success in wetlands in Maine. It is also looking at the levels of methylated mercury (a pollutant from industrial activity that contributes to climate change) in rail blood from Maine wetlands.

10:39 AM

Evidence for Climate Oscillations During Deglaciation in Maine

Brenda Chase
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The deglacial period, lasting from about 14-10 ka 14C in Maine, was punctuated by 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 climate oscillations during deglaciation by looking at terrestrial and aquatic ecological changes, as represented by biological proxies and sediment characteristics of lacustrine sediment cores. 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. So far, I have collected sediment cores from Moulton Pond, Dedham, Maine and analyzed the stratigraphy and organic content. I also developed a radiocarbon chronology. Further assessments will include pollen counts to qualify vegetation changes.

11:00 AM

Professor David Clayton Smith : A Retrospective

Bird & Bird Professor Emeritus of History & Climate Change Institute

12:00 PM
Lunch

Introduction to Posters (one or two slides)

Short information about poster

01:00 PM

Poster: Evaluating carbon emission scenario impacts on atmospheric CO_2 and temperature using a dynamic systems model

Eliza Kane, University of Maine
Owen McGlamery, University of Maine
Karl Kreutz, University of Maine

Jim Wilson

The Intergovernmental Panel on Climate Change (IPCC) has published a range of carbon emissions scenarios for the 21st century, ranging from fossil fuel intensive to predominately non-fossil fuel. Evaluation of these scenarios and the potential impact on atmospheric CO_2 and temperature typically relies on general circulation models, which given their complexity tend to obscure critical feedback processes. Here we develop a carbon cycle model using dynamic systems concepts, and evaluate the effect of photosynthetic and ocean/atmosphere gas exchange feedbacks on atmospheric CO_2 concentration trajectories. We also evaluate atmospheric temperature evolution using climate sensitivity approximations based on paleoclimatic observations. When our results are compared to IPCC temperature predictions, we conclude that simplified carbon cycle models are very effective for gaining insight into Earth system processes.

Poster: Connecting Climate to Curriculum: a State-funded Math-Science Partnership

Kara Soule, Center for Science and Mathematics Education Research
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For a second year, Bangor area middle and high school science teachers and teachers from United Technologies Center continued to meet to develop and implement teaching activities that integrate ideas related to climate science into their instruction. Our poster presents some of their activities with students and a preliminary assessment of what students are learning.

01:04 PM

Poster: K-12 Inquiry Based Science Education. Oxygen Isotope Analysis of Millinocket Snowfall

Introne Douglas, University of Maine, Climate Change Institute, Orono, ME.
McKoy Chad, Stearns High School, Millinocket. ME.
Cunningham Jonathan, Stearns High School, Millinocket. ME.
Kranich, Amanda, Stearns High School, Millinocket. ME.
Karl Kreutz , University of Maine, Climate Change Institute, Orono, ME.

Inquiry based science education focuses on a student constructed learning process as opposed to information transmitted by teachers to students. It promotes scientific literacy and critical thinking, while promoting the scientific method and encouraging students to pursue careers in scientific fields. The ideal is to "learn while doing" which reinforces memory and sparks interest and creativity. As part of the Climate Change Institute's educational outreach and service mission, a research project using The Climate Change Institute's laboratory and instrument facilities was designed and carried out by three Maine high school students under the guidance of UMaine researchers Introne and Kreutz.. The students participated "hands on" in all aspects of this research from formulating a hypothesis, to sample collection and analysis, reducing the data, testing the hypothesis and publishing the results contained in this poster.

The chemistry of snowfall contains information ranging from atmospheric composition and solar activity, to weather and climate records. Ice caps, snow, glaciers and firn provide unique logs of past climatic events and on smaller time scales - weather events. One way in which weather information can be extracted from snow is by isotope ratio mass spectrometry. Isotopic measurements determine the amount of ^{18}O to ^{16}O left in snow as a residual signature of the storm which deposited it. The ratio of heavy ^{18}O atoms to lighter ^{16}O atoms in H_2O reflects both evaporative and

precipitation processes. These follow a theoretical Rayleigh distillation but the measured abundance of each isotopic species may be complicated by multiple water vapor source areas and other natural occurrences. In an effort to better understand how these atmospheric processes work and what effect they have on the isotopic composition of snow, we collected snow from three distinct winter storm events and measured the average isotopic composition of each. Prior to analysis we hypothesized an estimate of what the isotopic composition of the snow would be, based on known weather data. By correlating our measurements with weather information about each storm we show how isotopic signature changes with storm path, storm intensity and proximity to moisture source area.

Short talks (one or two slides)

Updates by faculty and staff members

01:06 PM

A new climate initiative

Paul Mayewski, Climate Change Institute
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The concept of climate change has become synonymous with modern global warming for much of the public, media, governments, non-governmental agencies and the private sector. An emerging climate initiative provides a more robust view of the term climate change and the impact of humans on the climate system. The new initiative encourages knowledge-based actions that are critical to a human and ecosystem health, a thriving economy, and greater security.

01:08 PM

Deglaciation of the Ross Sea - the View from Scott and Beardmore Glaciers

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The timing of ice recession in the Ross Sea has important implications for the behavior of the West Antarctic Ice Sheet (WAIS). Two limitations on the existing age control are the scarcity of reliable ages offshore and the lack of data from the southern Ross Sea region. To address these limitations, we dated deposits at the mouths of Scott and Beardmore Glaciers.

We obtained exposure ages of glacial erratics on Mt Rigby, at the foot of Scott Glacier, and Mt Hope, adjacent to Beardmore Glacier. Both peaks were overrun by ice during the last glaciation. Our samples are basal clasts that were exposed on the mountainsides as the glaciers receded. The data show that at ~8200 yr B.P. Scott Glacier underwent a large thinning event during which the glacier surface lowered by ~300 m in less than 1500 years. At this same time, our data from Mt. Hope suggest that the Ross Sea grounding line reached Beardmore Glacier. The grounding line did not reach Scott Glacier, however, which maintained a surface elevation of 600 m until a second period of thinning, commencing at ~6000 yr B.P.

There is now strong evidence that the Ross Sea ice sheet receded from the northern and southern Victoria Land coasts, Darwin, and Beardmore Glaciers in a millennial-scale event at ~8000 yr B.P. The brief duration of this interval, and the evidence that deglaciation extended as far south as Beardmore Glacier, are not easily explained by the "swinging gate" model of grounding-line migration along the Transantarctic Mountains. Instead deglaciation appears to have spread south and westwards from the central Ross Sea, reaching the Victoria Land coast, Darwin and Beardmore Glaciers within a single short-lived event.

01:10 PM

Melting alpine glaciers enrich lake ecosystems with reactive nitrogen

Jasmine Saros
Andrea Nurse
Krista Slemmons

Over the last century, alpine glaciers have receded rapidly in many regions of the world, and increasing glacial runoff has altered physical and biogeochemical aspects of downstream aquatic ecosystems. We compared nutrient concentrations in two sets of high-elevation lakes: those fed by snowpack melt alone (SF lakes) and those fed by both glacial and snowpack meltwaters (GSF lakes). We found that nitrate concentrations in the GSF lakes were one to two orders of magnitude higher than in SF lakes. Although nitrogen (N) limitation is common in alpine lakes, algal biomass was consistently lower in highly N-enriched GSF lakes than in the N-poor SF lakes. Contrary to expectations, GSF lakes were more transparent than SF lakes to ultraviolet and visible light. High influxes of reactive N from glacial meltwater have changed the stoichiometric balance of critical limiting nutrients in these lakes, altering both the structure and function of these ecosystems.

01:12 PM

Culture and Ethnometeorology: A Funding Proposal

Paul Roscoe, University of Maine
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Current attempts to model the human dimensions of climate change a) reduce the cultures of the world to nation-states or regional geographical blocks and b) model human-climate interactions primarily in economic terms. In this presentation, I outline a funding proposal for research to complement this mainstream approach. I propose a) to create a database of global ethnometeorological information at a cultural-unit resolution and b) to initiate modeling of human-climate interactions at the ideological, political, and social (kinship, amity) levels. Feedback on the aim of the project and on potential funding outlets is solicited.

01:14 PM

Development and Issues of Climate Intervention Technologies

Fei Chai, School of Marine Sciences and Climate Change Institute

In late March, I attended the Asilomar International Conference on Climate Intervention Technologies (sometimes referred to as “geoengineering”). More than 175 experts from 15 countries with a wide diversity of backgrounds spent five days at the Asilomar Conference Center in Pacific Grove to explore a range of issues related to climate intervention. Concerning about the pace of climate change, recently several reputable organizations (American Meteorological Society, UK’s Royal Society, and US National Academy of Sciences) have issued statements and reports calling for research into the scientific, technological, historical, ethical, legal, and social science aspects of geoengineering. The participants at the Asilomar Conference discussed issues and mechanisms that need to be addressed in order to ensure that research into the risks, impacts, and efficacy of various climate intervention methods. In my presentation, I will report some highlights and a few key recommendations from the Asilomar Conference.

01:18 PM

Examining the link between outlet glacier length and flow speed

Gordon Hamilton, Climate Change Institute
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A widespread acceleration of outlet glaciers is the major cause of a recent doubling in the sea level contribution from Greenland. Predictive models for future rates of sea level rise need to incorporate the processes responsible for the rapid changes in ice dynamics. We are addressing this need with a coupled program of field and satellite remote sensing measurements at one of Greenland's largest outlet glaciers. Helheim Glacier retreated 7 km and accelerated by 50 per cent between 2003 and 2005, implying a relationship between glacier length and glacier speed, at least on seasonal-annual timescales. On shorter timescales, the relationship is less clear, as shown by an analysis of daily speed anomalies and terminus position. We will discuss possible explanations for the differences in long-term and short-term behavior of the glacier.

01:20 PM

Oldweather: a Web interface to a historical climatology database

Sudarshan Chawathe, Computer Science and CCI, UMaine

The work of David Smith has produced a collection of historical climatological records from diverse sources such as diaries, journals, and ships' logs. Prior and ongoing work has resulted in a computerized database of some of these records. The oldweather system provides a Web interface to this database and permits the records to be conveniently searched and browsed. The system design is derived from three primary goals: (1) intuitive modes of access that appeal to users with diverse needs and backgrounds; (2) speed and scalability; and (3) standards-compliance. A live demonstration will be available.

01:22 PM

The Dilemma of RESOLUTION: How Good is Good Enough: A Case Study from Greenland

James Fastook, Climate Change Institute & Computer Science, University of Maine

Many of the whole-icesheet modelers involved with SeaRISE are attempting to predict the response of the Greenland and Antarctic Ice Sheets to projected climate change, and as such are using a database of the present icesheets' configurations provided by Jesse Johnson (http://websrv.cs.umt.edu/isis/index.php/SeaRISE_Assessment). These datasets include surface elevation, thickness, bedrock elevation, and other critical boundary conditions required by the icesheet models. Both Greenland and Antarctica are provided at 5 km resolution.

We have seen from previous work that an accurate representation of the bed is essential if models are to produce reasonable results. As we look at the response of the icesheets to projected climate change, we wonder how good our resolution must be, especially in the fast-flow areas of the ice streams, many of which are topographically controlled.

CRESIS has provided us with a very high-resolution representation of the bed in the Jakobshavn catchment area, and we show the results of 1) using this high-resolution dataset at a degraded resolution comparable to the whole-icesheet dataset provided by Jesse Johnson, and 2) using progressively higher resolutions to more accurately capture the deep channel in which the Jakobshavn Ice Stream flows. This is done using the embedded-model feature of UMISM, whereby a higher-resolution, small-domain model (the ice stream) is run inside a lower-resolution, broader-domain model (the whole icesheet).

01:24 PM

Construction of a continuous, high resolution and absolutely-dated marine chronology from the Gulf of Maine during the last millennium

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Reconstructing and understanding the spatiotemporal patterns of late Holocene climate variability remains a fundamental challenge in paleoclimatology, particularly with respect to coupled systems such as the North Atlantic Oscillation (NAO) and the Atlantic meridional overturning circulation (AMOC). Using live and fossil (dead-collected*) Arctica islandica* shells in the Gulf of Maine, we intend to produce a continuous annually dated master shell chronology spanning the last 1000 years, and use shell growth history and geochemistry (stable isotopes, radiocarbon) and relevant instrumental data in the GoM to address the following questions: 1) What are the specific relationships among the NAO mode, NAO extremes, seawater temperature in the Gulf of Maine, and the *Arctica islandica* master shell growth chronology and the shell geochemical record?; and 2) How did the ocean climate system in the Gulf of Maine respond to rapid climate changes during the last millennium, specifically during the MCA/LIA transition?

01:26 PM

The Community Structuring Effects of Chemical Climate: Biological cascades following landscape acidification

Brian Olsen, Climate Change Institute, School of Biology & Ecology
Jennifer Wharff, Department of Ecology and Environmental Sciences, University of Maine

Biologically available calcium is a critical nutrient for avian reproduction, limiting both egg production and nestling growth. Landscape acidification may therefore represent a potential constraint on the demography of birds in calcium-limited ecosystems, and such limitation may cause a cascade of effects along food webs. As insectivores, songbirds can control arthropod communities via selective foraging on spiders and other large-bodied predatory insects. Using an experimentally acidified landscape in Washington County, Maine, we described the arthropod and songbird communities as a preliminary investigation of the community-organizing effects of chemical climate.

01:28 PM

Is tropical tephra present in the WAIS Divide ice core?

Andrei Kurbatov, Climate Change Institute, University of Maine
Karl Kreutz, Climate Change Institute and Department of Earth Sciences
Nelia Dunbar, New Mexico Institute of Mining and Technology

Tephra particles and aerosols produced by a number of major (tropical) explosive volcanic eruptions were previously identified in all major ice cores collected in Antarctica. Geochemical fingerprint (composition) and age are two major characteristics used for cross -correlation of tephra layers in ice cores and to known volcanic eruptions.
We examined five depth intervals in the WAIS Divide Project ice core (WDC06A (79º28.058'S, 112º05.189'W) for the presence of tephra layers from historical eruptions of Agung 1963, Krakatau 1883, Cosiguina 1935, Tambora 1815, and Unknown 1809. The time scale and ice chemistry developed by WAIS Divide members was used to select sampling intervals at 16.29-16.41, 40.12-40.99, 53-45-53.88, 58.71-59.25, and 60.25-60.76 meters.

In this presentation, we describe up-to-date research results, encountered problems and discuss possible solutions.

01:30 PM

Desert Resource Management and Punctuated Environmental Change in Prehispanic and Spanish Colonial Peru

Gregory Zaro, Department of Anthropology and Climate Change Institute
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Alissa Dubois, Department of Anthropology
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The Atacama Desert of South America constitutes one of the driest landscapes on Earth, yet humans have occupied this fragile ecosystem for millennia. However, this hyper-arid region is regularly interrupted by punctuated flooding episodes, earthquakes, and periods of intense drought. Each of these processes poses a significant challenge to populations that have developed adaptive strategies for long-term success in such extreme conditions. Thus, understanding human responses to such occurrences becomes a significant anthropological question in the context of contemporary global change. Along the Tambo-Ilo coast of southern Peru, archaeological and geological records point to a series of late Holocene catastrophes. Massive debris flows from El Niño-related floods in the 14th and 17th centuries plagued canal-and-terrace farmland, while an explosive volcanic eruption historically dated to A.D. 1600 led to massive population decline and resettlement throughout southern Peru. The archaeological record indicates that village societies persisted to varying degrees in the face of these challenges: some fell into complete abandonment, while others experienced moderate decline. Still, others prospered after these disasters, though specific managerial responses remain unknown. During the Spring 2010 semester, we carried out a research program of archaeological excavation at the *Cola de Zorro* site, an abandoned farming complex occupied intermittently from the 12th through 18th centuries. Evidence for occupational history and subsistence was targeted to identify changes in resource management (e.g., resource switching, diversification, abandonment) in the context of punctuated environmental challenges identified in the material record. In this presentation, we share our preliminary conclusions from this work.

Long talks

Extended talks by CCI faculty and visiting scientists.

01:32 PM

Comparison of Glaciomarine Seismic Stratigraphy of the Northwestern Irish Coast with Coastal Maine, USA

Daniel Belknap, Earth Science Department, University Of Maine
Joseph Kelley, Earth Science Department, University Of Maine
J. Andrew Cooper, Environmental Science, University of Ulster
Derek Jackson, Centre for Coastal & Marine Research, University of Ulster
John McKenna, Environmental sciences, University of Ulster
Rory Quinn, Centre for Maritime Archaeology, University of Ulster

Lough Swilly is a glacially sculpted estuarine embayment on the northern Donegal coast of Ireland. Seismic data from 2009 images bedrock in most cross-lines. A prominent seismic facies with a well-stratified concentrically draping character is identical to glaciomarine (GM) units in Maine. This GM reaches over 60 m thickness near the estuary axis, and is capped everywhere by a distinct erosional unconformity. Unlike the more uniform Presumpscot Fm. formed at the grounding line of the Laurentide continental ice sheet in Maine, the Lough Swilly GM shows a distinct gradation from coarse, very well stratified reflectors to the SE (proximal) to a poorly stratified, uniform finer-grained

unit at the mouth of the Lough (distal), consistent with a valley-confined deglaciation. A main paleochannel and several subsidiaries trace the lowstand valley of Swilly River, to a depth of at least 30 m at the outer headlands. This depth is consistent with our previously established local relative lowstand off Northern Ireland. The incised valley is filled with paleofluvial and estuarine deposits, including beachface sands off several modern strands.

01:48 PM

Isotopic variations in the recent sediments of the Caspian Sea: a record of Quaternary continental weathering?

Marie-Claire Pierret Neboit
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The region of the Caspian Sea was subjected to important climatic and sea-level changes during the Quaternary.
This study presents combined mineralogical, chemical and isotopic (87Sr/86Sr and U-Th disequilibria series) analyses on bulk sediments and on distinct mineral phases (carbonates and clays) from a 10-m-long core drilled in the the southern Caspian Sea and containing Late Pleistocene and Holocene records.
The data allowed us to identify 1) the main variations, 2) the processes having induced these variations, and possibly 3) the influence of the main climatic and/or Caspian Sea level changes in the region since the Last Glacial Maximum.
The study of the bulk sediments, clays and carbonates reflect an increase of chemical weathering since about 10 ka BP.
Our results suggest then an evolution of the continental weathering conditions in the drainage basin of the Caspian Sea from mechanical/physical erosion during the cold LMG period to a continuous increase of weathering since about 10,000 yr, which illustrates the strong relation between climate and weathering processes.

02:00 PM Poster Session & Coffee Break

02:30 PM Long Talks (Cont.)

An ice core from the Pine Island Glacier ice divide: looking for South American environmental signals

Jefferson Simoes, Universidade Federal do Rio Grande do Sul
Francisco Aquino, Universidade Federal do Rio Grande do Sul
Heitor Evangelista, Universidade do Estado do Rio de Janeiro
Luiz Fernando Reis, Universidade Federal do Rio Grande do Sul
Marcelo Arevalo, Universidad Magallanes

Few studies have explored climatic connexions between South America and Antarctica, albeit the relevance to the former continent atmospheric circulation. The CASA (Climate of the Antarctic and South America) initiative proposes to investigate these relationships, improving our understanding on air masses transport to and from Antarctica and providing ice cores to link to the tropical and subtropical paleoclimatic records from South America. This presentation introduces the newest CASA ice core obtained at the ice divide of the Pine Island drainage basin, West Antarctic Ice Sheet. In the austral summer of 2008, during the first Brazilian national expedition to interior of Antarctica, we recovered a 95 m long core from Mount Johns (79°55'S, 94°23'W, 2.125 a.s.l., 12-m borehole temperature -33 °C, estimated accumulation rate 30-40 cm yr^{-1} water equivalent). We review the site environmental setting, fieldwork investigations and proposed analysis. Besides standard studies (*e.g.*, ionic chromatography, stable isotopes, traces elements, microparticles), core sections were also sampled for some exotic components, like levoglucosan, a biomass burning subproduct that may

provide information on the impact of the Amazon/Africa rain forests deforestation on the atmospheric chemistry.

Subglacial water detection

Gordon Oswald, Climate Change Institute

We have been engaged in a study of subglacial water since 2006, using through-the-ice radar to sense the presence of highly-reflective water between Polar ice and its less reflective bedrock. We have worked with the CReSIS team at the University of Kansas and their radar database derived from NASA's PARCA program. Since publishing our method for identifying subglacial water in early 2008, we have completed a study of water in Northern Greenland, showing that extensive areas are infiltrated by basal water, containing water equivalent to about 40 cm of sea level. Present work is under way under a new NSF-funded study in which the rest of the CReSIS Greenland database is being processed, yielding a subglacial water map of Greenland. This implies a new set of boundary conditions for ice sheet models, and current and future programs here, in Kansas, in Colorado and in Copenhagen will begin to introduce this information to ice sheet modeling efforts for both Greenland and Antarctica.

Afternoon Session

(10 minutes talk and 2 minutes questions)

02:42 PM

The atmospheric footprint of the Antarctic Cold Reversal in southern middle latitudes

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As registered in ice cores, the Antarctic Cold Reversal (ACR) constituted a stall, accompanied by slight cooling, in the warming over Antarctica during the last glacial termination. The regional extent of the ACR beyond the Antarctic continent is unresolved, however, and hence the cause of the ACR remains a puzzle of Southern Hemisphere palaeoclimatology. Here, we present a ^{10}Be surface-exposure

chronology of novel accuracy dating a classic late-glacial moraine set of the Southern Alps, New Zealand. This chronology documents a glacier resurgence culminating at 12,970 ± 300 years ago, at the end of the ACR, followed by marked recession that tracked Antarctic warming and CO_2 rise. These results extend the footprint of ACR atmospheric cooling over Antarctica and the Southern Ocean as far north as the middle latitudes of the Southern Hemisphere. We suggest that interlocked shifts of southern mid-latitude westerlies and atmospheric CO_2 produced this extensive ACR signal.

03:06 PM

Detroit Plateau Ice core – glaciochemical records

Mariusz Potocki, 1 Climate Change Institute and Department of Earth Sciences, University of Maine, 2 Department of Antarctic Biology, Polish Academy of Sciences, Poland
Paul Mayewski, 1 Climate Change Institute and Department of Earth Sciences, University of Maine
Andrei Kurbatov, 1 Climate Change Institute and Department of Earth Sciences, University of Maine
Michael Handley, 1 Climate Change Institute and Department of Earth Sciences, University of Maine
Douglas Introne, 1 Climate Change Institute and Department of Earth Sciences, University of Maine
Sharon Sneed, 1 Climate Change Institute and Department of Earth Sciences, University of Maine

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The Detroit Plateau (DP) 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°C decade^{-1}, *Turner et al., 2005*).
The goal of this study is to reconstruct the past temperature, precipitation, atmospheric circulation, and air mass chemistry over the Antarctic Peninsula and South America. This project, based on DP ice coring, is also part of CASA (Climate of Antarctica and South America). The aim of CASA to provide the 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 (~5m, over the last 4 years). The 98 meter deep core covers ~30 years from the end of the 1970s to 2007. Trace metal analysis reveals pronounced enhancement in concentrations attributed to emissions of heavy metals to the atmosphere from human activities in South America and Australia, especially non-ferrous metal mining and smelting in Chile and Australia. Moreover, it is observed that atmospheric pollution for heavy metals is not limited to Pb and Cu, but also affects several other metals such as U and Cd.

03:18 PM

2010 Research Update: Late Glacial Environmental Change and Early Human Exploration of the High Andes, Peru

Kurt Rademaker

Our team's discovery of potentially early archaeological sites at the Pucuncho wetland (4365 m), southern Peru, suggests that Paleoindians were exploring and possibly settling the high Andes during the late-glacial period, the highest areas on earth entered by people at that time. This coming field season we will conduct geoarchaeological and paleoecologic investigations to better understand the timing, duration, seasonality, and environmental context of these settlements.

03:30 PM

2MBIA09 - Searching for the Oldest Ice on Earth

Nicole Spaulding, Climate Change Institute & Department of Earth Sciences, University of Maine
Andrei Kurbatov, Climate Change Institute & Department of Earth Sciences, University of Maine
Paul Mayewski, Climate Change Institute & Department of Earth Sciences, University of Maine

2MBIA is a collaborative research project focusing on the exploration of a potentially 2.5 million year ice climate archive from the Allan Hills blue ice area of Antarctica. Currently the time period covered by existing ice cores is 800,000 years. Extension of the record of global paleoatmospheric chemistry, volcanism, dust and greenhouse gas concentrations beyond 800 ka may help to eliminate fundamental uncertainties in our understanding of natural and human imposed climate change by revealing the nature of the 40 kyr world, the transition from the 40 kyr world to the 100 kyr world, as well as that of millennial scale events. This talk will summarize the current state of understanding concerning the cyclicity of past climate and expand upon the benefits of a record from Allan Hills.
The time range encapsulated in this region in combination with its ease of accessibility makes it an extremely attractive location for continued paleoclimate research. Our vision for future work in Allan Hills will also be discussed.

03:42 PM

Increase in barium concentration since 1980 AD as recorded in SPRESSO ice core

Elena Korotkikh, Climate Change Institute
Paul Mayewski, Climate Change Institute
Michael Handley, Climate Change Institute

Barium and other trace elements (Na, Mg, Ca, Sr, Cd, Cs, La, Ce, Pr, Pb, Bi, U, As, Al, S, Ti, V, Cr, Mn, Fe, Co, Cu, Zn, Li and K) have been measured in the upper ~18-meter of the SPRESSO (South Pole Remote Earth Science and Seismological Observatory) ice core from South Pole at a temporal sample resolution of ~12 samples per year. This section covers the period from 1910 to 2002 AD. Low background concentrations of barium (~19 ng/L) are observed until 1980 AD, after which increased barium concentrations (~292 ng/L) suggest an anthropogenic influence. The barium enrichment factor rises from ~0.8 before 1980 AD to ~9 (with a maximum values reaching 44) after 1980 AD. The increase in barium since 1980 AD may be attributed to increased coal production in Australia during this time. However, activity at Amundsen-Scott South Pole Station could also be responsible for the barium rise.

03:54 PM

The North Atlantic Oscillation and the Greenland Ice Sheet

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Variations in atmospheric circulations exert a major influence on continental glaciations and the health of ice sheets. The Greenland Ice Sheet is particularly exposed to the North Atlantic Oscillation (NAO), a well-known atmospheric fluctuation in sea level pressure between the Icelandic Low and Bermuda-Azores High. Average surface temperature and total precipitation data from six distinctive years in the NAO record are used to drive University of Maine Ice Sheet Model (UMISM) simulations of the Greenland Ice Sheet under these persistent atmospheric conditions. Comparisons to a modern-day Greenland Ice Sheet reconstruction identify the resulting changes to the ice sheet. NAO is chosen

as a characteristic climate driver because it is an identifiable major modern oscillation influencing temperature and precipitation on Greenland and may aid in predicting the future response of the Greenland Ice Sheet as well as along with improving the interpretation of its past.

04:06 PM

Dogs and Garbage: A specialzed taphonomy at work in Machias, Maine

Rob Ingraham, University of Maine

Faunal remains deposited in the shell-rich middens of Machias Bay on the Northern Maine Coast have been well preserved, and may offer a unique view into the complex relationships between human occupants and the foods they consumed. Field school excavations spanning from 1973 to 2009 have provided a wealth of data, from which surprising trends have emerged, shedding light on ethnographically supported forms of "hunting magic" in practice at the site. Full understanding of these patterns hinges not only on what is present, but what is absent, and will be used to actively modify the model for further investigation at the site in June of 2010.

04:18 PM

Accumulation Rate Effects on High Precision Density Profiles of Antarctic Firn Cores

Daniel Breton, University of Maine Physics / Climate Change Institute

Firn density profiles of the WAIS Divide core and several East Antarctic cores have been measured by the Maine Automated Density Gauge Experiment (MADGE). Using an optimized gamma-ray density gauge, MADGE produces continuous density profiles at 3.3 mm resolution and a typical density uncertainty of ±0.004 g/cm^3. Analyses of these density profiles demonstrate the distinct changes in density variability and densification patterns between cores collected in areas of differing accumulation rates. These results are directly applicable to both firn densification studies and models of electromagnetic wave propagation for remote sensing platforms.

04:30 PM

Better Physics for Modeling Ice Streams in Ice Sheets

Debra Kenneway
James Fastook

Inland glaciers are commonly modeled using the shallow-ice approximation which neglects all stresses except basal drag. Ice shelves are commonly modeled using the Morland equations which neglect all stresses except longitudinal stresses. Ice streams are transitional between inland glaciers and ice shelves. Hence the full momentum equations must be solved in which no stresses are neglected.

This work models ice streams as a multiphysics system of coupled components. The nonlinearity of the material properties adds to the complexity of the coupled nature of the problem making it difficult to solve for components. In addition, sliding is physical feature that must be included in the model. To do this, we model sliding using a new slippery layer approach.

04:42 PM

Massaging raw data to interpretable results using *P301dx*

Mark Royer, Computer Science, UMaine
Sudarshan Chawathe, Computer Science and CCI, UMaine
Andrei Kurbatov, CCI, UMaine
Paul Mayewski, CCI and Earth Sciences, UMaine

P301dx is a workbench for managing scientific datasets related to climate-change research, with an emphasis on data from ice cores. A primary objective of P301dx is enhancing and accelerating the process of transforming raw datasets, such as those emerging from instruments, into meaningful representations that allow data to be easily interpreted. This process of transforming the data includes sub-tasks such as data cleaning, data integration, data mining, end-user programming, visualization, and provenance management. P301dx enables these tasks to be performed iteratively and with interactive response times, in a context that is tailored to the specific needs of climate-change researchers. We demonstrate these ideas using a few representative examples drawn from our recent and ongoing work with a group of CCI researchers (faculty, staff, and students).

Day 2

07:30 AM Coffee & Light Refreshments

08:00 AM Summary for the day

Morning Session

(10 minutes talk and 2 minutes questions)

08:12 AM

Improving Drought Reconstructions in Prairie Saline Lakes in the Great Plains (USA): An Ecological Perspective

Courtney Wigdahl, University of Maine
Jasmine Saros, University of Maine

Fossil diatoms preserved in sediments of prairie saline lakes are frequently used to reconstruct drought. However, diatom-based drought reconstructions from different sites in the Great Plains have yielded disparate results. Here we investigate whether drought-related changes in lake level alter food web interactions and subsequently modify the fossil diatom record. Cladoceran zooplankton remains were analyzed in sediment cores from Moon Lake and Coldwater Lake (North Dakota, USA) in order to assess changes in food web interactions and habitat characteristics. Key zooplankton taxa differ across lakes and time, with *Bosmina* sp., *Alona* sp., and *Chydorus sphaericus* present in Coldwater Lake, and larger bodied taxa present in Moon Lake. These data, in combination with additional biological and physical proxies, suggest differences in grazing pressure on diatoms between the two lakes, and will aid in improving the accuracy of drought indicators and paleosalinity reconstructions for the Great Plains.

08:24 AM

How do trace chemical species vary over the Antarctic on seasonal to centennial scales and what can be considered the natural background?

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Mike Handley, Climate Change Institute
Sharon Sneed, Climate Change Institute

An inductively coupled plasma mass spectrometer (ICP-MS) allows us to measure over 35 different elements at ultra-trace levels using less than 2.5ml of sample volume. In the field of ice core glaciochemistry this instrument affords us many new and exciting opportunities to examine climate parameters as represented by the chemistry trapped in ice cores. Several of these ICP-MS elements exhibit a seasonal signal in our ice cores. This presentation will elucidate on a number of these and examine mechanisms such as source strength and atmospheric transport pathway.

08:36 AM

Exploring Patterns of Nitrogen Loading from Glaciers in the Lakes of Torres del Paine, Chile

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An increase in glacial run-off has been observed in alpine regions worldwide. Recent research in the Rocky Mountains of North America has revealed that meltwater from glaciers is nitrate rich. Meltwater drains into lake ecosystems, thereby enriching them with nitrate to levels two orders of magnitude higher than lakes not receiving meltwater. Nitrogen is a key limiting nutrient in alpine lakes, hence this influx of nitrate-rich glacial meltwater may have profound effects on productivity and species diversity in these systems. However, research on the effects of meltwater on the chemistry of alpine lakes has largely occurred in the northern hemisphere. Therefore, an expedition was conducted to sample lakes that are and are not receiving glacial meltwater to ascertain if similar patterns exist in the Andes. The results suggest glacial inputs do affect the amount of available nitrogen in alpine systems and have the potential to cause shifts in phytoplankton communities.

08:48 AM

Understanding Environmental Controls on Calving Events in Greenland

Kristin Schild, University of Maine, Climate Change Institute
Gordon Hamilton, University of Maine, Climate Change Institute
Leigh Stearns, University of Kansas

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 and developing a simple computer model which incorporates these frontal changes in geometry to understand their impact on up-glacier flow behavior. *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.

09:00 AM

Impacts of White Perch Introductions on Lake Plankton: Combining

Paleolimnological and Whole-Lake Biomanipulation Approaches

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Introduction and removal of planktivorous fish in lakes can alter plankton communities via cascading interactions in food webs. Less is known about the long-term effects of the introduction of fish with more generalist feeding habits. Both whole-lake biomanipulation and paleolimnological approaches were used to analyze the responses of plankton communities to the introduction of white perch (*Morone americana*), a fish that often dominates fish assemblages and switches from planktivory to omnivory (including benthic insects and juvenile fish) during maturation. Results suggest an increase in zooplankton body size and decrease in algal production following white perch introduction. These results are counter to predictions from a top-down trophic cascade as may be expected from the introduction of strictly planktivorous fish. This study highlights the importance of trophic interactions in structuring lake food webs and the utility of combining approaches that span spatial and temporal scales to investigate complex trophic interactions in lakes.

09:12 AM

Probable Australian Dust Source for West Antarctica

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All previous deep ice core data from Antarctica have identified South America as the dominant dust source. However, dust provenance has not been identified for West Antarctica, where we hypothesize that Australia is the primary source of dust. Here, we present preliminary results from proton-induced x-ray and gamma-ray emission (PIXE-PIGE) and microprobe analysis of atmospheric dust from surface snow at the West Antarctic Ice Sheet Divide ice core drilling site. Results indicate that Australia is the probable source for West Antarctica, although some overlap with East Antarctic

dust chemistry suggests that Patagonia cannot be excluded. Identifying dust source for West Antarctica will provide insight into dominant atmospheric circulation patterns and has implications for our understanding of Fe biogeochemistry in the Pacific sector of the Southern Ocean.

09:24 AM

Climate-induced variations in the Indicators of Hydrologic Alteration of the Han River, Korea

Jongsuk Kim, Department of Civil and Environmental Engineering, University of Maine
Shaleen Jain, Department of Civil and Environmental Engineering, University of Maine

Typhoons in the western North Pacific basin exert a strong influence on the hydrologic variation in the Korean region. Recent climate assessments suggest that the number and intensity of cyclones is likely to increase during the 21st century. We pursue a diagnostic study of the impact of typhoons on the hydrologic variability in the Han River Basin. Furthermore, as a managed system, the impact of altered hydrologic regime on stream and riparian ecosystems is an important consideration for developing appropriate environmental flow standards. Given the increasing stresses due to water allocation, urbanization in the floodplains and future plans for new dams, this river basin is especially vulnerable to hydrometerological extremes-the nature and scale of future changes continues to be an urgent concern for water resources management, planning, and design of infrastructure.

09:36 AM

Was the Late-glacial advance at ~14.0 ka B.P. in Torres del Paine (South Patagonia, 51ºS) the most extensive glacial pulse of Oxygen Isotope Stage 2?

Juan Luis García, Earth Sciences Department and Climate Change Institute

The last glacial cycle in Torres del Paine is represented by four main moraine belts (TDP I-IV, from outer to inner). Fifty-nine cosmogenic surface-exposure 10Be dates from boulders on top of these moraines allow us to make the following preliminary conclusions: (1) The maximum glacial extent occurred at 41.0 ka BP, well before the LGM at most Northern Hemisphere sites, but similar to an event in New Zealand; (2) Ice was nearly as extensive at ~14.5 ka, during the Antarctic Cold Reversal; such a large late-glacial advance, relative to the LGM extent, is abnormal. There are no moraines between those dated to ~14.5 ka and 41 ka. These conclusions raise the question of why there are no LGM (~20-25 ka) moraines or why the local LGM occurred at ~14.5 ka BP and not at 20-25 ka BP as recorded elsewhere in the Southern Hemisphere.

09:48 AM

Snow Accumulation Variability Across Antarctica

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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. Snow accumulation varies on both local and regional scales across Antarctica. A lack in data makes not only quantifying the mass input component difficult but the mass balance as well.

Continuing on work done by previous UMaine graduate students, we are further developing a method of calculating accumulation rates, and thus the volume of mass coming into the continent, by combining GPS, ground-penetrating radar (GPR), and ice core data. Here we present methods, new results, and ongoing challenges.

10:00 AM Break

10:15 AM

The Effect of Climate Change on Territory Quality in the Common Loon (Gavia Immer)

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Common loons (*Gavia immer*) maintain one of three territory types during the breeding season and high quality habitat is often defended by the highest quality individuals within a population. Offspring production in loons is consistent within a territory even as territory ownership varies. Climate forecasts indicate that the common loon breeding range will shift northward and will ultimately not include Maine lakes. Due to this probable alteration in breeding range, we will attempt to validate climate models by matching the predicted conditions with the range of variation over the past twenty years. We aim to quantify the expected shift in lake territory quality with respect to loon breeding success. Additionally, we will compare energetic cost and reproductive success on lakes that are correlated with anticipated future lake quality measures versus current lake quality measures.

10:27 AM

Oldest Evidence for Domestic Dog in the New World

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A portion of a dog skull was found in paleofeces directly dated to 9400 cal. B.P., representing the oldest evidence for domestic dog in the New World. The bone was identified through zooarchaeological examination and DNA analysis, and provides the oldest evidence for the consumption of dog. The paleofecal sample was recovered from Hinds Cave in southwest Texas, and confirms the Old World origins of ancient American domestic dogs.

10:39 AM

Timing of the Last Glacial Termination in the Western United States

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Recent improvements in cosmogenic ^{10}Be dating methods allow for the construction of precise glacial chronologies. Research in the western United States has yielded consistent dates for the timing of the last termination. New ^{10}Be dates from the Wind River Range, Wyoming suggest the termination took place 17,800 yrs ago and progressed slowly until 16,100 yrs ago, after which time the Wind River Ice Cap retreated rapidly. A new study of the type-Pinedale moraines at Fremont Lake will provide a detailed retreat sequence, which may then be compared to other areas of the world.

10:51 AM

Glaciological Reconstruction of the Wind River Ice Cap, Wind River Mountains, Wyoming, USA

Sean Birkel, University of Maine
Aaron Putnam, University of Maine
George Denton, University of Maine
Peter Koons, University of Maine

We used a glaciological model to reconstruct the former Wind River Ice Cap in an examination of western U.S. climatological conditions before and during the last glacial termination. Our model demonstrates the ice cap could have formed in response to a 5°C cooling in conjunction with a doubling of precipitation relative to modern values. These results are consistent with an expanded polar atmospheric cell, and southward-shifted westerly circulation during glacial times. Deglaciation experiments reveal that the former ice cap was extremely sensitive to snowline changes, and that a 3-4°C warming could have reduced the system to isolated cirque glaciers within 100 years. The latter is in good accord with geomorphic evidence indicating that ice throughout the range was restricted to cirques following the termination.

11:03 AM

Modeling energy balance and melt layer formation on the Kahiltna Glacier, Alaska

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Understanding melt on alpine glaciers is required both for accurate mass balance modeling and ice core paleoclimate reconstruction. In alpine regions with complex meteorology and topography, modeling melt through the quantification and balance of all identifiable energy fluxes is the most complete way of describing how local meteorology influences melt layer formation and snowpack evolution. To meet this goal at our field site on the Kahiltna glacier, located in the Alaska Range, we have developed an energy balance model from 2008 meteorological data from Kahiltna Base Camp (2100 m elevation). Current model results show the dominance of turbulent heat transfer at the study site and the importance of site parameters in controlling melt. Changing albedo, for instance, by 10% increases melt by 50%. This May, we will sample the snowpack across the glacier for analysis of stratigraphic and chemical evolution in relation to another year of weather data to improve our understanding of melt layer formation.

Final Remarks/Discussion

12:00 PM BBQ/Lunch