http://gcmd.nasa.gov/Data/portals/amd/. Contributing your own data descriptions for Antarctic data that you have collected is also easy. Scientists can start by submitting a short data description first (as a placeholder in the AMD, and to satisfy National Science Foundation (NSF) reporting requirements), and then add to, modify or update their record whenever it is appropriate. An easy to use on-line tool and a simple tutorial are available at: http://nsidc.org/usadcc. With NSF Office of Polar Programs (OPP) funding, the National Snow and Ice Data Center (NSIDC) operates the U.S. Antarctic Data Coordination Center (USADCC), partly to assist scientists in using and contributing to the AMD. The USADCC website is at http://nsidc.org/usadcc.

URL: http://nsidc.org/usadcc

PP31C-0273 0830h POSTER

Antarctic Glaciological Data at NSIDC: field data, temperature, and ice velocity

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An extensive collection of many Antarctic glaciological parameters is available for the polar science community upon request. The National Science Foundation's Office of Polar Programs funds the Antarctic Glaciological Data Center (AGDC) at the National Snow and Ice Data Center (NSIDC) to archive and distribute Antarctic glaciological and cryospheric system data collected by the U.S. Antarctic Program. AGDC facilitates data exchange among Principal Investigators, preserves recently collected data useful to future research, gathers data sets from past research, and compiles continent-wide information useful for modeling and field work planning. Data sets are available via our web site, http://nsidc.org/agdc/. From here, users can access extensive documentation, citation information, locator maps, derived images and references, and the numerical data. More than 50 Antarctic scientists have contributed data to the archive. Among the compiled products distributed by AGDC are VELMAP and THERMAP. THERMAP is a compilation of over 600 shallow firn temperature measurements ('10-meter temperatures') collected since 1950. These data provide a record of mean annual temperature, and potentially hold a record of climate change on the continent. The data are represented with maps showing the traverse route, and include data sources, measurement technique, and additional measurements made at each site, i.e., snow density and accumulation. VELMAP is an archive of surface ice velocity measurements for the Antarctic Ice Sheet. The primary objective of VELMAP is to assemble a historic record of outlet glaciers and ice shelf ice motion over the Antarctic. The collection includes both PI-contributed measurements and data generated at NSIDC using Landsat and SPOT satellite imagery. Tabular data contain position, speed, bearing, and data quality information, and related references. Two new VELMAP data sets are highlighted: the Mertz Glacier and the Institute Ice Stream. Mertz Glacier ice velocity provides an upper limit for change in velocity for this glacier over the past decade. Two pairs of Landsat images were used to compare velocities from 2000-2001 to 1989-2000. No significant change in velocity is observed. A new ice discharge flux of 17.8 km3a-1 was determined, and basal melting at the grounding line was re-calculated at 11 m per year (Berthier et al., 2003, in press). Velocity data for the Institute Ice Stream was compiled at NSIDC using a Landsat images from 1986, 1989, and 1997. The data were recently used in a study outlining the velocity, mass balance, and morphology of the Institute ice stream and nearby Ronne ice shelf area. (Scambos et al., 2003, in review). The study indicates the Institute has regions with flow and morphology characteristics similar to the Ross Embayment ice streams. Ice velocity research contributes to understanding the mass balance and overall stability of the Antarctic Ice Sheet. The archiving of velocity data has proven to be a useful tool to the Antarctic science community, and VELMAP continues to grow as a valuable resource through PI contributions. If you have velocity data that you would like to contribute to the VELMAP archive please contact agdc@nsidc.org. The velocity data used in the two studies presented here can be accessed on the VELMAP web site at http://nsidc.org/data/velmap.

URL: http://nsidc.org/agdc

PP31C-0274 0830h POSTER

Past Ice Flow in Pine Island Bay, West Antarctica, From Marine Geophysical Evidence

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Marine geophysical and geological data from two recent cruises allow us to investigate the past extent and flow of a late Quaternary ice sheet in Pine Island Bay (PIB). Swath bathymetric data show that the shelf deepens inshore, and that cross-shelf troughs are present on both the inner and outer shelf. Three main types of sea-floor bedform were observed on the shelf. (a) Bedrock, with associated drumlinoid features probably formed by glacial erosion of the inner shelf. (b) Streamlined, elongate bedforms formed in soft sediments, found mainly in troughs on the mid and outer shelf and extending to the shelf edge. These features are interpreted as glacial lineations, inferred to be a product of soft-sediment deformation beneath former ice streams. They allow reconstruction of past ice-flow direction, and may also define former ice streams. Their presence at the shelf edge confirms that ice filled PIB at the last glacial maximum. Sub-bottom profiler records confirm that the sea floor is sedimentary and that there are in some places reflectors at a few metres depth defining an upper unit in whose surface the lineations are formed. Sometimes several reflectors appear to cross-cut one another, each with a similar acoustic unit above, suggesting shifting paleo-ice stream margins. (c) A highly irregular pattern of linear scour marks found in water depths <450-500 m, representing sediment reworking by iceberg keels produced from the 500 m or so thick floating tongues of the modern Pine Island and Thwaites glaciers. Geophysical evidence from the continental slope beyond PIB between 107° to 115°W shows several sets of gullies or channels, up to about 100 m deep and 30 km long. The gullies are found mainly in two 50 km-wide groups at 113°20'W and 108°40'W. On the mid-slope and beyond, in over 2000 m of water, there is some evidence of wider channels, indicating that downslope transfer of glacier-derived sediments has taken place from the continental slope to the Amundsen Sea abyssal plain. During full-glacial conditions, sediments and meltwater would have been delivered from the ice front directly at the shelf break, leading to downslope mass-wasting, probably as turbidity currents and debris flows. It is likely that the gully or channel systems were formed by mass-flow activity, driven by either sediment-laden glacial meltwater or cold and saline water associated with sea-ice formation in a semi-permanent polynya at the former ice-sheet margin.

PP31D MCC: 3004 Wednesday 1020h

The Last Interglacial I *(joint with A, OS, C, GC)*

Presiding: **G H Miller,** University of Colorado**; B L Otto-Bliesner,** National Center for Atmospheric Research

PP31D-01 1020h INVITED

The Eem Interglacial Strata in the Deep Greenland ice Cores. New Compelling Evidence From the NorthGRIP ice Core for the 5e/5d Transition.

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While most Antarctic deep ice cores have Eem strata with high stratification integrity, Eem strata found in most Greenland deep ice cores show disrupted layering. In contrast, the order of magnitude higher accumulation rates in Greenland move these layers close to bedrock where they can be badly disrupted by ice flow over bedrock undulations. A perfect example is found in the GRIP and GISP2 ice cores. The isotope profiles are almost identical back to MIS 5c and uncorrelated below the onset of 5c. In this near bottom ice several layers with 3 per mille higher oxygen isotope ratios are found in both cores pointing to ice of warm Eem origin. In other deep cores like Camp Century, Renland and Dye-3, Eemian like ice is found in the very lowest strata boosting 4 to 5 per mille higher oxygen isotope ratios than the corresponding present day values. This implies that there was ample ice in NW Greenland and on South Dome during the Eem interglacial. The NorthGRIP core has suffered strong bottom melting due to high geothermal heat fluxes south of the drill site. This has, combined with the flat bedrock, helped to preserve the stratification all the way to bedrock while estimated 7 ka of the early Eem strata together with all older ice has been melted away. The warmest and deepest ice from the NorthGRIP Eem has the same isotopic values as the GRIP and GISP2 layers that we have assigned to the Eem period. Correlation with the planktonic isotopes of the Iberian margin core MD95-2042 for the Eem/last glacial transition shows that known cold pollen events like Montaigue and Melisey I make a definit imprint on the NorthGRIP isotope profile. A new Greenland isotope interstadial IS25 is found at the very end of the Eem interglacial.

PP31D-02 1035h

Estimating peak last-interglacial warmth in the Eastern Canadian Arctic

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The last interglacial is represented by stratified lake sediments and buried soils across much of Baffin Island, Arctic Canada. Seven lakes situated distal to the limits of the last glacial maximum Laurentide Ice Sheet outlet glaciers preserve undisturbed interglacial sediments, and one lake just inside this limit yielded stratified interglacial sediment beneath a thin till. Macrofossil remains from all of the interglacial units yield radiocarbon dates in excess of 40 ka. Two of the sites have been dated by luminescence methods to more than 90 ka. All exhibit evidence of terrestrial summers warmer than at any time in the Holocene. Pollen assemblages are dominated by exotic taxa, mostly Alnus and Betula that do not currently live at these sites. Pollen percentages and absolute concentrations are much higher than at any time in the Holocene, but difficulties in separating exotic influxes from locally produced pollen limit quantitative summer paleotemperature estimates. Chironomid assemblages provide a second summer-temperature proxy, and because they live where they are found, are less susceptible to the uncertainties characteristic of palynology at high latitudes. Chironomid transfer functions are based on 40 modern surface samples from Baffin Island, and additional sites from eastern North America and Greenland. One third of the interglacial chironomid taxa are extralimital; collectively the interglacial taxa from two lakes suggest summer temperatures 3 to 10°C higher than in the Holocene. An alternative method for quantifying summer temperatures is reconstructing d18O of precipitation from the d18O of chironomid larvae chitin. Assuming similar basic circulation patterns in the last and present interglacials, we can estimate mean annual temperatures from the reconstructed d18O of precipitation. These independently derived estimates (one lake) suggest peak last interglacial warmth 2°C higher than the mid Holocene.

PP31D-03 1050h INVITED

The Last Interglacial in the Northern and Southern Hemispheres

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Evidence from several North Atlantic deep-sea sediment cores indicates that interglacial warmth outlasted the ice volume minimum during marine isotope substage 5e (MIS5e). It has been suggested that this lag may be the result of northward heat transport by a vigorous meridional overturning circulation at the same time that glaciers began to build up during MIS 5d. We first examine this temporal relationship of warm sea-surface temperatures (SST) and ice growth to confirm the spatial pattern of prolonged warmth. We then show a close correspondence between deep-sea cores and the new North Grip isotope record from Greenland, demonstrating a regional coherence to the climate pattern. We next investigate two proxies for the deep circulation, benthic d13C and 231Pa/230Th, from the Atlantic, in combination with a new benthic d13C record from the deep Pacific. Finally we compare proxies for the surface and deep hydrography in the North Atlantic to new records from sites in the Southern hemisphere in order to determine the phasing of hydrographic changes in the respective hemispheres before, during and after MIS 5e. One southern site is in the western subtropical Atlantic near the Brazil margin. The other is in the eastern subpolar Pacific, near the Chilean margin. Our results provide insights into the deepwater-climate connection between north and south.

PP31D-04 1105h

Milankovitch Forcing of Last Interglacial Warming of the Arctic

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The Arctic climate response at the Last Interglacial (LIG) to Milankovitch changes of solar radiation is simulated using the fully coupled, non-flux corrected National Center for Atmospheric Research (NCAR) Community Climate System Model (CCSM2). The model is forced with trace gas concentrations and solar insolation changes for 130 ka. At 70°N, positive solar insolation anomalies at the top of the atmosphere occur from March-July with a maximum anomaly in excess of 70 W m-2 in May. The Arctic positive solar anomalies exceed those of the Holocene from 133-127 ka. During the LIG summers, the CCSM indicates warming up to 3°C over the Arctic Ocean and significant reduction in sea ice. The large positive solar anomalies in late spring-early summer allow sea ice to melt earlier resulting in enhanced summer warming of circum-Arctic ocean waters. Greenland warms by 1-5°C during the summer months with surface temperatures above freezing in the southern and coastal areas. The depth of snow remaining year-round decreases along the northern, western and southern edges of the Greenland ice cap. These simulations agree with proxy evidence of summer warming over the circum-Arctic land areas but underestimate the magnitude of warming over Siberia and southern Greenland. Feedbacks with vegetation and land ice, both fixed at present-day distributions in the LIG simulations, will need to be explored in additional simulations. Summer Arctic sea ice retreat and Greenland warming simulated by the CCSM for the LIG and increasing atmospheric CO2 levels will be compared.

PP31D-05 1120h INVITED

Ice-Sheet Model Simulations of the Greenland Ice Sheet and Canadian Arctic Ice Caps in the Last Interglacial Period

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An ice sheet model is used to reconstruct high Arctic ice masses during the last interglacial period, based on climate model simulations from the NCAR CSM (B. Otto-Bleisner, unpublished). The ice dynamics models includes subgrid topographic and mass balance parameterizations that allow simulation of regional-scale icefields in the Canadian Arctic. Model simulations address the hypothesis of Koerner and Fisher (2002) that high Arctic icefields retreated dramatically in the last interglacial period. Simulations of Greenland Ice Sheet retreat based on ice-core climate reconstructions are compared to Eemian ice sheet reconstructions driven by the NCAR CSM simulations. The time scale of Eemian ice sheet retreat is discussed in the context of comparisons between Eemian and future climate change.

References

Koerner, R.M. and D.A. Fisher, 2002, Ice-core evidence for widespread Arctic glacier retreat in the Last Interglacial and the early Holocene. Annals of Glaciology, 35, 19–24.

PP31D-06 1135h

A modeling experiment on the grounding of an ice shelf in the central Arctic Ocean during MIS 6

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High-resolution chirp sonar subbottom profiles from the Lomonosov Ridge in the central Arctic Ocean, acquired from the Swedish icebreaker Oden in 1996, revealed large-scale erosion of the ridge crest down to depths of 1000 m below present sea level [Jakobsson, 1999]. Subsequent acoustic mapping during the SCICEX nuclear submarine expedition in 1999 showed glacial fluting at the deepest eroded areas and subparallel ice scours from 950 m water depth to the shallowest parts of the ridge crest [Polyak et al., 2001]. The directions of the mapped glaciogenic bed-forms and the redeposition of eroded material on the Amerasian side of the ridge indicate ice flow from the Barents-Kara Sea area. Core studies revealed that sediment drape the eroded areas from Marine Isotope Stage (MIS) 5.5 and, thus, it was proposed that the major erosional event took place during Marine Isotope Stage (MIS) 6 [Jakobsson et al., 2001]. Glacial geological evidence suggests strongly that the Late Saalian (MIS 6) ice sheet margin reached the shelf break of the Barents-Kara Sea [Svendsen et al. in press] and this gives us two possible ways to explain the ice erosional features on the Lomonosov Ridge. One is the grounding of a floating ice shelf and the other is the scouring from large deep tabular iceberg. Here we apply numerical ice sheet modeling to test the hypothesis that an ice shelf emanating from the Barents/Kara seas grounded across part of the Lomonsov Ridge and caused the extensive erosion down to a depth of around 1000 m below present sea level. A series of model experiments was undertaken in which the ice shelf mass balance (surface accumulation and basal melting) and ice shelf strain rates were adjusted. Grounding of the Lomonosov Ridge was not achieved when the ice shelf strain rate was 0.005 yr-1 (i.e. a free flowing ice shelf). However this model produced two interesting findings. First, with basal melt rates of up to 50 cm yr-1 an ice shelf grew from the St. Anna Trough ice stream across the section of the ridge where there is evidence for grounding. Second, even with ultra low rates of basal melting, the ice shelf thickness was always less than 200 m over the ridge. We conclude that grounding of the Lomonosov Ridge by a free-flowing ice shelf is not possible. When the strain rate was reduced to zero, however, the shelf thickness increased substantially. Such conditions are likely only to have occurred during periods of large-scale glaciation across the Eurasian Arctic such as in the Saalian, and if a substantial stagnant thickened sea ice was present in the ocean, buttressing the shelf flowing from the Barents Sea. Our results are interpreted using new techniques for dynamic 3D-visualization. Jakobsson, M., Løvlie, R., Arnold, E. M., Backman, J., Polyak, L., Knutsen, JO., and Musatov, E., , Pleistocene stratigraphy and paleoenvironmental variation from Lomonosov Ridge sediments, central Arctic Ocean, Global and Planetary Change, 31(1-4), 1-21, 2001. Jakobsson, M., First high-resolution chirp sonar profiles from the central Arctic Ocean reveal erosion of Lomonosov Ridge sediments, Marine Geology, 158, 111-123, 1999. Polyak, L., Edwards, M. H., Coakley, B. J. and Jakobsson, M., Ice shelves in the Pleistocene Artic Ocean inferred from glaciogenic deep-sea bedforms, Nature, 410, 453-457, 2001. Svendsen, J.I. et al, Late Quaternary ice sheet history of Nortern Eurasia, submitted to Quaternay Science Reviews, in press.

PP31D-07 1150h

Synchronous high lake levels in East Africa at 135 kyr BP

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Variations in the temporal and spatial distribution of solar radiation caused by orbital changes provide a partial explanation for the observed long-term fluctuations in African lake levels. The understanding of such relationships is essential for designing climate-prediction models for the tropics. Our assessment of the nature and timing of East African climate change is based on lake-level fluctuations of the Central-Kenyan- Rift Lakes Naivasha and Nakuru-Elmenteita, as they were inferred from sediment characteristics, diatoms, authigenic mineral assemblages and single-crystal 40Ar/39Ar age determinations on intercalated tuff layers. Using a simple lake-balance modeling approach, potential precipitation-evaporation changes in the lake basins were estimated. Our results show that the hydrologic and hence the climate conditions in East Africa at 135 kyr BP were significantly different from today. The main difference is a 15% higher value in precipitation compared to the present. An adaptation and migration of vegetation in the cause of climate changes would result in a 30% increase in precipitation. Assuming that these fluctuations reflect orbitally-induced climate changes, the lake records demonstrate that periods of increased humidity in East Africa mainly followed maximum equatorial solar radiation in March or September. Interestingly, the reconstructed high lake levels are consistent with other well-dated low-latitude climate records, but do not correspond to peaks in Northern Hemisphere summer insolation as the trigger for the ice-age cycles. Our East African lake records therefore provide evidence for low-latitude forcing of the ice-age climate cycles.

PP31D-08 1205h

Comparative Molecular Biomarker Assessment of Phytoplankton Paleo-productivity for the last 160 kyr off Cap Blanc, N.W. Africa

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High-resolution molecular data for chlorins, alkenones, dinosterol, long chain diols and n-alkanes/n-alkanols, and for TOC and opal from ODP Site 658 (20^o45'N, 18^o35'W; 2,263 m water depth) are compared to evaluate paleo-productivity changes for this upwelling site over the last two glacial/interglacial cycles. The content of chlorins is used as a total phytoplankton productivity proxy, while the contents of opal, dinosterol, alkenones and diols are used as productivity proxies for diatoms, dinoflagellates, haptophyceae and eustigmatophytes, respectively. Five high total productivity intervals (HPI) are identified: two at the glacial/interglacial transition boundaries of 132-122 ka and 15-8 ka, two within the warmer periods of MIS3 (50-30 ka) and the late Holocene (4-0 ka), and only one within the glacial period of MIS 4 (67-60 ka). Productivity was the lowest during both the penultimate glacial maximum of MIS 6 (150-140 ka) and the last glacial maximum (22-18 ka), as revealed by both the total phytoplankton and individual phytoplankton productivity indicators. However, during the transitions from lower to higher productivity of the Termination II HPI, the algal productivity increases started with diatoms and eustigmatophytes, followed by dinoflagellates, and then haptophyceae. This type of sequence operating over hundreds to thousands of years is provisionally termed <ETH>chrono-eco-successionî. Such sequences are discussed in context of the changing amounts and nature of nutrient inputs contributed by the various regional sources, including eolian dusts, river influxes, ocean currents and upwelling water masses.

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