PP21A MC: Hall D Tuesday 0830h

Modes and Mechanisms of Holocene Climate Variability *(joint with IP, A, OS, GC)*

Presiding: **P B deMenocal,** Lamont-Doherty Earth Observatory of Columbia University**; L D Keigwin,** Woods Hole Oceanographic Institution

PP21A-0455 0830h POSTER

High - Resolution Carbonate Cycles in the Holocene Slope Wedge of Great Bahama Bank

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The main research topics of this project are the evaluation of the Holocene to Recent carbonate production, distribution, and overall sedimentation pattern.LECO - Carbon analyser, Xray diffraction, sequential Xray fluorescence, stable oxygen and carbon isotopes, a high - resolution record of carbonate cycles could be established. The 38m long sediment core MD992201 was taken from leeward margin of Great Bahama Bank (lat.: 25°53.49 N and long.: 79°16.34 W), north off Bimini Island. By Atomic Mass Spectrometry (AMS) a core bottom age of 7,156 years BP was determined. With a sampling interval of 5cm, a decadal time resolution could be achieved. A total of six U/Th and nine ^{14}C datings were performed, which resulted in sedimentation rates ranging from 325 to 1380 cm/kyr. These variations show that the concept of a more or less uniform Holocene with respect to carbonate production, sedimentation and preservation pattern needs re-evaluation.content ranges from 96 to almost 100 wt%, most of which is aragonite (83-92wt%). With 2-9 wt%, High Magnesium Calcite (HMC), makes up the second major fraction. Low Magnesium Calcite only occurs with minor percentages (0.5-4 wt%).Spectrum Analysis (SSA) of the aragonitic carbonate phase showed two different trends and four oscillatory signals with distinct frequencies confirmed by Wavelet Power Spectrum.first eigenvector captures the long-term trend extending over the time period of the last 7,200 years. The second trend indicates variations on timescales of 800 - 1,300 years. Four quasi-periodic signals were found with wavelengths of 600 - 700, 350 - 400, 250 - 300, and 180 - 200 years, respectively, which were confirmed by Wavelet Power Spectrum.Analysis shows that all modes seem to fluctuate through time, showing stronger signals with higher amplitudes alternating with weaker signals (lower amplitudes). The time intervals showing weaker signals are always slightly out of phase. After these short times of disturbance, quasi-periodic cyclicity re-develops to the modes described above. Additionally a series of statistically relavant signals in decadal and century scale could be identified.precise paleoclimatic processes steering these variations form the topic of ongoing research.

PP21A-0456 0830h POSTER

C-14 Dating and High-Resolution Physical Properties data from Holocene IMAGES core MD992286, Skagerrak

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A long piston core, MD992286, was retrieved from Skagerrak in 1999 during leg 3 of the IMAGES V cruise. The investigated area is characterised by high sedimentation rates and intense water mass mixing, as a branch of the North Atlantic Current turns anti-clockwise, slows down and blends with other waters to form the Norwegian Coastal Current. Present day SSTs in Skagerrak are strongly linked to the NAO-index.

The sediments in the core consist of relatively homogenous silty clay with a slight coarsening upwards. A preliminary age model has been made from four AMS C-14 datings on shells, and the 32.4 m long core spans c. 11.800 cal years BP. This is nearly 50% older than expected from sediment thickness in Chirp-Sonar profiles and calculated sedimentation rates of about 4 mm/yr (Be et al., 1996), and shows that MD992286 is the longest piston core covering the entire Holocene, ever retrieved. Further carbon dating of core MD992286 will be performed on foraminifera.

The CALYPSO-corer is believed not to preserve the topmost sediments undisturbed. Therefore, a 1.5 m long Gravity core, Sk000209-2, was retrieved from the same location in order to get better recovery of the surface sediments. High-resolution susceptibility point-measurements at 1 cm resolution, of both core MD9922868 and Sk 000209-2, was used to correlate the two cores. The susceptibility correlation indicates that the sediment in the CALYPSO core is expanded 150% relative to the Gravity core. Susceptibility and L a b-colour data will be presented, along with water content and MST measured density log data displaying sub-centennial variability.

Given the length of the core and the high sedimentation rate, a high resolution study of climate variability throughout the Holocene is possible in core MD992286.

References: Be, R., Rise L., Thorsnes, T. H., de Haas, H., Saether, O. M. and Kunzendorf, H.1996. Seabed sediments and sediment accumulation rates in the Norwegian part of Skagerrak. Nor. geol. unders. Bull. 430, 75-84.

PP21A-0457 0830h POSTER

The Role of Atlantic Ocean Heat Transport in Decade to Century Scale Climate Variability.

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The global oceanic circulation is responsible for a large (2-3 PW) poleward transport of heat and is a fundamental part of the climate system. The Thermohaline Circulation (THC) plays a crucial role in this heat transport, and is recognised as being potentially unstable (Marotzke, 2000). We investigate the role of ocean heat transport anomalies in the climate of the Little Ice Age (LIA), using an atmospheric model coupled to a mixed layer ('slab') ocean of constant depth. The model requires the ocean heat flux convergence (OHFC) to be prescribed, and thus changes in this field can be imposed to study the coupled response to this forcing. We diagnose the relationship between the THC strength and OHFC in a 500 year control run of the Hadley Centre coupled model (HadCM3). This information is used to impose a realistic OHFC anomaly in the coupled, mixed layer model. Results will be presented from these studies demonstrating the potential sensitivity of the climate system to ocean heat transport anomalies associated with fluctuations in the THC. Furthermore, comparison of the simulated response with climatic reconstructions of the LIA will be presented to evaluate the potential role of a changed THC as a forcing factor for this large scale climatic deterioration.

PP21A-0458 0830h POSTER

Holocene Atmospheric Circulation Variability as recorded in the Siple Dome A Ice Core Major Ion Chemistry Series

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The Siple Dome A-Core deep drilling project in West Antarctica provides a detailed look into long-term climate variations. High resolution (approx. bi-annual sampling) ion chromatography analysis was conducted on this core to produce glaciochemical time series of the major cations (Na, Mg, Ca, K) and anions (Cl, SO4, NO3). Previous work has linked variations in the Siple Dome glaciochemistry to atmospheric pressure changes in the Amundsen-Ross Seas region of the southern Pacific Ocean. This instrumental calibration allows the Siple Dome ion chemistry to be used to investigate past atmospheric circulation changes in this region of the Southern Pacific.

The background sea-salt trend in the Siple Dome is generally increasing from the mid-Holocene (approx. 5000 years before present) to the present. The corresponding trend in insolation at 60 degrees Latitude for this time period is decreasing for the season of sea-salt deposition September-October). This relationship is inverse to the background sea-salt values over the same period in the Greenland Ice Sheet Project Two (GISP2) (O'Brien et al., 1995). GISP2 displays decreasing sea-salt values over the same time period that correspond to an increasing trend in insolation at 60 degrees North in the winter (December-February), the season of sea-salt deposition at GISP2. The relationship between the orbital cycles and atmospheric circulation variations represented by the ice core sea-salts appear to have influence on long-term time scales as well as in conjunction with other climate events.

These background trends in sea-salts also have an influence on the transition into the classic Little Ice Age (LIA) climate change event seen at Siple Dome and GISP2. Kreutz et al. (1997) discussed the presence of elevated sea-salts during the LIA at Siple Dome and compared this to the elevated sea-salts seen in the GISP2 record (O'Brien et al., 1995). The recent extension of the Siple Dome time scale shows that increase in sea-salts at Siple Dome precede the increase in sea-salts in GISP2.

In addition to constructing a longer bipolar comparison between Siple Dome and Greenland, the Siple Dome record helps complete a transect of chemistry sites across the Pacific sector of Antarctica. The quality of these ice cores records (Siple Dome, Taylor Dome, South Pole, Law Dome) allows for detailed survey of the last 1000 years. Variations in these records show climate events within the LIA that have similar timings and structure as seen in the tree ring Carbon-14 residuals (proxy for solar irradiance). There are, however, differences in these cores that most likely arise from the different atmosphere circulation patterns across the Pacific sector of Antarctica.

PP21A-0459 0830h POSTER

Ice Core Evidence of Regionalization of Holocene Climate in the Circum-Arctic Region

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Comparison of high resolution Holocene glaciochemical ice core records recovered from the Penny Ice Cap, Baffin Island with those from Summit, Greenland reveal distinct differences that can be related to different source regions and/or transport distances. These records can therefore be used to investigate different aspects of the Arctic climate system. For example, the Penny sea-salt sodium records shows an overall decrease during the Little Ice Age due to an increase in sea ice extent in the nearby source regions in Baffin Bay and Davis Strait, while the GISP2 record shows an overall increase in sea-salt sodium related to an intensification of atmospheric circulation during cold periods. A new high resolution five thousand year glaciochemical record has been developed from the Devon Ice Cap in the eastern Canadian Arctic and is compared and contrasted with the Penny and Summit records. In addition to considerable decadal and century scale variability and a decrease in sea-salt concentrations during the Little Ice Age, the Devon and Penny sea-salt records also show a long-term decrease since the mid-Holocene, suggesting a long-term regional increase in sea ice extent. We also investigate dust deposition and recent anthropogenic signals at the three sites. We conclude that glaciochemical records developed from small ice caps throughout the circum-Arctic region provide valuable measures of regional-scale paleoenvironmental change that are critical for our understanding of the climate change in the region over the mid to late Holocene.

PP21A-0460 0830h POSTER

Eastern North Atlantic Deep-Sea Corals: Tracing Intermediate Water ^{14}C During the Holocene

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Deep-sea corals have a great potential as recorder of intermediate to deep water column chemistry and circulation during the past and present. Here we investigated deep-sea corals from the Rockall Trough (55°32' N, 15°40' W, 725 mbsl) and Porcupine Bight (53°48' N; 13°54' W, 745 mbsl) utilizing combined ^{230}Th/U and ^{14}C dating. ^{230}Th/U-ages have been obtained on several recent and Holocene specimens of *Lophelia per.* and *Madrepora.* Pre-bomb Δ^{14}C was determined to be on average -74$^{o}/_{oo}$ for three corals ranging in absolute Th/U-age from 703 yr BP to 1969±10. The youngest specimen clearly records the increase of atmospheric bomb ^{14}C in the North Atlantic. The bottom part of this coral yield a Δ^{14}C of -74.8±8.1$^{o}/_{oo}$, while the top gives a Δ^{14}C of 0.51±8.4$^{o}/_{oo}$. The peak of bomb radiocarbon is not recorded as the Δ^{14}C of a modern coral is +15$^{o}/_{oo}$. The deep-sea coral ^{14}C increase lags the atmospheric record by about 10 years, reflecting the exchange time between surface and intermediate water column at ∼ 725 mbsl. This result nicely cooperates with the hydrographic situation of the Rockall Trough allowing for fast mixing of surface and upper intermediate water. A *Madrepora* coral found in the same depth of a box core were a *Lophelia per.* yield a Th/U-age = 629±10 yr BP and Δ^{14}C = -73$^{o}/_{oo}$ shows a Δ^{14}C of -43$^{o}/_{oo}$. The 30$^{o}/_{oo}$ higher value of this coral is in agreement with a rise of atmospheric Δ^{14}C by +25$^{o}/_{oo}$ around 620 yrs BP. With respect to the marine Δ^{14}C calibration the modern Δ^{14}C of *Lophelia per.* seem to be slightly depleted by ∼ -10$^{o}/_{oo}$.

We further investigated one *Lophelia per.* from the Porcupine Bight yielding a Th/U age of 10420±50 yrs BP and having a Δ^{14}C of +54±9$^{o}/_{oo}$. If compared to the marine Δ^{14}C calibration curve the Δ^{14}C of the Lophelia is similar within uncertainty. A slight depletion from the marine Δ^{14}C calibration was not found. By applying a 400 yr reservoir correction the Δ^{14}C of the deep-sea coral fits nicely the atmospheric calibration curve indicating that the coral records a fast mixing between surface and upper intermediate water. The data presented here are the first results of an ongoing project to study deep-sea corals in the North Atlantic in terms of past ^{14}C variations and ocean circulation.

PP21A-0461 0830h POSTER

Centennial-scale variation in late Holocene planktonic foraminifer assemblages at Orphan Knoll, Labrador Sea.

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At a site located on the boundary between the Labrador Sea and the North Atlantic Drift, several species of planktonic foraminifer show peaks at 250-300 yr intervals through the last 2800 yrs. This interval is near the 250 yr period that has been detected in global proxy temperature reconstructions and the 300 yr period that has been found in diatom assemblages and geochemical indicators in Icelandic coastal lakes. Previous faunal, isotopic and geochemical work has detected the bi-modal "Little Ice Age" and a surface cooling event at 1600 yrs BP that corresponds to a similar event at Bermuda Rise. KN158-4-23MC is 33 cm long and was collected from a sediment drift on the east flank of Orphan Knoll. The high rate of sediment accumulation permits halving the sampling interval to 0.5 cm for current work, yielding a temporal resolution of 25-50 yrs. The centennial-scale oscillation is most apparent in most species present with an inverse relationship between subpolar and polar species. The Gulf Stream indicator species, Globoconella inflata, also shows centennial-scale variation with preceding those in the Neogloboquadrina pachyderma (s) record by 50-100 yrs. Finally, there is a long-term trend in the record with subpolar Globigerina bulloides and Turborotalita quinqueloba dominating the >1500 yr BP interval and Neogloboquadrina pachyderma (s) and (d) dominating the <1500 yr BP interval.

PP21A-0462 0830h POSTER

Antarctic Holocene Climate Change: Stable Isotopic Record from Palmer Deep

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The first moderate to high-resolution Holocene marine stable isotope record from the near-shore Antarctic continental shelf (ODP Hole 1098B) suggests sensitivity of the western Antarctic Peninsula hydrography to westerly wind strength and ENSO-like climate variability. Despite its proximity to corrosive Antarctic water masses, sufficient $CaCO_3$ in Palmer Deep sediments exists to provide a high-quality stable isotopic record (especially in late Holocene). Coherence of benthic foraminifer δ^{18}O, δ^{13}C, sedimentologic, and $CaCO_3$ fluctuations suggests that rapid (<20 yr) Palmer Deep bottom water temperature fluctuations of 1-1.5°C are associated with competitive interactions between two dominant oceanographic/ climatic states. An abrupt shift from a warmer, stable Upper Circumpolar Deep Water (UCDW) state to a cooler, variable Shelf Water state occurred at 3.6 ka. Palmer Deep bottom waters oscillated between UCDW and shelf water-dominated states between 3.6 and 0.05 ka. Cool shelf water intervals correlate with Neoglacial events; the most recent and largest being the Little Ice Age (LIA; 0.7-0.2 ka). Similarities between Palmer Deep and global Holocene records and the rapidity of inferred bottom water fluctuations suggest that western Antarctic Peninsula shelf hydrography has not been controlled by thermohaline reorganizations, but by variable strength and/ or position of the Southern Hemisphere westerly wind field. We suggest that these atmospheric perturbations may have originated in the low latitude tropical Pacific.

PP21B MC: Hall D Tuesday 0830h

General Paleoceanography and Paleoclimatology Contributions II

(joint with OS, GC)

Presiding: **D M Anderson,** NOAA Paleoclimatology Program**; G L Bracco Gartner,** University of Miami

PP21B-0463 0830h POSTER

Paleogeographic Study of the West Florida Panhandle Coast and Margin

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The dominant factors in the evolution of a passive margin shelf and coast are sea-level change and fluvial-marine sediment transport processes. On many U.S. coasts, beach nourishment sand has become an increasingly scarce and expensive resource. A regional sand search has recently been undertaken to identify offshore targets for beach nourishment sand along the western Florida Panhandle coast. A major task of the project has been the development of a conceptual model for finding potential nourishment sand. The modeling work has involved the collection of existing data, including published literature, sediment samples, sub-bottom seismic data, and paleogeographic analyses. Paleogeography was recognized as a potentially powerful tool for use in identifying shelf sand bodies, because they are products of sea-level change and shelf evolution. As part of the project, a more detailed study has been undertaken to acquire and assemble all available paleogeographic and paleoshoreline data for the western Florida shelf. These data include studies of the Quaternary paleogeography of the Panhandle coast, still-stand paleoshorelines, high-resolution bathymetry, global and eustatic sea-level curves, beach ridge systems, coastal river and inlet retreat paths, and barrier island evolution. The data have been compiled into a Geographic Information System (GIS) database from which maps of the shelf paleogeography can be created, representing selected periods in the Quaternary evolution of the West Florida Panhandle coast and margin.

PP21B-0464 0830h POSTER

Sensitivity of Mid Holocene Global Climate to Changes in Vegetation Reconstructed From the Geologic Record

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The influence of land surface changes upon global and regional climate has been shown both for anthropogenic and non-anthropogenic changes in land surface distribution. Because validation of global climate models (GCMs) is dependent upon the use of accurate boundary conditions, and because changes in land surface distribution have been shown to have effects on climate in areas remote from those changes, we have tested the sensitivity of a GCM to a global Mid Holocene vegetation distribution reconstructed from the fossil record, a first for a 6 ka GCM run. Large areas of the globe exhibit statistically significant seasonal warming of 2 to 4 °C, with peak warming of 10 °C over the Middle East in June-July-August (JJA). The patterns of maximum warming over both Northern Asia and the Middle East strongly coincide with the patterns of maximum decrease in albedo in all seasons. Likewise, cooling of up to 4 °C over Northern Africa associated with the expansion of savanna and broadleaf evergreen forest also coincides with increases in surface heat flux of up to 35 W/m^2 in March-April-May (MAM) and 60 W/m^2 in JJA. At both the regional and global scale, the magnitude of vegetation forcing is equal to that of 6 ka orbital forcing, emphasizing the importance of accurate land surface distribution for both model validation and future climate prediction.

PP21B-0465 0830h POSTER

Precise *in situ* ^{238}U-^{234}U-^{230}Th isotopic analysis of U-rich speleothems using laser ablation multiple-collector ICPMS

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We have developed a method for the direct measurement of U-series isotopes, without chemical separation, in solid samples. We combine laser ablation sampling with multiple collector ICP magnetic sector mass spectrometry (MC-ICPMS) for the rapid in situ measurement of U-Th isotopic compositions at the semimicro (50-100 μm) scale.

Initial experiments were carried out at the University of Michigan (U-M) using a Plasma 54 MC-ICPMS coupled with a Cetac LSX 200 laser. Using this system, measurements for ^{234}U/^{238}U and ^{230}Th/^{238}U were acquired with permil-level ($2\sigma_M$) precision on samples containing 4 ng of U. This translates to $2\sigma_M$ errors in the ^{230}Th-age of 2500 years in 100,000-yr-old samples (Stirling et al., 2000), although the technique was applicable to samples with U contents in the 100-ppm range only.

We are currently developing in situ ^{238}U-^{234}U-^{230}Th measurement techniques at the ETH-Zurich using a new generation Nu Plasma MC-ICPMS coupled to an automated GeoLas 200CQ Excimer laser system. The results to date show a significant improvement in U-Th sensitivities compared with our earlier U-M data. The implications of this are two-fold: First, permil-levels of precision can be obtained for high-U (several hundred ppm) samples using significantly smaller spot sizes in the 10-50 micron range and reduced sample sizes. Second, good levels of precision can be attained for samples with U contents in the 10 ppm range using 100 micron spot sizes. This opens up a range of new research possibilities for the U-series systems in paleoclimate, magmatic zircon geochronology and paleohydrology studies.

We are presently applying our laser ablation technique to high-U speleothems from continental Europe. These samples provide a record of climate change during the critical interval spanning the penultimate deglaciation. Speleothems are ideally suited to laser ablation sampling: individual growth bands occur at a fine (μm-mm) scale and conventional sampling at high-resolution requires labour intensive procedures that are very difficult.

References