Jean Lynch-Stieglitz[1] (845-365-8866; jean@LDEO.columbia.edu)

Thomas P Guilderson[2] (1-925-422-1752; guilderson1@popeye.llnl.gov)

[1]Lamont-Doherty Earth Observatory, Rt. 9W, Palisades, NY 10964, United States

[2]Center for Accelerator Mass Spectrometry, UC/LLNL L-397 7000 East Avenue, Livermore, CA 94551, United States

Understanding the mechanisms driving natural millennial-scale climate change is critical for distinguishing human impacts on the climate system from its inherent variability. We investigated Holocene variations in Southern Hemisphere subtropical sea-surface temperatures using Mg/Ca, stable isotopes, and faunal abundances of planktonic foraminifera from Ocean Drilling Program (ODP) Site 1084B off the coast of Namibia (23.5S, 13.0E, 1992m water depth). Mg/Ca measurements were made at 1-cm intervals by ICP-OES on ∼75 individuals of *G. bulloides*, a species associated with winter upwelling in this region. 13 AMS radiocarbon dates extending to 17,000 calendar years ago constrain the age model. Coretop Mg/Ca values indicate calcification in 13.6°C waters, consistent (within analytical error) with observed winter SSTs for this location. Site 1084B has high deglacial and Holocene sedimentation rates (11-27 cm/kyr) and is located within the Benguela coastal upwelling system. Historical SST variations in this region reflect variations in the intensity and zonality of the trade winds, as well as the northward advection of cooler waters by the subtropical gyre: faunal abundance data help distinguish these two influences on the Mg/Ca temperature record.

The "8200 year cold event" appears in this record as an abrupt 1.5°C cooling at 8100 yr ago, accompanied by shifts in faunal abundances that suggest increased upwelling. A nearby Holocene paleotemperature record from a non-upwelling region does not show this cooling event (Kim et al. 2002), suggesting that in the Southern Hemisphere subtropics, this event was driven more by changes in wind strength than changes in ocean circulation. The 1084B Mg/Ca record also exhibits the Younger Dryas cool period 13-11.5 kyr ago, indicating that subtropical Southern Hemisphere deglacial climate variations were in-phase with the Northern Hemisphere. This is consistent with several other tropical, subtropical, and midlatitude Southern Hemisphere records (Kim et al. 2002, Kirst et al. 1999, Little et al. 1997, and Moreno et al. 2001). High-latitude records, however, show the "Antarctic Cold Reversal" preceding Younger Dryas cooling (Blunier et al. 1998, Charles et al. 1996). Perhaps this spatial pattern is explained by changes in ocean circulation (Stocker et al. 2000). The 1084B record does not show Younger Dryas faunal abundance shifts indicating changes in upwelling, as seen at the 8200 year cold event. This suggests that different mechanisms caused these two cooling events.

PP72B-12 1635h

Abrupt Climate Oscillations During Termination I as evidenced in the Great Australian Bight (ODP Leg 182, Site 1127): Record of Synchronous Interhemispheric Climate Change

Miriam S Andres[1] (+41 1 632 3691; miriam@erdw.ethz.ch)

Stefano M Bernasconi[1] (+41 1 632 3693; stefano@erdw.ethz.ch)

Judith A McKenzie[1] (+41 1 632 3828; sediment@erdw.ethz.ch)

[1]Geological Institute, ETH-Zurich, Zurich 8092, Switzerland

The transition from the last glacial maximum to the Holocene was marked by several climatic fluctuations. In the Northern Hemisphere, a rapid return to near-glacial conditions is observed during Younger Dryas, whereas in the Southern Hemisphere ice-core records show two significant but separate cooling events: the Antarctic Cold Reversal (Jouzel et al., 1995) and the Oceanic Cold Reversal (Stenni et al., 2001). The relative timing of these two reversals compared to the Northern Hemisphere Younger Dryas event is central for our understanding of interhemispheric linkages and to explain causes and mechanisms of abrupt climatic change. Apart from the Antarctic ice cores, high-resolution and well-dated paleoclimatic records from the Southern Hemisphere are sparse, yet they would be important for our understanding of the last glacial cycle on a global scale. Here, we report on an unprecedented high-resolution, southern mid-latitude marine archive from the Great Australian Bight. ODP Leg 182 Site 1127, is situated on the continental shelf facing the open ocean in a mid-latitude Southern-Hemisphere location. The deglaciation oxygen isotope record of G. ruber shows a stepwise decrease with a plateau between 16.2 and 13.2 cal. ky B.P. The subsequent decrease is interrupted by two significant reversals, which are 14C-dated from 13.1 to 12.3 and 12.3 to 11.1 cal. ky B.P and separated by a brief but significant decrease. Interpreted as a pure temperature signal, the reversals translate to an up to 3 degrees C cooling in SST. Within the error of dating, the timing and nature of these two reversals correlates to the recently proposed Oceanic Cold Reversal observed in the mid-latitude Indian Ocean. The second, more intense abrupt reversal, although smaller in amplitude, resembles and is synchronous with the Younger Dryas Chronozone as evidenced in the Northern Hemisphere. Our oxygen isotope record of Site 1127, which most likely represents a combination of temperature and hydrographic change, indicates a direct link, probably ocean-driven, between Northern and Southern Hemisphere climate.

References: Stenni B. et al., (2002) Science 293, 2074-2077; Jouzel et al., (1995) Clim. Dyn. 11, 151-161

PP72B-13 1650h

Holocene and deglacial paleoenvironmental history of the Peru-Chile current system and adjacent continental Chile

Frank Lamy[1] (++49 421 2188955; flamy@uni-bremen.de)

Dierk Hebbeln[1] (++49 421 2189079; dhebbeln@uni-bremen.de)

Junghn Kim[1] (+49 421 2188929; jungkim@uni-bremen.de)

Mahyar Mohtadi[1] (++49 421 2188926; mohtadi@uni-bremen.de)

Carsten Ruehlemann[1] (++49 421 2187110; ruehl@uni-bremen.de)

[1]Fachbereich Geowissenschaften, Universitt Bremen Postfach 330440, Bremen 28334, Germany

A combined analysis of terrigenous and biogenic compounds in marine sediments from the Chilean continental slope allows detailed reconstructions of both the paleoclimatic and paleoceanographic history of this region during the last glacial and Holocene. Based on sediment cores recovered during two cruises with the German R/V Sonne, we found evidence for changes both in continental rainfall, most likely induced by latitudinal shifts of the Southern Westerlies, and marine productivity as well as sea surface temperature (SST) changes within the Peru-Chile Current system on time scales ranging from Milankovitch to centennial-scale. On Milankovitch time-scales, we found strong evidence for precession-controlled shifts of the Southern Westerlies implying e.g. more humid conditions during the LGM in the Chilean Norte Chico and a trend towards more arid climates during the deglaciation culminating in the early Holocene. These shifts are paralleled by paleoceanographic changes indicating generally higher productivity during the LGM mainly caused by increased advection of nutrients from the south through an enhanced Peru-Chile current. SSTs off central Chile were about 3.5 C lower than present during the LGM. On shorter time-scales, extremely high resolution sediment cores from the southern Chilean margin provide evidence of significant short-term Holocene climate changes with bands of variability centred at ca. 900 and 1500 years, periodicities also well known from Northern Hemisphere records. Our data point to strong interhemispheric connections of climate change both on multi-centennial to millennial and Milankovitch timescales with a major role of the tropics for the interhemispheric transfer of climate signals involving changes within the Hadley circulation and/or probably long-term modifications of the El Nio-Southern Oscillation system. The recently drilled ODP Sites 1233 (ca. 41S) and 1234/1235 (ca. 36S) at the southern Chilean margin have the potential to extent our promising ultra high resolution Holocene records from this region to the last glacial/interglacial cycle.

PP11A MCC: Hall D Monday 0830h

Pre-Quaternary Paleoceanography and Paleoclimatology Posters *(joint with A, OS, GC)*

Presiding: **B L Otto-Bliesner,** National Center for Atmospheric Research

PP11A-0297 0830h POSTER

Neogene Benthic Foraminiferal Mg/Ca Records

Kathleen D Scheiderich[1] ((302)645-4075; scheidek@udel.edu)

Katharina Billups[1] ((302)645-4249; kbillups@udel.edu)

[1]University of Delaware , College of Marine Studies 700 Pilottown Road, Lewes, DE 19958, United States

We use paired measurements of foraminiferal Mg/Ca ratios and oxygen isotope values at several sites spanning the Neogene to investigate the evolution of the oxygen isotopic composition of seawater. Our ultimate goal is to use the oxygen isotopic composition of seawater as a proxy for sea level change, and to compare it to sea-level records established with sequence stratigraphy. Thus far we have generated Mg/Ca records from intermediate water sites 1088 (subantarctic Southern Ocean) and 757 (tropical Indian Ocean) to compare with the published record from intermediate water depth Southern Ocean site 747 (Billups and Schrag, 2002). Comparison of Mg/Ca records reveals that variability among the three sites can be considerable. For example, all sites show a late Miocene maximum (8 Ma), but the amplitude differs among the records. Both Southern Ocean sites (sites 1088 and 747) display a distinct decrease in Mg/Ca ratios during the Pliocene, reaching a minimum during the early Pleistocene (1.5 Ma). In contrast, Mg/Ca ratios at Indian Ocean site 757 remain relatively constant throughout this interval of time. Using the Mg/Ca ratios as an independent temperature proxy, we illustrate that the trends in the calculated oxygen isotopic composition of seawater agree only in that values have increased since the mid Miocene. For example, an increase in the oxygen isotopic composition of seawater, expected from the growth of Northern Hemisphere ice sheets beginning in the Pliocene, is only apparent at Indian Ocean site 757. These observations illustrate that regional water mass hydrography can be variable, which highlights the necessity for generating records from multiple sites in order to obtain a record representative of global, glacioeustatic processes. To this end, we expand this work with records from the North Atlantic and Pacific.

PP11A-0298 0830h POSTER

Paleoceanographic Variability of the Benguela Upwelling System at the time of Onset of the Northern Hemisphere Glaciation (NHG)

Matthias Bork[1] (00494212183926; mbork@uni-bremen.de)

Karin A. F. Zonneveld[1] (00494212187119; zonnev@uni-bremen.de)

Helmut Willems[1] (00494212182236; willems@uni.bremen.de)

Lydie Dupont[2] (00494212188912; dupont@uni-bremen.de)

[1]University of Bremen, Division of Palaeontology, Postfach 330 440, Bremen 28334, Germany

[2]University of Bremen, Division of Marine Geology, Postfach 330 440, Bremen 28334, Germany

The causes of the intensification of growth of the northern Hemisphere ice caps at around 3.2 and 2.74 Ma BP (the so-called onset of the northern Hemisphere glaciations) are still unclear. Possible causes are changes in the global ocean circulation and the global carbon cycle, which might have resulted from tectonic processes, solar insolation changes, or the interaction between both processes.

The Benguela upwelling area forms a key area within the global ocean system. Here, warm and saline Indian Ocean waters enter the South Atlantic Ocean and are transported to the north. Variability of this inflow may thus result in changes in deep-water production in the North Atlantic, thereby influencing the global thermohaline circulation. Furthermore, the Benguela area is characterized by extremely high bioproductivity in surface waters as a result of year-round upwelling. Variations in the upwelling intensity might lead to changes in atmospheric pCO2.

Various upwelling cells in the Benguela upwelling region are responsible for the high bioproductivity. Variations in the upwelling intensity are dependent on the strength and direction of the prevailing trade winds, which in turn are steered by the difference in air pressure between the South Atlantic high pressure cell and the low pressure cells over the African continent.

To enhance our insight into the steering mechanisms and causes of the onset of the NHG, detailed reconstructions of the paleo-circulation patterns and the variations in upwelling intensity in the Benguela region will be established based on the analysis of organic-walled dinoflagellate cysts, pollen and spores from a high-resolution core covering the time interval from 3.3 to 2.5 Ma BP.

URL: http://alf.zfn.uni-bremen.de/~micropal/

PP11A-0299 0830h POSTER

Time-Frequency Analysis -Using Wavelet Transform- From Lithological Logs of the South-East Basin (France, Kimmeridgian).

Christine LAUER-LEREDDE[1] (lauer@dstu.univ-montp2.fr)

Louis BRIQUEU[1] (briqueu@dstu.univ-montp2.fr)

Alexis MOUSSINE-POUCHKINE[1] (alexis@dstu.univ-montp2.fr)

[1]Universit de Montpellier II/ODP-NEB, Universit de Montpellier II Place Eugne Bataillon GTS, UMR 5573, cc 060, Montpellier 34095, France

The early Kimmeridgian (Hypselocyclum and Divisum zones) of the South East France Basin is represented by alternating pelagic carbonate and marl beds of variable thickness. These alternations, at a dm- or m-scale, were observed over a 5000 km2 zone within the basin with a good biostratigraphic control based on Ammonites.

25 sections were logged at a cm-scale with three types of lithology: calcareous mudstone (> 90% CaCO3), marly carbonate (90%>x>70%) and marl (<70%), distinguished only in the field. These lithologies are clearly grouped into more carbonated and more marly packages, defining cycles (couplets of marl and carbonate beds). The cross-correlation between the sections, biostratigraphically controlled, allows the definition of 37 cycles. Related to the duration of biostratigraphic units considered here, the cycle duration is about 20 ka, close to the Milankovitch precession period.

Whereas the cycles are made of simple marl/limestone couplets within the thinnest sections, the thicker logs show that the cycles are more complex: limestone packages display thin marly intercalations, and marly packages display thin carbonate intercalations, these intercalations defining sub-cycles. The number of sub-cycles increases with the thickness of the cycles, varying from 3 to 17. Most of these sub-cycles are relatively well correlated across the basin. This suggests an external forcing with a period lower than the precession.

In order to study more precisely these sub-cycles, we used wavelet transforms. As physical measurements were not available, we constructed signals from the lithological logs, using the three lithological groups. Some signals were processed with wavelet transform and the apparent frequencies contents were finally compared for each section to see if the contribution of some frequencies different from those of Milankovitch is revealed and to look at the coherency of the correlations.

PP11A-0300 0830h POSTER

Evidence for a Widespread Disruption Layer Associated With the Cretaceous-Tertiary Boundary in the Upper Fox Hills Formation Throughout the Badland National Park Region of South Dakota

Philip W. Stoffer ((650)329-5028; pstoffer@usgs.gov)

U.S. Geological Survey, 345 Middlefield Road MS975, Menlo Park, CA 94025, United States

A widespread zone of disrupted bedding (0.5 to 3.0 m thick) is preserved in the upper Fox Hills Formation throughout the Badlands National Park region. This unit, the Disturbed Zone (DZ), is recognizable in park outcrops extending for twelve miles (east to west) along the crest of the Sage Creek Arch. It also extends at least 20 miles north of the park along the Cheyenne River valley. The DZ features an abundance of soft-sediment liquefaction characteristics including rolled-up sandy beds (now mostly concretions) with an east-to-west axis orientation. The current mapped extent of the DZ covers about 3,000 square kilometers in central South Dakota, but may be much greater.

In the park, the DZ unit rest on top of richly fossiliferous marine marls bearing marine mollusks (mostly ammonites and belemnites) of Late Maestrichtian age. After many seasons of searching, the sandstone and shale units overlying the DZ have not yielded any Cretaceous fossils. However, the overlying beds do preserve an abundance of small traces fossils, arthropod and fish remains, and plant material. In the park, this uppermost unit above the DZ ranges up to 16 meters thick, and the upper part preserves a series of paleosols known locally as the Yellow Mounds.

The Fox Hills Formation in the park preserves the same biozonation sequence as the Type Fox Hills in the Missouri Valley region. In both regions the thickness of the formation varies, but the measurable maximum thickness is about the same (50 meters). In the Badlands National Park area, structural patterns preserved in the underlying Pierre Shale seem to have influenced sedimentation characteristics (including sand content and fossil distribution) in the overlying Fox Hills Formation. In addition, the thickness of the Fox Hills Formation is controlled by the distribution and pattern of ancient stream valleys preserved beneath the overlying Tertiary White River Group.

PP11A-0301 0830h POSTER

Chronology of Tropical Glaciation from Cosmogenic Dating

Jacqueline A. Smith[1] (1-315-443-2672; jasmit10@syr.edu)

Daniel L. Farber[2] (1-925-424-2256; farber2@llnl.gov)

Geoffrey O. Seltzer[1] (1-315-443-4980; goseltze@mailbox.syr.edu)

Robert C. Finkel[2] (1-925-422-2044; finkel1@llnl.gov)

Donald T. Rodbell[3] (1-518-388-6034; rodbelld@union.edu)

[1]Syracuse University, Dept. of Earth Sciences, 204 HGL, Syracuse, NY 13244-1070, United States

[2]Lawrence Livermore National Lab, 7000 East Ave., Livermore, CA 04550, United States

[3]Union College, Geology Dept., Olin Building, Schenectady, NY 12308-2311, United States

Moraines from multiple glaciations dating back more than a million years are preserved in deglaciated valleys bordering the Junin Plain in the Peruvian Andes. We have used cosmogenic dating (^{10}Be) of boulders on moraines in Alcacocha Valley (S 11° 03', W 75° 58', elev. ~4100-4800 m) to identify deposits ranging in age from the last glaciation (~12-33 ka) to >1.5 Ma. This may be the longest and most detailed record of tropical glaciation yet produced. In Alcacocha Valley, lateral moraines of several older glaciations are considerably larger and extend farther downvalley than end moraines of the last glacial maximum. Preservation of the older moraines and of polished surfaces on some old boulders argues for extremely low boulder erosion rates. We estimate a maximum erosion rate of ~0.3 m/Myr, which approaches published rates for Antarctica and suggests that aridity is important in slowing boulder erosion. Our findings are consistent with results from other Andean locations, such as the Cordillera Real in Bolivia, where moraines of older glaciations are also more extensive than those of the last glacial maximum. Tectonics, climate, or a combination of both may have been responsible for the apparent decrease in glacial extent and ice volume in the Junin Plain during the Quaternary. A late Tertiary pulse of tectonism may have resulted in an increase in high-elevation topography in the Junin region, allowing growth of large ice masses. The subsequent trend in decreasing ice volume could have been caused by either a decrease in the area of high-elevation topography through glacial erosion or a decrease in the amplitude of climate variability. These hypotheses could be tested by analyzing the sediment record preserved in the Junin basin.

PP11A-0302 0830h POSTER

Sensitivity of the Late Triassic Climate System to Changes in Atmospheric CO_2: Results from a Fully Coupled Ocean-Atmosphere Model

Tran T. Huynh[1] (213-740-1971; huynht@earth.usc.edu)

Christopher J. Poulsen[1] (213-740-7952; poulsen@earth.usc.edu)

David J. Bottjer[1] (213-740-6100; dbottjer@earth.usc.edu)

[1]Department of Earth Sciences, University of Southern California, University Park, Los Angeles, CA 90089-0740, United States

A major perturbation of the global carbon cycle across the Triassic-Jurassic boundary is indicated by a large negative carbon isotopic excursion, recorded in marine carbonates and organic matter, and paleosols. Furthermore, studies of stomatal characters of fossil leaves, changes in sea level, and flood basalt volcanism suggest that atmospheric CO_2 increased significantly at the end of the Triassic. These events coincided with one of the largest biotic crises of the Phanerozoic and broadly with emplacement of the Central Atlantic Magmatic Province flood basalts. Thus, CO_2-induced global warming due to volcanic outgassing has been invoked as a cause for the mass extinction at the end of the Triassic. It is yet unclear how changes in atmospheric CO_2 content can affect the paleoceanographic conditions of the Late Triassic, or even if CO_2 increases have significant influence on the climate system at this time.

This study examines the sensitivity of the Late Triassic climate system to CO_2 forcing using the fully coupled Fast Ocean Atmosphere Model (FOAM). To test the effect of CO_2 on the climate system, we varied only the atmospheric CO_2 level while all other boundary and initial conditions were kept identical between simulations. Atmospheric CO_2 levels were varied from 2-8 times the present atmospheric level. Late Triassic conditions were simulated using a Norian (216 Ma) paleogeography, reduced solar luminosity (94% present day level), and uniform land surface characteristics.

Preliminary results show that higher atmospheric CO_2 levels during the Triassic cause an increase in temperatures globally due to greater greenhouse forcing. The global average temperature, however, does not vary significantly between Triassic simulations, ranging from 21-22°C. Nevertheless, increases in CO_2 can have significant impact on regional oceanic circulation during the Late Triassic. For example, in the southern hemisphere sea surface temperatures can be up to 10°C colder at high latitudes when atmospheric CO_2 is doubled from 4 to 8 times present-day levels. Higher levels of CO_2 in these simulations resulted in the reduction of both the oceanic heat transport and meridional oceanic overturning. These results suggest that rapid increases of atmospheric CO_2 during the Late Triassic are sufficient to cause dramatic paleoceanographic changes. The influence of these changing oceanographic conditions on biota requires further examination.

PP11A-0303 0830h POSTER

Pliocene-Pleistocene Sea Surface Temperature Record in the Eastern Equatorial Pacific as Recorded in Alkenone Saturation Ratios

Petra S Dekens[1] (831-459-5061; dekens@cats.ucsc.edu)

Ana Christina Ravelo[1] (acr@emerald.ucsc.edu)

Michael W Wara[1] (mwara@emerald.ucsc.edu)

Matthew D McCarthy[1] (mdmccar@cats.ucsc.edu)

[1]University of California at Santa Cruz, Ocean Sciences Department Earth and Marine Science Building A316, Santa Cruz, Ca 95064, United States

The sustained warm period of the early Pliocene (4.6Ma to 3.1Ma) is the most recent period in the Earths history when long-term equilibrium temperatures exceeded those of today. The subsequent continuation of the Earths general cooling trend after 3.1Ma has been well documented, predominantly with records from the high latitudes of the Northern Hemisphere. Some prevailing hypotheses for this cooling trend and the formation of major northern hemisphere glaciation are related to tectonic activity in the tropical oceans; in particular the closing of the central American seaway and the changes in the Indonesian Seaway. Yet, there are few robust records of climate change from the tropical and subtropical regions that can be used to test these hypotheses. Thus, in order to develop a clearer picture of climate evolution through this interval it is crucial to develop sea surface temperature (SST) records in both mid and low latitude locations. This is particularly important in the Pacific Ocean where little is as yet understood about regional changes within the context of this global trend. As an initial step toward our goal of understanding the links between low and high latitude climate change, we will present a SST record from Ocean Drilling Program site 847 (0° 12N, 95° 19W, 3346m water depth), which is located in the south equatorial current and therefore provides an excellent record of eastern tropical Pacific climate.

Results from subsurface and surface dwelling planktonic foraminiferal δ^{18}O indicate that there was a major tropical Pacific climate reorganization with two steps: one between 4-5Ma, and then one just after 2 Ma. However, these previous studies do not document SST alone because δ^{18}O reflects both ice volume and local salinity changes in addition to SST. Since tropical SST is clearly directly related to climate through its influence on many aspects of the Earths heat budget and net radiative conditions (water vapor, clouds), it is imperative that we have a clear understanding of changes in SST. As part of a multi-proxy study, we generated a low-resolution sea surface temperature (SST) record of ODP site 847 in the eastern tropical Pacific from 0-5Ma using an alkenone saturation index (U^k_{37}). The alkenone saturation index is very reliable at this location where organic carbon content is relatively high (0.4%), and can be used to cross check with foraminifera-based proxies that can potentially be influenced by calcite dissolution.

PP11A-0304 0830h POSTER

Glacio-eustatic Control on Plio-Pleistocene Sedimentation Along the Northern California Ocean Margin

Nell M Green Nylen[1] (1-650-322-0797; nellgree@pangea.stanford.edu)

David A Zinniker[1]

James C Ingle[1]

J Michael Moldowan[1]

[1]Stanford University Department of Geological and Environmental Sciences, Bldg. 320, Rm. 118, Stanford, CA 94305-2115, United States

Over the last 3.5 million years major climatic and tectonic changes have resulted in high frequency fluctuations in relative sea level adjacent to the northern California shoreline. A detailed record of these changes is preserved in two sedimentary sequences currently exposed along the coast: the neritic to nonmarine Merced Formation near San Francisco and the bathyal to neritic Rio Dell Formation north of Cape Mendocino. With the goal of deciphering the Plio-Pleistocene paleoenvironmental histories of these expanded ocean margin sequences, detailed stratigraphic sections were measured and described from the lower portion of the Merced Formation and from the Upper Rio Dell Formation. Samples are being analyzed for benthic foraminiferal assemblage, palynological assemblage, stable carbon and oxygen isotope composition of foraminiferal carbonate, and organic geochemistry. These data provide insight into paleo-water characteristics and paleobathymetry, global ice volume and climate, terrestrial and marine ecosystem composition and structure, specific sources of sedimentary organic material, the frequency and magnitude of wildfires on land during deposition, and redox conditions during early diagenesis.

Variations in these climate and environmental proxies appear to demarcate glacial and interglacial cycles. These results generally support previous interpretations of glacio-eustatic control on the cyclicity of sedimentary facies within the Merced and Rio Dell formations. Ongoing work aims to explore the relationship between local and global climate proxies and to develop a more detailed model of northern California ocean margin sedimentary response to rapid Plio-Pleistocene sea-level change.

PP11A-0305 0830h POSTER

The Freezing Conditions of Planets: Effect of Obliquity

Yutaka Abe[1] (+81-3-5841-4629; ayutaka@eps.s.u-tokyo.ac.jp)

Ayako Abe-Ouchi[2] (+81-3-5435-3955; abeouchi@ccsr.u-tokyo.ac.jp)

[1]Department of Earth and Planetary Science, University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan

[2]Center for Climate System Research, University of Tokyo, 4-6-1 Komaba, Meguro, Tokyo 153-8904, Japan

Condition for the occurrence of the completely frozen state (a "snow-ball" state) might be a critical measure related to the habitability of the planet. It is investigated with a particular reference to the obliquity for both a land planet case and an aqua planet case. Obliquity change may cause freezing and unfreezing of planet if the freezing condition depends on the obliquity. Effect of obliquity on the freezing is also an important issue for the investigation of the paleo-Mars.

Here we investigated the freezing condition by a general circulation model, CCSR/NIES AGCM 5.4g. We applied the Earth condition, but assumed no topography and applied a bucket model with the saturation depth of 10 cm for ground water calculation for the land planet case and 50m slab ocean for the aqua planet case.

The results are summarized as follows: 1. A land planet shows stronger resistance to the complete freezing than an aqua planet. 2. A land planet in an oblique regime falls in the completely frozen state at a smaller solar constant than an upright regime. 3. On a land planet in an oblique regime, low latitude area is more susceptible to freezing than the mid latitude area. Implication for the paleo-Mars will be discussed in the presentation.

PP11A-0306 0830h POSTER

Spatial and Temporal Variations of the Indidura Formation (Cenomanian-Turonian) in Northeastern Mexico, Coahuila State

Fabian Duque-Botero[1] (1-305-348-3147; fduqu002@fiu.edu)

Florentin J Maurrasse[1] (1-305-348-2350; maurrass@fiu.edu)

[1]Department of Earth Sciences, FL Int. University, Miami, FL 33199, United States

Rock sequences of Cenomanian-Turonian age commonly assigned to the Indidura Formation in northeastern Mexico, Coahuila State, are shown to include distinct facies indicative of significant spatial variability over the carbonate platform of that region. The type section at Las Delicias is characterized by very-pale orange (10YR8/2) bedded biocalcirudites (10-30 cm thick), without internal structures, and comprises fossil assemblages rich in epifaunal groups, as well as nektonic and planktic taxa. Total inorganic carbon (TIC) varies between 48 % and 94 % , with fluctuation in total organic carbon (TOC) between 0.73 % and 1.58 %.

The section at la Casita Canyon, farther southeast, consists of pale yellowish brown (10YR6/2) interbedded biocalcilutites and olive gray (5Y3/2) shales between 3 and 30 cm thick. They also show no apparent original internal structures, and allochems consist essentially of sparse fragments of planktonic foraminifera and radiolarian. TIC content varies between 0.84 % and 59.3 %, whereas TOC changes between 0.17 % and 5.85 %.

In contrast, in the Parras Mountains, located south of La Delicias and northwest of la Casita, the succession occurs under a characteristic sequence showing interbeds of light olive gray (5Y6/1) and brownish black to olive black (5YR2/1 5Y2/1) shales and marly biocalcilutites 30 to 100 cm thick. They display distinct internal structures arranged in nearly even parallel varve-like dual lamina (<3 mm thick). Few planktonic foraminifera are present, but epifaunal remains are absent, except for occasional rare pelecypods (Inoceramus) that occur intermittently. Laminae from either the shales or limestone facies show that they are formed by differences associated with varying abundance of micro spheres and micro-ooids, interpreted to be of cyanobacterial origin. TIC content varies from 43 % to 78.3 %, while TOC content remains relatively high with values between 7.35 % and 24.39 %, but more consistently higher than 20 %.

Assuming that these facies are coeval, microfacies studies of these rocks as well as acid etched polished rocks, and scanning electron microscope examination (secondary and backscatter imaging) further substantiate these spatial differences. TOC-rich black shales in the Parras region further document unique paleoceanographic conditions, which was also characterized by oxygenation of oceanic waters less effective than usual. These unique paleoceanographic conditions imply that oxygenation of oceanic waters remained apparently less effective than usual throughout the sequence. Temporal distribution of the epifauna and carbon/carbonate variations in the Parras region suggest the effects of strong dysoxic/anoxic bottom conditions on the biota with rhythmical production and disappearance of cyanobacterial mats which remained dominant throughout.

PP11B MCC: Hall D Monday 0830h

Interhemispheric Climate Change I Posters *(joint with A, OS, GC)*

Presiding: **J R Toggweiler,** NOAA Geophysical Fluid Dynamics Laboratory**; P U Clark,** Oregon State University

PP11B-0307 0830h POSTER

Does Poseidon Keep the Holy Grail? Changes in Southern Ocean and North Atlantic Deep Water Production as the Driver of the Deglacial CO2 Rise

Richard E. Zeebe (+49-471-4831-1848; rzeebe@awi-bremerhaven.de)

Zeebe, R. E., Alfred Wegener Institute for Polar and Marine Research, Bremerhaven D-27570, Germany

The 'Holy Grail' of glacial/interglacial CO_2 research is to identify the cause for variations in atmospheric CO_2 on this time scale. A simple mechanism has hitherto remained elusive. Here I use an entirely new approach to the problem, namely a global vertical advection-diffusion balance of tracers in the ocean that includes effects of deep water production and the biological pump on atmospheric CO_2. The model adequately reproduces modern pCO_2 and vertical profiles of temperature, ΣCO_2, Alkalinity, PO_4, and O_2 in the ocean. A reduction of the ocean's deep water production and an associated decrease of O_2 and the remineralization efficiency for organic matter in the water column leads to the glacial pCO_2 of 200 μatm. Assuming changes in Southern Ocean and North Atlantic deep water production consistent with proxy records over the deglacial transition, model results excellently reproduce the observed temporal evolution of the deglacial atmospheric CO_2 rise and deep ocean $CaCO_3$ saturation. The magnitude and timing of the ocean's deep water production rate in the northern and southern hemisphere is hence identified as the dominant driver of glacial/interglacial CO_2 variations through its effect on the vertical distribution of heat and elements in the sea.

PP11B-0308 0830h POSTER

Black Body Temperature in Terms of Earth's Orbital Elements and the Milankovitch Precession Index

David P Rubincam (301-614-6464; rubincam@core2.gsfc.nasa.gov)

Geodynamics Branch Code 921, Laboratory for Terrestrial Physics NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States

The temperature T of a black or gray body orbiting the Sun can be expressed in terms of spherical harmonics in latitude and longitude, its Keplerian orbital elements, and a variable describing rotation about its axis. Assuming that the Earth is a gray body, the resulting equation for T exhibits previously unrecognized odd-degree zonal terms dubbed Seversmith psychroterms. They cause a hemispheric temperature gradient which depends upon e sin w, where e is the orbital eccentricity and w is the Suns argument of perihelion measured in an Earth-centered frame. The hemisphere containing perihelion is the cooler. For a gray body with the Earths average albedo of 0.3, an emissivity of unity, and an obliquity of 23.5 degrees, the pole-to-pole temperature difference for the combined first and third degree spherical harmonic psychroterms can reach 3.4 K for the present eccentricity of 0.016, and 12.9 K for the maximum eccentricity of 0.06. While a black body with its boiling hot subsolar point and nights at absolute zero is a poor model for the Earth, the Seversmith psychroterms survive in more realistic models (although with smaller amplitudes) because the Earth radiates nonlinearly in T. The psychroterms acts in the direction opposite to the Milankovitch precession index, which also depends on e sin w: by warming the cool northern summers, the psychroterms make it harder for the traditional Milankovitch mechanism to operate. It may in fact be the Seversmith psychroterms which are actually responsible for the ice sheets which cycle with e sin w, instead of the Milankovitch mechanism. By cooling the southern hemisphere when perihelion is in the south, the psychroterms may somehow cause the southern hemisphere to control the northern ice sheets associated with the 19 kyr and 23 kyr periods (kyr = kiloyear), possibly through ice-albedo feedback in the sea-ice surrounding Antarctica.

PP11B-0309 0830h POSTER

Interhemispheric Variation in the Response to Solar Forcing Over the Past 1000 Years

Paula Jo Reimer[1,2] (925-422-7151; pjreimer@llnl.gov); F. G. McCormac[1] (f.mccormac@qub.ac.uk); Ron W. Reimer (r.reimer@qub.ac.uk); Alan G. Hogg[3] (a.hogg@waikato.ac.nz); Thomas F. G. Higham[3,4] (thomas.higham@rlaha.ox.ac.uk); Jonathan G. Palmer[1] (j.palmer@qub.ac.uk)

[1]School of Archaeology and Palaeoecology, Queens University Belfast, Belfast BT7 1NN, United Kingdom

[2]Now at: Center for Accelerator Mass Spectrometry L-397, Lawrence Livermore National Laboratory P.O. Box 808, Livermore, CA 94550, United States

[3]Radiocarbon Dating Laboratory, University of Waikato Private Bag, Hamilton 3105, New Zealand

[4]Now at: Oxford Radiocarbon Accelerator Unit, Research Laboratory for Archaeology and the History of Art, Oxford OX1 3QJ, United Kingdom

The difference in atmospheric ^{14}C levels in the Northern and Southern Hemispheres (NS offset) has recently been shown to vary between 1 and 10 over the last millennium (1, 2). More than 80 % of the variation is explained by three quasi-periodic cycles with ca. 200, 130, and 80-year periods.

The 205-year de Vries cycle in atmospheric ^{14}C levels can confidently be ascribed to a solar origin based on comparisons to cosmogenic isotope records, (3, 4). Additionally, a significant 130-year cycle is found in the ^{10}Be ice core record of the South Pole. Observing these cycles in the NS offset requires either variable input of 14C into the troposphere in each hemisphere or a differential response of the carbon reservoirs to solar variations.

The amplitude of the de Vries cycle increases throughout the past millennium in the individual records of Northern and Southern Hemisphere tree-ring ^{14}C. The Southern Hemisphere amplitudes are smaller until ca. AD 1500 when the amplitudes in both hemispheres are roughly the same. This interhemispheric difference in amplitudes results in pseudo-cyclic behavior in the NS offset that disappears after AD 1400. Because the de Vries cycle in the South Pole ^{10}Be record has nearly constant amplitude during this same time period, the increase in the amplitude in the atmospheric ^{14}C records must include a climatic component possibly related to millennial-scale ocean circulation changes.