record from Rarotonga extends from 1997 back to 1726 A.D. and the δ^{18}O signal since 1874 has been replicated using other corals from the island. At Fiji we have analyzed one core extending from 1997 back to 1780 A.D. As previously reported, at Rarotonga coral Sr/Ca is well correlated to instrumental sea surface temperature (SST) on seasonal and interannual time-scales (Linsley et al., 2000). We find the same degree of correlation between Sr/Ca and SST at Fiji. Coral δ^{18}O at both sites primarily reflects variations in SST and South Pacific Convergence Zone related precipitation. In this study we focus on interdecadal variability in Sr/Ca and δ^{18}O, and compare our results to indices of interdecadal climate variability in the Pacific based on the instrumental record (PDO and IPO), and to published coral δ^{18}O results from New Caledonia (22°S, 166°E), and Maiana Atoll (1°N, 173°E). These records indicate that interdecadal climate variability in the southwest Pacific became more organized and spatially coherent after approximately 1880 A.D, particularly from 1880 to ~1950 A.D. This transition in the late 1800s coincided with a previously reported widespread freshening of surface ocean salinity in the southwest Pacific (Hendy et al., 2002) that may have resulted from a reduction of trade wind and South Equatorial Current influence in the region.

PP72B MCC: 106 Sunday 1330h

Patterns of Holocene and Deglacial Climate Variability in the Tropics and Subtropics II *(joint with C, A, H, OS, GC)*

Presiding: **T Koutavas,** Lamont-Doherty Earth Observatory of Columbia University**; C Farmer,** Lamont-Doherty Earth Observatory of Columbia University

PP72B-01 1330h INVITED

What happened to El Nino during the early Holocene?

S George Philander (609-258-5683; gphlder@princeton.edu)

Princeton University, Dept of Geosciences Guyot Hall, Princeton, NJ 08540, United States

Coral records from the tropical Pacific indicate that interannual fluctuations associated with El Nino today were absent during the early Holocene until approximately 5000 years ago. Some authors claim that, at that time, the waters off Ecuador and northern Peru were permanently warm, but explaining the persistence of arid conditions along the coast is then a problem. Another ossibility, supported by some measurements, is that El Nino occurred less often, every decade or so. To theoreticians, these findings raise two sets of questions. First, El Nino can be regarded as part of a natural mode of oscillation that depends on background conditions such as H the mean depth of the thermocline, TX the intensity of the mean winds etc. What changes in the background conditions, in values of H, TX etc, will result in either permanently warm conditions, or El Nino with a very low frequency? Stability analyses of ocean-atmosphere interactions indicate that if the thermocline was deeper than today, then weak winds would have resulted in permanently warm conditions, but strong trades would have resulted in infrequent El Nino episodes. Next we have to ask why the background conditions changed. During the Holocene precession of the Earths axis caused first the northern hemisphere, then the southern hemisphere to experience warmer summers, colder winters. As a result the Sahara had lakes, Lake Titicaca was dry, and apparently the trade winds were strong during the early Holocene. To test the inference that El Nino became a very low frequency phenomenon during the early Holocene requires information about the depth of the thermocline and the intensity of the trades at that time.

PP72B-02 1345h INVITED

A Super-ENSO pattern of SST and SSS Variability in the Western Tropical Pacific Through the Holocene

Lowell D. Stott[1] (213-740-5120; stott@usc.edu)

Robert C. Thunell[2] (803-777-7593; thunell@geol.sc.edu)

[1]Lowell D. Stott, Dept. Earth Sciences Univ. Southern California, Los Angeles, CA 90089, United States

[2]Robert C. Thunell, Department of Geological Sciences University of South Carolina, Columbia, SC 29208, United States

We have analyzed a suite of high deposition rate marine cores collected from the Indonesian archipelago by the IMAGES program in an effort to constrain the history of SST and SSS variability in the Western Pacific Warm Pool. Three of the cores have sediment accumulation rates through the Holocene in excess of 70cm/kyr based on radiocarbon measurements of biogenic carbonate. Measurements of d18O and Mg/Ca of Globigerinoides ruber were conducted at centimeter intervals through the Holocene. This species appears to produce primarily during the summer months. These data are used to infer whether there have been large scale changes in ocean/atmopheric variability over the western tropical Pacific through the Holocene. We find that the Holocene Mg/Ca SSTs averaged between 28.5 and 30oC throughout the Holocene. However, the d18O of G. ruber became progressively lighter through the Holocene, from about -2.2per mil at the end of the Younger Dryas to about -3.0per mil in the most recent sediments. If interpreted as temperature this d18O record would imply a progressive increase in temperature of nearly 4oC. However, this is not supported by the Mg/Ca paleothermometry. We interpret the oxygen isotopic record to reflect a progressive change in the summer surface salinities in the western tropical Pacific. As surface salinities are strongly affected by the strength of atmospheric convection over the WPWP, the progressive change in salinity could be interpreted to reflect a systematic change in atmospheric conditions over the tropics. Superimposed on the long term isotopic trend are millennial-scale oscillations in d18O that are similar in character to those we have previously reported on from the Pleistocene and interpreted to reflect changes in the strength of ENSO. We suggest that the same millennial-scale oscillations in the strength of ENSO have persisted throughout the Holocene, providing further evidence that the tropics and perhaps the entire global climate exhibits a persistent pattern of variability at millennial time scales. This has important implications for assessing the uniqueness of the late Holocene climate changes including the 20th century warming.

PP72B-03 1400h

Mechanisms of ENSO Response to Glacial and Milankovitch Forcing in the NCAR Climate System Model

Bette L Otto-Bliesner[1] (303-497-1723; ottobli@ucar.edu)

Esther C Brady[1] (303-497-1396; brady@ucar.edu)

Christine Shields[1] (303-497-1312; shields@ucar.edu)

[1]National Center for Atmospheric Research, PO Box 3000, Boulder, CO 80307, United States

The tropical Pacific climate response to Holocene/glacial boundary conditions is examined for the last glacial-interglacial cycle with simulations using the fully coupled, non-flux corrected NCAR CSM model. The present-day CSM simulation reproduces both the spatial and temporal character of the observed equatorial Pacific variability quite well. The standard deviation of the model Nino-3 index is 0.68°C, comparable to values calculated from observations. The model simulates weaker El Ninos compared to present for the last 11,000 years (Nino-3 index = 0.54°C at 11 ka) and stronger El Ninos for the Last Glacial Maximum (Nino-3 index = 0.81°C at 21 ka). The changes in intensity for the last 11,000 years are traced to modulation of wind stresses across the tropical Pacific Ocean by the summer Asian monsoon and weakening of the tropical thermocline. Seasonal and annual solar radiation anomalies associated with Milankovitch forcing drive these changes and are shown to dominate the effect of the residual continental ice sheets. For the Last Glacial Maximum, changes in the intensity are traced to a sharpening of the tropical thermocline and weakening of the east-west sea surface temperature gradient. The ocean dynamical thermostat mechanism in the tropics and subduction of colder waters from Southern Hemisphere latitudes associated with the expansion of sea ice are important. Reduced atmospheric greenhouse gases force these ocean temperature changes at the LGM.

Decreased ENSO variability going back to 11 ka, with more occurrences of small and less occurrences of large El Ninos and La Ninas compared to present, agrees with interpretation of laminae changes in an alpine lake in Ecuador by Rodbell and collaborators. The CSM suggests that the reduced amplitudes of glacial ENSO variability documented by Tudhope and collaborators in corals from New Guinea are associated with weaker teleconnections to precipitation changes over the region that occur with a shift eastward of the Walker Circulation and a reduction in mean precipitation amounts at LGM compared to present.

PP72B-04 1415h

Magnitude and Timing of Temperature Change in the Indo-Pacific Warm Pool During Deglaciation

Robert Thunell[1] (803-777-7593; thunell@geol.sc.edu)

Katherine Visser[2] (508-457-2331; kvisser@usgs.gov)

Lowell Stott[3] (213-740-5120; stott@usc.edu)

[1]Department of Geological Sciences, University of South Carolina, Columbia, SC 29208, United States

[2]United States Geological Survey, 384 Woods Hole Road, Woods Hole, MA 02543, United States

[3]Department of Earth Sciences, University of Southern California, Los Angeles, CA 90089, United States

The ocean-atmosphere interactions presently occurring in the tropical Pacific exert a strong control over global heat and water vapor transport and thus are an important component of the climate system. Specifically, changes in sea surface temperatures (SST) and convection in the tropical Indo-Pacific region are responsible for interannual (i.e. ENSO) to decadal (i.e. NAO and PDO) climate variability observed in extratropical regions. The question to be answered is, what role, if any, do the tropics play in fostering longer term (i.e. millennial and/or orbital scale) changes in global climate. In this study we consider both the magnitude and timing of SST changes at a site in the Indo-Pacific warm pool during the last two glacial-interglacial transitions (Terminations 1 and 2). High-resolution δ^{18}O and Mg/Ca records from the planktonic foraminifer *Globigerinoides ruber* were generated in order to document changes in SST in this region during these periods of deglaciation. As the Mg/Ca of planktonic foraminifer is not influenced by the same parameters as δ^{18}O, it can be used in parallel with δ^{18}O to estimate how much of the isotope signal is due to ice volume. Additionally, by measuring paired Mg/Ca and δ^{18}O on the same sample we can directly determine the phase relationship between SST change and ice volume change, independently of the chronology that is used.

The Mg/Ca results indicate that SST within the Indo-Pacific warm pool increased by 3.5- 4.0 °C during the last two transitions from glacial to interglacial conditions. The warming of this region during deglaciation occurred synchronously with a global increase in atmospheric CO_2 and a warming in the Antarctic but two to three thousand years prior to the melting of the Northern Hemisphere ice sheets. These observations suggest that the tropical Pacific plays a major role in driving global climate change, principally through regulating the poleward flux of heat and water vapor.

PP72B-05 1430h

Glacial-Interglacial Dynamics of the Eastern Equatorial Pacific Cold Tongue-ITCZ Complex.

Athanasios Koutavas[1] (845-365-8411; athan@ldeo.columbia.edu)

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

Thomas M. Marchitto[1] (845-365-8415; tmarchit@ldeo.columbia.edu)

[1]Lamont-Doherty Earth Observatory and Department of Earth and Environmental Sciences, Columbia University, Rt 9W, Palisades, NY 10964, United States

Wind-driven upwelling in the eastern equatorial Pacific (EEP) forms a characteristic tongue of cold waters centered just south of the equator, which displaces the region of warmest sea surface temperature (SST) coincident with the Intertropical Convergence Zone (ITCZ) to the north. The cold tongue-ITCZ complex in the EEP is marked by one of the steepest meridional SST gradients observed presently in the tropics, and its dynamics are linked to the coupled ocean-atmosphere interactions that modulate the intensity of upwelling over seasonal and interannual timescales. Cold tongue-ITCZ dynamics are therefore of central importance for the equatorial circulation across the entire Pacific and hence for global climate as well.

Here we use oxygen isotope and Mg/Ca ratios measured on planktonic foraminifera from nine EEP sites to investigate the glacial-interglacial pattern of variation in this system from the Last Glacial Maximum (LGM) through the Holocene. We find that the cross-equatorial hydrographic front separating the cold tongue and ITCZ was attenuated to approximately half its present strength during the LGM. Because the strength of this front is presently related directly to the intensity of upwelling in the cold tongue, we infer reduced upwelling in glacial times, most likely associated with a weakening of the equatorial trade winds. This is in agreement with evidence from land for reduced Hadley circulation in glacial times. We suggest that the dominant mean climate mode in the glacial EEP resembled a quasi-El Niño state, with a less well-developed

cold tongue, more symmetric SST distribution about the equator, and southward shift of the mean ITCZ position. Low-latitude zonal and meridional SST gradients were reduced with potentially large impacts on the Pacific-wide and global general circulation.

PP72B-06 1445h

Atmospheric $\Delta^{14}C$ during the Younger Dryas: An estimate of the equatorial Pacific contribution

David C Lund (508-289-3490; dlund@whoi.edu)

Woods Hole Oceanographic Institution, Mail Stop 24, Woods Hole, MA 02543, United States

The Younger Dryas (YD) cold interval, and its accompanying abrupt increase and subsequent gradual decrease of atmospheric $\Delta^{14}C$, is commonly attributed to variable Atlantic thermohaline circulation. Models of thermohaline-driven $\Delta^{14}C_{atm}$, however, generally fail to adequately reproduce the observed YD $\Delta^{14}C$ record. Long-term shifts in the frequency of ENSO, recently postulated as an alternate causative mechanism for the Younger Dryas, may contribute to changes in $\Delta^{14}C_{atm}$ during this time interval. To evaluate this hypothesis, we use a simple geochemical box model capable of reproducing modern $\Delta^{14}C$ distributions, and then alter equatorial Pacific gas exchange and upwelling parameters in accordance with modern ENSO characteristics, but extrapolated for centuries. If equatorial Pacific upwelling increases by 2x (persistent La Niña conditions), $\Delta^{14}C_{atm}$ decreases by ∼10 per mil due to enhanced flux of atmospheric ^{14}C into the surface ocean. Alternately, if the transient upwelling rate is 0 Sv (El Niño conditions), $\Delta^{14}C_{atm}$ increases by ∼20 per mil. The results indicate that long-term shifts in equatorial Pacific dynamics could account for a significant portion, but not all, of the $\Delta^{14}C_{atm}$ changes observed during the Younger Dryas. The simulations also suggest that the equatorial Pacific may have played a role in the smaller $\Delta^{14}C_{atm}$ oscillations observed in Holocene tree-ring records.

PP72B-07 1520h

The Timing and Magnitude of SST Changes Since the Last Glacial Maximum Near the Bahamas

William B Curry[1] (508-289-2591; wcurry@whoi.edu)

Delia W Oppo[1] (508-289-2681; doppo@whoi.edu)

[1]Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, United States

Large changes in $\delta^{18}O$ of *G. sacculifer* occur a Bahamas core that spans the transition from the maximum of the last glaciation through to the late Holocene. The core (OCE205-103GGC) was recovered from 965 m and contains well preserved *G. sacculifer* throughout the entire record. Based on fourteen radiocarbon dates measured on *G. sacculifer*, sedimentation rates in the core vary from 11 cm kyr^{-1} in the Holocene, to 7 cm kyr^{-1}during the deglacial transition, to low values of 2 cm kyr^{-1} during the glacial maximum.

The glacial-Holocene transition is large (2.2 $^{o}/_{oo}$) and begins with an abrupt 1 $^{o}/_{oo}$ decrease at 15 Ka. This decrease occurs between samples that differ in age by less than 500 years. Another abrupt decrease of 0.4 $^{o}/_{oo}$ occurs at 11 Ka. Holocene values are reached by 7 Ka with small fluctuations of 0.1-0.2 $^{o}/_{oo}$ occurring during the most recent 7,000 years of the record.

The amplitude of the *G. sacculifer* $\delta^{18}O$ record (2.2 $^{o}/_{oo}$) is nearly twice as large as the amplitude of $\delta^{18}O$ that can be caused by ice volume changes (1.0-1.2 $^{o}/_{oo}$). In addition, the early 1 $^{o}/_{oo}$ decrease in *G. sacculifer* $\delta^{18}O$, which occurred about the same time as Melt Water Pulse 1A, is too large to have been caused solely by this event. Thus large changes in temperature, salinity, or both must have affected the deglacial record. Using the Barbados sea level curve as a proxy for $\delta^{18}O$ changes in ice volume, it is possible to calculate the residual ($\Delta\delta^{18}O$) caused by changes in temperature, salinity or both. The glacial-interglacial amplitude of $\Delta\delta^{18}O$ is 1 $^{o}/_{oo}$. Millennial-scale variations in $\Delta\delta^{18}O$ have the same shape as the GISP2 ice core $\delta^{18}O$ record: there is an abrupt 1 $^{o}/_{oo}$ decrease in $\delta^{18}O$ during Bolling-Allerod transition, which would equal a 4° C warming if it was solely the result of temperature variability. The Younger Dryas shows up as a 0.4 $^{o}/_{oo}$ increase in the residual $\Delta\delta^{18}O$, a 2° C cooling. The Bahamas *G. sacculifer* $\Delta\delta^{18}O$ record is highly correlated with the GISP2 $\delta^{18}O$ record (r = -0.81), even though the two records are derived from independent chronologies. The extent to which the residual $\Delta\delta^{18}O$ record reflects temperature changes will be evaluated using Mg/Ca measurements on the foraminifera.

PP72B-08 1535h

Deglacial Events in the Cariaco Basin During Terminations I and II

Larry C. Peterson[1] (lpeterson@rsmas.miami.edu)

Capri O'Hara[1] (cohara@rsmas.miami.edu)

Gerald H. Haug[2] (haug@erdw.ethz.ch)

Hui-Ling Lin[3] (hllin@mail.nsysu.edu.tw)

[1]RSMAS - University of Miami, 4600 Rickenbacker Cswy., Miami, FL 33149, United States

[2]Dept. of Earth Sciences, ETH - Zurich, Zurich CH-8092, Switzerland

[3]Institute of Marine Geology, National Sun Yat-Sen University, Kaohsiung 804, Taiwan

Anoxic depositional conditions during glacial Terminations in the Cariaco Basin allow for careful examination of deglacial events without fear of biases from bioturbational mixing. Comparisons of deglacial sequences spanning Terminations I (MIS 1/2) and II (MIS 5/6) from ODP Site 1002 reveal both similarities and differences in a variety of indicators. Planktic oxygen isotope data from Termination II indicate a climate reversal reminiscent of the Bolling-Allerod/Younger Dryas (BA/YD) events of the most recent deglacial. Like the BA/YD interval in Cariaco Basin, the equivalent sequence from Termination II is characterized by high abundances of G. bulloides and biogenic opal, indicators for high surface production over the basin. In contrast, timing differences in the repopulation of this region by taxa of the G. menardii complex suggest oceanographic differences between the two intervals.

Repopulation of the Atlantic Ocean by Globorotalia menardii and G. tumida has been historically used to define the base of the Holocene in the Atlantic basin. Abundance data from Cariaco Basin, however, shows that only the reappearance of G. tumida marks this boundary, with the first occurrence of G. menardii at about 7000 radiocarbon yrs BP lagging by several thousand years. During Termination II, both taxa reappear and reach peak abundances simultaneously at the end of the YD-equivalent interval. These observations, combined with evidence that menardiform species were in fact continuously present in the SE Atlantic over this period of time, suggest the possibility that the periodic absence of G.menardii and G. tumida in the Caribbean and tropical Atlantic is a function of transport issues, perhaps related to the interhemispheric exchange of thermocline waters that occurs when the thermohaline conveyor is fully operative. Implications of this scenario for heat transport into the North Atlantic are consistent with paleotemperature data and with the relative differences in repopulation timing between the two deglacial intervals.

PP72B-09 1550h

Deconstructing LGM climate in the tropical Atlantic with AGCM-slab ocean model

John C Chiang[1,2] (jchiang@atmos.washington.edu)

[1]JISAO, University of Washington, Box 354235 , Seattle, WA 98195-4235, United States

[2]Dept of Geography, University of California , 547 McCone Hall, Berkeley, CA 94720-4740, United States

Recent paleoevidence have indicated significant millenial-timescale changes to the mean position of the Atlantic Intertropical Convergence Zone (ITCZ). They appear related to changes associated with the dominant mode of interannual-to-decadal variability in that region, namely the meridional (aka gradient) mode. I investigate this issue for the Last Glacial Maximum (LGM) situation using a model configuration - an atmospheric general circulation model (AGCM) coupled to a 50m slab ocean model (SOM) - that gives a credible simulation of the modern meridional mode variability.

LGM (21K bp) forcing (CO2, land and sea ice extent, and orbital) cause a marked increase in the Atlantic northeasterly trades, colder north tropical Atlantic sea surface temperature (SST), and southward shift in the Atlantic ITCZ, very much after the fashion of the meridional mode. The ice sheet forcing is primarily responsible for the southward ITCZ shift and associated changes. While the ice sheet (in particular its impact on albedo) is directly responsible for the increase in the northeasterly trades, tropical thermodynamic ocean-atmosphere feedbacks associated with the meridional mode are essential to bring the ice sheet influence into the tropics.

Sensitivity studies show that ocean heat transport change associated with the Atlantic thermohaline circulation, and the equatorial Pacific zonal SST gradient, can also significantly alter the LGM Atlantic ITCZ position. These forcing quantities are, however, currently poorly constrained. Interestingly, the LGM AGCM-SOM simulation shows an initial tendency for the equatorial Pacific zonal SST gradient to reduce in strength and the ITCZ there to move equatorwards. Experiments with an intermediate coupled ocean-atmosphere model suggests that ENSO dynamics takes these tendencies further to reduce the mean zonal SST gradient by 1.5-2K across the basin. This is in apparent agreement with a recent observational study showing reduced zonal equatorial Pacific SST gradient during LGM.

PP72B-10 1605h

Deglacial and Holocene Records of Climate Change in the Tropics from Lake Sediments, Cordillera de Merida, Venezuela

Pratigya J Polissar[1] (polissar@geo.umass.edu); Mark B Abbott[2] (mabbott1@pitt.edu); Aldo Shemesh[3] (cishemes@wiccmail.weizmann.ac.il); Bruce P Finney[4] (finney@ims.uaf.edu); Alexander P Wolfe[5] (awolfe@ualberta.ca); Valenti Rull[6] (rullv@yahoo.es); Maximiliano Bezada[7] (mbezada@cantv.net); Raymond S Bradley[1] (rbradley@geo.umass.edu)

[1]Department of Geosciences, University of Massachusetts, Amherst, MA 01003, United States

[2]Department of Geology and Planetary Science, University of Pittsburgh, Pittsburgh, PA 15260, United States

[3]Department of Environmental Sciences, The Weizmann Institute of Science, Rehovot 76100, Israel

[4]Institute of Marine Science, University of Alaska, Fairbanks, AK 99775, United States

[5]Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB T6G 2E3, Canada

[6]Exploration and Production, Petroleos de Venezuela P.O. Box 829, Caracas 1010-A, Venezuela

[7]Sciencias de la Tierra, Universidad Pedagogica Experimental Libertador, Caracas 999, Venezuela

Tropical regions, covering 50% of the globe (30N-30S), are a substantial component of the climate system. They are an influential factor in both the global energy balance and hydrologic cycle, therefore climatic changes in the tropics can have global climate effects. Here we present results from a project which aims to reconstruct the Holocene climate history of the Venezuelan Andes on century to millennial timescales using multi-proxy analyses of lake sediment cores.

Sediment records from four lakes in the Cordillera de Merida, Venezuelan Andes, record changing moisture balance and glacial activity from ∼15,000 years BP to the present. Sediments from Laguna Mucubaji a lake with no glaciers presently in the watershed and maximum watershed elevations approximately 500m below the modern glaciation limit (5200m), show variations in clastic input which appear to be caused by the establishment and fluctuations of glaciers in the watershed. Biogenic opal oxygen isotope records from Laguna Verdes Alta and Baja, small lakes 4200m a.s.l., reflect changing regional moisture balance and possibly shifts in the isotopic composition of precipitation during the Holocene. The lakes are situated 0.5km from each other but have different hydrologic balances, thus viewing the records in tandem may give a better understanding of hydrologic change in the region. Diatom species abundance records from these lakes constrains the magnitude and timing of lake-level change associated with hydrologic change. The fourth lake, Laguna Blanca, is a small bog located 1800m a.s.l. The sediments from this lake alternate between organic rich and organic poor facies, apparently as a result of changing hydrologic balance. Lower lake levels result in greater organic sedimentation dominated by plant macrofossils while higher lake levels produce clayey organic poor sediments.

Following deglaciation (∼15,000 calibrated years BP) generally drier and/or cooler conditions prevailed in this region. Sediments from Laguna Mucubaji record significant glacial activity in the early Holocene. Relatively quiescent conditions prevailed during the middle-and late- Holocene punctuated by a distinct climate shift coeval with the Little Ice Age. Sediments from Mucubaji indicate glacial activity in the watershed while Lagunas Blanca and Verdes Baja record wetter conditions during this interval.

PP72B-11 1620h

The Younger Dryas and the 8200-Year Cold Event in the Southern Hemisphere Subtropics

Emma Christina Farmer[1] (1-845-365-8814; christa@LDEO.columbia.edu)

Peter B deMenocal[1] (1-845-365-8483; peter@LDEO.columbia.edu)

Thomas M Marchitto[1] (1-845-365-8415; tmarchit@LDEO.columbia.edu)

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/