

## PP21C-1188 0830h POSTER

### Using Milankovitch Cyclicity as a High-Resolution Dating and Correlation Tool to Understand the Stratigraphic Evolution of the Late Neogene Central California Margin

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Natural gamma ray logs from Ocean Drilling Program (ODP) sites off the Central California margin and from oil wells on the outer continental shelf show cyclical variation at Milankovitch periodicities in the Neogene upper-Monterey and Sisuque Formations and their offshore equivalents. The well-dated ODP Site 1016, 150 km offshore of Point Conception, provides the basis for development of an orbital cyclicity-refined age/depth scale that can be applied to the mid-latitude North American margin region. We correlate silica-rich/detritus-rich cycles in logs from this site to cycles in more proximal offshore and on-shore oil wells in a transect across the Santa Maria Basin, thereby helping to refine dating of these rapidly-accumulated, biostratigraphically-impoorished, fine-grained sediments, which are otherwise difficult to date. The higher resolution, orbitally-based age-depth scale provides refined dating of oil well logs, revision of the numerical age range of biostratigraphic markers, recognition and quantification of changes in sedimentation rates over time and in space, and identification of generalized climatic/sedimentation trends along the Alta-Baja California margin. For example: the new age model indicates that regional age ranges of some radiolarian biostratigraphic markers extend later than previously documented in other regions. Linear sedimentation rates decrease by an order of magnitude from 45-75 cm/ky to 7-8.5 cm/ky between proximal offshore locations and the distal Site 1016A. Analysis of the frequency modulation of the major harmonic in the frequency spectrum of the gamma ray vs. depth curve reveals the presence of condensed sections between 4.4-4.8 Ma and 5.3-5.6 Ma at Site 1016A. These two intervals may be associated with Neogene Hiatus 7 of Keller and Barron (1983). Natural gamma ray logs from deep-sea sites of ODP Leg 167 and the proximal Santa Maria basin wells show a similarity in gross secular trends along a 1300 km stretch of the Alta-Baja California margin, during the late Miocene to early Pliocene (7.0 to 3.5 Ma). Gamma ray count-inferred to reflect terrestrial detrital content—corresponds roughly with the broad rise and fall of eustatic sea level.

## PP21C-1189 0830h POSTER

### Links Between the Eastern Equatorial and Mid-Latitude Regions of the Eastern Pacific Ocean During the Pliocene-Pleistocene Transition

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The sustained warm period of the early Pliocene (4.6Ma to 3.1Ma) was the most recent period in the Earth's history when long-term equilibrium temperatures exceeded those of today. The subsequent continuation of the Earth's general cooling trend after 3.1Ma has been well documented, predominantly with records from the high latitudes of the Northern Hemisphere. The Pliocene - Pleistocene provides an excellent opportunity to better understand the importance of the connection between high latitudes and the tropical Pacific via the California and the Peru-Chile subtropical systems, during a major climate transition. We present the first comprehensive investigation of the role of the eastern Pacific Ocean in the Pliocene-Pleistocene transition using  $b^{18}O$  records of SST. ODP site 847 (0°12'N, 95°19'W, 3346m water depth) is located within the equatorial upwelling zone in the Eastern Equatorial Pacific (EEP) and serves as an excellent recorder of tropical Pacific climate dynamics. ODP site 1014 (32°50'N, 119°59'W, 1165m water depth) is located within the California Current (CC), and ODP site 1237 (16°0.4'S, 76°22.7'W, 3212m water depth) is located within the Peru-Chile current (PCC). These sites record both the strength of the eastern boundary currents in which they are located, which serve as a direct link between high and low latitudes via the advection of cold water, as well as changes in SST related to offshore upwelling. Sites 1014 and 1237 are

also indicative of conditions within the ventilated thermocline, an additional connection between the subtropical and tropical Pacific. Temperature records in both the tropic and subtropical Pacific show a gradual cooling trend, rather than a stepwise change at 2.75Ma often seen in northern hemisphere and ice volume records. Initial results indicate that the temperatures in the CC decreased by 8°C from 3 to 2Ma, and that modern conditions along the California margin were established by 2Ma. Temperatures in the EEP decreased by 3°C from 4Ma to the present, with increased variability in the last 1Ma. These results imply that reorganization in the tropical and subtropical Pacific was occurring before, during, and after the onset of major Northern Hemisphere glaciation, therefore making a tropical mechanism for increased northern hemisphere ice volume shift unlikely.

## PP21C-1190 0830h POSTER

### What Lies Beneath: 5 Million Year Record of Subsurface and Surface Ocean Conditions From the Eastern Equatorial Pacific Ocean

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Our results show that the Plio-Pleistocene (5.3 - 0.0 Ma) has been a period of dramatic change in the subsurface temperature and vertical structure of the Eastern Equatorial Pacific Ocean (EEP). We present records of subsurface and surface ocean temperature derived from magnesium calcium ratios (Mg/Ca) in foraminiferal calcite. Our estimates of absolute ocean temperature at the base of the photic zone (~100m) indicate a total cooling over the last 5 m.y. of approximately 10°C, occurring in two major steps. The first subsurface cooling, from ~19°C to ~14°C, occurred between 4.6 and 4.0 Ma and is not associated with a major change in EEP sea surface temperature (SST). The second subsurface cooling, from ~14°C to ~10°C, occurred between 2.5 and 0.0 Ma and is associated with an equivalent reduction in SST. We interpret a gradual trend in the carbon isotope composition of the subsurface dwelling foraminifera over the entire 5.3 Ma interval to indicate a change in the relative contributions of northern and southern sources to the thermocline in the EEP. Our estimates of subsurface ocean temperature are derived from Mg/Ca ratios in *Globorotalia tumida* (355-425 om) at Ocean Drilling Program site 847 (0°N, 95°W, 3347m water depth). Our SST estimates are derived from *Globogermoides sacculifer* (w/o sac; 355-425 om) in the same samples. *G. tumida* has been shown in plankton tow and core top studies to occupy a relatively stable depth at the base of the photic zone (~100m in the EEP) while *G. sacculifer* has been shown to calcify predominantly in the mixed layer. Thus Mg/Ca ratios in *G. tumida* and *G. sacculifer* are a monitor of ocean temperature at these respective depths. We present a core-top calibration verifying the Mg/Ca-temperature relationship for *G. tumida* in the modern tropical Atlantic and Pacific oceans. The shift from a warmer (~19°C) to a cooler (~10°C) regime at 100m in the EEP has two possible causes. The first is an overall cooling of the subsurface driven by temperature changes in the subtropical northeast and southeast Pacific ocean, the regions that supply water to the EEP thermocline. The second is a shift in the depth of the thermocline from below to above 100m driven by changes in wind driven upwelling.

## PP21C-1191 0830h POSTER

### A Record of Oceanic Lithium Isotope Composition for the Last 7Ma

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Continental weathering plays an important role in global climate change but has proved difficult to reconstruct for the past. New geological tools with which to assess the past rate and style of weathering are therefore urgently required. One such tool is Li isotope fractionation. Recent studies [1,2] have shown preferential release of <sup>7</sup>Li into the aqueous phase and retention/adsorption of <sup>6</sup>Li during weathering processes such as partial dissolution and secondary mineral formation. Lithium behaves conservatively in the oceans, with a residence time of ~1Ma, so that a history of ocean Li isotope composition provides information about the average rate and style of global continental weathering on long timescales. The incorporation

of lithium as a trace element in marine carbonates enables the construction of a record of oceanic Li-isotopic variation and is the focus of this work. Carbonate Li-isotope compositions are lighter than seawater by ~8 per mil, but this fractionation is not temperature dependent. This has been demonstrated by measurement of Li isotopes in inorganically precipitated calcites (5-30°C) [3], in coralline aragonite (25-30°C) [3] and in benthic foraminifera *Uvigerina* (7-23°C). This lack of T-dependent fractionation suggests that the variation in the isotope composition of planktonic foraminifera will solely reflect changes in oceanic Li isotope composition, which in turn is strongly influenced by changes in continental weathering. ODP site 758, located on the Ninetyeast Ridge in the Indian Ocean (5°N, 90°E; 2925m), was sampled at 2m intervals, over a depth corresponding to the last 7Ma, to produce 55 samples with a temporal resolution of approximately 130Ka. Site 758 is previously well studied with an existing chronology and high resolution Sr, O and Nd isotope data. Individual foraminifera species in the core top were first investigated to assess inter-species fractionation effects. Down core lithium isotope variation was examined by measurement of hand picked and fully-reductively cleaned *G. menardii*. *G. menardii* was chosen because of its abundance throughout the core enabling the required 30-40mg of carbonate to be readily picked. Lithium isotope composition will be measured using a well established MC-ICP-MS technique [2,3] with a precision of better than ±1 per mil to provide a record of the Li isotope composition of seawater for the last 7Ma and to identify changes in continental weathering during this period. 1. Huh Y. et al. (2001) EPSL 194, 189-199. 2. Pistiner J. S. & Henderson G. M. (In press) EPSL. 3. Marriott C. S. et al. (2002) GCA S1 66, A485.

## PP21D MCC: 3004 Tuesday 1020h

### ITCZ Dynamics of Past Climates II (joint with A, H, OS, C, GC)

Presiding: A Koutavas, Massachusetts Institute of Technology; G Haug, GeoForschungsZentrum Potsdam

## PP21D-01 1020h

### Insolation-Driven Changes in Aridity Within the Amazon Basin Over the Last 40,000 Years

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Annual precipitation over the Amazon Basin is thought to be strongly linked to the average latitudinal position of the Inter-Tropical Convergence Zone (ITCZ). A more southerly ITCZ is considered to bring moisture to the Basin via the humid northeasterly trade winds, drawn in from the tropical North Atlantic. When the ITCZ is constrained further to the north these trades are restricted, and so the Basin should become more arid. Past changes in Amazon Basin hydrology therefore have the potential to monitor shifts in the palaeo-latitude of the ITCZ over northern South America. However, great debate surrounds the Pleistocene moisture history of the Amazon Basin largely due to the paucity of reliable, uninterrupted, regionally-representative proxy records back through the last glacial maximum (LGM). As a result, reconstructions are often highly-localised and based on qualitative indicators of change. On the other hand, material collected from the Amazon Fan (ODP Site 942) has allowed us to examine an average effective moisture signal from the whole of the Amazon Basin for the last

40 ka within a single sedimentary sequence. Quantitative reconstructions of effective moisture based upon  $\delta^{18}\text{O}$  analyses of planktonic foraminifera, suggest a significant reduction in Amazon River outflow during both the LGM and Lateglacial (to ~60% and ~55% of modern flow, respectively), becoming increasingly moister toward the modern day. This trend is similar to other records from South America, including the Cariaco Basin, and correlates well with insolation records implying the ITCZ as a driver. The signal also displays centennial and millennial-scale variability which are most likely climate-driven, and Heinrich Events are apparent as more arid periods within the record. We provide further evidence for glacial-stage aridity vs. Holocene humidity through a quantified reconstruction of the fire history of the Amazon Basin, where biomass burning-specific biomarkers are of coincident increased abundance throughout the more arid periods.

#### PP21D-02 1035h

##### Caribbean Salinity Variation During the Last Glacial Cycle

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Evaporation exceeds precipitation in the tropical Atlantic, resulting in a net freshwater removal across the Central American Isthmus. Because most of the north Atlantic's subtropical gyre water circulates through the Caribbean before flowing north to subtropical regions via the Gulf Stream, changes in tropical atmospheric circulation have the potential to affect the salinity and density structure of the entire north Atlantic, thereby influencing glacial-interglacial oscillations in North Atlantic Deep Water (NADW) formation. Here, we combine Mg/Ca measurements (a proxy for the temperature of calcification) and  $\delta^{18}\text{O}$  analyses of shells from the surface-dwelling foraminifera *Globigerinoides ruber s.s.* (white var.) from the western Caribbean Colombian Basin at ODP Site 999A (2827m; 4cm/ka sed. rate) and VM28-122 (3623m; 4-10cm/ka sed. rate) to produce the first continuous record of western tropical Atlantic  $\delta^{18}\text{O}_{\text{SEAWATER}}$  ( $\delta^{18}\text{O}_{\text{SW}}$ ) during the last 130ka. In order to generate a record for sea surface salinity (SSS) due to regional hydrological change, we removed the  $\delta^{18}\text{O}_{\text{SW}}$  signal due to glacial ice volume variation and normalized the residual to the modern  $\delta^{18}\text{O}_{\text{SW}}$  value for the Colombian Basin ( $0.8^\circ/\text{oo}$ ). The resulting ice volume-free ( $\Delta\delta^{18}\text{O}_{\text{IVF-SW}}$ ) record shows that Caribbean  $\Delta\delta^{18}\text{O}_{\text{IVF-SW}}$  increased by  $\sim 0.5^\circ/\text{oo}$  during the Last Glacial Maximum and Marine Isotope Stage 4. Using a modern western Caribbean  $\delta^{18}\text{O}_{\text{SW}}$ :SSS relationship, these enriched  $\delta^{18}\text{O}_{\text{SW}}$  values suggest glacial Caribbean salinities were 2.3 - 2.8 $^\circ/\text{oo}$  higher than modern after removing the influence of ice-volume. Our data supports the hypothesis that the tropics might have been in a state more similar to the modern El Niño mode, characterized by a more southerly position of the ITCZ, during cold phases of the last glacial cycle. Within the resolution of our  $\Delta\delta^{18}\text{O}_{\text{IVF-SW}}$  record from VM28-122, elevated glacial Caribbean salinity decreased to modern levels at the onset of the Bolling-Allerød (B/A) interstadial event (14.6 cal ka) as NADW formation reinitiated and the ITCZ migrated northward. We hypothesize that the transport of salty tropical waters into the North Atlantic during the early deglaciation, in combination with a reorganization of ocean circulation, may have served to increase subpolar surface water density and amplify the overturning circulation that produced the warm B/A. The B/A salinity reduction occurs simultaneously with previous evidence for wetter conditions in the Cariaco Basin, suggesting a northward shift in the ITCZ to a wetter, more La Niña-like state in the tropics.

#### PP21D-03 1050h

##### 500,000-year History of Fluvial Discharge into the Caribbean Sea as Revealed by Elemental Geochemical Analysis of ODP Site 999A

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Records spanning the last glacial/interglacial interval indicate significant changes in the moisture balance of the neotropics. Because the Intertropical Convergence Zone (ITCZ) plays a critical role in controlling the hydrological balance of the tropics, past changes in rainfall patterns have been interpreted as resulting from long-term fluctuations in the zonality and/or intensity of the ITCZ. To evaluate glacial/interglacial changes in the ITCZ beyond the last glaciation, we are studying a marine core from the Caribbean Sea. Our goal is to reconstruct changes in the hydrological balance of northern South America, which are chiefly driven by fluctuations in the ITCZ. For this purpose, we study the upper 20 m of ODP Site 999A from the Colombia Basin. The chronology of the record is based on the oxygen-isotopic composition of specimens of planktonic foraminifera (*G. sacculifer* and *Neoglobobulimina duterrei*) that were manually picked out of sediment samples. The obtained isotopic record indicates that the studied interval encompasses the last 500,000 years, which is also supported by chronostratigraphic control provided by the relative abundance of *Globorotalia menardii*, *G. inflata*, and *G. truncatulinoides*. Detrital material accumulating in the Colombia Basin mainly comes from the Colombian Andes via the Magdalena River. Because measurements of detrital load in the river show a strong relationship with rainfall in the northern Andes, we use titanium and aluminum concentrations in the sediment samples as proxies for detrital material influx from the northern Andes. Our results show that while high aluminum/titanium ratios occur in interglacial intervals, low ratios typically occur in glacial intervals. Time-series analysis indicates a cyclic distribution of titanium and aluminum concentrations, showing periodicities closely related to Earth's orbital variations. We interpret these cyclic distributions of titanium and aluminum as evidence for glacial/interglacial fluctuations in the dynamics of the ITCZ that were forced by orbital-induced changes in insolation.

#### PP21D-04 1105h

##### Using Paired Mg/Ca and Oxygen Isotopic Measurements of Planktonic Foraminifera to Estimate Tropical Atlantic Thermocline Shape

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Dynamic feedbacks between atmospheric circulation and upper ocean water masses determine sea surface temperature patterns in the tropics. Easterly tropical trade winds shoal the thermocline and drive vigorous upwelling in eastern basins, cooling upper ocean temperatures there. Warmer SSTs and a deeper thermocline characterize western tropical warm pools. Geochemical compositions of depth-stratified planktonic foraminifera allow paleoceanographic reconstructions of tropical wind-driven upper ocean temperatures. Initial results using only oxygen isotopic ratios indicated that the tropical thermocline shape (between 0 and 40m) could be reconstructed with an average standard error of  $\pm 1.6^\circ\text{C}$  for a set of 24 Atlantic coretops. This study uses paired Mg/Ca and isotopic data and new statistical techniques to enhance the utility of this approach. Mg/Ca values were measured by ICP-OES in the same samples used in the oxygen isotope calibration, as well as for many additional new coretop samples. Foraminiferal Mg/Ca has been shown to be exponentially dependent on the temperature at which the organisms grew. While this relationship is subject to complication by dissolution and ontogenetic effects, it is unaffected by variations in continental ice volume. In general, Mg/Ca of *G. sacculifer* (without final chamber), *G. ruber* (white), *N. tumida*, and *G. menardii* species show a higher correspondence with upper ocean temperatures than was apparent for the oxygen isotope dataset, promising increased accuracy of thermocline reconstruction estimates. Additional calibration improvements result from reconstructing depth and temperature of inflection points in the upper ocean temperature profile rather than simply temperature at discrete depths. So instead of regressing Mg/Ca or isotopic data of any one species on temperature at 50m, for example, higher correlations and better predictive skill are obtained by relating Mg/Ca of each species to the temperature and depth of the mixed layer, the steepest point in the thermocline, and the base of the thermocline.

URL: <http://www.ldeo.columbia.edu/~christa/MATHESIS/MATHESIS.html>

#### PP21D-05 1120h

##### Is It Possible To Maintain A Megalake Chad At Mid Holocene ? Analyses Of Model Simulation At 6ka With Emphasis On Hydrologic Cycle variation

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The orbital forcing variations through Holocene may explain the shift in latitude of the ITCZ and its seasonal variations. This feature has been depicted by many modeling studies. There is also many data over continental areas (Africa and South America) that depict the changes in ITCZ through the whole Holocene. In this study we use a coupled Atmosphere-Ocean-Biosphere General Circulation Model (IPSL) to simulate the climate of Mid-Holocene (6Ka BP). Our main goal is to focus on the response of Chad Lake to the hydrologic changes due to orbital parameters variations. We show that the induced changes in ITCZ location and on hydrology around the Lake are consistent with the existence of a Megalake 6000 years ago. We then discuss the periodicity of the occurrence of a Megalake since there are evidences that such variations occurred since Mid-Miocene and the possible modulation of these oscillation due to tectonics (uplift of the African rift and variation in the Indonesian throughflow).

#### PP21D-06 1135h

##### An ~1500 year history of El Niño Southern Oscillation rainfall anomalies and land use the Isthmus of Panama from speleothem calcite

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The history of the El Niño Southern Oscillation (ENSO) over the past two millennia remains poorly constrained. To document further the tropical paleoclimatic response to ENSO, we present a precisely-dated (180 B.C. to 1310 A.D.), high-resolution ( $\sim 3$  yr / sample), cave calcite isotopic time series from the Isthmus of Panama, a region that experiences ENSO-forced rainfall anomalies. We show evidence for rapid and dramatic rainfall variation in southern Central America, as inferred from stalagmite  $\delta^{18}\text{O}$  isotope stratigraphy. Isthmian convective rainfall from 550 A.D. to 1300 A.D. was both less intense and more variable than the period 180 B.C. to 550 A.D. Speleothem growth spanned the interval of the Classic Maya Collapse (750 - 950 A.D.), and provides additional evidence for dry anomalies at this time. Carbon isotopes document changing vegetation from native rainforest to grasslands and/or maize, a period of soil erosion associated with pre-Columbian agriculture, and final forest recovery. We suggest that ENSO-forced sea surface temperature anomalies in the eastern equatorial Pacific Ocean resulted in isthmian rainfall anomalies over much of the past two millennia. Our data suggest that El Niño events are associated with decreased isthmian rainfall, and that increased ENSO activity results in generally drier and more variable conditions.

PP21D-07 1150h

### SPCZ- and ENSO-related Salinity Variations Recorded in the Skeletal Geochemistry of a Porites Coral from Espiritu Santo, Vanuatu

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Variations in sea surface temperature (SST) and sea surface salinity (SSS) are important components of climate variability in the tropical ocean-atmosphere system. Instrumental SST time series are much more readily available than are instrumental SSS time series, which are exceedingly rare. SSS variations are strongly linked to seawater  $\delta^{18}\text{O}$  variations in the tropics, thus coral-based reconstructions of seawater  $\delta^{18}\text{O}$  offer an opportunity to reconstruct the history of SSS variations in the tropical oceans. Seawater  $\delta^{18}\text{O}$  is obtained by combining coral skeletal  $\delta^{18}\text{O}$ , which varies in response to changes in seawater  $\delta^{18}\text{O}$  and SST, with coral skeletal Sr/Ca, which varies in response to SST changes. This method has great potential for reconstructing past salinity variations. We explore this potential using a monthly-resolved, 65-year record of skeletal  $\delta^{18}\text{O}$  and Sr/Ca variations in a Porites coral from Espiritu Santo, Vanuatu (16.0°S, 166.7°E). Santo is well positioned for such a study because ENSO-related climate variability strongly influences local salinity through changes in the position of the center of South Pacific Convergence Zone (SPCZ) convection/precipitation and associated salinity front movements. Moreover, a 24-year record of SSS variations is available from this region, which permits a ground-truth assessment of the robustness of the coral-based seawater  $\delta^{18}\text{O}$ -SSS reconstruction. Investigation into different methods of combining coral  $\delta^{18}\text{O}$  and Sr/Ca to reconstruct SSS reveals that the coral  $\delta^{18}\text{O}$  anomaly time series provides the best fit to the SSS time series. A post-1976/1977 freshening trend in the  $\delta^{18}\text{O}$  anomaly time series, which has been documented in other proxy time series, increases our confidence that this time series accurately reflects changes in the hydrologic balance in the western tropical Pacific. The Vanuatu coral  $\delta^{18}\text{O}$  anomaly time series also correlates strongly with the Southern Oscillation Index, the Niño 3.4 SST anomaly time series, and with a SPCZ index derived from rainfall records. The results of this study confirm that coral geochemical records from Espiritu Santo, Vanuatu are climatologically significant and that longer modern coral records and fossil coral records from this area contain a robust archive of past variability in SSS, SPCZ and ENSO.

PP21D-08 1205h

### A Paleoclimate Record of the Great Australian Bight Provides Tropical-Extratropical Linkage for the Past 18,000 Years

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Present climate in southern Australia is dominated by the strength and position of the subtropical high-pressure belt (STHB) and mid-latitude Westerlies. The STHB, in turn, is powered by the position and strength

of the Intertropical Convergence Zone (ITCZ). Shifts in strength and position of either the STHB or Westerlies, results in significant changes of rainfall over southern Australia. A sediment core from the Great Australian Bight (GAB) is used to evaluate the position, strength and influence of these climate regimes during the past 18,000 years. ODP Leg 182 Site 1127 provides a record with high sedimentation rates and abundant planktic foraminifers allowing a  $^{14}\text{C}$ -dated chronology and paleoceanographic reconstruction. Its coastal proximity links the terrestrial and oceanic climate evolution using the sedimentary iron content. Iron is a major constituent of dust and only reaches the GAB if entrained in pre-frontal northerly dust plumes that are subsequently scavenged by precipitation related to westerly low-pressure systems over the Bight. Very little iron reached the GAB during the last glacial maximum when strong Westerlies blew dust offshore into the Tasman Sea and Southern Ocean. Stepwise deglacial warming and increasing dust deposition reversed during the Younger Dryas implying a return to dry and windy conditions. High Fe values during the early Holocene coincide with warm and wet conditions related to low summer insolation and reduced seasonality. Reduced ITCZ migration south allowed for northerly penetration of rainbearing Westerlies. In contrast, decreasing Fe input since 7000 years coincides with aridification related to increasing seasonality and large latitudinal migration of the ITCZ. Holocene climate variability is the result of insolation-driven seasonality producing the large-scale features of atmospheric circulation and climate characteristics of southern Australia today. Sensitive to changing influence of Westerlies and Hadley circulation, this record provides evidence for a tropical-extratropical teleconnection.

### PP22A MCC: Level 2 Tuesday 1330h

#### ITCZ Dynamics of Past Climates III Posters (joint with A, H, OS, C, GC)

Presiding: A Koutavas, Massachusetts Institute of Technology; G Haug, GeoForschungsZentrum Potsdam

PP22A-1192 1330h POSTER

#### Linking Surface Hydrology in the Tropical Indian Ocean, Ocean Circulation, and Atmospheric Methane Over the Last two Climatic Cycles

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Core MD 98-2165 (9°38'96 S, 118°20'31 E, 2100 m) from the tropical Indian Ocean has been studied at a time resolution of about 200 y over the two last climatic cycles within the POP project. Oxygen and carbon isotopic composition ( $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ ) of benthic and planktonic foraminifera has been measured. The benthic  $\delta^{18}\text{O}$  record is remarkably similar to Antarctica ice deuterium ( $\delta\text{D}$ ) or  $\delta^{18}\text{O}$  records. 15 AMS  $^{14}\text{C}$  dates covering the last 26 kys allowed us to verify that our benthic  $\delta^{18}\text{O}$  record is perfectly synchronous with the ice records. This finding indicates that the impressive similarity found between a benthic  $\delta^{18}\text{O}$  record from the Iberian Margin and Vostok  $\delta\text{D}$  (Shackleton, 2000) between 24 and 64 kys BP, is not restricted to this particular deep sea core and to marine isotopic stage 3. Correlating our high resolution benthic  $\delta^{18}\text{O}$  records to Dome Fuji ice  $\delta^{18}\text{O}$  record dated by the inverse approach of Parrenin et al. (2001), we obtain a high resolution marine time scale which is consistent with the

Antarctic ice cores time scales. Moreover, the error on the relative age of the marine versus ice core records is necessarily lower than the duration of the millennial events recognised in both records, hence yielding a great improvement in our ability to compare marine and ice records over the last two to three climatic cycles. In this new marine chronology, we examine the relative timing of changes in surface and deep-water variability in the tropical Indian Ocean with respect to the air temperature and atmospheric methane concentration records from Antarctic ice cores. Our results highlight a tight correspondence between sea surface salinity in the tropics and atmospheric methane concentration. In contrast, the millennial scale climatic variability characterising glacial periods does not exhibit a clear relationship between sea surface salinity in the tropical Indian Ocean and atmospheric methane concentration.

PP22A-1193 1330h POSTER

### Atlantic Intertropical Convergence Zone Variability: a Clay Mineralogy Study of Cariaco Basin Sediments Over the Last 1000 Years

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The Cariaco Basin's high deposition-rate laminated sediments make it one of the best recorders of tropical Atlantic climate and Intertropical Convergence Zone (ITCZ) variability. Different drainage basins within the South American continent and the clays that are fluvially transported from them should be affected as the position of the ITCZ and its associated rainfall migrates through time. Over glacial-interglacial time scales it has been suggested that variations in the paleo-position of the ITCZ influences the suite of clay minerals deposited in Cariaco Basin sediments. Here we present results of much higher resolution clay mineralogy analyses of box and gravity core sediments deposited in the basin over the last 1000 years to examine ITCZ variability on sub-decadal to century time scales. Continuous sampling of well-dated box and gravity core sediments at consecutive 1-mm intervals provides a record with a temporal resolution of 1-3 yrs for the time period ca. A. D. 1000 to 1990. The clay and fine silt size fraction (<10  $\mu\text{m}$ ) was analyzed using x-ray diffraction for semi-quantitative and qualitative analysis. Kaolinite and illite co-vary over the length of the record suggesting that variations in these minerals are indicative of fluctuations of terrigenous input to the basin rather than changing weathering regimes. Between A. D. 1000 and 1550 variations in quartz, kaolinite, and illite positively correlate with a prior study of sediment titanium content, an inferred indicator of terrigenous input to the Cariaco Basin. However, the clay/titanium correlation becomes strongly negative between A. D. 1550 and 1990 suggesting a possible change in the source region, and hence paleo-position of the ITCZ, for either the clays or the titanium fraction over this interval. In contrast, chlorite is negatively correlated to sediment titanium percentages over the entire length of the record.

PP22A-1194 1330h POSTER

### Seasonal Variability in Terrigenous Input to the Cariaco Basin, Venezuela.

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Abstract. Previous studies have interpreted variation in Cariaco Basin sediments as representing paleoclimatic changes related to meridional shifting of the Intertropical Convergence Zone and its effect on the relative amount and composition of the terrigenous and biogenic components deposited there. We report results from major, trace, and rare earth element analysis of sediment trap material gathered as part of the CARIACO Time Series Program from two traps (275 m