New temperature-depth (T-z) measurements in boreholes previously used for heat flow and borehole paleoclimate studies between 1979 and the present provide a critical test of borehole paleoclimatology and may provide a means of determining anthropogenic forcing of surface temperature. In 2001 and 2002, we obtained new T-z profiles in boreholes in North Dakota, South Dakota, Nebraska and Ontario that were drilled and logged initially for heat flow research and later were used in paleoclimate analysis. Comparison of the T-z logs reveals changes in subsurface temperatures, which correlate with air temperature records at nearby meteorological stations. These repeat measurements solve a problem in comparing the borehole temperature record to the instrumental meteorological surface-air-temperature (SAT) record in that data for the same time periods are compared. In previous comparisons, the borehole T-z profile at the beginning of the SAT record was unknown and a pre-observational mean was assumed for the SAT.

The results of this test can be used to compute the thermal energy stored in the ground between measurements. Comparison of these results to radiative flux measurements from meteorological and satellite instruments for the time periods represented by the data may allow determination of relative changes and differences in radiation and thermal energy storage. However, energy storage in the ground is a complex process involving a number factors that influence energy exchange including, soil moisture, ground cover, wind, precipitation, solar radiation, surface heat flow, soil temperature, and air temperature. If these factors can be accurately determined, extraction of the anthropogenic signal from the borehole data should be possible.

PP61A-0311 0830h INVITED POSTER

Is Low Latitude Sea Surface Temperature the primary regulator of atmospheric pCO2 Changes Associated with Glacial Cycles?

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Numerous hypotheses have been proposed to explain the 80 ppm reduction in atmospheric carbon dioxide concentration that distinguishes glacial periods from interglacials. The role of increased solubility of CO2 associated with cooling of low and mid latitude surface waters plays only a minor contributing role in previously published scenarios. Here we show, using the Toggweiler 7-box ocean carbon cycle model, that the role of low and mid latitude sea surface temperatures may have been underestimated. The most substantial difference between glacial and interglacial climates is, after all, temperature. We show that global sea surface temperature changes could be the primary driver of atmospheric CO2 on these timescales. In our hypothesis, additional systematic feedbacks, such as those which have been suggested as possible primary mechanisms in the past, play a secondary role. The relevance to future concerns associated with warming ocean temperature and increasing greenhouse gas concentrations in the atmosphere will be discussed.

PP61A-0312 0830h POSTER

Unbalanced Air-Sea Carbon Flux at the Last Glacial Maximum

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In an equilibrium climate state, the global air-sea carbon flux integrates to zero. It is only during climate transitions that imbalances between different reservoirs lead to net carbon exchange. The atmospheric carbon-dioxide partial pressure pCO_2 therefore depends on the history of the climate system. Using a box model and the deconvolution method, we find that the glacial air-sea carbon flux was at times unbalanced, suggesting that the glacial carbon cycle was not in equilibrium. Analyzing present-day ΔpCO_2 and CO_2 flux maps of the global ocean, as well as the output of an ocean general circulation model subject to sea-surface boundary conditions characteristic of the last glacial maximum (LGM), we consider the main physical factors that control the air-sea carbon flux, such as sea-surface temperature, wind speed and sea-ice cover. The LGM sea-surface boundary conditions are based on reconstructions with a stronger tropical cooling and less sea-ice in the Nordic Seas than inferred by CLIMAP. Finally we compare the glacial climate change with the ongoing modern climate change, i.e., a warming at high latitudes of the Northern Hemisphere by a few tenths of a degree Celsius and, possibly, a decrease in Arctic sea-ice cover by 10-15% and thickness by 40%.

PP61A-0313 0830h POSTER

Catastrophic Ecosystem Collapse in Pleistocene Australia

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Extinction of the Australian megafauna (505ka) occurred shortly after human colonization (555ka). A link between the two has been suggested, including the possibility that landscape modification was influential, but pinpointing the role of humans remains elusive. To evaluate changes at the ecosystem level across the extinction event we utilize dietary information recorded by d13C preserved in eggshells of the extant emu (Dromaius novaehollandiae), a large flightless bird. Emus are opportunistic feeders; their diet reflects the range of food sources available in the weeks before nesting (June). d13C quantifies the proportion of C3 vs C4 vegetation that constitutes the emus diet.

A 150,000-year record of emu dietary intact has been reconstructed using more than 300 individuals from Lake Eyre (south-central Australia) dated by 14C, luminescence and/or racemization. Prior to 50 ka emu diet was highly variable, ranging from 100% C3 to 100% C4. However, immediately after 50 ka, emu diet shifted dramatically: the C4 contribution never exceeded 50% (n=200) after 50 ka, whereas more than half the samples older than 50 ka old contain >50% C4 dietary sources. We attribute the observed changes in emu diet to a fundamental rearrangement of the plant ecosystems in semi-arid central Australia. Such a change in plant communities may have contributed to the extinction of many dependent herbivores. The coincidence in time of megafauna extinction and ecosystem collapse shortly after human colonization suggests there may be a causal link. Development of similar records of vegetation change for other regions of Australia are currently underway to evaluate whether the Lake Eyre record reflects a continental scale reorganization of the Australian biota.

PP61B MCC: 104 Saturday 0830h

Past Changes of the Hydrological Cycle in the Tropics and Subtropics I

(joint with A, H, OS, GC)

Presiding: **A C Clement,** University of Miami**; L C Peterson,** University of Miami

PP61B-01 0830h

Tropical Ice Core Isotopes Reveal Changes in Convection from the Last Glacial Maximum to the Present

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The oxygen isotopic composition of water vapors over the tropical oceans has been measured. Samples were collected at three locations: 8.4N 167.6E, 16.0N 97.2W, and 24.5N 81.6W over 3 to 8 week periods two to three times per day. Isotope values varied from -10 to -24 per mil. Dew points varied from 20 to 28 degrees centigrade. The lowering of isotope values below isotopic equilibrium with seawater was caused by exposure of air parcels to rainfall upwind of the sampling location. The higher the intensity and the better the organization of tropical rain systems the lower were the isotope values. This isotopic variation is transferred to tropical ice cores such as those in the Andes Mountains. Raleigh Distillation model curves along the moist adiabat show how isotopes in water vapor and precipitation vary from the ocean surface to the ice core site. Isotope values of precipitation today at the ice core site are lower than those predicted from the Raleigh model assuming that the oxygen isotopic composition of the starting vapor was in near isotopic equilibrium with the sea surface. Simply by lowering the isotopic composition of water vapor over the oceans in the source region it is possible to achieve overlap of model results with measured values. The average oxygen isotope value of ice over the range of present-day measured temperatures matches the model-calculated values if we assume that the initial oxygen isotope value for the source water vapor is about -17 per mil. The average oxygen isotope value of ice at the Last Glacial Maximum (LGM) over the range of estimated temperatures overlaps Raleigh model calculated values. The closer proximity of this data field to the model calculated values can be explained by a higher oxygen isotope value for the source water vapor. Less intense and less organized convection over the tropical oceans at LGM would have resulted in higher oxygen isotope values for the source vapors.

In addition, examination of cloud top echoes from passages of the NASA Tropical Rainfall Measuring Mission (TRMM) satellite over the two Andes ice core sites suggests a lower condensation temperature than has been assumed in earlier interpretations of the ice core data. This also improves the overlap of model-calculated and measured isotope values.

PP61B-02 0845h INVITED

Ice Core Evidence of Past Changes in the Hydrological Cycle of the Tropics and Subtropics

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Ice core records from South America, Africa, the Himalayas and the Tibetan Plateau provide records of past changes in the hydrological cycle over a wide range of latitudes. Ice cores from seven high elevation (>5300 m asl) sites raise questions about the synchroneity of glaciation and the relative importance of temperature and precipitation in governing the growth of permanent ice fields in low latitude mountain ranges. Cores from Huascarán (Peru at 9°S) and Sajama (Bolivia at 18°S) contain continuous records back ∼19 ka and 25 ka, respectively and thus extend into Late Glacial Stage (LGS). Both glaciers undoubtedly survived the early Holocene warm period (10 to 6 ka B.P.), but neither contains a record of the entire LGS back to the previous interglacial. Thus, both mountains, among the highest in South America, appear to have been ice-free during a time when the Earth was in the grip of a 'global' glaciation. Conversely, the ice core records from the Dasuopu (28°N) and Puruogangri (34°N) glaciers suggest that ice existing today in the Himalayas and central Tibet formed during the early Holocene warm period. Glacier formation/starvation in the tropics and subtropics appears to be controlled by wetter/drier conditions in response to precession-driven changes in solar radiation.

These ice core records are combined with more than 120 other paleoclimate to produce a global map of effective moisture changes between the Last Glacial Maximum and the Early Holocene. Changes in the tropical hydrological system over the last 25 ka have been extreme with the global pattern of climate in the Early Holocene being nearly opposite that during the Last Glacial Maximum. For example, the zonal belts in the deep tropics that experienced greater aridity during the LGS attained maximum humidity in the Early Holocene while at the same time the humid subtropical and mid-latitude belts became drier. The symmetry of these changes in moisture about the equator suggests a strong role for the Hadley circulation, and that either its position or its intensity or both were altered as the Earth moved from glacial to interglacial conditions.

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PP61B-03 0900h

A >100 kyr Record of Glaciation from the Southern Tropical Andes

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Drill cores from Lake Titicaca (16°S, 70°W, 3810 masl) contain a record of tropical glaciation through at least the last global glacial cycle. Glaciation in the cordillera surrounding the lake is represented in cores by sediments high in magnetic susceptibility and low in total organic and inorganic carbon. These periods are separated by stratigraphic units high in total organic and inorganic carbon and low in magnetic susceptibility. Seismic reflection data indicate that more than 60 kyr BP, lake level was at least 240 m lower than it is today, as indicated by erosional truncation of seismic reflections and by clinoforms, which we interpret as low-stand deltaic deposits. The correlative organic- and carbonate-rich sediments, which are low in magnetic susceptibility, likely represent the last interglacial in the tropical Andes. The subsequent glaciation, accompanied by a rise in lake level, lasted until ca. 22 to 19.5 cal kyr BP. At this time glaciers began to retreat to higher elevations in response to climatic warming, during an interval when lake level remained high. Analysis of glacial snowlines in the cordillera surrounding Lake Titicaca indicate that mean annual temperatures were 5° to 9°C colder at the last glacial maximum in the tropical Andes. Wet conditions in the tropical Andes persisted until ca. 15 cal kyr BP, which supports the interpretation that deglaciation from the last glacial maximum was primarily in response to increased mean annual temperatures. Evidence from deeper in the Lake Titicaca drill cores suggests that similar glacial intervals and lake level changes have occurred in the southern tropical Andes several times in the late Pleistocene.

PP61B-04 0915h

Geochemical and Diatom Records of Hydrologic Variability in the Tropical Andes During the Late Quaternary From Drill Cores of Lake Titicaca

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Seven drill cores were recovered from Lake Titicaca during the NSF/ICDP/DOSECC drilling expedition of 2001. Sub-lake floor drilling depths ranged from 53 to 139 m; water depths ranged from 40 to 232 m; recoveries ranged from 75 to 112%. Our most detailed multi-proxy analyses to date have been done on Core 2B raised from the central basin of the lake from 232 m water depth, drilled to 139.26 m sub-lakefloor with 140.61 m of total sediment recovered (101%). A basal age of 200 Ka is estimated by linear extrapolation from radiocarbon measurements in the upper 25 m of core; Ar-Ar dating of interbedded ashes is underway.

The volume and lake level of Lake Titicaca have undergone large changes several times during the late Quaternary. Proxies for these water level changes (each of different fidelity) include the ratio of planktonic-to-benthic diatoms, sedimentary carbonate content, and stable isotopic content of organic carbon. The most recent of these changes, have been described previously from earlier piston cores. In the early and middle Holocene the lake fell below its outlet to 85 m below modern level, lake salinity increased several times, and the Salar de Uyuni, which receives overflow from Titicaca, dessicated. In contrast, Lake Titicaca was deep, fresh, and overflowing (southward to the Salar de Uyuni) throughout the last glacial maximum from prior to 25,000 BP to at least 15,000 BP. According to our extrapolated ages, the penultimate major lowstand of Lake Titicaca occurred around 75,000 to 80,000 BP, when seismic evidence indicates that lake level was about 240 m lower than present. Near the end of this lowstand, the lake also became quite saline. There are at least three, and possibly more, older lowstands, each separated temporally by periods in which the lake freshened dramatically and overflowed.

Our analyses include decadal resolution of the stable isotopic composition of lowstand carbonate sediments. Taking advantage of a quantitative relationship between precipitation amount and δ^{18}O of the precipitation, we use model calculations and the observed oxygen isotopic record to reconstruct precipitation rates during the carbonate-bearing intervals. These are compared with similar analyses and calculations done on the highstand deposits in the Salar de Uyuni (contemporaneous deposits in Lake Titicaca contain no carbonate).

PP61B-05 0930h

The Importance of Precession Signals in the Tropical Hydrological Cycle

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Past research on the climate response to orbital forcing has placed considerable emphasis on the changes in global ice volume and global mean temperature that recur on an approximately 100-kyr timescale. This paper suggests that such an emphasis has obscured an important part of the problem. In the tropics, far from the regions of the ice sheets, local orbital forcing is large and has a climate response that is quite distinct from the 100-kyr cycle of climate change. An atmospheric general circulation model is used to illustrate this point. Experiments are performed to compare the response of the tropics to precessional and obliquity forcings, and Last Glacial Maximum boundary conditions. It is found that while the annual mean glacial temperature change is more than an order of magnitude larger than the precessional changes, the hydrologic signals are comparable in magnitude. Rather different mechanisms produce these distinct climatic signatures. The response to the glacial forcing has a significant projection onto the zonal mean circulation, resulting in a strengthening and southward shift of the boreal winter Hadley cell. This appears as a glacial decrease of precipitation in the northern tropics and an increase in the southern tropics. The precessional forcing, on the other hand, induces large zonal asymmetries in the circulation and hydrologic fields with little zonal mean signal. These asymmetries arise primarily through dynamical coupling between heating over land and a remote response over the ocean. In both the glacial and precessional cases, large regions of the tropics are linked through dynamics, and the model results illustrate that tropical climate change, particularly as it relates to the atmospheric circulation and hydrologic cycle, can not be viewed in a one-dimensional sense. Examples from the paleoclimate record are presented to argue that it is of primary importance to understand the precessional response in the tropics in order to properly interpret past climate changes there.

PP61B-06 0945h INVITED

Millennial Scale Temperature and Hydrological Response of Galapagos Surface Waters During Marine Isotope Stage 3

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High resolution records of surface ocean response during the last glaciation are now available from a number of tropical Pacific sites. Detailed records from the western Pacific (Wang et al., South China Sea; Stott et al., Mindanoa; Rosenthal et al., Sulu Sea) suggest that millennial scale variability during MIS 3 was dominated by variability in the hydrological cycle, presumably through the influence of the East Asian Monsoon and ENSO systems. Because of the tight zonal connections in the tropical Pacific, a detailed MIS 3 record from the eastern Pacific is needed for comparison.

Core TR163-22 (92.5W, 0.5N, 2830m) lies just to the NW of the Galapagos Platform at the transition between cool Equatorial Undercurrent and warm North Equatorial Current waters (modern SST is 24.5 degrees). This core has a sedimentation rate of 10 cm/ky through MIS 3, and we have re-sampled continuously at 2.5 cm spacing to achieve an age resolution of 250 y. The chronology is based on 6 calibrated C14 dates (to 27 ky calendar) and benthic O18 stratigraphy for older intervals.

We have analyzed Mg/Ca (for SST) and O18 (for temperature and O18w) in the surface-dwelling planktonic foraminifera G. ruber. Our record indicates large millennial scale oscillations in SST during MIS 3. These oscillations are as large as 3 degrees and match the full glacial - interglacial SST change. Some events go from minimum to maximum temperatures in less than 1 ky (10 cm). Based on the accompanying O18 record, associated oscillations in salinity were relatively small. This observation suggests that while the western Pacific was dominated by hydrological shifts on millennial scales in MIS 3, the eastern Pacific experienced large changes in SST. These rapid shifts, presumably linked through the Walker cycle, further demonstrate the potential climate impact of the tropical Pacific during glaciation.

URL: http://www.geol.ucsb.edu/~lea/

PP61B-07 1030h

Using Multi-Species Foraminiferal δ^{18}O to Reconstruct Hydrologic Changes in the Gulf of Panama From LGM to Present

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Currently, an excess in precipitation minus evaporation (P-E) maintains a low-salinity surface layer and a shallow pycnocline in the Gulf of Panama. In contrast, the Caribbean has high salinity due to high evaporation relative to precipitation. The strong salinity gradient between these two regions is sustained by northeasterly trade winds, which carry evaporated moisture from the Caribbean over the Panama Isthmus and into the Gulf of Panama, where high SSTs attract the moisture-laden air masses. This leads to atmospheric convection and heavy rainfall on the Pacific side of the Isthmus in the Gulf of Panama. Since the majority of the rainfall in this region originates as water vapor in the Caribbean, changes in vapor transport can be estimated by changes in upper ocean structure in the Gulf of Panama. A multi-species approach is used in a Panama Basin sediment core to reconstruct changes in cross-isthmus vapor transport from LGM to present. We measure δ^{18}O in two species of planktonic foraminifera, one that lives at the surface and one that lives at the base of the pycnocline, in order to estimate the isotopic contrast across the pycnocline, which is directly related to net precipitation in the Gulf of Panama (i.e., an increase in δ^{18}O contrast between the sea surface and the base of the pycnocline is associated with an increase in P-E).

PP61B-08 1045h INVITED

ENSO and Floods: Multi-Scale Variations and Surprise when Analyzing Hydrologic Extremes

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Teleconnections between the tropical Pacific and the occurrence of floods in Western United States are now generally recognized. Recognizing that ENSO represents interannual as well as century and longer scale variations, it is interesting to consider a dynamic

risk (i.e., risk slowly and systematically changing with time) framework for flood frequency analysis as an alternative to the current practice of estimating the 100 year flood as a measure of static risk implied by a stationary process. Spatio-temporal variations in flood occurrence over a subset of the Western United States are first analyzed in the frequency domain. Then, we explore the implications of treating the flood process as stationary by computing the exceedances of a T-year flood estimated from a n-year record in the subsequent n years. This is done with one record of annual maximum floods from the West, and with a 1000 year series of annual maximum NINO3 values derived from a stationary climate run of the Cane-Zebiak model for the tropical Pacific. We compare the results from this analysis to a parallel analysis where the n years for estimating the T-year flood and the subsequent n years for computing the exceedances are drawn at random from the same record. The latter provides an analog for a climate-flood process that has no temporal structure. The probability distribution for the number of exceedances is seen to be much more heavy tailed for the structured case than for the random case, for all values of n explored, suggesting that the multi-scale variability in climate and floods will regularly translate into surprises for decisions on flood control where a static risk paradigm is used. This observation also has implications for the assessment of evidence of anthropogenic climate change in terms of climate extremes.

PP61B-09 1100h

Tropical Modulation of Low Frequency Precipitation Variability in the Western US During the Past 1200 Years

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We examine the relation between proxy reconstructions of Sacramento river flow and Southwestern US drought severity from tree-ring data, and tropical proxies for El Niño (Laguna Pallcacocha alluvial sediment record, Ecuador) and Pacific decadal variability (δ^{18}O from the Quelccaya ice cap, Peru). An important new result is a robust positive relation between El Niño activity and precipitation in Central and Northern California over the past 1200 years. This relationship is important from a paleo-climatic perspective because it establishes the multi-century stability of the response to El Niño forcing in this region, and because it provides support for the quality of both proxy records. A second important result is that the relation between proxy El Niño activity and indicators of precipitation over the Southwest US appears transitory rather than the positive relationship seen in the instrumental record. In contrast, we do find consistent agreement between proxy for Pacific decadal variability (Quelccaya δ^{18}O) and Southwestern US precipitation at multi-decadal time scales from various indices going back to 450 AD. This variability can also be found in records that have recently been used to document trans-hemispheric co-variability in decadal scale climate fluctuations in proxy records. Composites constructed using the proxy data indicate that the modulation of the El Niño- non-El Niño-related precipitation response over the Southwest demonstrated from the instrumental record has been a feature of the regional climate over the past 1000 years. We hypothesize on how this modulation is realized.

PP61B-10 1115h INVITED

The Little Ice Age in Mesoamerica

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The spatial and seasonal distribution of rainfall is highly variable across the Yucatan Peninsula today, and is affected by climate variability of both Pacific (e.g., ENSO) and Atlantic (e.g., NAO) origin. The northwest coast is driest and is marked by a steep precipitation gradient from a low of 450 mm/yr near Progreso (21.3°N), increasing to 1000 mm/yr at Merida (21.0°N), and 1150 mm/yr at Abala (20.7°N), representing almost a 3-fold increase over a distance of only 65 km with negligible topographic relief. The region is highly attractive for paleoclimate study because of the steep rainfall gradient that is this sensitive to past changes in the position of the ITCZ. Consequently, we studied a 5.1-m sediment core from Aguada Xcaamal (20.61°N, 89.72°W, max. depth = 12 m), a sinkhole lake located near the town of Abala, Mexico. Between 1400 and 1500 A.D., oxygen isotope ratios of the gastropod *Pyrgophorus coronatus* (spinose) increased by $3^{o}/_{oo}$ and the benthic foraminifer *Ammonia beccarii* became abundant in the sediment profile, providing strong evidence for a pronounced increase in evaporation/precipitation ratio (E/P) and the salinity of Aguada Xcaamal. This interpretation is supported by historical accounts of intense drought in the mid-1400s described in the Book of Chilam Balam of Mani (Gill, 2000), a town located only 45 km southeast of Aguada Xcaamal. Oxygen isotope values in sediment cores from Lake Chichancanab (19.9°N) and Lake Salpeten (17°N) to the south also show an increase in the mid 15th century, although the magnitude is less than that recorded in northwest Yucatan. Increased E/P on the Yucatan Peninsula in the 15th century coincided with the start of the Little Ice Age (LIA), and is synchronous with increased aridity inferred from trace metals (Fe and Ti) in the Cariaco Basin off Venezuela, and with expressions of the LIA in tropical and polar ice cores. Colder temperatures during the LIA are well known to have had a societal impact in Greenland and Europe, and decreased precipitation in Mesoamerica may have contributed to cultural change such as the collapse of the Mayapan hegemony in the mid 15th century (Gill, 2000).

Gill, R.B. (2000). Great Maya Droughts, University of New Mexico Press, Albuquerque.

PP61B-11 1130h

Cyclic Variability in Moisture Balance in Central Equatorial Africa During the Past 5000 Years

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Paleohydrologic variations in Africa are recorded by the chain of large East African rift lakes, whose climatic sensitivity and high sedimentation rates make them ideal for high-resolution reconstruction of past continental moisture balance. Among these lakes, Lake Edward, Uganda-Congo is ideally configured to record past variations in the African monsoon, situated on the equator at the eastern edge of the Congo basin. Analyses of the stable isotopic and chemical composition of authigenic calcite in three cores from Lake Edward covering the past 5,000 years show large, coherent shifts that reflect past variations in hydrologic balance. These chemical and isotopic stratigraphies exhibit both a long-term trend, suggesting increasingly arid conditions from 5 kyr BP culminating at 2 kyr BP, and high-amplitude sub-millennial variability. This short-term variability documents arid intervals centered at 4.6, 4.0, 3.4, 2.7, 2.0, 1.4, and 0.8 kyrs BP, the latter correlating with the Grand Solar Maximum and the European Medieval Warm Period.

The controls on past African moisture balance appear complex, potentially driven by solar forcing and/or related to Indian and Atlantic Ocean SSTs and high latitude events. The geochemical events in Lake Edward are not consistently correlated with solar forcing or with northern or subtropical Atlantic cold events. Spectral analysis of the Lake Edward data shows several weakly significant $<$ 200 year periodicities, as well as a highly significant period at 725 yrs. This 725-year period has been previously recognized in marine records from the Arabian and South China seas, suggesting teleconnections between East Africa rainfall and the Indian Ocean/Asian monsoon operate on long time-scales.

PP61B-12 1145h

Holocene South Asian Monsoon Climate Change Potential Mechanisms and Effects on Past Civilizations

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Planktonic oxygen isotope ratios from the laminated sediment core 63KA off the river Indus delta dated with 80 AMS radiocarbon ages reveal significant climate changes in the south Asian monsoon system throughout the Holocene. The most prominent event of the early-mid Holocene occurred after 8.4 ka BP and is within dating error of the GISP/GRIP event centered at 8.2 ka BP. The late Holocene is generally more variable, and shows non-periodic cycles in the multi-centennial frequency band. The largest change of the entire Holocene occurred at 4.2 ka BP and is concordant with the end of urban Harappan civilization in the Indus valley. Opposing isotopic trends across the northern Arabian Sea surface indicate a reduction in Indus river discharge at that time. Consequently, sustained drought may have initiated the archaeologically recorded interval of southeastward habitat tracking within the Harappan cultural domain. The hemispheric significance of the 4.2 ka BP event is evident from concordant climate change in the eastern Mediterranean and the Middle East. The late Holocene cycles in South Asia, which most likely represent drought cycles, vary between 250 and 800 years and are coherent with the evolution of cosmogenic radiocarbon production rates in the atmosphere. This suggests that solar variability is the fundamental cause behind late Holocene rainfall changes at least over south Asia.

PP62A MCC: Hall D Saturday 1330h

Past Changes of the Hydrological Cycle in the Tropics and Subtropics II Posters *(joint with A, H, OS, GC)*

Presiding: **A C Clement,** University of Miami**; L C Peterson,** University of Miami

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PP62A-0314 1330h POSTER

Sea Surface Temperature and Seawater Oxygen Isotope Variability Recorded in a Madagascar Coral Record

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Within KIHZ a coral from the lagoon of Ifaty off southwest Madagascar in the Mozambique Channel was examined. Based on temporal variability of skeletal oxygen isotopes annual mean sea surface temperatures are reconstructed for the period from 1658 to 1995. Sr/Ca ratios were measured for selected windows with monthly resolution (1973 to 1995, 1863 to 1910, 1784 to 1809, 1688 to 1710) to validate the SST reconstructions derived from oxygen isotopes. The coral proxy data were validated against gridded SST data sets.

The Sr/Ca-SST agree well with SST observations in the validation period (1863 to 1910), whereas the d18O derived SST show largest discrepencies during this time interval. By taking into account the SST values derived from coral Sr/Ca, we were able to reconstruct d18O seawater variability. This indicates that