Climate modeling studies predict that under a global greenhouse-gas warming situation the ocean's thermohaline circulation (THC) might weaken or even shut down. The detailed conditions for such an event are not well understood, it is however likely that a more or less complete collapse of the thermohaline circulation could be triggered by changes in surface conditions leading to fresher and/or warmer sea surface in high latitudes. Current observations indicate a freshening of the North Atlantic and concomitant reduction in the Iceland-Scotland overflow suggesting that a change of the THC might already be in progress. The North Atlantic, however, is a region that undergoes considerable hydrographic variations on annual to decadal timescales. Hence, additional observations from locations other than the North Atlantic, that allow for the early detection of THC change are required. We used benthic foraminiferal oxygen isotope ratios from two sediment cores recovered at 426 m and 1299 m water depth in the eastern and western tropical Atlantic to show that strong reductions in thermohaline overturning during the last deglaciation were associated with rapid and intense warming of intermediate-depth waters. A climate model simulation revealed that a similar temperature pattern is expected for a reduction in modern thermohaline overturning in response to changes in the North Atlantic freshwater budget. We suggest that a temperature increase of tropical Atlantic mid-depth waters, as it is already observed for the past century, could serve as a sensitive indicator of THC slowdown with a high signal-to-noise ratio.

URL: http://www.palmod.uni-bremen.de/~gerrit/film

PP62B-08 1535h

Climate Change in the North Pacific Region Over the Last Three Centuries as Expressed in an ice Core From Mount Logan

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The relatively short length of most instrumental climate datasets restricts the study of variability that exists in the climate system. This is particularly true regarding the atmosphere where high quality spatially dense data exists only since the late 1940s. With this data, the Pacific North America pattern (PNA) has been identified as one of the dominant modes of variability in the atmosphere. The PNA is related to an inter-decadal mode of climate variability known as the Pacific Decadal Oscillation (PDO). The PDO has been shown to influence marine productivity in the North Pacific as well as modulating the impact of the El Nino-Southern Oscillation in North America and Australia. Here we present an updated 301-year ice core record from Mount Logan in northwestern North America that shows a statistically significant and accelerating positive trend in snow accumulation from the middle of the 19th century that appears to be associated with secular changes in the PNA and PDO. A manifestation of this trend has been a warming over northwestern North America both at the surface and throughout the lower atmosphere.

PP62B-09 1550h

Clathrates, Ice sheets and Global Climate Change?

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Ice age cycles are associated with large fluctuations in the concentration of atmospheric methane and carbon dioxide. The cause for these fluctuations remains unexplained, although clathrates are often proposed as a potential source of methane. However, the mechanism for methane release from clathrates into the atmosphere has not been established. We examine the possiblity that clathrates accumulate below continential ice sheets during periods of glaciation, permitting substantial release of methane during deglaciation. The source of the methane is due to microbial decomposition of organic material below the ice sheet. We assume that organic material in soils ahead of the ice sheet is frozen in place due to low atmospheric temperatures. Once the ice sheet is present and sufficiently thick, the geothermal gradient adjusts to bring the sediments to the melting point of water. Assuming anaerobic conditions underneath the ice sheet, the presence of methanogens at the basal surface of the ice sheet allow for the conversion of organic carbon to methane. This methane is stored as clathrate when the temperature and pressure conditions at the basal surface permit thermodynamic stability (ice thickness in excess of 250m at 0°C). Subsequent deglaciation destabalizes clathrate causing the release of methane into the atmosphere. We use a numerical model of the Laurentide-Cascade ice sheet (Marshall et. al., 1999) for the areal extent, thickness, and the thermal conditions at the base of the ice sheet as a function of time. In order to bound the available carbon below the ice sheet, we consider two estimates of soil carbon inventory based on tundra and present potential vegetation. Our model quantifies the decrease of carbon in the soil and the accumulation of clathrate as the ice sheet advances. As the ice sheet retreats we track the amplitude and timing of methane released into the atmosphere. The amplitude of predicted fluctuations in atmospheric methane are 80-200ppbv, which are of the same order as those recorded in the ice cores from Greenland and Antarctica. Our findings suggest that clathrates have played a role in global climate change.

Marshall S.J., Clarke G.K.C. 1999. Climate Dynamics, 17(7):533-550

PP62B-10 1605h INVITED

A Long-term Perspective on Sensitivity of ENSO to Anthropogenic Forcing

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State-of-the-art coupled ocean-atmosphere models used to project future changes in climate produce very mixed results as to how the El Nino/Southern Oscillation (ENSO) may be influenced by anthropogenic forcing. In some models, ENSO variability increases as the Earth warms, in others it decreases, and in others it remains unchanged. Clearly, the approach of using coupled models alone to understand the sensitivity of ENSO and its possible future behavior is insufficient. The instrumental record can provide information on how ENSO has behaved over the past century when greenhouse gases have been steadily increasing. However, this approach is also limited since it is difficult to separate the natural fluctuations of ENSO, which can occur on interannual, decadal and perhaps longer timescales, from anthropogenically forced changes.

To address the question of whether human activities may influence the future behavior of ENSO, a long-term perspective is needed. We need to characterize the natural fluctuations of ENSO that arise from internal instabilities in the tropical Pacific climate system that may appear on timescales ranging from the interannual to the millennial. These fluctuations must then be distinguished from changes in ENSO behavior that may arise in response to forced changes in the mean climate state. The paleoclimate record provides the opportunity to characterize such behaviors. Because of the large magnitude of the ENSO signal, archives that are preserved in the oceans and on land contain information about the frequency and amplitude of the phenomenon at different times in the past.

This paper will compare paleoclimate records with available model results to determine whether it is possible to capture past ENSO behavior using our current understanding of the phenomenon as it is represented in models. It is shown that the observed increase in ENSO variability over the last 10,000 years is consistent with model results under the variations in solar forcing due to changes in the Earth's orbital parameters that occurred over that time. However, the effect of conditions at the Last Glacial Maximum, a time of reduced atmospheric carbon dioxide and lower global temperatures, produces mixed model results, and paleoclimate data are presently sparse. It is suggested that a focus on the LGM and other times of cooler planetary temperatures will provide understanding of the effect of changes in the mean climate state on ENSO, which can be applied to the problem of how ENSO will behave in the future as the climate changes under anthropogenic forcing.

PP62C MCC: 104 Saturday 1630h

Cesare Emiliani Lecture *(joint with C, OS, GC)*

Presiding: **P U Clark,** Oregon State University**; B L Otto-Bliesner,** National Center for Atmospheric Research**; J W White,** University of Colorado

PP62C-01 1630h INVITED

'Prepare Immediately for Whatever Is Going to Happen Next': A Paleoclimatic View of the Future

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The Earth's climate has been highly sensitive and variable, as shown by voluminous, reliable paleoclimatic data. Changes, including those associated with ice ages and with millennial events such as the Younger Dryas, have had global impacts despite little or no globally averaged forcing. Natural variability, ranging from interannual shifts through decadal-centennial droughts to millennial abrupt jumps, often has been larger than documented by the valuable but short instrumental records. Analogy suggests future climate surprises. Complex climate models are improving rapidly, but frequently simulate less sensitivity and variability in the climate system than documented by paleoclimatic records. Because larger and faster changes are harder to deal with, the future may prove somewhat more challenging than anticipated by many people, and Christina Hulbe's dictum in the title may be good advice.

PP71A MCC: Hall D Sunday 0830h

Patterns of Holocene and Deglacial Climate Variability in the Tropics and Subtropics I Posters *(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

PP71A-0372 0830h POSTER

Deglacial Warming in the Gulf of Mexico Preceded Laurentide Ice Sheet Meltwater Input: Implications for Tropical Climate Forcing

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As part of the Western Hemisphere Warm Pool (WHWP), the Gulf of Mexico is an important source of heat and moisture to the North American continent and the higher latitudes. Orca Basin on the Louisiana slope in the northern Gulf of Mexico is ideally located to record deglacial WHWP sea-surface temperature (SST) warming in relation to meltwater input from the Laurentide Ice Sheet (LIS). Paired δ^{18}O and Mg/Ca data on planktic foraminifera (*Globigerinoides ruber*, white variety) from cores EN32-PC4 and -PC6 are used to separate deglacial changes in SST and δ^{18}Oseawater due to low-salinity meltwater. In core EN32-PC4, Mg-SST increases from near full-glacial values of about 24°C at ca. 15 ka ^{14}C to >28°C at ca. 12.8 ka ^{14}C, including a sharp increase of >3°C from 14.2-13.3 ka