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We exploit the unprecedented ability to synchronize two high-resolution sedimentary records from the Oman and Pakistan margins of the Arabian Sea to derive sea surface temperature (SST) gradient estimates over the last 65 Kyr. Millennial-scale cycles in monsoon dominance parallel Dansgaard-Oeschger events recorded in Greenland. Switches occurred during the last glacial period between a strong summer monsoon climate mode (inter-stadials) and an intensified winter monsoon (during stadials). The amplitude of individual monsoon events and Greenland temperature extremes appears broadly comparable, suggesting that the response to, and likely forcing for, such events was quasi-global in nature. The fidelity of the sedimentary nitrogen isotope record has allowed us to identify a 20cm interval at ODP Site 723 on the Oman margin containing a stadial/inter-stadial between 43-42 Kyr BP. We employ sedimentary δ^{15}N, chlorin pigment and alkenone abundances, major and minor element analyses of 2mm samples across this interval to generate a comprehensive, multi-proxy data set to understand the sequence of climatic events, especially the relative intensity of summer and winter monsoons, during these times. A lack of evidence for bioturbation in excess of our sampling resolution facilitates decadal-scale climatic reconstructions. Using a four-component flux-dilution model, we show that the deposition of carbonate decreased in parallel with an increase in TOM flux from stadial to interstadial time. This interval is also marked by a significant drop in lithogenic flux, analogous to a similar decrease noted during deglaciation in the western Arabian Sea. Combined with alkenone $U_{37}^{K'}$-derived estimates for SST, we conclude that the climatological shift from stadial to inter-stadial conditions at low latitudes was characterized by several switches in mean monsoon state. The winter monsoon was the dominant mode during maximum stadial conditions, and conversely that the summer monsoon was dominant during maximum interstadial-like conditions. However, each interval was separated by a distinct inter-monsoon' mode, indicated by a higher continental dust flux but warmer SST. Proxy records for changing bottom-water oxygenation show near-identical results down to the mm-scale, but hint at increased export production leading the onset of anoxia during the stadial/inter-stadial transition. The coherence of all sedimentary signals depicts a wholesale reorganization of the Arabian Sea climate and marine ecosystem over approximately 200 years, an interval that may be associated with monsoon modulation by small oscillations in solar irradiance.

URL: http://www.smast.umassd.edu/cmastweb/biohigginson.html

GC12A-0153 1330h POSTER

Seasonal Variations of Precipitation δ^{18}O in Eastern Asia

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Climate change often occurs through changes in seasonal influences, but paleoclimate records rarely have intra-annual resolution. The precipitation δ^{18}O, either directly measured or indirectly inferred from other datable materials, is one of the most widely used proxies for paleoclimate studies. It is important, therefore, that we understand the seasonal distribution of meteoric δ^{18}O in relation to climate dynamics. In most land areas, the precipitation δ^{18}O is higher in the summer and lower in the winter. However, this isotopic seasonality is reversed in the coastal regions of East Asia, while moving further inland it becomes normal. The mechanisms causing this spatial distribution of the isotopic seasonality in East Asia have not been discussed. We have identified nine overlapping mechanisms responsible for isotopic seasonality, either normal or reversed. These mechanisms include, 1) temperature, 2) vertical atmospheric stability, 3) time span of moisture transport from coast to inland, 4) amount effect, 5) seasonal migration of the Intertropical Convergence, 6) seasonal migration of the Polar Front, 7) marine *versus* terrestrial evaporation ratio, 8) condensation to liquid *versus* ice and 9) seasonal difference in relative humidity. Using a simple δ^{18}O model we show that the most important mechanism for the observed isotopic pattern in Asia may be the interseasonal variations in vertical atmospheric stability. The stability of air above land in the winter is greater relative to that above the ocean, and the opposite occurs in the summer. These variations are reflected in interseasonal variations of the horizontal and vertical advection of moisture by the large-scale Walker circulation, and of small-scale mixing by diffusion. Our results indicate that the complex causes of interseasonal, interannual, and interepochal variations of meteoric δ^{18}O require considerable caution in the attribution of records of past δ^{18}O variations to changes in specific climate variables.

GC12A-0154 1330h POSTER

Greenhouse Warming and Severe Summer Precipitation over Europe

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Projections of future climate change of extreme precipitation for Europe already exist, but are deficient in terms of their regional detail. High-resolution climate change simulations for an area covering the entire European continent and a substantial part of the North Atlantic are part of the PRUDENCE project financed by the EU 5th framework program. More than 8 different regional models are taking part in the project, using resolutions between 25 and 50 km. All experiments are driven by similar large-scale atmospheric boundary conditions from relatively high-resolution global models. The emission scenarios used were the IPCC SRES scenarios A2 and B2. 30-year time slice experiments were conducted with the regional models for periods representing the present (1961-1990) and the future (2071-2100) in the two scenarios. Resolution limitation in a global model precludes the simulation of realistic extreme events and the spatial structure of precipitation over heterogeneous surfaces. Due to a much better representation of the surface topography in a regional model, the geographical distribution of seasonal mean precipitation patterns generally represents a substantial improvement compared to the driving model. Likewise, high resolution is needed to provide sufficient information on the statistical distribution of daily rainfall events. Daily precipitation statistics for the summer period of several regional simulations is presented. As a robust result, high percentiles of precipitation show general increasing trends even in areas that experience a decrease in average precipitation, in particular in southern Europe.

GC12A-0155 1330h POSTER

A Novel Method for Analyzing and Interpreting GCM Results Using Clustered Climate Regimes

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A high-performance parallel clustering algorithm has been developed for analyzing and comparing climate model results and long time series climate measurements. Designed to identify biases and detect trends in disparate climate change data sets, this tool combines and simplifies large temporally-varying data sets from atmospheric measurements to multi-century climate model output. Clustering is a statistical procedure which provides an objective method for grouping multivariate conditions into a set of states or regimes within a given level of statistical tolerance. The groups or clusters–statistically defined across space and through time–possess centroids which represent the synoptic conditions of observations or model results contained in each state no matter when or where they occurred. The clustering technique was applied to five business-as-usual (BAU) scenarios from the Parallel Climate Model (PCM). Three fields of significance (surface temperature, precipitation, and soil moisture) were clustered from 2000 through 2098. Our analysis shows an increase in spatial area occupied by the cluster or climate regime which typifies desert regions (i.e., an increase in desertification) and a decrease in the spatial area occupied by the climate regime typifying winter-time high latitude perma-frost regions. The same analysis subsequently applied to the ensemble as a whole demonstrates the consistency and variability of trends from each ensemble member. The patterns of cluster changes can be used to show predicted variability in climate on global and continental scales. Novel three-dimensional phase space representations of these climate regimes show the portion of this phase space occupied by the land surface at all points in space and time. Any single spot on the globe will exist in one of these climate regimes at any single point in time, and by incrementing time, that same spot will trace out a trajectory or orbit among these climate regimes in phase space. When a geographic region enters a state it never previously visited, a climatic change is said to have occurred.

URL: http://climate.ornl.gov/

GC12A-0156 1330h POSTER

Mega-14C Plateau Provides Global Age Tie Point for Pre-Boelling DO Event 1

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Between 12,400 and 12,750 "atmospheric" 14C yr B.P. occurs an exceptionally broad 14C plateau that in total spans more than 800 calendar (cal.) years, from 15,250 to 14,420 cal. yr B.P. The plateau was first identified in Swiss lake sediments by Lotter et al. (1992) and more narrow-ly constrained on the basis of spline-interpolated coral and varve dates by Stuiver et al. (1998). A slight 14C age reversal by more than 200 years at the end of the plateau culminates near 14,500 cal. yr B.P., coeval with the Boelling peak warming in the GISP2 ice record and subsequent to the prominent DO warming event 1 at 14,680-14,665 cal. yr B.P. The start of the age reversal lies near 15,000 cal. yr, that is during the most recent part of the Heinrich 1 stadial (sensu lato). The plateau and its final 14C age increase were also identified in sediment cores from the South China Sea and the far northwestern Pacific, and possibly also in the Santa Barbara Basin (Hendy et al., 2002). Accordingly, the plateau helps to pin down for the time of the early Boelling the local paleo-14C reservoir ages to 800 years (compared to approx. 500 yr in the modern South China Sea and 800 yr in the northern North Pacific today) and thus provides a high-precision tool for global age correlations of regional paleoclimate events with the Greenland ice core record. Most significantly, the early onset of the 14C age reversal at about 15,000 cal. yr B.P. is equal to a drop in atmospheric 14C of about 120 per mil. In part, this shift may reflect a short-term but large-scale outgassing of "old" CO2 from the deep ocean to the atmosphere. Since the drop in 14C slightly preceded the abrupt climatic amelioration over Greenland, the outgassing may have its origin in early deglacial sea ice reduction that occurred in the Southern Ocean. In part, the extended 14C plateau may be linked to a short-term strong increase in geomagnetic intensity that was found both in the North Pacific and South Atlantic right during this time and may have induced a marked reduction in atmospheric 14C production.

GC12A-0157 1330h POSTER

Riparian Permafrost Dynamics Associated With Climatic Changes at Tree Line During the Late Holocene

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Thawing of permafrost has been a widespread phenomenon in the Northern Hemisphere since the beginning of the 20th century. Because future global warming is expected to be more pronounced in high latitude regions, it is of major interest to evaluate the influence of forcing factors on permafrost dynamics. In subarctic Quebec, most palsas are found in peatlands. The formation and degradation of these periglacial landforms are influenced by several regional and local factors such as air temperature, depth of snow cover and peat insulation. However, mineral palsas are also observed on river margins. Due to their peculiar position near the river bed, the dynamics of these mineral palsas are influenced by another factor: water level fluctuations associated with variations in winter (snow) precipitation. Studying such terrestrial ecosystems with a high hydrologic component can help distinguish the relative influence of temperature and precipitation on permafrost