Geophysical Research Abstracts
Vol. 13, EGU2011-6139, 2011
EGU General Assembly 2011

Early-Middle Pleistocene interglacial climate variability: a high-resolution study of Marine Isotope Stages 19 and 21 from the North Atlantic Ocean

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There is no doubt that the average climate state evolved towards generally colder conditions with larger ice sheets during the Pleistocene, and the overall periodicity of the glacial–interglacial cycles changed from a dominant 41 kyr obliquity periodicity prior to ∼0.9 Ma to a dominant late Pleistocene 100 kyr variance. Whether these changes in glacial and orbital boundary conditions affected the frequency and amplitude of millennial-scale climate variability is still open to doubt. An improved understanding of the mechanisms and feedbacks among the different components of the climate system requires the evaluation of the sensitivity of the Earth system to different forcings; in this context, past intervals of time characterized by different combinations of climate boundary conditions represent important archives of climatic information.

Here we examine the characteristics of millennial-scale climate variability under a climate regime different from that of the late Pleistocene, and characterized by higher-frequency, lower-amplitude glacial-interglacial cycles. Millennial-scale changes in sea-surface and deep-water conditions, the dynamics of thermohaline deep-water circulation and ice-sheet ocean interactions have been reconstructed from late in Marine Isotope Stage (MIS) 23 to MIS 19 (910-750 ka), within the Mid-Pleistocene Climate Transition, at Integrated Ocean Drilling Program Site U1313 in the North Atlantic. Today this site is in the path of the deep North Atlantic Deep Water (NADW) western boundary current as it exits the northernmost Atlantic, and surface waters in this region are derived from the North Atlantic Current (NAC). Continuous high-resolution stable isotope (oxygen and carbon) records from benthic and planktonic foraminifera have been reconstructed, allowing the assessment of the phase relationship between surface- and deep-water signals.

These results permit preliminary discussion of the magnitude of surface- and deep-water changes during glacial/interglacial transitions and the interglacials themselves.
Special emphasis will be placed on constraining the presence and characteristics of millennial-scale variability in North Atlantic sea surface and deep-water hydrography during MIS 19, considered a potential astronomical analogue for the Holocene and its future evolution, and the preceding interglacial MIS 21, a rather climatically unstable interglacial period within the mid-Pleistocene climate shift. We will discuss the climate differences between MIS 19 and 21, climate variability within these interglacials and attempt to establish their intensity and duration.