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North Atlantic millennial-scale climate variability, 910 to 790 ka

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The Mid-Pleistocene transition (MPT) was the time when quasi-periodic (∼100 kyr), high-amplitude glacial variability developed in the absence of any significant change in the character of orbital forcing, leading to the establishment of the characteristic pattern of late Pleistocene climate variability. It has long been known that the interval around 900 ka BP stands out as a critical point of the MPT, when major glaciations started occurring most notably in the northern hemisphere. Here we examine the record of climatic conditions during this significant interval, using high-resolution stable isotope records from benthic and planktonic foraminifera from a sediment core in the North Atlantic (Integrated Ocean Drilling Program Expedition 306, Site U1313). We have considered the time interval from late in Marine Isotope Stage (MIS) 23 to MIS 20 (910 to 790 ka).

Our data indicate that interglacial MIS 21 was a climatically unstable period and was broken into four isotopic substages, which have been identified and correlated across the North Atlantic region. These extra peaks tend to contradict previous studies that interpreted the MIS 21 variability as consisting essentially of a linear response to cyclical changes in orbital parameters. Cooling events in the surface record during MIS 21 were associated with low benthic carbon isotope excursions, suggesting a coupling between surface temperature changes and rates of the Atlantic meridional overturning circulation.

Time series analysis performed on the whole interval indicates that benthic and planktonic oxygen isotopes have significant concentrations of spectral power centered on periods of 10.7 kyr and 6 kyr, which is in agreement with the second and forth harmonic of precession. The excellent correspondence between the oxygen isotope records and insolation variations at the Equator in March and September suggests that a mechanism related to low-latitude precession variations, advected to the high latitudes by tropical convective processes, might have generated such a response. This scenario accounts for the presence of oscillations at frequencies equal to precession harmonics at Site U1313, as well as the occurrence of higher amplitude oscillations between the MIS22/21 transition and most of MIS 21, times of enhanced insolation variability.