Geophysical Research Abstracts,
Vol. 11, EGU2009-11080, 2009
EGU General Assembly 2009

Southern Ocean sea surface temperature variability across the Plio-Pleistocene Climatic Transition

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The Pliocene climate is considered to provide an accessible scenario for assessing the sensitivity of the climate system in a future warming world. Paleotemperature reconstructions of this period and the subsequent transition to colder climate conditions are hence essential for assessing hypotheses and validation of climate models. Previous studies have focused in the low latitudes and to a lesser extent in the high northern latitudes, but no quantitative paleotemperature estimates have previously been available from the Southern Ocean (SO), a key region in the regulation of global climate. Here we report the first continuous high-resolution reconstruction of Subantarctic (ODP Site 1090) Plio-Pleistocene sea surface temperatures (SST), which shade light on Antarctic criosphere evolution and SO millennial-scale variability across the last 3.65 My. This record reveals a 4-5ºC warmer but highly variable Pliocene SO, which may be consistent with the persistence of a dynamic east Antarctic ice-sheet (EAIS) through the late Pliocene and early Pleistocene. In favour of this interpretation the evolutive spectra of our SST record show precession phasing during the late Pliocene and early Pleistocene, providing a strong field evidence in favour of the novel interpretation of the Milankovitch theory recently proposed by Raymo et al 2006. However, our data suggest that the change towards a obliquity-driven marine-based EAIS proposed by Raymo et al to occur around 1 Ma, start to took place as early as around 1.5Ma. These findings have hence great implications for our understanding of Antarctic climate evolution, the interpretation of the Plio-Pleistocene 18O record, and the Milankovith theory of climate.