Geophysical Research Abstracts, Vol. 8, 07616, 2006
SRef-ID: 1607-7962/gra/EGU06-A-07616

Mediterranean paleocirculation: response to precession-induced climate change

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As evidenced by the sediments deposited in its basins, the circulation of the Mediterranean Sea has varied through time in response to changes in geography (i.e., tectonics) and changes in climate. A distinct feature of geological records from the Mediterranean Sea are the occurrence of sapropels (black layers rich in organic matter). Sapropels are deposited when Northern Hemisphere summer coincides with the Earth being closest to the Sun ("precession minima").

Sapropels are thought to reflect anoxic conditions of the deep water, conditions that are promoted by the presence of a thick stabilising freshwater layer at the sea surface. This freshwater layer is suggested to result from increased discharge by the Nile when monsoonal precipitation over Africa is high due to the enhanced temperature difference between land and ocean that developes at a precession minimum.

We investigate the relation between Earth's orbit and the marine sedimentary record using numerical models in a two step approach. First, we employ a global fully coupled atmosphere-ocean-sea ice model to isolate the atmospheric response to precession. Second, we use the model-derived changes between present-day climate and climate at precession minimum to modify the atmospheric forcing of a more detailed ocean model for the Mediterranean Sea. The results reveal that both increased discharge from the northern borderlands and increased net precipitation over the Mediterranean Sea influence the Mediterranean circulation more effectively than increased discharge from the river Nile.