Geophysical Research Abstracts, Vol. 7, 08737, 2005
SRef-ID: 1607-7962/gra/EGU05-A-08737

Acceleration technique for Milankovitch type forcing in transient simulations of Holocene and Eemian climates

S. J. Lorenz (1), G. Lohmann (2,3), T. Felis (3), J.-H. Kim (4), N. Rimbu (4), R. R. Schneider (5)

(1) Max-Planck-Institut für Meteorologie, Modelle und Daten, Hamburg, Germany (e-mail: lorenz@dkrz.de), (2) Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven, Germany (3) DFG Forschungszentrum Ozeanränder, Bremen, Germany, (4) Universität Bremen, FB5 Geowissenschaften, Bremen, Germany, (5) Christian-Albrechts-Universität zu Kiel, Institut für Geowissenschaften, Kiel, Germany.

A method is introduced which allows the simulation of long-term climate evolution within the framework of a coupled atmosphere-ocean general circulation model (ECHO-G). The change in the seasonal cycle of incident solar radiation induced by varying orbital parameters has been accelerated by factors of 10 and 100 in order to allow transient multi-millennial simulations. In contrast to conventional time-slice experiments, this approach is not restricted to equilibrium simulations and is capable to utilise all available data for validation.

Long-term ensemble integrations have been performed, covering the orbitally driven climate evolution of the last 140,000 years using this method. The last interglacial (Eemian, 125,000 years ago) and the Holocene (the last 7,000 years) climates are analysed. Comparison with alkenone data for Holocene temperature trends reveals that opposing Holocene climate trends in tropics and extra-tropics, apparent in the alkenone proxies, are a robust feature in our experiments using different acceleration factors.

The simulations are compared with chemical analysis of seasonally-resolved coral proxy records of last interglacial, late Holocene, and present-day climate from the northernmost Red Sea, a region sensitive to the Arctic Oscillation/North Atlantic Oscillation climate phenomenon (AO/NAO). Coral records and simulation results demonstrate that a change in the mean AO/NAO state contributes to increased Middle East temperature seasonality during the last interglacial. In the model, a tendency toward the high index AO/NAO during the last interglacial leads to a spatially non-uniform temperature difference from the present day in the North Atlantic region, with colder Middle East winters but warmer winters in Europe, consistent with European proxy records. This pattern is caused by changes in the orbital parameters with high eccentricity during the Eemian and the following transition into the last glacial climate, 115,000 years ago.

The simulations were extended into the time period 1800 to 2000 AD, where, in contrast to the Holocene climate, increased concentrations of greenhouse gases in the atmosphere provide for the strongest driving mechanism. The experiments indicate that a Northern Hemisphere cooling trend over the Holocene is completely cancelled by the warming trend during the last century, which brings the recent global warming into a long-term context. Moreover, the anthropogenic emissions of greenhouse gases during the last century affect a tendency toward the high-index state of the AO/NAO in the same order of magnitude as do paleoclimate changes in the orbital parameters during the last interglacial period, 125,000 years ago.