Geophysical Research Abstracts, Vol. 7, 02247, 2005
SRef-ID: 1607-7962/gra/EGU05-A-02247

Transient simulations of the Mid-Holocene with a coupled GCM (MIDHOL): Variability of the southern hemispheric westerlies

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The DEKLIM (German Climate Research Program) project MIDHOL aims at improving our understanding of the magnitude and spatial structure of Holocene climate variability and its causes by undertaking multi-centennial transient climate simulations with the coupled atmosphere-ocean sea ice General Circulation Model ECHO-G for the Mid-Holocene period between 7 and 4.5 ka BP.

Two simulations are being undertaken, one forced by orbital variations, the other including also solar and greenhouse gas forcing. Here results from the orbitally forced simulation for the period 7-5.4 ka BP will be presented.

In a first step hypotheses related to the spatial and temporal variability of the southern hemispheric (SH) westerlies are investigated, which have been derived from proxy data over the southern parts of South America (DEKLIM projects SALSA and PROSIMUL). These hypotheses are related to a northerly position of the SH westerlies before 6 ka BP and a subsequent southward movement until 5.2 ka BP.

In the model output analysis the SH westerlies over South America are represented by the 500 hPa zonal wind velocities along 70° W. The orbitally forced simulation shows during JJA a high velocity band between 25° S and 48° S, whereas during DJF the westerlies are narrowed and deflected poleward in a band between 40° S and 52° S. Both seasons show a considerable amount of decadal to centennial variability. The two seasons show similarities in the period between 6.4 ka and 6.0 ka BP with in general reduced wind velocities with respect to the mean state. After 6 ka BP the mean velocities increase, especially during the SH winter season. With respect to the

spatial variability the seasonal displacements dominate the decadal to multi-centennial variations.

The question is whether changes of the external forcing are related to the intensity changes of the SH westerlies. A mechanism that might explain the increasing zonal winds is related to the increase in the pole-equator temperature gradient that is induced through changes of the differential heating caused by changes in the external orbital forcing.

In the framework of the MIDHOL project further analysis will be undertaken for North American drought spells and the European climate during the Mid-Holocene.