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A multi-centennial climate simulation of the last glacial inception with a coupled atmosphere-ocean general circulation model

F. Kaspar (1), K. Prömmel (2), U. Cubasch (3)

(1) Max-Planck-Institute for Meteorology, Model and Data Group, Hamburg, Germany (kaspar@dkrz.de), (2) Institute for Coastal Research, GKSS Research Center, Geesthacht, Germany, (3) Institute for Meteorology, Freie Universität Berlin, Germany

The coupled ocean-atmosphere model ECHO-G has been used to perform a multi-centennial simulation of the climate at the end of the Eemian interglacial. The model consists of the ECHAM4 atmosphere model at T30 resolution (˜3.75°) coupled to the HOPE-G ocean model at T42 (˜2.8°). The simulation is performed as equilibrium experiment with constant boundary conditions. Orbital parameters and greenhouse gas concentrations have been set to values of 115,000 years before present. A simulation of the preindustrial climate is used for comparison. As greenhouse gas concentrations are very similar to preindustrial conditions the observed differences in simulated climate are mainly caused by orbitally induced differences in insolation. Compared to today the combined effect of lower obliquity and greater eccentricity of the Earth's orbit leads to a weakening of the seasonal cycle of insolation on the northern hemisphere. A consistent reaction of the northern hemispheric temperature is simulated, with the strongest differences on the continents. A long term cooling trend of the global annual near surface air-temperature occurs. This trend is almost linear during the 2000 years of the simulation. It is connected to a continuous increase in northern hemisphere sea ice volume and an expansion of the permanently snow-covered areas over North America. Due to the reduced summer insolation an increased meridional temperature gradient occurs which leads to an amplification of the atmospheric circulation and therefore to an increased meridional transport of moisture. In particular in the summer months a significantly stronger poleward transport of moisture is simulated. The decreased summer temperatures combined with the increased moisture availability lead to an increase in snowfall and support the expansion of the snow-

covered areas. During the simulated interval this effect occurs on the North-American continent only. The accumulation of snow on these areas would presumably cause a built-up of an ice sheet, but as the model does not include an inland ice model this process is not simulated. The amount of snow which is accumulated over the North American continent is equivalent to a reduction of the sea level of around 7 cm per century. The reduction of the sea level due to temperature related density changes in the ocean is of the same order. In summary, in this simulation the orbitally induced insolation changes are sufficient to trigger the onset of a glaciation.