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Feedback analysis of mid-Holocene winter warming

J. Otto (1,2), T. Raddatz (1), M. Claussen (1,3), V. Brovkin (4), V. Gayler (1), C.H. Reick (1)

(1) Max Planck Institute for Meteorology, Hamburg, Germany (juliane.otto@zmaw.de / Phone: +49-40-41173-260), (2) International Max Planck Research School on Earth System Modelling, Germany, (3) Meteorological Institute, University of Hamburg, Germany, (4) Potsdam Institute for Climate Impact Research, Potsdam, Germany

The Arctic is very susceptible to climate change. In this region, feedbacks between atmosphere, ocean, sea ice, and vegetation may enhance or dampen an initial forcing. One well known example of climate change is the winter warming over Northern Europe during the mid-Holocene, which has been detected by observation based reconstructions. Up to now it is not clear, however, whether this winter warming is predominantly caused by stronger-than-present westerly winds or by feedbacks, especially by the synergy between the taiga-tundra feedback and the sea-ice albedo feedback.

To quantify the impact of feedbacks and their synergy effects on the high northern latitude climate we use a comprehensive Earth system model consisting of an atmosphere/ocean general circulation model (ECHAM5/MPIOM) coupled to a recently developed dynamic land cover model. Simulations are performed with present and mid-Holocene (6000 years BP) orbital forcing implying a distinct difference in the seasonal and regional distribution of solar insolation. We determine the contribution of each dynamic Earth system component to the total climate signal.

Our results reveal significant changes in the simulated mid-Holocene climate, which comprise seasonal changes in temperature, a reduction in meridional overturning and changes in Arctic sea ice. Furthermore, we observe that the boreal forest expands northward, which is in general agreement with proxy data and previous studies.