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On the sensitivity of the global ocean circulation to reconstructions of paleo-bathymetry

Tobias Weber (1) and Maik Thomas (1,2)

(1) Helmholtz Centre Potsdam, GFZ German Research Centre For Geosciences, Potsdam, Germany, (2) Institute of Meteorology, Freie Universität Berlin, Berlin, Germany

The ability to model the long-term evolution of the climate does considerably depend on the accuracy of ocean models and their interaction with the atmosphere. Thereby, the ocean model's behavior with respect to uncertain and changing boundary conditions is of crucial importance. One of the remaining questions is, how different reconstructions of the ocean floor influence the model. Although of general interest, this effect has mostly been neglected, so far.

We modeled Pliocene and pre-industrial ocean currents with the Max-Planck-Institute Ocean Model (MPIOM), forced by climatologies derived from an atmospheric and vegetational Global Circulation Model (GCM). We equipped it with different reconstructions of the bathymetry, what allowed us to study the model's sensitivity regarding changes in bathymetry. On the one hand we examined the influence of reconstructions with different locations of major ridges, but the same treatment of the shelf. On the other hand, reconstruction techniques that treated the shelf areas differently were taken into consideration. This leads to different oceanic circulation realizations, which induce changes in deep ocean temperature and salinity. Some of the simulations result in unrealistic behavior, such as an increase in surface temperature by several degrees. Most important, small bathymetric changes in the areas of deep water formation near Greenland and the Antarctic alter the thermohaline circulation strongly. This leads to its complete cessation in some of the simulations and therefore to stationary deep laying ocean masses. This shows that not all bathymetric reconstruction sequences are applicable for the generation of boundary conditions for GCMs.

In order to obtain reliable and physically realistic data from the models, the reconstruction method to be used for the paleo-bathymetry also needs to be applied to the present day bathymetry. This reconstruction can then be used in a control simulation which can be validated against measurements. Hereby systematic errors introduced by the reconstruction technique are identified.