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Sensitivity of the Ocean System to the Bathymetry in Numerical Simulations of Climate

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This study investigates the sensitivity of the ocean system to different bathymetric configurations. The results are obtained by running long term simulations using the MIT general circulation model (MITgcm). The purpose of this work is to provide the required knowledge to perform simulations at different geological time slices (with various distributions of continents) for which bathymetry may be affected by relatively large uncertainties. The main objective is therefore to reproduce the global ocean circulation and climates of the past with more confidence.

The MITgcm is a numerical model designed to study the ocean and/or the atmosphere. The ocean model can thus be run in a one-way mode or coupled to the atmospheric component for climate studies. Here, one-way simulations were run at a 2.8° horizontal resolution on a cubed-sphere grid with vertical layers of varying thickness increasing with depth. The meteorological inputs are provided by a set of monthly-averaged NCEP reanalysis data (January 1979 to December 2012) concatenated over a 1000-year period. Sensitivity of the oceanic system to the bathymetry is investigated using three different configurations. The reference simulation is based on the 2-Minute Gridded Global Relief Data (Etopo2v2) whereas the other two use a flat ocean relief of 2000 m and 4000 m constant depth.

Comparisons of the simulated profiles of temperature and salinity show that at a global scale the ocean turns out to be warmer and saltier in the 2000 m and 4000 m fixed-depth simulations. In terms of global overturning, circulation is a little stronger in the 4000 m fixed-depth simulation than in the reference simulation. In the 2000 m fixed-depth simulation, the deep overturning cell completely disappears in the northern Hemisphere.