Fourth International Conference on Earth System Modelling
4ICESM-50, 2017

Ocean modelling with varying topographic boundaries

V. Meccia and U. Mikolajewicz
Max Planck Institute for Meteorology, Hamburg, Germany. (virna.meccia@mpimet.mpg.de)

In most standard Earth System Models (ESMs) the land-sea mask is fixed throughout simulations. However, for long-term simulations with large changes in sea level, bottom topography and ice extents, it is necessary to consider transient ocean boundaries. The generation of a new ocean model bathymetry implies several levels of manual corrections, a procedure that is not doable for very long-term simulations. This is one of the main problems towards simulating a complete glacial cycle with GCM models. We present a tool to allow for an automatic computation of bathymetry changes in the Max Planck Institute Ocean Model (MPIOM) resulting from changes in ocean mass (due to added or removed water from the interactive ice sheets) and isostatic adjustments.

As a first step, the tool remaps a high-resolution topography from ice sheet and glacial isostatic adjustment modelling to the coarse MPIOM grid (CR). Therefore, the algorithm ensures that ocean areas are connected in order to avoid isolated domains or lakes. Then, it modifies the bathymetry at some key straits and passages to provide for sufficient through-flow depths. Some examples are Gibraltar, Denmark and Nares straits, North-West Passage and Bab-el-Mandeb, among others. The strategy adopted is to modify the through-flow depth in the CR bathymetry according to the values found in the high-resolution data. Finally, the algorithm applies an inertia coefficient to avoid sequences of rapid flooding/drying events of a shelf.

As a second step, the tool adapts MPIOM restart files to changes in bathymetry and land-sea mask. To do that, the fields of sea surface height, temperature and salinity are vertically and horizontally redistributed to the new ocean model setup. The necessary water to fill a grid box for new wet points is taken from adjacent ocean boxes. The presented algorithm achieves an optimal balance between involving only few neighbouring grid points and a potential numerical model instability due to large gradients of sea surface height. Finally, important aspects to be considered are the conservation of mass and tracers both at global and regional scales.

We present the concepts of the algorithms together with first tests with the aim of showing how the tool works. Once tested thoroughly the module can be used with MPI-ESM to allow for transient simulations of the last terminations with interactive land-sea mask and bathymetry.