FESOM 2.0 high resolution configuration for the Arctic Ocean

Improving physics and efficiency of AWI-CM multi-resolution climate model


Kurzgefasst

The aims of the project are:

• establish high resolution configuration for the Arctic Ocean with FESOM 2.0 and AWI-CM 2.0
• investigate the role of eddy dynamics in maintaining the fronts of the major currents in the Arctic Ocean
• analyze the benefits from using high ocean resolution at poles in simulating the sea ice distribution, sea ice decline and the patterns of warming signal

FESOM is a global sea-ice ocean circulation model based on unstructured meshes. It allows to simulate the global ice-ocean system with extremely high resolutions in the regions of interest at affordable computational cost. The new version of FESOM based on Finite Volume discretization has emerged recently and promises a significant improvement in the performance of the ocean component as compared to its previous version 1.4. Therefore, it has been decided to replace the old version with FESOM 2.0 in both types of applications in coming years: the standalone ocean simulations and coupled model (AWI-CM2.0) simulations. In this project we prepare and validate global configurations of FESOM 2.0 which exploit ultra high resolution (1km) in the Arctic Ocean.

Highlight of the project: salt plume parameterization in AWI-CM

The qualitative comparison of both versions of FESOM has been made using a mesh with moderate resolution and under the standard set of model configurations. It has been shown that the new version provides results with the quality comparable to that of FESOM 1.4 (see et al. Danilov et al. 2017, Scholz et al. 2019). On another hand, the speedup in the code performance of the FESOM 2.0 allows for configurations which are not affordable with older versions.

Taking advantage of the improved code performance we designed the global ocean setup using 1km resolution in the Arctic Ocean (hereafter as HIGH). HIGH is built upon total amount of 11,000,000 surface nodes and is shown in Fig. 1. Since the Rossby Radius of deformation reaches below 1km in shelf parts of the Arctic Ocean the HIGH is eddy resolving in the interior of the Arctic Ocean and eddy permitting at shelves. As compared to the older Arctic configuration where 4.5km resolution (hereafter as LOW) was employed the eddy dynamics in 1km setup is better simulated. Indeed, Fig. 2 depicts the relative vorticity at 200m depth. While using 4.5km resolution simulates mainly the meandering along the main fronts the eddies start to appear only in 1km setup. The sea ice dynamics and the presence of linear kinematic features are accordingly enriched (not shown).

Thus far only several years have been simulated using HIGH. The continuation of this run for longer time period complemented with the extensive analysis are desired. HIGH mesh will be established as high resolution configurations for polar studies with FESOM 2.0 and AWI-CM 2.0.

WWW

http://www.awi.de/forschung/klimawissenschaften/klimadynamik.html

Weitere Informationen


Abbildung 1: Horizontal resolutions (km) of the Arctic Ocean configurations: 4.5 km resolution (left) and 1km resolution (right) meshes. The total amount of surface nodes are 650,000 and 11,000,000 respectively.

Abbildung 2: Snapshots of relative vorticity at 200m simulated with FESOM 2.0 using 4.5km (left) and 1km (right) resolution in the Arctic Ocean.