Project: **941**

Project title: **Investigation of Labrador Sea Dynamics with the High-Resolution Finite Element Sea Ice - Ocean Model FESOM**

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Text: maximum of two pages incuding figures.

Description of work done in 2015 (May – October)

In the working period 2015 we transferred the Finite Element Sea-Ice Ocean Model (FESOM) with a new setup from the former DKRZ Supercomputer 'Blizzard' to its successor 'Mistral'.

In terms of compiling FESOM on the new machine, only minor changes were necessary thanks to the sophisticated technical environment and the helpful support of DKRZ. The major part was the implementation of 1) a new mesh and 2) an atmospheric forcing dataset, which were both not used before in combination with FESOM.

Regarding the new mesh, we first had to determine the maximum model time step at which our model-mesh configuration performs stable, to be able to simulate a maximum of model years at a minimum of the computational costs. By conducting several test runs we found that our model configuration performs optimal at a time step of 960 seconds. We further had to check if the quality of the unstructured triangular surface mesh is sufficient enough, which means that the inner angels of the triangle elements are not to small, which otherwise can also lead to instabilities in the model.

During the implementation of the atmospheric NCEP reanalysis data as forcing which was not used before in combination with FESOM (global gridded 6-hourly data from 1948 to today, by NCEP/NCAR, Kalnay et al. 1996), we discovered that there were several bugs in the numerical core of FESOM regarding the implementation of the NCEP forcing as well as regarding the vertical mixing scheme, which only appeared on DKRZ Mistral. For the debugging of the code and the isolation of the errors we required a lot of the computational resources

Finally, we were able to produce a first spinup run (model-years 1948–2014) of FESOM, which we now analyse. Fig. 1 shows the Atlantic Meridional Overturning Circulation (AMOC) calculated from the first spinup data for the 1948–2014 period. The mean AMOC of the first spinup cycle, features a upper (clockwise) AMOC cell with a strength of around 23 Sv (1 Sv = 10^6 m^3s^{-1}), while the strength of the lower (counter clockwise) AMOC is too weak at a value of around 1 Sv. From our experince with the spinup of FESOM in other mesh configurations we know that especially the strength of the lower AMOC cell should increase, while the strength of the upper AMOC cell should decrease during the further spinup (Scholz et al. 2012). The temporal evolution of the maximum of the AMOC (not shown) exhibits a range of 22–23 Sv in the 50s, 60s, and 70s, followed by a steep increase during the 80s to 26–27 Sv. Finally, the maximum decreases again to a level of approx. 23 Sv.

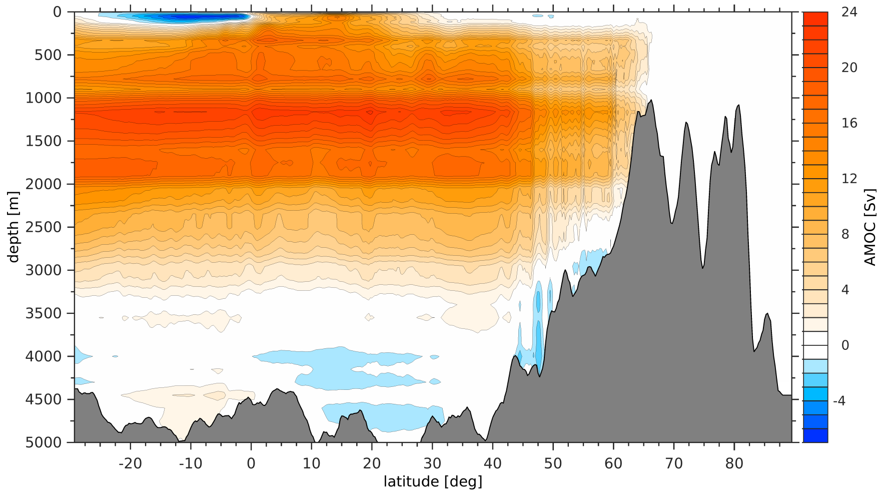

Fig. 1: Mean Atlantic Meridional Overturning Circulation (AMOC) calculated from the first[t] spinup cycle for the period 1948-2014.

Through the local mesh-refinement of our FESOM configuration we are able to reproduce the ocean dynamics in the Labrador Sea and the surrounding North Atlantic Gyre on a horizontal resolution of approx. 6 km (see Fig. 1 in Request_2016_project_941.pdf). Thus, meso-scale mixing and transport processes such as eddies can be numerically resolved in that area. Fig. 2 shows the spatial distribution of eddy kinetic energy in the North Atlantic subpolar gyre in 50 meters depth calculated from the first spinup data for February 2014. High eddy kinetic energy in the North Atlantic Current (NAC), in the West Greenland Current (WGC) and in the Labrador Sea indicates areas where small-scale variabilities of the horizontal mean flow alter properties of the involved water masses. Especially in the Labrador Sea the importance of the interplay between the western boundary current (WBC) and the deep convection area becomes clear (see details and references in Request_2016_project_941.pdf).

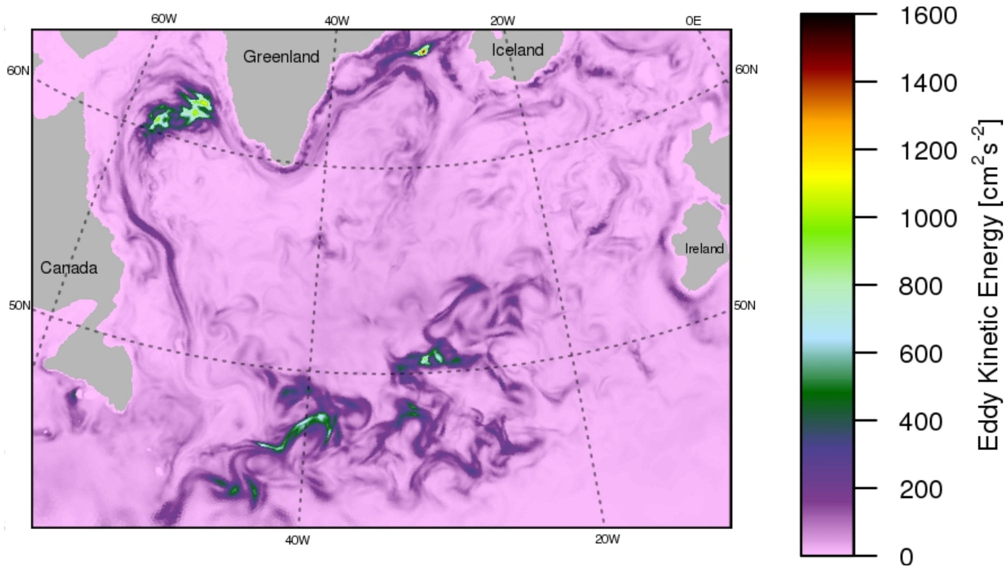

Fig. 2: Spatial distribution of eddy kinetic energy in 50 meters depth in the subpolar North Atlantic Gyre calculated from the first spinup cycle for February 2014.