Global climate modelling on eddy-resolving scales with AWI-CM3

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Resolving mesoscale eddies in general ocean circulation models is still a challenging task in climate research. This is partly related to strong spatial variability of the first internal Rossby radius which roughly defines the size of mesoscale eddies generated through baroclinic instabilities. It varies between several ten kilometers in subtropics to just a few kilometers in high latitudes or on the ocean shelves. Most of the climate research is carried out with models formulated on structured meshes. Although the resolution of meshes commonly used in them is refined by approximately a factor of three in the direction from the equator to the poles, partly taking into account the latitudinal behavior of the phase speed of inertia-gravity waves and hence the first internal Rossby radius, it does not cover all the details of its behavior.

It this project we will explore the utility of the Rossby-radius resolution scaling, provide and analyze the results of simulations performed on a mesh that resolves the Rossby radius with four grid cells over most of the ocean, with the mesh cell size bounded to 1 km on the fine scale and 15 km on the coarse scale. To estimate an impact of ocean eddies on simulated climate we will carry out similar simulations utilizing eddy permitting mesh with resolution set to the half of the Rossby radius and the range from 4 to 25 km. Additionally the resolution of both the suggested meshes is emphasized in the eddy active regions obtained from the observations (Fig.1).

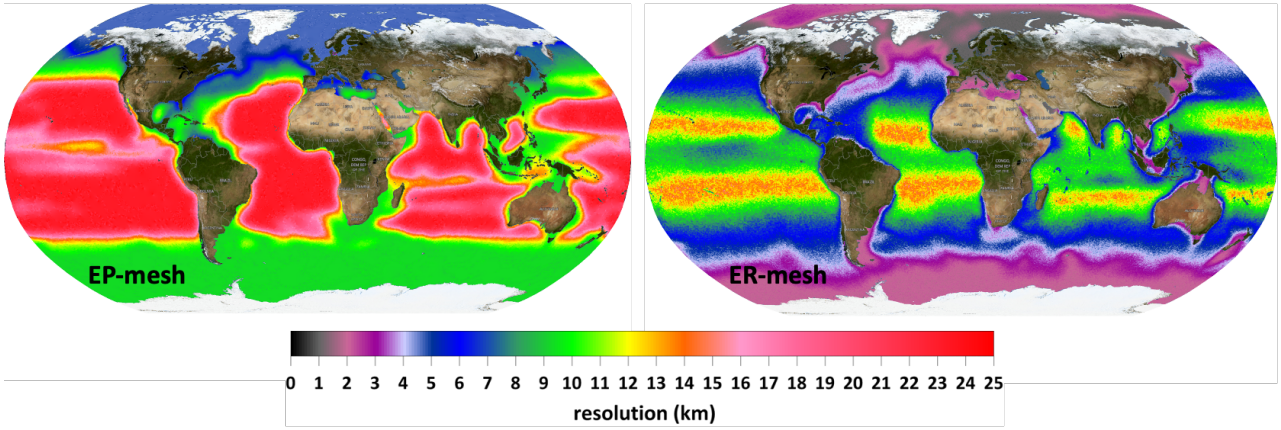

Figure 1. Eddy permitting (EP) and eddy resolving (ER) meshes resolution

First we will run the ocean model (FESOM2) in stand alone mode with ERA-5 forcing and validate its results against observations focusing on ocean eddies. Due to the close cooperation with the MOSAiC project the analysis of the eddy induced dynamics will be particularly emphasized on the Arctic Ocean.

After the understanding the role of the eddies in long-term ocean dynamics we will run AWI-CM3 containing eddy permitting FESOM2 setup coupled to 25 km OpenIFS atmosphere (TCO399) as well as eddy resolving FESOM2 coupled to 12 km OpenIFS

(TCO799). The coupled simulations will follow HighResMIP protocol, containing 50 years spin-up with 1950 forcing and production runs from 1950 till 2100 (ssp585 scenario).

Suggested high resolution eddy-resolving climate simulations will help to understand the role of the ocean eddies in climate dynamics, possible necessity in resolving the eddies in ocean models, impact of the ocean eddies in ocean heat transport and ocean-atmosphere heat exchange on relatively long time scales including the climate change scenarios.