Project: **939**

Project title: **Global eddy permitting ocean modelling with focus on the Agulhas system**

Project lead: **Dmitry Sein**

Report period: **1.1.2017 - 31.12.2017**

The simulations with two global coupled setups of FESOM/ECMAM6 (AWI-CM) were carried out and compared. The first one employs a coarse ocean mesh with nominal resolution of about 1° in the global ocean, about 25~km north of 50°N, about 1/3º in the equatorial band, and moderate refinement along the coasts. The ECHAM6 has T63L95 resolution. This setup is further referred to as LR (low resolution).

The second setup uses a locally eddy-resolving mesh. Its design relies on the AVISO satellite altimetry product. The coarsest resolution on this mesh is set to 60~km, and the finest resolution is 10~km. The refinement was determined by a low-pass filtered SSH variance (SSHV) pattern derived from the AVISO data. Fine resolution is obtained in regions with high SSHV, including the pass ways of main currents -- the Gulf Stream, Kuroshio, Antarctic Circumpolar Current (ACC) and Agulhas Current (Sein et al.,2016, 2017). The ECHAM6 in this coupled setup has T127L95 resolution. This setup is referred to as HR (high resolution). The FESOM mesh contains about $1.3 \cdot 10^6$ surface grid nodes, which is close to the number of nodes on a Mercator 1/4°mesh (only wet nodes are dealt with on unstructured meshes). This mesh size was also selected to ensure reasonably fast simulations with available computational resources.

The first problem we were faced running the HR AWI-CM setup was connected with very strong cold bias in the Labrador Sea and generally colder 2m temperature over all the globe. To reduce this problem, we had to change the vertical mixing scheme in FESOM from PP to KPP and to do some additional model tuning. The result is shown on Fig.1.

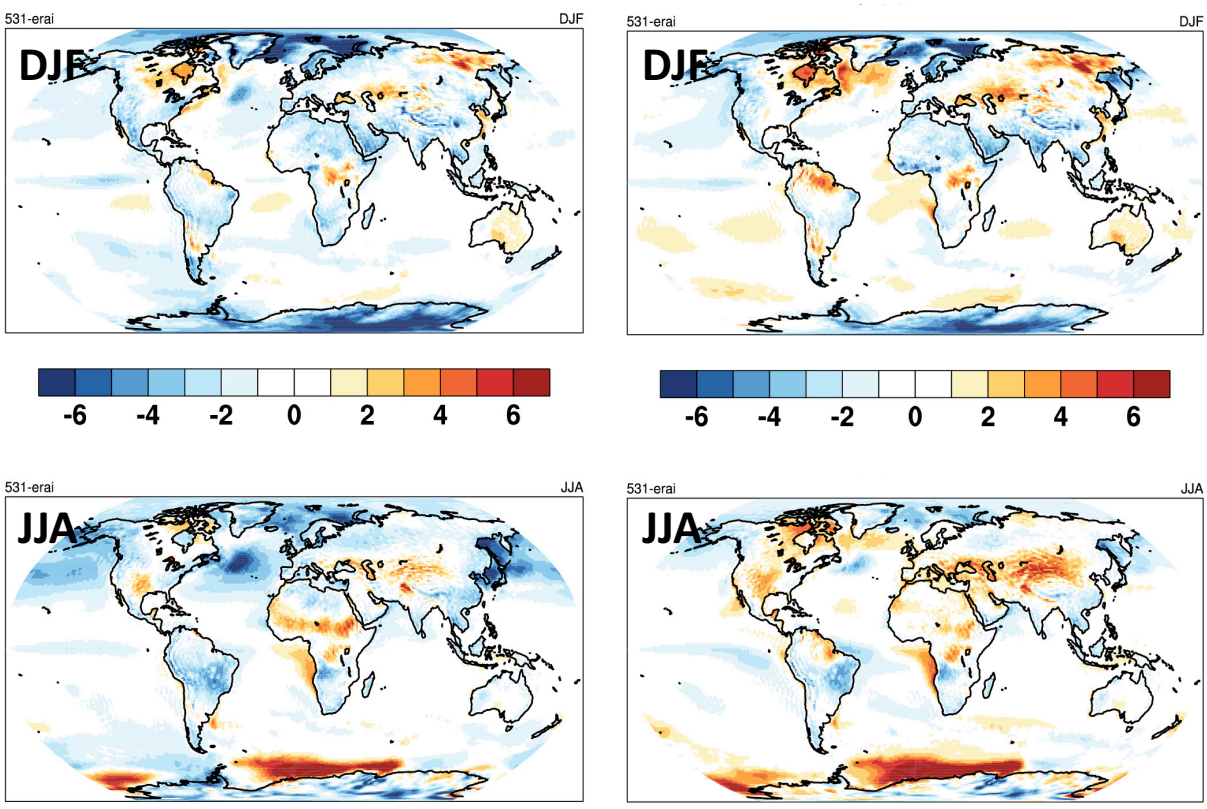

Fig.1. The bias in mean 2-meter temperature (K) with respect to the ERA-Interim reanalysis for FESOM with PP (left) and KPP (right) mixing scheme (control simulations).

After the model tuning both the LR and HR setups were span up for 50 years with 1950 forcing and then ran for the next 55 years (1951-2005) with historical CMIP5 forcing. The added value of the HR setup was analyzed and some results of this analysis are demonstrated on Fig.2. The

improvements in HR setup in particular over the ocean are clearly seen.

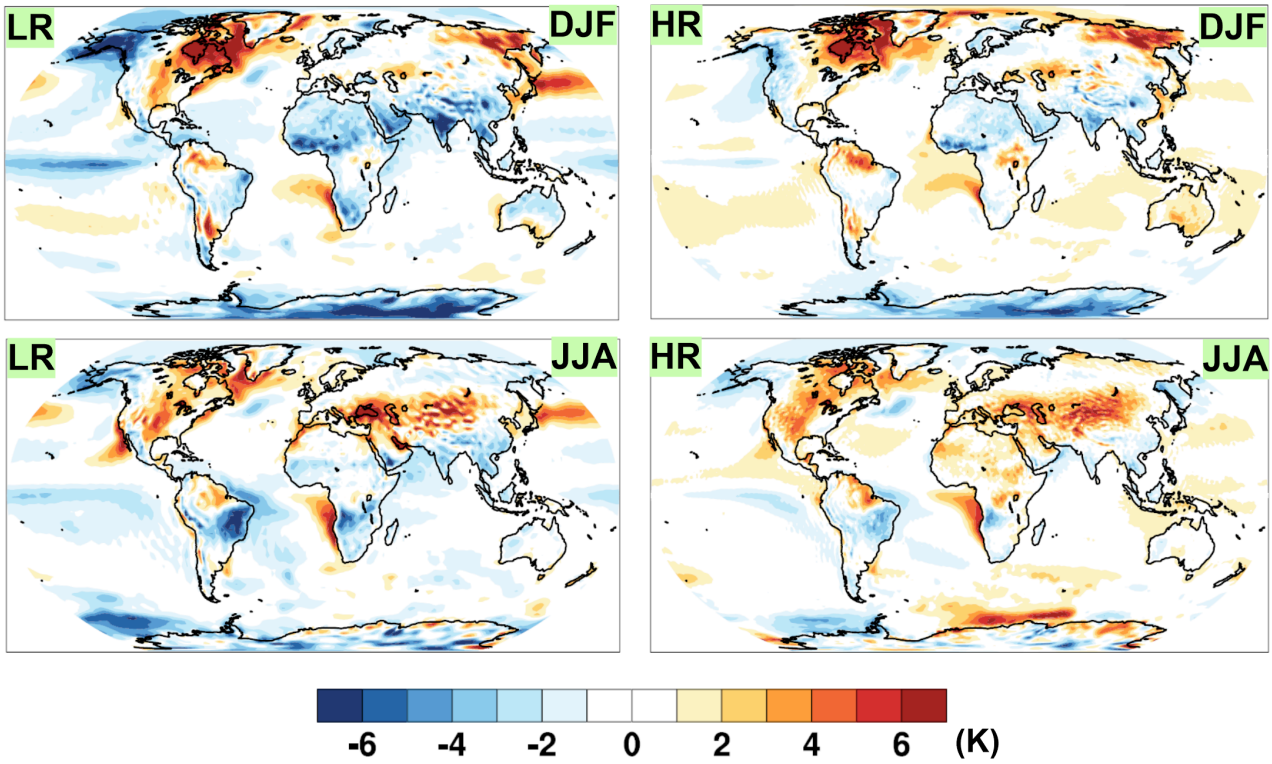

Fig.2. The bias in mean (1980-2000) 2-meter temperature with respect to the ERA-Interim reanalysis for LR (left) and HR (right). Historical CMIP simulations.

Presently we analyze the Atlantic Meridional Overturning Circulation (AMOC) and its dependence on Agulhas leakage in AWI-CM. One of the main points of this analysis is that LR setup is not eddy permitting in this region, whereas HR setup resolves the Agulhas rings. We plan to finish this analysis by the end of this year and to start from 2018 the climate change simulations.

References

Sein, D. V., S. Danilov, A. Biastoch, J. V. Durgadoo, D. Sidorenko, S. Harig, *and* Q. Wang *(*2016*),* Designing variable ocean model resolution based on the observed ocean variability, J. Adv. Model. Earth Syst., 8, 904–916, *doi:*10.1002/2016MS000650.

Sein, D. V., Koldunov, N. V., Danilov, S., Wang, Q., Sidorenko, D., Fast, I., Rackow, T., Cabos, W. and Jung, T. (2017), Ocean Modeling on A Mesh with Resolution Following the Local Rossby Radius. J. Adv. Model. Earth Syst.. Accepted Author Manuscript. doi:10.1002/2017MS001099