Project: 1252

Project title: Abrupt Climate Shifts and Extremes over Eurasia In Response to Arctic Sea Ice Change (ACE)

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During reporting period, the following simulations and tasks were performed.

1. The HR FESOM mesh was modified by enhancing resolution in High latitudes and Northern Pacific (in comparison with "old" HR mesh), see Fig.1. After the modification 200 years ocean stand-alone spin-up and further 50 years coupled AWICM3 spin-up were performed.



Figure 1. Old HR (a) and new HR (b) resolution

2. Because of the lack of CPU time, during the reporting year we focused on AWICM3-HR (FESOM-HR (Fig.1b) and OpenIFS TCO319L19) and AWICM3-LR historical and ssp585 scenario simulations which were planned for the year 2024. The planned mid-Holocene simulations were postponed to the year 2024. Resuming, in addition to model spin-up we simulated historical period (1900-2014) and ssp585 (2015-2100) scenario.



Figure 2. Mean ocean 30m velocity changes (1971-2100 minus 1975-2014) for LR (a) and HR (b) simulations

The climate change signal in upper ocean dynamics (Fig. 2) strongly depends on ocean model resolution. Comparing low- and high-resolution ocean setups we can see that changes in HR setup are much stronger than in LR. In addition, there is not only quantitative, but qualitative

difference too. Whereas LR setup shows increase (e.g., Kuroshio) or decrease (e.g., Gulf Stream) in upper ocean velocity, HR setup simulates a clear shift in the ocean currents. These differences are mainly occurred in eddy active regions where HR setup is eddy permitting, but LR setup not. The northward shift of Gulf Steam and Kuroshio as well as the southward shift of Agulhas current are already observed in the present days, but it cannot be simulated into the coarse resolution CMIP ocean models. Therefore, we can conclude that for qualitatively proper simulation of ocean dynamics climate change, the ocean model should be at least eddy permitting.

3. The model is prepared for the mid-Holocene simulations and we are going to perform first 200 years of simulations by the end of the year 2023

4. Preparing the simulations for year 2024 we made an eddy resolving FESOM setup for Last Glacial Maximum (LGM) simulations. The resolution of new setup varies from 2 to 25 km and adopted to the 1/4 of baroclinic Rossby radius. The mesh contains 12 million surface nodes. Mesh resolution as well as preliminary results of first 30 years FESOM simulations are shown on figure 3. Note, that glacier mask is not added yet and the realistic simulations are planned for the year 2024.



Figure 3. FESOM XR mesh, prepared for LGM simulations (left) and simulated mean sea surface height (right)