Project: **1084**

Project title: **Applicate**

Principal investigator: **Claudia Hinrichs**

Report period: **2018-01-01 to 2018-12-31**

Project goal

The project goal is to improve the representation of the long-term ocean and sea ice dynamics in the Arctic in coupled climate models. Our approach is to use locally high resolution in the Arctic Ocean (4.5 km) which was previously not affordable for climate simulations. The experiment plan is to compare climate simulations following the HighResMIP (High Resolution Model Intercomparison Project) protocol with historic CO2 and aerosol forcing and under the RCP8.5 scenario on a coarse resolution, reference grid ('CORE' grid) and a high-resolution grid ('fArc' grid). The grid size of the low-resolution mesh is 24 km north of 50°N (127,000 surface nodes; see Figure 1, left panel). For the high-resolution grid the resolution in the Arctic Ocean is refined to 4.5 km (~640,000 surface nodes; see Figure 1, right panel). The resolution in the atmospheric component ECHAM6 is at T127/L95 in both cases.

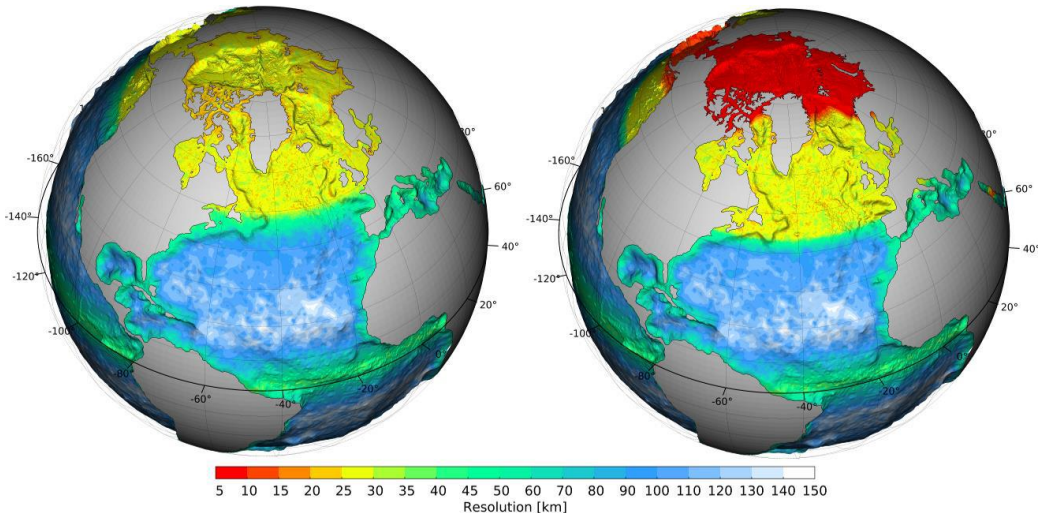

Figure 1: Mesh resolutions in km used in the ocean and sea ice component of the model

Project Progress

So far, the 50-year spin-up run has been completed and the output has been analysed and compared to the low-resolution control run (CORE grid/T127). One initial finding was that the simulated sea ice was considerably thinner than in coarser resolution, especially in the central Arctic. This was attributed to the sea ice solver not converging numerically in the higher resolution and it lead to further testing with different numbers of subcycling steps for the sea-ice solver. Some computing resources were put into finding the optimal number of subcycling steps to use for solving the sea ice equations, and now the effect of increasing the number of subcycling steps in the coupled system (e.g. ocean-atmosphere heat flux, 2m temperature) is being investigated

with at least two members per set-up. These findings will be of relevance for other modelling groups as well, who are striving for high-resolution configurations in polar regions. Therefore, we are planning to document these results in the peer-reviewed literature.

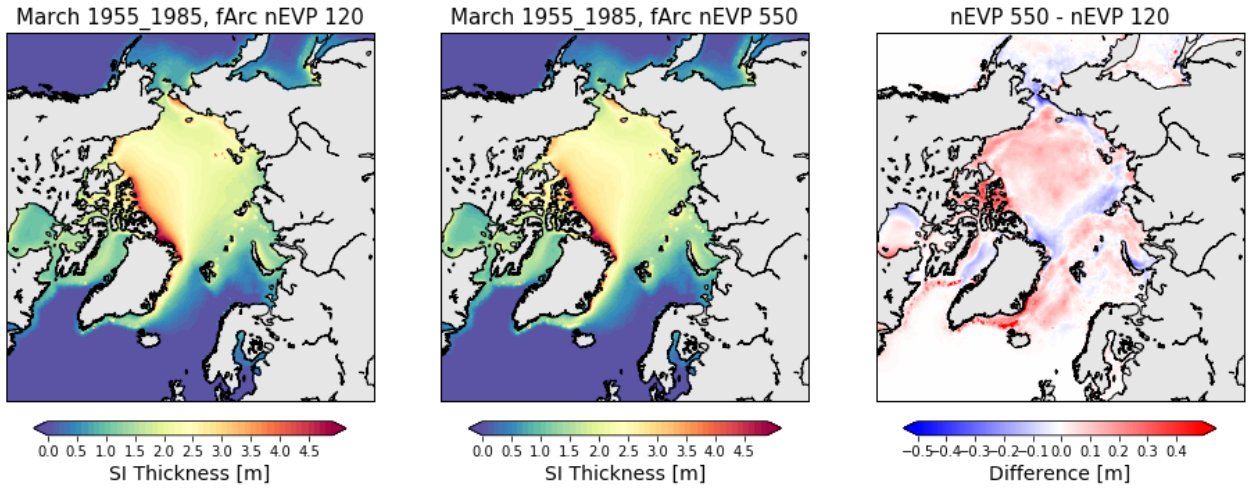

Figure 2: Comparison of mean March sea ice thickness with 120 (left) and 550 (middle) subcycling steps. Right plot shows the difference

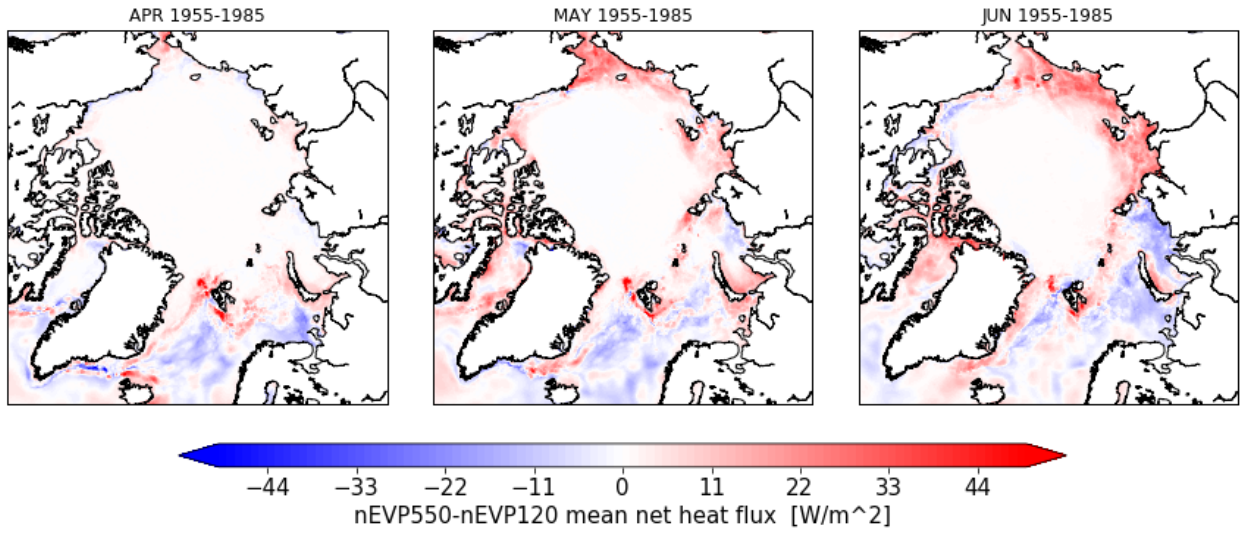

Figure 3: Difference in mean monthly heat flux (AMJ) between simulations with 550 and 120 subcycling steps

Another issue that arose recently, was that the momentum transfer through the Fram Strait into the Arctic Ocean appears to be less well represented in the coupled system than in forced sea ice-ocean model simulations. This issue is currently under investigation by testing the sensitivity of several atmospheric and oceanic model parameter changes.

Project Outlook for 2018 and 2019

The rest of time in 2018 will be spent on running at least one more member to investigate the sea ice solver iteration question and to do more tests on the sensitivity of Fram Strait momentum transport to atmospheric and oceanic model parameters changes.

By the beginning of 2019, it is planned to continue the production runs and therefore use the resources that were originally requested for 2018.