Project: **1084**

Project title: **Applicate**

Principal investigator: **Claudia Hinrichs**

Report period: **2019-01-01 to 2019-12-31**

The planned production runs have to be moved to 2020 because the principle investigator is on maternity leave from June 2019 until January 2020. Therefore, the previously submitted request still stands and is resubmitted for 2020. Progress so far is reported below.

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 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 CO_2 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.

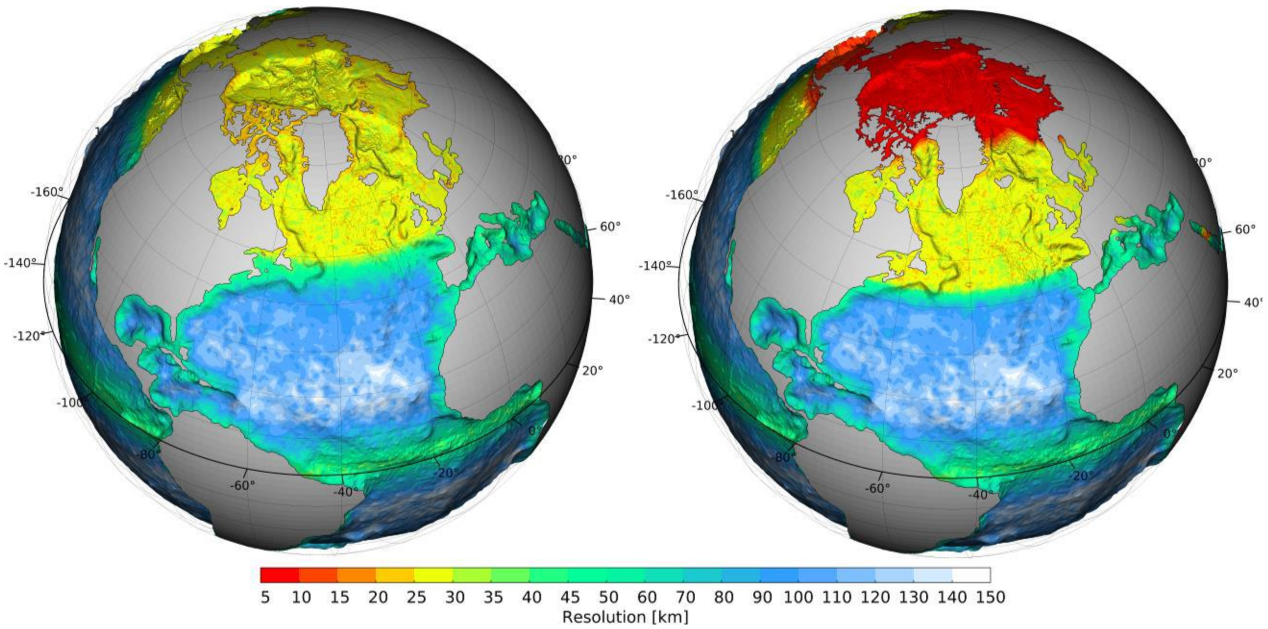

Figure 1: Mesh resolutions in km used in the ocean and sea ice component of the model

Project Progress 2019

The 50-year spin-up was completed and the output has been analysed and compared to the low-resolution run in 2018. 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 this finding lead to further testing with different numbers of subcycling steps for the sea-ice solver. In 2019, some resources were put into test runs to find the optimal number of subcycling steps to use for solving the sea ice equations and to document the effect of this increase. Increasing the subcycling steps from the default 120 to 550 showed convergence in the number of counted linear kinematic features (LKFs) (Koldunov et al. 2019). Figure 2 shows a comparison of the counted LKFs per month for the default subcycling steps and the increased subcycling steps.

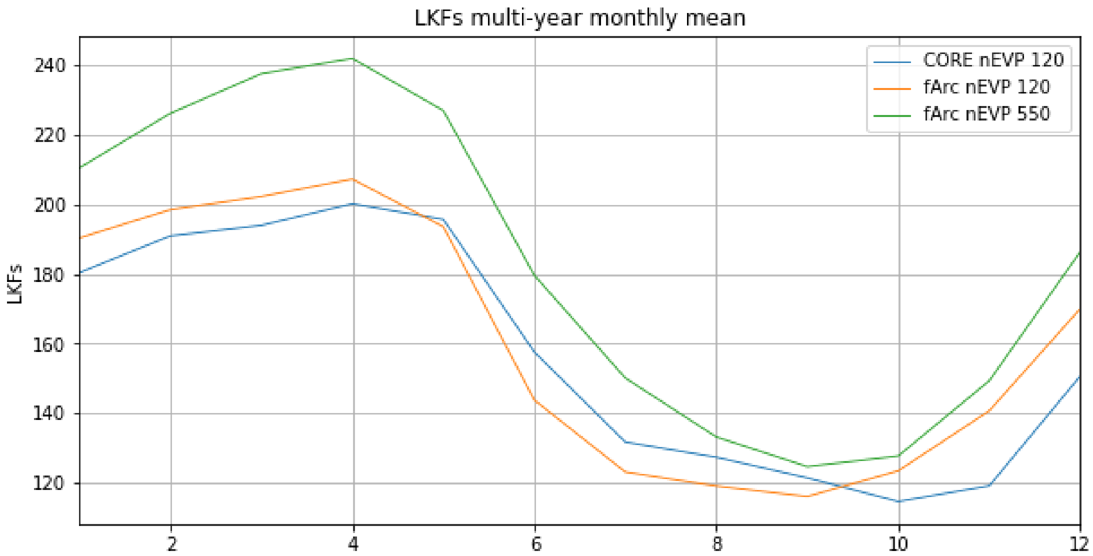

Figure 2: 30-year monthly mean of counted LKFs for different grids and EVP subcycling steps

The increase in subcycling steps for the sea ice solver also led to overall thicker sea ice both in winter and in summer over most of the Arctic Ocean (Figure 3) which is more in agreement with the model performance on the coarse resolution grid.

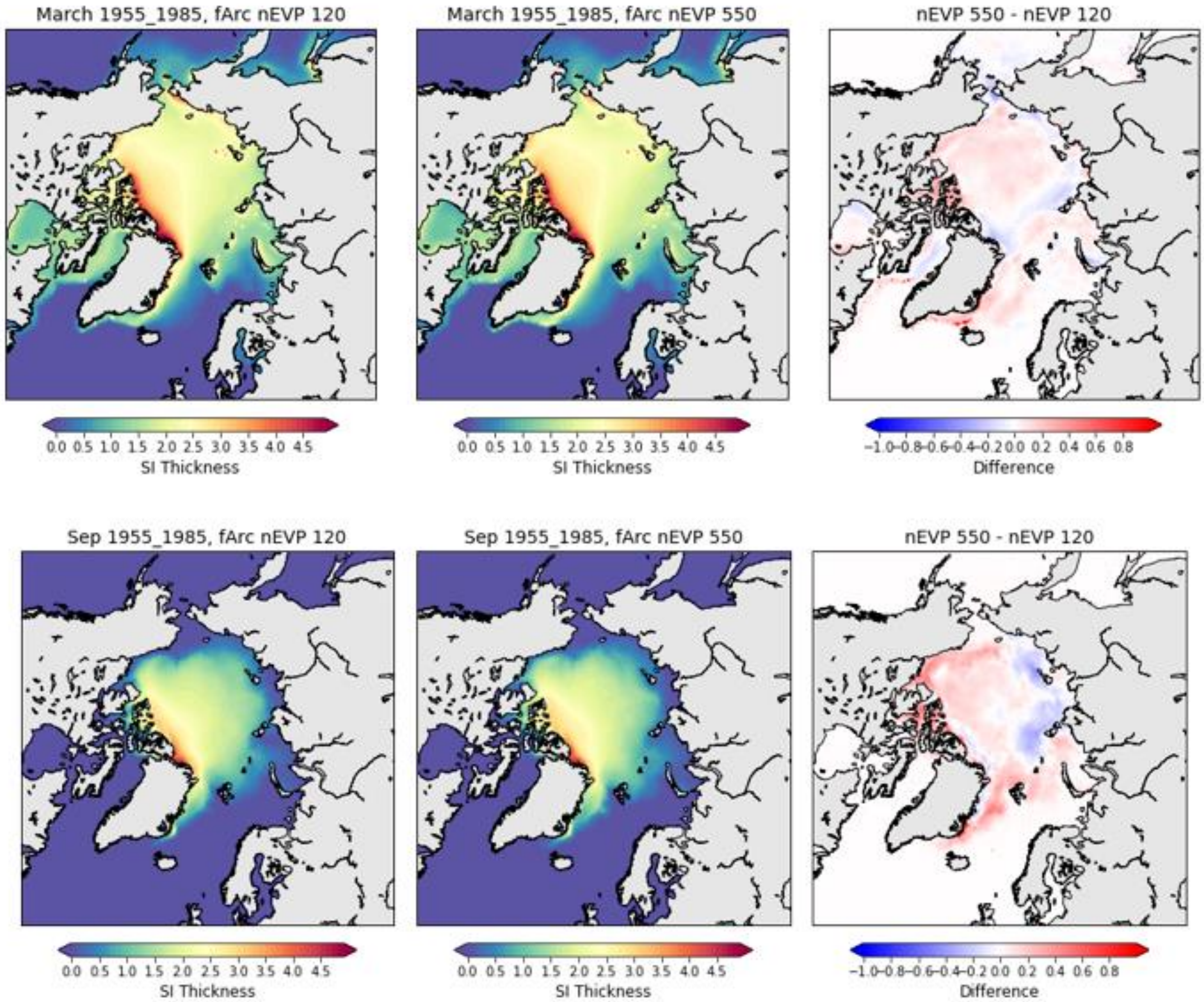

Figure 3: Comparison of 30-year mean sea ice thickness [m] for 120 (left) and 550 (middle) subcycling steps, and mean difference (right)

Project Outlook for 2020

By the beginning of 2020, it is planned to continue the production runs and therefore use the resources that were originally requested for 2019.

References

Koldunov, N.V., S. Danilov, D. Sidorenko, N. Hutter, M. Losch, H. Goessling, N. Rakowsky, P. Scholz, D. Sein, and Q. Wang. 2019. Fast EVP Solutions in a High-Resolution Sea Ice Model. *Journal of Advances in Modeling Earth Systems*.