Project: **921**

Project title: **ICE-ARC**

Project lead: **Ruediger Gerdes**

Report period: **1.1.2014 - 31.12.2015**

Project acronym: ICE-ARC

Project full title: " Ice, Climate, and Economics - Arctic Research on Change "

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Modified from the Description of work of the project :

Task2.1: Evaluation and improvement of model parameterizations with respect to sea-ice processes

Participants: AWI (leader), OASYS

Here, we will focus on representation of sea ice processes since sea ice is one of the key elements in recent and future changes in the physical environment of the Arctic. Sea ice change is also essential for ecological and economic consequences of Arctic climate change. An example of parameterizations that fail to take into account the shift of the operation point of the Arctic climate system is the treatment of momentum transfer between atmosphere and sea ice and ocean and sea ice. The momentum transfer at these interfaces in nature depends on changes in surface roughness as due to preferential loss of ridged ice and an increase of the number of melt ponds. Usually models employ constant drag coefficients leading to too little sea ice convergence in the Beaufort Sea . Another example is the handling of snow. Snow is handled differently in sea ice components of the type of models used in this project. Only some models take into account the sub-grid distribution of snow (normally the same that is used for sub-grid parameterizations of ice thickness). This causes differences in the simulated ice thickness of up to 2 m locally with a mean difference of about 0.5 m over the whole Arctic. With available thickness data is it is hard to decide which parameterization is superior. Especially the IMB and AFAR drifters (T1.1) together with the remotely sensed ice data from WP1 will give valuable information of ice thickness and snow depth but also about the absorption and transmission of radiation, as well as the surface temperature of snow and ice. A combination of these data will be used to calculate the heat budget in snow and ice that can be compared to the heat budget in the models and finally allow for improved parameterizations. Also information about the ice drift and deformation will be gathered from the combined analysis of ice drifters and remote sensing in WP1 which will be used to evaluate the dynamics of the ice models.

Task 2.5: Incorporation of new parameterizations into climate model system

Participants: AWI (leader), OASYS

Based on the uncertainty analysis (T2.1, T2.4, T2.6), improvements to parameterizations will be implemented leading to reductions in uncertainties. First the well-proven regional coupled sea ice-ocean model NAOSIM will be utilized. NAOSIM is driven with realistic atmospheric forcing from a reanalysis project (probably ERA interim). Because this model is able to reproduce observed variability it allows a direct comparison with observations from WP1. The new parameterization will be implemented and their effect on sea ice and freshwater pathways (comp. T2.4) will be evaluated. Then, in a second step, the -OM parameterizations will be implemented into the current climate model ECHAM6/MPI-OM. Because of the internal variability of the coupled atmosphere-ocean-sea ice system the impact of the improved parameterizations has to be analyzed statistically. The focus will be on the ability of the model to reproduce recent observed changes in the Arctic as seen by remote sensing. The climate model forms the basis for the main ice-ocean-atmosphere

modelling effort in the project. The results of this climate model will form a bridge between the observations of WP1, the improvement in parameterizations, and the application to the economics model (WP4/T4.2). The improved climate dataset for selected climate scenarios will further be used as input for the coupled biophysical model (.7).

Experiments with the MPI-ESM are to follow the exploration of processes in sea ice and subsequent adaptations of parameterizations- first to be incorporated into a renown Arctic sea ice ocean model. Some of the parameterizations should be the result of the analysis of data provided by other work packages of the project Ice-Arc. Although several processes have been incorporated in our coupled sea-ice ocean model, tests have not yet been performed with MPI-ESM .

The data delivered so far cover only two years, so full statistics are not yet available. Model improvements due to the data could not be gained so far.

The deliverable

Report on first simulations with improved parameterization in the climate model and the effect on the environmental variables to be coupled to the economic model of WP4

is due in January 2017.