High resolution ICON simulations for the AC^3 project

Arctic Amplification, the accelerated warming of the Arctic relative to the global trend, significantly influences local and global climate dynamics by accelerating sea ice loss, altering atmospheric circulation, and amplifying climate feedbacks. Understanding its underlying mechanisms is critical for present and future climate scenarios. The AC^3 project addresses this challenge through intensive observational campaigns and numerical weather simulations.

Under the Z04 modelling infrastructure of AC^3, we propose to perform high-resolution ICON (Icosahedral Nonhydrostatic) model simulations to complement intensive Arctic observational campaigns (in the Fram Strait as well as Station North, covering time periods from 2017 until 2025). We will perform high-resolution limited-area simulations, reaching horizontal resolutions from 2 km to 50 m, according to the objectives of each campaign. This requires a variety of domain sizes encompassing satellite, flight, or balloon tracks to correctly address the evolution of clouds, moisture transport, and boundary layer evolution. Additionally, we intend to use a recently developed PAMTRA (Passive and Active Microwave TRAnsfer) plugin directly in ICON to retrieve simulation output along observation flight tracks during a model run, improving the temporal match between observations and simulations.

These simulations will serve dual purposes: 1) to validate model outputs against observational data, including airborne and satellite measurements from different campaigns, and (2) to investigate the impact of model resolution (high vs. low) and test the effect of varying parameterizations (e.g., cloud scheme) compared to explicit large-eddy simulations (LES) on Arctic amplification drivers, such as the clouds. Using DKRZ's computational power, this project will produce high-quality simulation datasets, providing critical insights into Arctic climate dynamics in a global warming scenario.