

## High-resolution modelling around supersites for cloud and precipitation observations

Clouds play a crucial role in Earth's climate. Their representation in numerical circulation models for weather prediction and climate simulation is still poor, and is in need of significant improvement. In order to better understand clouds and precipitation processes and to better constrain their representation in models, an increasing number of observational supersites with different configurations of in-situ and ground-based remote sensing instruments have been established at various locations in the world. While the application of a synergy of different measurement methods has proven successful for observing many processes more efficiently, the samples taken by these installations are still limited in space and time. For complementing observational data record and to allow interpretation of point measurements, high resolution modelling around those supersites can be beneficial. Recently Large-Eddy Simulation (LES) has been used to this purpose; however, recent research has also shown that comparability to measurements can suffer from simplifications in the model setup that are typically applied in LES. The ICON-LEM (Large-Eddy Model) contains two key innovative features that can address these shortcomings; one is the use of open boundaries and nesting, the other the option to include a realistic topography. These two features improve the realism of fine-scale simulations around observational supersites which in turn can be evaluated against high-resolution observations. In this proposal we apply for computation time to scientifically explore and test these new features in great detail, by means of high-resolution simulations at two selected supersites in different climate regimes; the JOYCE-CF located in Jülich (Germany) and the French - German Arctic Research Base AWIPEV at Ny-Ålesund (Svalbard).

JOYCE-CF has just recently been awarded by DFG as a National Core Facility for atmospheric observations with particular focus on clouds and precipitation. Its observations are indispensable for several research projects at University of Cologne such as the new Emmy-Noether-Research Group OPTIMIce which focusses on novel radar remote sensing techniques to derive microphysical process fingerprints of the still poorly understood ice processes in clouds. Based on these high-end observations, the simulations around JOYCE will be focused on improvements of the representation of microphysical processes in the ICON-LEM but also for coarser resolutions. For this purpose several sensitivity studies will be applied to gain a better understanding of the influence of resolution on the representation of microphysical processes and their interactions. Such a tight combination of high-end observations and an innovative simulation framework such as ICON-LEM creates unprecedented opportunities to make significant progress in improving the representation of ice microphysical processes in the ICON-LEM model.

The simulations around Ny-Ålesund will be part of the Transregional Collaborative Research Centre TR 172 ArctiC Amplification: Climate Relevant Atmospheric and Surface Processes, and Feedback Mechanisms (AC). These simulations will be more focused on the evaluation of the ICON-LEM under Arctic conditions based on the observations

from the supersite and the ACLOUD (Arctic CLOUD Observations Using airborne measurements during polar Day) campaign. Here, challenges are, for example, the complex terrain at the supersite and the frequent occurrence of mixed-phase clouds and very strong inversions. Additionally, the simulations will be used to put the measurements from the supersite and the campaign into a 3D dimensional context. Due to the complex terrain at Svalbard, again the capability of ICON-LEM to include topography will be very beneficial and allow us to test the influence of the topography on the formation of clouds.

**Our main scientific goals of the simulations will be:**

- To combine observations and simulations in order to improve our understanding of ice microphysical processes (e.g., depositional growth, aggregation, riming, secondary ice), and to improve and constrain the representation of cloud microphysics in models.
- To better understand the influence of model resolution on microphysical processes. Can certain observational characteristics be represented in the model when increasing the resolution? Or are they purely due to microphysical representation? Does the impact of the orography on the cloud structure and flow field change once it is better resolved?
- To investigate the formation of clouds under arctic conditions in order to understand their influence on the Arctic Amplification.