Exploring the representation of clouds and humidity in the Arctic with cloud-resolving simulations using ICON-LEM

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The discussions around Arctic Amplification have led to extensive research, as done in the transregional collaboration (AC)³. One focus are the feedback mechanisms that are strengthening or weakening the warming. Several of these feedbacks involve moisture in the atmosphere in all phases. To understand these better we have been running and analysing daily cloud-resolving simulations. We performed these simulations for a region more strongly affected by the warming around Ny-Ålesund (Svalbard), which is challenging due to its diverse surface properties and mountainous surrounding. We have created an outstandingly large data set of several months of these simulations with 600 m resolution, using the Icosahedral non-hydrostatic model in the large-eddy mode (ICON-LEM).
To gain some understanding of how well the model can represent such a complex location, we evaluated the performance of the model. For this, we used a range of observations from the measurement super-site located at Ny-Ålesund. This included radiosondes [1], a rain gauge, a microwave radiometer and further processed remote sensing data. Combining the measurements and simulations enables us to provide thorough statistics for different variables connected to clouds and to establish an understanding of how well they are represented.
We show that the model is capable of simulating the two distinct flow regimes in the boundary layer and the free troposphere. Further, we found a tendency in the model to misrepresent liquid and mixed-phase clouds as purely ice clouds. Though the water vapour is well captured, we found further steps in the chain towards precipitation formation are insufficiently represented. Through the use of forward simulations and expanded model output, we can continue to get a better picture of possibilities to understand and improve the microphysical processes.
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References

[1] M. Maturilli, High resolution radiosonde measurements from station Ny-Ålesund (2017-04 et seq). *Alfred Wegener Institute - Research Unit Potsdam, PANGAEA*, https://doi.org/10.1594/PANGAEA.914973 (2020)