Online display version: comments are marked in red.

A performance baseline for the representation of clouds and humidity in cloud-resolving ICON-LEM simulations in the Arctic

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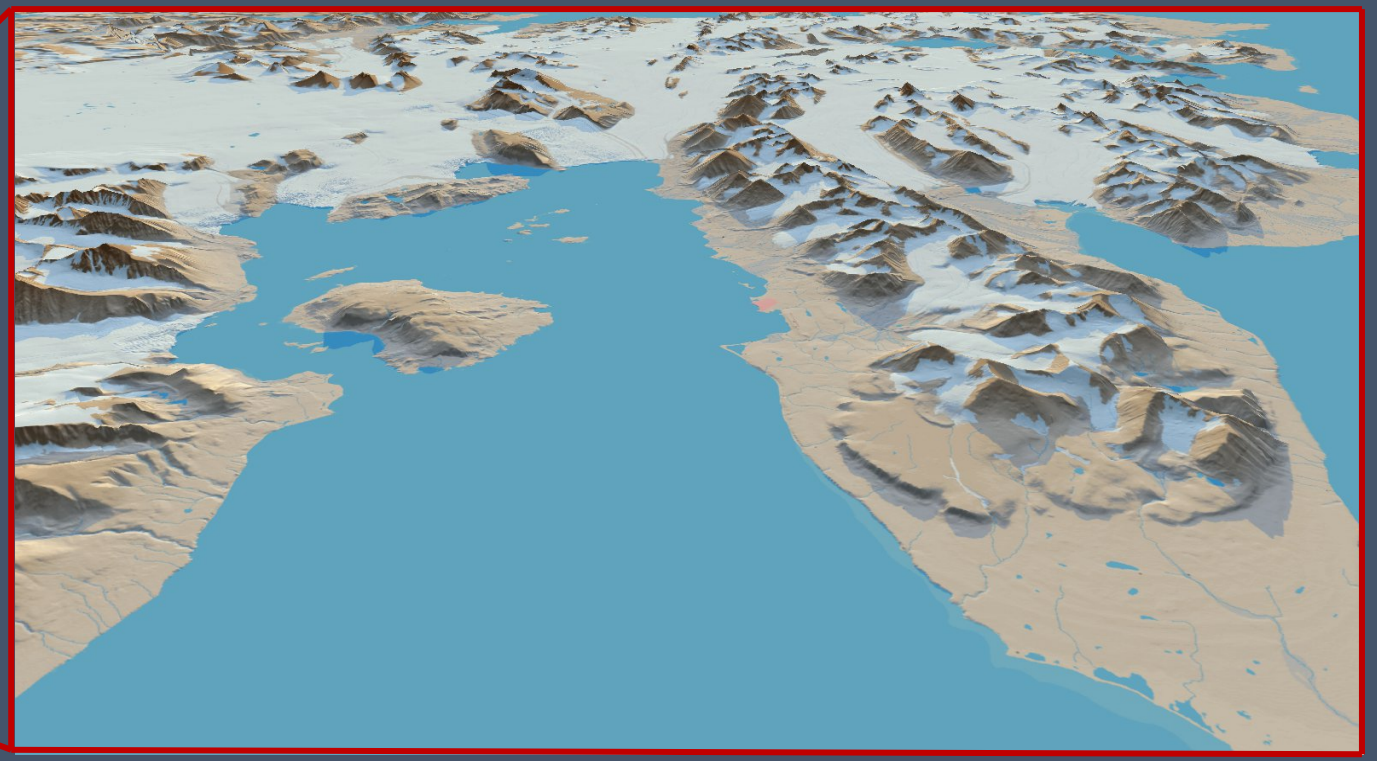
Why care about simulated clouds in the Arctic?

- Arctic shows increased warming -> Arctic amplification
- Many models are developed and tuned for mid-latitudes
- Uncertainties in models largely induced by representation of clouds/cloud micro-physics
- We want to see how well the ICON-LEM model can represent clouds and humidity, as well as, the general thermo-dynamics of a complex Arctic location.

Regional Focus

- In general Arctic measurements are scarce but some “super-sites” exist
- Example: “Observational village” **Ny-Ålesund** (Svalbard)
- In this study we focus on the super-site Ny-Ålesund due to the abundance of observations available there.



Simulations setup and observations

We ran 2 daily simulations. The first one uses the ICON-NWP global model for forcing and the 600m simulation uses the limited area simulation with ICON-NWP and 2.4km as forcing.

ICON-NWP global with 13 km resolution

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ICON-NWP limited area with 2.5 km resolution

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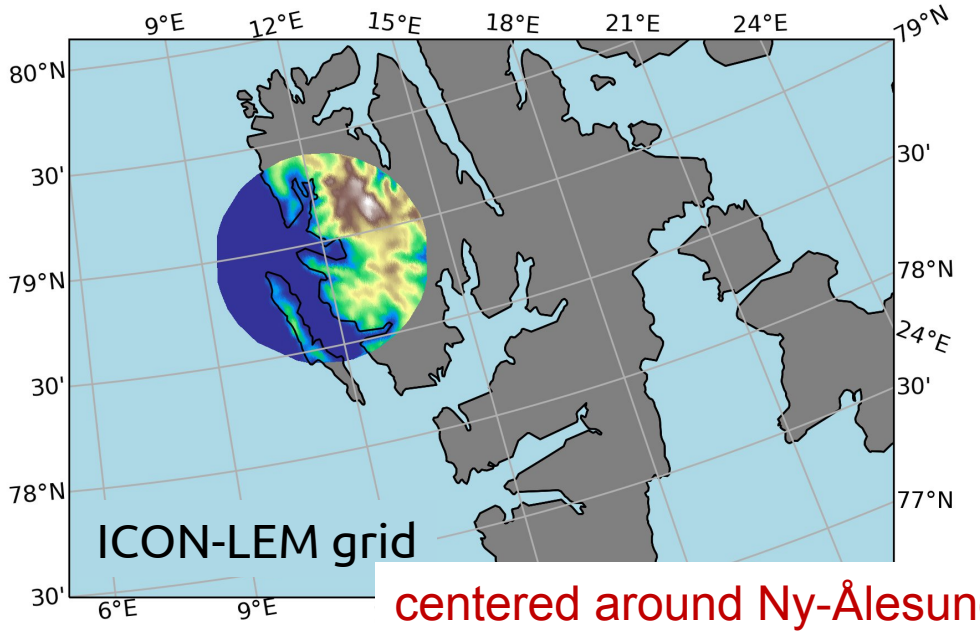
ICON-LEM domain with 600 m resolution



centered around Ny-Ålesund

Observational data:

- Daily radiosondes
- Microwave radiometer
- Precipitation gauge
- Cloud classification based on remote sensing “Cloudnet”

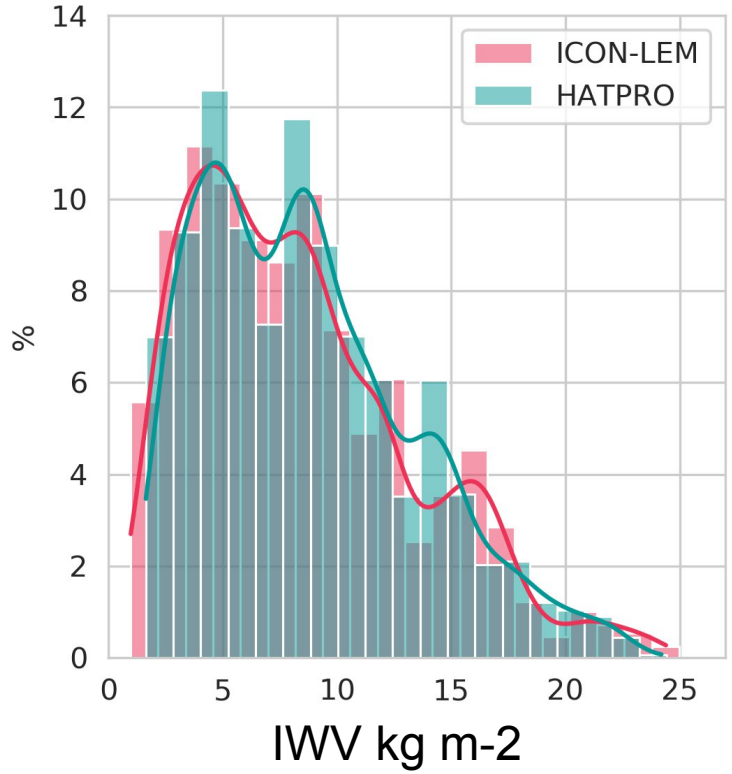
Methodological highlight: 5 months of daily simulations (Aug. to Dec. 2020)

➡ Statistical evaluation of high resolution simulations possible

Results: Insights into clouds

Very low bias in integrated water vapour (IWV)
Can also be seen in the timeline. Integrated water vapour is the water vapour contained in the entire column . Distribution does show differences for cloudy and clear conditions.

Distribution of integrated water vapour:



Combination of Cloudnet, IWV and integrated cloud liquid shows for the model:

- Too many clouds
- Too efficient ice production

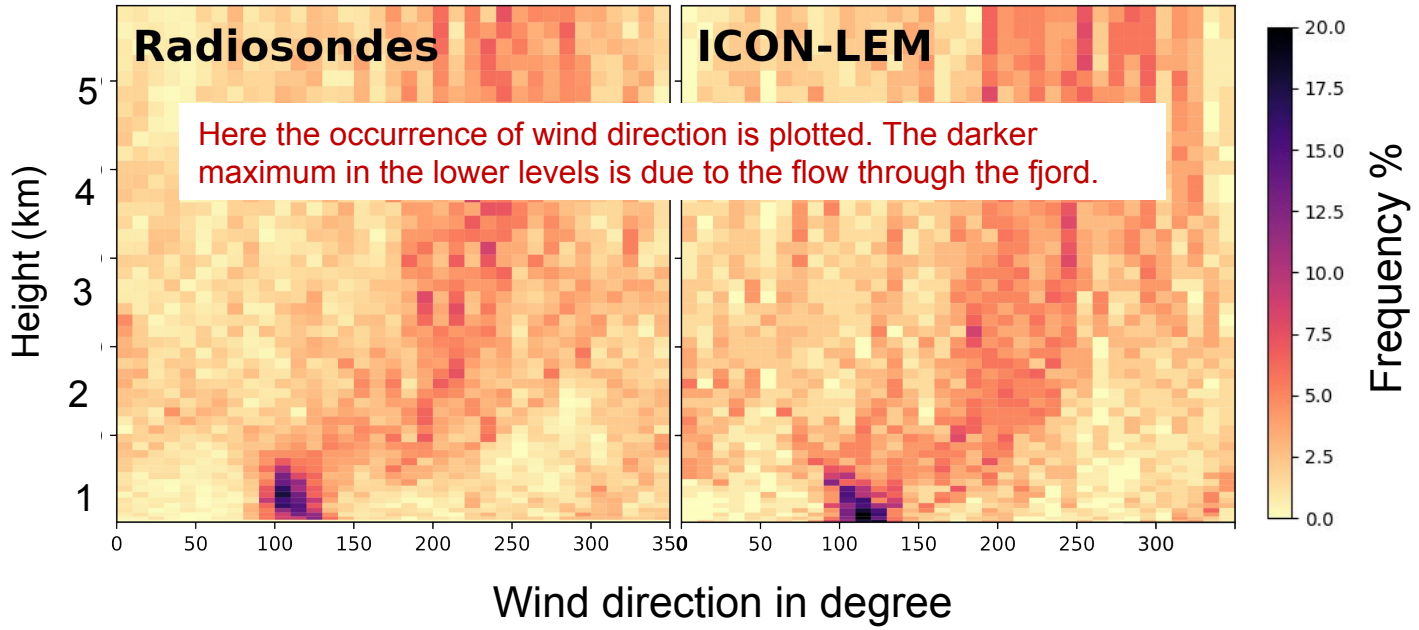
Next steps: Focus of work shifted to microphysical parameterization: Two-moment scheme by Seifert and Beheng (2006). We are currently working on a wrapper to use the implemented version of the 2-mom SB scheme offline. We want to build on what we have found out so far.

	Total cloudy columns	Cloudy columns pure ice
ICON-LEM	79 %	65-72 %
Observations	71 %	30-46 %

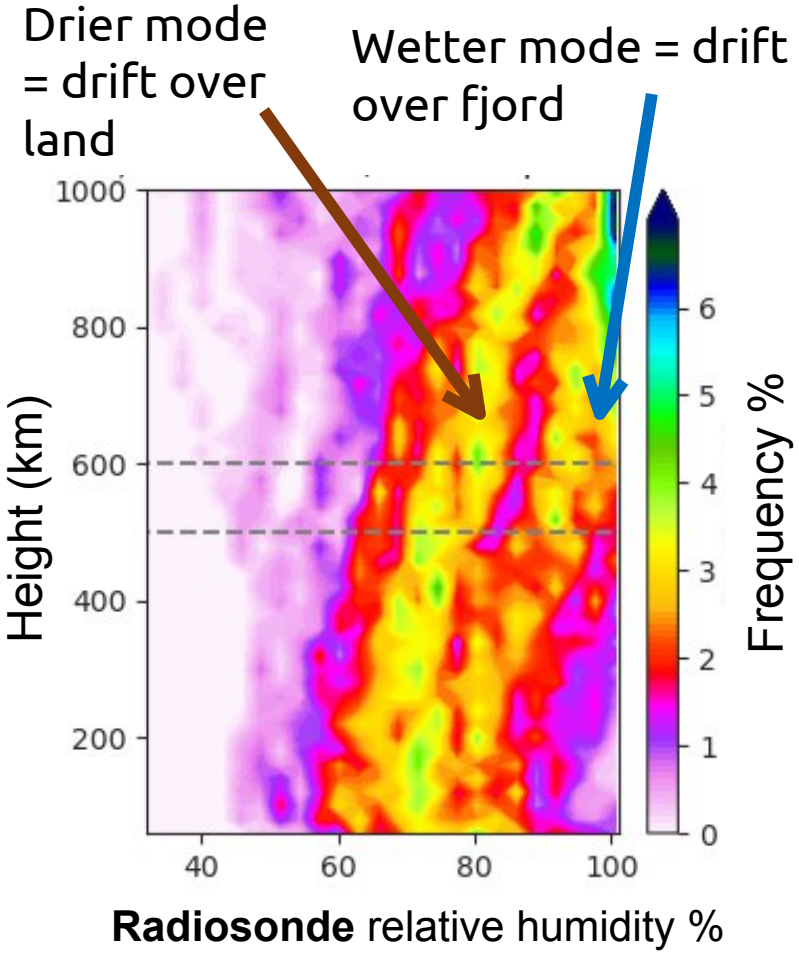
Results: Local dynamics and variability

- Insights into local scale humidity variability
- Model captures wind flow in BL accurately (below)

➡ Using high resolution is advantageous for complex heterogeneous terrain



Here we looked at the radiosondes in more detail because we found discrepancies between the model and the radiosonde. The difference were due to the drift of the Radiosonde in the BL. (see two modes in figure)



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