Simulation of airborne radar measurements in the Arctic using weather models and an advanced forward operator

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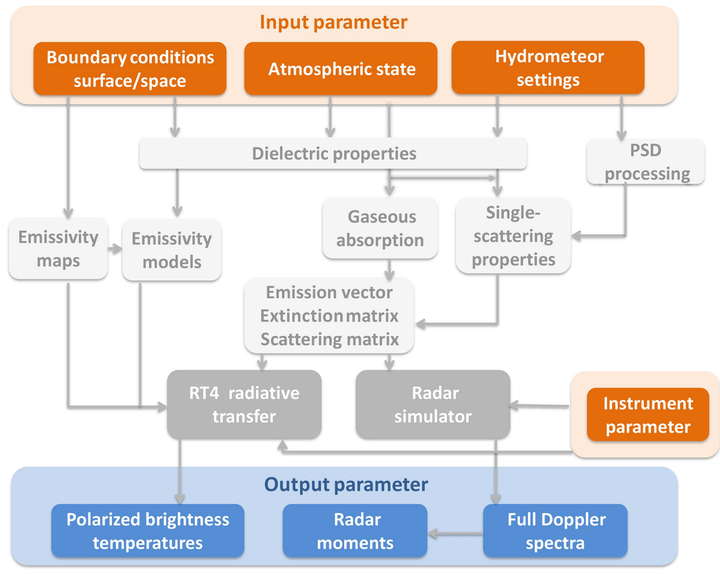
1. Motivation

1) Weather models are an essential component of the upcoming HALO-AC3 campaign. Applications include better **flight planning** and actual interpretation of the collected data

2) Model domain and resolution needs to be optimized for best results

3) **Forward operators** are useful to simulate the expected measurements

Fig. 1: Schematics of the forward operator PAMTRA which implements the most advanced scattering methods. ***Ensure consistency with the model*** *microphysical assumptions. Capable of simulating consistently active and passive microwave measurements.*



2. Data and methods

MEASUREMENTS

AFLUX aircraft campaign (2019)

- 94 GHz MIRAC radar
- 14 days of measurements

MODELS

ICON (global) and **IFS** (+ PAMTRA)

- 13 km and 9 km horizontal grid spacing
- 1 mom bulk microphysics
- +18h to +28h forecast time

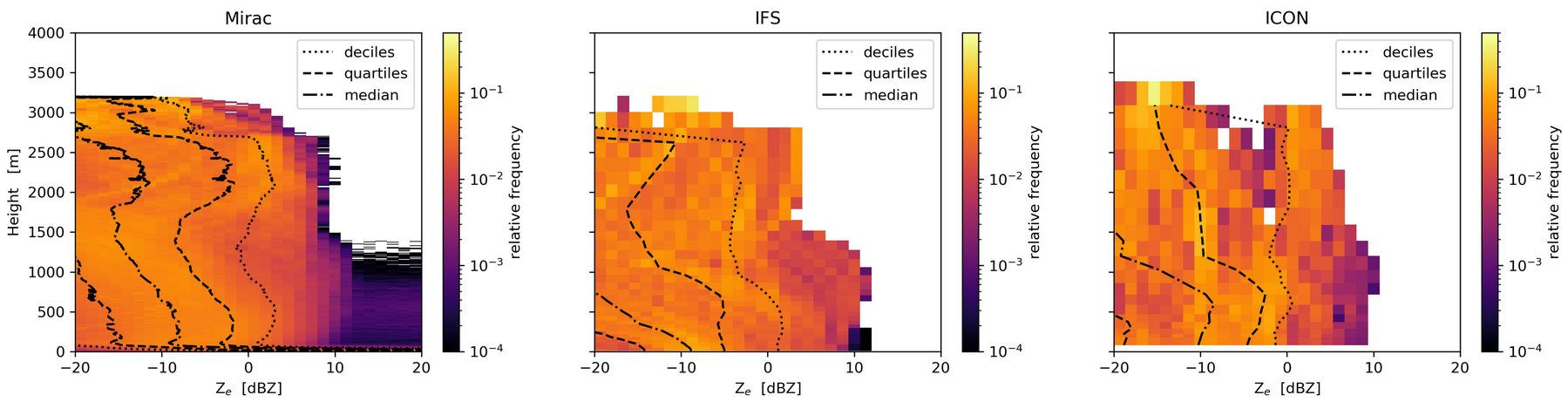


Fig. 2: Contoured Frequency Altitude Diagram (CFAD) of measured and simulated reflectivity. The distribution of simulated ***Z is well matched at the surface*** *(precipitation rate is good) but the models tend to predict* ***too low reflectivity at higher levels****.*

3. High Resolution ICON

Test added value of high resolution LES models.

- **ICON-LEM** 600m horizontal resolution
- 2mom bulk microphysics
- 1 test case 31-03-2019 cold outbreak

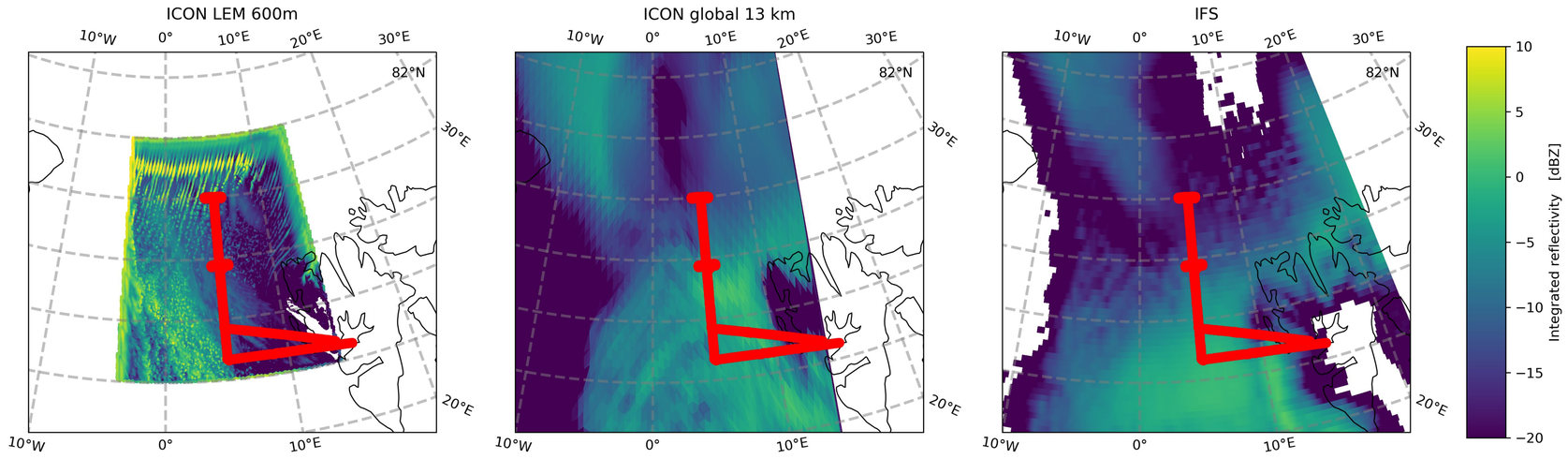


Fig. 2: Simulated, vertically integrated reflectivity (31-03-2019). The ICON-LEM 600m (2-mom microphysics) is compared with the operational ICON and IFS models (both 13 km resolution). The flight path is shown with a red line.

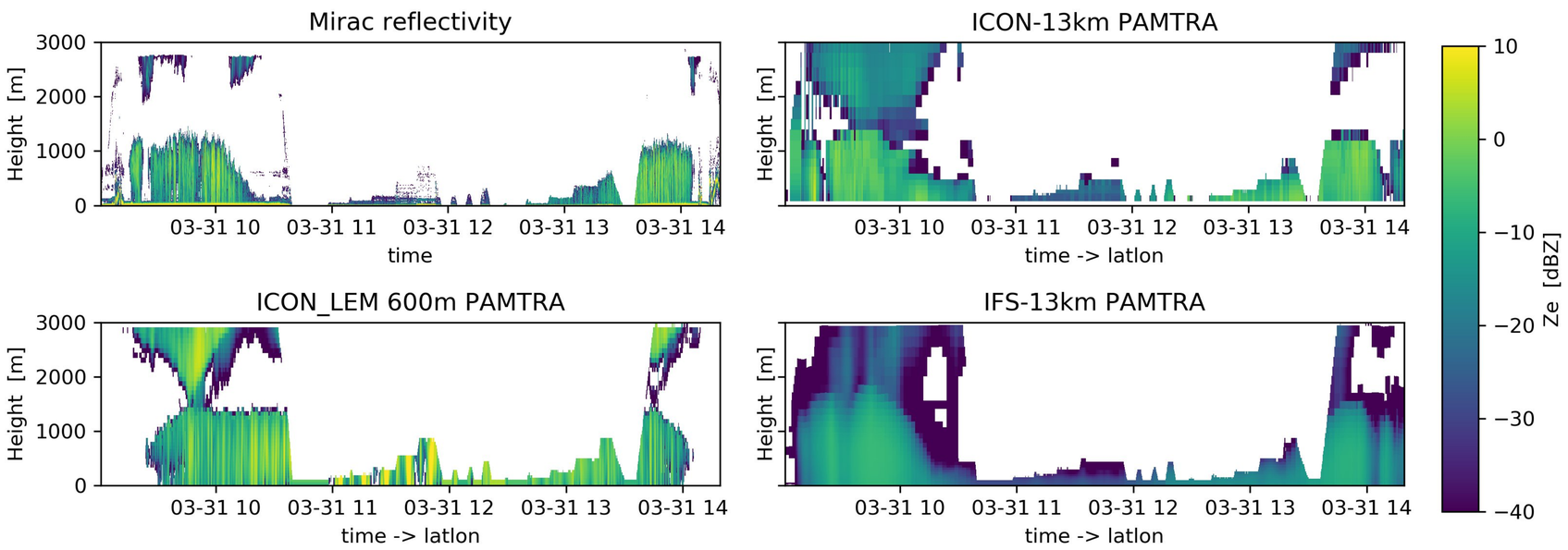


Fig. 2: The radar measurements (top-left panel) are compared with the simulated radar reflectivity along the flight track. The higher resolution of the ICON-LEM (bottom-left) allows to see the horizontal variability of the clouds simulated reflectivity values are closer to the observations.

<u>Results:</u>

- Better resolved cloud organization
- Reflectivity values closer to measurements

4. Conclusions & Outlook

- The higher-resolution simulations allow for a better **representation of clouds**. The size of the simulation domain must be adapted to reduce the computational cost
- The instrument forward simulations will help in the **flight planning** phase and in the post-mission **data interpretation**

<u>Future work:</u>

- Forward simulations are also expensive. Working on a LUT implementation for fast computations during the HALO-AC3 campaign
- Further experiments with high-resolution ICON to assess the statistical significance of the results
- Evaluate the weather simulations at longer forecast time that are relevant for flight planning

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HALO-SPP 1294: Understanding clouds and precipitation at the sub kilometer scale using HALO and ICON - Air mass transformations in the Arctic (UCP-Arctic)