EarthCARE CPR Cal/Val using forward simulated ground-based measurements

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1.Motivation

Need for pre-launch assessment of Satellite Cloud Profiling Radar (CPR) measurements and products. **Ground based radar networks** (FRM4Radar, ACTRIS) have a **good global coverage** and have large data sets, and offer perfect conditions for CPR Cal/Val activities. However one has to transform the ground based data sets to satellite view [1,2,3] for

Research questions:

- How is the CPR's **performance for different clouds**?
- **Can the Doppler capability be used** to capture cloud microphysical processes?

Task: Transform ground based radar data into satellite view!

- Assessment of of CPRs Doppler capabilities
- Generate a large data sets for evaluation (statistical and objective)

2. Simulator Algorithm

Input: Ground based W-band radar data (reflectivity and Doppler velocity). Conversion from 35GHz to 94GHz included [1].

1) Data re-gridding and axis conversion

- Along-track: use constant v_{hor} = 6 ms^{-1} to convert time along track
- Re-gridding: conmon range grid (multiple chirp tables)
- Introduce a surface echo (52 dBZ)

2) Data convolution along track and integration along track [2,3]
Convolution along track for each bin flexible along track integration

- Along track integration: EarthCare 500 m along track steps
- Add Doppler velocity error due to satellite motion

3) Data Convolution along range [2]

- Convolution of data according to CPR range resolution (pulse length)

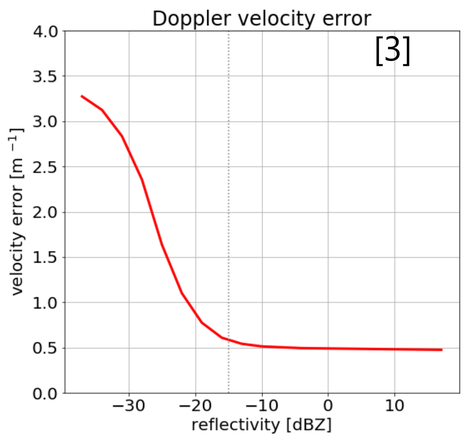
➢ **Best radar measurements from space**

4) Add error to the forward simulated Ze- and Vm data [3,4,5]

Doppler velocity error: non-uniform beam filling, antenna pointing

- Doppler velocity error up to +/- 3 ms^{-1}
- Folding to the Doppler velocity – Nyquist velocity +/- 5.7 ms^{-1}

➢ **Forward simulated data set for statistical comparison and retrieval evaluation**



5. Take home messages

Pre-launch statistics of L1 data CPR data against ground truth are generated to validate the EarthCAREs CPR performance.

- Filtered cloud classes for better CPR comparison/validation.
- Potential to use all ACTRIS stations for Cal/Val.

Next: Comparte ground and simulation to actual CPR measurements
Additional Application: CPR simulation based on airborne data [6]

References:

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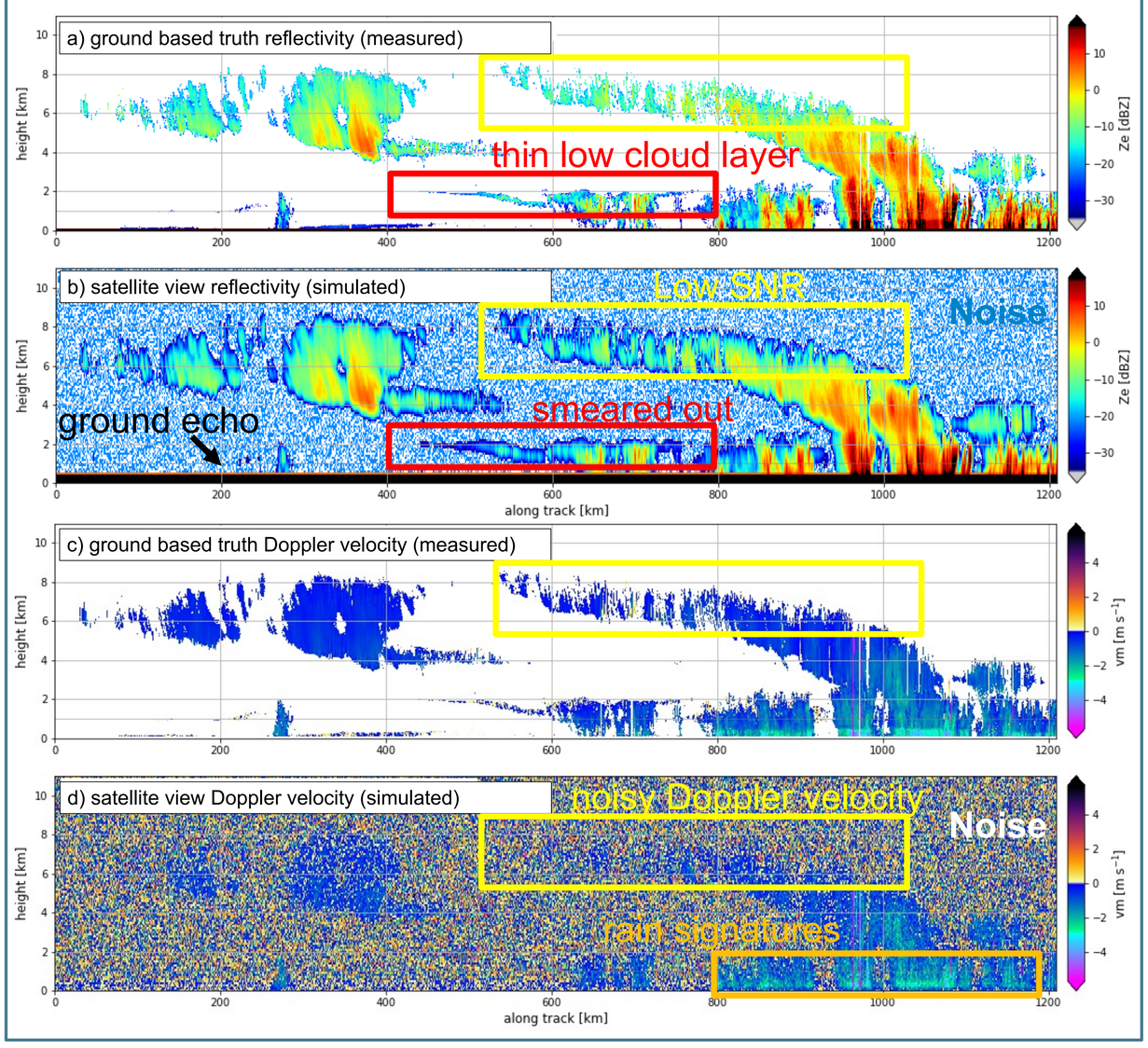
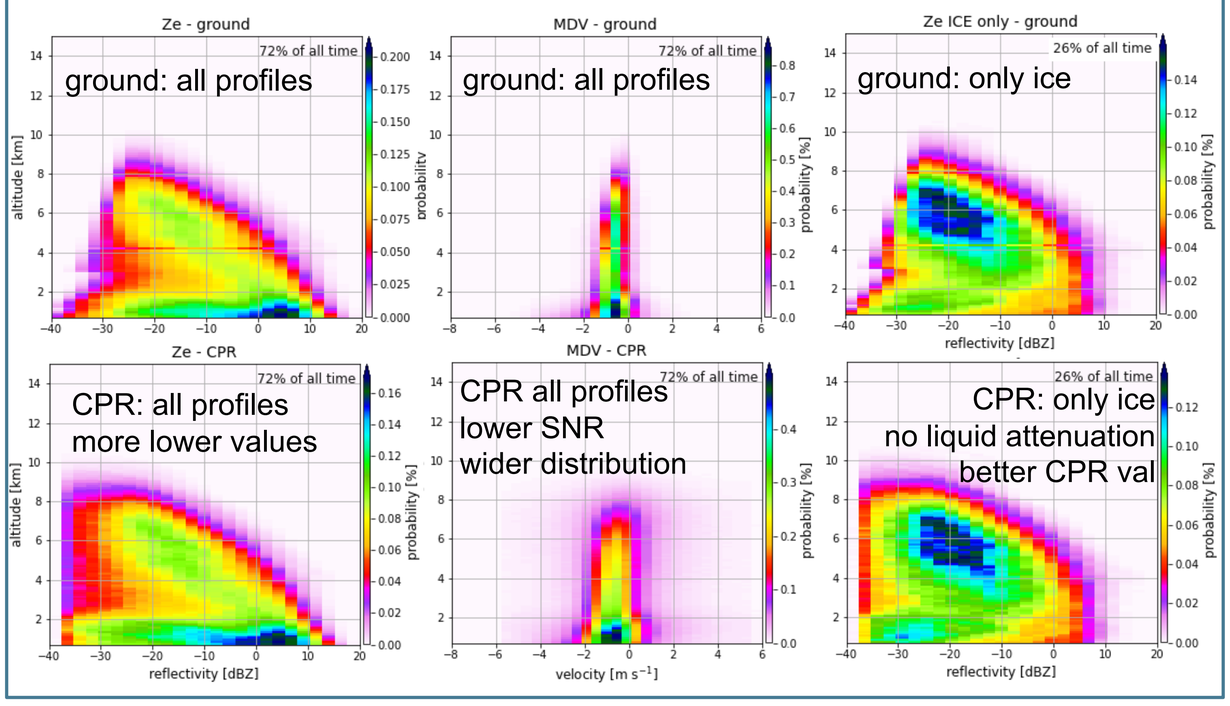
[5] Delanoë, J. and Hogan, R. J., 2010, Combined CloudSat-CALIPSO-MODIS retrievals of the properties of ice clouds, JGR, vol. 115, D00H29, doi:10.1029/2009JD012346, 2010

[6] Schirmacher, I., Kollias, P., Lamer, K., Mech, M., Pfitzenmaier, L., Wendisch, M., and Crewell, S.: Assessing Arctic low-level clouds and precipitation from above – a radar perspective, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2023-636, 2023.

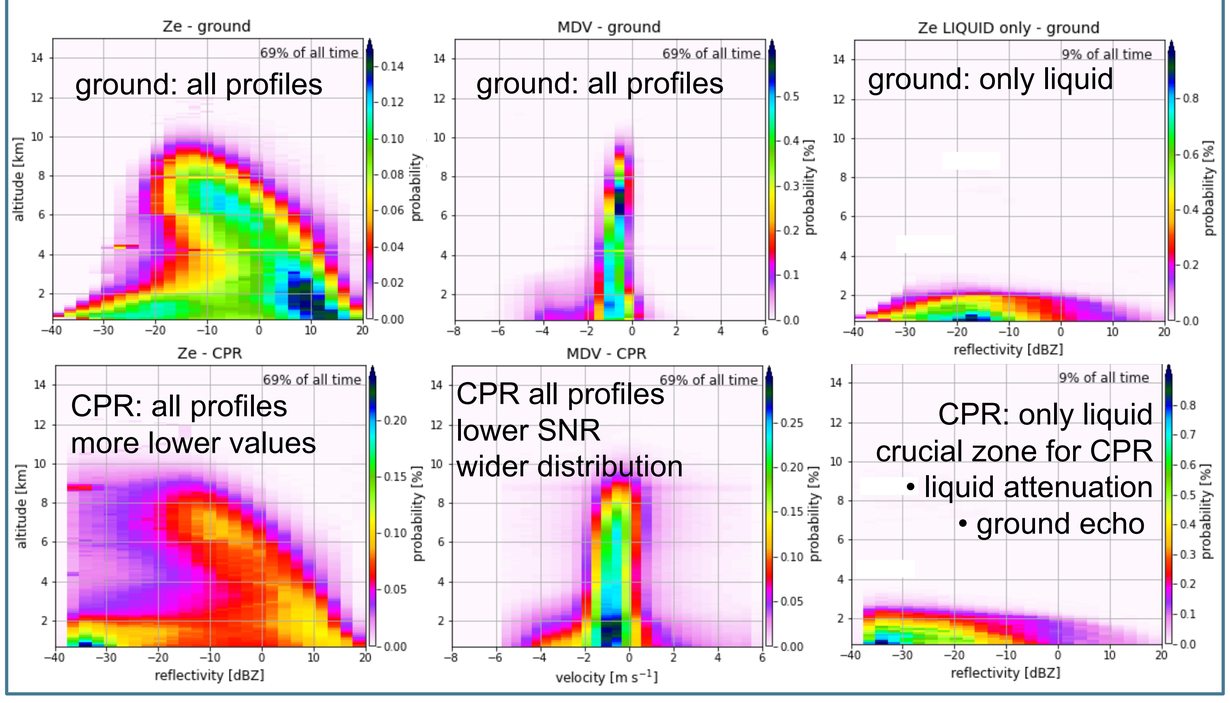
3. CPR simulator: Case Study



4.1. CPR simulator: Statistics NyAlesund – 2021



4.2. CPR simulator: Statistics JOYCE – 2020-12 – 2021-11



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