Using Higher Radar Moments to Study Ice Clouds

Evaluating Ice Cloud Parameterizations

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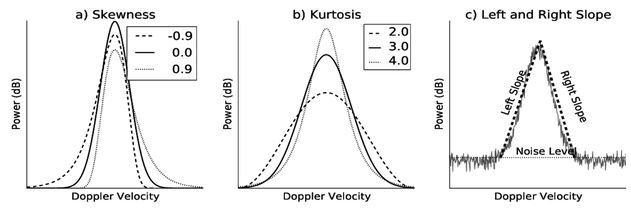
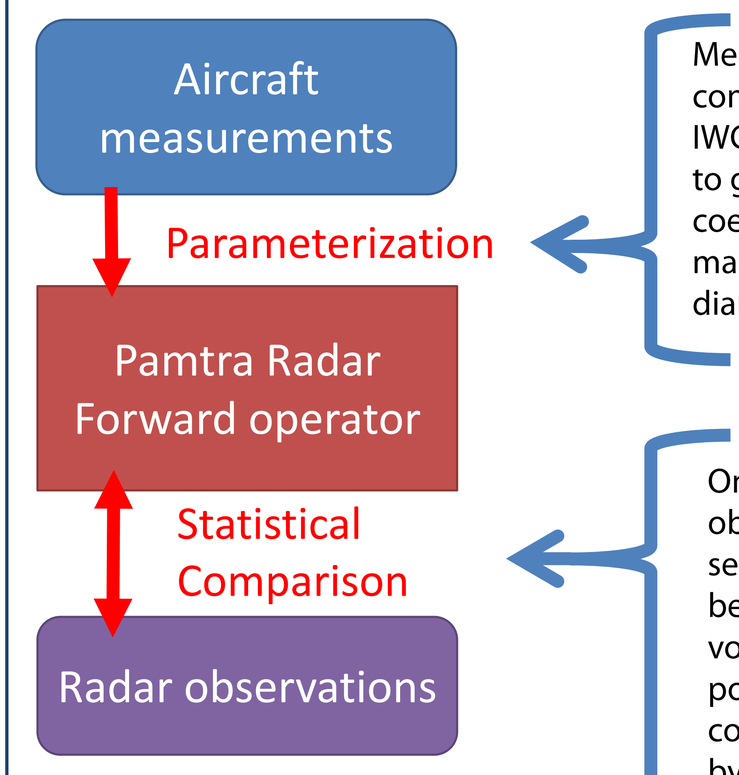
1. Motivation

- There are still gaps in the understanding of microphysical properties and processes of ice clouds. Almost any attempt to fill these gaps requires that ice cloud properties such as particles number, mass or area have to be expressed by in dependence of a size descriptor (D).
- Evaluating these laws and the methods to gain the required coefficients using remote sensing instruments is challenging because errors in the various parameterizations and assumptions can cancel each other out.
- Radars do not only observe reflectivity and mean Doppler velocity, but a full Doppler spectrum. The higher moments spectral width, skewness and kurtosis together with the slope of the peaks provide additional information which makes cancelation of errors less likely.



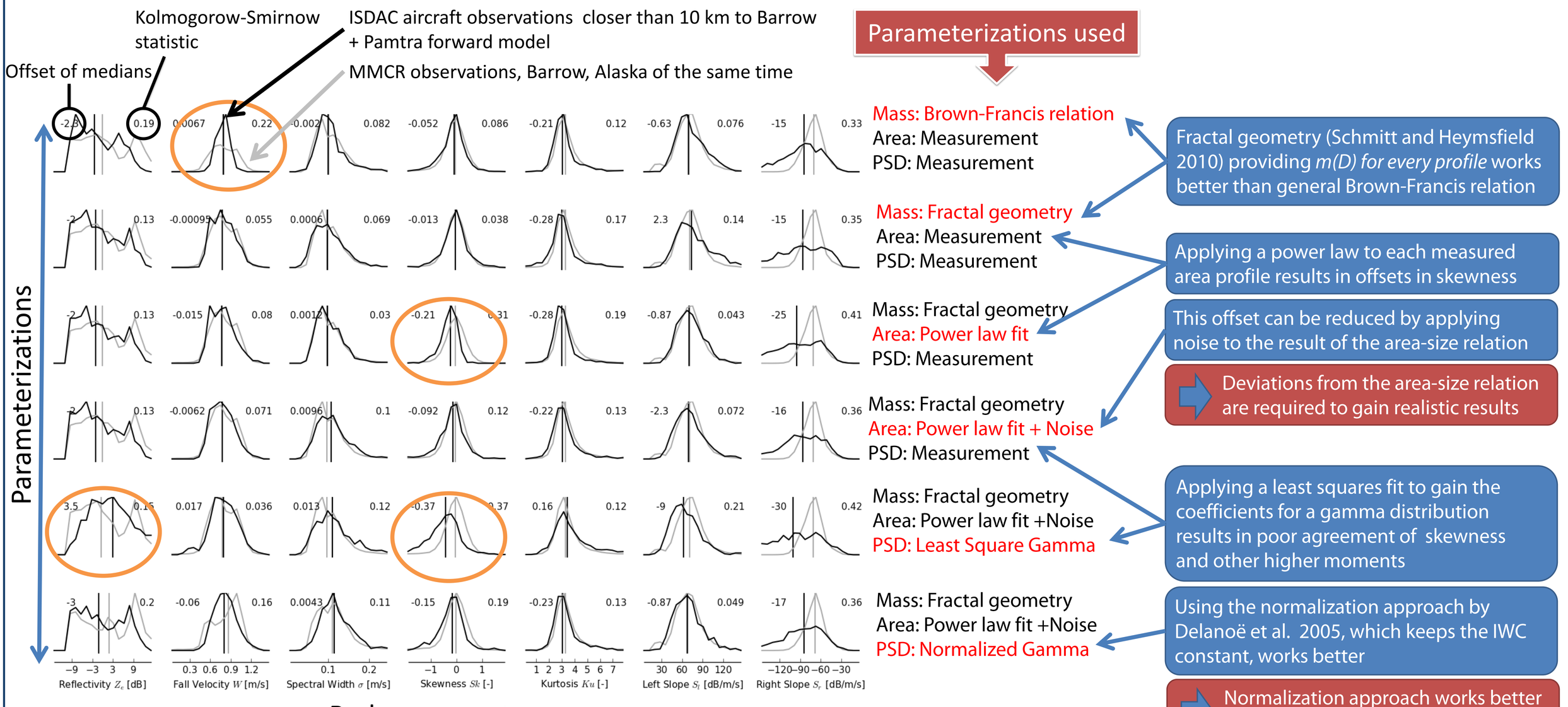
- We use the Pamtra model developed at U Cologne as a forward operator. It can simulate active and passive microwave measurements using the T-Matrix approach for calculation of scattering properties.

2. Setup



→ Which parameterizations work best?

3. Statistical Comparison using Histograms



Not all radar moments are equally well suited for evaluation: Reflectivity might be biased by calibration offsets, Doppler velocity by vertical air motion. The right slope is highly influenced by rare, large particles, which are difficult to measure with in-situ aircraft instruments.

4. Conclusions & Outlook

- We are able to simulate higher radar moments. Simulations are consistent with observations
- The use of additional radar moments gives new possibilities to evaluate the use of various microphysical parameterizations of number concentration, area and mass of ice clouds.
- In the future, higher moments can be also used for testing NWP models or as additional closure for retrievals.
- The parameterizations found in this study can be used to investigate the potential of higher moments for retrieval development.

Maahn, M., U. Löhnert, P. Kollias, R. C. Jackson, and G. M. McFarquhar, 2014: Observing ice clouds with Doppler radar higher moments. Part 1: Evaluating ice cloud parameterizations. Journal of Atmospheric & Oceanic Technology, submitted.

References:

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