1. Introduction

The melting of ice particles is known to produce distinctive radiative features at microwave frequencies such as the radar bright band and increased signal attenuation. An accurate characterization of the scattering properties of melting ice particles is not only relevant for precipitation retrievals from space but also for utilizing the observational fingerprints e.g. for model evaluation. While the number of available datasets for complex aggregates and rimed particles is rapidly increasing during recent years, the number of available scattering datasets for realistic melting particles is very limited (especially regarding the number of particle sizes, shapes, and melted fractions included). This is certainly connected to the high complexity of the melting process and the large computational cost of scattering simulations. We used two recent scattering datasets of realistically shaped melting snowflakes to calculate triple frequency scattering signature and to perform a simple melting layer model that assumes constant melted fraction for all particle sizes and compare with radar observations of the ML.

2. Modeled triple frequency properties

We modeled the triple-frequency X (Ku for Johnson 2016), Ka and W properties by integrating the scattering properties over an inverse exponential PSD with different mean volume diameters $D_v$. We assume constant melting fraction over the whole PSD. The predicted general effect of melting is to increase both DWRs and LDRs (figure 4). BJ database produces “extreme” LDR signatures: up to -15dB or 10 to 15 dB more than DO. Here $D_v$ is increasing along the curves. By using LDR as an indicator of the melting stage we can better characterize the effect of melting on the triple-frequency scattering properties (figure 6).

3. Modeled triple frequency properties

Assuming that aggregation dominates close to the melting layer, we use the mean volume size of the PSD $D_v$ as vertical coordinate (figure 5). Johnson et al. (2016) database simulates a monotonically increasing of LDR with PSD mean size. This is due to the constant shape of the particle which is simply scaled to get to the larger sizes. Ori et al. (2014) simulates different particle for different sizes and shows a dip in the profile corresponding to the onset of aggregation. Smaller crystals are giving higher LDR due to their asymmetry. Current modeling also does not take into account antenna crossed isolation.

4. Radar Observation

TRIPex campaign: Vertically pointing ground-based triple-frequency doppler radar
Contributors: Uni. of Cologne, Uni. of Bremen, Karlsruhe Institute of Technology
Location: KITCE super S – Julich (Germany)
From 11/11/15 To 1/4/16

Conclusions

The scattering databases of melted snowflakes available so far are not able to fully reproduce the observed triple frequency characteristics in the melting layer.

The biases can be partially explained by the highly simplified melting layer model adopted (constant melted fraction) and more sophisticated assumption can be employed to evaluate the sensitivity of the scattering properties to the melting layer model. The simplified melting model used produces too high LDR values.

The scattering databases of melted snowflakes available so far are not able to fully reproduce the observed triple frequency characteristics in the melting layer. General features and relation among observables can be reproduced, but the absolute values are affected by substantial biases. The biases can be partially explained by the highly simplified melting layer model adopted (constant melted fraction) and more sophisticated assumption can be employed to evaluate the sensitivity of the scattering properties to the melting layer model. The simplified melting model used produces too high LDR values.

More detailed melting models might help, but the scaling of the aggregate mass with size still plays a major role in defining the snow scattering properties.

References

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