Introduction and motivation

• The practical utilization of the backscatter differential phase $\delta$, a tell sign for Mie scatterers, is not well explored yet.

• $\delta$ bears important information about the dominant size of raindrops and wet snowflakes in the melting layer.

• The magnitude of $\delta$ can be utilized as an important calibration parameter for improving microphysical models of the melting layer.

• Thus, analyses of $\delta$, together with horizontal reflectivity $Z_H$, differential reflectivity $\Delta DR$, and cross-correlation coefficient $\rho_{HV}$ within the melting layer measured at X band in Germany and at S band in U.S. have been performed to further explore its informative content for microphysics studies.

Moderate $\delta$ at X Band observed in Germany

480 snapshots for 13 different storms observed with the polarimetric X-band radars in Bonn (BoXPol) and Jülich (JuXPol) have been analyzed.

Observations of dendritic growth

Results

• Backscatter differential phase $\delta$ within the ML is a reliably measurable parameter which exhibits high variability.

• Contrary to expectation, much higher $\delta$ has been observed at S band compared to X band (Fig.4,5).

• Theoretical simulations which assume spheroidal shape of melting snowflakes in the absence of aggregation $\delta_{\text{ML}}$ within the ML yield much lower values of $\delta$ than observed in the experiments, especially at S band.

• As expected, correlation between $\delta$ and $\Delta Z_H$ in the ML is not significant because $\delta$ does not depend on particle concentration.

• Strong correlation between $\delta$ and $\Delta Z_H$ is observed in only one case (4 December 2011, see Fig. 2), which is in contrast with expectations.

• The height level of $\delta$ maximum is generally below the $\rho_{HV}$ minimum and the $Z_{\text{DR}}$ maximum, whereas the relation to the $Z_H$ maximum is not as clear. This is in full agreement with polarimetric theory of the melting layer (Fig.1).

• Larger $\delta$ should be associated with larger size aggregates above the ML. No correlation between $\delta$ and the depth of the cloud identified so far. However, some link may exist between the appearance of the zone of intense dendritic growth aloft and $\delta$ within the ML (see Fig.3).

• The $\delta$ signature definitely contains very important microphysical information which has to be further explored.

Huge $\delta$ at S band observed in the US

The data for 7 storms observed with the WSR-88D S-band radars in the US were analyzed. All days show well pronounced $\delta$ ranging from 18 to 40°.

Fig. 2: Correlations between anomalies in the melting layer observed on 4 December 2011 from the 7° elevation angle PPI taken by the BoXPol polarimetric radar in Bonn.

Fig. 1: Relative heights in $Z_{\text{DR}}$, $\rho_{HV}$, and $\delta$ in the melting layer observed with BoXPol and JuXPol.

Fig. 3: PPIs of ZH, $Z_{\text{DR}}$, $\rho_{HV}$ observed with BoXPol on December 4, 2011, 21:41UTC at elevation 4.1°.

Fig. 4: PPIs and quasi-vertical profiles of $Z_{\text{DR}}$, $\rho_{HV}$, and $\delta$ in the melting layer observed with KJAX radar in Jacksonville, Florida, at 9.5° elevation on 26 June 2012.

Fig. 5: PPIs and quasi-vertical profiles of $Z_{\text{DR}}$, $\rho_{HV}$, and $\delta$ in the melting layer observed with KCLE radar in Cleveland, Ohio, at 10° elevation on 8 September 2012.