The triple-frequency retrieval of the characteristic size and width of rain drop size distribution

*Kamil Mroz[1], Alessandro Battaglia[1,2], Stefan Kneifel[3], Leo Pio D'Adderio[4]

1. National Centre for Earth Observation, 2. Earth Observation Science, Department of Physics and Astronomy, University of Leicester, Leicester, United Kingdom, 3. Institute for Geophysics and Meteorology, University of Cologne, Cologne, Germany, 4. Italian National Research Council, Institute of Atmospheric Sciences and Climate ISAC-CNR, Roma, Italy

Over the last decade the availability of simultaneous measurements of the mean Doppler velocity at W-, Ka- and X-bands from airborne platforms and ground-based sites have hugely increased. Such observations have potential for retrieving characteristics of the drop size distribution (DSD) but such potential needs to be properly assessed. In this study, a statistical relation between the difference in mean vertical Doppler velocities at W, Ka and X bands and the mass-weighted mean raindrop diameter and mass-weighted spectrum variance of the DSD is formulated. The algorithm is based on approximately 3,150 hours of DSD measurements collected for the Ground Validation program of the Global Precipitation Measurement Mission and their simulated Doppler velocities. Additionally, a retrieval of a mean mass-weighted diameter (D_m) based only on the X-W measurements is developed; its performance is compared to the analogous algorithm based on higher frequency bands (Ka-W). The validation is performed with the data gathered for the TRIple-frequency and Polarimetric radar Experiment held at the Juelich observatory where disdrometer measurements were gathered in close proximity to vertical profiles of triple frequency reflectivities. The triple Doppler velocity retrieval of D_m works to within a precision of 25% for characteristic sizes ranging from 0.75 mm to 2 mm; this performance is comparable to DDV techniques for sizes below 1.2 mm; however it significantly surpasses the Ka-W algorithm for larger drops (20% versus 35% bias). There is also an improvement of approximately 5% over the X-W retrieval for the high end of considered diameters. The triple Doppler velocity retrieval of the width of the DSD has an uncertainty of 30-40%, which improves the climatological value that corresponds to the retrieved D_m by 5%

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