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A detailed climatology of quasi-vertical profiles (QVPs) under stratiform conditions with identification and analysis of different microphysical processes (MPPs)

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We present a comprehensive climatology of QVPs of polarimetric variables based on the measurements of the X-band radar located in the city of Bonn in western Germany between 2013 and 2023. QVPs under stratiform conditions are selected, with particular attention paid to the signatures in the melting layer (ML) and the dendritic growth layer (DGL). Due to the unprecedented sample size and the inclusion of all seasons, this comprehensive climatology enables the verification of existing hypotheses with statistical evidence and a better understanding of MPP. Furthermore, this climatology provides a reference for the evaluation of numerical models and parameterization development. Statistical methods, e.g. correlation matrices, are used to analyze polarimetric variables in relation to the ML, DGL and the layer in between, e.g. the ML thickness or the maximum of the radar reflectivity factor (ZH) within the DGL/ML. Hypotheses from former studies are tested, e.g. the seasonality of ML thickness or the ML amplitude, and to reveal dominating MPPs. To analyze the latter more precisely, so called microphysical fingerprints are utilized, in which the gradients of the polarimetric variables are used to identify different MPPs. For this purpose, existing techniques are used, e.g. the aggregation fingerprint, showing increasing ZH with simultaneous decreasing in the specific differential phase (KDP) and the differential reflectivity (ZDR) towards the ML. Additional innovative approaches are presented, such as the inclusion of the mean Doppler velocity from the birdbath scan in order to distinguish between aggregation and riming. In order to ensure the high significance of the climatology, a sufficiently precise calibration of the radar is guaranteed. ZH is calibrated using the relationship between ZH and ZDR in light rain. This method is highly dependent on an accurate calibration of the ZDR. We highlight shortcomings that can occur when using the often preferred birdbath scan technique to correct ZDR and compare the corresponding results with an alternative calibration method that uses QVPs in light rain. The ZH offsets calculated with this technique are validated using both self-consistency relationships applying KDP and satellite information, demonstrating the suitability of this method.

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Session

Enhancing Process Understanding: New observations for modeling and parameterization development

Preferred Contribution Type

Oral Presentation

Presenting Author

Tobias Scharbach

Email Address of Presenting Author

toscha@uni-bonn.de

Affiliation of Presenting Author

University of Bonn, Institute for Geosciences - Section Meteorology

Address of Presenting Author

53121 Bonn, Auf dem Hügel 20

Authors: TRÖMEL, Silke (University of Bonn, Institute for Geosciences - Section Meteorology); SCHARBACH, Tobias (University of Bonn, Institute for Geosciences - Section Meteorology)

Presenter: SCHARBACH, Tobias (University of Bonn, Institute for Geosciences - Section Meteorology)