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Hydrometeor partitioning ratios for polarimetric ground-based and dual-frequency space-borne and radar observations

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Broadly used radar-based Hydrometeor Classification (HMC) algorithms solely identify the dominant hydrometeor class within a resolved radar volume. More recently, however, methods have been developed to estimate the proportions of individual hydrometeor types (hydrometeor partitioning ratios, HPR) within the mixture. These advanced algorithms (HMC-DP) are exploiting dual-polarization (DP) measurements of ground-based weather radars (GR), while similar algorithms for space-borne radar (SR) observations with dual-frequency (DF) capabilities are not yet available. In this study, we exploit the combination of DF SR and DP GR to develop an algorithm for HPR estimation based on satellite DF observations (HMC-DF) and to improve the HMC-DP based on GR DP observation. The evaluation of HPR retrievals, derived from either GR or SR, is challenging. However, this study also presents an evaluation of the HPR retrievals derived from HMC-DP and HMC-DF.
Therefore, the DP observations of NEXRADs WSR-88D GRs are matched with the measurements of the Dual-frequency Precipitation Radar (DPR) of the Global Precipitation Measurement (GPM) core satellite. The matched volumes, represented by averaged DF or DP measured variables, contain a few SR but several hundred GR measurement volumes, depending on the distance to the GR. This large difference in observation resolution allows the determination of quasi HPR (qHPR) per matched volume obtained from the dominant hydrometeor types (standard HMC) classified by the GR. The matched DF and DP are utilized to derive centroids and covariance matrices for each individual hydrometeor class based on the qHPR. These centroids and covariance matrices serve as the basis for the HMC-DP and HMC-DF algorithms and their HPR retrievals, which in turn are verified with the qHPR.
Results demonstrate a high degree of agreement between the HPR distributions derived with HMC-DF and HMC-DP. The HPR derived with HMC-DP show a higher correlation with the qHPR in comparison to the HPR derived with HMC-DF. This is due to the fact that DP, compared to the DF observations, provide additional information, for example, regarding the orientation, shape and homogeneity of the hydrometeors within the measurement volume. However, both HMC-DF and HMC-DP underestimate snow with biases of -5%, overestimate HPRs of graupel with biases up to 3% and show low correlations of 0.37 for DP and 0.16 for DF estimates of big drops HPR.

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From Classical to Integrated Remote Sensing: New retrieval and estimation techniques (e.g. fusion, Bayesian)

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