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Drop Size Distribution, Radar Observation and Rainfall Estimation: A Focus on the Tropics

Abstract

The majority of the world's rainfall occurs in the tropics. However, compared to rainfall in the midlatitudes, this is not as well-explored. To study tropical precipitation, two-dimensional video disdrometer (2DVD) were analyzed from two equatorial Indian (Gan) and west Pacific Ocean (Manus) islands. The 2DVD data from Manus (18 months) and Gan (3.5 months) islands show that 1) the two sites have similar drop size distribution (DSD) spectra of liquid water content, median diameter, rain rate R, radar reflectivity z, normalized gamma number concentration N_w, and other integral rain parameters; 2) there is a clear separation between convective (C) and stratiform (S) DSDs at both sites. The 2DVD data indicate an equatorial, maritime average C/S rainfall accumulation fraction (frequency) of 81/19 (41/59) at these locations. It is hypothesized that this convective fraction and frequency estimates are slightly higher than previous studies because the ubiquitous weak, shallow convection (<10 mm hr^{-1}), which is common in the warm pool, is properly resolved and identified in the high-resolution DSD dataset.

The Manus Island disdrometer dataset was used to quantify the impacts of tropical oceanic DSD variability on dual-polarization radar variables and their resulting utility in rainfall estimation. Variables that were analyzed include differential reflectivity Z_{dr}; specific differential phase K_{dp}; reflectivity Z_h; and specific attenuation A_h. New X-, C-, and S-band R estimators were derived: $R(K_{dp})$, $R(A_h)$, $R(K_{dp}, \zeta_{dr})$, $R(z, \zeta_{dr})$, and $R(A_h, \zeta_{dr})$, which use linear versions of Z_{dr} and Z_h, namely ζ_{dr} and z. Except for $R(K_{dp})$, convective/stratiform partitioning was unnecessary for these estimators. All dual-polarization estimators outperformed updated $R(z)$ estimators derived from the same dataset. The best-performing estimator was $R(K_{dp}, \zeta_{dr})$, followed by $R(A_h, \zeta_{dr})$ and $R(z, \zeta_{dr})$.

Keywords

Drop size distribution, rainfall estimation

Reference

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