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Distributional correspondence of 94-GHz radar reflectivity with the variation in water cloud properties

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This paper studied the behavior of 94-GHz radar reflectivity (Ze) with variation in the properties of low-level water clouds, such as the effective droplet radius (re), geometrical thickness (Dcld), and liquid water path (LWP), over the northwest Pacific and China. The changes in the distribution of maxZe (the largest Ze within a cloud layer) were examined in terms of variation in the cloud parameters such as small, mid and large categories. While maxZe had monomodal distributions regarding variation in re and Dcld, that appeared bimodal in the small category of LWP. It was confirmed that the small category of LWP contained both non-precipitating clouds in the incipient stage and raining clouds in the dissipating stage. Next, optically-measured particle size was combined with LWP derived from the microwave measurement to classify the precipitation type. Applying maxZe and Dcld to the analysis of classified precipitation types corroborated the importance of Dcld for examining the occurrence of precipitation. Finally, the position of maxZe relative to the cloud top was investigated using a measure of the probability of precipitation (POP) according to variation in re. The results showed that the Pacific and China had 'bow' and 'funnel' shapes, respectively. The emergence of these shapes according to the variation in re was interpreted as the enhancement of Ze due to droplet collisional growth and the attenuation of Ze by the presence of large particles. Furthermore, a detailed analysis of smaller particles (<10 micron in radius) reinforced the idea of rapid, efficient particle growth in the lower part of the cloud.

Keywords: CloudSat, Radar reflectivity, cloud physics, aerosol, precipitation