Observations and parameterizations of tropical stratiform particle size distributions: Results from TRMM field campaigns

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The evolution of the particle size distributions (PSDs) and particle habits during slow, Lagrangian-type spiral descents through deep tropical stratiform ice and liquid clouds was studied using data from the Tropical Rain Measuring Mission (TRMM) field campaigns in Florida, Brazil, and Kwajalein, Marshall Islands. A total of nine spirals, most of which began a cloud top and ended at cloud base or below the melting layer were studied; overflying aircraft provided nearly coincident Doppler radar data for eight of the cases. In the ice regions sampled, mean dBZ_e were primarily in the range 5 to 25 dBZ_e, while In the rain regions, the dBZ_e were in the 20 to 30 range. The study is unique in that new instrumentation--a high volume particle sampler (HVPS) provided a much larger sample volume to characterize the concentrations of the smaller particles, a cloud particle imager (CPI) provided high quality particle habit information--, and new techniques to analyze the data were employed.

Examination of the PSDs in the vertical showed that the PSDs broadened downwards. The largest particles at the top of the spirals are several millimeters whereas at the bases of the spirals or at the top of the melting layer were one centimeter in most cases. The concentrations of particles below 600 microns decreased with height. The larger particles grew through aggregation, depleting the concentration of the smaller particles.

The systematic variations in the PSDs noted with distance below cloud top for all cases were captured and parameterized through curve fits to the PSDs. Exponential fits to the ice size distributions of the form N = No exp(-lambda D) provided excellent fits to the data below -5C. The parameters No and lambda each varied in a systematic way with temperature, and were highly correlated to each other. Above -5C, the quality of the curve fits deteriorated, and the PSDs were better represented by power-law curves. Below the melting layer, the PSDs approached the Marshall-Palmer representation. The No and lambda are correlated to the precipitation rate calculated from the PSDs.

The talk to be presented at this meeting will report on these new observations and parameterizations.