Millimeter-Wave Spectral Observations of Clouds and Precipitation from Aircraft and Spacecraft

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Abstract:
Detection of clouds and precipitation using passive microwave imagery and millimeter wavelengths requires removal of most effects of surface emissivity, temperature profile, and humidity profile variations. The general approach studied here involved four steps: 1) principal-components analysis of observed microwave spectra over diverse cloud-free regions, 2) removal of the first 1-3 principal components from all data, 3) principal-components analysis of filtered data containing variable clouds and precipitation, and 4) choice of a cloud-detection metric in the multi-dimensional space of this second group of principal components.

The data employed to test this method were obtained from two passive microwave instruments: (1) the NPOESS Aircraft Sounder Testbed - Microwave Temperature Sounder on the NASA ER-2 high-altitude aircraft, which has eight channels in the 50-56 GHz oxygen band and eight double-sideband channels distributed symmetrically within +/- 4 GHz around the oxygen absorption line at 118.75 GHz, and which measures brightness temperatures with spatial resolution of approximately 5 km; (2) the Advanced Microwave Sounding Units-A/B on the NOAA-15 polar-orbiting satellite, with 15 channels and spatial resolution of approximately 50 km in the 23-89 GHz band, and 5 channels with spatial resolution of approximately 16 km in the 89-190 GHz band.

Overpasses of thunderstorms in central Florida show distinctive signatures of absorption and scattering by hydrometeors. When channels having similar gaseous opacities are compared, the perturbations to the clear-air brightness temperatures are, as expected, larger in the 115-123 GHz band than in the 50-56 GHz band; these perturbations are related to the altitude, size distribution, and liquid/ice phase of the hydrometeors.

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