

# Hydrometeor Scattering in 53- and 118-GHz Observations of Brightness Temperatures over Precipitation Cells

A.J. Gasiewski\* and D.H. Staelin  
Research Laboratory of Electronics  
Massachusetts Institute of Technology  
Cambridge, Massachusetts 02139

Nadir observations of microwave brightness temperature over convective precipitation cells have been made using two narrowband  $O_2$  channels at 53.65 GHz and  $118.75 \pm 1.47$  GHz. The observations were made using a multichannel millimeter-wave imaging spectrometer on board the NASA ER-2 high-altitude aircraft during the Cooperative Huntsville Meteorological Experiment (COHMEX) 1986. The two channels have similar clear-air nadir temperature weighting functions (Fig. 1), hence yield nearly identical brightness temperatures over cloud-free regions.

The response of the two channels to liquid and frozen hydrometeors, however, is markedly different. Over precipitating regions, small negative perturbations ( $\leq 35$  K) in the 118-GHz brightness temperature are found to be 2-3 times as large as coincident 53-GHz perturbations. Such perturbations are common over weak precipitation. Negative 118-GHz perturbations larger than 35 K track coincident 53-GHz perturbations more closely, and have been associated with strong convective precipitation. A scatter plot of the perturbed brightness temperatures for the two channels is shown for observations of precipitation on June 29, 1986 (Fig. 2).

The observed brightness temperature perturbations have been compared to numerical results from a simple one-dimensional radiative transfer model incorporating an ice-phase scattering layer. The ice layer was assumed to extend from 7 to 10 km, consistent with coincident radar observations. Ice particles were assumed to have Mie scattering cross-sections and equal forward- and back-scattered components. Brightness temperatures were computed for ice densities up to  $5.0 \text{ g/cm}^2$  ( $13.8 \text{ g/m}^3$ ) for selected particle radii between 100  $\mu\text{m}$  and 1.5 mm (Fig. 3). The calculated 118- and 53-GHz perturbations match the observations most closely for  $\approx 1 \text{ mm}$  particle radii, but are quite sensitive to the assumed particle size and density.

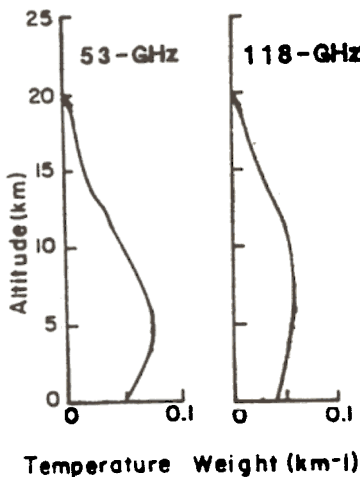


Figure 1.

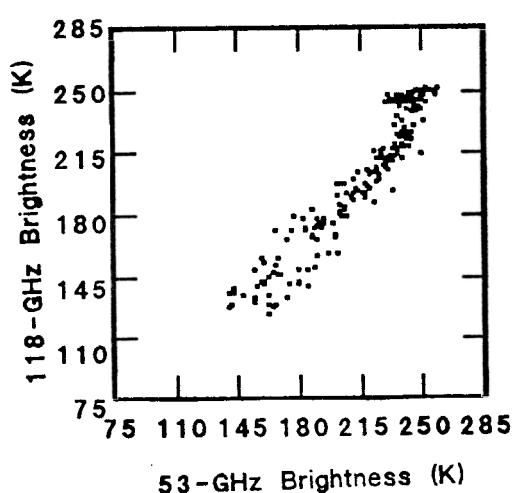


Figure 2.

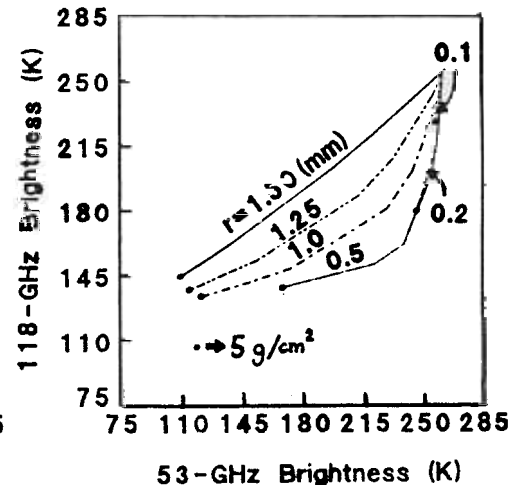


Figure 3