Microwave-IR Polarimetry and Radiometry for Remote Sensing of Cloud Ice Microphysical Properties

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Abstract

Polarimetric differences can be induced in passive microwave-IR radiances, or brightness temperature (TB), by the scattering of various shaped frozen particles in the atmosphere. However, polarimetric scattering differences of ice clouds are not well measured and investigated. Studying the vertically (V) and horizontally (H) polarized radiances from the spaceborne GMI 89 and 166 GHz radiometers, as well as those from the airborne CoSSIR 640 GHz radiometers, we found that cloud polarimetric differences (PD, or V-H) are ubiquitous globally. Large polarization occurs mostly near the convective outflow region (i.e., anvils or stratiform precipitation), while the polarization signals become saturated and diminished in the core of strong deep convective clouds. Most of the observed PD-TB relationships can be explained by a simplified 2-layer radiative transfer model. To characterize global cloud ice microphysical properties (i.e., particle size and shape), we propose to use dual-polarization (V, H) radiometers at three window frequencies (240 GHz, 680 GHz, and 11 μm) with matched footprints under a conical-scan operation. Because of their short wavelengths, these polarimetric receivers can be made small to fit within typical SmallSat or CubeSat configurations. Recent advances in MMIC technologies have produced high sensitivity, low power submm-wave receivers, allowing such compact designs and efficient operation of multiple polarimetric receivers for future spaceflight missions.