Design, Fabrication, and Testing of an Ambient Calibration Target for the Tropospheric Water Vapor and Cloud ICE (TWICE) Millimeter- and Sub-millimeter-wave Radiometer Instrument

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Global observations of ice cloud particle size and ice water content can provide needed information to benefit weather forecasting and climate prediction. The interaction between ice particles and upwelling radiation at sub-millimeter wavelengths strongly depends on ice particle size and observation frequency. The CloudSat 94 GHz cloud radar and Aqua's MODIS 10 μm infrared radiometer in NASA's A-Train provide space-borne measurements of ice cloud particles with diameters greater than 1 mm and less than 100 μm, respectively. Sub-millimeter-wavelength radiometry provides the capability to fill this observational gap by allowing the detection and sizing of ice particles with diameters between 100 μm and 1 mm.

To meet this need, the Tropospheric Water and Cloud ICE (TWICE) millimeter- and sub-millimeter-wave radiometer instrument is currently under development for 6U-Class satellites in a joint effort among Colorado State University (lead), NASA/Caltech Jet Propulsion Laboratory, and Northrop Grumman Corporation. The TWICE radiometer instrument is designed to provide global measurements of cloud ice and water vapor profiles in the upper troposphere/lower stratosphere. The TWICE radiometer instrument has 15 frequency channels near 118 GHz for temperature profiling, near 183 and 380 GHz for water vapor profiling, and centered on 240, 310 and 670 GHz quasi-window channels for ice particle size.

The TWICE instrument performs end-to-end, two-point, in-orbit radiometric calibration by observing an ambient temperature calibration target and cold sky reflector during each conical scan. The ambient calibration target has been designed for simultaneous blackbody measurements at all TWICE millimeter- and sub-millimeter-wave channels. Calibration target design parameters, including size, geometry, thermal and electromagnetic properties, have been chosen to meet the performance requirements of the ambient target and to minimize temperature gradients. Reflection coefficient measurements have been performed in the millimeter to sub-millimeter wavelength range of the TWICE channels. Thermal analysis of the ambient calibration target has been performed using ANSYS software. The resulting ambient calibration target design meets functional requirements as well as size and weight constraints to fit into a 6U-Class satellite.