IceCube's 15-Month Experiment with a Commercial 883-GHz Cloud Radiometer

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This paper will summarize the 15-month IceCube spaceflight technology demonstration and performance of the CubeSat and instrument. The IceCube experiment shows that the 883-GHz commercial receiver can last long in space and operate over a wide (18°C-30°C) temperature range. IceCube adopted a simple design without any scan mechanisms. Instead, the cloud radiometer relied on the spacecraft to spin around the Sun vector for the maximum power input. The spinning CubeSat also provided periodical views between Earth and space for radiometric calibration. The CubeSat has demonstrated various spin rates between 0.25°-3.3° per second as well as the full 24/7 operation of the 5.6-W cloud radiometer. The spacecraft continued to spin at orbital altitudes of ~200 km before its reentry on October 3, 2018. The 883-GHz radiometer exhibited a small degradation at the designed operation temperature (20°C +/- 2°C), but the degradation was larger at warmer temperatures. IceCube also carried out a noise-source experiment onboard to diagnose receiver characteristics in the intermediate frequency (IF) subsystem.

Successful spaceflight demonstration of the commercial 883-GHz radiometer on IceCube enables fast-track, low-cost implementation of submm-wave remote sensing for future Earth science missions. In the 2017 Decadal Survey (DS) targeted observables under Clouds, Convection and Precipitation (CCP), which addresses a principal source of uncertainty in understanding climate change, the requirements for process-level observation, coverage and sampling are challenging. The IceCube-like submm-wave remote sensing can make a critical contribution to the cost-capped DS science mission by filling the sensitivity gap between microwave and infrared sensors, and by providing the spatiotemporal sampling (via CubeSat constellation) as needed for understanding fast CCP processes.