

Wide-Band Millimeter and Sub-Millimeter Wave Radiometer Instrument to Measure Tropospheric Water and Cloud Ice (TWICE)

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TWICE is a new, multi-frequency millimeter and sub-millimeter-wave radiometer instrument to provide critically needed measurements in NASA's Earth Science Focus Areas of Climate Variability & Change and Water & Energy Cycle. Specifically, the instrument addresses the need for measurements of water vapor and cloud ice in the upper troposphere at a variety of local times, to provide data not currently available from microwave sensors in sun-synchronous orbits. Second, this capability will address the need for measurements of cloud ice particle size distribution and water content in both clean and polluted environments to investigate the effect of aerosol pollution on cloud properties and climate. Additionally, this instrument will provide humidity and temperature profiles covering most of the troposphere in nearly all weather conditions.

The TWICE instrument will perform water vapor and temperature sounding near multiple absorption lines from 118 to 380 GHz as well as cloud ice particle sizing at multiple window frequencies from 235 to 670 GHz. Advancement of low noise Indium Phosphide (InP) MMIC amplifier technology enabled us to develop miniature submillimeter-wave receivers for a CubeSat scale instrument that achieves 6 km spatial resolution. The heritage of InP MMICs includes continuous operation for four years in the PLANCK Low Frequency Instrument and providing world-record sensitivity with high reliability in several airborne instruments. We have developed a set of InP MMICs for receivers at 240, 310, 380 and 670 GHz with significantly lower noise than previously reported. The noise temperature is NT=450 K at 240 GHz, NT=550K at 310 GHz and NT=650 K at 380 GHz. The 670 GHz LNAs provide a NT of 2400 K. These channels are complemented by the previously developed and airborne-proven 183 and 118 GHz MMIC receivers that were tested to TRL 6.