The Temporal Experiment for Storms and Tropical Systems Technology Demonstration (TEMPEST-D) Mission for Cloud and Precipitation Observations from 6U-Class SmallSats

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The Temporal Experiment for Storms and Tropical Systems (TEMPEST) mission is a proposed constellation consisting of 5-10 identical 6U-class satellites with rapid, 3-6 minute temporal sampling to observe cloud and precipitation processes. The payload for each 6U-Class satellite is a five-frequency millimeter-wave radiometer (90-183 GHz) with the capability to remotely sense the interior of the cloud to observe microphysical changes in water and ice as precipitation begins and ice accumulates inside the storm. Such a 6U-class satellite constellation mission would enable the first global measurements of clouds and precipitation on the time scale of a few to a few tens of minutes and the corresponding single-storm cell spatial scale of a few hundred m to a few km. TEMPEST is planned to improve understanding of cloud and precipitation processes as well as helping to constrain one of the largest sources of uncertainty in cloud models. Such a mission is to provide critical information on temporal signatures of clouds and the onset of precipitation.

For TEMPEST, 6U-class satellites are chosen to provide substantial margins on mass, power, satellite-to-ground communications and capability for microwave radiometer calibration. To demonstrate the feasibility of a constellation of 6U-class TEMPEST satellites, the TEMPEST Technology Demonstration (TEMPEST-D) mission is underway to raise the TRL of the instrument and key satellite systems from 6 to 9, as well as to demonstrate the observational capabilities required to achieve a full TEMPEST mission. The Level 1 requirements for the TEMPEST-D mission are to: (1) demonstrate precision inter-satellite calibration between TEMPEST-D and one other orbiting radiometer, i.e., NASA/JAXA's Global Precipitation Microwave Imager (GMI) or the Microwave Humidity Sounder (MHS) on NOAA and ESA/EUMETSAT operational satellites, measuring at similar frequencies; and (2) demonstrate orbital drag maneuvers to control altitude to 100 m or better, as verified by GPS, sufficient to achieve required temporal spacing in a constellation of 6U-Class satellites.

A partnership among Colorado State University (Lead Institution), NASA/Caltech Jet Propulsion Laboratory and Blue Canyon Technologies, TEMPEST-D will provide observations at five millimeter-wave frequencies from 90 to 183 GHz using a single compact instrument that is well suited for 6U-class satellites and has been demonstrated in the laboratory, vibration and thermal vacuum testing to be TRL 6. TEMPEST-D has been manifested for launch on Orbital ATK-9 commercial resupply service on May 1, 2018, for deployment into orbit by NanoRacks from the Japanese Experiment Module's (JEM) robotic arm on the International Space Station. The mission will consist of one month of on-orbit commissioning and three months of technology demonstration, with an initial orbit at 400-km altitude and 51.6° inclination.

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