Advanced CubeSat Capabilities for Passive Microwave Remotes Sensing of the Atmosphere[1]

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The need for early detection of storms, and monitoring and forecasting of storm track, intensity, and associated precipitation and storm surge has been underscored by the heightened activity in the Atlantic basin since 1995 and the occurrence of major events such as Hurricanes Katrina (2005) and Sandy (2012). The 2007 Decadal Survey recommended the Precipitation and All-weather Temperature and Humidity (PATH) mission as a means of obtaining three-dimensional (3D) temperature and humidity measurements as well as precipitation with temporal refreshing of 15-30 minutes. New technologies now make possible the formation of constellations of smallsat radiometers capable of delivering PATH measurements with median refresh rates near 20 minutes and near global coverage at a small fraction of the cost of previous approaches. Additionally, there is vast potential for low-cost smallsat systems to mitigate the risk of a gap in continuity of weather observations in the NOAA satellite enterprise.

To increase technical readiness for the missions described above, four nanosatellite advanced technology missions flying microwave radiometers for high-resolution atmospheric sensing are in varying stages of development at MIT Lincoln Laboratory (MIT LL). The first mission, the Microsized Microwave Atmospheric Satellite (MicroMAS), was developed to demonstrate temperature sounding in nine channels near 118 GHz on a 3U CubeSat (10x10x34 cm; 4.25 kg). MicroMAS was released in March 2015 from the International Space Station for a 100-day mission, and while an eventual transmitter failure prevented demonstration of the radiometer payload, all key spacecraft subsystems provided on-orbit data to validate performance. A second MicroMAS mission (“MicroMAS-2”) is in development with an advanced four-band radiometer observing near 90, 118, 183, and 206 GHz to provide precipitation, temperature, and humidity measurements from a 3U CubeSat. The first of two MicroMAS-2 flight units will launch in late 2016. The Microwave Radiometer Technology Acceleration (MiRaTA) CubeSat will demonstrate multi-band atmospheric sounding and co-located GPS radio occultation on a 3U CubeSat. MiRaTA will launch in 2016 as a secondary payload on the JPSS-1 mission. MiRaTA is designed for a one-year mission life and will fly a tri-band sounder (60, 183, and 206 GHz) and a GPS radio occultation sensor comprising a modified COTS receiver and antenna patch array. Finally, the Earth Observing Nanosatellite-Microwave (EON-MW) mission is being formulated by MIT LL for the NOAA National Environmental Satellite, Data, and Information Service as part of the Polar Follow-On (PFO) budget request to extend JPSS for two more missions. The baseline EON-MW design accommodates a scanning 22-channel high-resolution microwave spectrometer on a 12U CubeSat platform to provide data continuity with the existing AMSU and ATMS microwave sounding systems. EON-MW will nominally be launched into a sun-synchronous orbit for a two to three year mission in 2019 and will extend technology demonstration beyond what MicroMAS and MiRaTA will achieve.

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