RainCube, a Ka-band precipitation radar mission in a CubeSat

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RainCube (Radar in a CubeSat) is a technology demonstration mission to enable Ka-band precipitation radar technologies on a low-cost, quick-turnaround platform. Within three years, the RainCube project developed a 35.75 GHz radar (miniKaAR-C) with a deployable 50 cm parabolic mesh antenna (KaRPDA) on a 6U CubeSat. On July 13, 2018, RainCube deployed from the International Space Station and began its three-month mission in Lower Earth Orbit to measure precipitation in Earth's atmosphere. On August 27, 2018, after successfully commissioning the satellite and deploying the radar antenna, RainCube successfully measured rain on Earth. Since then, RainCube continues collecting precipitation profiles and it has been verified that all radar performance requirements are met with margin. RainCube will continue its mission through January 2019 and further demonstrate the feasibility of this type of science payload on a CubeSat and small satellite platform. RainCube is fully funded under the Science Mission Directorate's (SMD) Research Opportunities in Space and Earth Science (ROSES) 2015 In-Space Validation of Earth Science Technologies (InVEST) solicitation.

Two key technologies have been validated in the space environment; miniKaAR-C, a miniaturized Ka-band precipitation profiling radar that occupies a 2.5U volume and KaRPDA, a 0.5m Ka-band parabolic deployable antenna that stows in a 1.5U volume. The radar payload was built at JPL and delivered to Tyvak, which provided the bus and was responsible for the mechanical and electrical integration and for mission operations. The RainCube radar architecture reduces the number of components, power consumption and mass by over one order of magnitude with respect to the existing spaceborne radars. The baseline instrument configuration for the RainCube concept is a fixed nadir-pointing profiler at Ka-band with a measured detectable reflectivity factor of +10 dBZ at 250m range resolution and 8km horizontal resolution and a power consumption in transmit mode of only 22W. The technology readiness of the Ka-band radar architecture and antenna has increased from an entry TRL 4-5 to an exit TRL 7.

Numerical climate and weather models depend on measurements from space-borne satellites to complete model validation and improvements. Precipitation profiling capabilities are currently limited to a few instruments deployed in Low Earth Orbit (LEO), which cannot provide the temporal resolution necessary to observe the evolution of short time-scale weather phenomena and improve numerical weather prediction models. A constellation of precipitation profiling instruments in LEO would provide this essential capability, but the cost and timeframe of typical satellite platforms and instruments make this solution prohibitive. RainCube's technology and accomplishments could enable future Earth Science missions to fly a constellation of precipitation profiling radars, which could provide a new paradigm for weather and climate measurements.