RainCube, a Ka-band precipitation radar mission launching in 2018

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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. The 6U CubeSat will begin assembly, integration, and test in April of 2017 for a planned delivery in September 2017. RainCube has been manifested to be deployed from the ISS as part of ELaNa-23 in the first half of 2018.

Two key technologies will be validated in the space environment, a miniaturized Ka-band precipitation profiling radar that occupies a 2.5U volume and a 0.5m Ka-band parabolic deployable antenna that stows in a 1.5U volume. RainCube will enable constellations of precipitation profiling radars and revolutionize climate science and weather forecasting. The same radar technology can also be used in other radar applications, such as radar altimetry. 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.

The radar payload will be built at JPL and delivered to Tyvak, which will provide the bus and be responsible for the mechanical and electrical integration and for mission operations. The integrated CubeSat will be launched and operated from LEO, and post-processing of the on-orbit data will be used to validate the functional operation and performance of the radar payload. The proposed mission will increase the technology readiness of the Ka-band radar architecture and antenna from an entry TRL 4-5 to an exit TRL 7 in a period of performance of about two years.

Radar instruments have often been regarded as unsuitable for small satellite platforms due to their traditionally large size, weight, and power (SWaP). A novel architecture compatible with the 6U class (or larger) has been developed at JPL. The key lies in the simplification and miniaturization of the radar subsystems. The RainCube 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 minimum detectable reflectivity factor better than +20 dBZ (CBE 11dBZ) at 250m range resolution. The footprint size (i.e., horizontal resolution) is determined by the antenna size. For a nominal orbital altitude of 400 km, the RainCube antenna produces approximately an 8.5 km footprint.

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. Thus, a new instrument architecture that is compatible with low-cost satellite platforms, such as CubeSats and SmallSats, will enable constellation missions and revolutionize climate science and weather forecasting.