KA-BAND HIGHLY CONSTRAINED DEPLOYABLE ANTENNA FOR RAINCUBE: ENGINEERING DEVELOPMENT AND PATTERN MEASUREMENTS

Yahya Rahmat-Samii[1*], Eva Peral[2], Richard Hodges[2] and Gregg Freebury[3]

1- ECE Department, University of California, Los Angeles, USA
2- Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109
3- Tendeg, Louisville, CO 80027
rahmat@ee.ucla.edu

Precipitation radars in Low-Earth-Orbit (LEO) provide vertically resolved profiles of rain and snow on a global scale. Nevertheless, observations available from LEO platforms are sparse in time, and cannot monitor the short time scale evolution of most atmospheric processes. CubeSats and SmallSats enable cost-effective deployments, where multiple copies of the same instrument achieve the goal for short time scale observations. As part of the RainCube (Radar in a CubeSat) initiative, we have demonstrated a Ka-band precipitation profiling radar instrument in a 10x10x20cm^3 volume, excluding the antenna. As a next step, our goal is to design, fabricate and test a 1.0m deployable mesh reflector antenna with a gain greater than 45dB at 35.75GHz and a stowed volume less than 2.5-3.0U (10x10x25cm^3). This provides a 5km radar footprint from 400km LEO orbit. A successful demonstration brings the complete radar instrument to TRL 5, paving the way for a flight demonstration of RainCube.

We have developed a novel offset mesh reflector system with a 1.0m aperture diameter to accomplish the RainCube mission objectives. Developing this reflector involved a detailed characterization, design, prototyping and measurement of many important system components. Other detailed characterization of the overall antenna system has been performed including: mesh surface effects, realistic surface profile of the reflector antenna, interaction with the CubeSat bus, etc. A detailed efficiency table was generated to budget losses from all aspects of the reflector antenna system design.

The reflector is a tensegrity design utilizing spiral wrapped ribs as the compression members and tensioned offset dual nets. The front net includes a reflective gold wire mesh. Cross ties from the back to front net provide the paraboloid shaping. The reflector achieves 100:1 compaction ratios and can be scaled to larger apertures. An engineering model has demonstrated packaging, deployment and surface repeatability through surface measurements using laser ranging.

The antenna has been measured at the JPL Mesa near field measurement facility and detailed comparisons have been made with the simulation results. Representative results will be shown and the overall antenna performance in terms of directivity, gain, patterns, etc. will be highlighted.