CubeSat Based Sensors for Global Weather Forecasting

Albin J. Gasiewski [(1)] , Brian T. Sanders [(2)] and David Gallaher [(3)]

(1) University of Colorado-Boulder, Department of Electrical Engineering, Boulder, Colorado, USA
(2) University of Colorado-Boulder, Colorado Space Grant Consortium, Boulder, Colorado, USA
(3) University of Colorado-Boulder, National Snow and Ice Data Center, Boulder, Colorado, USA

The positive impact of passive microwave observations of tropospheric temperature, water vapor, and surface variables on short term weather forecasts has been clearly demonstrated in recent error growth studies. However, current-era spaceborne passive microwave sensors remain singularly expensive and risky components of global weather forecast systems, while at the same time offer only limited temporal sampling capabilities. A fleet of small, low-cost satellite microwave sensors has the potential to provide reduced system cost and risk while simultaneously improving the time sampling of rapidly evolving weather.

In an effort to study the potential of such a fleet the University of Colorado is developing the first low-cost cubesat-based passive microwave sounder for demonstration as an element of a larger fleet of sounders for weather forecasting. The PolarCube satellite is an 8-channel 118-GHz temperature sounder providing ~15 km spatial resolution from an orbital altitude of ~350 km. It is based on a spin-scanned concept using the CU ALL STAR 3U cubesat bus with a two point calibration method using a warm load and cold space. The development of the radiometer payload and bus are led by student teams at CU using low cost components. A launch into a sun-synchronous orbit for evaluation of polar sounding and imaging capabilities is tentatively scheduled for late 2013.

The 3U to 6U cubesat envelope is well suited to passive microwave imaging at frequencies at approximately V-band and higher due to the available aperture size and anticipated orbital altitudes for cubesats. The use of redundant satellites within a fleet launched either in groups or as single payloads will moreover provide enhanced temporal resolution previously attainable using only geostationary concepts. While data communications to such fleets will likely require relay satellites at higher altitudes it is envisioned that the available orbital lifetimes without propellant boost will require fleet replenishment at rates modest enough for reduced operational system costs as well as facilitate regular technology infusion into sensing, navigation, data, and control electronics.

In this presentation the design characteristics of the PolarCube satellite will be discussed, along with the ramifications of the cubesat envelope restrictions on the cost, sampling characteristics, scanning capabilities, communications requirements, and expected measurement precision of a cubesat passive microwave fleet.