CubeSounder: A Low-SWaP-C Weather Cubesat for 3D Water Vapor and Temperature Sounding

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Abstract
CubeSounder is a weather cubesat employing a novel low-SWaP-C microwave sounding sensor, bringing this key capability to the cubesat platform for the first time. Data from legacy microwave sounding satellite sensors is the current leading driver of global weather forecast accuracy. Wider deployment enabled by cubesats offers a disruptive opportunity for improved forecast lead time and accuracy. In this talk, we present the conceptual design of the mission and payload, the measured performance of a prototype sensor in the lab, and simulations of the resulting temperature and humidity sensitivity in flight.

Mission Overview
Weather forecasting requires global 3D data on temperature and humidity with frequent revisit time. Current microwave sounding sensors deliver this data by measuring the pressure broadening of the oxygen lines at 60 GHz to reconstruct the temperature vs altitude below the satellite sensor. Measuring the 183 GHz water line traces the humidity, and cross-track scanning from a polar orbit delivers global 3D atmospheric coverage.

CubeSounder measures both lines with a higher channel count than the state-of-the-art ATMS sensor and similar sensitivity from a 6U cubesat bus developed by UNSW, similar to the successful Buccaneer mission currently on orbit.

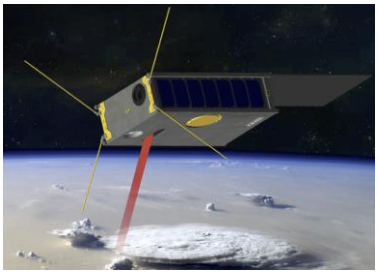

Fig. 1: CubeSounder observing a storm from orbit.

Sensor Technology and Performance
Replacing legacy sensors and expanding deployment to improve forecast accuracy naturally drives the mission towards the cubesat platform. Current sensors rely on high-SWaP-C LO/mixer/RF components unsuitable for cubesats. At ASU we developed a sensor that avoids these components by amplifying the broadband signal with an LNA then channelizing with a waveguide filter bank. Each frequency along the pressure broadened line is detected with a separate diode detector. We demonstrated a prototype sensor in the lab and it has excellent measured sensitivity.

Conclusions
The CubeSounder mission brings state-of-the-art atmospheric sounding capability to the cubesat platform for the first time. Our novel sensor technology performs well in the lab. The mission enables wider deployment of this technology to drive transformative improvements in global weather forecast accuracy and lead time.

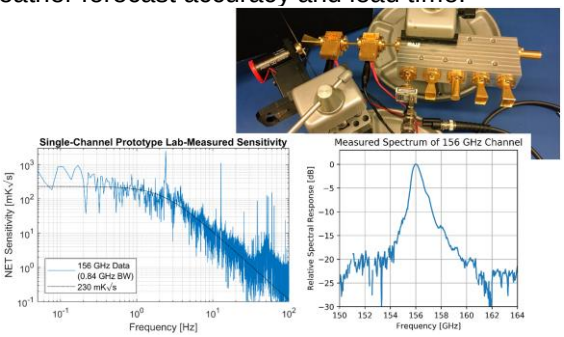

Fig. 2: Lab-measured sensitivity and passband of a 156 GHz prototype sensor channel

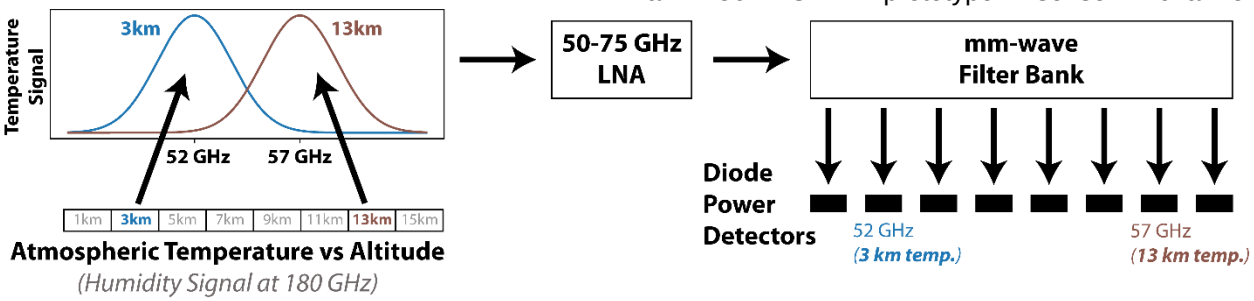

Fig. 3: Diode detectors at each filter output measure temperature/humidity signals from each altitude.