The RAVAN CubeSat Mission: On-orbit results

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The small imbalance between the incident solar irradiance and Earth-leaving fluxes of total and shortwave solar-reflected energy is vital to understanding and predicting climate change. Accurately quantifying the spatial and temporal variation of Earth's outgoing energy from space is a challenge—one potentially rendered more tractable with the advent of multipoint measurements from small satellite or hosted payload constellations. The Radiometer Assessment using Vertically Aligned Nanotubes (RAVAN) 3U CubeSat, launched November 11, 2016 and still operating over a year later, is a pathfinder for a constellation to measure the Earth's energy imbalance. Funded by NASA's Earth Science Technology Office, the objective of RAVAN is to establish that compact, broadband radiometers calibrated to high accuracy can be built and operated in space for low cost. We present a (brief) overview of the mission and on-orbit results demonstrating RAVAN's two key technologies. First, we show measurements of the solar irradiance and Earth's outgoing energy with radiometers that use vertically aligned carbon nanotube (VACNT) absorbers. VACNT forests are some of the blackest materials known and have an extremely flat spectral response over a wide wavelength range. The measurements are made at both shortwave, solar wavelengths and in the thermal infrared. Second, we show the performance of two gallium phase-change cells that are used to monitor the degradation of RAVAN's radiometer sensors. A 3-axis controlled CubeSat bus allows for routine solar and deep-space attitude maneuvers, which are essential for calibrating RAVAN's Earth radiation measurements. RAVAN also demonstrates partnering with a commercial vendor for the CubeSat bus, payload integration and test, and mission operations. This paradigm has allowed us to focus on technology development essential to the new Earth measurement.