Role of GPSRO Calibration in an Operational Capacity for MiRaTA

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The Microwave Radiometer Technology Acceleration (MiRaTA) Mission is a 3U CubeSat mission developed by MIT and MIT Lincoln Laboratory and supported by the NASA Earth Science Technology Office (ESTO). MiRaTA aims to increase the quality and temporal coverage of Earth atmospheric microwave sounding measurements while leveraging the low costs associated with the CubeSat form factor. Microwave radiometry is a significant contributor to weather and climate monitoring programs, but the typical sun-synchronous orbits of radiometers' host satellites limit revisit times. A low Earth orbiting constellation of CubeSats would enable global coverage with low revisit times. MiRaTA will perform multi-channel microwave radiometry over three frequency bands: 52-58 GHz (temperature), 175-191 GHz (water vapor), and 206-208 GHz (cloud ice). Another challenge for microwave radiometers on meteorological satellites is the difficulty in achieving reliable ground calibration of brightness temperature measurements, because internal calibration targets are subject to on-orbit variability that is difficult to model on the ground. Traditional internal calibration targets for microwave radiometers are bulky and not easily accommodated on CubeSats; noise diodes are currently used, and also experience drift and variability. To address the calibration challenge, MiRaTA hosts the Compact Total Electron Count (TEC) / Atmospheric GPS sensor (CTAGS), a GPS Radio Occultation (GPSRO) system developed by The Aerospace Corporation that uses a modified off-the-shelf GPS receiver and a custom patch antenna array. MiRaTA will use CTAGS to improve radiometer calibration with an internal noise diode by augmenting with co-located GPSRO measurements and thus referencing a traceable standard. The calibration technique consists of a quadratic regression on the GPSRO refractivity profile, which is used to obtain retrieved brightness temperatures to reference radiometer gain against. We will describe the as-built spacecraft, then discuss the calibration processes, the expected performance, and sensitivity to orbit determination and attitude knowledge as well as GPSRO penetration depths and SNR. The MiRaTA CubeSat has completed integration and environmental testing, and is awaiting launch as part of ELaNa XIV, currently scheduled in November 2017, with the Joint Polar Satellite System 1 (JPSS-1). We also will discuss updates on the data processing pipeline and operational plans.