Geophysical Research Abstracts
Vol. 13, EGU2011-5189, 2011
EGU General Assembly 2011


# Radio Occultation on CLARREO

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The Climate Absolute Radiance and Refractivity Observatory (CLARREO), a Tier 1 Decadal Survey mission of NASA, has entered Phase A and is scheduled for first launch in 2017. Its suite of detectors is a thermal infrared interferometer, a reflected shortwave spectrometer, and a GNSS radio occultation (RO) receiver. The defining property of CLARREO is that all of its instruments are traceable to international standards in a way that permits the empirical evaluation of uncertainty, and the final requirement on uncertainty must be that it is significantly less than internal variability of the climate. Sampling error must be considered as a source of uncertainty for each instrument, and in the case of the GNSS radio occultation instrument, it is the dominant contributor of uncertainty. GNSS RO contributes to climate monitoring by serving as a direct, truly global, and highly accurate proxy for global surface air temperature and by helping to resolve ambiguities in longwave feedbacks in the thermal infrared spectrum.

At this CLARREO requires that radio occultation be a climate benchmark between 5 and 20 km altitude with an eye toward extending the requirement down to 2 km. The traceable observable is phase delay rate, and its uncertainty requirement should correspond to 0.1% in refractivity at 20 km. With just one satellite, this requirement can only be met by tracking at least two GNSS constellations with fore and aft viewing occultation antennas. The orbit must be a precisely 90$^\circ$ polar orbit in order to circumvent biases induced by the diurnal cycle. Two 90$^\circ$ polar orbits separated 6 hours in local time is more preferable because it offers the possibility of empirical verification of suppression of the diurnal cycle in annual average climatologies. Single event upsets are shown to have minimal impact in biasing climatologies.