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Role of climate forcings and feedbacks in mission definition of CLARREO

Kurtis Thome (1), Bruce Wielicki (2), David Young (3), and Martin Mlynczak (4)

(1) NASA/GSFC, Greenbelt, United States (kurtis.thome@nasa.gov), (2) NASA/LaRC, Hampton, United States (b.a.wielicki@nasa.gov), (3) NASA/LaRC, Hampton, United States (david.f.young@nasa.gov), (4) NASA/LaRC, Hampton, United States (m.g.mlynczak@nasa.gov@nasa.gov)

The Climate Absolute Radiance and Refractivity Observatory (CLARREO) is a climate-focused mission designed to observe climate change in a rigorous fashion on decade time scales. The decadal change observations are the most critical method to determine the accuracy of climate change projections such as those used in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR4). The CLARREO mission accomplishes this critical objective through highly accurate observations that are sensitive to many of the key uncertainties in climate radiative forcings, responses, and feedbacks that in turn drive uncertainty in current climate model projections.

The presentation summarizes new methods used to determine the observing system requirements in terms of the accuracy of decadal change versus a perfect observing system limited only by natural variability. One approach described is climate model OSSEs (Observing System Simulation Experiments) that predict CLARREO's utility in testing climate models and understanding climate forcings, response, and feedbacks to anthropogenic change. These OSSEs include new ways to use infrared and reflected solar spectra as fingerprints of climate change, avoiding the uncertainties of traditional satellite retrievals.

The OSSE studies and theoretically-based statistical studies of climate systems lead to a requirement for CLARREO SI-traceable accuracy of 0.07 K (95% confidence or k=2 for metrology) for the infrared spectra, and 0.3% (k=2) for reflected solar spectra. Defining the CLARREO mission requirements in terms of accuracy of the entire observation system for decadal change trends permits a trade space in mission design between calibration, spectral fingerprint orbit sampling, instrument noise, and pointing capabilities for intercalibration sampling with other sensors in orbit. The requirements allow CLARREO to achieve decadal change accuracy within 20% of a perfect observing system, and time to detect trends within 15% of a perfect observing system.

Instrument approaches to meet the above accuracies require factors of 3 to 10 improvement in benchmark accuracy over current observations. The CLARREO observations will include a nadir viewing infrared interferometer covering the spectral region of 200 to 2000 1/cm, with 0.5 1/cm unapodized spectral resolution, and with an absolute accuracy on orbit of 0.07 K (k=2). They also include a nadir viewing reflected solar spectrometer covering the spectral region from 320 to 2300nm, with 4 nm spectral sampling, and accuracy in nadir reflectance of 0.3% (k=2). The solar spectrometer will be capable of pointing to the moon and sun for calibration, as well as tracking time/angle/space matched observations when used as a SI traceable transfer radiometer for Reference Intercalibration of other radiometers such as CERES or VIIRS. Finally, the observations include radio occultation receivers and antennas to allow use of both the GPS and Galileo Global Navigational Satellite Systems. The first launch is planned for 2018, with follow on instruments launched in 2020.