Introduction

The CLimate Absolute Radiance and Refractivity Observatory (CLARREO) mission is a new remote sensing mission begun by the National Aeronautics and Space Administration (NASA). The infrared component of the CLARREO mission utilizes advances in radiometric standards pioneered by the precision metrology community. These standards provide an on-orbit link to the International System of Units (SI), deemed necessary to accurately capture small secular trends associated with anthropogenic climate forcing. This paper investigates the quantification of type B uncertainties arising in the use of these traceable, on-orbit standards (blackbodies) for the quantification of CO2 measurements culled from a wide variety of investigators in a review paper by Slocum (1955).

Spectral IR Radiances for Climate

The infrared radiation exchanged within the Earth’s atmosphere, oceans, land surface, and cryosphere, and emitted back to space to balance the solar radiation absorbed by the system, controls the long-term climate of the Earth. For this reason, long-term, high accuracy, comprehensive observations of infrared radiation from space are essential to the success of climate research and the ensuing delivery of timely and relevant decision support.

Checking Uncertainty On-Orbit

These observations must possess the capability to provide on-orbit demonstration that the required level of measurement accuracy is met to a critical adjudicator. Practically, this capability is obtained via a nadir-observing infrared spectrometer in Earth orbit measuring absolute spectrally resolved radiance with high accuracy (0.1 K/3-sigma brightness temperature).

An SI Traceable Climate Index

Profiles of microwave refractivity obtained by radio occultation using the Global Navigation Satellite System (GNSS) provide a benchmark of climate that is on-orbit traceable to the international definition of the second.

Traceability to NMIs

Meeting the CLARREO traceability objective requires the development of satellite-borne infrared standards that are analogous to the measurement standards maintained by National Measurements Institutes (NMIs). The basis of modern measurement standards is the International System (SI). By deploying infrared remote sensors with measurement scales directly traceable to the SI, this observational goal may be met.

Conclusions

Experimental prototypes have been built for on-orbit temperature calibration and emissivity monitoring have been demonstrated. Direct measurement of blackbody performance on-orbit is an improvement over previous methods for remote sensing calibration which have relied on pre-launch data or to intercomparisons campaigns that only test system-level uncertainty. These blackbody diagnostics underpin the strategy for constraining type B uncertainties for the infrared component of the CLARREO mission. The resulting CLARREO measurements, with high-accuracy validation, will enable on-orbit, facilitate meeting the societal objective of improved long-term climate forecasts.