Inter-comparison Study of Terra and Aqua MODIS Reflective Solar Bands Using On-orbit Lunar Observations

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Abstract. Long-term Earth-observing, climate, and environmental data records are often built with measurements made by different sensors, including those designed at different time and possibly with different technologies. In order to produce high quality climate data records (CDR), all the sensors must be fully calibrated and characterized, pre-launch and on-orbit, with consistent traceability to the well-established national or international standards. Ideally each sensor's mission should be overlapped for a period of time by the sensors that proceed and follow its mission. Consequently the capability and quality of inter-comparison of measurements made by different sensors are of great importance. In this paper we present an approach that could be used by most Earth-observing sensors to track their long-term data (measurements) stability and to ensure the capability of inter-comparison with other sensors through their on-orbit lunar observations and its application to the Moderate Resolution Imaging Spectroradiometer (MODIS).

The MODIS) is one of the key instruments for the NASA's Earth Observing System (EOS). It is currently operated on-board the EOS Terra and Aqua spacecraft launched in December 1999 and May 2002 respectively [1,2]. Each MODIS instrument has 36 spectral bands. Bands 1-19 and 26 are the reflective solar bands (RSB) covering wavelengths from 0.41 to 2.2 micrometers and bands 20-25 and 27-36 are the thermal emissive bands (TEB) with wavelengths from 3.7 to 14.4 micrometers. It makes observations at three nadir spatial resolutions: 0.25km (bands 1-2), 0.5km (bands 3-7), and 1km (bands 8-36) over a wide field-of-view (FOV) range. The sensor's in-flight calibration and characterization are primarily provided by a set of the on-board calibrators that include a solar diffuser (SD) panel, a solar diffuser stability monitor (SDSM), a blackbody (BB) panel, and a spectro-radiometric calibration assembly (SRCA) [3-5].

For the MODIS reflective solar bands (RSB), the specified calibration uncertainty requirements are ±2% in reflectance and ±5% in radiance. The RSB on-orbit calibration is performed regularly using the solar diffuser (SD) and solar diffuser stability monitor (SDSM) system. In addition both Terra and Aqua MODIS have been making monthly lunar observations through the space view (SV) port. The initial objective of this operation was to track the sensor's RSB radiometric stability. For this purpose, the lunar observations by each sensor have been planned to be approximately of the same lunar phase angle via spacecraft roll maneuvers. Limiting the lunar phase angle range for the long-term stability trending significantly reduces the uncertainty in the corrections to the lunar viewing geometry difference [6,7]. In addition to the viewing geometry difference, other factors, such as the spectral response function difference (center wavelength and band width) and over sampling effect must be considered.

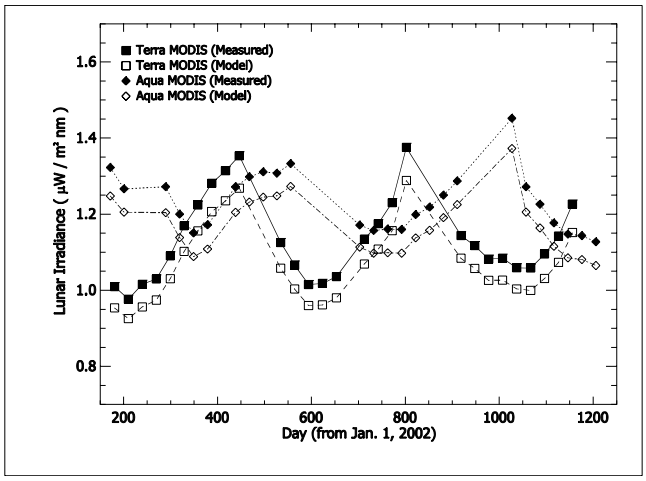

Figure 1. Measured lunar irradiance by Terra and Aqua MODIS band 3 (center wavelength of 0.47 micrometer) and corresponding modeling results under the same viewing geometry as the measurements.

This paper will focus on the methodologies developed for and the results derived from inter-comparison studies of Terra and Aqua MODIS reflective solar bands (RSB) calibration using their on-orbit lunar observations (over five years from Terra MODIS and three years form Aqua MODIS). Figure 1 shows the measured lunar irradiance by Terra and Aqua MODIS band 3 (center wavelength at 0.47 micrometer) using their lunar observations over the same period. It includes the modeling results computed under the same observation conditions. The sensor measured lunar irradiance by each spectral band or channel should be normalized to the modeling results before comparing with each other. The lunar observation results show that both Terra

and Aqua MODIS have been consistently calibrated to within 1.0% and that the overall long-term stability of each sensor is better than 0.3%. We have also applied this method to inter-compare with other sensors, such as the SeaWiFS and MISR.

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