P1.6 MODIS RADIANCES AND REFLECTANCES FOR EARTH SYSTEM SCIENCE STUDIES AND ENVIRONMENTAL APPLICATIONS

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1. Introduction

The Moderate Resolution Imaging Spectroradiometer (MODIS), a major component of NASA's Earth Observing System (EOS), was designed to provide improved long-term global observations of land, ocean and atmosphere features relative to "heritage sensors". MODIS was launched aboard the Terra satellite on December 18, 1999 (10:30 am equator crossing time, descending node, Sun-synchronous near polar orbit). MODIS with its 2330 km viewing swath width provides almost daily global coverage. It acquires data in 36 high spectral resolution bands between 0.415 and 14.235 microns with spatial resolutions of 250 m (2 bands), 500 m (5 bands), and 1000 m (29 bands). This year a similar instrument will be flown on the EOS-Aqua satellite (1:30 pm equator crossing time, ascending node). This will enable studies of the diurnal variation of rapidly varying systems. The radiance data measured by MODIS with some new channels (never used before for remote sensing from space) provides improved information about the physical structure of the Earth system. Measured raw sensor counts, radiometrically calibrated and geolocated radiances along with derived atmosphere and ocean data are archived (Ahmad et al. 2002) at the NASA Goddard Earth Sciences (GES) Distributed Active Archive Center (DAAC). These products and other MODIS derived products archived at other NASA centers are made freely available to the public and scientific community.

The purpose of this presentation is to provide key characteristics of the MODIS radiance and reflectance products (referred to as the Level 1B product) with some examples of applications of the MODIS radiances in detecting human impacts on the earth and its climate and how this data is used in improving the predictions and characterization of natural disasters such as wild fires, volcanoes, floods and drought.

2. MODIS Instrument

MODIS, a cross-track scanning radiometer, provides high spectral resolution data from 36 bands with center wavelengths ranging from 0.412 to 14.235 microns (Barnes et al. 1998). MODIS spectral band passes are shown in Table 1. MODIS carries 490 detectors that are aligned in parallel rows on four separate focal planes (Visible, NIR, SWIR/MWIR, and LWIR).

The number of detectors per band are 10 for 1000 m, 20 for 500 m, and 40 for 250 m spatial resolution bands. In addition, 2 of the 1000 m spatial resolution bands provide measurements for the same scenes at two gains, 13 L and 14L at low gains for measuring bright scenes and 13H and 14H at high gains for measuring dark ocean scenes.

The instrument's 110 degree field of view is swept over the focal planes by the double sided rotating scan mirror. Each mirror rotation provides two scans (one for each mirror side). The scan period is 1.477 sec. During each scan, 5 view sectors (solar diffuser, spectral radiometric calibration assembly, blackbody, space, and earth view) are observed. The 110 degree-wide instrument field of view sweeps out a ground swath approximately 2330 km wide during the 0.451 seconds of earth view. The ground swath (± 55 deg viewing angles relative to nadir) exhibits significant earth curvature effects. The 55 degree scan angle increases to approximately 65 degree due to earth curvature. In addition, ground resolution increases with scan angle.

7. Summary

The strengths of MODIS include its global coverage, high radiometric resolution, appropriate dynamic ranges, and accurate calibration in reflective and thermal infrared bands designed for retrievals of atmospheric, land and sea surface properties. Almost 40 higher level science standard products are being produced from MODIS Level 1B radiance data. Even though data validation activities are still in progress, the provisional radiometrically calibrated radiances and reflectances, and derived products (version-3) show very fine details and exceed the expectations when compared to in-situ observations. Almost one year of consistent data processed with an improved calibration algorithm (version-3), will soon be made available to the public and science user community. These high radiometric accuracy measurements can be used by the scientific community to detect subtle signatures of climate change, study regional and global phenomena, and for prediction and characterization of natural disasters such as wild fires, volcanoes, floods and drought. MODIS radiance counts, calibrated radiance and reflectance, geolocation products, and all derived geophysical atmospheric & ocean products are archived at the Goddard DAAC (http://daac.gsfc.nasa.gov). All land products are archived at Earth Resource Observation System (EROS) Data Center (EDC), and snow & ice products are archived at the National Snow and Ice Data Center (NSIDC). MODIS products, ancillary and related data, documents, and data analysis and visualization tools are freely made available to the public and science user community from these data archive centers via NASA EOS Data Gateway (EDG) at http://eos.nasa.gov/imswelcome.

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