Analysis of calibration differences between MODIS and MISR

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ABSTRACT

MODIS and MISR are two Earth Observing System instruments flown onboard Terra satellite. Their synergistic use could greatly benefit the broad user community by ensuring the global view of the Earth with high-quality products. A necessary condition for data fusion is radiometric calibration agreement between the two instruments. Earlier studies showed about 3% absolute radiometric difference between MISR and respective MODIS land bands in the visible and near-IR spectrum, which are also used in aerosol and cloud research. This study found a systematic bias of +(0.01-0.03) between two surface albedo products derived from MODIS and MISR L1B data using the AERONET-based Surface Reflectance Validation Network (ASRVN). The primary cause of the bias is inconsistencies in the cross-sensor calibration. To characterize MODIS-MISR calibration difference, top-of-atmosphere MODIS and MISR reflectances were regressed against each other over liquid water clouds. The empirical regression results have been adjusted for the differences in the respective MISR and MODIS spectral responses using radiative transfer simulations. The MISR-MODIS band gain differences estimated with this technique are +6.0% in the blue, +3.3% in the green, +2.7% in the red, and +0.8% in the NIR band. About 2.1%-3.6% of the difference in the blue band is due to the difference in the MODIS-MISR solar irradiance models.

Keywords: MODIS, MISR, cross-calibration, cloud reflectance, spectral correction

1. INTRODUCTION

MODIS and MISR are two major Earth Observing System (EOS) [1] instruments flown onboard of TERRA satellite, and used to produce global information about aerosol, cloud and land surface parameters. An optimal synergy of MODIS-MISR products could greatly benefit the broad user community.

At present, the MODIS and MISR absolute radiometric scales are known to differ by about 3% over most of the visible spectrum [2-4]. This difference propagates into the higher level land, ocean and atmospheric products, impeding the data fusion applications and science data analysis. We found this difference in the surface albedo derived by the AERONET-based Surface Reflectance Validation Network (ASRVN). The ASRVN [*in preparation*] is an operational processing system that receives MODIS and MISR calibrated reflectance (L1B) data around 160 AERosol RObotic NETwork (AERONET) [5] sites globally, and uses AERONET well-calibrated aerosol and water vapor data to independently and self-consistently derive surface bi-directional reflectance factor (BRF) and albedo. The ASRVN retrievals show a systematic positive MISR-MODIS albedo bias of +(0.01-0.03). Because spectral band differences are accounted for through the radiative transfer, the most likely explanation for the bias is a calibration inconsistency between the sensors.

The two instruments employ different calibration strategies, and known radiometric differences of about 3% are within the uncertainties of the respective calibration methods. A brief overview of the MODIS and MISR calibration procedures and associated accuracies is given in Section 2.

To independently assess the MISR-MODIS calibration differences, we regressed MISR-MODIS TOA reflectances over liquid water clouds, with a theoretical correction for the sensors spectral differences. The methodology and results of the

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regression analysis are described in section 3. This section also investigates the effect of different solar irradiance models used in MODIS and MISR calibration that can explain about a half of the observed band gain difference in the blue band. Section 4 summarizes and concludes this study.

4. CONCLUSIONS

This work started with the observation of the systematic biases between the surface albedo and BRF retrieved by ASRVN from MODIS and MISR data near AERONET sites, which is most likely explained by calibration inconsistencies between the two sensors. Using TOA regression method over clouds with spectral adjustment, the following cross-sensor calibration biases were found: 6.0% in the Blue (of which about half is due to the difference in the solar irradiance model), 3.3% in the Green, 2.7% in the Red, and 0.8% in the NIR bands. These discrepancies are generally within the calibration uncertainties of the two instruments, 2-4% for MISR absolute radiance, and 2% for MODIS reflectance. However, they may lead to observable systematic differences in the geophysical parameters affecting multi-instrument data analysis and data fusion approaches. For example, the derived band gain difference is spectrally-dependent, increasing from NIR to Blue band. This can be important e.g. for the aerosol particle size and mixture composition retrievals as it affects spectral slope of aerosol optical thickness (e.g. [31]). Furthermore, the systematic difference in surface albedo of 0.01-0.03 in the visible part of spectrum may bias retrievals of vegetation parameters, important for global carbon analysis.