THE USE OF THE SONORAN DESERT AS A PSEUDO-INVARIANT SITE FOR OPTICAL SENSOR CROSS-CALIBRATION AND LONG-TERM STABILITY MONITORING

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1. INTRODUCTION

The Sonoran desert is a large flat pseudo-invariant site near the United States-Mexico border. It is one of the largest and hottest deserts in North America, with an area of 311,000 square km. This site is particularly suitable for calibration purposes because of its high spatial and spectral uniformity and good temporal stability [1]. This study uses measurements from four different sensors—Terra Moderate Resolution Imaging Spectroradiometer (MODIS), Landsat 7 (L7) Enhanced Thematic Mapper Plus (ETM+), Aqua MODIS, and Landsat 5 (L5) Thematic Mapper (TM)—to assess the suitability of this site for long-term stability monitoring and to evaluate the biases between similar sensors [2], [3], [4]. Observations from MODIS and Landsat sensors have made significant and long-term contributions to studies of land surface properties.

2. METHODOLOGY AND RESULTS

Near-nadir images acquired over the Sonoran desert site from these four sensors between January 1999 and March 2009 were used in the analysis. Figure 1 shows an example of Terra MODIS acquisition over this site. Top-of-Atmosphere (TOA) reflectances were computed for the closely matching visible and near-infrared (VIS/NIR) spectral bands of all four sensors. A common region of interest (ROI) was selected for all four sensors and their TOA reflectances were calculated. The temporal trending results are shown in Figure

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2. In general, the drift in the TOA reflectance of each sensor, over a span of nine years, is within the calibration uncertainties [2]. Monthly precipitation measurements of the Sonoran desert region were obtained from the Global Historical Climatology Network (GHCN) [5], and their impacts on the retrieved TOA reflectances were evaluated. To monitor the stability of the spectral signature from the Sonoran desert site, multiple Earth Observing-1 (EO-1) Hyperion granules over the Sonoran desert were chosen to provide a TOA estimate of the spectral signature of the ground target.

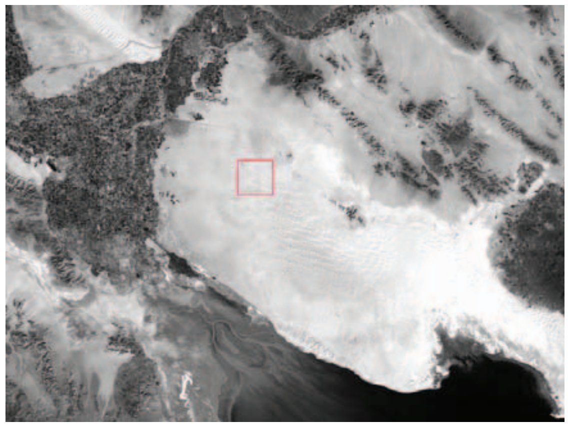

Fig 1. Sonoran desert image from Terra MODIS acquired on January 13, 2009. The rectangular box shows the region of interest (ROI) used for the analysis.

Because of varying overpass times of these sensors, the directional observations are both a function of solar and sensor illumination and view geometry. To account for the combined uncertainties in the TOA reflectance due to the surface and atmospheric Bi-directional Reflectance Distribution Function (BRDF), a semi-empirical BRDF model has been adopted to monitor and reduce the impact of illumination geometry differences on the retrieved TOA reflectances [6]. Since Terra and Aqua MODIS have very closely matched spectral response functions, the TOA reflectances after BRDF normalization should approximately yield the calibration differences between the two sensors. A similar strategy has been applied for ETM+ and TM, where the calibration differences were evaluated after BRDF normalization. However, to evaluate calibration differences between the MODIS and Landsat sensors, correction for spectral response differences using a hyperspectral sensor is necessary [7]. Since a very limited number of Hyperion scenes over the Sonoran desert are available, obtaining an accurate estimate of the spectral response differences is challenging. In addition to calibration stability of individual sensors, details on calibration inter-comparison among these sensors, including spatial and spectral corrections, will be discussed in this paper.

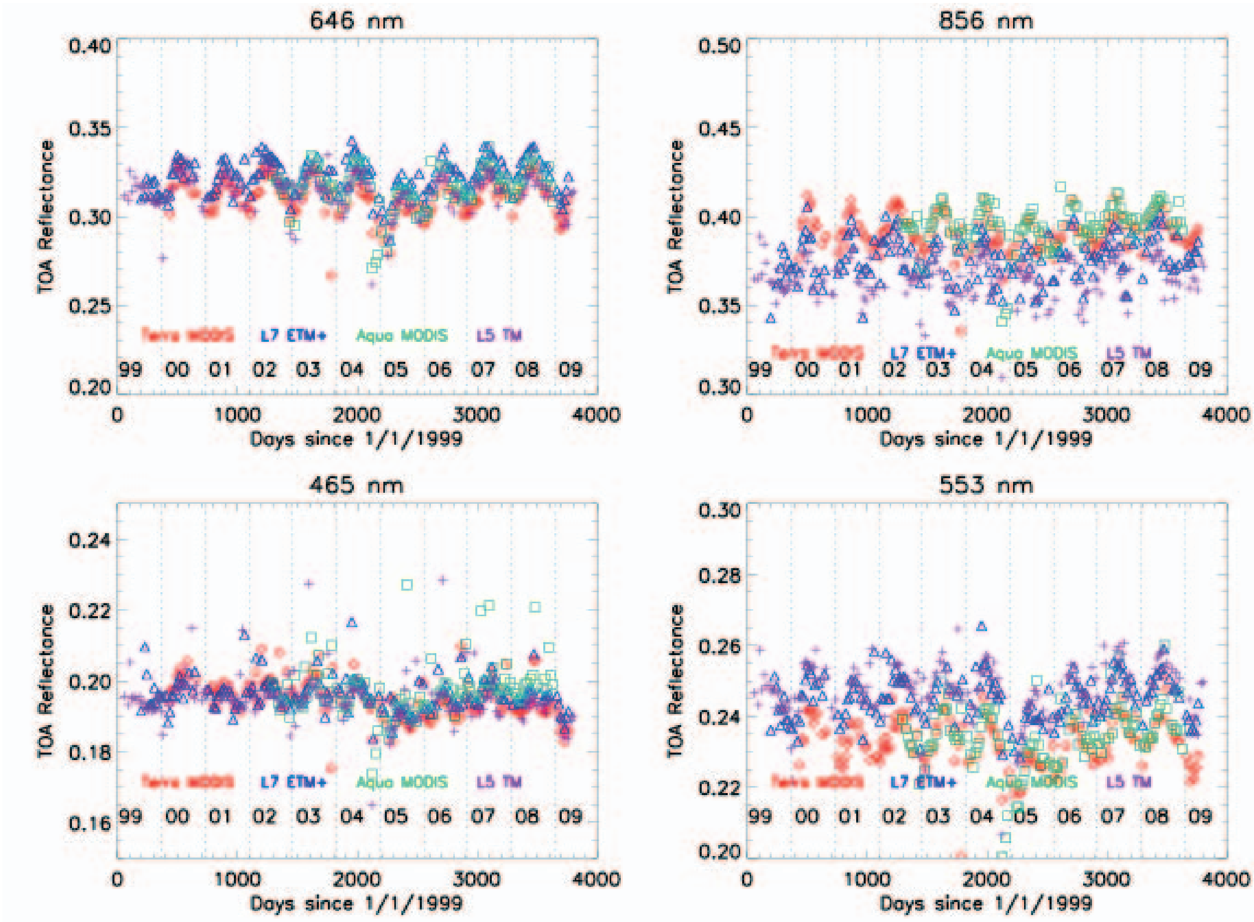

Fig 2. TOA reflectance trending over the Sonoran desert target.

3. REFERENCES

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