# Summary of the Final Report of Research Results

**1) Title of proposed research**

Evaluation and validation of GOSAT CAI vegetation index products using MODIS, AVHRR, and in situ data over the conterminous United States and Hawaii

**2) Principal Investigator (PI)) and Co-Investigators (Co-Is)**

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**3) PI's affiliation**

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**4) Summary of the Final Report of Research Results**

The proposed project was aimed at characterizing the overall behavior of the CAI NDVI product. We conducted two activities to accomplish the goal. First, we performed a spectral compatibility analysis using airborne and satellite hyperspectral data with the objective of developing reference relationships of CAI reflectance and vegetation indices (VIs) with those from other sensors. The airborne hyperspectral data were obtained with an Analytical Spectral Devices (ASD) FieldSpec Pro FR spectrometer in Brazil, whereas the satellite data consisted of Earth Observing-One (EO-1) Hyperion hyperspectral images acquired across the conterminous United States. The airborne data were calibrated into surface reflectance using the method described in Miura and Huete (2009), whereas the Hyperion images were processed into spectrally-convolved surface reflectance and VIs using the procedure described in Miura and Yoshioka (2011).

Second, we cross-compared actual CAI reflectance and VI products to those of Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the Aqua satellite platform, which had the two objectives of characterizing CAI reflectance and VIs in comparison with MODIS, and developing an in-house CAI product generation protocol (e.g., the atmospheric correction of the 380 nm band). CAI L1B and Aqua MODIS daily surface reflectance products were obtained over nine AERONET sites in the conterminous United States. CAI L1B data were atmospherically corrected with the 6SV (1.1) radiative transfer code constrained with in situ AERONET atmospheric optical depth measurements and processed into VIs.

Four VIs were considered in both studies: the NDVI, the enhanced vegetation index (EVI), the 2-band enhanced vegetation index without a blue band (EVI2), and the land surface water index (LSWI).

The hyperspectral data analysis showed very good compatibility of CAI and MODIS reflectances for the red, near-infrared (NIR), and shortwave-infrared (SWIR) bands. The CAI 380nm band was compared to the MODIS blue band and, thus, their band reflectances were subject to systematic differences where the CAI reflectance was consistently lower than the MODIS counterpart. The CAI VIs and MODIS VIs correlated well, but subject to systematic differences ranging between +/- 0.06 VI units. These hyperspectral data analysis results were used as a reference when comparing actual CAI data against actual MODIS data in the second study.

Reflectances from actual CAI and MODIS data correlated well, but subject to larger systematic differences than those observed in the first study (Fig. 1). This was due primarily to the bidirectional reflectance distribution function (BRDF) effects, where the view zenith angles of CAI and MODIS observations differed. While also subject to systematic differences, VIs from CAI and MODIS showed good compatibility (Fig. 2).

In summary, CAI reflectance and VIs had good "spectral" compatibility with those of MODIS. Sun-target-view zenith angle differences need to be accounted for or normalized using a BRDF model when analyzing CAI VI time series or combined CAI and MODIS VI time series. The LSWI was the best compatible index between CAI and MODIS, followed by the NDVI.

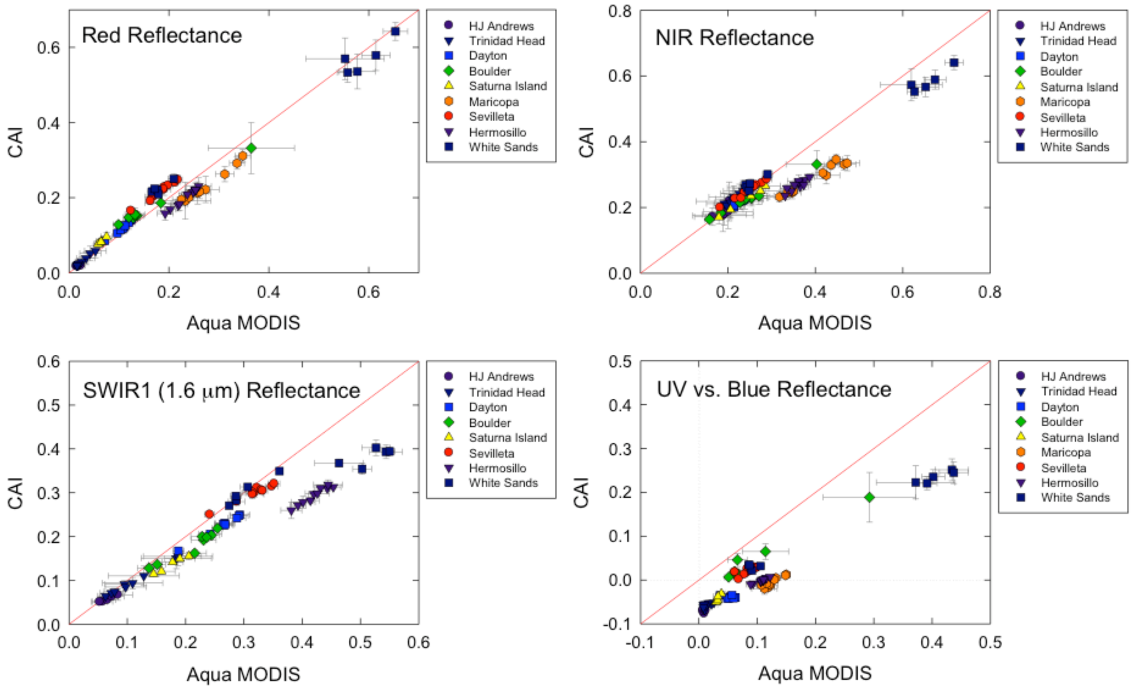


**Fig. 1.** CAI vs. Aqua MODIS reflectance crossplots.

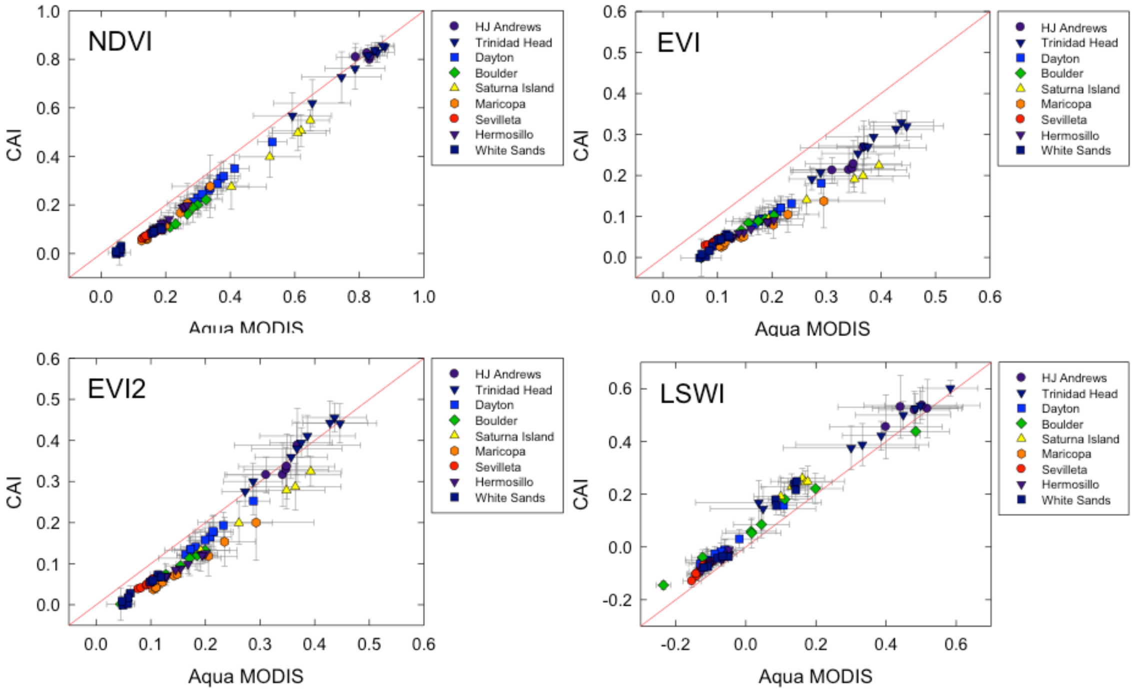


**Fig. 2**. CAI vs. Aqua MODIS VI crossplots.

**References**

Miura, T., and Huete, A. R. (2009) Performance of three reflectance calibration methods for airborne hyperspectral spectrometer data. *Sensors* **9**, 794-813.

Miura, T., and Yoshioka, H. (2011) Hyperspectral data in long-term, cross-sensor continuity studies. In *Hyperspectral data in long-term, cross-sensor continuity studies*. eds. Thenkabail, P. S., Lyon, J. G., and Huete, A. pp. 611-633. Taylor and Francis.

**5) List of publications relating to the proposed research**

Miura, T., & Yoshioka, H. (2011). Hyperspectral data in long-term, cross-sensor continuity studies. In P. S. Thenkabail, J. G. Lyon, & A. Huete (Eds.), *Hyperspectral Remote Sensing of Vegetation* (pp. 611-633). Taylor and Francis.