Assessment of Cross-sensor Vegetation Index Compatibility between VIIRS and MODIS Using Near-coincident Observations

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Comparison of MODIS and VIIRS

**Spectral Bandpass**

*Disparate blue bands*

**Spatial Resolution**

*MODIS:* 250 m & 500 m @ nadir
0.5 km-by-1.2 km & 1 km-by-2.4 km @ edge-of-scan

*VIIRS:* 375 m & 750 m @ nadir
800 m-by-800 m & 1.6 km-by-1.6 km @ edge-of-scan

**Algorithm Performance**

*Cloud masks*

*Atmospheric correction*

**VI Products**

*MODIS:* Gridded, 16-day or monthly composites (CV-MVC)

*VIIRS:* Granule, daily
Objective

- To characterize radiometric compatibility of VIs between MODIS and VIIRS using 2015 global data
  - Used observation pairs along overlapped orbital tracks
  - Evaluated cross-sensor VI differences across dynamic range, seasons, and view zenith angles
Data & Processing

- Suomi NPP VIIRS (IDPS) and Aqua MODIS (Collection 6)
  - Year 2015 @ monthly (32 days) intervals
  - 4 km grid spatially-aggregated
  - High quality pixels adopted by the JPSS program (no cloud, low aerosol loading, & solar zenith < 65°)
- Subsamples from overlapped orbital tracks
  - 0° – 7.5°, 20° – 27.5°, 40° – 47.5°, 55° – 62.5° (backward & forward)
  - ~2,000 observation pairs randomly selected for each sun/view geometry per month
- Four VIs analyzed
  - “Top-of-Atmosphere (TOA)” NDVI, “Top-of-Canopy (TOC)” NDVI, TOC EVI, & TOC EVI2
S-NPP & Aqua Orbital Tracks

- Ground tracks overlap on 3 days over a 8-day period

DOY: 250, View zenith: (0-7.5), Blue: Rel. Az. is 0-90, Red: Rel. Az. is 90-180.
Spatial Distribution of Near-Coincident Observation Pairs
Difference (VIIRS minus MODIS) Over Dynamic Range: TOA NDVI vs. TOC EVI

VZA: 0°-7.5°, August 2015

TOA NDVI

TOC EVI

MD: 1.9% (.014)
SD: 1.8% (.013)

MD: 2.2% (.017)
SD: 1.5% (.012)
Difference (VIIRS minus MODIS) Over Dynamic Range: TOA NDVI vs. TOC EVI

VZA: 55°-62.5° (backward), August 2015
Difference (VIIRS minus MODIS)
Across Seasons: TOA NDVI vs. TOC EVI

0° – 7.5° (Backward)

40° – 47.5° (Backward)

40° – 47.5° (Forward)

40° – 47.5° (Forward)
Difference (VIIRS minus MODIS) Across View Angles: TOA NDVI vs. TOC EVI

August 2015
Band Decomposition Analysis

- Employed an error propagation equation to investigate the mechanism by which each band contribute to overall VI differences

\[
\Delta VI \approx \frac{\partial VI}{\partial \rho_{\text{red}}} \cdot \Delta \rho_{\text{red}} + \frac{\partial VI}{\partial \rho_{\text{NIR}}} \cdot \Delta \rho_{\text{NIR}} + \frac{\partial VI}{\partial \rho_{\text{blue}}} \cdot \Delta \rho_{\text{blue}}
\]

- Red Band Component
- NIR Band Component
- Blue Band Component
Band Decomposition Analysis: TOA NDVI vs. TOC EVI

TOA NDVI

TOC EVI
Summary & Discussions

- Overall, VIIRS and MODIS VI differences were small (1.3% - 2.5% of its dynamic range)
  - Fairly constant across dynamic range and seasons
- However, TOC EVI and TOC EVI2 differences showed view zenith angle dependencies
  - Their differences larger for larger view zenith angles
- Observation geometries, including platform orbital differences, should be taken into account for a combined use of MODIS and VIIRS VI products
  - Nadir BRDF-adjusted reflectance

### VIIRS vs. MODIS VI Difference Summary

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<thead>
<tr>
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<th>MD</th>
<th>RMSD</th>
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<tbody>
<tr>
<td>TOA NDVI</td>
<td>0.013 (1.7%)</td>
<td>0.018 (2.4%)</td>
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<tr>
<td>TOC NDVI</td>
<td>0.012 (1.4%)</td>
<td>0.021 (2.4%)</td>
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<tr>
<td>TOC EVI</td>
<td>0.020 (2.5%)</td>
<td>0.023 (2.9%)</td>
</tr>
<tr>
<td>TOC EVI2</td>
<td>0.010 (1.3%)</td>
<td>0.016 (2.0%)</td>
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