Suomi NPP VIIRS Reflective Solar Band On-orbit Radiometric Performance Assessment

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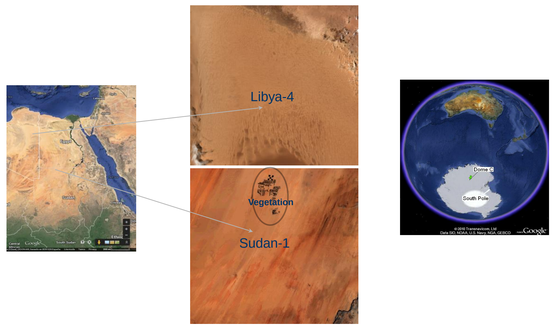
Introduction

- The radiometric stability and accuracy of VIIRS is critical to make its data useful for weather and climate applications.
- VIIRS on-orbit radiometric performance is regularly monitored and analyzed using well established calibration sites (such as Libya-4, Sudan-1, Dome C calibration sites) and through the inter-comparison with other satellite instruments such as AQUA MODIS and Landsat 8 OLI.
- The radiometric stability of VIIRS moderate resolution reflective solar bands analyzed using desert sites are better than 1% for most of the bands with uncertainty less than1%.
- Radiometric bias estimated through VIIRS and MODIS inter-comparison using TOA reflectance time series over desert is within 2% for bands M1-5 and M10. Similarly, VIIRS and OLI intercalibration suggested about 5.4% bias for VIIRS band M11.
- In addition, VIIRS Radiometric performance is analyzed through SNOx based intercomparison with MODIS over low latitude North African desert sites and ocean.
- VIIRS bias time series estimated from early 2012 to the early 2015 indicates a number of major calibration updates, anomalies and gain change over time.
- Bias time series for bands M1-4 suggest a very good correlation with the F factors.

Methodology

1. Sensors and data sets used:
   a) SNPP VIIRS Moderate channels (M1 to M11 with spatial resolution ~750 m)
   b) AQUA MODIS (1 km L1B data)
   c) Landsat-8 OLI (30m L1GST data)
   c) EO-1 Hyperion (30 m) and NASA AVIRIS (~10 m)
2. Calibration Sites:



Libya-4 and Sudan-1 Deserts

- Libya-4 (28.55, 23.39) is a CEOS endorsed cal/val site.
- Both Libya-4 and Sudan-1 are Saharan desert sites used mostly for on-orbit cal/val of VNIR radiometers.
- Sudan-1 (21.74, 28.22) is used by NOAA series AVHRR for post-launch relative calibration.

Antractica Dome C

- Dome C (-75.102°, 123.395°) is endorsed by the Committee on Earth Observation Satellites (CEOS).
- Large homogenous snow field in Antarctica at an altitude of 3.2 km
- high altitude; high reflectance; > 75% of cloud-free time; low water vapor content; very cold and dry climate; low aerosol and dust etc.
- Limitations: accessibility, availability of data only during austral summer, high BRDF, not visible by GOES/GOES-R instruments etc.

Collect L1B Data of VIIRS and AQUA MODIS over Libya-4, Sudan-1 and Dome C
http://www.nsof.class.noaa.gov/
http://ladsweb.nascom.nasa.gov/

↓ Extract TOA Reflectance

↓ Extract ROI (30*30 km) and calculate Mean and Stdev of pixels within ROI

↓ Derive reflectance time series and analyze Radiometric Stability and Bias

Figure 1. VIIRS radiometric performance over Lobya-4, Sudan-1 and Dome C

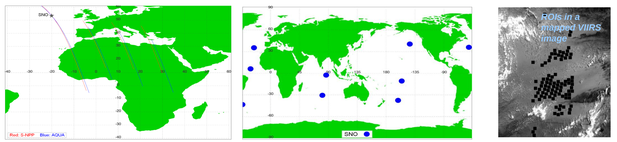


Figure 2. Extended SNOs based intercomparison

Results

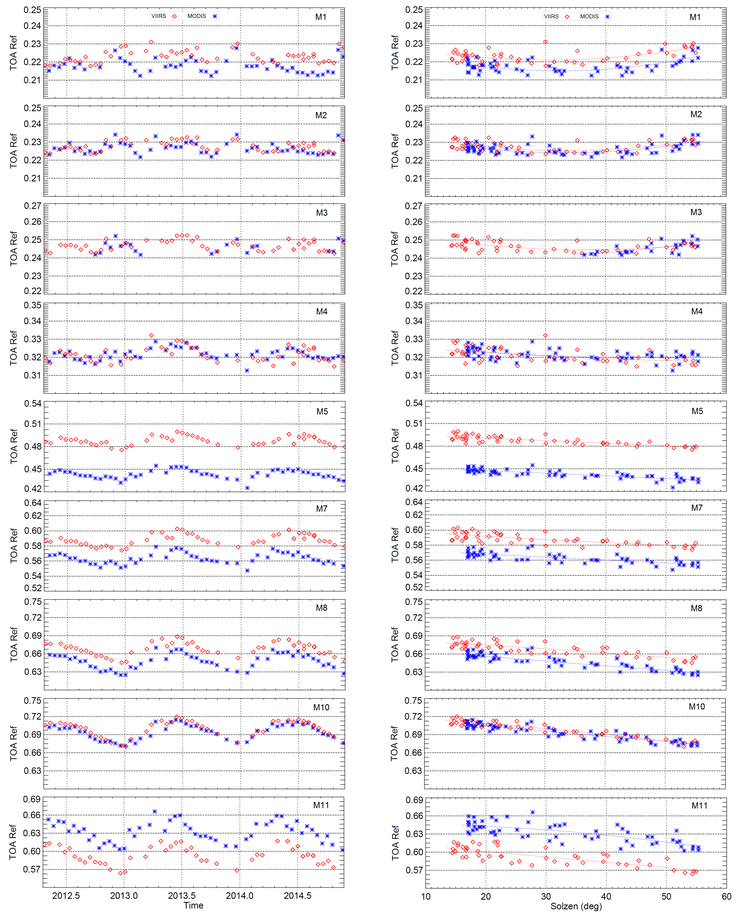


Figure 3. VIIRS and MODIS TOA reflectance over Libya-4 as a function of a) Time b) Solar Zenith Angle

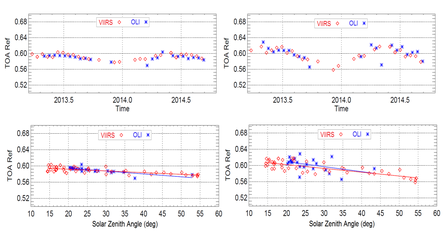


Figure 4 VIIRS and OLI comparison over Libya-4 desert

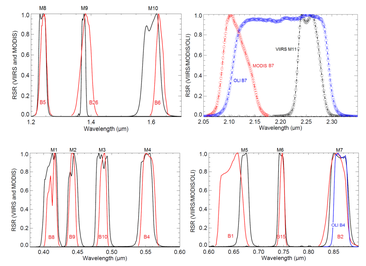


Figure 5. VIIRS, MODIS and OLI matching bands.

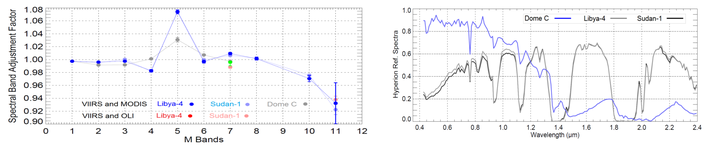


Figure 6. Left: SBAF computed for VIIRS relative to MODIS and OLI Right: Spectral reflectance of Libya-4, Sudan-1 and Dome C using Hyperion

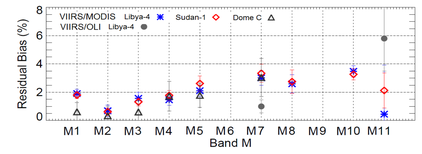


Figure 7. VIIRS bias over desert estimated using TOA reflectance trending, Bias=(V-M)×100%/M (after accounting RSR differences between the matching VIIRS and MODIS bands by using EO-1 Hyperion)

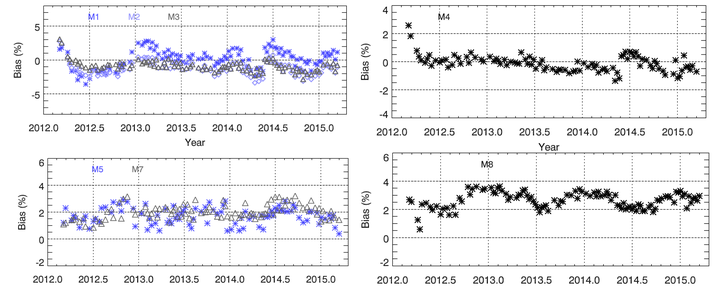


Figure 8. VIIRS bias over desert estimated using SNO-x, Bias=(V-M)×100%/M

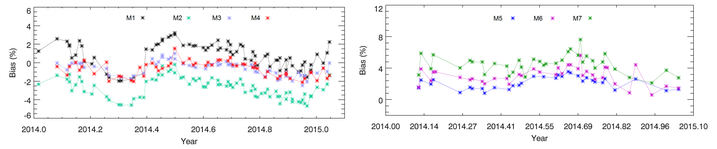


Figure 9. VIIRS bias over ocean estimated using SNO-x.

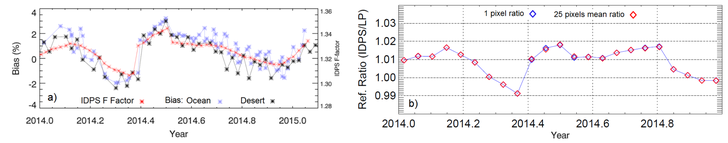


Figure 10. a) IDPS F factors along with VIIRS bias trends over ocean and desert b): Reflectance ratio of M1 SDR data from IDPS and LandPeate

Summary

- VIIRS calibration stability and radiometric accuracy computed at Libya-4 and Sudan-1 sites agree very well with each other and with Dome C to within 1%.
- VIIRS moderate resolution reflective solar bands analyzed are temporally stable with radiometric stability within 1% for most of the bands except bands M7 and M11 with nearly 1.5%.
- VIIRS radiometric bias (analyzed after accounting for spectral differences) relative to MODIS at three sites agrees to within 1%. VIIRS and MODIS agree to within 2% ± 1% for bands M1 through M5 while M7 and M8 suggest larger bias of nearly 3%.
- VIIRS and OLI inter-comparison over Libya-4 for NIR band M7 suggest 0.9% bias and SWIR band M11 indicates larger inconsistency with more than 5% bias.
- VIIRS Radiometric performance is also analyzed through SNOx based intercomparison with MODIS over low latitude North African desert sites and ocean.
- VIIRS bias time series estimated from early 2012 to the early 2015 indicates a number of major calibration updates, anomalies and gain change over time.
- VIIRS bias relative to MODIS analyzed for bands M1-8 is mostly within 2% ± 1% however the short term bias are sometimes larger by as much as 3.5%.

References:

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[2] Cao, C., F. Deluccia, X. Xiong, R. Wolfe, and F. Weng: Early on orbit performance of VIIRS, submitted to TGRS, (2013).

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[4] Uprety, S., C. Cao, X. Xiong, S. Blonski, A. Wu, and X. Shao, "Radiometric Inter-comparison between Suomi NPP VIIRS and Aqua MODIS Reflective Solar Bands using Simultaneous Nadir Overpass in the Low Latitudes," Journal of Atmospheric and Oceanic Technology (2013).

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