MODIS-VIIRS reflectance comparisons on the Atmosphere SIPS

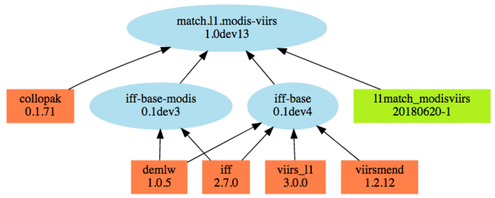
Greg Quinn, Kerry Meyer*, Andrew Sayer*, Robert Holz, Frederick Nagle, Paolo Veglio, Alexa Ross
Space Science and Engineering Center, University of Wisconsin - Madison
*Goddard Space Flight Center, NASA

Motivation

A continuous atmospheric climate record from multiple satellite instruments requires understanding relative calibration performance among sensors.

NASA's Atmosphere SIPS supports characterization of reflective solar band calibration by producing a joint MODIS (Aqua) and VIIRS (Suomi NPP, NOAA 20) dataset containing collocated and view-aligned observations.

Bias corrections derived by science team members using the collocated reflectance values have been incorporated into VIIRS level 2 algorithms for cloud mask, cloud properties, and aerosol properties (Deep Blue).



SIPS version specification (used for provenance and reproducibility) of a recent match-file processing run for both Suomi NPP and NOAA 20

Atmosphere SIPS: Creates collocated and view-aligned "matchfiles"

Each matchfile contains:

- Level 1 data from both sensors, including both reflective solar and thermal emissive bands.
- MODIS level 2 products selected by science team; currently includes MYD35 cloud mask and MYD06 cloud height and optical properties
- Geolocation data (earth location, sensor and solar angles, scattering angle)
- Along- and across-track collocation indexes, which enable use with additional pixel-level MODIS and VIIRS datasets

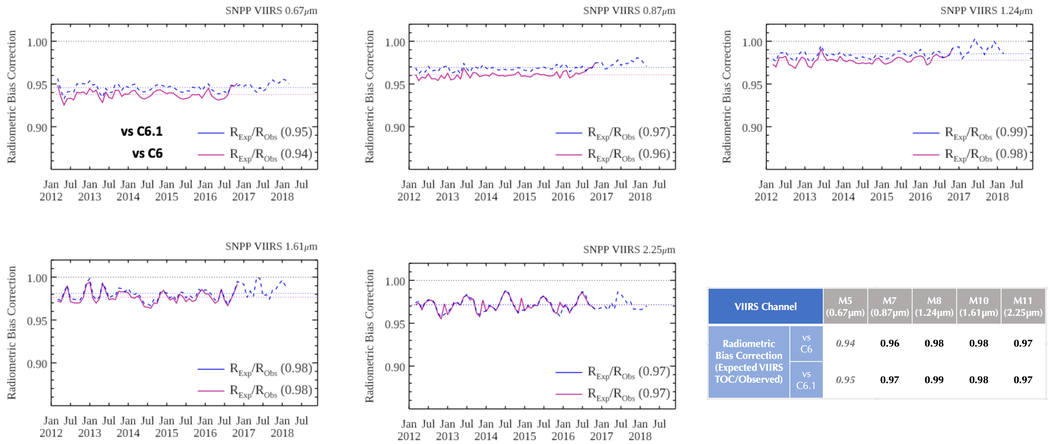
Processing workflow

1. A job is created and sent to the SIPS processing cluster for every pair of overlapping MODIS/VIIRS granules with coincident data observed less than 10 minutes apart. Granule combinations are calculated using the **overtake** utility from SSEC's suite of orbital navigation tools: https://sips.ssec.wisc.edu/orbnav/ (OrbNav)
2. Pixel-level collocation is performed using the **mvcolloc** program from SSEC's collocation toolkit: https://www.ssec.wisc.edu/~gregq/collopak/, which also includes routines for several other sensor combinations (both LEO and GEO). (Collopak)
3. A matchfile is created using radiometric data from both sensors. Only collocated data with closely aligned viewing geometry (sensor zenith and azimuth angles both within 5 degrees) is included.

☆ Use of the Atmosphere SIPS processing system enables both mission-length reprocessing of match files and forward stream production (for monitoring trends in sensor calibration).

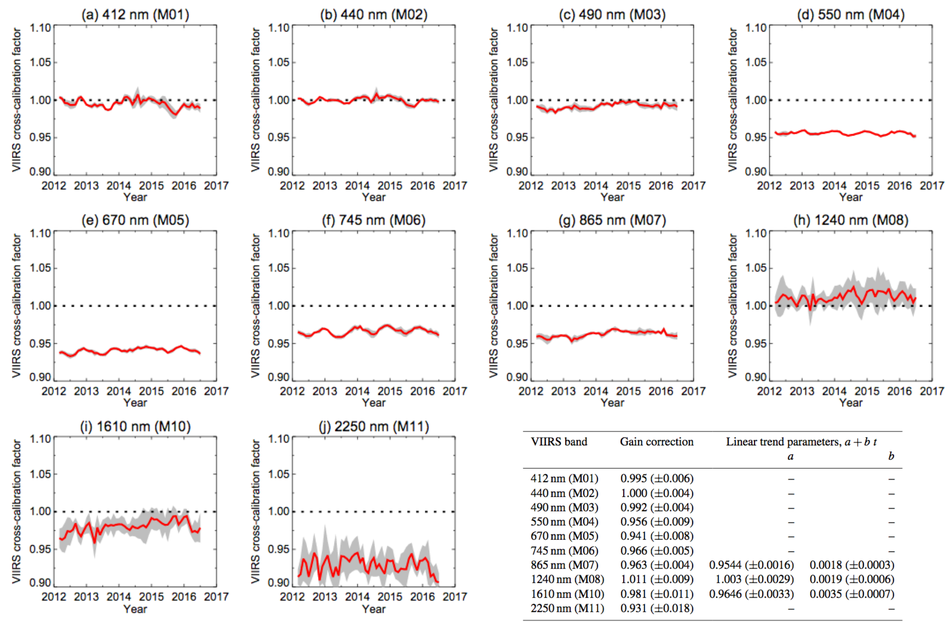
Science Team: Derives bias factors for multi-sensor continuity

Cloud results (cloud mask, cloud properties):



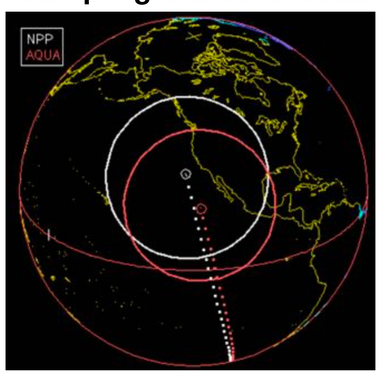
VIIRS Channel		M5 (0.67μm)	M7 (0.87μm)	M8 (1.24μm)	M10 (1.61μm)	M11 (2.25μm)
Radiometric Bias Correction (Expected VIIRS TOC/Observed)	vs C6	*0.94*	**0.96**	**0.98**	**0.98**	**0.97**
	vs C6.1	*0.95*	**0.97**	**0.99**	**0.98**	**0.97**

Aerosol results (Deep Blue algorithm):

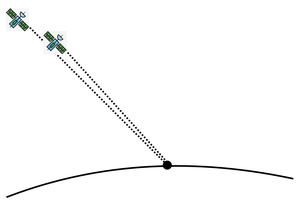


VIIRS band	Gain correction	Linear trend parameters, $a + b\,t$	
		a	b
412 nm (M01)	0.995 (±0.006)	–	–
440 nm (M02)	1.000 (±0.004)	–	–
490 nm (M03)	0.992 (±0.004)	–	–
550 nm (M04)	0.956 (±0.009)	–	–
670 nm (M05)	0.941 (±0.008)	–	–
745 nm (M06)	0.966 (±0.005)	–	–
865 nm (M07)	0.963 (±0.004)	0.9544 (±0.0016)	0.0018 (±0.0003)
1240 nm (M08)	1.011 (±0.009)	1.003 (±0.0029)	0.0019 (±0.0006)
1610 nm (M10)	0.981 (±0.011)	0.9646 (±0.0033)	0.0035 (±0.0007)
2250 nm (M11)	0.931 (±0.018)	–	–

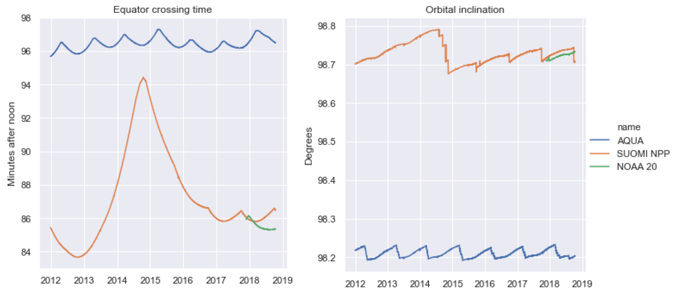
Sampling characteristics



Aqua-SNPP and Aqua-NOAA20 have overlapping swaths with observations within 10 minutes (a "tandem event") for roughly 12 hours out of every 2.67 days.



Reflectance comparisons require observations that follow similar paths through the atmosphere (within 5 degrees for SIPS match-files) in addition to being collocated at the surface.



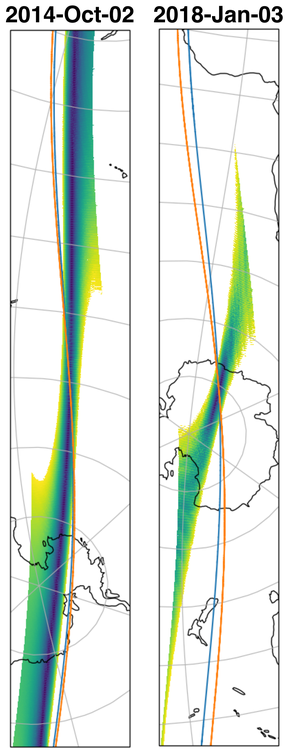
Change in orbital parameters over time (from NORAD two line element [TLE] data)

Sampling behavior is sensitive to the MODIS-VIIRS orbital relationship.

In 2014, Aqua and Suomi NPP's local equator crossing times (and thus orbital planes) were close. View-aligned comparisons are available throughout orbits when MODIS and VIIRS made near-simultaneous observations.

In 2018, the orbital planes are further apart. When near-simultaneous observations are made, view-aligned comparisons are only available close to where the spacecrafts' nadir paths cross (simultaneous nadir overpasses).

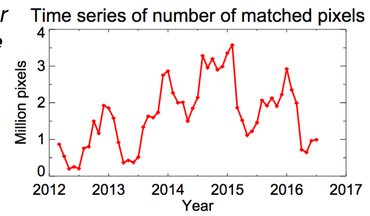
Yield throughout each orbit also varies in relation to the time lag between observations.



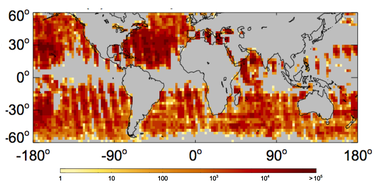
Blue: Aqua nadir track
Orange: SNPP nadir track
Gradient: angle-matched pixels within 0° (dark blue) to 3° (yellow)

Comparison yield (after filtering) for Deep Blue analysis.

Top: number of monthly comparisons over time.



Bottom: number of comparisons (2.5° grid, NH meteorological autumn only).



See also

Talk: *Assessment of relative shortwave radiometry between S-NPP and MODIS Aqua*
Kerry Meyer, 2018 MODIS/VIIRS Science Team Meeting

Poster: *Atmosphere SIPS: technological overview*
Steve Dutcher, Bruce Flynn, 2018 MODIS/VIIRS Science Team Meeting

Paper: *Cross-calibration of S-NPP VIIRS moderate-resolution reflective solar bands against MODIS Aqua over dark water scenes*
Andrew Sayer et al. Atmos. Meas. Tech., 10, 1425-1444, 2017