Effective Band Center Wavelengths for MODIS and VIIRS for Open Ocean Waters

Puneeta Naik[a,b] and **Menghua Wang**[b]

[a]NOAA National Environmental Satellite, Data, and Information Service
Center for Satellite Applications and Research
College Park, MD 20740, USA
[b]CIRA, Colorado State University, Fort Collins, CO 80523, USA

Wednesday, May 14, 2014, College Park, Maryland

Acknowledgements: We thank the MOBY team (IP: Ken Voss) for the MOBY in situ data.

INTRODUCTION

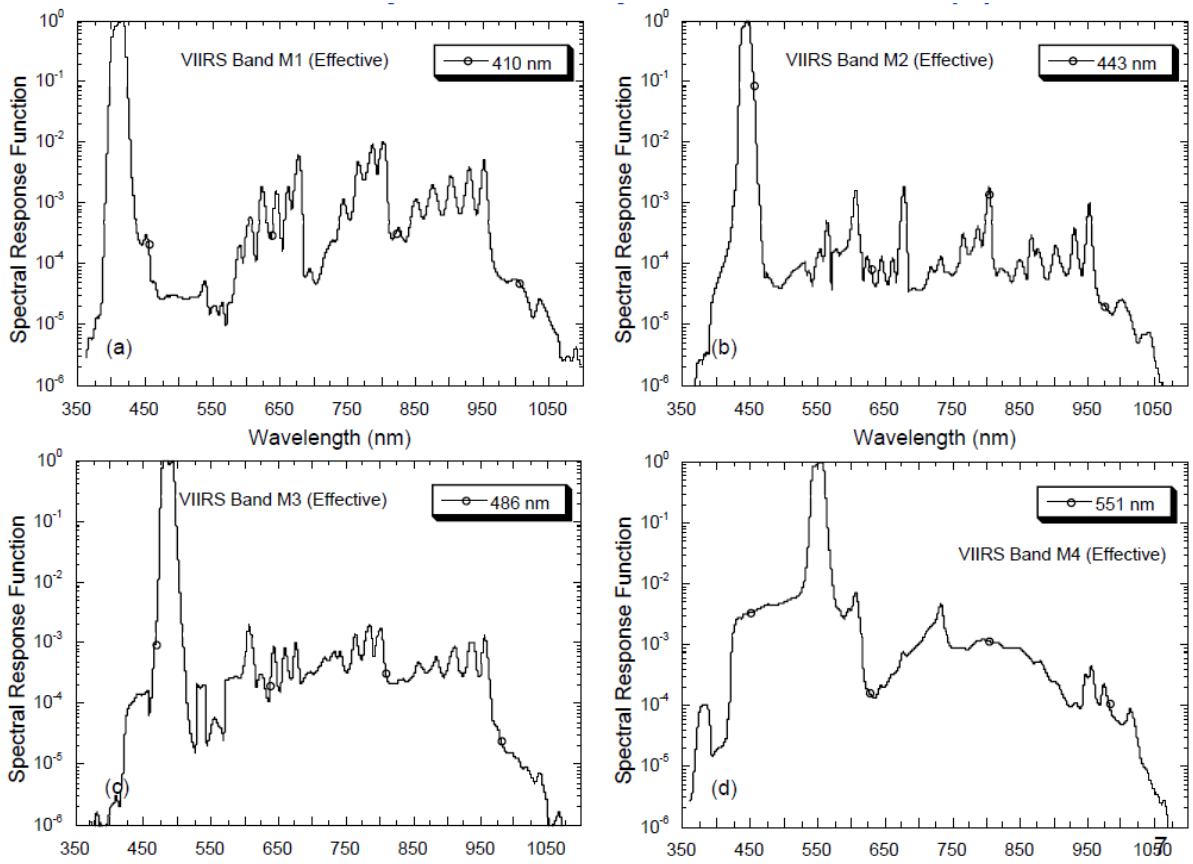
- The in-band and out-of-band responses refer to sensor spectral response contribution from within and outside the spectral bandwidth of the sensor bands, while total-band refers to the contribution from in-band as well as out-of-band regions.

- Most ocean color satellite sensors in addition to an in-band contribution, have a significant contribution from out-of-band region. Although the out-of-band effects can be small, it is not uniform over all bands hence can cause biases in derived biogeochemical variables.

- The out-of-band contributions for Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and Moderate Resolution Imaging Spectroradiometer (MODIS) are relatively well characterized as compared to Visible Infrared Imaging Radiometer Suite (VIIRS).

OBJECTIVES

- Analyze the sensor out-of-band effects for MODIS and VIIRS.
- Determine the effective spectral band center wavelengths for MODIS and VIIRS.



VIIRS Spectral Response Function

http://cioss.coas.oregonstate.edu/CIOSS/workshops/VIIRS_CalVal_Mar_10/VIIRS_Presentations/Wang_Algorithm_Evaluation.pdf

METHODS AND DATA

➢ Convolving normalized water leaving radiance ($nL_w(\lambda)$) with respect to satellite sensor spectral response functions:

Total-band

$$nL_w^{(Total)}(\lambda) = \frac{\int_{All} nL_w(\lambda) RSR(\lambda)\, d\lambda}{\int_{All} RSR(\lambda)\, d\lambda}$$

In-band

$$nL_w^{(In\text{-}Band)}(\lambda) = \frac{\int_{\pm 1\%} nL_w(\lambda) RSR(\lambda)\, d\lambda}{\int_{\pm 1\%} RSR(\lambda)\, d\lambda}$$

$RSR(\lambda)$ --- Sensor spectral response function

Sensor Out-of-Band Effects:

$$OOB(\%) = \left(\frac{nL_w^{(Total)}(\lambda)}{nL_w^{(In\text{-}Band)}(\lambda)} - 1 \right) \times 100$$

METHODS AND DATA

- In situ data:

  Marine Optical Buoy (MOBY)
  (http://coastwatch.noaa.gov/moby/)

- MOBY is deployed in clear oligotrophic oceanic waters (chlorophyll-a is in the range of ~0.01–0.1 mg m^{-3}).

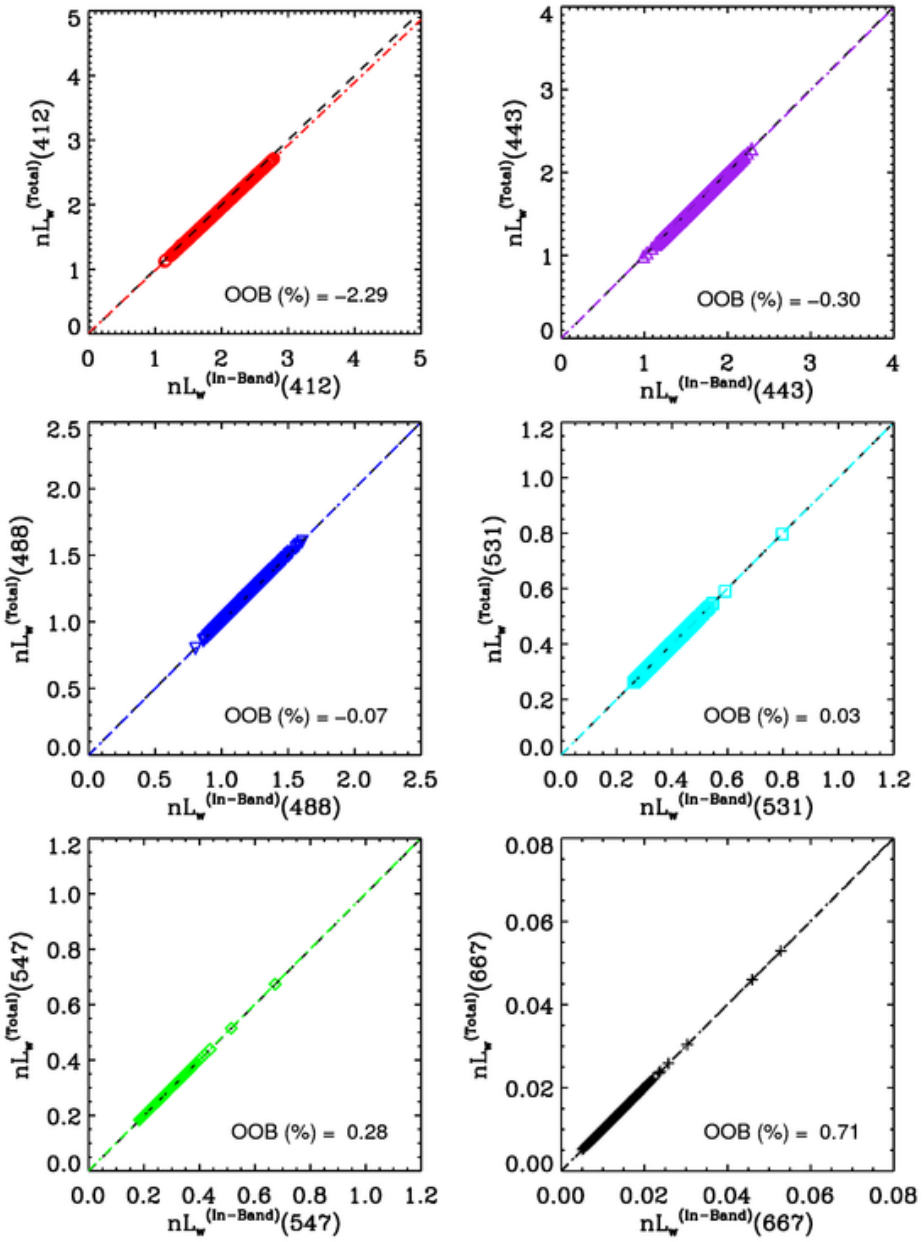
- Hyperspectral *nLw(λ)* data from MOBY covers wavelengths range from ~ 340 nm to 750 nm.

- The hyperspectral resolution of *nLw(λ)* from clear oceanic waters makes MOBY an optimum platform to analyze sensor out-of-band effects.

http://moby.mlml.calstate.edu/

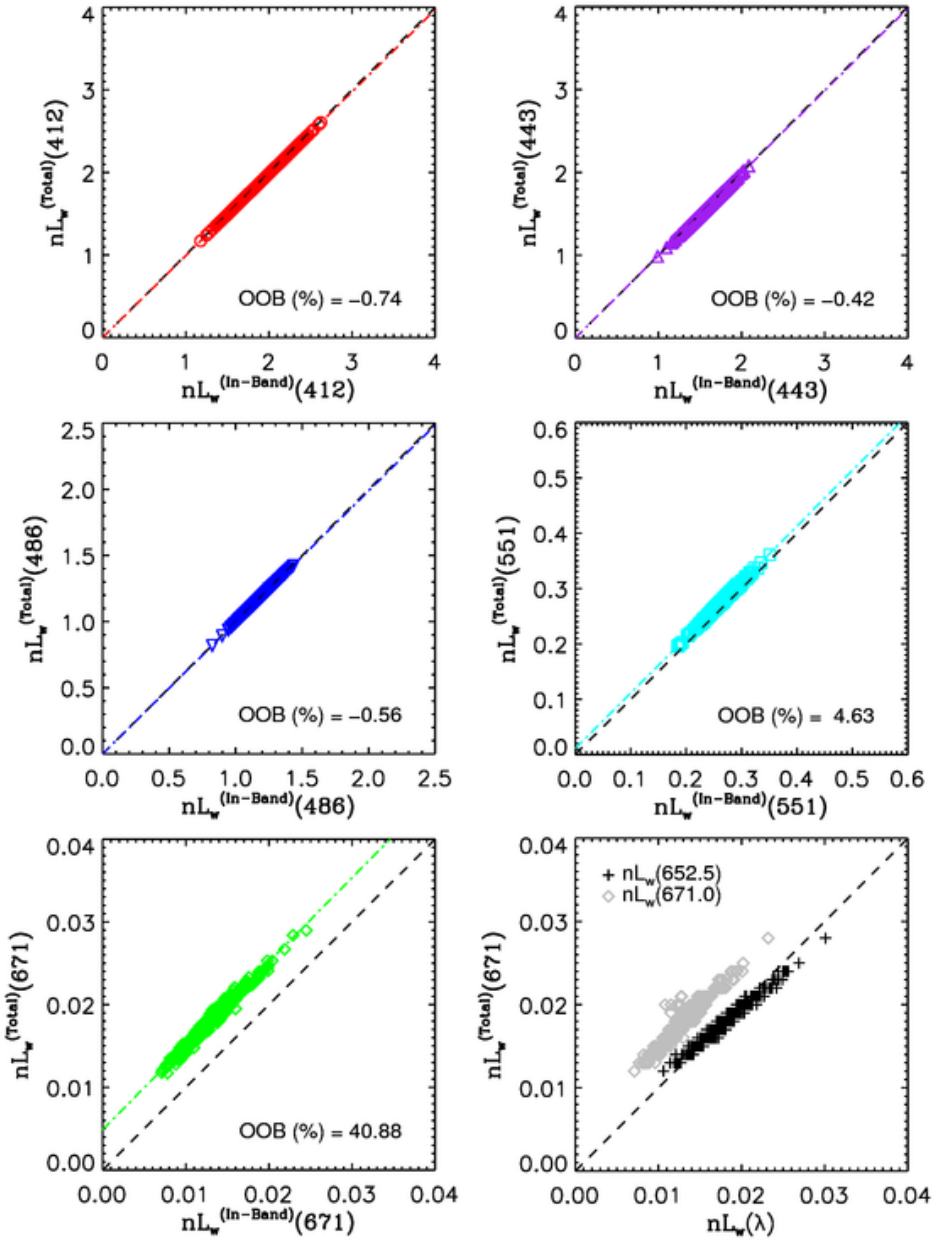
RESULTS

Total-band and In-band comparisons for **MODIS**



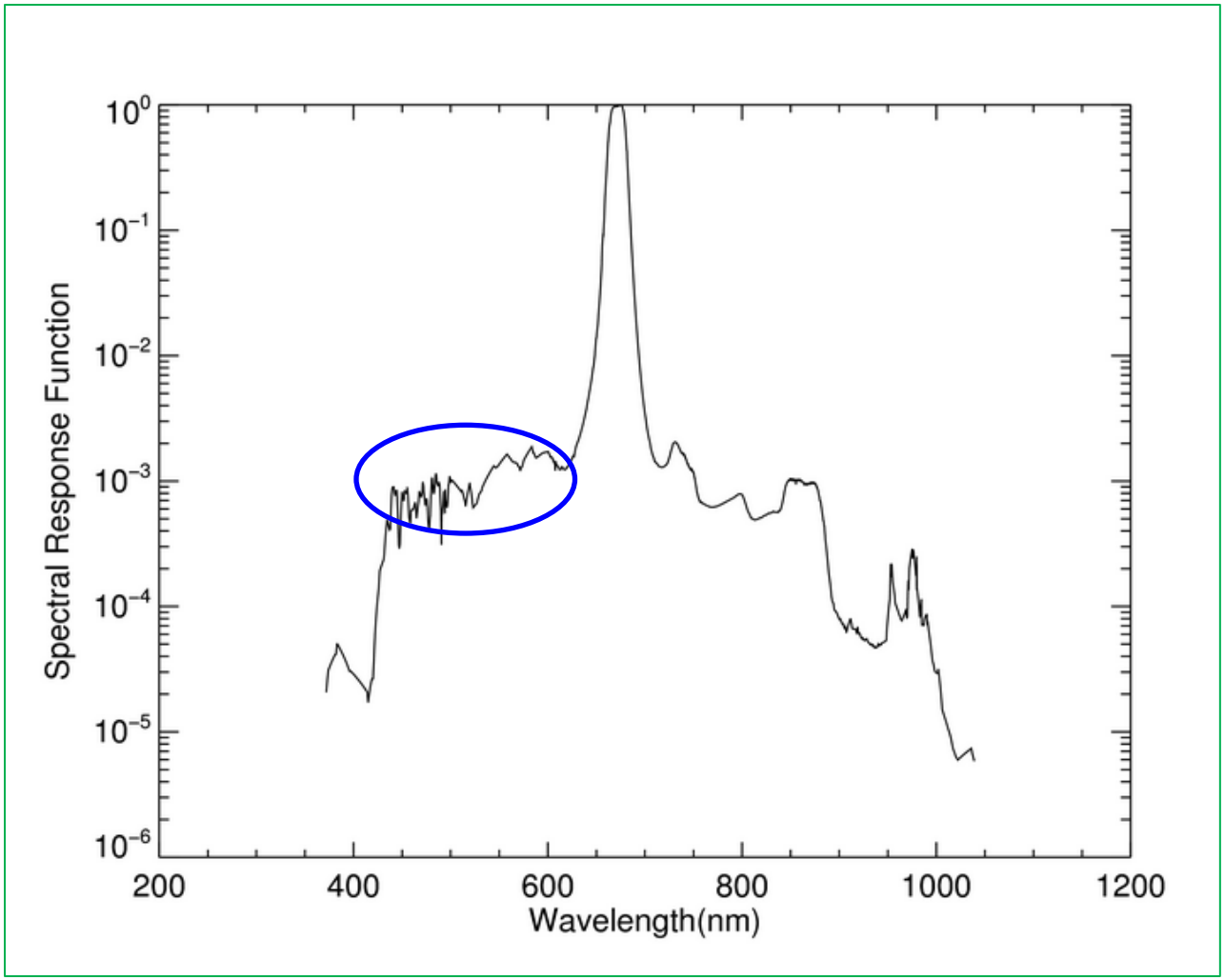
RESULTS

Total-band and In-band comparisons for **VIIRS**



RESULTS

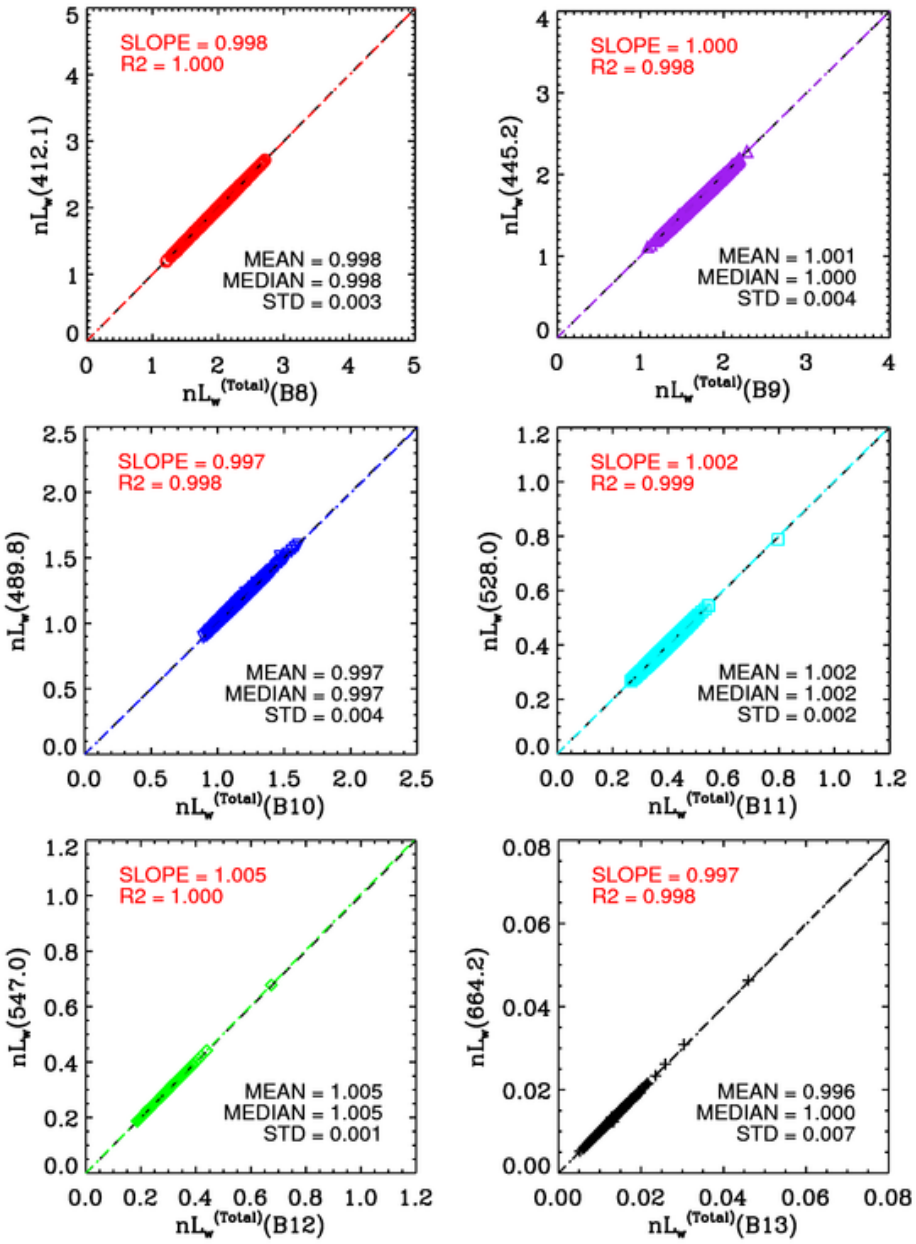
VIIRS Spectral Response function – band M5 (671 nm)



Large Leakage of light from blue region of the spectrum.

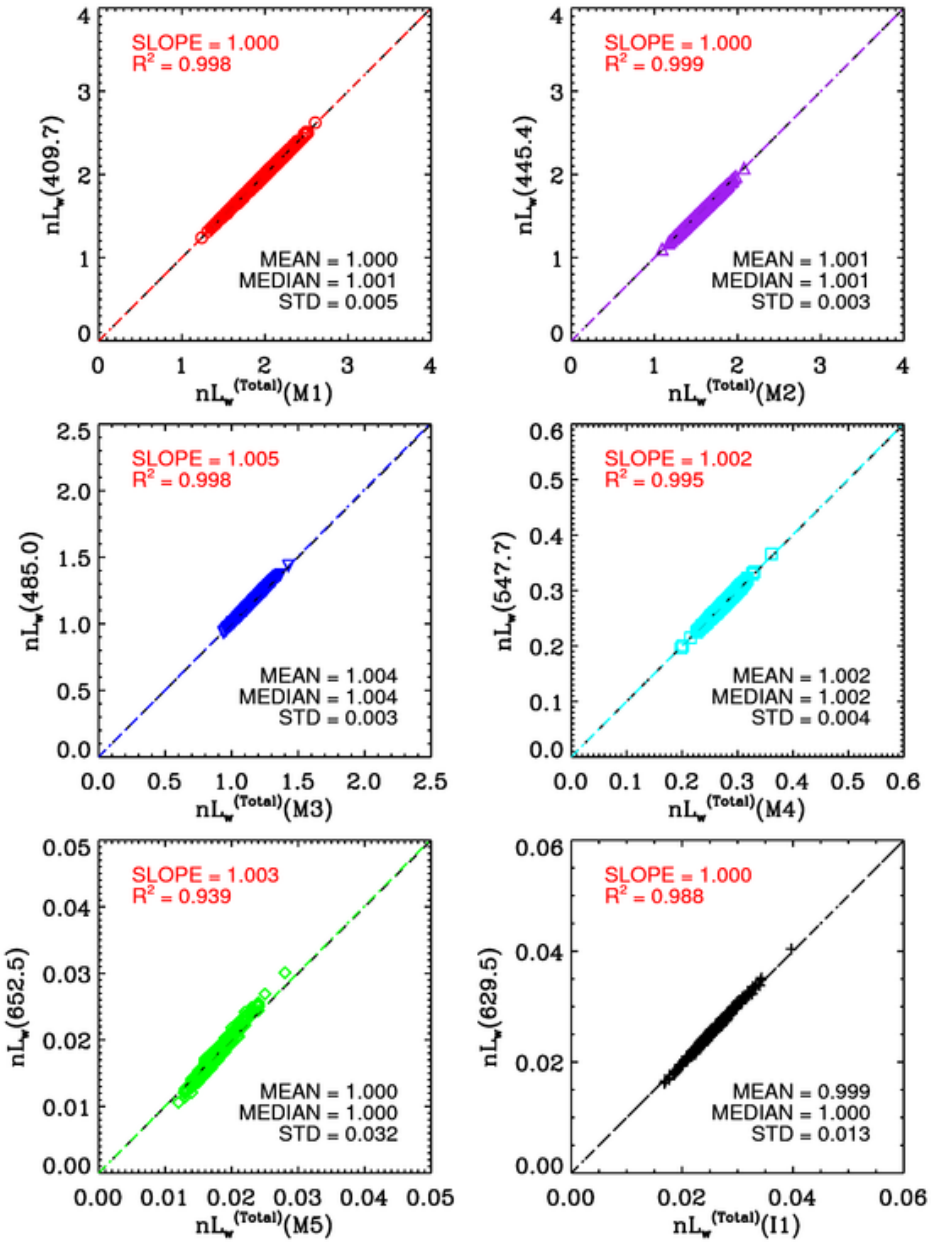
RESULTS

Effective band center wavelengths for **MODIS**



RESULTS

Effective band center wavelengths for **VIIRS**



RESULTS

Nominal and effective center wavelengths for MODIS and VIIRS

MODIS			VIIRS		
Nominal Center Wavelength (nm)	***nL*$_w$(nominal)/ *nL*$_w$(Total)**	**Effective Center Wavelength** (nm)	**Nominal Center Wavelength** (nm)	***nL*$_w$(nominal)/ *nL*$_w$(Total)**	**Effective Center Wavelength** (nm)
412 (B8)	0.994	412.1	410 (M1)	1.022	409.7
443 (B9)	1.034	445.0	443 (M2)	0.959	445.4
488 (B10)	0.977	489.8	486 (M3)	1.072	485.0
531 (B11)	1.012	528.0	551 (M4)	1.078	547.7
551 (B12)	1.005	547.0	671 (M5)	1.399	652.5
667 (B13)	0.977	664.2	635 (I1)	1.070	629.5

The effect of the out-of-band response on the derived $nL_w(\lambda)$ at nominal center wavelengths can be evaluated by taking a ratio of the radiance at nominal center wavelength to total-band averaged radiances, i.e., $nL_w(\lambda) \Big/ nL_w^{(Total)}(\lambda)$

CONCLUSIONS

- For the MOBY site (open oceans) the out-of-band contribution for MODIS is less than ~3% for the bands we have analyzed. While, for VIIRS, the out-of-band contribution is less than ~5% except for band M5 (671 nm).
- The high out-of-band contribution at the band M5 of VIIRS is due to a large leakage (out-of-band spectral distribution) from the blue region of the spectrum.
- In general, the out-of-band response is greater for VIIRS relative to MODIS, except at the blue band.
- The effective band center wavelengths are within ±6 nm of the nominal center wavelengths for both MODIS and VIIRS, except for the VIIRS M5 band.
- It is noted that the effective band center wavelengths represent the center band wavelengths of MODIS and VIIRS-measured $nL_w(\lambda)$ for open ocean waters.

THANK YOU