Evaluating multi-sensor agreement of satellite particulate backscatter retrievals by validatin against in-water measurements

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Overview

1. Biogeochemical-Argo profiling floats have increased in situ data density across multiple water types, creating new opportunities to evaluate satellite instrument-to-instrument differences in particulate backscattering coefficient (b_{bp}).
2. Retrievals of b_{bp} from identical GIOP algorithm configurations differ between satellite instruments due to 1) algorithm input differences and 2) radiometric differences.
3. Instrument-to-instrument differences must be considered before creating a merged timeseries of satellite ocean color products, in order to distinguish real, environmental contributions from spurious algorithmic or radiometric ones.

Emerging Data Sources

Figure 1: BGC-Argo profiling floats are an emerging source of b_{bp} data collected autonomously throughout the global oceans over the last 10+ years.

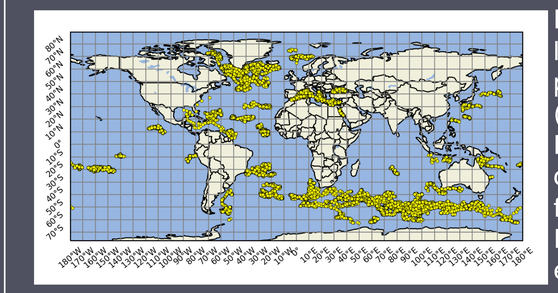
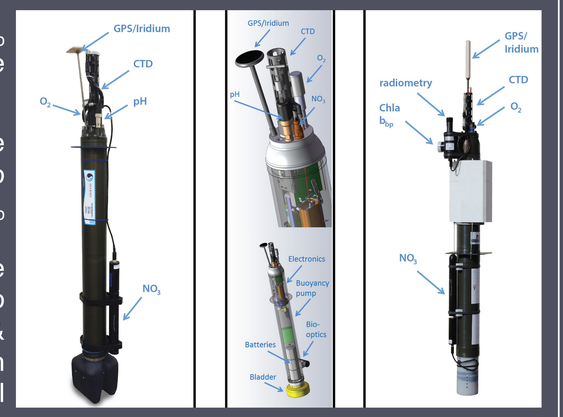


Fig. 1A (left): the location of BGC-Argo profiles measuring b_{bp} (700 nm) since 2010.

Fig. 1B (right): Three common BGC-Argo floats: Navis, APEX, & PROVOR (Roemmich et al., 2019); not all collect b_{bp}.



RESULTS: MODIS-Aqua vs VIIRS-SNPP

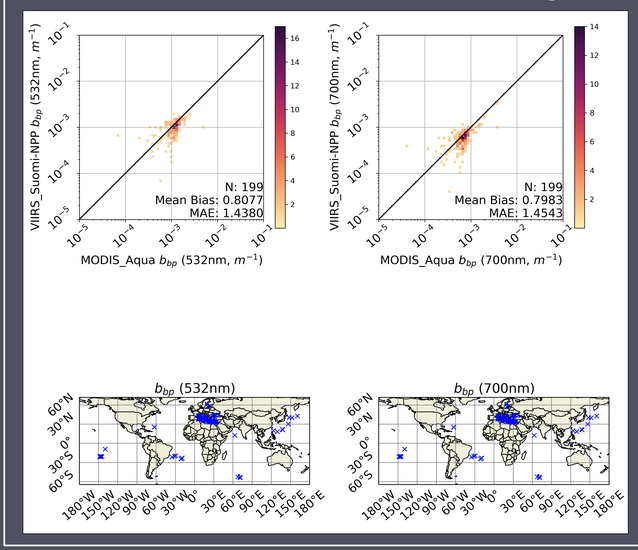


Figure 2: Scatterplots of MODIS-Aqua b_{bp} (532 nm, upper left) and b_{bp} (700 nm, upper right) BGC-Argo float matchups versus VIIRS-SNPP b_{bp} matchups. Lower panels depict the locations of the matchups.

MODIS-Aqua b_{bp} is biased high relative to VIIRS-SNPP by 19.2% at 532 nm and 20.1% at 700 nm.

RESULTS: MODIS-Terra vs VIIRS-SNPP

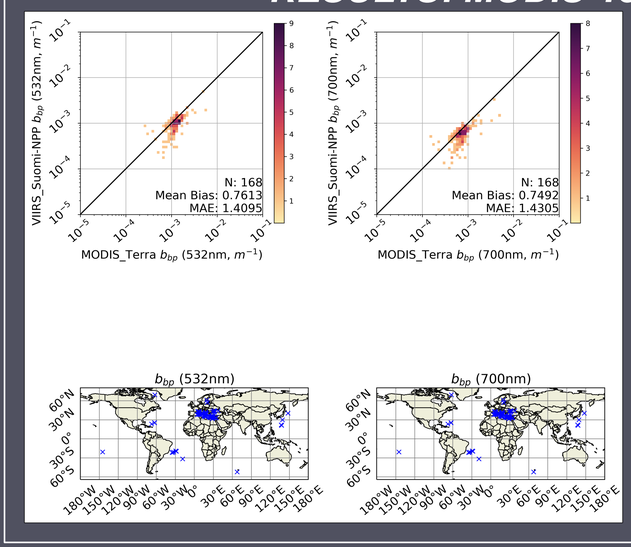


Figure 3: Same as Fig. 2 but for MODIS-Terra vs VIIRS-SNPP. The majority of the match-ups between both MODIS and VIIRS instruments occur in the Mediterranean and Baltic Seas.

MODIS-Terra b_{bp} is biased high relative to VIIRS-SNPP by 23.9% at 532 nm and 25.1% at 700 nm.

RESULTS: MODIS-Aqua vs MODIS-Terra

Figure 4: Same as Fig. 2 but for MODIS-Terra vs MODIS-Aqua, with greater global coverage than when each MODIS is separately compared to VIIRS-SNPP.

Both MODIS instruments agree well with each other, with a mean bias of 0.4% and 0.7% for b_{bp} at 532 nm and 700 nm, respectively, with an MAE of 21.0%. These differences are expected to be solely due to radiometric differences.

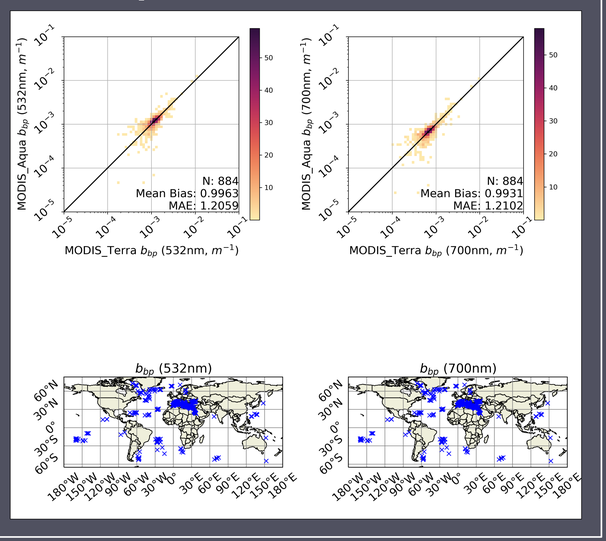


Table 1: Summary of comparison metrics.

		#	Mean bias	MAE
b_{bp} (532 nm)	MODIS-Terra vs MODIS-Aqua	884	0.9963	1.2059
	MODIS-Aqua vs VIIRS-SNPP	199	0.8077	1.4380
	MODIS-Terra vs VIIRS-SNPP	168	0.7613	1.4095
b_{bp} (700 nm)	MODIS-Terra vs MODIS-Aqua	884	0.9931	1.2102
	MODIS-Aqua vs VIIRS-SNPP	199	0.7983	1.4543
	MODIS-Terra vs VIIRS-SNPP	168	0.7492	1.4305

– Summary of previous work: Werdell & McKinna (2019)

- Werdell & McKinna (2019) quantified the effects on GIOP retrievals due exclusively to differences in the input wavelengths, all else being equal (e.g. – GIOP configuration, radiometric data, etc).
- GIOP retrievals were conducted using a single reflectance dataset, sampled to both a MODIS band set and a VIIRS band set.
  - MODIS: 412, 443, 488, 531, 547, 667 (nm)
  - VIIRS: 410, 443, 486, 551, 671 (nm)
- Depending on water type, b_{bp} (443 nm) differs between MODIS and VIIRS instruments purely due to algorithm band input differences between -2.68% and 4.74% median UPD.

– Data

- In situ b_{bp} (532 nm, m^{-1}) and b_{bp} (700 nm, m^{-1}) from BGC-Argo merged synthetic profiles, Argo Global Data Assembly Centre (GDAC)
- MODIS-Aqua, MODIS-Terra, & VIIRS-SNPP b_{bp} retrievals from the default GIOP configuration, L2 data, IOP suite, R2018, NASA Ocean Biology Processing Group (OBPG)

– References

Bailey, S. W., & Werdell, P. J. (2006). A multi-sensor approach for the on-orbit validation of ocean color satellite data products. Remote Sensing of Environment, 102(1–2), 12–23. https://doi.org/10.1016/j.rse.2006.01.015

Bisson, K. M., Boss, E., Westberry, T. K., & Behrenfeld, M. J. (2019). Evaluating satellite estimates of particulate backscatter in the global open ocean using autonomous profiling floats. Optics Express, 27(21), 30191. https://doi.org/10.1364/OE.27.030191

Roemmich, D., Alford, M. H., Claustre, H., Johnson, K., King, B., Moum, J., et al. (2019). On the Future of Argo: A Global, Full-Depth, Multi-Disciplinary Array. Frontiers in Marine Science, 6(August), 1–28. https://doi.org/10.3389/fmars.2019.00439

Seegers, B. N., Stumpf, R. P., Schaeffer, B. A., Loftin, K. A., & Werdell, P. J. (2018). Performance metrics for the assessment of satellite data products: an ocean color case study. Optics Express, 26(6), 7404. https://doi.org/10.1364/oe.26.007404

Werdell, P. J., & McKinna, L. I. W. (2019). Sensitivity of Inherent Optical Properties From Ocean Reflectance Inversion Models to Satellite Instrument Wavelength Suites. Frontiers in Earth Science, 7(March), 1–21. https://doi.org/10.3389/feart.2019.00054

– Methods

- BGC-Argo quality-control and adjustment to the surface follow Bisson, et al., (2019)
- L2 satellite matchups are generated relative to the BGC-Argo data via Bailey & Werdell (2006)
- MODIS and VIIRS GIOP retrievals of b_{bp} are adjusted from 443 nm to 532 and 700 nm using the retrieved GIOP backscattering spectral parameter.
- Comparison metrics: mean bias, mean absolute error (MAE), and unbiased percent difference (UPD); selected following Seegers, et al., (2018)