Satellite radiometric validation with VAL-Argo and hyperspectral floats

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Simple concept: can profiling floats be used for CAL/VAL activities?

1. Why will it be useful?
2. What are the technical issues that need to be surmounted?
3. What has been done to date?
4. What is planned in the near future?

Current strategies for Cal/Val of Ocean Color

Instrumented buoy or AERONET-C station, e.g. MOBY, BOUSSOLE

Demonstrated high quality data

Limited spatial coverage.

Great temporal coverage.

Oceanographic cruises

Demonstrated high quality data

Limited spatial coverage.

Limited temporal coverage.

Both are expensive and take significant time to gather sufficient data early in sensor's life

Fleet of Instrumented profiling float

Data quality unknown

Great spatial and temporal coverage.

Relatively inexpensive

Motivation:

Early in a mission lifetime it is critical to get as many matchups as possible to be able to provide quality data. Mission-average calibration reaches stability after 20-40 high quality calibration samples (several years).

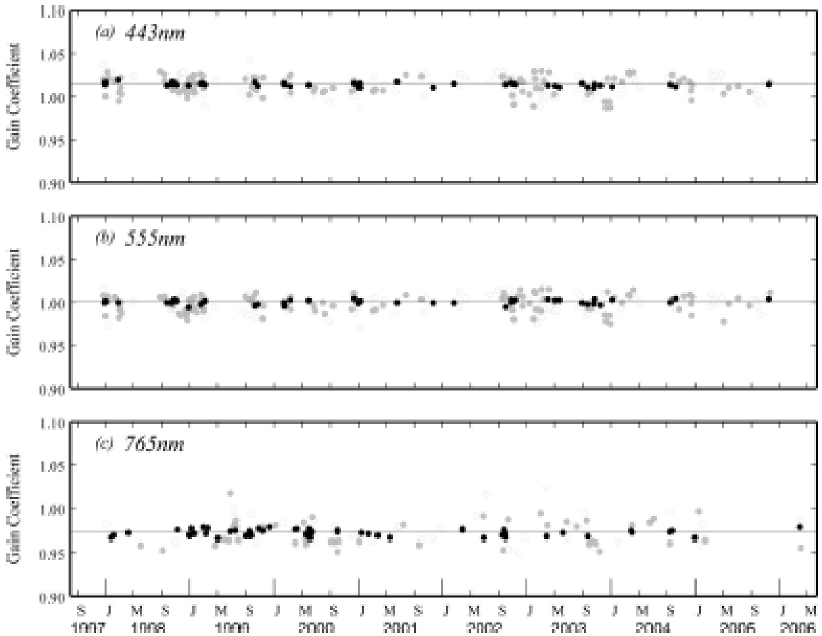


Fig. 3. Vicarious gains derived for SeaWiFS bands at 443, 555, and 765 nm based on calibration samples spanning the mission lifetime from September 1997 to March 2006. The individual calibration gains (circles) are distributed around the mission mean gain line, w is constant for all time. The filled circles are the gains that passed the quality screening process, with the grey and black fill us distinguish the cases that fell outside or within the semi-interquartile range, respectively. The J, M, and S labels indicate January, M and September, respectively.

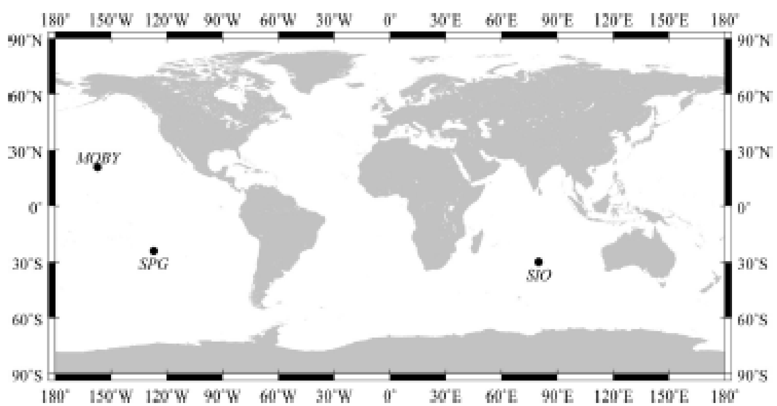


Fig. 2. Map showing location of the vicarious calibration sites used operationally by the OBPG for the calibration of SeaWiFS and other ocean color sensors. The MOBY site is used for the calibration of the visible wavelengths. The locations in the SPG and SIO are used for the vicarious calibration of the NIR wavelength(s).

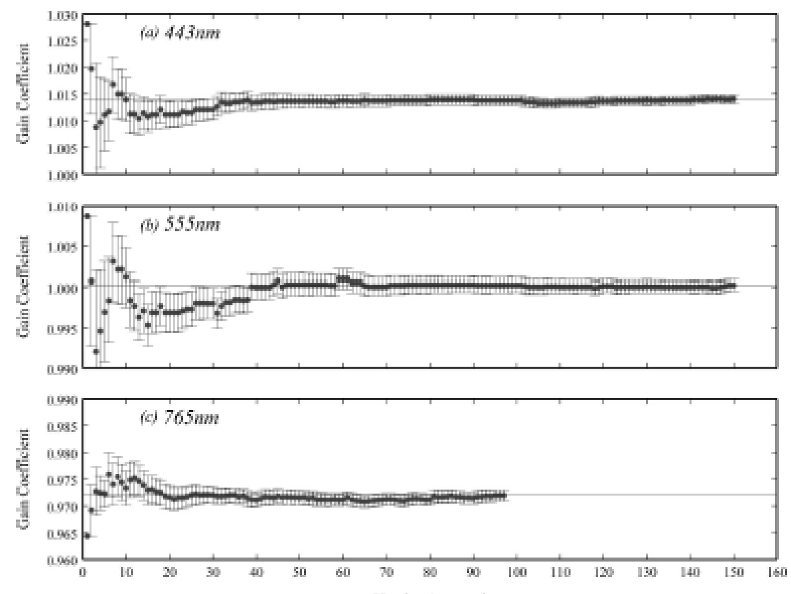
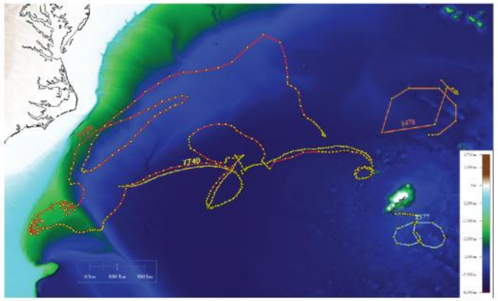
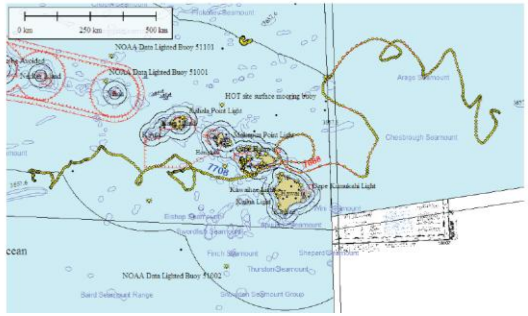


Fig. 6. Mean vicarious gains, $\bar{g}(\lambda)$, derived for SeaWiFS bands at 443, 555, and 765 nm based on calibration samples spanning the mission lifetime from September 1997 to March 2006. Individual gains from the mission-long set of calibration match-ups were randomly sampled, growing the sample set one case at a time and averaging to show the effect of increasing sample size on $\bar{g}(\lambda)$. Vertical error bars show the standard error on the mean at each sample size.

Results from NOPP/NASA effort (6 floats, 4λ)

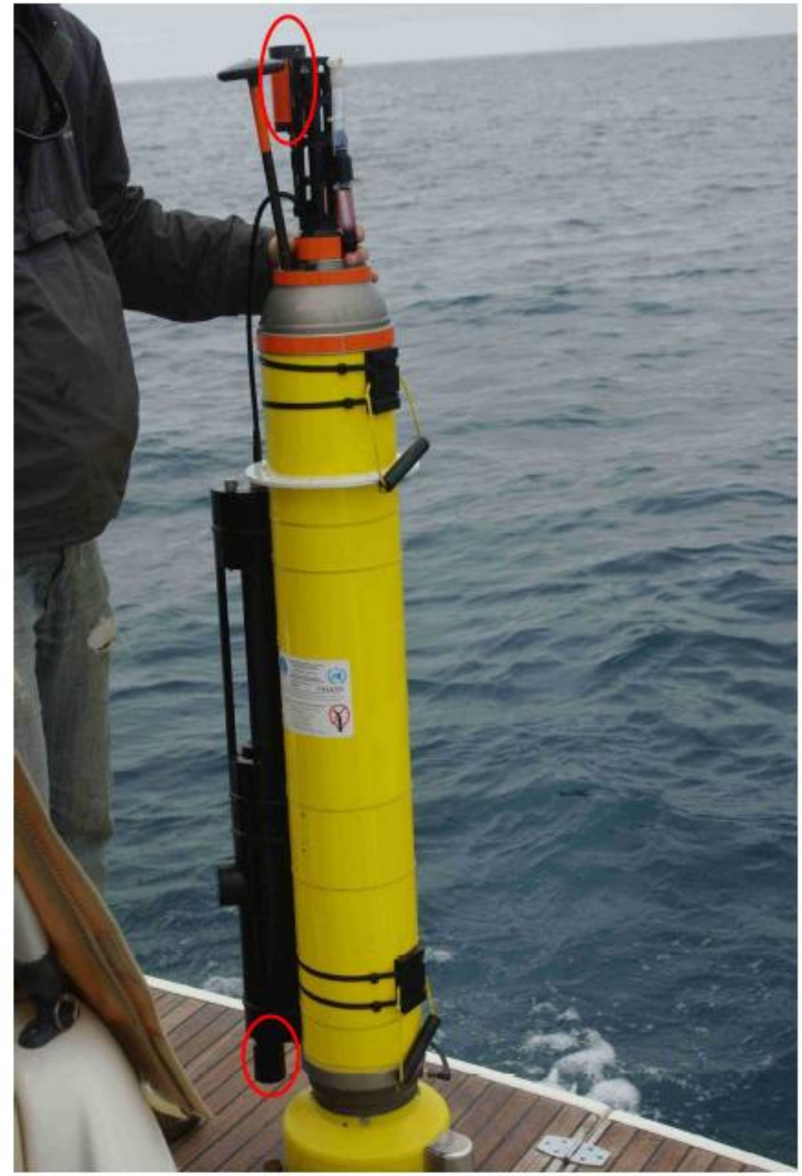




+BOUSSOLE

float name	location	start date	end date	# prof.
Mediterranean A	near BOUSSOLE	12 Jul, 2011	13 Sep, 2011	29
Mediterranean B	near BOUSSOLE	12 Jul, 2011	15 Sep, 2011	28
Hawaii A	near MOBY	17 Dec, 2011	20 Jul, 2013	332
Hawaii B	near MOBY	18 Dec, 2011	8 Nov, 2013	360
Atlantic A	NW of Bermuda	3 May, 2012	29 Sep, 2013	300
Atlantic B	NW of Bermuda	3 May, 2012	12 Nov, 2012	132

~1100 profiles



QA/QC tests:

1. NASA tests (relatively homogeneous 5x5, Es near clear atmosphere)

2.

$$k_L > 0$$

$$k_L < 1\ \mathrm{m}^{-1}$$

$$\left| \frac{k_{L4} - k_{L3}}{0.5(k_{L4} + k_{L3})} \right| < 1.5,$$

$$L_u(z_b) > \widehat{L_{u4}} > \widehat{L_{u3}} > \widehat{L_{u2}} > \widehat{L_{u1}},$$

$$L_u(z - z_m) = \widehat{L_u}(z_m) e^{(z - z_m) k_L}$$

$$f_{Lu} = \frac{L_u(z) - \widehat{L_u}(z)}{\widehat{L_u}(z)} < 0.05$$

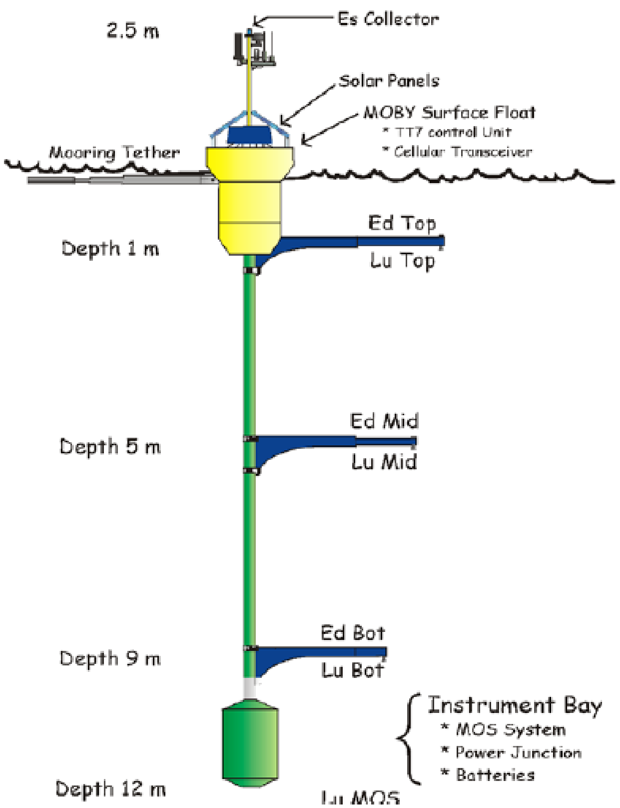
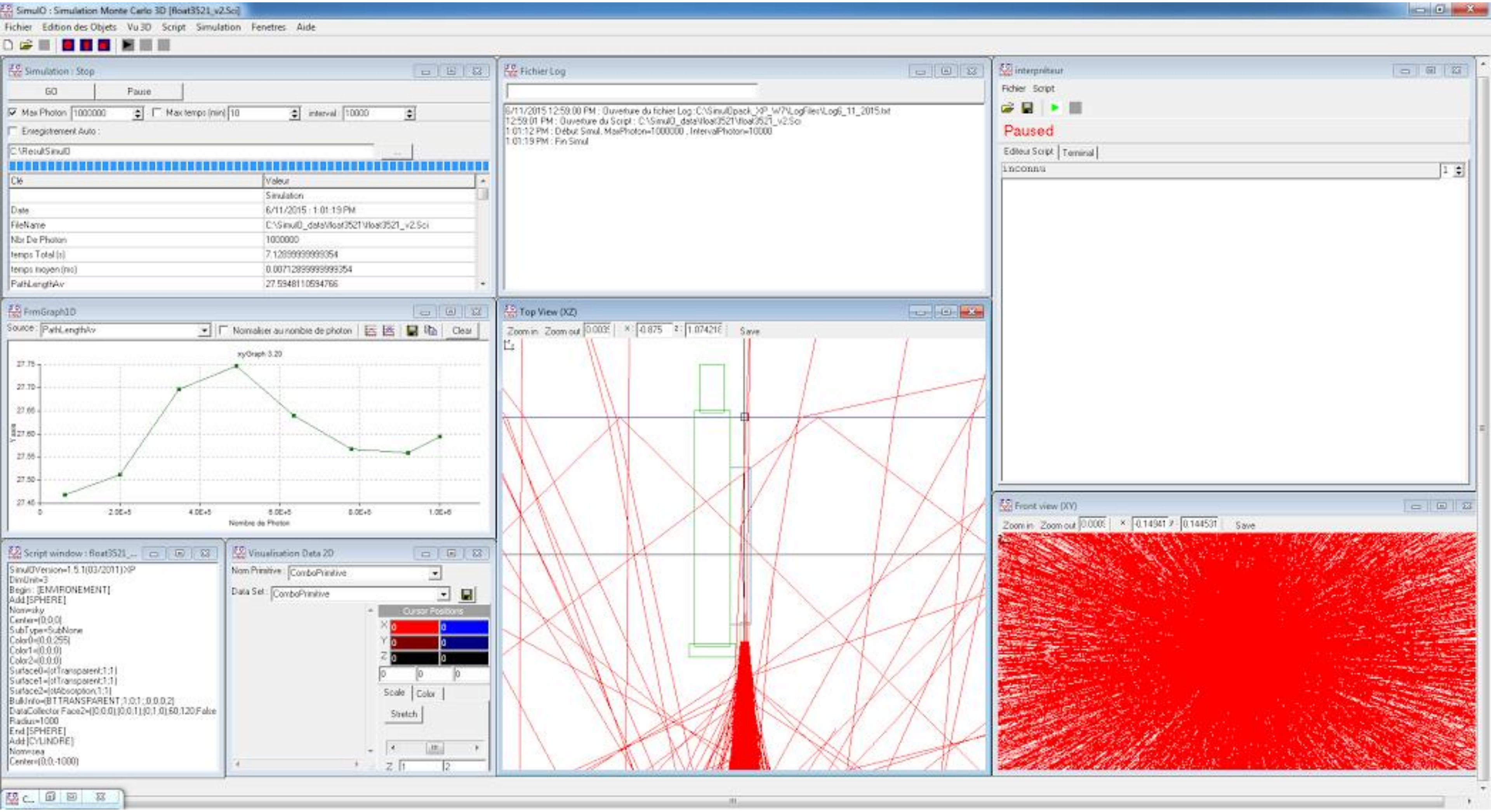


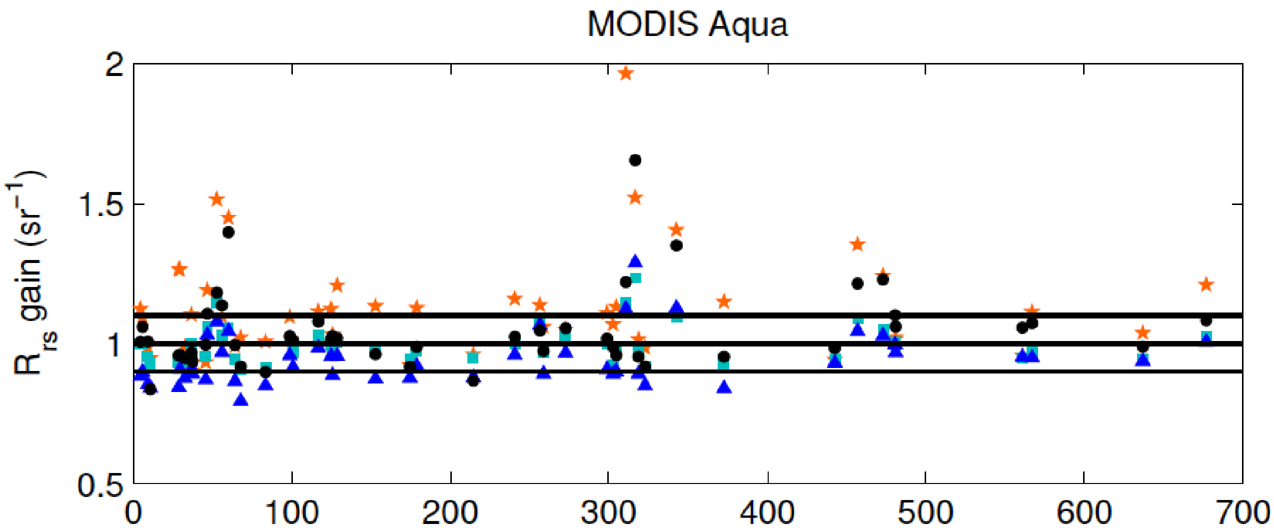
Fig. 1. Schematic diagram of MOBY.

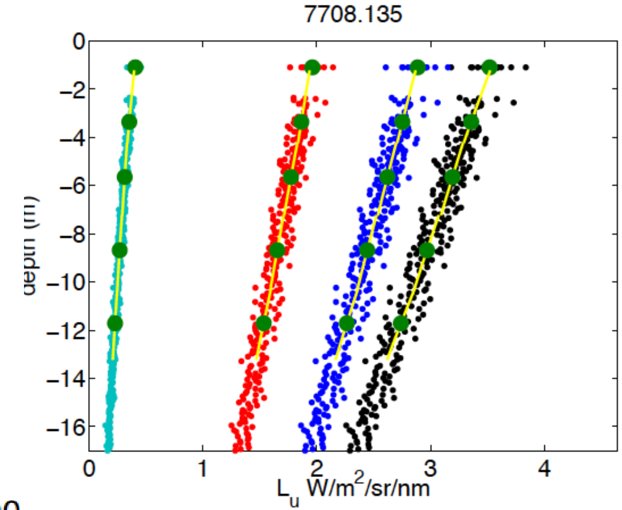
Bin data to 4 3m bins below 1.2m.

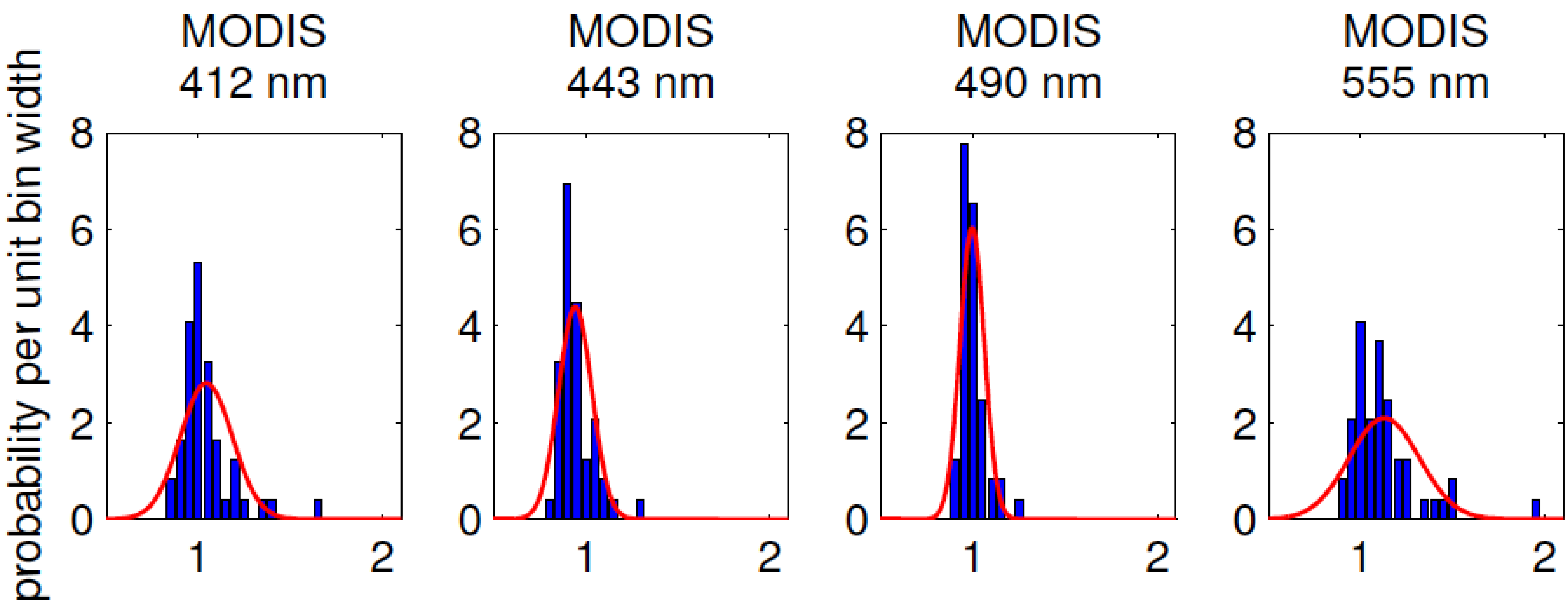
Shading studies (SimulO)



Results from NOPP/NASA effort (6 floats, 4λ)







MODIS matchups:

$\lambda\,(nm)$	N	mean	median	$2\sigma_G/\sqrt{N}$
412	76	1.033	1.012	0.033
443	76	0.936	0.922	0.024
488	76	0.988	0.979	0.017
555	76	1.113	1.088	0.042

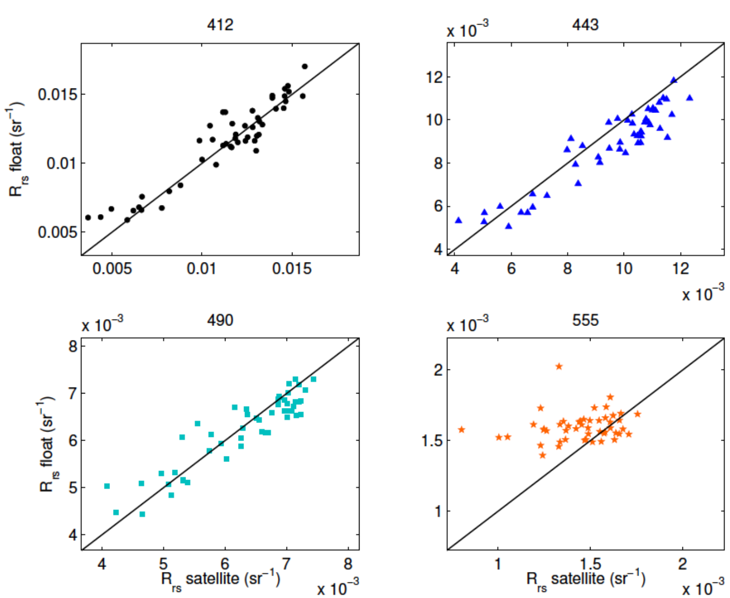


FIG. 9. Scatter plot of R_{rs} for floats and MODIS Aqua

VIIRS matchups:

$\lambda\,(nm)$	N	mean	median	$2\sigma_G/\sqrt{N}$
412	19	1.042	1.048	0.048
443	19	1.001	1.004	0.048
488	19	0.986	0.983	0.037
555	19	0.995	0.983	0.067

Issues:

1. How do we assess/constrain sensor drift over time?

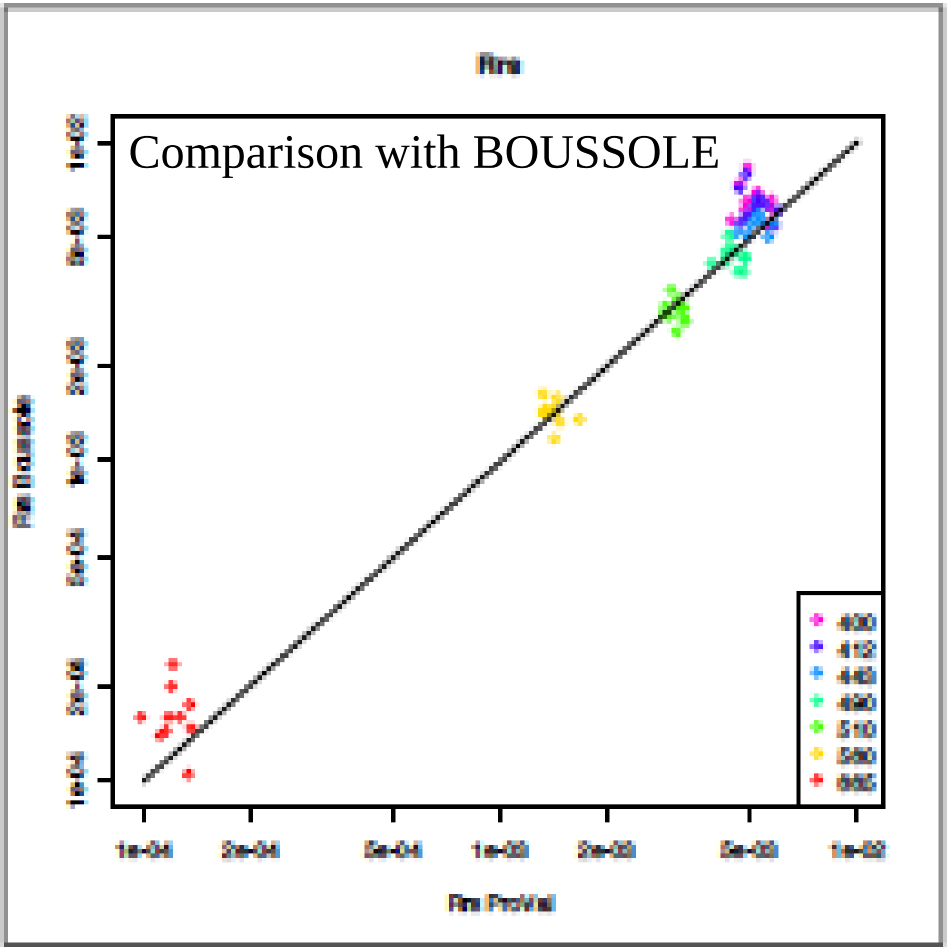
2. Assigning uncertainties.

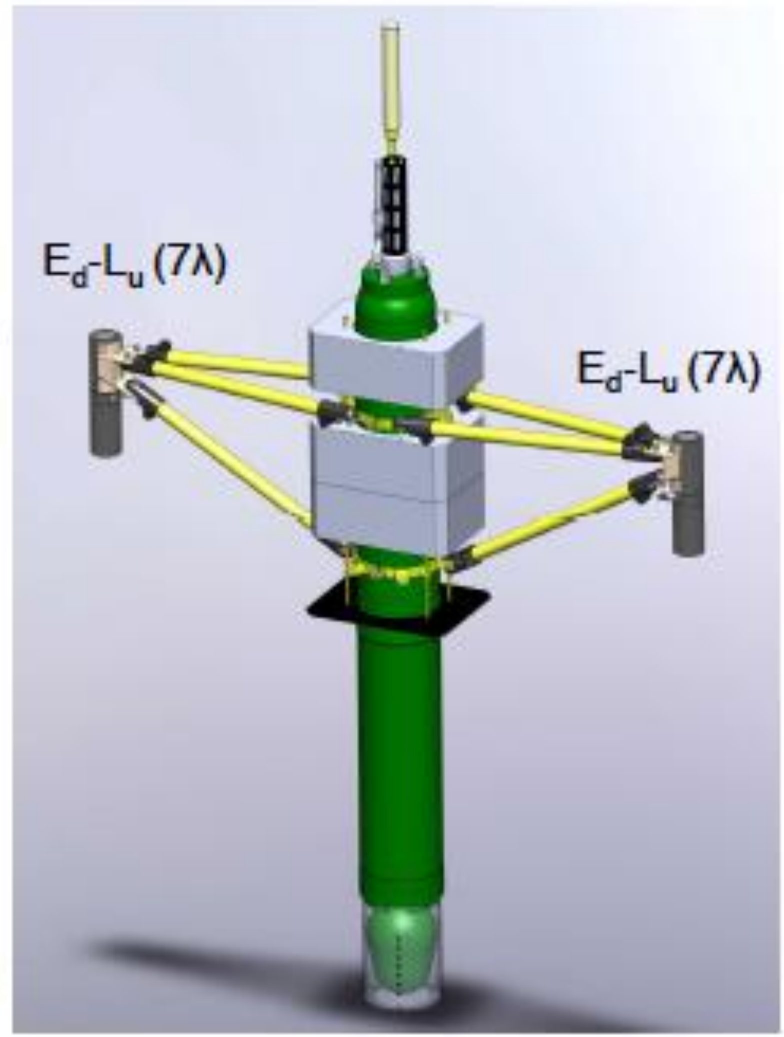
3. Sub pixel environmental variability.

4. What E_s to use for reflectance.

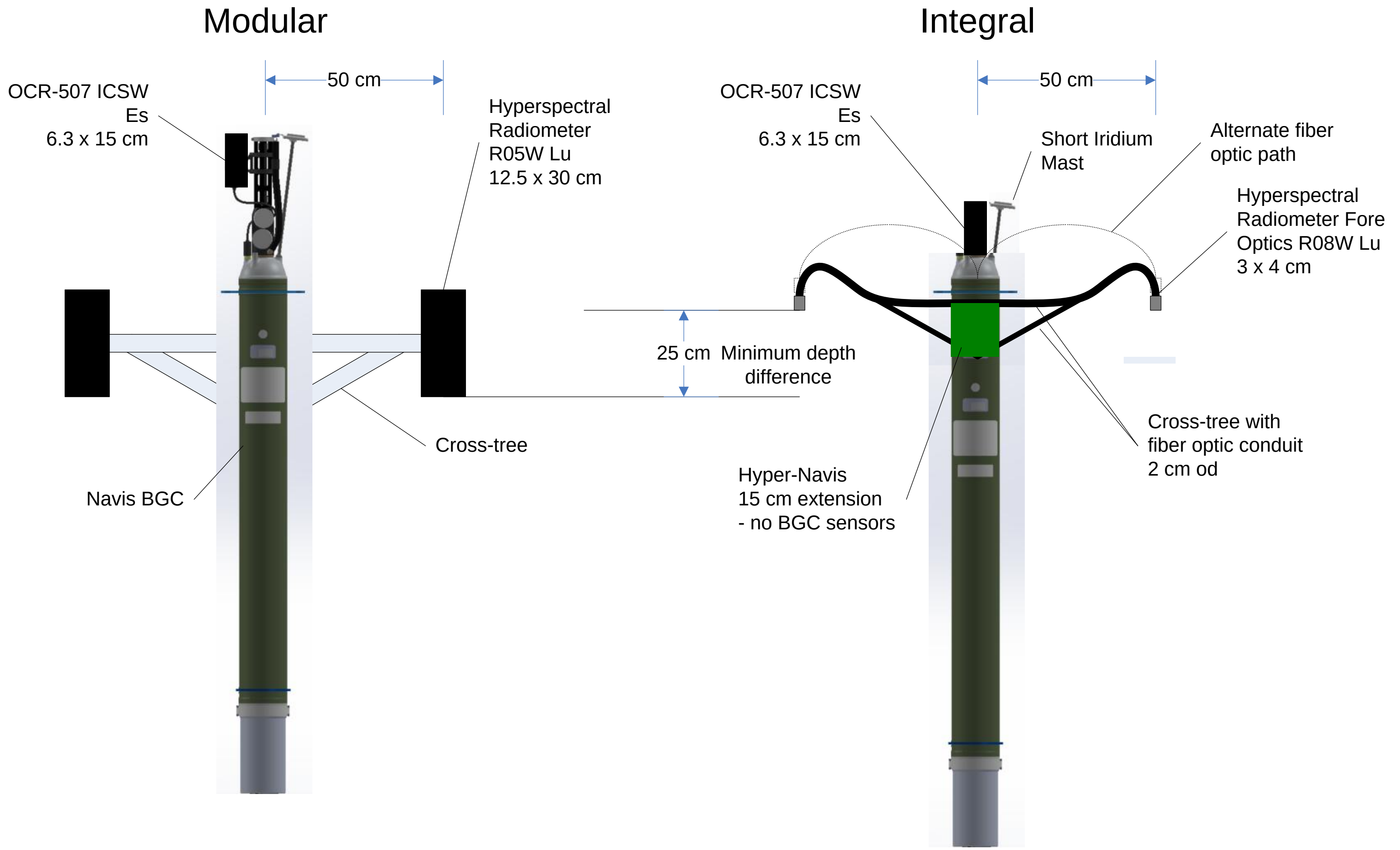
5. BRDF correction

Results from the ProVal effort (6 floats, 4λ)





HyperNav



Two hyperspectral radiometers for Lu

One spectral radiometer for Ed