Hyperspectral radiometric device for accurate measurements of water leaving radiance from autonomous platforms for satellite vicarious calibrations

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ABSTRACT

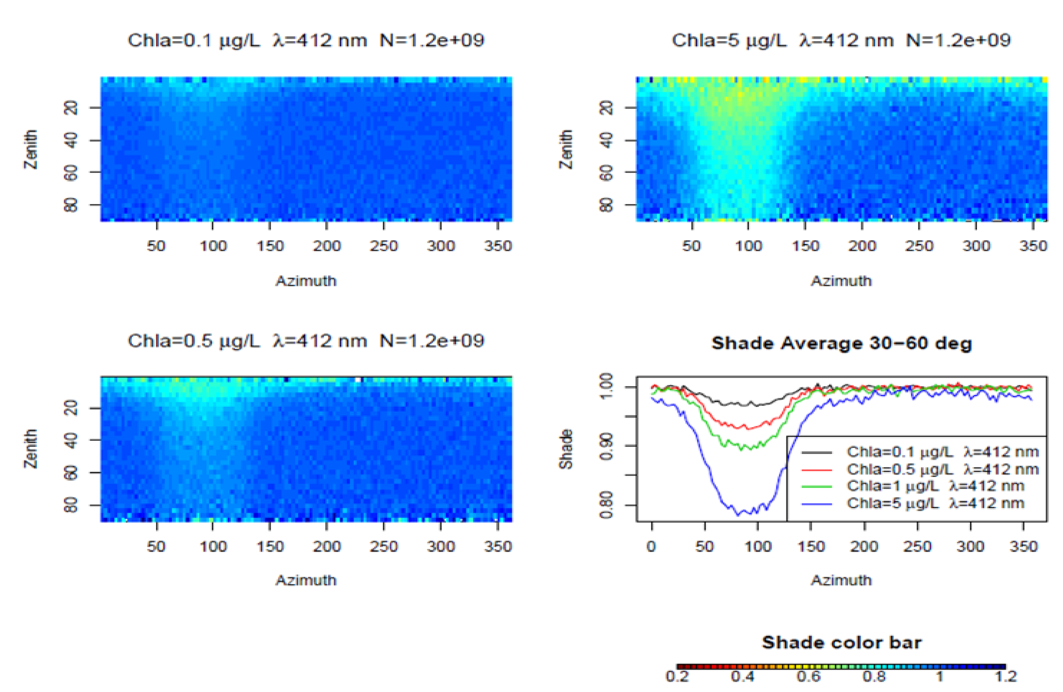
Maintaining sufficient accuracy over the lifetime of satellite-based ocean-viewing radiometry missions requires a robust vicarious calibration program to enable routine verification of the ocean color instrument calibration while on orbit. In addition to a small number of highly instrumented sites, a spatially extensive network of vicarious calibration match-up data points helps to achieve the desired level of calibration uncertainty. The next generation of ocean color satellite sensors such as the Pre-Aerosol Clouds and ocean Ecosystem (PACE) mission builds on past ocean color remote sensing efforts to provide a global observational basis for understanding the living ocean and for improving skill in forecasting and projecting variability of the Earth System over a wide range of time and space scales. These are being enabled by significant advances in ocean color satellites including enhanced spatial resolution and a wider spectral range extending into the UV and near-infrared (350 - >900 nm) with hyperspectral resolution (5 nm). These enhancements drive the need to augment vicarious calibration capabilities, notably in regard to the extended spectral range into the UV, and especially with regard to the increased spectral resolution.

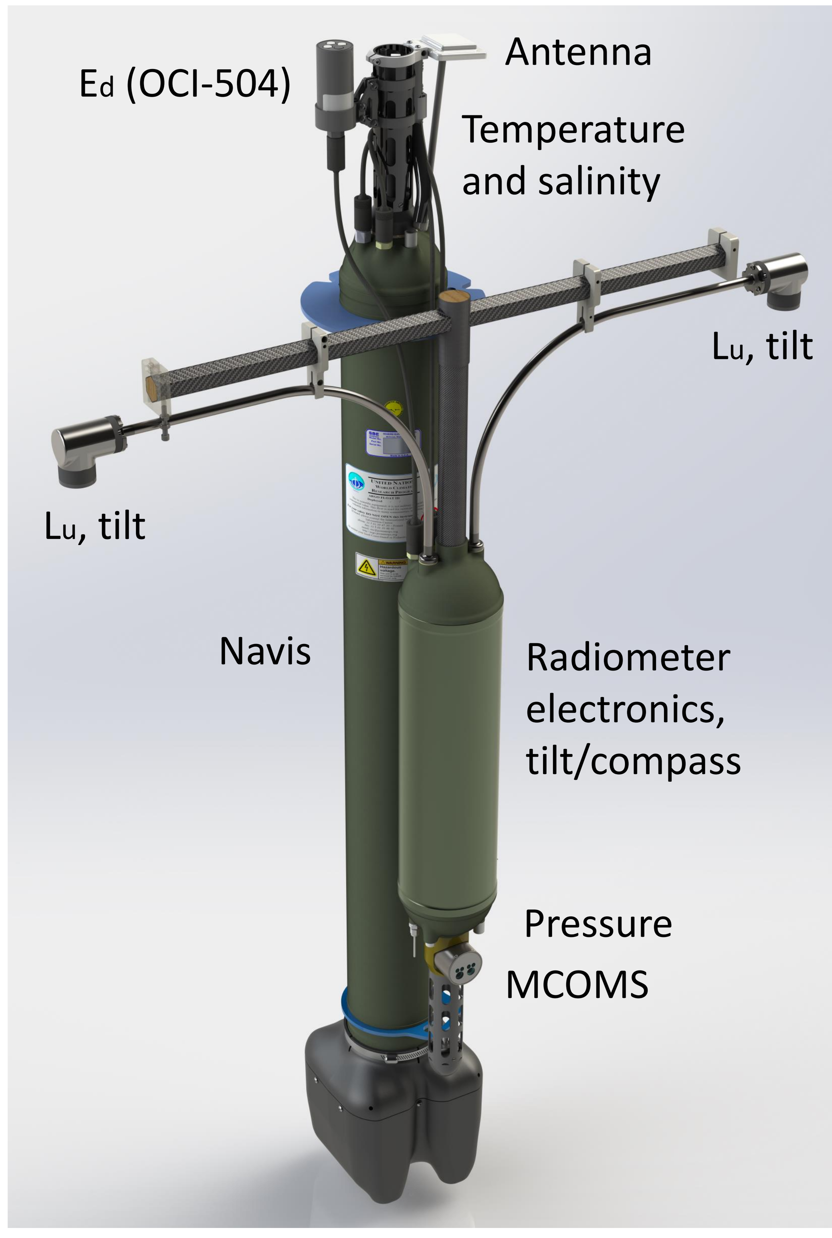
Here we propose to build on a strong heritage to achieve an evolutionary development of a new hyperspectral radiometer system capable of meeting new requirements for spectral resolution (<3 nm), for observations in the UV and near IR (350-900 nm) and which will maintain the demonstrated accuracy, precision and stability of existing radiometers. Working with NIST, the radiometers will be fully calibrated and characterized following existing protocols. The instruments will be integrated onto autonomous profiling floats for untended optical profiling over periods of 3+ years in the open ocean. Lastly, field evaluations and validations are planned near the two fixed calibration sites near Hawaii and in the Mediterranean Sea. The benefit will be a new vicarious calibration capability for PACE and other ocean color remote sensing instruments.

ANCILLARY SENSORS

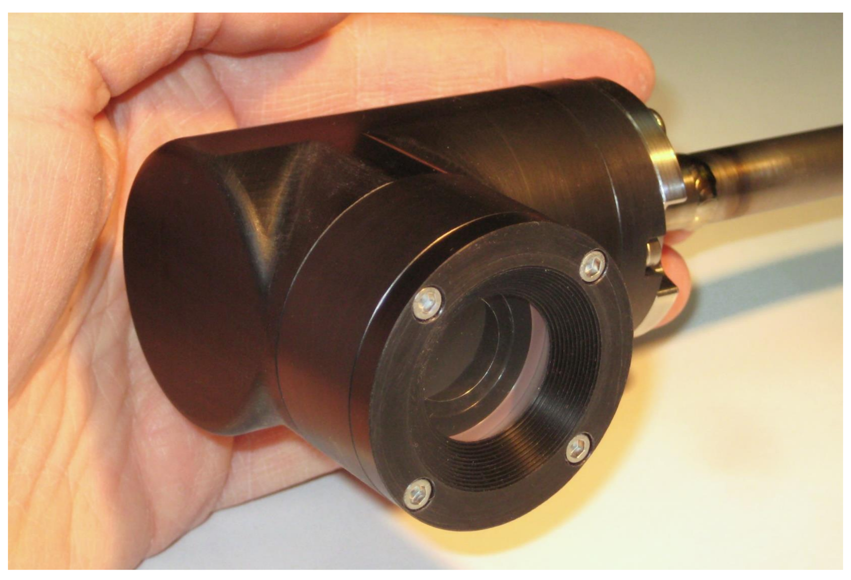
SENSOR	LOCATION	PURPOSE
OCI-504	Top of Navis mast	(380nm, 490nm, 590nm, PAR) Validation, sky conditions
MCOMS	Base of radiometer	(Chl, 700 BB, FDOM) Data validation
Pressure	Base of radiometer	High resolution depth for surface extrapolations
Temperature and Salinity	Top of Navis mast	For use with pressure for depth calculation
Tilt/Compass	Radiometer body	Quality control, orientation to the sun
Tilt	Radiometer heads	Head alignment and monitoring

SELF-SHADING SIMULATIONS

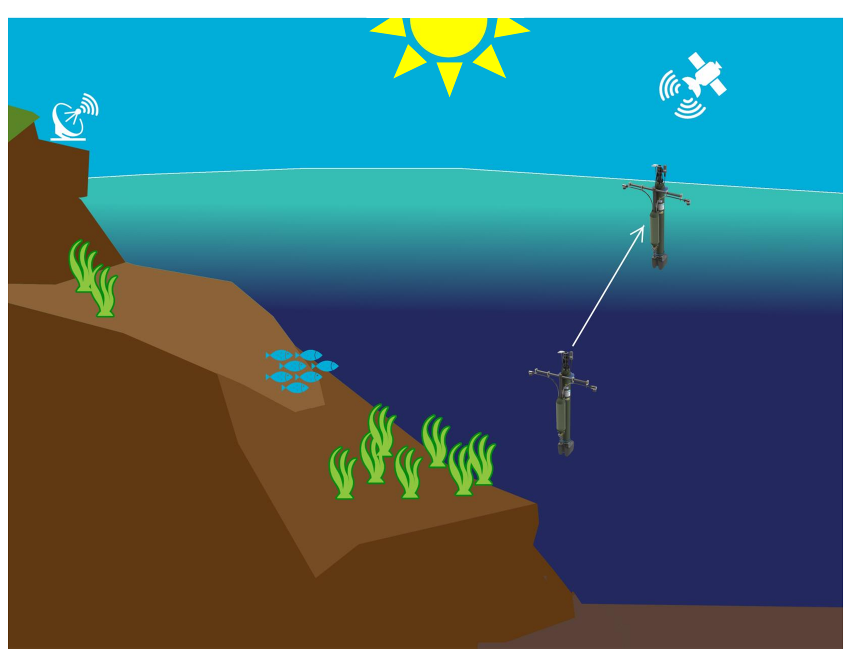




The radiometer attached to a Navis float. An OCI-504 is mounted on the mast. The two Lu heads are at the ends of the arms. An MCOMS is at the base of the housing. Carbon fiber tubes rigidly support the arms.



Close up of the radiometer head prototype. The head includes a shutter and tilt sensor.



The float will park at 1000m to inhibit biofouling. On assent, data will be collected from 300m to the surface (radiometers <0.5m), with frame rate increasing near the surface. The data collection schedule can be reprogrammed from shore.

UNCERTAINTIES

SOURCE	TARGET % @550nm	METHOD OF VALIDATION	MITIGATION
Calibration			
Irradiance standard	0.78	Provided by NIST	Use NIST calibrated lamp
Reflectance target	1.8	Provided by manufacturer	Use corrections for 0-45 deg
Reproducibility	1.5	Repeated calibrations	Careful lab procedures
Instrument			
Immersion factor	0.3	Repeated determinations	Careful lab procedures
Linearity	TBD	NIST beam conjoiner	Characterization and correction
Stray light	0.04	NIST laser scanning	Characterization and correction
Thermal effects	0.02	At calibration station over 4-30 C	Characterization and correction
Polarization effects	TBD	At calibration station with polarizer	Careful optical design
Wavelength accuracy	0.4	Provided by mfr., verified with gas lamps	Quality control on spectrometers
Field			
Wave focusing	1.0	Field measurements	High frame rate near surface
Self-shading	0.5	Monte Carlo	Model corrections
Tilt effects	0.5	Tilt sensors in heads	Only collect data when tilts are good
Biofouling	2.0	Retrieval of floats, post calibration	Park in aphotic zone
Total	3.5		

NEXT STEPS...

	J	F	M	A	M	J	J	A	S	O	N	D
Fabrication and assembly	■	■	■	■								
Characterization and lab testing					■	■	■					
Field testing in Bedford Basin					■							
Field testing off Hawaii at Moby						■						
Month-long deployments								■	■	■		

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