The Calibration and Validation Office (CVO): *Preparing for the Next NASA (Coastal) Mission*

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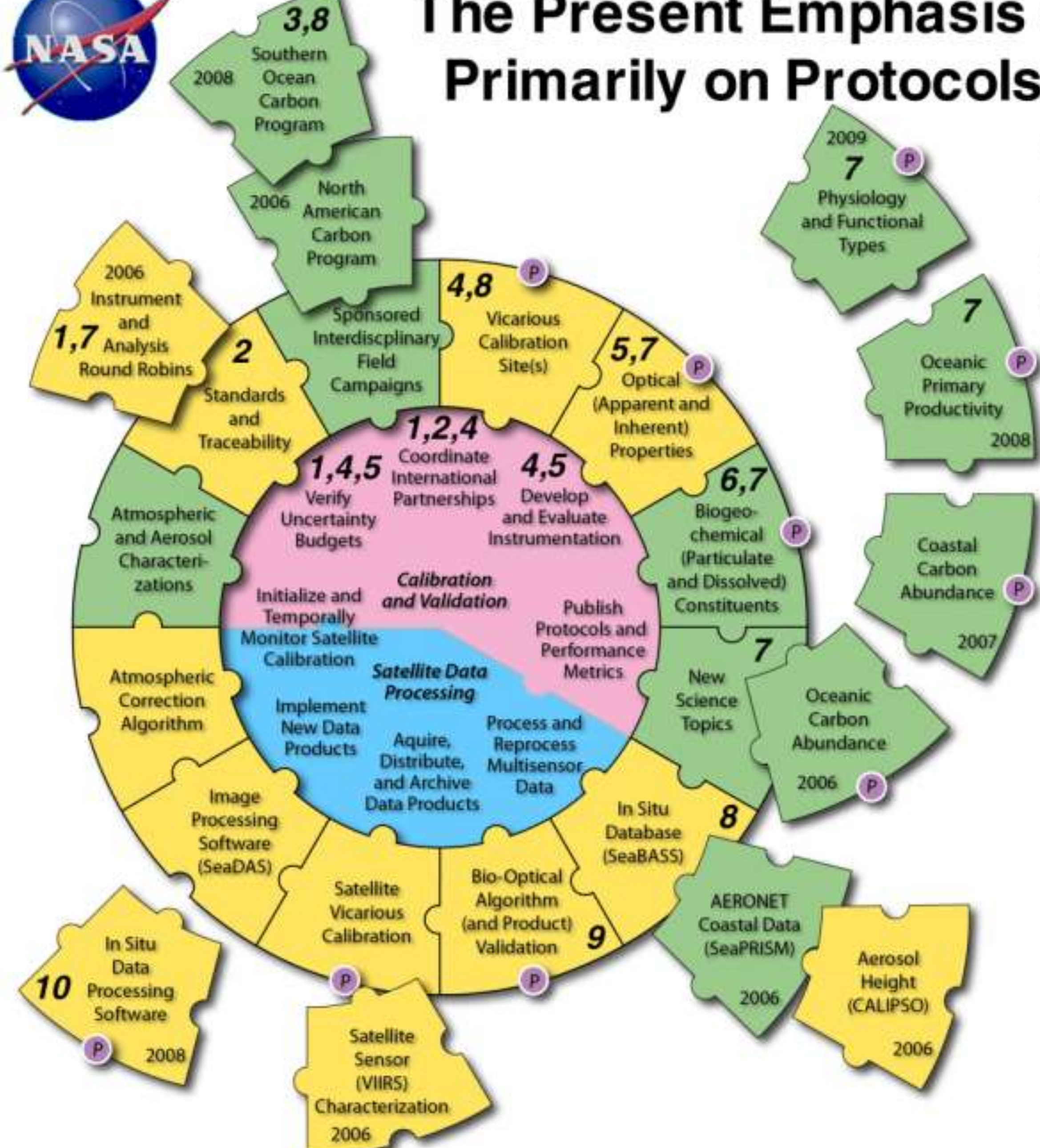
The Present Emphasis of CVO Activities is Primarily on Protocols and Uncertainties



The CVO has started to fulfill the internal and connecting-core tasks identified in the Calibration and Validation Plan (Hooker et al. 2007):

1. SeaHARRE-4 and -5 plus the first IOP round robin,
2. IMPACT and review of bio-optical data products,
3. CLIVAR (2008 and 2009),
4. BOUSSOLE and OSPREy,
5. SHALLO and the new BSI microradiometers,
6. C-LABS and biogeochemical protocols,
7. New hires (biology, chemistry, and IOP experience),
8. All data into SeaBASS,
9. Validation and protocols for shallow waters, and
10. PROSIT (Web-based data processing interface).

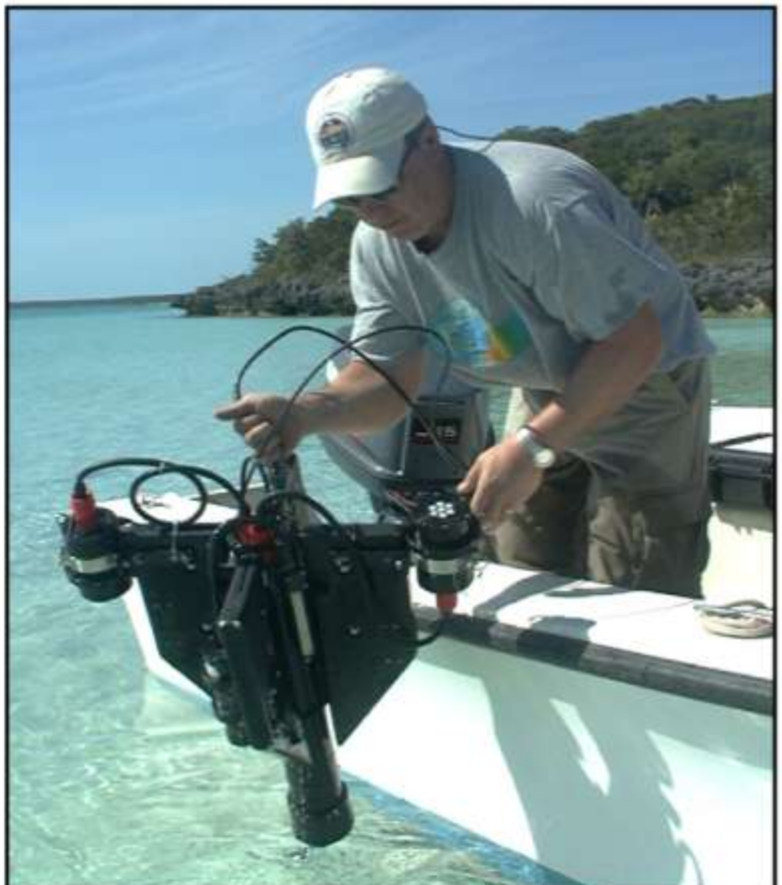
PPig Uncertainties for SeaHARRE-4 (Coastal) Samples: the Quality-Assured (QA) Subset (A′)

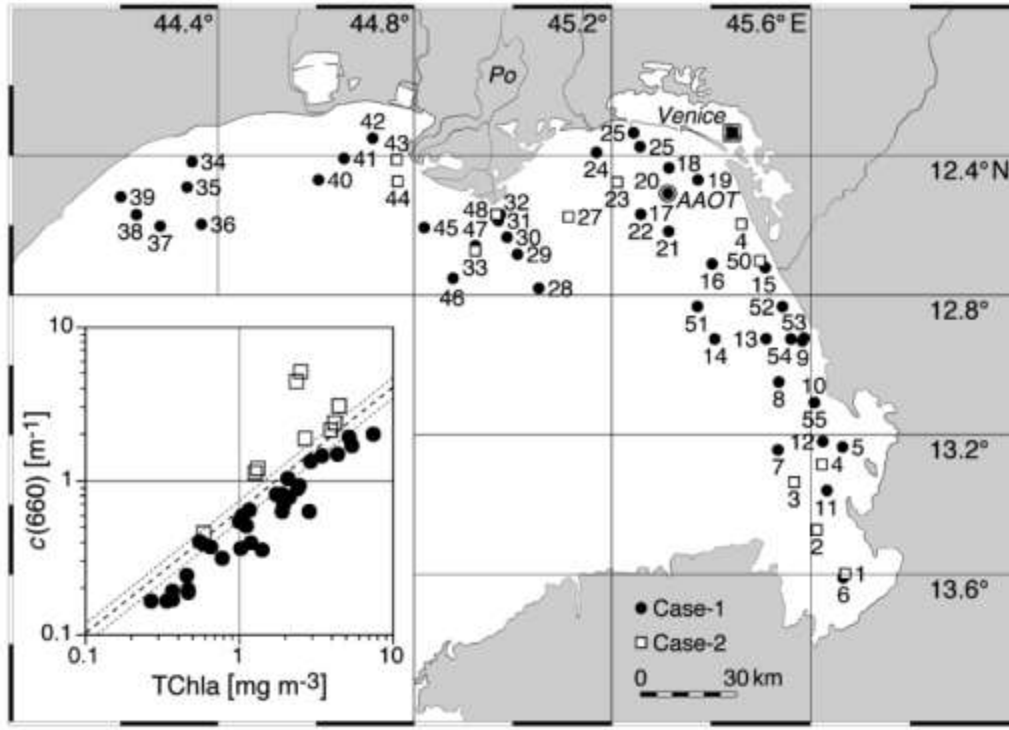
Lab.	TChl *a*	TChl *b*	TChl *c*	Caro	But	Hex	Allo	Diad	Diato	Fuco	Peri	Zea	PPig
C	4	16	31	7	79	78	27	16	56	12	53	21	33
D	5	14	30	18	65	46	9	8	31	6	104	17	30
G	8	7	9	4	76	62	14	8	66	3	52	21	28
H	7	7	17	12	145	57	9	7	64	8	68	15	35
L	7	18	15	6	71	45	6	7	32	3	57	20	24
L'	8	23	14	4	93	46	12	12	32	5	57	21	27
A'	7	14	19	9	88	56	13	10	47	6	65	19	29
SH1	7	14	26	18	24	25	39	16	56	9	13	11	21
SH2	6	16	22	17	31	10	20	9	21	5	15	21	16
SH3	6	14	15	13	15	6	4	5	18	11	30	10	12

The SeaHARRE-4 results from QA laboratories show the PPig uncertainties are frequently within the requirements for calibration and validation activities, *15% for TChl a and 25% for all the other pigments* (black), and often meet the refinement objectives (blue). Many results exceed the threshold (red), however, and the PPig average is above 25% for the first time in any SeaHARRE activity (although all laboratories are within ±5.5%). The latter is due to the difficulties in quantitating But, Hex, Diato, and Peri. The problems with these pigments are caused by analyst-to-analyst differences in quantitating peaks in the presence of elevated contributions from degradation products and extraneous compounds not found in Case-1 waters.

The Legacy of AOP Free-Fall Profilers: *Rapidly Descending Rocket-Shaped Instruments*

In the late 1990s, free-fall profilers used with small boats had high descent speeds because they were rocket-shaped devices.

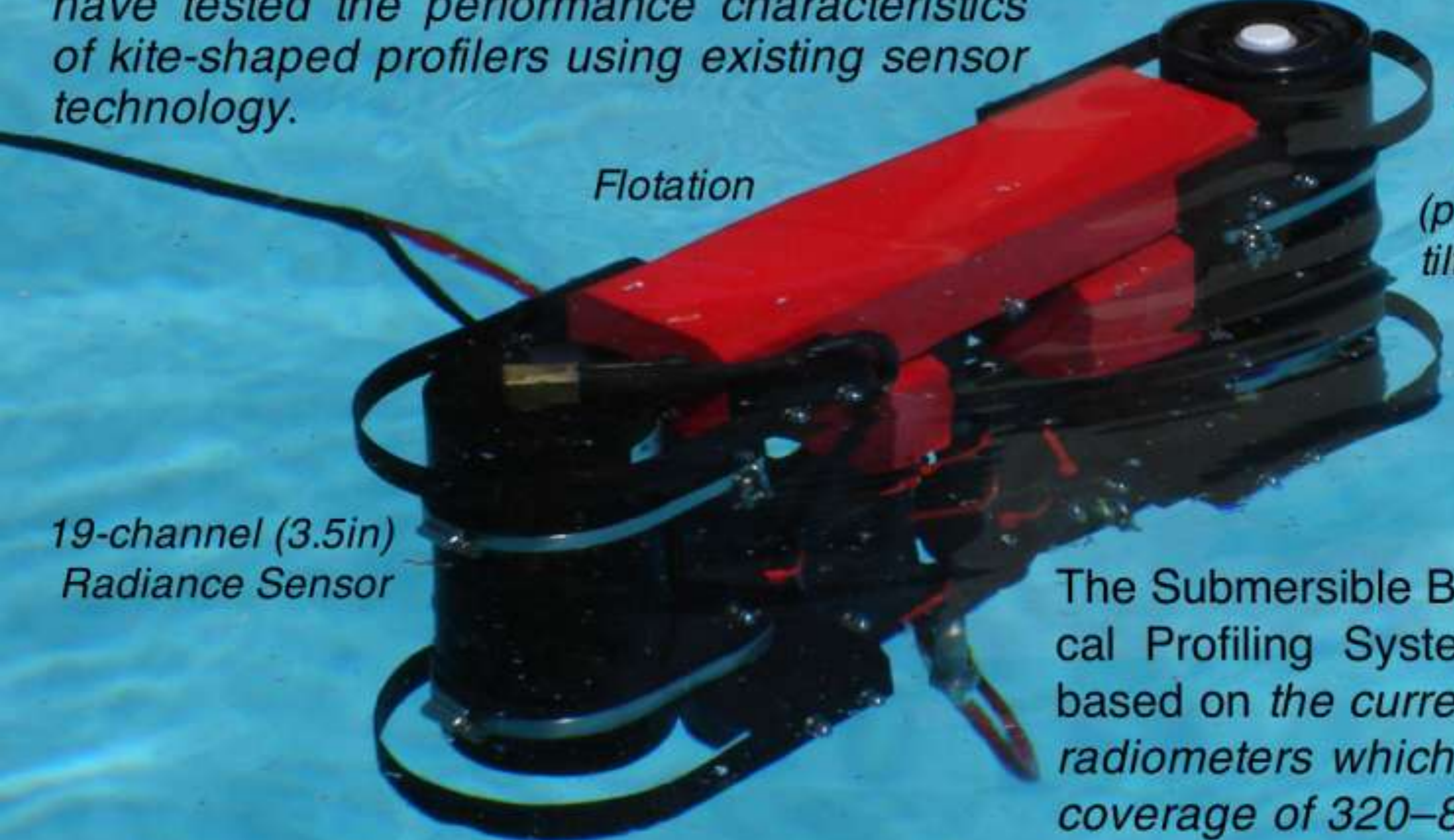




In order to improve vertical resolution, the profiler was dropped to a shallow depth, pulled to the surface and re-released. This method ultimately led to multi-casting (combining multiple casts into one) in the ADRIA-2000 field campaign. The latter works in Case-1 (homogeneous) waters, but much less so in Case-2 (heterogeneous) waters.

Practical Advancements in AOP Instruments to Improve Observations in Shallow (Coastal) Waters

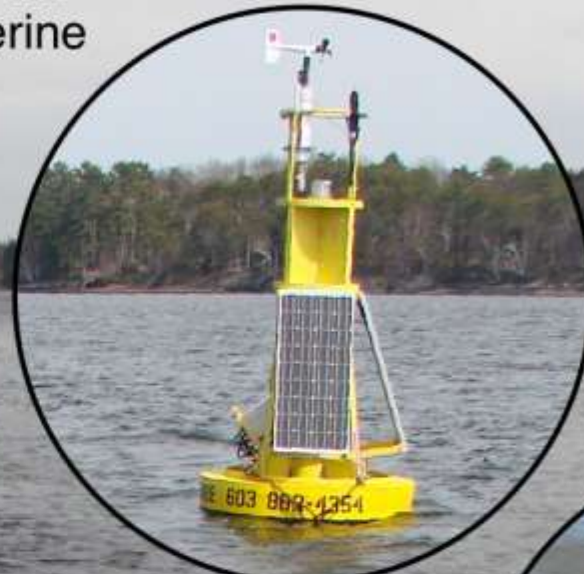
Free-fall profilers are needed to avoid platform (ship shadow) perturbations. Most are rocket-shaped devices, but *recent advances have tested the performance characteristics of kite-shaped profilers using existing sensor technology*.



The Submersible Biospherical Optical Profiling System (SuBOPS) is based on *the current PRR series of radiometers which have a spectral coverage of 320–865 nm*. The profiler is about 15 in H and 20 in W.

Submersible Hydro-optical Applications for Light-Limited Oceanography (SHALLO)

The stable dynamics of kite-shaped profilers makes them easy to trim even for very slow descents (less than 10 cm/s). The enhanced stability permits new goals for vertical tilts and resolution, even for the higher currents in estuarine and riverine waters: *2.5° (versus 5°) and 1 cm (versus 10 cm).*



For the cast shown in the left graphic, which was executed in the Newitchawonk River (New Hampshire) in 4 m water depth, there are 136 data points in the first 1 m of the cast (385 points total over 3.3 m).

Additional Advances in AOP Sensors for Optically Complex Waters

The aggregator controls the 19 individual sensors as one sensor and can store the data

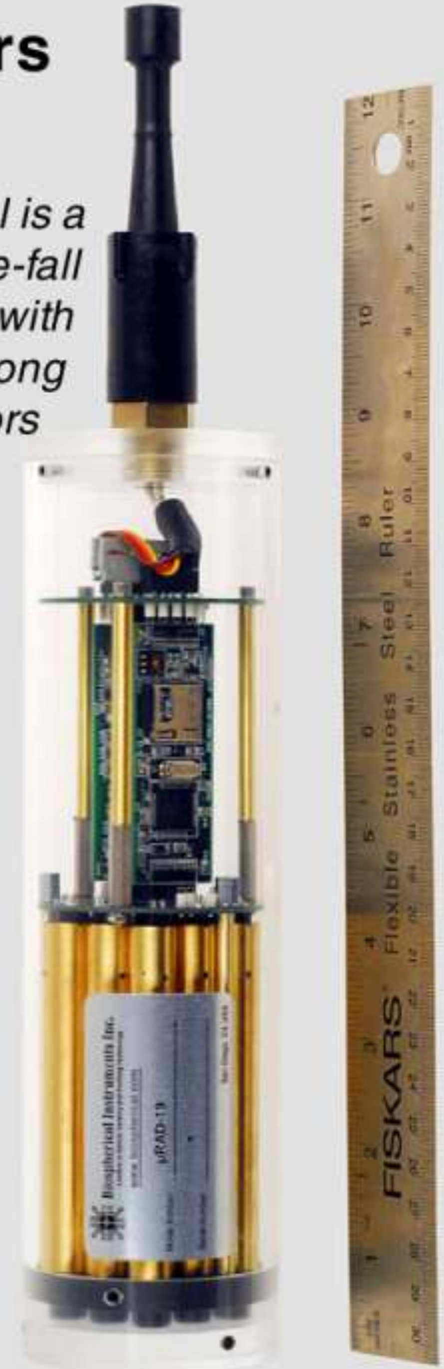
Each brass cylinder is an individual sensor

A 19-channel micro-radiometer fits in a 2.5 in (6.4 cm) cylinder—a 29% size reduction over present instruments

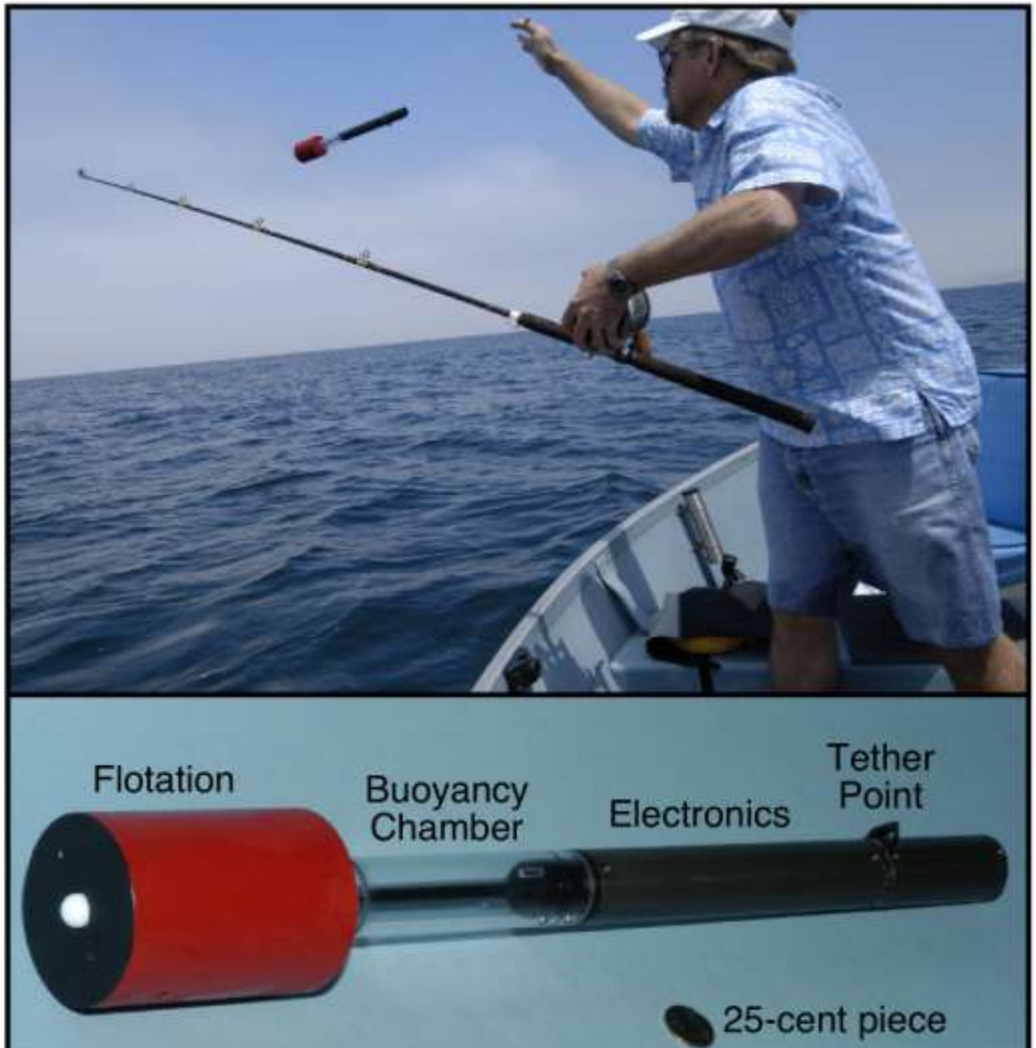
The ICs and the detector set the present size limit

A completely functional (networked) sensor with no fore-optics

The goal is a new free-fall profiler with 15 cm long sensors



Application of the Micro-Radiometers to a New AOP Deployment System: *The Castaway*



Although micro-radiometers are well suited for a variety of new applications (e.g., gliders, autonomous vehicles, balloons, etc.), *the original concept was to produce a new and easily deployed system for small-boat operations* in shallow waters. The deployment scenario is as follows:

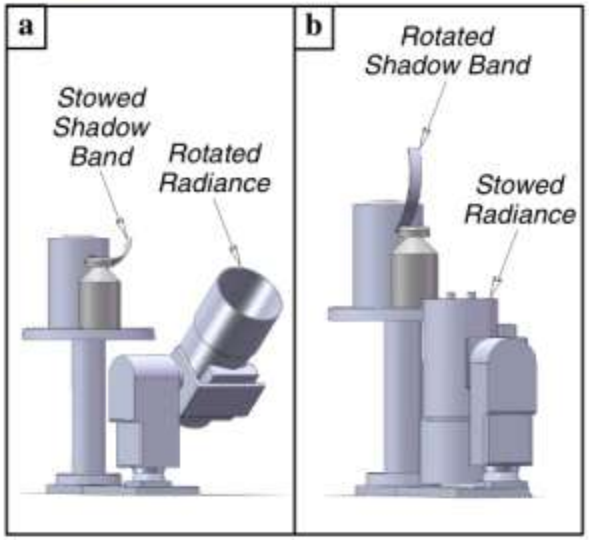
- Throw or *cast* the tethered profiler away from the boat,
- *The impact (splash) dissipates as a buoyancy chamber slowly fills with seawater*,
- The profiler begins to sink very slowly (*based on the hole size in the buoyancy chamber*), and
- Once the buoyancy chamber is completely flooded, the profiler accelerates to the terminal velocity.

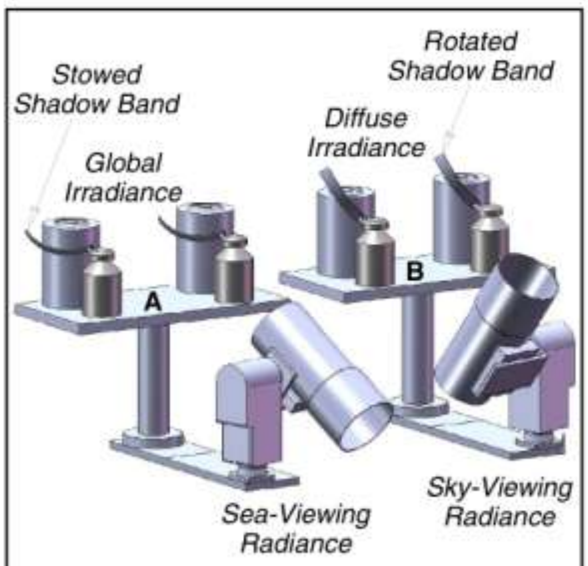
Calibration and Validation for the Next-Generation, Coupled Ocean-Atmosphere Ocean Color Satellite

The next generation of ocean color research emphasizes the coastal ocean and most likely requires simultaneous atmospheric measurements. The types of characterization problems for the spaceborne sensor which must be anticipated (e.g., polarization), are best addressed with an easily replicated system that can be set up at multiple sites in both hemispheres. The latter also permits rapid assessment of a sensor shortly after launch. The dynamic range of some of the problems is more easily fulfilled if calibration data can be acquired in waters more typically associated with validation, so bio-fouling must be minimized.

The Optical Sensors for Planetary Radiant Energy (OSPREy) concept is based on enhanced commercial off-the-shelf (COTS) above-water sensors for vicarious calibration coupled with new micro-radiometers for in-water validation.

The Principal Design Characteristics of the OSPREY Vicarious Calibration System

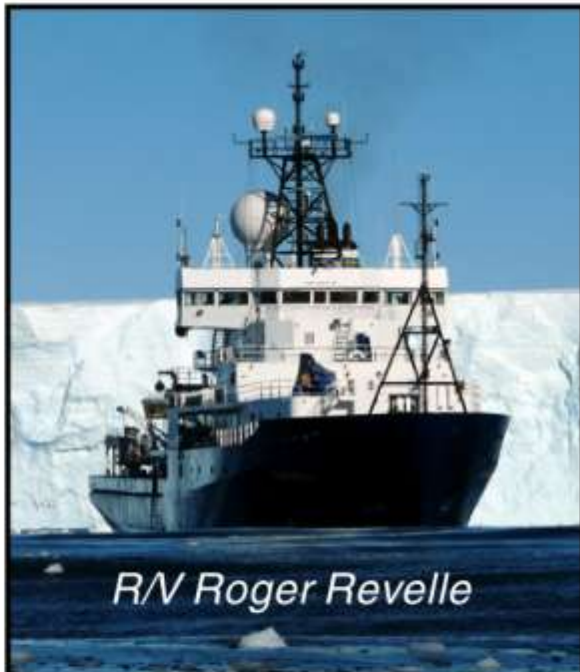


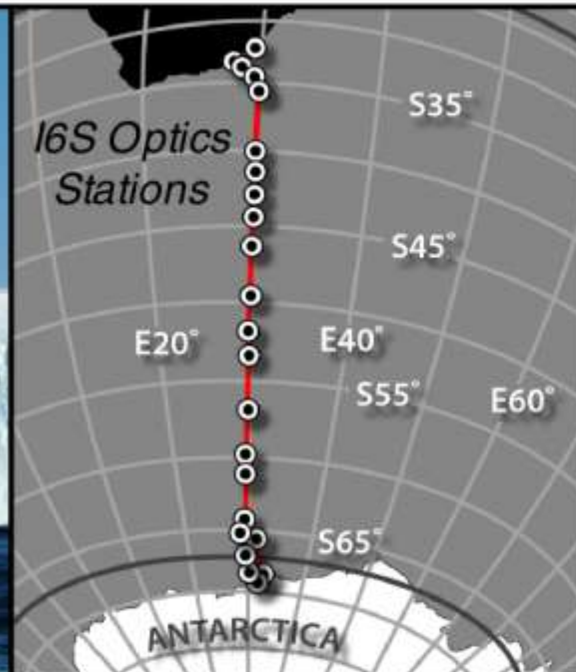


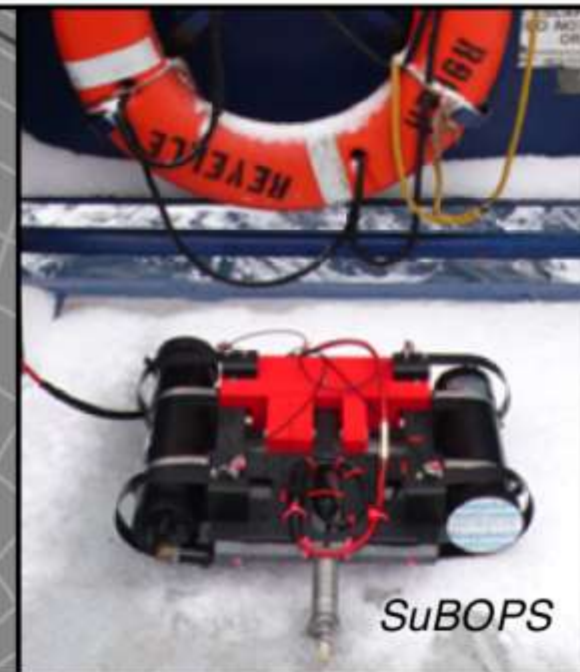
The OSPREy system is comprised of the following:

- *COTS above-water sensors to minimize bio-fouling and enhanced for accuracy and spectral coverage*;
- *Two duplicate sensor triads that are intercompared to improve data quality and minimize data gaps*;
- Programming scenarios preventing any loss of data products if one or more sensors in a set malfunctions;
- A set of mostly meteorological instruments for ancillary measurements (e.g., detecting hazardous conditions);
- *Shadowband attachments on the irradiance sensors in support of atmospheric measurements*;
- *A Sun-tracking capability to provide the needed metrology for sea and sky radiance measurements, as well as sun photometer data products*;
- Autonomous operations using solar and wind power;
- *Monthly calibration monitoring with a portable source*;
- NIST traceability and *intercalibration with other sites via the OSPREy Transfer Radiometer* (OXR); and
- *Operational deployment on an offshore structure to reduce infrastructure costs and enhance survivability.*

Climate Variability (CLIVAR) I6S Cruise: Durban (South Africa) to the Antarctic Ice Edge and Back







The primary reason for participating in the CLIVAR I6S cruise was to address the paucity of data in SeaBASS for high latitudes. SuBOPS was deployed at 24 stations, for a total of 66 casts. Of the total, 39 casts (59% of the data) were at the crucial 50 °S or higher latitudes. Seawater was also collected after each AOP cast for HPLC pigment analysis, particulate absorption, particulate organic carbon and nitrogen, and total suspended matter. In addition, biogeochemical samples for chromophoric dissolved organic matter (CDOM), flow cytometry, special CDOM characterization, and future CDOM experiments were also obtained for N. Nelson (UCSB).