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

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ABSTRACT. Over the time span of the SeaWiFS mission, there has been increased attention paid to ocean color field activities in coastal waters and a continuing commitment to produce better instrumentation. Shallow waters pose special challenges for typical oceanographic profiling systems. In-water legacy systems are not always well suited for properly resolving the optical complexity near shore, principally because of overall instrument size, proximity of the sampling platform, or rate of descent. To meet the needs of researchers interested in coastal AOP measurements, Biospherical Instruments has produced a new series of instruments specifically designed to deploy in shallow waters. The first of several optical profilers, called SuBOPS for Submersible Biospherical Optical Profiling System, is mounted to a kite-like free-fall backplane, specifically designed for stability at low fall rates. SuBOPS includes separate sensors to measure (simultaneously) multichannel downward irradiance and upwelling radiance at depth, plus global solar irradiance above the water’s surface. SuBOPS is designed for low speed descent. Unprecedented buoyancy control and low-speed stability allow safe deployments in shallow, optically complex waters. The profiles associated with Great Bay, New Hampshire. Irradiance and radiance vertical profiles were collected in stations with depths of less than 4 m of water, using freefall profiling techniques with speeds less than 10 cm/s and vertical resolutions of less than 1 cm. Deeper profiles collected at a station offshore of Isles of Shoals (Gulf of Maine) provided a more oceanic comparison.

Field Comparison

Rocket-shaped legacy instruments depend upon rapid descent speeds for stability. In contrast, the kite-shaped SuBOPS is designed for low speed descent. Unprecedented buoyancy control and low-speed stability allow safe deployments in shallow, optically complex waters. The profiles shown below display tilt angles of SuBOPS and a SeaWiFS Profiling Multichannel Radiometer (SPMR) cast in less than 5 m of water. The Case-2 limit of 1/Kd(440) in this example is <2.5 m.

Distinguishing features of the SuBOPS radiometers (and variants) are:

- Wide spectral coverage (19 wavebands 10 nm FWHM bandwidths);
- High-speed, low-noise, 3-stage amplification and 16-bit digitization circuitry (each detector is individually amplified by an electrometer grade FET operational amplifier with variable gain (10², 3 × 10², and 10⁵ V/IA) that covers more than nine decades of light levels;
- Minimum detectable signals are less than 10 fA and 1.3µV for the least significant bit;
- Out-of-band blocking greater than six decades;
- Very wide dynamic range (the system does not saturate at natural light levels even when the radiance aperture is pointed directly at the solar disk);
- Irradiance cosine departure of less than 2% from 0 - 65° and less than 10% from 65 - 85°.

Moving Ahead in 2008

With support from the NASA SBIR NNG06CA03C, in 2008, Biospherical Instruments will introduce a series of new, expandable, in situ sensors based on an entirely new technology: the microradiometer. A microradiometer consists of a photodetector, preamplifier with controllable gain, high resolution analog to digital converter (24 bit ADC), microprocessor, and an addressable digital port, all on one small, thin circuit assembly. Clusters of microradiometers, matched with front end optics (collector/window/filter stack) and coordinated by an aggregator assembly form small, fast, less expensive multichannel radiometers ideal for a variety of applications. Multiple microradiometers matched with front end optics (collector/window/filter stack) is the basis for C-OPS, the Compact Optical Profiling System. C-OPS multichannel radiometers offer a smaller, faster, and less expensive profiling alternative ideal for a variety of applications – even hyperspectral measurements.