Profiling floats for calibration/validation of ocean color

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Introduction

Earth based calibration of satellite-bound radiometers is not sufficiently accurate for ocean color applications, and hence vicarious calibration, once the radiometer is in orbit, is necessary.

Current vicarious calibration is performed using data collected at fixed sites (MOBY, BOUSSOLE) where highly accurate radiometers are moored. The limitations of such systems include: 1. small number of matchups per year (~20), 2. limited dynamic range of conditions where they operate, and 3. discrete measurements in the vertical from which surface upwelling radiance is extrapolated.

Bailey et. al., 2008, have shown that data collected on cruises from profiling radiometers and radiometer buoys can provide data of sufficient quality to be used for vicarious calibration.

Profiling floats, if proved to obtain data of high enough accuracy, provide a possibility to obtain a large number of matchups at a relatively short time after launch (by being distributed at several locations across the globe).

Including IOP sensors on the floats allows 1) closure between AOPs and IOPs to increase confidence in radiometer performance, and 2) validation of ocean color derived products.

We have begun testing the platforms (~50 profiles near BOUSSOLE in three deployments).

Platform & Measurements

A Teledyne-Webb APEX profiling float is instrumented with the Satlantic/WETLabs bio-optical sensor system. Sensors are positioned to minimize shading of radiometers and tilt of platform.

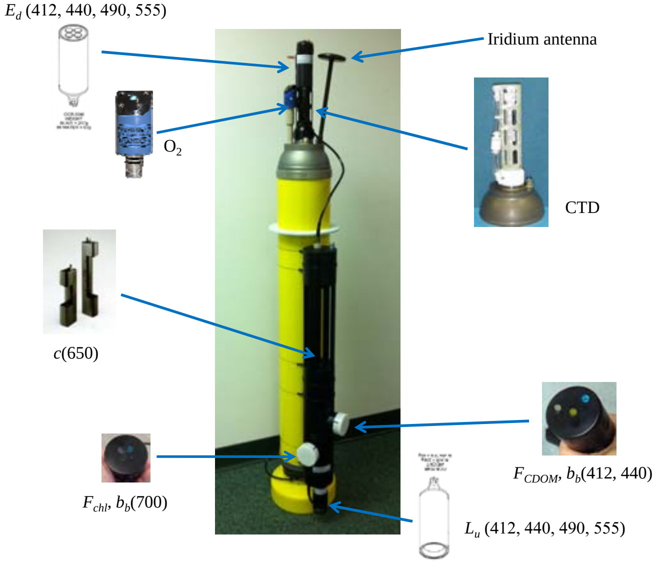

Figure 1. The BGC profiling float and its associated sensors

Deployment strategy

The float combines two frequently used deployment methods to obtain normalized water leaving radiances (nL_w): profiling radiometry and surface buoy radiometry.

1. **Profiling radiometer**:
The float collects data as it rises trough the water column. Rise velocity is typically O(8 cms^{-1}) slowing down to O(4 cms^{-1}) at the top 50m.

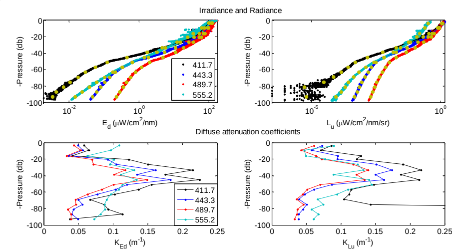

Figure 2. Radiance, irradiance and derived diffuse attenuation

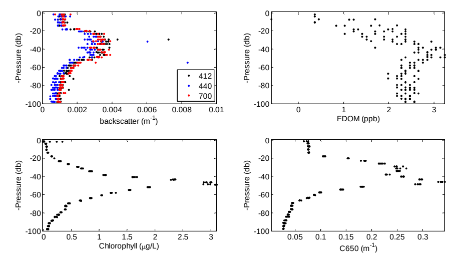

Figure 3. Spectral backscattering, CDOM and Chlorophyll fluorescence and beam attenuation. Notice correspondence of vertical features with diffuse attenuation.

IOPs and AOPs provide validation data to ocean color products. Comparisons between them increases confidence in both (closure) . Diffuse attenuation coefficients near the surface are then used to extrapolate the upwelling radiance, L_u, to the air-water interface.

2. **Radiometer buoy**:
The float collects IOP and radiometric data after surfacing (Fig. 4, 5). Tilt and compass data can be used to filter data and evaluate the effect of shadowing by float.

Figure 4. Photos of float at the surface, in the 'radiometer-buoy' position. The irradiance meter is above the air-water interface (Photos by Emilie Diamond).

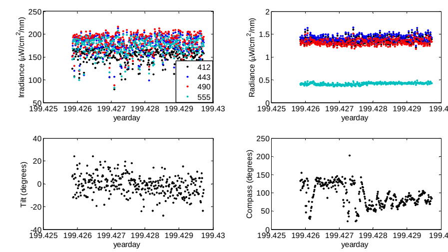

Figure 5. (float 5293, 7/18/2011). Surface radiometry (top panels) and float tilt and orientation (bottom panels).

Discussion

In order to use the float data for 'Cal' activities, uncertainties will need to be assessed and computed. Sources of uncertainties are associated with the instrumentation (e.g. drift, shadow) and processing methodology (e.g. extrapolation of L_u above the surface).

In addition, comparison between AOPs and IOPs can help in assessing quality (via closure) and bounding uncertainties on variables used in 'Val' activities.

Parting words

This work is the result of a unique partnership between academic institutions, a government lab and private companies. The fruits of this partnership are already available as commercial products (the bio-optical sensor system from Satlantic & WETLabs) and full optical float systems (Teledyne-Webb). In addition web tools to control floats (CLS in prep.), and web tools to obtain remotely sensed data associated with float location/time (NASA, in prep.) are being tested at this time.

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