A one-Year Pilot Study for the Inclusion of Active Optical Sensors into PALACE Floats

Final Report
for the National Aeronautics and Space Administration

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PROJECT FINAL REPORT

PROJECT OBJECTIVES:

The goal of this proposal was to test the use of a new generation of low drag, low power, active optical sensors on PALACE floats, similar to those used in the ARGO program. Measurements of chlorophyll *a* fluorescence and scattering of particles in the backward direction provide estimates of phytoplankton biomass and particulate concentration (which in the open ocean is mostly from biogenic sources). The major objective of this proposal is to demonstrate to the physical oceanographic community that measurements of critical interest to understanding the global carbon cycle can be made without compromising the quality of the physical measurements or the ARGO-like mission requirements. Without the physical oceanographic community's consent and endorsement, there is little hope of obtaining biogeochemical measurements within future AGRO-like programs.

PROJECT ACTIVITIES:
The efforts under this proposal can be divided into four parts:

Part 1. Sensor development and testing: A novel small sensor based on a previously developed sensor developed under NOPP was developed for this proposal integrating a Light Scattering Sensor (LSS) and a chlorophyll fluorometer with enhanced sensitivity into one small Hockey-puck size instrument. Following through testing this phase resulted in stable sensors that are resilient under pressure (see below).

Part 2. Development of an auxiliary board to interface the optical sensor with the PALACE float: Development of the auxiliary board took place at the University of Washington in collaboration with SeaBird Electronics.

Part 3. Development of a testing protocol for sensor on PALACE float: The University of Washington together with WET Labs have come up with a testing protocol that maximizes the likelihood of optimal performance in the field.

Part 4. Deployment of PALACE float with optics: We have deployed one profiling float in the North Atlantic in June of 2004 and are planning to deploy the second at the end of August 2005 in the North Pacific (it is on its way to being deployed from the R/V Thompson).

We are happy to report, despite some delays, that we were able to accomplish what we have proposed, namely the deployment of two profiling floats with CTD and an optical sensor in the ocean.

PRESENTATIONS:
NASA OCRT meeting Miami, FL, April 2003.
NASA OCRT meeting Portland, OR, April 2005.

RESULTS:
We have deployed successfully two profiling floats (Fig. 1).

Figure 1. A profiling float float equipped with Conductivity temperature and depth sensor, oxygen sensor and the optical puck (the black sensor on the right-hand side). The integration of the optics into the float was the main thrust of this proposal.

The first float has so far provided 87 water column profiles (1000m to the surface). The float has maintained position at the mouth of the Labrador Sea (Fig. 2).

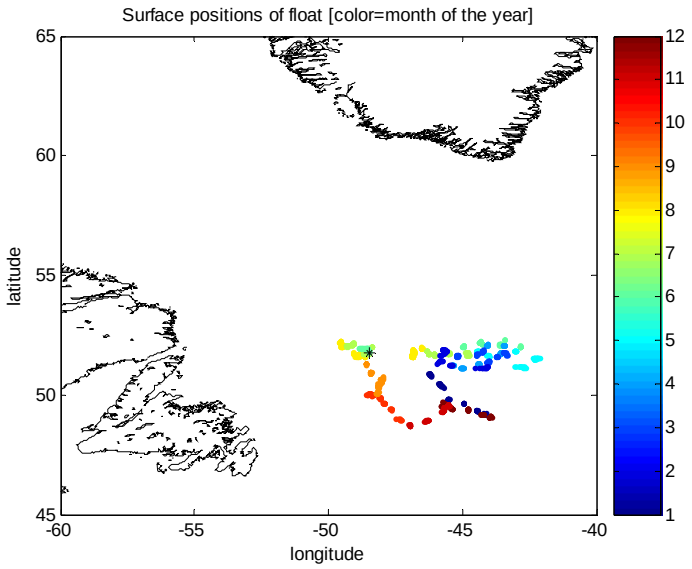

Figure 2. Position of the float as function of month of the year. Black star denotes the first position in June of 2004.

Based on the reading at 1000m the optical sensor is maintaining stability (Fig. 3). Comparison with satellite derived chlorophyll (Fig. 4) highlight the possible usefulness of this approach to interpolate in time when satellite coverage is missing due to clouds.

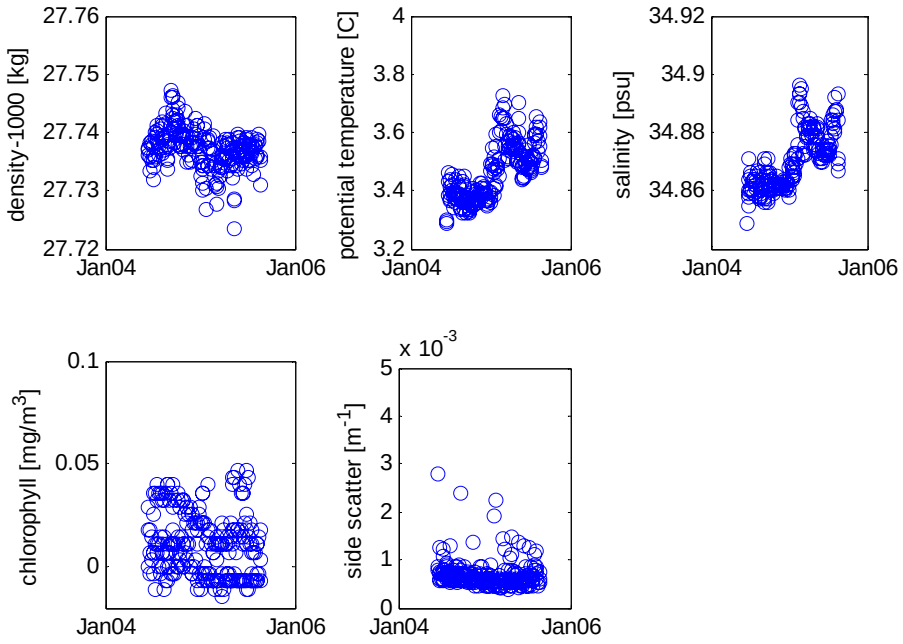

Figure 3. Values of physical and optical variables in the 900-1000m depth horizon as function of time. No noticeabletemporal drift is observed in the optical data.

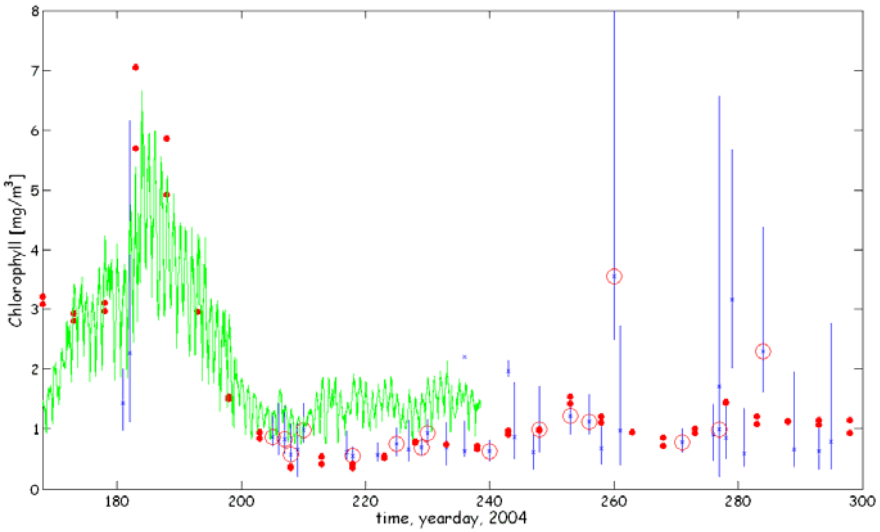

Figure 4. Comaprison of three different estimates of Chlorophyll concentration; red dots denot those based on the profiling float, green line those based on a mooring deployed at the same time as the float and blue red circles the median from NASA's SeaWIFS (with blue line enclosing 67% of the data within 50km from the float).

Compilation of the data for float 005 shows a strong annual cycle in both physical and optical properties (Fig. 5).

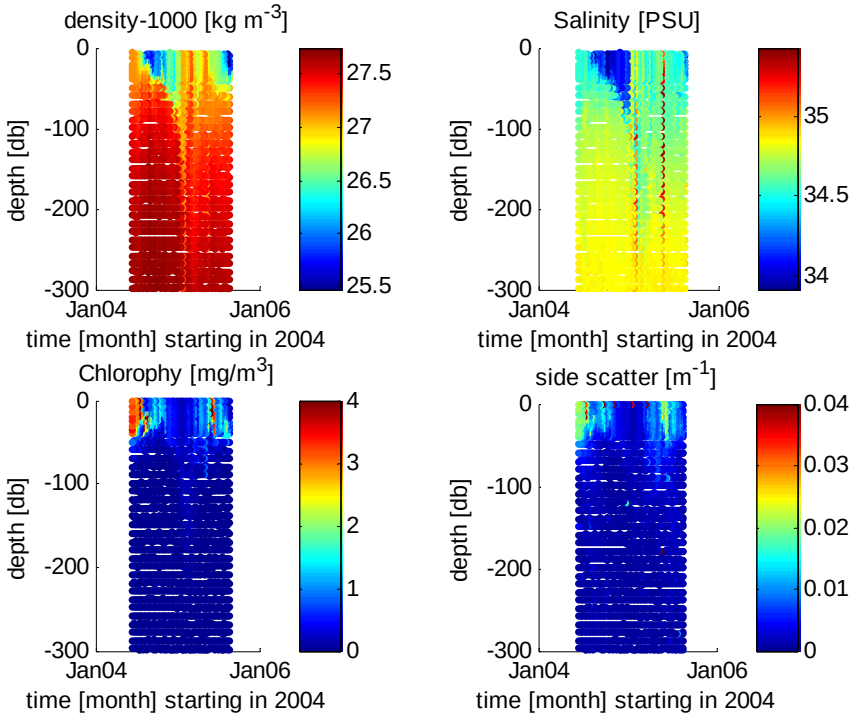

Figure 5. Density, salinity, chlorophyll and side scattering distributions at the upper 300m of the ocean from the 87 profiles performed by float 005.

Data from the floats is automatically made available to the community through the ARGO program. An additional web site where the data is displayed is: http://flux.ocean.washington.edu/argo/ . The first optical float is float 005 at this site and the second one is float 015.

We have just obtained the first profile of float 015. All seems well with the float except for noise in the backscattering data. We are currently analyzing the data to determine the source of this noise.

Following our success with optical floats several members of the oceanographic community have purchased similar sensors from WET Labs Inc. for incorporation on profiling floats (for example, Drs. Letelier from OSU and Chavez from MBARI).

RECOMMENDATIONS:

Given the success of this work NASA should get more involved in programs such as ARGO and push for inclusion of optical sensors on profiling floats in the future. Such sensors will provide unprecedented coverage of Carbon related properties extending satellite derived Carbon properties to depth. More work should be done on analyzing profiler data together with satellite data to quantify the usefulness of the approach in enhancing remote sensing coverage of biogeochemical parameters in the oceans.