Float Network Adds Ocean Biogeochemistry Data Acquisition

There are just over 3,900 floats scattered in the oceans of the globe, to continuously measure the physical characteristics of the oceans. They integrate that information into a global database: ARGO. For over 15 years the scientific community has been collecting temperature and salinity data. In 2010, a new generation of floats, with new sensors, was set up: PROVOR CTS4.

PROVOR CTS4 floats, also named PROVBIO, are equipped with biogeochemical sensors opening up new opportunities. For the floats, the sea state is not a limiting factor. At sea, as soon as the wind reaches the strength 4 or 5, measurement is impossible.

However, a float-based observation is often less accurate than the equivalent based on the ship, because some sensors are being optimised, but it allows a much wider field of view. In the case of Nitrate concentration sensor, for example, the accuracy of the observations from floats is largely lower than those of the ship based estimation. However, in the Mediterranean, 4 PROVBIO collected in two years almost the same number of profiles than those available in the existing databases based on more than 20 years of observations. Finally, research ships, floats networks, data networks and satellite observations are complementary tools. The major present debates focus more on the integration of these elements into a global ocean observing system.

Implementation

It was important for the scientists to establish an implementation framework. Indeed, the systematic mobilisation of an oceanographic vessel for the deployment of the floats is not possible, the costs would be too high.

Various methods have been used. The relatively simple deployment procedure allows to use ships of opportunity such as sailboats or trawlers for standard ARGO floats; however for the PROVBIO floats, research teams use oceanographic cruises.

In May 2015, a dedicated campaign was organised in the Mediterranean. The operator prepares the float by removing a magnet, enabling the process of starting a mission of the craft. The float performs self-testing: verification of the CTD sensor, batteries, hydraulic members, etc. When all self-testing are validated, the solenoid valve beacons some rattling, indicating that the float can serve a mission.

From a technical perspective the researcher is satisfied with this simple protocol, only the clicking of the system deserves to be optimised.

Data Acquisition

The acquisition of biogeochemical data generally occurs during the rising phase of the float. Sampling is done at a rate of 2 seconds (the speed of the float is 10cm per second). There is therefore a very high resolution with more than 2000 points per profile.

Fabrizio remembers the first ARGO floats, 10 years ago, with a few KB of internal memory ... Today, they are equipped with 8MB of memory. PROVOR-CTS4 offer a great sampling flexibility. So the team of the LOV has defined a seasonal strategy, based on the phytoplankton seasonal cycle.

In summer and fall, the cycle is scheduled for ten days. In winter, it is four days in the Atlantic, and two days in the Mediterranean. In the spring, during the planktonic bloom, the floats are wedged on cycles of one day or even three cycles a day.

In this case, the float neither has the time nor the usefulness to dive to 1,000m depth. Then it made two profiles at 400m and 1,000m depth. The idea is to develop a future project that would carry the float to conduct 6 cycles in 24 hours.

PROVOR allow even to change the drifting deep stalled initially at 1,000m. A flexibility that moves away a little of the ARGO philosophy, which must follow a very precise protocol, but which is extremely interesting in the exploratory phase, including for the physicists.

Accessibility of PROVOR data and results

All data PROVOR CTS4 are free, but not always accessible. Indeed, it is first need an international consensus for the scientific validation, before the data distribution. Fabrizio says: "A lesson learned following the first tests for measurements of oxygen, the first biogeochemical parameter measured by float. A hundred floats were deployed, and the observations were available with only a partial quality control, as the data format was different, as well as the methods used to evaluate Oxygen. All of this generated a lot of confusion, and some misleading in the interpretation of data. We learn about this experience. And now, before giving open access to PROVBIO observations,

we wait to have a robust, solid and internationally approved quality control”.

Currently, data are sent to Coriolis service center, based at IFREMER Brest, which manages the ARGO database. International experts are engaged to define a unique data processing and quality control for biogeochemical parameters, In few years, when protocols will be established and tested by research teams, Coriolis will apply them in an operational way, and it will be also in charge of their distribution.

For some parameters, such as chlorophyll, the procedure is validated (generally as published in a Rank A paper and then approved by the ARGO instances) and the data are accessible. For others, such as the Nitrates, the procedure is still under validation by the international instances.

End of Life Recovery

The recovery of certain PROVBIO remained over 3 years at sea during the Bio-Argo-Med campaign proved their robustness and quality as they were observed as being in excellent condition.

This recovery is possible with PROVOR CTS4, with an Iridium antenna. A command called "end of life" has been developed in this direction. The float is on stand-by, on the surface, and transmits its position every 15 minutes. This is doubly useful. In the Mediterranean, it can allow teams to reuse a float, to analyse its performances, and optimise the technique. A key asset for research engineering teams. However, this operation is rare in the Atlantic, due to a too large navigation basin.

In addition, the recovery of the floats can also allow to identify the reasons for the loss of some of them. These losses constitute less than 10% of the deployed fleet and correspond to floats that would have a disfunctioning between 5 and 40 cycles.

Float Development History

For over 15 years, ARGO floats follow the same basic cycle. The float is activated, dives at 1,000m depth at which it derives for 9 days, then submerged at 2,000m depth and back on the 10th day to the surface by performing a CTD (i.e. Conductivity Temperature Depth) profile, which will be sent on land via satellite. Then, the float dives again to follow the same cycle, this until it has no more batteries. A float has a life span that ranges from 4 to 7 years. Thus, a network of autonomous floats permanently supplies the ARGO database.

Inspired by the huge result of the ARGO network, the team of the Oceanographic Laboratory of Villefranche-sur-Mer (LOV) in 2006 expressed the need to add biogeochemical sensors on floats.

Thus, in addition to the conventional sensors of pressure, temperature and salinity, a series of optical sensors has been installed on a new generation of floats, which was called CTS3: a transmittance sensor for the measurement of opacity, ECO3 a sensor which measures simultaneously fluorescence, backscatter, and CDOM (dissolved organic material), and an irradiance sensor. There are also two nutrients sensors (American SUNA and ISUS sensors) and a sensor (AAnderaa Optode) for measuring dissolved oxygen.

In 2010, the European project remOcean (PI. Hervé Claustre, LOV) conducted to the establishment of another step forward: the CTS4 float. On CTS4 two different electronics cards are put in place, which improves the technique without changing the displacement method. Additional sensors can be easily added to the float and for most of all, the capacity of storage, processing and volume of the transmitted data can be increase thanks to resolutions much finer and modifiable by the user.