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E-AIMS

Euro-Argo Improvements for the GMES Marine Service

Deep float experiment design

D2.221

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1. Introduction

1.1. General presentation

This document gathers the design of the test to be performed with the Argo Deep floats in the framework of the E-AIMS project

The IEO is leading *task 2.2 Test of new deep float* and will be testing two prototype of deep Argo floats designed by Ifremer that are capable of reaching depth up to 4000 dbar. These prototypes are now commercialized by NKE who is in charge of performing the industrialization tasks. The floats to be tested in the framework of task 2.2 will be part of the first batch prototypes and of the second generation of floats. The test will be carried out in the Canary Basin.

This report is the deliverable D2.221 identified in the description of work in the table WT 3, page 12, which is due by the end of October 2013 (T0+10), T0 being the 1st of January 2013.

1.2. Applicable documents

DA-1: Annex 1 to the grant agreement N0 312642: "Description of work", date 21 Junel 2012.

2. Extending Argo to the deep ocean

The Argo network is actually the most important component of the Global Ocean Observing system (GOOS) with 3500 floats that profiles every 10 days the upper 2000m of the ocean. Since the launch of the program, about 10 years ago, the Argo network has collected more that 1 million profiles over the global ocean, which corresponds to about twice the number of profiles than had been collected by all the research vessels during the whole 20th century. These data have been crucial to contribute to understand the role of the ocean in the climate system. However, the concern that part of the budget of sea level rise may be due to the steric contribution from the deep ocean (>200m) has increased the interested in the deep ocean. Data from the repeated hydrographic sections program have been used to estimate this contribution (Johnson et al., 2008 and Purkey and Johnson, 2010). Nevertheless, the sparse geographical and temporal coverage of accurate measurements of deep water, with oceanographic sections covered, at most, every 5 years (Vélez-Belchí et al., 2010), has raised concerns about the statistical significance of decadal trends in the deep ocean estimated from the spare hydrographic data (Aucan and Llovel, 2013).

In this context, monitoring the deep ocean below 2000 meters is one of the main necessary evolutions of Argo.

3. Test for the deep Argo prototypes

The initial implementation plan for the upper ocean (<2000m) Argo array was designated based upon the experience of the XBT program, the TAO array and the Jason altimeter mission. Altogether these three different operational programs permitted to do the statistical analysis necessary to define the targeted 3x3 density and establish 1500m as the parking. This network configuration permits the sampling of global anomalies in temperature and heat storage and a cost-effective signal-to-error sampling of large-scale oceanic variability.

However the case for the deep ocean is by far very different, since there are fewer deep ocean observations, and even fewer time series. Possibly, the Hawaii Ocean Time series (HOT) and the

Bermuda Atlantic Time-series Study (BATS) are the only deep ocean time series.

In this context, the first test of the deep Argo floats pursue the objective of maximizing the amount and frequency of deep ocean data, but keeping it cost-effective, in the sense that the deep Argo floats should have a lifetime (3yrs) close to the upper ocean Argo floats.

Ifremer has designed a prototype of deep Argo floats (Arvor) that is capable of reaching depth up to 4000 dbar. These prototypes are now commercialized by NKE who is in charge of performing the industrialization tasks.

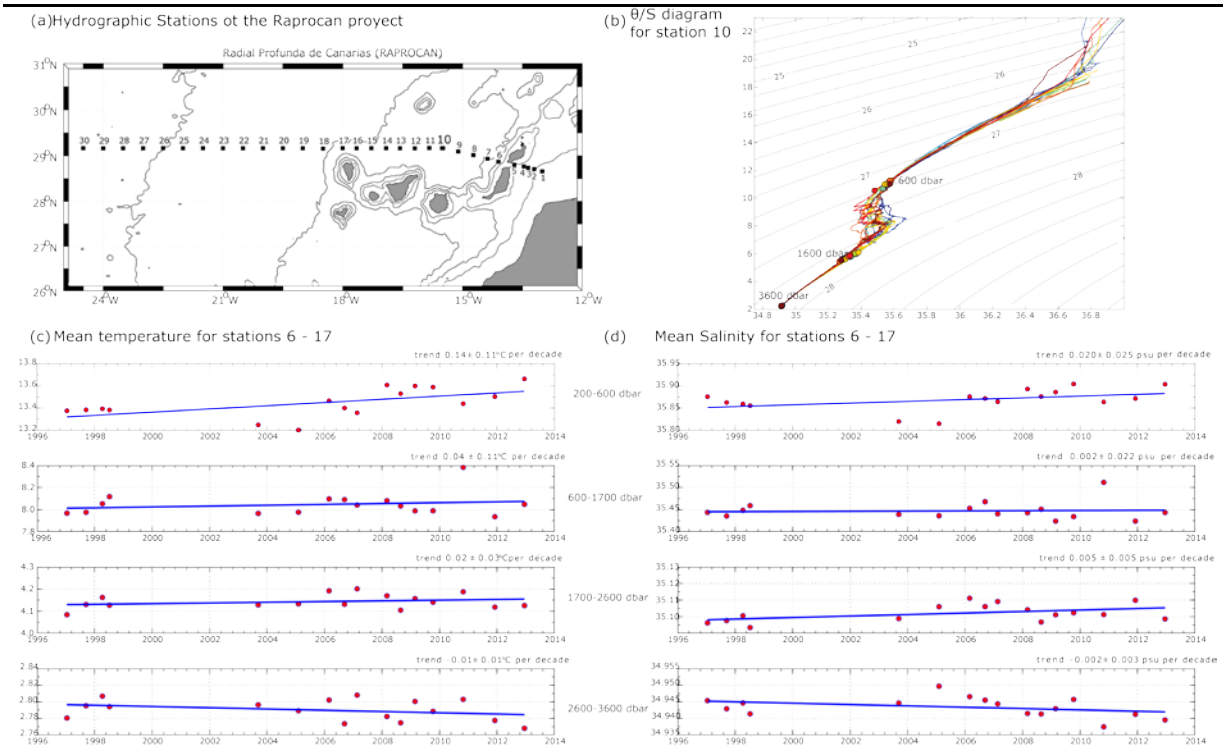

Figure. (1) Distribution of CTD stations performed twice a year in the Canary basin by the IEO in the framework of the core program Raprocan. (b) T/S diagram of the 1997-2013 time series at station 10. Trends of (a) temperature and (d) salinity at different pressure intervals.

Two of these deep Argo floats designed by Ifremer will be deployed in the Canary Basin during 2014.

The Canary Basin has been chosen because of its relatively quiescent environment that will make possible to assess the long-term stability of the float sensors at depth. Additionally, the IEO is conducting periodic hydrographic surveys every two years since 2006, and extending back at different sampling rates to 1997. The 16-year times series has permitted to establish a trend for the upper deep waters (2600-3600dbar) of 0.001ºC and 0.002 in salinity per year. These values (per year) are smaller than the accuracy of the CT sensors in the present generation of Argo floats.

To optimize the feedback with the developers (NKE and Ifremer) of the deep Argo floats, the deployments will be done in the second year[1]:

During winter of 2014 (March/April) the first deep Argo will be deployed in the Canary basin, in the area (station 10) covered by the hydrography program of the IEO (Raprocan). This float will be part of the first batch of prototypes.

[1] This is different to what was established inthe DOW, however it better suits the objectives of the project, since this deployments scheme will allow to optimize the feedback with the developers witinh the duration of the project.

With the results of the first tests, the second float will be constructed and updated if necessary, and deployed at the end of 2014 (October) in the Canary basin. This float will be part of the second generation of industrial prototypes.

There are planned cruised for both dates, and in the worst case scenario, there are back up planned cruises In the Iberian basin, where the IEO has also a long term observation program.

To maximize the amount of data but keeping the floats cost-effective three sea-experiments has been designed.

In the first one, to be carried out during the first 3 months, the floats will be parked at 1500dbar, profiling to 3500 dbar every 10 days, in the same way the upper ocean Argo floats sample. This experiment will permit to assets the local variability of the deep ocean in the Canary basin, and estimate the power consumption of the prototype. During this test, the CTD is continuously pumped from the start profile depth, and 200 points (roughly the same resolution as most of the Argo floats) will be used.

In the second one, and after the initial 3 months, the floats will be parked at 1500dbar, profiling to 2000 dbar every 10 days, and to 3500 dbar every 5 profiles (once a month). This experiment will permit to assets the local variability of the deep ocean in the Canary basin, and estimate the power consumption of the prototype in an power-consumption scenario that should be closer to the one for the upper ocean argo floats. During this test, the CTD is continuously pumped from the start profile depth, and 200 points (roughly the same resolution as most of the Argo floats) will be used.

In the third one, and after the initial 6 months, the floats will be parked at 1500dbar profiling to 2000 dbar every 10 days, and to 3500 dbar every 5 profiles (once a month). The vertical sampling scheme will be modified from the continous mode, used in the previous experiments, to a single point measruemtent in order to assest the power comsumption asosciated to the continuos mode.

The three tests will be repeated during the lifetime of the prototype. During the tests the IEO's scientist from this task will be in touch with the developers (NKE and Ifremer) in order to adapt the monitoring of the prototype performance or to modify the tests in order to maximize the amount of deep ocean data.

In the DOW it was described that this deliverable would be due by the end of October 2013 (T0+10), however the final pressure test of the first prototypes will be carried out at the Ifremer facilities in Brest during January/February 2014. If after the discussion during this test this report should be upgraded, an updated version would be written before the sea-tests.

4. Summary

Two deep Argo floats developed by Ifremer will be tested by the UIEO in the Canary basin during 2014. The tests has been designed to maximize the amount of data, since the deep ocean time series are scarce, but keeping the floats cost-effective and therefore monitoring the power consumption. During the first month of 2014 the final pressure tests of the floats will be carry. IEO's scientist from this task may assist in the test and discuss with the developers of the floats any update in the design of the sea-test of the floats. Any change will be updated in this report.

References

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