Deep-Arvor floats (4000m) : first results and future plans

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Deep-Argo: A pilot study in the North-Atlantic Ocean

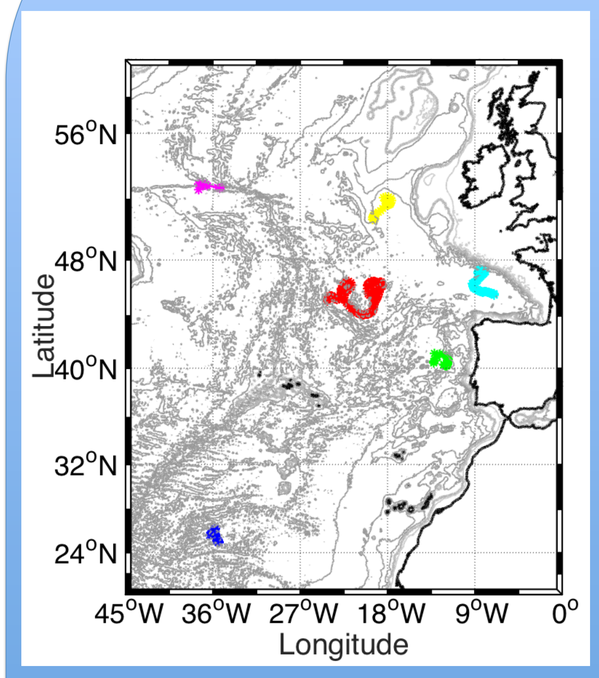


Figure 1: Positions of the 8 Deep-Arvor deployed in the North-Atlantic since 2012.

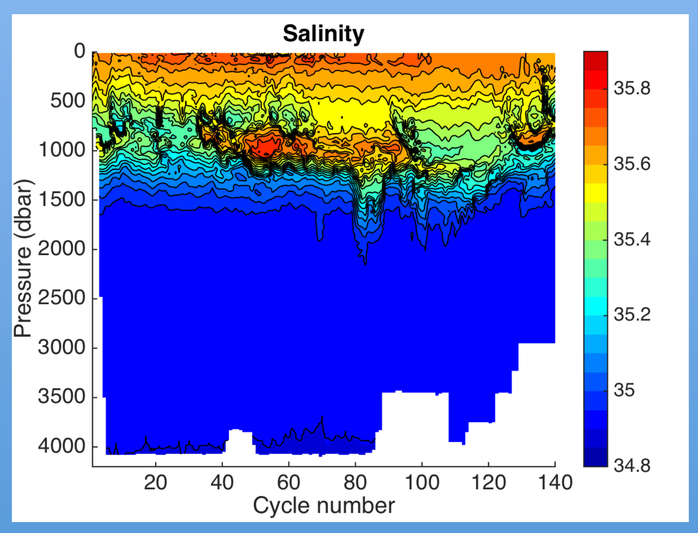
As part of the NAOS project (Equipex/ANR), 8 Deep Arvor were deployed in the North-Atlantic Ocean since 2012 to conduct a pilot study for a future Deep-Argo array (Figure 1). 16 additional floats will be deployed as part of this project before end of 2017.

The Deep-Arvor float is an Argo float designed to achieve more than 150 profiles at 4000m m (4120 db) depth (Le Reste et al., 2015). It is equipped with a SBE41CP CTD. Oxygen measurements are in option (4330 optode).

The floats were deployed either in stable area to assess the quality of the CTD sensor or in the highly variable North-Atlantic where the deep water masses are formed.

The floats were programmed either following Argo recommendation (10 days cycle, 1000 m parking depth) or with a very specific programmation:

- 2 days cycle to get a rapid feedback on the behavior of the float and of the sensors
- Parking depth at 2750 m to follow deep water mass pathways



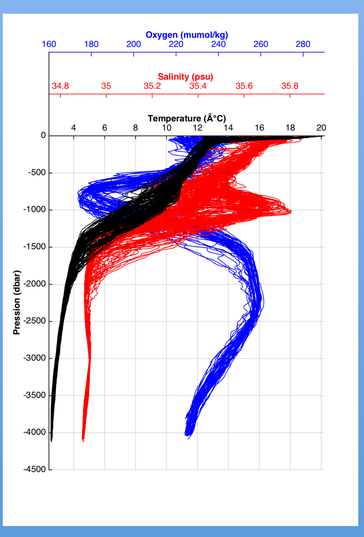


Figure 2: Data of float 6901632 (red stars on Figure 1) that acquired 142 cycles (1/3 of the profiles measured O2) down to 4000m depth or the bottom. (Left panel) Salinity section. (Right panel) Vertical profiles of temperature, salinity and oxygen.

Is the SBE41 CTD biased toward low reading ?

The 4 floats deployed between 2012 and 2014 underestimated salinity by 0.01-0.02. This is shown by the reference profile acquired at float deployment and by the OW method (Owens and Wong 2009) modified for the North-Atlantic by Cabanes et al., (2015) and applied to each float (Figures 3 and 4).

Interestingly, in most cases the OW method would not have detected those bias with 0-2000m profiles only (Figure 4).

First analysis suggests that 2 of the 4 floats deployed in 2015 (yellow and pink stars on Figure 1) also underestimate salinity.

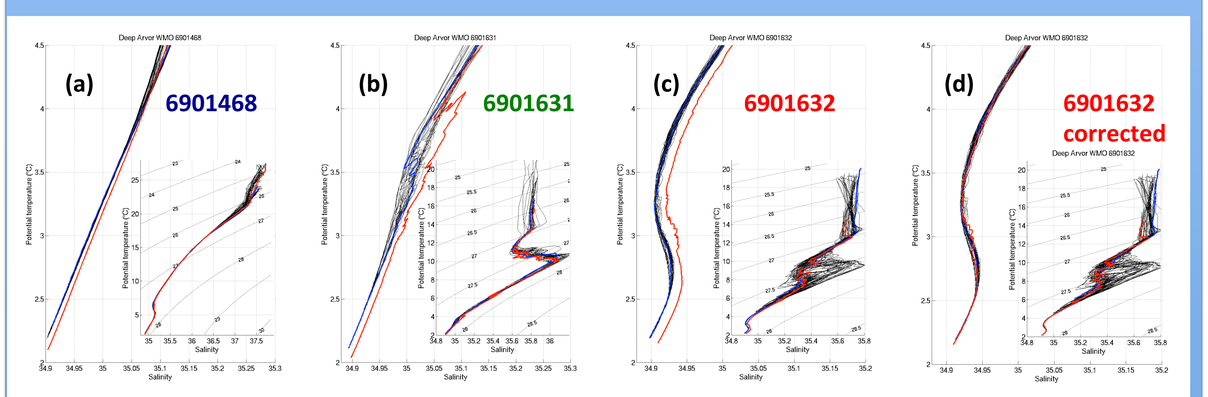


Figure 3: Theta/S diagram of the profiles collected by (a) float 6901468, (b) float 6901631, (c) float 6901632 and , (d) 6901632 in using the corrected salinity following the OW method. The floats are identified by the blue, red and green stars on Figure 1, respectively. On each panel, the large figure is the theta/S diagram in the deep layers while the theta/S diagram in the inner plot represent the diagram for the full water-column. (Black curves) Deep-Arvor floats data. (Red curves) Calibrated reference profiles collected at float deployment. (Blue curves) Nearest float profile compared to the calibrated reference profile.

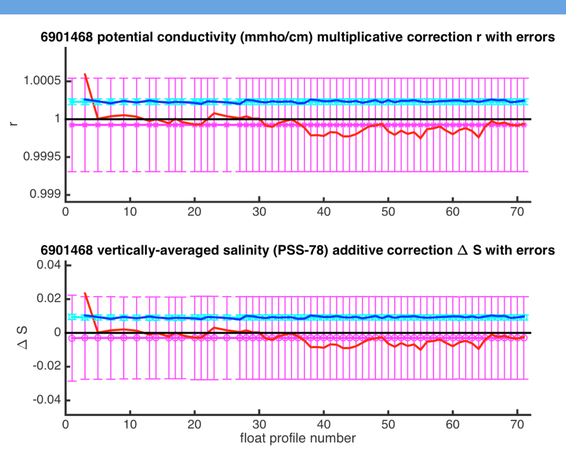
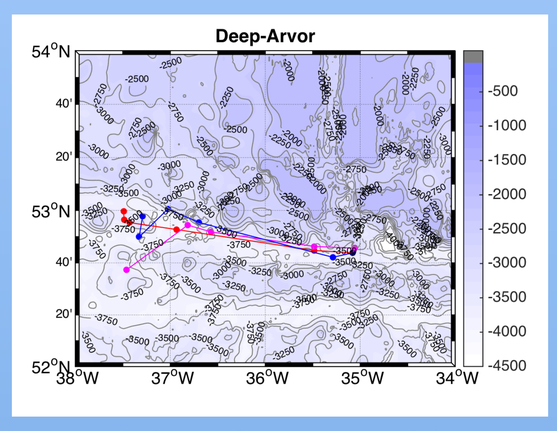


Figure 4: Correction proposed by the OW method for Deep-Arvor floats 6901468 (identified by blue stars on Figure 1). (Upper panel) The red (blue) curve represents the conductivity correction term for each profile while the magenta (cyan) line is the final correction term with one sdandard error when considering layers shallower than 2000 dbar (layer deeper than 3000 dbar). (Lower panel) Same as upper panel but for the vertically averaged salinity correction.

Monitoring deep water masses

Four floats were deployed in 2015. Three of them (pink stars on Figure 1) were deployed in the Charlie Gibbs Fracture zone in order to follow the pathways of the Iceland-Scotland Overflow Water and the evolution of its properties.



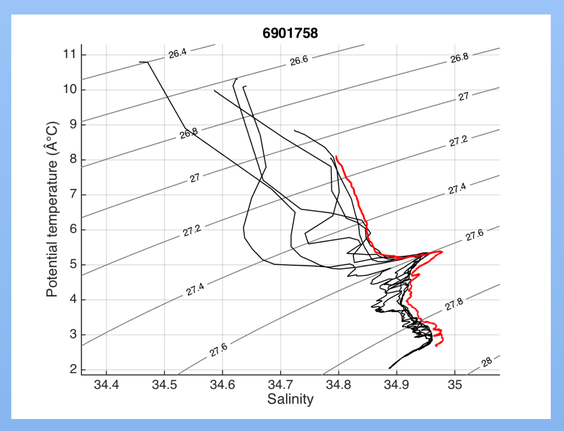


Figure 5: (Left panel) Trajectory of the 3 Deep Arvor deployed in the Charlie Gibbs Fracture Zone in 2015. (Right panel) (Black curves) Data of float 6901758 (Red curves) Pre-calibrated reference profiles collected at float deployment.

Conclusion

Eight Deep-Arvor floats were deployed between 2012 and 2015. The ability to achieve profiles at 4000m has been proven since one prototype already achieved 142 cycles with oxygen measurements and the CTD pumping continuously.

The data are of good quality although a systematic bias of about 0.01-0.02 toward lower salinity was observed. The bias is not pressure dependent and owing to the water mass stability below 2000m, it is easily detected and corrected, which is not the case when considering the 0-2000m layer only.

As part of the NAOS project, new deployments are planned for 2016 (4) and 2017 (12).

References

C. Cabanes, V. Thierry, C. Lagadec, Improvement of bias detection in the conductivity sensor of Argo float. Application to the North Atlantic Ocean. To be submitted to DSRI.

Owens, W.B. and Wong, A. P. S., 2009. An improved calibration method for the drift of the conductivity sensor on autonomous CTD profiling floats by Θ-S climatology. Deep-Sea Res. Part I, 56:450–457.

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