Deep-Arvor: Technology & results from the first deployment

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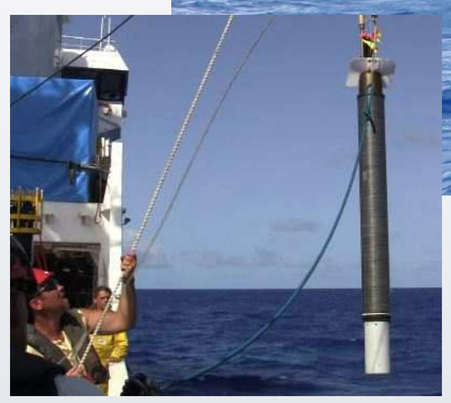
Deep-Arvor has been designed to achieve more than 150 profiles from 4000 meters depth, with CTD continuously pumping and oxygen measurements. The first prototype of Deep-Arvor was deployed in August 2012. High resolution profiles are transmitted by the Iridium satellite system. Deep-Arvor maintains the self-ballasting feature of Provor/Arvor and the easy deployment of Arvor thanks to its light weight.



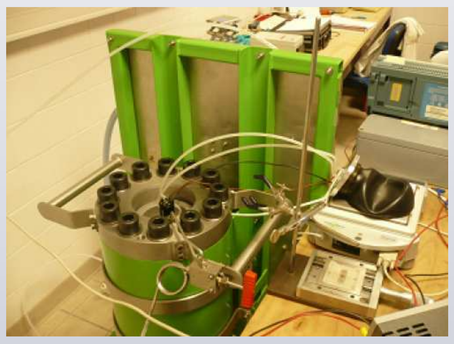
Deep-Arvor deployment (Strasse 2012)

✓ The starting point of the development is Arvor (2000m), whose sub-assemblies have been improved and extended: the SBE41CP CTD includes a reinforced pump, the volume of the hydraulic pump has been decreased in order to address the high pressure constraint, the volume of oil has been increased to fit with the new range of depth (and future additional sensors) and the antenna has been strengthened.

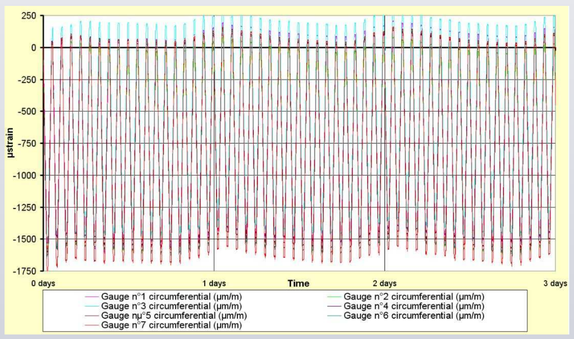
The housing is made by filament winding. This technology gives lightness while maintaining the withstand of the pressure. It also offers manufacturing advantages (ordering by few units, reducing costs).

The heart of Deep-Arvor is the I535 electronic controller already used in Arvor for several years.

✓ Sub-assemblies have undergone intensive tests: several hydraulic engines passed the equivalent of 150 cycles at operating pressure; the composite housings withstood the cycles of compression and steady state which are representative of their life; the effect of swell has been assessed; real time missions were performed in the pressure tanks or in pool.



Hyperbaric tests of hydraulic engine



Housing: pressure cycling, circonferential gauges.

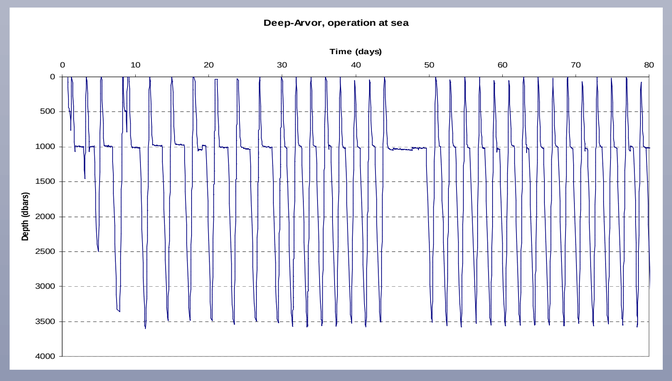
Pressure tank testing

Swell testing in pool

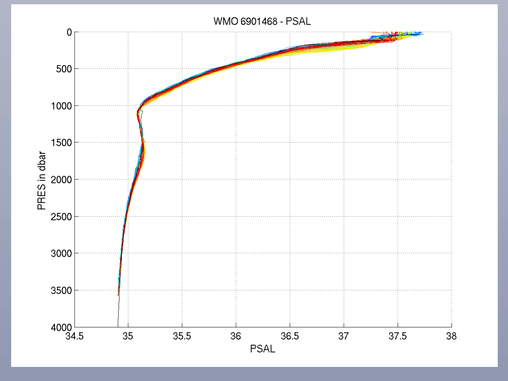
✓ Industrialization phase: first units planned for 2013 (NKE Manufacturer)

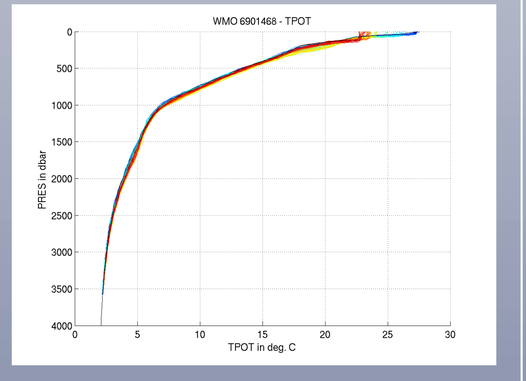
First results at sea:

- The first prototype has achieved 60 profiles at 3500 dbar between August 2012 and January 2013, cycling every 3 days in mid-Atlantic ocean.
- It was not only deployed in a very stable area but it also remained in a 2x2 box. This allows a quantification of sensor bias and drift through comparison to nearby historical CTD profiles and a calibrated CTD profile acquired few days after deployment. The temperature sensor works very well. The salinity sensor exhibits a fresh bias of 0.01. The oxygen sensor is biased by about 40 μ mol/kg (a correction as function of oxygen is proposed) and the data suggests a drift of the oxygen sensor of about few μ mol/kg over the 6-month lifetime of the float.



First Deep-Arvor cycles

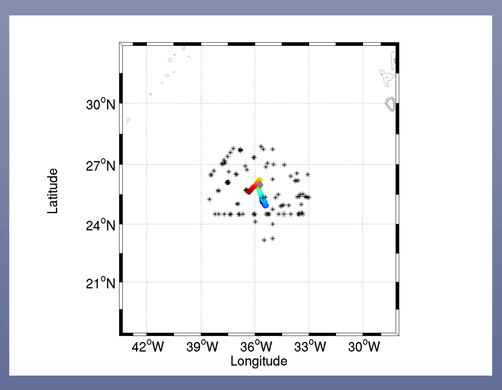




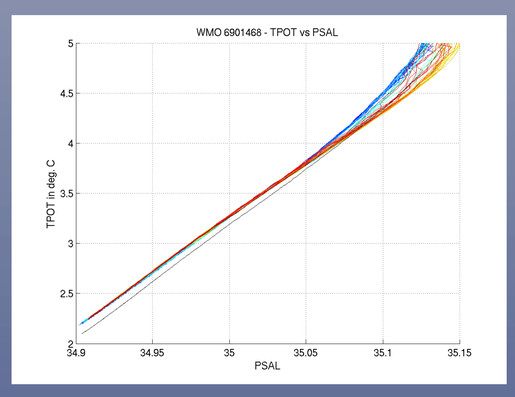
Deep-Arvor salinity (left panel) and potential temperature (right panel) profiles. The colors characterize the date of the profiles: the first profile is in blue and the last one in red.

Main features of Deep-Arvor:

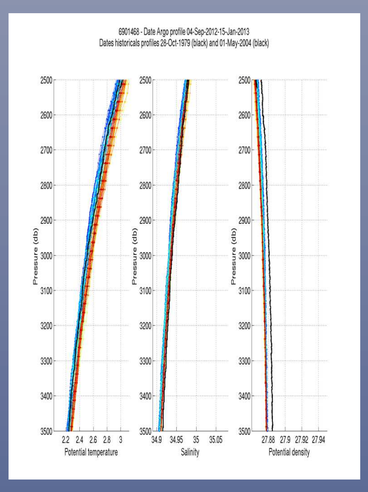
- Operational depth: 4000 meters,
- Pressure test: 4580 dbars
- 150 profiles at 4000 meters depth,
- Seabird 41CP CTD + Aanderaa 4330 optode (raw data: phases + T),
- Fully programmable cycle during operation (period, parking & profile pressure, alternate pressure to go deeper every *n* cycle…),
- 3 sampling areas (depth, middle, surface) with high resolution capabilities (1 meter),
- Over 1000 points profile with CTD & DO transmitted (programmable),
- Iridium transmission & GPS positioning, mission parameters are remote controlled,
- Weight in air: 26 kg,
- Dimensions: hull diameter 14 cm, total length 216 cm.



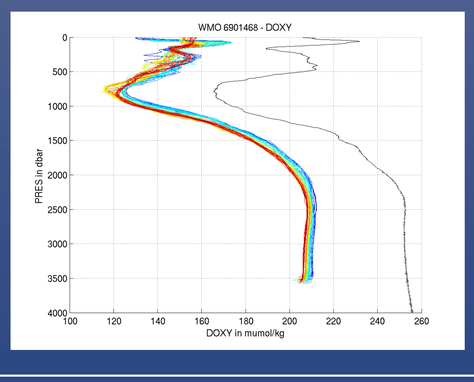
Position of Deep-Arvor cycles (colored circles), of the historical CTD (black crosses), and of the CTD acquired at the float deployment (gray circle). The colors characterize the date of the profiles: the first profile is in blue and the last one in red.



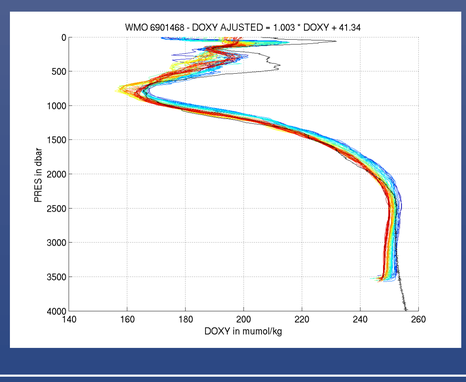
θ/S diagram in the deep levels. Data from the Deep-Arvor are colored (see legend on the left) and data from the calibrated CTD acquired at float deployment are in black. The comparison suggests a fresh bias of the conductivity sensor of about 0.01.



Deep potential temperature, salinity and potential density profiles. Data from the Deep-Arvor are colored (see legend on the left) and data from historical CTD are in black. The comparison also suggests a fresh bias of the conductivity sensor of about 0.01.



*Oxygen profiles. Data from the Deep-Arvor are colored (see legend above) and data from the calibrated CTD-O2 data are in black. The comparison suggests a bias of about 40 µmol/kg and the float profiles exhibit a drift toward lower oxygen value. (Left panel) Uncorrected Argo data. (Right panel) Corrected Argo data (DOXY_ADJUSTED = 1.003*DOXY +41.3).*



This development has been achieved within the **NAOS - Novel Argo Ocean observing System -** project framework (www.naos-equipex.fr). It is one of the projects selected in the *Equipex* call for proposals of the French program "*Investissements d'avenir"* (www.naos-equipex.fr). Its two main objectives are:

• To consolidate the French contribution to the Argo core mission (global temperature and salinity measurements) by deploying 10 to 15 additional floats per year from 2012 to 2019 (in total 110 floats).

•To develop and validate the next generation of Argo profiling floats. New float capabilities will include: improved performances, integration of biogeochemical sensors, deeper measurements and under ice operations in the polar seas. NAOS is a strong partnership between IFREMER (coordinator), UPMC (co-coordinator), CNRS, UBO/IUEM, SHOM and two private companies: CLS for satellite telecommunication aspects and the NKE SME which is in charge of the industrialization and commercialization of French Argo floats.

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