Extending the Argo network to the deep ocean

Authors: Pedro Vélez (IEO), Virginie Thierry (IFREMER), Serge Le Reste (IFREMER)

Description of the new technology and its importance for science and applications and E-AIMS experiment

The actual Argo global array of profiling floats measures temperature and salinity of the upper 2000 m of the ocean, but there are scientific evidences that demonstrate that the deep ocean plays an import role in the climate system. Since the mean depth of the ocean is about 4267 m, the measurements in more than half of the ocean volume relies in sparsely and infrequently ship born repeat hydrography cruises (Figure 1). The sparsely sampled deep ocean data indicates that the deep ocean is an appreciable contributor to the intake of the 90% of the thermal energy accumulated in the Earth's climate system over the last four decades and absorbed by the ocean. These data also reflects changes in the hydrological cycle, since the observed changes in the deep and abyssal water masses properties are consequence of changes in the processes that control freshwater fluxes, this is evaporation and precipitation (Rawlins et al. 2010), sea ice production and export (Serreze et al. 2006), and glacier and ice sheet melting (Hanna et al. 2013). Since warming and freshening seawater expands and therefore raise sea level. A significant contribution to mean sea level rise come from a warming of the abyssal ocean below 2000 m (Purkey and Johnson 2010, Kouketsu et al. 2011, Frajka-Williams et al. 2011). To understand fully the sea level rise budget, we must measure routinely and globally temperature and salinity in a statistically significant part of the ocean, not just half of the ocean volume as routinely measured nowadays by Argo. The impact of the deep ocean is not only in terms of the heat and freshwater budget, the deep-ocean currents as well as deep-reaching mesoscale eddies contribute to the global redistribution of temperature, salinity, and other water properties including nutrients, oxygen, and carbon. The sparsely sampled deep ocean data indicates circulation variability in the deep western boundary currents (Johnson et al. 2008), which suggest that climate variability may be rapidly communicated to the global deep ocean via deep boundary currents (Masuda, et al. 2010, Heimbach et al. 2011).

Results The *Deep-Arvor* float has been designed by Ifremer to achieve up to 150 profiles to 4000 meters depth, with a continuous pumping of the CTD. The objectives were to keep a high level of measurement quality with a cost affordable instrument. The first manufactured prototypes of *Deep-Arvor* were successfully deployed in May 2013 in the North Atlantic ocean (Figure 1). As part of E-AIMS, two *Deep-Arvor* floats will be tested by the IEO in the Canary basin during 2015, a region characterized by its stable deep waters (Vélez-Belchí et al, 2010).

Conclusions: Today, the *Deep-Arvor* float is fully operational at sea. The first two models have cumulated 180 cycles at 3500 meters (Figure 2) and two industrial prototypes capable of reaching 4000 meters have successfully reached 100 cumulated cycles. Technological advances during the past few years have made float prototypes available, which could probe the deep ocean down to, at least, 4000 m.

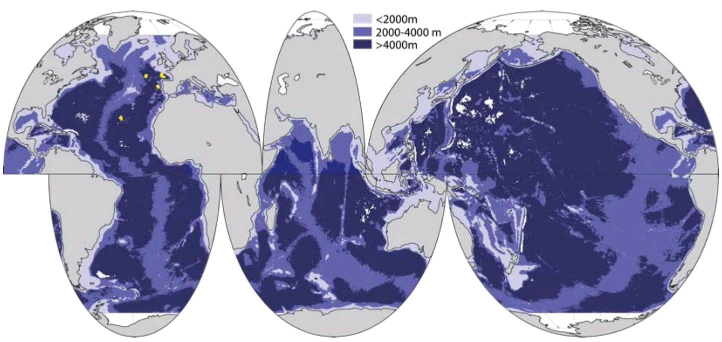

Figure 1. *Global bathymetric map indicating the regions covered (<2000m depth) and not covered (>2000m depth) by the actual Argo network. In yellow are the trajectories of the 4 Deep-Arvor floats deployed so far in the North Atlantic*

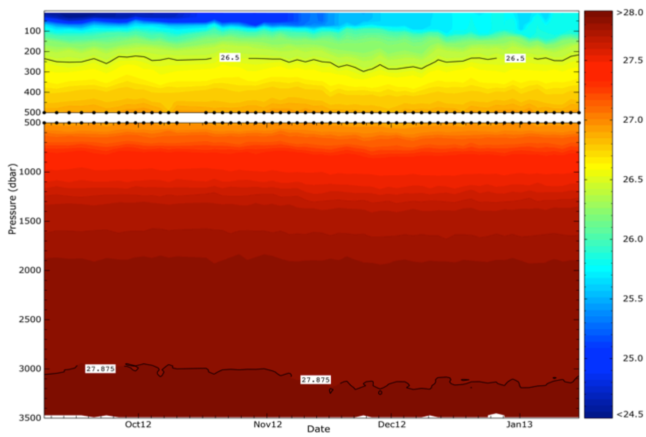

Figure 2. *Potential density section of a Deep-Arvor float deployed in the central North Atlantic. The isopycnal 27.875 kg/m^3, with mean depth at 3090m, shows excursions up to 300 m in amplitude.*