The Argo program

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In 1999 a program was launched to significantly improve the collection of data from the interior of the ocean by measuring more often and at more places: Argo.

Argo profilers

Highs and Lows determine the atmospheric circulation. Likewise, the currents in the ocean are determined by pressure differences. Pressure in the ocean depends on temperature (the warmer, the lighter) and salinity (the saltier, the heavier) of the water. These two quantities are therefore important for learning something about currents in the sea.

Temperature (T) and Salinity (S) are relatively easy to measure, much easier than currents. However, the ocean is large and deep, the number of ships is limited, and hirimg a vessel is expensive. Therfore, measurements of T and S are sparse. The Argo profilers (sometimes also called buoys or floats) present a solution to this problem. They operate idependently, are relatively cheep (about 12,000 euro per float), easily brought into the water (just throw them overboard), and they last for four to five years. During that time they measure every ten days a profile of T and S between a depth of 2 km and the surface.

Their 10-days cycle look as follows: From the surface they dive down to a “parking” depth of 1 km, far away from ship propellers and fishermen's nets. After about nine days they decend further down to 2 km, immediately followed by their seven hours ascent during which they measure T and S at about 70 pre-selected depths. After having reached the surface they transmit their data to a data centre. This takes about half a day. One cycle is now complete, and the profiler returns to its safe parking position.

Internationale cooperation

As already mentioned, the ocean is large. To get a good impression of the whole ocean one profiler per 3°×3° square is needed – 3000 in total. This is only possible with international cooperation, which is coordinated by the Argo Project Office (http://www.argo.ucsd.edu/). Each institue or country is responsible for its own contribution to the Argo program by buying and deploying floats. At present (Sept. 2006) 23 countries participate. In total more than 2500 floats heve been deployed (see Fig. 1). Thus less 500 are still missing. When the target of 3000 floats is reached it will be necessary to replace the floats that have reached the end of their lifetime. A European infrastrcutural programme has been drafted to secure long-term funding for float replacement and data storage.

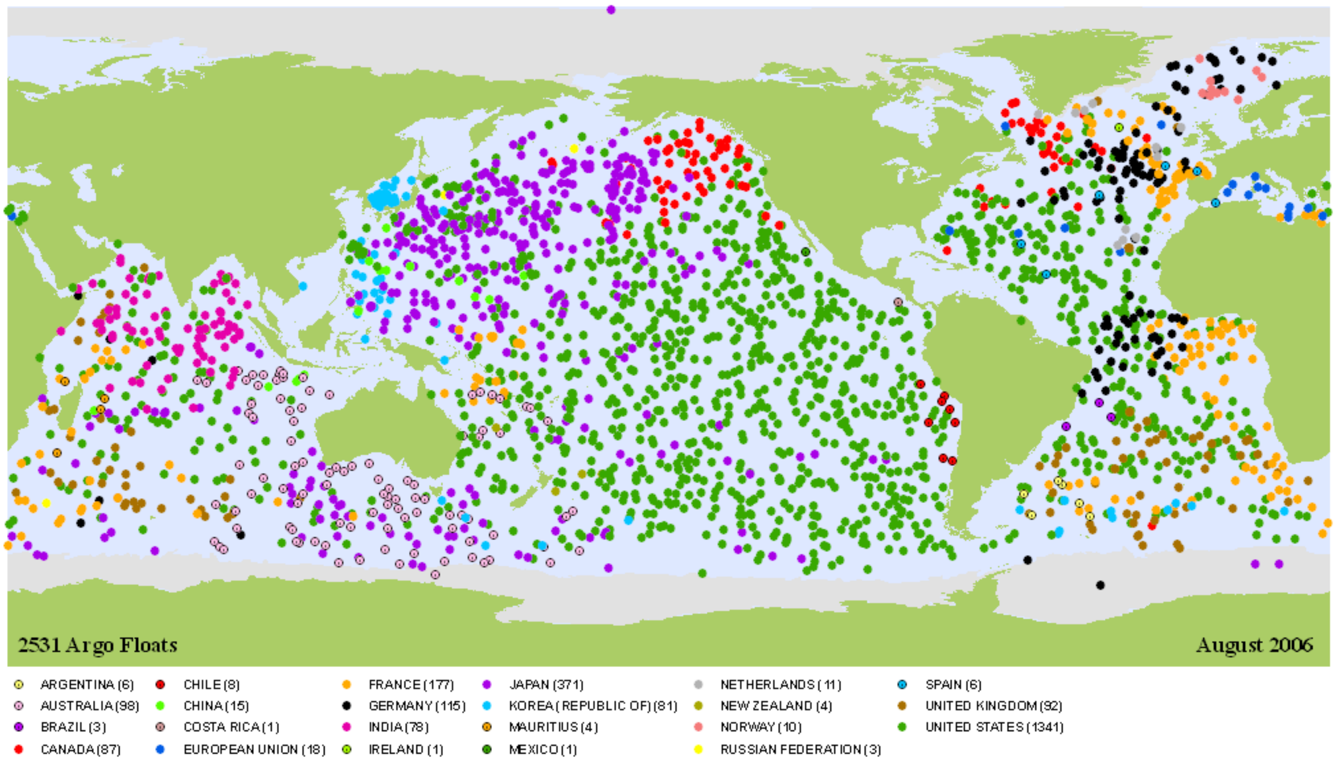


Figure 1: *Argo floats per country. De grey dots are the Dutch ones.*

The data are collected and stored at two data centres, one in France and the other in the US. After a short quality-check they are made publicly available, usually within 24 hours. This open-data policy is an important reason for the success of Argo. On the one hand researchers everywhere on earth can easily use the data. On the other hand it takes away suspicions of espionage that many coastal states had against Argo. It thus became possible that even countries as Chili and Argentinia are now taking part in Argo.

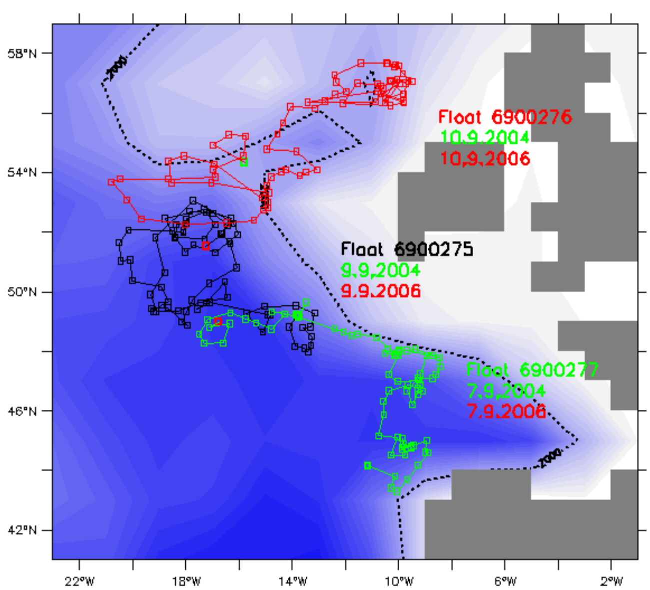
The Dutch contribution

Since 2004 The Netherlands are contributing to Argo. KNMI bought three floats, and the R/V Pelagia of NIOZ (Royal Netherlands Institute for Sea Research) deployed them during a cruise in the North Atlantic Ocean between Spain and Rockall (Figure 2). In September of 2005 four floats were deployed in the Irminger Sea, and in May 2006 four others in the Canary Basin. In both cases deployment took place from the Pelagia. Figure 2 shows how a float is prepared for launch on bord of this vessel.

Figure ***2****: An Argo float is prepared for launch (2004).*

Trajectories

Figure 3 displays the positions from where the floats have transmitted data, i.e, where they have measured a profile from a depth of 2 km to the surface. The green and read squares mark the launch and end positions, respectively. The squares are 10 days apart.



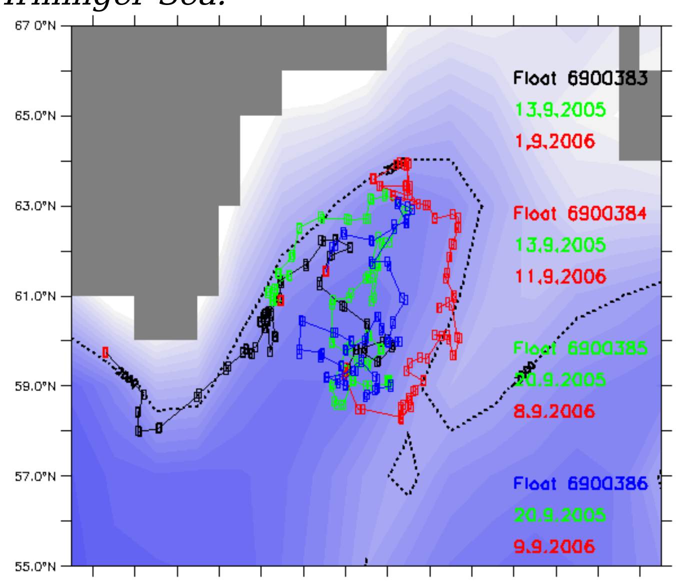


Figure 3: *Trajectories of the floats in the north-eastern Atlantic and in the Irminger Sea.*

The trajectories in the north-east Atlantic (between Spain and Rockall) clearly show that in this part of the ocean the average currents flow to the north-west, along the continental margin. However, embedded in this current are large eddies, so that the foats proceed in large circles. The northernmost float (690076) is most affected as the topography continually produces new eddies.

From the trajectories in the Irminger Sea we infer a strong current along the circumference of the basin. At the eastern side it flows northward along Reykjanes Ridge, turns westward towards Greenland and follows Greenland's coast soutwards. Finally all floats will follow 6900383 and drift around Cape Farewel into the Labrador Sea.

Results

Figure 4 shows an example of the messurements that have been done so far. The Figure shows sections of temperature (upper panel), salinity (middle) and density (below) along the trajectory of float 690077. As the float moves one sees changes in both space and time. At the beginning of the section (thus off the coast of northern Spain) a saline and warm layer is well visible at a depth of 1 km. This is water originating from the Mediterranean Sea. It can be found in most of the North Atlantic basin. With increasing distance from the Straits of Gibraltar the salinity adapts to that of the surroundings. Another feature that pops into the eye is the annual warming at the surface during summer which only penetrates a few tens of metres into the water.

Web page

More about the floats can be found at http://www.knmi.nl/~sterl/Argo (in Dutch). This page contains the actual positions and measurements of the Duch floats as well as links to the international Argo sites.

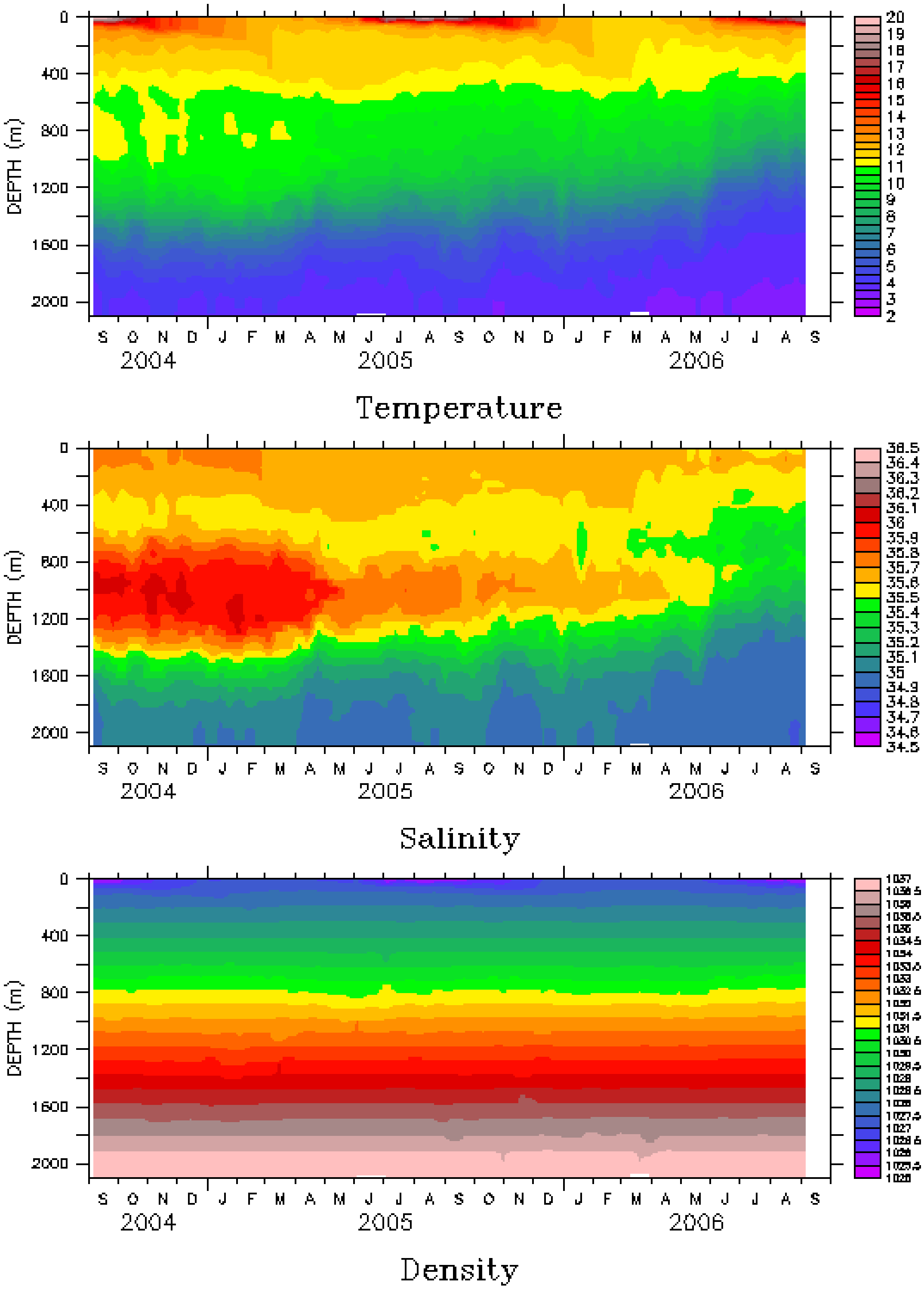


Figure 4: *Sections of temperature (upper), salinity (middel) and density (lower) along the trajectory of 6900277.*