CGM/CMA Pasteur

Aramis
tracks salt waters in the Tropical Atlantic

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The Aramis project

Aramis (Altimétrie sur un Rail Atlantique et Mesures In-Situ) is an experiment to conduct low-frequency monitoring of thermohaline structures in ocean surface layers using expendable bathythermograph (XBT/XCT) and expendable conductivity-temperature-depth (XCTD) probes in the Tropical Atlantic Ocean. In the Tropics, due to the big contrast between the warm upper and cold lower layers of the ocean, using satellite altimetry data in combination with temperature-salinity profiles can tell us more about ocean transports. If measurements are obtained over a long-enough period to derive realistic statistics, it can also provide insights into phenomena at lower depths.

A regular shipping line between Europe and South America (line AX11) is therefore used twice a year. This line transects the Southern Equatorial Current (SEC) and the Northern Equatorial Current (NEC) going westwards, and the Northern Equatorial Counter-Current (NECC), which transports warm waters from South America toward Africa. The NECC also transects the ground track of the Intertropical Convergence Zone (ITCZ) and the two salinity maximum zones in the northern and southern hemispheres, which are markers of climate anomalies.

In addition to these profiles, measurements from a thermosalinograph provide continuous sea-surface temperature (SST) and sea-surface salinity (SSS) data along the route. These data are fed into the Coriolis database in real time. They are complemented by XBT launches along the same line, performed by Germany's BSH (Bundesamt für Seeschiffahrt und Hydrographie).

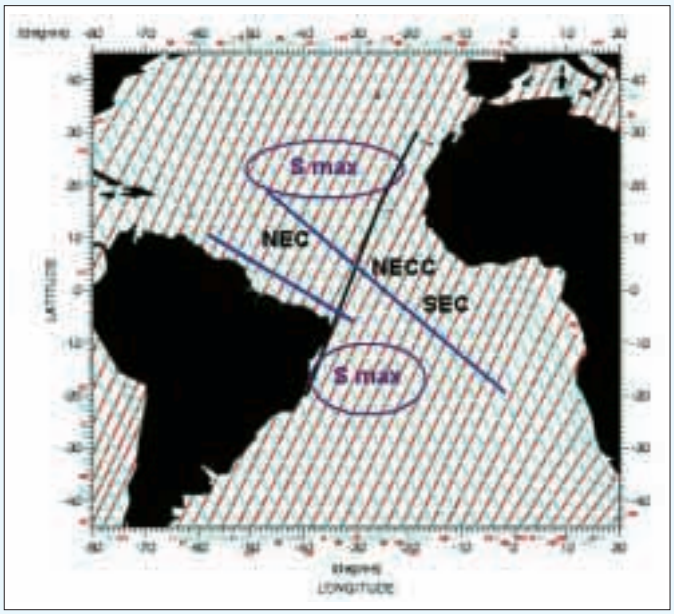

Figure 1. Aramis route (AX11) in black, compared with NOAA lines (AX08 and AX27) in blue, and Jason-1 tracks (Topex/Poseidon is midway between Jason-1 tracks) in red (ascending tracks) and green (descending tracks). The main currents-NECC, NEC, and SEC-and zones where salinity maximum waters form (S max) are also shown.

Aramis 1 and Aramis 2 validate Jason-1 in the Tropical Atlantic

Aramis 1, in July 2002, and Aramis 2, in March 2003, took place on the CGM/CMA Pasteur owned by the Hambourg Sud shipping company, between Santos, Brazil, and Southampton, United Kingdom. During each cruise, 50 XBTs and 50 XCTDs were launched alternately between 20°S and 33°N. The data obtained from these cruises are very good quality.

During Aramis 2, the surface layers in the southern hemisphere warmed in response to the seasonal variability of heat flows. The salinity signal is more difficult to distinguish, but it reflects the significant formation of salinity maximum waters in March (September) in the northern (southern) hemisphere [Blanke et al., 2002]. Seasonal upwelling is observed around the equator during Aramis 1, with relative extreme values shifted slightly southward. Significant surface desalting, related to the ITCZ, can also be seen between 2°N and 9°N. During Aramis 2, a salinity maximum near 0°30'S and at 60 m is associated with the equatorial subcurrent.

These two cruises were undertaken for the purposes of Jason-1 calibration and validation. Apart from a bias of 15.1 cm, no really significant difference was found between Topex/Poseidon and Jason-1 on the same paths during Aramis 1. The correlation between dynamic and altimetric sea-surface heights (SSH) is ~0.7, and the rms difference is ~3 cm. Because the Coriolis parameter is canceled out, geostrophic surface velocities obtained from dynamic and altimetric SSH are an excellent variable for comparisons in equatorial zones.

Each of the estimates reveals the surface circulation system in the Tropical Atlantic, with a very intense westward SEC between 8°S and 3°N, interrupted by the geostrophic equatorial divergence; eastward NECC between 3°N and 11°N [Arnault et al., 2004]; and westward NEC above 10°N. The amplitude of the currents and the points at which they change direction are very close.

Conclusions and future directions

The Aramis cruises obtained not only temperature profiles, but above all-and this is where they innovated-salinity profiles along line AX11 in the Tropical Atlantic, between 30°N and 20°S. The first results are already raising interesting scientific questions about monitoring circulation in the surface layers of the ocean in this region. When these results are combined with

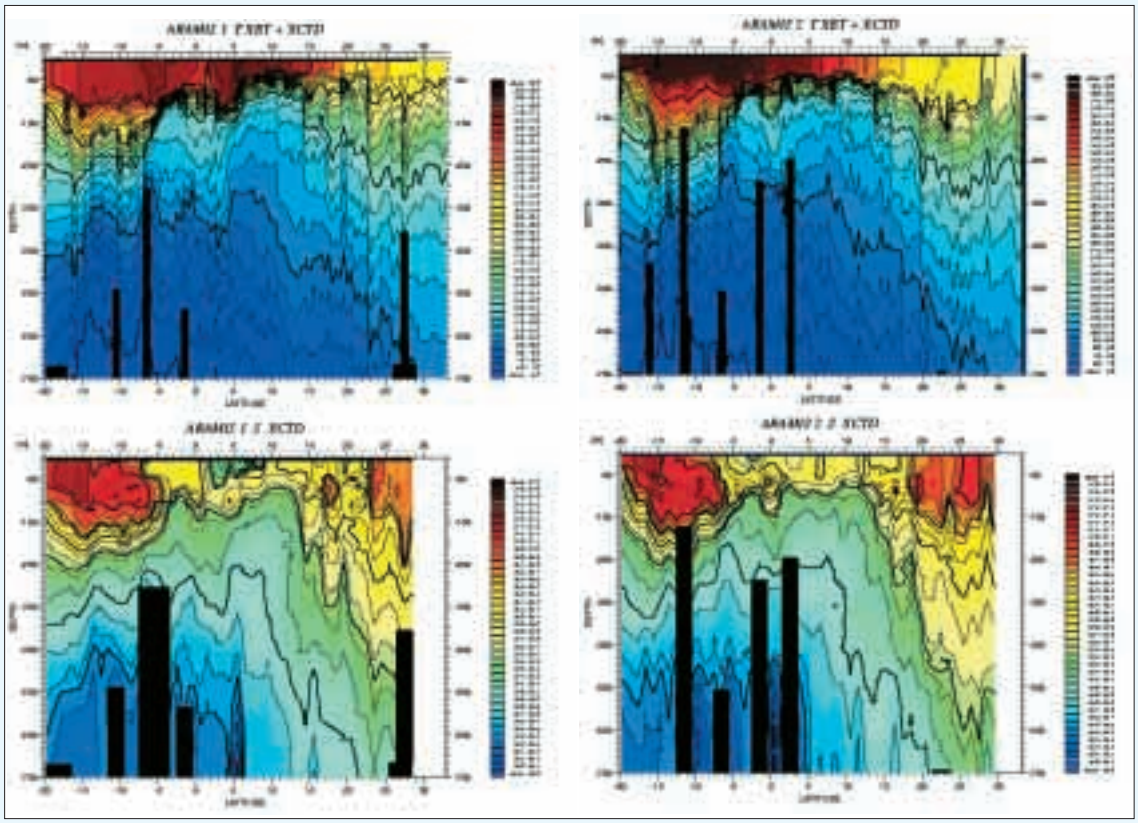

Figure 2. Temperature (XBT+XCTD) and salinity (XCTD) sections obtained during Aramis 1 (left, July 2002) and Aramis 2 (right, March 2003)

Topex/Poseidon and Jason-1 altimetry data, the benefits are clear.

After two cruises for Jason-1 Calval, the Aramis project has entered a phase of consolidation (2003-2007). Moreover, it is set to become a veritable Tropical Atlantic observatory starting in 2005. The project plans to complement temperature and salinity data by monitoring partial carbon gas pressure (investigator N. Lefèvre) and releasing drifting buoys as part of the international Argo program (with NOAA Miami). From 2007, Aramis will have a fully operational capability to supply the scientific community with long time series of data on temperature and salinity structures in the Tropical Atlantic.

Acknowledgments

The authors would like to thank everyone who helped to conduct the first Aramis experiments, and in particular Mr. Huet at Hambourg Sud and the commanding officers on the CGMA Pasteur, Messrs Harms and Remp, and their crews. The experiment was co-funded by the French space agency CNES (Centre National d'Etudes Spatiales) and the French development research institute IRD (Institut de Recherche pour le Développement).

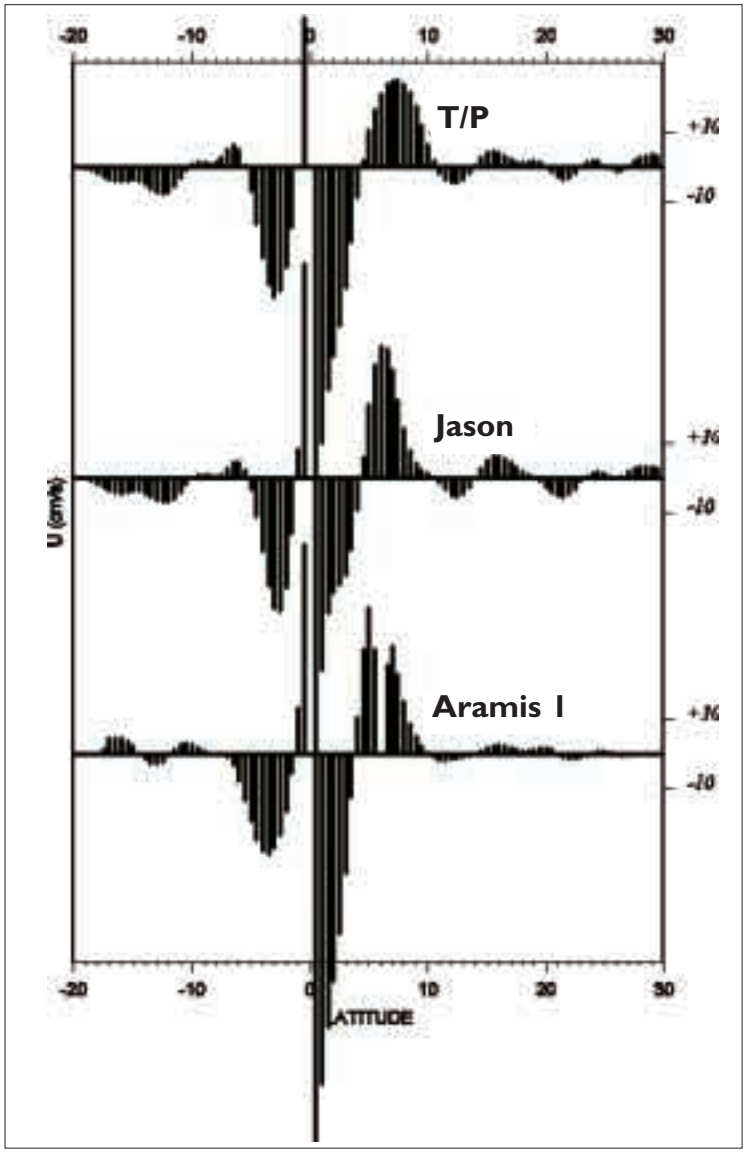

Figure 3. Comparison of geostrophic currents during Aramis 1: cruise measurements and Topex/Poseidon - Jason-1 altimetry (in cm/s). Satellite data are referenced to the mean surface from Rio [2003].

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