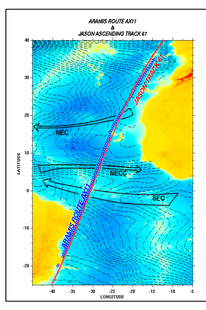
First results from the ARAMIS project

S. Arnault[1], P. Lattes[1], D. Diverrès[2], S. Jacquin[3], M. Carn[2]

(1) LOCEAN/IPSL, Université Pierre et Marie Curie, Tour 45-5ème étage, Case 100, 4 place Jussieu, 75252 Paris Cedex 05, France

(2) Centre IRD de Brest, BP 70, 29280 Plouzané Cedex, France *(3) MétéoFrance, quai des Abeilles, 76600 Le Havre, France*



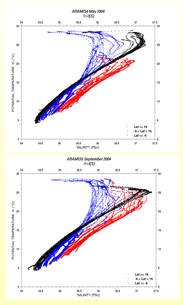
The ARAMIS Project

The ARAMIS project (Altimétrie sur un Rail Atlantique et Mesures In Situ) has been developed by the french CNES (Centre National d'Etudes Spatiales) and IRD (Institut de Recherche pour le Développement) organizations in order to get a long term survey of thermo-haline structures in the tropical Atlantic. Combined with satellite data such as TOPEX/Poséïdon and Jason ones, this experiment will offer the opportunity to approach scientific questions such as the characteristics of the surface circulation long term variability in the tropical Atlantic Ocean, the role of specific oceanic processes in that variability or the connection to other parameters, other oceanic basins and climatic indexes.

ARAMIS began in July 2002 for a 5 year-duration. The merchant ship AX11 line crosses the major equatorial currents (westward North/South Equatorial Currents –NEC/SEC-, eastward North Equatorial Counter-Current –NECC-, the InterTropical Convergence Zone and the Atlantic regions of Maximum Salinity Water around 20°S and 30°N which are important features in a climatic context. The line is also superimposed to Jason track n°61.

Twice a year, in boreal spring then fall, when the tropical Atlantic oceanic circulation reaches its minimum/maximum intensity in the surface layers, 50 eXpendable BathyThermograph -XBT- and 50 eXpendable Conductivity-Temperature-Depth -XCTD- are launched alternatively along the ship route between 20°S and 30°N, together with on route information collect (Sea Surface Salinity -SSS-, Sea Surface Temperature -SST-, meteorological conditions).

First Results, ARAMIS 1-9, July 2002 – October 2006



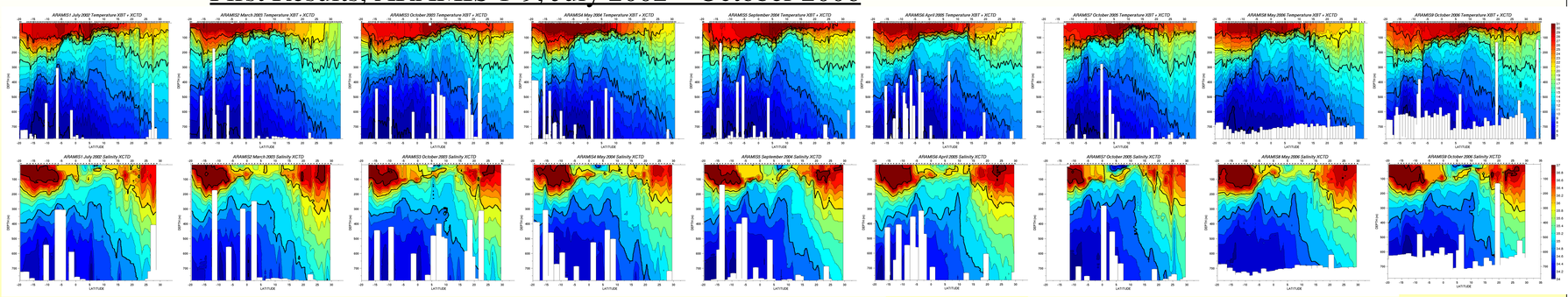
T-S diagrams evidence the different water masses identified during the ARAMIS transects :

The ***North Atlantic Water*** (red), with S maximum above and below the thermocline, can be observed along the route from 16°N to 35°N;

The ***South Atlantic Water*** (black), with S maximum above the thermocline, minimum below, from 20°S to 6°S;

The ***Eastern tropical Atlantic Water*** (blue), with S minimum above and below the thermocline, from 6°S to 16°N.

Seasonal variability can also be seen in the upper layer NAW and SAW with T increasing/decreasing during the respective hemisphere spring/fall seasons.



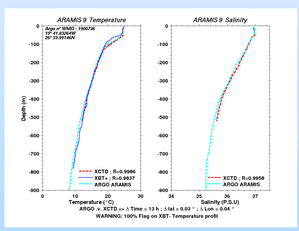
Temperature and salinity structures are coherent. During boreal spring cruises, surface layers warm and refresh in the southern hemisphere. These temperature variations are in agreement with the seasonal cycle of oceanic upper layers in response to heat fluxes. Salinity varies in agreement with the maximum salinity water formation which is important in March (September) in the northern hemisphere (southern) (Blanke et al., 2002). In the equatorial region, seasonal upwelling can be observed during ARAMIS1, with a southward displacement of the signal as expected. Fresh waters between 2 and 9°N can also be observed during some cruises and can be related to ITCZ migration.

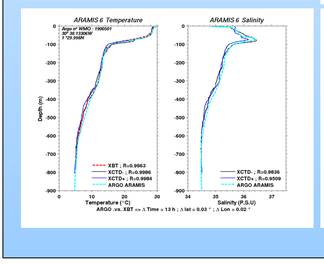
Comparison with ARGO floats

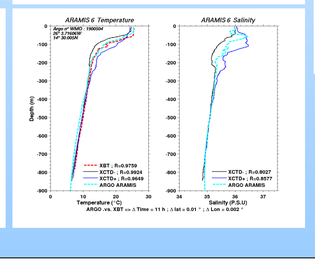
In 2004, a collaboration with NOAA Miami was developed to deploy ARGO SOLO floats along the ARAMIS ship route. Starting with ARAMIS 5, 4 to 8 floats per cruise have been launched simultaneously with an expendable probe (usually an XBT). Comparison between ARGO T-S profiles and the neighbouring XBT/XCTD datas can be done within a time lag between the profiles not exceeding a few hours.

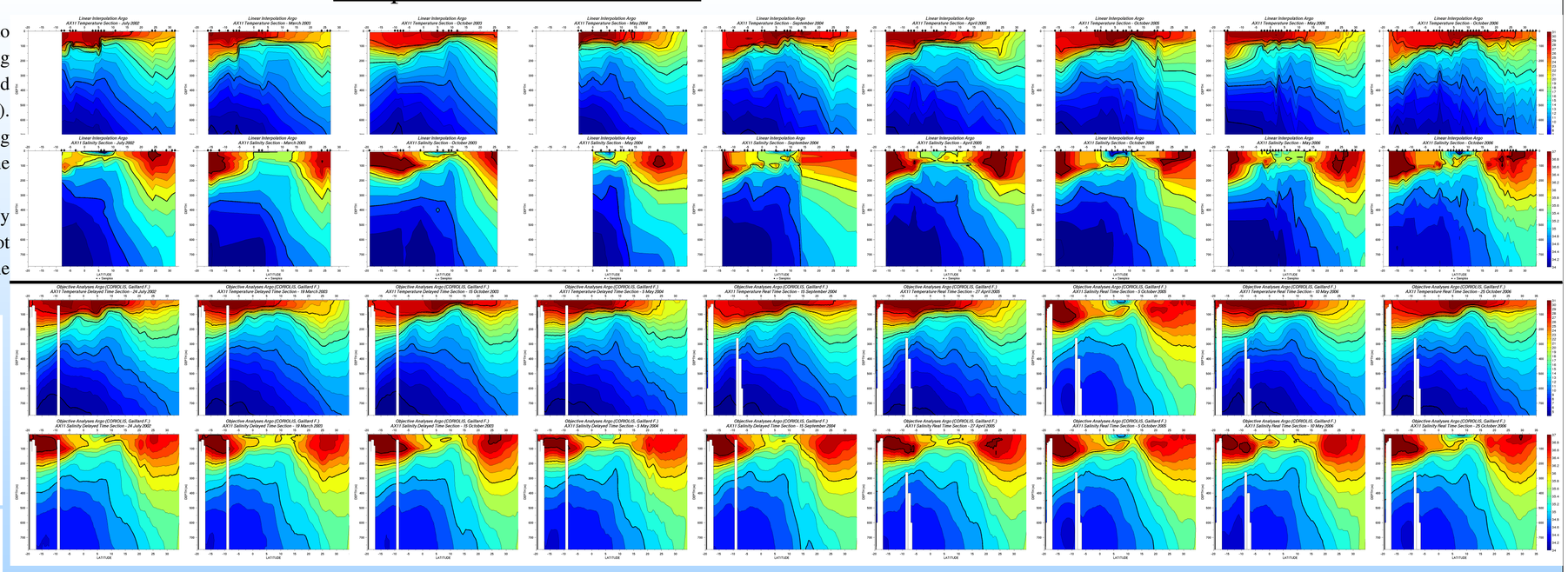
The total number of deployed ARGO floats is presently 28, but only 16 of them can be used for such a study: the first 8 ones were not tuned to give T-S profiles within launching period (cycle 0), one was definitely lost, and 3 others were flagged.

Comparison is usually very good with correlation above the thermocline > 0,90. When occuring, discrepancies are associated with frontal areas, especially for S.









Transects along the ARAMIS route and during the cruise durations have been recomposed from the ARGO floats. We used 2 techniques. The first one consists in a linear interpolation directly from the rough data. Second one is based on the results of an objective analysis (courtesy of F. Gaillard).

The large scale structures and the seasonality described with the ARAMIS sections clearly appear on both ARGO products even if the objective analysis smoothing is evident.

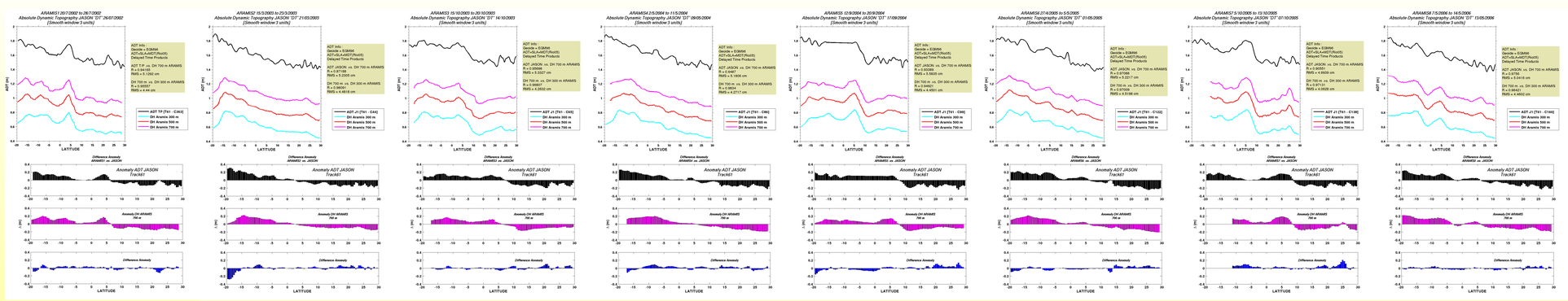
The impact of the number of floats available in the domain is important. For instance, the agreement between ARAMIS and the linear interpolation of the ARGO floats in October 2006 (more than 30 profiles collected along the ship route versus 15 for the first cruises) is impressive -even considering small scale variability- compared to the first sections..

Comparison with TOPEX/Poséïdon and Jason altimetry

Dynamic heights have been computed from the ARAMIS XBT and XCTD datas. In order to get density from XBT temperature, salinity interpolation from the adjacent XCTDs has been performed. 3 different reference levels were checked: 300 dbar, 500 dbar and 700 dbar. When the profiles missed the reference depth from a few meters, in the deep layers, density was extrapolated.

AVISO absolute dynamic topography along the track n°61 is used for these comparison.

Apart from a mean bias, agreement between all the quantities is quite good with correlations higher than 0.8, frequently more



equatorial band with a succession of highs and lows. Winter-fall situations only reveal a general North-South slope. These results confirm the major role of baroclinicty of the Tropical Atlantic Ocean.

Conclusion and Perspectives

The aim of the ARAMIS project is to perform a survey of the tropical Atlantic Ocean between 2002-2007 to give, in association with altimetric missions, a realistic picture of the ocean time-space variability.

In this study we did intensive comparisons with the concomittent data sets that exist in that area: ARGO floats and altimetry.

The general good agreement between all the data sets has good propects for the purposes of the project.

Next step will consist in adding model information thanks to modelling experiments such as Mercator Ocean.

Acknowledgements:

The ARAMIS project is supported by the CNES and IRD french agencies.

The authors are grateful to the Hamburg Sud and CGM-CMA ship's captains and crews who helped them during the ARAMIS cruises.

Special thanks to V. Thierry, C. Coetlogon et F. Gaillard for their advices concerning the ARGO floats and use of ARGO climatology.