TROPICAL ATLANTIC VARIABILITY: IS THERE ANYTHING NEW ON THE WESTERN FRONT?

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Compared with the Pacific where known variability is predominantly on seasonal to interannual time-scales, the Atlantic signal is characterised by even longer periods. Cross equatorial heat and salt fluxes are required to understand this climatic Atlantic signal due to the northward extension of the basin and the resulting "conveyor belt". Earlier studies also reveal that part of this northward flux should be concentrated on the western boundary, a complicated area with eddies, current retroflection, undercurrents and through flows.

Early modeling studies indicated that this advection of South Atlantic waters into the subtropical gyre of the North Atlantic was the result of continuous western boundary transport [Philander et Pacanowski, 1986]. However, results from the WOCE community modeling effort do not indicate such major direct transport along this route [Schott and Boning, 1991], and recent observations indicate that some transport occurs along the western boundary via intermittent shallow boundary currents and eddies that peak off from the North Brazil Current retroflection [Richardson et al., 1994].

We tried to investigate this problem using two different approaches: numerical modeling and in-situ observations combined with TOPEX/POSEIDON data.

Our modeling effort involves altimetric data assimilation. Carton et al. [1996] have demonstrated that altimetric data assimilation has a greater impact than expendable bathythermograph (XBT) or mooring data assimilation on sea level and current variability in the tropical Pacific. Assimilation is also a common way of spreading the 2D-altimetric information into deeper oceanic layers. Figure 1 gives the results of a numerical experiment where two years (1993-1994) of TOPEX/POSEIDON altimeter sea level anomalies, XBT profiles, sea surface salinities and temperatures have been assimilated into a non-linear primitive equation model of the tropical Atlantic ocean . The results are analyzed by comparison with reference data sets such as CITHER 1 (PIs: M. Arhan, H. Mercier, LPO; C. Oudot, B. Bourlès, Y. Gouriou, ORSTOM). Clear oscillations in the meridional velocity fields, alternatively positive and negative, which were not previously reproduced by the forced model, appear now both in the data and in the assimilated run along 7°N, in the North Equatorial CounterCurrent area, west of 30°W. These oscillations propagate westward, with a mean velocity of around 15 cm/s, amplitude 25-30 cm and wavelength 800 km. They also strongly influence northward transport, as they affect the whole 200 m-depth layer and could be related to current instability in that area.

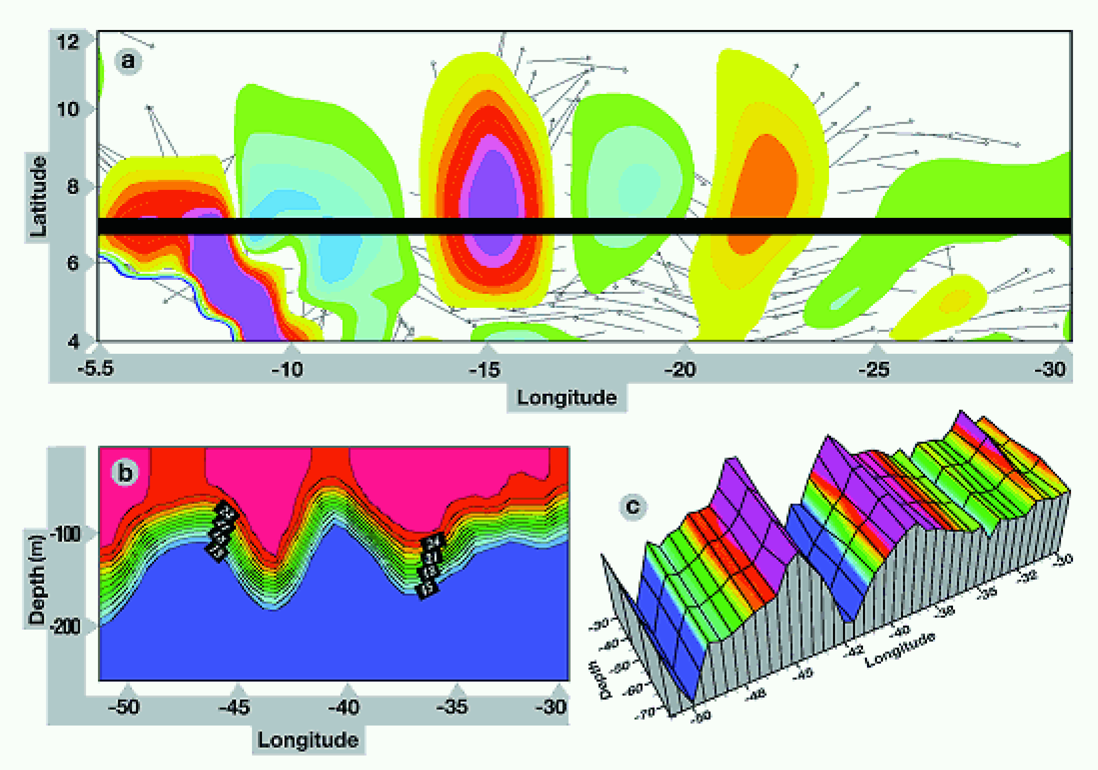

Figure 1

North Equatorial counter current oscillations revealed by TOPEX/POSEIDON assimilation and CITHER 1 ADCP measurements at 7°N in February 1993.
(a) Velocity and temperature fields as given by an OGCM with T/P assimilation;
(b) Meridional velocity field from CITHER 1 ADCP measurements;
(c) Temperature field from CITHER 1 ADCP measurements.

During the ETAMBOT 1 and 2 cruises (P.I.: C. Oudot, ORSTOM), in October 1995 then April 1996, in-situ measurements were also gathered intensively in the western part of the tropical Atlantic ocean. Comparisons in that area between TOPEX/POSEIDON geostrophic currents and ADCP measurements sampled during the ETAMBOT cruises reveal excellent agreement between the two current estimates (figure 2).

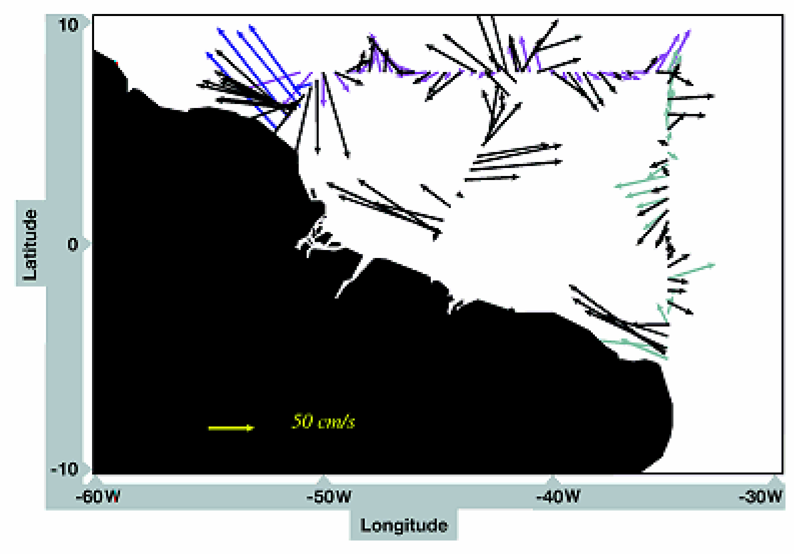

Figure 2

Comparison of altimetric geostrophic currents obtained from TOPEX/POSEIDON data and ADCP measurements during ETAMBOT cruise. Black: ETAMBOT1 cruise results, all legs. Other colours: results derived from T/P (by leg: sky blue: 35°W, pink: 7°30'N, purple: Ceara leg)

This altimetric/in situ data study is a crucial step towards replacing the ETAMBOT data in a general geographical and temporal context. It reinforces our confidence in altimetry, even in that difficult geographic area, for monitoring eddies and the variability of the North Brazil Current retroflection and thus of northern transport.

References :

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