FURTHER EVIDENCE FOR A TROPICAL WATER GYRE IN THE SOUTHWESTERN ATLANTIC

Marcio Luiz Vianna (vianna@dir.inpe.br) & Viviane Vasconcellos de Menezes (viviane@vmoceanica.com.br)

Instituto Nacional de Pesquisas Espaciais- INPE, São José dos Campos, SP.

VM Oceânica S/C Ltda, São José dos Campos, SP.

ABSTRACT

Two views for the gyre structure of the upper layer geostrophic circulation in the southwestern Atlantic Ocean has been presented in the literature: (i) a single gyre, limited in the north at 10S-15S, and in the south by the Brazil-Malvinas confluence, with a recirculation cell centered at 35º S, and (ii) a double-gyre structure, with the northern gyre dominated by a single water mass, the Salinity Maximum Water (SMW), with about the same northern limit, but with its southern limb coinciding with a subtropical front and its associated eastward current at about 28º S. We discuss evidence favoring the double-gyre view, by focusing on analysis of new data (ADCP, hydrographic and Topex/ERS altimeter). Evidence supporting the existence of a strong (50 cm/s) geostrophic eastward current at 28º S, and a Brazil Current upper layer retroflection near this latitude, is described. This eastward current reaches depths of 300m, and its dynamics may be the same as the open-ocean Subtropical Countercurrents of the north Pacific and Atlantic oceans. Transport estimates will be presented. The detailed structure of recirculation cells inside this gyre domain is presented, and its annual cycle described. It is shown that while variability to the east of the gyre domain is dominated by Rossby waves, inside its domain the gyre is dominated by frontal eddies aligned along the 28S-30S quasi-zonal front, by eddies at the shelf break and possibly by open ocean eddies related to subsidence of mixed layer water into the thermocline. The data analysis suggests future research priorities could be oriented into processes that might explain such complex interaction patterns between the atmosphere, the upper water layer, the intermediate layer and the abrupt change in the coastline, not far from the Brazilian coast, but still further into the open ocean than present-day programs. It could require a system of deep sea moorings to study the evolution of the water column, as was done in the FASINEX program in the north Atlantic. We may add that biogeographic studies reporting the discovery of the presence of a strong gradient in zooplankton biodiversity at that same latitude is suggested as consistent with the existence of the countercurrent, which also supports a rich tuna fishery exploited by fishing industry based in the city of Itajaí.

In the Western North Pacific and Atlantic Oceans the presence a zonal band of eastward currents (the so called Subtropical Countercurrents STCC) around 20ºN-25ºN is now well-established. In the Southwestern Atlantic the presence of a equivalent STCC has been suggested by very few authors (Tsuchiya, 1985; Mémery et al., 2000.

We summarize here some further evidence of this existence, and suggest that it merges with the upper flow of the South Equatorial Current to form a northern cell of a double cell SA Subtropical Gyre.

STCC CHARACTERISTICS: 20º-30º Latitude Band; Strong Vertical Shear; Zonal Eddy Band; Associated Thermal Front.

DATA SETS

1. ADCP Current Profiles from WOCE Cruise Cither 2 (Jan-Mar 1994);
2. Mean Hydrography Boyer and Levitus (1997);
3. Eddy Kinetic Energy (EKE) from Satellite-derived (T/P and ERS2) geostrophic velocities from 1995 to 2000;
4. Drifter tracks

RESULTS

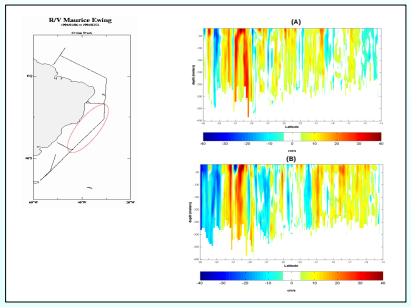

Figure 1 – ADCP profiles of (a) zonal velocity and (b) meridional velocity, suggesting a strong cydonic eddy on a broad flow pattern to the SE-20S-30S (<300m).

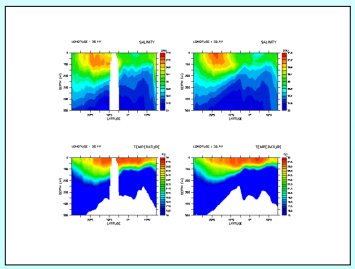

Figure 2 – Mean latitude-depth profiles of T and S at 35W and 30W, suggesting a Subtropical Front for Tropical Water (<200m).

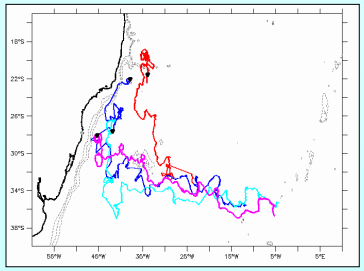

Figure 3 – Drifter tracks (LCD`s from Brazilian PN-Boia project), suggesting a Subtropical Countercurrent to the SE 28S-34S.

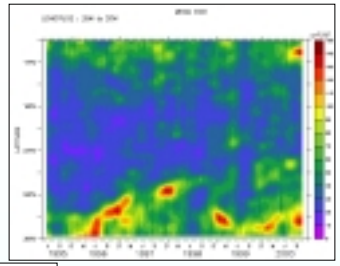

Figure 4 – Mean EKE (35W-20W, 70 day running mean) time latitude plot, showing a characteristic maximum at 28S-30S, with annual and interannual variation in strength and position, suggesting the Subtropical Countercurrent.

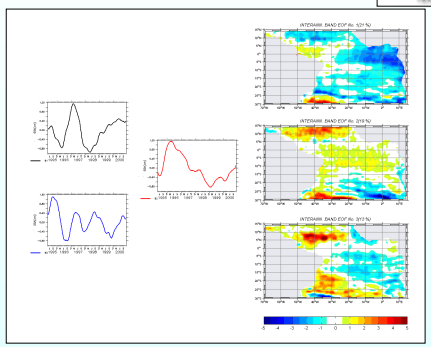

Figure 4 – EOF/PC modes of altimeter SSHA in the interannual period band (T>400 days). The sharp gradients south of 22S and especially 28S-30S are signatures of a STCC/eddy band of variability. EOF3 is suggestive of a upper water recirculation gyre.

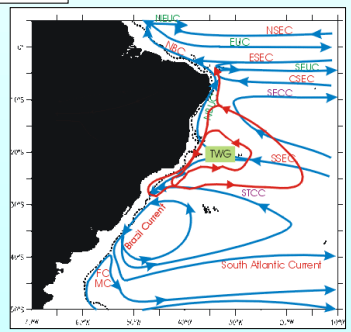

Figure 5 – A new schematics in agreement with Tsuchiya (1985) and Memery et al. (2000), and with our results: a shallow (<300m) tropical water gyre pressed against the coast running over the Subtropical Gyre involving SACW.

REFERENCES

Mémery,L.; Arhan, M.; Alvarez-Salgado, X.A.; M.-J. Messias; Mercier, H.; Castro, C.G.; Rios, A.F. The water masses along the western boundary f the south and equatorial Atlantic. Progress in Oceanography, 47, 69-98, 2000.

Tschuchya, M. Evidence of a double cell subtropical gyre in the south Atlantic Ocean. Journal of Marine Research, 43, 57-65, 1985.