Anomalous Penetration of Brazil-Malvinas Waters in the South Brazil Bight

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Project COROAS (Circulação Oceânica na Região Oeste do Atlântico Sul, or Oceanic Circulation in the Western Region of the South Atlantic) is a major contribution of the Brazilian oceanographic community to the international WOCE (World Ocean Circulation Experiment) program. Its primary objective is the determination of seasonal mean fields of velocity, heat and mass transports by the Brazil Current and the Antarctic Intermediate Water flowing into the coastal region of southeastern Brazil.

Analysis of hydrographic, drifter and satellite data for the austral winter of 1993 has revealed the presence of a tongue of relatively cold (14–17°C) and low salinity (33.0–34.0) water between the coast and the Brazil Current, extending from south of the Rio de La Plata estuary (35°S) to latitudes as low as 23°S, with a typical average northbound velocity of 10.7 cms^{-1}. These three data sets rule out the possibility that the origin of this water is river runoff or from deeper water upwelled near the coast, due to Ekman dynamics.

Usual T-S characteristics of the water observed on the shelf indicate that South Atlantic Central Water (SACW) is upwelled near the shelf break by the meandering of the Brazil Current and deposited on the shelf *Campos, Gonçalves and Ikeda*, 1995]. The upwelled water spreads out as the bottom layer, reaching the shallower regions near the coast. This

mechanism is very efficient during the Summer, when there is a positive combination of the effects of large-scale (100-300 kilometer) BC cyclonic meanders, and of coastal upwelling forced by the prevailing NE wind during the summer. During the winter when the wind direction changes frequently to southwesterly, owing to the passage of cold fronts, this mechanism is weakened but not completely eliminated. That is, intrusion of SACW into the inner shelf regions could still occur. During the winter of 1993, however, the SACW was found found only in regions deeper than 100 m, even though an upwelling-favorably cyclonic meander was observed in the nearby Brazil Current and the wind blowed constantly from the NE during the cruise (about 12 days). Impeding the further penetration of the SACW was the low-density anomalous water coming from the south on the continental shelf.

Thus, one of the immediate consequences of the presence of the water from the Malvinas region in such low latitudes was the observed blocking of the nutrient-rich South Atlantic Central Water (SACW) in the outer regions of the continental shelf. Figure 1, representing the vertical profiles of temperature (T) and salinity (S) along a transect extending perpendicularly to the coastline from near Santos to the adjacent deep regions, shows clearly a strong thermo-haline front separating, near the bottom, waters with SACW characteristics ($T \leq 20$–$21°C$, $S \leq 36.6$) from waters with approximately the same temperatures but with much lower salinities in the shallower regions of the continental shelf.

A conclusive answer about the origin of this cool and low salinity water reaching the SBB is not yet available. Satellite imagery suggest that it comes from the Brazil-Malvinas confluence or even more to the south. The analyses of wintertime IR images suggest, however, that the northernmost penetration of this seasonal water mass during the winter changes

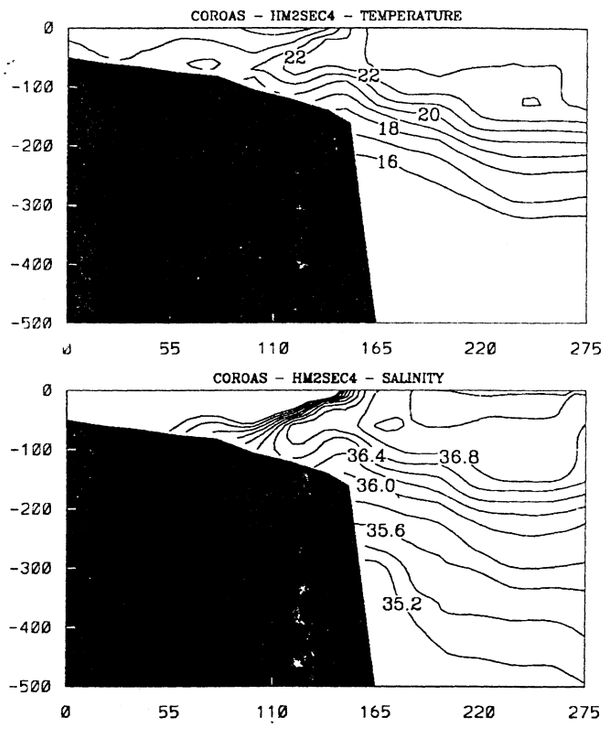

Figure 1: Temperature and salinity distributions along transect perpendicular to the coastline. Austral Winter of 1993.

from year to year, suggesting that for El Niño years it is enhanced and penetrates further north.

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References

Campos, E. J. D., J. E. Gonçalves and Y. Ikeda, 1995: Water Mass Structure and Geostrophic Circulation in the South Brazil Bight – Summer of 1991. *J. Geophys. Res.*, 100 (C9), 18537-18550.