Abstract View

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Annual Cycle of Subsurface Thermal Structure in the Tropical Atlantic Ocean

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ABSTRACT

The subsurface thermal structure in the tropical Atlantic Ocean (30°N–20°S, East of 80°W) is studied on the basis of an extensive data bank of subsurface soundings. Calendar monthly maps are presented showing mixed layer depth, base of thermocline, thermocline thickness, and vertical temperature gradient across the thermocline. These maps are complemented by vertical cross sections depicting mixed layer depth, base of thermocline, and selected isotherms: a zonal profile along the equator (50°W–10°E), a meridional transect across the Eastern Atlantic (4°N–18°S), and a meridional section across the Central Atlantic (30°N–18°S).

The basinwide subsurface thermal structure is dominated by the annual cycle of the surface wind field with extrema around April and August. The mixed layer is relatively shallow between 20°N and 10°S, with overall grater depth in the western as compared to the eastern portion of the basin. Two systems of annual cycle variation of mixed layer depth stand out. (i) Along the equator, the mixed layer depth increases from around April to about August, with largest variations to the west, in direct response to the annual variance of the zonal wind component in the equatorial zone. (ii) In the North Equatorial Atlantic, a northward migration of a band of shallowest mixed layer is apparent from April to August, broadly concordant with the seasonal migration of the confluence zone between the northeast trades and the cross-equatorial airstreams from the Southern Hemisphere, Concomitant with this northward displacement, a belt of maximum mixed layer depth builds up immediately to the north of the equator. The evolution of this trough–ridge structure in mixed layer depth is related to the seasonal reversal of the North Equatorial Countercurrent. Various recent numerical model experiments are in qualitative agreement with the present empirical documentation of the annual cycle of the basinwide pattern of mixed layer depth.

The thermocline is likewise thinnest and most intense and most intense in the low latitudes, especially in the eastern

portion of the basin, but its spatial pattern and seasonal variations differ from those of mixed layer. The near-equatorial thermocline structure is characterized by a wide vertical separation of isothermal surfaces at the Equator and extremum zones of thinnest and most intense thermocline at 4°S year round and at 4°N especially in the latter part of the boreal winter semester. It is conjectured that easterly surface winds produce, at the equator, upwelling above and downwelling below the thermocline and the opposite pattern of vertical motion at some distance from the equator, thus leading to the observed thick and weak thermocline at the equator and the isotherm packing around 4°N and S. The marked asymmetry of the surface wind field and the associated wind stress curl pattern within the cross-equatorial airstreams at the height of the boreal summer may be factors for the absence of this extremum zone of thermocline characteristics at 4°N at this time of the year. The comprehensive documentation of subsurface thermal structure presented here is relevant in recent and ongoing empirical and modeling studies of the tropical Atlantic Ocean.

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