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A Model Study of the Seasonal Mixed Layer Heat Budget in the Tropical Atlantic

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Modifications of Sea Surface Temperature (SST) in the tropical Atlantic play a primordial role on regional climatic variability. The goal of the present study is to understand the physical processes which control the seasonal cycle of the oceanic upper layer. These modifications result not only from atmospheric forcings (heat fluxes and wind stress), but also from local and remote oceanic processes (currents, oceanic waves and exchanges with the subsurface through the thermocline). The variations of the energy exchanges trough air-sea interface are primarily conditioned by those of the thermal contents and those of the oceanic mixed layer depth (MLD).

This study is based on the use of the OPA model in the configuration of the experiment CLIPPER. It reproduces the main features of the tropical Atlantic and this good agreement with observations provides confidence in the comprehensive three-dimensional circulation and thermal structure of the model. A close examination of mixed layer heat balance is thus undertaken. It is demonstrated that the mean state is dominated by the subsurface cooling and the atmospheric forcing warming at first order, i.e. by one-dimensional processes. Nevertheless, the mixed layer heat balance is also modulated by high frequency advection, which is obtained by decomposition of the total advection terms in high ($<$ 35 days) and low frequencies ($>$ 35 days), adapted from the formalism previously employed in the Tropical Pacific (Vialard et al, 2002). This high frequency advection term represents mainly the contribution by eddies, especially the TIWs, and play an important role in the mixed layer warming, in particular in the central and western parts of the basin, between the equator and the thermal front. On the contrary, the low frequency advection is found to account for a little part in the heat budget.

At seasonal scale, the dominant terms of the heat budget in the equatorial band are the forcing and the subsurface cooling effects in the eastern part of the basin. West, the TIWs also play an important role during the boreal summer and in smaller extent in winter; low frequency advection only has influence there during the summer cooling (through meridional advection east of 15˚W and zonal advection west of 10˚W).

Furthermore, the analysis of the latitudinal structure allows us to distinguish two zones with different dynamics. South of the equator, the heat storage is principally governed by the atmospheric forcing, whereas north of the equator, the strong eddies generated at the location of the thermal front is the main contributor to the heat budget along with the atmospheric forcing.

Finally, comparisons with heat budget calculated from observations (Foltz et al, 2003) are discussed.

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