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Wind stress and heat fluxes over a Brazilian Coastal Upwelling

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Coastal upwelling zones have been intensively studied in the last decades especially due to their importance to the biological cycle. The coastal upwelling system of the Cabo Frio region (east coast of the Rio de Janeiro state, Brazil) keeps the surface water cold during most part of the year, what induces a stable atmospheric boundary layer associated to northeast winds. The main goal of this study is to investigate the wind stress and heat fluxes exchanges between the ocean and the atmosphere in that area. For this purpose, a set of hourly data meteorological and oceanographic data collected by a Wavescan metocean buoy anchored at 23o59S; 42oW, were used, as well as solar radiation and relative humidity from a terrestrial meteorological station from the Instituto Nacional de Meteorologia (InMet). COARE 3.0 algorithm was used to calculate the latent and sensible heat fluxes. In this discussion, positive values represent fluxes towards the ocean. The average net heat flux over our study period is 88 W m-2. The reduction of the net heat flux is due to the increase of the ocean latent heat loss, although a reduction in incoming shortwave radiation and an increase in ocean long wave cooling also contributes. The latent heat is 20 times larger than the sensible heat flux, but the mean value of the latent heat flux, 62 W m-2, is half the typical value found in open ocean. The temporal variability of both sensible and latent heat fluxes reflects their dependence on wind speed and air-sea temperature differences. When upwelling events, here periods when diurnal SST is lower than 18oC, are compared with undisturbed (without upwelling) events, it can be noted the sensible heat fluxes are positives and 10 times greater in magnitude. This is related to an increment, during these upwelling events, of the air-sea temperature difference and an increasing of the wind speed. The cold waters of the upwelling increase the air-sea temperature gradient and, also, the horizontal land-sea gradient. This could intensifies the sea breeze. At the same time, the latent heat flux to the atmosphere is reduced. As expected, cold waters from the upwelling imply in the reduction of the evaporation, and so the latent heat fluxes also reduce significantly. As upwelling events in this region are associated to the presence of the South Atlantic high pressure, NE winds, during these periods of cold water the net heat flux toward the ocean surface is intensified.