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Seasonal cycle of the mixed-layer heat and freshwater budget in the eastern tropical Atlantic

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A new seasonal mixed-layer heat flux climatology is used to explore the mechanisms driving seasonal variability of sea surface temperature and salinity in the eastern tropical Atlantic (ETA) with a focus on the eastern boundary upwelling regions. Until recently, large areas at the continental margins of the ETA were not well covered by publically available hydrographic data hampering a detailed understanding of the involved processes. In a collaborative effort between African and European partners within the EU-funded PREFACE program, a new seasonal climatology for different components of the heat and freshwater budget was compiled for the ETA using all publically available hydrographic data sets and a large trove of previously not-publically available hydrographic measurements from the territorial waters of western African countries, either from national programs or from the FAO supported EAF-Nansen program. The publically available data includes hydrographic data from global data repositories including most recent ARGO floats and glider measurements. This data set was complemented by velocity data from surface drifter and ARGO floats to allow determining horizontal heat and freshwater advection. Monthly means of air-sea heat fluxes were derived from the TropFlux climatology while precipitation rates were derived from monthly mean fields of the Global Precipitation Climatology Project. Finally, microstructure data from individual measurement campaigns allow estimating diapycnal heat and salt fluxes for certain regions during specific months.

A detailed analysis of the seasonal cycle of mixed-layer heat and freshwater balance in previously poorly covered regions in the eastern tropical Atlantic upwelling is presented. In both eastern boundary upwelling region, off Senegal/Mauritania and off Angola/Namibia, average net surface heat fluxes warm the mixed layer at a rate between 50 and 80 W/m^2 with maxima in the respective summer seasons. Horizontal advection contributed to cooling of the mixed layer but a residual cooling term remains in both upwelling regions. A surprising result is that this residual is largest in the Angolan upwelling region, where upwelling-favourable winds are generally weaker than off Namibia and in the north-eastern upwelling region. The contributions of windstress-derived vertical advection and diapycnal heat and freshwater fluxes are discussed. In addition, the TropFlux climatology is evaluated against radiative and turbulent ocean-atmosphere heat and freshwater fluxes derived from ship-board observations.