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Mixed layer heat and freshwater budget during the onset of the 2011 Atlantic cold tongue

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The mixed layer (ML) temperature and salinity changes during the equatorial Atlantic Cold Tongue (ACT) development from May to July 2011 were studied during a dedicated experiment (cold tongue experiment, CTE). The CTE was based on two successive research cruises, a glider swarm deployment, and moored observations. This in-situ dataset together with satellite data, atmospheric reanalysis data, and assimilation model output were used to evaluate the ML heat and freshwater budgets for two sub-regions: 1) the western ACT between 23°-10°W showing strong cooling during the CTE and 2) the region north of the ACT influenced by the northward migrating Intertropical Convergence Zone.

The strong loss of mixed layer heat content typical for the ACT region during boreal summer was found to be the result of a balance between warming due to a net surface heat gain and cooling due to diapycnal mixing and zonal advection. The dominant role of diapycnal mixing was deduced from direct turbulence observations as well as conjectured from the residual of the heat budget excluding diapycnal mixing by using climatological diapycnal diffusivities and vertical temperature gradients at the base of the ML. In the region north of the ACT the weak ML cooling was achieved by the balance of net surface heat flux, zonal advection and entrainment.

During the CTE, the salinity content of the ACT ML slightly increased. The dominant terms in the ACT ML freshwater balance are zonal freshwater advection and net surface freshwater flux. Zonal advection varied strongly during CTE while net surface freshwater flux increased salinity. Diapycnal mixing, which acts to erode the high salinity core of the Equatorial Undercurrent, cannot fully explain the remaining residual in the freshwater ACT balance. In the region north of the ACT, elevated precipitation dominated the freshwater flux balance. Zonal advection changed sign during the CTE period, contributing to a ML freshening in the beginning and a salinity increase towards the end of the CTE.