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On the freshwater budget in the eastern tropical Atlantic during the development of the cold tongue

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The most striking sea surface temperature (SST) phenomenon in the tropical Atlantic is the seasonal appearance of the Atlantic Cold Tongue (ACT). Onset, duration, spatial extent and strength of cooling are subject to significant interannual variability. The ACT onset is also associated with remarkable changes in upper ocean salinity. To examine the different contributions to these changes we here focus on and present a mixed layer freshwater budget in the eastern tropical Atlantic.
Our investigation is based on an exceptionally large set of observations during the onset of the ACT in late boreal spring/ early boreal summer 2011: more than 5400 CTD-profiles acquired by seven gliders running simultaneously to two research cruises, 180 ship based CTD-profiles, time series data from the PIRATA buoy array as well as measurements from the Argo float program are used to derive mixed layer depth, lateral and vertical salinity gradients. To derive turbulent mixing and inferred diapycnal salt flux, microstructure observations are taken into account. Furthermore satellite measurements of sea surface salinity (SSS) by the SMOS mission and of SST by the TMI radiometer as well as atmospheric reanalysis data and the OSCAR project products are implemented.
Freshwater budget terms were calculated for different sub-regions. These sub-regions are chosen using pre-defined thresholds in SSS, SST or mixed layer depth. Overall the freshwater budget is dominated by the net surface freshwater flux and horizontal advection by strong zonal currents. Other terms, like entrainment and diapycnal mixing are found to be regionally important. In particular, the observed increase in salinity in the near-equatorial region during ACT onset is found to be the result of the northward migration of the ITCZ associated with reduced net surface freshwater flux at the equator as well as mixing of salty subsurface waters into the surface mixed layer.