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Mixed layer freshwater budget in the eastern tropical Atlantic during 2011 cold tongue development

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The most striking sea surface temperature phenomenon in the tropical Atlantic is the seasonal appearance of the Atlantic Cold Tongue (ACT). The ACT, characterized by strongly reduced temperatures, develops in late spring/early summer with the strengthening of the southeast trade winds along the equator and last until late fall/early winter. Onset, duration, spatial extent and strength of cooling vary significantly from year to year. From recent investigations, the individual mixed layer heat budget terms (advection, entrainment, air-sea exchange) in the ACT region are rather well estimated. The role of near-surface salinity variations for ACT onset and development as well as the mixed layer freshwater budget are less understood. Here we present a first mixed-layer freshwater budget for the onset of the ACT in May to June 2011.
Our investigation is based on an exceptionally large set of observations: 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 and lateral and vertical salinity gradients. Freshwater fluxes through the air-sea interface were estimated from direct meteorological observations from the ship (meteorological weather station, rain measurements, turbulence measurements) and from autonomous flux measurements at the PIRATA buoys. Moreover atmospheric reanalysis data was used. To estimate the effect of ocean transport, the 'Ocean Current Analysis real-time' (OSCAR) project products were used. The observational data was interpolated to monthly mean fields (May, June and July) and on a standard (1° x 1°) regular grid.
Averaged over the whole ACT region the freshwater variability is driven mainly by the variability in the surface freshwater flux. However, on a local scale other terms such as the horizontal advection can be important. The locally large residual is supposed to result from the unaccounted diapycnal mixing in accordance with findings for the mixed layer heat budget. The output from the 1/12°-MERCATOR model, running for the same period, was compared with the observations to both better understand how the experimental data resolve spatial and temporal (model) variability in the region and to test the realism of the simulated ACT onset in the MERCATOR model.