Investigation of the surface and subsurface salinity wakes of tropical cyclones

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1. Motivation

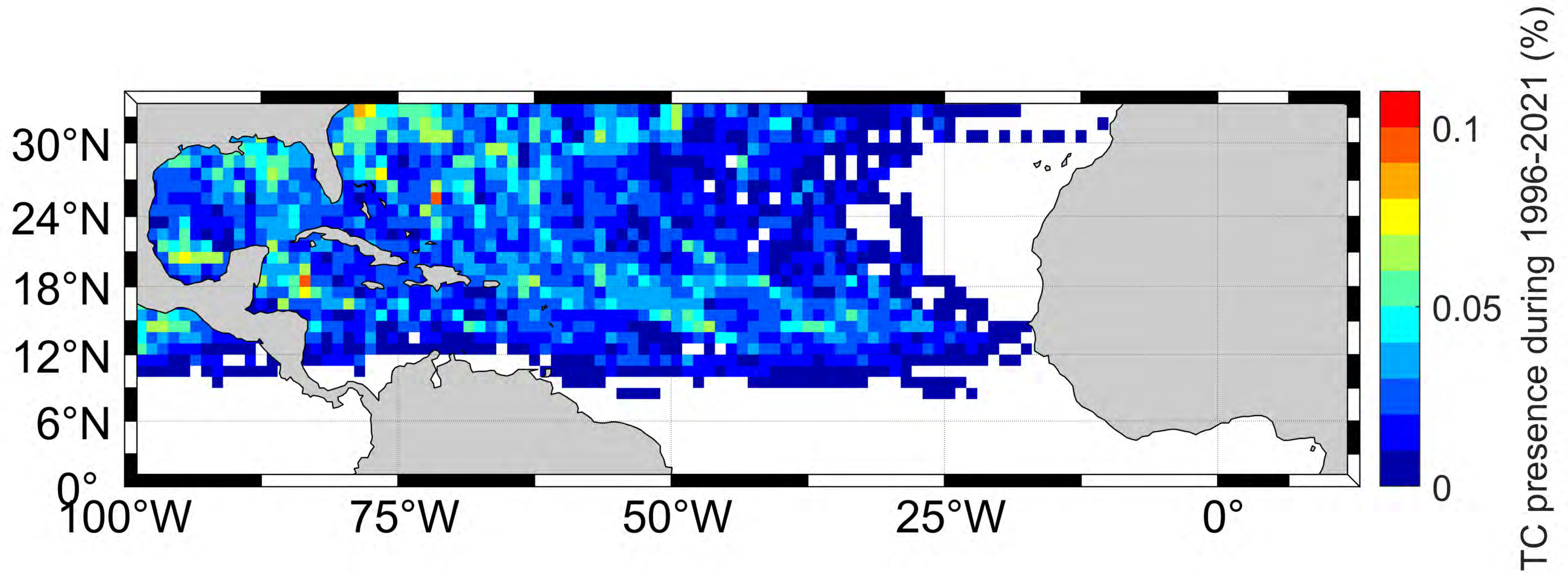
The northwestern tropical Atlantic Ocean is a breeding ground for devastating tropical cyclones (TC) that are also prominent upper ocean mixing agents. In this region, freshening from TC rainfall and freshwater input from river runoff cause salinity stratification that can reduce TC-induced sea surface temperature cooling. The reduced cooling makes TC rapid intensification more likely. Freshwater anomalies in this region also have the potential to alter the properties of the waters involved in the upper limb of the Atlantic Meridional Overturning Circulation and further north crucially change the water stability in the convection sites of the subpolar gyre, therefore having climatic impacts. Locally and over smaller time-scales, salinity anomalies can induce changes in the tropical surface mixed-layer, upper-ocean salt budgets, and consequently in the position and strength of equatorial and off-equatorial currents.

The impact of TCs on heat transport and circulation has been explored, but there is very limited understanding of the impact of TCs on upper-ocean salinity, salinity transport and ocean circulation. It is therefore crucial to understand the role of TC-induced salinity variability in the physics of the upper ocean. In this study, the surface signature and vertical structure of salinity signal in the TC wakes (henceforth called salinity wakes) on various timescales are presented using data from Argo floats and satellite observations.

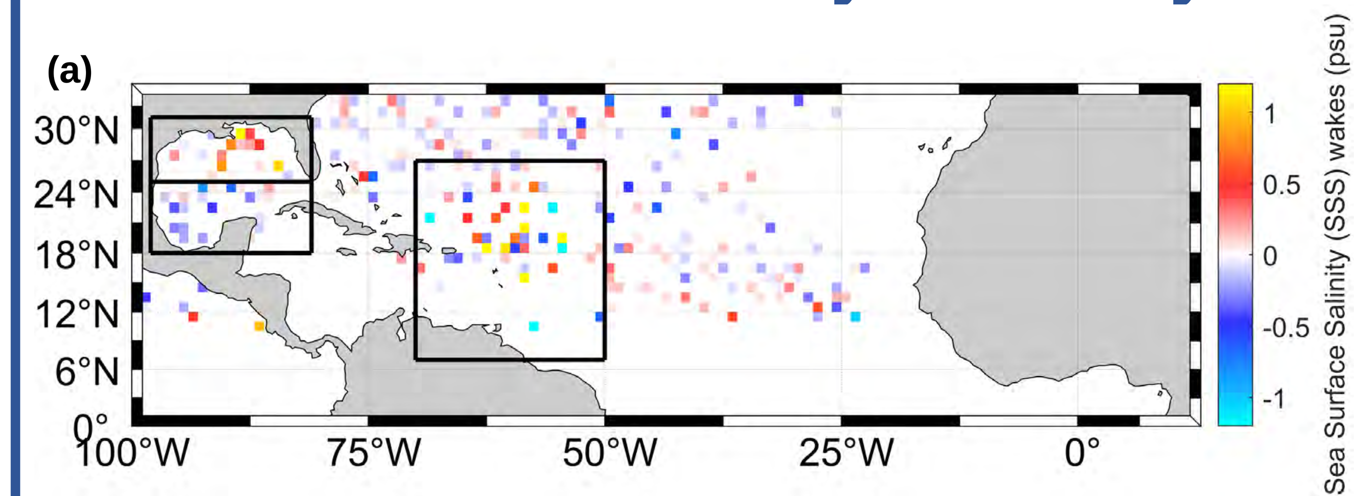
2. Tropical cyclone (TC) presence

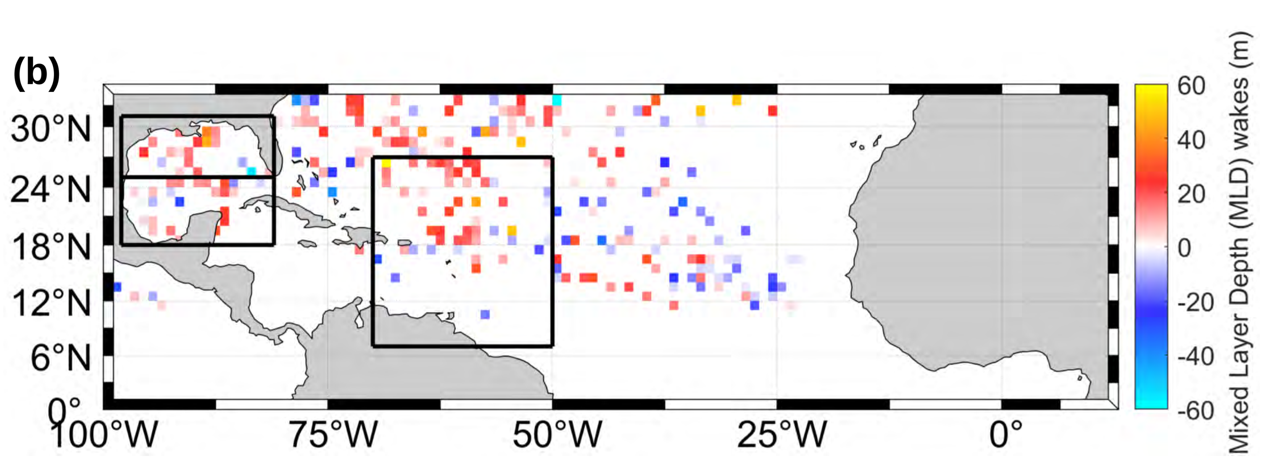
Percentage of time during twenty-six years (1996-2021) when tropical cyclones (TC) are present.

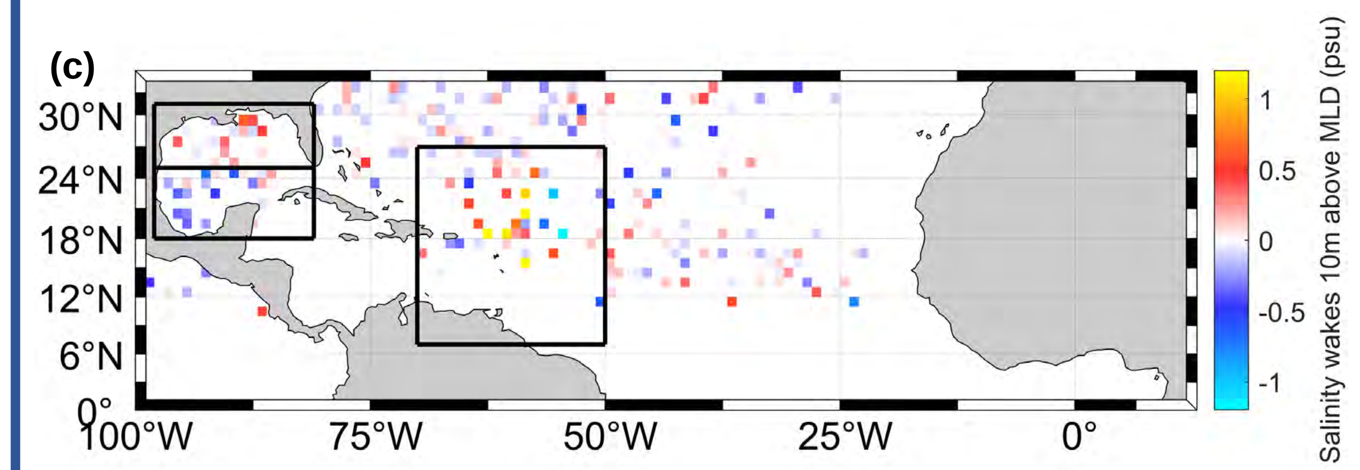
TCs with maximum sustained winds of 34 knots and higher are considered here. Maximum sustained wind speed data is six hourly, from the International Best Track Archive for Climate Stewardship (IBTrACS).



3. Surface and mixed layer salinity







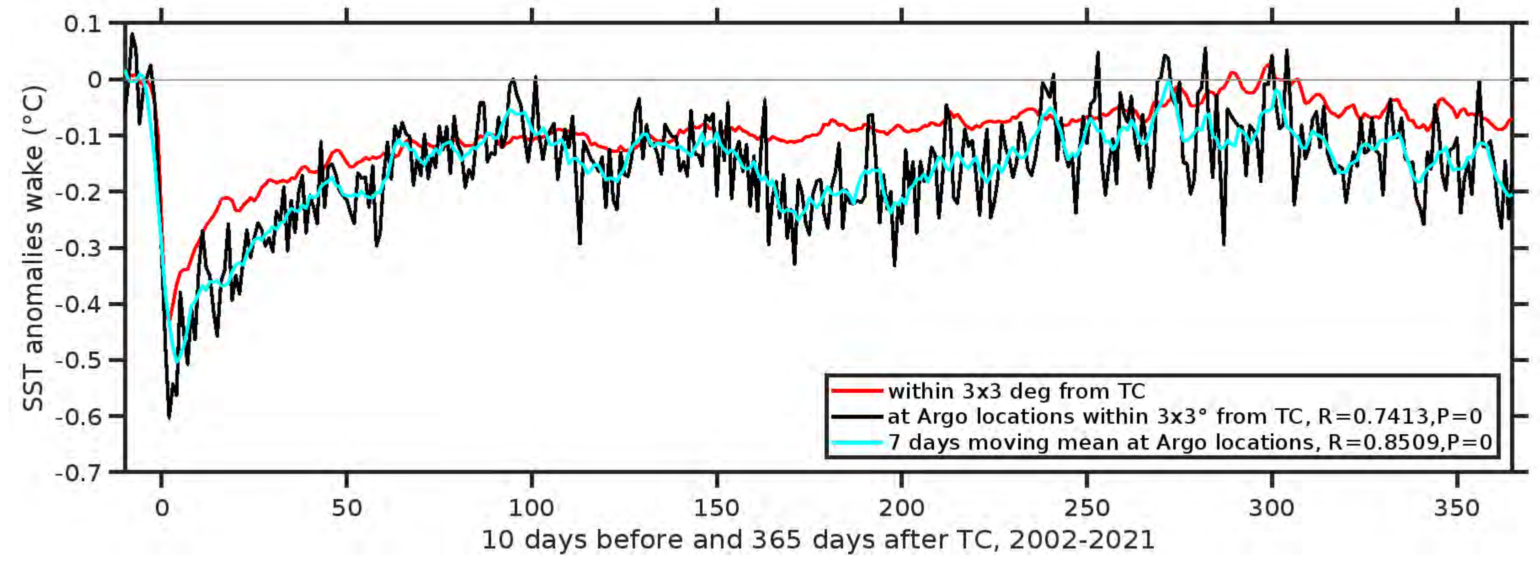
(a) Sea surface salinity (SSS) wakes, (b) Mixed Layer Depth (MLD) wakes, and (c) salinity wakes 10 m above the MLD, two days after TC passage for TCs present during the years 1996-2021. Prepared using Argo floats. The black boxes delimit the areas of significant salinity wakes.

- There is a saline surface salinity wake in the Amazon plume region and in the northern Gulf of Mexico. The southern Gulf of Mexico shows predominantly a fresh wake.

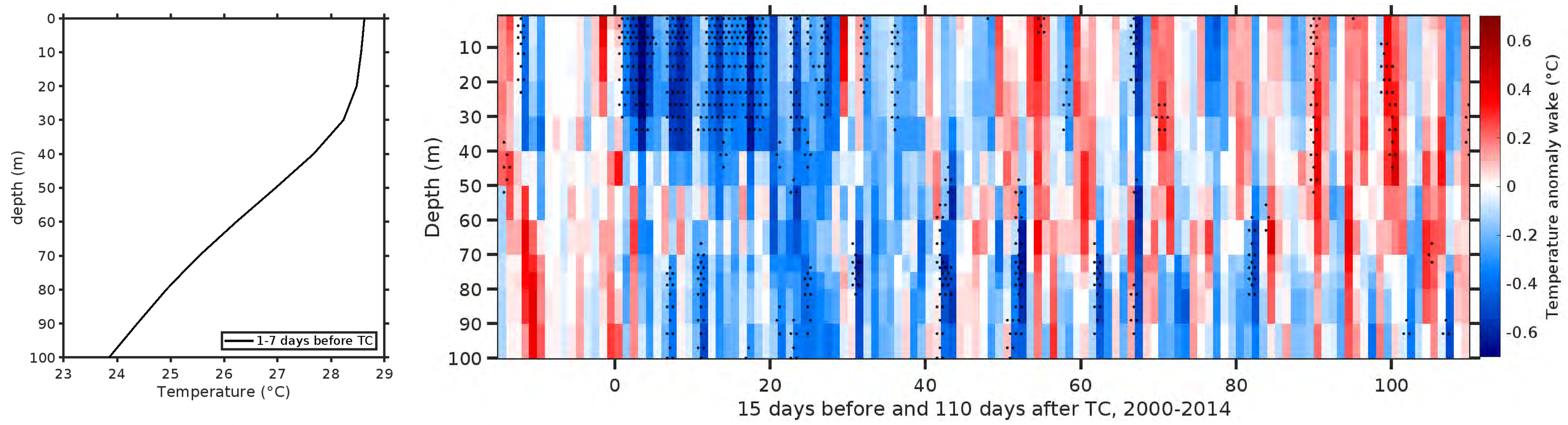
- SSS wakes and salinity wakes 10 m above the MLD show similar pattern.
- MLD increases two days after TC passage.

4. Argo vs. Satellite

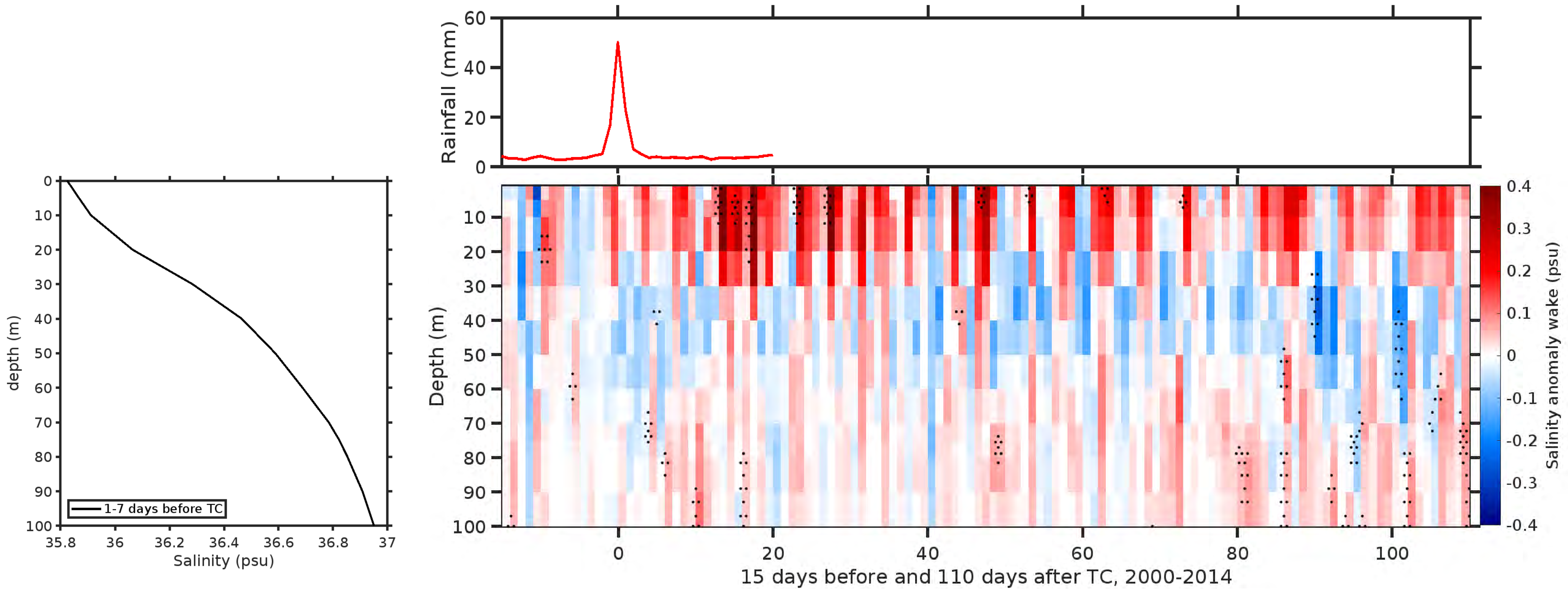
There is good agreement between sea surface temperature (SST) wake in the 3x3 degrees box around TC and the SST just at the Argo locations in that box.



5. TC impact on subsurface temperature and salinity in the Amazon plume region



- Dominant cold surface wake and subsurface warming.



- A saline surface salinity wake and subsurface freshening dominate. Predominantly fresh surface waters from river runoffs in this region mixes down to greater depths. Salinity maximum water at the subsurface is mixed to shallower depths.

6. Concluding remarks and future work

- Mixing down of fresh surface waters from river runoffs in the Amazon plume region, and upward advection of salinity maximum water possibly explains the salty surface salinity wake and subsurface freshening in this region.
- Expanding the analysis to other basins with dominant TCs.