Sea Surface Salinity Fronts and Associated Salinity Minimum Zones in the Tropical Ocean

Problem: The Intertropical Convergence Zone (ITCZ) is a major source of the surface freshwater input to the tropical open ocean. Under the ITCZ rain bands, zonally oriented sea-surface salinity (SSS) fronts are observed by the Aquarius/SAC-D mission and Argo floats (Fig.1). This study is to investigate the evolution and forcing mechanism of the tropical SSS fronts.

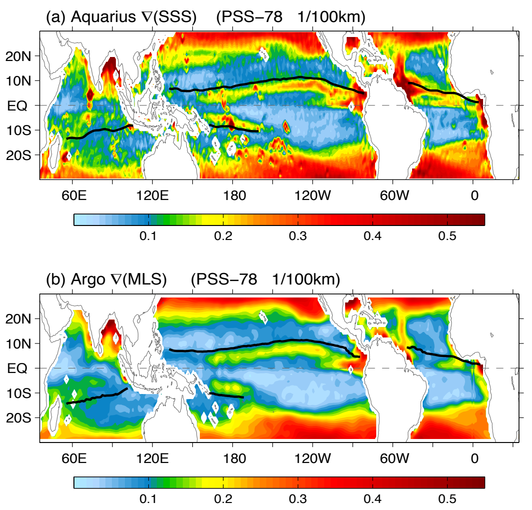

Fig 1. SSS gradients (fronts) constructed from (a) Aquarius and (b) Argo superimposed with the respective Smin location line (thick black).

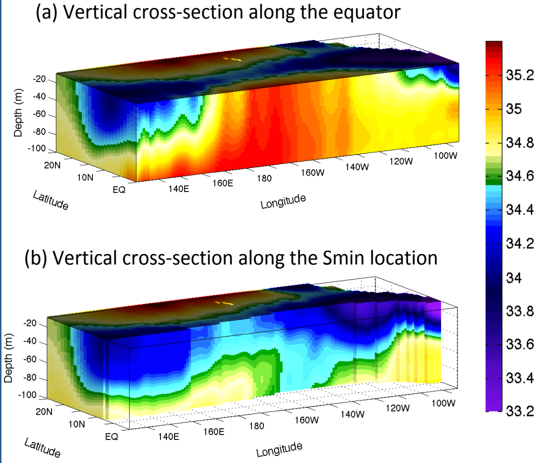

Fig 2. The upper 100m vertical cross-section of mean salinity in the tropical Pacific with the southern boundary set (a) at the equator, and (b) along the varying Smin location line. The northern boundary is fixed at 25°N.

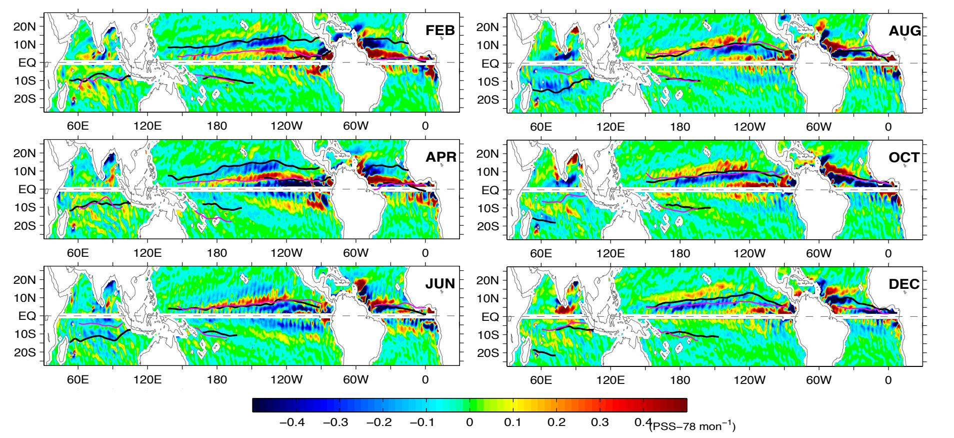

Fig 3. Bi-monthly evolution of salt advection by Ekman mean transport. Positive (negative) anomalies denote advection of saltier (fresher) surface waters. The Smin (black) and Pmax (magenta) locations are superimposed.

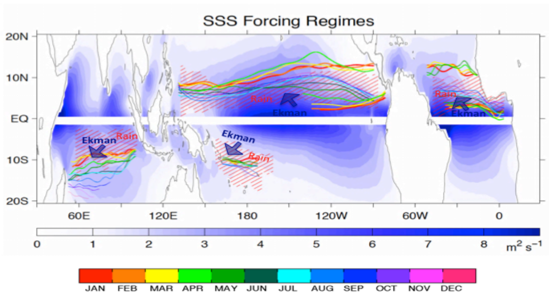

Fig 4. Schematic diagram depicting the Smin location lines (color-coded by month) with respect to two forcing regimes: the trade-wind Ekman transport (the background blue shading) and the ITCZ rain (denoted by the Pmax migration latitudes in the red hatch-filled region).

Finding: The surface salinity minima (Smin) are organized not along the ITCZ maximum rainfall (Pmax; Fig. 1) but along the poleward edges of the SSS fronts. These SSS fronts are a surface manifestation of the salinity minimum zone (SMZ) of 50-80 m deep (Fig.2), formed by Ekman convergence of rain-freshened surface waters. Collocation between the Ekman convergence zones and the SSS fronts is evident (Fig.3), supporting the conventional concept that salinity front is the boundary of two surface water masses - the ITCZ-freshened surface waters and the ambient saltier surface waters in this case. The forcing influence of the Ekman transport and rainfall on the seasonal generation and variations of the SMZ is depicted by a schematic diagram (Fig.4). The coupling of the SSS front with Ekman convergence sustains the structure of the rainfall-induced low-salinity in the SMZ, making the SMZ susceptible to the ocean circulation driven by the trade winds.

Significance: Salinity is a conservative tracer. Once salinity anomalies are generated, the properties are not changed except by mixing and diffusion. One distinct feature of the SMZ is the possession of the closed isohaline contours that bound the low-salinity waters sourced from the ITCZ by a closed volume. The salinity budget could be formulated for this choice of control volume that does not have the advective contribution in it, thus relating the surface freshwater flux directly to the tendency of the salinity volume and the mixing processes across the bounding surface.

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