Characterization of the Sea Surface Salinity Interannual Variability in the Eastern Tropical Pacific Ocean through Satellite Observations and Numerical Modeling

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Goal

Which is the **main mechanism** controlling spatial and temporal **SSS variability** in the Easter Tropical Pacific Ocean?

Hypothesis and facts

Annual largest rainfall record
Colombian Pacific coastal area
8000-13000 mm/yr. [1,2]

NECC[3]
Strengthening: Aug-Jan
Weakening: Boreal Spring

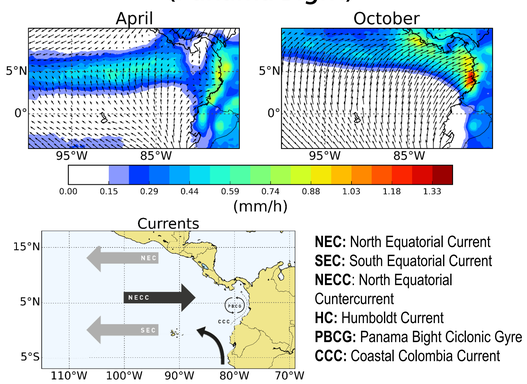
Fresh Pool extends from 85°W (Dec) to 95°W (Apr).[1]

Lowest SSS in december around **28-30** psu.[1]

Most active winds
1. Low level westerly Choco Jet
→ Oct-Nov 6-8 m/s 5°N [2]
2. Northeasterly Panama gap wind
→ Jan-Apr 8°N [1]

Effect
1. SSS lowest core
2. Ekman pumping

Eastern tropical Pacific (Panama Bight)



NEC: North Equatorial Current
SEC: South Equatorial Current
NECC: North Equatorial Cuntercurrent
HC: Humboldt Current
PBCG: Panama Bight Ciclonic Gyre
CCC: Coastal Colombia Current

Fig.1 Top: Monthly average surface wind climatology (QuikSCAT 2000-2009) and precipitation (TRMM 1998- 2014). Bottom: Main ocean currents in the region.

Methodology

Data Analysis

- EOF
- Correlations
- Scatter Plot
- Histograms
- Quartiles

Data sources
Salinity (SSS): SMOS (0.25°), Aquarius (1°), ORAS4 (1°)
Rainfall: TRMM (0.25°)
Sea Level Anomalies (SLA): AVISO (0.25°)
Sea Surface temperature (SST): NOAA OI SST (1°)
U,V velocity components: ORAS4 (1°)

Numerical Modeling

Model: ROMS Agrif
Horizontal resolution: 0.25°
Vertical levels: 20

Bathymetry: Etopo 5
Inicial Conditions: SODA 2.4.1
Boundaries: Open boundaries at the North, West and South edges, and close boundary in the East.
Validation: ORAS4 (Salinity, u, v velocity components)

Experiments:
0. Control run: Climatology

March Conditions:
1. Lowest rainfall run
2. Panama gap wind active run

The Eastern Pacific Fresh Pool

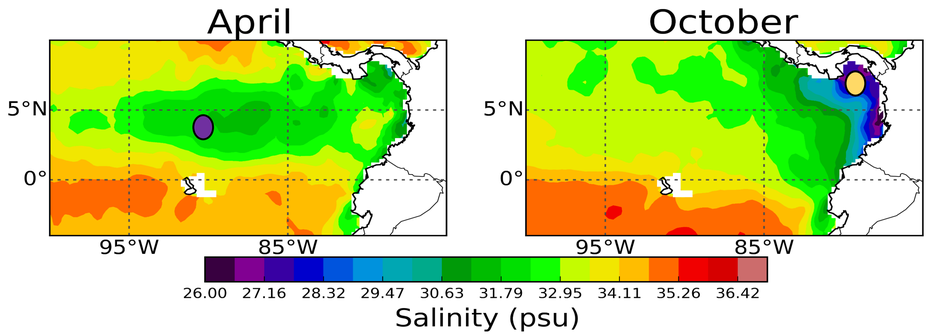


Fig.2 Sea surface salinity climatology from SMOS Locean V2013. Left: April and Right: October.

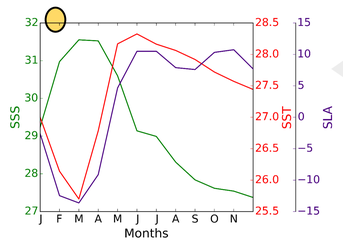


Fig.3 SST,SSS and SLA annual cycle at 6.75°N-79°W.

Active upwelling during Boreal winter-early Spring.

The plume reaches its westernmost position.

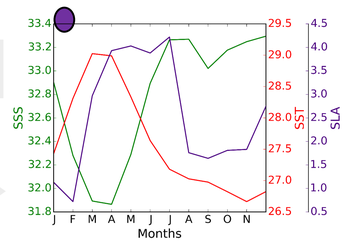


Fig.4 SST,SSS and SLA annual cycle at 4°N-90°W.

Mean Behavior

Comparison between AQUARIUS and SMOS

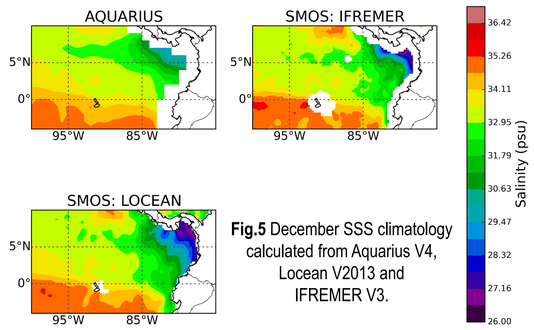
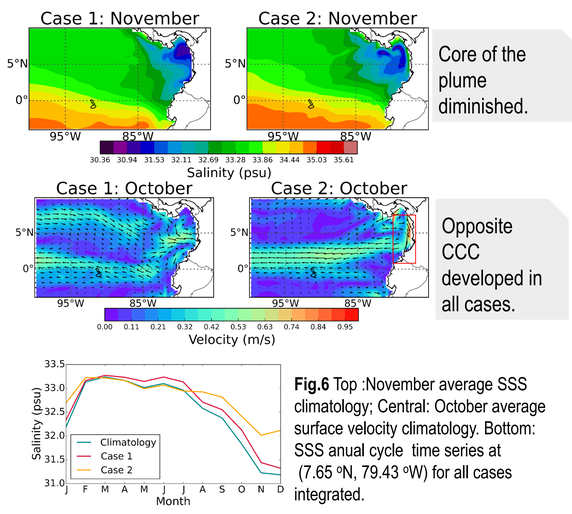


Fig.5 December SSS climatology calculated from Aquarius V4, Locean V2013 and IFREMER V3.

Model Results

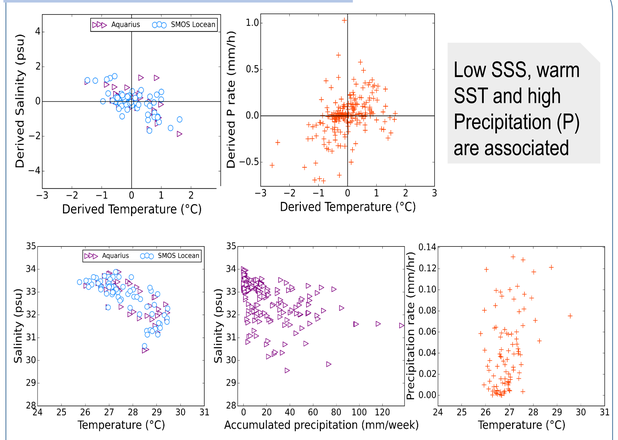


Core of the plume diminished.

Opposite CCC developed in all cases.

Fig.6 Top :November average SSS climatology; Central: October average surface velocity climatology. Bottom: SSS anual cycle time series at (7.65 ºN, 79.43 ºW) for all cases integrated.

Feedbacks



Low SSS, warm SST and high Precipitation (P) are associated

Fig.7 SSS, SST, precipitation rate and accumulated precipitation at (4°N,90°W) (lower panel), derived variables (upper panel).

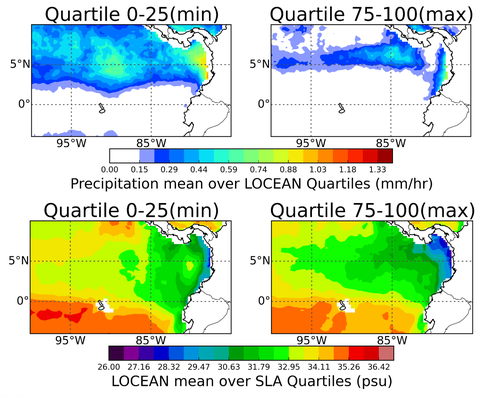


Fig.8 Precipitation and SSS mean mapped as two panels conditioned to quartiles (minimum and maximum) of SSS and SLA respectively at upper panel and lower panel.

ENSO

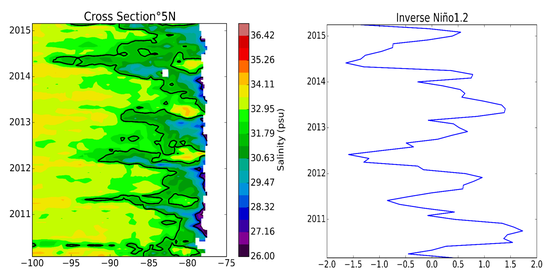
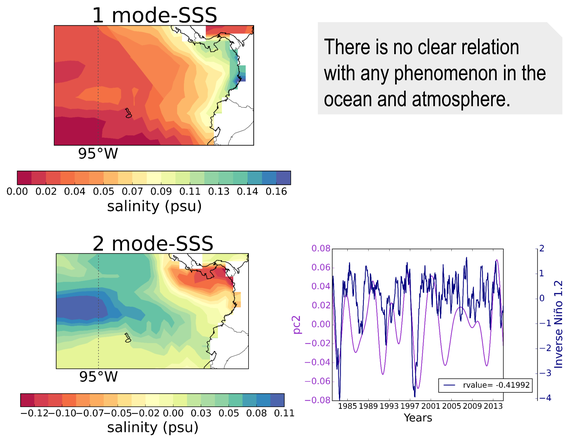


Fig.9 Left: Hovmöller diagram of average monthly SSS at 5°N (LOCEAN) 32 psu isohaline (black line), Right: El Niño 1.2 index two months lead-inverse.



There is no clear relation with any phenomenon in the ocean and atmosphere.

Fig.10 First (top) and second (bottom) EOF of monthy mean SSS. The expalined variance fraction is 55% for EOF1 and 15 % for EOF2. PC2 and Inverse Niño 1.2 index time series (Bottom left).

Conclusions and Future work

- Sea Surface Salinity at the Eastern Tropical Pacific Ocean is modulated by changes in both the atmosphere and the ocean. In the seasonal scale, the interaccion between SSS, P and SLA is clear. However, their relationships are quite complex in the interannual scale, specially in the 3-7 year window.
- Model simulations recreate the spatial distribution of Eastern Pacific Fresh Pool for all cases. However, in order to capture the complex meso and submesoescale processes that take place in the region and to clearly discern between the main physical processes that modulate the salinity variability in the región, a higher spatial resolution simulation should be implemented, including feedbacks with the atmosphere.

Bibliography

[1] Alory, G., Maes, C., Delcroix, T., Reul, N., & Illig, S. (2012). Seasonal dynamics of sea surface salinity off Panama: The far Eastern Pacific Fresh Pool. *Journal of Geophysical Research*, *117* (C4).

[2] Poveda, G & Mesa, O (2000). On the Existence of Llor6 (the Rainiest Locality on Earth): Enhanced Ocean-Land-Atmosphere Interaction by a Low Level Jet. *Geophysical Research Letters*, *27* (11).

[3] Kessler, W. S. (2006). The circulation of the eastern tropical Pacific: A review. *Progress in Oceanography*, *69* (2-4).