Formation of the South Pacific Subtropical Surface Salinity Maximum

Frederick Bingham (1), Julius Busecke, Arnold Gordon, Claudia Giulivi (2)
(1) Center for Marine Science, University of North Carolina Wilmington, binghamf@uncw.edu, (2) LDEO of Columbia University

Abstract

The surface salinity (SSS) in the eastern South Pacific has a large maximum centered near (21ºS, 120ºW). It is separated from another much smaller and less distinct SSS maximum feature in the western South Pacific near Australia. Its features:

- High evaporation and surface Ekman convergence on northern side
- Weak SSS variability and seasonality on northern side, stronger on southern side
- Mean surface currents that flow toward and through the feature from the north
- Large surface density gradient on northern side
- Veering (northeastward to northwestward) currents underneath

These characteristics highlight the role of mesoscale stirring, subduction, Ekman transport convergence and interaction with the underlying circulation in the formation and maintenance of this prominent feature.

Introduction

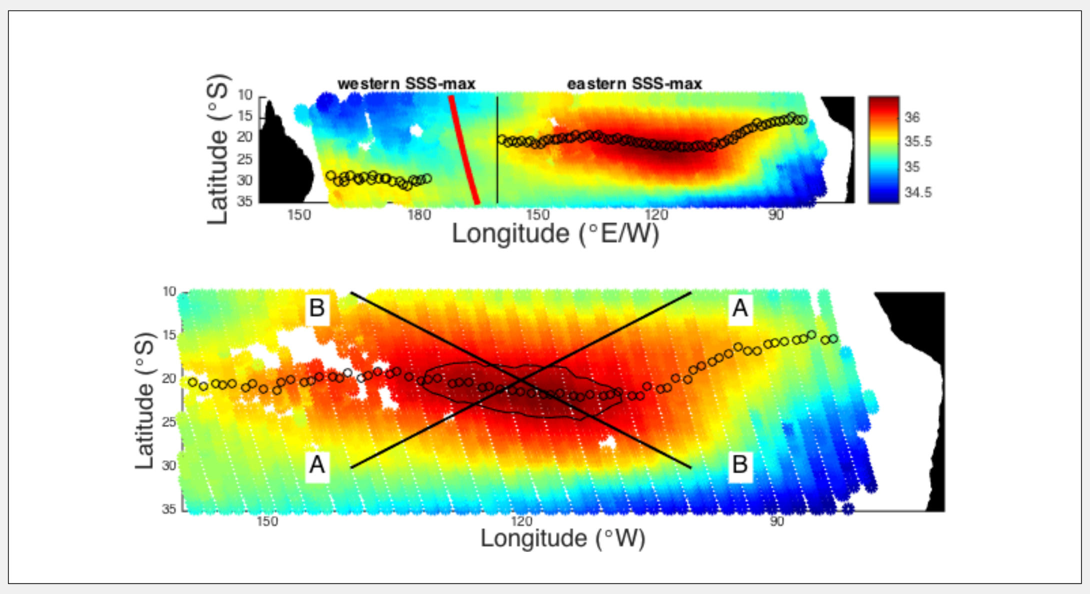

Figure 1. Mean SSS (unitless salinity) in the South Pacific from Aquarius L2 data. Black circles are the mean positions of the maximum SSS along each track. Circle is the approximate location of the 36.258 isohaline.

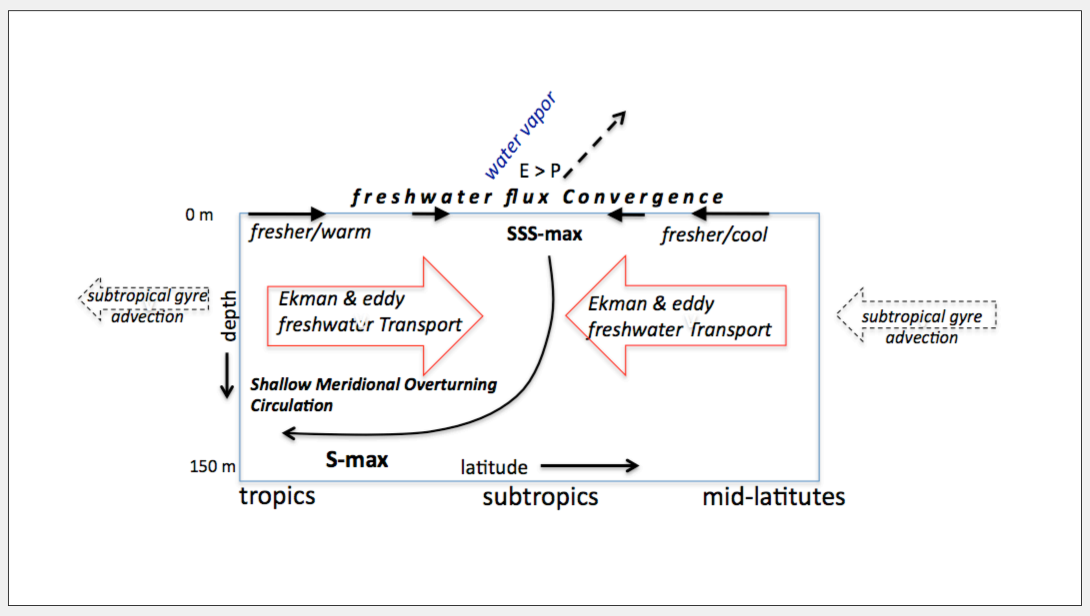

Figure 2.The formation process of the SSS-max (Gordon and Giulivi, 2014). High SSS waters are a result of poleward Ekman advection along with net evaporation at the surface.

Data and Methods

Aquarius data: Level 2 non-CAP, V.3.0, 10° S-35° S. Along-track passes were averaged into 0.5° latitude bins and put into repeat orbits to form time series at "nodes".

Time series at nodes were used to do a fit to an annual harmonic to get amplitude and phase.

Other datasets used: MOAA_GPV OI argo SSS, TRMM precipitation, OAFlux evaporation, MIMOC mixed-layer depth climatology, OSCAR Currents.

Surface freshwater forcing (FWF)

$$FWF = S_0 \frac{(E-P)}{h}$$

Results

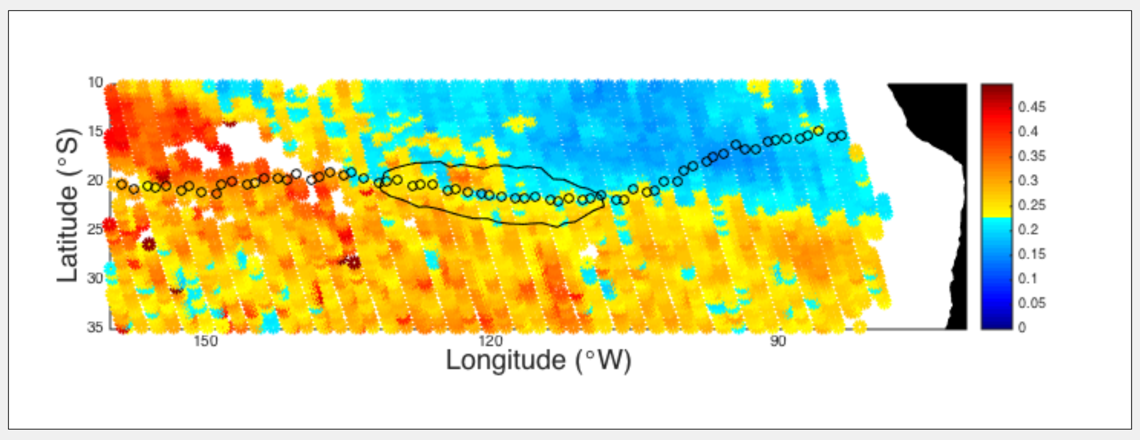

Figure 3. Standard deviation of SSS from Aquarius data (unitless salinity). Black circles are the mean positions of the maximum SSS along each track. The variability of SSS changes dramatically from one side of the maximum SSS to the other.

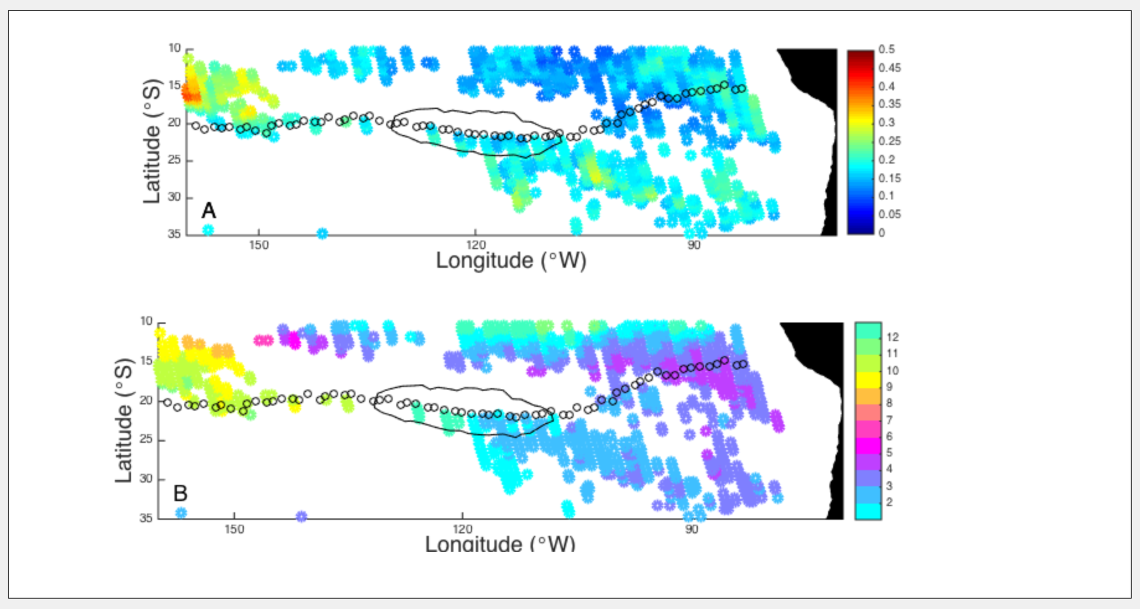

Figure 4. A) Seasonal amplitude (unitless salinity) and B) phase of SSS from Aquarius data. Phase indicates month of maximum SSS. Red circles are the mean positions of the maximum SSS along each track. The maximum SSS forms a boundary between areas of small and large seasonal variability.

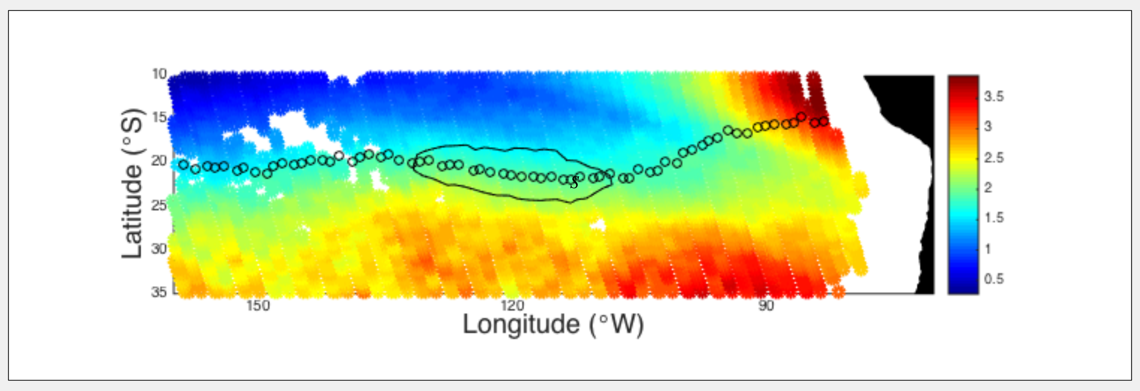

Figure 5. Amplitude of the seasonal cycle of SST (ºC). Red circles are the mean positions of the maximum SSS along each track. This again shows the SSS-max as a boundary between areas of high and low variability.

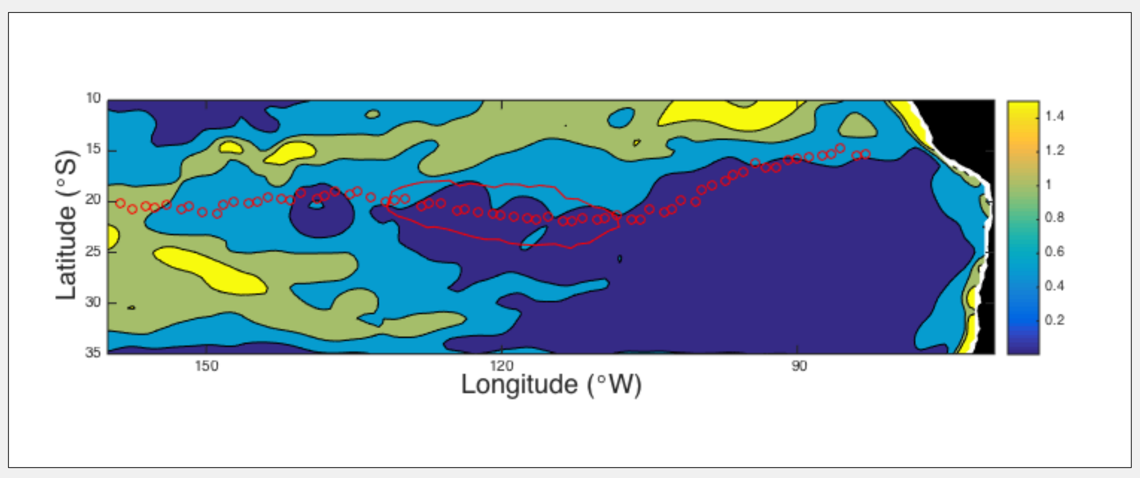

Figure 6. Horizontal gradient of surface density (SSDgrad) computed from the MIMOC dataset. The units are 10^{-6} kg/m^3 / m. Red circles are same as Fig. 1. The area north of the SSS-max has a high SSDgrad relative to the area south of it.

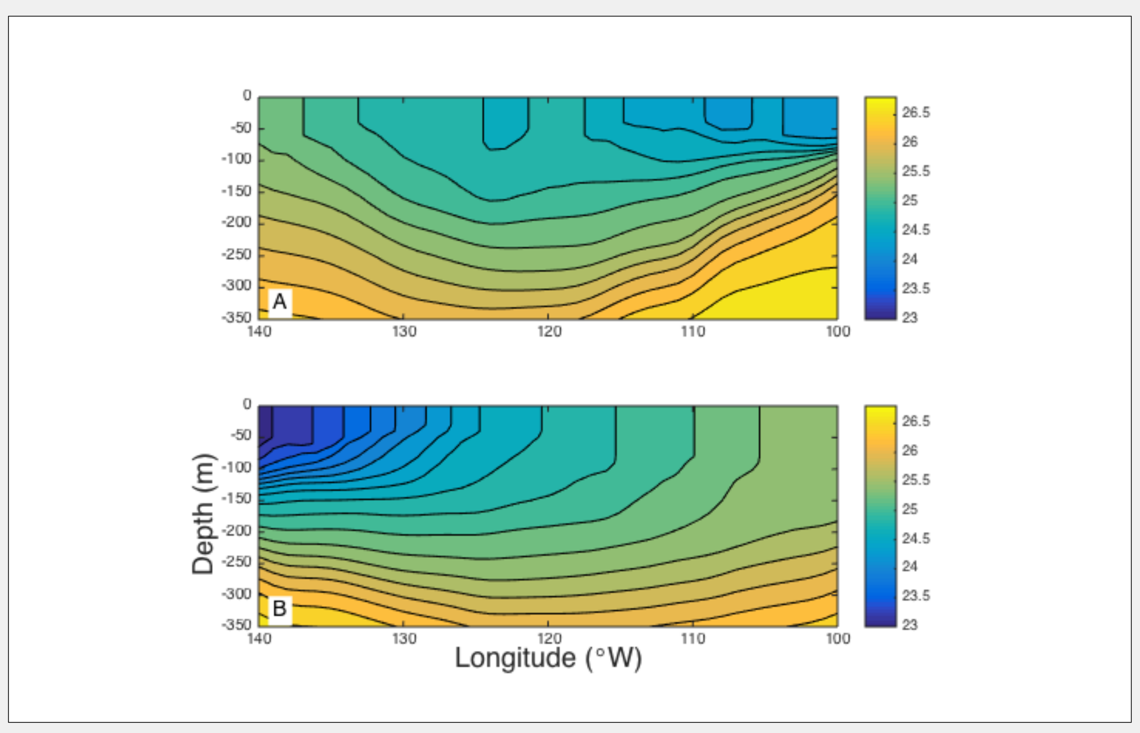

Figure 7. A) Potential density (kg/m^3) section from MIMOC data along the southwest-northeast white line (line A) in Fig. 1. B) Same but for the northwest-southeast line (line B).

Results

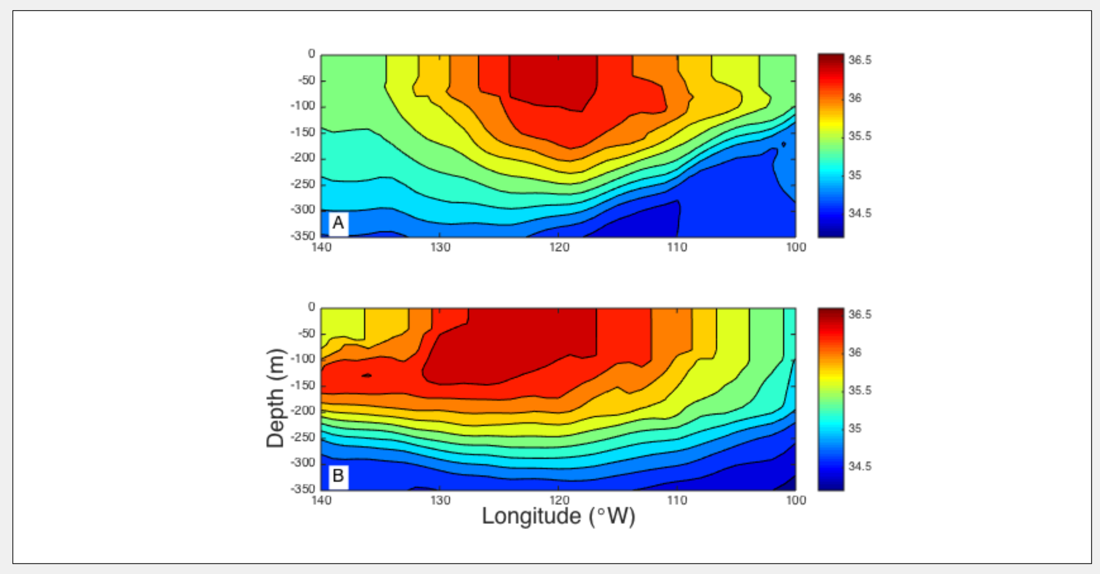

Figure 8. Same as Fig. 11, but for salinity (pss).

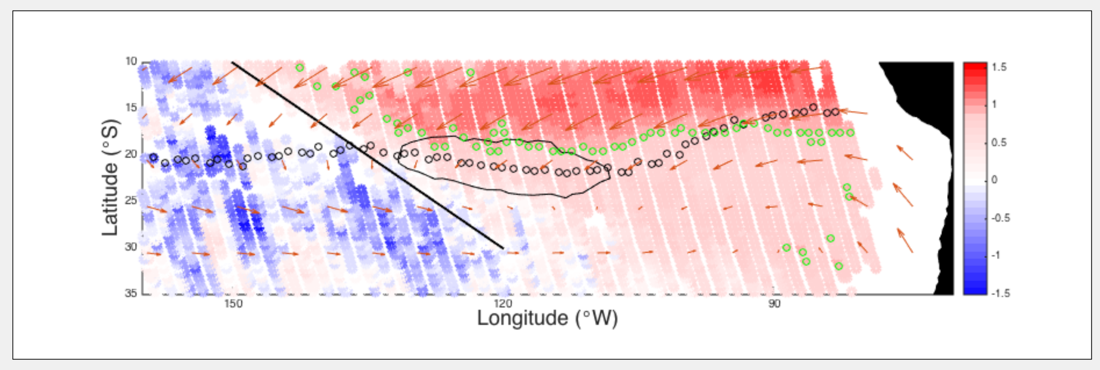

Figure 9. 1993-2014 mean OSCAR current vectors (red arrows) and 2011-2014 mean freshwater forcing (colors, in pss/year). Black "o"'s are the same as Fig. 1. Black line is approximate position of eastward extent of high rainfall South Pacific Convergence Zone. Green circles are location of 0.7 pss/year isoline.

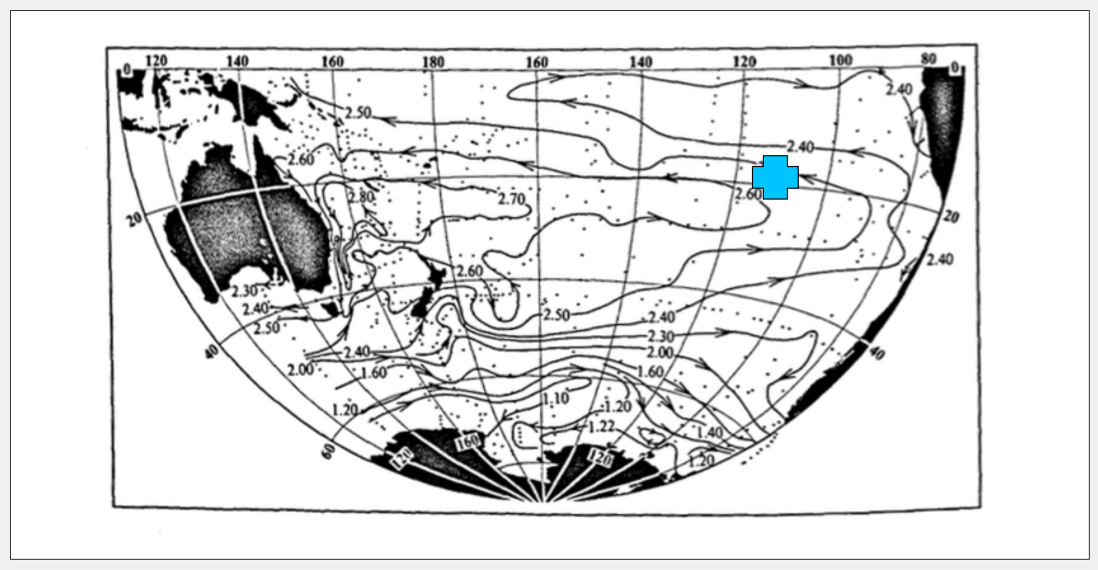

Figure 10. Adjusted steric height at 200 dbars (10 J kg^{-1}) from Reid (1986). The location of the center of the SSS-max region is indicated.

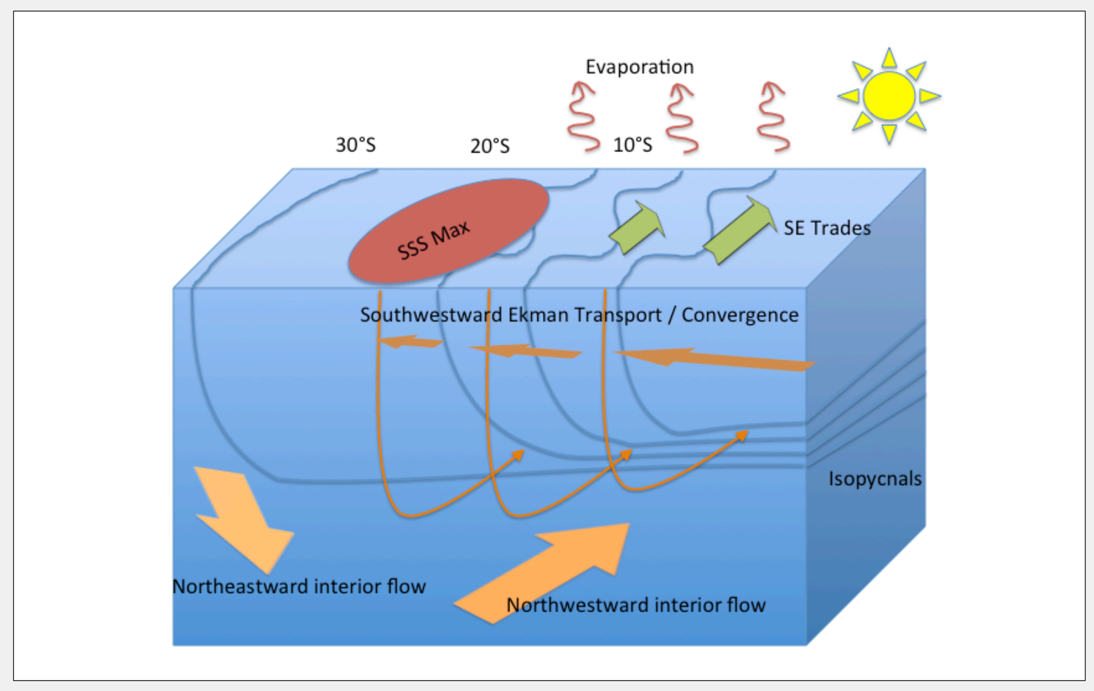

Figure 11. Schematic picture of the formation process of the SSS-max, showing evaporation, Ekman transport, subduction and interior flow.

Summary

The SSS-max is a prominent feature of the subtropical South Pacific. It forms a boundary between two regions. To the north, the SSS has very small variability, small seasonal cycle, surface FWF dominated by evaporation. To the south, the SSS has larger, though still relatively weak SSS variability, a larger seasonal cycle, weaker surface FWF.

Surface water being advected by southward Ekman flow towards the SSS-max is salinified by the excess evaporation while being subducted into the interior circulation.

Interaction between surface and subsurface are likely an important aspect of SSS-max formation.

Acknowledgments

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