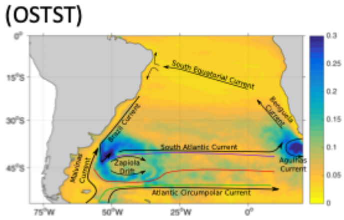
Ocean Surface Topography Science Team Meeting (OSTST)

Sea Level Trend and Fronts in the South Atlantic Ocean



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The understanding of the physical drivers of sea level trend is crucial on global and regional scales. In particular, little is known about the sea level trend in the South Atlantic Ocean in comparison with other parts of the world. The South Atlantic presents a very complex circulation: the encounter of two large western boundary currents, the presence of several fronts and eddies. These main processes can impact on the sea level trend. Thus, in this work, we compute the South Atlantic mean sea level (SAMSL) trend from 25 years of satellite altimetry data, and we analyze the contributions of steric height (thermosteric and halosteric components) and ocean mass changes for the period 2005–2016 when all the source data used (Argo, GRACE and satellite altimetry) overlap.

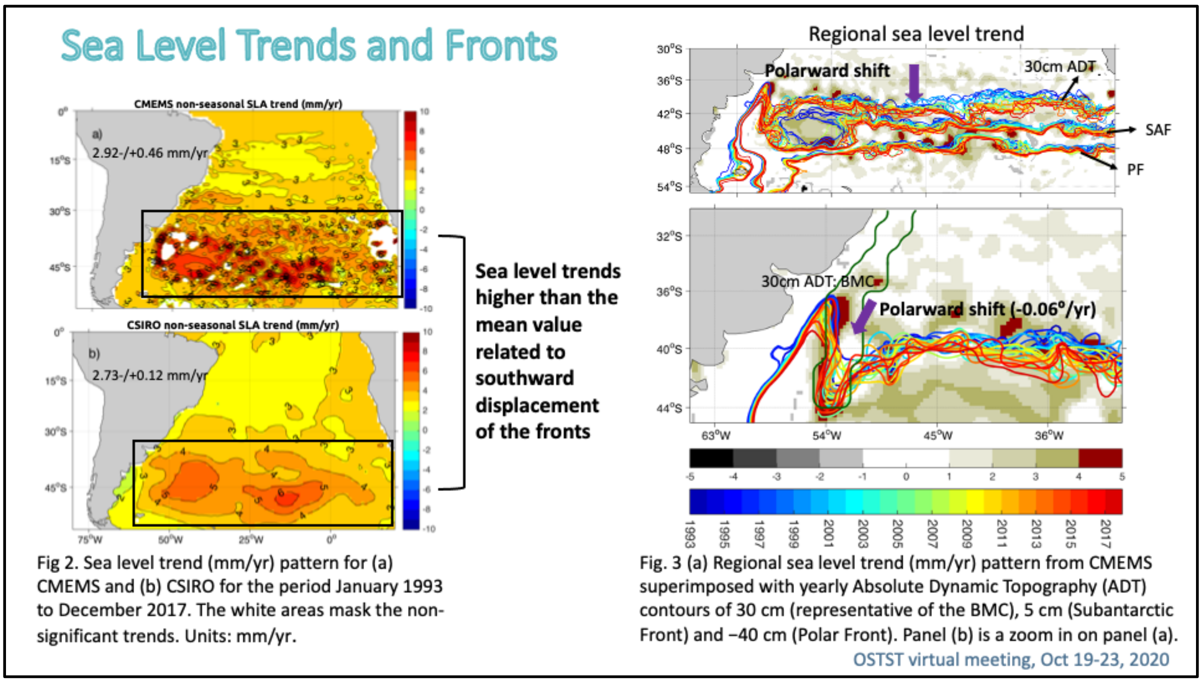

Fig 2. Sea level trend (mm/yr) pattern for (a) CMEMS and (b) CSIRO for the period January 1993 to December 2017. The white areas mask the non-significant trends. Units: mm/yr.

Fig. 3 (a) Regional sea level trend (mm/yr) pattern from CMEMS superimposed with yearly Absolute Dynamic Topography (ADT) contours of 30 cm (representative of the BMC), 5 cm (Subantarctic Front) and −40 cm (Polar Front). Panel (b) is a zoom in on panel (a).

Non-seasonal SLA trend maps from CMEMS and CSIRO, both were corrected by GIA, present a similar spatial pattern (fig. 2): the trend values are positive in the entire region, with relatively high values in the latitudinal band between 33° S and ~50° S, in good agreement with the results obtained by [Qu et al., 2019]. CMEMS shows finer spatial structures compared to CSIRO, since the latter cannot resolve wavelength shorter than 10^3km [Royston et al., 2020]. Fig. 2 shows three regions with tendencies higher than the mean trend (black box). One of those regions is located in the southwest of the extended Brazil region. We associated the presence of this hotspot to the southern shift of the BMC (e.g., [Leyba et al., 2019]) and to the intensification of the Brazil current [Artana et al., 2019]. The interannual evolution of the Brazil Malvinas Confluence (BMC) showed a trend of −0.06 °/yr (Fig. 3). A southward displacement of ADT contours was also observed for the Subantarctic Front (ADT contour of 5 cm) and the Polar Front (ADT contour of −40 cm) across the Atlantic (Fig. 3). The southward shift of the fronts contributes to a clear thermosteric trend that translates into the SLA trend observed in the Zapiola Drift and between 25° W and 0° W. The poleward shift of the fronts might be related to changes in the wind regime. The southward trend in the westerlies [Qu et al., 2019], and southwest expansion of the South Atlantic Subtropical High [Leyba et al., 2019] generate a displacement of the wind-driven ocean circulation towards high latitudes.

What Are the Drivers of SLA Trends in the South Atlantic?

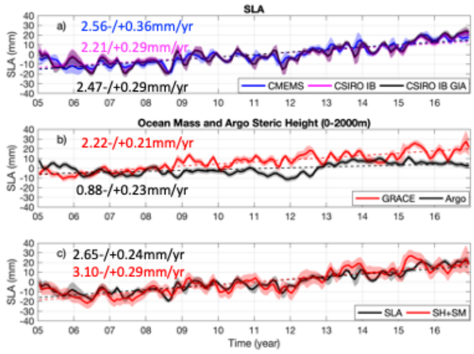

Fig. 4. South Atlantic mean sea level (SAMSL) time series without seasonal cycle derived from (a) CMEMS, CSIRO and CSIRO corrected by GIA, (b) GRACE and Argo (steric height) and (c) average of CMEMS and CSIRO corrected by GIA (SLA) and the sum of GRACE (SM) and Argo (SH) for the period January 2005 to December 2016. The dashed lines represent the linear regression. The blue, red and black shaded areas represent one standard error. Units: mm.

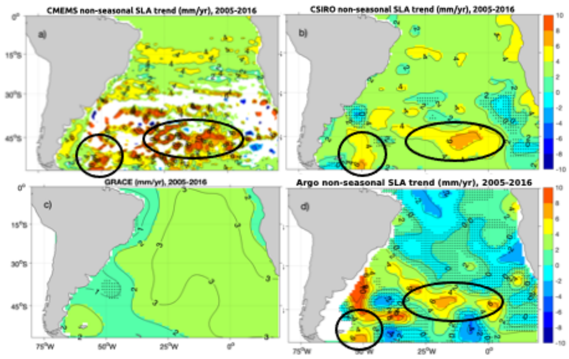

Fig. 5. Sea level trend spatial pattern derived from (a) CMEMS, (b) CSIRO, (c) GRACE (mean of JPL, GFZ and CSR) and, (d) Argo (steric height). The white area in panel (a) and the black dots in the panels (b–d) represent the non-significant trends. Units: mm/yr.

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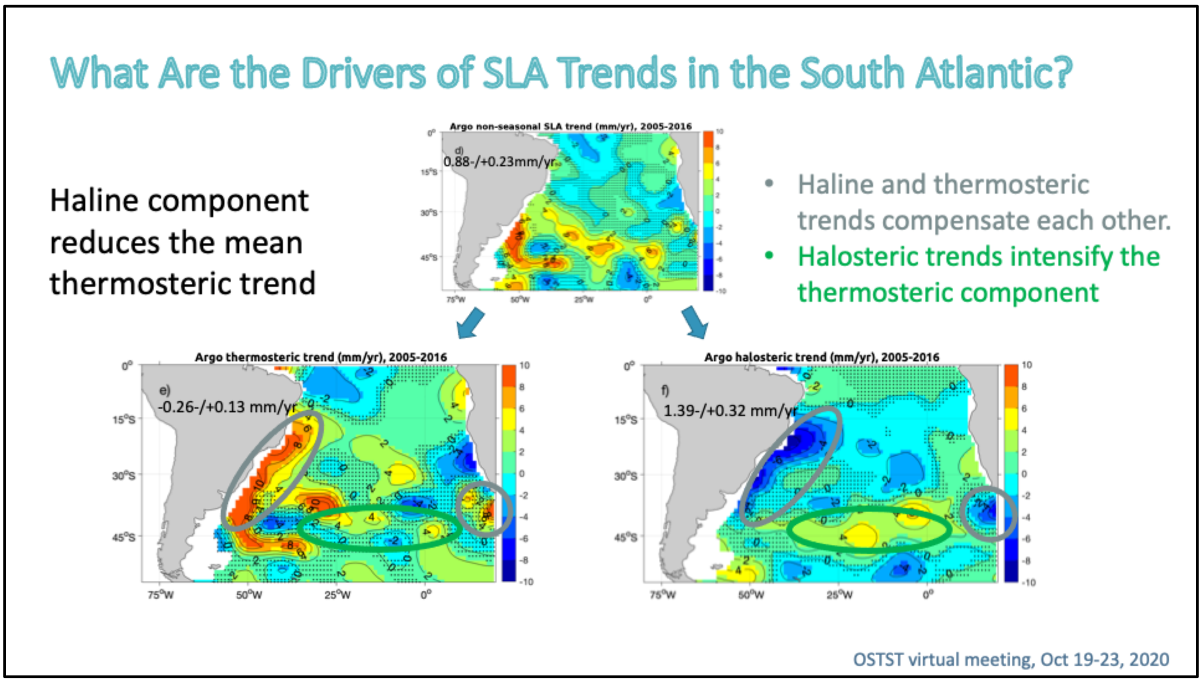
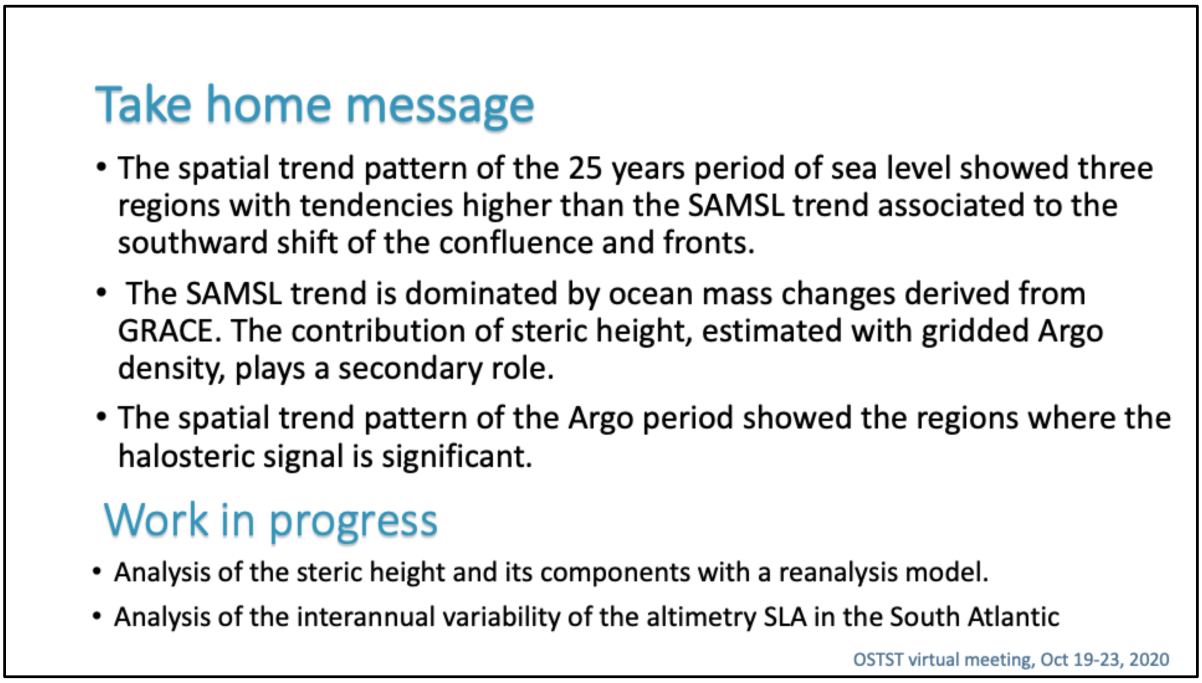
The linear trends were calculated using the least square method. We approximated the uncertainty of the linear trends by the standard error of the fitted slope. The significance of the trends was calculated with a Student's t-test with a level of confidence of 95%. From Fig. 4, we concluded that the South Atlantic Mean Sea Level (SAMSL) trend is dominated by ocean mass changes. The contribution of steric height, estimated with gridded Argo density data for the period of time coincident with the GRACE measurements, is smaller than the mass change contribution. This is in agreement with global mean sea level trend studies (e.g., [Tapley et al., 2019]). The analysis of the sea level trend spatial pattern derived from CMEMS, CSIRO, GRACE and Argo (Fig.5) revealed that the steric height dominates the sea level trend in the Brazil–Malvinas Confluence, around the Zapiola Drift and in the mid-Atlantic between 33° S and 50° S. North of 30° S and in the Agulhas retroflection, the ocean mass change contributions are dominant.



In general, the spatial pattern of the steric height trends is dominated by the thermosteric
component, except for a few areas where the haline component is not negligible. In the case of the two hotspot areas (<50° W and 55°–50° S, between 25° W and 0° E), the halosteric height trends intensify the positive thermosteric trends. As an opposite situation, there is a region in the west, between 30° S and 15° S, where the positive high thermosteric trends are compensated by negative halosteric trends. This region is related to the Brazil Current (BC), which carries warm and salty water. The trend maps indicate that the BC is getting warmer and saltier as it was shown by Artana et al., (2019) using 25 years of Mercator ocean reanalysis data in the upper 1000 m. At the same time, the halosteric signal near 15° S coincides with the subtropical salinity maximum.



Thank you for your attention

Ruiz-Etcheverry, L. A., & Saraceno, M. (2020). Sea Level Trend and Fronts in the South Atlantic Ocean. *Geosciences*, *10*(6), 218.

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