# Sea surface salinity variability in the South Atlantic from satellite and model data

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## I Introduction

Salinity variability in the South Atlantic is one of the least understood subjects, mainly due to the absence of broad and long-term sustainable in situ observations. Gradually, this has been changing with the surge of salinity measuring satellite missions and increase of ARGO profilers. In this study we investigate sea surface salinity (SSS) variability by analyzing satellite data (SMOS, Aquarius) and salinity outputs from the "Estimating The Circulation and Climate of the Ocean" consortium (ECCOv4r3) (Wunsch et al., 2009), which assimilates nearly all modern observations in a general circulation model (MITgcm)(Marshall et al., 1997).

## II Objectives

- Estimate and analyze spatial and temporal variability of sea surface salinity (SSS) in the South Atlantic;
- Identify and determine the distribution of SSS absolute gradients in the South Atlantic as permanent salinity oceanic fronts;
- Investigate the mean contribution and variability of the separate terms of the SSS budget by using the ECCO solutions.

## III Data and Methods

Data:

- SSS from satellites NASA-Aquarius-SAC/D and ESA-Soil Moisture and Ocean Salinity (SMOS).
- Salinity and salinity budget from ECCO outputs.

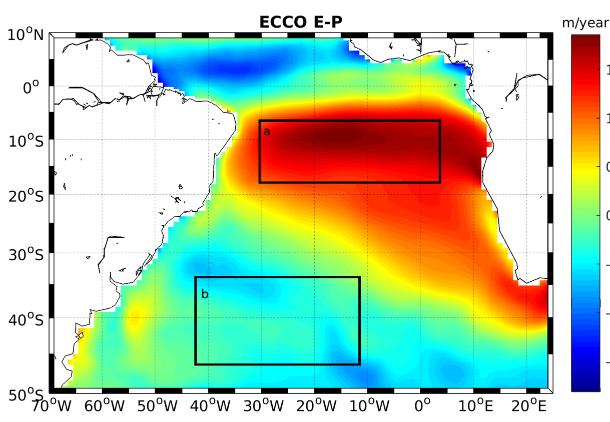


Fig. 1: Hydrological cycle forcing (E-P) from ECCO and delimited averaged areas (a) and (b), for the calculation of salinity budget terms.

ECCO salinity budget equations (Forget et al., 2015):

- $\mathcal{A} = -\frac{1}{s^*}\left[\frac{\partial s^*}{\partial t} + \nabla_{z^*} \cdot (s^* S \vec{v}_{res}) + \frac{\partial S w_{res}}{\partial z^*}\right]$
- $\mathcal{F} = s^*(S(E-P-R) - \mathcal{F}_s)$
- $\mathcal{D} = s^*(\mathbf{D}_{\sigma,S} + \mathbf{D}_{\perp,S})$

**Salinity Budget**

$$\frac{\partial S}{\partial t} = \mathcal{A} + \mathcal{F} + \mathcal{D}$$

## IV SSS Fronts

SSS fronts are estimated as $\|\nabla S\| = \sqrt{(\frac{\partial S}{\partial x})^2 + (\frac{\partial S}{\partial y})^2}$ :

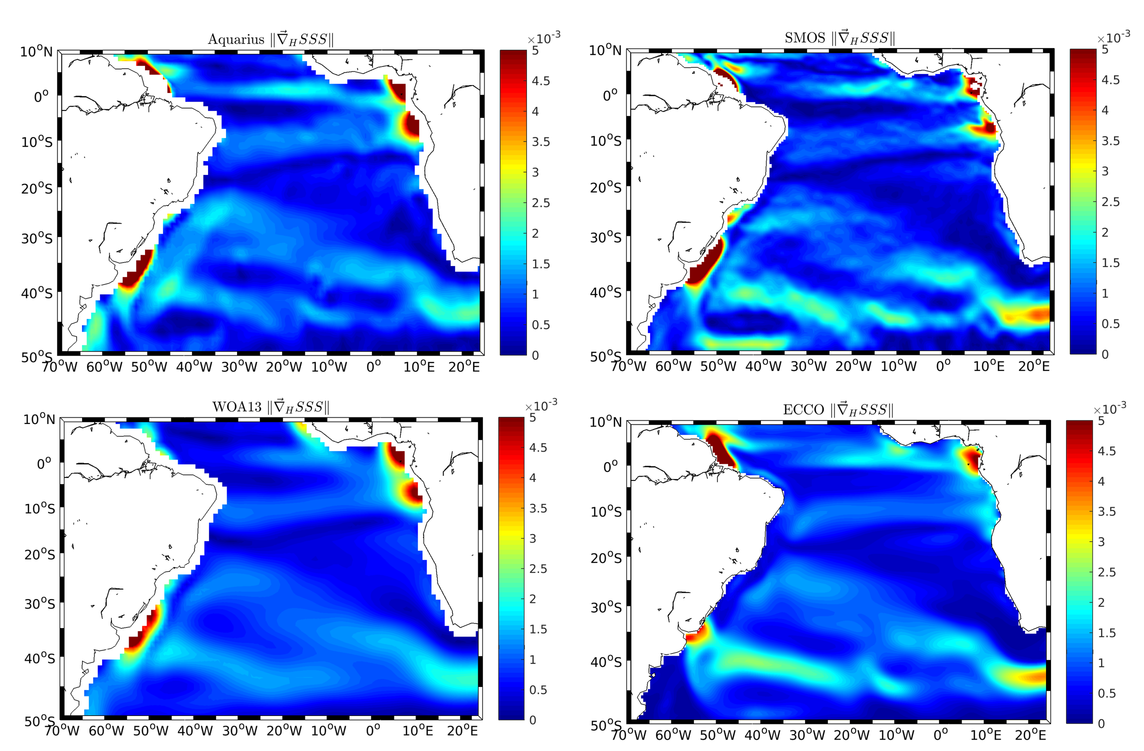

Fig. 2: Mean SSS absolute gradient, calculated from different data sources. Values are in g/kg.km$^{-1}$.

## V ECCO surface salinity budget

Salinity and budget terms variability over interannual scales:

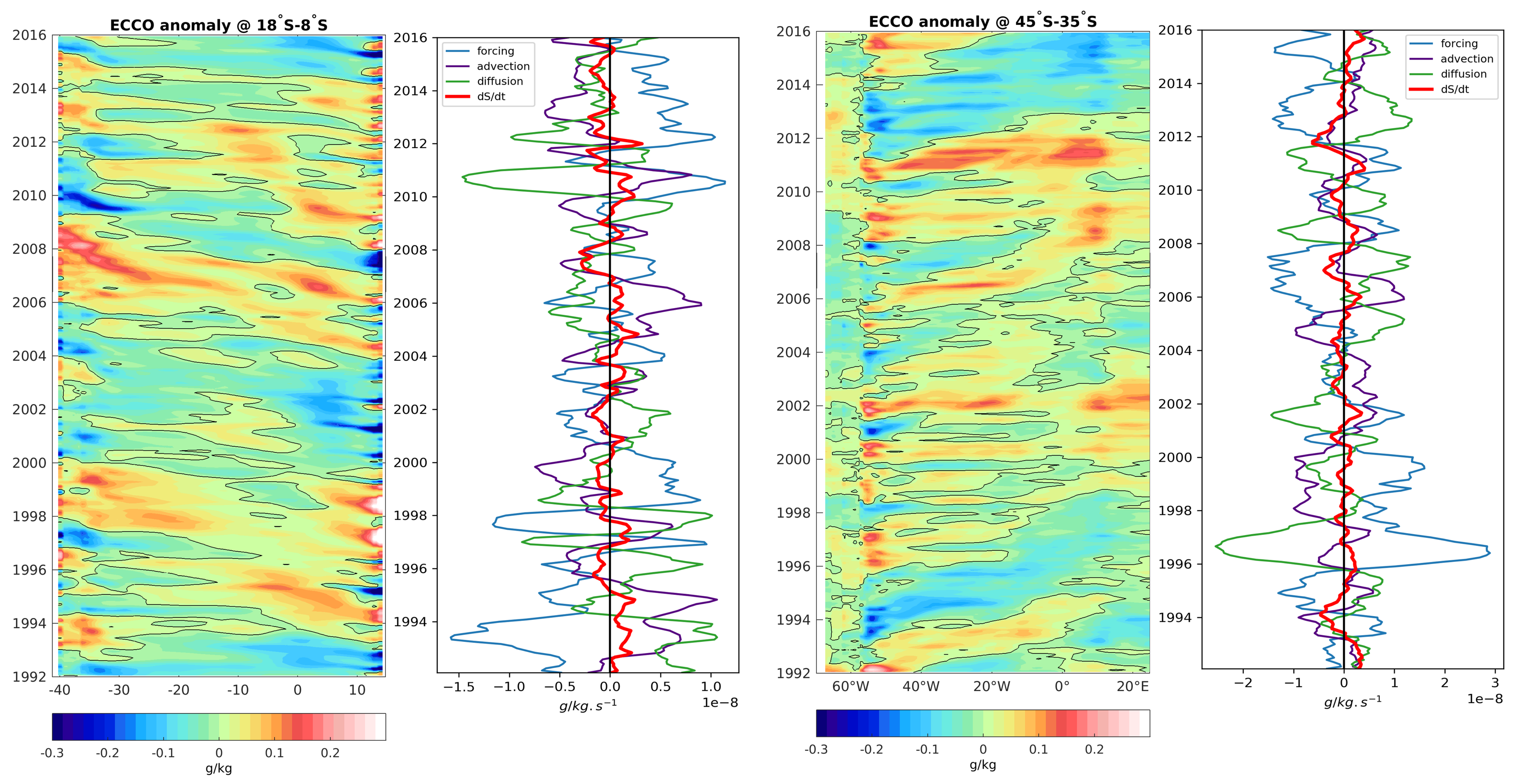


Fig. 3: Hovmöller diagram of ECCO SSS interannual anomalies (total-annual cycle), averaged from 18-8°S (left) and 45-35°S (right), and interannual variability of the terms of SSS budget calculated from ECCO solutions averaged in regions a (left) and b (right) (fig. 1).

Budget terms mean distribution shows how they affect SSS in the South Atlantic:

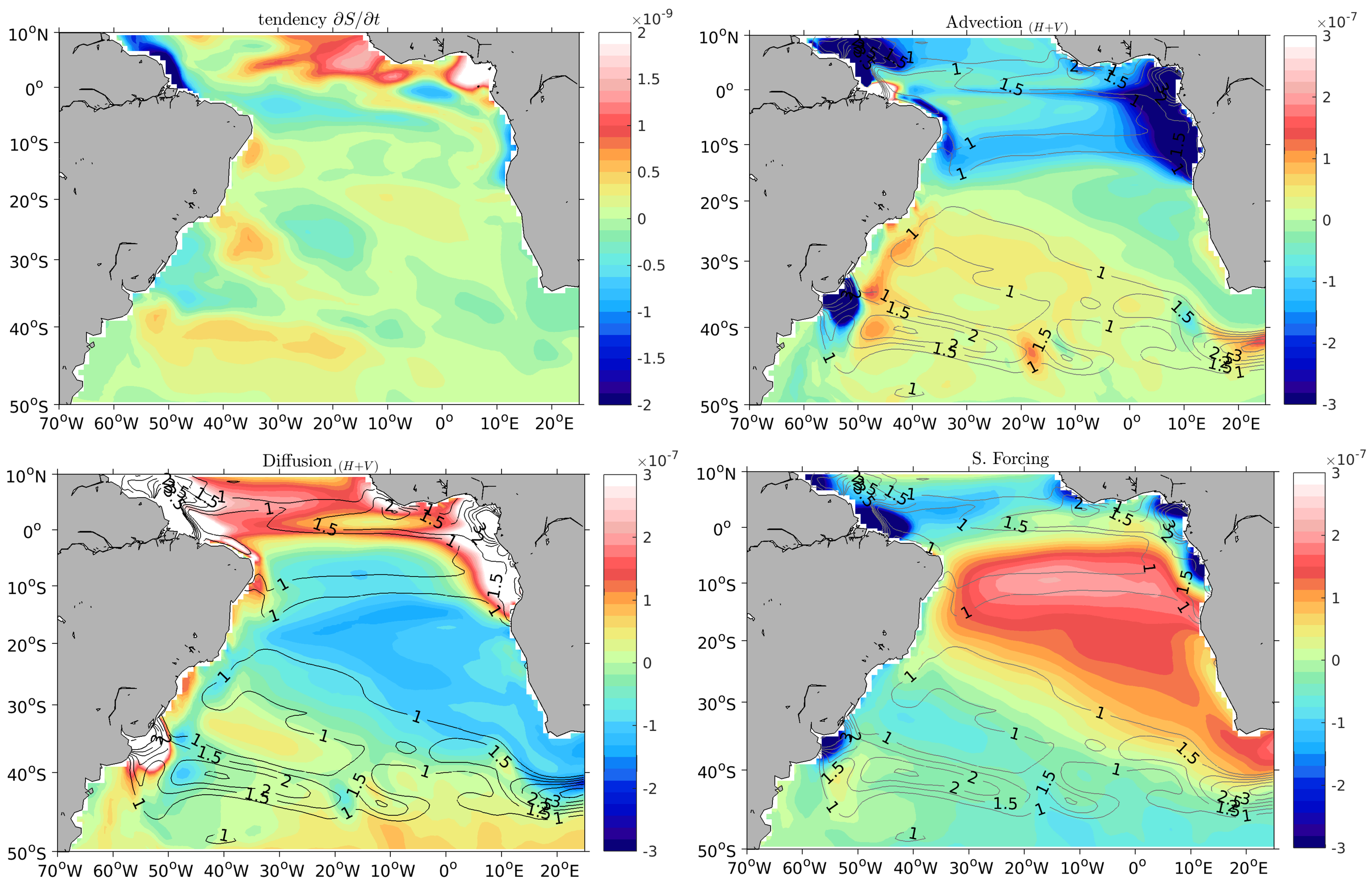


Fig. 4: Distribution of average ECCO surface salinity budget terms in the South Atlantic in units of g/kg.s$^{-1}$. Black contours indicate ECCO absolute salinity gradients in $10^{-3}$ g/kg.km$^{-1}$.

## VI Concluding Remarks

- Satellite, climatology and model data shows similar distribution of surface salinity gradients.
- ECCO results are equivalent to satellite and climatology SSS fields, and it reproduces well the interannual variability
- SSS variability is in the order of $10^{-1}$ g/kg and were found to be greater in the equatorial region (10°S-10°N), and at the southern boundary of the subtropical gyre (45°S-35°S).
- Results indicated that sea surface salinity variability in the South Atlantic is governed by a complex relationship between surface forcing, advective and diffusive mixing. Advection correlates well with regions of salinity fronts and the effect of the surface forcing on the surface salinity is mostly counterbalanced by vertical diffusive mixing, resulting in a tendency of the salinity variability to follow the variation of the advective terms.

## References

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