Salinity variability associated with changes in the hydrological cycle variables

Olga Sato Paulo Polito

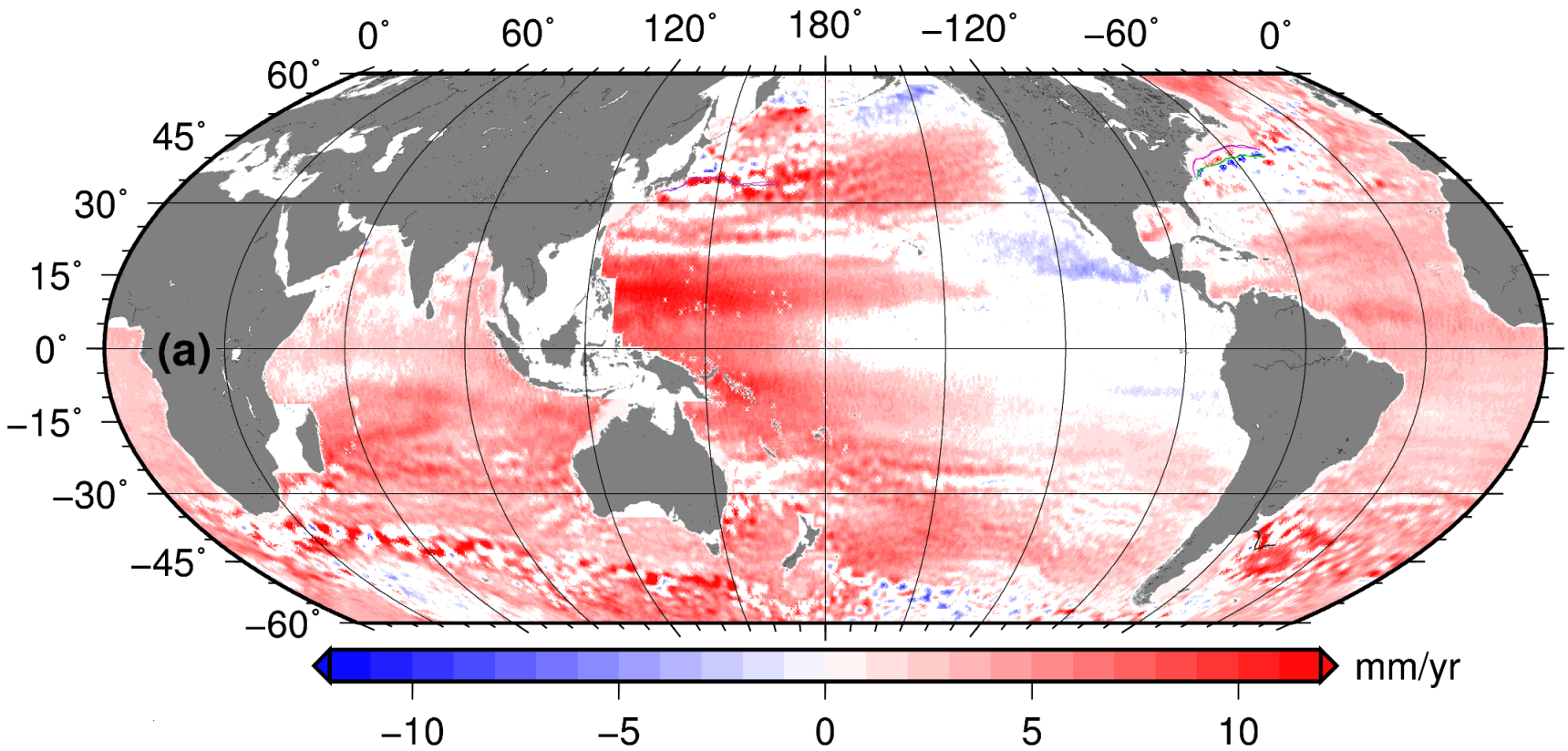
olga.sato@usp.br

Oceanographic Institute of the University of SÃčo Paulo

Laboratório de Oceanografia por Satélites

Outline

Sea surface height trend from satellites (1993–2010) (AVISO)

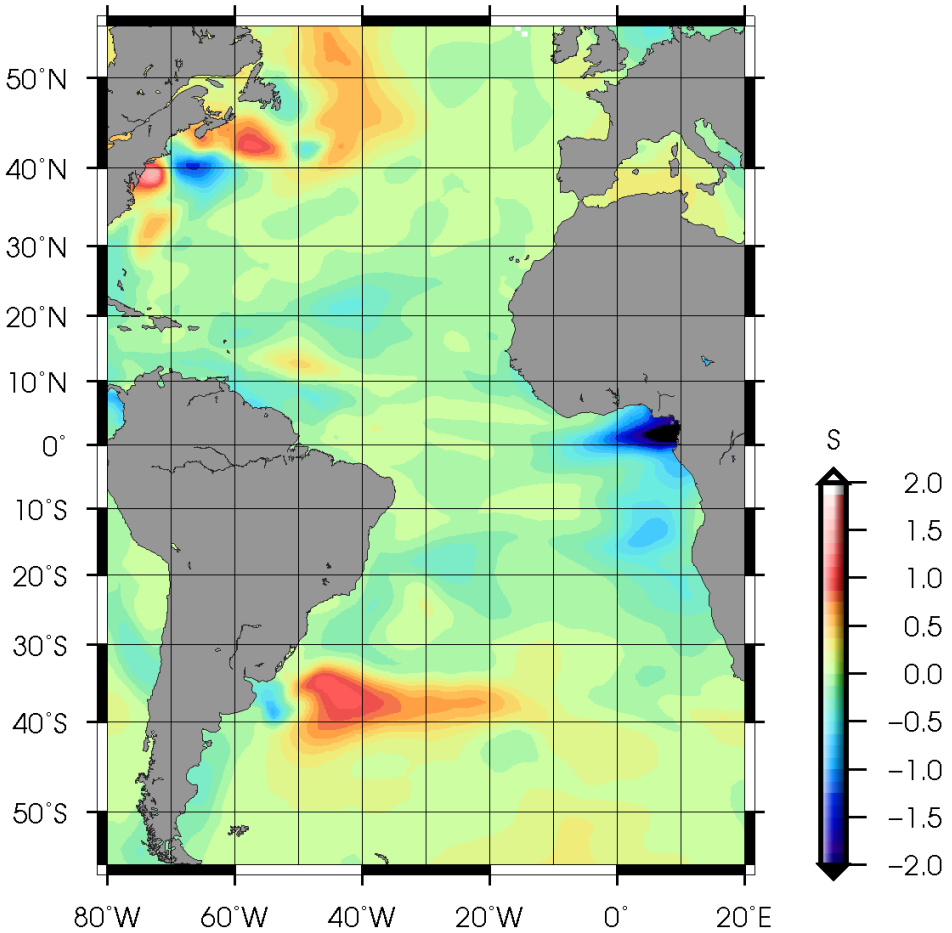


- Global increasing trend of (3.6 $\pm$ 2.4) mm/year;
- SW Pac. (4.2 $\pm$ 2.1) mm/year;
- SW Atl. (3.3 $\pm$ 2.2) mm/year.

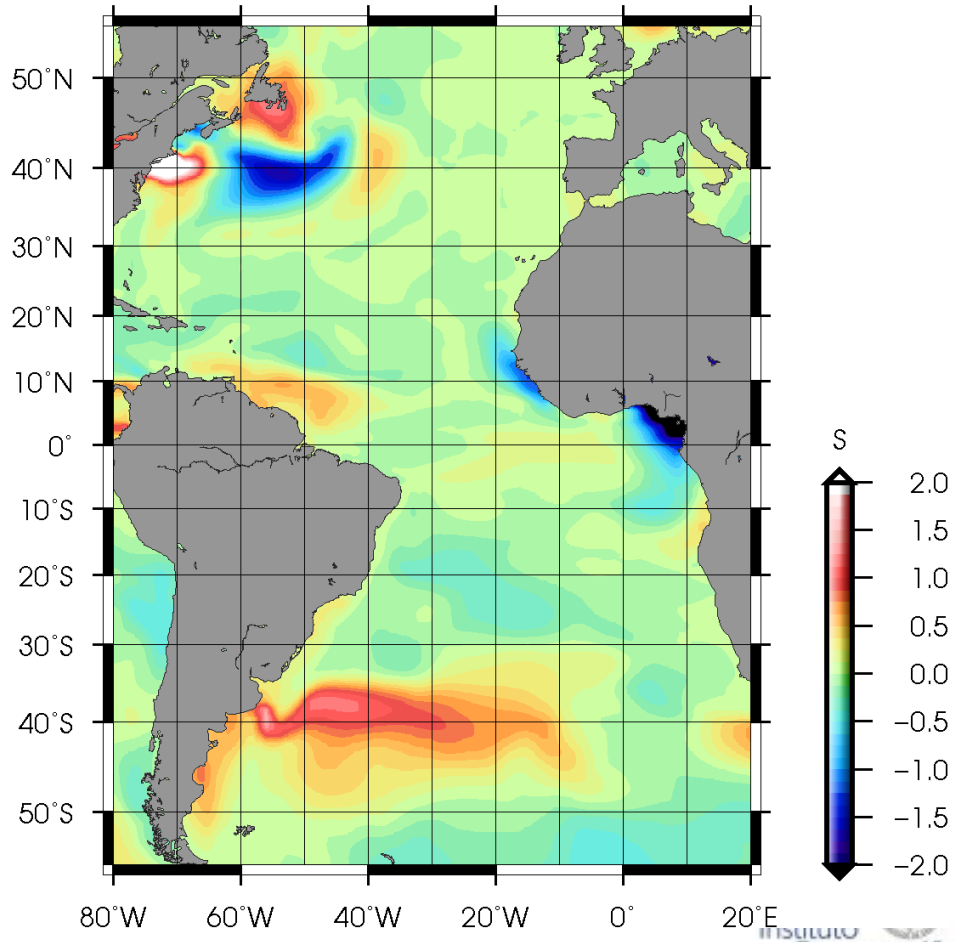
Salinity trends at surface: GODAS

Comparison between: 1980–1995 and 1996–2010.

Trend Surface (1980–1995)



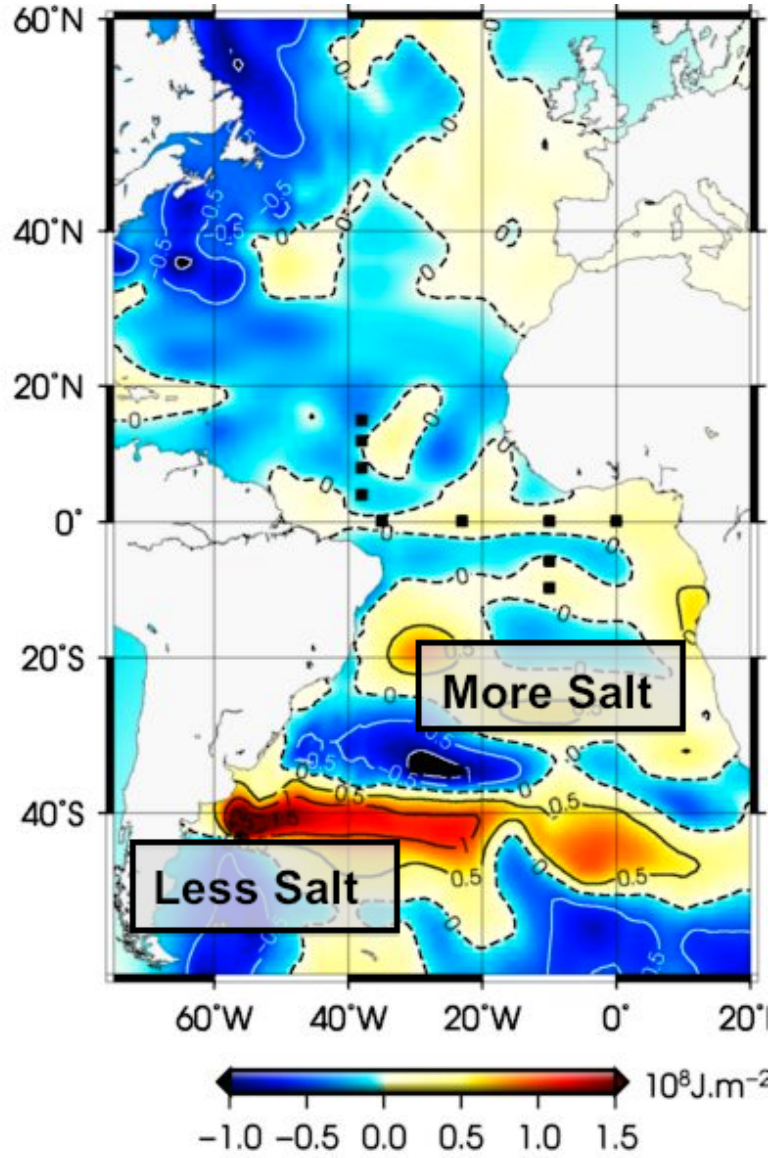
Trend Surface (1996–2010)



Instituto Oceanográfico

Implications for the Circulation

Sato and Polito (2008)



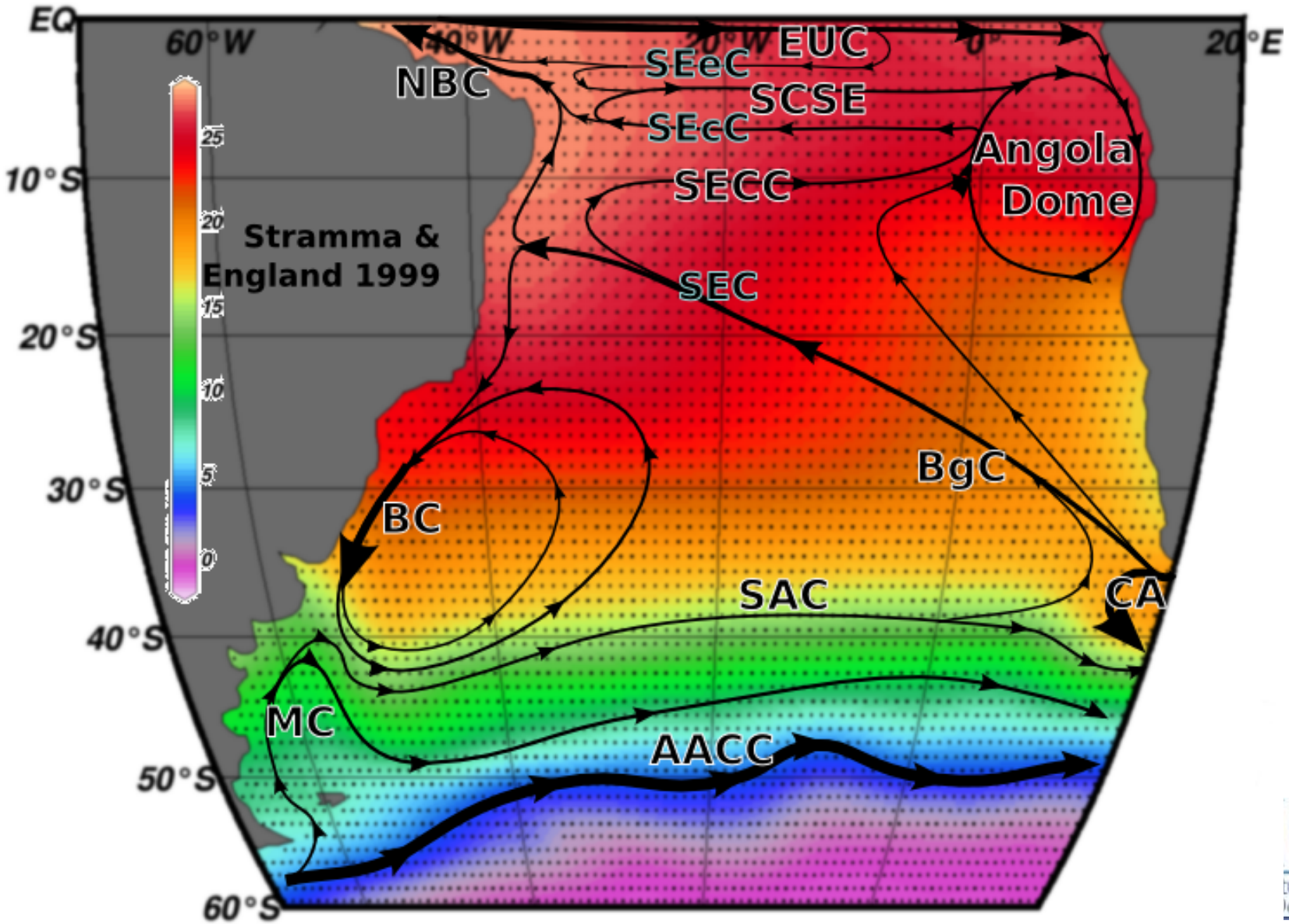
Haline contraction effect:

- Decrease in height $\rightarrow$ salinity increase
- Increase in height $\rightarrow$ salinity decrease
- Show opposite trends in the height in the SW South Atlantic.

- Weakening of the geostrophic currents in the subtropical gyre.
- Southward migration of the gyre.

Instituto Oceanográfico

South Atlantic circulation



Some questions

About the changes in the SW corner of the South Atlantic:

- Are the salinity trends due to air–sea interaction processes at the surface (E-P) or by changes in the water column (mode water formation, ventilation)?
- A local or remote process?
- Are the low frequency fluctuations associated with signals advected by currents, for instance, Agulhas leakage?
- Why is the signal so intense at the South Atlantic?

Using global ocean models

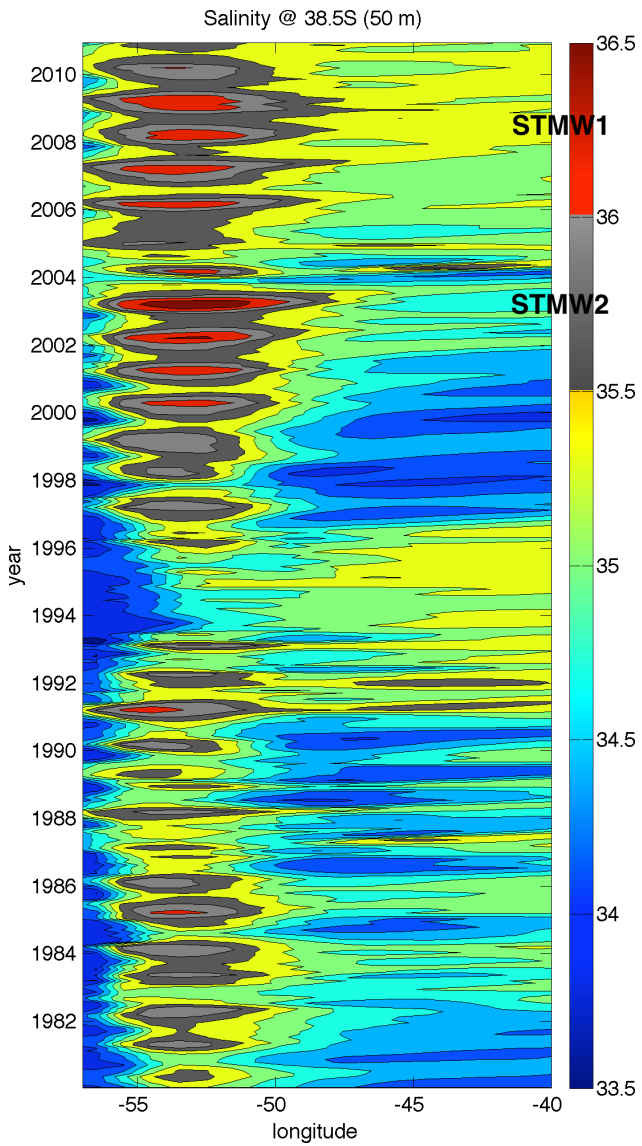
NCEP Global Ocean Data Assimilation System (GODAS)

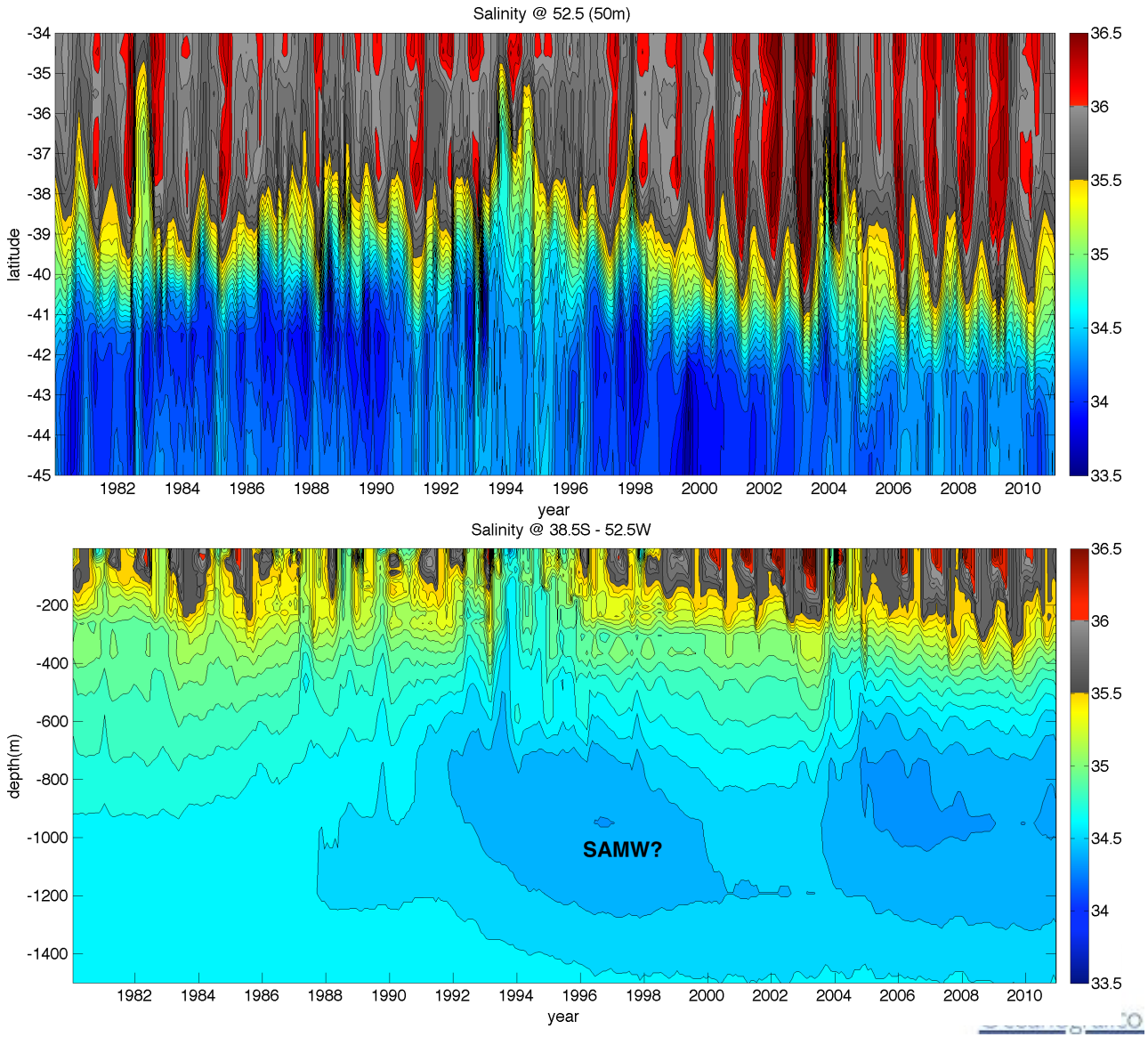
- Based on the GFDL MOM. v3 and forced by variables from NCEP Reanalysis 2.
- Assimilation of TS *in situ* data with synthetic salinity profiles computed from climatological data when needed. Behringer and Xue (2004).

OCEAN GENERAL CIRCULATION MODEL (ECCO)

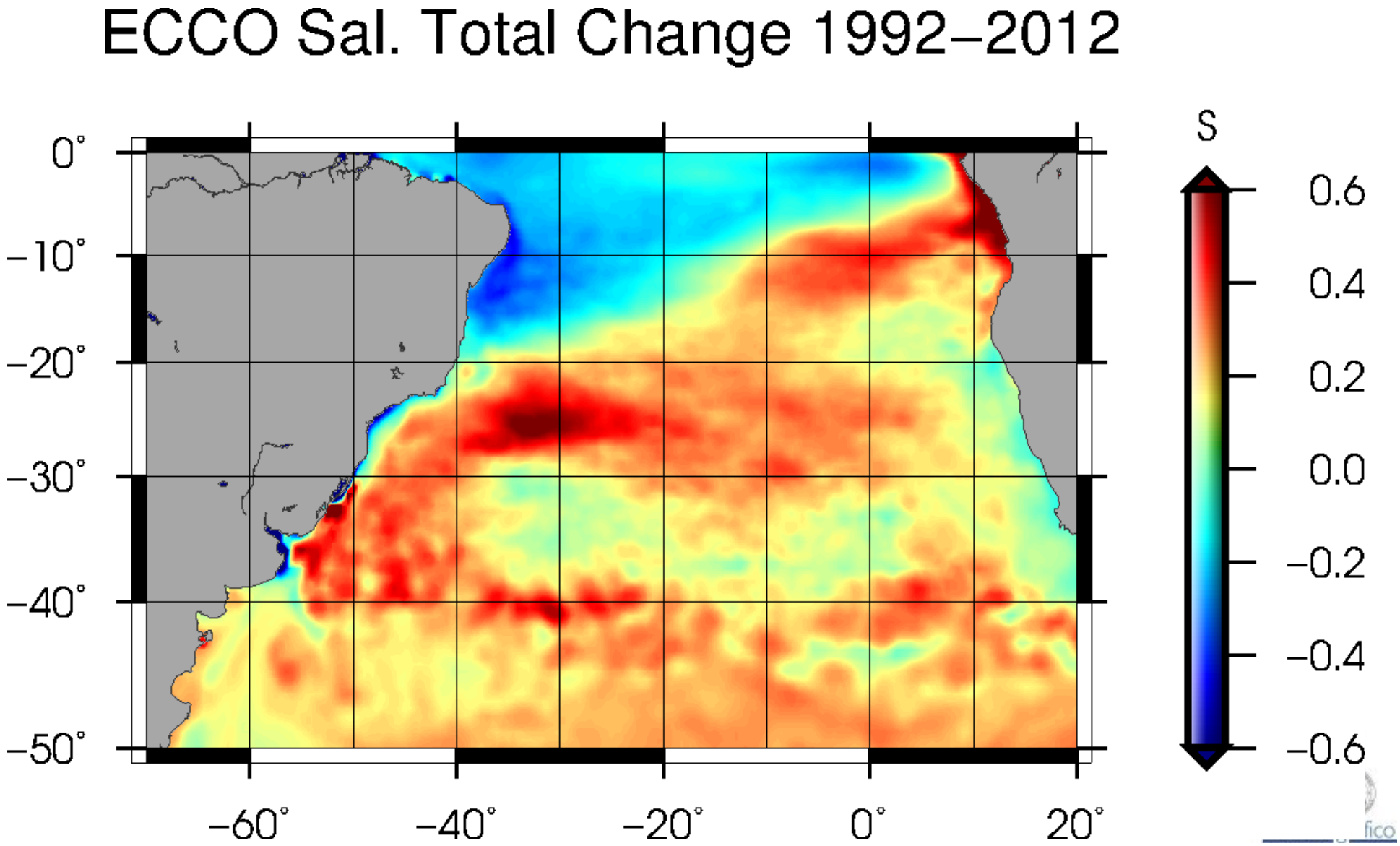
- Based on the MIT general circulation model (MITgcm).
- Combination the general circulation model with diverse observations to depict the time-evolving global ocean state. (ECCO Consortium)

Temporal evolution @ 52°W - 38°S - 50 m (GODAS)

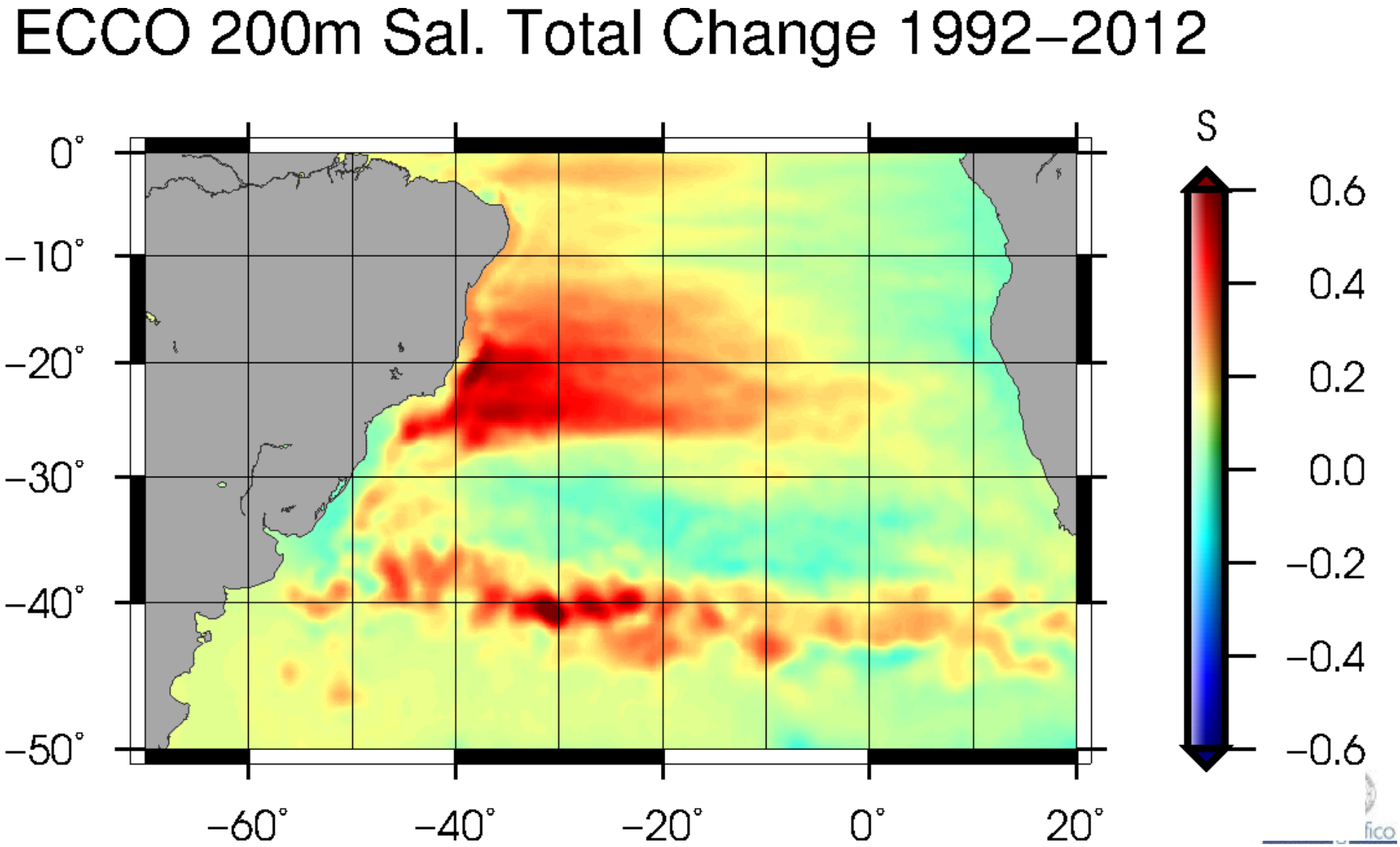




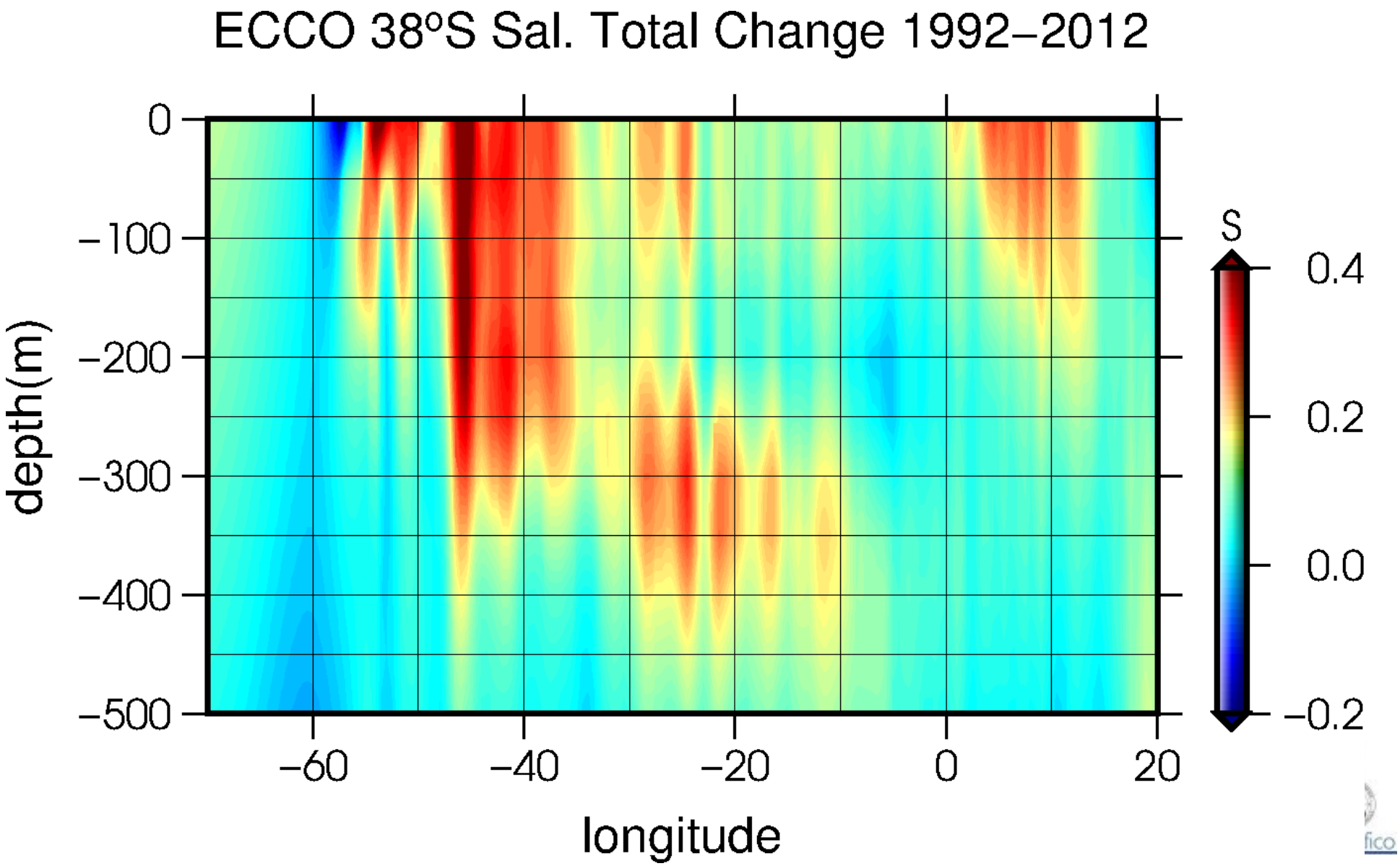
Salinity total change at surface from ECCO



Salinity total change at 200m from ECCO



Salinity total change at 38°S from ECCO



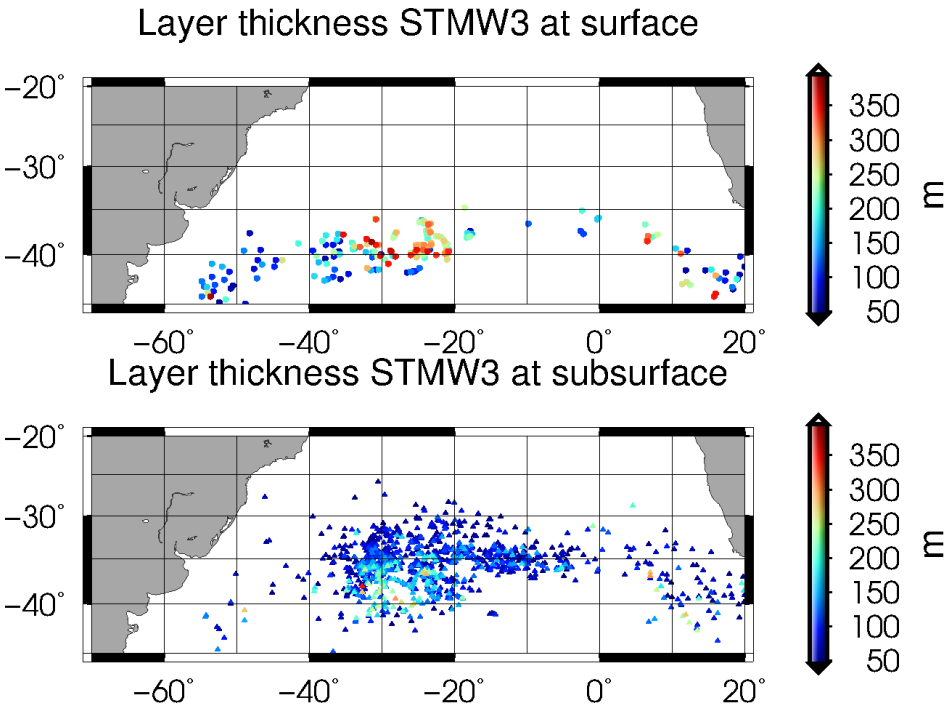
Mode Waters of the SW South Atlantic

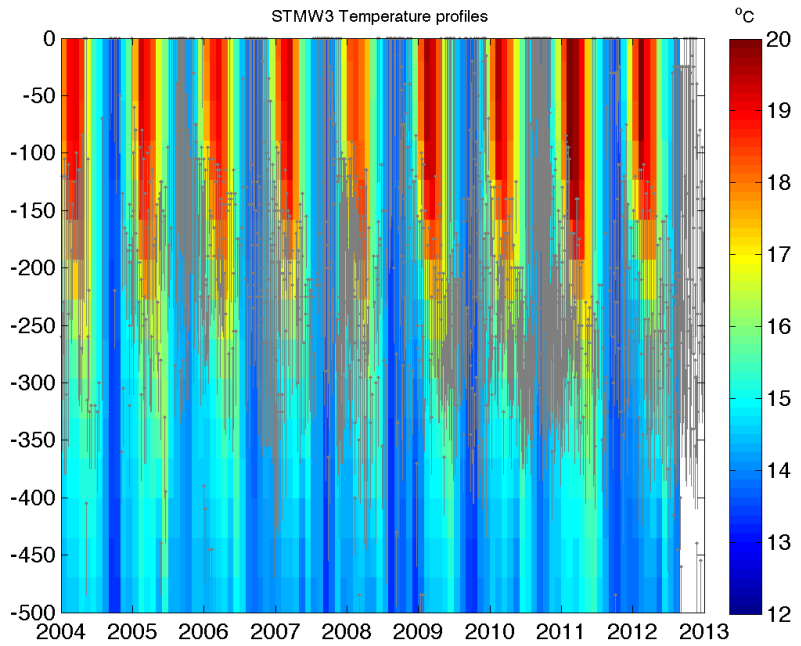
- Three types of Subtropical Mode Waters (STMWs) (Provost et al., 1999).
- Specific (T, S, σ_θ) values and potential vorticity minimum.

- Brazil–Malvinas Confluence region:
  - Brazil Current (BC): southward, carries warm and salty South Atlantic Central Water (SACW)
  - Malvinas Current (MC): northward, transports cool and fresh Subantarctic Surface Water (SASW)

- Southward extension of warm BC encounters cold weather $\rightsquigarrow$ STMW formation by convection;
- Northward flow of MC carries Subantarctic Mode Water (SAMW) toward the confluence.

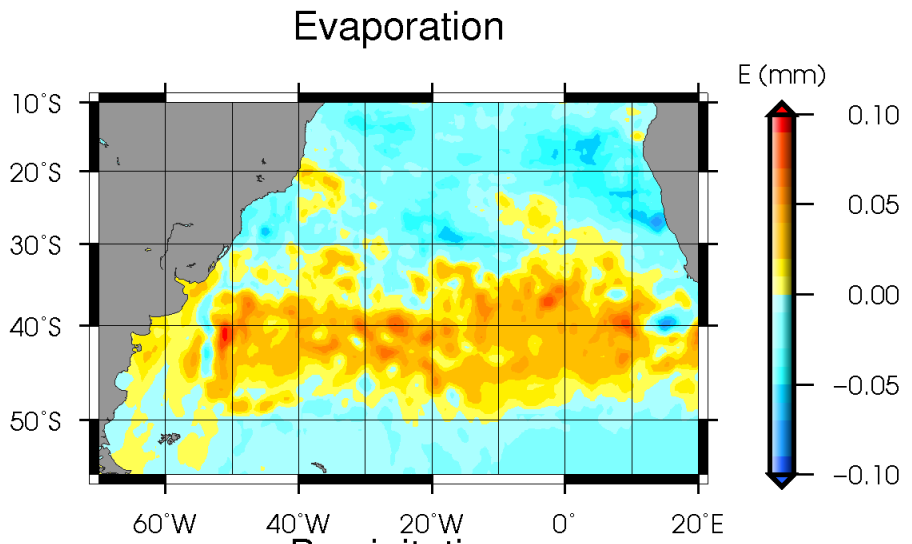
Subtropical Mode Water 3

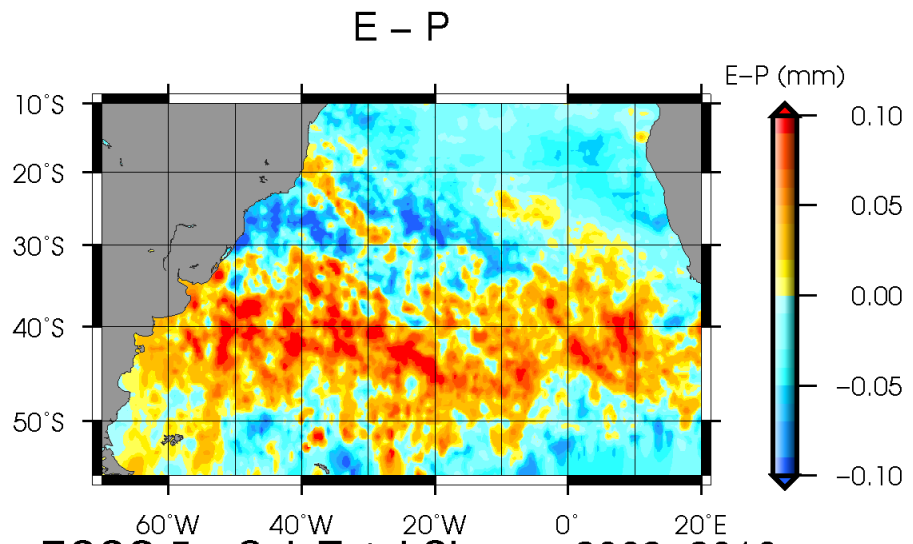


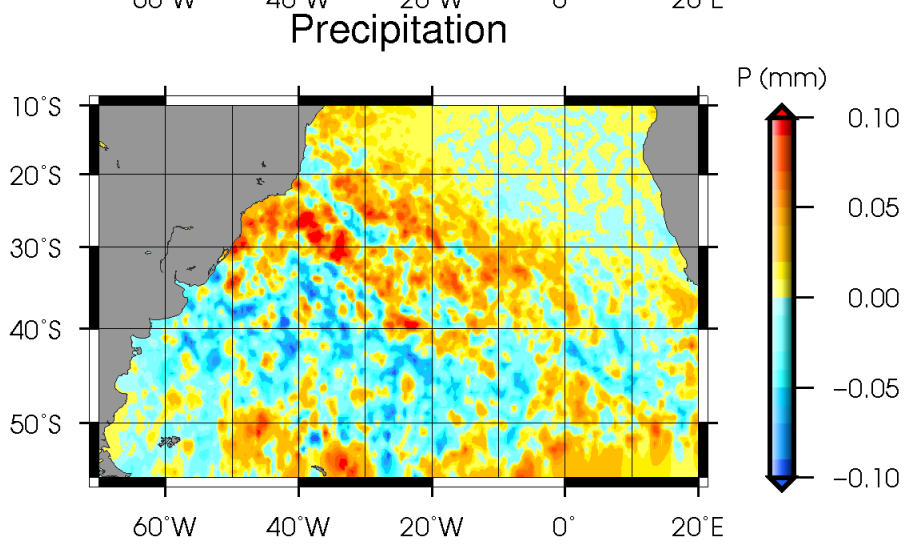


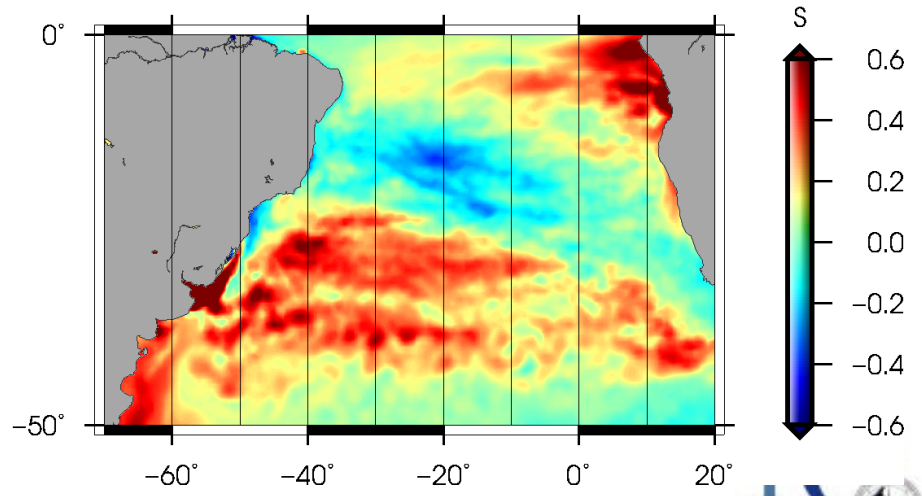
- The ventilation process occurs between July and October when the new STMWs are formed.
- STMWs are also identified at subsurface layers year round usually displaced from its formation region.

Total change in the hydrological cycle





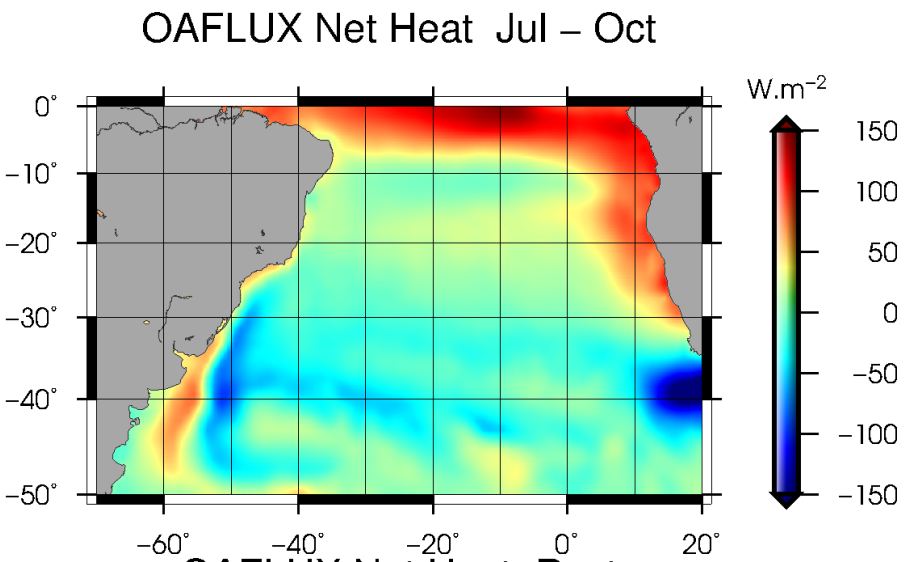


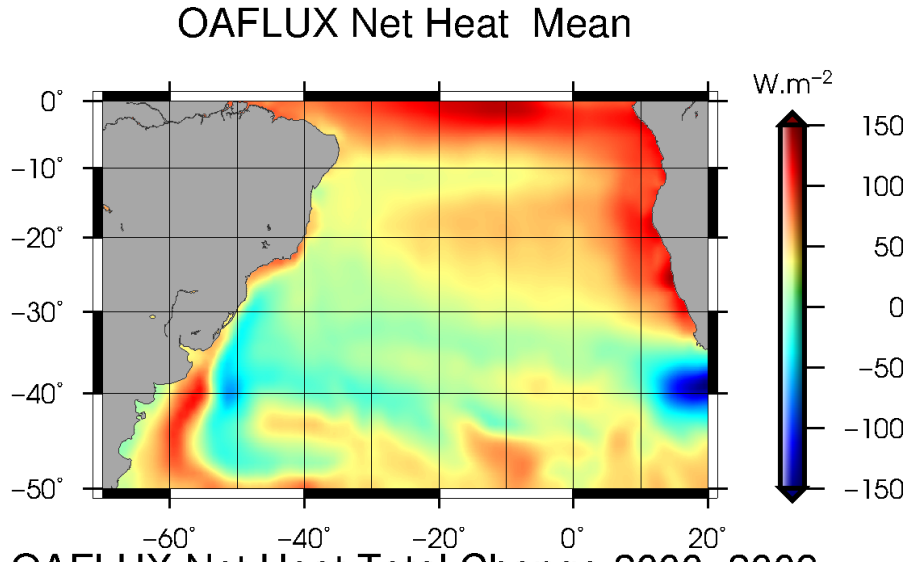


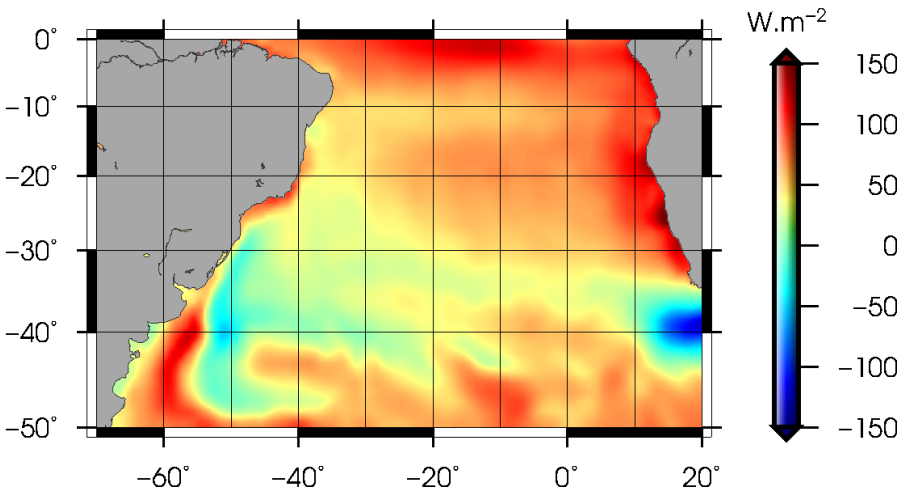
- AMSR-E: 2003 to 2010
- ECCO: 2003 to 2010

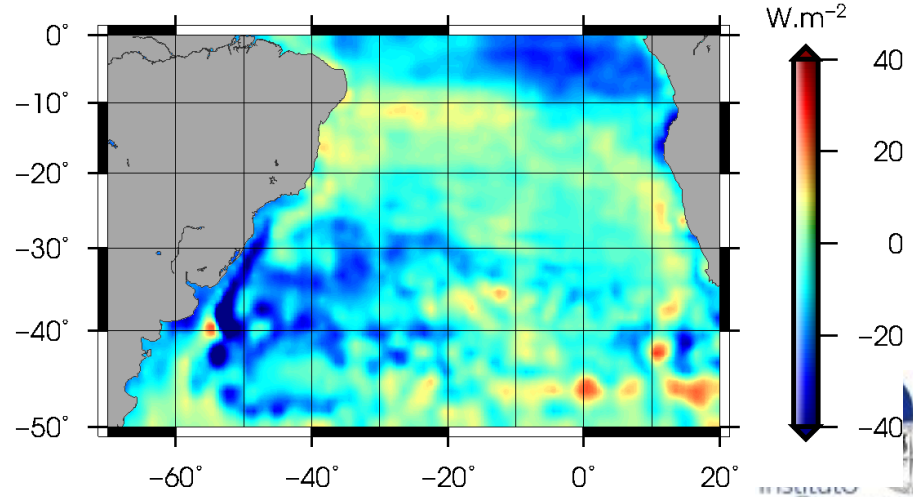
Instituto Oceanográfico

Total change in Surface Heat Fluxes from OAFLUX







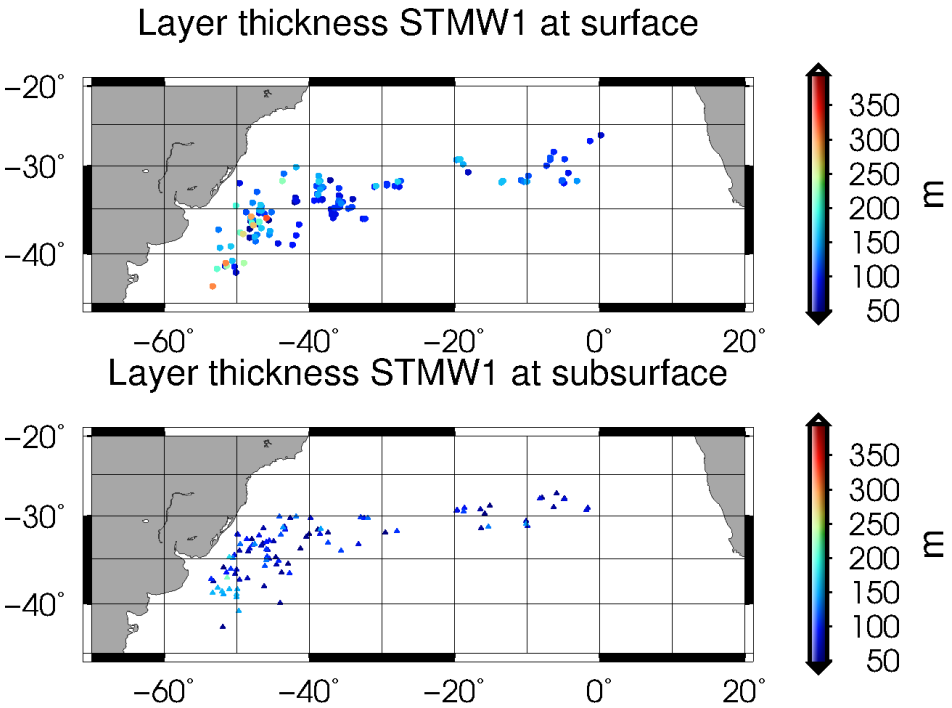


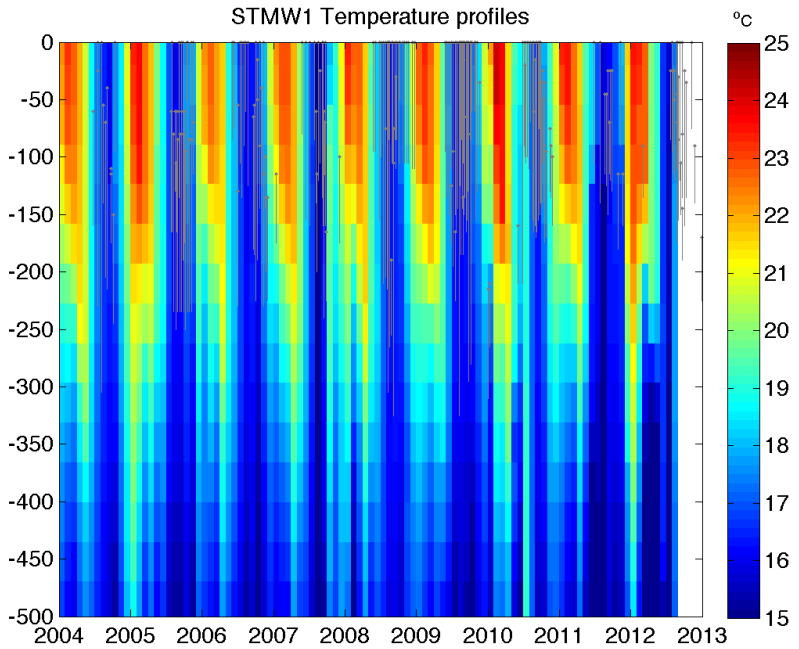
Concluding remarks

- Increasing trends for the second 15–year period, 1996–2010, correspond to more frequent and intense southward excursions of the BC (SACW);
- The surface heat budget presents spatial patterns that are consistent with the idea that heat losses trigger the subduction of BC waters.
- We found interannual trends in the surface heat budget at the western South Atlantic region where STMWs are observed.
- Evidences indicate that the inter–annual signal comes from air–sea interaction process rather than advection by the Agulhas Current.

Thank you!

Subtropical Mode Water 1





Subtropical Mode Water 2