Seasonal and Interannual Variability of the South Indian Ocean Sea Surface Salinity Maximum

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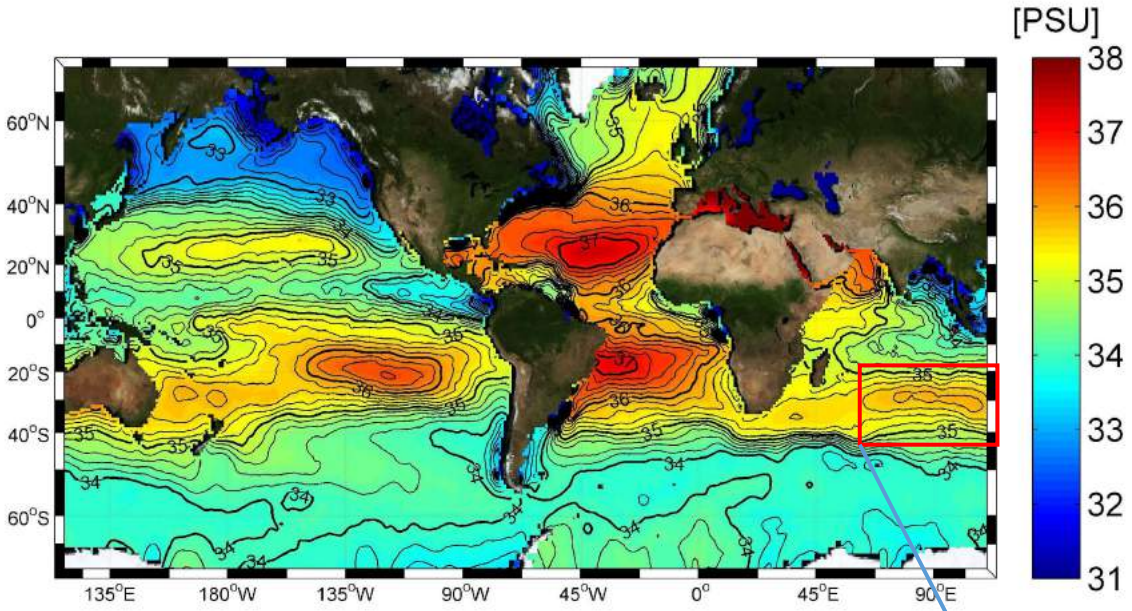
Funding

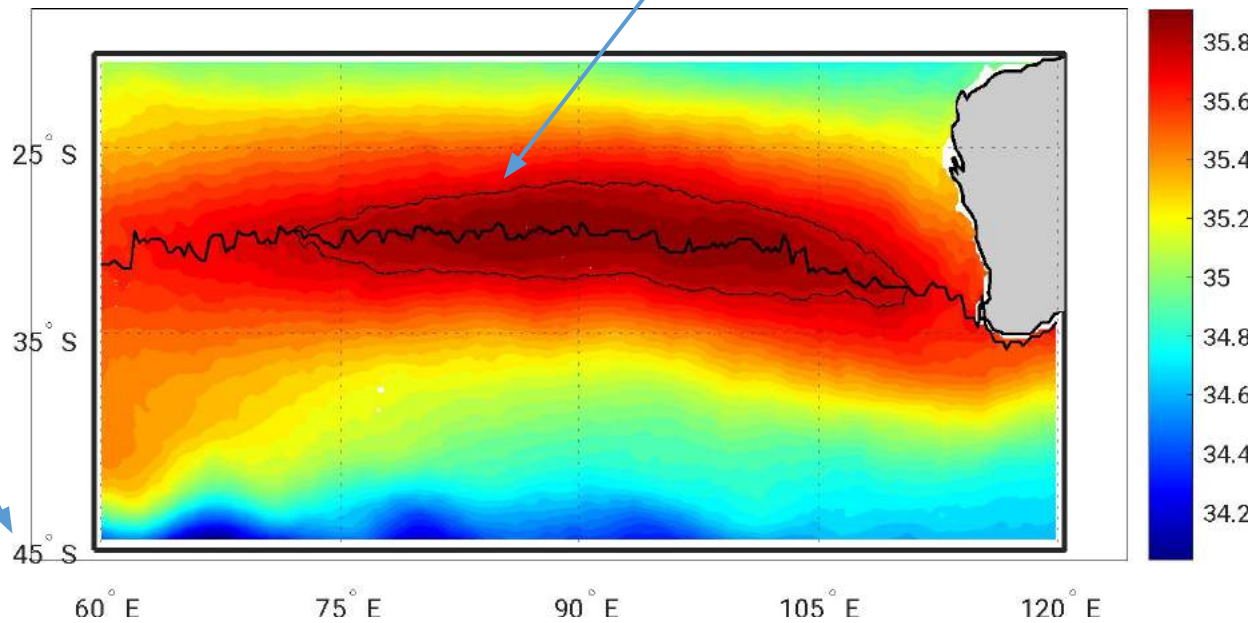
Global Ocean surface salinity (SSS)



Annual mean SSS from the World Ocean Atlas

http://www.salinityremotesensing.ifremer.fr/sea-surface-salinity/salinity-distribution-at-the-ocean-surface

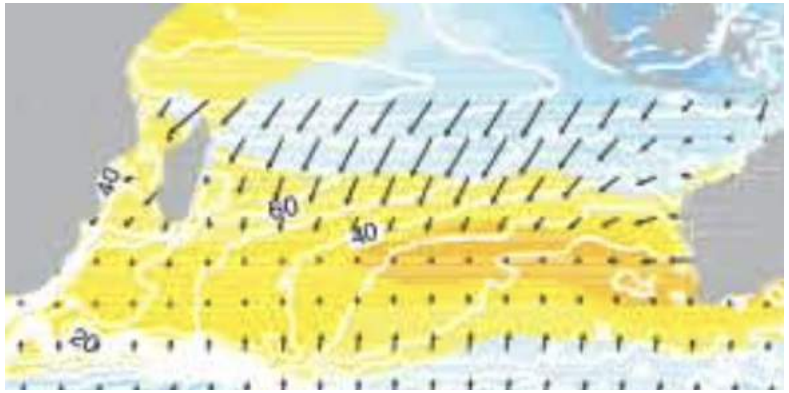
35.772 isohaline



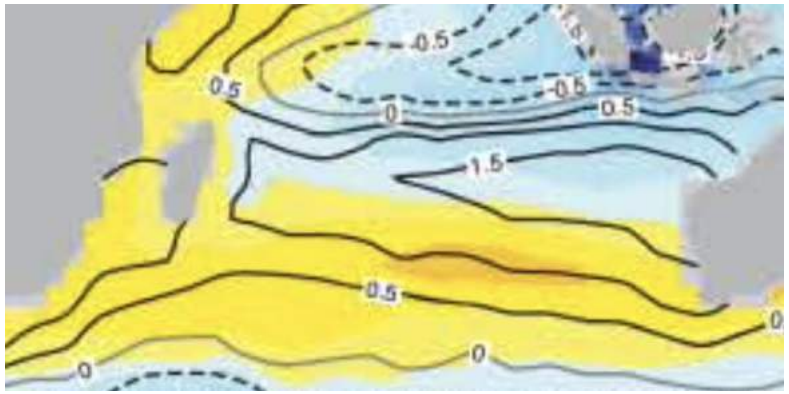
South Indian Ocean

2010-2020 mean

Mean SSS from climatology in the South Indian



Plus Ekman transport and
mean dynamic topography



Plus mean E-P

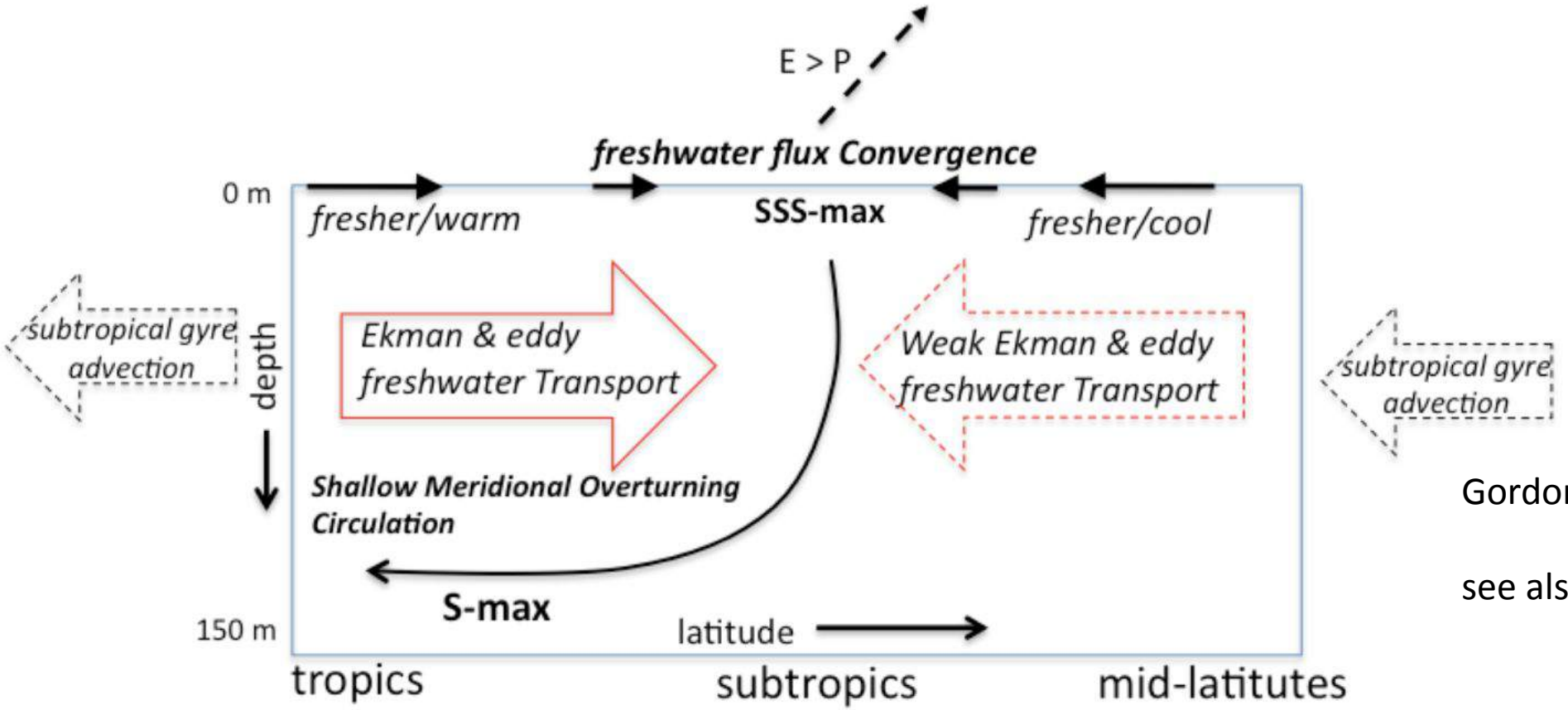
What are the characteristics of the seasonal and interannual variability of the SSS maximum of the South Indian Ocean?

Can they be related to surface forcing, advection, entrainment, etc?

Gordon et al., 2015

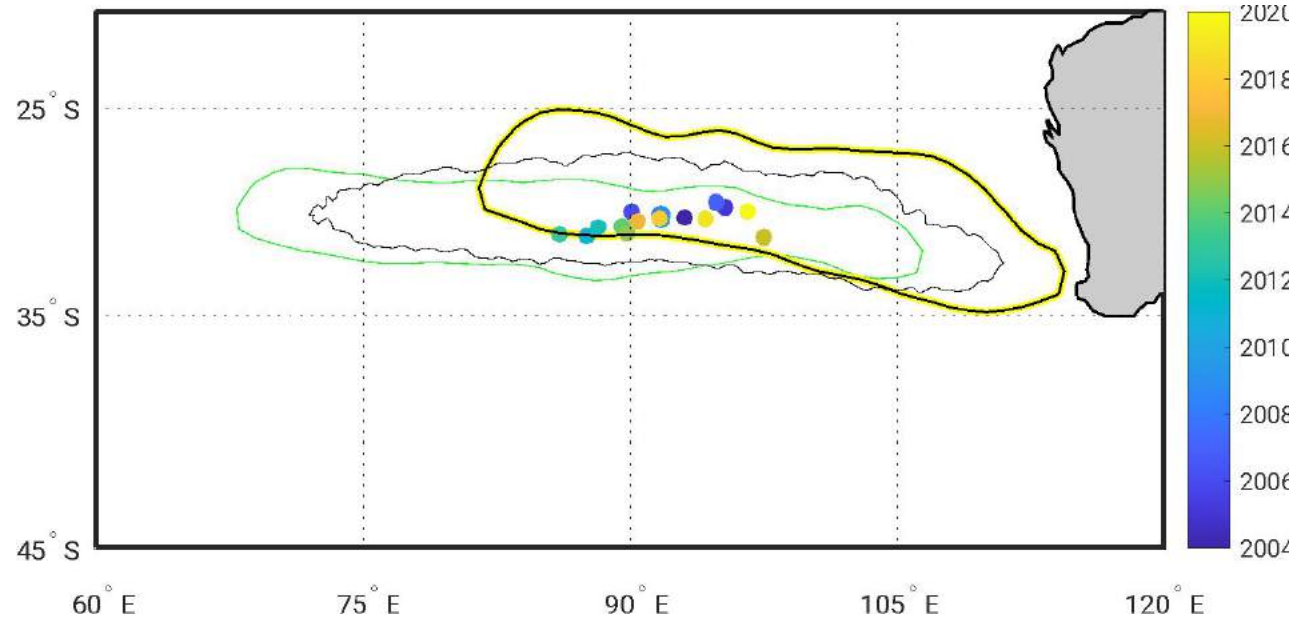
The classic picture

Salinity in the SSS-max is largely a balance between surface flux of freshwater and vertical entrainment and horizontal advection



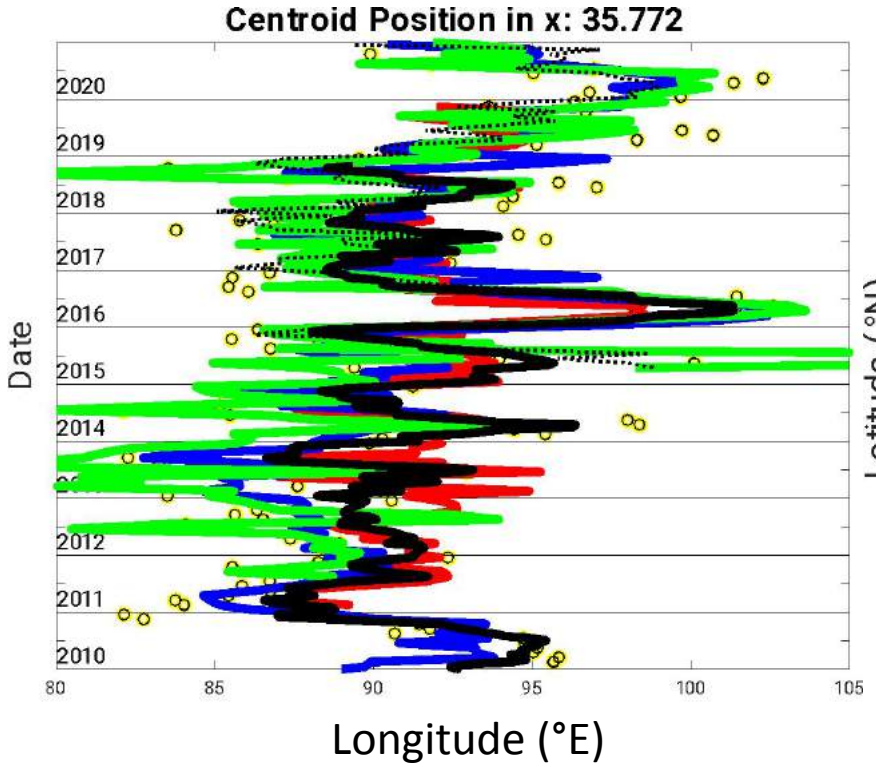
Gordon & Giulivi, 2014

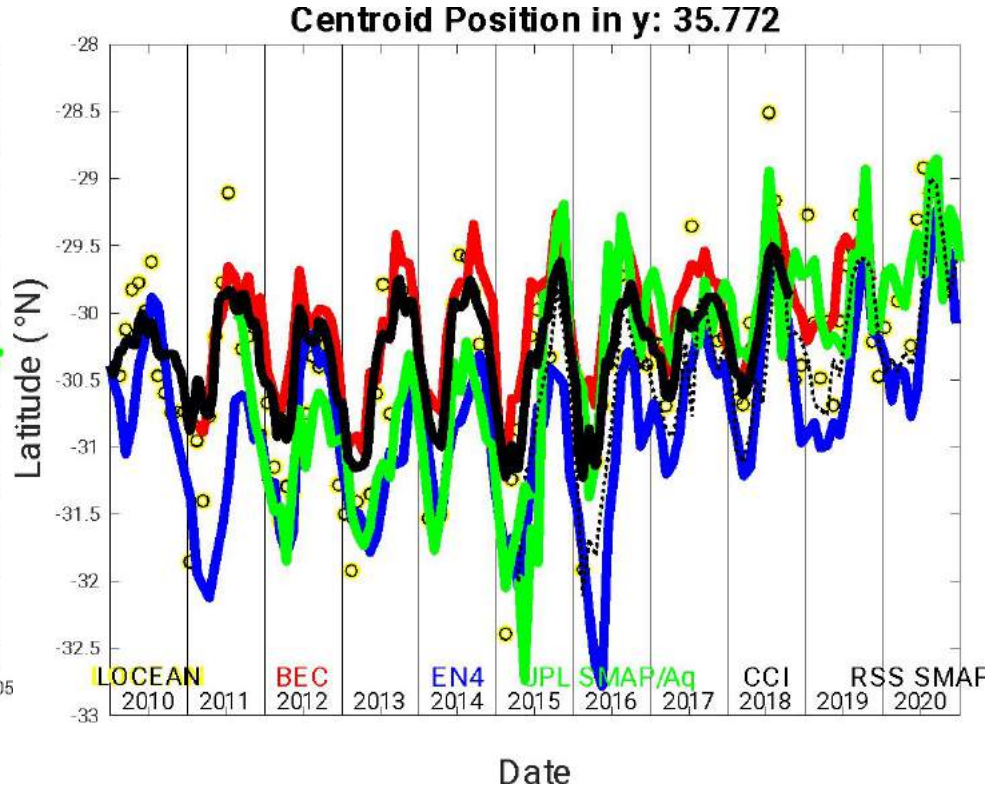
see also Worthington, 1976



Interannual variability

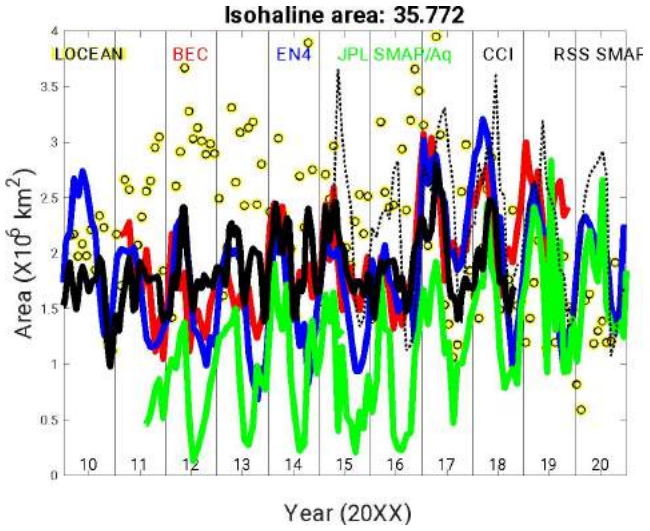
Centroid motion in the South Indian from many different satellite and in situ products

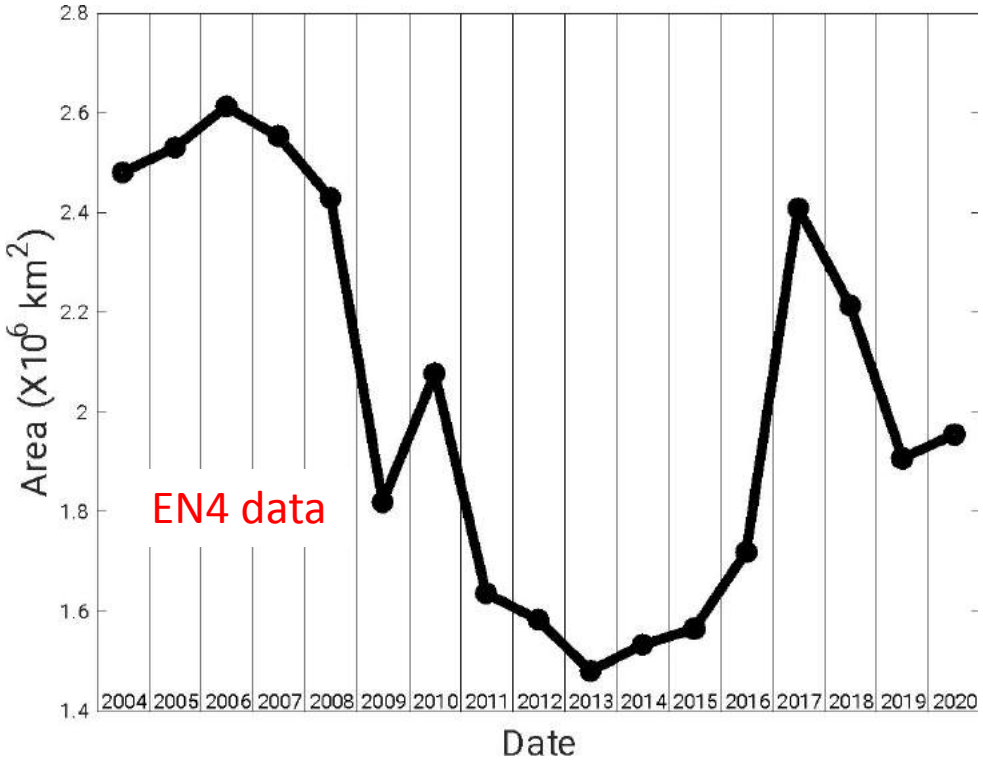




Centroid has moved equatorward and eastward since 2012.

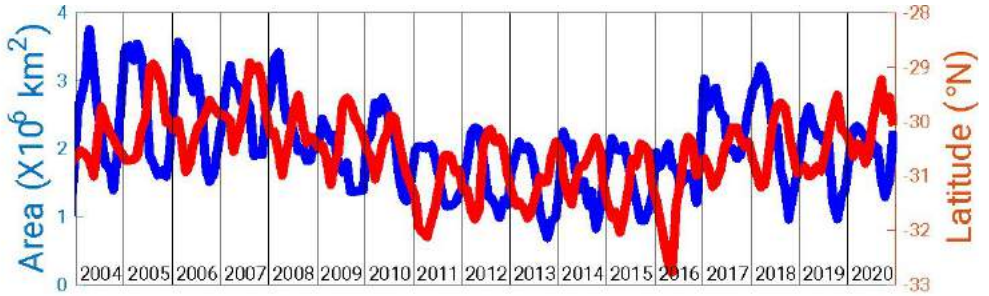
Isohaline area



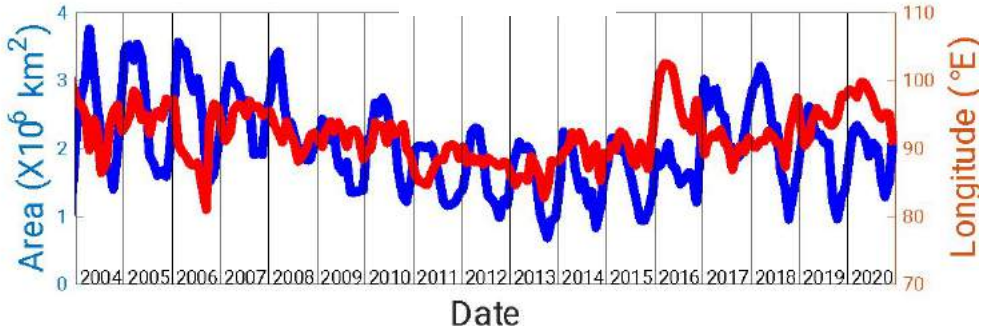


Interannual variability

Changes in area of SSS>35.772 in the South Indian Ocean

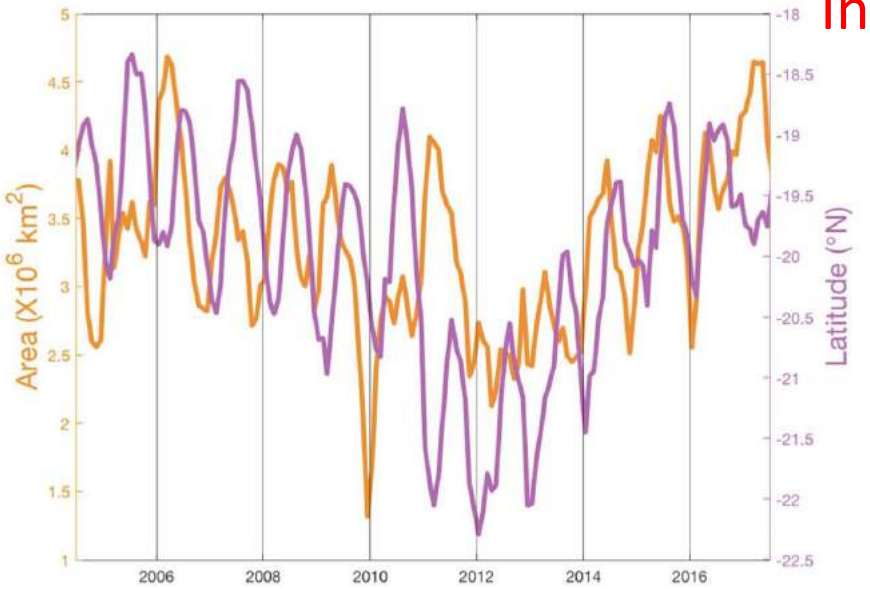


EN4 data



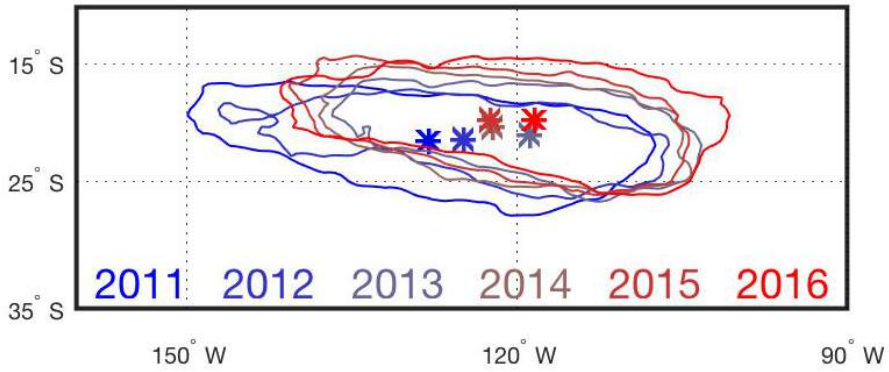
Changes in area and position are synchronized

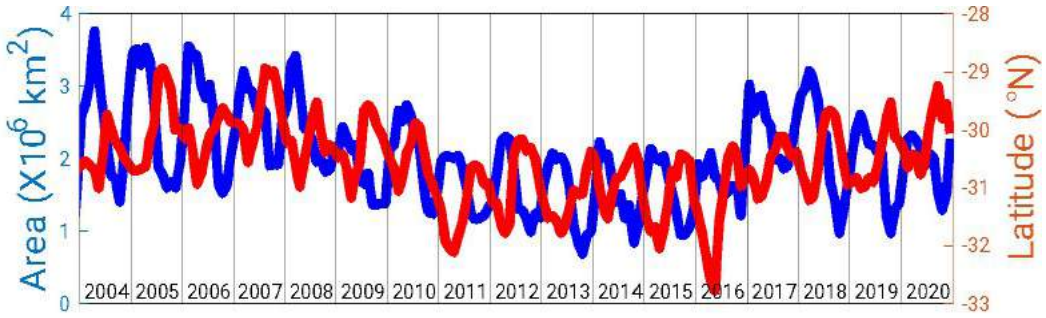
Interannual variability



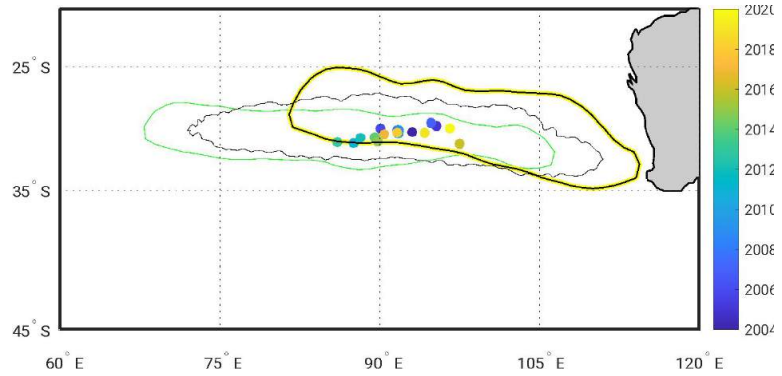
South Pacific

Bingham et al., 2019





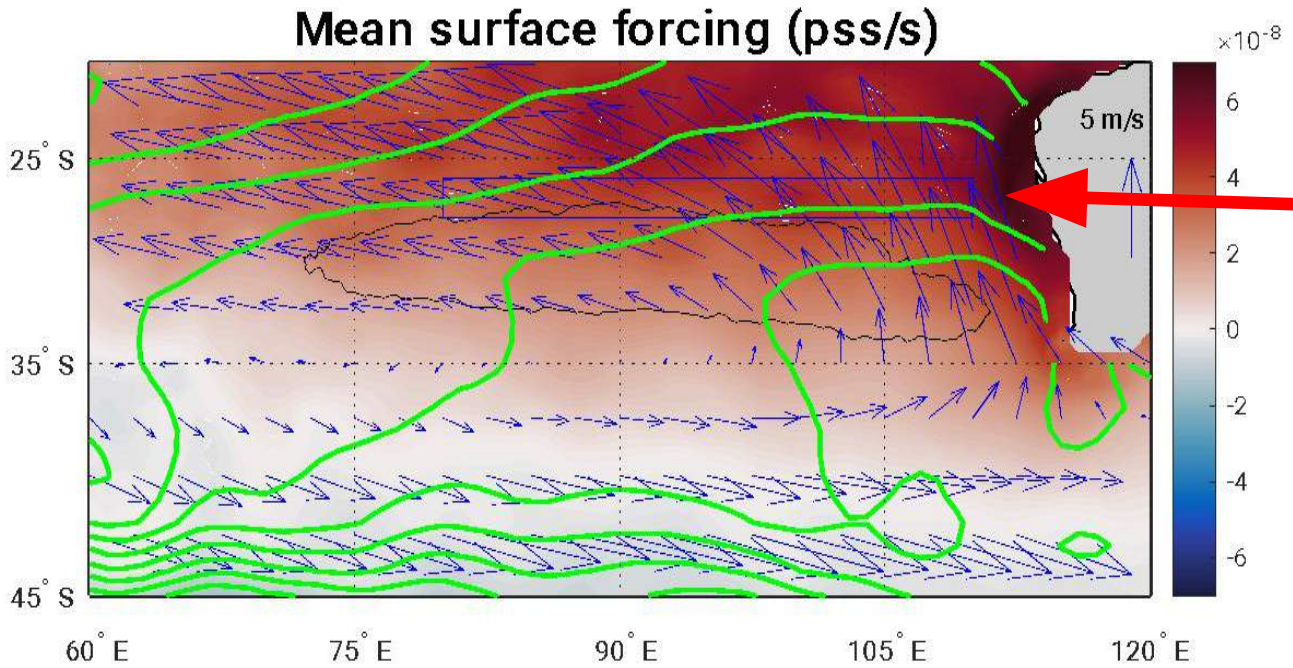
South Indian

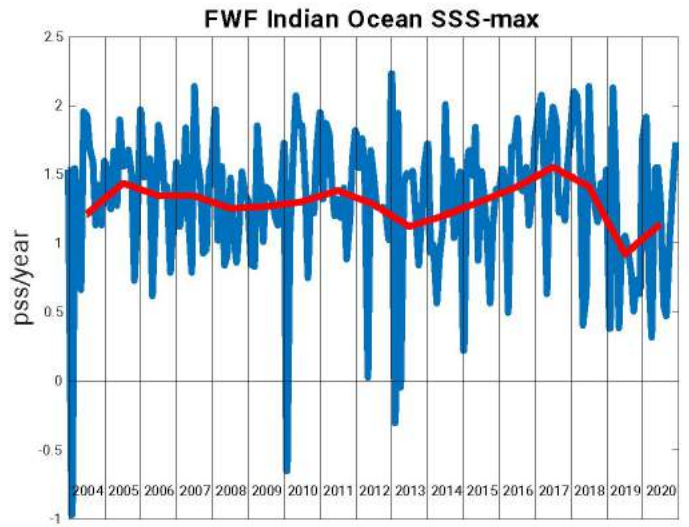


South Indian and South Pacific vary in similar way

The South Indian may be lagging the South Pacific by ~2 years

Ekman transport and surface geostrophic flow are in opposite directions over much of the subtropical SIO





Surface freshwater forcing within along 27°S

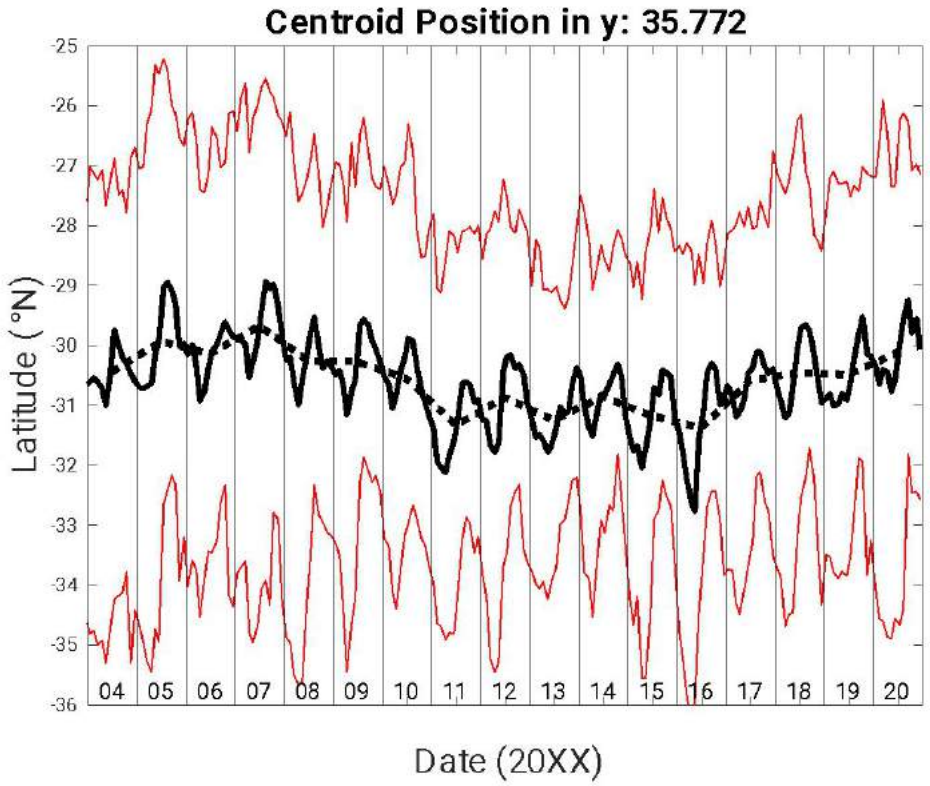
Colors: Mean surface forcing in pss/s. Red is positive, i.e. net evaporation

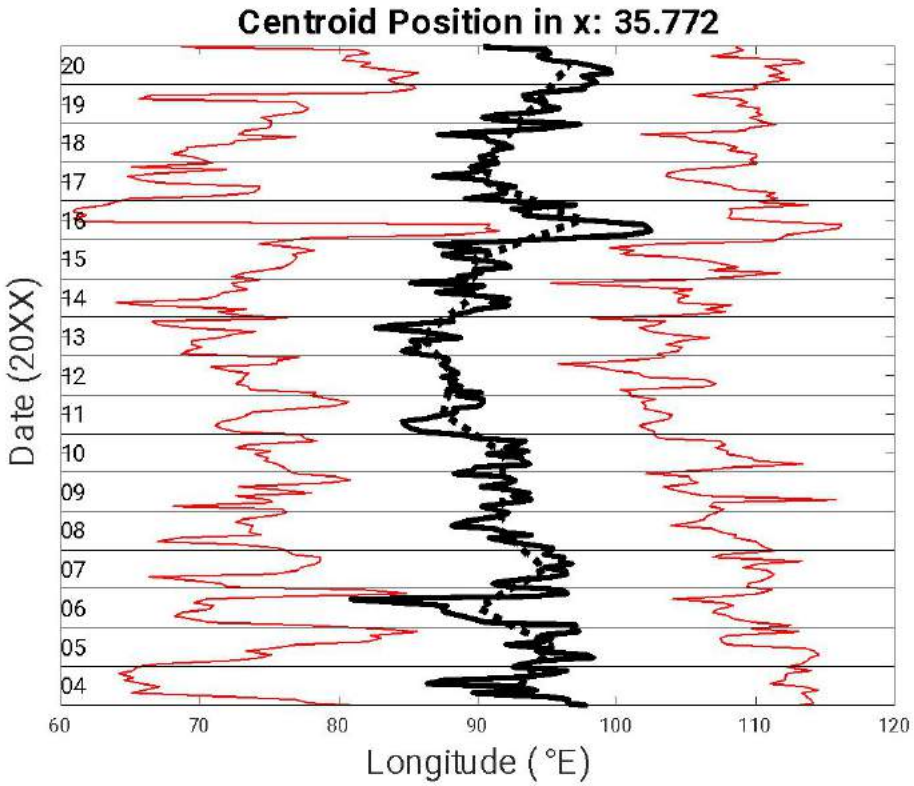
Green contours: Dynamic height, contour interval 0.1 dyn-m (surface relative to 2000 m)

Blue arrows: Mean wind vectors

Equatorward boundary associated with interannual variability

Poleward boundary associated with seasonal variability

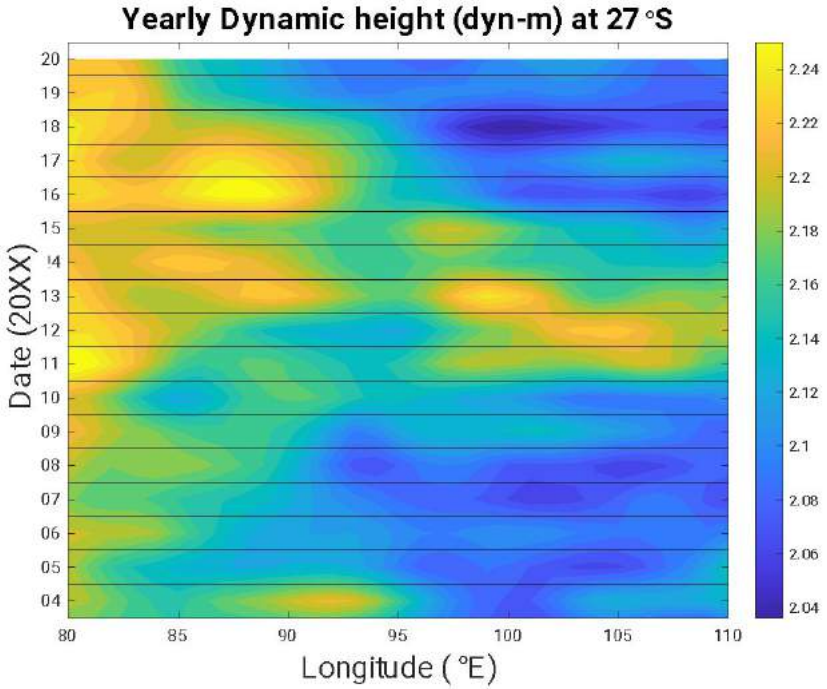


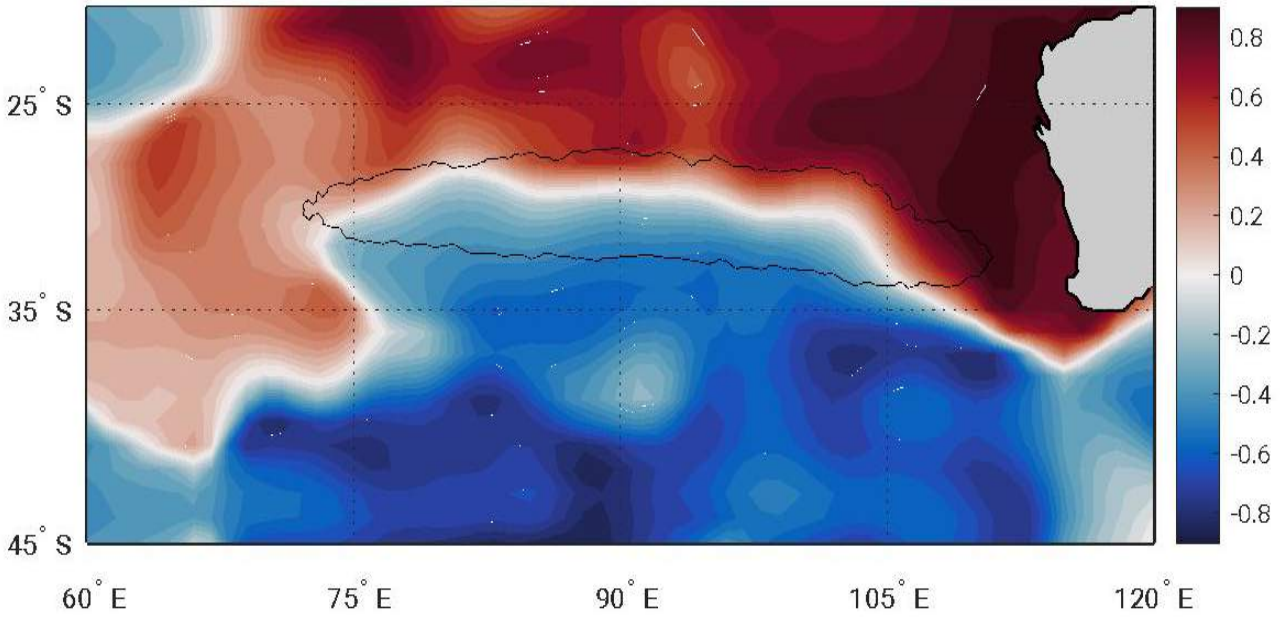


Black lines – monthly and yearly position of centroid

Red lines – 95th percentile on both poleward/eastern and equatorward/western sides (monthly)

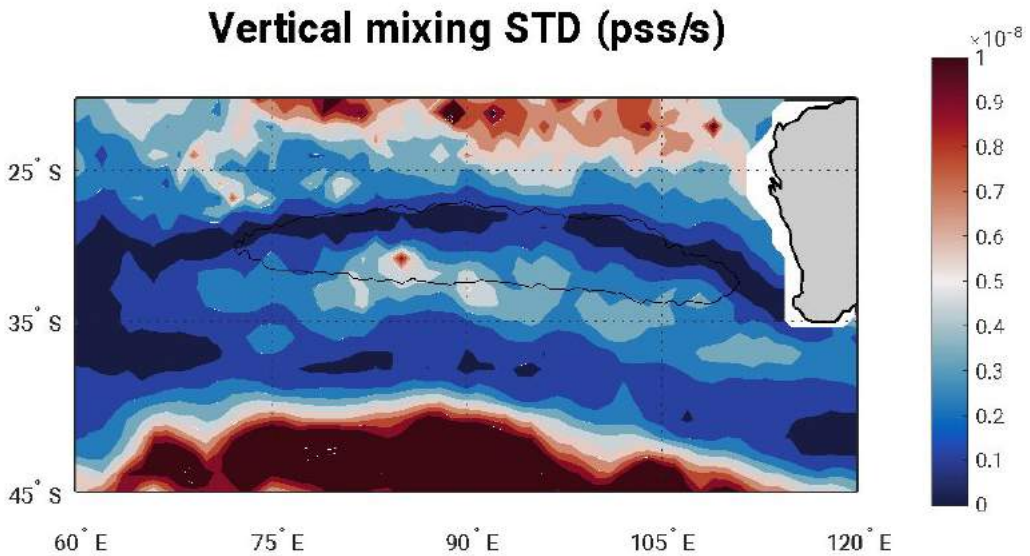
Dynamic height at 27°S

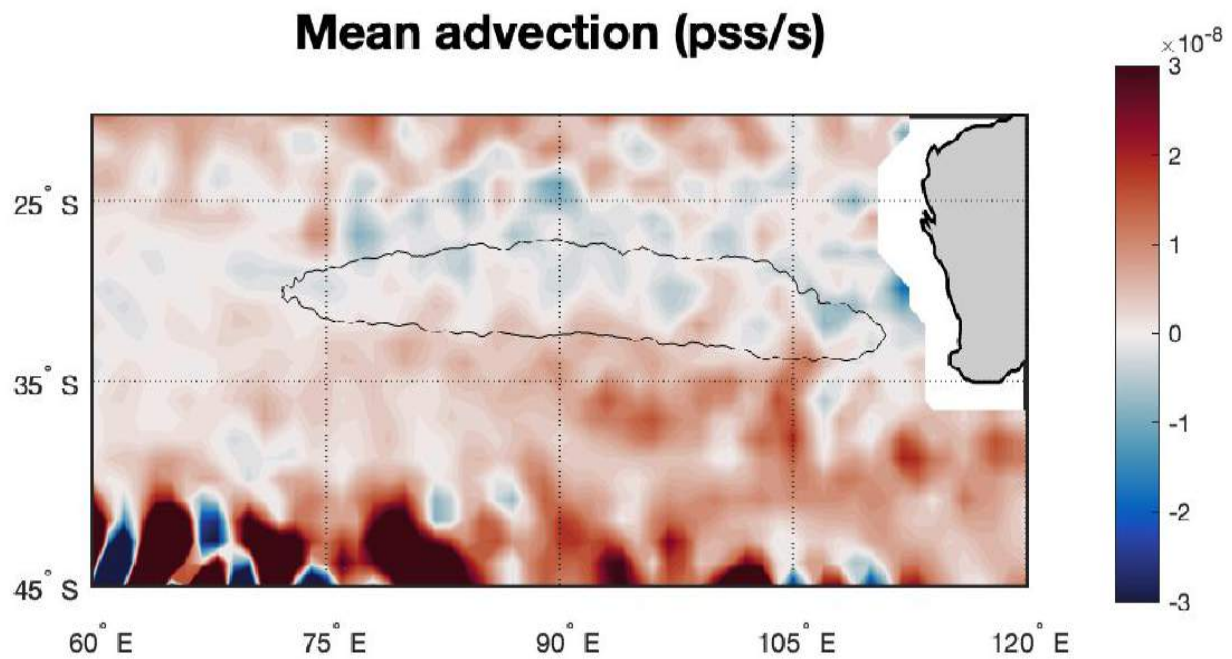




SSS correlation with yearly isohaline area

Advection and vertical entrainment





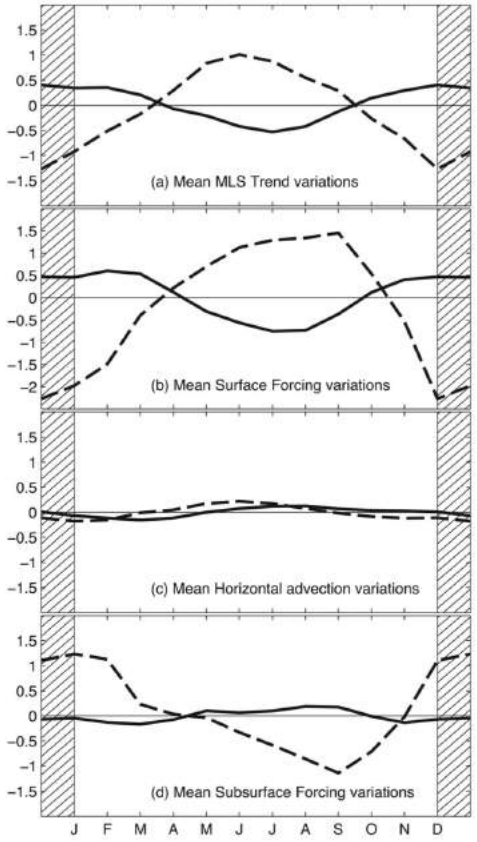
Final thoughts…

- The SSS-maximum in the SIO is a delicate balance between surface freshwater forcing, horizontal geostrophic and Ekman advective fluxes and vertical entrainment*. Changes in position of the feature indicate shifts in this balance.
- The SSS-maximum has a clear pattern of shifting to the northeast (southwest) as it gets bigger (smaller) and saltier (fresher). The same pattern exists in the South Pacific.
- Interannual variability in this feature appears to be related to changes in the structure of the subtropical gyre and the wind field, not so much to surface forcing
- Seasonal variability is related to surface forcing and vertical mixing at the poleward edge

*Gordon & Giulivi, 2014

EXTRA SLIDES…

Salinity budget within the SSS max



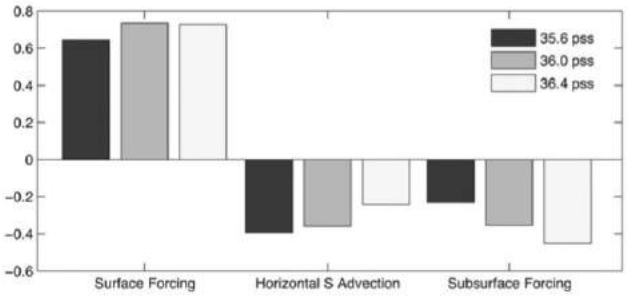
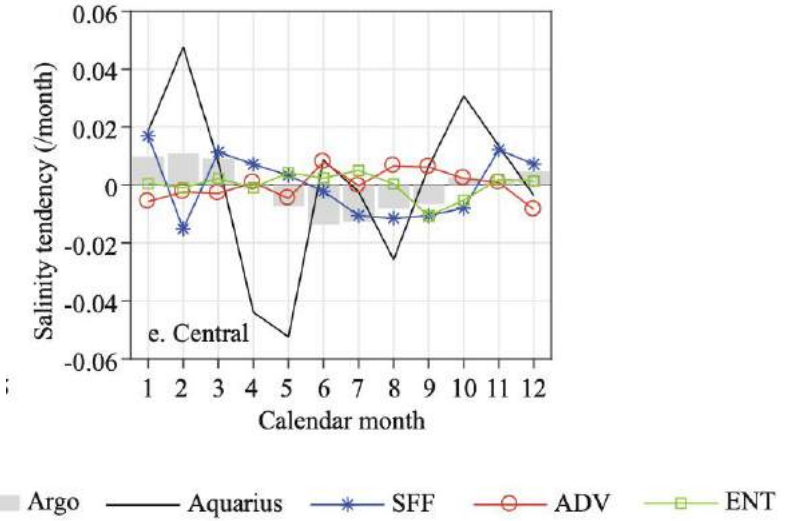
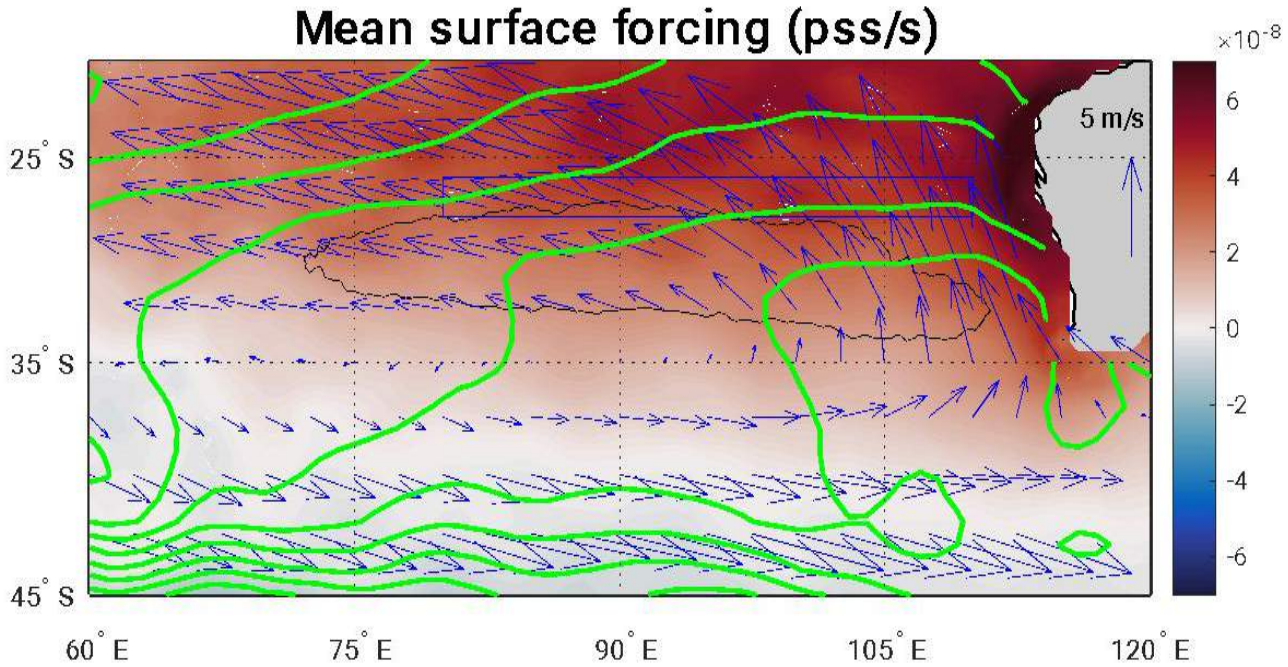


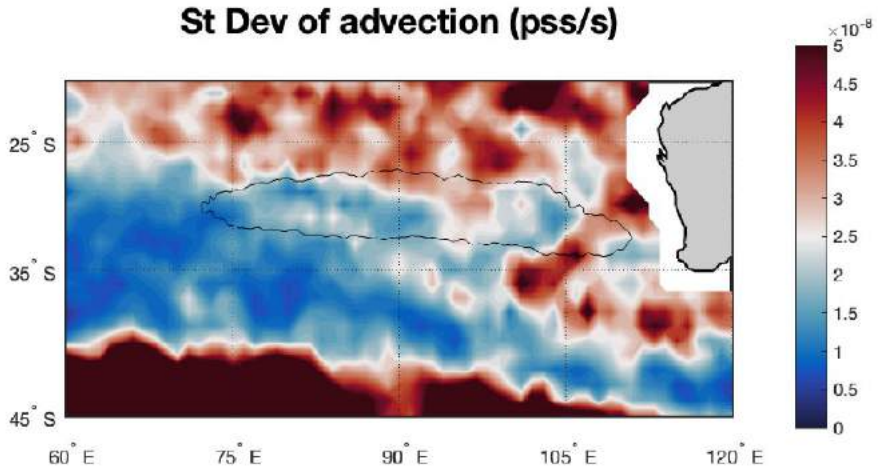
Figure 3. Mean modeled mixed-layer salinity budgets (pss/yr) in the high-salinity regions bounded by the 35.6, 36, and 36.4 isohalines shown in Figure 1a.

Wang et al.,2020
South Indian



Eddy advection is strong on the equatorward side of the SISSS-max, and weaker on the poleward side



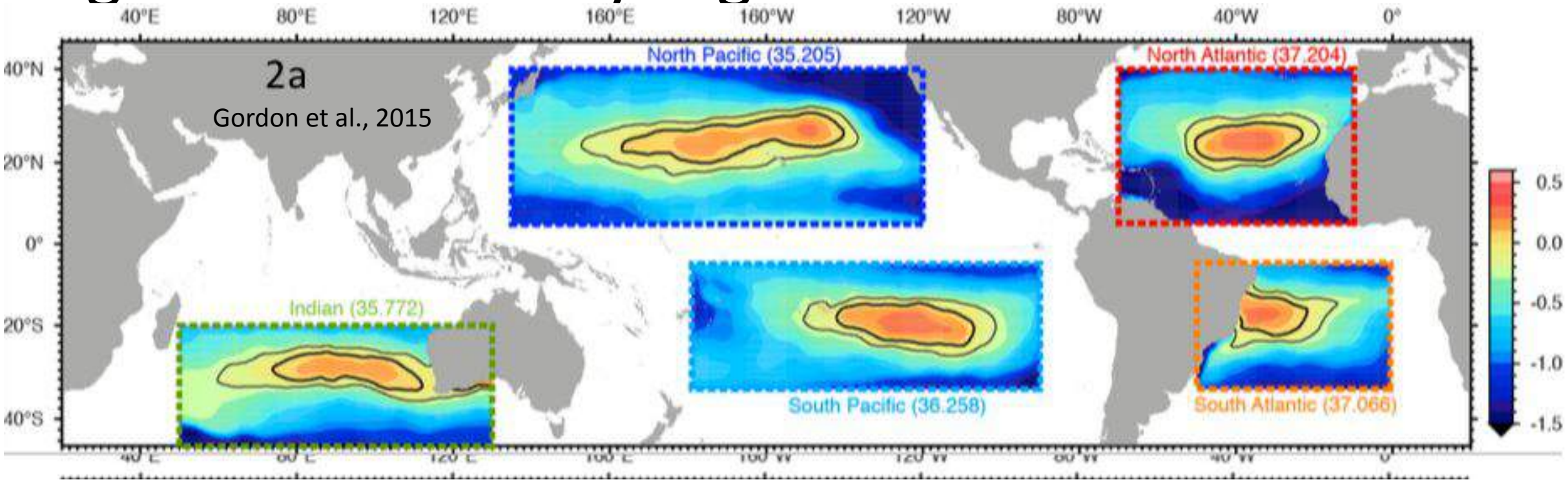


Colors: Mean surface forcing in pss/s. Red is positive, i.e. net evaporation

Green contours: Dynamic height, contour interval 0.1 dyn-m

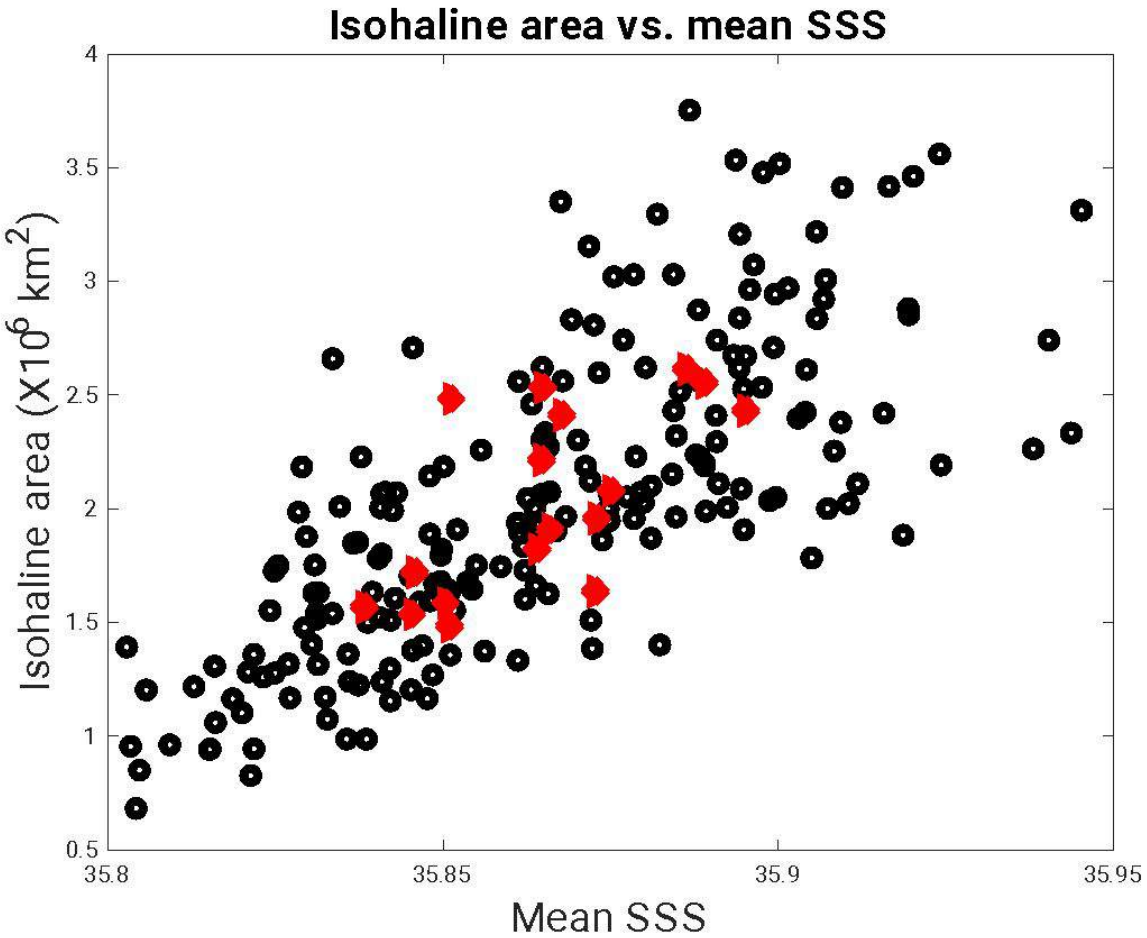
Blue arrows: Mean wind vectors

High surface salinity regions



SSS relative to the given reference SSS in each ocean basin

The Indian Ocean SSS-max is situated much further poleward than other ocean basins, centered at ~30°S



Mean SSS within the 35.772 contour

The isohaline area and mean SSS within the SSS-max vary in tandem

Black circles are monthly

Red symbols are yearly