

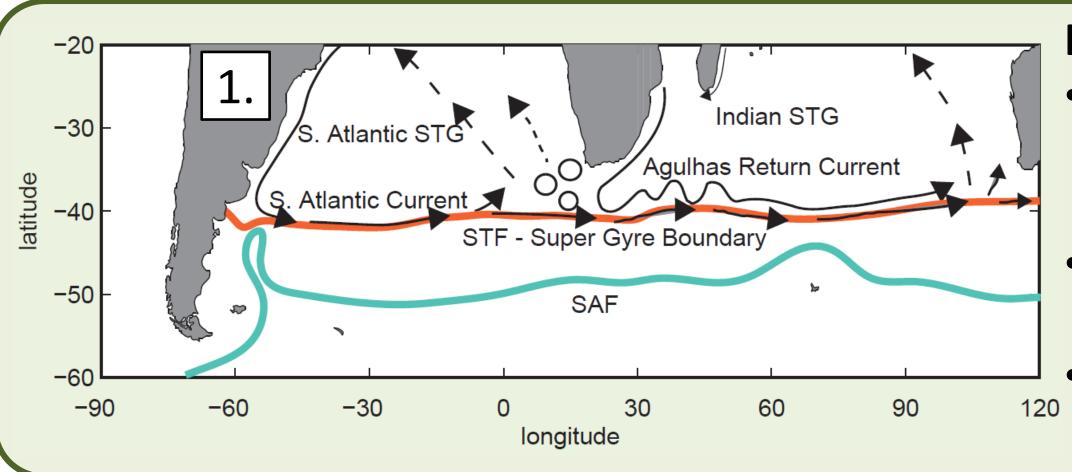
The Dynamical Subtropical Front

Bolin Centre for Climate Research

Robert M. Graham, Agatha M. De Boer

robert.graham@geo.su.se

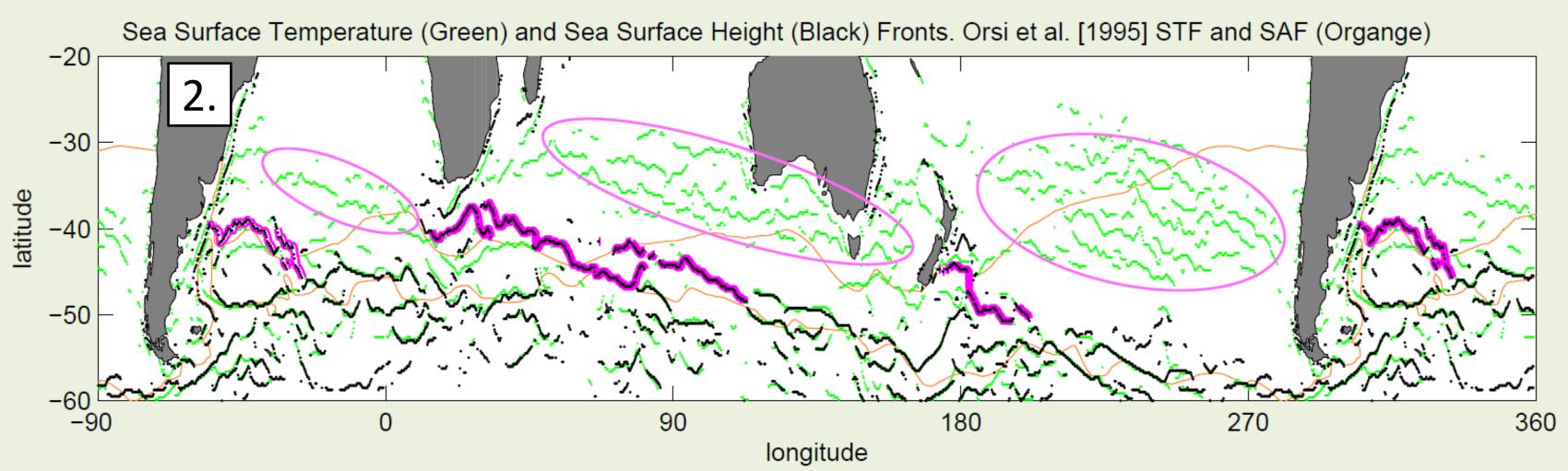




Introduction

- Theory predicts that the latitude of the Subtropical Front (STF)/Super Gyre boundary is set by the zero wind stress curl (WSC) and determines the width of the Agulhas Leakage Gate Way (Fig 1). A more northern STF is thought to equate to less leakage. The salt flux from Agulhas Leakage is considered a vital component of the meridional overturning circulation¹.
- However, it is unclear from literature whether the STF is shallow^{2,3} or deep^{4,5}; continuous^{6,7}or discontinuous^{2,3}; a single front^{4,6} or frontal zone^{2,7}; a strong current^{4,5} or density compensated^{2,3}; has a large^{3,8} or small^{2,9}seasonal cycle; etc.
- Here we show that two distinct physical features (The Dynamical Subtropical Front (DSTF) and the Subtropical Frontal Zone (STFZ)) exist at the Orsi et al. [1995] STF surface water mass boundary, and that the STF does not coincide with the zero WSC.

Figures: 1) Schematic of existing view of the Atlantic/Indian STF system. **2)** Location of SST (green) and SSH fronts (black), identified as local maxima in the mean SST and SSH gradients. Orsi et. [1995] STF and SAF (Orange). New DSTF climatology (Pink lines) derived from SSH fronts. **3)** 1999-2009 Satellite SST gradients^{10,11}. **4)** 1999-2009 Satellite SSH gradients. (delay time mean annual dynamic topography, AVISO). **5)** 800 dB Salinity. 1 degree resolution gridded ARGO data¹². **5)** Mean annual wind stress curl (1999-2009, satellite)¹⁰, smoothed by 6° lat x 10° lon. Zero WSC line is shown in back. STF climatologies as given in title.

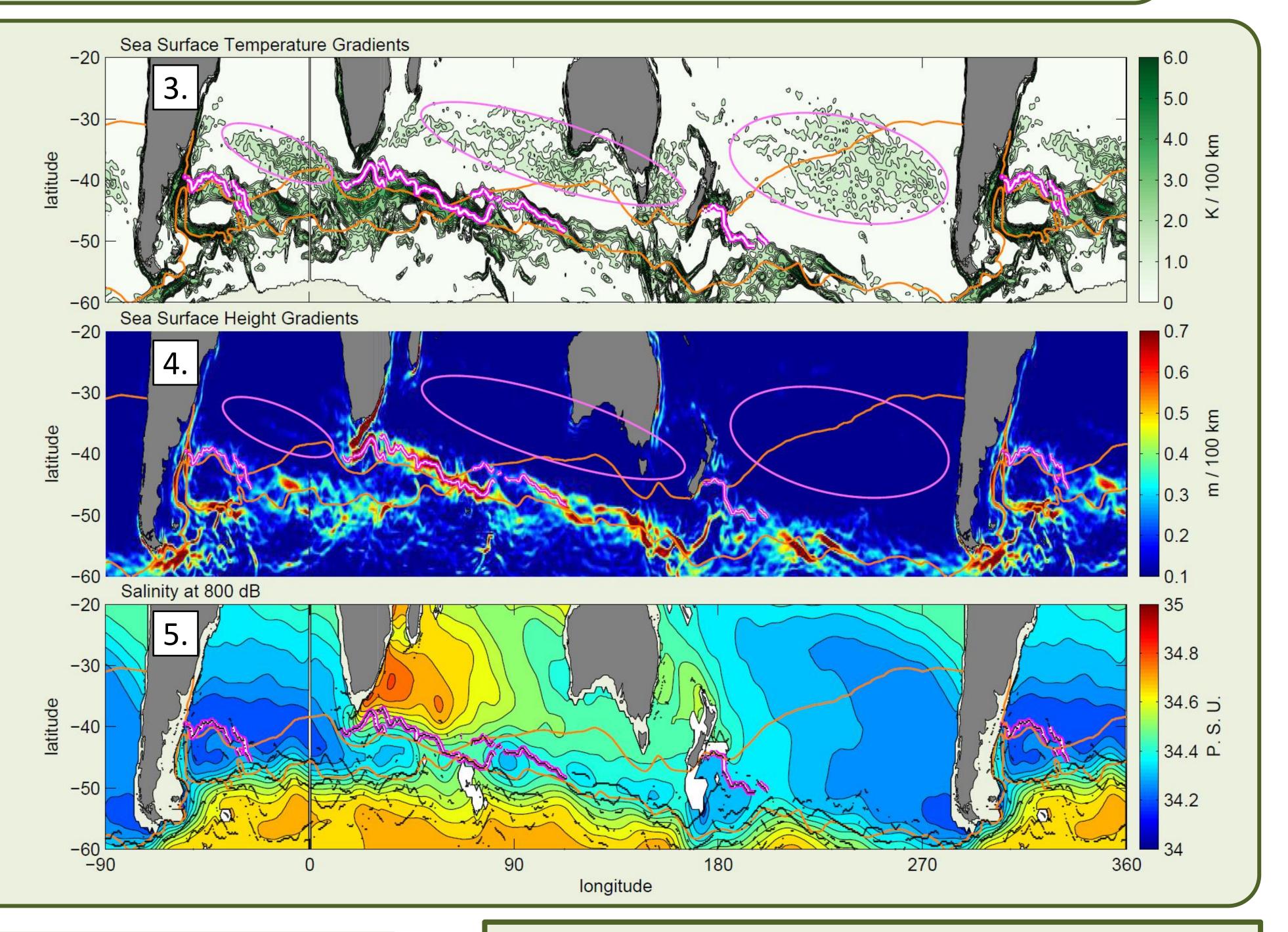


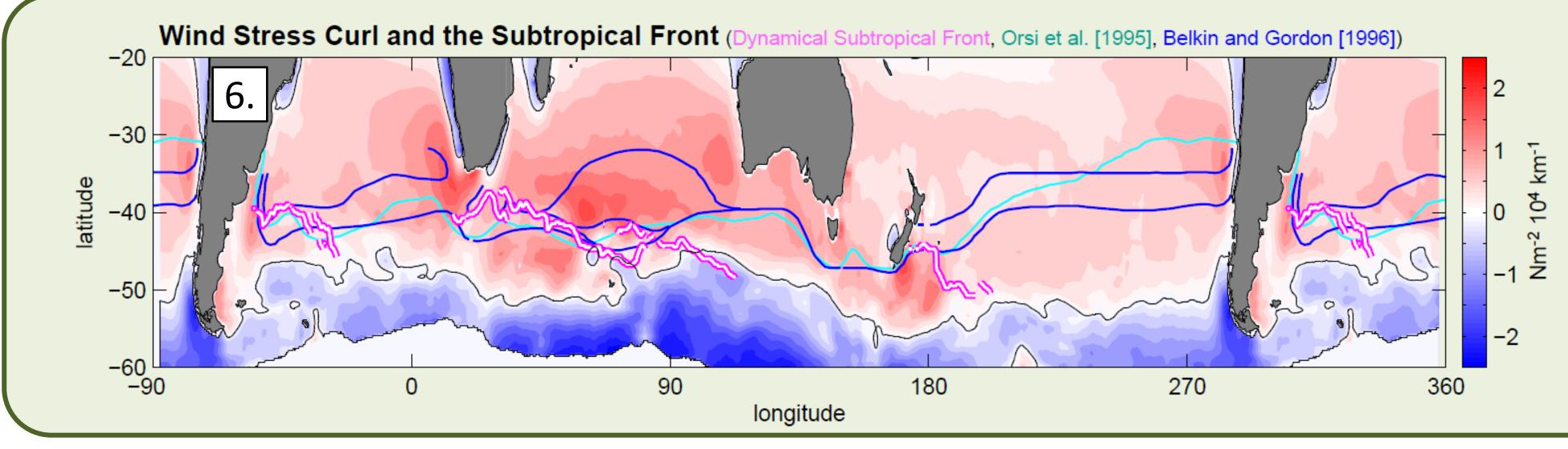
The Dynamical Subtropical Front (Pink Lines)

- Western side of basins (Figs 2 and 4).
- Detached Western Boundary Current.
- SST and SSH gradients (Figs 3 4)
- Deep front (Fig 5).
- Tracks south-eastwards and merges with the SAF (Figs 2 and 4).
- No seasonal cycle¹³.
- Subtropical Gyre Boundary NOT Super Gyre Boundary (Fig 5).

The Subtropical Frontal Zone (Pink Ovals)

- Eastern side of basins (Fig 3).
- Multiple SST fronts (Figs 2-3).
- No SSH gradients (Fig 4).
- Shallow (Fig 5).
- Separated from DSTF by region of weak SST gradients (Fig 3).
- Large seasonal cycle¹³.
- Wide latitudinal span (Figs 2-3).
- Flow perpendicular to SST fronts¹³.





- Regardless of definition / climatology the STF is >5° north of zero WSC (Figure 6).
- Area south of STF is controlled by bottom pressure torque¹⁴.
- Unclear how a shift of the Westerlies would impact the location of the STF.

Take Home Message

- The STF is currently used to describe several completely different physical features. This is misleading.
- We suggest using the term DSTF when referring to the strong current on the western side of basins.
- Similarly the term STFZ to refer to the area of enhanced temperature gradients towards the east.
- The STF is not the super gyre boundary or zero WSC.
- It remains unclear how a shift in the SH westerlies would impact the latitude of the STF or Agulhas Leakage.

References: 1. Beal et al. (2011) On the role of the Agulhas system in ocean circulation and climate. Nature. 2. Burls & Reason (2006), Sea surface temperature fronts in the midlatitude South Atlantic Current. JPO. 5. Stramma (1992), The South Indian Ocean Current. JPO. 6. Orsi et al. (1995), On the meridional extent and fronts of the Antarctic Circumpolar Current. DSR. 7. Belkin & Gordon (1996), Southern Ocean fronts from the Greenwich meridions from the Greenwich meridions. JGR. 8. Saraceno (2004) Brazil Malvinas Frontal System as seen from 9 years of advanced very high resolution radiometer data. JGR. 9. Wainer et al. (2000), Annual cycle of the Brazil-Malvinas confluence region in the National Center for Atmospheric Research Climate System Model. J. Clim. 10. Risien & Chelton (2008), A global climatology of surface wind and wind stress fields from eight years of QuikSCAT scatterometer data, JPO. 11. Reynolds et al. (2007), Daily high-resolution-blended analyses for sea surface temperature, J. Clim. 12. Hosoda, et al. (2008), A monthly mean dataset of global oceanic temperature and salinity derived from Argo float observations, JAMSTEC. 13. Graham & De Boer et al. (2013), The control of the Southern Hemisphere Westerlies on the position of the Subtropical Front, JGR.