Shallow and Deep Eastern Boundary Currents in the South Atlantic at 34.5°S: Mean structure and variability

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The Eastern Boundary Currents

- The Eastern Boundary Currents (EBCs) in the South Atlantic carry components of the Meridional Overturning Circulation (MOC) – Temporal and spatial variability affect the meridional heat and salt transports – Global climate system
- 34.5°S - Crucial latitude to understand the MOC variability and the impact of inter-ocean exchanges
- Eastern part of the South Atlantic MOC Basin-wide Array (SAMBA) – SAMBA-East
- The upper-EBCs main gateway for surface and intermediate Indian/Pacific waters → South Atlantic Ocean
- Southward flowing deep-EBCs: Origins; branch of cold and salty waters coming from the basin interior, and/or a local deep re-circulation in the Cape Basin (e.g., Arhan et al., 2003; Garzoli et al., 2015)

Objectives

- Evaluate the mean structure of the EBCs, the water mass properties carried by these currents, and the associated volume transport variability
- Comparison to other available in situ data sets as well as to the output from an ocean general circulation model
- EBC flow variability on time scales ranging from a few days to a few months
- Possible causes for the largest observed upper and deep EBC variations (Kersalé et al., 2018)

Mean EBC structure and time variability

- Time-mean absolute geostrophic velocity section from the CPIES data at 34.5°S reveals:
  1. Benguela Current and a portion of the northward flowing Cape Peninsula Jet east of 11°E
  2. Weak southward current influenced by transient Agulhas Rings west of 11°E
  3. Southward flowing deep-EBC adjacent to the slope associated with the presence of recently ventilated NADW water

- Similar zonal and vertical mean structures from Argo and XBT products, and OFES model output with finer horizontal scales: two cores of the Benguela Current; offshore poleward surface flow; hints of deep-EBC

Conclusions

- First direct continuous in situ EBCs observations along 34.5°S over a 23 month period
  1. CPIES data reveal the presence of the Benguela Current east of 11°E with a volume transport of 24 ± 17 Sv
  2. Time-mean transport agrees with other in situ data sets and model output estimates
  3. Daily observations are essential to successfully resolve the short time scale variability

EBC Transport and Energy spectral distribution

- Benguela Current and deep-EBC volume transports demonstrate strong variations at a wide range of time scales
- Robust relationship between both time series is not evident (r=0.4)
- Time-mean Benguela Current transport - Good agreement from all data sets, model output and previous estimates
- Strong variability at high frequencies is not captured in the other data sets
- Time-mean deep-EBC transport larger than historical estimate (Arhan et al., 2003) and 54% larger than the model output → Presence of recirculation cells

- Spectral analysis of the Benguela Current and deep-EBC transport time series from CPIES reveals:
  - 30 - 90 days: Predominant variability consistent with the propagation of Agulhas Rings
  - 180 days: Characteristic of upwelling time scale in the area; Caution: relatively short record (~2 years)
  - 2 - 15 days: Characteristic of poleward propagating coastally-trapped waves (typical period of 8.5 days)

- Modeled transport variability is weaker than the observed at all time scales except a peak at around 90 days in the upper part
- Consistent with Dong et al. (2014) - Artificially strong vertical density shear → No translocation of energy to deeper levels

- Spectral analysis of the Benguela Current and deep-EBC transport time series reveals the predominant variability is at time scales between 30 and 90 days, consistent with the expected time scales associated with the propagation of Agulhas Rings
- Relative short records length of the observation (≈23 months) introduces large uncertainties at scales larger than 180 days

References

- Kersalé et al., 2018. Shallow and Deep Eastern Boundary Currents in the South Atlantic at 34.5°S: Mean structure and variability. In prep.

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