Eastern boundary circulation and hydrography off Angola - building Angolan oceanographic capacities

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Motivation: Boundary circulation, Coastal upwelling and Benguela Niños

Occurrence of seasonal upwelling

Benguela Niño event in February 2011
Data set used in this study

Data collected as part of the FAO EAF-Nansen program
- Feb. – Apr. (Austral summer)
- Jul. – Aug. (Austral winter)

- CTD data from 1995-2017
- Vessel mounted ADCP data from 2005-2016
Average along-shore velocity along the coast during austral summer (February-April) and austral winter (June-August)

During austral summer the southward Angola Current intensifies and is concentrated in the upper 150 m.

During austral winter the Angola Current is weaker, but deeper reaching.
Average southward Sverdrup transport along the coast during austral summer (February-April) and austral winter (June-August)

- Reasonable agreement between Sverdrup transport and moored transport estimate.
- Elevated transport within the Angola Current just north of the Angola-Benguela Front.
Climatology of hydrography along the continental margin

- CTD profiles (1995-2017) were used to investigate climatology of temperature/salinity

- Note that $26 \text{ kgm}^{-3} \leq \sigma_{\theta} \leq 26.5 \text{ kgm}^{-3}$ is situated between 100 - 200m depth during summer and 50 - 150m depth during winter
Climatological current and hydrographic upper-ocean cross-shore sections averaged between 10°S and 12°S

- The flow is stronger and confined to shallower depths during austral summer.

- Warm, low-salinity surface layer throughout the section during austral summer.

- Weak stratification during austral winter.
Interannual temperature variability in the upper thermocline off Angola and Angola - Benguela SST index

Angola-Benguela Area Index (20°S to 10°S, 8°E to 15°E)

Average temperature anomalies between isopynals ($\sigma_0$) 26 kgm$^{-3}$ - 26.5 kgm$^{-3}$

Thermocline Anomalies:
- Warm and saline anomalies: SACW
  - 1999 - 2001
  - 2008 - 2012
- Cold and fresh anomalies: ESACW
  - 1996 - 1998
  - 2002 - 2004
  - 2015 - 2016
Mean profiles of salinity from observations and various reanalysis products

- The Nansen data set of Angola is now public and is available to improve future reanalysis products.
Conclusions: Eastern Boundary circulation

- Velocity sections across the Angola Current suggest a southward flowing boundary current along the continental margin of Angola;
- During austral winter (Jun. to Aug.), the Angola Current is weaker, but deeper reaching;
- During austral summer (Feb. to Apr.), it is surface intensified and concentrated in the upper 150 m;
- The southward strengthening with a velocity maximum just north of the Angola Benguela Front can be related to the local wind stress curl forcing;
- The seasonal variability is most likely explained by coastally trapped waves.
Conclusions: Interannual variability of water masses

- Interannual variability of thermocline temperature anomalies have amplitudes of 0.6°C;
- Warm anomalies will prevail during periods of a stronger Angola Current advecting SACW into the Angola-Benguela area;
- On interannual timescales, the hydrographic data reveals remarkable variability in subsurface upper ocean heat content. In particular, the 2011 Benguela Niño was preceded by a strong subsurface warming of about 2 year duration;
- Thermocline heat anomalies may serve as a preconditioning for the occurrences of Benguela Niños/Niñas;
Obrigado
Thank you