South Africa: Where three oceans meet

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Outline

1. General Circulation

2. Why is this region so important?

3. GoodHope – a case study of a successful XBT line

4. Future work
(b) GLOBAL SURFACE-WATER CURRENT PATTERN
Mean Circulation in the Ocean

Ideal region to study the influence of both western and eastern boundary currents
A major link in the global conveyor belt
**Agulhas Current to the rescue of the north**

In a new paper, UCT and European oceanographers suggest that Southern Africa’s Agulhas Current is feeding its northern counterparts with enough warm and salty water to save parts of Europe from a bad case of frostbite.

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For too long now, he explains, it's been taken for granted that if any ocean phenomenon has a say in weather conditions around the US and Europe, it's the Gulf Stream (the main current in the northern hemisphere) and its northern extension towards Europe, the North Atlantic Drift.

Not surprisingly, hardly a footnote has been spared for its distant, southern-led cousin, the Agulhas Current.

Originating in the Indian Ocean, the Agulhas Current flows southward along the eastern coast of South Africa, negotiating its way past icebergs and cold currents before taking a sharp bend and, renamed the Agulhas Return Current, heading back into the Indian Ocean. Huge eddies and rings escape from the current’s head and tail, towards Brazil, India and the Indian Ocean into the Atlantic Ocean - back to where it started.

But down south is a treasure trove of oceanographers, both from the UK’s Department of Oceanography with the support of various institutions and funders from Europe, who have slowly been feeding on the current’s steady heat and salt content for the past 35 years, he says.

A new study hopes to cement that case by expanding on previous work and showing that the current’s warming over the past 25 or so years has been a major factor in Europe’s climate change.

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Beal et al., 2011

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**Deep-water oxygenation**

**More**

**Agulhas leakage**

**Less**

**Strong**

**AMOC**

**Weak**
1. Variability due to Agulhas Rings
2. Need to investigate transport fluxes between the Indian and Atlantic Oceans
3. Trajectory of Agulhas Rings and influence of topography
4. Variability of the ACC south of Africa

..........................however......
South of Africa and Southern Ocean:
Serious lack of observations coupled with the problem of 4000 km ACC crossing makes for poor sampling resolutions.
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Therefore AIM was to provide methods which:

1. Improve transport and circulation understanding of the ACC
2. Estimate heat and salt content in the ACC and bordering ocean domains

Real benefits of ARGO program are now starting to be realised...
Case Study – AX25 Programme

AX25

- Initiated February 2004...
- Links into Bonus-GoodHope
- 5 CTD transects
- 18 XBT transects
- PIES
- Float deployment opportunity
- (>150 ARGO to date)
Importance of the AX25 Line

1. Western Boundary / Eastern Boundary / ACC interaction
2. Indo-Atlantic exchanges & effects on THC
3. Impact on southern African climate variability
4. African ACC chokepoint- little research
Subtropical-Subantarctic communication

Swart & Speich, 2010
Subtropical-Subantarctic communication

Rings are formed approximately 2.7 times a year!

Problem: Restricted to December – February season

How do we get more out of XBT data?

Swart & Speich, 2010
Vianello et al., 2011
1. DH & T<sub>0-600</sub>

Following work by Rintoul and Sokolov 2002

From 18 XBT crossings:

\[ \text{Tr}_{2500} = 90 \pm 2 \text{ Sv} \]

\[ \text{Tr}_{\text{bottom}} = 145 \pm 4 \text{ Sv} \]

2. Transports from DH

Swart et al., 2008
Altimetry (Jason) derived transport

ACC = 85 Sv
SAF = 33 Sv
APF = 41 Sv
Sthn Fr= 11 Sv

88 % Using this method enables us to measure the transport fluxes

Swart et al., 2008
GEM applied to altimetry

The GEM is created by projecting the hydrographic data from eight CTD transects onto streamline coordinates of pressure and dynamic height - see Swart and Speich 2010

Swart et al., 2010
Vertical proxies: GEM and XBT

Following Watts et al, 2001; Sun & Watts, 2002...
Altimetry-GEM timeseries

17 years, weekly

DS GEM SALT: 14-Oct-1992

DS GEM TEMP: 14-Oct-1992
Main Points

Upper ocean temperature measured using XBTs provides a good proxy for dynamic height

Dynamic height directly related with $T_{2500}$ = altimetry transports

Well organised structure of the ACC allows for firm DH to T, S relationships

Which provides T and S slices of the ACC over altimetry period and spatial coverage

The AGEM allows for estimating the HC and SC anomalies to identify mesoscale structures at fronts and of subtropical origin entering ACC

Thanks to... SANAP & NRF NOAA CNRS, LPO and special thanks to IAPSO for support
Opportunities to collect underway measurements on all relief voyages
Future of XBT research in South Africa

- Improved ocean-going facilities 2012
- Link XBT with UCTD and glider studies
- Call for national/international proposals 2011 - Involvement in large scale projects i.e. SAMOC and Lisa Beal’s planned Agulhas Observing system including Agulhas Return Cruise (NRL – J. Book)
SA Agulhas II delivery 1st May 2012
June 2012 Winter (shakedown) AX 25 cruise
Thank you!