# Transport variability of the ACC and teleconnection with the Southern Annular Mode (SAM) south of Africa

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## 1 Introduction and data

Since December 2002 the AWI operates numerous Pressure Inverted Echo Sounder (PIES) along the Good Hope line South of Africa (Fig. 1). They had been deployed to investigate the variability of the Antarctic Circumpolar Current (ACC). Meredith et al. (2004) found a teleconnection of the ACC transport and the Southern Annular Mode (SAM) in Drake Passage. This work investigates the possibility of a similar teleconnection south of Africa.

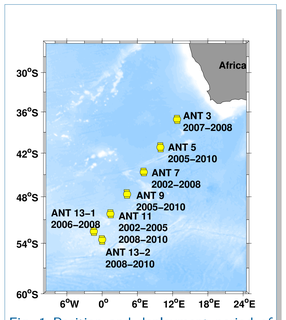


Fig. 1 Position and deployment period of the PIES

$$\tau = 2 \cdot \int_0^{p_b} \frac{dp}{\rho \cdot g \cdot c(T,S,p)} \quad (1)$$

PIES are moored devices measuring ocean bottom pressure and acoustic travel time. The acoustic travel time $\tau$ is two times the time an acoustic impulse needs from the bottom to the sea surface and back (Eq. (1), c...sound speed).

## 2 Method: Gravest Empirical Mode

The Gravest Empirical Mode (GEM, Meinen and Watts, 2000) method projects hydrographic profiles onto a vertical integrated property like the acoustic travel time. The method makes no assumption about the vertical structure, in fact it simply fits hydrographic data (lookup table). Because of the depth limitation of the ARGO floats a reference level of 2000m was chosen for the lookup table. The travel times measured by the PIES had to be corrected for this reference level.

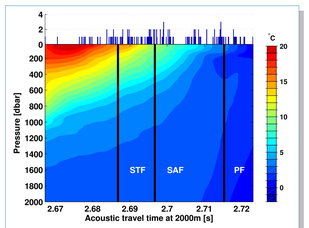


Fig. 2 Lookup table for potential temperature with a histogram of the profiles used for its creation.

Fig. 2 shows the lookup table for potential temperature. 56 CDT profiles and 126 ARGO profiles indicated as a histogram had been used for its creation. The three major fronts, Subtropical Front (STF), Subantarctic Front (SAF), and Polar Front (PF) are indicated as solid black lines. Figure 3 shows a time series of potential temperature derived with the GEM method.

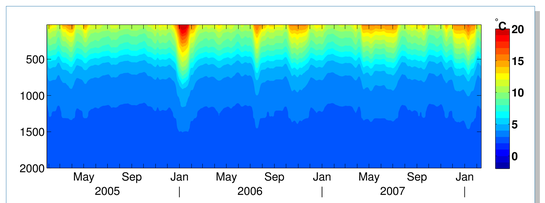


Fig. 3 Potential temperature time series derived at the position ANT_5 using the lookup table

## 3.1 Results: ACC Transport

The potential temperature and salinity time series derived with the GEM method are used to calculate a geostrophic velocity (Eq. 2). The vertical integral of $v_g$ times the distance $dx$ between the stations results in the transport $T$ (Eq. 3, $z_{12}$...common depth of two stations).

$$v_g(z+dz) = v(z) + \frac{g}{1035kg/m^3 \cdot f} \cdot \frac{d\rho(z)}{dx} dz \quad (2) \qquad T = dx \cdot \int_{z_{12}}^{0} v_g(z) dz \quad (3)$$

The geostrophic ACC transport is derived between 41.2°S (ANT_5) and 53.5°S (ANT_13).

**Mean Transport:**

**2006-2008**
**147.2Sv±12Sv**

**2008-2010**
**142.8Sv±5.2Sv**

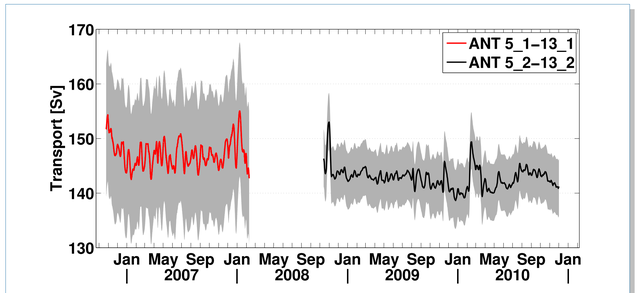


Fig. 4 ACC transport for two different deployment periods with error bounds, due to the error propagation of the lookup table rms-errors, indicated as gray shaded area.

## 3.2 Results: Teleconnection of the ACC transport with the Southern Annular Mode (SAM) index

The Southern Annular Mode (SAM) represents the climate variability in the southern hemisphere and is characterized by the SAM index. Meredith et al. (2004) found evidence that the SAM forces the interannual variability of the ACC transport through Drake Passage. In this study the hypothesis of a teleconnection between the SAM and the ACC transport is tested along the Good Hope line. A daily SAM index provided by the National Oceanic and Atmospheric Administration (NOAA) was averaged to weekly means and correlated with the derived ACC transports.

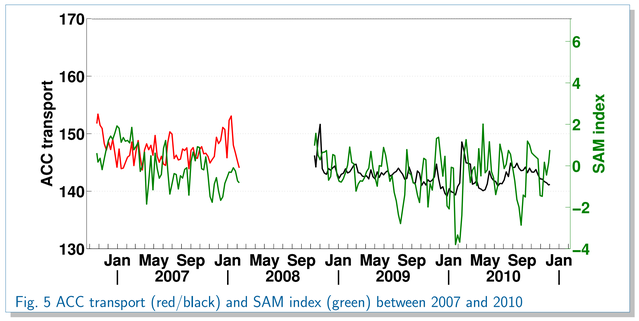


Fig. 5 ACC transport (red/black) and SAM index (green) between 2007 and 2010

## 3.3 Results: Cross correlation of ACC transport and SAM index

Figure 6 shows the cross correlations of the two ACC transport time series with the weekly SAM index.

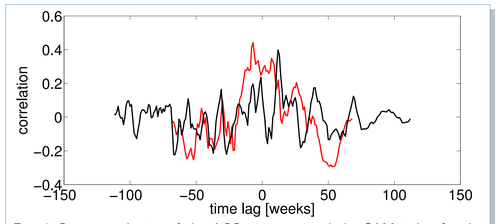


Fig. 6 Cross correlation of the ACC transport and the SAM index for the first (red) and the second (black) time period.

**Maximum Correlation and Time Lag:**

| | Dec.2006-Feb.2008 | Sept.2008-Dec.2010 |
|---|---|---|
| Maximum correlation | 0.44 | 0.4 |
| Time lag [weeks] | -7 | 12 |

## 4 Conclusion and Discussion

- Different mean transport might be due to the somewhat different position of the PIES ANT_13 during the first and second deployment period.
- Correlation between SAM index and ACC transport is maximal 0.4-0.44 with different time lags. ⇒ **Highest correlation between the ACC transport and the SAM index are not at similar time lags.**

Meredith et al. (2004) found evidence in their study that the SAM forces interannual changes of the ACC transport through Drake Passage. The recent study can not support these findings. One reason might be that the ACC is located further north of the Antarctic continent at the Good Hope line compared to Drake Passage. Another reason is that Meredith et al. (2004) analyzed interannual variability using time series of ten years which barely can be resolved by a one or two year time series. New PIES data will increase the time series in the upcoming years and help to overcome this problem. Further studies will look at the role of the barotropic part of the ACC transport.

## Acknowledgments

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## References

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