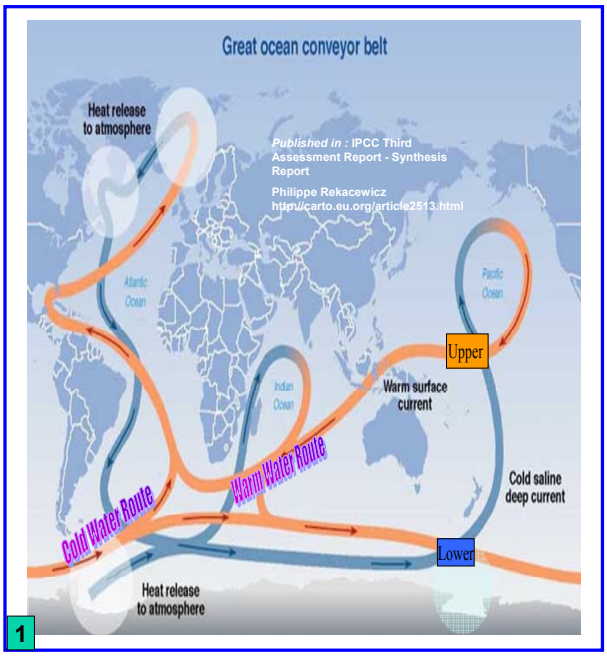
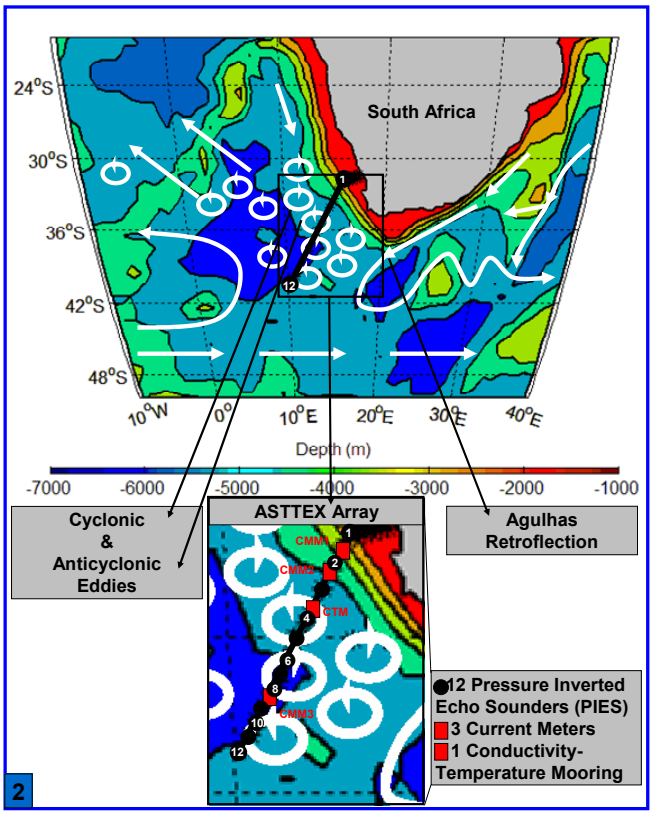
Sheekela Baker-Yeboah, D. Randolph Watts, Deirdre Byrne, and Neal R. Pettigrew

**1.** This work focuses on eddy processes which play a role in the Meridional Overturning Circulation (MOC).

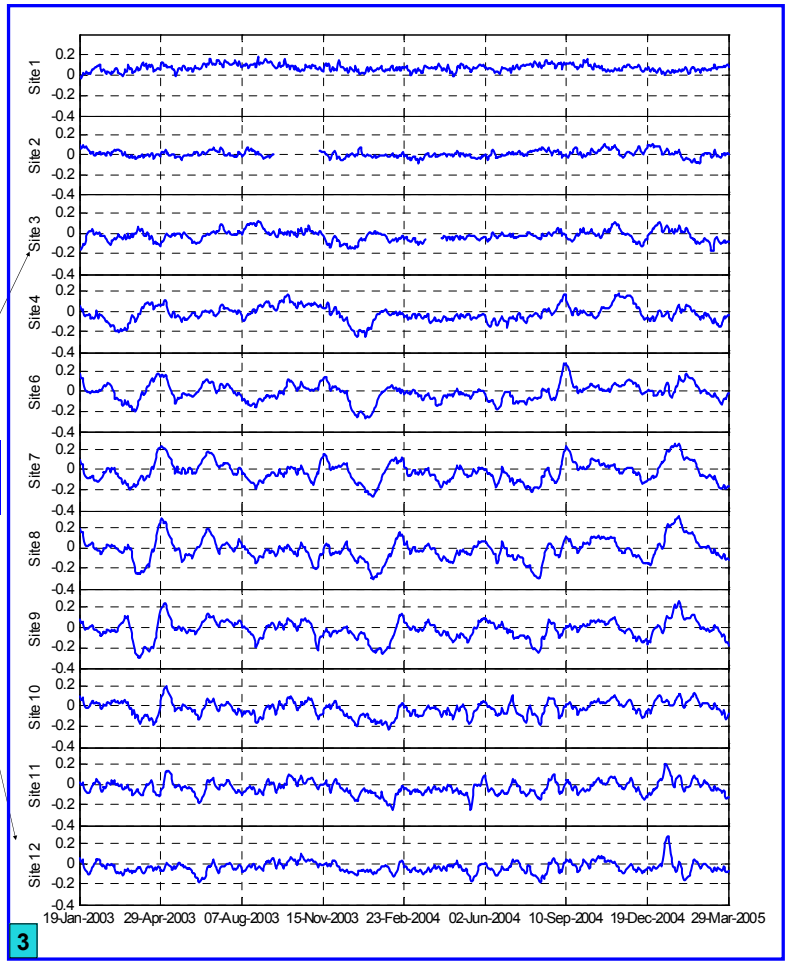



**2.** The ASTTEX (Agulhas South-Atlantic Thermohaline Transport Experiment) moored array crossed an "eddy corridor" where Agulhas rings transit into the South Atlantic. (Color contours indicate bottom topography.)




**3.** Bottom pressure anomaly records detided, demeaned, and lowpass filtered (72 hrs). The periodicities in the pressure records range from 20 – 150 days.

Coherent pressure signals between sites 3-12.

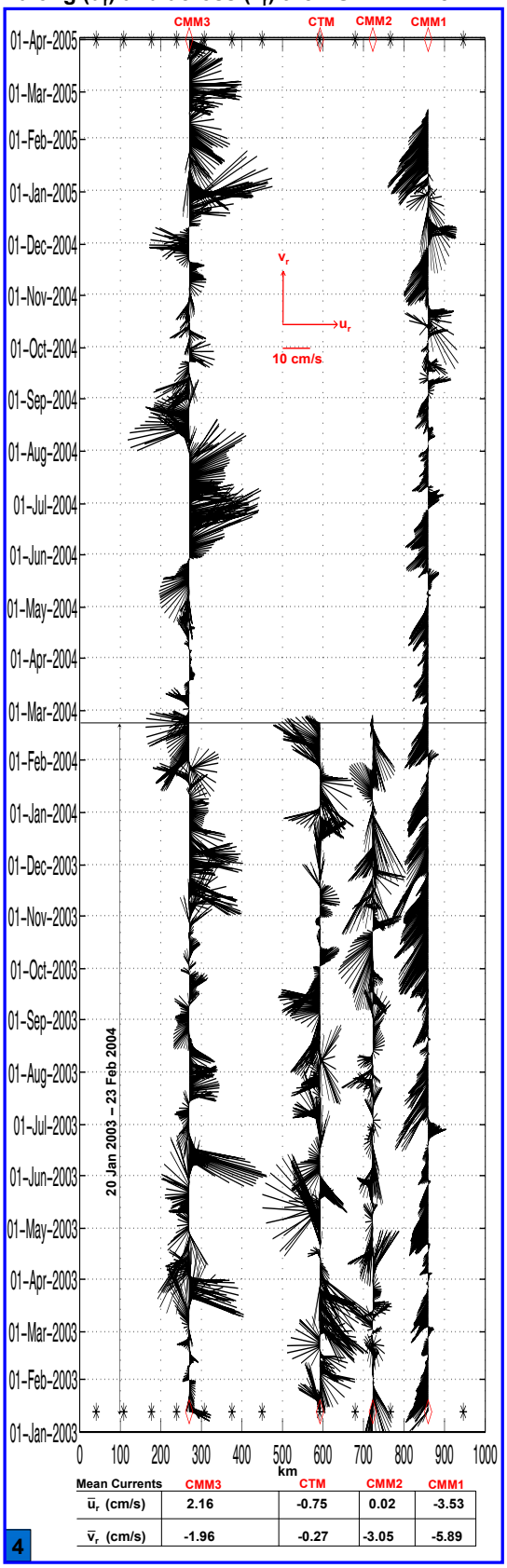



An improved understanding of Agulhas eddies and leakage will provide insight into the salt and heat fluxes that contribute to the MOC (Figure 1). An array of instruments was deployed during January 2003-March 2005 along a TOPEX POSEIDON/Jason satellite altimeter ground-track southwest of South Africa, crossing the "eddy corridor" where Agulhas rings pass, carrying Indian Ocean water into the South Atlantic (Figure 2).

Large pressure signals of ±0.29 dbar with lateral scales of 200 to 400 km had a periodicity of 20-150 days (Figure 3). Deep current meters reveal weak mean currents of 1 to 6 $cms^{-1}$ and deep eddies with speeds as high as 33 $cms^{-1}$ (Figure 4). The time series of pressure (P) and acoustic travel time ($\tau$) were optimally interpolated along the ASTTEX line using a correlation length scale of 200 km for P and 110 km for $\tau$ (Figures 5 and 6). High pressure centers are associated with anticyclonic circulation (counter clockwise in the southern hemisphere), while low pressure centers have cyclonic circulation (clockwise). Strikingly, the deep eddies have larger lateral scales (300 km) than the upper eddies (200 km) for both high and low pressure centers.

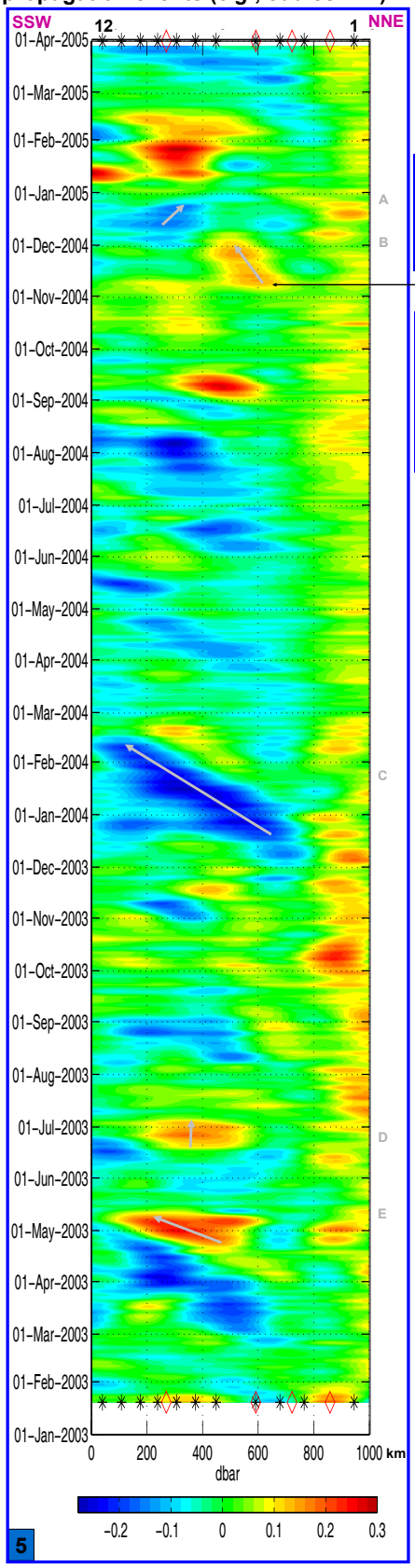
# Deep Pressure Signals and Eddies in the South Atlantic Cape Basin Measured During ASTTEX

**4.** Deep currents from current meter data along ($u_r$) and across ($v_r$) the ASTTEX line.




| Mean Currents | CMM3 | CTM | CMM2 | CMM1 |
|---|---|---|---|---|
| $\bar{u}_r$ (cm/s) | 2.16 | -0.75 | 0.02 | -3.53 |
| $\bar{v}_r$ (cm/s) | -1.96 | -0.27 | -3.05 | -5.89 |

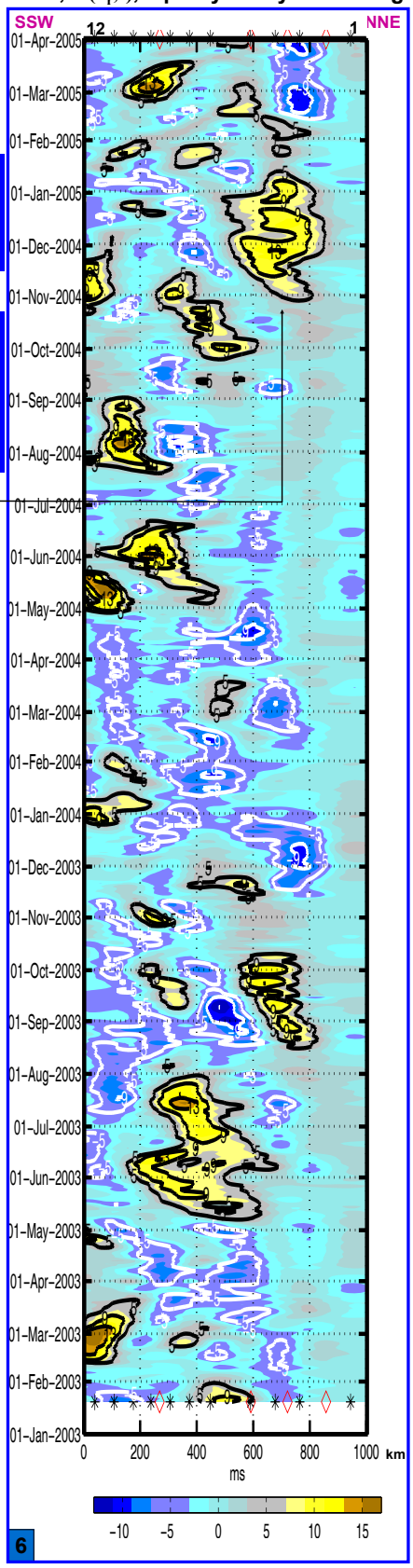
**5.** The deep pressures $P(x_r,t)$ reveal eddy propagation events (*e.g.*, eddies A-E).




**6.** Upper eddy events revealed by acoustic travel time, $-\tau(x_r,t)$, a proxy for dynamic height.

Deep ocean signal: pressure anomaly ($P'$)

Upper ocean signal: acoustic travel time anomaly ($-\tau'$)



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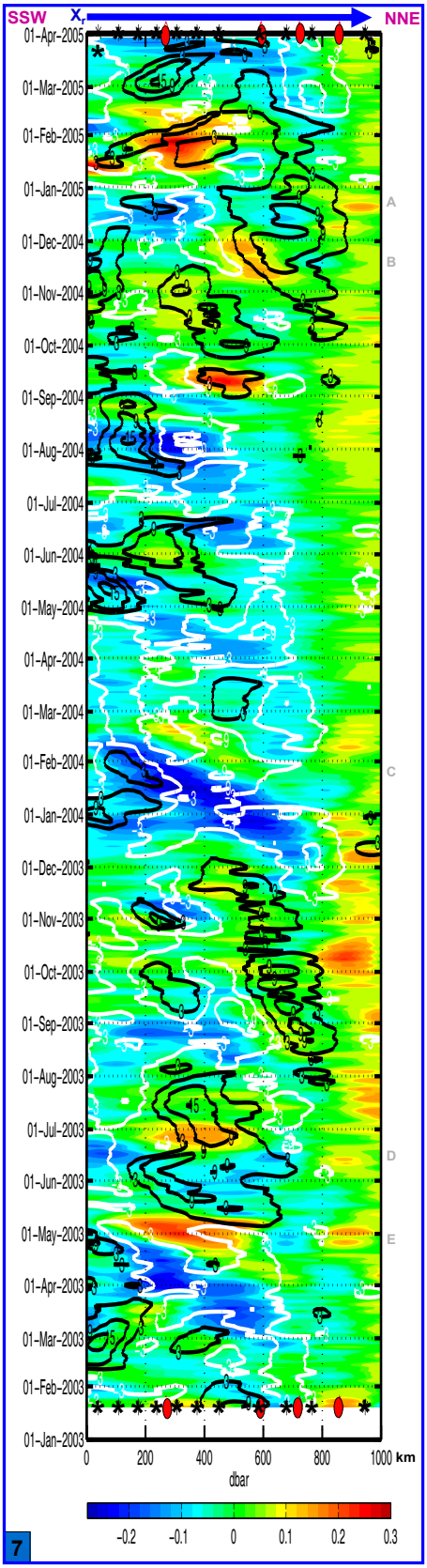
Graduate School of Oceanography, University of Rhode Island. Narragansett, RI. USA. sbaker@gso.uri.edu

**7.** The deep and upper eddies are coupled. -τ' is in black {+} and white {-}.

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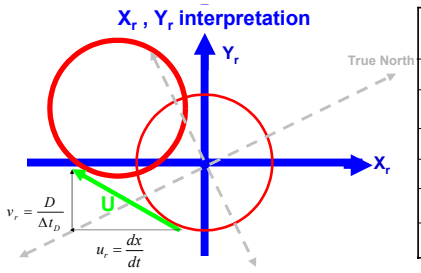
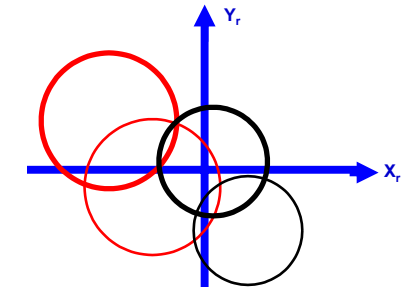
**8.** Most eddies in the Cape Basin region have a vertical tilt, with deep eddies (red circle) leading the upper eddies (black circle). Plan view.

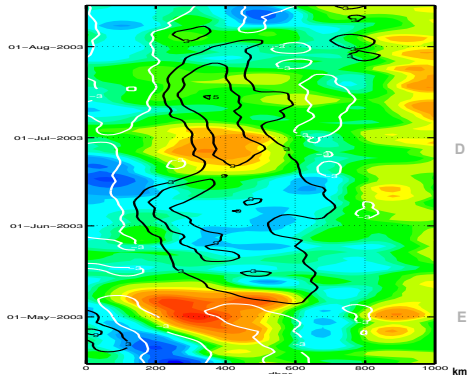



(a) Illustration of a deep eddy propagating across the ASTTEX line with a WSW propagation direction in geographical coordinates ($X_r$, $Y_r$).

| Case | Δx (km) | Diameter (km) | Δt (days) | $\Delta t_D$ (days) | $(u_r,v_r)$ (km $d^{-1}$) |
|---|---|---|---|---|---|
| A | 76 | 229 | 16.5 | 16.5 | (4.6,13.8) |
| B | -105 | 162 | 16.5 | 27.6 | (-6.4,6.1) |
| C | -362 | 340 | 38.6 | 55.1 | (-9.4,6.2) |
| D | 0 | 314 | 16.5 | 16.5 | (0,19.0) |
| E | -190 | 357 | 11.7 | 20.7 | (-16.2,17.2) |




(b) A deep and upper eddy propagate together as a vertically tilted eddy in the ocean.

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**9.** The baroclinic SSH signal across strong upper eddies is about 0.8 m. The deep barotropic SSH signal across the strong deep eddies adds about 0.5 m to the SSH variation.

$$\eta_{BC} = \eta_{1500} = \frac{1}{g}\int_0^{1500} \frac{1}{\rho} dp \approx 0.8m \qquad \text{and} \qquad \eta_{BT} = \frac{P}{\rho g} \approx 0.5m$$

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Observations indicate upper and deep eddies are coupled (Figure 7). Moreover, baroclinic and deep barotropic eddies often travel in clusters of two, three, or sometimes four in close proximity in space and time (Figures 5 and 6).

Most eddies propagate west-southwest (Table) as they transit the ASTTEX line, whereas a few travel northwest or west. Eddies propagate 10 - 25 km $d^{-1}$, which is much faster than the surrounding deep circulation (~5 km $d^{-1}$). Furthermore, these speeds are much faster than the fastest baroclinic Rossby wave: $c = -\beta a^2 \sim -3$ km $d^{-1}$, where a = 40 km, the Rossby radius of deformation.

These speeds and directions appear to be enhanced by vortex-vortex interactions. In the two strongest cases of deep eddies, a low leads a high in a persistent pairing, as they transit WSW, while simultaneously the upper ocean is populated by several cyclones. Often, deep pressure signals are a precursor of upper eddies with 80-150 km spatial offsets and 10-30 day temporal offsets. Thus, most eddies in the Cape Basin exhibit a vertical tilt, with deep eddies leading the upper eddies (Figure 8).

The baroclinic SSH signal across upper eddies is typically ~0.8 m and the barotropic SSH signal across strong deep eddies is ~0.5 m (9). Hence, the barotropic component adds a comparable and independently varying SSH signal.