

Observed eddy dissipation in the Agulhas Current

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Key points

When predicting the energy potential of the Agulhas Current, it is important to consider the mesoscale variability in the region.

1. Eddies dissipate as they approach the Agulhas Current
2. Eddies affect Agulhas Current velocities and position
3. Eddy dissipation is not well resolved in existing numerical models

The Agulhas Current System

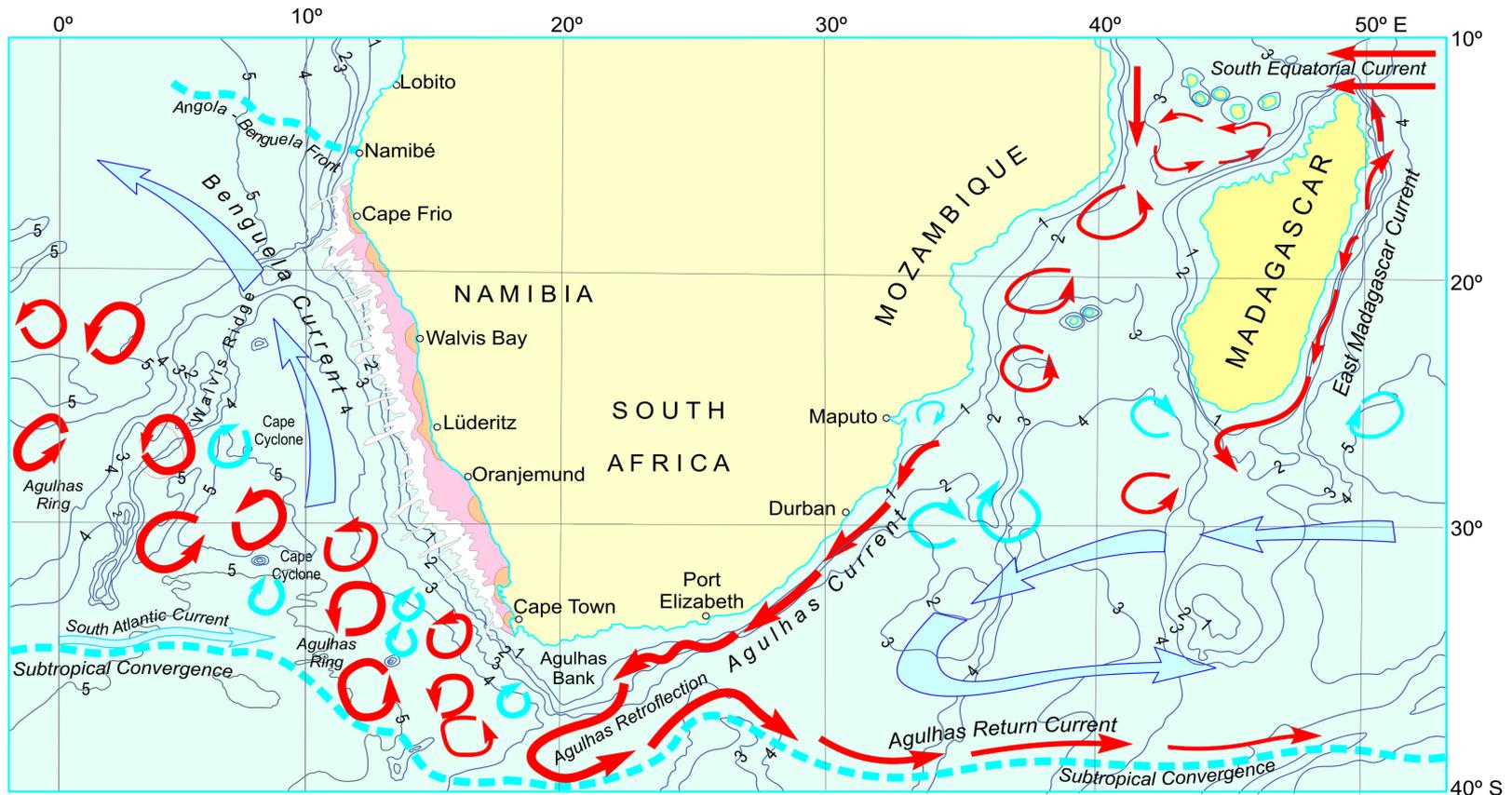
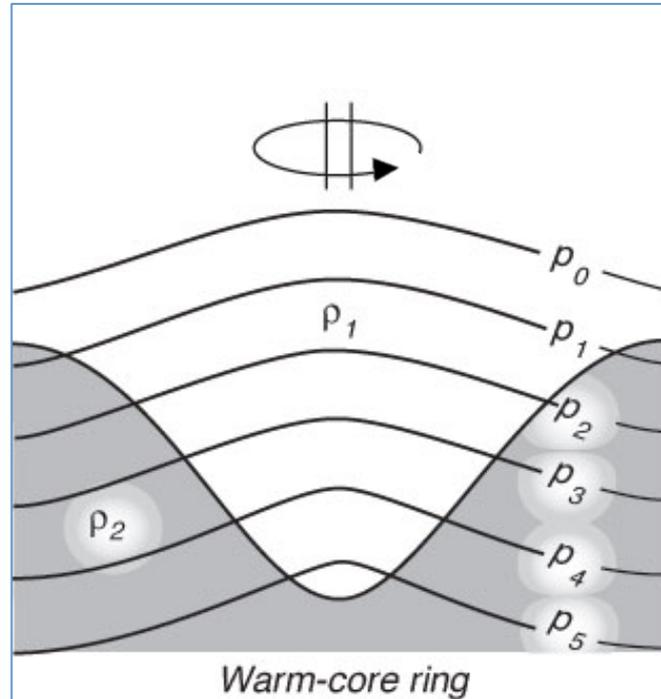
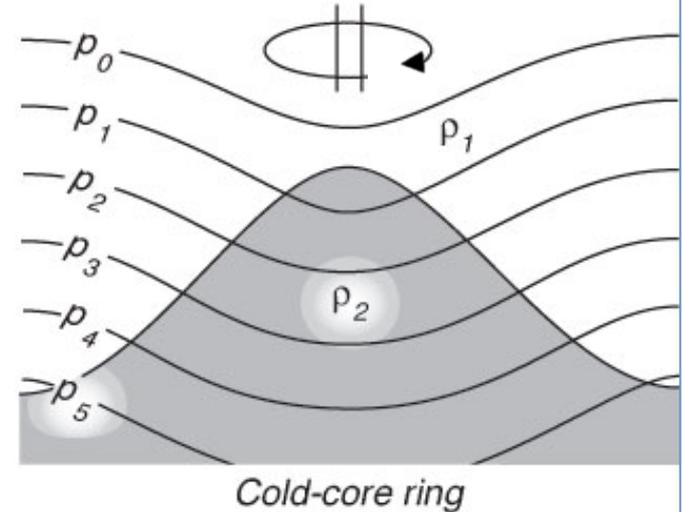


Figure 1: The prominent circulation features of the greater Agulhas Current system. The mesoscale eddy activity in the Mozambique Channel and south of Madagascar is shown. Both anti-cyclonic and cyclonic eddies propagate towards the Agulhas Current. (Source: Ansorge and Lutjeharms, 2006).

Anti-cyclonic eddy



Cyclonic eddy



Mean Eddy Stats

Radii: 90km

Amplitudes: 8cm

Life time: 32 weeks

Numbers: 4-7 anti-cyclonic, 6-8 cyclonic per year

Source: Stewart, 2005. Introduction to Physical Oceanography.

Eddy dissipation and entrainment is poorly resolved in numerical models

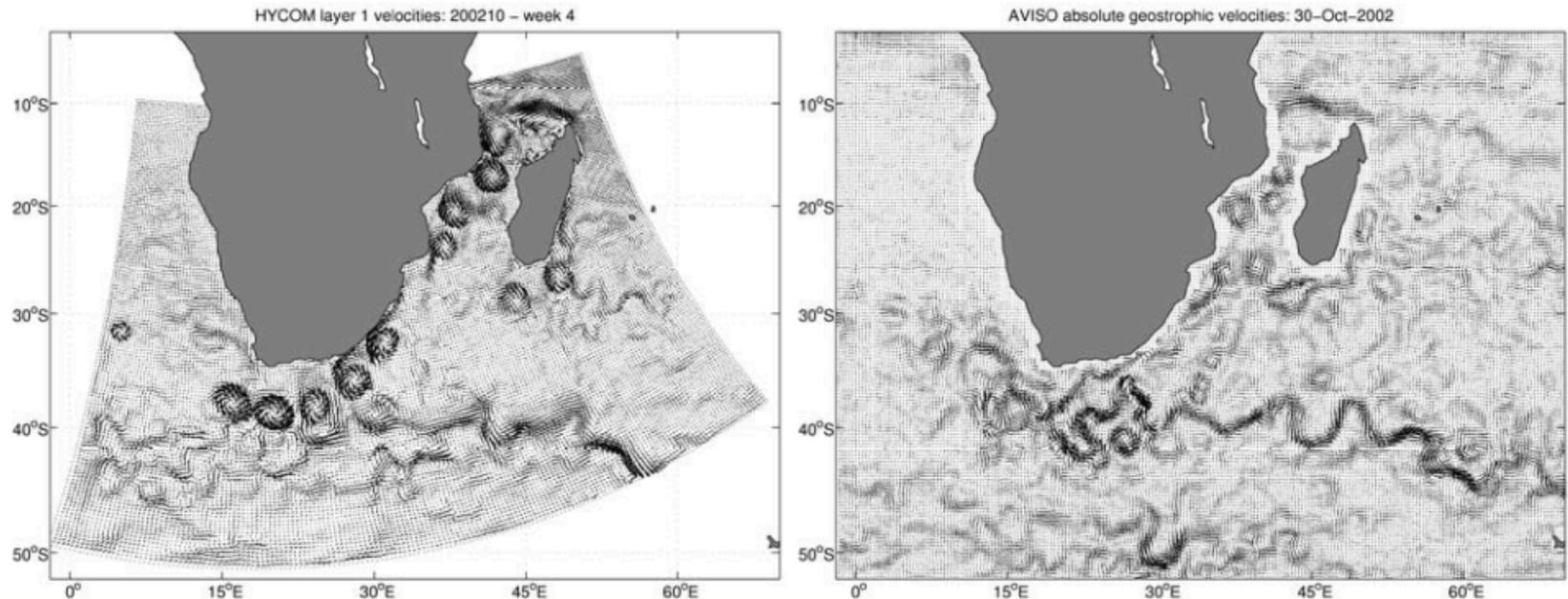
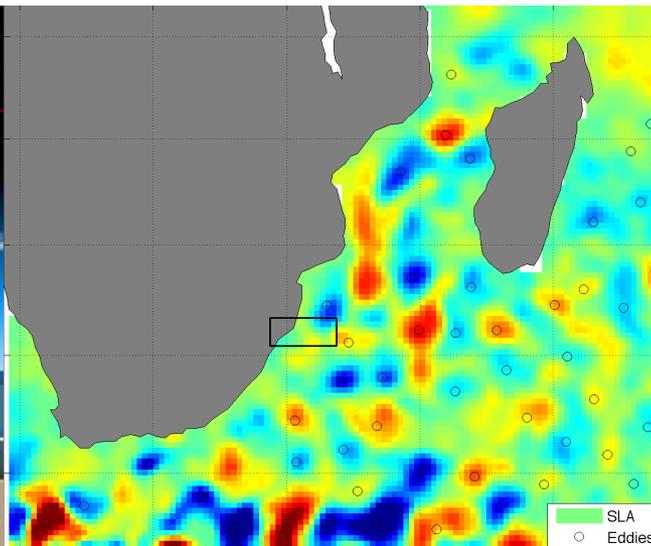
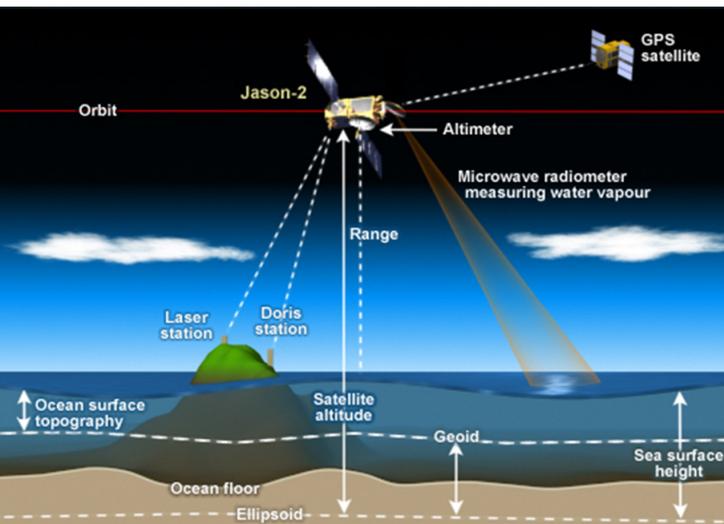


Figure 2: Weekly surface velocities from a) HYCOM (model) and b) AVISO (satellite). (Source: Backeberg et al., 2008)

Data and Methods

- Satellite altimetry data from AVISO
- Mesoscale eddy tracking data (Chelton et al., 2011)
- In-situ SVP drifter data from the Global Drifter Programme

Source: <http://www.star.nesdis.noaa.gov>



Validation of the eddy tracking algorithm

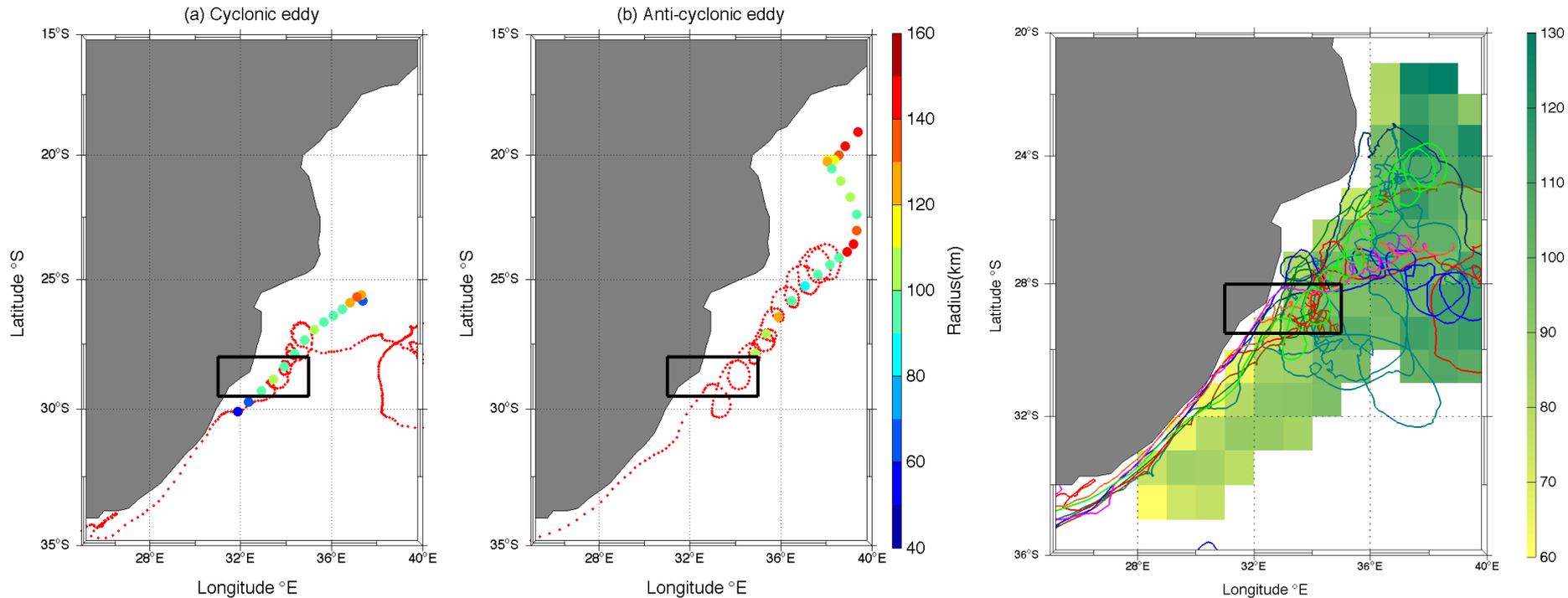


Figure 3: Drifter trajectories (red) with corresponding eddy radii and trajectories overlaid (color) for a) a cyclonic eddy, b) an anti-cyclonic eddy, c) trajectories of drifters passing through 28°- 29.5°S and 31°- 35°E (the black box) overlaid on a 1°x1° grid of the mean eddy radii from October 1992 and April 2012.

Eddies dissipate upon arrival at the Agulhas Current

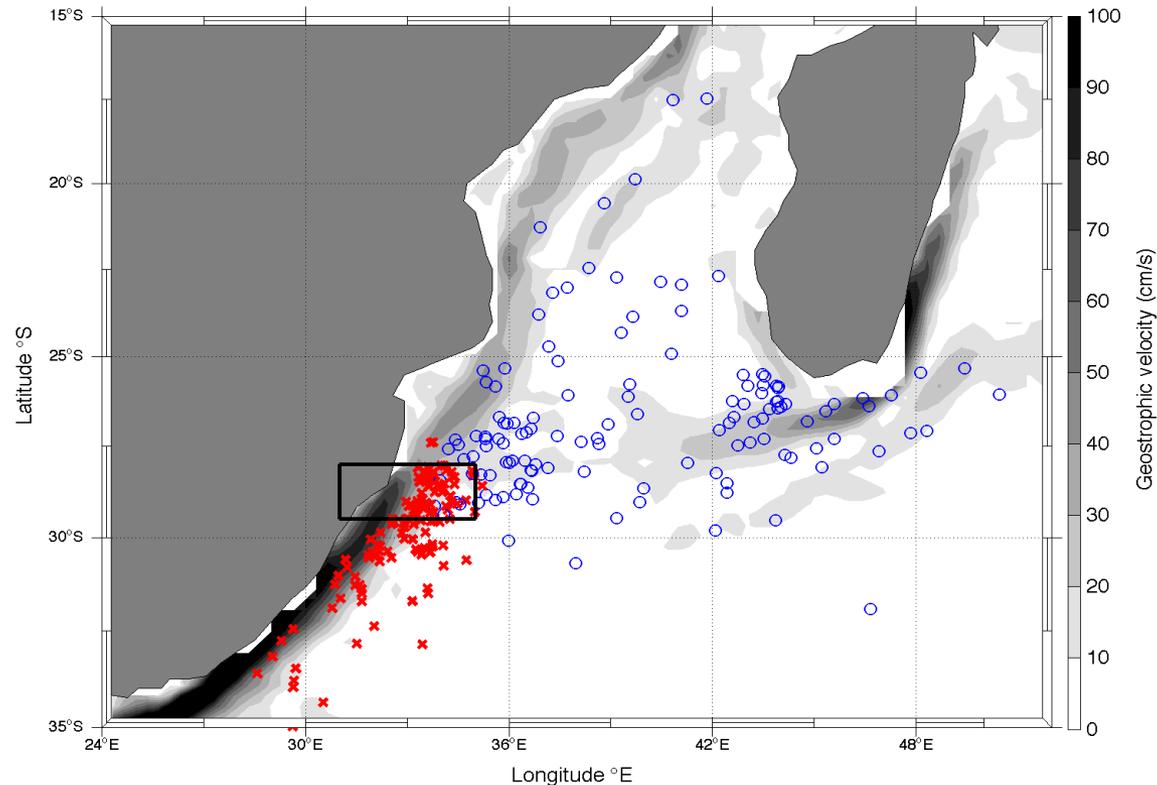


Figure 4: Formation (circles) and termination (x's) sites of all cyclonic and anti-cyclonic eddies passing through 28°- 29.5°S and 31°- 35°E (the black box) overlaid on the mean geostrophic current derived from the satellite altimetry observations between October 1992 and April 2012.

Eddies radii and amplitudes decrease as they approach the Agulhas Current

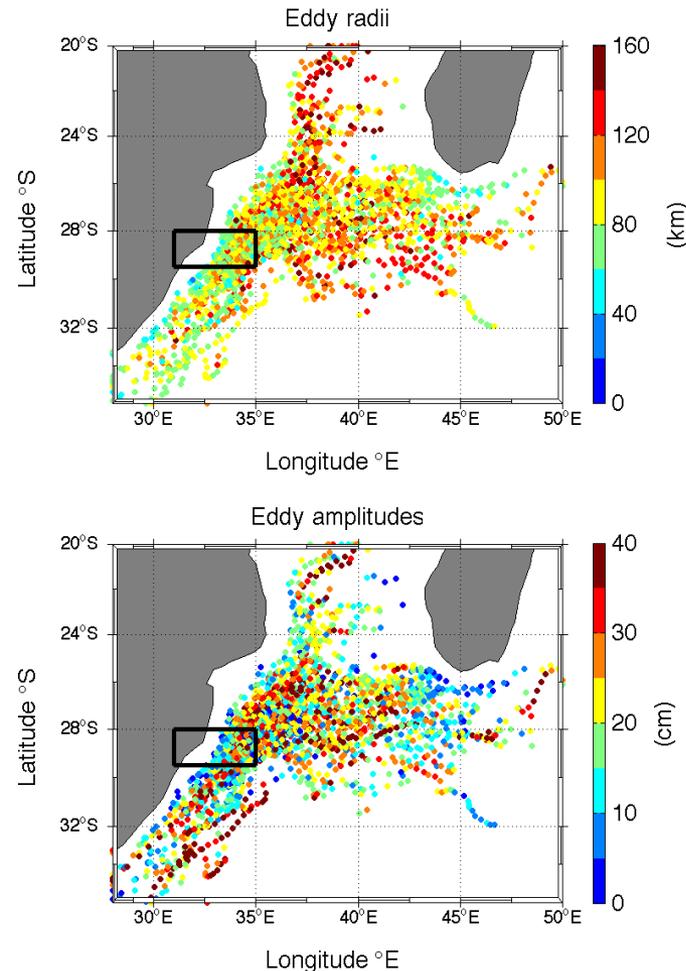


Figure 5: The a) radii (km) and b) amplitudes (cm) of all eddies passing through 28°-29.5°S and 31°- 35°E (the black box) from October 1992 until April 2012.

Meridional mean geostrophic velocity, eddy amplitudes and radii for 28°-29.5°S, 31°-35°E

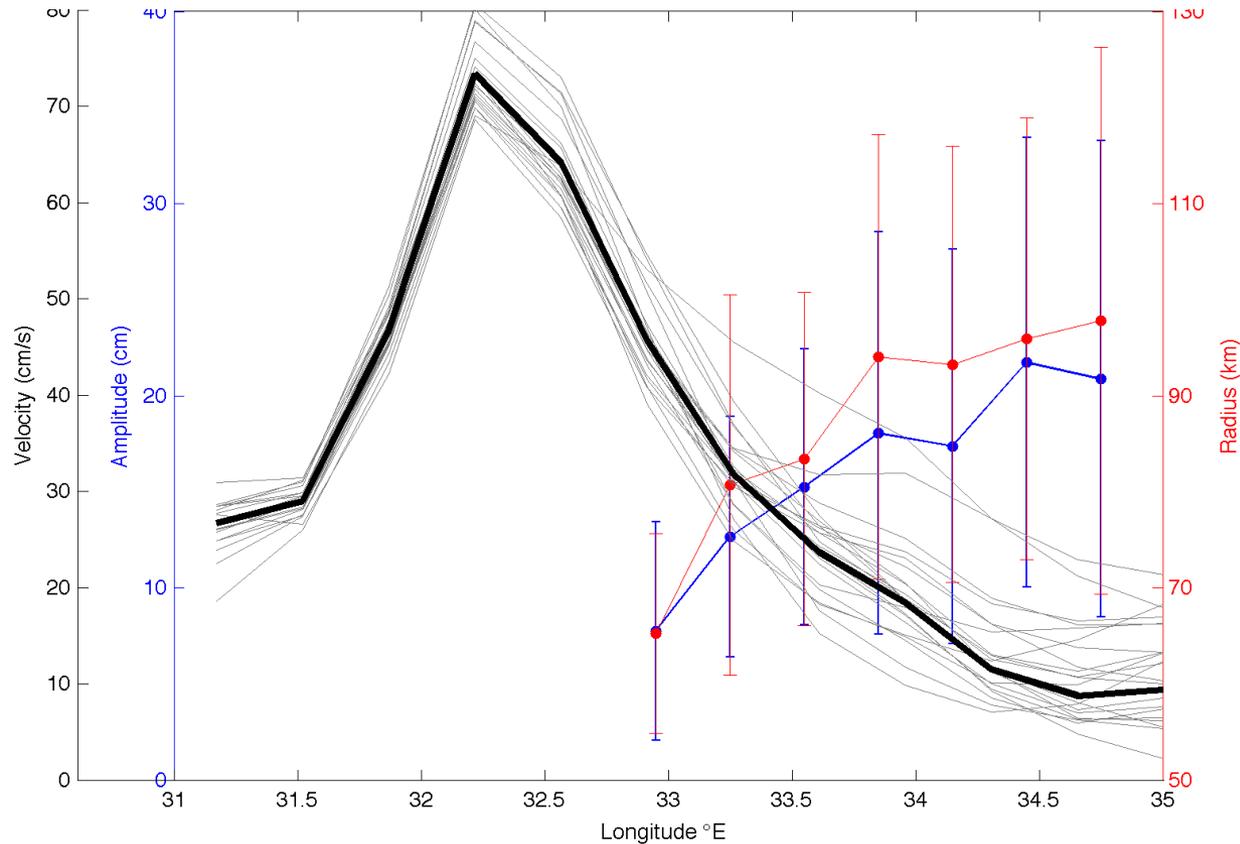


Figure 6: The meridional mean and standard deviation of the radii (red) and amplitudes (blue) of eddies as they approach the Agulhas Current meridional mean indicated by the black line. Annual mean velocities of the Agulhas Current are shown by thin grey lines.

Eddy dissipation mechanisms

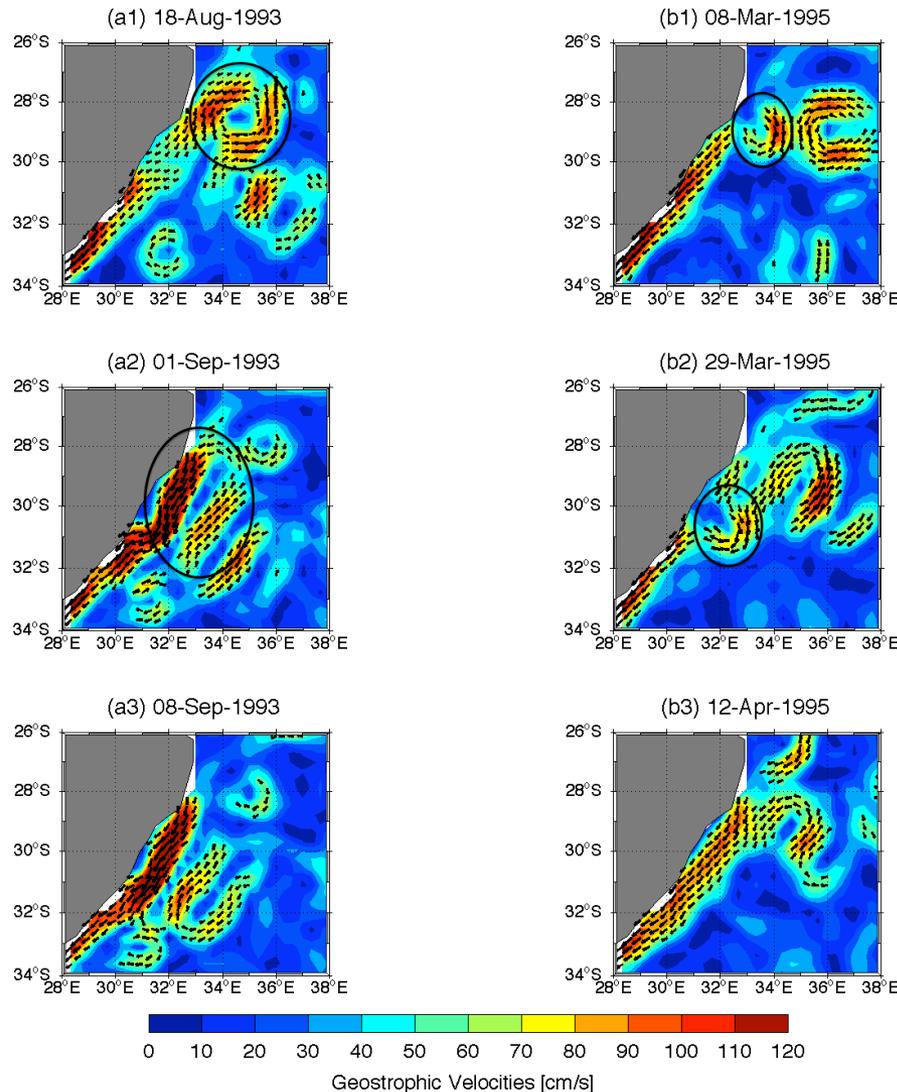


Figure 7: Stages of dissipation of a) an anti-cyclonic eddy and b) a cyclonic eddy shown by geostrophic velocities (cm/s) derived from satellite altimetry SSH means. Arrows indicate regions with velocities over 50 cm/s. Black circles are used to highlight the position of the eddies used in these case studies.

Eddies affect the velocity and position of the Agulhas Current core.

Mean velocity of the Agulhas Current core: $0.91\text{m}\cdot\text{s}^{-1}$

Mean core distance from coast: 68.71km

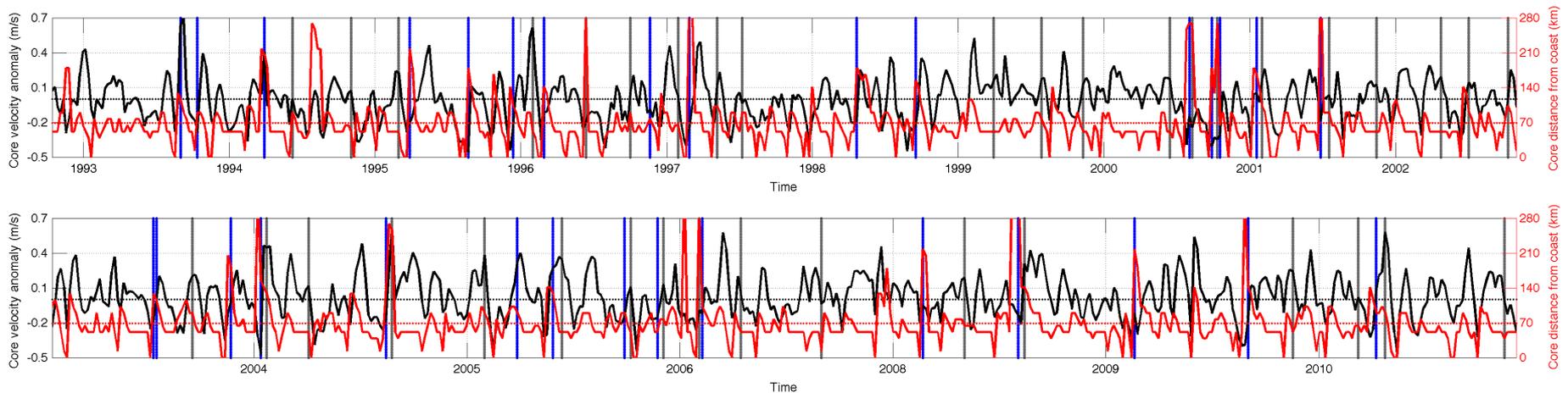


Figure 9: The velocity anomaly of the Agulhas Current core (m/s), with the **distance of the Agulhas Current core from the coast (km)** and **cyclonic** and **anti-cyclonic** eddy interaction with the Agulhas Current core is also shown from a) 1992-2002 and b) 2003 -2012.

Anti-cyclonic eddies can increase Agulhas Current velocity

Mean core velocity increase: $0.14\text{m}\cdot\text{s}^{-1}$

Anti-cyclonic mean core distance from coast: 100.95km

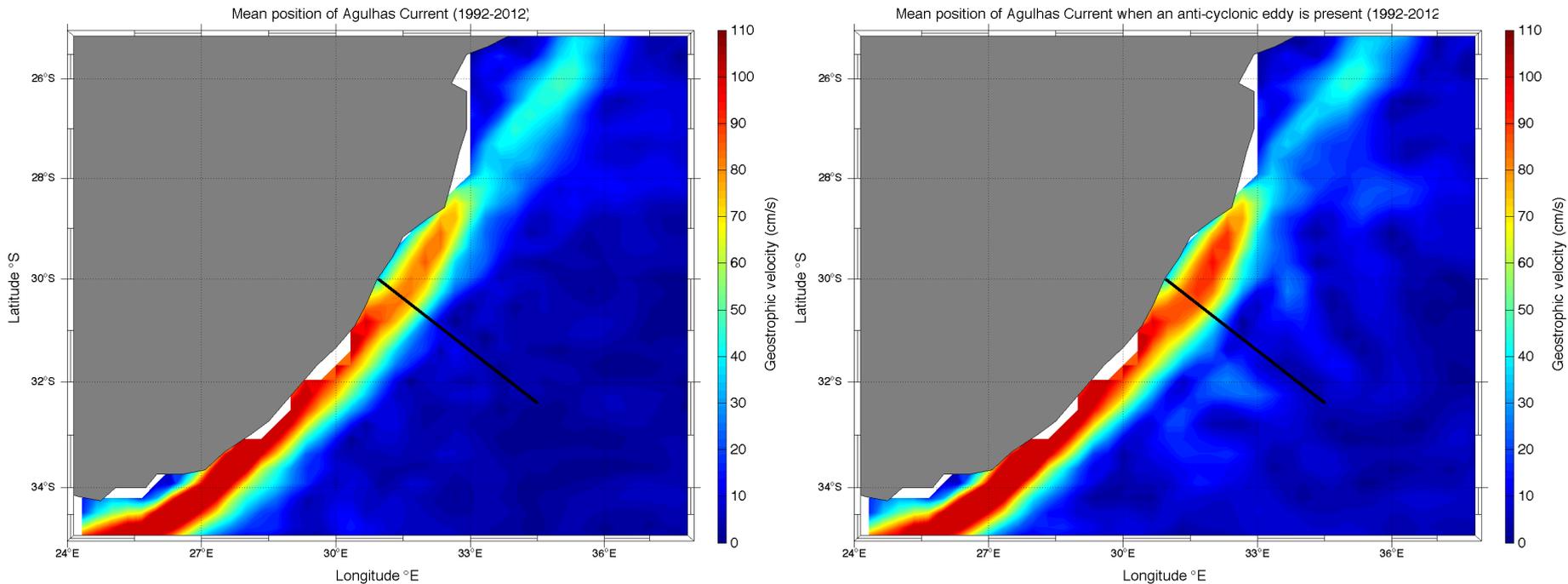


Figure 10: a) the mean position and velocity of the Agulhas Current b) the mean position and velocity of the Agulhas Current when an anti-cyclonic eddy is present. The transect across which the Agulhas Current core properties were studied is shown by a black line.

Cyclonic eddies can cause a meander in the Agulhas Current and a decrease in current velocity

Mean core velocity decrease: -0.10m.s^{-1}
Cyclonic mean core distance from coast: 164.14km

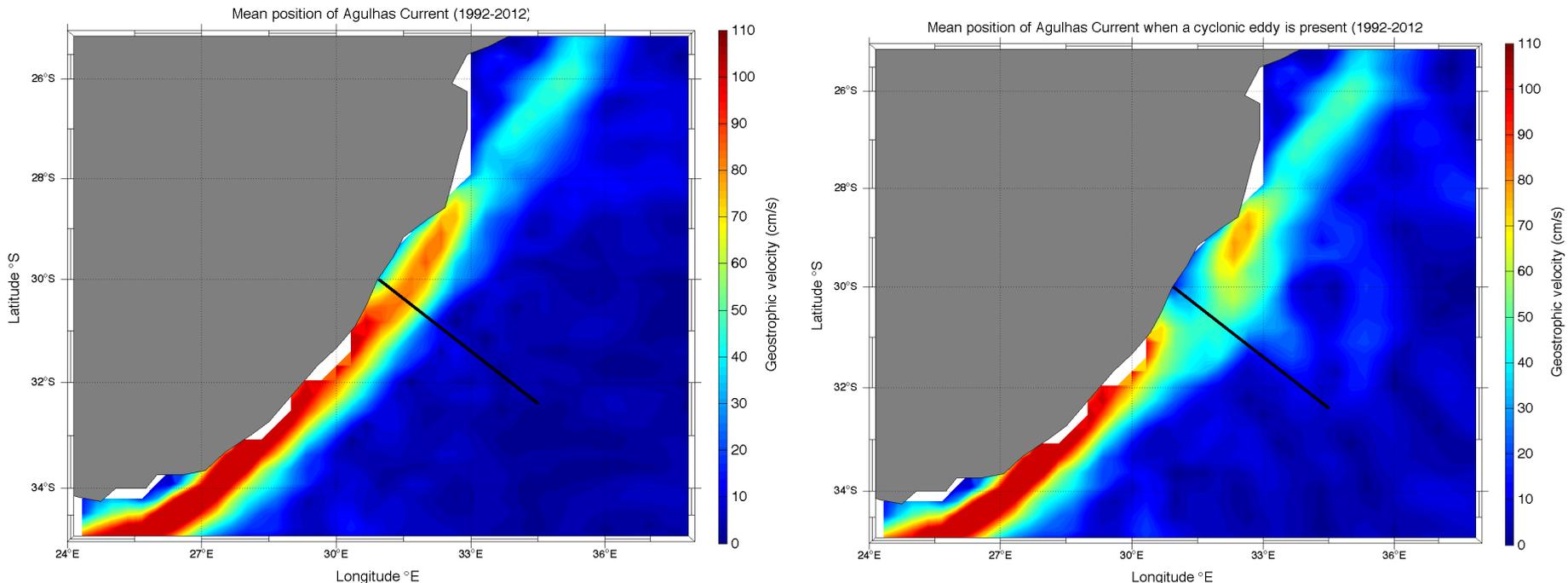


Figure 11: a) the mean position and velocity of the Agulhas Current b) the mean position and velocity of the Agulhas Current when a cyclonic eddy is present. The transect across which the Agulhas Current core properties were studied is shown by the black line.

Conclusion

- Cyclonic and anti-cyclonic eddies interact with the Agulhas Current and can affect the velocity and position of the Agulhas Current core and therefore the amount of energy that could be generated from the Agulhas Current.
- Eddy dissipation processes are not well represented in numerical models, affecting our ability to accurately predict the energy potential of the Agulhas Current.