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Interactive comment on "The surface thermal signature and air–sea coupling over the Agulhas rings propagating in the South Atlantic Ocean interior" *by* J. M. A. C. Souza et al.

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Response to reviewer #1:

First of all, we would like to thank the reviewer for the constructive comments. We fill they helped us improve the manuscript, clarifying some important points. In relation to the figure showing the eddy tracks, since this was already published in a previous paper we added a modified version as supplementary material. The space-time diagram of Figure 2 illustrates the variation of the T' and SLA structure of the eddies. Keeping that in mind and aiming to respond tot he reviewer second general comment, we added as complimentary material a figure with 3 snapshots at different stages of a long-lived

eddy.This figure shows how the observed relations are consistent along the eddy life. In relation to the Argo drifters, the sparse nature of this dataset in both space and time makes it impossible to generate snapshots of the eddy vertical structures. This is why in Souza et al. 2011B we combine all drifters along an eddy life to build its mean structure. Complimentary material to this publication show the structure for each of the 16 observed eddies.

Comments/questions: 1) How is the ring core defined at depth?

For the purposes of the present study, it is not. Since this paper focus on the air-sea interactions, the ring core is defined only in the surface. Nevertheless, in our previous study (Souza et al. 2011B – Geophysical Research Letters) we define the core at depth following the Flierl (1981) criteria, using the geostrophic velocities calculated from the Argo derived density structure and considering a 1500m reference depth. This definition for the ring core comprises the region where the water is effectively trapped inside the eddy.

2) Could you justify your choice of spatial filtering (over temporal filtering or averaging) to identify the anomalies? In the 2011b paper, for example, I seem to understand that the anomalies are computed by simply subtracting the long-term time average.

You are wright about he 2011b paper. But, after working for some time on the Agulhas rings we started to question how robust our mean field really is. Since this region is dominated by the signal of the propagating rings, the mean field is contaminated by the large contribution from the anti-cyclones. With that in mind and since what we are trying to do is in reality a spatial scale separation – isolating the rings from the contribution from the mean flow and large scale processes (such as Rossby waves) – the spatial filter is a better approach. Looking at the obtained correlations between the SST and wind, this ends up to be the case.

3) page 2334, line 17: how is the 'mean' wind calculated?

In this case, the mean wind is the total (no spatial separation) temporal mean over the eddies. This is justified by the fact we wanted to explore the influence of the large scale atmospheric circulation on the coupling. We added an explanation in the text.

4) About Fig. 1: I don't find the two thin lines (max and min T') very illuminating because they don't say much about the spatial structure of T'. Perhaps one could add the evolution of T' averaged over the ring core?

The idea of the two thin lines is to show that, together with Figure 2, the eddy SST is defined as a dipole with cold anomalies in the center and warm anomalies in the edge of the ring cores. Moreover this figure shows that, similar to the SLA, T' exponentially decrease along the eddy lives. If we average T' this information would be lost.

5) page 2337, line 14: the two sentences 'but also the relative..' and 'The spatial pattern for the wind...' seem vague and confusing. Please rephrase/elaborate.

Following the reviewer suggestion, the sentences were rephrased to: In our case, two processes contribute to the air-sea coupling over the rings: (a) the wind accelerates (decelerates), with slight changes in wind direction, over warm (cold) SST anomalies, and (b) the impact of the oceanic eddy velocities on the relative air-water velocity on diametrically opposite sides of the eddies systematically act to modify the wind field. Indeed, the spatial pattern for the wind perturbations in Figure 5 suggests an influence of the oceanic eddy velocities, reducing (augmenting) the wind in the upper (lower) part of the ring.

6) page 2339, line 15: how is the mean wind speed calculated here? and the latitude?

The mean wind is the temporal mean of the total wind over the eddies. The mean latitude is the mean latitude of the eddy centers over their lives.

7) paragraph between the end of page 2339 and the beginning of page 2340: can the authors better explain the observed anticorrelation with latitude in the present study?

We modified the explanation in the following way (added sentences in bold): The influ-

ence of the latitude on the coupling can be explained through its impact on the thermal wind balance over the rings. A "temperature island" effect occurs due to the modifications in the heat flux over the SST anomalies. This heat flux generate pressure gradients in the lower MABL that create secondary cells of circulation. Following the thermal wind equation (), the magnitude of the geostrophic wind perturbation (ug') due to this pressure gradient () is inversely proportional to the Coriolis factor (f). Since f is larger in higher latitudes ug' will be smaller, that is, the pressure gradient mechanism will be less effective. Chelton et al. (2004) also observed the influence of the latitude in the air-sea coupling and affirmed that the SST influence on the mean wind stress is mostly restricted to regions poleward of 40° of latitude and the tropics, though the authors associated this effect to the persistence of the SST fronts in time. In the present study we show that such effects are observed in lower latitudes as well ($\sim$30°S) and transient fronts, what can also be depicted from the results of O'Neill et al. (2010).

8) at various points in the manuscript, I would use 'wind curl' instead of 'wind rotational'.

Modified following the reviewer suggestion.

9) page 2340, lines 24-26: it is mentioned that Chen et al. (2003) don't find the latent heat flux mechanism to be important, but nothing is said about what they do find important for the coupling.

In the particular case of Chen et al. (2003), the effect of the topography was important in maintaining a shelf-break front. This is not relevant in our case though, since we are dealing with baroclinic eddies in the deep ocean. Nevertheless, the fact they observe that latent flux is not an important mechanism in face of other processes is important.

10) Figs 7-8: please add caption for the histogram panels.

The following sentence was added to the captions: The histogram in the lower panel presents the relative distribution of the data between the bins. 11) Some typos or English incorrections: Modified following the reviewer suggestions.

Interactive comment on Ocean Sci. Discuss., 10, 2327, 2013.

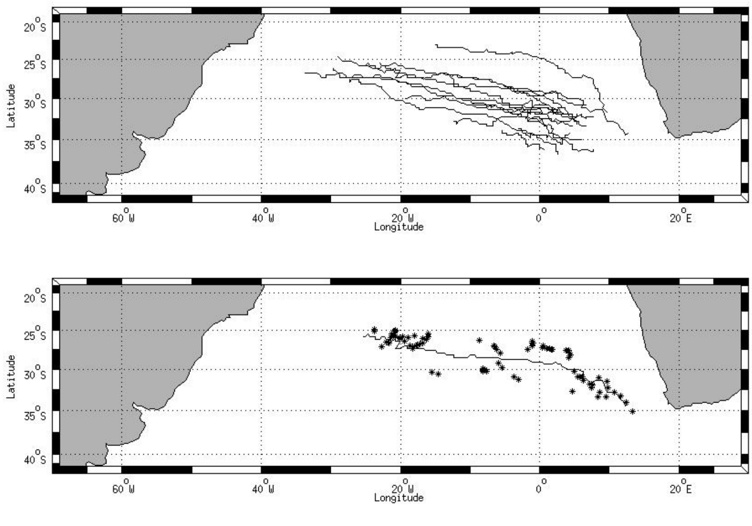

Fig. 1. (upper panel) Tracks of the 16 Agulhas rings used to study the air-sea interactions, and (lower panel) example of the Argo drifters used to build the vertical structure of one of the eddies.

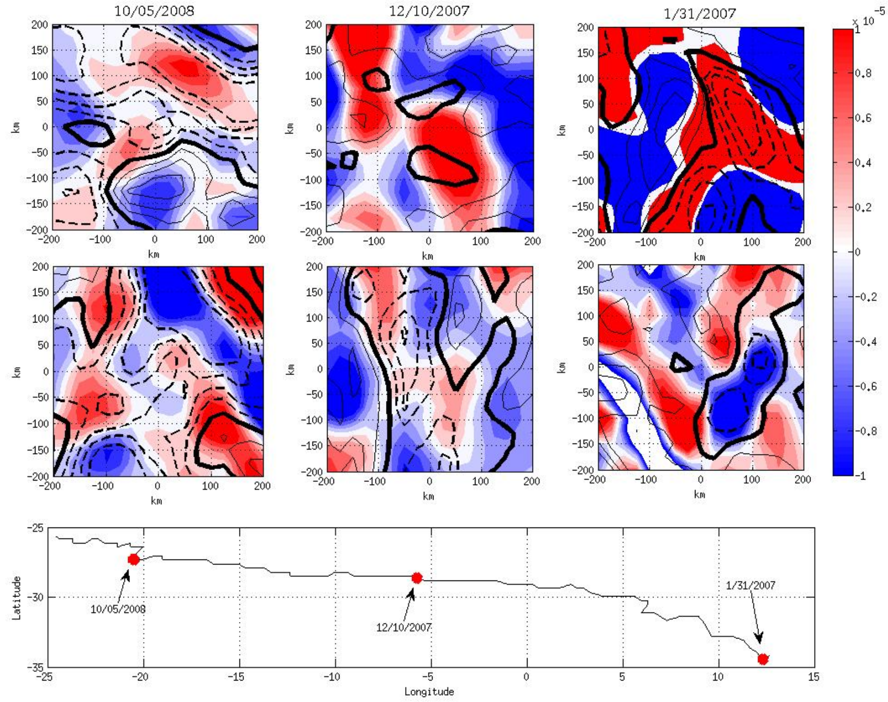

Fig. 2. Snapshots of (upper row) (color contours) and(black contours – c. i. 5x10-6 °C per 100km), and (middle row)(color contours) and(black contours – c. i. 5x10-6 °C per 100km). The thick black lines repr