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# ***Interactive comment on “Southern Ocean overturning across streamlines in an eddying simulation of the Antarctic Circumpolar Current”***

**by A. M. Treguier et al.**

**A. M. Treguier et al.**

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We thank David Marshall for his comments and for pointing out very interesting references.

## **Averaging along time-mean streamlines**

We do not think that the precise choice of streamlines matters for our results; indeed at the beginning of this work we tested contours based on barotropic streamlines and contours based on sea surface height, and they were not very different. The formalism using the Bernoulli potential contours (Polton and Marshall) is very interesting but more complex to explore. A brief discussion is now added to the text. Note that there is no approach that avoids all aliasing of transient eddy fluxes into standing eddy

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fluxes, when heat and salt balances are considered separately in a realistic model of the Southern Ocean. Because of the strong temperature and salinity gradients on isopycnals, there is no way to define contours across which both heat and salt fluxes due to standing eddies vanish at all depths.

We have not tested in detail the sensitivity of the diagnostics to the smoothing. We are confident in their robustness since the calculations have been performed at least three times with slightly different values of the barotropic streamfunction. The small smoothing is used just to be able to define one continuous contour all around the Southern Ocean, and eliminate neighbouring closed contours.

### **Relation of the meridional overturning circulation to buoyancy forcing**

We agree with you that the time-dependence is not likely to be significant for the shallow cells. We think that the relative smallness of the drifts compared to the transports in the heat and salt balances in section 5 of the paper is further proof of that. Regarding the discussion, we only say that the relationship between residual circulation and buoyancy is "not simple and straightforward"; we don't pretend it does not exist.

### **Transient versus standing eddies**

We have considered the Marshall et al (1993) paper but chosen not to refer to it. In the quasi-geostrophic framework it is relatively easy to define streamlines so that "standing eddy" fluxes vanish across them. It is not so in realistic primitive equation models with heat and salt fluxes (see the above remark)

### **Residual circulation in the Southern Ocean**

We agree with the remark, and we now quote Danabasoglu et al. when introducing the eddy/mean cancellation.

### **Typographical errors**

We have no explanation for the missing spaces (we will ask help from the technical

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editor). Daniele Iudicone's name start with an "i" and not an "l". It is in the reference list at the letter "i". Other spelling errors have been corrected.

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