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Ocean Science Discussions

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 the reviewer for his comments. We have slightly modified our discussion of two-dimensional models, as well as the abstract. We have added the remark (end of first paragraph page 658) that Olbers and Visbeck have included diabatic effects in their model. Diabatic effects are also mentioned page 670 in the discussion of the model meridional circulation and its vertical structure. We still believe, however, that it will be difficult to obtain much predictive capability from two dimensional models. Considering the large alongstream variations of mixed layer depths (fig 7) perhaps one could consider the range of depths intermediate between the shallowest and the deepest mixed layer as the "slope layer" in Olbers and Visbeck's two dimensional model. However in that case the thickness of the slope layer as well as the intensity of the diabatic effects

would certainly depend on the alongstream variation of the surface buoyancy fluxes, an effect that is not easy to take into account in a two dimensional framework.

Definition of the eddy driven streamfunction

The definition of the eddy driven streamfunction presented in (1) is just mentioned as part of the introduction. The form used in the present paper is the transport in density coordinates (2), also used by Lee et al (2007). We try to make this more clear at the beginning of section 4, and add a reference to Held and Schneider (1999). The density coordinate formulation is probably the most adequate to test equation (3), since (3) is derived from a density equation. We agree with the reviewer that the issue of how the streamfunction in (3) must be defined is complex (see also John Marshall's questions and our answers).

Definition of potential density

We apologize for the confusion with the issue of conservation. We never meant to say that potential density is not materially conserved following a fluid parcel (this is, indeed, its definition) but rather that it is not possible to write an integral conservation statement for potential density, involving only boundary fluxes and surface forcings. Integral conservation equations are straightforward for salt and potential temperature, but a similar equation for potential density has additional terms. With the nonlinear equation of state undesirable source terms arise in the flux form of the density equation, due to cabelling and thermobaric effects. We hope that our statements are clarified in the revised version of the paper.

Further comments

eq(1): The sentence "This requires ..." has been removed following the reviewer's remark.

Figs 4, 5 and page 665: We have defined the ACC Northern boundary as the northermost barotropic streamline that goes through Drake Passage. Our "ACC belt region"

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does not cover the subtropical front nor the subtropical regimes of Ekman downwelling. The subtropical gyres have different structures in the three ocean basins, and it is not obvious to us how to define circumpolar contours along which a meaningful average can be calculated. The study of the exchanges between the ACC and the subtropical basins is a topic in itself, that cannot be dealt with in detail in the present paper.

Minor points and corrections

The problem of missing blanks will be forwarded to the technical editor.

The order of the figures has been corrected.

Equation 3 has been corrected.

p 667, line 17: the reference has been changed to point to the right figure (8).

p 670, line 5: “transient” has been changed to “eddy-driven” as suggested.

p 674, p 679: corrections made.

Interactive comment on Ocean Sci. Discuss., 4, 653, 2007.