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Ocean Science Discussions

Interactive comment on "The subtropical Deacon cells" *by* J. A. Polton and D. P. Marshall

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In the revised manuscript we completely restructure the theoretical background subsection (2.1) in order to clarify how we are constructing a framework that preserves impermeability and is a function of time-mean variables. We also distinguish it from the classical definitions of potential vorticity flux determined from instantaneous variables (e.g. Haynes and McIntyre, 1987). In light of this possible confusion we take an addition step to redefine all variables that are a function of time-mean (over-bar) quantities with tildes. By taking the suggested more structured path in defining the PV flux integral constraint (following White and Bromley, 1997) it is clearer that dropping w in the Bernoulli potential definition is a result of the model assumptions but that retaining only the vertical component of q in $\tile{Q}$ is an additional assumption. Accordingly the section on diagnosing terms from the data (3.2) is improved to better reflect these observations.

The reviewer highlights a confusion in the flux figures. The contours were meant to

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illustrate the form of the Bernoulli contours, and are plotted for every 2nd colour interval, rather than represent any kind of area over which flux averaging was done. Instead contouring in intervals of Bernoulli potential proves to detract from the data as certain constriction zones (such as the Drake Passage) end up obscured by black contours. The meaning of the contours is clarified in the revised manuscript.

Doos and Webb (1994) first show that the Deacon cell is largely an artifact of zonal averaging in depth coordinates. Most recently Drijfhout (2005) showed that the ACC overturning cell obtained by zonally averaging the velocities can be cancelled by 30% if one includes surface eddy fluxes and by 70% is one averages along isopycnals rather than at constant depths. The reviewer points out that our analysis is quite different from that in Drijfhout, so there is some confusion in making comparisons between our findings and his. We maintain that our potential vorticity findings in the ACC are consistent with the established evidence that there is at least a partial cancellation of the overturning cell by an eddy flux. By construction, the net flux of PV is not allowed to cross mean density surfaces (though component fluxes may). So, where we show the balance being between advective and eddy fluxes we are showing that any apparent diapycnal flux associated with advection most be cancelled by an eddy flux.

Interactive comment on Ocean Sci. Discuss., 3, 867, 2006.