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Interactive comment on "Friction and mixing effects on potential vorticity for bottom current crossing a marine strait: an application to the Sicily Channel (central Mediterranean Sea)" *by* F. Falcini and E. Salusti

Anonymous Referee #2

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Friction and mixing effects on potential vorticity for bottom current crossing a marine strait: an application to the Sicily Channel (central Mediterranean Sea) by F. Falcini and E. Salusti

— Summary —

Falcini and Salusti describe the vorticity and potential vorticity evolution of the near-bottom flow of Eastern Mediterranean Deep Water (EMDW) through the Sicily Channel by integrating the shallow-water equations along the flow, estimating the friction and entrainment parameters needed to make the model match observations.

— Critique —

I have some concerns about whether this paper is suitable for publication. The most fundamental concerns are the following:

(1) It is not clear to me why the EMDW layer should even be treated with a streamtube model when it dynamically seems to be better described as the lower portion of the weakly-stratified Levantine Intermediate Water (LIW) layer. Although the EMDW can be identified by its density and T-S anomaly, as described in the previous paper by Astraldi et al (JPO 2001), the thermal wind shear appears to be quite small compared to the shear at the top of the LIW, so the layer may not really be dynamically distinct.

(2) The theoretical development of potential vorticity conservation in a shallow-water layer is not exactly a new concept, and the model does not, in the end, even yield a prediction that can be tested with the observations. The end result is a set of friction parameters estimated by requiring the model to fit the data (i.e., the friction is used to explain the residual in the budget). As a result, these friction parameters are a combination of all un-resolved aspects of the dynamics and can't really be said to yield any insight about topographic effects in dense-water flows.

(3) I did not find the paper easy to follow–particularly with regards to understanding the assumptions being made in the theoretical model and evaluating the results and their implications.

The most novel aspect of the paper is the calculation of PV as an integral (albeit from an unknown initial value and involving unknown friction and entrainment terms) and the illustration of the insensitivity to initial conditions some distance downstream if friction plays a role.

— Suggestions —

If the paper is to be published, I have the following suggestions for improvement:

The abstract should clearly state the *purpose* of the research, the essential elements

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of the *method*, and the *results* obtained. At present, it is mostly background and doesn't really describe the methods used or the results.

Give a clear explanation of how the LIW and EMDW layer thicknesses and velocities were estimated. The A01 paper may include all of the details, but the essential method and assumptions should be stated here since these are the core "measurements" used. How is EMDW defined if the density interface changes? What level of no motion was used for geostrophic calculations? Were *any* velocity measurements made or only density? Was other information used to constrain transports? Are the velocities in Table 2 and Fig. 5 averages over a few stations or total transport divided by cross-sectional area?

Since the theory for the multi-layer streamtube model (Eq.1+2) is not, in the end, used in the data analysis, it ends up mostly being a distraction. I'd suggest reducing the treatment to a single layer.

Similarly, the parameterization of friction with arbitrary exponents n and m on velocity and thickness (Eq.4) seems unnecessary, since it is never used.

Entrainment is included in the thickness budget (2c) but not in the momentum budget (2a and 2b). Why not? Since friction with the overlying layer (F) is included, the momentum impact of entrainment (entrainment drag) should probably be as well. (Although it just ends up being another term that is lumped into the residual.)

The Sannino et al (2009) numerical model results really could and should be used in the evaluation of the vorticity and PV results (Fig.6). This is a simple comparison, much like the velocity. Friction and momentum budget terms in the model could also be compared with the streamtube results (Figs.7+8), though this will be more difficult.

— Minor Comments/typos —

The greek letters zeta (for vorticity) and xi (for along-stream coordinate) are sometimes used incorrectly. See Fig.5

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Definitions in the Fig.2 caption don't match the figure. For example, if H1 and H2 are the separate mean layer thicknesses and the mean sea-surface is z=0, then the surface height should be h1 (not H1+h1), the interface between layers 1 and 2 should be at z=H1+h2 (not H2+h2), etc.

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