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Comment

# ***Interactive comment on “An improved parameterization of tidal mixing for ocean models” by A. Schmittner and G. D. Egbert***

## **Anonymous Referee #1**

Received and published: 21 October 2013

Review of "An improved parameterization of tidal mixing for ocean models" by Schmittner and Egbert

The manuscript describes two modifications to an existing tidal mixing parameterization used in the ocean modeling community. The modifications concern specification of a vertical distribution of the tidal energy flux based on the actual ocean bottom topography and increasing the local dissipation efficiency for the diurnal tides. Use of tidal energy flux estimates based on satellite altimetry is also advocated instead of the flux estimates based on a tidal model. The impacts of these changes on ocean model solutions are investigated via a systematic set of sensitivity experiments. These simulations generally show some modest improvements of model solutions in the coarse-resolution University of Victoria Earth System Model, but there is also room for further improve-

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ments. Indeed, in some regions and depth ranges, the modified parameterization does not perform as well as the original parameterization in considered fields. I believe this is a very useful study for the ocean modeling community. I only have minor comments listed below. Among these, I would like to particularly see some more implementation details regarding the regularization of the parameterization; a more detailed discussion of diffusivity differences at depth between the ER03 2D and SJ01 2D simulations; and elimination of references to Lumpkin and Speer (2007) results as "observations". I trust that the authors will address them. I recommend that the manuscript is published after minor revisions.

Comments and suggestions:

- p.4477, l.9: Indicate why 178m-depth is chosen for demarcation.
- p.4477, l.11: .... has little effect ....
- p.4478, l.7-9: Explain why larger scale fluxes are well constrained.
- p.4478, l.21: Indicate which is longitude and latitude.
- p.4480, l.5 and l.7: Use the degree symbol for the first fractions as well.
- p.4480, l.18-19: JS01 value from Table 1 is 1.99 and it is 16% more.
- p.4480, l.21: 1.23 TW should be 1.50 TW.
- p.4481, l.1: Indicate that the energy available depends on model grid or resolution used.
- p.4481, Eq.4: It will be useful to include the explicit form for  $F(z, z')$  here.
- p.4482, l.3: (e.g., ....) ?
- p.4482, l.24 and l.26: Use the degree symbol for the first numbers as well.
- p.4482, l.24: Add reference for etopo20.

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- p.4482, l.27: I do not follow "where only one vertical level has a value different from zero."
- p.4483, l.7: Both here and elsewhere throughout the manuscript, replace "models" with "simulations" or "experiments" because the same model is being used in the manuscript.
- p.4483, section 2.4: Explain how the second term on the right-hand-side of Eq.(1) is regularized as  $N^2$  approaches zero. In other words, is there a maximum cap on the resulting  $k_v$ ? Is the available energy fully used?
- p.4484, l.2: Reword the title for section 3.1.
- p.4484, l.6: 75% should be 82% and 4% should be less than 1%.
- p.4484, 7-8: Both here and elsewhere (e.g., Table 3), replace sum-of-squared-errors with root-mean-square (rms) error as it is more conventional. rms has the same units as the variable being considered.
- p.4484, section 3.2: Figure 4 is not discussed at all. It is a very useful figure and I suggest that it is kept.
- p.4484, last paragraph: I do not understand this paragraph. More dissipation at shallower depths explains the differences between the 2D and 3D cases, not the differences between ER03 and SJ01 cases. Indeed, as also stated here, ER03 and SJ01 cases have similar diffusivities at shallower depths. With relatively similar 2D energy (2.77 TW in JS01 and 2.92 TW in ER03), why are the resulting diffusivities differ so much at depth between 2DE and 2DJ cases as shown in Figs. 4 and 5?
- p.4485, l.8 and l.20: Replace "faster" with "stronger" or "larger".
- p.4486, section 3.3.1: Lumpkin and Speer (2007, LS07) do not represent observations. They use an inverse model with many caveats. Please do not refer to LS07 as observations or observational indices. This needs to be addressed throughout the

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manuscript. I suggest using the RAPID data set for the Atlantic Ocean at 26.5°N. "mid global" values can be either kept or deleted.

- p.4486, l.8: Given the general results of this paper, I do not think that use of "inferior" is justified.
- p.4486, l.13 and l.16: Lumpkin
- p.4487, l.11: .... the largest ....
- p.4487, l.24: Diffusive vertical .... Also, define T.
- p.4488, l.1: Insert a reference to Fig. 8 right after "600 m".
- p.4488, l.4: Define t.
- p.4488, second paragraph: References are needed here for the observations.
- p.4488, l.19-20: Rephrase saying that models are consistent with observations.
- p.4488, section 3.3.3: Given the observational spread in the upper 500 m and the lack of observations below this depth, it is not clear to me if judgmental statements can be made. For example, all cases appear to be within the observational range below about 100 m depth.
- p.4489, l.10: Fig.11 should be Fig.12.
- p.4489, l.22-23: Replace "slow" with "low".
- p.4489, l.24-25 and p.4490, l.1-3: I believe "larger" should be "smaller". ... or, this sentence needs some rewording to avoid confusion.
- p.4490, last paragraph: I recommend deleting the geothermal heating experiment because a different model version is used and it is not a clean comparison. In addition, other parameterization choices can of course impact the results.
- p.4494, l.18: Not sure if this reference is cited in the text.

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- p.4495, Table 1 label: Replace  $1/3^\circ$  with  $1/6^\circ$ .
- Fig.1: The red labels over Asia are difficult to read.
- Fig.3 caption: As indicated above, I do not follow "On this grid there is only one level of non-zero data. Ditto for "which leads to some latitudes having more than one non-zero values in the figure."
- Fig.4 caption: Fig.2 should be Fig.3.
- Fig.5 and Fig.11: Use a different (more distinguishable) color for 3DE  $q_d=0.3$  case.
- Fig.5 caption: Jayne should be replaced with JS01.
- Fig.6 caption: Replace "2000" with "4000", "World Ocean" with "global", and the last "left" with "right".
- Fig.7 caption: Include a reference for WOA05.
- Fig.8 caption: as Fig.7 .... Also, what is  $K/a$ ?
- Fig.9 caption: Indicate these are horizontally-averaged and both 10-day and equilibrium distributions are shown. Also, I do not follow the choice of  $2.7^\circ$ .
- Fig.11 caption: Indicate that both 10-day and equilibrium distributions are shown.
- Fig.12 caption: The latter observations need references.

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