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Ocean Science Discussions

Interactive comment on "Geothermal heating, diapycnal mixing and the abyssal circulation" *by* J. Emile-Geay and G. Madec

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Thank you for your thoughtful comments on our manuscript. Following your suggestions, it has been extensively reworked by cutting the section on the Sverdrup balance and the scaling analysis, which was indeed an awkward redundancy of the density binning estimate.

The main concern you state seems to be one of semantics. Since geothermal heating appears as an external forcing of the heat equation and is able to generate sizable circulations even in the limit of very small mixing, it seems appropriate to label it as a "driving force". We do, however, make clear that it is not a quantitatively important as diapycnal mixing for the present-day ocean circulation.

Answer to General Comments : This section was removed.

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Answer to Specific Comments : 1. This is a good point that we had overlooked. A footnote was added in the revised manuscript.

2. irrelevant as pertains to deleted section 3. irrelevant as pertains to deleted section 4. irrelevant as pertains to deleted section 5. missing prime fixed 6. line now reads : Fig 5b displays the area of the seafloor that is covered by each isopycnal layer (i.e. water masses whose density falls between σ and $\sigma + \Delta\sigma$, with $\Delta\sigma$ the binning interval as before) 7. Very good point. The line was removed as the section using the simple scaling law was dropped. 8. Corrected 9. Again a very good point. Indeed, vertical potential temperature gradients are very small in that experiment, and the road to numerical equilibrium ($|\partial_t T| < 0.01$ deg/century) is rather rugged : since the vertical mixing rate in those experiments is inversely proportional to $\partial_z T$ (see model description in Madec et al 98), some abrupt mixing events occur when the gradients fall below a small numerical threshold. We left out this phenomenology as this article focuses on equilibrium responses.

10. the word “heating” was added

11. “In fact, given the same increase in heat flux at the bottom of the ocean (the geothermal heating), the transport of heat out of the bottom ocean should be identical”. This is only true for strictly identical thermal structures, which is not the case here. You are correct that the shortness of subpolar latitude circles can magnify small differences, which at any rate are especially pronounced in the southern ocean between the two sets of experiments.

Interactive comment on Ocean Sci. Discuss., 5, 281, 2008.