Ocean Sci. Discuss., 6, C544–C545, 2009
www.ocean-sci-discuss.net/6/C544/2009/

Ocean Science Discussions

Interactive comment on "A review of the role of submarine canyons in deep-ocean exchange with the shelf" *by* S. E. Allen and X. Durrieu de Madron

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Received and published: 25 September 2009

We would like to thank Don Boyer for his thoughtful review. He has raised some important points.

First the role of turbulence and friction. As shown by the scaling arguments in Boyer et al (2004), frictional processes are one side of the dynamic balance determining the mean flow generated by oscillatory flow over a canyon. Similarly, Wåhlin (2002) showed that frictional processes and Ekman flux are one side of the dynamic balance determining flux of cascading flows down a canyon. On the other hand, for upwelling/downwelling driven by shelf-break currents, the basic dynamic balance does not include frictional processes. This difference between the flows under consideration in the review needs to be made much clearer in the manuscript and our revised

manuscript will do so.

In the laboratory, our ability to model canyon flows quantitatively is linked to the importance of frictional processes. As Don Boyer stated in his review, we cannot match Reynolds' numbers in the laboratory to real world values and so the amount of turbulent mixing is not likely to match the real world. In the case of upwelling/downwelling flows driven by shelf-break currents where frictional processes are secondary we can aspire to quantitative laboratory models. In the other cases it will be much more difficult.

Lastly, our optimism regarding quantitative models for canyon flows. It is true that numerical models have had difficulty in reproducing the observed flows. Boyer et al (2004) had to use enhanced horizontal viscosity in order to keep the model stable. However, models are improving. Canyons are indeed one of the toughest test-beds for numerical models but we remain optimistic that with continued efforts at least process study numerical models will be able to reproduce the observed flows.

In addition to clarifying the role of friction/turbulence and arrested boundary layers, in our revised manuscript we will provide the warning Don Boyer suggests. Specifically, we will include more comments on the complexities of the flows around canyons and the difficulties in modeling canyon flows physically and numerically.

References

Boyer, D. L., Haidvogel, D. B., and Pérenne, N.: Laboratory-Numerical Model Comparisons of Canyon Flows: A parameter study, J. Phys. Oceanogr., 34, 1588–1609, 2004.

Wåhlin, A. K.: Topographic steering of dense currents with application to submarine canyons, Deep-Sea Res., 49, 305–320, 2002.

Interactive comment on Ocean Sci. Discuss., 6, 1369, 2009.