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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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A brief commentary by Don L. Boyer

The authors have indeed taken on a complex subject, the dynamics of flow in the vicinity of submarine canyons. While numerous issues can be raised relative to their communication, the fact that they have put to print a survey of the field work, numerical simulations and laboratory investigations on the subject, alone, merits publication.

This referee is perhaps not as positive as the authors in believing that we will be able to grapple with the details of flow in a real canyon. The one real weakness of the review is that it does not hint at the complexity of the subject or to discuss in some detail the barriers to modeling the systems being considered. For example, it is not at all clear that laboratory experiments will ever be able to simulate in any more than a qualitative way, the dynamics of a current impinging on a canyon.

One feature of the prototype that, to date, simply cannot be simulated is the nature of the turbulence of the ocean flow. In fact for most laboratory experiments performed on one to two meter diameter turntables, the flow is laminar and it is problematic at best to relate laminar flows to statistically mean turbulent ones. Even experiments performed on the 13 m diameter turntable of the Coriolis laboratory in Grenoble, France, cannot be conducted at sufficiently high Reynolds numbers to simulate the ocean. This matter of turbulence is simply an issue that cannot be circumvented. There are possible approaches to resolving the matter, but these are not considered in the manuscript. This is considered as perhaps the most serious hurdle in simulating the ocean.

Another bothersome, but perhaps not insurmountable issue, is that the numerical experiments for laminar flows in Boyer, Haidvogel and Perenne (2004) were unable to predict quantitatively the laminar laboratory experiments reported therein. The principal reason was the lack of computational capacity to both resolve the Ekman boundary layers and the interior flow. How then can one project that numerical simulations will be able to capture the complexities of turbulent Ekman boundary layers which are intimately tied to the interior flows in the canyon geometry being considered.

Such a “complexity statement” should also clearly inform the reader of the difficulty of simulating (i) the complex geometry of the prototype (in the laboratory, for example, one is almost always faced with distorting the vertical to horizontal length scales, not to mention the typically almost impossibly complex nature of the vertical relief, (ii) the vertical density structure (the authors should clearly state the characteristic density structure they refer to in most of their discussions for they , for example clearly do not consider homogeneous flows for which the flow would be felt above the shelf break), (iii) the nature of the current impinging on the canyon (for the most part the authors are assuming a uniform current and this should be so-stated because currents with horizontal and vertical shear could behave quite differently than that discussed in the manuscript), and (iv) bottom roughness (here the issue is the nature of the bottom on scales of say 10 m or less recognizing that larger scale irregularities are covered in (i)). So as not to be to sound too pessimistic, it should be noted that the effect of the Earth's rotation can be nicely modeled on a turntable because canyon scales are sufficiently small as to neglect beta effects.

In this referees judgment giving the reader "a cigarette warning along the lines of the above would significantly strengthen the paper because the reader would recognize some of the roadblocks or, at the very least, limitations of the scientific inquiries being addressed.

Reference:

Boyer, D.L., D. Haidvogel, N. Perenne, 2004: Laboratory-Numerical model comparisons of canyon flows: A parameter study, Journal of Physical Oceanography, 34, No. 7, 1588-1609.

Sincerely,

Don L. Boyer

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