**Ocean Science
Discussions**

Interactive comment on "First images and orientation of internal waves from a 3-D seismic oceanography data set" by T. M. Blacic and W. S. Holbrook

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The authors show us the first 3D seismic images from the ocean water column, focus on two strong reflectors that can be imaged and tracked in 3D, and infer that one of them is associated with an internal wave with wavelength ∼500m and wave number orientation in the WNW direction (or 180 degrees away). The paper does a great job of showing us the potential value of 3D seismic ocean imaging, but it does little to convince me that the tracked reflectors are actually an internal wave with the stated directionality. I think this interpretation would be stronger if some corroborating evidence could be found and cited, if the fit procedure were improved, and the question of how

the wave produces the observed reflector was addressed (at least partially). I know the question of reflector production is a difficult one, but this is a good data set in which to try and address it.

The directionality is determined by plotting the direction of elevation contours over a small portion of a wavelength - a somewhat ad-hoc procedure using too limited a range of data. I think that the directionality analysis should be put on a firmer footing, which would also yield estimates of wave amplitude and wave length (points 1 and 2 below). I also think the authors should discuss how an internal wave can produce a reflector, whether or not the reflector is parallel to isopycnals, how the wave amplitude should be related to the temperature strain and therefore reflector amplitude, and whether the observations are consistent with these estimates (points 3 and 4 below).

Specific points:

0. Maybe a search of the physical oceanographic literature from the Gulf might turn up some papers, perhaps from satellite images showing slicks, or current meter arrays, showing tidally-generated internal waves propagating shoreward in the generally NW direction, and comparing with such results would strengthen the story.

1. In figure 4, you plot contour lines of elevation for a short segment of reflector 2 and estimate wave directionality with a rose plot of contour orientation. I'm concerned that you're doing this over a segment that only about a wavelength long, and that similar analysis of other segments will give a very different result. How robust is your directionality estimate? How much does the direction vary as you look at different parts of the data?

2. Related question - fitting to the direction of contour lines seems to be a highly non-linear procedure that could depend on the contouring algorithm and on the weighting scheme you use. Plus it looks to me as though your results will depend strongly on which bits of the data are used for the fit. A more defensible procedure would be to fit the observed tracked reflector height field h(x,y) to a model of the form:

h(x,y) = A sin(K*x+L*y) + noise

I would suggest a fit to the whole tracked reflector unless you can state a reason to fit a smaller area.

I think a model of this sort should give results independent of the kind of smoothing you do, and independent of migration, since the feature is larger than the smoothing and the unmigrated resolution. Your discussion on page 2347 top would then be moot.

3. What is creating the reflectors? In this case it's important to know whether the tracked reflectors are following isopycnals (possibly temperature fine structure produced by previous mixing), or are produced by internal wave strain (which should NOT produce reflectors that track isopycnals), or are the result of other processes (intrusions, etc.). Can you tell the reader what the cause of the tracked reflectors is, or at least discuss this important point? I don't expect these questions to be completely settled, but I'd love to see them considered.

From the XBT data and some thoughtful T/S analysis, you may be able to superpose XBT-inferred isopycnals on your figure 3a inset. You could also plot temperature gradient (or calculated reflection amplitude) from each XBT trace and superpose on the inset. These two things might allow a distinction to be made (and you can probably argue against thermohaline origins). There appear to be a few XBTs on the swath of reflector 2, but I can't easily tell from figure 1.

4. Amplitudes - From the size of temperature steps at the XBT traces (and perhaps the TS relation from Levitus), you can calculate a good estimate of reflection amplitude. Are the amplitudes of the tracked reflectors at least roughly consistent with these estimates? Given the internal wave amplitude, wavelength, and a model of nonlinear internal waves, you could predict the strain pattern and the reflector amplitude for comparison with observed. Does it match?

Editorial suggestions:

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Figure 1 - the bathymetric info would be more readable if it were done as a filled contour plot. Since you have used color anyway, maybe you should consider using a colored rather than black/white colorbar.

Fig 2 refers to shotpoint values but these are not indicated in figure 3. Maybe labelling the positions of the XBTs in figure 3 with small colored triangles on top would clarify.

Fig 3 - the inset to figure 3a contains the important information, and is too small to read. I suggest making a larger version, as a separate figure 3b. -The present figure 3b could probably be improved with a little re-scaling and playing around looking for the optimal view orientation.

Figure 4 is slightly confusing wrt orientation. Unless using cross-swath direction as the zero direction is an accepted standard in 3D seismics, I would find it more natural to do everything with respect to along-swath direction, giving 0 degrees at the top of figure 4b.

Figure 5 - This figure leaves me wondering just what oceanographic information can be extracted from it. It seems to show a lot of detail, and of course makes the point that the data have 3D information, yet I can see no features that an oceanographer would interpret, and none are interpreted. Should further analysis be done, or should the authors consider pulling the figure?

Interactive comment on Ocean Sci. Discuss., 6, 2341, 2009.