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Interactive comment on "Deep drivers of mesoscale circulation in the central Rockall Trough" *by* T. J. Sherwin et al.

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Interactive comment on "Deep drivers of mesoscale circulation in the central Rockall Trough"

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Anonymous Referee #1

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This paper presents results from a study of mesoscale circulation in the Rockall Trough, eastern North Atlantic, based on data from a five-month glider mission, one research cruise on board the RRS Discovery, and satellite altimetry. The manuscript contains

a thorough comparison of depth-averaged current from the glider and the geostrophic surface current derived from satellite altimetry, and presents some interesting findings about the mesoscale variability in this region.

We thank the referee for their positive comments, and have done our best to improve the manuscript along their suggested lines. However, we need to point out that the referee has asked us to make a lot of additional investigations, which whilst being of obvious value and interest would extend the length of the manuscript considerably turning it into a paper more suitable for Progress in Oceanography than OS. GENERAL COMMENTS/QUESTIONS

1. There is a lack of references to recent literature on the use of gliders, in particular other studies comparing glider and altimetry data. Some papers of interest are for example Alvarez et al., 2012; (Davis et al., 2012), Bouffard et al., 2010; Hátún et al., 2007; Ruiz et al., 2009.

Partially agreed There is now a new section (3.5) which provides a brief discussion of the limitations of combining altimeter and glider data. This section seemed to be the most natural place to refer to other closely related studies of mesoscale currents elsewhere.

2. The motivation of this paper should be spelled out more clearly. The subpolar gyre is mentioned in the introduction, but it is not clear if the mesoscale variability in the Rockall Trough links back in a significant way to the larger scale circulation. If this study is mainly important on the local/regional scale then the glider observations could be put into context for example by saying something more about the long-term time series from the Ellett line (mentioned briefly in section 3.1) .

Agreed The Introduction has been expanded to give a fuller justification for the work, by emphasising the need for a more comprehensive understanding of the internal processes and boundary exchanges of the SPG, of which the Rockall Trough is part, in the context of the thermohaline circulation. The Ellett Line occupations are introduced

here to provide a justification for the glider deployment.

3. The choice to use only gridded altimetry data: could anything have been gained from using along-track data? Other studies have used both gridded and along- track data. Were there any tracks that could have been used in this study (suitable in time and space)?

Yes. This was done when the altimeter data were first looked at but after looking at the data such a study was ruled out as being unlikely to bear fruit. We believe that we have demonstrated that using gridded altimeter data was the right way to go. To some extent new §3.5 alludes to this point by effectively saying we're going to study gridded altimetry. There is much more work that could be done but one has to draw the line somewhere.

4. Have you considered using the glider C, T, P measurements to calculate an estimate of dynamic height (relative to say 1000 m), for comparison with the dynamic height from altimetry? There is no level of no motion in this range and as you mention in the discussion, the mesoscale features can extend below 1000 m, so getting geostrophic currents from the hydrographic (glider) data might not work but perhaps the hydrographic data could be used to help you analyse the cause of differences between glider drift currents and satellite-derived surface geostrophic currents?

Yes In fact we did a pretty thorough investigation but the results were inconclusive. There were quite a few problems in interpretation, one of which, that the glider was carried away from the peaks and troughs, is now mentioned briefly in §3.5. The main reason for the difficulty is that the dynamic height calculations were restricted to regions of relatively small SSH changes but strong in situ currents. Rather than take the discussion further into an inconclusive cul-de-sac the along glider track SSHs are shown for eyeball comparison with the CTD sections and the in situ current vectors in Fig 6.

SPECIFIC COMMENTS/QUESTIONS

Abstract I suggest briefly mentioning already in the abstract where the Rockall Trough is located, broadly speaking (north-eastern North Atlantic).

Done But said 'west of British Isles'

Section 2 Background As mentioned above, this section could be more specific on why the Rockall Trough is of interest. For example, you could refer to Hátún et al., 2005 (now cited only in sec. 4.3 regarding EKE) or other literature for the idea that the salinity of the Atlantic inflow to the Nordic Seas is in part determined by the location of the NAC relative to topography in/near the Rockall Trough, this being a main passageway for these inflows.

Agreed. This is now incorporated into the Introduction and Background

Section 3 Methods What bathymetry data were used (e.g. for figures 2 and 4)?

This now spelt out

Section 3.4 Data analysis Spatial mean EKE, does this mean you use spatial variances of u and v (variance relative to the spatial mean over 9âŮę-13âŮęW and 56âŮę-58âŮęN respectively)?

Done Variance at each grid point.

Section 6.1 Correlations between in situ and altimetry-derived current components: the closer correlation between eastward than northward components is somewhat surprising especially since the northward component is stronger (generally calculation of current velocity from satellite altimetry works better in regions of strong currents). You later explain that the dominant cause of the bad correlation for the northward component is an error in the slope current. It might still be worth looking at how the correlations (zonal and meridional) compare with other studies. There is a large body of literature comparing in situ and altimetry- derived currents - are there any general findings of zonal agreement being better than meridional (or the other way around)? And can you speculate in a reason for why this large error in the slope current occurs? What is the

typical Rossby radius of deformation here, and how does it compare to the resolution of observations? Can we expect a significant level of noise from small-scale phenomena here?

The referee is asking too much here. Nevertheless, we have beefed up §3.4 with a more informed discussion of the relationship between the Geoid and the MDT produced by Rio et al. Rio et al. computed their MDT as a global product and tuned it to match in situ velocity observations and hydrography so there's not much point in taking it any further. They only claim to have a better MDT than just using the raw GRACE data. They did not specifically address slope currents which are generally too narrow and too small a transport to show up in a region of rapidly changing bathymetry. We have specifically made clear that we are only writing about the Rockall Trough, although we recognise that there may be a more general problem here. We are users rather than experts in satellite altimetry and so we see it as our role to simply point out the problem rather than indulge in a detailed investigation. We believe that the case for a mismatch between the meridional currents is well made and we choose not to open the discussion any further in this manuscript.

Section 7. Discussion

- P2626, L1-5: Interesting results. I wonder what this finding means for the historical and continuing regular observations along the Ellett line – is this monitoring less meaningful in terms of inter-annual variability and long-term trends, if local circulation patterns play such an important role?

We appreciate the referee's point, but this is an idea that has the potential of being a big investigation. We feel that it is the role of this manuscript t point out the explanation for the high temperatures on the Ellett line in winter 2009/10 observed by Sherwin (2010) but to leave it to others to investigate the implications.

- P2625, L5-10: If I follow this correctly, you argue here that the observed eddies are too deep to be wind-forced, so their origin is more likely to be instabilities in the NAC

front or the slope current. From this you go on to make your conclusion 1 (in section 8) that the eddies originate from the NAC. (Why not the slope current?) Can you strengthen the argumentation about the origin of the observed eddies? Any possibility of for example comparing water masses in/outside of eddies from glider data??

Thank you for this point. We have reviewed what we said about the origin of the eddies and whilst we still discount local generation allow for eddy incursion from the north. We have also had a look at profiles inside the eddies, but unfortunately the glider only penetrated one anti-cyclonic eddy and the question of the origin of the cyclonic ones in uncertain.

Figure 1 Consider labelling the Malin Shelf, which is mentioned in text.

Done

Figure 4 Add a colour scale bar (or similar; alternatively label more contour lines). The x axis needs a label (deg. W).

Done

Figure 5 What does it mean that some glider tracks go further south than the dashed lines showing the zonal averaging bins – are data south of 56âÚę 30' N excluded from averaging?

The lines have been lengthened to remove ambiguity and the border has been brought in to improve clarity.

Figure 6 (1) The caption refers to "a" and "b" but I see no such labels in the figure(s). (2) You could adjust the subplot axes positions in this figure to reduce the amount of white space between subplots. Right now the text (axis labels and "0.2 m/s" next to the scaling arrows) in especially the right hand column is tiny; this could be improved with more efficient use of page space. (3) The caption talks of a dotted red line, but I see red dots plus a whole red line - what do they mean? (4) The colour scale is not very clear, most of the sections are a more or less uniform cyan to me. Maybe this

is exactly the point, to show how homogeneous the water column becomes. Then I would recommend using a white-to-[some colour] colour scale so that the low densities present in the first three plots are in colour, and later plots are mostly white / light colour as the density contrasts disappear (obviously in this case, the ADT line should not be yellow but dark). I think this might be clearer to see and interpret (and if nothing else, saves ink when printing) (5) Perhaps add a colour scale bar?

Thank you for all these suggestions. Figures 6 have been redrawn and improved to encompass them.

Figures 7 and 9 It says figure 9 has the same colour scale as Fig. 7, but there is no colour scale bar for either? The numbers in figure 9 are tiny.

Good point. Both figures have been redrawn, with colour scales and slightly different titles.

MINOR POINTS âĂć All in-text references seem to be in brackets – check use of “citet” vs “citep” if using LaTeX.

Agree Upgraded from Endnote 4 to Endnote 6 and sorted out the brackets

âĂć Velocity units: mixture of m s^{-1} and cm s^{-1} in text (and also in figures)

Changes have been made so that all velocities below 1 m s-1 are quoted as cm s-1

âĂć Units in figure axes labels: I had to look this up, but as far as I could see (at physics.nist.gov), when you follow the convention of using “/” between a quantity and its unit, it is still customary to use round brackets around the unit, e.g. “”Depth /(m)” or “Speed /(cm s^{-1})”

Disagree A debate about the correct way to label figures can be a good subject for a coffee morning discussion. We agree that we should be consistent, but take the line that labels need only be non-dimensional. Thus we agree with the ‘/’ but not the ‘( )’.

âĂć In section 6.2 it says data are averaged into 10’ of longitude bins. That is not

exactly the same as the 0.1° or ca 6 km mentioned in section 3.4 (10’ longitude here should be more like 10 km?) so what is actually shown in Fig 5?

Whoops! Thank you Typos corrected

âĂć Section 4.2 (a) “along flank of the Rockall Trough” - should it be “along the western flank”? (b) Malin Shelf – see comment at Figure 1 (probably not everyone knows where it is). (c) “Its source” instead of “it source”.

Changes made

Interactive comment on Ocean Sci. Discuss., 11, 2607, 2014.

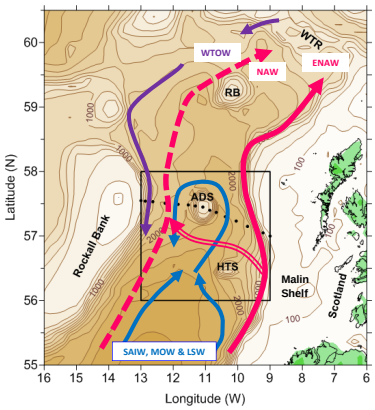

Figure 1

Fig. 1.