

Comments on Redondo et al., Eddy measurements, coastal turbulence and statistics in the Gulf of Lions, *Ocean Science Discussion* **10**, 55-81, 2013.

Wolf-Gerrit Früh, 24 February 2013

## Overall impression

This discussion paper matches the scope of the Ocean Science publications very well. It describes methods on how to use satellite measurements to identify, classify and investigate ocean eddies. A systematic application of these techniques to the area studied and more generally can be a powerful tool to extract dynamically important features (and their spatio-temporal evolution) using remote sensing.

The analysis methods applied to the data appear to be valid and appropriate, with sufficient explanation and references to the literature.

The results presented are valid, and mostly clearly justified by the presentation of the results, although I have the feeling that the results have not been exploited as much as they could have been to reach substantial conclusions.

The main results are

- the demonstration of the validity of using SAR images for eddy detection and analysis,
- a correlation of the eddy statistics with the local bathymetry, in particular the submarine canyons
- a correlation of the eddy statistics with the local Rossby radius which is a function of the local density differences and thermocline depth (this is explained in the text but not sufficiently demonstrated in the figures)

## Some general comments

It would be interesting to see the link between the Rossby radius of deformation and the eddy radius demonstrated in a graph.

The summary map shows the eddies distinguished between cyclonic and anticyclonic. The discussion itself does not analysed in great detail; could this be elaborated in any way: is there a reason for the difference in the number of vortices? Is there a difference in the distributions (size, anisotropy, orientation) between cyclonic and anticyclonic? In the discussion of the size, the authors state that there is a seasonal difference as the Rossby radius of deformation changes over the seasons. Might it be instructive to distinguish the summer and winter eddies in the summary map?

The authors have made some suggestions for location or alignment of eddies with local features (canyons and currents). Again, could that be demonstrated in a graphical way?

The authors refer to a standard (hyperbolic) distribution consistent with (at least one – but which?) of their observed distributions. It would be good to see a bit more detail on this.

## Specific comments (listed by page number:line number):

The language on the whole is fluent but there are a number of lexical and syntactical corrections suggested.

**Title:** the title is not very clear, especially what the 'statistics' applies to. As turbulence itself is not a primary focus, I feel that a title like 'Eddy measurements and statistics in the Gulf of Lions' would be more appropriate.

56:2-5: Too many instances of 'may'. The tone set by the first sentences is far too cautious to encourage further reading. I would replace the first two instances of 'may' (lines 2 and 4) with 'can'. (The 'may' in line 5, however, is fully appropriate)

56:7: the comma is wrong. This should be a full stop

56:9: what do you mean by 'convenient' environmental conditions? Does it refer to conditions favourable for generation of the type of eddies observed? If so, what are the criteria for counting eddies and what includes 'convenient'?

56:14-17: the comma between 'eddy forcing' and 'coastal radar' does not make sense. Should this be a full stop. Are all SAR observations confirmed by coastal radar? If not, which in particular are confirmed?

57:5: placement of bracket; do you mean: '(7.5 km s<sup>-1</sup> approximately)'?

57:7: 'converted': 'may be used to construct a virtual antenna' or shorter 'may be used as a virtual antenna'.

57:12: 'The dark areas' → 'Dark areas'

57:13: Mismatch between plural 'Other' and singular 'phenomenon': 'Another phenomenon'

58:24: Do you mean?: 'The corresponding Kolmogorov time scale,  $T_k$ , is ...'

59:1-4: A reference to a text book or (review) article(s) covering Thorpe, Ozmidov, Monin-Obukov, Kraichnan would be useful here.

59:7: 'vortexes' → 'vortices'

59:9: 'which have a maximum...'

59:20: 'sen' → 'sin'

59:22/Figure 2: The spatial orientation of the vortices is actually not that easy to see in the figure. If it is not too difficult, it might help to add the major axis to each vortex.

Regarding the size of the vortices: What is your criterion for determining the size of a vortex; how did you calculate it? Some detail on this might be useful here.

59:27: 'nearby': do you mean 'close' or 'narrow'

60:1: 'canyons, where most'

60:2: 'left': what do you mean by that? Left with respect to which direction?

60:10/ Section 3: It not entirely clear which SAR measurements are confirmed through which coastal radar measurements (This is something you mention in the abstract, 56:15-16)

60:11: Introduce the acronym WERA

60:22: 'responsible of for anticyclonic'

60:26: Introduce the acronym ROFI

61:1-3: The syntax of this sentence is such that I am not sure what is meant here. I get lost in the bit 'factor analysis related eddy formation'. Do you possibly mean 'A previous investigation of eddy formation using factor analysis (ref) was able to ...'

61:3: non linear → either non-linear or nonlinear

61:10: Introduce acronyms TSM SPOT

61: 10 – 12: doubtful syntax. Ok until '... wind condition' but then it is unclear what was able to reconnect

61:16: distribution of vortices

62: 4: fist → first

62:8/Figure 5: This is somewhat confusing. The text implies that Figure 5 gives information about the orientation of the eddies, yet Figure 5 itself shows the distribution of the **size** of the eddies for the whole region and the Barcelona area. It is unclear how this paragraph is related to 65:14-16 and Figure 7.

Figure 5 (and following) might be a little clearer if the two distributions shown use (thin) connecting lines between the symbols to guide the eye.

62:15: 'extension' → 'extent'?

62:15-17: There seems to be a mismatch between the figures and the numbers quoted here. The text seems to refer to Figure 8 (even though it refers to the non-existing Figure 13, long before even Figure 6 has been introduced). From Figure 8, I added up that ~ 63% of the vortices had an area of less than 100 km<sup>2</sup>, as opposed the quoted 78%.

62:18 – 19 appears to refer to Figure 5 but this is not made explicit – but again it is difficult to align the quoted numbers with Figure 5. When you say '7 km', do you mean '7 km or less'? Finally, the indefinite article 'a' in front of the percentage numbers should be deleted: 'About 60% of vortices have a minor diameter of 7 km or less, 21% .... And 16% between...'

62:20: replace 'mainly due' by 'for'

63:5: use subscript d for  $R_D$

63:7: 'broken into smaller...'

63:19: give a reference to the Levitus data base

63:24: '... in dominant sizes of between 6.2 km....'

64:11: You refer to Fig 3 and 4 for a comparison of sizes with the Rossby radius. Since Figures 3 and 4 do not show vortex sizes, this comparison cannot be made. To provide evidence for your statement, you should actually show a plot of vortex diameter against the Rossby radius. (maybe use different symbols for winter/summer and cyclonic/anticyclonic)

64:23: Introduce the constant  $C(x,y)$ . Is this  $g^{1/2} f^{-1} (\Delta\rho/\rho_0)^{1/2}$  ? (in which case it would be  $(C \cong 1900 \text{ m}^{1/2})$  ).

65:3: ... 1998, most .... elliptical ??? form whose ratio between the principal and secondary axis varied between 1.25 and 1.5 (Fig. 6). This supports the suggestion elliptical vortices are more stable ~~that~~ than circular ones.

65:6: all → entire

65:8: extension → extent

65:8-13: This describes Figure 8 but you refer to figure only in paragraph 65:14 -16... What is the difference between the discussion of the area in this paragraph compared to that in 62:15-17?

65:14-15: I cannot see that preferred orientation in Figure 7. To me it looks as if there is a preference for northerly alignment in the Barcelona region but no clear preference in the Gulf of Lions.

65:17-18: Which of the distributions shown in Figures 5 to 8 is consistent with a hyperbolic distribution? I might be instructive to overlay that hyperbolic distribution over the observed distributions and give the distribution parameters.

66:1-3: The syntax of that sentence makes it difficult to understand. I would suggest splitting it into two sentences.

66:4: situation →? location

66:7: 'size the area' What does that mean? Should there be a comma to separate 'their [the eddies'] size' as one item and 'the area of observed slicks' as another? (What is a vertical slick?).

66:9-11: Suddenly we get the concept of fractal dimension referred to without any prior introduction or reference... ?

67:8: 'Balistic' → ballistic

67:8: non-lineal → non-linear or nonlinear

67:8: dominant → dominate

67:19: here the local ? → where the local

67:19-20: 'on the long run' → in the long run

67:20-21: 'so' feels too informal. I would suggest to split the sentence: '... average out. As a result, using a single integral length scale defined in (in what/where?) will be enough, together with the inertial frequency.

67:21-22: 'The method ...' Which method? Give a reference or detail/

67:27: lower case waves

69:5: bathimetry → bathymetry

69:12: 'space' what do you mean there. Isn't it enough to say: '... with in-situ observations...'?

69:14: inferr → infer

69:24: I don't think the comma is needed (though you can use it a couple of words later), and a typo in elliptical: ... vertical elliptical regions, as well...

70:4: subscript and italics:  $R_d$

70:5: extraneous full stop: ... 20 km agree with ...