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Ocean Science
Discussions

Interactive comment on "Two typical merging events of oceanic mesoscale anticyclonic eddies" *by* Zi-Fei Wang et al.

Anonymous Referee #2

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General comments :

This manuscript applied conservation laws to two merger events observed by satellite in the South China Sea. Sea-level anomaly and temperature are used to determine the eddy type (surface or subsurface). Two cases are then detailed : first, the merging of two surface anticyclones, then of two subsurface ones. Vertical ocean structure is given by GODAS Ocean re-analysis and a 2-layers model is fitted to observations. Evolution of the eddies parameters, circulation, angular momentum, vorticity, energy and enstrophy are observed during the merging processes. The main findings are that angular momentum is conserved (unlike PV) when taking into account for the orbital momentum of the pair of eddies rotating around each other, and a significant decrease of EPE is observed and interpreted as due to the sinking of the eddies during merger.

I found the manuscript generally well organized, but still needs to be clarified. The language requires some correction too. Figures are useful and illustrative. I believe this manuscript represents an important contribution to the knowledge of mesoscale eddy mergers, but in order to be accepted for publication in Ocean Science, I recommend a major revision to be done following the comments listed below.

Specific comments :

- About the method : I couldn't find how h1 and h2 were determined in the text. How the interface of the eddies were chosen according to its vertical structure? Data and Method section needs to clarify this point, and also readers would appreciate to see the vertical structure of the eddies/background as an illustration and visual check.

- It is not clear how eddy properties are considered below the surface. If I understand correctly what is here done, eddy properties inferred from surface observations are taken as average over the layer defining the eddy. If this can be acceptable for surface anticyclones, I wonder if this assumption not too strong when considering subsurface eddies with subsurface velocity maximum? What is the depth a typical subsurface eddies in the South China Sea? Alternatively, velocity fields from ocean re-analysis can be used in the considered layer.

- H1 is chosen as a constant value, but in the real ocean, this likely not true and can lead to substantial variation in eddy properties. The reference provided to justify this choice are from different places with different stratification. How sensitive are the result to the choice of H1?

- How are the lateral boundary of integration chosen? This is not details neither, and, I presume, can lead to significantly different results. Again, how sensitive are the results to the choice of this parameter?

- The paper lacks of a statistical generalization of the results. Have you studied other examples of merging before choosing to focus on the two presented in the paper? I

presume that once the work is achieved for two examples, it can easily be applied on others examples. Otherwise, based on only two examples, the conclusions about generalization of the conservation rules, and splitting, needs to be mitigated.

Technical corrections :

l19 "by trapping them", please rephrase l20 "the most energetic component in the ocean", please provide reference l22 "eddy's life-cycle and transports." l24 "than before", please be more precise (than pre-existant eddies, than the sum of the two original eddies...) l25 "by Gill and Griffiths", Is there no reference for this work? l28 "Pandora's box", l40 & 300 "are less than", please specify ("less numerous") and correct in the whole manuscript l45 "field", please prefer research cruises to "voyage" l60 "eddy merging", please rephrase "after two typical eddy mergers", merging is not a noun... l65 "for the global" l80 "as previously used", please provide reference l89 "eddy area but eddy radii is an extensive quantity", please rephrase this is not clear l92 "compositing", this is not a verb, please rephrase l96 Do you mean " too small and can be ignored"? l106 PV anomaly? Please provide a reference or a demonstration that the average circulation is equal to the surface integrated PV anomaly. l110 Where is the x- and y-axis origin? l112 u and v refer to surface eddy velocity but considered as average swirling velocity of the eddy, right? l114 & l116 Why is there no (H1+h1+h2) factor in the integral? l114 Please provide the expression of the reduced gravity. l116 Please provide a definition and expression for ksi. Again this is for a surface parameter I presume. l126 Please provide number in meter too for h2. l127 "the parameters of both eddies" l135 & 184 "experienced changes" l158 "described in the previous" l161 Please provide number in meter for h1 and h2. l156-161 Consider moving some of this part to methods with more detailed explanation on the choice of the density interface rho0, rho1 and rho2. l165 "came close to each other with a" l166 "this subsurface merging event" l175-177 Is it a stacking process? or the two cores coalesce? How the vertical structure of the eddies evolve during the merger? l185 This is wrong, now h1 is same order as h2. l198 and following : What the +/- corresponds to? Please be consistent with

number of significant digits between parameters (sometimes 3, sometimes 4, I would give 2). l203 Please provide a reference l209 "as mentioned previously" l219 "merging" "non-negligible" l241 "sported"? l242 "in the northern ocean"? l245-247 How is the eddy gravitational PE wrt background sea level computed? Please provide the formula applied here to infer the numbers. l258 "rarely-evoked" "poorly-known" "underrated" l264-265 Please rephrase this sentence is not clear. l266 "enstrophy decreased" l272 "in the inverse energy cascade" l275 "mostly baroclinically" l280 "persists" l285 "observation of two cases of eddy merger" l286 "fitted to" l289-290 " Thus, parts of these ... in future." What do you mean here? l297 H1 is fixed here... l308-309 Why eddy splitting will work similarly than merging? Splitting can have very different causes (instability processes of the eddy itself, or interaction with external flow) and might not work the same way as mergers work. The authors should prove or illustrate their statement with an example, or remove the last column of table 1 and mitigate their conclusions.

Figure 1 : The top panels are suited to introduce the 2-layer model, while the bottom panels already detail some results. Please split into two figure with one put at the end of the manuscript with the conclusion. In (b) please draw isopycnals as lines, the colors are confusing. Please also specify H0 and H2. Figure 2 and 4 : Please mark the eddies described in the text (AE1, AE2, A1, A2 and A) Figure 3 and 5 : Please give more details, what is "A2+A2+ob" for instance? Hard to know without reading carefully the paper.

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