Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2019-67-RC1, 2019

Ocean Science Discussions

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

Anonymous Referee #1

Received and published: 10 July 2019

This study nicely examines the potential conservation and conversion laws during the merging of eddies, using observational data and theoretical models. This research leads to some new result that total mass (volume), total circulation (area integration of vorticity) and total angular momentum (AM) are conserved under given certain conditions, which provide new insights from previous similar studies including explaining some previous confusions. This study would be interesting to the research community of coherrent eddy dynamics. I do have a few medium to minor comments that the authors need to consider carefully before it may be accepted.

* line 65: "the products are available on a daily scale with a $0.25^\circ \times 0.25^\circ$ resolution in the global ocean as DUACS DT14 [Pujol et al., 2016]."

It is important to remind the readers that this 0.25 degree resolution is only the data

Printer-friendly version

Discussion paper

resolution, not the physical signal resolution. The real signal resolution of Aviso is mostly only 100-200 km.

* line 100: “In the present study, both H 0 and H 1 are chosen to be 200 m, partly according to some recent observations”

is your result sensitive to your choice of 200m? Need some discussion here.

* line 20: “During their lifetime, complex dynamic processes occur, such as merging and splitting, which are associated with an eddy’s genesis and termination. ”

While eddy merging and splitting are an important topic, please clarify that you mainly focus on coherent eddies in this study (e.g. those you can count and recognize) rather than general eddy field. Note that eddies include not only coherent vortexes (your focus) but also all the rotational but incoherent turbulent structures such as chaotic filaments and fronts. Most of eddy kinetic energy (EKE) in the ocean are not from coherent eddies but from incoherent ones; and eddy transport of tracers is mostly due to incoherent motions: e.g. see and cite the following papers: Partitioning Ocean Motions Into Balanced Motions and Internal Gravity Waves: A Modeling Study in Anticipation of Future Space Missions, Journal of Geophysical Research, 123, 8084–8105 and this paper: Ocean submesoscales as a key component of the global heat budget. Nature Communications, 9, 775. Another example is your line 75 “Surface eddies are distinguished from subsurface eddies by whether their core is in the surface layer or located inside the water column (Fig. 1a)”. Incoherent eddies usually do not have a core and do not have the concept of eddy radii. This is not a trivial comment and you should treat seriously: your first paragraph seems to mix/confuse these two together.

* line 245: “we calculated the change of eddy gravitational PE”

Most people will not understand this term. Define “eddy gravitational PE”, its meaning and difference from EPE and indicate how you calculate it.

* around line 280: “This strong stratification provides a large PE support for eddy merg-

ers." Is this correct? usually a stronger stratification has a weaker PE, e.g. see QG PE density b'^2/b_z

This is nice but it will benefit the readers by citing related papers here such as the paper on the nonlinear interaction of eddies (e.g. inverse cascade): e.g. a review paper Klein et al. 2019. Ocean-Scale Interactions from Space. Earth and Space Science, 6, 795-817.

* line 260: "eddy PE dominates the increase of total mechanical energy, and that the EPE increase is converted from the eddy body sink."

Most people will get lost by what you mean of "mechanical energy". Do you mean EKE + EPE? Please explain clearly. Also, explain what you mean by eddy body sink and why you have this sink? Avoid unusual jargon as much as possible.

* line 240: "The large increase of PE cannot be explained by the loss of EKE, since that eddy PE is, in general, an order of magnitude larger than the EKE"

This is correct but it is better to support this by citing related papers here such as this one: On the Minimum Potential Energy State and the eddy-size-constrained APE Density. JPO, 46, 2663–2674.

* This paper use the method of a two-layer model, which has its advantage but you should discuss the limitation caused by using this simple model. E.g., discuss how much uncertainty it may cause.

* line 274: "The eddy merging process provides an effective means of mesoscale genesis, which might be a link in the chain for another long-term problem of what physical processes govern the seasonal variability of EKE [Marshall et al., 2002]."

Eddy merging is indeed a potential important mechanism affecting eddy seasonality. But you should mention explicitly here that submesoscale itself usually has a seasonality (which affect mesoscale by inverse cascade). For example, recently there is a significant observation in North Atlantic about the seasonality of submesoscale, which

you may cite: Yu et al. 2019. An Annual Cycle of Submesoscale Vertical Flow and Restratification in the Upper Ocean. JPO, 49, 1439–1461.

++++++++++++++++++ minor comments:

* line 201: “we find the second conservation law of total circulation. ”

Do you mean “we find that the second conservation law of total circulation holds”? Why call it second conservation law? do you invent this term? Do you mean the second conservation law is about the conservation of total circulation? It reads confusing.

* around line 25: please specify the structures/sections of your paper here.

* around line 90: “For a two-layer model, . . .” Do you mean you use a two-layer model? or this is is set up of a usual two-layer model?

* line 120: “The first merging event . . .” what do you mean by “first” here? relative to what?

* around line 140: “It is noted that the vorticity of AE2 is significantly smaller, although it had a larger amplitude.”

what quantity do you mean here for larger amplitude? It is confusing.

* line 192: “Finally, we calculated the energies of eddies. Both the EKE and EPE had similar variations before merging.”

So what? any explanation or implication by this result? clarify what is the point here?

* line 230: “which is hardly calculated in complex environments.” Do you mean “which is hard to calculate” here?

* around line 280: “The strong eddy activity in turn modulates the mixed layer depth [Gaube et al., 2019].”

This is correct but it is very helpful to mention that eddy activity in general modulate the isopycnals (more than just mixed layer depth), e.g. may see and cite this paper: An

idealized model of Weddell Gyre export variability. JPO, 44, 1671-1688.

* around line 255: “A rarely known paper illustrates such a phenomenon [Carnevale and Valli’s, 1990].”

The sentence is awkward; suggest to remove the word “rarely known”.

* line 201: “In both cases, the total circulation of the eddies seldom changes.”

Please specify number or figure to show this result, if any

* line 266: “The eddy enstrophy also decreased after merging, even smaller than mean enstrophy of eddies.”

Specify the figures for this result, if any.

* line 232: “0.121 PJ to 0.094 PJ” The unit of PJ is awkward here; no one will have a feel on it. Please change to (m/s)ˆ2

Interactive comment on Ocean Sci. Discuss., https://doi.org/10.5194/os-2019-67, 2019.

Printer-friendly version

Discussion paper