We thank editor for the useful comments and suggestions.

The main revisions includes:

1. All figures are redrawn accordingly.
2. We clarify the data and method with more details and formulas.
3. The sensitivity of result to parameters are discussed in a new subsection.
4. The possible vertical process are also discussed in a new subsection.
5. The changes according to Referee #1, #2, and editor are marked with red, blue, and green, respectively.

Q: 1. Please see if you can have the language and style improved with help from colleagues. Alternatively you can consider professional services. Also please check for typos throughout.

A: We have applied professional services for language.

Q: 2. Make sure all cites are included in the reference list, e.g. Gill and Griffiths

A: We have added the references.

Q: 3. I like one referee's suggestion of splitting Fig 1 into two and showing the lower panels later toward the conclusions.

A: We have split it into two by following your and reviewer's suggestion.

Q:4. li45-46: There has been some observational work from the Lofoten Basin (I recall Roshin Raj's paper demonstrating some mergers).

A: We have cited a work from the Lofoten Basin (Bashmachnikov et al., 2017). Now we add Raj's paper (Raj et al., 2016).

Q:5. li54: "without any assumption" is a *very* strong statement. You do use 2-layers (or 1 or 3), approximate SLAs as Gaussian, assume H0=H1=200m, and calculate the velocity and vorticity from geostrophy! etc.

A: We are sorry for the unclear statement. The assumption is not for calculation itself, but for conservation law. We have modified it.

Q:6. li76: SST is not the only contributor to density. Is this a regional statement?

A: Yes, it is a regional statement. Although both SST and SSS contributes to density, density anomaly is dominated by SST anomaly since SSS anomaly is very small.

Q:7. Eq.2 and on with integrals: are these accurate? It's not clear to me how you define the volume. How are the anomalies of u and rho calculated? Please describe how you obtained h2.

A: Yes. We have added these accordingly following your and reviewers' suggestions.

Q:8. li198-199: now we have plus/minus (which is good), but what are these? Standard error, standard deviation, uncertainty? Please describe.

A: They are the standard deviation. We add these in figures.

We thank Referee #1 for the useful comments and suggestions.

The main revisions includes:

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9. The possible vertical process are also discussed in a new subsection.
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Q:* line 65: “the products are available on a daily scale with a 0.25_ _ 0.25_ 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 resolution, not the physical signal resolution. The real signal resolution of Aviso is mostly only 100-200 km.
A: Thanks, we have added this notation accordingly.
Q:* 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.
A: We have added the discussion in a new section accordingly.
Q:* 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.
A: Thanks for the useful information, we have clarified this according to your suggestion. We also add “Besides, there are incoherent eddies, which usually do not have a core and do not have the concept of eddy radii. These incoherent eddies are also important, since most of eddy kinetic energy (EKE) in the ocean are from incoherent ones [Torres et al., 2018]; and eddy transport of tracers is mostly due to incoherent motions [Su et al., 2018]”.
Q:* 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.
A: Suggestion followed, we have added the formula as Eq. (10).
Q:* around line 280: “This strong stratification provides a large PE support for eddy mergers.” 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.
A: Suggestion followed, we have cited the paper.
Q:* 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.
A: Yes, it is EKE+EPE. We have added Eq. (10) to illustrate this.
Q:* 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 APEDensity. JPO, 46, 2663–2674.
A: Thanks, we have added the reference.
Q:* 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.
A: Thanks for the suggestion, we have added a new section to discuss this.
Q: * 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.
A: Thanks, we mention this explicitly according to your suggestion.

++++++++++++++++++ minor comments:
Q: * 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.
A: We are sorry for the unclear. The second conservation law is about the conservation of total circulation. We have modified it.
Q:* around line 25: please specify the structures/sections of your paper here.
A: We specify the structures/sections of the paper at the last paragraph of section 1.
Q:* around line 90: “For a two-layer model, : : :” Do you mean you use a two-layer model? or this is set up of a usual two-layer model?
A: A usual two-layer model.
Q:* line 120: “The first merging event : : :” what do you mean by “first” here? relative to what?
A: we remove “first”.
Q:* 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.
A: we are sorry for the confusing, it is eddy amplitude, a parameter associated with SLA in Eq. (1). We have clarified this.
Q:* 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?
Q:* line 230: “which is hardly calculated in complex environments.” Do you mean “which is hard to calculate” here?
A: Yes. We have modified it.
Q:* 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.
A: Thanks for suggestion, we have added the words.
Q: * 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”.
A: Thanks for suggestion, “rarely known” is removed.
Q: * line 201: “In both cases, the total circulation of the eddies seldom changes.” Please specify number or figure to show this result, if any
A: We add figures.
Q: * line 266: “The eddy enstrophy also decreased after merging, even smaller than mean enstrophy of eddies.”Specify the figures for this result, if any.
A: We add figures.
Q: * 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
A: We have modified it accordingly.

We thank Referee #2 for the useful comments and suggestions.
The main revisions includes:

1. All figures are redrawn accordingly.
2. We clarify the data and method with more details and formulas.
3. The sensitivity of result to parameters are discussed in a new subsection.
4. The possible vertical process are also discussed in a new subsection.
5. The changes according to Referee #1, #2, and editor are marked with red, blue, and green, respectively.

Specific comments :
Q:- 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.

A: We add the detail in section 2.3. The upper surface $h_1 = \frac{\rho_1}{\rho_1 - \rho_0} A$ and the lower surface $h_2 = \frac{\rho_1}{\rho_2 - \rho_1} A$ satisfy $h_1 \sim h_2 << H_1$.

Q:- 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.
A: Yes, eddy properties inferred from surface observations are taken as average over the layer defining the eddy. The eddies are not in the South China Sea, but in the western tropical Pacific. Such thick of subsurface eddies are from previous observation [Li et al., 2017] and numerical simulation [e.g. Wang 2017].
Q:- 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?
A: The sensitivity of result to H1 is discussed in a newly appended section 4.1.
Q:- 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?
A: The sensitivity of result to lateral boundary is discussed in a newly appended section 4.1.
Q:- 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.
A: Thanks for your comments, we have added the discussion of results in this new version.

Technical corrections :
Q:l19 "by trapping them", please rephrase
A: “by trapping those tracers along with the water”
Q:l20 "the most energetic component in the ocean", please provide reference
A:Thanks, reference added.
Q:l22 "eddy’s life-cycle and transports."
A:Thanks, suggestion followed.
Q:l24 "than before", please be more precise (than pre-existant eddies, than the sum of the two original eddies...)
A:Thanks, “than the sum of the two original eddies”.
Q: l25 "by Gill and Griffiths", Is there no reference for this work?
A: The reference is “GILL, A. E. and GRIFFITHS, R. W. 1981 Why should two anticyclonic eddies merge? In Ocean Modelling, 41. Unpublished manuscript.”
Q:l28"Pandora’s box",
A:Thanks, suggestion followed.
Q:l40 & 300 "are less than", please specify ("less numerous") and correct in the whole manuscript
A:Thanks, suggestion followed.
Q:l45 "field", please prefer research cruises to "voyage"
A:Thanks, suggestion followed.
Q:l60 "eddy merging", please rephrase "after two typical eddy mergers", merging is not a noun...
A:Thanks, suggestion followed.

Q:l65 "for the global"
A:Thanks, suggestion followed.
Q:l80 "as previously used", please provide reference
A:Thanks, suggestion followed.
Q:l89 "eddy area but eddy radii is an extensive quantity", please rephrase this is not clear
A:Thanks, suggestion followed.
Q:l92 "compositing", this is not a verb, please rephrase
A:Thanks, suggestion followed.
Q:l96 Do you mean " too small and can be ignored"?
A:Thanks, suggestion followed.
Q:l106 PV anomaly? Please provide a reference or a demonstration that the average circulation is equal to the surface integrated PV anomaly.

A: $\xi - f\frac{h_1+h_2}{H_1}$ is PV anomaly (Gill A.E., p 192). Then

$$\Gamma = \iint \left(\xi - f\frac{h_1+h_2}{H_1}\right)dxdy = \iint \left(\frac{f+\xi}{H_1+h_1+h_2} - \frac{f}{H_1}\right)(H_1+h_1+h_2)dxdy$$

Q:l110 Where is the x- and y-axis origin?
A: the x- and y-axis origin at eddy center.
Q:l112 u and v refer to surface eddy velocity but considered as average swirling velocity of the eddy, right?
A: Yes.
Q:l116 Why is there no (H1+h1+h2) factor in the integral?
A: We assume that only h1 and h2 change during the merging process but H1 does not change during the merging process. So only the potential energy associated with interface is considered [e.g., Lumpkin et al., 2000].
Q:l114 Please provide the expression of the reduced gravity.
A: suggestion followed.
Q: l116 Please provide a definition and expression for ksi. Again this is for a surface parameter I presume.
A: Yes, it is a surface parameter. And suggestion followed in Eq. (2).
Q:l126 Please provide number in meter too for h2.
A: suggestion followed.
Q:l127 "the parameters of both eddies"
A:Thanks, suggestion followed.
Q:l135 & 184 "experienced changes"
A:Thanks, suggestion followed.
Q:l158 "described in the previous"
A:Thanks, suggestion followed.
Q:l161 Please provide number in meter for h1 and h2.
A:Thanks, suggestion followed.
Q: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.
A:Thanks, we have added more details in method.
Q:l165 "came close to each other with a"

A:Thanks, suggestion followed.
Q:l166 "this subsurface merging event"
A:Thanks, suggestion followed.
Q:l175-177 Is it a stacking process? or the two cores coalesce? How the vertical structure of the eddies evolve during the merger?
A: It is two cores coalesce. The stacking process is quite different from the two cores coalesce in that the area of “merged eddy” in stacking process is significantly smaller than the total area of two eddies. We did find examples of such stacking process.
Q:l185 This is wrong, now h1 is same order as h2.
A:Thanks, suggestion followed.
Q: 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).
A: Thanks, we have modified them.
Q: l203 Please provide a reference
A:Thanks, suggestion followed.
Q:l209 "as mentioned previously"
A:Thanks, suggestion followed.
Q:l219 "merging" "non-negligible"
A:Thanks, suggestion followed.
Q:l241 "sported"?
A:Thanks, suggestion followed.
Q:l242 "in the northern ocean"?
A:Thanks, "in oceans of the northern hemisphere. ".
Q:l245-247 How is the eddy gravitational PE background sea level computed? Please provide the formula applied here to infer the numbers.
A:Thanks, we add the formula in Eq. (10).
Q:l258 "rarely-evoked" "poorly-known" "underrated"
A:Thanks, suggestion followed.
Q:l264-265 Please rephrase this sentence is not clear.
A:Thanks, suggestion followed.
Q:l266 "enstrophy decreased"
A:Thanks, suggestion followed.
Q:l272 "in the inverse energy cascade"
A:Thanks, suggestion followed.
Q:l275 "mostly baroclinically"
A:Thanks, suggestion followed.
Q:l280 "persists"
A:Thanks, suggestion followed.
Q:l285 "observation of two cases of eddy merger"
A:Thanks, suggestion followed.
Q:l286 "fitted to"
A:Thanks, suggestion followed.
Q:l289-290 " Thus, parts of these ... in future." What do you mean here?
A: Removed.

Q:l297 H1 is fixed here...
A: Yes, modified.
Q: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.
A: Thank for your comments. We have modified by following your suggestion.
Q: 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.
A: Suggestion followed.
Q: Figure 2 and 4 : Please mark the eddies described in the text (AE1, AE2, A1, A2 and A)
A: Suggestion followed.
Q: Figure 3 and 5 : Please give more details, what is "A2+A2+ob" for instance? Hard to know without reading carefully the paper.
A: Suggestion followed.