

Comment from Referee #1

The authors performed a satisfactory review job and most of my comments have been addressed. I have remaining concerns on the approach currently adopted for validation, which could be improved.

Response: Thank you for your thoughtful feedback and positive assessment of our manuscript. We greatly appreciate your constructive comments, which have significantly improved the quality and clarity of this work. We have carefully considered your remaining concerns regarding the validation approach and further revised the manuscript accordingly. Our detailed point-by-point responses are provided below.

The comparisons shown in Fig. 7 are valuable, but making sense of differences is quite difficult. I would suggest to show difference quantities (e.g., relative or percent differences) to make this clearer. From this picture a reader does not have much incentive to select your dataset over others. Also some time series analysis, at least over specific regions (for example with known trends or variability), would provide useful validation insights. Moreover, is analysis of the TOEddies dataset shown, as suggested by another reviewer? The He 24 dataset looks extremely similar to the one discussed.

Response: Thank you for your valuable suggestions. To facilitate a clearer comparison among the datasets, we added both difference maps and temporal comparisons in this revision.

First, we added a comparison of our dataset with the TOEddies dataset (please refer to Figs. 6–7 and 11–12 in the revised manuscript, or Figs. R1–R4 below), together with maps showing the differences in mean eddy-induced temperature anomalies between the present dataset and the He24, SS26, and TOE datasets (please refer to Figs. 8–9 in the revised manuscript, or Figs. R5–R6 below). Similar to the comparisons with the SS26 and He24 datasets, the geographic patterns of eddy-induced temperature and salinity anomalies derived from the TOE dataset are highly consistent with those obtained from the present dataset (Figs. R1–R4). Compared with TOE, the present dataset generally produces stronger temperature anomalies in the midlatitude western boundary current systems (Figs. R5–R6). A possible explanation is that the TOE dataset identifies a larger proportion of relatively weak eddies (*Ioannou et al.*, 2024), leading to weaker composite temperature anomalies after averaging.

Second, we added a comparison of the temporal evolution of eddy-induced temperature anomalies among the four datasets (please refer to Fig. 10 in the revised manuscript, or Fig. R7 below). The four datasets exhibit highly consistent temporal variability throughout most of the study period. More noticeable differences occur prior to 2000, particularly in the Southern Ocean (the Agulhas System and the Brazil–Malvinas Confluence), where hydrographic observations were sparse before the Argo era. Consequently, the Argo-based TOE dataset exhibits larger temporal fluctuations and substantial data gaps during the early years. By incorporating quality-controlled observations from multiple platforms, the present dataset provides a more temporally

continuous record of eddy-induced temperature anomalies while remaining highly consistent with previous datasets. This improved temporal continuity extends the applicability of the dataset to investigations of seasonal-to-interannual variability and potential long-term changes in eddy-induced thermohaline anomalies.

These new analyses have been incorporated into Figs. 6–12 and Lines 316–320 and 338–351 of the revised manuscript. We did not include corresponding comparisons for salinity (like Figs. R5- R7) because both the spatial differences and temporal evolution are generally similar to those obtained for temperature anomalies.

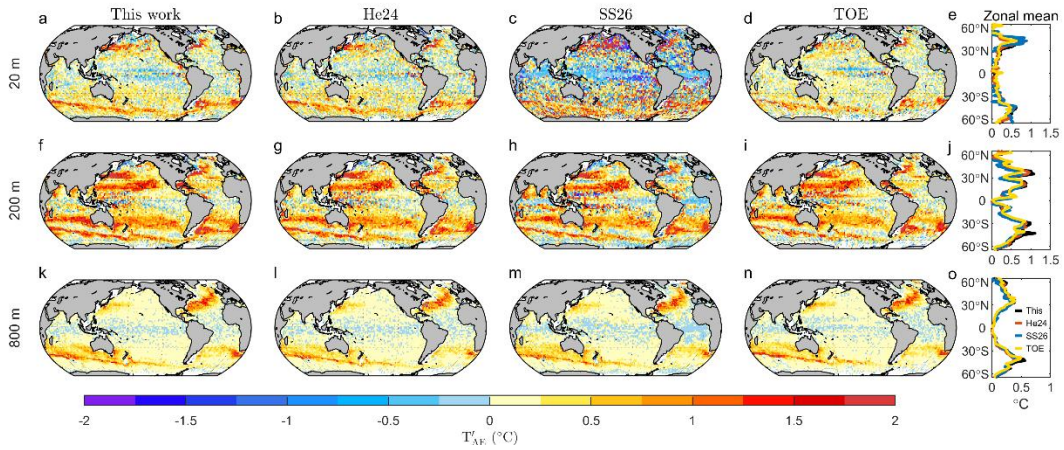


Fig.R1 Geographic distribution of mean temperature anomalies within anticyclonic eddies, estimated within each $2^{\circ} \times 2^{\circ}$ grid box, at the depths of (top to bottom) 20 m, 200 m, and 800 m. The left four panels are eddy-induced temperature anomalies estimated from the profile dataset in this study, *He et al. (2024b)* (He24), *Simoes-Sousa et al. (2026)* (SS26), and *Ioannou et al. (2024)* (TOE), respectively. The right panel is the zonal mean of the left four panels.

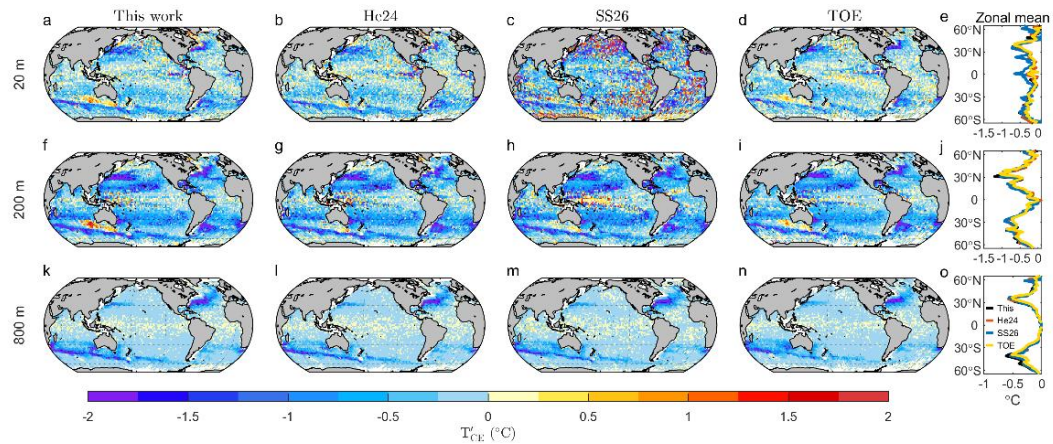


Fig.R2 The same as Fig.R1, but for mean temperature anomalies within cyclonic eddies.

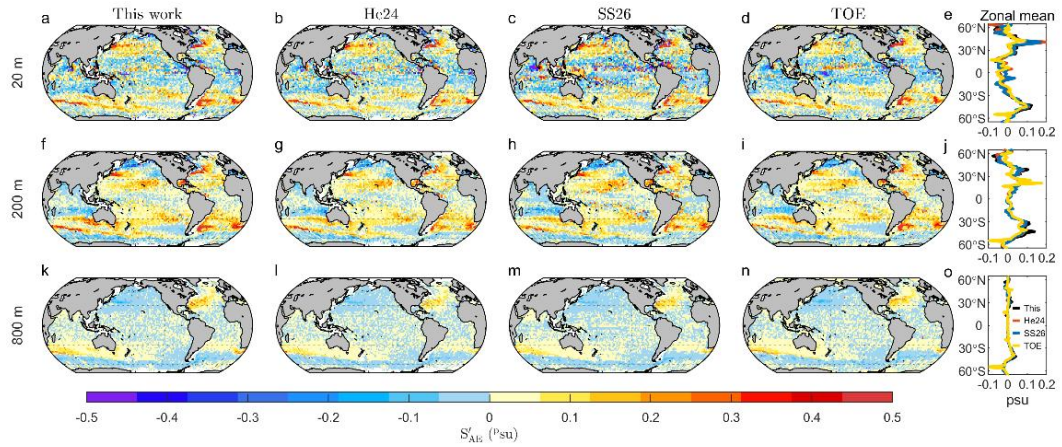


Fig.R3 The same as Fig.R1, but for mean salinity anomalies within anticyclonic eddies.

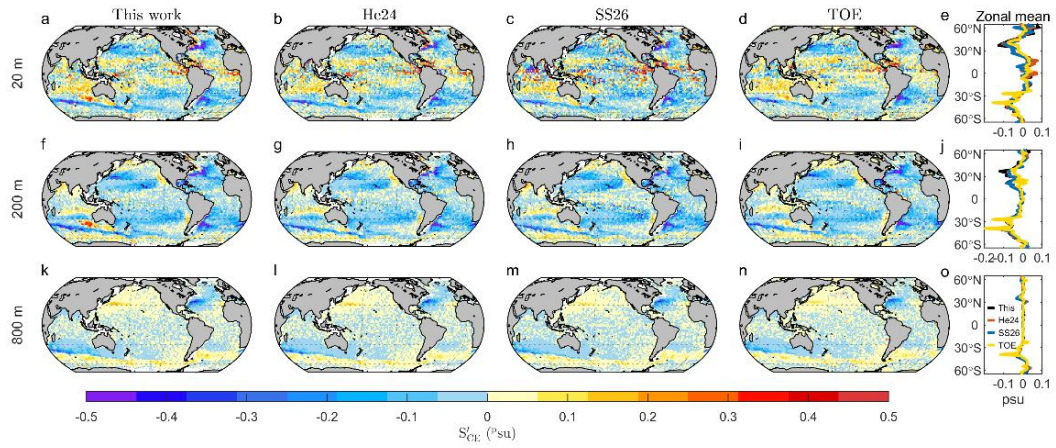


Fig.R4 The same as Fig.R1, but for mean salinity anomalies within cyclonic eddies.

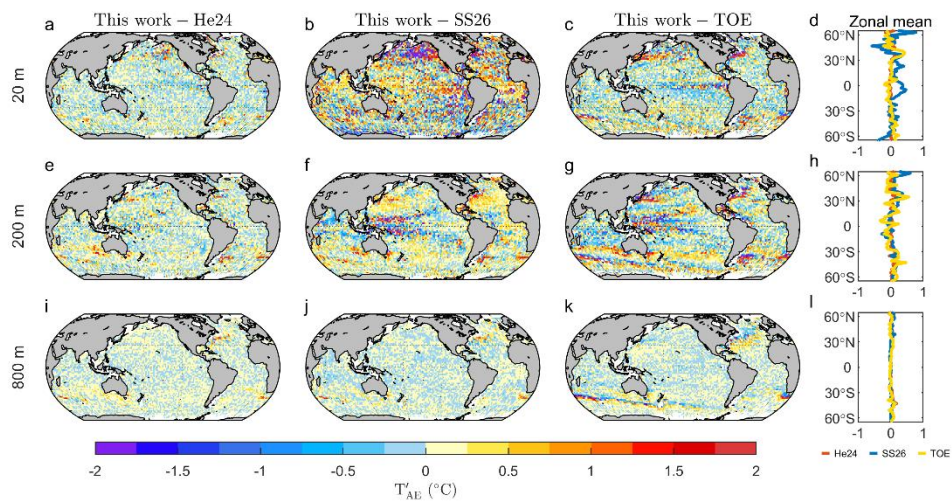


Fig.R5 Difference between temperature anomalies within anticyclonic eddies calculated from our work and those from other data, estimated within each $2^{\circ} \times 2^{\circ}$ grid box, at the depths of (top to bottom) 20 m, 200 m, and 800 m. The left three panels

are the difference between and He et al. (2024b) (He24), Simoes-Sousa et al. (2026) (SS26), and (TOE) respectively. The right panel is the zonal mean of the left three panels.

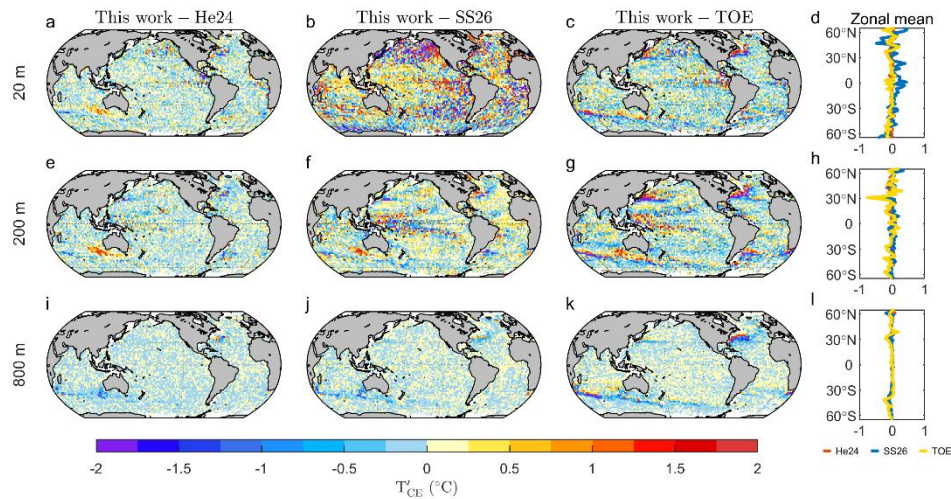


Fig.R6 The same as Fig.R5, but for temperature anomalies within cyclonic eddies.

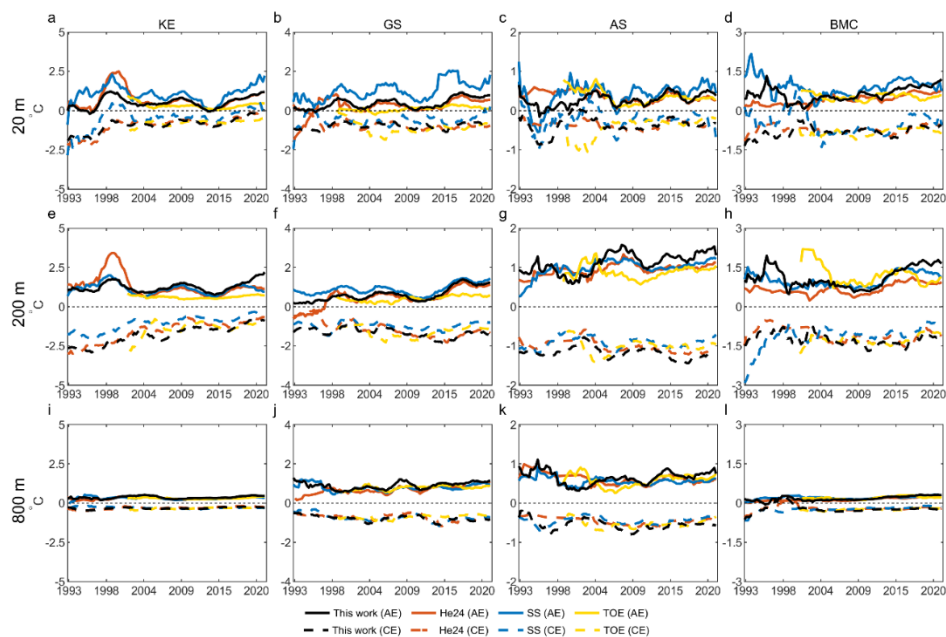


Fig.R7 Time series of eddy-induced temperature anomalies within anticyclonic and cyclonic eddies at depths of (top to bottom) 20, 200, and 800 m, estimated using a 12-month running mean. Columns correspond to the Kuroshio Extension (KE, 28°N-40°N and 140°E-180°E), the Gulf Stream (GS, 35°N-50°N and 30°W-70°W), the Agulhas System (AS, 27°S-42°S and 0°W-40°W), and the Brazil-Malvinas Confluence (BMC, 35°S-55°S and 30°W-65°W), respectively. Black, red, blue, and yellow curves represent estimates derived from the dataset developed in this study, He24, SS26, and TOE, respectively.

An additional author (Lijing Cheng) was included. The motivation for this change is not explained as far as I can see (not track changed in the "Author contributions", at least), but this should be provided.

Response: Thank you for pointing this out. The updated CODC-v2 profile dataset used in the revised manuscript was produced and shared by Prof. Lijing Cheng. As this dataset forms the basis of the revised data product presented in this manuscript, we invited Prof. Cheng to join the author team in recognition of his contribution to the updated dataset and the revision of the manuscript.

His contribution was described in the Author contributions section, but the corresponding revision was inadvertently not highlighted in the previous tracked-changes version. In this revision, we have marked the change in red: “L. C. contributed to the quality control of the updated T–S profile data, ...” (Lines 667–668 in the revision). We apologize for this oversight.

Minor suggestions (tracked changes file version)
152 a reference could be useful

Response: Thank you for your suggestion. We have added references to *Dong et al.* (2017) and *Frenger et al.* (2015) in Lines 154–155 to support the statement that eddy-associated temperature anomalies become much weaker below 1000 m depth.

References:

Dong, D., P. Brandt, P. Chang, F. Schütte, X. Yang, J. Yan, and J. Zeng (2017), Mesoscale eddies in the northwestern Pacific Ocean: Three-dimensional eddy structures and heat/salt transports, *J Geophys Res Oceans*, 122(12), 9795-9813.
Frenger, I., M. Münnich, N. Gruber, and R. Knutti (2015), Southern Ocean eddy phenomenology, *J Geophys Res Oceans*, 120(7413-7449), doi:10.1002/2015JC011047.

412 "conserved" rather than "conservative"? Add reference

Response: Thank you for your suggestion. We have revised the sentence to avoid the ambiguous wording and added an appropriate reference. It now reads: “...behaves more conservatively than temperature (*McDougall*, 2003), ...” (Lines 455–458 in the revision).

Reference:

McDougall, T. J. J. J. o. P. O. (2003), Potential enthalpy: A conservative oceanic variable for evaluating heat content and heat fluxes, 33(5), 945-963.

Please update the zenodo link to <https://zenodo.org/records/20607854>. I do not find it ideal to have both the 1993-2021 and the individual year files in the same repository, or in any case the file naming should be made uniform to indicate the difference is only in the chunking.

Response: Thank you for your careful review and helpful suggestion. We have updated the Zenodo link to <https://zenodo.org/records/20607854>.

We would like to clarify that the annual files are not simply a split (chunked) version of the original unified file. Instead, they represent an updated version of the dataset, generated using the CODC-v1 quality-controlled profile product following Reviewer 2's suggestion. Therefore, the differences are not limited to file chunking, but also involve the underlying profile data and quality-control procedures.

The unified file "Eddy_Collocated_T-S_profiles_Global_1993-2021.nc" corresponds to the original version of the eddy-located profile dataset used in our initial submission. The updated dataset is now provided as annual files with a consistent naming convention ("T_S_profile_eddy_YYYY.nc"), which reduces file size and facilitates data access.

Unfortunately, Zenodo does not allow published files to be removed from an existing record. Therefore, the original unified file has been retained in the repository for users who may wish to access the previous version of the dataset. To avoid confusion, we have updated the README file to clearly describe the organization of the repository and the relationship between the two data products. Specifically, the README now states that the annual files ("T_S_profile_eddy_YYYY.nc") constitute the updated dataset, whereas the unified file ("Eddy_Collocated_T-S_profiles_Global_1993-2021.nc") is retained as the original version used in He et al. (2024) for reference.

We believe that this arrangement both preserves the reproducibility of the originally submitted dataset and provides users with access to the updated data product.

Comment from Referee #2

Below are my comments for the revised manuscript of He et al. submitted to ESSD.

I thank the authors addressed most of my comments, especially using the CODC dataset to improve the datasets quality, as well as comparing the collocated datasets with He et al., 2024 and SS26. Most of the comments had been addressed, and thus I have only a few remaining comments that should be addressed before final acceptance:

Response: Thank you for your positive evaluation of our revision and for your thoughtful comments and suggestions. We greatly appreciate the time and effort you have devoted to reviewing our manuscript. Your insightful suggestions have been invaluable in improving the quality, robustness, and clarity of this work. We are pleased that the use of the CODC dataset, together with the additional comparisons with the He24, and SS26 datasets, has addressed your major concerns. We have carefully considered your remaining comments and further revised the manuscript accordingly. Our detailed point-by-point responses are provided below.

(1) In the response letter, the author said that the added-value of the current dataset is “..... In the present dataset, we fill this important gap by providing the relative distance and azimuthal angle of each profile relative to its collocated eddy”. This makes sense, and I agreed. However, in the revised manuscript, the practical advantage of these two additional variables is not yet sufficiently demonstrated. I cannot find a detailed description of how well the ‘distance’ and ‘azimuthal angle’ perform. The authors need to add a short diagnostic or example showing how the relative distance and azimuthal angle can be used. For example, the authors could show the radial and azimuthal sampling distribution of profiles, or an example application demonstrating information that cannot be obtained from a simple inside/outside eddy classification. This could be added in Section 4.

Response: Thank you for your valuable suggestion. We agree that an example application is helpful for demonstrating the practical advantages of the additional variables. In the previous version, we provided an example of reconstructing the mean three-dimensional eddy temperature anomaly structure in the northern Bay of Bengal using the relative distance and azimuthal angle of profiles with respect to the collocated eddy center (previously presented in Section 2.5). However, this example may not have been sufficiently noticeable because it was included in the Methods section.

Following your suggestion, we have reorganized the manuscript by moving this example to the beginning of Section 4.1, where the applications of the dataset are introduced. We also added the following statement: “Compared with existing eddy-collocated products, the inclusion of the relative distance and azimuthal angle of profiles with respect to their collocated eddy centers enables the reconstruction of the regional mean three-dimensional thermohaline structure of mesoscale eddies” (please refer to Fig.13 and Lines 388–390 in the revision).

Additionally, we added a statement that “the reconstruction of regional three-

dimensional eddy structures enables systematic interregional comparisons of eddy vertical structure that cannot be achieved using a simple inside/outside eddy classification” (please refer to Lines 414–416 in the revision). Together, these additions more clearly demonstrate the added value of including the relative distance and azimuthal angle in the present dataset.

Moreover, as you had been replaced the WOD old one, and found that it is less noisy than SS26, also found that ‘the spikes and “dirty points” previously visible in Figs. 8a, 8e, 8f, and Fig. 10c disappeared’. So I think another added-value would be related to the data quality (than the He24), right? This should be stated. This improvement is worth stating more explicitly in the manuscript, because it may be useful for users who are not primarily interested in the distance and azimuthal-angle variables but who need a cleaner eddy-collocated hydrographic dataset.

Response: Thank you for your valuable suggestion. We agree that the improved quality of the T-S profile observations is another important advantage of the updated dataset. To make this improvement more explicit, we have added the following statement to Lines 331–333 in the revision: “the improved quality control and expanded observational sampling are expected to reduce sampling-induced outliers in the estimated eddy-induced temperature anomalies, particularly in regions and time periods with sparse Argo observations, while enabling more robust analyses of mean eddy imprints at finer regional scales”.

(2) In the response letter, the author said “In addition, we expanded the discussion and comparison of eddy-induced temperature anomaly intensities and core depths in representative regions, including the Bay of Bengal (Sarma et al., 2018; Sarma et al., 2020), the South China Sea (He et al., 2018; Sun et al., 2018; Yang et al., 2015), tropical southeastern Indian Ocean (Yang et al., 2015), southeastern Pacific Ocean (Chaigneau et al., 2011), Kuroshio Extension (Dong et al., 2017; Sun et al., 2017), Southern Ocean (Frenger et al., 2015), and Brazil–Malvinas Confluence (Mason et al., 2017).”. Thank you so much for the validation. Here, I would like to see how it performs in the Agulhas System, please add it in Figs 11-12.

Response: Thank you for this valuable suggestion. We have added the reconstructed eddy-induced temperature and salinity anomaly structures for the Agulhas System to Figs. 14–15 (Figs. R1–R2 below) and included a comparison with the results of *Laxenaire et al.* (2019) in the revised manuscript. The reconstructed structures show strong eddy-induced thermohaline anomalies that penetrate to depths exceeding 1000 m, consistent with the characteristics reported by *Laxenaire et al.* (2019) and comparable to those in other western boundary current systems. We have incorporated this comparison into the discussion of the regional variability of eddy vertical structures (Lines 424–425 in the revision).

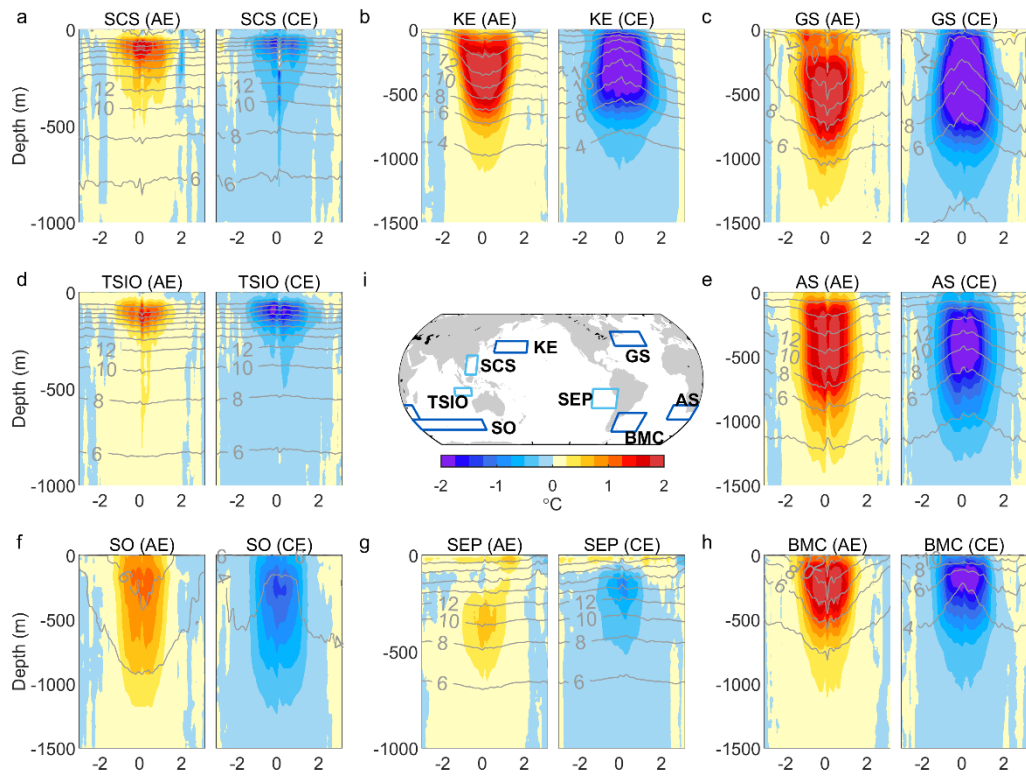


Fig.R1 Composite mean eddy temperature anomaly structures in representative regions of the global ocean. **a-h**, West-east sections of mean temperature anomalies across the composite centers of anticyclonic (AE) and cyclonic (CE) eddies in the South China Sea (SCS), the Kuroshio Extension (KE), the Gulf Stream (GS), the tropical southeastern Indian Ocean (TSIO), the Agulhas System (AS), the Southern Ocean (SO), the southeastern Pacific Ocean (SEP), and the Brazil-Malvinas Confluence (BMC). **i**, The statistical regions (boxes) of (a-h).

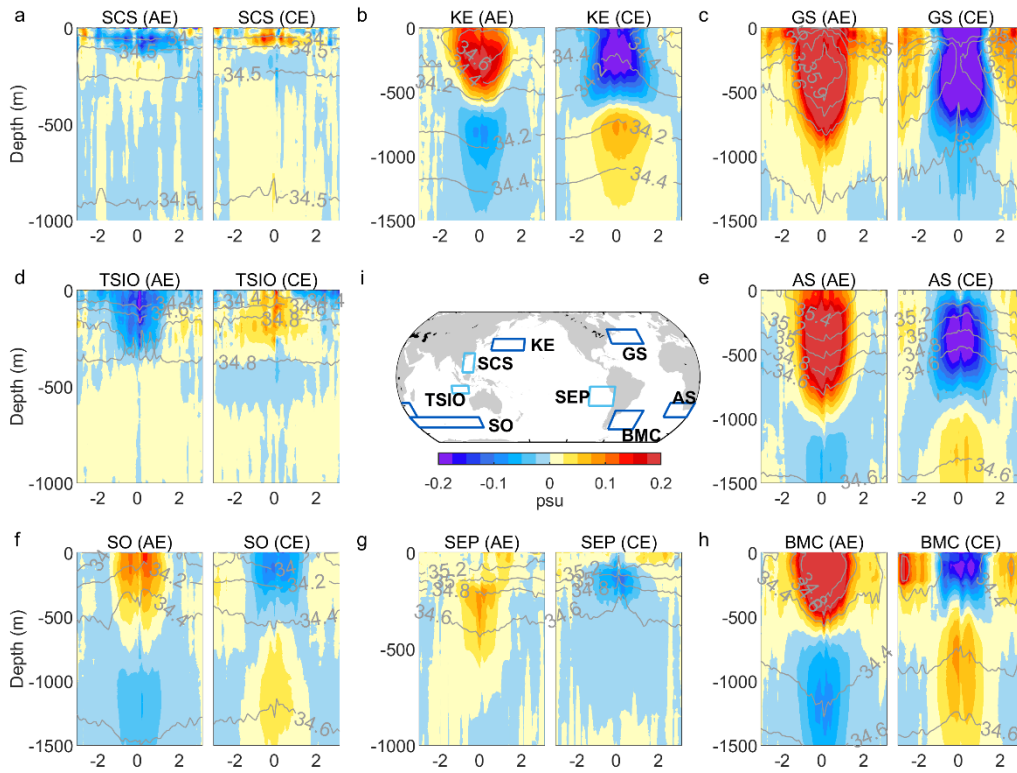


Fig.R2 The same as **Fig.R1**, but for eddy salinity anomaly structures.

(3) In my previous comments, I suggested the author comparing the dataset with the TOEddies, but I didn't find this comparison, and I didn't see any explanation of why the author didn't want to do this. Although this will not substantially influence my final recommendation to accept this manuscript, I'd like to know the reasons (if without providing further comparisons).

Response: Thank you for your comments. Following your suggestion, we have now included a comprehensive comparison between the present dataset and the TOEddies dataset. Specifically, we added comparisons of the mean eddy-induced temperature and salinity anomalies (Figs. 6–7 and 11–12 in the revised manuscript, or Figs. R3–R6 below), together with maps showing the differences in mean eddy-induced temperature anomalies between the present dataset and the He24, SS26, and TOE datasets (Figs. 8–9 in the revised manuscript, or Figs. R7–R8 below).

The comparison shows that, similar to the He24 and SS26 datasets, the geographic patterns of eddy-induced temperature and salinity anomalies derived from the TOE dataset are highly consistent with those obtained from the present dataset (Figs. R3–R6). Compared with TOE, the present dataset generally produces stronger temperature anomalies in the midlatitude western boundary current systems (Figs. R7–R8), possibly because the TOE dataset identifies a larger proportion of relatively weak eddies (Ioannou et al., 2024), leading to weaker composite temperature anomalies after averaging.

Additionally, we added a comparison of the temporal evolution of eddy-induced temperature anomalies among the four datasets (please refer to Fig. 10 in the revised manuscript, or Fig. R9 below). The four datasets exhibit highly consistent temporal variability throughout most of the study period. More noticeable differences occur prior to 2000, particularly in the Southern Ocean (the Agulhas System and the Brazil–Malvinas Confluence), where hydrographic observations were sparse before the Argo era. Consequently, the Argo-based TOE dataset exhibits larger temporal fluctuations and substantial data gaps during the early years. By incorporating quality-controlled observations from multiple platforms, the present dataset provides a more temporally continuous record of eddy-induced temperature anomalies while remaining highly consistent with previous datasets. This improved temporal continuity extends the applicability of the dataset to investigations of seasonal-to-interannual variability and potential long-term changes in eddy-induced thermohaline anomalies.

These new analyses have been incorporated into Figs. 6–12 and Lines 316–320 and 338–351 of the revised manuscript. Note that we did not include corresponding comparisons for salinity (like Figs. R5–R7) because both the spatial differences and temporal evolution are generally similar to those obtained for temperature anomalies.

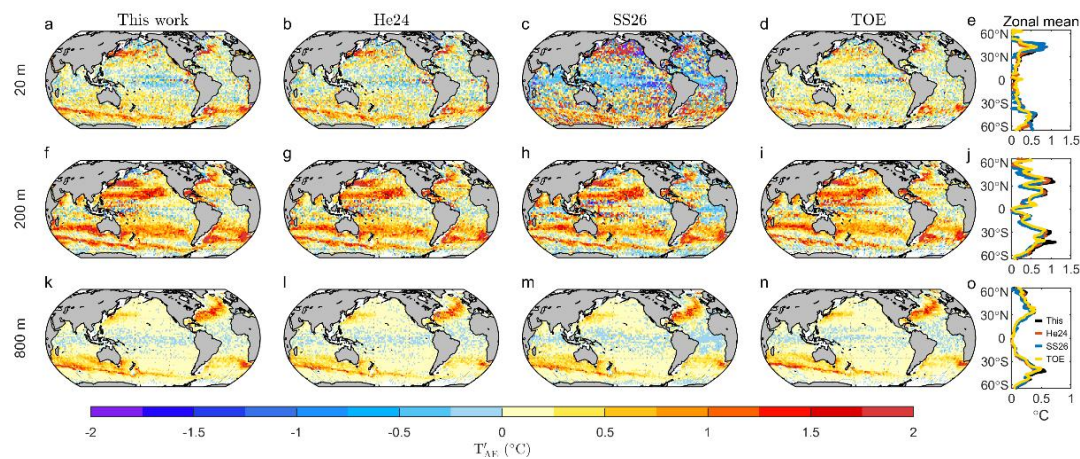


Fig.R3 Geographic distribution of mean temperature anomalies within anticyclonic eddies, estimated within each $2^\circ \times 2^\circ$ grid box, at the depths of (top to bottom) 20 m, 200 m, and 800 m. The left four panels are eddy-induced temperature anomalies estimated from the profile dataset in this study, *He et al. (2024b)* (He24), *Simoës-Sousa et al. (2026)* (SS26), and *Ioannou et al. (2024)* (TOE), respectively. The right panel is the zonal mean of the left four panels.

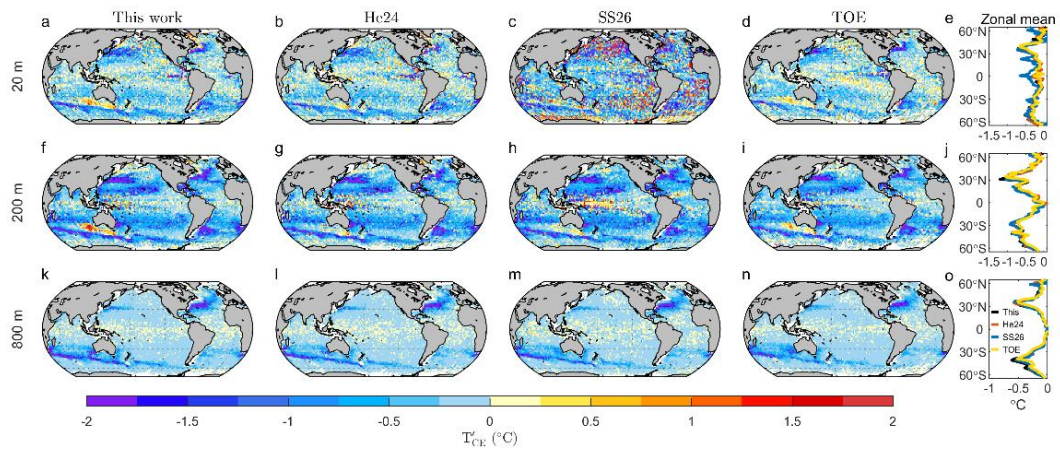


Fig.R4 The same as Fig.R3, but for mean temperature anomalies within cyclonic eddies.

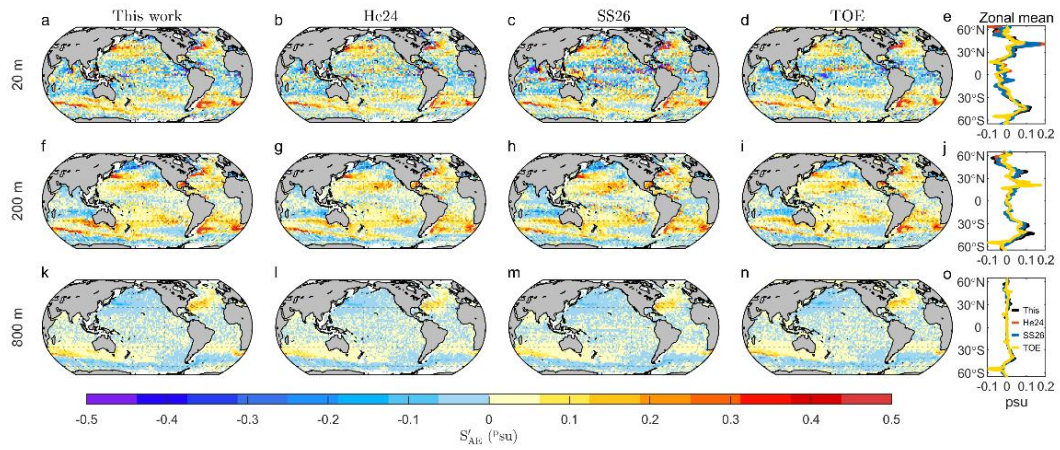


Fig.R5 The same as Fig.R3, but for mean salinity anomalies within anticyclonic eddies.

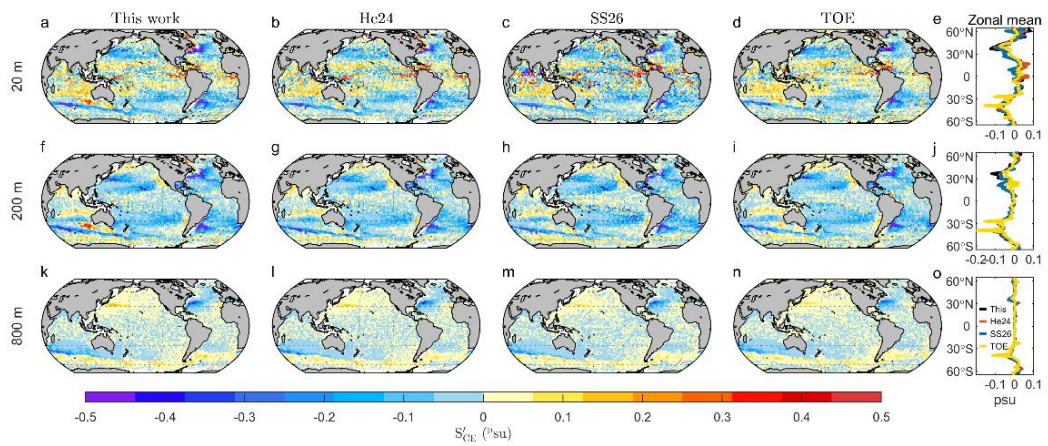


Fig.R6 The same as Fig.R3, but for mean salinity anomalies within cyclonic eddies.

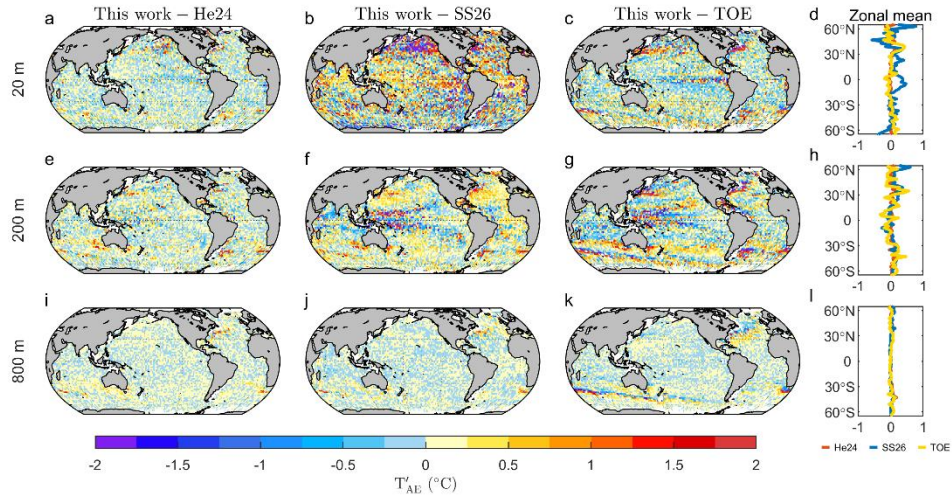


Fig.R7 Difference between temperature anomalies within anticyclonic eddies calculated from our work and those from other data, estimated within each $2^\circ \times 2^\circ$ grid box, at the depths of (top to bottom) 20 m, 200 m, and 800 m. The left three panels are the difference between and He et al. (2024b) (He24), Simoes-Sousa et al. (2026) (SS26), and (TOE) respectively. The right panel is the zonal mean of the left three panels.

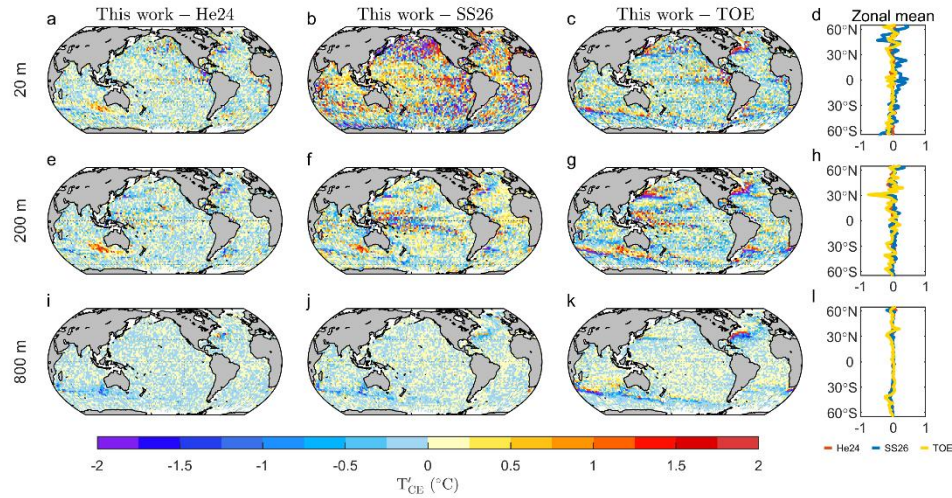


Fig.R8 The same as Fig.R7, but for temperature anomalies within cyclonic eddies.

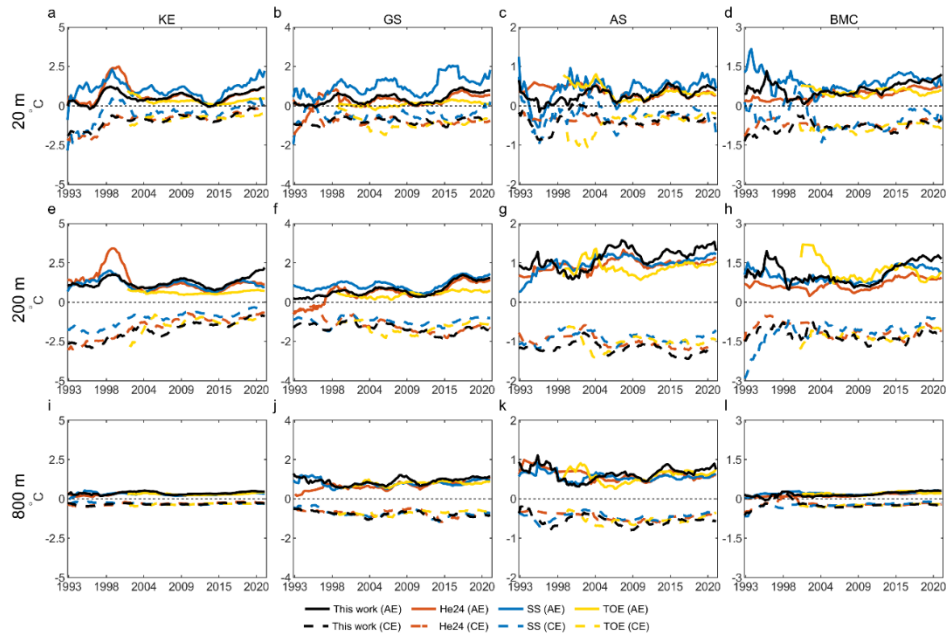


Fig.R9 Time series of eddy-induced temperature anomalies within anticyclonic and cyclonic eddies at depths of (top to bottom) 20, 200, and 800 m, estimated using a 12-month running mean. Columns correspond to the Kuroshio Extension (KE, 28°N-40°N and 140°E-180°E), the Gulf Stream (GS, 35°N-50°N and 30°W-70°W), the Agulhas System (AS, 27°S-42°S and 0°W-40°W), and the Brazil–Malvinas Confluence (BMC, 35°S-55°S and 30°W-65°W), respectively. Black, red, blue, and yellow curves represent estimates derived from the dataset developed in this study, He24, SS26, and TOE, respectively.

(4) “Unfortunately, we were unable to locate the specific reference listed as “Schubert et al. (2021)” in your comments.”: Schubert et al. (2021) is <https://www.nature.com/articles/s43247-021-00271-y>

Response: Thank you for providing this reference. We have now included the citation to Schubert et al. (2021) in the Introduction to support the corresponding statement (Line 48 in the revised manuscript).

(5) Line 612 - Code and Data Availability: “The codes for producing eddy-collocated T-S profile data can be accessed on Zenodo”. Where are the codes? I cannot find in the Zenodo link. Please also put the version and download link of CODC.

Response: Thank you for your careful review and for pointing this out. We apologize for the misleading statement in the previous version. We do not provide the data processing code. Therefore, we have revised the Code and Data Availability section by removing the statement referring to the code and replacing it with: “The eddy-collocated T-S profile dataset used in this study is publicly available at <https://zenodo.org/records/20607854>”. In addition, we have updated the Zenodo link to the latest version of the dataset and added both the version information (CODC-v2) and the download link for the underlying CODC dataset (http://www.ocean.iap.ac.cn/ftp/cheng/CODCv2_Insitu_T_S_database/) (Please refer

to Lines 657-661 in the revised manuscript).

(6) Line 614: only temperature profile?

Response: Thank you for pointing this out. We have corrected this sentence to: “The original WOD temperature and salinity profile dataset is available at https://www.nodc.noaa.gov/OC5/WOD/pr_wod.html.” (Line 662 in the revised manuscript).

(7) Table 1, ‘profile_lon’ is described as “latitude”, typo?

Response: Thank you for pointing this out. We have corrected the typo in Table 1 by replacing “latitude” with “longitude” in the description of the variable profile_lon.

(8) Line 139: WOD citation ‘Boyer et al., 2016’ is out of date. WOD23 is released.

[1] Mishonov A.V., T. P. Boyer, O. K. Baranova, C. N. Bouchard, S. Cross, H. E. Garcia, R. A. Locarnini, C. R. Paver, J. R. Reagan, Z. Wang, D. Seidov, A. I. Grodsky, J. G. Beauchamp, (2024): World Ocean Database 2023. C. Bouchard, Technical Ed., NOAA Atlas NESDIS 97, 206 pp.

[2] H. Garcia, T. Boyer, S. Levitus, J. Reagan, A. Mishonov, L.-Q. Jiang, Z. Wang, C. Paver, E. Nyadjro, S. Cross, World Ocean Database 2023: A Foundational Data Resource for and by the Global Ocean and Coastal Communities. Scientific Data 13, 613 (2026).

Response: Thank you for pointing this out and for providing the updated references. We have updated the WOD citations accordingly by citing *Mishonov et al.* (2024) and *Garcia et al.* (2026) in Lines 139–140 of the revised manuscript.

(9) codes:

The file ‘Eddy_Collocated_T-S_profiles_Global_1993-2021.nc’ in the <https://zenodo.org/records/20607854> seems to be the old one and didn’t use the new one to replace. Please use the new one to replace it. In addition, in this file, for each variable, still no basic information such as ‘long_name’, ‘units’. Does the author take seriously of the dataset seriously?

Response: Thank you for your careful review and for pointing out these important issues. You are correct that the unified file "Eddy_Collocated_T-S_profiles_Global_1993-2021.nc" corresponds to the original version of the dataset used in our initial submission. Unfortunately, Zenodo does not allow published files to be removed from an existing record. Therefore, the original unified file has been retained in the repository for users who may wish to access the previous version of the dataset.

Following your previous suggestion, the revised dataset is now provided as annual files named "T_S_profile_eddy_YYYY.nc", which are generated from the updated CODC-v2 quality-controlled profile dataset. This organization not only substantially reduces file size and facilitates data access, but also clearly distinguishes the updated product from the original version. In these updated files, all variables now include the corresponding descriptive attributes, including “long_name”, “units”, and other

standard metadata data (e.g., title, data sources and references), to improve the usability and self-descriptiveness of the dataset.

To avoid confusion, we have updated the README file to clearly describe the organization of the repository and the relationship between the two data products. Specifically, the README now states that the annual files ("T_S_profile_eddy_YYYY.nc") constitute the updated dataset, whereas the unified file ("Eddy_Collocated_T-S_profiles_Global_1993-2021.nc") is retained as the original version used in He et al. (2024) for reference.

We hope this clarification makes the organization of the repository clear to users.

(10) Line 513: use the new version Zenodo's link to replace the old one.

Response: We have updated the dataset link to the latest Zenodo record (<https://zenodo.org/records/20607854>) in Line 658 of the revised manuscript. Thank you.

Comment from Referee #3

Although the authors omitted my second suggestion to use vertical displacement, I understand the difficulties they explained and agree that my suggestion is optional for accepting this manuscript. I think it would be useful to obtain background vertical temperature structure to compare the discrepancies with and without eddies, but it can be estimated in reverse from both the temperature and the anomaly terms in the dataset. Therefore, I am not against the publication of this manuscript.

Response: We sincerely thank you for your constructive comments and positive evaluation of our manuscript. We greatly appreciate your understanding regarding the practical considerations associated with your suggestion on using vertical displacement, as well as your recognition that the existing dataset provides sufficient information for users to derive the corresponding background temperature structure if needed. Your insightful comments have greatly helped improve the clarity and quality of the manuscript, and we are grateful for your recommendation to accept the paper.
