1. Consider adding information on the formation mechanism of SSEs in the regions to provide readers with a more comprehensive understanding of SSEs. What's the dominant mechanism of SSE generating in NIO? What cause the different chlorophyll features between SEs and SSEs? If necessary, please give explanations with Argo/BGC-Argo results.

Response: Thanks for the suggestion. Firstly, we have incorporated relevant information about the formation mechanisms of subsurface Submesoscale Eddies (SSEs) in the introduction, aiming to provide readers with a comprehensive understanding: "The mechanisms behind the emergence of SSEs are hypothesized to stem from eddy–wind interaction, localized adiabatic processes, barotropic and baroclinic instabilities, or topographic influences (Badin et al., 2011; McGillicuddy, 2015; Meunier et al., 2018; Thomas, 2008)."

Next, in Section 4 of the study, Figs. 8-9 reveal that the difference in the subsurface structure between SEs and SSEs is largely confined to the MLD. Such a result indicates that the formation of SSEs is dominated by eddy–wind interaction (McGillicuddy, 2015), which leads to lens-shaped disturbances in the thermocline. The relative motion between surface winds and eddy surface currents leads to anomalous Ekman upwelling (downwelling) within AEs (CEs), which can induce doming (depressing) of the upper ocean density surfaces inside AEs (CEs) (Gaube et al., 2015).

Moreover, the vertical potential density structures within SEs and SSEs are constructed using the Argo profiles, as shown in Fig 9. The result shows the distinct displacements of isopycnals between SEs and SSEs, which provides insight into the contrasting impacts on Chl-a distribution. The convex of isopycnals within SSAEs leads to the ascent of deeper water to the surface layer. This process facilitates the vertical transport of nutrients, promoting enhanced biological productivity and higher concentrations of Chl-a within SSAEs than SAEs. The vertical movement of water masses and the associated nutrient supply contribute to the favorable conditions for phytoplankton growth and the accumulation of Chl-a in SSAEs. Similarly, the concave of isopycnals within SSCEs leads to the subduction of surface water, resulting in lower Chl-a concentrations compared to SCEs.

By integrating these findings, we underscore the primary role of eddy–wind interaction in driving SSE formation, while the distinctive isopycnal displacements illuminate the underlying mechanisms contributing to varying Chl-a characteristics within these eddy types.

2. The manuscript concluded that SSEs account for nearly 50% of the total eddies, which needs further consideration. The sea surface temperature can be easily disturbed by environment, such as wind speed. Therefore, identifying SSEs according SSTA<0 (or SSTA>0) may increase the noises from low-energy eddies. It is suggested to set threshold for SSEs identification, such as amplitude, lifetime, which should increase the accuracy of SSEs identification.

Response: Thanks for the suggestion. Considering the resolution and precision of the SSHA product (Pujol et al., 2016), individual eddies with amplitudes ≥ 2 cm and radii ≥ 35 km are selected to avoid the noises from low-energy eddies in the study. Consequently, it is worth noting that the proportion of SSEs declined from the initial 44% to the current 39%. This adjustment is a direct outcome of utilizing the refined threshold dataset. Subsequent to this refinement, we have replotted Figures 4-9 and made appropriate modifications to the numerical values within Table 1 based on the updated data.

3. The paper proposes an identification method for SEs and SSEs using deep learning, along with validation and analysis of their temperature and chlorophyll characteristics. Consider refining the title to align more accurately with the manuscript's content.

Response: Thanks for the suggestion. The title has been revised to "Impact of Surface and Subsurface-Intensified Eddies on Sea Surface Temperature and Chlorophyll-a in the Northern Indian Ocean Utilizing Deep Learning."

4. Line 104: Reword 'as described by Assassi et al. (2016)' to 'as described in the study by Assassi et al. (2016)'.

Response: Revised as suggested.

5. Line 114-117: Has the sign of SSρ/SSHA been previously used as an indicator to distinguish SEs and SSEs in any studies? Please provide references if available.

Response: Since SSρ cannot be directly measured from remote sensing observations. Instead, at first order, SSρ are primarily influenced by SST variations, which can be observed remotely. Therefore, the sign of SST/SSHA has been successfully used as an indicator to distinguish SEs and SSEs in previous studies (Greaser et al., 2020; Trott et al., 2019; Wang et al., 2019). Detailed information has been added in Section 2.2.1 of the revised manuscript.

6. Line 145: Please include the formula for the dice loss function.

Response: The formula for the dice loss function can be seen in the following:

$$\mathrm{Loss} = 1 - \mathrm{Dicecoef}(\mathrm{P}, \mathrm{G}) \tag{1}$$

The dice coefficient is a popular cost function for segmentation problems in deep learning. Given the predicted segmentation P and the ground truth region G, the dice coefficient is calculated as:

$$\mathrm{Dicecoef}(\mathrm{P}, \mathrm{G}) = \frac{2|P \cap G|}{|P| + |G|} \tag{2}$$

where |.| is the sum of elements in the area. A good segmentation result is explained by a dice coefficient close to 1. A low dice coefficient (near 0) indicates poor segmentation performance. Detailed information has been added in Section 2.2.1 of the revised manuscript.

7. Line 146: What is the specific definition of accuracy for the DL-based model? Clarify this point.

Response: The categorical accuracy is used to estimate the eddy identification accuracy for the DL-based model. Categorical accuracy is a metric that calculates the mean accuracy rate across all predictions for multi-class classification problems. It is defined as follows:

$$Categorical\ accuracy = \frac{TP+TN}{TP+TN+FP+FN} \tag{3}$$

where TP, TN, FP, and FN represent the number of true positives, true negatives, false positives, and false negatives, respectively. Detailed information has been added in Section 2.2.1 of the revised manuscript.

8. Line 167: Provide detailed information on the inversed distance weighting interpolation method.

Response: Inverse distance weighting (IDW) is a deterministic method for multivariate interpolation with a known scattered set of points. The assigned values to unknown points are calculated with a weighted average of the values available at the known points. In the study, the temperature and potential density anomalies within 1.5R of mesoscale eddies were interpolated into 0.1R × 0.1R grid points up to a horizontal distance of 1.5R by the IDW interpolation method (Bartier & Keller, 1996) at each depth level (Dong et al., 2017; Sun et al., 2019; Yang et al., 2013). For each grid point, Argo profiles located within the horizontal range of 0.1R are set the weight value:

$$w_i = e^{-(\frac{d}{R})^2} \tag{4}$$

where d denotes the distance from the profile to the grid point. The final temperature or potential value at each grid point, N_{grid}, is calculated from the profile values N_i as:

$$N_{grid} = \frac{\sum w_i N_i}{\sum w_i} \tag{5}$$

Detailed information has been added in Section 2.2.2 of the revised manuscript.

9. Line 258: Revise 'to accurately determine the most intense core's location' to 'to determine the location of the most intense core accurately.'

Response: Revised.

10. Figure 5: The Chl-a anomalies induced by SSAEs and SSCEs displayed in the current color bar are not easily discernible. It is recommended to modify the color bar to enhance the visibility of the differences.

Response: The color bar in Figure 5 has been revised as suggested.

Reference

Badin, G., Tandon, A., & Mahadevan, A. (2011). Lateral mixing in the pycnocline by baroclinic mixed layer eddies. *Journal of Physical Oceanography, 41*(11), 2080-2101.

Bartier, P. M., & Keller, C. P. (1996). Multivariate interpolation to incorporate thematic surface data using inverse distance weighting (IDW). *Computers & Geosciences, 22*(7), 795-799. https://doi.org/10.1016/0098-3004(96)00021-0

Dong, D., Brandt, P., Chang, P., Schütte, F., Yang, X., Yan, J., & Zeng, J. (2017). Mesoscale Eddies in the Northwestern Pacific Ocean: Three-Dimensional Eddy Structures and Heat/Salt Transports. *Journal of Geophysical Research: Oceans, 122*(12), 9795-9813. https://doi.org/10.1002/2017jc013303

Gaube, P., Chelton, D. B., Samelson, R. M., Schlax, M. G., & O'Neill, L. W. (2015). Satellite observations of mesoscale eddy-Induced Ekman pumping. *Journal of Physical Oceanography, 45*(1), 104–132. https://doi.org/10.1175/jpo-d-14-0032.1

Greaser, S. R., Subrahmanyam, B., Trott, C. B., & Roman-Stork, H. L. (2020). Interactions between mesoscale eddies and synoptic oscillations in the Bay of Bengal during the strong monsoon of 2019. *Journal of Geophysical Research: Oceans, 125*(10), e2020JC016772. https://doi.org/10.1029/2020JC016772

McGillicuddy, D. J., Jr. (2015). Formation of Intrathermocline Lenses by Eddy-Wind Interaction. *Journal of Physical Oceanography, 45*(2), 606-612. Article. https://doi.org/10.1175/jpo-d-14-0221.1

Meunier, T., Tenreiro, M., Pallàs-Sanz, E., Ochoa, J., Ruiz-Angulo, A., Portela, E., et al. (2018). Intrathermocline eddies embedded within an anticyclonic vortex ring. *Geophysical Research Letters, 45*(15), 7624-7633.

Pujol, M.-I., Faugère, Y., Taburet, G., Dupuy, S., Pelloquin, C., Ablain, M., & Picot, N. (2016). DUACS DT2014: the new multi-mission altimeter data set reprocessed over 20 years. *Ocean Science, 12*(5), 1067–1090. https://doi.org/10.5194/os-12-1067-2016

Sun, B., Liu, C., & Wang, F. (2019). Global meridional eddy heat transport inferred from Argo and altimetry observations. *Scientific Reports, 9*(1), 1345. https://doi.org/10.1038/s41598-018-38069-2

Thomas, L. N. (2008). Formation of intrathermocline eddies at ocean fronts by wind-driven destruction of potential vorticity. *Dynamics of Atmospheres and Oceans, 45*(3-4), 252-273.

Trott, C. B., Subrahmanyam, B., Chaigneau, A., & Roman-Stork, H. L. (2019). Eddy-induced temperature and salinity variability in the Arabian Sea. *Geophysical Research Letters*. https://doi.org/10.1029/2018GL081605

Wang, Z.-F., Sun, L., Li, Q.-Y., & Cheng, H. (2019). Two typical merging events of oceanic mesoscale anticyclonic eddies. *Ocean Science, 15*(6), 1545-1559. https://doi.org/10.5194/os-15-1545-2019

Yang, G., Wang, F., Li, Y., & Lin, P. (2013). Mesoscale eddies in the northwestern subtropical Pacific Ocean: Statistical characteristics and three-dimensional structures. *Journal of Geophysical*

Research: Oceans, 118(4), 1906-1925. https://doi.org/10.1002/jgrc.20164