

Response to Reviewer 1

Thank you for your comments on our paper. Below, please see our responses (in black) to the comments (in blue). We hope that you find our manuscript to be improved and suitable for publication.

The authors developed a new method for detecting oceanographic fronts by employing PCA, GMM, and I-metric. By utilizing B-SOSE, they have demonstrated that their new methods successfully detect fronts, which vary in time and space. In general, I think their scientific discussions are sound. I think this manuscript is well-written. However, for readers who do not know much about these analyses methods, some parts of the text are difficult to follow. I suggest minor revision before publication.

Thank you for these comments, we have endeavoured to improve the manuscript in response to these recommendations.

Minor comments

Section 2.1 For those people who do not know much about ECCO, it would be great if authors can elaborate a bit about what other ECCO products are available and why authors choose B-SOSE.

Good suggestion, thank you. That has been added.

Lines 117-126: This part of the text is difficult to follow without reading Pauthenet et al., 2017 carefully. A bit more explanation (e.g., equations (1) in Pauthenet et al., 2017) and something similar to Fig. 4 in Pauthenet et al., 2017 would be helpful for better understanding.

Thank you for pointing this out. We have added additional detail to section 2.2, and we have added an appendix (Appendix B) with our version of Fig. 4 from Pauthenet et al. (2017) (Figure B2). We hope that this helps clarify our procedure.

Line 147-170: If I am not wrong, I think PCA is used just to compress the data (reduce its number of dimensions), rather than to investigate the structure of its covariance matrix. This point is not stressed in this paper. The authors should clarify this point if this is correct.

The PCA is not just used to compress the data, we also look at the PC spatial distribution in figure 1, which helps us understand the main modes of the thermohaline structure.

In addition, it becomes easier to understand if the authors can elaborate on (1) why GMM is used rather than PCA (advantages and disadvantages) and (2) the difference (or relations)

between vertical modes of temperature and salinity obtained from PCA analysis and figure 5. For me, this manuscript was initially very confusing because it took me a while to understand that PCA is only used to compress the data but main analysis was conducted using GMM.

Thank you for these comments, that is helpful. I have tried to add an additional sentences to prime the reader with this purpose.

Abstract and Summary :

Authors conduct analysis using Sobel edge operator but they do not argue how it can be useful in the abstract and conclusion. A sentence describing how it can be useful and comparisons with GMM is going to be useful.

Thank you for this comment, we have added more comments to the abstract (lines 15-19), summary, and conclusions (lines 396-397). Specifically, we mention that Sobel edge detection may be useful for defining and tracking smaller-scale fronts in model and reanalysis data.