

ESSD-2025-514: Reply to comments from Referee #1  
(Reviewer comments in bold, author responses in blue)

This is an interesting paper that has potential to become a major contribution pending major revisions. The results (presented as maps of fronts) look quite realistic. Every front in these maps corresponds to a similar front reported by other researchers. [Similarity here means location and configuration of the front.] Some fronts reported by other researchers are missing in the frontal maps presented in the reviewed manuscript. This is not surprising since most fronts are seasonal. Therefore, it is possible that such fronts can be found in the entire 30-year dataset generated in this study and made freely available by the authors on the Web. Summing up the above, the manuscript should be published. At the same time, the manuscript suffers from major drawbacks enumerated below. Therefore, the manuscript needs a major revision, after which the revised manuscript must be reviewed very carefully to make sure that all major issues have been adequately addressed. The authors should be given ample time to revise the present manuscript radically and meticulously. The Methods section must be elaborated. The Results section should be expanded. A comparison of the authors' results with the results of published papers on fronts in the China Seas should be considered.

We would like to express our sincere gratitude to Referee #1 for the positive evaluation of our manuscript and for providing constructive suggestions. Your comments have been invaluable in helping us further strengthen our arguments, refine the data interpretation, and enhance the overall quality of the manuscript. In the following sections, we will provide a specific, point-by-point response to all of your comments and suggestions. We have also compared our results with those reported in published papers on the China Seas and have added corresponding citations in the text. “In terms of seasonal and spatial distribution characteristics, the results align with prior observations (Hickox et al., 2000).”

The text is sloppy. On several occasions, the authors use wrong terms instead of correct terms. In some cases, sentences with wrong terms become incomprehensible. Numerous characteristics of fronts are neither defined, nor explained or illustrated. The text is peppered with redundant passages (some reproduced below). Main conclusions are not supported by data. Descriptions of methods and algorithms are too cursory. Some descriptions are cryptic because of their brevity and non-standard (or non-defined) terms used. Therefore, the results cannot be reproduced and validated by other researchers. The reference list is a total mess. Every reference must be rechecked and corrected. Some references are incomplete and must be completed. The corrupted references resulted in a series of corrupted citations, especially in the Introduction (such citations are listed below).

The current version of the manuscript exhibits shortcomings in terminological accuracy, clarity of descriptions, methodological details, robustness of conclusions,

and standardization of references. We have systematically reviewed the entire text and replaced all non-standard or erroneous terminology. Concurrently, we have removed the redundant paragraphs you identified to make the argument more concise and the logic clearer. We have thoroughly checked and corrected the entire reference list to ensure the completeness of each entry and have synchronized all erroneous citations in the main text, particularly in the introduction section, to eliminate any citation inconsistencies. To fundamentally address issues of linguistic clarity and structural logic, we engaged a professional academic editing service to conduct a thorough edit and optimization of the entire text. The service focused on enhancing the professionalism and fluency of the English expression, as well as the overall readability of the article. All scientific content, data, conclusions, and academic arguments remain the sole responsibility of the authors and were finally confirmed by us.



Title: "ocean" should be "Ocean"

Thank you for pointing out this typographical error. We have followed your suggestion and corrected the term "ocean" to "Ocean" in the title.

L23: jumping zone – Wrong term

Thank you for pointing out this terminology error. You are absolutely correct. We

have revised the original term "jumping zone" to the more accurate and standard description, "a narrow transition zone."

L38-40: "Park and Il-Seok 2003... Cun-Jin et al. 2008... Qingling and Jianyu 2010...Gen-Yun et al. 2012... Park and Il-Seok 2003..." – These citations are wrong because the respective references are wrong. Fix the reference list, then fix the citations.

Thank you for pointing out these critical errors. We fully agree with your assessment that the citations in the original text did not match the entries in the reference list and that there were issues with non-standard author name spellings and duplicate citations. In accordance with your suggestions, we have conducted a comprehensive review of the reference list.

L41:"...these algorithms may not effectively distinguish between genuine ocean fronts and other image features or artifacts." – This vague criticism is unsubstantiated. Delete.

We agree with the reviewer's comment. The original sentence indeed constituted a generalized statement lacking concrete supporting evidence. To maintain the rigor of our argument, we have completely removed the sentence on line 41. Thank you for pointing this out, as it has strengthened the solidity of our discussion.

L50:"dual I value" – What's that?

The expression "dual I value" is inappropriate, and we have corrected it in the original text.

L53:"Chuan-Yu and Fan 2009" – Wrong citation. See L38-40 above.

In accordance with your suggestions, we have conducted a comprehensive review of the reference list.

L55:"Traditional methods based on gradient thresholds often struggle to accurately detect complex and diverse ocean fronts. These methods may overlook subtle variations in the gradient values or fail to capture the intricate patterns and transitions associated with complex fronts. This limitation hampers the ability to comprehensively study and understand the dynamics of ocean fronts. In summary, traditional methods for extracting ocean fronts suffer from limitations such as subjective threshold selection, inadequate handling of complex fronts, dependency on edge detection algorithms, and limited adaptability to changing conditions. Overcoming these limitations is essential for achieving accurate and comprehensive detection of ocean fronts." -- This unsubstantiated criticism of all previous algorithms is uncalled for, unwarranted, and unfair. Delete.

We fully understand and appreciate the reviewer's important comment on this point. We acknowledge that the original paragraph presented an overly generalized and absolute critique of the entire field of traditional methods, which was indeed not rigorous or fair. Accordingly, we have removed the entire content of paragraph 55.

L81: "depth learning" should be "deep learning"

Thank you very much for pointing out this typographical error. We have thoroughly checked the entire text to ensure consistency in the use of this standard terminology.

L90: "The study area for this research is spanning a latitude range of 0° to 50°N and a longitude range of 100° to 150°E (Fig.1). The research area includes Bohai Sea, Yellow Sea, East China Sea, South China Sea, and Western Pacific. These waters cover various ecosystems such as coastal plains, deep trenches, islands, and coral reefs. The marine hydrological conditions are diverse, covering temperate, subtropical, and tropical waters. The changes in ocean temperature, salinity, and ocean currents have significant impacts on marine ecology and climate. The convergence of ocean currents such as the East China Sea Warm Current, Kuroshio, and Philippine Current in this region has a significant impact on marine ecology and climate change. And it has abundant marine resources, including fishery resources, oil and natural gas reserves, mineral resources, as well as renewable energy such as wind and tidal energy. By specifically examining this region, the research aims to gain insights into the dynamics of ocean fronts and their characteristics in this area. Understanding the behavior and distribution of ocean fronts in the South China Sea is crucial for various applications, including marine ecology, fisheries management, and weather prediction. The chosen geographic extent provides a representative and comprehensive view of the oceanic features and processes occurring in this dynamic and economically important region." – Except for the first sentence, the entire paragraph is trivial and does not belong here. Keep the first sentence. Delete the rest of the paragraph.

We fully agree with the reviewer's comment. The extended description in the original paragraph regarding the ecological, resource-related, and economic significance of the study area indeed had weak relevance to the core content of this paper, which focuses on front detection algorithms, and was therefore redundant. We have strictly followed your suggestion by retaining only the first sentence to define the study area and have removed all subsequent content from that paragraph.

L95: Philippine Current should be Mindanao Current

Thank you to the reviewer for this professional correction. It is worth noting that the entire paragraph (Paragraph 90) containing this terminology has been completely removed in accordance with your request in the previous comment (regarding L90).

L113:"from the top to the bottom" – Delete

We agree with the reviewer's comment. The phrasing was redundant. We have deleted it from line 113. The revised sentence is more concise while retaining the original meaning. Thank you for helping us refine the language.

L115:"The Unit is Celsius" should be "°C"

Thank you for your correction. We have revised the non-standard expression in the original text to the standard unit symbol as per your suggestion. Line 115 has now been corrected to: "The units are °C;". Furthermore, we have checked and standardized the representation of all temperature units throughout the entire text to ensure the consistent use of the standard symbol "°C". We apologize for the previous oversight.

L125: saltation – Wrong term

We thank the reviewer for pointing out this terminology error. We agree that "saltation" is inappropriate in this context. After verification, we have corrected it to a more precise term that aligns with the semantic meaning of the context.

L135: types of houses – What's that?

We sincerely thank the reviewer for pointing out this confusing expression. You are absolutely correct that the phrase "types of houses" in the original sentence was a grammatical error and logically inconsistent within the context. We have completely rewritten the entire descriptive paragraph (originally around L135) containing this issue, removing all inaccurate expressions.

Table 2:"Cell thickness" – Wrong term

We have updated the content of Table 2.

Table 2: "Mercator Ocean Internationa" should be "Mercator Ocean International"

Thank you to the reviewer for pointing out this spelling error. We have corrected it to the proper spelling "Mercator Ocean International." We apologize for this oversight and appreciate your thorough review.

L230-235:This paragraph is an example of the extremely redundant and verbose style of this manuscript: "To create a gradient image, the gradient of the original temperature data was computed using formulas .... Fig.5 displays the gradient image of the Ocean Front Time Series in January 2023. The gradient image represents the spatial distribution of ocean fronts, indicating areas of sharp temperature gradients within the specified time period. The colors in the image represent different gradient intensities, with warmer colors indicating stronger gradients. The gradient image

provides valuable insights into the spatial patterns and variability of ocean fronts during the specified time frame. It allows for a visual identification of regions with pronounced frontal activity, which is essential for understanding ocean dynamics and processes." – Comments: The word "gradient" is repeated in every one of six sentences above, except for the last sentence.

We have revised the text as follows: To generate the frontal indicator field, we first calculated the temperature gradient by using Formulas (1) – (3). Fig. 5 shows the resulting field for January 2023, which highlights regions in which the sea surface temperature changes rapidly, revealing the spatial structure of the ocean fronts. Warmer colours correspond to stronger transitions. This representation clearly outlines areas of active frontal variability and facilitates a straightforward visual assessment of their distribution and evolution during the month. We have applied the principle of "avoiding repetition and refining expression" throughout the revision of the entire manuscript. Once again, we sincerely thank you for helping us significantly improve the linguistic quality of the manuscript.

Figure 6 (below):The image before marking (left panel) and after marking (right panel). Comments: The marking algorithm is not explained.

We have added explanatory notes in both the main text and the figure captions to specify that the algorithm was manually annotated.

L318:"depth learning" should be "deep learning"

Thank you very much for pointing out this typographical error. We have thoroughly checked the entire text to ensure consistency in the use of this standard terminology.

L327-329:"Calculate the feature elements of the ocean front, extract the intensity and width of the ocean front at the corresponding longitude and latitude based on the recognition results of the ocean front, and thus achieve intelligent extraction of the position, intensity, and width of the ocean front." -- Poor grammar. "Feature elements" have not been defined.

"Feature elements" refer to width and intensity, and the manuscript has been revised accordingly.

L333: "number of fronts" is a meaningless characteristic. Depending on a particular front detection algorithm, the number of fronts can vary by order of magnitude.

We agree with your point and have removed the description regarding the number of fronts.

L334:"accuracy" has not been defined

After careful consideration, we have decided not to address the number of detected ocean fronts at this point and therefore will not discuss detection accuracy in this context. We have removed the description regarding accuracy.

L336:

intensity refers to the temperature gradient magnitude

L340: "width" has not been defined

the width was calculated as the distance from the centerline to the boundary.

L356: "ocean fronts are the most active and numerous in summer" – This conclusion is highly questionable. See Hickox et al. (2000, GRL) ("Climatology and seasonal variability of ocean fronts in the East China, Yellow and Bohai seas from satellite SST data").

We thank the reviewer for the comment. We have cross-referenced the paper by Hickox et al. (2000, GRL) and carefully examined our own figures, and have now made the necessary corrections.

L373:"Meteorological conditions such as wind, clouds, precipitation, and atmospheric pressure may affect the clarity and visibility of satellite images." – Atmospheric pressure does not affect satellite images.

Thank you for pointing out this inaccuracy. You are absolutely correct that atmospheric pressure itself does not directly affect the clarity of satellite imagery. We have removed "atmospheric pressure" from the list in that sentence.

L375: "surges" – What's that?

Revised to the more accurate expression "storm surge".

L389:"The rapid changes in hydrological conditions may affect the shape and position of the front." – Shape has not been defined.

"Shape" here refers to the spatial structure.

L393: "Underwater" should be "Subsurface"

Thank you for your precise correction. We agree that "subsurface" is the more

appropriate and standard term in this oceanographic context. We have revised "underwater" to "subsurface" in the manuscript.

L396: "comprehensive" should be "combined"

Thank you for this precise suggestion. We agree that "combined" more accurately conveys the intended meaning in this context. We have revised "comprehensive" to "combined" on line 396.

L406-408: "An important ocean phenomenon, rapid and accurate detection of ocean front is of great significance to marine ecology, fishery resources and typhoon path prediction. In view of the scarcity and weak edge characteristics of ocean front data, the data are expanded in various forms to increase the data set effectively." – Just another example of "word salad" of little, if any, interest to the reader. The "weak edge characteristics" have never been explained or illustrated. The phrase "the data are expanded in various forms to increase the data set effectively" is meaningless.

Thank you for your critical comment. We agree that the original sentences were vague and unsupported, which was unhelpful to the reader. We have revised the text accordingly. The term "weak edge characteristics" refers to the fact that ocean fronts are small-target entities in SST remote sensing imagery, where the edge information is inconspicuous, variable, and exhibits low contrast, demonstrating weak edge properties.

L408: "depth learning" should be "deep learning"

Thank you very much for pointing out this typographical error. We have thoroughly checked the entire text to ensure consistency in the use of this standard terminology.

L410: The phrase "the recognized front has good independence and integrity" is meaningless.

We have removed this expression.

L414: "small-scale fronts" are mentioned here but scales have not been discussed at all.

The manuscript indeed does not address the scale issue; we have removed this statement.

L420: "The deep learning method outperforms traditional methods in extracting feature parameters such as ocean front intensity and width." – There is no proof in this study. Such claims must be supported by data.

We have revised the manuscript to emphasize that the AI-based approach achieves results comparable to traditional extraction methods, while also addressing the issue of inconsistent threshold selection criteria in gradient-based algorithms. L422: "scale" is mentioned again. See L414.

L422: "scale" is mentioned again. See L414.

The manuscript indeed does not address the scale issue; we have removed this statement.