

## Response to Reviewer #2 (Dr. Urmaz Raudsepp)

Dear Dr. Urmaz Raudsepp, thank you for reading and suggesting modifications to our manuscript entitled “Establishing a Monitoring Approach for Marine Heatwaves in the Black and Mediterranean Seas”.

We believe that your review has helped to substantially improve the revised manuscript. The changes in the manuscript have been highlighted in red. Additionally, please find below a list with our point-by-point answers (*in italic*) to your comments and suggestions.

The manuscript “**Establishing a Monitoring Approach for Marine Heatwaves in the Black and Mediterranean Seas**” provides a comprehensive analysis of marine heatwaves (MHWs) in two climatically important semi-enclosed basins. Overall, this is a strong contribution that combines well-established surface temperature metrics with a novel subsurface perspective. The study addresses an important gap – previous MHW research in the Mediterranean Sea is extensive, but the Black Sea has seen very limited attention (indeed only one prior dedicated study). By tackling both regions together and integrating subsurface indicators, the authors advance our understanding of MHW characteristics in these basins. The work is timely, given the pronounced warming trends observed in the Mediterranean and Black Seas over recent decades, and the need for improved monitoring of extreme thermal events in the upper ocean.

My overall impression is very positive. To further improve the manuscript, I suggest the following minor refinements:

- **Emphasize key findings in plain language:** After sections of heavy analysis, add one or two sentences that plainly state what the numbers mean. These statements help ensure the reader takes away the main messages.

*We agree with the reviewer’s suggestion. To improve clarity and readability, we have added plain-language sentences at the end of each relevant section of the manuscript to emphasize the key findings and clearly state what the results mean for the reader. We would greatly appreciate the reviewer’s feedback on these additions to ensure they effectively communicate the intended messages.*

- **SST vs OHC definition clarity:** Clarify the parallel between the SST-based and OHC-based MHW definitions. The paper could explicitly say, “We apply the same 90th-percentile threshold approach to daily OHC anomalies (0–40 m) to define subsurface MHW events,” just to eliminate any doubt. This would reinforce that the two approaches are methodologically consistent.

*We agree with the reviewer and have clarified this point in the first paragraph of the Methods section (lines 120-130). We now explicitly state that the Hobday et al. (2016) MHW framework, originally formulated for SST, is extended to upper-ocean heat content and applied independently to each selected thermal field. This clarification reinforces the methodological consistency between the SST-based and OHC-based MHW definitions.*

- **Figure presentation:** Ensure all multi-panel figures are reader-friendly. Large composite figures might be split across pages or be hard to read. The authors might consider splitting a figure into two if it’s overly crowded (e.g. Figure 1), or at least use

panel labels (a, b, c, ...) and refer to them in the caption and text. For instance, instead of “rows 6 and 7 in Figure 1,” using “Figure 1f–g” (if panels are labelled) could be clearer.

*We have addressed the reviewer’s suggestion for Figure 1. All panels in Figure 1 are now clearly labeled, and we have referred to these panel labels consistently in the figure caption, throughout the figure description in the Results section, as well as throughout the text.*

- **Discussion of implications:** The conclusion could go a step further in discussing what the findings imply for ecosystem management or forecasting. The introduction references mass mortality events and bloom disruptions from MHWs. Perhaps the authors can speculate briefly in the conclusion about how having a subsurface MHW indicator might aid early warning systems for marine parks or fisheries in these seas. This would enhance the impact of the work for a broad audience.

*We have addressed the reviewer’s suggestion. The last paragraph of the Conclusion has been updated to include the requested discussion on implications for ecosystem management and early warning systems. The revised paragraph is as follows:*

*“While the need to provide information on both surface and subsurface characteristics of MHWs is made clear in this study for the Mediterranean and Black Sea, and in Sun et al. (2023) at global scale, the depth ranges of interest depend greatly on region and application. The 0–40 m layer was selected here to capture the biologically productive upper epipelagic zone, which supports key ecological functions and socio-economic activities. Incorporating a subsurface MHW indicator provides valuable insights for ecosystem management and early warning systems. Monitoring OHC-based heat anomalies can help anticipate thermal stress on sensitive habitats, aquaculture sites, or commercial fisheries before surface signals appear, enabling timely management actions and reducing the impacts of mass mortality events and disruptions in biological productivity. Future studies should therefore explore region-specific depth thresholds that account for local oceanographic dynamics and ecological sensitivities”.*