

Revision of manuscript **sp-2024-31**

This paper investigates the horizontal and vertical intensity and propagation of the 2023 MHW in the North Atlantic upper water column. While the study contains some interesting findings, the lack of clarity and rigour in the explanations and interpretations detracts from its overall impact. The manuscript is difficult to read and understand in several parts.

The Methods section needs to be more rigorously worded, and all calculations listed in the manuscript need to be explained.

The Results need to be improved and appropriate references to figures should be made at the appropriate points in the text to facilitate understanding and strengthen the link between the text and Figures.

The paragraph “Characterisation of Marine Heatwave” should be revised to clearly explain the rationale for the methodological choices and how these choices improve the plausibility and reliability of the results. Providing this context will not only improve readability but also enhance the scientific credibility of the paper.

Specific Comments:

Line 47: “MOI weekly bulletin”, add a link or a reference.

Line 51: add references to justify the sentence: “Furthermore, MHW have been well studied for the surface where long satellite records exist, but description and understanding 51 of their vertical structure remains incomplete.”

Line 52: add references to Juza et al. (2022) and Pirro et al. (2024)

Juza M, Fernández-Mora À and Tintoré J (2022) Sub-Regional Marine Heat Waves in the Mediterranean Sea From Observations: Long-Term Surface Changes, Sub-Surface and Coastal Responses. *Front. Mar. Sci.* 9:785771. doi: 10.3389/fmars.2022.785771

Pirro, A., Martellucci, R., Gallo, A., Kubin, E., Mauri, E., Juza, M., Notarstefano, G., Pacciaroni, M., Bussani, A., and Menna, M.: Subsurface warming derived from Argo floats during the 2022 Mediterranean marine heat wave, in: 8th edition of the Copernicus Ocean State Report (OSR8), edited by: von Schuckmann, K., Moreira, L., Grégoire, M., Marcos, M., Staneva, J., Brasseur, P., Garric, G., Lionello, P., Karstensen, J., and Neukermans, G., Copernicus Publications, State Planet, 4-osr8, 18, <https://doi.org/10.5194/sp-4-osr8-18-2024>, 2024.

Lines 52-58, Pag 2: I take a different view of this statement. For example, Juza et al. (2022) and Pirro et al. (2024) have successfully used SeaDataNet climatology to derive anomalies from Argo float profiles without encountering problems related to 'incomplete reconstruction'. Could you please elaborate on this point and provide additional explanation? In particular, what factors lead to the conclusion that modelling products are more suitable for defining and detecting MHWs than in-situ data?

To rigorously evaluate this claim, a detailed comparison between the 3D model output and in-situ data during a well-documented MHW event is essential. Such a study would assess the ability of the model to reproduce the observed trends, particularly in terms of intensity, duration and spatial variability. A key question is whether the model accurately represents the observed dynamics or whether it over-smooths the data, potentially underestimating localised extremes.

Pag 4, Lines 85-90: Which layer did you use to define the occurrence of MHW and apply the method of Hobday et al. 2026? Did you use only the first layer of the model (surface layer) or the 0-200 m layer? Please clarify.

Pag 4, Lines 90-92: This sentence is rather unclear and raises questions about the authors' methodology and aims. Why did the authors estimate the MHW for the entire water column in 2023, but limit their analysis to the surface layer for the period 1993–2022? What was the purpose of these different approaches? The reasons for these estimates are not clearly explained, leaving the reader uncertain about the authors' goals and the reasons for their choices.

Introduction and Line 35, Pag:5: There was also a marine heatwave in 2021 and 2022 in the North Atlantic and the Mediterranean (e.g. <https://www.mercator-ocean.eu/en/news/state-of-the-climate-in-europe-2022-report-2/>). Include these events in the introduction and relate it to that of 2023. Could it be the occurrence of these earlier events that intensified the MHW of 2023?

Figure 3a: The difference in colour between NASE (brown) and CARB (red) is too difficult to see in the legend. Why not use less similar colours?

Pag 8, Line 78: There is also a peak (absolute maximum) in March in the CRAB region but no comment on it in the text.

Pag 9, Lines 81-94: This paragraph is very difficult to follow for a number of reasons: the relative figures are not quoted in the text and/or are quoted incorrectly (this applies to the entire results section); the depths of the layers quoted in the text do not coincide with those in Figure 3 (e.g. 100 m in the text and 156 m in the figure); the references to MLD are incomprehensible as the MLD is not shown in any of the figures.

Pag 9, Line 96: “The evolution of the mean intensity for NATR describes...” In which layer?

Pag 10, Lines 22-38: If this map was created by averaging the selected areas in latitude, how did you manage the overlap in longitude of the NASE and NATR sections? If I look east of 40°W, am I looking at NATR, NASE or both?

Pages 10-11: How were all the velocities estimated on these pages (lines 36, 51, 58) There is no reference to velocities in the methods.

Figure 4f: What is the meaning of the blank areas in Figure 4f? Is it the lack of data? Why is it that when you use a model there is no data in some areas? Could you please describe this figure better, explain how it was made and how it should be interpreted?