**General Comments**

The authors examine the role of air-sea heat flux during Marine Heatwaves (MHWs) events in the Mediterranean Sea over the last 30 years. These events were identified using satellite-derived Sea Surface Temperature (SST) data from 1993 to 2022. An analysis of the ocean mixed layer heat budget was conducted to determine the change in SST attributed to the net surface heat budget during onset and decline phases of MHWs. Air-sea heat fluxes are found to be the primary driver of most MHW onsets, particularly in warmer months and during onset phases, while oceanic processes play a key role in regulating SST during decline periods. A progressively decreasing mixed layer depth (MLD) is observed over the entire event duration, particularly for shorter-lasting events, with significant mixed layer deepening occurring after the end of the decline period. This study underscores the importance of considering subsurface information to better describe the evolution of these extreme events. Combining observations and ocean reanalysis systems appears promising for improving monitoring and early warning of MHWs.

In general, this paper is well-organized and presented in a coherent manner. While the findings may not be groundbreaking, they are relevant within the context of the Mediterranean Sea and can contribute to the advancement of knowledge on this topic.

My main concern, however, is the emphasis placed by the authors on oceanic processes, such as horizontal advection and vertical mixing. Specifically, some findings are just deduced by the authors without conducting a thorough analysis of these processes (e.g., lines 12-13; 227-229; 231-233; 265-268 and so on). Hence, I suggest either revising the sentences highlighting oceanic processes or providing additional analysis to support the findings.


**Specific Comments**

[Lines 12-13]. "Our findings suggest that oceanic processes...". Based on my last comment given in the General Comments, I would rephrase this sentence giving more emphasis to the role of heat fluxes, which is the topic of this work.

[Line 44]. I suggest the authors the following reference that investigates the role of atmospheric forcing and wind-driven mixing during the 2022/2023 MHW event in the Mediterranean Sea.

   Marullo, S., Serva, F., Iacono, R., Napolitano, E., di Sarra, A., Meloni, D., ... & Santoleri, R. (2023). Record-breaking persistence of the 2022/23 marine heatwave in the Mediterranean Sea. Environmental Research Letters, 18(11), 114041. https://doi.org/10.1088/1748-9326/ad02ae

[Line 59]. Please, expand acronyms: NRT CMEMS.

[Line 68-69]. Please, clarify how the climatology was computed (is it just an average or did you apply a smoothing window?)

[Table 1]. For your information, here are the references for products n.1 and n.2:

   (a) Product n.1. Pisano, A., B. Buongiorno Nardelli, C. Tronconi, and R. Santoleri (2016). The new Mediterranean optimally interpolated pathfinder AVHRR SST Dataset (1982 – 2012). Remote Sensing of Environment, Vol. 176, pg. 107-116. http://dx.doi.org/10.1016/j.rse.2016.01.019

(b) Product n.2. Buongiorno Nardelli, B., Tronconi, C., Pisano, A., and Santoleri R. (2013). High and Ultra-High resolution processing of satellite Sea Surface Temperature data over Southern European Seas in the framework of MyOcean project. Remote Sensing of Environment, Vol. 129, pg. 1-16. http://dx.doi.org/10.1016/j.rse.2012.10.012

[Line 113]. "Events tend to last longer in eastern part…". I recommend to include the central-western region of the Mediterranean into this consideration as well.

[Line 114-115]. "…frequency…closely follows intensity…". Honestly, I do not see this 'high correlation'. I recommend to quantify the correlation or rephrase the sentence.

[Line 121-125]. I recommend to quantify the trends of intensity, duration and frequency with confidence intervals as well.

[Figure 1]. Concerning the trend maps (d-e-f), I would suggest to put black dots over non-significant pixel values (that is, just switch the overlapping criterion).

[Figure 2]. The label for x-axis is DSSTQnet/DSSTA while you used $\Delta SSTQnet/\Delta SSTA$ in eq. 3. I recommend to adopt the same notation. Same comment for Figures 3 and 4.

[Line 166-167]. This sentence is somewhat misleading and complex ("are not the primary driver in…"). It appears to contradict what is stated at line 129. I would suggest rephrasing it. Overall, I recommend greater clarity when distinguishing between the roles of heat fluxes and oceanic processes, as in some cases one is more significant than the other and, in other cases, the opposite.

[Line 186-188]. This sentence is a repetition of what already stated above. I suggest to rephrase or remove it.

[Line 192]. "a significant MLDA-SSTA correlation is absent…". What do you mean with this sentence? To me is not clear.

[Line 248]. "…and oceanic processes". I would suggest to substitute oceanic processes with mixed layer heat budget analysis (or something equivalent).