Responses to Reviewers for the manuscript:
"On the Marine Cold Spells in the Mediterranean Sea " by Darmaraki et al., July 2026

##Replies to Reviewer 2

General Comments and Summary

This manuscript provides a valuable and necessary investigation into the physical drivers of Mediterranean Marine Cold Spells (MCSs) under historical and future climate scenarios. Using a mixed-layer heat budget (MLHB) to decompose forcing mechanisms (atmosphere, advection, and mixing) offers insights into how extreme cold anomalies evolve in a warming ocean. The dual-baseline approach effectively demonstrates the shifting nature of future extremes. The study is concise and well-written. I recommend the manuscript for publication after a few minor clarifications and visual refinements are addressed.

We would like to thank the Reviewer for providing their feedback and suggestions that improve our work.

Specific Comments

1. In Section 3.1, the spatial consistency between modeled and observed surface MCS characteristics is noted as weak, attributed primarily to differences between the 0.5 m near-surface model temperature and satellite skin-layer measurements. Since grid interpolation alone is unlikely to cause a discrepancy of this magnitude, it would strengthen the paper to briefly expand on this.

Response:
Thank you for this comment. We agree with the Reviewer that it is unlikely that the grid interpolation alone explains the differences in the identified MCSs across the datasets. Our intention here was to highlight that uncertainties and biases inherent to the satellite dataset, together with differences in their spatial and temporal resolution between the SST and MLT products, may contribute to the observed differences in the detected MCS characteristics. Following the suggestion by the other Reviewer, we will clarify this statement in the revised manuscript. Previous studies on marine heatwaves have similarly shown that differences in the resolution of the temperature datasets can lead to variations in the estimated event properties (e.g., Pilo et al., 2019). *Reference: Pilo, G. S., Holbrook, N. J., Kiss, A. E., & Hogg, A. M. (2019). Sensitivity of marine heatwave metrics to ocean model resolution. Geophysical Research Letters, 46(24), 14604-14612.*

2. The manuscript utilizes historical observational satellite data ending in 2017. The "Mediterranean Sea - High Resolution L4 Sea Surface Temperature Reprocessed" product is available up through 2026. Given that basin temperatures have been on a steep, documented rise in recent years, it would be interesting to discuss (at the authors' discretion) whether the projected trends—specifically the initial reduction or regional disappearance of MCSs—are already beginning to emerge in the actual observational record over the last decade.

Response:
Thank you for this useful comment. We agree that it will be interesting to check the evolution of MCS properties during the extra years of the observational product. We will include this analysis in the supplementary material in the updated version of the manuscript.

Technical Corrections

- **General Figure Comment:** For the multi-panel figures, the darker gray tone used for landmasses competes visually with the sea, often requiring the reader to zoom in. Using a lighter gray shading for the land would make it much easier to focus on the marine data.

Response;
Thank you for this comment. We will use a lighter gray shading for the land in the updated version of the manuscript.

- **Figures 1 & 2:** Ensure panel titles are consistent in capitalization (e.g., "WINTER").

Response:
Thank you for this comment. We will make sure that the titles are consistent in the updated figures

- **Figure 5:** Using white as a value color makes it difficult to distinguish between areas with low event counts and regions where MCSs are completely absent/masked out.

Response:
We agree with the Reviewer and we will update the colorbar of the figure.

- **Figures 6 and 8:** The visual dominance of red across most panels is confusing for a relative fractional shift metric. It visually implies a near-uniform increase across all drivers simultaneously. If regional weightings or absolute frequencies cause this apparent contradiction, it would help to clarify this in the text/caption, or to display the absolute base frequencies alongside the changes. Alternatively, refining the color shading (better contrast perhaps) in Figures 5 and 7, where the base frequencies are shown, could help resolve this visual ambiguity.

Response:
We agree with the Reviewer's comment. As already discussed in one of replies to the other Reviewer, the apparent dominance of red across most panels is primarily due to very small values close to zero, resulting from a numerical artifact introduced during the calculation of the relative contribution of each term. These near-zero values were assigned to the red range of the colour scale, leading to a misleading visual representation. This issue will be addressed in the revised version of our manuscript to provide a clearer and more accurate visualization of the results. In particular, this figure will be replaced by a figure showing the basin-mean percentage of MCS driven by Forcing, Advection and Mixing throughout the 21st century. The new figure will provide a clearer representation to the reader of how the different type of events change with time and higher global warming levels.

- **Table S6 (Supplement):** The column header "GWL3" is visually misaligned.
- **Line 44:** Capitalize the "W" in western Mediterranean (WMED).
- **Line 144 (Equation 1):** The MLHB equation contains a typographical artifact in the forcing component denominator "$\varrho 0Cph$". Please verify the typesetting.

Response
Thank you for pointing out these details. All of these will be changed in the updated version of the manuscript.