Manuscript title: Deep Learning for Super-Resolution of Mediterranean Sea Surface Temperature Fields
Authored by: Claudia Fanelli, Daniele Ciani, Andrea Pisano, and Bruno Buongiorno Nardelli
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REVIEWER #1

Reviewer: The article presents a study on improving the resolution of Sea Surface Temperature (SST) fields in the Mediterranean Sea using deep learning models, specifically a dilated convolutional multi-scale learning network. This approach allows for better capture of small scale features and gradients in SST data, overcoming limitations of traditional satellite-based measurements and interpolation methods. The study demonstrates significant improvements in the accuracy and resolution of SST reconstructions, highlighting the potential of deep learning in enhancing oceanographic data analysis and climate research. But the experiment needs some work.

Response: The authors would like to thank the anonymous reviewer for their interest in reading our manuscript. We think that the revised version of the manuscript has been enhanced significantly as a result of the reviewers' feedback. Please find the detailed responses below with the reference to the modifications carried out in the re-submitted files (highlighted in yellow).

Reviewer: Incorporate additional independent datasets for validating the improved SST fields, ensuring the model's robustness across various conditions and regions within the Mediterranean Sea.

Response: We agree with the reviewer that a larger test dataset was needed to provide a more robust assessment. Therefore, we built a new independent dataset using SST fields over one year (2021) and performed a new test. The main results of this extended test are described in new Section 3.2.

Reviewer: Compare the performance of the proposed deep learning model against existing other deep learning super-resolution models, such as GAN series, providing a comprehensive analysis of its advantages and limitations.

Response: Following the reviewer suggestion, we have included in the revised text a comparison between the results obtained with the dADR model and other deep baseline computer vision methods. The outcomes are now presented in Table 1. We are currently working on the application of Generative Adversarial Networks to the problem, but our study is still in a preliminary phase and does still require a substantial effort to be ready for publication. As such, considering also some subtle theoretical aspects related to the application of generative approaches to observational data, we prefer to dedicate an entire new scientific article to discuss/present our findings, as now discussed in lines 321-328 of the revised version of the manuscript.

Reviewer: Conduct a sensitivity analysis to understand the impact of different parameters within the dilated convolutional multi-scale learning network, optimizing the model's performance.

Response: Thanks to the reviewer's comment, we realized that we did not explain why we had chosen a specific configuration of the network, and we also understood that at least one additional test was needed. In fact, we did not develop a new architecture but exploited the one developed by Buongiorno Nardelli et al. (2022) (https://doi.org/10.3390/rs14051159), and also aimed to reduce computational costs. As such, we originally relied on the choices made in that specific work . In the revised paper, however, we now describe one additional test carried out by modifying the network depth, i.e. reducing the number Multiscale Adaptive Residual Blocks (called dADRSR/2 in the revised version of the manuscript) and compare that also with the results obtained by other deep learning methods (i.e., the EDSR and the ADR networks). The assessment of the various network configurations considered are now presented in Table 1.

Reviewer: Could the article be enriched by including a paragraph discussing how high-resolution SST fields can be incorporated into regional climate models to improve the accuracy of climate projections in the Mediterranean region?

Response: To our knowledge, using observation-based SST data is not a standard procedure to improve the accuracy of climate projections, which generally do not rely on assimilation strategies. High resolution SST fields are indeed used for the improvement of operational ocean model re-analyses (e.g. within Copernicus Marine Service), which tackle a very different problem with respect to climate projections. Even if there is evidence of the important role of small structures of SST on different processes that are clearly relevant in modulating climate (e.g. atmosphere-ocean interactions, see Renault, et al. "Modulation of the Oceanic Mesoscale Activity by the Mesoscale Thermal Feedback to the Atmosphere". *J. Phys. Oceanogr.* **53**, 1651–1667, 2023), we feel that introducing a specific discussion on this topic would be distracting and not relevant for the readers.