

Responses to the Reviewers' Comments – Reviewer 2

Manuscript egusphere-2026-1549 — “Evaluation of a Coupled Regional Reanalysis for the Mediterranean Region Covering the Period 1993–2024”

We thank the Editor and the Reviewer for their careful reading and constructive comments. We have revised the description of the ocean analysis, atmospheric spectral nudging, open-boundary treatment, coupling strategy, verification datasets, and interpretation of the sensitivity experiments. We have also prepared a new Appendix A containing the principal ocean 3DVAR and atmospheric spectral-nudging equations. Terminology has been revised throughout to distinguish ocean data assimilation from the scale-selective large-scale constraint applied to the atmosphere.

Reviewer 2

We thank Reviewer 2 for the positive assessment and for the three focused suggestions. They have led to substantial clarification of the model-coupling and atmospheric-constraint choices.

1. Definition of MESMAR-R in the Abstract

Corrected. The acronym is now expanded at first occurrence.

2. Why the air–sea bulk fluxes are computed in WRF

We agree and have added a dedicated paragraph. The choice is motivated by physical and numerical consistency rather than horizontal resolution alone. WRF supplies the near-surface gradients, stability, roughness, and boundary-layer closure needed by the bulk formulation; the resulting surface fluxes also constitute the lower boundary condition for the atmospheric vertical turbulent-diffusion solve, which is treated implicitly in the PBL implementation. Computing the same fluxes in WRF therefore keeps the atmosphere's surface tendency and the flux passed to NEMO consistently and avoids using a second, potentially inconsistent, bulk algorithm. The atmospheric time step is much shorter than the ocean baroclinic time step (60 s versus 450 s), so WRF resolves the rapid boundary-layer and diurnal adjustment and accumulates the fluxes over the 30 min coupling interval before conservative remapping to NEMO. The finer ocean grid does not create additional atmospheric information; calculating fluxes there would first require interpolation of the 15 km atmospheric state. We also cite Marti et al. (2021) and Schüller et al. (2025), which show that using temporally synchronized atmospheric fluxes reduces splitting and solar-radiation phase errors. We clarify that MESMAR-R does not implement their iterative Schwarz solution, so residual non-iterative coupling error may remain.

3. Why spectral nudging is used instead of full atmospheric data assimilation

The revised text explains in section 2.2 that MESMAR-R is designed as a multidecadal regional coupled reconstruction rather than a stand-alone operational atmospheric reanalysis. Spectral nudging provides a computationally affordable and temporally homogeneous large-scale constraint from ERA5 while preserving regional mesoscale development. It avoids observation processing, cycling, changing observing-system effects, and additional imbalance risks

associated with a full regional atmospheric analysis. The choice is supported by the sensitivity tests in Storto et al. (2023), where spectral nudging preserved effective regional resolution and performed better than full-field/grid-point nudging for several coupled ocean and medicane diagnostics. We have also added the formulation in Appendix A.