RC1, 'Comment on egusphere-2024-1468', Anonymous Referee #1, 18 Jul 2024. Citation: https://doi.org/10.5194/egusphere-2024-1468-RC1

The manuscript mostly concentrated on the Evaluation Run and its statistical properties by comparing the ocean model output with the available observations (SST, SLP, T). However, the manuscript missing a detailed analysis of the climate runs which is the main promise of the manuscript. The statistical analysis made for the Evaluation Run (Atmospheric forcings, Sea level variability and circulation patterns, Thermohaline properties, Extreme thermal events) should be repeated for all the climate runs.

In this work the model validation was given a large attention as the idea was not only to assess the validity and limitations of the finding on the climate part, but also to provide some guidance on the use of the ensemble dataset associated with the present paper. Nonetheless, we concur on the opportunity of having a broader view on the climate results and we will expand this section for some relevant processes/quantities.

In the framework of this expansion it is important to notice (and we make it clearer in the revised version, as in the first one it was probably not sufficiently explicit) that the methodology for evaluation runs does not fully apply to the historical runs. While the former are driven by a reanalysis, which means that the RCM forcing the ocean model receives as boundary conditions reanalysis fields constrained to the observed atmospheric variability, the latter are driven by GCM fields, which result from a free run incorporating the observed variability "only" in terms of radiative fluxes (consistently with the constraints that can/cannot be controlled in a climate perspective) and generating the internal atmospheric variability as a free evolution under this condition. As a consequence, while atmospheric variability in reanalysis-driven runs is synchronised with the observed variability (and therefore it is licit to perform a direct one-to-one comparison of model and observations – that is, for instance, modelled fields for one day should match observed data for the same day), in GCM-driven runs this is only valid in statistical terms, and the modelled variability is expected to only match the statistical properties of atmospheric processes corresponding to a given radiative forcing regime. This is the reason why some assessment of the performance of the climate runs was actually included in the first version (Figures 13 and 16) only in aggregated terms.

On this ground, and with an eye on keeping the manuscript within a reasonable length, in the revised version we will expand along the following lines:

- *Comparison of wind statistics in the climate run in CTR conditions against observations (*Figure 1*)*
- *Seasonal ensemble variations (percentiles) between SCE and CTR conditions in sea surface temperature (*Figure 2*) and net surface heat fluxes (*Figure 3*) .*
- *Differences in the statistical distribution of sea surface temperature and net heat fluxes for the different subdomains (*Figure 4*,* Figure 5*), particularly in the perspective of supporting the interpretation of the results in terms of thermal extremes (see also comments by Rev. 2 and our response).*

As it is known, the open boundary conditions (OBCs) for the ocean models are critical, especially in the Adriatic Sea, the small differences in the salinity and temperature specified at the OBCs significantly affect the dense water formation and physical properties. In the manuscript, how the OBC data were generated to force the ROMS model is not clear, need to be specified the methods and justified that could be used safely in a climate model.

*We thank the reviewer for pointing this out. In the revised version we will expand the "model setup" Section with a more detailed explanation of how we imposed the boundary conditions and their modulation in the future scenario, and some comments on their suitability for the purposes of this study. Flanking the description of the methodology adopted we include a new figure (*Figure 6 *in this document) showing potential temperature and salinity distributions along the boundary cross section together with the velocity contours, also considering the EV* run. In order to check that the prescribed climatological variations are realistic, we also include a comparison of the average trends, finding that the multidecadal tendency for potential temperature in the climate run in the historical period is well bracketed between the evaluation values (namely, the CMEMS reanalyses used as boundary conditions), while salinity trends (less clear in the reanalysis) appear slightly underestimated in the climate runs. The thermohaline properties appear consistent with typical values from the literature, particularly in terms of Modified Levantine Intermediate Water (MLIW, see for instance Bonaldo et al., 2016, and references therein). The known cyclonic flow across the boundary cross section is weaker in EV than in EV*, but is recreated internally as geostrophic circulation (*Figure 8*), restoring the typical climatological values for MLIW around 0.10 m* s^{-1} *(Orlić et al., 1992; Artegiani et al., 1997). Furthermore, the subdomain-based analysis of the evaluation run in the Results section has been expanded focusing on the surroundings of the model domain boundary (red polygon in Figure 7), and the Taylor diagram (Figure 9) now includes an assessment of the model in that region, showing a good agreement with measurements, with skill metrics comparable with the AdriSC reference (Pranić, et al., 2021).*

References

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Pranić, P., Denamiel, C., & Vilibić, I. (2021). Performance of the Adriatic Sea and Coast (AdriSC) climate component - A COAWST V3.3-based one-way coupled atmosphere-ocean modelling suite: Ocean results. *Geoscientific Model Development*, *14*(10), 5927–5955. https://doi.org/10.5194/gmd-14-5927-2021

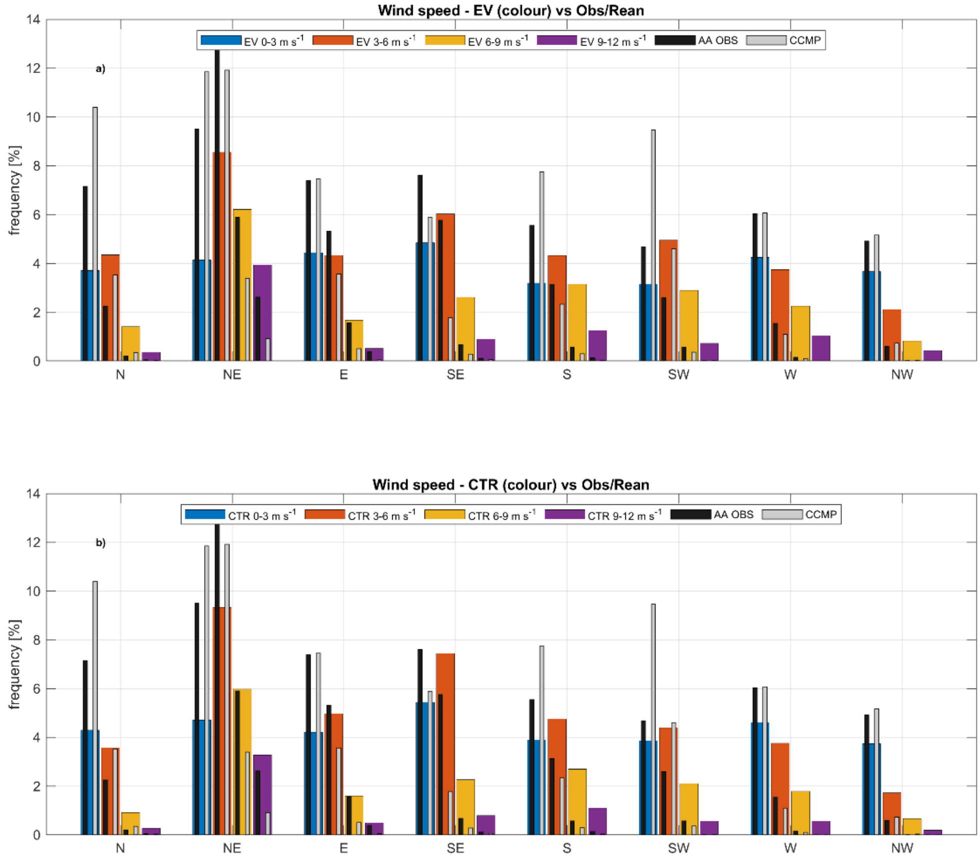

Figure 1: Revised version of Figure 4. Comparison of SMHI-RCA4 fields used: a) in the EV run, and b) in the climate ensemble (coloured bars) against CCMP directional wind statistics and in situ observations at AA.

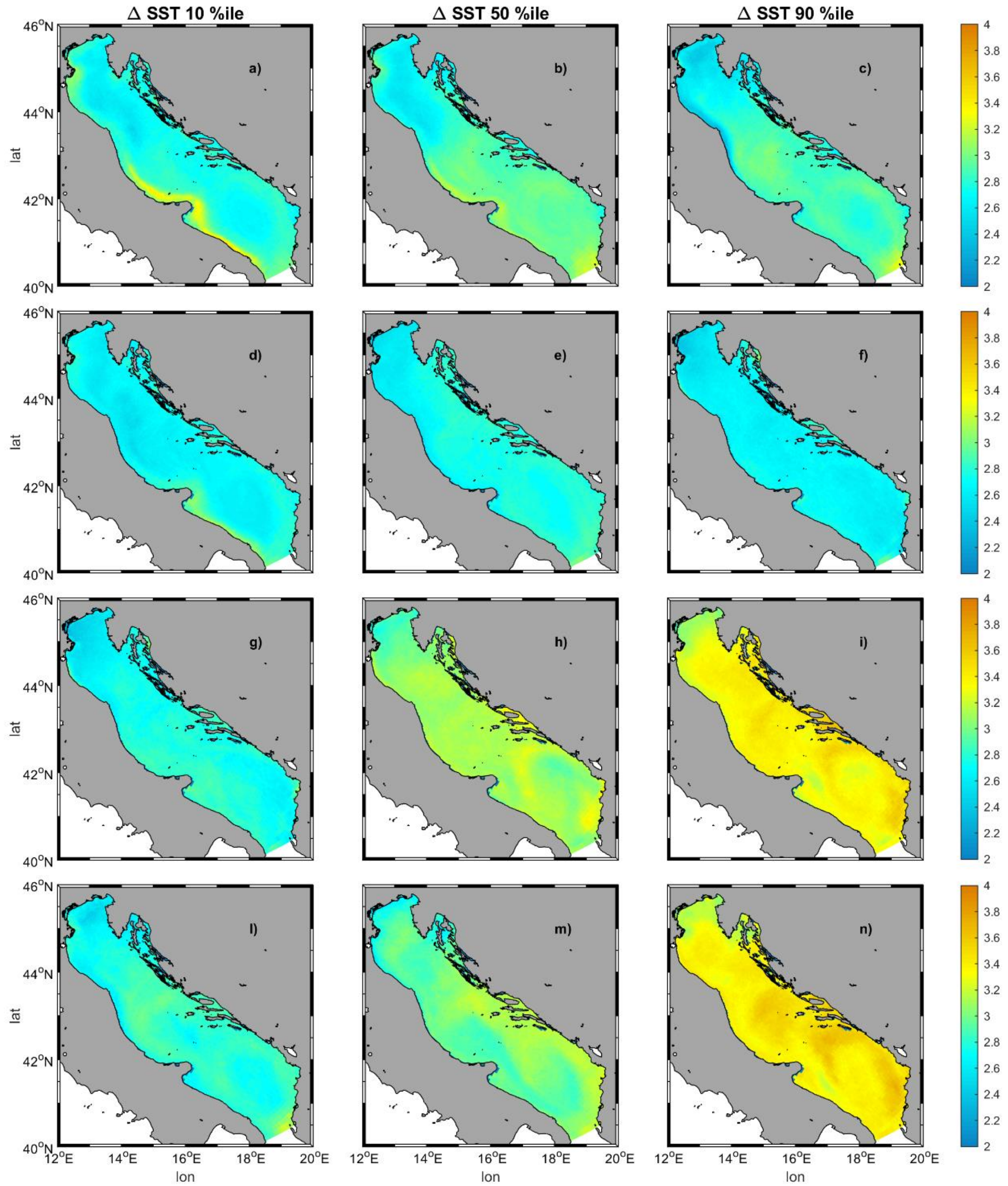

Figure 2: Seasonal variations (SCE-CTR) of the 10, 50, 90 percentile SST

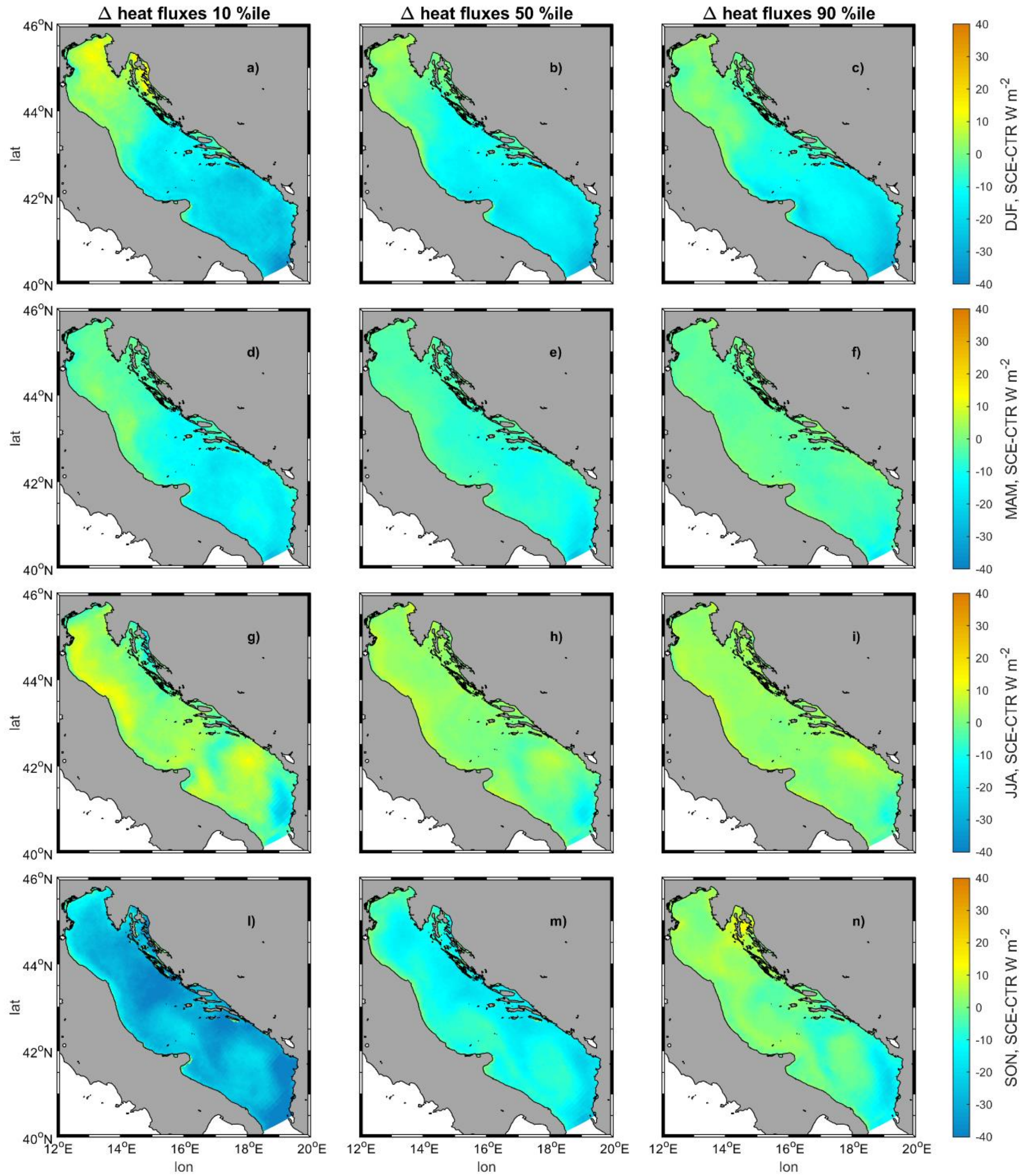

Figure 3: Seasonal variations (SCE-CTR) of the 10, 50, 90 percentile net surface heat fluxes

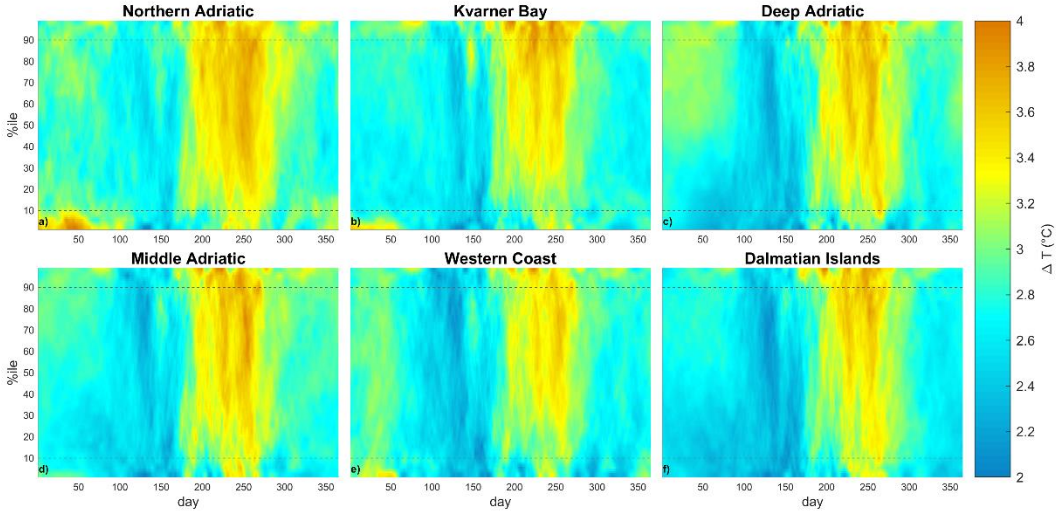

Figure 4: Variations (SCE-CTR) in the daily statistics for SST

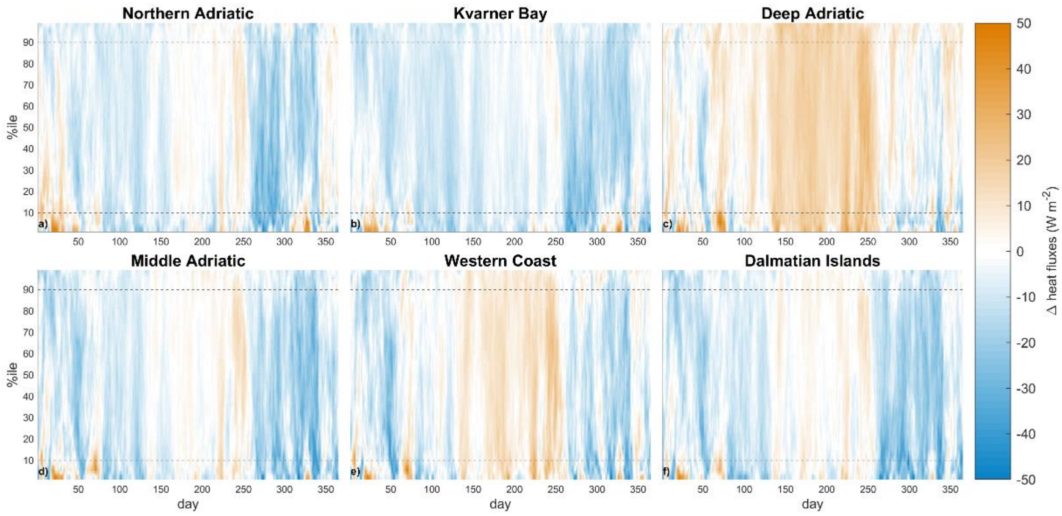

Figure 5: Variations (SCE-CTR) in the daily statistics for SST

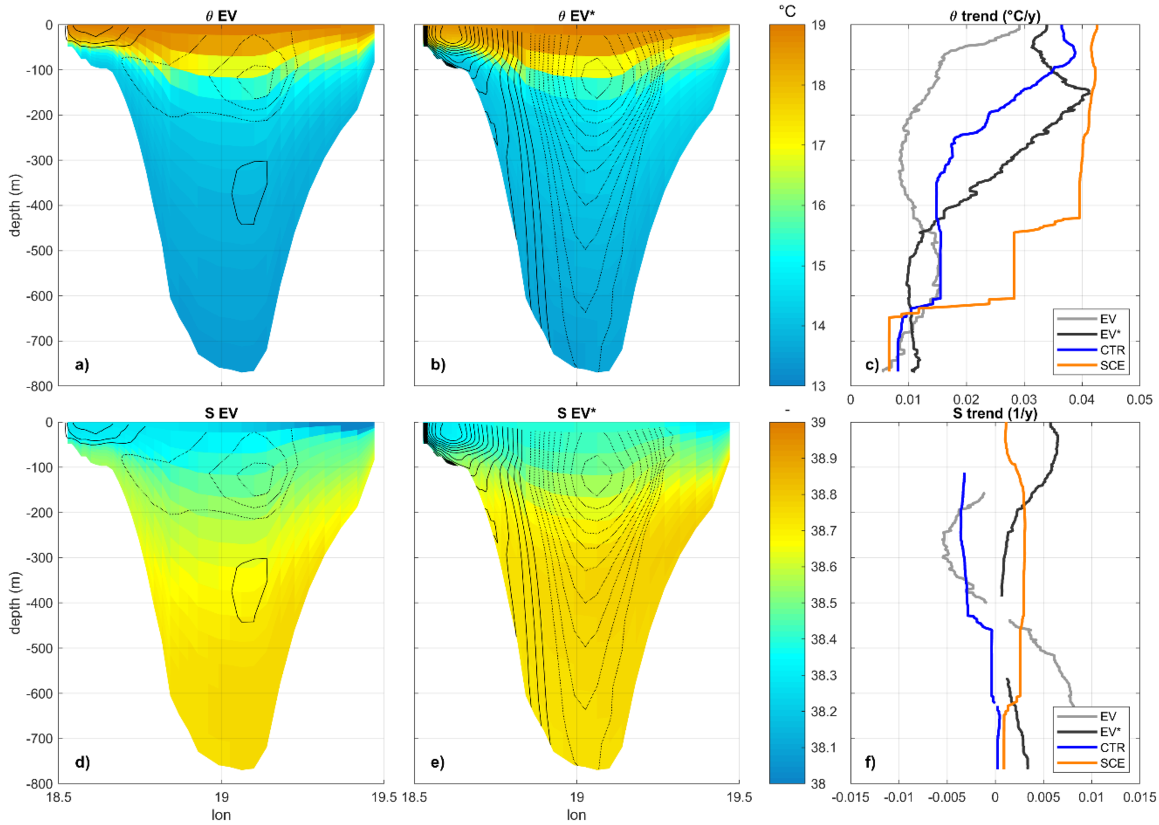

Figure 6: Time-averaged boundary conditions (panels a, b, d, e) and trends (panels c, f). Thick lines and dotted lines represent 0.01 m/s velocity contours in the outflow and inflow direction respectively.

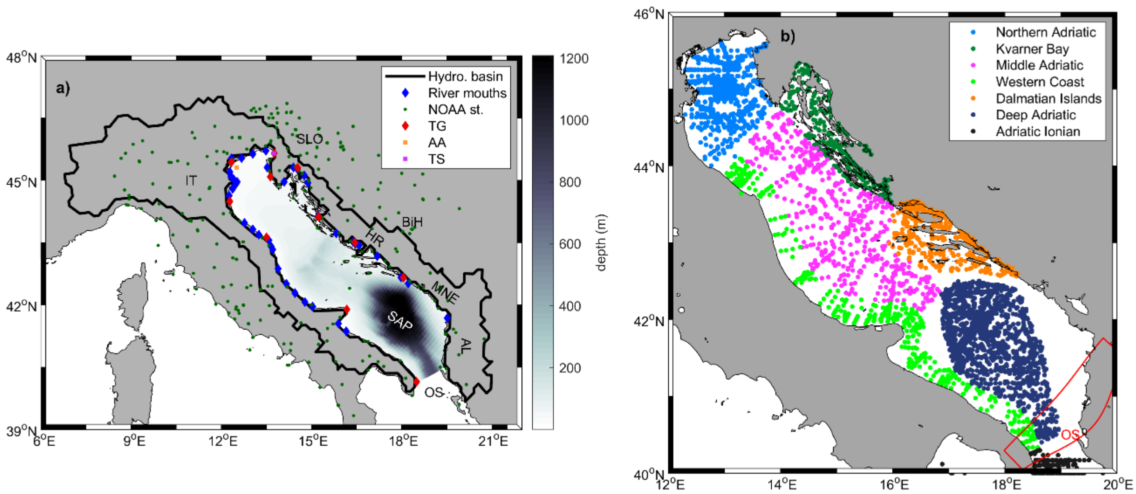

Figure 7: revised version of Figure 1

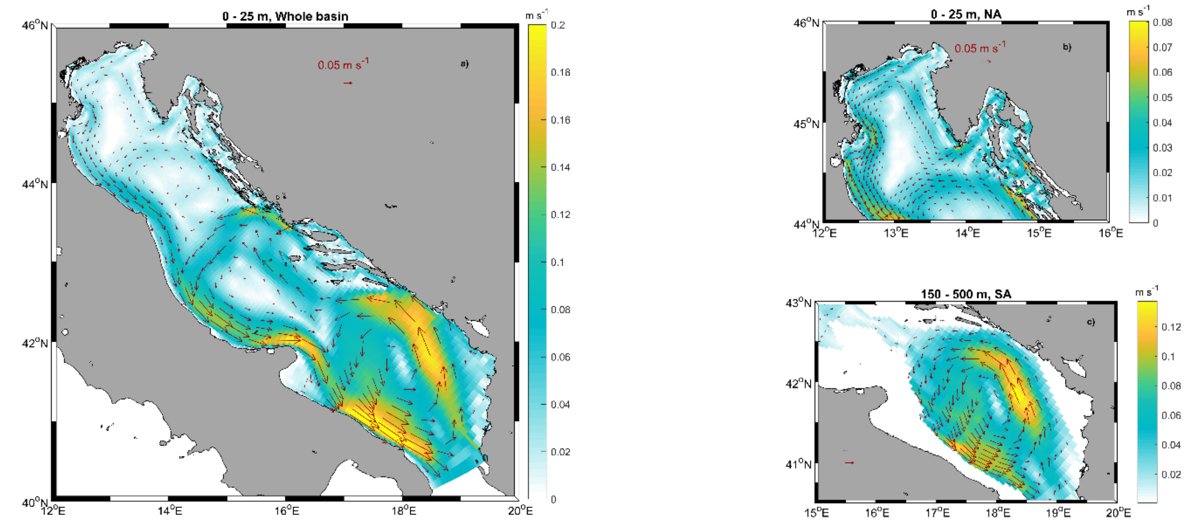

Figure 8: Revised version of Figure 6, adding circulation patterns in the 150-500 m depth range (panel c)

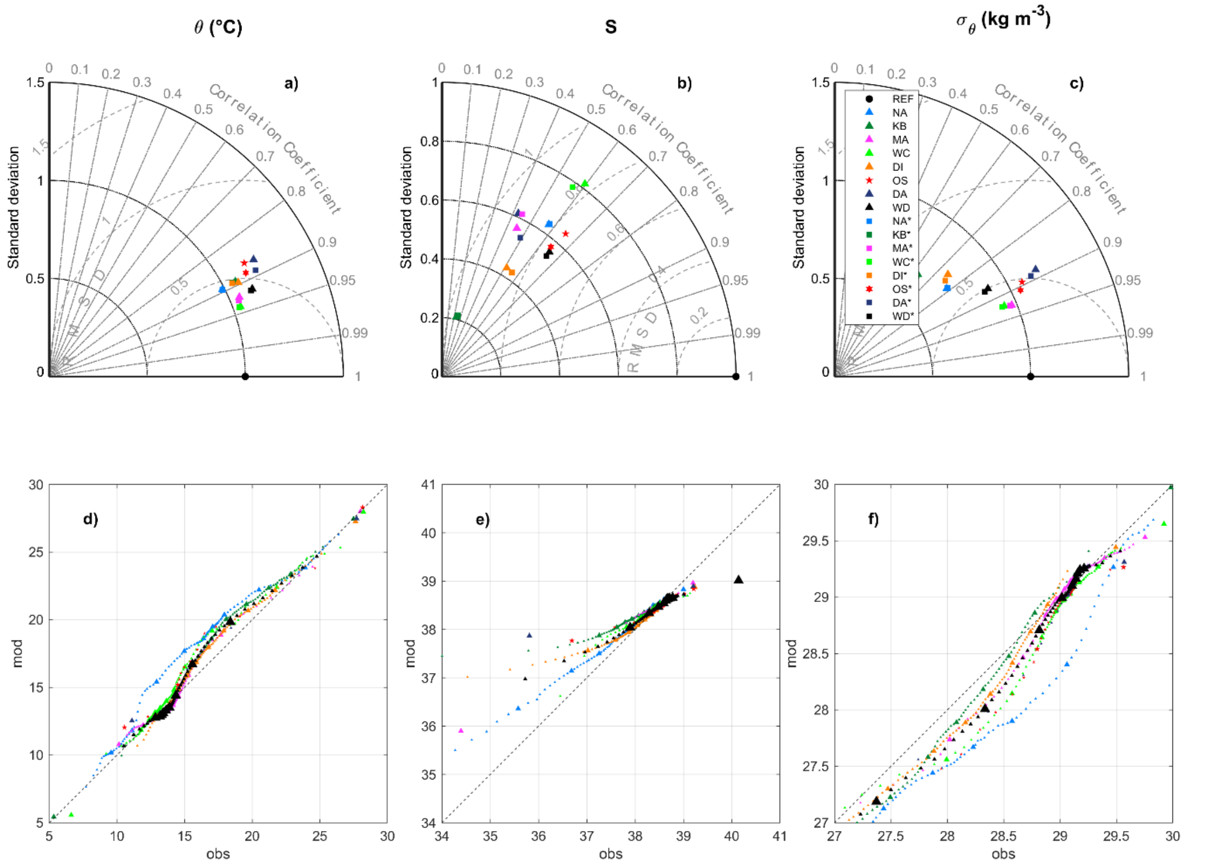

Figure 9: Revised version of Figure 10, including OS (Otranto Strait) as an additional subdomain alongside those defined in Pranić et al. 2021.