A New Operational Mediterranean Diurnal Optimally Interpolated SST Product within the Copernicus Marine Environment 2 **Monitoring Service**

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A new operational MEDiterranean Diurnal Optimally Interpolated Sea Surface Temperature (MED DOISST) product has been developed within the Copernicus Marine Environment Monitoring Service (CMEMS). MED DOISST is characterized by hourly mean maps (Level-4) of sub-skin SST at 1/16° horizontal resolution over the Mediterranean Sea from January 2019 to present. The sub-skin SST is the sea temperature at ~1 mm depth, which is subject to a large diurnal cycle.
The product is built by blending hourly SST data from SEVIRI and model analyses from the CMEMS MED-MFC system (Clementi et al. 2021) through optimal interpolation. The use of model SST as first-guess substitutes the adoption of climatologies or **previous analyses,** providing improved physically consistent estimates of hourly SSTs.

The manuscript after a first revision has been improved, answering the reviewers comments and it is accepted for further publication. However there are some issues, which I summarize hereafter, that I kindly ask you to take into consideration.

We thank the reviewer for these comments that will furtherly improve the manuscript. Though not part of this review, we removed the expression 'Copernicus Marine Environment Monitoring Service', and then its acronym CMEMS, since it is today obsolete. We substituted it with Copernicus Marine Service.

Line 15: I would specify which model dataset (as for SEVIRI) defining a name to keep over the manuscript --> some suggestions: MED-MFC (Clementi et al. 2021) or MedFS or Med-currents.

We thank the reviewer for this comment. We now use 'MedFS' instead of 'model' in the whole manuscript.

Line 18: *"…in the absence of any observation or in situ measurement"* This phrase is misleading since there are surface drifting buoys data that you use for validation. Why didn't you blend SEVIRI with in situ data? Could you please clarify?

The background (or first-guess), as defined within the optimal interpolation (OI) theory, has to be a spatially- and temporally-complete field used to fill in the gaps generated by missing observations (satellite and/or in situ), and model data, by definition, satisfy this completeness criterion. In situ data can be used in OI as observations but not as background, since they do not satisfy the above completeness criterion. However, we agree that the sentence is misleading and has been removed.

Line 29: This statement should be clarified, how would it improve the model predictability? Would you assimilate or use this product to correct the heat fluxes in other general ocean circulation models or do you refer to atmospheric models? Please make a consistent statement on the product usability with the one in your conclusions (lines 586-588).

We rephrased this sentence as follows: "This product can contribute to improve the prediction capability of numerical models that assimilate or correct the heat fluxes starting from Level-4 SST data"

Lines 33-36: The product landing page presents a different DOI https://doi.org/10.48670/moi 00170. Please check with the data publisher and display the correct one, together with the "How to Cite" instruction which is a best practice (see https://support.datacite.org/docs/landing-pages).

Corrected. The doi 'https://doi.org/10.48670/moi-00170' now replaces the previous one (https://doi.org/10.25423/CMCC/SST_MED_PHY_SUBSKIN_L4_NRT_010_036)

Line 67: *"…the European Space Agency (ESA) Climate Change Initiative (CCI) SST,…*" add SST, or dataset, or product

Corrected.

Lines 105-107: *"…Though model analyses by definition also assimilate observations, which could thus in principle include hourly SEVIRI data, in the present configuration they are not able to deal with such frequent updates (see section 2.2), and the approach presented here represents an effective way to improve the reconstruction of SST daily cycle from high-repetition satellite measurements…"*
This phrase is not clear since you did not describe the MED-MFC system (physical component of the Med-MFC called Med-Currents) yet. Is the MedFS system assimilating or using (correction of the surface heat forcing) any satellite SST data? If yes, which one? Are SEVIRI data and MedFS model SST independent?

I suggest to insert in the intro some specification, i.e. resolution, accuracy (i.e. 0.76C when comparing SST to satellite L4 dataset, see page 5 of the QUID) about the **MedFS** (*Clementi et al. 2021, see also https://medfs.cmcc.it/backend/public/medfs/short-description.html*) as done for SEVIRI.

This paragraph has been rephrased, see lines 101-107 in the revised manuscript with track changes activated. We also modified Section 2.2, which introduces and describes MedFS, adding e.g. the accuracy of the first-layer temperature fields.

Lines 150-152: please use the citation and DOI, no need for the URL link. Please adopt a coherent approach for all your datasets references in the text. A suggestion would be to move the first paragraph in the introduction.

Corrected.

Line 154: please use MedFS instead of (MFS) as indicated at *https://medfs.cmcc.it/backend/public/medfs/short-description.html*.

Corrected.

Please add also references at line 158:

- *Clementi E., J. Pistoia, D. Delrosso, G. Mattia, C. Fratianni, A. Storto, S. Ciliberti, B. Lemieux, E. Fenu, S. Simoncelli, M. Drudi, A. Grandi, D. Padeletti, P. Di Pietro, N. Pinardi (2017). A 1/24 degree resolution Mediterranean analysis and forecast modeling system for the Copernicus Marine Environment Monitoring Service. Extended abstract to the 8th EuroGOOS Conference, Bergen.*
- *Clementi E., Oddo P., Drudi M., Pinardi N., Korres G. and Grandi A. (2017). Coupling hydrodynamic and wave models: first step and sensitivity experiments in the Mediterranean Sea. Ocean Dynamics. doi: https://doi.org/10.1007/s10236-017-1087-7.*

Added.

Line 162: please include the right citation of the product, not the URL, and check the doi at the landing page https://doi.org/10.48670/moi-00172

Corrected.

Table 1: I wouldn't use "model" but either use the product identifier (or MedFS), since you are using a specific dataset.

Corrected. 'Model' has been replaced by 'MedFS' in the whole manuscript.

Line 182: Same citation issue to be solved:

- https://resources.marine.copernicus.eu/product detail/INSITU_MED_NRT_OBSERVATIONS_013_035/INFORMATIO N there is a doi at this page without the citation instruction https://doi.org/10.48670/moi-00044
- https://resources.marine.copernicus.eu/product detail/INSITU_IBI_NRT_OBSERVATIONS_013_033/INFORMATION there is a doi at this page without the citation instruction https://doi.org/10.48670/moi-00043 Please be aware that it exists also this https://doi.org/10.13155/75807.

Solved.

Line 199: The link you provided is not resolving to any landing page, please check and provide the right citation https://resources.marine.copernicus.eu/product-200 detail/SST_GLO_SST_L4_NRT_OBSERVATIONS_010_001/INFORMATION The PUM link you provide afterwards reports a different product name, SST-GLO SST-L4-NRT-OBSERVATIONS-010-014.

Corrected. The DOI https://doi.org/10.48670/moi-00167 has been added.

Lines 239-241: please check the English

This sentence has been rephrased, see lines 236-240 in the revised manuscript.

Line 260: " *in the absence of ...*" As mentioned earlier, this sentence seems misleading, since drifters data might be available, I suggest to erase it.

This sentence was removed.

Line 264: which anomalies? The observation anomalies (□□□□− _□□ _)?

Corrected. Now reads: 'The observation anomalies'

Line 274: I suggest to use the same nomenclature for MedFS SST or substitute "*model output*" with model SST (first layer model temperature).

Corrected.

Line 281: same comment as for line 162 above, please provide the DOI and citation instead of the URL.

Corrected.

Line 290: as suggested above, please avoid repetitions "*hourly MedFS seawater potential temperatures at 1.0182 meter (first level) characterized by 0.042° grid resolution.*

Corrected.

Line 291: What do you mean by regridding? Do you interpolate SEVIRI (0.05°) and MedFS SST onto the 1/16th grid before OI? How do you obtain the SST anomalies. Please specify.

This sentence has been rephrased as follows: "Module M2 extracts and regrids (through

bilinear interpolation) both SEVIRI and MedFS SST data over the DOISST geographical domain at 1/16° grid resolution (see Table 2)".

Concerning the second question, the definition of anomaly has been introduced in the background section. However, it is also repeated at the end of this section:

- *Subtract hourly model SSTs from valid SSTs to produce SST anomalies;*

Lines 317-325 are redundant if you improve the text of the paragraph answering the question above.

If the reviewer agrees, we would prefer to leave this synthesis, that can be anyway useful as a recap. This synthesis scheme has also been rephrased to improve its clearness, see lines 311-327.

Line 350: I suggest to rephrase: "*In order to ~~evaluate~~ assess the DOISST performance with respect to ~~the~~ MedFS SST analyses ~~model~~ and verify the correctness of the data blending, the same ~~validation p~~rocedure has been applied to the modeled SST*." In this case I would talk about verification since you verify that DOISST is improving with respect to its input dataset.

This sentence was removed since it is now included at the beginning of Section 3.3. Indeed, also following another comment of the reviewer (Line 439), we made more homogeneous and compact the description of the validation framework.

Line 373: I suggest "*DOISST and MedFS SST show similar but opposite behaviours*." I would also underline that the results are coherent with expectations, since MedFS represents the background field corrected by SEVIRI observations.

Here, since we are talking of mean bias, it would be preferable to leave the sentence as it is. However, we substituted 'model' with 'MedFS'.

Figure 3, 4, 5 and captions, please add (a) (b) …

Corrected.

Please consider to switch fig 3 and 4. I would prefer to see first the mean diurnal SST cycle as reconstructed by DOISST, MedFS and drifters, then to see the metrics.

We agree with the reviewer that this switch would be of better impact. However, since this change would imply a restructuring of the whole section, we would prefer to leave the sequence as it is, if the reviewer agrees.

Line 391: getting warmer warming

Corrected.

Table 5: I would put WINTER/SPRING/ in the first column and leave the months in the caption.

Corrected.

Line 424: I would take this out since you repeat it at line 431.

Removed.

Line 437: 2021 or 2020?

Corrected (2020).

Line 439: "*The grid resolution of OSTIA…*" This phrase is misleading, please clarify. Do you select the nearest grid point from each dataset? Do you use the MedFS regridded on the $1/16^{th}$ grid? What about SEVIRI data. (this links to the issue above see the comment referred to Line 291).

We do agree with the reviewer. We moved this sentence in Section 4.1, where the validation framework is introduced. We also clarified the space criterion (namely, nearest neighbor) and the grid resolution relative to DOISST, SEVIRI, MedFS and OSTIA diurnal.

Figure 9, caption and text: again, please use the specific name (i.e. MedFS) instead of the generic "model" or "model outputs".

Corrected.

Data Availability section: please use the right citation and DOI as asked above (**Lines 33-36)**
Corrected.

Line 532: please specify which model, consistently with satellite data, as suggested before.

Corrected.

Line 536: I suggest: "*In an ideal case, ~~all~~ the DOISST input data and the validation dataset would be g~~enerated~~ available ~~and compared~~ at the same depth.*"

Corrected.

Lines 545-546: "*This product is also more accurate than the input model, which shows a mean bias of ~-0.1 K and RMSD 545 of ~0.47 K. A warm (positive) and cold (negative) bias characterizes the DOISST and the model, respectively, also during 546 seasons (Fig. 5).”* I would strengthen here that DOISST is more accurate than MedFS SST as expected by the blending procedure, since it is used as background field, corrected by SEVIRI data. As I suggested before, I consider this part a verification of your blending procedure that successfully brings DOISST closer to the observed SST by drifters data.

We added this sentence: “These results also confirm the robustness of this blending algorithm that, even if based on model analyses used as first-guess, it successfully brings DOISST closer to the in situ measured SST than the MedFS estimates”.

Line 549: I suggest *“…due to the vertical heat transfer ~~heat process~~.”*

Corrected.

Line 554: "*The reduced bias could be ascribed to the fact that valid SEVIRI SST values are always interpolated in DOISST, while they are left unchanged in the original method*" This sentence is not clear to me, what do you mean by left unchanged? Did they impose the SEVIRI observed values? Please rephrase.

We rephrased this sentence as follows: ‘they are left unchanged (not interpolated, see section 3.3) in the original method ’. This concept is actually introduced at the end of section 3.3.