Responses to reviewers comments:

Cirano et al., A description of existing Operational Ocean Forecasting Services around the Globe

On behalf of the co-authors, I would like to thank both reviewers for their comments that have been well received and acted upon. Please see, in blue, our responses to each comment that have significantly improved this manuscript.

We would like to emphasize that, due to the major changes in the revised manuscript, we have highlighted all modifications and additions in blue. We chose this approach because the tracked changes version made the text difficult and confusing to read.

CC1: P. Sakov

There are a number of factual inaccuracies concerning the Australian forecasting system OceanMAPS.

Thanks a lot for your proposed corrections. In the new revised version of the paper we have addressed them as in the following.

1. L. 75-76. , "the Blue Link Ocean Forecasting Product by Commonwealth Scientific and Industrial Research Organisation (CSIRO)"

(1) The Australian forecasting system developed in Bluelink project is called OceanMAPS.

Now at line 179 the correct reference to OceanMAPS has been properly included, together with the link http://www.bom.gov.au/marine/index.shtml added as footnote, similarly to the other listed systems.

(2) Bluelink is a cooperation between Royal Australian Navy (RAN), Bureau of Meteorology (BoM), and Commonwealth Scientific and Industrial Research Organisation (CSIRO).

The specific suggested explanation of Bluelink is now extensively reported in lines 175-182.

(3) The reference to Schiller et al. 2019 is much outdated. The recent reference is Brassington, G. B., Sakov, P., Divakaran, P., Aijaz, S., Sweeney-Van Kinderen, J., Huang, X., and Allen, S.: OceanMAPS v4. 0i: a global eddy resolving EnKF ocean forecasting system, in: OCEANS 2023-Limerick, IEEE, 1–8, https://doi.org/10.1109/OCEANSLimerick52467.2023.10244383, 2023.

Added in the references.

2. In Table at l. 90-95, row 10: "BLUELINK (Ocean Forecasting Australia Model (OFAM3))" should be changed to OceanMAPS; "Global/Regionsl" should be changed to "Global"; "CSIRO" should be changed to "BoM" because all

development in Bluelink is coordinated by BoM; the web reference should be changed to https://reg.bom.gov.au/oceanography/forecasts/system-info.shtml.

Please note that the table included in the first version of the manuscript has been removed in the revised manuscript, to address one comment as provided by another Reviewer. The proposed link has been included in the answer to your point 1.

3. The authors may want to note that since v4.0 (operational since June 2022) OceanMAPS is using the ensemble Kalman filter (EnKF). In fact, it is the first and so far the only global eddy resolving operational ocean forecasting system using "4D" data assimilation method.

As specified in the previous answer, the description of the system has been now incorporated in the paragraph available in lines 178-182.

RC1: **Pierre-Yves Le Traon**

Summary:

The paper presents an overview of the status of operational ocean forecasting systems in 8 key regions in the world ocean: the West Pacific and Marginal Seas of South and East Asia, the Indian Ocean, the African Seas, the Mediterranean and Black Sea, the North-East Atlantic, the South and Central America Seas, the North America and the Arctic. This is not an easy task but the paper provides a useful summary of the existing operational oceanography offer.

Thank you for your constructive feedback. We appreciate your recognition of the effort involved in summarizing operational ocean forecasting systems and are pleased that you find the paper useful. We acknowledge that there is room for improvement and will carefully address the points raised to enhance the clarity and quality of the manuscript.

General comments:

The paper needs, however, to be improved in several ways before it can be accepted:

1. A general introduction is needed where the authors should explain how the international ocean prediction community is organized at global level through the OceanPredict international programme and the role now played by the UN OceanPrediction DCC (e.g. DCC regional teams, DCC atlas that will provide up to date information on the different systems including operational readiness level information). Explain also the scope of the paper: physical systems including wave and sea ice? BGC systems? real time and reanalyses? and the methodology used to gather this information and its limitation (you cannot be comprehensive in particular for coastal systems). You should also limit the scope to operational systems for which data are readily available.

   To address this comment, we have included a paragraph at the end of the Introduction to clarify the organization of the international ocean prediction community. Additionally, we have introduced a new section, '2 Global Ocean Forecasting Services,' to provide a detailed description of global-level forecasting systems.

2. Global systems should be described in a specific section as they all serve the 8 regions. Explain in addition the role of global systems to provide boundary conditions to regional and coastal systems.

   We agree with RC1. To address this comment, we have included a new section titled '2 Global Ocean Forecasting Services,' where we describe the global systems in detail. Additionally, all global systems were removed from the other sections to ensure a more focused presentation. In this new section, we also explain the role of global systems in providing boundary conditions for regional and coastal forecasting systems.

3. There is strong need to homogenize the description of the different systems (including for tables that should all have the same content). Provide core information to all systems you describe (eg model resolution, assimilated data sets, physics or physics + BGC) . A recent and an up to date reference should also be provided for all systems you mention and the way to access products (e.g. URL).

We thank RC1 for raising these important points. In response, the following actions were taken in the revised manuscript: 1) we removed the tables provided by the Regional Teams and retained a single table for the global systems, based on the OceanPrediction DCC Atlas; 2) where available, we included relevant core information for each system, such as system setup, resolution, etc. Additionally, we provided links to the system's webpage and included recent and up-to-date references for each system mentioned.

Specific comments:

Abstract : physical peculiarities ? What do you mean ? What about biogeochemical ?

Abstract : Authors => authors

Corrected.

Abstract : is the scope limited to physical systems ?

The abstract has been revised to refer explicitly to biogeochemistry, but also waves and ice.

Abstract : « and the ways forward to improve the essential ocean variables predictability from regional to coastal scales, products reliability and accuracy ». This is not or barely discussed in the paper

The sentence has been revised and reference to products reliability and accuracy removed, giving more emphasis to the core of the paper: the ocean forecasting systems.

Line 57 : « we explore the collaborative efforts and international initiatives aimed at enhancing global ocean forecasting ». Where ?

This sentence has been removed in this revised version of the manuscript.

Need consistent information for all tables and all regions, e.g. model resolution, assimilated data sets, URL to access forecasts.

Following comments by reviewers, in this revised version of the manuscript we removed all tables as proposed for the regions in favour of a more descriptive narrative of the available systems in each of them. Only for the Global Ocean we decided to maintain it, summarizing relevant information on systems as available in the OceanPrediction Atlas, as discussed in lines 68-115.

Use Copernicus Marine / Copernicus Marine Service instead of CMEMS everywhere in the paper

We are now using Copernicus Marine.

Table 4. 2.3 degree => 2.3 km ?

As mentioned above, we suppressed all tables as shown in the first version of the manuscript.

Line 283. From the GLORYS Copernicus Marine reanalyses producted by Mercator Ocean International.

The proposed correction for referring to GLORYS has been incorporated at its first appearance in this revised version of the manuscript (now at lines 295-296).

Line 459. Figure 5 should be removed. It is no more up to date and includes operational and non operational systems. The main message should be operational systems are organized through the Copernicus marine service and are interfaced to a series of downstream coastal systems organized a national level

We removed the outdated figure, which is in any case available in the provided reference of Capet et al. (2020). We substitute it with a composite map grouping IBI, NWS and BAL MFCs, discussed in the corresponding Section 7.1.

Page 12. IBI MFC developed by Mercator Ocean International (MOi) and operated by NOLOGIN as part of the EU Copernicus Marine Service.

To homogenize among MFCs we are now firstly referring to Copernicus Marine. In the specific case of IBI-MFC the new references are as in the following:

- lines 233-234: we included the link to Copernicus Marine Producers' page and removed "operated by NOW Systems" being now redundant since all information are in the new provided link.
- line 384: we included the link to the DOI for the IBI-PHY system.
- line 425: no changes, since we have the reference to Toledano et al., (2022), which was provided also in the first version of the manuscript.
- line 437: no change, since we have the link to DOI (as provided in the first version of the manuscript).
- line 471: only added "IBI-MFC" with no link since with time it appeared in lines 233-234.

Line 342. MFS INGV is the Med Sea Copernicus Marine MFC described above. To be removed.

We thank RC1 for raising this point. The Mediterranean Forecasting System (MFS) which is operational at INGV is not the one delivered through the Copernicus Marine Service (it was operational within CMEMS until 2018, but now it is not anymore part of CMEMS catalogue).

The MFS operational within CMEMS is instead developed and maintained by CMCC since 2018 and has different characteristics (and resolution for example) with respect to the one maintained by INGV. Therefore, for clarification purposes, we decided to keep both the CMCC CMEMS MFS and the INGV MFS.

Line 425. The Copernicus Marine Service (CMEMS) (CMS is not the right acronym for Copernicus Marine. When an acronym is needed, CMEMS should be used)

As suggested also in one of the comments above, we are now using Copernicus Marine.

Section 9.1 add the Mercator Ocean global model 1/12° here (part of Copernicus Marine)

The reference to GLO-MFC is now fully incorporated in a dedicated Section 2, in particular in Table 1.

Line 697. Suggest to remove this paragraph on statistical model (out of scope – or you should do it in the other sections, eg AI based forecasts).

The paragraph was deleted in this revised version of the manuscript.

Explain that all European operational ocean prediction activities in global and regional operational oceanography are federated as part of the Copernicus Marine Service (marine.copernicus.eu) implemented by Mercator Ocean International and are available through a common marine data store and a common user service component.

In the new version of the paper, the reference to the Copernicus Marine framework has been better addressed, linked to all global and regional existing initiatives.

RC2: **Anonymous Referee #2**

Summary:

The manuscript lists and provides a short description of the existing operational ocean forecasting systems around the Globe focusing in particular on 8 different regions. I found the manuscript very interesting and personally discovered many ocean products I did not know about. It is a reference for any reader who need ocean forecasts for specific applications and provide a clearer picture of the ocean products available. I still believe the list is partial, but it is a good starting point and there could be new updates every year or so.

Have said that, the manuscript requires mayor corrections before I can support the publication. As it stands, the manuscript is chaotic and heterogeneous, the products are described without precise guidelines: some products are carefully written with detailed references, some others are described with few inaccuracies, for others it is not even clear whether they are operational and which are the forecasted variables. Moreover the same product can have multiple descriptions and different acronyms, some operational systems are listed in the tables but do not have a description in the text, several links are misplaced and/or do not work. I would add also a section "conclusion" as recommended by the Journal although I will not insist on this last point.

We thank RC2 for the detailed comments and constructive feedback. In response to the suggestions, the following actions have been taken to improve the manuscript:

1) Improved clarity and consistency in descriptions: The updated version of the manuscript addresses the issues of heterogeneity and inconsistency in the descriptions. Where necessary, references have been carefully added to ensure the accuracy of the information.

2) Links and acronyms: All links have been refreshed and verified to ensure they are functioning correctly. Additionally, the acronyms used throughout the text have been standardized to avoid confusion.

3) Clearer guidelines and product descriptions: The descriptions of the systems and their products have been homogenized, ensuring that readers can better understand the characteristics of each system.

4) Inclusion of a conclusion section.

We believe these changes resolve the issues pointed out and make the manuscript more cohesive and easier to read.

Major Comments:

-) The description of each ocean product should be systematic and homogenised. A list of required info to be provided for each product could be the following:

- Resolution of the product

- Availability of the product
- All variables are forecasted
- Whether the products are freely available or not
- Whether they are operational or not
- Whether they include a data assimilation scheme
- Link to a webpage

Optional info can be

- Info on initial condition
- Quality of the forecasts and link to quality documents

We Thank RC2 for this valuable feedback. To address your concern about the need for a more systematic and homogenized description of each ocean product, we have revised the manuscript accordingly. Specifically, we have removed the tables and adopted a new layout that ensures a more consistent structure across regions.

We have also standardized the descriptions of all products by following a uniform set of criteria, ensuring that key aspects such as availability, operational status, and accessibility are clearly defined. Additionally, we have verified and updated the references and links to improve accuracy.

We believe these changes significantly enhance the clarity and coherence of the manuscript.

-) In several regions the Authors list global products together with regional ones. It would be probably better to have a section on global ocean forecasts and remove them from the regional description. For global ocean forecasts the Authors can refer to the OceanPredict website https://oceanpredict.org/science/operational-ocean-forecasting-systems/ocean-models/#section-model-characteristics

We appreciate the reviewer's suggestion. Following this recommendation, we have added a dedicated section on global ocean forecasts and removed global products from the regional descriptions. Instead of linking to the OceanPredict website, we preferred to refer to the OceanPrediction Decade Collaborative Centre (DCC) website (https://www.unoceanprediction.org/en/atlas) for comprehensive information on global ocean forecasting systems.

-) Since there are plenty of acronyms, it can be probably worth to include a "table of acronyms" at the beginning.

We appreciate RC2's suggestion regarding the inclusion of a table of acronyms. After carefully reviewing the use of acronyms in the manuscript, we ensured that each acronym is clearly defined upon first use and used consistently throughout the text. Given this, and to maintain readability, we decided not to include a separate table. However, we remain open to further changes if the reviewer believes that the inclusion of a table is still necessary.

Minor Comments:

Line 105

This is the only product with an exact value for RMSE. I do not find it particularly useful since it cannot be compared to any other products. The Authors can safely remove it.

We removed the paragraph related to discussion of the metrics and left only the reference.

Line 129-132 - Is this the DREAMS system described in the table 1?

The reference to DREAMS' system is now incorporated in the main paragraph, please refer to lines 133-136.

Figure 2 - This Figure is too crowded, can be replotted?

We decided to remove it, in order to be consistent with the other sections.

Line 159,161 - Rather then SSH (sea surface height) the system probably assimilates SLA (sea level anomaly). SSH is used many times instead of SLA in the text, please double check it.

Checked and corrected.

Line 161: "it assimilates daily data of […] SST (e.g., AVHRR SST, RTG-SST and OSTIA)".

The SST list is a mix of L3 and L4 products, I am not sure the system assimilates all these products every day, please double check

The revised version of the manuscript shows global systems in a dedicated section, providing references to OceanPrediction Atlas that should report all the necessary information about the system

Line 164: "Mercator provides […] their website (http://bulletin.mercator-ocean.fr/)"

As before, all references to global systems are discussed in Section 2 and considering information as reported in the OceanPrediction Atlas.

Is this a different product with respect to the global ocean analysis and forecast available from CMEMS website?

No, the systems are the same. We reported details in Table 1.

Line 165 - The Authors list also products at eddy-permitting resolution. In this case also FOAM (Blockey et al, 2014, 10.5194/gmd-7-2613-2014) provides the global forecasts at a similar resolution, but there are also other global ocean forecasts at higher resolution (please check the OceanPredict website).

As before, the references to global systems have been included in Section 2.

Line 166/174: Is NOAA-GFS different from GFS?

No. We homogenized references to NCEP GFS where pertinent.

Line 206: Why the Indian Ocean Forecasting System (INDOFOS) is listed for the African Seas and not for the Indian Ocean?

We have corrected the reference, so now it is under Section 4.

Line 211 and 213 - GFS and ECMWF are listed but I believe those are atmospheric products.

Thanks to the review done on the manuscript, we restructured it to have a dedicated section on global systems and GFS & ECMWF are not reported anymore in the corresponding Table 1.

Line 212: is this different from Bluelink?

Bluelink is now fully described in Section 3.

Line 259: The link seems not related to GLOSSIS.

Corrected, now at line 267 we have a footnote reporting this link https://www.deltares.nl/en/expertise/projects/global-storm-surge-information-system-glossis

Line 269: "the Global Ocean Analysis and Forecasts system provided by Copernicus Marine Service "

Is this the same product of MOI line 164?

Yes, it is. Now, in the revised version of the manuscript, we took care of homogenizing the references to systems: where needed, like in the case of the Global Ocean forecasting system delivered in the framework of the Copernicus Marine, we are referring to GLO-MFC.

Line 275: Two different atmoheric forcings are used in this product?

According to the information provided by the authors, yes. The model seems to be able to use both forcing in specific cases.

Line 282: The Authors mentioned GLORYS, but this is a reanalysis product. I believe the system uses the corresponding CMEMS analysis product, that should be the same of line 164 and 269.

Thank you for this helpful observation. We agree that GLORYS is a reanalysis product and should not be referred to in the context of forecasting. We have revised the text accordingly to clarify that the coastal system is designed to use

both hindcast and forecast ocean boundary conditions. Specifically, we now state that the GLORYS12 reanalysis (GLOBAL_REANALYSIS_PHY_001_030) is used for hindcast simulations, while the Copernicus GLO-MFC (GLOBAL_ANALYSIS_FORECAST_PHY_001_024) is used for the operational forecast. This update also aligns with references made earlier in lines 164 and 269 in the submitted version of the manuscript.

Line 286: "nature based solutions (NBS)" This acronym is not used elsewhere.

It is now removed.

Line 329: "The systems assimilate in situ and satellite data". Which satellite data?

CMEMS Satellite data are assimilated: Sea Level Anomaly along track altimetry data, Significant Wave Height, Sea Surface Temperature, and Chlorophyll-a concentration. A sentence was added in the revised version of the manuscript. See lines 350-351.

Line 343: " based on NEMO and implementing a data assimilation scheme". Which data assimilation scheme?

A 3D Variational Data Assimilation scheme (OceanVar, Dobricic and Pinardi, 2008). A sentence was added in the revised version of the manuscript. See lines 365-366.

Line 362: " NEMO model integrated with a data assimilation scheme." Which data assimilation scheme? Are, the systems described in this paragraph, operational?

The data assimilation scheme used is the Mercator Ocean assimilation system SAM2, which allows a multivariate assimilation of sea surface temperature together with all available satellite sea level anomalies and in situ observations. A sentence is added in the revised version of the manuscript. See lines 385-387.

Line 425: Copernicus Marine Service component (CMS). The acronym CMEMS is used previously, please choose between CMEMS or CMS.

Following the comment from RC1, we removed references to CMEMS in favour of Copernicus Marine Service.

Line 544: GLORYS is mentioned here, is the reanalysis used or the operational analysis?

It is GLORYS, we corrected it by removing "12" (before, it was GLORYS12).

Line 604: Ocean boundary conditions are from Mercator and river run-offs from 35 point sources are used based on the FLOW products. Is "Mercator" referring to the CMEMS global ocean analysis and forecast product? What is FLOW product?

We corrected it now, removing reference to FLOW, please refer to lines 629-630.

Table 7: Not all the systems have a description in the text.

This table has been suppressed.

Line 985: where are the references for North America?

In the revised version of the manuscript, a new contribution for North America is included, accounting for Canada, US and Mexico.

LINKS that do not work or point to a wrong webpage:

- Page 4, footnote 5

This reference is now suppressed

- Table 2, Table 3, Table 4

These tables are not included anymore.

- Line 270-271

We are now providing the right link.

TYPOS:

Line 55: "w e" ->"we"

Line 64: "activities ," -> "activities,"

Line 82: "Princeton Ocean Model" misses the acronyms (POM) that is used in the rest of the text

Table 4: 2.3 degree -> probably 2.3km

Line 261:INAM31 -> INAM

Line 263: (SAWS)38 ->(SAWS)

Line 282-283: GLORIS -> GLORYS

Line 497/499: km2->km^2

Line 583 and others: 1/12o -> 1/12˚ , 1/24o -> 1/24˚ , 1/60o -> 1/60˚

Line 585: include -> includes

We tried to solve all of them, surely they will be definitively addressed during the proofreading.