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Interactive comment on "Developing European operational oceanography for Blue Growth, climate change adaptation and mitigation and ecosystem-based management" *by* J. She et al.

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The authors thank the useful comments give by the reviewer. We divided the comments into 6 questions and reply to them one by one. Q1: This position paper has been drafted by leading scientists, all deeply involved in the development of various components of operational oceanography at national, regional, and global scales. The paper is quite extensive and despite the fact that the various sections are well written, certain sections confuse the reader, probably due to jumps from one topic to another: as for example on page 9, lines 10-27. Reply: The paragraph mentioned here (p9, L10-27) is about satellite oceanography. As pointed out by the reviewer, the topic is shifted from in-situ observations to satellite. I proposal to use following sentences from

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L10, to avoid such a feeling of jump of topics: Besides the progresses made in in-situ marine observations, the development of satellite oceanography in the last two decades has also been significantly advanced in the last two decades and become a major component of operational oceanography , as documented by Le Traon et al. (2015). Satellites provide real time and regular, global, high spatial and temporal resolution observation of key ocean variables that are essential to constrain ocean models through data and/or to serve downstream applications.

Q2: The paper has to be shortened and be more focused on those aspects that indeed concern practical topics of operational oceanography, and not on the theoretical topics. This is because several activities mentioned in the paper, as for example those regarding the ocean monitoring and data management, are not directly related to operational oceanography (SeaDataNet, EMODNET, ICES). Reply: In view of the authors, the future development of operational oceanography will not only be limited in the Operational Oceanography (OO) community, the development of OO will have to engage some key non-operational players in the monitoring and modelling community. One issue is the coordination and integration of the OO observations with non-operational observing components: on the one hand, this will provide much larger datasets, both near real time and offline data, for operational modelling, assimilation and forecasting. On the other hand, the OO community integrates data with models which maximize the value of observations from environmental, fishery and research monitoring activities. Considering this is a strategic paper, the authors think that we should keep the relevant issues described in the paper, which will be difficult to reach if the paper is shortened. Q3: As clearly stated by the terms of the service operation, operational oceanography at coastal waters is not addressed by CMEMS. Following ECOOP, there was almost no serious-coordinated attempt to harmonize coastal operational oceanography on a systematic way, in order to align the models for example with the new developments implemented at regional levels of CMEMS. Any effort on coastal operational oceanography, particularly on forecasting, was mainly based on national interest. Reply: In Europe, it is expected that the future coastal OO will be covered by following components: 1. National operational agencies w hich are providing some coastal operational services, e.g., storm surge, hydrological forecast, oil spill drift forecast, agitation, inundation/flooding forecast etc. This part of the coastal OO will be expanded due to the increasing user needs, improved monitoring and forecasting capacities; 2. Private companies which have extensive experiences in the coastal services. It is expected that some of their service areas will be transformed into an operational approach, either through cooperation with operational agencies or run the service by themselves; 3. EC funded coastal service, e.g., through CMEMS. Through enhanced resolution, two-way nesting or unstructured grid, regional models can also provide certain type of coastal services based on modelling and forecast of hydro-biogeochemical parameters. Similar experiments have been carried out in ECOOP. However, due to the complexity in the coastal waters, significant research on the estuary-coast-sea interaction will be needed to fill in the knowledge gaps. 4. European ROOSs are the main coordination body which covers the coastal OO. It can be expected that the ROOSs will play a more active role in the integration of coastal OO in the future. So, the integration of coastal OO in Europe is a complicated multi-actor program, which landscape has not yet well defined. This is also why the paper does not go into details for the future solution. However, as suggested in Q6c by the reviewer, that the coastal OO section will be rewritten to reflect more state-of-the-art and potential approaches for building up the coastal services. Q4: The extended references for an ocean UOM system are indeed a vision. However, the operational oceanographic community at present, need to be consolidated with common tools that will ensure the harmonization with CMEMS in the coming years, to reproduce the correct sea conditions, assimilating in a common way in-situ and remote sensing observations. Reply: The authors agree. The short-term research objective of the ocean modelling is to optimize the deterministic models, data assimilation scheme etc, which is consistent with what is mentioned by the reviewer. The paper has promoted community models (e.g. NEMO is mentioned). Q5: Within the section on research priorities in the coastal waters, on page 30, lines 23-28, the text on EuroGOOS new membership does not add any important issue to the scope of the paper, therefore these lines must be deleted. Reply: We do believe EuroGOOS new membership for private companies will strengthen the cooperation between operational agencies and private companies, especially in developing future coastal operational oceanography. However, as this is just an expectation from the authors and the situation in the future can be quite complicated, we would like to be more careful about this statement. Therefore we decide to delete it, as suggested by the reviewer.

Q6: The paper as is in its present form is quite extensive, therefore I propose: a) To reduce it, excluding those paragraphs that do not add important or signiïňĄcant information about the needs and the aspects of operational oceanography. b) Present in a different and separate ways the vision for both global and regional operational oceanography, which despite their similarities are quite different. c) Provide further information about the coastal scale operational oceanography and expand on what has been achieved so far, as very little information is given in the paper at the present. Reply: Q6a: we haven't covered all important issues in OO but we tried to address major important issues in the four knowledge areas. The authors would like to keep the current structure of the paper. Q6b: the suggested extension to cover the global part will make the text further lengthy. Actually, many challenges in global operational oceanography, e.g., monitoring and modelling systems, have not been addressed by the paper. This is the weakness of the paper. Similar to satellite oceanography (not fully addressed in the paper), global OO should be addressed in a separate paper. Nevertheless the authors have decided to focus on regional operational oceanography. Q6c: Coastal OO will be re-written, to add state-of-the-art in the area and to give a more clear picture about what has been done and what are still needed. The modified text of section 4.1.1 is as follows: 4.1.1 State-of-the-art Monitoring: Monitoring in the coastal waters has been particularly active in the past decade through both in situ and remote sensing. Comprehensive coastal observatories have been established and maintained in the UK, Germany and some other countries. Integrated monitoring using HF radar, ferrybox, mooring buoy, shallow water Argo floats, gliders, integrated sensors and satellites have provided huge amounts of observations. An important feature is that many of these in-situ datasets have high spatial or temporal resolution, which reveals mesoscale and sub-mesoscale features in coastal waters and processes of estuary-coast-sea interaction. The EC has also strongly supported the development and integration of coastal monitoring infrastructure, e.g. through projects JERICO, COMMONSENSE, JERICO-NEXT and other funding instruments (e.g. European structural funds). Monitoring for commercial purposes also represents a significant data source. However, the value of existing observations in the coastal waters has far from been fully exploited, especially for operational oceanography. First, project-oriented observations have poorly been integrated into operational data flow for forecasting;, second, new knowledge generated from the high resolution observations in the coastal waters is still limited; third, the coastal observations have rarely been assimilated into operational models in near real time mode.

In the next few years, a large amount of high resolution satellite observations will be available including the ocean colour (Sentinel 3), sediment (FCI from Meteosat Third Generation) and coastal altimetry (Sentinels). In the long-run it is expected that SWOT will provide altimetry sea level in swath and hydrological monitoring of big rivers. This will provide a sustainable monitoring base for operational oceanography in coastal waters. Vertical stratification in coastal areas, especially in the river mouths, estuaries and enclosed basins, largely influences the vertical transport of substances as well as their transformation in the pycnoclines, redoxcline and at the water–sediment interface. Thus, high resolution observations through the entire water column to resolve relevant features and processes in stratified regions have to be applied. The challenge here is to achieve the proper resolution both in time and in space. Modelling and forecasting: There have been two major issues in focus in the past decade: one is to develop forecasting models and systems for new operational coastal services, e.g., agitation forecast, inundation forecast, estuary/fjord flooding forecast and different types of drift forecasts etc.; the other is how to bridge and couple the global and basin scale forecasting systems with coastal modelling applications; the other is and to integrate

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the fragmented coastal modelling systems at European scale (She and Buch, 2003). For the first issue, the new operational services are mainly developed by national operational agencies. The horizontal resolution has been refined to 100-2 meters. This part of the coastal OO is expected to be expanded due to the increasing user needs, improved monitoring and forecasting capacities. Private companies have also played a major role in coastal services which are mostly case by case services. Significantly advanced coastal modelling systems have been developed and applied in the coastal services. Some of these systems have been used for operational forecasting. It is expected that some of the commercial service areas will be transformed into an operational approach, either through cooperation with operational agencies or run the service by themselves. The European research community has also contributed significantly to the coastal modelling systems, by developing a variety of coastal solutions, e.g. two-way nesting, unstructured grid, coupled systems and data assimilation. However, the existing coastal operational modelling, forecasting and services are fragmented. The coordination only happens at a limited level, mainly done by ROOSes. A significant effort made for integrating existing coastal monitoring and forecasting capacities is the EC funded The FP6 project ECOOP, which aims was developed with the objective toat consolidatinge, integratinge and further developing existing European coastal and regional seas operational observing and forecasting systems into an integrated pan-European system targeted at detecting environmental and climate changes, predicting their evolution, producing timely and quality assured forecasts, and providing marine information services (including data, information products, knowledge and scientific advices). Unfortunately the integrated approach in ECOOP did not continue. In Copernicus service, the coastal service has been regarded as a downstream activity and therefore has not been part of CMEMS. Recently Such objectives and tasks are now largely taken over by CMEMS. Tthe research in this area has been identified as a CMEMS research priority - Seamless interactions between basin and coastal systems (CMEMS STAC, 2015). However, many key dynamic processes in the CSW have not been well resolved by the existing forecasting systems developed in ECOOP and CMEMS. This includes coupling between sediment, optics, physical and ecosystem, vertical exchange between atmosphere, water and bottom, bathymetry change, interaction between river and sea waters, small scale features such as sub-mesoscale eddies, river plumes etc., Sediment transport and coastal morphology models have not been included as part of the forecasting system. Alternatively, the coupled hydrodynamic-wave-sediment models have been developed and used in commercial applications for many years. Some of them are even made available for the public use. It is expected that the existing knowledge and modelling tools for CSW will be integrated into operational systems through close cooperation between the operational oceanography community and the private sector.

Please also note the supplement to this comment:
http://www.ocean-sci-discuss.net/os-2015-103/os-2015-103-AC3-supplement.pdf

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