

Thank you very much for your very relevant comments. In the following text we present your comments followed by our answers and the modification that we propose following your comments to the final variant of the manuscript.

Referee's Comment 1

page 1, line 30 and page 2, line 1: "thousands of rescue operations" are mentioned, but not the time span over which they occurred. Per year? Per decade? More specific numbers of the rate (e.g. incidents per year) would be welcome.

Authors' answer

We fully agree with the referee, we have added the following phrase in page 1, line 27: "(e.g. 2.649 standard SAR operations which led to the rescue of 5.885 persons and 938 SAR operations related to immigrants fluxes which led to the rescue of 154.018 persons in 2015)"

Note 1: Source of information: "Annual report of the operational activities of Italian Coast guard for 2015"

Referee's Comment 2

page 3, line 18: uncertainty in current forcing is considered to be negligible compared to uncertainty in wind forcing. This should be justified somehow.

Authors' answer

We agree with the Referee's comment and we have rephrased the paragraph as following:

"The uncertainty on the current forcing field is considered to be negligible compared to the uncertainty on the wind forcing. This is warranted by the fact that the ocean data have a higher spatial and temporal resolution. Moreover, the uncertainty on the effect of the wind forcing is further amplified by the uncertainty on the leeway itself. Therefore, only the perturbation for the wind is taken into account:"

Referee's Comment 3

page 4, line 29: Is ECMWF model only available for 3 days ahead? Web interface (present version) allows simulations of duration up to 97 hours (4 days).

Authors' answer

ECMWF is available for 10 days but CMEMS hourly currents are available only for 5 days. We have consequently decided to have a homogeneous forecasting capability ahead in time of 5 days (120h). Each day (e.g. T1) at 1am approximately we make available to OCEAN-SAR the wind forecast starting at 12:00 am of T1-1 (the day before of T1). In the User Interface the parameter "simulation Duration" that the Referee has found equal to 97 is changing depending on the starting time of the simulation. In fact, if the user will select a simulation starting the day before of the current day he/she will be able to do a simulation 24 longer.

Referee's Comment 4

page 4, line 30: resolution should be given in km (as for currents above), not miles.

Authors' answer

We agreed with the Referee's comment and we have corrected the paragraph as suggested.

Referee's Comment 5

page 5, line 2: Does details such as the name of the server component "Okeanos" have any meaning to people outside of CMCC? Should otherwise be omitted, rather referring to "the server".

Authors' answer

We agreed with the Referee's comment and we have corrected the paragraph removing the reference to the name of the server.

Referee's Comment 6

page 5, line 9 onwards: The listing of components does not match directly the diagram in Figure 1. Where (and what) is the "Data pre-processing system"? Are the UIs the same as the "Client devices"? Is the server "Okeanos" (where the model is actually run?) a part of CDAM or outside? Later (page 7, line 11) it is said that output from Okeanos is "sent back to CDAM", so apparently it is another machine/server?

Authors' answer

We agreed with the Referee's comment and we have removed the "Data pre-processing system" that was not presented in the figure 1. In fact the Data pre-processing system is part of the CDAM back-end. The UI has been developed for each Client device typology (e.g. web and mobile). The UI is the software component that run on the hardware device. We have added the UI in figure 1. CDAM software runs on Okeanos where also the Leeway model runs. We have added Leeway model in the Figure 1 to distinguish it from the CDAM.

We have removed the name Okeanos from the text as suggested by the Referee in a previous comment.

Referee's Comment 6

page 6 line 5: It is not clear what Figures 2 and 3 add to the paper. The figures should be made (or described) clearer, or perhaps omitted.

Authors' answer

We agree with the Referee, the two figures were not clearly. We would propose to keep the two figures since they present to important component of the OCEAN-SAR related to the brokerage of the messages and to the storage of the simulations.

We propose to better describe the two figures as following:

"All the relevant information provided by the users through the UI (e.g. LKN, duration of the simulation) are transferred through a stream of data using the JavaScript Object Notation (JSON). This stream of data is first passed to the SSA platform through the Message Broker and then to the CDAM again through the Message Broker.

All the messages are exchanged by the components using the JSON format. The communication and the data exchange between the client devices and the SSA platform via the Representational State Transfer (REST) web services established by means of the Message Broker component that receives and forwards the requests to the CDAM hosted on the computational cluster at CMCC (Figure 2). The Message Broker is capable of store, in a database (grey cylinder in Figure 2) the # of request per user in order to avoid simultaneous submissions by the same user."

All the user requests as well as the results of the simulations are stored in a database by a component of the SSA platform, which ensure the data persistency (Figure 3). This component is used by the OCEAN-SAR for instance to store and retrieve previously dome simulations.

Referee's Comment 7

page 6, line 12: The term "The system" which is used here (and also later) is quite vague. Should be more specific on which component (ref Fig 1) is discussed.

Authors' answer

We agree with the Referee and we have substituted the term "The system" with the specific components mentioned in Figure 1 (e.g. UIs, SSA Platform, CDAM).

Referee's Comment 8

page 6, line 14: All the object categories are for objects at the surface, so why is there an option to use ocean currents at lower levels? If there is no wind, any object would (in the Leeway model) simply drift with the currents in the exact same manner.

Authors' answer

The Authors have received requirements from users to search for objects that might have been sunk at a certain depth or at the bottom of the ocean. Therefore, in the present version of OCEAN-SAR we have implemented the possibility of running a simulation using only currents at a selected depth. In the case of a simulation not at surface but at a certain depth the wind effect is put to zero and the transport of the objects is calculated only using the currents component at the selected depth that might be different in direction and intensity from the currents at surface in the same positions.

Referee's Comment 9

page 6, line 18: details such as names of Fortran routines (SeaOverLand, lwseed) should not be mentioned, but rather which actions are performed by the code.

Authors' answer

We have better specified the actions performed by the routine SeaOverLand, we would prefer to keep the name of the routine since it synthetically presents the concept of the procedure that optimally extrapolates the wind and ocean from the ocean point into the grid points closer to land. We have added the following text to the paragraph:

"The wind and current data at sea are extrapolated the ocean data towards the coast using a procedure called SeaOverLand (De Dominicis et al, 2013; Mannarini et al, 2016), which performs an extrapolation of the original data considering for each cell grid point an average of the 8 nearest values and then doing different iterations. This procedure optimally fills, for the currents, the gaps that remain between the ocean model domain and the high-resolution coastline. Moreover also the wind data over the ocean model domain are extrapolated over the land point to ensure that the simulation is performed with data of wind over the ocean and is not affected by wind over land. Then a high-resolution mask is applied to remove the part of the extrapolated ocean data on land."

As mentioned in the text above we have added the following references:

De Dominicis, M., Pinardi, N., Zodiatis, G., and Lardner, R.: MEDSLIK-II, a Lagrangian marine surface oil spill model for short-term forecasting – Part 1: Theory, *Geosci. Model Dev.*, 6, 1851-1869, 2013.

Mannarini, G., Pinardi, N., Coppini, G., Oddo, P., and Iafraiti, A.: VISIR-I: small vessels – least-time nautical routes using wave forecasts, *Geosci. Model Dev.*, 9, 1597-1625, doi:10.5194/gmd-9-1597-2016, 2016.

Referee's Comment 10

page 6, line 29: How can the CDAM module use the "Message broker" to return results to the SSA module, when the "Message broker" is illustrated (Fig 1) to be a component of the latter? Or does CDAM have its own "Message broker"?

Authors' answer

We understand the concern of the referee and we have added the following text now at page 7 line 14:

“The Message Broker is a unique component hosted by the SSA Platform. As illustrated in fig. 1 it is responsible for the communication both among client devices and SSA platform and between CDAM and SSA platform. The CDAM receives input data from the SSA platform through the Message Broker and send back the results produced by the model to the SSA platform through the Message Broker.”

Referee's Comment 11

page 7, line 8: Very much overlap with Figure 1, could these figures be merged?

Authors' answer

We agree with the referee in the sense that the 2 figure are similar but Figure 1 shows the OCEAN-SAR logical architecture and all its components conversely Figure 4 shows only how the messages are exchanged and in which temporal sequence among the different components via REST web services. We would propose to keep the two figures separately.

Referee's Comment 12

page 7, line 15: "results are provided to the user via graphically displayed fields". Is WMS or any other functionality used here? This should be described in more detail. Also in the web interface, only currents can be shown as "environmental fields", but it would also be of interest to show the wind. It is also not clear whether the displayed current field is for the start or end time of the simulation. Ideally one would like to have a time slider in the user interface, where both the currents/winds and particles would update/move.

Authors' answer

Following the comment of the referee on WMS we have added the following text at page 7, line 15: “, in particular, the particles and their trajectory are presented on the map respectively as yellow and black circles making use of Google shapes² and the currents are presented overlaying tiles provided by a WMS service.”

Where the note 2 is: “<https://developers.google.com/maps/documentation/javascript/shapes>”

We understand the comments of the referee on the visualization of environmental fields. We agree that wind should be added together with currents and then a time slider also should be added to view the particles intermediate positions and the wind and currents vectors.

We have developed a similar visualization in the witoil.com decision support system.

We plan to include these new visualization features in the next version of OCEAN-SAR that will be issued in the next months.

Referee's Comment 13

page 8, line 14: On Figure 5, the screenshot shows that start and end-time of LKP can be specified, but not the "end position" which is indicated in the text box outside of the figure. Several of the validation cases (Table 1) have used seeding on a line between two points, which is not possible through the shown interface. In the present version at <http://www.ocean-sar.com> it is also not possible to specify the end-time, only start-time and start-position.

Authors' answer

The present version of OCEAN-SAR does not allow to specify end position and end time of the seeding.

We have corrected the Figure 5 erasing the terms “End position” and “End Date” in the box of Figure 5. These features were not included in this version of OCEAN-SAR because they were though not to be essential in the first implementation of the decision support system.

As well the seeding along a line was not foreseen in the first operational version of the OCEAN-SAR presented in the paper. It was used in the validation phase of the OCEAN-SAR for instance in the case of the person lost from the Ferry.

We have understood the relevance of these features and they will be included in the next version of the OCEAN-SAR.

Referee’s Comment 14

page 10, line 6: also a red contour line is shown around the drifters, is this a convex hull?

Authors’ answer

Yes, the referee is right we also display a red contour line around the drifter which is a convex hull also referred in the text as search area.

We have added this text to the paragraph:

“Red contour line around the drifters, a convex hull that identified the search area.”

Referee’s Comment 15

page 11, line 5: It should be mentioned which of the current products have been used for the validation exercises. The accuracy of the current is of primary concern, and is more important for the final results than the "search-and-rescue system" itself.

Authors’ answer

We agree with the referee’s recommendations and we have added the following text to the paragraph:

“Environmental fields used in the validations exercises have been the surface currents analysis provided by CMEMS MED-MFC and the wind analysis provided by ECMWF, both described in paragraph 3.1.”

Referee’s Comment 16

page 11, line 11: The layout/indents in the following is a bit messy.

Authors’ answer

We agree with the referee’s comment, we have revised the indents creating sub-sections (5.1-5.5) for each of the study cases (5 and not 6 as previously written in the text). We have added a title to the last part of this section that now is called 5.7 “Discussion on each validation case”.

Referee’s Comment 17

page 12: positions (longitude and latitude) are given both in Table 1 (page 13) and in the text, giving possibilities for inconsistencies. I would suggest giving coordinates only in the table. Coordinates are given sometimes as minutes plus decimal degrees (e.g. 37_41.6’N) and sometimes as minutes, degrees and arc-seconds (e.g. 38_39’6’’N). In some cases, notation is wrong: 39_54’.716 N should probably be 39_54.716’ N. I would prefer to use only decimal degrees, but at least notation should be consistent.

Authors’ answer

Following the suggestion of the referee we have converted the positions give as minutes, degrees and arc-seconds into decimal degrees. Positions are now reported only in Table 1 and not in the text to avoid possibilities for inconsistencies.

Referee's Comment 18

page 13, table 1: units could be given in table column headers. Radius is given as "0,1", probably meaning "0.1", and this is presumably in km (and not degrees?), i.e. 100 meters? For Calabria1/2 the Leeway classes 1 and 7 have been interchanged. The wind conditions makes a real difference to the simulations, and would be a useful addition to the table or Figure captions below. E.g. "winds between 5 and 10 m/s from south-south-west.". E.g. for high winds one would expect a larger difference between a raft and a person-in-water than for weaker winds.

Authors' answer

Following referee's comment, we have inserted units in table 1 column headers, including the km for the radius and we have corrected the Classes of Calabria1/2 in the table. For the Calabria exercises, where a direct comparison of wind behavior is possible, we have added to the figure caption: "During the exercise the wind speed ranged from approximately 3 to 10 m/s, predominantly in the south-southwest direction."

Referee's Comment 19

page 17, Figure 12: four figures are shown, presumably a time series of the evolution. This is useful, but the caption and discusses only the final position (lower right figure).

Authors' answer

We have added sub-captions (a)-(d) to the four figures to make the description of the time series more clear.

Referee's Comment 20

page 22, Table 3: in rows 10-13, default values are shown also in the Name-column. "Format" and "Default values" should be separate columns. Radius for seeding is stated to be in meters, but correct is presumably kilometers. Longitude and latitude are stated to be given as "minutes and seconds", but correct is presumably decimal degrees, as the default values are given as single floats.

Authors' answer

We have updated the table to include these suggestions and corrections.

Technical corrections:

There are several minor errors and misprints throughout the text which should be checked and corrected. There are also several badly/incompletely phrased sentences such as e.g. the caption on Figure 5: "Parameters of Simulation displayed on the UI".

Authors' answer

We have check and correct the errors and misprints. We have check and corrected the incomplete phrases in the text:

- 1) The phrase "OCEAN-SAR high-level architecture" in page 5, line 15 has been corrected to "OCEAN-SAR high-level architecture describing the main components of OCEAN-SAR (UIs on client devices, SSA platform, CDAM, Leeway model)."
- 2) The phrase "Message Broker" in page 6, line 9 has been corrected to: "Message Broker main functionalities are presented consisting of the exchange of messages between the SSA platform and the CDAM."
- 3) The phrase "SSA component responsible for data persistence" in page 7, line 3 has been

corrected to “SSA component responsible for data persistence and for the exchange of information between the UI and the Message Broker.”

- 4) The phrase “Data flow among components” in page 7, line 9 has been corrected to “Data flow among OCEAN-SAR components”
- 5) The phrase “Parameters of Simulation displayed on the UI” page 8, line 14 has been corrected to: “The Parameters of Simulation displayed on the UI are available on the left side of the UI. The boxes on the left side of the figure describe the different parameters.”
- 6) The phrase “Help option overview of parameters” page 9, line 1 has been corrected to: “Each parameter simulation in the UI show a question mark which consists of the help option of that parameter. By clicking on the question mark the user will obtain a pop-up box (Yellow box) with explanation on the meaning of the selected parameter.”