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Interactive comment on “Evaluation of numerical models by FerryBox and Fixed Platform in-situ data in the southern North Sea” by M. Haller et al.

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Author's Response to Anonymous referee #2

The authors wish to thank the anonymous referee #2 for the detailed and constructive review of the submitted paper.

The responses to the comment points are the following:

1) The introduction is long and goes into details that are not so relevant for the paper. In addition, the description of the residual circulation is not very clear. I find this to be particularly true when describing the connection between the Baltic Sea and the North Sea. It is also important to note that the description of the circulation is actually that of the residual circulation, and that tides are actually of high importance in the

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region. Tides are not even mentioned as one of the drivers for the residual circulation. Other smaller details in the introduction deserve attention: the isobaths mentioned in the introduction are not really visible in Fig. 1; although the North Sea is part of the Coastal Ocean, it is probably not correct to refer to it as "a costal ocean".

The introduction has been shortened. The isobaths in the figure are now more pronounced than before as the isobaths lines itself are now drawn. The North Sea is a major part of the North-West European continental shelf which is by definition (depth <200 m) a coastal ocean. Thus we consider also the North Sea as a coastal ocean.

2) The use or lack of units for salinity is not consistent. In p. 361, l. 25 it is said that "salinity values are quoted in dimensionless numbers, even though Ferry Box measurements are performed in practical salinity units". First note that in principle the practical salinity units do not really exist and that the practical salinity scale is already dimensionless.

The sentence has been removed. All salinity values are described in dimensionless numbers.

3) Section 2.6 is unclear. In general, it is not clear how the data was extracted from the models and observations. In addition, there are a couple of repetitions that add to the confusion. I find this section to be particularly important because the data extraction is the basis for all future analysis. Therefore, it is difficult to evaluate the validity of the paper as a whole if this is not clear.

FerryBox data have been taken from the HZG FerryBox database. There, data are stored with 10 seconds resolution. The GPS coordinates of the transect between England and Germany have been used with 0.05° resolution. Model data have been taken from HZG model archive (BSHcmod) and from MyOcean database (AMM7). For each transect position, a search radius of 0.02° and a time window of ± 1 hour has been used for nearest neighbor interpolation of model data. For the detailed analysis of three positions in the North Sea (English East coast, Oyster Ground and German Bight), an

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internal search routine of HZG database has been applied. There, a search radius of 5 km around the fixed positions has been used for the retrieval of FerryBox data (5 km is the default search radius). The retrieved time series of FerryBox data have been filtered for model time steps with a time range of ± 30 minutes. In the next step, the nearest model grid point of BSHcmmod and AMM7 has been allocated to that fixed positions.

4) It is said that the data of the AMM7 model are available for 2011 and 2012. However, the analysis covers only the period from April 2011 to April 2012. This has to be made clear in the text.

Text in abstract has been changed to: "Two operational hydrodynamic models have been evaluated for different time periods: results of BSHcmmod v4 are analysed for 2009–2012, while simulations of FOAM AMM7 NEMO have been available from My-Ocean data base for April 2011 to April 2012." All other text passages have also been adjusted to "April 2011 to April 2012".

5) I would suggest that a large portion of the "Summary and conclusions" section goes into another section of discussion about perspectives for the combined use of FerryBox data and numerical models. In this way the conclusions can be more concise. I would really appreciate a concise conclusion in terms of the lessons learned to improve the models.

We follow here the suggestions of both reviewers #1 and #2 to structure the end of the paper in a way that the majority of text from the conclusions is put into a new section called "Discussion" and the conclusions part is strongly trimmed to a concise section.

6) It is not clear why it is mentioned that BSHcmmod v4 contains general vertical coordinates. They are not used, right? Are only z coordinates used? This is confusing.

For a clearer description of the coordinate system of BSHcmmod this section has been reformulated:

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“The model is based on the Reynolds-averaged Navier-Stokes equations which are discretized on a geographical Arakawa-C grid and on adaptive vertical coordinates. A two-way nesting approach is applied with a coarse resolution grid (5km grid spacing) in the North and Baltic Sea and a fine resolution grid (900 m grid spacing) in the German Bight and the western part of the Baltic Sea (focus region). Internally, BSHcm v4 is making use of adaptive layers with variable thickness, depending e.g. on tidal amplitude (8m in the English Channel, 1-2 m in the German Bight). The number of layers is 36 in the coarse and 25 in the fine resolution domain. When archived, BSHcm data are interpolated on a coarser and constant vertical layer resolution. Thus, the archived data applied here are from the upper layer which has a thickness of 5 m and is having a temporal resolution of 15 minutes.“

Minor comments:

- The expressions "accounting to" and "accounts to" are used several times. Do the authors mean "amounts to"?

“Accounting to” has been changed in the document to “amounting to”.

- The authors use the preposition "at" in several places such as "the stde is at 0.8 K". In this cases, "at" is not necessary.

The preposition has been removed in some cases, especially when describing statistical values.

- The fonts in most figures are too small.

The fonts have been enlarged from 12 pt to 14 pt.

- It is probably of use to rename the subfigures as a), b), c), ... in order to refer to a specific plot.

We already solved that by referring to e.g. “upper left” or “lower right” which we think should be equivalent to naming a) b) etc.

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- In several places the authors use "according" when they probably mean "corresponding"

"According" has been changed in the text to "corresponding".

- The explanation of the cost function cf is unclear.

The cost function is the mean of the absolute cost function values of the field the analysis has been applied to. A cf value of 0.5 means that the model error is on average 0.5 times the standard deviation of observations. So, the difference between model and observation is related to the normal variation of the field variable (Søiland and Skogen, 2000).

- p. 366, l. 19: . . . frontal zones form in this region. . .

Has been changed.

- p. 368, l. 3: rephrase "it would be suggestive"

"It is recommended to cross-check the water temperature instruments with an additional certified temperature probe on board."

- p. 370, l. 19: the limiting values 0.7 and 1.2 are not observed in Fig. 6. They seem to be 0.8 and 1.1.

The numbers have been corrected to be 0.8 and 1.1 in the text.

- p. 372, l. 22: the fact that there is a minimum of 0.15 at 0.5°E is not reflected in the Fig. 8.

In Fig. 8 the minimum of skvar for salinity amounts to 0.15 and is located at 0.8°E. The longitude has been corrected in the text.

- p. 376, l. 22: Do the authors mean that "the observed variability" cannot be reproduced by either model"?

Rephrased to "cannot be reached by either models"

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- p. 377, l. 16: the sentence on the freshwater eddies should be made clearer.

The sentence about freshwater eddies has been rephrased:

“Moreover, long-persisting low-saline water masses seem to cover only small scales in space and could be missed either by the model or the FerryBox traveling along the route, resulting in higher discrepancies between model and FerryBox. In this context, the different spatial features of model and FerryBox should be reminded. Whereas the FerryBox samples data of spots along a track, the model covers an area of several kilometres.”

- p. 378, l. 21-23: It is said here that the salinity values are underestimated however it seems that they are actually overestimated. The drop, however, is underestimated. In addition, it is difficult to see this in the figure since the model data is plotted at the back.

The intention was to describe, that the simulated salinity is in comparison to observation too high. So, the text has been rephrased:

“The next event in January 2011 is recognized timely but the salinity values are obviously overestimated. The third event is recognized by BSHcmmod v4, but not on the correct date. The salinity drop is also underestimated by AMM7.”

- p. 378, l. 26: remove "should both"

“should both” has been removed

- Fig. 1, caption: A green line is mentioned, but it does not appear in the figure.

The sentence about a green line has been still in the caption text by mistake, originating from a former version of the manuscript. The text read now:

“Figure 1: FerryBox routes and crossing points in the North Sea. Contour lines indicate the bathymetry. The blue line marks the TD route Cuxhaven-Immingham and the red lines indicate the LB route England-Norway-Germany. Specific analysis points of

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FerryBox routes are indicated by black points and labelled p1, p2, p3, respectively. p1 is situated at the English East Coast. p2 marks the analysis point in the Oyster Ground area. At p3, the MARNET station Deutsche Bucht is located."

- Fig. 5, it might be useful to plot a rectangle on the left figure, denoting the time covered by the AMM7 data. Also, the caption has to be corrected: change psi to K.

The caption has been corrected.

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