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Ocean Science Discussions
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Interactive comment on "Numerical modelling of physical processes governing larval transport in the Southern North Sea" *by* M. C. H. Tiessen et al.

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We would like to thank referee 1 for his/her careful examination of the presented paper. We have carefully considered the points raised, and we address them point by point here. Please note that the original comments are presented in **bold** whereas our replies are presented as normal text. Please find enclosed a revised version of the document, as attached supplement. Alterations to the original document are shown highlighted in grey.

The discussion mainly focuses on technical details like which spawning areas were chosen, how behavior, mortality and temperature (might) have changed

the results the sensitivity of the outcome but the findings on interannual variability the different states of the system that lead to favorable or unfavorable conditions, the implications that a longer vs. a shorter transport duration would have on the stock etc. are missing. Therefore the discussion is also relatively short (4 pages) in contrast to the 10 pages and 13 figures (not including the sensitivity and validation studies) of results.
We have changed the text and it now includes both a more quantified as well as a broader description of the findings of our research into the "Discussion" section of the paper.

Parts of the result section (especially the validation part) should go into the Material Method section.
We have moved part of the validation-subsection into the MM section.

Due to the previously mentioned shortcomings of the discussion also the second part of the abstract could benefit from a more thorough investigation on e.g.: what patterns (strong wind from xy direction lead to x% less particles that settled etc. temperatures above x degrees C increased settling success by . . .) lead to which observations and what are the implications for the species in such years.
We agree with the referee that a quantification of the inter-annual processes was lacking. We have rewritten part of the abstract to incorporate more direct relationships between forcing and drift and settlement dynamics. Additionally, in the results and discussion sections a more extensive quantification of the different processes and the variability is presented. Also please note that Fig. 9 (originally Fig. 8) showing the wind-speeds has been altered to highlight the importance of South Westerly wind component. This is subsequently used to quantify the impact of wind direction on settlement success.

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The overall presentation is well structured and clear, but due to the high number of graphs and results the figures could be reorganized and the result part would benefit if each paragraph would start with a summary of the findings described in that part. This has been done in some paragraphs but not in all and would increase the readability and understanding in my point of view.
We have examined the different sections and sub-sections of the paper, and where suitable included a summary of the section. The alterations to the various figures will be discussed in the "Technical comments" section below.

Technical comments:
page 3, L 19: change become into come
The mistake has been corrected.

page 3, L 29: delete a
We have removed the entire sentence, as it formed a repetition of a statement later in the same paragraph.

page 4, L 15: Were particles stopped as soon as they settled. Could particles settle in different locations. If the first settling location was used does that have implications on the results and which?
We slightly reformulated the specific statement to point out that particles would settle at the first opportunity provided (once they became juvenile plaice). In the "Discussion" section of the paper, the impact of different approaches is now presented.

page 5, L 5: Change mile to miles
We changed it.

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page 5 L 12: How were temperature included, as start values or for daily adjustion of the modelled values? Were they only included in the coarser model?
The temperature distribution over lat, lon and depth was calculated at every time step of the hydrodynamic model. The conditions were adjusted every month to correspond with observed values. In the particle tracking routine, the temperature experienced by each individual particle was calculated as an interpolation of the surrounding temperature data from the hydrodynamic model at each time-step. As a result, the temperature experienced by each particle was different, and variable over time. This has now been clarified in the section "Set-up of plaice model runs".

page 6 L17: change latter to later
We have altered this in the present document.

page 6 L 20 change perquisite to prerequisite
We have corrected it.

page 7 L 1 – 24: Put this paragraphe into the MM section
Done. This section has now been moved to material and methods.

page 7 L 25- page 8 L 4: Put this part into the discussion
We carefully analysed this paragraph, and apart from some minor changes, kept it in the "Results" section, as it introduced the results concerning the presented validation.

page 11 L 23: change intern to inter
We have corrected it.

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page 12 L 1: change Holland to Dutch
We agree with the referee that the term “Holland” was not very well chosen. We intended this term as a description of that section of the Dutch coastline that directly faces the North Sea (in contrast to the part which borders the Wadden Sea), we have rephrased it as the “Dutch North Sea coast”.

page 12 L 16: Plaice eggs are positively buoyant and are therefore mainly located in the upper water column. Is the setting with random distribution over the whole water body realistic and would it change the results and findings?
The current runs did not take the positive buoyancy of plaice eggs into account. We have included a paragraph emphasizing the impact of this assumption in the “Discussion”.

page 13 L13: The instead of he
This sentence has now been rewritten, and does not contain this typographical error any more.

page 13 L 17: replace coarseness with lower resolution
We agree with the referee that the alternative phrase is better, and amended the document to incorporate it.

page 14 L 2: Why were 120 days chosen if this was not sufficient to fulfill a complete development?
We re-examined our results carefully and found a minor error in our numerical code. The implementation of the 30-day settlement threshold was flawed, and resulted in a number of particles settling beyond this threshold (however, within the 120-day limit).

This only occurred for higher water temperatures, and is therefore mainly confined to particles released in the English Channel.

Fig. 1 of this response presents the impact of the altered code. The top graphs show the original results, whereas the bottom graphs show the new results. The overall settlement characteristics per area show a slight decrease in the number of settling particles, which can be attributed mainly to the settlement in the English Channel (shown in black) settlement in the other areas remains nearly unchanged, and all show the same inter-annual variability as presented in the original document. Settlement characteristics in the Western Wadden Sea (shown on the right) show a slight reduction in the number of settling particles at the end of the 120-day drift duration, and at the end of the numerical simulations (shown along the y-axis for values higher than 150). Please note that, although all affected figures presented here and in the paper have been redrawn, the presented outcomes and conclusions have not been altered as a result of this.

Concerning this 120-day numerical simulation limit. This was based on literature (cf. Bolle et al., 2009; Hufnagl et al., 2013) indicating a maximum drift duration of less than 120 days. However, the impact of this assumption was investigated, by extending this to 180 days for the three years examined in the paper (Fig. 20). The findings are presented in the Sensitivity analysis section of the paper. Generally, the impact is small, although for 1996 a significantly higher number of particles are able to settle in the Western Wadden Sea.

page 14 L 18: When were plaice allowed to settle? If there was no restriction, is it valid to say that already yolk sac larvae could settle and would the results change if not the first settling location would be taken (see earlier comment)
We agree with the referee that the original formulation concerning this settlement-duration was not very clear. We have rephrased this in the Introduction, which is now in line with what is stated in the Material and Methods section. Settlement only could

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commence once a particle was assumed to have reached the juvenile stage. As a result, settlement during the egg and yolk-sac larvae stages was not possible.

page 15 L 12: Wasn't the maximum 120 days?
This is correct, what we intended to say was that the shortest drift durations occurred around yearday 140. This has now been corrected.

page 15 L 19: include did
We have now included "does" instead of "did".

page 15 L 25: showed an instead of showed a
We have corrected this.

page 18 L 13: Later instead of latter
It has now been corrected.

Figure 3 and 2 could perhaps be combined
Prior to original submission, we have attempted to show the impact of both the individual particles and this circle of particles around the release-point of the drifter-buoys in a single figure. However, we found this figure to contain too much information, which complicated the analysis. We would therefore prefer to keep them as two separate figures.

Figure 4 chould go together with 7 for an interannual comparison and chould include a smaller version of Figure 1 to indicate the start areas
The present set-up of the paper highlights an individual year first, before identifying

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inter-annual variability, as such Fig. 4 (in present manuscript Fig. 5) has a different purpose (introducing the various methods of analysis), than Fig. 7 (Fig. 8) (expressing the inter-annual changes). However, we do agree with the referee that the inclusion of Fig. 1 as an inset to the graphs presented in Fig. 4 and 7 would be a good addition. This has now been included.

Fig 5 could go together with Figure 9 to allow for an interannual comparison In all maps shift the D for Germany upwards as at the moment it looks like the DK belongs to the German coast
We would prefer not merging Fig. 5 (now Fig. 6) and 9 (now Fig. 10), for the same reason as presented in the previous comment. However, for all figures the position of the D has been shifted to point out that part of the North Sea coast is in fact German.

Include the latters a) b) c) d) in the figures
We have included these into the relevant figures.

Figure 6 and 10 could be combined to allow for interannual comparisons
This suggestion was also considered carefully, but similar to the suggestions for Fig. 4 and 5, was not adopted, since the figures serve a different purpose.

Fig 11. Give percentages as well on the y-axis label
We agree with the referee that this would be a useful addition, and have included it in the present version of the figure.

Fig 11 I do not really understand the legend and the color coding. You have particles that make it to the nursery which are blue. Then you have the fraction that do not make it. These can be separated into those that have not finished

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the larval stage (over the 120 days) which are red and you have those that do not reach a nursery which are gray. What exactly are the orange? Did the red ones reach a nursery but are not finished with development?
We thank the referee for point out the incomprehensibility of the legend. We have amended it now both in this figure as well as in the text (in the sub-section Particle drift settlement success). The orange and red particles both do not settle, and both to not reach the end of their 30-day settlement period. However, the red particles do also not reach the beginning of the 30-day settlement period. When the simulations are truncated after 120 days, these are still in their larval stage.

Fig 12: This figure might be different if particles do not settle at the first suitable place. Is this of relevance?
This is an interesting point, as certain settlement areas would be less suitable to support juvenile plaice than others. For instance the Dutch North Sea coastline is assumed to be less suitable than the Wadden Sea. If plaice juveniles would be able to postpone their settlement this would enable them to drift past the Dutch North Sea coastline and settle into the Wadden Sea. The possible impact of this is now included in the Discussion.

Fig 13 14 15: I would have expected more of these results in the discussion and the relevance they have for plaice.
We have extended the Discussion section of the paper, to also include a broader interpretation of the findings presented in this manuscript.

Please also note the supplement to this comment:
http://www.ocean-sci-discuss.net/10/C938/2014/osd-10-C938-2014-supplement.pdf

Interactive comment on Ocean Sci. Discuss., 10, 1765, 2013.

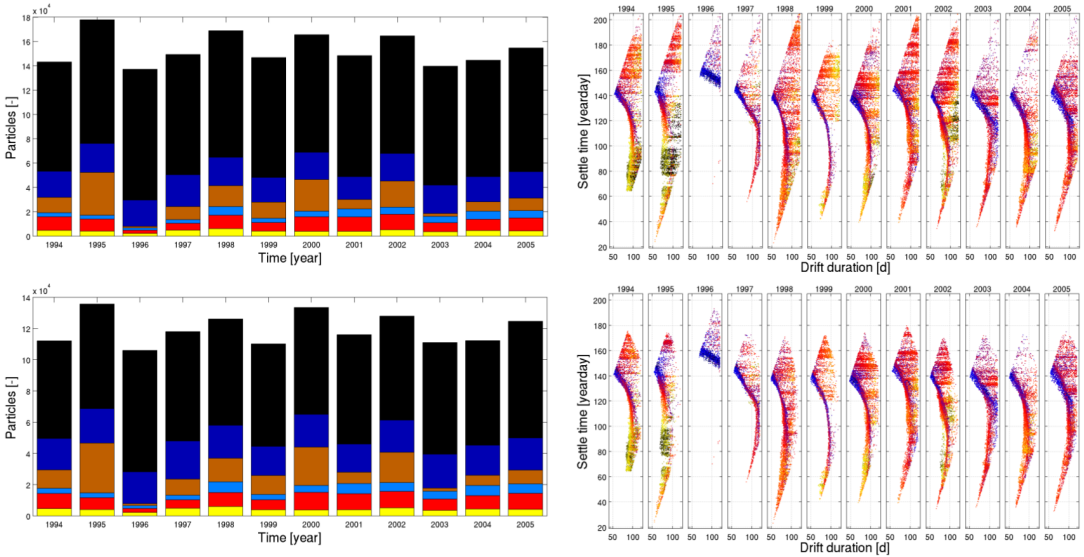

Fig. 1.

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