



Comment on **essd-2021-103**

Anonymous Referee #1

Referee comment on "North SEAL: a new dataset of sea level changes in the North Sea from satellite altimetry" by Denise Dettmering et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-103-RC1>, 2021

Summary

This manuscript describes a new satellite altimetry dataset dedicated to the North Sea. Recent advances in coastal altimetry, its processing and its corrections appear to form the main motivation for this new dataset. The behavior of monthly mean sea-level anomalies through time, the linear trends fitted through monthly means and the amplitudes of the mean annual sea-level cycle derived from this dataset are compared with tide gauge data corrected for vertical land motion. The agreement of NorthSEAL with tide gauge data based on these metrics is found to be improved compared to prior altimetry datasets, and clearly this will be beneficial for scientists studying sea level in the North Sea. The manuscript describing the new dataset is well written and the figures look good. Nevertheless, I have a number of comments and suggestions for the authors to improve the manuscript. Lacking relevant expertise on the processing of altimetry data, my review is mostly from the sea level point of view and I would recommend that the manuscript is reviewed by an altimetry expert as well.

Main comments

Introduction

L41-52: as part of their motivation for an improved altimetry dataset for the North Sea, the authors point out that most studies investigating MSL changes in the North Sea are based on TGs, which do not provide open ocean information. While it is true that TGs cannot provide open ocean information, multiple studies have used existing altimetry data and regional models to gain more understanding of the processes driving sea-level change & variability and its spatial characteristics in the North Sea and on the wider continental European shelf, for example: <https://doi.org/10.1002/2014JC009901>, <https://doi.org/10.1002/2016GL070750>, <https://doi.org/10.1029/2020JC016325>, <https://doi.org/10.1007/s00382-020-05378-0>, <https://doi.org/10.1029/2003GL017041>, <https://doi.org/10.1029/2012JC008285>. Including more of these and other relevant studies would make the introduction more comprehensive. The authors may also consider to draw the connection with modeling studies for the North Sea – one of the applications of (improved) altimetry data is model validation and this is currently not mentioned in the manuscript.

In light of this I am also wondering whether the authors have considered extending their dataset to the whole northwestern European continental shelf?

Altimetry comparison with TGs

L71: 'i.e. trends and annual amplitudes' the motivation for evaluating these metrics specifically is missing. The analysis of the correlation of monthly mean timeseries (6.1) could also be mentioned. Additionally, evaluating the interannual variability of annual mean sea level would also be very helpful for future studies.

Section 3.4: should establish both how and why these metrics are compared, and in combination with Section 6.1 raises the question why only the correlation of detrended monthly means is assessed but not the magnitude of the difference?

Section 6.2: the authors mention that due to the short time periods, the trend uncertainties are of such a magnitude that the trend differences between altimetry and TG, and presumably between different altimetry products as well, are statistically insignificant. Does this mean no robust conclusions can be drawn about whether NorthSEAL outperforms the other altimetry datasets in terms of trends? Since the other comparisons focus on monthly mean timeseries and the seasonal cycle, should NorthSEAL also be preferred over existing altimetry datasets by users interested in interannual sea-level variability and trends? It may help to extend the analysis by looking at both the correlation and the RMSE of monthly and annual mean timeseries.

Another thing worth considering is to extend Table 3, which nicely summarizes the comparison of trends, by adding a summary of the key statistics of the comparison of the other metrics as well.

Abstract & Conclusions

L12 & 404-405: "*It will enable further investigations of ocean processes, sea level projections*" & "*Moreover, NorthSEAL can also contribute to improve sea level projections*" I would suggest some additional explanation on how a regional observational sea-level dataset for the North Sea can directly contribute to improved sea-level projections. Projections do not rely on altimetry observations per se. I can imagine improved process understanding that could result from this dataset could eventually help to improve & interpret projections, or that it may help to better estimate the time of emergence of projected sea-level change above observed variability.

L405-408: "*and it provides an observational basis for planning coastal protection measures. Examples include national and international dike building projects, or an improved understanding whether projects like the Northern European Enclosure Dam NEED (Groeskamp and Kjellsson, 2020) can be a solution for mitigating sea-level related climate change impacts*" an improved observational dataset can help to monitor and detect early warning signals to inform adaptation planning, but I wonder what application it finds in studying the feasibility of an idea such as NEED. I would encourage the authors to focus on the direct uses of their dataset in the conclusions instead, including those they already mentioned, such as improved process understanding, model validation and monitoring.

Other comments

Figures: it is better to use sequential colormaps for non-diverging colorbar ranges. I find this study very helpful for figures: <https://doi.org/10.1038/s41467-020-19160-7>

Title: capitalize 'new'?

L3: 'sea level mean annual amplitudes' could be rephrased to 'amplitudes of the mean annual sea-level cycle'?

L5: 'innovative methods' if possible to specify these methods in a few words it may be worth doing so

L60: 'most probably' can the authors confirm this with the authors of cited paper?

Section 2.1: although the overview is nice, it may be worth checking if all the information in this section is relevant (for example, does the reader need to know the average North Sea temperature?)

Section 2 & 3: can the authors please add how they account for the inverse barometer effect (is it included in the altimetry dataset?)

L141: 'refer to' replace by 'see'

Figure 2: in addition to using a different colorbar range for subplot d), perhaps a different colormap could be used as well to distinguish from the other subplots straight away instead of through the note in the caption.

Figure 2: in subplot a), a vertical 0 line appears at 0 degrees – might be due to longitude wrapping and the authors could try to fix that; in subplot d) there is a similar vertical line at the left-hand side of the plot.

L185: for a detailed description of the methods in this manuscript the reader is referred to a study currently under review, is that problematic?

L208: 'annual amplitudes' may not be readily understood as 'amplitudes of the mean annual sea-level cycle' which I think the authors mean

L224: you compute the amplitude of the mean annual sea-level cycle using the maximum and minimum values in each year. How do you avoid the possibility that the maximum of year 1 is found in December of year 1, and of year 2 in January of year 2, and so effectively the maxima of two years are both found in the same Winter?

L227: could the authors please add a few words on why they prefer this approach?

L245: is there a recommended way of interpolating the data on your unstructured grid to a regular grid that end users may prefer to work with?

Table 2: it may help to add a column with the dimensions of each variable (for example, if the grid is unstructured the longitude and latitude are presumably 2D?)

L263-264: not entirely clear what this sentence means, please rephrase

L282: flagged as what?

L326: does the '23.1%' refer to the percentage of tide gauges at which correlations are lower for NorthSEAL than for SL_cci? How does this align with 'only for a few TG'?

L397-399: the amplitude of the annual cycle is not mentioned here

L403-404: "*This enables basin-wide studies of physical processes driving sea level variability, such as the impact of atmospheric wind and pressure forcing.*" – such studies already exist, so it may be helpful to specify which processes in the North Sea future studies can now investigate using NorthSEAL that previous studies could not?