

# ***Interactive comment on “Reassessment of long-period constituents for tidal predictions along the German North Sea coast and its tidally influenced rivers” by Andreas Boesch and Sylvin Müller-Navarra***

**Andreas Boesch and Sylvin Müller-Navarra**

andreas.boesch@bsh.de

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Dear Reviewer #3.

Thank you very much for your time and effort to review our manuscript. Please find below our replies to your comments. The different items from the review report are first cited, followed by our responses.

1) “They asserted the slight improvement using the new set of constituents through just one year (2016) verification. I recommend that the authors should conduct additional

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two year (2017-2018) comparison between prediction and observation to clearly show the improvement.”

» The main focus of the manuscript is the preparation of the list of tidal constituents as used by the operational tidal forecasting service. We think that in this context the verification over one year is sufficient. The old sets of constituents have proven over several decades to deliver good results and no major differences were expected. The presented comparison shows that the new set of constituents can be expected to work equally well or even better because several frequencies in the residuals are now removed (see Fig. 10 and 11). We argue that an additional comparison over two years is not likely to show any significantly different results, but rather inflate the manuscript unnecessarily. Furthermore, quality-checked times and heights of high and low waters are not yet available from the respective authorities for several tide gauges for the year 2018. This would limit the comparability of the different verifications. We hope that the referee understands our arguments and does not insist on further verification studies.

2) “As the authors mentioned, the HRol is not widely used in comparison with a ‘standard harmonic analysis and prediction (HAP)’ method even if it has the better computational efficiency. Is it because that the HRol is not open to the public or inconvenient to use? Additionally, I wonder if tidal prediction accuracy for the HRol is better than that of the HAP. Can it predict tides at any time interval like the HAP? I think that the authors need to explain the additional reason why the HRol is still used at BSH but most of countries have not used it. What are the advantages of using this method?”

» We are not in a position to judge why the HRol is not used more widely. The method has been published (as referenced in the manuscript) and it is fairly easy to use. The original implementation of the HRol, as described in Sect. 2, uses recorded time series of times and heights of high and low waters in order to predict times and heights of high and low waters. The concept of the HRol can be generalized to determine the full tidal curve based on equally spaced water level records (e.g. 10 minute intervals). This generalized concept is explained in Müller-Navarra (2013; full reference in the

manuscript) and is not subject of the analysis presented in the manuscript. The characteristics (including advantages) of the HRol are mentioned in Sect. 1 and 2, but we agree that this aspect is scattered throughout the two sections and should be cleaned up and expanded. In the revised manuscript, we will remove the last paragraph of Sect. 2 and insert it after the second paragraph of Sect. 2. The paragraph will also be expanded to address the advantages in more detail. The comparison of the HRol with other methods (e.g. the harmonic method) is not the subject of this paper and would be beyond its scope. Reliable harmonic constants exist only for a few German tide gauges and a comparison study of this kind would need a lot of resources that are not available at present. We agree that this testing is interesting and invite others to use the HRol for their applications and comparisons.

3) “On p. 2 line 4: 44 angular velocities -> 45 angular velocities (Need to check it)”

» The list of partial tides published by Horn (1960) consists of 44 angular velocities. These 44 angular velocities are also marked in our Table 2. The sentence in the manuscript is correct.

4) “In Table 3 and Table 4, angular velocity (!) should be expressed more than seven decimal places.”

» We will add one decimal place to the angular velocities in Tables 3 and 4 in the revised manuscript; also to make it consistent with the angular velocities in Table 2 and the operational usage. More decimal places would be beyond the uncertainty estimate which is of the order of  $1\text{e-}7$  degrees/transit number.

5) “On p. 6 line 21: The authors need to explain how to determine the criteria of 60% of high and low waters in more details. It seems to me that the value is low. As shown in Table A1, there are a lot of data sets with more than 90% completeness.”

» This selection criterion ensures that only data from tide gauges that record both high and low water are included in the analysis. Some tide gauges fall dry at low water

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and do not record meaningful tidal data during this time (and no low water height and time is included in the quality-checked time series). These tide gauges have a data completeness of 50% at most. The threshold at 60% is rather conservative in this regard.

6) “On p. 7 line 12: What is ‘tidal events’?”

» High water and low water are referred to as “tidal events”. We will clarify the language in the revised manuscript.

7) “On p. 19 lines 1 and 2: in the residua -> in the residual (?); the two residua -> the two residual (?)”

» Yes, this is a typo. The sentence should read “The change of constituents has an influence on the remaining periodicities in the residuals.” This will be corrected in the revised manuscript.

8) “In Figure 7: The authors need to explain how to determine a bin width for time and height differences.”

» The number and the width of the bins are chosen in such a way that the central bin is centred at the origin.

9) “The authors need to use the subscript in expressing name of tidal constituents throughout the manuscript. That is,  $S_a$  ->  $S_a$  (subscript a)”

» We followed the naming scheme of the “Standard List of Tidal Constituents” by the IHO which does not use subscripts. We will add this information on page 6, line 2 in the revised manuscript, but prefer to keep the naming as it is if the reviewer does not have any objections.

Best regards, Andreas Boesch and Sylvain Müller-Navarra

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