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Ocean Science Discussions

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

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Dear Reviewer #2.

Thank you very much for your detailed review report. We appreciate that you have taken the time to read the manuscript and to comment on it. Please find below our replies to your comments. The different items from the review report are first cited, followed by our responses.

1) "An important point is mentioned in sentence "the HRoi combines the best from

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the harmonic and the nonharmonic method." (p 6). I think it could also be written in abstract section to emphasize it from the very start of the paper.

» The quoted passage is taken from Horn(1960) and might be too subjective to be included in an abstract. However, it is a good idea to specify the nature of the HRoI in the abstract and we will add this information in the revised manuscript.

2) "I'm interested in knowing the time sampling for tide gauges records. Independently, did you use time series sampling (1) every x (hours? minutes?) or did you use (2) HW, LW recorded time series values? Following the method, keeping with the developments and discussion, it should be answer (1). Could you confirm?"

» The recorded sampling rate of the tide gauges is 1 minute (for about the last 20 years, depending on the individual tide gauge; previously only high and low water data were available). The presented prediction method uses time series of times and heights of high and low water (and predicts only times and heights of high and low water).

3) "What is the maximum gap you observed in the tide gauges time series? And the longest continuous time series¿'

» The longest continuous time series are from Cuxhaven and Hamburg, each with 115 years and a maximum data gap of half a day, which means that no more than one high or low water is missing at a time. The maximum gaps can be longer than 10 years but the 60% criterion ensures that a sufficient amount of data is available from each tide gauge.

4) "The last sentence, page 10, is important. The fact that this relates to parameters introduced in table 2, the fundamental variables, could be added in a note or in bracket."

» Thank you for this remark. We will add a note that the parameters, for which we define the ranges on page 11, are related to the parameters in Table 2. Furthermore, we will rework this part of Sect. 4.3 to improve the readability (see also items 5, 6, 16).

5) "Fig. 4 displays the periodogram of lunitidal intervals (L) after normalization. I un-

derstand that the normal variable (value) is the maximum value of lunitidal intervals. Fig. 4, I think it is useful to add in legend, the normalization variable in order to define what is the reference variable used for normalization. It's simple note but it drives the results and plots; Same suggestion for height variable."

» see answer to comment 16.

6) "I understand from ms, mh, mp, mN' fundamental parameters limits selection specific for this study (p 11) that these expressions are introduced in the text because they are useful for functions arguments development. But, this development is not included in the paper, nor cited/referenced. I'd say that if this part can't be used in the paper to help understanding the discussion, results or development, it could be removed from the text. But, if I'm wrong and if these expressions shouldn't be removed from text, then (1) addition of equations where these parameters are used would be useful for understanding or (2) one sentence could be added to say how it's useful to know the what type of selection have been done on ms, mh, mp, mN'."

» We will rework this part of Sect. 4.3 (see also items 4, 5, 16) and include information on the calculation of the angular velocities (and add references to Section 2 and Table 2). The definition of the ranges of the linear coefficients m should stay in the manuscript as it sets the limits for the assignment of possible partial tides.

7) P 12: Table 4: To get a short analysis of the percentage presented in this table, what is the importance of the main partial tide? Could you precise in table 4 legend, that the results of the most influencing tidal wave is a synthesis from all the selected tide gauges?

» The importance of the main partial tide (half synodic month) can be derived from table 3, where the average line intensities from the periodograms are listed. A quantitative statement (in physical units) is difficult, because of the averaging of data from different tide gauges and the normalization of the generalized Lomb Scargle periodogram. We will make it clear in the legend of table 4 (and table 3) that the results are a synthesis

from all the selected tide gauges.

8) “P 17: Could you confirm that the results (fig. 7, p17) are residuals representative of both HW, LW? I think yes if I’m referring to fig 8. and 9, later in the paper. Fig. 7 validates the method in the frame of HW, LW prediction. Writing the residual mathematical formula is needed, I think, to sustain the text above fig. 7.”

» Yes, Fig. 7 shows the results for both high water and low water. Residuals are the difference between observed and predicted vertices (high or low water) with the same transit number and event index k. We will add the information on how the residuals are calculated in the revised manuscript.

9) “HW/LW prediction improvement percentage presented in tables could be completed by few words to provide some elements of analysis and understanding, to follow the reassessment.”

» We will add the formula for calculation of the changes and a few sentences about the contents (especially the extreme bins) of Fig. 8 and 9.

10) “For my interest, I’d like to see a result based on harmonic analysis and least squares minimization for the region of interest, in order to be able to compare its capacity to solve tidal dynamics to the HRoi method presented in the paper (for example in section 5). But therefore, I understand that the authors would have to make some other computations using tools and different methods from those which are presented and used here. So it’s more a point for future discussion. Is the paper the first publishing for HRoi of investigations on long period constituents, as it is written in the paper? I’m not aware about the previous HRoi investigations publications for long time period constituents.”

» This is the first publication in which the investigation of long-period constituents for the HROI is described. Older publications on the HROI, as cited in the manuscript, only present the list of constituents without details about its preparation. We will add

a sentence in the conclusions about the need to conduct a comparison study with the harmonic analysis to gain more insight on the relative performances.

11) “P 2: angular velocities: After the word in text “omega”, the mathematics notation !i could be introduced, because it’s used later, as the first reference in the text.”

» We will add the mathematics notation “omega” after “angular velocities” on page 2.

12) “P 3: - y ËĘ to be define in legend (equation 1) (predicted value I think, with y for height or lunitidal interval). I think adding units in equation 1 is needed. Eq.2: symbol L for partial tide: Doodson reference for Eq.1 and Eq. 2 should be cited. They are derived from Laplace and Doodson theory and from harmonic analysis technics. Particularly, Doodson number is in the first column in tables 2 and 3 and is more generally a number currently used in tidal studies.”

» We add some information on variable names and units to better guide the reader and include the references to the alphanumeric Doodson number. The symbol J (not L) is correct in Eq. 2 as the sum runs over the J data points.

13) “P 4: In table 2, I think there is a need to write the thinking who makes you remove the fundamental parameter tau ( ), respective to first letter in Doodson notation? , s, h, p, N’ for fundamental parameters to describe tides. to refer to hour angle of “mean” Moon. Just a suggestion: If you think it’s relevant, I’d move table 2 in annex for it to play its role of quantitative reference (Tab 2 section 2).”

» By construction of the method (HRoI) only long-period constituents need to be used, i.e. the parameter belonging to tau is always equal to zero. We will revise the corresponding sentence. We think that Table 2 is more than a quantitative reference, but a central element of the paper that connects our work with previous studies and presents fundamental information for all constituents. Therefore, we would like to keep the table in the main part of the paper instead of moving it to the appendix.

14) “P 5: Could you give a clear distinction between tn symbol used (p 4, p 5) and

nt =lunar transit number (p3)? Reading page 5 and section 4.2 (page 7), could you write tn versus nt? It'd ease the reading and ease the comparison withp3, when transit number is introduced. Its formal symbol should be written (first sentence below table 1)."

» The symbol "tn" is the unit symbol for transit number (such as "h" for hour). The symbol "n_t" is the variable that stands for a value of the transit number (such as "t" for time). We move the introduction of the unit symbol to the sentence with the definition of the transit number. This gives a better distinction between the two notations.

15) "P 7: section 4.1 Data preparation: For both, Â′n lunar transit number", Â′nthe calculation of lunitidal intervals" my opinion is that adding symbols would be benefit for reading. nt and y ËĘ (I suggest)."

» The symbol for the transit number is added in the corresponding sentence. The lunitidal intervals do not have a unique symbol (the symbol "y" can stand for lunitidal intervals or heights) and is therefore not included in the sentence. Instead, we included the symbol "y" in the first sentence in Sect. 4.2.

16) "P 10: May I ask you to add slight modification to Li, Lh expression adding legend and adding units in these 2 expressions. I think it could be good to read the units ex: of angular velocity degree per h (cf table 2)? Degree per tn and L units."

» The expressions Li and Lh are unitless as the generalized Lomb-Scargle periodogram is normalized to unity. A value of 0 indicates no improvement of the fit and a value of 1 a "perfect" fit (see Zechmeister and Kürster 2009, full reference in the manuscript). We will add this information on page 10.

17) "P 12: Table 4 could be inserted in table 3, by adding: column R (table 4) after column Nh [%] in table 3, column description/name (table 4) in table 3"

» We think that table 3 and table 4 should be kept separate. Table 3 shows the results from the initial analysis based on the defined rules. Table 4 shows the final results, after

manual adjustments have been made to the selection of partial tides. Keeping these two tables (which also belong to different sections) separate makes the procedure more transparent.

18) “Fig. 6 (p 16): I appreciate the synthetic view of figure 6. Suggestion: could you add if possible, the explanation of number above the figure (relating the upper points of partial tides [rank]).”

» The numbers at the top of the figure are just the counts of partial tides (number of circles) in each “column”. This is mentioned in the caption.

19) “If possible, it could be interesting to see on map fig.1, the location of Borkum tide gauge, Cuxhaven, Steubenhöft and Emden, Große Seeschleuse tide gauges used in the paper to highlight results”

» Thanks for this great suggestions. These three stations (and Hamburg) will be highlighted in Fig.1 in the revised manuscript.

Best regards, Andreas Boesch and Sylvin Müller-Navarra

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