

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

Anonymous Referee #2

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The concept underlying the paper involves a method to compute water level in a context of high tide water (HW) and low tide water (LW) prediction in a semi-diurnal regime. The presented study, going with developments and signal processing, is focused on computational method and an operational direction comes through quite clearly due to a need for quick computations and robust results. The paper is descriptive and the founding principle is based on two main existing technics with on the one hand a harmonic analysis (Doodson, etc.) and on the second hand, a non harmonic method used to take into account non linear waves interactions, partial tides and the non tidal dy-

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namics. I think that HRoi method is a smart development for situation fitting the domain of validity introduced in the paper. Updated results along the German north sea coast show it's an effective method in this context; context well identified in the abstract. The presented processing and method offer an interesting view on tide prediction in coastal area where tide and river flux impact dynamics. My first feedback is that it is interesting to see the papers approach providing the method description and I appreciate the concise paper writing where the method constraints and objectives are clearly presented. In the paper, there is a part of discussions addressing the importance of observation pre-processing (ex: p8) and of computation conditioning (frequency analysis, noise reduction, regression, least squares minimization). It raises the question of nonlinear dynamics and the paper proposes a way to deal with it that fit the HRoi objective. The uncertainty for each step (observation, method, HW/LW prediction) is to my opinion an important part of the water level forecast and tide prediction. This contribution addresses part of the uncertainty question. I think it could be interesting to add few words to analyse the results presented in the paper, in terms of uncertainties or in standard deviations diagnostics, particularly in coastal areas with environmental challenges. This could echo the standard deviation values presented in the tables of the paper. I have some suggestions and several items to address. Otherwise, I think this paper describes a method and presents results on high and low water tidal prediction that are valuable to be published in Ocean Science, after having taken into account the remarks hereafter.

Please, see my suggestions, questions and notes below: An important point is mentioned in sentence “the HRoi combines the best from 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.

Tide gauges sections provide a good and updated view of the large tide gauges network. Reading the paper, the sensitivity of the results to the time series length is in our mind. This point is well discussed in the paper. I'm interested in knowing the time

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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?

“tidal events are irregularly spaced in time. Additionally, there are many longer data gaps which cannot be interpolated.” (section 4.2, p 7). What is the maximum gap you observed in the tide gauges time series? And the longest continuous time series?

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.

Fig. 4 displays the periodogram of lunitidal intervals (L) after normalization. I understand 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.

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'.

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

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gauges?

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.

Just a suggestion: 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.

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.

Legends and notations: Please see my suggestions and notes: P 2: angular velocities: After the word in text “omega”, the mathematics notation ω_i could be introduced, because it's used later, as the first reference in the text.

P 3: - $y^{\wedge}$ 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.

P 4: In table 2, I think there is a need to write the thinking who makes you remove the

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fundamental parameter tau (τ), respective to first letter in Doodson notation? τ , s, h, p, N' for fundamental parameters to describe tides. τ 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).

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 with p3, when transit number is introduced. Its formal symbol should be written (first sentence below table 1).

P 7: section 4.1 Data preparation: For both, "lunar transit number", "the calculation of lunital intervals" my opinion is that adding symbols would be benefit for reading. nt and $y^{\wedge}$ (I suggest).

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.

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

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]).

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.

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