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4 Review comments and response

5 Robust validation of trends and cycles in sea level and
6 tidal amplitude in the Dutch North Sea

7 Hessel G. Voortman

8

9 Editorial changes to inputs of editor and reviewers are marked as **[bold in brackets]**. Response to
10 comments is given in *italic*.

11

12 Dear **[author]**:

13

14 We have reached a decision regarding your submission to Journal of Coastal and Hydraulic
15 Structures, "Robust validation of trends and cycles in sea level and tidal amplitude".

16

17 We decided that you need to resubmit your paper after moderate-to-major revisions.

18

19 I have received two formal reviews, which both note that the manuscript needs further revisions. A
20 first reviewer is principle in favor of accepting the manuscript after inclusion of several good
21 comments on various aspects of the work. The second reviewer, who has seen the contribution the
22 second time, has commended the author(s) for the improvement the manuscript has undergone;
23 however, the reviewer also notes some still concerning aspects, pertaining to the analysis which has
24 not yet distinguished the temporal evolution of the sea level rise signal over the period of the
25 available data. The reviewer suggests that this part is especially addressed, by, i.e., determining sea
26 level rise trends for short periods of time, within the total data set, to elaborate on temporal trends
27 over the longer time span. This way, the change in sea level rise could be elaborated, and changes in
28 the acceleration be pinpointed much more clearly.

29

30 Moreover, I concur with the second reviewer that the title, as well as the last part of the conclusion
31 needs special consideration; the author(s) is/are asked to ponder on whether the results found
32 warrant the final conclusion which challenges the IPCC scenarios. Unless a more balanced stance
33 and mature discussion is presented, I will still consider recommending rejection of this work. I
34 therefore urge the author(s) to take the recommendations and advice seriously.

35

36 *My interpretation is that this relates to reviewer A's comment regarding the comparison of the*
37 *trend and the projection. As I explained in my answer to that specific comment, the comparison is*
38 *made on the rate of rise in 2020 and not on the sea level itself. Rates under the projections are*

39 *published by the IPCC in the sea level projection tool (NASA) and used by me in unmodified form*
 40 *to make the comparison. In my view, a comparison at a specific point in time is appropriate if it is*
 41 *rates rather than levels that are compared.*

42
 43 *So, as stated in my response to reviewer A, I chose to better clarify my approach rather than*
 44 *modifying it.*

45
 46 Please revise your paper considering the remarks and needs of modifications of the reviewers and
 47 provide a description of your revisions in an extra file (rebuttal letter). In this text, the consideration
 48 of all reviewers' remarks and proposals must be addressed.

49
 50 Best regards,

51
 52
 53
 54 Editor of Journal of Coastal and Hydraulic Structures

55
 56
 57
 58 -----

59 Reviewer A:
 60 Recommendation: Revisions Required

61
 62 Please see file 25508-1, for comments received via email during a period of vacation of reviewer A.

63 -----
 64 **[the file mentioned above is included fully below]**

65 Dear Author, dear Editor,

66
 67 The article/topic is basically interesting, the conclusions from the comparison of IPCC
 68 scenarios/projections and modelled water level observations are very important for practice. The
 69 article has been extensively revised and has thus gained significantly in quality and scientific basis!
 70 *Thank you*

71
 72 This also made the article about 30% longer.
 73 *I consider this to be an observation and not a request to shorten the paper.*

74
 75 Some more information:
 76 The topic is of interest to the field: Yes
 77 Distinct novel aspects are treated in the paper: Yes
 78 The novelty is well substantiated by a thorough and complete literature review: ok
 79 These novel aspects are clearly written in the abstract: ok
 80 Clear objectives are given: Yes
 81 A sound methodology and correct mathematics are used: ok
 82 The conclusions are supported by the data: ok
 83 The paper is properly organized: ok The paper is to the point and concise: ok
 84 The paper is written clearly using correct grammar and syntax: improved, but I am not a native
 85 speaker
 86 All illustrations and tables are useful and of good quality: Yes
 87 The references are relevant and well-formatted in author-date style: yes

88 The format follows the Journal template (for final acceptance): yes
 89 Appropriate and complete keywords are provided: not yet
 90 *Due to formatting, the heading “keywords” is on page 1 with the keywords on page 2. I assume the*
 91 *reviewer has therefore missed the keywords. I corrected the formatting; heading and keywords are*
 92 *now together on page 1. Please note that this is still the case in the “tracked changes” version but*
 93 *not in the clean version.*

94
 95 Some comments in detail:
 96 - the title should refer to the NL coast.
 97 *The title is modified*
 98
 99 - the diverse international literature of corresponding analyses of German tide gauge data is
 100 meanwhile included.
 101 *I consider this to be an observation. No action is taken*
 102
 103 - the term in the title "robust" is not justified in my opinion, currently only the trend for the period
 104 from 1945 to 2022 is given for 6 Dutch gauges.
 105 *With “robust” is meant a method that incorporates changes in tides and uses well-established and*
 106 *explicit statistical hypothesis testing to gain insight in cycles and trends of sea level. I concur that*
 107 *this terminology is not well clarified in the first submission and I did therefore elaborate.*

108
 109 These trends are compared with general IPCC scenarios etc. Unfortunately the reference period for
 110 these scenarios is missing, only the value for year 2020 is given in each case.
 111 *The comparison is made on the rate of rise in 2020, or the first derivative in time of the sea level*
 112 *excluding the multi-year cycles. The IPCC gives, in the Sea level projection tool, the value and the*
 113 *rate of rise in separate tables. Reviewer appears not to have understood that from the paper and*
 114 *therefore I elaborated this point, hoping to be more clear.*

115
 116 - This is also where my main criticism comes in, it would be desirable to give a time function for
 117 the MSL trend over the period 1945 to 2022 for the six gauges, e.g. over the period of the nodal
 118 tide, i.e. 19 years: 1945-1963, 1946-1964, 1947-1965 etc.. This would allow the temporal
 119 development of the trends to be shown. With only one MSL rise value over the entire period from
 120 1945 to 2022, a phase of lower sea level rise (1940 to 1970) is balanced with a phase of higher rise
 121 values (starting in 1980).
 122 *This would be an alternative to the method chosen in the paper, which is to include multi-year*
 123 *astronomic cycles in the regression model. Indeed the rate of rise including the cycles reveals a*
 124 *pattern of accelerating and decelerating rise. I call this the short-term rate. The long-term rate of*
 125 *rise is the rate found from the regression model excluding the periodic term. I removed this*
 126 *distinction from the paper in a late stage, feeling it would be confusing.*

127
 128 *Considering that the IPCC projections exclude the multi-year cycles, I feel the long-term rate (as*
 129 *defined above) to be the appropriate quantity to compare to the projections. And as stated above,*
 130 *the comparison is made on the rate of rise rather than on the reported level.*

131
 132 *In summary, I did not adopt the suggestion made by the reviewer to consider more periods, as I feel*
 133 *this is covered by the inclusion of two multi-year tidal cycles. I did however attempt to more clearly*
 134 *explain my approach in the second submission, adding additional information in several places in*
 135 *the paper.*

136

137 *Specifically addressing the year 1980 mentioned in the comment. As explained in the paper the full*
 138 *regression model allows for acceleration of the long-term rate to commence in a specified interval,*
 139 *corresponding to the prevailing insights from climate and sea level science. The starting point of*
 140 *the acceleration is bounded between 1960 and 1995, as is explained in the paper. Hence, if an*
 141 *acceleration of the long-term rate (excluding the multi-year cycles) would be present, the method*
 142 *allows it to be found. The short-term rate of rise (including the multi-year cycles) shows a marked*
 143 *acceleration around 1979, in accordance with reviewer's expectations.*

144
 145 - Offset in Fig. 4. below (Vlissingen) should be better explained.
 146 *Shown in the figure is the adjusted R^2 value as a measure of the quality of the harmonic*
 147 *reconstruction of the water level. Hence, it is not an "offset" of a water level but of a statistical*
 148 *measure of accuracy.*

149
 150 *The better score of Vlissingen in comparison to the other locations is explained in the paper (first*
 151 *submission): "The reconstruction is a better description of the actual water levels if the tidal*
 152 *amplitude is large, such as in Delfzijl and Vlissingen, in comparison to stations with a smaller tidal*
 153 *amplitude such as Harlingen and Den Helder. This is explained from the fact that wind effects are*
 154 *proportional to the squared wind velocity (Voortman, 2003; Vrijling & Bruinsma, 1980; Webbers et*
 155 *al., 2003), and in the relatively small North Sea this implies that daily wind effects will be of the*
 156 *same order of magnitude on all locations. In case of large tidal amplitude, the same wind deviation*
 157 *is smaller relative to the tide, leading to a higher coefficient of determination."*

158
 159 *I therefore struggle to see in what respect reviewer expects a better explanation, especially since*
 160 *the reviewer refers to an "offset" that is confusing in relation to an R^2 value. But I am open for*
 161 *suggestions. I did not modify the paper in view of this comment.*

162
 163 - Comparisons of MSL rise are only meaningful if the period of analysis is also identical!
 164 *If levels are compared: yes. But as explained previously, the comparison is made on the long-term*
 165 *rate of rise for which it is possible to compare point values in time. As stated previously, better*
 166 *explanation is provided in the paper. Specifically, I explained in more detail the information that is*
 167 *made available by the Sea Level Projection tool. And I explained why I feel a comparison of*
 168 *estimates of rate of rise in 2020 is justified.*

169

170

171 Reviewer B:

172

173 The research paper “Robust validation of trends and cycles in sea level and tidal amplitude”
 174 provides a straightforward method for analyzing mean sea level based on standard tidal harmonic
 175 analysis. It raises some interesting concerns regarding a few recent studies and supports its
 176 arguments well using empirical data. It combines a solid background regarding current sea level
 177 research, a simple but convincing methodology and results that are of interest to both the scientific
 178 community and coastal management. The paper can still be improved after a few minor corrections,
 179 but otherwise I would recommend it for publication.

180

181 *Thank you*

182

183 [General Comments]

184

185 Page 5

186

187 Line 5: Regarding Haigh (2020) paper – “Although mentioned in their paper, anthropogenic
 188 changes to the estuaries is not in the list of six”. I think this is a misinterpretation of that paper. One
 189 factor in that six is Depths of Channels and Flats which often occurs due to anthropogenic changes.
 190 In section 3.2.1 of that paper, Haigh states “Over long time scales, channel deepening for shipping
 191 has shifted tidal processes in multiple estuaries...” – which is clearly linking anthropogenic changes
 192 to changes in tides. The six factors listed by Haigh et al. (2020) are the physical processes which
 193 lead to changes in tides, which may all be influenced by anthropogenic changes. Thus, I think the
 194 statement from line 5 is misleading and should be omitted/changed.

195 *I reread Haigh (2020) following reviewers comments and modified the paper in accordance with*
 196 *this comment. Thank you.*

197

198 Page 18

199

200 In section 4.3 (Page 13, from line 16), estimates of MSL are said to be below those provided by
 201 PSMSL. From Figure 5, they seem to be in the order of 2-5cm. Now in Section 4.5, there is a small
 202 contribution to MSL from atmospheric forcing of less than 5cm. To me, it seems this may explain
 203 the deviation in MSL estimates with PSMSL. Has this been checked? If so, I think it should be
 204 noted.

205 *Indeed astronomic forcing (called wind effect in the paper) gives a difference of a few cm between*
 206 *the arithmetic mean sea level and the tidal mean. The results show that that result is hardly*
 207 *influenced by the sampling method (indicated with open and closed symbols as explained in the*
 208 *paper) and is thus not an explanation for the differences with PSMSL in the older part of the*
 209 *record.*

210 *My own hypothesis is that the data has been delivered to PSMSL over the years and that possibly*
 211 *half-tides (means of high and low) were provided in the early days. As I show in the second*
 212 *submission in section 4.3 (added following your suggestion) the effect is profound.*

213 *Further investigating this difference would have taken more time and energy than I wished to spent*
 214 *on this, especially after finding the profound effect of the Zuiderzee closure (1932) making all data*
 215 *prior to 1932 suspect anyhow.*

216

217 Page 21

218

219 Line 19-22: There is mention here that the PSMSL differs from both the astronomic estimate of
 220 MSL and the arithmetic mean water level when only the high and low waters are available. I am
 221 interested to see how the reconstructed tide differs when the harmonic analysis is performed with
 222 just the high and low waters, compared to when 8 or more samples are available daily. It is
 223 suggested in section 4.3 (page 13, lines 7-12) that the flat high waters and sharp low waters bias the
 224 arithmetic mean lower. Obviously, this is accounted for when the sample rate is higher (8 or more
 225 daily). Does the tidal reconstruction based on only the high and low waters recreate this
 226 phenomenon? If not, this may be the source of the difference? In any case, maybe its more useful to
 227 replace Figure 6 with a comparison of the tidal reconstructions produced using high sample
 228 observations (hourly data) and low sample observations (high and low waters only). Where the
 229 former would show the flat peaks and sharp troughs and the latter would not.
 230 *This suggestion is adopted. The effect of sample frequency on the tidal reconstruction is*
 231 *demonstrated as suggested and the resulting graph included in the paper; see section 4.3.*
 232

233 [Minor Comments]

234 *I wish to express my gratitude to the reviewer to comment on this level of detail. All comments were*
 235 *considered and a selection was processed using “track changes”. Some I consider due to a*
 236 *difference in writing style and were ignored without explanation. In case of potential differences of*
 237 *opinion, an explanation is given below.*

238
 239 Page 3

240 Line 7: “to provide insight to provide the insights...”

241 Line 42: “The reasons for this appear not to be fully known” change to “The reasons for this are not
 242 fully known”

243
 244 Page 4

245 Line 4: Missing parenthesis “(e.g, Frederikse et al (2020))”

246 Line 6: “Discussion has focused on the question of whether...”

247 Line 30-31: “From my personal experience, Coastal planning requires local estimates of relative sea
 248 level, rather than global estimates of absolute sea level (Parker & Ollier 2016). make a similar
 249 claim.” I think this is generally well understood and adding that it is your personal experience does
 250 not add any weight to the argument.

251 *I do not agree. Taking note of the available literature, a lot of attention is given to the global sea*
 252 *level budget. And only in AR6 the IPCC reported on local and relative sea level rise after reporting*
 253 *global sea level rise only in the first five (!) reports. Whether my personal opinion adds weight to*
 254 *the argument remains to be seen, once we leave the “anonymous phase” of this paper 😊*
 255

256 Line 34: “Sea levels and tides in the North Sea are have been under investigation...”

257 Line 45: “already investigated...”

258 Line 35: “Steffelbauer et al (2022), Keizer et al (2022) and Deltares (2023)”

259 *I gave the full reference the first time a study appears in the section at hand. In the rest of the*
 260 *section, I abbreviated the study in view of readability of the text. This is a response to several*
 261 *comments below as well.*

262
 263 Page 6

264 Line 3: “Steffelbauer et al (2022), Keizer et al (2022) and Deltares (2023)” Missing years

265 Line 12: “Steffelbauer et al (2022)” Missing year

266
 267 Page 13

268 Line 15: “Also shown in the graph...” -> “Also shown in Figure 5...” I think that’s the graph the
269 author is referring to, right?
270 Line 31: “It is used as input...”
271 Line 33: “Regulators discharge water to the sea...”
272 Line 34: “analysing” – “analyzing” (The first is british English and the second is American. I’m not
273 sure what is preferred by the Journal but best to be consistent).
274 Line 35: “(personal experience)” – The point has been justified and this statement does not
275 necessarily add anything. I rather find that it distracts the reader. Personally, I would remove it.
276
277 Page 21
278 Line 30: “MLS” -> “MSL”
279
280 Page 22
281 From Line 35: A number of the citations are missing the year (e.g. Frederikse and Gerkema, Pugh
282 and Woodworth). This has occurred earlier in the paper which I noted, and further past this point.
283 Please check and correct these.
284
285 Recommendation: Accept Submission