

## ***Interactive comment on “A mechanistic classification of double tides” by J. A. Mattias Green et al.***

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Detailed comments from the topic editor on 'A mechanistic classification of double tides' by Green et al. in Ocean Science Discussions.

I had independently made my own review of the paper as topic editor, which I enclose below. I hope that they complement those already made by R1 and R2.

This short paper uses a modern ocean tide model and a global tide gauge data set to determine where, and under what circumstances, that double high or low tides occur. It extends earlier work at Port Ellen published in this journal. I have a number of comments on the paper, although some of them are to do with the text and are easily fixed.

C1

First, I am surprised that only 13 sites were identified globally. Pugh (1987), Pugh and Woodworth (2014) and Woodworth (J Geodesy 2017) mention a number, and I would have expected there to be over 13 on the south coast of England and adjacent European coasts alone. Also, another example, Reviewer 1 mentioned Courtown which has double highs now and again - see Figure 1.2 of Pugh and Woodworth (2014). The fact that we know of others which are not identified here presumably means that the criteria chosen for the classes are not optimum.

For example, lines 33-35 say:

This means that any location with a double high tide has a nearby location with a double low tide as well. [which is probably correct] Arguably, the best known double tide occurs in Southampton (UK), where the prolonged high water associated with the double low tide [this should read 'double high tide'] provided the port with a commercial advantage.

which is also correct. So it would be nice here to mention Weymouth for example as the double-low counterpart of S'ton, and to include it in the list (but possibly it does not fit into the criteria).

Second, I don't agree completely with the statements (e.g. line 19 and elsewhere) about 'manual work' always being needed. I have nothing against manual confirmation, but it is straightforward to write software to detect double tides. That software can work on, say, 1-minute predictions from the fits, even if the original data is hourly. Sometimes the double highs (lows) are marginal, when the central low (high) is just a mild inflection, but criteria can be written for selecting them - see for example the discussion of NOAA methods developed by Steacy Hicks in Section 5.3 of Woodworth (2017).

However, these things aside, one problem I had with the paper was the book-keeping:

(1) line 14 says 13 cases were found across the classes. It would be good to say clearly how many in each class. Even after reading the Results section and looking at figure 1 I was unclear where they were. If there are as few as 13 then it would be good to have

C2

a table listing them all.

(2) It seems to me that the sentence 'The search criteria' should come before 'Thirteen locations' as that is the logical order of the searching. And to make it clearer that one is now using tide gauge data instead of model, say something like 'Thirteen actual tide gauge locations were eventually ..'

(3) line 16 - says over 400 candidate locations from the model for classes 1 and 2, whereas line 96 says 219 and 140 which is not 'over 400'.

Line 32 - harmonic

35 - it would be good to give a reference to the S'ton example (Bowers et al., 2013 maybe?)

40 - Doodson proposed. Give a reference.

44-45 'The revised parameter is  $B = br^2/a$  ..' would be better expressed as something like 'The revised criterion is  $b/a > 1/r^2$  or  $B > 1$ , where  $B = br^2/a$  and  $r$  ...'

I have a little problem here in that the reader will have no idea what 'r' actually is, without reading Byrne et al. Maybe that is ok.

They → Byrne et al. (2017)

when DTs occur (i.e. M6 is the source of the DT).

.. increase the ratio to meet the above criterion.

53 - class 1 - I am uneasy seeing S'ton mentioned here. The double high at S'ton is discussed by Pugh and Woodworth (2014) and Bowers et al. (2013) and by Doodson earlier, and it is clearly not a simple situation of M2 and M4. So I don't think this should refer to a textbook situation like this for S'ton.

58 - cant - this should be 'can' presumably.

65 - TPXO9 references should be given here when first mentioned.

C3

The para has 'see below for details' twice which is a bit repetitive

I am not sure TPXO9 should be referred to 'altimetry data'. It is a model assimilation of the altimeter data. A pure altimeter map, which I guess is the input to the model, would look a bit different.

74 - I am not surprised resolving bays for the class 3 work was a problem when using a 1/6 deg model which is rather coarse. The FES2014 model is readily available which is 1/16 deg globally and is probably a generally better model as well.

76 - to avoid confusion it would be good to show the ratio as being M4/M2

This is really an extreme criterion choice with M4 much larger than M2, and M2 being selected as very small. There can't be many places like that, and this selection is possibly why you find so few candidates.

77 - should this read ratio between S2 and M2 (i.e.  $S2/M2 > 0.9$ )?

78 - ratio

I would reword '.. we obtain a lot of candidate points where this is fulfilled, but these occur (in the model) along straight coastlines instead (in reality) in bays or gulfs, due to the coarse model resolution. Consequently, this class requires further substantial ..

84 - GESLA would be better called GESLA-2

<http://gesla.org> should be <https://www.gesla.org>

85 - why were only 7 constituents considered? many double tides will be due to several constituents in the quarter and sixth diurnal bands.

86 - TPXO-data → TPXO9 model.

87 - TG → define acronym

89 - with the DTs found through visual inspection.

C4

[But why? See my comment above]

For clarity, we only show data in the following from single 2-day periods during which DTs were found.

This is where I got really confused by the classes and numbers and what appears in the text and figure 1. Let's consider figure 1 first:

(i) all 3 panels repeat in showing M2 amplitude superimposed on which are black triangles for GESLA-2 sites. The triangles saturate coastal areas of interest where M2 is large (non-blue) such as the North Sea. So it looks just like a generally blue ocean with black edges.

I think I would have 2 separate panels showing the M2 amplitude in one alone, and the GESLA stations in the second.

(ii) then in (a), what are the white circles? The caption does not say. there does not seem to be 219 as you would expect from line 96. There are 2 arrows I can see - whereas the caption says arrows are for places discussed in the text: Denhelder, Rio Grande and Pari (lines 107-111) so the Pari arrow is missing.

then in (b), what are the dozen or so white crosses? The caption does not say. It has 3 arrows ok (Rio Grande, Thevenard and Victor Harbor I guess). I was expecting to see 140 dots for class 2 as mentioned on line 96.

then in (c), what are the red dots? The caption does not say. One arrow for Nar Bay presumably.

I think this figure needs to be much better and the caption improved.

Back to the text:

96-105 - could this be reworded a bit to clean up the typos and make it clear how many stations in which class candidates from the model and then found in GESLA? So:

C5

98 - .. something we did not take into account in the initial ..

99 - were then

101 - 'previously reported on'. what does this mean? what are the four? what reference? that is why it would be good to have a list in a table.

From these 13 [presumably], we opted ..

103 - Victor Harbor is usually spelt without the 'u'

Imtuba should be Imbituba.

put the countries after each as some people will not know where they are e.g. Den Helder (Netherlands).

.. are summarised ... locations of these seven [presumably] gauges ..

are marked in Figure 1b. But why? Are they all class 2?

107 - because an amphidrome

113 - between two

120 - below.

122 - in the data .. Harbor ..

129 - drop the hyphen

134 - define L. H is defined on page 1

140 - shown in Figure 5(a)

141 - is this 43.50 - 44.535 supposed to be the same as the 39-40.035 mentioned in Table 2 caption, and what looks like 43.9-44.5 in the figure? These bands need clarifying at least.

150 - mention again where this is

C6

(e.g., at Daya Bay, China, Song et al., 2016)

154 - visual inspection. see comments above.

157 - Figure 5(b)

164 - resonant period

180 - cycle influences

181 - actually, as odd as it sounds, S2 can have an apparent nodal variation in standard tidal analysis due to interactions with M2 etc. - see for example Figure 4 of Woodworth (2010, CSR) or a couple of papers by Amin.

189 - I don't think 'exciting' is a good word to use. Why and what does it excite? 'Interesting' maybe.

198 - Figure 7 should be 6(a)

define THT

the triples occur

damped-down

204 - Imbituba

also has triple highs (Figure 6(b)).

211 - M4 or M6 etc.

214 - again I am not sure visual inspection is so important, although doesn't do any harm. See above.

227 - and the south coast of England and Holland surely

230 - <https://www.gesla.org>

231 - tide gauge data contributors

C7

references - need doi adding for some.

261 - refers to

262 - this 'pha' value is not much use to anyone unless you also say when the starting point was, or give the Greenwich phase lag in the normal way.

266 - see comment for line 141

266 - it would be good to refer to the '25 hours' and 'annual neap' terms in the text where these things are discussed.

Say in the caption what 'Amplification' refers to.

Figure 1 - see above

Figure 2 and others: 'time [year day]' is not a good label as year does not appear in the scale. Perhaps 'time (day in year)' would be better.

caption (a,b):

The colours show M2 and M4 amplitudes from TPXO9 in (a) and (b) respectively, while the white (black) lines show the M2 and M4 Greenwich phase lags separated every 60 deg. The amphidromic .. arrows in (a).

but anyway I can't see any black lines, they are all white

.. O1, M2 and M4 curves respectively (see Table 1 ..

I think there has to be some statement that the colour scales in (a) and (b) saturate. For example M2 amplitude at Newhaven is over 2 m which is lot more than 0.2. There could also be an arrow on the colour scale at 0.2m.

Figure 2(c) and also later ones. As mentioned above, there is no reason why you have to plot the total fits and the individual terms as hourly values, even if the original data is hourly. You could for example plot them as 1-minute values which will make the double tides much easier to appreciate by inspection.

C8

fig3 caption - (data from 2011) ... (data from 2004)

The fit here is a poor description of the data. Maybe that is what you are trying to show?

figure 4 - in (a) we have data for Providence in red, and in (b) the same data are shown in blue which is potentially confusing. I suggest the red and blue are switched in (a).

HA → harmonic analysis. No point having acronyms if not necessary.

fig 5 caption - two different times in 20xx?

the critical value for

fig 6 caption - Imbituba

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