Ocean Sci. Discuss.,
doi:10.5194/os-2017-12-RC3, 2017

Ocean Science Discussions

Interactive comment on "The double high tide at Port Ellen: Doodson's criterion revisited" *by* Hannah A. M. Byrne et al.

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Received and published: 30 April 2017

30 April 2017

Comments on "The double high tide at Port Ellen: Doodson's criterion revisited" by Byrne et al. (OSD)

This is an entertaining little paper in the style of papers by tidal scientists a century ago. It discusses the 'Doodson criterion' whereby harmonics (M4, M6 etc.) of the main tidal constituent (M2) can generate a double high or low water such as occurs at Southampton. The criterion, which is mentioned in Doodson and Warburg (1941, p.221) and more recently in Pugh and Woodworth (2014, p.138), is clearly stated to reflect the ideal situation of producing a double tide, when the phase relationships are optimal. The present paper aims to extend consideration of that special situation

into the more general case when there are different relative amplitudes and phases between the different constituents.

I found it to be quite an educational exercise and it overlaps with some of my own work as will be apparent from the comments below. So I have no objection to its publication. I have some small comments and a couple of more general ones.

Small comments:

p1, first para of the Introduction -I found this wording disappointing as the authors have just paraphrased p133 of Pugh and Woodworth (2014). I think if I had been them I would have worded it to say that, given the spatial scales of the harmonics are shorter than that of M2 (as they discuss below), then whenever you have a place like S'ton with a double high then there is probably a place with a double low a short distance away (Weymouth in this case). For example, if you travel along the French/Belgian/Dutch coast, double highs are interleaved with double lows several times, not just at isolated places like Den Helder. This becomes most evident using tide models of course.

Then some mention of other places such as the US would be appropriate by all means. There is discussion of Weymouth and the Doodson criterion in Woodworth (2017). The Redfield reference for New England corresponds to what Woodworth (2017) calls the 'Newport enclave'.

Finally, I suspect there may be a location not too far from Port Ellen where there are double lows at times. Maybe you could look into that.

p2, 14 - value of it

same line - spring-neap

19 - I wouuld say 'about 4 hours'

25 (Nunes and Lennon, 1986)

26 - a should be in italics

28 - This wording might confuse some people. It is quite reasonable for you to investigate when the harmonics are larger than M2, and it is an extension to Doodson's work, but it is not an extension to the Doodson criterion as such, which was explictly to do with harmonics smaller than M2.

p3, 7 - b/a = 0.25 and a = 1 metre

21 - you should state that tprime is the time of the dip

23 - I think this should read 'in the (semidiurnal) high water'

eq.6 - b/b should be b/a

p4, fig.1a - the D seems to at 14 hours and not at the time of the dip at about 12.5 hours. Can you have an arrow pointing to the dip?

In the caption, mention that time is measured from the peak of the M2 tide, as you do in the text.

p5, 4 - f should be phi

6 - 1/32 should be 1/9

7-8 - 'at least about' sounds like you don't know what it really is. drop 'about'.

I had to read this paragraph twice as it was not clear at the start that what was being discussed was the approximate parameterisation - it became clear at line 9, and it is clear in fig.2 caption. Perhaps review the wording here.

p6, 3 - I wondered if a subheading was appropriate here as the discussion now switches to the opposite situation of large b/a.

section 3 - I don't know where you got the data from - it may well have been from someone in PSMSL, but PSMSL is not usually associated with the UK 15-minute data. I would credit the source as BODC (www.bodc.ac.uk) or NTSLF (www.ntslf.org), or maybe you got it from the IOC Facility (www.ioc-sealevelmonitoring.org).

28 - 1800 should be 180 deg

drop the last sentence this page - this repeats from above.

p7, Fig.3 - I would drop this. The exact location of Port Ellen is of no importance to the reader, all he needs to know is that it is a place with similar M2 and S2 amplitudes. If you want to keep it, I would make it more useful by adding the M2 tidal map from a model - I am sure Dr. Green has one.

6 - tides should be times

Fig5 caption - Observed (bold black) and fitted (grey) ...

line 3 - there is no Fig.3a. You mean 4 or 5a?

p11, 14-17 from 'We expect' to 'critical lines'. Why do you expect this etc? It is not obvious to me.

24-31 - make it clear that these limits derived from table 1 apply to an M2/M6 situation and not an M2/M4 situation.

p12, 18-19 - there are already criteria for defining double tides in some operational agencies e.g. in the US (NOAA), where they have more double tides than in the UK. See the references to the criteria of Hicks in section 5.3 of Woodworth (2017).

p13, 4 - spring-neap

p14, 3 - the title of this paper is capitalised when Nunes and Lennon for example is not. Also doi's should be added for as many as possible.

p15, line 3 of caption - time difference in hours

line 6 - add a comma ... to being formed,

More general comments:

p12, 29-31 - this sentence is not true and you must remove or reword it. There are far

more than 'just a few places' - we have mentioned already that there are many in the Channel for example. Also this sentence devalues your own reasons for writing this paper! There are important practical reasons for understanding double highs and lows, for example in the need to understand the difference between reported MTL and MSL measurements, as discussed in Woodworth (2017).

Also, I don't agree with the justification that you do give for doing the work - the classification of tides. First, the definition of form factor that you give on p12-13 is the wrong way up - the form factor is usually defined as (K1+O1)/(M2+S2). (There is a typo in the equation bottom-right on p77 of Pugh and Woodworth, 2014 where it is also shown the wrong way). But, second, form factors like this are never going to be complicated by people further to take into account the temporal dependence such as you suggest - you may as well just look at the actual data. Form factors are just handy, simple descriptors of complicated situations, like climate indices.

Personally, I would rewrite the whole Conclusions section to review what you have actually done in the paper regarding the Doodson criterion and leave it at that. If you must mention the tides classification business then don't go into detail. Also mention how the maths changes with regard to double lows - I guess phi just moves to phi+180 - but double lows are of just as much interest. Also you could mention that, while you have extended the original Doodson criterion, and extended the discussion to when b/a is large, you have not covered all situtations - for example, on page 5-6 you just gave up when phi gets larger than an hour.

p10, section 3.2 and p12, about line 24 - this underlines the limitations of using real data in a paper like this. This paper is basically a game of playing with combinations of cosines, and the discussion would be much cleaner if you had used simulated data e.g. tidal predictions for Port Ellen based on harmonic constants derived from observations and readily available from BODC. I guess for scientists it is always attractive to use real data, and you could do that as well.

Anyhow, I enjoyed reading it.

Phil Woodworth

Extra references mentioned above:

Pugh, D.T. and Woodworth, P.L. 2014. Sea-level science: Understanding tides, surges, tsunamis and mean sea-level changes. Cambridge: Cambridge University Press. ISBN 9781107028197. 408pp.

Woodworth, P.L. 2017. Differences between Mean Tide Level and Mean Sea Level. Journal of Geodesy, 91, 69-90, doi:10.1007/s00190-016-0938-1.

Interactive comment on Ocean Sci. Discuss., doi:10.5194/os-2017-12, 2017.