Ocean Sci. Discuss.,
https://doi.org/10.5194/os-2019-133-AC1, 2020

Ocean Science
Discussions
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Interactive comment on "Predicting tidal heights for extreme environments: From 25 h observations to accurate predictions at Jang Bogo Antarctic Research Station, Ross Sea, Antarctica" *by* Do-Seong Byun and Deirdre E. Hart

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Received and published: 3 February 2020

Format: We are very grateful for this review as it has been useful in helping to improve our paper. Below we have copied each individual reviewer comment, and written below it a response.

p1, line35: Could you add these neighbouring sites to the map? And it would be good to find out what data is publicly available, and use them for further validation if possible. Response: According to reviewer's comment, these sites have been added. Thank

you for the suggestion regards validation and other publically available records. Unfortunately it appears relatively difficult to find recent online records but we found mention of a 1 year record from McMurdo Station in a Padman et al. (2003) paper and of a tide gauge being set up at Mario Zucchelli Station (formerly named Terra Nova Station) from 1996 (see https://www.geoscience.scar.org/geodesy/perm_ob/tide/terranova.htm). We will indeed attempt to track down these and any other available Ross Sea records for a further paper on the tides of this very interesting area. We have added these references to our paper so that out authors can see the data sources behind our comment. Padman, L., Erofeeva, S. and Joughin, I.: Tides of the Ross Sea and Ross Ice Shelf cavity. Antarctic Science 15(1), 31-40, 2003.

p4, line22: thanks for mentioning atmospheric conditions, too often ignored. Response: Yes, agreed.

p4, line148: you could mention somewhere here that bundling all the constituents in a species together is valid due to the "credo of smoothness" assumption. Response: According to reviewer's comment, this has been added.

p6, line206: In figure 6, it looks like the ADI is negative as the peak is before the max declination? Response: Thank you for this query – upon checking, we found that location of symbols for Moon's maximum (âŰš) and zero declination (âŰă) was not correct. The Moon's maximum declination is 1900 7/2/2017 (18.867°) and the zero declination is around 0930 1/2/2017. We have now fixed these in Figure 6.

p7, line 251: (And elsewhere, please check all), Msf should be MSf [Moon-Sun-fortnight]. Similarly Msm should be MSm [Moon-Sun-month]. Response: Yes, these are now fixed throughout.

p7, line 270: Given MSf is important, I wonder if it might be worth including MS4? It might mop up the high frequency residual in figure 8. Worth checking the amplitude in the long record. Response: Thank you - we have now checked the MS4 amplitude from the one year (2013) harmonic analysis results of ROBT. The amplitude was 0.69

cm, indicating that the MS4 tide is not a major tidal constituent here.

p8, line 302: So the tides in the Ross Sea will be almost 1.5 times larger in 2025 than in 2016? I wonder how aware the ice modelling community are of this? Response: We have added some additional text to draw attention to the diurnal tide variation and this phenomenon as follows: "The resulting variations in tidal height are less pronounced in the semi-diurnal Weddell Sea, while the diurnal regime of the Ross Sea experiences large tidal range variations across 18.61 y cycles due to the influence of diurnal nodal factor variation, which is greater than that of the semi-diurnal M2 tide (e.g. compare nodal factors between 2016 and 2025 in Figure 12a). Of note, variations in the nodal factors of the O1 and K1 tides are out of phase with that of the M2 tide. Variations in the nodal angle of the K1 tide is in phase with that of the M2 tide but out of phase with that of the O1 tide (Figure 12b). Our results clearly indicate that such spatial and temporal tidal variation processes should be represented in studies of tide-coupled ice-ocean models for Antarctic waters.".

fig 6: Is the split y axis really necessary here? Response: We originally thought to employ a split y-axis scale in order to show as clearly as possible (magnify) the difference in RMSE results between Fig. 6(a) and Fig. 7. However, the effect of the split was a minor one, so we have changed these axes in line with your comment as it was not fully necessary.

Language: I am particularly impressed by how clearly written this paper is - I thank the authors for making the reviewing task easy. I wish I wrote as well!

p1,line9: "Though" should be "However" Response: This has been changed according to this comment.

p7 line 246: -tropic ? Response: The misplaced hyphen before 'tropic' has been removed.

p8 line 275: The abreviations DD etc aren't used again, delete. Response: Yes, these

have been deleted.

References: P&W 2014: Pugh, D.T. and Woodworth, P.L. 2014. Sea-level science : understanding tides, surges tsunamis and mean sea-level changes. Cambridge University Press https://doi.org/10.1080/00107514.2015.1005682 M&C 1966: Tidal spectroscopy and prediction, Walter Heinrich Munk and David Edgar Cartwright https://doi.org/10.1098/rsta.1966.0024 Oh, and you need to add doi to some of your other references! Response: We have added the Pugh and Woodworth reference, and added the doi numbers where they were missing from existing references.

List of figures submitted with this comment:

Figure 2. Maps showing locations of (a) the two tidal observation stations in the Ross Sea of Antarctica employed in this study: Jang Bogo Antarctic Research Station (JBARS, âŰš) and Cape Roberts (ROBT, âŮŔ), and. (b) these study sites relative to McMurdo Station (âŰă), and Mario Zucchelli Station (âŮŔ).

Figure 6. (a) Time series of Root Mean Square Errors (RMSE, thick line with âŮŔ) and coefficients of determination (R2, thin line with âŮŃ) between JBARS 10 min interval sea level observations (29 January to 15 February 2017) and the CTSM+TCC prediction datasets generated for this site using harmonic analysis results from the daily (25 h) sea level data slices from JBARS plus concurrent daily (25 h) tidal prediction slices and harmonic analysis results from ROBT station's yearlong (2017) tidal predictions. (b) Time series of predicted 2017 tidal heights (thin line) and daily tidal ranges (thick line with âŮŃ) for ROBT, based on harmonic analysis of this station's 2013, 5 min interval sea level records, plus an indication of the moon's phase and declination.

Figure 7. Time series of Root Mean Square Errors (RMSE, thick line with âŮŔ) and coefficients of determination (R2, thin line with âŮŃ) between JBARS 10 min interval sea level observations (29 December 2018 to 18 January 2019) and the CTSM+TCC prediction datasets generated for this site using harmonic analysis results from daily (25 h) summertime 2017 sea level data slices from JBARS plus concurrent daily (25

h) tidal prediction slices and harmonic analysis results from ROBT station's yearlong (2017) tidal predictions.

Figure 8. Time series of JBARS sea level observations, predicted tidal heights, and sea level residuals (i.e. predictions minus observations) from (a) 29 January to 15 February 2017 and (b) 29 December 2018 to 18 January 2019. The JBARS predictions were generated using CSTM+TCC, with a daily (25 h) slice of local sea level observations from 8 February 2017 (dashed box in (a)), plus concurrent predictions and yearlong (2017), 5 min interval ROBT tidal predictions.

Figure 12. Variation in nodal factors and nodal angles for the three main lunar tidal constituents (K1, O1 and M2) over a 20 year period from 2011 to 2030 at Jang Bogo Antarctic Research Station (JBARS), estimated at daily intervals from the t_vuf.m program of T_Tide (Pawlowicz et al., 2002).

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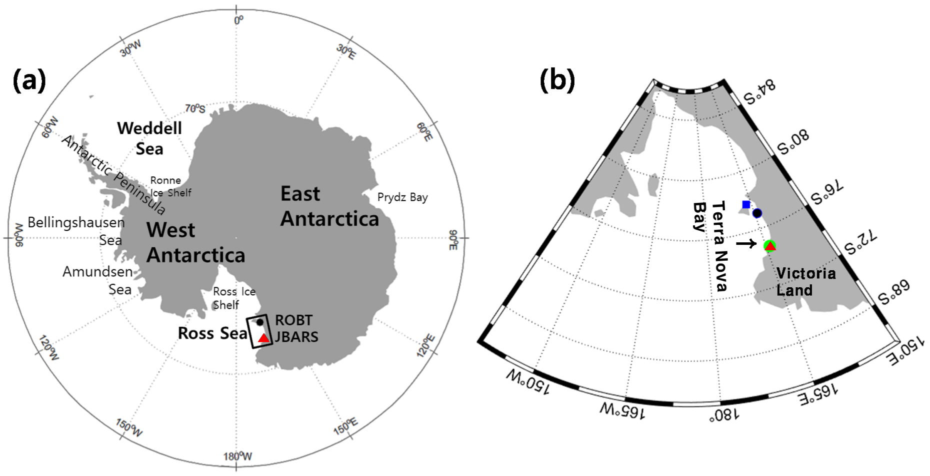

Fig. 1. Figure 2

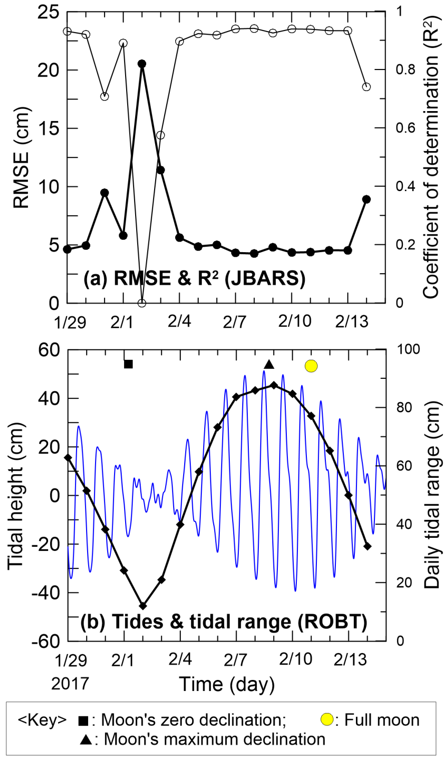

Fig. 2. Figure 6

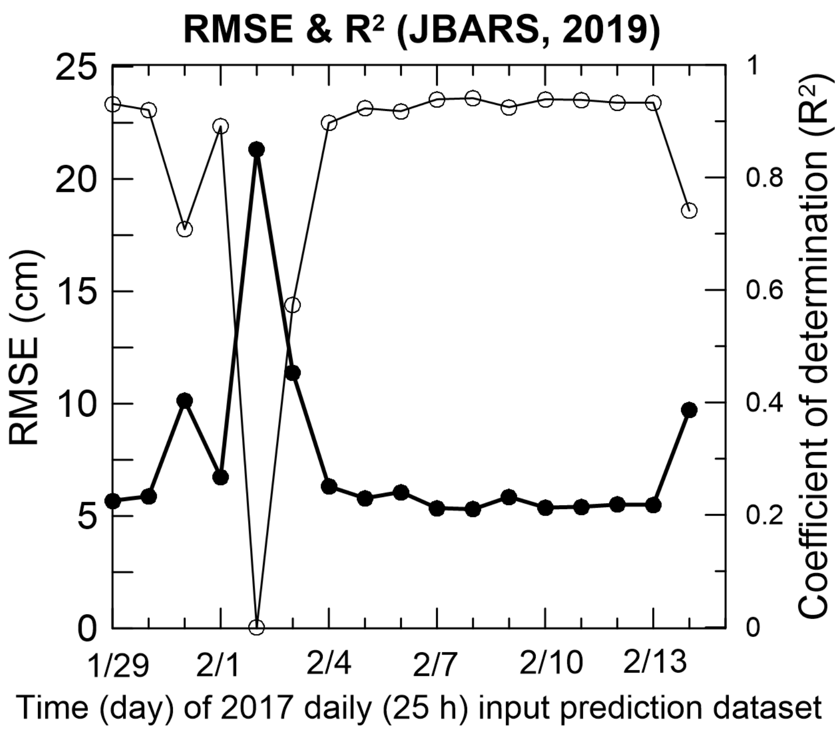

Fig. 3. Figure 7

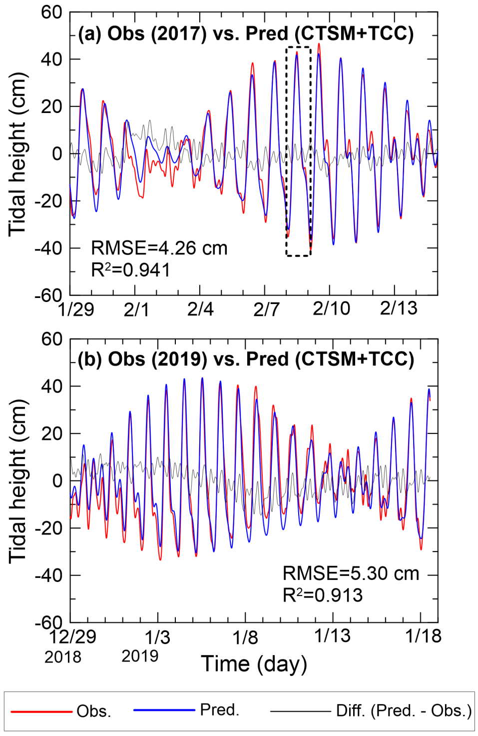

Fig. 4. Figure 8

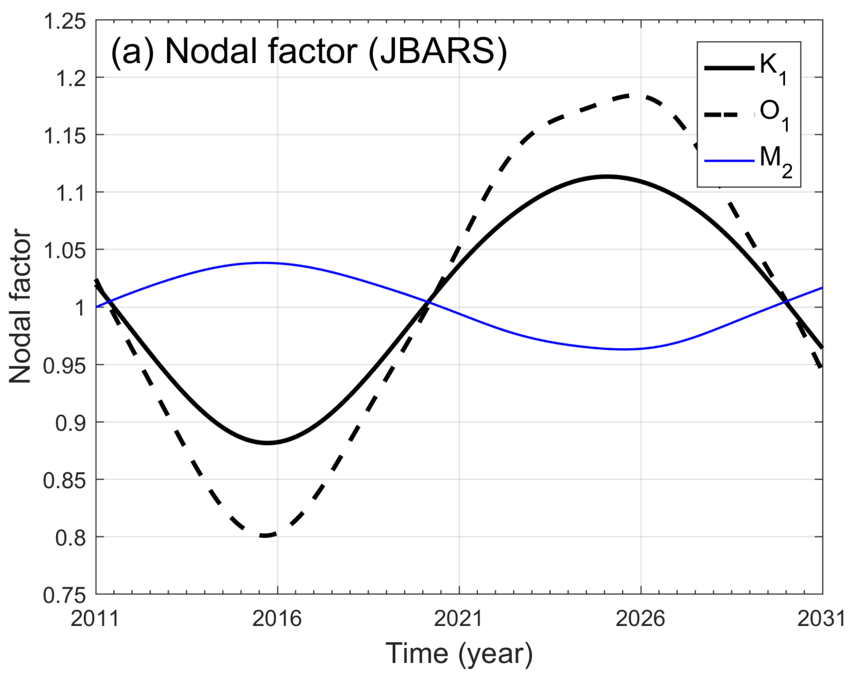

Fig. 5. Figure 12a

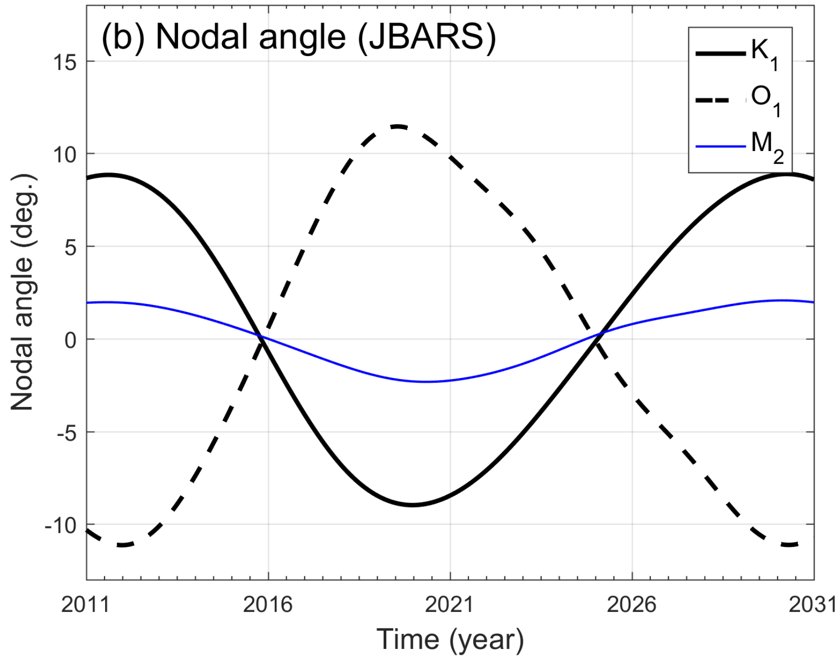

Fig. 6. Figure 12b