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Errors and Other Oddities in 'Sea-Level Science: Understanding Tides, Surges, Tsunamis and Mean Sea-Level Changes' by D.T. Pugh and P.L. Woodworth, Cambridge University Press, 2014.

We are grateful to readers who have pointed out some of the errors below.

page iv - has 'pages cm' with no values shown.

ch1, p8- the caption of Figure 1.4(a) says the high water level shown is from November 1966 but is really from November 2002 with a level of 1.47 m on 16 November as shown in the figure itself. The highest ever level recorded was in fact that of 1.94 m on 4 November 1966.

ch3, p38-39 - the subscript '1' for the lunar mass in the last equation, right column on page 38, and first equation, left column on page 39 should be in italics as in equation (3.2).

ch3, p41, eq. 3.7 - the 3rd term of the equation should be squared top and bottom and not cubed

ch3, p41, right, equation 3.9 right hand sign should be plus and not minus

right column, line 2 – 'Horizontally ...' is not aligned ok

ch3, p49-50, Tables 3.2 and 3.3 – there were some errors in these two tables which are corrected below. One was that ω5 should be defined as the rate of change of N' where N'=-N, if 'f' and 'σ' in Table 3.2 are to be considered positive. Similarly, p49, last line column 1, N should be N'. See also the comment on ch4, p65, Table 4.1 below.

ch3, p53, section 3.4.5 - not an error but an explanation. Books on tides never explain why the nodal period is 18.61 years. This is in fact rather complicated but an explanation can be found in for example: Fitzpatrick, R. (2012). An introduction to celestial mechanics. See Chapter 10, equation 10.101 and discussion.

ch3, p57, figure 3.16 - the x-scale should be 1980-2050 not 2040. The caption is correct and one can see there are 2 histogram bars per year.

ch4, p62, 3 lines below eq. 4.1 – N should be N'

p63, equation for C_2 near bottom of left column, $2C_1$ should be $2C_l$ (i.e. subscript lower case L, this is the same font problem as on page 38)

p63, 4 lines from top right – λ_e should be λ_l (i.e. subscript lower case L)

p63, right, 3 lines of equations following 'and approximate' - 2e should be 4e ch4, p65, Table 4.1 – the columns i_b to i_f should be headed s, h, p, N', p' (and not s, h, p, N, p') as Doodson numbers are defined in terms of these quantities and in particular in terms of N' and not N – see Cartwright and Tayler (1971) which is reference [10] in this chapter.

ch4, p65, Table 4.1a – the Extended Doodson Number (EDN) for Sa, Ssa, Mm and Mf should be 180 deg and not 0 deg. The 180 deg simply reflects the minus sign for the amplitude in the tables of Cartwright and Tayler (1971).

ch4, p65, Table 4.1b - the Doodson number for the third term in M1 should be 1,0,0,1,0,0 and not 1,0,0,-1,0,0 and those of both terms of K1 should be 1,1,0,0,0,0 and not 1,0,0.0,0.0

ch4, p69 – there are four errors on this page: (i) last line of paragraph 3 left column has $(\omega_1 \pm \omega_4)$ after R_l. The $(\omega_1 \pm \omega_4)$ should be deleted, (ii) paragraph 3 right column line 2 has $(2\omega_0)$ which should be $(2\omega_1)$, (iii) line 3 has $(2\omega_1)$ which should be $(2\omega_0)$, (iv) line 13 has $[2(\omega_0 + \omega_2) = (2(\omega_0+\omega_3)]$ which should be $[2(\omega_1 + \omega_2) = (2(\omega_0+\omega_3)]$

ch4, p71, Table 4.3 – there are several sign errors in the 'f' column, and some of the months for N=0 and for maximum M2 amplitude are incorrect. The corrected table is given below.

ch4, p75, Table 4.5. Not an erratum as such, but the paper (Ray, R.D. 2017. On tidal inference in the diurnal band. Journal of Atmospheric and Oceanic Technology, 34, 437-446, doi:10.1175/JTECH-D-16-0142.1) suggests that the relationship between P1 and K1 should be more like 0.318 than the 0.331 given in the Related Constituents in Table 4.5 on page 75. The point is that the 0.331 of the classical tidal potential (correct as shown) is modified to become a smaller value in reality because of a nearby (in frequency to K1 and P1) resonance in the diurnal band arising from a free rotational mode of the Earth caused by the fluid core. This issue does not affect the other related constituents in the table. Also see Agnew, D.C. 2018. An improbable observation of the Diurnal Core Resonance. Pure and Applied Geophysics, 175, 1599-1609, doi:10.1007/s00024-017-1522-1.

ch4, p75 – next to last equation, bottom-right of the page, left hand side of the equation, the sigma_1 should be sigma_0.

ch4, p76, bottom of right column, form factor F is the wrong way up.

ch4, p85 - at the end of the footnote V_n should be in italics.

ch4, p87 – in the equation top right +139.4 degrees should be -139.4 degrees.

ch4, p89, equation top left – this is not an error, but should be clarified more. The symbol ω here refers to frequency and not angular frequency. As stated, if the non-tidal residual variance in the averaging band, of width Δω, is $S_{\Delta\omega}^2$, then the noise density is $S_{\Delta\omega}^2/\Delta\omega$. (The energy of the constituent peak should not be included in this background noise density estimate.) Then, consider a record of length T consisting of N hourly values. There will be N/2 'elemental bands' involved with 'elemental frequencies' spanning 1/N to 0.5 cph (the Nyquist) in steps of 1/N cph, and the frequency of the constituent in question will either fall on one these elemental frequencies, or between a pair of them. If we assign the energy between a pair as contributing to the uncertainty in the amplitude of the constituent, then the value of S^2 to be used to calculate standard errors is given by $[S_{\Delta\omega}^2/\Delta\omega]*(1/N)$. This is a somewhat schematic view of errors, assuming that the constituent peak has zero width. If the peak spans more than one elemental frequency then the calculation would need to be modified accordingly.

ch4, p90 – there were a number of errors in Table 4.11. A corrected table is given below.

ch5, p103 - equation D.15, second line, should be sqrt(g/D) and not sqrt(gD). The same equation is correct on page 373.

ch5, p110 - Figure 5.9, page 110 is from Deutsches Hydrographisches Institut, 1963. Handbuch fuer das Rote Meer und der Golf von Aden. Nr. 2034. The phases shown are 'average time of high water after passage of the moon at Greenwich' which will indeed closely correspond to M2 phase lag. However, the heights shown are in fact 'range of average spring tide' and not M2 amplitude.

ch5, p112, Table 5.4 – the row under the latitudes should say “f (10^{-5} rad/s)” and not as shown

ch5, p115 - Figure 5.12, page 115 is from Shen Yujiang, Numerical computation of tides in East China Sea, Collected Oceanic Works, 4, 36-44, 1981. The cotidal chart shows M2 amplitude in cm and the phases as times in hours in Beijing time (GMT+8).

Fig 5.23 - degrees are missing from the latitude and longitude annotations

Fig 5.24 - the distance ‘r’ in the annotations of the x and y axes is the same as the distance ‘s’ mentioned in the caption.

ch5 - references [38] and [72] are the same but with a credit to Dr. Richard Ray in the latter. So mention of [72] in the text should be replaced by [38], the [38] reference itself replaced by the present [72], and [72] deleted.

chapter 6 - in the running head ‘shallaw’ should be ‘shallow’

ch 6, p136, fig.6.4 - last line of caption should say "from adding M4 (thin black line) and M2 (heavy black line)."

ch 6, page 138, equation 6.8 should read: $9 H_{M6} > H_{M2}$ and not H_{M4}

ch 6, p145 - equation for H_0 at end of section 6.6, H_0 should be proportional to the reciprocal of the product on the right of the equation.

ch7, p161, Figure 7.4 – the schematic description of a skew surge in this figure would be better to have tick marks on the x-axis annotated as 4, 8 and 12 hours (instead of 5, 10 and 15) so as to better represent a semidiurnal astronomical tide.

ch7, p162, section 7.3.3 - the references to [15] in the first paragraph should be [16]

ch7, p184, reference [40] - Gonnert should be Gönnert

ch8, p203, near top of right column - this would better read:

Then the leading part of this long wave will sample shallower water, where phase velocity is smaller, before its trailing part, so the wave will compress, and the wavelength will shorten while wave period remains the same.

The words "Kinetic energy will be converted into potential energy" are not correct (or at least misleading). Averaged over a wavelength, the wave has equal amounts of kinetic and potential energy. The density of both increases as the wave propagates into shallower water because the energy density times propagation speed is constant.

ch9, p235, figure 9.10 - a more correct and complete caption for this would be:

Distribution of presently known surface gravity measurements from land and marine surveys. Figure from Dr Sylvain Bonvalot, Director Bureau Gravimétrique International (BGI). Land data are represented by green dots, solid green indicates a dense data distribution. Some areas that are known to have measurements appear with green grid-points but no detailed information is available on the actual data distribution. Ship tracks of known marine gravity measurements are shown.

ch10, figure 10.23 - this shows two black straight lines. The lower one, which goes through the data points, refers to the 3.2 mm/yr shown. The upper one was not in the original figure and was somehow introduced in the publication process.

ch10, p290 – reference 100 should be dated 2003 and not 1983

ch11, p296, last line bottom right; p297, line 4; p298, Figure 11.2 caption – the GPS ‘receivers’ referred to in these sentences should really be referring to ‘antennas’. The receivers themselves will be installed safely in the tide gauge buildings with antennas connected to them with cables.

ch11, p298, equation 11.1 - R should be R–dot as mentioned in the line above.

Fig 11.9 - the numbering of the colour bar in (b) and the mm/yr have a different font to those in (a)

ch12, p338 - the two ‘unknowns’ at the end of Table 12.5 should be deleted

ch13, p346, section 13.3 - mangroves occupying "75% of the world's coastlines in 1970" should read "tropical coastlines" or "tropical and subtropical coastlines". There is the same error in the reference [7] given, which is by Barbier et al. (2011).

ch13, p354, section 13.4.3, paragraph 2 - the 'In Chapter 1' is a reference to the Chapter 1 in Pugh (1987).

Appendix A, p361, the ‘d’ in the ‘dt’ in the first term of eq. (A.3) should be a partial as in (A.2).

Appendix C, p369, box C2 for M4 and its following text should be corrected as below.

One then has for **M4**:

$$MHW = Z_0 + (1-Q)H_{M_2} + H_{M_4}\cos(-2r\sin\vartheta + \vartheta)$$

$$MLW = Z_0 - (1-Q)H_{M_2} + H_{M_4}\cos(2r\sin\vartheta + \vartheta)$$

$$MTL = Z_0 + H_{M_4}\cos(2r\sin\vartheta)\cos\vartheta \qquad \text{(C.2)}$$

$$MTR = 2(1-Q)H_{M_2} + 2H_{M_4}\sin(2r\sin\vartheta)sin\vartheta$$

where Z_0 is Mean Sea Level (MSL), $\vartheta = \left(2g_{M_2} - g_{M_4}\right)$ and $r = \frac{2H_{M_4}}{H_{M_2}}$ and $Q = (rsin\vartheta)^2/2$.

Box C3 for M6 and its following text should be corrected as below.

For **M6**, similar calculations give:

$$MHW = Z_0 + (1-Q)H_{M_2} + H_{M_6}\cos(-3r\sin\vartheta + \vartheta)$$

$$MLW = Z_0 - (1-Q)H_{M_2} - H_{M_6}\cos(-3r\sin\vartheta + \vartheta)$$

$$MTL = Z_0 \qquad \text{(C.3)}$$

$$MTR = 2(1-Q)H_{M_2} + 2H_{M_6}\cos(-3r\sin\vartheta + \vartheta)$$

where this time $\vartheta = \left(3g_{M_2} - g_{M_6}\right)$ and $r = 3\frac{H_{M_6}}{H_{M_2}}$

The ratio *r* is very small, and so for **M4** it can be seen that the influence on MTL is potentially significant because of the cosine term. **M6** does not contribute to MTL. Similarly, **M8** contributes to MTL and **M10** does not; but these and higher terms are usually neglected.

Corrected Table 3.2 Basic astronomical periods and frequencies

	Period		Frequency		Angular speed	
			f cycles per mean solar day	σ degrees per mean solar hour radians	Symbol in rate of	Rate of change of
Mean solar day	1.00	mean solar days	1.00	15.0000	ω0	C_s
Mean lunar day	1.0351	mean solar days	0.9661369	14.4921	ω1	C_l
Tropical month	27.3216	mean solar days	0.0366011	0.5490	ω2	s
Tropical year	365.2422	mean solar days	0.0027379	0.0411	ω3	h
Moon's perigee	8.85	Julian years	0.0003093	0.0046	ω4	p
Regression of Moon's nodes	18.61	Julian years	0.0001471	0.0022	ω5	N'
Perihelion	20,942	Julian years	–		ω6	p'

Corrected Table 3.3 Different days, months and years expressed in mean solar days

Type		Frequency	Period (msd)
Days			
Sidereal	Fixed celestial point	$\omega s = \omega 0 + \omega 3$, $\omega s = \omega 1 + \omega 2$	0.9973
Mean solar	Solar transit	$\omega 0$	1.0000
Mean lunar	Lunar transit	$\omega 1$	1.0350
Months			
Nodical	Lunar ascending node	$\omega 2 + \omega 5$	27.2122
Tropical	Vernal equinox	$\omega 2$	27.3216
Sidereal	Fixed celestial point		27.3217
Anomalistic	Lunar perigee	$\omega 2 - \omega 4$	27.5546
Synodic	Lunar phases	$\omega 2 - \omega 3$, $\omega 0 - \omega 1$	29.5307
Years			
Tropical	Vernal equinox	$\omega 3$	365.2422
Sidereal	Fixed celestial point		365.2564
Anomalistic	Perihelion	$\omega 3 - \omega 6$	365.2596

Corrected Table 4.3

Corrected Table 4.3				
Basic nodal modulation terms for the major lunar tidal constituents				
		f		*u*
Mm		1.000-0.130 cos(N)		0.0^0
Mf		1.043+0.414 cos(N)		-23.7^0 sin(N)
Q1, O1		1.009+0.187 cos(N)		10.8^0 sin(N)
K1		1.006+0.115 cos(N)		-8.9^0 sin(N)
2N2, Mu2, Nu2, N2, M2		1.000-0.037 cos(N)		-2.1^0 sin(N)
K2		1.024+0.286 cos(N)		-17.7^0 sin(N)
N=0 March 1969, November 1987, June 2006, January 2025, September 2043..., at which times the diurnal terms have maximum amplitudes, whereas **M_2** is a minimum. **M_2** has maximum Equilibrium amplitudes in July 1978, February 1997, October 2015, May 2034, December 2052, …				

[In an earlier version of this errata we gave the last date as December 2052/January 2053, as the maximum spans the new year, but it is more accurate as just December 2052.]

Corrected Table 4.11

From analysis H_{M2}= 1.701 m g_{M2}= 134.5^0 Table 4.9

Z_0 = 3.125 m above Admiralty Chart Datum

From Table 4.2:

s = 183.3^0
h = 110.8^0
p = 54.5^0 0000 13 July 2043
N = 3.2^0 Day 194
p' = 283.7^0

From Table 4.1(c) and Section 4.2.1:

$$V_{M_2} = -2s + 2h = -145.0^0$$

(in solar time **M_2**=2 -2 2 0 0 0)

and from Table 4.3

$$f_{M_2} = 1.000 - 0.037\cos(N) = 0.963$$

$$u_{M_2} = -2.1\sin(N) = -0.1^0$$

The **M_2** harmonic is :

$$H_{M_2} f_{M_2} \cos\left[\omega_{M_2} t - g_{M_2} + \left(V_{M_2} + u_{M_2}\right)\right]$$

$$= 1.701 * 0.963 * \cos[28.98^0 t - 134.5^0 + (-145.0^0 - 0.1^0)]$$

t is measured in hours from midnight

$$= 1.638 * \cos[28.98^0 t - 279.6^0]$$

Some calculated values are

0000	Z0+0.27=3.40 m	ACD
0600	Z0-0.44=2.68 m	
1200	Z0+0.61=3.73 m	
1800	Z0-0.77=2.36 m	
2400	Z0+0.91=4.04 m	

Figure 4.10 shows the curve through the hourly values of the **M_2** constituent predictions, and through the full predictions for 13 July 2043, based on the sum of 100 constituents.

[Note: these changes to Table 4.11 change the solid line in Figure 4.10, although not in any major way to invalidate the point being made.]