8 Tidal Variations in the Earth's Rotation (28 April 2006)

Periodic variations in UT1 due to tidal deformation of the polar moment of inertia were first derived by Yoder *et al.* (1981) and included the tidal deformation of the Earth with a decoupled core, an elastic mantle and an equilibrium ocean tide. This model used effective Love numbers that differ from the bulk value of 0.301 because of the oceans and the fluid core, producing different theoretical values of the ratio k/C for the fortnightly and monthly terms. However, Yoder *et al.* recommend the value of 0.94 for k/C for both cases. Tables in previous IERS Technical Notes defined UT1R−UTC, $\Delta - \Delta$R, and $\omega - \omega$R where Δ refers to the length of day and ω the Earth's rotational speed.

The IERS Conventions recommends that only UT1 and LOD be used in routine data exchange applications in order to avoid possible confusion regarding the exact implementation of tidal models. In research applications, analysts must be careful to specify unambiguously any tidal models used.

Note that UT1R refers to UT1 with the effect of the tides with periods less than 35 days removed. UT1S is UT1 with the effects of all tidal constituents removed, including the long-period tides (up to 18.6 years). The numerical implementations can be found in the IERS Conventions (1996).

Periodic variations in UT1 due to tidal deformations for an Earth model with a decoupled core and an inelastic mantle have been computed by Defraigne and Smits (1999). The mantle inelasticity model is the same as for the displacement and potential Love numbers (Chapters 6 and 7), *i.e.* a frequency dependence of $(f_m/f)^\alpha$ where $\alpha = 0.15$, f_m is the seismic frequency corresponding to a period of 200 s, and f is the tidal frequency. The ocean effects are included in the model using a transfer function that is constant with frequency (k_{ocean}=0.044) computed by Mathews *et al.* (2002) for an equilibrium ocean tide model. Note that Dickman (2003) finds a value k_{ocean}=0.04323 for dynamic oceans. The decision to use a constant admittance is due to the absence of agreement between the existing models of non-equilibrium ocean tide effects for the long-period tides (Dickman, 1993; Seiler and Wünsch, 1995).

Table 8.1 provides corrections for the tidal variations in the Earth's rotation with periods from five days to 18.6 years. These corrections (δUT1, $\delta\Delta$, $\delta\omega$) represent the effect of tidal deformation on the physical variations in the rotation of the Earth. To obtain variations free from tidal effects, these corrections should be subtracted from the observed UT1−UTC, length of day (Δ) and rotation velocity (ω).

$$\delta \mathrm{UT1} = \sum_{i=1}^{62} B_i \sin\xi_i + C_i \cos\xi_i,$$

$$\delta\Delta = \sum_{i=1}^{62} B'_i \cos\xi_i + C'_i \sin\xi_i,$$

$$\delta\omega = \sum_{i=1}^{62} B''_i \cos\xi_i + C''_i \sin\xi_i,$$

$$\xi_i = \sum_{j=1}^{5} a_{ij}\alpha_j,$$

B_i, C_i, B'_i, C'_i, B''_i, and C''_i are given in columns 7–12 respectively in Table 8.1. a_{ij} = integer multipliers of the α_j (l, l', F, D or Ω) for the i^{th} tide given in the first five columns of Table 8.1.

To avoid confusion among possible tidal models, it is recommended that the terms δUT1, $\delta\Delta$, $\delta\omega$ be followed by the model name in parenthesis, *e.g.* δUT1(Defraigne and Smits, 1999).

The routine "ortho_eop.f", available from the IERS Conventions web page, provides corrections modeling the diurnal and sub-diurnal variations in polar motion and UT1. It was provided by Eanes (2000) and based on Ray *et al.* (1994). The difference with the model of the Conventions (1996) can exceed 100 microarcseconds for polar motion and 10 microseconds for UT1.

The model includes 71 tidal constituents with amplitudes on the order of tenths of milliarcseconds in polar motion and tens of microseconds in UT1. The coefficients of these terms have been derived from time series of these variations determined from "ortho_eop.f", and are reported in Tables 8.2 and 8.3. As Table 8.2 and 8.3 cannot be found in the code of "ortho_eop.f", the IERS Earth Orientation Center has proposed the alternative software "interp_f" (ftp://hpiers.obspm.fr/eop-pc/models/interp.f), directly based on Table 8.2 and 8.3. The two routines agree at the level of a few microarcseconds in polar motion and a few tenths of a microsecond in UT1.

In the past there has been some confusion over comparison of models appearing in the *IERS Conventions* and the values published in the Yoder *et al.* (1981) paper. J. Williams (private communication (2005)) points out that there are four known errors in the Yoder *et al.* (1981) table. (1) The amplitude of term 22 (14.73-day period) should read −50 instead of 50. (2) The period of term 58 (1095.17-day period) should read −1095.17 instead of 1095.17, (*i.e.* the motion is retrograde). (3) The amplitude of term 59 (1305.47-day period) should read −448 instead of −449. (4) The amplitude of term 60 (3232.85-day period) should read +43 instead of −43.

Table 8.1 Zonal tide terms. Columns headed by the titles δUT1, $\delta\Delta$, and $\delta\omega$ provide the regularized forms of UT1, the duration of the day Δ, and the angular velocity of the Earth, ω derived from the Defraigne and Smits (1999) model. The units are 10^{-4} s for UT1, 10^{-5} s for Δ, and 10^{-14} rad/s for ω. The column titled "Period" provides the absolute value of the period without a positive or negative sign to indicate a prograde or retrograde motion.

ARGUMENT					PERIOD	δUT1		$\delta\Delta$		$\delta\omega$	
								Coefficient of			
l	l'	F	D	Ω	Days	Sin	Cos	Cos	Sin	Cos	Sin
1	0	2	2	2	5.64	-0.02	0.00	0.26	0.00	-0.22	0.00
2	0	2	0	1	6.85	-0.04	0.00	0.38	0.00	-0.32	0.00
2	0	2	0	2	6.86	-0.10	0.00	0.91	0.00	-0.76	0.00
0	0	2	2	1	7.09	-0.05	0.00	0.45	0.00	-0.38	0.00
0	0	2	2	2	7.10	-0.12	0.00	1.09	0.01	-0.92	-0.01
1	0	2	0	0	9.11	-0.04	0.00	0.27	0.00	-0.22	0.00
1	0	2	0	1	9.12	-0.41	0.00	2.84	0.02	-2.40	-0.01
1	0	2	0	2	9.13	-1.00	0.01	6.85	0.04	-5.78	-0.03
3	0	0	0	0	9.18	-0.02	0.00	0.12	0.00	-0.11	0.00
-1	0	2	2	1	9.54	-0.08	0.00	0.54	0.00	-0.46	0.00
-1	0	2	2	2	9.56	-0.20	0.00	1.30	0.01	-1.10	-0.01
1	0	0	2	0	9.61	-0.08	0.00	0.50	0.00	-0.42	0.00
2	0	2	-2	2	12.81	0.02	0.00	-0.11	0.00	0.09	0.00
0	1	2	0	2	13.17	0.03	0.00	-0.12	0.00	0.10	0.00
0	0	2	0	0	13.61	-0.30	0.00	1.39	0.01	-1.17	-0.01
0	0	2	0	1	13.63	-3.22	0.02	14.86	0.09	-12.54	-0.08
0	0	2	0	2	13.66	-7.79	0.05	35.84	0.22	-30.25	-0.18
2	0	0	0	-1	13.75	0.02	0.00	-0.10	0.00	0.08	0.00
2	0	0	0	0	13.78	-0.34	0.00	1.55	0.01	-1.31	-0.01
2	0	0	0	1	13.81	0.02	0.00	-0.08	0.00	0.07	0.00
0	-1	2	0	2	14.19	-0.02	0.00	0.11	0.00	-0.09	0.00
0	0	0	2	-1	14.73	0.05	0.00	-0.20	0.00	0.17	0.00
0	0	0	2	0	14.77	-0.74	0.00	3.14	0.02	-2.65	-0.02
0	0	0	2	1	14.80	-0.05	0.00	0.22	0.00	-0.19	0.00
0	-1	0	2	0	15.39	-0.05	0.00	0.21	0.00	-0.17	0.00
1	0	2	-2	1	23.86	0.05	0.00	-0.13	0.00	0.11	0.00
1	0	2	-2	2	23.94	0.10	0.00	-0.26	0.00	0.22	0.00
1	1	0	0	0	25.62	0.04	0.00	-0.10	0.00	0.08	0.00
-1	0	2	0	0	26.88	0.05	0.00	-0.11	0.00	0.09	0.00
-1	0	2	0	1	26.98	0.18	0.00	-0.41	0.00	0.35	0.00
-1	0	2	0	2	27.09	0.44	0.00	-1.02	-0.01	0.86	0.01

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(Table 8.1: continued)

1	0	0	0	-1	27.44	0.54	0.00	-1.23	-0.01	1.04	0.01
1	0	0	0	0	27.56	-8.33	0.06	18.99	0.13	-16.03	-0.11
1	0	0	0	1	27.67	0.55	0.00	-1.25	-0.01	1.05	0.01
0	0	0	1	0	29.53	0.05	0.00	-0.11	0.00	0.09	0.00
1	-1	0	0	0	29.80	-0.06	0.00	0.12	0.00	-0.10	0.00
-1	0	0	2	-1	31.66	0.12	0.00	-0.24	0.00	0.20	0.00
-1	0	0	2	0	31.81	-1.84	0.01	3.63	0.02	-3.07	-0.02
-1	0	0	2	1	31.96	0.13	0.00	-0.26	0.00	0.22	0.00
1	0	-2	2	-1	32.61	0.02	0.00	-0.04	0.00	0.03	0.00
-1	-1	0	2	0	34.85	-0.09	0.00	0.16	0.00	-0.13	0.00
0	2	2	-2	2	91.31	-0.06	0.00	0.04	0.00	-0.03	0.00
0	1	2	-2	1	119.61	0.03	0.00	-0.02	0.00	0.01	0.00
0	1	2	-2	2	121.75	-1.91	0.02	0.98	0.01	-0.83	-0.01
0	0	2	-2	0	173.31	0.26	0.00	-0.09	0.00	0.08	0.00
0	0	2	-2	1	177.84	1.18	-0.01	-0.42	0.00	0.35	0.00
0	0	2	-2	2	182.62	-49.06	0.43	16.88	0.15	-14.25	-0.13
0	2	0	0	0	182.63	-0.20	0.00	0.07	0.00	-0.06	0.00
2	0	0	-2	-1	199.84	0.05	0.00	-0.02	0.00	0.01	0.00
2	0	0	-2	0	205.89	-0.56	0.01	0.17	0.00	-0.14	0.00
2	0	0	-2	1	212.32	0.04	0.00	-0.01	0.00	0.01	0.00
0	-1	2	-2	1	346.60	-0.05	0.00	0.01	0.00	-0.01	0.00
0	1	0	0	-1	346.64	0.09	0.00	-0.02	0.00	0.01	0.00
0	-1	2	-2	2	365.22	0.82	-0.01	-0.14	0.00	0.12	0.00
0	1	0	0	0	365.26	-15.65	0.15	2.69	0.03	-2.27	-0.02
0	1	0	0	1	386.00	-0.14	0.00	0.02	0.00	-0.02	0.00
1	0	0	-1	0	411.78	0.03	0.00	0.00	0.00	0.00	0.00
2	0	-2	0	0	1095.17	-0.14	0.00	-0.01	0.00	0.01	0.00
-2	0	2	0	1	1305.47	0.43	-0.01	-0.02	0.00	0.02	0.00
-1	1	0	1	0	3232.85	-0.04	0.00	0.00	0.00	0.00	0.00
0	0	0	0	2	3399.18	8.20	0.11	0.15	0.00	-0.13	0.00
0	0	0	0	1	6798.38	-1689.54	-25.04	-15.62	0.23	13.18	-0.20

Table 8.2a Coefficients of sin(argument) and cos(argument) of diurnal variations in pole coordinates x_p and y_p caused by ocean tides. The units are μas; χ denotes GMST+π.

	argument						Doodson	Period	x_p		y_p	
Tide	χ	l	l'	F	D	Ω	number	(days)	sin	cos	sin	cos
	1	-1	0	-2	-2	-2	117.655	1.2113611	0.0	0.9	-0.9	-0.1
	1	-2	0	-2	0	-1	125.745	1.1671262	0.1	0.6	-0.6	0.1
2Q1	1	-2	0	-2	0	-2	125.755	1.1669259	0.3	3.4	-3.4	0.3
	1	0	0	-2	-2	-1	127.545	1.1605476	0.1	0.8	-0.8	0.1
σ1	1	0	0	-2	-2	-2	127.555	1.1603495	0.5	4.2	-4.1	0.5
	1	-1	0	-2	0	-1	135.645	1.1196993	1.2	5.0	-5.0	1.2
Q1	1	-1	0	-2	0	-2	135.655	1.1195148	6.2	26.3	-26.3	6.2
	1	1	0	-2	-2	-1	137.445	1.1136429	0.2	0.9	-0.9	0.2
RO1	1	1	0	-2	-2	-2	137.455	1.1134606	1.3	5.0	-5.0	1.3
	1	0	0	-2	0	0	145.535	1.0761465	-0.3	-0.8	0.8	-0.3
	1	0	0	-2	0	-1	145.545	1.0759762	9.2	25.1	-25.1	9.2
O1	1	0	0	-2	0	-2	145.555	1.0758059	48.8	132.9	-132.9	48.8
	1	-2	0	0	0	0	145.755	1.0750901	-0.3	-0.9	0.9	-0.3
T01	1	0	0	0	-2	0	147.555	1.0695055	-0.7	-1.7	1.7	-0.7
	1	-1	0	-2	2	-2	153.655	1.0406147	-0.4	-0.9	0.9	-0.4
	1	1	0	-2	0	-1	155.445	1.0355395	-0.3	-0.6	0.6	-0.3
	1	1	0	-2	0	-2	155.455	1.0353817	-1.6	-3.5	3.5	-1.6
M1	1	-1	0	0	0	0	155.655	1.0347187	-4.5	-9.6	9.6	-4.5
	1	-1	0	0	0	-1	155.665	1.0345612	-0.9	-1.9	1.9	-0.9
χ1	1	1	0	0	-2	0	157.455	1.0295447	-0.9	-1.8	1.8	-0.9

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(Table 8.2a: continued)

π1	1	0	-1	-2	2	-2	162.556	1.0055058	1.5	3.0	-3.0	1.5
	1	0	0	-2	2	-1	163.545	1.0028933	-0.3	-0.6	0.6	-0.3
P1	1	0	0	-2	2	-2	163.555	1.0027454	26.1	51.2	-51.2	26.1
	1	0	1	-2	2	-2	164.554	1.0000001	-0.2	-0.4	0.4	-0.2
S1	1	0	-1	0	0	0	164.556	0.9999999	-0.6	-1.2	1.2	-0.6
	1	0	0	0	0	1	165.545	0.9974159	1.5	3.0	-3.0	1.5
K1	1	0	0	0	0	0	165.555	0.9972695	-77.5	-151.7	151.7	-77.5
	1	0	0	0	0	-1	165.565	0.9971233	-10.5	-20.6	20.6	-10.5
	1	0	0	0	0	-2	165.575	0.9969771	0.2	0.4	-0.4	0.2
ψ1	1	0	1	0	0	0	166.554	0.9945541	-0.6	-1.2	1.2	-0.6
ϕ1	1	0	0	2	-2	2	167.555	0.9918532	-1.1	-2.1	2.1	-1.1
TT1	1	-1	0	0	2	0	173.655	0.9669565	-0.7	-1.4	1.4	-0.7
J1	1	1	0	0	0	0	175.455	0.9624365	-3.5	-7.3	7.3	-3.5
	1	1	0	0	0	-1	175.465	0.9623003	-0.7	-1.4	1.4	-0.7
SO1	1	0	0	0	2	0	183.555	0.9341741	-0.4	-1.1	1.1	-0.4
	1	2	0	0	0	0	185.355	0.9299547	-0.2	-0.5	0.5	-0.2
OO1	1	0	0	2	0	2	185.555	0.9294198	-1.1	-3.4	3.4	-1.1
	1	0	0	2	0	1	185.565	0.9292927	-0.7	-2.2	2.2	-0.7
	1	0	0	2	0	0	185.575	0.9291657	-0.1	-0.5	0.5	-0.1
ν1	1	1	0	2	0	2	195.455	0.8990932	0.0	-0.6	0.6	0.0
	1	1	0	2	0	1	195.465	0.8989743	0.0	-0.4	0.4	0.0

Table 8.2b Coefficients of sin(argument) and cos(argument) of semidiurnal variations in pole coordinates x_p and y_p caused by ocean tides. The units are μas; χ denotes GMST+ π.

	argument						Doodson	Period	x_p		y_p	
Tide	χ	l	l'	F	D	Ω	number	(days)	sin	cos	sin	cos
	2	-3	0	-2	0	-2	225.855	0.5484264	-0.5	0.0	0.6	0.2
	2	-1	0	-2	-2	-2	227.655	0.5469695	-1.3	-0.2	1.5	0.7
2N2	2	-2	0	-2	0	-2	235.755	0.5377239	-6.1	-1.6	3.1	3.4
μ2	2	0	0	-2	-2	-2	237.555	0.5363232	-7.6	-2.0	3.4	4.2
	2	0	1	-2	-2	-2	238.554	0.5355369	-0.5	-0.1	0.2	0.3
	2	-1	-1	-2	0	-2	244.656	0.5281939	0.5	0.1	-0.1	-0.3
	2	-1	0	-2	0	-1	245.645	0.5274721	2.1	0.5	-0.4	-1.2
N2	2	-1	0	-2	0	-2	245.655	0.5274312	-56.9	-12.9	11.1	32.9
	2	-1	1	-2	0	-2	246.654	0.5266707	-0.5	-0.1	0.1	0.3
ν2	2	1	0	-2	-2	-2	247.455	0.5260835	-11.0	-2.4	1.9	6.4
	2	1	1	-2	-2	-2	248.454	0.5253269	-0.5	-0.1	0.1	0.3
	2	-2	0	-2	2	-2	253.755	0.5188292	1.0	0.1	-0.1	-0.6
	2	0	-1	-2	0	-2	254.556	0.5182593	1.1	0.1	-0.1	-0.7
	2	0	0	-2	0	-1	255.545	0.5175645	12.3	1.0	-1.4	-7.3
M2	2	0	0	-2	0	-2	255.555	0.5175251	-330.2	-27.0	37.6	195.9
	2	0	1	-2	0	-2	256.554	0.5167928	-1.0	-0.1	0.1	0.6
λ2	2	-1	0	-2	2	-2	263.655	0.5092406	2.5	-0.3	-0.4	-1.5
L2	2	1	0	-2	0	-2	265.455	0.5079842	9.4	-1.4	-1.9	-5.6
	2	-1	0	0	0	0	265.655	0.5078245	-2.4	0.4	0.5	1.4
	2	-1	0	0	0	-1	265.665	0.5077866	-1.0	0.2	0.2	0.6
T2	2	0	-1	-2	2	-2	272.556	0.5006854	-8.5	3.5	3.3	5.1
S2	2	0	0	-2	2	-2	273.555	0.5000000	-144.1	63.6	59.2	86.6
R2	2	0	1	-2	2	-2	274.554	0.4993165	1.2	-0.6	-0.5	-0.7
	2	0	0	0	0	1	275.545	0.4986714	0.5	-0.2	-0.2	-0.3

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(Table 8.2b: continued)

K2	2	0	0	0	0	0	275.555	0.4986348	-38.5	19.1	17.7	23.1
	2	0	0	0	0	-1	275.565	0.4985982	-11.4	5.8	5.3	6.9
	2	0	0	0	0	-2	275.575	0.4985616	-1.2	0.6	0.6	0.7
	2	1	0	0	0	0	285.455	0.4897717	-1.8	1.8	1.7	1.0
	2	1	0	0	0	-1	285.465	0.4897365	-0.8	0.8	0.8	0.5
	2	0	0	2	0	2	295.555	0.4810750	-0.3	0.6	0.7	0.2

Table 8.3a Coefficients of sin(argument) and cos(argument) of diurnal variations in UT1 and LOD caused by ocean tides. The units are μs; χ denotes GMST+ π.

	argument						Doodson	Period	UT1		LOD	
Tide	χ	l	l'	F	D	Ω	number	(days)	sin	cos	sin	cos
	1	-1	0	-2	-2	-2	117.655	1.2113611	0.40	-0.08	-0.41	-2.06
	1	-2	0	-2	0	-1	125.745	1.1671262	0.19	-0.06	-0.32	-1.05
2Q1	1	-2	0	-2	0	-2	125.755	1.1669259	1.03	-0.31	-1.69	-5.57
	1	0	0	-2	-2	-1	127.545	1.1605476	0.22	-0.07	-0.39	-1.21
σ1	1	0	0	-2	-2	-2	127.555	1.1603495	1.19	-0.39	-2.09	-6.43
	1	-1	0	-2	0	-1	135.645	1.1196993	0.97	-0.47	-2.66	-5.42
Q1	1	-1	0	-2	0	-2	135.655	1.1195148	5.12	-2.50	-14.02	-28.72
	1	1	0	-2	-2	-1	137.445	1.1136429	0.17	-0.09	-0.51	-0.97
RO1	1	1	0	-2	-2	-2	137.455	1.1134606	0.91	-0.47	-2.68	-5.14
	1	0	0	-2	0	0	145.535	1.0761465	-0.09	0.07	0.41	0.54
	1	0	0	-2	0	-1	145.545	1.0759762	3.03	-2.28	-13.31	-17.67
O1	1	0	0	-2	0	-2	145.555	1.0758059	16.02	-12.07	-70.47	-93.58
	1	-2	0	0	0	0	145.755	1.0750901	-0.10	0.08	0.46	0.60
T01	1	0	0	0	-2	0	147.555	1.0695055	-0.19	0.15	0.91	1.14
	1	-1	0	-2	2	-2	153.655	1.0406147	-0.08	0.07	0.45	0.50
	1	1	0	-2	0	-1	155.445	1.0355395	-0.06	0.05	0.31	0.35
	1	1	0	-2	0	-2	155.455	1.0353817	-0.31	0.27	1.65	1.87
M1	1	-1	0	0	0	0	155.655	1.0347187	-0.86	0.75	4.56	5.20
	1	-1	0	0	0	-1	155.665	1.0345612	-0.17	0.15	0.91	1.04
χ1	1	1	0	0	-2	0	157.455	1.0295447	-0.16	0.14	0.84	0.98
π1	1	0	-1	-2	2	-2	162.556	1.0055058	0.31	-0.19	-1.18	-1.97
	1	0	0	-2	2	-1	163.545	1.0028933	-0.06	0.03	0.22	0.39
P1	1	0	0	-2	2	-2	163.555	1.0027454	5.51	-3.10	-19.40	-34.54
	1	0	1	-2	2	-2	164.554	1.0000001	-0.05	0.02	0.16	0.30
S1	1	0	-1	0	0	0	164.556	0.9999999	-0.13	0.07	0.44	0.84
	1	0	0	0	0	1	165.545	0.9974159	0.35	-0.17	-1.07	-2.19
K1	1	0	0	0	0	0	165.555	0.9972695	-17.62	8.55	53.86	111.01
	1	0	0	0	0	-1	165.565	0.9971233	-2.39	1.16	7.30	15.07
	1	0	0	0	0	-2	165.575	0.9969771	0.05	-0.03	-0.16	-0.33
ψ1	1	0	1	0	0	0	166.554	0.9945541	-0.14	0.06	0.41	0.91
ϕ1	1	0	0	2	-2	2	167.555	0.9918532	-0.27	0.11	0.70	1.69
TT1	1	-1	0	0	2	0	173.655	0.9669565	-0.29	0.04	0.28	1.87
J1	1	1	0	0	0	0	175.455	0.9624365	-1.61	0.19	1.22	10.51
	1	1	0	0	0	-1	175.465	0.9623003	-0.32	0.04	0.24	2.09
SO1	1	0	0	0	2	0	183.555	0.9341741	-0.41	-0.01	-0.04	2.74
	1	2	0	0	0	0	185.355	0.9299547	-0.21	-0.01	-0.03	1.44
OO1	1	0	0	2	0	2	185.555	0.9294198	-1.44	-0.04	-0.25	9.70
	1	0	0	2	0	1	185.565	0.9292927	-0.92	-0.02	-0.16	6.23
	1	0	0	2	0	0	185.575	0.9291657	-0.19	0.00	-0.03	1.30
ν1	1	1	0	2	0	2	195.455	0.8990932	-0.40	-0.02	-0.17	2.77
	1	1	0	2	0	1	195.465	0.8989743	-0.25	-0.02	-0.11	1.77

Table 8.3b Coefficients of sin(argument) and cos(argument) of semidiurnal variations in UT1 and LOD caused by ocean tides. The units are μs; χ denotes GMST+ π.

	argument						Doodson	Period	UT1		LOD	
Tide	χ	l	l'	F	D	Ω	number	(days)	sin	cos	sin	cos
	2	-3	0	-2	0	-2	225.855	0.5484264	-0.09	-0.01	-0.12	1.02
	2	-1	0	-2	-2	-2	227.655	0.5469695	-0.22	-0.03	-0.37	2.57
2N2	2	-2	0	-2	0	-2	235.755	0.5377239	-0.64	-0.18	-2.06	7.44
μ2	2	0	0	-2	-2	-2	237.555	0.5363232	-0.74	-0.22	-2.61	8.72
	2	0	1	-2	-2	-2	238.554	0.5355369	-0.05	-0.02	-0.18	0.58
	2	-1	-1	-2	0	-2	244.656	0.5281939	0.03	0.01	0.16	-0.39
	2	-1	0	-2	0	-1	245.645	0.5274721	0.14	0.06	0.70	-1.68
N2	2	-1	0	-2	0	-2	245.655	0.5274312	-3.79	-1.56	-18.57	45.20
	2	-1	1	-2	0	-2	246.654	0.5266707	-0.03	-0.01	-0.18	0.41
ν2	2	1	0	-2	-2	-2	247.455	0.5260835	-0.70	-0.30	-3.57	8.33
	2	1	1	-2	-2	-2	248.454	0.5253269	-0.03	-0.01	-0.16	0.38
	2	-2	0	-2	2	-2	253.755	0.5188292	0.05	0.02	0.27	-0.60
	2	0	-1	-2	0	-2	254.556	0.5182593	0.06	0.03	0.31	-0.68
	2	0	0	-2	0	-1	255.545	0.5175645	0.60	0.27	3.23	-7.34
M2	2	0	0	-2	0	-2	255.555	0.5175251	-16.19	-7.15	-86.79	196.58
	2	0	1	-2	0	-2	256.554	0.5167928	-0.05	-0.02	-0.26	0.59
λ2	2	-1	0	-2	2	-2	263.655	0.5092406	0.11	0.03	0.43	-1.37
L2	2	1	0	-2	0	-2	265.455	0.5079842	0.42	0.12	1.44	-5.25
	2	-1	0	0	0	0	265.655	0.5078245	-0.11	-0.03	-0.36	1.32
	2	-1	0	0	0	-1	265.665	0.5077866	-0.05	-0.01	-0.16	0.58
T2	2	0	-1	-2	2	-2	272.556	0.5006854	-0.44	-0.02	-0.24	5.48
S2	2	0	0	-2	2	-2	273.555	0.5000000	-7.55	-0.16	-2.00	94.83
R2	2	0	1	-2	2	-2	274.554	0.4993165	0.06	0.00	0.00	-0.80
	2	0	0	0	0	1	275.545	0.4986714	0.03	0.00	-0.01	-0.34
K2	2	0	0	0	0	0	275.555	0.4986348	-2.10	0.04	0.52	26.51
	2	0	0	0	0	-1	275.565	0.4985982	-0.63	0.01	0.19	7.91
	2	0	0	0	0	-2	275.575	0.4985616	-0.07	0.00	0.02	0.86
	2	1	0	0	0	0	285.455	0.4897717	-0.15	0.04	0.48	1.87
	2	1	0	0	0	-1	285.465	0.4897365	-0.06	0.02	0.21	0.82
	2	0	0	2	0	2	295.555	0.4810750	-0.05	0.02	0.24	0.63

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