CHAPTER 11 TIDAL VARIATIONS IN UT1

To properly compare UT1 results obtained at different epochs, the high frequency tidal effects must be accounted for. Thus, a standard expression for the tidal variations in UT1 is required. The periodic variations in UT1 due to tidal deformation of the polar moment of inertia have been rederived (Yoder, et al., 1981) including the tidal deformation of the Earth with a decoupled core. This model leads to effective Love numbers that differ from the bulk value of 0.301 because of the oceans and the fluid core which give rise to 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. Periodic terms in UT1 are given in Table 11.1 and are discussed in Explanatory Supplement to the IERS Bulletins A and B, March 1989 as well as the Annual Reports of the IERS. Table 11.1 includes terms due to zonal tides, with periods up to 35 days, with k/C = 0.94. Table 11.2 lists the remainder of the tidal terms (with periods greater than 35 days).

UT1R, ΔR, and ωR represent the regularized forms of UT1 (including periods up to 35 days), of the duration of the day Δ, and of the angular velocity of the Earth, ω. The units are 10^{-4} s for UT, 10^{-5} s for Δ, and 10^{-14} rad/s for ω.

It should be mentioned that the oceanic tides with short periods cause variations in UT1 which are only partially represented by the model given below. According to Brosche, et al., (1989) the contribution of the oceanic tides should be split into a part which is in phase with the solid Earth tides and into an out-of-phase part. The discrepency between the model of Yoder, et al., (which already contains a general influence of the oceans) and the model of Brosche, et al., amounts to a maximum of ± 0.08 msec for the fortnightly and monthly terms. The influence of the ocean tides with periods less than or equal to 24^h is at the level of ± 0.1 msec.

REFERENCES

Brosche, P., Seiler, U., Suendermann, J., and Wuensch, J., 1989, "Periodic Changes in Earth's Rotation due to Oceanic Tides," paper accepted by Astronomy and Astrophysics.

Yoder, C. F., Williams, J. G., Parke, M. E., 1981, "Tidal Variations of Earth Rotation," J. Geophys. Res., **86**, pp. 881-891.

Table 11.1. Zonal Tide Terms With Periods Up to 35 Days.

ARGUMENT*					PERIOD	UT1-UT1R	Δ-ΔR	ω-ωR
						Coefficient of	Coefficient of	
l	l'	F	D	Ω	Days	Sin (Argument)	Cos (Argument)	
1	0	2	2	2	5.64	-0.02	0.3	-0.2
2	0	2	0	1	6.85	-0.04	0.4	-0.3
2	0	2	0	2	6.86	-0.10	0.9	-0.8
0	0	2	2	1	7.09	-0.05	0.4	-0.4
0	0	2	2	2	7.10	-0.12	1.1	-0.9
1	0	2	0	0	9.11	-0.04	0.3	-0.2
1	0	2	0	1	9.12	-0.41	2.8	-2.4
1	0	2	0	2	9.13	-0.99	6.8	-5.8
3	0	0	0	0	9.18	-0.02	0.1	-0.1
-1	0	2	2	1	9.54	-0.08	0.5	-0.5
-1	0	2	2	2	9.56	-0.20	1.3	-1.1
1	0	0	2	0	9.61	-0.08	0.5	-0.4
2	0	2	-2	2	12.81	0.02	-0.1	0.1
0	1	2	0	2	13.17	0.03	-0.1	0.1
0	0	2	0	0	13.61	-0.30	1.4	-1.2
0	0	2	0	1	13.63	-3.21	14.8	-12.5
0	0	2	0	2	13.66	-7.76	35.7	-30.1
2	0	0	0	-1	13.75	0.02	-0.1	0.1
2	0	0	0	0	13.78	-0.34	1.5	-1.3
2	0	0	0	1	13.81	0.02	-0.1	0.1
0	-1	2	0	2	14.19	-0.02	0.1	-0.1
0	0	0	2	-1	14.73	0.05	-0.2	0.2
0	0	0	2	0	14.77	-0.73	3.1	-2.6
0	0	0	2	1	14.80	-0.05	0.2	-0.2
0	-1	0	2	0	15.39	-0.05	0.2	-0.2
1	0	2	-2	1	23.86	0.05	-0.1	0.1
1	0	2	-2	2	23.94	0.10	-0.3	0.2
1	1	0	0	0	25.62	0.04	-0.1	0.1
-1	0	2	0	0	26.88	0.05	-0.1	0.1
-1	0	2	0	1	26.98	0.18	-0.4	0.3
-1	0	2	0	2	27.09	0.44	-1.0	0.9
1	0	0	0	-1	27.44	0.53	-1.2	1.0
1	0	0	0	0	27.56	-8.26	18.8	-15.9
1	0	0	0	1	27.67	0.54	-1.2	1.0
0	0	0	1	0	29.53	0.05	-0.1	0.1
1	-1	0	0	0	29.80	-0.06	0.1	-0.1
-1	0	0	2	-1	31.66	0.12	-0.2	0.2
-1	0	0	2	0	31.81	-1.82	3.6	-3.0
-1	0	0	2	1	31.96	0.13	-0.3	0.2
1	0	-2	2	-1	32.61	0.02	0.0	0.0
-1	-1	0	2	0	34.85	-0.09	0.2	-0.1

* l = 134°96 + 13°064993(MJD-51544.5) Mean Anomaly of the Moon
l' = 357°53 + 0°985600(MJD-51544.5) Mean Anomaly of the Sun
F = 93°27 + 13°229350(MJD-51544.5) L-Ω: L: Mean Longitude of the Moon
D = 297°85 + 12°190749(MJD-51544.5) Mean Elongation of the Moon from the Sun
Ω = 125°04 - 0°052954(MJD-51544.5) Mean Longitude of the Ascending Node of the Moon

Table 11.2. Zonal Tide Terms With Periods Greater than 35 Days.

ARGUMENT*					PERIOD	UT1-UT1R	Δ-ΔR	ω-ωR
						Coefficient of	Coefficient of	
l	l'	F	D	Ω	Days	Sin (Argument)	Cos (Argument)	
0	2	2	-2	2	91.31	-0.06	0.0	0.0
0	1	2	-2	1	119.61	0.03	0.0	0.0
0	1	2	-2	2	121.75	-1.88	1.0	-0.8
0	0	2	-2	0	173.31	0.25	-0.1	0.1
0	0	2	-2	1	177.84	1.17	-0.4	0.3
0	0	2	-2	2	182.62	-48.25	16.6	-14.0
0	2	0	0	0	182.63	-0.19	0.1	-0.1
2	0	0	-2	-1	199.84	0.05	0.0	0.0
2	0	0	-2	0	205.89	-0.55	0.2	-0.1
2	0	0	-2	1	212.32	0.04	0.0	0.0
0	-1	2	-2	1	346.60	-0.05	0.0	0.0
0	1	0	0	-1	346.64	0.09	0.0	0.0
0	-1	2	-2	2	365.22	0.83	-0.1	0.1
0	1	0	0	0	365.26	-15.36	2.6	-2.2
0	1	0	0	1	386.00	-0.14	0.0	0.0
1	0	0	-1	0	411.78	0.03	0.0	0.0
2	0	-2	0	0	1095.17	-0.14	0.0	0.0
-2	0	2	0	1	1305.47	0.42	0.0	0.0
-1	1	0	1	0	3232.85	0.04	0.0	0.0
0	0	0	0	2	3399.18	7.90	0.1	-0.1
0	0	0	0	1	6790.36	-1617.27	-14.9	12.6

* l = 134°96 + 13°064993(MJD-51544.5) Mean Anomaly of the Moon
l' = 357°53 + 0°985600(MJD-51544.5) Mean Anomaly of the Sun
F = 93°27 + 13°229350(MJD-51544.5) L-Ω: L: Mean Longitude of the Moon
D = 297°85 + 12°190749(MJD-51544.5) Mean Elongation of the Moon from the Sun
Ω = 125°04 - 0°052954(MJD-51544.5) Mean Longitude of the Ascending Node of the Moon