ESTIMATION OF THE SHORT-TERM ZONAL TIDES FROM UT1 OBSERVATIONS

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ABSTRACT. Zonal tides with periods shorter than 35d, according to the latest IERS model, are estimated by means of UT1-TAI series from the solution C04 of the IERS. Corrections of AAM and OAM influences on UT1 variations are applied. The accuracy of the estimated amplitudes of the fortnightly and monthly zonal tides is about 4μs. After removing the estimated zonal tides from UT1-TAI variations, the residual time series contain significant oscillations with periods below 35d. New 56 terms are involved and proposed here 97-term model of fortnightly and monthly zonal tides yields estimation of tidal amplitudes with accuracy of about 2.1μs and residuals below 13μs.

1. AAM INFLUENCE ON UT1-TAI VARIATIONS

Atmospheric Angular Momentum (AAM) function excites Length of Day (LOD) variations and provides strong disturbances at frequencies of short-term zonal tides, which should be removed before the tide estimation. AAM influence on UT1 periodical oscillations are determined by a numerical integration of AAM / LOD function after removing the AAM constant part. The resulting series still contain significant linear trends for time intervals 1962.0-1977.3; 1977.3-1995.8; 1995.8-2007.0 (Fig. 1, left graph). The final UT1 corrections for AAM are determined after removing of these trends (Fig. 1, right graph). Similar corrections of UT1 variations, due to Ocean Angular Momentum (OAM) are determined and applied.

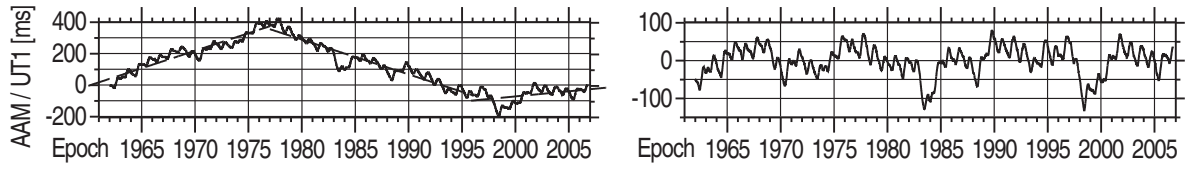

Figure 1: AAM influence on UT1 determined by numerical integration of AAM/LOD function (left) and UT1 corrections for AAM after removing the linear trends (right).

2. ESTIMATION OF MONTHLY AND FORTNIGHTLY ZONAL TIDES

The filtration of long-term UT1 variations is made by Fourier approximation of UT1 data between 1962.0-2007.0 with number of used harmonics equal to 470. The residuals of this approximation contain short-term UT1 oscillations with periods below 35d only. The UT1 data before 1983.0 contain relatively high level of noise, so the data after 1983.0 will be used in the next computations. The spectrum of tidal residuals according Yoder's model contain signals with significant amplitudes above 10μs. Additional zonal tide terms are used in (Schastok et al., 1994) and 6 of them are recognized here. Their values are marked by asterisks in Table 1. Additional 50 terms with amplitudes above 9μs are included in the estimation, so the original Yoder's model is expanded to 97-term model of fortnightly and monthly zonal tides. The periods of additional tidal terms are chosen to be close to the spectral peaks of the residuals and their fundamental arguments should be defined more accurately after comparison of the estimated and theoretical tidal amplitudes. The new model yields certain decrease of tidal residuals for

UT1 data before 1983.0 and excellent behavior of UT1 residuals after 1983.0 (Fig. 2). The estimated tidal amplitudes are in range 9–37μs with accuracy of about 2.1μs and residuals below 13μs (Fig. 2).

Table 1: Periods and estimated amplitudes of new tidal terms, added to original model of zonal tides.

l	l'	F	D	Ω	Period [d]	A[μs]	l	l'	F	D	Ω	Period [d]	A [μs]
2	1	0	0	4	13.381	13.3	4	-1	-2	-1	-1	28.396	13.9
4	1	-2	0	-1	13.413	22.4	4	-2	-1	-2	2	28.635	15.8
0	0	2	0	-4	13.498	17.5	-1	-1	2	0	-2	28.767	14.1
-2	2	2	2	1	13.519	25.9	0	0	0	1	-4	29.026	9.6
0	0	2	0	-1	13.54 *	36.7	0	0	0	1	-1	29.40 *	23.1
2	1	-1	1	4	13.918	16.0	1	-1	0	0	-1	29.673	13.9
2	-4	-2	2	4	18.092	12.7	1	-1	0	0	1	29.934	10.4
0	-4	-2	4	1	19.663	11.8	0	1	-1	2	4	30.186	12.8
4	4	-2	-1	0	20.509	9.4	1	-1	0	0	4	30.335	27.4
1	2	2	-2	0	21.036	10.3	-2	0	1	2	-4	30.788	20.3
-2	2	4	-1	-1	21.660	9.8	4	-2	-2	-1	-3	30.513	8.6
-4	4	4	1	4	21.715	14.2	-2	0	1	2	-2	31.070	18.9
2	1	1	-2	0	22.552	16.5	-1	0	0	2	-4	31.227	10.1
-2	1	4	-1	-1	23.025	11.9	-2	0	1	2	1	31.501	23.4
1	2	0	0	2	24.112	15.1	-1	0	0	2	2	32.112	17.1
2	1	0	-1	1	24.207	12.3	0	0	-1	2	0	32.281	9.7
1	2	0	0	4	24.284	21.0	1	-2	0	0	0	32.45 *	23.0
-2	2	2	1	-1	24.753	19.7	1	-1	-1	1	1	32.763	21.9
-1	1	2	0	1	25.13 *	23.2	1	0	-2	2	2	33.082	32.5
-1	2	1	1	4	25.506	16.5	2	-1	-2	1	1	33.261	34.2
2	1	-1	0	4	26.327	12.1	1	0	-2	2	4	33.408	11.5
-4	1	4	1	4	26.428	18.9	-2	-1	1	2	-4	33.623	35.7
4	0	-2	-1	1	26.553	20.7	-4	1	1	4	1	33.755	21.4
-1	0	2	0	-1	26.77 *	13.6	-4	1	1	4	2	33.927	26.1
-1	0	2	0	4	27.310	15.6	-2	-1	1	2	-1	34.129	17.2
0	2	-1	2	4	27.882	19.8	-1	-2	1	1	-2	34.319	31.4
4	-1	-2	-1	-4	28.045	34.3	-1	-2	1	1	0	34.669	14.5
-3	0	2	0	1	−28.15 *	22.0	-1	-1	0	2	1	35.026	19.2

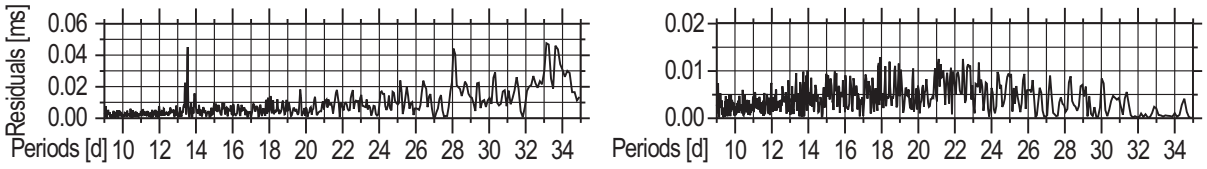

Figure 2: Residual spectra of fortnightly and monthly zonal tides determined by UT1 observations after 1983.0, according to the original model (left) and expanded 97-term model (right).

3. CONCLUSIONS

The UT1 time series from the solution C04 of the IERS contain high-accuracy data after 1983, which is possible to use for zonal tides estimation. The AAM affects various UT1 oscillations with periods below 35 days. The corrected UT1 series for AAM influence are useful for estimation of zonal tides. The estimation accuracy of fortnightly and monthly zonal tides increases significantly when new terms are added to the classical Yoder's model. The 97-term model of fortnightly and monthly zonal tides proposed here yields estimation of tidal amplitudes with accuracy of about 2.1μs and residuals below 13μs. The fundamental arguments and exact periods of the new terms should be defined more accurately after comparison of the estimated and theoretical tidal amplitudes.

4. REFERENCES

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Schastok, J., Soffel, M., Ruder, H., 1994, "A contribution to study of fortnightly and monthly zonal tides in UT1", A&A 283, pp. 650–654.