ON THE LONG-PERIODICAL OSCILLATIONS OF THE EARTH ROTATION

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The most accurate time series of the length of day (LOD) variations is from the solution C04 of the IERS (Fig.1). An empirical model of the long-periodical oscillations of the Earth rotation according this time series is proposed here. The lowest frequency oscillation in the model is with period 48 years, which is closed to the period of 45-year solar asymmetry cycles. These cycles are due to the North-South asymmetry of the solar differential rotation with periodicity $45.5a \pm 11.5a$ and they have strong correlation with Earth rotation (Georgieva, 2002). The half of the 48-year oscillation is quite visible in the LOD series for the interval 1962-1986 (Fig.1) and this 24-year oscillation is closed to the period of magnetic cycle of the Sun about 22a. Other long-periodical oscillations in the model of the LOD series are with the period of the Lunar node 18.6a; the period of the solar activity - about 11a; the oscillations with period of 6.4a, which are discovered in UT1 series (Chapanov et al., 2005), and the periods of ENSO event in the band 2-4a, represented by the high harmonics of the above periodicities. The empirical model includes also a polynomial of degree 2 and seasonal oscillations. The coefficients and amplitudes of the long-periodical oscillations of the LOD are estimated and the correlation between the LOD variations and solar activity is determined by means of the proposed empirical model here.

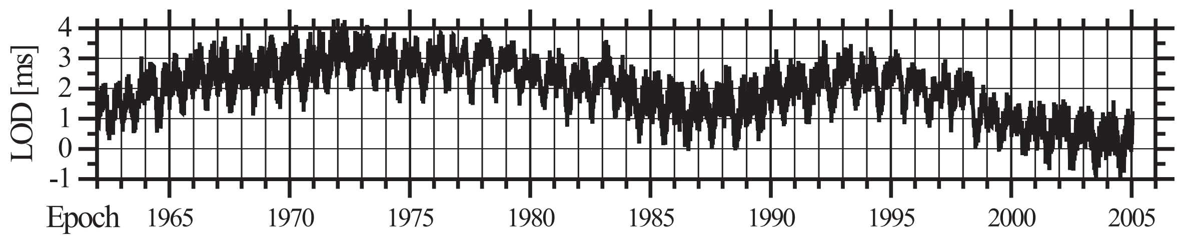

Figure 1: Variations of LOD (in ms) according the solution C04 of the IERS.

The proposed here model of the long-periodical LOD variation is

$$f = f_\circ + f_1(t - t_\circ) + f_2(t - t_\circ)^2 + \sum_{k=1}^{5} \sum_{i=1}^{n_k} a_{ik} \sin i\omega_k t + b_{ik} \cos i\omega_k t, \qquad (1)$$

where the middle epoch $t_\circ$ is 1983.5 and the frequencies $\omega_k = 2\pi/P_k$ correspond to the five periods P_k: $48a$; $18.6a$; $10.3a$; $6.4a$ and $1a$. The three solar activity cycles for the interval 1962-2005 have mean period of 10.3 year, which is used in the model (1). The number of harmonics

Table 1: Coefficients and amplitudes of the periodical oscillations of the LOD series [ms].

P_k	i	a_{ik}	b_{ik}	A_{ik}	$\sigma_{A_{ik}}$	i	a_{ik}	b_{ik}	A_{ik}	$\sigma_{A_{ik}}$
P_1=48a	1	-0.776	-0.190	2.057	±0.089	2	+0.372	-0.021	0.373	±0.027
P_2=18.6a	1	-0.495	-0.218	0.541	±0.015	3	-0.059	+0.082	0.101	±0.018
	2	+0.174	-0.034	0.178	±0.011	4	-0.048	+0.012	0.049	±0.006
P_3=10.3a	1	-0.204	+0.145	0.250	±0.011	3	+0.006	+0.061	0.062	±0.007
	2	-0.016	+0.058	0.061	±0.006	4	-0.045	-0.019	0.048	±0.009
P_4=6.4a	1	+0.174	-0.016	0.175	±0.019	3	-0.057	+0.031	0.065	±0.007
	2	-0.053	-0.046	0.071	±0.011	4	-0.015	-0.018	0.024	±0.006
P_5=1a	1	-0.176	-0.327	0.371	±0.006	2	-0.194	-0.288	0.348	±0.006

of the model (1) is as follow: 2 harmonics for the 48-year cycle, 10 harmonics for the 18.6-year cycles, 4 harmonics for the solar activity cycles, 5 harmonics for the 6.4-year cycles and 4 harmonics the seasonal changes. The successful separation of the oscillations with close periods of 18.6 and 24 years needs an observation span at least 83 years long. Here these periods are separated by a loose restriction of the solution for the coefficients of the second harmonic of the 48-year cycle. The possible hidden singularity of the normal matrix, due to close frequencies in the model is controlled by the Singular Value Decomposition solution with ratio 10^8 between the maximum and minimum values of the used singular values. Several of the estimated harmonically coefficients are shown in Table 1. The estimates of the polynomial coefficients in the model (1) are $f_\circ = 3.92ms \pm 0.07ms$, $f_1 = 0.0031ms/a \pm 0.001ms/a$, $f_2 = -0.011ms/a^2 \pm 0.0004ms/a^2$.

The decadal variations of the LOD due to the solar activity are determined as a sum of the residuals of the approximation of the LOD series by the model (1), after filtration of the high-frequencies with periods less then one year, and the 10.3-year oscillation of the LOD. The resulting curve, shown in Fig.2 is very close to the shifted with +1.6a curve of the smoothed Wolf's number. The correlation between the shifted time series is high with coefficient +0.87.

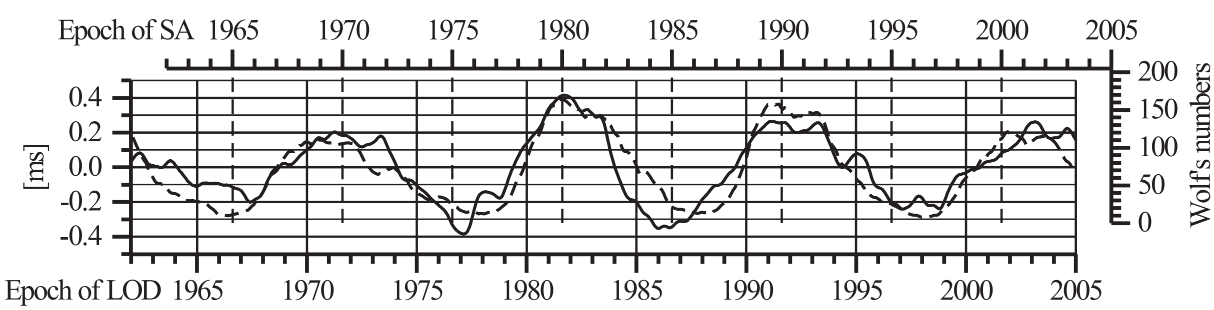

Figure 2: Comparison of the decadal variations of LOD at the solar activity frequency with mean period 10.3a (solid line) and smoothed Wolf's numbers (dashed line). The phase delay of the LOD changes is 1.6a. The correlation coefficient between the shifted time series is +0.87.

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