METHOD FOR PREDICTION OF ΔT BASED ON LONG-PERIODIC TERMS IN THE EARTH'S RATE OF ROTATION

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ABSTRACT. In this paper we have examined possibilities for prediction of ΔT by searching for similarities in variations of the Earth's rate of rotation and solar activity for the past 250 years. Some results indicate that solar activity, directly or indirectly, has a significant influence on the changes in the Earth's rate of rotation.

1. ANALYSIS

By analyzing variation in the length of day (LOD) and variation in the Solar activity, namely number of Sun spots (NSS), some interesting relations were noticed. If Figure 1 are shown 11 years moving averages of these two variations from 1761. to 1997.

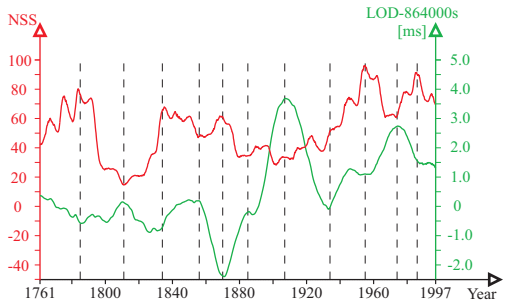

Figure 1: Variation of NSS and LOD

Vertical lines in Figure 1 show that local extremes of both variations are coupled in such a way that maxima in Solar activity match minima in LOD and vice versa, which indicates that the Earths rate of rotation is somehow connected with the solar activity.

In order to find out if there are some mutual periodical changes in these two parameters, we applied different types of spectral analysis on the data shown in the Figure 1. We assumed that these two sets of data can be approximated with polyharmonic function of the form:

$$y = C_0 + \sum_{i=1}^{n} C_i \cos\left(\frac{2\pi}{T_i}t + \varphi_i\right) \tag{1}$$

Where C_0 is a free term, $C_i s$ are amplitudes, $T_i s$ periods, $\varphi_i s$ phases and n is a number of the assumed harmonics.

2. RESULTS

The data from the Figure 1 are approximated with the equation (1) with 9 harmonics and their periods in years, amplitudes and phases are shown in Table 1.

LOD	T_i	20	23	28	33	40	54	80	86	230	$C_0 = 0.54$
	C_i	0.11	0.24	0.24	0.44	0.27	0.94	1.32	0.46	1.33	
	φ_i	296.2	231.2	221.7	164.8	167.7	108.8	37.9	202.5	65.5	
NSS	T_i	21	22	27	30	41	56	86	167	224	$C_0 = 48.56$
	C_i	3.22	2.56	3.27	3.82	5.29	8.40	12.77	22.18	29.51	
	φ_i	211.1	241.9	346.5	172.4	111.4	197.6	308.5	151.3	18.8	

Table 1: Periods in years, free terms, amplitudes and phases of the harmonics

From the Table 1, it can be seen that LOD and NSS can be approximated with polyharmonic functions with 9 harmonics, from which 8 are with same or nearly same periods.

According to Stephenson and Morrison, for a very near future, mathematical modelling can be used to project values of ΔT with great confidence. Accepting their suggestion, we made a mathematical approximation of the form:

$$\Delta T = C^0 + C^1 t + \sum_{i=1}^{n} C_i \cos\left(\frac{2\pi}{T_i} t + \varphi_i\right) \tag{2}$$

Periods in years of the harmonics in the approximation (2) are given in Table 2.

T_i	222.2	46.0	22.2	19.5	12.5	9.3	7.9	6.5	5.8	5.3	4.6	4.1	3.6	1.1	1.0	0.5

Table 2: Periods in years of the harmonics in the approximation (2)

Comparing Tables 1 and 2, it can be seen that there are three terms in approximations of ΔT, LOD and NSS that have almost same periods. In Figure 2 is shown this approximation and extrapolation to 2025.

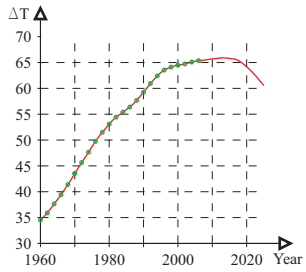

Figure 2: Approximation of ΔT from 1962. to 2025. (points are IERS data)

3. CONCLUSION

The above analysis shows that solar activity, directly or indirectly, has a significant influence on the changes in the Earth's rate of rotation. This allows us to use changes in the solar activity to predict changes in LOD and thus ΔT. This could also be done backward in time to estimate solar activity based on historical data of ΔT.

4. REFERENCES

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