DETECTION OF THE MUTUAL PERIODICAL CHANGES IN THE EARTH RATE OF ROTATION AND THE SOLAR ACTIVITY BY SINGULAR SPECTRUM ANALYSIS

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ABSTRACT. During the examination of regular and irregular changes in the Earth's rate of rotation and solar activity we noticed that there are a lot of repeating matches of the extreme values of these two phenomena in the sense that minimums in one quantity match maximums in the other quantity and vice versa. We used Singular Spectrum Analysis as a modern tool in spectral analysis to detect some harmonics in both phenomena that have very similar periods. The results indicate that there are some periodical changes in these two phenomena that could be connected and some of these periods which are quite long are already identified by some researches of the solar activity.

1. INTRODUCTION

The actual value of the length of day (LOD) originates from some long-term trend with short-term fluctuations between ±3 ms on the time scale of decades. At periods longer than few years, extending to many tens of years, the so-called decadal variations, the sources of excitation for the LOD are more enigmatic. The difficulty is the fact that at these periods many effects may be important, including viscoelastic behavior such as postglacial rebound and exchange of angular momentum with the fluid core. It has become common to invoke the core as the major cause of the decadal LOD changes. Although some climatic forcing of long period LOD changes has been recognized (Hide and Dickey, 1991), it is uncertain at what time scale the atmosphere and ocean become less important than the core. A further difficulty in assessing the atmosphere/ocean role at long periods is that the torques required to cause decadal LOD variations are utterly insignificant when compared with those applied by the atmosphere at shorter time scales.

Some of the recent records of Earth Orientation Parameters (EOP) and algorithms (Vondrák et al, 1998) are considered. The past solutions based on optical astrometry were merged with the combined solutions from the modern techniques (Vondrák and Čepek, 2001). The existing EOP series have been analyzed by many scientists. The most extensive reviews were given in well-known monographs (Munk and MacDonald, 1960; Lambeck, 1980).

By analyzing variation in the LOD and variation in the solar activity, namely number of Sun spots (NSS), some interesting relations were noticed. In Figure 1 are shown 11 years moving averages of these two parameters from 1761–1997 and also the results from the Singular Spectrum Analysis (SSA) (Golyandina et al, 2001) that was applied on these data.

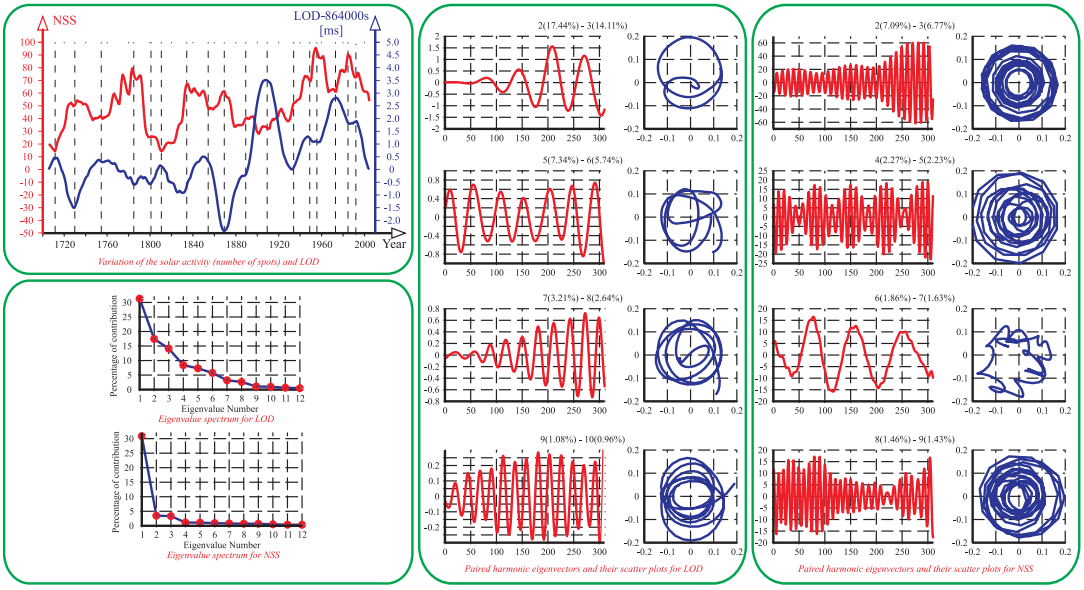

Figure 1: Variation of LOD and NSS and the SSA results

2. RESULTS

The harmonic component 2-3 for LOD has a period of 63 years and its amplitude is modulated with a period of about 178 years. The Amplitude of this component for NSS which has period of 11 years is also modulated with a period of about 178 years. This can be connected with the *Jose cycle* (9 Jupiter/Saturn synodic periods) of the solar activity.

The harmonic component 5-6 for LOD has a period of 47 years and its amplitude is modulated with a period of about 210 years which can be connected with the *de Vries cycle* of the solar activity and also with a period of 84 years which is roughly the period of amplitude modulation of harmonic 6-7 for NSS.

The harmonic term 9-10 has a period of 22 years (two solar cycles) and its amplitude is modulated with a period of about 230 years which can be connected with the *Suess cycle* of the solar activity.

3. CONCLUSIONS

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

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