PERIODICAL REGULARITIES OF POLAR MOTION IN THE PULKOVO LATITUDE VARIATIONS

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ABSTRACT. The work studies the main component of Polar Motion, obtained from variations in the Pulkovo latitude. We employed different methods of analysis of time series: Singular spectral analysis, and Fourier and Hilbert transforms. Six components in the interval of 1.1–1.3 year were found by . The first two components possess repeated structural features well apparent during the periods of 1850–1930 and 1930–2010 in the time variations of phase and amplitude.

1. DECOMPOSITION SSA

A detailed study of Pulkovo combined time series of latitude Phi (1840.4–2014.0) was carried out in this work. The rate of sampling is 0.1 yr. The latitude observations at Pulkovo began in 1840. The latitude variations obtained from X.I. Peters's observations with Ertel vertical circle by A.A. Ivanov and from V.J. Struve's observations with Repsold transit instrument in the first vertical by B.Wanah were used to develop a time series Phi (1840–1848) (Miller & Prudnikova, 2010). The latitude variations obtained observations with ZTF-135 were used to develop a time series Phi (1904–1941, 1948–2006). In addition, the longest records of pole coordinates (IERS C01) for 1846–2009 and 2010–2014 (IERS C04) were used. Measurements of the Pulkovo latitude Phixy were calculated by the IERS time series of pole coordinates. The Singular Spectrum Analyses (SSA) method (Vityazev et al., 2010) was used for the investigation time series Phi, Phixy. The variations of amplitude and a phase of the CW and annual components were calculated with the help of Hilbert transform.

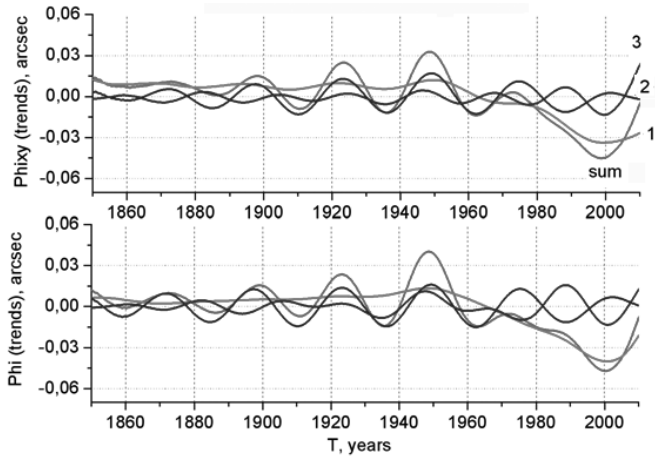

Figure 1: The comparison of the decomposition SSA of the trends Phi and Phixy.

We obtained by SSA the following main components of the polar motion: trend (1.96%), Chandler (63.67%) and annual (19.62%) wobbles. The sum reconstruction of the main components contributes 90% for Phixy time series and 85% for Phi. Results of research for 1840–2009 are shown in (Miller, 2011).

The new SSA decomposition affords interesting comparison of non-linear trends in the Phi with the trends Phixy. Results of research are shown in Fig. 1.

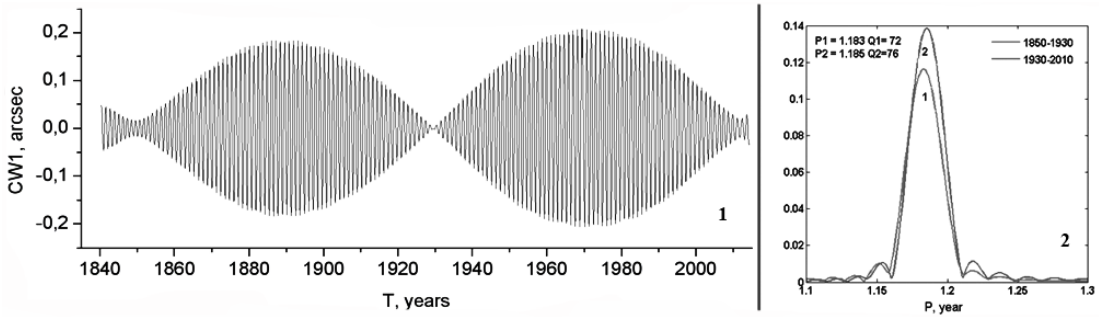

Figure 2: 1: the CW1 - main CW component, 2: spectra of CW signal computed for both intervals.

Six initial components were obtained at the Chandler wobble (CW) frequency using the SSA. The main CW component: CW1 is the sum of the first two initial components, which makes contribution 52.9%, and the sum of other four initial components CW2 makes 10.77% (CW=CW1+CW2). The first component CW1 has two intervals of similar behavior, 1850–1930 and 1930–2010 (Fig. 2 (1)). Fig. 2 (2) presents spectra of CW signal computed for both intervals. From these plots one can clearly see that the CW amplitude variations are similar for both intervals. This result can provide an evidence of a new CW period of 80(0.2) yr (Malkin & Miller, 2010).

The residual series (14%) were found after exclusion of all components described above. The residual series are well approximated by a random process. This means that the bulk of regular components are already excluded.

2. CONCLUSION

1 The full research of fine structure of pole movement obtained by SSA is presented on the scheme by the time series variations in the Pulkovo latitude (1840–2014).

2 We have found two epochs when the CW amplitude decreased near 1850 and 2010, which are also accompanied by a large phase jump, similar to well known event in 1930s. This result can provide an evidence of a new CW period of 80(0.2) yr. Unfortunately, we can't finally confirm this result as both periods of the phase disturbances described in this example are located at the edges of the interval of the studied time series.

3 The CW parameters (P = 1.183, 1.185 yr, A = 0.18, 0.21", Q = 72, 76) were calculated for each of the two spans: 1850–1930 and 1930–2010 separately. Moreover, calculations were carried out across the width of the spectral line separately for the two intervals with a known constant phase.

4 The periods of 11, 16, 20, 29, 44 years were found in the amplitude of the second component of the CW2 after 1900.

5 There is increase of the amplitude by 0.03" and phase by 45 deg during 174 years in annual fluctuation.

6 The main trend has peculiarities of behavior after 1980.

3. REFERENCES

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