AMPLITUDE AND PHASE VARIATIONS OF THE CHANDLER WOBBLE FROM 164-YR POLAR MOTION SERIES

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ABSTRACT. This paper is aimed at investigation of the Chandler wobble (CW) at the 164-year interval to search for the major CW amplitude and phase variations. The CW signal was extracted from the IERS polar motion series using digital filtering. The CW amplitude and phase variations were examined by means of several methods which yield very similar results. Results of our analysis have shown that, besides the well-known CW phase jump in the 1920s, two other large phase jumps have been found in the 1850s and 2000s, all three contemporarily with a sharp decrease in the CW amplitude.

1. INTRODUCTION

The Chandler wobble (CW) is one of the principal eigenmodes of the Earth rotation, and investigation of its properties such as period, amplitude and phase variations is very important for the understanding of the physical processes in the Earth. Among other interesting CW peculiarities, the phase jump of about 180° with simultaneous drastic decreasing of the CW amplitude occurred in the 1920s and supposed to be an unique event is a subject of intensive investigation by many authors. However recent work of Miller (2008) has shown clear evidence of two other large CW phase jumps that occurred in the beginning and the end of the IERS C01 PM series used for the analysis. In this paper, we performed more detailed investigation of the 164-year PM series to confirm that preliminary finding. Our study consists of three steps: forming the longest available IERS PM time series joining C01 and C04 series, extracting CW signal, and analyzing this signal. To improve reliability of our conclusions, several methods of analysis were used, and their results corroborate each other. This work is similar to our previous study (Malkin & Miller 2009) with more data added to the end of the interval.

2. DATA PROCESSING AND RESULTS

To extract the CW signal from the PM series one have to separate it from trends and all periodic and quasi-periodic terms out of the CW frequency band. This was done by means of using Fourier and Singular Spectrum Analysis (SSA) filtering. To extract the CW amplitude and phase variations from the filtered PM series two different techniques were used. First, we used the method previously developed for study of the Free Core Nutation, which allows us to find the CW amplitude and phase variations using wavelet technique (Malkin 2007). Secondly, we used the SSA and the Hilbert transform (HT) to compute an independent time series of the CW amplitude and phase.

The CW amplitude variations are shown in Fig. 1 for two methods used. One can see that both methods show very similar behavior of the CW amplitude, with some differences near the ends of the interval. In both CW series, three deep minima of the amplitude below 0.05 mas around 1850, 1925 and 2005 are unambiguously detected.

The results of the computation of the CW phase variations using Hilbert transform after removing the linear trend are shown in Fig. 2. Using wavelet transform yields very similar results (Malkin & Miller 2009). One can see similar behavior of the CW phase obtained in two variants, with some differences near the ends of the interval. However, substantial phase jumps in the the 1850s and 2000s are clearly visible in all the cases, and their epochs are contemporary with the minima of the CW amplitude as shown in Fig. 1. So, we can conclude that the well-known event in the 1920s of the simultaneous deep minimum of the CW amplitude and the large phase jump in the 1920s may be not unique.

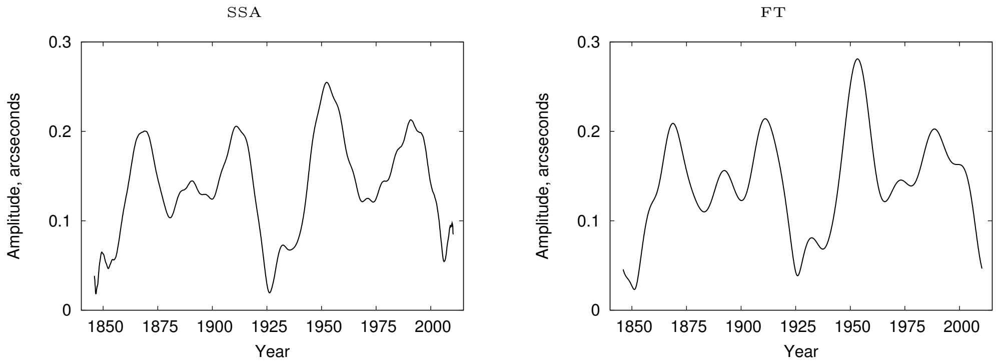

Figure 1: The CW amplitude computed for SSA-filtered and FT-filtered CW time series. Unit: mas.

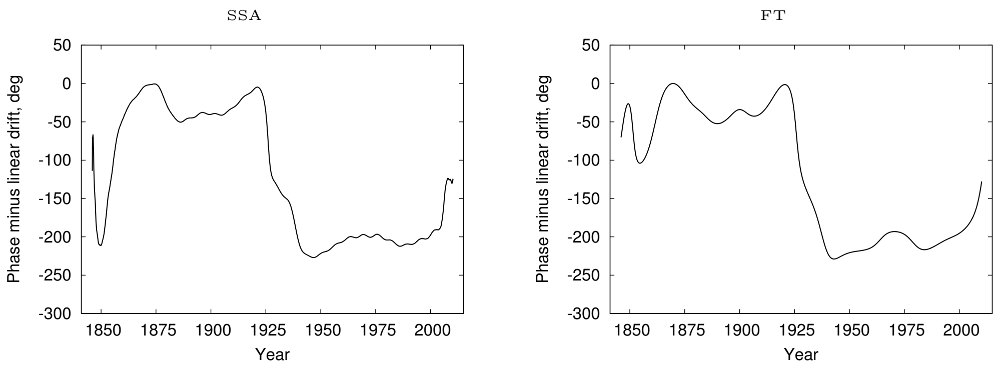

Figure 2: The CW phase variations computed for SSA-filtered and FT-filtered CW series. Unit: degrees.

3. CONCLUSIONS

In this paper, we have investigated the whole 164-year PM series available from the IERS with the main goal to reveal and evaluate the major CW phase jumps. To improve the reliability of the results we used several analysis methods. All the methods gave very similar results, with some differences at the ends of the interval. These discrepancies can be most probably explained by different edge effects of the methods used, but they can hardly discredit the final conclusion that can be made from this study about existence of two epochs of deep CW amplitude decrease around 1850 and 2005, which are also accompanied by a large phase jump, like the well-known event in the 1920s. Thus, the latter seems to be not unique anymore.

Unfortunately, both periods of the phase disturbances found in this paper are located at the edges of the interval covered by the IERS EOP series. As for the end of the interval, the next decade will allow us to quantify the phase jump in the beginning of the 21st century more accurately. On the other hand, a supplement study seems to be extremely important to try improve our knowledge of the PM in the 19th century, including an extension of the PM series in the past.

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4. REFERENCES

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