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Linear drift and periodic variations observed in long time series of polar motion

H. Schuh[1], S. Nagel[2], T. Seitz[2]

[1] Institut für Geodäsie und Geophysik, Techn. Univ. Wien, Gusshausstr. 27-29, A-1040 Wien, Austria
e-mail: hschuh@luna.tuwien.ac.at; Tel.: +43-1-58801-12860; Fax: +43-1-58801-12896
[2] Deutsches Geodätisches Forschungsinstitut (DGFI), Marstallplatz 8, D-80539 München, Germany

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Abstract. Two long time series were analysed: the C01 series of the International Earth Rotation Service and the pole series obtained by re-analysis of the classical astronomical observations using the HIPPARCOS reference frame. The linear drift of the pole was determined to be 3.31 ± 0.05 milliarcseconds/year towards 76.1 ± 0.80° west longitude. For the least-squares fit the a priori correlations between simultaneous pole coordinates x_p, y_p were taken into account, and the weighting function was calculated by estimating empirical variance components. The decadal variations of the pole path were investigated by Fourier and wavelet analysis. Using sliding windows, the periods and amplitudes of the Chandler wobble and annual wobble were determined. Typical periods in the variable Chandler wobble and annual wobble parameters were obtained from wavelet analyses.

Key words: Polar motion – Chandler wobble – Wavelet analysis

1 Introduction

Polar motion research still has a lot of unanswered questions:

> Is there a long-term drift of the pole with respect to the Earth's surface?
> If so, what are the main causes for this drift, which is often called 'secular polar motion'?
> What are the causes of the observed decadal variations of polar motion?
> Are the decadal variations stable or irregular?
> Why is the amplitude of the Chandler wobble (CW) not steadily decreasing with time due to damping, and what are its excitation mechanisms?
> What are the reasons for the apparent rapid variations of the CW period, also expressed as phase jumps and/or the strong CW amplitude variations, which have been reported by many from analysis of polar motion time series?

The reasons for the investigation presented in the present paper are as follows.

(1) New precise and consistent time series of polar motion exist, as will be described in the next paragraph.
(2) The wavelet analysis is a relatively new and useful technique to detect quasi-periodic, partly irregular variations in time series.
(3) Powerful computers are available which allow big matrices to be inverted in a short time. Thus, the stochastical model of the analyses can be extended and completed, as will be shown.

Starting from these prerequisites and using the tools mentioned above, an analysis was carried out to determine the linear drift and decadal variations of the pole and to investigate the CW and the annual wobble (AW). Wavelet transformation was used, which has been proven a powerful tool for investigating the time-variable Earth rotation (see e.g. Chao and Naito 1995; Gibert et al. 1998 and references therein). The goal of this investigation is to fully describe what can be seen in the polar motion data and to reveal previously unstudied effects. Further interpretations of the results might help to answer the questions given above.

2 Long time series of polar motion

Several time series of polar motion were initially analysed with respect to a linear drift. The linear model was then combined with periodical models of CW and AW. The decadal variations were investigated by Fourier analysis and wavelet analysis. Finally, the CW and AW parameters were repeatedly determined by a sliding window analysis, and their variability was analysed by wavelet transformation.

Correspondence to: H. Schuh