ON THE ACCURACY OF THE TRIGONOMETRIC SOLUTION FOR THE PERIODICAL COMPONENTS OF THE POLAR MOTION

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ABSTRACT. The classical approximation of the polar motion by trigonometric functions with constant amplitudes and phases may lead to a significant increase of the errors of the estimated parameters of the annual and Chandler oscillations. The increase of the errors of the estimated parameters of the polar motion is analyzed here by means of the simulation of the polar motion, based on the solution C04 of the IERS. The simulated model of the polar motion includes such variations of the annual and Chandler amplitude, so that the simulated motion is close to the real motion. After that, the variations of the annual and Chandler amplitude are estimated by the Least Squares Method over the spans of 6 years. The differences of the estimated and modelled variations of the amplitudes are obtained. It is shown that the errors of the estimated parameters of the periodical components of the polar motion are significantly higher than the accuracy of the modern determinations of the pole coordinates.

The mathematical models for determination of the periodical components of the polar motion consists of trigonometric functions of common type

$$x = x_0 + x_1 t + \sum_{i=1}^{n} a_{ai} \sin i\omega_a t + b_{ai} \cos i\omega_a t + \sum_{j=1}^{m} a_{cj} \sin j\omega_c t + b_{cj} \cos j\omega_c t,$$
$$y = y_0 + y_1 t + \sum_{i=1}^{n} c_{ai} \sin i\omega_a t + d_{ai} \cos i\omega_a t + \sum_{j=1}^{m} c_{cj} \sin j\omega_c t + d_{cj} \cos j\omega_c t, \qquad (1)$$

where x and y are the pole coordinates, x_0, y_0, x_1, y_1 - the mean coordinates and their rates in the middle of the six-year time interval respectively, $a_{ai}, b_{ai}, c_{ai}, d_{ai}, i = 1, \ldots, n$; $a_{cj}, b_{cj}, c_{cj}, d_{cj}, j = 1, \ldots, m$ - unknown harmonic coefficients of the components with known seasonal (annual) frequency w_a and Chandler frequency w_c; t is the observation epoch. Usually the number of harmonics is equal to 1 (n=m=1), for study of the semi-annual and semi-Chandler oscillations the value of harmonics n and m may increase to 2.

To estimate the real errors of the approximation of the polar motion with trigonometric functions of the type (1), a simulation of the polar motion with known variations of the parameters of the seasonal and Chandler oscillation, which are close enough to its real changes in the time, is used here. The parameter values of the simulated polar motion are obtained by the model (1) from the solution C04 of the IERS with running 6-year observation spans. The beginning and end of the time series of the obtained parameters are lengthened with constant values, so the simulation of the polar motion is given for the period 1955-2013 (Fig.1).

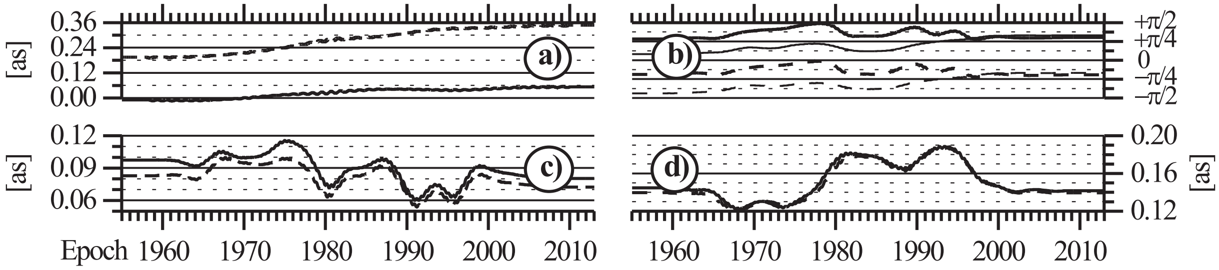

Figure 1: Parameter variations of the simulated polar motion (solid line for x-coordinate and dashed line for y-coordinate): a) - for the mean values; b) - for the annual (bold lines) and the Chandler (thin lines) phases; c) - for the annual amplitudes; d) - for the Chandler amplitudes.

The polar motion parameters are determined by means of the simulated pole coordinates. After that an estimation of the real errors of the parameters in the model (1) is made by comparisons of the obtained and original values of the parameters. The differences between the "true" and estimated annual and Chandler amplitudes and phases are shown in Figs. 2 and 3. The maximal values of the estimated "real" errors reach 11 mas for the annual amplitude and 19 mas for the Chandler amplitude and their standard deviations are 3.9 mas and 5.9 mas respectively. The maximal "real" errors for the annual and Chandler phases are $-6.9°$ and $-4.9°$ with standard deviations $2.2°$ and $1.8°$. These errors are by two – three orders higher than the accuracy of the modern determinations of the pole coordinates.

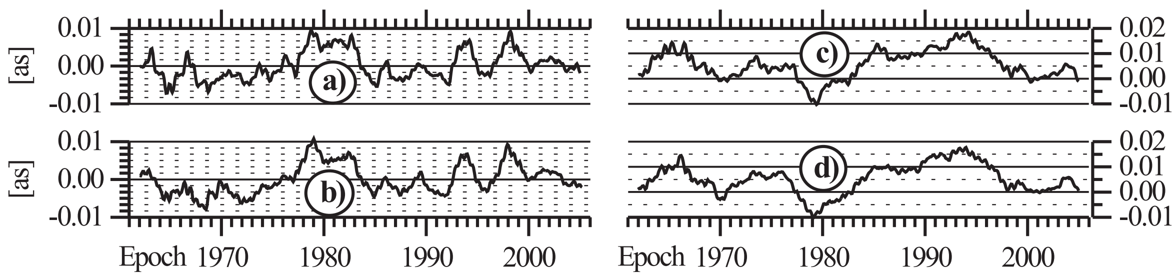

Figure 2: Estimation of the real errors of the annual amplitudes - a) for y and b) for x, and Chandler amplitudes - c) for y and d) for x pole coordinates.

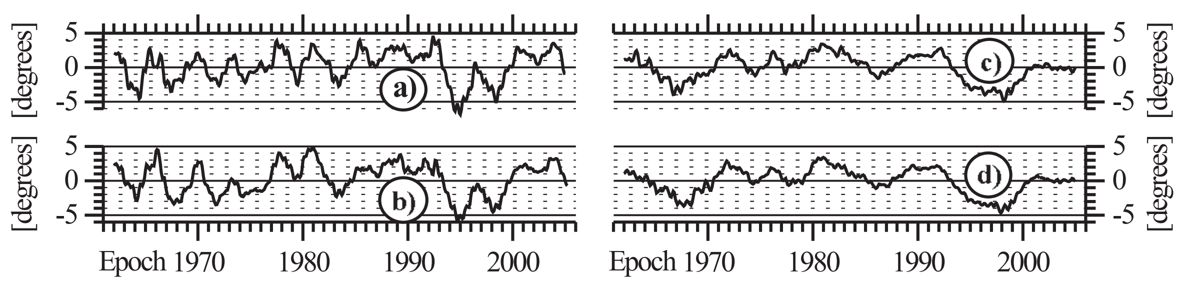

Figure 3: Estimation of the real errors of the annual phases - a) for y and b) for x, and Chandler phases - c) for y and d) for x pole coordinates.

Acknowledgements. This study was supported by contract No. NZ-1213/02 with the National Council for Scientific Research at Bulgarian Ministry of Education and Science.