IRREGULAR SHORT PERIOD VARIATIONS IN EARTH ROTATION

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ABSTRACT

Irregular variations in Earth Rotation Parameters (ERP) were detected by the autocovariance and autoregressive prediction methods applied in the forward and backward directions of time. Time variable Fourier Transform Band Pass Filter (FTBPF) spectra of the unpredictable variations of the ERP reveal that pole coordinates data are mostly disturbed in the spectral range from about 50 to 250 days while length of day (LOD) data are mostly disturbed in the spectral range from about 20 to 110 days. The most energetic irregular variations in the ERP occurred in the beginning of 1988 and 1995 years.

ANALYSIS

Irregular variations are such variations that cannot be predicted by any linear prediction method. They are caused by irregular changes of amplitudes and/or phases of oscillations. To detect irregular variations in the ERP data (x, y pole coordinates data and LOD data) the autocovariance (Kosek 1993, 1997; Kosek et al. 1998) and autoregressive (Priestley 1981) prediction methods together with time variable FTBPF (Kosek 1995; Popiński and Kosek 1995) spectral analysis were applied. In these both prediction methods the first prediction point in the future and in the past is computed and added at the end or at the beginning of data, respectively, so the next prediction point can be computed. The difference between the prediction and data in the future or in the past computed at different starting prediction epochs reveals unpredictable or irregular variations of the ERP.

The ERP (x, y and LOD) IERSC04 (IERS 1998) with the sampling interval of 1 day were used to detect their irregular variations. LOD data were converted to LODR data by removing tidal model of the IERS Conventions (McCarthy 1996). The ERP data were filtered by the Butterworth high pass filter (HPF) (Otnes and Enochson 1972) with the 270-day cutoff period to remove longer period oscillations. To detect irregular variations the autocovariance and autoregressive prediction methods were applied to compute predictions in forward and backward directions of time. The number of data used for prediction computation was equal to N=3000. This data span was sliding in forward or backward directions along the whole data interval of 1962-1999.3 with a time step equal to 1 day to compute the prediction points in 14th and 21st day in the future and in the past, respectively. The irregular variation time series are computed as the differences between short period ERP data and their predictions. These prediction errors in 14th day in the future and in the past do not exceed the value of 20 mas in case of pole coordinates data and 0.8 ms in case of LOD data as it was shown previously by Kosek et al. (1995, 1998). Usually, the prediction error in y is smaller than in x pole coordinate data. To see better the time moments of irregular variations as well as the agreement between the two prediction methods the absolute values of the differences in 14th
and 21\textsuperscript{st} day in the future and in the past were smoothed with a boxcar window with the half a year time length. These smoothed irregular variations are shown in Figure 1.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Half a year mean of the absolute value of the difference between short period IERS\textsuperscript{C04} ERP data and their forward and backward autocovariance and autoregressive predictions in 14\textsuperscript{th} (lower line) and 21\textsuperscript{st} (upper line) day in the future and the past.}
\end{figure}
These differences for forward and backward autocovariance and autoregressive prediction methods are of the same order and they reveal unpredictable variations in the short period ERP data. The mean differences in 14th and 21st day in the future are very similar in case of both prediction methods as well as forward and backward directions though their values at 21st day are greater than in the 14th day as expected. These is also a good agreement between the mean irregular variations computed by the two prediction methods after 1980 year. Before 1980 the amplitudes of irregular variations computed by the autoregressive prediction method are smaller than those computed by the autocovariance prediction method.

To see in what frequency range short period oscillations are disturbed by irregular variations the FTBPF was applied to compute the time variable spectra of the difference between short period ERP data and their forward autocovariance prediction in 14th day in the future. It can be noticed that the time variable spectra are very similar in the case of x, y and LOD data what shows that in the particular time moments these ERP data cannot be predicted with a high precision (Fig. 2). In x and y pole coordinates data the oscillations with periods from about 50 to 250 days are mostly disturbed by irregular variations while in LOD data the oscillations with periods from about 30 to 100 days are mostly disturbed.

**Fig. 2.** The FTBPF amplitude spectra ($\lambda=0.002$) of the difference between short period ERP data and their forward autocovariance prediction in 14th day in the future.

**CONCLUSIONS**

The forward and backward autocovariance and autoregressive prediction methods reveal the existence of irregular variations in short period ERP data. The most energetic irregular variations occured in the beginning of the following epochs:
The prediction accuracy of the autoregressive and autocovariance prediction methods are of the same order for LOD data for x, y pole coordinates data after 1980 year. Time variable amplitude spectra of irregular variations in x, y pole coordinates data are very similar after 1980.

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