THE INFLUENCE OF VARIABLE AMPLITUDES AND PHASES OF THE MOST ENERGETIC OSCILLATIONS IN THE EOP ON THEIR PREDICTION ERRORS

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ABSTRACT. The Discrete Wavelet Transform (DWT) based on the Morlet wavelet was applied to determine the variable amplitudes and phases of the dominant oscillations in the Earth Orientation Parameters (EOP) data. Next, the model EOP data were constructed using constant amplitudes and phases computed by the LS method as well as variable amplitudes and phases computed by the DWT. The model data and the original EOP data were then predicted using forward and backward prediction by the combination of the least–squares model extrapolation (LS) and the autoregressive prediction (AR) denoted as LS+AR. Comparison of the forward and backward predictions of the EOP data and the model data, computed at different starting prediction epochs has enabled examination of irregular variations in the EOP data as well as influence of variable amplitudes and phases of the most energetic oscillations in the EOP data on their prediction errors.

1. DATA

In the analysis x, y pole coordinates and length of day Δ data of IERS EOPC04 in 1962.0-2007.6 were used. The Δ–$\delta\Delta$ data were obtained from Δ data by subtracting the tidal model $\delta\Delta$.

2. COMPUTATION TECHNIQUES APPLIED

Coefficients of the DWT can be obtained by the formula:

$$W(T_j, t_k) = \frac{1}{C_{jk}} \sum_{i=1}^{N} x_i \overline{\psi}\left(\frac{t_i - t_k}{T_j}\right), \tag{1}$$

where $C_{jk} = \sum\limits_{i=1}^{N} |\psi\left(\frac{t_i - t_k}{T_j}\right)|$ and $\psi(t) = e^{-\frac{t^2}{2\sigma^2}} e^{-2\pi i t}$ is the Morlet wavelet function. Instantaneous DWT amplitudes and phases of the oscillations with periods T_j can be determined from the DWT coefficients by the following formulae (Kosek et al. 2006):

$$A_j(t_k) = \mathrm{abs}[W(T_j, t_k)], \ \ \phi_j(t_k) = \arg[W(T_j, t_k)] - \frac{2\pi t_k}{T_j} \tag{2}$$

In the LS+AR method, the LS residuals of the EOP data are determined as the difference between these data and their fitted LS models (Kosek et al. 2004). Next, the AR prediction method is applied to the LS residuals of the EOP data. The final prediction of the data is the sum of the LS model extrapolation and the AR prediction of the LS residuals.

3. RESULTS

To find the contribution of variable amplitudes and phases of the most energetic oscillations in the EOP data to their LS+AR prediction errors, the models of the EOP data were constructed using constant LS amplitudes and phases and variable DWT amplitudes and phases of the most energetic oscillations. The model data consists of the Chandler (Ch), Annual (An) and semi-annual (Sa) oscillations in case of x, y data and An and Sa oscillations in case of $\Delta - \delta\Delta$ data. Next, the LS+AR predictions of different model data were computed. The UT1–UTC forecasts were computed by summing the Δ–$\delta\Delta$ predictions and adding tidal model together with leap seconds. The absolute values of the difference between the

EOP data and their LS+AR predictions are shown in Fig. 1. The mean prediction errors of the EOP data are shown in Fig. 2.

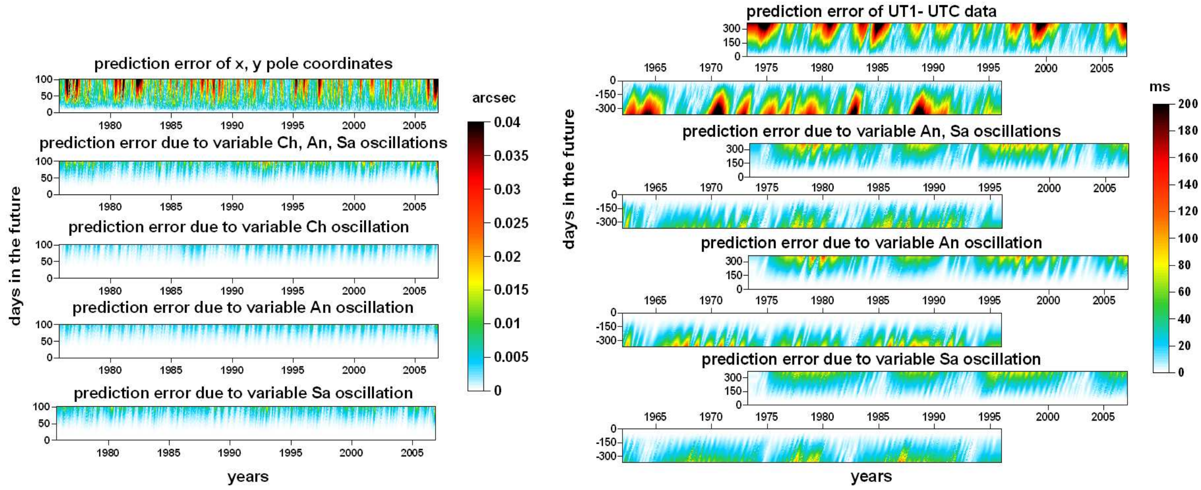

Figure 1: The LS+AR prediction error of x, y pole coordinates (left) and the LS+AR backward and forward prediction errors of UT1-UTC (right) data and of model data constructed with the use of constant LS and variable DWT amplitudes and phases.

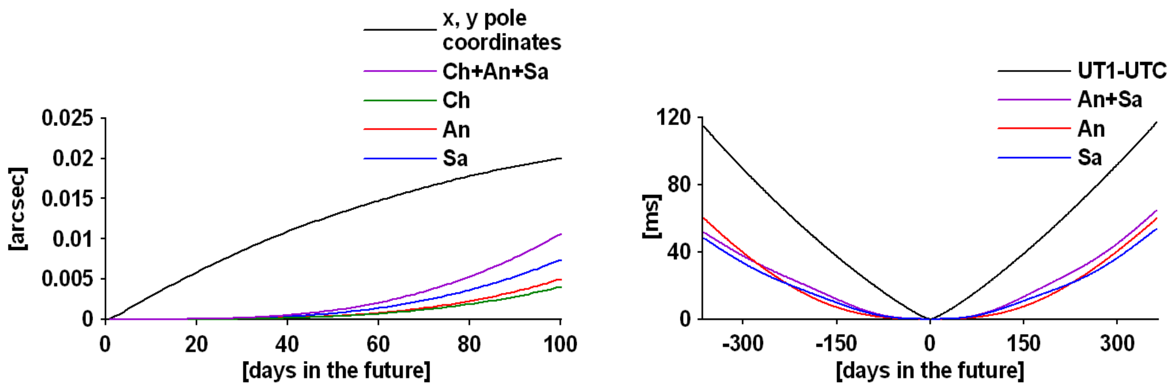

Figure 2: The LS+AR prediction error of x, y pole coordinates (left) and UT1–UTC (right) data and of the model data constructed with the use of variable amplitudes and phases computed by the DWT.

4. CONCLUSIONS

It has been shown that influence of the variable semi–annual oscillation in EOP data up to 100 days in the future is greater than influence of the annual (and Chandler) oscillations. Considering UT1–UTC data, the greatest prediction errors occur at almost the same moments of time independently of the prediction direction. The prediction errors of x, y pole coordinates and UT1–UTC data cannot be explained by the most energetic monochromatic oscillations in these data with variable amplitudes and phases.

5. REFERENCES

Kosek, W., McCarthy, D.D., Johnson, T.J., Kalarus, M., 2004, "Comparison of polar motion prediction results supplied by the IERS Sub-bureau for Rapid Service and Predictions and results of other prediction methods", Proc. Journées 2003, pp. 164-169.

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