GEODYNAMIC SIGNALS IN TIME SERIES OF ASTROMETRIC OBSERVATIONS AT BOROWA GORA OBSERVATORY

J. KRYNSKI[1], Y.M. ZANIMONSKIY[2]

[1] Institute of Geodesy and Cartography
27 Modzelewskiego St., 02-679 Warsaw, Poland
e-mail: krynski@igik.edu.pl

[2] Institute of Radio Astronomy of NASU
4 Chervonopraporna St., Kharkiv, 61002, Ukraine
e-mail: zanimonskiy@rian.kharkov.ua

ABSTRACT. Since 1963 astronomical observations are conducted at Borowa Gora Observatory with the use of transit instrument. Instrumental, technological and methodical improvements in acquiring and pre-processing of rotational time observations make the time series inconsistent over the whole period of operation of the instrument. Complex spectral analysis of a long-standing rotational time data series from 1986.0–2010.6 was performed. A number of periodic terms separated from the series investigated were used to create numerical model of the series. The effects of beats observed in the numerical model were discussed. The existence of a distinguished weekly term in the data investigated has been observed. The results obtained were compared with the spectra of EOP from the analysis of IERS data.

1. INTRODUCTION

Although astromertic observations are not used any longer to calculate EOP provided by IERS, they, in contradiction to all space techniques (VLBI, SLR, GNSS, DORIS) contain information on the direction of the plumb line. As such they are of special interest for geodynamic research as well as for classical geodesy that uses surveying instruments oriented with respect to the actual plumb line. Analysis of time series of astrometric was a subject of numerous publications, e.g. (Kruczyk et al., 1999; Gorshkov and Shcherbakova, 2002; Chapanov et al., 2005). The extensive analysis of variations of astronomical longitude with the use of data acquired with transit instrument at the Borowa Gora Geodetic-Geophysical Observatory (BG) of the Institute of Geodesy and Cartography, Warsaw, within the time span 1986.0–2005.5 was performed (Krynski et al., 2005). Extension of the time series of astrometric observations at BG by 20% due to high data quality from last five years makes it much more attractive for the analysis.

2. ASTROMETRIC DATA FROM BOROWA GORA OBSERVATORY

Astrometric observations at BG are conducted since 1963 with the use of transit instrument of Zeiss Jena equipped with photoelectric registration. A long-standing rotational time data series from 1986.0-2010.6, i.e. from last almost 25 years referred to the Hipparcos catalogue is available for complex analysis. Observations cover 1865 nights when either one (481 nights) or two groups of stars were observed. Single determination of rotational time corresponds to a group of stars consisting of 10–11 stars. The differences between mean universal time $UT1^{BG}$ determined at BG and mean universal time $UT1^{BIH}$ of BIH, i.e. the offset of UT1 obtained in BG with respect to that of BIH, are the subject of analysis. Time span of consecutive data in time series investigated varies from 1 day to 167 days (in average 4.82 days). Uncertainty of data (averaged result of observation session of a number of stars) varies from ± 0.0034 s to ± 0.0155 s (Krynski et al., 2005).

3. SPECTRAL ANALYSIS OF THE OBSERVED TIME SERIES OF THE OFFSET OF UT1 DETERMINED AT BOROWA GORA FROM 1986.0-2010.6

The technique of iterative spectral analysis applied (Box and Jenkins, 1976; Nuttall and Carter, 1982), well suited for the unevenly spaced data. It sequentially eliminates periodic components from the data, till the residuals meet certain criteria of the random process with the quasi-uniform spectral density, like that of the white noise. The results are presented in Figure 1.

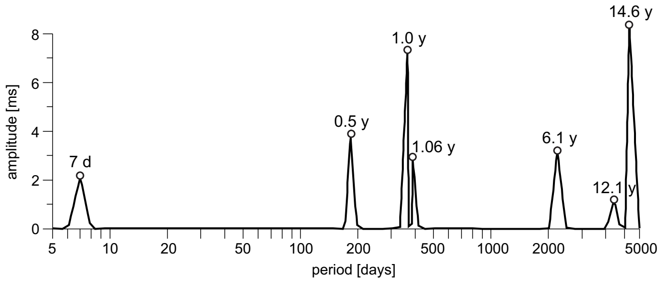

Figure 1: Spectrum of rotational time (UT1 – UTC)^{BG} - (UT1 – UTC)^{BIH} data series

4. SUMMARY AND CONCLUSIONS

Iterative spectral analysis of the observed time series of the offset of UT1 has enabled to allocate seven periodic terms. Available literature signalizes the presence of weekly variations of meteorological parameters, an amount of atmospheric aerosols and storm activity. Corresponding redistribution of moisture changing the moment of inertia of troposphere causes the variations of LOD.

Semi-annual and annual periods may be associated with seasonal redistribution of atmospheric and hydrological masses. The mechanism connecting those seasonal processes with the variations of the direction of the plumb line might be the same as in variations of gravity determined from GRACE data.

Annual term has an adjacent component with period near 387 days. Beat effect of those two terms produces an amplitude modulation of the offset of UT1 with period about 18 years. The consistency of modulation of the offset of UT1 with variations of coordinates of a celestial pole as well as of the difference (UT1 – UTC) is clearly visible. Beat leads to the regular change of phase of annual variations according to changes of amplitude. The largest deviation takes place in the autumn and in the regular way it slides approximately for one month within 18–19 years.

The term with period of 6 years was attempted to be associated with local variations of the direction of the plumb line. 12 year periodic term is rather connected with solar activity. The term with period near 14 years is mentioned in literature but it has not been associated with any physical phenomenon.

Seasonal variations of the refraction can follow the variations due to the weather conditions. Less likely, but still possible are weekly and long-periodic variations of the refraction. Simultaneous observations using different techniques, in particular those including space gravity missions may bring new material that will help to draw more certain conclusions.

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