On detection of the free inner core nutation from VLBI data

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Several attempts to discover the FICN signal in VLBI nutation series made during last years failed. In this paper, we present some results of our further steps in this direction, unfortunately not successful either. We investigated several VLBI CPO series by means of spectral and wavelet analysis. It has been shown that there are several periodic signals with close amplitude around the expected FICN period without any prevailing one that could be associated with the FICN. Wavelet analysis revealed relatively stable oscillation with period of about 750-800 days, which is, however, beyond the intervals found in other studies. It seems to be necessary to improve theoretical estimates of the FICN period to make its search in the observational data more promising.

Introduction

Free inner core nutation (FICN,) is one of the four free rotational modes of the Earth considered in the theory of the Earth's rotation. Detecting of this signal in the observational data is a very important scientific task allowing us to substantially improve our knowledge about the Earth's interior and rotation.

According to Mathews et al. (2002) the FICN period is between 930 and 1140 days. Koot et al. (2010) estimated it from several VLBI nutation series and obtained the period from 904±29 to 945±30, i.e. between 875 and 975 (1-sigma interval). Due to small expected amplitude of the FICN oscillation its detection can be successful only from the most accurate nutation series obtained from the VLBI observations. Several attempts made during last years to find the FICN component in these series failed, see, e.g., Lambert et al. (2012) and papers cited therein. Moreover, the results depend on the celestial pole offset (CPO) series used.

In this work, we performed a new analysis of all available CPO series to investigate possible geophysical signals in expected FICN frequency band.

Data analysis

We analyzed several CPO series obtained in different IVS analysis centers by means of spectral and wavelet analysis. These series include the combined IVS series, as well as individual CPO series obtained in IVS Analysis Centers: AUS (Australia), BKG (Germany), CGS (Italy), GSF (USA), IAA (Russia), OPA (France), USN (USA).

As it was shown in many studies, the main components of CPO include long-term trend caused by the errors in modelling precession and low-frequency nutation terms, and free core nutation (FCN). Both components have an average amplitude of about 0.15 mas. Both trend and FCN were removed from the CPO time series prior to further analysis.

Firstly, the spectral (periodogram) analysis was applied to all CPO series in complex form *dX+i*dY*. Result of these computations is presented in Fig. 1. One can see from these spectra that the CPO variations in the FICN frequency band show several unstable harmonics of similar amplitude. Correlation between the spectra of different series is not very good and can be explained by both presence of real physical signal and using the same observational data. In any case, no prevailing signal is seen that can be reliably associated with the FICN.

Figure 2 shows the result of wavelet analysis applied to the IVS combined CPO series after removing trend and FCN. One can see a complicated structure of the CPO variations without a clearly detected signal around the expected FICN period.

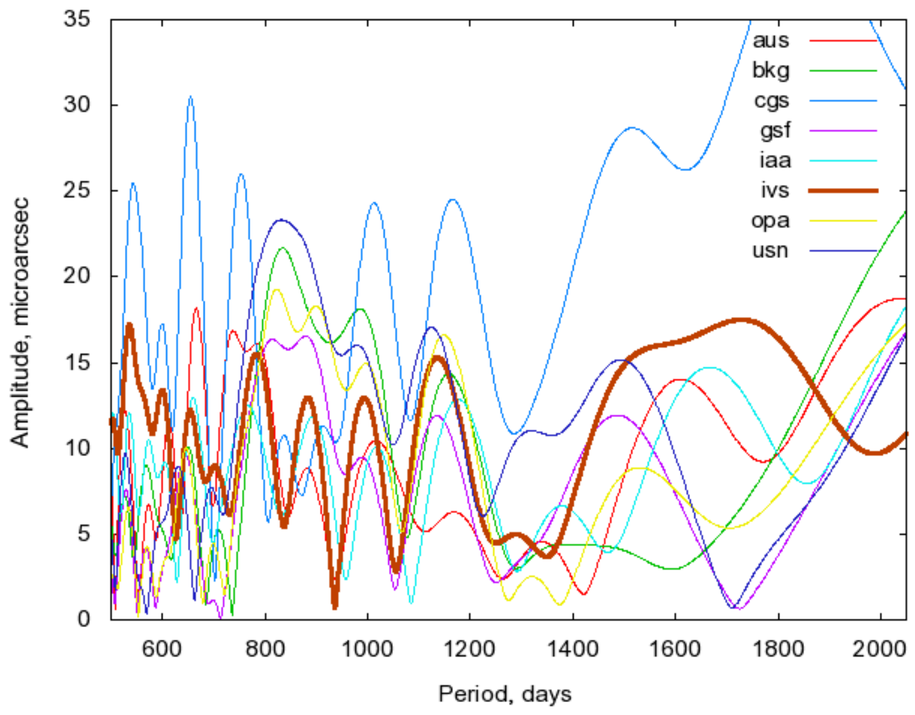

Fig. 1. Periodogram of the CPO series after removing FCN.

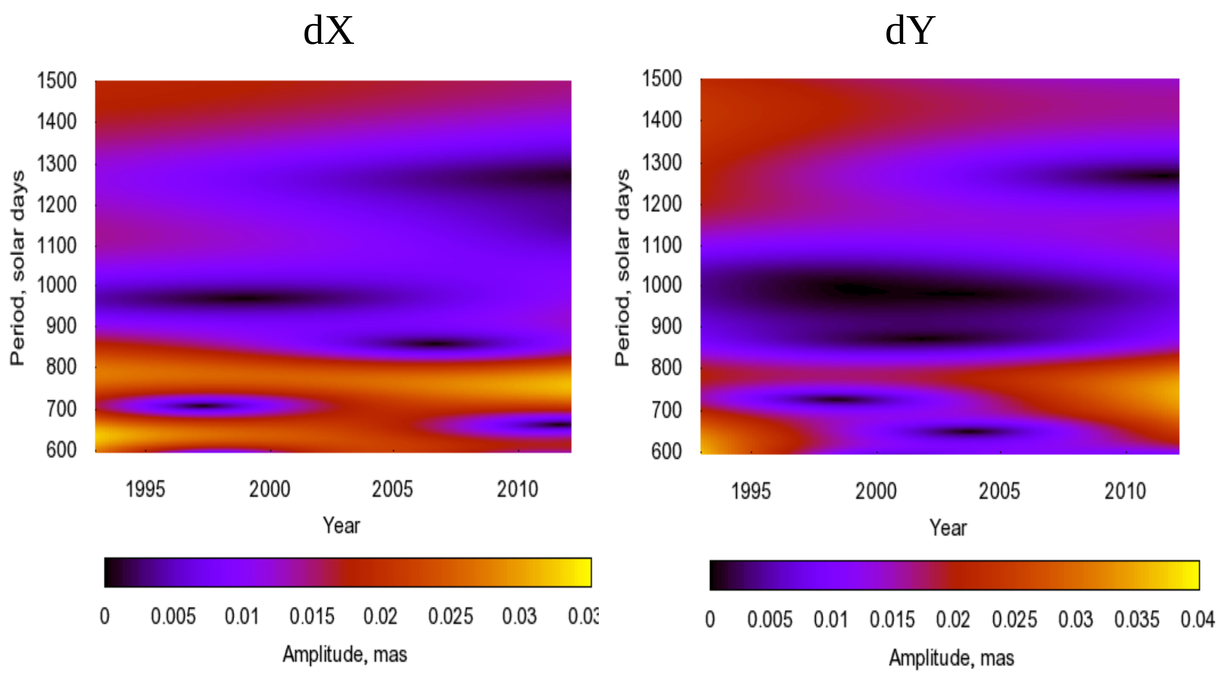

Fig. 2. Wavelet scalograms for the IVS CPO series after removing FCN.

Conclusion

Results of this study show that the CPO variations in the FICN frequency band have a complicated structure, as was already shown by Lambert et al. (2012). Several, mostly unstable, harmonics of close amplitude are present in the spectra, and no prevailing signal can be associated with the FICN. Wavelet analysis revealed relatively stable oscillation with period of about 750-800 days, which is, however, beyond the intervals found in other studies.

Unfortunately, the theoretical prediction of the FICN period is not so accurate to unambiguously connect one of the oscillations with the FICN. It should be improved to make its search in the observational data more promising.

References

Koot L., et al., 2010, Geophys. J. Int., 182, 1279.

Mathews P.M., et al., 2002, J. Geophys. Res. , 107(B4), 2068.

Lambert S.L., et al., 2012 IVS 2012 GM Proc., 370.