Analysis Center of Saint-Petersburg University

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Abstract

This report includes information about the activity of the Analysis Center of Saint-Petersburg University for the year 2005, staff members and background information. This year we focused our efforts on the study of polar motion in diurnal frequency band. Some results are presented here.

1. Introduction

Sobolev Astronomical Institute is located in Petrodvorets, near St. Petersburg. It is a research institute of the Saint Petersburg State University. In 1998 Analysis Center of Saint Petersburg University was established in the Institute. The main activity of AC SPU for International VLBI Service consists in routine processing of 24-hours and 1-hour observational sessions for obtaining Earth Orientation Parameters (EOP) and rapid UT1-UTC values respectively. During the year 2005 activity of AC SPU was supported by Ministry of Education and Science of Russian Federation (in frame of grant 37847).

2. Staff

The staff members who are involved in the activities of the Analisys Center are listed below:

- Veniamin Vityazev – Director of Astronomical Institute of Saint-Petersburg University, PhD., Prof. General coordination and support of activity at the Astronomical Institute.
- Maria Kudryashova – Research assistant of Astronomical Institute of Saint-Petersburg University. Processing of VLBI data.

3. Activities in 2005

As in the previous years we continued to provide the series of five EOPs (spu0003i.eops) and rapid estimations of UT1-UTC (spu00002.eopi) values on a regular basis. Detailed description of the solutions obtaining strategy have been given in our previous reports (see for instance [1], [2]). This year we add sessions from Int2 observational program in the process of obtaining our intensive solution spu00002.eopi. During the year 2005 our main efforts have been focused on the analysis of sub-diurnal variations of Polar Motion (PM).

3.1. Derivation of Sub-Diurnal Polar Motion

In our analysis we used observations from 24-hour geodetic VLBI sessions from January 1989 till April 2004. Whole amount of the processed experiments was 987. The time span covered by these data was longer than 15 years.

In order to obtain a time series of Polar Motion (PM) with sub-diurnal resolution we applied the least-square collocation method (LSQM) as it is implemented in OCCAM 6.0 software. In frame of this method, a model with 3 types of parameters is realized (see [5]). These three groups of parameters are the following:

1. global parameters under which radiosource positions are usually comprehended;
2. "daily" parameters which are supposed to be constant during each 24-hour session (among these parameters were corrections to station coordinates, offsets of the Celestial Ephemeris Pole as well as the statistical expectations of stochastic parameters);
3. stochastic parameters (as such parameters we treated x, y coordinates of the pole, $UT1 - UTC$, clock rates and offsets, zenith delays and tropospheric gradients).

In this study an improvement of the existing Celestial Reference Frame (CRF) was not of our interest, therefore we just fixed the CRF to a priory catalogue ICRF-Ext.1. Thus we assumed that we know the radiosource coordinates quite exactly. In this case model with three groups of parameters could be reduced to the model with two groups of them:

$$Bv + Cw + \xi = l, \tag{1}$$

where l is the vector of differences between the observed and calculated values (O-C); ξ is the vector of measurement errors; B, C are the matrices of partial derivatives; v is the vector of 'daily' parameters and w – stochastic ones. Formulas for estimating these parameters and more details concerning this procedure can be found in [3],[4], [5].

As a result of applying the LSQM we derive unevenly sampled time series of the PM and UT1-UTC. Note that in this series the model of the diurnal and sub-diurnal variations in polar motion and $UT1$ due to oceanic tides has already been taken into account. The model contains 71 diurnal and sub-diurnal terms and was calculated by R. Eanes based on the paper by Ray et al. (1994). The time resolution of the output ERP series is three to ten minutes during one session and two to seven days-long gaps between the sessions. As a result, it is needed to apply special methods of analysis.

3.2. Analysis of Polar Motion

Hereafter we will consider polar motion as complex value $f = x - iy$. In order to extract signals in the diurnal frequency band we used the method of complex demodulation. This method has been described in detail for instance in [6]. Here we only outline the main ideas of the method. After applying the demodulation transformation, frequencies ω are transformed into $\omega' = \omega - \sigma_0$, where σ_0 is the so-called demodulation frequency which could be chosen arbitrarily. In this work we used $\sigma_0 = \Omega$ in order to extract prograde diurnal motion, where Ω is a diurnal sidereal frequency equal to 1 cycle per sidereal day. In the frequency domain, due to the Fourier transform property, such transformation just shifts spectrum of the initial series by the value σ_0 such a way that $\omega = \sigma_0$ becomes 0.

The advantage of the transformation is that variations with frequencies from the vicinity of σ_0 become long-periodical, i.e. slowly varying with time. All other variations are removed by a low-pass filter (Gaussian filter has been used here) which in addition significantly reduce an amount of values in the time series under estimation.

After applying the procedure described above, we derived the amplitudes (A) and phases (ϕ) of the most powerful tidal components as well as a constant term by least-squares fitting. In the diurnal frequency band these components are P_1, S_1 and K_1. First line of Table 1 contains refined estimations of A, ϕ parameters of S_1, P_1 terms in comparison with [3]. Amplitudes and phases of the terms have also been compared with the parameters inferred from geophysical data

(Atmosphere Angular Momentum - AAM). AAM series have been obtained from IERS Special Bureau for the Atmosphere [7].

Table 1. Amplitudes and phases of S_1 and P_1 components

	S_1		P_1	
	A(μas)	$\phi(deg)$	A(μas)	$\phi(deg)$
VLBI	4.8	-167.2	1.0	-66.7
AAM (mass term)	4.9	-169.7	0.8	13.0
AAMIB (mass term)	4.9	-169.7	0.8	13.0

As was expected, the most significant contribution in sub-diurnal polar motion after applying of tidal variations model [8] is due to S_1 term. Parameters of this term derived from VLBI observations show very good agreement with those evaluated from AAM data in contrast to P_1, K_1 components. It is due to the fact that the ocean tide contribution to the amplitude of S_1 is about 4 times smaller than evaluated from VLBI data and thus this harmonic was not totally excluded by applying the Ray model. In contrast to S_1 term, the amplitudes of P_1, K_1 terms have already been taken into consideration in the model mentioned above.

References

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