IAA VLBI Analysis Center Report 2004

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Abstract

The report contains a brief overview of IAA VLBI analysis activities in 2004 and the plans for the coming year.

1. General Information

The IAA IVS Analysis Center (IAA AC) is located at the Institute of Applied Astronomy of the Russian Academy of Sciences in St. Petersburg, Russia. Several groups are involved in VLBI data analysis and related studies. Their activities in 2004 are described below. The IAA AC web page `http://www.ipa.nw.ru/PAGE/DEPFUND/GEO/ac_vlbi/` is supported.

2. Organization and Staff

After reorganization in the end of 2004, IAA groups contributing to the IAA AC activities are:

1. Lab of Space Geodesy and Earth Rotation (LSGER): Dr. Zinovy Malkin (Head, 30%), Prof. Vadim Gubanov, Dr. Elena Skurikhina, Sergey Kurdubov, Julia Sokolova (all 100%). The main tasks of this group are EOP service, computation and investigation of operational and long-term series of EOP, station and radio source coordinates, tropospheric parameters, comparison and combination of space geodesy products. The group makes use of OCCAM/GROSS software for regular data processing. Vadim Gubanov and Sergey Kurdubov of former QUASAR Group continued development of the QUASAR software which is intended to provide complete processing of VLBI observations, global analysis in the first place.

2. Lab of Ephemeris Astronomy (LEA): Prof. George Krasinsky (Head, 80%), Nadia Shuygina (5%). The main activities of this group in VLBI analysis are using VLBI data for developing of a new Earth precession-nutation numerical model, and combining of the VLBI and satellite data for computation of daily UT1 and celestial pole offset series, and high-frequency EOP variations. This group uses a method of combination of observations obtained with different techniques at the observational level using ERA software.

Besides, Igor Surkis, now the Head of the Lab of Correlator Processing continues to help in support of QUASAR software, and Alexey Melnikov of this Lab is working on porting SKED to Linux in cooperation with the GSFC team.

3. Analysis Activities

3.1. LSGER Group

The activities of the LSGER group in 2004 were as follows:

- Development of the OCCAM/GROSS software. Main improvements made in 2004 are implementation of a Vienna Mapping Function (data provided by IGG TUW is used), output of hourly tropospheric parameters in the IVS TROPO format, adding possibility of use of non-linear station motion. Some other changes with no significant influence on the results were made.

- Operational processing of the "24h" and intensive VLBI sessions, submitting the results to the IERS and IVS. Processing of the intensive sessions is fully automated. At the moment, the EOPS series contains 2933 estimates of pole coordinates, UT1 and celestial pole offsets, and the EOPI series contains 4697 estimates of UT1.
- A new 25-year session station coordinates, baseline lengths, and tropospheric parameters (ZTD, gradients) time series were obtained. Analysis of the results is in progress.
- Session SINEX files were regularly sent to the IVS for the IVS Baseline Length PP.
- Regular computation of FCN contribution using the model proposed in [5] started in 2004, and is available at the IAA AC web page, along with regularly updated mean pole series used for modelling of the pole tide.
- Operational computation of NGS cards as requested by the IVS CC was started. All historical databases had been also processed.
- Support of IAA archive of VLBI observations and products. At present all available X and S databases and NGS cards are stored.
- Porting SKED to Linux in cooperation with GSFC was carried out, and is expected to be finished early 2005.

In 2004 the QUASAR group continued preparation for a global analysis of all available VLBI observations. Details of this project and first results can be found in [1, 2]. 1979-2002 VLBI data were processed by means of the least-squares collocation technique (LSC). Autocovariance functions (ACF) of intraday stochastic signals (UT1, WTD and clocks) were revised by using the LSC interpolation of the preliminary signals. The results show that the normalized ACF have a global nature and do not depend on site and time of observations. However, the variances of local signals vary from site to site and for different seasons (Table 1). All these data were included into the global collocation process.

Table 1. Examples of averaged WTD variances (in mm^2) for four seasons.

Station	Months				Mean	Number of sessions
	12-02	03-05	06-08	09-11		
GILCREEK	44.0	40.9	75.4	51.9	54.4	1760
KOKEE	88.2	64.8	107.4	105.2	90.8	832
WETTZELL	69.6	67.6	117.5	88.0	86.0	1773
WESTFORD	345.8	340.7	466.1	427.3	394.9	1446
NYALES20	26.5	28.0	40.7	34.4	32.4	431

Coefficients of Chebychev's expansion of EOP trends were estimated as global parameters. The regularized random EOP corrections are obtained for all series [2].

The global solution was derived from NEOS-A, NEOS-B and IVS-R4 programs. Corrections to coordinates and proper motions of 22 stations and 319 sources were calculated. Corrections to EOP were obtained as well, their uncertainties are showed in Table 2.

Table 2. WRMS of EOP uncertainties.

EOP	$\Delta\psi\cos(\epsilon)$	$\Delta\epsilon$	Δ(UT1-UTC)	ΔX_p	ΔY_p
Unit	mas	mas	0.1 ms	mas	mas
WRMS	0.074	0.109	0.067	0.107	0.118

Annual variations of the Wettzell coordinates were detected, the spectra are shown in Figure 1.

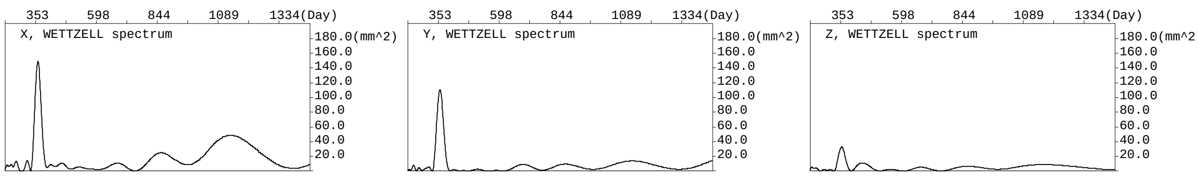

Figure 1. Power spectrum density of Wettzell coordinates variations.

The IERS Conventions (2003) algorithm of transformation between TRS and CRS was implemented.

A new procedure of source coordinates and proper motions determination is under development. Corrections are divided into systematic and random parts. Systematic components are represented as expansion by spherical functions. Its coefficients are estimated as global parameters, and random components are estimated separately in the second iteration.

The project is carried out under financial support of the Russian Foundation for Basic Research (grant No. 03-02-17591).

3.2. LEA Group

1. A preliminary version of numerical theory of rotation of the non-rigid Earth with the two-layer core is constructed and fitted to the VLBI based positions of the Celestial Pole (GSFC data of 1984-2004, 3432 points). Unlike the adopted Nutation IAU 2000, the theory describes both the nutational and precessional motions. In this preliminary analysis, effects of the inner core are considered only approximately.

From the fitting to the VLBI data the following parameters were estimated: initial values of $\theta^{(0)}$, $\phi^{(0)}$ of the Euler angles of nutation and precession referred to the ecliptical inertial frame J2000 for the initial epoch 1983 Dec 24; initial values of the derivatives $\dot{\theta}^{(0)}$, $\dot{\phi}^{(0)}$; initial values of the equatorial projections $v_1^{(0)}$, $v_2^{(0)}$ of the differential angular velocity of the core at the same epoch and reference frame; the ellipticity e of the Earth as a whole and that e_c of the core; the static k_2 and dynamic Love number k_2^d; the lags δ, δ_c of the body tide in the Earth as a whole and in the core; a parameter characterizing ocean tides; the unmodelled secular trend in the obliquity; two empirical parameters supposedly absorbing effects of the inner core. The overall post-fit RMS of the residuals $d\theta$ and $\sin\theta d\phi$ of the theory with the VLBI data under consideration is 0.20 mas.

The unmodelled obliquity rate is estimated as 1.5 ± 0.1 mas/cy being considerably less then the unmodelled rate -25 mas/cy for Nutation IAU 2000. After removing remaining annual oscillations the RMS diminishes to the values 0.169 mas for $d\theta$ and 0.190 mas for $\sin\theta d\phi$. These values are to be compared with the corresponding values 0.182 mas and 0.193 mas for Nutation IAU 2000.

The theory accounts for the relativistic geodetic precession (1980 mas/cy). Unfortunately, due to strong correlations with e and $\phi^{(0)}$, it appears that the geodetic precession cannot be estimated simultaneously with other parameters as an unmodelled secular trend in the precessional angle ϕ. Omission of this effect increases the RMS by 18 percent. Probably that is the first experimental confirmation of the effect of the geodetic precession. A preliminary version of the model is described in [3] with a short exposition given in [4].

2. Monthly series of VLBI observations obtained in the NEOS campaign and laser ranges to geodetic satellites Lageos, Lageos-2, and Etalon-1, Etalon-2 were processed applying Kalman filtering for EOP. The method used allowed us to obtain UT1 and celestial pole offset with diurnal resolution.

4. Outlook

Plans for the coming year include:

- Further improvement of algorithms and software for processing of VLBI observations.
- Continue regular computation of operational and long-time EOP, station coordinates, and troposphere parameters series with OCCAM software. Submit the results to IVS and IERS.
- Obtain first results of global analysis of the VLBI data with QUASAR software.
- Continue investigations of VLBI estimation of EOP, station coordinates, and troposphere parameters, and comparison with satellite techniques.
- Develop a model for seasonal variations of WZD [6]. Implement modelled values as a priori during data analysis.
- Resume activity in computation, investigation, combination of source catalogs. Participate in the Radio Source Catalogs IVS PP.

References

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