IAA VLBI Analysis Center Report 2007

Elena Skurikhina, Sergey Kurdubov, Vadim Gubanov, George Krasinsky

Abstract

This report presents an overview of IAA VLBI Analysis Center activities during 2007 and the plans for the coming year. The main directions of IAA AC activities are: daily SINEX file generation on a regular basis for IVS-R1 and IVS-R4 sessions; TRF/CRF estimation from global VLBI data analysis; routine computations of Earth orientation parameters (EOP) for submission to IERS; baseline length and tropospheric parameters from 24-h sessions; UT1-UTC from IVS Intensive sessions; time series of source position calculation and analysis at the scope of the IERS/IVS Working Group on the Second Realization of the ICRF; EOP, UT1-UTC, and station position estimation from domestic observation programs; software development, and NGS-file generation.

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. The IAA AC submits to IVS products such as daily SINEX files, TRF, CRF, rapid and long-term series of EOP, baseline length, and tropospheric parameters. Source position time series have been calculated and have been analyzed using the covariance function technique as part of the efforts of the IERS/IVS Working Group on the Second Realization of the ICRF. EOP, UT1-UTC, and station positions were estimated from domestic observation programs RU-E and RU-U. The QUASAR software was further developed. The IAA AC performs NGS-file generation.

2. Component Description

The IAA AC performs data processing of all kinds of VLBI observation sessions.

For VLBI data analysis we use QUASAR and OCCAM/GROSS software. All reductions are in agreement with the IERS Conventions (2003). Both sets of software use NGS-files as input data.

The IAA AC contributes to all IVS products: daily SINEX-files for EOPS and EOPS-rates and station position estimations, TRF, CRF, baseline length, and tropospheric parameters.

QUASAR and OCCAM/GROSS software is supported and developed at the IAA AC.

IVS NGS-files are generated on a regular basis in automatic mode.

3. Staff

– Vadim Gubanov, Prof.: development of the QUASAR software, development of the methods of stochastic parameter estimation.

– Sergey Kurdubov, scientific reseacher: development of the QUASAR software, global solution and DSNX-file calculation.

– Elena Skurikhina, Dr.: VLBI data processing, OCCAM/GROSS software development.

– George Krasinsky, Prof.: development of new Precession-Nutation Theory based on numerical integration of refined differential equations of the Earth rotation.

4. Current Status and Activities

- **Software development for VLBI processing**
  The QUASAR software is being developed to provide contributions to IVS products. The software is able to calculate all types of IVS products. The capability of SINEX-file generation for IVS-Intensive sessions was added.

- **Global solution**
  In 2007 two global solutions (iaa2007a and iaa2007b) [1, 3] were calculated using the QUASAR software and submitted to IVS. For the last solution all available data from 1979 until the end of 2007 were processed. Stochastic signals were estimated by means of the least-squares collocation technique. The radio source coordinates, station coordinates and velocities were estimated as global parameters. EOP, WZD (linear trend plus stochastic signal), troposphere gradients, and station clocks (quadratic trend plus stochastic signal) were estimated as arc parameters for each session.

  3,984 24-hour sessions with 5,376,127 delays have been processed. 2,760 global parameters have been estimated: 963 radio-source positions and the positions and velocities of 129 VLBI stations (12 with discontinuities).

  Transformation parameters between ITRF2005 and catalogues obtained for two epochs are listed in Table 1. The residuals are 6 mm for 1997.0 and 8 mm for 2005.0. 38 stations were used for the calculations.

Table 1. Transformation parameters between ITRF2005 and obtained catalogue for two epochs.

EPOCH	T1,mm	T2,mm	T3,mm	D, 10^{-9}	R1,mas	R2,mas	R3,mas
2005.0	6.4	-4.8	19.2	-1.6	-0.080	0.139	-0.018
1997.0	4.7	-5.3	5.0	-1.6	-.062	-.090	-.005

The mean formal errors of the source catalogues are 0.15 mas for right ascension, and 0.11 mas for declination. The WRMS difference vs. ICRF.Ext2 is 0.2 mas in right ascension and declination. (For the statistics on differences, a total of 574 common sources observed in more than 3 sessions and more than 20 times were used).

- **Participation in the IERS/IVS Working Group on the Second Realization of the ICRF**
  Two time series iaa000b and iaa000c with more than 600 sources were calculated using the QUASAR software for VLBI data processing. Most available VLBI observations (excluding DSN and VCS sessions) since August 1979 to May 2007 were used.

  Source positions for every source were obtained from single series analysis by fixing the coordinates of all other sources. A priori source positions were used from the ICRF-Ext.2 radio source position catalogue. Station positions were not estimated for either series. The TRF was fixed by ITRF2005, and the CRF was fixed by ICRF-Ext.2. The following parameters were estimated in these solutions: position of one source, EOP (only for iaa000b solution), WZD (linear trend and stochastic), troposphere gradient (east and north), and station clock offset (quadratic trend and stochastic).

We analyzed time series using a covariance function technique adopted for equidistant time series with the aim of exposing more stable sources. The global solutions with different sets of sources for NNR constraints were obtained. Transformation parameters between obtained source catalogues were calculated and compared.

- **Routine analysis**
  In March 2007 the IAA AC started generating daily SINEX files for IVS-R1 and IVS-R4 sessions for rapid solution (iaa2007a.snx) and submitted to IVS SINEX files based on all 24-hr experiments of the Quarterly Solution [3].

  During 2007 the routine data processing was performed with OCCAM/GROSS software using Kalman Filter. IAA AC provided the operational processing of the "24h" and Intensive VLBI sessions. Submitting the results to the IERS and IVS was performed on a regular basis. Processing of the Intensive sessions is fully automated. The EOP series iaa2007a.eops and iaa2005a.eopi, the baseline length series iaa2007a.bl, and the troposphere parameter series iaa2007a.trl were continued. At the moment, the EOPS series contains 3463 estimates of pole coordinates, UT1, and celestial pole offsets, and the EOPI series contains 5821 estimates of UT1. Long-time series of station coordinates, baseline lengths, and tropospheric parameters (ZTD, gradients) were computed with the station position catalog ITRF2005.

- **Station position estimation**
  The station positions of Zelenchukskaya and Badary (Table 2) were calculated in the ITRF2005 reference frame. A priori values for the velocity components were used from GPS data analysis in both cases. The station position of Zelenchukskaya was calculated from the analysis of 76 IVS 24-hour sessions. The station position of Badary was calculated from 24 domestic (2006–2007) and IVS (2007) sessions. The results are presented in Table 2.

Table 2. Station positions and velocities for Zelenchukskaya and Badary, epoch 2000.0, in ITRF2005

Station	Station Position, m			Velocity, mm/year		
	X	Y	Z	V_x	V_y	V_z
Badary	-838200.729	3865751.573	4987670.956	-.0253	0.0002	-.0037
	± 0.008	± 0.008	± 0.009			
Zelenchukskaya	3451207.821	3060375.231	4391914.941	-.0221	.0141	.0089
	± 0.014	± 0.012	± 0.015			

- **EOP parameter calculation from domestic QUASAR network observations**
  The regular determination of Earth orientation parameters with QUASAR VLBI-Network Svetloe-Zelenchukskaya-Badary using the S2 registration system started in August of 2006 [4]. Correlation is performed at the IAA correlator. The observations are carried out in the framework of two national programs: 24-hour sessions for the determination of five EOP parameters at three observatories of Network (RU-E programs) and 8-hour sessions for the determination of Universal time at the base Zelenchukskaya–Badary observatories (RU-U programs). Each of these two sessions are carried out twice per month. RMS deviations of EOP values from IERS05 C04 series obtained from RU-E program are 0.88 mas for X-pole and 1.0 mas for Y-pole, 34 μs for UT1-UTC and 0.61 mas for Celestial Pole Offsets (for 17

sessions since Aug 2006 till the end of 2007). RMS deviations of the Universal time values for RU-U program from IERS05 C04 series are 134 μs (for 23 sessions).

- **IVS NGS card generation**
  Operational computation of the NGS cards was continued. NGS cards are computed in automated mode. IAA archive of VLBI observations and products was supported. At present, all available X and S databases and NGS cards are stored.

5. Future Plans

- Continue to submit all types of IVS product contributions and start to submit SINEX files for IVS Intensive sessions.
- Continue investigations of VLBI estimation of EOP, station coordinates, and troposphere parameters, and comparison with satellite techniques.
- Continue the studies in the frame of the IERS/IVS Working Group on the Second Realization of the ICRF.
- Further improve algorithms and software for processing VLBI observations.
- Continue to compute and provide to IVS the NGS cards for every 1-hour Intensive session.

References

[1] Gubanov V. S., Kurdubov S.L. On global solution from VLBI observations. IAA Comm., v. 13, 2005, p.434–439.

[2] Kurdubov S. L. Covariation analysis of stochastic parameters of VLBI observations model. IAA Comm., v. 14, 2006, p.138–157.

[3] Kurdubov S. QUASAR software in IAA EOP service: Global Solution and Daily SINEX. In Proceeding of the 18th European VLBI for Geodesy and Astrometry Working Meeting ed. by Johannes Böhm, Andrea Pany, and Harald Schuh, GEOWISSENSCHAFTLICHE MITTEILUNGEN, Heft Nr.79, 2007, pp. 79-82.

[4] Finkelstein A.M., Skurikhina E.A., Surkis I.F., Ipatov A.V., Rahimov I.A., Smolentsev S.G. USE OF THE QUASAR VLBI NETWORK FOR FUNDAMENTAL TIME-POSITIONING SERVICE 0F GLONASS, AJ Letters (in print).