IAA VLBI Analysis Center Report 2009

Elena Skurikhina, Sergey Kurdubov, Vadim Gubanov

Abstract

This report presents an overview of IAA VLBI Analysis Center activities during 2009 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. The IAA AC contributes to IVS products, such as daily SINEX files, TRF, CRF, rapid and long-term series of EOP, baseline length, and tropospheric parameters. A source position catalog has been calculated within the scope of the IERS/IVS Working Group on the Second Realization of the ICRF. Several ways of source selection with NNR constraints were proposed and tested. EOP, UT1, and station positions were estimated from domestic observation programs Ru-E and Ru-U. The IAA AC generates NGS files.

2. Component Description

The IAA AC performs data processing of all kinds of VLBI observation sessions. For VLBI data analysis we use the QUASAR and the OCCAM/GROSS software packages. All reductions correspond to the IERS Conventions (2003). Both packages use NGS files as input data.

The IAA AC submits to the IVS Data Centers all kinds of products: daily SINEX files for EOP and EOP-rates and station position estimations, TRF, CRF, baseline length, and tropospheric parameters.

The QUASAR and the OCCAM/GROSS software packages are supported and developed.

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

3. Staff

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

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

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

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 capable of calculating all types of IVS products. A scale problem was fixed in the QUASAR software during 2009.

- **Global solution**

  In 2009 two global solutions (iaa2008c and iaa2009a) using the QUASAR software were calculated and submitted to IVS. All available data for 1980–2009 (through the end of March 2009, a total of 6,353,387 delays) were processed. CRF was fixed by NNR constraints to 203 radiosources. TRF was fixed by NNR and NNT constraints to station positions and velocities of 11 stations: MATERA, KOKEE, WETTZELL, FORTLEZA, WESTFORD, ALGOPARK, NYALES20, NOTO, ONSALA60, LA-VLBA, and MK-VLBA. 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.

  3,165 global parameters have been estimated: 2,918 radio source positions, and the positions and the velocities of 141 VLBI stations (14 with discontinuities).

  Global solution iaa2009a is different from the iaa2008c solution only in corrected (corresponding to the other ACs) relativistic formulae; as a result, the scale factor was improved.

- **Participation in the IERS/IVS Working Group on the Second Realization of the ICRF**

  Global solutions with different sets of sources for NNR constraints were obtained. Transformation parameters between obtained source catalogs were calculated and compared.

  A ranking method of source sets was suggested, in order to select the list of sources that better defines the orientation parameters of rigid rotation transformation from one system to another. Formal errors of the transformation parameters were selected as a characteristic of the source set.

- **Routine analysis**

  The IAA AC submits daily SINEX files for the IVS-R1 and IVS-R4 sessions as rapid solution (iaa2008a.snx) and SINEX files based on all 24-hour experiments for the Quarterly Solution.

  During 2009 the routine data processing was performed with the OCCAM/GROSS software using a Kalman Filter. The IAA AC operationally processed the "24h" and Intensive VLBI sessions. Submitting the results to the IERS and the IVS was performed on a regular basis. Processing of the Intensive sessions is fully automated. The EOP series iaa2007a.eops and iaa2005a.eopi, baseline lengths iaa2007a.bl, and troposphere parameters iaa2007a.trl were continued. At the moment, the EOPS series contains 3,718 estimates of pole coordinates, UT1, and celestial pole offsets, and the EOPI series contains 6,490 estimates of UT1. Long-time series of station coordinates, baseline lengths, and tropospheric parameters (ZTD, gradients) were computed with the station position catalog ITRF2005.

- **EOP parameter calculation from domestic QUASAR network observations**

  Since February 2009 the QUASAR VLBI Network Svetloe—Zelenchukskaya—Badary has used the Mark 5B registration system for regular determination of Earth orientation parameters. 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 from the full network (Ru-E program) and one baseline 1-hour sessions for the determination of Universal Time on the Zelenchukskaya—Badary (or the Svetloe—Badary) baseline (Ru-U program). Each of these two sessions is run twice per month. The mean RMS EOP deviations from the IERS 05C04 series in the Ru-E program are 1.03 mas for Pole position, 46 s for UT1-UTC, and 0.66 mas for Celestial Pole position for 46 sessions. The RMS deviation of the Universal Time values from the IERS C04 series for 73 sessions for the Ru-U program is 98 μs. Since February 2009, a year of observations within the Russian Domestic programs was carried out using the Mark 5B registration system. For 14 sessions from the Ru-E program, the rms from the IERS 05C04 series is 1.12 mas for Pole position, 49 μs for UT1-UTC, and 0.41 mas for Celestial Pole position. For 36 Ru-U Mark 5B sessions, the rms from the UT1 IERS 05C04 was 46 μs. Station positions were specified in the ITRF2005 and VTRF2008 catalog systems for both domestic and IVS observations.

- **Antenna axis offset estimation from VLBI**

  The antenna axis (AO) offsets were estimated from global solution and single sessions. We have built a set of global solutions from all available sessions and from a set of sessions between stations discontinuous in observations. We compared offsets estimated on different intervals for some stations which are discontinuous due to repair work. For the stations of the QUASAR network, we compared our estimations to local surveying data. For some stations the value of axis offset has been changed after repairs: at time spans
  03.03.04 – 06.05.04: $AO_{Svetloe}$ = -15.5 $\pm$ 3.5 (mm) (from local surveying: -12.5 (mm)); 06.08.03 – 07.06.21: $AO_{Svetloe}$ = -10.0 $\pm$ 2.8 (mm) (from local surveying: -7.5 $\pm$ 0.5 (mm)), and 07.06.21 – 09.11.12: $AO_{Svetloe}$ = 1.0 $\pm$ 2.0 (mm) (from local surveying: -3.0 $\pm$ 1.5 (mm)).

- **CONT08 data processing**

  15 daily CONT08 sessions were united in one 15-day session and processed with OCCAM/GROSS software. Pole position, UT1, WZD, and clock offsets were estimated as stochastic parameters with Kalman filter. EOP are modeled as a random walk dynamical process with an a-priori standard deviation of 1 mas and a Power Spectral density of ruled white noise of 0.000010 as^2 a day. The results of the comparison of Total Zenith Delay (TZD) to data calculated from GPS observations by CODE AC are presented in Figure 1 and in Table 1.

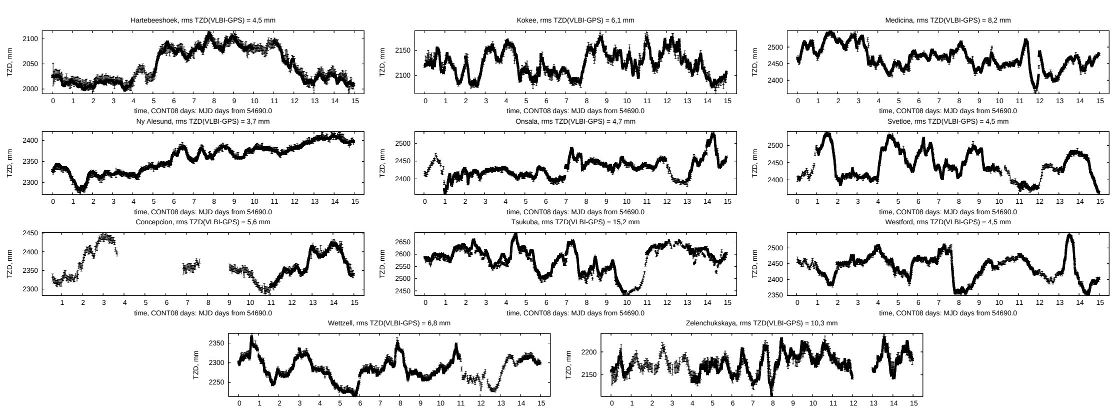

Figure 1. TZD from VLBI and GPS comparison

Table 1. CONT08: TZD comparison for VLBI and GPS

Station	Hh	Kk	Mc	Ny	On	Sv	Tc	Ts	Wf	Wz	Zc
bias, mm	1.9	0.1	-1.2	0.3	-1.1	-0.5	-0.2	-9.6	-1.8	2.5	0.9
rms, mm	4.4	6.1	8.1	3.5	4.3	4.2	5.7	11.0	6.6	5.4	9.9

Figure 2 presents 1-hour estimations of Xp, Yp, and UT1 relative to slowly varying daily a-priori series. The subdaily RMS residuals after removing the IERS Conventions (2003) model (for diurnal and sub-diurnal variations in polar motion caused by ocean tides and nutation terms with periods less than two days) are 249 μas for Xp, 223 μas for Yp, and 15 μs for UT1.

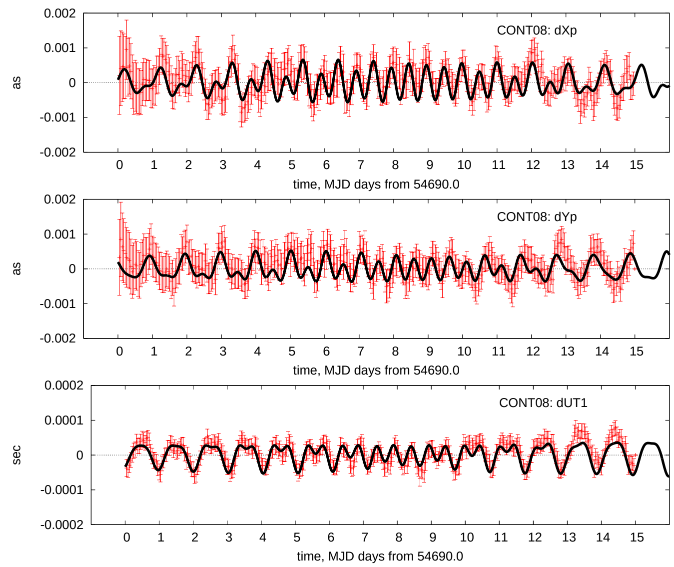

Figure 2. Subdaily estimates of EOP at 1-hour intervals compared to the IERS Conventions (2003) model of EOP diurnal and sub-diurnal variations (tidal plus nutation terms)

5. Future Plans

We plan to:

- Continue to submit all types of IVS product contributions.
- Continue investigations of VLBI estimation of EOP, station coordinates, and troposphere parameters, and comparison with satellite techniques.
- Calculate CRF and TRF from global solutions.
- Further improve algorithms and software for processing VLBI observations.