IAA VLBI Analysis Center Report 2010

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Abstract

This report presents an overview of IAA VLBI Analysis Center activities during 2010 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. 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. 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 are performed in agreement with IERS Conventions (2003). Both packages use NGS files as input data.

The IAA AC submits to the IVS Data Center all kinds of products: daily SINEX files for EOP and EOP-rates and station position estimates, 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 files 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 in 2009.

- **Routine analysis**

During 2010 the IAA AC continued to submit daily SINEX files for the IVS-R1 and IVS-R4 sessions as rapid solution (iaa2010a.snx) and SINEX files based on all 24-hour experiments for the Quarterly Solution.

The routine data processing was performed with the OCCAM/GROSS software using a Kalman Filter. IAA AC operationally processed the "24h" and Intensive VLBI sessions and submitted the results to the IERS and IVS 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. 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**

  The regular determinations of Earth's orientation parameters with the QUASAR VLBI Network Svetloe-Zelenchukskaya-Badary and single baseline 1-hour observations for UT1 with e-VLBI transfer were performed weekly. Correlation is performed at the IAA correlator. For 2010 the mean RMS EOP deviations from the IERS 05C04 series in the Ru-E program were 1.1 mas for Pole position, 35 s for UT1-UTC, and 0.37 mas for Celestial Pole position for 20 sessions. The RMS deviation of the Universal Time values from the IERS C04 series for 49 sessions of the Ru-U program was 59 μs. Station positions were specified in the ITRF2008 reference frames for both domestic and IVS observations.

- **Antenna Axis Offset Estimation from VLBI observations**

  We performed a study of the stability of the axis offset value after repairs [1] and estimated how its value affects EOP estimations. The antenna axis offsets were estimated from global solutions and single sessions. We have built a set of global solutions from R1 and R4 sessions from the sets of sessions before and after the SVETLOE repair. We compared our estimates with local survey data for the stations of the QUASAR network. The Svetloe station axis offset values have changed in the repairs. For non-global networks, the axis offset value of a single station can significantly affect the EOP estimations. The main task of this study is to check the stablility of the axis offset after repairs. The axis offset estimations from single sessions are very unstable; therefore we used global solutions over several time intervals. For the estimation of the SVETLOE axis offset we used the R1 and R4 sessions divided into four intervals:

  - 2003.03.06-2005.05.26: 55 sessions, from start of operation until test rail repair
  - 2005.07.21-2006.05.04: 40 sessions, from test rail repair until full rail repair and removing of large equipment cabin
  - 2006.08.03-2007.06.21: 55 sessions, from full rail repair until repair of the bearings
  - 2007.08.30-2009.06.25: 141 sessions, from bearings repair until now

  We performed three on-site measurements of the SVETLOE axis offset: in 2005 and 2006 by Igor Shahnabiev and in 2009 by "Yustas Ltd". A comparison between our estimated values (designated as "VLBI") and on-site Local Geodetic Surveying measurements (designated as "On-site") are presented in Table 1.

Table 1. Values of SVETLOE axis offset from VLBI and on-site measurements (in mm).

	2003.03.06-2005.05.26	2005.07.21-2006.05.04	2006.08.03-2007.06.21	2007.08.30-2009.06.25
VLBI	-15.5 ± 3.2	-15.9 ± 3.6	-10.0 ± 2.8	$+1 \pm 2$
On-site	$-12.5\pm??$		-7.5 ± 0.5	-3.0 ± 1.5

In order to determine how the difference in axis offset can affect our EOP estimations from local network observations, we have processed 41 sessions of our domestic Ru-E [1] program. These are 24-hour sessions with the network "Quasar" [1] consisting of three observatories Svetloe, Zelenchukskaya, and Badary and scheduled for the EOP estimation. The biases and RMS (after removing bias) between obtained EOP and IERS 05C04 series are presented in Tables 2 and 3. For the results presented in Table 2 a single axis offset value for SVETLOE was used for all sessions. For the results in Table 3 the estimated and measured values were taken in their corresponding time intervals.

Table 2. Biases and RMS w.r.t. IERS EOP 05 C04 in EOP estimates with a single SVETLOE offset value.

offset value	-75mm		-3mm		-125mm	
EOP	bias	rms	bias	rms	bias	rms
Xp, mas	-0.114 ± 0.165	0.952	-0.109 ± 0.166	0.959	-0.101 ± 0.157	0.908
Yp, mas	0.588 ± 0.212	1.225	0.790 ± 0.211	1.221	0.342 ± 0.210	1.216
UT, ms	0.009 ± 0.008	0.046	0.005 ± 0.008	0.046	0.012 ± 0.008	0.046
Xc, mas	-0.608 ± 0.120	0.695	-0.596 ± 0.118	0.684	-0.619 ± 0.118	0.679
Yc, mas	-0.093 ± 0.114	0.660	-0.094 ± 0.113	0.652	-0.104 ± 0.109	0.631

One can see from the comparison of the bias values of Table 2 that a difference of 1 cm in the axis offset can result in a difference of up to 0.5 mas in the Y-pole coordinate for our network configuration. The differences in axis offset did not have much impact on the RMS, but it can introduce systematic biases in the EOP.

Table 3. Biases and RMS w.r.t. IERS EOP 05 C04 in EOP estimates using estimated (SVETLOE offsets = -16 mm, -10 mm, 1 mm) and measured (SVETLOE offsets = -12.5 mm, -7.5 mm, -3 mm) values for the corresponding intervals.

offset value	estimated		measured	
EOP	bias	rms	bias	rms
Xp, mas	-0.111±0.161	0.956	-0.090 ± 0.161	0.932
Yp, mas	0.690 ±0.210	1.213	0.590 ± 0.210	1.210
UT, ms	0.006±0.008	0.046	0.008 ± 0.008	0.046
Xc, mas	-0.615±0.116	0.667	-0.602 ± 0.120	0.693
Yc, mas	-0.087±0.111	0.641	-0.110 ± 0.115	0.644

The value of the antenna axis offset can significantly affect the parameters estimated from VLBI data. Offsets can change through repair work at the stations. In order to improve the accuracy of VLBI results it is necessary to estimate the axis offset after the repair at the the stations by on-site measurement or from reprocessing of observations. The differences between estimated and measured values need to be investigated.

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.
- Further improvement of algorithms and software for processing VLBI observations.

References

[1] A. Finkelstein, E. Skurikhina, I. Surkis, A. Ipatov, I. Rahimov, S. Smolentsev, "QUASAR National Programs of EOP Determinations", Measuring the future, Proceedings of the Fifth IVS General Meeting, ed. A. Finkelstein, D. Behrend, St-Petersburg, "Nauka", 2008, p. 319–323.

[2] S. Kurdubov et al.: Antenna Axis Offset Estimation from VLBI, IVS 2010 General Meeting Proceedings "VLBI2010: From Vision to Reality", Edited by Dirk Behrend and Karen D. Baver NASA/CP-2010-215864 December 2010, p. 247–250.