IAA VLBI Analysis Center Report 2013

Elena Skurikhina, Sergey Kurdubov, Vadim Gubanov, Daniil Shigaev

Abstract This report presents an overview of the IAA VLBI Analysis Center activities during 2013 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 lengths, 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 Activities during the Past Year

2.1 Software Development for VLBI Processing

The QUASAR software is capable of calculating all types of IVS products. The possibility of outputing source positions to DSNX files was realized.

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2.2 Routine Analysis

During 2013 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. The 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 and troposphere parameters iaa2007a.trl were continued. Long-term series of station coordinates, baseline lengths, and tropospheric parameters (ZTD and gradients) were computed with the station position catalog ITRF2005.

2.3 Global Solution

iaa2012crf and iaa2012trf were submitted to IVS. A new global solution was calculated using all available data from 1980 until 2012 (through the end of September 2012 we had 5,654 sessions). A total of 6,912,198 delays were processed. The CRF was fixed by NNR constraints to 212 radio sources. The TRF was fixed by NNR and NNT constraints to the station positions and velocities of 15 stations: MATERA, KOKEE, WETTZELL, FORTALEZA, WESTFORD, ALGOPARK, NYALES20, ONSALA60, HARTRAO, BR-VLBA, FD-VLBA, HN-VLBA, KP-VLBA, LA-VLBA, and NL-VLBA. Stochastic signals were estimated by means of the least-squares collocation technique. The radio source coordinates, station coordinates, and corresponding velocities were estimated as global parameters. EOP, WZD, troposphere gradients and station clocks were estimated as arc parameters for each session. 6,690 global parameters were estimated: 3,635 source positions, and the positions of the velocities of 156 VLBI stations.

2.4 EOP Parameter Calculation from Domestic "Quasar" Network Observations

VLBI observations using the "Quasar" network for EOP monitoring are carried out in the framework of two domestic programs: Ru-E and Ru-U.

The purpose of the Ru-E program is to provide EOP results on a regular basis from 24-hour sessions using three-station network: "Svetloe" – "Zelenchukskaya" – "Badary".

The purpose of the Ru-U program is to provide UT1-UTC results on a regular basis from Intensive sessions using one baseline "Badary" – "Zelenchukskaya" ("Badary" – "Svetloe").

Correlation analysis is performed using the IAA ARC correlator.

Observational data from 1-hour Ru-U sessions are transmitted to the correlator using e-VLBI data transfer. Calculation of UT1 time series is performed automatically. The result is a UT1-UTC time series available at ftp://quasar.ipa.nw.ru/pub/EOS/IAA/eopi-ru.dat.

Since April 2013 we have used e-VLBI data transfer for the data of 24-hour observations from "Badary" and "Zelenchukskaya". Data of 24-hour sessions are shipped to the IAA correlator on disk modules only from "Svetloe" observatory. The EOP time series is available at ftp://quasar.ipa.nw.ru/pub/EOS/IAA/eops-ru.dat.

During 2013, 48 Ru-E and 356 Ru-U sessions were observed. AC IAA performed analysis of these observations. The accuracy obtained in 2013 for EOPs in comparison to the IAA EOP 08 C04 series is presented in Table 1.

Table 1 RMS differences with EOP IERS 08 C04.

EOP	N_{sess}	Bias	RMS
X_p, mas	48	0.45	0.97
Y_p, mas	48	-0.67	1.23
UT1-UTC,μs	48	-15	35
X_c,mas	48	-0.13	0.34
Y_c, mas	48	-0.19	0.33
UT1-UTC Int., μs	356	25	67

2.5 CONT11 Data Analysis

Secondary treatment of the CONT11 program's observations was carried out using software package OCCAM/GROSS. In the calculation of diurnal EOP, 15 daily sessions were combined into one 15-day session (consisting of 16,430 scans and 145,214 delays), which was processed using package OCCAM/GROSS using the forward run of the Kalman filter to estimate the stochastic parameters. As stochastic parameters are considered EOP (pole coordinates and universal time), the date, time, wet component of the tropospheric delay at the zenith (WZD).

Diurnal variations of X_{pol}, Y_{pol}, and $dUT1$ were compared with the model of diurnal variations from the EOP IERS Conventions (2003) model of subdaily EOP variations (designated here as "model"). The results are presented in Figure 1. RMS differences between EOP and the model are presented in Table 2.

Table 2 CONT11: RMS differences between EOP and "model".

EOP	N_{point}	RMS
X_p, μas	16123	167
Y_p, μas	16123	164
dUT1,μs	16123	18

The values of Tropospheric Total Zenith Delay (TZD) obtained during CONT11 from VLBI are in good agreement with data obtained from GPS observations. The results are presented in Figure 2.

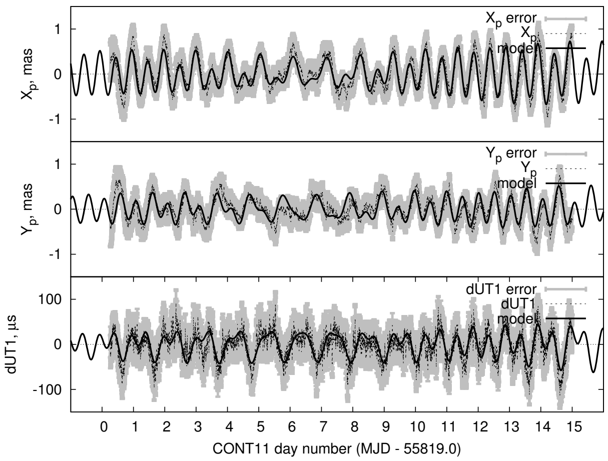

Fig. 1 EOP intra-day variations from CONT11.

2.6 *Study of Systematic Errors of Reference Frames*

First, directly from the data processing of VLBI observations from about 30 years and using systematic errors obtained from the QUASAR software, coordinates for ICRF2 radio sources were calculated as two-dimensional maps of distributions of radio source position errors on the celestial sphere and orthonormal expansion in spherical harmonics up to the ninth order. At some areas, the value of the errors is about 1 mas. Radio source and station position variations were then analyzed to study reference frame stability.

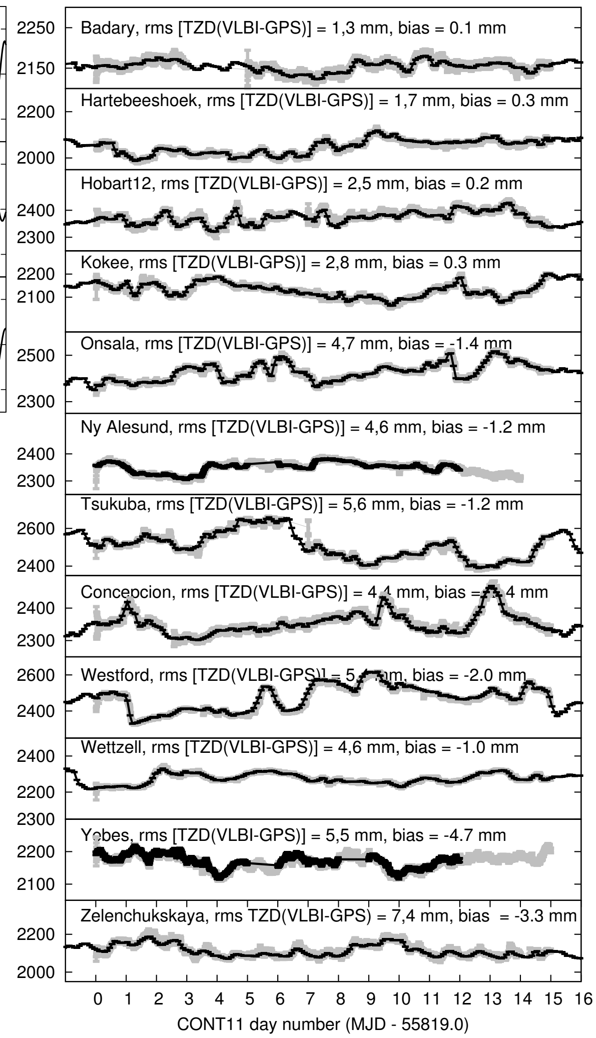

Fig. 2 TZD intra-day (VLBI compared with GPS) variations from CONT11.

3 Current Status

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 (2010). 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 being developed.

4 Future Plans

We plan to:

- Continue to submit all types of IVS product contributions.
- Continue investigations into VLBI estimation of EOP, station coordinates, and tropospheric parameters, and comparison with satellite techniques.
- Further improve algorithms and software for processing VLBI observations.
- Contribute to ICRF3 Working Group study.