IAA VLBI Analysis Center Report 2003

Zinovy Malkin, Elena Skurikhina, Vadim Gubanov, Yuriy Rusinov, George Krasinsky,
Nadia Shuygina

Abstract

The report contains a brief overview of IAA activity as IVS Analysis Center in 2003 and the plans for nearest future.

1. General Information

The IAA Analysis Center (IAA AC) is located at the Institute of Applied Astronomy of the Russian Academy of Sciences in St. Petersburg, Russia. The main fields of the activity include EOP service, computation of station and radio source coordinates, geodynamical investigations, comparison and combination of EOP, TRF and CRF realizations, development and comparison of models and software for processing VLBI observations. The IAA AC web page `http://www.ipa.nw.ru/PAGE/DEPFUND/GEO/ac_vlbi/` is supported.

Three groups at the IAA contribute to IAA AC activity:

1. Lab of Space Geodesy and Earth Rotation (LSGER group, contact *malkin@quasar.ipa.nw.ru*): Dr. Zinovy Malkin (Head, 30%), Elena Skurikhina (100%). The main tasks of this group are determination of long-time EOP series, station and radio source coordinates, comparison and combination of space geodesy products. The group also maintains EOP service, space geodesy observations and various data bases. The group explores OCCAM and GROSS software.

2. Group of processing of VLBI observations with the QUASAR software (former Lab of New Methods in Astrometry and Geodynamics, QUASAR group, contact *gubanov@quasar.ipa.nw.ru*): Prof. Vadim Gubanov (Head, 100%), Iraida Vereshagina (Kozlova) (100%, left IAA in October 2003), Yuriy Rusinov (50%). The main task of this group is determination of EOP, station and source coordinates and other astrometric and geophysical parameters using QUASAR software with emphasis on investigation of stochastic parameters (EOP, troposphere, clocks).

3. Lab of Ephemeris Astronomy (LEA group, contact *nvf@quasar.ipa.nw.ru*): Prof. George Krasinsky (Head, 10%), Nadia Shuygina (20%). The main IVS related activity of this group is the investigations in Earth sciences and dynamical astronomy based on processing VLBI observations, and combining VLBI, satellite, radar and optical observations at the observational level, using ERA software.

2. Analysis Activities

2.1. LSGER Group

The activities of the LSGER group in 2003 included:

- Development of the OCCAM and GROSS software used for processing of the VLBI observations. Main improvements made during the period are implementation of a new atmospheric loading model (data provided by GSFC is used), new TRF realization VTRF2003 with updates for stations SVETLOE and GGAO, new FCN model. Many other changes with no significant systematic effect were made.

- Continued 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. New EOP series iaao0307.eops and iaai0307.eopi were started. At the moment, the eops series contains 2792 estimates of pole coordinates, UT1 and nutation, and the eopi series contains 4618 estimates of UT1.
- 24-year session station coordinates, baseline lengths, and tropospheric parameters (ZTD, gradients) time series are obtained. Analysis of the results is in progress. In particular, ZTD series (one value for each session) is analyzed. Long time ZDT behavior can be described as combination of seasonal term and linear drift. Some results are presented in Table 1. The comparison with meteodata series is also made [4].

Table 1. Parameters of WZD time series.

Station	Nobs	Time span	Bias, mm	Drift, mm/year	Ann. amp., mm
ALGOPARK	429	1992.4–2003.8	84.8±2.5	-1.4±0.8	60.9±0.9
FORTLEZA	622	1993.3–2003.8	250.6±1.7	-1.0±0.6	56.4±2.4
GILCREEK	929	1984.5–2003.8	52.0±1.1	0.7±0.2	42.3±1.3
HARTRAO	459	1986.0–2003.8	95.3±3.2	2.1±0.5	58.3±3.3
HRAS 085	480	1980.5–1990.8	84.3±5.2	2.1±1.8	5.2±4.1
KAUAI	345	1987.5–1994.2	80.7±3.1	2.3±1.7	27.3±2.8
KOKEE	859	1993.4–2003.8	89.8±1.2	0.3±0.4	19.1±1.7
MATERA	382	1990.7–2003.8	99.3±2.4	-0.2±0.6	42.3±2.7
MOJAVE12	447	1983.4–1992.6	54.0±3.5	0.7±1.3	13.3±3.3
NRAO20	173	1995.1–2000.4	72.9±4.5	-2.9±4.3	33.2±4.9
NRAO85 3	374	1989.2–1996.6	92.9±2.7	2.5±1.4	44.4±4.2
NYALES20	328	1994.7–2003.7	40.0±1.2	1.9±0.4	28.3±1.5
RICHMOND	646	1984.0–1992.6	201.1±3.9	5.5±1.5	46.5±4.0
WESTFORD	830	1981.3–2003.8	83.9±2.8	1.7±0.5	18.0±3.2
WETTZELL	1584	1984.0–2003.8	81.5±1.2	-0.1±0.2	27.4±1.4

- 24-year session station coordinates time series in the SINEX format is prepared for the IVS Baseline Length Pilot Project.
- Investigation of nutation series available in the IVS data base was continued. Corrections to the IAU2000 precession in longitude and obliquity have been estimated, and a new FCN model is proposed [2].
- Comparison of European baseline length variations derived from VLBI and GPS observations was continued [3].
- Support of IAA data base of VLBI observations and products. At the moment more than 8500 X band NGS files and more than 10,000 X and S databases are stored.

2.2. QUASAR Group

In 2003 software QUASAR was prepared for processing all observations made during 1979–2003 to improve terrestrial and celestial reference systems and EOP [1]. New database of observations in the QUASAR format was created. The special features of this database are:

1. Using special graphic system of QUASAR, the diurnal trends of clock for all stations were reduced to general quadratic model.

2. The series, containing more than 2000 observations (e.g. VLBA, BB023), were shared in several subseries, each containing less than 2000 observations. This allows us to process observations with limited computing resources.

All observations had preliminary processing, new evaluations of autocovariance functions of stochastic signals such as WTD fluctuation, clock instability, and UT1 variation were obtained. It was proved that the Least Squares Collocation (LSC) method gives estimates of signals that are stable with respect to uncertainty of their a priori covariance functions. The efficiency of database correction is demonstrated in Figure 1. One can see that two subseries of CONT94 program give very close LSC-estimates of WTD coinciding with the direct WVR measurements.

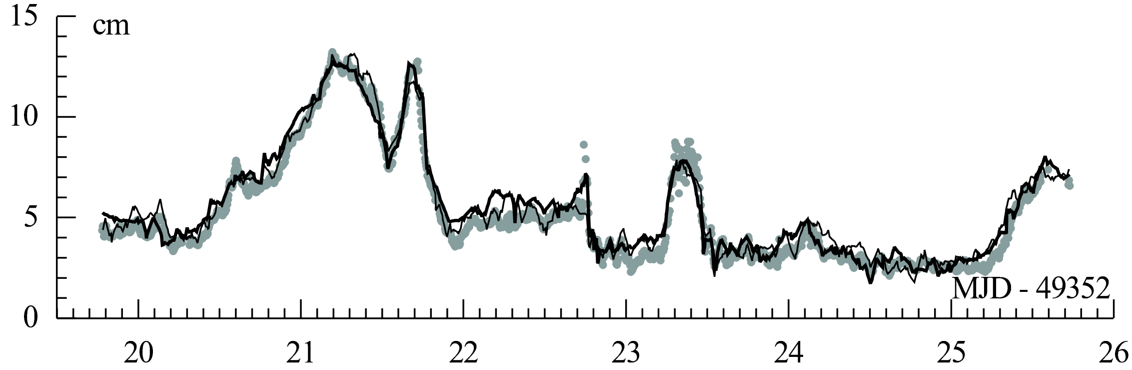

Figure 1. LSC-estimation of WTD at Onsala with comparison of two subseries (thick and thin lines) and WVR-measurements (bullets).

During January–September 2003 estimates of total tropospheric path delay were submitted to the IVS Troposphere Pilot Project.

2.3. LEA Group

A combined analysis of VLBI and SLR measurements at the observation level is carried out for improving the accuracy and time resolution of EOP. Both SLR and VLBI observations are processed by the same software ERA, using the same astronomical constants and models for different kinds of measurements.

At the first stage condition equations for VLBI and SLR observations are obtained from independent processing of each technique. For VLBI measurements zenith component of troposphere delay and its gradients are adjusted as stochastic signals for each day of observation. Both coordinates of quasars and site coordinates are not improved in this solution. For SLR data we used laser ranges to geodetic satellites LAGEOS (L1), LAGEOS 2 (L2), and Etalon 1&2 (E). The short arc technique with the arc length of 7 days is applied to all the SLR measurements to adjust orbital parameters along with radiation pressure coefficient, and along track acceleration, which are considered as non-stochastic.

At the second stage the SLR and VLBI condition equations are mixed to determine corrections to parameters mentioned above along with five Earth rotation parameters. Kalman filtering procedure is used to solve the system of condition equations. Combining SLR and VLBI measurements on one day arcs makes it possible to improve the standard deviations of pole coordinates in comparison with those obtained by each technique separately. Table 2 illustrates corrections to the Earth orientation parameters w.r.t. the EOP(IERS)C04 and their formal uncertainties obtained from different sets of observations for daily intervals. Applying Kalman filtering method also allows us to derive EOP variations with subdiurnal periods.

Table 2. Corrections to EOP(C04) and formal uncertainties obtained from different sets of observations.

Parameter	VLBI	L1+L2+E	VLBI+L1	VLBI+L1+L2	VLBI+L1+L2+E
Xp, mas	-0.276	-0.035	-0.551	0.189	0.188
	110	36	19	18	18
Yp, mas	-0.114	-0.556	-0.348	0.841	0.839
	98	37	29	24	24
UT1-UTC, ms	0.004		0.011	-0.005	-0.005
	6		5	6	6
Dpsi, mas	-0.189		-0.115	-0.342	-0.336
	180		197	250	224
Deps, mas	0.513		0.553	0.512	0.120
	86		95	120	119

3. Outlook

Plans for the coming year include:

- Improvement of algorithms and software for processing of VLBI observations. In particular, implement the IMF and/or VMF mapping function(s).
- Continue regular computation of EOP series, station coordinates, and troposphere parameters with OCCAM software. Submit the results to IVS and IERS.
- Obtain a preliminary results of global analysis of the VLBI data with QUASAR software.
- Continue investigations of VLBI EOP, station coordinates, and troposphere delays series.
- Continue to support data base of VLBI observations and products.

References

[1] Gubanov, V. Project: Global analysis of 1979–2003 VLBI data. Presented at the Journées 2003, St. Petersburg, Russia, Sep 22–25, 2003.

[2] Malkin, Z. M. Comparison of VLBI nutation series with the IAU2000A model. Presented at the Journées 2003, St. Petersburg, Russia, Sep 22–25, 2003.

[3] Skurikhina, E., N. Panafidina, Y. Sokolova. GPS and VLBI Baseline Length Variations Presented at the Journées 2003, St. Petersburg, Russia, Sep 22–25, 2003.

[4] Skurikhina, E. Long time ZTD series for some stations. To be presented at the 3rd IVS General Meeting, Ottawa, Canada, Feb 9–11, 2004.