IAA VLBI Analysis Center Report 2002

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Abstract

The report contains a brief overview of IAA activity as IVS Analysis Center in 2002 and the plans for the near future. Results of investigations obtained during period passed since the last report are described.

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 activity include EOP service, computation of station and radio source coordinates, geodynamical investigations, comparison and combination of EOP, TRF and CRF realizations, and development and comparison of models and software for processing VLBI observations. The IAA AC works in close cooperation with the IERS and IVS. We regularly submit the results of operational computation of EOP (both "24h" and intensive series) to the IERS and IVS, and yearly submit long-time EOP series (starting from 1996) to the IERS Annual Reports. In 1999-2001 we also submitted our CRF solutions to the IERS Annual Reports. The IAA AC web page `http://www.ipa.nw.ru/PAGE/DEPFUND/GEO/ac_vlbi/` was originated in 2001.

2. Organization and Staff

Three VLBI groups of 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%), Natalia Panafidina (10%). The main tasks of this group related to IVS activity are: operational EOP service, determination of long-time EOP series, station and radio source coordinates from all available observations, comparison and combination of VLBI, GPS, and SLR products. The group also maintains space geodesy observations and EOP series data bases for use by all interested groups of the IAA. The group explores OCCAM and GROSS software.

2. Lab of New Methods in Astrometry and Geodynamics (LNMAG group, contact *gubanov@quasar.ipa.nw.ru*): Prof. Vadim Gubanov (Head, 100%), Dr. Igor Surkis (100%, moved to the IAA correlator team in November of 2002), Iraida Vereshagina (Kozlova) (100%), Yuriy Rusinov (80%). The main task of this group related to IVS activity 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) [1].

3. Lab of Ephemeris Astronomy (LEA group, contact *kra@quasar.ipa.nw.ru*): Prof. George Krasinsky (Head, 25%). The main IVS related activity of this group is development of the ERA software for investigations in Earth sciences and dynamical astronomy based on processing VLBI observations including combining VLBI, SLR, LLR, radar and optical observations on the observational level. In particular, determination of EOP from the combination of VLBI and SLR observations is under development.

3. Analysis Activities

3.1. LSGER Group

The activities of the LSGER group in 2002 included:

- Development of the OCCAM and GROSS software used for processing of the VLBI observations. Main improvements made in the period are:
  - Tropospheric gradients are estimated as single constant value during the session (main source of systematic differences with the previous series).
  - XY(CIO) are reported instead of dPsi/dEps (it is not a result of real estimation of dX/dY, but mere transformation of estimated dPsi/dEps).
  - Implementation of the IERS2003 models was continued.
  - Many other changes with no significant systematic effect: updated model of tropospheric refraction, new a priori STD of estimated parameters (100 mas for EOP, 100 m for station coordinates), new reference temperatures for antenna thermal deformation, GOT00 model for ocean loading, new processing options, fixing bugs, etc.
  - Software for comparison and combination of EOP and station coordinates has been advanced.
- 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 iaao0301.eops and iaai0301.eopi were started.
- New results were submitted to the IERS in May of 2003. Those are two EOP series (2428 "24h" sessions over a period from September 1980 till April 2002 and 4028 intensive sessions over a period from April 1984 till April 2002).
- More than 20-year session station coordinates and baseline lengths time series are obtained. Analysis of the results is in progress. In particular, influence of antenna thermal deformation is investigated [6].
- Investigation of nutation series available in the IVS data base was continued. Corrections to the IAU2000 precession in longitude and obliquity have been estimated [4]. Further investigation of VLBI nutation series is in progress.
- Investigations of systematic differences between VLBI series was continued. In particular, differences between R1 and R4 observing programs are under study.
- Comparison of European baseline length variations derived from VLBI and GPS [3].
- Investigation of the accuracy of EOP rates obtained from VLBI [5].
- Support of IAA data base of VLBI observations and products. At the moment all available X band NGS files (more than 8000 sessions) and about 6800 X and S databases are stored.

3.2. LNMAG Group

Since July 2002 the group participates in the IVS Pilot Project "Tropospheric Parameters" which deals with determination of hourly total and wet zenith path delays for VLBI sessions obtained from the IVS-R1 and IVS-R4 observing programs. Calculation of the delays

has been made using collocation or Kalman filter methods depending on number of observations in the session, and correlated signal model. Both methods, along with other ones, are implemented in the QUASAR software which was used for this work. Results of computation and comparison with others series can be found on the IVS Pilot Project web site at the `http://luna.tuwien.ac.at/forschung/radiointerferometrie/IVS-AC/`.

Phase fluctuations of H-masers at Svetloe were estimated from measurement of phase differences between two CH1-80 masers. Technical support of this work was provided by Alexander Vytnov. In total, 83 24-hour series of measurements were made. The results are shown in Figure 1 after removing quadratic trend.

Averaged covariance function can be approximated with the following model

$$q(\tau) = \sigma^2 \sum_{i=1}^{2} a_i \exp(-\alpha_i|\tau|)(\cos\omega_i\tau + \gamma_i \sin\omega_i|\tau|)\,.$$

Parameters of the model are presented in Table 1. Measured correlation function and comparison with model are shown in Figure 2.

Table 1. Parameters of covariance function model.

σ, ps	a_1	α_1	ω_1	γ_1	a_2	α_2	ω_2	γ_2
60	0.679	11.122	8.578	-1.297	0.321	2.994	10.011	-0.253

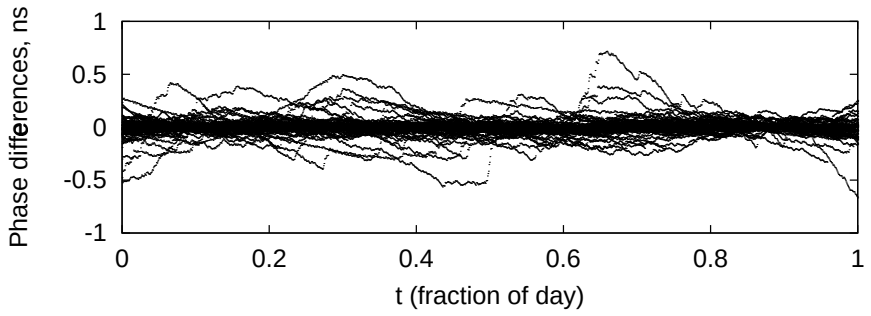

Figure 1. Measured phase differences between two H-masers.

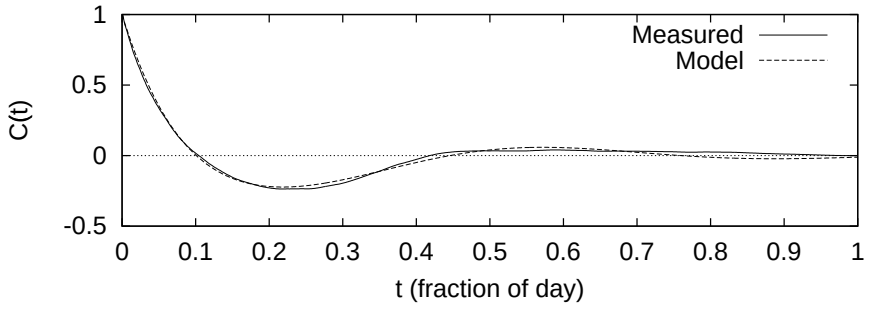

Figure 2. Measured and model correlation functions of H-maser phase fluctuations at Svetloe.

3.3. LEA Group

Simple analytical expressions to model diurnal oscillations in site displacements and in the coefficients c_2^1, s_2^1 of the geopotential caused by the centrifugal potential of the Earth's fluid core are derived in terms of nutational coefficients. Amplitude of the largest tidal constituent $K1$ in the radial site displacements and the Love numbers h_2 and l_2 are determined from analysis of VLBI observations of NEOS-A program 1998–2001. The estimated amplitude of the $K1$ term appears to be 19 ± 1 mm and statistically differs from the value 12.2 mm recommended by IERS Conventions (1996). According to the developed theory this amplitude is proportional to the dynamic Love number h_2^d; thus applying the derived analytical expression the estimate $h_2^d = 0.095 \pm 0.005$ follows. For the static Love numbers h_2, l_2 the estimates $h_2 = 0.626 \pm 0.001, l_2 = 0.0922 \pm 0.0005$ are obtained. Results of the research are published in [2].

4. Outlook

Plans for the coming year include:

- Continue improvement of algorithms and software for processing of VLBI observations.
- Continue regular computation of EOP series and station coordinates with OCCAM package.
- Begin regular submission of results obtained with the QUASAR package.
- Continue investigations of VLBI EOP, station coordinates, and troposphere delays series.
- Continue activity in comparison and combination of results obtained from VLBI and other space geodesy techniques.
- Continue to support data base of VLBI observations and products.

References

[1] Gubanov V. S., Kozlova I. A., Surkis I. F., Rusinov Yu. L. Processing of VLBI observations: Software QUASAR. Parts 1–5. Comm. IAA RAS, 141–145, 2002. (in Russian)

[2] Krasinsky G. A. Diurnal pole tides and determination of static and dynamic Love numbers from analysis of VLBI observations 1998–2001. Comm. IAA RAS, 150, 2002.

[3] Malkin Z., Panafidina N., Skurikhina E. Length Variations of European Baselines Derived from VLBI and GPS Observations. In: D. Behrend, A. Rius (eds.), Proc. 15th Working Meeting on European VLBI for Geodesy and Astrometry, Barcelona, Spain, September 07–08, 2001, 116–123.

[4] Malkin Z. A Comparison of the VLBI Nutation Series with IAU2000 Model. In.: IVS 2002 General Meeting Proceedings, eds. N. R. Vandenberg, K. D. Baver, NASA/CP-2002-210002, 2002, 335–339.

[5] Malkin Z. Preliminary Analysis of VLBI EOP Rate Results. Presented at the Third IVS Analysis Workshop, Tsukuba, Japan, Feb 8, 2002.

[6] Skurikhina E. On Computation of Antenna Thermal Deformation in VLBI Data Processing. In: D. Behrend, A. Rius (eds.), Proc. 15th Working Meeting on European VLBI for Geodesy and Astrometry, Barcelona, Spain, September 07–08, 2001, 124–130.