IAA VLBI Analysis Center Report 2008

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Abstract

This report presents an overview of IAA VLBI Analysis Center activities during 2008 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. Source position time series and CRF have 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-UTC, and station positions were estimated from domestic observation programs RU-E and RU-U. AC IAA generates NGS files.

2. Component Description

AC IAA 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.

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

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

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.

- **Global solution**

  In 2008 two global solutions (iaa2007b and iaa2008a) using the QUASAR software were calculated and submitted to IVS. All available data for 1979–2008 were processed. 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.

  4,202 24-hour sessions with 5,882,972 delays have been processed. 3,165 global parameters have been estimated: 1,038 radio source positions, and the positions and the velocities of 141 VLBI stations (14 with discontinuities). Also the following parameters were estimated: PPN parameter $\gamma = -0.0002 \pm 0.0002$; the nominal values of Love numbers $h2_0 = 0.6078$ and $l2_0 = 0.0847$ and their corrections $dh2_0 = 0.0016 \pm 0.0003$ and $dl2_0 = -0.0002 \pm 0.0001$; and tidal lag $= -3.3' \pm 1'$.

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

  Time series for more than 600 sources were calculated using the QUASAR software for VLBI data processing. Source positions for every source were obtained from single series analysis by fixing the coordinates of all the sources. A priori source positions were used from the ICRF-Ext.2 radio source position catalog. Time series analysis is performed with the covariation analysis technique adopted for equidistant time series with the aim of detecting more stable sources. Global solutions with different sets of sources for NNR constraints were obtained. Transformation parameters between obtained source catalogs were calculated and compared.

  Two ways of selecting the set of defining sources were proposed and tested. The first used covariation functions for the time series analysis, and the second used orientation parameter accuracy functions for radio source catalogs.

- **Routine analysis**

  Since March 2007, AC IAA has submitted 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 2007 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. Submitting the results to the IERS and 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 3,463 estimates of pole coordinates, UT1, and celestial pole offsets, and the EOPI series contains 5,821 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**

  The regular determinations of Earth's orientation parameters with QUASAR VLBI-Network Svetloe-Zelenchukskaya-Badary using the S2 registration system started in August of 2006 [5]. 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 8-hour sessions for the determination of Universal Time on the Zelenchukskaya—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 0.83 mas for Pole position, 43 s for UT1-UTC, and 0.69 mas for Celestial Pole position. The RMS deviation of the Universal Time values from the IERS C04 series for the RU-U program is 110 μs. First results of observations using the Mark 5B registration system were obtained. Station positions were specified in the ITRF2005 and VTRF2008 catalog systems for both domestic and IVS observations.

- **FCN study**

  Retrograde Free Core Nutation (RFCN) from VLBI observation data analysis was performed by Prof. V. Gubanov [1, 2]. At the first step, Celestial pole offset time series referred to the new model IAU 2000 (X_c, Y_c) were analyzed. Analysis of the combined IERS&NEOS time series by the envelope method in the interval 1984-2008 has shown that both amplitude and frequency vary in a wide range. Retrograde Free Core Nutation (RFCN) periods estimated for three consecutive time intervals (see Figures 1 and 2) amounted to (1) -423.2 ± 0.3, (2) -667.5 ± 0.8 and (3) -452.4 ± 0.4 days. An analysis using the S. Lambert RFCN model [3] leads to close results.

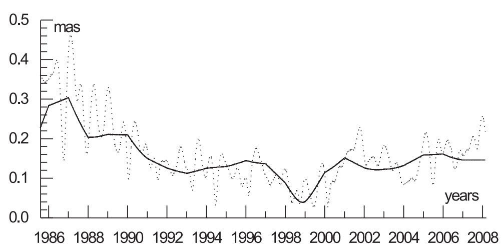

Figure 1. Variations of the RFCN amplitudes derived from the LAM (solid line) and LSC (dotted line) models

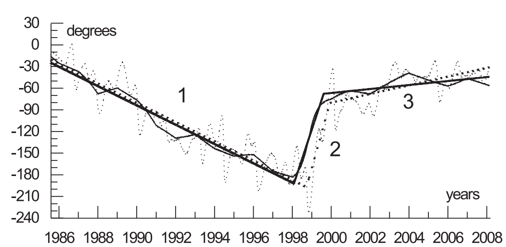

Figure 2. RFCN phase variations and their trends derived from the LAM (solid line) and LSC (dotted line) models

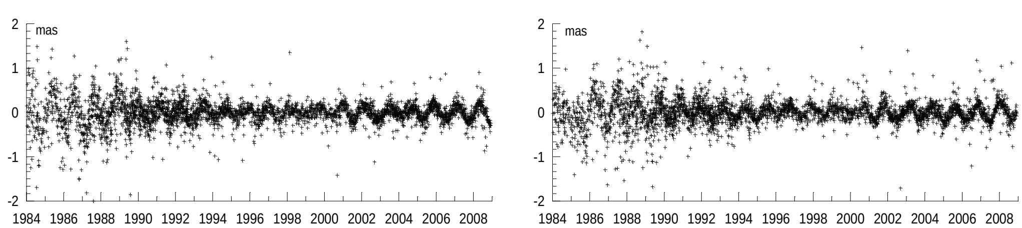

Figure 3. Weighted mean daily values of X_c (left) and Y_c (right)

In a further study, RFCN new X_c, Y_c time series were calculated with QUASAR software. These time series were combined with more long time series from several IVS ACs (AUS, BKG, GSFC, IAA, OPA, SPbU, and USNO) after removing polynomial trends [1]. As a result the time series of CIP from 3,741 points presented in Figure 3 was generated. Further amplitude-frequency analysis of the RFCN time series is planned.

5. Future Plans

- We plan to continue to submit all types of IVS product contributions and to start to submit SINEX files for IVS Intensive sessions.
- Continue investigations of VLBI estimation of EOP, station coordinates, and troposphere parameters, and comparison with satellite techniques.
- Continue studies in the frame of the IERS/IVS Working Group on the Second Realization of the ICRF.
- Further improvement of algorithms and software for processing VLBI observations.

References

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[3] S. Lambert (2007), ftp://tai.bipm.org/iers/convupdt/chapter5/fcnnut.f

[4] S. Kurdubov, E. Skurikhina, Source positions time series generation and analysis. Journees 2007 ISBN 978-2-901057-59-9, 2008, 44-45.

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