# IAA VLBI Analysis Center Report 2005

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**Abstract**

The report contains a brief overview of IAA VLBI analysis activities in 2005 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. Several groups are involved in VLBI data analysis and related studies. Their activities in 2005 are described below. The IAA AC web page `http://www.ipa.nw.ru/PAGE/DEPFUND/GEO/ac_vlbi/` is supported.

## 2. Organization and Staff

IAA groups that contributed to the IAA AC activities are:

1. Lab of Space Geodesy and Earth Rotation (LSGER): Dr. Zinovy Malkin (Head, 30%), Prof. Vadim Gubanov, Dr. Elena Skurikhina, Sergey Kurdubov, Julia Sokolova (all 100%). The main tasks of the lab are EOP service, computation and investigation of operational and long-term series of EOP, station and radio source coordinates, tropospheric parameters, comparison and combination of space geodesy products. For most products and studies the group makes use of OCCAM/GROSS software. Vadim Gubanov and Sergey Kurdubov continued development of the QUASAR software which is intended to provide complete processing of VLBI observations including global analysis and investigation of the stochastic geophysical signals.

2. Lab of Ephemeris Astronomy (LEA): Prof. George Krasinsky (Head, 80%). The main activity was directed to processing VLBI-based EOP for fitting the parameters of new precession-nutation theory (as well as that of UT1 variations) ERA-2005 constructed by numerical integration of refined differential equations of the Earth rotation.

## 3. Analysis Activities

### 3.1. LSGER Group

The activities of the LSGER group in 2005 were as follows:

- Development of the OCCAM/GROSS software was continued. Main improvements made in 2005 were:
  - Implementation of the Vienna Mapping Function VMF1;
  - Using VMF1 data for correction of erroneous station meteo data;
  - Modification of the software to provide processing of the large sessions (continuous CONT05 data set consisting of almost 100,000 observation was successfully processed).

Many other changes with no significant influence on the results were made.

- Operational processing of the "24h" and intensive VLBI sessions, and submitting the results to the IERS and IVS was performed on a regular basis. Processing of the intensive sessions is fully automated. New EOP series iaa2005a.eops and iaa2005a.eopi, along with new series of the session station coordinates iaa2005a.bl and troposphere parameters iaa2005a.trl were started. The main difference of the iaa2005a solution with respect to the previous one is using the VTRF2005 catalog of station positions and velocities, except SVETLOE and GILCREEK stations for which alternate models are used. At the moment, the EOPS series contains 3195 estimates of pole coordinates, UT1, and celestial pole offsets, and the EOPI series contains 5165 estimates of UT1.
- New 26-year long-time series of station coordinates, baseline lengths, and tropospheric parameters (ZTD, gradients) were computed. Analysis of the results is in progress.
- Investigations in the framework of the IVS Pilot Project "Next ICRF" were started. Main directions of this activity are computation of source catalogs, their comparison and combination. In 2005 several tools in Fortran and MATLAB were developed for investigations of systematic differences between catalogs. The first catalog with QUASAR software was obtained and is now under investigation.
- Special processing of about 100 sessions with participation of the IAA SVETLOE station was performed with the goal to improve the station position and velocity, in particular to provide accurate computation of UT1 from the Intensives series observed in the sessions involving SVETLOE. It was found that accounting for the seasonal variations of the station coordinates substantially affects the velocity estimate. More details can be found in [1].
- Operational computation of the NGS cards was continued. NGS cards are computed in automated mode. To reduce the delay in delivering NGS cards to the users, IVS data archive is now checked for new observations every 6 hours.
- IAA archive of VLBI observations and products was supported. At present, all available X and S databases and NGS cards have been stored. The total volume of the data storage has reached 55 GB.

In 2005 the first global solution using the QUASAR software was obtained. All available data for 1979–2005 were processed by means of the least-squares collocation technique. The radio source coordinates, and station coordinates and velocities, along with antenna axis offsets for all stations were estimated as global parameters. EOP, WZD (linear trend plus stochastic signal), troposphere gradients, station clocks (quadratic trend plus stochastic signal) were estimated as arc parameters for each session. For testing of the results, some investigation was carried out. In particular, EOP from R1/R4 and Intensive sessions were computed with OCCAM and QUASAR software using various source and station catalogs. Results of this test are shown in (Table 1). One can see that the bias of the EOP series obtained with the QUASAR catalogs is larger than the one for the EOP series obtained with VTRF/ICRF systems. This problem is now under study.

### 3.2. LEA Group

The current VLBI-based offsets of the Celestial Pole positions provided by Analysis Centers GSFC, USNO, BKG, IAA (OCCAM and QUASAR series), MAO, AUS (time interval 1984, Jan 1 –

Table 1. WRMS residuals of the EOP series w.r.t. EOP(IERS)C04 after removing linear trend.

| TRF/CRF | | Xp $\mu$as | Yp $\mu$as | UT1 0.1$\mu$s | Xc $\mu$as | Yc $\mu$as | UT1(Int) 0.1$\mu$s |
|---|---|---|---|---|---|---|---|
| OCCAM | | | | | | | |
| VTRF05/ICRF-Ext.2 | wrms | 113 | 110 | 51 | 68 | 70 | 152 |
| | bias | –215±6 | 405±6 | –14±3 | 20±4 | 6±4 | –102±6 |
| QUASAR TRF/CRF | wrms | 112 | 104 | 51 | 67 | 71 | 156 |
| | bias | –638±6 | 603±5 | –112±3 | –18±3 | -36±4 | –177±6 |
| QUASAR | | | | | | | |
| VTRF05/ICRF-Ext.2 | wrms | 139 | 159 | 77 | 88 | 100 | 161 |
| | bias | –245±7 | 447±8 | –10±4 | 2±5 | 46±5 | –108±6 |
| QUASAR TRF/CRF | wrms | 115 | 122 | 55 | 86 | 100 | 170 |
| | bias | –631±6 | 614±6 | –127±3 | –35±4 | 1±5 | –177±6 |

2005, Oct 20) were discussed applying the Earth's rotation theory ERA-2005 constructed by numerical integration of differential equations of rotation of the deformable Earth with the two-layer fluid core [2, 3]. As a result, it appeared possible to estimate objectively quality of all the analyzed series: see Table 2 in which the entries are arranged in accordance with the values of the WRMS errors of the residuals $\sigma(d\phi \sin\theta)$ and $\sigma(d\theta)$ with the ERA-2005 ($\theta$, $\phi$ being the Euler's angles of nutation and precession). Smallness of these errors characterizes quality of the corresponding series. The columns $N_{obs}$ and $N_{del}$ of Table 2 provide numbers of the data used and rejected, respectively.

Table 2. Numerical model: statistics $\sigma_{d\theta}$, and $\sigma_{d\phi}$ (mas), Dec 1983 – Oct 2005

| Series | $\sigma(d\theta)$ | $N_{obs}$ | $N_{del}$ | $\sigma(d\phi)\sin\theta$ | $N_{obs}$ | $N_{del}$ | Package |
|---|---|---|---|---|---|---|---|
| GSFC | 0.136 | 3546 | 42 | 0.129 | 3545 | 43 | Calc/Solve |
| USNO | 0.138 | 3260 | 29 | 0.131 | 3255 | 34 | Calc/Solve |
| IAA | 0.138 | 3041 | 55 | 0.131 | 3041 | 55 | OCCAM/GROSS |
| IAA1 | 0.139 | 3074 | 79 | 0.132 | 3056 | 97 | QUASAR |
| BKG | 0.140 | 2916 | 56 | 0.133 | 2922 | 50 | Calc/Solve |
| AUS | 0.170 | 1466 | 2 | 0.171 | 1455 | 13 | OCCAM |
| MAO | 0.179 | 2852 | 2 | 0.198 | 2849 | 4 | SteelBreeze |

Considering the best series of the offsets, the corresponding WRMS values are significantly less than those for the adopted model IAU2000. For instance, the GSFC values $\sigma(d\theta)$, $\sigma(d\phi)\sin\theta$ are 0.136 mas and 0.129 mas, while for the IAU2000 model they are 0.172 mas and 0.165 mas, respectively. Intercomparison of the Earth's rotation theories ERA-2005 and IAU2000 (in the sense ERA-2005 minus IAU2000) is illustrated by Figure 1 for the time span 2000–2010. Figure 1 also shows the residuals of the GSFC series with the IAU2000 theory for the time span for which VLBI data are available (Jan 1, 2000 – Dec 27, 2005). The solid smooth curves present the differences ERA-2005 minus IAU2000. One can see that by 2009 the discrepancy in the precessional angle $\phi$ will reach –2 mas and its absolute value will increase after that epoch. Because the residuals of IAU2000 with the VLBI data for the recent years demonstrate their deterioration (unlike those of ERA-2005 model) we believe that these discrepancies have to be attributed to errors of IAU2000, but not to those of the numerical theory ERA-2005. The WRMS error of differences between the observed UT1 (GSFC series) and the ERA-2005 model is equal to 18 ms for the period 1984–2005. More details are given in [4].

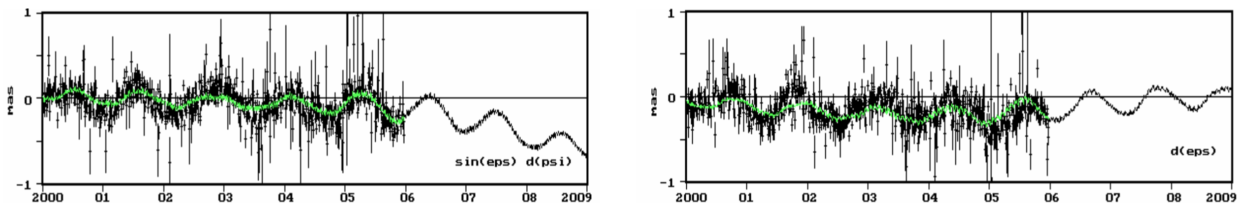


Figure 1. Observed and predicted corrections to IAU2000, GSFC series.

## 4. Outlook

Plans for the coming year include:

- Further improve algorithms and software for processing of the VLBI observations.
- Continue regular computation of operational and long-time EOP, station coordinates, and troposphere parameters series with OCCAM software. Submit the results to IVS and IERS.
- Perform global analysis of the VLBI data with QUASAR OCCAM 6.1 software [6]; comparison of the results.
- Continue investigations of VLBI estimation of EOP, station coordinates, and troposphere parameters, and comparison with satellite techniques.
- Advance a model for seasonal variations of WZD [5].
- Continue investigation in comparison and combination of source catalogs; participate in the IVS Pilot Project "Next ICRF".

## References

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