IAA VLBI Analysis Center Report for 2000

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1. Introduction

The IAA Analysis Center (IAA AC) is located at the Institute of Applied Astronomy of the Russian Academy of Sciences. 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 algorithms and software for processing VLBI observations. IAA AC works in close cooperation with IERS and IVS.

2. Staff

Three VLBI groups of IAA contribute to IAA AC activity:

1. Lab of Space Geodesy and Earth Rotation: Dr. Zinovy Malkin (head), Elena Skurikhina, Dr. Maria Sokolskaya. The main tasks of this group related to IVS activity are: management of the IAA EOP Service, determination of EOP, station and radio source coordinates, comparison and combination of VLBI, GPS, and SLR products. The group explores two program packages: OCCAM for EOP and TRF computation, and ERA for EOP and (mainly) CRF computation.

2. Lab of Ephemeris Astronomy: Prof. George Krasinsky (head). The main IVS related activity of this group is development of program package ERA for investigations in Earth sciences and dynamical astronomy based on processing VLBI observations including combining VLBI, SLR, LLR, and optical observations. In particular, determination of EOP from combination of VLBI and SLR observations is under development.

3. Lab of New Methods in Astrometry and Geodynamics: Prof. Vadim Gubanov (head), Igor Surkis, Iraida Kozlova, Yuriy Rusinov. The main task of this group related to IVS activity is determination of EOP, station and source coordinates using new package QUASAR with emphasis on investigation of stochastic parameters (EOP, troposphere, clocks).

3. Analysis Activities

3.1. EOP service

IAA EOP Service based on regular processing of SLR and VLBI observations has been operating since 1994. Regular processing of VLBI observations started in 1996. Both operative and yearly final EOP series are regularly contributed to both the IERS and the IVS. Accuracy of these series is presented in Table 1. Along with EOP, station coordinates for every 24h session are computed. In 2000 we started operative processing of the NEOS Intensives series.

In 2000 two EOP final solutions EOP(IAA)00R01 (1984–1999) obtained with OCCAM package and EOP(IAA)00R02 (1994–1999) obtained with ERA package have been submitted to the IERS 1999 Annual Report. For all solutions the model of reduction and the method of parameter estimation were practically analogous to those described in the IVS 1999 Annual Report.

Table 1. Accuracy of EOP series obtained with the OCCAM package for 1999–2000.

Series (program)	X_p, mas	Y_p, mas	$UT1$, 0.1 ms	$\Delta\psi\ \sin\varepsilon$, mas	$\Delta\varepsilon$, mas
IAAo9907 (NEOS-A+CORE)	0.19	0.15	0.09	0.13	0.15
IAAo9907 (NEOS-A)	0.14	0.14	0.07	0.12	0.14
IAAi0011 (NEOS-I)	—	—	0.22	—	—

3.2. Radio source coordinates

The computation of radio source catalogues from global processing VLBI observations using ERA package was continued in 2000. Two catalogs of 312 radio sources have been submitted to the IERS 1999 Annual Report. Moreover, the first version of software for comparison and combination of catalogs is advanced. The latest radio source catalog was transformed to the ICRF system and compared with ICRF-Ext.1. Result of comparison is presented in Figure 1.

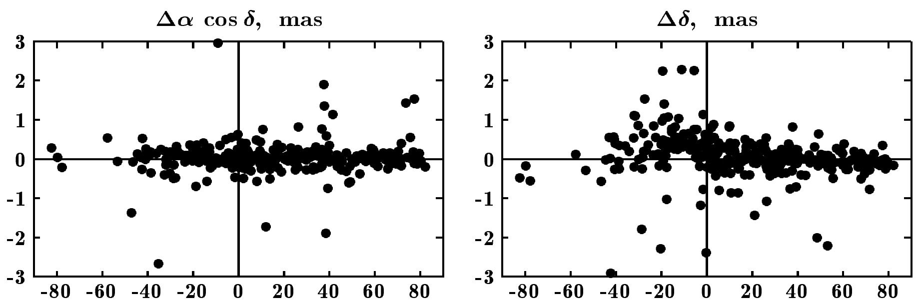

Figure 1. Differences of radio source coordinates RSC(IAA)–ICRF-Ext.1.

A special study was performed to investigate possible dependence of radio source coordinates on observational programs (NEOS-A – CORE-A).

3.3. Processing long time series VLBI observations

All available 24h VLBI sessions were processed to obtain session station coordinates and troposphere zenith delay time series. An example of wet troposphere delay time series is presented in Figure 2.

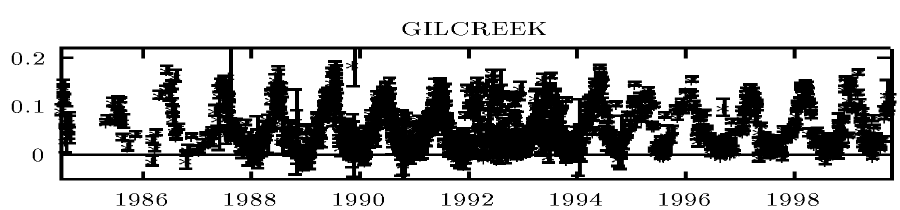

Figure 2. Time series of wet zenith troposphere delay for station Gilmore Creek.

A series of UT1 based for period 1984–2000 has been also obtained and submitted to the IVS.

3.4. Comparison and combination of EOP series

The basic software for comparison of EOP series is developed. This software allows us to compute and investigate systematic differences of EOP and TRF series and related statistics. It is in every-day use in the EOP service. Software for combining EOP series including those obtained from different observational techniques is also advanced.

In 2000 we performed intensive study of systematic differences between EOP series and CRF realizations obtained from NEOS-A and CORE programs with OCCAM and ERA packages. It was found, in particular, that EOP results substantially depend on software and CRF used for computation. The differences between EOP series contain significant systematic components. Table 2 presents some obtained results.

Table 2. Wrms of differences between EOP series obtained from different observational programs using two program packages and two radio source catalogues with EOP(IERS)C04 before/after removing linear trend.

Program / catalog / package	X_p, μas	Y_p, μas	UT1, 0.1 μs	$\Delta\psi$, μas	$\Delta\varepsilon$, μas
NEOS-A / IAA / ERA	323/271	287/246	170/105	570 /531	254/201
NEOS-A / WGRF / ERA	273/265	268/232	140/97	550 /521	206/192
NEOS-A / IAA / OCCAM	219/200	202/165	103/93	328 /306	142/133
NEOS-A / WGRF / OCCAM	219/201	202/165	103/93	328 /305	142/134
CORE-A / IAA / ERA	453/389	448/320	261/229	808 /619	325/252
CORE-A / WGRF / ERA	398/361	343/306	238/214	737 /630	241/228
CORE-A / IAA / OCCAM	213/194	247/170	114/107	467 /420	180/174
CORE-A / WGRF / OCCAM	204/194	219/173	124/114	489 /426	188/184
CORE-B / IAA / ERA	357/313	298/287	247/192	763 /725	268/203
CORE-B / WGRF / ERA	374/322	317/294	270/207	764 /729	240/226
CORE-B / IAA / OCCAM	273/207	250/218	158/140	545 /521	185/170
CORE-B / WGRF / OCCAM	273/208	258/225	159/141	550 /526	190/176

3.5. First results of program package QUASAR

The multi-functional package QUASAR is aimed at processing observations of global VLBI networks with the purpose of studying Earth rotation and improving coordinate systems accuracy. The package runs under Windows 9x. Main features of the package are:

1. Flexible parameterization.
2. Different methods of parameter estimation: multi-parameter least squares (MPLS) (realized); multi-group least squares (MGLS) (realized); moving least squares filter (MLSF) (planned); optimal Kalman filter (OKF) (realized); moving Kalman filter (MKF) (planned); least squares collocation (LSC) (realized).
3. Multi-window control system which allows the user to select and tune the reduction model, to correct or reject outliers, and organize input-output database control.

Package QUASAR was applied to processing NEOS-A observations for period 1997–1998. Data were processed using LSC techniques. The accuracy of EOP determination in comparison with

EOP(IERS)C04 series is presented in Table 3. Comparative analysis of EOP results obtained with different estimation techniques is underway.

Table 3. Accuracy of EOP series obtained with the QUASAR package for 1997–1998.

X_p, mas	Y_p, mas	$UT1$, 0.1 ms	$\Delta\psi\,\sin\varepsilon$, mas	$\Delta\varepsilon$, mas
0.16	0.17	0.09	0.14	0.20

NEOS Intensives observations for 1998–2000 were processed using MPLS, OKF and LSC techniques. The most accurate estimations were obtained by MPLS with use of stochastic regularization.

Twelve sessions carried out during CONT94 experiment were processed using LSC technique and estimates of intraday stochastic components were obtained as follows:

- wet component of zenith troposphere delay for all stations (for station Onsala result is in good agreement with independent WVR measurements); significant horizontal gradients of wet troposphere zenith delay were found for some stations.
- residual variations of PM and UT with reference to Ray's and Gipson's models that are consistent within ±0.1–0.3 mas.

The same observations were used for determination of global nominal and secular Love and Shida numbers. The following values were obtained: $h^{(0)}$=0.579±0.003, $l^{(0)}$=0.087±0.001, h_s=0.795±0.009, l_s=0.129±0.002. Secular numbers are related to total permanent tide in the reference frame ITRF'97. Moreover, nominal Love and Shida numbers were estimated from 12 daily sessions. These results show some instability of local number h that may be caused by insufficient modelling of vertical motion of Earth crust.

LSC technique has been also applied to processing observations of programs IRIS (1984–1992) and NEOS-A (1993–1999). Estimates of all stochastic parameters and their autocovariance functions were obtained. Significant instability of these functions was detected; therefore further LSC evaluation will be carried out by use of iteration process.

4. Outlook

We plan for the coming year:

- Regular computation of combined `eops` and `eopi` series and submission of results to the IVS Analysis Coordinator for further investigation.
- Development of algorithms and software for analysis, comparison and combination of radio source catalogs.
- Regular computation of session station coordinates in SINEX format.
- Comparison of weekly station coordinates and troposphere delay solutions obtained from VLBI and GPS.
- Beginning of regular submission of EOP computed from NEOS-A and NEOS-I sessions with QUASAR package.