IAA VLBI Analysis Center 2019–2020 Report

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Abstract This report presents an overview of the IAA VLBI Analysis Center activities in 2019 and 2020, and future plans.

1 General Information

The IAA IVS Analysis Center (IAA AC) operates at the Institute of Applied Astronomy of the Russian Academy of Sciences, St. Petersburg, Russia. The IAA AC contributes to IVS products, such as daily SINEX files, TRF and CRF solutions, and rapid and long-term series of EOP obtained from the IVS observational sessions. The IAA AC stopped submitting IVS NGS files due to the transition of IVS to the new vgosDB data format. The IAA AC generates NGS files from VGOS files for the QUASAR and OCCAM/GROSS softwares. Besides IVS VLBI data, the IAA AC deals with the data treatment of the domestic observations produced by both the RT-32 radio telescopes (SVETLOE, ZELENCHK, and BADARY) and the RT-13 VGOS radio telescopes (ZELRT13V, BADRT13V, and SVERT13V).

2 Staff

- Dr. Sergey Kurdubov: development of the QUASAR and analysis software.
- Prof. Vadim Gubanov: development of the QUASAR software and the methods of stochastic parameter estimation.
- Dr. Elena Skurikhina: team coordination; VLBI data processing, and OCCAM/GROSS software development.
- Svetlana Mironova: development of the QUASAR software, VLBI data processing, global solution and DSNX files calculation, data combination with SINCOM software
- PhD Student Alexey Kudelkin: studies in the field of the stochastic data modeling, development of new technique of schedule for VLBI observations.
- Marina Gribanova: VLBI data processing, development of new technique of EOP prediction.

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3 Activities during the Past Years

During 2019 and 2020, the IAA AC analyzed data of the IVS (legacy S/X and VGOS) and domestic observations, submitted to the ITRF2020, and made some investigations.

3.1 Routine Analysis

In 2019 and 2020, the IAA AC continued to generate daily SINEX (DSNX) files from analysis of IVS-R1 and IVS-R4 sessions using the QUASAR software. DSNX files were submitted to the IVS for combination with results of other Analysis Centers.

The IAA AC operationally processed the 24-hour and Intensive VLBI sessions using OCCAM/GROSS

and submitted the results to the IERS and the IVS on a regular basis. Processing of the Intensive sessions is fully automated.

Calculation of new EOP time series with ITRF2014 and ICRF3 were performed as well.

3.2 Analysis of Domestic Sessions

The IAA Analysis Center processes all observational data of the domestic VLBI programs RuE, RI, R, and test sessions. A detailed description of the main kinds of the domestic sessions is given in the previous IVS Biennial Report [1].

Observational data from all these sessions are transmitted to the correlators using e-vlbi data transfer. The processing of RI sessions is fully automated. Calculated UT1–UTC time series is available at ftp://quasar.ipa.nw.ru/pub/EOS/IAA/eopi-ru.dat. The EOP time series calculated from RuE data is available at ftp://quasar.ipa.nw.ru/pub/EOS/IAA/eops-ru.dat.

In 2019 and 2020, 67 RuE and 718 RI sessions were observed using the QUASAR legacy network. RI sessions are the most rapid with latency at about 2.5 hours. During 2019 these sessions were duplicated on the PT13 network (RI RT13 sessions), but in 2020 this program was stopped.

Coordinates for the new radio telescope RT-13 at Svetloe observatory (SVERT13V) were the preliminary estimates from a 24-hour session on a six-station network (SVERT13V, SVETLOE, ZELENCHK, BADARY, ZELRT13V, and BADRT13V). The results are presented in Table 1. Values of velocities were fixed for the solution by the values from ITRF2014: for SVERT13V we used the velocities of SVETLOE.

Table 1 SVERT13V station positions at 2010.0 epoch.

Station	Svetloe
X, m	2730074.965 ± 0.001
Y, m	1562230.721 ± 0.001
Z, m	5530072.747 ± 0.001

Since March 2019 the new radiotelescope RT13 at Svetloe observatory started observations on experimental mode twice a day for the R program. Since the end of 2019 until February of 2020 we have the experimental observations using new receivers with linear polarization on the SVERT13V–BADRT13V baseline; these sessions are designated as LP in Table 2. From March 2020, SVERT13V station participates in all sessions for the R and X programs. SVERT13V was commissioned on 24/11/2020.

Program X is the experimental series at S/X/Ka range. It was a 0.5-hour duration from 2016 until 2019, while from March 2020 onward the X sessions are one hour. From the end of March until June 2020, once a day we observed R with experimental scheduling with long scans. Since August 07, 2020 we observe R sessions four times a day at a two-hour duration. Some statistics for the domestic Intensive sessions for the years 2019 and 2020 are given in Table 2.

Table 2 Statistics for the RT-13 sessions of the years 2019 and 2020.

Program	Number of sessions used	rms [μs]	bias [μs]
2019			
RI	354	61.6	46.1
RI RT13	339	42.9	4.5
R	1358	39.5	5.2
2020			
RI	351	60.3	66.0
LP	170	36.7	−37.0
R	992	28.3	−15.0
X	311	39.5	−11.2

The IAA RT13 Intensive time series composed from one-hour and two-hour S/X range sessions R, RI, and X as compared to the IERS finals.dat series is presented in Figure 1. The number of points is 3,173, rms is 37.6 μs, and bias is −7.3 μs.

The two-hour R sessions as compared to the IERS finals.dat series is presented in Figure 2. The rms is 18.7 μs, and the bias is 13.1 μs.

3.3 New Software Package for Scheduling VLBI Intensive Sessions

A new software package for scheduling VLBI Intensive sessions, called “aa_skd”, was developed. This package uses a modification of the covariance matrix optimization method. From March to July 2020, a series of experimental VLBI sessions scheduled by

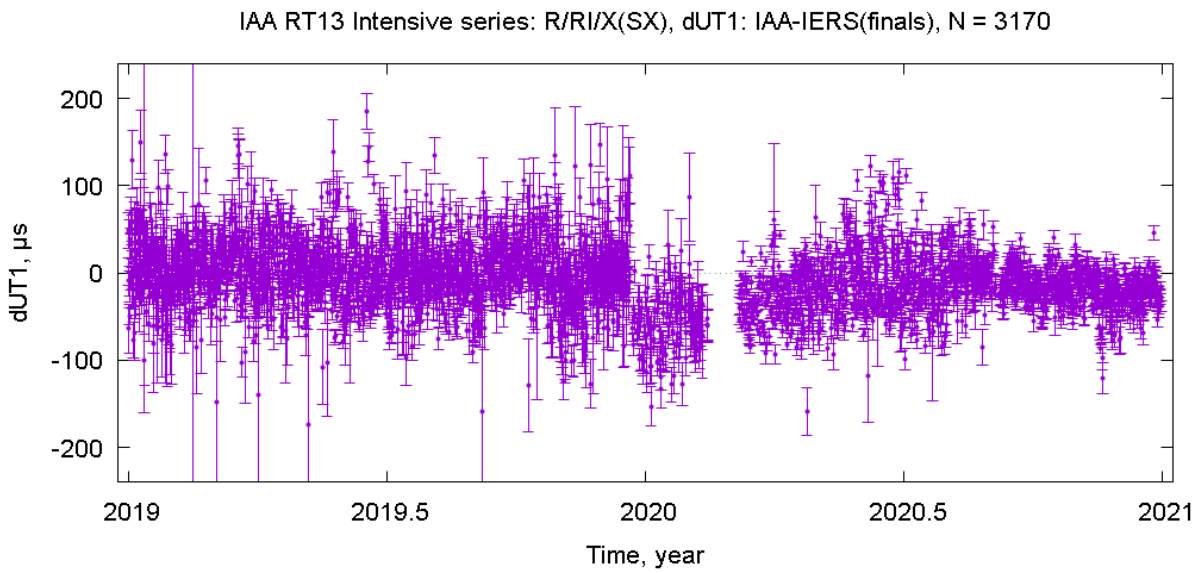

Fig. 1 IAA Intensive series vs. IERS finals.dat.

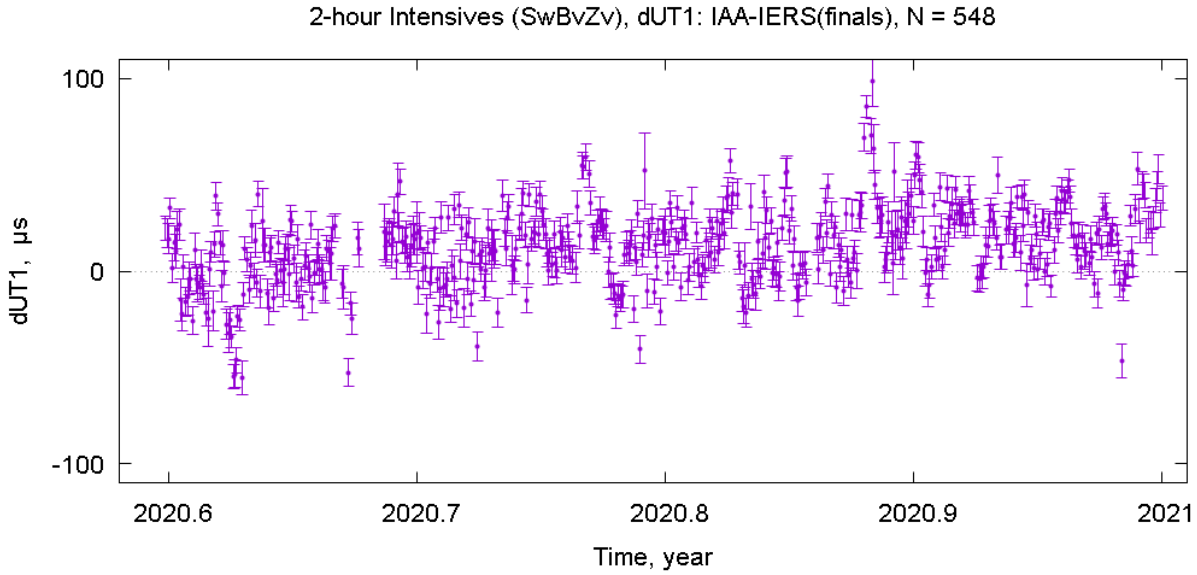

Fig. 2 IAA Intensive series vs. IERS finals.dat, 2-hour R (SwBvZv).

"aa_skd" was carried out. Figure 3 shows the results that were obtained. Regularly sessions scheduled by "Sched" software using sky covering algorithm [2] are indicated by a dot, while the experimental sessions scheduled by "aa_skd" are shown as a star.

As shown in the figure, this method provides potentially better WRMS than sky covering one; however, it gives greater dispersion of UT1–UTC correction. It is probably due to low reliance on tropospheric turbulence. Another issue is inaccurate computation of the a priori observation variance for some sources. For this reason, at the beginning of the experimental sessions, there is a weak quality of parameters determination and WRMS.

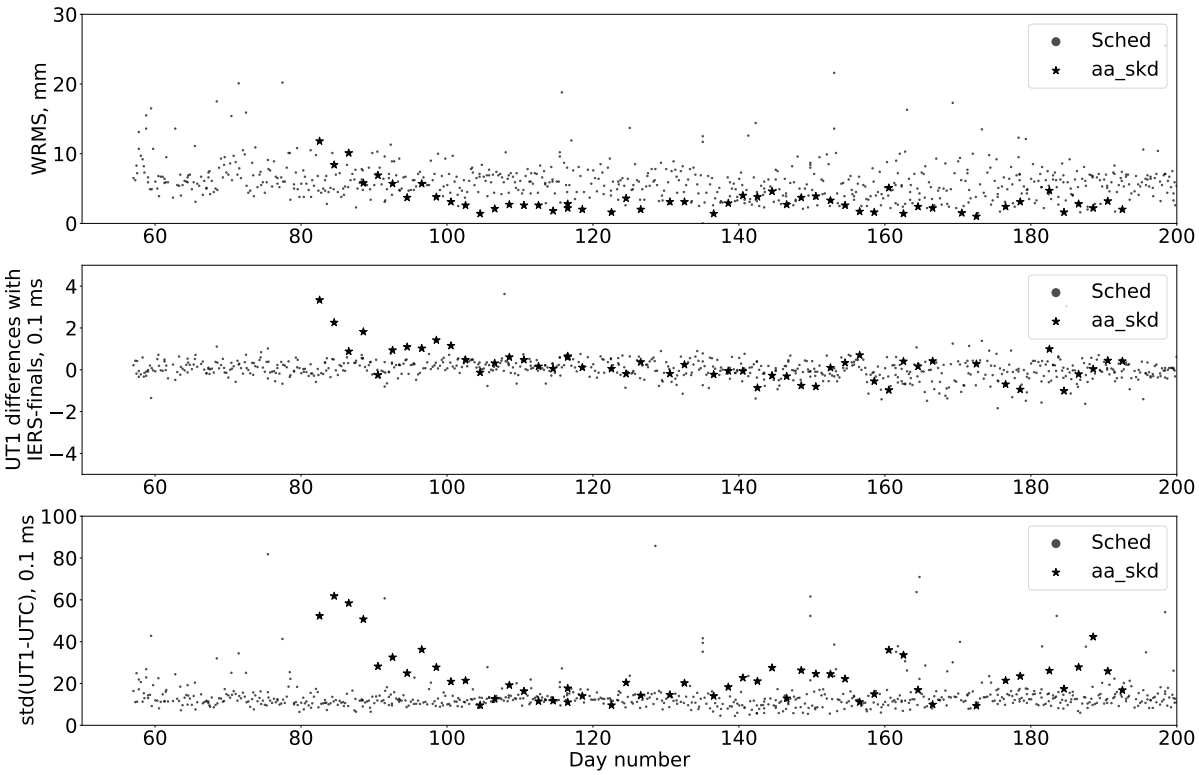

Fig. 3 "Sched" and "aa_skd" comparison.

4 Current Status

The IAA AC processes the data of all kinds of VLBI geodetic observation sessions. We use the QUASAR and the OCCAM/GROSS software packages for VLBI data analysis. All observation models in these packages are compliant with the IERS Conventions (2010). Both packages use NGS files as input data. The QUASAR and the OCCAM/GROSS software packages are supported and developed further. The QUASAR software was modified to adhere to ITRF2020 requirements.

5 Future Plans

- To continue submitting all types of IVS product contributions.
- To continue investigations of EOP, station coordinates, and tropospheric parameter time series.
- To improve algorithms and software for processing VLBI observations.
- Further work is planned to take stochastic tropospheric effects into account and increase the accuracy of a priori observation variance.

References

1. E. Skurikhina at al, "IAA VLBI Analysis Center 2017-2018 Biennial Report", in International VLBI Service for Geodesy and Astrometry 2017+2018 Biennial Report, edited by K. L. Armstrong, K. D. Baver, and D. Behrend, NASA/TP-2020-219041, pages 211–214,2020.
2. J. Sun, J. Böhm, T. Nilsson, H. Krásná, S. Böhm, H. Schuh, New VLBI2010 scheduling strategies and implications on the terrestrial reference frames, Journal of Geodesy, vol. 88, pages 449–461, 2014.