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EOP Determination from Domestic Observations of the Russian VLBI Network "QUASAR"

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Abstract

We present the state-of-the-art Russian VLBI network "Quasar". Domestic observations are carried out within the scope of two programs: Ru-U for the operational determination of Universal Time in near real-time and Ru-E for the determination of EOP from 24-hour sessions. Correlation of the data is performed at the IAA correlator ARC. The IAA Analysis Center performs data processing with the QUASAR and OCCAM/GROSS software packages. We show the progress in the EOP determination accuracy after upgrading the registration system to the R1002M DAS developed at IAA.

1. "QUASAR" Domestic Programs

Russian domestic EOP determination is very important for the GLONASS system and for the international VLBI community due to its contribution to the improvement of station and source positions and the densification of EOP time series.

Observations have been carried out within the scope of the domestic programs Ru-U and Ru-E since 2006 [1]. Currently observation sessions are scheduled once a week on Fridays. One-hour Ru-U sessions on the baseline Zelenchukskaya — Badary are performed for dUT1 determination and 24-hour Ru-E sessions on the QUASAR network are for EOP determination. Before Ru-U sessions are observed, Ru-F sessions with three scans for the entire network are run to check the data transfer.

The observation schedule is compiled by the Technical Consulate for a year and is accepted every month with necessary corrections. The Operating Center prepares the schedule file for current observation sessions. Observation data from the 1-hour Ru-U sessions are transmitted to the IAA correlator using e-VLBI data transfer. The 24-hour session media are shipped to the correlator by air. The data correlation is carried out on the IAA correlator ARC (Astronomical Radiointerferometric Correlator) [2]. Resulting NGS-files are available in the IAA ftp area [4]. The secondary data treatment is performed at the IAA Analysis Center and results of EOP determinations are placed in the IAA ftp area [5] (files veopi-ru.dat and veops-ru.dat for Ru-U and Ru-E results, respectively).

The scheduling of sessions are performed with the NASA/SKED software adapted for Linux at IAA. Schedules are optimized for the best estimation of EOP, clock, and tropospheric parameters. Specifications of the Ru-U and Ru-E sessions are presented in Table 1.

In May and December of 2011 two week-long series of daily Ru-U sessions were successfully carried out.

Table 1. Specifications of the Ru-U and Ru-E sessions.

Program	Ru-U	Ru-E
Stations	BdZc(Sv)	SvZcBd
Duration, hours	1	24
Aim	dUT1	EOP (Xpol, Ypol, dUT1, Xc, Yc)
Turn-around time	2 hours	3-5 days
Schedule	weekly, Friday, 20:00UT	weekly, Friday, 22:00UT
Range	X/S	X/S
Scan duration, min	1	1
Sources set	159 (>0.25 Jn)	63 (>0.5 Jn)
Number of sources per session	20	50
Sampling	1-bit	1-bit
Bandwidth, MHz	8	16
Data Rate, Mbit/s	256	512
Number of scans	20	300-350
Number of observations	20	1000

2. “QUASAR” Network Modernization

In 2011, a significant modernization of the “QUASAR” network was completed. As a result, all observatories of the “QUASAR” network are equipped uniformly: a 32-m radio telescope with low-noise receivers, frequency and time keeping systems with H-masers (VCH-1003M), control computers, and recording terminals Mark 5B+, and DAS R1002M. The new digital DAS R1002M [3] was designed and created at the IAA RAS. In 2011, the correlator control software was improved to obtain near-complete automatical data transfer and processing in e-VLBI mode.

3. Results of EOP Determination

At the IAA Analysis Center, the QUASAR software is used for data analysis and the OCCAM/GROSS software is used for data verification. All data reduction procedures correspond to IERS Conventions (2010). The celestial reference frame is fixed to the ICRF2 catalog of radiosources, and the TRF is fixed to the station position catalog from our global solution [6].

Ru-U sessions are processed in automatical mode as soon as NGS-files become available after correlation. Tropospheric gradients are not estimated in our data analysis.

Differences between EOP calculated from 24-hour Ru-E sessions and IERS EOP 08 C04 time series are presented in Figures 1–5. The differences for dUT1 calculated from the Ru-U sessions are presented in Figure 6. Figure 7 illustrates the same values for the sessions with e-VLBI data transfer. For 38 Ru-E sessions in 2011, the mean RMS of EOP deviations from the IERS 08 C04 series were 1.0 mas for Pole position, 35 μs for UT1-UTC, and 0.37 mas for Celestial Pole position. The RMS of the Universal Time deviations for 58 Ru-U sessions was 53 μs.

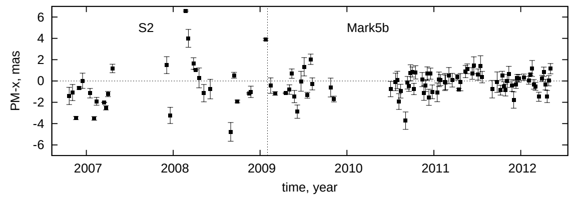

Figure 1. Xpol: differences between IAA estimates and IERS EOP08 C04.

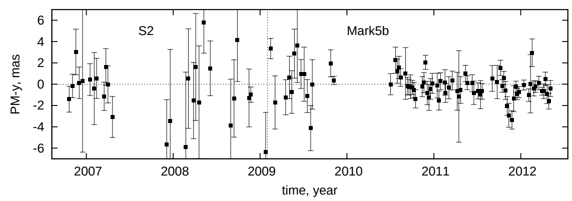

Figure 2. Ypol: differences between IAA estimates and IERS EOP08 C04.

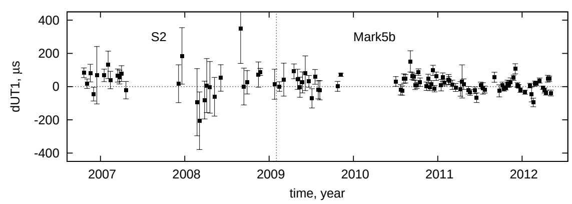

Figure 3. dUT1: differences between IAA estimates and IERS EOP08 C04.

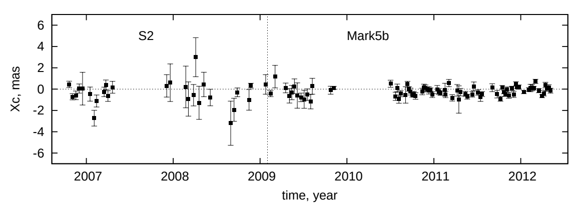

Figure 4. Xc: differences between IAA estimates and IERS EOP08 C04.

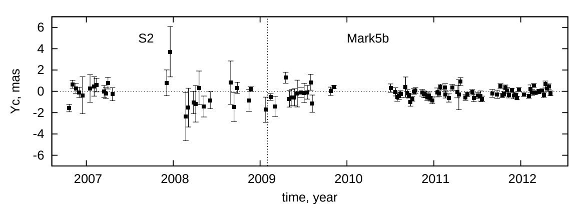

Figure 5. Yc: differences between IAA estimates and IERS EOP08 C04.

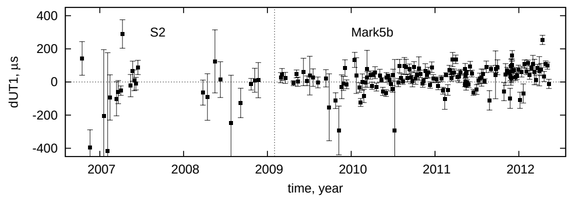

Figure 6. dUT1: differences between IAA estimates (Ru-U) and IERS EOP08 C04.

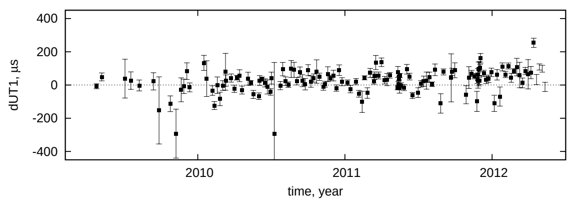

Figure 7. dUT1: differences between IAA estimates with e-VLBI data transfer and IERS EOP08 C04.

4. Supplementary Tests

We made additional tests to check the quality of our results. For comparison of EOP results we used observations of IVS-R4 sessions with participation of all three stations of the "QUASAR" network. The EOP were then determined from observations of the Svetloe, Zelenchukskaya, and Badary stations selected from the NGS-files of IVS-R4 sessions. The number of selected IVS observations was smaller than for the domestic sessions (350–600 versus 600–800). The only difference in data treatment was the estimation of tropospheric gradients when processing observations of IVS sessions. The UT1 estimates from the Ru-U sessions were compared with the results from the IVS-Int2 sessions (Wettzell-Tsukuba32) for 2011. Results of these tests are shown in Table 2.

Table 2. RMS of differences between "Quasar" network EOP results and IERS 08C04.

EOP	Domestic sessions		IVS sessions	
	N_{sess} 2011.2–2012.2	RMS	N_{sess} 2007–2011	RMS
UT1-UTC, Int., μs	53	59	125	37
X_p, mas	30	0.72	34	0.73
Y_p, mas	30	1.13	34	1.13
UT1-UTC, μs	30	35	34	37
X_c, mas	30	0.41	34	0.29
Y_c, mas	30	0.39	34	0.34

The accuracy of the EOP calculated from the Russian domestic sessions is very close to the accuracy of the EOP obtained from "Quasar" network observations from selected IVS sessions. Nevertheless, careful analysis of effects such as the number of excluded observations or the unstable work of some devices (channels in DAS and picosecond impulse generator) should be done. We hope that this analysis can improve the accuracy of the EOP from "Quasar" network domestic sessions.

References

[1] A. Finkelstein, A. Salnikov, A. Ipatov, S. Smolentsev, I, Surkis, I. Gayazov, I. Rahimov, A. Dyakov, R. Sergeev, E. Skurikhina, S. Kurdubov EOP determinations from observations of Russian VLBI-network QUASAR. Procceedings of the 20th EVGA Meeting. 2011, Bonn, P. 82–85.

[2] I. Surkis, V. Ken, A. Melnikov, V. Mishin, V. Shantyr, V. Zimovsky, IAA Correlator Center, in International VLBI Service for Geodesy and Astrometry 2010 Annual Report, edited by D. Behrend and K.Baver, NASA/TP-2011-215880, 2011. P. 141–143.

[3] S. A. Grenkov, E. V. Nosov, L. V. Fedotov, N. E. Koltsov. A Digital Radio Interferometric Signal Conversion System. Instruments and Experimental Techniques, 2010, Vol. 53, No. 5. P. 675–681.

[4] ftp://quasar.ipa.nw.ru/pub/EOS/IAA/ngs

[5] ftp://quasar.ipa.nw.ru/pub/EOS/IAA/

[6] ftp://cddis.gsfc.nasa.gov/vlbi/ivsproducts/trf/iaa2009a.trf.gz