Combination of IVS Intensive sessions using SINCOM software (P-12)

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Abstract

The SINEX files of hourly VLBI sessions were combined in order to calculate the series of corrections to the Earth orientation parameter UT1-UTC. SINEX files provided by a number of VLBI analysis centers (BKG, GSFC, USNO) as a result of processing of approximately 1000 VLBI Intensive sessions from the period for 2015 to 2020 were used in combination. The combination was performed by SINCOM software, developed in the IAA RAS for the combination of SINEX files [1]. Combined series was calculated as a result of combining the individual series. The comparison of individual and combined series with the recommended series IERS EOP C04 and "finals" was made. The combined series has better consistency with recommended series than individual series.

SINCOM software

SINCOM software was developed by IAA RAS for combining SINEX files as a result of processing VLBI, GNSS, SLR data. SINCOM uses the method of solving combining normal equation systems stored in SINEX files [2]. In this work we use SINCOM software to combine SINEX files of IVS Intensive sessions of 2015-2020 years processed by different VLBI analysis centers.

Most of VLBI analysis centers consider ΔUT1 and its rate, terrestrial pole coordinates and their rates, station coordinates as estimated parameters. SINCOM makes combined series of ΔUT1 by two steps: making individual series of ΔUT1 (one series for the each analysis center) and making combined series of ΔUT1. Individual series are made by fixing station coordinates and deleting ΔUT1 rate, terrestrial pole coordinates and their rates. Combined series are made by eliminating station coordinates.

Individual ΔUT1 series of VLBI analysis centers BKG, GSFC, USNO

SINEX files of IVS Intensive sessions were collected from the number of VLBI analysis centers to create individual series of universal time. SINEX files were provided by website ivs.bkg.bund.de [4]. There are several solutions for each VLBI analysis center, we used the latest solutions if it was possible. The table 1 illustrates the latest solutions for the VLBI analysis centers BKG, GSFC, USNO. In order to process sessions from 2015 to 2020 we use SINEX files from the solutions bkg2014a, gsf2019a, usn2020b.

Table 1: Available SINEX files of IVS Intensive sessions, created by VLBI analysis centers BKG, GSFC, USNO

Analysis center	Name of solution	Time interval
BKG	bkg2014a	1999-2021
BKG	bkg2020a	2018-2021
GSFC	gsf2019a	1995-2021
USNO	usn2020b	2000-2021

Individual ΔUT1 series of VLBI analysis center IAA RAS

We process IVS Intensive sessions of 2015-2020 years using QUASAR software [3]. In each session we estimate parameters ΔUT1, troposphere gradients, clock offset, clock offset rate, wet troposphere delay, wet troposphere delay rate. We store in SINEX file parameters ΔUT1 and its rate, terrestrial pole coordinates and their rates, station coordinates.

Comparison of individual and combined ΔUT1 sevies with BULLETIN B (323, 1 January 2015)

IERS publishes BULLETIN B every month in which the differences between ΔUT1 made by different techniques are presented [4]. In the table 2 the differences between Intensive ΔUT1 estimations on January 2015 are presented. In the first part of table the difference between Bulletin B estimation and bkgint14.eopi, gsf2014a.eopi, iaa2005a.eopi, pul2010a.eopi, usn2014.eopi. In the other parts current estimations of ΔUT1 on January 2015 are presented.

Table 2: The mean difference and its standard deviation between ΔUT1 series combined by SINCOM software and IERS ΔUT1 series

Series 1	Series 2	Mean ΔUT1, μs	Standard deviation ΔUT1, μs	Number of sessions
BKG (bkgint14.eopi)	Bulletin B	7	16	29
GSFC (gsf2014a.eopi)	Bulletin B	12	12	29
IAA (iaa2005a.eopi)	Bulletin B	10	13	18
PUL (pul2010a.eopi)	Bulletin B	10	18	20
USNO (usn2014.eopi)	Bulletin B	12	12	29
c04	BKG	-18	23	16
c04	GSFC	6	19	16
c04	IAA	-9	17	16
c04	USNO	-10	19	16
c04	comb	-5	15	16
"finals"	BKG	-12	20	16
"finals"	GSFC	12	13	16
"finals"	IAA	-3	7	16
"finals"	USNO	-4	13	16
"finals"	comb	1	5	16

Comparison of individual and combined ΔUT1 sevies with c04 and "finals" series

We compared individual and combined ΔUT1 series generated by SINCOM software with ΔUT1 series recommended by IERS: c04 and "finals". For comparison, we use the same number of VLBI sessions from each VLBI analysis center, too high ΔUT1 values were rejected. For example, if ΔUT1 on one date in one of the individual series was too high, all other ΔUT1 on the same date was rejected. The differences between individual, combined and recommended ΔUT1 series are presented in the picture 1 and the table 3. The same differences, made by using data only from two VLBI stations (base KOKEE-WETTZELL), are presented in the picture 2 and the table 4.

Table 3: The mean difference and its standard deviation betweenΔ UT1 series combined by SINCOM software and ΔUT1 series from c04/"finals", all stations

Series 1	Series 2	Mean ΔUT1, μs	Standard deviation ΔUT1, μs	Number of sessions
c04	bkg	-6	27	928
c04	gsf	12	23	928
c04	iaa	0	18	928
c04	usn	-3	23	928
c04	com	0	16	928
"finals"	bkg	-6	22	897
"finals"	gsf	12	18	897
"finals"	iaa	0	9	897
"finals"	usn	-3	19	897
"finals"	com	0	6	897

Table 4: The mean difference and its standard deviation between ΔUT1 series combined by SINCOM software and ΔUT1 sevies from c04/"finals", base KOKEE-WETTZELL

Series 1	Series 2	Mean ΔUT1, μs	Standard deviation ΔUT1, μs	Number of sessions
c04	BKG	-4	25	574
c04	GSFC	11	22	574
c04	IAA	-2	16	574
c04	USNO	-4	22	574
c04	comb	0	14	574
"finals"	BKG	-3	21	566
"finals"	GSFC	12	17	566
"finals"	IAA	-1	9	566
"finals"	USNO	-2	17	566
"finals"	comb	1	5	566

Conclusions

1. IVS Intensive series of 2015-2020 years was processed using QUASAR software.
2. Individual ΔUT1 series was combined from the solutions bkg2014a, gsf2019a, usn2020b made by BKG, GSFC, USNO analysis centers.
3. Combined ΔUT1 series was made from individual series. The standard deviation between combined series and c04 is 16 μs, between combined series and "finals" is 6 μs.
4. The standard deviation between combined series made by KOKEE-WETTZELL VLBI observations and c04 is 14 μs, between combined series and "finals" is 5 μs.

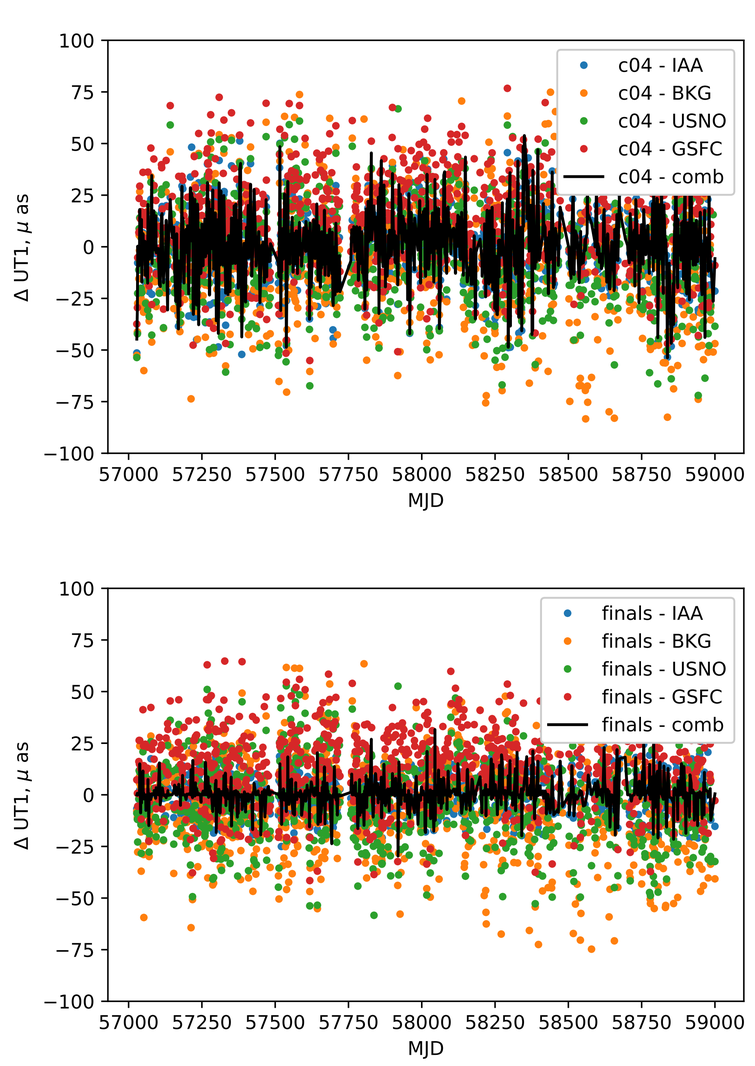

Figure 1: The difference between ΔUT1 series combined by SINCOM software and ΔUT1 sevies from c04/"finals", all stations (in μs)

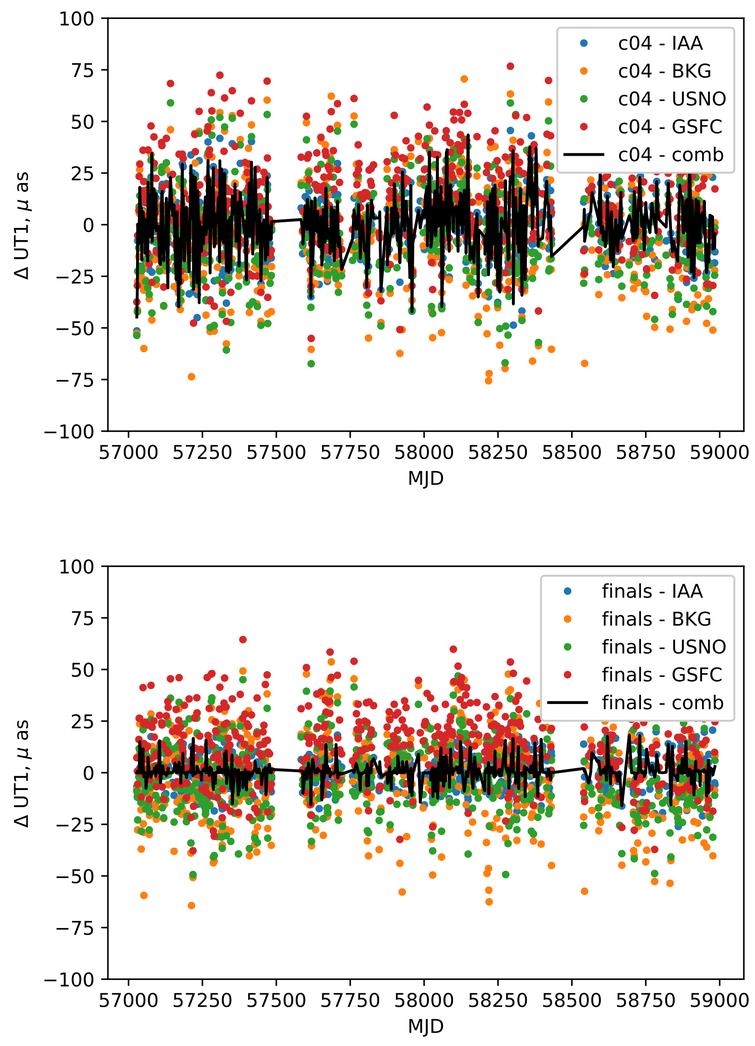

Figure 2: The difference between ΔUT1 series combined by SINCOM software and ΔUT1 sevies from c04/"finals", base KOKEE-WETTZELL (in μs)

References

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