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Supporting Information for "Baseline vector repeatability at the sub-millimeter level enabled by radio interferometer phase delays of intra-site baselines"

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Introduction The detail of data analysis is presented. The VLBI sessions analyzed in the study are listed in the tables with the statistics from geodetic solutions, and three figures are shown to support the study.

1. Data analysis for the baselines with only one or two global sessions

The detail of the data analysis in Sect. 3.2 of the main body of the paper is presented here.

1.1. SESHAN13–SESHAN25

The new antenna SESHAN13 in Shanghai, China, so far participated in only one IVS session, AOV056 (February 03, 2021). The receiver cannot observe at frequencies around 2 GHz at S band, and therefore the observations of the antenna have not been used in the IVS routine data analysis. However, we analyzed the X band observations of the baseline SESHAN13–SESHAN25 to derive the baseline vector.

For this 56 m baseline, we estimated a constant parameter of dZWDs over 24 hours for antenna SESHAN13 only, and modeled the clock of antenna SESHAN13 relative to antenna SESHAN25 as a PWL function with an interval of 30 minutes to account for the rapid variations. With 411 used observations, the WRMS delay residual is 8.6 ps from the phase delay analyses and 20.9 ps from the group delay analyses. The difference between group delay analyses and phase delay analyses for this baseline is as large as 1 cm in both the east and up directions. The significant differences need to be monitored further by new observations in the future. Note that in the session both antennas do not have corrections for cable delays, which are the path delays through the cable from the frequency standard to the phasecal generator in the receiver.

This position tie allows SESHAN13 to obtain its position in the ITRF. As SESHAN13 is one of the three antennas in a Chinese domestic VGOS network aimed for the EOP determination, it can help to determine the positions of the other two antennas in the ITRF and thus a consistent set of EOP based on the observations of this domestic network.

1.2. WETTZ13S–WETTZELL

As WETTZ13S observes with a broadband and linearly polarized receiver and WETTZELL observes with a circularly polarized receiver, the mixed mode was used to make observations and perform data processing for this baseline (and other baselines between VGOS antennas and legacy antennas). The aim of the mixed mode sessions is to tie the positions of the VGOS antennas to those of the legacy antennas. In addition to the session RD1810 already reported, currently there are another two IVS mixed mode sessions available: RD2005 (June 24, 2020) and RD2006 (July 08, 2020). We should remark that the results from these mixed mode sessions may be considered as preliminary because the data processing of this new observing mode is still under investigation and may be improved in the future. The WRMS delay residual is 6.0 ps for the 370 phase delays in session RD2005 and 6.6 ps for the 423 phase delays in RD2006.

The results from both sessions have uncertainties at the sub-millimeter level in the three components. However, a significant difference of 4.3 mm was detected in the up component between the two sessions, which were observed only two weeks apart, while the differences in the horizontal plane are smaller than 0.3 mm, consistent with their formal errors. In the data processing, an important difference is that the phase calibration phases of station WETTZELL were turned on and used for session RD2005, whereas they were not used for session RD2006 through manual phase calibration (Brian Corey, personal communication, August 30, 2021).

1.3. RAEGYEB–YEBES40M

The receiver of antenna RAEGYEB is not able to observe below 3 GHz, and RD2005 is the only session that RAEGYEB participated in with the mixed mode. Therefore, without analyzing the observations at X band only, the position tie for antenna RAEGYEB, as well as for antenna SESHAN13, would have been lost. Both antennas have the cable delays measured. The measured cable delays for antenna RAEGYEB have a peak-to-peak fluctuation of more than 200 ps, which is four times that of antenna YEBES40M. Without applying the cable delays of antenna RAEGYEB, the WRMS delay residual was 17.4 ps for the 392 group delays and 9.9 ps for the 407 phase delays; it increased to 22.0 ps for the same set of group delays and 15.5 ps for the 417 used phase delays when the cable delays were applied. The cable delays introduced non-negligible additional noise of about 12 ps, a demonstration that there are unknown issues with the cable delay corrections.

The results are based on the solutions without applying the cable delay corrections of antenna RAEGYEB. The difference in the baseline vector estimates between group delays and phase delays is not significant with respect to the uncertainties of the group delay result. Applying the cable delay corrections would change the Up position of antenna RAEGYEB by 5.3 mm for group delay analyses and by 6.3 mm for phase delay analyses.

1.4. KOKEE12M–KOKEE

With 422 available observations of baseline KOKEE12M–KOKEE in session RD2006, the WRMS delay residual is 15.7 ps for the 382 group delays and 3.7 ps for the 385 phase delays. Note that antenna KOKEE has the cable delays directly measured, and antenna KOKEE12M has the proxy cable delay corrections through an indirect way. The results of this baseline from session RD2005 are not reported because the WRMS delay residuals are significantly larger for both phase and group delays than those from session RD2006 due to yet unknown reasons.

1.5. ONSALA60–ONSA13NE–ONSA13SW

We report the results of these baselines based on the phase delays in sessions RD2005 and RD2006. As antenna ONSA13NE cannot observe at 2.0 GHz, its observations in session RD2005 were removed in the IVS routine data analysis, and its observations in session RD2006 were even not processed by the IVS at the visibility level. Nevertheless, we analyzed its observations in session RD2005.

Both the dZWDs and the clocks were estimated for antennas ONSA13NE and ONSA13SW as PWL functions with an interval of one hour (ONSALA60 was the reference). The WRMS delay residual is 3.0 ps for the 998 phase delays of the three baselines in session RD2005, and it is 5.3 ps for the 400 phase delays of baseline ONSALA60–ONSA13SW in session RD2006. Note that there is a difference of 3.24 mm in the up direction of baseline ONSALA60–ONSA13SW between these two sessions, while the differences in the horizontal directions are less than half a millimeter, insignificant to the uncertainties.

Table S1: List of the 24-hour sessions of baseline WETTZ13N–WETTZELL with usable observations as of July 2021. The number of the used observables n_{used} and the WRMS delay residual r_{WRMS} are presented for both types of observables.

Session	n_{total}	Group delays			Phase delays		
		n_{used}	r_{WRMS} [ps]	σ_{add} [ps]	n_{used}	r_{WRMS} [ps]	σ_{add} [ps]
19JAN29XH	293	277	31.6	33.3	277	4.1	4.3
19MAR26XH	360	300	41.1	42.8	295	4.4	4.6
19APR11XE	246	200	19.6	21.1	199	4.4	4.7
19APR15XA	188	185	7.3	7.9	186	3.6	3.9
19APR23XA	97	97	7.8	9.1	95	2.4	2.8
19APR25XE	162	144	12.6	14.0	145	3.0	3.3
19MAY02XE	160	145	14.7	16.3	148	4.1	4.6

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Session	n_{total}	Group delays			Phase delays		
		n_{used}	r_{WRMS} [ps]	σ_{add} [ps]	n_{used}	r_{WRMS} [ps]	σ_{add} [ps]
19MAY07XA	77	76	6.3	7.8	77	3.1	3.8
19OCT08XA	298	267	9.0	9.5	279	2.8	2.9
19OCT10XE	308	259	9.8	10.2	276	2.7	2.8
19OCT17XE	384	377	14.4	15.0	377	2.8	2.9
19OCT21XA	106	100	6.5	7.6	104	1.8	2.1
19OCT24XE	381	370	11.2	11.7	373	2.9	3.0
19OCT28XA	244	233	13.9	14.8	241	2.9	3.1
19OCT30XE	352	341	15.9	16.6	343	3.0	3.1
19NOV04XA	85	84	7.4	9.0	85	3.0	3.7
19NOV07XE	380	362	16.1	16.8	370	2.7	2.8
19NOV18XA	138	136	10.4	11.6	135	2.6	2.9
19NOV19XH	371	364	40.4	42.1	354	2.8	2.9
19NOV21XE	290	255	10.8	11.4	260	2.9	3.1
19NOV26XE	302	275	16.9	17.8	274	3.3	3.5
19DEC05XE	366	324	17.2	18.5	324	3.3	3.6
19DEC10XH	404	387	53.7	55.9	384	3.9	4.1
19DEC12XE	293	252	22.8	24.0	256	4.0	4.2
19DEC17XA	158	146	6.1	6.8	148	2.9	3.2
19DEC19XE	329	308	13.5	14.2	309	2.6	2.7
20JAN02XE	429	396	17.8	18.4	399	2.9	3.1
20JAN09XE	338	310	17.5	18.2	307	2.7	2.8
20JAN16XE	303	267	15.9	16.7	266	3.1	3.3
20JAN23XE	356	337	15.6	16.2	340	2.8	3.0
20JAN27XA	172	171	12.1	13.2	170	2.7	3.0
20JAN30XE	349	327	17.3	18.0	325	3.3	3.4
20FEB06XE	353	306	19.7	20.5	306	3.0	3.2
20FEB10XA	170	146	12.4	13.8	147	3.3	3.7
20FEB13XE	247	174	19.0	20.7	174	5.3	5.8
20FEB17XA	159	159	11.3	12.4	157	3.4	3.7
20FEB24XA	229	226	10.8	11.5	225	2.8	3.0
20MAR02XA	141	137	11.3	12.7	139	2.3	2.6
20MAR05XE	451	372	16.3	17.0	375	3.8	4.0
20MAR09XA	176	175	19.2	20.9	172	2.6	2.8
20MAR19XE	306	266	17.9	18.8	263	3.0	3.2
20MAR26XE	306	258	15.8	16.6	255	2.4	2.5
20APR02XE	286	187	16.5	17.6	186	2.8	3.0
20APR08XE	275	252	17.2	18.1	247	2.5	2.7
20APR16XE	299	261	16.2	17.1	261	2.8	2.9
20APR22XE	339	315	17.0	17.7	314	3.3	3.4
20APR27XA	146	140	14.4	16.0	141	3.5	3.9
20APR29XE	302	239	16.1	17.1	241	3.2	3.4
20MAY11XA	61	61	9.9	13.2	61	3.1	4.2

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Session	n_{total}	Group delays			Phase delays		
		n_{used}	r_{WRMS} [ps]	σ_{add} [ps]	n_{used}	r_{WRMS} [ps]	σ_{add} [ps]
20MAY26XA	138	133	9.5	10.7	132	3.3	3.7
20JUN08XA	124	124	6.2	7.0	123	2.9	3.3
20JUN18XE	309	273	13.7	14.4	272	3.2	3.4
20JUN25XE	310	252	13.9	14.6	253	2.8	2.9
20JUL01XE	252	225	19.2	20.4	224	3.5	3.7
20JUL09XE	295	266	15.1	15.9	259	2.6	2.7
20JUL23XE	297	272	15.9	16.7	270	4.2	4.4
20JUL30XE	270	238	14.0	14.9	235	5.1	5.4
20AUG06XE	265	153	13.9	15.3	200	6.3	6.8
20AUG13XE	359	308	13.1	13.8	311	5.2	5.4
20AUG20XE	209	152	12.0	13.0	152	3.6	4.0
20AUG27XE	332	297	11.5	12.1	295	4.0	4.2
20SEP03XE	335	286	13.6	14.3	282	3.2	3.4
20SEP10XE	353	320	11.9	12.9	323	3.6	3.9
20SEP17XE	236	212	17.9	19.0	214	4.5	4.8
20SEP24XE	266	190	17.0	19.3	190	3.3	3.8
20NOV12XE	227	166	13.4	14.6	169	4.3	4.7
20NOV26XE	261	223	16.3	17.3	226	5.1	5.4
20DEC10XE	335	301	16.9	17.8	303	5.4	5.7
20DEC22XE	327	289	19.1	20.1	288	4.8	5.1
21JAN04XA	310	300	14.8	15.6	303	5.3	5.6
21JAN07XE	324	227	22.9	24.4	231	6.1	6.5
21JAN21XE	327	251	19.4	20.4	252	4.8	5.1
21JAN25XA	240	218	12.5	13.2	221	6.5	6.8
21FEB01XA	386	376	17.6	18.3	381	8.1	8.4
21FEB08XA	424	418	17.4	17.9	418	5.2	5.3
21FEB16XA	411	407	14.4	14.8	409	5.4	5.6
21FEB18XE	270	224	15.9	16.9	227	7.1	7.6
21FEB22XA	414	411	17.0	17.5	412	4.8	4.9
21MAR04XE	378	322	16.1	16.8	324	4.5	4.7
21MAR08XA	317	307	14.6	15.4	313	4.6	4.8
21MAR15XA	284	274	10.8	11.4	277	4.3	4.5
21MAR18XE	345	277	17.7	18.6	280	4.7	4.9
21MAR23XA	402	394	13.1	13.6	397	5.2	5.4
21MAR25XE	261	237	16.1	17.1	238	4.7	5.0
21MAR31XE	354	288	13.6	14.3	297	4.6	4.8
21APR19XA	436	423	11.7	12.1	428	4.8	4.9
21APR22XE	284	274	17.3	18.2	274	4.2	4.4
21APR29XE	264	239	18.7	19.9	243	3.9	4.1
21MAY03XA	356	354	15.1	15.7	355	4.7	4.9
21MAY06XE	279	250	15.8	16.8	254	5.5	5.9
21MAY10XA	434	431	9.7	10.0	431	3.7	3.8

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Session	n_{total}	Group delays			Phase delays		
		n_{used}	r_{WRMS} [ps]	σ_{add} [ps]	n_{used}	r_{WRMS} [ps]	σ_{add} [ps]
21MAY13XE	287	264	14.5	15.3	271	4.7	4.9
21JUN09XE	525	499	13.3	13.7	495	4.4	4.5
22JAN31XA	347	325	14.2	14.8	328	5.1	5.3
22FEB03XE	345	322	16.3	17.0	323	4.1	4.3
22FEB07XA	375	364	11.6	12.1	364	3.8	4.0
22FEB10XE	384	375	12.9	13.4	373	3.8	4.0
22FEB21XA	359	348	16.4	17.1	348	4.4	4.6
22FEB24XE	473	461	14.8	15.3	461	4.3	4.4
22FEB28XA	532	518	19.7	20.3	516	4.6	4.7
22MAR10XE	458	449	22.1	22.8	453	5.0	5.2
22MAR24XE	467	463	18.9	19.5	463	6.4	6.6
22MAR31XE	387	381	22.4	23.3	381	4.7	4.9
22APR07XE	410	403	13.4	13.8	400	4.2	4.3
22MAY05XE	357	347	11.1	11.6	346	3.4	3.5
22JUN09XE	321	301	13.4	14.0	297	3.8	4.0
22JUN16XE	357	345	18.2	19.0	339	3.9	4.1

Table S2: Intensive session list of baseline `WETTZ13N`–`WETTZELL` as of July 2021. The number of the used observables n_{used}, the WRMS delay residual r_{WRMS}, and the additive sigma σ_{add} to achieve the reduced χ^2 being unity are presented for both types of observables.

Session	n_{total}	Group delays			Phase delays		
		n_{used}	r_{WRMS} [ps]	σ_{add} [ps]	n_{used}	r_{WRMS} [ps]	σ_{add} [ps]
19MAR04XK	43	39	12.1	13.2	43	2.3	2.5
19MAR18XK	45	43	11.4	12.3	43	3.3	3.5
19MAR25XK	46	46	7.1	7.6	46	5.3	5.7
19APR15XK	39	37	7.8	8.5	37	2.8	3.0
19APR29XK	48	46	9.5	10.2	47	2.8	3.0
19MAY06XK	46	43	7.1	7.6	42	1.7	1.8
19OCT14XK	40	37	5.0	5.4	39	2.3	2.5
19OCT21XK	50	49	5.9	6.3	49	1.8	1.9
19OCT28XK	50	50	9.0	9.6	50	4.5	4.8
19NOV04XK	49	48	12.2	13.0	47	2.0	2.2
19NOV11XK	49	47	10.1	10.9	47	2.0	2.2
19NOV18XK	51	51	9.3	9.9	51	2.5	2.7
20MAR02XK	47	45	15.9	17.1	45	2.5	2.7
20MAR09XK	47	47	12.4	13.3	47	2.6	2.8
20MAR16XK	38	35	10.7	11.8	35	1.7	1.9
20MAR23XK	37	35	9.8	10.8	36	2.3	2.5
20MAR30XK	48	42	8.3	8.9	46	3.7	4.0
20APR20XK	37	34	8.1	8.9	34	2.0	2.2
20APR27XK	40	35	8.0	8.8	37	2.4	2.6
20MAY04XK	37	32	9.3	10.3	33	2.2	2.4
20MAY11XK	47	46	10.1	10.9	46	2.0	2.2
20MAY18XK	41	41	8.8	9.6	40	2.3	2.5
20MAY25XK	47	43	10.9	11.7	43	3.4	3.7
20JUN08XK	47	45	9.6	10.3	45	3.3	3.5
20JUN15XK	48	44	8.2	9.1	44	2.3	2.5
20JUN22XK	39	33	7.3	8.1	33	2.0	2.2
20JUN29XK	38	28	6.7	7.5	29	3.2	3.6
20JUL06XK	39	35	12.9	14.2	35	3.5	3.8
20JUL13XK	41	37	5.5	6.0	38	2.0	2.2
20JUL20XK	40	38	9.2	10.0	38	2.8	3.0
20JUL27XK	40	38	10.6	11.5	39	3.4	3.7
20AUG03XK	38	33	11.4	12.7	34	4.0	4.4
20AUG24XK	38	33	8.8	9.8	35	6.8	7.5
20AUG31XK	40	31	7.7	8.6	32	3.0	3.3
20SEP07XK	43	35	7.9	8.7	37	3.3	3.6
20SEP14XK	43	37	6.6	7.2	38	2.3	2.5
20SEP21XK	42	38	5.1	5.5	39	4.0	4.3

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Session	n_{total}	Group delays			Phase delays		
		n_{used}	r_{WRMS} [ps]	σ_{add} [ps]	n_{used}	r_{WRMS} [ps]	σ_{add} [ps]
20SEP28XK	41	38	8.8	9.6	39	3.1	3.4
20OCT12XK	38	35	11.5	12.6	35	5.0	5.5
20NOV09XK	40	37	7.0	7.6	40	3.4	3.7
21JAN11XK	45	28	14.3	16.1	31	5.0	5.6
21JAN18XK	43	32	11.0	12.2	33	4.3	4.8
21FEB01XK	44	44	12.1	13.0	44	3.1	3.3
21FEB08XK	41	40	14.4	15.7	40	3.0	3.3
21MAR01XK	43	40	7.3	7.9	41	4.4	4.8
21MAR08XK	42	37	8.4	9.1	38	2.2	2.4
21MAR15XK	44	42	8.6	8.7	43	4.8	5.2
21MAR22XK	44	34	13.1	14.4	36	4.6	5.1
21MAR29XK	43	42	4.6	4.9	40	1.9	2.1
21APR12XK	42	35	22.6	24.8	35	3.5	3.8
21APR26XK	42	36	12.4	13.6	37	3.8	4.1
21MAY03XK	35	34	6.2	6.8	34	4.1	4.5
21MAY10XK	41	35	6.2	6.8	36	1.9	2.1
21MAY17XK	54	53	16.0	17.0	53	3.8	4.0
21MAY31XK	39	38	9.6	10.4	38	3.9	4.2
21JUN07XK	38	34	5.8	6.4	34	2.8	3.1
21JUN21XK	41	37	9.1	9.9	37	2.5	2.7
21JUN28XK	40	35	8.4	9.2	34	3.2	3.5

Table S3: Session list of baseline NYALE13S–NYALES20. The number of used observables n_{used} and the WRMS delay residual r_{WRMS} is presented for both group delays and phase delays (at X band). For comparison, these two statistics from the official IVS results based on the observables at S/X band are presented in the last two columns.

Session	n_{total}	Group delays			Phase delays			S/X-band delays[1]		
		n_{used}	r_{WRMS} [ps]	σ_{add} [ps]	n_{used}	r_{WRMS} [ps]	σ_{add} [ps]	n_{used}	r_{WRMS} [ps]	σ_{add} [ps]
20MAY26XA	155	152	25.3	22.3	151	17.2	19.4	76	49.1	43.1
20JUN22XA	305	297	24.7	20.8	298	17.3	18.9	291	30.4	25.2
21MAY25XA	286	207	58.1	49.1	213	17.2	19.3	185	65.6	53.1
21MAY31XA	363	313	48.7	38.5	317	15.8	17.1	306	54.0	42.1
21JUN07XA	300	295	18.6	17.1	295	13.9	15.2	277	25.4	22.5
21JUN09XE	341	333	26.2	22.3	334	16.5	17.8	243	35.4	–
21JUN14XA	299	216	40.4	29.3	220	16.5	18.3	188	57.6	48.3
21JUN17XE	484	475	32.8	25.3	477	19.5	19.9	381	71.1	–
21JUN21XA	114	107	27.4	22.5	106	12.6	16.1	102	40.0	–
21JUN24XE	329	307	46.6	36.5	307	15.2	16.5	252	86.0	72.7
22FEB07XA	263	260	30.3	32.9	232	15.4	17.3	251	40.4	30.0
22FEB24XE	361	342	43.3	46.6	309	15.3	17.2	145	87.2	70.6
22MAR22XA	328	326	32.2	34.6	296	16.5	18.1	318	44.2	32.3
22MAR24XE	378	372	35.7	38.4	346	15.7	17.4	107	76.6	62.6
22APR25XA	394	394	31.4	33.4	390	17.2	18.5	392	42.2	30.9
22MAY12XE	359	355	33.2	36.1	282	13.0	14.9	104	41.3	49.7
22MAY23XA	339	337	26.3	28.3	330	11.9	12.9	333	36.8	27.8
22JUN09XE	251	236	52.8	58.0	234	15.2	17.7	173	71.2	53.0
22JUN16XE	263	259	30.7	33.7	261	16.8	18.7	62	55.6	41.8

Table S4. Session list of baseline ISHIOKA–TSUKUB32. The number of used observables and the WRMS delay residual are presented for both types of observables.

Session	n_{total}	Group delays		Phase delays	
		n_{used}	r_{WRMS} [ps]	n_{used}	r_{WRMS} [ps]
15AUG26XA	238	220	14.00	219	10.40
15OCT19XA	396	365	16.00	355	13.20
15NOV10XH	175	172	17.10	167	9.60
15NOV12XF	448	420	20.90	399	12.90
15NOV16XA	393	357	21.60	335	13.40
15DEC07XA	347	337	16.50	327	12.40
15DEC14XA	312	296	18.80	286	13.90
15DEC15XH	169	169	22.60	168	14.50
15DEC16XA	288	236	23.20	238	11.80
16APR11XA	447	432	16.30	420	13.50
16MAY17XA	361	342	21.10	331	14.00
16JUN13XA	454	427	23.10	405	15.60
16OCT24XA	448	426	25.30	413	16.50
16OCT31XA	463	437	19.30	403	14.60
16DEC05XA	195	180	17.70	178	13.60
16DEC20XA	361	341	9.90	341	9.00
16DEC27XA	352	338	14.90	314	11.00

Table S5. Session list of baseline HARTRAO–HART15M. The number of used observables and the WRMS delay residual are presented for both types of observables.

Session	n_{total}	Group delays			Phase delays		
		n_{used}	r_{WRMS} [ps]	σ_{add} [ps]	n_{used}	r_{WRMS} [ps]	σ_{add} [ps]
13AUG05XA	117	89	5.7	6.4	94	4.9	5.8
13AUG26XA	109	109	12.2	13.8	109	9.7	11.3
13SEP09XA	262	256	11.9	9.5	257	8.6	9.1
13NOV25XA	92	92	9.8	10.6	92	8.8	9.8
14AUG04XA	218	212	12.6	12.1	212	10.1	10.9
15JUL27XA	235	233	12.9	11.3	233	10.3	10.8
15NOV09XA	248	243	13.2	12.4	243	10.0	10.5
17OCT02XA	158	158	9.1	9.2	154	7.6	8.4

Table S6. Baseline vectors from the ITRF2020(see `https://itrf.ign.fr/en/solutions/ITRF2020` for more details) (units: mm).

Baseline	Monument	X	σ_X	Y	σ_Y	Z	σ_Z	L	σ_L
`Wn–Wz`	7387–7224	−88036.50	1.28	−38731.90	1.20	77162.90	1.50	123307.33	1.36
`Ns–Ny`	7392–7331	1391823.40	25.21	605216.00	25.31	−256263.50	27.42	1539197.77	25.29
`Hh–Ht`	7232–7378	48035.80	1.98	−102302.80	1.63	4129.10	1.84	113094.43	1.70
`Ws–Wz`	7388–7224	−119343.30	1.61	−89238.20	1.44	113294.80	1.84	187195.06	1.66
`Yj–Ys`	7389–7386	−69318.70	2.30	145344.80	1.50	108530.90	2.30	194188.44	1.89
`K2–Kk`	7623–7298	−6075.90	3.89	19218.50	2.97	23722.70	3.45	31129.31	3.29
`On–Ow`	7213–7637	340934.30	2.94	−383169.50	1.97	−169945.90	4.51	540311.64	2.72
`Oe–On`	7636–7213	−283455.50	2.47	346477.20	1.79	138820.20	3.54	468683.82	2.25
`Oe–Ow`	7636–7637	57478.80	3.62	−36692.30	2.41	−31125.70	5.56	74959.63	3.80

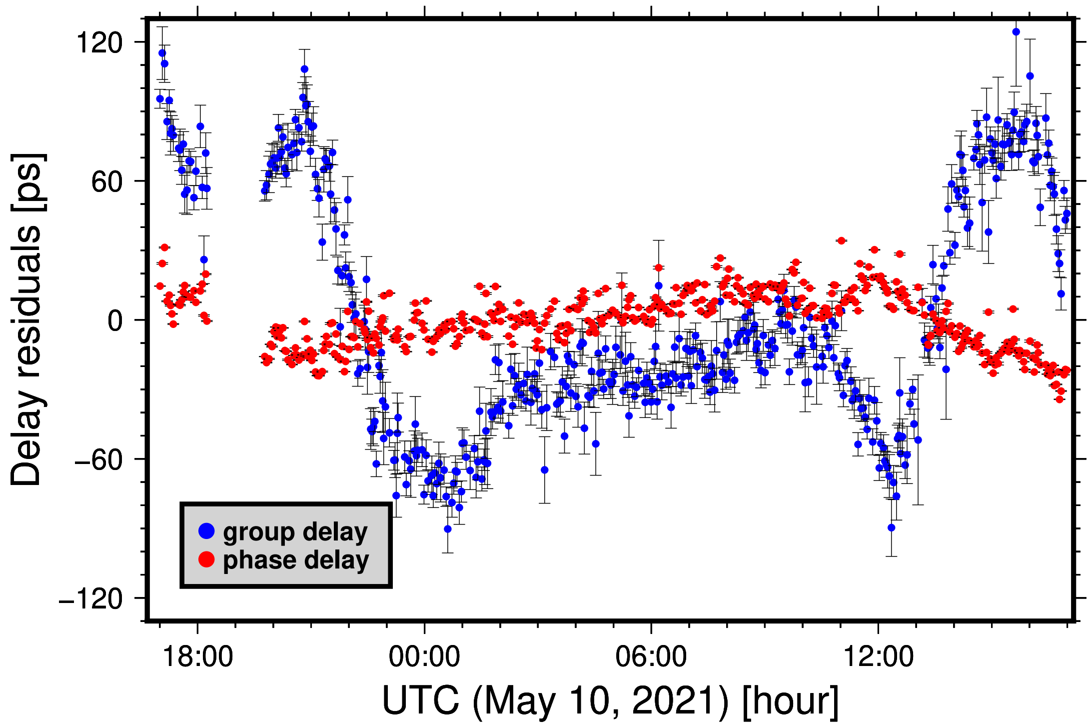

Figure S1. Delay residuals of baseline `WETTZ13N–WETTZELL` from geodetic solutions when estimating a constant offset and a linear rate of the clock (two parameters only) based on group delays (blue dots) and phase delays (red dots) in session 21MAY10XA. For the direction comparison of the group delays and the phase delays, refer to Fig. 2 in the main body of the paper.

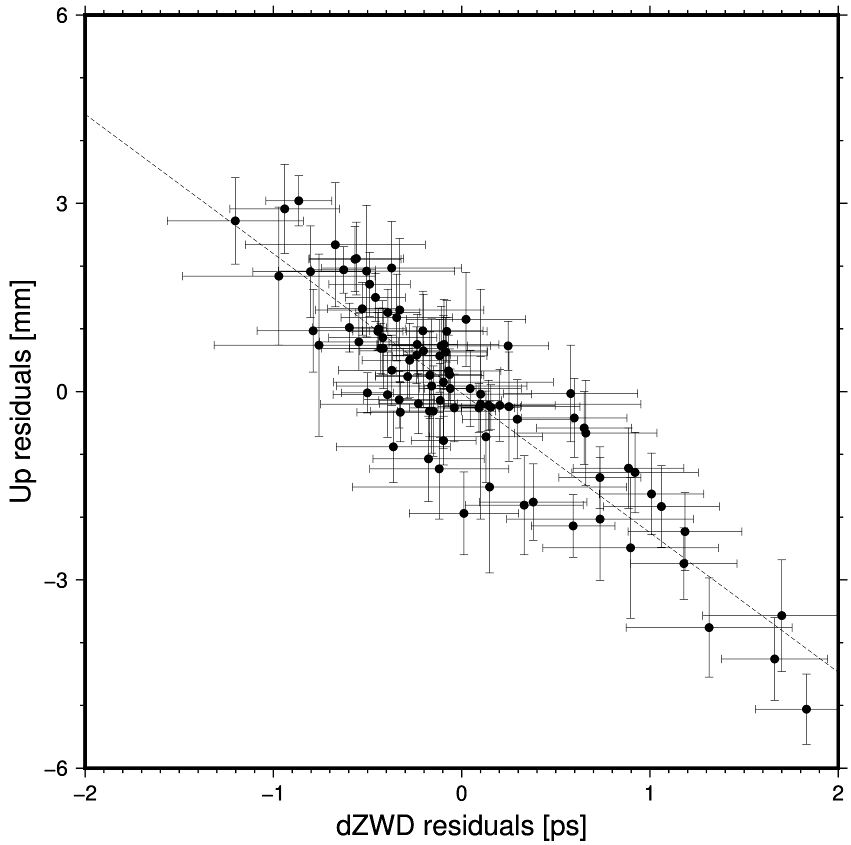

Figure S2. Up residuals of baseline vector `WETTZ13N−WETTZELL` from phase delay analysis as a function of the dZWD residuals, which are the differences of the estimated dZWDs with respect to the mean value.

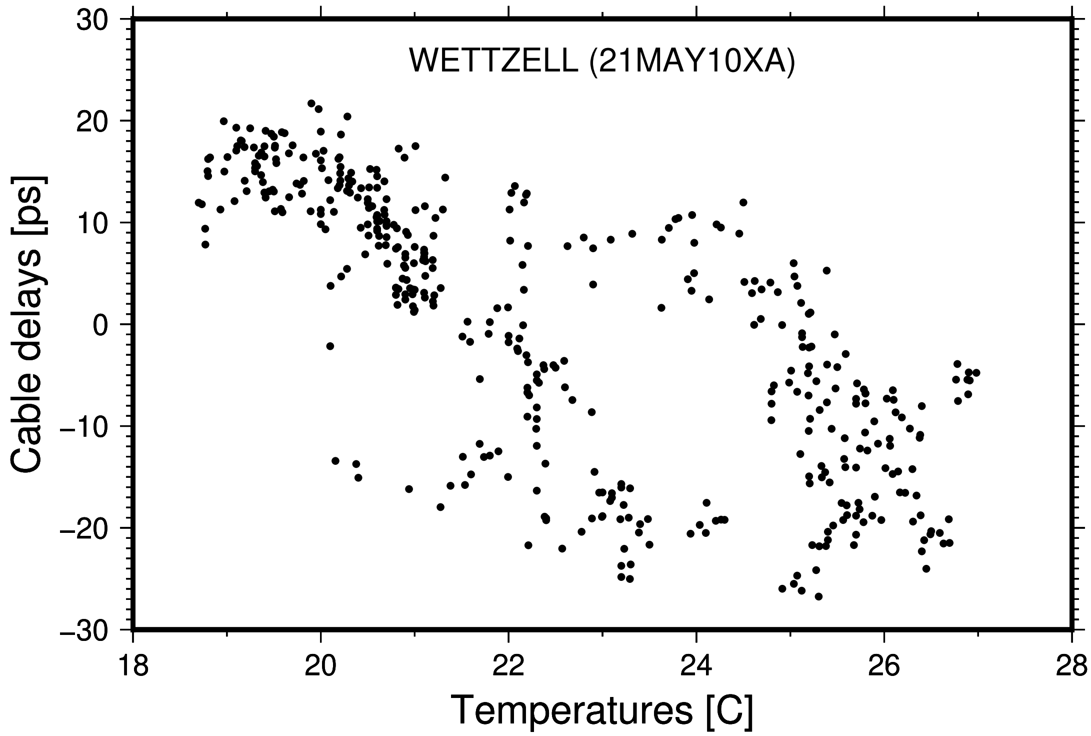

Figure S3. Corrections for cable delays of antenna `WETTZELL` in session 21MAY10XA as a function of the temperatures at the site.