GPS and GLONASS P3 All-in-view combination

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R2CGGTTS update

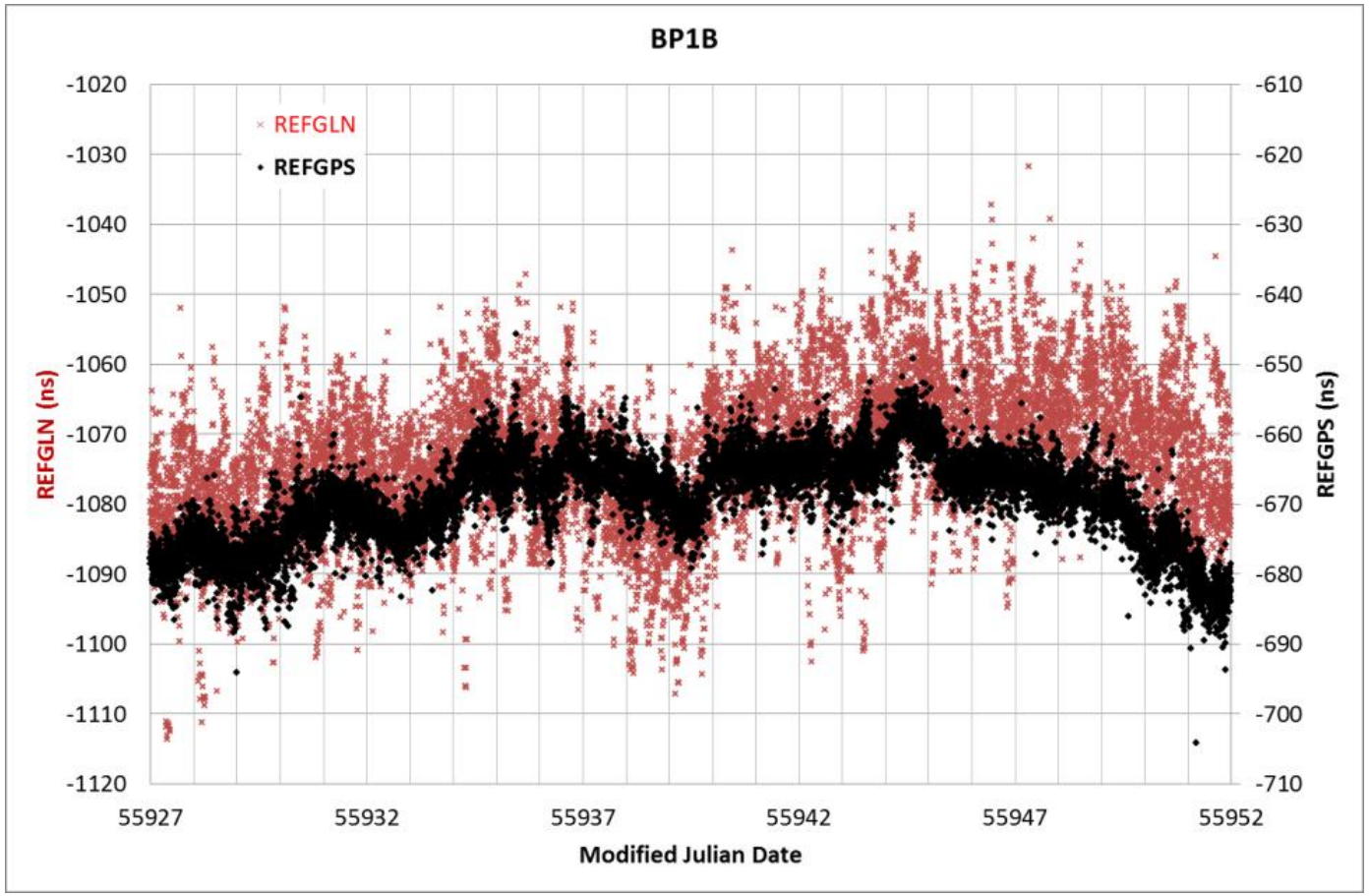
2010 July ➔2012 March

R2CGGTTS version 5.0 = V4.3 **+ GLONASS P3**+ small GPS updates

```
CGGTTS GPS/GLONASS DATA FORMAT VERSION = 02
REV DATE = 2002-07-01
RCVR = SRC AOS TTS-4, SN:0102              R2CGGTTS v5.0
CH = 12 (GPS)
IMS = SRC AOS TTS-4, SN:0102
LAB = BP1B
X = +4203645.79 m (GPS)
Y =  +162934.22 m (GPS)
Z = +4778191.44 m (GPS)
FRAME = ITRF, PZ-90->ITRF Dx = 0.0 m, Dy = 0.0 m, Dz = 0.0 m, ds = 0.0, Rx = 0.0, Ry = 0.0, Rz = 0.000000
COMMENTS = NO COMMENTS
INT DLY =    0.0 ns (GPS P1),    0.0 ns (GPS P2)
INT DLY =    0.0 ns (GLONASS P1),    0.0 ns (GLONASS P2)
CAB DLY =  139.3 ns (GPS)
REF DLY =   27.1 ns
REF = BP1B
CKSUM = 9C
```

PRN	CL	MJD	STTIME	TRKL	ELV	AZTH	REFSV	SRSV	REFSYS	SRSYS	DSG	IOE	MDTR	SMDT	MDIO	SMDI	MSIO	SMSI	ISG	FR	HC	FRC	CK	PS1	PS2
			hhmmss	s	.1dg	.1dg	.1ns	.1ps/s	.1ns	.1ps/s	.1ns		.1ns	.1ps/s	.1ns	.1ps/s	.1ns	.1ps/s	.1ns						
12	FF	55927	000600	780	518	2288	-446102	-116	-6790	-93	31	92	103	-11	8	+40	8	40	23	0	0	L3P	FA	L1P	L2P
9	FF	55927	000600	780	808	3532	-1294607	+3	-6776	+28	18	16	82	-1	-29	-32	-29	-32	11	0	0	L3P	14	L1P	L2P
15	FF	55927	000600	780	439	1724	+948434	-71	-6786	-63	25	107	117	+17	21	+52	21	52	16	0	0	L3P	2F	L1P	L2P
119	FF	55927	000600	780	150	219	+1845332	-46	-10796	-36	64	1	310	+116	173	+37	173	37	52	0	0	L3P	36	L1P	L2P
101	FF	55927	000600	780	343	2497	+1791478	-24	-10883	-24	52	1	143	+24	322	+42	322	42	43	0	0	L3P	34	L1P	L2P
17	FF	55927	000600	780	309	563	-1580639	+1	-6778	-20	59	33	157	+14	-34	+6	-34	6	38	0	0	L3P	A	L1P	L2P
120	FF	55927	000600	780	425	768	+795687	+5	-10811	+5	32	1	120	-4	296	-10	296	-10	26	0	0	L3P	ED	L1P	L2P
111	FF	55927	000600	780	648	3334	+703859	+28	-10857	+28	39	1	89	-3	303	-23	303	-23	31	0	0	L3P	18	L1P	L2P
110	FF	55927	000600	780	397	716	+794427	+85	-10775	+85	32	1	127	+17	382	-46	382	-46	27	0	0	L3P	42	L1P	L2P
121	FF	55927	000600	780	275	1399	+792528	-3	-10747	-3	46	1	175	-49	203	-14	203	-14	38	0	0	L3P	1B	L1P	L2P

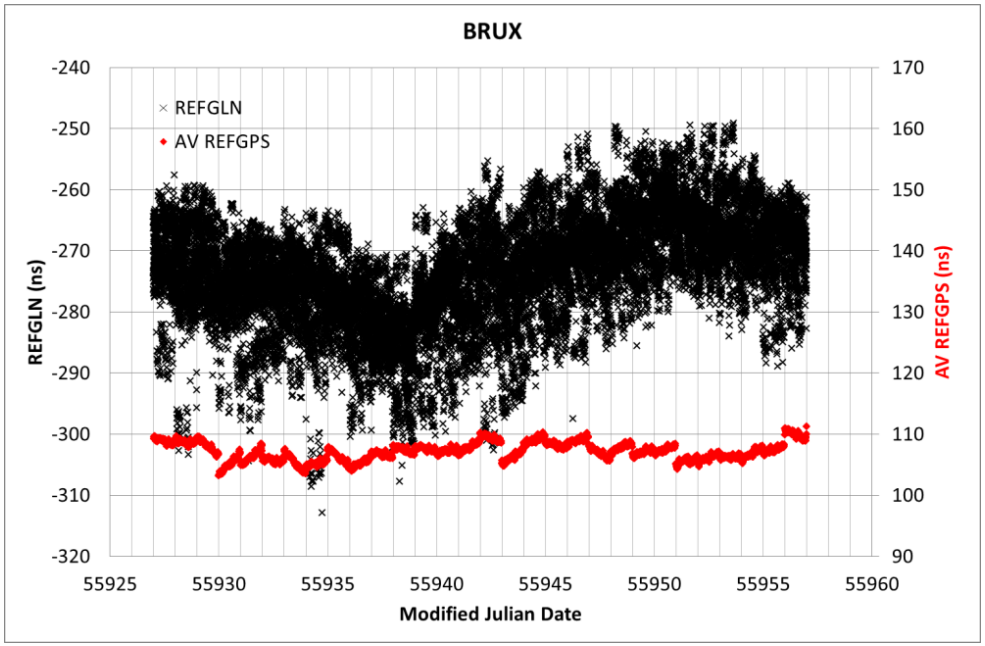
R2CGGTTS update



➔ **Noise(REFGLN) due to inter-frequency biases**

InterFrequency Biases correction

- **Daily** changes in the difference REFGLN-REFGPS due to daily biases in ESOC products
⇒ we determine daily IFB using GPS All-in-view as **reference**

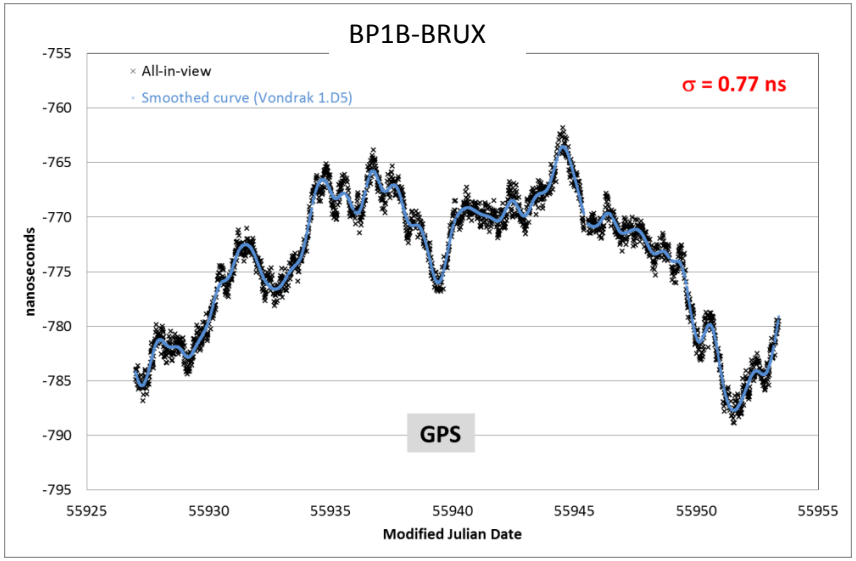


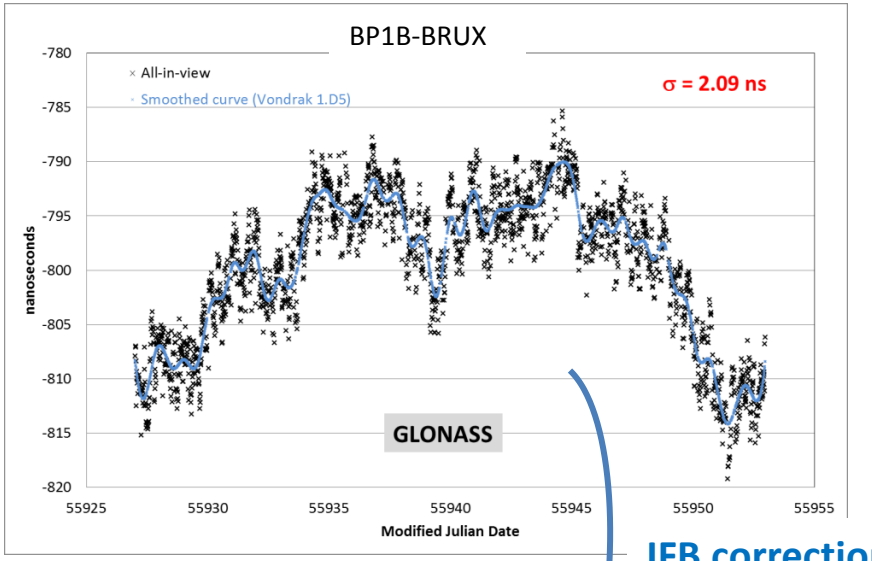
IFB over one day for each satellite is:

$$IFB(sat, day) = \frac{\sum_{t=1}^{n} w(sat,t)\ (REFGLN(sat,t) - Av.REFGPS(t))}{\sum_{t=1}^{n} w(sat,t)}$$

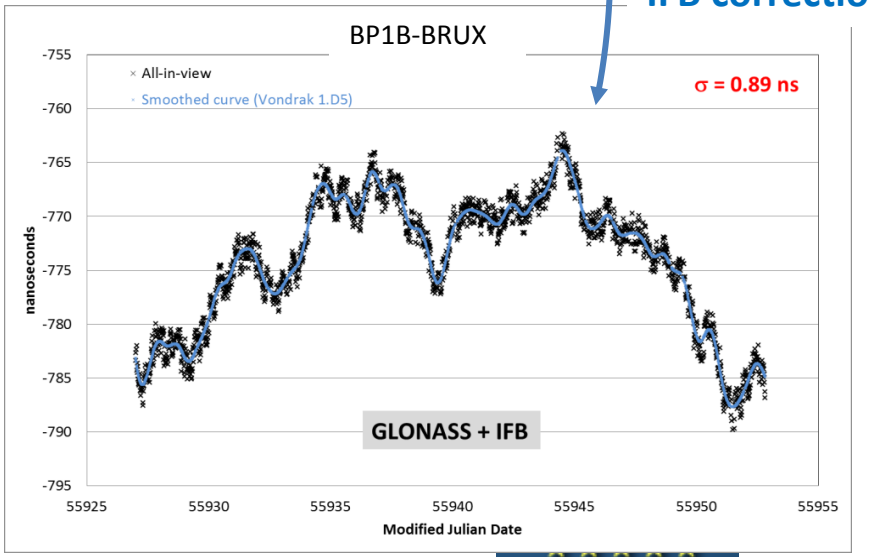
Where $w(sat,t)$ is the weight = sin²(elevation)

InterFrequency Biases correction





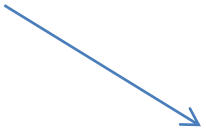
IFB correction



➔ Gain of about 60% on GLONASS P3 time links when correcting IFBs

All in view GPS + GLONASS

As ESOC clock products are given with respect to the same reference for GPS and GLONASS satellites, a global AV solution can be computed.

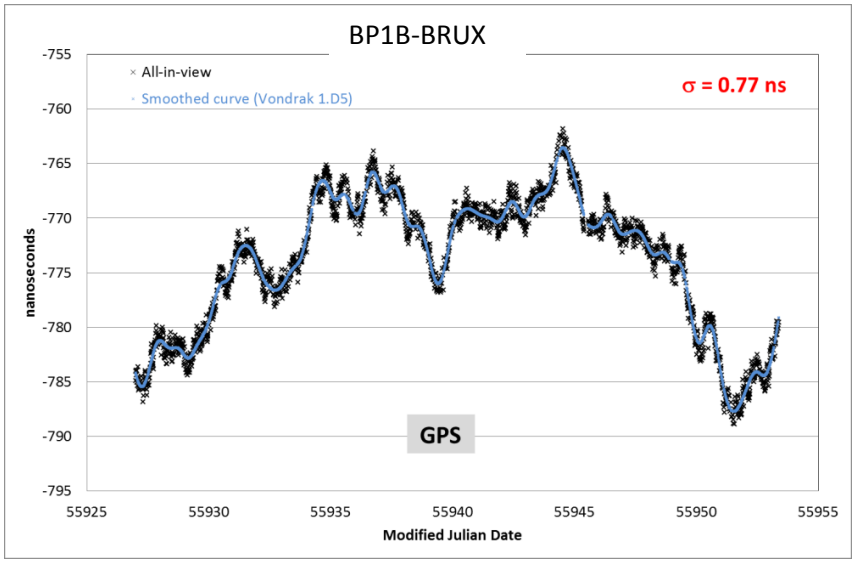


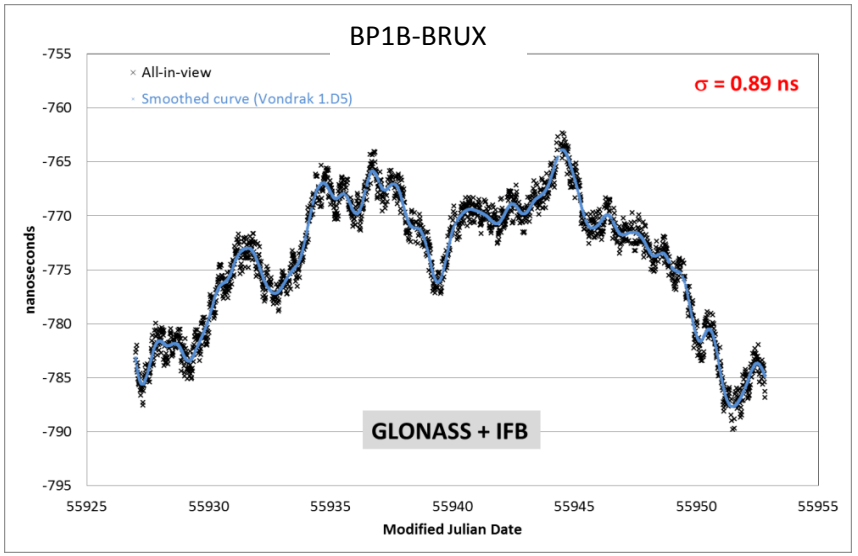
UTC(k) - REF

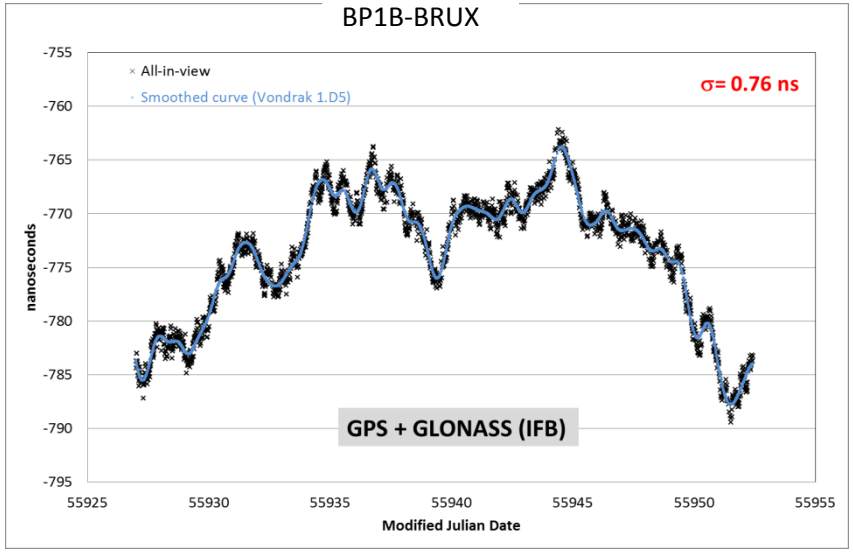
<u>Proposed procedure</u> :

1. R2CGGTTS with GPS + GLONASS (broadcast orbits/clocks)
2. Correction with ESOC rapid products for orbits/clocks
3. Compute AV-GPS
4. Determine IFB for each GLONASS sat w.r.t. AV-GPS
5. Compute the global solution : AV-GPS+GLO(IFBcor)

GPS+GLONASS P3 All-in-view time links



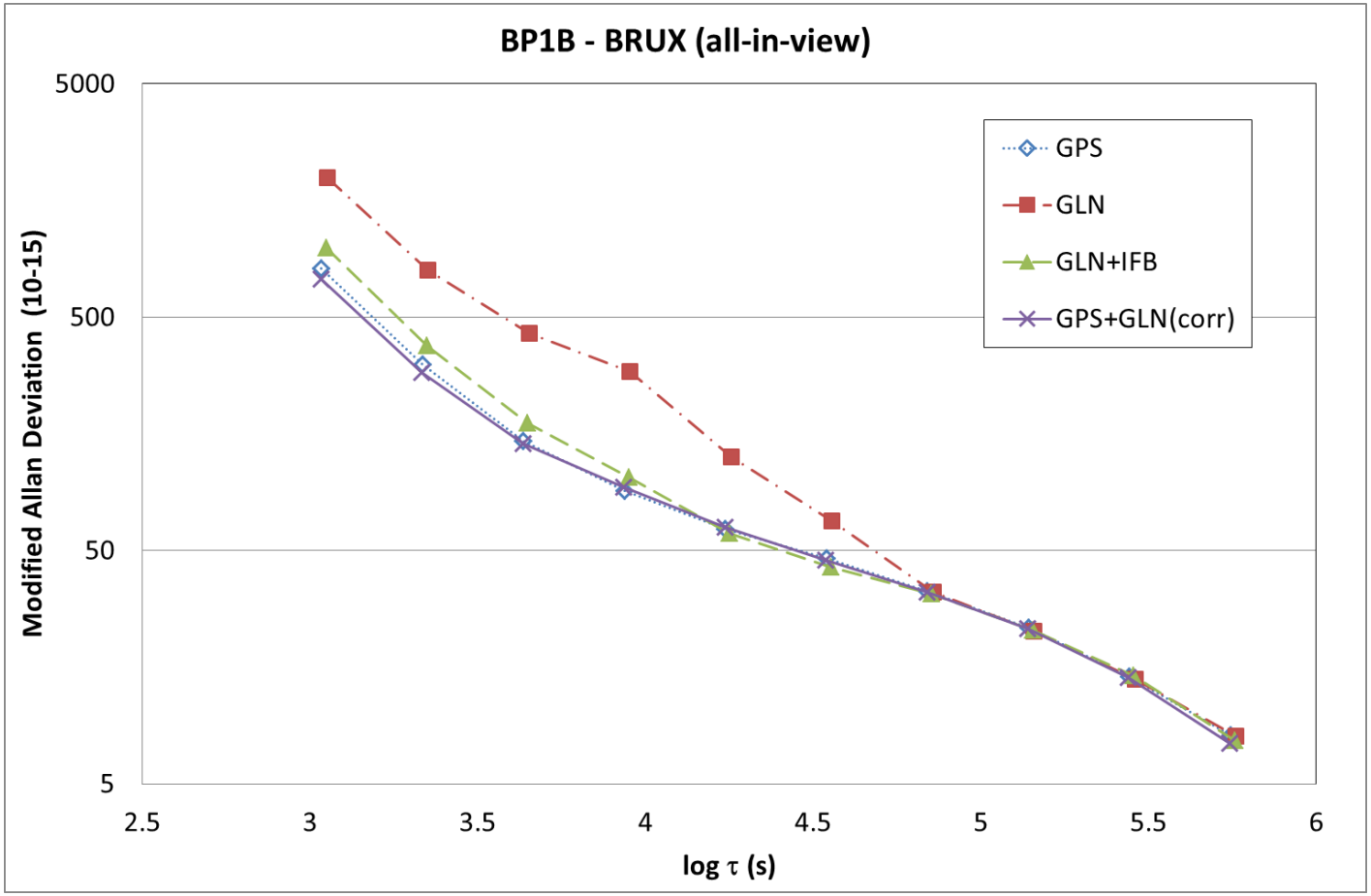




No significative improvement w.r.t. GPS-only

Use of multi-technique

Frequency stability



Results from other receivers

	All-in-View (σ /ns)					
	GPS	GLN	GLN +IFB	GPS+GLO (IFB)	Gain IFB % (AV)	Baseline (km)
AOS-BP1B	0.80	6.02	0.91	0.79	85	1120
BP1C-BP1B	0.64	3.04	0.97	0.64	68	0
IPQ-BP1B	1.30	1.75	1.19	0.96	32	1450
AOS-IPQ	1.24	6.08	0.93	0.89	85	2510
BP1C-IPQ	1.36	3.08	1.34	1.17	57	1450
BP1C-AOS	0.79	6.07	1.24	0.80	80	1120
AOS-AUS	0.73	6.76	0.90	0.72	87	12060
BP1C-AUS	0.90	4.02	1.31	0.89	67	12370
IPQ-AUS	1.32	3.23	1.22	0.97	62	16210
AUS-BP1B	0.92	3.59	1.21	0.89	66	12370
AOS-BRUX	0.31	5.23	0.54	0.29	90	900
IPQ-BRUX	1.23	2.31	0.90	0.88	61	1710
BP1B-BRUX	0.77	2.09	0.89	0.77	57	270
BP1C-BRUX	0.78	2.65	1.18	0.77	55	270
AUS-BRUX	0.73	3.59	0.87	0.69	76	12320
SPT0-BP1B	0.79	1.68	0.90	0.78	46	1210
ONSA-BP1B	0.80	2.43	0.90	0.75	63	1150
WTZR-BP1B	1.34	2.62	1.96	1.41	25	780
SPT0-BRUX	0.37	1.84	0.55	0.30	70	950
ONSA-BRUX	0.35	3.02	0.57	0.30	81	890

Thank you for your attention

Defraigne P., Harmegnies A., Petit G., Time and frequency transfer combining GLONASS and GPS data, Proc. Joint Meeting of the EFTF and IEEE FCS, 2011, 676–680.

Defraigne P., Baire Q., Harmegnies A., Time and frequency transfer combining GLONASS and GPS data, Proc. 42nd PTTI Meeting 2010, 263–274.