Results from the VLBI Analysis Software Comparison Campaign 2015 (VASCC2015)

Grzegorz Klopotek*, T. Artz, A. Bellanger, G. Bourda, M. Gerstl, D. Gordon, S. Halsig, G.A. Hjelle, U. Hugentobler, A. Iddink, A.S. Kirkvik, S. Lambert, L. Plank, R. Schmid, F. Shu, O. Titov, F. Tong, G. Wang, M. Xu, W. Zheng

*Department of Earth and Space Sciences, Chalmers University of Technology, Sweden

OUTLINE

(1) IDEA

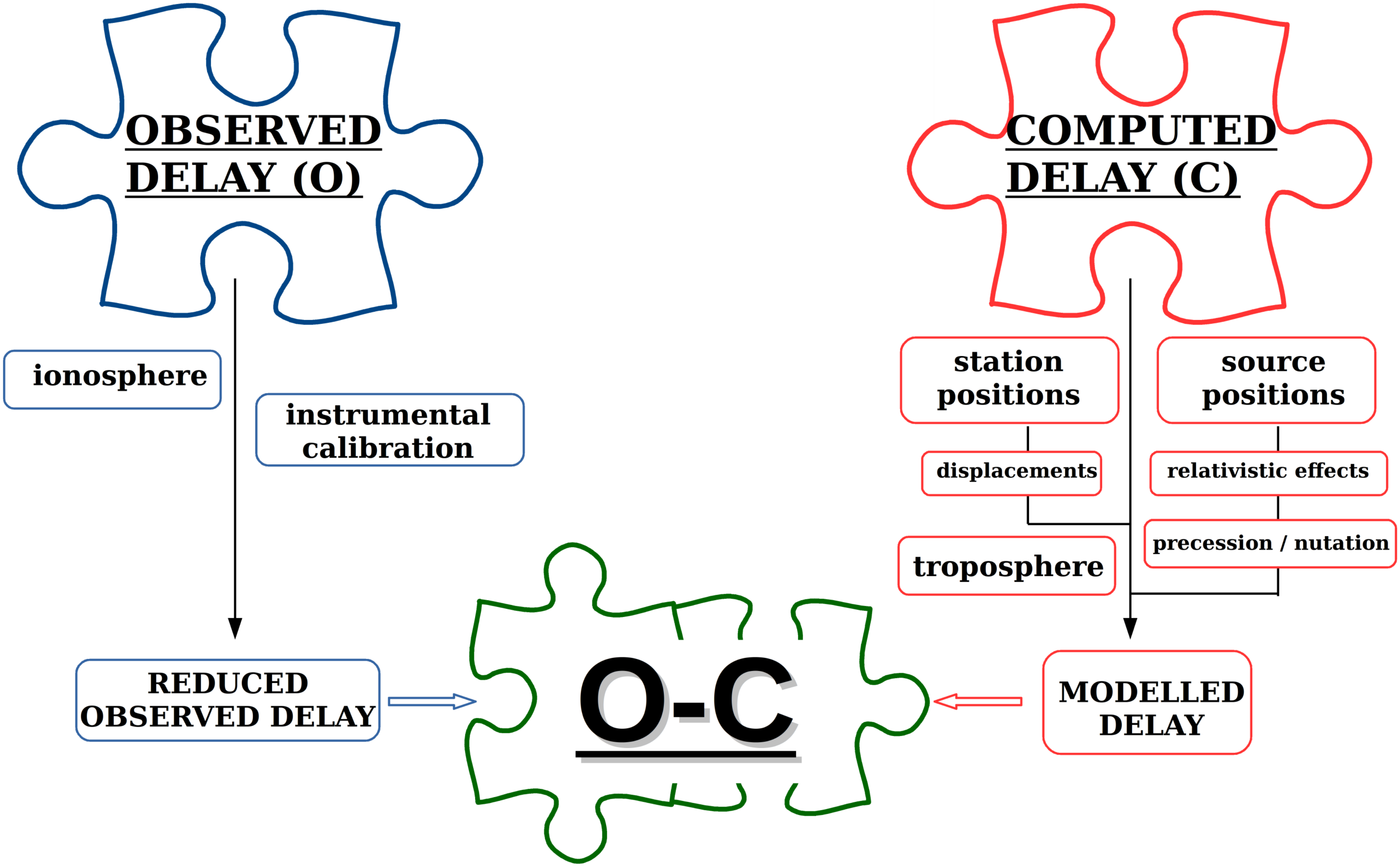
(2) NETWORK GEOMETRY

(3) RESULTS

(4) CONCLUSIONS

(5) OUTLOOK

VASCC 2015 - IDEA



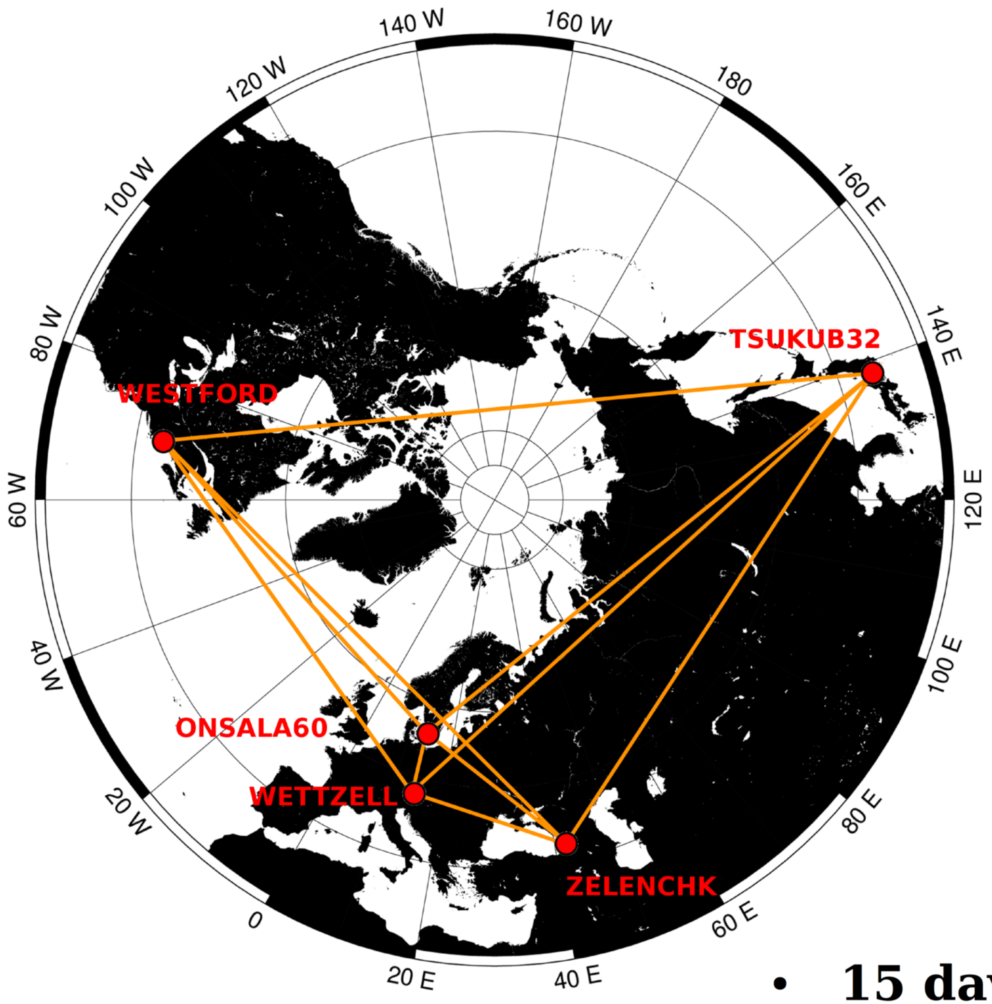
VLBI Analysis Software Comparison Campaign 2015

- Comparison of softwares on the basis of:

$$\boxed{\tau_{comp} = \tau_{geometric} + \tau_{gravitational} + \tau_{tropo} + \tau_{axisoffset} + \tau_{thermdef}}$$

- τ_{comp} obtained from different Research Groups / Institutes
- In accordance to the IERS Conventions (2010)

NETWORK GEOMETRY - NH

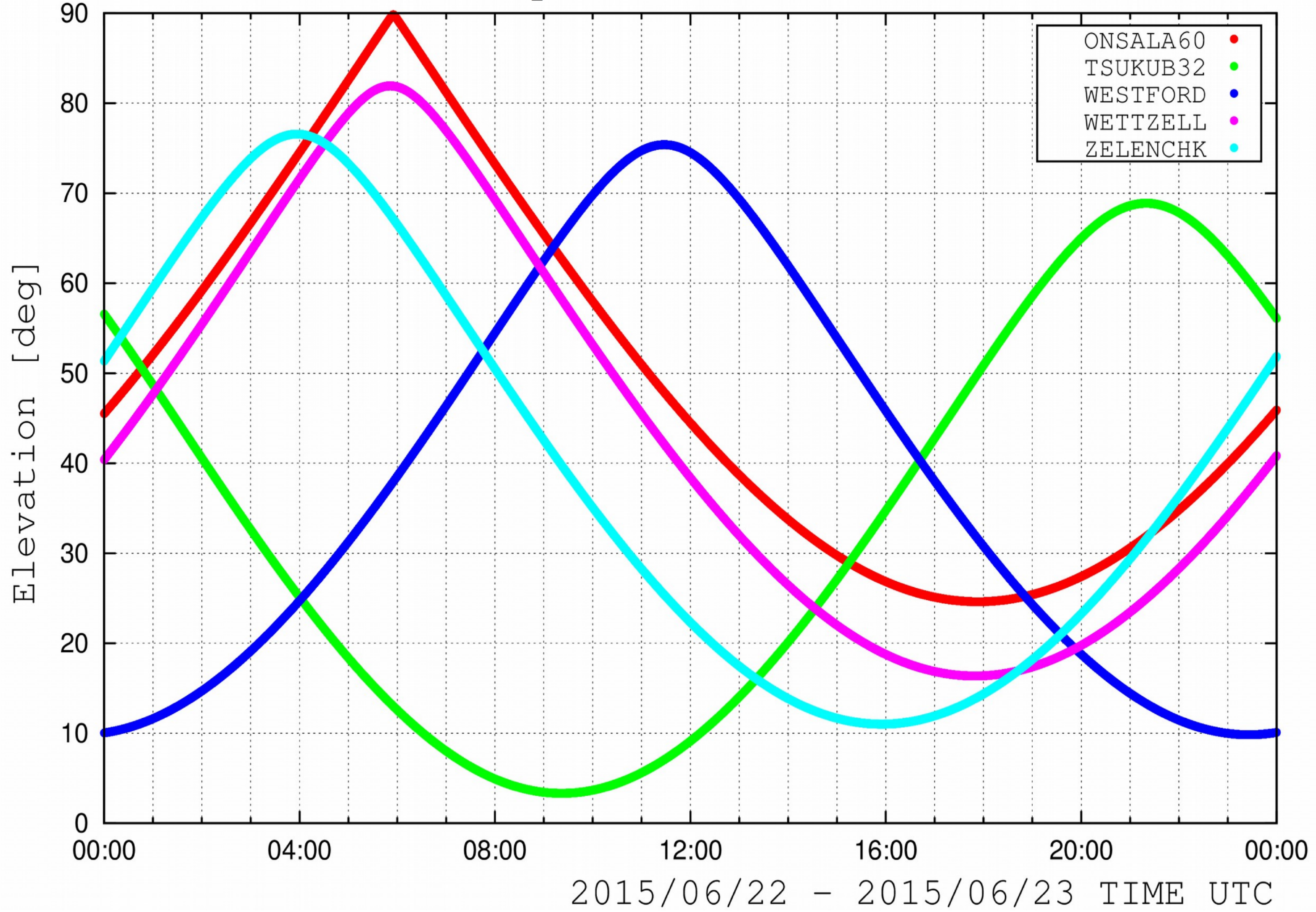


- Fictitious observations
- 15 x 24 h session
- **1 min resolution**
- Source: 0039+568
- **10 baselines per epoch**
- **Continuous observations**
- **15 days period:**

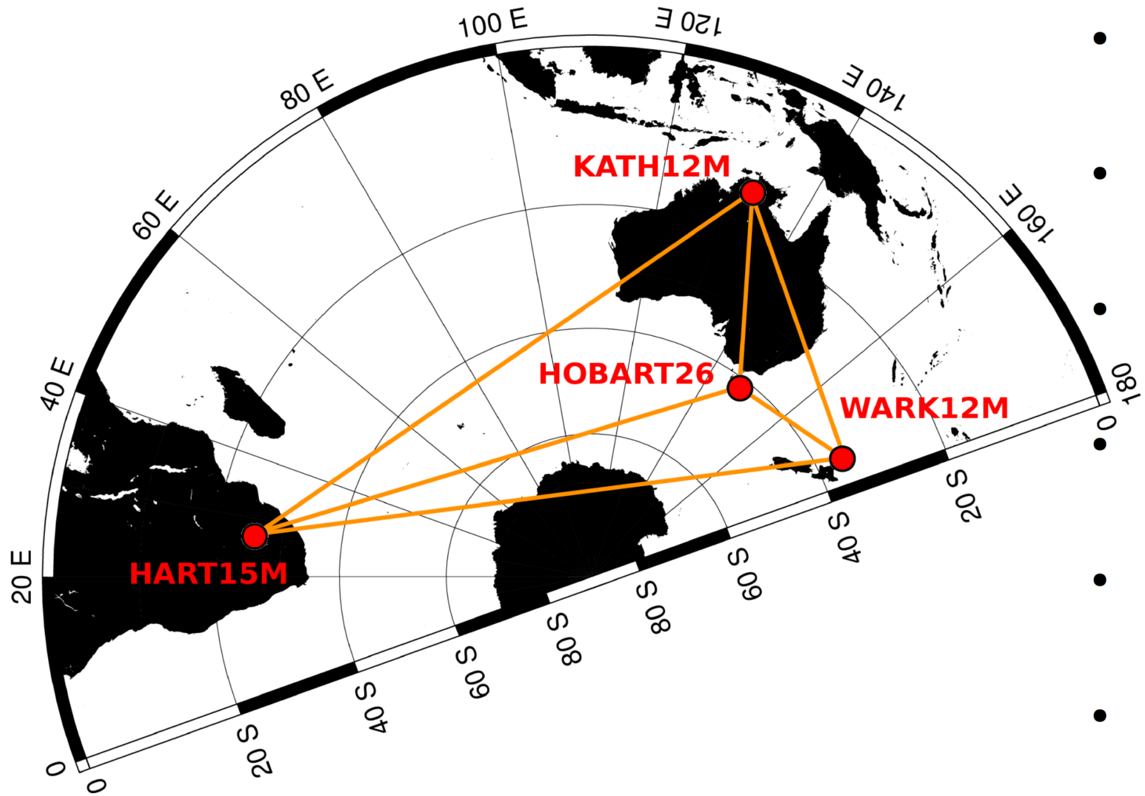
2015/06/22 00:00:00 UTC – 2015/07/07 00:00:00 UTC

NETWORK GEOMETRY - NH

Northern Hemisphere - 1 source: **0039+568**



NETWORK GEOMETRY - SH

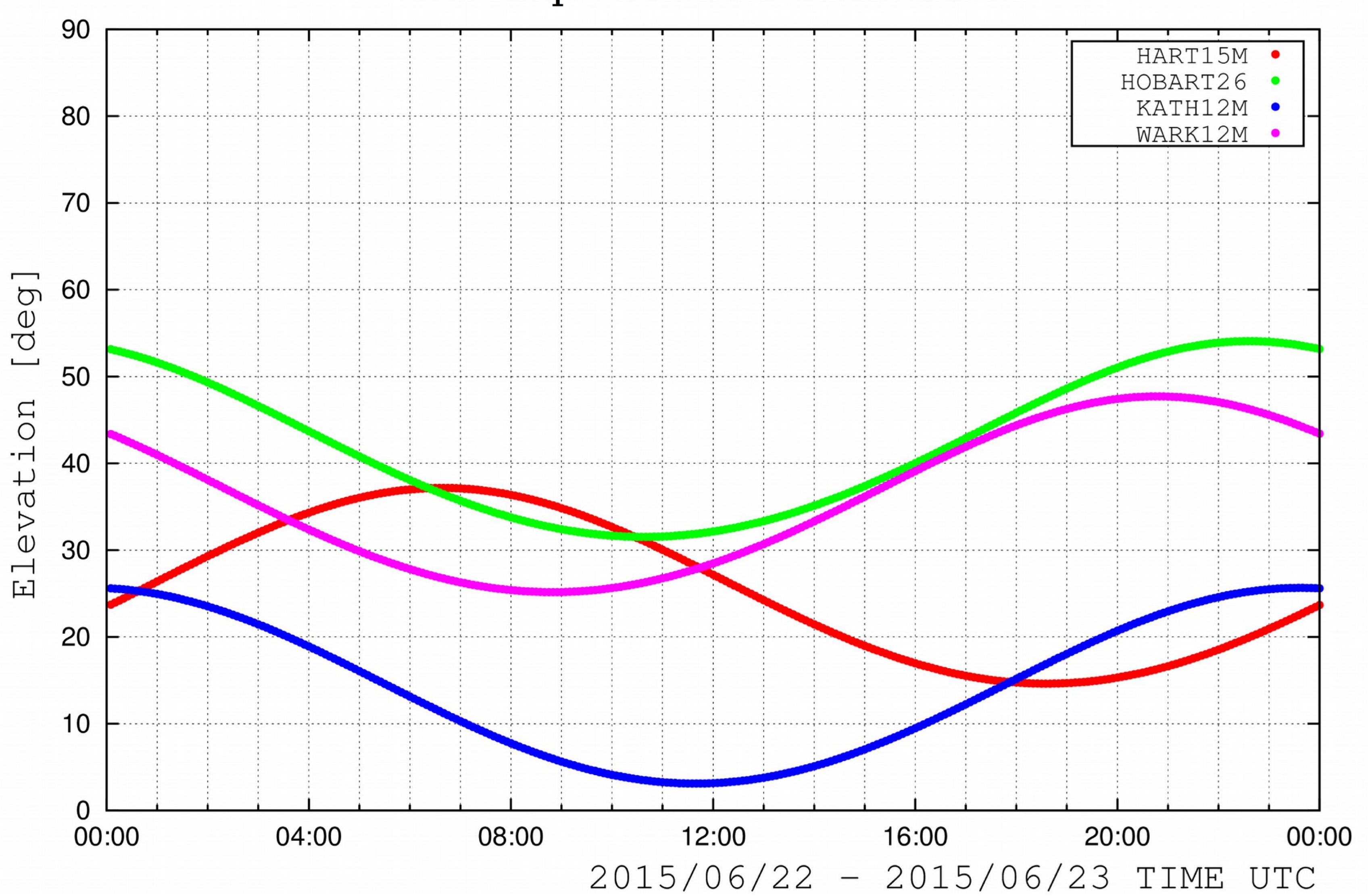


- Fictitious observations
- 15 x 24 h session
- **1 min resolution**
- Source: 0230-790
- **6 baselines per epoch**
- **Continuous observations**
- **15 days period:**

2015/06/22 00:00:00 UTC – 2015/07/07 00:00:00 UTC

NETWORK GEOMETRY - SH

Southern Hemisphere - 1 source: **0230-790**



A priori settings & data format

INPUT PARAMETERS:

- **Constant** EOP + high freq. EOP variations
- 1000 hPa & 20 degree Celsius **at all sites**
- Relative humidity 50% **at all sites**
- Cable delays: 0s **at all sites**

NOT APPLIED:

- Tidal S1/S2 and non-tidal atmosphere loading
- A priori wet ZD & gradients
- Station eccentricities

30/06/2015 – 01/07/2015 – leap second

- **DATA FORMAT: NGS, MK3DB*, VGOSDB**
- **AUXILARY DATA: text files** (EOPs, station & source coordinates)

*MK3DB (conversion from NGS) – provided by David Gordon (GSFC)

AGREED PARTICIPATION

	Software	Participants (provision of results)
1	Bernese GNSS	Technische Universität München
2	c5++	Chalmers University of Technology
3	Calc11	Goddard Space Flight Center (GSFC), NASA
4	Calc11	Shanghai Astronomical Observatory (SHAO)
5	DOGS-RI	Technische Universität München (DGFI - TUM)
6	GEOSAT	Norwegian Mapping Authority
7	GINS	Laboratoire d'Astrophysique de Bordeaux
8	GLORIA	Observatoire de Paris
9	ivg::ASCOT	Bonn University
10	OCCAM	Geoscience Australia
11	QUASAR	Russian Academy of Sciences, IAA
12	SHAO software correlator (SCORR)	Shanghai Astronomical Observatory (SHAO)
13	VieVS	University of Tasmania

COMPARISON STATUS

	Software	I Initial submission	II Adjustment of settings	**III Final solution**
1	Bernese GNSS	YES	YES	**-**
2	**c5++**	YES	YES	**YES**
3	**Calc11(GSFC)**	YES	YES	**YES**
4	Calc11(SHAO)	YES	YES	**-**
5	**DOGS-RI**	YES	YES	**YES**
6	GEOSAT	YES	YES	**-**
7	GINS	YES	YES	**-**
8	GLORIA	YES	YES	**-**
9	**ivg::ASCOT**	YES	YES	**YES**
10	OCCAM	YES	YES	**-**
11	QUASAR	-	-	-
12	**SCORR(SHAO)**	YES	YES	**YES**
13	**VieVS**	YES	YES	**YES**

COMPARISON STATUS

	Software	I Initial submission	II Adjustment of settings	**III Final solution**
1	Bernese GNSS	YES	YES	**-**
2	**c5++**	YES	YES	**YES**
3	**Calc11(GSFC)**	YES	YES	**YES**
4	Calc11(SHAO)	[illegible]	[illegible]	**-**
5	**DOGS-RI**	[illegible]	[illegible]	**YES**
6	GEOSAT	YES	YES	**-**
7	GINS	YES	YES	**-**
8	GLORIA	YES	YES	**-**
9	**ivg::ASCOT**	YES	YES	**YES**
10	OCCAM	YES	YES	**-**
11	QUASAR	-	-	-
12	**SCORR(SHAO)**	YES	YES	**YES**
13	**VieVS**	YES	YES	**YES**

BUG-FIXING STAGE

In case of some softwares: 2^{nd} stage still ongoing

RESULTS

AGREEMENT

FULL DELAY MODEL

RMS for 15 X 24 h

	RMS [mm]	1	2	3	4	5	6
		ivg::ASCOT	Calc11(GSFC)	c5++	DOGS-RI	SCORR(SHAO)	VieVS
1	ivg::ASCOT	x	0.38	0.17	0.59	0.41	0.17
2	Calc11(GSFC)	-	x	0.43	-	0.57	0.44
3	c5++	-	-	x	0.61	0.44	0.22
4	DOGS-RI	-	-	-	x	0.71	0.59
5	SCORR(SHAO)	-	-	-	-	x	0.44
6	VieVS	-	-	-	-	-	x

Note:
Therm. Def. turned off for all comparisons incl. Calc11

0-1 mm
1-2 mm
2-5 mm
> 5 mm

Mean RMS among 6 softwares: 0.44 mm (1.5 ps)

AGREEMENT

FULL DELAY MODEL

Max abs. value for 15 X 24h

	Max. Abs. Value [mm]	1	2	3	4	5	6
		ivg::ASCOT	Calc11(GSFC)	c5++	DOGS-RI	SCORR(SHAO)	VieVS
1	ivg::ASCOT	x	1.82	1.04	1.52	1.24	0.83
2	Calc11(GSFC)	-	x	1.76	-	2.68	2.06
3	c5++	-	-	x	1.87	1.48	1.14
4	DOGS-RI	-	-	-	x	2.05	1.71
5	SCORR(SHAO)	-	-	-	-	x	1.37
6	VieVS	-	-	-	-	-	x

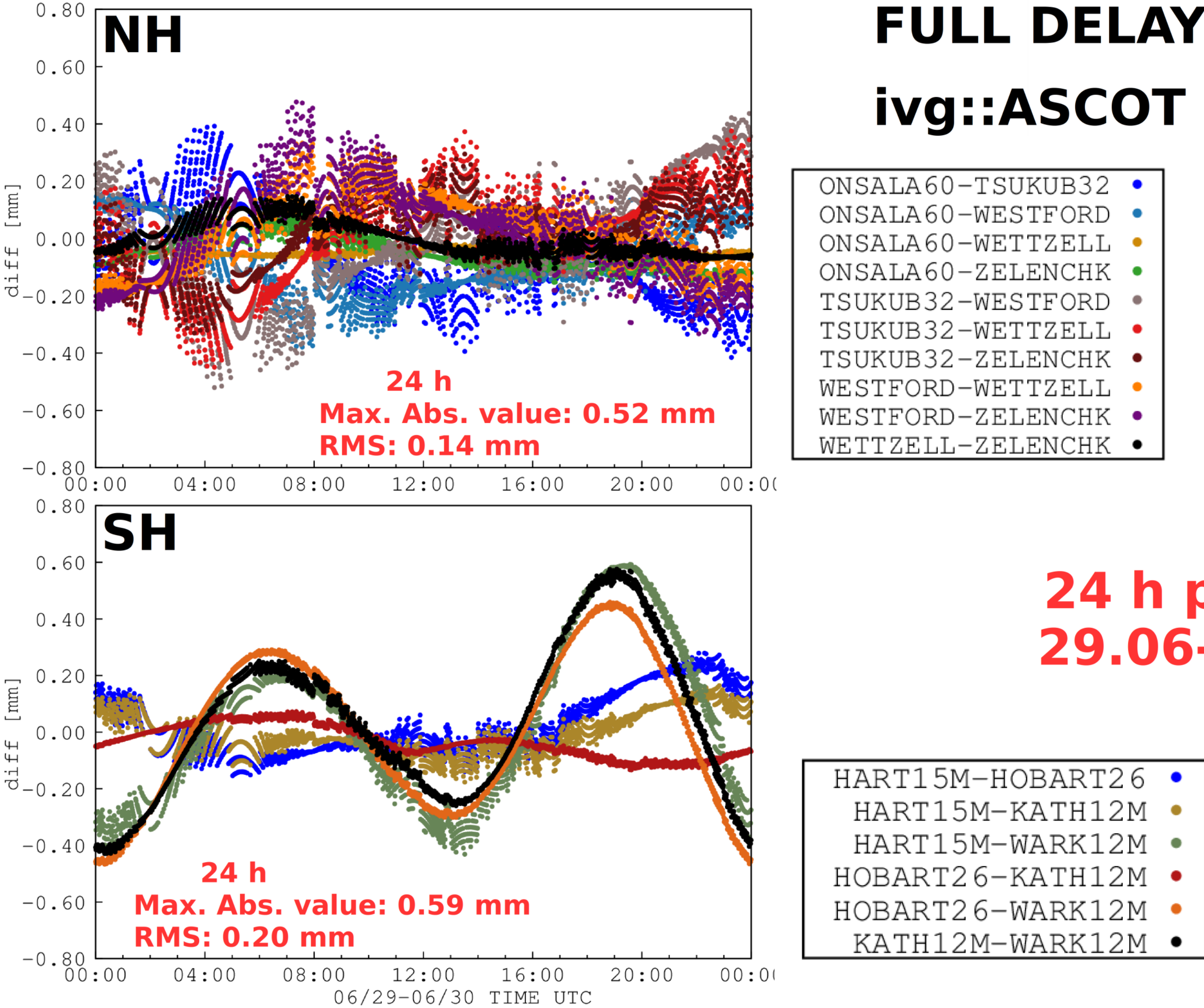
Note:
Therm. Def. turned off for all comparisons incl. Calc11

0-1 mm
1-2 mm
2-5 mm
> 5 mm

Example of good agreement (24 h)

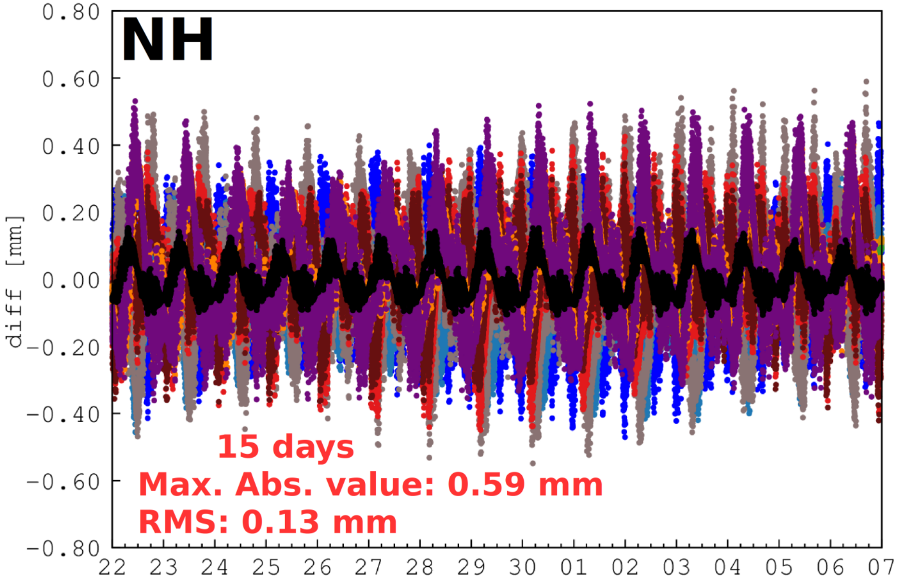
FULL DELAY MODEL

ivg::ASCOT - VieVS



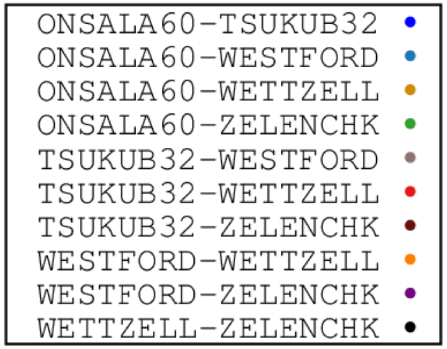
24 h period:
29.06-30.06

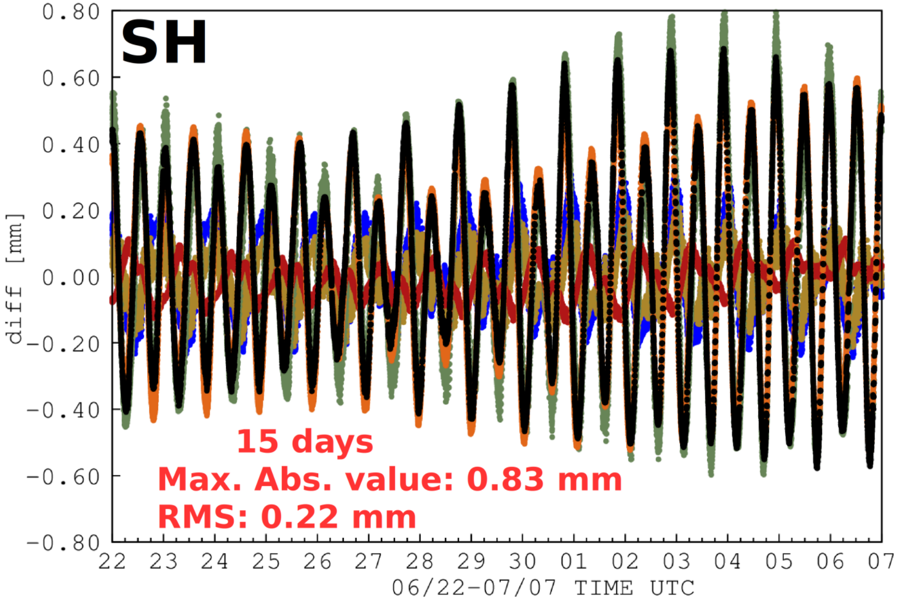
Example of good agreement (15 days)



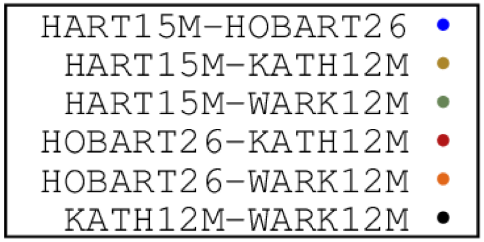
FULL DELAY MODEL

ivg::ASCOT - VieVS



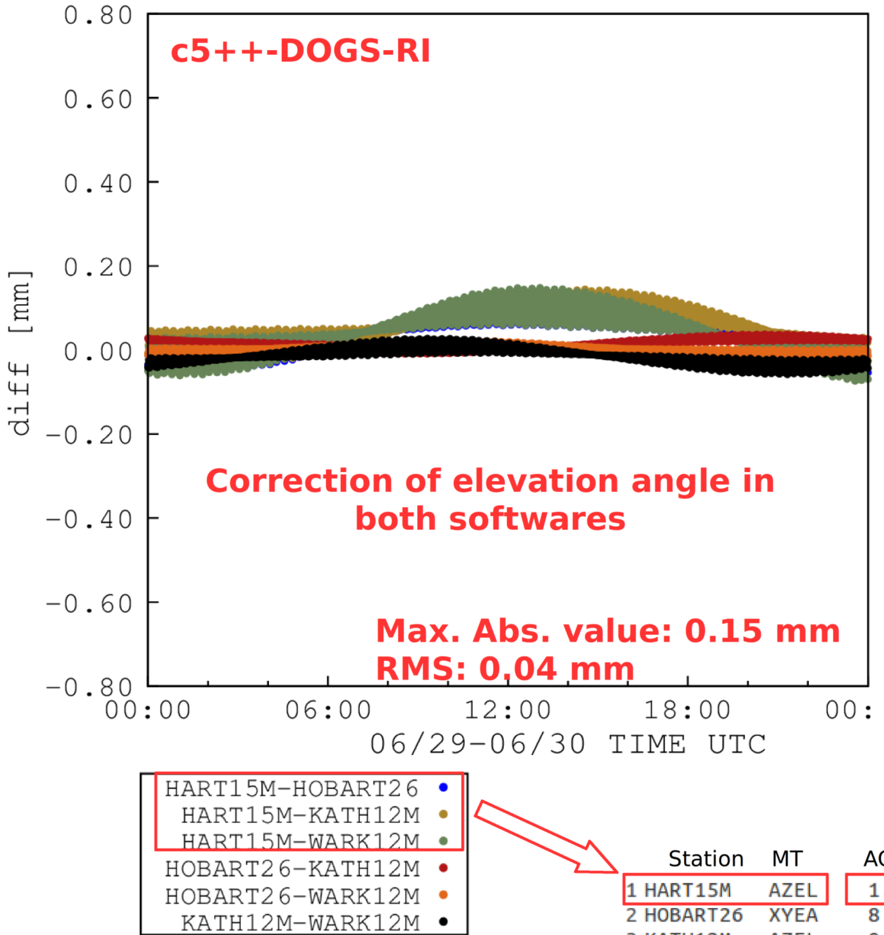


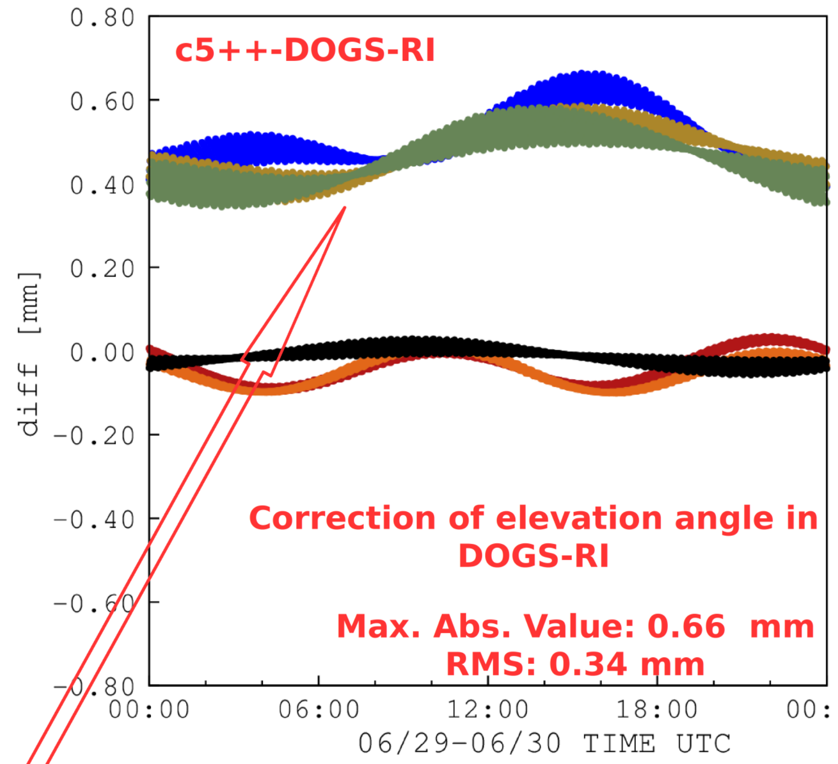
15 day period



Example of differences (1)

Delay: Vacuum + Gravitational + Axis Offset





	Station	MT	AO [m]
1	HART15M	AZEL	1.4950
2	HOBART26	XYEA	8.1913
3	KATH12M	AZEL	0.0043
4	ONSALA60	AZEL	-0.0060
5	TSUKUB32	AZEL	0.0049
6	WARK12M	AZEL	0.0010
7	WESTFORD	AZEL	0.3182
8	WETTZELL	AZEL	-0.0001
9	ZELENCHK	AZEL	-0.0115

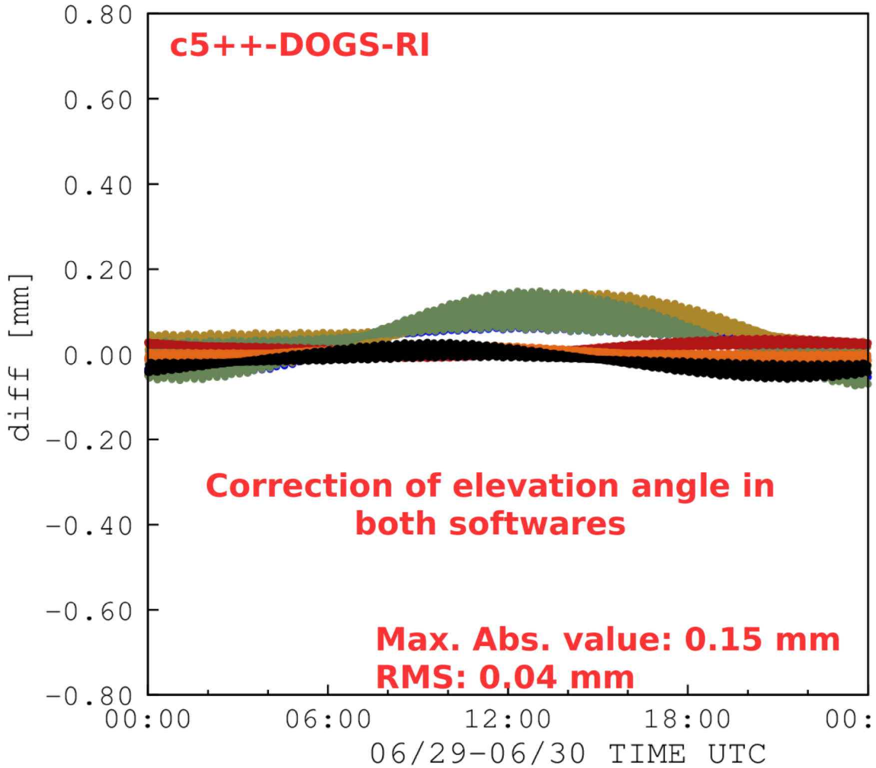
Fictitious value

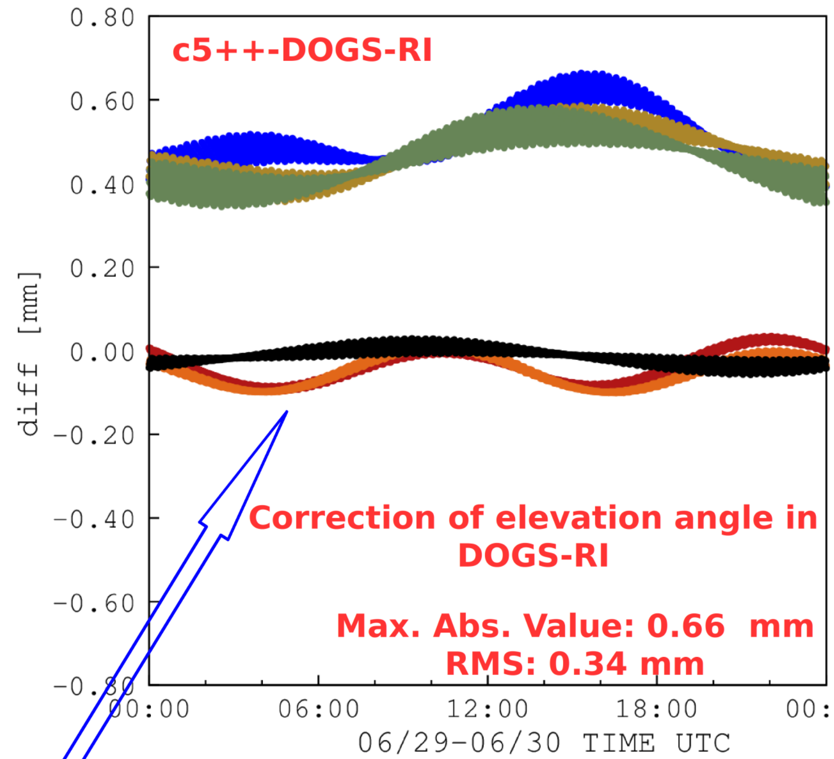
Major effect

vlbi.geod.uni-bonn.de/Analysis/Thermal/antenna-info.txt

Example of differences (1)

Delay: Vacuum + Gravitational + Axis Offset





HART15M−HOBART26
HART15M−KATH12M
HART15M−WARK12M
HOBART26−KATH12M
HOBART26−WARK12M
KATH12M−WARK12M

	Station	MT	AO [m]
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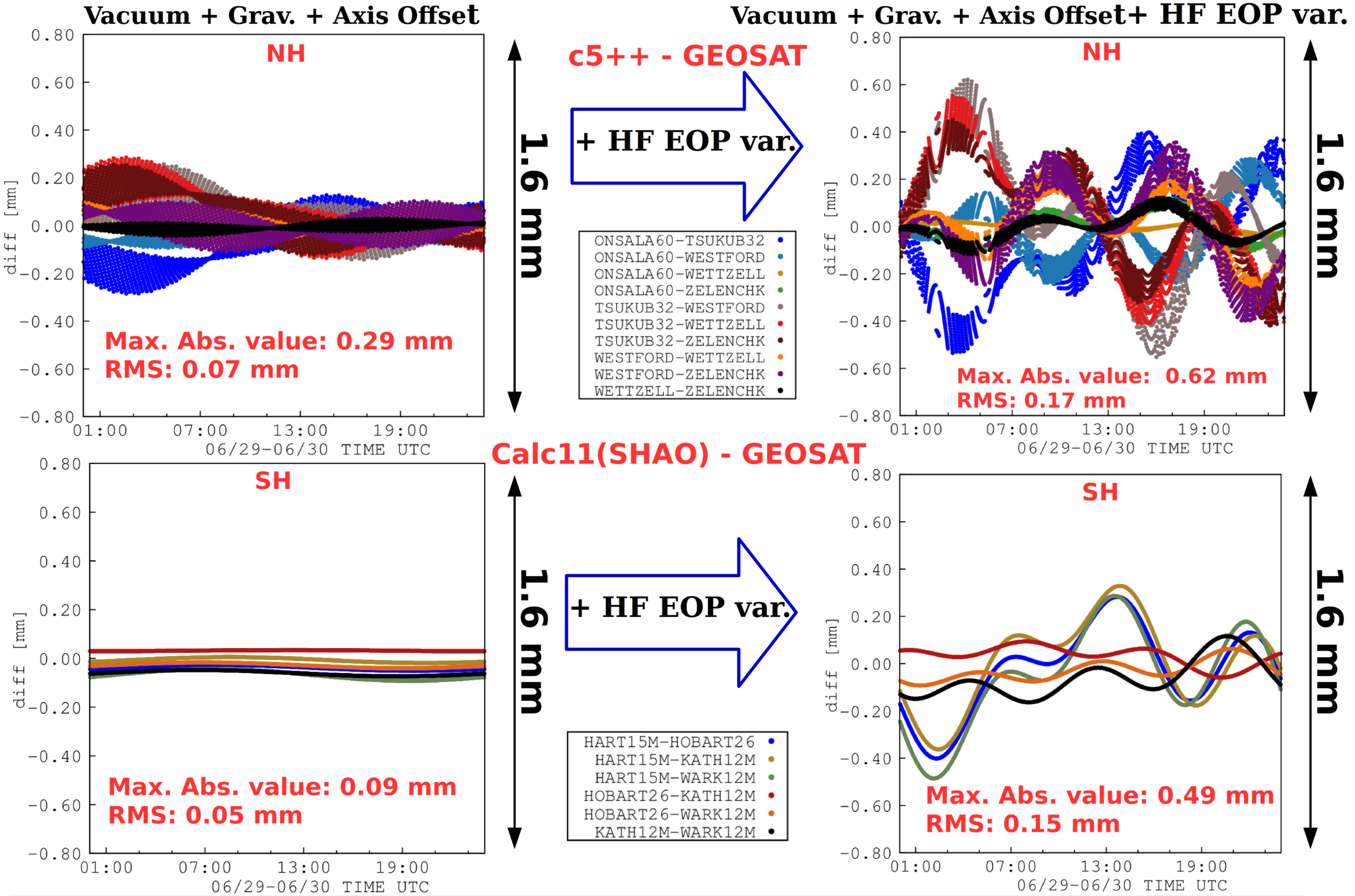
9	ZELENCHK	AZEL	-0.0115

Minor effect

vlbi.geod.uni-bonn.de/Analysis/Thermal/antenna-info.txt

Example of differences (2)



CONCLUSIONS

- Sub millimeter agreement (RMS) among 6 softwares
- Discrepancies after:
  - computation of geometric (vacuum) delays
  - computation / inclusion of correction of source elevation angles
  - introduction of EOP variations

  and / or caused by:
  - unidentified bugs
  - numerical issues
- Usage of different ephemerides - no impact (not shown here)

OUTLOOK

- Bring all software packages to the submillimeter agreement
- Investigate remaining software modeling discrepancies
- Discuss definition of the elevation angle for $\Delta\tau_{AO}$ & $\Delta\tau_{thermDef}$
  (see IVS Analysis WS, this conference)
- Modify the geometry of networks or initial settings
- Utilize simulated observations

THANK YOU FOR YOUR ATTENTION !

grzegorz.klopotek@chalmers.se