The Importance of Correct Antenna Calibration Models for the EUREF Permanent Network

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Calibration Models for GPS antennas

- In the beginning only phase centre offsets were applied.
- Later also direction dependent corrections were introduced.

These direction dependent corrections have been estimated based on one specific reference antenna (usually AOAD/M_T)

→ Relative Calibration Models

Absolute antenna calibration models were possible since the introduction of

- Calibration methods in an anechoic chamber (Schuppler, Campell)
- Calibration with a robot (Wübbena, Menge)

Problems with the absolute phase centre corrections

Anechoic chamber calibrations (Campell) and robot calibrations agreed lately quite well, therefore absolute PCV (Phase Centre Variations) are verified by two independent techniques.

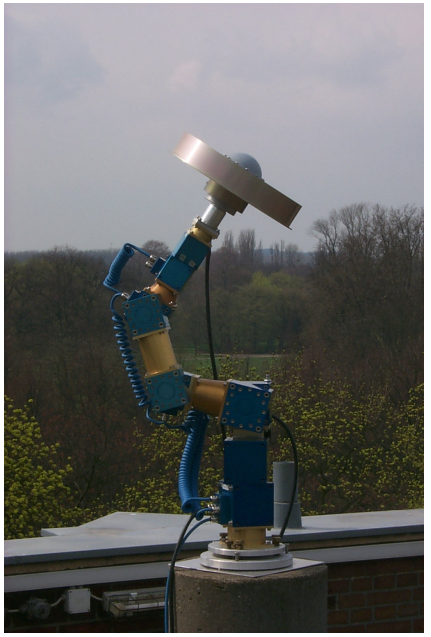
Remaining problem:

Applying the new absolute PCV for network of regional or global extend leads to a scale factor of :

14 ppb

Solution:

Review the PCV and Offsets of the GPS space craft



Current Status

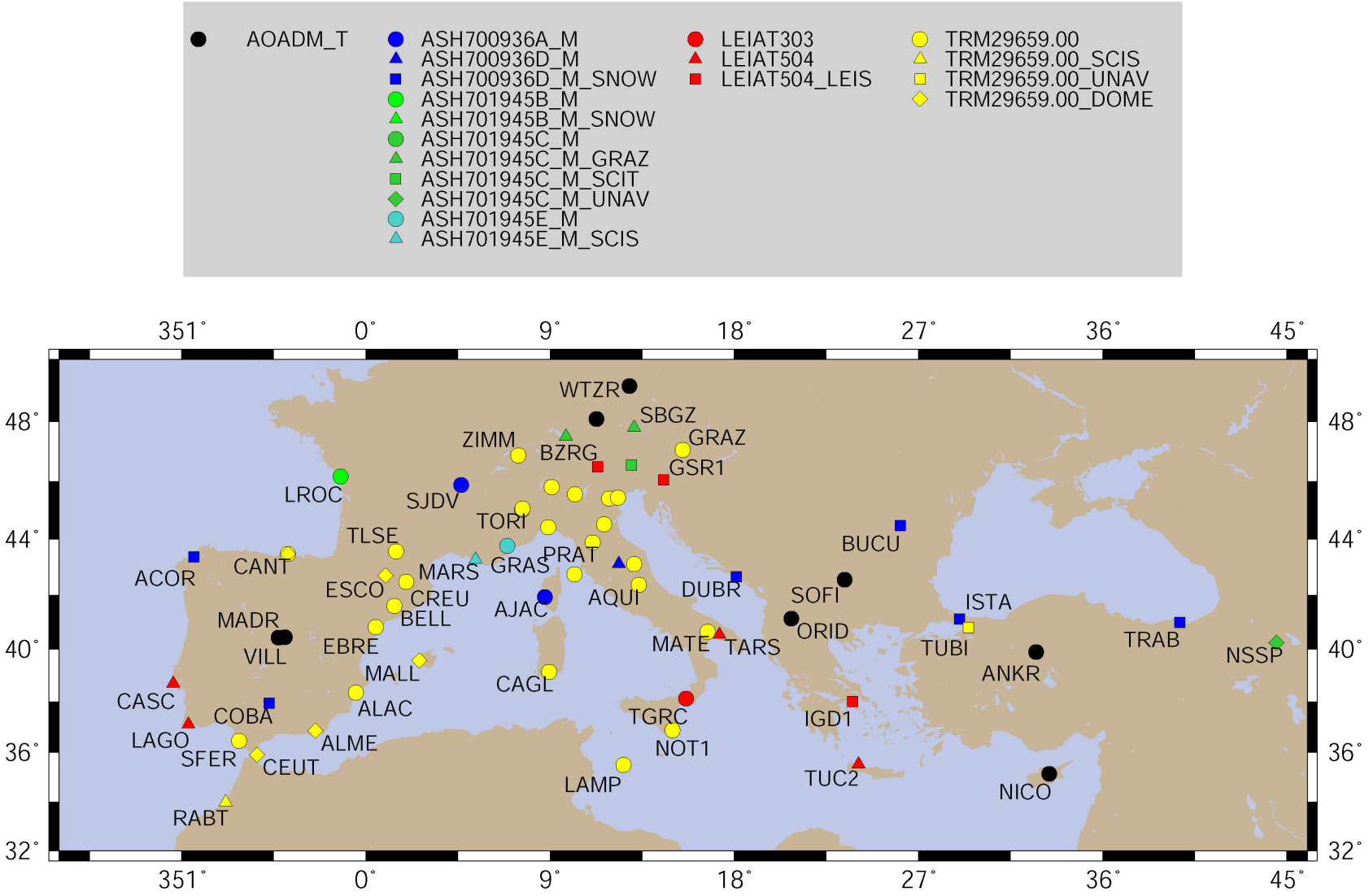
The IGS network and the EPN are still processed using relative PCV (bases on igs_01.pcv).

New satellite offsets and PCV are estimated in dependence of absolute PCV for ground antennas by the TU Munich (Rothacher & Schmid) and GFZ (Gendt)

IGS-Mail 5149 announced a new absolute data (igs_test05.atx) set of ground and space based GPS antennas with their offsets and PCV.

This new data set is used for the EPN subnetwork used by the BEK and tested

Antenna Distribution (Subnetwork BEK)



Antenna Type	Mader	Geo++	IGS_TEST.05
AOAD/M_T	X	X	Geo++
ASH700936A_M	X	-	AOAD/M_T Geo++
ASH700936D_M	X	X	Geo++
ASH700936D_M_____SNOW	X	X	Geo++
ASH701945B_M	X	-	Geo++
ASH701945B_M_____SNOW	X	-	NGS
ASH701945C_M	X	-	AOAD/M_T Geo++
ASH701945C_M_____GRAZ	-	-	-
ASH701945C_M_____SCIT	-	-	NGS/TUM
ASH701945C_M_____UNAV	-	-	-
ASH701945E_M	X	X	AOAD/M_T Geo++
ASH701945E_M_____SCIS	-	-	-
JPSREGANT_DD_E	X	X	Geo++
LEIAT303	X	X	Geo++
LEIAT504	X	X	Geo++
LEIAT504_____LEIS	X	X	Geo++
LEISR399_INT	X	-	converted TUM
TRM29659.00	X	X	Geo++
TRM29659.00_____SCIS	-	-	-
TRM29659.00_____UNAV	X	X	NGS/TUM
TRM29659.00_____DOME/TCWD	-	X	-

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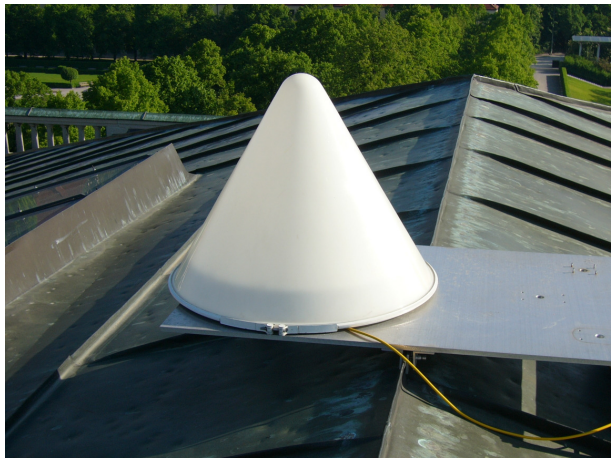
Absolute PCV Models

TRM29659.00____DOME (TCWD)

EPN-Logfiles:

ALME, CANT, CEUT, ESCO,
LPAL and MALL are identified
carrying the dome as “DOME”.



Pictures verified it as:

TRM29659.00____TCWD

MALL

LPAL

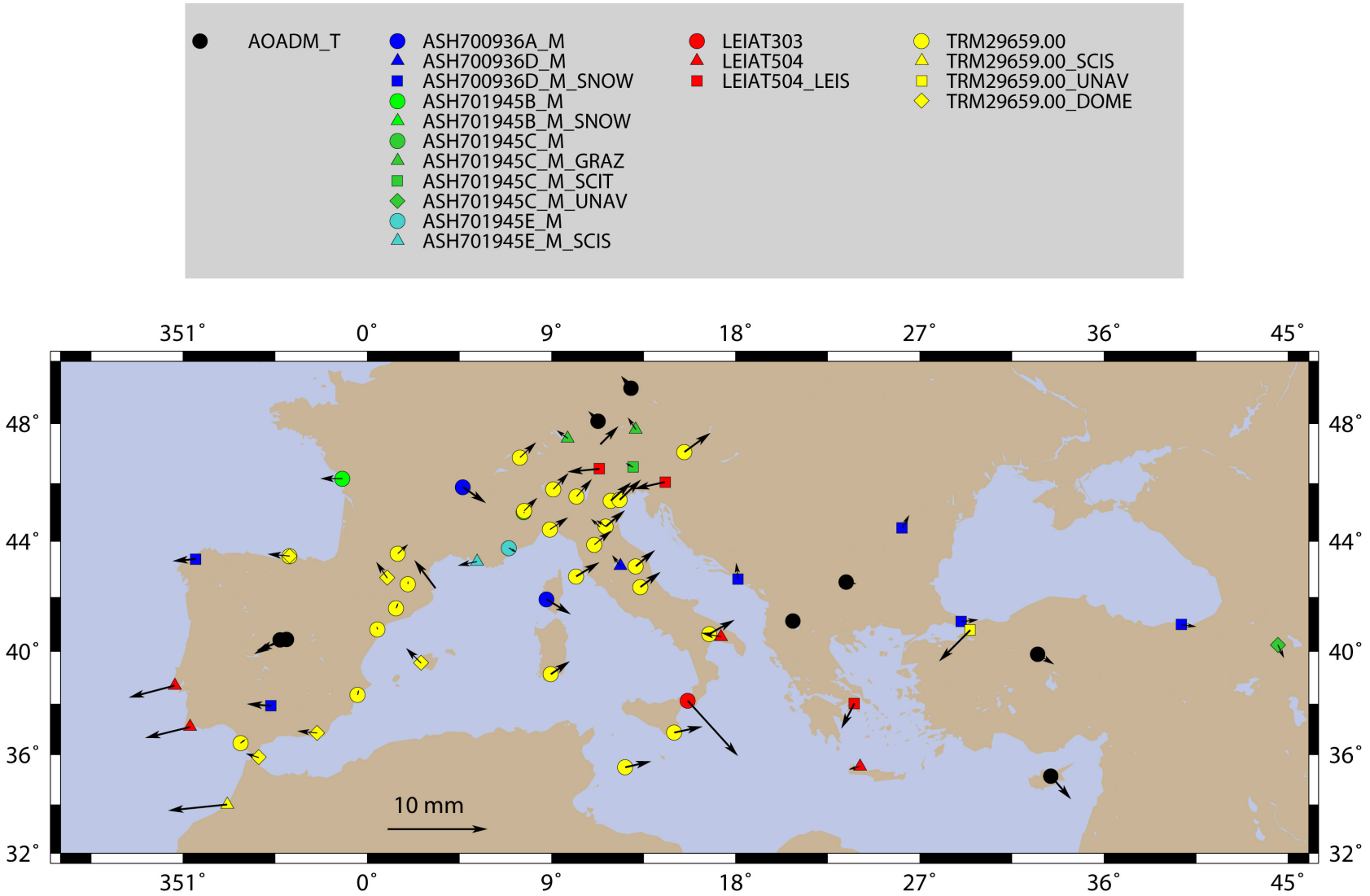
ALME

Processing Characteristics

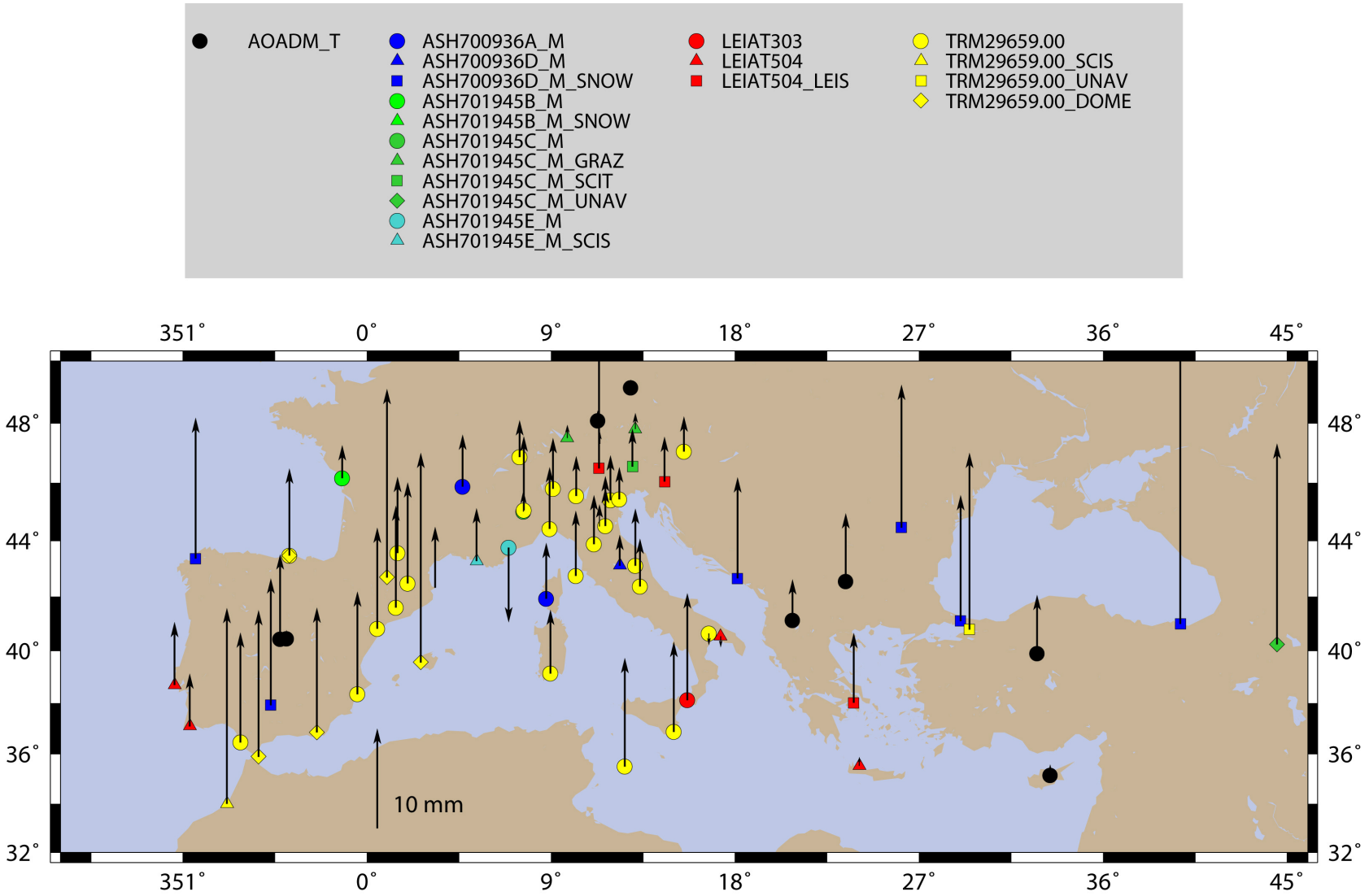
- Using the data of the week 1317 with approx. 70 stations.
- Bernese 5.0 is used, which enables the use of satellite PCV.
- Processing is based on the RNX2SNX script with small modifications.
- Minimum constraint solution based on the stations:
  - VILL, WTZR, NICO and MATE (no scale)

- Difference due to two different antenna models:
  - IGS_01.PCV (relative, mostly no domes considered)
  - IGS_05TEST.ATX (absolute, domes are considered)

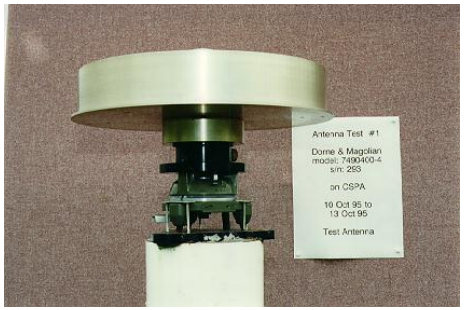
Horizontal Components



Vertical Components



Impact of abs. PCV versus rel. PCV in the regional network of the BEK



Antenna Type/ Samples	East	North	Height
	[mm]		
AOAD/M_T / 8	-0,7 ± 1.9	-0.6 ± 1.2	3.6± 3.1
LEIAT504 / 5	-3.1 ± 1.5	-1.2 ± 1.6	2.8 ± 3.5
LEIAT504__LEIS / 3	-2.3 ± 1.2	-0.7 ± 1.2	8.3 ± 5.1
TRM29659.00__NONE/ 24	1.4 ± 1.1	1.1 ± 0.6	6.5 ± 3.1
TRM29659.00__TCWD / 6	-1.9 ± 0.8	0.7 ± 0.6	15.5 ± 4.5
ASH700936D_M__SNOW /6	-0.3 ± 1.4	0.3 ± 0.5	15.0 ± 6.5

EUREF Symposium

Vienna 2005

Zero Baseline Simulation

Estimation of the difference between absolute AOAD/M_T and individual antennas (also absolute PCV):

- Simulate zero baseline with identical data (elev.=0°)
- Apply different antenna correction models to these sets of data
- Estimate L_3 (L_0) solution
- Do not apply tropospheric corrections

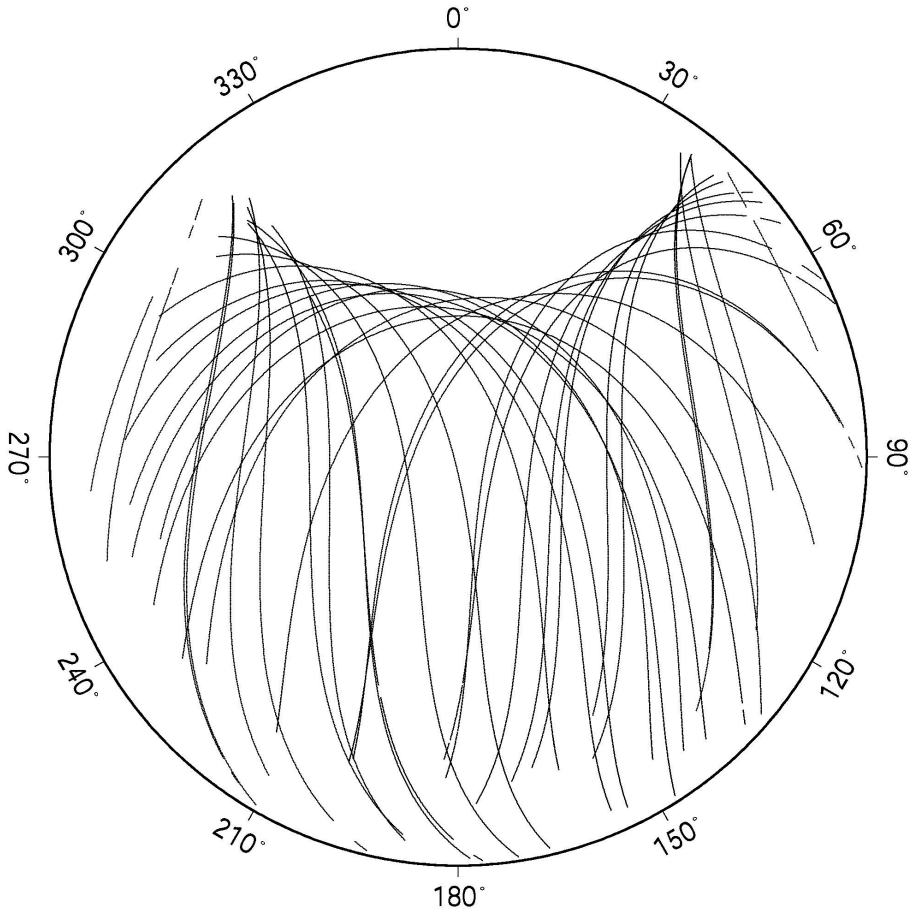
For the simulation two sides with different geometric conditions were selected:

MAS1 (φ=27°45`) and NYA1 (φ=78°56`)

The following antenna types were tested:

TRM29659.00, TRM29659.00__TCWD, LEIAT504, LEIAT504__LEIS, ASH700936D_M, ASH700936D_M__SNOW

MAS1

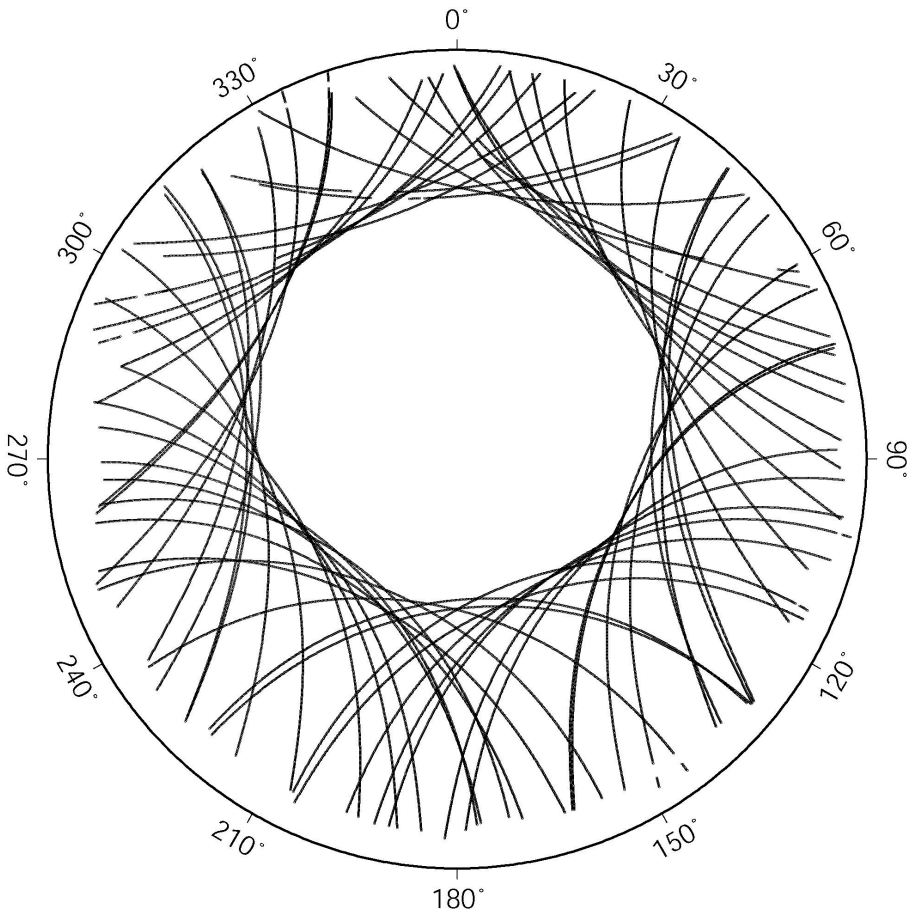


Type	North	East	Height
	[mm]		
TRM29659.00_____NONE	2.4	4.4	0.2
TRM29659.00_____TCWD	1.5	-0.4	-15.9
LEIAT505_____NONE	1.4	1.4	-5.7
LEIAT504_____LEIS	-1.3	0.6	-2.0
ASH700936D_M____NONE	1.1	-0.4	-2.2
ASH700936D_M____SNOW	1.2	-0.1	-0.5

Largest horizontal deviation:
TRM29659.00
N=2.4 mm, E=4.4 mm

Largest vertical deviation:
TRM29659.00____TCWD
H=-15.9 mm

NYA1



Type	North	East	Height
	[mm]		
TRM29659.00_____NONE	2.9	4.2	-1.1
TRM29659.00_____TCWD	2.3	-0.6	-19.7
LEIAT505_____NONE	1.6	1.5	-6.2
LEIAT504_____LEIS	-0.9	0.7	-3.3
ASH700936D_M____NONE	1.4	-0.4	-2.0
ASH700936D_M____SNOW	1.4	-0.1	-3.2

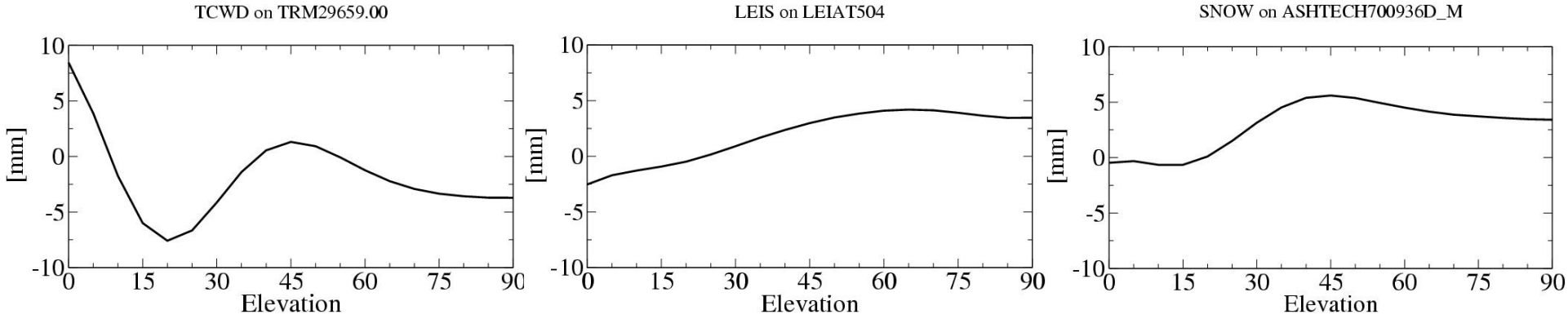
Largest horizontal deviation:
TRM29659.00
N= 2.9 mm, E= 4.2 mm

Largest vertical deviation:
TRM29659.00____TCWD
H= -19.7 mm

The Impact of Domes in Regional Networks

Based on LROC	MAS1			WTZR			NYA1		
	[mm]								
	N	E	H	N	E	H	N	E	H
TRM29659.00_____TCWD	0.5	-4.1	-1.4	-0.5	-4.0	-12.8	-1.1	-4.0	-33.8
LEIAT504_____LEIS	-2.2	-0.7	6.1	-2.9	1.0	7.5	-4.0	-1.2	3.4
ASH700936D_M____SNOW	0.9	0.5	16.5	0.2	0.5	12.1	-0.9	0.7	4.9

PCV-Difference for L_3



Conclusions

- Moving from relative to absolute models will lead to several jumps in the coordinates due to
  - Transition between relative to absolute models
  - Domes will in many cases considered for the first time
- The PCV for the satellite and receiver antennas seem to be consistent (1 cm in height remains).
- Absolute PCV will change the realisation of the ETRS significantly
- Remaining problem:
  - All antennas used in the EPN should be calibrated
  - Site dependent impacts on the reception of the signals remain