Station calibration of the SWEPOS GNSS network

Martin Lidberg[1], Per Jarlemark[2], Kent Ohlsson[1], Jan M Johansson[2,3]
[1]Lantmäteriet,
[2]SP Technical research Institute of Sweden,
[3]Chalmers University of Technology

Martin.Lidberg@lm.se

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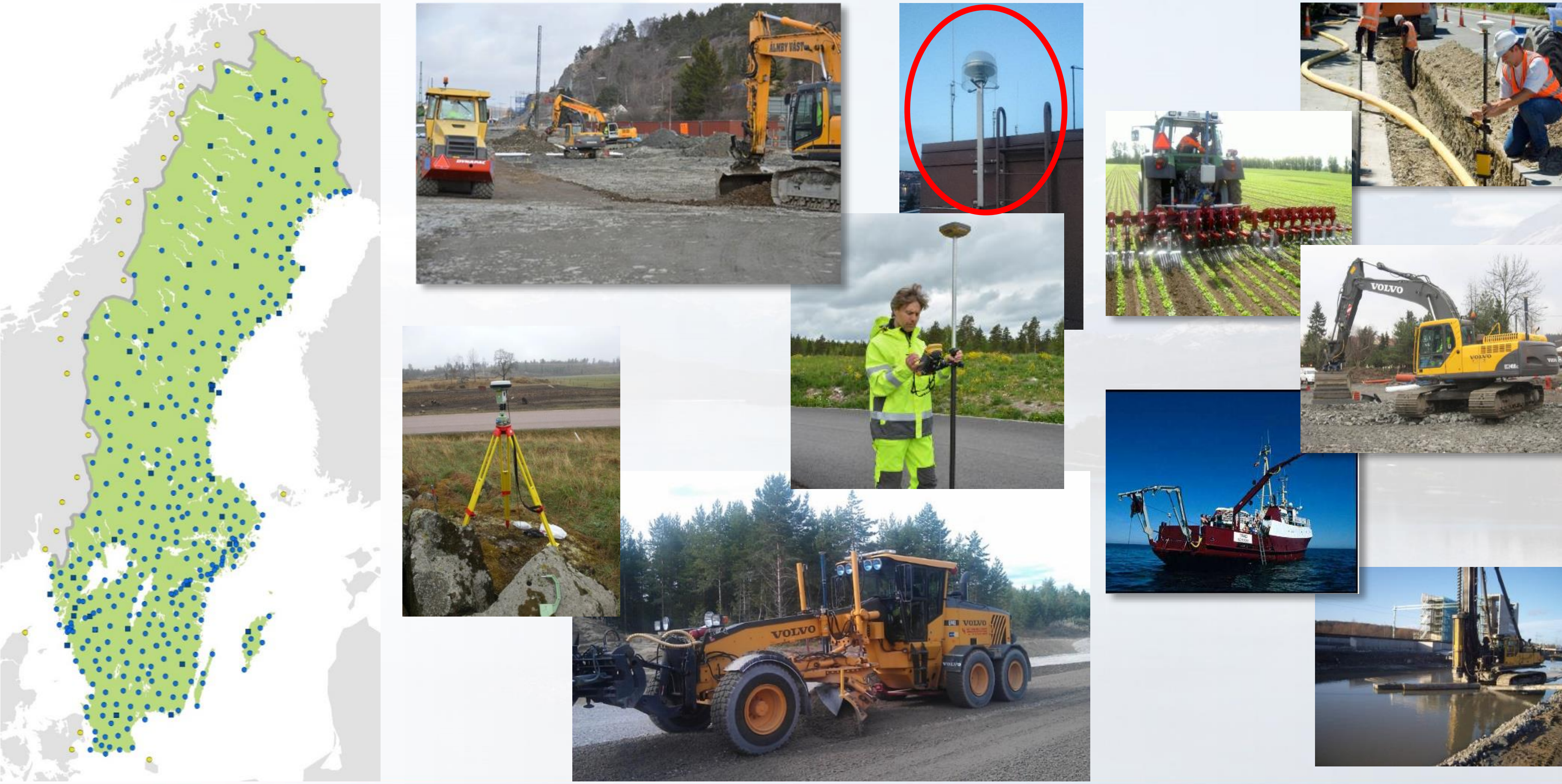
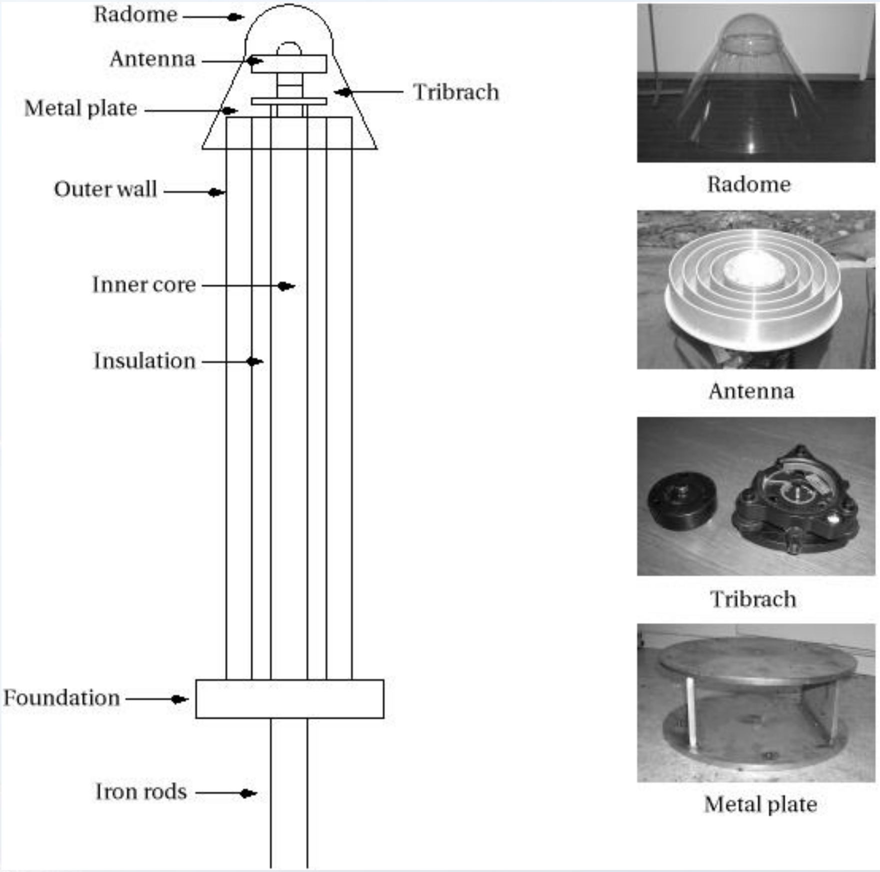
Summary

- Station dependent effects at CORS is a limiting error source for future developments of GNSS applications
- Individual antenna calibration is not sufficient (PCV/PCO change when installed to a monument)
- Our real-time users asks for sub-cm uncertainty also in height
- On-site station calibration is feasible and results are presented here
- Lots of details to improve and develop further

Motivation – users asking for improved performance



The field calibration setup



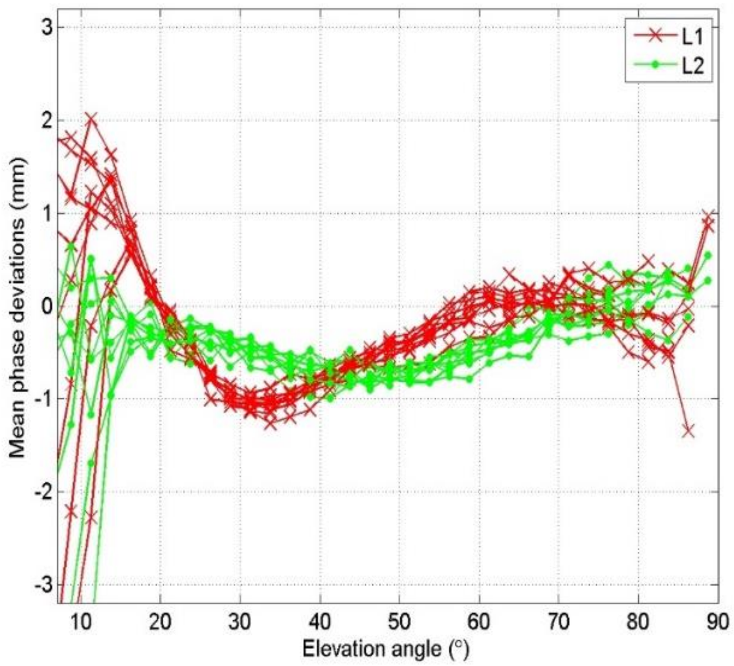
Method and principles for the field calibration

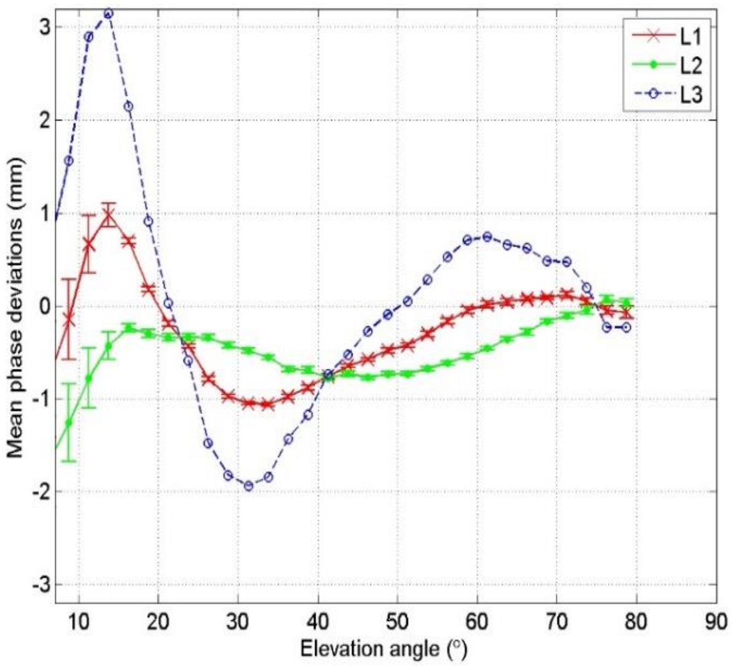
- The physical height difference between the monument, and the antennas on tripod are determined using terrestrial methods
- Three reference antennas on tripods allow for gross error detection and some noise error reduction
- 5 days continuous observations
- Microwave absorbing material at the reference antennas reduce the effect from multipath (but questionable?)

- Phase residuals in baseline between reference antenna on tripod and the CORS are considered to be caused by limitations in the CORS installation

- Booth the concrete pillar monument from 1993, as well as the truss mast monument from 2012 are considered

Results – field calibration of 9 SWEPOS pillar stations (2009, 2010)



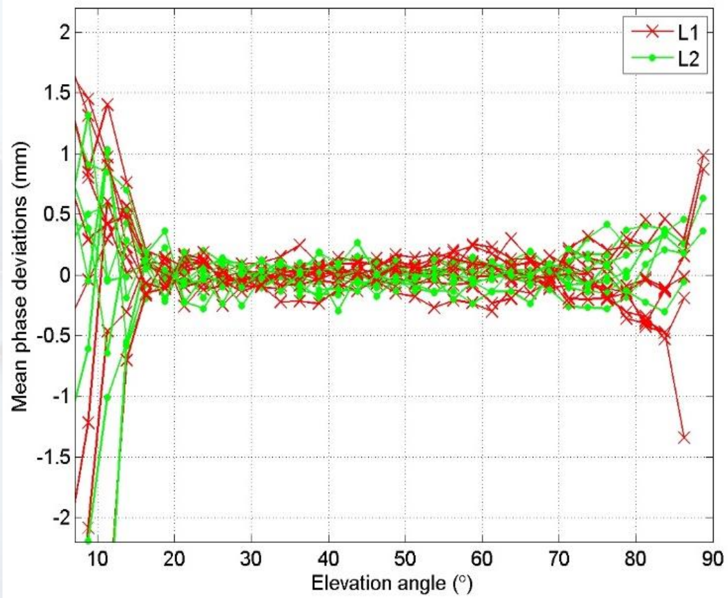


Left: Individual results for 9 stations

Right: Mean value for L1 and L2. An L3 curve (blue) also included

Apply "monument specific" PCV and PCO model and compare

Station	Original antenna model		Updated antenna model	
	L1 vertical offset (mm)	L2 vertical offset (mm)	L1 vertical offset (mm)	L2 vertical offset (mm)
Östersund	2.6	3.2	2.2	1.9
Sundsvall	-0.3	0.4	-0.8	-0.9
Leksand	1.5	3.3	0.2	1.4
Karlstad	1.1	1.0	0.7	-0.3
Vänersborg	-0.3	0.9	-0.7	-0.3
Norrköping	-0.3	1.6	-0.7	0.4
Jönköping	-0.6	0.6	-1.0	-0.6
Oskarshamn	0.8	1.8	0.5	0.6
Hässleholm	-0.7	0.4	-1.0	-0.8
Mean	**0.4**	**1.5**	**-0.1**	**0.2**
Std	**1.1**	**1.1**	**1.1**	**1.0**

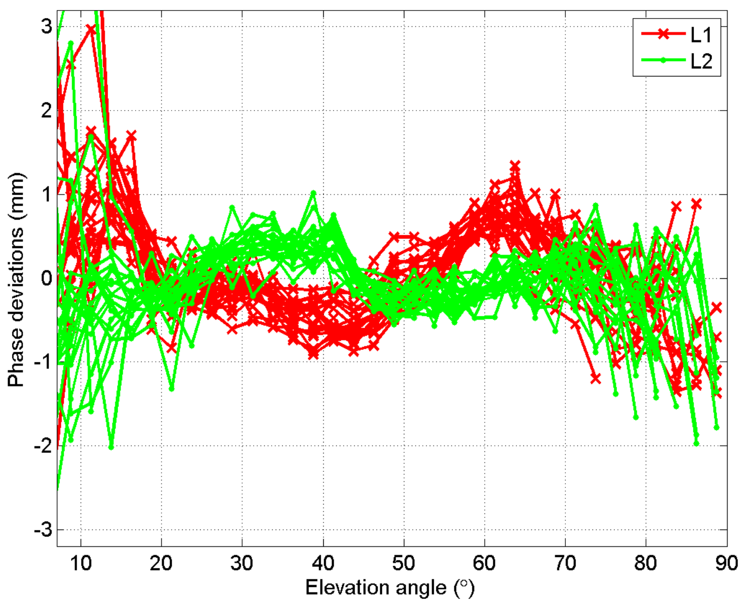


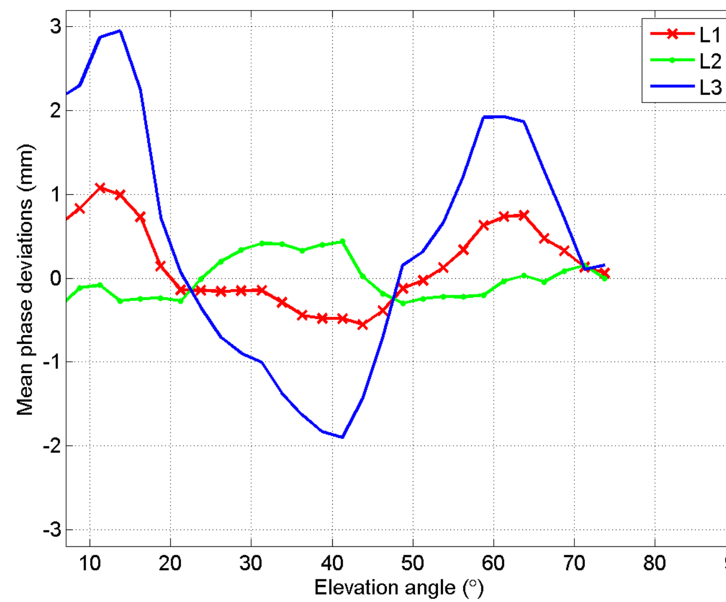
L3t solution: Ionosphere free obs. and Solve for troposphere

Station	Original antenna Model		Updated antenna model	
	Vertical offset (mm)	Atmospheric delay offset (mm)	Vertical offset (mm)	Atmospheric delay offset (mm)
Östersund	-10.4	3.6	2.4	0.1
Sundsvall	-13.6	3.5	-1.4	0.2
Leksand	-9.2	2.4	-1.4	-0.1
Karlstad	-7.0	2.4	4.7	-0.8
Vänersborg	-13.6	3.5	-2.1	0.4
Norrköping	-14.1	3.1	-2.6	0.0
Jönköping	-15.7	4.0	-4.2	0.8
Oskarshamn	-12.3	3.5	-0.8	0.3
Hässleholm	-13.0	3.2	-1.5	0.1
Mean	**-12.1**	**3.2**	**-0.8**	**0.1**
Std	**2.6**	**0.5**	**2.5**	**0.4**

New monuments with LEIAR25.R3 + LEIT installed in 2012

Calibrating the 19 steel-grid-masts from the pillar monuments

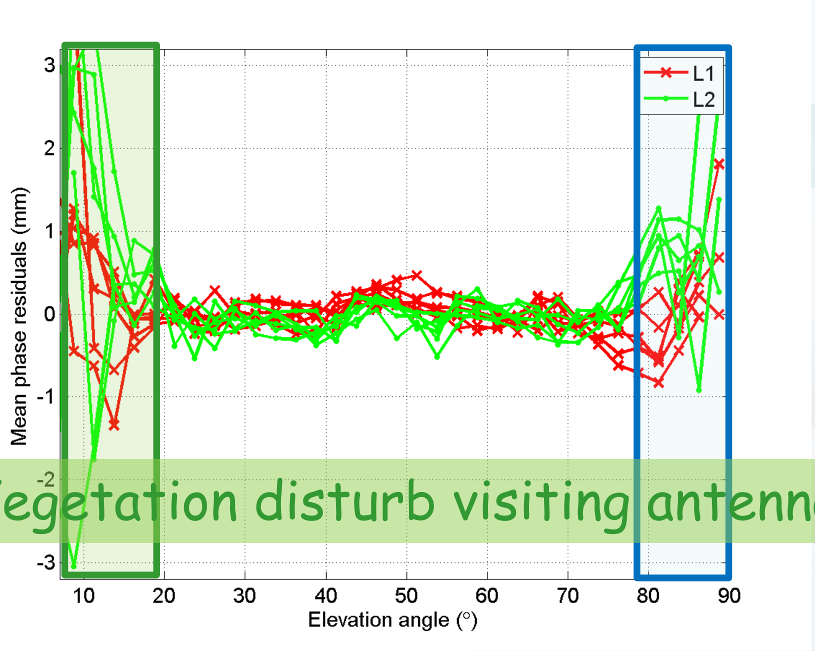


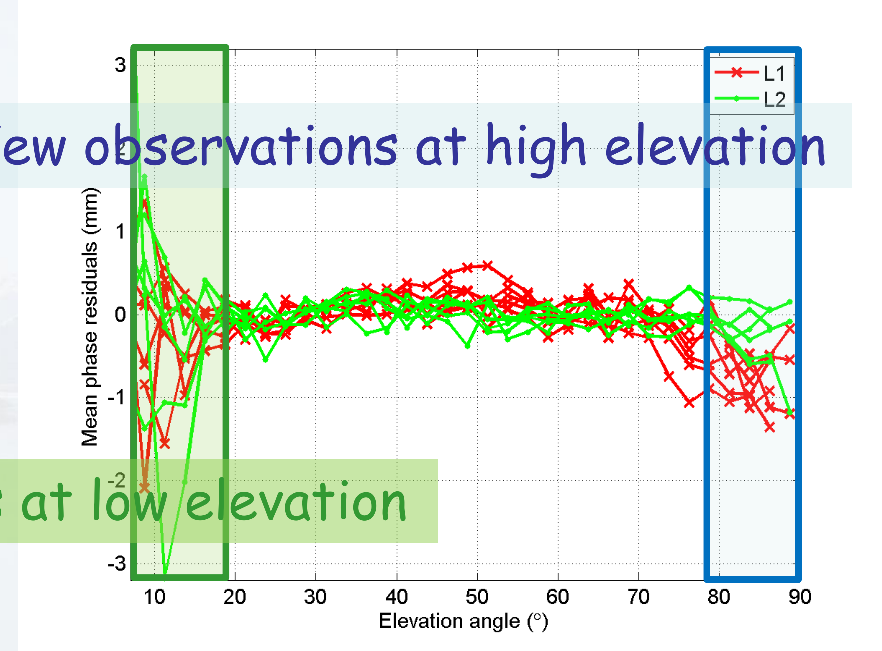


The LEIAR25.R3 + LEIT at the new mast monument calibrated relative to the pillar

Vertical offset from simulated L3t solution:
Mean: -11.5 mm, Std: 5.0 mm (19 sites)

Checking the models from re-calibration at 6 sites in 2015





The pillar monuments. Vertical offset in **L3t; mean:2.3 mm, std: 3.5 mm**

The mast monuments: Vertical offset in **L3t; Mean: 1.5 mm, Std: 6.9 mm**

Discussion

- Users ask for better performance also in height
- On-site calibration of GNSS CORS is feasible!
- Microwave absorbing material at the reference antennas reduce the effect from multipath, but need further study
- Disturbance from vegetation at visiting antennas is a “growing” problem.