Station Calibration of the SWEPOS™ Network

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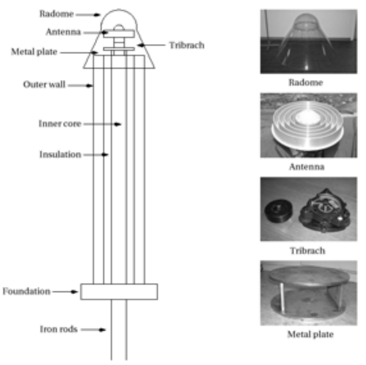
Site-dependent effects are important and limiting factors in high-accuracy GNSS positioning. Electrical coupling between the antenna and its near-field environment changes the characteristics of the antenna from what has been determined in e.g. absolute robot calibration.

Lantmäteriet has started in-situ station calibration of its permanent reference stations, SWEPOS™. The station calibration intends to determine the electrical centre of the GNSS antenna, as well as the PCV (phase centre variations) when the antenna is installed at a SWEPOS station. One purpose of the calibration is to examine the site-dependent effects on the height determination in SWEREF 99 (the national reference frame). Another purpose is to establish PCV as an alternative or complement to absolute calibrations of the antenna–radome pair.

Initial tests were performed in 2008. The station calibration campaigns started in 2009 and continued in 2010. Here we present results of the site-dependent effects on heights as well as PCV.

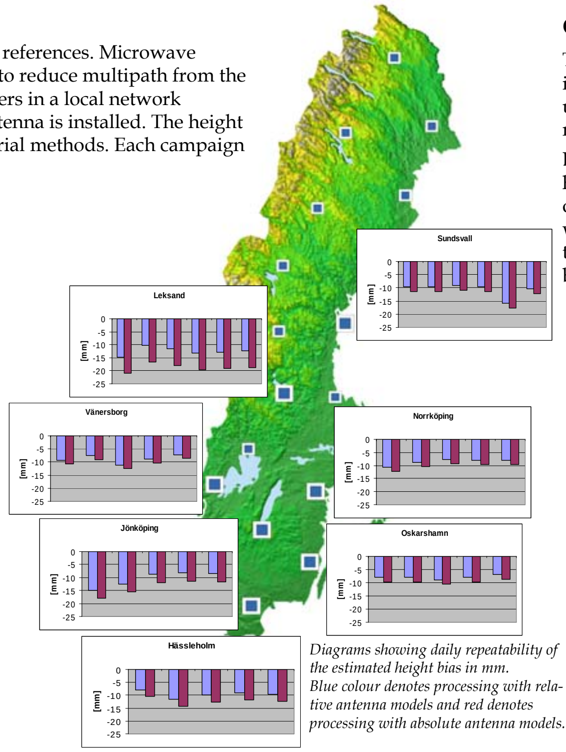
Surveying

We use three well calibrated antennas on tripods as references. Microwave absorbing material (Eccosorb®) is installed in order to reduce multipath from the ground. The reference antennas are placed on markers in a local network surrounding the concrete pillar where the CORS antenna is installed. The height differences are determined to sub-mm using terrestrial methods. Each campaign lasts five full 24 h sessions.



Principle design of a concrete pillar foundation in SWEPOS. Note the relatively large metal plate used as foundation for the tribrach. This may be a cause for disturbance. Designed 1992.

Vänersborg 2009. SWEPOS antenna monument, together with two benchmark set-ups.



Diagrams showing daily repeatability of the estimated height bias in mm. Blue colour denotes processing with relative antenna models and red denotes processing with absolute antenna models.

Note the systematic results where the GNSS heights of the pillars are too low by approx. 10 mm. Note also the difference between the use of relative and absolute antenna models of approx. 2 mm.

GNSS Processing (to find height bias)

The magnitude of the bias from site-dependent effects is dependent on the processing strategy including the used frequency, elevation cut-off angle and antenna models.

Different processing strategies have been applied, but here the results from processing with 10° elevation cut-off angle and L3 (ionosphere-free linear combination) with estimation of troposphere parameters are presented. Both relative and absolute antenna models have been evaluated.

Hässleholm, 2010. One of the benchmark set-ups. An Eccosorb plate is mounted directly below the choke ring antenna. The GNSS receiver is kept in the SWEPOS equipment cabin during the campaign.

References

Dilβner et al. (2008): Impact of Near-Field Effects on the GNSS Position Solution. International Technical Meeting, ION GNSS 2008, September 16-19, Savannah Georgia, USA.
Granström C (2006): Site-Dependent Effects in High-Accuracy Applications on GNSS. Department of Radio and Space Science, Chalmers University of Technology, Göteborg.
Ning T (2010): Global Navigation Satellite Systems – Applications With Time Scales From Seconds to Decades. Department of Radio and Space Science, Chalmers University of Technology, Göteborg.

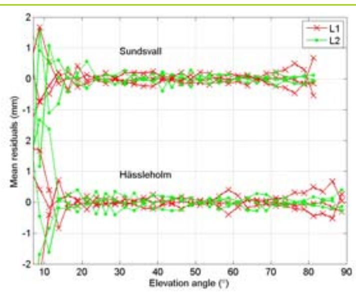


Fig 1. Phase residuals while computing between only the three reference antennas at two sites. The low noise (above 15° elevation) indicates good observations.

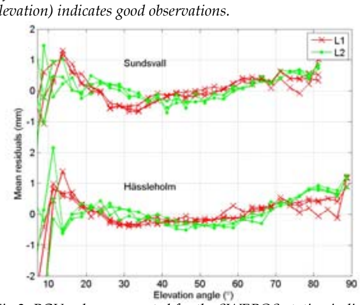


Fig 2. PCV values computed for the SWEPOS station individually from each of the three reference antennas at two sites. Good repeatability indicates that the method gives reliable results (at least above 15° elevation).

Looking for phase centre variations (PCV)

We try to find the residual part of the PCV that we assume to be a consequence of installation of an antenna to its foundation. This residual PCV may cause height bias and bias in troposphere estimates. Eventually we would like to establish a site or monument specific PCV correction to be able to improve the use of GNSS observations from our existing permanent stations.

Computed Models

	dh L1(mm)		dh L2 (mm)	
	Mean	Std of mean	Mean	Std of mean
Östersund	5.0	0.1	4.9	0.0
Sundsvall	2.3	0.1	2.1	0.1
Leksand	3.2	0.2	4.4	0.3
Karlstad	3.7	0.2	2.6	0.3
Norrköping	2.3	0.1	3.3	0.1
Jönköping	2.1	0.3	2.2	0.3
Oskarshamn	3.5	0.1	3.4	0.1
Hässleholm	2.0	0.2	2.0	0.2

Consequences

	dh L3 (mm)	
	Mean	Std of mean
Östersund	-3.3	0.4
Sundsvall	-7.8	0.3
Leksand	-7.2	0.3
Karlstad	-2.0	0.8
Norrköping	-6.1	0.5
Jönköping	-7.9	0.9
Oskarshamn	-4.1	0.4
Hässleholm	-5.3	0.6

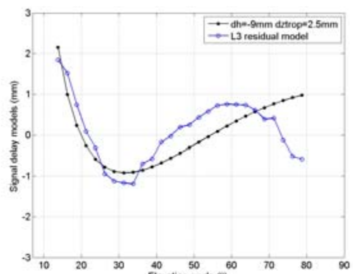


Fig 5. The black curve is constructed from three different curves giving the same bias effect on height difference, troposphere and clock bias, as the blue curve gives.

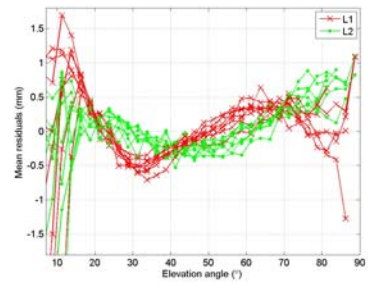


Fig 3. Mean of PCV values (see fig 2) at five sites in the same plot. Note the similarity between sites.

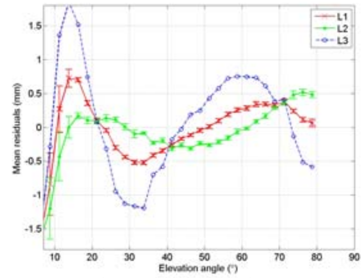


Fig 4. Mean of PCV in L1 and L2 for five sites, as well as computed L3 ionosphere-free linear combination (based on the values from L1 and L2). Note the amplification when forming L3.

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