NKG LAC Status report

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Outline

- Daily/weekly solutions based on final IGS-products
- NRT-analysis based on hourly data
- Other activities related to EPN and EUREF

KELY
THU3
QAQ1
NYA1

Network

- 49 stations
- Added since last EPN LAC-WS:
  SUUR 1395
  KURE 1477
  TOIL 1477
  TORA 1477
  PULK 1480
  REDZ 1483
  SWKI 1483
- Proposed:
  SCOR

Daily / weekly solutions

- Collect data
- Update antenna files and station file
- Processing
- Weekly combination
- Submit data

Data collection

1. RINEX-data from BKG (OLG, IGN and CDDISA)
2. Orbits and clocks from IGS
3. Code biases and ionosphere models from CODE
4. SATELLIT.I05 and I05.ATX from AIUB
5. Antenna file automatic updated using PHCCNV

Processing

- Processing using modification of RNX2SNX.PCF. Since GPS-week 1400:
- Absolute antenna models
- final solution:3 ° cutoff
- gradients
- FES2004.BLQ
- Additional solutions: 10 °, 25° and comparisons

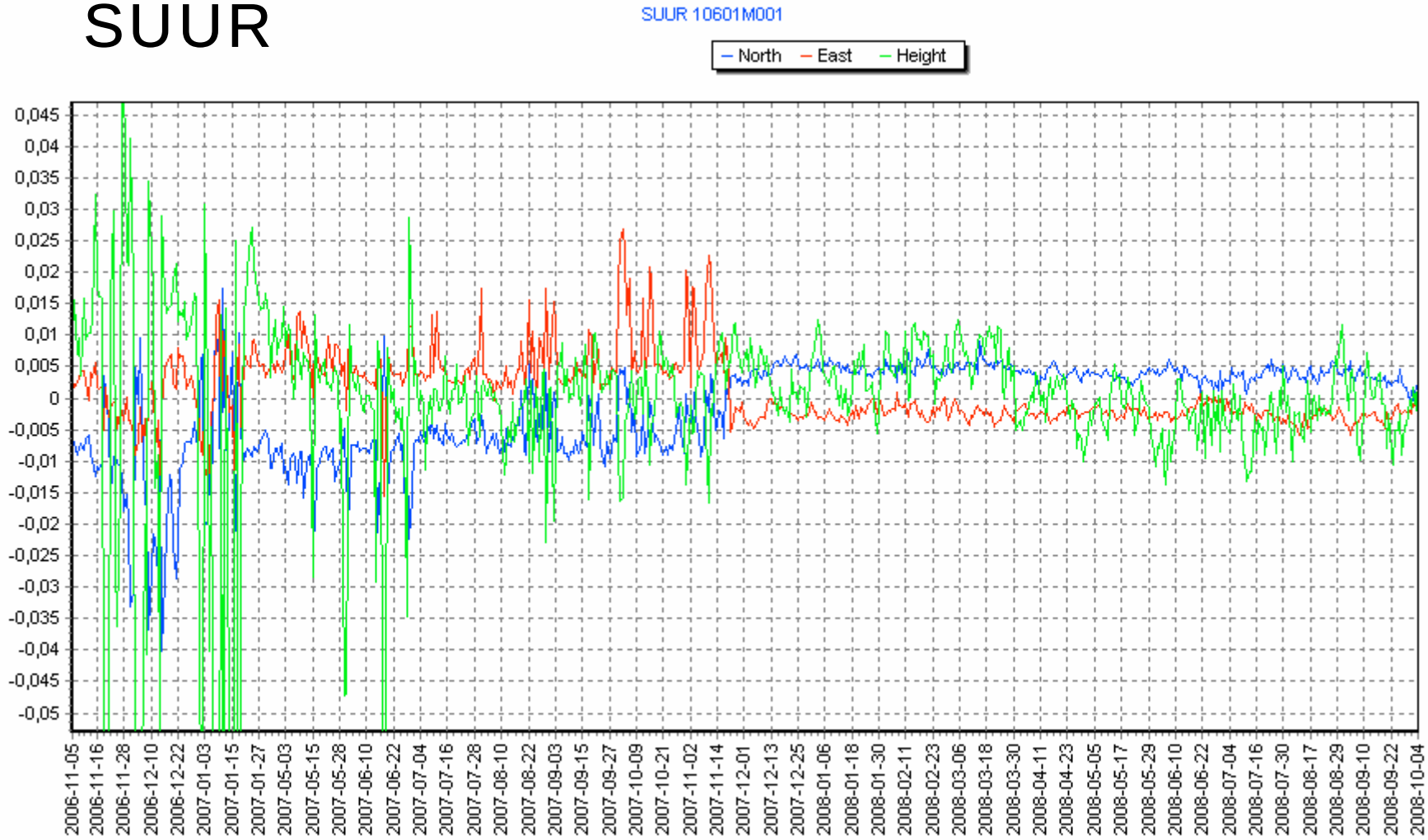
Weekly combined solution

- minimum constrained - no translation to IGS05 (BRUS, HOFN, JOZE, KELY, METS, NYA1, ONSA, POTS, QAQ1, REYK, THU3, TRO1, WSRT, WTZR).
- Re-substitution of weekly coordinates for computation of troposphere parameters
- Submit weekly and daily files SINEX and TRO-files

Problems

- No serious problems
- Less manual interaction since the RINEX-check was introduced (RNXGRA)
- Need to automatize data check with “Station Inconsistencies” and retrieval from other data centers, also check on small files
- Problems related to some stations: SUUR, SKE0, SODA, SPT0, (PULK) –see time series
- Elevation cut-off test: JOZE, KLOP, WSRT

SUUR


SUUR 10601M001
North
East
Height
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0,04
0,035
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0,02
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0,005
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-0,005
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2006-11-16
2006-11-28
2006-12-10
2006-12-22
2007-01-03
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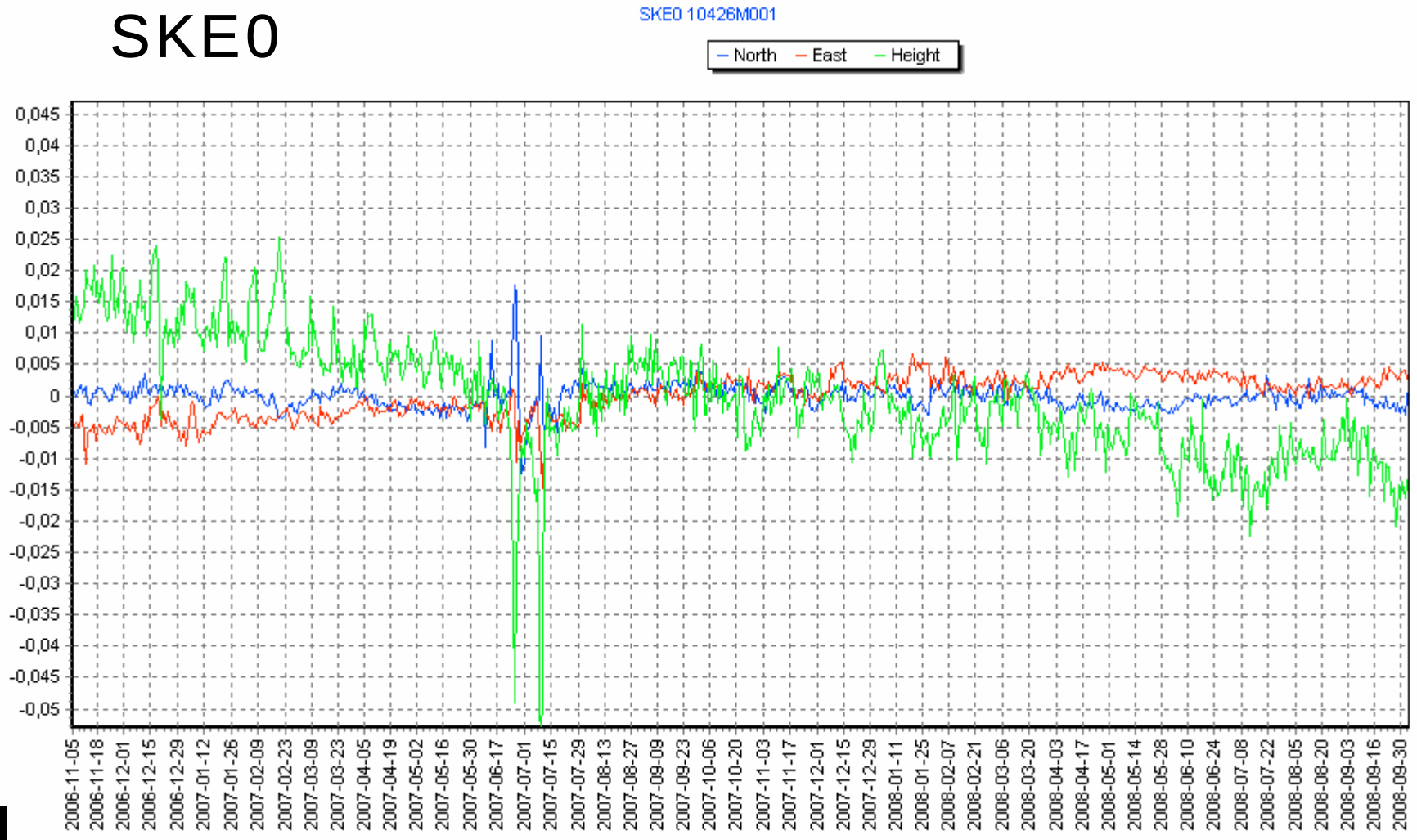
2008-09-10
2008-09-22
2008-10-04

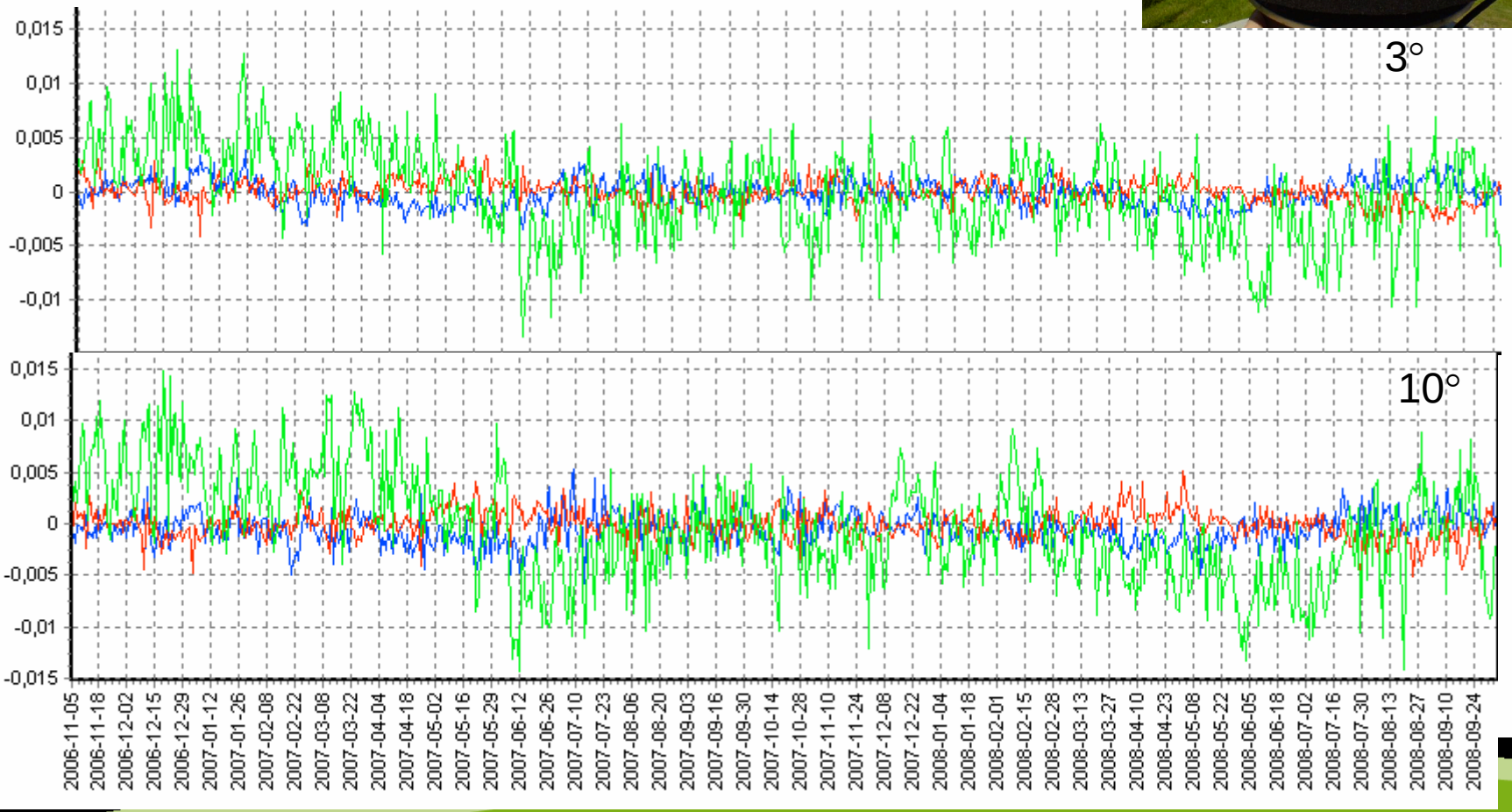
SKE0



vandalized 2007-06-07

LANTMÄTERIET

SPT0 3° and 10°


3°
10°
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-0,01
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2006-12-15
2006-12-29
2007-01-12
2007-01-26
2007-02-08
2007-02-22
2007-03-08
2007-03-22
2007-04-04
2007-04-18
2007-05-02
2007-05-16
2007-05-29
2007-06-12
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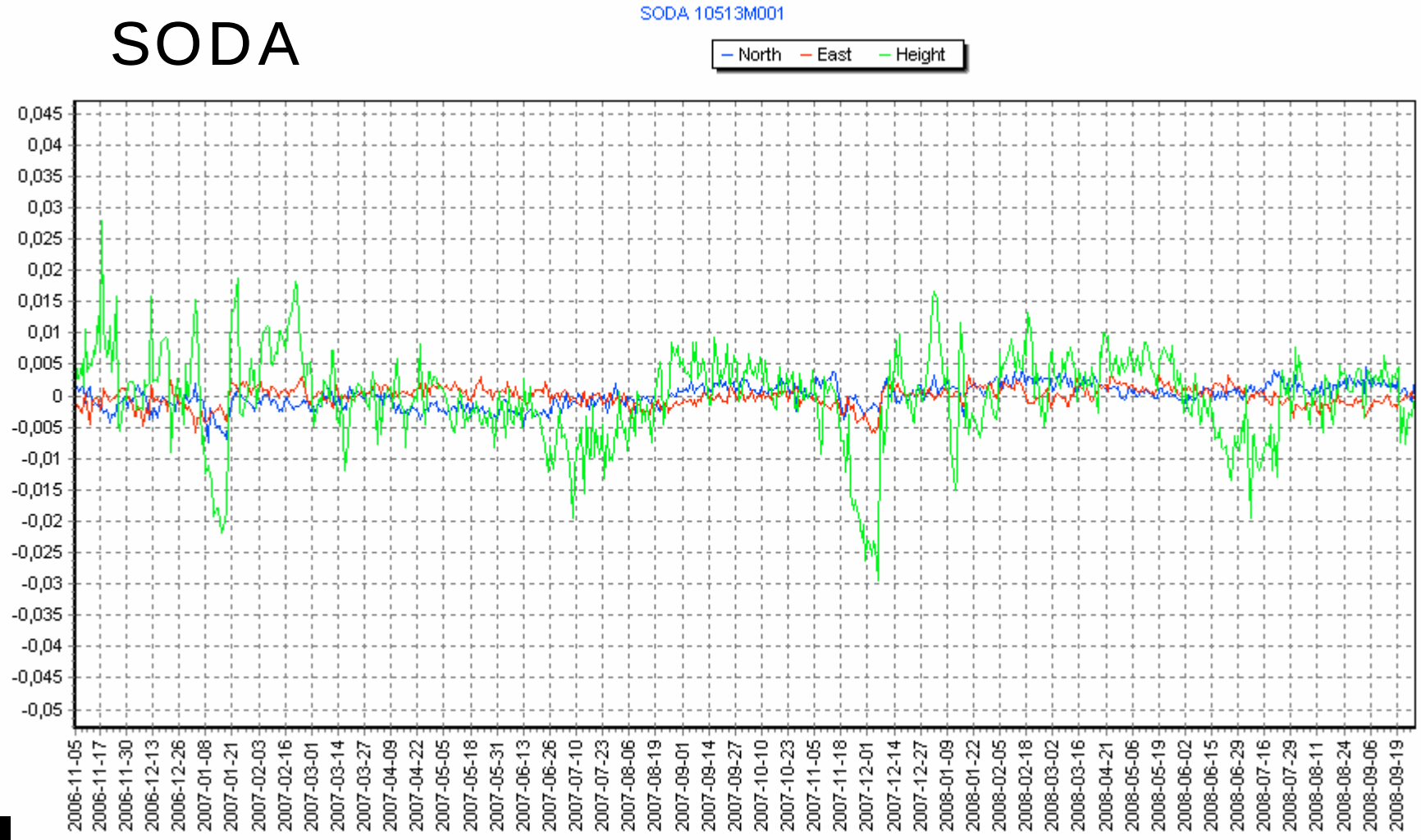
2008-09-24

SODA


SODA 10513M001
North
East
Height
0,045
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0
-0,005
-0,01
-0,015
-0,02
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-0,035
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2006-11-17
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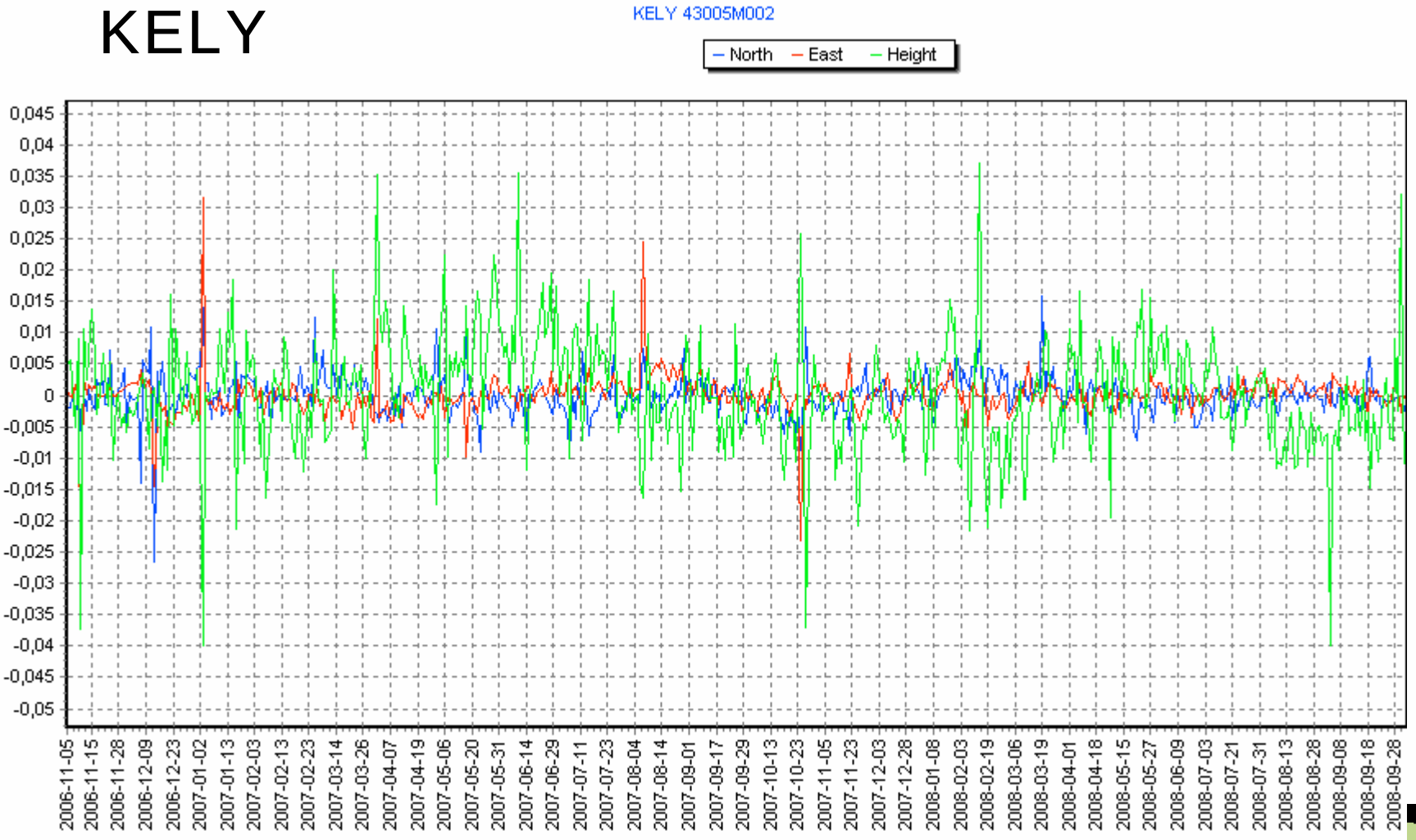
2008-09-06
2008-09-19

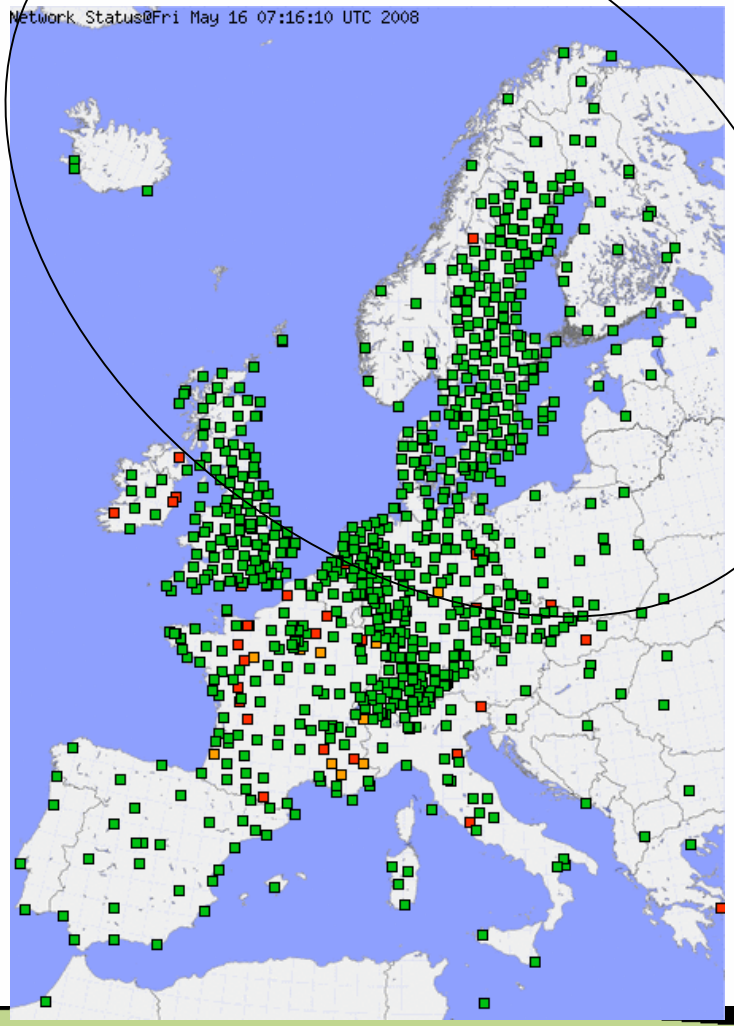
KELY



LANTMÄTERIET

NRT-solution

- NGAA – E-GVAP /Jan Johansson
- GNSS data processing hosted at the SMHI operational center since 2007
- Data from Denmark (30), Finland (23), Iceland (2), Norway (15), Sweden (155) and surrounding countries (35), totally 260 stations.
- The map (→) is missing Thule & Scoresbysund (Greenland) Ny Aalesund (Svalbard), and 3 stations in the Moscow region.
- Data from the previous hour is processed and results (integrated tropospheric content) for all stations delivered to EGVAP no later than 40 minutes after full hour.



NKG NRT for EPN

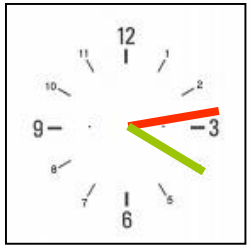
- Special setup at Onsala with the NKG EPN sub-network, 49 stations
- Same analysis strategy, GIPSY PPP – next slide
- Start to submit? Today?
- SINEX-format

NKG EPN NRT

GIPSY, 10 h sliding interval

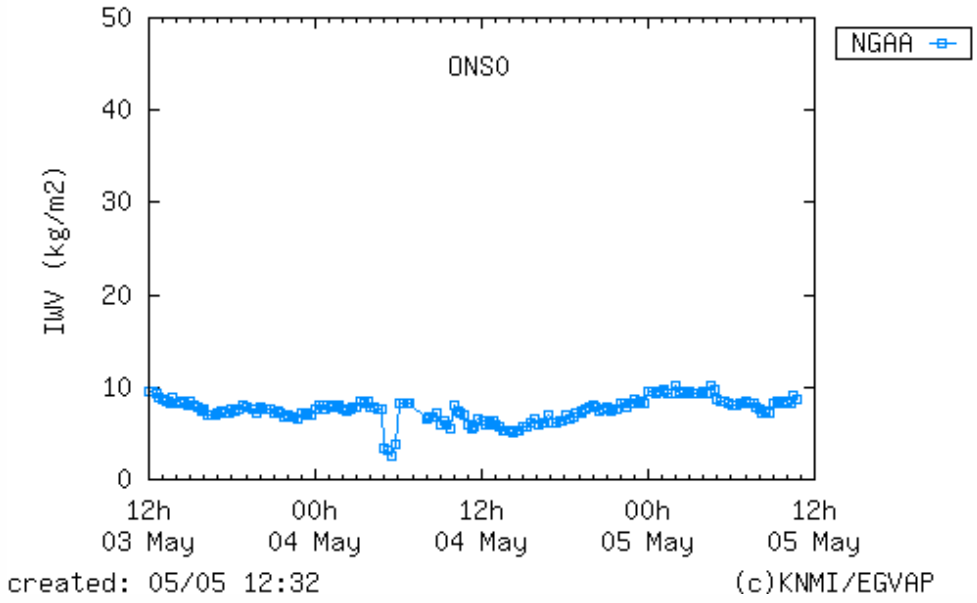
1. Regional network . Data collection RINEX from BKG/ IGN/ CDDISA and IGU-orbits and clocks from IGS/GFZ. Estimating satellite clocks and orbit improvement.

2. NKG LAC subnetwork. PPP, coordinates and troposphere, 10 stations/minute



NRT problems

- RINEX-data not available on time (for the clock and orbit analysis)
- Has improved lately (better software for data collection and more stable data centers)



Other activities

- NKG2008 campaign, GPS-week 1499, stations in Nordic and Baltic countries as well as Greenland, Iceland, Svalbard and Faroe Islands, permanent and non-permanent stations
- NKG-transformation from ITRF to national ETRS 89

- Studies of antenna and site effects including the effect of the OSOD radome

Antenna and Site effects, OSOD - motivation

- No absolute calibration values for antenna+OSOD
- Reducing multipath and site effects by using microwave absorbing material like Eccosorb
- Attaching Eccosorb to a SWEPOS-pillar changes the estimated vertical component up to 10 mm dependent on elevation cut-off.
- What happens when new GNSS, new signals, and new ground and satellite antennas are introduced?

OSOD radome

Thin hemispherical radome + a “skirt” that protects the pillar top

The radome is not attached to the pillar and not to the antenna -> makes absolute calibration of antenna + radome on robot impossible

With a conventional radom attached to the antenna, snow would probably pile up around the antenna on the wide pillars

LANTMÄTERIET

LMV antenna calibration field

Test at LMV test field

Radome holder

Radome

Upper position →

Lower position →

3x24 h for each setup

LANTMÄTERIET

OSOD-radome –results LMV 2007

L3 trop, unit: mm	dN	dE	dU	σdN	σdE	σdU
w and w/o OSOD (OSOD minus no radome)						
Holder lower position	0.1	-0.4	0.9	0.3	0.2	0.4
Holder upper position	-0.5	0.8	1.6	0.2	0.3	1.0
No OSOD, different level of holder						
Upper minus lower	0. 6	-0.1	2.5	0.2	0.3	0.3
Upper minus none	0.4	-0.2	2.8	0.2	0.3	0.3
Lower minus none	-0.2	-0.1	0.3	0.2	0.2	0.4

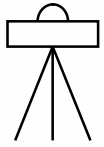
More tests will follow…

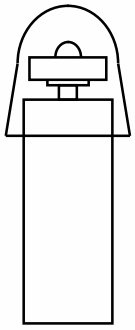
Station calibration

Two methods of calibration where developed and evaluated for the SWEPOS sites

1. In-situ

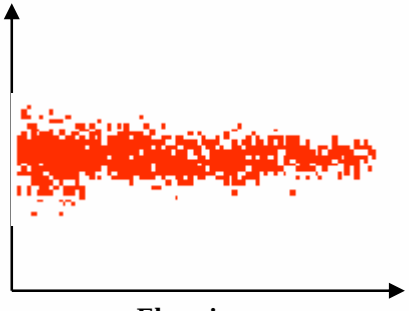
Reference antenna





~ 5 m

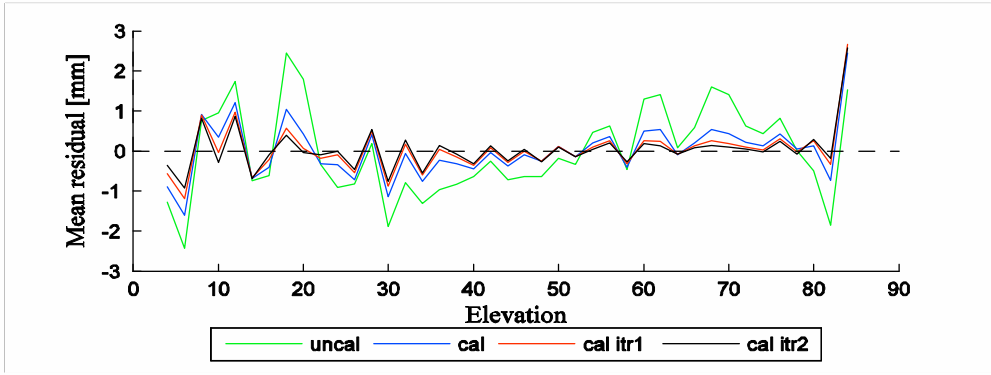
2. Statistical



Residual plots

Statistical Station Calibration

- Based on 6 years of post fit phase residuals from reprocessed data (1999-2004).
- Precise Point Positioning (PPP) processing strategy using GIPSY-OASIS software.
- Elevation cut-off angle set to 0 degrees
- Calibration matrix resolution 2x5 degrees in elevation and azimuth angles
- Residual outliers removed, empty grid boxes filled with nearest neighbouring averaging technique.
- Iterative approach used to absorb all systematic error sources in the calibration matrix
- Number of iteration steps is 2



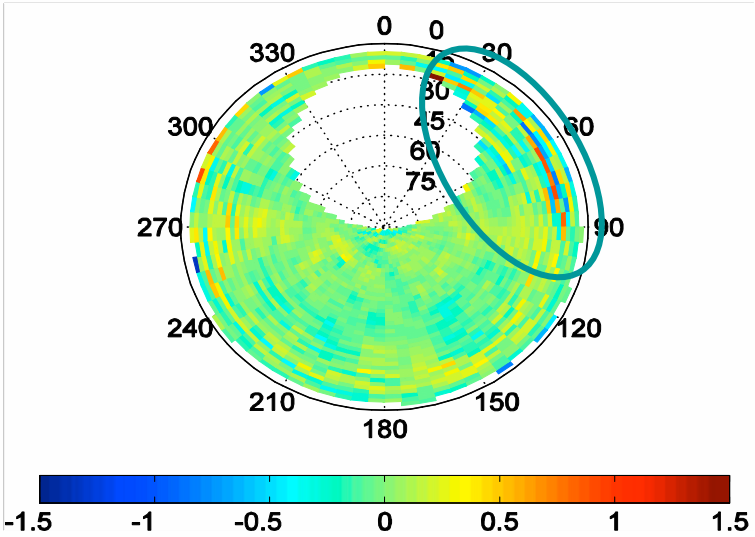
Example of residual pattern improvement due to iteration for the station Mårtsbo

The PPP post-fit phase residuals includes not only site dependent effects but all non modelled error sources

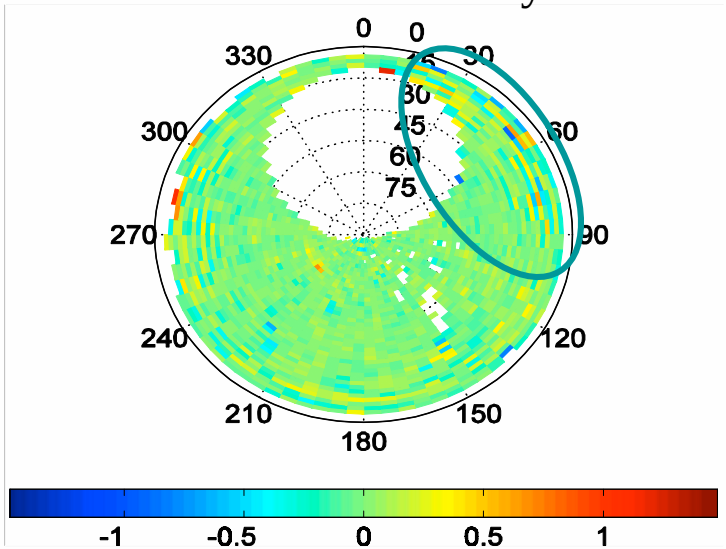
Statistical Station Calibration Results

Averaged PPP residuals for the Onsala station with and without calibration implemented

Uncalibrated based on 6 years data



Calibrated based on 1 year data



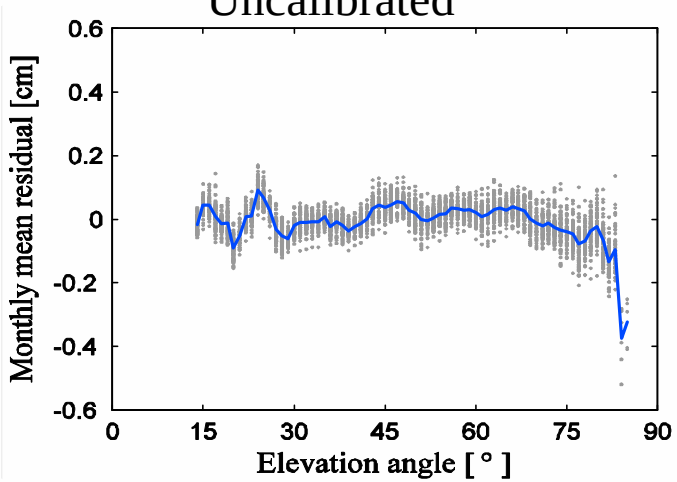
Mean residual [cm]

Mean residual [cm]

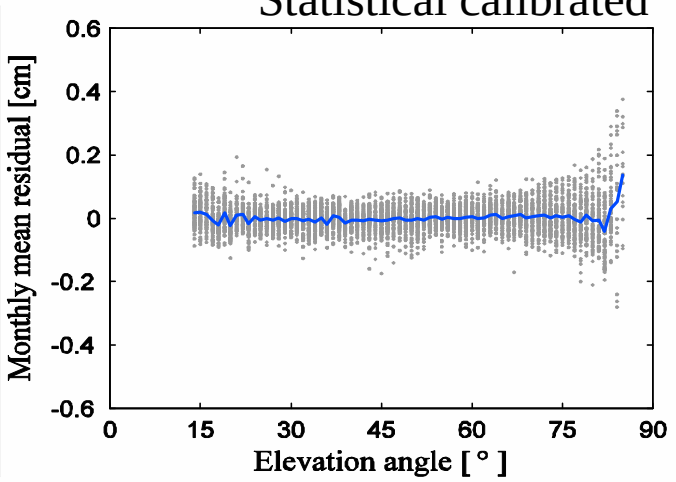
Statistical Station Calibration Results

Averaged PPP residuals over 6 years of data
for the Onsala station with and without calibration implemented
Elevation cut-off angle is 15 degrees

Uncalibrated

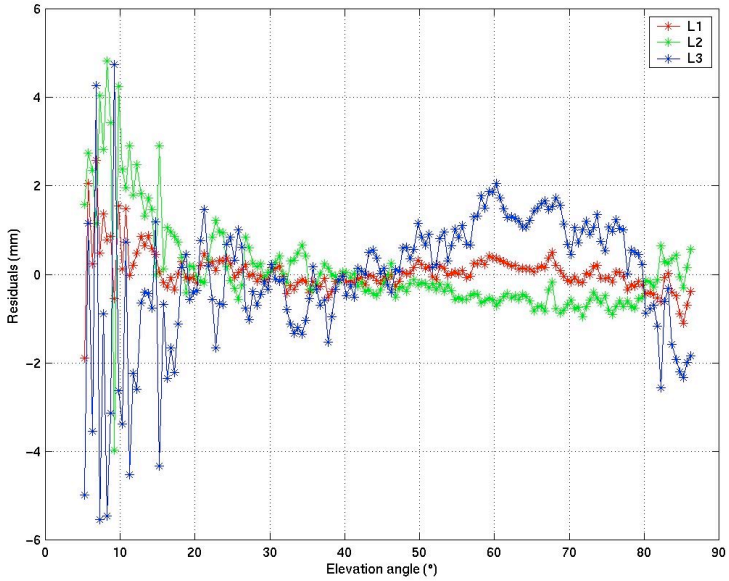


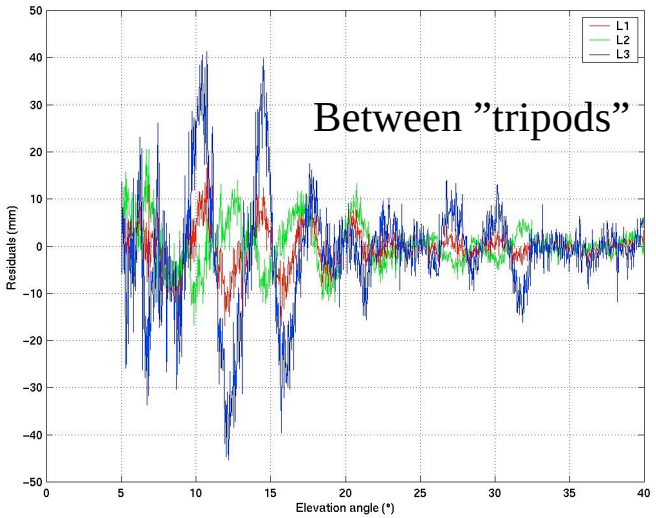
Statistical calibrated

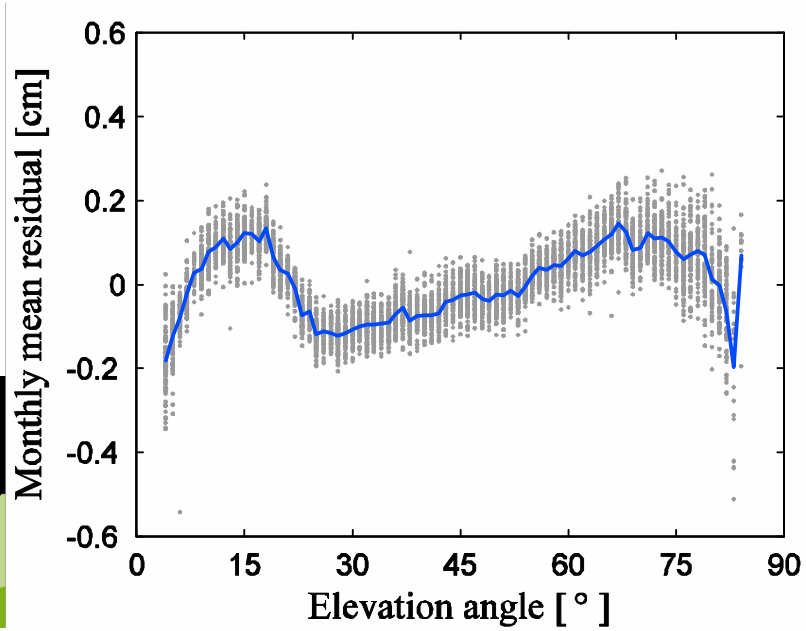


The residual pattern is straight for the calibrated case

In-Situ Station Calibration in Norrköping



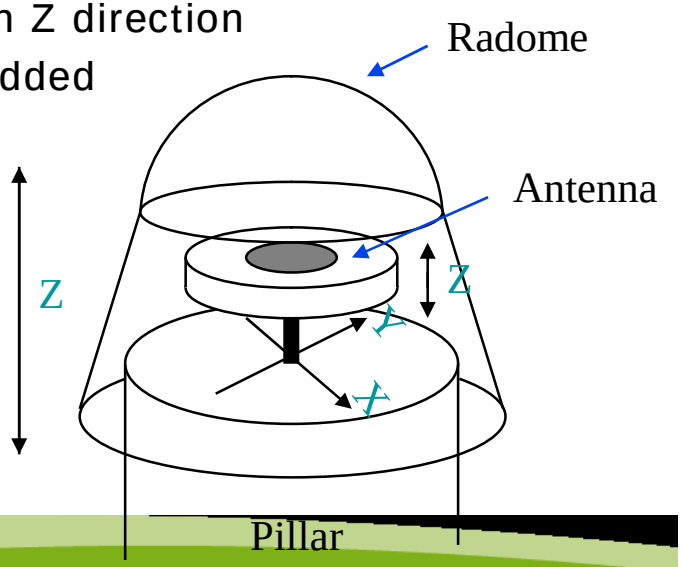




Three reference antenna of type Dorn Margolin type T

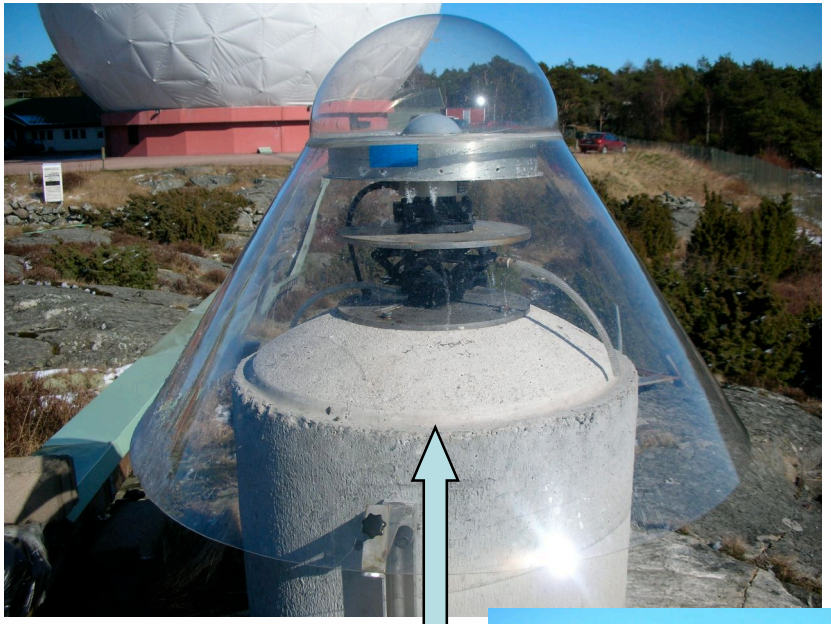
The New Calibration Station at Onsala

- Construction during fall 2005 at Onsala
- Antenna movable in X, Y and Z inside radome
- Radome movable in Z direction
- Eccosorb may be added



Investigation of effects from misalignment of antenna, radome and pillar

Results show clear "SWEPOS-like" residual pattern



ONTE without ECCOSORB

ONTE with ECCOSORB

ONSA

MR – Microwave Radiometer

Weeks (see Fig 3)	Difference(mm) SWEPOS* – MR* RMS	Bias	Std	MR – ONTE* RMS	Bias	Std	SWEPOS – ONTE RMS	Bias	Std	The geometry of the installation of the antenna and the radome on the experimental station(ONTE)
1st	6.8	-0.1	6.8	8.7		7.2	5.5	-4.8	2.7	Both the antenna and the radome are at the Optimal position.
2nd	8.1	4.9	6.5	10.5		6.0	5.1	-3.8	3.4	The radome is at the optimal position and the antenna Horizontally move south.
3rd	8.2	4.2	7.0	10.5		7.0	4.5	-3.6	2.6	The radome is at the optimal position and the antenna Horizontally move west.
4th	8.5	3.0	7.9	10.2		7.6	4.0	-2.7	2.6	Both the antenna and the radome is at the optimal position with ECCOSORB on the top of the pillar.
5th	6.2	0.8	6.2	6.6		6.6	2.6	0.9	2.5	Both the antenna and the radome is at the Optimal position with ECCOSORB on the top of the pillar and around the antenna.
6th	8.3	3.8	7.4	12.8		7.4	6.9	-6.6	2.2	The antenna is at the optimal position and the radome moves up 9.5cm to the antenna.
7th	4.2	5.2	5.4	10.4		5.5	4.2	-3.6	2.6	The antenna is at the optimal position and the radome moves up 5cm to the antenna.
8th	9.5	0.5	9.5	9.0		8.9	2.8	-0.8	2.7	Both the antenna and the radome is at the optimal position with ECCOSORB on the top of the pillar.

SWEPOS stands for the permanent geodetic station
ONTE stands for the experimental station
MR stands for the Microwave Radiometer

Summary – site effects and OSOD

- Mitigation of site dependent effects is important in order to achieve higher accuracy in positioning (and estimation of troposphere parameters)
- Statistical and in-situ station calibrations
- Tests with Eccosorb for multipath rejection
- Tests with OSOD show negligible effect – more tests ongoing
- Stations with similar design and equipment suffers from similar elevation dependent effects

Summary

- 49 stations in northern Europe
- Standard processing, daily and weekly solutions with final IGS-products, Bernese software
- NRT (hourly data), GIPSY, delivery to EPN very soon
- Weakest part – data collection
- Test with OSOD – negligible effect – more tests
- A lot of efforts on station calibration – statistical and in-situ
  -> try to use site-specific calibration corrections in reprocessing (BIFROS/GIPSY, what about the Bernese?)
  -> estimate errors (in coordinates) due to site effects

Thankyou for your attention!