Processing of the NKG2008 campaign

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Outline

- The NKG2008 campaign – objectives
- NKG2003
- Methods for processing, distributed processing
- Connection to ITRF
- Comparison to NKG2003
- Conclusion

Objectives of NKG2008

- Improve and update the transformations from ITRF to the national ETRS 89 realisations in the area.

- Establish a common reference frame in the Nordic-Arctic region

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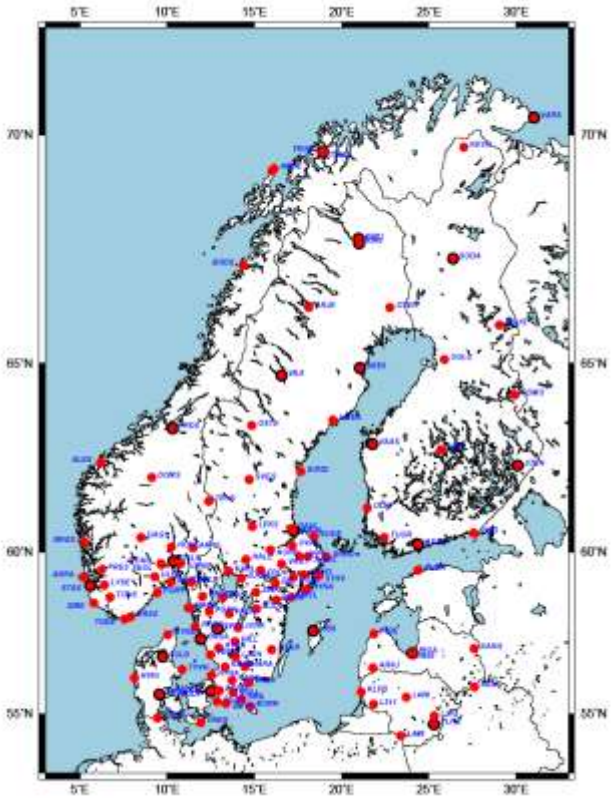
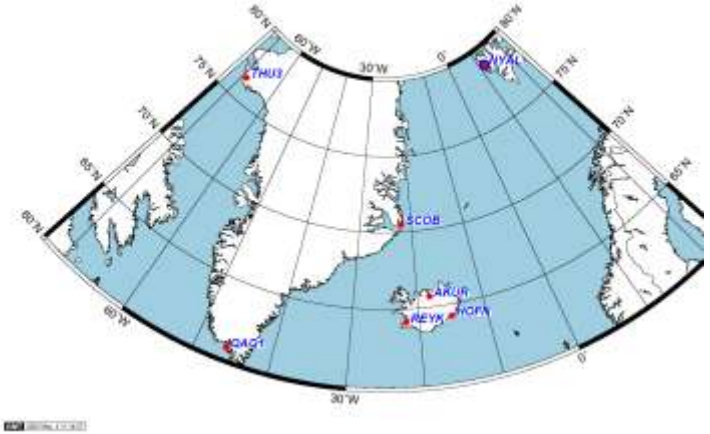
NKG2003





133 stations

Week 40 in 2003, GW 1238

Final solution is based on an average of solutions from GIPSY, GAMIT and Bernese and has a global connection to ITRF2000

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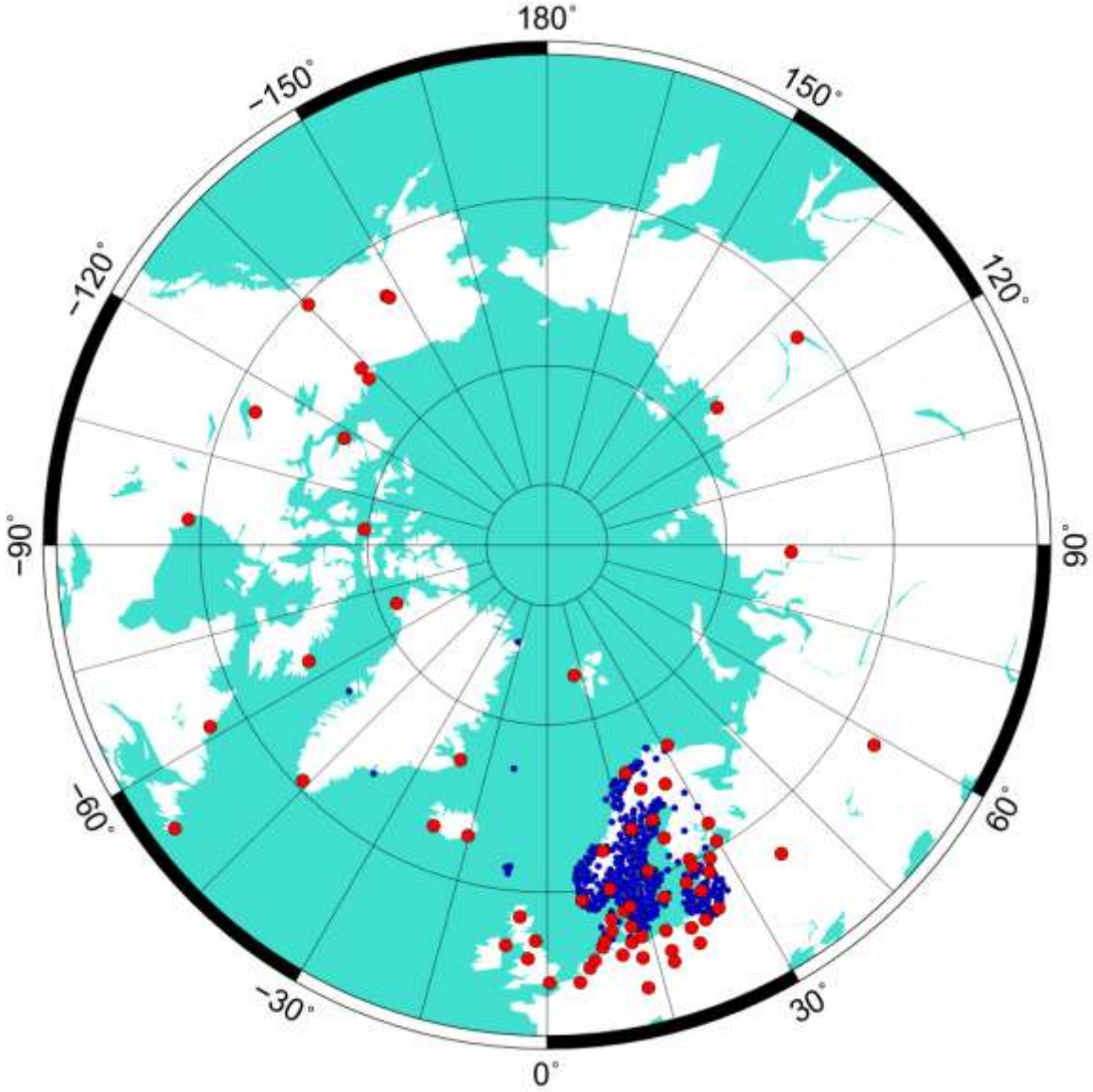
NKG2008

- GPS-week 1499 28/9-4/19 2008 week 40
- Totally 417 stations including additional 39 IGS/EPN
- Mainly permanent stations, campaign stations in Norway, Denmark, Faroe Islands, Latvia, Lithuania
- RINEX-data, quality check and solutions at an ftp-server at KMS



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Processing of NKG2008

Same ambition as with NKG2003:

- Process with different softwares to have a better chance to detect problems
- Use "state of the art"-modelling in GPS-processing, but higher order ionoshere terms and modern troposphere mapping functions like GMF and VMF are not implemented in the current version of the Bernese.

- Considering the large network and our agendas, we decided to distribute the processing.
- To ensure the consistency between the sub networks, we defined a backbone consisting of 70 IGS/EPN-stations which all processing centers should process.

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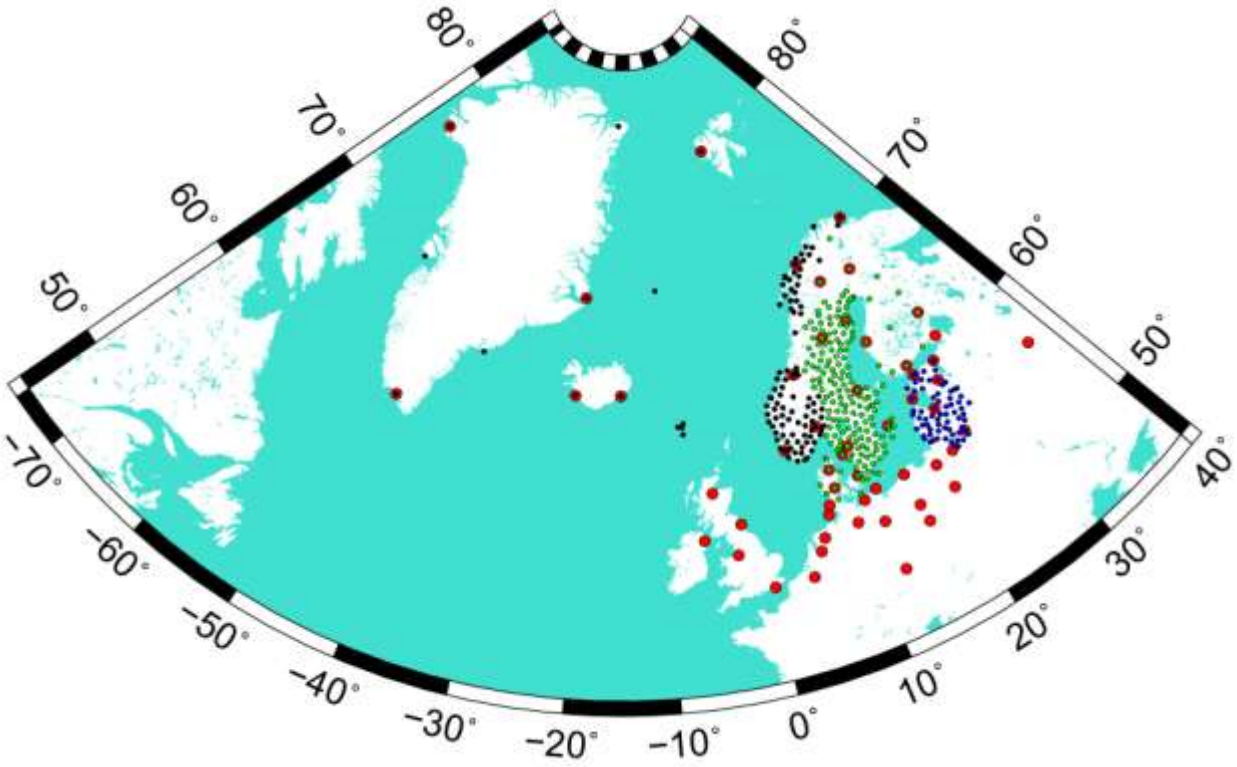
Distributed processing with Bernese SW



- ELB(Priit) – Baltic states (71) + BB
- LM(Lotti) – Denmark, Sweden, Finland (190) + BB
- SK(Oddvar) – Norway, Greenland, Iceland (116) + BB

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Additional processing

DTU (Abbas) – Denmark, Greenland, Faoe Islands + BB , Bernese PPP (IGS/MIT) , GIPSY PPP(JPL)

SK (Gunstein) - Norway, Greenland, Faroe Islands, Iceland (111) + BB, GIPSY PPP (rel)

(GAMIT:

- LM(Martin) Full net (417) + BB (no solution yet))

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Processing strategy

Solution with absolute antenna models

- 3 deg, 10 deg and 25 deg
- Absolute antenna models (PHAS_NKG08.I05), individual calibrated
- IGS05

Alternative solution with relative antenna models – to be comparable with the old campaign

- 10 deg and 25 deg
- Relative antenna models (PHAS_NKG08.I01)
- ITRF 2005

Both

- Ionosphere free linear combination
- FES2004 Ocean tide loading
- Saastamoninen troposphere model and Niell mapping functions (dry and wet)

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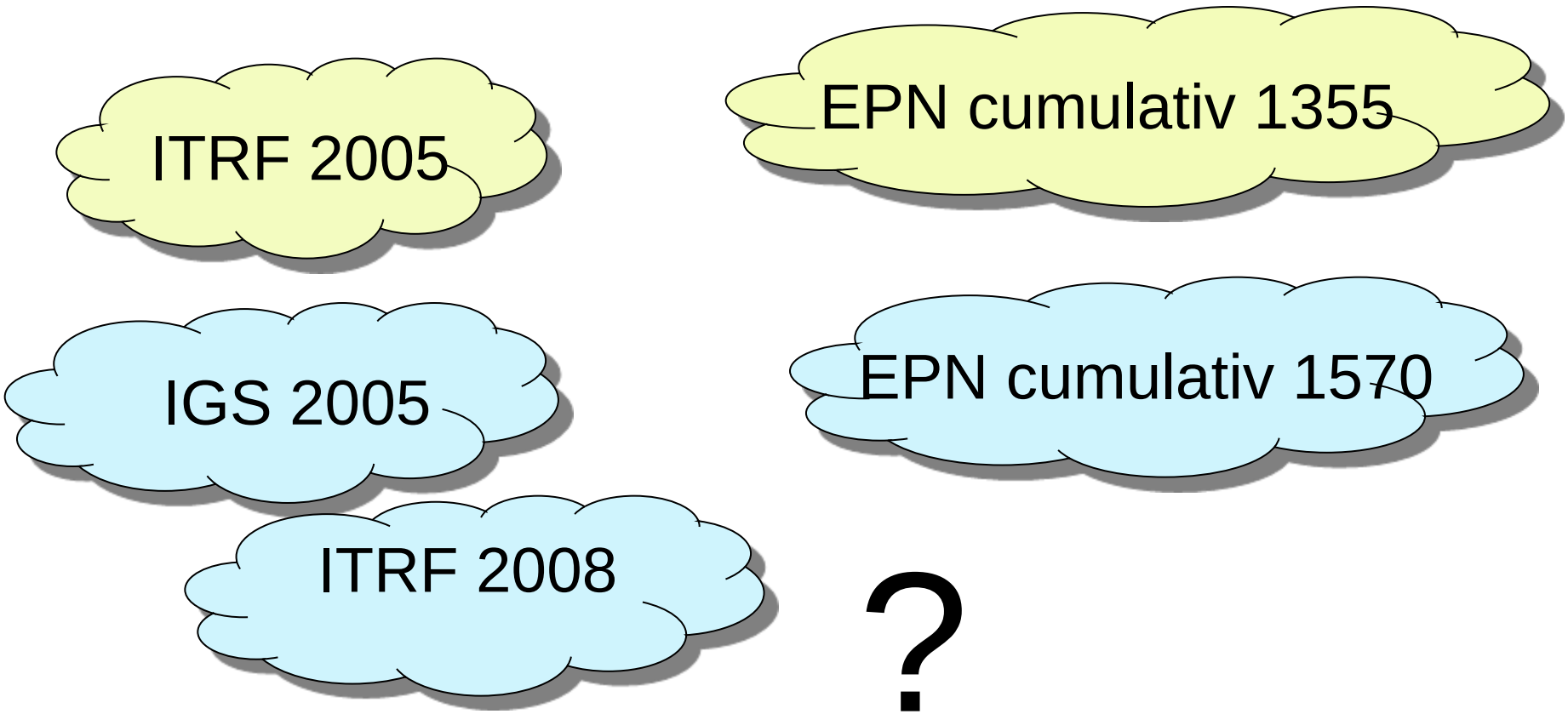
Evaluation of GPS-processing

- Daily repeatbility
- Ambiguity resolution
- Fix-float
- Elevation cut-off test
- Comparisons to national solutions, e.g. SWEPOS

Connection to ITRF –which ITRF?



Connection to ITRF – how?

- Regional or global?
- Heavily constrained or minimum constrained?
- Which parameters to constrain in a minimum constrained solution?
- Additional Helmert?

Regional or global?

The solution from NKG2008 will be the starting point for the transformation between ITRF and the national ETRS 89, thus the answer depends on the use of the transformation

- Regional/national network solutions in ITRF e.g. EPN-solutions, EUPOS-solutions or own national solutions -> regional constraint
- Points determined with PPP-strategies -> global constraint

Regional or global? cont

- EPN has densified ITRF and it make sense to use it as the main definition of ITRF in our region
- Regional network solutions have higher accuracy demands than PPP

-> the main solution should have a regional constraint

- A regional constraint in the EPN-area for the FULL network is not suitable, additional solution for the full network needed

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Heavily or minimum constrained?

- The minimum constrained solution gives discrepancies to the official values
- The constrained solution destroys the internal accuracy

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Parameters in a minimum constrained solution

Estimated crd = (1+dS) • rot • reference crd + translation

- Bern: no-net-translation for regional networks (0.01 mm)
- Bern: no-net-rotation for global networks (0.1 mm)
- Bern: scale condition- just in rare cases
- Altamimi: condition on all 7 paramters, 1 mm

- If a scale or rotation is present in the network it would makes sense to constrain also this parameters to get a better alignmnet with the reference coordinates

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Example of conditions on translation and scale with different weights

BERN_A03 to ITRF2008								
Sigmas m		Rms of residulas in Helmert-transformations between constrained solution and ITRF2008						
Transl	Scale	0-par			4-par			Scale ppb
0.00001	no scale	4.1	2.9	5.1	1.1	1.1	4.2	-2.3
0.00001	0.001	1.1	1.1	13.8	1.1	1.1	4.2	-2
0.00001	0.0001	1.2	1.4	9.0	1.2	1.4	4.8	-1.2
0.00001	0.00001	1.6	2.5	7.4	1.6	2.5	7.4	0
0.001	0.001	11.9	10.9	44.1	1.2	1.0	4.2	-0.8

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Conclusions from the testing on minimum constrained solution

- We have not found an optimal minium constrained solution found that absorbs the scale without degrading the heighs
- Add a Helmert afterwards to solve the scale

- Constraining both translation and rotation absorbs a tilt between the reference frames
- In the Bernese ADDNEQ2 a constraint on 1 mm is too loose (at least if the network not is global)– too large difference to the reference coordinates

Final official solution of NKG2008

- Regional constrained to EPN cumulative solution EPNGW1570
- Minimum constrained translation and rotations
- Absolute antenna models, 3 deg cut-off

- Mc61570a03.crd/snx/nq0

- Additional solutions: 4_IG05_A03, 4GIT08_A03 …

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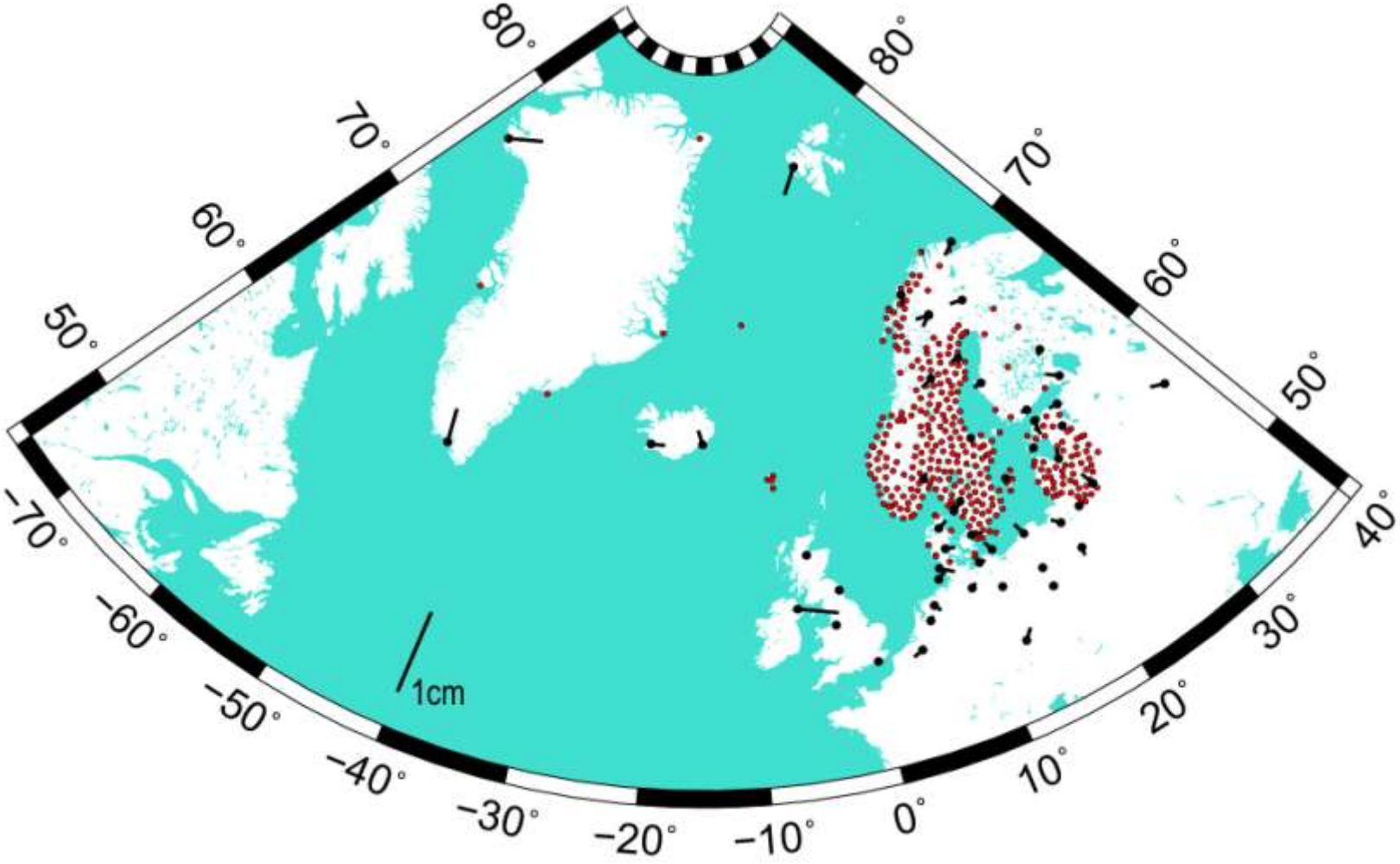
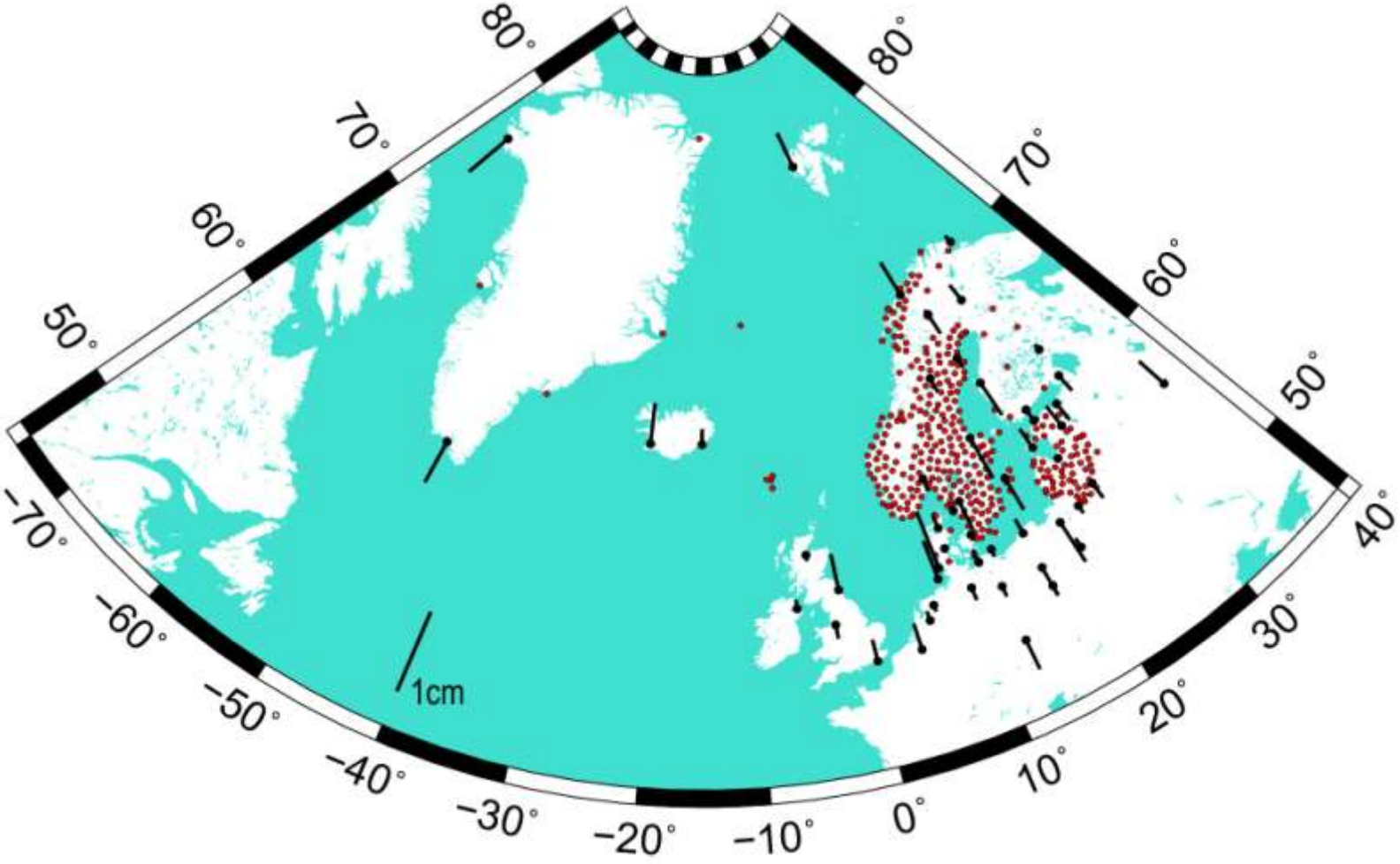
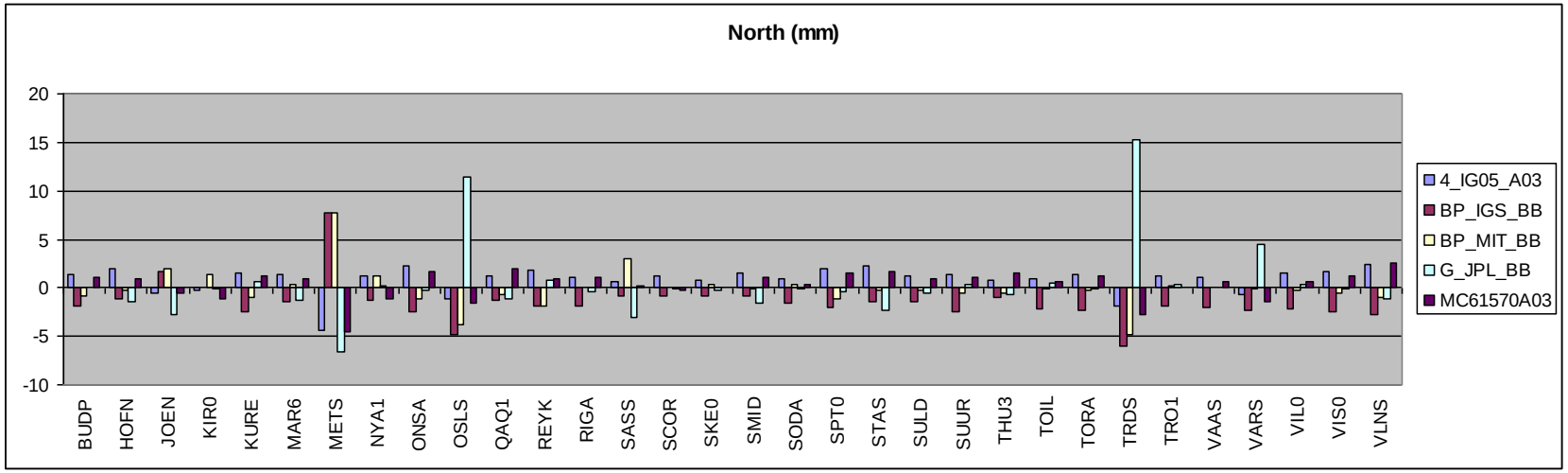
Final solution minus official values, horisontal

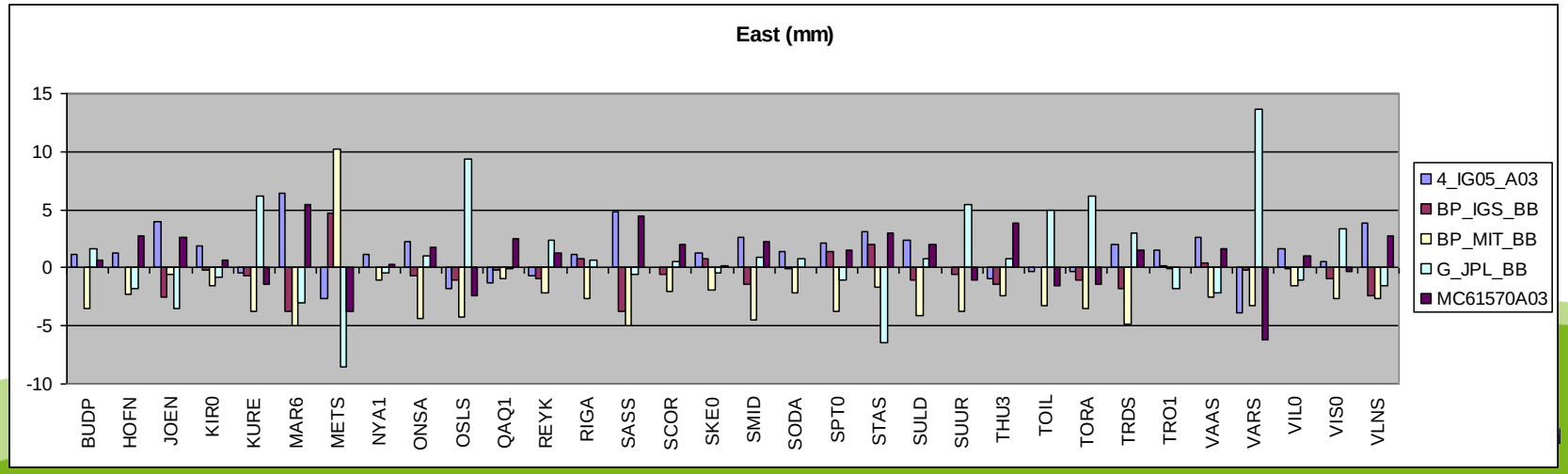


Final solution minus official values, vertical



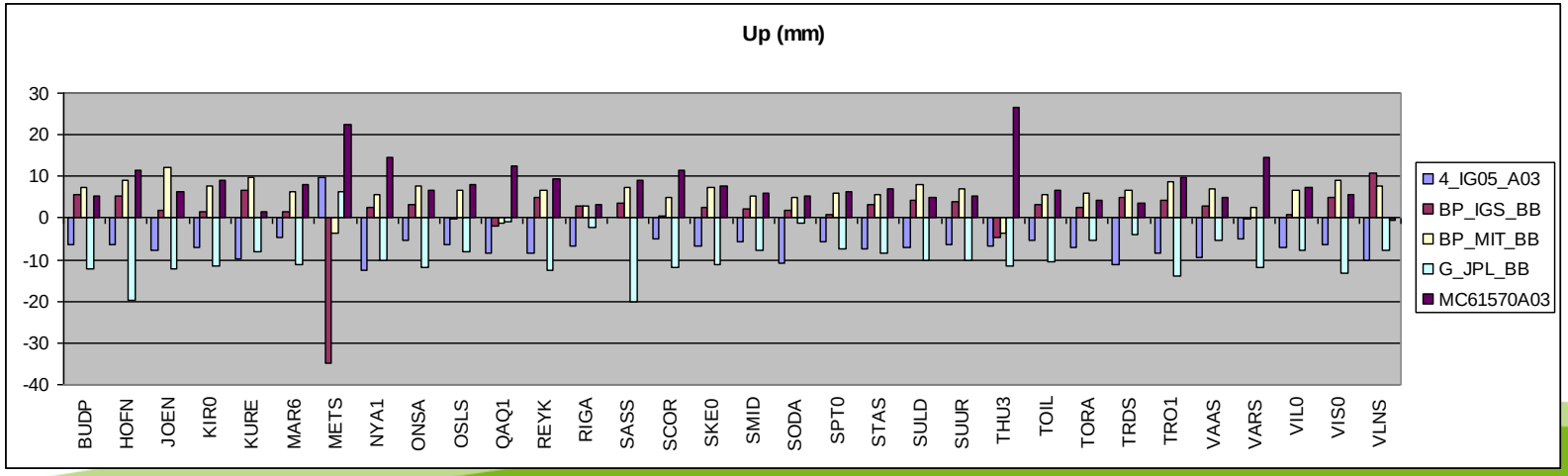
Comparison between different solutions





Comparison between different solutions

- systematic in horizontal < 5 mm
- c:a 15 mm height diff between MC61570A03 and 4_IG05_A03
- Bernese PPP inbetween, but closer to MC61570A03
- c:a 3 mm in height between Bernese PPP with IGS or MIT-orbits
- 4_IG05_A03 and G_JPL_BB agree quite well in height
- Some outliers



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Absolute and relative antenna models

7-parameter-fit between solutions with relative and absolute antenna models

- Systematic scale difference
- Residulas up to 40 mm, many stations 10-20 mm
- Fit on just SWEPOS-stations (163 stn) rms 1.3 mm -> consistent set of antenna/radome pairs gives no problem

Comparison to NKG2003

R10 and A03 solutions fitted to NKG2003 after reduction with NKG_RF03.VEL. RMS of residuals in mm in the table.

- Tilt and scale
- A03 and R10 equivalent
- If fit just on stable Swedish and Finnish stations: 1.5, 1.6, 2.9 mm

	#par	n	e	u
R10	3	4.9	7.0	12.2
A03	3	5.3	7.1	12.6
R10	7	3.3	2.8	7.9
A03	7	3.3	2.8	8.6

Conclusions

- Good internal precision in the network
- The largest uncertainties are connected to the connection to ITRF
- The choice of ITRF connection is related to the use of the reference frame
- The internal consistency is not changed much when going from relative to absolute antenna models, if a homogenius set of antenna-radome pairs are used