Report from the project NKG GNSS Analysis Centre

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Aim/motivation:

- Need for a dense and consistent field of station velocities to maintain national ETRS89 realizations in the future and for studies like GIA modelling.

Main outcome:

- Common and combined GNSS solutions for the Nordic and Baltic countries.
- Operational solutions could be used for maintenance of national ETRS 89 realizations.

NKG EPN LAC since 1996 for EUREF permanent network

NKG GNSS AC solutions could be considered as a densification of EPN

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Current time table

Start up March 2012

Prestudy - part 1: Questionnaire to survey resources
- 8 national LACs, 2 combination centres

Prestudy – part 2: Processing strategy
- EPN guidelines for LAC
- Bernese ver 5.0-> ver 5.2
- Testing of processing strategy
- Common BPE-setup, Benchmark test
- Test to combine national solutions with NKG EPN solution

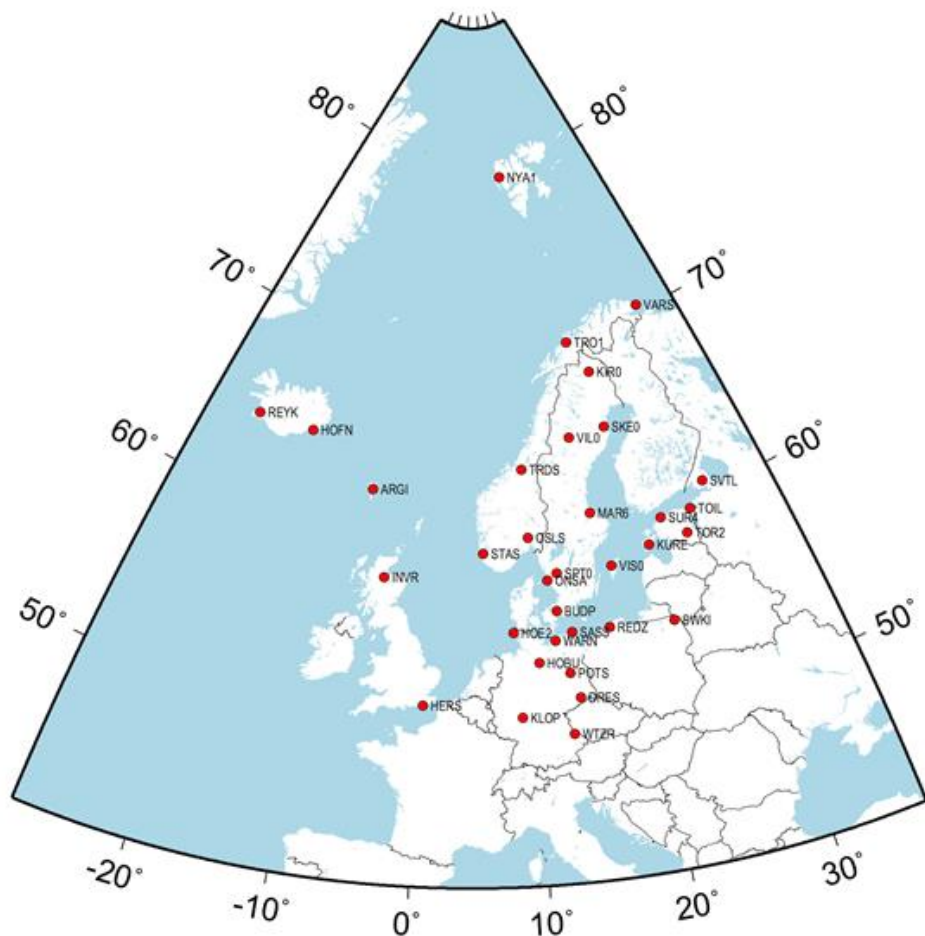Definition phase: Subnetworks, FTP-archive, roles and responisbilities

Operational phase: Start with GPS-week 1795

Reprocessing: back to year 1997

Time series stackning/analysis and velocity estimation:

Bechmark test

35 EPN-stations.
All GPS/GLONASS stations of NKG EPN LAC.
GPS-week 1682 (april 2012).

BPE-setup provided.

Processing strategy

Following guidelines for EPN LAC

GPS+GLONASS

Solutions with different elevation cut-off: 3º, 10º, 25º

Some testing:

- Troposphere modelling: VMF1 (ECMRWF) or GMF (GPT)?
- The benefit of the new ambiguity resolution scheme
- Clustering (for large networks)

Definition of national sub-networks

NKG EPN LAC solution acts as backbone, national non-EPN-stations just processed by national LAC

- Stable good performing stations, reasonable national coverage

- Enough stations for constraint to IGSxx (IGb08)
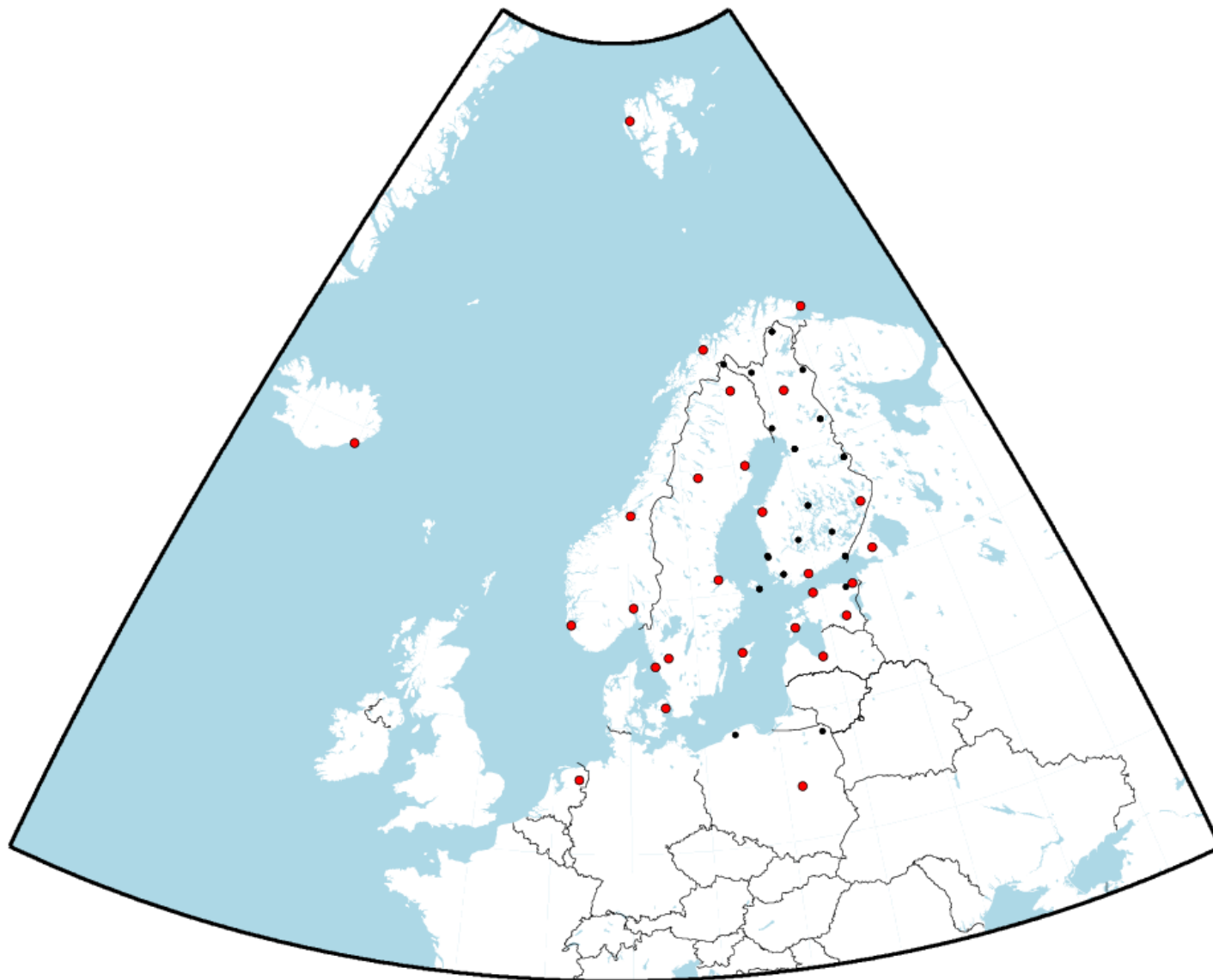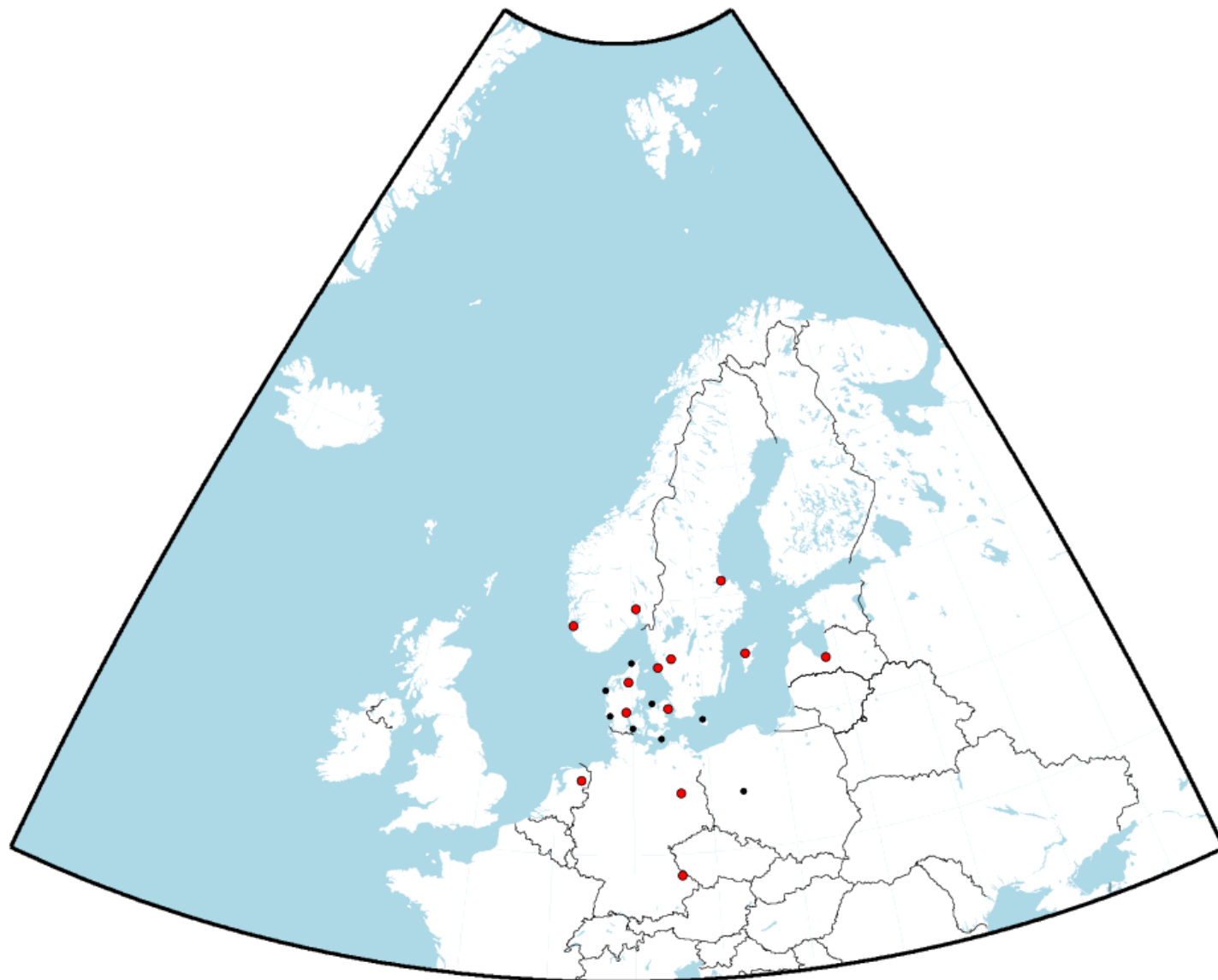
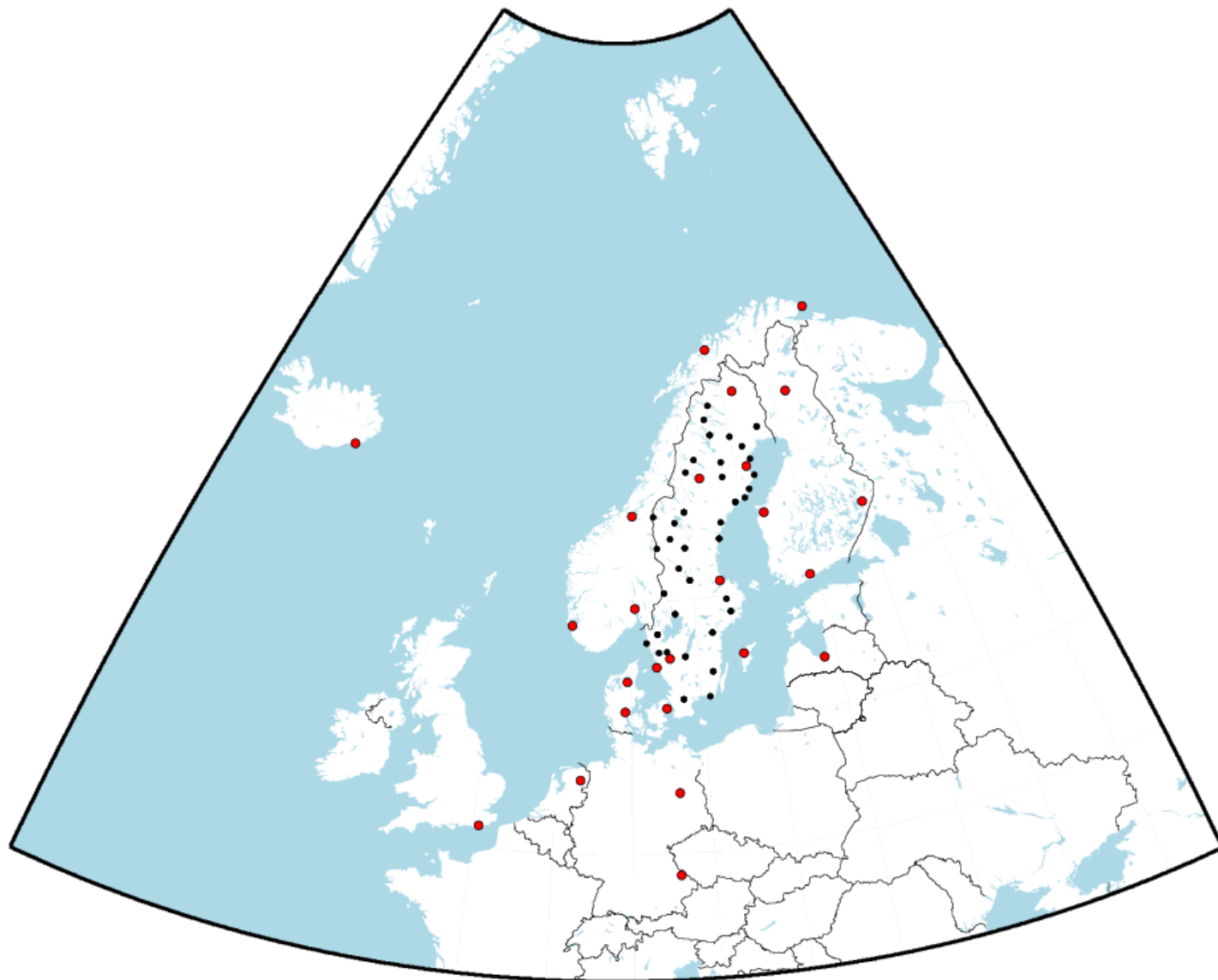- Enough common stations with neighbouring countries

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EST

FGI

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GST
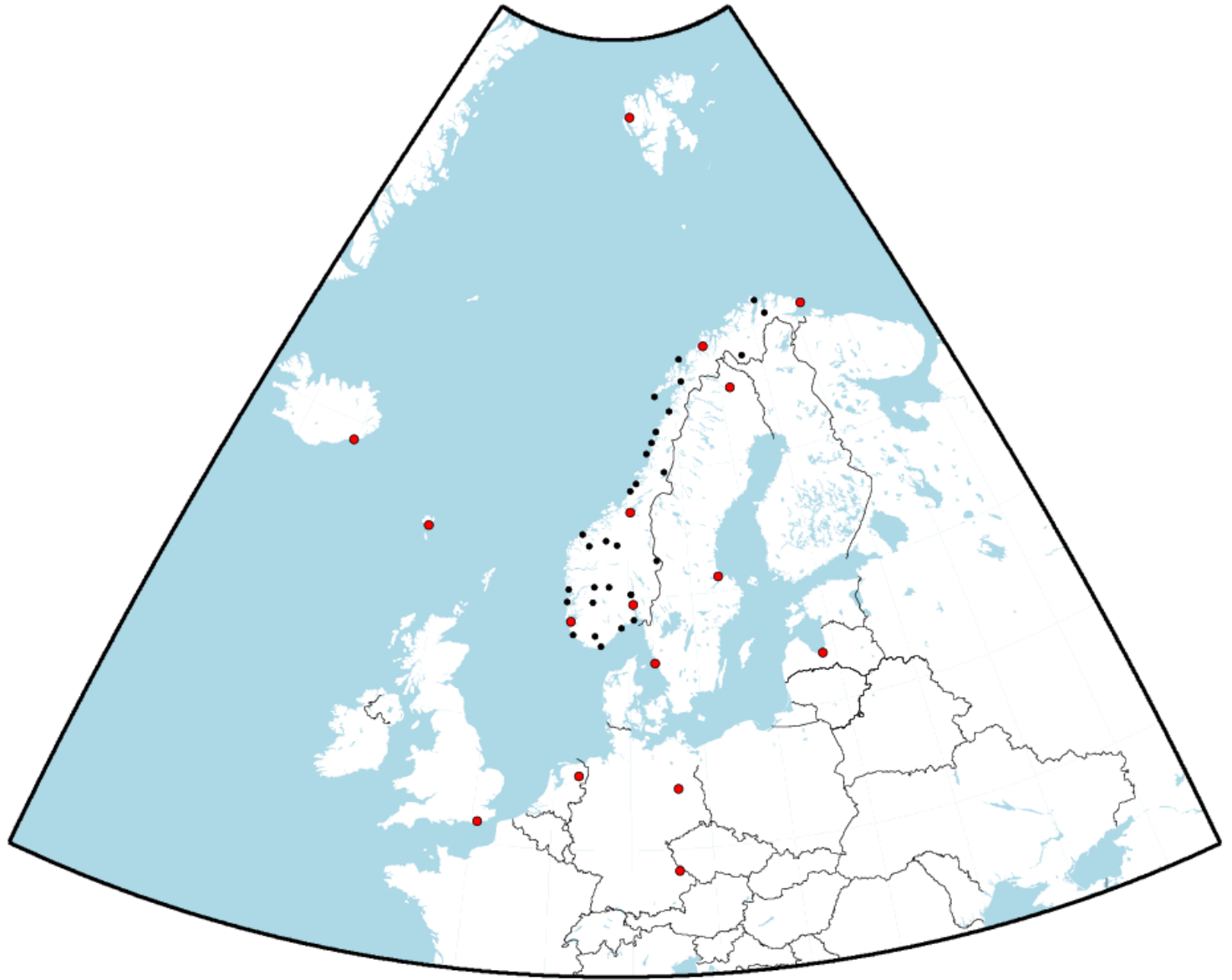
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LAT preliminary
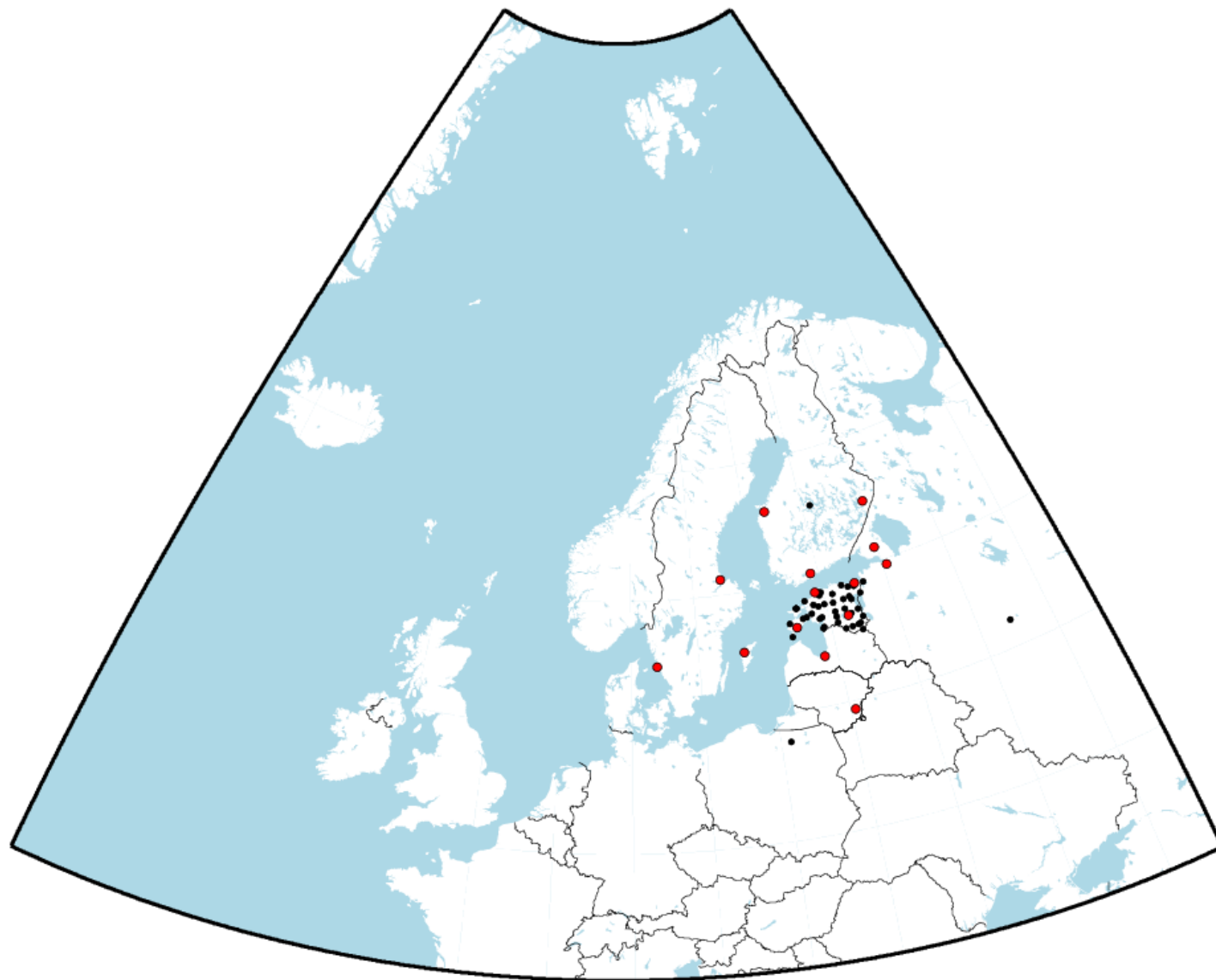
LM_

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SK_

Combined network

LAC number of stations
(GPS-week 1785)

NKG EPN LAC 51
EST 60
FGI 56
GST 21
LM_ 84
SK_ 47
LAT 17 (10)?

In total: 230 stations

Results from the combination of national sub-networks and NKG EPN-solution

- Week 1785

- ENG, EST, FGI, GST, LM_, SK_, (LAT)

- Combination with ADDNEQ2 – NKL, Lotti
- Combination with CATREF – NKF, Sonja

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Combination strategy ADDNEQ2 - NKL

1. Convert SNX -> NQ0, CRD (reconstruct original NEQ from Bernese SINEX)
2. Extrapolate reference coordinates to middle epoch of day/week
3. Merge extrapolated reference coordinates with coordinates from step 1
4. Combine NQ0 from sub-nets + NKG EPN-solution using ADDNEQ2 with **no-translation condition to IGb08**.
5. Check for outliers
6. Check of fiducial stations in combined solution with 3-parameter Helmert to IGb08

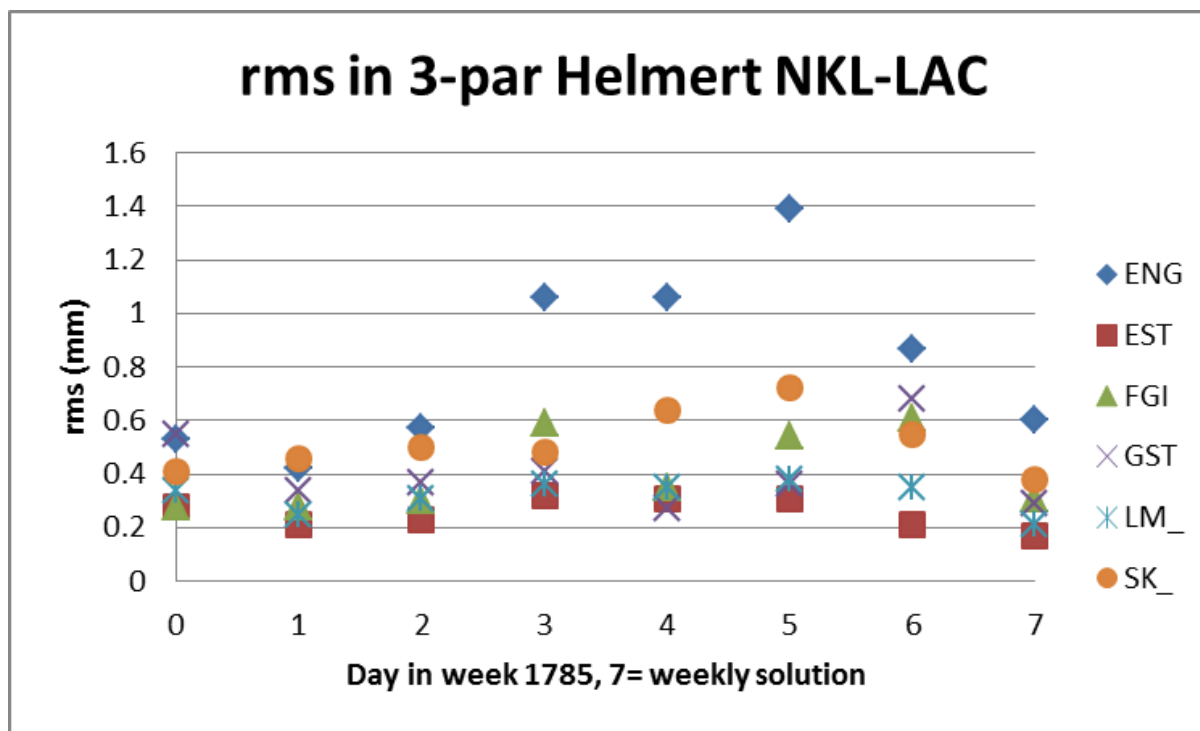- This is repeated for each of the 7 days and the weekly solution, both 3 and 10 deg.

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Coordinate repeatability between LACs 3 deg
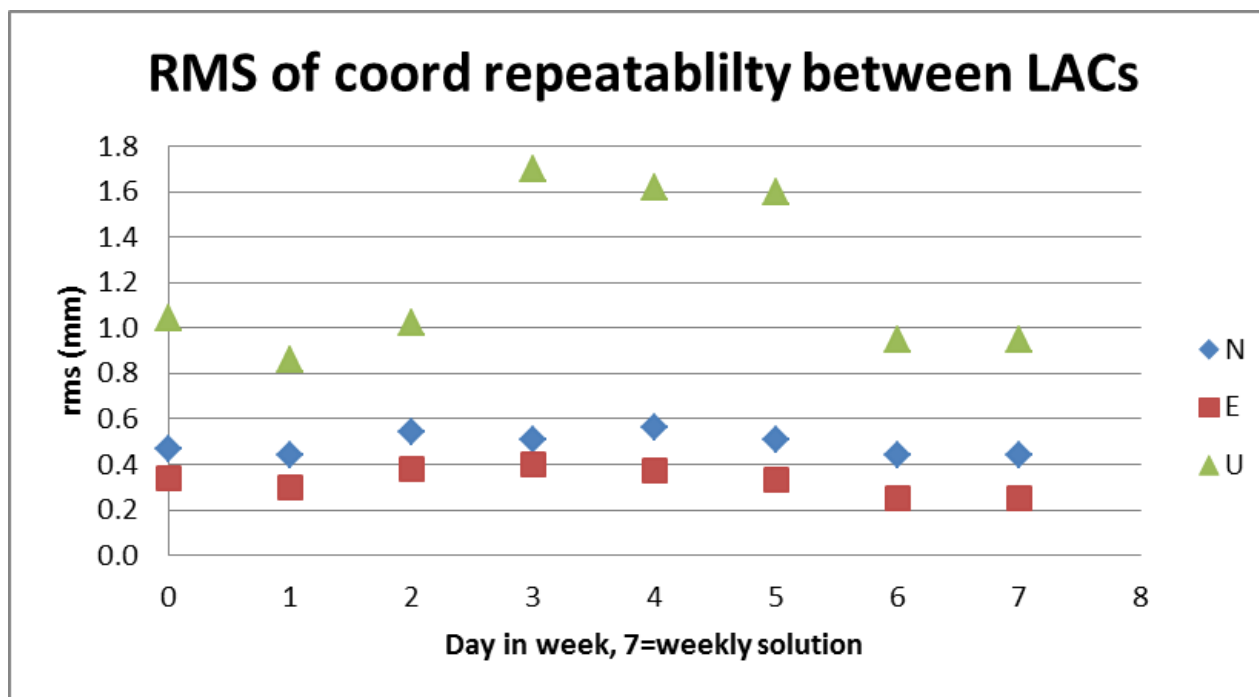
The fit of each LAC to the combined solution

Largest residulas in weekly combination of NKL17857.OUT

Outliers in weekly combined solution NKL17857.OUT			
Stn	SOL	Comp.	Residual (mm)
POTS	ENG	N	1.03
POTS	GST	N	1.02
POTS	SK_	N	-2.69
THU3	ENG	U	-4.05

Residulas >(1, 1, 2 mm for n,e,u)
More "outliers" in daily combinations, upp to 5 mm i U

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Combination strategy CATREF (NKF)

- Preparation of Bernese SINEX for CATREF
  - Solving normal equations with loose constraints
  - Applying minimum constraints for the solutions
- Combination of all solutions
  - **Solving 7 Helmert parameters between each individual solution and combined solution**
- Check for outliers
- Weighting of the solutions according to variance factors
- Iteration of the combination
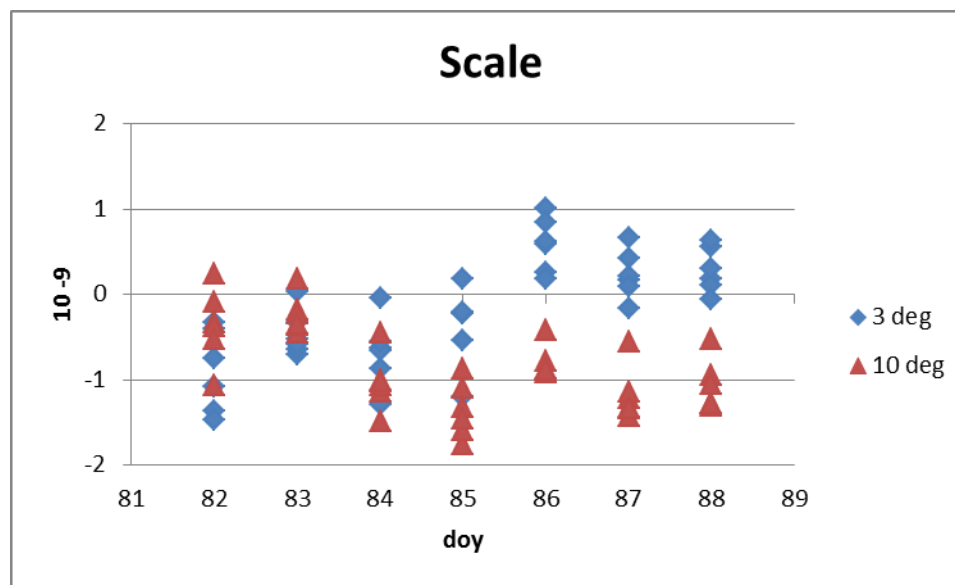- Comparison of datum and solution

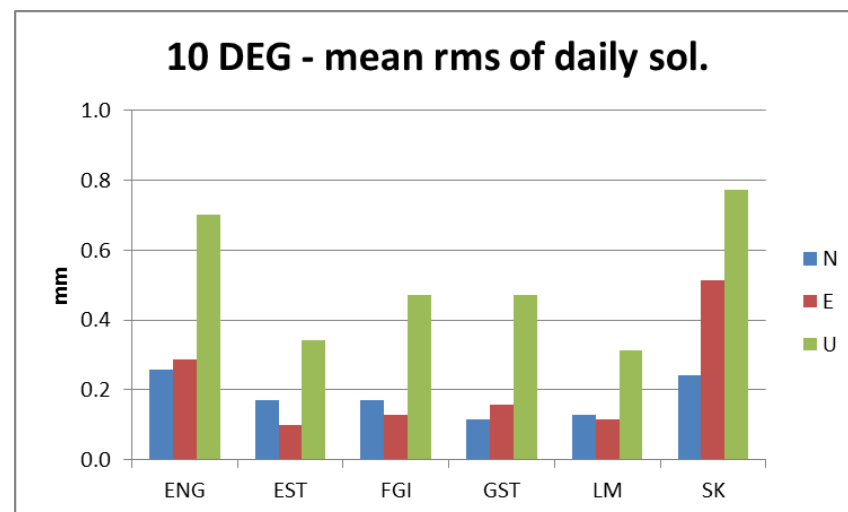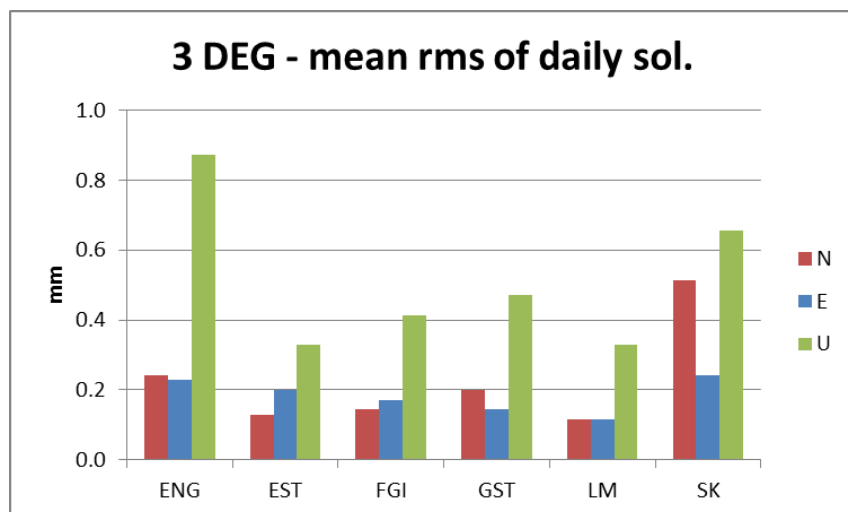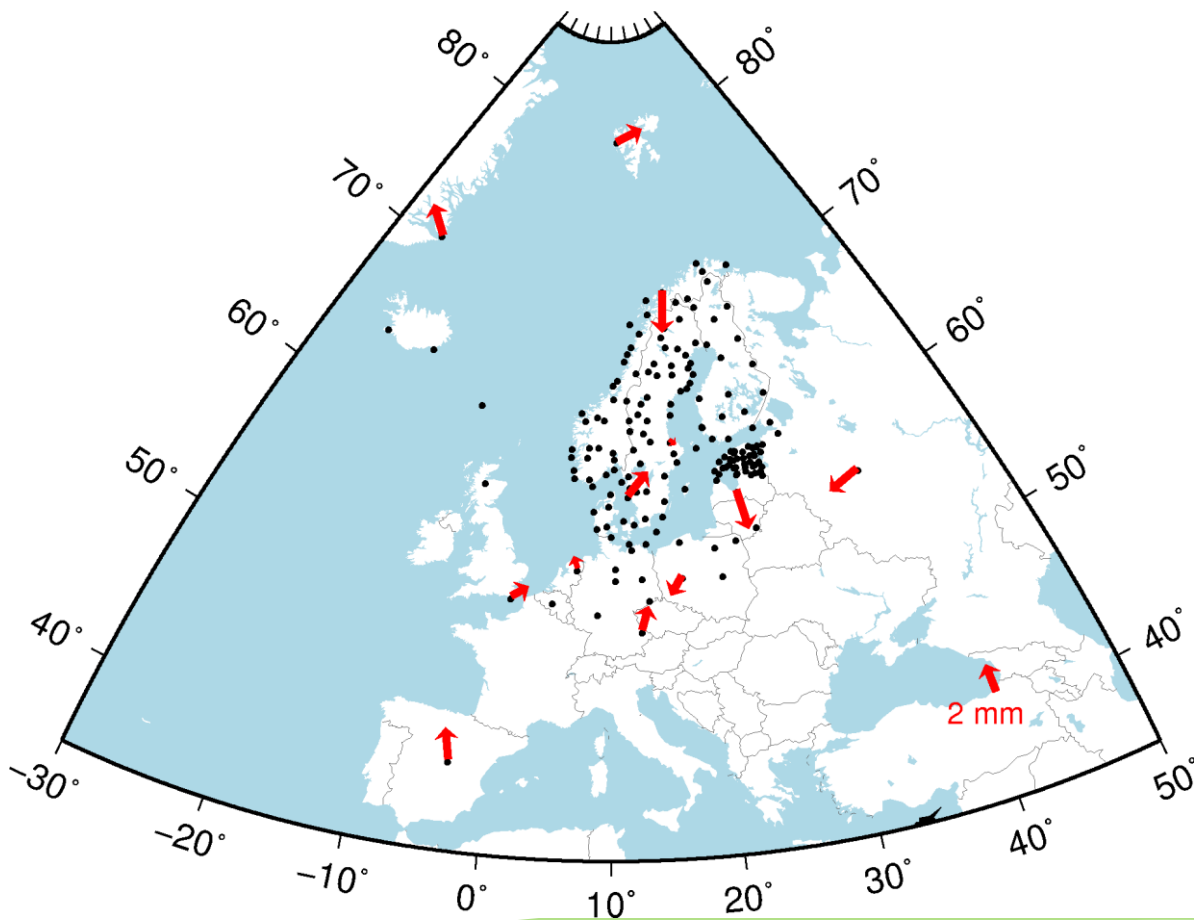# Daily solutions – estimated params.
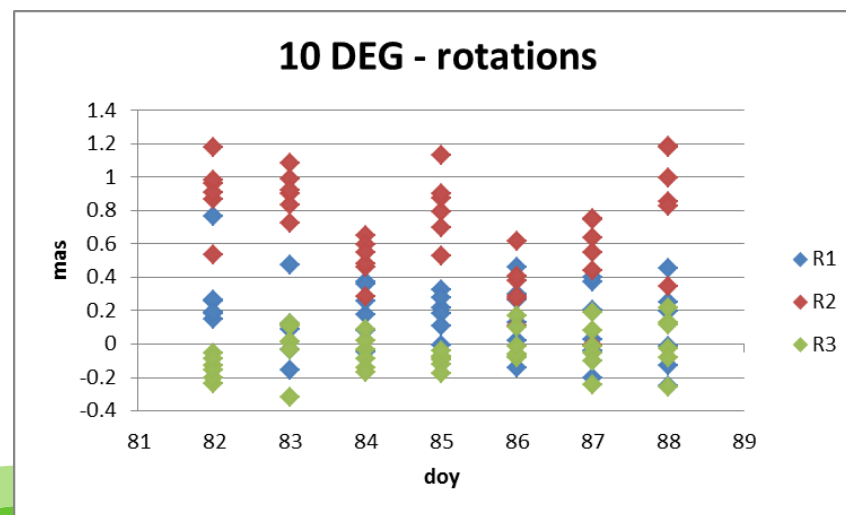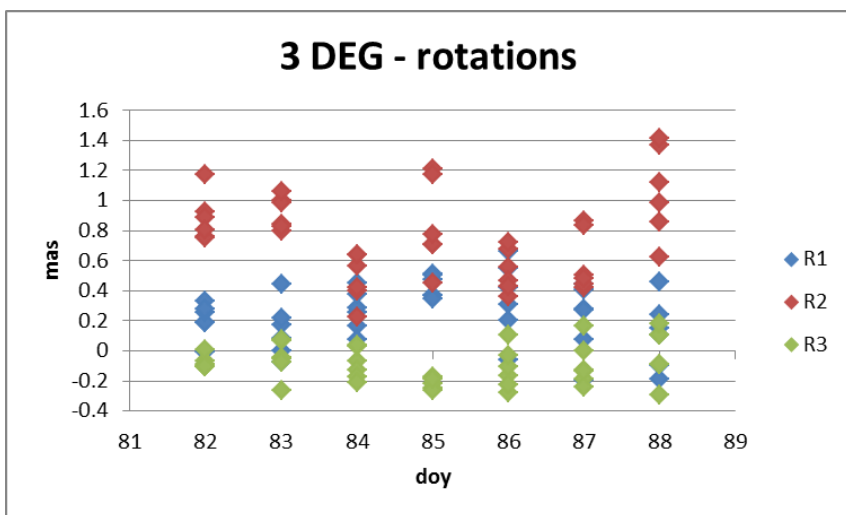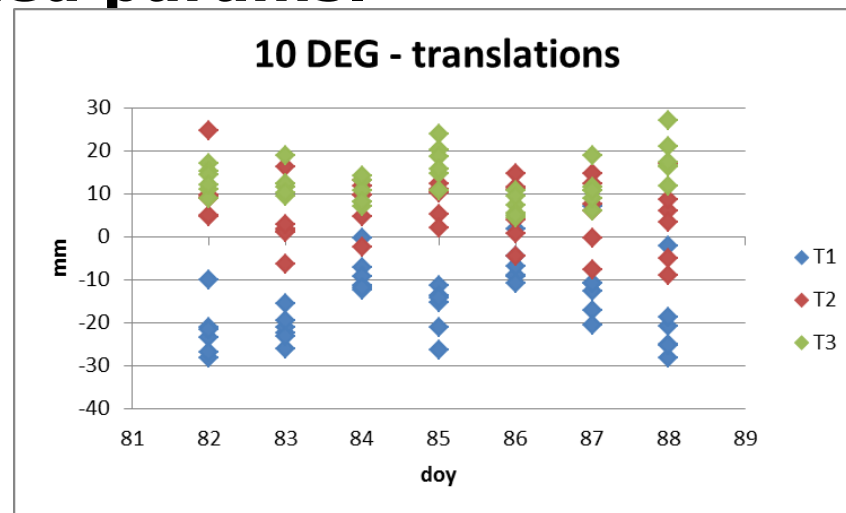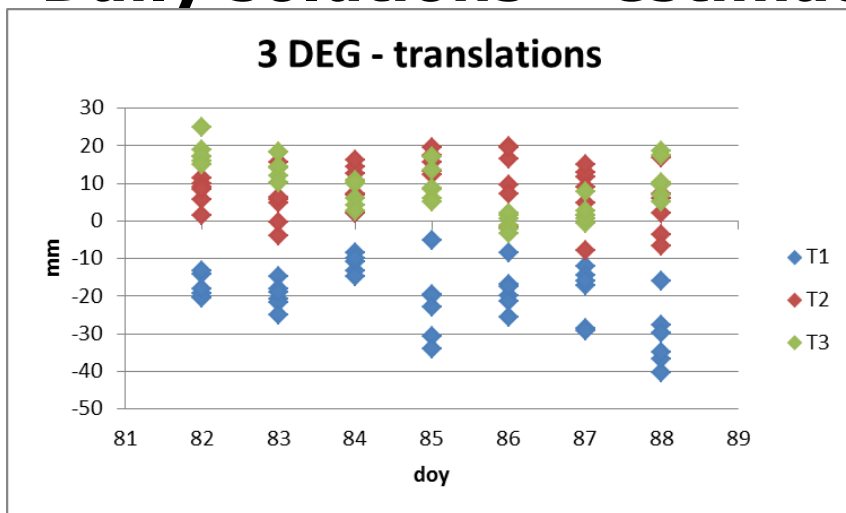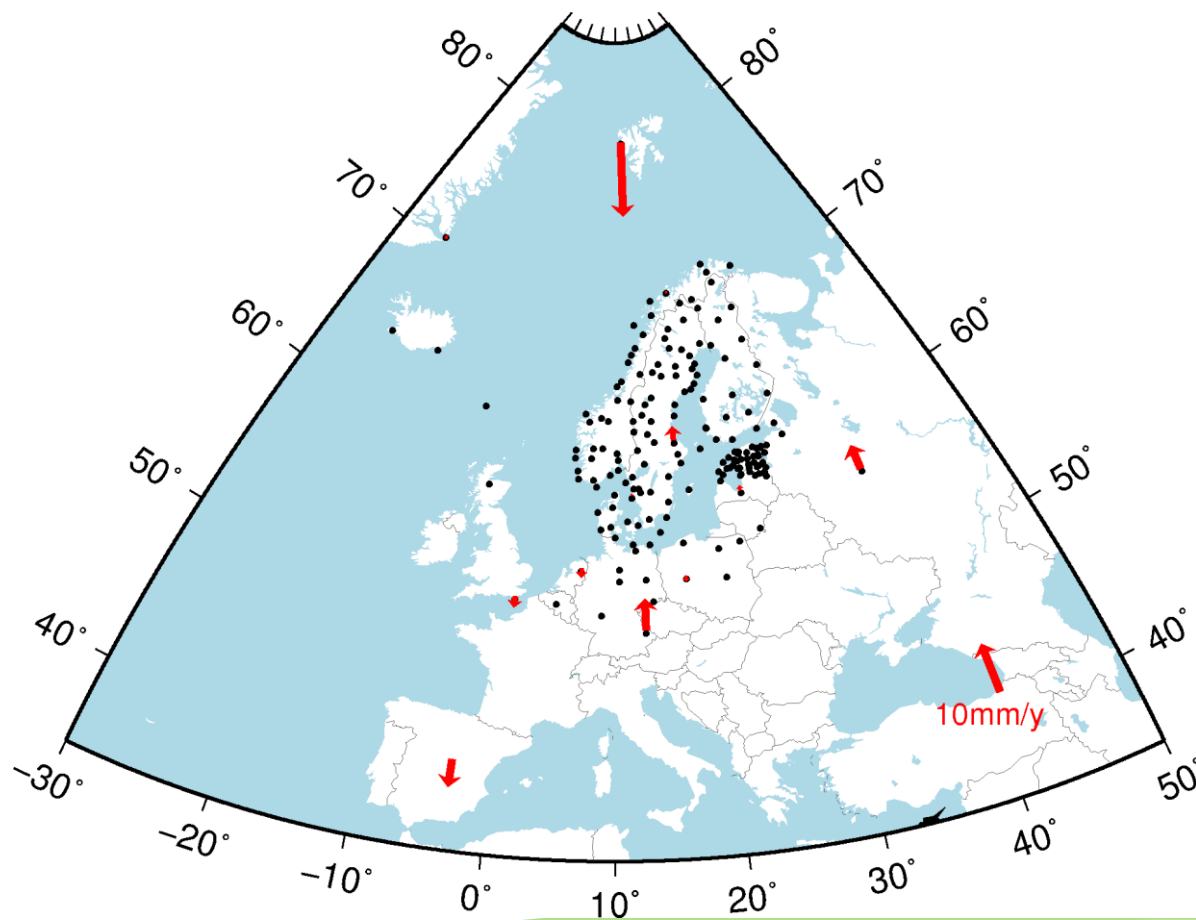
Daily solutions (cont.)

Mean RMS of daily solutions by AC

Datum check, horizontal, weekly 3 deg sol

Datum check, vertical, weekly 3 deg sol

The NKG GNSS AC FTP-archive

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▲ 📁[Products]
    ▲ 📁[Operational]
        ▷ 📁[Combined_FGI]
        ▲ 📁[Combined_LM]
            ▲ 📁[03DEG]
                📁[1795]
                📁[1796]
            ▷ 📁[10DEG]
        ▲ 📁[EPN_NKG]
            ▲ 📁[03DEG]
                📁[1795]
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            ▷ 📁[10DEG]
        ▷ 📁[EST]
        ▷ 📁[FGI]
        ▷ 📁[GST]
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        ▷ 📁[LM_]
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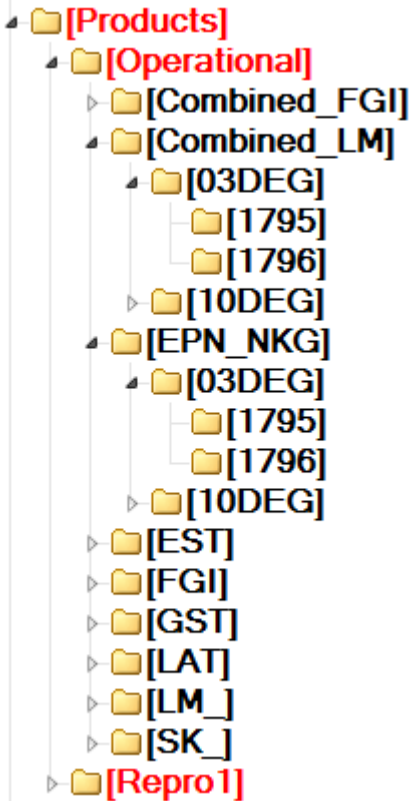
- Hosted by the Danish Geodata Agency
- Operated by "Statens IT" in Denmark
- Windows-platform (Windows server 2003)
- The FTP-server has been used by the WG of Reference Frames, Positioning and Navigation for the last 10 years
- When setting it up as an operational archive for NKG GNSS AC solutions and products, some measures are taken to increase the sequirity:
    - Separate logins for each LAC
    - User dependent reading/writing access
    - Backup routines

Danish Ministry
of the Environment
Danish Geodata Agency

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Summary

- NKG GNSS AC could be seen as a densification of NKG EPN LAC
- Processing is following EPN-guidelines, but more strict than EPN -> more homogenous solutions
- Benchmark test and combination of national solutions have been iterated several times
  - Ver 5.0-> ver 5.2, VMF->GMF
  - Inconsistencies in LAC-solutions, e.g. antenna models, apriori-coordinates, stations for constraint…
- Operational phase started up in the summer 2014 (now 4 LACs with 8-10 weeks)
- When the operational phase is running smoothly we will start the re-processing (GPS), preliminay in November 2014, finnished hopefully by June 30 and then daily/weekly combinations

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