SWEPOS™ Network-RTK service – establishment, status and experiences

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SWEPOS™

- Background

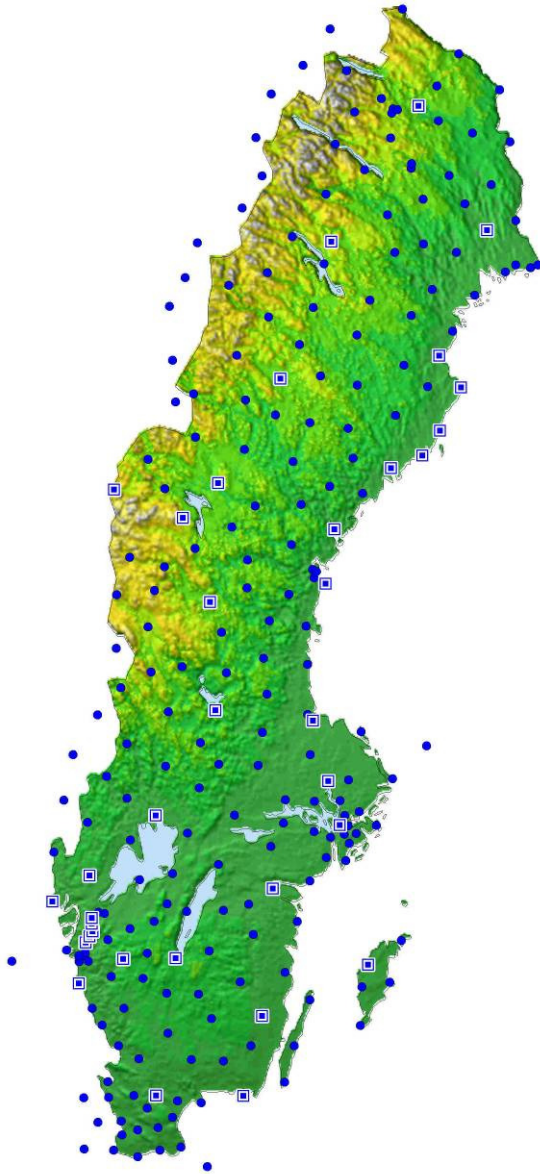- Operation

- The densification of SWEPOS

- CLOSE projects

- Services

SWEPOS™

- A national network of permanent GNSS stations, a part of the national geodetic infrastructure

- Establishment costs finansed via governmental funding

- Maintenance, the running of the stations and future upgrades finansed by the user community via user subscriptions

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SWEPOS™ – Purpose

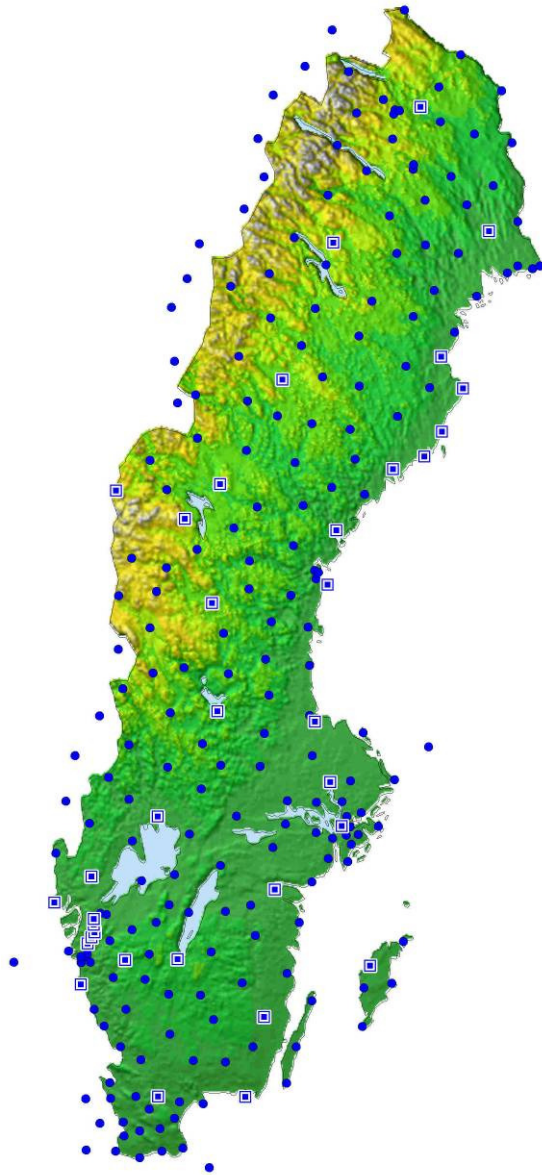The purposes of SWEPOS is to:
- provide GNSS data for post-processing
- provide DGNSS and RTK corrections
- act as high-precision control points, a tool for connection to the national reference system SWEREF99
- provide data for scientific studies, study land uplift, meterology
- Monitor the integrity of the GNSS systems

SWEPOS Stations

40 class A stations   209 class B stations

5 IGS- och 7 EPN-stations

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SWEPOS control centre

- Surveillance of CORS /GNSS- stations, datacommunication, electricity and backup power, temperature.
- Problem solving
- Customer support
- Qualitycontrol of data

Operating: 24 hours per day 7 days in the week

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First generation SWEPOS 1992 - 2001

- First generation, 21 stations established in the beginning/middle of the 1990

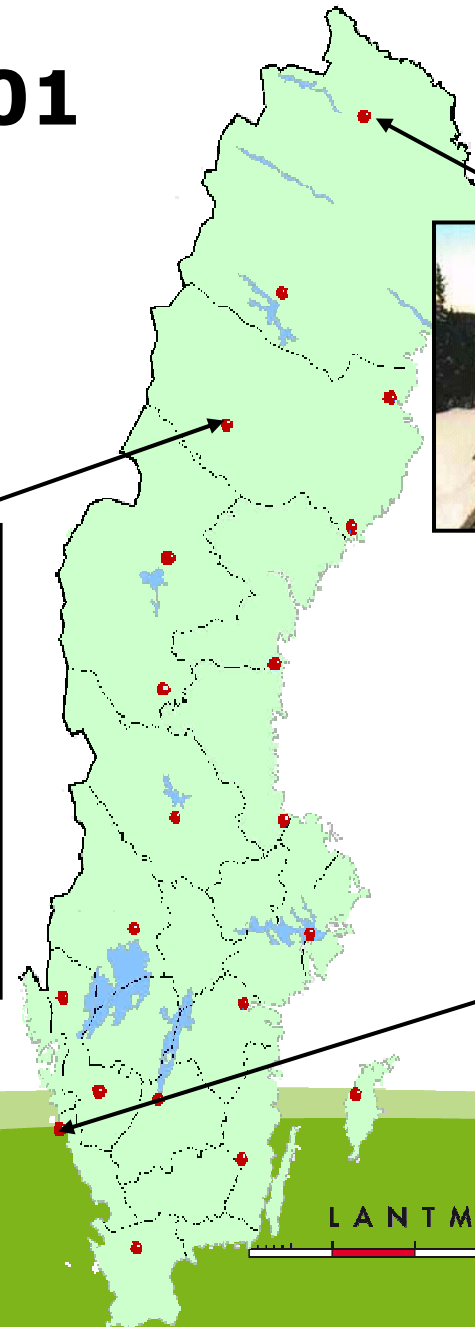- 21 "fundamental" stations on bedrock with redundant equipment for GNSS-measurement, datacommunicatio
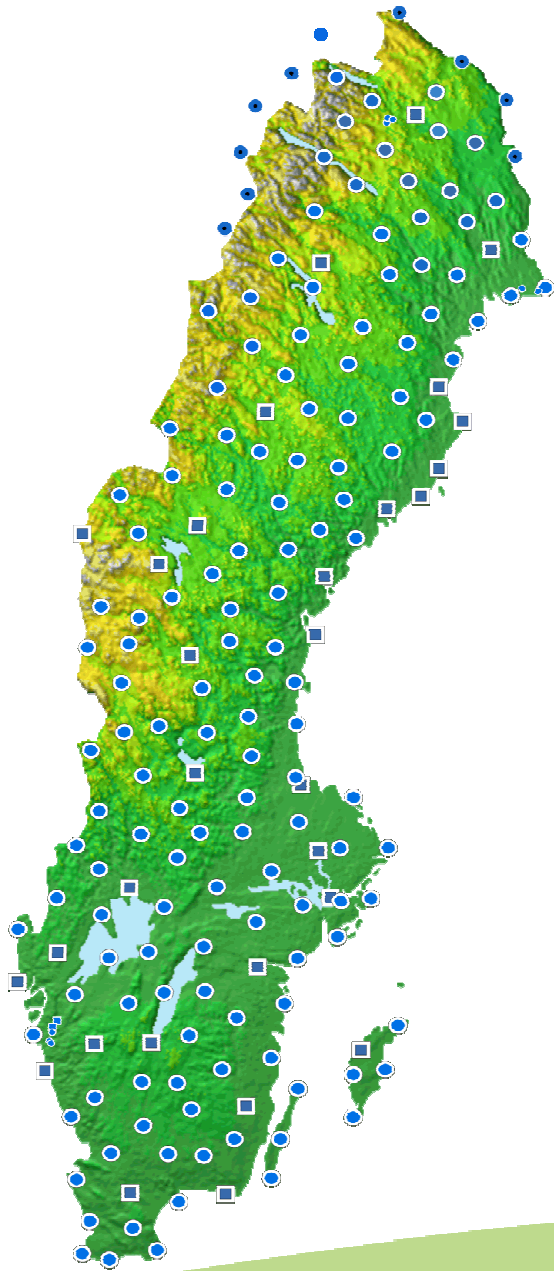

Kiruna

Vilhelmina

Onsala

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Second generation SWEPOS 2002 – 2010

SWEPOS

- The second generation consisted of regional densifications (interstation distance of 70 km) and was established during 2002-2009

- Further densifications down to 10-15 km interstation distances in cooperation with the national road administration for infrastructure projects, project adapted network-RTK

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Customer survey 2008

- 400 answers
- Users are satisfied with service from SWEPOS control centre
- The users are satisfied with pricing of the SWEPOS Network-RTK service.

Expectaitions for the future

- Adjustments of subscription fees
- High availability
- Improved heighth accuracy

New survey 2012

CLOSE-RTK project

- CLOSE-RTK was initiated by Lantmäteriet, SP Technical Research Institute of Sweden and Chalmers University of Technology

- Main objectives for this project were to:
  - **Current:** Investigate the achievable uncertainty for network-RTK based on a detailed study of contributing error sources
  - **Future:** Evaluate the expected quality of network-RTK positioning, given possible changes in the infrastructure of space and ground segments

Measurement accuracy in Network-RTK

Ragne Emardson, Per Jarlemark, Sten Bergstrand, Tobias Nilsson, and Jan Johansson

SP Technical Research Institute of Sweden

Measurement Technology
SP Report 2009:23

# CLOSE – Future situation
New GNSS constellation

- **Future GNSS constellation + higher elevation cut-off angle =** lower position uncertainty

- **The availability of future GNSS =** reduces the vertical uncertainty from 27 mm to 20 mm (68%)
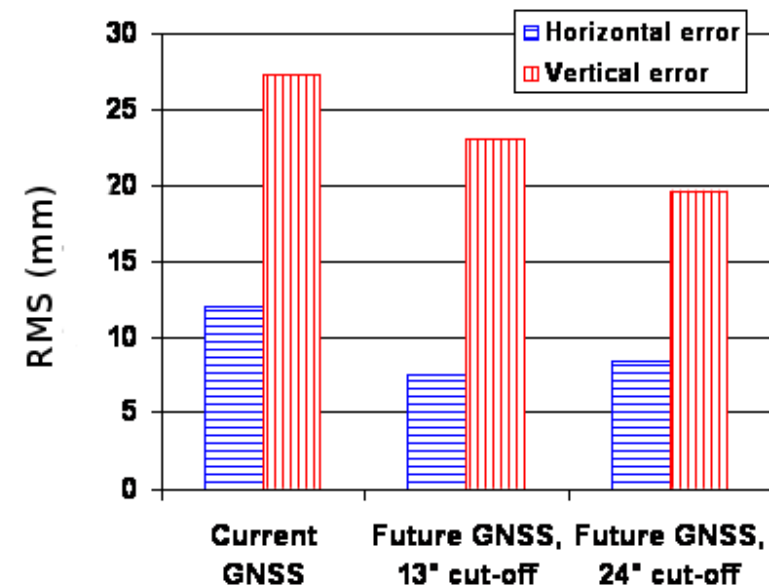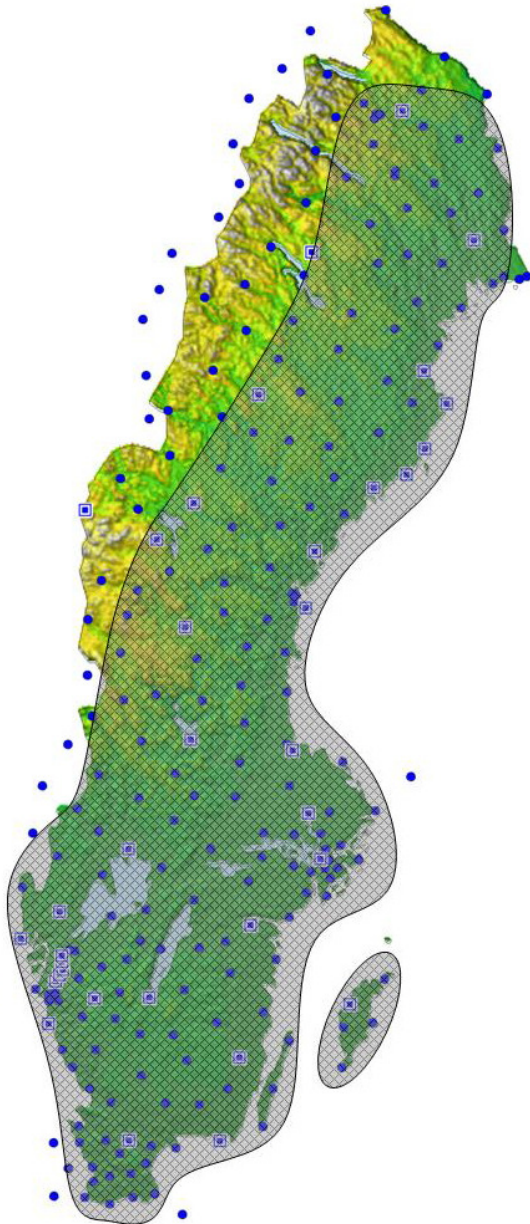
CLOSE – Future situation
Densified reference network

- **Densified network (35 km) + current GNSS constellation** = reduces the vertical position uncertainty from 27 mm to 20 mm (68%)

- **Densified (35 km) + future GNSS constellation** = vertical position uncertainty of 14 mm (68%)

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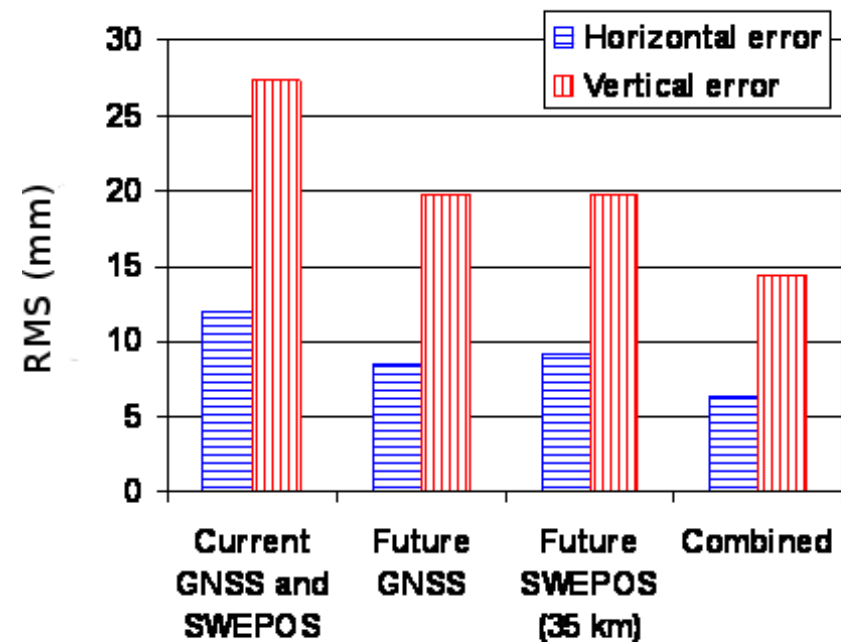
# Third generation SWEPOS 2011 -

SWEPOS

- During recent years many users have requested improvements especially in the vertical position uncertainty

- Results and experiences from previous studies (e.g. CLOSE) have inspired the development for a 3rd generation network

- The **3rd generation** SWEPOS network will be an almost nation-wide densification of the 2nd generation network, with in-between distances of **~35 km**

- Within 4-5 years further improvements with new satellite signals and systems.

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Status and plans for 2012

- **Shaded areas** – already densified to interstation distance of 35 km

- **Crosshatched areas** – planned densification for 2012
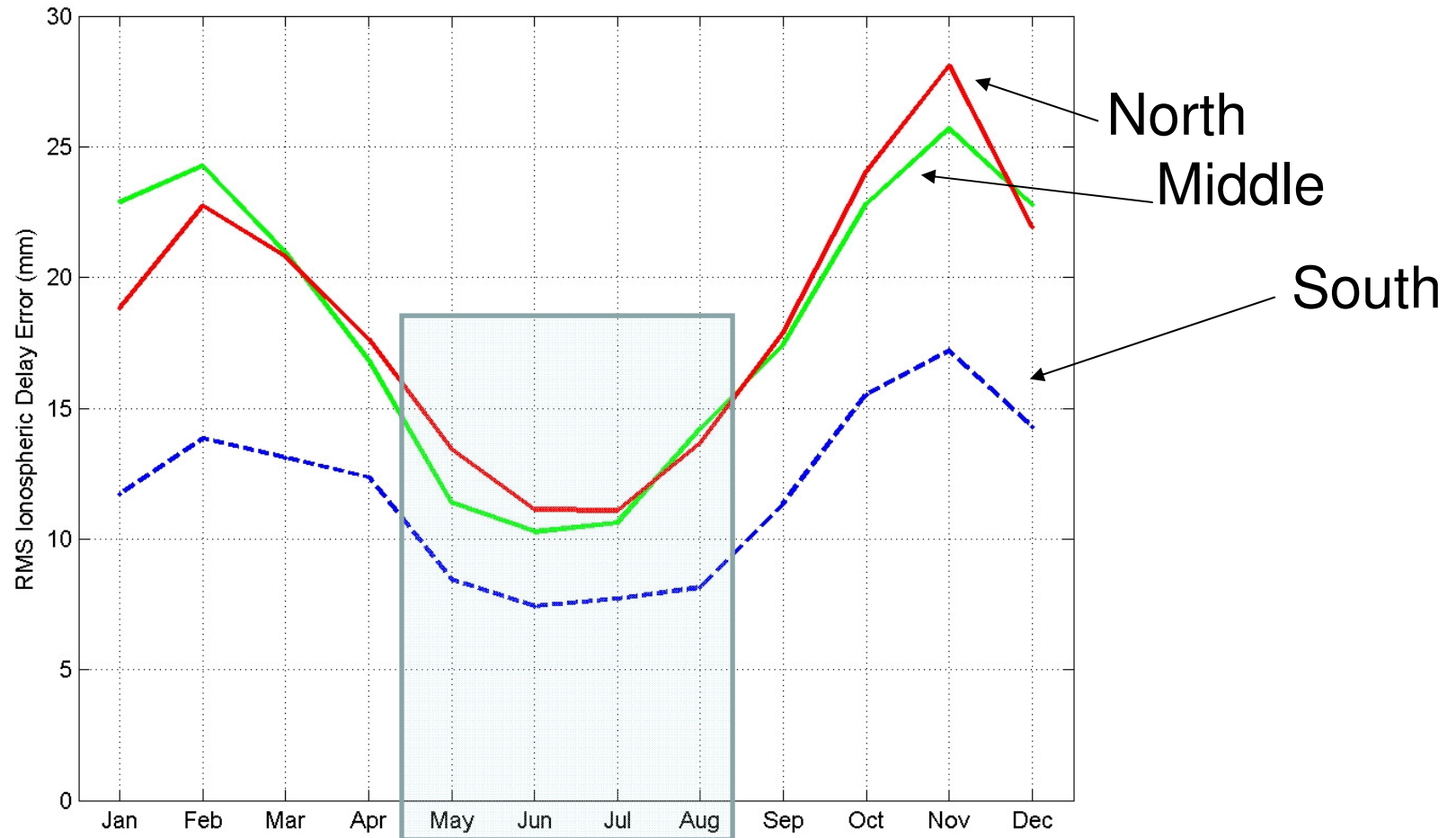
SWEPOS
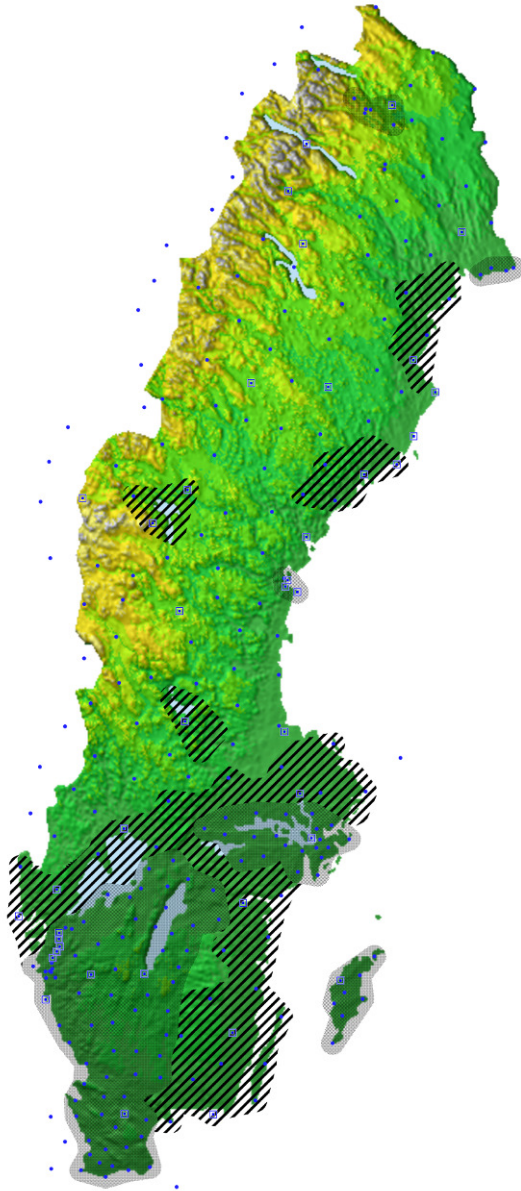
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CLOSE II

Lantmäteriet, SP Technical Research Institute of Sweden and Chalmers University of Technology

- CLOSE II
- Purpose; predict what to expect during the next solar maximum around 2012 by studies of GPS data and GPS measurements from previous period of high ionosperic activity
- How will GNSS receivers and network-RTK software be affected by the increased ionospheric activity
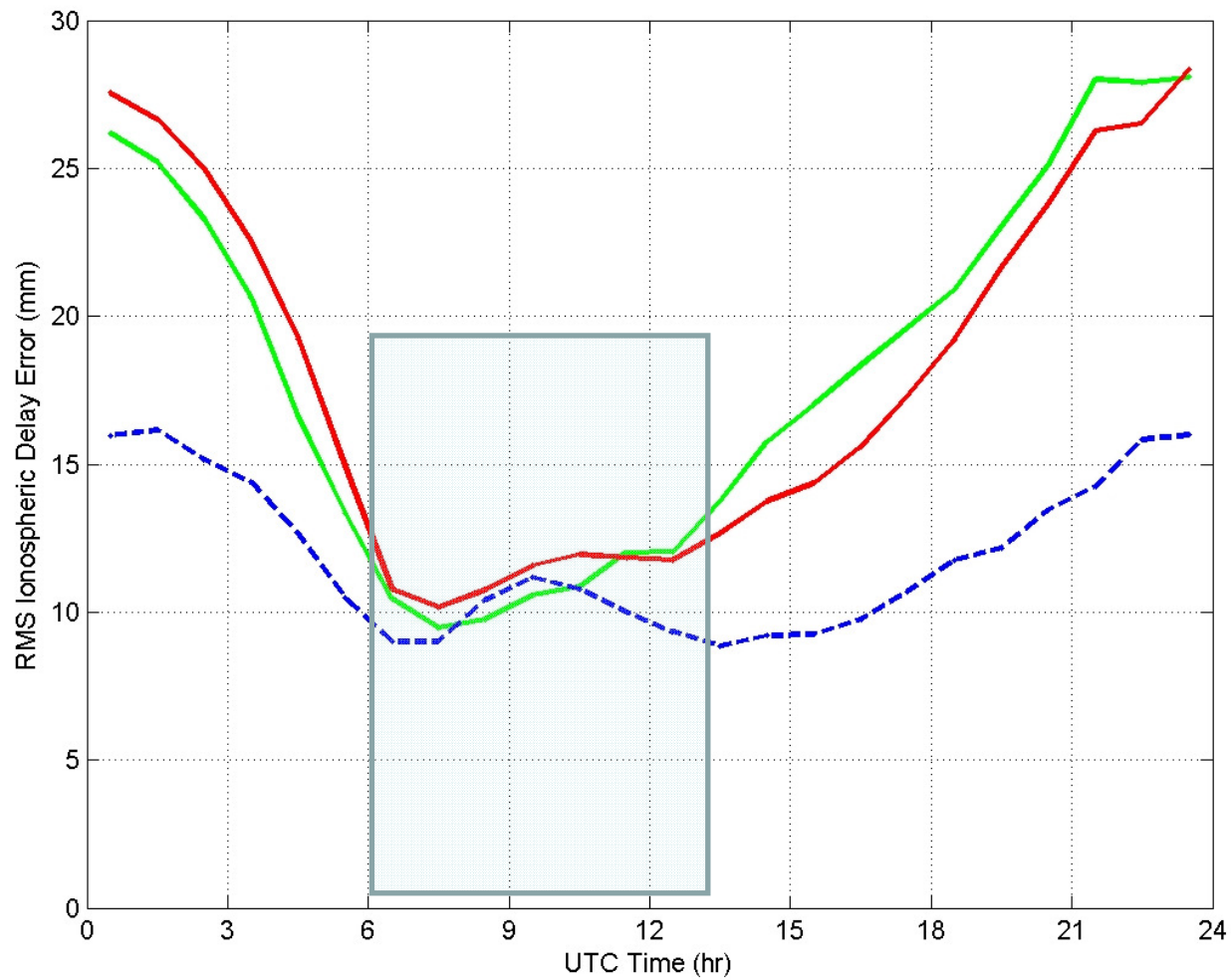- Development of a realtime ionospheric monitoring service

Activity on a yearly basis

Activity on a daily basis

Ionospheric monitor
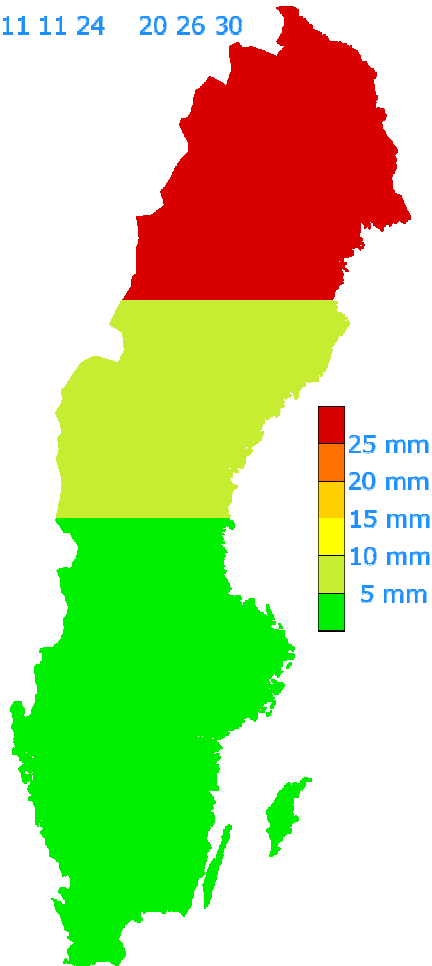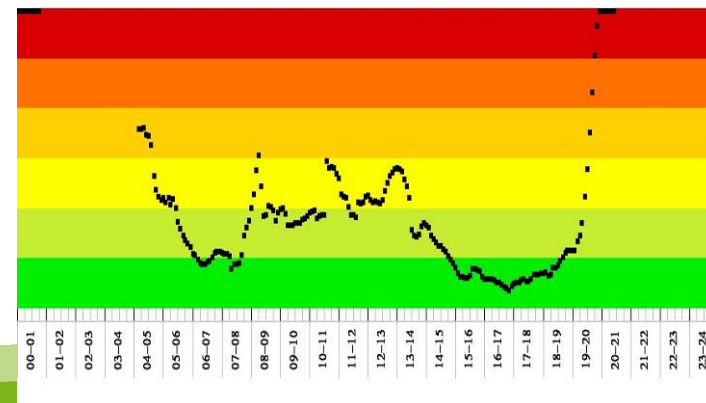
Ionospheric monitor on www.swepos.com

We can see that the ionospheric activity has increased during the fall of 2011

Also possible to download as an application for mobile phones on Android market (search word SWEPOS).

2011 11 24   20 26 30

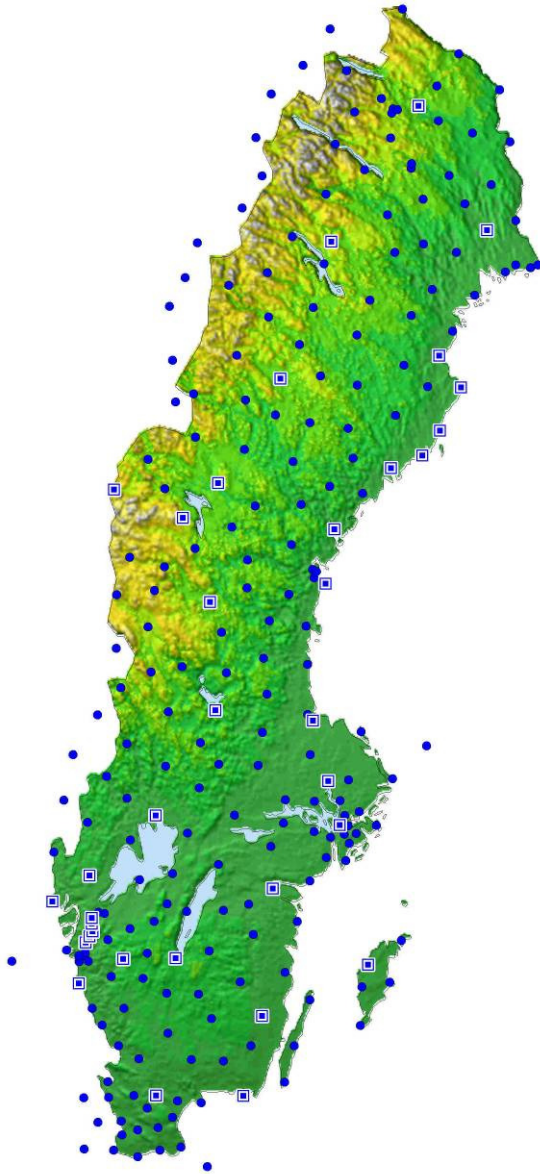25 mm
20 mm
15 mm
10 mm
5 mm

L A N T M Ä T E R I E T

SWEPOS® services

- Post processing data (RINEX-data)
- Virtual RINEX-data – quite new

- SWEPOS Automatic calculation service

- Real time services
  - Network-DGPS–service
  - Network-RTK–service

- SWEPOS-website
  - Coordinate transformation
  - Satellite prediction
  - monitorstations
 - Ionosphere monitor

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Our users

- SWEPOS has more than 2300 users

- Municipalities (22%)
- Surveying companies (21%)
- Construction companies (21%)
- Governmental agencies (10%)
- Power prod. companies (3%)
- Agriculture (3%)
- University, dealers (free of charge)

Project adapted Network-RTK

Cooperation between
Lantmäteriet/SWEPOS – National Road
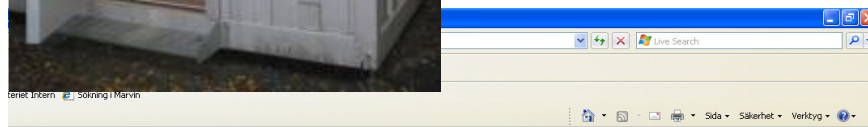## Administration and National Rail Administration
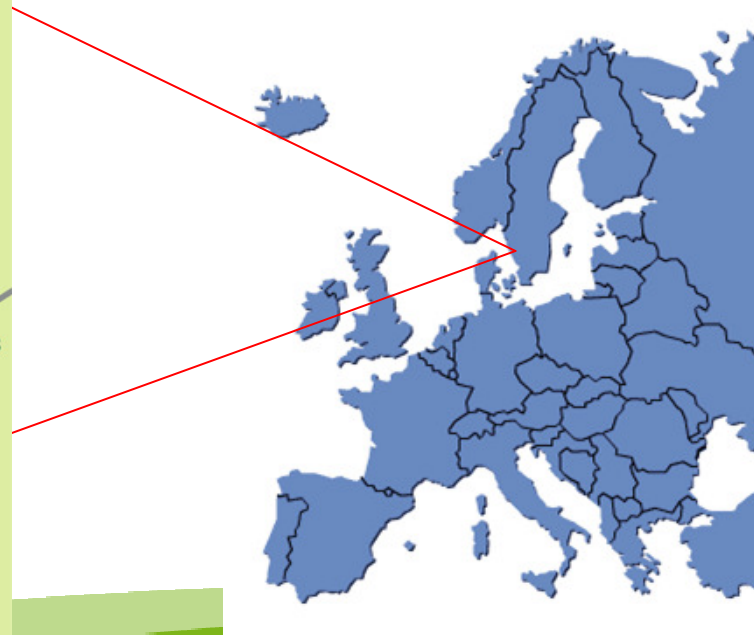
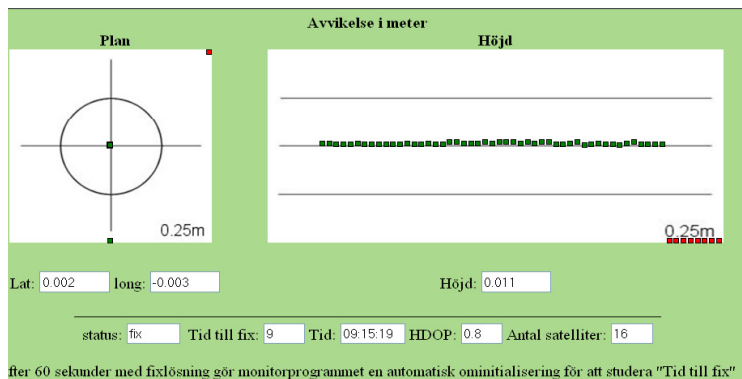# Network-RTK adapted to construction projects (1)

Purposes

- One realtime positioning system for the workarea

- Monitoring of transmitted corrections on the worksite

- Easier to make quality checks for the National Road adm.

- Promotes standardisation in GNSS-measurements and machine-control

Approximately 200 RTK- units running simultaniously on the project

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New applications

Machine control for
KC/pillar -machines

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Conclusions

- The theoretical simulation in the CLOSE project confirmed the empirical values (from previous studies) for the vertical uncertainty

- Results from the CLOSE project and similar projects will continue to guide the development of SWEPOS to meet the demands of the user community

- This include a densification of the current reference station network, but also development of tools for real-time users, such as ionosphere monitoring via the SWEPOS web page

- The ongoing quality assessment of the SWEPOS Network-RTK services provides valuable information about the error sources and how they affect positioning

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Thank you for your attention
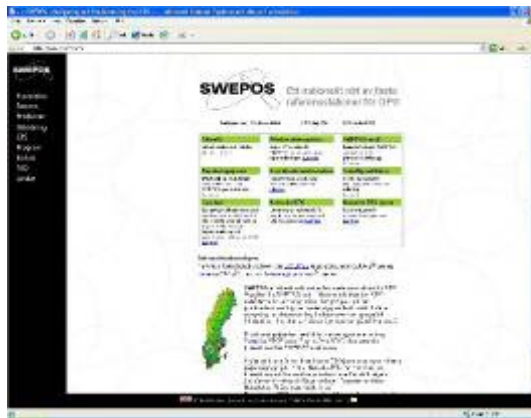
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