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Monitoring EGNOS in Norway

NKG General Assembly 2014, Göteborg, Sweden

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EGNOS

Outline

1. Motivation for NMA's involvement in EGNOS
2. Brief description of the EGNOS system
3. Examples of results and performance shortcomings in northern areas

Why does NMA analyse EGNOS?

- The Norwegian government has invested a considerable amount of money in the development of EGNOS and Galileo.

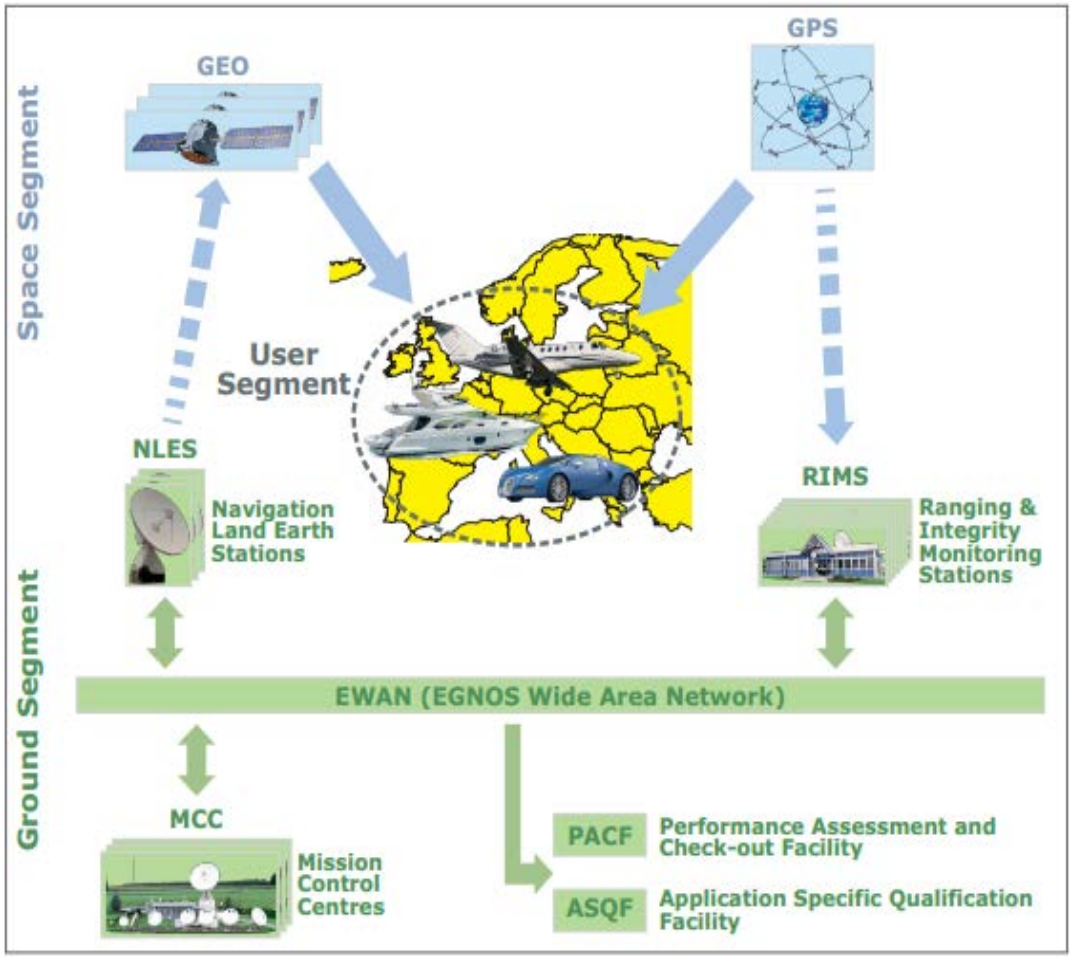
  →*Someone should independently check that the system performance reaches its target, also in Norway*

- NMA is the only public entity in Norway that has both the necessary infrastructure and knowledge for monitoring EGNOS performance.

Maintaining this knowledge gives opportunities to identify weaknesses in the system performance, especially at high northern latitudes

→ *Possible to contribute to future improvements*

EGNOS system overview



RIMS network

SBAS output

- Orbit and clock corrections for each GNSS satellite
- Iono correction grid model
- Degradation factors

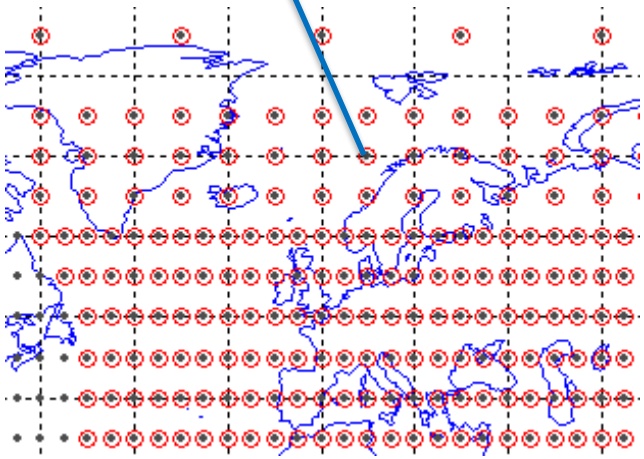
Fast corrections
dR

Long-term corrections
dX, dY, dZ, dT

Integrity (UDRE)

GIVD(L1)

Integrity (GIVE)



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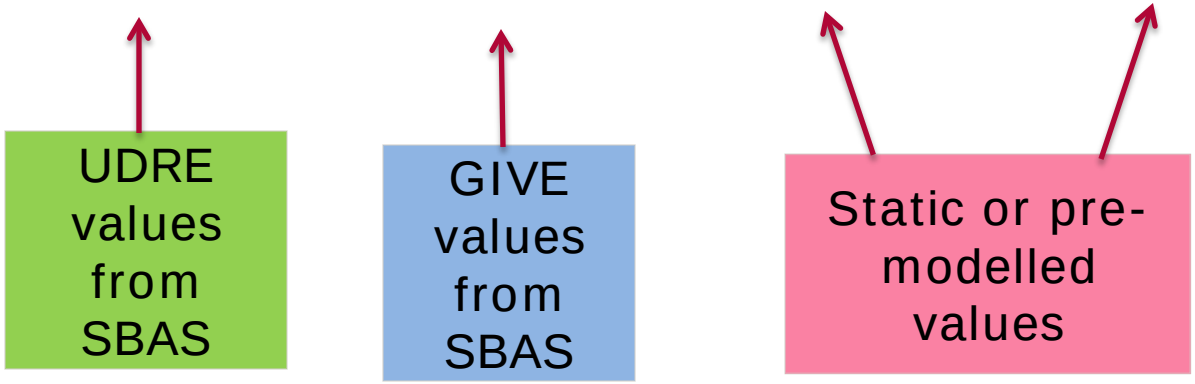
SBAS integrity concept (RTCA DO-229)

High level error budget:

$$\sigma_i^2 = \sigma_{i,orb\&clk}^2 + \sigma_{i,iono}^2 + \sigma_{i,tropo}^2 + \sigma_{i,rec}^2$$



σ_i^2 are used for:

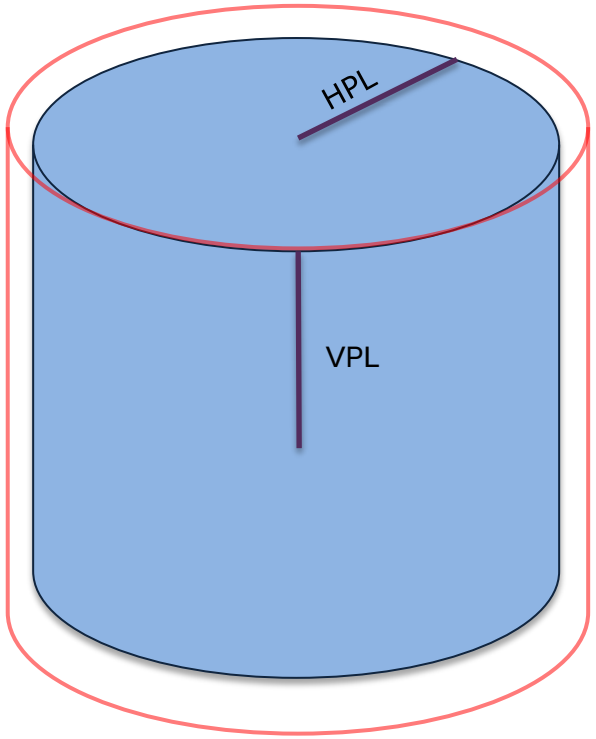
1. Weighting the different GNSS satellites in position solution
2. Calculating Protection Levels

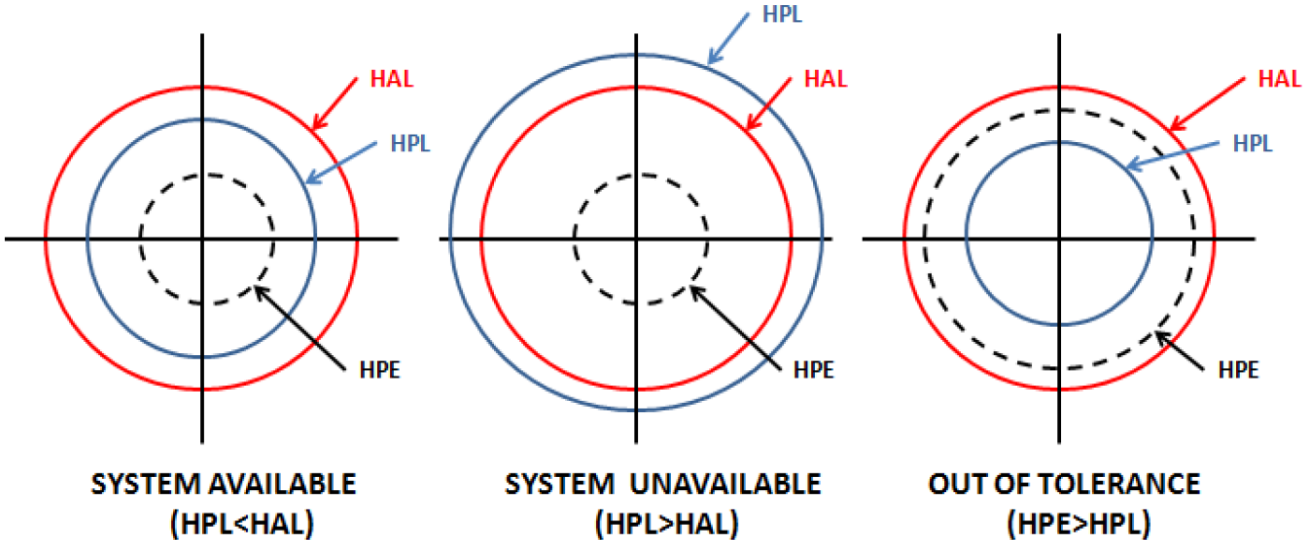
Protection levels and alert limits

$$HPL = 6 \cdot s_{HorizMax}$$

P(PE>PL) ≤ $2*10^{-7}$

$$VPL = 5.33 \cdot s_{Vert}$$





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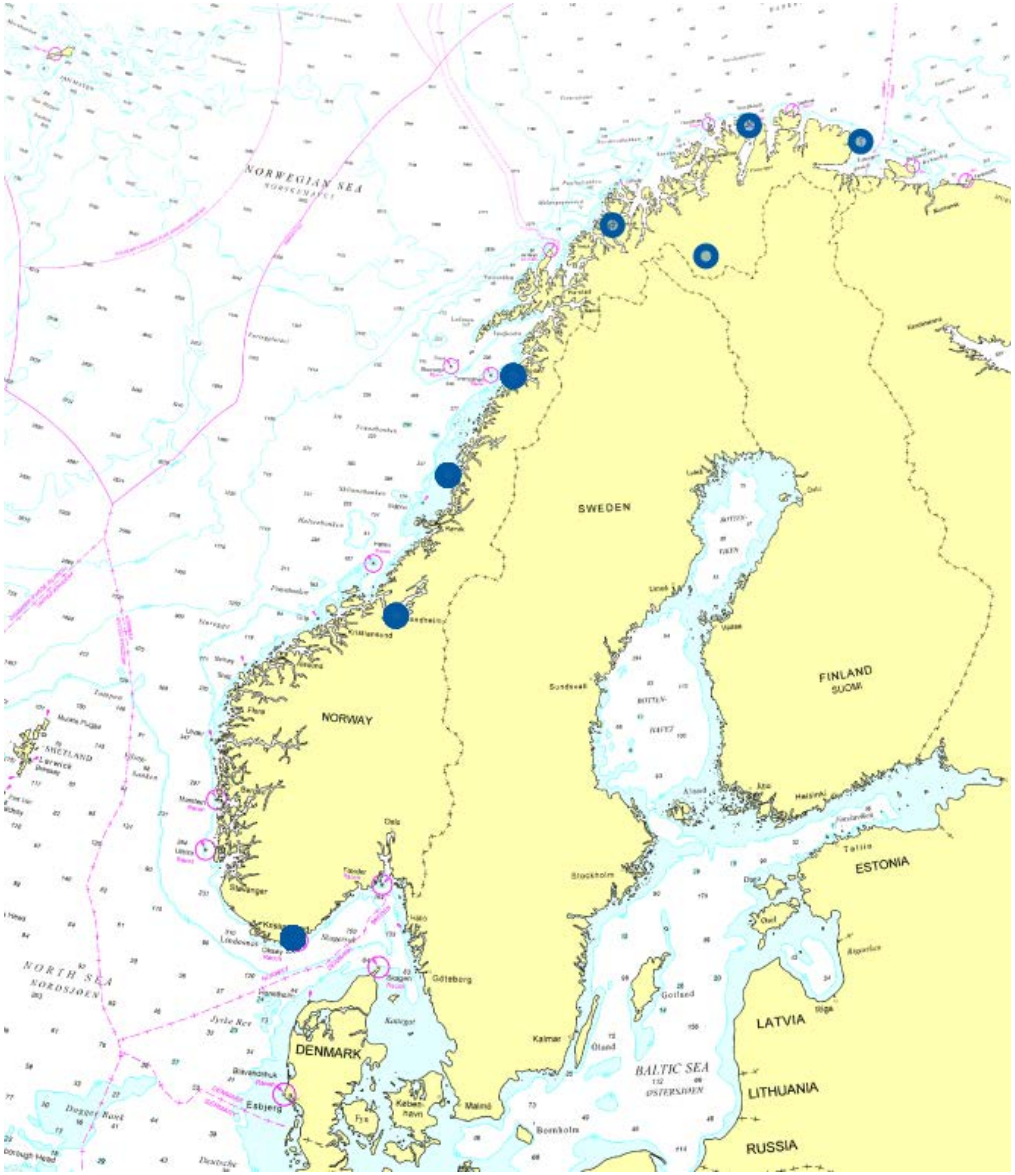
NMA monitor stations

8 stations are used:

Station	Abbreviation	Latitude	Longitude
Kristiansand	krss	58.083°N	7.907°E
Trondheim	trds	63.371°N	10.319°E
Vega	vegs	65.673°N	11.964°E
Bodø	bod3	67.288°N	14.434°E
Tromsø	tro1	69.663°N	18.940°E
Kautokeino	kaus	69.022°N	23.020°E
Honningsvåg	hons	70.977°N	25.965°E
Vardø	vars	70.336°N	31.031°E

These are ordinary GNSS reference stations providing 1 Hz observation data and are part of e.g. the CPOS NRTK service.



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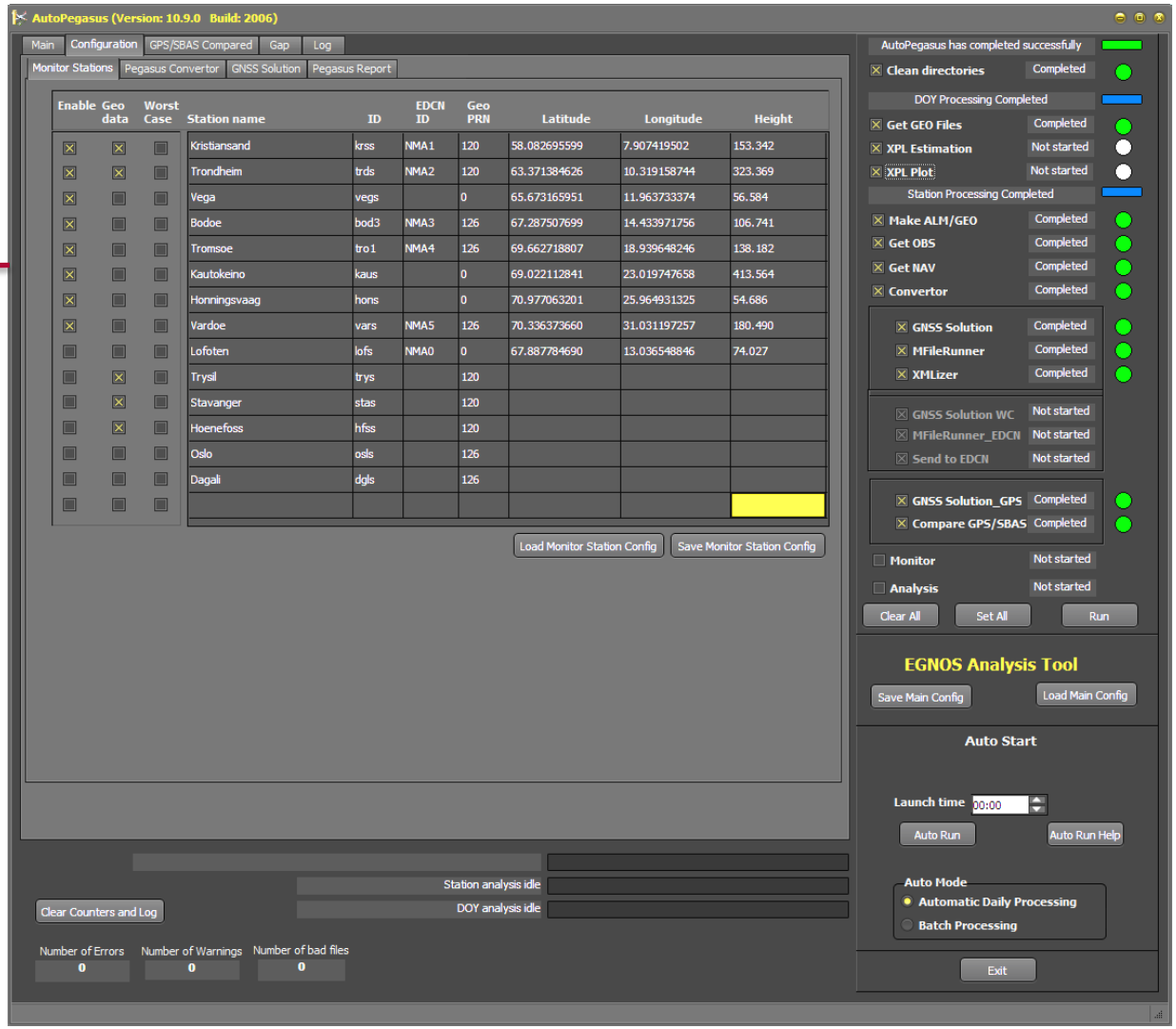
NMA monitoring system

Processing tool:
PEGASUS (developed by EUROCONTROL)

In-house SW made for automatic daily data retrieval and processing

Input:
- 24 hours 1 Hz RINEX GPS obs
- 24 hours RINEX GPS brdc navmsg
- 24 hours RINEX SBAS msg



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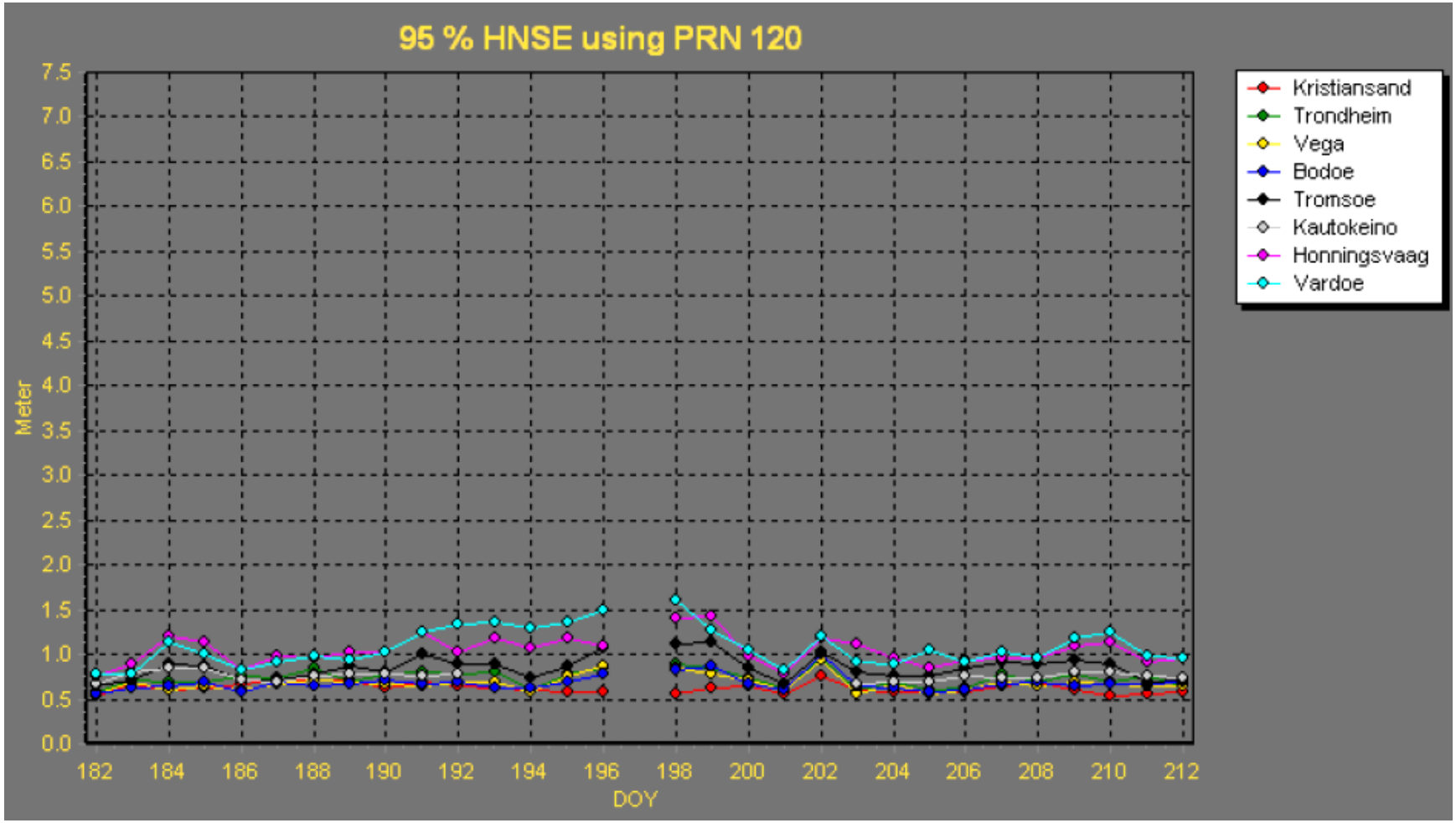
EGNOS: Horizontal accuracy, July 2014



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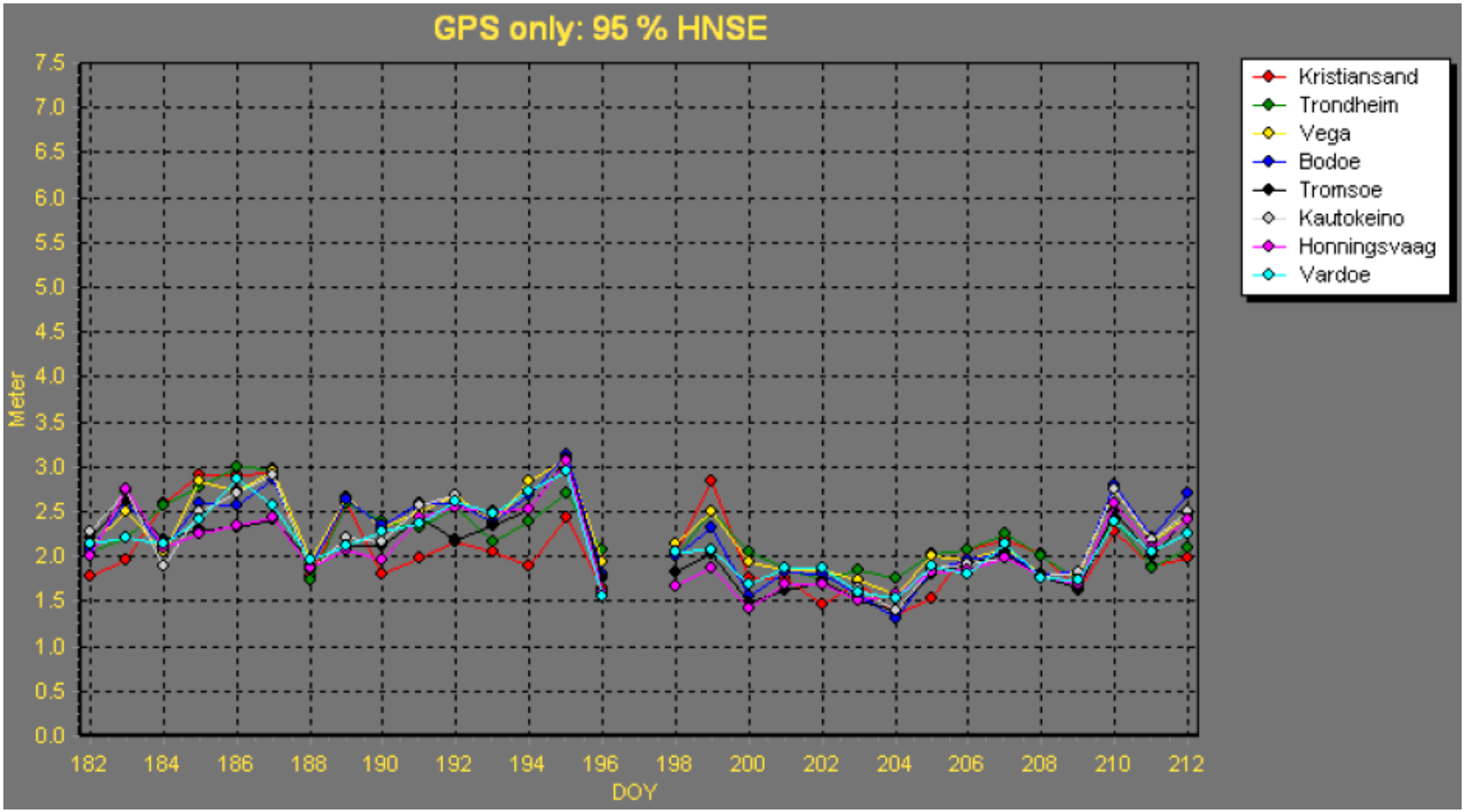
”Uncorrected” GPS: Horizontal accuracy, July 2014



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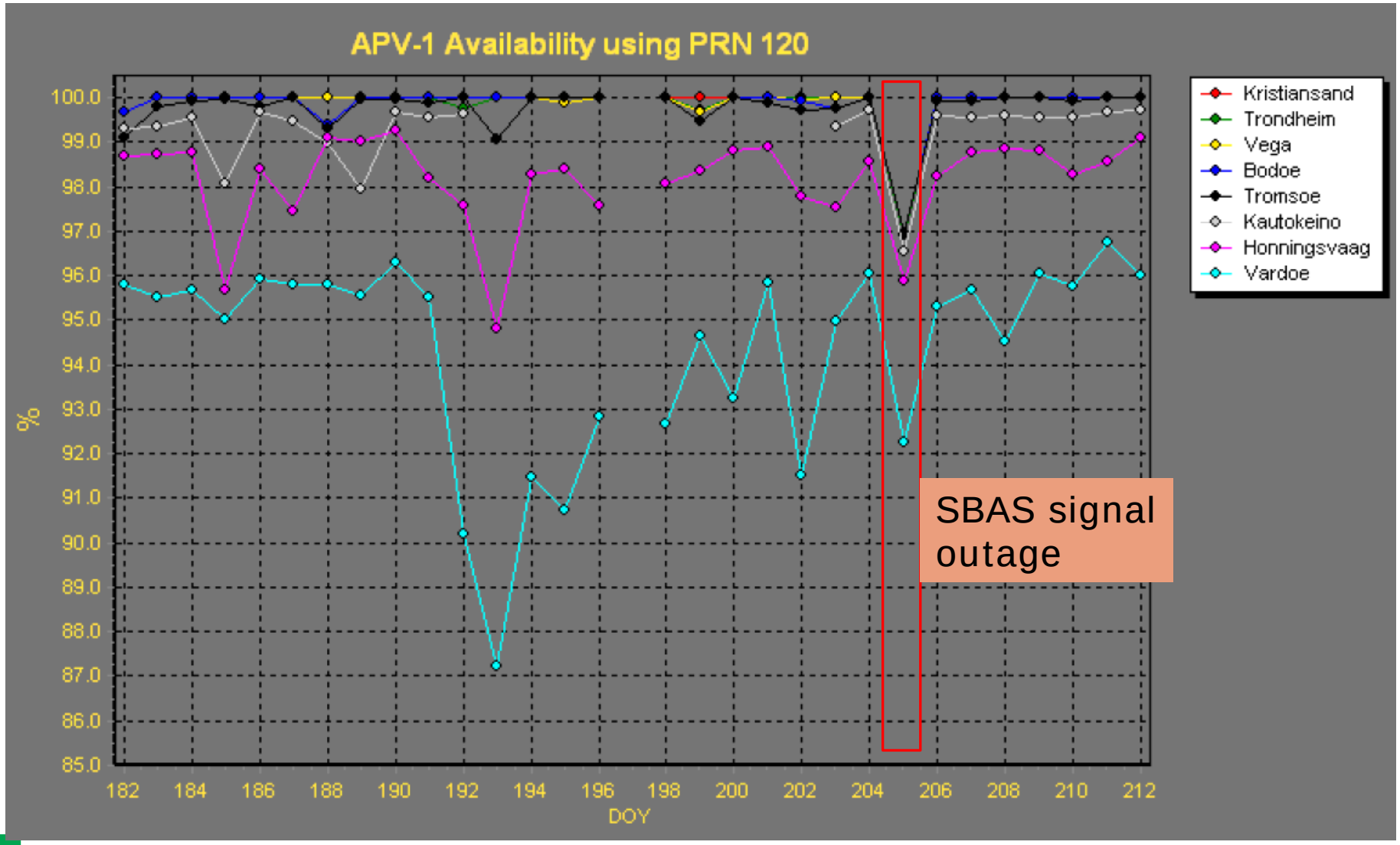
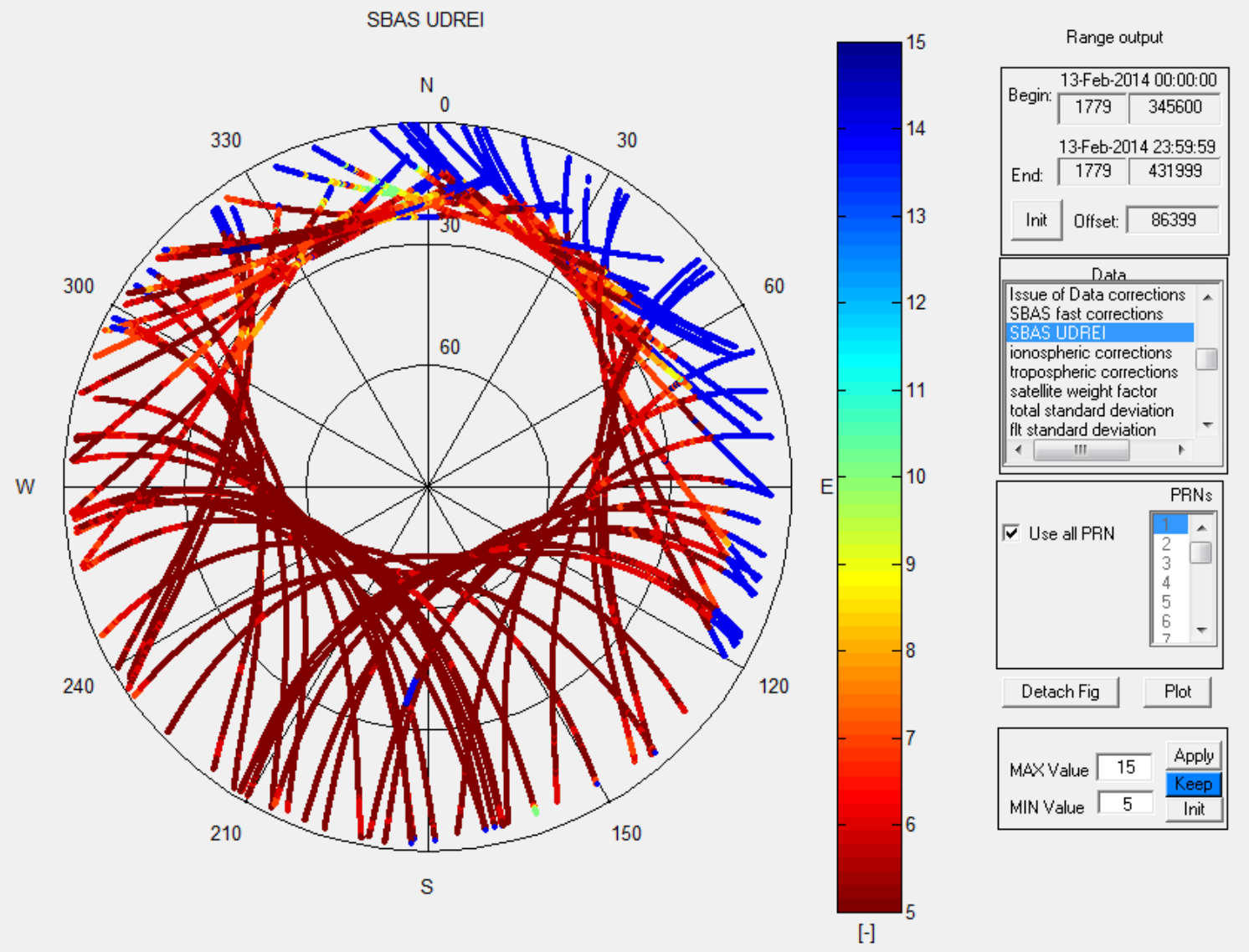
EGNOS: July 2014



Unstable performance at high latitudes

Example: Tromsø, 13-02-2014



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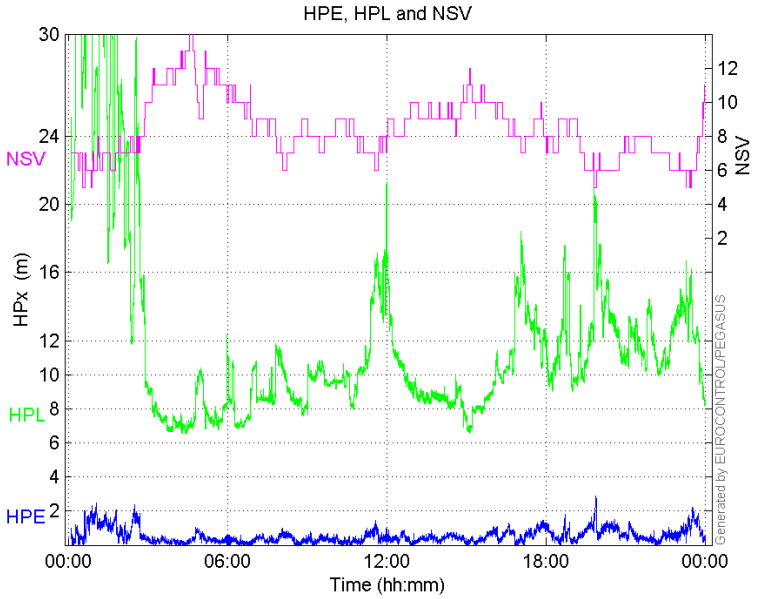
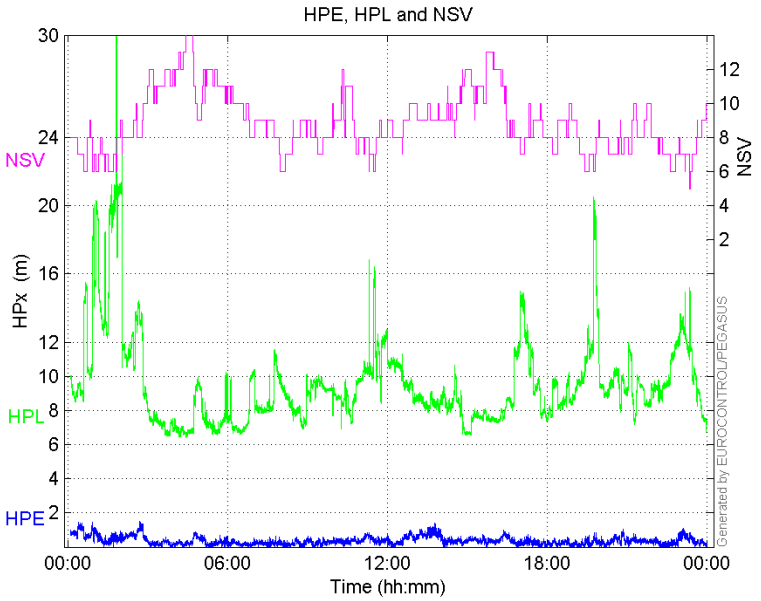

HPE, HPL and NSV
NSV
HPL
HPE
HPx (m)
NSV
Time (hh:mm)
00:00
06:00
12:00
18:00
00:00
Generated by EUROCONTROL/PEGASUS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NSV
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00:00
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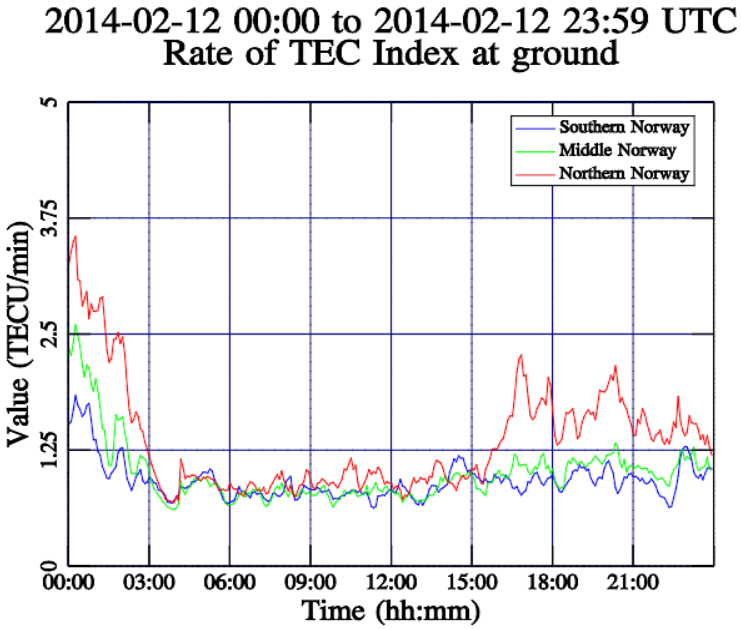
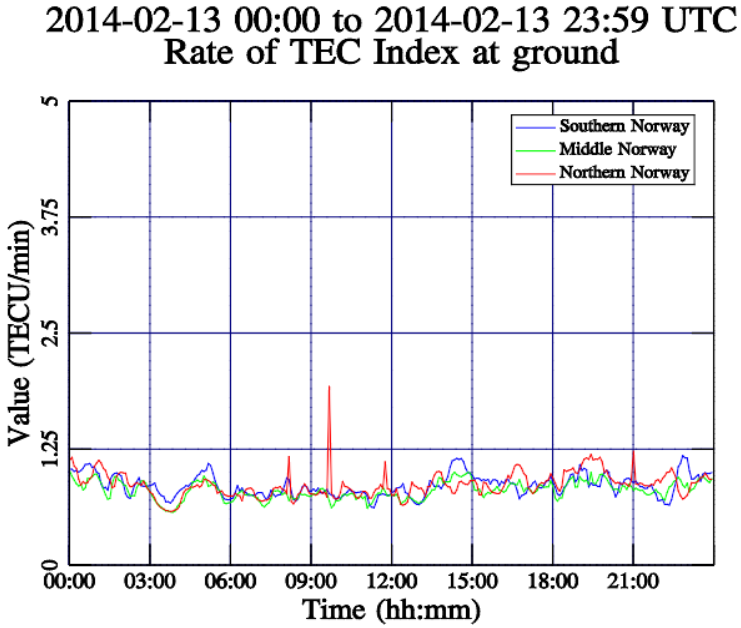

2014-02-12 00:00 to 2014-02-12 23:59 UTC
Rate of TEC Index at ground
Southern Norway
Middle Norway
Northern Norway
Value (TECU/min)
Time (hh:mm)
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00


2014-02-13 00:00 to 2014-02-13 23:59 UTC
Rate of TEC Index at ground
Southern Norway
Middle Norway
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Value (TECU/min)
Time (hh:mm)
00:00
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Thank you!

Questions?

Jan Mayen.
Photo: Rune Hanssen

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