Results from 15 years of data from the SWEPOS network

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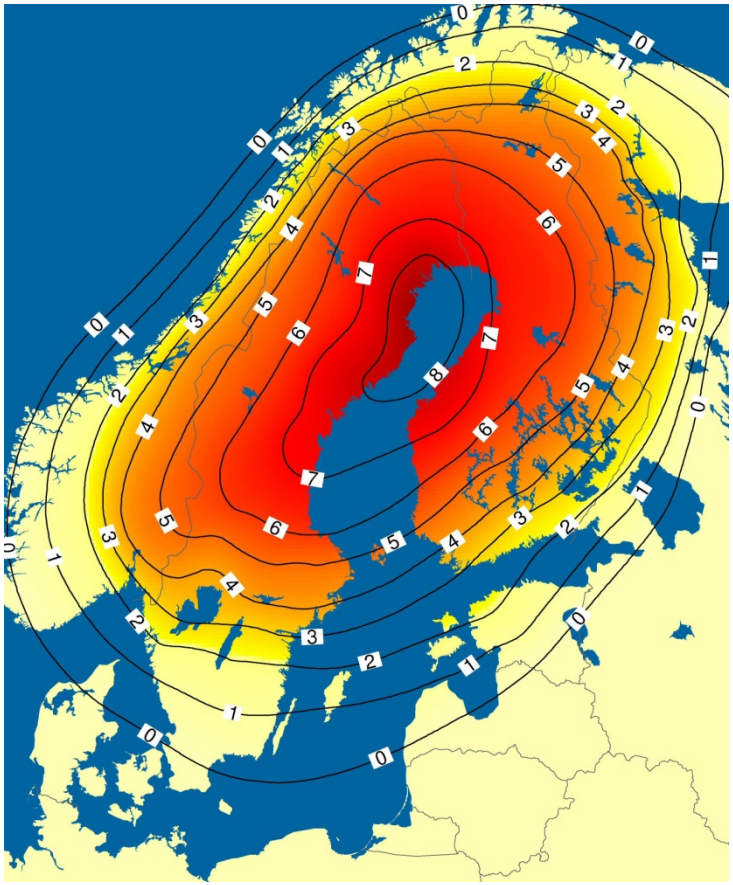
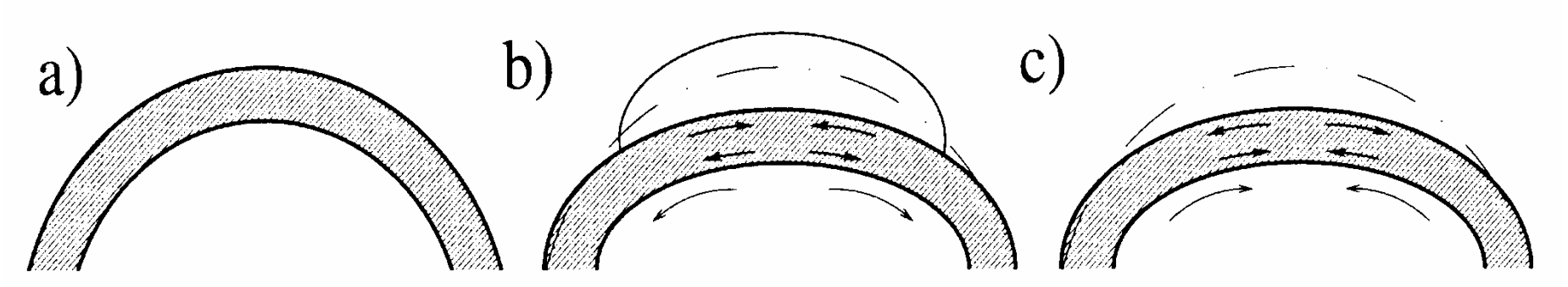
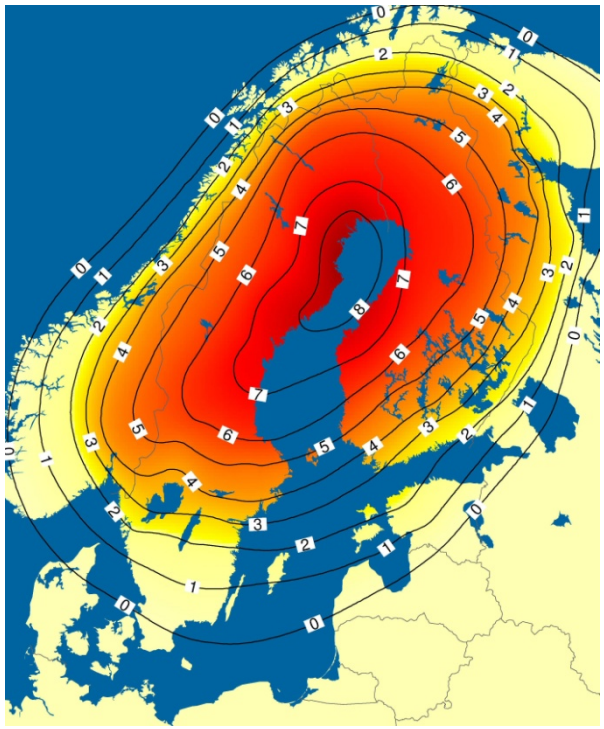
The Glacial Isostatic Adjustment (GIA) visible in Fennoscandia



Glacial Isostatic Adjustment (GIA)



(From Bergstrand, 2002)



a) The relaxed earth

b) The earth surface are depressed due to the load from the ice-sheet.

c) The earth rebounds when the ice-load has disappeared

Determination of horizontal rates and absolute land uplift values need a Geodetic Reference Frame

The BIFROST network

Period of analysis:
Aug. 1993 – Oct. 2008
Totally: 83 sites

GAMIT/GLOBK analysis

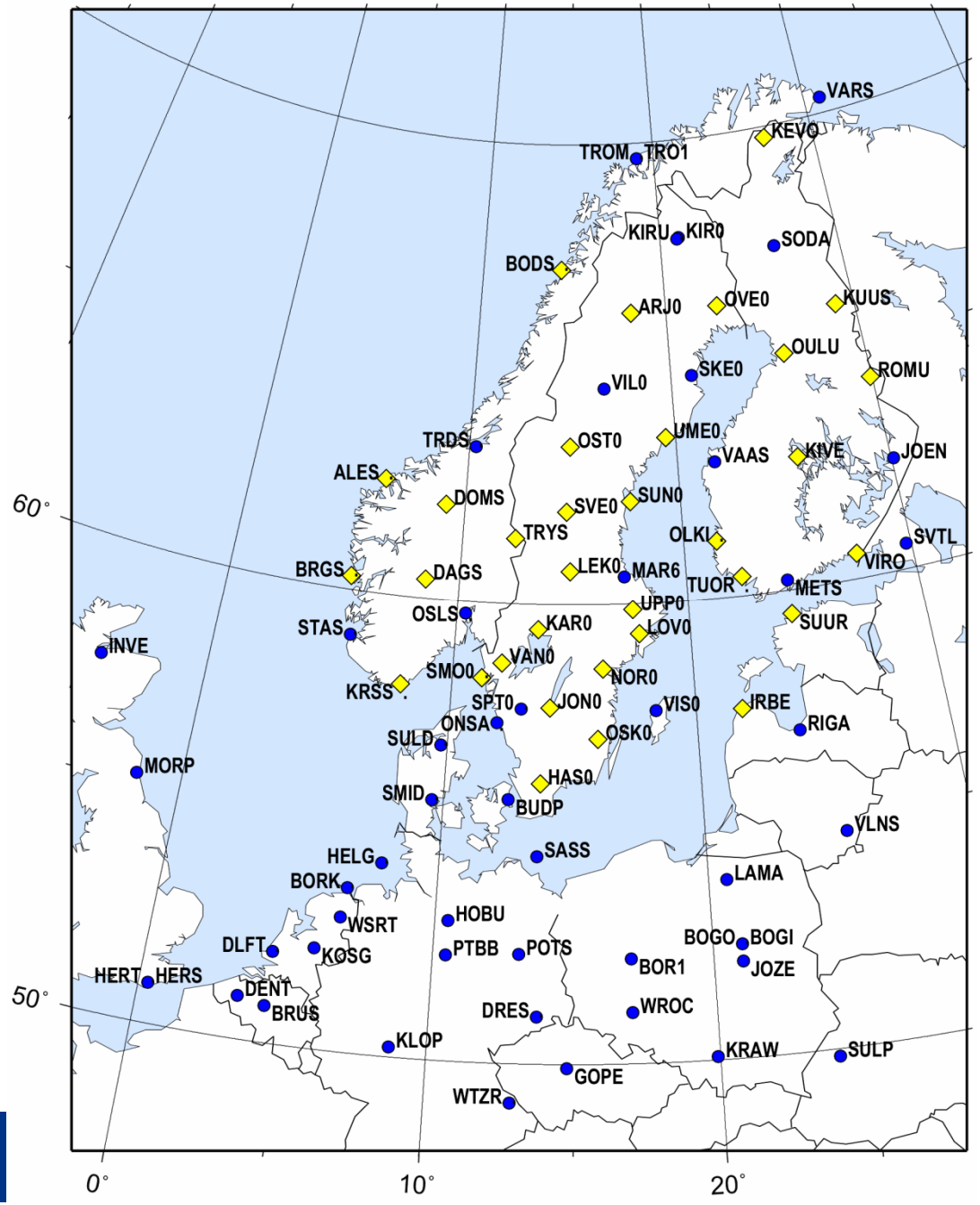
-Similar strategy as past

-ITRF2005

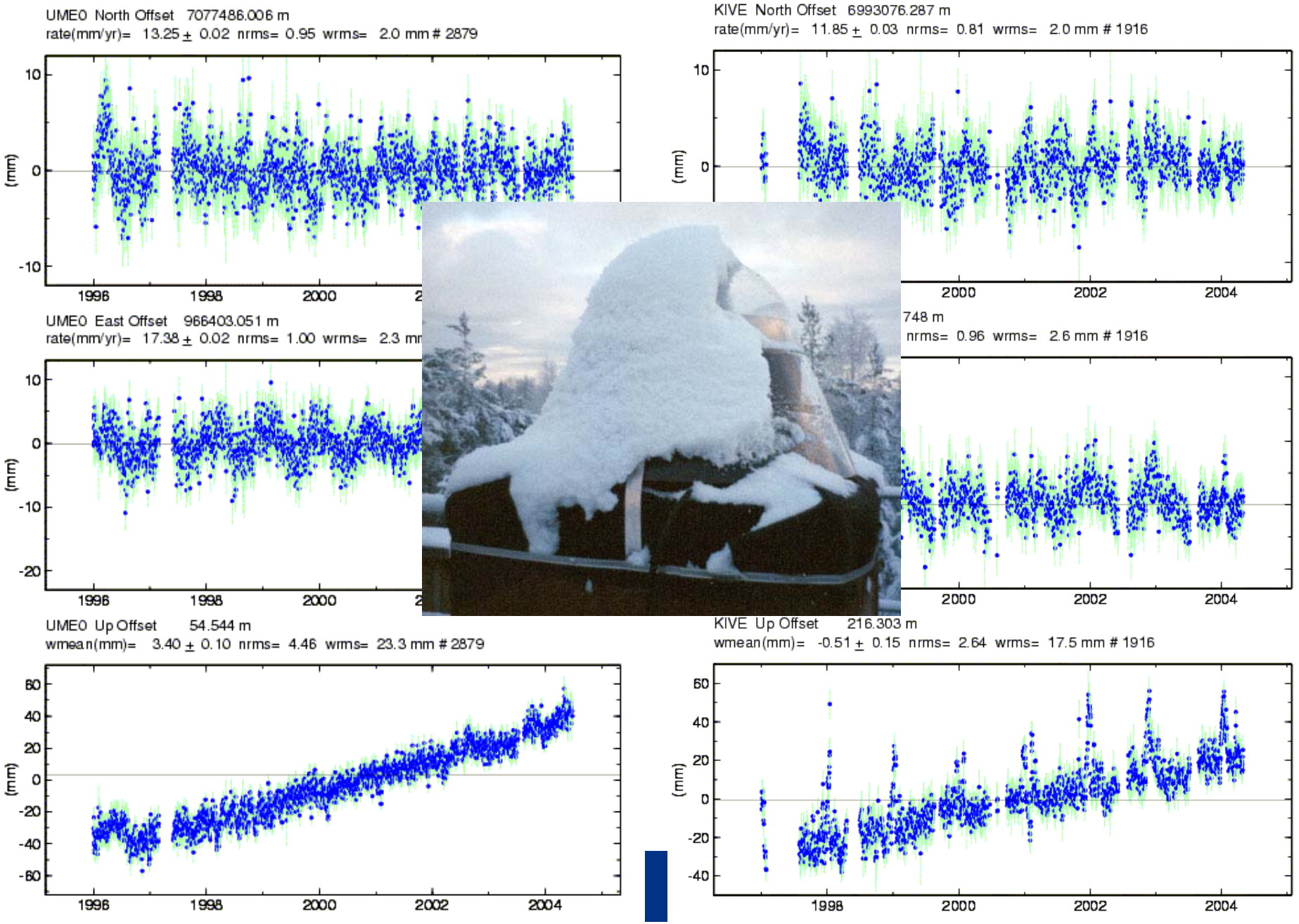
GIPSY

- Precise Point Positioning (PPP) using JPL products
-Ambiguity fixing
-Other models similar to the GAMIT setup

⇒ VALIDATION OF THE GAMIT SOLUTION



Time series of GPS positions before editing



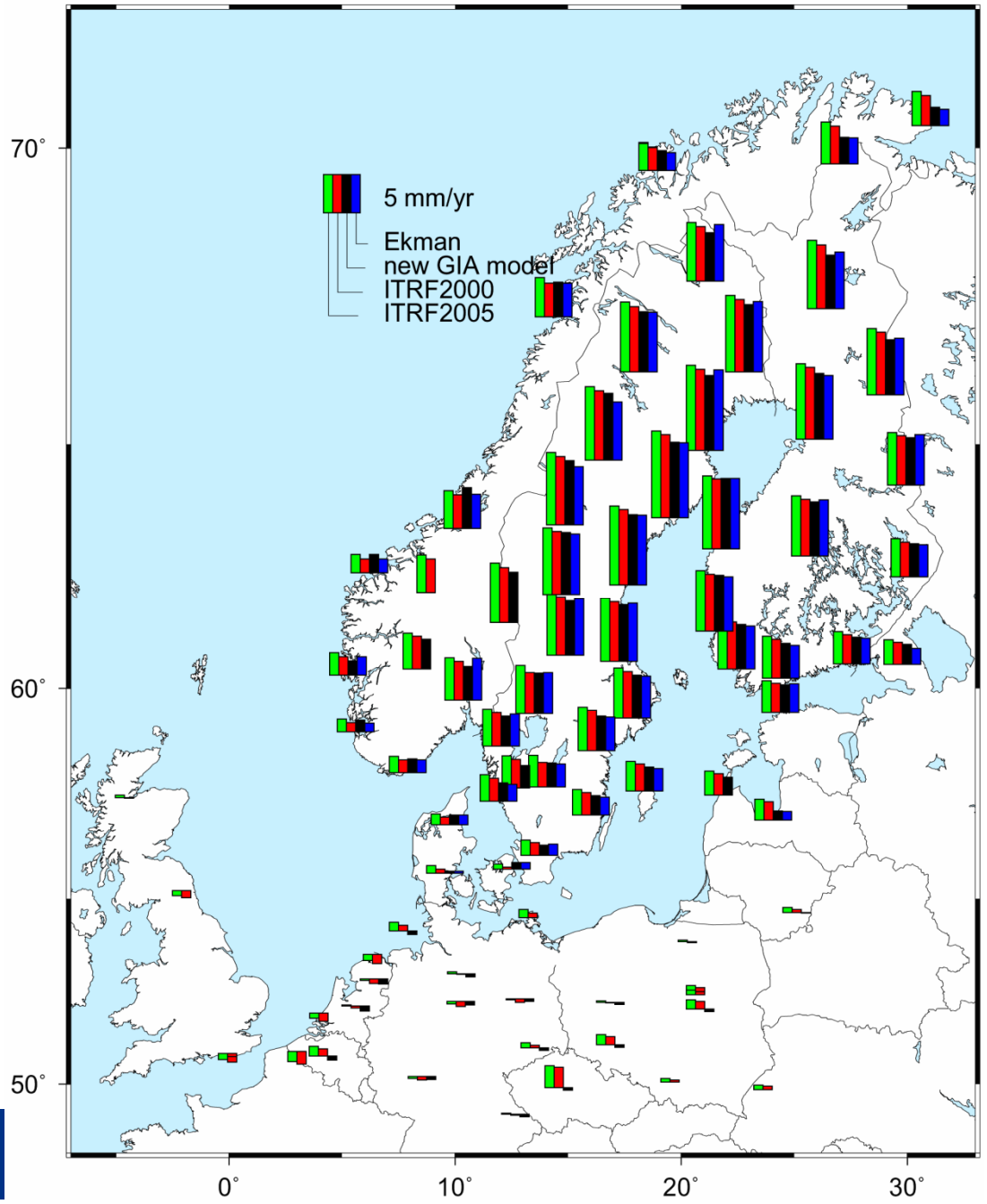
Vertical velocity

ITRF2005
ITRF2000
New GIA model
Ekman (1998) based on:

- mareographs and levellings,
- 1.2 mm/yr eustatic sea level rise
- change of the geoid based on Ekman & Mäkinen (1998)

Compared to the ITRF2000 values:

	mean	Std (mm/yr)
ITRF2005	0.4	0.1
GIA model	-0.4	0.5
Ekman	-0.4	0.6

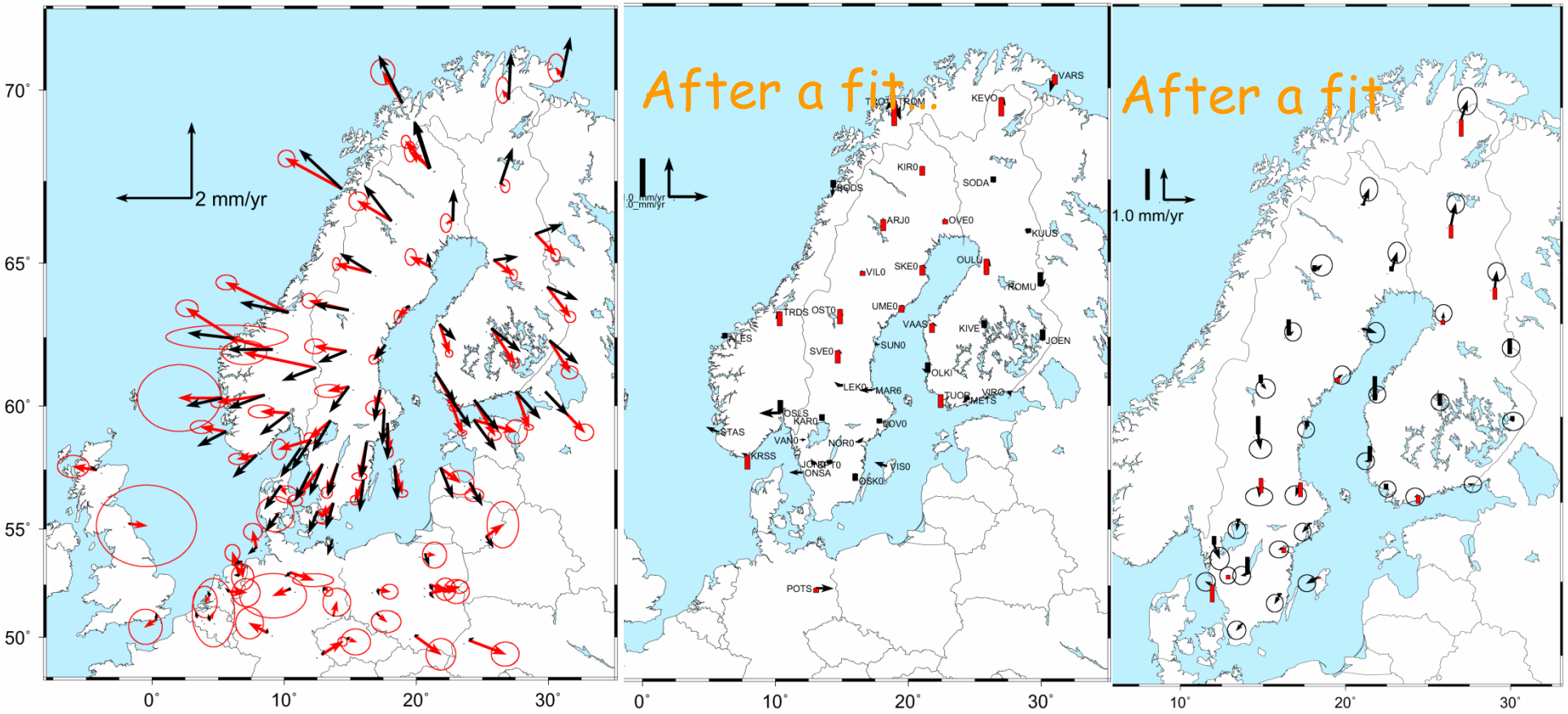


The new station velocities

The new GAMIT/GLOBK solution (in ITRF2005) And GIA model

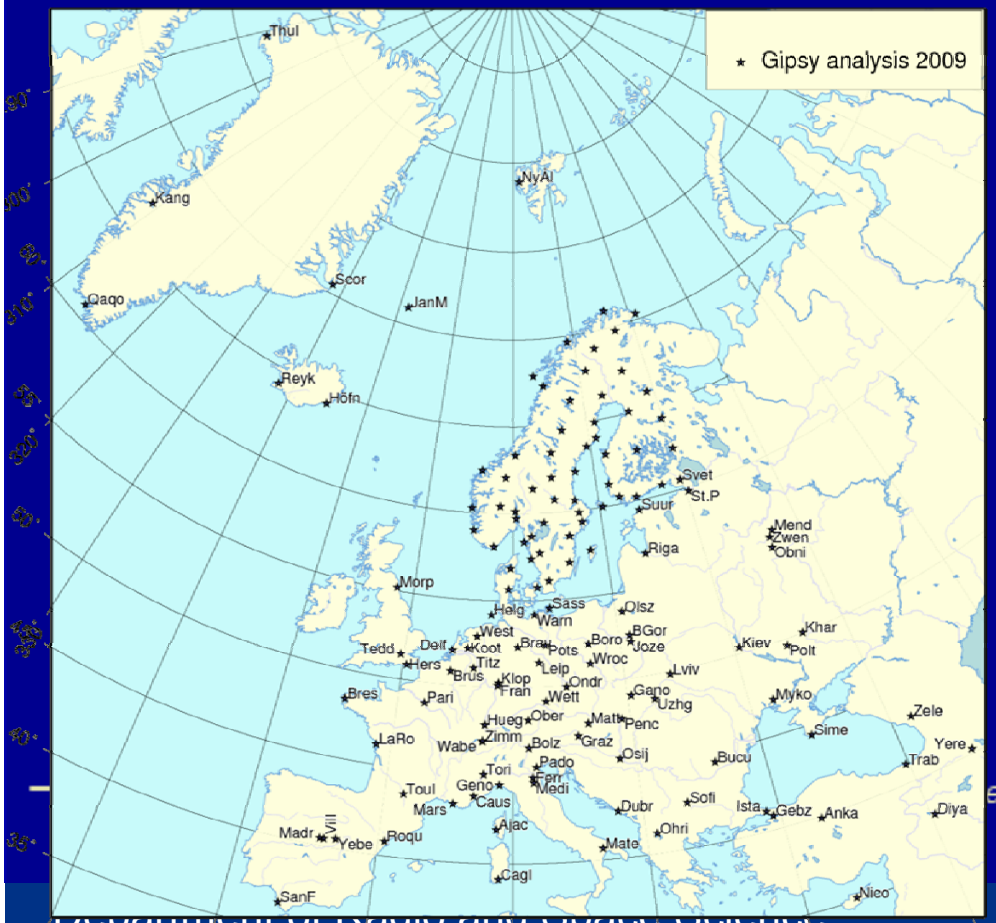
Validation using GIPSY (0.1, 0.1, 0.2) (n,e,u) mm/yr

New GIA model minus GPS, "best sites" (0.3, 0.2, 0.3) (n,e,u) mm/yr

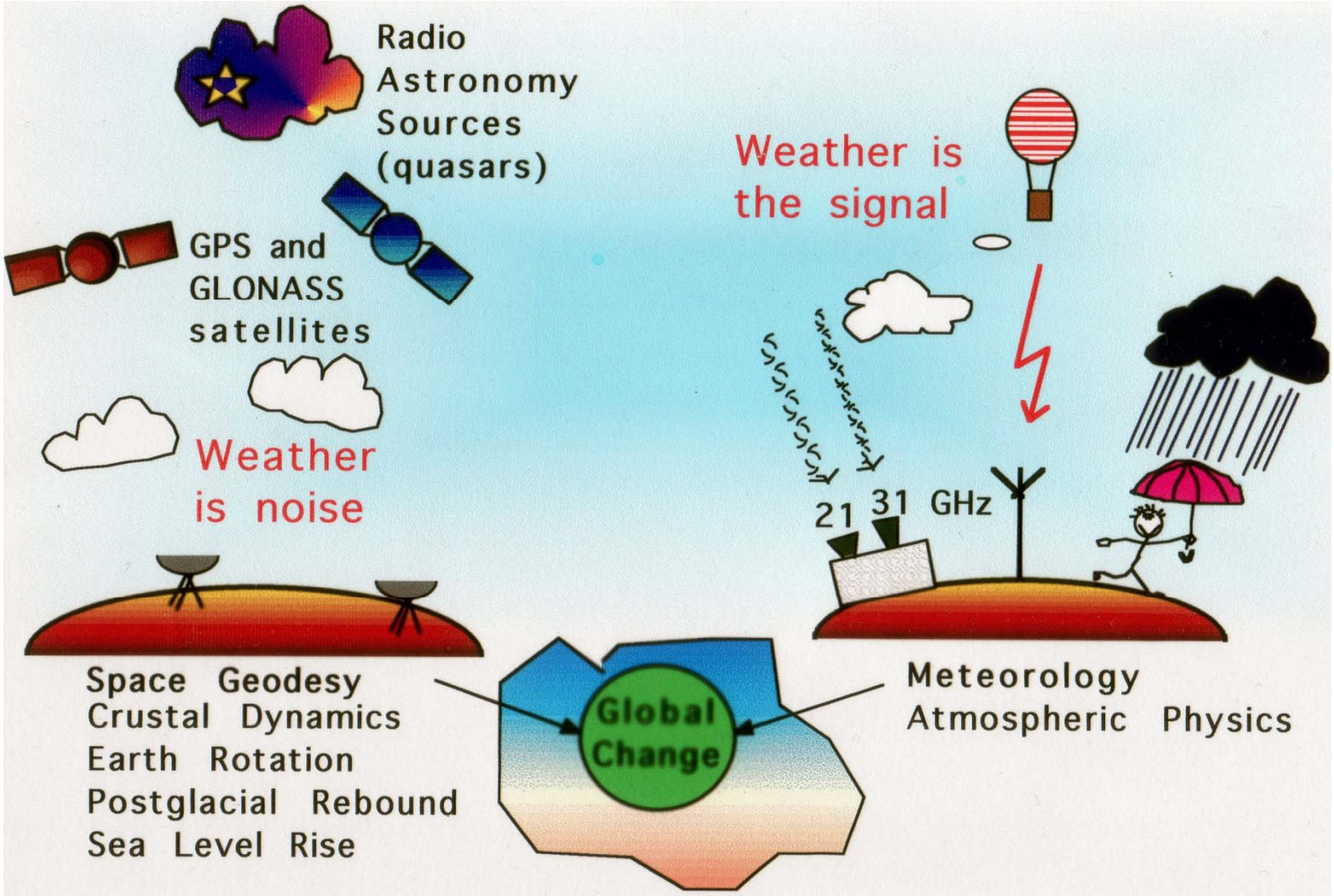


Ongoing re-analysis with GIPSY-OASIS using > 200 stations 1993-2009 (to be ready by 2010-03-01)

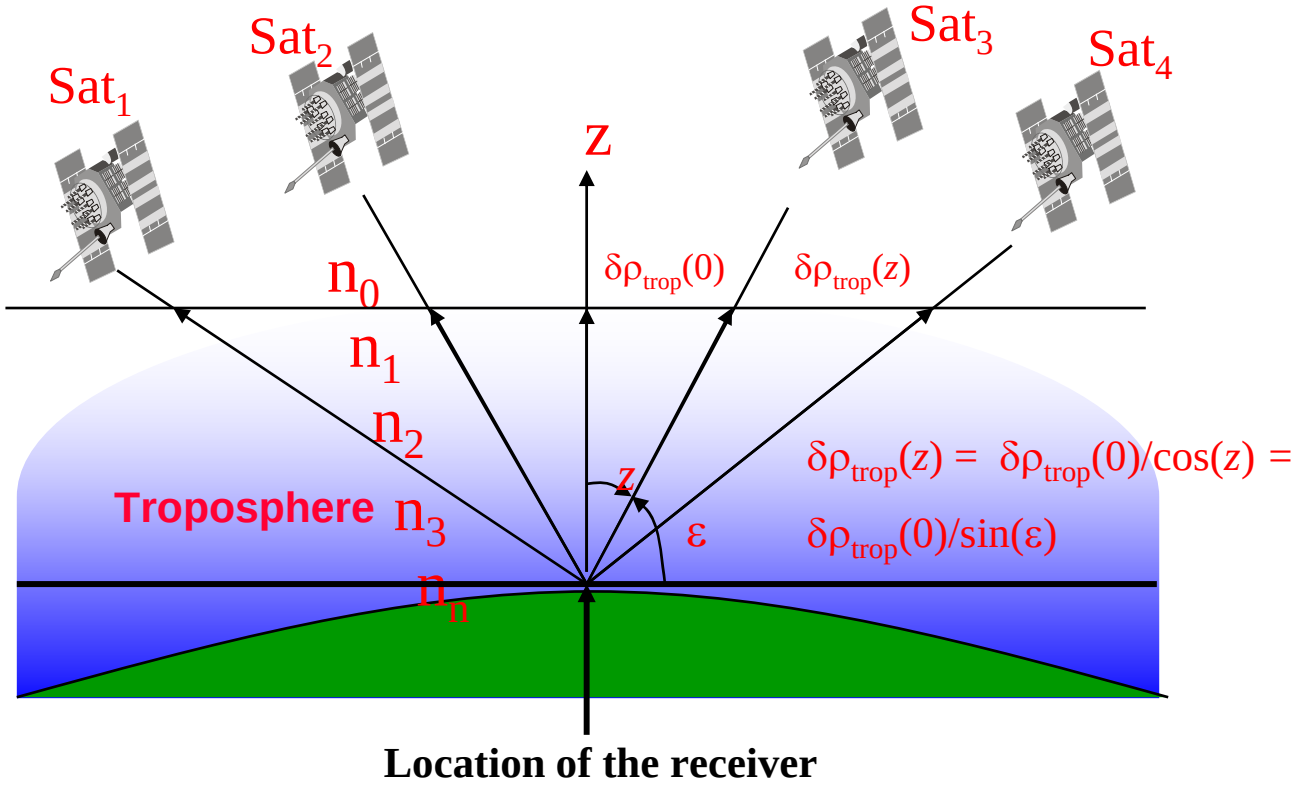
Europe



Fennoscandian


Radio
Astronomy
Sources
(quasars)
GPS and
GLONASS
satellites
Weather
is noise
Weather is
the signal
21 31 GHz
Space Geodesy
Crustal Dynamics
Earth Rotation
Postglacial Rebound
Sea Level Rise
Global
Change
Meteorology
Atmospheric Physics

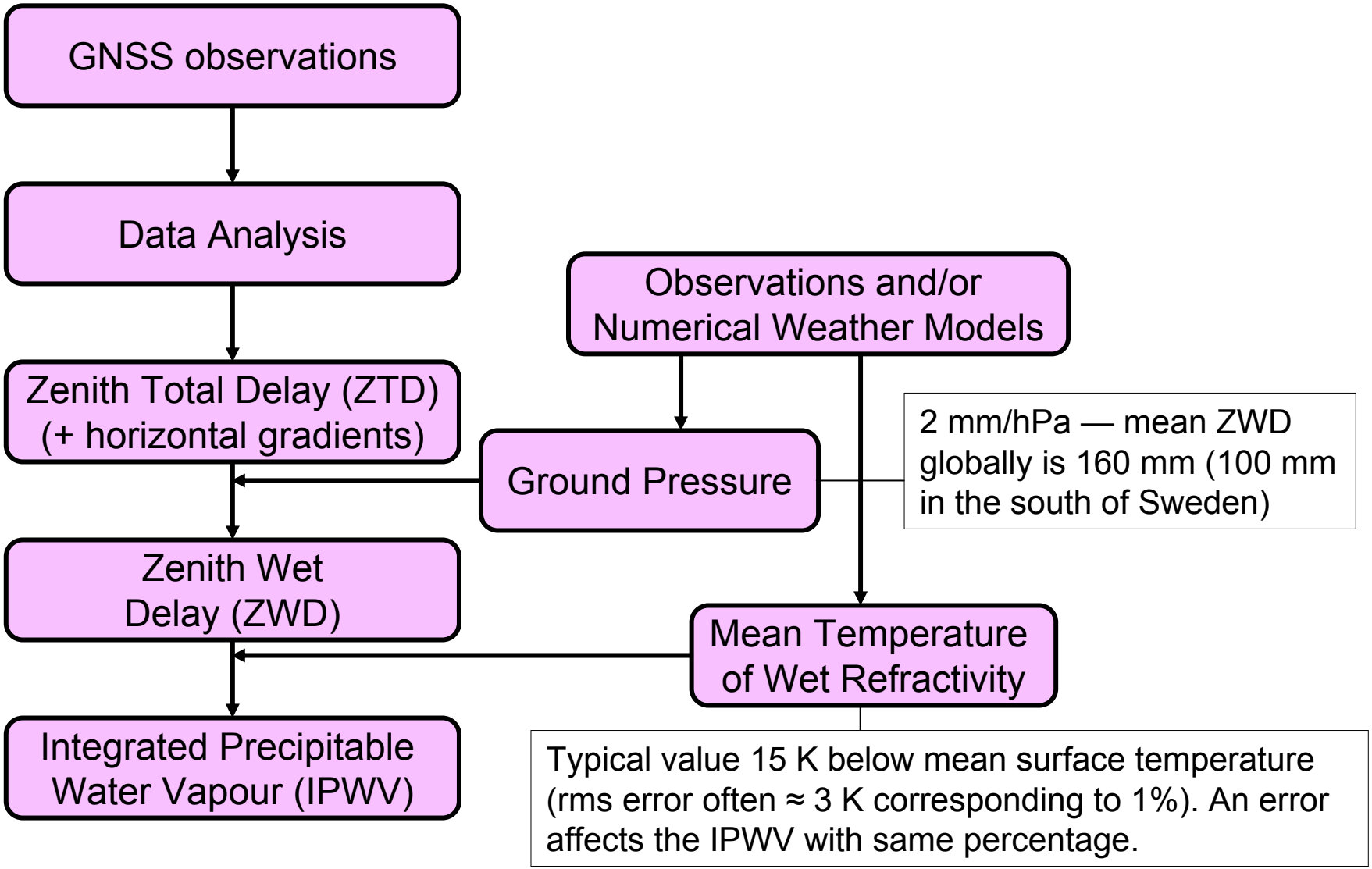
Tropospheric model



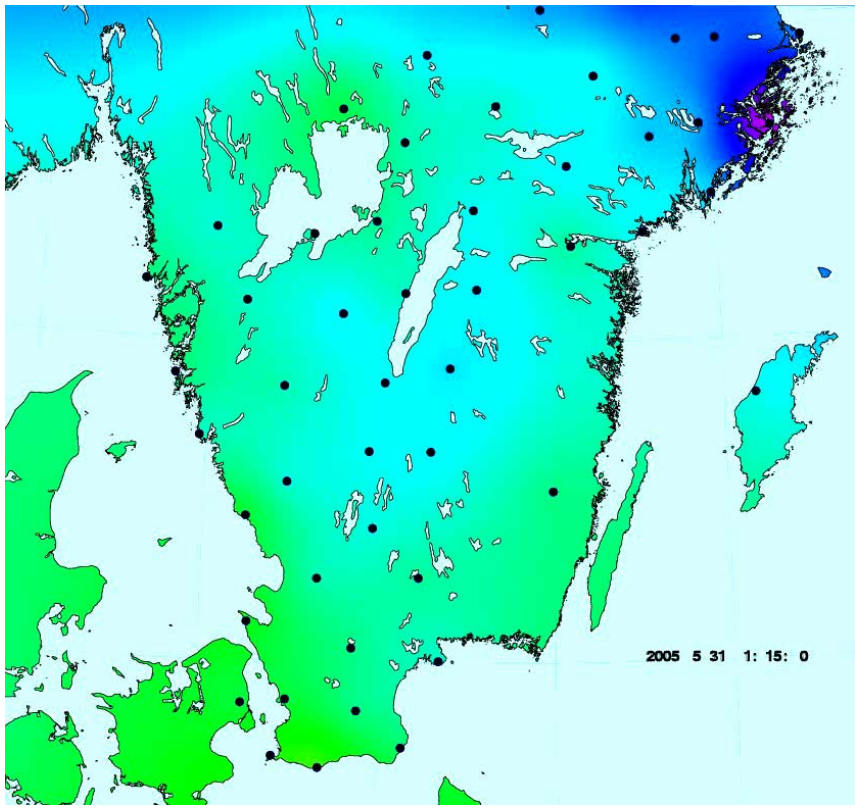
Zenith Hydrostatic Delay = ZHD
Zenith Wet Delay = ZWD
Zenith Total Delay = ZTD

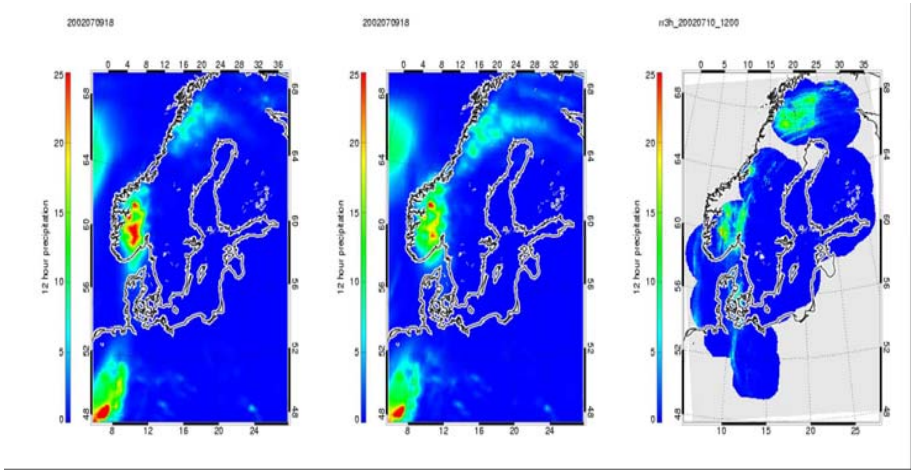
$$ZTD = ZHD + ZWD$$

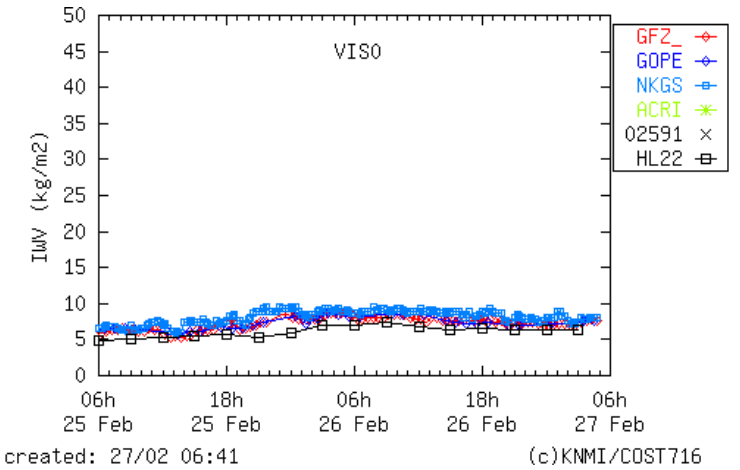
Water vapour time series from GNSS observations



Near Real Time (NRT) Water Vapor Estimation for Weather Forecasting



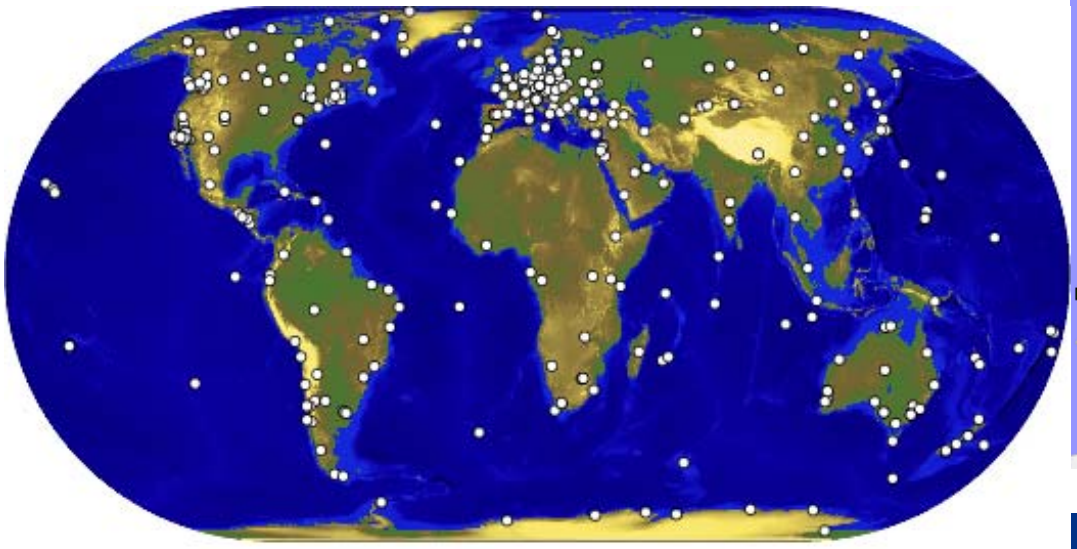


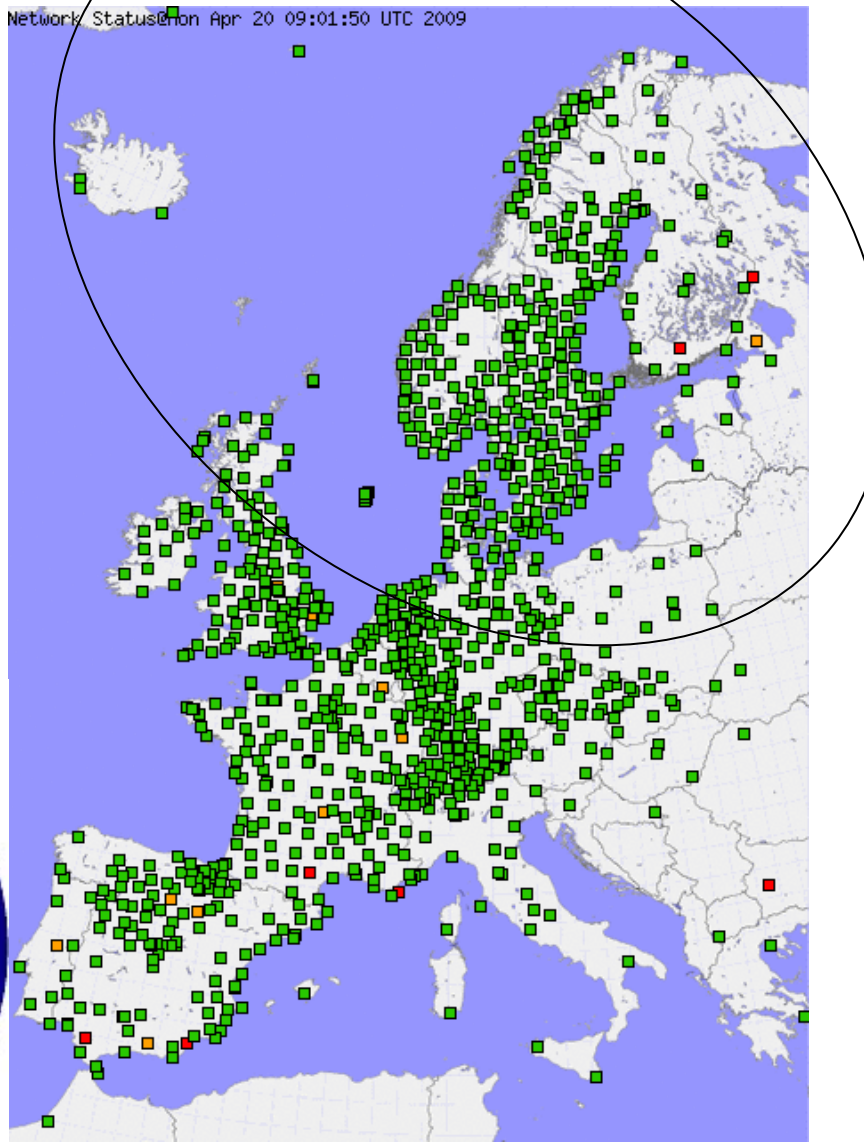


- Blue: ”cool and dry” air
- Red: ”warm and humid” air

NKG/NGAA analysis center

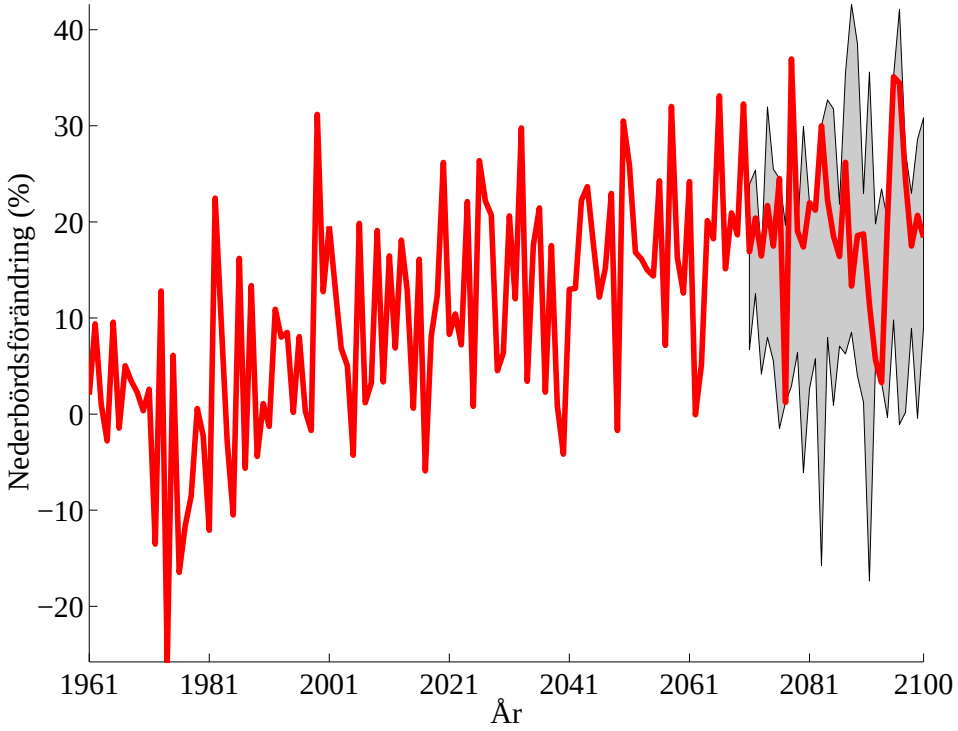
- GNSS data processing center handling data from 300-500 stations every hour
- Results (i.e. integrated tropospheric water vapor) above all stations delivered to E-GVAP (EUMETNET) no later than 40 minutes after full hour.



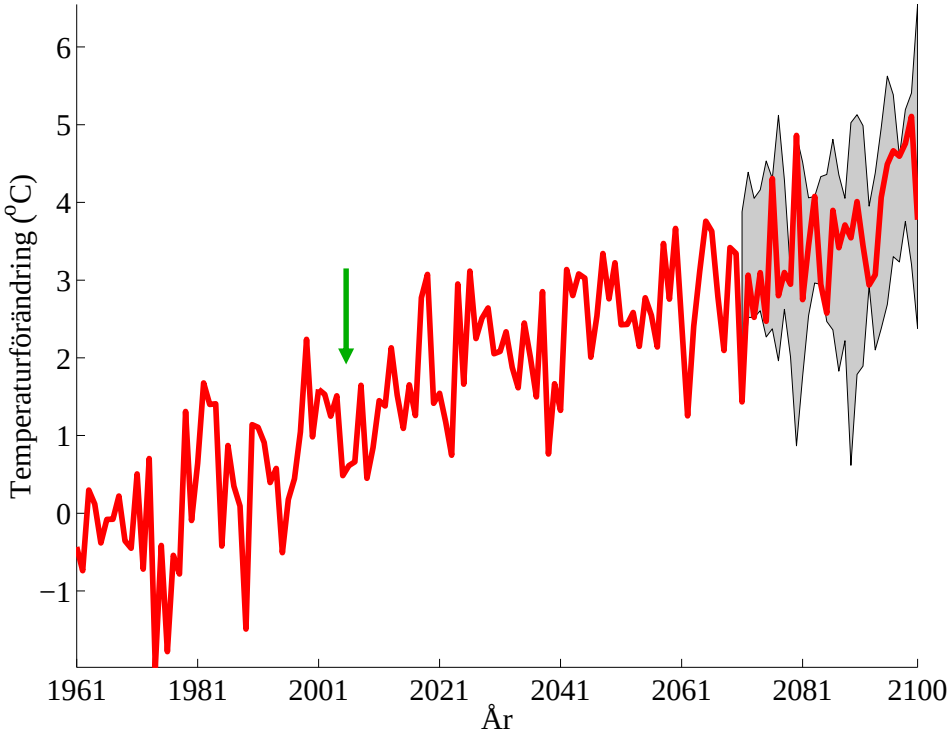


Estimated ”climate change” in Sweden relative to the period 1961-1990

Annual precipitation



Annual mean temperature



Red line shows Rossby Centres most recent simulation of ”climate change”.
Grey indicates results from 4 earlier simulations.

SMHI

Why monitor the atmospheric water vapour content?

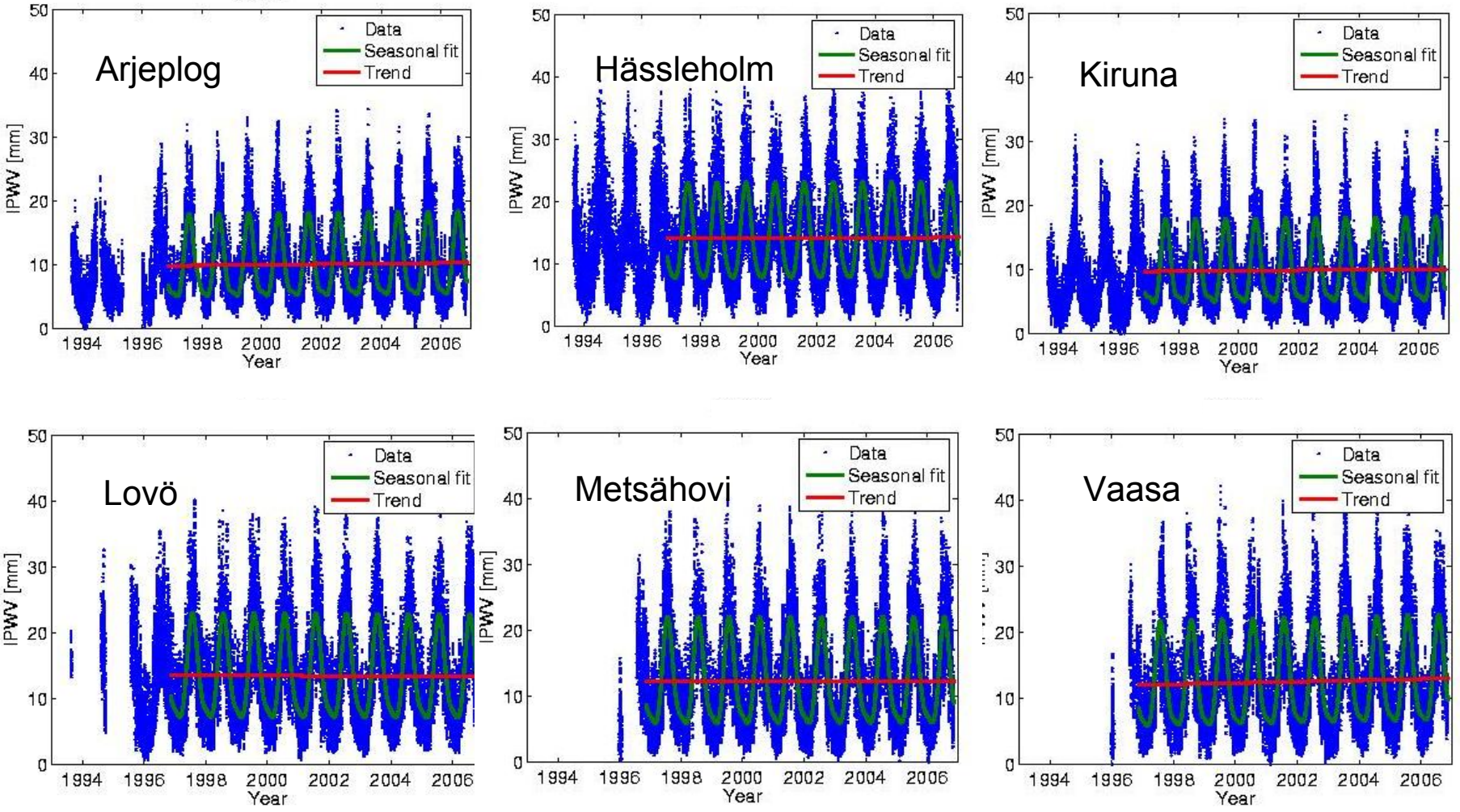
The increase of the global mean of Integrated Precipitable Water Vapour (IPWV) is expected to be ~ 6 [%/K] (following the Clausius-Clapeyron relation assuming conservation of relative humidity [Trenberth et al., Bull. Am. Meteorol. Soc., 2003]).

The global mean of IPWV is 24.9 mm [Trenberth and Smith, J. of Climate, 2005].

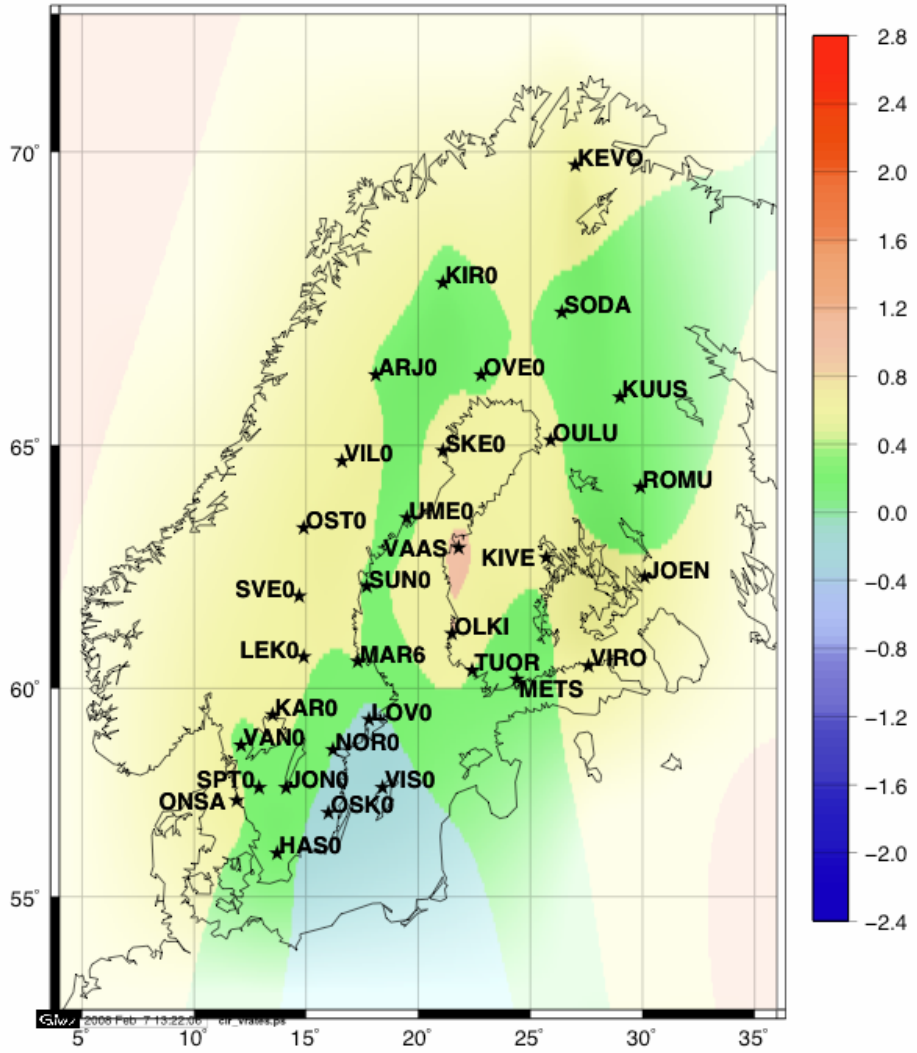
ERA40 shows [Bengtsson et al. JGR, 2004]:
+0.11 K/decade in global temperature 1979–2001
+0.36 mm/decade in IPWV 1979–2001 — which is too large by a factor of 2 (0.11 K/decade * 6%/K * 24.9 mm = 0.16 mm/decade), which is explained by artifacts in the global observing system.

All this means that accurate observations of the IPWV are fundamental in climate monitoring / climate research.

IPWV trends for some stations in Sweden and Finland

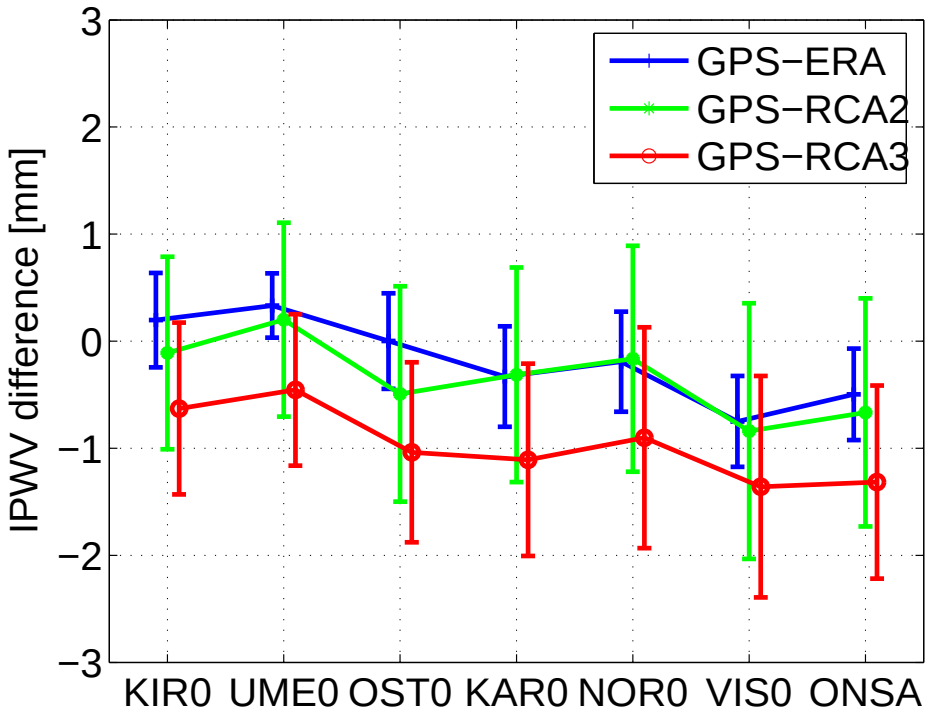


IWV trends over Sweden and Finland



- Analysis period: 10 years, November 16, 1996 – November 15, 2006
- IWV trends varies from –0.5 to +1.5 kg/m^2/decade
- Uncertainties in the trends are ~0.4 kg/m^2/decade (taking temporal correlations into account)

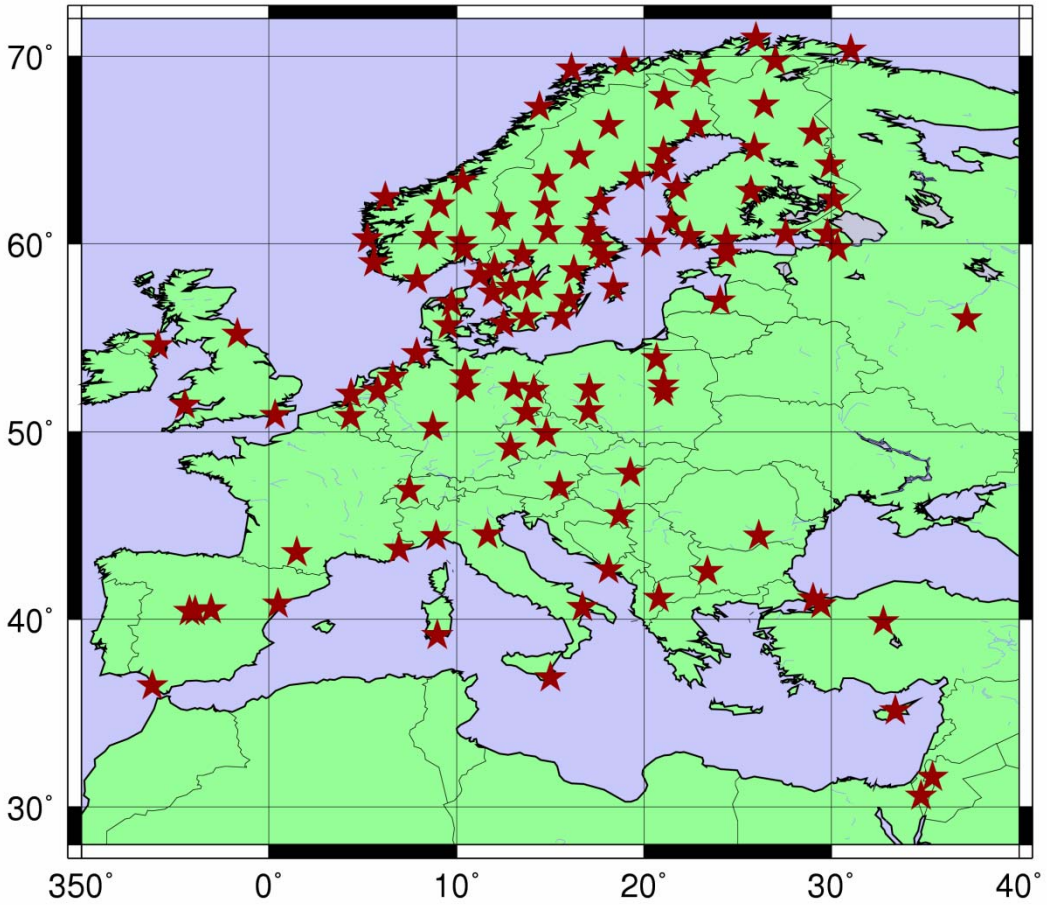
Comparison with climate models



Average for all seven stations:
GPS – ERA = –0.2 ± 0.4 mm
GPS – RCA2 = –0.3 ± 1.0 mm
GPS – RCA3 = –1.0 ± 0.9 mm

- The average difference between GPS derived IPWV with IPWV from ERA and RCA models, for a few stations.
- Errorbars indicate the RMS scatter around the average.
- In general larger differences for the southern stations. Could be due to higher IPWV in the south.
- RCA3 model has a larger bias but a slightly lower RMS compared to the RCA2. This is in agreement with other investigations which indicate that RCA3 overestimates the IPWV.

Ongoing GPS data and numerical weather model analysis



More than 100 stations

GPS data processed with GIPSY 5.0

Now data from 1997 to 2006

Later this year: 1993–2009

Conclusion: GNSS give important contributions to scientific investigations (e.g. geophysics and atmosphere – climate change) as well as weather forecasting

What will happen now?

- Process the GPS data from > 200 European sites from 1993 to 2009
- Comparisons to the numerical weather models (ECMWF and RCA model) and geophysical models (tectonic plate motion, glacial isostatic adjustment – historic and current, etc)
- Try to understand the differences …