

Status of UELN – Steps on the way to EVRS-2007

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Contents:

- **History of UELN since 1998**
- **Including of the new data of Scandinavia**
- **UELN datum realization**



History of UELN since 1998 (1)

- **Resolution No. 4 of the EUREF symposium Bad Neuenahr-Ahrweiler 1998: Adjustment UELN-95/13 was made available as UELN-95/98 solution**
- **Handing over to the participating countries in January 1999**

1999

- **Handing over of the networks of Estonia and Latvia (without connection to UELN)**
- **additional measurements of Poland for better integration of EUVN stations**
- **Extension of UELN by first order levelling network of Romania**

History of UELN since 1998 (2)

2000

- **Handing over of the levelling network of Lithuania
→ Extension of UELN by the levelling networks of the Baltic states Estonia, Latvia and Lithuania**
- **Change of the connection between Denmark and Germany across the Fehmarn Belt**

2002

- **Replacement of the Swiss network block by the measurements of LHN95**

2003

- **Extension of UELN by first order levelling network of Bulgaria**

History of UELN since 1998 (3)

2004

- Replacement of the Danish network by new preprocessed data of the same epoch (1980-1995)
- Replacement of the Dutch network block by the 5th Primary Levelling (1996-1999)

2005

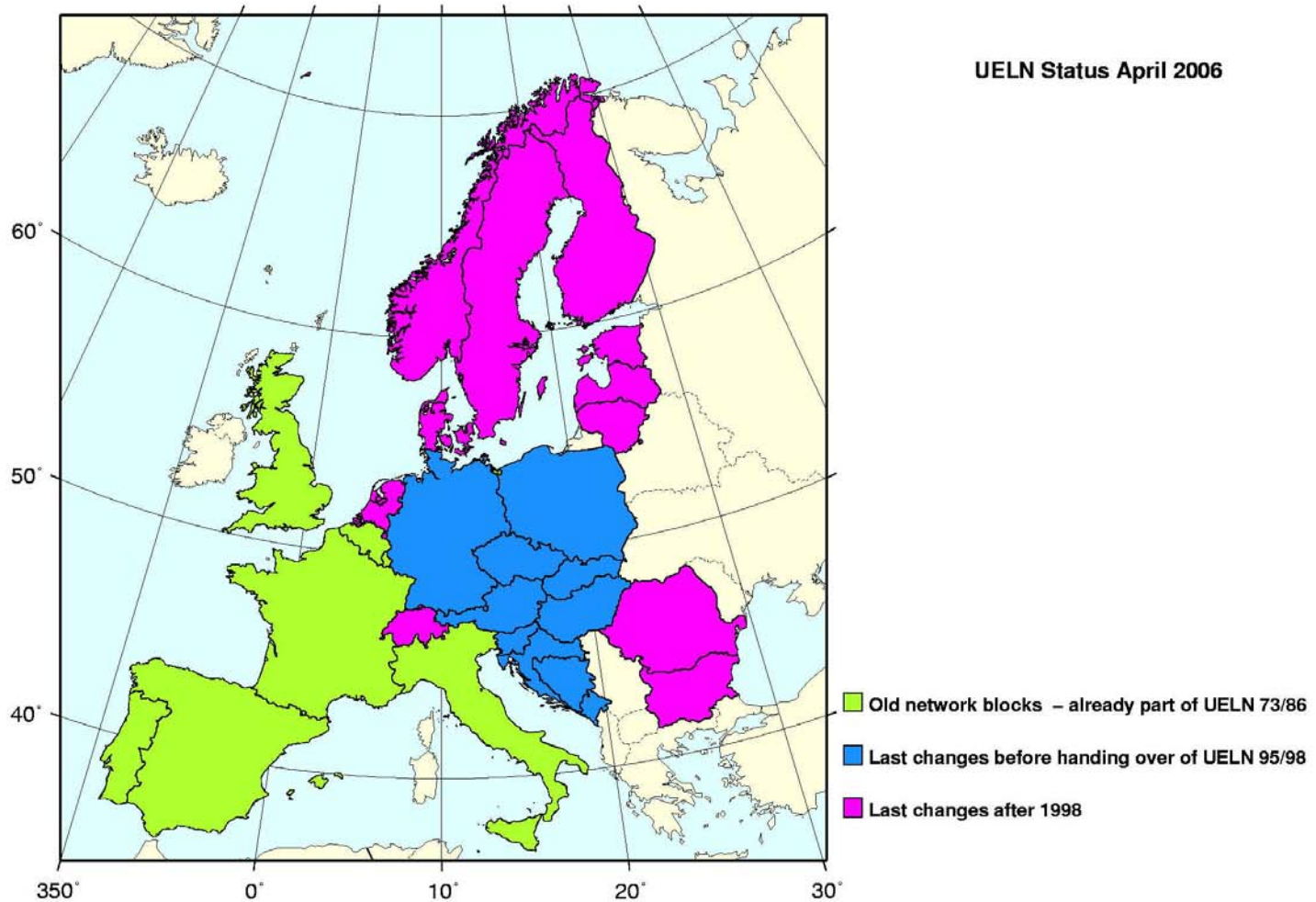
- Replacement of the levelling networks of Finland, Norway and Sweden (referred to epoch 1960) by data of new measurements referred to the epoch 2000.0

2006

- Announcement of handing over a new epoch of the first order levelling network of Poland

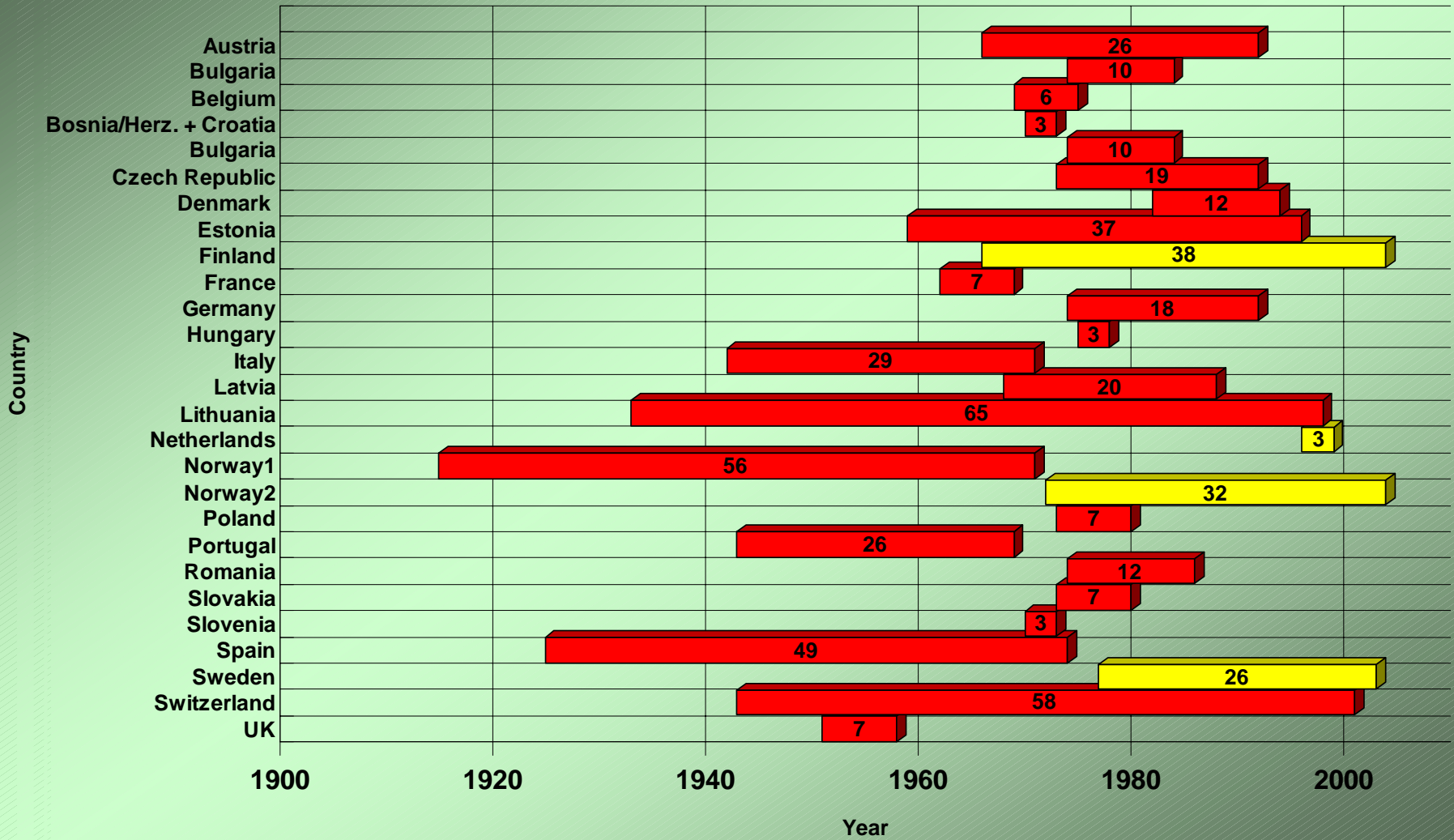


New data in UELN





Epochs of measurement in UELN



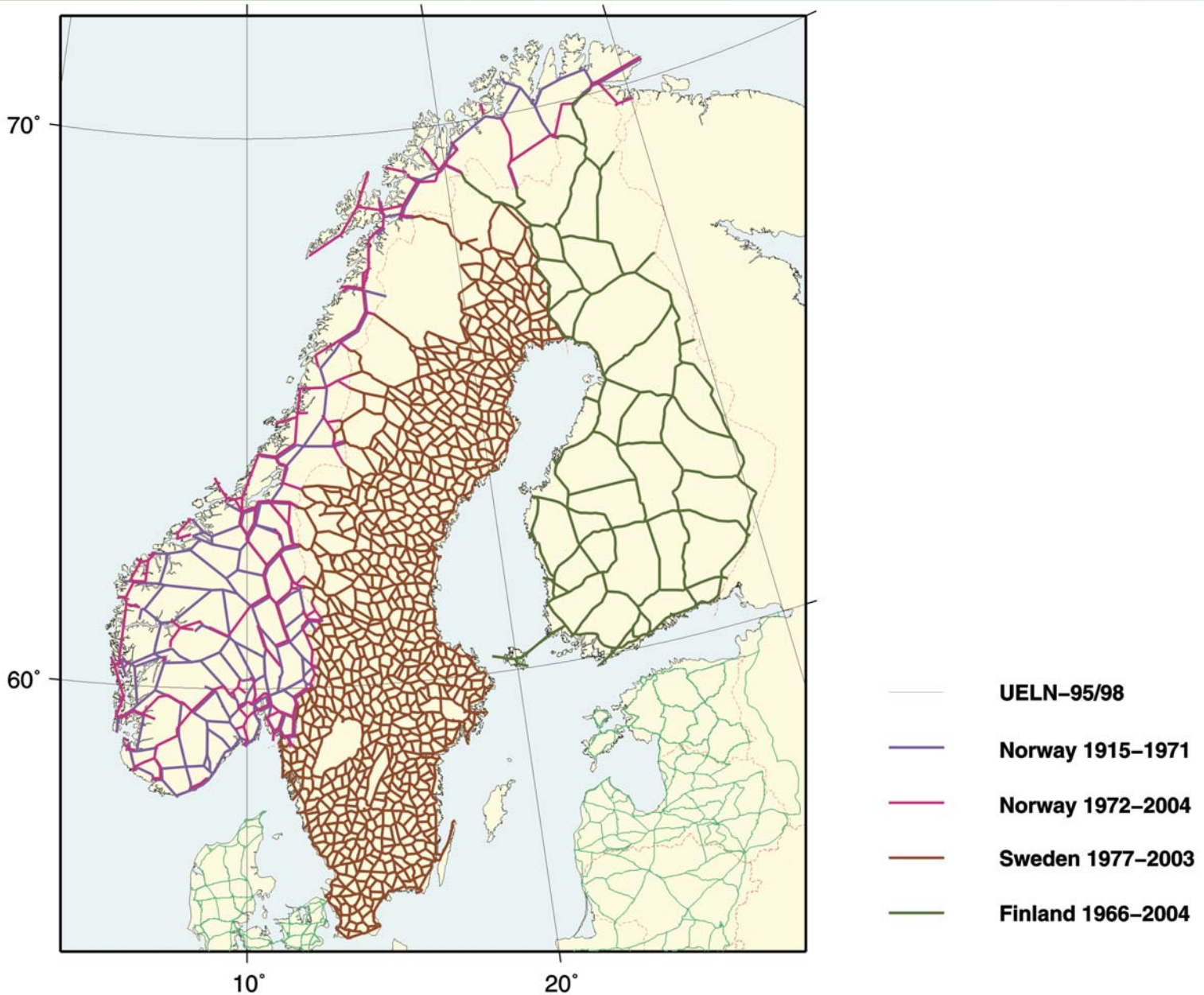
New data of Scandinavia (1)

- **Delivery of the data in July/August 2005**

Country	measurements	points	lines	nodal points	epoch
Norway	361	393	341	354	1915-1971
	313		294		1972-2004
Sweden	5811	6040	4093	3390	1977-2003
Finland	653	594	192	133	1966-2004

- **Reduction to the epoch 2000.0 by land uplift values provided by NGK**

New data of Scandinavia (2)



Adjustment results of the Scandinavian network

- **2 groups of measurements for Norway (stated by NGK):**
 - epoch 1915 – 1971 a-priori $s_0 = 1.36 \text{ kgal}\cdot\text{mm}/\text{km}^{-1/2}$
 - epoch 1972 – 2004 a-priori $s_0 = 1.11 \text{ kgal}\cdot\text{mm}/\text{km}^{-1/2}$
- **groups of all other national networks:**
a - priori $s_0 = 1 \text{ kgal}\cdot\text{mm}/\text{km}^{-1/2}$
- **Results of the free adjustment**
 - a-posteriori s_0 of 1 km = 1.035 kgal·mm
(7140 measurements, 6040 points)
- **a-posteriori standard deviation computed by variance component estimation**
 - Norway 1915 – 1971 1.58 kgal·mm/km^{-1/2}
 - Norway 1972 – 2004 1.30 kgal·mm/km^{-1/2}
 - Sweden 1977 – 2003 1.00 kgal·mm/km^{-1/2}
 - Finland 1966 – 2004 0.74 kgal·mm/km^{-1/2}

Adjustment results of UELN after replacement of the Scandinavian data

Parameters of the adjustment:

Number of datum points:	13
Number of unknowns:	7225
Number of measurements:	9542
Number of condition equation:	1
Degrees of freedom:	2318
A-posteriori standard deviation referred to 1 km levelling distance :	1.07 kgal-mm
Mean value of the standard deviation of the adjusted geopotential numbers:	17.19 kgal-mm
Average redundancy:	0.243



Future Datum of UELN (1)

- the only datum point of present UELN realization was situated in the Netherlands – an area with considerable height changes
- realization of the datum by only one benchmark is neither contemporary nor advantageous
- attempt to keep level of UELN after changing datum realization by useful distribution of datum points
- requirement to keep the level follows more a popular wish of the user than scientific reasons
- in every case free adjustment \longrightarrow only constant vertical offset of the adjusted heights between the different solutions



Future Datum of UELN (2)

4 Variants:

(1) One datum point in the Netherlands

- fundamental point in the near of the former datum point
- no height changes related to the previous epochs

(2) One datum point in Germany

- datum point of the German network
- checked stability

(3) 13 datum points in Europe

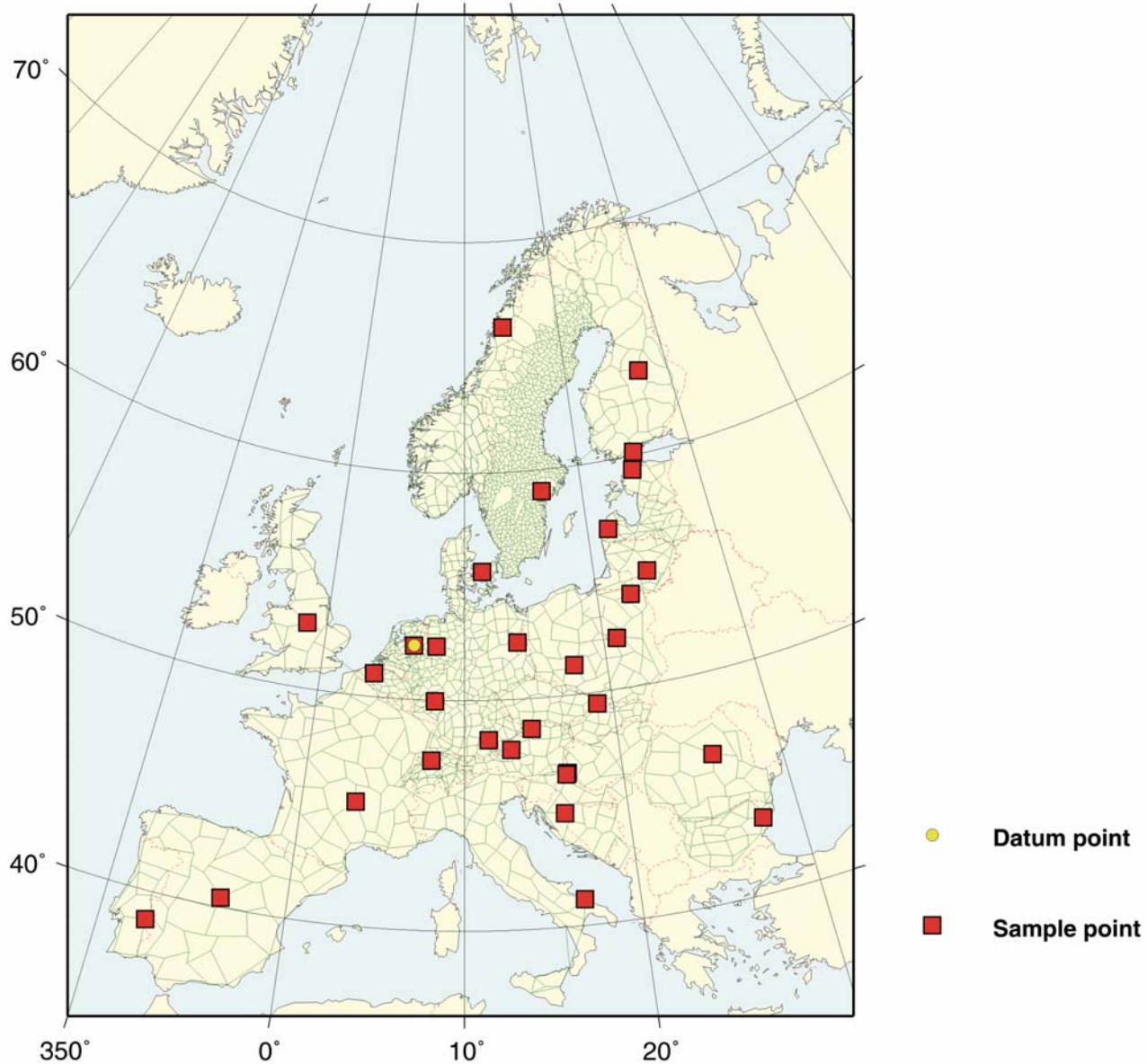
- only in countries with the same data as in the UELN-95/98 solution
- no points in Great Britain and Scandinavia because of weak connection to the mainland

(4) 7 datum points in Germany and Poland

- additionally to point (3) topical networks without appreciable crustal movements

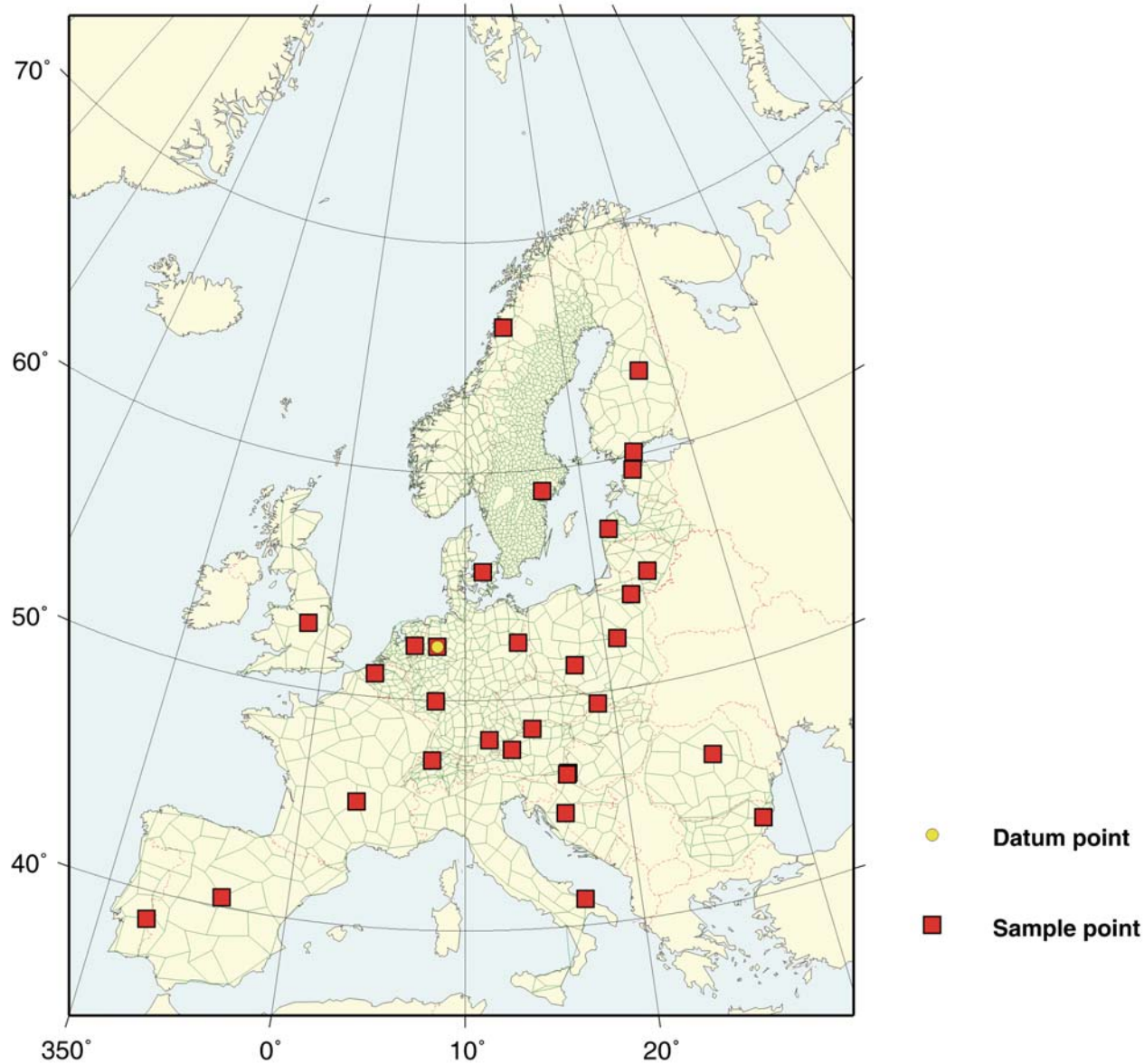
Distribution of sample points

1 datum point in NL

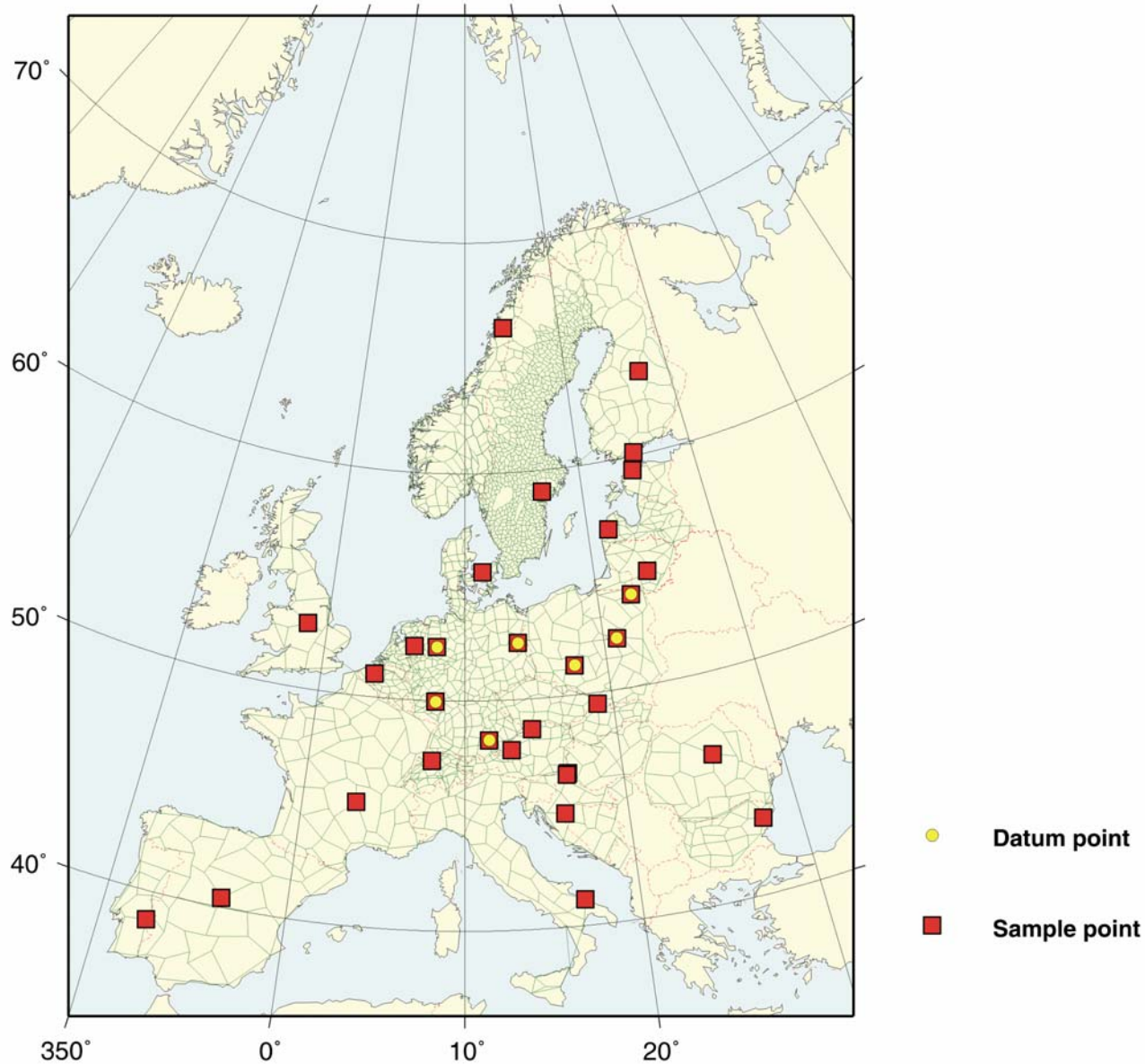


Distribution of sample points

1 datum point in DE

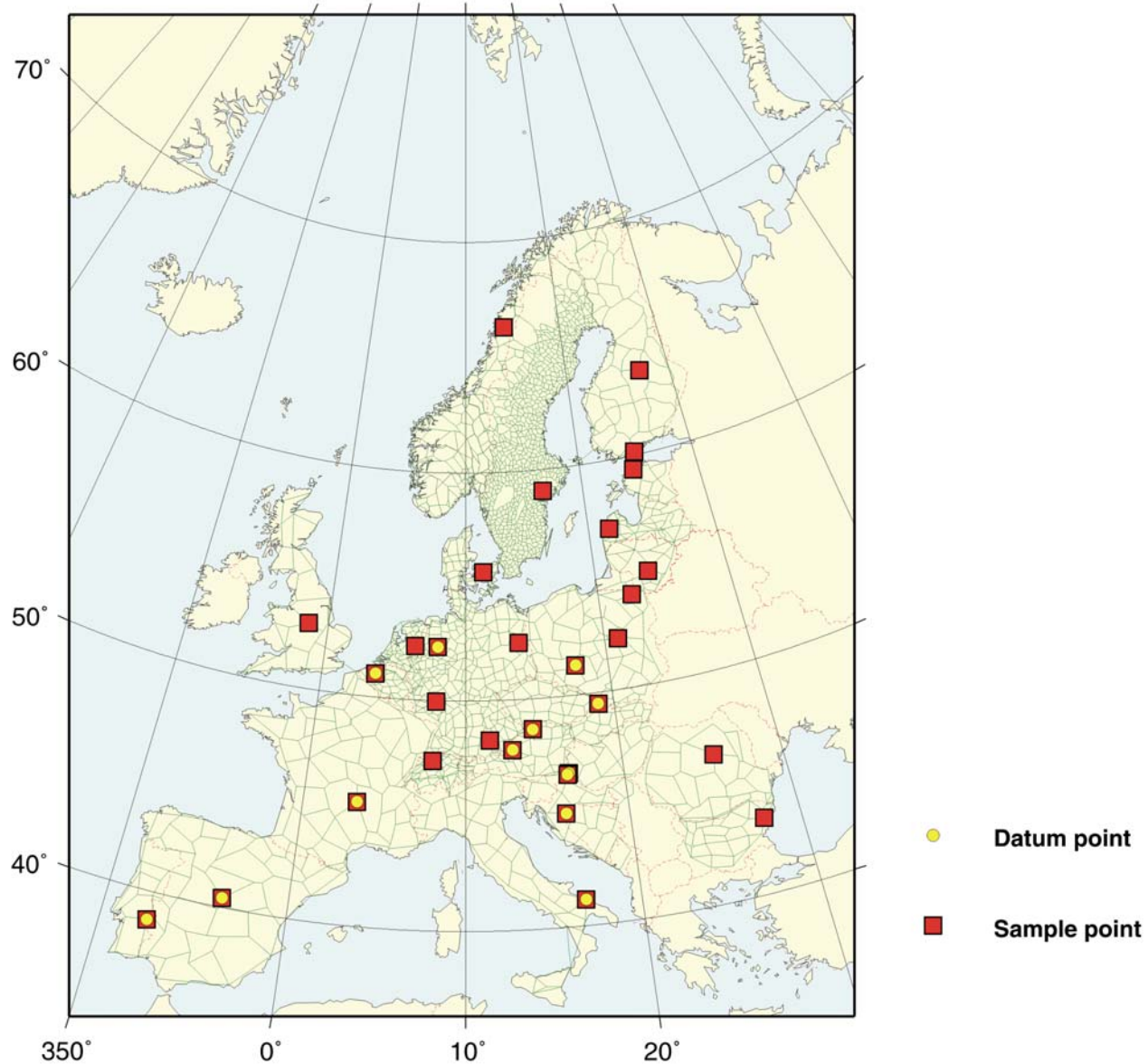


Distribution of sample points 7 datum points in DE and PL



Distribution of sample points

13 datum points

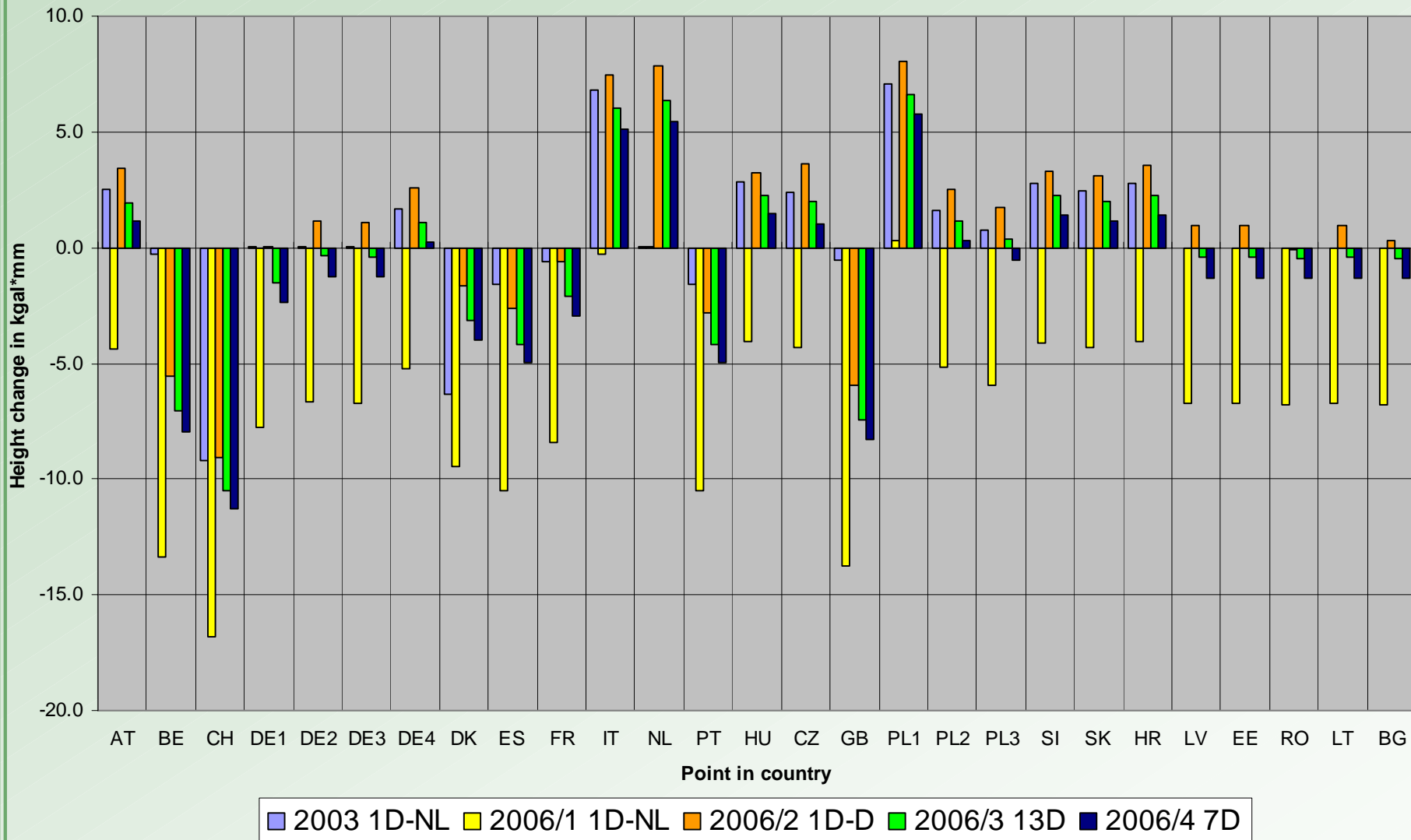




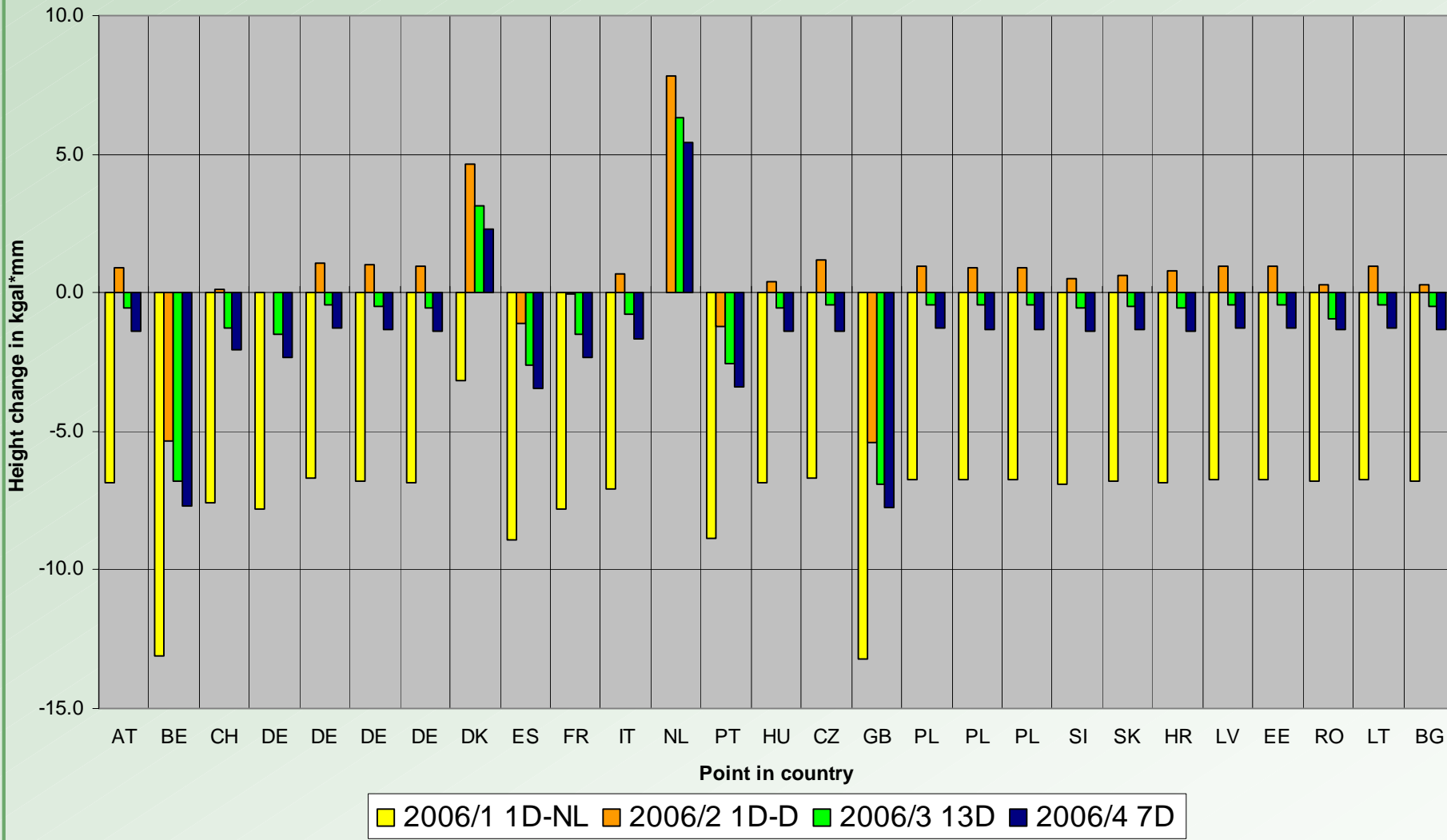
Future Datum of UELN (3)

- **sample points in every country to visualize height changes related to**
 - (1) UELN-95/98 solution
 - (2) adjustment 2003 with previous epochs of the Netherlands and Scandinavia
- **separate view on the Scandinavian points**
 - (1) heights of the UELN-95/98 solution in Scandinavia are reduced to the epoch 1960.0
 - (2) heights of the new Scandinavian data are reduced to the epoch 2000.0
 - (3) 2 different epochs, 2 different land uplift models heights aren't comparable
 - (4) conversion of the UELN-95/98 heights to the epoch 2000.0 to obtain comparability – still residuals of several dm in Finland

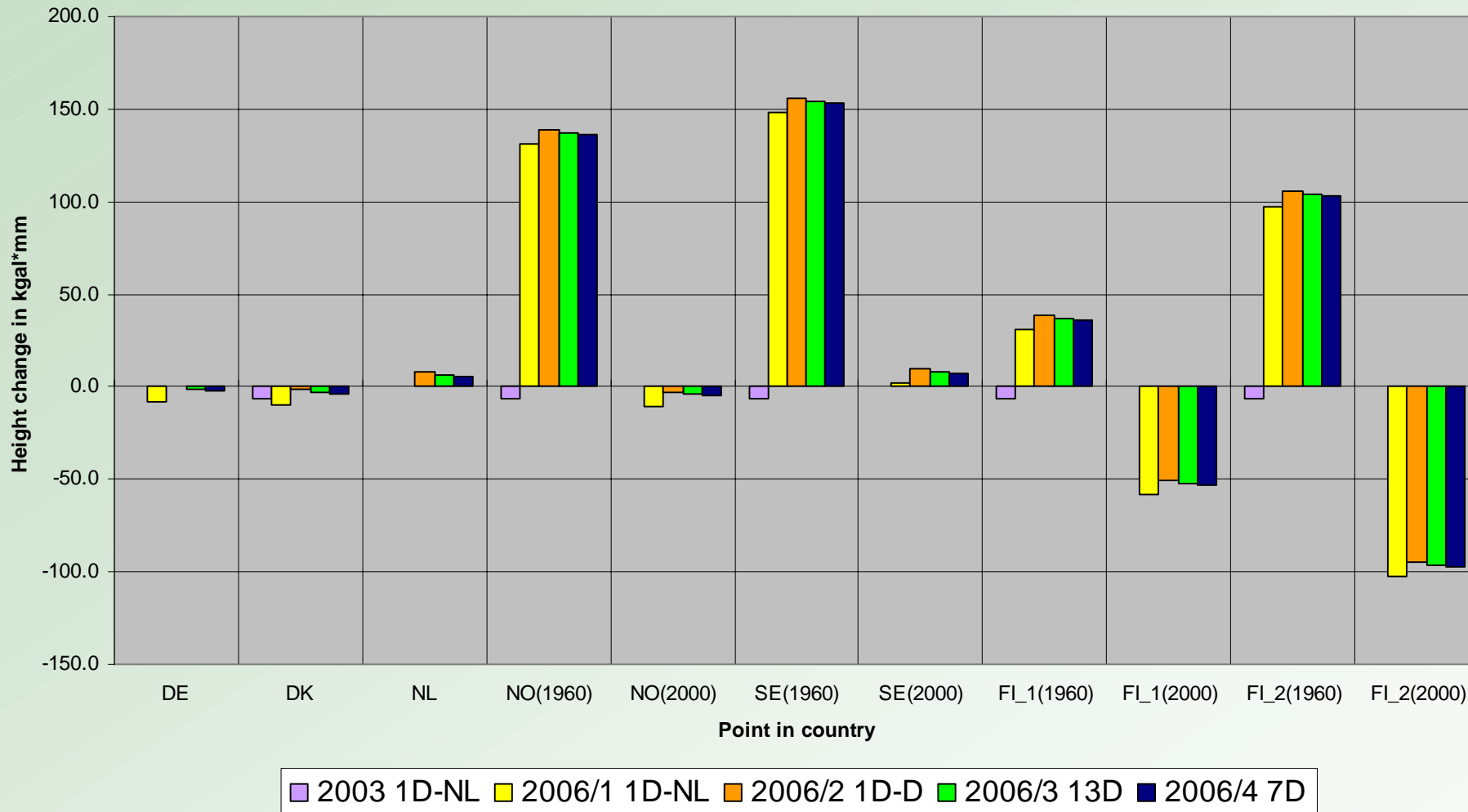
Height changes to UELN-95/98 depending on datum realization



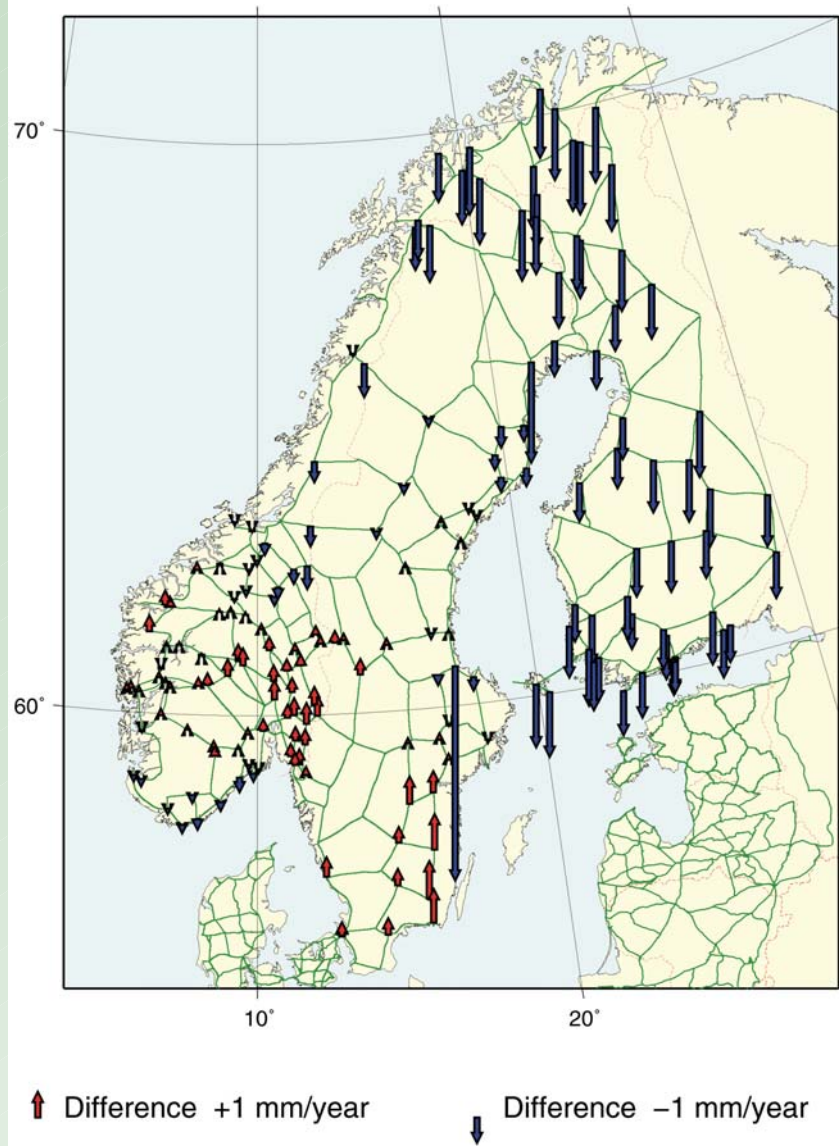
Height changes to adjustment 2003 depending on datum realization



Height changes to UELN-95/98 depending on datum realization



Comparison of adjusted UELN heights of UELN-95/98(1960) and new network part(2000)



- comparison of differences between
 $(H_{2000_{new}} - H_{1960_{UELN95/98}}) / 40 \text{ years}$
and
 v from land uplift model
in the identical points
- Differences are influenced by errors in the measurements of both networks and errors in both land uplift models.
- Are large differences in Finland the consequence of unfavorable error propagation in the old network?
- The importance of closing the Baltic Ring is obviously !



Conclusions and Outlook

- **New data of first order levelling networks of several European countries have been integrated in UELN since 1998 – especially more than 7000 points of Scandinavia**
- **additional data are expected**
- **publication of a new UELN solution is indicated**
- **new datum realization is necessary because of considerable height changes in the Netherlands**
- **the level of the new UELN datum can be defined by the geopotential values of the UELN-95/98 solution of several points in Europe**
- **the choice of several points in countries with the same measurements as 1998 leads to minimal height variations in the network**