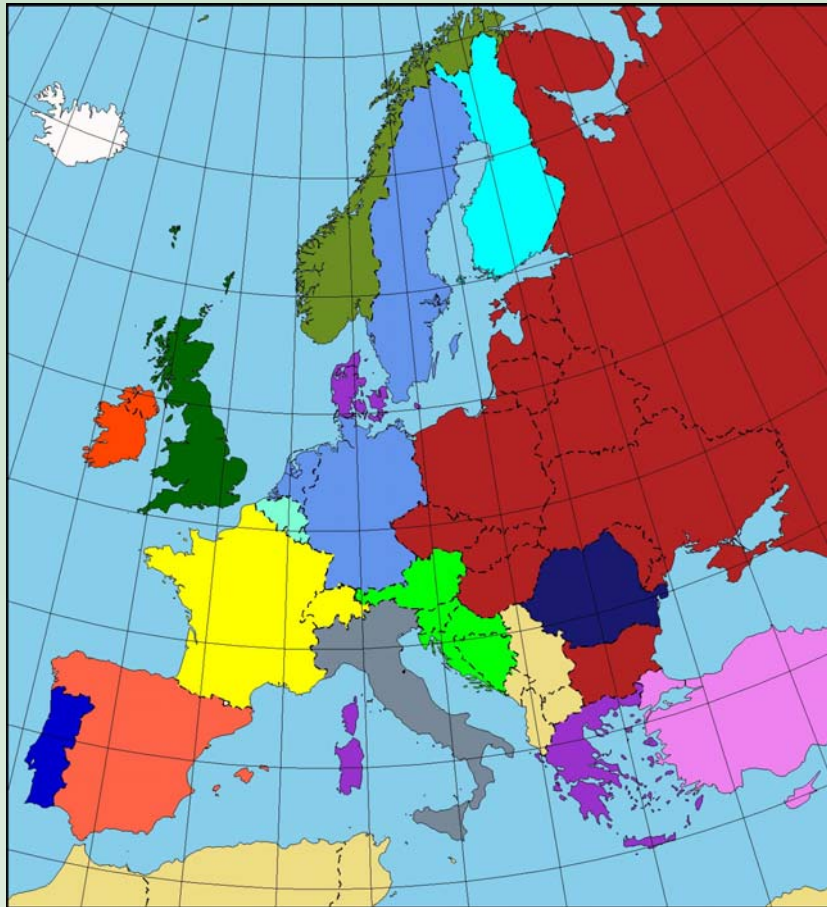


The European Data and Analysis Centre of the UELN

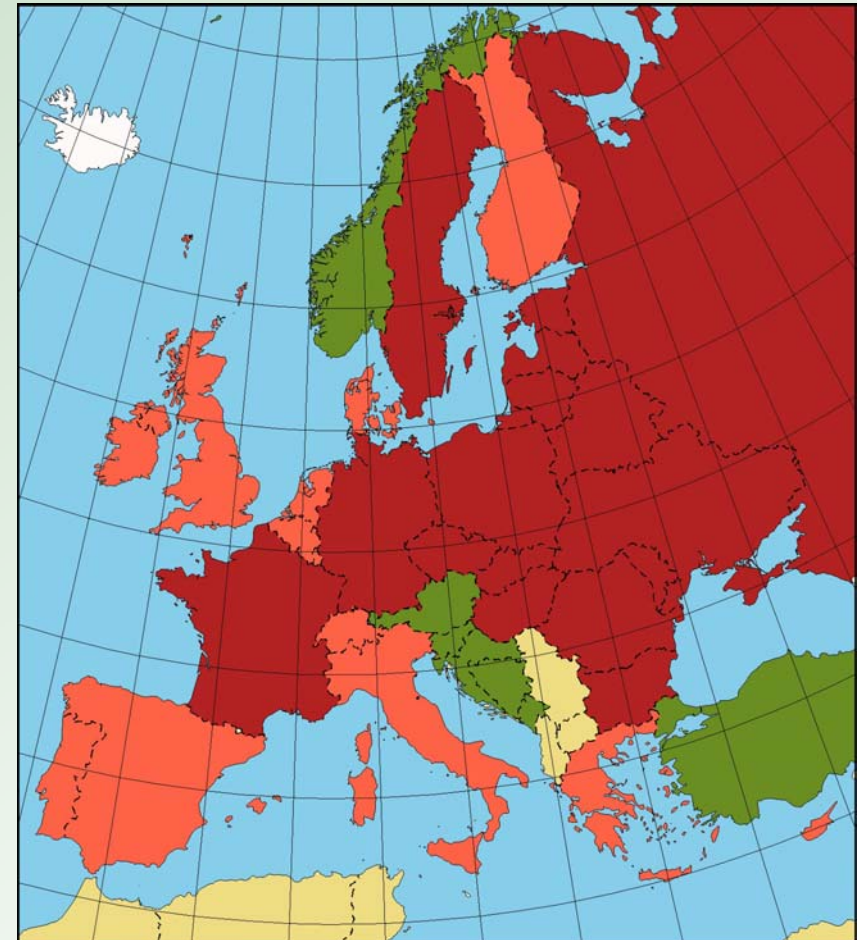
Contents:

1. Height systems in Europe
2. United European Levelling Network 1995 (UELN 95)
3. General principles and objectives
4. UELN Data base
5. European Vertical Reference System (EVRS)

Height Systems in Europe



July 01, 1998



July 01, 1998



Development steps towards a unified European height system

- **1864 - 1890**
Central European Triangulation
- **1954 – 1963**
 - **United European Levelling Network (UELN, REUN) of Western Europe: UELN55, NAP, geopotential numbers, networks 1.0, 2 blocks, 3 methods, 4 computing centres,**
 - **Uniform Precise Levelling Network (EPNN) of Eastern Europe: gauge Kronstadt, networks 1.0.**
- **1971/73-1986**
 - **UELN 73/86**
 - **EPNN 76 (HN 76)**
 - **Map of the Recent Vertical Crustal Movements of Eastern Europe**

Development steps towards a unified European height system (part 2)

- 1994 - now
 - IAG Subcommittee for Europe (EUREF)
 - Objective: uniform European height system for tasks of georeferencing with an accuracy of 1 cm (CERCO)
Foundations: NAP, geopotential numbers/normal heights, networks 1.0
Methodology: new adjustment with current observations,
extension towards the East
Weaknesses: static reference system, no uniform reductions, no gauge stations in the concept
 - Results under the name UELN 95/98
 - EVS 2000: kinematic height reference system

General principles and objectives

- 1994 resumption of the work at the UELN
- Establishing an Unified Vertical Datum for Europe at the one decimeter level to respond to an urgent request of CERCO (Resolution no. 3 of the EUREF Symposium 1994 in Warsaw)
- Enlargement of UELN as far as possible to the Eastern European countries (Resolution no. 3 Warsaw)
- Zero point: Normaal Amsterdams Peil (NAP)
- Conversion of the UELN results to normal heights (Resolution no. 2 of the EUREF Symposium 1996 in Ankara)
- Static adjustment model
- Data center: Bundesamt für Kartographie und Geodäsie (Resolution no. 4 of the EUREF Symposium 1996 in Ankara)
- Stepwise development of an European geokinematic height reference network ➡ UELN/EVS2000 (Resolution no. 4 Ankara)

Status of the Adjustment and Enlargement



- Old network blocks - parts of UELN 73/86
- Changed network blocks with new measurements
- New network blocks of East- and Southeast Europe

October 2003



Handing over of the Results of UELN-95/13

- **Resolution No. 3 of the EUREF Symposium 1998 in Bad Neuenahr-Ahrweiler:**
 - **Handing over of the results of the UELN-95/13 adjustment under the name UELN-95/98 to the participating countries**
 - **The resolution was realized in January 1999**
 - **The relevant data of the own respective country inclusive the junction points to the neighbouring countries were handed over to each participating country**
- **After 1999 the development of the UELN continued:**
 - **Integration of Estonia, Latvia and Lithuania**
 - **Extension to the Black Sea by integration of Romania and Bulgaria**
 - **Including new data of Switzerland**

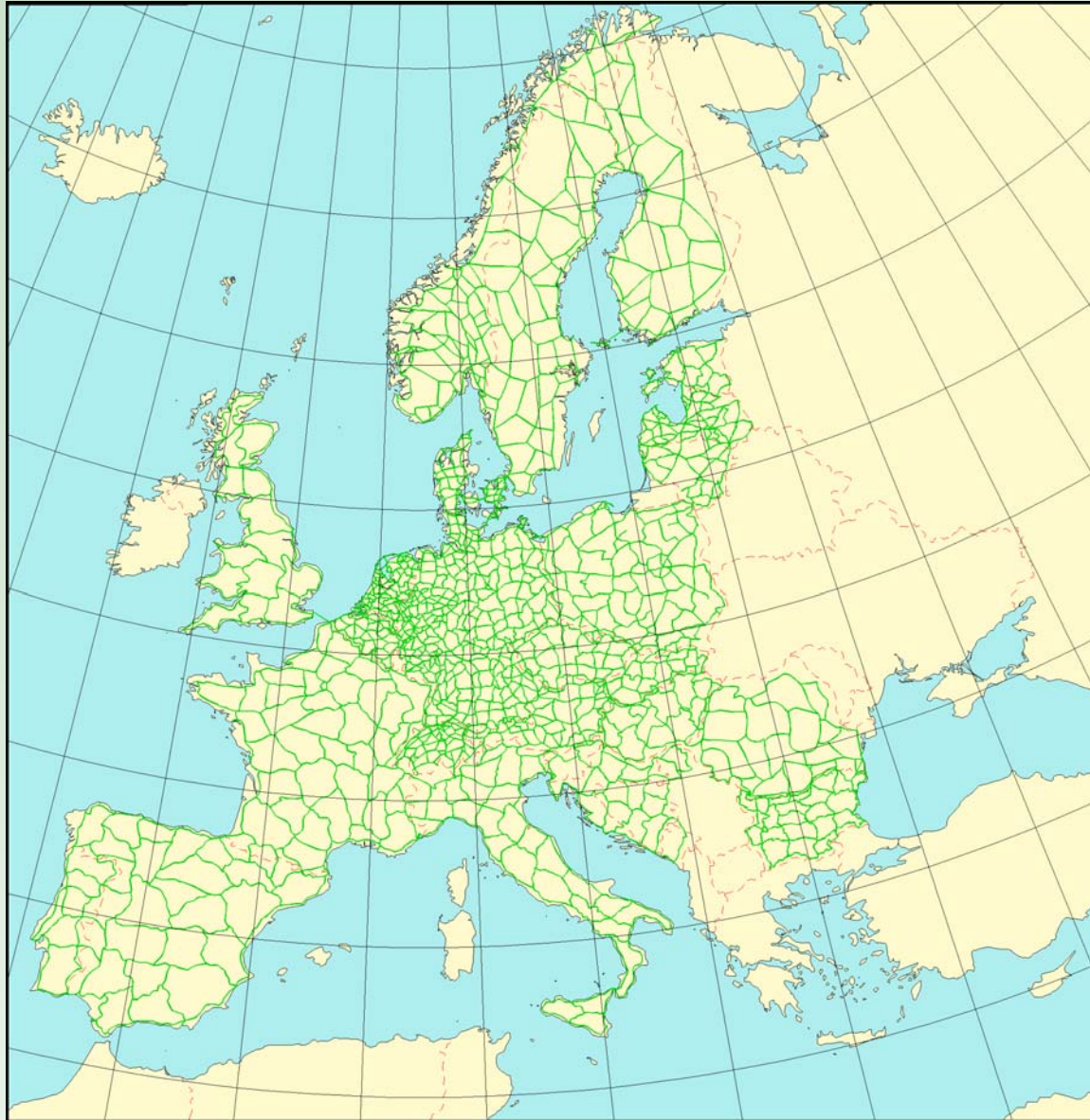
Statistical Data of the current adjustment version UELN-95/17:

- number of fixed points: 1
- number of unknowns: 3653
- number of measurements: 5127
- degrees of freedom: 1474
- a-posteriori standard deviation referred to the levelling distance of 1 km: 1.13 kgal · mm
- mean value of the standard deviation of the adjusted geopotential numbers (= heights): 19.35 kgal · mm
- average redundancy: 0.287

Results of the variance component estimation

| Block | Number of observations | Sum of redundancies = [pvv] | a posteriori standard deviation [kgal · mm] |
|--|-------------------------------|------------------------------------|--|
| Austria | 144 | 39.101 | 0.81 |
| Belgium | 54 | 19.483 | 1.22 |
| Switzerland | 387 | 150.433 | 1.09 |
| Germany | 766 | 273.188 | 0.85 |
| Denmark | 1038 | 312.869 | 0.59 |
| Spain | 101 | 27.235 | 1.84 |
| France | 175 | 46.289 | 2.03 |
| Italy | 97 | 32.544 | 1.75 |
| The Netherlands | 935 | 163.942 | 1.08 |
| Portugal | 22 | 5.858 | 1.77 |
| Great Britain | 60 | 15.000 | 1.72 |
| Norway | 194 | 70.992 | 1.67 |
| Finland | 89 | 20.142 | 0.76 |
| Sweden | 122 | 34.865 | 1.74 |
| Czech Republic | 82 | 26.995 | 1.02 |
| Hungary | 60 | 13.733 | 0.51 |
| Poland | 219 | 61.626 | 0.97 |
| Slovakia | 73 | 18.572 | 1.41 |
| Bosnia/Herzegovina, Croatia, Monte Negro, Slovenia, Vojvodina | 79 | 19.397 | 0.90 |
| Romania | 90 | 31.481 | 1.75 |
| Estonia | 46 | 10.377 | 1.31 |
| Latvia | 159 | 35.561 | 1.67 |
| Lithuania | 72 | 20.073 | 0.94 |
| Bulgaria | 63 | 24.244 | 1.19 |
| | 5127 | 1474.000 | |

United European Levelling Network 1995 (Status 10/2003)



October 2003

Further Developments

Weak points:

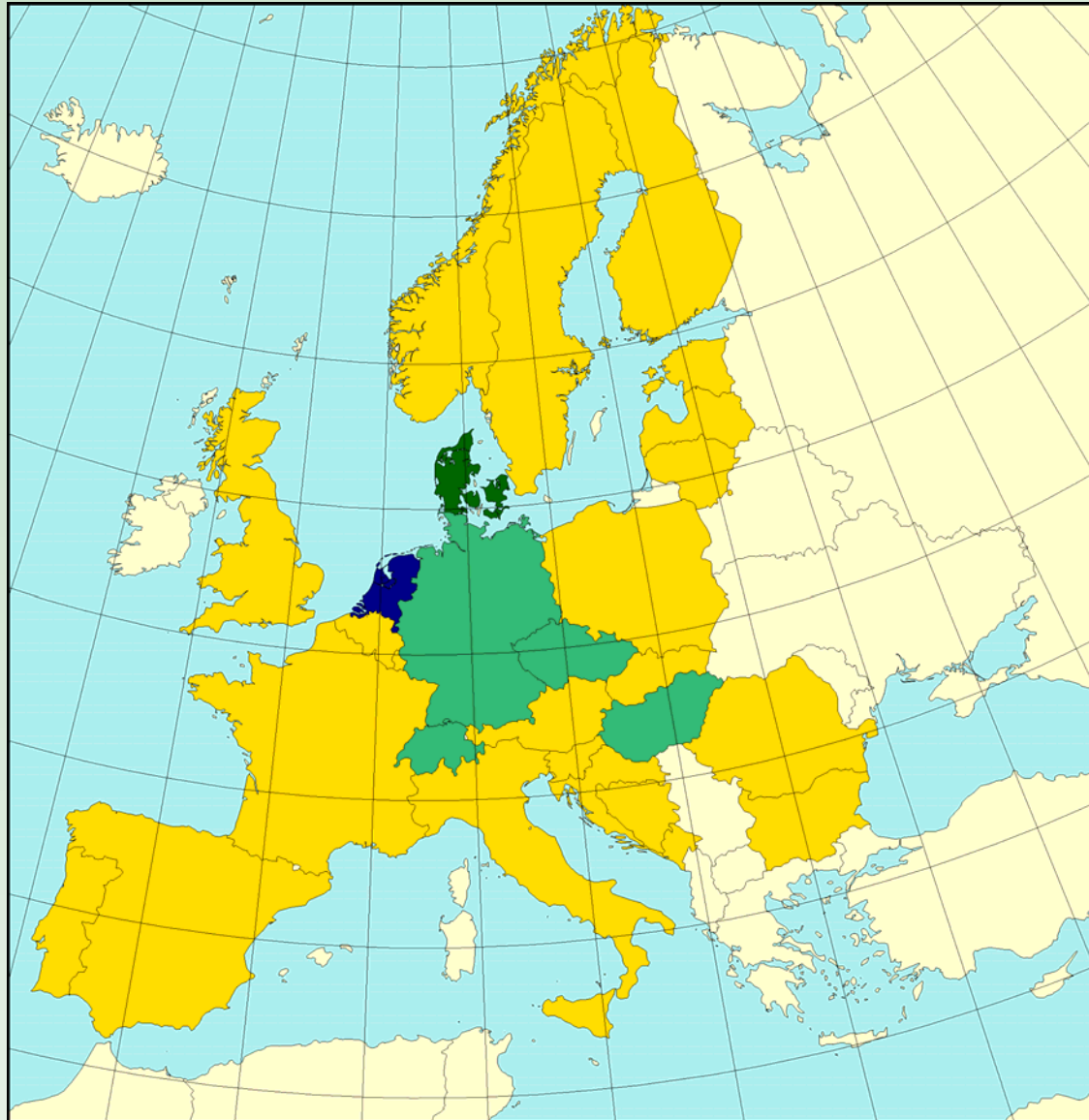
- **Static reference system**
- **many different epochs of measurements**
- ⇒ **Stepwise development to a kinematic height system**
- **No uniform reductions**
- **Only one connection between France and Great Britain**
- **Only one connection between the main network and the Scandinavian part**
- ⇒ **New data of the area of the Baltic sea are expected**
- ⇒ **Visit of a Russian delegation at the BKG in February 2004 – first discussions about the exchange of levelling data with Russia**

Contents of the UELN Data Base

Table 1 Contents of the UELN/EVS - Data Base

| Country | Number of Nodal Points | Number of Observations | National Heights Available | Whole First Order Network | Epoch of Observation | Epoch of each Meas. known | Year of Input in UELN | Kind of Observations | Further Epochs |
|------------------------|------------------------|------------------------|----------------------------|---------------------------|----------------------|---------------------------|-----------------------|----------------------|---------------------------------------|
| Austria | 96 | 145 | X | X | 1966-1992 | X | 1995 | ΔC | |
| Belgium | 35 | 54 | | | 1969-1975 | | 1980 | | |
| Bosnia/Herz. + Croatia | 46 | 64 | X | X | 1970-1973 | X | 1998 | $\Delta C, \Delta h$ | |
| Bulgaria | 36 | 62 | X | X | 1974-1984 | X | 2003 | $\Delta C, \Delta h$ | |
| Czech Republic | 53 | 82 | X | X | 1973-1992 | X | 1995 | $\Delta C, \Delta h$ | 1939-1959 |
| Denmark | 738 | 1035 | X | X | 1982-1994 | X | 1998 | ΔC | 1885-1905, 1943-1961 |
| Estonia | 35 | 45 | X | X | 1959-1996 | X | 1999 | $\Delta C, \Delta h$ | |
| Finland | 67 | 89 | | | 1935-1972 | X | 1980 | ΔC | |
| France | 126 | 1785 | | | 1962-1969 | X | 1980 | ΔC | |
| Germany | 498 | 1508 | X | X | 1974-1992 | X | 1995 | $\Delta C, \Delta h$ | east 1953-1959 west 1934-1964 |
| Hungary | 43 | 51 | | X | 1975-1978 | X | 1995 | $\Delta C, \Delta h$ | |
| Italy | 64 | 97 | | | 1942-1971 | X | 1980 | $\Delta C, \Delta h$ | |
| Latvia | 126 | 158 | X | X | 1968-1988 | | 1999 | $\Delta C, \Delta h$ | |
| Lithuania | 46 | 72 | X | X | 1933-1998 | X | 2000 | $\Delta C, \Delta h$ | |
| Netherlands | 842 | 932 | X | X | 1969-1975 | X | 1997 | $\Delta C, \Delta h$ | 1926-1940, 1950-1964, 1986-1996 |
| Norway | 120 | 194 | | | 1912-1978 | X | 1980 | ΔC | |
| Poland | 118 | 217 | X | | 1973-1980 | | 1996 | ΔC | |
| Portugal | 15 | 22 | | | 1943-1969 | X | 1980 | $\Delta C, \Delta h$ | |
| Romania | 65 | 89 | X | X | 1974-1986 | X | 1999 | $\Delta C, \Delta h$ | |
| Slovakia | 53 | 74 | | X | 1973-1980 | | 1996 | ΔC | |
| Slovenia | 11 | 15 | X | X | 1970-1973 | X | 1996 | ΔC | |
| Spain | 79 | 101 | | | 1925-1974 | X | 1980 | $\Delta C, \Delta h$ | |
| Sweden | 92 | 122 | | | 1950-1967 | | 1980 | ΔC | |
| Switzerland | 232 | 380 | X | X | 1943-2001 | X | 2002 | $\Delta C, \Delta h$ | 3 additional epochs |
| United Kingdom | 45 | 60 | | | 1951-1958 | | 1980 | ΔC | |

Number of Epochs in the UELN Data Base



- no measurements
- one epoch
- two epochs
- three epochs
- four epochs

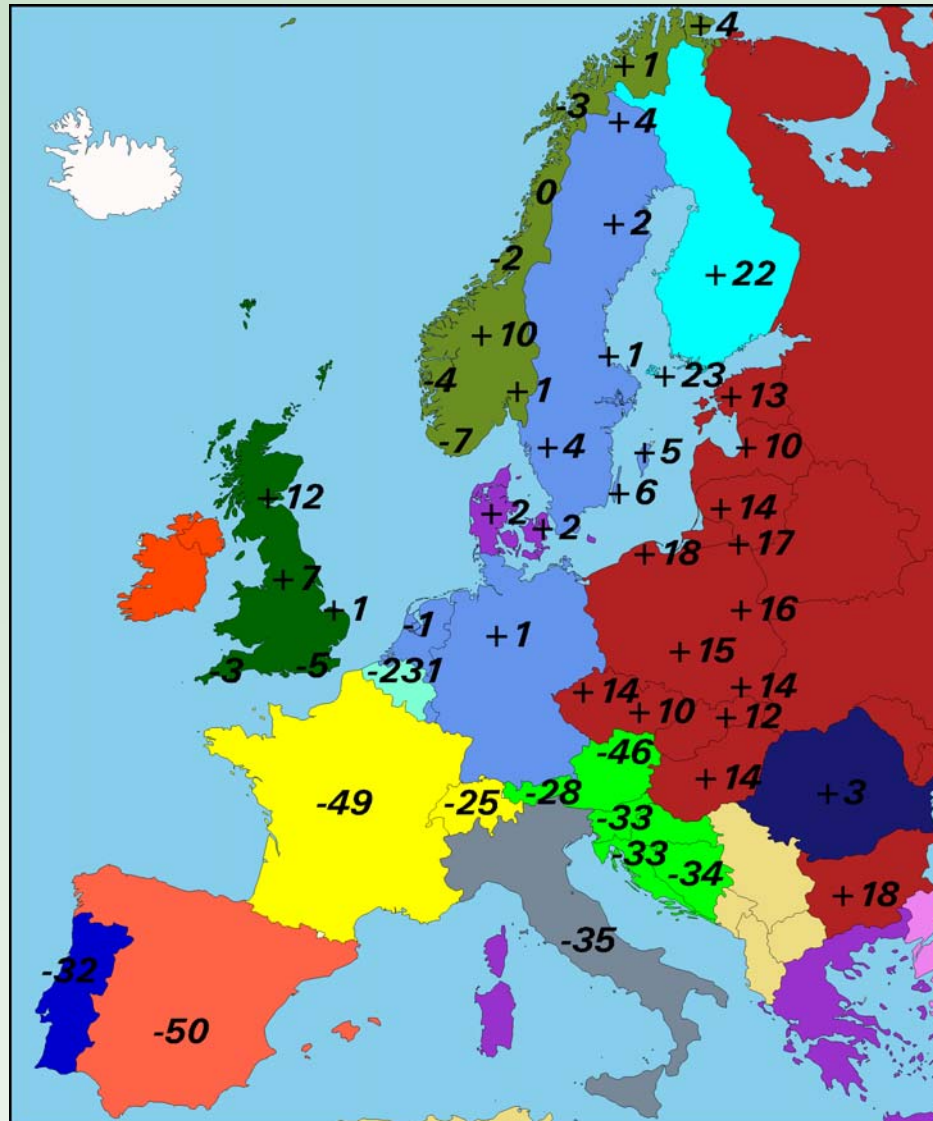
October 2003



European Vertical Reference System (EVRS)

- The European Commission adopts the results of the EUVN/UELN projects as basis for a definition of a vertical datum and gravity related heights
- The IAG Subcommittee for Europe – EUREF – was asked to define a European Vertical Reference System.
- The EVRS is realized by the results of the UELN-95/98 in relation to the Normaal Amsterdams Peil (NAP).
- The geopotential numbers and normal heights are available for the participating countries under the name EVRF2000.

Relations between UELN heights and national heights in Europe (in cm)



October 2003

Differences between UELN heights and national heights in Europe (in cm)