Advancements of the Unified Leveling Network since the adoption of EVRF2007

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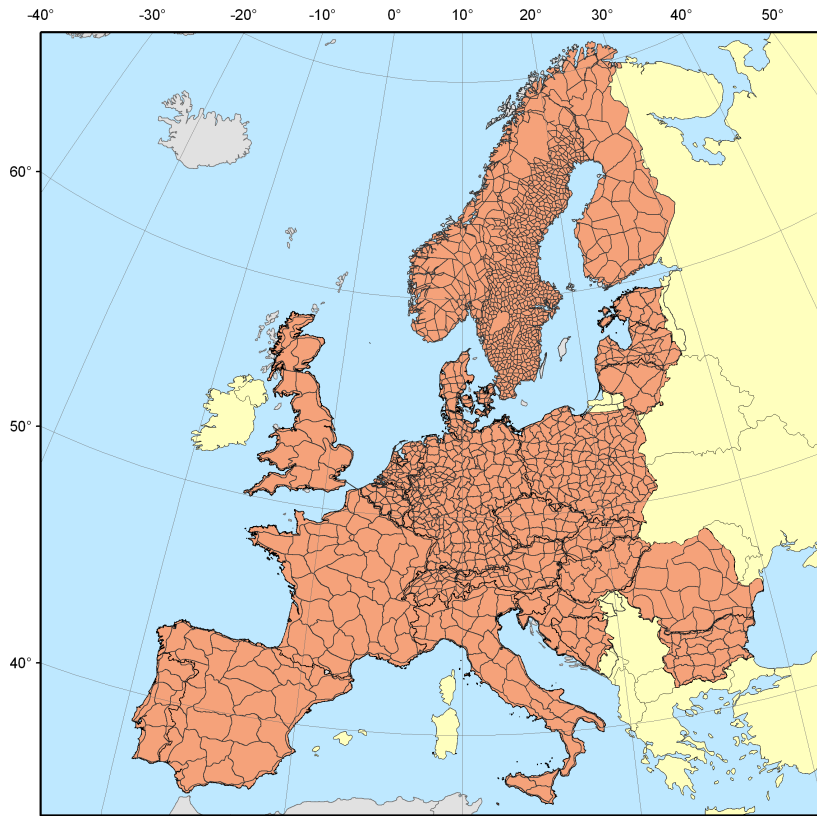[2] Latvian Geospatial Information Agency , Latvia
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[5] Finnish Geodetic Institute, Finland

1. Retrospect
2. New Data in UELN since 2008
   a. Latvia
   b. Russia
   c. Spain
3. Overview about UELN adjustment 2012
4. Future Development

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EVRF2007 network configuration

EVRF2007

- Released 2008 in Brussels

- 27 countries

- 13 datum points

- 7939 nodal points

- 10347 lines

- s_0 = 1.11 kgal·mm

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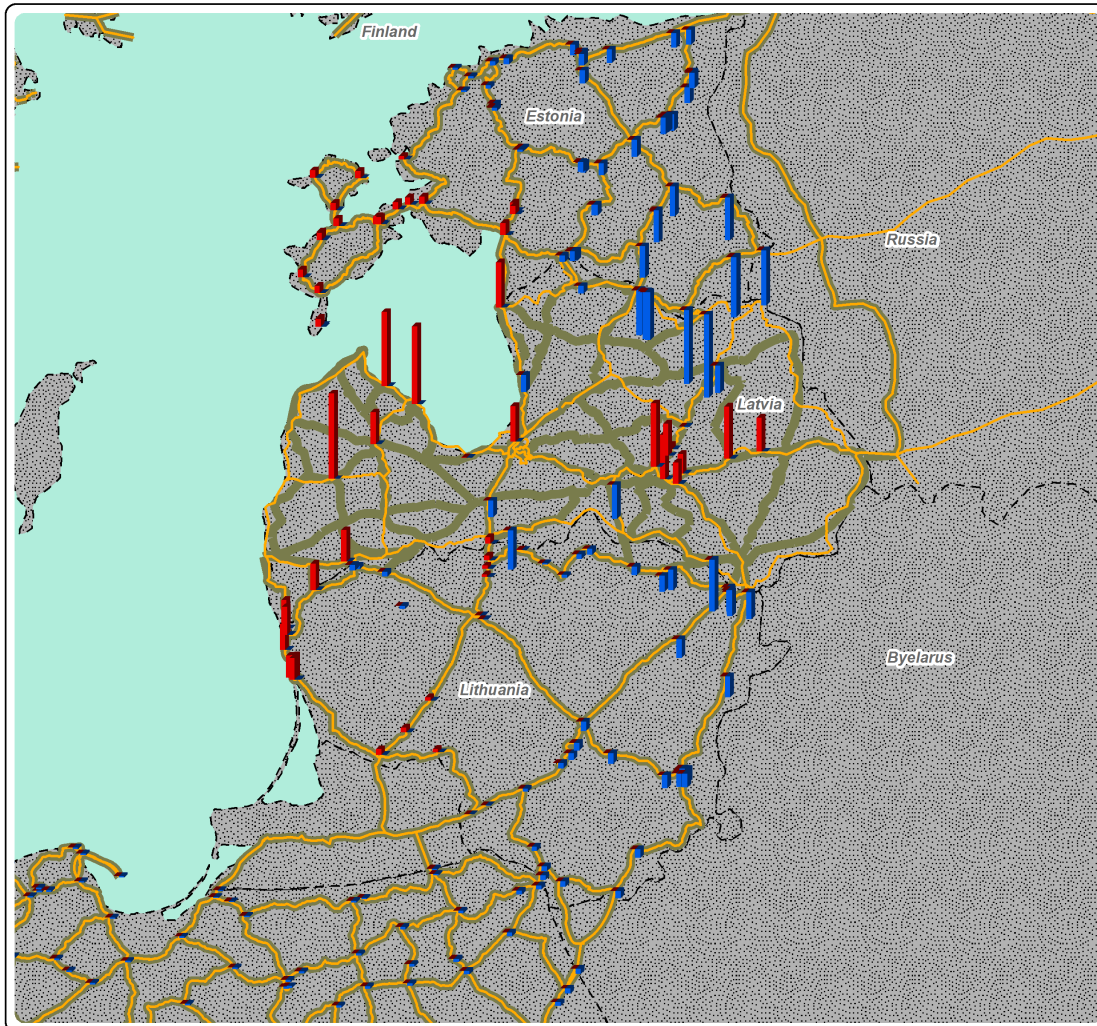
- 2009 Russia provided leveling network of European part of the country

- Conjunction measurements of the neighboring countries had to be supplied by UELN data center

- 2011 new leveling data of Latvia

- 2012 handing over of first order measurements of Spanish leveling network

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Legend:
- UELN status 2012
- UELN status 2008

- Measurements between 2000 and 2011
- Reduced to epoch 2007 by Latvia (original data not available)
- 137 nodal points
- 151 lines
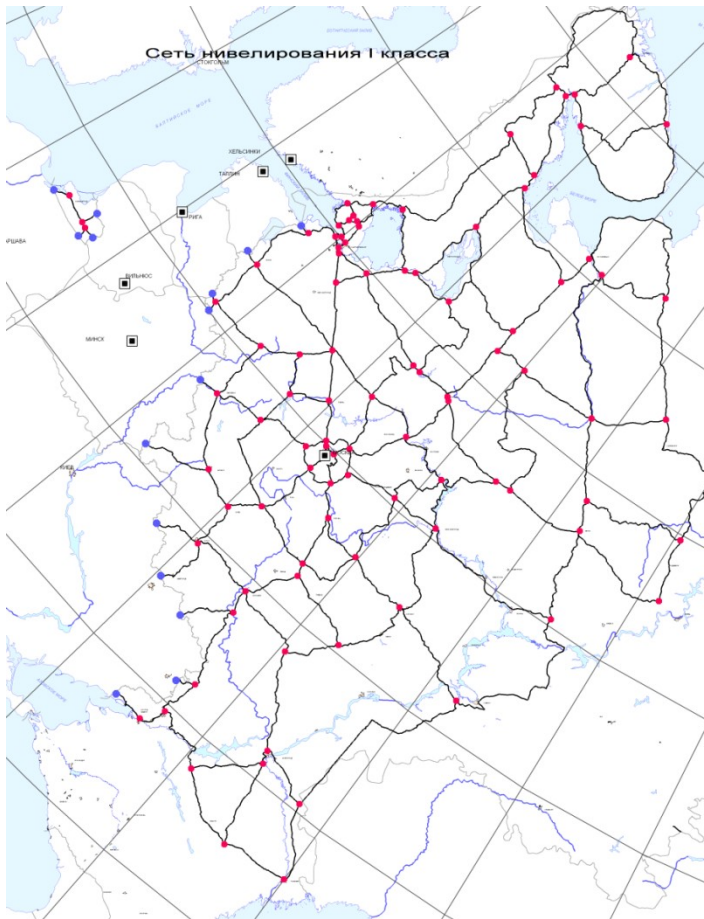- $s_0 = 0.74$ kgal·mm
- (old network of LV in EVRF2007: $s_0 = 1.72$ kgal·mm)

Height variations because of:

- Land uplift
- new border connections to Lithuania and Estonia
- Higher precision of the new network

Legend:
0.010 m height variation — pos. / neg.
— Lines 2012
— Lines EVRF2007

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Leveling network 1.O. of Russia

Part of Russian Leveling network in UELN

UELN status 2012

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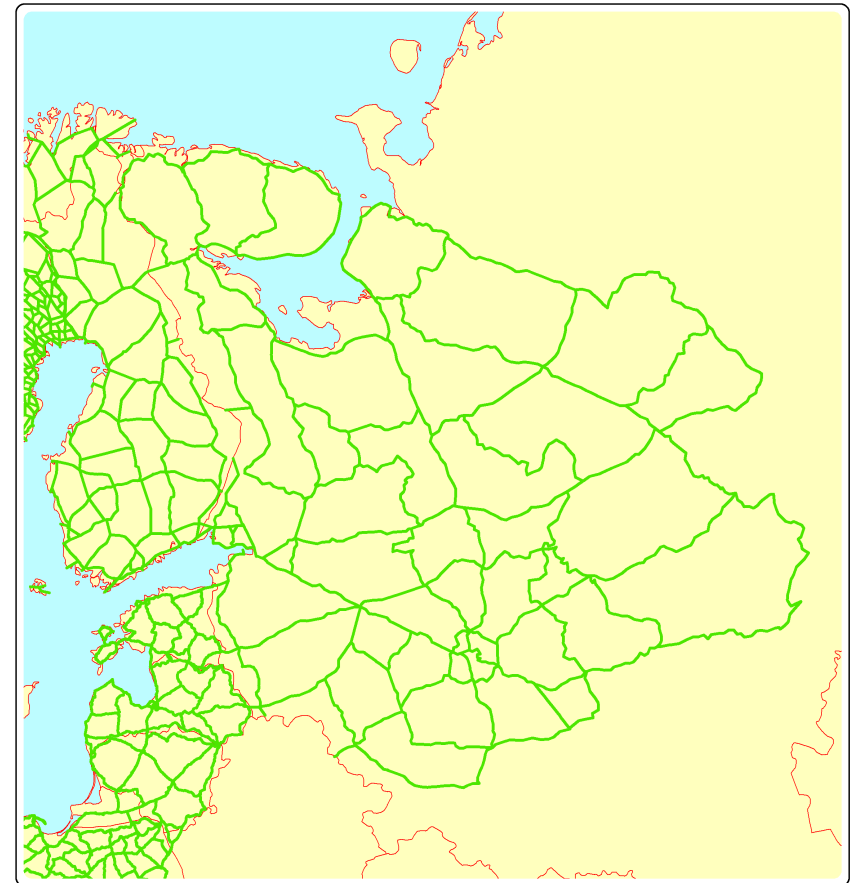
- Border connections mainly from the 1970s to
  - Estonia (2)
  - Latvia (1)
  - Lithuania (2 to Kaliningrad Region)
  - Poland (2 to Kaliningrad Region)

- Border connections to Finland
  - 8 connections have been observed between1989 and 2006
  - 6 connections already useable, 2 only incompletely available

- Parameter of the network
  - 109 nodal points
  - 155 observations
  - a-posteriori-s_0 (1 km): 2.03 mm
  - Problem: no uniform epoch (measurements from1967 – 2006)
 - Border connections to Baltic states about 40 years old

- 358 lines from DK(13), SE (212), FI(38), RU(13), EE(13), LV(30),LT(9), PL(17), DE(13) reduced to epoch 2000 (by NKG2005LU)

- Perimeter 7052 km, Misclosure 45.5 kgal·mm

- permissible value $Z_U = \pm 2 \cdot \sqrt{U}$
 (Z_u in mm, U perimeter in km):

168 mm
(ca. 164.6 kgal·mm)

Height variations to EVRF2007 in the neighboring countries of Russia

0.025 m | pos. | neg.
height variation
— Lines 2012
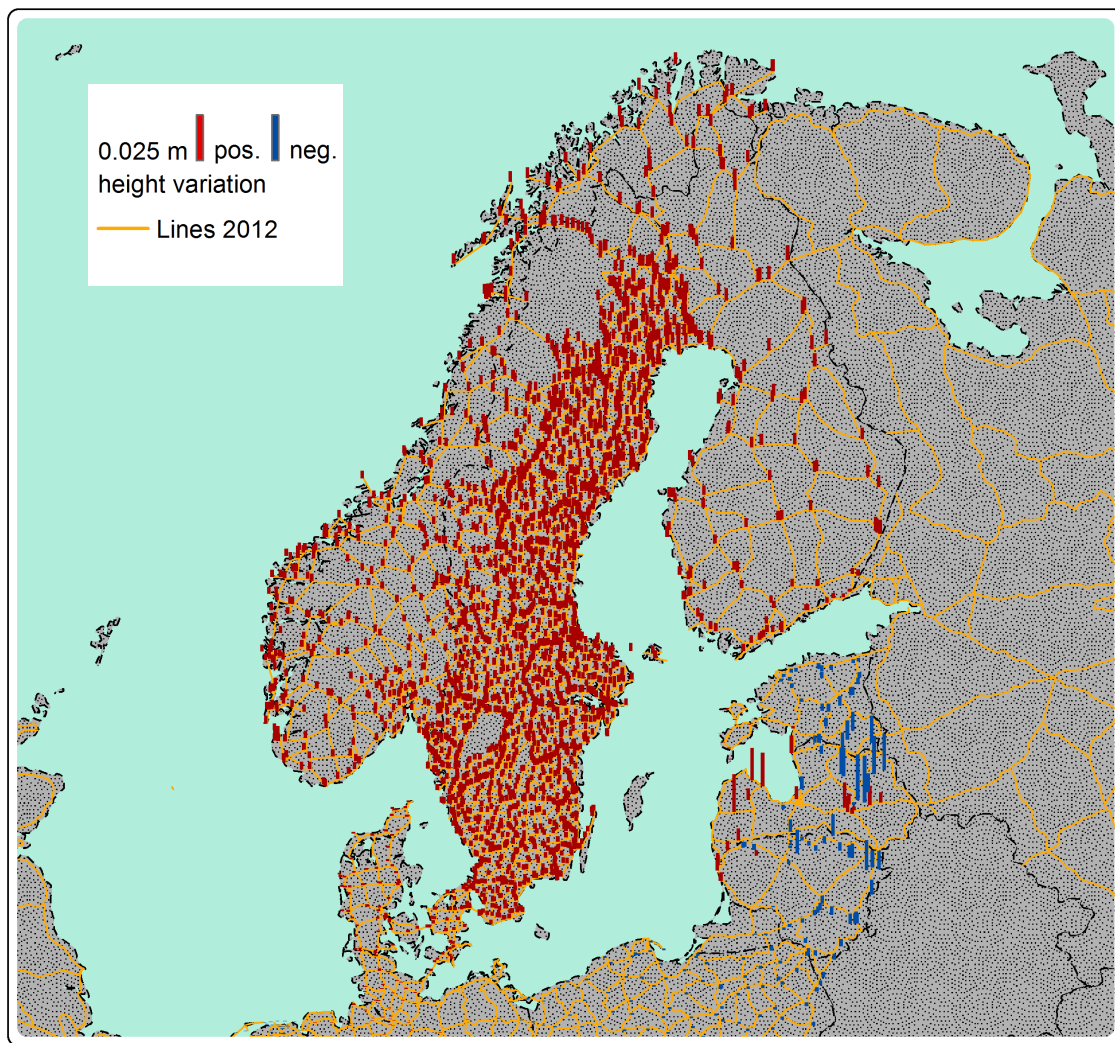
- Misclosures of cross-border loops influence mainly the network with the bigger variance!

- Variance component estimation - standard dev. /variance factor:

  - DK: 0,91/ 0,83
  - SE: 1,00/ 1,00
  - FI: 0,74/ 0,54
  - RU: 2,26/ 5,11
  - EE: 1,22/ 1,49
  - LV: 0,77/ 0,59
  - LT: 0,83/ 0,69
  - PL: 0,89/ 0,78
  - DE: 0,85/ 0,71

Height variations in the neighboring countries of Russia (modified variances in RU)
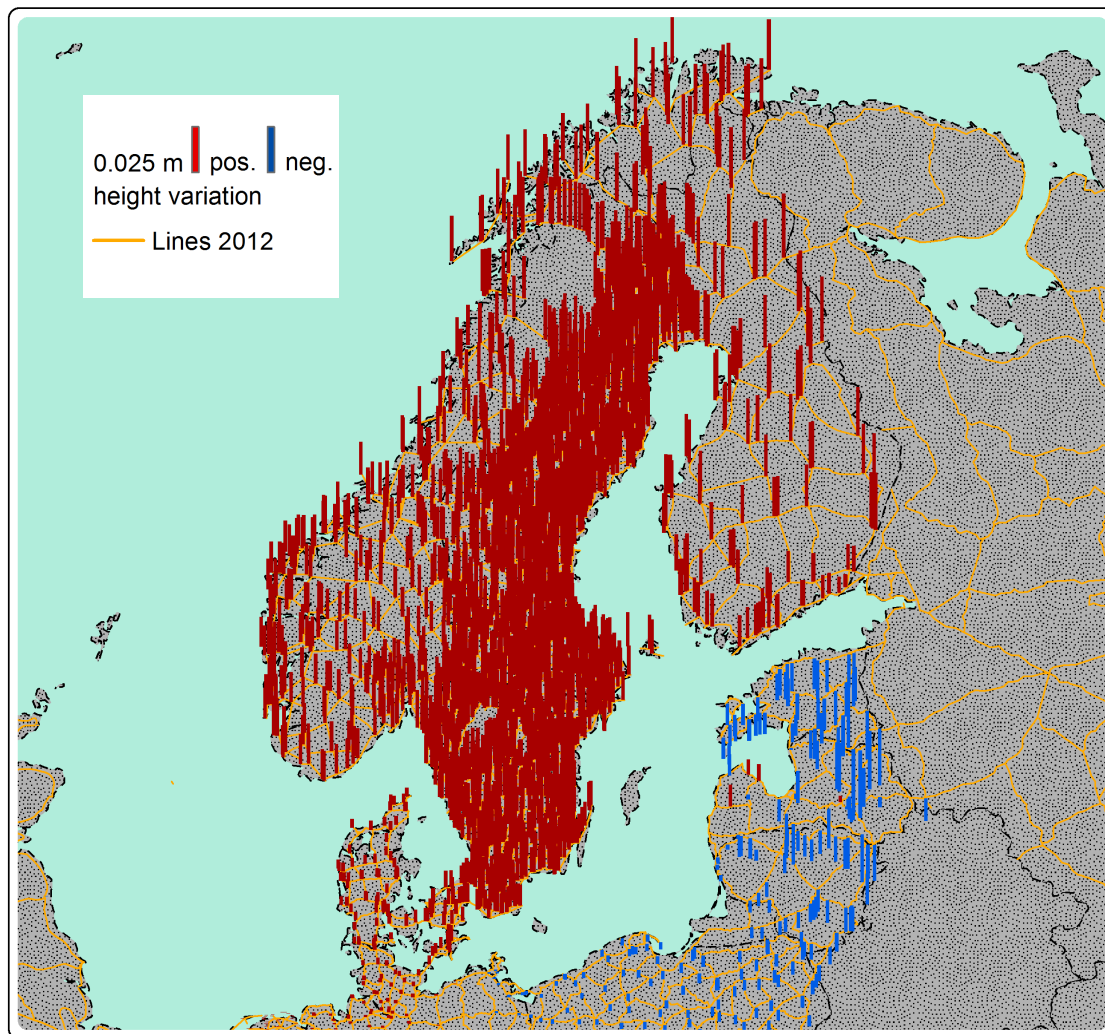
n Russia variance factor set to 1,00:

- DK: 0,83
- SE: 1,00
- FI: 0,54
- RU: 1,00
- EE: 1,49
- LV: 0,59
- LT: 0,69
- PL: 0,78
- DE: 0,71

- Measurements between 2001 and 2008

- Denser then the old network part in EVRF2007

- 150 nodal points

- 219 lines

- s_0 = 2.39 kgal·mm

- Different network configuration

- Fitting of border connections?

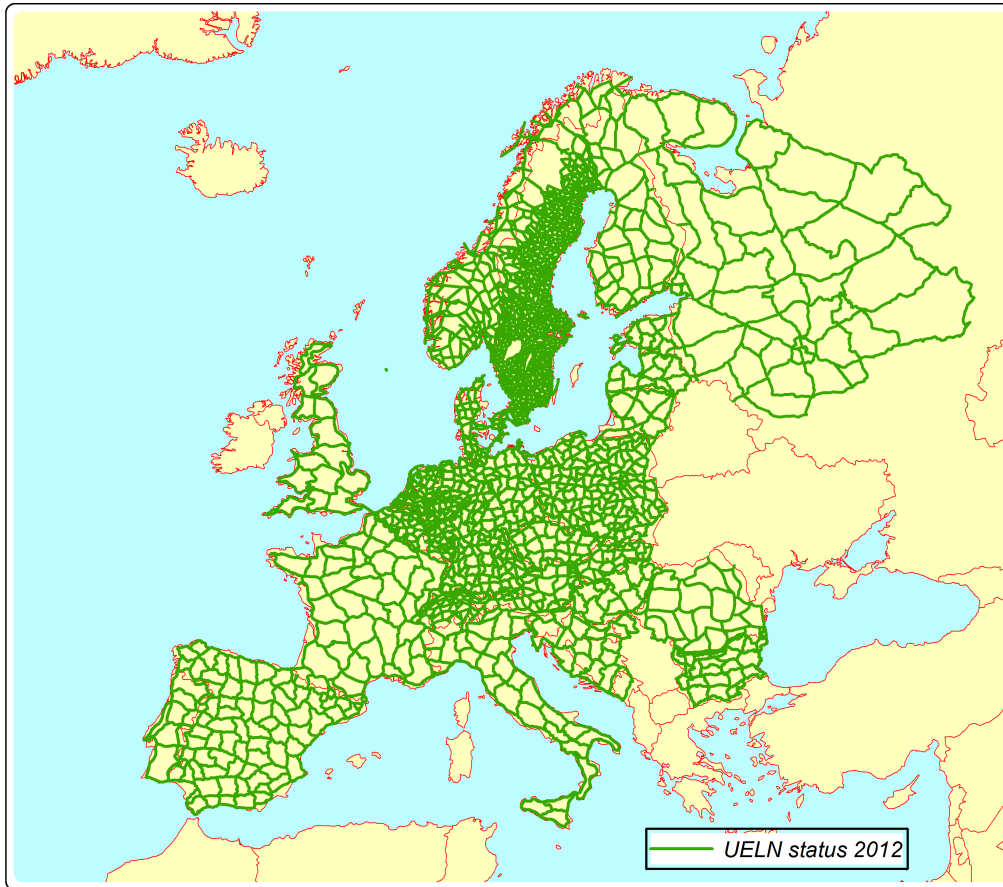- Only a few identical points (most of them are border connection points)

UELN status 2012
UELN status 2008

Differences between EVRF2007 and adjustment 2012 - Spain
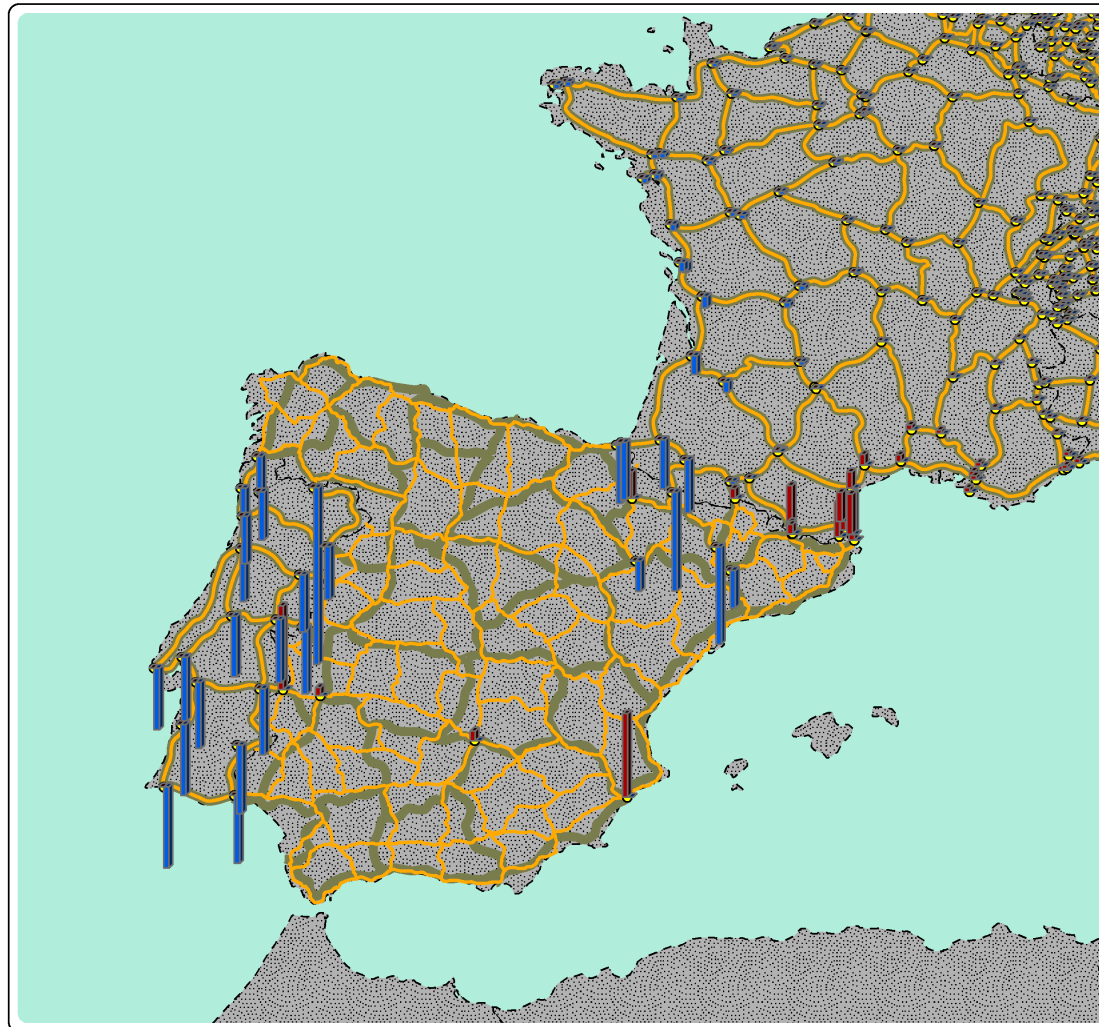
0.025 m pos. neg.
height variation
— Lines 2012
— Lines EVRF2007
○ identical points

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UELN status 2012

- 28 countries
- 13 datum points of EVRS2007
- 8318 nodal points
- 10834 lines
- s_0 = 1.19 kgal·mm *(EVRF2007: 1.11)*
- s_H = 16.36 kgal·mm

Comparison of the adjustment parameters

Adjustment 2012 with new data of Russia, Latvia and Spain:

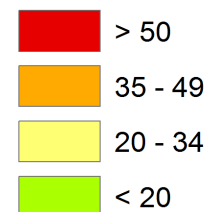| Parameter	UELN 95/98	EVRF07	Adjustment 2012
Number of datum points:	1	13	13
Number of unknowns:	3063	7939	8318
Number of measurements:	4263	10347	10834
Number of condition equations:	0	1	1
Degrees of freedom:	1200	2409	2517
A-posteriori standard deviation referred to 1 km levelling distance in kgal·mm:	1.10	1.11	1.19
Mean value of the standard deviation of the adjusted geopotential numbers (heights), in kgal·mm:	19.64	16.05	16.36
Average redundancy:	0.281	0.233	0.232

- point "Kronstadt" is Datum point in the Russian system with H=0.000 m

- Adjustment with the same parameters as in EVRF2007:
$$H_{zero} \text{ (Kronstadt)} = 0.187 \text{ m}, s_H = 0.023 \text{ m}$$

- Conversion to mean tidal system
$$H_{mean} \text{ (Kronstadt)} = \textcolor{red}{0.150 \text{ m}}$$

- 2 Vertical Coordinate Reference Systems in Eastern Germany – possibility of comparision:
  - SNN76 (related to Kronstadt by measurements from the 50s)
  - DHHN92 (related to NAP by UELN73/86)
  - Mean Difference: 0.142 m

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Age of Measurements

Years

🟥	> 50
🟧	35 - 49
🟨	20 - 34
🟩	< 20

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Country	Status	Data available at EVRS data center	Problems, missing data …
France	information about zero-order leveling network NIREF (1983-2011?)	no	tilt between IGN69 and NIREF, N-S bias in IGN69 suspected (23 cm)
Russia	European part of 1. O. leveling network provided	yes	2 border connections to Finland incomplete
Belarus	data preparation and border connections finished	no	
Ukraine	data preparation in progress	no	
Montenegro	March 2012: Request to participate in UELN	no	
Germany	Re-observation of German 1.O. leveling network	yes	Measurements will be finished end of 2012
Italy	New leveling data will be provided in the next years	no	Gravity data and border connections to CH are in preparation

Thank you for your attention!