Federal Agency for
Cartography and Geodesy

New data of Belarus and Estonia and the new Nordic land uplift model contribute to UELN

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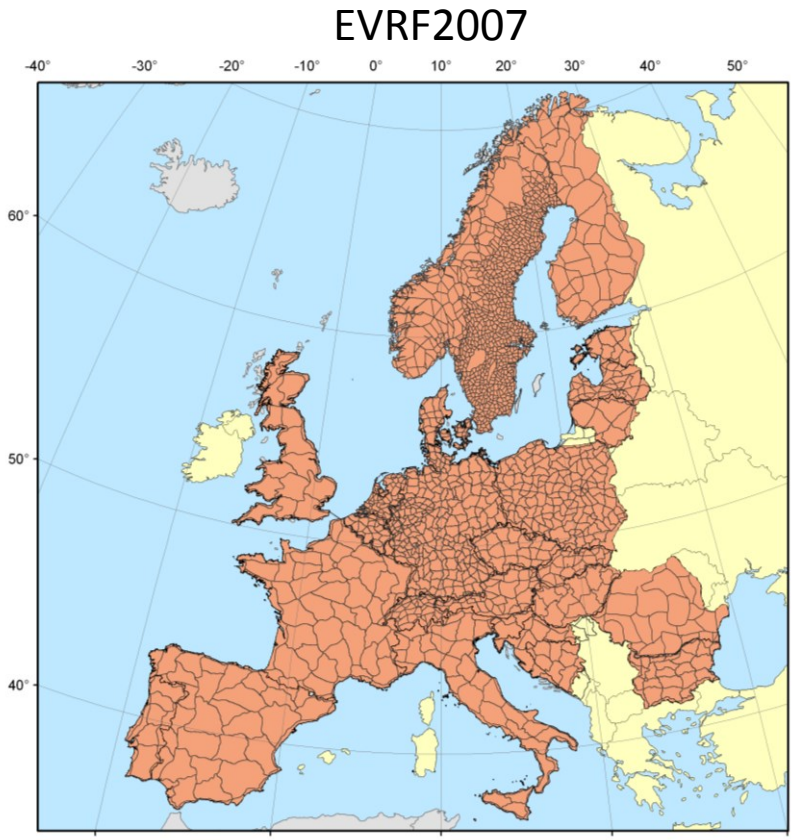
Contents

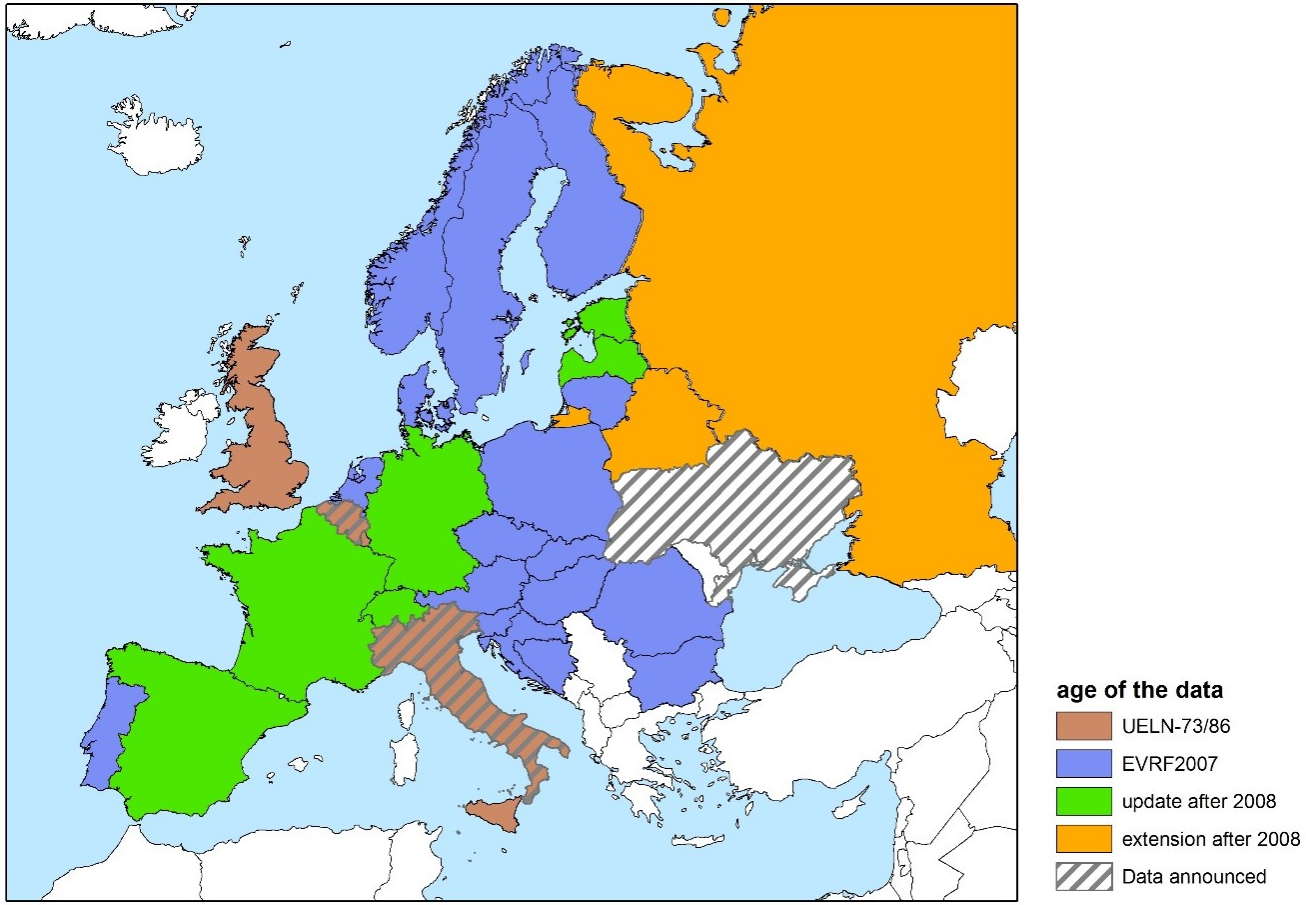
- **Development since 2008**
- New data of Estonia
- Adding the leveling network of Belarus
- Data corrections in the Netherlands
- Effect of the new land uplift model NKG2016LU_lev
- Outlook

Development since 2008

Latvia (2011)	update
Russia(2012)	extension
Spain (2012)	update
Report on results Paris 2012	
Latvia (2012)	update
Germany (2015)	update
Report on results Leipzig 2015	
France (2015)	addition of NIREF
Switzerland (2015)	update
Report on results San Sebastian 2016	
Netherlands (2016)	corrections
Estonia (2016)	update
Belarus (2017)	extension



Currentness of leveling data



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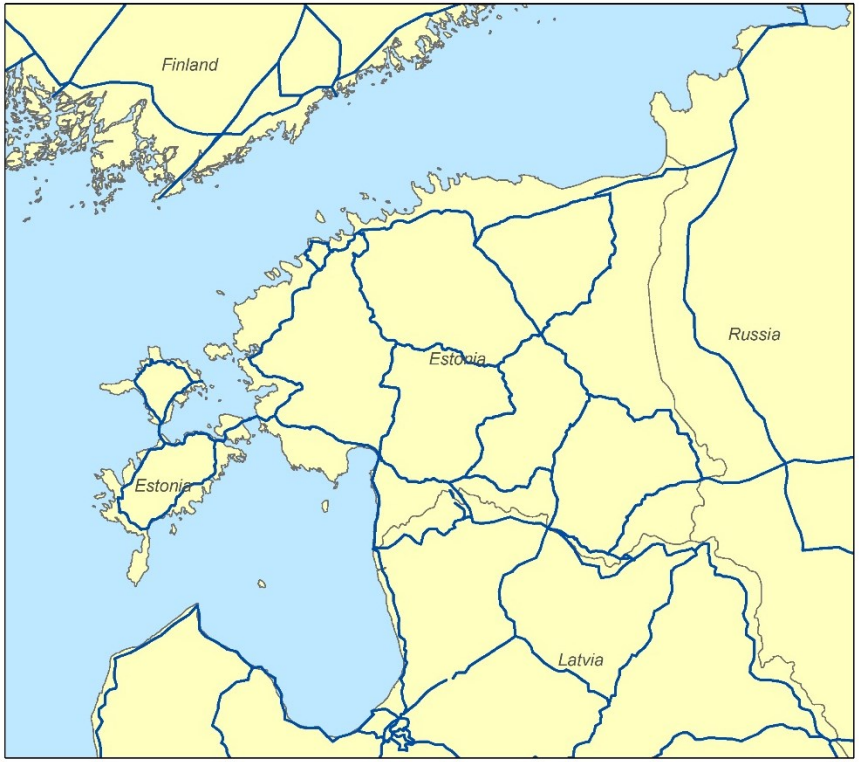
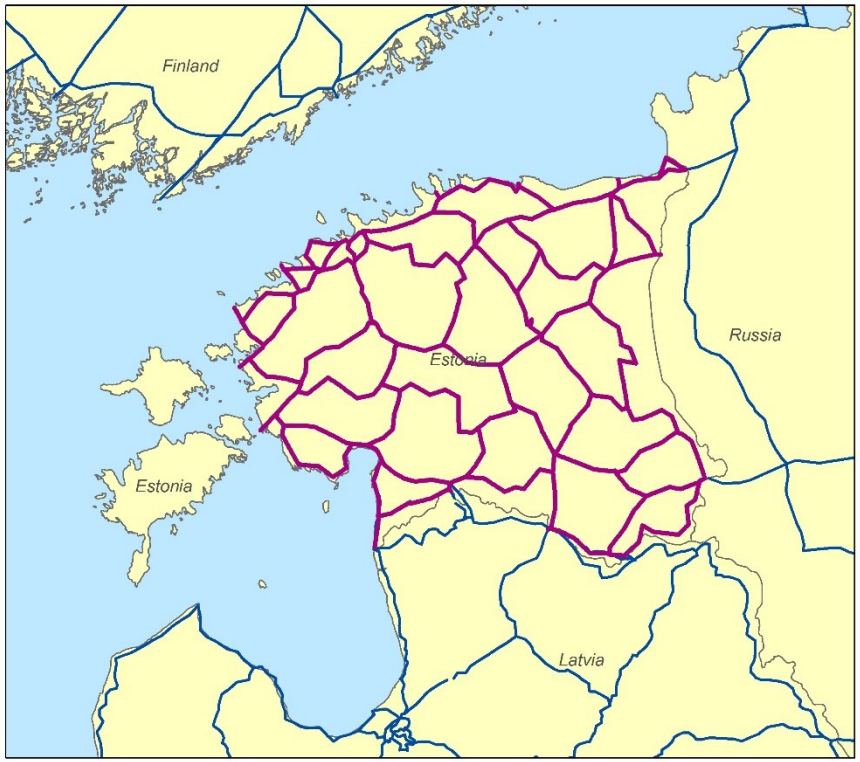
Leveling data of Estonia

Epoch 1970-1996



Epoch 2003-2016



Adjustment results for Estonia

	Epoch 2003-2016	**Epoch 1970-1996**
Number of nodal points	367	68
Number of observations	418	76
Degrees of freedom	52	9
A-posteriori standard deviation (in kgal·mm)	0,25	1,27

Border connections to Latvia (4, new)
Russia (2, old)

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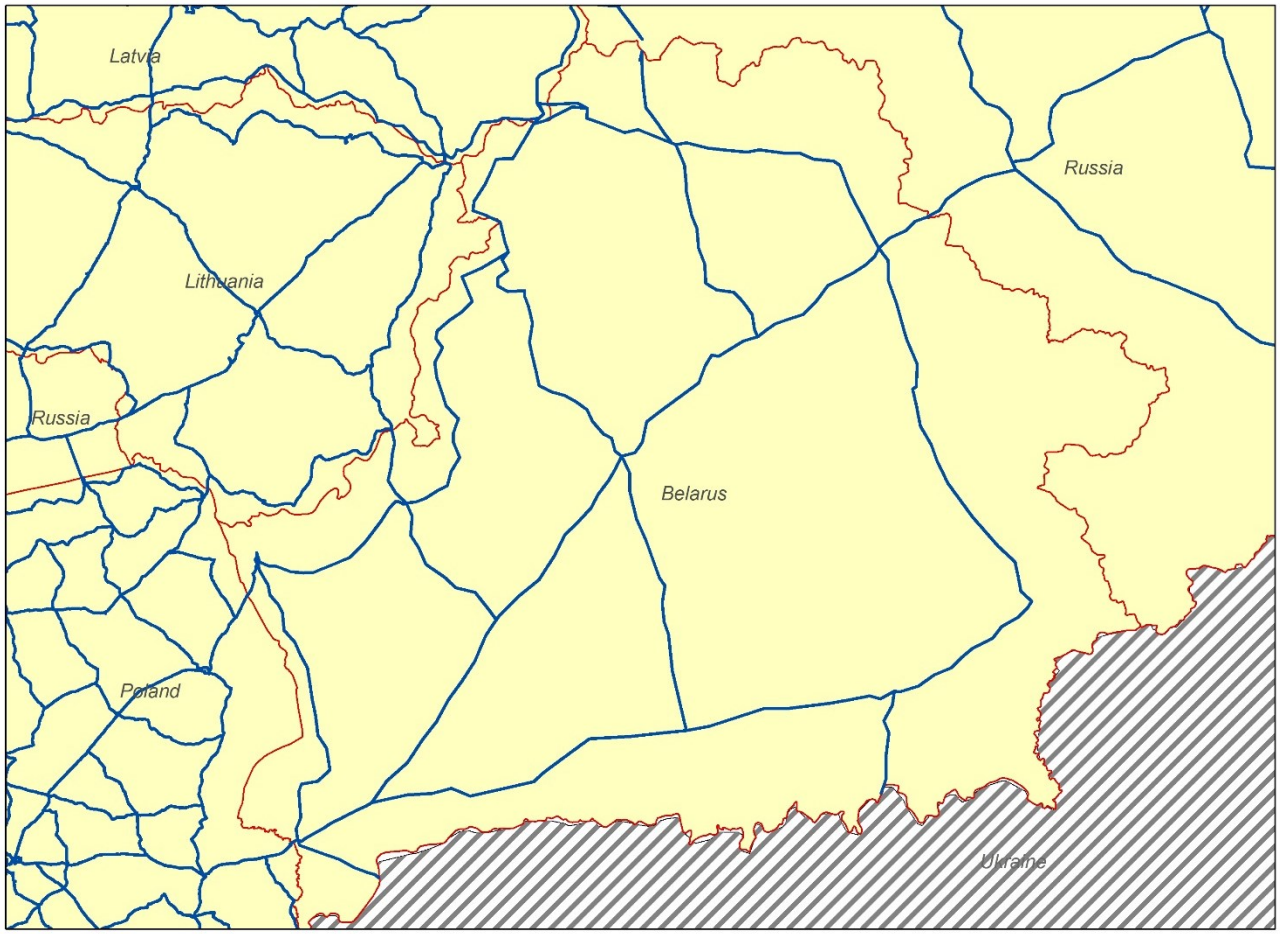
Including of leveling network of Belarus



Adjustment results for Belarus

Epoch of measurements	1993-2004
Number of nodal points	24
Number of observations	30
Degrees of freedom	7
A-posteriori standard deviation (in kgal·mm)	2,05

Border connections: 2 to Poland (1977, 1975)
1 to Lithuania (1972)
2 to Latvia (1980, 1986)
2 to Russia (1993, 2003)

available for the future: 2 to Ukraine (1970, 1994)

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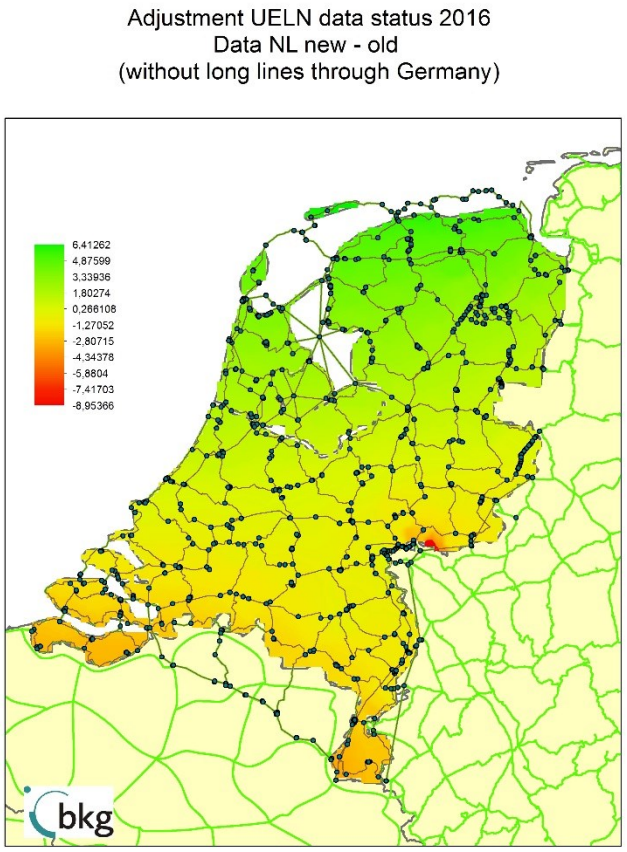
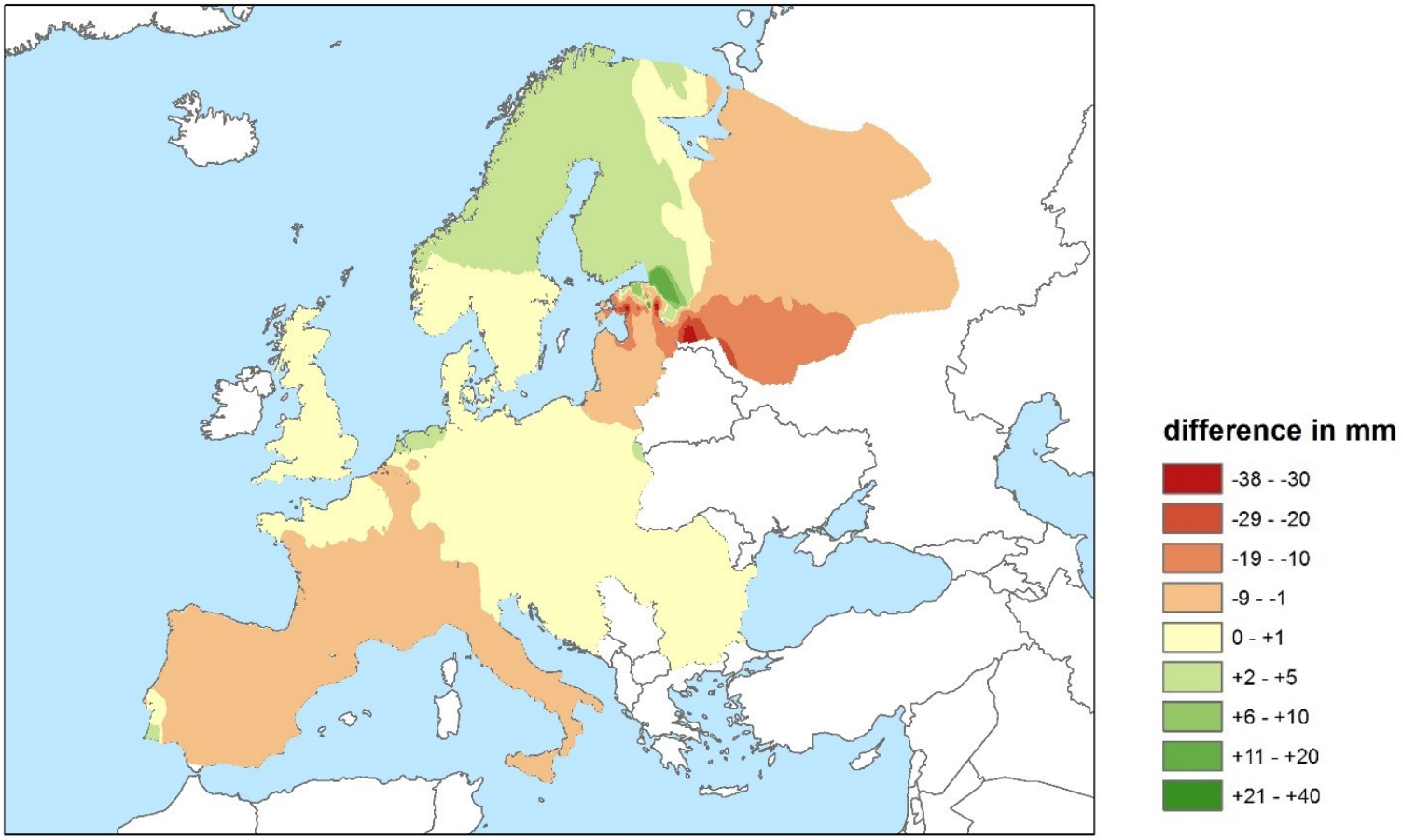
Corrections of the Dutch dataset



- Within the scope of a master's thesis at TU Delft (in collaboration with Rijkswaterstaat) a corrected dataset of the Netherlands has been provided
- Geopotential numbers are corrected because of corrected gravity values in some areas
- Deleting of some long lines which run through German territory - there are more recent measurements in the German dataset from 2015
- Tilt in the N-S direction from +6 to -3 mm
- Local differences up to -8mm

Effect of the new data on the adjusted heights

Difference Adjustment results
UELN 2017/03 minus UELN 2016/08



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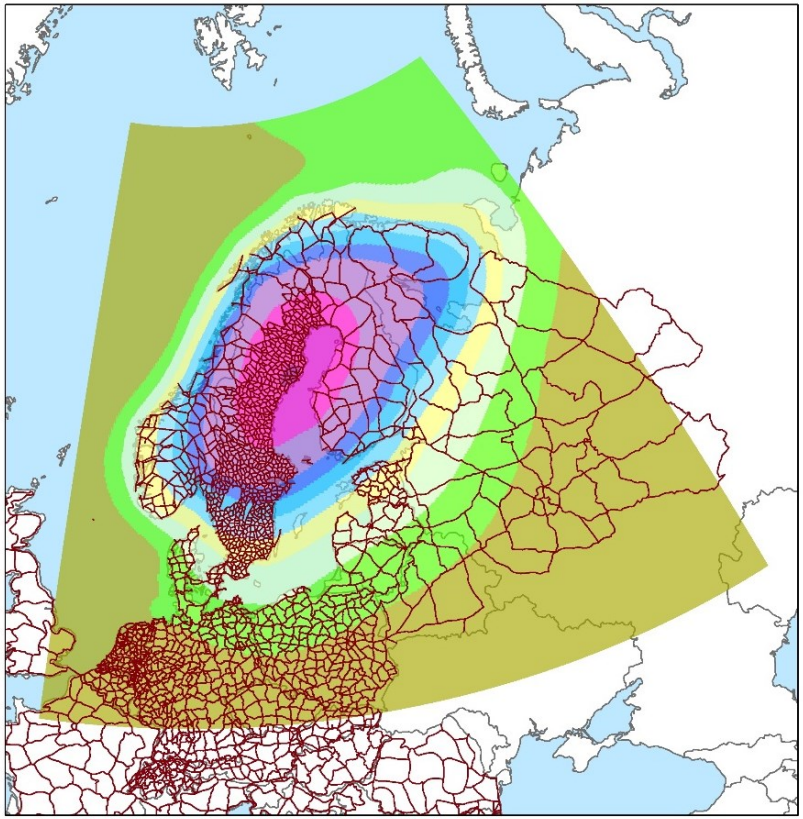
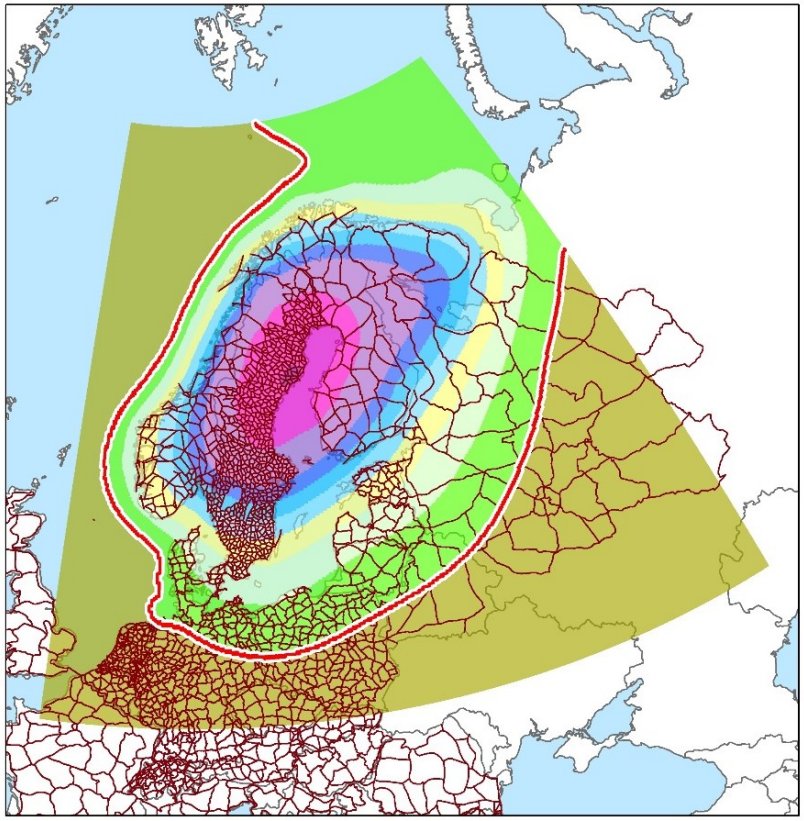
NKG2005LU



velocity in mm/year

- -2,99 - -2,00
- -1,99 - -1,00
- -0,99 - 0,00
- +0,01 - +1,00
- +1,01 - +2,00
- +2,01 - +3,00
- +3,01 - +4,00
- +4,01 - +6,00
- +6,01 - +8,00
- +8,01 - +9,63
- UELN lines status 03/2017

NKG2005LU with contour line of -2mm/year

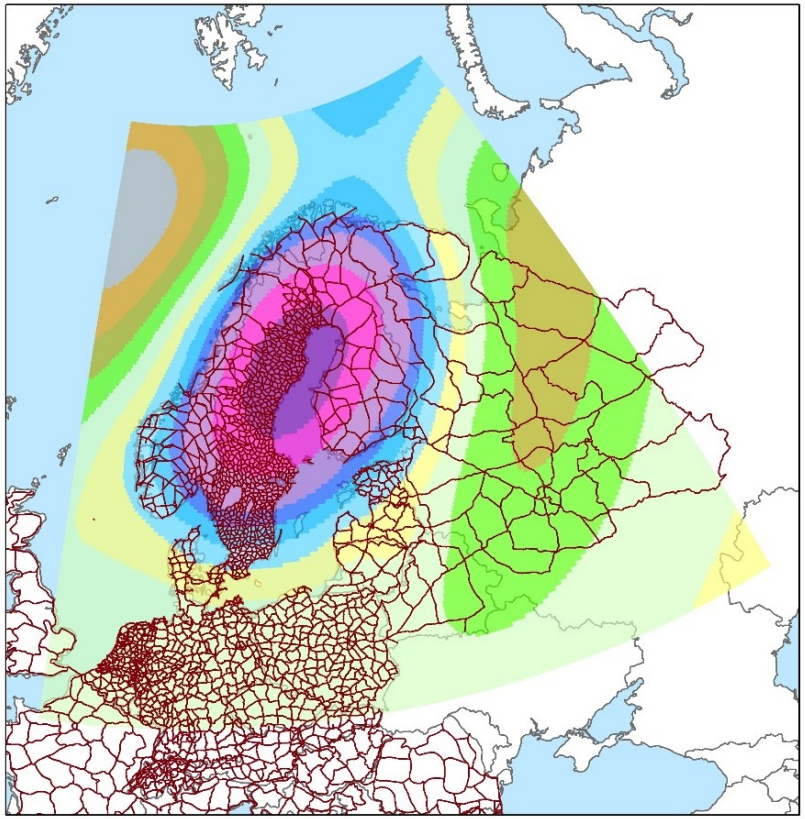


Outside contour line -2mm/year all values are truncated to this value

velocity in mm/year

- -2,99 - -2,00
- -1,99 - -1,00
- -0,99 - 0,00
- +0,01 - +1,00
- +1,01 - +2,00
- +2,01 - +3,00
- +3,01 - +4,00
- +4,01 - +6,00
- +6,01 - +8,00
- +8,01 - +9,63
- Countour of -2mm/year in NKG2005LU
- UELN lines status 03/2017

NKG2016LU_lev

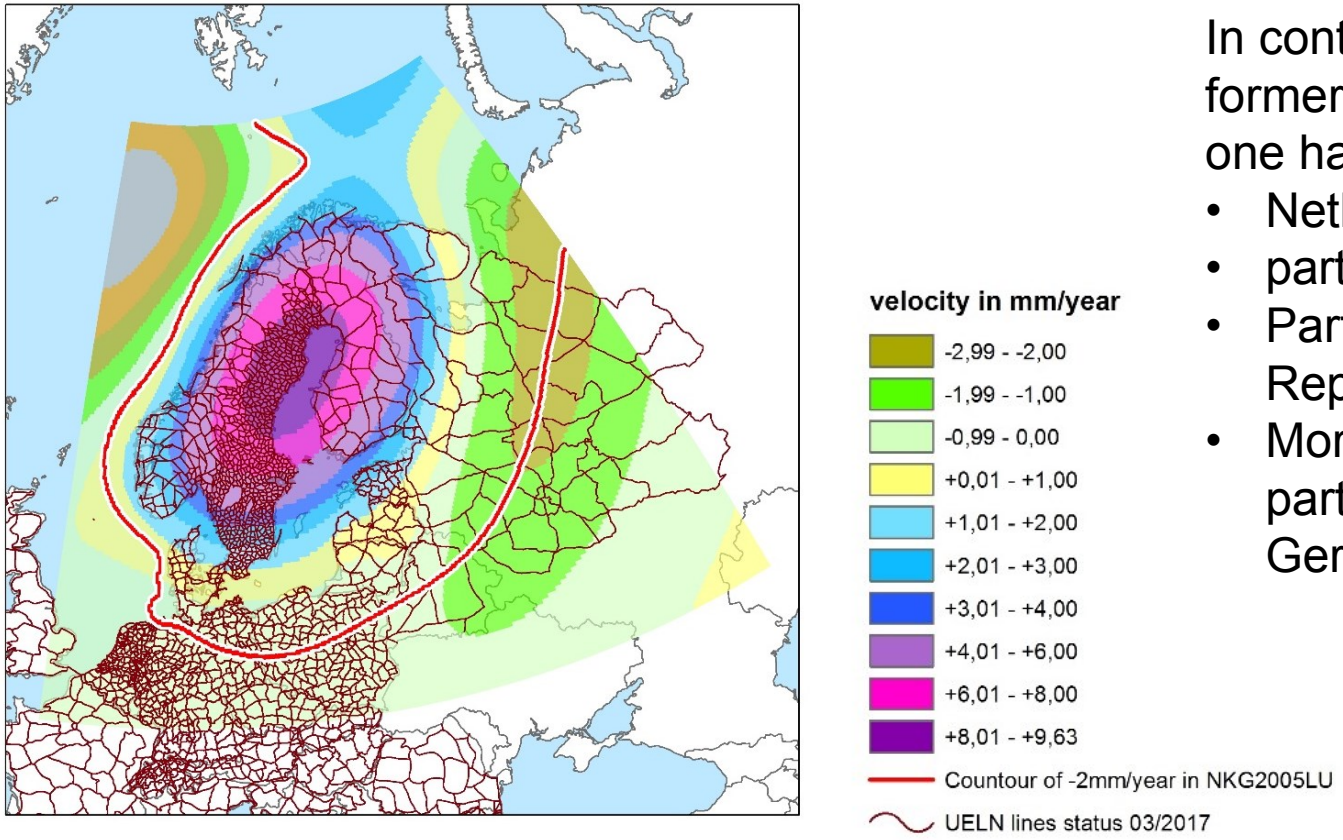


Vestøl et al: **NKG2016LU, an improved postglacial land uplift model over the Nordic-Baltic region.** *NKG meeting WG of Geoid and Height Systems. June 2016*

velocity in mm/year

- -2,99 - -2,00
- -1,99 - -1,00
- -0,99 - 0,00
- +0,01 - +1,00
- +1,01 - +2,00
- +2,01 - +3,00
- +3,01 - +4,00
- +4,01 - +6,00
- +6,01 - +8,00
- +8,01 - +9,63
- UELN lines status 03/2017

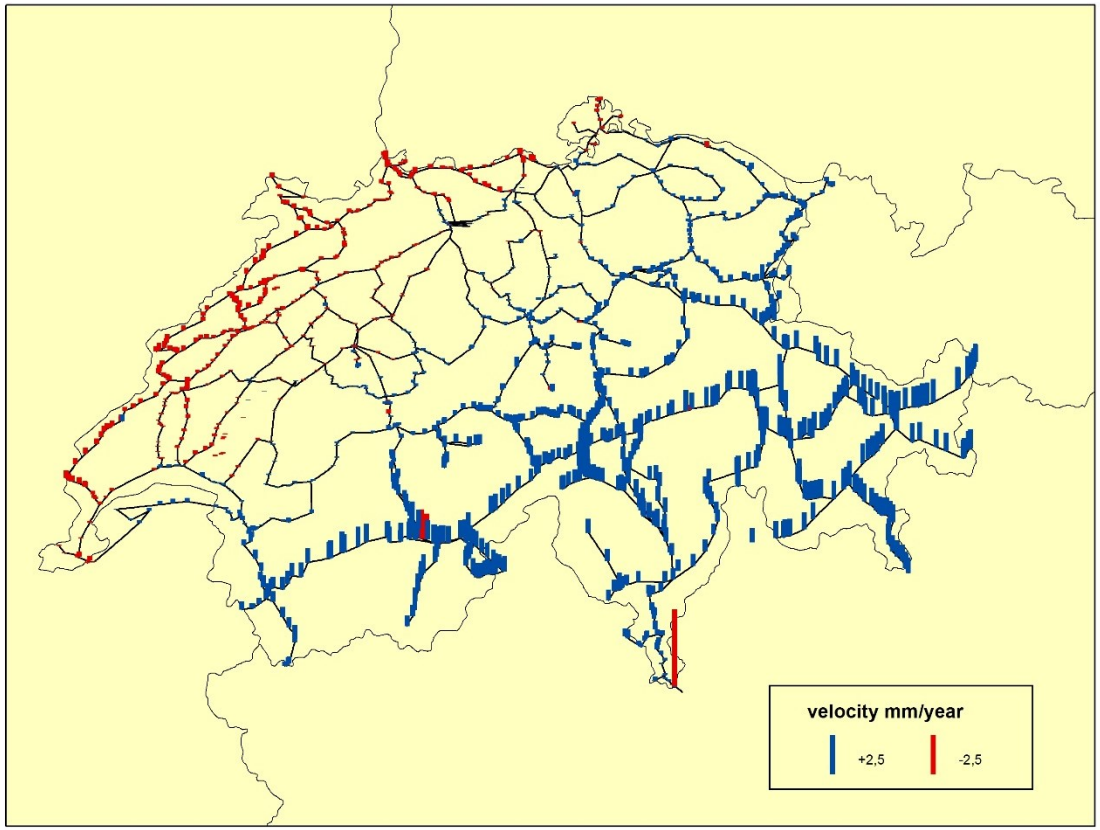
NKG2016LU_lev with contour line of NKG2005LU -2mm/year



In contrast to the former model the new one has impact on

- Netherlands
- parts of France
- Parts of Czech Republic
- More southern parts of Poland, Germany

Consideration of the vertical velocities of the Swiss points

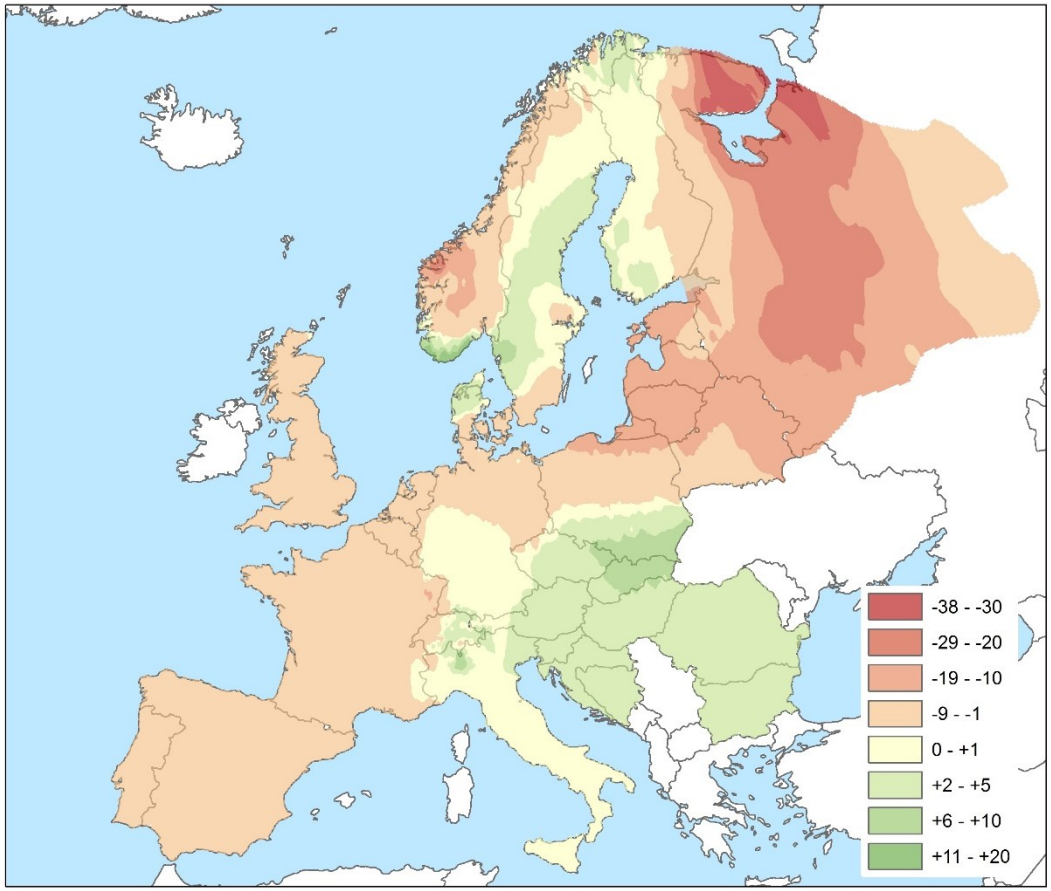


- Velocities from dataset UELN2015
- Graphic shows all points in UELN adjustment – including any instable points
- A posteriori - Standard deviation from adjustment CH in kgal·mm:
  - Static: 1,09
  - Kinematic : 0,86

Velocities from:
CHVRF15/UELN15
Bundesamt für Landestopografie swisstopo
Bereich Vermessung
Dr. Andreas Schlatter / Dr. Urs Marti

Effect of the new uplift model on the adjusted heights

Adjustment UELN 2017/03 with NKG2016LU_lev (+ CH kinematic) minus NKG2005LU (CH static)

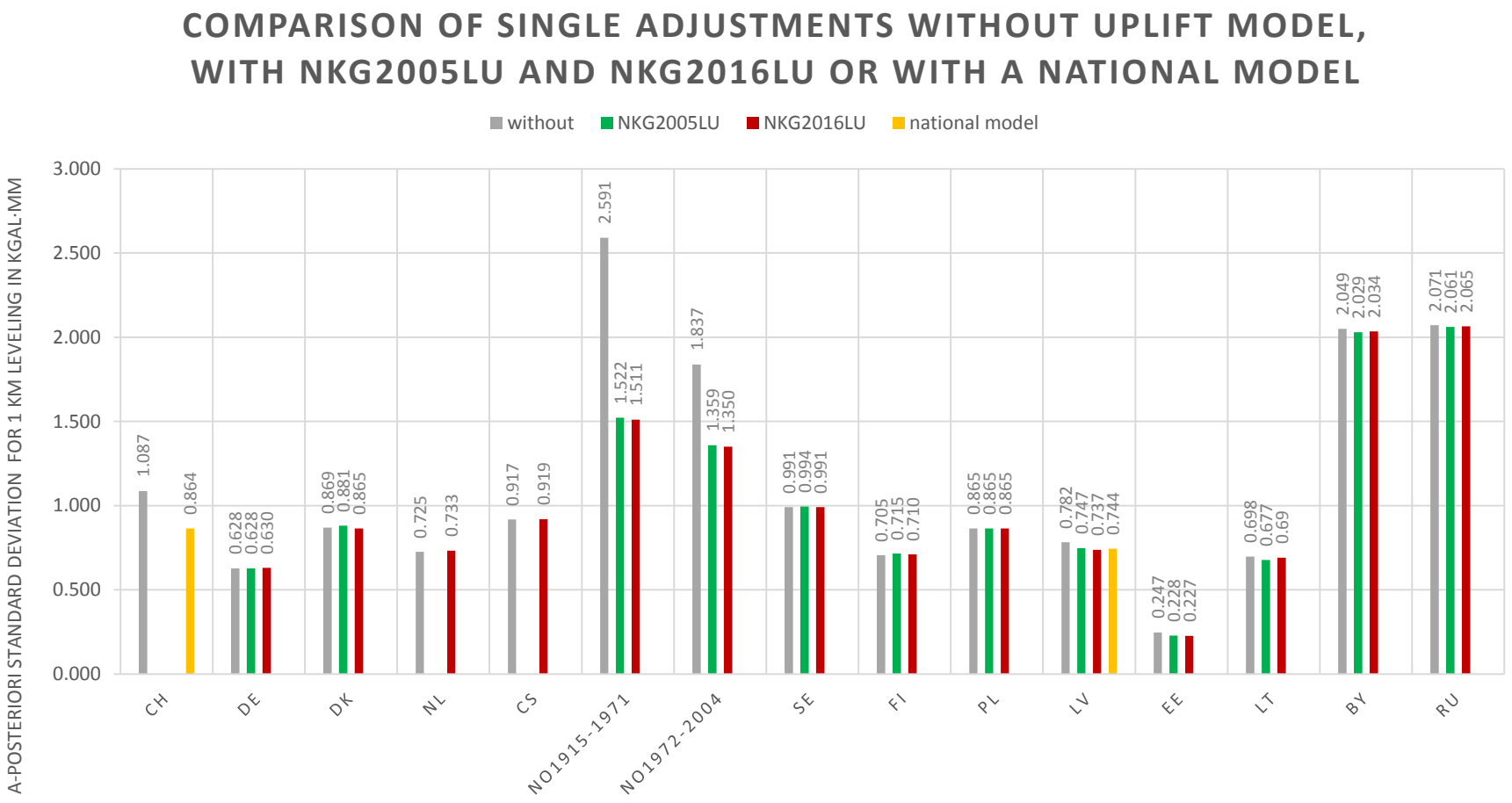


country	mean	min	max
RU	-13,9	-39,3	0,7
LT	-11,3	-11,8	-10,8
LV	-10,8	-11,8	-8,6
EE	-10,4	-11,8	-7,8
BY	-9,5	-13,0	-3,0
NO	-3,5	-24,3	19,5
PT	-2,3	-2,3	-2,3
ES	-2,3	-2,3	-2,3
FR	-2,1	-28,0	-0,1
PL	-1,7	-13,1	10,0
GB	-1,5	-1,5	-1,5
BE	-1,2	-1,3	-1,1
DK	-1,2	-3,9	5,1
NL	-1,1	-1,5	-1,0
DE	-1,1	-7,0	1,8
FI	-0,1	-3,6	4,8
CH	0,2	-28,7	16,8
SE	0,5	-6,8	7,0
IT	0,7	-0,3	2,1
SI	1,8	-1,2	3,1
AT	2,0	0,1	3,5
CS	3,0	-1,7	7,7
HR	3,1	2,6	3,4
HU	3,7	0,4	4,8
BG	4,3	4,3	4,3
RO	4,3	4,1	4,5
SK	6,0	3,2	9,1

Effect of land uplift model on accuracy of adjustment results

- On one hand: A realistic model should result in a higher accuracy of the adjustment
- On the other hand: on the edges of the model the effect of the land uplift is probably smaller than other effects including leveling errors

Effect on the standard deviation from single adjustments



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Effect of land uplift model on accuracy of adjustment results

- On one hand: A realistic model should result in a higher accuracy of the adjustment
- On the other hand: on the edges of the model the effect of the land uplift is probably smaller than other effects including leveling errors
- Altogether the effect on the standard deviation is very small: in the most cases only the 3rd decimal place is affected
- Effect of the land uplift model on leveling adjustment depends on time difference between neighboring measurements (time required for closing a loop)

Adjustment results with the new data of Belarus and Estonia and small corrections in the Netherlands

Results of free adjustment with 13 datum points of EVRF2007:

	Adjustment 2016/08	**Adjustment 2017/03 NKG2005LU**	**Adjustment 2017/03 NKG2016LU_lev**
Number of nodal points	9869	10165	10165
Number of observations	12574	12882	12882
Degrees of freedom	2706	2718	2718
A-posteriori standard deviation (in kgal·mm)	1,12	1,12	1,11
Mean standard deviation of adjusted heights (in kgal·mm)	19,13	19,18	19,17

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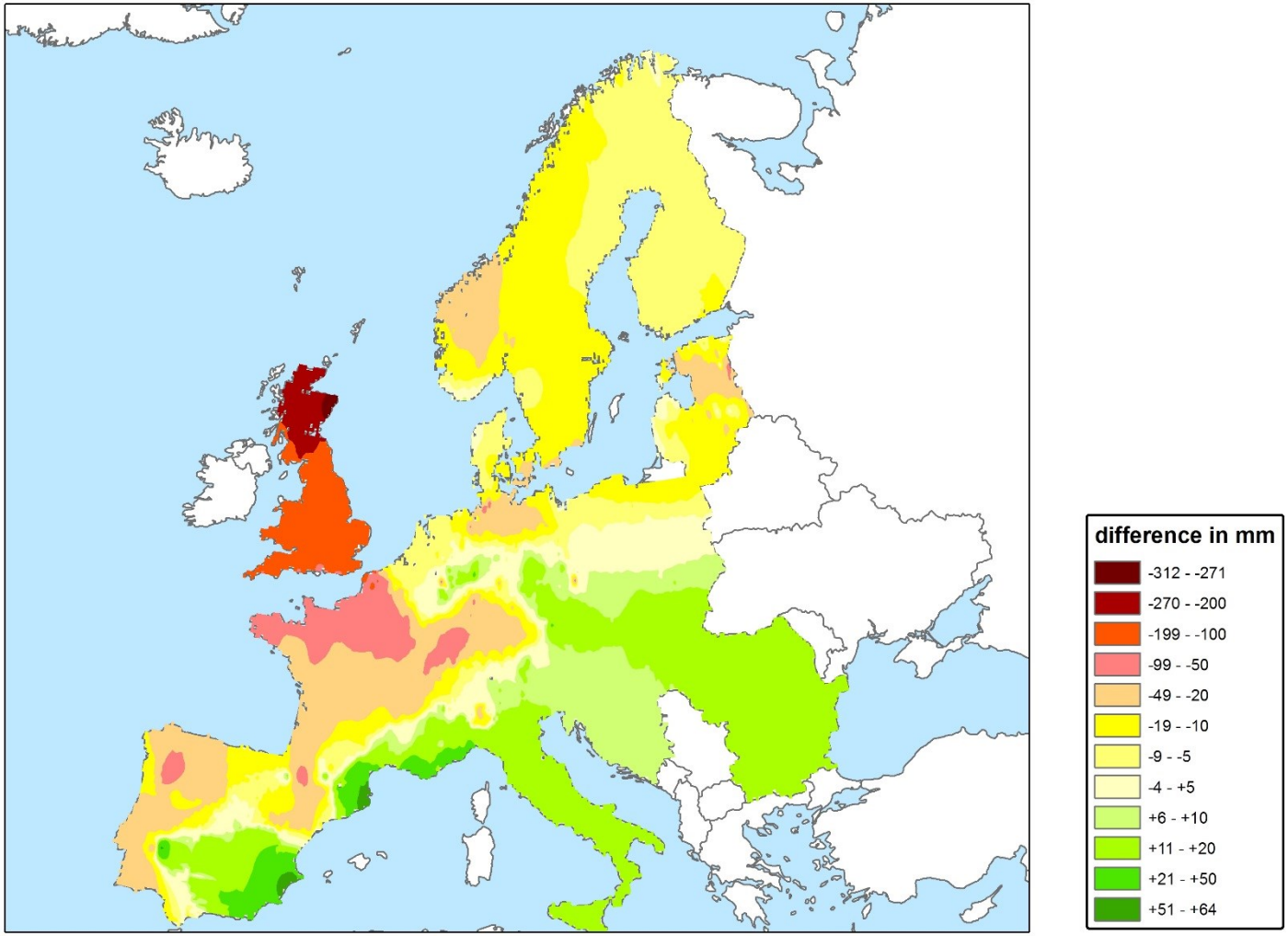
Conclusions and Outlook (1)

- Still waiting for data from Italy
- Update of the network of Slovenia announced
- More recent data of Belgium announced
- Contact with Ukraine has been resumed
  - They still intend to join UELN
  - Data preparation nearly finished
- Any further new data?
  - Resolution No. 4 EUREF 2015:… **“asks the NMAs to provide any new levelling to the UELN data center “**
- All incoming data are promptly analyzed – a new EVRS realization can be published upon request

Difference adjustment results UELN 2017/03 - EVRF2007



Conclusions and Outlook (2)

- EVRF2007 was published 2008
- New EVRS realization should be provided 2018/2019
- Consideration of the kinematic characteristics
  - postglacial land uplift model NKG2016LU_lev
  - Swiss vertical uplift model
  - At the time of publication the reference epoch 2000 will be dated back nearly 20 years
  - Influence of the velocity errors increases with the difference between epoch of the measurements and reference epoch
  - Providing an additional reference epoch close to the time of publication of EVRFxx
  - and/or publishing also the velocities of the leveling points

Conclusions and Outlook (3)

- Choice of the Tidal system
  - **IAG resolution No. 16** adopted in **Hamburg 1983** recommends **zero tide** for various geodetic quantities (never implemented by the GNSS community)
  - **IAG resolution No. 1** adopted in **Prague 2015** resolves **mean tide** for an International Height System
  - Users expect conformance of heights with mean see level
  - Providing mean tide for “normal users” + conversion term to zero tide for scientific approaches
- Subsequent providing a corresponding gravity field approach
  - EUVN_DA update
  - Leveling part can easily be changed
  - Request for available new GNSS data
  - Finally providing of a correction surface to a European geoid model

Thank you for your kind attention!

Contact:

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