Federal Agency for
Cartography and Geodesy

EVRF2019 as new realization of EVRS

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Development of the network since 2008

New data already included before symposium 2018

Latvia	(2011)	update
Russia	(2012)	extension
Spain	(2012)	update
Latvia	(2012)	update
Germany	(2015)	update
Switzerland	(2015)	update
France	(2015)	addition of NIREF
Netherlands	(2016)	corrections
Estonia	(2016)	update
Belarus	(2017)	extension
Belgium	(2018)	update
Ukraine	(2018)	extension
Czech Rep.	(2018)	update

Data input after EUREF symposium 2018

Data included additionally in preliminary solution:

- Slovenia: April 2018
- Italy: August / September 2018
- Norway (Addition of measurements later than 2004): September 2018
- Czech Republic (minor update): September 2018
- Slovakia (minor update): September 2018

Preliminary solution of EVRF2019 in March 2019

Data delivered after March 2019:

- Austria (with many new border connections): April 2019
- 4 Slovenian border connections to Italy: April 2019

Further announced:

- Southern Italy
- Bulgaria
- North Macedonia

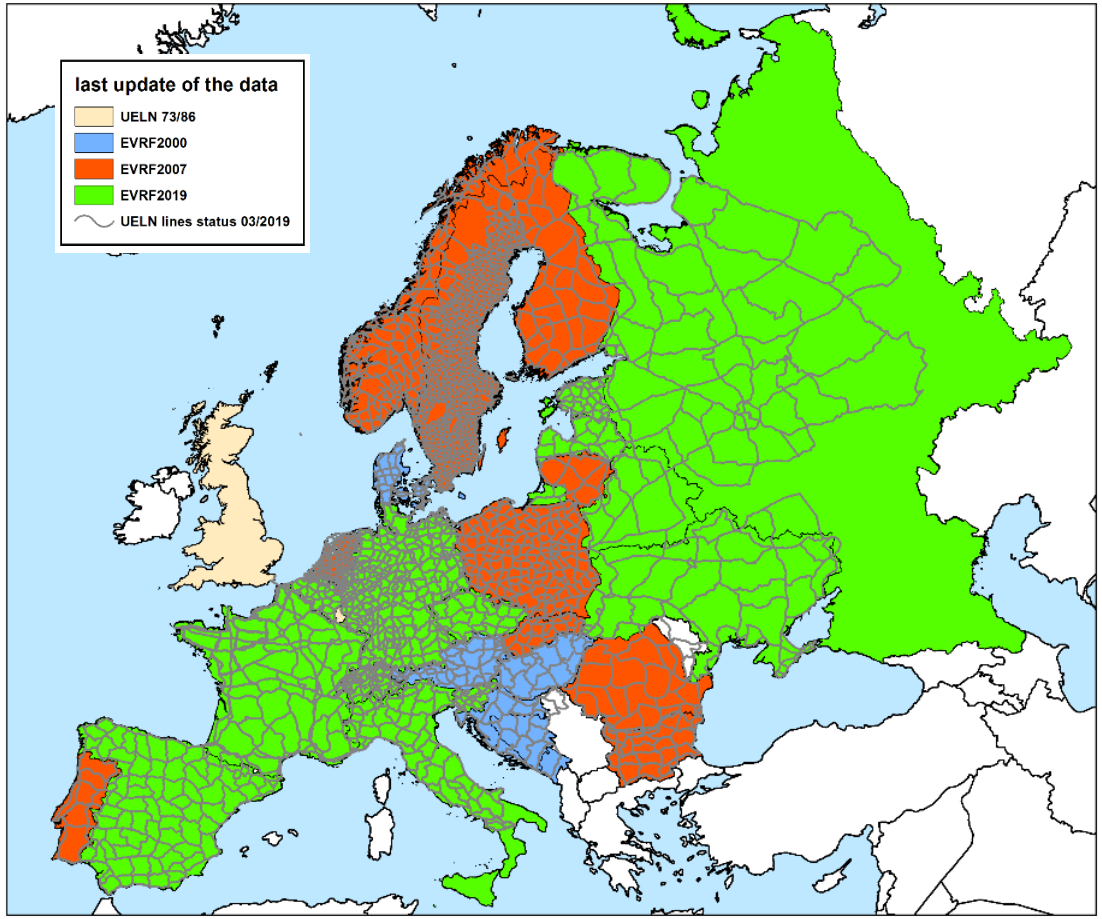
New leveling network of Slovenia

- Denser network than before
- Standard deviation for 1km ca. 0,50 mm
- Several former border connections have been destroyed
- In the solution of March 2019 only
  - 2 connections to Austria
  - 2 to Croatia
  - 0 to Italy
- **Since April 2019 available:**
  - 4 new connections to Italy measured in 2018
  - New connections to Austria possible because of new Austrian data

New data of Italy

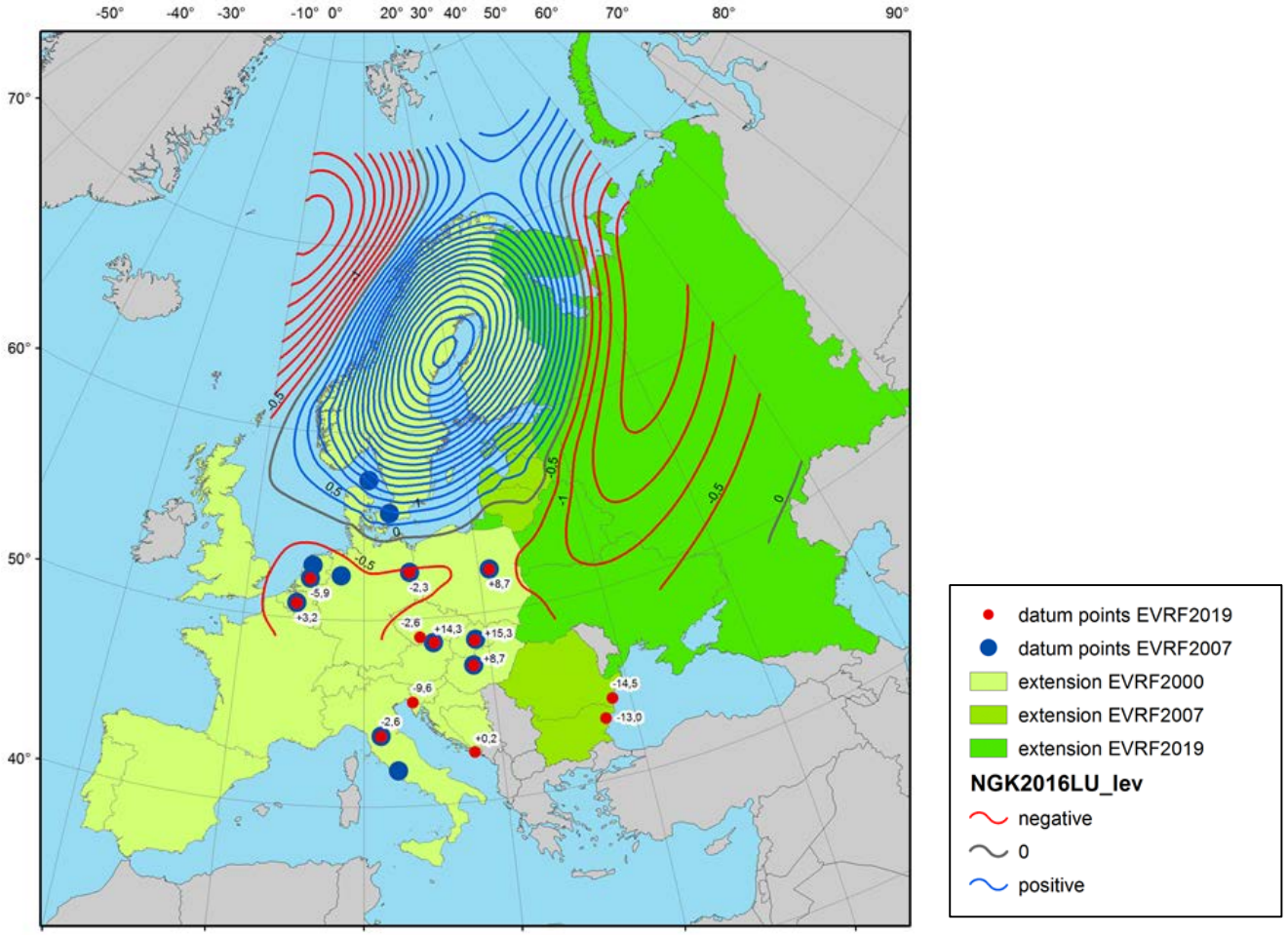
- New measurements don’t cover the whole country
- Standard deviation for 1km ca. 1.2mm
- Border connections to
  - France 4, 1 deleted → 3
  - Switzerland 4 (possibly 2-3 additionally)
  - Austria 2
  - Slovenia: 0
- Remaining data in the South are announced
- **Since April 2019 available:**
  - 4 connections to Slovenia
  - New connections to Austria possible

EVRF2019



- Update of the leveling networks of 13 countries since 2008
- Extension of the network to Russia, Belarus and Ukraine
- Computation of the heights for Great Britain as offset to national heights
  1. Height difference between ODN and EVRF2019 in mean tide determined by tunnel measurement
  2. Conversion of the difference to zero tide

Selection of datum points

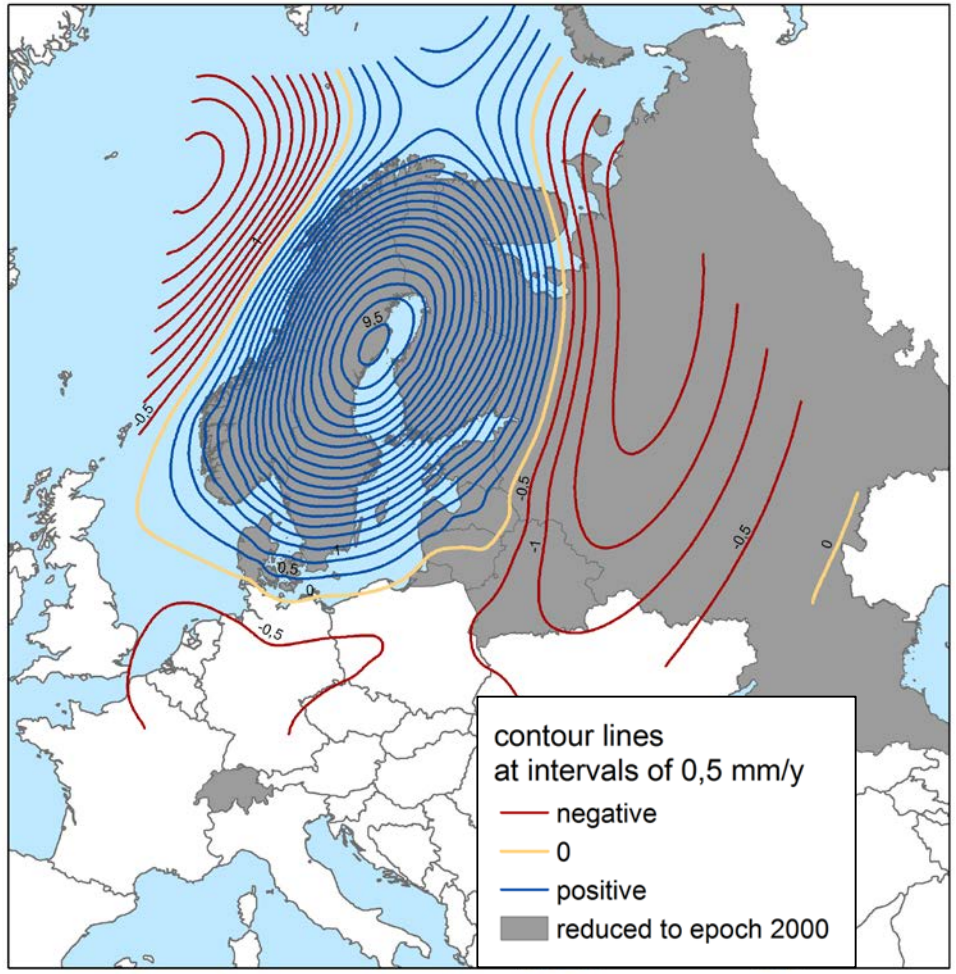


- Intention: widely distributed, 1 point per country
- No datum points in areas of known vertical land movements
- no datum points in countries with known systematic tilts or big differences to the former realization
- 8 of 13 points are identical to datum points of EVRF2007

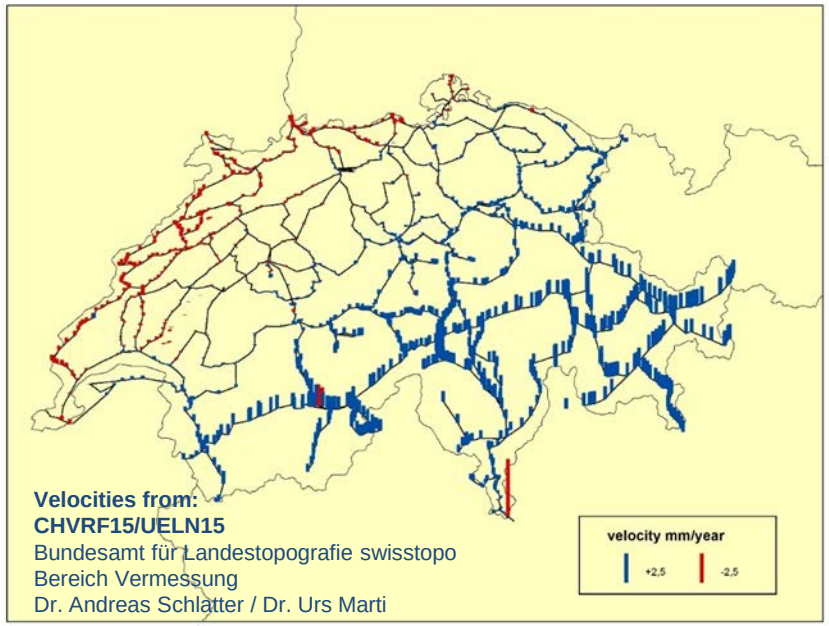
Tidal corrections

- **EVRS is a zero-tide system** according to it's definition
- IAG resolution No. 16 Hamburg 1983 recommended zero-tide for gravity field and mean tide for 3D-positioning
- In practice used:
  - Gravity: zero-tide
  - GNSS: Conventional tide-free
  - Leveling: mixed, mostly mean tide
- International height system will be provided in mean tide (IAG resolution No. 1 Prague 2015)
- For many applications physical heights should describe how the water flows → mean tide
- Assistance for users who are not familiar with the concept of the permanent tides.
- **EVRF2019 will be additionally provided in mean-tide**

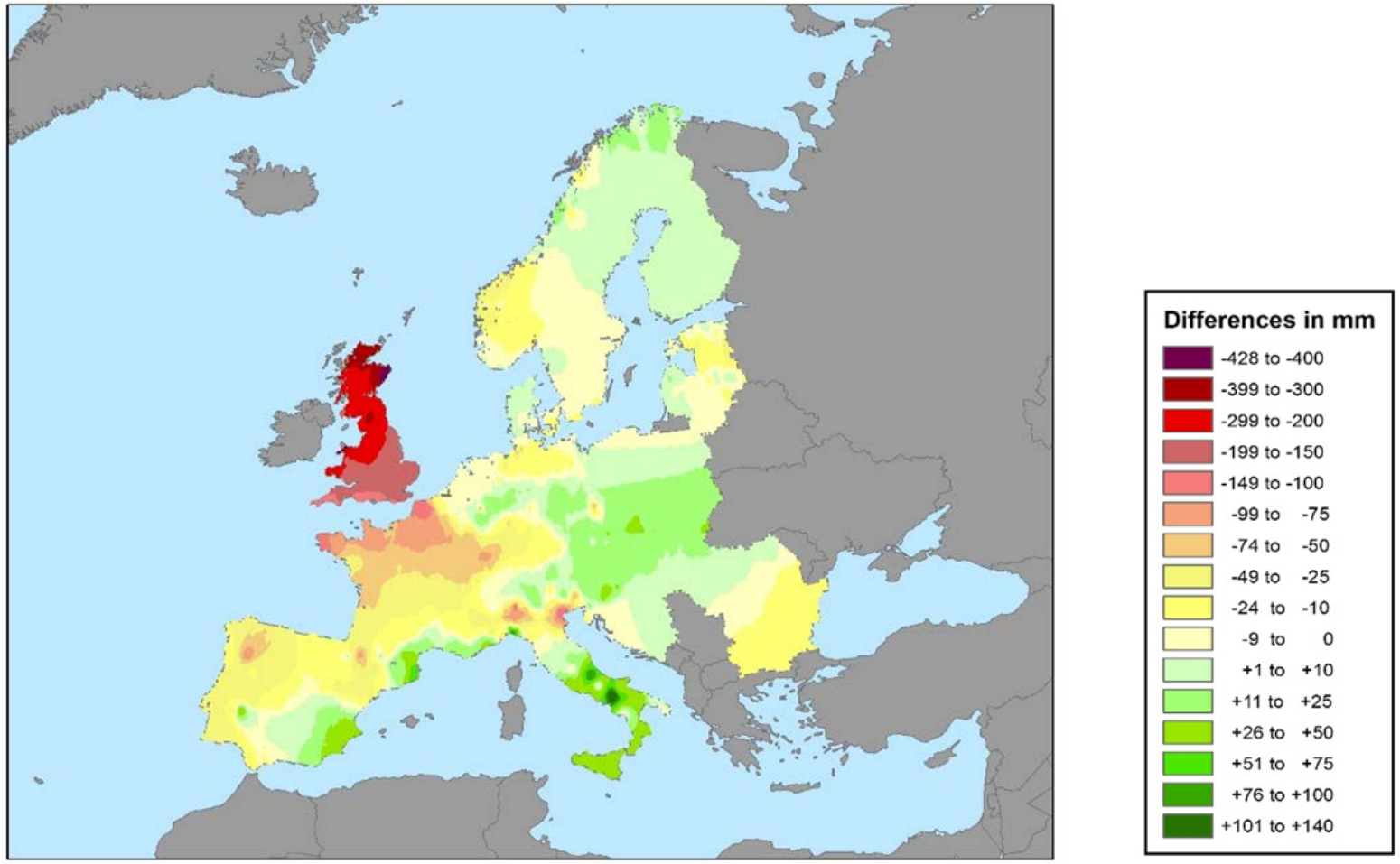
Reduction to epoch 2000



- Reduction to epoch 2000 using new uplift model for the Nordic countries NKG2016LU_lev
- Reduction of the Swiss data by velocities of Swiss points delivered with data set in 2015



Comparison EVRF2007 - EVRF2019



Adjustment parameters

Parameter	EVRF2007	EVRF2019
Number of datum points:	13	13
Number of unknowns:	7942	10698
Number of measurements:	10354	13540
Number of condition equations:	1	1
Degrees of freedom:	2413	2843
A-posteriori standard deviation referred to 1 km levelling distance in kgal·mm:	1.11	1.10
Mean value of the standard deviation of the adjusted geopotential numbers (heights), in kgal·mm:	16.00	19.34
Average redundancy:	0.233	0.210

Results of variance component estimation

Country / group	EVRF2007		EVRF2019		Country / group	EVRF2007		EVRF2019	
	number of observations	s_0 [kgal·mm] (1 km)	number of observations	s_0 [kgal·mm] (1 km)		number of observations	s_0 [kgal·mm] (1 km)	number of observations	s_0 [kgal·mm] (1 km)
Austria	167	0.82	**160**	**0.94**	Czech Republic new			**185**	**0.77**
Belgium	63	1.24	**113**	***0.55***	Czech Republic old	100	1.16	**83**	**1.31**
Switzerland	413	1.09	**718**	**0.91**	Hungary	82	0.47	**83**	**0.49**
Germany	846	0.85	**1112**	**0.66**	Croa.,Bosn./Hc	112	0.90	**81**	**1.08**
Denmark	194	0.91	**196**	**0.85**	Slovenia			**67**	**0.50**
Spain	110	1.75	**227**	**2.38**	Poland	456	0.88	**473**	**0.87**
France	348	2.02	**344**	***3.08***	Slovakia	214	1.55	**196**	**1.48**
France (NIREF)			**1223**	**1.39**	Romania	90	1.75	**133**	**1.80**
Italy	110	1.75	**202**	**1.20**	Estonia	78	1.30	**418**	**0.23**
Netherlands	1424	0.75	**1373**	**0.75**	Latvia	159	1.72	**151**	**0.85**
Portugal	30	2.09	**30**	**2.01**	Lithuania	72	0.87	**64**	**0.74**
Great Britain	60	1.72	**4**		Bulgaria	109	1.14	**109**	**1.15**
Norway new	360	1.33	**489**	**1.34**	Russia			**176**	**2.21**
Norway old	341	1.57	**410**	**1.44**	Belarus			**31**	**2.19**
Finland	262	0.73	**272**	**0.74**	Ukraine			**211**	**1.71**
Sweden	4154	1.00	**4206**	**1.00**	**Total**	**10566**	**1.11**	**13540**	**1.10**

new data after 2008
small update after 2008

Questionnaire about publishing and exchange of the data of EVRF2019

- Distribution of the questionnaire together with adjustment results and report in March 2019
- Options:

adjusted geopotential numbers, normal heights and coordinates may be

1. Published on a website in the scope of EUREF
2. Delivered to all countries that are part of the United European Leveling Network (UELN). In return we will get the EVRF2019 results for the points of the other countries too.
3. Only delivered to our own country. In this case we won't get any data of other countries.

Questionnaire reply status May 17

Country	option 1	option 2	option 3	Country	option 1	option 2	option 3
Austria	x						
Belarus		x		Latvia	x		
Belgium	x			Lithuania	x		
Bosnia/Hercegovina				Netherlands	x		
Bulgaria	x			Norway	x		
Croatia				Poland	x		
Czech Republic	x			Portugal	x		
Denmark	x			Romania	x		
Estonia	x			Russia		x	
Finland	x			Slovakia	x		
France	x			Slovenia	x		
Germany	x			Spain	x		
Great Britain	x			Sweden	x		
Hungary				Switzerland	x		
Italy	x			Ukraine		x	

Outlook

- NMAs of BA, HR, HU:

Please send the filled questionnaire asap to the UELN data and computation center at BKG (e-mail address at the bottom of the questionnaire) !

- Including of additional data :
  - new measured border connections between Slovenia and Italy
  - Current leveling data of Austria with many new border connections to the neighboring countries
- Including of further announced data (provided the data will be delivered before end of July 2019):
  - Southern Italy
  - Bulgaria
  - North Macedonia
- Distribution of the final solution in autumn 2019
- Publishing of the results on a web site – only for the countries that agreed

Thank you for your kind attention!

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