European Vertical Reference System (EVRS) 2007
- Principles and Strategy -

Johannes Ihde, Martina Sacher, Jaakko Mäkinen

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EVRS 2007 Realization
– Principles and Strategy -

(1) Network
(2) Datum
(3) Relationship to a IVRS
(4) Time evolution
(5) Tidal system
(6) Summary
(7) Next steps

(1) EVRS Realization - Network

New (free) adjustment of the UELN

by

using all current available levelling and gravity observations reducing to the epoch 2000

$$c_P = -\Delta W_P = W_0 - W_P$$

Development of UELN-95

1998

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

1999 - 2006

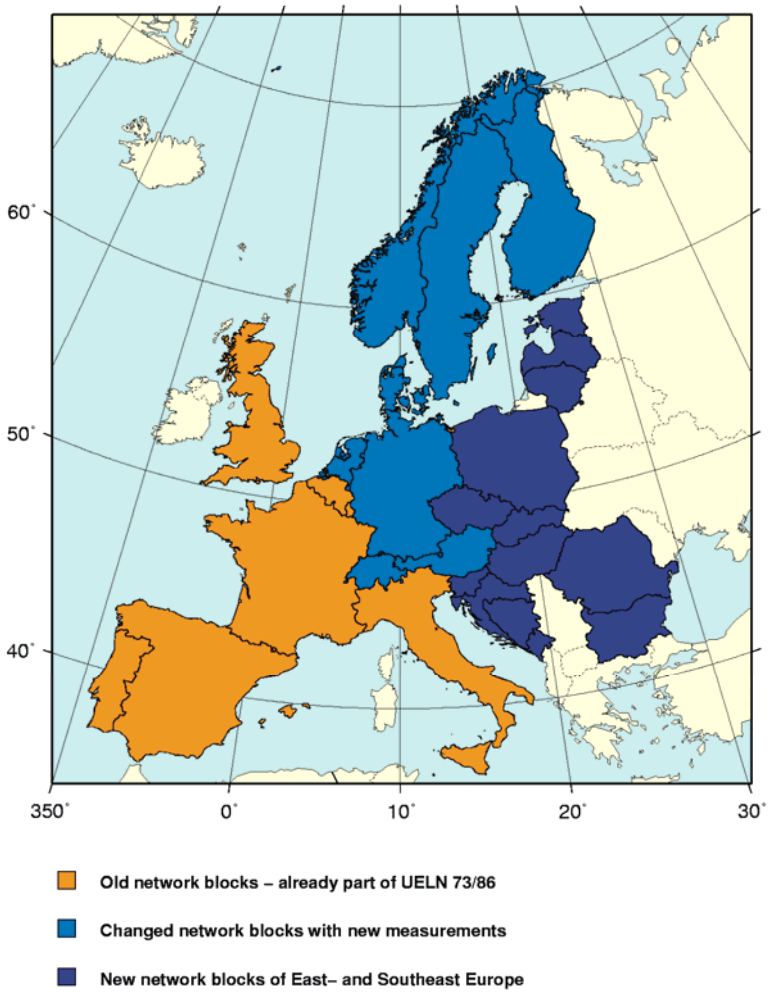
- **extension of UELN by new data of**
  - **Estonia**
  - **Latvia**
  - **Lithuania**
  - **Romania**
  - **Bulgaria**
- **replacement of the levelling data of the following countries by new topical measurements**
  - **Switzerland**
  - **The Netherlands**
  - **Finland**
  - **Norway**
  - **Sweden**

Present status of common adjustment of existing 1st order levelling networks

UELN of

26 countries

No. of measurements:	9542
Degrees of freedom:	2318
A-posteriori σ 1 km levelling distance in kgal·mm:	1.07
Mean value of σ of adjusted c_P (heights), in kgal·mm:	17.19
Average redundance:	0.24



(2) EVRS Realization - Datum

Keeping the vertical datum European NAP level of UELN95/98 at Epoch 2000

by

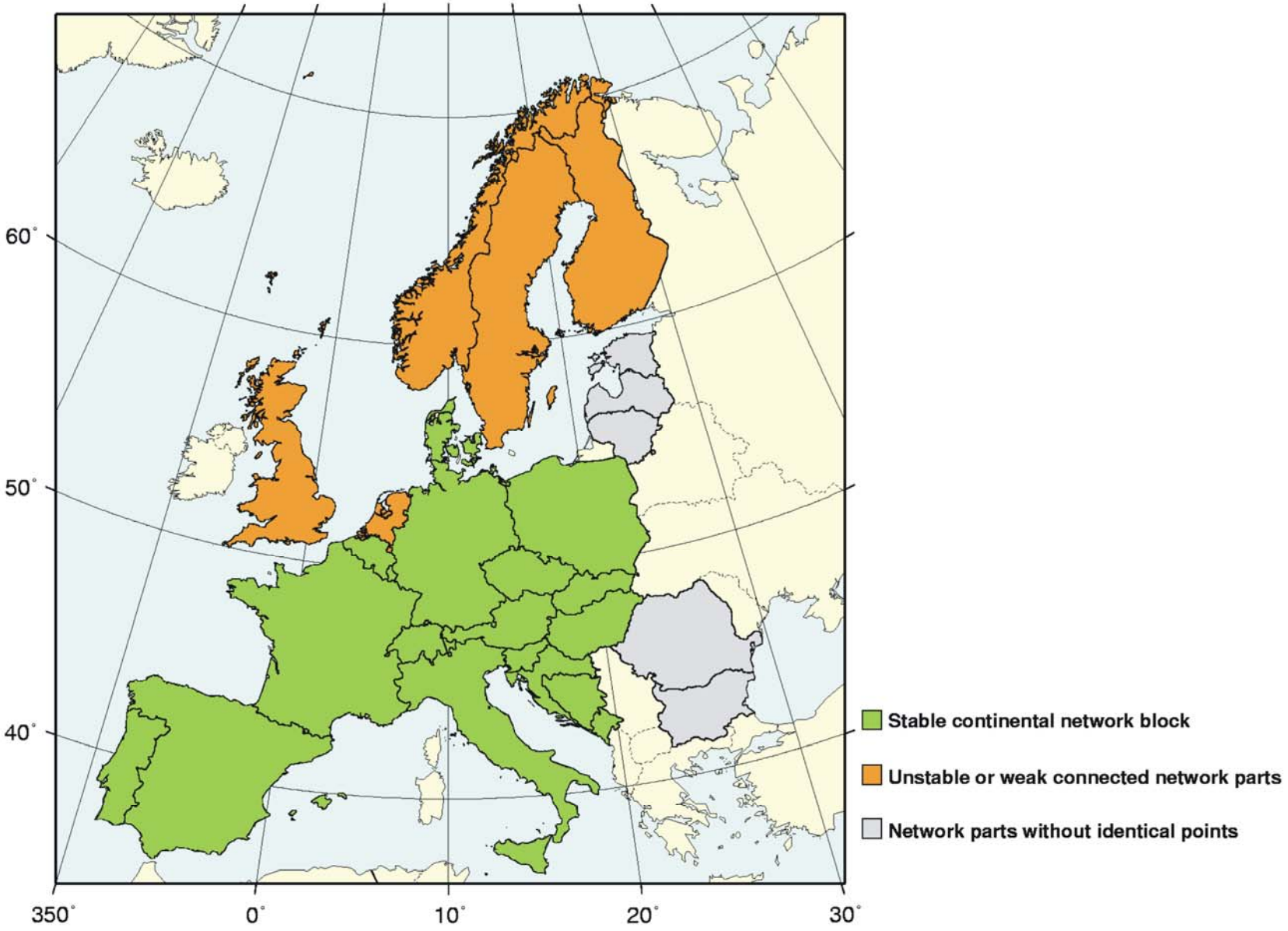
Fitting the UELN07 (free) adjustment to the UELN95/98 solution by identical points.

Selection of a couple (3 – ?) of identical points for which it can assumed, that they are stable marked and located in the stable part of the European part plate and connected by precise measurements

$$\sum_{i=1}^{n} (c_{P2007} - c_{P95/98}) = 0$$

Country	Number of identical points to UELN 95/98	Supply of new measurements since 1998	Remarks
Austria	115		
Belgium	35		
Bosnia/Herz. + Croatia	46		
Bulgaria	-	included 2003	
Czech Republic	53		
Denmark	46		
Estonia	-	included 1999	
Finland	45	2005	not appropriate because of land uplift
France	126		
Germany	484		
Hungary	34		
Italy	64		
Latvia	-	included 1999	
Lithuania	-	included 2000	

Country	Number of identical points to UELN 95/98	Supply of new measurements since 1998	Remarks
Netherlands	237	2005	height variations
Norway	87	2005	not appropriate because of land uplift
Poland	120	announced	
Portugal	13		
Romania	-	included 1999	
Russia	-	announced 2007	
Slovakia	52		
Slovenia	9		
Spain	79		
Sweden	42	2005	not appropriate because of land uplift
Switzerland	11	2004	
Ukraine	-	considered	
United Kingdom	45		not appropriate because of assumed tilt of the network


60°
50°
40°
350°
0°
10°
20°
30°
Stable continental network block
Unstable or weak connected network parts
Network parts without identical points

(3) EVRS Realization – IVRS Alignment

Determination of a W_{0E} at Epoch 2000, fixing it and observe the relationship to a W_0 of a IVRS

by

GPS/levelling points of EUVN and ECGN and a European geoid bases on IVRS conventional GGM

(4) EVRS Realization- Time Evolution

Observation of vertical movements of UELN against a conventional value W_{0E}

by

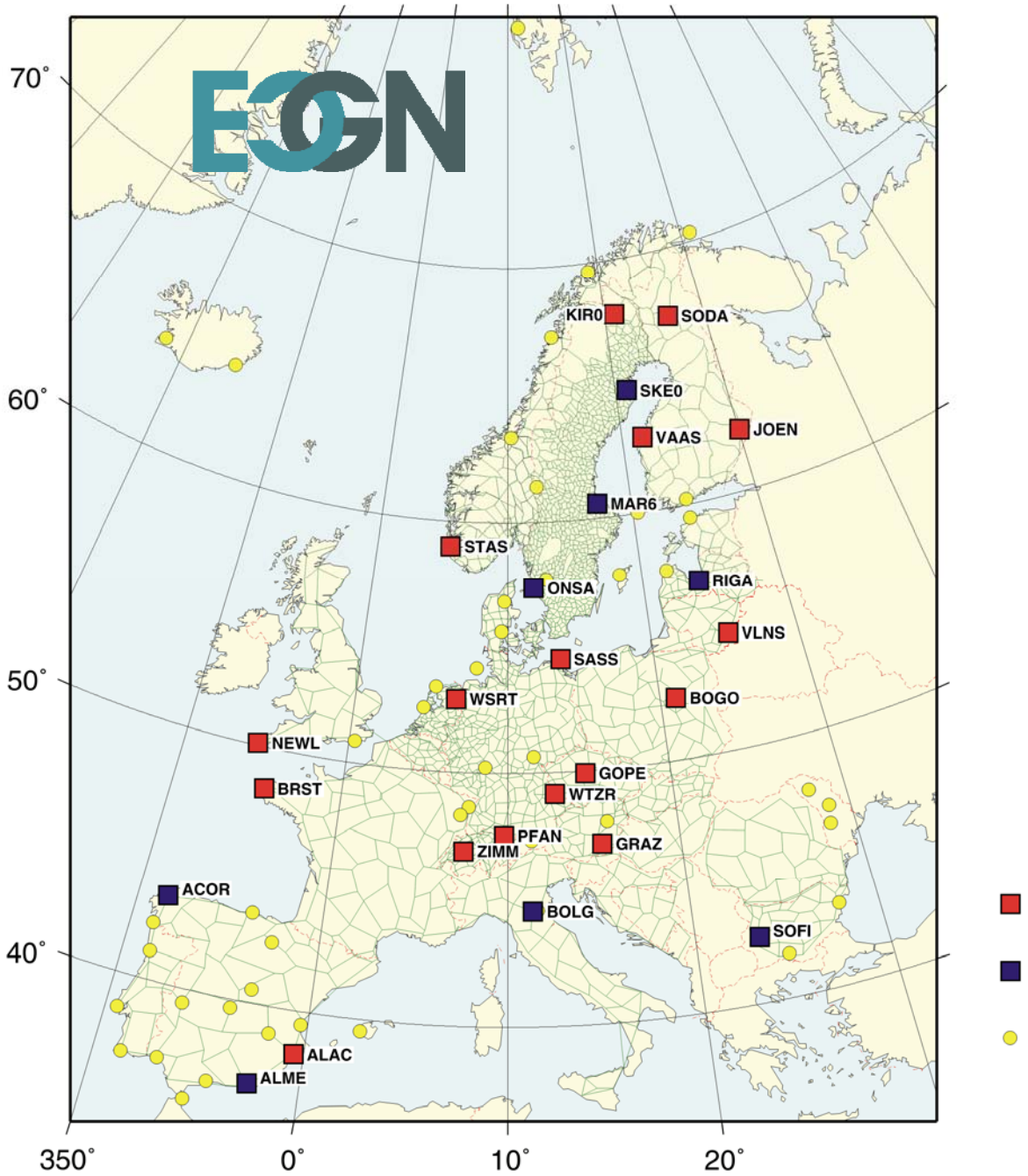
Time series observations of the ECGN as carrier network of the European Vertical Reference Frame and its datum

Under the condition,

$$v_{hi} = v_{Hi}$$

the velocities of the physical heights H can be derived from time series of the the ITRFxx heights h:

$$H_P(t) = H_P^0 + \dot{h}_P^0 (t - t^0)$$



Selected ECGN stations for EVRS2007 time evolution control

Stations with GNSS, levelling, AG

Desirable additional stations

ECGN stations with missing elements

(5) EVRS Realization – Data Harmonisation

Reduction of data – Tidal System

	gravity g/Δg	geoid W/N	levelling height ΔH	altimetry h	mean sea level msl	position X/h
Mean tidal system **Mean/zero crust** (Stokes is not valid if masses outsite the Earth surface)	Δg_m	N_m	ΔH_m	Relation to N_m for oceanographic studies	h_{msl}	
Zero tidal system **Mean/zero crust** (Recommended by IAG Res. No. 16, 1983)	Δg_z Stokes	N_z (EGG97)	ΔH_z c_p			
Tide-free system **Tide-free crust** (unobservable, far away from the real earth shape – there is no reason for the non tidal/tide free concept)	Δg_n Stokes	N_n (EGM96)				X_n ITRFxx, ETRS89

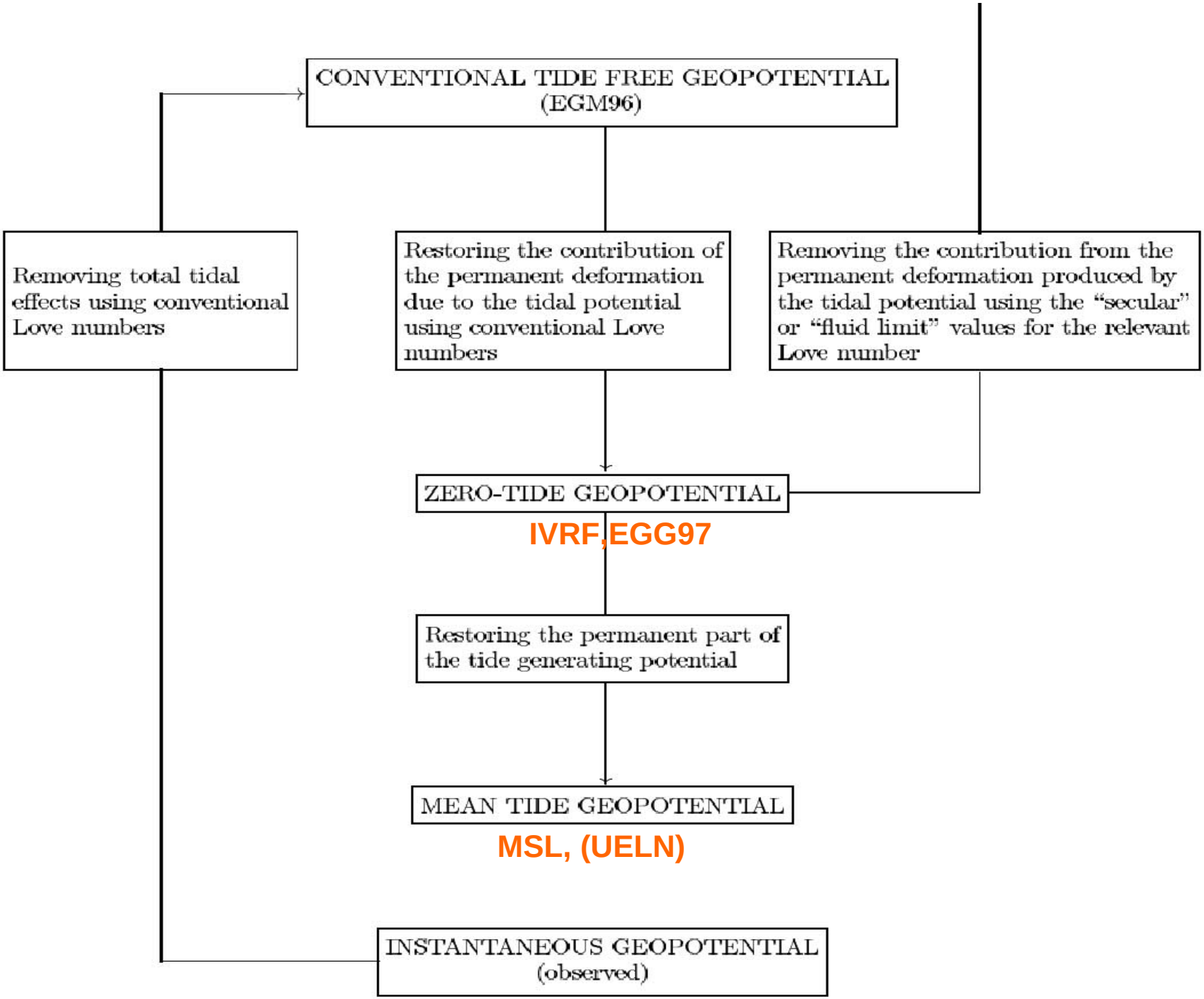


Figure 1.2. Treatment of observations for tidal effects in the geopotential (see Chapter 6).

Country	Number of identical points to UELN 95/98	Supply of new measurements since 1998	Correction status concerning tide
Austria	115		(mean tide)
Belgium	35		unknown
Bosnia/Herz. + Croatia	46		unknown
Bulgaria	-	included 2003	(mean tide)
Czech Republic	53		unknown
Denmark	46		(mean tide)/zero tide available at BKG
Estonia	-	included 1999	(mean tide)
Finland	45	2005	(mean tide)/zero tide available at NKG
France	126		(mean tide)
Germany	484		(mean tide)
Hungary	34		(mean tide)
Italy	64		unknown
Latvia	-	included 1999	unknown
Lithuania	-	included 2000	(mean tide)

Country	Number of identical points to UELN 95/98	Supply of new measurements since 1998	Correction status concerning tide
Netherlands	237	2005	(mean tide)/ tide free in the nat. network
Norway	87	2005	(mean tide)/zero tide available at NKG
Poland	120	announced	unknown
Portugal	13		(mean tide)
Romania	-	included 1999	unknown
Russia	-	announced 2007	
Slovakia	52		(mean tide)
Slovenia	9		(mean tide)
Spain	79		(mean tide)
Sweden	42	2005	(mean tide)/zero tide available at NKG
Switzerland	11	2004	(mean tide)
Ukraine	-	considered	
United Kingdom	45		(mean tide)

6. Summary

- New (free) UELN adjustment 2007, all participating countries are asked to contribute up-to-date data
- Fixing the EVRS2000 datum (NAP)
- Using the ECGN for EVRS time evolution
- Using IAG EGG 2007 solution (on basis of a IAG GGM)
- Alignment to IVRS

7. Next Steps

(1) Selection of identical levelling points

(UELN-DC together with participating countries

Letter to responsible agencies) *Dec. 2006*

(2) Selection of ECGN/EVRS datum points and determination of all measure elements

(Letter to responsible agencies) *Dec. 2006*

(3) New adjustment of the UELN

(UELN-DC) *March 2007*

(4) Time series analysis of ECGN stations

Beginning Jan. 2007?

(5) Decision about the EVRS level, tide system, sets of parameter *(EUREF Symposium 2007)* *May 2006*

(6) Full parameter determination with EGG07 and IVRS realization *Sep. 2007*

(7) Distribution of results to participating countries

Nov. 2007