The Height Solution of the European Vertical Reference Network (EUVN)

J. IHDE[1], J. ADAM[2], W. GURTNER[3], B. G. HARSSON[4], M. SACHER[1],
W. SCHLÜTER[5], G. WÖPPELMANN[6]

Abstract

For the EUVN stations the final height solution is given. The heights are related to the solution of the United European Levelling Network 1995/1998 (UELN95/98) which was distributed in January 1999 to the participating countries. The vertical datum of the UELN95/98 is related to the Normaal Amsterdams Peil (NAP), the heights are computed as geopotential numbers and given as normal heights. The height accuracy is within 5 cm level. For islands and countries which are not connected with the UELN, the heights are given to local tide gauges/vertical datums. For all stations GPS/levelling height anomalies by using ETRS89/97.4 heights are given and compared with the European quasigeoid EGG97.

1. The EUVN height concept

The initial practical objective of the EUVN project is to unify different European vertical datums within few centimeters. In addition to the United European Levelling Network 1973 (UELN 73) for Western and Northern Europe and the United Precise Levelling Network 1982 (UPLN 82) for Central and Eastern European countries national height systems exist with vertical datums and different kinds of heights. The vertical datum for the UELN is given by the tide gauge Amsterdam and for the UPLN it is the tide gauge Kronstadt. The level difference is about $h_{Amsterdam} - h_{Kronstadt} = 0{,}15\text{m}$.

The application of the GPS technique for practical levelling would dramatically extend if the geoid would be known precisely enough in relation to the concerned GPS reference system and the levelling reference system. To derive such a geoid, a European reference geoid is required in the reference system ETRS89 and the reference system of UELN. Up to now there is no precise geoid available for Europe with an accuracy of a few centimeters which fulfils the requirement for the practical applications. This project contributes to a geoid tailored for the GPS-levelling methods by combining the existing reference network EUREF/ETRS89 with the UELN95.

Independently of an uniform height level for the maritime countries the knowledge of the sea level and, under special conditions, of the variations of the adjacent oceans is vitally important. Tide gauges provide access to a local information which generally results from a combination of sea level changes and vertical movements of the earth crust at the tide gauge site. Therefore, global sea level studies based on tide gauge data require to monitor the vertical crustal velocities at the tide gauge sites with respect to a geocentric reference frame, in order to recover a global geocentric assessment of the sea level variations.

Following recommendations by CARTER et al., 1989 several institutions around Europe have carried out regional tide gauge GPS surveys. At least three common points between two networks are needed for a rigorous combination of the coordinates and for the subsequent description of the regional campaign results in a common geocentric reference frame (BOUCHER et al., 1994). The information provided by the tide gauges has been taken into account in the design of the EUVN network.

The EUVN project contributes to the realization of an European vertical datum and to connect different sea levels of European oceans with respect to the work of PSMSL (Permanent Service Mean Sea Level) and of anticipated accelerated sea level rise due to global warming. The project provides a contribution to the determination of an absolute world height system as shown by BALASUBRAMANIA, 1994.

[1] Johannes Ihde, Martina Sacher: Bundesamt für Kartographie und Geodäsie, Aussenstelle Leipzig, Karl-Rothe-Strasse 10-14, D-04015 Leipzig, Germany; Tel.: 0341 5634 424, Fax: 0341 5634 415, E-mail: ihde@leipzig.ifag.de

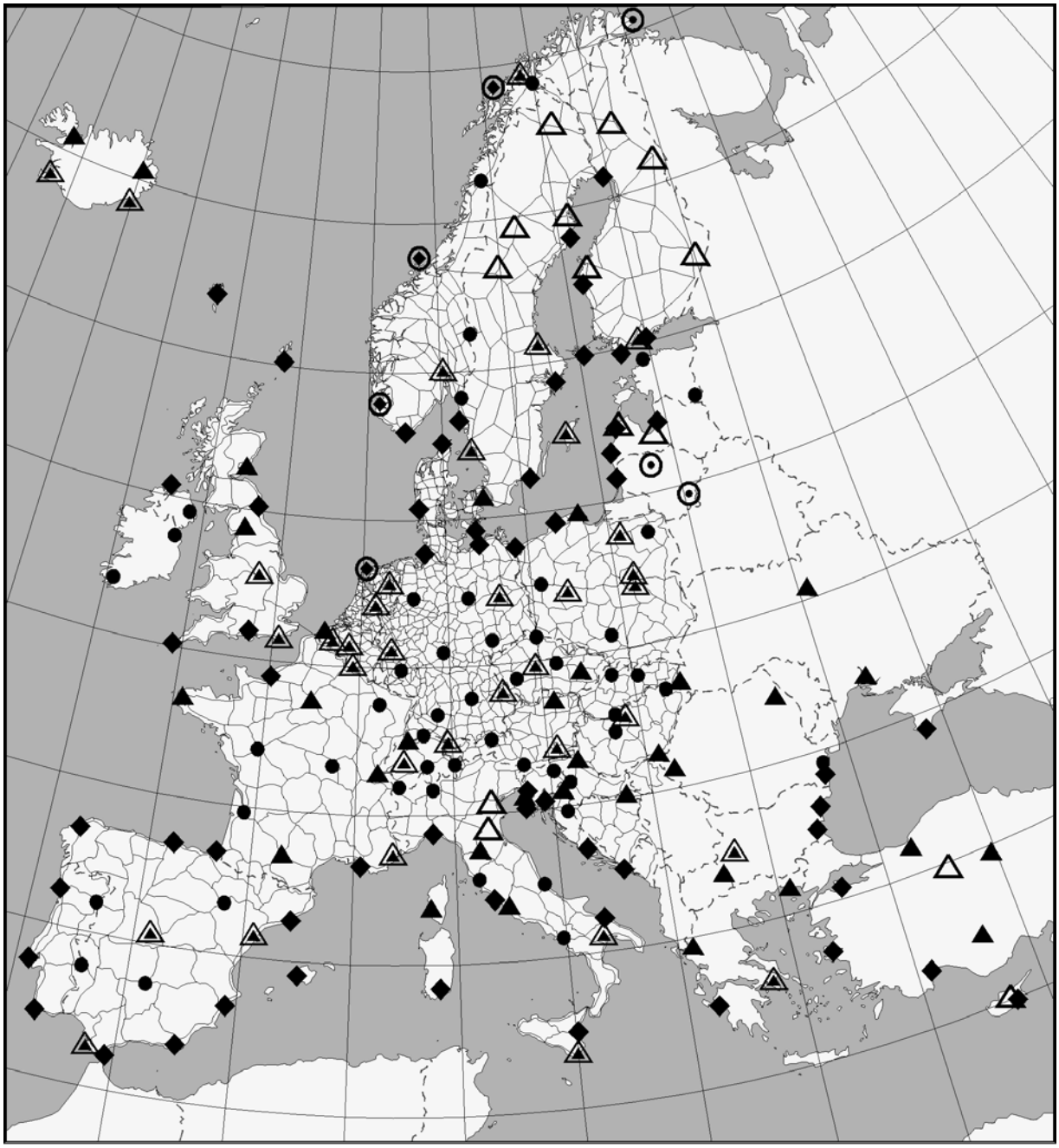
[2] József Ádám: Technical University of Budapest, Department of Geodesy, Mueegyetem rkp. 3.I.61, HU-1111 Budapest, Hungary; Tel.: +36 1 463 3222, Fax: +36 1 463 3192, Telex: 225931 muegy, E-mail: jadam@epito.bme.h

[3] Werner Gurtner: Astronomisches Institut der Universität Bern, Sidlerstrasse 5, CH-3012 Bern, Switzerland; Tel.: +41-31-631 85 91, Fax: +41-31-631 38 69, Telex: 912643 pibe ch, E-mail: gurtner@aiub.unibe.ch

[4] Björn Geirr Harsson: Statens Kartverk, N-3500 Hønefoss, Norway; Tel.: +47 32 11 81 00, Fax: +47 32 11 81 01, E-mail: bjorn.geirr.harsson@gdiv.statkart.no

[5] Wolfgang Schlüter: Bundesamt für Kartographie und Geodäsie, Fundamentalstation Wettzell, Sackenrieder Strasse 25, D-93444 Kötzting, Germany; Tel.: +9941 603 107, Fax: +9941 603 222, Telex: 69937 wesat d, E-mail: schlueter@wettzell.ifag.de

[6] Guy Wöppelmann: formerly:Institut Géographique National, 2. Avenue Pasteur B.P.68, F-94160 Saint-Mandé, France; Tel.: +33 - 1 - 43 98 81 46, Fax: +33 - 1 - 43 98 84 88, E-mail: guy@schubert.ign.fr / now: Centre Littoral de Geophysique, Universite de la Rochelle, Avenue Michel Crepea, 17042 La Rochelle, CEDEX France, e-mail: gwoppelm@univ-lr.fr



June 2000

Figure 1 EUROPEAN VERTICAL REFERENCE NETWORK (EUVN)

▲ EUREF sites
⊙ GPS permanent stations - nodal points
◬ GPS permanent stations - EUREF
◆ Tide gauge sites
△ GPS permanent stations
⊙ GPS permanent stations - tide gauge
• UELN & UPLN nodal points
UELN lines

At all EUVN points *P* three-dimensional coordinates in the ETRS89 $(X_p, Y_p, Z_p)_{ETRS}$ and geopotential numbers c_p are to be derived. The geopotential number $c_p = W_{o\ UELN} - W_p$ is the difference between the potential of the earth gravity field of the reference tide gauge of the UELN (W_{oUELN}) and of the gravity potential in the EUVN points (W_p). Finally the EUVN is representing a geometrical-physical reference frame (Figure 1). In addition to the geopotential numbers c_p normal heights $h_n = c_p / \bar{\gamma}$ are to be provided ($\bar{\gamma}$ is the mean normal gravity value between the ellipsoid and the telluroid.).

The EUVN is a step to establish a fundamental network for a further geokinematic height reference system such as EVS 2000 under the special consideration of the Fenno-scandian uplift and the uplift in the Carpathian-Balkan region (AUGATH, 1996).

2. EUVN heights in the UELN 95/98 solution

In order to fulfil future requests of the EUVN project it was necessary to connect the EUVN stations by levellings with nodal points of relevant levelling networks. So it will be also in the future possible to use levelling observations to update the gravity related EUVN heights in connection with new adjustments of UELN.

All countries which are members of the UELN project connected their EUVN stations to the nearest UELN nodal points. All other countries connected the EUVN stations to such levelling points which will be stations of their national UELN part in the future.

This information had been requested in the levelling/gravity form (see Annex 2). In 1998 the working group sent in connection with the EUVN Circular Letter No 6 individual letters directly to the national agencies in order to request the necessary levelling and gravity information.

In order to support the correct completion of the levelling/ gravity forms, the following general hints were given:

(1) With respect to the objectives of EUVN, each EUVN marker has to be connected to at least one nodal point of one of the three height reference systems:

a) United European Levelling Network (UELN) 1995 for all countries which are members of the UELN (for about 80 % of the EUVN points).

b) United Precise Levelling Network (UPLN) 1982 for all countries which are members of the UPLN (for about 10 % of the EUVN points).

c) National height systems for all countries or parts of countries which are not members of UELN and UPLN or which are not connected with the European continent.

(2) For the identification of the UELN95 nodal points the following illustrations were made available to the responsible agencies:

a) Relevant national part of the UELN95 with the respective point numbers.

b) Map with the local situation around the EUVN point and the corresponding UELN95 points.

c) Lists of the UELN95 nodal points with UELN point numbers, national point numbers, coordinates and geopotential numbers.

(3) The connection levelling between the EUVN marker and the nodal points or the tide gauge bench mark had to be given in geopotential numbers. The levelling accuracy had to be equal to the requirements of a first order levelling (better than 1 mm per km). The geopotential number difference D*c* of a line had to be calculated by

$$\Delta c = \sum_{i=1}^{n} \Delta h_i \cdot g_i \qquad [\mathrm{m}^2 \times \mathrm{s}^{-2}]$$

Dh_i are the levelled height differences between the intermediate points in a distance of about 1 km along the levelling lines, g_i is the mean gravity value in IGSN71 derived from the gravity values in the vicinity of the intermediate points *S* and *E* along the line

$$g_i = \frac{g_S + g_E}{2}$$

(4) Gravity values for reduction of the levelling measurements to geopotential numbers had to be given in the intermediate points *S, E* in a distance of about 1 km along the levelling lines with an accuracy of about 1 mgal. For connection levellings shorter than 0.5 km the gravity value was only necessary in one of the considered points: EUVN GPS marker, UELN nodal point or tide gauge bench mark.

(5) The connections between the EUVN marker and the levelling networks D*c* could be carried out principally in three ways (see Annex 3):

a) With a levelling line or a levelling loop respectively to a nodal point (Annex 3, Sketch 1).

b) With a connection levelling to a line point LP between 2 nodal points. In addition to D*c* the geopotential number differences between the nodal points and the line point LP Dc_1 and Dc_2 had to be given (Annex 3, Sketch 2).

c) With a local height network (the national height network can be used) which is connected at least to 2 UELN or UPLN nodal points (Annex 3, Sketch 3). In that case the geopotential number differences of a local network had to be given as observations.

The available information and measurements for the single EUVN stations were used to compute normal heights in the UELN-95/98 system. Countries which are not members of UELN have made directly available the heights in their national height system. Table 1 in Annex 1 shows the final height solution for the EUVN stations in connection with the GPS solution.

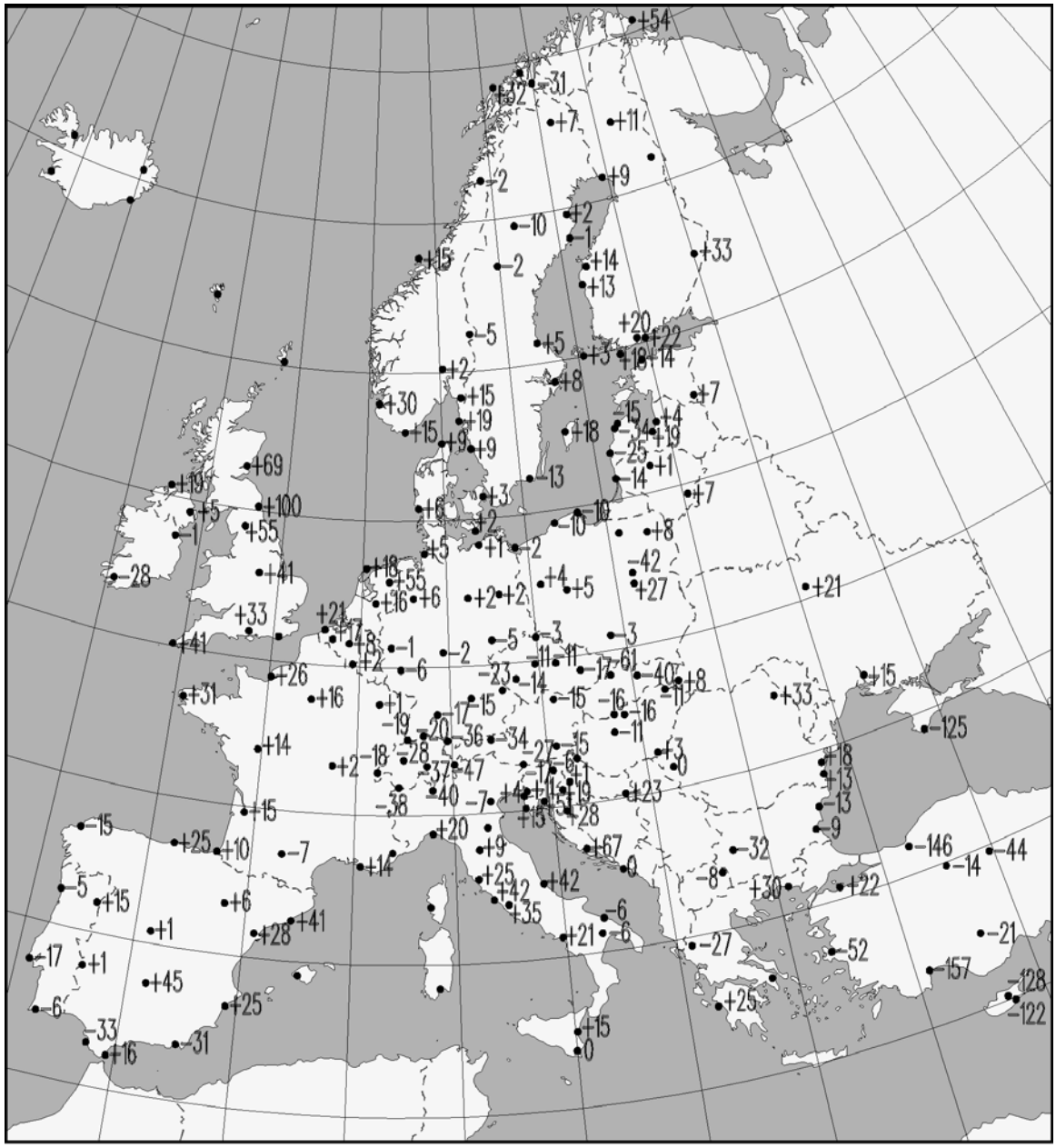


Figure 2 Differences between EUVN GPS / levelling geoid and EGG97 geoid (in cm)

3. Contribution to the European geoid

To get an integrated European spatial reference system a tailored geoid solution is necessary. At present the European gravimetric quasigeoid EGG87 is available for practical use (Denker, Torge, 1997). For further developments of combined geoid solutions with gravity and GPS/levelling data the EUVN gives a Europe-wide basis. Figure 2 and Table 2 in Annex 2 contain the differences between the EGG97 quasigeoid and the GPS/levelling quasigeoidal height anomalies of the EUVN stations.

The heights of the Scandinavian EUVN stations in Finland, Norway, Sweden were reduced from the epoch 1960 to the epoch of the GPS measurement (1997) by the values of the land uplift which were delivered from the countries for the adjustment version UELN-73/86. For the countries which are not members of the UELN and which have a national height system in relation to the tide gauge Kronstadt, the heights were reduced to the UELN level by + 15 cm. These are Bulgaria and Ukraine.

Acknowledgement

Thanks are due to all national mapping agencies participating in the EUVN project for close cooperation in collecting and providing the height information.

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Table 1: The EUVN Height Solution **Annex 1**

Station Name		Ellipsoidal Coordinates in ETRS89 (ETRF96, Epoch 1997.4)			Normal Heights in UELN-95/98 in m
		Latitude j in ° ' "	Latitude φ in ° ' "	Longitude λ in ° ' "	
GRAZ	11001M002	47 4 1.65744	15 29 36.51428	538.290	490.925
GRAA	11001M003	47 .76700	15 29 36.55742	540.068	
AT01	HUTBIEGL	48 39 16.38501	15 35 54.25296	457.606	411.123
PFAN	11005S002	47 30 55.17219	9 47 4.77756	1090.310	1043.183
AT03	THOERL-MA	46 33 15.11686	13 41 .37626	687.372	638.588
AT04	WOERGL	47 29 45.77751	12 4 58.77923	630.059	582.508
BRUS	13101M004	50 47 52.13436	4 21 33.17660	149.668	104.437
BRUT	13101M003	50 47 55.15784	4 21 31.82508	157.470	
DENT	13112M001	50 56 1.33118	3 23 58.80359	63.894	19.518
DOUR	13113M001	50 5 41.54594	4 35 41.81538	282.695	236.643
BE01	OSTENDE	51 14 5.77503	2 55 38.79050	54.461	10.213
BG01	BURGAS	42 29 .62331	27 28 55.47220	41.743	2.836 (1)
BG03	SOFIA	42 33 21.93149	23 23 41.02232	1119.557	1074.357 (1)
BG04	VARNA	43 11 33.68566	27 54 33.38345	38.243	1.922 (1)
HR01	BAKAR	45 15 19.60331	14 35 9.26800	182.398	137.380
HR02	BRUSNIK	45 34 42.89927	15 34 12.82566	268.988	223.239
HR03	DUBROVNIK	42 39 28.38641	18 3 38.76129	46.673	5.347
HR04	VELIKO_GR	45 9 14.21431	18 42 42.06173	146.095	101.613
HR05	SPLIT	43 30 23.91399	16 26 18.45382	47.627	5.186
HR06	ZAGREB	45 48 22.31105	15 58 43.11745	160.909	115.025
HR07	ROVINJ	45 5 2.48873	13 37 45.65525	53.589	9.385
HR08	PLITVICE_	44 50 42.37874	15 40 46.55741	713.172	667.464
CY01	LARNAKA	34 55 41.39614	33 38 42.69724	31.203	5.887 (9)
NICO	14302M001	35 8 27.54140	33 23 47.19228	190.040	162.277 (9)
CZ01	CHRASTAVA	50 49 2.06015	14 58 9.49211	3.38631547e+29	2.9574450e+29
CZ02	KOTOUN	49 27 45.23280	13 40 .21868		
CZ03	PREDNI_PR	49 30 21.27087	17 14 47.24416		
CZ04	KOSTELEC	49 51 30.33739	15 56 6.75002		
GOPE	11502M002	49 54 49.32651	14 47 8.22569		
DK01	KOBENHAVN	55 44 19.91747	12 29 59.84248	87.938	51.840
DK0A	KOBENHAVN	55 44 19.71618	12 29 59.32996	86.715	50.616
DK02	HIRTSHALS	57 35 42.13692	9 57 44.44644	42.208	4.040
DK03	ESBJERG	55 27 36.55347	8 26 23.31363	43.303	2.519
DK04	GEDSER	54 34 19.65630	11 55 28.33467	40.619	2.643
DK05	THORSHAVN	62 0 15.97013	-6 45 40.05651	58.073	
EE01	OTSA	57 50 32.39263	27 14 55.62698	107.504	8816265993
EE02	SUURUPI	59 27 48.87862	24 22 48.91655	84.272	
FI01	DEGERBY	60 1 52.84863	20 23 4.08149	21.647	2.913
FI02	HANKO	59 49 21.63882	22 58 35.43499	24.858	5.251
FI03	HELSINKI	60 9 13.23464	24 57 24.23468	24.177	6.566
JOEN	10512M001	62 23 28.21581	30 5 46.14856	113.676	96.532
FI05	KASKINEN	62 20 33.67633	21 12 58.60787	25.273	5.957
FI06	KEMI	65 40 27.69623	24 31 5.66259	26.114	7.092
KUUS	KUUSAMO	65 54 36.88749	29 2 .50245	378.951	
METS	10503S011	60 13 2.89058	24 23 43.13359	94.568	75.875
META	METSAEHOV	60 13 2.91888	24 23 43.17087	94.520	
SODA	10513M001	67 25 15.08483	26 23 20.56346	299.730	279.063
VAAS	10511M001	62 57 40.28637	21 46 14.27088	58.042	40.090
FR01	100077M00	41 55 38.59292	8 45 45.69211	96.797	49.069 (2)
GRAS	10002M006	43 45 17.04528	6 55 14.05096	1319.310	
FR02	100013M00	44 48 56.40426	-0 33 42.64376	53.915	7.380
FR03	100086M00	46 37 12.57573	3 44 7.01632	257.485	209.154
FR04	BREST	48 24 28.31549	-4 30 13.78707	104.411	53.301
FR05	LE_HAVRE	49 28 54.80772	0 6 21.69082	53.632	8.131
FR06	100073M00	43 16 43.56059	5 21 13.62263	61.797	12.394
FR07	100087M00	48 45 45.97069	6 7 42.26196	241.724	194.365
FR08	100001M01	48 50 40.00410	2 25 29.89673	126.148	81.867
TOUL	10003M004	43 33 38.77295	1 28 50.72467	207.106	157.740
FR09	100088M00	43 23 42.56047	-1 40 54.25268	54.264	5.010
FR10	100089M00	46 59 25.55485	-0 11 57.89549	133.433	86.065
DE01	FLECHTING	52 20 7.94007	11 13 43.03066	153.490	110.580
DE02	BRONNZELL	50 30 30.56765	9 40 54.55663	334.877	287.133
DE03	CUXHAVEN	53 52 5.06677	8 43 1.31452	45.021	5.653
DE04	EUSKIRCHE	50 40 25.75319	6 45 41.65039	217.982	170.947
DE05	HONAU	48 24 .66761	9 17 1.28705	760.506	711.848
DE06	NIEDERWEI	49 54 53.25543	7 17 44.68828	526.493	477.835
DE07	MEERANE	50 50 27.28046	12 29 14.97670	334.308	288.907
DE08	SCHERNFEL	48 55 2.61945	11 8 29.55923	597.626	550.771
POTS	14106M003	52 22 45.46023	13 3 57.91424	144.420	104.216
DE09	WALLENHOR	52 21 50.17271	8 0 26.13160	128.934	85.191
DE10	WARNEMUEN	54 10 40.77808	12 5 20.17587	49.546	11.251
WTZR	14201M010	49 8 39.10400	12 52 44.06095	666.026	619.249
WTZA	WETTZELL_	49 8 38.31674	12 52 42.52335	660.272	
WTZT	14201M011	49 8 39.21409	12 52 44.17266	665.937	
GR01	ASKITES	40 55 40.86988	25 33 58.39334	182.585	141.838 (6)
DION	DIONYSOS	38 4 42.71911	23 55 57.52273	514.553	
GR02	KARITSA	39 44 3.30089	20 39 53.39835	598.607	566.089 (6)
GR03	KATAKOLO	37 38 38.79058	21 19 13.11326	26.885	3.424 (6)

Station Name		Ellipsoidal Coordinates in ETRS89 (ETRF96, Epoch 1997.4)			Normal Heights in UELN-95/98 in m
		Latitude j in ° ' "	Latitude φ in ° ' "	Longitude λ in ° ' "	
HU01	BAKSIPART	48 22 37.26767	21 37 56.47244	155.772	116.021
HU02	CSANADALB	46 19 10.43654	20 40 14.78981	142.470	100.000
HU03	NADAP	47 15 20.47693	18 37 9.29651	234.628	190.670
PENC	11206M006	47 47 22.56111	19 16 53.48804	291.748	248.387
IC01	ENNISHOEF	65 34 53.03124	-21 19 21.68671	339.469	
HOFN	HOEFN	64 16 2.24107	-15 11 52.52345	82.533	
IC03	HOFTEIGUR	65 21 22.76964	-14 52 8.57196	211.624	
REYK	10202M001	64 8 19.61165	-21 57 19.74353	93.017	
IE01	KENMARE	51 52 17.34783	-9 34 58.94911	62.621	4.464 (3)
IE02	SLANE	53 42 41.63763	-6 32 28.11949	135.615	79.140 (3)
IE03	MALIN_HEA	55 22 17.91376	-7 20 20.51504	82.705	25.617 (3)
IT01	BARI	41 7 55.46062	16 52 4.43851	63.116	17.251
CAGL	12725M003	39 8 9.27209	8 58 21.89643	238.378	
IT02	CATANIA	37 30 4.15287	15 5 40.79122	51.971	10.502
IT03	CIVITAVEC	42 5 46.37802	11 47 17.27499	57.488	9.050
IT04	BATTIPAGL	40 38 58.25648	14 51 1.21613	86.635	39.101
IT05	GENOVA	44 24 43.57613	8 55 32.38364	49.339	4.014
IT06	MONTEPESC	42 52 18.07072	11 4 30.27040	68.406	19.904
IT07	IROE	43 48 13.70271	11 13 51.55821	144.673	99.295
MATE	12734M008	40 38 56.86283	16 42 16.03975	535.657	490.042
MEDI	12711M003	44 31 11.83515	11 38 48.51928	50.057	
IT08	MTE_MARIO	41 55 20.95976	12 27 9.19168	201.931	153.528
NOTO	12717M003	36 52 33.98539	14 59 23.30331	126.244	84.441
UPAD	12750M002	45 24 24.17549	11 52 40.54568	84.043	39.582
IT09	PESCARA	42 27 53.85037	14 12 47.54993	68.747	24.921
IT10	TRIESTE	45 38 49.96956	13 45 33.88255	56.199	11.075
IT11	CAGLIARI_	39 12 37.86174	9 6 54.64764	60.143	14.681 (4)
LV01	LV01	57 18 57.21329	24 24 36.30856	26.406	6.760
LV02	LV02	56 30 53.78643	21 0 3.26669	36.258	12.184
LV03	LV03	57 23 45.22477	21 32 16.65063	27.941	6.633
LV04	LV04	57 33 15.89707	21 51 7.17656	40.611	19.645
RIGA	RIGA	56 56 55.02145	24 3 31.56681	34.702	14.017
LT01	SIAULIAI	55 54 48.78221	23 22 17.18426	164.821	141.381
LT02	VILNIUS	54 39 11.30512	25 17 55.19023	240.831	215.798
LT03	MOLAS	55 43 47.23801	21 4 58.88451	29.329	4.638
MK01	BOROVA_CU	42 0 5.54874	22 51 49.20842	1264.161	1219.003 (5)
KOSG	13504M003	52 10 42.32572	5 48 34.70529	96.846	53.589
KOAS	KOOTWIJK_	52 10 42.69962	5 48 36.33394	89.310	
TERS	13534M001	53 21 45.84905	5 13 9.78733	56.091	14.718
WSRT	13506M005	52 54 52.58902	6 36 16.20621	82.275	40.747
NO01	TREGDE	58 0 23.35472	7 33 17.24195	43.822	2.804
NO02	STAVANGER	58 57 42.66581	5 46 8.40796	45.534	1.879
NO03	HALDEN	59 7 32.21886	11 26 29.82401	141.486	104.895
NO04	HOENEFOSS	60 8 36.73503	10 14 56.58109	177.613	137.358
NO05	HOENEFOSS	60 8 36.85964	10 14 56.60413	177.626	
NO07	NYBERGSUN	61 15 37.29707	12 20 8.38071	449.165	413.484
NO08	MAUSUNDVA	63 52 6.18561	8 39 52.31812	50.941	9.204
NYAL	10317M001	78 55 46.49585	11 51 54.28638	78.394	
NO09	RANA	66 18 57.57724	14 7 51.28332	40.308	7.039
NO10	STORFJORD	69 15 49.03195	19 55 38.33703	44.638	14.437
NO11	ANDENES	69 19 18.90135	16 7 51.00300	39.236	3.755
TROA	TROMSOE_A	69 39 45.77566	18 56 22.70580	138.034	
NO12	VARDOE	70 22 39.15821	31 5 44.70425	21.132	2.968
BOGI	BOROWA_GO	52 28 29.96065	21 2 6.75757	139.882	108.760
BOR1	12205M002	52 16 37.03435	17 4 24.42748	124.366	89.027
PL01	BRUDZOWIC	50 30 44.02523	19 12 6.51250	367.231	327.338 65.098
PL02	CHELMSKO	52 34 42.27685	15 33 9.22722	101.438	110.244
JOZE	12204M001	52 5 50.17993	21 1 53.52337	141.447	
LAMA	12209M001	53 53 32.63080	20 40 11.77451	187.031	126.367
PL03	PROSTKI	53 44 2.55374	22 21 34.40648	154.602	41.668
PL04	ROZEWIE	54 49 39.01581	18 19 35.35935	70.796	6.655
PL06	SWINOUJSC	53 55 39.24781	14 13 36.44709	42.205	1.603
PL07	USTKA	54 35 15.67906	16 51 13.86726	33.861	
PT01	BARCA_D'A	41 1 19.59645	-6 56 28.21817	221.752	165.953
PT02	CASCAIS	38 41 24.33179	-9 25 34.04221	65.808	12.147
PT03	ELVAS	38 52 43.91112	-7 3 6.14307	229.935	174.931
PT04	LEIXOES	41 11 46.91513	-8 42 25.25164	70.070	14.866
PT05	LAGOS	37 6 .11198	-8 40 7.47344	55.347	2.597
RO01	SIRCA_(IA	47 14 33.71258	27 12 14.46214	222.944	190.136
RO02	CONSTANTA	44 10 6.94908	28 39 32.41187	37.216	3.561
RO03	TIMISOARA	45 44 18.08291	21 20 45.34545	140.156	96.980
RO04	HEIGHT_ZE	44 35 17.36028	28 37 26.56572	156.390	122.777
SK01	KAMENICA	47 50 11.87136	18 43 45.94329	261.732	218.047
SK02	GANOVCE	49 2 4.60560	20 19 24.64845	743.178	701.273
SK02	STRECNO	49 9 57.33752	18 53 4.17326	415.054	372.356
SI01	VELIKA_PI	46 17 10.92746	15 11 7.51470	342.172	2.952553e+17
SI02	LENDAVSKE	46 33 57.18228	16 28 36.85146	385.191	
SI03	MALIJA	45 30 13.62833	13 38 36.19974	323.127	

Station Name		Ellipsoidal Coordinates in ETRS89 (ETRF96, Epoch 1997.4)			Normal Heights in UELN-95/98 in m
		Latitude j in ° ' "	Latitude φ in ° ' "	Longitude λ in ° ' "	
ES01	ALICANTE	38 20 20.10263	-0 28 52.43684	60.347	9.998
ES02	ALMERIA	36 51 8.88805	-2 27 33.18463	125.048	74.251
ES03	BARCELONA	41 21 3.30031	2 9 26.63153	67.660	18.170
ES04	CASETAS	41 43 17.56091	-1 1 28.67937	269.634	219.285
EBRE	13410M001	40 49 15.18643	0 29 32.49211	107.810	57.708
ES05	LA_CORUNA	43 21 51.76943	-8 23 56.16992	66.957	12.123
MADE	MADRID/RO	40 25 38.02687	-4 14 57.08054	815.088	762.103
ES06	PALMA_DE_	39 33 9.34372	2 37 28.59801	59.085	10.083
ES07	PUERTOLLA	38 41 12.31361	-4 6 37.76599	763.213	709.871
ES08	SANTANDER	43 27 41.04807	-3 47 21.96555	59.281	8.968
SFER	13402M004	36 27 51.63250	-6 12 20.33325	84.180	38.939
VILL	13406M001	40 26 36.92482	-3 57 7.13580	647.362	
KIR0	10422M001	67 52 39.26356	21 3 36.84326	497.968	469.314
KIRR	KIRUNA_R	67 52 39.26352	21 3 36.84356	497.963	
SE02	KUNGSHOLM	56 6 15.25902	15 35 20.50882	35.189	2.415
MAR6	10405M002	60 35 42.50804	17 15 30.67770	75.372	50.485
MARR	MAARTSBO_	60 35 42.50803	17 15 30.67783	75.379	
ONSA	10402M004	57 23 43.06581	11 55 31.84758	45.547	9.099
ONS0	10402M004	57 23 43.06579	11 55 31.84738	45.558	
SE03	OESTERSUN	63 26 34.04833	14 51 29.03092	490.008	458.334
SE04	RATAN	63 59 8.11785	20 53 44.03682	31.320	9.993
SE05	SKELLEFTE	64 52 45.10123	21 2 53.82525	81.189	58.850
SE0R	SKELLEFTE	64 52 45.10122	21 2 53.82525	81.188	
SE06	SMOEGEN	58 21 12.46157	11 13 4.52608	45.196	9.035
SE07	STOCKHOLM	59 19 20.39806	18 5 27.24415	35.084	11.954
VIS0	10423M001	57 39 13.92220	18 22 2.32435	79.787	54.846
VISR	VISBY_R	57 39 13.92211	18 22 2.32441	79.788	
VIL0	10424M001	64 41 52.24148	16 33 35.73380	449.934	420.092
VILR	VILHELMIN	64 41 52.24144	16 33 35.73407	449.936	
CH01	CHRISCHON	47 34 1.38501	7 40 6.98289	504.933	455.773
CH02	BOURG_ST.	45 57 30.98020	7 12 34.23705	1683.443	1629.321
CH03	LA_GIVRIN	46 27 14.68981	6 6 7.32564	1258.258	1207.278
CH04	OBERALP	46 39 35.12553	8 40 13.71807	2094.219	2042.489
CH05	SIBLINGEN	47 42 46.86246	8 29 55.98166	563.324	514.832
CH06	STABIO	45 51 5.21055	8 56 25.21413	429.707	382.128
CH07	ZERNEZ	46 41 54.87577	10 6 2.59009	1612.690	1560.915
ZIMM	14001M004	46 52 37.54033	7 27 54.98332	956.342	906.877
ANKR	20805M002	39 53 14.52729	32 45 30.48374	976.056	939.301 (7)
TR01	ANTALYA	36 49 42.59595	30 36 33.65628	31.554	4.926 (7)
TR02	ERDEK	40 23 25.67861	27 50 42.29168	40.005	1.656 (7)
TR03	20803M001	37 22 39.58212	33 11 28.50994	1357.758	323.541 (7)
TR04	MENTES	38 25 35.88762	26 43 2.94563	58.650	20.348 (7)
TR05	20804M001	40 56 13.17999	31 26 19.66877	822.685	785.624 (7)
TR06	20802M001	39 48 1.90002	34 48 46.84053	1677.058	1641.991 (7)
UK01	KIEV	50 21 51.01571	30 29 48.38253	224.877	199.370 (1)
UK02	UZHGORAD	48 33 46.35914	22 27 9.42239	273.801	235.264 (1)
UK03	MYKOLAIV	46 58 17.46768	31 58 24.23034	78.244	52.518 (1)
UK04	SIMEIZ	44 24 55.27519	33 59 29.76881	386.480	361.964 (1)
GB01	13299S001	55 12 46.03424	-1 41 7.79798	144.401	95.483
GB02	BELFAST	54 37 20.04452	-5 55 26.52005	67.897	11.813 (6)
GB03	13296M002	56 28 42.58493	-2 46 58.76766	57.779	6.810
GB04	GIBRALTAR	36 7 54.40412	-5 21 20.91484	45.469	2.456
GB05	SOUTHAMPT	50 55 50.75915	-1 27 2.49852	98.586	52.185
GB06	LERWICK	60 8 53.92142	-1 8 25.82813	96.130	46.853 (8)
HERS	13212M007	50 52 2.31861	0 20 10.56577	76.489	
HERE	HERSTMONC	50 52 2.64621	0 20 8.19909	70.809	
GB07	KIRKBY_ST	54 26 47.74472	-2 23 10.95587	356.112	304.233
GB08	NEWLYN	50 6 10.58834	-5 32 34.54661	57.507	4.495
GB09	NOTTINGHA	52 56 26.47639	-1 11 32.22810	98.465	49.923
ZWEN	12330M001	55 41 57.41151	36 45 31.04174	204.993	
KIT3	12334M001	39 8 5.15694	66 53 7.58466	622.534	

(1) normal Heights /Kronstadt
(2) normal Heights /Ajaccio
(3) orthom. Heights /Malin Head
(4) normal Heights /Cagliari
(5) normal-orth. Heights /Trieste
(6) height system and/or tide gauge unknown
(7) normal-orth. Heights /Antalya
(8) orthom. Heights /Lerwick
(9) orthom. Heights /Larnaka

Table 2: The EUVN GPS/Levelling Quasi-Geoid

Station Name		Ellipsoidal coordinates in ETRS89			Normal Height H in UELN-95/98 in m	h-H in m	EGG97 Geoid in m	EGG97 - (h-H) in cm
		Latitude φ in ° ' "	Longitude λ in ° ' "	Height h in m				
GRAZ	11001M002	47 4 2	15 29 37	5,383e+36	4,909254e+30	4,74e+24	4,72e+29	-15
GRAA	11001M003	47 4 2	15 29 37					
AT01	HUTBIEGL	48 39 16	15 35 54					-15
PFAN	11005S002	47 30 55	9 47 5					-36
AT03	THOERL-MA	46 33 15	13 41 0					-27
AT04	WOERGL	47 29 46	12 4 59					-34
BRUS	13101M004	50 47 52	4 21 33	149.668	104.437	45.231	45.311	48
BRUT	13101M003	50 47 55	4 21 32	157.470			45.310	
DENT	13112M001	50 56 1	3 23 59	63.894	19.518	44.376	44.547	
DOUR	13113M001	50 5 42	4 35 42	282.695	236.643	46.052	46.069	
BE01	OSTENDE	51 14 6	2 55 39	54.461	10.213	44.248	44.454	
BG01	BURGAS	42 29 1	27 28 55	4,174e+16	2.986 (1)	3,88e+14	3,87e+14	-9
BG03	SOFIA	42 33 22	23 23 41		1074.507 (1)			-33
BG04	VARNA	43 11 34	27 54 33		2.072 (1)			-13
HR01	BAKAR	45 15 20	14 35 9	1,824e+44	1,373802e+41	4,50e+39	4,55e+39	204
HR02	BRUSNIK	45 34 43	15 34 13					
HR03	DUBROVNIK	42 39 28	18 3 39					
HR04	VELIKO_GR	45 9 14	18 42 42					
HR05	SPLIT	43 30 24	16 26 18					
HR06	ZAGREB	45 48 22	15 58 43					
HR07	ROVINJ	45 5 2	13 37 46					
HR08	PLITVICE_	44 50 42	15 40 47					
CY01	LARNAKA	34 55 41	33 38 43	3,120e+10	5.887 (9)	2,53e+09	2,41e+09	-122
NICO	14302M001	35 8 28	33 23 47		162.277 (9)			-128
CZ01	CHRASTAVA	50 49 2	14 58 9	3,386e+29	2,957445e+29	4,29e+24	4,29e+24	- 3
CZ02	KOTOUN	49 27 45	13 40 0					-14
CZ03	PREDNI_PR	49 30 21	17 14 47					-17
CZ04	KOSTELEC	49 51 30	15 56 7					-11
GOPE	11502M002	49 54 49	14 47 8					-11
DK01	KOBENHAVN	55 44 20	12 29 60	8,794e+29	5,184051e+21	3,61e+24	3,61e+29	23
DK0A	KOBENHAVN	55 44 20	12 29 59					
DK02	HIRTSHALS	57 35 42	9 57 44					
DK03	ESBJERG	55 27 37	8 26 23					
DK04	GEDSER	54 34 20	11 55 28					
DK05	THORSHAVN	62 0 16	-6 45 40					
EE01	OTSA	57 50 32	27 14 56	1,075e+10	88.162	1,93e+09	1,94e+09	21
EE02	SUURUPI	59 27 49	24 22 49		65.993			
FI01	DEGERBY	60 1 53	20 23 4	2,165e+57	2,913538e+40	1,87e+44	1,88e+54	143
FI02	HANKO	59 49 22	22 58 35					
FI03	HELSINKI	60 9 13	24 57 24					
JOEN	10512M001	62 23 28	30 5 46					
FI05	KASKINEN	62 20 34	21 12 59					
FI06	KEMI	65 40 28	24 31 6					
KUUS	KUUSAMO	65 54 37	29 2 1					
METS	10503S011	60 13 3	24 23 43					
META	METSAEHOV	60 13 3	24 23 43					
SODA	10513M001	67 25 15	26 23 21					
VAAS	10511M001	62 57 40	21 46 14					
FR01	100077M00	41 55 39	8 45 46	9,680e+67	49.069 (2)	4,77e+54	4,92e+59	273
GRAS	10002M006	43 45 17	6 55 14					
FR02	100013M00	44 48 56	-0 33 43		7.380			
FR03	100086M00	46 37 13	3 44 7		209.154			
FR04	BREST	48 24 28	-4 30 14		53.301			
FR05	LE_HAVRE	49 28 55	0 6 22		8.131			
FR06	100073M00	43 16 44	5 21 14		12.394			
FR07	100087M00	48 45 46	6 7 42		194.365			
FR08	100001M01	48 50 40	2 25 30		81.867			
TOUL	10003M004	43 33 39	1 28 51		157.740			
FR09	100088M00	43 23 43	-1 40 54		5.010			
FR10	100089M00	46 59 26	-0 11 58		86.065			
DE01	FLECHTING	52 20 8	11 13 43	153.490	110.580	42.910	42.929	-53
DE02	BRONNZELL	50 30 31	9 40 55	334.877	287.133	47.744	47.723	
DE03	CUXHAVEN	53 52 5	8 43 1	45.021	5.653	39.368	39.416	
DE04	EUSKIRCHE	50 40 26	6 45 42	217.982	170.947	47.035	47.022	
DE05	HONAU	48 24 1	9 17 1	760.506	711.848	48.658	48.492	
DE06	NIEDERWEI	49 54 53	7 17 45	526.493	477.835	48.658	48.596	
DE07	MEERANE	50 50 27	12 29 15	334.308	288.907	45.401	45.355	
DE08	SCHERNFEL	48 55 3	11 8 30	597.626	550.771	46.855	46.706	
POTS	14106M003	52 22 45	13 3 58	144.420	104.216	40.204	40.219	
DE09	WALLENHOR	52 21 50	8 0 26	128.934	85.191	43.743	43.800	
DE10	WARNEMUEN	54 10 41	12 5 20	49.546	11.251	38.295	38.304	
WTZR	14201M010	49 8 39	12 52 44	666.026	619.249	46.777	46.548	
WTZA	WETTZELL_	49 8 38	12 52 43	660.272			46.547	
WTZT	14201M011	49 8 39	12 52 44	665.937			46.548	
GR01	ASKITES	40 55 41	25 33 58	182.585	141.838 (6)	40.747	41.051	+30
DION	DIONYSOS	38 4 43	23 55 58	514.553			38.349	
GR02	KARITSA	39 44 3	20 39 53	598.607	566.089 (6)	32.518	32.251	-27
GR03	KATAKOLO	37 38 39	21 19 13	26.885	3.424 (6)	23.461	23.707	+25

Station Name		Ellipsoidal coordinates in ETRS89			Normal Height H in UELN-95/98	h-H in m	EGG97 Geoid	EGG97 - (h-H)
		Latitude φ in ° ' "	Longitude λ in ° ' "	Height h in m	in m		in m	in cm
HU01	BAKSIPART	48 22 37	21 37 56	155.772	1.160211e+23	39.751	39.638	-11
HU02	CSANADALB	46 19 10	20 40 15	142.470		42.470	42.498	+ 3
HU03	NADAP	47 15 20	18 37 9	234.628		43.958	43.849	-11
PENC	11206M006	47 47 23	19 16 53	291.748		43.361	43.200	-16
IC01	ENNISHOEF	65 34 53	21 19 22	339.469			65.725	
HOFN	HOEFN	64 16 2	15 11 53	82.533			65.150	
IC03	HOFTEIGUR	65 21 23	14 52 9	211.624			65.629	
REYK	10202M001	64 8 20	21 57 20	93.017			66.446	
IE01	KENMARE	51 52 17	-9 34 59	62.621	4.464 (3)	58.157	57.874	-28
IE02	SLANE	53 42 42	-6 32 28	135.615	79.140 (3)	56.475	56.464	- 1
IE03	MALIN_HEAD	55 22 18	-7 20 21	82.705	25.617 (3)	57.088	57.281	+19
IT01	BARI	41 7 55	16 52 4	63.116	17.251	45.865	45.810	- 6
CAGL	12725M003	39 8 9	8 58 22	238.378			46.552	
IT02	CATANIA	37 30 4	15 5 41	51.971	10.502	41.469	41.623	+15
IT03	CIVITAVEC	42 5 46	11 47 17	57.488	9.050	48.438	48.856	+42
IT04	BATTIPAGL	40 38 58	14 51 1	86.635	39.101	47.534	47.742	+21
IT05	GENOVA	44 24 44	8 55 32	49.339	4.014	45.325	45.529	+20
IT06	MONTEPESC	42 52 18	11 4 30	68.406	19.904	48.502	48.749	+25
IT07	IROE	43 48 14	11 13 52	144.673	99.295	45.378	45.471	+ 9
MATE	12734M008	40 38 57	16 42 16	535.657	490.042	45.615	45.559	- 6
MEDI	12711M003	44 31 12	11 38 49	50.057			39.725	
IT08	MTE_MARIO	41 55 21	12 27 9	201.931	153.528	48.403	48.752	+35
NOTO	12717M003	36 52 34	14 59 23	126.244	84.441	41.803	41.800	- 0
UPAD	12750M002	45 24 24	11 52 41	84.043	39.582	44.461	44.391	- 7
IT09	PESCARA	42 27 54	14 12 48	68.747	24.921	43.826	44.241	+42
IT10	TRIESTE	45 38 50	13 45 34	56.199	11.075	45.124	45.161	+ 4
IT11	CAGLIARI_	39 12 38	9 6 55	60.143	14.681 (4)	45.462	46.358	+90
LV01	SKULTE	57 18 57	24 24 36	26.406	6.760	19.646	19.685	+ 4
LV02	LIEPAJA	56 30 54	21 0 3	36.258	12.184	24.074	23.825	-25
LV03	VENTSPILS	57 23 45	21 32 17	27.941	6.633	21.308	20.967	-34
LV04	IRBENE	57 33 16	21 51 7	40.611	19.645	20.966	20.766	-20
RIGA	12302M002	56 56 55	24 3 32	34.702	14.017	20.685	20.873	+19
LT01	SIAULIAI	55 54 49	23 22 17	164.821	141.381	23.440	23.446	-6
LT02	VILNIUS	54 39 11	25 17 55	240.831	215.798	25.033	25.102	
LT03	MOLAS	55 43 47	21 4 59	29.329	4.638	24.691	24.552	
MK01	BOROVA_CU	42 0 6	22 51 49	1264.161	219.003 (5)	45.158	45.078	- 8
KOSG	13504M003	52 10 42	5 48 35	96.846	53.589	43.257	43.418	+16
KOAS	KOOTWIJK_	52 10 43	5 48 36	89.310			43.418	
TERS	13534M001	53 21 46	5 13 10	56.091	14.718	41.373	41.554	+18
WSRT	13506M005	52 54 53	6 36 16	82.275	40.747	41.528	41.703	+18
NO01	TREGDE	58 0 23	7 33 17	43.822	2.804	41.018	41.164	+15
NO02	STAVANGER	58 57 43	5 46 8	45.534	1.886	43.648	43.968	+30
NO03	HALDEN	59 7 32	11 26 30	141.486	105.021	36.465	36.618	+15
NO04	HOENEFOSS	60 8 37	10 14 57	177.613	137.495	40.118	40.136	+ 2
NO05	HOENEFOSS	60 8 37	10 14 57	177.626	413.706		40.136	
NO07	NYBERGSUN	61 15 37	12 20 8	449.165	9.278	35.459	35.406	- 5
NO08	MAUSUNDVA	63 52 6	8 39 52	50.941		41.663	41.816	+15
NYAL	10317M001	78 55 46	11 51 54	78.394	7.176			
NO09	RANA	66 18 58	14 7 51	40.308	14.541	33.132	33.115	- 2
NO10	STORFJORD	69 15 49	19 55 38	44.638	3.828	30.097	29.785	-31
NO11	ANDENES	69 19 19	16 7 51	39.236		35.408	35.735	+32
TROA	TROMSOE_A	69 39 46	18 56 23	138.034	3.042		30.672	
NO12	VARDOE	70 22 39	31 5 45	21.132		18.090	18.629	+54
BOGI	BOROWA_GO	52 28 30	21 2 7	139.882	108.760	31.122	30.706	-42
BOR1	12205M002	52 16 37	17 4 24	124.366	89.027	35.339	35.385	+ 5
PL01	BRUDZOWIC	50 30 44	19 12 7	367.231	327.338	39.893	39.863	- 3
PL02	CHELMSKO	52 34 42	15 33 9	101.438	65.098	36.340	36.375	+ 4
JOZE	12204M001	52 5 50	21 1 54	141.447	110.244	31.203	31.470	+27
LAMA	12209M001	53 53 33	20 40 12	187.031			29.255	
PL03	PROSTKI	53 44 3	22 21 34	154.602	126.367	28.235	28.310	+ 8
PL04	ROZEWIE	54 49 39	18 19 35	70.796	41.668	29.128	29.027	-10
PL06	SWINOUJSC	53 55 39	14 13 36	42.205	6.655	35.550	35.531	- 2
PL07	USTKA	54 35 16	16 51 14	33.861	1.603	32.258	32.158	-10
PT01	BARCA_D'A	41 1 20	-6 56 28	221.752	165.953	55.799	55.949	+15
PT02	CASCAIS	38 41 24	-9 25 34	65.808	12.147	53.661	53.496	-17
PT03	ELVAS	38 52 44	-7 3 6	229.935	174.931	55.004	55.017	+ 1
PT04	LEIXOES	41 11 47	-8 42 25	70.070	14.866	55.204	55.157	- 5
PT05	LAGOS	37 6 0	-8 40 7	55.347	2.597	52.750	52.693	- 6
RO01	SIRCA_(IA	47 14 34	27 12 14	222.944	190.136	32.808	33.137	+33
RO02	CONSTANTA	44 10 7	28 39 32	37.216	3.561	33.655	33.781	+13
RO03	TIMISOARA	45 44 18	21 20 45	140.156	96.980	43.176	43.178	+ 0
RO04	HEIGHT_ZE	44 35 17	28 37 27	156.390	122.777	33.613	33.792	+18
SK01	KAMENICA	47 50 12	18 43 46	261.732	2.180477e+17	43.685	43.523	-16
SK02	GANOVCE	49 2 5	20 19 25	743.178		41.905	41.506	-40
SK03	STRECNO	49 9 57	18 53 4	415.054		42.698	42.085	-61
SI01	VELIKA_PI	46 17 11	15 11 8	342.172	2.952553e+17	4.69e+14	46.751	-17
SI02	LENDAVSKE	46 33 57	16 28 37	385.191			45.308	-6
SI03	MALIJA	45 30 14	13 38 36	323.127			45.047	+11

Station Name		Ellipsoidal coordinates in ETRS89			Normal Height H in UELN-95/98	h-H in m	EGG97 Geoid	EGG97 - (h-H)
		Latitude φ in ° ' "	Longitude λ in ° ' "	Height h in m	in m		in m	in cm
ES01	ALICANTE	38 20 20	-0 28 52	60.347	9.998	50.349	50.598	201
ES02	ALMERIA	36 51 9	-2 27 33	125.048	74.251	50.797	50.489	
ES03	BARCELONA	41 21 3	2 9 27	67.660	18.170	49.490	49.903	
ES04	CASETAS	41 43 18	-1 1 29	269.634	219.285	50.349	50.412	
EBRE	13410M001	40 49 15	0 29 32	107.810	57.708	50.102	50.379	
ES05	LA_CORUNA	43 21 52	-8 23 56	66.957	12.123	54.834	54.685	
MADE	MADRID/RO	40 25 38	-4 14 57	815.088	762.103	52.985	52.992	
ES06	PALMA_DE_	39 33 9	2 37 29	59.085	10.083	49.002	50.090	
ES07	PUERTOLLA	38 41 12	-4 6 38	763.213	709.871	53.342	53.796	
ES08	SANTANDER	43 27 41	-3 47 22	59.281	8.968	50.313	50.564	
SFER	13402M004	36 27 52	-6 12 20	84.180	38.939	45.241	44.914	
VILL	13406M001	40 26 37	-3 57 7	647.362			51.859	
KIR0	10422M001	67 52 39	21 3 37	497.968	469.536	28.432	28.505	+ 7
KIRR	KIRUNA_R	67 52 39	21 3 37	497.963			28.505	
SE02	KUNGSHOLM	56 6 15	15 35 21	35.189	2.430	32.759	32.630	-13
MAR6	10405M002	60 35 43	17 15 31	75.372	50.728	24.644	24.697	+ 5
MARR	MAARTSBO_	60 35 43	17 15 31	75.379			24.697	
ONSA	10402M004	57 23 43	11 55 32	45.547	9.129	36.418	36.508	+ 9
ONS0	10402M004	57 23 43	11 55 32	45.558			36.508	
SE03	OESTERSUN	63 26 34	14 51 29	490.008	458.645	31.363	31.339	- 2
SE04	RATAN	63 59 8	20 53 44	31.320	10.310	21.010	20.997	- 1
SE05	SKELLEFTE	64 52 45	21 2 54	81.189	59.179	22.010	22.029	+ 2
SE0R	SKELLEFTE	64 52 45	21 2 54	81.188			22.029	
SE06	SMOEGEN	58 21 12	11 13 5	45.196	9.098	36.098	36.285	+19
SE07	STOCKHOLM	59 19 20	18 5 27	35.084	12.103	22.981	23.060	+ 8
VIS0	10423M001	57 39 14	18 22 2	79.787	54.846	24.941	25.121	+18
VISR	VISBY_R	57 39 14	18 22 2	79.788			25.121	
VIL0	10424M001	64 41 52	16 33 36	449.934	420.321	29.613	29.510	-10
VILR	VILHELMIN	64 41 52	16 33 36	449.936			29.510	
CH01	CHRISCHON	47 34 1	7 40 7	504.933	4.5577363e+47	49.160	48.971	-19
CH02	BOURG_ST.	45 57 31	7 12 34	1683.443		54.122	53.747	-38
CH03	LA_GIVRIN	46 27 15	6 6 7	1258.258		50.980	50.798	-18
CH04	OBERALP	46 39 35	8 40 14	2094.219		51.730	51.357	-37
CH05	SIBLINGEN	47 42 47	8 29 56	563.324		48.492	48.294	-20
CH06	STABIO	45 51 5	8 56 25	429.707		47.579	47.175	-40
CH07	ZERNEZ	46 41 55	10 6 3	1612.690		51.775	51.306	-47
ZIMM	14001M004	46 52 38	7 27 55	956.342		49.465	49.188	-28
ANKR	20805M002	39 53 15	32 45 30	976.056	939.301 (7)	36.755	36.612	-14
TR01	ANTALYA	36 49 43	30 36 34	31.554	4.926 (7)	26.628	25.057	-157
TR02	ERDEK	40 23 26	27 50 42	40.005	1.656 (7)	38.349	38.573	+22
TR03	20803M001	37 22 40	33 11 29	1357.758	323.541 (7)	34.217	34.007	-21
TR04	MENTES	38 25 36	26 43 3	58.650	20.348 (7)	38.302	37.784	-52
TR05	20804M001	40 56 13	31 26 20	822.685	785.624 (7)	37.061	35.601	-146
TR06	20802M001	39 48 2	34 48 47	1677.058	641.991 (7)	35.067	34.629	-44
UK01	KIEV	50 21 51	30 29 48	224.877	199.520 (1)	25.357	25.564	+21
UK02	UZHGORAD	48 33 46	22 27 9	273.801	235.414 (1)	38.387	38.465	+ 8
UK03	MYKOLAIV	46 58 17	31 58 24	78.244	52.668 (1)	25.576	25.726	+15
UK04	SIMEIZ	44 24 55	33 59 30	386.480	362.114 (1)	24.366	23.121	-125
GB01	13299S001	55 12 46	-1 41 8	144.401	95.48	48.918	49.913	416
GB02	BELFAST	54 37 20	-5 55 27	67.897	11.813 (6)	56.084	56.136	
GB03	13296M002	56 28 43	-2 46 59	57.779	6.810	50.969	51.661	
GB04	GIBRALTAR	36 7 54	-5 21 21	45.469	2.456	43.013	43.171	
GB05	SOUTHAMPT	50 55 51	-1 27 2	98.586	52.185	46.401	46.732	
GB06	LERWICK	60 8 54	-1 8 26	96.130	46.853 (8)	49.277	49.838	
HERS	13212M007	50 52 2	0 20 11	76.489			45.026	
HERE	HERSTMONC	50 52 3	0 20 8	70.809			45.026	
GB07	KIRKBY_ST	54 26 48	-2 23 11	356.112	304.233	51.879	52.428	
GB08	NEWLYN	50 6 11	-5 32 35	57.507	4.495	53.012	53.419	
GB09	NOTTINGHA	52 56 26	-1 11 32	98.465	49.923	48.542	48.955	
ZWEN	12330M001	55 41 57	36 45 31	204.993			15.203	
KIT3	12334M001	39 8 5	66 53 8	622.534			-36.686	

Remarks

(1) normal Heights transformed from tide gauge Kronstadt to tide gauge Amsterdam by +15cm
(2) normal Heights /Ajaccio
(3) orthom. Heights /Malin Head
(4) normal Heights /Cagliari
(5) normal-orth. Heights /Trieste
(6) height system and/or tide gauge unknown
(7) normal-orth. Heights /Antalya
(8) orthom. Heights /Lerwick
(9) orthom. Heights /Larnaka

Annex 2

Technical Working Group EUREF **EUVN** Levelling/Gravity Form Page 1 of 2

EUVN Working Group

Levelling/Gravity Form

EUVN ID CODE_____ Version 1.1 Date_____

This Form is valid for height difference measurements between GPS Marker and next Levelling Nodal Point. Please use for height differences between GPS Marker and Tide Gauge Bench Mark as well as Levelling Nodal Point and Tide Gauge Bench Mark the same form. Then change the designation of I and II.

Information should be compatible with marker information in the GPS Site Information Form and GPS Occupation Form.

Station Name: _____ 4-Char. EUVN ID: _____ National site number: _____
Location: _____ City/Area: _____ Country: _____
Responsible Agency (Full Adress): _____

Reported by: _____ Telephone: _____

I EUVN GPS Marker: _____

Official No. of other networks (EUREF):_____

GPS Mark Inscription: _____
GPS Mark Identifier: _____
Marker type, monumentation type, foundation: _____

Ellipsoidal coordinates in ETRS89

Latitude: ° ′ ″ _____

Longitude: ° ′ ″ _____

Gravity value in m/s^2: _____
(For reduction of geopotential number)
Gravity system: _____
Approximate accuracy of gravity in 10^{-5} ms^{-2} (mGal): _____

II Nodal Point Marker: _____ Official No.: _____

Mark Inscription: _____
Mark Identifier: _____
Marker type, monumentation type, foundation: _____

of UELN ☐ of UPLN ☐

or of other networks ☐ _____

Ellipsoidal coordinates in ETRS89

Latitude: ° ′ ″ _____

Longitude: ° ′ ″ _____

Gravity value in m/s^2: _____
(For reduction of geopotential number)
Gravity system: _____
Approximate accuracy of gravity in 10^{-5} ms^{-2} (mGal): _____
Geopotential number in $m^2 \cdot s^{-2}$: _____

Technical Working Group EUREF **EUVN** Levelling/Gravity Form Page 2 of 2

EUVN Working Group

Levelling/Gravity Form

EUVN ID CODE_____ Version 1.1 Date_____

still II

or

Levelling height in m: _____

kind of height :

normal ☐ orthometric ☐

normalorthometric ☐ or other ☐ _____

Kind of height system: _____

_____

Related to which tide gauge: _____

Difference of geopotential number between **I-II** in $m^2 \cdot s^{-2}$ (measured value): _____

Precision of geoptential number difference in $m^2 \cdot s^{-2}$: _____

Distance between point I and II in km: _____

or

Height **difference** between **I-II** in m (measured value): _____

Precision of height difference in m: _____

Distance between point I and II in km: _____

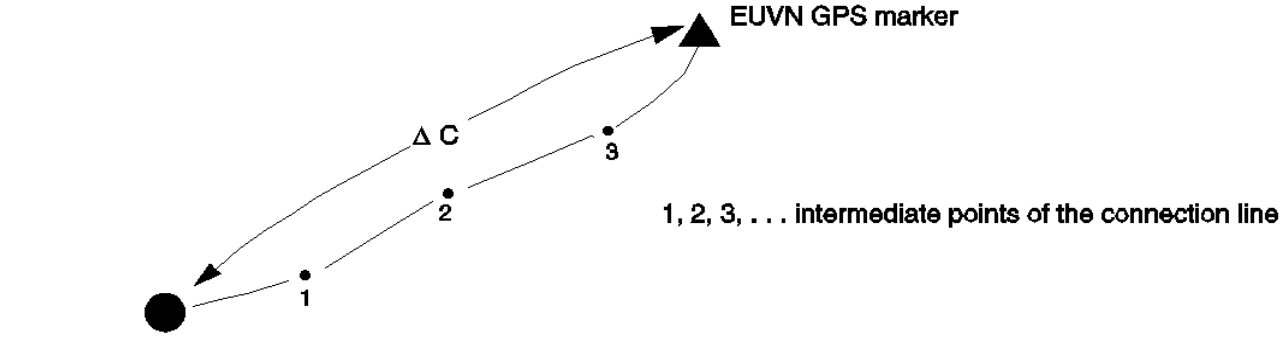
Kind of height difference

normal ☐ orthometric ☐

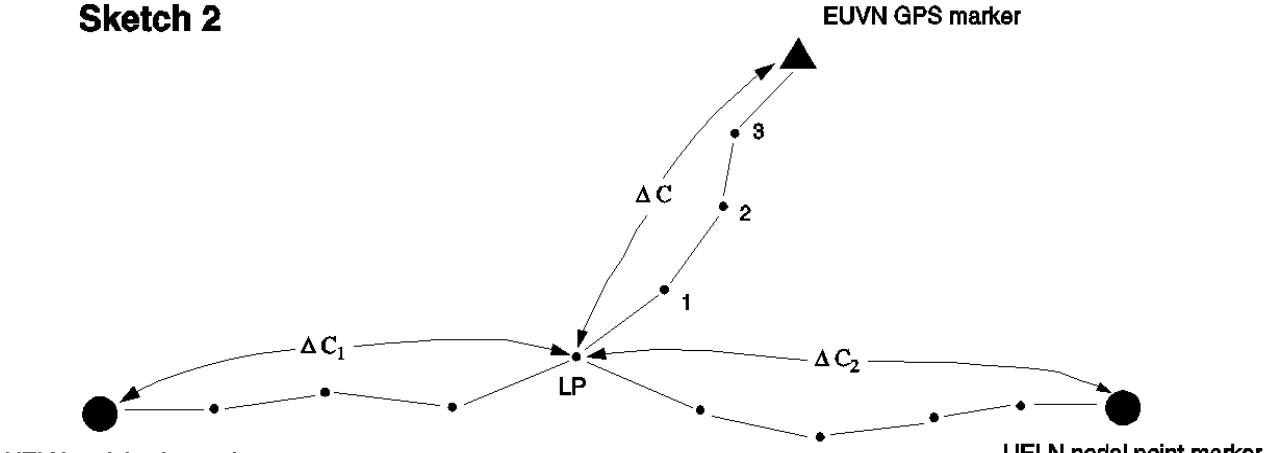
normalorthometric ☐ or other ☐ _____

Annex 3

Sketch 1

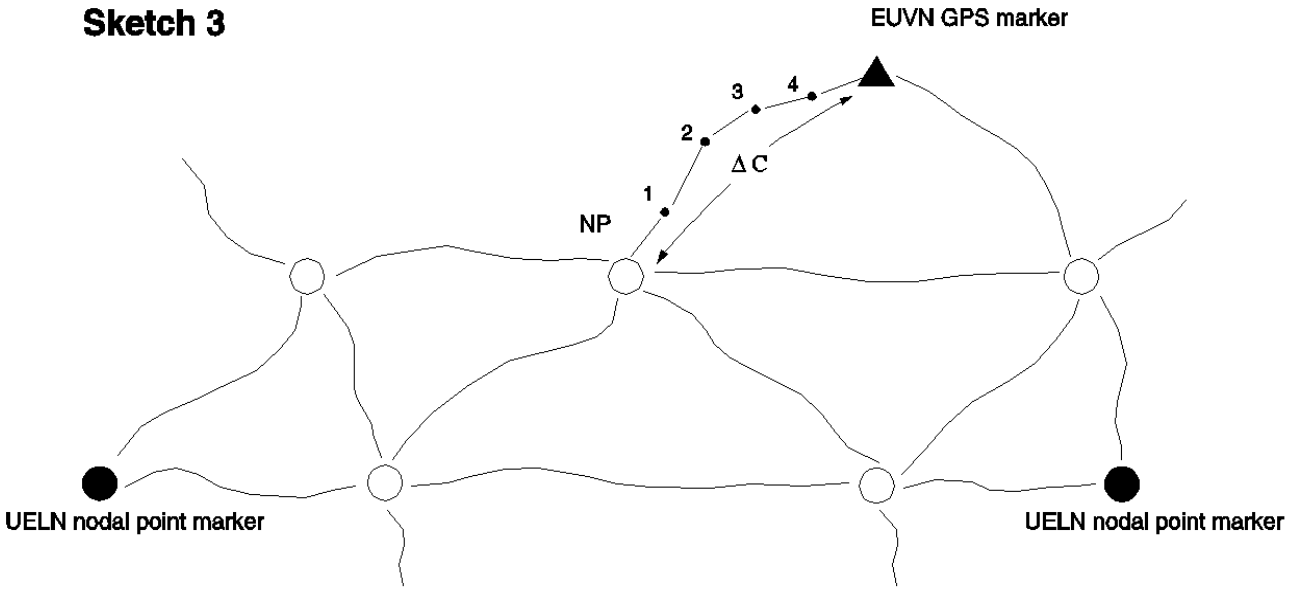


Sketch 2



LP point of the UELN line

Sketch 3



NP Network point of the national height network