EUVN 97 Combined GPS Solution

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Abstract

The European Vertical Reference Network 97 (EUVN 97) GPS campaign was performed from May 21 to May 29, 1997. For the data processing the network was divided into eight subnetworks. Ten different analysis centers were involved in the distributed network analysis. The Bundesamt für Kartographie und Geodäsie (BKG) at Leipzig and the Center for Orbit Determination in Europe (CODE), located at the Astronomical Institute of the University of Berne, were responsible for the combination of the subnetwork solutions into an official EUVN 97 solution.

All the observed GPS data, collected and checked by various preprocessing centers, have been made available to the analysis centers by the EUVN data center located at BKG in Leipzig. The entire network consists of 217 GPS sites, out of which 37 sites have known ITRF 96 coordinates.

In order to examine different processing strategies, solutions with different elevation cut-off angles, with introduction of elevation-dependent weighting, and with introduction of satellite-specific weighting were generated. For the final solution the strategy using a 15-degree elevation cut-off angle without introduction of elevation-dependent weighting was chosen. For the realization of the Terrestial Reference Frame the network was fixed to ITRF 96 coordinates (epoch 1997.4).

The following final products were generated: two coordinate files containing geocentric coordinates (ITRF 96 and ETRF 96 at epoch 1997.4) and a file in the Solution-INdependent EXchange (SINEX) format [6], containing in addition to the coordinates the variance-covariance information of the EUVN 97 GPS network. These products will be available at the EUREF data information system at IGN Paris and at the EUVN data center at BKG in Leipzig.

1. Introduction

During the EUVN Analysis Center Workshop at the Bundesamt für Kartographie und Geodäsie (BKG) in Leipzig (September 17–18, 1997) it was decided that BKG and CODE (Center for Orbit Determination in Europe) should contribute to the EUVN combined solution. Further activities of BKG to the realization of EUVN were the operation of the EUVN Data Center and the analysis of a subnetwork in Central Europe.

CODE is located at the Astronomical Institute of the University of Berne (AIUB). In addition to its main function — to operate as an IGS Global Analysis Center — CODE is also involved in the processing of the European permanent GPS network (as Local Network Associated Analysis Center (LNAAC) and combination center).

The official observation period of the EUVN 97 GPS campaign started on May 21, 1997 at 18:00 UTC (Day of the year 141) and ended on May 29, 1997 at 6:00 UTC (DOY 149). For the final solution only data of the seven full days (DOY 142 to 148), were used, i.e. six hours of data were dropped from the first and last day each.

Three EUVN Analysis Center Workshops were held at Leipzig (September 17–18, 1997), Berne (February 5–6, 1998), and Wettzell (April 2–3, 1998) to discuss data exchange, processing strategies, detected problems, preliminary results, and the selection of the final solution.

The combination of the various subnetwork solutions into one final network solution was done at CODE with the latest version of the Bernese GPS Software [1], which is running on a VMS Alpha cluster and at BKG Leipzig with the Bernese GPS Software, Version 4.0 on the basis of a CONVEX workstation with operating system SPP-UX 1.0.

2. General Remarks on the Combined Solution

2.1 The EUVN 97 GPS Network

The EUVN 97 GPS network consists of 217 processed sites: 37 sites with known ITRF 96 coordinates (used for fixing the network) and 180 sites with new determined coordinates. A map of these 180 new sites can be seen in Figure 1. Not shown on the Map are the sites `NYAL` (Ny-Alesund, Spitsbergen) and `KIT3` (Kitab, Uzbekistan). The following kind of points are part of the EUVN 97 GPS network:

- EUREF permanent GPS stations
- EUREF sites
- Permanent GPS stations
- United European Levelling Network (UELN) and United Precise Levelling Network (UPLN) nodal points
- Tide gauge sites

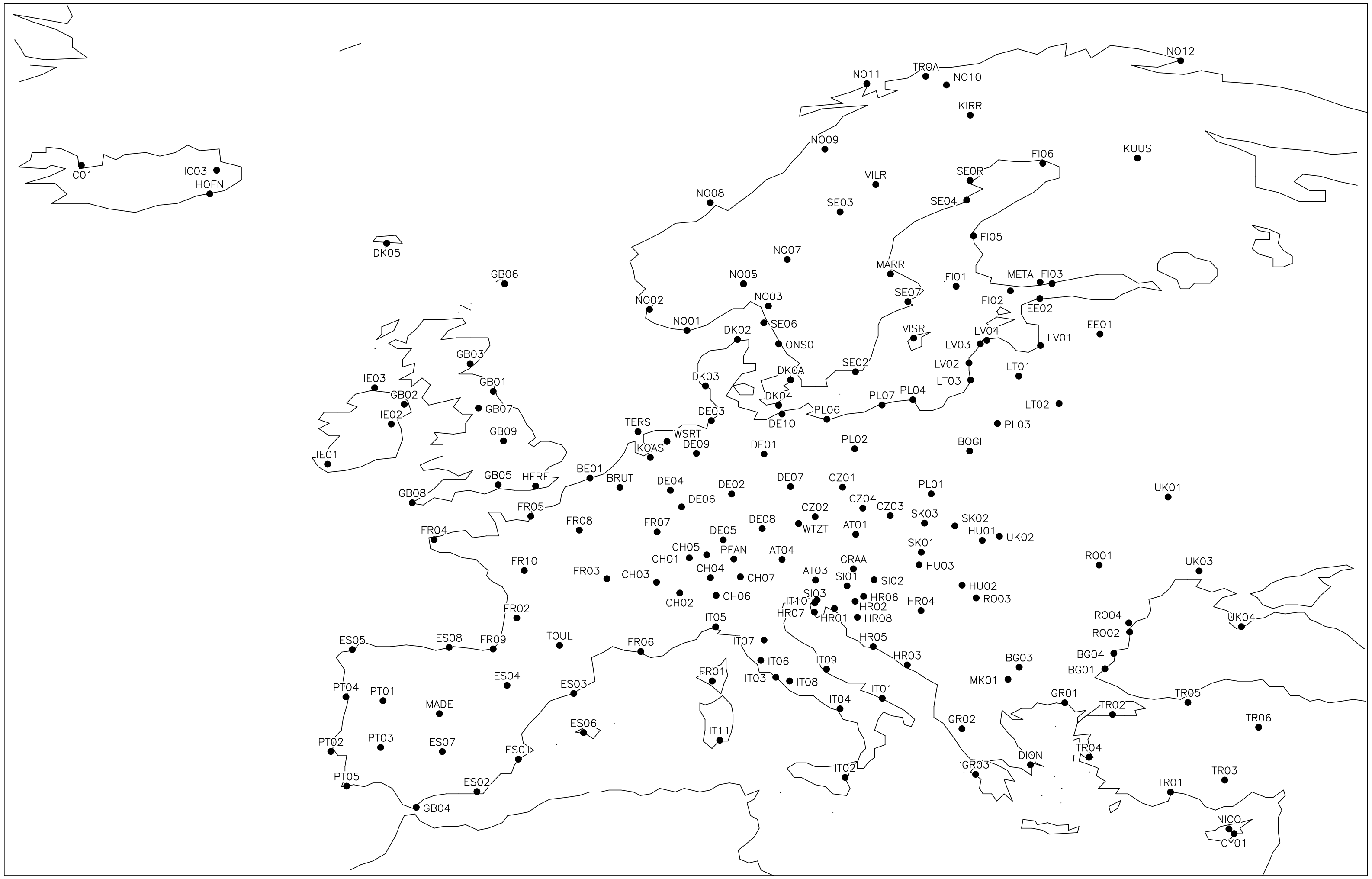

Figure 1: Map of the new points within the EUVN 97 GPS network

2.2 Contributing Analysis Centers

The EUVN 97 GPS network was divided into eight different subnetworks, and the approach of a distributed processing was selected. The eight Analysis Centers (ACs) involved in the processing of the subnetworks are listed in Table 1. In addition the Table contains short statistics of the total number of processed subnetwork sites, the number of sites with known ITRF 96 coordinates, and the number of redundant sites (sites which are part of at least two subnetworks but not used as fiducials).

The daily subnetwork solutions were combined by the ACs to one subnetwok solution for the entire campaign period. All these subnetwork campaign-solutions were combined by the combination centers BKG and CODE to one official EUVN 97 solution.

Table 1: Contributing analysis centers

	Total processed sites	ITRF 96 sites	Redundant sites
AC Austria	48	8	10
AC Belgium	24	5	4
AC Czech Republic	22	5	2
AC Germany	54	11	12
AC France	20	5	9
AC Poland	39	12	12
AC Sweden	53	12	10
AC Turkey	15	4	5

As additional analysis centers AC Croatia and AC Finland were involved in the analysis of EUVN 97 GPS data as follows:

AC Croatia This Center was responsible for the analysis of the collocation points and the investigation of the biases introduced by using different antenna types within one GPS network. Results are presented in [3].

AC Finland Simultaneously with the EUVN 97 campaign a Baltic Sea Level (BSL) GPS campaign was performed. There are some points which are part of both networks. Therefore, the two networks could not only be connected by constraining them to the same reference frame (ITRF 96), but also by a common computation of both networks. The BSL campaign was processed by the Finnish Geodetic Institute. Solutions were also delivered to the EUVN Data Center at Leipzig. A combination was done for testing and checking purposes, only. Some inconsistencies in the naming conventions between EUVN 97 and the BSL campaign were detected and removed. So it is possible to connect both networks without any inconsistencies.

2.3 Problem Areas

During the combination of the subnetwork solutions the following kind of problems occurred:

- For a few sites different antenna names were introduced into the subnetwork solutions and therefore unequal antenna phase center eccentricities were used. If this was the case, the analysis center agreed on the correct antenna names and introduced them into the computations.
- Inconsistencies in the site names were removed.
- A few sites were not usable for EUVN 97 due to very poor data quality or very few available data. They were excluded by the analysis centers themselves from the subnetwork solutions (see analysis center reports). All sites contained in the final subnetwork solutions were used for the combined solution.

3. Investigated Solution Types

The analysis centers produced different solution types in order to investigate the influence of the processing strategy on the results. Mainly the following three types of solutions were looked at:

15 degrees without weighting: The 'standard' solution with the highest priority. Data down to an elevation cut-off angle of 15 degrees were used for generating this solution type. All observations were introduced with the same weight into the parameter estimation process. This solution type corresponds to the processing strategy used for the permanent EUREF network at the time of the EUVN campaign.

5 degrees with elevation-dependent weighting: Measurements down to an elevation cut-off angle of 5 degrees were used for this solution type. In addition, the observations were weighted with $w = \cos^2(z)$, where z is the zenith angle of the observed satellite.

Satellite-specific weighting: The IGS precise orbit files (in SP3 format) contain accuracy codes for each satellite. These accuracy codes can be used by the Bernese GPS Software to weight the corresponding observations. Solutions of this type were not delivered by all analysis centers, and therefore no combined solution was generated. It was the goal of this solution type to get experienced with the influence of such a satellite-specific weighting on the site coordinate repeatability. Furthermore, the EUVN 97 campaign was a good opportunity to test different weighting schemes and their impact on the estimated coordinates. Results are presented in the analysis center reports.

The processing options applied to *all* of the above mentioned solution types were described in [2]. Let us just summarize here the most important ones:

- Data sampling rate of processing: 180 sec
- Ambiguity resolution with Quasi Ionosphere-Free (QIF) strategy [1]

- Estimation of one troposphere parameter per 2 hours, absolute and relative a priori standard deviations of 10 m (i. e., virtually no constraints)
- Use of IGS final orbits and earth orientation parameters
- Introduction of correct inter-baseline correlations

4. Quality Checks

4.1 Daily Repeatabilities

An interesting quality parameter to look at is the repeatability of the daily solutions. Such a comparison of the daily solutions could only be done for the individual subnetwork solutions, because no daily combined solutions were generated.

Different repeatability values were obtained by the individual analysis centers (depending on the subnetwork geometry and the quality of the subnetwork sites). On the average the values amount to 4–5 mm for the height and 1-2 mm for north and east component. More detailed results may be found in the analysis center reports.

4.2 Comparison of Redundant Sites

To gain further insight into the quality of the solutions, the redundant sites within the EUVN 97 GPS network were investigated. A redundant site is a site which is part of at least two different subnetworks and which is not used as fiducial to fix the network to ITRF 96.

When combining the eight different subnetworks, the program ADDNEQ, the normal equation stacking program of the Bernese Software, automatically computes the residuals of all redundant points with respect to the final coordinates.

An RMS of each coordinate component was calculated as follows:

$$m_C = \sqrt{\frac{\sum_{k=1}^{N_r} r_{k,C}^2}{N_r - N_p}} \quad , \tag{1}$$

where

m_C	is the estimated RMS for the north (m_N), east (m_E) and height (m_H) component,
$r_{k,C}$	is the residual of component C (N, E or H) of the individual solution with respect to the combined solution,
N_p	is the total number of redundant points,
N_r	is the total number of residuals per component.

For the computation of the residuals $r_{k,C}$ the combined solution was fixed to ITRF 96 coordinates. The estimated RMS values are shown in Table 2.

Table 2: RMS of redundant sites in [mm]

	m_N	m_E	m_H
15 degrees, no weighting	1.3	1.8	3.7
5 degrees, elevation-dependent weighting	1.6	1.2	4.2

The values above should not be mistaken as a measure of the absolute accuracy of the determined coordinates. They only show the differences in the site coordinates when a station is computed by two or more analysis centers. The most important reasons for the occurrence of such differences are:

- Redundant points are computed within two different subnetworks and as such connected with different sites, involving different observations.
- The subnetworks are constrained to different ITRF 96 sites. That means that errors in the ITRF 96 coordinates can add to the difference between two subnetwork solutions.

4.3 Residuals of Helmert Transformations with Respect to ITRF 96

To verify the agreement of the EUVN 97 network with the ITRF 96 coordinates (at epoch 1997.4) Helmert transformations of the unweighted 15-degree solution and the weighted 5-degree solution to ITRF 96 coordinates were performed. Results are summarized in Table 3. Within the EUVN 97 campaign special emphasis was put on the height component: For the unweighted 15-degree solution the height residuals of the Helmert transformation were below 10 mm for all sites except `VILL` (10.6 mm). The estimated height RMS was of the same quality (5.1 mm) for both investigated solution types.

This RMS value agrees well with the repeatability values of the height component seen within the EUREF permanent GPS network. The comparison of several weekly EUREF solutions gives a value of the same order (4-5 mm). This means that the height residuals of the Helmert transformation are about as good as the weekly repeatabilities of the permanent GPS network itself. EUVN 97 therefore agrees well with ITRF 96 and no systematic effects seem to be introduced by defining the terrestrial reference frame for EUVN 97 through ITRF 96. Two problematic sites were detected by means of the Helmert transformation (these two stations are not listed in Table 3):

- `TOUL`: The ITRF 96 coordinates of site `TOUL` are of very poor quality (the permanent GPS site did not yet contribute to the ITRF 96 solution). The differences between the ITRF 96 coordinates and the EUVN 97 solution were 75 mm in the north, 99 mm in the east, and 41 mm in height, respectively. Therefore `TOUL` was not used as fiducial site.

Table 3: Residuals after performing a seven-parameter Helmert transformation of the unweighted 15-degree solution and the weighted 5-degree solution to the ITRF 96 coordinates

Solution type	15 degrees, unweighted			5 degrees, weighted		
Station name	Residuals [mm]			Residuals [mm]		
	North	East	Up	North	East	Up
GRAS 10002M006	-0.9	-4.2	3.2	-1.0	-4.5	1.7
REYK 10202M001	-7.9	-1.7	1.0	-4.5	-3.1	2.4
NYAL 10317M001	-1.2	-7.5	8.0	-3.4	-6.3	13.5
ONSA 10402M004	-0.3	-2.4	9.8	0.8	-2.0	8.0
MAR6 10405M002	0.5	5.3	5.0	-0.6	5.0	-6.1
KIRO 10422M001	-2.6	4.0	-7.6	-4.4	4.5	-5.1
VISO 10423M001	-2.1	3.3	-1.5	-1.6	3.0	-7.2
VILO 10424M001	-1.1	5.3	0.4	-4.0	5.3	-7.9
METS 10503S011	-0.4	-1.2	4.0	0.3	-1.6	1.7
VAAS 10511M001	1.1	6.5	0.9	-0.6	5.5	-3.3
JOEN 10512M001	4.5	4.7	6.4	2.6	3.4	4.2
SODA 10513M001	3.6	1.6	1.1	0.4	1.2	1.7
GRAZ 11001M002	0.9	-1.7	6.4	0.7	-1.7	7.0
PENC 11206M006	3.0	-1.8	-2.0	3.1	-1.0	0.9
GOPE 11502M002	2.0	-1.6	-5.8	2.9	-2.0	-5.5
JOZE 12204M001	2.3	-1.9	-4.7	3.3	-0.7	-7.7
BOR1 12205M002	-0.2	-2.0	1.1	0.6	-2.0	-1.7
LAMA 12209M001	0.8	-1.0	-2.9	1.9	-0.3	1.2
RIGA 12302M002	0.6	5.8	-2.2	1.7	5.6	-3.4
ZWEN 12330M001	0.6	-3.4	-4.9	3.4	-1.0	-0.5
MEDI 12711M003	-0.8	4.3	-7.8	-1.3	3.9	-5.9
NOTO 12717M003	-3.8	-1.7	7.9	-4.5	-1.3	8.0
CAGL 12725M003	2.9	3.4	-0.5	3.0	3.3	-3.6
MATE 12734M008	-0.8	-3.2	5.2	-1.5	-2.4	9.2
UPAD 12750M002	-0.5	1.6	2.0	0.4	1.9	1.4
BRUS 13101M004	-1.2	-1.8	-2.8	-0.1	-2.8	0.6
DENT 13112M001	-0.8	-1.3	-6.2	-0.2	-3.0	1.2
DOUR 13113M001	-0.7	-0.3	-8.0	0.1	-1.7	-3.1
HERS 13212M007	0.3	0.5	-6.6	0.7	-1.1	-0.3
SFER 13402M004	4.9	-6.6	-1.5	3.7	-6.5	-2.9
VILL 13406M001	-2.3	-2.6	10.6	-1.2	-1.3	2.0
EBRE 13410M001	-4.6	4.0	1.0	-5.0	3.8	-2.1
KOSG 13504M003	-1.2	0.7	-2.0	-1.1	-0.6	4.5
ZIMM 14001M004	2.0	-0.9	-1.8	1.4	0.5	-6.8
POTS 14106M003	0.4	-1.8	-6.0	1.2	-1.8	-2.2
WTZR 14201M010	0.9	0.4	-2.6	1.2	0.1	2.1
ANKR 20805M002	1.8	-0.8	3.9	1.6	1.6	3.9
RMS per component	2.5	3.4	5.1	2.4	3.2	5.1
RMS of transformation	3.9			3.8		

- MADR: Site MADR showed severe problems in the EUREF permanent network solutions during the time period of the EUVN 97 campaign (jumps in the north component of about −20 mm and in the east component of about 40 mm). Therefore MADR was judged to be unreliable and was not used for EUVN 97 at all. The nearby IGS/EUREF site VILL (Villafranca) was used as fiducial, instead.

4.4 Comparison of the Unweighted 15-Degree and the Weighted 5-Degree Solution

The unconstrained unweighted 15-degree solution was compared with the unconstrained weighted 5-degree solution in order to get an overview of the influence of the chosen processing strategy. The comparison was done with a seven-parameter Helmert transformation. A total of 217 points were compared. All points were used for the determination of the transformation parameters except point KIT3 (which is located rather far from the actual EUVN 97 area). The overall RMS was 1.7 mm in the north, 1.1 mm in the east, and 5.4 mm in height, respectively. Table 4 shows all points with a height residual larger than 10 mm and Table 5 shows all points with a residual larger than 5 mm for the north or east component.

Large residuals in this comparison indicate that the obtained coordinates of these points are sensitive to the applied processing model. Therefore Table 4 indicates that the height values in particular of sites IT06 (Montepescali) and FR06 (Marseille) may be biased by systematic influences and should be treated with caution.

Table 4: Comparison of the unweighted 15-degree solution and the weighted 5-degree solution: Points with Helmert-residuals larger than 10 mm in height

		Residuals in [mm]		
Station name		N	E	H
META	METSAEHOVI A	1.9	2.1	10.2
IE03	MALIN HEAD	-3.1	2.3	-10.5
SEOR	SKELLEFTEAA R	4.4	1.1	10.7
DK03	ESBJERG	-0.5	-1.7	11.1
MAR6	MAARTSBO	2.0	0.7	11.4
IE01	KENMARE	-1.7	2.1	-11.4
FI01	DEGERBY	1.9	1.4	11.5
SE05	SKELLEFTEAA	4.6	1.2	11.7
HR05	SPLIT	-1.0	1.4	14.9
IT06	MONTEPESCALI	-3.1	0.2	23.6
FR06	MARSEILLE	-2.5	-1.7	27.0

Table 5: Comparison of the unweighted 15-degree solution and the weighted 5-degree solution: Points with Helmert-residuals larger than 5 mm in north or east

		Residuals in [mm]		
Station name		N	E	H
`NO11`	ANDENES	5.2	0.0	3.6
`IC01`	ENNISHOEFDI	-6.2	1.7	-7.4

5. Final Solution

5.1 Selection of the Solution Type

The question which solution to choose as the official EUVN 97 solution (the unweighted 15-degree solution or the weighted 5-degree solution), was discussed during the Analysis Center Workshop at Wettzell (April 2–3, 1998): The unweighted 15-degree solution was selected as the official one [5].

The following aspects had to be taken into account:

- The comparison of the height component of redundant points in both solution types showed a slightly better repeatability for the unweighted 15-degree solution (See section 4.2).
- The Helmert transformation of the two different solution types to ITRF 96 led to almost identical results, in particular for the height component (see section 4.3).
- Daily repeatability tests within the subnetworks did not really prove a better quality of the weighted 5-degree solution. Different results were obtained by the different analysis centers (depending on the subnetwork structure, see also analysis center Reports).
- Not all sites within EUVN 97 were tracking satellites below 15 degrees with the same quality and quantity. For some sites the number of observations is hardly increasing when changing to the lower cut-off angle, whereas for others the number of observations increased by up to 20% (See e.g. [4]). Therefore the site coordinates within the EUVN 97 GPS network could be more inhomogeneous in the 5-degree solution.
- The elevation-dependent antenna phase center variations are not yet well known below 10 degrees. Introduction of poorly defined corrections could lead to additional systematic errors.
- We do not yet have enough experiences with the performance of the tropospheric mapping functions at very low elevations.

- The ITRF 96 coordinates of the European reference sites are strongly influenced by the EUREF permanent GPS network. Computations of this network are done using an elevation cut-off angle of 15 degrees. Selecting the same cut-off angle for the EUVN 97 final solution decreases the probability of introducing systematic effects through different processing options for the new network and the reference frame.

5.2 Selection of the Fiducials

A map of all the sites used for the definition of the reference frame is shown in Figure 2, except `NYAL` (Ny-Alesund, Spitsbergen).

The final solution is constrained to ITRF 96 coordinates (epoch 1997.4) with an a priori standard deviation of 0.01 mm for each coordinate component. As a consequence of these tight constraints the resulting coordinates of the reference points are virtually identical with the ITRF 96 values.

The file containing the ITRF 96 coordinates used for the constraints was prepared by CODE and made available at the Data Center Leipzig. All sites common to the EUVN 97 network, except `MADR` (Madrid) and `TOUL` (Toulouse), were used.

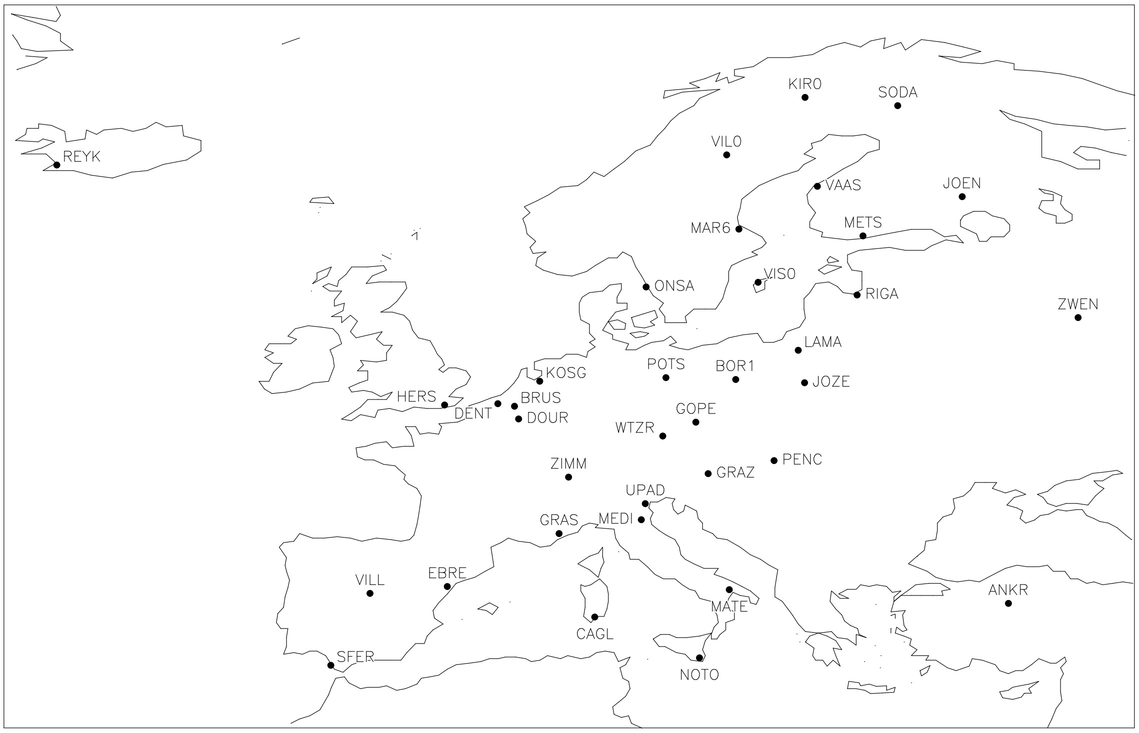

Figure 2: Map of the fiducials used to define the reference frame

5.3 Combination of the EUVN 97 and the ITRF 96 Solution

At the EUREF-Symposium 1998 at Bad Neuenahr–Ahrweiler the idea arised to combine the EUVN 97 solution with the ITRF 96 solution, taking into account the full variance–covariance information of both solutions. The task of this combination was to investigate the influence of the tight constraints of the fiducials on the height component of the newly determined points.

The ITRF 96 solution was introduced using the SINEX file `ITRF96_EUROPE.SNX` [7], containing full variance–covariance information. The rescaling factors between the two solutions were selected in a way, that the residuals of the ITRF sites with long-time series of coordinates obtained reasonably small values ($0 - 2\,mm$, with respect to the original ITRF 96 solution). ITRF 96 velocities were used to relate both solutions to the same epoch (1997.4). For the combined solutions all a priori constraints were removed and free network conditions were set up.

The resulting coordinates of this combination were compared with the ones of the fixed EUVN 97 solution: the differences in the height component were below 2 mm for all sites with unknown ITRF coordinates. All ITRF sites showed corrections in height lower than 4 mm with one exception: site JOEN (7.5 mm).

Therefore it can be stated, that the tight constraining of the EUVN 97 solution to ITRF 96 (what was done for the final solution) is not deteriorating the homogeneity of the EUVN 97 network.

5.4 EUVN 97 Final Coordinates (ITRF 96, Epoch 1997.4)

A comparison of the combined solutions of BKG and CODE showed that these two solutions were identical. Therefore no further combination had to be done. The final coordinate values of all EUVN 97 sites are summarized in Appendix A. For this final solution the EUVN 97 GPS network was fixed to ITRF 96 coordinates (epoch 1997.4). The last column in the table of Appendix A indicates whether the point was fixed (F) or whether it is a newly determined point (N).

At six sites two different receivers (Ashtech and Rogue) were connected to the same antenna (Dorne Margolin). All these sites (`KIRR`, `MARR`, `ONSO`, `SEOR`, `VILR` and `VISR`) were part of the subnetwork processed by AC Sweden. The coordinates of these sites are listed in Appendix C together with the solution of the corresponding 'official' receiver. The differences in the coordinates are caused by the fixing of the 'official' solutions to ITRF 96 coordinates and are *not* due to the different receiver types. In [3] it is shown that the differences generated by the usage of different receiver types is below 1 mm for each coordinate component (this can also be seen in the unconstrained combined EUVN 97 solution).

5.5 Transformation to ETRS 89 (ETRF 96, Epoch 1997.4)

For many practical purposes it is useful to have the ETRS 89 coordinates available (see Appendix B). To get conformity with other projects, the general relations between ITRS and ETRS should be used. The following formula transforms coordinates from ITRF 96 to ETRF 96 [8]:

$$\vec{X}_{ETRF\,96,t_c} = \vec{X}_{ITRF\,96,t_c} + \begin{pmatrix} T_1 \\ T_2 \\ T_3 \end{pmatrix} + \begin{pmatrix} 0 & -\dot{R}_3 & \dot{R}_2 \\ \dot{R}_3 & 0 & -\dot{R}_1 \\ -\dot{R}_2 & \dot{R}_1 & 0 \end{pmatrix} \vec{X}_{ITRF\,96,t_c} \; (t_c - 1989.0)$$

with

$\vec{X}_{ETRF\,96,t_c}$	X, Y, Z coordinates in ETRF 96, epoch 1997.4
$\vec{X}_{ITRF\,96,t_c}$	X, Y, Z coordinates in ITRF 96, epoch 1997.4
t_c	observation epoch 1997.4
T_i	translation parameters from ITRF 96 to ITRF 89, $T_1 = 4.1\,cm,\ T_2 = 4.1\,cm,\ T_3 = -4.9\,cm$
$\dot{R}_i$	rotation parameters due to the motion of the European plate with the motion model NNR-NUVEL1A in 0.001"/y, $\dot{R}_1 = 0.20,\ \dot{R}_2 = 0.50,\ \dot{R}_3 = -0.65$

References

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Appendix A: EUVN 97 Coordinates (ITRF 96 epoch 1997.4)

Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
ANKR	ANKARA	20805M002	4121948.599	2652187.957	4069023.674	F
BOR1	BOROWIEC	12205M002	3738358.605	1148173.598	5021815.700	F
BRUS	BRUSSELS/UCCLE	13101M004	4027893.862	307045.706	4919475.035	F
CAGL	CAGLIARI	12725M003	4893378.945	772649.638	4004182.057	F
DENT	DENTERGEM	13112M001	4020711.602	238850.995	4928949.570	F
DOUR	DOURBES	13113M001	4086778.272	328451.865	4869782.550	F
EBRE	EBRE	13410M001	4833520.253	41536.958	4147461.448	F
GOPE	PENCY	11502M002	3979316.270	1050312.358	4857067.017	F
GRAS	GRASSE	10002M006	4581691.018	556114.698	4389360.690	F
GRAZ	GRAZ	11001M002	4194423.962	1162702.566	4647245.318	F
HERS	HERSTMONCEUX	13212M007	4033470.232	23672.768	4924301.230	F
JOEN	JOENSUU	10512M001	2564139.232	1486149.666	5628951.352	F
JOZE	JOZEFOSLAW	12204M001	3664940.325	1409153.758	5009571.319	F
KIRO	KIRUNA	10422M001	2248123.327	865686.599	5886425.682	F
KOSG	KOOTWIJK	13504M003	3899225.254	396731.825	5015078.349	F
LAMA	LAMKOWKO	12209M001	3524523.081	1329693.533	5129846.286	F
MAR6	MAARTSBO	10405M002	2998189.533	931451.670	5533398.573	F
MATE	MATERA	12734M008	4641949.710	1393045.289	4133287.338	F
MEDI	MEDICINA	12711M003	4461400.905	919593.439	4449504.680	F
METS	METSAEHOVI	10503S011	2892570.928	1311843.344	5512634.052	F
NOTO	NOTO	12717M003	4934528.661	1321262.241	3806479.516	F
NYAL	NY AALESUND	10317M001	1202430.646	252626.658	6237767.516	F
ONSA	ONSALA	10402M004	3370658.668	711877.038	5349786.868	F
PENC	PENC	11206M006	4052449.634	1417681.005	4701407.030	F
POTS	POTSDAM	14106M003	3800689.777	882077.276	5028791.245	F
REYK	REYKJAVIK	10202M001	2587384.492	−1043033.498	5716563.978	F
RIGA	RIGA	12302M002	3183899.351	1421478.386	5322810.727	F
SFER	SAN FERNANDO	13402M004	5105519.095	−555145.990	3769803.257	F
SODA	SODANKYLAE	10513M001	2200146.815	1091638.262	5866870.686	F
UPAD	PADOVA	12750M002	4389531.294	923253.657	4519256.345	F
VAAS	VAASA	10511M001	2699864.454	1078263.900	5658064.766	F
VILO	VILHELMINA	10424M001	2620258.716	779138.054	5743799.369	F
VILL	VILLAFRANCA	13406M001	4849833.796	−335049.170	4116014.836	F
VISO	VISBY	10423M001	3246470.386	1077900.403	5365278.016	F
WTZR	WETTZELL	14201M010	4075580.691	931853.676	4801568.047	F
ZIMM	ZIMMERWALD	14001M004	4331297.197	567555.747	4633133.848	F
ZWEN	ZWENIGOROD	12330M001	2886325.547	2155998.412	5245816.138	F
AT01	HUTBIEGL	-	4066170.635	1135173.269	4765611.941	N
AT03	THOERL-MAGLERN	-	4269552.617	1039497.462	4608324.749	N
AT04	WOERGL	-	4221962.730	903799.911	4679665.615	N
BE01	OSTENDE	-	3996496.547	204372.974	4949994.020	N
BG01	BURGAS	-	4179321.474	2173955.760	4285392.059	N
BG03	SOFIA	-	4319372.239	1868687.653	4292063.867	N
BG04	VARNA	-	4115657.708	2179981.707	4343159.466	N

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continued from previous page

Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
BOGI	BOROWA GORA I	–	3633815.477	1397454.013	5035280.890	N
BRUT	BRUSSELS/UCCLE	13101M003	4027828.599	307014.186	4919540.135	N
CH01	CHRISCHONA	–	4273147.790	575368.401	4684903.763	N
CH02	BOURG ST. PIERRE	–	4407673.511	557562.090	4563260.462	N
CH03	LA GIVRINE	–	4377795.365	468008.744	4601077.398	N
CH04	OBERALP	–	4336578.153	661303.193	4617410.165	N
CH05	SIBLINGEN	–	4252539.308	635461.695	4695882.685	N
CH06	STABIO	–	4396411.594	691631.222	4554070.695	N
CH07	ZERNEZ	–	4315304.078	768728.777	4620021.393	N
CY01	LARNAKA	–	4358072.147	2900454.019	3631353.954	N
CZ01	CHRASTAVA	–	3900991.588	1043027.975	4920986.997	N
CZ02	KOTOUN	–	4036220.113	981441.714	4824567.909	N
CZ03	PREDNI PRICKA	–	3963414.835	1230404.443	4827514.664	N
CZ04	KOSTELEC	–	3961862.444	1131198.939	4852979.340	N
DE01	FLECHTINGEN	–	3830805.799	760508.839	5025824.777	N
DE02	BRONNZELL	–	4006695.120	683568.761	4899211.859	N
DE03	CUXHAVEN	–	3725573.539	571226.438	5128135.694	N
DE04	EUSKIRCHEN	–	4022131.883	476874.377	4910797.762	N
DE05	HONAU	–	4187473.321	684501.324	4747104.616	N
DE06	NIEDERWEILER	–	4082139.263	522626.226	4857094.624	N
DE07	MEERANE	–	3940501.872	872686.013	4922647.102	N
DE08	SCHERNFELD	–	4120602.692	811533.473	4784977.464	N
DE09	WALLENHORST	–	3864996.090	543689.236	5027735.606	N
DE10	WARNEMUENDE	–	3658231.710	783518.322	5148404.355	N
DION	DIONYSOS	–	4595216.457	2039452.965	3912626.814	N
DK01	KOBENHAVN	–	3513649.457	778954.648	5248201.892	N
DK02	HIRTSHALS	–	3374587.817	592744.596	5361737.945	N
DK03	ESBJERG	–	3585285.365	531974.654	5230633.593	N
DK04	GEDSER	–	3625568.098	765648.944	5173951.478	N
DK05	THORSHAVN	–	2980913.283	−353401.285	5608798.706	N
DK0A	KOBENHAVN A	–	3513655.743	778946.882	5248197.376	N
EE01	OTSA	–	3025358.186	1558080.882	5376502.680	N
EE02	SUURUPI	–	2959056.482	1341058.317	5470427.175	N
ES01	ALICANTE	–	5009051.290	−42072.344	3935057.626	N
ES02	ALMERIA	–	5105223.243	−219258.125	3804380.023	N
ES03	BARCELONA	–	4791585.155	180506.313	4191802.007	N
ES04	CASETAS	–	4767076.783	−85259.666	4222749.104	N
ES05	LA CORUNA	–	4594489.827	−678367.957	4357066.048	N
ES06	PALMA DE MALLORCA	–	4919369.038	225504.810	4039845.443	N
ES07	PUERTOLLANO	–	4972908.206	−357377.581	3965709.881	N
ES08	SANTANDER	–	4626748.303	−306451.266	4364891.077	N
FI01	DEGERBY	–	2994064.936	1112559.057	5502241.376	N
FI02	HANKO	–	2959210.971	1254679.120	5490594.441	N
FI03	HELSINKI	–	2885137.391	1342710.230	5509039.119	N
FI05	KASKINEN	–	2767237.370	1074245.461	5626366.818	N

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continued from previous page

Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
FI06	KEMI	-	2397071.577	1093330.313	5789108.447	N
FR01	AJACCIO	100077M003	4696992.023	724001.528	4239671.532	N
FR02	BORDEAUX	100013M001	4531872.731	−44441.098	4472878.316	N
FR03	BOURBON-LANCY	100086M001	4379327.828	285906.691	4613052.035	N
FR04	BREST	-	4228877.074	−333104.161	4747180.953	N
FR05	LE HAVRE	-	4151867.832	7683.105	4825589.462	N
FR06	MARSEILLE	100073M008	4630532.862	433946.189	4350142.617	N
FR07	FROUARD	100087M001	4188395.145	449710.790	4773391.475	N
FR08	PARIS	100001M011	4201791.919	177941.900	4779287.032	N
FR09	ST. JEAN DE LUZ	100088M001	4639942.656	−136229.890	4359542.439	N
FR10	THOUARS	100089M001	4358530.067	−15169.620	4641136.997	N
GB01	MORPETH	13299S001	3645667.940	−107277.344	5215053.427	N
GB02	BELFAST	-	3681235.841	−381979.326	5177205.094	N
GB03	BUDDON	13296M002	3526416.342	−171421.093	5294098.797	N
GB04	GIBRALTAR	-	5134911.043	−481396.405	3740038.373	N
GB05	SOUTHAMPTON	-	4026784.288	−101977.401	4928770.608	N
GB06	LERWICK	-	3182200.930	−63351.954	5508804.048	N
GB07	KIRKBY STEPHEN	-	3713868.520	−154772.517	5166095.569	N
GB08	NEWLYN	-	4079955.844	−395940.497	4870185.427	N
GB09	NOTTINGHAM	-	3851174.353	−80151.748	5066647.145	N
GR01	ASKITES	-	4353444.709	2082666.472	4156506.738	N
GR02	KARITSA	-	4596042.482	1733476.898	4055720.962	N
GR03	KATAKOLO	-	4710606.630	1838512.779	3874257.578	N
GRAA	GRAZ A	11001M003	4194422.497	1162703.106	4647248.924	N
HERE	HERSTMONCEUX E	-	4033459.067	23626.422	4924303.213	N
HOFN	HOEFN	-	2679690.007	−727951.322	5722789.127	N
HR01	BAKAR	-	4352648.017	1132636.916	4507507.137	N
HR02	BRUSNIK	-	4307965.917	1200393.305	4532778.852	N
HR03	DUBROVNIK	-	4466353.862	1456445.353	4299660.951	N
HR04	VELIKO GRADISTE	-	4267436.778	1445417.813	4499533.591	N
HR05	SPLIT	-	4444024.133	1311189.648	4368530.000	N
HR06	ZAGREB	-	4281822.772	1226066.042	4550373.198	N
HR07	ROVINJ	-	4383992.410	1062976.879	4493984.520	N
HR08	PLITVICE LAKES	-	4361672.107	1224335.342	4475663.239	N
HU01	BAKSIPART	-	3945622.823	1564760.587	4744941.629	N
HU02	CSANADALBERTI	-	4128720.498	1557707.458	4589954.373	N
HU03	NADAP	-	4110020.223	1384712.143	4661277.043	N
IC01	ENNISHOEFDI	-	2463207.122	−961488.265	5785116.333	N
IC03	HOFTEIGUR	-	2577684.129	−684377.793	5774580.235	N
IE01	KENMARE	-	3891188.512	−656960.577	4994036.575	N
IE02	SLANE	-	3758592.174	−430971.721	5117918.092	N
IE03	MALIN HEAD	-	3602912.067	−464038.531	5225072.685	N
IT01	BARI	-	4604015.864	1395990.074	4173523.319	N
IT02	CATANIA	-	4891562.414	1319356.307	3861697.449	N
IT03	CIVITAVECCHIA	-	4639918.274	968326.578	4253578.588	N

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Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
IT04	BATTIPAGLIA	-	4684234.747	1242032.056	4133027.453	N
IT05	GENOVA	-	4508320.965	708053.248	4440951.252	N
IT06	MONTEPESCALI	-	4594522.474	899334.145	4317112.434	N
IT07	IROE	-	4522401.668	898001.896	4392484.999	N
IT08	MTE MARIO	-	4641092.968	1024874.238	4239336.989	N
IT09	PESCARA	-	4568085.491	1157024.054	4283890.612	N
IT10	TRIESTE	-	4338306.976	1062332.457	4537962.636	N
IT11	CAGLIARI HABOUR	-	4886140.583	783960.863	4010490.869	N
KIT3	KITAB	-	1944945.345	4556652.208	4004325.987	N
KOAS	KOOTWIJK A	-	3899208.442	396761.221	5015079.483	N
KUUS	KUUSAMO	-	2282711.599	1267071.785	5800215.760	N
LT01	SIAULIAI	-	3288941.450	1421306.222	5259190.391	N
LT02	VILNIUS	-	3343600.780	1580417.639	5179337.220	N
LT03	MOLAS	-	3358793.381	1294907.415	5247584.401	N
LV01	SKULTE	-	3143836.710	1426775.085	5345000.663	N
LV02	LIEPAJA	-	3292890.347	1264082.170	5296320.898	N
LV03	VENTSPILS	-	3204401.451	1264700.422	5349808.017	N
LV04	IRBENE	-	3183612.160	1276706.561	5359310.754	N
MADE	MADRID/ROBLEDO T	-	4849333.094	−360298.570	4114740.685	N
META	METSAEHOVI A	-	2892569.977	1311843.544	5512634.445	N
MK01	BOROVA CUKA	-	4374796.464	1844718.410	4246577.097	N
NICO	NICOSIA	14302M001	4359415.862	2874116.998	3650777.714	N
NO01	TREGDE	-	3358069.041	445365.533	5386157.864	N
NO02	STAVANGER	-	3280059.938	331383.677	5441785.450	N
NO03	HALDEN	-	3215956.722	650882.039	5451251.620	N
NO04	HOENEFOSS	-	3132538.951	566401.815	5508609.933	N
NO05	HOENEFOSS A	-	3132535.604	566401.572	5508611.866	N
NO07	NYBERGSUND	-	3003947.595	656925.446	5569744.277	N
NO08	MAUSUNDVAER	-	2784637.209	424345.537	5703313.863	N
NO09	RANA	-	2491540.525	627261.072	5818227.650	N
NO10	STORFJORD	-	2129342.509	771959.751	5942490.095	N
NO11	ANDENES	-	2169937.750	627585.718	5944784.548	N
NO12	VARDOE	-	1839606.903	1109535.953	5985335.527	N
PFAN	PFAENDER	11005S002	4253560.190	733544.846	4681452.911	N
PL01	BRUDZONICE	-	3838174.546	1336729.834	4899501.280	N
PL02	CHELMSKO	-	3741888.376	1041415.396	5042252.151	N
PL03	PROSTKI	-	3496922.753	1438440.899	5119413.621	N
PL04	ROZEWIE	-	3495579.445	1157845.614	5190403.715	N
PL06	SWINOUJSCIE	-	3648326.517	924984.031	5132035.272	N
PL07	USTKA	-	3545014.330	1073939.772	5174949.947	N
PT01	BARCA D'ALVA	-	4783826.252	−582394.696	4164421.717	N
PT02	CASCAIS	-	4917648.195	−816414.998	3965563.234	N
PT03	ELVAS	-	4934349.106	−610382.404	3982001.653	N
PT04	LEIXOES	-	4750917.478	−727587.685	4178903.290	N
PT05	LAGOS	-	5035163.397	−767677.173	3826286.768	N
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Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
RO01	SIRCA (IASI)	–	3858208.700	1983192.110	4660288.089	N
RO02	CONSTANTA	–	4021069.258	2197733.193	4421574.217	N
RO03	TIMISOARA	–	4153382.405	1623173.034	4545098.726	N
RO04	HEIGHT ZERO POINT	–	3993862.319	2179699.539	4454979.882	N
SE02	KUNGSHOLMSFORT	–	3434083.464	958104.771	5270952.915	N
SE03	OESTERSUND	–	2763885.341	733247.413	5682653.440	N
SE04	RATAN	–	2620558.097	1000461.598	5709038.717	N
SE05	SKELLEFTEAA	–	2534031.014	975174.477	5752078.427	N
SE06	SMOEGEN	–	3290543.656	652615.122	5406535.487	N
SE07	STOCKHOLM	–	3101008.862	1013021.037	5462373.383	N
SI01	VELIKA PIRESICA	–	4261425.029	1156639.401	4587549.392	N
SI02	LENDAVSKE GORICE	–	4212714.595	1246016.076	4608998.534	N
SI03	MALIJA	–	4351694.601	1056274.829	4526994.713	N
SK01	KAMENICA	–	4062233.230	1377316.178	4704896.603	N
SK02	GANOVCE	–	3929172.868	1455278.749	4793644.518	N
SK03	STRECNO	–	3953831.753	1352503.882	4802958.956	N
TERS	TERSCHELLING	13534M001	3798580.716	346993.932	5094780.943	N
TOUL	TOULOUSE	10003M004	4627846.135	119629.193	4372999.719	N
TR01	ANTALYA	–	4399214.737	2602657.535	3802195.030	N
TR02	ERDEK	–	4301483.867	2272242.446	4111129.587	N
TR03	MELENGICLIK	20803M001	4247620.359	2778639.035	3851607.632	N
TR04	MENTES	–	4469012.223	2249388.236	3942689.280	N
TR05	YIGILCA	20804M001	4117361.810	2517076.974	4157679.152	N
TR06	YOZGAT	20802M001	4029730.516	2802093.271	4062068.138	N
TROA	TROMSOE A	–	2102928.623	721619.382	5958196.189	N
UK01	KIEV	–	3512887.371	2068982.507	4888901.366	N
UK02	UZHGORAD	–	3908590.563	1615205.770	4758733.187	N
UK03	MYKOLAIV	–	3698609.553	2308760.851	4639662.124	N
UK04	SIMEIZ	–	3783746.477	2551362.664	4441445.118	N
WSRT	WESTERBORK	13506M005	3828735.996	443304.842	5064884.630	N
WTZA	WETTZELL A	–	4075601.902	931826.557	4801547.784	N
WTZT	WETTZELL T	14201M011	4075577.621	931855.298	4801570.206	N

Appendix B: EUVN 97 Coordinates (ETRF 96 epoch 1997.4)

Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
ANKR	ANKARA	20805M002	4121948.793	2652187.856	4069023.563	F
BOR1	BOROWIEC	12205M002	3738358.778	1148173.499	5021815.584	F
BRUS	BRUSSELS/UCCLE	13101M004	4027894.012	307045.600	4919474.907	F
CAGL	CAGLIARI	12725M003	4893379.088	772649.517	4004181.915	F
DENT	DENTERGEM	13112M001	4020711.749	238850.889	4928949.441	F
DOUR	DOURBES	13113M001	4086778.421	328451.758	4869782.420	F
EBRE	EBRE	13410M001	4833520.380	41536.837	4147461.301	F
GOPE	PENCY	11502M002	3979316.437	1050312.254	4857066.895	F
GRAS	GRASSE	10002M006	4581691.163	556114.582	4389360.552	F
GRAZ	GRAZ	11001M002	4194424.128	1162702.459	4647245.193	F
HERS	HERSTMONCEUX	13212M007	4033470.374	23672.663	4924301.099	F
JOEN	JOENSUU	10512M001	2564139.427	1486149.593	5628951.263	F
JOZE	JOZEFOSLAW	12204M001	3664940.506	1409153.661	5009571.207	F
KIRO	KIRUNA	10422M001	2248123.511	865686.532	5886425.595	F
KOSG	KOOTWIJK	13504M003	3899225.408	396731.722	5015078.224	F
LAMA	LAMKOWKO	12209M001	3524523.261	1329693.439	5129846.176	F
MAR6	MAARTSBO	10405M002	2998189.712	931451.587	5533398.470	F
MATE	MATERA	12734M008	4641949.872	1393045.174	4133287.206	F
MEDI	MEDICINA	12711M003	4461401.061	919593.325	4449504.547	F
METS	METSAEHOVI	10503S011	2892571.116	1311843.264	5512633.954	F
NOTO	NOTO	12717M003	4934528.814	1321262.120	3806479.378	F
NYAL	NY AALESUND	10317M001	1202430.821	252626.617	6237767.444	F
ONSA	ONSALA	10402M004	3370658.837	711876.946	5349786.756	F
PENC	PENC	11206M006	4052449.808	1417680.901	4701406.910	F
POTS	POTSDAM	14106M003	3800689.944	882077.176	5028791.125	F
REYK	REYKJAVIK	10202M001	2587384.622	−1043033.572	5716563.868	F
RIGA	RIGA	12302M002	3183899.538	1421478.299	5322810.625	F
SFER	SAN FERNANDO	13402M004	5105519.198	−555146.114	3769803.100	F
SODA	SODANKYLAE	10513M001	2200147.005	1091638.197	5866870.601	F
UPAD	PADOVA	12750M002	4389531.451	923253.545	4519256.214	F
VAAS	VAASA	10511M001	2699864.639	1078263.824	5658064.671	F
VILO	VILHELMINA	10424M001	2620258.894	779137.979	5743799.273	F
VILL	VILLAFRANCA	13406M001	4849833.912	−335049.291	4116014.685	F
VISO	VISBY	10423M001	3246470.565	1077900.314	5365277.910	F
WTZR	WETTZELL	14201M010	4075580.854	931853.571	4801567.923	F
ZIMM	ZIMMERWALD	14001M004	4331297.347	567555.635	4633133.715	F
ZWEN	ZWENIGOROD	12330M001	2886325.752	2155998.333	5245816.047	F
AT01	HUTBIEGL	-	4066170.803	1135173.163	4765611.818	N
AT03	THOERL-MAGLERN	-	4269552.780	1039497.353	4608324.622	N
AT04	WOERGL	-	4221962.890	903799.802	4679665.487	N
BE01	OSTENDE	-	3996496.694	204372.869	4949993.891	N
BG01	BURGAS	-	4179321.660	2173955.655	4285391.943	N
BG03	SOFIA	-	4319372.417	1868687.544	4292063.745	N
BG04	VARNA	-	4115657.895	2179981.604	4343159.351	N

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continued from previous page

Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
BOGI	BOROWA GORA I	-	3633815.657	1397453.917	5035280.779	N
BRUT	BRUSSELS/UCCLE	13101M003	4027828.748	307014.080	4919540.007	N
CH01	CHRISCHONA	-	4273147.942	575368.291	4684903.632	N
CH02	BOURG ST. PIERRE	-	4407673.660	557561.977	4563260.328	N
CH03	LA GIVRINE	-	4377795.512	468008.632	4601077.264	N
CH04	OBERALP	-	4336578.305	661303.082	4617410.033	N
CH05	SIBLINGEN	-	4252539.462	635461.585	4695882.555	N
CH06	STABIO	-	4396411.746	691631.110	4554070.562	N
CH07	ZERNEZ	-	4315304.233	768728.666	4620021.262	N
CY01	LARNAKA	-	4358072.339	2900453.915	3631353.840	N
CZ01	CHRASTAVA	-	3900991.757	1043027.873	4920986.877	N
CZ02	KOTOUN	-	4036220.278	981441.609	4824567.786	N
CZ03	PREDNI PRICKA	-	3963415.007	1230404.339	4827514.545	N
CZ04	KOSTELEC	-	3961862.614	1131198.835	4852979.219	N
DE01	FLECHTINGEN	-	3830805.962	760508.738	5025824.656	N
DE02	BRONNZELL	-	4006695.278	683568.656	4899211.734	N
DE03	CUXHAVEN	-	3725573.700	571226.339	5128135.574	N
DE04	EUSKIRCHEN	-	4022132.037	476874.271	4910797.635	N
DE05	HONAU	-	4187473.476	684501.215	4747104.487	N
DE06	NIEDERWEILER	-	4082139.416	522626.119	4857094.496	N
DE07	MEERANE	-	3940502.037	872685.910	4922646.980	N
DE08	SCHERNFELD	-	4120602.852	811533.366	4784977.338	N
DE09	WALLENHORST	-	3864996.248	543689.134	5027735.482	N
DE10	WARNEMUENDE	-	3658231.877	783518.224	5148404.237	N
DION	DIONYSOS	-	4595216.632	2039452.852	3912626.688	N
DK01	KOBENHAVN	-	3513649.625	778954.553	5248201.778	N
DK02	HIRTSHALS	-	3374587.983	592744.504	5361737.832	N
DK03	ESBJERG	-	3585285.527	531974.557	5230633.475	N
DK04	GEDSER	-	3625568.265	765648.847	5173951.362	N
DK05	THORSHAVN	-	2980913.429	−353401.369	5608798.593	N
DK0A	KOBENHAVN A	-	3513655.911	778946.787	5248197.262	N
EE01	OTSA	-	3025358.378	1558080.799	5376502.582	N
EE02	SUURUPI	-	2959056.670	1341058.235	5470427.077	N
ES01	ALICANTE	-	5009051.410	−42072.467	3935057.475	N
ES02	ALMERIA	-	5105223.356	−219258.250	3804379.868	N
ES03	BARCELONA	-	4791585.286	180506.193	4191801.862	N
ES04	CASETAS	-	4767076.908	−85259.785	4222748.957	N
ES05	LA CORUNA	-	4594489.939	−678368.073	4357065.900	N
ES06	PALMA DE MALLORCA	-	4919369.167	225504.688	4039845.295	N
ES07	PUERTOLLANO	-	4972908.318	−357377.704	3965709.728	N
ES08	SANTANDER	-	4626748.424	−306451.383	4364890.931	N
FI01	DEGERBY	-	2994065.119	1112558.974	5502241.275	N
FI02	HANKO	-	2959211.157	1254679.038	5490594.342	N
FI03	HELSINKI	-	2885137.580	1342710.149	5509039.022	N
FI05	KASKINEN	-	2767237.554	1074245.383	5626366.721	N

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continued from previous page

Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
FI06	KEMI	-	2397071.765	1093330.243	5789108.359	N
FR01	AJACCIO	100077M003	4696992.170	724001.410	4239671.394	N
FR02	BORDEAUX	100013M001	4531872.862	−44441.213	4472878.174	N
FR03	BOURBON-LANCY	100086M001	4379327.970	285906.579	4613051.899	N
FR04	BREST	-	4228877.203	−333104.271	4747180.815	N
FR05	LE HAVRE	-	4151867.971	7682.996	4825589.328	N
FR06	MARSEILLE	100073M008	4630533.003	433946.072	4350142.477	N
FR07	FROUARD	100087M001	4188395.295	449710.681	4773391.345	N
FR08	PARIS	100001M011	4201792.062	177941.790	4779286.899	N
FR09	ST. JEAN DE LUZ	100088M001	4639942.782	−136230.007	4359542.295	N
FR10	THOUARS	100089M001	4358530.203	−15169.732	4641136.859	N
GB01	MORPETH	13299S001	3645668.085	−107277.442	5215053.303	N
GB02	BELFAST	-	3681235.977	−381979.425	5177204.967	N
GB03	BUDDON	13296M002	3526416.486	−171421.189	5294098.675	N
GB04	GIBRALTAR	-	5134911.148	−481396.531	3740038.215	N
GB05	SOUTHAMPTON	-	4026784.426	−101977.507	4928770.476	N
GB06	LERWICK	-	3182201.081	−63352.042	5508803.934	N
GB07	KIRKBY STEPHEN	-	3713868.662	−154772.617	5166095.444	N
GB08	NEWLYN	-	4079955.974	−395940.604	4870185.292	N
GB09	NOTTINGHAM	-	3851174.495	−80151.850	5066647.017	N
GR01	ASKITES	-	4353444.889	2082666.364	4156506.618	N
GR02	KARITSA	-	4596042.651	1733476.784	4055720.834	N
GR03	KATAKOLO	-	4710606.799	1838512.663	3874257.448	N
GRAA	GRAZ A	11001M003	4194422.664	1162702.998	4647248.799	N
HERE	HERSTMONCEUX E	-	4033459.208	23626.316	4924303.082	N
HOFN	HOEFN	-	2679690.145	−727951.398	5722789.017	N
HR01	BAKAR	-	4352648.180	1132636.805	4507507.009	N
HR02	BRUSNIK	-	4307966.082	1200393.195	4532778.725	N
HR03	DUBROVNIK	-	4466354.029	1456445.241	4299660.823	N
HR04	VELIKO GRADISTE	-	4267436.949	1445417.704	4499533.467	N
HR05	SPLIT	-	4444024.297	1311189.535	4368529.871	N
HR06	ZAGREB	-	4281822.938	1226065.933	4550373.072	N
HR07	ROVINJ	-	4383992.571	1062976.767	4493984.390	N
HR08	PLITVICE LAKES	-	4361672.272	1224335.231	4475663.112	N
HU01	BAKSIPART	-	3945623.002	1564760.485	4744941.513	N
HU02	CSANADALBERTI	-	4128720.673	1557707.352	4589954.252	N
HU03	NADAP	-	4110020.396	1384712.037	4661276.921	N
IC01	ENNISHOEFDI	-	2463207.256	−961488.337	5785116.226	N
IC03	HOFTEIGUR	-	2577684.270	−684377.867	5774580.128	N
IE01	KENMARE	-	3891188.638	−656960.680	4994036.441	N
IE02	SLANE	-	3758592.308	−430971.821	5117917.963	N
IE03	MALIN HEAD	-	3602912.202	−464038.628	5225072.558	N
IT01	BARI	-	4604016.027	1395989.959	4173523.188	N
IT02	CATANIA	-	4891562.569	1319356.187	3861697.311	N
IT03	CIVITAVECCHIA	-	4639918.427	968326.462	4253578.452	N

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continued from previous page

Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
IT04	BATTIPAGLIA	-	4684234.905	1242031.940	4133027.319	N
IT05	GENOVA	-	4508321.116	708053.133	4440951.116	N
IT06	MONTEPESCALI	-	4594522.627	899334.030	4317112.299	N
IT07	IROE	-	4522401.822	898001.781	4392484.865	N
IT08	MTE MARIO	-	4641093.123	1024874.122	4239336.853	N
IT09	PESCARA	-	4568085.650	1157023.939	4283890.480	N
IT10	TRIESTE	-	4338307.138	1062332.346	4537962.507	N
IT11	CAGLIARI HABOUR	-	4886140.726	783960.742	4010490.727	N
KIT3	KITAB	-	1944945.588	4556652.165	4004325.936	N
KOAS	KOOTWIJK A	-	3899208.596	396761.118	5015079.358	N
KUUS	KUUSAMO	-	2282711.792	1267071.718	5800215.675	N
LT01	SIAULIAI	-	3288941.635	1421306.133	5259190.286	N
LT02	VILNIUS	-	3343600.968	1580417.549	5179337.116	N
LT03	MOLAS	-	3358793.563	1294907.325	5247584.294	N
LV01	SKULTE	-	3143836.897	1426774.999	5345000.562	N
LV02	LIEPAJA	-	3292890.529	1264082.081	5296320.792	N
LV03	VENTSPILS	-	3204401.634	1264700.335	5349807.913	N
LV04	IRBENE	-	3183612.344	1276706.474	5359310.651	N
MADE	MADRID/ROBLEDO T	-	4849333.209	−360298.691	4114740.535	N
META	METSAEHOVI A	-	2892570.165	1311843.463	5512634.348	N
MK01	BOROVA CUKA	-	4374796.640	1844718.301	4246576.974	N
NICO	NICOSIA	14302M001	4359416.053	2874116.894	3650777.599	N
NO01	TREGDE	-	3358069.204	445365.441	5386157.750	N
NO02	STAVANGER	-	3280060.098	331383.587	5441785.336	N
NO03	HALDEN	-	3215956.891	650881.951	5451251.510	N
NO04	HOENEFOSS	-	3132539.120	566401.729	5508609.825	N
NO05	HOENEFOSS A	-	3132535.772	566401.485	5508611.757	N
NO07	NYBERGSUND	-	3003947.767	656925.362	5569744.172	N
NO08	MAUSUNDVAER	-	2784637.377	424345.457	5703313.761	N
NO09	RANA	-	2491540.701	627261.000	5818227.555	N
NO10	STORFJORD	-	2129342.692	771959.687	5942490.009	N
NO11	ANDENES	-	2169937.929	627585.653	5944784.460	N
NO12	VARDOE	-	1839607.095	1109535.896	5985335.449	N
PFAN	PFAENDER	11005S002	4253560.346	733544.737	4681452.782	N
PL01	BRUDZONICE	-	3838174.722	1336729.734	4899501.163	N
PL02	CHELMSKO	-	3741888.547	1041415.297	5042252.034	N
PL03	PROSTKI	-	3496922.936	1438440.806	5119413.512	N
PL04	ROZEWIE	-	3495579.623	1157845.520	5190403.604	N
PL06	SWINOUJSCIE	-	3648326.687	924983.934	5132035.156	N
PL07	USTKA	-	3545014.505	1073939.677	5174949.834	N
PT01	BARCA D'ALVA	-	4783826.362	−582394.815	4164421.566	N
PT02	CASCAIS	-	4917648.295	−816415.119	3965563.078	N
PT03	ELVAS	-	4934349.212	−610382.526	3982001.498	N
PT04	LEIXOES	-	4750917.584	−727587.803	4178903.138	N
PT05	LAGOS	-	5035163.496	−767677.296	3826286.610	N

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continued from previous page

Station name		Domes no.	X [m]	Y [m]	Z [m]	F/N
RO01	SIRCA (IASI)	–	3858208.888	1983192.011	4660287.978	N
RO02	CONSTANTA	–	4021069.447	2197733.092	4421574.104	N
RO03	TIMISOARA	–	4153382.581	1623172.928	4545098.606	N
RO04	HEIGHT ZERO POINT	–	3993862.509	2179699.438	4454979.769	N
SE02	KUNGSHOLMSFORT	–	3434083.638	958104.678	5270952.803	N
SE03	OESTERSUND	–	2763885.517	733247.335	5682653.340	N
SE04	RATAN	–	2620558.280	1000461.523	5709038.623	N
SE05	SKELLEFTEAA	–	2534031.198	975174.404	5752078.335	N
SE06	SMOEGEN	–	3290543.825	652615.032	5406535.377	N
SE07	STOCKHOLM	–	3101009.041	1013020.952	5462373.279	N
SI01	VELIKA PIRESICA	–	4261425.194	1156639.292	4587549.265	N
SI02	LENDAVSKE GORICE	–	4212714.763	1246015.968	4608998.410	N
SI03	MALIJA	–	4351694.762	1056274.718	4526994.584	N
SK01	KAMENICA	–	4062233.403	1377316.074	4704896.483	N
SK02	GANOVCE	–	3929173.045	1455278.647	4793644.401	N
SK03	STRECNO	–	3953831.927	1352503.780	4802958.838	N
TERS	TERSCHELLING	13534M001	3798580.870	346993.831	5094780.819	N
TOUL	TOULOUSE	10003M004	4627846.269	119629.076	4372999.577	N
TR01	ANTALYA	–	4399214.925	2602657.428	3802194.912	N
TR02	ERDEK	–	4301484.051	2272242.339	4111129.469	N
TR03	MELENGICLIK	20803M001	4247620.552	2778638.932	3851607.519	N
TR04	MENTES	–	4469012.404	2249388.127	3942689.158	N
TR05	YIGILCA	20804M001	4117362.003	2517076.872	4157679.040	N
TR06	YOZGAT	20802M001	4029730.714	2802093.173	4062068.030	N
TROA	TROMSOE A	–	2102928.805	721619.319	5958196.103	N
UK01	KIEV	–	3512887.566	2068982.415	4888901.262	N
UK02	UZHGORAD	–	3908590.743	1615205.669	4758733.071	N
UK03	MYKOLAIV	–	3698609.749	2308760.756	4639662.019	N
UK04	SIMEIZ	–	3783746.676	2551362.568	4441445.012	N
WSRT	WESTERBORK	13506M005	3828736.152	443304.741	5064884.507	N
WTZA	WETTZELL A	–	4075602.065	931826.451	4801547.660	N
WTZT	WETTZELL T	14201M011	4075577.785	931855.192	4801570.081	N

Appendix C: EUVN 97 Coordinates of sites with a second receiver connected to the same antenna (ITRF 96 epoch 1997.4)

Station name		X [m]	Y [m]	Z [m]	F/N
KIRR	KIRUNA R	2248123.325	865686.601	5886425.678	N
KIR0	KIRUNA	2248123.327	865686.599	5886425.682	F
MARR	MAARTSBO R	2998189.536	931451.674	5533398.578	N
MAR6	MAARTSBO	2998189.533	931451.670	5533398.573	F
ONS0	ONSALA 0	3370658.675	711877.036	5349786.877	N
ONSA	ONSALA	3370658.668	711877.038	5349786.868	F
SE0R	SKELLEFTEAA R	2534031.014	975174.477	5752078.427	N
SE05	SKELLEFTEAA	2534031.014	975174.477	5752078.427	N
VILR	VILHELMINA R	2620258.717	779138.058	5743799.370	N
VIL0	VILHELMINA	2620258.716	779138.054	5743799.369	F
VISR	VISBY R	3246470.389	1077900.405	5365278.016	N
VIS0	VISBY	3246470.386	1077900.403	5365278.016	F