The Recomputation of the EUREF GPS Campaigns in Slovenia

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Abstract

A new recomputation of the three EUREF GPS campaigns, carried out on the territory of Slovenia, was performed. All the three campaigns were processed in the ITRF 96 at the mean epoch of each individual campaign, starting from raw data. Final IGS orbits and Earth rotation parameters were transformed from their original reference frames to the ITRF 96. Finally, a combined solution at the mean epoch of the three campaigns was computed. A priori velocity model was used for the combined solution. Results were analyzed and compared with the previous solutions. The purpose of the recomputation was to check the accuracy of the official EUREF sites in Slovenia. The results showed the need for their coordinates to be replaced with the new ones.

1 Introduction

In order to connect the Slovene national coordinate system to the ETRS, three EUREF GPS campaigns have been carried out on the territory of Slovenia. The first campaign goes back to 1994 (Slovenia and Croatia '94), the second one to 1995 (Slovenia '95), and the third one to 1996 (Croatia '96).

The data for each of these three campaigns were processed independently in the period from 1995 to 1997, for each campaign starting from the IGS reference sites. There was a good opportunity to check the results of the first campaign and also to improve them; a densification of the network according to the first campaign was noticeable and the observation time was extended. This also holds true for the campaign in 1996; this time the densification was made for the territory of Croatia, but there was a certain overlapping with Slovenia. Consequently, three sets of coordinates were obtained. The first campaign was processed in the ITRF 92, epoch 1994.4 [Altiner et al. 1995]. The second campaign was processed in the ITRF 93, epoch 1995.7 [Altiner et al. 1997a]. The last campaign was processed in the ITRF 94, epoch 1996.7 [Altiner et al. 1997b]. The official coordinates of the EUREF sites in Slovenia are still those from the first campaign.

Comparing the results (in the ETRS 89) after conclusion of the first computations, we obtained coordinate differences of up to 4 cm at certain sites. To meet our expectations, the coordinates from different years should agree at least in order of 1–2 cm. Meanwhile, a new recomputation of the EUREF GPS campaigns for Slovenia and Croatia has been realized [Altiner et al. 1999]. A new problem connected with this new recomputation was identified. The combined solution was not satisfying, because the sites not observed in all three campaigns had not been treated appropriately. So, a completely new solution was proposed, based on the ITRF 96 [Seeger 2001]. A need for the recomputation of the EUREF campaigns in Slovenia was explained in the EUREF Publication No. 10 [Stopar et al. 2002].

The Surveying and Mapping Authority of the Republic of Slovenia decided for the new recomputation at the beginning of 2001. The majority of work was entrusted to the Geodetic Institute of Slovenia, in collaboration with the Faculty of Civil and Geodetic Engineering at the University of Ljubljana and Mr. Marijan Marjanović from the State Geodetic Administration of the Republic of Croatia. The expert support was kindly offered also by the Federal Agency for Cartography and Geodesy, Frankfurt on the Main, Germany, where the recomputation was initiated. This cooperation was made possible by the financial reimbursement of the costs from EuroGeographics.

2 Campaign overview

The first campaign on the territory of Slovenia (Slovenia and Croatia '94) lasted from May 30 to June 02, 1994. The mean epoch was 1994.41. Four daily sessions of 24 hours were completed. There were 14 sites taken into the recomputation; see Table 1. Altogether, 56 daily RINEX files were used, all the sites were observed for 4 days.

The second campaign (Slovenia '95) lasted from September 25 to October 01, 1995. The mean epoch was 1995.74. Seven daily sessions of 24 hours were completed. There were 57 sites taken into the recomputation; see Table 1. Altogether, 219 daily RINEX files were used, in average 3.8 per site. Majority of sites were observed for 3 days, which was also the shortest observation time span. Beside 4 reference sites, 8 new sites were observed for all 7 days.

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The third campaign (Croatia ’96) lasted from August 29 to September 11, 1996. The mean epoch was 1996.68. Fourteen daily sessions of 24 hours were completed. There were 16 sites taken into the recomputation; see Table 1. Altogether, 165 daily RINEX files were used, in average 10.3 per site. The shortest observation time span was 2 days. Beside 4 reference sites, 4 new sites were observed for all 14 days.

In order to fix the network, 4 IGS reference sites were used, namely Graz (GRAZ) in Austria, Matera (MATE) in Italy, Wettzell (WTZR) in Germany, and Zimmerwald (ZIMM) in Switzerland. Six additional control sites were taken to be able to check the results, but also to improve the network configuration. There were IGS sites Hafelekar (HFLK) in Austria and Padova (UPAD) in Italy and four EUREF sites in Croatia, namely Novoselsko brdo (0726), Brusnik (0727), Pula (0729), and Žirje (0731); see Figure 1. Coordinates of the latter sites were determined as the combined solution of the same three campaigns, but taking into account mostly sites from the territory of Croatia [Marjanović & Bačić 2002].

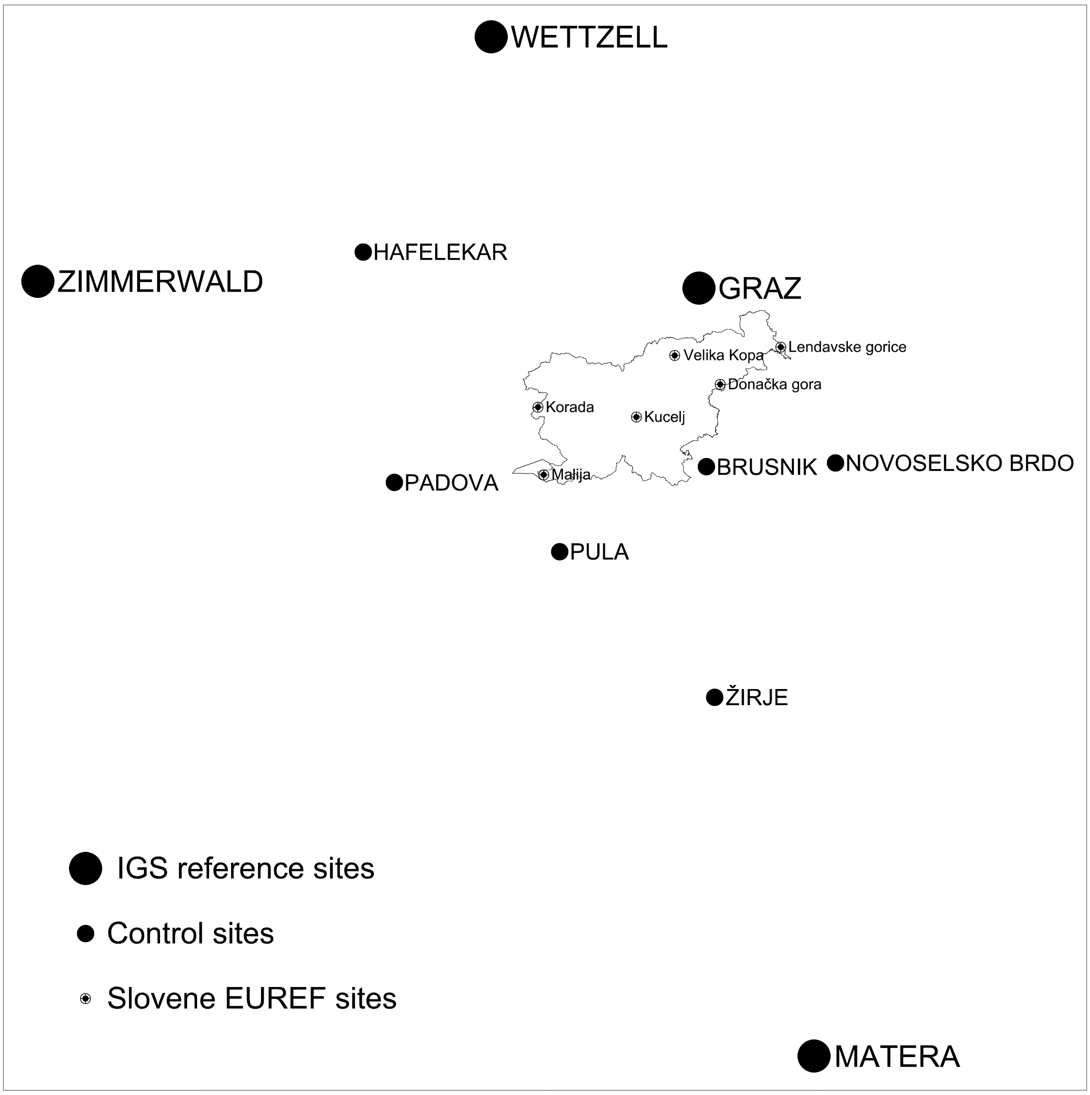


Figure 1: IGS reference sites and EUREF sites taken into the recomputation.

On the territory of Slovenia, there were 49 sites observed in these three campaigns; 35 of them create the complete first order triangulation network of Slovenia, the others are second order and geodynamic sites. Among all of them, five sites observed already in 1994 were selected as the official EUREF sites. These were Lendavske gorice (0720), Velika Kopa (0721), Kucelj (0722), Korada (0723), and Malija (0724); see Figure 2. A complete list of sites can be found in Appendix 1.

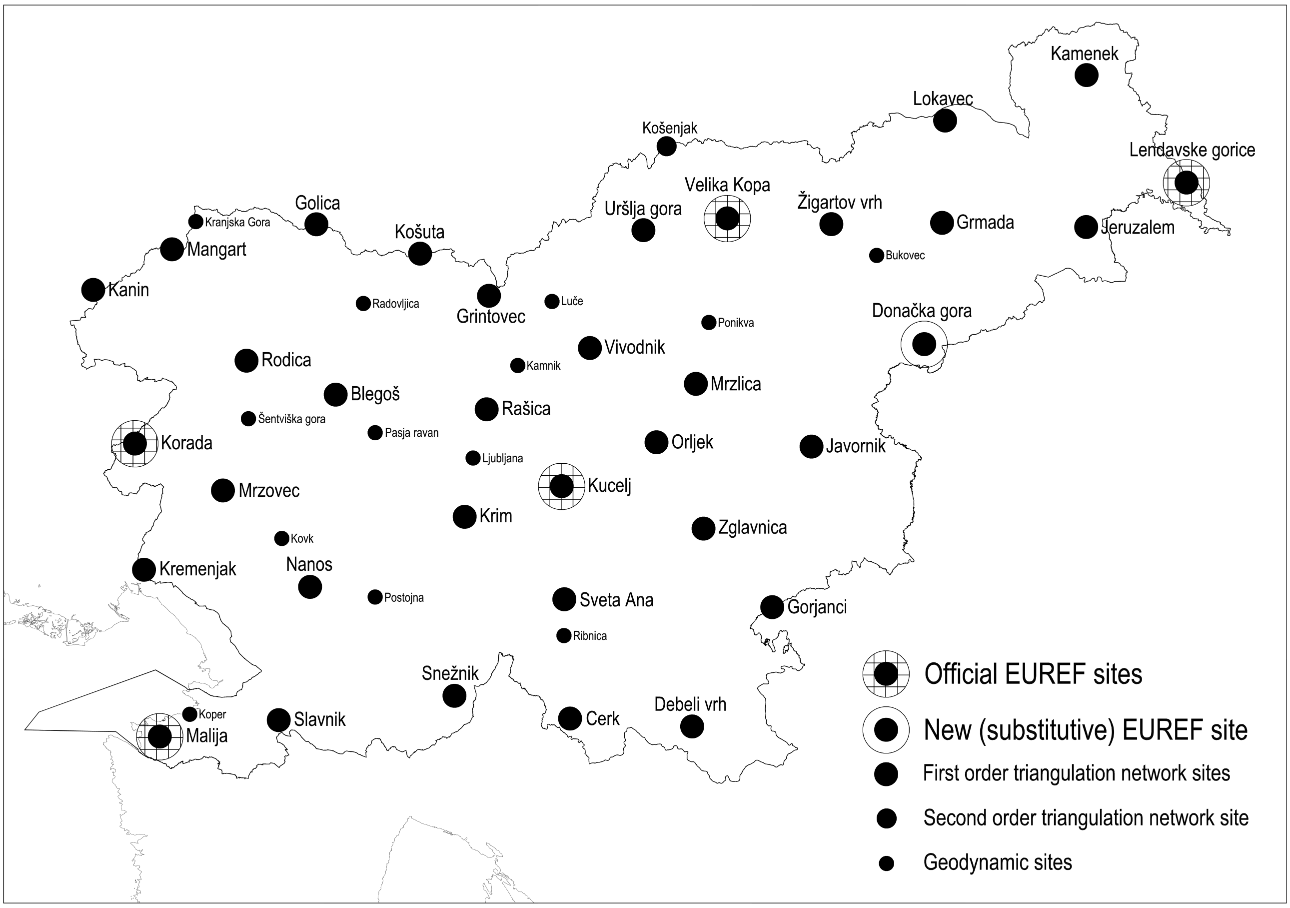


Figure 2: Sites on the territory of Slovenia taken into the recomputation.

It was found out, that the local stability of the pillar on EUREF site Lendavske gorice was not ensured. So this EUREF site is going to be replaced with the site Donačka gora; see chapter 5.

Table 1: Number of sites taken into the recomputation.

Campaign	SLO&CRO '94	SLOVENIA '95	CROATIA '96
IGS reference sites	**3**	**4**	**4**
IGS control sites	-	2	2
Control sites in Croatia	4	3	4
Slovene EUREF sites	**4 (5)**	**5**	**3**
Slovene I & II order triangulation sites	3	31	2
Slovene geodynamic sites	-	12	1
Total number of sites	**14**	**57**	**16**

3 Network design

Altogether, 25 daily sessions were completed during the three EUREF GPS campaigns on the territory of Slovenia. In the first campaign all the receivers occupied the same sites during all the observation period. In the second campaign, most of the receivers moved to another site on the fourth day of the campaign (from the west to the east part of the country). So, there were 3 different network configurations. In the last campaign there were 8 different network configurations. Altogether, 12 different combinations were detected; 12 different phases were dealt with in all the three campaigns.

Least of all, 8 baselines were used (in the 6th and 10th phase; campaign 1996, days 244, 247, 248, 251, and 252), and 34 baselines at the outside (in the 4th phase; campaign 1995, days 272, 273, and 274). There were 13 different baselines used for the first campaign, 69 baselines for the second, and 19 baselines for the third campaign. Altogether, 80 different baselines were used in the three campaigns. The shortest observation time span was 2 days (baseline Kucelj–Gorjanci), the longest was 21 days (baselines Malija–Padova, Hafelekar–Padova, Hafelekar–Wettzell, and Padova–Matera). Figures of the baseline selection by phases can be found in Appendix 3.

The shortest baseline was 7.8 km long (Sveta Ana–Ribnica) and the longest one 658.3 km (Padova–Matera). The median baseline length in the first campaign was 67.3 km, in the second campaign 23.9 km, and in the third campaign 138.5 km. The median baseline length in all the three campaigns was 67.3 km – the same as those in the first campaign; see Table 2.

Table 2: Number of baselines and baseline lengths.

Campaign	S&C '94	SLOVENIA '95			CROATIA '96							
Phase	1	2	3	4	5	6	7	8	9	10	11	12
Number of different baselines	13	33	11	34	12	8	13	11	12	8	12	13
	13	64			19							
	80											
Average beseline length [km]	131.4	69.6	178.9	69.7	187.4	222.5	173.0	204.3	190.1	226.6	165.0	175.5
	131.4	75.3			192.3							
	124.9											
Median beseline length [km]	67.3	21.3	98.8	23.7	129.0	176.9	119.4	138.5	135.7	176.9	126.1	132.8
	67.3	23.9			138.5							
	67.3											

4 Data processing

The recomputation of EUREF GPS campaigns comprises three main steps:

- the recomputation of all three campaigns in the ITRF 96, at the mean epochs of each campaign,
- computation of combined solution of the three campaigns in the ITRF 96, at the mean epoch of the three campaigns, and
- transformation of coordinates from the ITRF 96 to the ETRS 89.

4.1 Measurement instruments

Six different receiver types were used for observations on the sites taken into the recomputation. Trimble 4000SSE and Trimble 4000SSI receivers were used on all the sites except some permanent IGS sites. Those were observed also with the Rogue SNR-8, Rogue SNR-8C, Rogue SNR-8000, or Rogue SNR-8100. For the complete list of the receiver types by sites and campaigns see Appendix 2.

Four different antenna types were used for the observation on sites taken into the recomputation. 4000ST L1/L2 GEOD (TRM14532.00) and TR GEOD L1/L2 GP (TRM22020.00+GP) antennas were used on all the sites except some permanent IGS sites. Those were observed also with the Dorne Margolin B (AOAD/M_B) or Dorne Margolin T (AOAD/M_T) antennas with chokerings. For the complete list of the antenna types by sites and campaigns see Appendix 2.

4.2 Software and hardware

Bernese GPS Software, version 4.2 (dated November 16, 2001), was used for the recomputation. It was the DOS version installed on the Windows 2000 Professional operating system. Additional program used for the transformation of orbits and Earth rotation parameters was TrnfSP3N, developed by Jan Kouba. A proprietary software was used for the epoch transformation in the ITRF 96 and for the transformation between the ITRF 96 and the ETRS 89. All the computations were done on the laptop computer HP Omnibook XE 4500, Intel Pentium 4M, 1.7 GHz, with 256 MB RAM and 30 GB hard disk capacity.

4.3 Data used for processing

A complete 24 hours of 15-second-interval data (except downloading period) for all the new sites and 30-second-interval data for the IGS reference sites were used from each daily session. The elevation mask was 15 degrees for all the three campaigns. Altogether, 8.8 million of observations were dealt with in all the three campaigns; 1.2 million (14.0 %) in the first campaign, 5.1 million (57.6 %) in the second, and 2.5 million (28.4 %) in the third campaign; see Tables 5–7.

The official set of coordinates and corresponding velocity components of the IGS sites was used in the ITRF 96, epoch 1997.0; see Table 3. All the computations were done in several iterations. For the a priori coordinates of new sites, the final coordinates were used in the last iteration (coordinates did not change any more).

The antenna height and antenna type information for the IGS sites were taken from the station log files at the IGS web site [http://igscb.jpl.nasa.gov/network/list.html]. All the other antenna heights were taken from the observation sheets and were checked again. The elevation dependent phase center corrections for various antenna types were applied. The complete list of antenna heights by sites and daily sessions can be found in Appendix 1.

The final IGS precise orbits with corresponding Earth rotation parameters in the ITRF 92 for the first campaign, ITRF 93 for the second, and ITRF 94 for the third campaign were used and transformed to the ITRF 96.

The satellite-specific data and satellite problems information (for bad observation intervals elimination) were applied. Some additional intervals to remove observations from the third campaign (Croatia '96) were added manually into the sat.crx file, because some daily satellite orbit RMS values were too large (up to 0.5 m).

4.4 Processing strategy

Before starting with the processing of each individual campaign, the IGS orbits and Earth rotation parameters were transformed from their original reference frames (ITRF 92, ITRF 93, and ITRF 94) to the ITRF 96.

The coordinates of IGS reference sites were transformed from the ITRF 96, epoch 1997.0, into the mean epochs of each individual campaign, using corresponding velocity components. The coordinates were obtained as follows:

$$X_{ITRF96}(t) = X_{ITRF96}(1997.0) + V_{ITRF96} \cdot (t - 1997.0)$$

where:

$X_{ITRF96}(1997.0)$ ... are coordinates in the ITRF 96, epoch 1997.0,
$X_{ITRF96}(t)$ ... are coordinates in the ITRF 96 at the epoch of observation, and
V_{ITRF96} ... are velocity components in the ITRF 96.

The coordinates of the IGS sites with their corresponding velocity components were taken from the IGS ftp server [http://igs.ifag.de/root_ftp/ITRF/ITRF96/ITRF96_EUROPE.SSC]; see Table 3.

Table 3: Coordinates and velocities of the IGS sites in the ITRF 96, epoch 1997.0.

	Reference coordinates			Velocities [cm/y]		
	X	**Y**	**Z**	**V_X**	**V_Y**	**V_Z**
Graz	4194423.968	1162702.559	4647245.314	-1.54	1.87	1.04
Matera	4641949.718	1393045.282	4133287.333	-1.89	1.92	1.36
Wettzell	4075580.697	931853.669	4801568.044	-1.59	1.74	0.70
Zimmerwald	4331297.201	567555.740	4633133.843	-1.11	1.73	1.26
Hafelekar	4248505.189	855575.605	4667172.186	-1.47	2.07	1.17
Padova	4389531.299	923253.651	4519256.340	-1.40	1.66	1.21

There was a 15 degree elevation mask used in all three campaigns. The troposphere model of Saastamoinen was applied (one site troposphere parameter on each 2 hours). The elevation dependent weights were applied (COSZ model). To form single-differences for each daily session, the shortest baselines possible were used with few exceptions – to increase the total number of observations, to reduce the number of different baselines, or empirically, to improve the results according to the RMS values.

Each individual campaign was processed according to all the criteria for processing EUREF GPS campaigns, starting from the raw data. The processing of double-difference observations was based on the ionosphere-free carrier phase linear combination L3. The ionosphere model was used for the resolving of the L5 ambiguities. The L1 & L2 ambiguities were solved using SIGMA-dependent strategy for the short baselines (up to 150 km); the quasi-ionosphere-free strategy was applied for the long baselines. Free daily solutions were computed using the correct correlation model. Daily normal equations were combined to make the final solution of each individual campaign and to make the combined solution of the three campaigns. A priori velocity model was used for the combined solution. A priori velocities for all new sites were determined on the basis of the Nuvel1a no-net-rotation plate motion model, applying the Eurasian plate.

Finally, transformation of coordinates from the mean epoch of the combined solution in the ITRF 96 to the ETRS 89 was realized using the corresponding transformation parameters. The coordinates were obtained as follows:

$$X_{ETRS89}(t) = X_{ITRF96}(t) + T_{ITRF96} + \begin{bmatrix} 0 & -R_{3\,ITRF96} & R_{2\,ITRF96} \\ R_{3\,ITRF96} & 0 & -R_{1\,ITRF96} \\ -R_{2\,ITRF96} & R_{1\,ITRF96} & 0 \end{bmatrix} \cdot X_{ITRF96}(t) \cdot (t - 1989.0)$$

where:

$X_{ETRS89}(t)$ ... are coordinates in the ETRS 89,
$X_{ITRF96}(t)$ ... are coordinates in the ITRF 96 at the epoch of observation,
T_{ITRF96} ... are translation parameters, and
R_{ITRF96} ... are rotation parameters.

Transformation parameters were taken from the Specifications for reference frame fixing in the analysis of a EUREF GPS campaign [Boucher & Altamimi 2001]; see Table 4.

Table 4: Parameters for transformation from the ITRF 96 to the ETRS 89.

Translation parameters [cm/y]			Rotation parameters [″/y]		
T_1	T_2	T_3	R_1	R_2	R_3
4.1	4.1	-4.9	0.00020	0.00050	-0.00065

5 Result analysis

The first results of the recomputation showed some problems with the horizontal components determination on the site Lendavske gorice. There is a 12-meter-high pillar made of fire-baked bricks; see Figure 3. It turned out that the pillar stability was not ensured.

Figure 3: The fireman's ladder on Lendavske gorice – possible reason for problems.

The heavy fireman's ladder was the most possible reason for problems. The ladder was lent against the pillar for all the observation time span of the first and in the last campaign, but was removed from the pillar after the antenna setup in the second campaign. So, the decision for the final solution was to keep the data from Lendavske gorice only from the second campaign.

Upon the proposal of the Surveying and Mapping Authority of the Republic of Slovenia, the EUREF TWG agreed on the XXXI[st] meeting in Paris, where the preliminary results were presented, that the official EUREF site Lendavske gorice should be replaced with the site Donačka gora.

The final coordinates of the combined solution can be found in Appendix 4.

5.1 Single difference RMS values

Single difference RMS values for each daily normal equation file were checked to have an overview about the impact of each contributing solution. The single difference RMS values for the first EUREF campaign (Slovenia and Croatia '94) are from 1.0 mm to 1.2 mm. For the complete list of the RMS values see Table 5.

Table 5: Single difference RMS values in the Slovenia and Croatia '94 campaign.

Day	RMS [mm]	Parameters	Observations
150	**1.1**	256	323860
151	**1.0**	246	305702
152	**1.0**	253	316832
153	**1.2**	264	289875
Σ	**1.1**	893	1236269

The single difference RMS values for the second campaign (Slovenia '95) are from 1.1 mm to 1.2 mm. For the complete list of the RMS values see Table 6.

Table 6: Single difference RMS values in the Slovenia '95 campaign.

Day	RMS [mm]	Parameters	Observations
268	**1.1**	617	796494
269	**1.1**	607	781238
270	**1.1**	601	731050
271	**1.2**	278	214557
272	**1.1**	637	874940
273	**1.1**	633	866922
274	**1.1**	651	833364
Σ	**1.1**	3538	5098565

The single difference RMS values for the third campaign (Croatia '96) are from 1.0 mm to 1.2 mm. For the complete list of the RMS values see Table 7.

Table 7: Single difference RMS values in the Croatia '96 campaign.

Day	RMS [mm]	Parameters	Observations
242	**1.1**	365	162863
243	**1.2**	307	182285
244	**1.1**	246	132154
245	**1.1**	344	258062
246	**1.0**	320	256822
247	**1.1**	248	109571
248	**1.1**	245	130034
249	**1.2**	303	174503
250	**1.2**	295	214132
251	**1.1**	191	107197
252	**1.0**	171	110729
253	**1.0**	255	222754
254	**1.1**	303	234828
255	**1.2**	340	218999
Σ	**1.1**	3486	2514933

There was no RMS value greater than 1.2 mm.

5.2 Unweighted RMS values for individual and for the combined solutions

Unweighted RMS values with respect to the fixed campaign solution were checked to be able to find out whether particular normal equations contain problems. The RMS values for the first campaign (Slovenia and Croatia '94) are about 1 mm in northing and easting and up to 3 mm in height; see Table 8.

Table 8: Unweighted RMS values in the Slovenia and Croatia '94 campaign.

	RMS [mm]				
Days →	**Σ**	**150**	**151**	**152**	**153**
N	**1.0**	1.1	0.8	1.0	1.0
E	**0.7**	0.5	0.6	0.6	1.1
U	**2.4**	2.6	1.4	2.9	2.8
Sites →	14	14	14	14	14

The RMS values for the second campaign (Slovenia '95) are about 1 mm in northing and easting and about 3 mm in height; see Table 9.

Table 9: Unweighted RMS values in the Slovenia '95 campaign.

	RMS [mm]							
Days →	**Σ**	**268**	**269**	**270**	**271**	**272**	**273**	**274**
N	**0.8**	0.9	0.5	1.1	0.4	0.8	0.8	0.8
E	**1.0**	1.4	0.5	0.8	0.6	0.7	1.5	0.8
U	**2.7**	2.4	2.5	3.5	4.5	2.4	2.1	2.4
Sites →	57	34	34	34	12	35	35	35

The RMS values for the third campaign (Croatia '96) are about 1 mm in northing and easting and about 4 mm in height; see Table 10.

Table 10: Unweighted RMS values in the Croatia '96 campaign.

	RMS [mm]														
Days →	**Σ**	**242**	**243**	**244**	**245**	**246**	**247**	**248**	**249**	**250**	**251**	**252**	**253**	**254**	**255**
N	**1.0**	1.6	0.6	1.0	1.0	0.8	1.3	0.5	0.8	1.3	0.7	1.0	0.7	1.2	1.7
E	**1.0**	1.6	0.8	0.6	1.1	0.8	0.7	0.6	1.2	1.1	1.1	1.0	0.8	0.9	1.5
U	**3.8**	5.5	5.5	2.9	2.0	4.3	5.9	2.5	4.3	5.3	2.1	2.6	2.9	3.5	2.9
Sites →	16	13	13	9	14	14	9	9	12	13	9	9	13	14	14

After finishing with each individual campaign, the unweighted RMS values with respect to the combined solution of all three campaigns were checked. The final RMS values for the combined solution are below 2 mm in northing and easting and below 4 mm in height; see Table 11.

Table 11: Unweighted RMS values in the combined solution.

	RMS [mm]			
Years →	**Σ**	**1994**	**1995**	**1996**
N	**1.9**	3.7	0.9	2.2
E	**1.1**	1.6	1.0	1.2
U	**3.9**	6.9	2.7	4.1
Sites →	59	14	57	16

5.3 Comparison of coordinates on reference sites (free network solutions matching)

The level of matching on reference sites was checked for each free daily solution to be able to detect systematic errors in the network. Best fit matching was applied through the 7 parametric similarity (Helmert) transformation. Residuals according to the given coordinates of the reference sites (transformed into the corresponding epochs) were calculated. In the first campaign (Slovenia and Croatia '94), three reference sites were used. The RMS values of the Helmert transformation of the four free daily solutions are from 1.3 mm (day 153) to 3.6 mm (day 150). For residuals on each reference site see Table 12. The extreme residual is -3.4 mm in northing (Graz, day 150).

Table 12: Free daily solution residuals on reference sites in the Slovenia and Croatia '94 campaign.

	Residuals [mm]								
	Graz			**Matera**			**Zimmerwald**		
Day	**N**	**E**	**U**	**N**	**E**	**U**	**N**	**E**	**U**
150	-3.4	1.4	-0.1	2.1	0.8	0.1	1.3	-2.3	0.0
151	-2.9	1.8	0.0	2.0	0.5	0.1	0.9	-2.2	0.0
152	-2.1	1.5	0.0	1.5	0.3	0.0	0.6	-1.7	0.0
153	-1.3	-0.4	0.0	0.4	0.7	0.0	0.9	-0.3	0.0

In the second campaign (Slovenia '95), four reference sites were used. The RMS values of the Helmert transformation of the seven free daily solutions are from 1.8 mm (day 272) to 6.7 mm (day 268). For residuals on each reference site see Table 13. The extreme residual is -9.9 mm in height (Graz, day 273).

Table 13: Free daily solution residuals on reference sites in the Slovenia '95 campaign.

	Residuals [mm]											
	Graz			**Matera**			**Wettzell**			**Zimmerwald**		
Day	**N**	**E**	**U**	**N**	**E**	**U**	**N**	**E**	**U**	**N**	**E**	**U**
268	-2.5	2.2	-9.2	-0.7	0.3	2.8	1.3	-5.3	8.6	1.8	2.8	-2.2
269	-2.0	-0.5	-5.1	0.6	0.3	1.6	1.5	0.6	4.7	-0.2	-0.4	-1.2
270	-0.6	1.9	-9.8	-0.4	0.2	3.0	-0.5	-3.2	9.2	1.5	1.2	-2.4
271	-6.0	1.8	-0.4	2.0	1.2	0.2	1.9	-2.5	0.2	2.2	-0.5	0.0
272	-2.1	1.4	-1.7	0.9	0.3	0.6	0.2	-1.2	1.5	0.9	-0.6	-0.4
273	-1.2	1.4	-9.9	1.3	-1.0	3.1	1.9	1.2	9.3	-2.0	-1.5	-2.5
274	-3.5	3.4	-4.4	0.1	0.2	1.4	1.3	-5.7	4.1	2.0	2.1	-1.0

In the third campaign (Croatia '96), four reference sites were used. The RMS values of the Helmert transformation of fourteen free daily solutions are from 0.8 mm (day 246) to 6.2 mm (day 247). For residuals on each reference site see Table 14. The extreme residual is -9.4 mm in height (Graz, day 247).

Table 14: Free daily solution residuals on reference sites in the Croatia '96 campaign.

	Residuals [mm]											
	Graz			**Matera**			**Wettzell**			**Zimmerwald**		
Day	**N**	**E**	**U**	**N**	**E**	**U**	**N**	**E**	**U**	**N**	**E**	**U**
242	0.9	0.1	-3.2	-0.1	-0.2	1.0	-0.6	0.4	3.0	-0.2	-0.3	-0.8
243	-1.1	-0.3	2.0	1.0	1.0	-0.6	-1.2	1.0	-2.0	1.3	-1.7	0.5
244	-2.5	-1.5	-2.1	0.7	1.5	0.7	0.2	0.7	1.9	1.6	-0.7	-0.4
245	-1.9	1.1	1.0	1.2	0.3	-0.3	0.1	-0.2	-1.0	0.6	-1.2	0.3
246	-1.2	-0.8	0.3	0.4	0.6	-0.1	0.3	0.6	-0.3	0.4	-0.4	0.1
247	-1.4	-0.8	-9.4	-0.6	1.0	2.9	0.6	-1.7	8.8	1.4	1.5	-2.2
248	-1.3	-1.8	1.8	0.1	1.2	-0.6	0.1	0.6	-1.8	1.1	0.0	0.5
249	-3.2	-0.4	-1.6	0.6	1.0	0.5	1.4	-0.9	1.4	1.2	0.3	-0.3
250	-1.5	0.6	-3.2	0.7	0.9	1.0	-0.8	-0.7	2.9	1.6	-0.8	-0.7
251	1.8	0.4	-6.8	-0.3	-0.4	2.1	-1.3	0.4	6.4	-0.2	-0.5	-1.7
252	1.0	2.3	-6.3	-0.3	-1.9	1.9	1.6	-1.2	6.0	-2.3	0.8	-1.7
253	0.6	0.9	0.1	-0.1	-0.3	0.0	-0.6	-0.6	-0.1	–	–	–
254	0.7	-0.1	3.8	-0.5	0.0	-1.2	-0.6	-0.6	-3.5	0.4	0.6	0.9
255	0.9	-1.9	-4.0	-1.0	0.8	1.2	-0.8	0.3	3.8	0.9	0.9	-0.9

All the absolute coordinate residuals of free daily session solutions reach up to 6 mm in northing and easting and are below 1 cm in height.

The RMS values of Helmert transformation of free campaign solutions are from 1.0 mm (year 1996) to 3.7 mm (year 1995). For residuals on each reference site see Table 15. The extreme residual is -5.2 mm in height (Graz, year 1995).

Table 15: Free campaign solution and free combined solution residuals on reference sites.

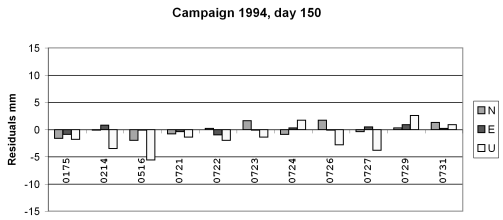
	Residuals [mm]											
	Graz			**Matera**			**Wettzell**			**Zimmerwald**		
Year	**N**	**E**	**U**	**N**	**E**	**U**	**N**	**E**	**U**	**N**	**E**	**U**
1994	-2.5	1.1	0.0	1.5	0.6	0.1	–	–	–	0.9	-1.7	0.0
1995	-2.5	1.6	-5.2	0.6	0.2	1.6	1.1	-2.2	4.8	0.8	0.4	-1.2
1996	-0.6	0.3	-1.3	0.3	0.3	0.4	-0.3	-0.3	1.2	0.6	-0.4	-0.3
Combined	-1.7	1.0	-3.3	0.7	0.2	1.0	0.5	-0.9	3.0	0.6	-0.3	-0.8

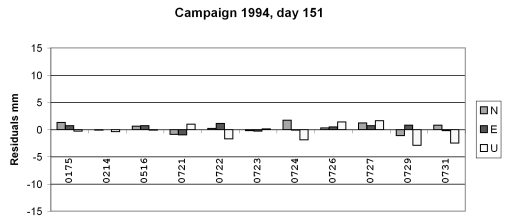
All the absolute coordinate residuals of free campaign solutions reach up to 2.5 mm in northing, 2.2 mm in easting, and 5.2 mm in height.

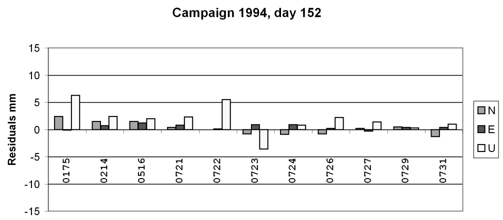
5.4 Residuals in individual solutions according to the final solution

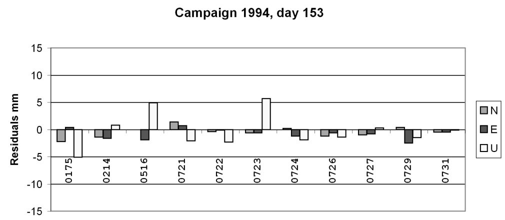
Trying to detect possible outliers, the results for each individual daily solution were compared with the final campaign solution. The coordinate repeatabilities are given in the local (northing, easting, upping) coordinate system. For the residuals in the first campaign (Slovenia and Croatia ’94) see Graphs 1–4. The extreme residuals in daily solutions are 2.4 mm in northing (Snežnik, day 152), -2.5 mm in easting (Pula, day 153), and 6.3 mm in height (Snežnik, day 152).

Graphs 1–4: Residuals in the Slovenia and Croatia ’94 campaign.



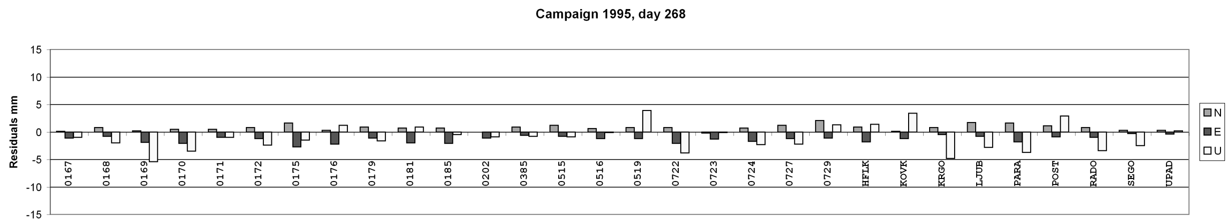


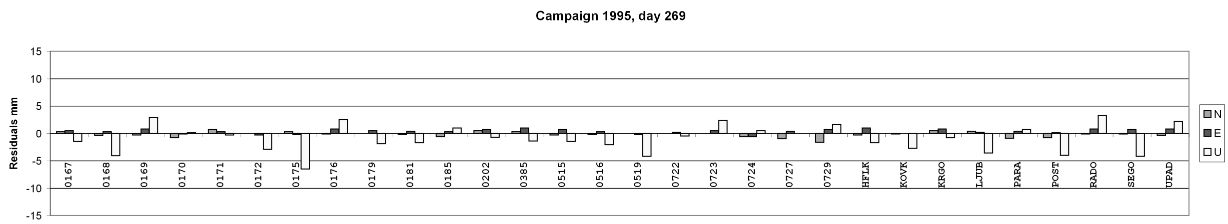


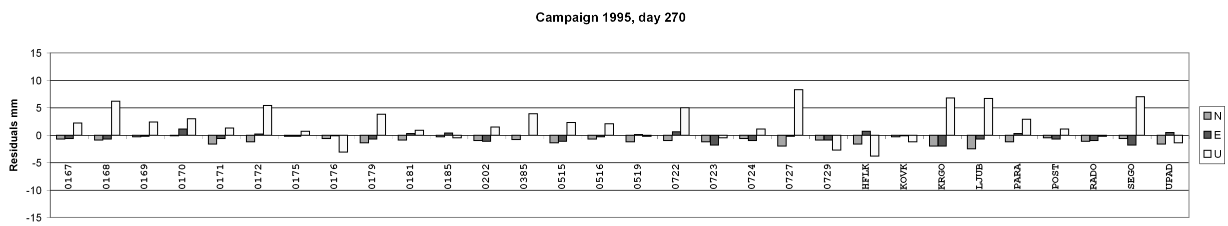


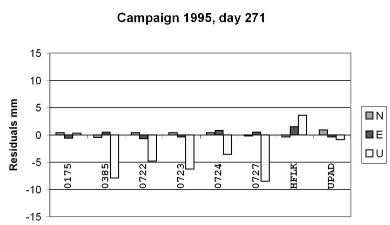
For the residuals in the second campaign (Slovenia Croatia ’95) see Graphs 5–11. The extreme residuals in daily solutions are -2.5 mm in northing (Ljubljana, day 152), ±2.7 mm in easting (Debeli vrh, day 273, Gorjanci, day 273, and Snežnik, days 268 and 273), and -8.5 mm in height (Brusnik, day 271).

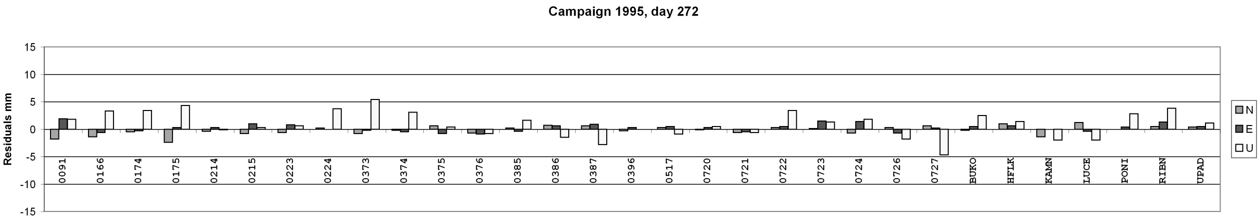
Graphs 5–11: Residuals in the Slovenia ’95 campaign.

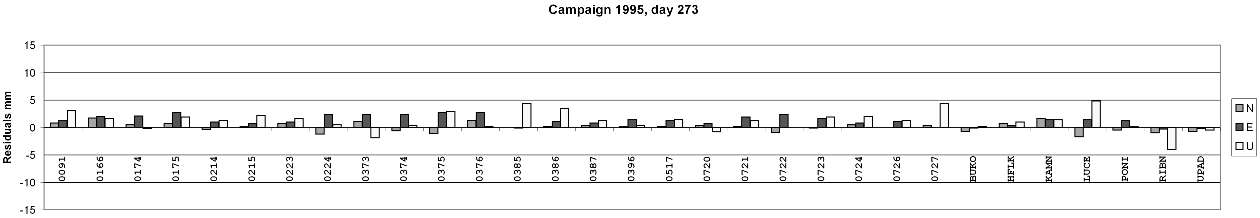


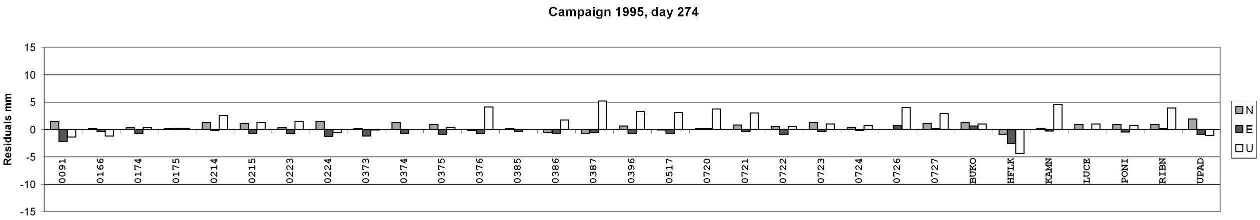






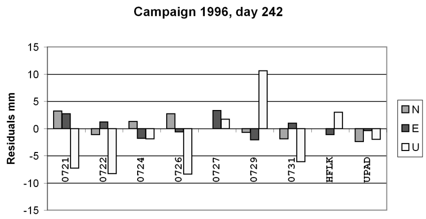


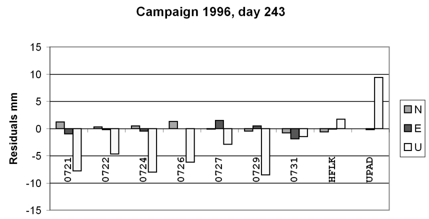


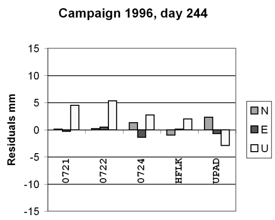


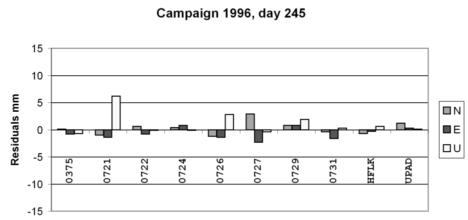
For the residuals in the third campaign (Croatia ’96) see Graphs 12–25. The extreme residuals in daily solutions are 4.0 mm in northing (Malija, day 255), 3.3 mm in easting (Brusnik, day 242), and -13.9 mm in height (Hafelekar, day 247).

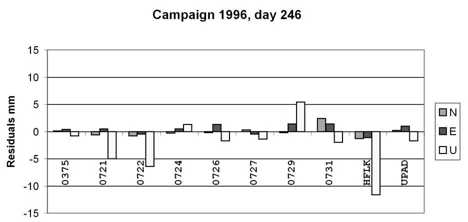
Graphs 12–25: Residuals in the Croatia ’96 campaign.

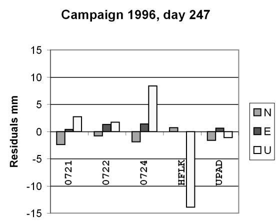


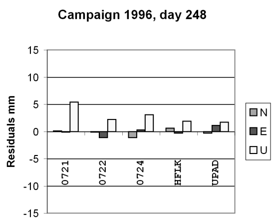


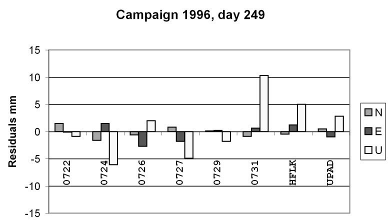


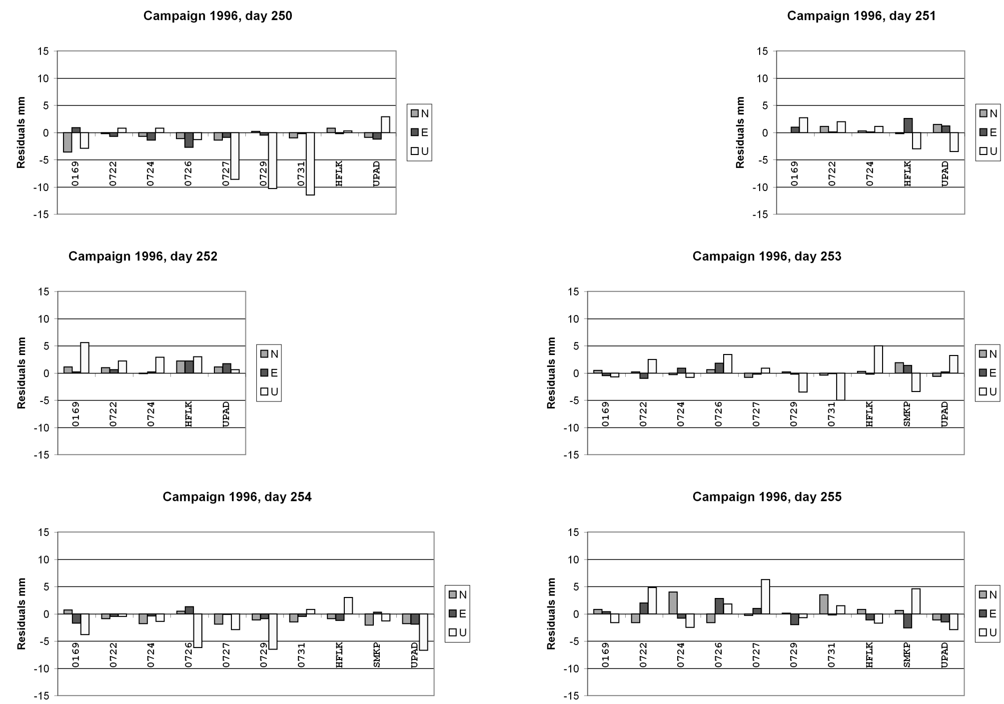






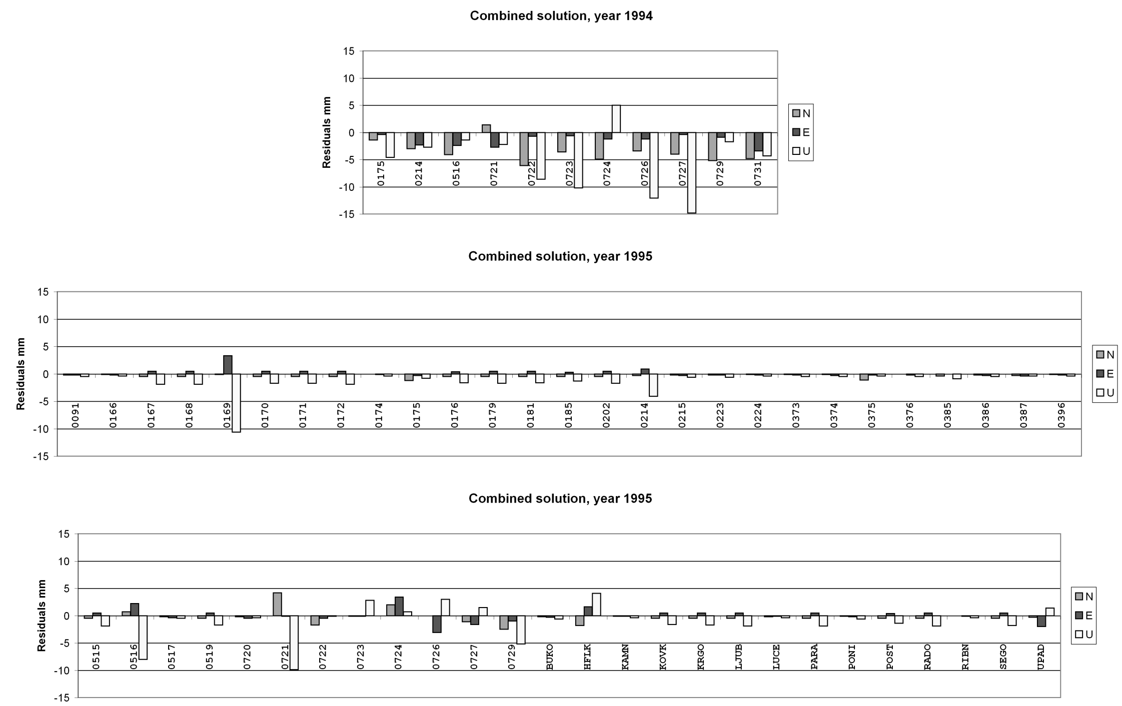


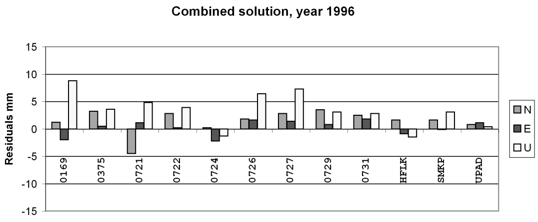




After finishing with each individual campaign, the combined solution of all three campaigns was performed. In order to verify proper antenna stabilization and to be able to detect eventual blunders such as mismeasured antenna heights, the results for each individual campaign solution were compared with the combined solution of all the three campaigns. The coordinate repeatabilities are given in the local (northing, easting, upping) coordinate system. The effect caused by the velocity impact was removed. For the residuals in the combined solution see Graphs 26–28. The extreme residuals in individual campaign solutions with respect to the combined solution are -6.1 mm in northing (Kucelj, year 1994), ±3.4 mm in easting (Malija, year 1995, and Žirje, year 1994), and -14.8 mm in height (Brusnik, year 1994).

Graphs 26–28: Residuals in the combined solution.





5.5 Comparison of a priori and estimated velocity components

Beside the reference sites, only for two sites (Hafelekar and Padova) among 55 sites determined in our three campaigns, the velocity components based on long time spans of data were available. For the other sites, a priori velocity model (NUVEL1A-NNR) was used for the combined solution. All the velocities are related to the ITRF 96. The consequence of unknown local (tectonic) movements along the area could be an incorrect coordinate shift. To be able to estimate the order of magnitude of possible coordinate shifts, a free site velocity estimation was performed, too.

The problem appeared, because 40 of 55 new sites were determined in only one campaign. Trying to set free all the velocity components, the estimated velocity components on the sites observed in only one campaign reached up to 50 cm/y, which is of course of no use. So, for the assessment of the impact of unknown velocities onto the final coordinates, only velocity components on sites observed at least in two campaigns were set free. Beside Hafelekar and Padova, 13 new sites were observed in at least two campaigns and only 6 of them in all three campaigns; see Table 16.

Table 16: Number of daily sessions for sites observed in at least two campaigns.

	SLO&CRO ’94	SLOVENIA ’95	CROATIA ’96	TOTAL
Velika Kopa	4	3	7	**14**
Kucelj	4	7	14	**25**
Korada	4	7		**11**
Malija	4	7	14	**25**
Blegoš		3	6	**9**
Snežnik	4	7		**11**
Donačka gora	4	3		**7**
Gorjanci		3	2	**5**
Golica	4	3		**7**
Brusnik	4	7	9	**20**
Novoselsko brdo	4	3	9	**16**
Pula	4	3	9	**16**
Žirje	4		9	**13**

Values 99.99 were specified as a priori standard deviations for the horizontal velocities and 0.01 for the vertical components [Hugentobler et al. 2001, p. 287], because the spans of data were not long enough. The extreme coordinate differences between the results where using a priori velocities as fixed or set them free were -1.3 mm in northing (Gorjanci) and 2.2 mm in easting (Blegoš); both extreme values were found on sites observed in only two campaigns. For the list of a priori and estimated velocities and the impact to estimated coordinates see Table 17.

Table 17: A priori and estimated velocities and the differences in estimated coordinates.

	A priori velocities [cm/y]			Estimated velocities [cm/y]			Coordinate differences [mm]		
	V_X	V_Y	V_Z	V_X	V_Y	V_Z	δ_N	δ_E	δ_U
Velika Kopa	-1.47	1.79	0.90	-1.31	2.00	0.70	0.1	-0.2	0.0
Kucelj	-1.45	1.80	0.92	-1.73	1.76	1.18	-0.8	-0.1	0.0
Korada	-1.42	1.81	0.93	-1.57	1.77	1.07	-0.2	-0.1	0.0
Malija	-1.42	1.82	0.94	-1.50	1.68	1.04	-0.3	0.2	0.0
Blegoš	-1.44	1.80	0.92	-1.39	1.26	1.00	0.0	2.2	0.0
Snežnik	-1.44	1.81	0.93	-1.40	1.81	0.88	-0.6	-0.1	0.1
Donačka gora	-1.48	1.79	0.90	-1.63	2.01	0.98	-0.5	0.5	0.1
Gorjanci	-1.46	1.80	0.91	-1.84	1.73	1.28	-1.3	0.0	0.0
Golica	-1.44	1.80	0.92	-1.75	2.05	1.14	0.2	0.8	0.0
Brusnik	-1.46	1.80	0.91	-1.67	1.82	1.10	-0.4	-0.1	0.1
Novoselsko brdo	-1.50	1.79	0.89	-1.67	1.85	1.03	-0.3	-0.2	0.0
Pula	-1.41	1.83	0.95	-1.68	1.83	1.20	-0.5	-0.1	0.1
Žirje	-1.44	1.83	0.94	-1.69	1.98	1.14	-0.3	-0.4	-0.1

Except one new site (Koper), all the sites observed in only one campaign were those from the campaign Slovenia ’95. Fortunately, the difference of the epoch of this campaign and the epoch of the combined solution is only 0.19 (69 days). So, the eventual coordinate misshift should not be significant.

5.6 Comparison of coordinates on control sites (constrained solutions)

There were six control sites taken into the processing, two of them were IGS sites. All these sites were treated as new sites in the network irrespective of the fact that their positions had already been determined with high accuracy. The comparison was realized in the ITRF 96, epoch 1995.55. Reference coordinates for the two IGS sites were IGS coordinates in the ITRF 96 (see Table 3) transformed into the mean epoch of the combined solution. The extreme coordinate differences were -2.2 mm in northing, 1.6 mm in easting, and -8.5 mm in height; all reached on Hafelekar. For the list of coordinate differences on the IGS control sites see Table 18.

Table 18: Coordinate differences on the IGS control sites in the ITRF 96, epoch 1995.55.

	X-Y-Z coordinate differences [mm]			N-E-U coordinate differences [mm]		
	δ_X	δ_Y	δ_Z	δ_N	δ_E	δ_U
Hafelekar	-4.4	0.7	-7.7	-2.2	1.6	-8.5
Padova	-1.7	1.0	-3.2	-1.2	1.3	-3.3

Reference coordinates for the other control sites were final coordinates from the Croatian recomputation of these three campaigns [Marjanović & Bačić 2002], also in the ITRF 96, epoch 1995.55. The extreme coordinate differences were -0.9 mm in northing (Novoselsko brdo), -1.0 mm in easting (Žirje), and -4.0 mm in height (Brusnik). For the list of coordinate differences on the control sites in Croatia see Table 19.

Table 19: Coordinate differences on the Croatian control sites in the ITRF 96, epoch 1995.55.

	X-Y-Z coordinate differences [mm]			N-E-U coordinate differences [mm]		
	δ_X	δ_Y	δ_Z	δ_N	δ_E	δ_U
Brusnik	-2.4	0.0	-3.3	-0.7	0.6	-4.0
Novoselsko brdo	-0.1	0.2	-1.3	-0.9	0.2	-1.0
Pula	1.5	0.9	1.8	0.1	0.5	2.5
Žirje	2.6	-0.3	1.3	-0.7	-1.0	2.7

5.7 Comparison of combined solution with each individual solution

Comparison of coordinates in the combined solution and the solutions of each individual campaign was done. All the coordinates were compared in the ETRS 89. The extreme coordinate differences according to the results of the first campaign were 5.9 mm in northing (Kucelj), 2.6 mm in easting (Velika Kopa), and 10.3 mm in height component (Korada). For the complete list of coordinate differences of the combined solution according to the results of the first campaign see Table 20.

Table 20: Coordinate differences of combined solution according to the
new solution of the Slovenia and Croatia ’94 GPS campaign, both in the ETRS 89.

	X-Y-Z coordinate differences [mm]			N-E-U coordinate differences [mm]		
	δ_X	δ_Y	δ_Z	δ_N	δ_E	δ_U
Velika Kopa	1.9	3.2	0.5	-1.6	2.6	2.2
Kucelj	1.7	0.8	10.3	5.9	0.3	8.7
Korada	4.6	1.6	9.6	3.2	0.5	10.3
Malija	-6.9	-0.6	-0.3	4.7	1.0	-5.0
Snežnik	2.3	0.8	4.1	1.2	0.2	4.6
Donačka gora	-0.7	2.1	3.9	2.8	2.2	2.7
Golica	-2.3	1.8	3.7	3.9	2.3	1.4

The extreme coordinate differences according to the results of the second campaign were -4.2 mm in northing (Velika Kopa), -3.6 mm in easting (Malija), and 10.6 mm in height component (Blegoš). For the complete list of coordinate differences of the combined solution according to the results of the second campaign see Table 21.

Table 21: Coordinate differences of the combined solution according to the new solution of the Slovenia '95 GPS campaign, both in ETRS the 89.

	X-Y-Z coordinate differences [mm]			N-E-U coordinate differences [mm]		
	δ_X	δ_Y	δ_Z	δ_N	δ_E	δ_U
Lendavske gorice	0.1	0.3	0.5	0.2	0.3	0.5
Velika Kopa	9.6	2.6	4.3	-4.2	0.0	10.0
Kucelj	-1.1	-0.1	1.3	1.7	0.2	0.2
Korada	-1.9	-0.5	-2.1	-0.1	0.0	-2.9
Malija	1.7	-3.3	-1.9	-2.0	-3.6	-0.7
Vivodnik	0.3	0.0	0.3	0.0	-0.1	0.4
Grintovec	1.1	-0.5	1.7	0.5	-0.8	1.9
Rašica	1.1	-0.4	1.7	0.5	-0.7	1.9
Blegoš	7.9	-1.6	7.7	0.1	-3.5	10.6
Rodica	1.0	-0.5	1.6	0.5	-0.7	1.7
Mrzovec	0.9	-0.5	1.5	0.5	-0.7	1.6
Krim	1.1	-0.4	1.7	0.5	-0.7	1.9
Sveta Ana	0.3	0.0	0.2	-0.1	-0.1	0.3
Snežnik	-0.3	0.1	1.4	1.2	0.2	0.8
Nanos	0.9	-0.4	1.5	0.5	-0.6	1.6
Mangart	1.0	-0.4	1.5	0.4	-0.6	1.7
Slavnik	0.9	-0.4	1.4	0.4	-0.6	1.5
Cerk	0.7	-0.4	1.4	0.6	-0.6	1.4
Kanin	1.1	-0.3	1.6	0.4	-0.5	1.8
Donačka gora	2.8	-0.4	3.2	0.4	-1.1	4.1
Žigartov vrh	0.2	0.2	0.5	0.2	0.1	0.5
Uršlja gora	0.3	0.1	0.5	0.1	0.0	0.6
Orljek	0.2	0.1	0.4	0.1	0.0	0.4
Mrzlica	0.3	0.2	0.4	0.0	0.1	0.5
Javornik	0.4	0.2	0.3	-0.1	0.1	0.5
Gorjanci	-0.4	-0.1	1.2	1.1	0.0	0.6
Debeli vrh	0.3	0.0	0.2	-0.1	-0.1	0.3
Grmada	0.5	-0.1	0.9	0.3	-0.2	1.0
Lokavec	0.2	0.3	0.6	0.2	0.2	0.6
Kamenek	0.1	0.3	0.5	0.2	0.3	0.5
Zglavnica	0.3	0.1	0.4	0.1	0.0	0.5
Košuta	1.1	-0.4	1.7	0.5	-0.7	1.9
Golica	6.4	-0.8	5.3	-0.7	-2.3	8.0
Jeruzalem	0.2	0.3	0.5	0.1	0.2	0.6
Kremenjak	0.9	-0.4	1.6	0.6	-0.6	1.7
Košenjak	0.1	0.0	0.5	0.3	0.0	0.4
Bukovec	0.2	0.2	0.5	0.2	0.1	0.5
Kamnik	0.2	0.0	0.3	0.1	-0.1	0.4
Kovk	1.0	-0.4	1.5	0.4	-0.6	1.7
Kranjska Gora	0.9	-0.4	1.5	0.5	-0.6	1.6
Ljubljana	1.1	-0.3	1.7	0.5	-0.6	1.9
Luče	0.2	-0.1	0.4	0.2	-0.1	0.4
Pasja ravan	1.1	-0.4	1.7	0.5	-0.7	1.9
Ponikva	0.2	0.1	0.5	0.2	0.0	0.5
Postojna	0.7	-0.3	1.3	0.5	-0.5	1.4
Radovljica	1.2	-0.5	1.7	0.4	-0.8	1.9
Ribnica	0.3	-0.1	0.3	0.0	-0.2	0.4
Šentviška gora	1.0	-0.5	1.5	0.4	-0.7	1.7

The extreme coordinate differences according to the results of the third campaign were 4.6 mm in northing (Velika Kopa), 1.9 mm in easting (Malija and Blegoš), and -8.7 mm in height component (Blegoš). For the complete list of coordinate differences of the combined solution according to the results of the third campaign see Table 22.

Table 22: Coordinate differences of the combined solution according to the new solution of the Croatia '96 GPS campaign, both in ETRS the 89.

	X-Y-Z coordinate differences [mm]			N-E-U coordinate differences [mm]		
	δ_X	δ_Y	δ_Z	δ_N	δ_E	δ_U
Velika Kopa	-6.0	-2.9	-0.2	4.6	-1.2	-4.7
Kucelj	-0.5	-0.6	-4.7	-2.8	-0.5	-3.8
Malija	0.4	2.1	0.8	-0.1	1.9	1.2
Blegoš	-5.7	0.5	-6.9	-0.9	1.9	-8.7
Gorjanci	-0.1	-0.7	-4.6	-3.0	-0.6	-3.5
Koper	-1.0	-0.4	-3.2	-1.5	-0.2	-3.0

Altogether, differences between each individual and combined solution are below 6 mm in northing, below 4 mm in easting, and up to above 1 cm in height component.

5.8 Comparison of combined solution with the previous solutions

Comparison of coordinates in the combined solution and the first solutions of each individual campaign was done. All the coordinates were compared in the ETRS 89. The first results of the first campaign (Slovenia and Croatia '94) were published in 1995 [Altiner et al. 1995]. The extreme coordinate differences according to this campaign were 10.3 mm in northing and 14.0 mm in easting. Both extreme values were reached on Lendavske gorice; the data from 1994 for this site were excluded from the combined solution (it was found out that the site was not stable). The extreme coordinate difference in height component was 50.7 mm (Korada). For the complete list of coordinate differences of the combined solution according to the first results of the first campaign see Table 23.

Table 23: Coordinate differences of the combined solution according to the first solution of the Slovenia and Croatia '94 GPS campaign, both in the ETRS 89.

	X-Y-Z coordinate differences [mm]			N-E-U coordinate differences [mm]		
	δ_X	δ_Y	δ_Z	δ_N	δ_E	δ_U
Lendavske gorice	1.3	15.0	20.7	10.3	14.0	18.8
Velika Kopa	28.7	16.0	19.9	-9.3	7.9	36.4
Kucelj	30.2	14.9	34.6	0.5	6.7	47.8
Korada	33.1	19.6	34.9	-2.1	11.3	50.7
Malija	16.9	16.4	26.3	4.1	11.9	33.0
Snežnik	27.5	15.3	29.5	-1.0	8.0	42.4
Donačka gora	26.8	12.1	24.3	-4.1	4.4	37.7
Golica	26.7	19.2	28.0	-2.8	12.1	41.4

The first results of the second campaign (Slovenia '95) were published in 1997 [Altiner et al. 1997a; Tavčar 1997]. The extreme coordinate differences were -12.7 mm in northing (Malija), -13.2 mm in easting (Blegoš), and 13.5 mm in height component (Krim). For the complete list of coordinate differences of the combined solution according to the first results of the second campaign see Table 24.

Table 24: Coordinate differences of the combined solution according to the first solution of the Slovenia '95 GPS campaign, both in the ETRS 89.

	X-Y-Z coordinate differences [mm]			N-E-U coordinate differences [mm]		
	δ_X	δ_Y	δ_Z	δ_N	δ_E	δ_U
Lendavske gorice	6.3	-9.0	-8.3	-8.3	-10.4	-3.6
Velika Kopa	18.7	-5.0	-0.1	-12.2	-9.7	11.5
Kucelj	8.2	-8.1	-6.4	-8.7	-9.9	-0.5
Korada	9.1	-7.4	-7.1	-10.0	-9.3	-0.1
Malija	14.9	-9.6	-5.7	-12.7	-12.8	4.5
Vivodnik	11.7	-7.8	-3.2	-8.9	-10.5	4.2
Grintovec	9.8	-7.6	-4.0	-8.2	-9.8	2.4
Rašica	10.2	-8.4	-3.5	-8.0	-10.7	2.9
Blegoš	15.3	-9.8	-0.3	-9.2	-13.2	8.4
Rodica	12.5	-7.7	-3.1	-9.6	-10.5	4.9
Mrzovec	9.2	-8.4	-7.1	-9.9	-10.4	-0.3
Krim	17.8	-5.9	3.5	-8.8	-10.2	13.5
Sveta Ana	7.7	-8.1	-7.1	-8.8	-9.8	-1.3
Snežnik	9.5	-7.7	-5.5	-9.0	-9.8	1.2
Nanos	9.3	-8.6	-5.4	-8.7	-10.6	1.0
Mangart	15.7	-7.7	-0.6	-10.1	-11.2	8.9
Slavnik	15.1	-7.3	0.5	-8.8	-10.7	9.4
Cerk	9.9	-7.4	-5.0	-9.0	-9.7	1.8
Kanin	9.4	-9.0	-6.9	-9.9	-10.9	-0.1
Donačka gora	9.8	-7.9	-5.7	-9.2	-10.3	1.0
Žigartov vrh	9.2	-7.7	-5.4	-8.7	-9.9	0.8
Uršlja gora	13.5	-6.8	-0.9	-8.8	-10.1	7.1
Orljek	9.1	-7.3	-4.6	-8.2	-9.4	1.5
Mrzlica	6.3	-8.9	-10.9	-10.3	-10.2	-5.2
Javornik	9.5	-6.8	-4.3	-8.3	-9.1	2.0
Gorjanci	8.2	-6.9	-4.1	-7.2	-8.8	1.3
Debeli vrh	8.7	-7.8	-5.5	-8.4	-9.8	0.6
Grmada	9.5	-8.9	-6.1	-9.1	-11.1	0.2
Lokavec	5.4	-8.5	-7.0	-6.9	-9.6	-3.1
Kamenek	5.4	-8.3	-8.5	-7.9	-9.5	-4.2
Zglavnica	9.6	-7.2	-4.2	-8.2	-9.5	2.2
Košuta	8.2	-8.5	-7.0	-9.1	-10.3	-1.0
Golica	12.7	-9.8	-4.0	-9.9	-12.6	4.0
Jeruzalem	4.3	-8.8	-10.1	-8.2	-9.6	-6.1
Kremenjak	7.8	-8.5	-7.0	-8.9	-10.1	-1.1
Košenjak	-0.6	-11.3	-13.4	-6.7	-10.8	-12.1
Bukovec	7.8	-7.5	-6.0	-8.1	-9.3	-0.5
Kamnik	7.7	-8.8	-6.9	-8.6	-10.5	-1.3
Kovk	9.7	-7.9	-6.0	-9.6	-10.0	0.9
Kranjska Gora	7.5	-9.7	-9.3	-10.0	-11.2	-3.3
Ljubljana	6.1	-10.0	-8.7	-8.5	-11.2	-3.9
Luče	9.6	-8.0	-6.5	-9.7	-10.2	0.3
Pasja ravan	11.4	-7.2	-3.9	-9.4	-9.8	3.7
Ponikva	8.5	-7.6	-7.8	-9.9	-9.6	-1.3
Postojna	14.0	-7.8	-1.4	-9.3	-11.0	7.2
Radovljica	10.5	-7.5	-3.0	-8.1	-9.8	3.6
Ribnica	3.6	-8.3	-11.0	-8.7	-8.9	-6.9
Šentviška gora	6.3	-9.1	-9.1	-9.2	-10.3	-3.8

The first results of the third campaign (Croatia '96) were published in 1997 [Altiner et al. 1997b; Marjanović & Rašić 1997]. The extreme coordinate differences were -16.8 mm in northing and 32.9 mm in easting. Both extreme values were reached on Lendavske gorice; the data from 1996 for this site were excluded from the combined solution (it was found out that the site was not stable). For the other sites, the coordinate differences in horizontal components reached up to 3.6 mm. The extreme coordinate difference in height component was 13.8 mm (Malija). For the complete list of coordinate differences of the combined solution according to the first results of the third campaign see Table 25.

Table 25: Coordinate differences of the combined solution according to the first solution of the Croatia '96 GPS campaign, both in the ETRS 89.

	X-Y-Z coordinate differences [mm]			N-E-U coordinate differences [mm]		
	δ_X	δ_Y	δ_Z	δ_N	δ_E	δ_U
Lendavske gorice	1.0	34.6	-13.0	-16.8	32.9	-2.0
Kucelj	6.6	0.2	2.3	-3.0	-1.5	6.1
Malija	8.8	5.8	9.6	-0.3	3.6	13.8
Gorjanci	8.7	1.4	6.4	-1.8	-0.9	10.7

In the first computation of the Croatia '96 GPS campaign all the data from the last phase of observation (geodynamic phase) were excluded. So, for the territory of Slovenia, there were no results for the sites Velika Kopa, Blegoš, and Koper.

6 Conclusions

Main differences of the three EUREF GPS campaigns in Slovenia were:
- number of sites observed in each campaign and consequently various network configurations and baseline lengths, and
- observation time span of each campaign.

Main differences in various computations of the EUREF GPS campaigns in Slovenia were:
- reference frames used (ITRF 92, ITRF 93, ITRF 94, and ITRF 96),
- selection of sites taken into the processing (territorial selection for the final Slovene and Croatian computations),
- elevation masks used during processing in various computations (15–20 degrees),
- software versions used for the computations (Bernese GPS software, versions 3.4–4.2),
- some receiver and antenna type information corrections,
- some antenna height corrections (changes done in the RINEX files), and
- some network configuration corrections:
  - by uniforming names of sites observed in various campaigns to avoid double solution, or
  - empirically, trying to improve results according to the RMS values.

The improvements of results of further computations were achieved mostly through:
- the use of better quality ITRF solution (ITRF 96 instead of ITRF 92–94),
- improvements in ambiguity resolution algorithms (in the latter versions of software),
- the application of elevation dependent phase center corrections for various antenna types,
- the introduction of the elevation dependent weights (COSZ model),
- the detection and elimination of some bad satellite orbit determination intervals, and
- the elimination of data from Lendavske gorice, which was found out as a non-stable site.

There are five official EUREF sites in Slovenia (with the EUREF numbers 0720–0724): Lendavske gorice, Velika Kopa, Kucelj, Korada, and Malija. Their official coordinates still originate from the first computation of the campaign Slovenia and Croatia '94. The differences between new and actual official coordinates reach up to 14 mm in horizontal components and up to 51 mm in height component. Furthermore, it turned out that the 12-meter-high pillar on Lendavske gorice was not stable enough to be able to achieve the required accuracy.

The analysis showed, that the actual official coordinates of the EUREF sites in Slovenia are not accurate enough to meet our requests. At the XXXIth EUREF TWG Meeting, held in Paris in March 2003, the new results were accepted [Hornik 2003]. The ccordinates of four EUREF sites in Slovenia (Velika Kopa, Kucelj, Korada, and Malija) are going to be replaced with the coordinates of the new combined solution and the leftover site (Lendavske gorice) is going to be replaced with the site Donačka gora.

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Appendix 1: Daily RINEX files overview (zero differences) and antenna heights.

<table>
<tr><td colspan="5"></td><th colspan="4">SLO&CRO ’94</th><th colspan="7">SLOVENIA ’95</th><th colspan="14">CROATIA ’96</th></tr>
<tr><th colspan="4">SITE NAME</th><th rowspan="2">Days</th><td>150</td><td>151</td><td>152</td><td>153</td><td>268</td><td>269</td><td>270</td><td>271</td><td>272</td><td>273</td><td>274</td><td>242</td><td>243</td><td>244</td><td>245</td><td>246</td><td>247</td><td>248</td><td>249</td><td>250</td><td>251</td><td>252</td><td>253</td><td>254</td><td>255</td></tr>
<tr><th colspan="2">Full name</th><th>4sn</th><th>2sn</th><th colspan="4">1</th><th colspan="3">2</th><th>3</th><th colspan="3">4</th><th colspan="2">5</th><th>6</th><th colspan="2">7</th><th colspan="2">= 6</th><th>8</th><th>9</th><th colspan="2">10</th><th>11</th><th colspan="2">12</th></tr>
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<tr><td>Wettzell</td><td>DE</td><td>WTZR</td><td>WT</td><td>21</td><td colspan="4"></td><td colspan="7">0.0710</td><td colspan="14">0.0710</td></tr>
<tr><td>Zimmerwald</td><td>CH</td><td>ZIMM</td><td>ZI</td><td>24</td><td colspan="4">0.0000</td><td colspan="7">0.0000</td><td colspan="11">0.0000</td><td></td><td colspan="2">0.0000</td></tr>
<tr><td>Lendavske gorice</td><td></td><td>0720</td><td>01</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.0715</td><td colspan="14"></td></tr>
<tr><td>Velika Kopa</td><td></td><td>0721</td><td>02</td><td>14</td><td colspan="4">0.1912</td><td colspan="4"></td><td colspan="3">0.0667</td><td colspan="7">0.1250</td><td colspan="7"></td></tr>
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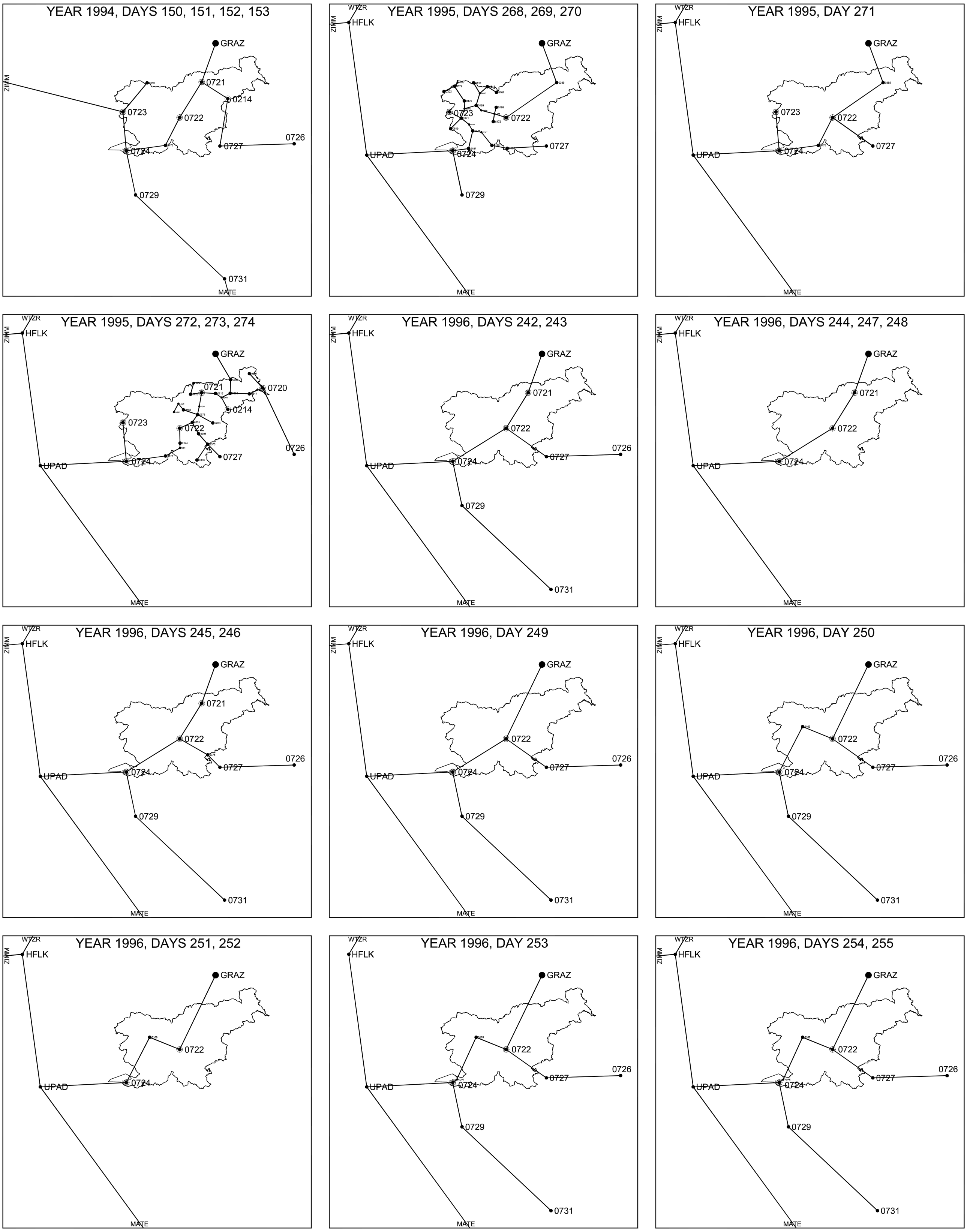
<tr><td>Kamenek</td><td></td><td>0387</td><td>30</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.0710</td><td colspan="14"></td></tr>
<tr><td>Zglavnica</td><td></td><td>0396</td><td>31</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.0861</td><td colspan="14"></td></tr>
<tr><td>Košuta</td><td></td><td>0515</td><td>32</td><td>3</td><td colspan="4"></td><td colspan="3">0.6010</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Golica</td><td></td><td>0516</td><td>33</td><td>7</td><td colspan="4">0.1191</td><td colspan="3">0.0711</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Jeruzalem</td><td></td><td>0517</td><td>34</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.6710</td><td colspan="14"></td></tr>
<tr><td>Kremenjak</td><td></td><td>0519</td><td>35</td><td>3</td><td colspan="4"></td><td colspan="3">0.0871</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Košenjak</td><td></td><td>0091</td><td>36</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.6055</td><td colspan="14"></td></tr>
<tr><td>Bukovec</td><td></td><td>BUKO</td><td>37</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.0700</td><td colspan="14"></td></tr>
<tr><td>Kamnik</td><td></td><td>KAMN</td><td>38</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.6000</td><td colspan="14"></td></tr>
<tr><td>Kovk</td><td></td><td>KOVK</td><td>39</td><td>3</td><td colspan="4"></td><td colspan="3">0.6000</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Kranjska Gora</td><td></td><td>KRGO</td><td>40</td><td>3</td><td colspan="4"></td><td colspan="3">0.6670</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Ljubljana</td><td></td><td>LJUB</td><td>41</td><td>3</td><td colspan="4"></td><td colspan="3">0.0729</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Luče</td><td></td><td>LUCE</td><td>42</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.6000</td><td colspan="14"></td></tr>
<tr><td>Pasja ravan</td><td></td><td>PARA</td><td>43</td><td>3</td><td colspan="4"></td><td colspan="3">0.6003</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Ponikva</td><td></td><td>PONI</td><td>44</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.6000</td><td colspan="14"></td></tr>
<tr><td>Postojna</td><td></td><td>POST</td><td>45</td><td>3</td><td colspan="4"></td><td colspan="3">0.6000</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Radovljica</td><td></td><td>RADO</td><td>46</td><td>3</td><td colspan="4"></td><td colspan="3">0.0733</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Ribnica</td><td></td><td>RIBN</td><td>47</td><td>3</td><td colspan="4"></td><td colspan="4"></td><td colspan="3">0.6723</td><td colspan="14"></td></tr>
<tr><td>Šentviška gora</td><td></td><td>SEGO</td><td>48</td><td>3</td><td colspan="4"></td><td colspan="3">0.6070</td><td colspan="4"></td><td colspan="14"></td></tr>
<tr><td>Koper</td><td></td><td>SMKP</td><td>49</td><td>3</td><td colspan="4"></td><td colspan="7"></td><td colspan="11"></td><td colspan="3">0.6020</td></tr>
<tr><td>Brusnik</td><td>HR</td><td>0727</td><td>BR</td><td>20</td><td colspan="4">0.0716</td><td colspan="7">0.1760</td><td colspan="2">0.1050</td><td></td><td colspan="2">0.1050</td><td colspan="2"></td><td colspan="2">0.1050</td><td colspan="2"></td><td colspan="3">0.1050</td></tr>
<tr><td>Hafelekar</td><td>AT</td><td>HFLK</td><td>HF</td><td>21</td><td colspan="4"></td><td colspan="7">0.0000</td><td colspan="14">0.0000</td></tr>
<tr><td>Novoselsko brdo</td><td>HR</td><td>0726</td><td>NB</td><td>16</td><td colspan="4">0.0776</td><td colspan="4"></td><td colspan="3">0.0770</td><td colspan="2">0.0753</td><td></td><td colspan="2">0.0733</td><td colspan="2"></td><td colspan="2">0.0733</td><td colspan="2"></td><td colspan="2">0.0733</td><td>0.0743</td></tr>
<tr><td>Padova</td><td>IT</td><td>UPAD</td><td>PD</td><td>21</td><td colspan="4"></td><td colspan="7">1.9620</td><td colspan="14">1.9620</td></tr>
<tr><td>Pula</td><td>HR</td><td>0729</td><td>PU</td><td>16</td><td colspan="4">0.1005</td><td colspan="3">0.0585</td><td colspan="4"></td><td colspan="2">0.1036</td><td></td><td colspan="2">0.1036</td><td colspan="2"></td><td colspan="2">0.1036</td><td colspan="2"></td><td colspan="3">0.1036</td></tr>
<tr><td>Žirje</td><td>HR</td><td>0731</td><td>ZR</td><td>13</td><td colspan="4">0.0755</td><td colspan="7"></td><td colspan="2">0.0895</td><td></td><td colspan="2">0.0895</td><td colspan="2"></td><td colspan="2">0.0895</td><td colspan="2"></td><td colspan="3">0.0895</td></tr>
<tr><td colspan="4" rowspan="2"></td><td rowspan="2">440</td><td colspan="4">14×4=56</td><td colspan="3">34×3=102</td><td>12</td><td colspan="3">35×3=105</td><td colspan="2">13×2=26</td><td>9</td><td colspan="2">14×2=28</td><td colspan="2">9×2=18</td><td>12</td><td>13</td><td colspan="2">9×2=18</td><td>13</td><td colspan="2">14×2=28</td></tr>
<tr><td colspan="4">56</td><td colspan="7">102+12+105=219</td><td colspan="14">26+9+28+18+12+13+18+13+28=165</td></tr>
</table>

Appendix 2: Measurement instruments information.

SITE NAME			SLO&CRO '94		SLOVENIA '95		CROATIA '96	
Full name	4sn	2sn	Receiver	Antenna	Receiver	Antenna	Receiver	Antenna
Graz AT	GRAZ	GR	ROGUE SNR-8C	DORNE MARGOLIN B	ROGUE SNR-8C	DORNE MARGOLIN B	ROGUE SNR-8000	DORNE MARGOLIN T
Matera IT	MATE	MA	ROGUE SNR-8	DORNE MARGOLIN B	ROGUE SNR-8	DORNE MARGOLIN B	ROGUE SNR-8100	DORNE MARGOLIN T
Wettzell DE	WTZR	WT			ROGUE SNR-8000	DORNE MARGOLIN T	ROGUE SNR-8000	DORNE MARGOLIN T
Zimmerwald CH	ZIMM	ZI	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD
Lendavske gorice	0720	01			TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Velika Kopa	0721	02	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD
Kucelj	0722	03	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	TR GEOD L1/L2 GP
Korada	0723	04	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Malija	0724	05	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	TR GEOD L1/L2 GP	TRIMBLE 4000SSE	TR GEOD L1/L2 GP
Vivodnik	0166	06			TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Grintovec	0167	07			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Rašica	0168	08			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Blegoš	0169	09			TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD
Rodica	0170	10			TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Mrzovec	0171	11			TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Krim	0172	12			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Sveta Ana	0174	13			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Snežnik	0175	14	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Nanos	0176	15			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Mangart	0179	16			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Slavnik	0181	17			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Cerk	0185	18			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Kanin	0202	19			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Donačka gora	0214	20	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Žigartov vrh	0215	21			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Uršlja gora	0223	22			TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Orljek	0224	23			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Mrzlica	0373	24			TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Javornik	0374	25			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Gorjanci	0375	26			TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD
Debeli vrh	0376	27			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Grmada	0385	28			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Lokavec	0386	29			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Kamenek	0387	30			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Zglavnica	0396	31			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Košuta	0515	32			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Golica	0516	33	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Jeruzalem	0517	34			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Kremenjak	0519	35			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Košenjak	0091	36			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Bukovec	BUKO	37			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Kamnik	KAMN	38			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Kovk	KOVK	39			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Kranjska Gora	KRGO	40			TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Ljubljana	LJUB	41			TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Luče	LUCE	42			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Pasja ravan	PARA	43			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Ponikva	PONI	44			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Postojna	POST	45			TRIMBLE 4000SSE	TR GEOD L1/L2 GP		
Radovljica	RADO	46			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Ribnica	RIBN	47			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Šentviška gora	SEGO	48			TRIMBLE 4000SSE	4000ST L1/L2 GEOD		
Koper	SMKP	49					TRIMBLE 4000SSE	TR GEOD L1/L2 GP
Brusnik HR	0727	BR	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSI	TR GEOD L1/L2 GP	TRIMBLE 4000SSE	4000ST L1/L2 GEOD
Hafelekar AT	HFLK	HF			ROGUE SNR-8C	DORNE MARGOLIN B	ROGUE SNR-8C	DORNE MARGOLIN B
Novoselsko brdo HR	0726	NB	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	TR GEOD L1/L2 GP	TRIMBLE 4000SSE	4000ST L1/L2 GEOD
Padova IT	UPAD	PD			TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD
Pula HR	0729	PU	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD	TRIMBLE 4000SSE	4000ST L1/L2 GEOD
Žirje HR	0731	ZR	TRIMBLE 4000SSE	4000ST L1/L2 GEOD			TRIMBLE 4000SSE	4000ST L1/L2 GEOD

Appendix 3: Baseline selection overview (single differences) by phases.



Appendix 4: Coordinates of combined solution in the ITRF 96, epoch 1995.55, and in the ETRS 89.

SITE NAME			Coordinates in ITRF 96, epoch 1995.55			Coordinates in ETRS 89		
Full name	4sn	2sn	X	Y	Z	X	Y	Z
Lendavske gorice	0720	01	4212714.6703	1246016.1743	4608998.4237	4212714.8103	1246016.0990	4608998.3157
Velika Kopa	0721	02	4244884.4407	1153155.7639	4605345.2430	4244884.5787	1153155.6880	4605345.1339
Kucelj	0722	03	4293438.7283	1129475.6056	4565202.0116	4293438.8652	1129475.5289	4565201.9016
Korada	0723	04	4310119.6450	1039590.8917	4570877.2498	4310119.7801	1039590.8146	4570877.1389
Malija	0724	05	4351694.6312	1056274.7981	4526994.6917	4351694.7659	1056274.7204	4526994.5803
Vivodnik	0166	06	4271848.2345	1129969.8766	4586202.3495	4271848.3717	1129969.8002	4586202.2398
Grintovec	0167	07	4270280.1979	1107185.9058	4594618.1358	4270280.3348	1107185.8294	4594618.0260
Rašica	0168	08	4285934.7495	1110917.2952	4576361.6775	4285934.8862	1110917.2186	4576361.5675
Blegoš	0169	09	4292630.7373	1079310.2350	4579117.0960	4292630.8733	1079310.1582	4579116.9857
Rodica	0170	10	4292631.1508	1059570.6231	4584247.0824	4292631.2865	1059570.5463	4584246.9719
Mrzovec	0171	11	4312783.1028	1059774.2497	4564605.1617	4312783.2382	1059774.1726	4564605.0509
Krim	0172	12	4303467.5124	1110727.5610	4560823.4558	4303467.6488	1110727.4841	4560823.3455
Sveta Ana	0174	13	4310107.6770	1134567.7128	4548613.2502	4310107.8137	1134567.6359	4548613.1399
Snežnik	0175	14	4330964.5044	1115839.1206	4534674.6322	4330964.6405	1115839.0433	4534674.5215
Nanos	0176	15	4322333.9357	1081616.9506	4550365.7464	4322334.0713	1081616.8734	4550365.6356
Mangart	0179	16	4280449.1941	1039866.1920	4600998.4268	4280449.3297	1039866.1153	4600998.3164
Slavnik	0181	17	4343454.5468	1080327.4222	4530230.1146	4343454.6821	1080327.3447	4530230.0035
Cerk	0185	18	4327552.8754	1140506.7428	4530962.9785	4327553.0119	1140506.6656	4530962.8680
Kanin	0202	19	4290595.7492	1025156.0088	4594746.4718	4290595.8844	1025155.9320	4594746.3611
Donačka gora	0214	20	4252206.8262	1198632.0631	4586161.4012	4252206.9648	1198631.9871	4586161.2923
Žigartov vrh	0215	21	4239847.1518	1174785.6201	4604282.8405	4239847.2902	1174785.5443	4604282.7316
Uršlja gora	0223	22	4251420.3319	1136326.9023	4603708.1314	4251420.4695	1136326.8262	4603708.0221
Orljek	0224	23	4281784.6228	1147343.4482	4571841.7031	4281784.7601	1147343.3717	4571841.5934
Mrzlica	0373	24	4271062.2217	1153198.7934	4580640.2436	4271062.3593	1153198.7171	4580640.1341
Javornik	0374	25	4273872.9525	1179497.1985	4571245.6761	4273873.0905	1179497.1222	4571245.5667
Gorjanci	0375	26	4299963.6336	1177803.7748	4547546.9387	4299963.7712	1177803.6981	4547546.8289
Debeli vrh	0376	27	4321783.2777	1165924.3683	4529550.1298	4321783.4147	1165924.2912	4529550.0195
Grmada	0385	28	4232819.4136	1197372.6338	4603687.4745	4232819.5525	1197372.5581	4603687.3659
Lokavec	0386	29	4217271.3784	1193915.6790	4618635.4494	4217271.5174	1193915.6035	4618635.3410
Kamenek	0387	30	4202414.0227	1221146.6289	4625014.5985	4202414.1624	1221146.5537	4625014.4905
Zglavnica	0396	31	4291721.8982	1160395.4374	4558817.9526	4291722.0356	1160395.3608	4558817.8428
Košuta	0515	32	4267391.6096	1091231.1439	4600426.7569	4267391.7462	1091231.0675	4600426.6470
Golica	0516	33	4268440.5125	1068560.1106	4604390.7910	4268440.6487	1068560.0342	4604390.6810
Jeruzalem	0517	34	4225126.2048	1227181.2907	4602678.5632	4225126.3443	1227181.2152	4602678.4549
Kremenjak	0519	35	4327909.2499	1046426.0658	4551790.3571	4327909.3848	1046425.9885	4551790.2460
Košenjak	0091	36	4237432.9286	1137800.0856	4615915.6877	4237433.0664	1137800.0097	4615915.5786
Bukovec	BUKO	37	4241306.0693	1185179.0473	4599003.8339	4241306.2078	1185178.9715	4599003.7250
Kamnik	KAMN	38	4277737.5318	1115558.2317	4582961.9810	4277737.6687	1115558.1552	4582961.8711
Kovk	KOVK	39	4316406.6211	1073774.1222	4557317.8658	4316406.7567	1073774.0451	4557317.7550
Kranjska Gora	KRGO	40	4273804.6008	1043435.2868	4603814.1160	4273804.7365	1043435.2103	4603814.0057
Ljubljana	LJUB	41	4293737.9856	1110067.8127	4569047.6665	4293738.1221	1110067.7360	4569047.5563
Luče	LUCE	42	4266917.2215	1119365.4983	4593334.1062	4266917.3586	1119365.4220	4593333.9965
Pasja ravan	PARA	43	4295775.6733	1088858.1796	4573139.1014	4295775.8094	1088858.1028	4573138.9911
Ponikva	PONI	44	4260698.5808	1153287.7656	4589225.0826	4260698.7185	1153287.6894	4589224.9732
Postojna	POST	45	4319956.4911	1095408.0243	4548544.8573	4319956.6270	1095407.9472	4548544.7466
Radovljica	RADO	46	4276816.4642	1081197.8780	4591886.3451	4276816.6005	1081197.8015	4591886.2350
Ribnica	RIBN	47	4315183.4570	1135854.2217	4542857.5013	4315183.5936	1135854.1447	4542857.3910
Šentviška gora	SEGO	48	4300244.8887	1062094.6598	4574775.6115	4300245.0243	1062094.5829	4574775.5009
Koper	SMKP	49	4346593.3625	1061522.8171	4530253.7126	4346593.4974	1061522.7395	4530253.6013
Brusnik HR	0727	BR	4307965.9391	1200393.2703	4532778.8228	4307966.0769	1200393.1935	4532778.7130
Hafelekar AT	HFLK	HF	4248505.2059	855575.5758	4667172.1614	4248505.3387	855575.4994	4667172.0503
Novoselsko brdo HR	0726	NB	4273227.8031	1314661.9820	4533897.0120	4273227.9433	1314661.9059	4533896.9035
Padova IT	UPAD	PD	4389531.3175	923253.6280	4519256.3193	4389531.4494	923253.5496	4519256.2064
Pula HR	0729	PU	4396623.9027	1083670.7838	4476822.9714	4396624.0372	1083670.7055	4476822.8594
Žirje HR	0731	ZR	4450950.2316	1246404.5109	4380514.2488	4450950.3679	1246404.4321	4380514.1370