EUREF-Slovakia 2001
COMPUTATION AND REALISATION OF THE TERRESTRIAL KINEMATIC REFERENCE FRAME FOR SLOVAKIA

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Abstract

Global positioning reference basis ETRS89, its model realization process on the territory of Slovakia by means of the Slovak Terrestrial Reference Frame SKTRF 2001 as a part of the ITRF 2000 and its official connection to the EUREF points class B. Effective connection of stochastic, spatial and dynamic structures, with minimum loss of information obtained by GPS measurement with emphasis on the estimate of parameters and their linear functionals of the 1st and 2nd order of kinematic terrestrial reference frame.

1. Slovak Kinematic Terrestrial Reference Frame 2001

The Slovak kinematic terrestrial reference frame 2001 (SKTRF 2001) represents the part of a spatial reference system ITRS and ETRS. For National Spatial Network and additional positioning purposes it is understood as a reference positioning standard. It is created from connecting (transforming) the solution of Slovak Geodynamic Reference Network (SGRN) to the ITRFyy and then to the ETRFyy.

2. Slovak Geodynamic Reference Network – SGRN

Basis of Slovakia's geodynamics research are repeated GPS measurements on the points of SGRN. Essentially it is about geokinematics, because for the research of geodynamics also forces effecting the given points should be researched. The first relevant GPS measurement in SGRN was carried out in campaign SGRN'93. Repeated measurements were carried out in GPS observation campaigns SGRN '95, '98, '99, '00 and '01. They are described in detail in 2.2.

SGRN points are divided into the points of **S**GRN **P**ermanent **O**bservation **S**tation (**SPOS**) and the points of **S**GRN **E**poch **O**bservation **S**tation (**SEOS**). At present there are 47 SGRN points, three of which are SPOS points (MOPI-EPN, BBYS, GANP). and 44 SEOS GANP is being prepared as a point of permanent observation, in perspective to be included in EUREF Permanent Network (EPN). Configuration of SGRN is given in the Fig. 1.

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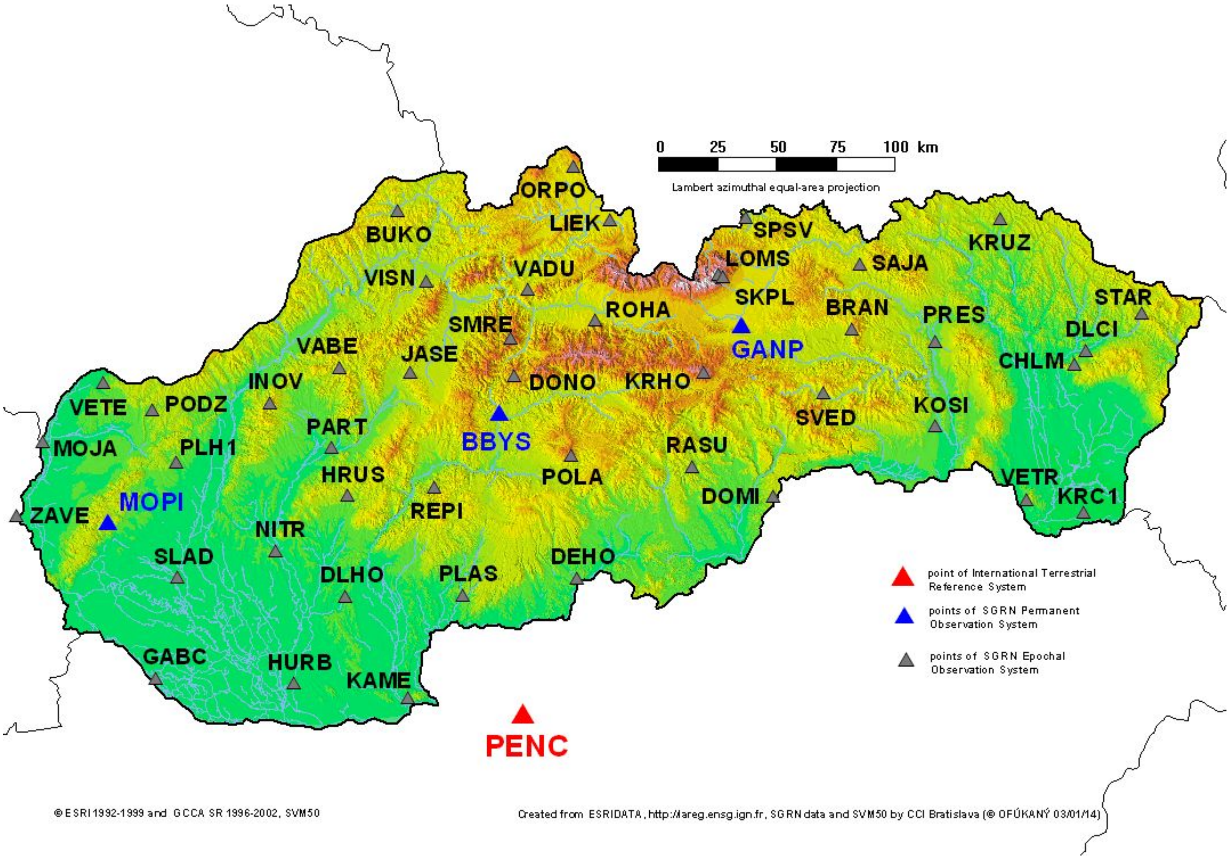

Fig. 1 Configuration of SGRN points

2.1. Establishing SGRN Points

SGRN points are located preferably in rock coming above to the ground and continuously passing into bedrock. In choosing such rock there was a close co-operation with a geologist. Into chosen rock special modules enabling forced centering of GPS antennas are permanently imbedded, which allows the elimination of centering error. In region without bedrock exceptionally also in-depth-embedded pillars established for other purposes, or markings of control stations by an iron bar nailed down were chosen. The depth of pillar's base or iron bar's nailing-down is 4 m as a minimum. To the top part of the pillar and the last part of the bar also centering modules for forced centering of GPS antennas were fixed. Sites of chosen rocks, pillars and iron bars meet the requirements for high-quality measurement, namely: undisturbed reception of signals from GPS satellites at elevation angle larger than 15^{o}, access to the point by a terrain car.

2.2. Description of GPS Measurement Campaigns

Since 1993, when the first measurement in SGRN network was carried out, repeated measurements were performed in 1995, 1998, 1999, 2000 and 2001. The measurements were performed exclusively using Trimble dual-frequency receivers. List of points measured in single years is given in **Tab. 1**.

Tab. 1 List of SGRN points

	SGRN	*1993*	*1995*	*1998*	*1999*	*2000*	*2001*
I	Site	Time in hours					
1	BBYS				88		138
2	BRAN		36		42		52
3	BUKO		36		42		52
4	DEHO	36	36	126	42		120
5	DEKO					50	
6	DLCI						120
7	DLHO	36	36	25	42	50	47
8	DOMI	72	108	33	39		52
9	DONO		36		42		52
10	GABC		36		42	50	52
11	GANO				56		
12	HLOH		36		42		
13	HRUS		36		42		65
14	HURB					50	120
15	CHLM		36		42		24
16	INOV		36		42		
17	JASE		36		42		
18	KAME		108		42	50	16
19	KOSI	36	36				60
20	KRHO		36		42		55
21	KRC1				42		52
22	KRCH	36	36	31			
23	KRUZ	36	36	31	42		61
24	KVET		36				
25	LIEK				59		120
26	LIES	36	36				
27	LOMS				59		
28	MOJA					50	46
29	MOPI	72	36	168	120	72	144

	SGRN	*1993*	*1995*	*1998*	*1999*	*2000*	*2001*
I	Site	Time in hours					
30	NITR	36	36		42	50	45
31	ORPO		36		42		
32	PART				42		120
33	PLAS		36		42		75
34	PLH1				42	50	
35	PLHO	36	36	24			
36	PODZ		36		42		30
37	POLA		36		42		66
38	PRES						114
39	RASU				42		
40	REPI		36		42		74
41	ROHA		36	29	59		52
42	SAJA	36	36		42		
43	SAND	36	36				
44	SKPL	72	108	126	59		120
45	SLAD					50	67
46	SMRE		36		42		
47	SPHR	36	36				
48	SPSV						67
49	STAR		36		42		67
50	STRE	36	36				
51	SVED		36		76		52
52	VABE		36		42		
53	VADU		36		42		67
54	VEIN	36					
55	VETE		36		38	50	
56	VETR		36		42		67
57	VISN				42		67
58	ZAVE		36		42	50	43

Up to now the most widespread campaign was the last one, organized in 2001, which more detailed description follows.
SGRN 01 campaign included 37 SGRN points, but only 10 of them are proposed to be EUREF points. Station occupations, receiver and antenna types used on these candidate points is given in **Annex 4, Tab. 13**.

2.3. Preprocessing of the campaign SGRN 01

In order to make possible the estimation of even very small changes in the position of geodynamic points, which within the framework of Euroasian lithospheric plate reach only several mm in a year, it is necessary to use a unified method of processing. For the processing of all campaigns in SGRN was used Bernese GPS Software. In the computation we have used the processing strategy recommended by EUREF TWG version 2.0, see Tab. 2.

Tab. 2 Processing strategy

interval of measurements	30s
precise orbits	1993-1999; precise orbits from CODE, parameters of Earth rotation (IERS), since 2000: precise orbits of final IGS with corresponding parameters of the Earth rotation
tropospherical effects	1993-1999; Saastamoinen's a priori model and estimate of one troposphere zenith-delay parameter for every point with 2-hour interval and a priori sigma 0.10 m for absolute and 0.01 m for relative parameters since 2000: no a priori model of troposphere, total trop. parameters in zenith estimated using dry-Niell mapping function for every 2-hour/day interval with a priori sigma 5m for absolute and 5m for relative parameters, option used for observations: elevation-dependent weighting $\cos^2(z)$ since 2001: for IGS points included into the processing a troposphere model from the CODE global solution
ionospherical effects	elimination using linear combination L3
corrections of antenna phase centres (APC)	known models of eccentricities and variations from the file phas-igs.01 were applied fttp://igscb.jpl.nasa.gov/igscb/station/general/igs 01.pcv http://www.grdl.noaa/GRD/GSP/Projects/ANTCAL/Files/ant.-info.003 since 2000 for antennas tested at GCI our own values of eccentricities APC were applied
ambiguity solutions	estimate of integer values of ambiguities using Quasi Ionosphere Free (QIF) method for each single baseline from all observations, then ELIMIN for all-day solution also from every observation, aprox. 80% ambiguities were solved, SAMPLING RATE:0
correlations	option for correct modelling of correlations was used
estimate of unknown parameters	free daily solutions using GPSEST, combination of normal equations from daily solutions to the common solution of the whole campaign using ADDNEQ program

All SGRN 1993 - 2001 campaigns were solved independently as free network solutions (minimally constrained). In SGRN 01 was provided the connection to ITRF2000 by constraining the coordinates of one IGS station, namely PENC with a priori sigma *0.0001* m. The coordinates of the reference point were shifted to the epoch of measurement using known values of velocities of the motion in ITRF2000.

The normal equations from daily solutions were combined with Bernese program ADDNEQ. The differences between station coordinates and RMS of the combination are shown in **Annex 2**. RMS valus per day with respect to the combined solution are given in **Tab. 3**.

Tab. 3 RMS values per day with respect to the combined solution

Component		day of year 2001					
	RMS	169	170	171	172	173	174
	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
North	2.1	2.4	0.9	2.3	1.5	2.9	1.8
East	1.9	2.3	0.8	2	1.8	1.7	2.5
Up	5.7	7.1	4.6	6.7	4.8	5.9	5.1
N.of stations	44	28	28	40	30	31	30

In the processing of all SGRN campaigns there were included also the observations on IGS European permanent stations. IGS stations used in the SGRN 01 campaign are shown in **Tab. 14**. There are given the official coordinates in ITRF2000 at epoch 1997.0, corresponding velocities and final coordinates in ITRF2000, epoch 2001.45. Coordinates of these IGS stations were estimated by a free network solution (with PENC as fixed), see **Tab. 4**. These estimated results were compared to the official ITRF2000 coordinates by means of 6- and 7-parameters Helmert transformation. In **Tab. 5** are shown residuals.

Tab. 4 Estimation of the IGS stations coordinates in ITRF2000, epoch 2001.45

station	$X^{\wedge}$	$Y^{\wedge}$	$Z^{\wedge}$
BOR1	3738358.5248	1148173.6564	5021815.7388
JOZE	3664940.2393	1409153.8123	5009571.3562
GOPE	3979316.1849	1050312.4194	4857067.0508
GRAZ	4194423.8882	1162702.6272	4647245.3731
PENC	4052449.5519	1417681.0670	4701407.0749

Tab. 5 Residuals after 6 and 7-parameters Helmert transformation between the coordinates of IGS stations determined by free network solution and their official ITRF2000 coordinates

EPN Station	6 - parameters			7 – parameters		
	n [mm]	e [mm]	u [mm]	n [mm]	e [mm]	u [mm]
BOR1	-0.3	1.0	1.6	1.1	0.9	1.7
JOZE	-0.6	-2.5	2.3	0.8	-1.2	2.3
GOPE	-3.5	4.0	-6.0	-3.5	3.0	-5.9
GRAZ	2.1	-3.5	6.7	0.5	-4.4	6.7
PENC	2.3	1.0	-4.7	1.1	1.7	-4.7
rms	2.4	3.1	5.2	2.0	2.9	5.2

After the processing of SGRN 01 campaign by means of Bernese GPS Software and the satisfactory results of the verification of the free network solution (**Annex 2** , **Tab. 3**, **Tab. 5**) we came up to the estimation of the Slovak Kinematic Terrestrial Reference Frame – SKTRF 2001.

3. Slovak Terrestrial Reference Frame - SKTRFyy

Every geodetic network laid-out both on the Earth's surface and underground is effected by geodynamic forces. Once this fact is not taken in account, motions of the points will be interpreted as measurement errors. For simultaneous effective estimate of motion equations and coordinates of the control points measured using GPS technology a mathematical model (Klobušiak, 1997c), (Hefty, 1998) and (Rogowski, Hefty et al. 1998), (Hefty 2001) and its realization using the WIGS program system (Klobušiak, 1995-2002) have been proposed. The procedure describes factors considered in the mathematical model, their parameters, and there are formulated equations of functional dependence of measured quantities on the parameters of the mathematical model and their co-variance matrix. From the above-mentioned papers there was set-up a complete mathematical model of the effective estimate of the coordinates of newly-determined points, of local motions of repeatedly measured non-identical points, of the estimate of nuisance parameters of a systematic effect of the deterministic character of every single campaign and of correction parameters of points eccentricity, if they have occurred.

3.1. Mathematical Model of Creating SKTRF

In building a national representative of a kinematic terrestrial reference frame in ETRS89 system there has been respected the fact that an object on which the system is realized using reference points (SGRN) is a dynamic one. In realizing the national kinematic terrestrial reference frame the motion of the points has been considered in respect of time.

Another problem that has been respected is a stochastic phenomenon of the xTRFyy terrestric frame. The coordinates of reference points are, in addition to temporal dependence, also random quantities.

Description of a complete dynamic, stochastic, stage-by-stage built model of the kinematic frame is in (Klobušiak et al.,2002).

Factors considered in the mathematical model of a national kinematic terrestrial reference frame and their parameters

1) Coordinates of reference points in the defined epoch ITRF2000 epoch 1997.0.
2) Reference point motion equations (velocities) defined by the reference frame ITRF*2000*. Parameters ν. The parameter of velocity can be divided into a model velocity of the whole tectonic lithospheric plate from NNR-NUVEL1A ν^{o} and a local velocity (differential motion) of the point $\delta\nu$. It is valid $\nu = \nu^{o} + \delta\nu$.
3) Estimated velocities of non-identical points ρ. The vector of the global velocity of non-identical points ρ can be divided into the sum of model ρ° and local-differential velocity $\delta\rho$, $\rho = \rho^{\circ} + \delta\rho$.
4) Estimate of the coordinates *XYZ* of non-identical points. Parameter β.
5) Transformation of the *j*-epoch of the network, which has been obtained by processing the measurement campaign as a free network, into a reference frame ITRF2000. Transformation parameters ϑ_j are nuisance parameters. It is possible to use orthogonal *7, 6, 4, 3* parametric similar transformation. Parameters ϑ_l and ϑ_k , where $l = 0, 1, \dots , s, k = 0, 1, \dots, s$ & $l \neq k$ are mutually independent, i.e. parameters ϑ_l or ϑ_k have impact only on the parameters Θ, β, ρ, ν of the epoch *l* or *k*.
6) Uncertainty in determining the centricity of the point. In case in some epochs there was the influence resulting in the eccentricity of the point, then such an inconsistency of the non-

identity of the point is modelled by unknown parameters of eccentricity χ (Klobušiak 1996, 1997a,b), (Hefty 1998, 2001).

3.2. SKTRF 2001 Points Coordinates and Annual Velocities Determination

All relevant repeated epoch measurements on the points of SGRN carried out in the period 1993-2001 were entered in the common processing of the estimate of coordinates and annual velocities of points in one model. They are especially the campaigns (see **Tab. 6**) :

- SGRN 1993 – 2001 (6x),
- CEGRN 1994 – 2001 campaigns (6x) (Hefty, 2001),
- TATRY 1998 – 2001 campaigns (4x) – a local geodynamic network,
- WHS 2001 campaign (1x) (World Height System).

Tab. 6 GPS campaigns on SGRN points

Project	*Epoch of measurement t*	*Length of observations in hours*	*Number of SGRN points*	*Reference frame*	*Reference point*
ITRF2000	1997.00	permanent		ITRF2000	
SGRN'93	1993.66	36	17	ITRF94	GRAZ
CEGRN'94	1994.34	120	3	ITRF92	GRAZ
CEGRN'95	1995.41	120	3	ITRF92	GRAZ
SGRN'95	1995.74	36	42	ITRF94	GRAZ
CEGRN'96	1996.45	120	3	ITRF94	GRAZ
CEGRN'97	1997.43	120	3	ITRF94	GRAZ
SGRN'98	1998.48	24 – 30	15	ITRF96	GRAZ
TATRY'98	1998.67	72	6	ITRF96	ROHA
CEGRN'99	1999.45	120	5	ITRF97	GRAZ
SGRN'99	1999.72	42	42	ITRF97	GRAZ
TATRY'99	1999.73	72	6	ITRF97	ROHA
SGRN'00-1st part	2000.34	48	6	ITRF2000	GRAZ
SGRN'00-2nd part	2000.57	52	11	ITRF2000	GRAZ
TATRY'00	2000.78	72 – 90	5	ITRF2000	ROHA
CEGRN'01	2001.46	120	5	ITRF2000	GRAZ
SGRN'01	2001.46	55 – 62	38	ITRF2000	PENC
TATRY'01	2001.69	72	6	ITRF2000	ROHA
WHS'01	2001.75	96	11	ITRF2000	PENC

CERGOP project is focused on the long-term GPS monitoring of tectonic processes in the Central European region by means of a high quality network of the CEGRN points. Five points from the SGRN network are part of the CEGRN network. By using CEGRN and SGRN in the common processing the more real estimate of a kinematic model of tectonic processes on the territory of Slovakia will be obtained, related to the neighbouring territory of the Central European region.

The processing was carried out in accordance with following principles:

1. all campaigns enter the processing as free network solutions after the pre-processing using Bernese GPS software with constraining the coordinates of one IGS point with a priori sigma *0.0001* m,
2. 7-parameter linear transformation for connecting free networks is used,
3. the target reference frame ITRF2000 epoch 1997.0 has the coordinates of IGS reference points (they act as a standard) fixed, but their inaccuracy considered in GCM is respected, which will influence the estimates of the national reference frame points coordinates and their RMS.

The estimate of SGRN points coordinates, co-variance matrix as well as the estimate of their global and local motion regarding the model velocity of NNR-NUVEL1A was carried out according to the mathematical model described in (Klobušiak et al.,2002).

In **Annex 3** are given the residuals each epoch of observation to the ITRF2000, epoch 1997.0, on ITRF sites in horizontal topocentric system [neu]. They achieve in horizontal level up to 5 mm.

On the graphs in **Annex 5** are shown the realisation of the coordinates in [neu], their annual velocity and 3σ confidence interval.

4. Comparison with other solutions

4.1. Comparison with ITRF

Into the processing was included IGS site PENC as a control site. In **Tab. 7** are compared the official ITRF 2000 values with computed ones. Since these differences are considered insignificant on the level of 3.5σ, in final solution there was used site PENC as IGS reference site. In **Tab. 8** is the comparison of the estimated local velocity within SKTRF 2001 to ITRF2000 on PENC station.

Tab. 7 Comparison of the coordinates on IGS site PENC

SKTRF 2001 in ITRF 2000				ITRF 2000		differences			
site		epoch 1997.0 [m]	RMS [mm]	epoch 1997.0 [m]	RMS [mm]	d*X* d*Y* d*Z* [mm]	RMS [mm]	dn de du [mm]	RMS [mm]
PENC	*X*	4 052 449.622	0.7	4 052 449.626	2.6	3.9	2.7	-0.3	0.1
	Y	1 417 680.986	0.3	1 417 680.986	1.2	0.7	1.2	0.7	0.2
	Z	4 701 407.034	0.8	4 701 407.038	3.1	4.0	3.2	5.6	4.4

Tab. 8 Comparison of the local velocities on IGS site PENC

	SKTRF2001		ITRF2000		rozdiel	
	δρ(neu) [mm/year]	σ(*δρ*) [mm/year]	*δρ(neu)* [mm/year]	σ(*δρ*) [mm/year]	d*δρ(neu* [mm/year]	[mm/year]
	0.9	0.1	0.4	1.3	0.5	1.3
PENC	1.8	0.1	1.0	0.6	0.8	0.6
	-3.9	0.5	-0.5	1.3	-3.4	1.4

4.2. Comparison with CEGRN

In (Becker et al., 2002) are estimated global velocities CEGRN points and their differences compared with the model NNR-NUVEL1A by means of another strategy (Becker et al., 2001) which was used by the computation of SKTRF 2001. For their estimation were used only CEGRN campaigns (1994 – 2001). The differences of velocities estimated by computation of

SKTRF 2001 and in CEGRN for 2 points in Slovakia are in Tab. 9. The differences between these two approaches are non-significant on 1-σ level.

Tab. 9 Differences of estimated velocities in SKTRF 2001 and CEGRN

	Global velocity						Local velocity					
	SKTRF2001		CEGRN		rozdiel		SKTRF2001		CEGRN		rozdiel	
bod	ρ (XYZ)	σ(ρ)	ρ (XYZ)	σ(ρ)	dρ (XYZ)	σ(dρ)	$\delta\rho$**(neu)**	σ($\delta\rho$)	$\delta\rho$**(neu**	σ($\delta\rho$)	d$\delta\rho$**(neu**	σ(d$\delta\rho$)
	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]
	-17.7	0.6	-18.3	1.9	0.3	2.2	1.5	0.2	1.5	0.5	0.0	1.1
DEHO	17.4	0.2	16.9	1.5	0.5	1.9	0.8	0.1	0.4	0.9	0.4	1.4
	8.4	0.7	7.6	4.2	0.8	3.1	-1.0	1.0	-2.1	5.6	1.1	3.6
	-18.2	0.3	-17.3	1.8	-0.9	2.1	1.5	0.1	1.6	0.5	-0.1	1.1
SKPL	16.3	0.1	16.7	1.5	-0.4	1.8	0.1	0.1	0.0	0.9	0.1	1.4
	7.6	0.4	9.0	4.2	-1.4	3.0	-1.8	0.5	-0.1	5.4	-1.7	3.4

4.3. Comparison velocity of EPN site MOPI

In **Tab. 10** are compared estimated global velocities of the EPN station MOPI from epoch observations within SKTRF 2001 and from permanent observation in duration of 3.8 years (Hefty, 2001a).The differences are non-significant on 2.5σ level.

Tab. 10 Comparison of estimated velocities on MOPI station with perm. obs.

	Global velocity					
	SKTRF2001		Perm.observation (3,8 years)		difference	
	ρ (neu)	σ(ρ)	ρ (neu)	σ(ρ)	dρ (neu)	σ(dρ)
	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]
	13.8	0.2	14.4	0.4	-0.6	0.4
MOPI	22.1	0.1	21.2	0.4	0.9	0.4
	2.6	1.0	3.3	2.3	-0.7	2.5

Remark. We didn't use Slovak EPN station for fixing to the reference frame ITRF2000, but we estimated its coordinates and velocity because of unrealistic velocity values in ITRF2000. See **Tab. 11**

In **Tab. 11** are compared estimated global velocities with velocities outlined in ITRF 2000 realisation.

Tab. 11 Comparison of estimated velocities on MOPI station with ITRF 2000

	Global velocity					
	SKTRF2001		ITRF2000		difference	
	ρ (neu)	σ(ρ)	ρ (neu)	σ(ρ)	dρ (neu)	σ(dρ)
	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]	[mm/year]
	13.8	0.2	14.0	0.1	0.2	0.2
MOPI	22.1	0.1	19.6	0.1	-2.5	0.1
	2.6	1.0	17.0	5.1	14.4	5.2

4.4. Comparison with EUVN

The results of SKTRF 2001 computed in above described way were compared with the results of EUVN 1997 GPS campaign (Ineichen et al., 1998). See **Tab. 12**.

Tab. 12 Comparison of coordinates on EUVN sites

site		SKTRF 2001 in ETRS 89		EUVN in ETRS 89		differences			
		epoch 1997.4	RMS	epoch 1997.4	RMS	d*X* d*Y* d*Z*	RMS	dn de du	RMS
		[m]	[mm]	[m]	[mm]	[mm]	[mm]	[mm]	[mm]
GANO	*X*	3 929 173.041	6.7	3 929 173.045	0.5	4.1	6.7	-3.3	0.2
	Y	1 455 278.650	2.8	1 455 278.647	0.2	-3.3	2.8	-4.4	0.5
	Z	4 793 644.403	8.0	4 793 644.401	0.6	-1.9	8.1	0.3	10.8
KAME	*X*	4 062 233.405	2.4	4 062 233.403	0.5	-2.0	2.4	0.1	0.2
	Y	1 377 316.070	0.9	1 377 316.074	0.2	4.2	0.9	4.3	1.2
	Z	4 704 896.481	2.7	4 704 896.483	0.6	2.3	2.8	3.0	3.6

5. Transformation of SKTRF 2001 to ETRS 89

Transformation from ITRF 2000 to ETRS 89 was carried out on the basis of *Specifications for reference frame fixing in the analysis of a EUREF GPS campaign* (Boucher, Altamimi, 2001).

6. EUREF-Slovakia 2001 list of selected points

In **Annex 1** we propose the connection of selected 10 points with high-quality monumentation to the EUREF class B. Their coordinates and velocities are computed within SKTRF 2001. In the Fig. 2 is outlined the connection of selected subset of EUREF-Slovakia 2001 points to the terrestrial reference frame ITRF. Coordinates and velocities were computed in the realization of SKTRF 2001.

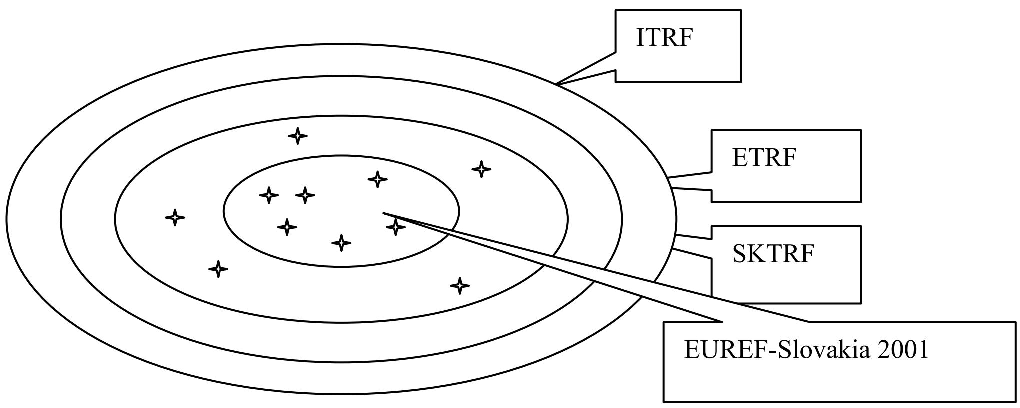

Fig. 2

7. Conclusion

We propose

- to integrate into the EUREF database ten selected points from the amount of 47 SGRN points as epoch stations with quality class B. Their coordinates, annual velocities and RMS in ETRS 89 are given in **Annex 1**,
- to withdraw the old epoch markers KVET, SAGR, VERA (Karský et al., 1993) and (Ehrnsperger et al., 1997)

By acceptance of the selected SGRN points with determined spatial coordinates and annual velocities in SKTRF 2001 epoch 1997.0 to the family of the EUREF points, for Slovakia will be fulfilled a basic authorization requirement usable in the common building of the **E**uropean **S**patial **D**ata **I**nfrastructure **ESDI** built on the **G**eographical **I**nformation **S**ystem's technology and coordinated by the European Commission in ETRS 89.

By gradual rebuilding of the SGRN points to the SPOS points and by their gradual connecting to the European Integrated Permanent Network the Slovak Permanent GNSS Service can be started. This keeps the door open for us in building the Integrated Global Geodetic Observation System IGGOS developed by IAG activities.

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Annex 1 ETRS 89 coordinates and velocities of proposed sites of EUREF-SK 2001

SKTRF 2001 in ETRS 89, reference frame ETRF2000, epoch 1997.0									
Site	Epoch	Number of campaigns	Kind of coordinates	Coordinates	Rms	Global velocity	Local velocity	Rms	Monumentation
				[° ' "] / [m]	[mm]	[mm/y]	[mm/y]	[mm/y]	
BBYS	1997.0	4	*B*	48 45 6.47591	2.5	15.0	2.7	0.3	pillar
			L	19 9 3.59482	2.9	21.1	-0.3	0.2	
			H	487.426	8.3	-1.6	-1.6	1.4	
			X	3 980 359.143	3.6	-18.6	-2.8	0.9	
			Y	1 382 291.876	1.4	15.8	-1.3	0.4	
			Z	4 772 771.760	4.3	8.7	0.5	1.1	
BUKO	1997.0	3	*B*	49 23 40.15269	2.4	14.0	1.5	0.3	rod
			L	18 38 22.03964	2.9	21.8	0.6	0.3	
			H	650.295	8.6	-0.8	-0.8	1.7	
			X	3 941 468.887	3.6	-17.5	-1.8	1.1	
			Y	1 329 473.138	1.5	17.1	0.0	0.4	
			Z	4 819 721.053	4.4	8.5	0.4	1.3	
DEHO	1997.0	10	*B*	48 13 28.10589	0.5	13.7	1.5	0.2	rod
			L	19 31 53.52101	0.6	22.3	0.8	0.1	
			H	360.233	1.8	-1.0	-1.0	1.0	
			X	4 012 396.858	1.7	-17.7	-1.9	0.6	
			Y	1 423 349.935	0.7	17.4	0.2	0.2	
			Z	4 733 809.973	2.0	8.4	0.2	0.7	
GABC	1997.0	5	*B*	47 52 40.33587	2.3	14.6	2.0	0.2	pillar
			L	17 31 50.30763	2.6	21.9	0.7	0.2	
			H	163.479	8.3	-3.0	-3.0	1.6	
			X	4 086 854.463	3.6	-18.9	-3.5	1.1	
			Y	1 290 983.540	1.3	17.0	-0.4	0.4	
			Z	4 707 900.438	4.1	7.6	-0.9	1.2	
CHLM	1997.0	4	*B*	48 53 26.76245	2.4	12.0	0.2	0.2	rock
			L	21 56 12.66861	2.9	22.1	0.3	0.2	
			H	301.947	7.3	-3.6	-3.6	1.4	
			X	3 897 567.776	3.3	-18.8	-2.4	0.9	
			Y	1 569 724.972	1.5	16.2	-0.7	0.4	
			Z	4 782 807.962	4.0	5.2	-2.6	1.1	
KRC1	1997.0	5	*B*	48 25 5.86930	1.0	13.2	1.4	0.3	rock
			L	21 57 41.60277	1.0	22.5	0.7	0.3	
			H	296.917	6.9	-0.5	-0.5	1.9	
			X	3 933 470.874	4.3	-17.9	-1.6	1.2	
			Y	1 586 156.166	2.0	17.1	0.1	0.5	
			Z	4 748 094.766	5.2	8.4	0.6	1.4	
KRHO	1997.0	3	*B*	48 53 0.21287	2.6	13.5	1.3	0.3	rock
			L	20 8 13.94608	3.0	20.2	-1.3	0.2	
			H	1 978.743	8.3	-0.6	-0.6	1.7	
			X	3 946 557.265	3.5	-16.8	-0.8	1.1	

			Y	1 447 141.623	1.4	15.4	-1.7	0.4	
			Z	4 783 531.909	4.3	8.5	0.4	1.3	
KRUZ	1997.0	5	*B*	49 21 52.49537	1.2	13.4	1.5	0.2	pillar
			L	21 35 30.18890	1.5	22.2	0.5	0.2	
			H	376.756	3.8	-4.8	-4.8	1.3	
			X	3 869 946.616	2.4	-20.5	-4.2	0.8	
			Y	1 531 573.300	1.1	15.7	-1.1	0.4	
			Z	4 817 347.923	3.0	5.1	-2.7	1.0	
MOPI	1997.0	18	*B*	48 22 21.80780	1.4	13.8	1.1	0.2	rock point of EPN
			L	17 16 25.94683	1.6	22.1	0.9	0.1	
			H	578.983	5.3	2.6	2.6	0.8	
			X	4 053 738.193	2.9	-14.7	0.6	0.5	
			Y	1 260 571.383	1.1	18.5	1.2	0.2	
			Z	4 744 940.649	3.4	11.1	2.6	0.6	
ROHA	1997.0	8	*B*	49 3 2.60227	1.0	12.6	0.4	0.2	rock
			L	19 36 31.32392	1.2	21.3	-0.2	0.2	
			H	779.590	3.6	1.5	1.5	1.1	
			X	3 945 770.374	2.3	-15.2	0.7	0.7	
			Y	1 405 700.859	0.9	17.2	0.1	0.3	
			Z	4 794 846.443	2.8	9.4	1.4	0.9	

Annex 2 Daily repeatibility of free network solutions

station		RMS	day of year 2001					
			169	170	171	172	173	174
		[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
BBYS	*n*	3.4	3.4	1.6	2.5	-0.7	-5.9	-1.5
	e	2.0	-0.8	0.3	3.1	0.1	-2.2	-2.0
	u	3.1	-2.1	-1.2	5.4	-3.6	1.0	0.0
BUKO	*n*	2.6	3.5	0.3	-1.2			
	e	0.5	-0.3	-0.7	0.1			
	u	11.8	12.7	-2.8	-10.3			
DEHO	*n*	1.4	0.7	0.1	0.9	0.0	-2.9	0.2
	e	0.7	-0.7	0.8	0.7	-0.7	-0.5	-0.5
	u	4.4	6.8	4.2	-3.3	-4.6	-0.8	0.5
ROHA	*n*	4.3	4.9	0.8	-3.6			
	e	1.9	-0.2	0.8	-2.5			
	u	2.3	-1.2	-2.3	1.9			
BOR1	*n*	1.7	1.1	0.8	1.6	-0.5	-2.8	-1.1
	e	1.5	-2.0	-0.7	0.2	0.4	0.5	2.5
	u	6.6	-1.1	-0.7	13.8	4.8	-0.7	0.4
JOZE	*n*	2.6	0.3	1.1	0.2	3.1	-4.7	-0.1
	e	3.6	-1.7	-0.7	-0.8	-0.7	-2.3	7.4
	u	1.1	-0.1	1.7	-1.2	1.0	0.8	-0.6
CHLM	*n*	1.7	1.7	0.0				
	e	1.7	-1.7	-0.1				
	u	0.3	0.0	0.3				
MOPI	*n*	2.1	2.3	0.9	1.4	-0.2	-2.2	-3.1
	e	2.9	-3.6	-1.8	0.0	-0.9	2.3	4.4
	u	2.2	-2.9	2.7	0.9	-0.9	-2.3	1.7
GABC	*n*	1.6	1.6	1.2	-1.0			
	e	1.3	-1.5	-0.6	1.0			
	u	2.7	2.6	-1.9	-2.0			
GOPE	*n*	0.9	0.8	0.0	0.6	0.2	-1.5	-0.9
	e	0.8	-0.2	-0.9	-0.7	0.8	0.6	0.9
	u	1.9	-2.6	0.1	-0.5	3.1	0.1	0.4
GRAZ	*n*	1.0	-0.3	0.7	-0.6	-1.8	-0.6	0.9
	e	2.6	-4.7	-1.3	0.0	0.2	1.7	2.7
	u	4.7	-3.3	-1.9	-1.4	5.4	0.3	-8.0
PENC	*n*	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	e	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	u	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UZHL	*n*	2.6	-3.3	1.7	-1.8	3.3	-2.0	-1.4
	e	3.0	-1.9	2.2	-1.0	4.2	-2.3	-3.5
	u	14.1	27.6	-7.4	-5.2	11.9	-1.5	3.2
KRC1	*n*	2.5	-1.6	-0.4	3.2			
	e	0.9	-1.0	0.6	-0.4			
	u	4.5	-6.1	1.0	1.3			
KRUZ	*n*	3.1			2.0	1.7	-4.7	-0.6
	e	2.9			-4.5	-0.8	1.9	0.8
	u	8.3			-5.2	1.4	9.0	-9.8
KRHO	*n*	1.4				-0.9	-1.5	-0.8
	e	1.9				-1.8	0.7	1.9
	u	5.1				-1.8	5.9	-3.7

Annex 3 Residuals on ITRF2000 sites

Site	Epoch	Residuals			Rms			Probability		
		r_n	r_e	r_u	σ_{rn}	σ_{re}	σ_{ru}	$P\ r_n$	$P\ r_e$	$P\ r_u$
		[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[%]	[%]	[%]
BOR1	101.46	-0.2	1.9	-1.1	2.0	1.0	1.9	12.8	95.0	41.9
	101.69	0.4	4.0	0.2	1.2	0.7	4.6	25.4	100.0	8.7
	101.75	-1.8	4.2	-1.5	2.1	1.1	2.0	58.9	100.0	53.2
	94.34	0.2	-1.6	-6.6	5.0	3.7	25.6	8.0	32.4	21.6
	95.42	0.6	0.4	1.7	4.4	3.0	21.2	13.8	14.1	10.4
	96.46	1.8	0.0	-0.1	2.2	1.5	10.3	58.3	7.1	6.0
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	-0.5	-0.1	-0.2	3.9	3.5	17.2	13.9	7.2	6.3
	99.45	2.5	3.0	-3.9	4.3	2.8	19.3	43.1	71.2	17.8
	99.72	2.5	5.4	2.0	0.7	0.4	2.6	99.9	100.0	55.2
GOPE	100.34	-1.7	1.5	-17.2	1.2	0.7	3.9	86.3	97.7	100.0
	100.57	-3.9	0.1	5.6	1.1	0.6	3.5	99.9	20.1	89.1
	100.78	-3.3	0.9	-17.1	1.2	0.7	3.8	99.2	79.1	100.0
	101.46	-2.1	-1.7	5.6	4.4	4.6	20.0	35.3	29.0	23.1
	101.46	-3.3	-1.2	0.2	2.1	1.0	2.1	88.2	78.9	10.5
	101.69	-2.7	0.1	-10.0	1.3	0.7	4.8	95.8	12.4	96.5
	101.75	-4.9	2.9	-3.7	2.3	1.1	2.2	97.2	99.4	91.9
	94.34	-1.0	1.5	-0.9	4.2	2.9	23.8	19.7	38.3	7.8
	95.42	-0.9	0.0	3.1	4.2	3.0	23.1	19.1	5.9	13.6
	96.46	0.5	1.9	-3.5	2.0	1.4	10.7	22.3	82.5	25.9
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	-0.8	0.0	-1.9	5.2	4.8	27.5	14.3	5.6	9.9
	98.67	0.3	0.4	-2.6	1.0	1.6	3.6	25.5	19.4	52.0
	99.45	-2.0	-0.8	0.9	3.9	2.7	19.6	38.5	23.4	8.6
	99.73	-0.3	0.6	-2.8	1.1	0.6	3.6	19.7	64.1	55.6
GRAZ	100.34	-1.2	-0.3	1.5	0.0	0.0	0.0	0.0	0.0	0.0
	100.57	-1.1	-0.1	10.0	0.0	0.0	0.0	0.0	0.0	0.0
	101.46	2.4	-2.8	0.7	2.0	1.0	2.4	78.7	99.6	22.9
	101.46	2.7	-4.6	2.6	0.0	0.0	0.0	0.0	0.0	0.0
	101.75	-1.5	-2.3	2.9	2.1	1.0	2.4	52.8	97.6	78.6
	93.66	1.7	5.7	-18.7	0.0	0.0	0.0	0.0	0.0	0.0
	94.34	2.2	-1.1	3.7	0.0	0.0	0.0	0.0	0.0	0.0
	95.42	1.6	-2.7	6.4	0.0	0.0	0.0	0.0	0.0	0.0
	95.74	2.3	-0.4	7.3	0.0	0.0	0.0	0.0	0.0	0.0
	96.46	0.7	0.1	2.2	0.0	0.0	0.0	0.0	0.0	0.0
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	0.2	1.1	-0.9	0.0	0.0	0.0	0.0	0.0	0.0
	98.49	-1.5	-0.7	-3.0	0.0	0.0	0.0	0.0	0.0	0.0
	99.45	2.2	0.3	4.4	0.0	0.0	0.0	0.0	0.0	0.0
	99.72	3.9	1.1	1.0	0.0	0.0	0.0	0.0	0.0	0.0
JOZE	100.34	-1.3	-0.7	7.2	0.9	0.5	2.0	84.1	87.9	100.0
	100.57	-1.3	-1.4	4.2	1.0	0.5	2.3	79.9	98.9	93.5
	100.78	0.6	-1.6	5.5	1.1	0.7	3.5	40.0	98.5	89.3
	101.46	-0.4	0.0	-1.6	4.7	4.8	20.0	10.7	5.4	10.4
	101.46	-0.8	-1.9	4.1	2.1	1.1	2.4	30.4	91.6	91.6
	101.69	-3.5	-1.0	10.8	1.3	0.7	4.6	99.2	81.7	98.2

	101.75	-4.0	-1.1	1.2	2.2	1.2	2.6	93.9	65.9	35.0
	93.66	0.2	3.1	11.7	1.5	1.3	8.0	15.4	98.2	86.1
	94.34	-2.5	2.4	-3.6	4.6	3.6	23.7	41.2	47.7	14.7
	95.42	-3.2	-0.2	-3.3	4.4	3.2	22.0	52.4	9.7	14.6
	95.74	-0.4	1.0	-11.1	0.7	0.6	3.9	39.7	91.7	99.5
	96.46	-0.4	1.0	-6.8	2.1	1.5	10.5	17.7	49.4	47.7
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	0.0	0.2	-5.3	3.8	3.6	17.2	5.7	9.0	24.9
	98.49	-0.5	-2.7	-0.4	0.6	0.4	2.7	61.4	100.0	13.8
	98.67	-2.0	0.0	3.1	1.1	1.7	4.2	93.9	7.1	54.2
	99.45	-0.8	0.4	5.7	4.1	2.9	17.9	17.9	13.0	25.3
	99.72	-2.8	-1.4	3.9	0.8	0.5	2.5	99.9	99.8	89.3
	99.73	1.0	-0.5	-3.1	1.1	0.7	3.8	59.2	55.4	58.6
KOSG	101.46	1.0	1.2	-1.8	5.8	5.9	24.9	16.2	17.9	10.0
	93.66	1.8	4.7	11.6	1.2	1.1	7.7	85.5	100.0	87.1
	94.34	0.3	-1.2	12.9	4.1	3.1	17.9	9.9	30.8	52.3
	95.42	1.7	-1.8	6.0	4.2	3.4	18.7	30.8	38.9	25.8
	96.46	1.0	-1.2	5.7	2.0	1.6	8.9	37.7	54.2	46.9
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	1.0	-0.7	4.7	4.1	3.9	17.8	19.7	16.7	22.1
	99.45	2.0	1.6	1.9	4.0	3.1	15.5	37.5	39.8	12.9
	99.72	3.8	0.3	12.1	0.7	0.4	2.3	100.0	51.2	100.0
MATE	101.46	-1.0	1.6	0.5	4.9	4.8	23.4	18.1	26.5	6.8
	93.66	-2.9	7.7	15.8	1.4	0.7	8.1	97.0	100.0	95.1
	94.34	-0.7	2.1	2.1	3.7	2.6	20.2	17.5	59.0	11.9
	95.42	0.2	-0.9	2.0	4.5	3.1	23.6	8.5	22.9	10.7
	95.74	-2.6	0.8	-2.5	0.9	0.4	5.4	99.6	94.8	35.4
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	2.5	0.0	-3.3	4.0	3.9	20.8	47.0	5.7	15.1
	98.49	0.8	-1.7	1.7	0.6	0.3	2.7	86.1	100.0	46.9
	99.45	0.5	-0.9	9.0	4.2	2.9	22.0	12.3	25.1	31.5
METS	101.46	-0.5	-1.0	0.1	6.3	4.5	19.6	10.1	18.8	5.5
	93.66	3.1	-1.2	-23.9	1.8	1.3	7.3	91.4	65.7	99.9
	94.34	1.1	-0.3	-6.2	6.1	3.3	21.6	16.2	11.8	23.3
	95.42	1.0	1.5	-0.2	6.3	3.6	20.8	15.7	31.8	5.9
	96.46	1.6	0.2	1.8	2.8	1.6	9.3	41.6	12.6	17.1
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	0.0	1.1	5.5	6.1	4.1	21.1	5.1	22.1	21.6
	98.49	-1.9	-0.1	-2.2	0.7	0.4	2.5	99.6	21.9	60.3
	99.45	-0.1	-3.0	-0.2	5.8	3.6	19.2	7.1	59.9	6.1
	99.72	-13.4	5.3	21.5	0.8	0.4	2.8	100.0	100.0	100.0
ONSA	101.46	0.6	0.2	-10.3	5.8	4.5	20.9	11.5	8.8	37.2
	93.66	-0.8	4.7	2.6	1.7	1.3	7.8	36.6	100.0	26.7
	94.34	2.3	2.7	10.8	5.1	2.7	19.1	34.4	66.9	42.2
	95.42	0.2	1.6	10.1	5.4	2.9	19.3	7.3	41.3	39.3
	95.74	3.4	-1.6	3.8	0.8	0.6	3.6	100.0	99.7	71.5
	96.46	0.8	0.1	1.2	2.5	1.3	8.9	25.5	9.2	13.9
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	-0.5	0.4	4.2	5.4	3.6	19.2	11.5	11.8	19.0
	98.49	-1.5	0.0	-11.0	0.6	0.3	2.6	98.1	5.3	100.0
	99.45	1.2	0.4	-7.8	4.8	2.6	18.0	21.6	14.4	33.3

	99.72	-5.2	-6.4	13.8	0.7	0.3	2.1	100.0	100.0	100.0
PENC	100.34	-1.9	-0.4	-14.0	1.5	0.8	3.2	80.1	39.4	100.0
	100.57	4.1	1.9	-8.8	1.6	0.9	3.5	99.0	97.3	98.7
	100.78	3.9	1.2	-16.4	1.7	1.0	4.5	97.9	77.0	100.0
	101.46	0.8	-0.2	-5.3	3.5	4.2	14.8	19.6	7.9	28.0
	101.46	2.3	1.8	-5.6	0.0	0.0	0.0	0.0	0.0	0.0
	101.69	0.2	1.9	-2.8	2.0	1.1	5.4	12.4	92.5	39.6
	101.75	-0.4	1.8	-9.6	0.0	0.0	0.0	0.0	0.0	0.0
	94.34	0.4	3.1	-0.4	3.4	2.5	16.6	13.0	78.5	7.1
	95.42	0.5	1.9	-0.9	4.1	3.2	20.9	12.4	44.5	8.2
	96.46	-1.9	1.5	-4.4	1.9	1.4	10.2	68.9	71.3	33.5
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	-1.9	0.6	-2.9	2.8	3.4	14.6	48.2	17.1	17.8
	98.67	-1.1	1.2	-12.7	1.2	1.8	5.6	62.0	47.3	97.9
	99.45	-1.4	-0.6	1.3	3.8	2.8	19.1	28.1	19.9	9.7
	99.73	0.9	2.5	-14.3	1.4	0.9	5.2	44.4	99.6	99.4
WTZR	101.46	0.9	-0.2	-0.5	4.7	4.6	21.7	17.5	8.0	7.0
	96.46	0.3	-1.4	2.4	1.9	1.4	9.4	16.6	69.1	21.0
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	1.5	0.0	-0.4	3.6	3.5	17.9	32.1	5.2	6.9
	98.49	0.3	-2.2	-8.2	0.5	0.4	2.8	40.6	100.0	99.7
	99.45	1.5	-1.3	0.8	3.6	2.6	15.5	31.3	36.8	8.6
	99.72	3.8	3.9	0.8	0.6	0.4	2.5	100.0	100.0	26.1
ZIMM	101.46	2.1	3.2	-12.9	4.5	5.0	21.6	35.5	46.7	44.1
	94.34	0.7	3.6	2.3	3.8	3.2	19.5	16.7	75.1	12.7
	95.42	-0.9	1.6	-1.9	3.8	3.4	20.0	20.2	35.0	11.3
	96.46	1.8	-1.1	6.1	1.8	1.6	9.5	66.9	51.0	47.1
	97.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	97.43	-0.1	-0.5	3.1	3.8	3.9	18.8	8.0	13.0	15.6
	99.45	2.4	4.8	-9.8	4.1	3.4	18.5	43.2	84.6	39.7

Annex 4 SGRN'01 campaign

Tab. 13 Description of SGRN 01 campaign

			Day of year 2001					
Station	Receiver	Antenna	169	170	171	172	173	174
External EPN Stations								
BOR1	ROGUE SNR-8000	AOAD/M_T	************	************	************	************	************	************
GOPE	ASHTECH Z18	ASH701946.022 SNOW	************	************	************	************	************	************
GRAZ	ASHTECH UZ-12	ASH701945C_M	************	************	************	************	************	************
JOZE	TRIMBLE 4000SSE	TRM14532.00	************	************	************	************	************	************
PENC	TRIMBLE 4000SSE	TRM14532.00	************	************	************	************	************	************
UZHL	TRIMBLE 4000SSI	TRM29659.00	************	************	************	************	************	************
EPN Station in Slovakia								
MOPI	TRIMBLE 4000SSI		************	************	************	************	************	************
SGRN Epoch Stations incl. EUREF Candidate Stations								
BBYS	TRIMBLE 4000SSi	TRM33429.00+GP	*********	************	************	************	************	************
BUKO	TRIMBLE 4000SSi	TRM22020.00+GP	*******	************	*******			
CHLM	TRIMBLE 4000SSi	TRM22020.00+GP	*******	************	******			
DEHO	TRIMBLE 4000SSE	TRM22020.00+GP	*******	************	************	************	************	******
GABC	TRIMBLE 4000SSi	TRM22020.00+GP	********	************	*******			
KRC1	TRIMBLE 4700	TRM33429.00+GP	*******	************	*******			
KRHO	TRIMBLE 4000SSE	TRM14532.00				**********	************	******
KRUZ	TRIMBLE 4000SSi	TRM33429.00+GP			***	************	************	****
ROHA	TRIMBLE 4000SSE	TRM14532.00	*******	************	******			

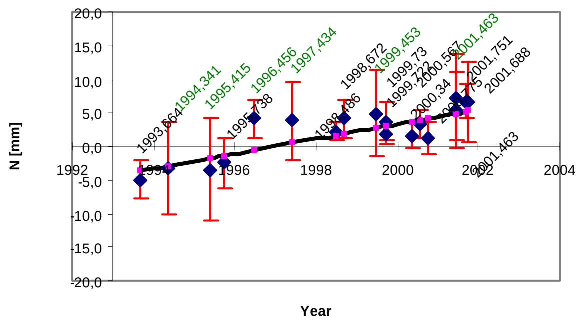
* - two hours interval

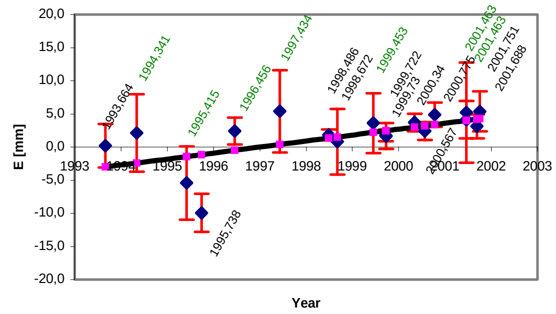
Tab. 14 IGS stations used in SGRN'01 campaign

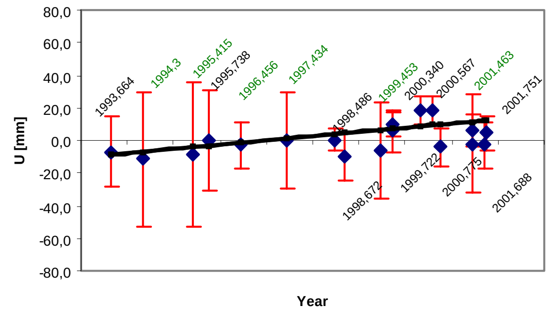
	ITRF2000, epoch 1997.0						ITRF2000, epoch 2001.45		
Station	X [m]	Y [m]	Z [m]	V_X [m/y]	V_y [m/y]	V_Z [m/y]	X [m]	Y [m]	Z [m]
BOR1	3 738 358.5984	1 148 173.5823	5 021 815.7053	-0.0170	0.0161	0.0075	3738358.5228	1148173.6539	5021815.7387
GOPE	3 979 316.2588	1 050 312.3397	4 857 067.0203	-0.0165	0.0170	0.0083	3979316.1854	1050312.4154	4857067.0572
GRAZ	4 194 423.9590	1 162 702.5491	4 647 245.3277	-0.0176	0.0181	0.0082	4194423.8807	1162702.6296	4647245.3642
JOZE	3 664 940.3147	1 409 153.7405	5 009 571.3225	-0.0181	0.0162	0.0074	3664940.2342	1409153.8126	5009571.3554
PENC	4 052 449.6259	1 417 680.9863	4 701 407.0382	-0.0166	0.0181	0.0082	4052449.5520	1417681.0668	4701407.0747

Annex 5 Time series of coordinates of EUREF-SK 2001

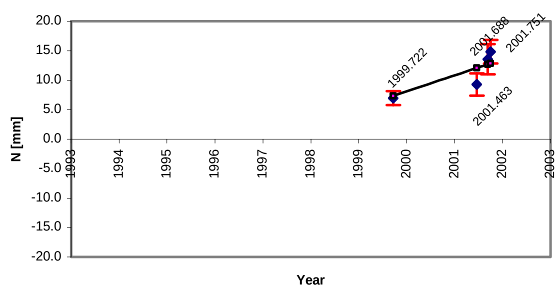
MOPI

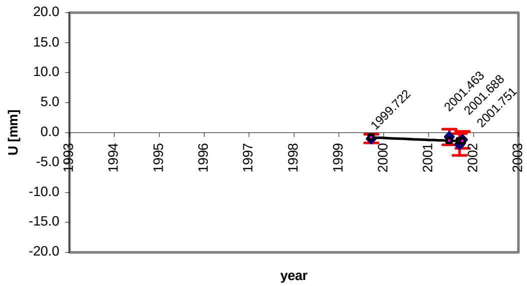


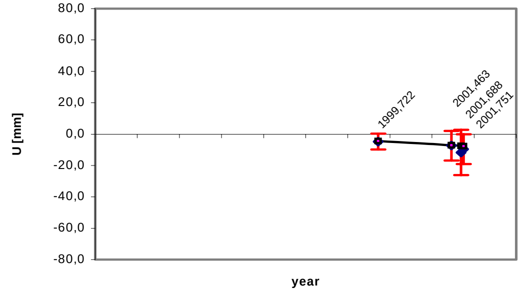




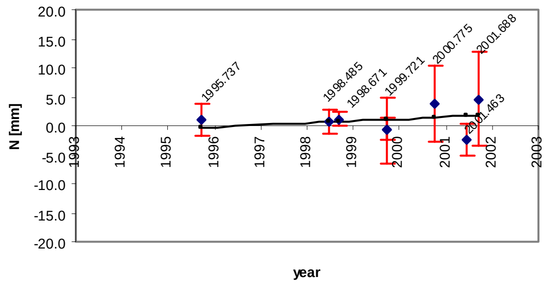
BBYS

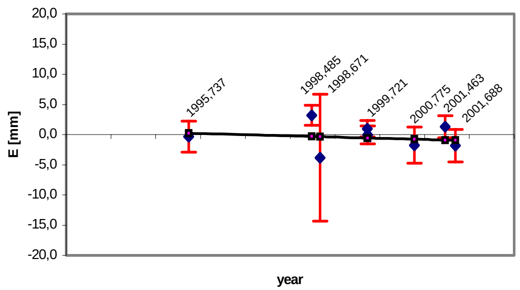


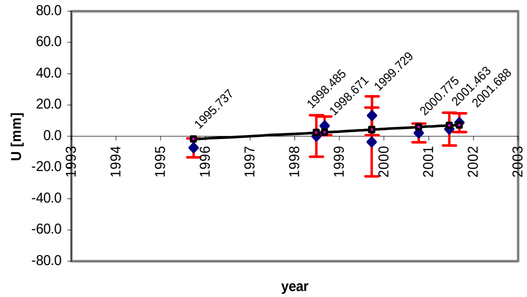




ROHA







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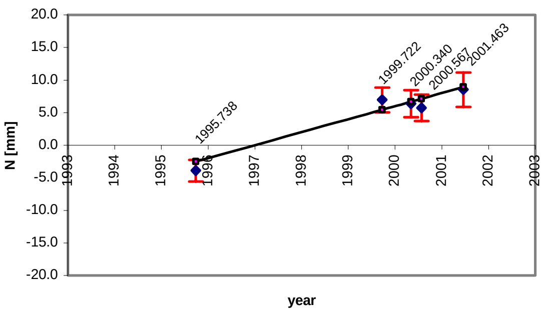

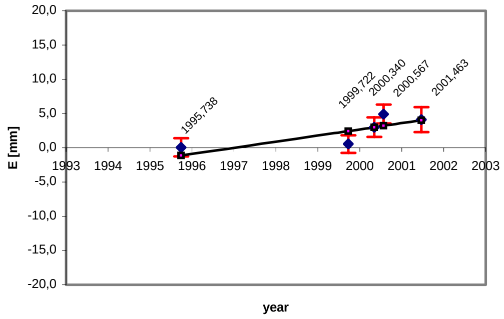

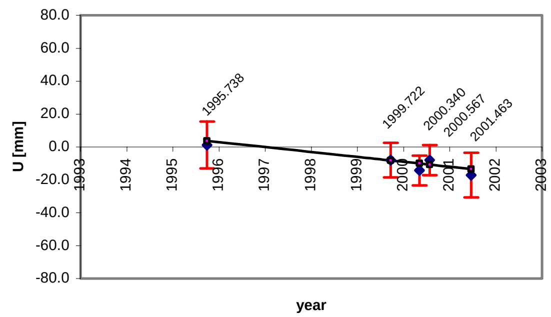

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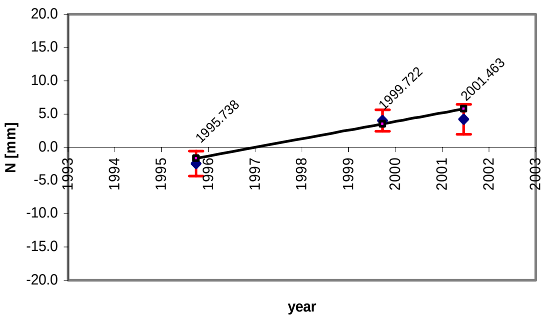

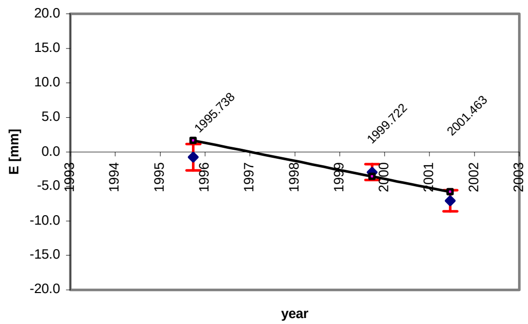

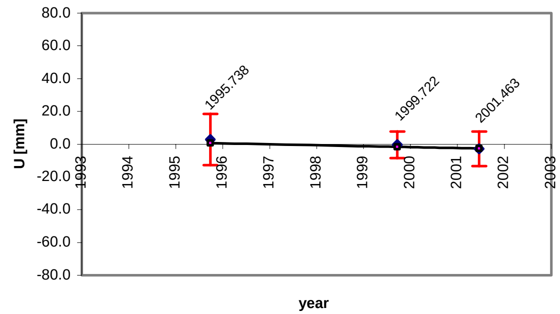

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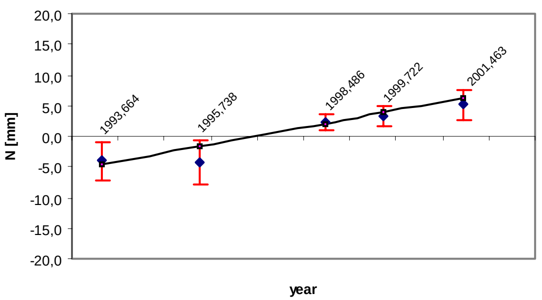

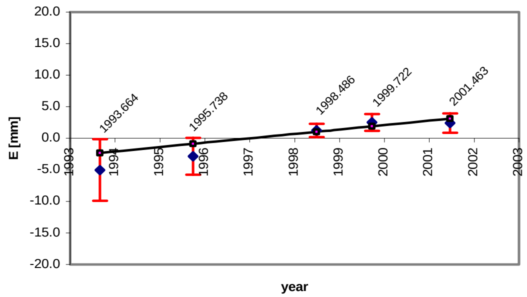

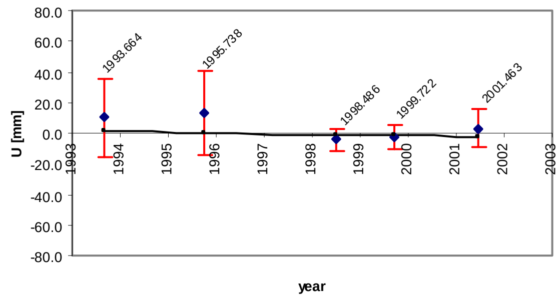

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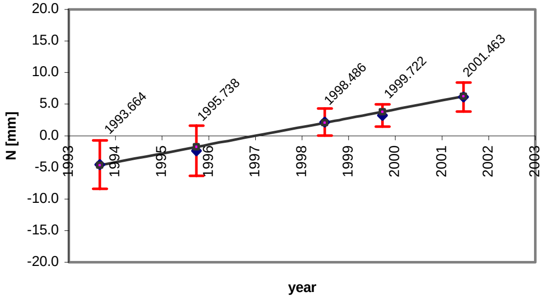

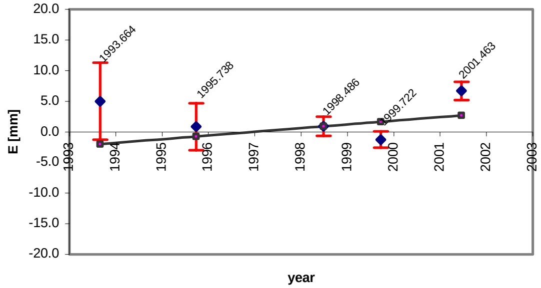

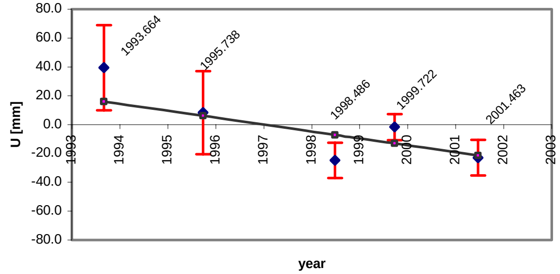

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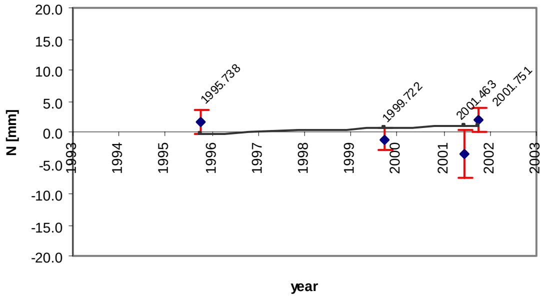

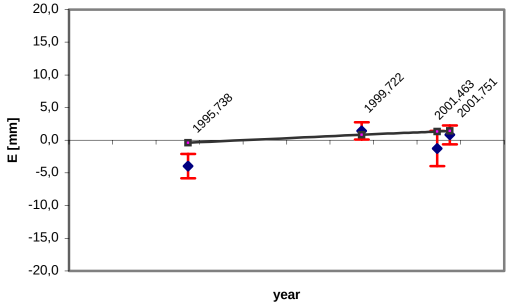

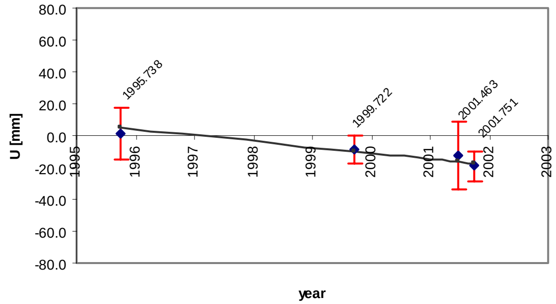

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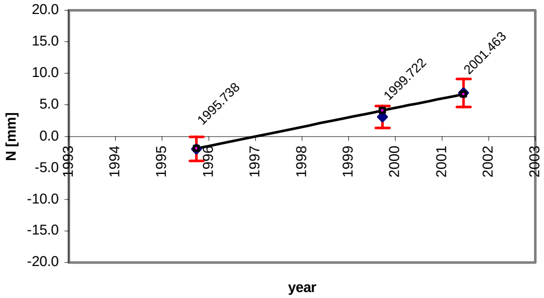

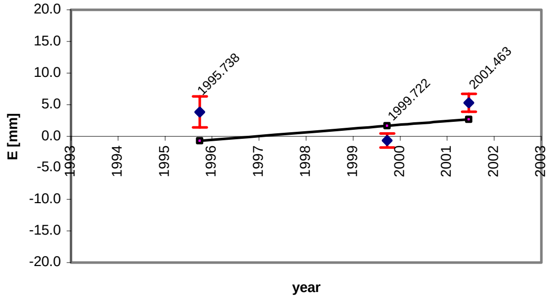

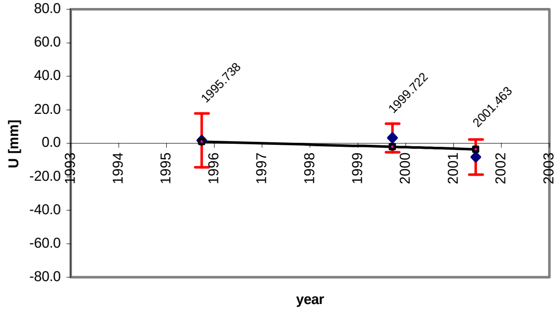

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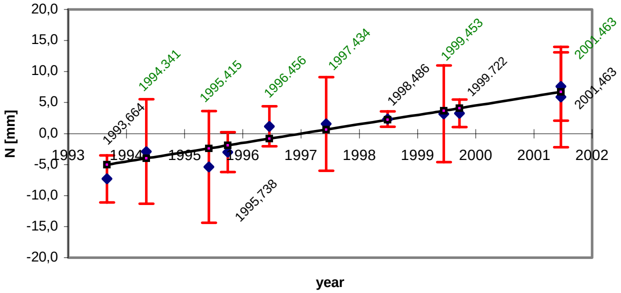
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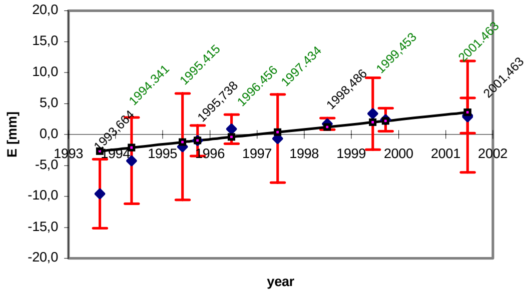
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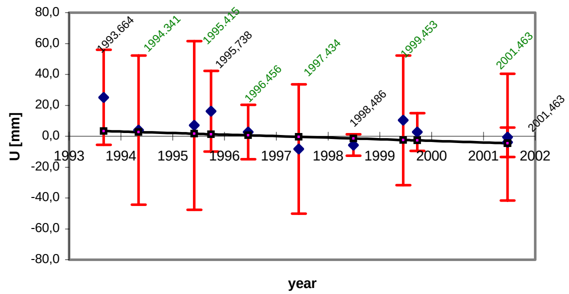
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