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ARMREF 02

Zero-order network of Armenia connected to ITRF 2000 and ETRS 89

presented by

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on behalf of

the State Committee of the Real Property Cadastre of the Government of the Republic of Armenia, SCC

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Background

- Swedesurvey engaged in the project "The development of the cadastral system in Armenia"
- A first GPS campaign on the zero order network carried out in the autumn 2000 (not successful)
- A second GPS-campaign on the zero order network carried out in the autumn 2002

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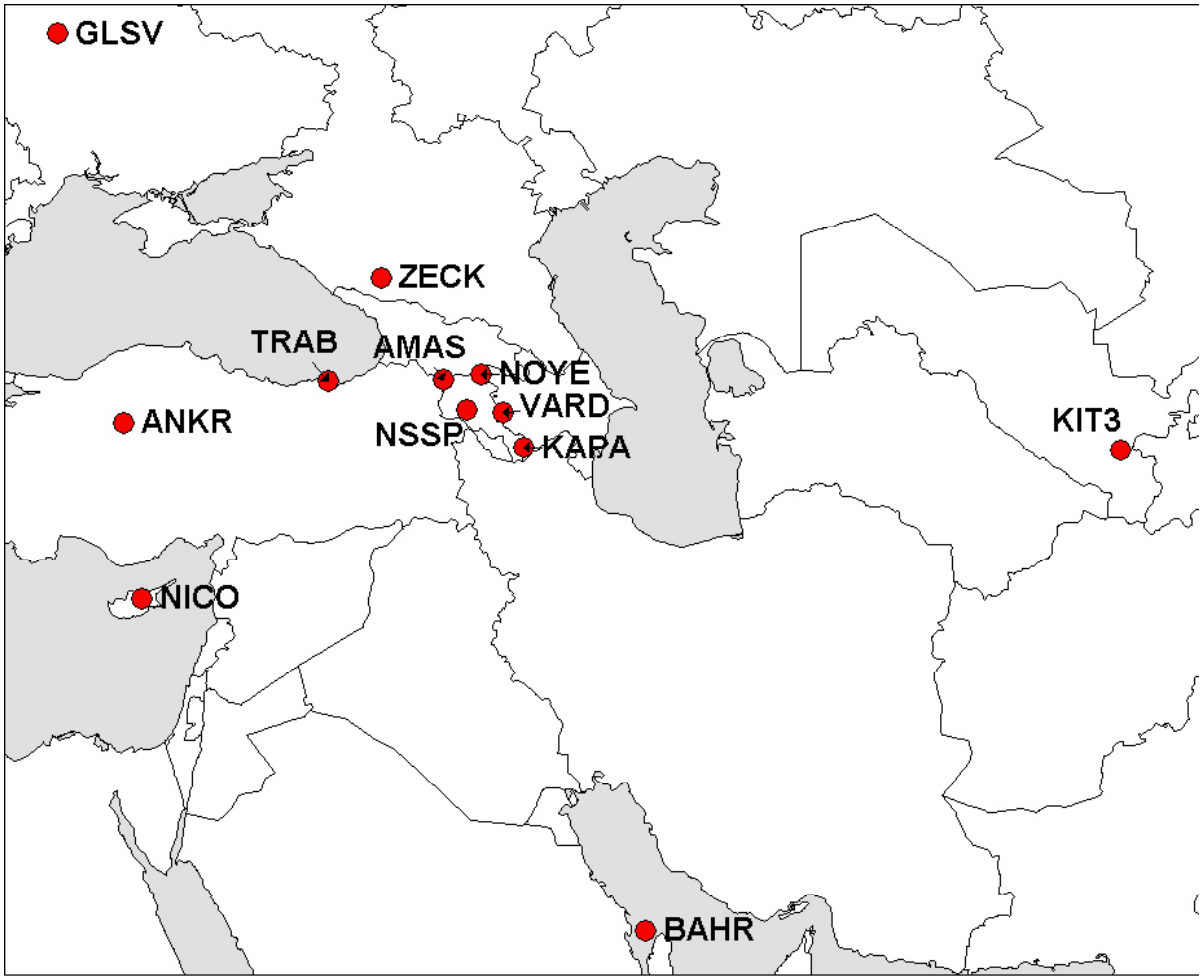
The campaign



4 new Armenian stations
8 EPN/IGS stations

5 x 24 hours sessions starting November 26th 2002 02:00

SCC observed all Armenian stations (including the IGS/EPN station NSSP)

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Stations and Equipment

Amasia

Noyemberyan

Kapan

All Armenian stations observed by SCC with:
Leica SR 520 and LEIAT502

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Data used

- **Co-ordinates: IERS ITRF 2000 epoch 2002.9**
- **Final IGS-orbits and corresponding EOPs**
- **Relative antenna models from PHAS_IGS.01 except for LEIAT502 which was taken from NGS**
- **Ocean tide loading from Onsala (H-G S)**
- **RINEX data from EPN/IGS and SCC**

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Processing strategy - session

- Bernese Software ver 4.2
- 10 ° cut-off, elevation dep weighting, dry Niell
- baselines formed as a star from NSSP
- pre-processing, trippel-differences
- first float-solution
- screening of residuals
- second float solution
- regional ionosphere model using L4
- amiguity resolution using QIF
- final network solution, EPN station ZECK constraine
- alternative final solution 15 ° cut-off
- test solution with 25 ° cut-off

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Processing Strategy - combination

- **Session solutions combined with ADDNEQ**
- **minimum constrained solution with just ZECK constrained**
- **Helmert-fit to IERS ITRF 2000 epoch 2002.9**
- **Constrained solution with all EPN/IGS constrained that fit well in the previous step constrained**

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Quality of daily solutions

Session	Res amb	RMS flt	RMS fix
330	85	1.1	1.2
331	81	1.1	1.1
332	81	1.1	1.1
333	77	1.1	1.2
334	78	1.1	1.2

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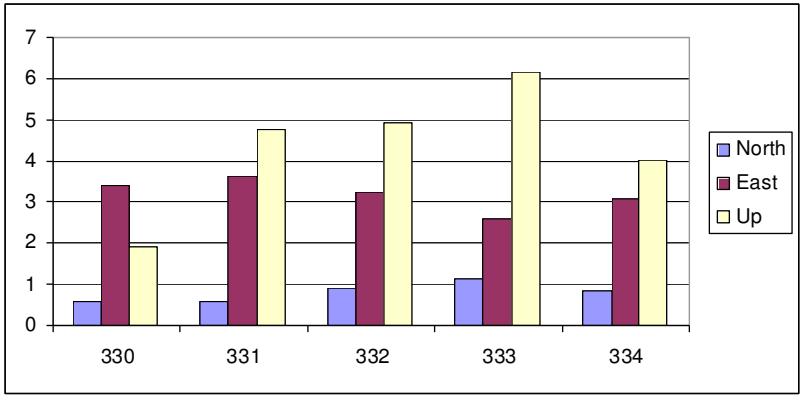
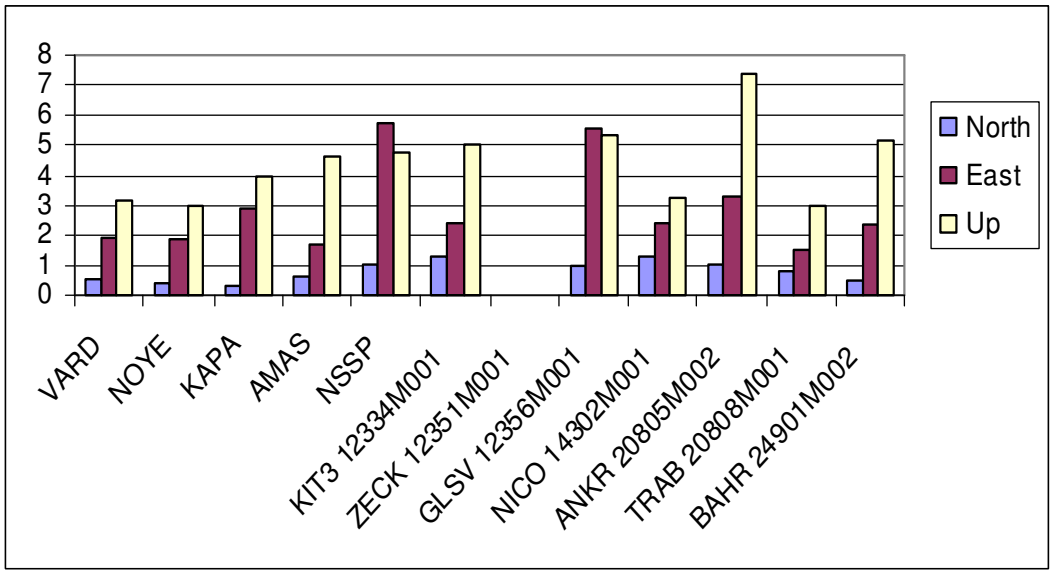
Float - Fixed solution



Unit = mm



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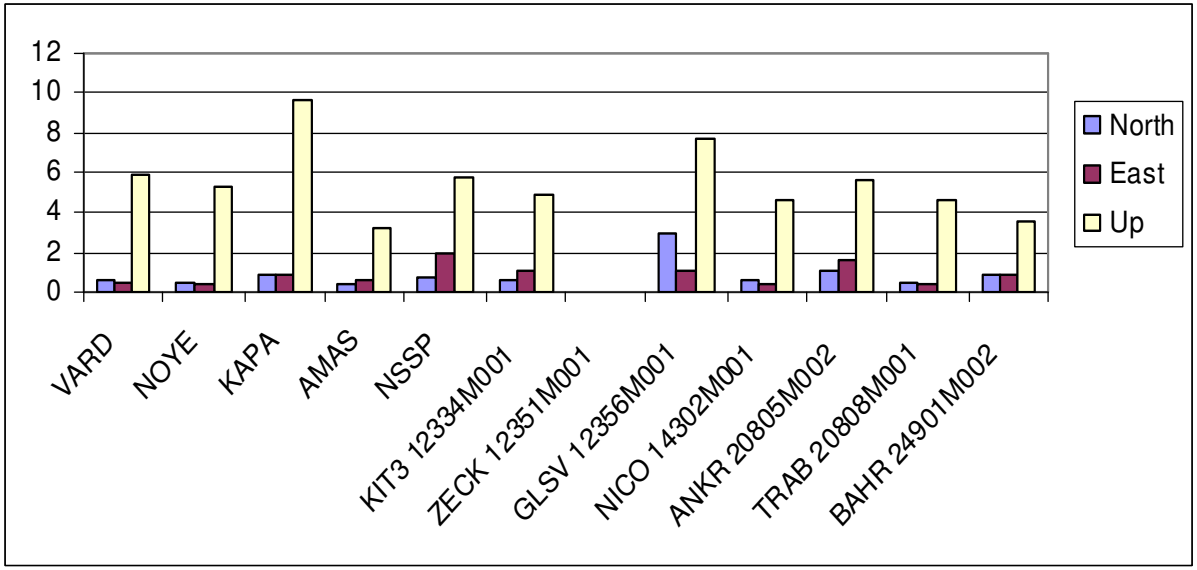
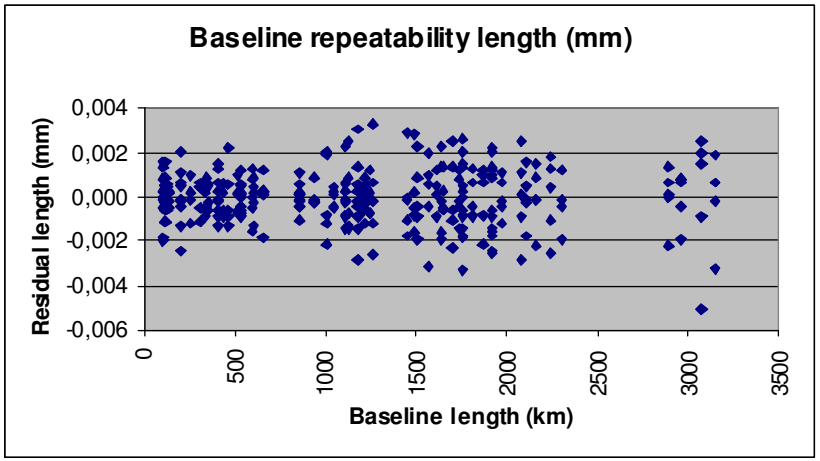
Daily repeatability





Unit = mm

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Comparison with ITRF

Minimum constrained solution compared to IERS ITRF 2000 epoch 20(

3-parameter, rms = 16.3 mm

Station	N(mm)	E(mm)	U(mm)
NSSP	1	3.3	-19
KIT3 12334M001	3.7	5.8	-6.9
ZECK 12351M001	-0.5	-1	-9.2
GLSV 12356M001	2.6	-3.2	3.5
NICO 14302M001	-2.4	0.9	5.7
ANKR 20805M002	-3	14.4	-31.9
TRAB 20808M001	1.4	-13.4	59
BAHR 24901M002	-3.3	-3.6	0.1
RMS / COMPONENT	2.6	8.1	26.8

6-parameter, rms = 17.5 mm

Station	N(mm)	E(mm)	U(mm)
NSSP	0.8	3.1	-18.7
KIT3 12334M001	2.1	4.5	-2.5
ZECK 12351M001	-0.5	-0.8	-9.2
GLSV 12356M001	3.8	-2.3	2.3
NICO 14302M001	-1.9	0.1	3.6
ANKR 20805M002	-2.3	14	-33.7
TRAB 20808M001	1.6	-13.6	58.5
BAHR 24901M002	-3.7	-4.9	1
RMS / COMPONENT	2.5	7.9	26.8

Minimum constrained solution compared to EPN-solution of GPS week 119

3-parameter, rms = 2.7 mm

Station	N(mm)	E(mm)	U(mm)
ANKR 20805M002	0.1	-0.2	-1.3
GLSV 12356M001	-1.8	0.6	6
ZECK 12351M001	-1	0.4	-1.3
NICO 14302M001	1.3	-0.2	-5.9
TRAB 20808M001	-0.1	-0.4	2
RMS / COMPONENT	1.2	0.4	4.4

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Comparison with ITRF

Outliers TRAB and ANKR excluded

3-parameter, rms = 5.8 mm

Station	N(mm)	E(mm)	U(mm)
NSSP	0.7	3.6	-14.3
KIT3 12334M001	3.5	4.6	-2.3
ZECK 12351M001	-1.1	-0.5	-4.4
GLSV 12356M001	1.6	-2	8
NICO 14302M001	-2.2	2	10.4
ANKR 20805M002	-3.2	15.5	-27.2
TRAB 20808M001	1	-12.8	63.8
BAHR 24901M002	-2.5	-3.8	4.9
RMS / COMPONENT	2.4	3.4	9.2

6-parameter, rms = 5.9 mm

Station	N(mm)	E(mm)	U(mm)
NSSP	0.3	3.1	-14.3
KIT3 12334M001	3.1	2.8	5.4
ZECK 12351M001	-1.3	-0.7	-4.4
GLSV 12356M001	2.7	-1.4	7.1
NICO 14302M001	-2.2	0.7	5.2
ANKR 20805M002	-2.8	14.6	-31.1
TRAB 20808M001	0.9	-13.3	62.4
BAHR 24901M002	-3	-4.2	3.4
RMS / COMPONENT	2.5	2.8	8.3

No significant rotations

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Minimum constrained - constrained

Stn	dN	dE	dU
NSSP	0	2	-14
AMAS	0	1	-4
KAPA	0	1	-4
NOYE	0	1	-4
VARD	0	1	-4

Unit = mm

Outliers TRAB and ANKR excluded/not constrained

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Comparison to 15°solution

Comparison of constrained solutions,
old standard solution 15° minus new 10 °

Station	dN (mm)	dE (mm)	dU (mm)
NSSP	0	1	0
AMAS	0	1	-5
KAPA	-1	0	-15
NOYE	0	-1	-4
VARD	0	0	-15

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Any elevation dependency?

25° solution minus 15° solution, daily differences

Station		330	331	332	333	334
VARD	N	0	2	0	1	1
	E	1	0	0	1	1
	U	37	49	38	42	39
NOYE	N	-1	1	0	1	0
	E	3	1	1	2	2
	U	20	25	20	25	19
KAPA	N	-1	3	0	1	0
	E	1	0	0	1	1
	U	53	57	41	32	39
AMAS	N	-1	1	1	1	1
	E	1	1	0	1	1
	U	20	31	14	19	14
NSSP	N	0	2	1	1	0
	E	0	-1	-2	0	-1
	U	10	22	7	8	6

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Conversion to ETRS 89

According to guidelines in “Specification of reference frame fixing in the analysis of a EUREF GPS campaign” ver 5.0

$$X_E(2002.9) = X_{00}(2002.9) + \begin{bmatrix} T1_{00} \\ T2_{00} \\ T3_{00} \end{bmatrix} + \begin{bmatrix} 0 & -\dot{R}3_{00} & \dot{R}2_{00} \\ \dot{R}3_{00} & 0 & -\dot{R}1_{00} \\ -\dot{R}2_{00} & \dot{R}1_{00} & 0 \end{bmatrix} \cdot X_{00}(2002.9) \cdot (2002.9 - 1989.0)$$

$X_E(2002.9)$ = Coordinate s in ETRS 89 at epoch 2002.9

$X_{00}(2002.9)$ = Coordinate s in ITRF 2000 at epoch 2002.9

$T1_{00} = 5.4$ cm

$T2_{00} = 5.1$ cm

$T3_{00} = -4.8$ cm

$\dot{R}1_{00} = 0.000081''$ /Y

$\dot{R}2_{00} = 0.000490''$ /Y

$\dot{R}3_{00} = -0.000792''$ /Y

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Final co-ordinates

- ~~The final co-ordinates in ETRS 89 epoch 2002.9~~ are based on ITRF 2000
- ARMREF 02 is the proposed name for the Armenian ETRS 89 realization
- Estimated accuracy: 1 cm (95%) for the horizontal co-ordinates and 2-3 cm (95%) for the vertical at the epoch of the observation.
- ARMREF 02 has been densified in a first order network (2002) and a second order densification is on-going
- SCC asks EUREF to adopt this solution as an ETRS 89 realization and to accept the selected points AMAS, KAPA and NSSP as national EUREF-points

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Comparison to campaign 2000

Comparison made in ITRF 2000 epoch 2002.9

	Strategy 1 for alignment to ITRF2000 epoch 2002.9			Strategy 2 for alignment to ITRF2000 epoch 2002.9		
Station	N (mm)	E (mm)	U (mm)	N (mm)	E (mm)	U (mm)
AMAS	+6	-2	-1	-8	-2	-4
KAPA	-9	-10	+8	-24	-10	+5
NOYE	-0	-28	+85	-15	-30	+83
VARD	-2	-16	+38	-18	-18	+36

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