- Processing of the NKG 2003 GPS Campaign







- •Need for a common coordinate set on 1 cm-level in the Nordic Area
- •GPS-campaign GPS week 1238 (October 2003)



Time frame





Guidelines/common settings

Use recommended settings for each program

- 10 deg cut-off angle
- Elevation dependent weighting
- Niel mapping function for tropospheric corrections
- Common ocean tide loading (FES 99)
- No atmospheric loading corrections
- Antenna pcv from IGS if available
- Final IGS orbits and clocks (if possible)
- Sub-division of the network not necessary
- ITRF 2000, epoch of the campaign (2003.75)

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Bernese connection to ITRF

3 alternatives were considered

- Directly use IERS ITRF 2000 coordinates not enough stations with good coordinates/velocities
- 2. For the Nordic-Baltic part an EPN-based ITRF was considered (5 weekly EPN-solutions densifying IERS ITRF for the EPN-network)
- 3. Using IGS cumulative solution (which is connected to ITRF 2000)





Four different solutions

AC	Softwar	Ambiguitie	ITRF
	е	S	connection
NMA	GIPSY	float	Global
			7 parameters
OSO	GAMIT	Fixed (?)	Global
			7 parameters
LMV	Bern	Fixed	Regional
	5.0	(88%)	3 parameters
KMS	Bern	Fixed	Regional
	4.2	(66%)	3 parameters



NMA, GIPSY/OASISII, strategy

- Fiducial free PPP, 5 min epoch intv
- JPL orbits, clocks and EOP
- No ambiguity resolution
- Transformation with JPL X-files (7 parameters) to ITRF 2000 (parameters based on a global fit of 65-70 IGS stations)

ΑΝΤΜΑ̈́ΤΕΡΙΕΤ

Weekly combined solution



NMA, GIPSY, problems

- RINEX-file editing
- Problems with some Swedish sites day 271 (273 and 274)- manual editing





OSO, GAMIT/GLOBK, strategy

- Network solution divided into 7 sub-networks with many common stations
- Ambiguity fixing
- Saastamoinen apriori, Niell mapping functions, gradients
- Orbits from SOPAC, solving for orbits
- Quasi observations calculated by GAMIT
- Combination with quasi observations from SCRIPPS (IGS global network) using GLOBK
- 39 "good" IGS stations globally distributed are constrained in the GLOBK stabilization while 7 Helmert par are solved for.

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OSO, GAMIT/GLOBK, problems

- Success rate of resolved ambiguities not presented
- High phase residuals: BRGS, HALD, KONG and SAND
- East component of BRGS sensitive to GPS processing strategy and choice of stations included in the solution
- Bug concerning handling of horizontal antenna excentricities corrected (Norweigian stations)



LMV, Bernese ver 5.0, Strategy

- Network solution (all 133)
- Ambiguity fixing
- Data files < 12 h rejected
- Saastamoinen apriori, Niell mapping functions, gradients
- Minimum constrained adjustment (no translation) to ITRF 2000 from IGS cumulative solution (up to GW1294)

. A N T M Ä T E R I E T



LMV, Bernese ver 5.0, Problems

- UMEA day 271 problems with SPP
- L311 and L409 day 273 and QAQ1 day 271 excluded (outliers in daily repeatability)
- BRGS east component higher daily repeatability than other stations (rms 3 mm instead of 1 mm)
- BRGS east 23 mm diff between fixed-float
- float sol for BRGS replaced the fixed in the final sol (after Helmert fit to surrounding stations)
- Elevation cut-off test, ANDO (39 mm diff between 10 and 25 deg cut-off)

L A N T M Ä T E R I E T



KMS, Bernese ver 4.2, Strategy

- Network solution, 6 clusters (4 in Nordic-Baltic, 2 in Atlantic part (one basline connecting two clusters)
- Ambiguity fixing
- No apriori trop model, dry Niell
- Minimum constrained adjustment (no translation) to ITRF 2000 from IGS cumulative solution (up to GW1294)

ΑΝΤΜΑ̈́ΤΕΡΙΕΊ





KMS, Bernese ver 4.2, Problems

- Rejected stations: 271: VLNS, SKIL, L311, QAQ1; 273: L312, L498, L409 INDR; 274: INDR, SODE; 276:GAVL
- Wrong antenna modells used in preliminary processing (1-2 cm in pcv -> 2-4 and 8 cm in coordinates and height)
- (BRGS east not an outlier in the fixed-float comparison as for LMV)

ΙΑΝΤΜ Α̈́ΤΕΡΙΕΤ





Position standard errors





KMS



BRGS from M. Lidbergs time series

BRGS East Offset 290567.449 m rate(mm/yr)= 17.11 <u>+</u> 0.10 nrms= 1.58 wrms= 5.5 mm # 1074





Fixed-float





Elevation cut-off test (10 vs 25 deg)







Direct comparison North (1)





Direct comparison Up (1)







OSO-KMS direct comparison







7-par fits between solutions

Solution	rms	Scale	dN	dE	dU
NMA	mm	ppm	Translations (mm)		\$
OSO	2,6	0,0000	2,2	-1,7	3,2
LMV	3,5	0,0028	-0,2	-0,5	9,5
KMS	3,7	0,0024	-0,2	0,2	6,0

Solution	rms	Scale	dN	dE	dU
OSO	mm	ppm	Trans (slations mm)	6
LMV	2,1	0,0028	-2,4	1,2	6,3
KMS	2,1	0,0023	-2,4	1,9	2,8

Solution	rms	Scale	dN	dE	dU
LMV	mm	ppm	Translations (mm)		าร
KMS	1,8	-0,0005	0,0	0,7	-3,5





Harmonizing the solutions





After harmonization -North







After harmonization -Up







RMS of all differences

- 0.9, 1.2 and 2.5 mm after harmonization
- 0.7, 1.0, 1.7 mm 16 stn (outliers) excluded
- 1.4, 1.5 and 4.7 mm in direct comparison

Residuals after harmonization

N	E	U	
< 2 mm	< 2 mm	< 5 mm	
93%	83%	89%	
			TERIET



Combined solution



Estimated accuracy (95%-level)

- Accuracy of the ITRF connection (few mm in horizontal, 1 cm in height)
- Systematic effects depending on un-modelled errors or wrong models (few mm in horizontal, 0.5-1 cm in height)
- Random errors, noise in the solutions (few mm both in horizontal and height with some exceptions)
- Generally: 0.5-1 cm in the horizontal and 1-2 cm in the vertical on 95%-level. (e.g. ANDO and L312 less accurate in height)

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Extra Lithuanian observations

- L311 was re-observed 5 days (292-296) together with VLNS and KLPD due to problems during GW1238 (271-277)
- The processing of L311 in GW1238 turned out be of normal quality
- The extra days were also processed by LMV to check if there was any systematic difference to the original campaign





Differences at L311

	Extra - original	original+extra - original
N (mm)	0.6	0.3
E (mm)	0.7	0.4
U (mm)	5.9	1.5

Conclusion: no need to add the extra observations

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Reflections

- Different connections to ITRF
- Internal differences between GIPSY/GAMIT/Bernese very small (few mm)
- Some errors were found in the comparison of the different solutions
- Comparison fixed-float solution useful to detect problems (BRGS)
- Elevation cut-off-test useful to detect antennaproblems
- The processing has indicated problems on some permanent stations (e.g. BRGS, ANDO) that need to be further investigated



Just a snap shot epoch 2003.75, better full time series of permanent stations

