EUREF LAC GOP processing development in 2005-2006

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SUMMARY

Strategy of EUREF subnetwork processing in LAC GOP was revised when implementing the Bernese GPS software V5.0 in spring 2005. The processing system was completely rewritten in perl to be compatible with all other GOP GPS analysis.

All 33 Czech permanent GPS stations were integrated into the analysis using clustered approach. New processing variants were setup in parallel and evaluated. The results of official and tested solutions were compared to the old processing (Bernese 4.2) and to the standard RNX2SNX processing scheme in Bernese 5.0. An absolute antenna phase centre model and more strategy improvements were tested.

Implementation of Bernese V5.0

- **BSW5.0 officially implemented since GPS week 1320**
- Created a system of perl-scripts and perl-modules, which can be uniquely exploited in all analyses at GOP for different aims, various scopes and conditions:
  - post-processing for European ref. frame (daily based, final products,...)
  - near real-time GPS meteorology system (hourly based, NRT orbits,...)
  - ultra-rapid orbit determination from the global network (6-hours batch,...)
- Therefore RNX2SNX example not applied in our system
- Clustered approach adopted for most of the processing steps to enable efficient solution.
- Set up of parallel processing variants (during 2005)
- whenever possible up-to-date models adopted (troposphere, ocean tide loading,...)

GOP and RNX2SNX comparison

- **14 days of RNX2SNX trial at GOP subnetwork** (2006/008-021) limited to 44 EPN stations.
- In ambiguity resolution similar results:

Variant	GOP		RNX2SNX
Strategy	L6 + L3, L5 + L3	QIF	QIF
Amb. resolved	86.0%	87,4%	87.1%

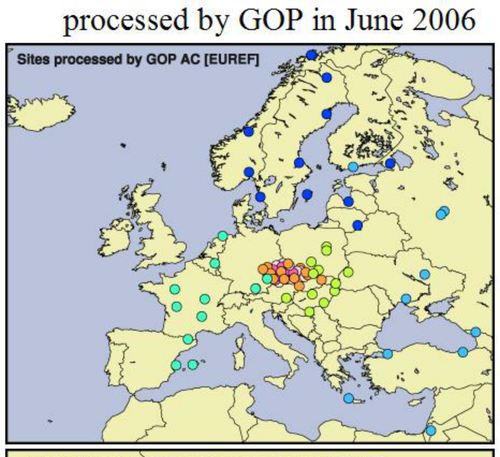
- Daily repeatabilities differ in up component:

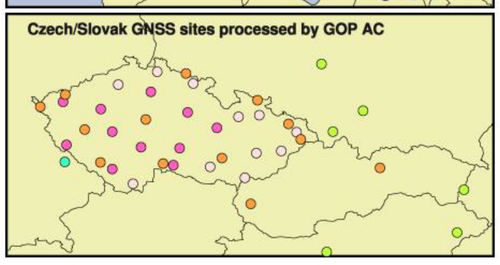
Daily repeatability [mm]	10° cutoff			3° cutoff, gradients		
	N	E	U	N	E	U
RNX2SNX	1.85	1.18	4.01	1.74	1.15	4.16
GOP	1.90	1.24	5.27	1.56	1.10	4.90

- RMS of Helmert ~2 mm, no scaling observed
- GOP solution additionally allows to calculate larger networks thanks to clustering.

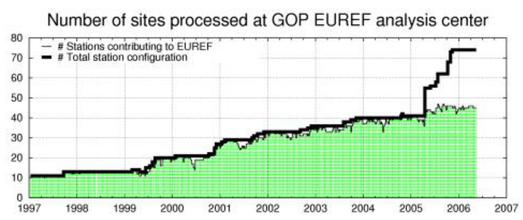
Network extension

- **Total 46 EUREF stations** processed by GOP in June 2006





- **Extension: 26 non-EPN stations** in Czech Republic area (CZEPOS and VESOG networks), excluded from the submitted solution



- **Clustered approach** allows further extension of the network
- **Planned including** more stations from the neighbouring countries

Preparation to absolute PCV model

- **Radome information included** in solution since GPS week 1372 (causes no results change)
- Tested **individual satellite offsets** in relative PCV model:

Horizontal displacement	< 1 mm
Vertical displacement	< 2 mm
RMS of Helmert	~ 2 mm
Scaling	~ –0.6 ppb

- **Collecting absolute PCV** for antennas used in GOP subnetwork
- Tests of absolute phase centres implementation (shown below)

Strategy specification

- Processing compatible with EPN recommendations
- Pre-processing based on low-elevation data
- Checking for the satellite/site large residuals
- Ambiguity resolution is supported by ionosphere model estimated from the data
- Tested variant using low elevation data (3 cut-off) and estimated tropospheric gradients
- Store the DD residuals after fixing all estimated parameters.

Processing variants

- **L2** L5 + L3 resolution for baselines < 1500km
- **W2** (official in GPS weeks 1320 - 1374): L6 + L3 resolution for baselines, L5 + L3 whenever poor code observations and baseline < 1500km
- **Q2** (official since GPS week 1375): QIF resolution strategy for baselines < 2000km
- **G2** low elevation data (3° cut-off), estimated troposphere gradients, ambiguities resolved by QIF

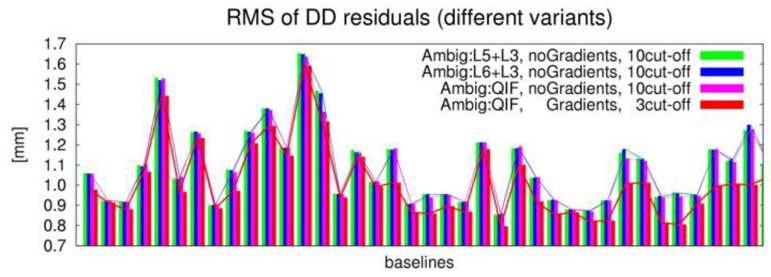
Comparison of variants

- Ambiguity resolution averaged from 14 days test (2006/008-021)
- Repeatability comparison calculated from 266 days (2005/100-365) with excluded outliers

Amb.strategy	Variant	L2	W2	Q2	G2
L6 + L3	rate		88%		
	L6		94.1%		
	L3		85.9%		
L5 + L3	rate		12%		
	L5	92.0%	90.7%		
	L3	87.6%	86.5%		
QIF				87.4%	87.4%
total		87.6%	86.0%	87.4%	87.4%
Daily repeatability [mm]	N	2.43	2.44	2.41	1.89
	E	1.85	1.88	1.77	1.50
	U	6.29	6.36	6.26	5.33

- Almost equivalent amounts of resolved ambiguities
- Small differences among **L2**, **W2** and **Q2**.
- **G2** gives more than by 20% smaller repeatabilites

Comparison of DD residuals RMS for the first x-baselines (after fixing all estimated parameters)



- EUREF consistent variants are comparable
- For most of the baselines, the DD residuals are significantly smaller in **G2** variant

Test of Absolute PCV model on GOP EUREF subnetwork

- **14 days GOP RNX2SNX trial** (variants use QIF strategy for ambiguities).
- Applied absolute PC corrections from *igs05_1365.atx* for receivers and satellites:
  - nadir-dependent patterns and individual offsets for satellites
  - radome-specific antenna calibrations for sites (where possible, 11 sites using "NONE" absolute PC corrections)
- General differences observed:

Daily repeatability [mm]	N	E	U
Relative PCV	1.73	1.15	4.14
Absolute PCV	1.59	1.09	4.42

Horizontal displacement	< 5 mm
Vertical displacement	< 30 mm
Scaling	~ 2.2 ppb

- Comparison result: **Identical differences of phase centre corrections generate similar coordinate shifts**
- Discerned 7 groups of sites with identical PC difference:

Group	Sites
AOAD/M_T equiv	8
ASH701945 C_M snow	3
ASH701946.2 snow	3
TRM29659.00 none	7
TRM29659.00 TCWD	2
TRM29659.00 UNAV	2
TRM41249.00 none	3
Other	17
Total	44

Relationship of PC differences and coordinate shifts

- Horizontal coordinate offsets agree on some sites with phase centre offsets difference on L3 linear combination.
- Possible reason for only partial agreement - the network is constrained on more sites with varied PC differences.

PC and GOPE coordinates

- **14 days GOP RNX2SNX trial**

1. *Individual vs. Antenna-type calibration*
   - Phase centres modified only on GOPE
   - used individual, semiabsolute (absolute in N, E) GOP calibration.
   - Horizontal coordinate movement agree with PC difference on L3.
   - Significant vertical shift ~ -14 mm.
2. *Relative vs. Absolute PC model*
   - PC on all sites set to new values
   - Partial agreement of horizontal shift and PC offsets difference on L3 (direction kept, shorter).
   - Vertical shift about -10 mm when PC correction differ on cm level.

GOPE Coordinate displacement	dN [mm]	dE [mm]	dU [mm]
Individual – Type	-3.10	1.90	-13.60
Relative – Absolute	1.10	-0.60	-10.20