GOP LAC Report

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Outline

- BSW 5.0 implementation at GOP
- Strategy specifications
- Network extension for non-EUREF sites
- Other GOP activities associated to EUREF

- Comparisons:
  - New and old solutions
  - GOP solution w.r.t. RNX2SNX example
  - Evaluating processing variants
  - Station time series behavior
  - Absolute antenna calibration study

- Summary

Bernese V5.0 implemented at GOP

- BSW5.0 was officially implemented in GPS week 1320
- we have created a system of perl-scripts and perl-modules, which can be uniquelly exploited in all analyses at GOP for different aims, various scopes and limiting 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 was not applied in our system
- clustered approach was addopted for most of the processing steps to enable efficient solution under limited conditions
- the processing variants were set up in parallel (during 2005)
- up-to-date models adopted whenever possible (troposphere, ocean tide loading,...)

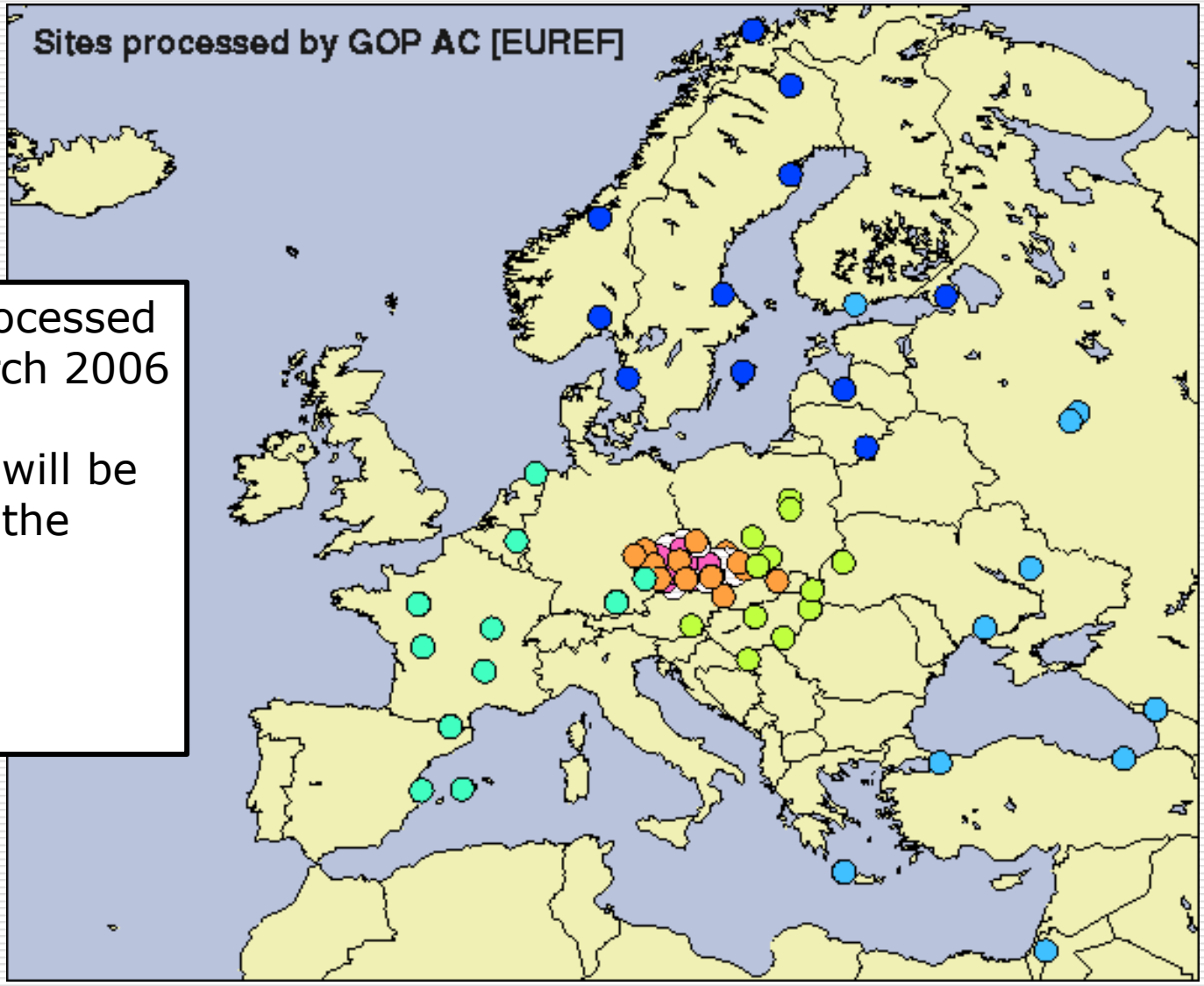
Strategy specification, processing variants

- Processing compatible with EPN recommendations
- Pre-processing based on low-elevation data
- Checking for the satellite/site large residuals
- Three different ambiguity resolution strategies applied
- 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.

Weekly combination

- Pre-combination of 28 last days for identifying problematic daily solutions.
- Testing reference sites for datum definition
- Combining also alternative variants
- Daily ZTD estimation using weekly GOP coordinates contributed to EUREF special project
- Daily solution repeatabilities useful for monitoring the product

EUREF network processed at GOP

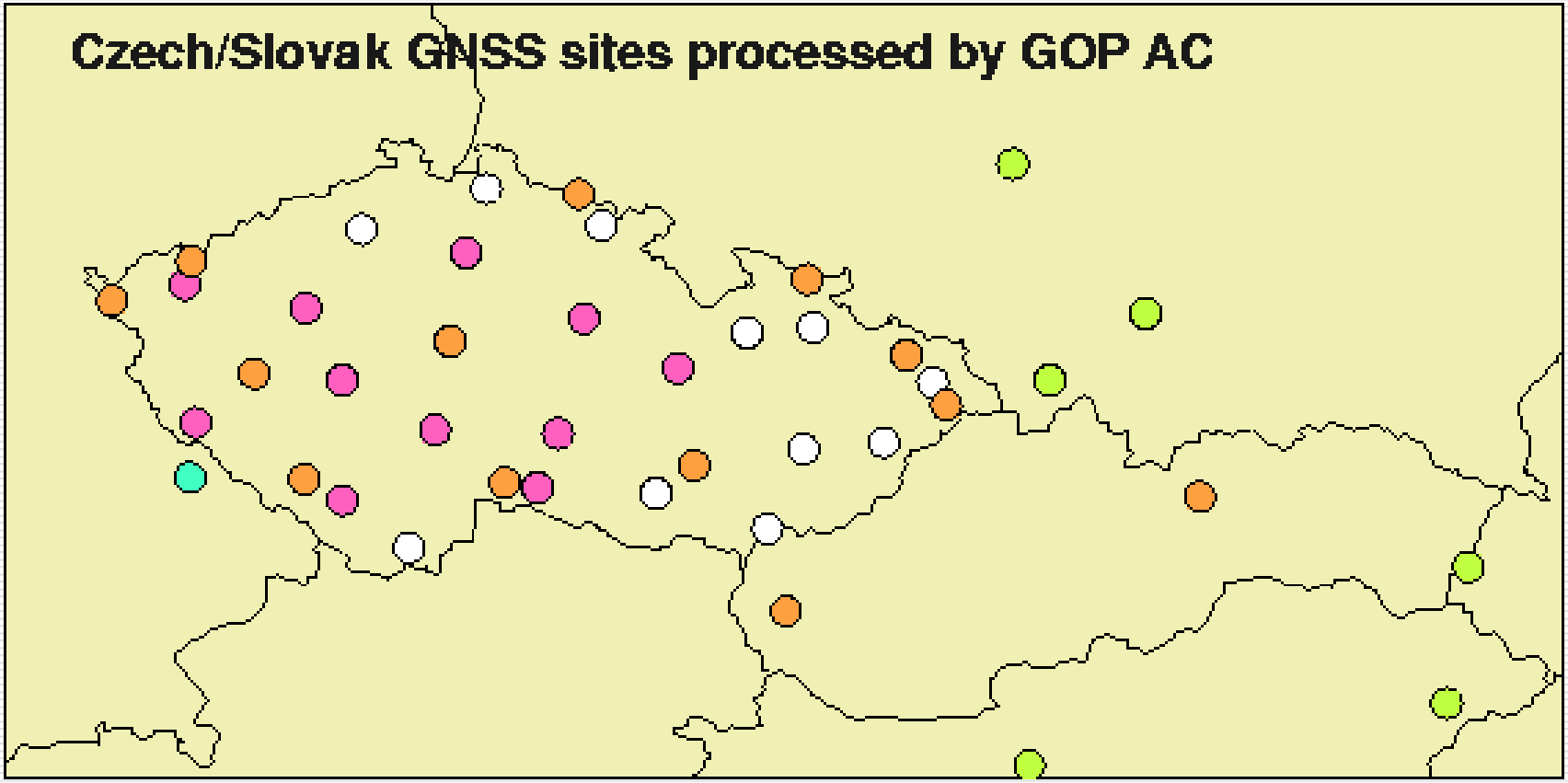


82 stations processed by GOP in March 2006

more stations will be included from the neighbouring countries

GOP network extension

- 26 sites from CZEPOS are processed simultaneously with EUREF solution and are pre-eliminated before the contribution to the EUREF
- thanks to the processing in clusters

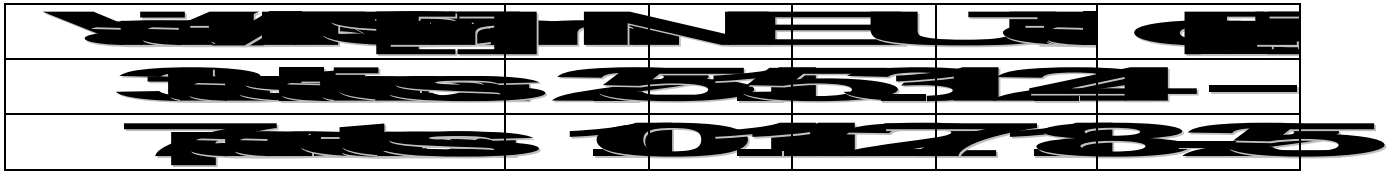


Other GOP activities within EUREF

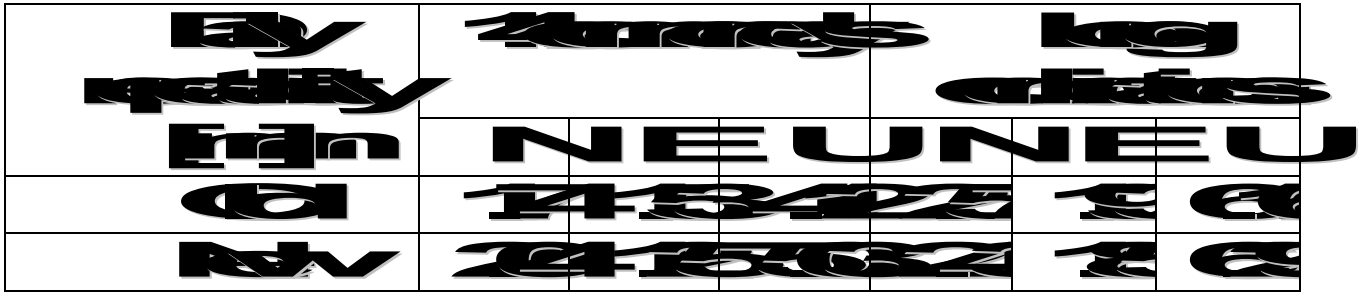
- Local data centre
  - collecting and providing hourly GNSS data
  - providing daily GNSS data (purely from hourly)
  - providing products and information for NRT processing
  - planning RT streaming available data to LDC
- EUREF-IP project
  - serving RTCM messages from GOPE (full data including GLONASS)
  - serving RTCM messages from TUBO station
  - running NTRIP caster with national scientific GPS stations
- EUREF Special project for Troposphere
  - providing ZTD for EUREF combination

Comparison of new and old GOP solution
(BSW 4.2 and 5.0)

- 14 days of simultaneous processing (DoY 100-113):
  - Helmert transformation - RMS 2.4 mm in NNT variant



  - Increased height repeatability in BSW5.0
- Combination in 2005 year
  - Old: DoY 001-113
  - New: DoY 100-365
  - Consistent repeatability from the combination > 100 days

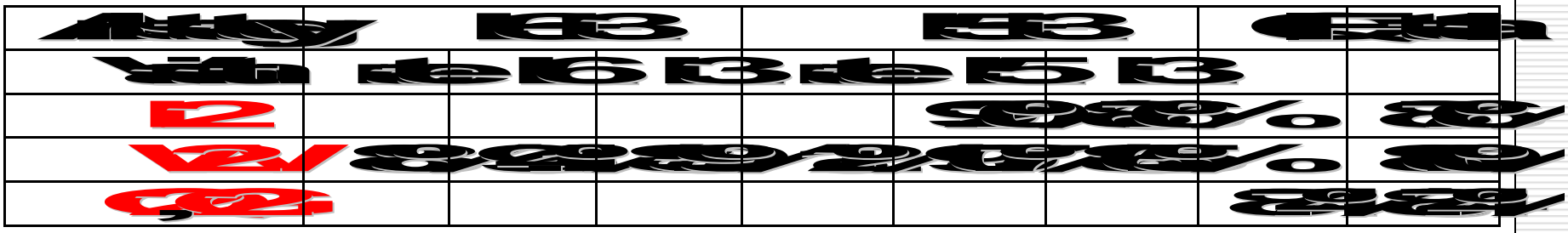


Evaluating processing variants - 1/3

- Processing variants:
  - **(L2)** L5 + L3 resolution for baselines < 1500km
  - **(W2 - official)** L6 + L3 resolution for baselines, L5 + L3 whenever poor code observations and baselines < 1500km,
  - **(Q2)** QIF resolution strategy for baselines < 2000km
  - **(G2)** low elevation data (3° cut-off), estimated troposphere gradients, ambiguities resolved by QIF
- 266-days testing combination:
  - DOYs 100-365 of 2005 in all variants
  - Constrained to GOP standard datum definition

Evaluating processing variants - 2/3

- Ambiguity resolution
  - Averaged from 14 days test (2006/008-021):



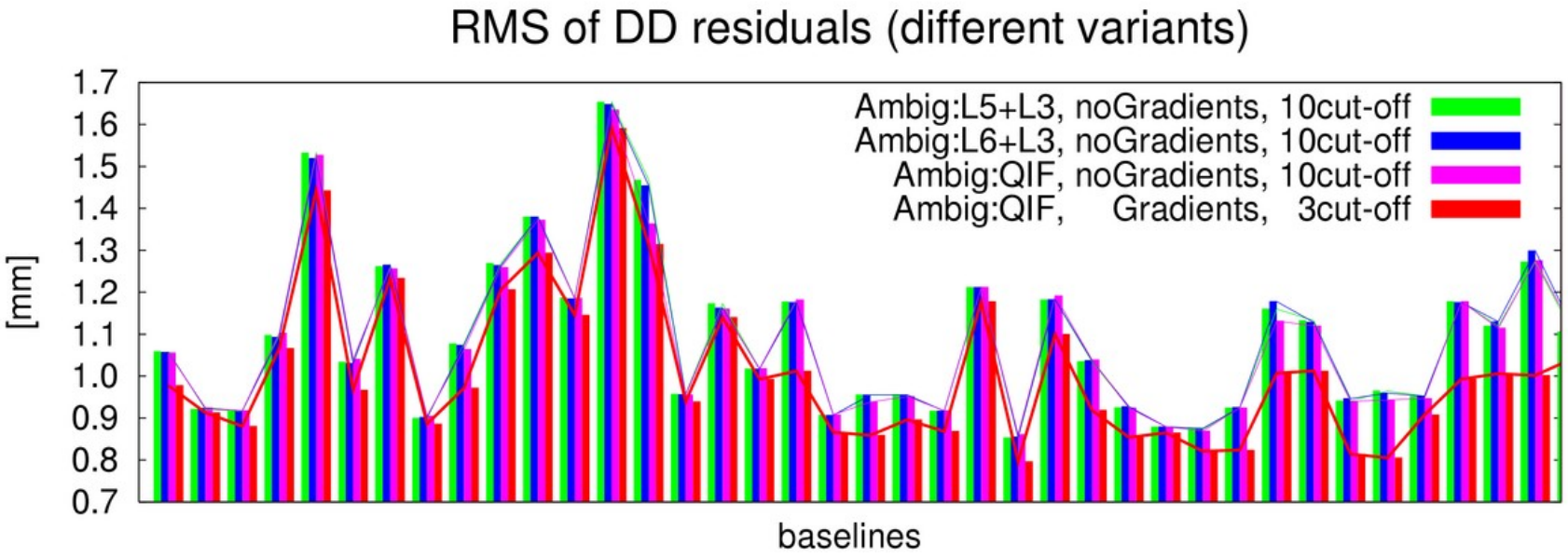
- Repeatability comparison from 266 days:

	N	E	U
	23	15	69
L2	24	18	66
W2	21	17	66
Q2	19	16	53

  - Small differences among **L2**, **W2** and **Q2**
  - **G2** gives more than by 20% smaller repeatabilites

Evaluating processing variants - 3/3

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



  - EUREF consistent variants (**L2**, **W2**, **Q2**) are comparable
  - For most of the baselines, the DD residuals are significantly smaller in **G2** variant

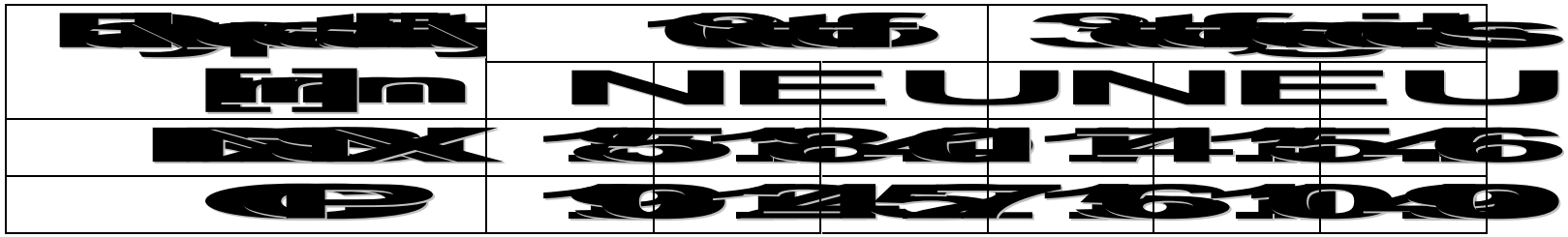
Comparison of GOP and RNX2SNX solution

- RNX2SNX example processing
  - Calculated 14 days of GOP EPN subnetwork (2006/008-021)
  - Only EPN sites selected (44 with data)
  - Variants:
    - **(G)** (*original*): Elevation cut-off 3° & estimated troposphere gradients (equivalent to GOP **G2**)
    - **(E)** (*EUREF-consistent*): Elevation cut-off 10°, no estimated gradients (equivalent to official GOP **W2**)
  - 14 days long combination constrained to GOP standard datum
- Ambiguities resolution

Variant	GOP (W2)	RNX2SNX (E)
Strategy	L6 + L3, L5 + L3	QIF
Amb. resolved	86.0%	87.1%

GOP and RNX2SNX - 2/2

- Daily repeatabilities

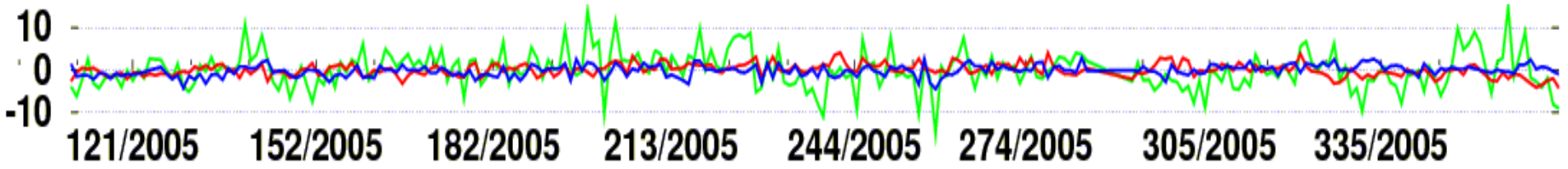


- Helmert transformation (key without inconsistent sites):
  - RMS of transformation ~ 2 mm
  - No scaling observed

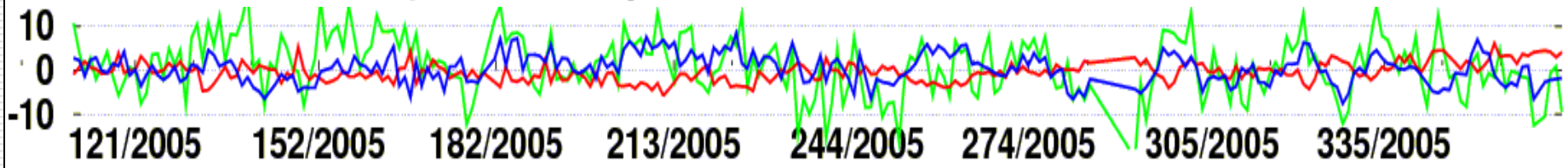
- Other features of GOP solution (not affecting tests):
  - Separation to clusters allows to calculate larger network
  - Detection and exclusion of outliers in weekly solution
  - Selection of sites to constrain based on outlier detection

Station behaviour - 1/4

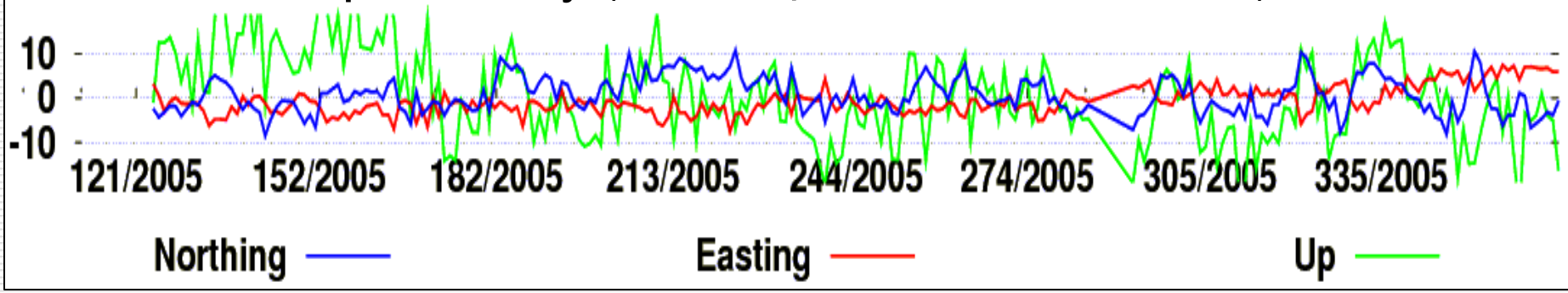
- Residuals on a good site (ONSA, rpt. 1.3, 1.5, and 4.3 mm)



- Worse repeatability (TUBI, rpt. 3.2, 2.1, and 6.5 mm)

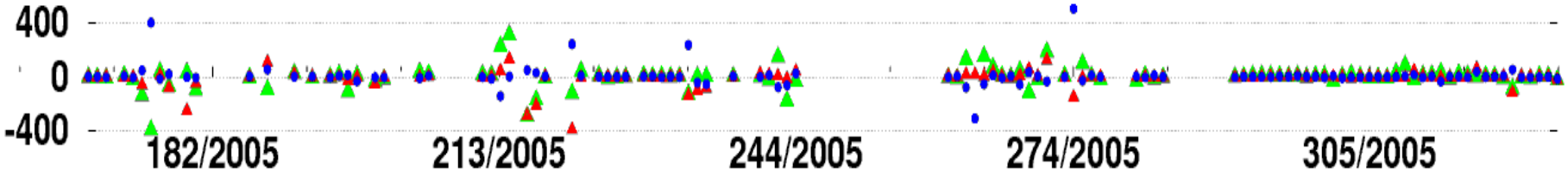


- Bad repeatability (DRAG, rpt. 4.0, 3.1, and 10 mm)

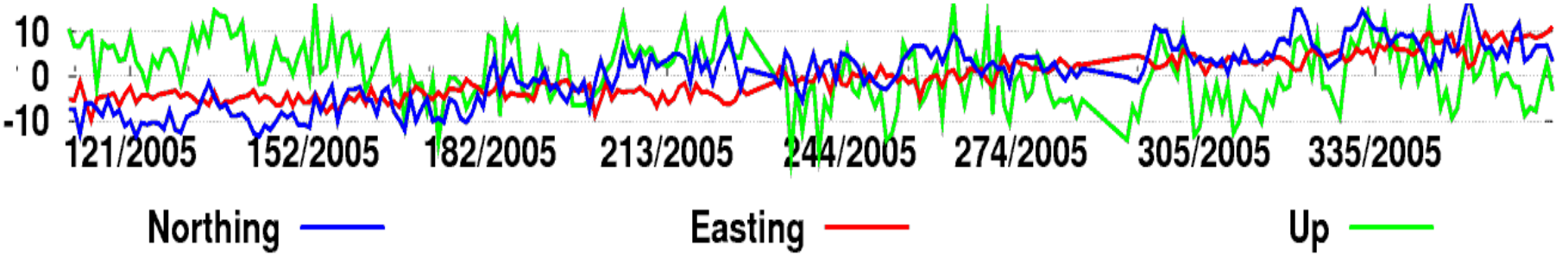


Station behaviour - 2/4

- OBE2 - data problem
  - missing data, large (up to 1 m) outliers
  - usually excluded from weekly combination

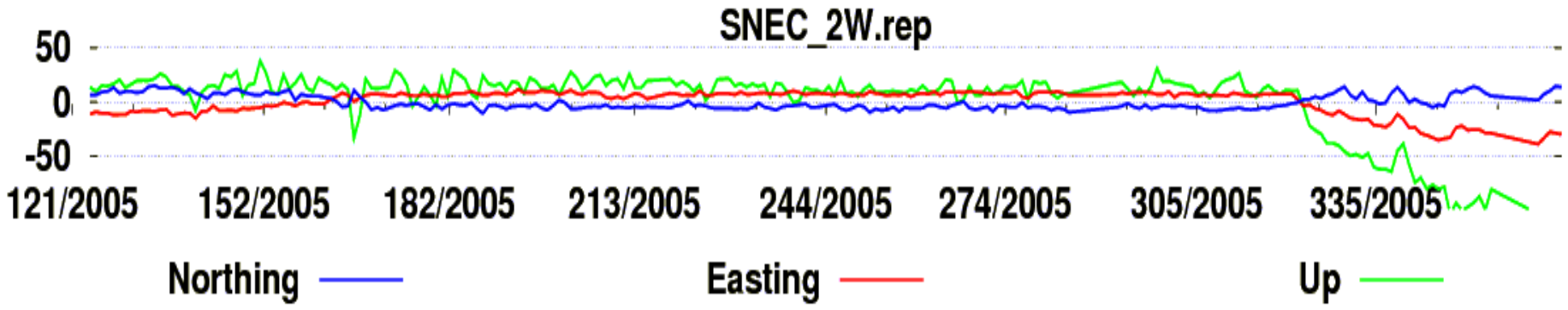


- TUC2 - Observed station movement
  - horizontal movement ~3 cm/year
  - located on Crete - geodynamic movement



Station behaviour - 3/4

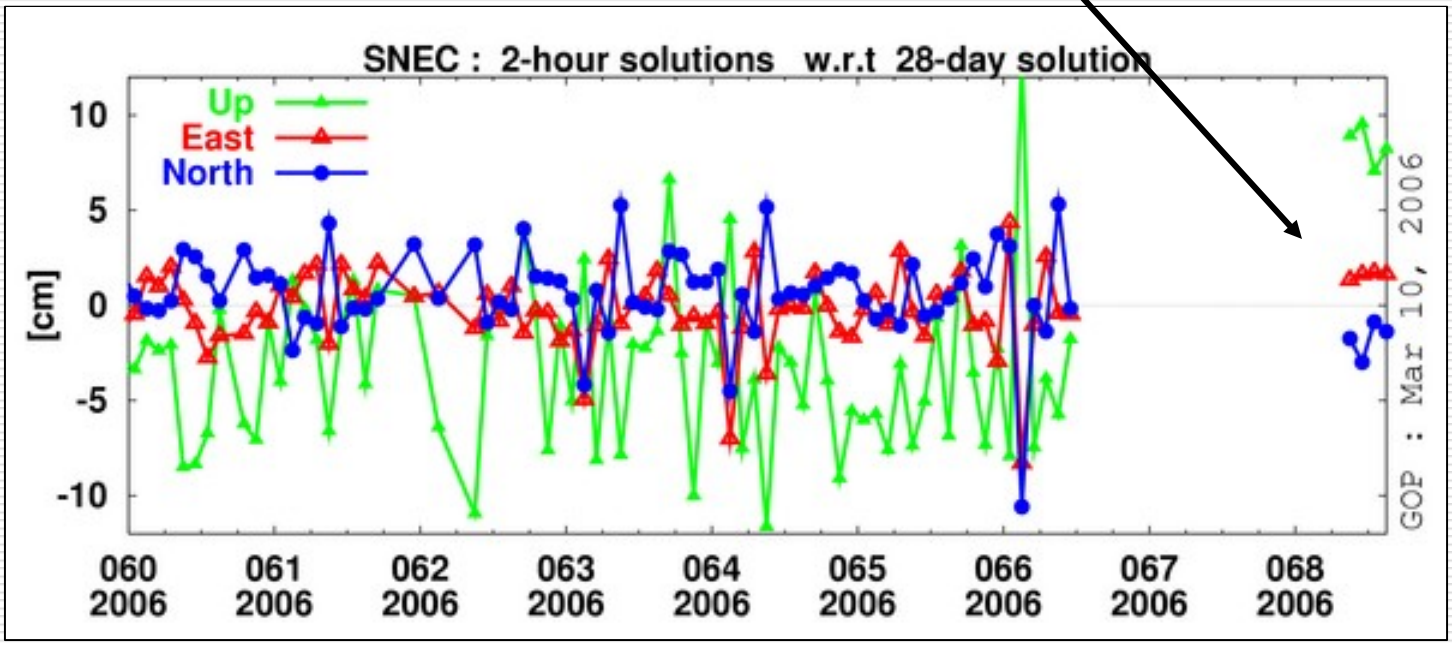
- SNEC - winter coordinate shifts
  - Shifts up to 30 mm in N,E and over 100 mm in U component



- First possible explanation – ice/snow coating
  - extreme weather conditions at the highest Czech Mountain
  - rapid start of the winter (snowing) last autumn very well coinciding with beginning of problems with SNEC (btw November 18-20, 2005)
  - similar problem indicated already at the spring until end of May...
  - After receiver replacement in March `06 problem vanished

Station behaviour - 4/4

- finally, the problem disappeared immediately after the ASHTECH Z18 receiver replacement in March 11, 2005 by TPS GB-1000 receiver
- unfortunately after few first hours, the data were not successfully uploaded



Absolute antenna calibration study - 1/4

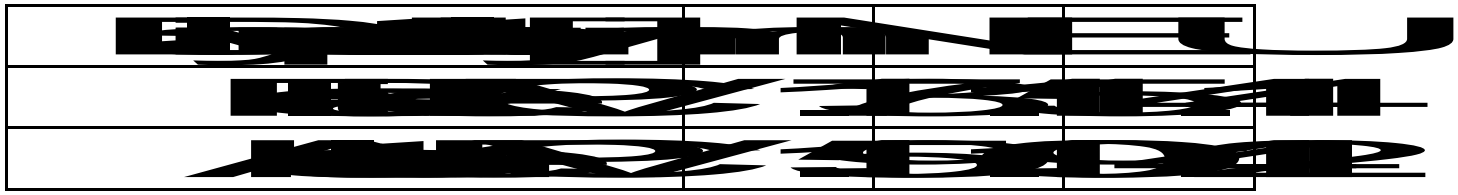
- Motivation
  - More realistic phase centre model
  - IGS application is coming soon
  - An opportunity to test radome-specific PCVs
- Test of absolute PCV in GOP RNX2SNX
  - Applied latest absolute phase centres IGS05_1365.atx for both satellite and receiver antennas.
  - On stations introduced:
    - radome-specific calibrations (where possible, about 80%)
    - azimuth PCV dependency (about 85% of sites)
  - On satellites introduced:
    - nadir-dependent patterns
    - partially satellite dependent calibrations

Absolute antenna calibration study - 2/4

- Modification of BSW processing:
  - Newly constructed phase centre correction file PHAS_I05.ABS
  - Changed offsets in SATELLIT. file
  - Radome info added into station information file (.STA)
  - Minor change in RXOBV3 setting ("*consider radome codes*")
- Complications:
  - Still not all antenna/dome combinations available (here 5/30)
    - On 11 sites used values for antennas without radomes
  - Inconsistent source of absolute calibrations (GEO++ / NGS)
  - Not available calibrations for newly launched satellites (esp. for GLONASS)
    - Satellites missing in atx. file were excluded from solution

Absolute antenna calibration study - 3/4

- Calculation with absolute PCV:
  - RNX2SNX on GOP subnetwork
  - only EPN sites
  - 14 days long combination (2006/008-021) comparable with testing of RNX2SNX example in GOP.
- Results of the comparison:
  - Changes of daily repeatabilities:



  - Observed scaling ~ 2.2 ppb.
  - Coordinate differences (offsets) < 5 mm (N,E), or < 30 mm (U)
  - Antenna type dependency of the offsets

Absolute antenna calibration study - 4/4

- Antenna type dependent offsets
  - Separated 7 groups with identical antenna types
  - Offsets from comparison of final coordinates

	8	5	-5	31	3	2	2
	3	15	-14	9	1	1	3
	3	20	-3	36	1	2	3
	7	14	23	8	2	3	21
	2	16	-12	31	3	3	14
	2	-6	-42	20	2	4	18
	3	40	0	47	2	2	3

  - Observed effects:
    - Coordinate shifts dependent on antenna type
    - Strong effect on heights
    - Radomes are causing significant height offsets

Summary - 1/2

- BSW5.0 implemented since GPS week 1320, processing system developed at GOP for multi-purpose usage
- Network processed at GOP was extended for 26 national stations
- New solutions compared to old (BSW4.2) solutions
  - comparable repeatabilites from long-term test (>100 days)
  - new solution better in E, slightly worse in U
- Ambiguity resolution strategy tested in three variants
  - all variants resolve comparable amount (> 86%) of ambiguities
- Alternative: Low cut-off & troposphere gradients
  - the best E,U coordinate repeatabilities (~ 15% lower)

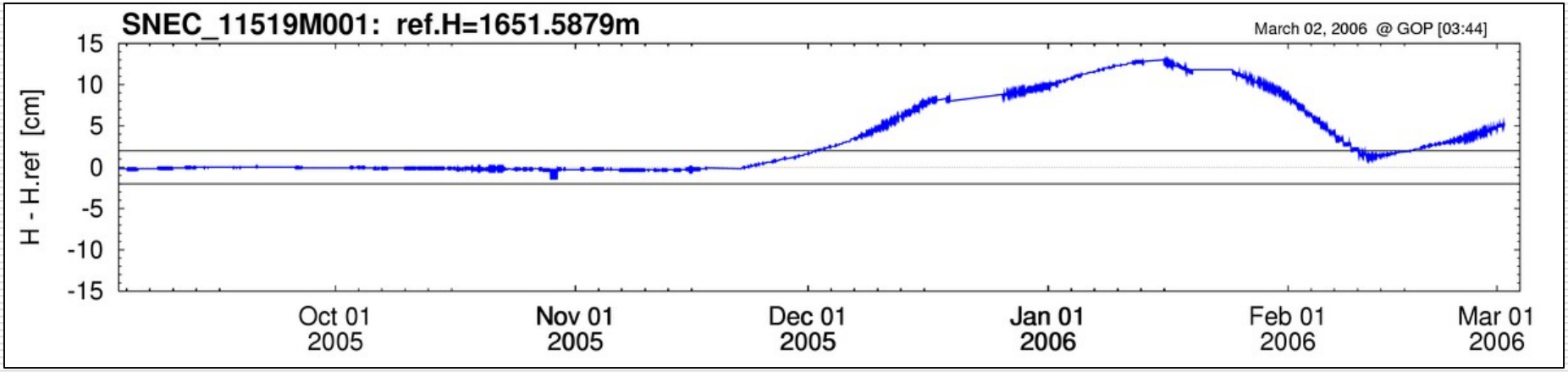
Summary - 2/2

- GOP EUREF contribution tested w.r.t RNX2SNX example
  - Ambiguities resolution L6+L3 (GOP) comparable with QIF (R2S)
  - Comparable repeatability in horizontal direction
  - Weaker results in the heights (under study)
- Problematic stations were identified in the network:
  - SNEC (spring & winter: receiver) , OBE2 (summer: data)
  - TUC2 (strong geodynamics effect ?), also TRAB & DRAG.
- Absolute antenna calibration study results:
  - Improved repeatability in horizontal direction
  - Coordinate and height shifts of sites depend on antenna type
  - An opportunity to introduce dome-specific PCV corrections
  - For future, individual calibrations are the goal

THE END

Thanks for Your attention

SNEC - station problem



- Height and position changes on cm level since 12/05
- Located on the top of the highest Czech mountain - extreme weather conditions