Processing of a regional EPN sub-network with global IGS sites at WUT EPN LAC

Experiences and preliminary results

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Abstract

The poster presents initial experiences and results stemming from common GPS analysis of a regional EPN sub-network together with global IGS stations obtained by Warsaw University of Technology (WUT). WUT is one of 18 Local Analysis Centers (LAC) of the EUREF Permanant Network (EPN). These analyses have been performed as a preparatory phase for WUT's contribution to EPN-Repro2 project which now includes a global extension of the EPN network. The EPN has became TIGA (Tide Gauge Benchmark Monitoring Project)(Schöne et al., 2009) Analysis Centre in 2011. The analysis has been performed using Bernese GPS Software ver. 5.0 (Dach et al., 2007). We processed 2.5 years of data of 60 regional EPN sites together with 90 IGS global sites. The poster presents strategy used for GPS data analysis and intial results.

The necessity to process regional network together with global sites in order to obtain reliable velocity field and geophysical interpretation of results was showed by Legrand et al., (2010).

The comparison of velocity fields obtained from 2.5 years of GPS data is also presented on the poster.

1 Types of solutions

Four different variants of processing have been performed:

1. **REG** – regional only solution of a subnetwork of 60 EPN sites (Figure 1)
2. **CORE** – IGS08 core network augmented by 5 IGS08 European sites, which are not part of core network, but present in IGS08 solution and in our regional EPN subnetwork
3. **REGEXT** – common processing of all sites from (1) and (2) on observation level (Figure 3). All stations (regional and global) processed as one cluster.
4. **REGEXTNEQ** – combined solution of solutions (1) and (2) on normal equation level

Results presented in section 3 are based on 2 years (2005 and 2006) of GPS data (GPS weeks 1304–1408) and in section 4 on 2.5 years (GPS Week 1277–1408).

The distribution of EPN stations used in solution **REG** is presented in Figure 1.

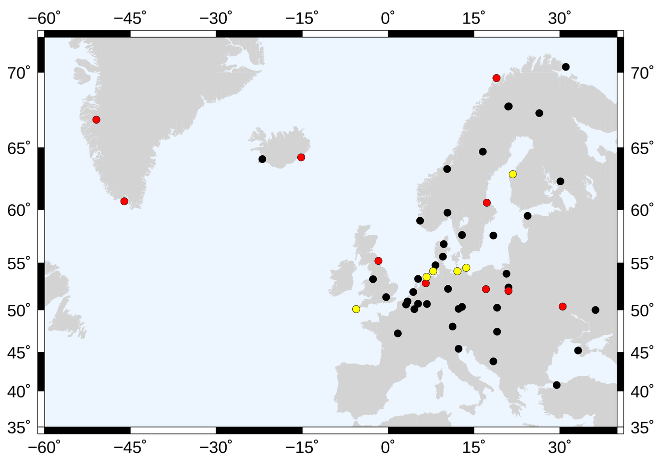


Figure 1: Map of 60 stations (THU3 and NYA1 outside of the map) processed by WUT EPN LAC in EPN Reprocessing project. Black circles: EPN site, Red circles: IGS08 site, Yellow circles: TIGA site

2 Analysis options

The data have been analyzed using Bernese GPS Software ver. 5.0 (Dach et al. 2007).

The analysis options used for **REG** solutions are mostly consistent with EPN LAC guidelines (www.epncb.oma.be).

Additional changes were required for processing of a global network e.g. ambiguity resolution for long baselines and introduction of redundant baselines.

Table 1: Analysis options

Feature	Value
Software	Bernese GPS Software ver. 5.0
Orbits and ERPs	IGS Repro1, fixed during processing
Elevation mask	3°
Satellite system	GPS
Baseline definition	max. common observations
Ambiguity resolution strategies	SIGMA L1&L2 ($L \le 20$ km)
	SIGMA L5/L3 ($20 < L \le 200$ km)
	QIF ($200 < L \le 2000$ km)
	MWB[a]/L3 ($2000 < L \le 6000$ km)
Troposphere *a priori* model	Saastamoinen + GMF[b], dry part
Mapping function for corrections	wet GMF
Interval for troposphere parameters	1 hour
Tropo. horizontal gradients	yes
Ionosphere model	CODE[c] global
P1C1 DCBs for satellites for MWB AR	CODE
Ocean loading	FES2004
Phase center offsets and variations	absolute igs08.atx_1685
Reference frame	IGS08
Reference frame realization	minimum constraints

[a]Melbourne-Wübbena linear combination of code and phase observations
[b]Global Mapping Function has been implemented by authors themselves
[c]Center for Orbit Determination in Europe

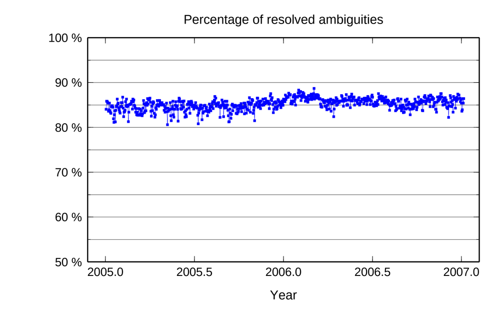
3 Daily solutions

For each solution type: **REG**, **REGEXT** and **CORE** GPS observations were processed according to options given in Table 1 and daily normal equations (NEQ) were created. Solution **REGEXTNEQ** was created by stacking NEQs from solutions **REG** and **CORE**.

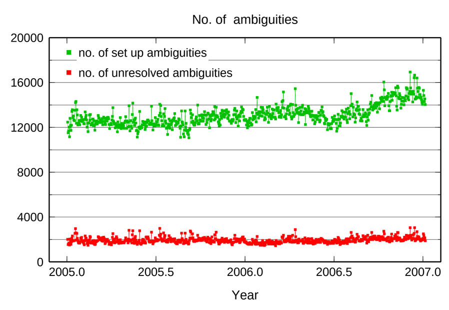
Ambiguity resolution

Ambiguities were resolved using four different methods according to the baseline length. The same criteria were used as in Steigenberger, (2009) and they are given in Table 1. Baselines were created according to the maximum common observations at both sites. The example of baselines created for May 31, 2006 for **REGEXT** is presented in Figure 3.

Melbourne-Wübbena linear combination was used in ambiguity resolution (AR) for baselines of length up to 6000 km. AR using MWB LC requires smoothed code observations and P1C1 differential code biases for satellites. Below, in Figure 4 the overall quality of ambiguity resolution is presented.



(a) % of resolved ambiguities



(b) no. of set up and unresolved

Figure 2: Quality of ambiguity resolution in **REGEXT** solution

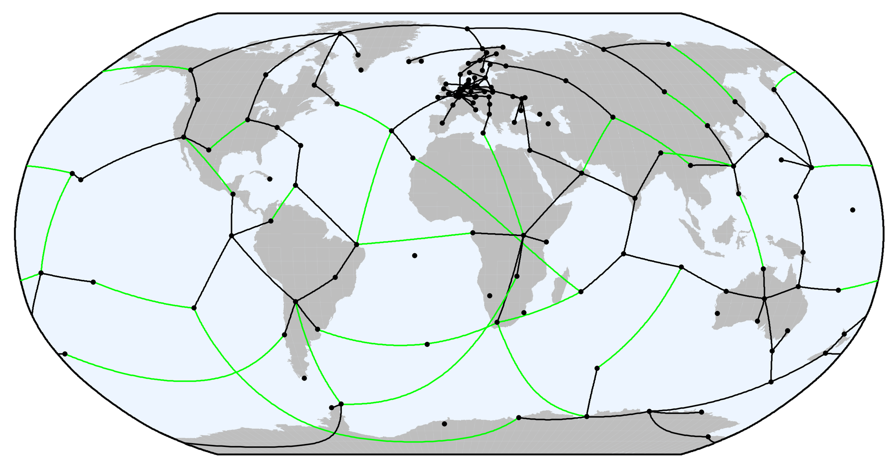


Figure 3: Baseline definition for solution **REGEXT** as of May 31, 2006. Black: $n-1$ baselines (n – number of stations); Green: redundant baselines (usually ~20 redundant baselines were created for each daily session)

Repeatabilities

Solutions **CORE** and **REGEXT**, for a period of one year, were computed with and without redundant baselines. Redundant baselines (Brockmann, 1997) strenghten global solutions. Comparison between these two variants for **CORE** solution is presented in Figure 4 below (left). It shows repeatabilities of daily solutions with respect to weekly solution.

Repeatabilities for solutions **REG**, **REGEXT**, **REGEXTNEQ** are presented in Figure 4 on the right.

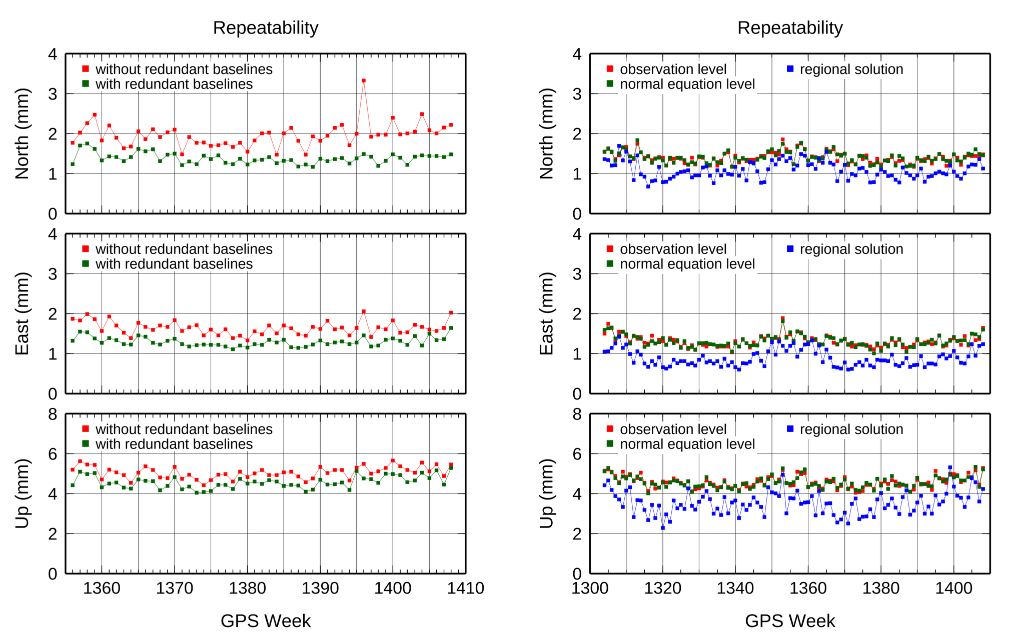


Figure 4: Comparison of repeatabilities of daily solutions wrt. weekly solution

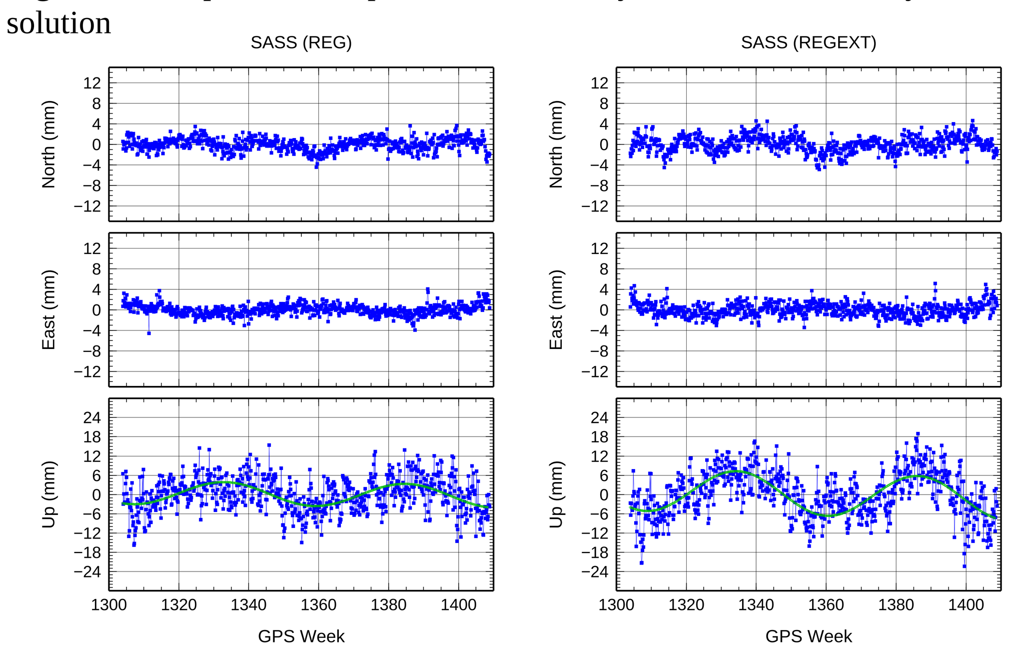


Figure 5: Example of time series (detrended) of daily coordinates for TIGA station SASS (Sassnitz Island of Ruegen, Germany) for solution **REG** (left) and **REGEXT** (right). For most stations (except Greenland ones) larger amplitudes (~ 2 mm) were observed for Up component in case of processing of regional network with global extension sites (**REGEXT**)

4 Long term solution

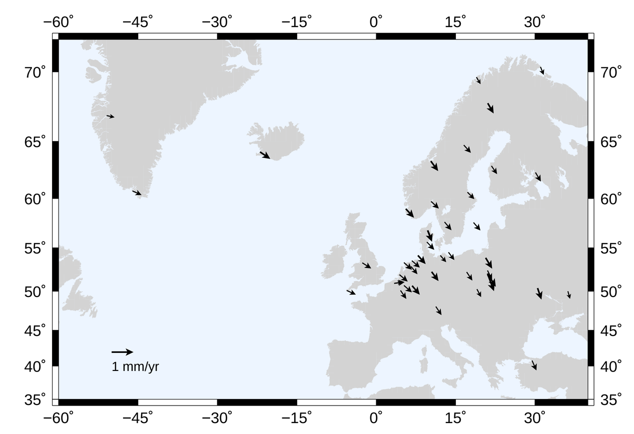
The long term solutions have been computed on the basis of daily normal equations from the period of 2.5 years (924 daily solutions). In addition to coordinates, velocities were estimated as well. Only stations with small data gaps have been accepted for these solutions. For IGS08 stations, official discontinuities were used.

Solution **REG** showed systematic differences in height (~ 1.6 mm) with respect to solution with global sites (**REGEXT**). To minimize these diffrences, in addition to the No Network Translation (NNT) minimum constraints condition also the No Network Scale (NNS) condition was applied.

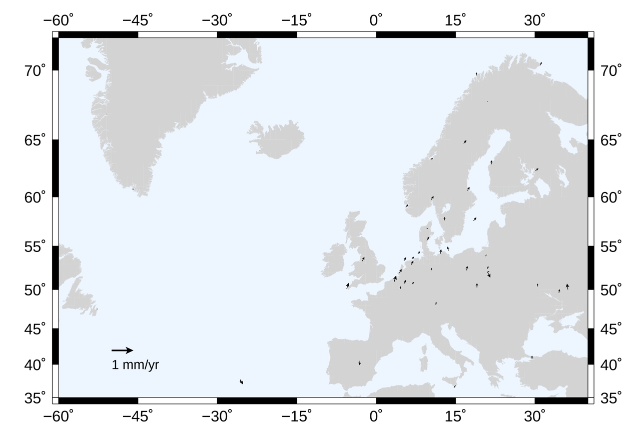
Table 2: Statistics of long term solutions

Solution type	Repeatability (mm) N	E	U	RMS (mm)	# of sites	# of solns	Minimum constraints
REG	1.37	1.25	6.12	1.09	44	47	**NNT+NNS**
REGEXT	2.28	1.94	6.52	1.16	109	127	**NNT+NNR**
REGEXTNEQ	2.29	1.92	6.47	1.14	109	127	**NNT+NNR**

Comparison of horizontal velocities



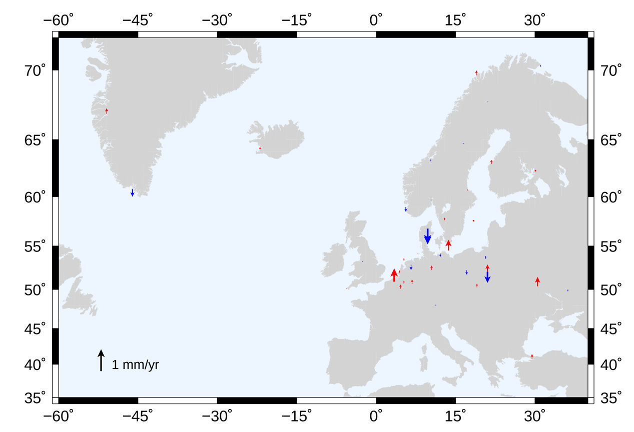
(a) solution **REGEXT** minus **REG**



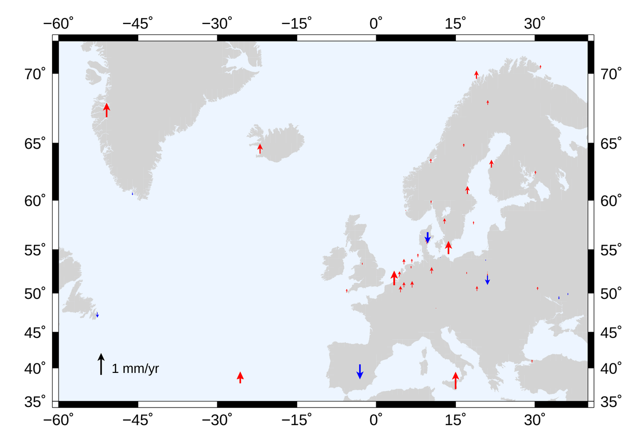
(b) solution **REGEXT** minus **REGEXTNEQ**

Figure 6: Differences of horizontal velocities for European sites

Comparison of vertical velocities



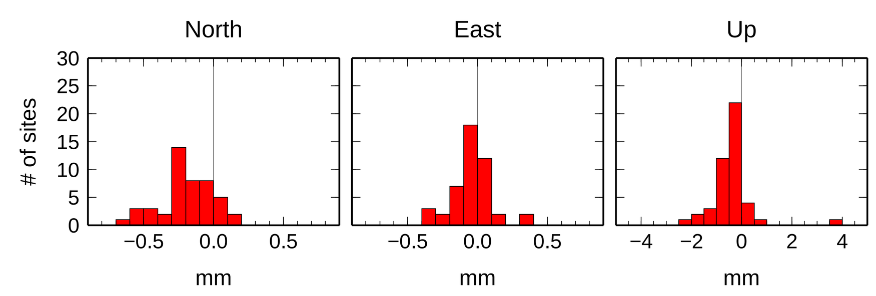
(a) **REGEXT** minus **REG**



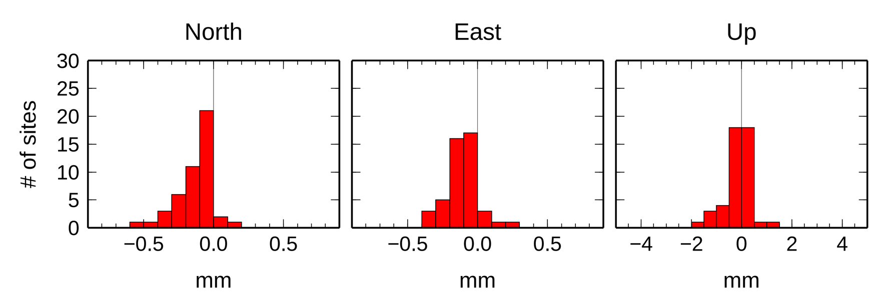
(b) **REGEXT** minus **REGEXTNEQ**

Figure 7: Differences of vertical velocities for European sites

Comparison of coordinates



(a) coordinate differences between **REGEXT** and **REG** solution



(b) coordinate differences between **REGEXT** and **REGEXTNEQ** solution

Figure 8: Histograms of coordinate differences

5 Conclusions

The processing of regional stations with global IGS stations has been set up and tested at WUT EPN LAC.

The comparison of solution **REGEXT** with **REG** reveals differences in estimated coordinates and velocities. These differences can be greatly reduced by combining regional solution (**REG**) with global (**CORE**) on a normal equation level (**REGEXTNEQ**). Solutions **REGEXT** and **REGEXTNEQ** give also very similar results in terms of coordinate repeatability (Table 2).

6 References

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