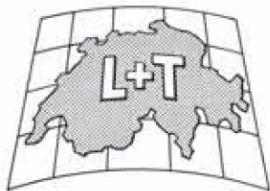




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LPT Report swisstopo



logo "Landestopographie" 1968 – 1979,
name + logo swisstopo since 2002

E. Brockmann, D. Ineichen, S. Schaer



Content

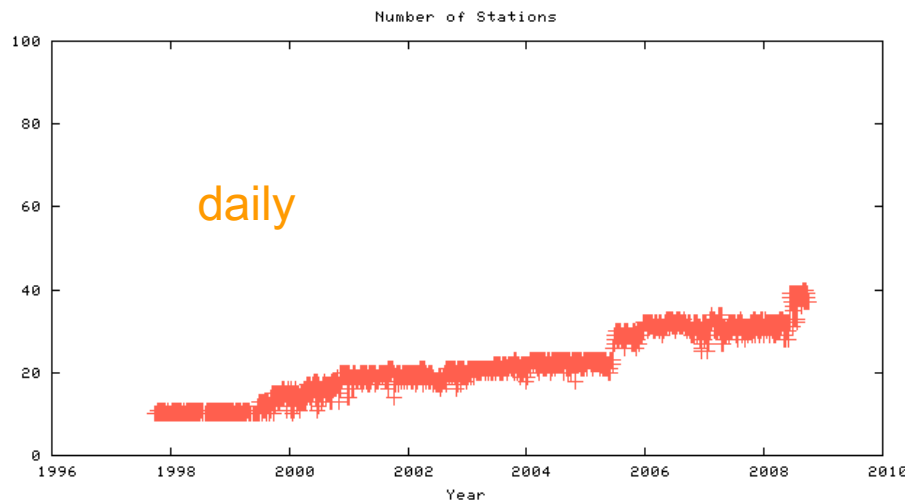
- swisstopo analysis center LPT
 - contributions to the EPN
 - connection to the national processing
- GNSS-meteorology
 - comparisons with radio sonde data
 - usage of troposphere in the processing validation



swisstopo (LPT) contribution to the EPN

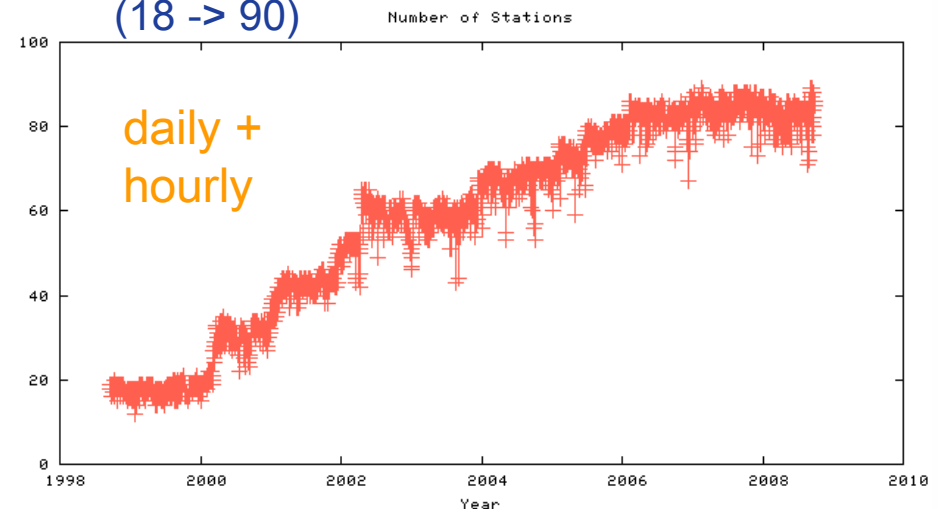
- since 1997: weekly SINEX files
- since May 1, 2007: rapid und ultra-rapid SINEX files based on NRT processing
- EUREF processing is “nested” within different additional processing schemes

sites: EPN post-processed (6 -> 40)



15/10/08 11:12

sites: 1/2 EPN + 1/2 AGNES post-processed (18 -> 90)



15/10/08 11:12



GNSS analyses using Bernese GPS Software at swisstopo

Final (weekly): SNX, TRO

network (#stations)	availability	comments
EUREF sub-network (40)	100 % daily	reference frame Europe
AGNES + sub-network EUREF (90)	100 % daily	reference frame Switzerland
AGNES + sub-network EUREF (80)	98 % hourly	monitoring + numerical weather prediction



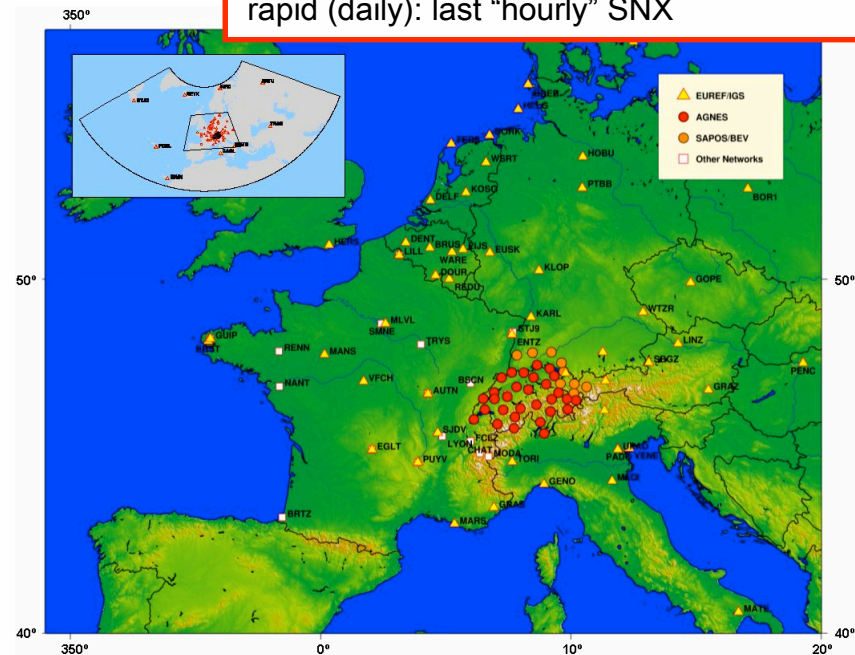
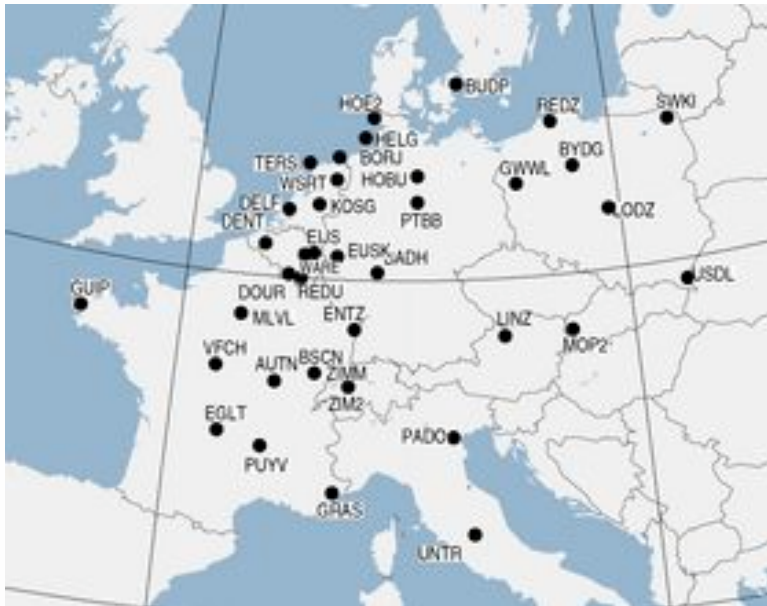
swisstopo



swisstopo



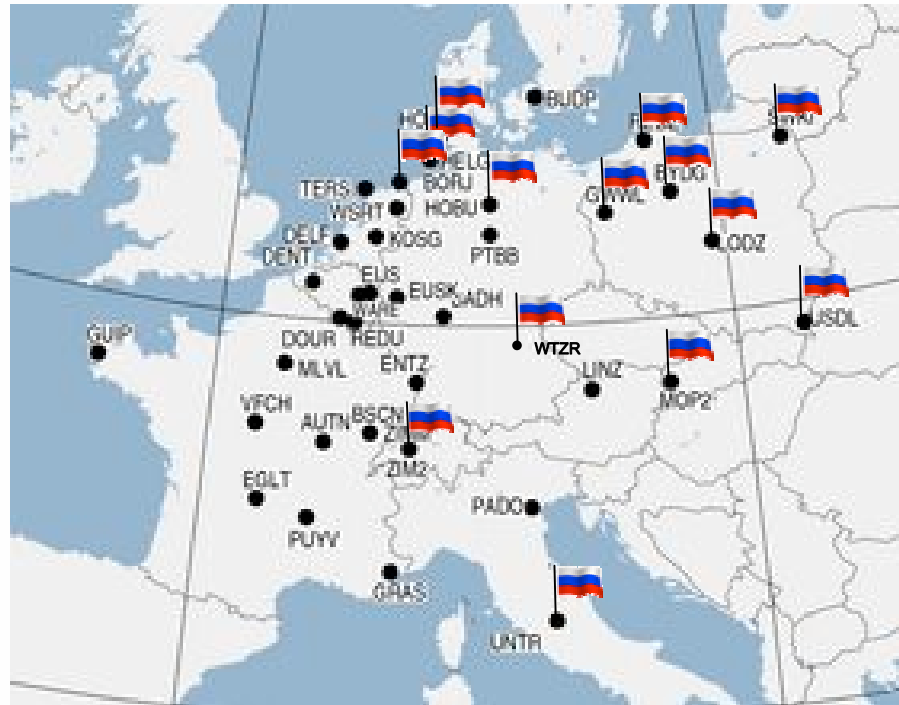
Ultra-rapid (hourly): 24 accumulated hourly SNX
rapid (daily): last "hourly" SNX






GLONASS data used for EUREF solutions

- swisstopo's official contribution based on GLONASS data (amb. float) since GPS week 1400 (Nov. 2006)
- National network AGNES was enhanced with GLONASS in Mid 2007
- New Swiss EUREF site ZIM2 providing GNSS data
- GLONASS ambiguity fixing implemented since Aug. 2007 (Bernese 5.0⁺ and processing optimizations) – Sept. 2007 for NRT
- Orbit information used from CODE (no combined product available from IGS)





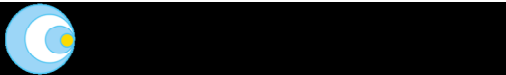


Further processing remarks

- GNSS ambiguity resolution (no ambiguities GPS-GLO)
 - QIF < 2000 km: 60 – 90 % (only for same frequencies)
 - L5/L3 < 200 km: 90 – 100%
 - L1/L2 < 20 km: 95 – 100%
- Combining GPS and GLONASS: a) GPS-only + GLONASS-only + NEQ stacking or b) directly processed together
- Coordinate repeatability: improvement due to GLONASS is small for the daily analyses + GLONASS-only solutions performing well in view of # satellites (see EUREF paper D. Ineichen et al.) → 
- On the national level: continuation of solutions based on relative antenna models (national coordinates based on rel. antenna models; as long as reprocessing is not done)



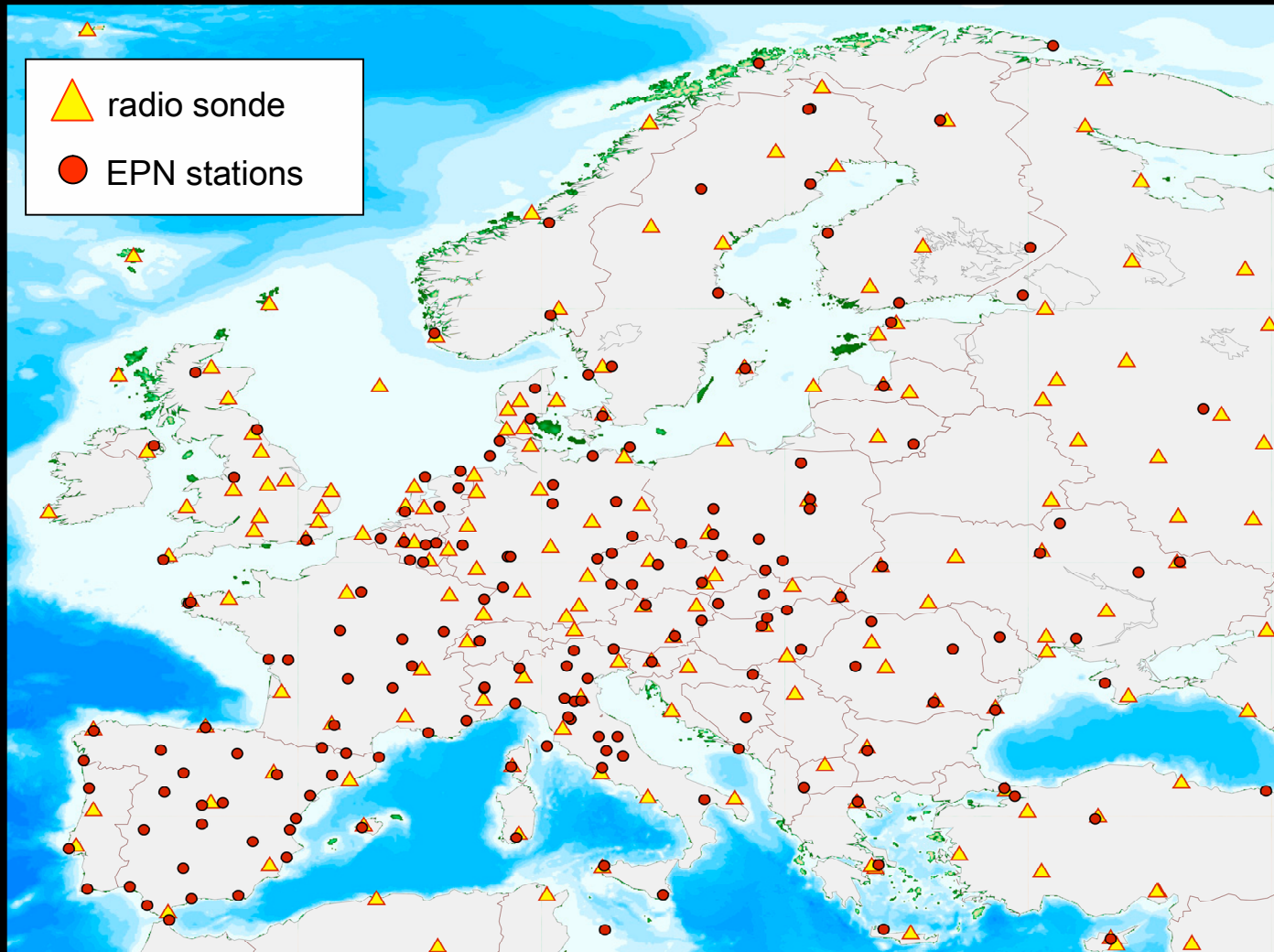
GNSS-meteorology within EUREF

- Collaboration EUREF with EUMETNET   
 - MoU signed in London, June 2007
 - data exchange between the two communities
 - usage of radio sonde (since April 2008) and synoptic observations (since June 2008) for geodetic scientific use
- Access of meteorological data
 - download via a password-protected ftp server
 - to get a login/password:
 - contact **Henrik Vedel** by e-mail [hev@dmi.dk]
 - sign a “condition of use” form (usage for non-commercial applications)



Radiosonde - EPN Collocation

The EUREF - EUMETNET Collaboration: First Experiences and Potential Benefits, [E. Pottiaux](#), E. Brockmann, W. Soehne, C. Bruyninx

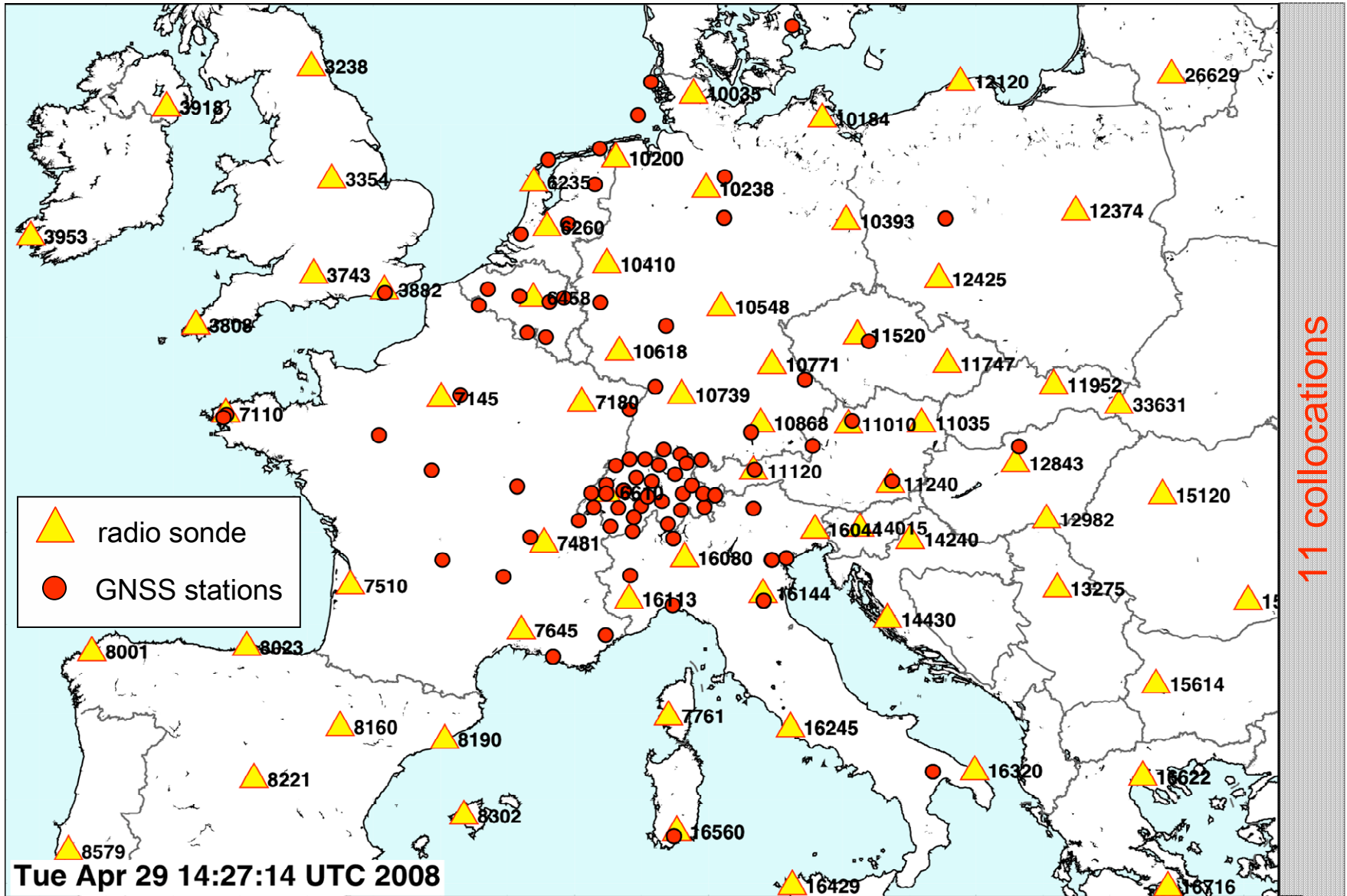


Report swisstopo (LPT)

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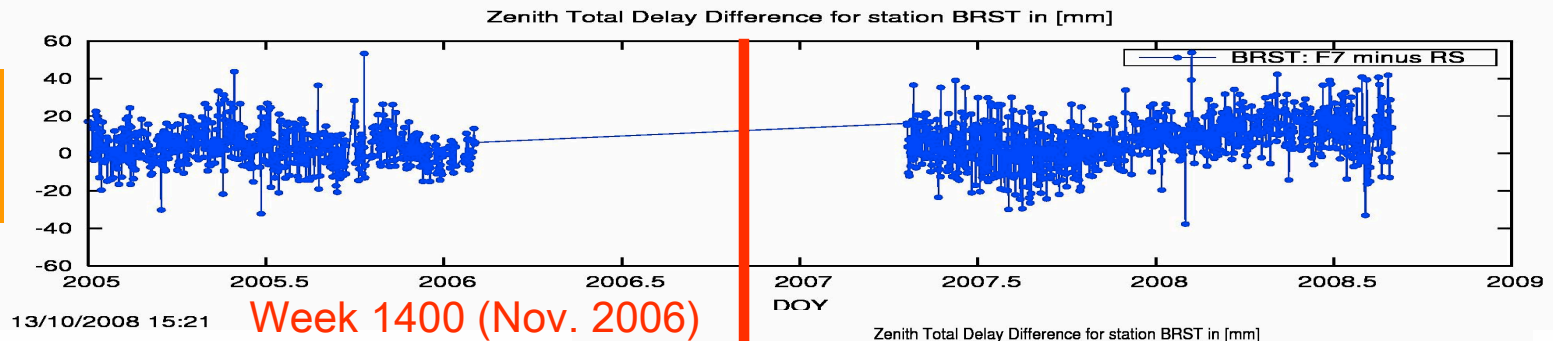
RS – swisstopo collocation



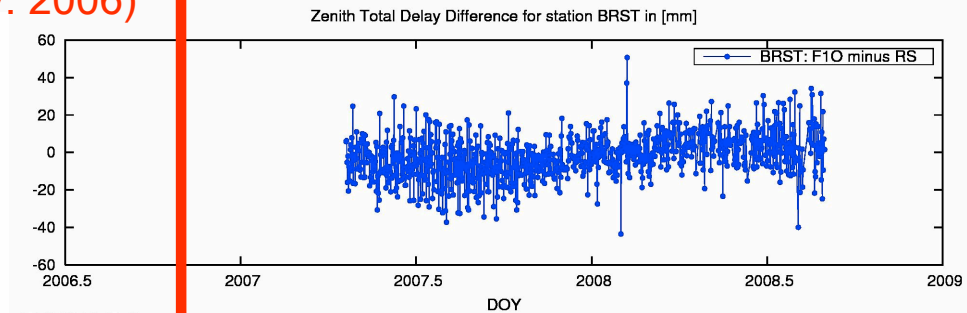


ZTD comparisons with radio sondes: Example BRST (GPS)

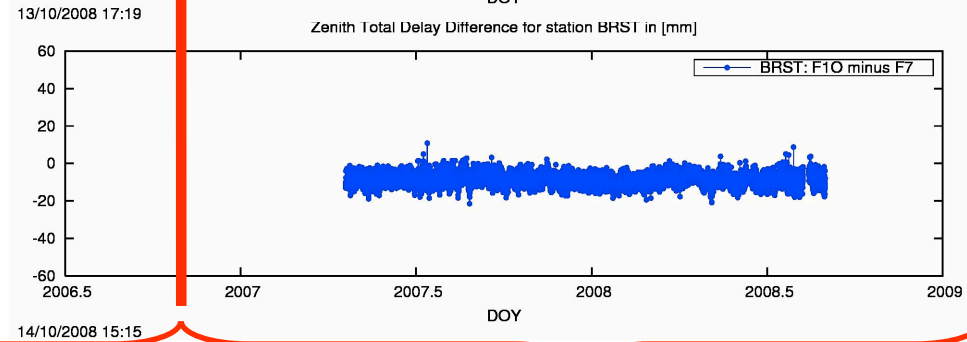
GPS rel. PCV
-
radio sonde



GNSS abs. PCV
-
radio sonde



GNSS abs. PCV
-
GPS rel. PCV



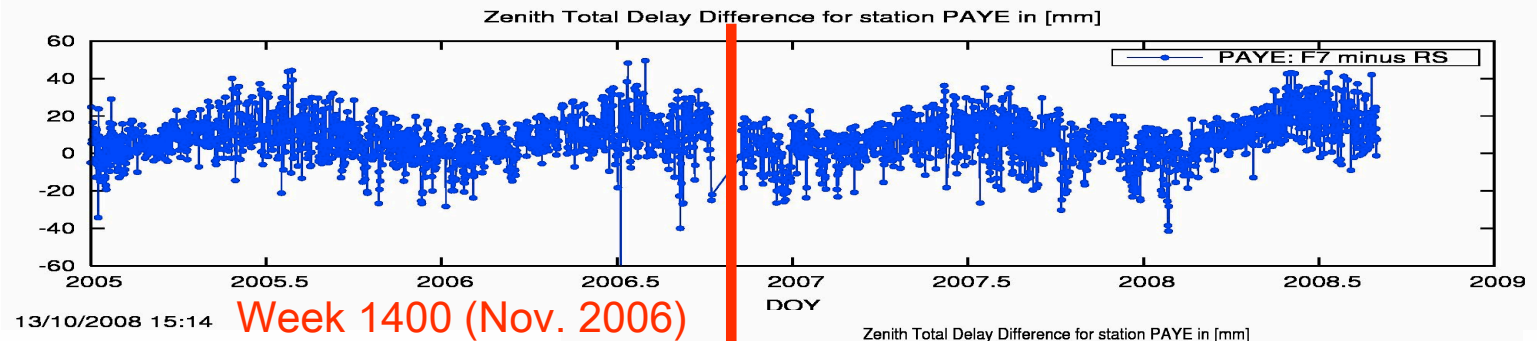
relative antenna PCVs

relative + absolute antenna PCVs

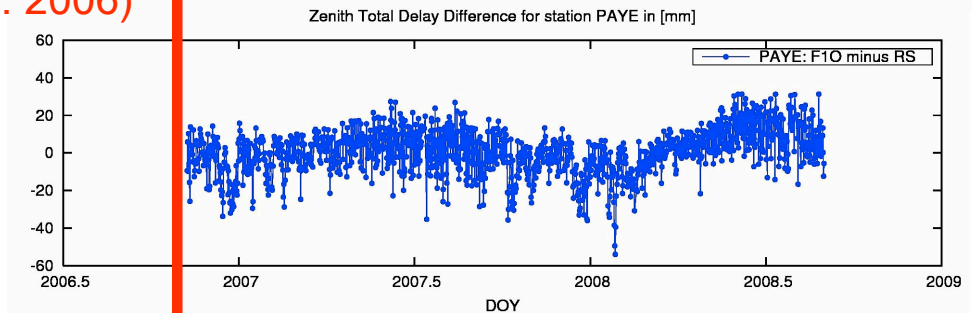


ZTD comparisons with radio sondes: Example PAYE (GNSS)

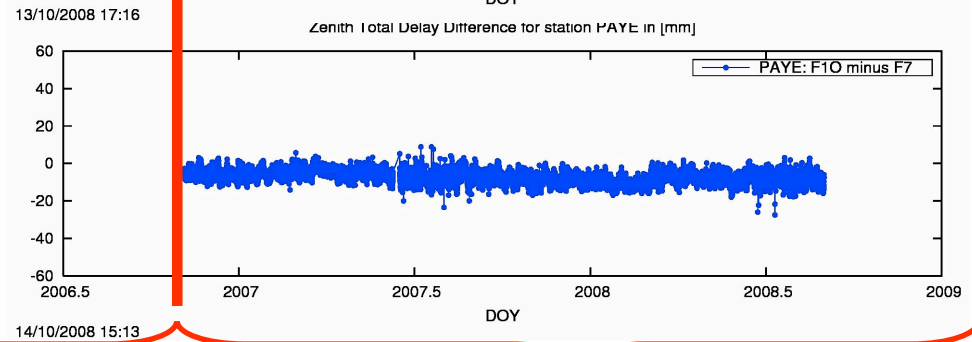
GPS rel. PCV
-
radio sonde



GNSS abs. PCV
-
radio sonde



GNSS abs. PCV
-
GPS rel. PCV



relative antenna PCVs

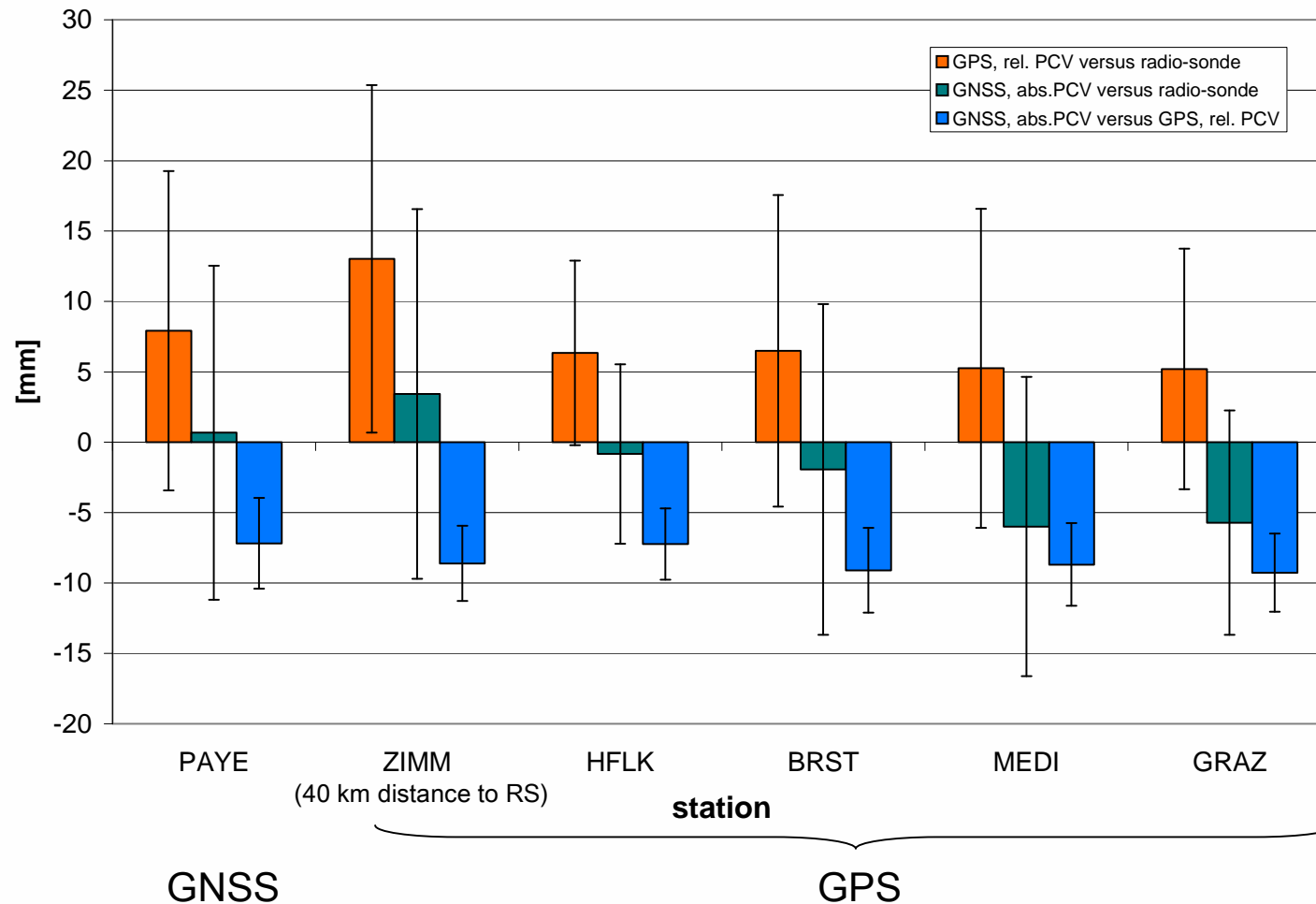
relative + absolute antenna PCVs



Statistics of RS comparisons

Abs. PCV TRP ~ 7-9 mm dryer as rel. PCV+ closer to RS

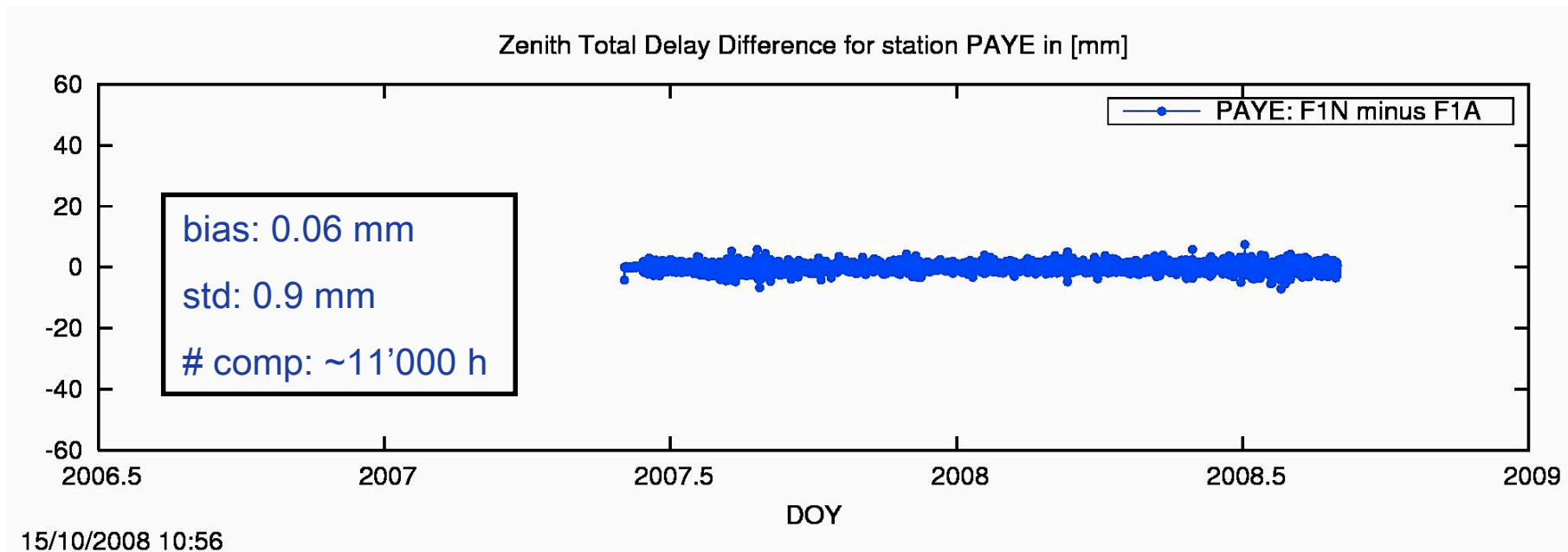
f (GNSS antenna type)





Influence GLONASS: Example PAYE

- GPS+GLONASS versus GPS-only: very small impact on ZTD for post-processed solutions

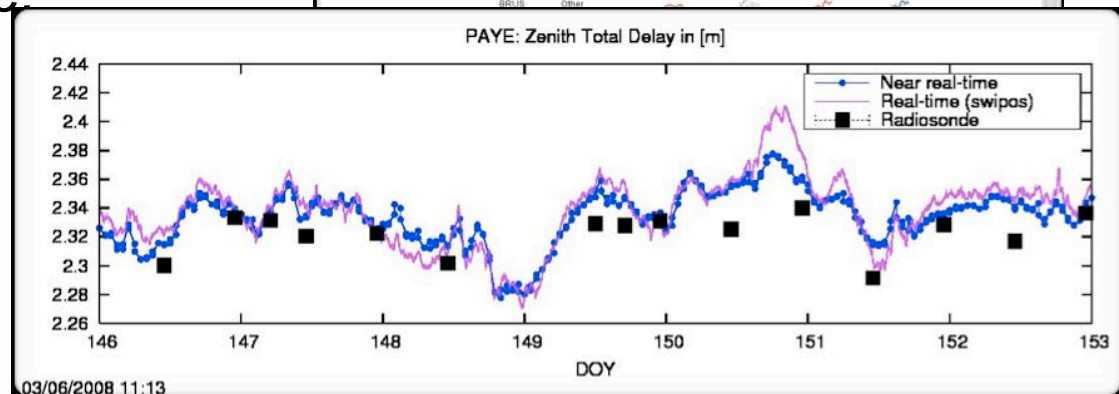
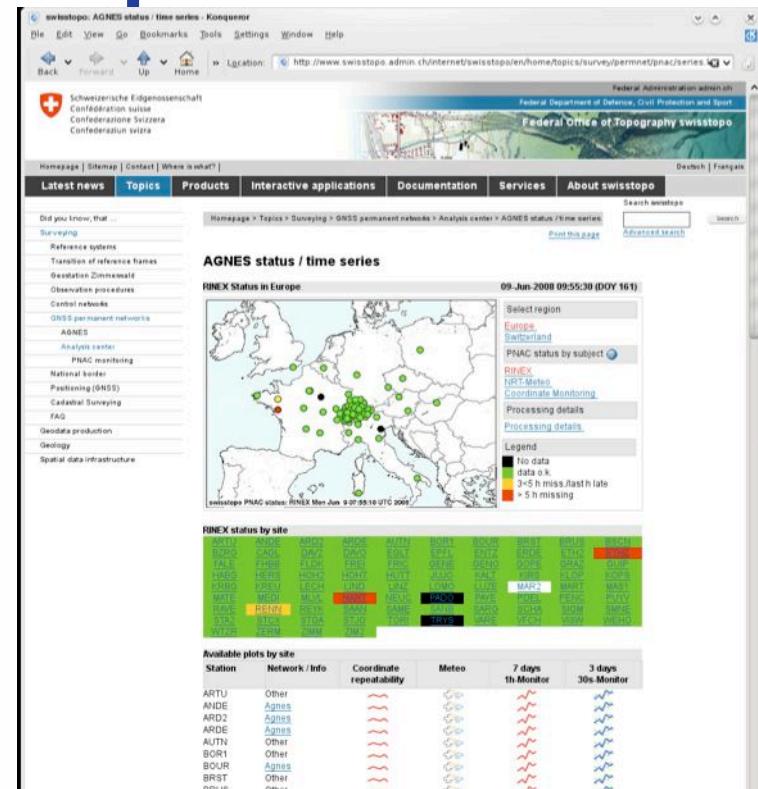


- (same is also valid for the NRT solutions covering 8 hours of data)



Monitoring NRT troposphere

- EPN + AGNES sites
- Web-based monitor
- Updated every 30 minutes
- Coordinates: postprocessed, NRT, positioning service
- Troposphere: postprocessed, NRT, positioning service
radio sonde



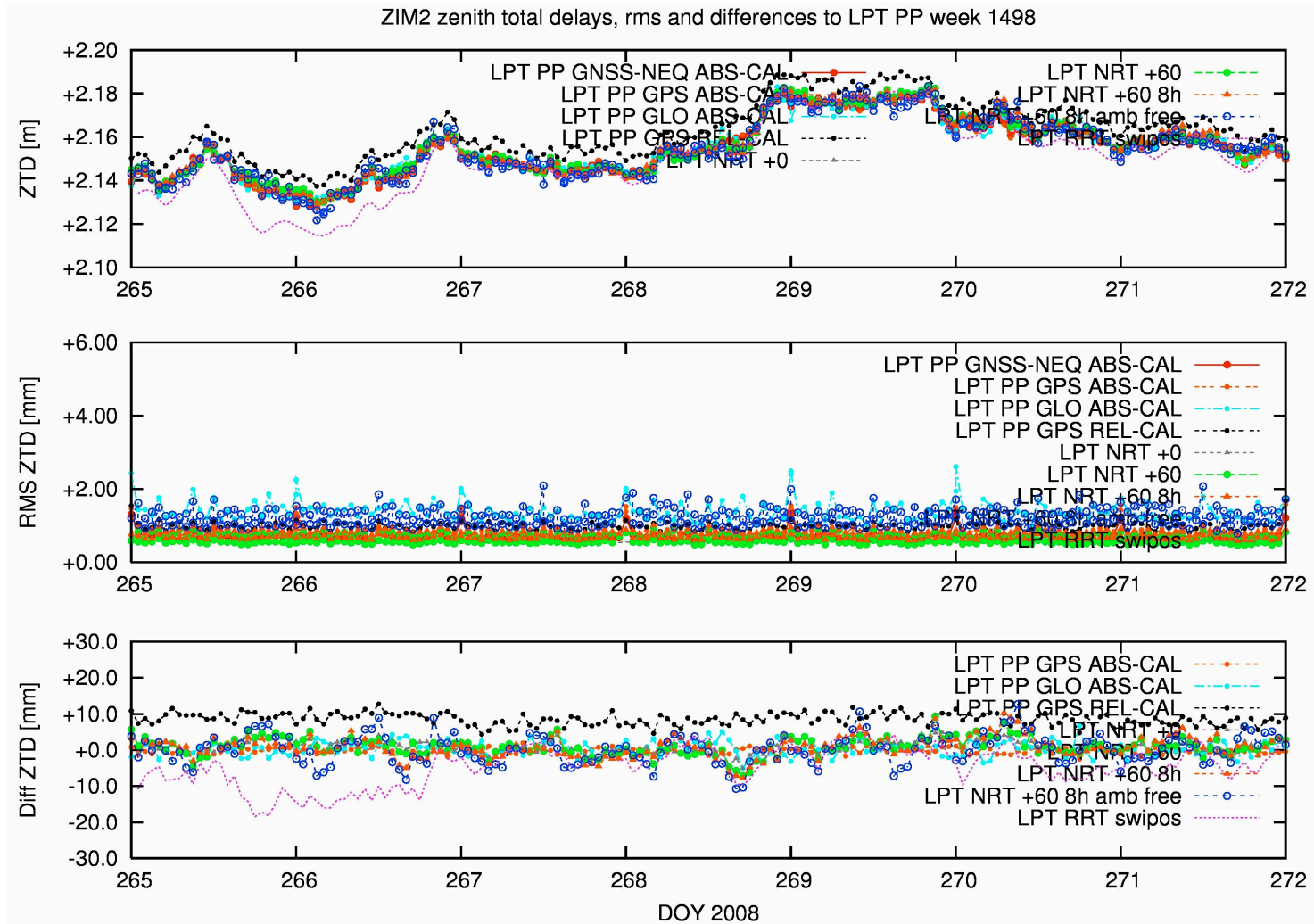
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Final ZTD check of all available solutions

Example: GPS-week 1498, site ZIM2





Conclusions

- GNSS data are routinely processed for EUREF including GLONASS ambiguity fixing on a daily and hourly basis (BSW 5.0⁺)
- Troposphere is routinely monitored together with coordinates – now also including comparisons with radio sonde data





Proposal: official ETRF coordinates on EPN site

- EUREF main goal: **maintenance of the reference frame** realized by
 - campaigns (“historically”, EUREF TWG classification + EUREF campaign database)
 - permanent networks
- coordinates of permanent stations:
 - EPN web portal gives detailed information on coordinates. coordinates are mainly “scientific” oriented:
 - weekly
 - ITRF / ETRF coordinates
 - EPN cumulative coordinate sets
 - EPN stations are also used to realize the national reference systems, which are mostly aligned to ETRS



Proposal: official ETRF coordinates on EPN site (2)

EPN

National level (e.g. CH)

COORDINATES from last weekly EPN solution, EPN cumulative and IERS in ITRS or ETRS89

	epoch t_0	X_{weekly}	Y_{weekly}	Z_{weekly}
IGS05	2008.66 (Wk No 1495)	4331297.0169 ± 0.0008	567555.9444 ± 0.0003	4633133.9816 ± 0.0009

	epoch t_0	Position (m)			Velocity (m/y)		
		X_{EPN}	Y_{EPN}	Z_{EPN}	VX_{EPN}	VY_{EPN}	VZ_{EPN}
ITRF2005 (from 182/98)	2000.0	4331297.1430 ± 0.0000	567555.7870 ± 0.0000	4633133.8850 ± 0.0000	-0.0131 ± 0.0001	0.0179 ± 0.0000	0.0123 ± 0.0001
ITRF2005 (from 310/98)	2000.0	4331297.1310 ± 0.0000	567555.7900 ± 0.0000	4633133.8720 ± 0.0000	-0.0131 ± 0.0001	0.0179 ± 0.0000	0.0123 ± 0.0001
ITRF2005 (from 309/06)	2000.0	4331297.1300 ± 0.0010	567555.7920 ± 0.0000	4633133.8720 ± 0.0010	-0.0131 ± 0.0001	0.0179 ± 0.0000	0.0123 ± 0.0001
ETRF00(RO5) (from 182/98)	2000.0	4331297.3420 ± 0.0000	567555.6350 ± 0.0000	4633133.7270 ± 0.0000	0.0007 ± 0.0001	0.0002 ± 0.0000	0.0016 ± 0.0001
ETRF00(RO5) (from 310/98)	2000.0	4331297.3300 ± 0.0000	567555.6380 ± 0.0000	4633133.7130 ± 0.0000	0.0007 ± 0.0001	0.0002 ± 0.0000	0.0016 ± 0.0001
ETRF00(RO5) (from 309/06)	2000.0	4331297.3290 ± 0.0010	567555.6400 ± 0.0000	4633133.7130 ± 0.0010	0.0007 ± 0.0001	0.0003 ± 0.0000	0.0016 ± 0.0001

	epoch t_0	Position (m)			Velocity (m/y)		
		X_{IERS}	Y_{IERS}	Z_{IERS}	VX_{IERS}	VY_{IERS}	VZ_{IERS}
ITRF2005	2000.0	4331297.1400 ± 0.0010	567555.7870 ± 0.0000	4633133.8820 ± 0.0010	-0.0126 ± 0.0001	0.0181 ± 0.0001	0.0127 ± 0.0001
ITRF2005 (from 310/98)	2000.0	4331297.1310 ± 0.0010	567555.7890 ± 0.0000	4633133.8720 ± 0.0010	-0.0126 ± 0.0001	0.0181 ± 0.0001	0.0127 ± 0.0001
ITRF2000	1997.0	4331297.1820 ± 0.0020	567555.7300 ± 0.0010	4633133.8450 ± 0.0020	-0.0138 ± 0.0004	0.0185 ± 0.0002	0.0100 ± 0.0005
ITRF2000 (from 312/98)	1997.0	4331297.1770 ± 0.0020	567555.7320 ± 0.0010	4633133.8400 ± 0.0030	-0.0138 ± 0.0004	0.0185 ± 0.0002	0.0100 ± 0.0005
ITRF97	1997.0	4331297.1970 ± 0.0020	567555.7370 ± 0.0010	4633133.8360 ± 0.0020	-0.0115 ± 0.0005	0.0177 ± 0.0004	0.0107 ± 0.0005
ITRF96	1997.0	4331297.2010 ± 0.0030	567555.7400 ± 0.0020	4633133.8430 ± 0.0030	-0.0111 ± 0.0003	0.0173 ± 0.0004	0.0126 ± 0.0003

	epoch t_0	Position (m)			Velocity (m/y)		
		X_{IERS}	Y_{IERS}	Z_{IERS}	VX_{IERS}	VY_{IERS}	VZ_{IERS}
ETRF2005	2000.0	4331297.3480 ± 0.0010	567555.6410 ± 0.0000	4633133.7270 ± 0.0010	0.0012 ± 0.0001	0.0005 ± 0.0001	0.0020 ± 0.0001
ETRF2005 (from 310/98)	2000.0	4331297.3390 ± 0.0010	567555.6430 ± 0.0000	4633133.7170 ± 0.0010	0.0012 ± 0.0001	0.0005 ± 0.0001	0.0020 ± 0.0001
ETRF2000	1989.0	4331297.3470 ± 0.0040	567555.6330 ± 0.0020	4633133.7170 ± 0.0040	-0.0007 ± 0.0004	0.0001 ± 0.0002	-0.0001 ± 0.0005
ETRF2000 (from 312/98)	1989.0	4331297.3420 ± 0.0040	567555.6350 ± 0.0020	4633133.7120 ± 0.0050	-0.0007 ± 0.0004	0.0001 ± 0.0002	-0.0001 ± 0.0005
ETRF97	1989.0	4331297.3310 ± 0.0040	567555.6360 ± 0.0030	4633133.7010 ± 0.0040	0.0015 ± 0.0005	-0.0004 ± 0.0004	0.0008 ± 0.0005
ETRF96	1989.0	4331297.3310 ± 0.0030	567555.6430 ± 0.0030	4633133.6930 ± 0.0030	0.0020 ± 0.0003	-0.0009 ± 0.0004	0.0026 ± 0.0003

If station used in national networks basing on ETRS

ETRF93	Epoch 1993.0	4331297.339	567555.638	633133.717
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swisstopo: Zimmerwald

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Federal Administration admin.ch
Federal Department of Defence, Civil Protection and Sport
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Did you know that ...

Surveys
Reference systems
Transition of reference frames
Geostation Zimmerwald
Observation procedures
Control networks
GNSS permanent networks

AGNES
Analysis center
National border
Positioning (GNSS)
Cadastral Surveying
FAQ
Geodata production
Map production
Geology
Spatial data infrastructure
Geoinformation

Zimmerwald

AGNES station ZIMM

GNSS receiver: TRIMBLE NETRS
GPS antenna: TRM29659.00
Antenna height: 0.000 m
Phase center L1: 0.110 m
Phase center L2: 0.128 m

Complete relative PCV antenna model (BERNESE format V5.0)

PCV antenna model

GNSS antenna
Phase center L1
Phase center L2
Reference point of antenna
Antenna height
Reference point

Antenna valid since: 23.02.2006
Information update: 20.08.2008

Reference coordinates: ETRF93
X = 4331297.339
Y = 567555.638
Z = 4633133.717
φ = 46° 52' 37.540669"
λ = 7° 27' 54.983511"
h = 956.338

LV95 (CH-1903+):
E = 2602030.740
N = 1191775.030
H = 906.550 (ell.)

Automatically via RINEX header

Personal communication (e-mail) from NMA / station manager or using standardized file format (ftp)



Proposal: official ETRF coordinates on EPN site (3)

Displaying of “official national ETRF coordinates” for stations used within EPN and national permanent networks on the EPN web site (optional for NMA’s)

- ☺ EUREF underlines the position as an umbrella of the national mapping agencies; the link EPN <-> NMA is visible on the web + info must flow
- ☺ for EUREF and all users of the data of the station: differences of “official national” to “scientific” ETRF coordinates. (evtl. “displacement” map of the differences show how well ETRS is realized: problems for sites / entire countries)
- ☺ for the mapping agencies: EPN monitors the compliance with ETRF scientific solutions as an service for the contribution countries; EUREF knows better about the used national coordinates in case of new reference frame definitions ETRF00(RYY).



Proposal: official ETRF coordinates on EPN site (4)

Displaying of “official national ETRF coordinates” for stations used within EPN and national permanent networks on the EPN web site (optional for NMA’s)

- ☹ to be done (EUREF TWG + EPN CB + NMA / station manager):
- list of EPN stations, which are part of national reference networks collection of the coordinates (could be with the RINEX header ?)
 - document about update procedure (changes are extremely rare; history is sufficiently archived by NMAs)
 - include info to the EPN web site; optional: generation of an downloadable coordinate file



Remarks, Comments, Suggestions?

- idea is to present that at the next EUREF TWG (only with some positive feedbacks...)
- I'm looking forward to your valuable input also later by mail



File format for information exchange

File name: CH_200810021.ETRF

Station	DOMES	X	Y	Z	Frame	Epoch	valid from	to
ZIM2	14001M008	4331300.14431	567537.08241	4633133.49770	ETRF93	1993.0	1995 01	01
ZIMM	14001M004	4331297.33878	567555.63796	4633133.71740	ETRF93	1993.0	2007 11	09



Example swisstopo

Difference between
“official” and
scientific coordinates

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Eidg. Departement für Verteidigung, Bevölkerungsschutz und Sport
Bundesamt für Landestopografie swisstopo

Startseite | Übersicht | Kontakt | Wo finde ich was?

Aktuell | Themen | Produkte | Interaktive Anwendungen | Dokumentation | Di...

Wissenswertes
Vermessung
Referenzsysteme
Bezugrahmenwechsel
Geostation Zimmerwald
Messverfahren
Fixpunktnetze
GNSS-Permanetnetze
AGNES
Auswertezentrum
PNAC monitoring
AGNES-Status / Zeitreihen
Landesgrenze
Positionierung (GNSS)

Startseite > Themen > Vermessung > GNSS-Permanetnetze > Auswertezentrum > Zeitreihen

AGNES-Status / Zeitreihen

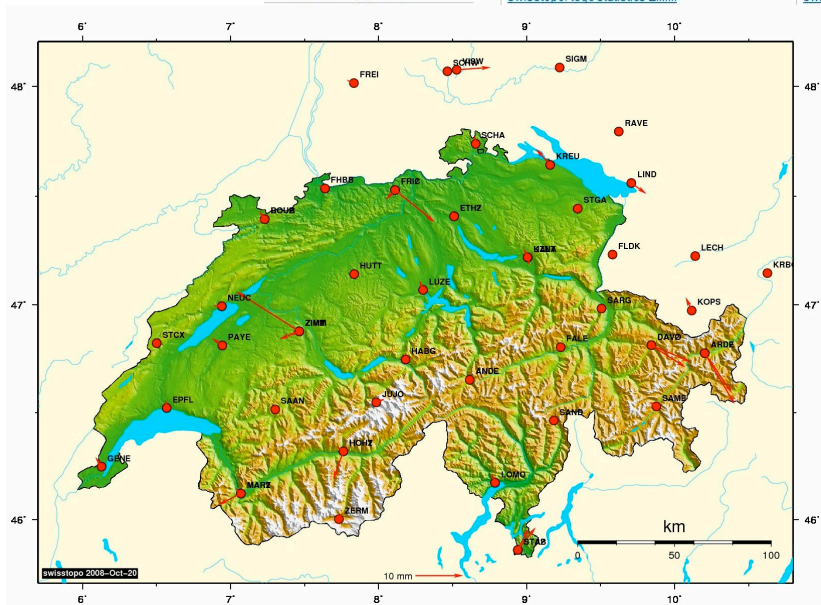
links of this page generated at: 17-Oct-2008 06:45:01

Data monitoring
[swisstopo: Hourly Check](#)
[swisstopo: Datapool summary file](#)
[swisstopo: Hourly missing data](#)
[swisstopo: Datapool hourly log file](#)
[swisstopo: Daily check](#)
[swisstopo: Datapool daily summary file](#)
[swisstopo: tenc statistics ZIMM](#)

Analysis monitoring
[swisstopo: PNAC s](#)
[swisstopo: PNAC p](#)
[swisstopo: AMET p](#)
[swisstopo: AMET h](#)
[swisstopo: AMET N](#)
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[topo: MULTI](#)
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NUM	NAME	FLG	RESIDUALS IN MILLIMETERS		
1	ANDE	E T	0.6	-1.3	1.6
1	ARD2	E T	-8.6	4.9	-10.0
1	ARDE	E T	-6.9	4.7	-6.4
1	BOU2	E T	1.2	-1.0	-0.4
1	BOUR	E T	-0.3	-1.1	-0.2
1	DAV2	E T	-4.2	5.6	-5.6
1	DAVO	E T	-3.2	6.5	-4.5
1	EPFL	E T	1.3	-0.2	0.5
1	ETH2	E T	1.2	-0.3	0.1
1	ETHZ	E T	-0.6	0.1	-0.5
1	FALE	E T	-0.2	-0.8	0.3
1	FHBB	E T	0.9	-1.3	-0.2
1	FLDK	E T	0.2	-0.3	-2.0
1	FREI	E T	0.8	-1.3	0.2
1	FRI2	E T	-4.7	6.7	19.4
1	FRIC	E T	-1.5	-1.4	-0.3
1	GENE	E T	1.7	-1.0	-2.2
1	HABG	E T	1.4	0.3	-2.3
1	HOH2	E T	1.0	-1.0	1.1
1	HOHT	E T	-4.6	-1.6	-6.4
...

[swisstopo: MULTI helmert to official crd](#)







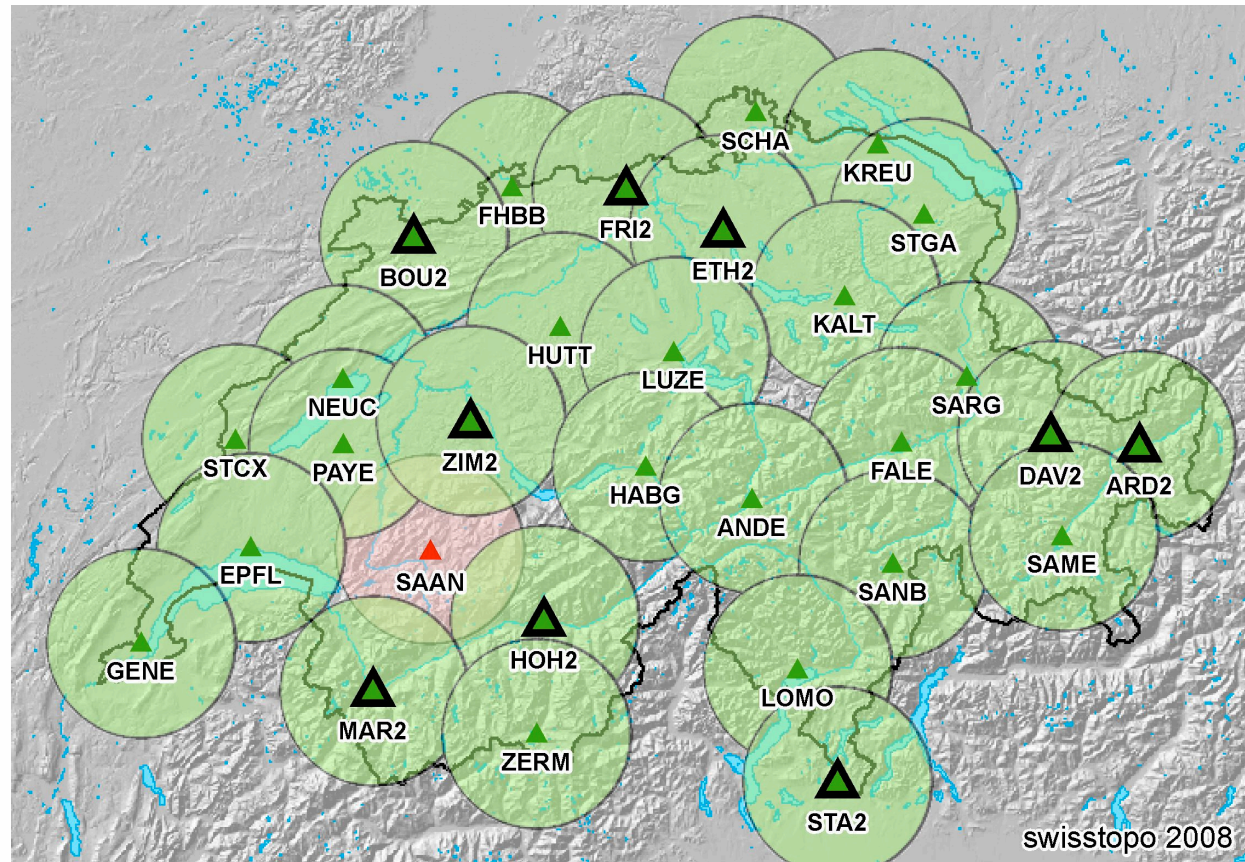
Current GNSS status of the AGNES network

▲ „Normal station“:
GNSS receiver and
antenna installed

▲ „Double station“:
New antenna mount for
GNSS antenna
GNSS and GPS run
simultaneously

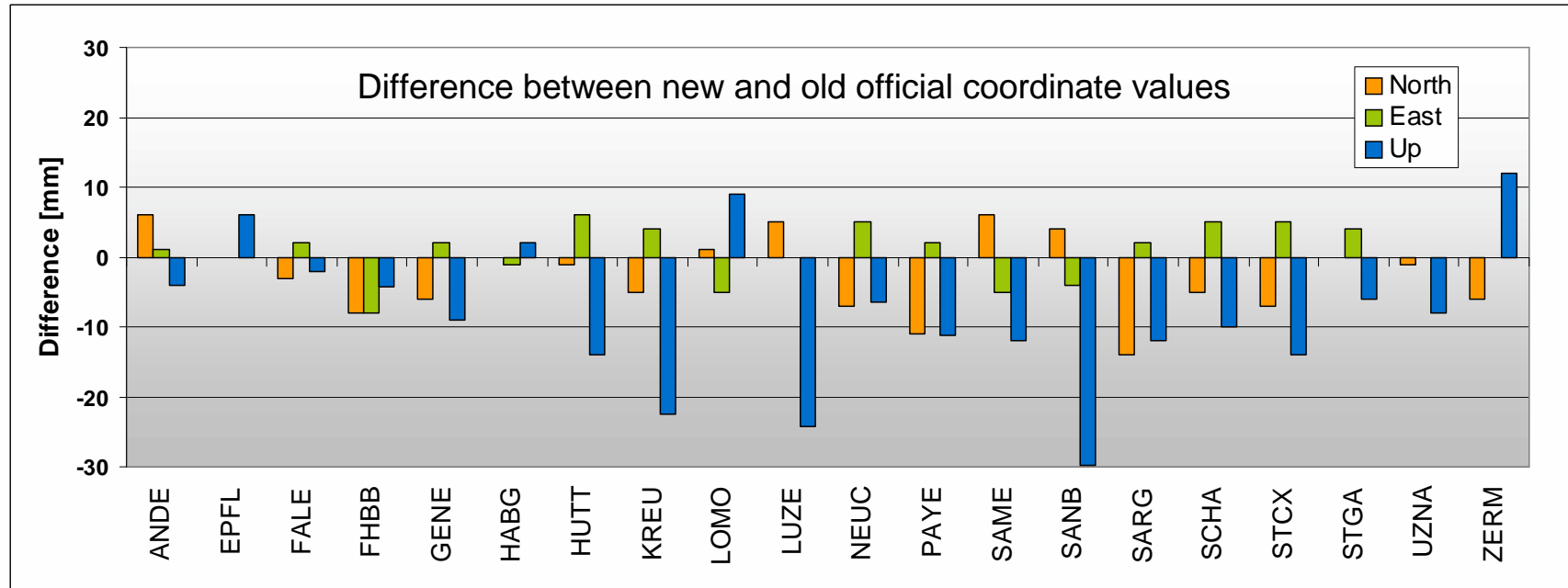
▲ „Double station“:
GNSS not yet installed

New equipment:
Trimble NetR5 receivers
and Zephyr GNSS antennas





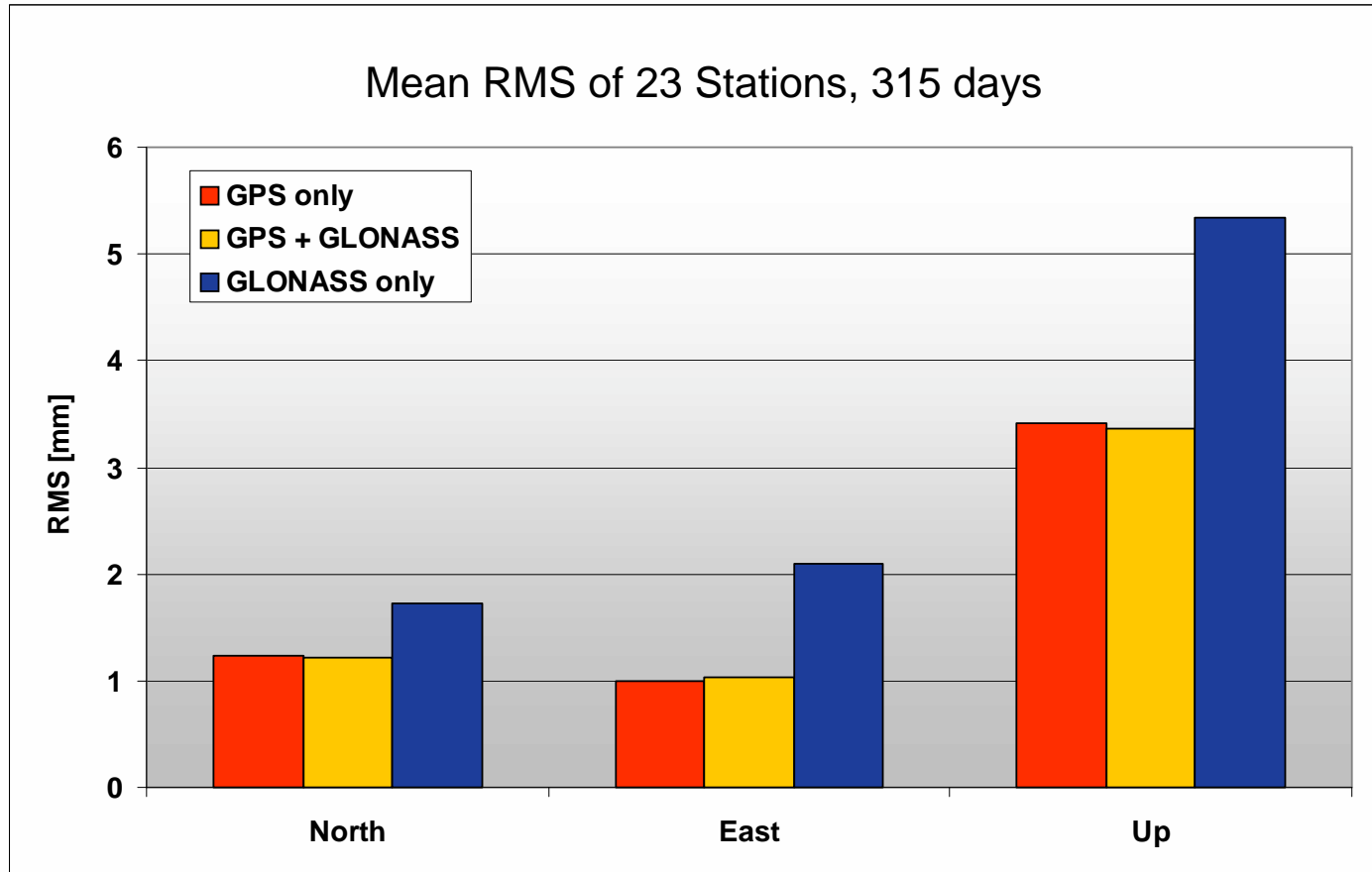
Reference frame stability: New coordinates for AGNES reference sites



- Total difference is the sum of antenna change, station movement since last determination, and rounding effects of the old coordinates
- Double stations help to ensure the consistency of the national reference frame during transition time



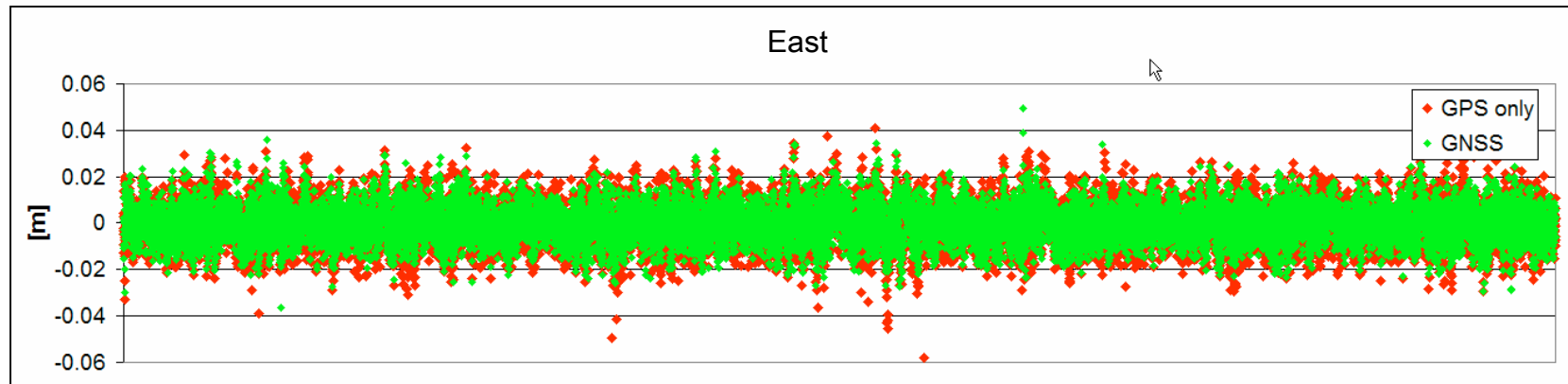
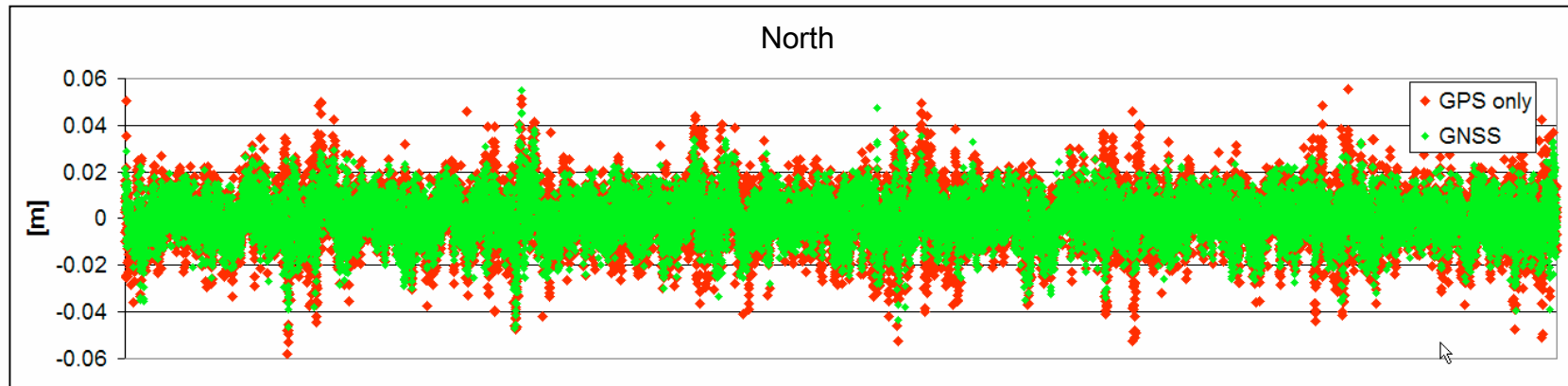
Post-processing of the AGNES network: Summary of the repeatability values





Kinematic solutions: Residuals of GPS vs. GNSS solutions

Station San Bernardino, 7 days, 19'000 position estimates





Kinematic solutions: Improvement using additional GLONASS data

Mean values of 7 days, 24 stations:

	North	East	Up
RMS GPS	7.3 mm	5.4 mm	12.4 mm
RMS GNSS	6.0 mm	4.8 mm	10.8 mm
Improvement	17 %	11 %	13 %

Gain up to 30% for North, 13% for East, and 16% for Height component for stations in mountainous regions