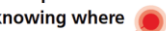




wissen wohin
savoir où
sapere dove
knowing where



Multi-GNSS developments for the EPN and for the Swiss networks

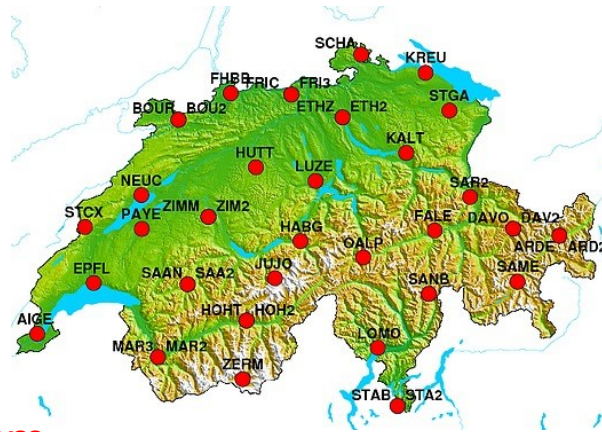
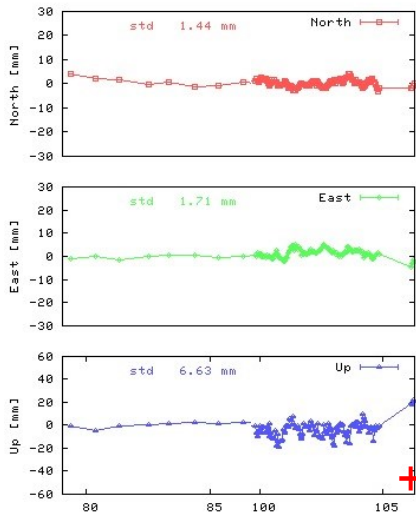
E. Brockmann, S. Lutz, D. Ineichen, S. Schaer
+ **EPN Multi-GNSS WG**



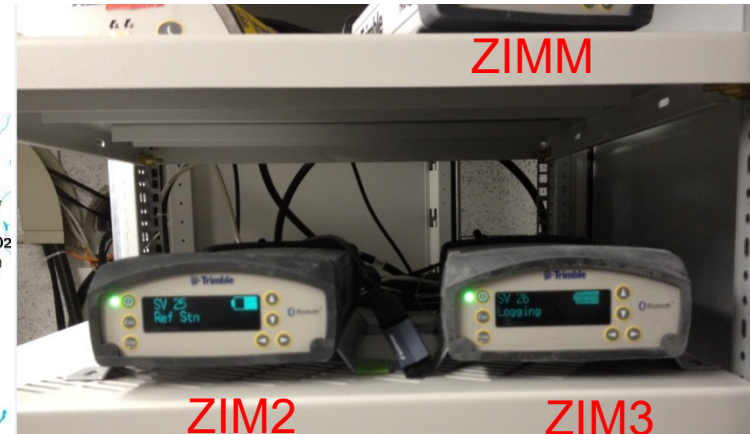
Multi-GNSS at Swiss permanent stations

- Feb-May 2015: all 41 Swiss stations are enhanced from **GPS/GLO receivers to Multi-GNSS** (+ 15 chokering antennas: causing jumps of ~ 2 cm despite individual antenna PCVs)
- June 19, 2015: **AGNES** data flow in RINEX3

PAYE



ZIMJ
(Javad)

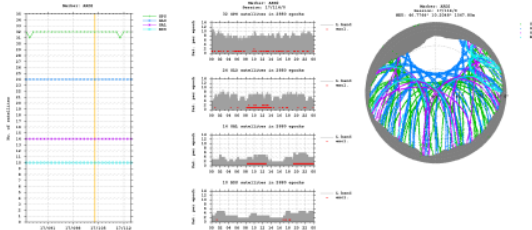




- Monitoring using Anubis and BNC

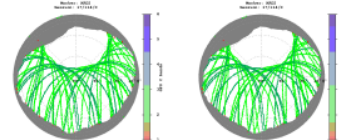
- 130 stations with RINEX3 (long and short names)

- BNC for editing an merging RINEX3



> 50 (R2) – 110 (R3)
plots/site/day

Bands



Sortable table

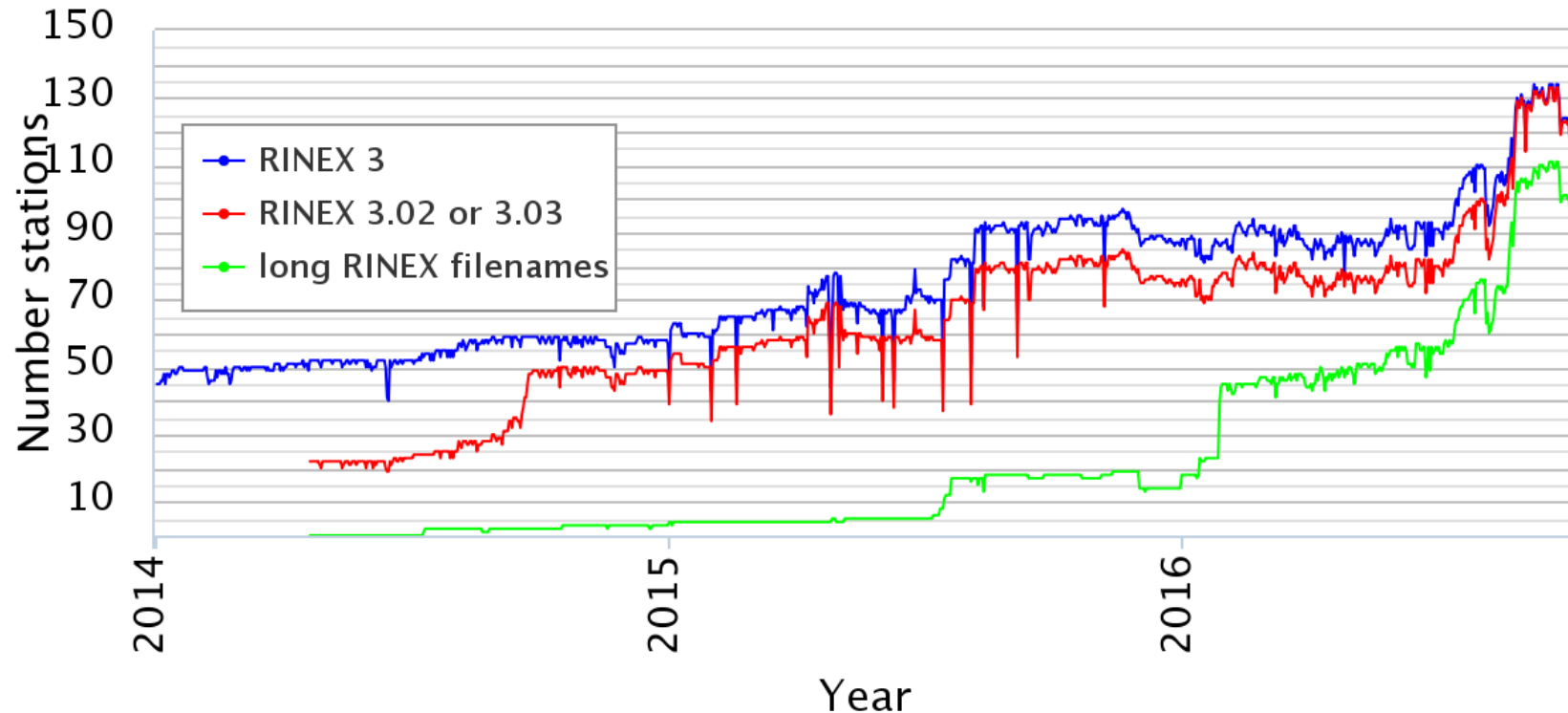
Multi-GNSS in EPN and CH

E. Brockmann



RINEX3 Format in Europe

EUREF
Multi-GNSS
WG



-> still, ~50% RINEX2, only

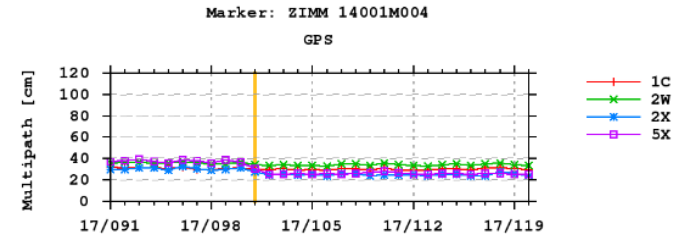
-> hourly RINEX3 far from operational



Firmware & RINEX3

EUREF
Multi-GNSS
WG

- Many lessons learned
 - during Multi-GNSS activities (RINEX3 checking)
 - during field equipment data flow testing
 - as station manager Zimmerwald
- Examples
 - Missing observables (in case of connecting to special antenna types)
 - Format issues (Header; observation records) – empty compressed RINEX3 files



Firmware 5.22
April 11, 2017





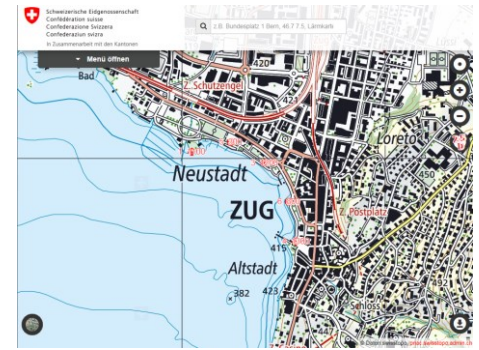
Field Equipment swisstopo

- Old GPS-only receivers end-of life reached
- Evaluation campaign in Thun (December 2015)
- All manufacturers fulfilled technical specifications
- Purchase of 8 **Multi-GNSS** receivers and antennas end of 2015: Trimble NetR9 in Feb. 2016; **RINEX3 data flow** in place





Zug GNSS Test campaign



- April 5-6, 2016
 - 1 session old equipment
 - 1 session new equipment
- Data flow validation (repair formats; missing APROX POSITION in RINEX3)
- BSW53 Tests
 - MGEX orbits CODE
 - 60 BSW53 BPE alternatives analysed





Influence: GPS -> Multi-GNSS

Session 1 versus Session 2

FILE 1: F1_160970.CRD: AUTOCAMP_160970: Final session coordinate results

FILE 2: F1_160980.CRD: AUTOCAMP_160980: Final session coordinate results

LOCAL GEODETIC DATUM: IGB08

RESIDUALS IN LOCAL SYSTEM (NORTH, EAST, UP)

NUM	NAME	FLG	RESIDUALS IN MILLIMETERS			
1	1100	A A	-0.08	0.01	0.58	
2	1131.652	A A	-0.37	1.79	13.27	V
3	1200	A A	-0.95	0.67	0.20	
4	1300	A A	0.22	-0.50	-1.24	
5	300	A A	0.45	-0.28	-0.60	
6	800	A A	0.36	0.09	1.06	
RMS / COMPONENT			0.57	0.44	0.92	
MEAN			0.00	0.00	0.00	
MIN			-0.95	-0.50	-1.24	
MAX			0.45	0.67	1.06	



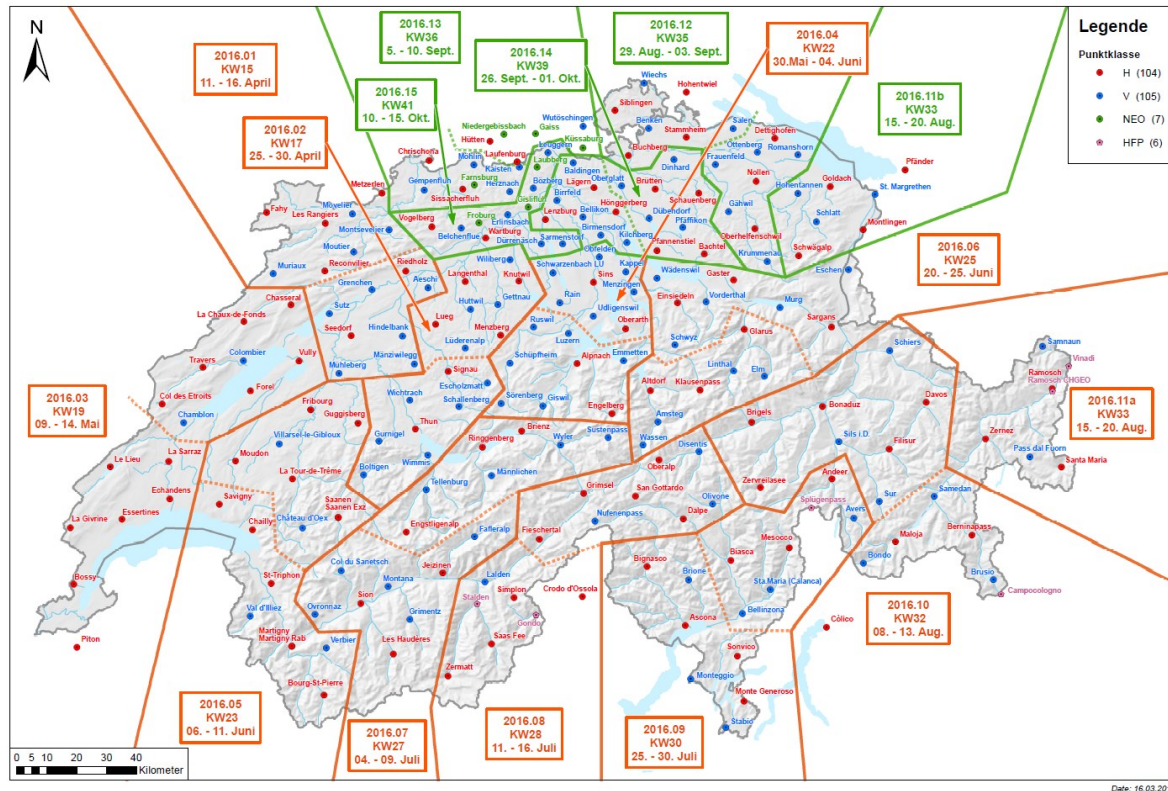
Comparison: Old (GPS) – New (Multi-GNSS)

Steel mast vs. Tripod
→ Tripod for CHTRF



CHTRF2016 Multi-GNSS campaign

- All ~200 reference points to be measured
- Multi-GNSS experiences gained on this campaign (permanent analysis second step; less time critical)





CHTRF2016 Multi-GNSS campaign

- 10 operators
- 15 weeks (Mo – Sa)
- April 11 – October 14, 2016
- ~ 44 hours of measurements per point
- All data analysed already: **Multi-GNSS; BSW53**
 - Horizontal position ~ 1 cm with official coordinates
 - Vertical position: to be validated (switch from relative to absolute antenna PCVs)

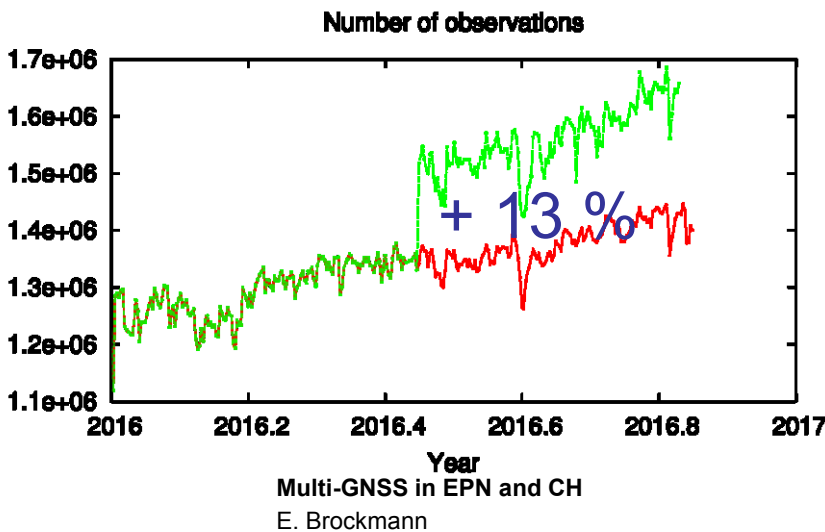




Switch to Multi-GNSS for EUREF

- E-Mail announcement on 29-Jul-2016 (EUREF Mail 8644)
- RINEX-3 observation data (if available), otherwise RINEX-2
- **CODE MGEX products available in time! Thanks to AIUB/CODE**
- Troposphere modelling changed from GMF to VMF
- ~ 13% more double-difference observations w.r.t. GPS+GLO (additional constellations not yet complete)
- Impact on coordinates is small: std N/E/Up: 0.3/ 0.3/0.7 mm

week 1905



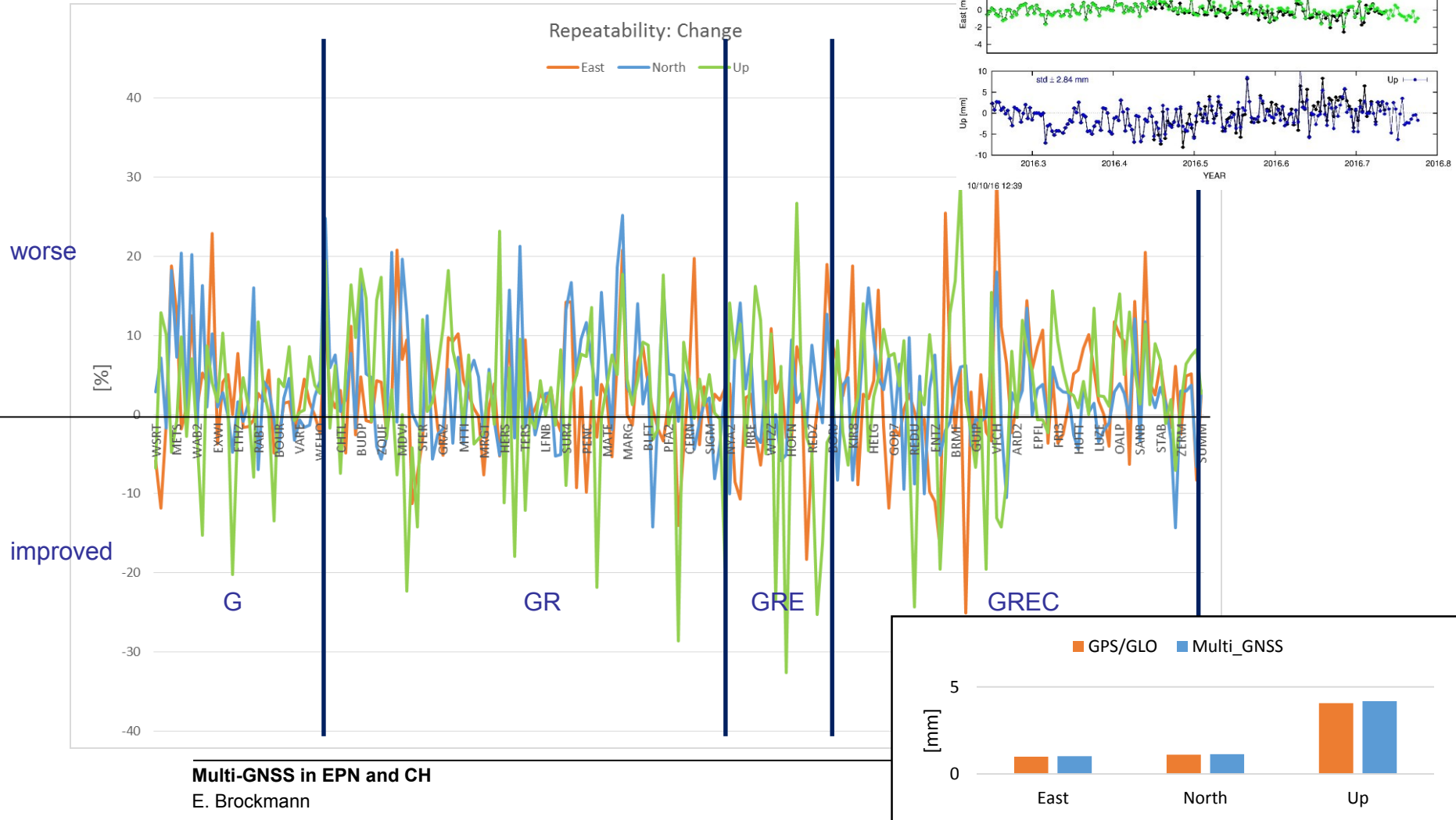
LIST OF OUTLIER STATIONS

STATION		RESIDUALS (MILLIMETERS)			
		N	E	U	
EGLT	10032M001	<u>-0.91</u>	-0.01	-0.87	Egletons, FR (GREC)
GUIP	10004M501	-0.37	<u>-0.87</u>	0.94	Guipavas, FR (GREC)
OBE4	14208M007	<u>1.14</u>	<u>0.87</u>	0.14	Oberpfaffenhofen, DE (GRE)



AGNES Multi-GNSS: Repeatabilities

- 206 stations, 15 parallel proc. weeks
new vs old processing scheme





Inter-System parameter

- AGNES processing using Multi-GNSS
- Since Nov. 2016 on pnac web

GPS (Ref)

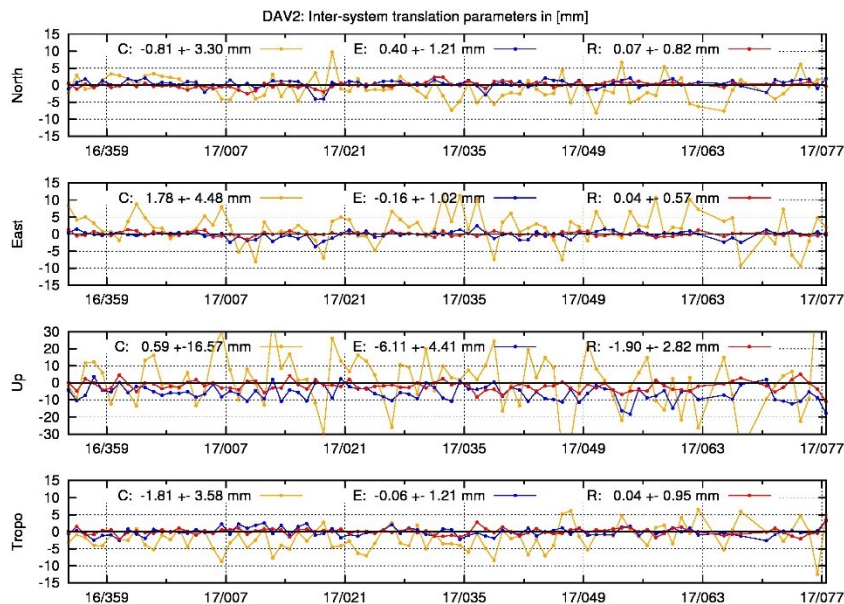
GLO

GAL

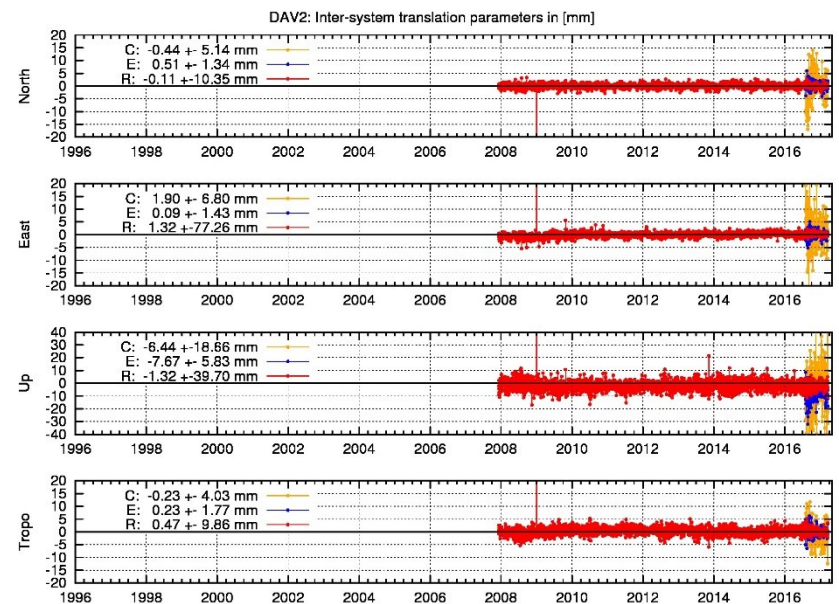
BDS

DAV2

Daily: last month



Daily: Long-term



GPS/GLO
from repro2

Multi-GNSS
BSW53



IGS14 antenna PCV change

IGS14
REFERENCE FRAME
TRANSITION
GPS WEEK 1934
29 JANUARY 2017

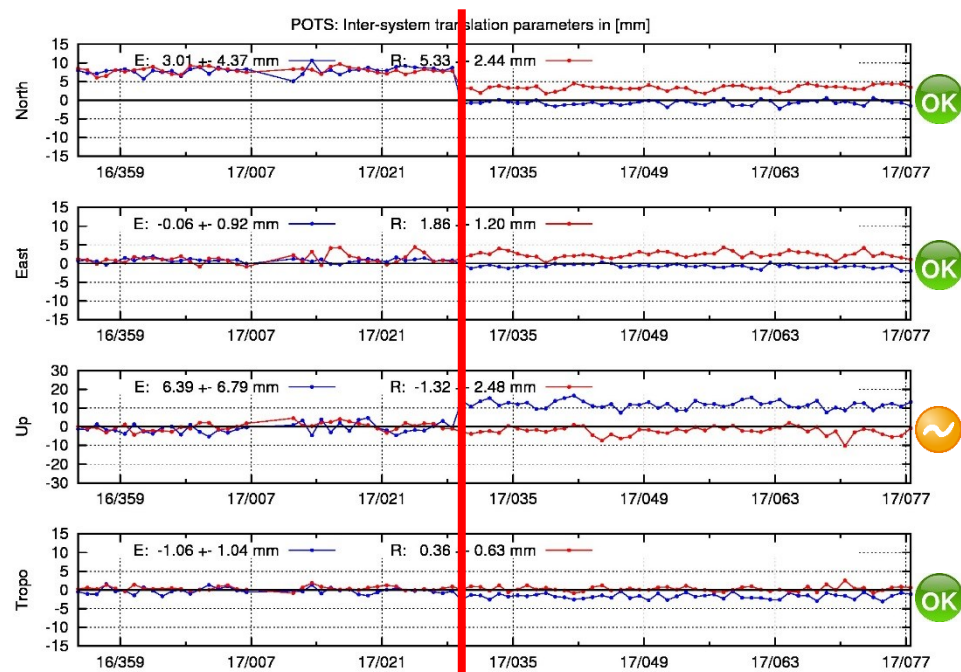
http://pnac.swisstopo.admin.ch/pages/en/qsumpots.html#TRA_MONTH

- POTS (JAV_RINGANT_G3T NONE 316)
case EPN: ind. PCVs from Robot incl. GAL

KOPS antenna change (2012)
APOS – dh 3 cm GLO-GPS

IGS08 group

E14 robot calibration



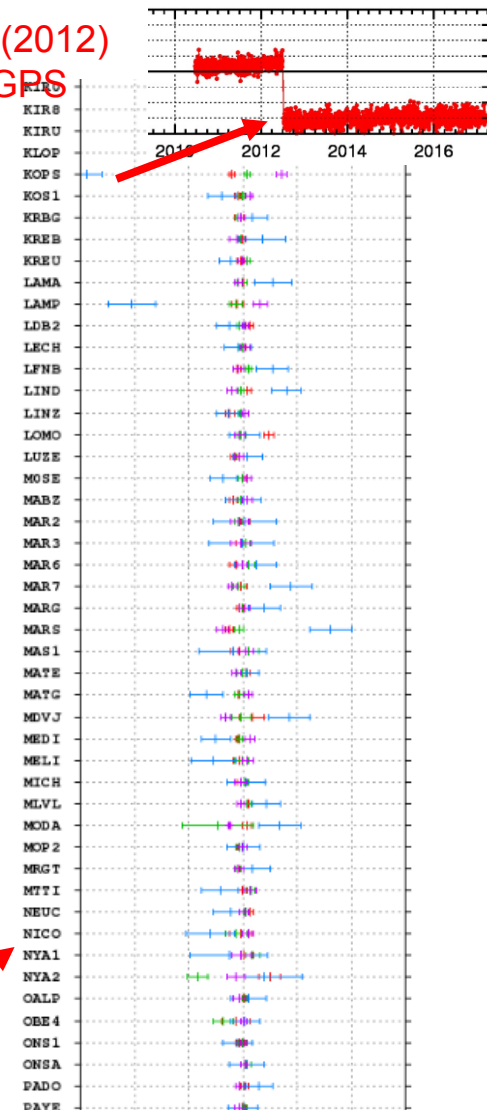
GLO
GAL

GAL satellite PCVs
from GPS/GLO

IGS14 rec. antenna model change
(Feb 2017)

Multi-GNSS in EPN and CH
E. Brockmann

Mean estimates for all stations: R :4P - 2P
Mean estimates for all stations: E :4P - 2P
Mean estimates for all stations: C :4P - 2P



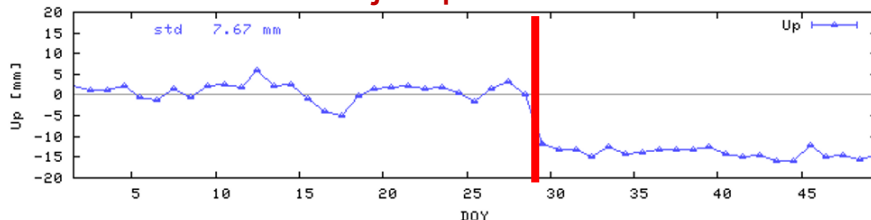


Antenna model change at 2017-01-29 -> long-term solutions

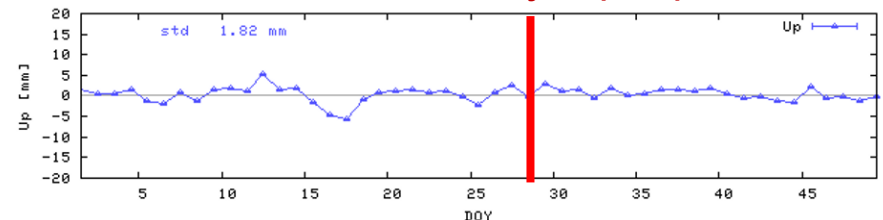
- reference frame change IGS08 -> IGS14 with no effect (network solutions simply aligned to another set of coordinates)
- antenna model (PCV): IGS08 -> IGS14 introduces jump in time series (mean of 20->25 antennas; usefull?)
- tested methods (using 204 stations EU+CH)
 - Keep I08 station PCVs + I14 satellite PVCs: no jump
 - 3 weeks parallel processing: jumps calculated + applied
jumps: N+E: < 8 mm ; H: < 15 mm (std: 1.5 | 4.2 mm)
3-W-std:N+E: < 0.1 mm; H: < 0.5 mm (mean: 0.03 | 0.15 mm)

SAPOS - SIGM (TRM59800.00 SCIS): Group->Indiv. PCVs

jump



continue I08 PCV OR jump repair I14 PVC

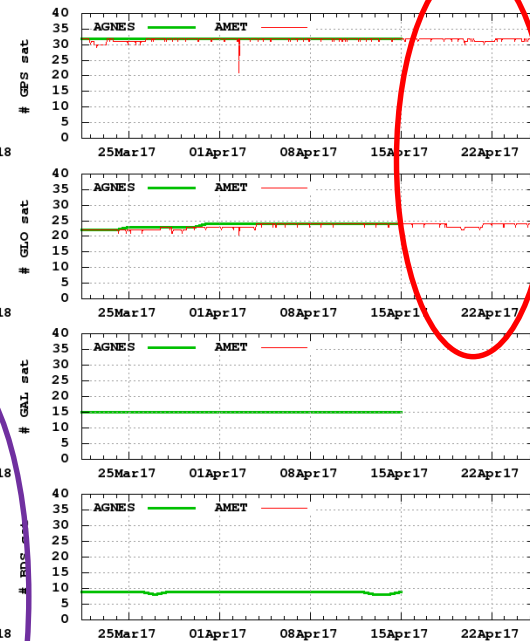
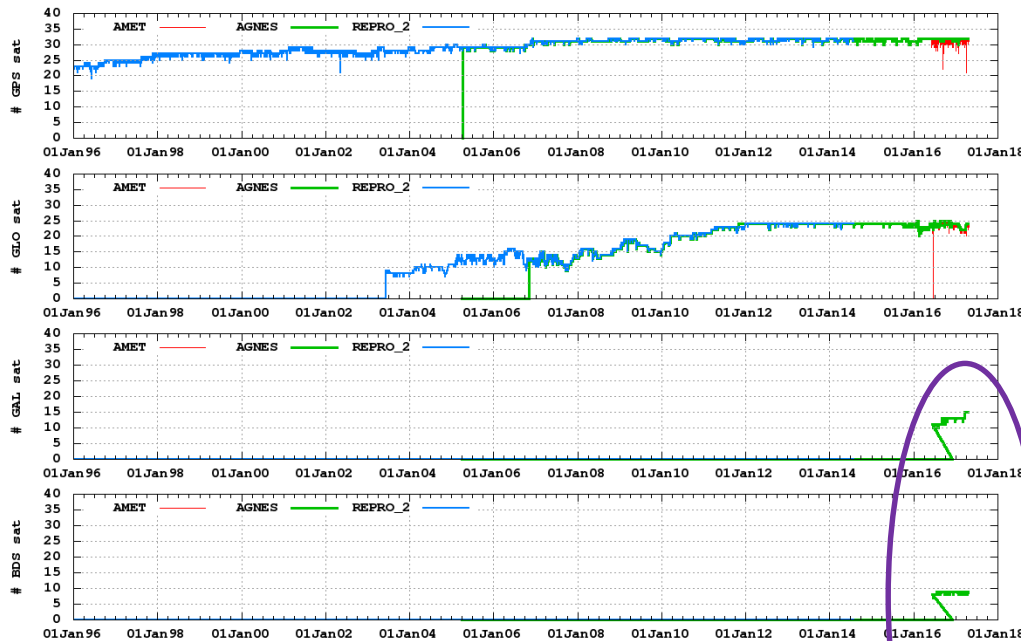




Summary (view on # satellites)

- Reprocessing 2(BSW52): GPS+GLO - next planned in 2-3 yrs **55**
- Campaigns (BSW53): GPS+GLO+GAL+BDS **80**
- EUREF / AGNES (BSW53): GPS+GLO+GAL+BDS
- AMET (hourly) (BSW53): GPS+GLO – Multi-GNSS if EPN hourly available

Number of processed satellites
(2017-04-25 10:39:51 UTC)



31 GPS

24 GLO

15 GAL

10 BDS

80 Total

23

Multi-GNSS in
E. Brockmann CH

38

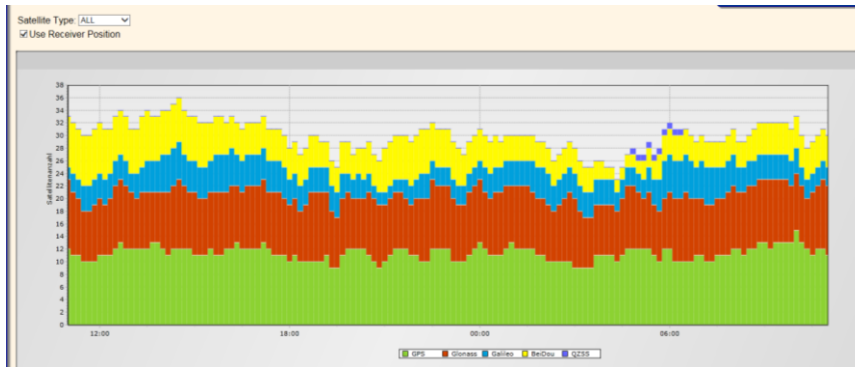
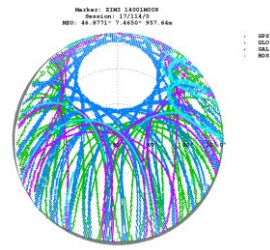
55

80

GAL+BDS



Thanks for your attention



GNSS view from Zimmerwald

