



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

armasuisse
Bundesamt für Landestopografie swisstopo

wissen wohin
savoir où
sapere dove
knowing where



swisstopo Report for EGVAP 2016

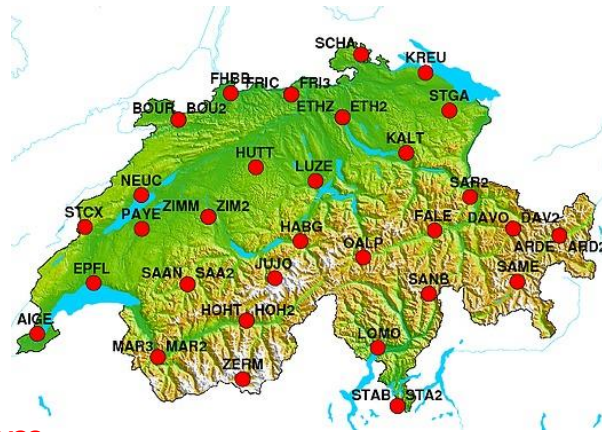
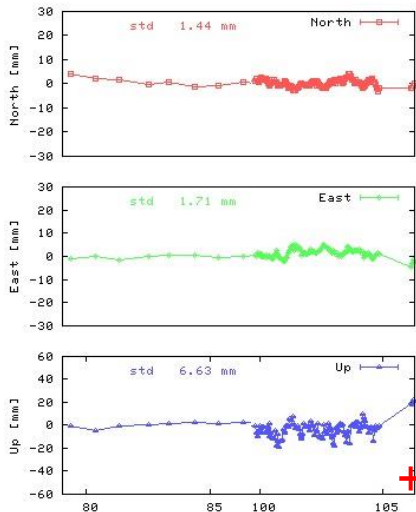
E. Brockmann



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



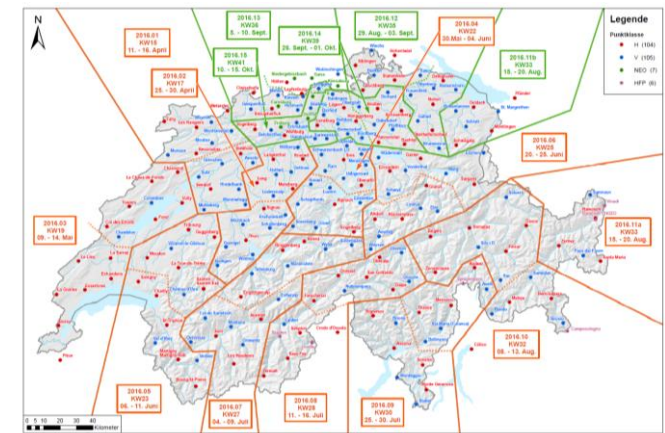
ZIMJ
(Javad)





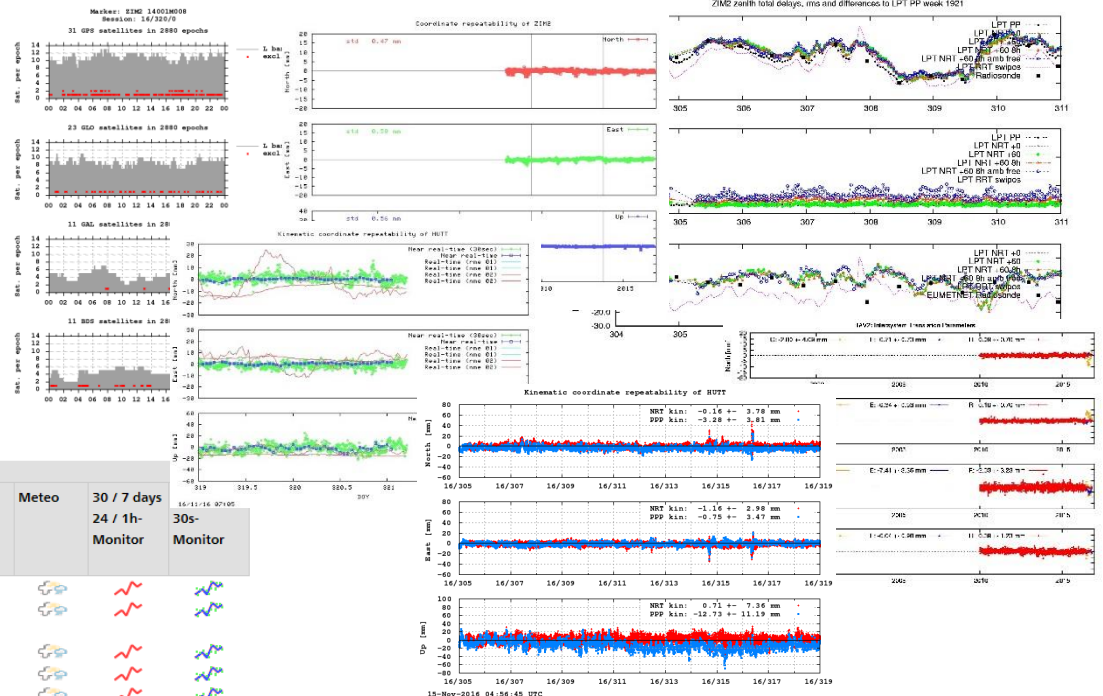
Further Multi-GNSS work

- Field equipment Multi-GNSS tested and purchased: Dec. 2015 - Feb. 2016
- Campaigns measurements, data flow and analysis adjusted
- Installation and testing BSW53 (devel. Version BSW)
- 200 control points measured + analysed in Multi-GNSS mode (April – Oct. 2016)





- Web based status of the processing with frequent updates
- Amazon web cloud based since Mid 2016
- Data, coordinates (kin, day, week, year), Tropo, short baselines, EPN/IGS/EGVAP/AIUB-links





Long file names in IGS and EPN

- Chair of Multi-GNSS WG EUREF
- Station Manager: exercise using ZIM? Data: Switched on Juli 28, 2016 (switch; not a duplication) -> most ACs did it like that; some duplicated data.

Obs Files ZIM2:

Day:

`zim22060.16d.Z -> ZIM200CHE_R_20162060000_01D_30S_MO.crx.gz`

Hour:

`zim2206g.16d.Z -> ZIM200CHE_R_20162060600_01H_30S_MO.crx.gz`

Nav Files ZIM2:

Day: `zim22060.16n.Z -> ZIM200CHE_R_20162060000_01D_GN.rnx.gz`

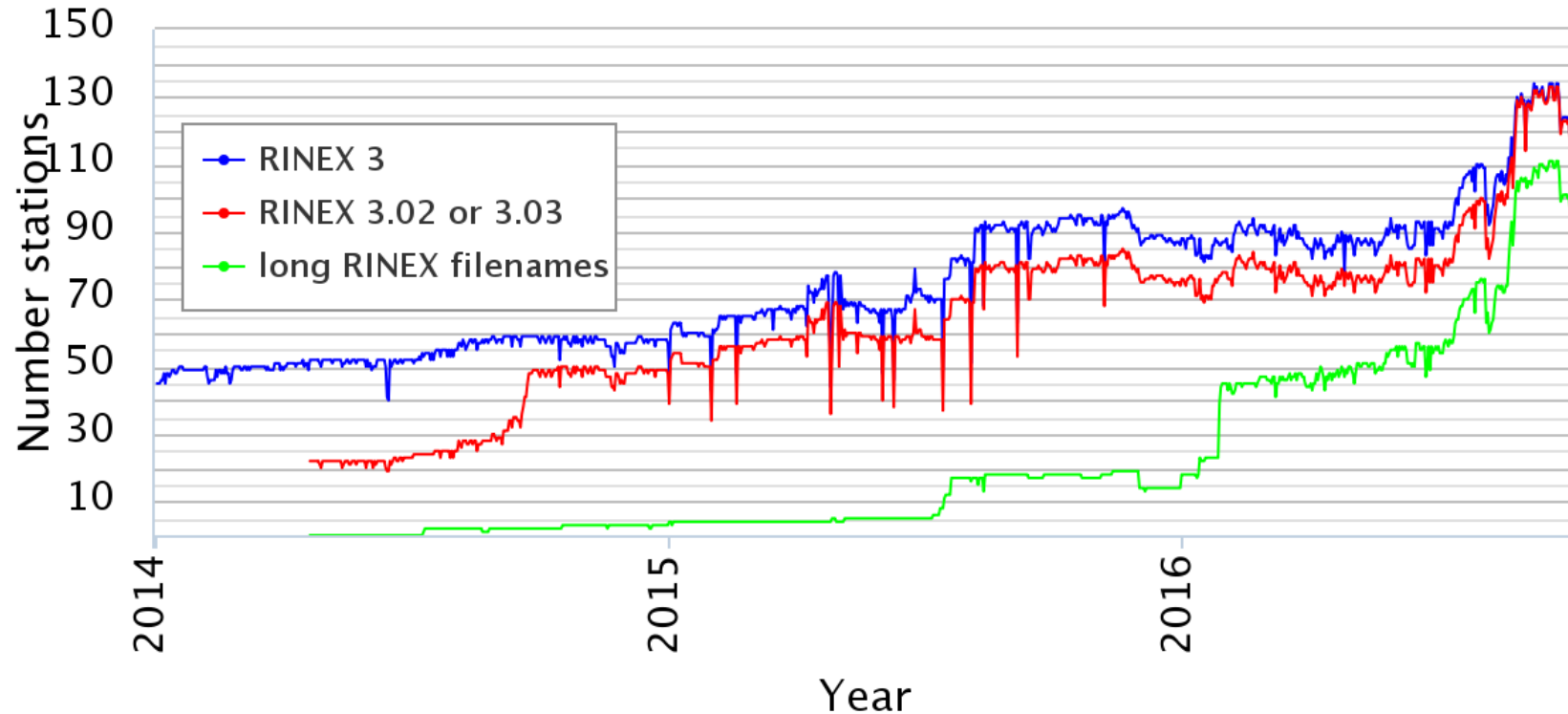
Meteo Files ZIMM:

Day:

`zimm2060.16m.Z -> ZIMM00CHE_R_20162060000_01D_30M_MM.rnx.gz`



RINEX3 Format in Europe



81.7 % stations using LongNames
(134/164) @ BKG-IGS

BKG IGS-obs daily: 177 RINEX2, 128
RINEX3-long; 82 RINEX2+3long ->
53% (95/177) RINEX2, only



RINEX3 Format Problems: AGNES

- Format overflow – bug report Trimble end 2015
- -> Files cannot be compressed
- -> data gaps in Files; repair pre-processor to fix problems
- Announcement of Trimble Oct. 18, 2016
“Both bugs will be removed in firmware 5.20 in Q4, 2016”



C05	39912943.531	6	207837287.791	6	36.600	39912938.891	6	160712943.069	6	38.100	39912934.727	6	168884690.568	6	39.700
C05	39912969.516	6	207837422.749	6	36.500	39912965.051	6	160713047.439	6	37.900	39912960.672	6	168884800.241	6	39.500
C05	39912994.508	6	207837553.645	6	36.200	39912990.148	6	160713148.672	6	38.700	39912985.711	6	168884906.620	6	39.500
C05	39913018.711	6	207837680.747	6	36.100	39913014.348	6	160713246.969	6	38.600	39913010.004	6	168885009.908	6	39.700
C05	67108862.992	6	2147492447.0516	6	36.200	67108858.617	6	2147491559.7216	6	38.500	67108854.328	6	2147491962.2616	6	39.900
C05	67108862.992	6	2147492331.91	6	36.600	67108858.594	6	2147491470.67	6	38.400	67108854.059	6	2147491868.69	6	39.800
C05	67108862.992	6	2147492220.40	6	36.000	67108858.523	6	2147491384.44	6	38.100	67108853.754	6	2147491778.07	6	39.700
C05	67108862.992	6	2147492112.89	6	36.200	67108858.945	6	2147491301.28	6	38.100	67108854.535	6	2147491690.69	6	39.800
C05	67108862.992	6	2147492009.06	6	36.900	67108858.352	6	2147491220.99	6	38.600	67108854.453	6	2147491606.32	6	39.500
C05	67108862.992	6	2147491909.43	6	36.300	67108859.051	6	2147491143.93	6	38.000	67108854.344	6	2147491525.34	6	39.800
C05	67108862.992	6	2147491813.61	6	36.000	67108858.488	6	2147491069.83	6	38.000	67108854.398	6	2147491447.48	6	40.000
C05	67108862.992	6	2147491721.75	6	36.600	67108858.586	6	2147490998.78	6	38.900	67108854.297	6	2147491372.81	6	40.200
C05	67108862.992	6	2147491633.63	6	36.700	67108858.879	6	2147490930.62	6	38.200	67108854.488	6	2147491301.19	6	40.300
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C05	67108862.992	6	2147491468.93	6	36.600	67108858.281	6	2147490803.22	6	38.300	67108854.020	6	2147491167.33	6	40.100
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C05	67108862.992	6	2147601212.95	6	36.800	67108858.395	6	2147575652.03	6	38.800	67108854.160	6	2147580330.31	6	40.100
C05	67108862.992	6	2147601163.73	6	36.400	67108858.406	6	2147575613.95	6	38.100	67108854.184	6	2147580290.31	6	39.900
C05	16777216.000	6	849221785.28316	6	36.400	16777210.980	6	656672170.78716	6	38.200	16777206.844	6	690062300.35916	6	40.000

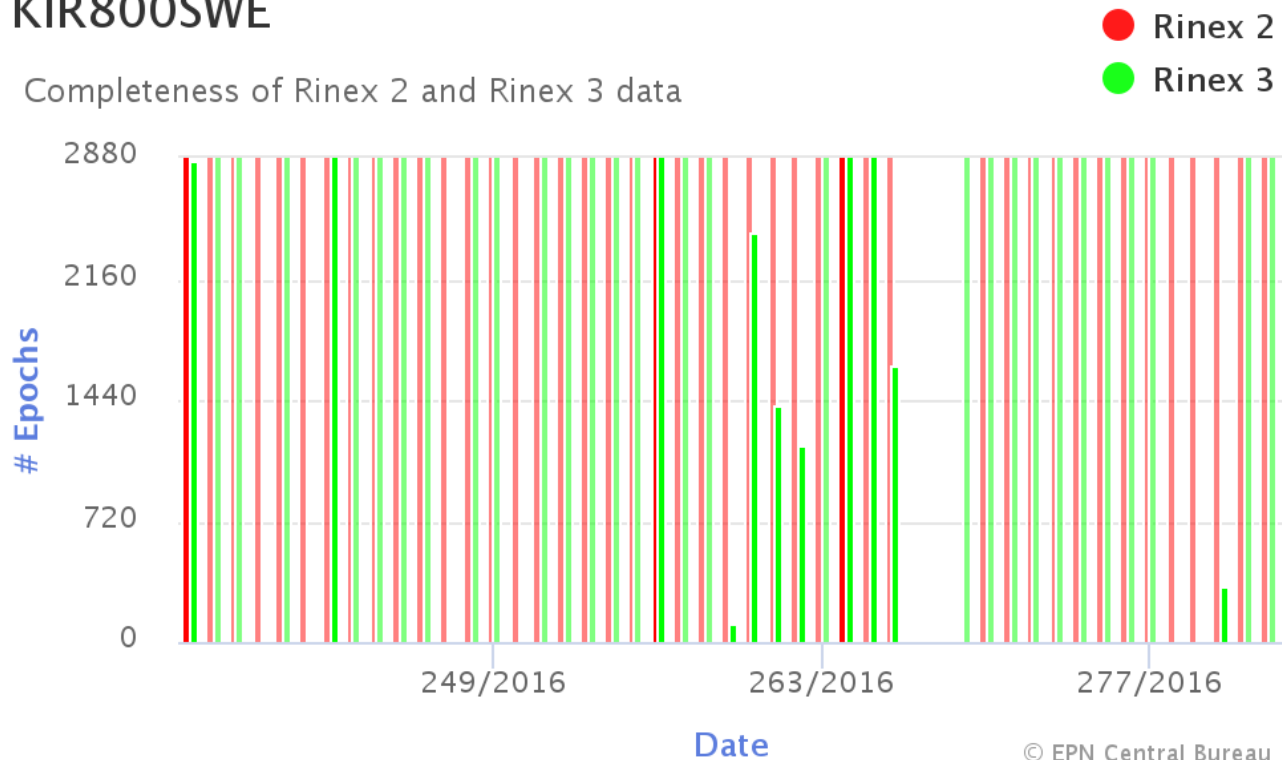


Example: Data gaps NetR9 in EPN

- due to format overflow and no repair pre-processor

KIR800SWE

Completeness of Rinex 2 and Rinex 3 data





LPT switch to Multi-GNSS processing as EPN AC

- E-Mail announcement on 29-Jul-2016 (EUREF Mail 8644):
“The LPT Local Analysis Centre (swisstopo) of the EPN switched from a two system (GPS and GLONASS) to a four system (GPS, GLONASS, Galileo and BeiDou) processing scheme for its final products.”
- Bernese GNSS Software version 5.3 (development version)
- RINEX-3 observation data (if available), otherwise RINEX-2
- CODE MGEX orbits, clocks and ERPs
Products available in time (as CODE Final)! **THANKS to AIUB/CODE!!**
- The new solutions are submitted to EUREF starting with GPS week 1905

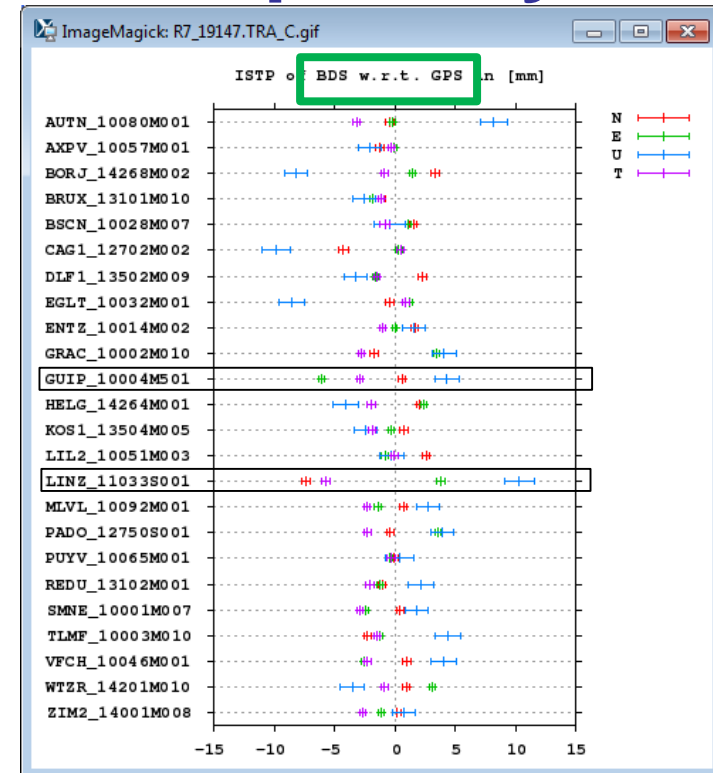
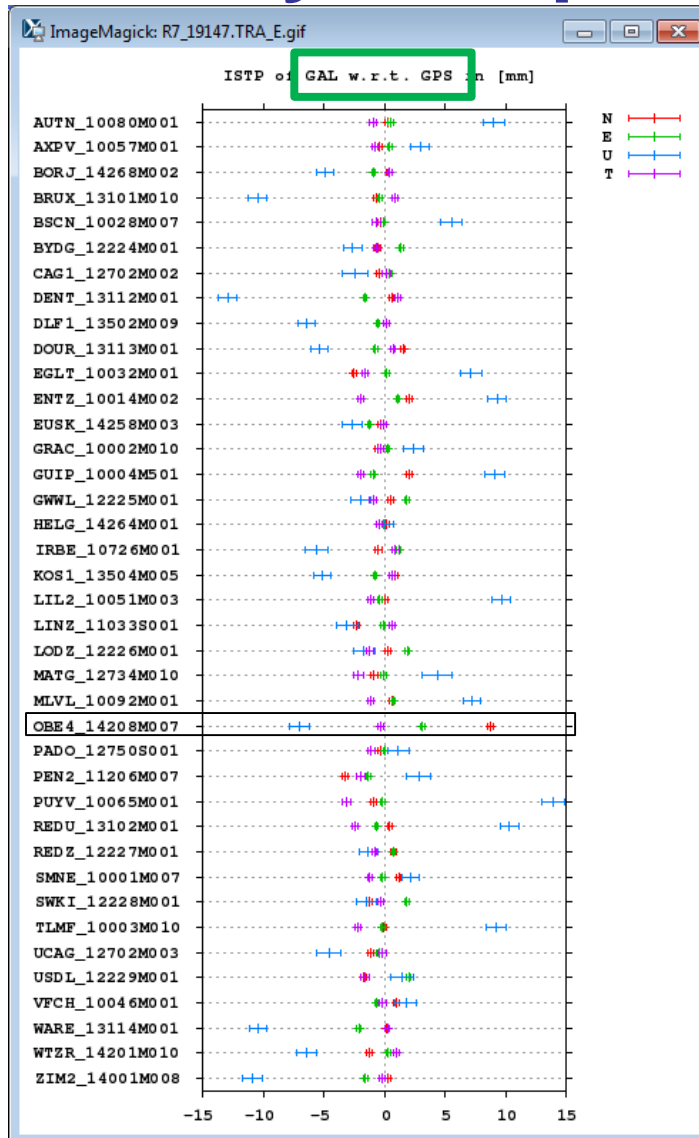


Switch to Multi-GNSS processing

- All included stations in the processing contribute GPS observations to the final results
95% GLONASS
66% Galileo
40% BeiDou
- ~ 13% more observations (constellations not complete, yet)
- Phase centre corrections of uncalibrated frequencies or systems are adopted from GPS
- Daily intersystem translation parameters (ISTP) w.r.t. GPS setup for coordinates (3 per station) and troposphere (1 per station)
- Galileo frequencies L5 used (alternative L7 with slightly different results due to PCVs)
- Robot calibrations used (chamber partly different values for Galileo frequencies)



Inter-System parameter: per day

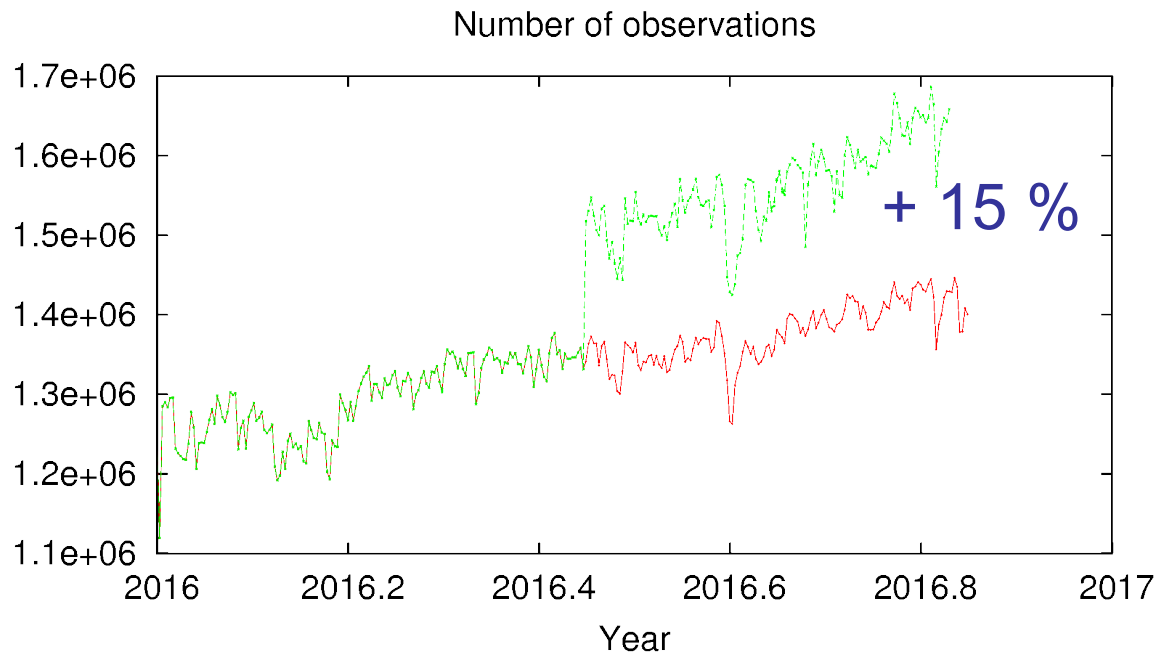


- Vertical: Less than 15 mm
(Exception: -35 mm TRF2 for GLO)
- Horizontal: Less than 5 mm
(Exception: OBE4 for GAL, GUIP and LINZ for BDS)



AGNES Multi-GNSS prototype (daily)

- Same network (RINEX-2 / RINEX-3 mixed processing)
- Red: GPS+GLO, green: GPS+GLO+GAL+BDS



- Unknown parameters: $\sim 15500 \approx +5 \%$ (ambiguities, ITPs)
- A posteriori RMS of unit weight not changed significantly



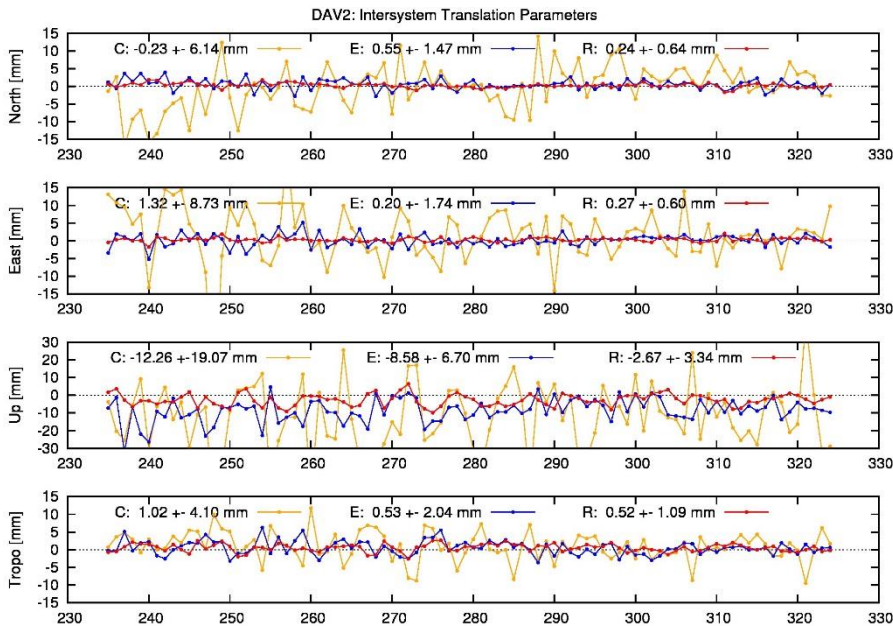
Inter-System parameter

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

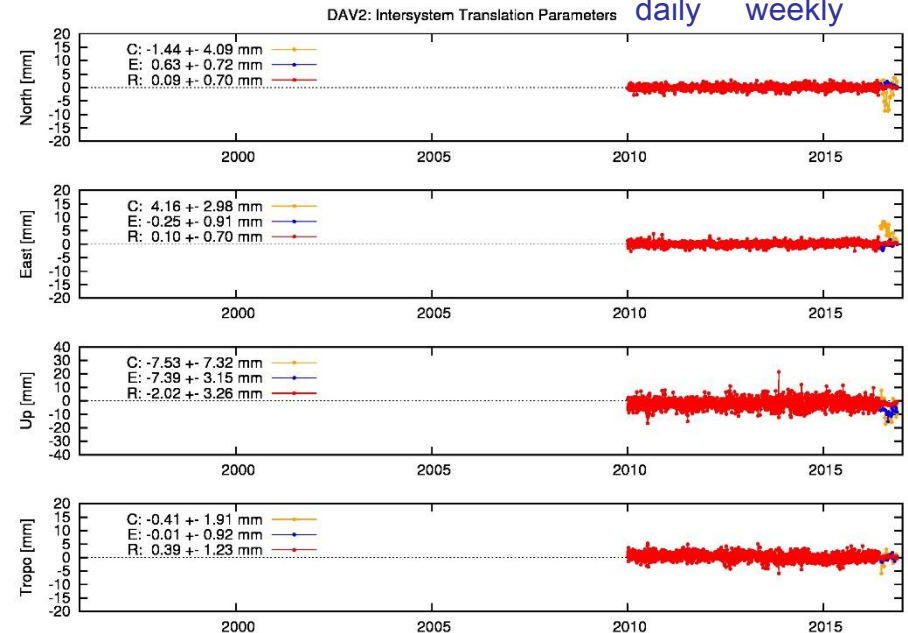
GLO
GAL
BDS

DAV2

daily



Long-term



daily weekly

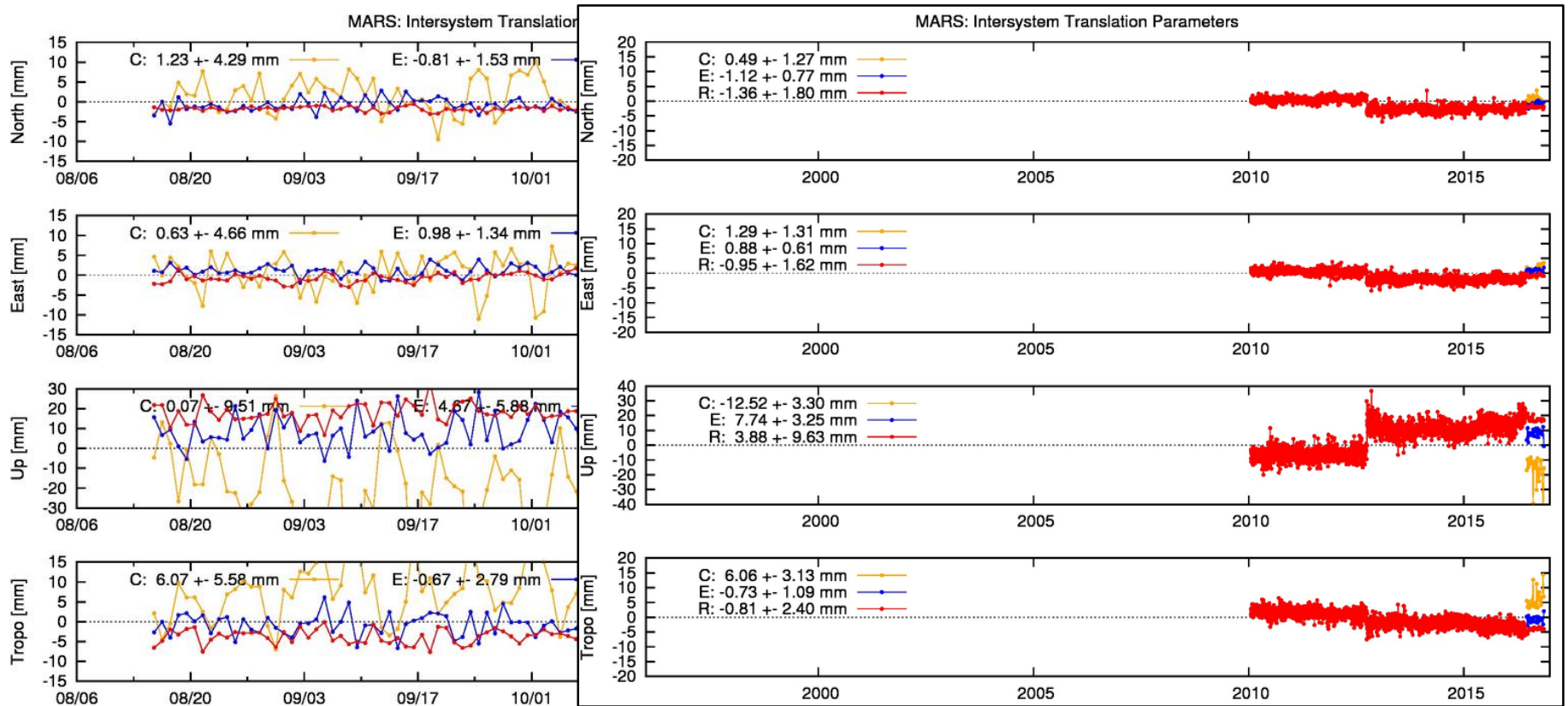
GPS/GLO
from repro2

Multi-GNSS
BSW53



AGNES Multi-GNSS prototype

MARS: Marseille, FR



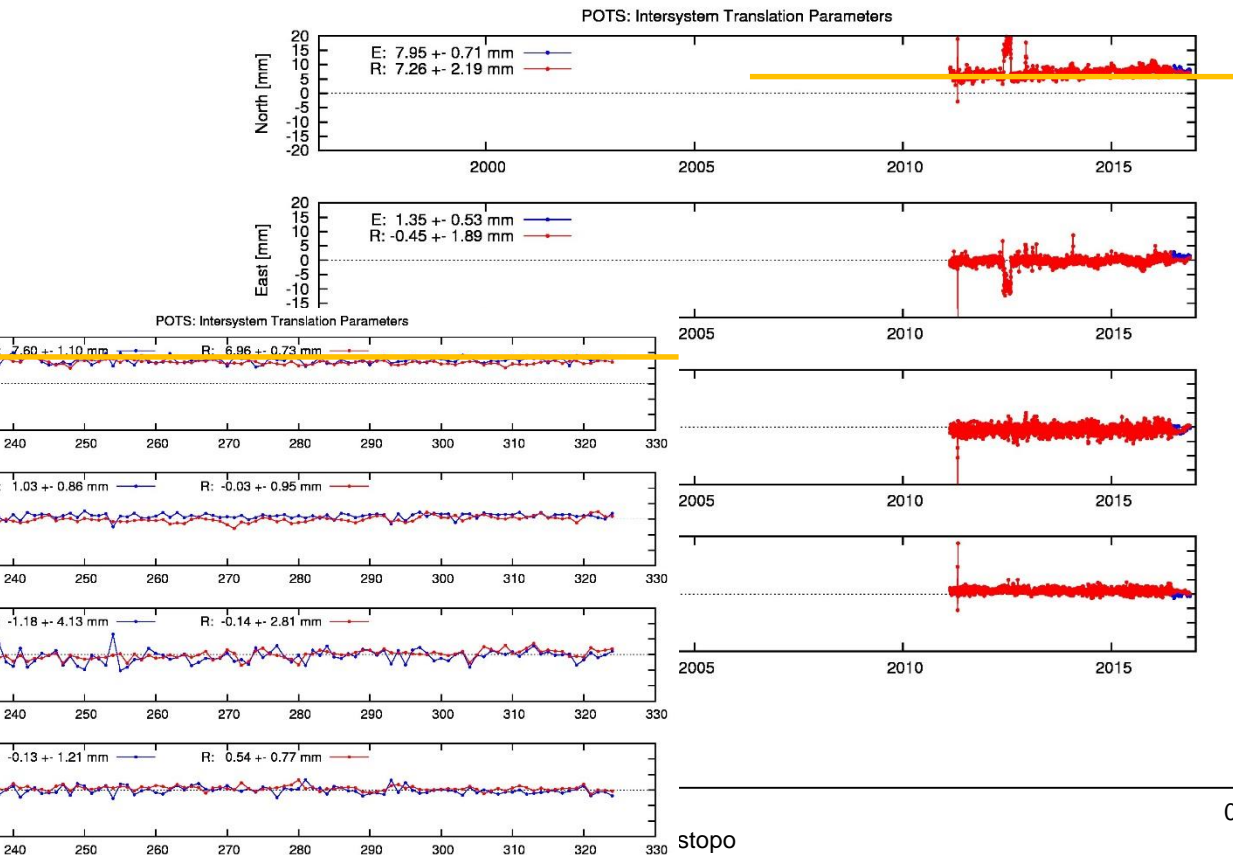
- ISTPs of GLO and GAL relatively stable, BDS not (yet?)
- Equipment change on 26-Sep-2012, “%JUMP” introduced



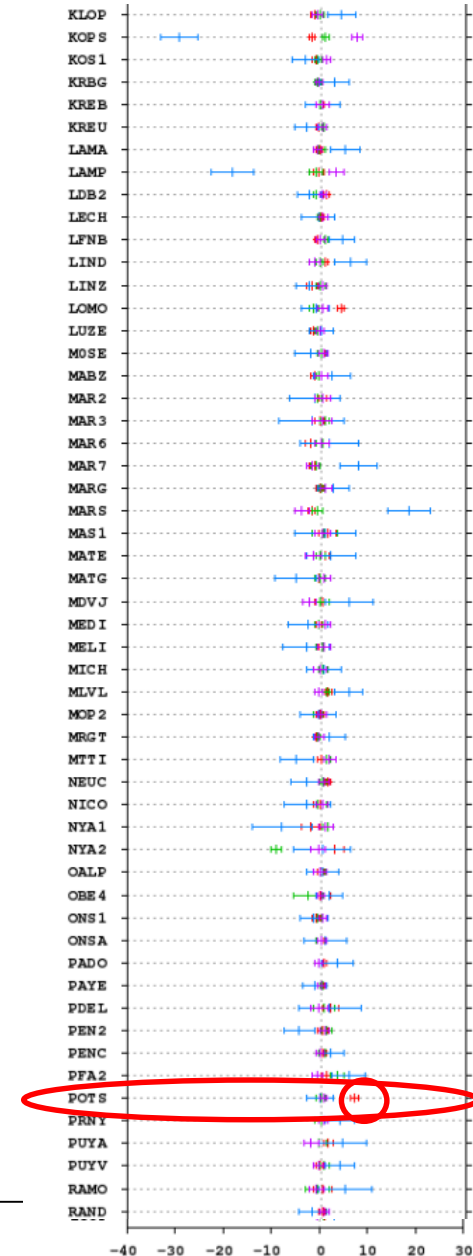
Examples: POTS+NYA2

AGNES monthly

- POTS: JAV_RINGANT_G3T NONE
NYA2: JAV_RINGANT_G3T NONE
North: 7 mm; GPS-GLO, 8 mm GPS-GAL



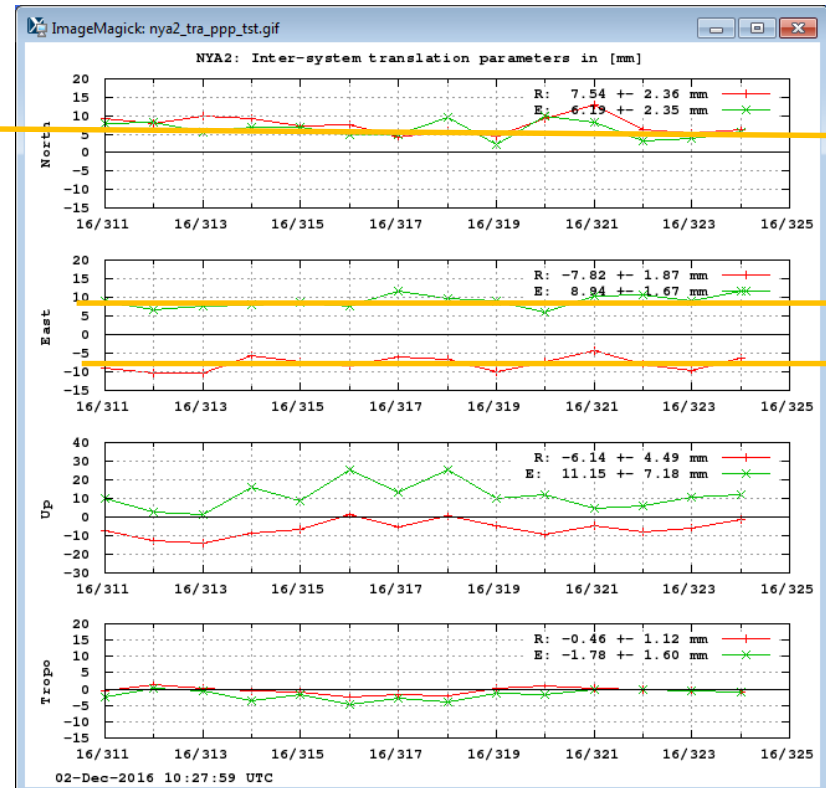
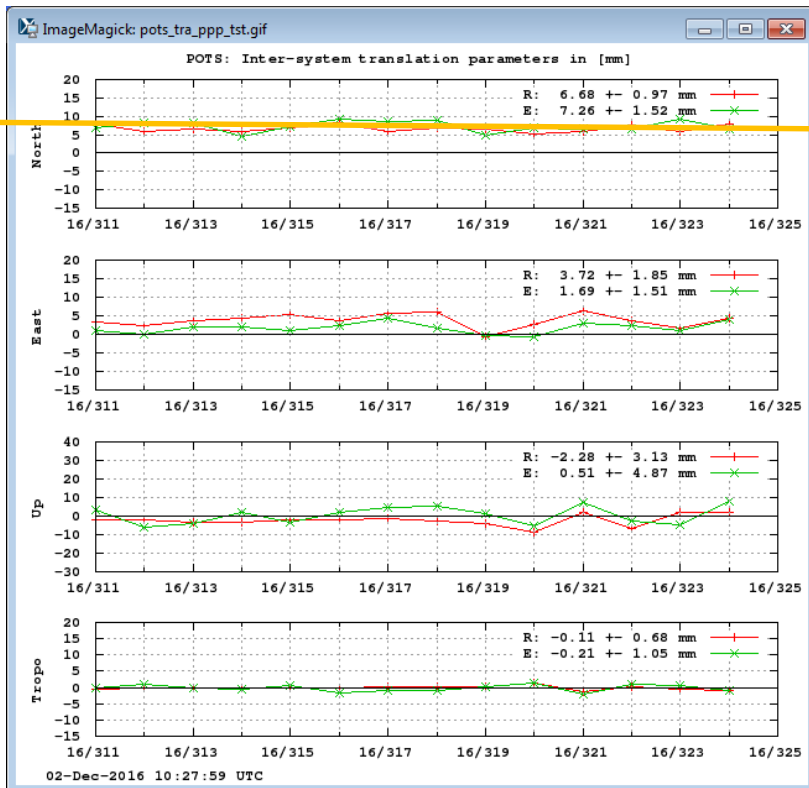
05.12.2016





...works also with PPP ...since Dec. 2 ...

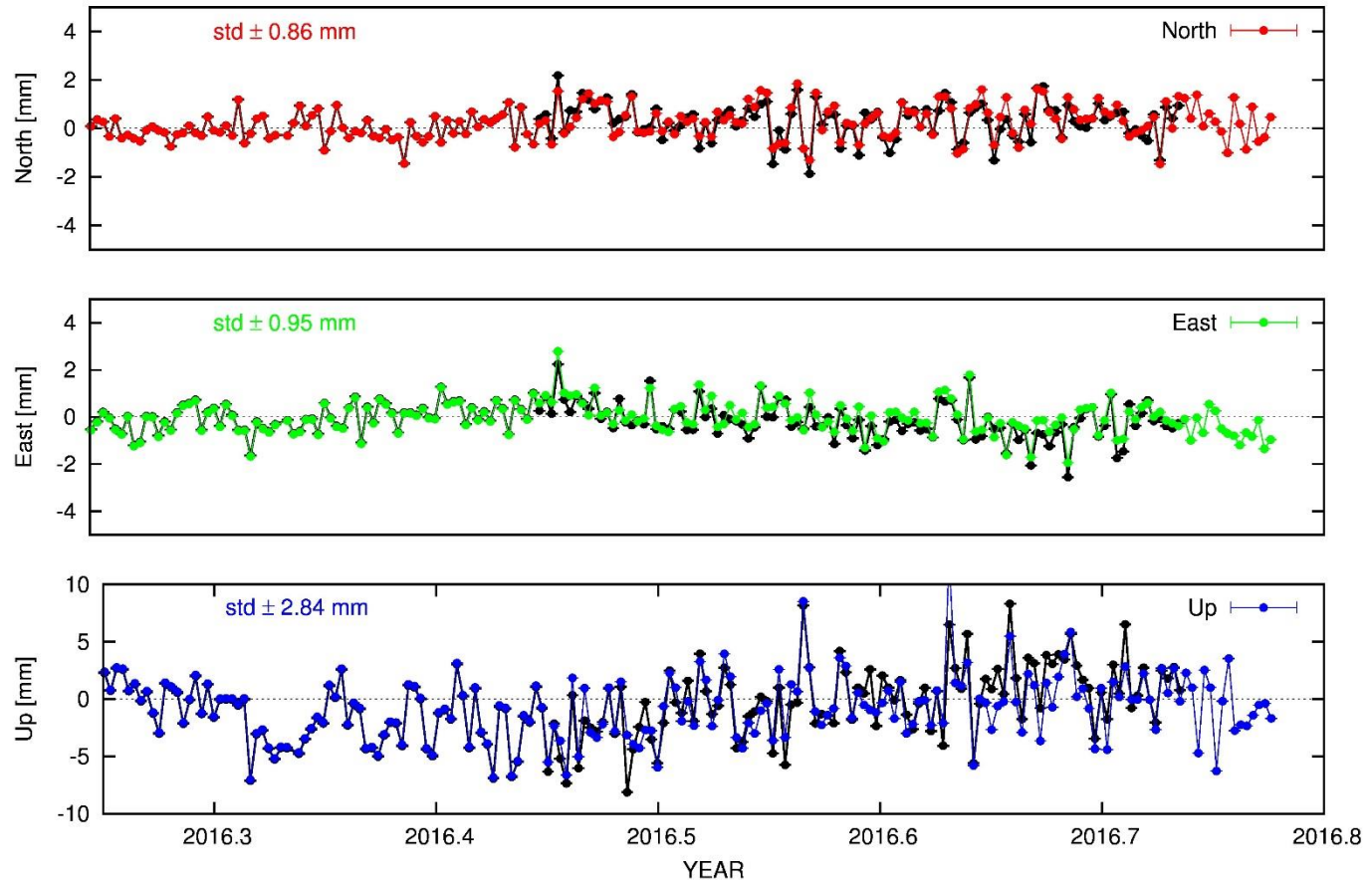
- North: 6-7 mm; GPS-GLO, 6-7 mm GPS-GAL





Multi-Annual solutions using Multi-GNSS: ZIM2 BSW52 + BSW53 (daily)

Coordinate repeatability of ZIM2

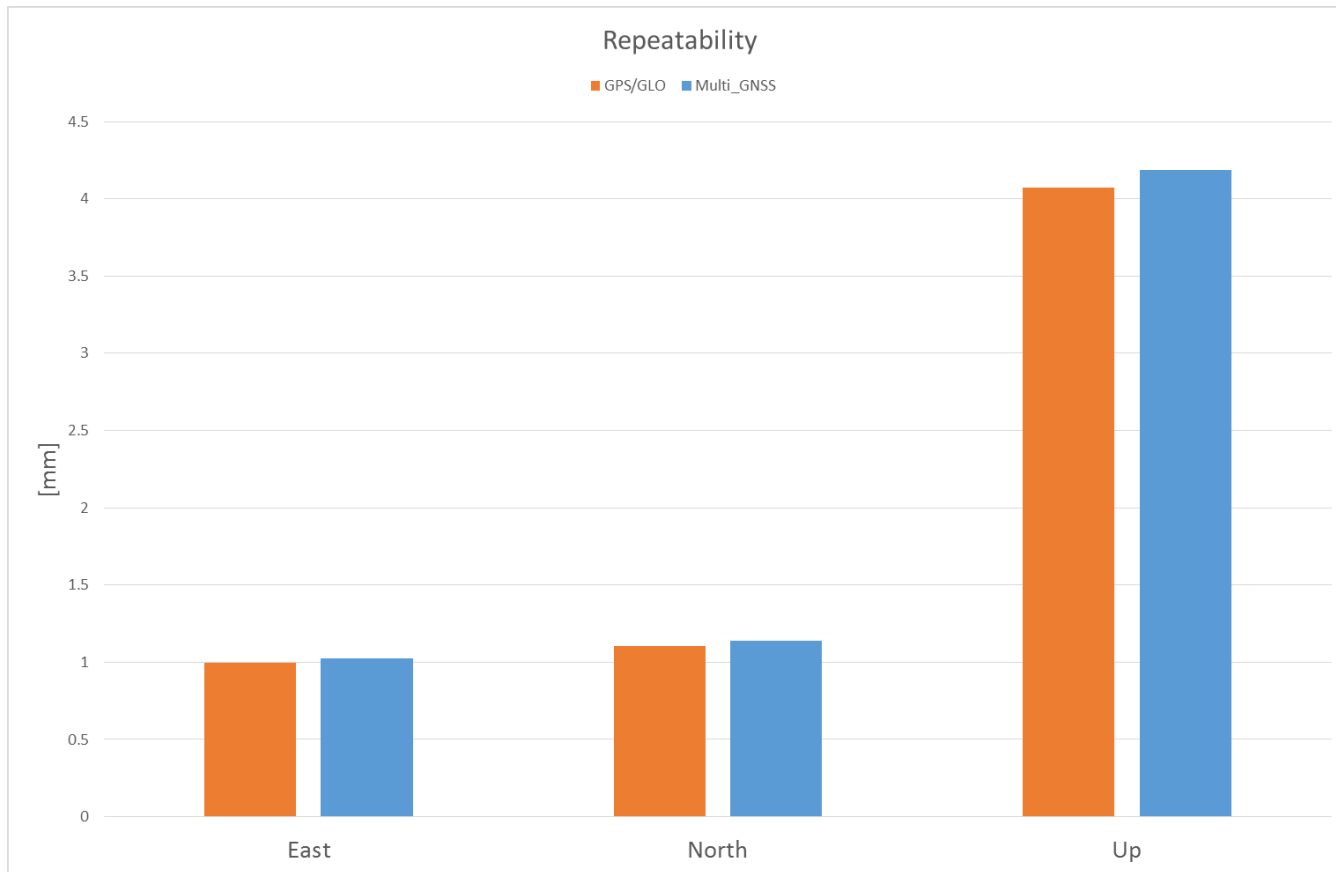


10/10/16 12:39



Multi-GNSS daily repeatability (daily)

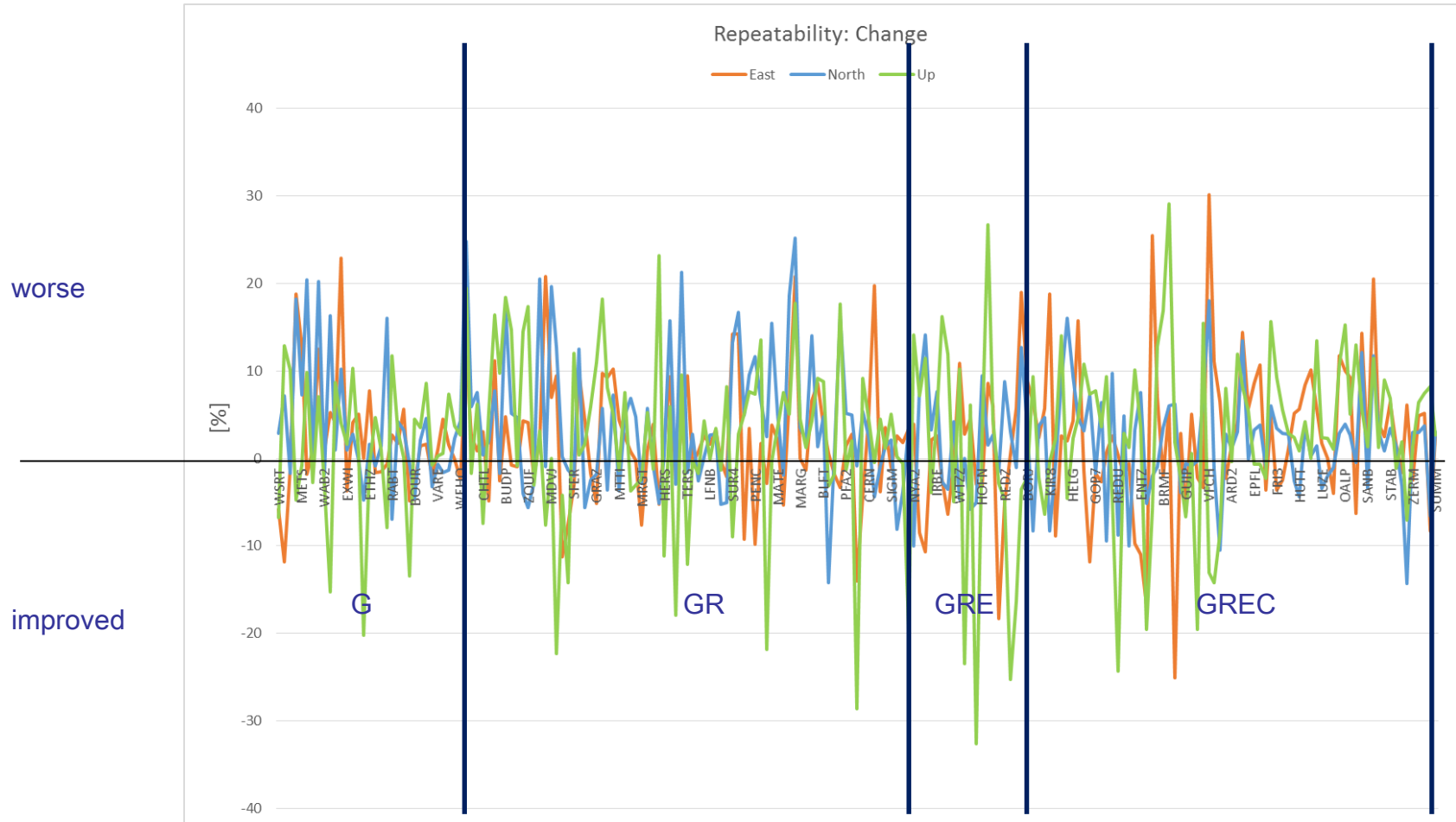
- 206 stations





AGNES Multi-GNSS prototype (daily)

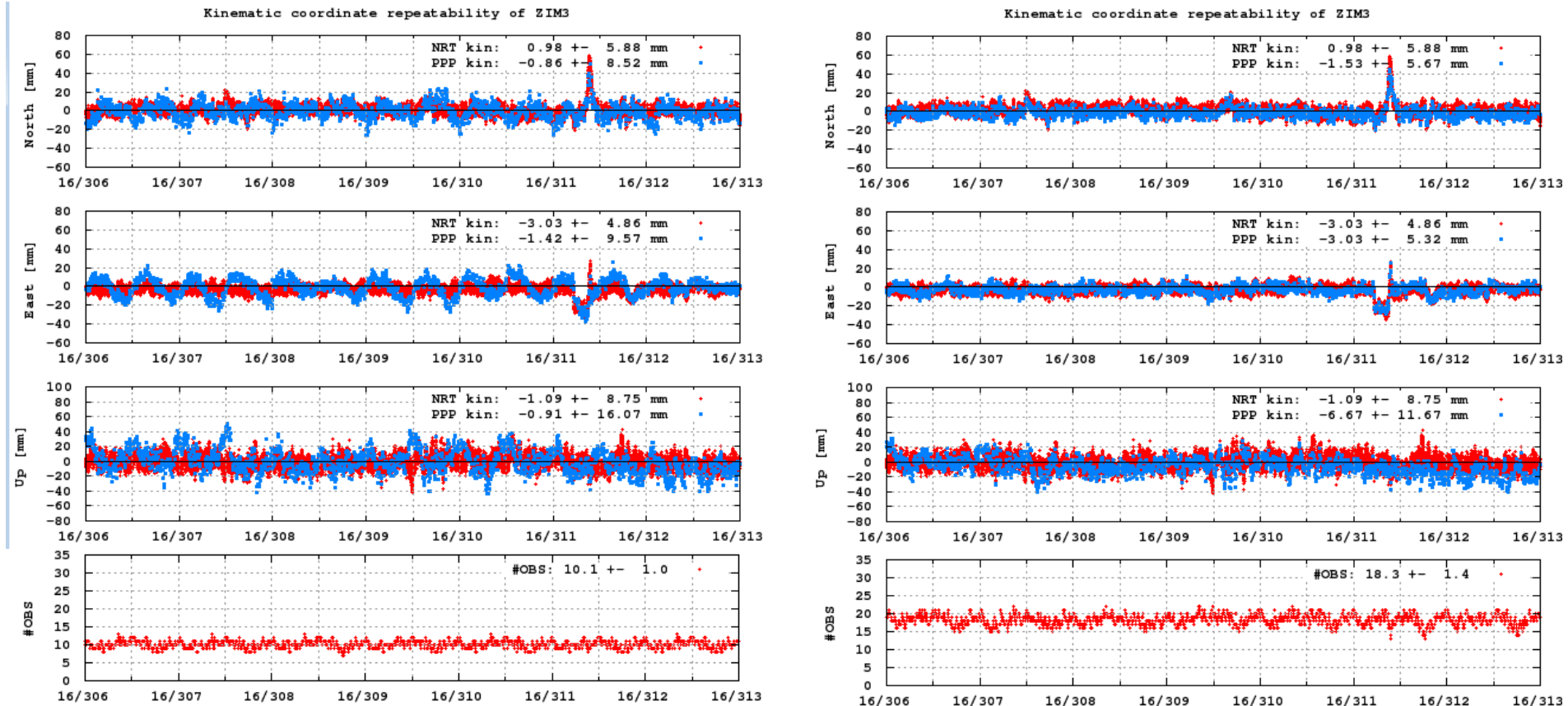
- 206 stations, new vs old processing scheme





Potential Improvement for Kinematics (short time intervals -> as hourly)

- CODE final rapid product
- Left: GPS only (V_USE=G), right: GPS+GLO (V_USE=GR)



- Better repeatabilities but absolute (mean) values may differ



Potential Improvement Kinematics: PPP for product/strategy evaluation

- Kin. coordinate repeatabilities over one week for ZIM3

V_B	V_USE	North [mm]	East [mm]	Up [mm]	#OBS/Epo
COD	G	8.52	9.57	16.07	10.1
COD	GR	5.67 (-33%)	5.32 (-44%)	11.67 (-27%)	18.3 (+81%)
COM*	G	11.23	11.42	21.79	9.9
COM	GR	6.86 (-39%)	7.03 (-38%)	14.56 (-33%)	17.7 (+79%)
COM	GRE	6.54 (-42%)	6.50 (-43%)	13.29 (-39%)	21.4 (+116%)
COM	GREC	6.27 (-44%)	6.21 (-46%)	13.22 (-39%)	24.2 (+144%)
GBM	G	9.06	9.78	17.46	10.1
GBM	GR	5.82 (-36%)	5.50 (-44%)	12.46 (-29%)	18.2 (+80%)
GBM	GRE	5.65 (-38%)	5.00 (-49%)	11.87 (-32%)	22.0 (+118%)
GBM	GREC*	5.78 (-36%)	10.24 (+5%)	13.49 (-23%)	25.4 (+151%)

*COM: Satellite clocks have 300 s sampling, all others 30 s

*GBM: Issue with C05 (GEO), which is not included in COM

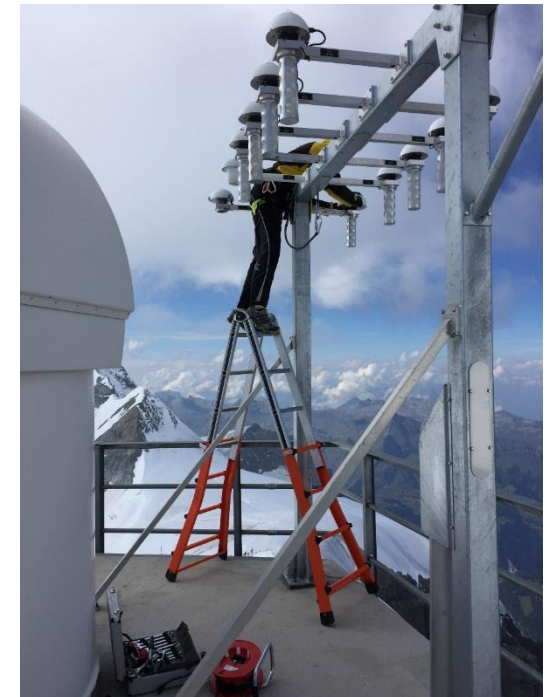
- General benefit adding more GNSS



JUJO new antenna



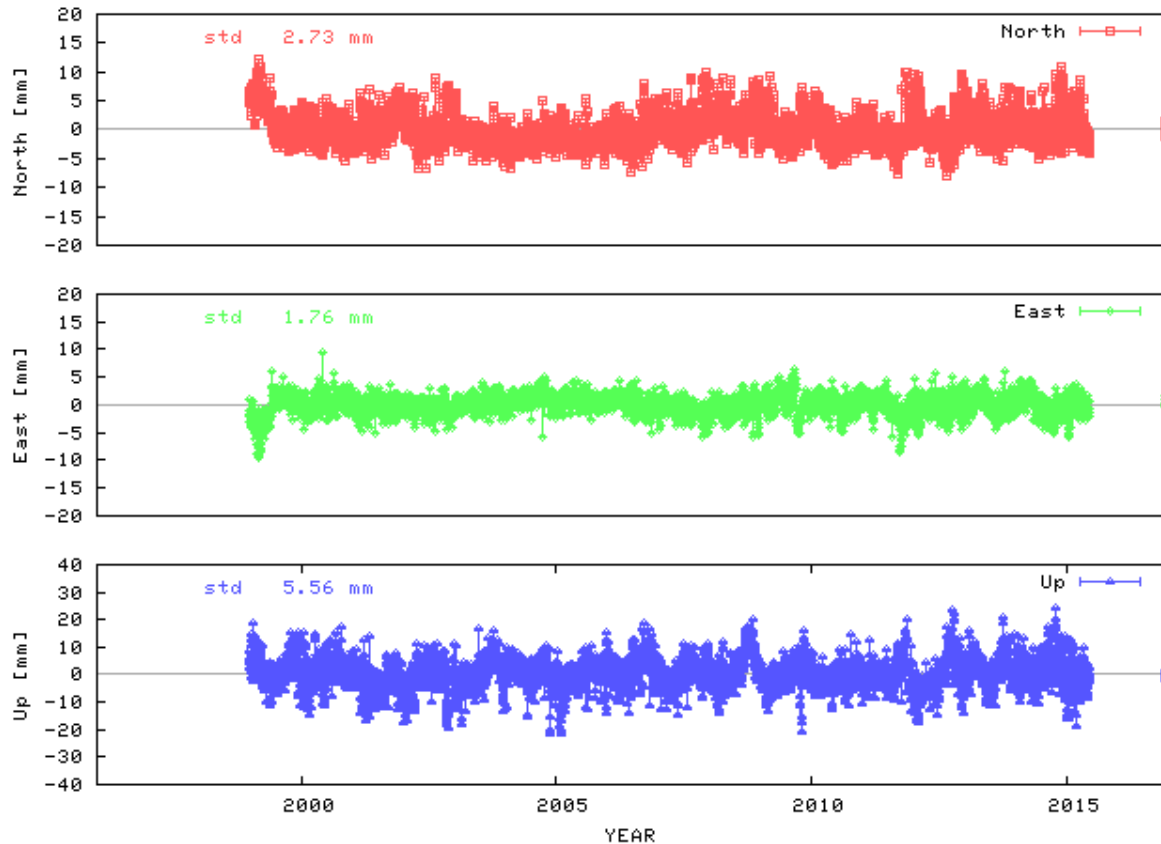
- New antenna / radom pair capable to track Multi-GNSS
- Antenna was individually calibrated in Feb 2016
- To be installed in March 2016 -> already malfunctioning pre-amp -> installation Oct 2016 sucessfull





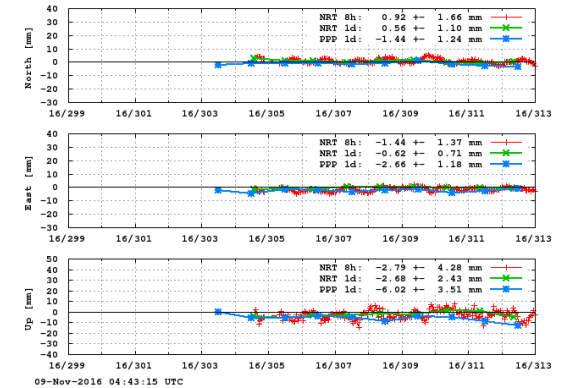
JUJO /JUJ2

Coordinate repeatability of JUJO

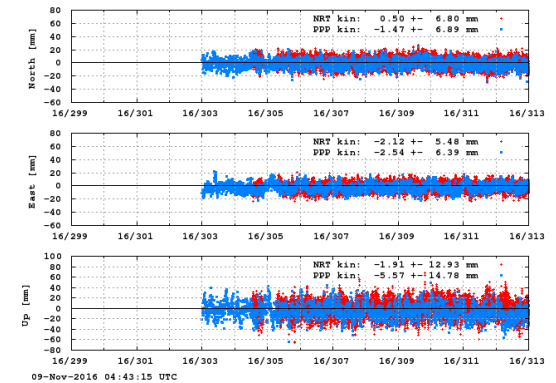


09/11/16 03:55

Coordinate repeatability of JUJ2



Kinematic coordinate repeatability of JUJ2





Multi-GNSS status: daily -> hourly processing



- Multi-GNSS is operational and running (daily)



- Prototype Hourly processing developed and running (mixed RINEX2/3 Input) for daily / campaign analysis



- Cutting-Scripts (8 hours) to be modified to RINEX3 handling



- hourly RINEX3 only for minority of stations available and stable



- Hourly products: available from GFZ (not yet CODE)