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Swiss Federal Office of Topography swisstopo

Multi-GNSS Working group

E. Brockmann, Carine Bruyninx, Alessandro Caporali, Rolf Dach, Jan Douša, Heinz Habrich, Wolfgang Sőhne, Christof Vőlksen

Content

- RINEX3 QC monitoring at swisstopo (Brockmann)
- Multi-GNSS Analysis (Caporali)
- RINEX3 issues and transition plan (Brockmann, Bruyninx)

RINEX3 QC montitoring at swisstopo (Brockmann)

Tools in use

- Status October 24, 2014, 13:36 MESZ
  - G-Nut/Anubis [1.2.1] compiled: Aug 18 2014 08:05:37 ($Rev: 844)
  - BNC [2.12] checkout version 6256

- Thanks a lot for the support and iterations necessary to make the quality monitoring operational !

  BKG + GOPE

RINEX Monitoring

RINEX 2 (160 CH-EU stations)

http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/anubis_monitor_r2.html

MARKER	RECEIVER		ANTENNA		FILE
AIGE	TRIMBLE NETR5	4.85	TRM55971.00	NONE	aige
AJAC 10077M005	LEICA GR25	3.10	TRM57971.00	NONE	ajac
ARD2	TRIMBLE NETR5	4.85	TRM59800.00	NONE	ard2
ARDE	TRIMBLE 4700	NAV 1.30 / BOOT 1	TRM33429.20+GP		arde
ARTU 12362M001	ASHTECH Z-XII3	CC00	ASH700936D_M	DOME	artu
AUBU 19977M001	TRIMBLE NETRS	1.13	TRM41249.00	NONE	aubu
AUTN 10080M001	LEICA GR25	3.10	TRM57971.00	NONE	autn
AXPV 10057M001	TRIMBLE NETR9	4.85	TRM57971.00	NONE	axpv
BADH 14288M001	LEICA GRX1200GGPRO	8.71/3.823	LEIAR10	NONE	badh
BCKL	LEICA GRX1200+GNSS	8.51/6.110	LEIAR25.R4	NONE	bckl
BLFT 19856M001	TPS NETG3	4.0	TPSCR.G3	TPSH	blft
BLG2 19809M002	TPS NETG3	3.3 12/22/08 P6	TPSCR.G3	TPSH	blg2
BOR1 12205M002	TRIMBLE NETRS	1.2-0 Apr 26 2007	AOAD/M_T	NONE	bor1
BRST 10004M004	TRIMBLE NETR9	4.85	TRM57971.00	NONE	brst
BRUX 13101M010	SEPT POLARX4TR	2.5.2	JAVRINGANT_DM	NONE	brux
BSCN 10028M007	LEICA GR25	3.10	TRM57971.00	NONE	bscn
BUDP 10101M003	LEICA GRX1200GGPRO	8.71	ASH701941.B	UNAV	budp
BYDG 12224M001	TRIMBLE NETR9	4.85	TRM59900.00	SCIS	bydg
BZBG	LEICA GRX1200+GNSS	8.51/6.110	LEIAR25.R4	NONE	bzbg
BZRG 12751M001	LEICA GRX1200+GNSS	8.50/6.110	LEIAR25.R4	LEIT	bzrg

sortable tables

ANTENNA
AOAD/M_B
AOAD/M_T
AOAD/M_T
AOAD/M_T
AOAD/M_T
AOAD/M_T
ASH700936A_M
ASH700936A_M
ASH700936A_M
ASH700936A_M
ASH700936C_M
ASH700936C_M
ASH700936D_M

pdf with all plots

RINEX 3 QC (35 stations)

MARKER	RECEIVER		ANTENNA		FILE
AJAC 10077M005	LEICA GR25	3.10	TRM57971.00	NONE	ajac
AUTN 10080M001	LEICA GR25	3.10	TRM57971.00	NONE	autn
AXPV 10057M001	TRIMBLE NETR9	4.85	TRM57971.00	NONE	axpv
BRST 10004M004	TRIMBLE NETR9	4.85	TRM57971.00	NONE	brst
BRUX 13101M010	SEPT POLARX4TR	2.5.2	JAVRINGANT_DM	NONE	brux
BSCN 10028M007	LEICA GR25	3.10	TRM57971.00	NONE	bscn
EGLT 10032M001	LEICA GR25	3.10	TRM57971.00	NONE	eglt
ENTZ 10014M002	LEICA GR25	3.10	TRM55971.00	NONE	entz
EUSK 14258M003	LEICA GR25	3.10.1633/6.403	LEIAR25.R4	LEIT	eusk
GUIP 10004M501	LEICA GR25	3.10	TRM57971.00	NONE	guip
HOFN 10204M002	LEICA GR25	3.10.1633/6.403	LEIAR25.R4	LEIT	hofn
KLOP 14214M002	TRIMBLE NETR9	Nav 4.85 / Boot 4.29	TRM57971.00	TZGD	klop
LAMP 12706M002	LEICA GR10	3.10.1633/6.403	LEIAR25	NONE	lamp
LIL2 10051M003	LEICA GR25	3.10	TRM57971.00	NONE	lil2
M0SE 12772M001	LEICA GR25	3.10.1633/6.403	LEIAR25.R4	LEIT	m0se
MARS 10073M008	LEICA GR25	3.10	TRM57971.00	NONE	mars
MAS1 31303M002	SEPT POLARX4	2.5.1p1	LEIAR25.R4	NONE	mas1
MLVL 10092M001	LEICA GR25	3.11	TRM57971.00	NONE	mlvl
NICO 14302M001	LEICA GR25	3.10.1633/6.403	LEIAR25.R4	LEIT	nico
PADO 12750S001	LEICA GR10	3.10.1633/6.403	LEIAR25.R4	NONE	pado
PEN2 11206M007	LEICA GRX1200+GNSS	8.51/6.110	LEIAR25.R4	LEIT	pen2
POTS 14106M003	JAVAD TRE_G3TH DELTA	3.4.7	JAV_RINGANT_G3T	NONE	pots
PUYV 10065M001	LEICA GR25	3.10	TRM57971.00	NONE	puyv
REDU 13102M001	SEPT POLARX4	2.5.1p1	SEPCHOKE_MC	NONE	redu
REYK 10202M001	LEICA GR25	3.10.1633/6.403	LEIAR25.R4	LEIT	reyk
SMNE 10001M007	TRIMBLE NETR9	4.85	TRM55971.00	NONE	smne
TLMF 10003M010	LEICA GR25	3.10	TRM57971.00	NONE	tlmf
TLSE 10003M009	TRIMBLE NETR9	4.85	TRM59800.00	NONE	tlse
VFCH 10046M001	LEICA GR25	3.10	TRM57971.00	NONE	vfch
VILL 13406M001	SEPT POLARX4	2.5.1p1	SEPCHOKE_MC	NONE	vill
WROC 12217M001	LEICA GR25	3.10.1633/6.403	LEIAR25.R4	LEIT	wroc
WTZR 14201M010	LEICA GR25	3.10.1633/6.403	LEIAR25.R3	LEIT	wtzr
ZIM2 14001M008	TRIMBLE NETR5	4.85	TRM59800.00	NONE	zim2
ZIM3 14001M008	TRIMBLE NETR9	4.85	TRM59800.00	NONE	zim3
ZIMJ 14001M006	JAVAD TRE_G3TH DELTA	3.4.9 Apr,18,2013	JAVRINGANT_DM	NONE	zimj

42 plots per day per station per RINEX version !

http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/anubis_monitor_r3.html

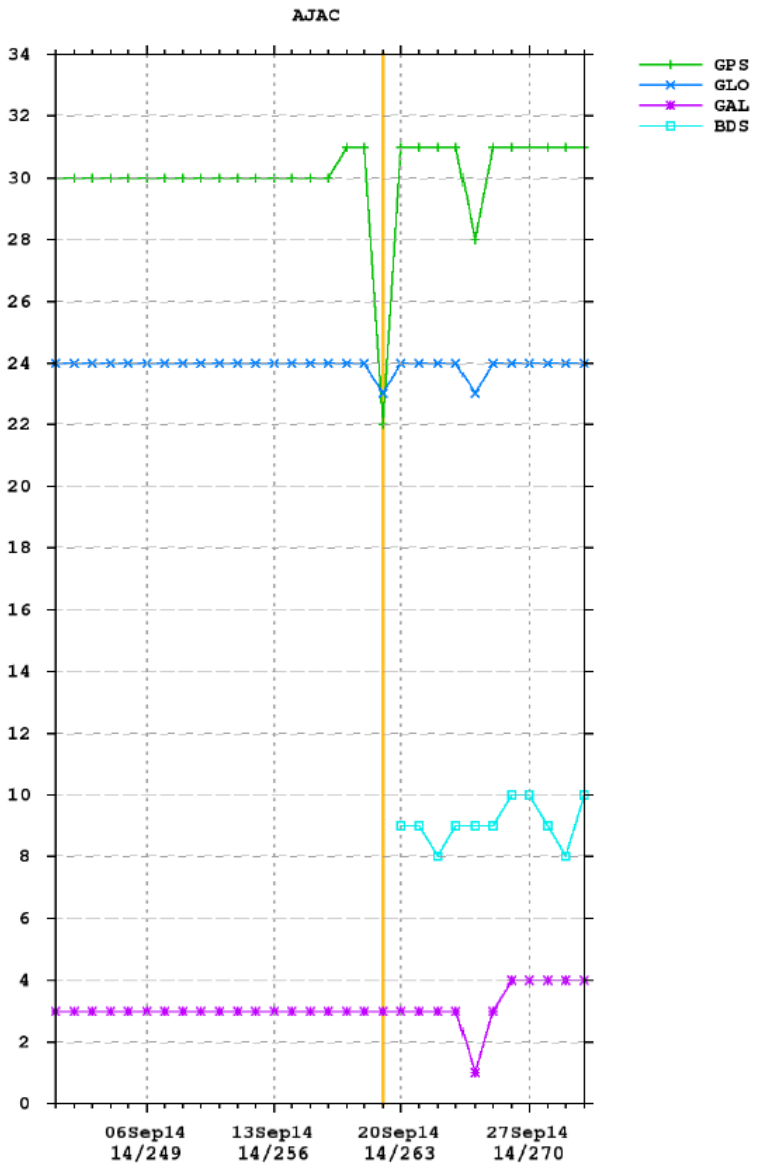
Anubis Plot examples (1/42 plots)

- Link to pdf

AJAC: Firmware version change: tracking BDS

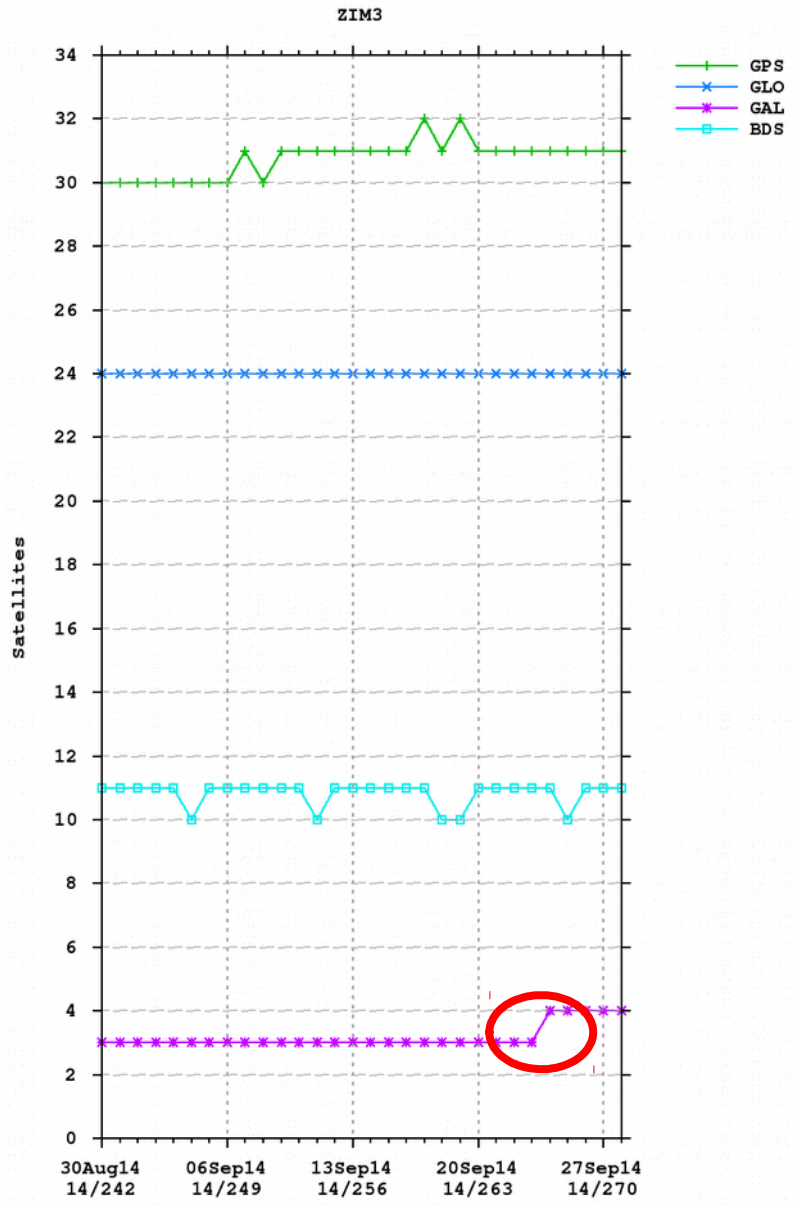
Equipment history

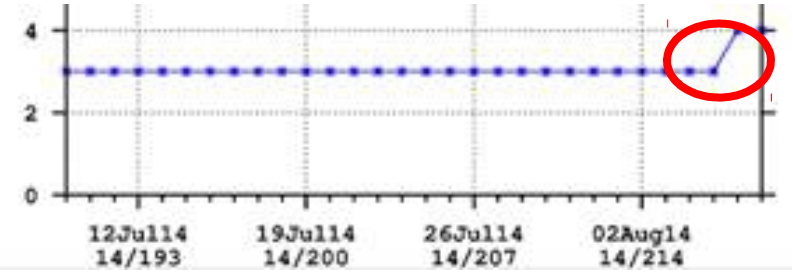
2014-09-01 00:00:00	LEICA GR25	3.03	1830139
2014-09-19 00:00:00	LEICA GR25	3.10	1830139



Anubis Plot examples

September 24



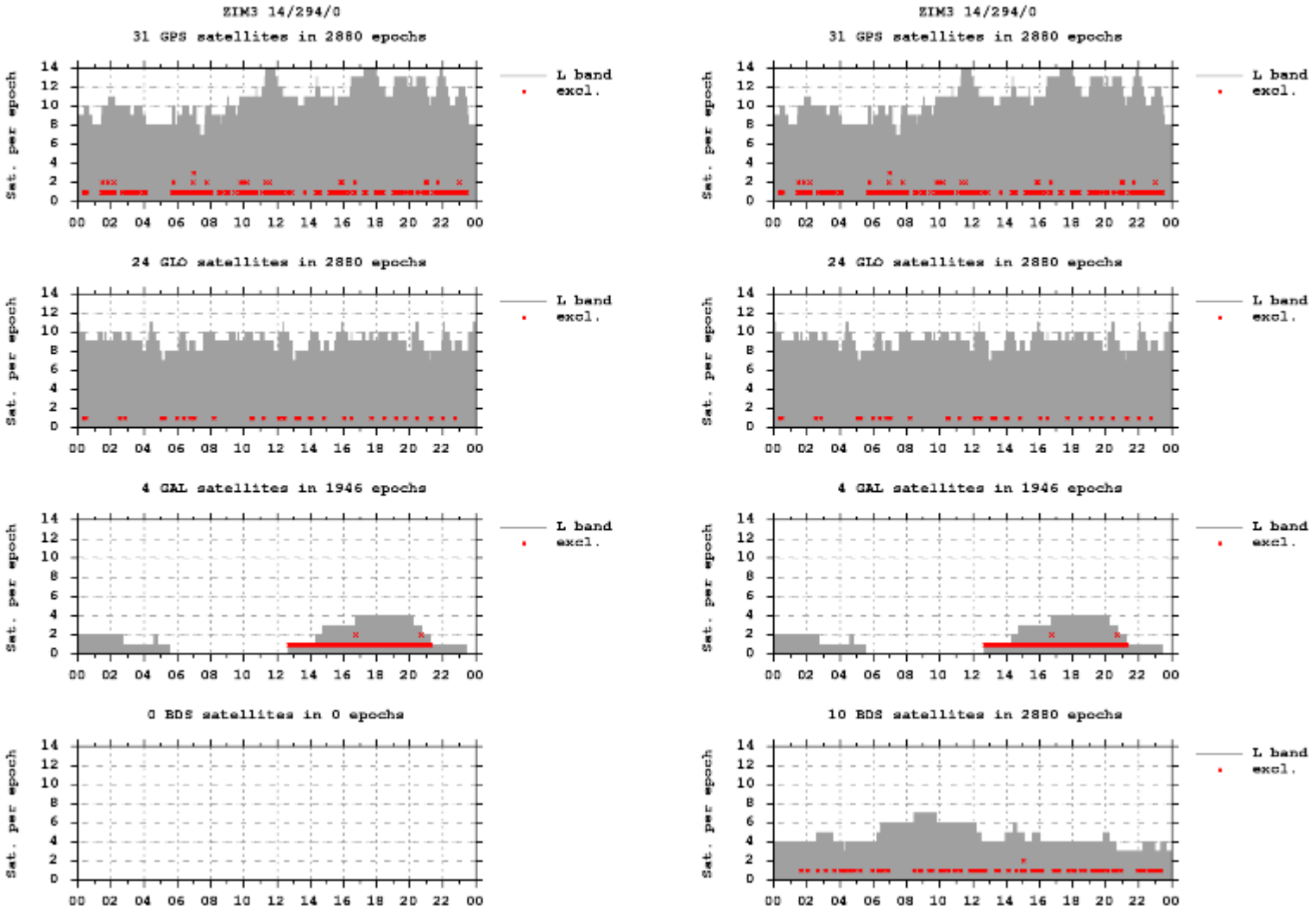


August 3

http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/qsumzim3.html

Cross-checking R2 / R3 monitoring

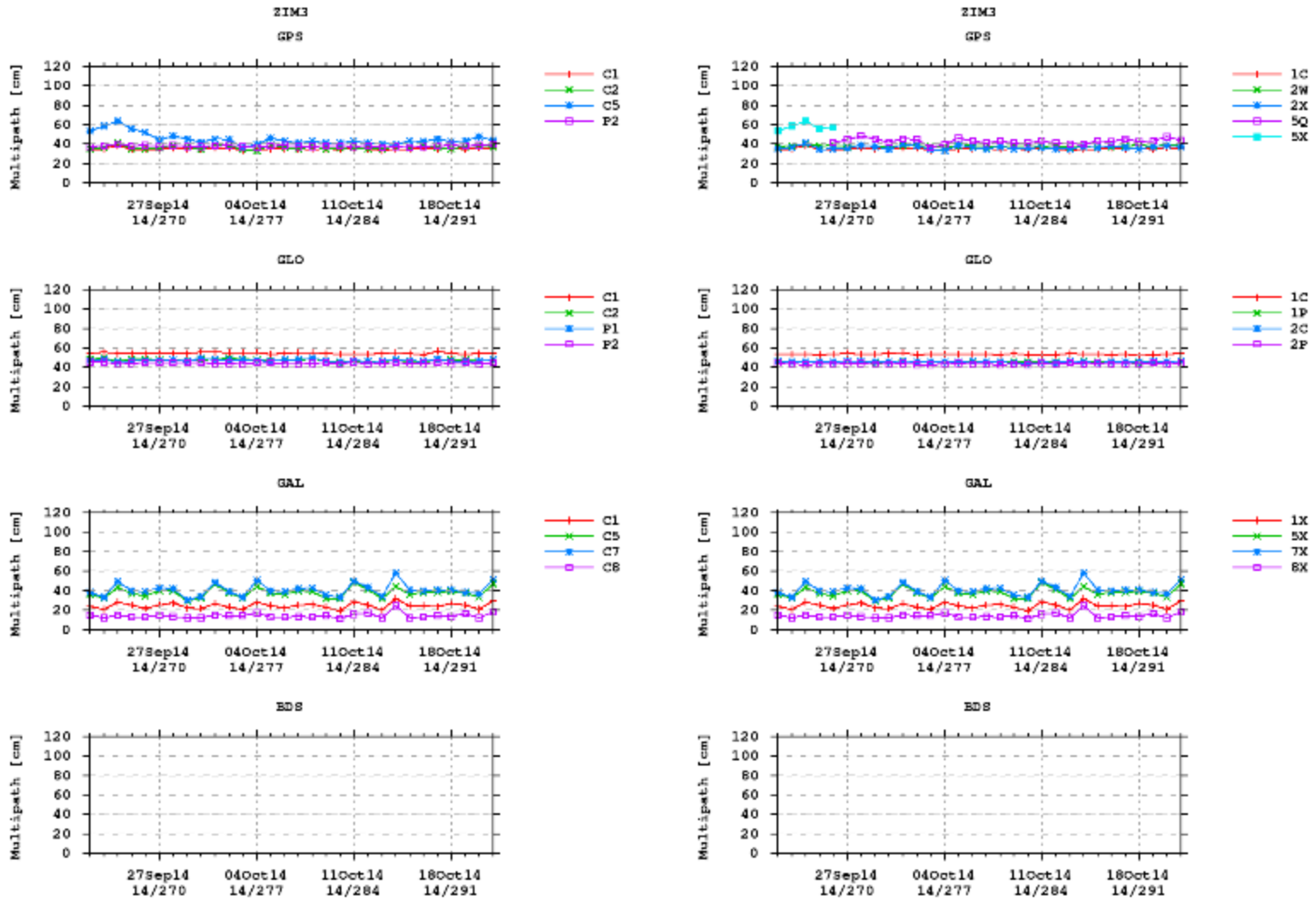
Number of observations (RINEX 2/3) last day



http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/qsumzim3.html

Cross-checking R2 / R3 monitoring

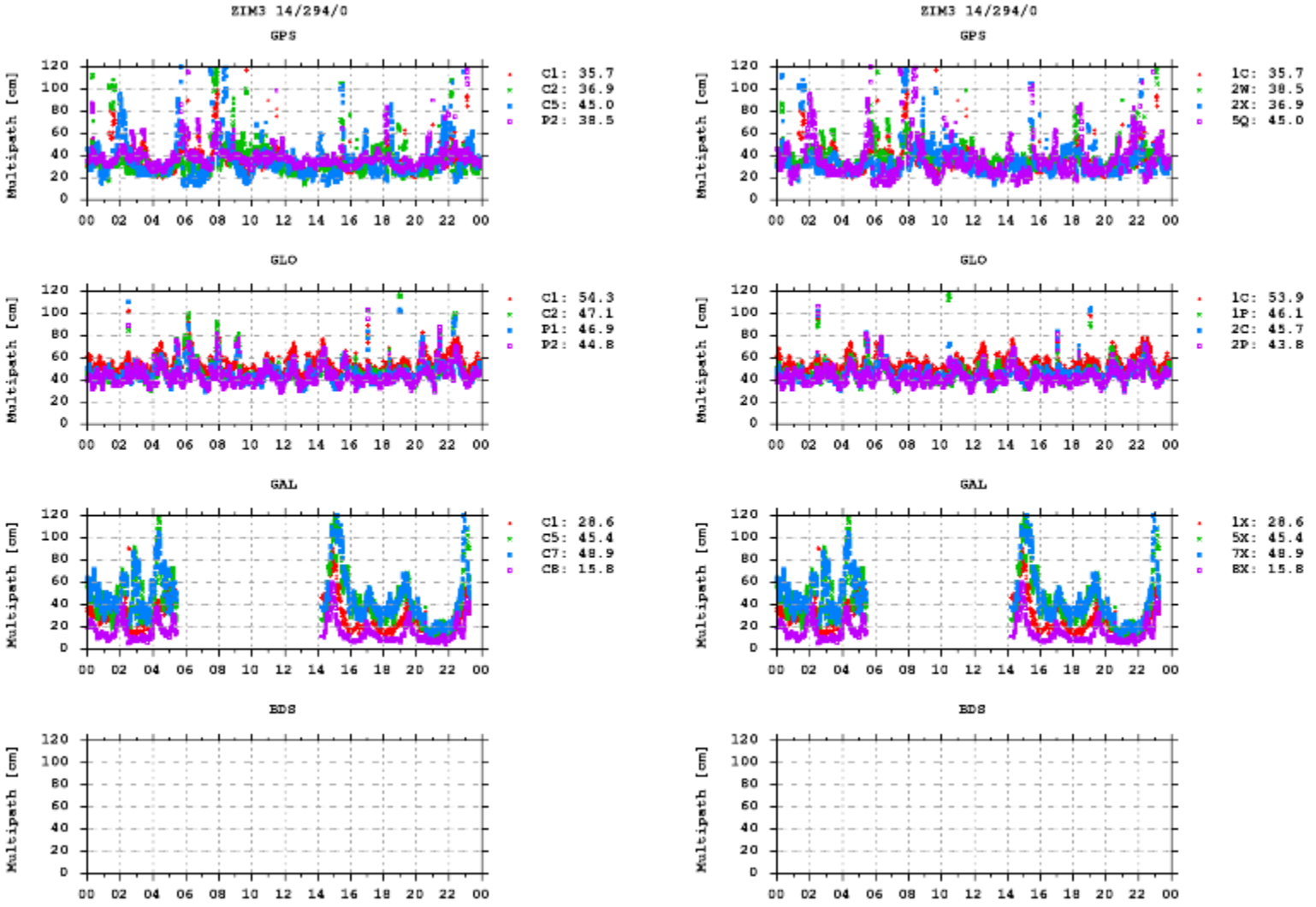
Multipath of observations (RINEX 2/3) last month



http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/qsumzim3.html

Cross-checking R2 / R3 monitoring

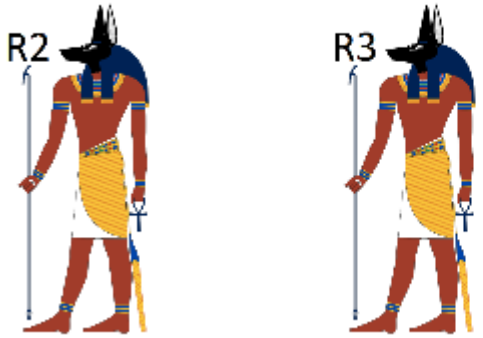
Multipath of observations (RINEX 2/3) last day



http://www.swisstopo.admin.ch/swisstopo/geodesy/pnac/html/en/qsumzim3.html

Cross-checking R2 / R3 monitoring

Detailed summary of data quality plots (RINEX 2/3)



pdf with all plots

Format issues: BDS 3.01 / 3.02 (Trimble NetR9)

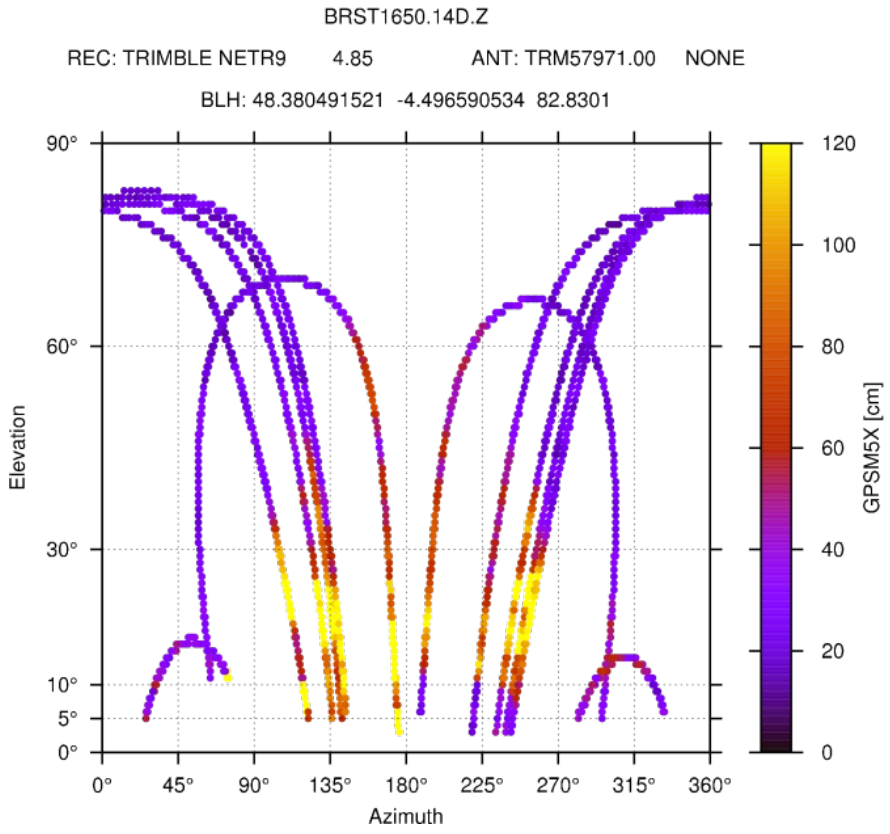
Example for ZIM31650.14D:

```
     3.02           OBSERVATION DATA    M (MIXED)           RINEX VERSION / TYPE
NetR9 4.85          Receiver Operator   14-JUN-14 00:00:00  PGM / RUN BY / DATE
ZIM3                                                        MARKER NAME
14001M008                                                   MARKER NUMBER
GEODETIC                                                    MARKER TYPE
TRIMBLE NETR9       SWISSTOPO                               OBSERVER / AGENCY
5229K50741          TRIMBLE NETR9       4.85                REC # / TYPE / VERS
60369               TRM59800.00     NONE                    ANT # / TYPE
  4331300.1495   567537.0851  4633133.5110                 APPROX POSITION XYZ
        0.0000         0.0000        0.0000                 ANTENNA: DELTA H/E/N
G   12 C1C L1C S1C C2W L2W S2W C2X L2X S2X C5X L5X S5X      SYS / # / OBS TYPES
S    3 C1C L1C S1C                                         SYS / # / OBS TYPES
R   12 C1C L1C S1C C1P L1P S1P C2C L2C S2C C2P L2P S2P      SYS / # / OBS TYPES
E   12 C1X L1X S1X C5X L5X S5X C7X L7X S7X C8X L8X S8X      SYS / # / OBS TYPES
J   12 C1C L1C S1C C2X L2X S2X C5X L5X S5X C6X L6X S6X      SYS / # / OBS TYPES
C    9 C2I L2I S2I C7I L7I S7I C6I L6I S6I                 SYS / # / OBS TYPES
```

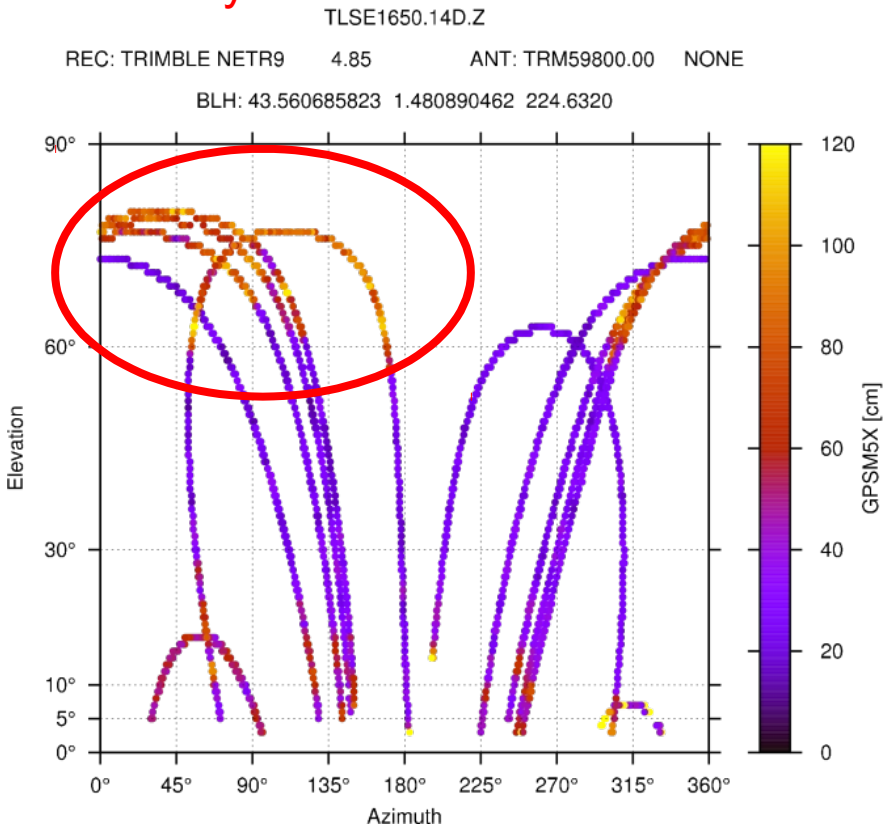
- C2I, L2I, and S2I (3.01) should be renamed to C1I, L1I, and S1I according to 3.02 format
- Trimble agreed, to update with next firmware

Quality issues: Trimble NetR9 Multipath GPS L5 and TRM59800.00 antenna: Bugreport June 17, 2014

Ok for cephyr antenna

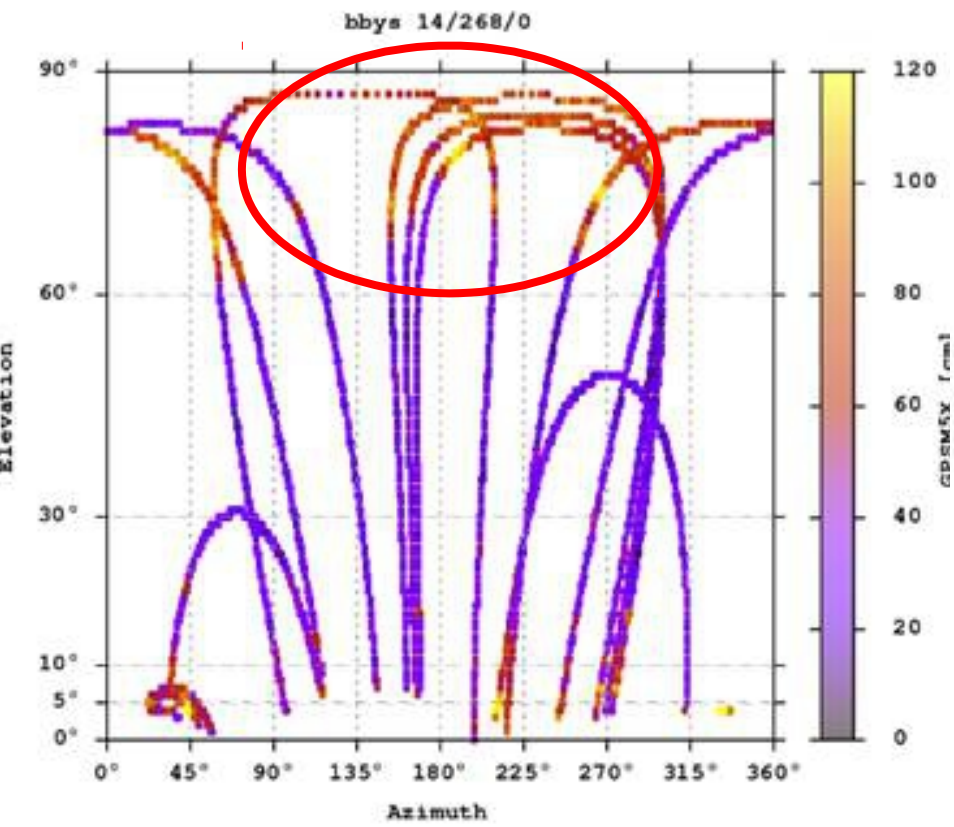


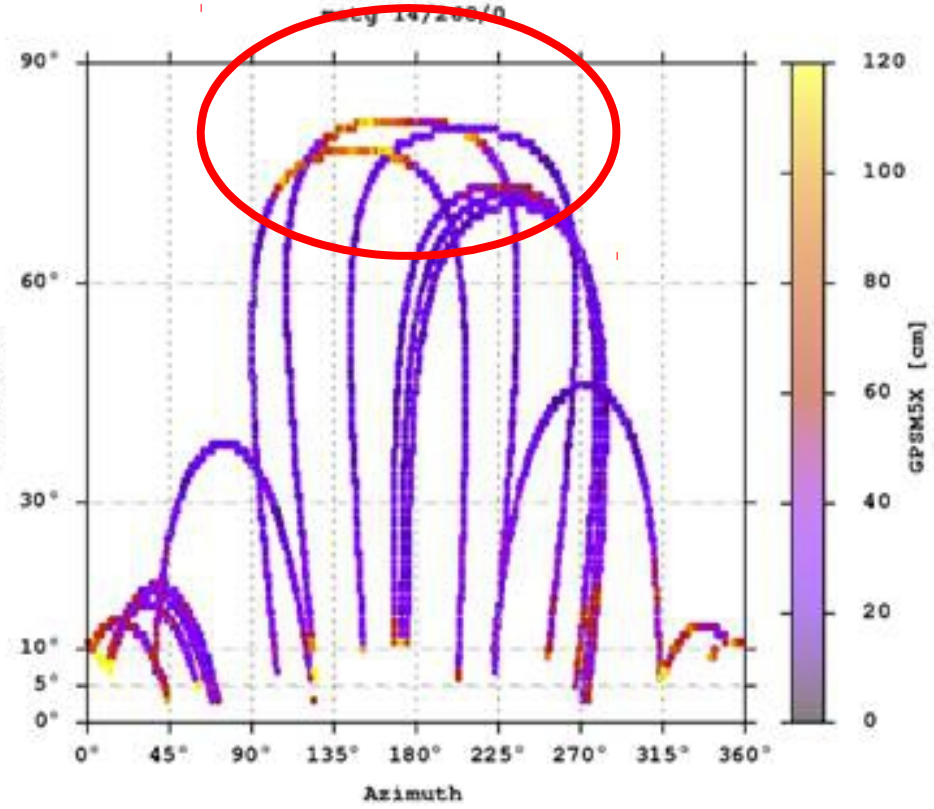
hight noise on high elevations only TRM59800 antenna



Same GPS MP5 problem for other MGEX stations

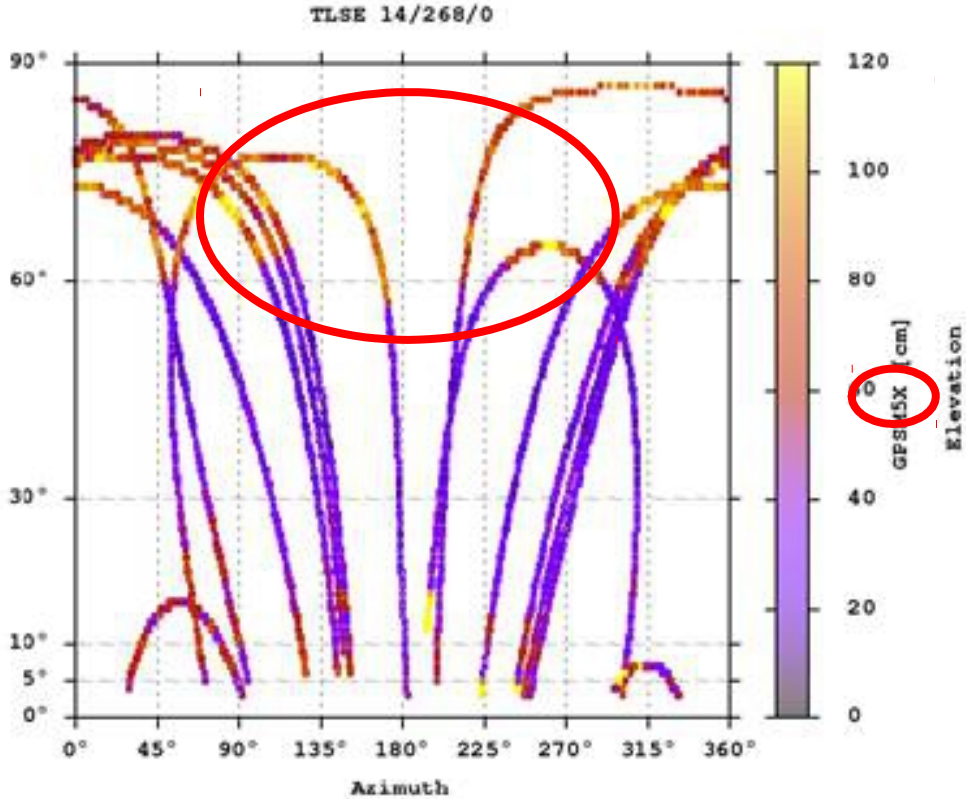
- X-Tracking: Trimble NetR9 (and `TRM59800.00`antenna)

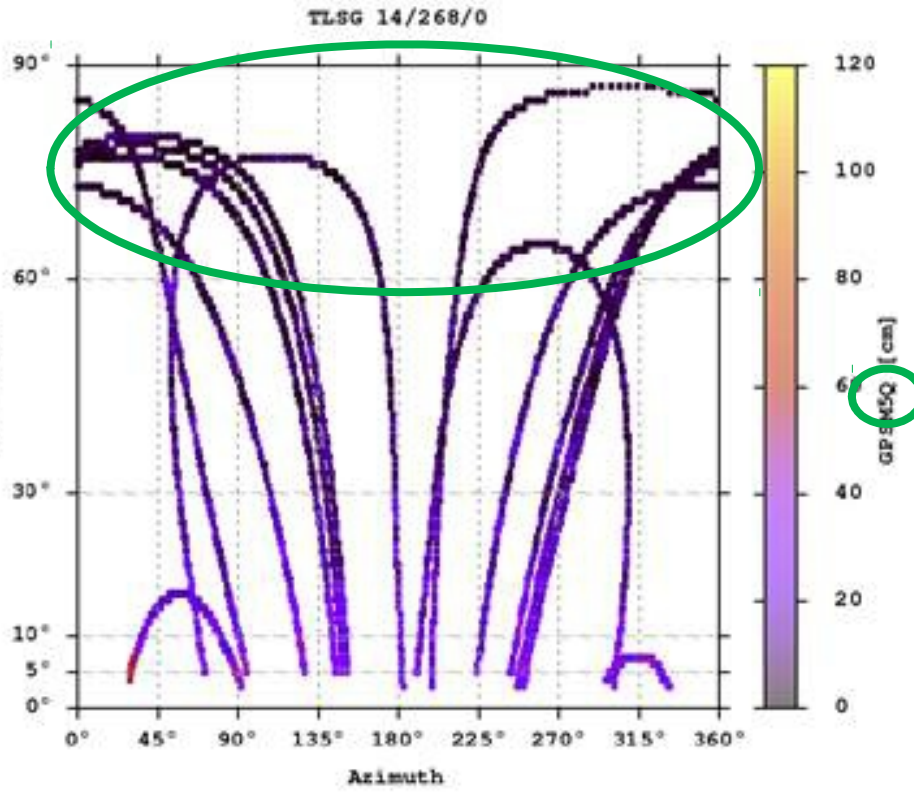




Antenna splitting: TSLE

TLSE	10003M009	Toulouse, FR	TRIMBLE NETR9	4.85	TRM59800.00	NONE
TLSG	10003M034	Toulouse, FR	SEPT POLARX4TR	2.5.2	TRM59800.00	NONE



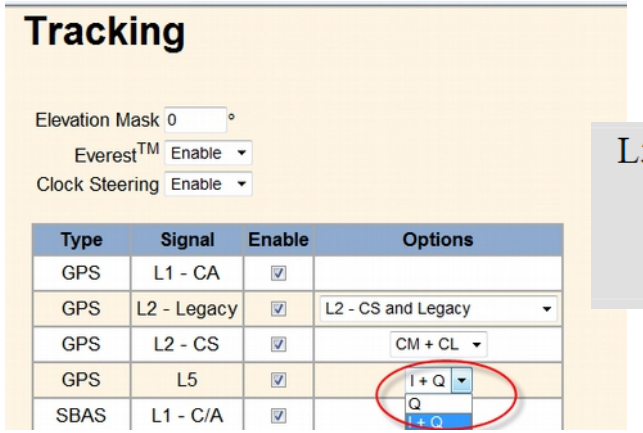


hight noise on high elevations
only TRM59800 antenna (X-Tracking)

Ok for Septrentio (Q tracking)

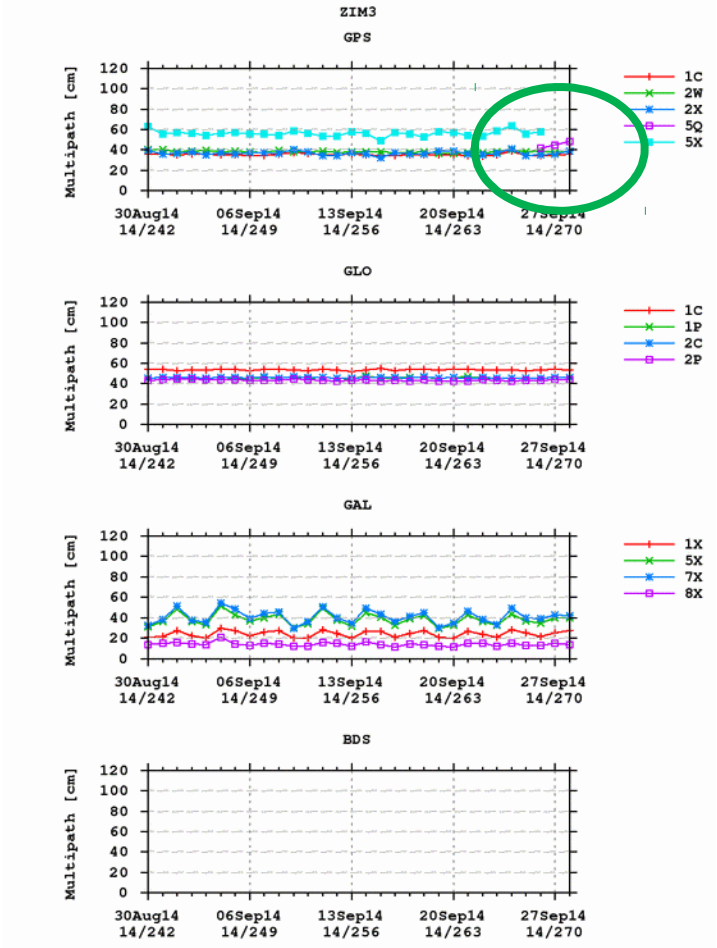
Trimble answer after 4 months + several iterations

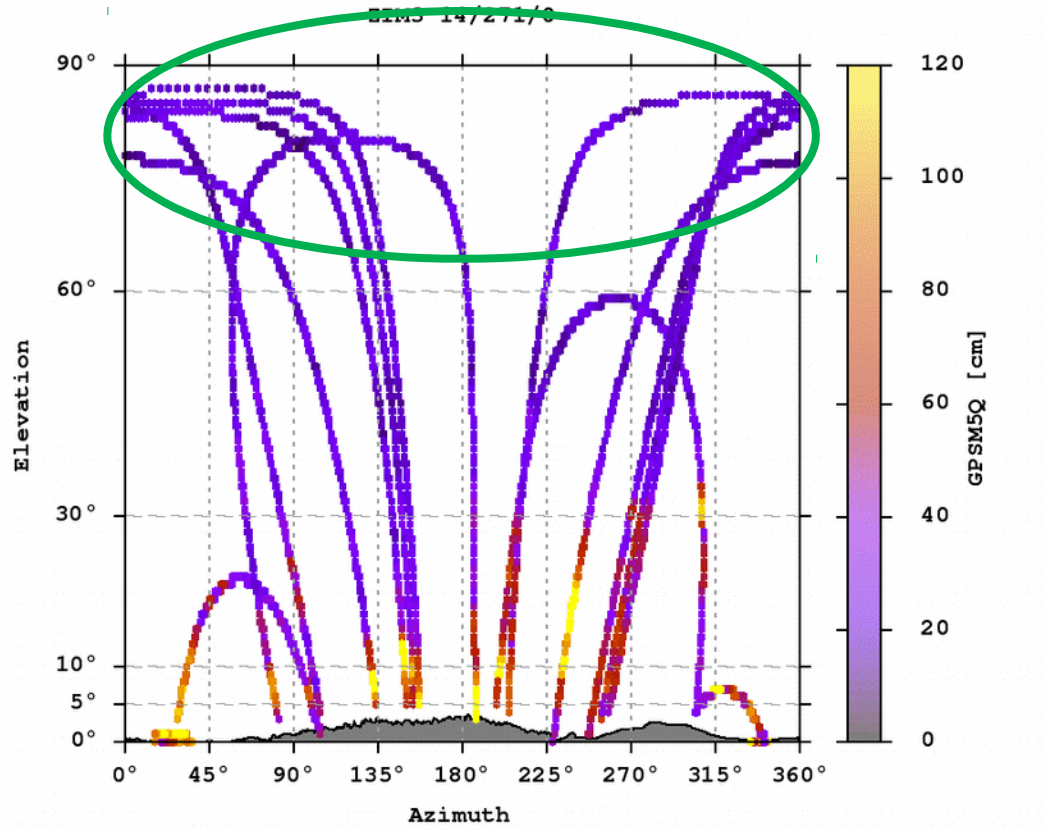
- October 7, 2014: “Based on the data provided by Swisstopo, Trimble was able to identify a section of firmware code which was not being properly handled at high gain/high CNo values. A firmware update will be released in the near future to correct this behavior.”
- ~ 10 MGEX stations will profit
- Other corrective action: switch to Q-tracking (Sept. 28)



L5	1176.45	I	L5I	None (Reference Signal)
		Q	L5Q	-¼ cycle
		I+Q	L5X	Must be aligned to L5I

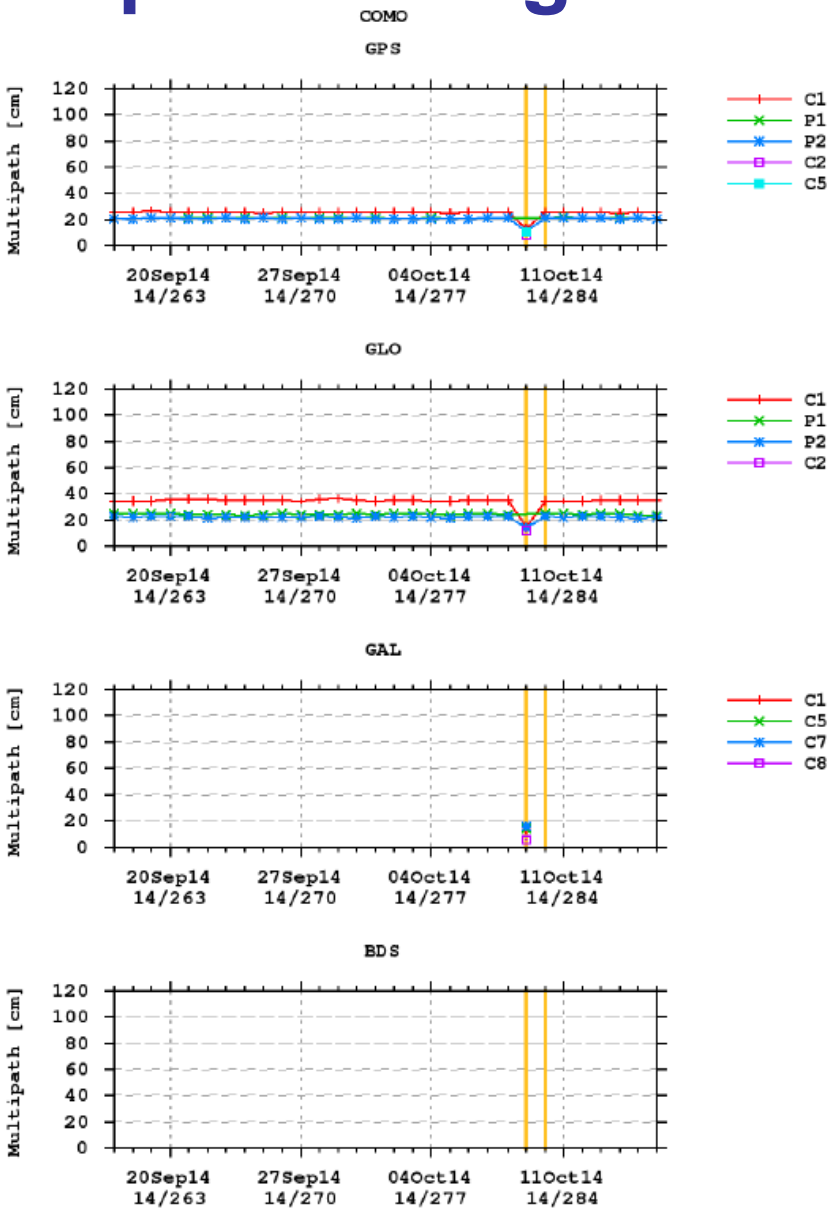
NetR9 Q-Tracking



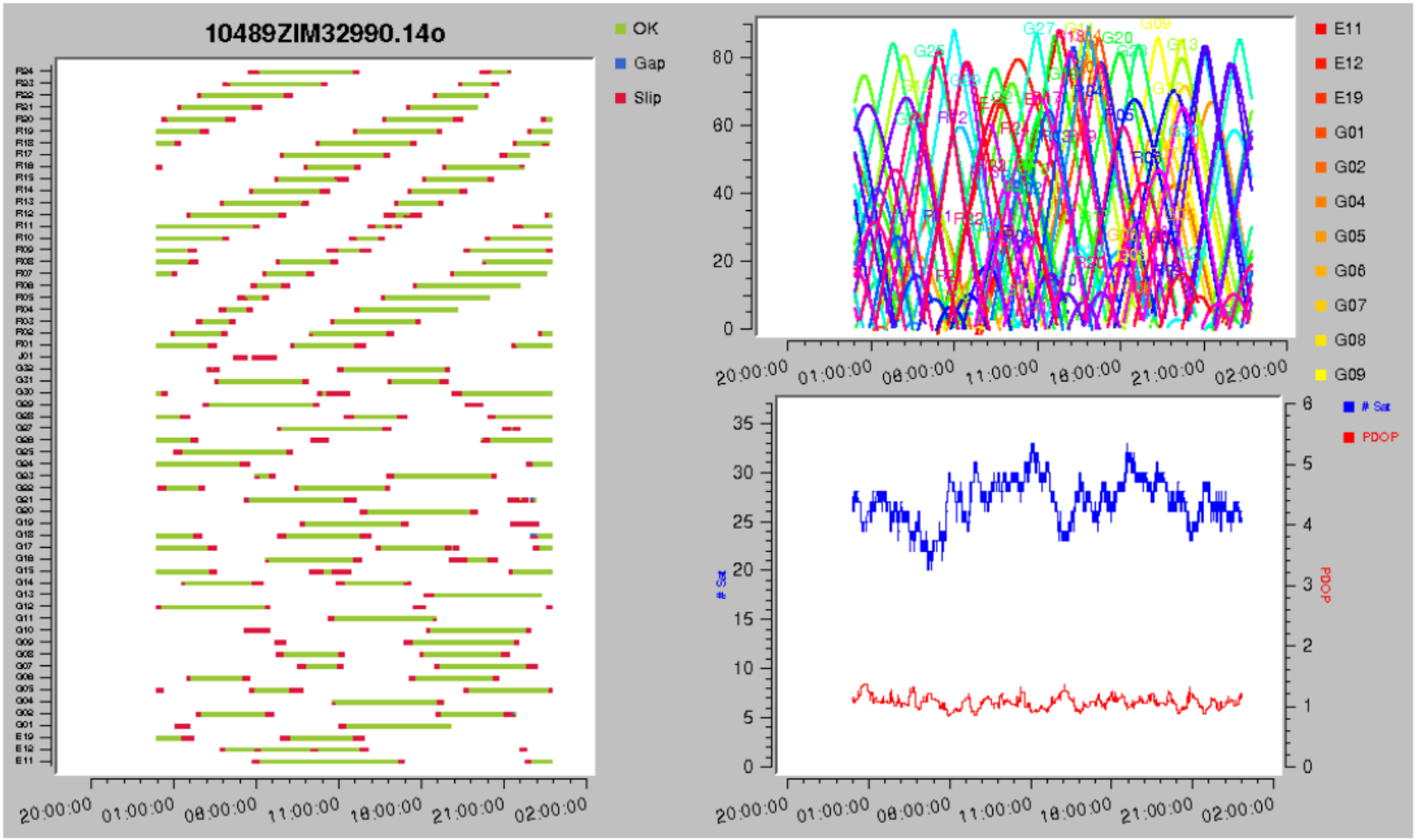


Helpfull for operation processing

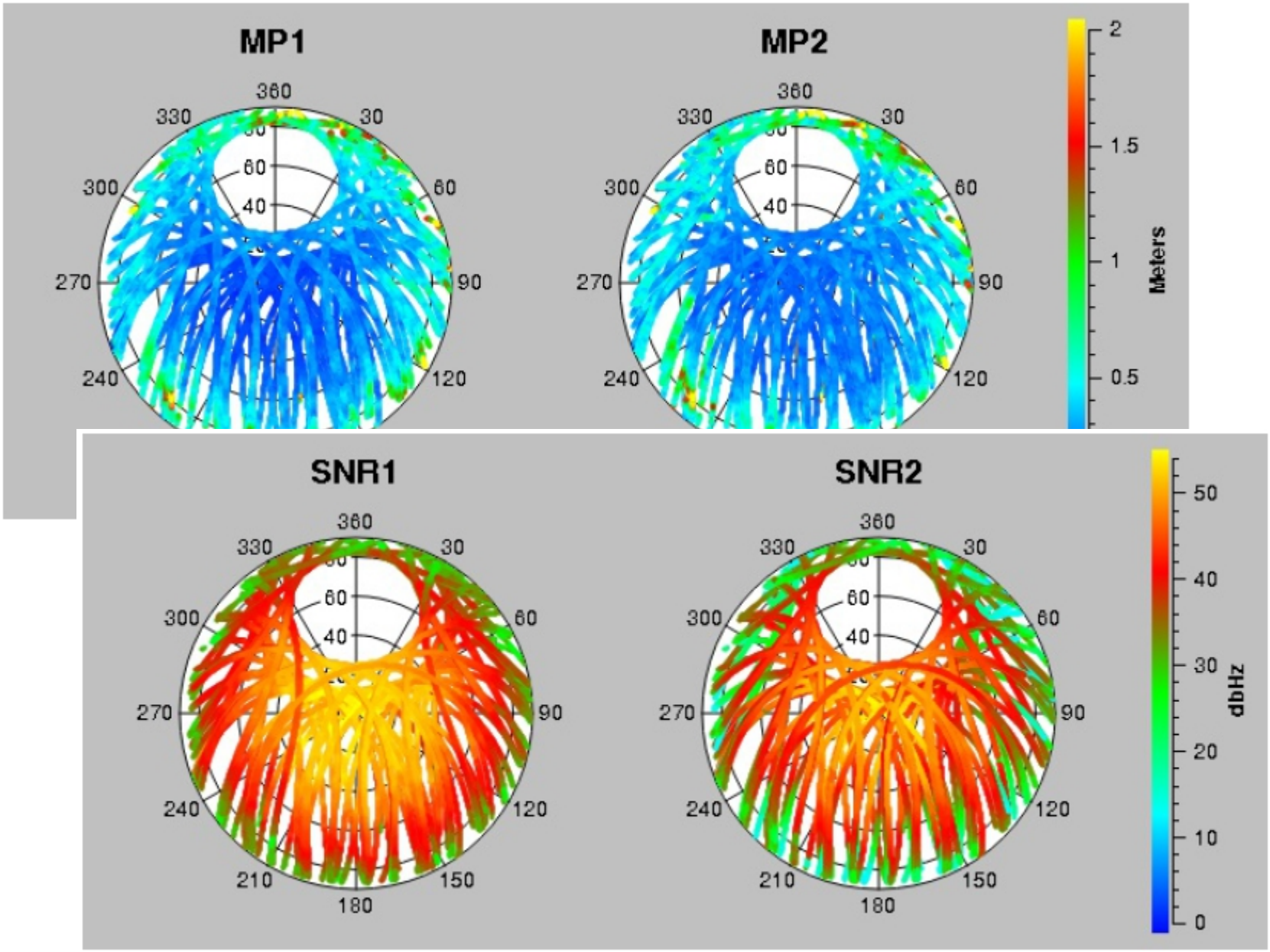
- COMO crashed operational processing on Oct. 9, 2014
- 1 day with wrong content



BNC Q-checks


10489ZIM32990.14o
OK
Gap
Slip
E11
E12
E19
G01
G02
G04
G05
G06
G07
G08
G09
Sat
PDOP
20:00:00
01:00:00
08:00:00
11:00:00
18:00:00
21:00:00
02:00:00

BNC Q-checks (2)



Todo QC monitoring

- Special handling low elevation data problem (-> GOPE)
- Plot interface based on common format in ASCII (->BKG)
- Multipath plots per satellite based on anubis (-> swisstopo)
- Automatic alarms (->swisstopo)

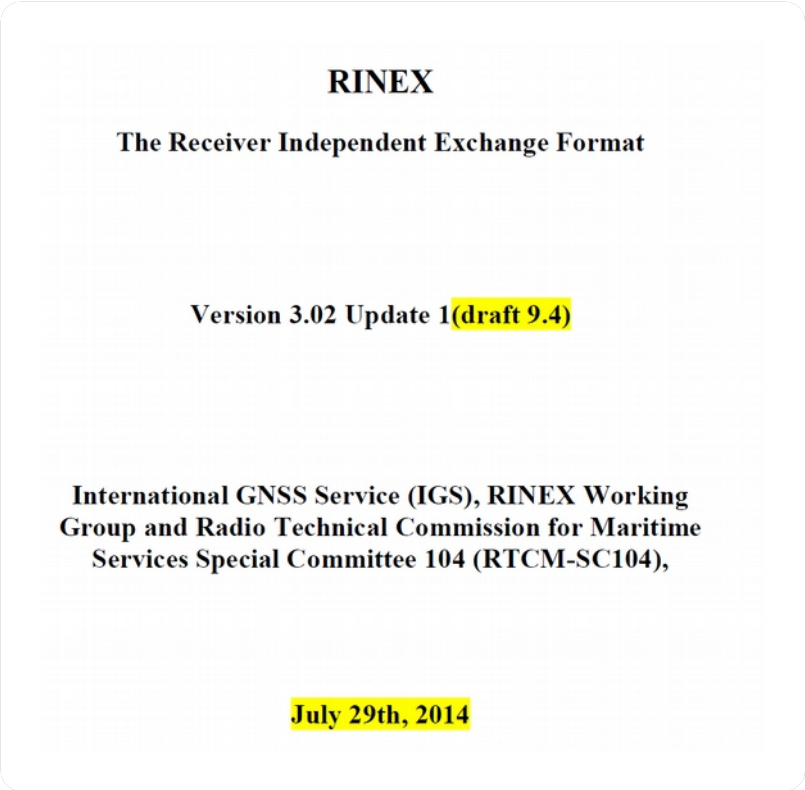
- Trial / comparison streaming data + R3->R2 conversions (BKG, swisstopo)

Multi-GNSS Analysis (Caporali)

IGS RINEX3 transition plan (Brockmann, Bruyninx)

Format Issues

- final RINEX 3.02 (draft 9.4) ready for the next RTCM meeting on Sept 8th and 9th in Tampa



RINEX

The Receiver Independent Exchange Format

Version 3.02 Update 1(draft 9.4)

International GNSS Service (IGS), RINEX Working Group and Radio Technical Commission for Maritime Services Special Committee 104 (RTCM-SC104),

July 29th, 2014

Development of RINEX3 files in EPN

- Status 24.10.2014: 58 stations delivering RINEX3
  - 13 stations 3.01 (10 Leica, 3 Javad)
  - 45 stations 3.02
- ~15 additional IGS-MGEX stations in Europe

EPN CB activities

From March 2014:

Check meta data in header of RINEX 3 data (crosscheck with site log, RINEX 2) → station manager notifications

From May 2014:

Actively push station managers to submit RINEX 3.02 instead of RINEX 3.01 (stalking by email…)

From Aug. 2014 (results in next slides):

Check validity of RINEX 3.02 format → station manager notifications ready in Nov. 2014

RINEX 3.02 format problems

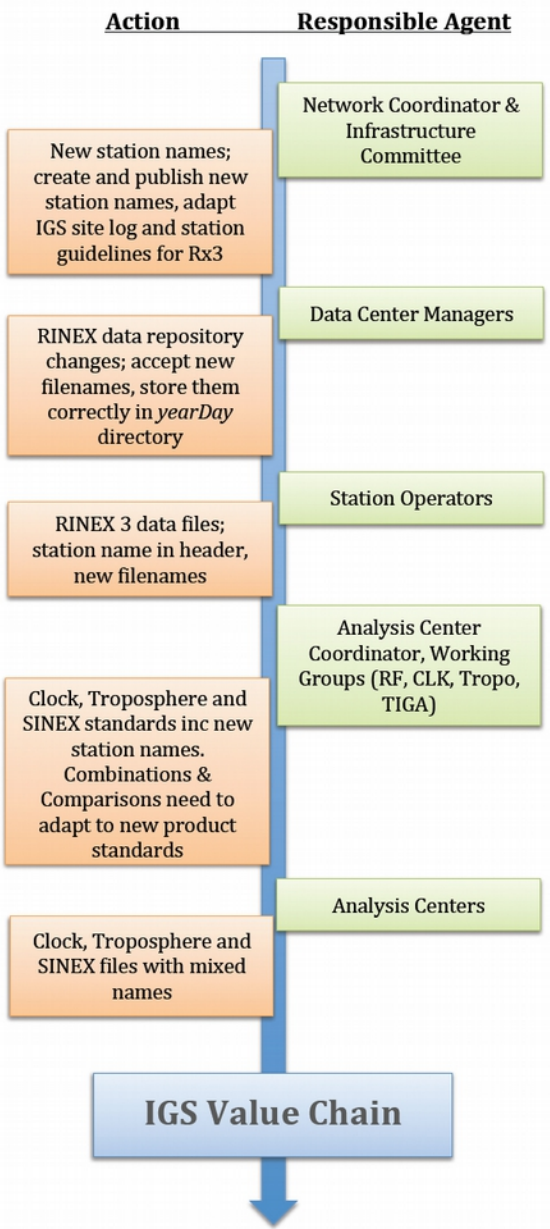
- Beidou wrong observation code (already presented before)
- QZSS with PRN J01, recorded as J93 when using cnvtToRINEX 2.17.0 (for conversion to RINEX)
  - BBYS (OK when using NetR9 4.81)
  - GANP (no QZSS in RINEX 3.02 when using BNC 2.10)
- RINEX headers without mandatory sections
  - SYS / PHASE SHIFT section (Phase shift correction used to generate phases consistent w/r to cycle shifts)
  - GLONASS SLOT / FRQ # section (GLONASS slot and frequency numbers)
  - GLONASS COD/PHS/BIS section (GLONASS Phase bias correction used to align code and phase observations)

15 stations with identified format issues

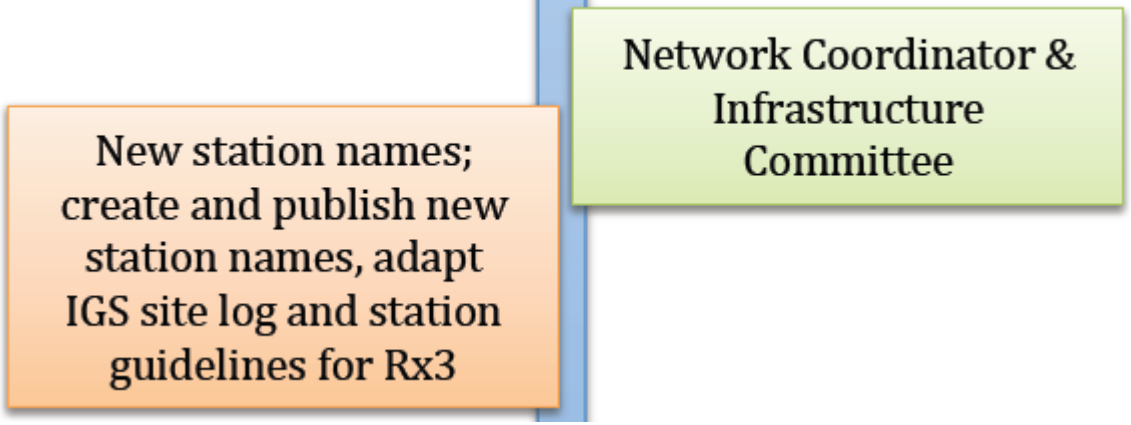
Summary of format issues

Station	Beidou	QZSS prn	SYS / PHASE SHIFT	GLONASS SLOT /FRQ #	GLONASS COD/PHS /BIS	Receiver	Firmware	RINEX conversion Program
AXPV						TRIMBLE NETR9	4.85	NetR9 4.85
BRST						TRIMBLE NETR9	4.85	NetR9 4.85
ILDX						TRIMBLE NETR9	4.85	NetR9 4.85
SMNE						TRIMBLE NETR9	4.85	NetR9 4.85
BBYS						TRIMBLE NETR9	4.85/4.71	NetR9 4.85
TLSE						TRIMBLE NETR9	4.85	cnvtToRINEX 2.21.0
DYNG						TRIMBLE NETR9	4.85	cnvtToRINEX 2.21.0
GANP						TRIMBLE NETR9	4.85/4.29	cnvtToRINEX 2.17.0
KLOP						TRIMBLE NETR9	4.85/4.29	TPP 3.1
ZIM2						TRIMBLE NETR5	4.85	cnvtToRINEX 2.17.0
BUTE						LEICA GR25	3.01/6.212	Geo++ RINEX V300
PEN2						LEICA GRX1200+GNSS	8.51/6.110	Geo++ RINEX V300
VEN1						LEICA GRX1200GGPRO (GPS+GLONASS)	8.71/3.822	BNC 2.10

IGS RINEX 3 Transition Plan v1.0



frastructure Committee, Rinex Working Group, Multi-GNSS ment.



- New station name centrally coordinated by IGS
- Only one station log R2/R3 – but updates necessary

mas1

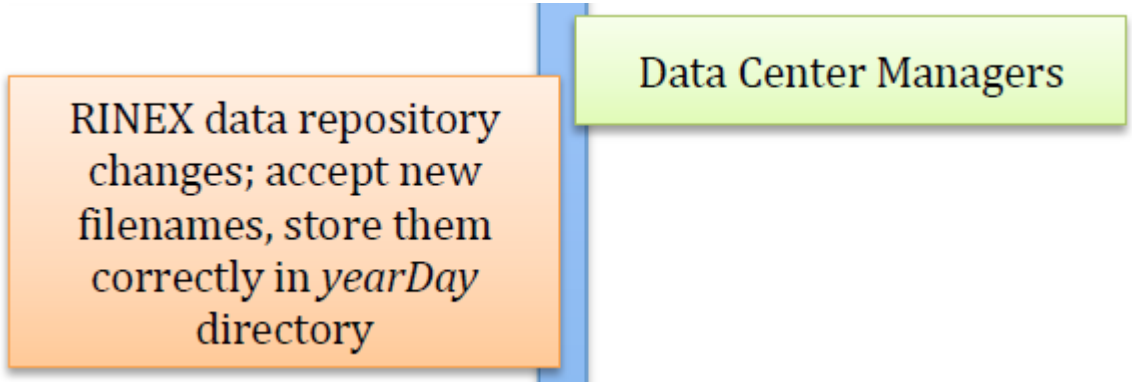
MAS100ESP

For **daily** Rx3 files we currently have in the *campaign/mgex/daily* directory:

mas12350.14d.Z

which becomes, with the Rx3 long names;

MAS100ESP_R_20142350000_01D_30S_MO.crx.gz



- R3->R2 converter ?
- [For future: R2 archives converted to R3?]

[**Open issue**: should the downcoverter Rx3 -> Rx2 be tested and provided by the NC/IC/CB (I think so) rather than as it is now by the ACC]

[**Open issue**: we need an indication from BKG about the possibility of BNC writing/reading the correct Rx3 filenames]

Station Operators

RINEX 3 data files; station name in header, new filenames

For **daily** Rx3 files we currently have in the *campaign/mgex/daily* directory:

mas12350.14d.Z

which becomes, with the Rx3 long names;

MAS100ESP_R_20142350000_01D_30S_MO.crx.gz

- Sites should provide Rinex 2 and Rinex 3 files as they want but the Rinex 3 have to use the correct long names . IF (and only if) a site wants to send only RINEX 3 (and the network accepts that!) then its OK to stop RINEX 2 since the data is redundant but no one should be forced to stop Rinex 2 files.

[**Open issue** as there is no renaming software available now; should the IGS CB provide a basic script to station operators to rename their Rx3 files correctly until vendor tools write the complete correct names?]

RINEX3 files + DCs (cont)

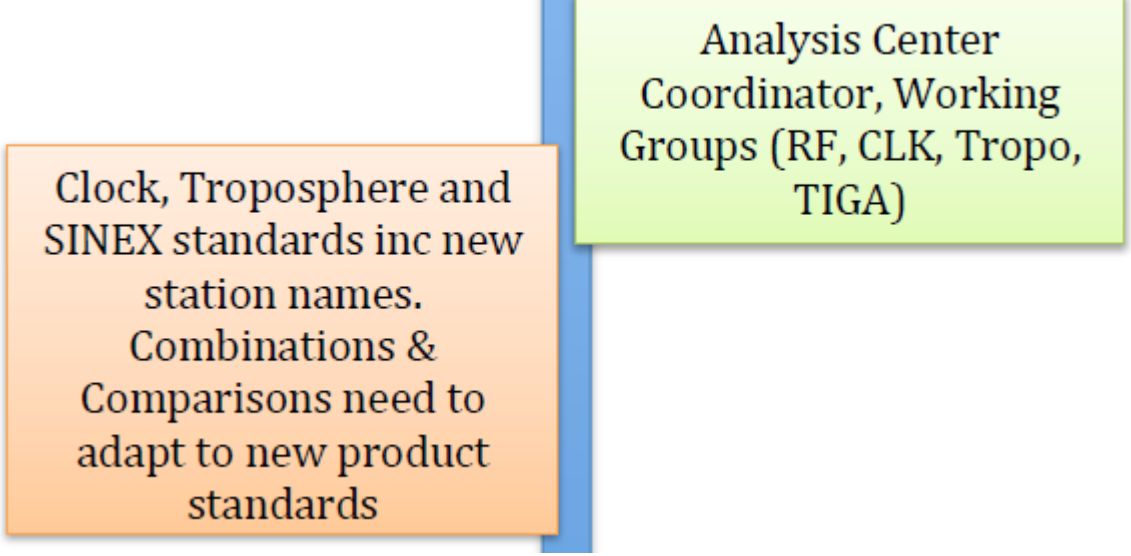
- Rinex 3 files with long filenames:
  ftp
  ://cddis.nasa.gov/gps/data/campaign/mgex/daily/rinex3/2014
  /260/crx
  /
- the final aim of the transition plan is that those files could be stored together in the gps/daily directory as our regular

FTP Directory: /gps/data/campaign/mgex/daily/rinex3/2014/260/crx/

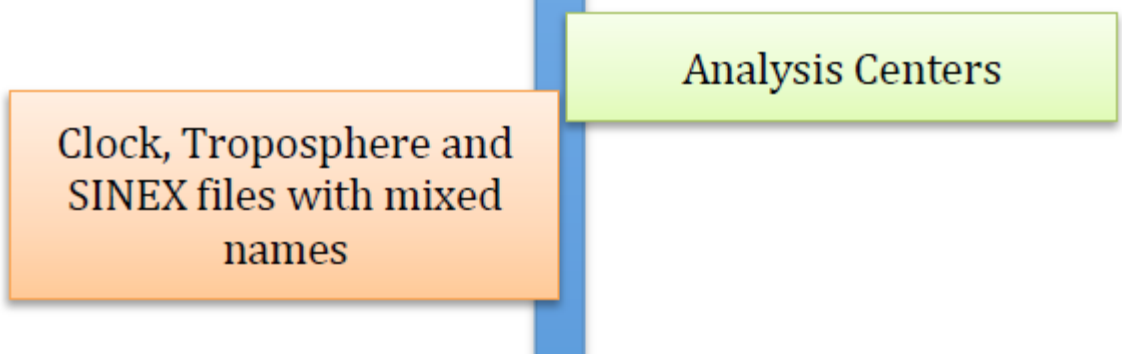
60/14d/

Up to higher level Directory

Type	Name	Size	Last Modification
	CEBR00ESP_R_20142600000_01D_30S_MO.crx.gz	1 MB	Sep 17 20:16
	FAA100PYF_R_20142600000_01D_30S_MO.crx.gz	2 MB	Sep 17 20:16
	KIRU00SWE_R_20142600000_01D_30S_MO.crx.gz	2 MB	Sep 17 20:16
	KOUR00GUF_R_20142600000_01D_30S_MO.crx.gz	2 MB	Sep 17 20:16
	MAL200KEN_R_20142600000_01D_30S_MO.crx.gz	2 MB	Sep 17 20:15
	MAS100ESP_R_20142600000_01D_30S_MO.crx.gz	2 MB	Sep 17 20:15
	MGUE00ARG_R_20142600000_01D_30S_MO.crx.gz	1 MB	Sep 17 20:15
	NNOR00AUS_R_20142600000_01D_30S_MO.crx.gz	2 MB	Sep 17 20:15
	REDU00BEL_R_20142600000_01D_30S_MO.crx.gz	1 MB	Sep 17 20:15
	VILL00ESP_R_20142600000_01D_30S_MO.crx.gz	1 MB	Sep 17 20:15

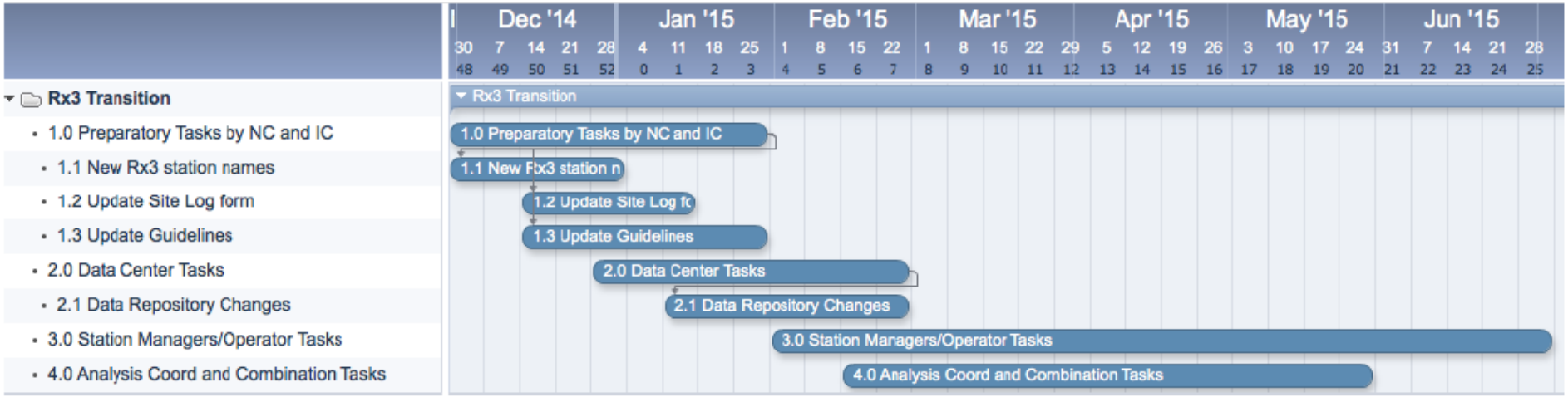


- SINEX format, etc. -> also **GNSS software need to be changed and submitted** to users (time consuming!)



- All output formats (SINEX, clock, TRP) … and also all “reading” software (users) are concerned

Timeline


Dec '14
Jan '15
Feb '15
Mar '15
Apr '15
May '15
Jun '15
30 7 14 21 28 4 11 18 25 1 8 15 22 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
48 49 50 51 52 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Rx3 Transition
1.0 Preparatory Tasks by NC and IC
1.1 New Rx3 station names
1.2 Update Site Log form
1.3 Update Guidelines
2.0 Data Center Tasks
2.1 Data Repository Changes
3.0 Station Managers/Operator Tasks
4.0 Analysis Coord and Combination Tasks

Feedback of EPN to that plan

- EPN simply follows IGS? -> almost
- is station name change / marker name change necessary? -> not, but usefull for future
- Station name coordination centrally by IGS / Domes number by IGN? -> coordination EPN by EPNCB?
- separate or common data archives? -> probably one direct.
- GNSS software need to be changed and submitted to users – alternatively as temporarily solution translation tables for reading / writing products (by regional network)? -> foresee longer time, where long names mapped back to short names
- Local/national networks? -> indiv. decision
- time schedule unrealistic !? -> ?

Feedback of EPN to that plan (cont)

- discussion results:
  - ….
  - ….