Twenty Years of EPN: Network Challenges Ahead

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May 25-27, 2016

ROYAL OBSERVATORY OF BELGIUM

Outline

How we evolved

- 1996-2016
- New EPN Stations
- EPN Densification
- EPOS

Network Challenges

- Updated EPN Guidelines
- Multi-GNSS
- Real-time Monitoring
- Site Log Submissions

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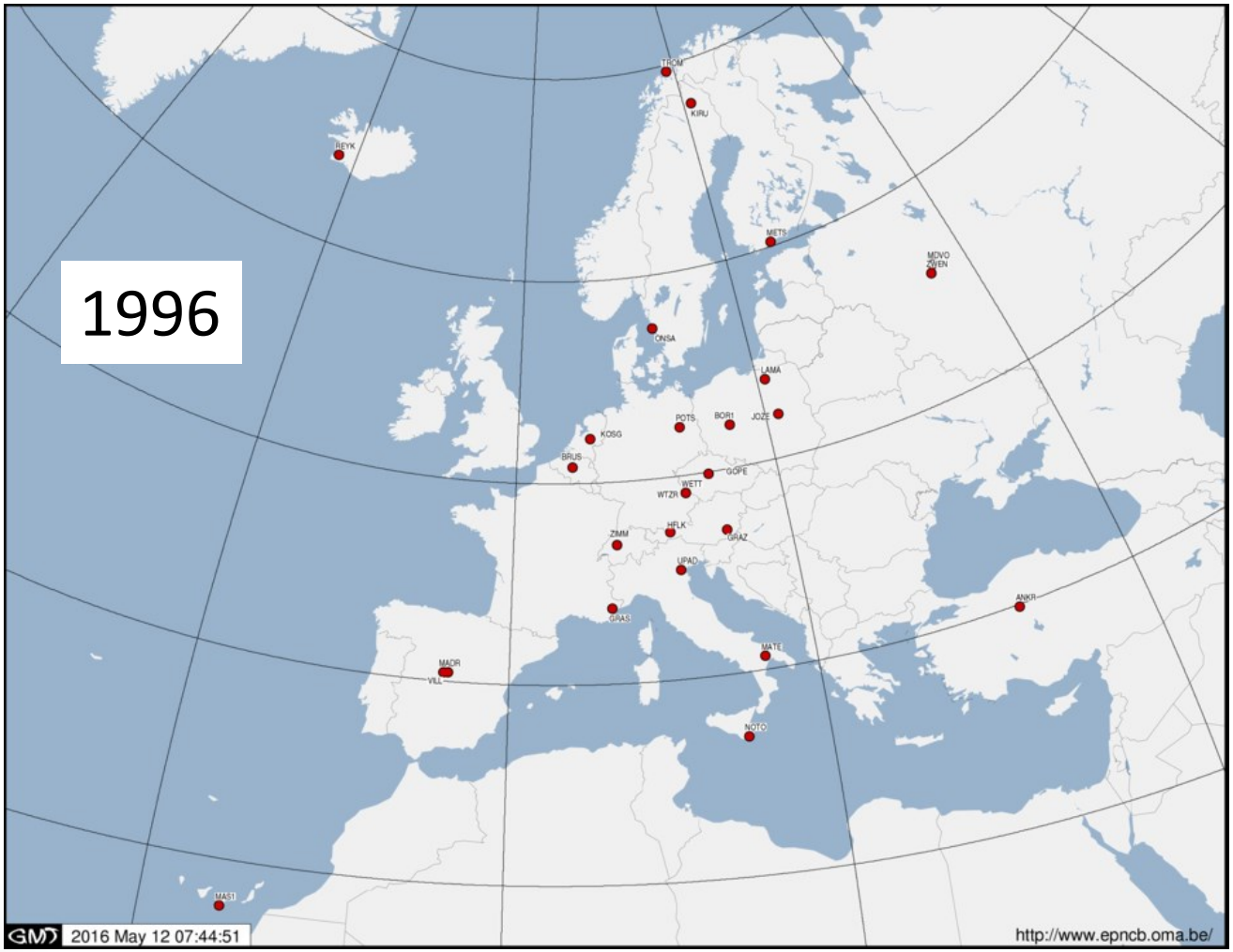
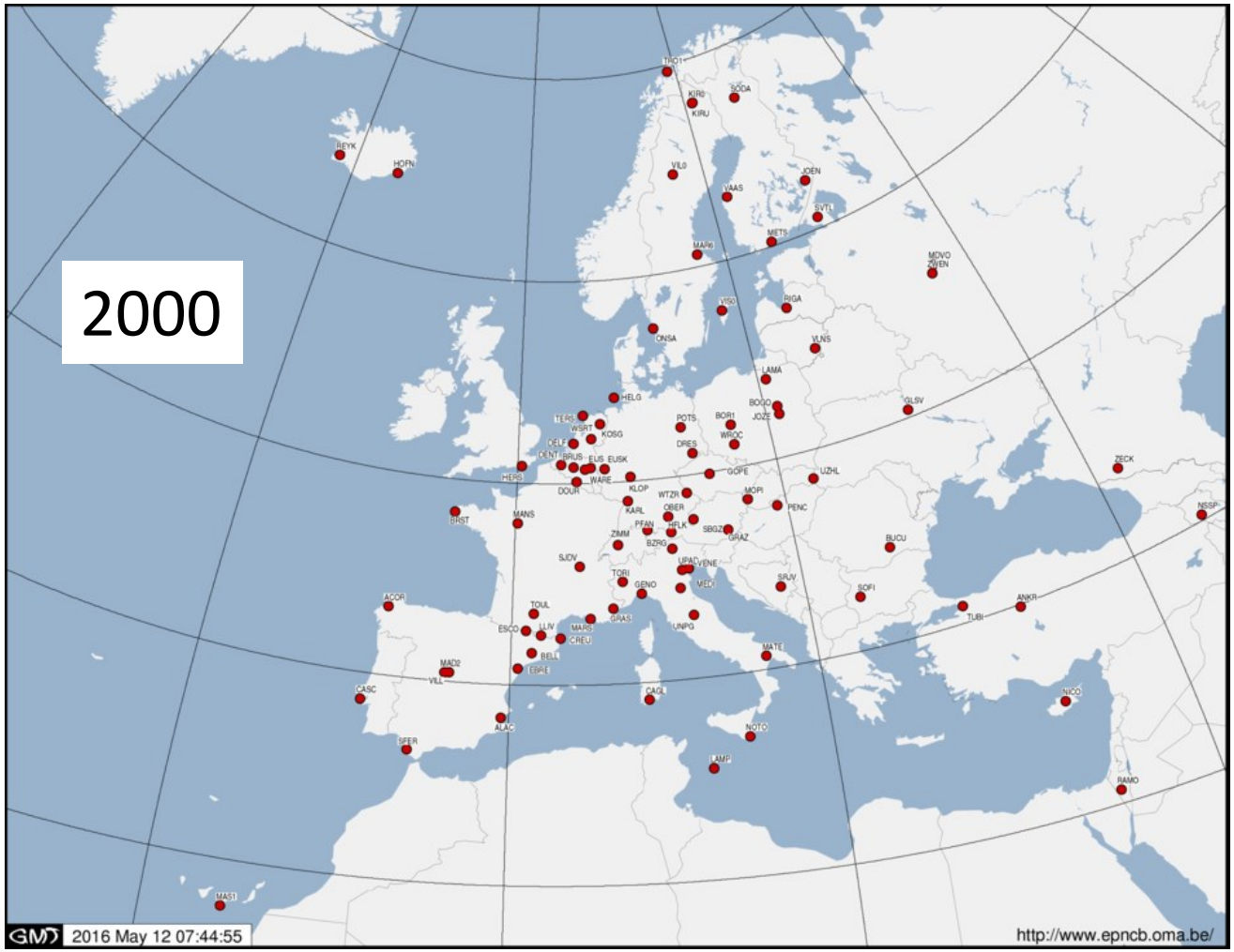
1996-2016 Tracking Network



1996-2016 Tracking Network



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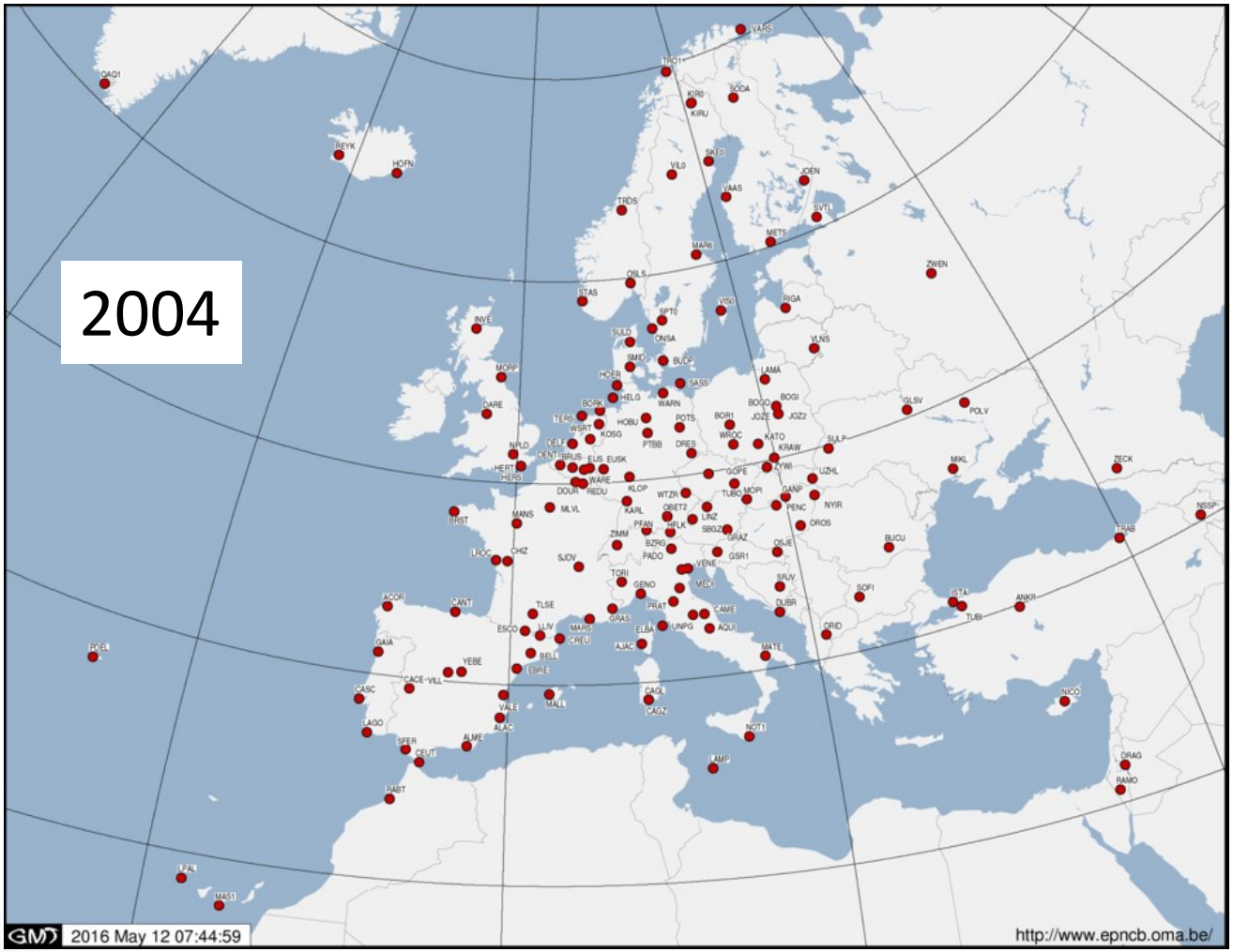

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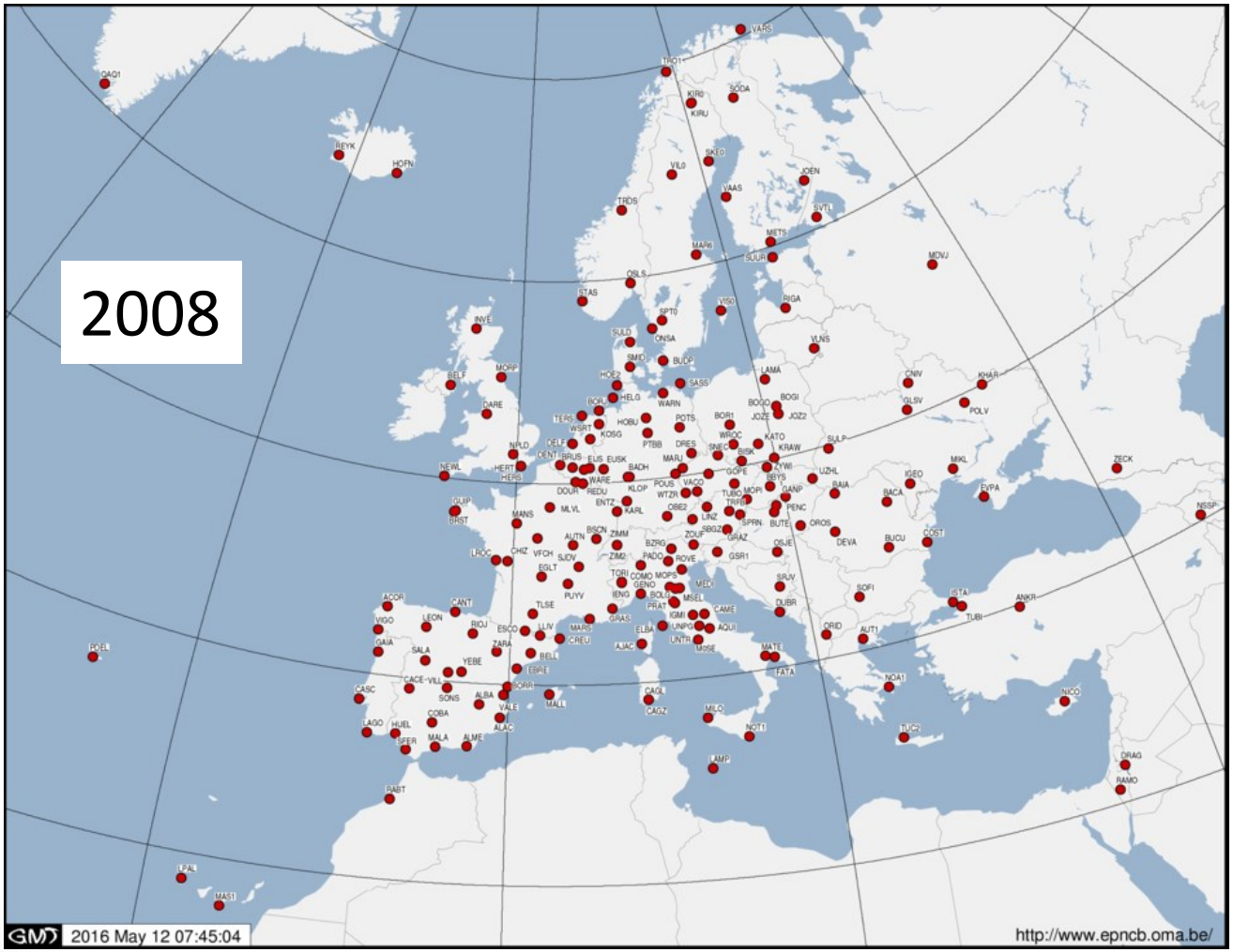

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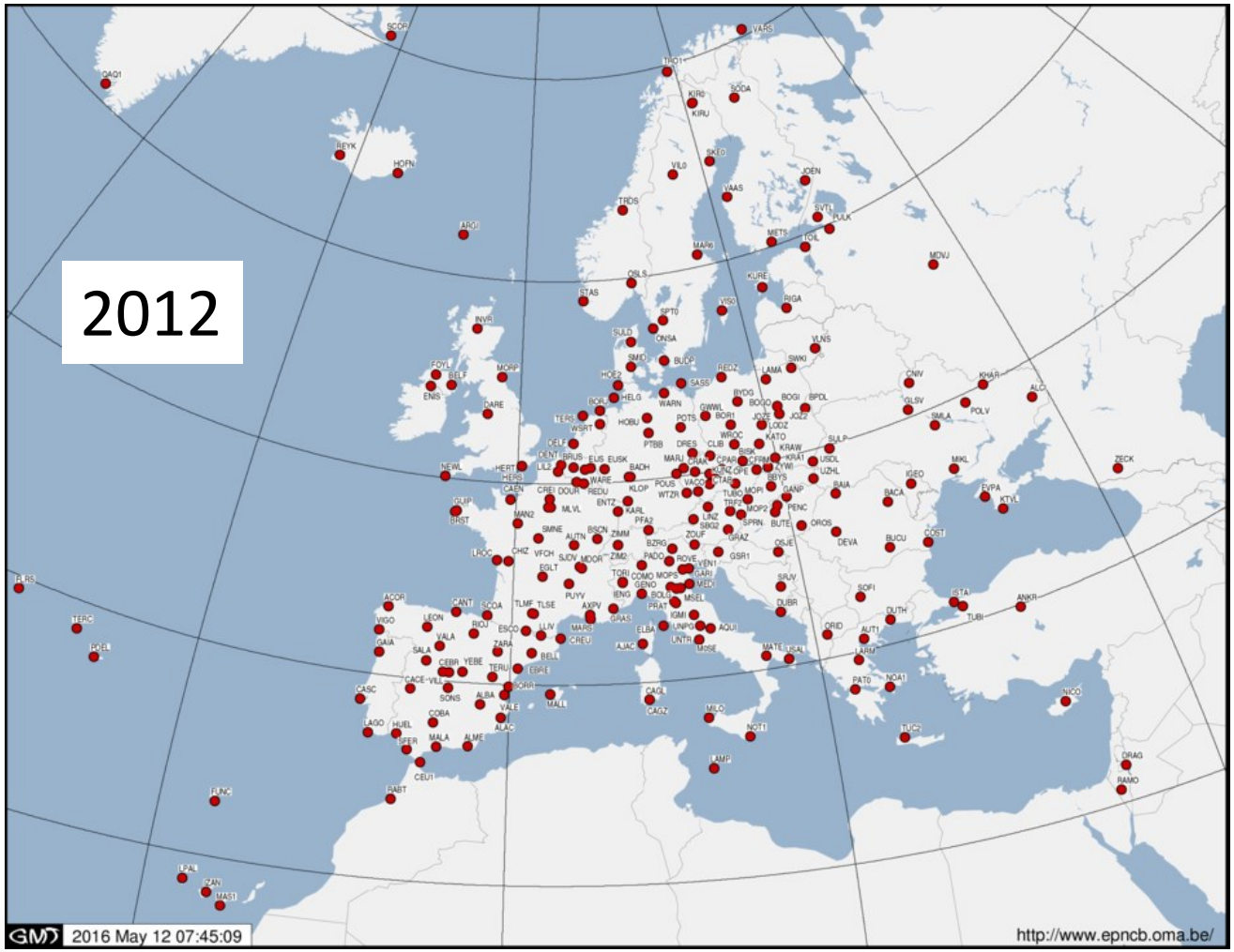

ROYAL OBSERVATORY OF BELGIUM

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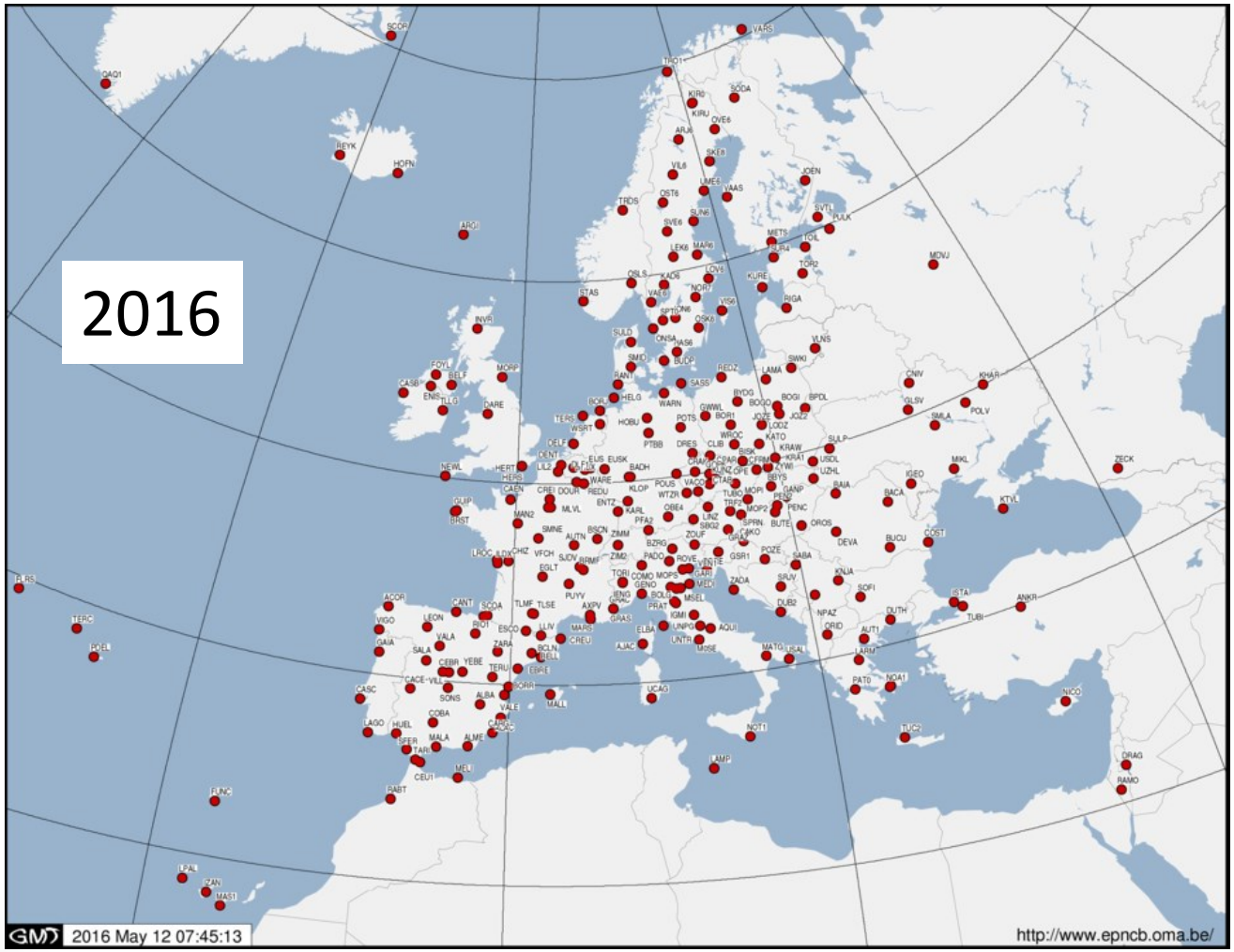
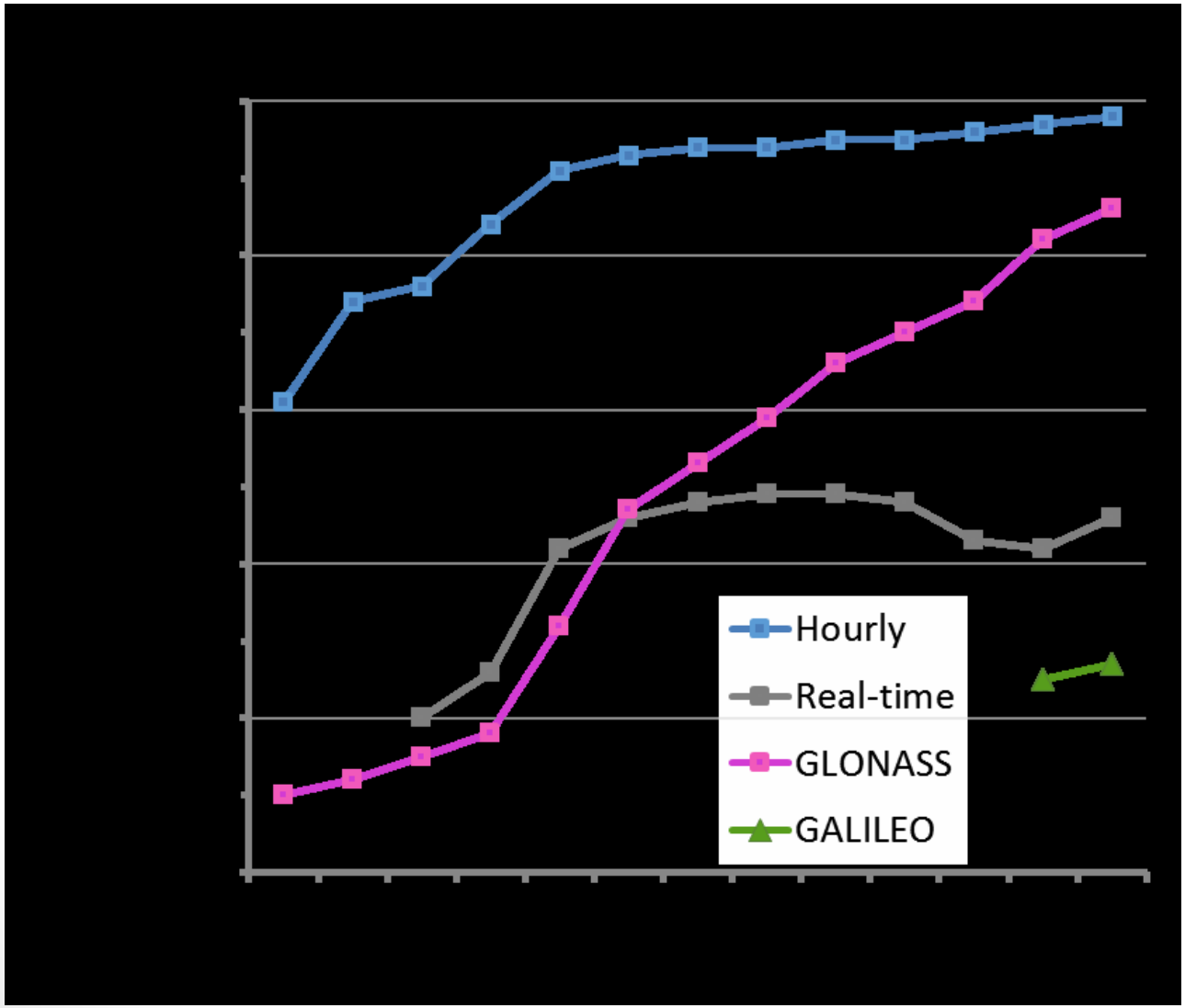
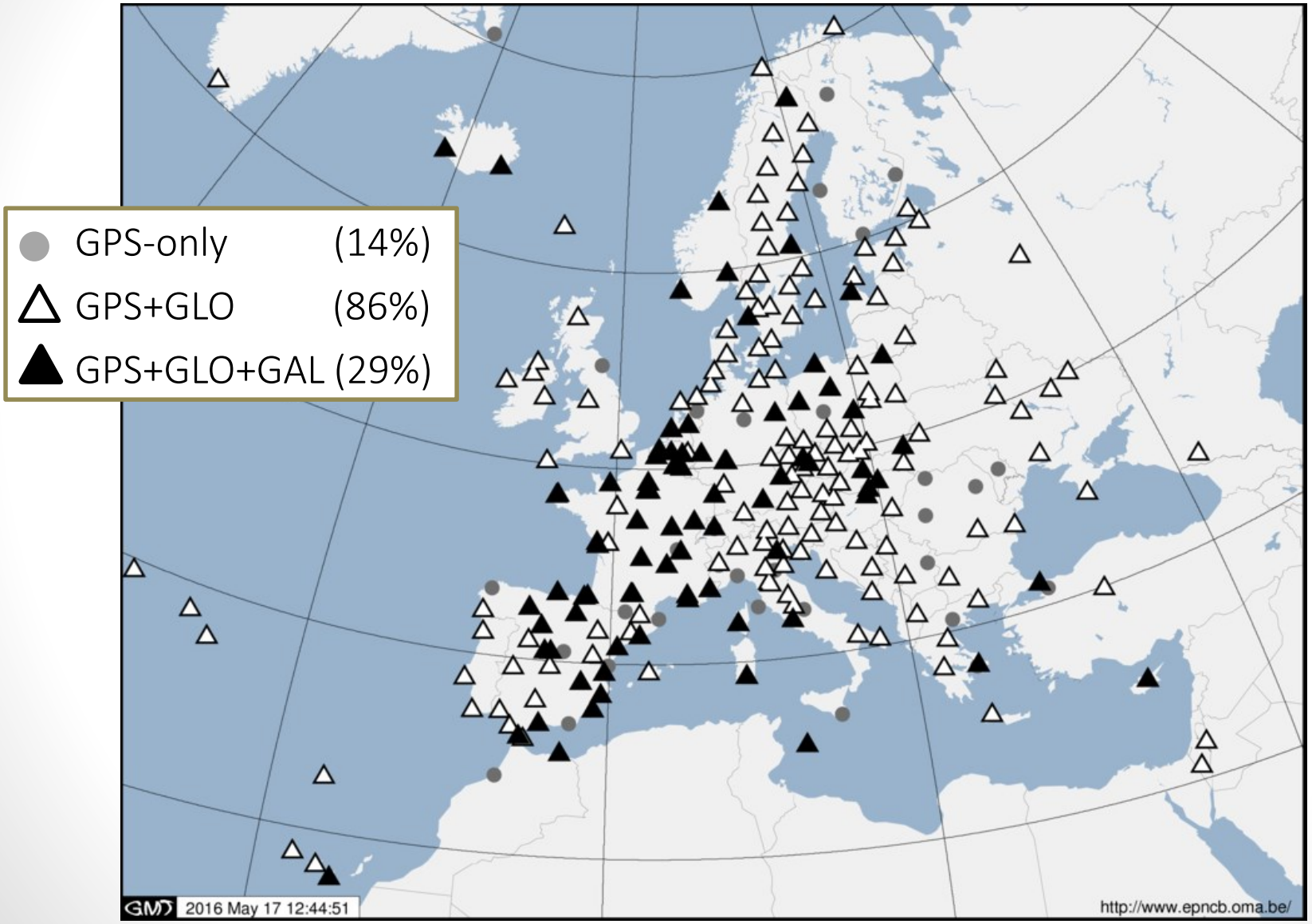


Station Capabilities

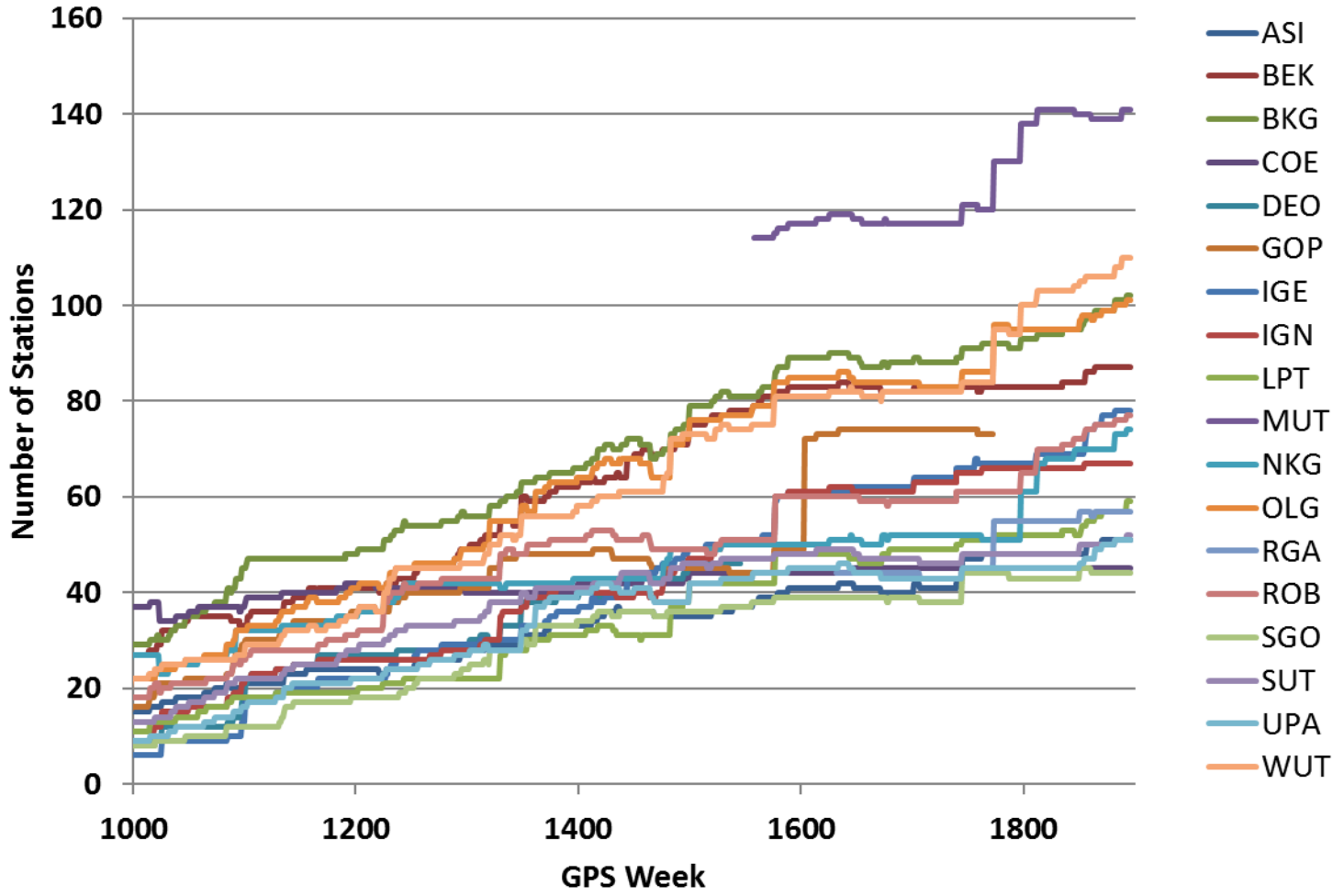


Glonass & Galileo Tracking



Analysis Centers

Nr of analysis centers



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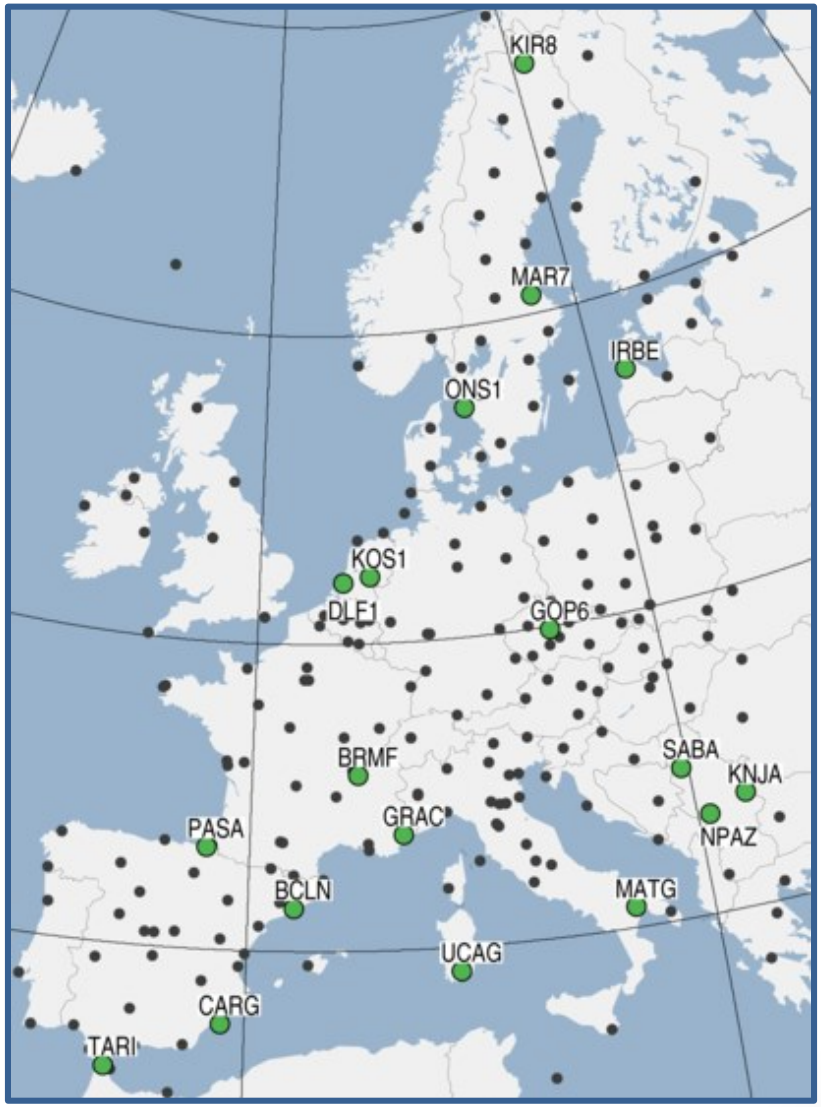
New EPN Stations

283 EPN stations

20 new stations :
4 in Spain
4 in Sweden
3 in Italy
2 in France
3 in Serbia
2 in the Netherlands
1 in Latvia
1 in Germany



Capabilities new stations

ROYAL OBSERVATORY OF BELGIUM

New active stations between GPS week No 1844 and 1896 (details) :

4-char ID	Location	Replacement or New	Sat. Sys. Tracking	R-T	Antenna Calibration	Included Since	Historical Data at EPNCB Since
BCLN	Sant Vicenc dels Horts, ESP	new	GPS GLO GAL	RT	Individual (GEO)	02-08-2015	07-02-2012
BRMF	Bron, FRA	replaces BRON	GPS GLO GAL BDS SBAS	RT	Type mean	26-07-2015	25-02-2014
CAG1	Cagliari, ITA	new	GPS GLO SBAS	RT	Type mean	31-01-2016	17-09-2013
CARG	Cartagena, ESP	new	GPS GLO GAL	RT	Individual (GEO)	27-09-2015	23-05-2014
DLF1	Delft, NLD	new	GPS GLO GAL BDS QZSS SBAS	RT	Individual (GEO)	27-09-2015	16-04-2011
GRAC	Caussols, FRA	new	GPS GLO GAL BDS SBAS	RT	Type mean	08-11-2015	26-03-2000
IRBE	Irbene, LVA	new	GPS GLO GAL		Type mean	17-04-2016	
KIR8	Kiruna, SWE	new	GPS GLO GAL BDS QZSS SBAS	RT	Individual (GEO)	31-01-2016	13-08-2011
KNJA	Knjazevac, SRB	new	GPS		Type mean	27-09-2015	12-05-2012
KOS1	Kootwijk, NLD	replaces KOSG	GPS GLO GAL BDS QZSS SBAS	RT	Individual (GEO)	17-04-2016	18-06-2013
MAR7	Gavle, SWE	new	GPS GLO GAL BDS SBAS	RT	Individual (GEO)	31-01-2016	27-04-2011
MATG	Matera, ITA	new	GPS GLO	RT	Type mean	09-08-2015	01-02-2012
NPAZ	Novi Pazar, SRB	new	GPS GLO		Type mean	21-06-2015	09-09-2011
ONS1	Onsala, SWE	new	GPS GLO GAL BDS SBAS	RT	Individual (GEO)	31-01-2016	28-01-2012
PASA	Pasaia, ESP	new	GPS GLO GAL BDS SBAS	RT	Individual (GEO)	08-11-2015	12-02-2007
RANT	Rantum / Island Sylt, DEU	new	GPS GLO GAL SBAS	RT	Individual (GEO)	24-05-2015	09-05-2014
SABA	Sabac, SRB	new	GPS GLO		Type mean	21-06-2015	09-09-2011
SUN6	Sundsvall, SWE	new	GPS GLO	RT	Individual (GEO)	17-05-2015	27-09-2011
TARI	Tarifa, ESP	new	GPS GLO GAL	RT	Individual (GEO)	02-08-2015	15-05-2010
UCAG	Cagliari, ITA	new	GPS GLO GAL	RT	Type mean	09-08-2015	16-04-2014

Capabilities new stations

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UCAG	Cagliari, ITA	new	GPS GLO GAL	RT	Type mean	09-08-2015	16-04-2014

All new stations are tracking Galileo

Exceptions:

Serbian stations: (SABA, NPAZ) → location

Swedish station: SUN6 → proposed already in 2013

Italian stations:

MATG → proposed with GAL, but presently tracking problem

CAG1 → proposed with GAL (twin station), but not (yet) tracking Galileo

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EPN Densification

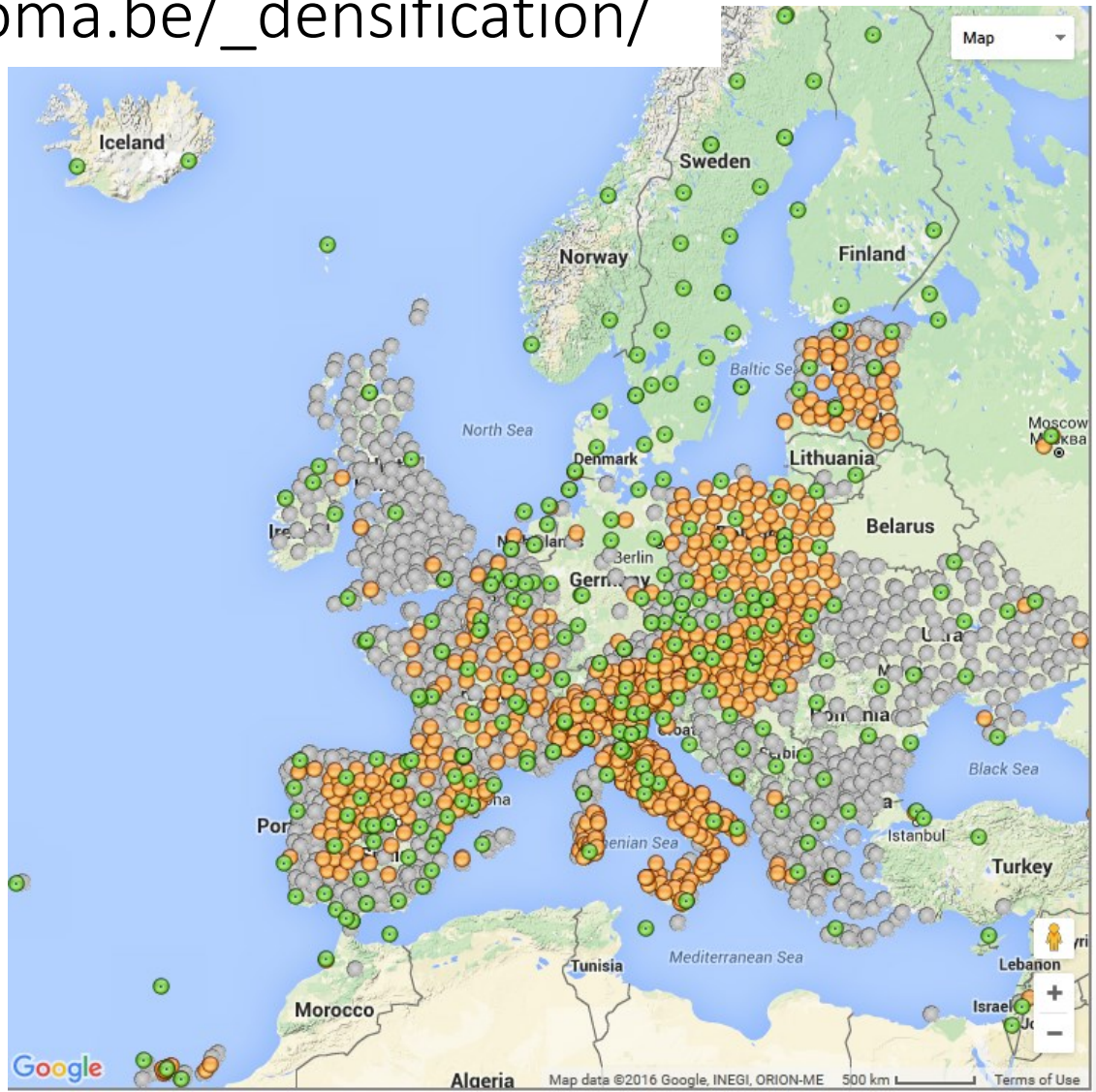
http://epncb.oma.be/_densification/

2337 stations (solution)

700 site logs collected

+ 125 site logs of new stations

+ indiv. ant. calib. (optional)



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EPOS

European Plate Observing System

https://www.epos-ip.org/

European E-infrastructure that is presently constructed.

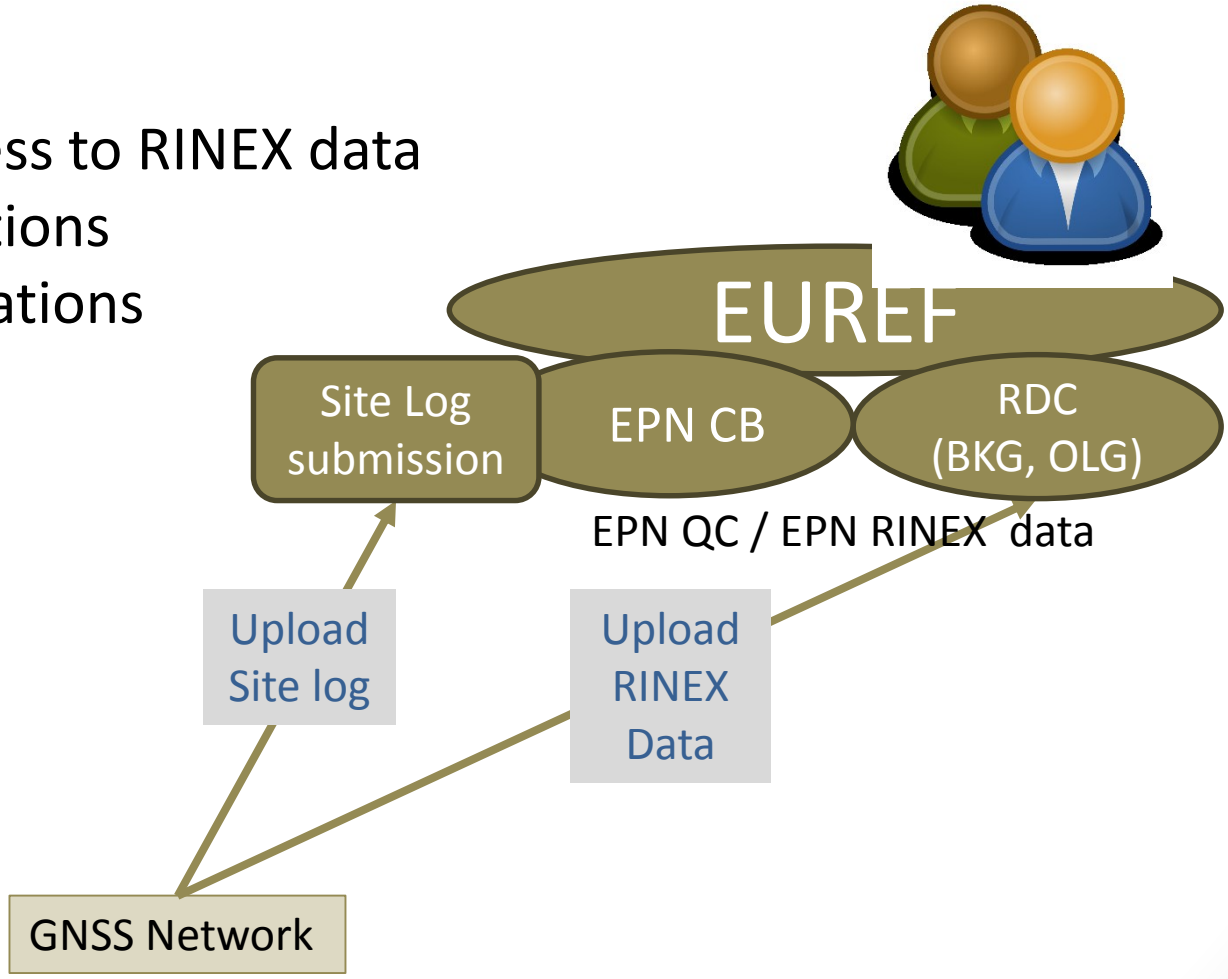
Builds on what already exists (observation networks, data processing capabilities,…)

European Plate Observing System - EPOS

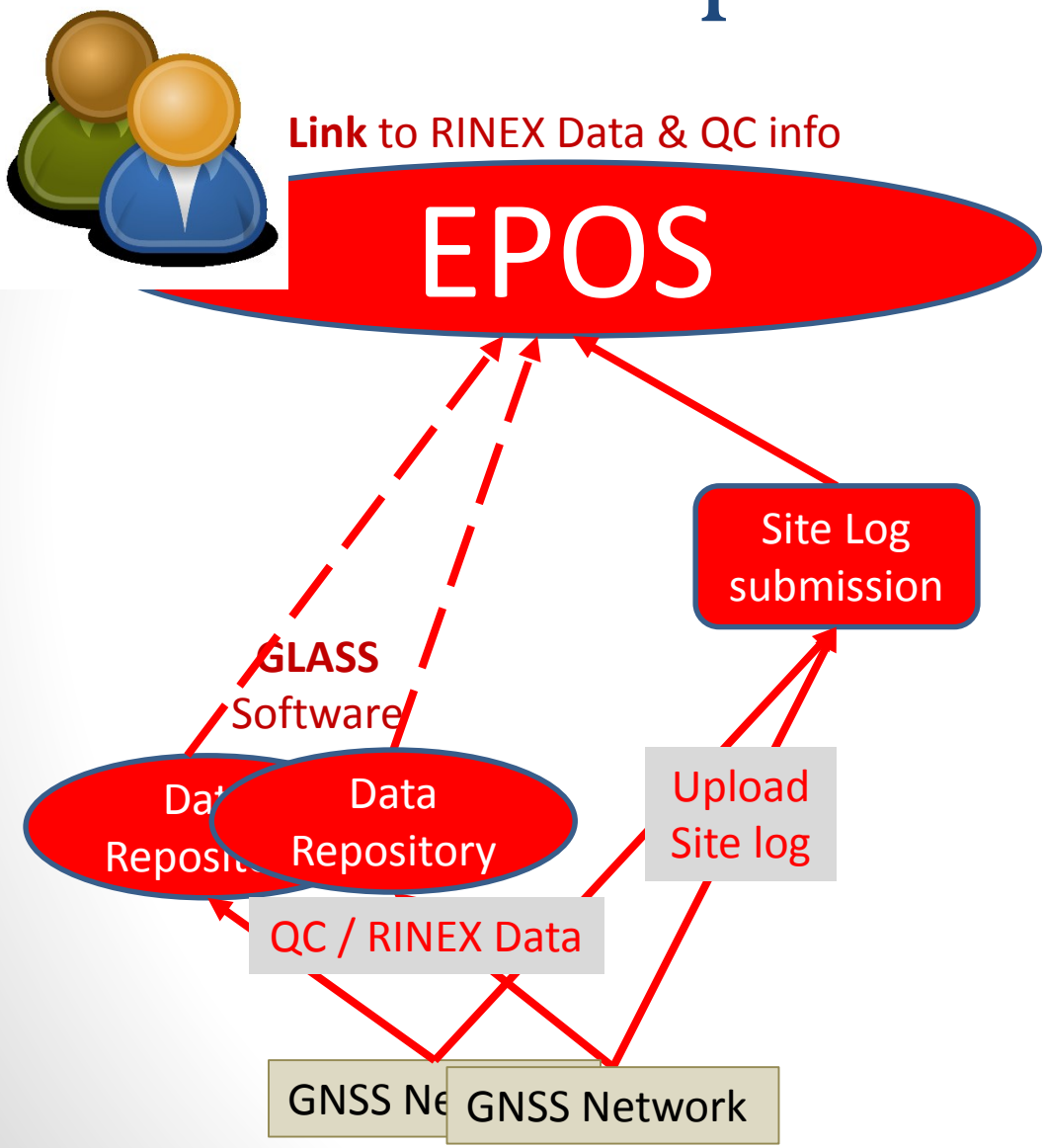
Integrated access to data, data products, and facilities from distributed research infrastructures, different disciplines

EPN Principle

OPEN access to RINEX data
EUREF stations
Not ALL stations



EPOS Principle

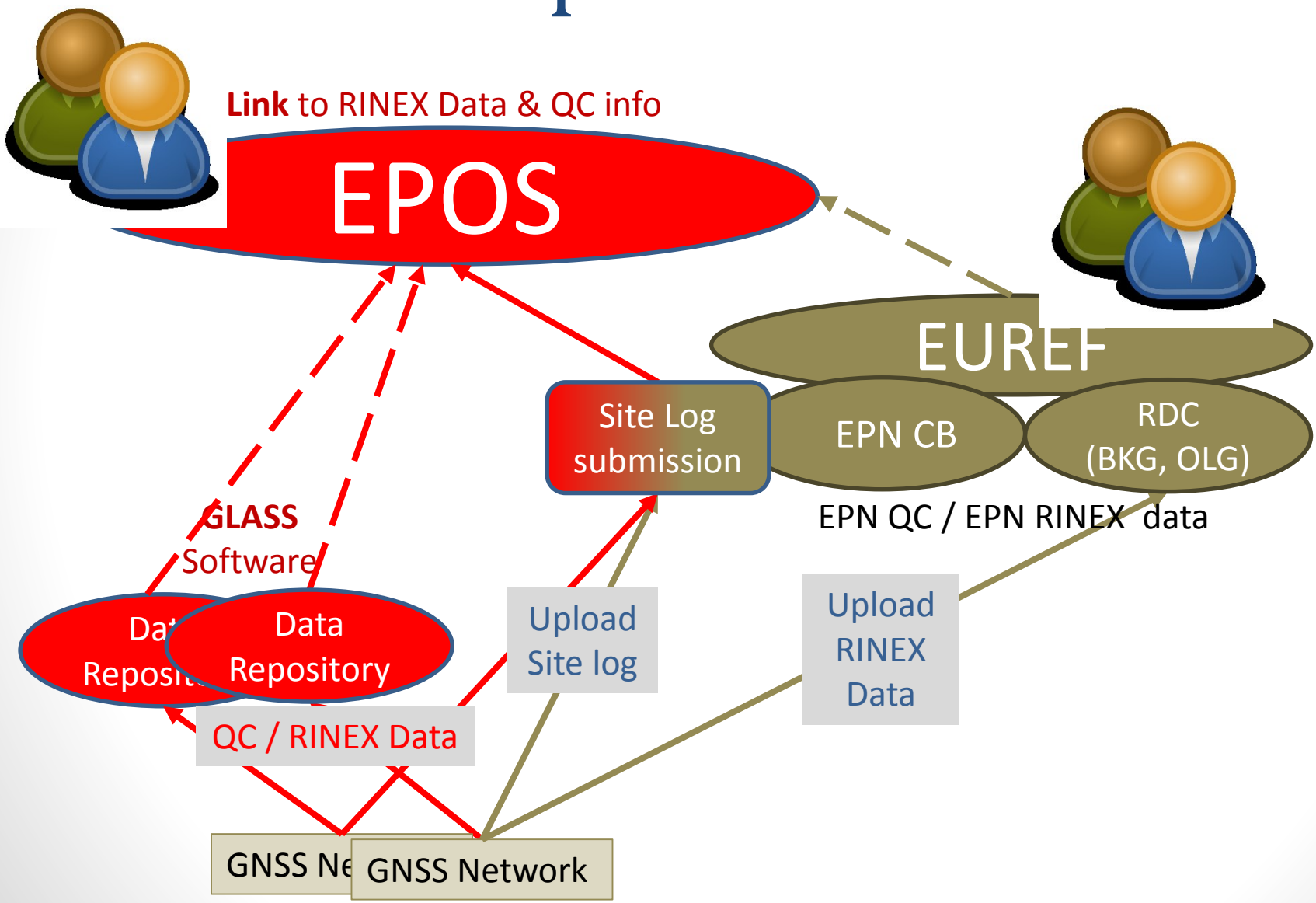


OPEN access to RINEX data

2500++ stations

GLASS software

EPOS Principle



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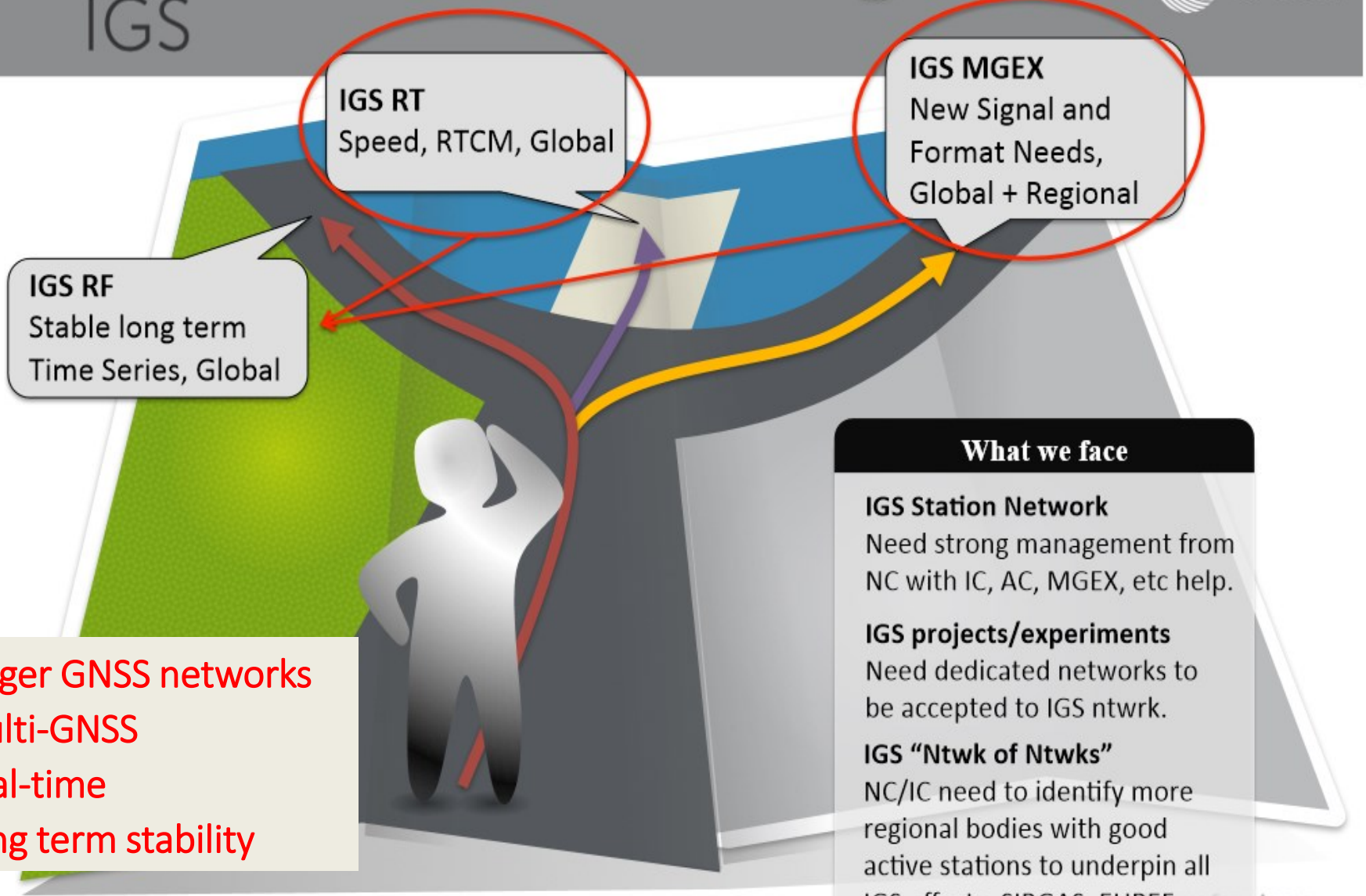
Overall Challenge

IGS

esa



Larger GNSS networks
Multi-GNSS
Real-time
Long term stability

What we face

IGS Station Network
Need strong management from NC with IC, AC, MGEX, etc help.

IGS projects/experiments
Need dedicated networks to be accepted to IGS ntwrk.

IGS "Ntwk of Ntwks"
NC/IC need to identify more regional bodies with good active stations to underpin all IGS efforts; SIRGAS, EUREF, AFREF,

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Updates of EPN Guidelines

- March. 2015

  Guidelines for EPN Data Centres & EPN Broadcasters

  - New guidelines for the broadcasters

- Oct. 2015

  Guidelines for EPN Stations and Operational Centers

  - RINEX 3 (long naming convention) recommended (in addition to RINEX 2) for stations providing more than dual freq. GPS+GLO
    - ftp://igs.org/pub/data/format/rinex303.pdf
    - ~~RINEX 3.01~~, RINEX 3.02 or later
  - Regional DCs (BKG and OLG) accept RINEX 3 data with long names
    - Data show up in same dir as RINEX 2 data

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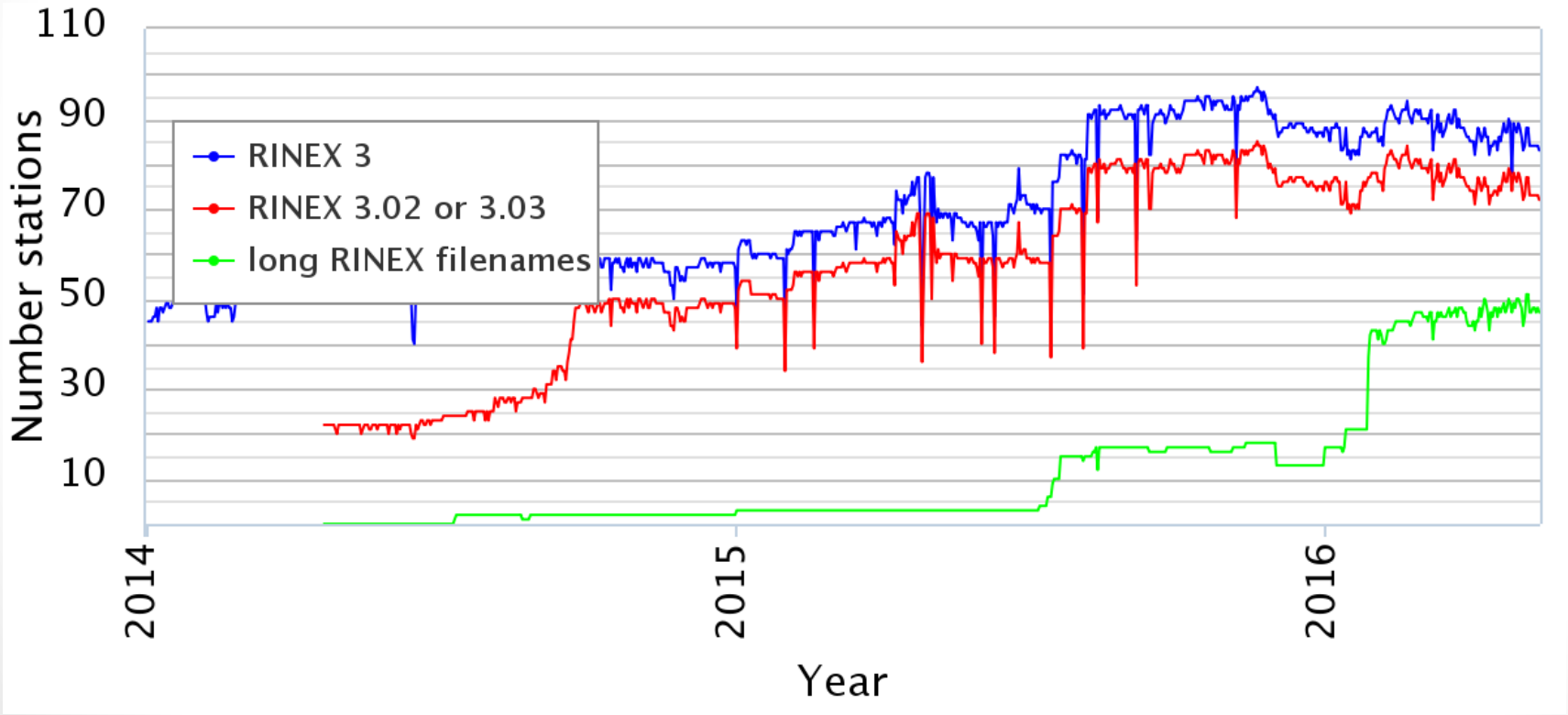
RINEX v. and long File Names



RINEX 3 @ EPN CB

EPN CB updates:

- MySQL database + major web pages updated for new 9-char station name
- RINEX v2 & v3 metadata checks (equipment & observed satellite systems) vs. site log
- RINEX v2 & v3 data availability monitored
- G-nut/Anubis data quality check software (Vaclavovic and Dousa, 2014) routinely run on all RINEX 2 and 3 data:
  - ✓ Used operationally for monitoring tracked satellite constellations and frequencies → tracked frequencies web page
  - ✓ Time series presently kept internally for evaluating capability to detect already known (historical) tracking problems.

Tracked Frequer

NETWORK & DATA

Network status | Station list | Maps | Tracked frequencies | Data access | Proposed stations | Station log submission | Station picture submission

NETWORK & DATA > **TRACKED FREQUENCIES**

Criteria

Frequency-band	GPS	GLO	GAL	BDS	QZSS	SBAS
1 (L1/G1/E1/B1)	☑	☑	☑	☑	☐	☐
2 (L2/G2)	☑	☐			☐	
3 (G3)		☐				
5 (L5/E5A)	☐		☐		☐	☐
6 (E6/B3/LEX(6))			☐	☐	☐	
7 (E5B/B2)			☐	☐		
8 (E5(A+B))			☐			

Using RINEX 3.02 conventions

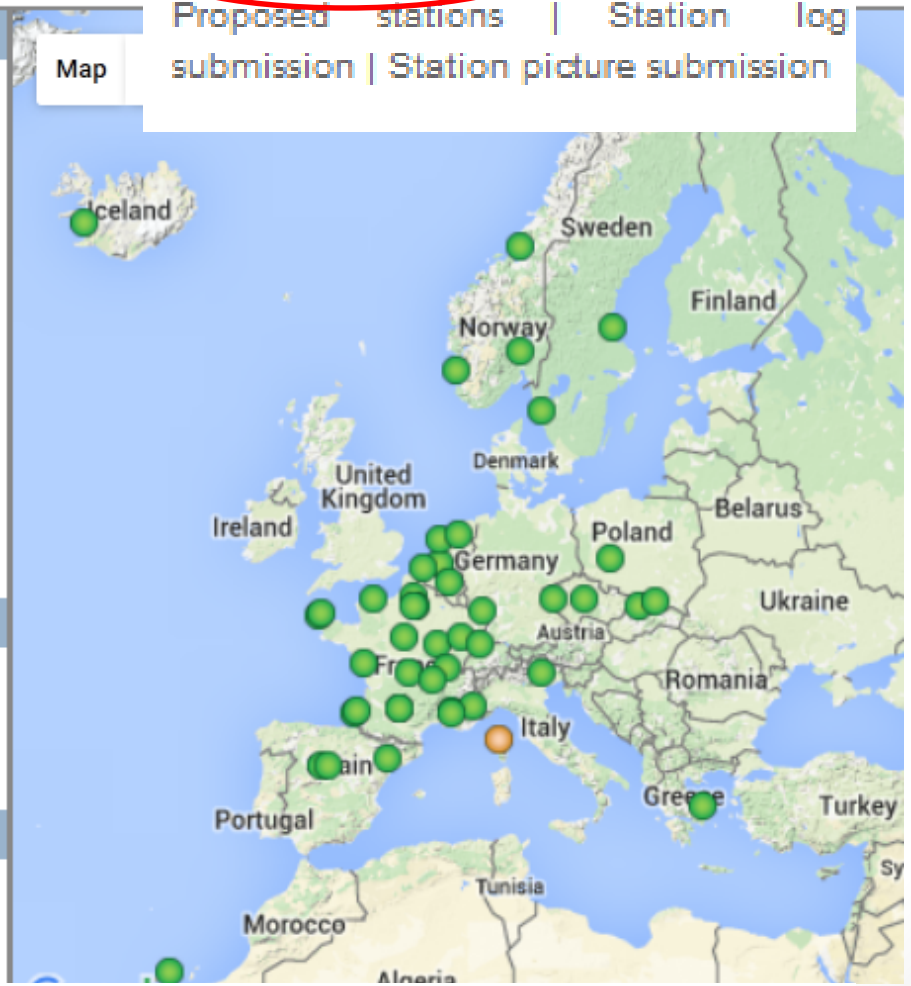
Update map

Stations responding to the criteria

- Select a station -

Additional tracking information available

- from the University of Bern



http://epncb.oma.be/_networkdata/trackedfrequencies.php

Tracked Frequencies

NETWORK & DATA > **TRACKED FREQUENCIES**

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1 (L1/G1/E1/B1)	☑	☑	☑	☑	☐	☐
2 (L2/G2)	☑	☐			☐	
3 (G3)		☐				
5 (L5/E5A)	☐		☐		☐	☐
6 (E6/B3/LEX(6))			☐	☐	☐	
7 (E5B/B2)			☐	☐		
8 (E5(A+B))			☐			

Using RINEX 3.02 conventions

Update map

Stations responding to the criteria

- Select a station -

Additional tracking information available

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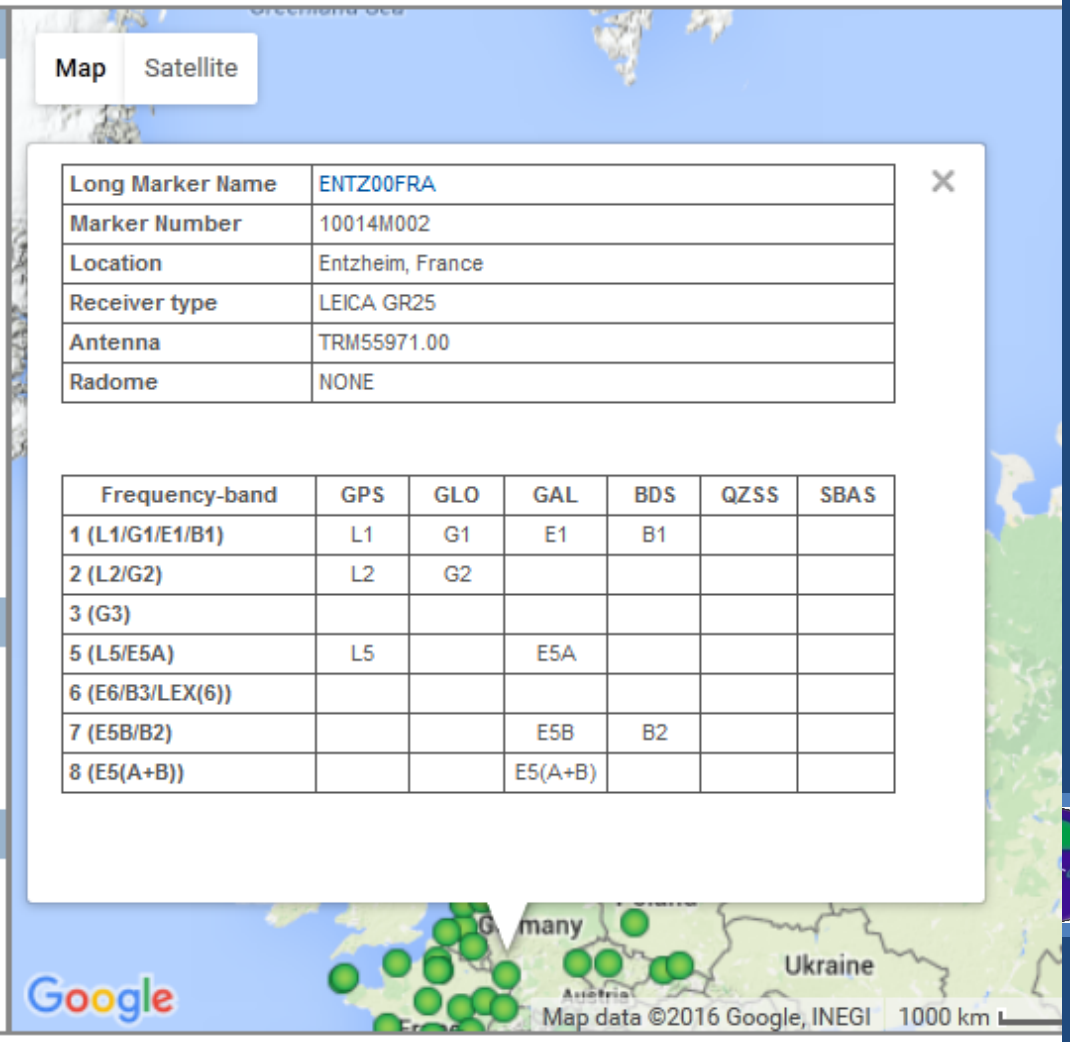
Map | Satellite

Long Marker Name	ENTZ00FRA
Marker Number	10014M002
Location	Entzheim, France
Receiver type	LEICA GR25
Antenna	TRM55971.00
Radome	NONE

Frequency-band	GPS	GLO	GAL	BDS	QZSS	SBAS
1 (L1/G1/E1/B1)	L1	G1	E1	B1		
2 (L2/G2)	L2	G2				
3 (G3)						
5 (L5/E5A)	L5		E5A			
6 (E6/B3/LEX(6))						
7 (E5B/B2)			E5B	B2		
8 (E5(A+B))			E5(A+B)			



Galileo only in RINEX 2

No RINEX 3:

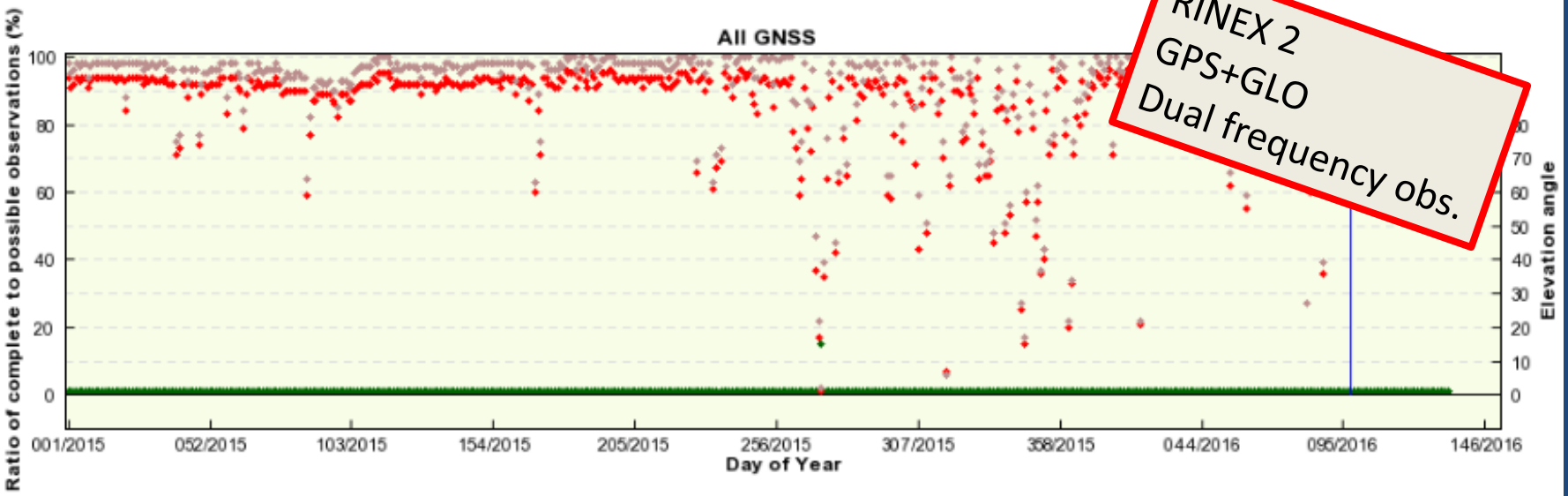
BORJ, CACE, CEU1, CHIZ, COBA, DRES, HELG, KARL, LROC, NEWL, RANT, SALA, SFER, VIGO, ZARA

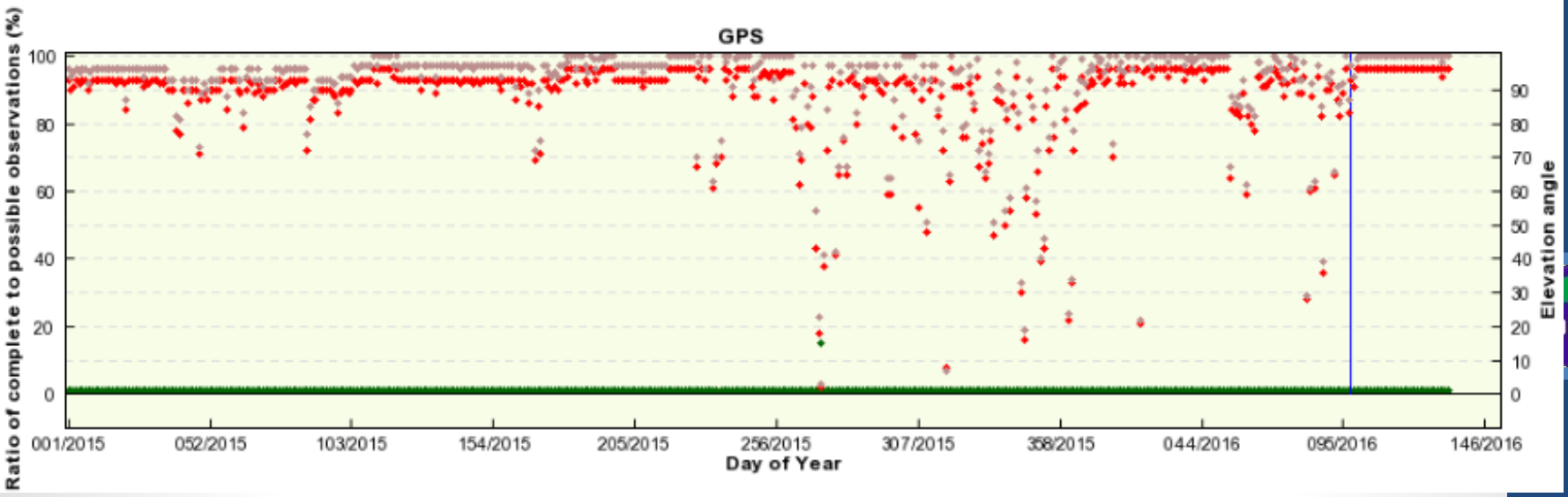
RINEX 3.01:

BOGI

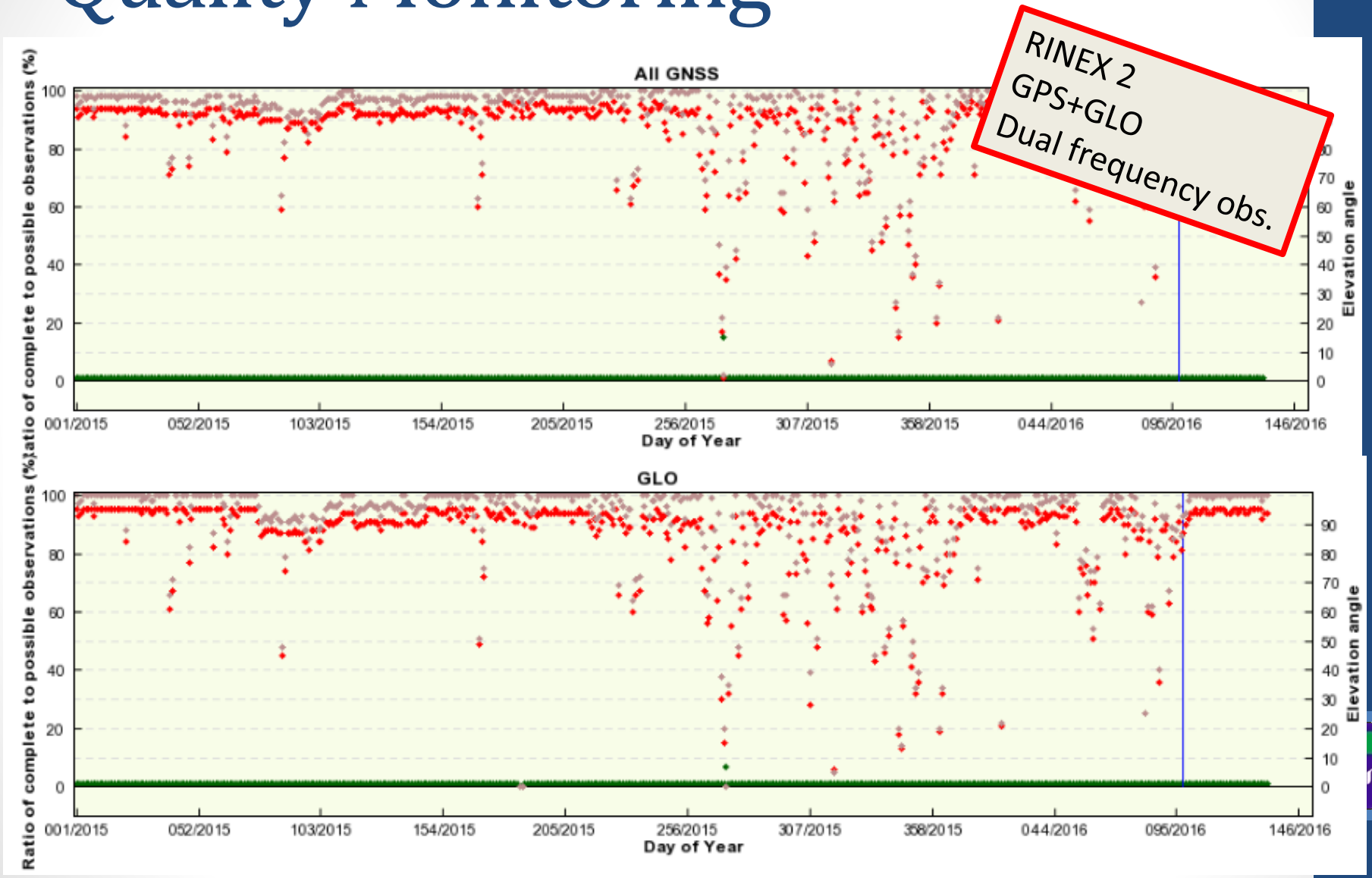
Quality Monitoring

RINEX 2
GPS+GLO
Dual frequency obs.





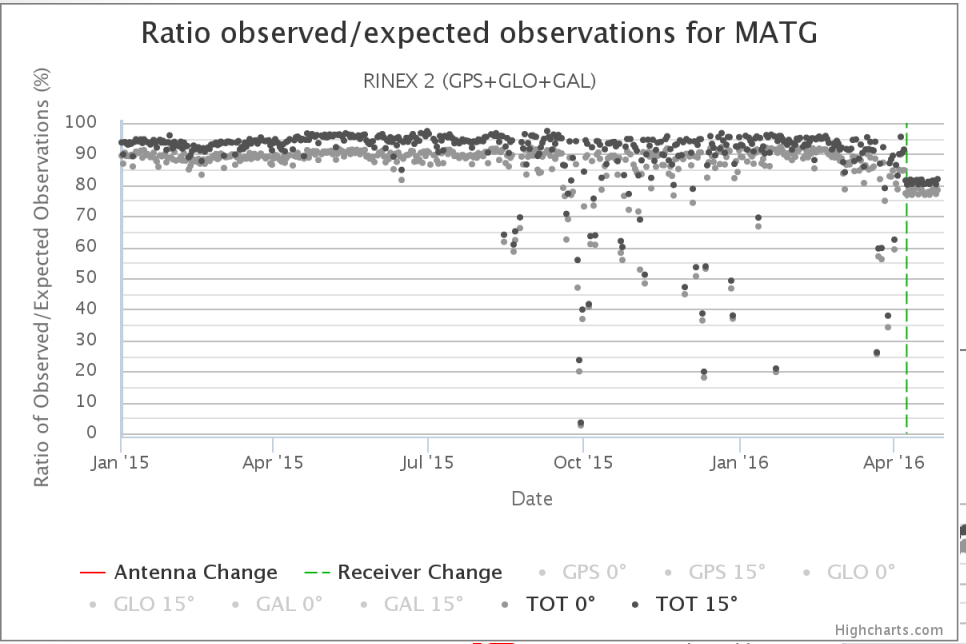
Quality Monitoring



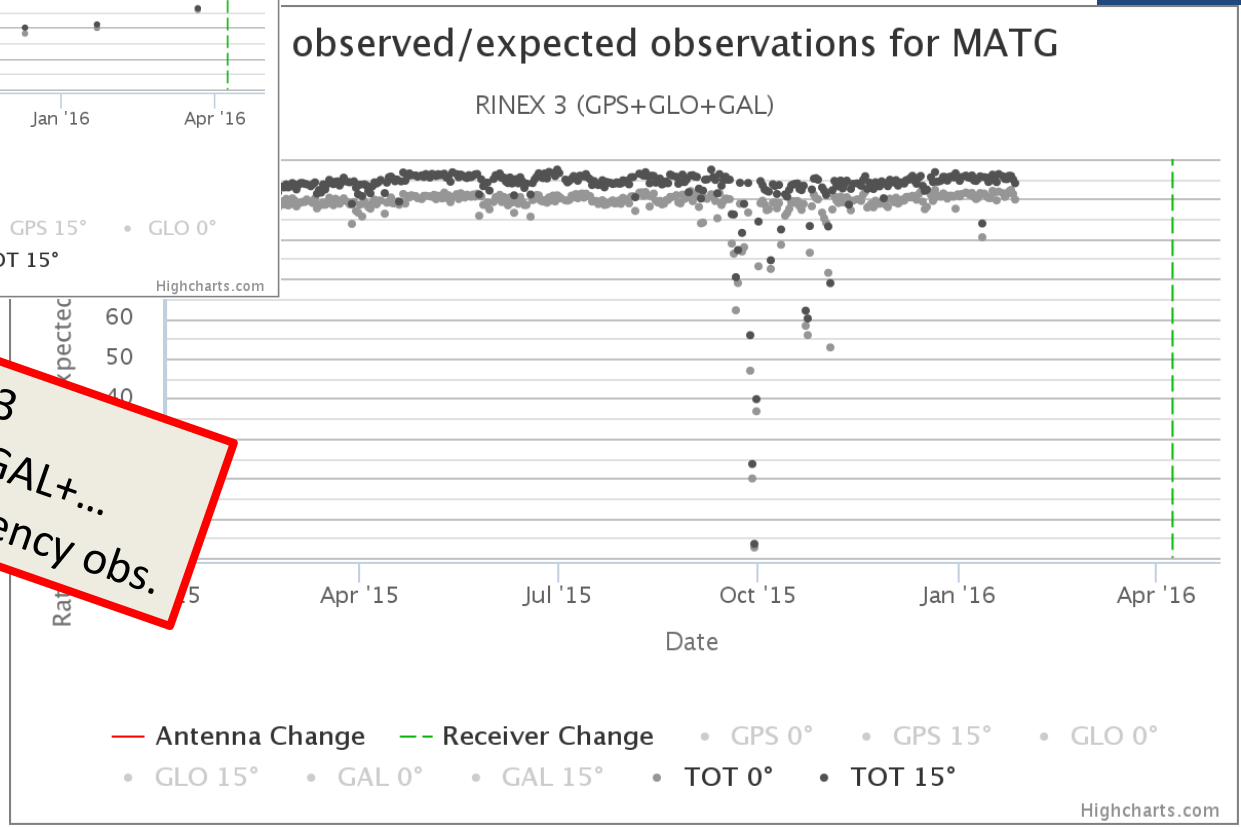
RINEX 2
GPS+GLO
Dual frequency obs.

ROYAL OBSERVATORY OF BELGIUM

Quality Monitoring Rx v2 & v3



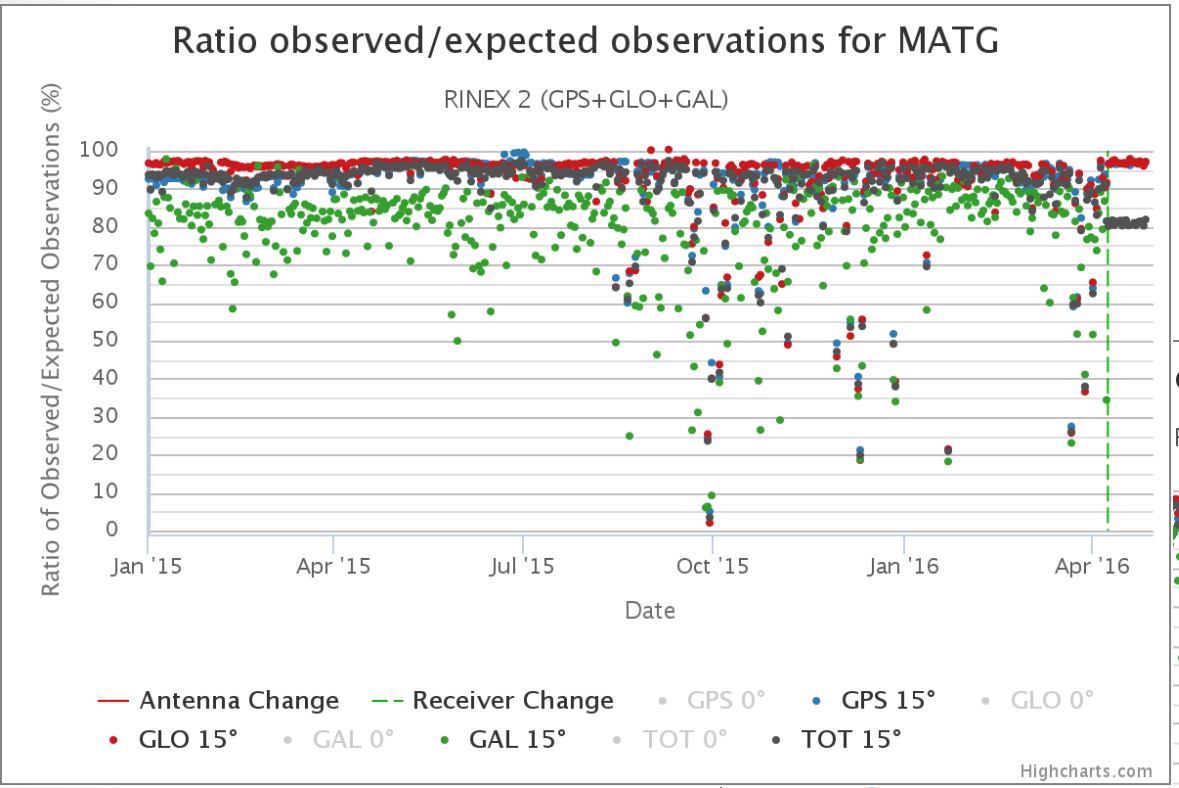
LEICA GRX1200+GNSS (8.71/6.112)

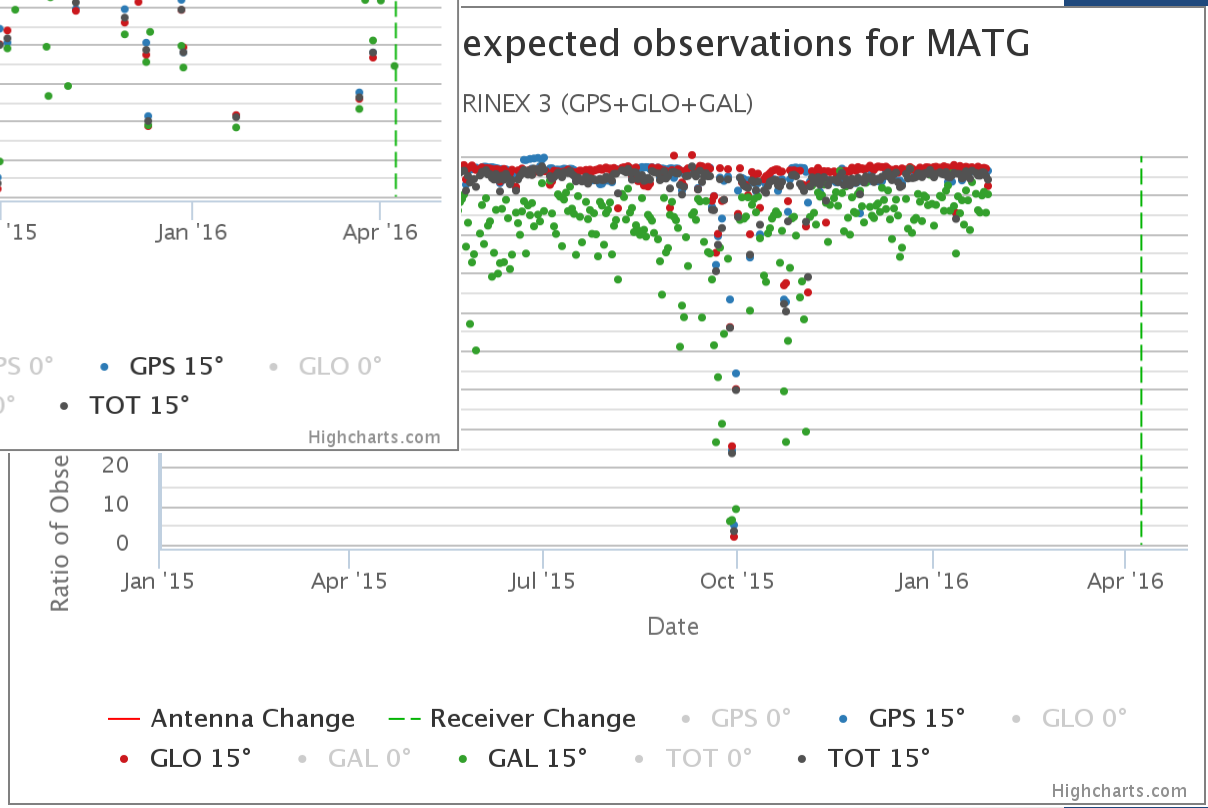


RINEX 2 + 3
GPS+GLO+GAL+...
Single frequency obs.

G-Nut/Anubis (Vaclavovic and Dousa, 2014)

Quality Monitoring





G-Nut/Anubis (Vaclavovic and Dousa, 2014)

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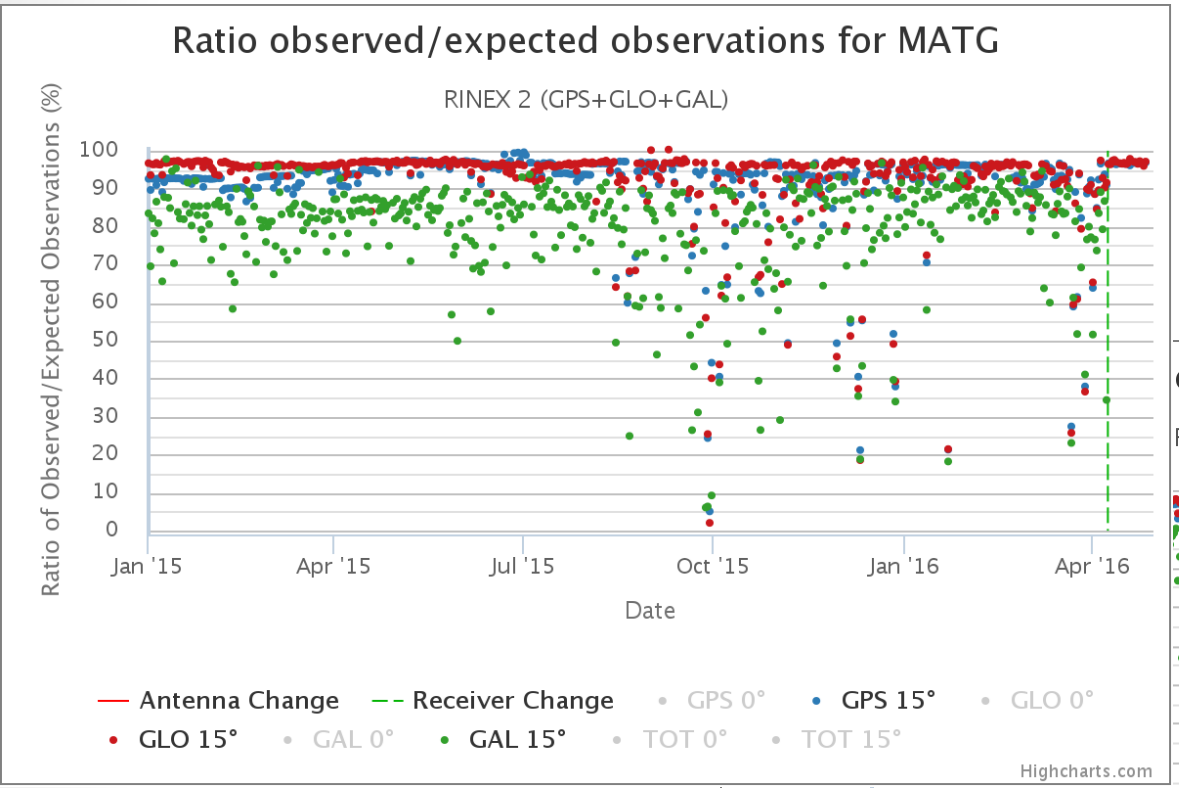

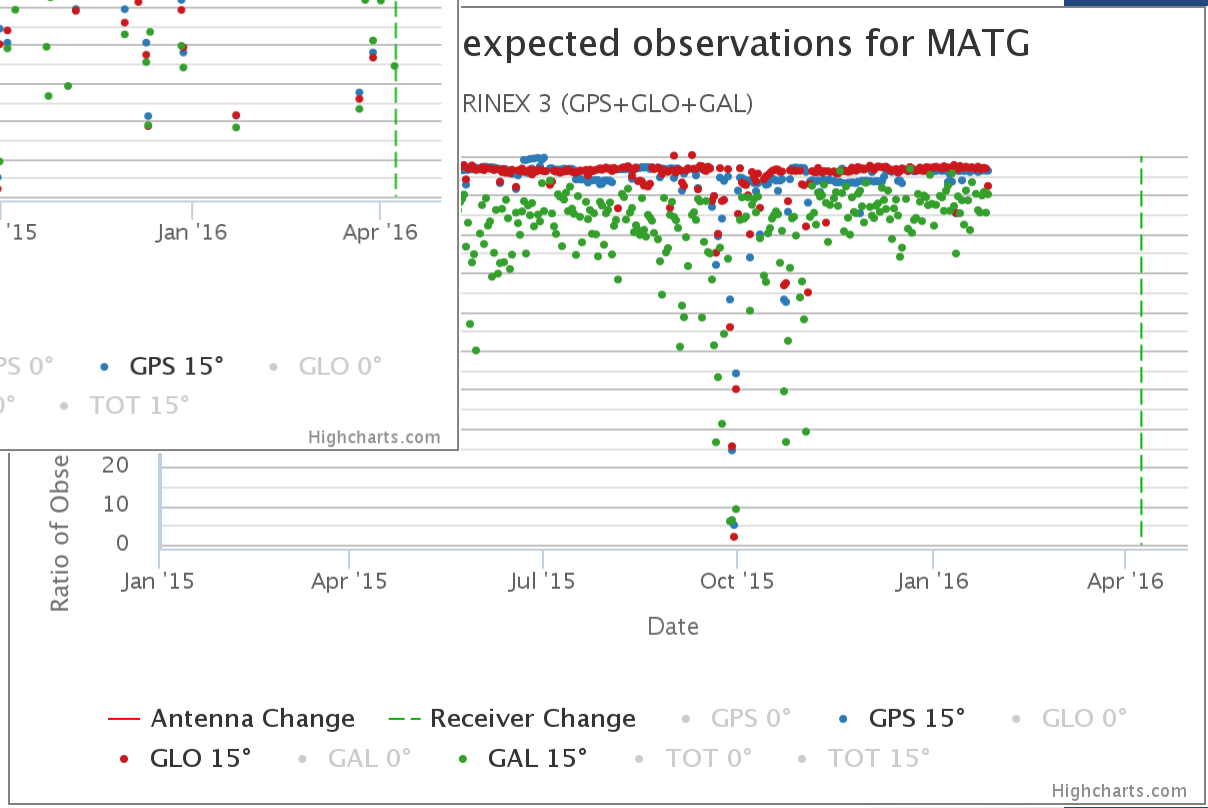

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Quick Ove…work Status

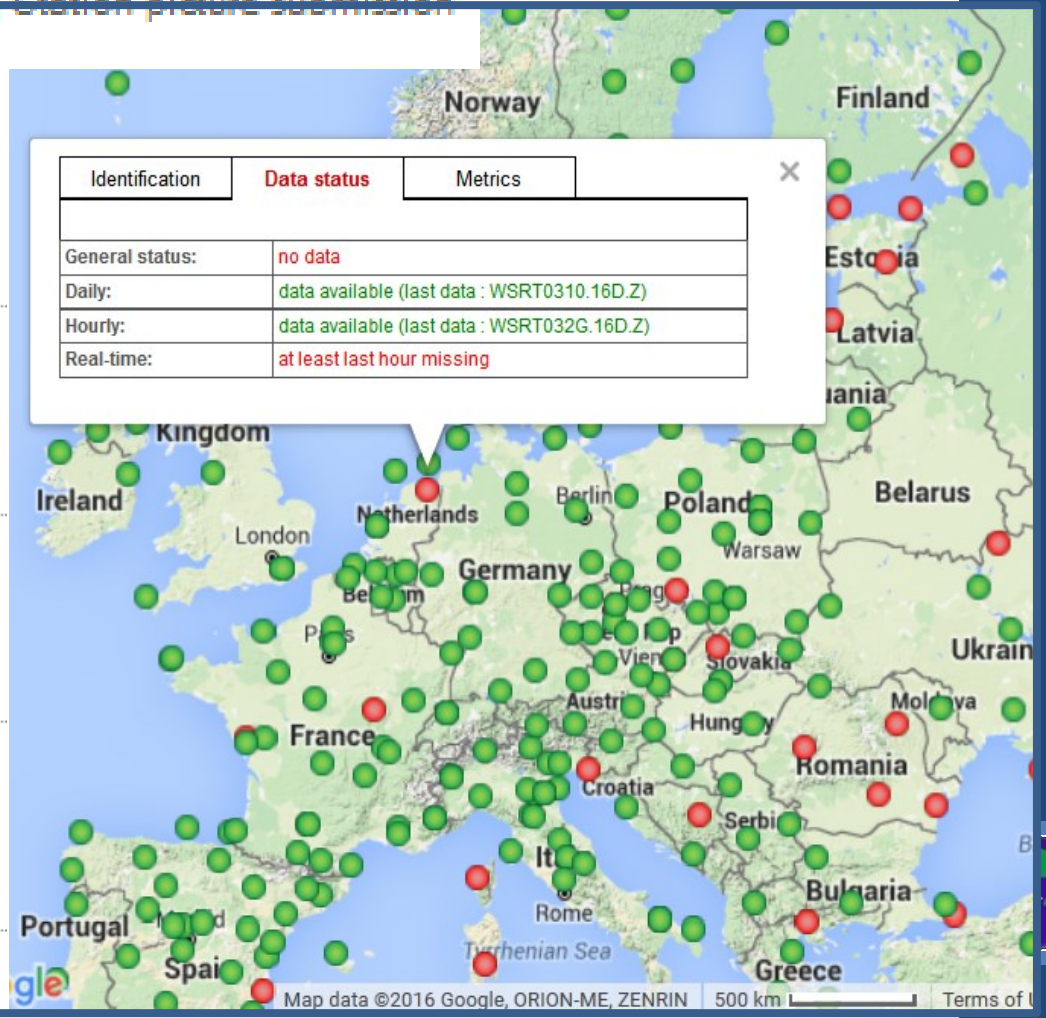
NETWORK & DATA

Network status | Station list | Maps | Tracked frequencies | Data access | Proposed stations | Station log submission | Station picture submission

Criteria

- **View overall data availability (how is it computed?)**
  - Data available
  - Data not available
- **View only availability of daily data**
  - Data available
  - At least last day missing
  - At least last 3 days missing
- **View only availability of hourly data**
  - Data available
  - At least last hour missing
  - At least last 3 hours missing
- **View only availability of real-time data**
  - Data available
  - At least last 15 minutes missing
  - At least last hour missing

Update map



EPN network status web page http://epncb.oma.be/_networkdata/network_status/

Real-time Monitoring

ROYAL OBSERVATORY OF BELGIUM

REAL-TIME DATA STREAMS

Mountpoint	ASI (status: 2016-01-22 10:45 UTC)	BKG (status: 2016-01-22 10:45 UTC)	ROB (status: 2016-01-22 10:45 UTC)
ACOR0	RTCM 3.1- ergnss-ip.ign.es:2101/ACOR0(1)	RTCM 3.1- ergnss-ip.ign.es:2101/ACOR0(1)	RTCM 3.1- ergnss-ip.ign.es:2101/ACOR0(1)
AJAC0	Last received on 2015-11-27 14:55 UTC	Last received on 2015-11-27 14:55 UTC	Last received on 2015-11-27 14:55 UTC
ALAC0	RTCM 3.1- ergnss-ip.ign.es:2101/ALAC0(1)	RTCM 3.1- ergnss-ip.ign.es:2101/ALAC0(1)	RTCM 3.1- ergnss-ip.ign.es:2101/ALAC0(1)
ALBA0	RTCM 3.1- ergnss-ip.ign.es:2101/ALBA0(1)	RTCM 3.1- ergnss-ip.ign.es:2101/ALBA0(1)	RTCM 3.1- ergnss-ip.ign.es:2101/ALBA0(1)
ALME0	RTCM 2.3- ergnss-ip.ign.es:2101/ALME0(1)	RTCM 2.3- ergnss-ip.ign.es:2101/ALME0(1)	RTCM 2.3- ergnss-ip.ign.es:2101/ALME0(1)
AUT10	Last received on 2016-01-13 11:35 UTC	Last received on 2016-01-13 11:35 UTC	Last received on 2016-01-13 11:35 UTC
BCLN0	RTCM 3.1- ergnss-ip.ign.es:2101/BCLN0(1)	RTCM 3.1- ergnss-ip.ign.es:2101/BCLN0(1)	RTCM 3.1- ergnss-ip.ign.es:2101/BCLN0(1)
BELF0	RTCM 3.1- www.euref-ip.net:2101/BELF0(1)	RTCM 3.1- OSNI	RTCM 3.1- www.euref-ip.net:2101/BELF0(1)
BELL0	RTCM 3.0- www.euref-ip.net:2101/BELL0(1)	RTCM 3.0- ICGC	RTCM 3.0- www.euref-ip.net:2101/BELL0(1)
BOGI0	Last received on 2015-03-12 12:15 UTC	RTCM 3.0- IGIK	RTCM 3.0- www.euref-ip.net:2101/BOGI0(1)
BOR10	RTCM 2.3- www.euref-ip.net:2101/BOR10(1)	RTCM 2.3- SRCPAS	RTCM 2.3- www.euref-ip.net:2101/BOR10(1)
BORJ1	RTCM 3.0- www.euref-ip.net:2101/BORJ1(1)	RTCM 3.1- BKG	RTCM 3.1- www.euref-ip.net:2101/BORJ1(1)
BORR0	RTCM 3.0- icverva.icv.gva.es:2101/RTBO1(1)	RTCM 3.0- IGE	RTCM 3.0- icverva.icv.gva.es:2101/RTBO1(1)

EPN stream availability at three regional EPN broadcasters (ASI – Italy, BKG – Germany, ROB – Belgium)

http://epncb.oma.be/_networkdata/data_access/real_time/status.php

Real-time Monitoring

Upgraded real-time monitoring of all EPN broadcasters (ASI, BKG, ROB) :

- ✓ Crosschecks of equipment metadata in streams with site log and sourcetable
- ✓ Crosschecks of message types and sampling rates in streams with sourcetable and streams from other broadcasters

```
ASI          UNTR0  RCVR in sourcetable TPS ODYSSEY_E <-> TPS NET-G3A in site log
ASI/BKG/ROB  TRDS0  Inconsistent format RTCM 3.0/RTCM 3.1/RTCM 3.1
ASI/BKG/ROB  JOZ20  Inconsistent messages
              ASI-TBL  1004(1),1006(60),1008(60),1012(1)
              ASI-STR  1004(1),1006(15),1008(15),1012(1),1033(15)
              BKG-TBL  1004(1),1006(15),1008(15),1012(1),1033(15)
              BKG-STR  1004(1),1006(15),1008(15),1012(1),1033(15)
              ROB-TBL  1004(1),1006(15),1008(15),1012(1),1033(15)
              ROB-STR  1004(1),1006(15),1008(15),1012(1),1033(15)
```

Outline

How we evolved

- 1996-2016
- New EPN Stations
- EPN Densification
- EPOS

Network Challenges

- Updated EPN Guidelines
- Multi-GNSS
- Real-time Monitoring
- Site Log Submissions

Station meta-data Challenges

- Consistency : Stations contributing to several networks (IGS, EPN, EPOS)
- Station managers with large networks (EPOS, EPN densification)
- *Present on-line site log validation and submission tool does not satisfy all needs*

Progress

- **Script** (perl) that station managers can run locally to validate site logs

  ftp://epncb.oma.be

  pub/software/CheckStationLogs/CheckStationLogs.pl

- **GeodesyML**
  - Machine-readable XML format that contains all info in the site log
  - Used to update & validate meta-data at 1 place only

    → Exchange using web-services

    http://geodesyml.org/

  Tests will be performed between IGS - EUREF – EPOS

Conclusion

- The work is not yet done….

- Release of new EPN CB web site

  Sept. 2016

EUREF Permanent GNSS Network

ROYAL OBSERVATORY OF BELGIUM

Welcome !

EUREF Permanent GNSS Network

The European Terrestrial Reference System 89 (ETRS89) is used as the standard precise GPS coordinate system throughout Europe. Supported by EuroGeographics and endorsed by the EU, this reference system forms the backbone for all geographic and geodynamic projects on the European territory both on a national as on an international level.

The ETRS89 is maintained by the IAG sub-commission EUREF and it is accessed through the EUREF Permanent GNSS Network (EPN), a science-driven network of continuously operating GPS reference stations with precisely known coordinates in the ETRS89.

All contributions to the EPN are voluntary, with more than 100 European agencies/universities involved, and the reliability of the network is based on redundancy and extensive guidelines guaranteeing the quality of the raw GPS data to the resulting station positons. Next to its key role in the maintenance of the ETRS89, the EPN data are also used for a wide range of scientific applications such as the monitoring of ground deformations, sea level, space weather and numerical weather prediction.

Download EPN flyer.

EPN Central Bureau

Quick Station Links

Information | Coordinates

(select a station)

Last Updated/New Pages

2016-04-14 : Official ITRF2014 coordinates/velocities issued by the IERS added to the individual station coordinates web page (e.g. ACOR00ESP).

2016-02-02 : New page showing the actual tracking status.

2016-01-29 : Real-time web page updated.

More ...

Next Meetings

2016-05-25/2016-05-27 :
EUREF Symposium 2016 (San Sebastian, Spain)

2016-05-30/2016-06-02 :
2016 European Navigation Conference (Helsinki, Finland)

2016-06-05/2016-06-09 :
18th International Symposium on Geodynamics and Earth Tides (Trieste, Italy)

More ...

EUREF Permanent GNSS Network

ROYAL OBSERVATORY OF BELGIUM

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Search...

STATUS

- Network status
- Station list
- Maps
- Tracked frequencies NEW
- Data access
- Proposed stations

TOOLS

- Station log submission
- Station picture submission

Data access:

- Daily
- Hourly
- Real-time
- Highrate

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