EUMETNET
European Meteorological Services Network

E-GVAP-III

The EIG EUMETNET GNSS Water Vapour Programme, phase III

2’nd expert team & members meeting
October 22-23, 2014 UK Met Office

The future of NGAA ZTD production
From Martin Ridal, SMHI

- **Processing currently made at SMHI**
  - **GIPSY software, PPP solution**
  - **Quality is not acceptable**
  - **Lack of knowledge and time to fix this**
  - **Our external partner/expert has no time**

- **One possible solution**
  - **Install the Bernese software at SMHI**
  - **Benefits: More widely used and we can get help from more people**
  - **Drawbacks: License cost and we will still need to put lots of time on it**

- **The most likely solution**
  - **The processing will be made at National Land Survey (SWEPOS)**
  - **Currently they calculate ZTD once a day but have an interest in more frequent updating**
  - **Benefits: Knowledge about the systems, they run two solutions, ...**

- **Why only “likely”**
  - **Is this a research or an operational service?**
  - **If it is operational there are higher demands, perhaps costs, documents and agreements...**
  - **To start with it will be set up as a research project, then things may evolve**

- **Time frame (if all works out...)**
  - **Test runs before the end of October (work already started...)**
  - **Fully “operational” at the end of the year**

Denmark, DMI

Ground-based GNNS data. Access and processing.

- **The NMA uploads hourly 30 s files to DMI shortly after the full hour. The files are available with a very small delay. This bypasses the non operational server at Chalmers.**
- **DMI is collaborating with the NRT GPS processing centre NGAA at SMHI, such that Danish GPS data are processed at SMHI.**

- **The Danish GNSS data currently come from one source, the national Danish mapping agency.**
- **Potentially data from a private network are available, but currently there is no agreement on access to those data**

- **It is being considered to start GNSS data processing at DMI in connection with fast access to data for NWP nowcasting, and improve of quality with respect to today.**

GPSnet (green, names) + Trimble network (red, numbers)

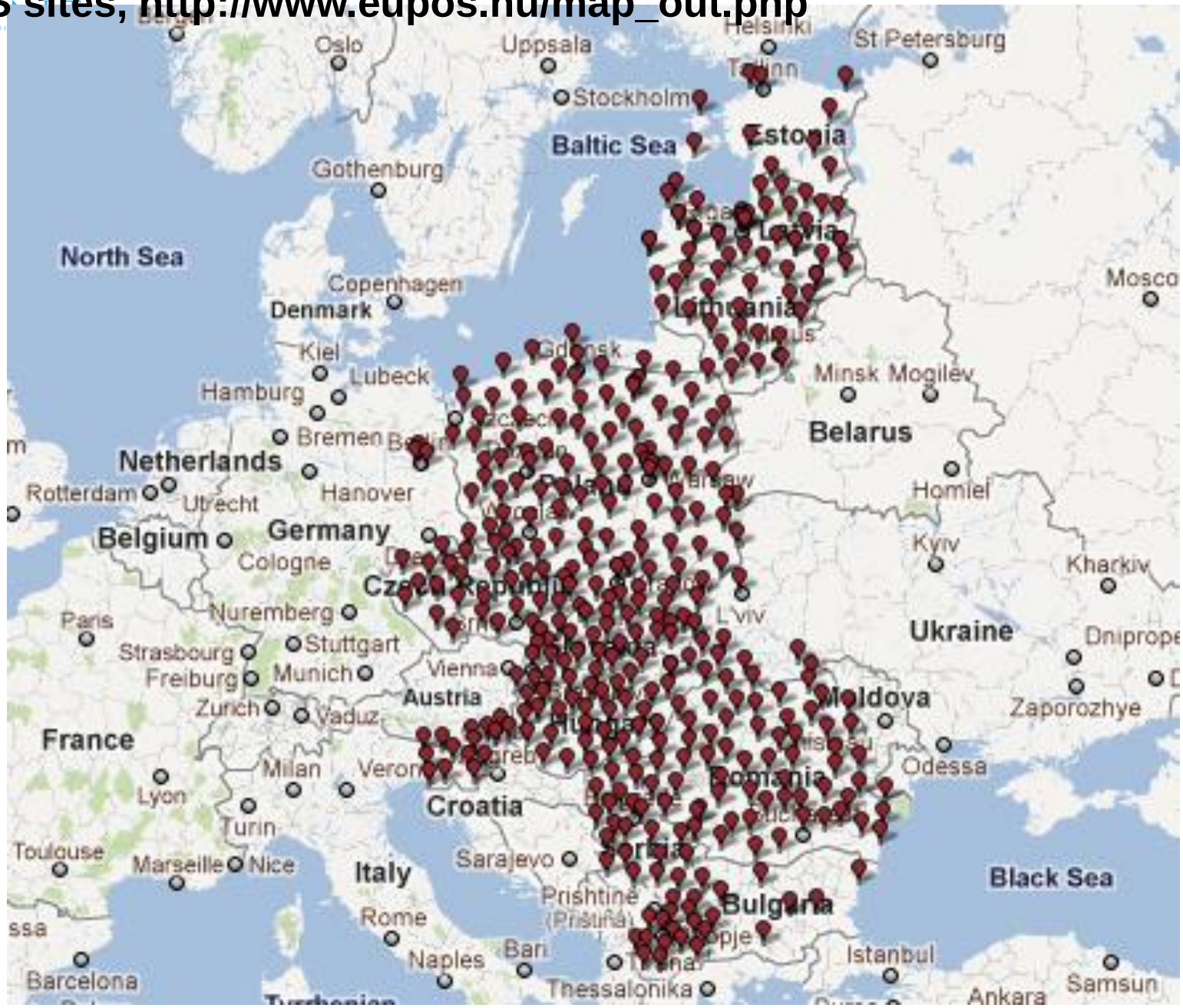
DMI

- Extraction of O-B site&AC specific statistics from passive assimimilation of all data uploaded data to E-GVAP as ”operational” (though only one ZTD per AC solution per site per assimilation cycle). Calculation of offset statistics. Continously since July 2007

- Derived preprocessing/data selection algorithms enabling selection of ”good and robust” ZTD data with Gaussian O-B distribtutions for assimilation resulting in whitelists.
  - Both processing centre and station dependent investigation.
  - Long term bias correction (more than a month of data).
  - Obserror from above statistics.

- Due to low number of Danish sites and instabilities in NGAA solution currently no active use of ZTDs.

EUPOS sites, http://www.eupos.hu/map_out.php



EUPOS sites

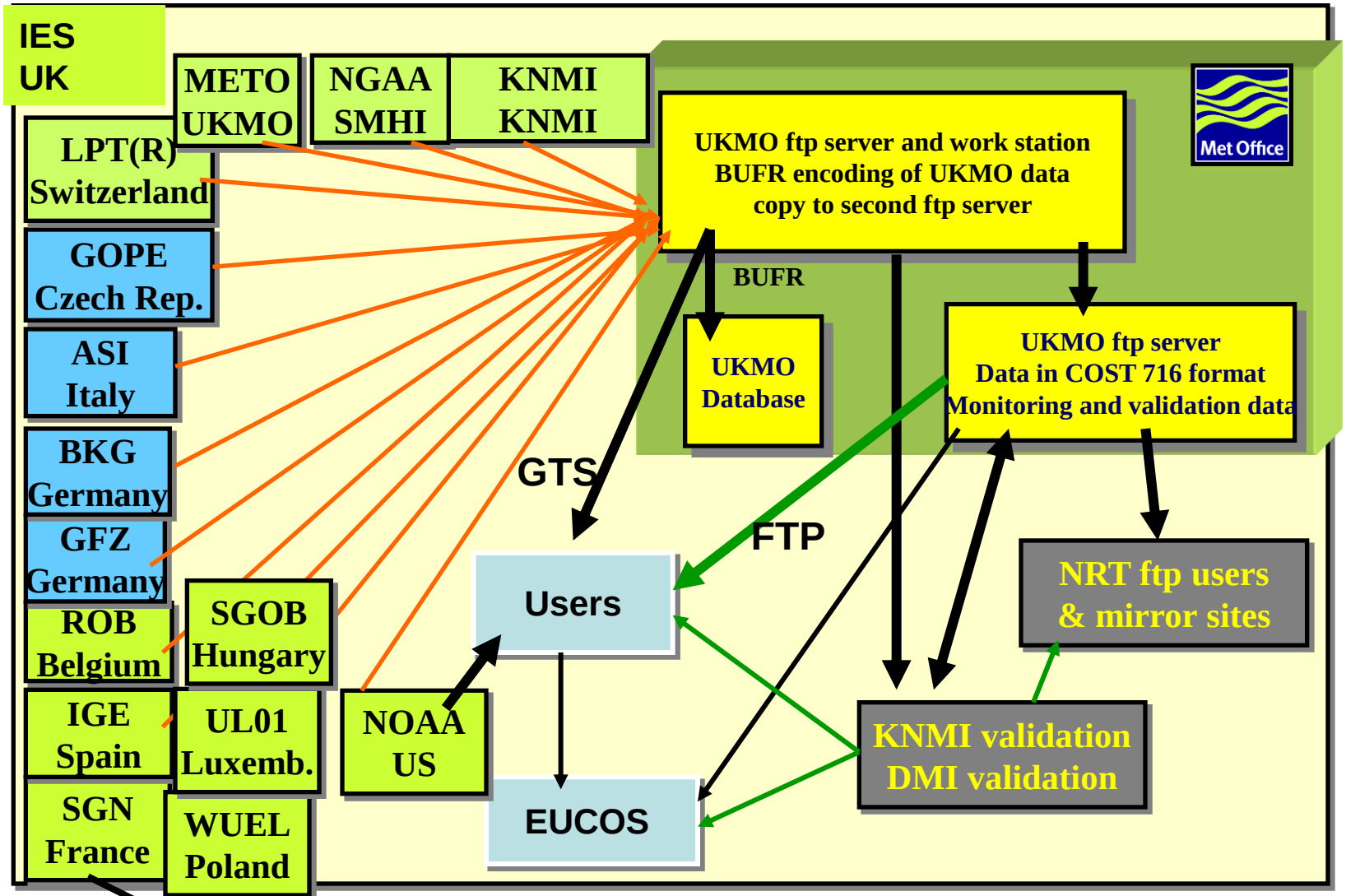
An MoU between EUPOS and EUMETNET has been signed.

This will function as a tophat MoU. Under this national MoUs between EUPOS members and EUMETNET members can be made about collaboration, or MoUs with EUMETNET/E-GVAP if no national met member is active, as necessary.

The collaboration with EUPOS is in part related to the preparation and launching of GNSS4SWEC. Already we see NRT ZTD data from Poland (AC WUEL) and Hungary (AC SGOB), in addition GPS data available from Bulgaria.

OBS system overview

NRT GNSS ZTD data flow Today



Analysis centres (ACs), each processing raw GNSS data from many sites.
In many cases only national AC can get access to the raw data.

Analysis centers (ACs)

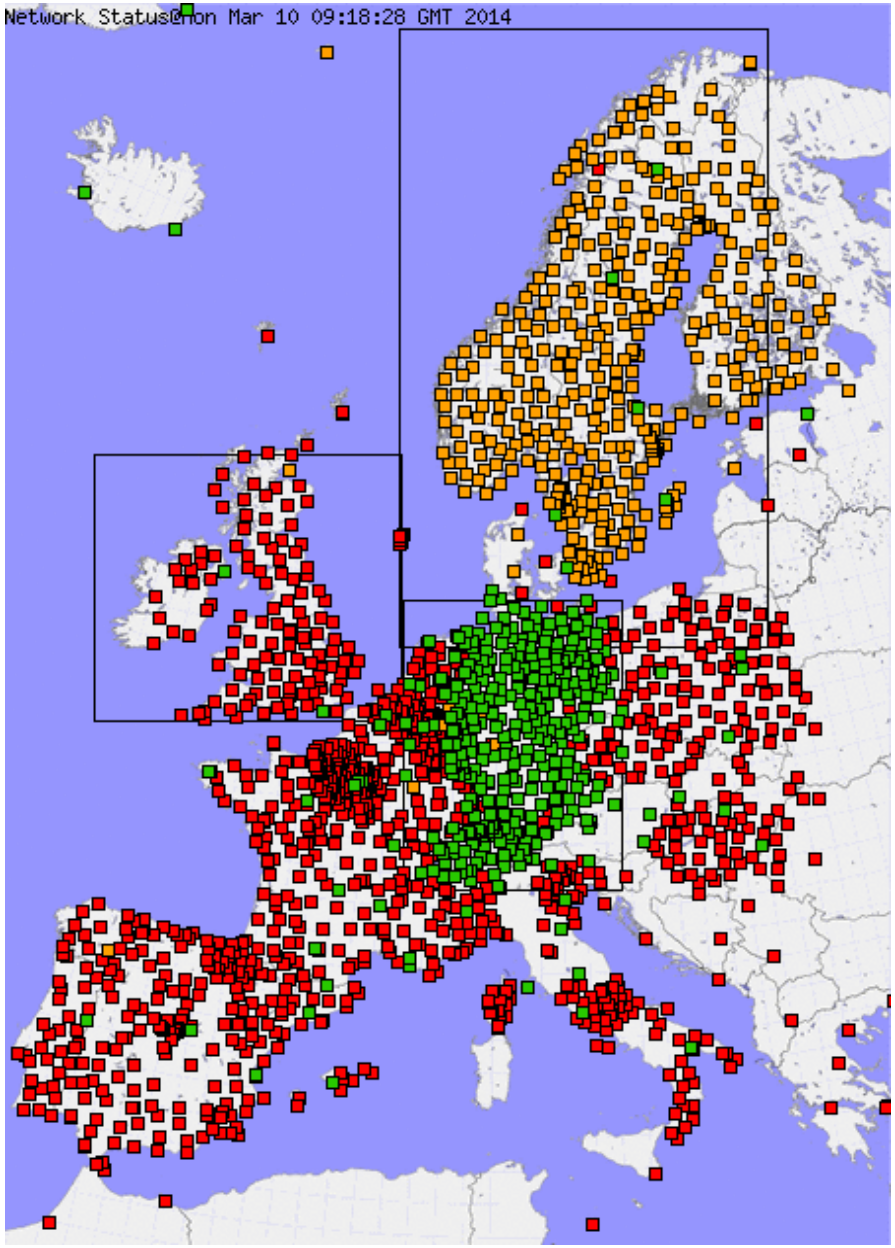
AC	Institution
ASI	e-geos/Telespazio, Italy
BKG	Federal Agency for Cartography and geodesy, Germany
GFZ	Helmholz Centre Potsdam, GFZ German Res. Cen. f Geosciences
GOPE	Geodectic Observatory Pecny, Czech Republic
IES	Inst. of Eng., Surv. And Space Geodesy, Univ of Nottingham, UK
IGE	Instituto Geografica National, Spain
KNMI	Royal Meteorological Institute of the Netherlands
LPT	SwissTopo, Switzerland
METO	UK Met Office
NGAA	Norrkøping GNSS Analysis Agency, SMHI, Sweden
NOAA	NOAA/NCEP, USA
ROB	Royal Observatory of Belgium
SGN	Institut Geographique National, France
SGOB	Satellite Geod. Obs, IGCRS + Technical Univ. Budapest, Hungary
UL01	University of Luxembourg, Fac. Of Science and Communication
WUEL	Wroclaw University + Inst. Of Geodesy and Geoinformatics, Poland

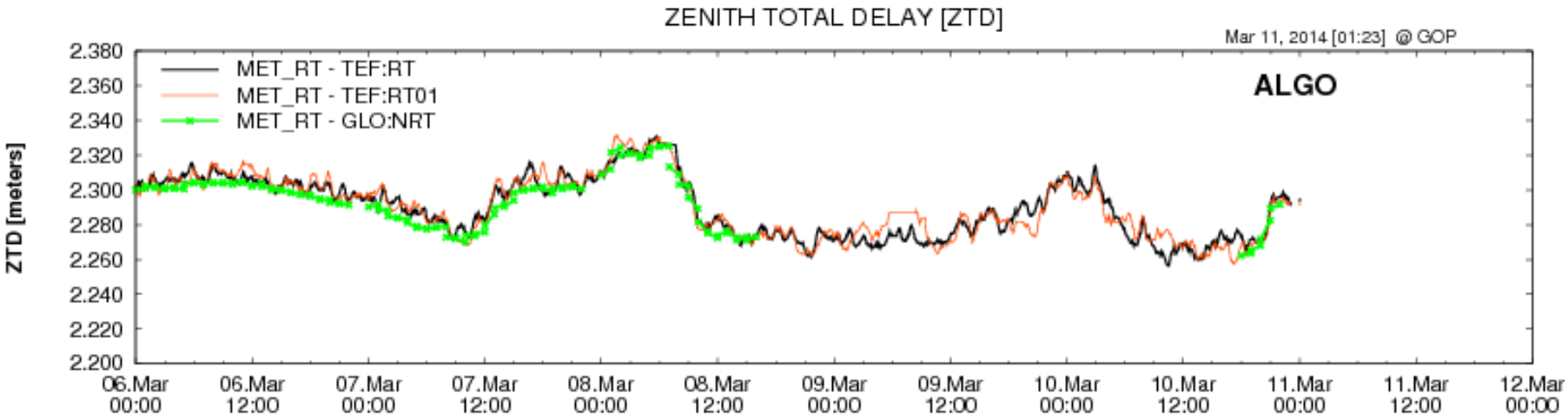
Data outage Saturday-Sunday-Monday, March 8-9. Due to a network outage at the facility producing the IGS ultra rapid and rapid products, used by much of the E-GVAP analysis centers, a very significant part of the E-GVAP delay data were not available for about 2 days. This is the first serious large scale failure to the E-GVAP observing system.

A significant part of the NRT E-GVAP delay data were missing for two days. The course turned out to be missing access to the IGS Ultra Rapid and Rapid products. Those are orbit determinations and predictions for the GNSS satellites. The majority of the E-GVAP ACs doing NRT delay estimation using a network solution relies on those products. A few ACs use alternative, own products, that is those doing using precise point positioning for their NRT solutions, and those doing real-time delay estimation.

Green: Data on time
Orange: Data delayed
Red: Data missing

From E-GVAP validation page





An example (from GOP) that their NRT solution failed, but the real-time solutions they run were not affected. From Jan Dousa.

The course of the missing IGS orbit products turned out to be a network outage at the facility processing the IGS products. They are made by combining orbit products from several institutions (in order to stabialise the product). The network outage only lasted for 4.75 hours on Saturday, but the system did not go back to normal mode before manual intervention the following Monday.

It is realised that enough institutions produce orbit estimates and are willing to make them available, that if IGS fails again, alternative orbit products can be used. What needs to be set up is routines doing such a switch.

Furthermore, having seen this particular type of failure, the IGS is in position to set up automated routines that will restart proper functionality once network connection is back. The main problem in this data outage was not the 4.75 hours of lack of network access, but that those few hours turned into two days of lack of GNSS delay data because the IGS orbit product combination did not restart automatically when network was back.

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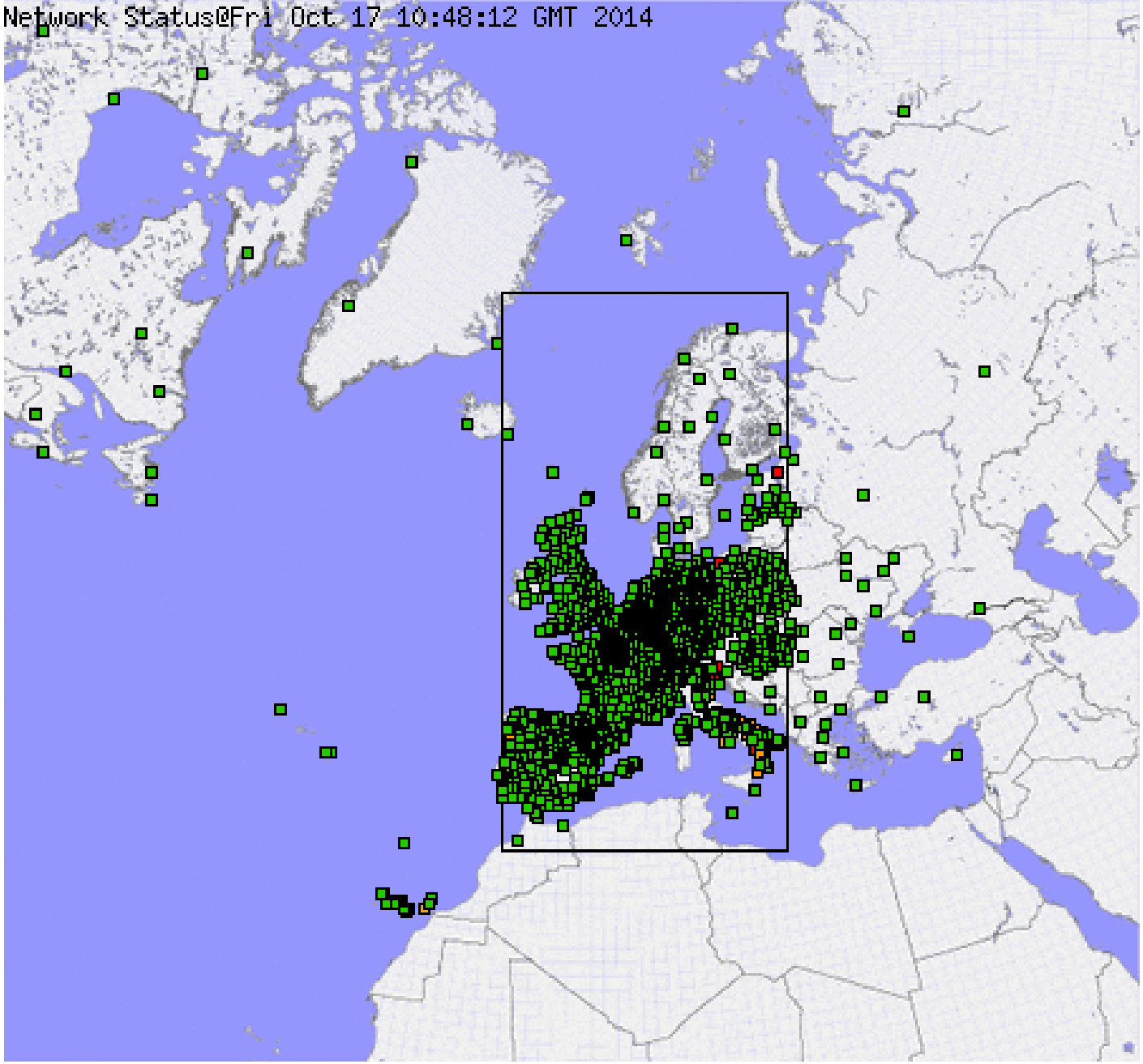
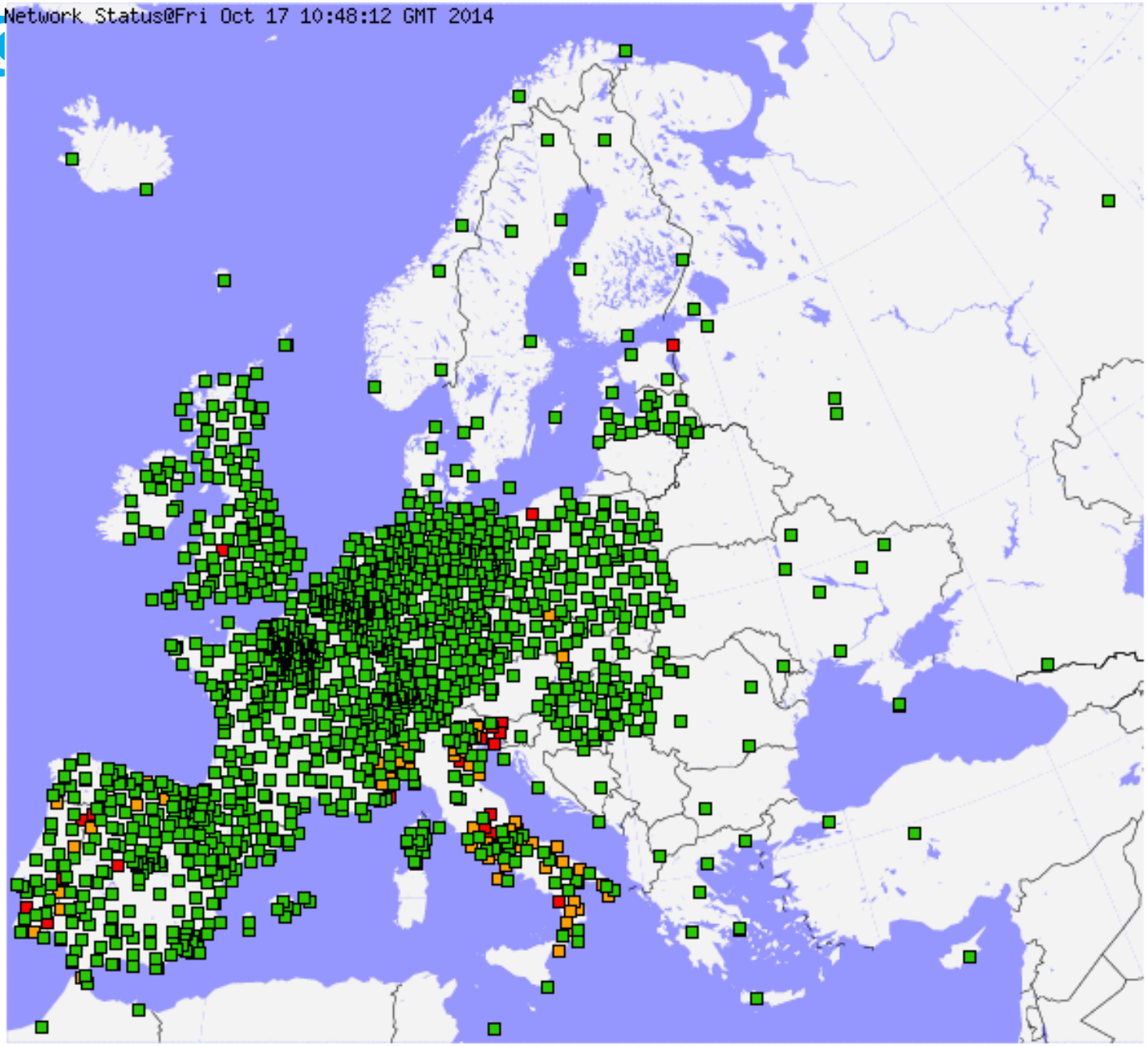
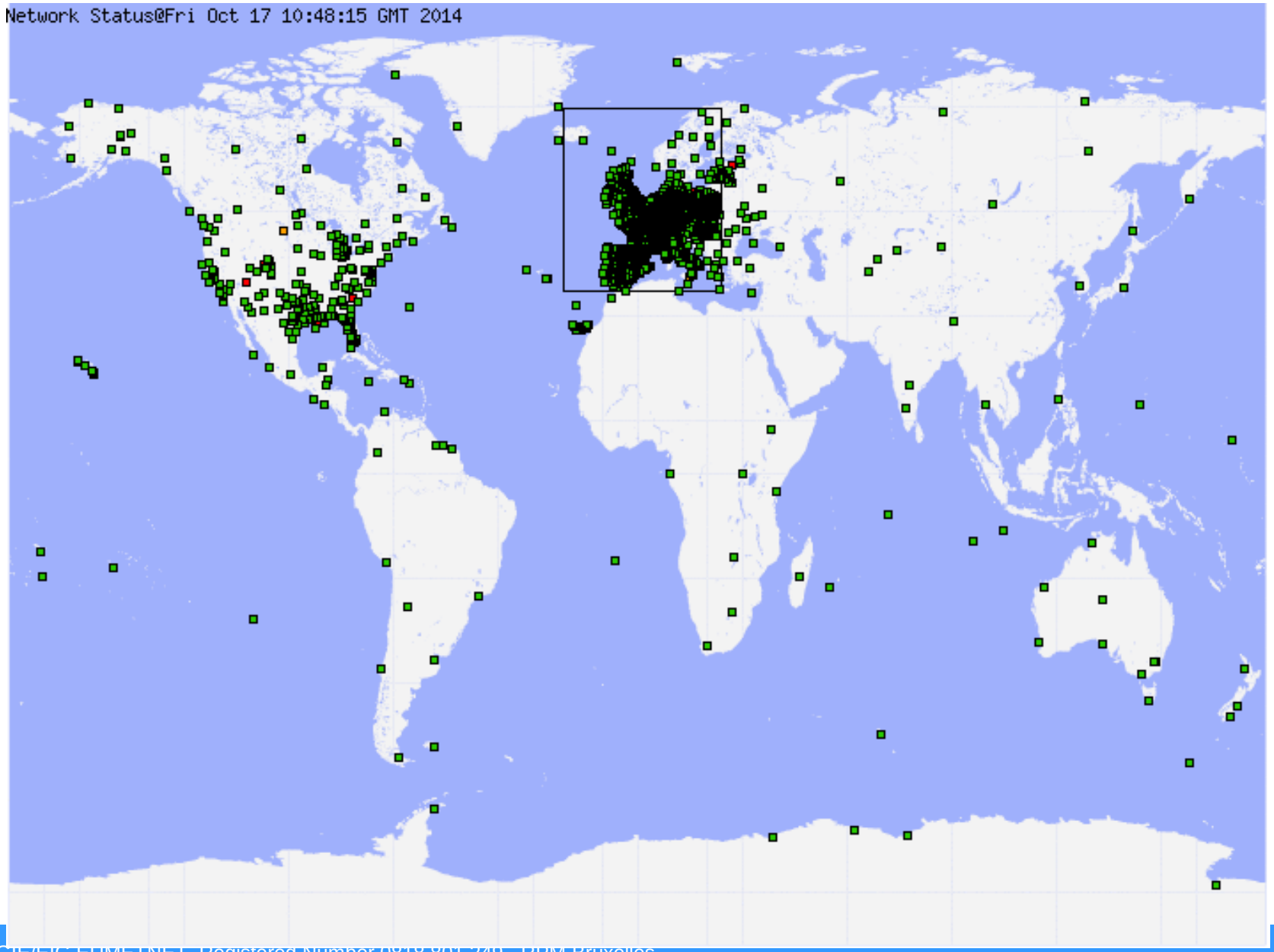
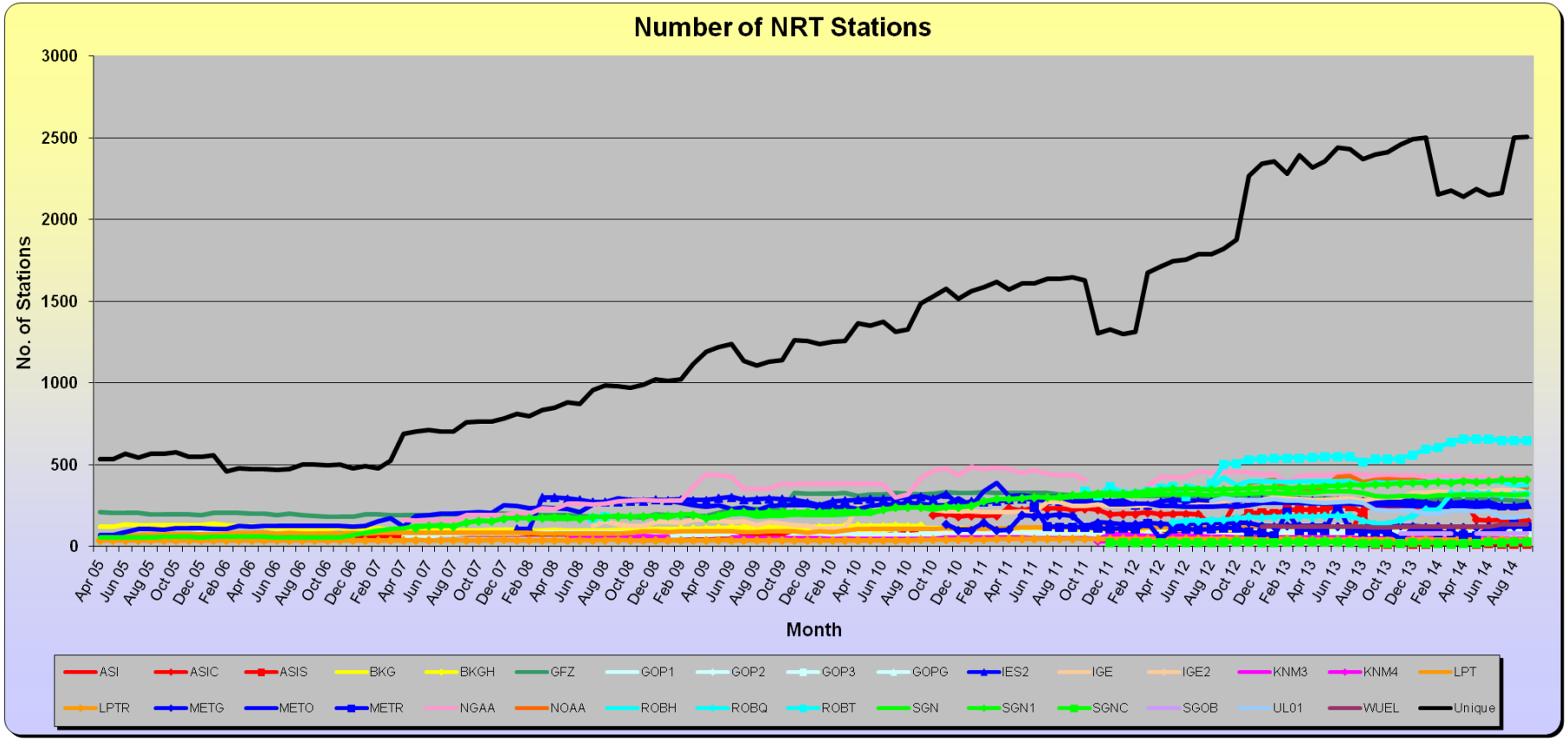


Coverage

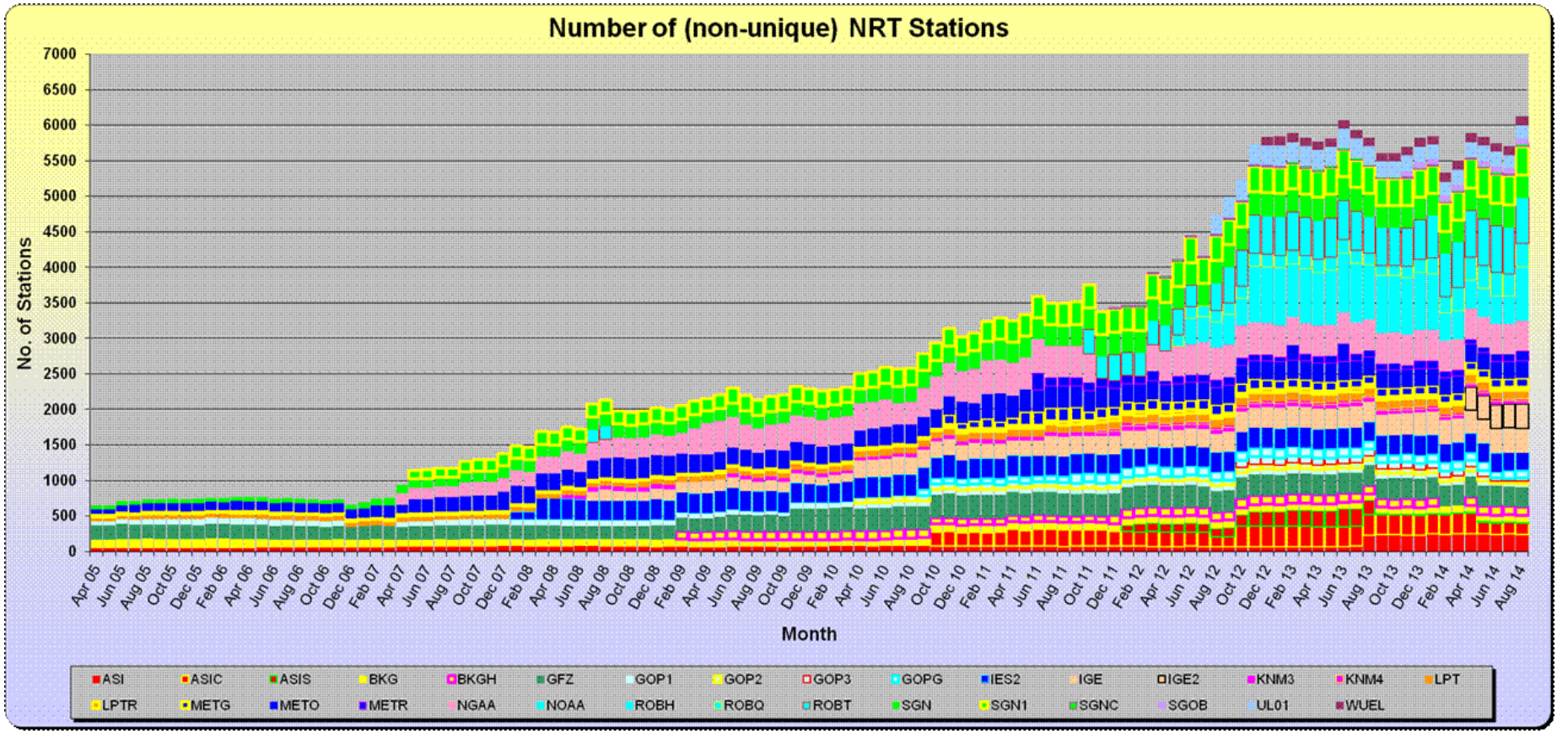


Coverage





Number of unique GNSS sites versus time.


Number of (non-unique) NRT Stations
No. of Stations
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Apr 05
Jun 05
Aug 05
Oct 05
Dec 05
Feb 06
Apr 06
Jun 06
Aug 06
Oct 06
Dec 06
Feb 07
Apr 07
Jun 07
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Apr 14
Jun 14
Aug 14
Month
ASI
ASIC
ASIS
BKG
BKGH
GFZ
GOP1
GOP2
GOP3
GOPG
IES2
IGE
IGE2
KNM3
KNM4
LPT
LPTR
METG
METO
METR
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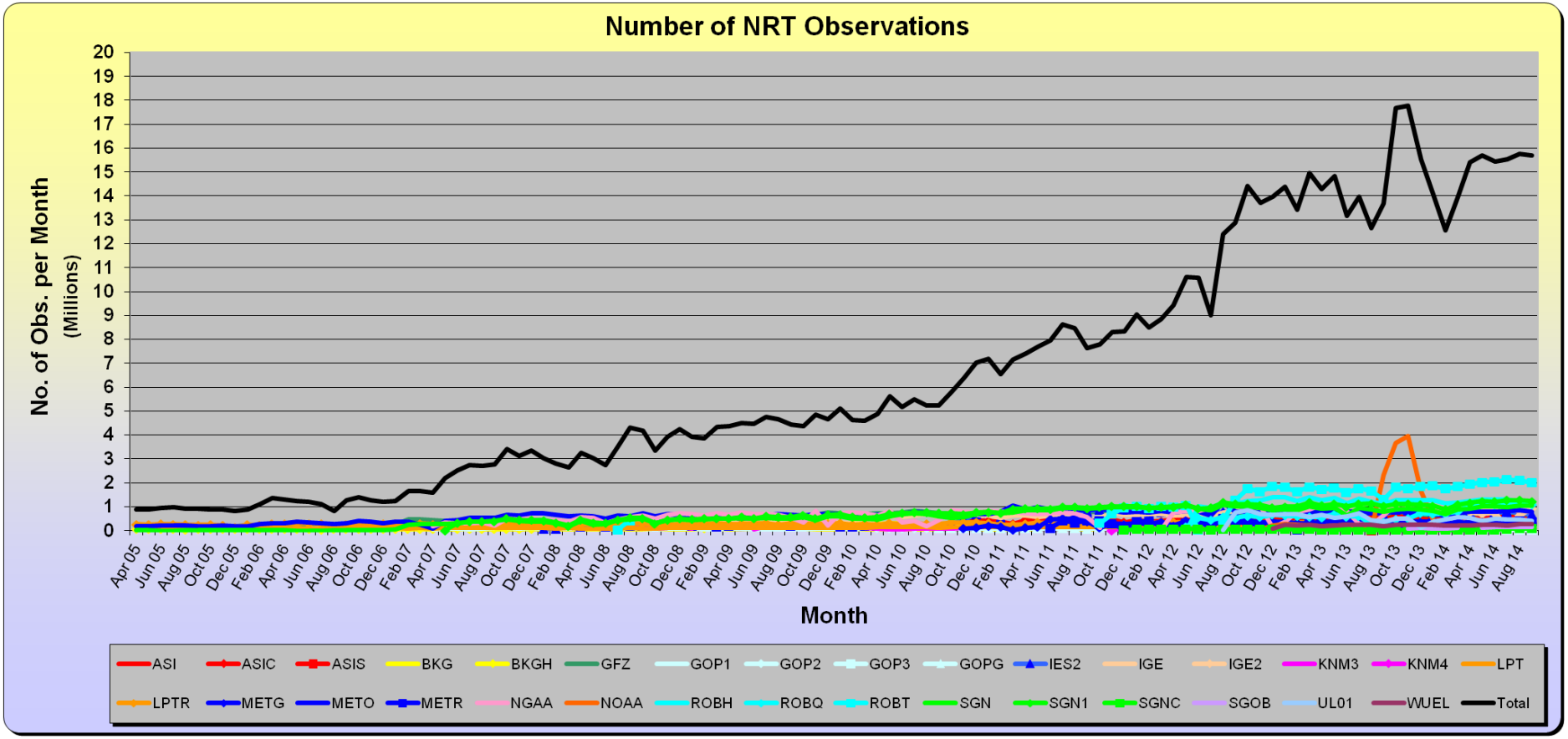
NOAA
ROBH
ROBQ
ROBT
SGN
SGN1
SGNC
SGOB
UL01
WUEL


Number of NRT Observations
No. of Obs. per Month
(Millions)
0
1
2
3
4
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11
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Apr 05
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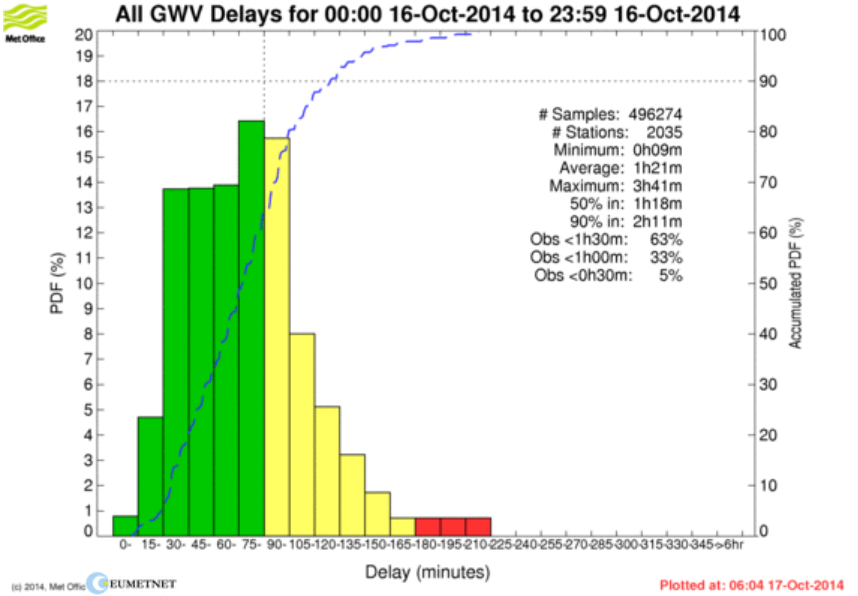
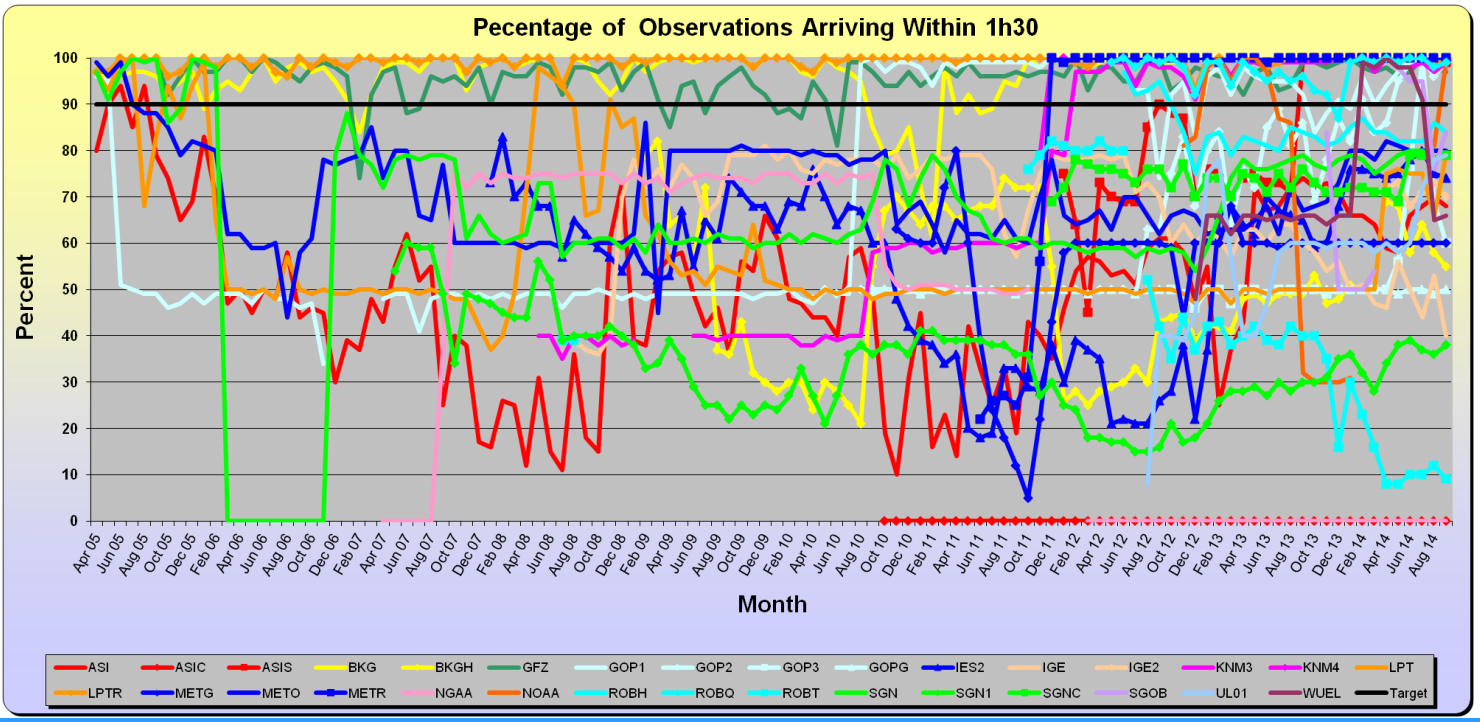
Apr 14
Jun 14
Aug 14
Month
ASI
ASIC
ASIS
BKG
BKGH
GFZ
GOP1
GOP2
GOP3
GOPG
IES2
IGE
IGE2
KNM3
KNM4
LPT
LPTR
METG
METO
METR
NGAA
NOAA
ROBH
ROBQ
ROBT
SGN
SGN1
SGNC
SGOB
UL01
WUEL
Total

Delivery timeliness

- Most (non-TEST) ACs providing data with good timeliness – on average, 90% of all ZTD obs arrive within 1h50m (*target 1h30m*)
- Future trends to shorter NWP model cut-off times will demand reduced latency





EUMETNET/Obs Programme QMP

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

EUMETNET Observations Quality Monitoring

Surface stations | Radiosonde stations | E-SURFMAR | E-GVAP | OPERA | E-ASAP | E-AMDAR | E-PROFILE

Data availability, timeliness and NWP results for E-GVAP stations

- Station map
- Monthly statistics: September | 2014 | LPTR | All | One ZTD timely
- Obs against NWP of the last 5 days: Supersites
- Monthly obs against NWP: October | 2014 | Supersites

E-GVAP validation tool (KNMI)

Imprint Privacy

Monthly statistic of E-GVAP data *(09 / 2014)*
Analysing Centre: LPTR one ZTD timely: true

Back

Legend

, Export as CSV

39 stations found

Identifier	Station	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Σ / Ø	%
AIGE	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96
		15	14	14	14	14	20	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	16	15	15	16	15	100
ARD2	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96
		15	14	14	14	14	20	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	16	15	15	16	15	100
BLFT	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96
		14	13	14	14	14	20	14	14	14	14	14	15	15	14	14	14	15	15	15	15	15	14	14	15	15	16	16	15	15	15	15	100
BOU2	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	14	10	24	24	23	24	24	24	24	24	668	93
		15	14	14	14	14	20	14	14	15	15	15	15	15	15	15	15	15	15	15	15	16	15	15	15	15	17	16	15	15	15	15	100
DAV2	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96
		15	14	14	14	14	20	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	16	15	15	16	15	100
EPFL	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96
		15	14	14	14	14	20	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	16	15	15	16	15	100
ETH2	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96
		15	14	14	14	14	20	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	16	15	15	16	15	100
FALE	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	23	24	24	24	23	24	24	24	24	24	691	96
		15	14	14	14	14	20	14	14	15	15	15	15	15	15	15	15	15	15	15	15	17	15	15	15	15	17	16	15	15	16	15	100
FHBB	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96
		15	14	14	14	14	20	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	16	15	15	15	15	100
FLDK	LPTR	24	24	24	24	23	22	24	24	24	24	24	13	6	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	663	92
		14	14	15	14	14	20	14	14	15	15	15	19	14	14	15	15	15	15	15	15	15	15	15	15	15	16	16	15	15	15	15	100
FREI	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96
		14	14	14	14	14	20	14	14	15	14	15	15	15	14	15	15	15	15	15	15	15	15	15	15	15	17	16	15	15	15	15	100
HABG	LPTR	24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96
		15	14	14	14	14	20	14	14	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	17	16	15	15	16	15	100
		24	24	24	24	23	22	24	24	24	24	24	24	24	23	23	8	18	24	24	24	24	24	24	24	23	24	24	24	24	24	692	96

The E-GVAP and EUMETNET QMP monitoring and validation are supplementary.

The EUMETNET QMP provides members of EUMETNET a QM product that is as similar to the the monitoring done by EUCOS for other obs programmes as possible, given the differences between the different observing systems.

The E-GVAP monitoring is more tailored to specific E-GVAP matters, faster to use, and more flexible.

The EUMETNET QMP includes a ”one observation timely” monitoring. Timeliness is relative to arrival at DWD database.

The EUMETNET QMP obs versus NWP is based on O-B data from UK Metoffice and statistiscs made at DMI. It is a daily O-B statistics

Plan to make monthly O-B statistics. Based on which model? Currently everything is based on UK Met Office global.

Important for ”test” to ”operational” movement of solutions.

Solve in connection with NWP data for GNSS4SWEC?!

Milestones year 2014

- **Continuation of existing E-GVAP-II data processing and distribution**
- **Update of User Requirements (depending on user interest)**
- **Update of document of common, minimum requirements to GNSS data processing as regards access to data from individual sites, to satellite orbit and clock estimates, and timeliness and precision.**
- **Reports from expert teams and E-GVAP team**

Key focus areas

- **Enable upload and distribution of sub-hourly GNSS delay data.**
- **Active quality control, AQC.**
- **Expanded coverage in data poor areas, both European and global.**

Product requirements

- Make inquirery?
- Make list of useful products, besides those defined from WMO guidelines?
- In collaboration with GNSS4SWEC?

Sub-hourly processing +file naming & formats

A naming scheme enabling sub-hourly upload of COST files now exists.

Besides identifying the timeinterval of the data in the file the naming scheme enables automatic BUFR encoding and routing of the file to GTS, GTS demo, or no BUFR encoding and GTS transmission.

The most recent ´COST-format´ File Specification for Ground-based GNSS delay and Water Vapour data" is version 2.2a, describing both content and naming.

Available via egvap.dmi.dk and via ftp-server at UK Met Office.

Site naming, sharing of occupied names

- **DOMES numbers are unique names for GNSS sites, but there is no current push in geodesy for all sites having DOMES numbers.**
- **In meteorology sites have unique names (numbers).**
- **At UK Met Office a list is kept of all ”occopied” 4 character sitenames, with a division into currently used and total.**
- **The list is available via the ftp-server. But the most easy way to use Dave Offilers online tool.**
- **It would make sense to move/mirror this system to www sites where it is very visible to GNSS geodesists.**
- **For AC´s uploading data to E-GVAP, we kindly ask them to check the list for eventual name clashes, and adjust accordingly.**

Standard rules for declairing test uploads ready for operations. For discussion.

Since NWP is not good at humidity, since height offsets are handled differently in diff. NWP models, and since observations operators have different precision, basic estimation of bias and standard deviation should be done againt GNSS ZTDs.

Comparison against operational ZTDs from supersites sites, or against post processed data.

Biases < ? Stdev < ?

Comparison against NWP (O-B) to identify and investigate eventual problems with single sites. Stdev < ?

Data should be monitored for minimum 3 months. When requirements fullfilled, data can be uploaded as operational.

For an AC already uploading ZTDs operationally for the same sites, an additional requirement is that the new solution has benefits compared to the old solution (precision, timeliness, computer efficiency, or robustness, etc.)

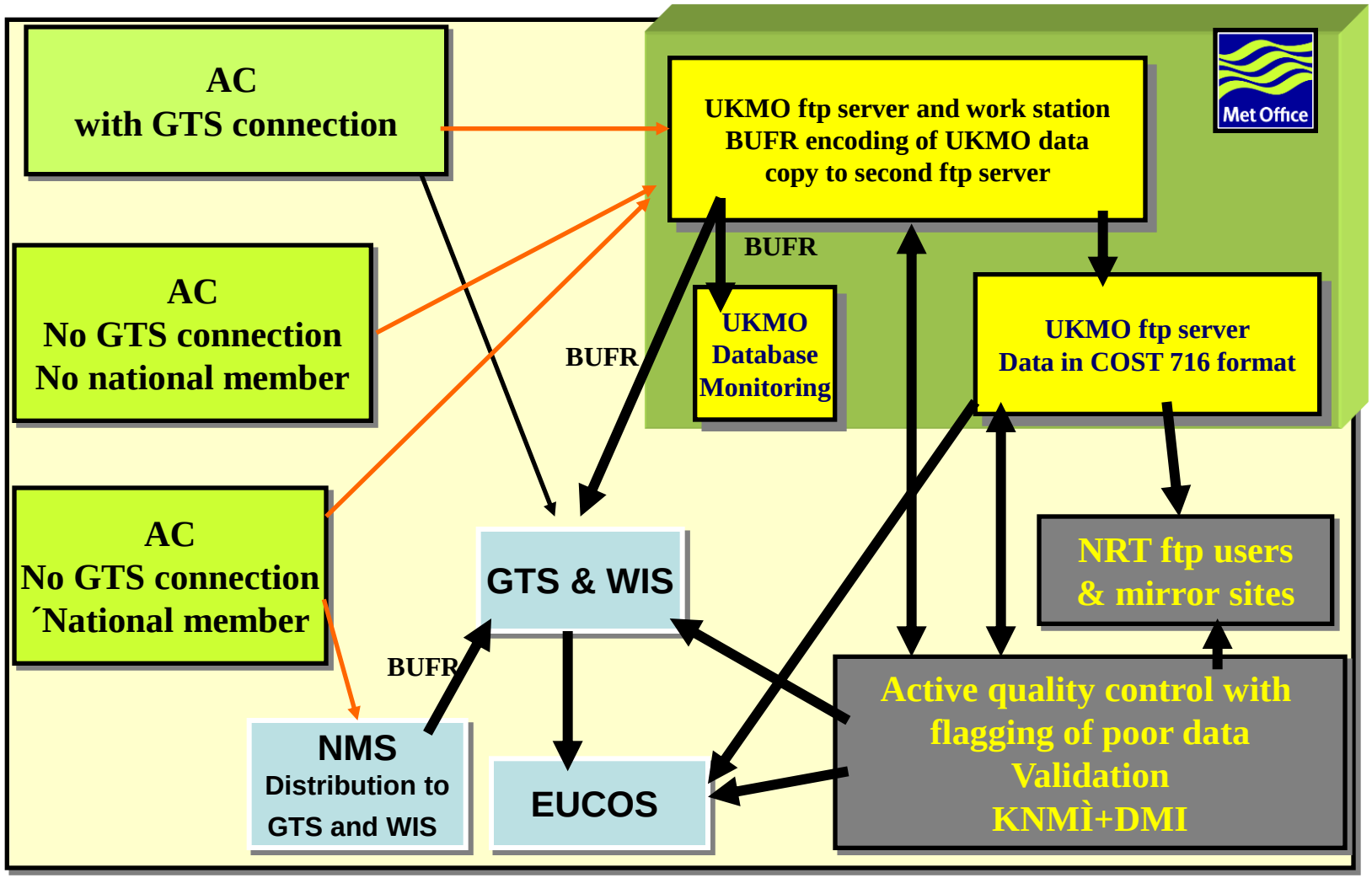
- **Active quality control, AQC, to be set up.**

- The distributions per AC of ZTD offsets relative to the MoM (median of medians) for sites processed by at least 4 ACs have been studied. Based on that, thresholds of 20 and 40 mm for “small”, respectively, “large” outliers have been found to be useful in AQC outlier detection.

- It is planned to run the AQC for the entire E-GVAP database, to provide a “cleaned” NRT ZTD dataset.
- This set can be converted to IWV as well. But this should await a general accepted approach to the ZTD to IWV conversion.

AQC can be used to on the fly detect whether an AC has a system wide problem.

NRT GNSS ZTD data flow Future



ACs which are not at an NMS, will have to transmit BUFR via NMS to GTS and WIS

- **E-GVAP expert team and plenary meeting, November 2013, DMI**
- **AGU, December 2013**
- **EUCOS PM & EUMETNET Core Team meetings, Jan 13-17, 2014, DWD**
- **GNSS4SWEC workshop in connection with data assimilation symposium, February, Munich.**
- **Session on GNSS geodesy and atmosphere, EGU, April 2014, Vienna**
- **ESAT, May 2014, ECMWF**
- **EUREF annual symposium, May 2014, Vilnius.**
- **GNSS4SWEC summer school and WG meeting, Sept. 8-11, Varna, Bulgaria**
- **E-GVAP expert teams and members meeting, October 22-23. 2014, UK Met Office, Exeter**
- **EUMETNET PM meeting, December 2014**
- **Obs PM meeting, primo 2015**
- **EGU, 12-17 April 2015**
- **GNSS4SWEC, mid May 2015**
- **EUREF, late May/early June, 2015**
- **E-GVAP expert teams and members meeting, ultimo 2015.**

Expert team on data processing

The primary contact point between the meteorological and geodetic side.

Team involves both the real processing experts, and people from institutes starting to process GNSS data for delivery to E-GVAP.

Rosa Pacione/Brigida Pace, e-geos, Italy
Jan Dousa, GOP, Czeck Republic.
Elmar Brockmann, Swisstopo, Switzerland
Galina Dick/Florian Zus, GFZ, Germany
Martin Ridal/Jan Johansson, SMHI/Chalmers Tech. Univ., Sweden
Jose Antonio Sánchez Sobrino, IGE/IGN, Spain
Lila Jean-Louis, SGN/IGN, France.
Eric Pottiaux/Carine Bruyninx, ROB, Belgium
Wolfang Soehne/Yuksel Altiner, BKG, Germany
Ambrus Kenyeres /Szabolcs Rozsa/Tivadar Horvath, SGOB, Hungary

To add:
Norman Terfele, UL01, University of Luxemburg, Luxemburg
Jaroslaw Bosy, WUEL, Poland
Guergana Guerova, Univ. Sofia, Bulgaria

Jonathan Jones, Siebren de Haan, Henrik Vedel.
Responsible person: Jonathan Jones.

Inter European scale (EUREF)

- Johannes ihde, Precident of EUREF.
- Elmar Brockmann, Swisstopo
- Rosa Pacione, e-geos.
- Ambrus Kenyeres, Hungary.
- Carine Bruyninx, Roy. Obs. Belgium, EUREF coordinator
- Henrik Vedel E-GVAP, DMI
- Jonathan Jones E-GVAP, UK Metoffice
- Siebren de Haan E-GVAP, KNMI

Responsible person: Henrik Vedel.

Very fine collaboration with EUREF geodesists.

Liaison

National scale.

- E-GVAP team.

Responsible person: Henrik Vedel.

- EUMETNET directors prefer national arrangements.
- Practical matters, e.g. national GPS data obtained by a national mapping agency also points to national arrangements.

- A changing liaison group, involving persons from currently active partners
- Database with examples of agreements/contracts between data owners and met. inst.

- EUMETNET Council: Agreements made between met. Offices and GPS providers
- Formally each E-GVAP member institute is responsible for making available GPS data from that country for E-GVAP, or trying to, depending on the current level of national GPS meteorological collaboration. Help in this process can be provided from the E-GVAP team.

Expert team on GNSS observation usage

Purpose: To further the use of gb GNSS data in NWP and now-casting through sharing of results and expertise, to provide guidance material for others, and to provide feedback to processing centres.

Gemma Bennitt & Dave Officer, UKMO,
(Daniel Leuenberger, MeteoSwiss, not working on GNSS usage currently)
Jana Sanchez Arriola, AEMET, Spain
Patrick Moll, Meteo-France.
Klaus Stephan/Michael Bender, DWD.
Henrik Vedel, DMI and E-GVAP
Jonathan Jones, UK Met Office and E-GVAP
Siebren de Haan, KNMI and E-GVAP.

Other?
The experts should cover the ”big nwp consortia” and be people active in using ground-based GNSS data in NWP and/or forecasting.

Responsible person: Henrik Vedel.

E-GVAP economy

The ordinary yearly E-GVAP-II budget is:

•Project manager	43.0 k€	DMI
•Contract to support hub/central processing	25.5 k€	UK Metoffice
•Contract to quality control facility	25.5 k€	KNMI
•Expert teams, liaison and project travel	25.0 k€	
•Total	119.0 k€	

The actual payment from members is less these years, due to the use of surplus money from previous years.

The surplus money are handled by the EUMETNET Secretariat in Brussels.

O-B and other NWP data for statistics (E-GVAP), and for use in realtime positioning experiments (GNSS4SWEC).

- **Currently O-B from UK Metoffice global model as regards EUCOS QMP, and from KNMI HIRLAM regarding the E-GVAP validation page.**
- **Need global coverage.**

  Need also European coverage with higher resolution models.
  - **For E-GVAP O-B.**
  - **For GNSS4SWEC need ZTD, surface pressure, T2m and <T>.**

- **List of cut off times at NWP centres**
- **Requirements regarding solution updates. Notification if bias is larger than something?**

GNSS4SWEC

Next meeting?

In connection with GNSS4SWEC meeting in Wroclaw, Poland?

Any other matter?

EUMETNET
European Meteorological Services Network

FIN

Contact Details

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