EUMETNET
European Meteorological Services Network

E-GVAP-III

The EIG EUMETNET GNSS Water Vapour Programme, phase III

3’rd expert team & members meeting
October 1-2, 2015, Wroclaw University of Environmental and Life Sciences

KTU, Turkey

Selma Zengin Kazancı, Emine Tanır Kayıkçı

I would like to give you a brief information about our analyses centre.

We met with some misfortune. We had some technical problem about the hard disk in our server. We had to change all hard disks. Now we figure out our problems and we take some extra precaution for a possible problem in our server.

System was re-installed, but we stuck at some stages. We talked Jan Dousa, he will help us. After that we will add TRAB station and the other Turkey stations.

We will continue our analysis.

See presentation

If the sub-WG meeting on data homogenisation's date is identified early, I will attend the meeting.

AUT, Greece

Chris Pikridas

- **From October 2014 we participate with 90 Greek permanent GNSS stations to EGVAP.**

- **But, until now we are under test and not as operational AC.**

NGAA processing centre (from Magnus)

- There are work towards moving the data processing for the NGAA processing centre to Lantmäteriet (the Swedish mapping, cadastral and land registration authority).

- Chalmers University of Technology, supported by SMHI and Lantmäteriet, is developing new implementations based on both the GIPSY and Bernese software packages.

- SMHI will handle the transfer of data to E-GVAP.

- A test and demo period for evaluation was started in June.

- Continuous data stream from 54 stations sent to SMHI will be started October 15, 2015. The data, both from GIPSY and Bernese implementations, will be evaluated by SMHI.

- Continuous full scale data stream (incl 500-700 stations) to SMHI and E-GVAP at the latest 1 January, 2016.

SMHI

LANTMÄTERIET

CHALMERS

Korea Meteorological Agency, KMA
Eunhee Lee

- Happy to receive E-GVAP data from UK Met Office.
- Testing assimilation of E-GVAP data in KMA Global model.
- Uploading KMA data to E-GVAP server has been delayed.
- Currently KMA is been receiving ZTD data from only 15 stations on Korea peninsula in near-real time.
- Recently, we are tring to use more data. But we have some problems with Bernese processing system.
- Expect using about 40 stations ZTD data at the end of this year.
- KMA use the UK Met Office Unified Model.
- First test is to use GNSS data for KMA local area model (1.5km spatial resolution, only covering Korea peninsula) using 3D-var.
- This results in a positive impact.
- See presentation.

Spanish Meteorological Institute, AEMET
Jana Sanchez

Presentation.

About a date to assimilate gnss in AEMET operationally it will be first term of next year, probably together with ATOVS, because we will get a BULL supercomputer installed by then.

From Stephen McPherson, Environment Canada

- Since November 2014, we use a hybrid 4D ensemble-variational (4DEnVar) data assimilation system which relies on 4D ensemble covariances estimated from an ensemble of background states taken from our global ensemble (EnKF) system.

  Operationally, we assimilate GPS ZTD obervations from the NOAA (North America) GPS PW network since November 2014 in our global and regional 4DEnVar systems. We are currently assimilating E-GVAP network ZTD observations in "parallel mode" in the global system, which should become operational this fall. We also assimilate the collocated surface met observations (pressure, temperature, RH) where available, mainly from the NOAA sites.

  We do not do any re-analysis.

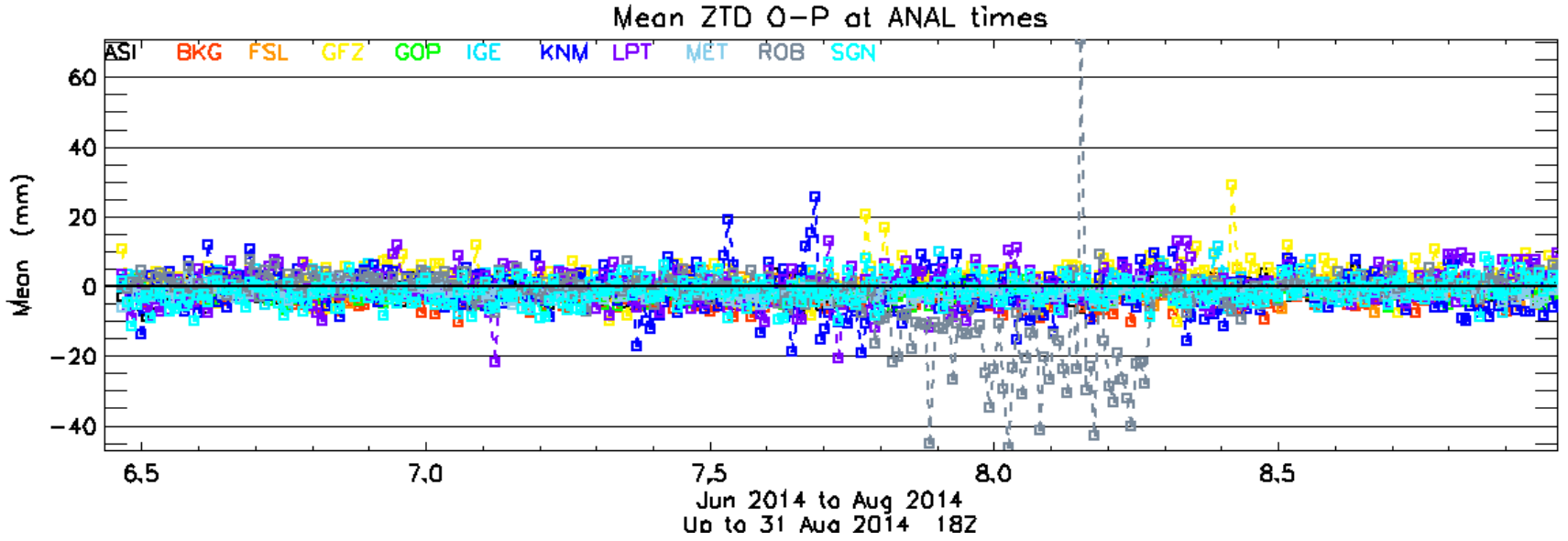
From Steven McPherson, Environment Canada

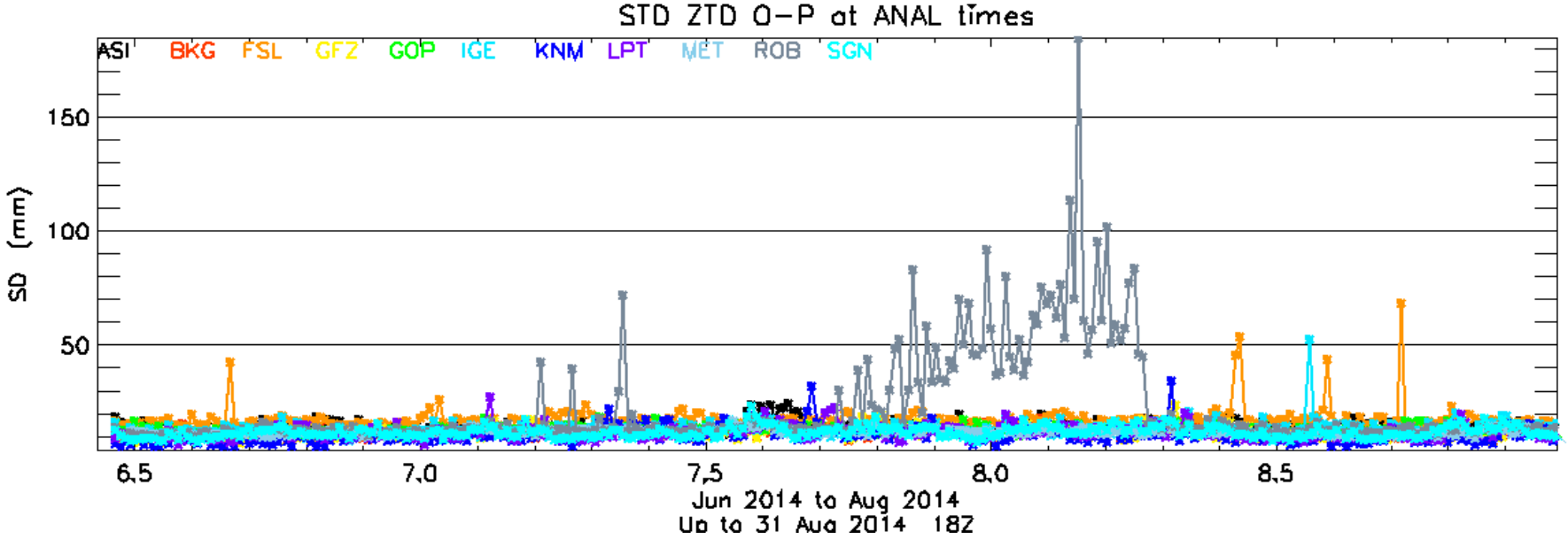
While the Greenland data sound interesting, what we really lack are real-time ZTD observations over Canada. There are only about 20 sites in Canada processed by NOAA and E-GVAP.

There are on the order of 500 GPS sites in Canada operated by private sector or provincial agencies that could potentially provide GPS data for ZTD estimation, and we have attempted in the past to get Natural Resources Canada Geodetic Division to access and process the data for us, but so far we have had no luck.

We do have in-house capability to process raw GPS data (RINEX) to obtain ZTD solutions, but unfortunately we lack both data access and the resources to maintain the capability.

From Steven McPherson, Environment Canada





Extract from mail from Michael Bevis (US) to Stephen McPherson (Canada)

Thanks for your very informative email. There does seem to be a serious misconnect between the geodesists and the meteorologists both in the USA and in Canada. NOAA, for example, does use ZTD from many more GPS stations than does EC, but, even so, it uses only a small fraction of the total on-line GPS station count. Most of the continuous GPS stations in the US are on-line these days. Do you know what fraction of the ~ 500 Canadian GPS stations are on-line?

It is wonderful that you now use 4DEnVar operationally, but I can't help but think that it is very unfortunate that neither EC nor NOAA does any reanalysis using this or similar assimilation schemes, since if you did so, even for a year or two, you could fairly easily obtain RINEX from huge numbers of GPS stations: i.e. from more than 2,000 GPS stns in the USA, not to mention 60 from Greenland, and another ~ 480 in Canada.

Surely showing the benefits of doing this (i.e. the impact on prediction skill) even in non-real time setting would provide the very rationale needed for streaming more of the GPS station data to the meteorologists.

Extract from mail from Michael Bevis (US) to Stephen McPherson (Canada)

The geodesists could bring about this change surprisingly inexpensively at the majority of stations in the USA and Canada, though it would be more expensive in Greenland and at some high Canadian Arctic stations. The geodesists truly seek more 'customers' and greater social impact for their GPS networks. But some modest level of funding would be needed just for the increased comms costs (not salary, etc), and the various governments are to unlikely to embrace this expense unless the benefits have been demonstrated at least in simulation (i.e. in re-analysis) mode.

It is great that the North Americans are contributing to E-GVAP, which is now the most advanced project of its kind in the world, even ahead of the excellent Japanese project, but the North Americans need to startup their own version of E-GVAP (or be better organized as a subset of E-GVAP) in order to push for much better nearly-real-time data collection, and to encourage re-analysis and impact studies using both global and regional models of the kinds exemplified by French, British and Japanese meteorologists.

E-GVAP has become a tremendous international framework for the coordination and R&D of 'GPS met', just as the Japanese GPS Met project was in the last decade. North American geodesists and meteorologists need a similar framework.

Consider the case of the Ohio real-time GPS network of ~ 60 stations. Originally intended very largely for surveyors, the single largest user group these days are Ohio's farmers. As a result the state agency in charge is very interested in addressing their concerns. And all farmers place a great deal of importance on weather forecasts - and even climate cycle predictions these days! The potential synergies are there, while money is an issue, the single largest barrier in my opinion is the lack of sufficient interdisciplinary coordination in the USA and Canada (and why not include Mexico?). Perhaps the existence of the European Union has played some positive role in this context.

As I see it, the greatest problem for the 'GPS met' agenda on our side of the Atlantic is balkanization of both the relevant meteorology groups and the relevant geodesy groups in North America. A horrible lack of coordination and shared purpose. We need to form a sister effort to E-GVAP, maybe NA-GVAP.

From Klaus Stefan, DWD:

Michael Bender has established a nice monitoring, but due to some technical reasons, he was not able so far, to run assimilation experiments. We still hope that this will be possible quite soon.

We plan to go pre-operational end of next year, at least with ZTD for global 3dVar.

We are also discussing the issue of membership in E-GVAP. Administration is still a bit reluctant.

Denmark

Ground-based GNNS data. Access and processing.

3 Networks in Denmark, two private and the national mapping agency.

- **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.**

- **These data are processed by ROB.**
- **Available for NGAA when it starts operating again. (Currently NGAA has access to same data via non-operational server at Chalmers)**

- **Plans to include the two private networks in data exchange when possible**

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

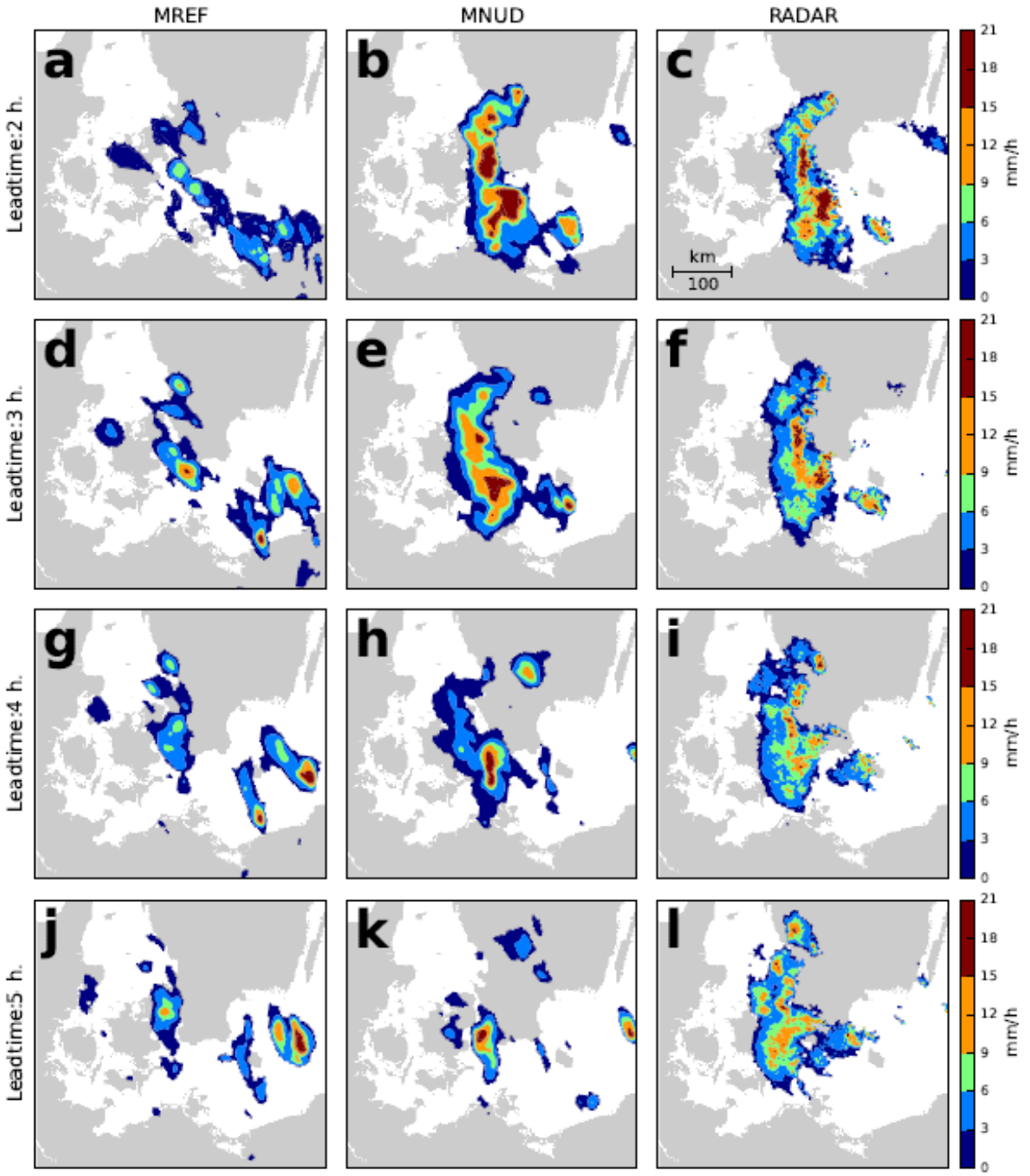
Posibility of data from additional stations on Greenland

1. **From DTU Space (Technical University), realtime access**
2. **From GNET (Michael Bevis, not real-time).**

DMI

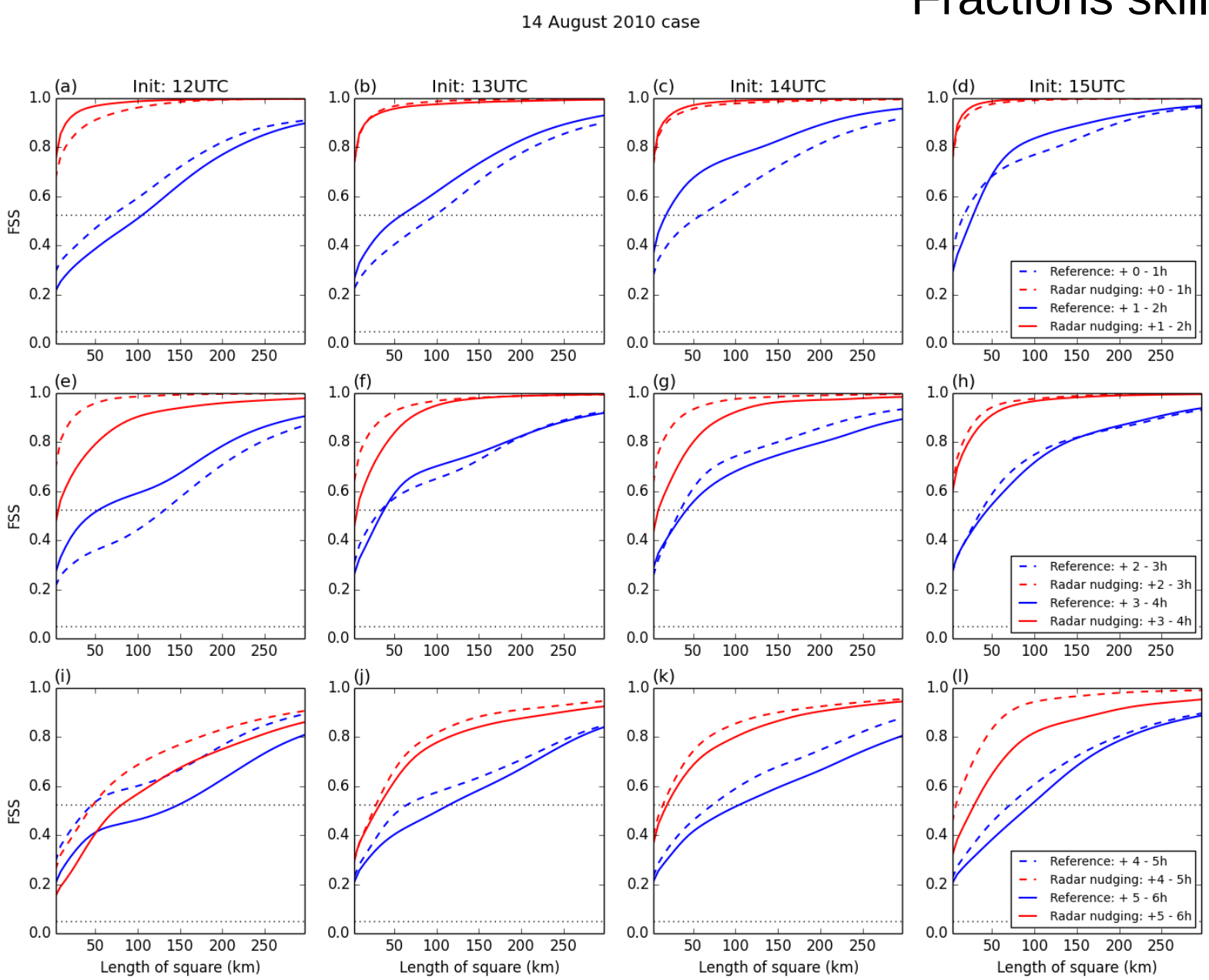
- Currently very strong focus on ”NWP nowcasting” at DMI.
- Prime goal is to improve forecasts of convective, heavy precipitation.
- Secondly to improve short term forecast of potential production of wind and solar power.
- Running rapid update cycling (RUC, hourly, potentially every 10 min) NWP.
- Very fine impact from radar data. Hope for additional fine impact from sub-hourly GNSS data and ADD (subhourly aircraft wind and temperature) data.

14/8-2010
Copenhagen



14/8-2010

Fractions skill score



Analysis centers (ACs)

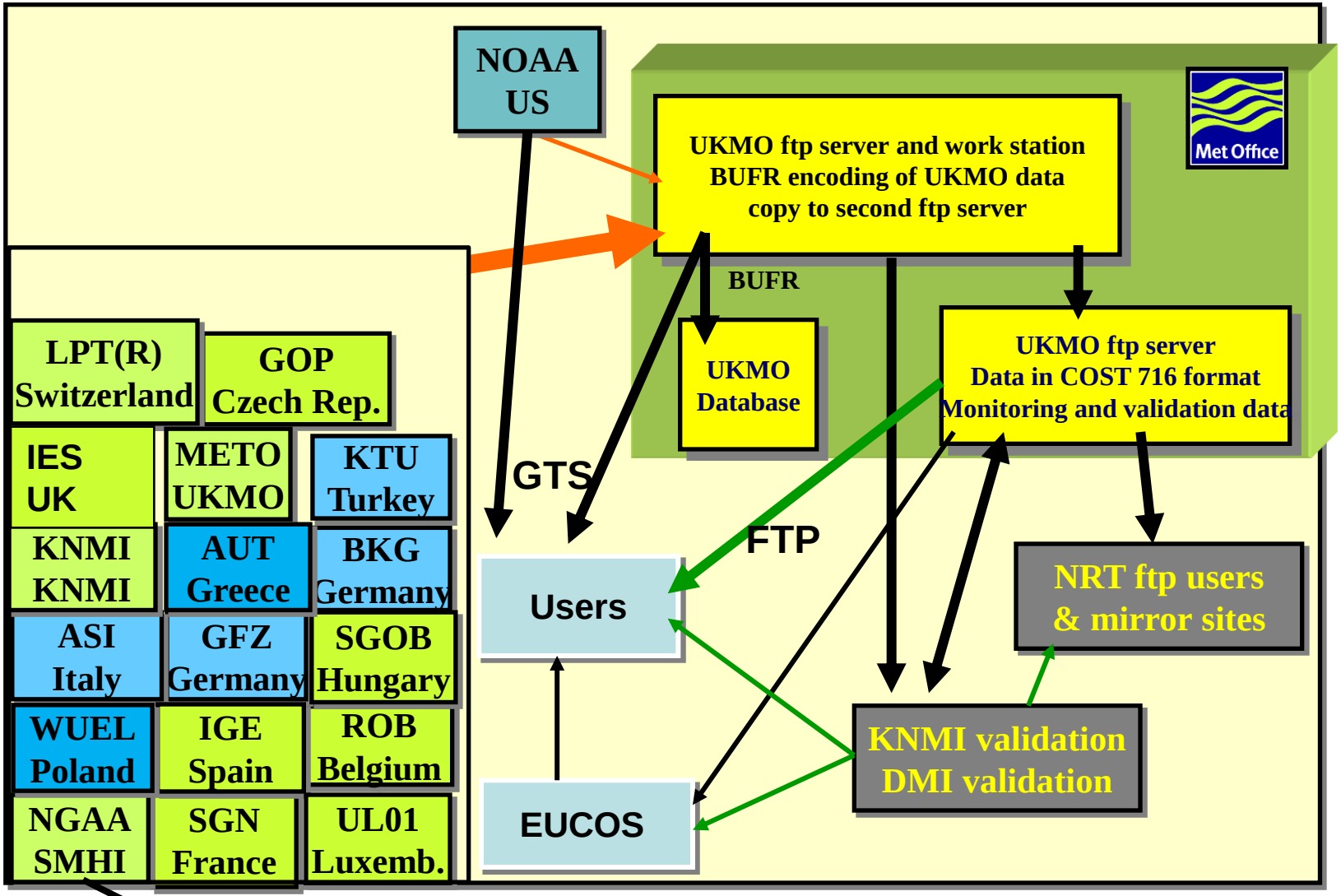
AC	Institution	
ASI	e-geos/Telespazio, Italy	
AUT	Aristotle University of Thessaloniki, Greece	NEW
BKG	Federal Agency for Cartography and geodesy, Germany	
GFZ	Helmholz Centre Potsdam, GFZ German Res. Cen. f Geosciences	
GOPE	Geodectic Observatory Pecny, Czech Republic	
IES	Inst. of Eng., Surv. And Space Geodesy, Univ of Nottingham, UK	
IGE	Instituto Geografica National, Spain	
KNMI	Royal Meteorological Institute of the Netherlands	
KTU	Karadeniz Technical University, Turkey	NEW
LPT	SwissTopo, Switzerland	
METO	UK Metoffice	
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	

E-GVAP members

1. Croatian Met Service, DHMZ
2. Danish Meteorological Insitute, FMI
3. Finnish Meteorological Institute, FMI
4. Hungarian Met Service, OMSZ
5. Icelandic Meteorological Office, IMO
6. Irish Meteorological Service, Met Eireann
7. Meteo France
8. Met Service Luzembourg, MeteoLux
9. Meteo Swiss
10. Norwegian Meteogolocial Institute, met.no
11. Portugeuse Inst. of Ocean and Asmosphere, IPMA
12. Royal Meteorolocial Instistute of Belgium, RMI
13. Royal Meteorological Inst. Of the Netherlands, KNMI
14. Spanish Meteorological Institute, AEMET
15. Swedish Meteorological and Hydrological Institute, SMHI
16. UK Met Office, MetO

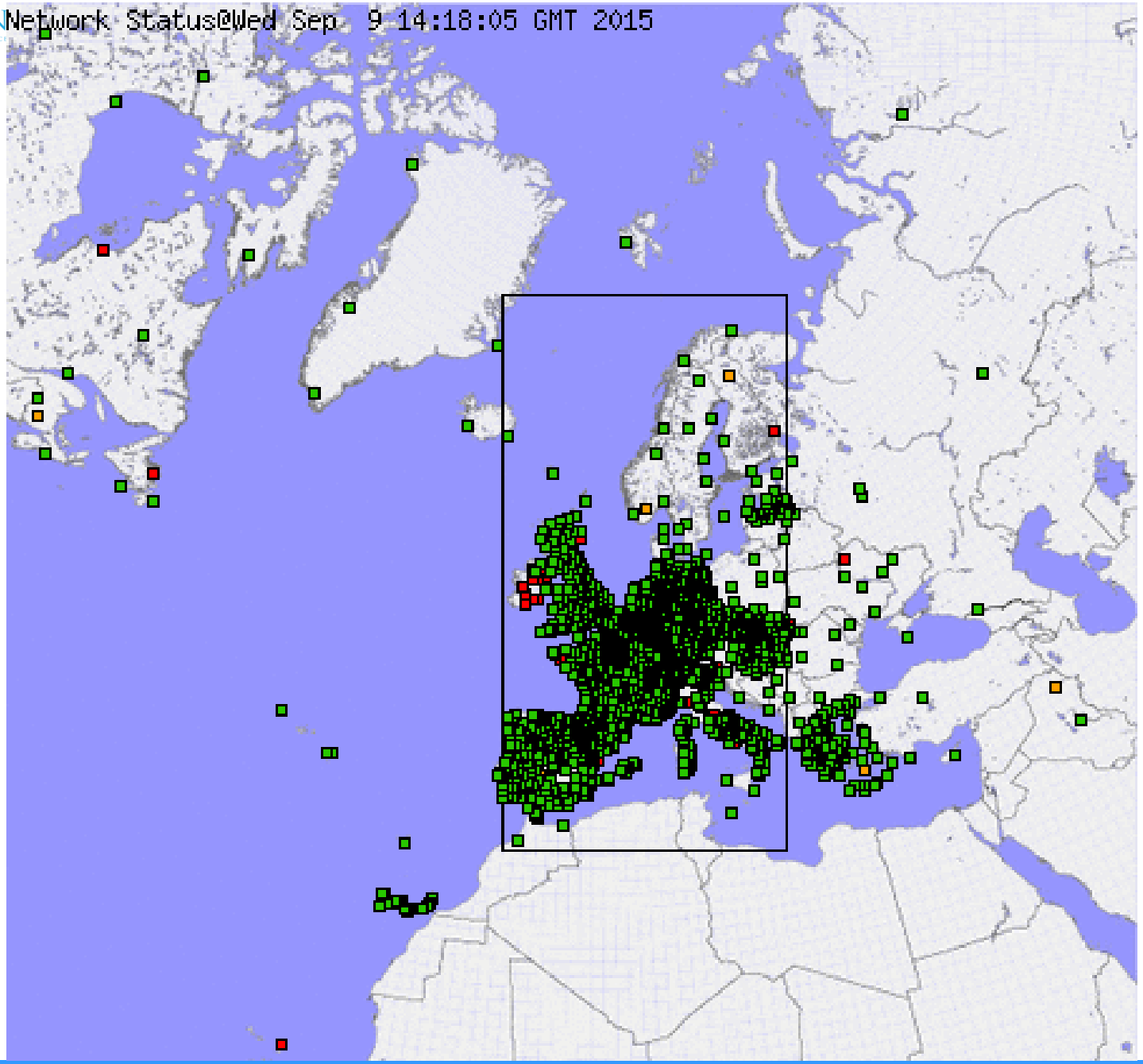
OBS system overview

NRT GNSS ZTD data flow

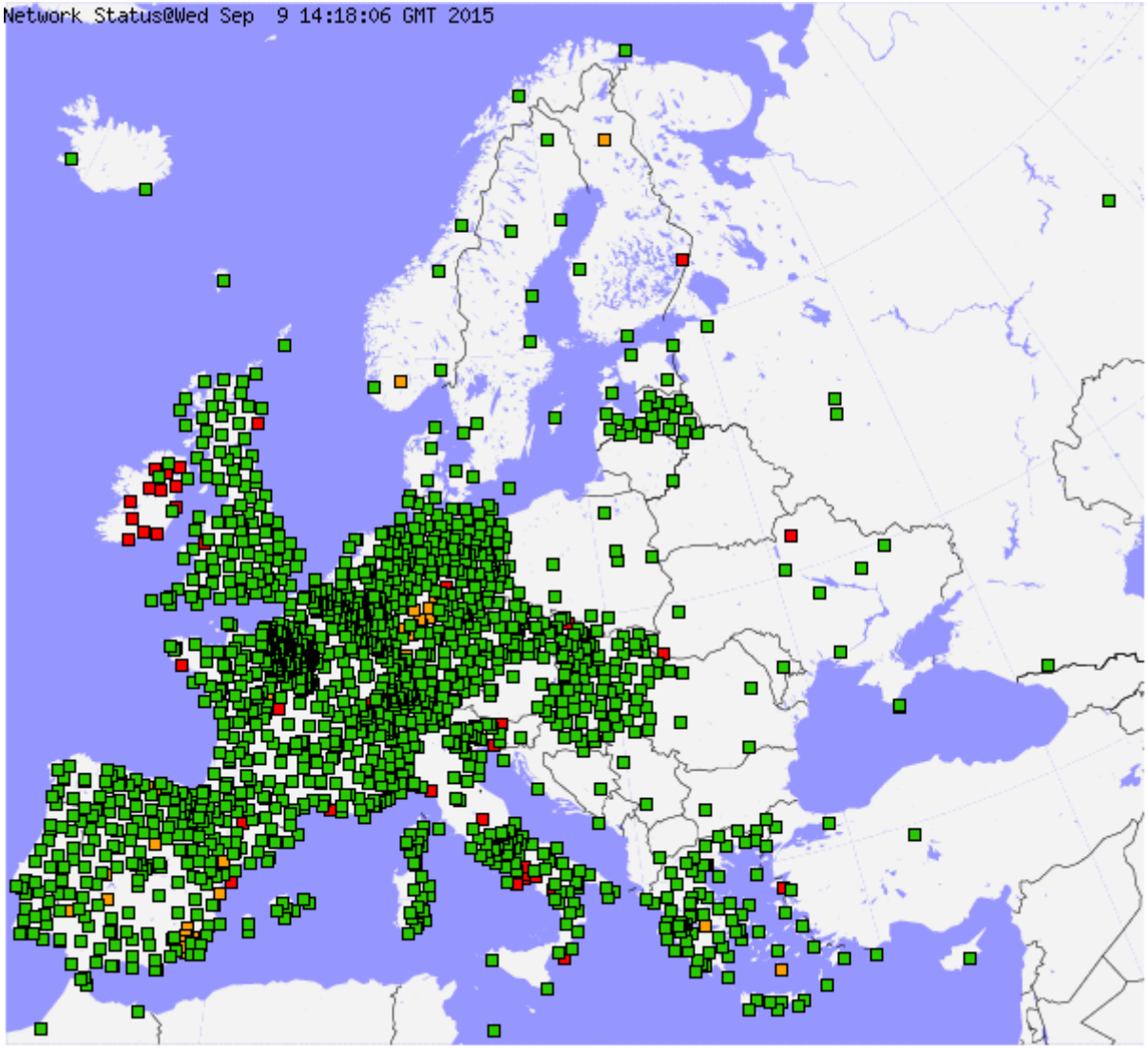


Analysis centres (ACs), each processing raw GNSS data from many sites. Each AC send data to UKMO.

EUMETNET
EUROPEAN METEOROLOGICAL SERVICES



Coverage



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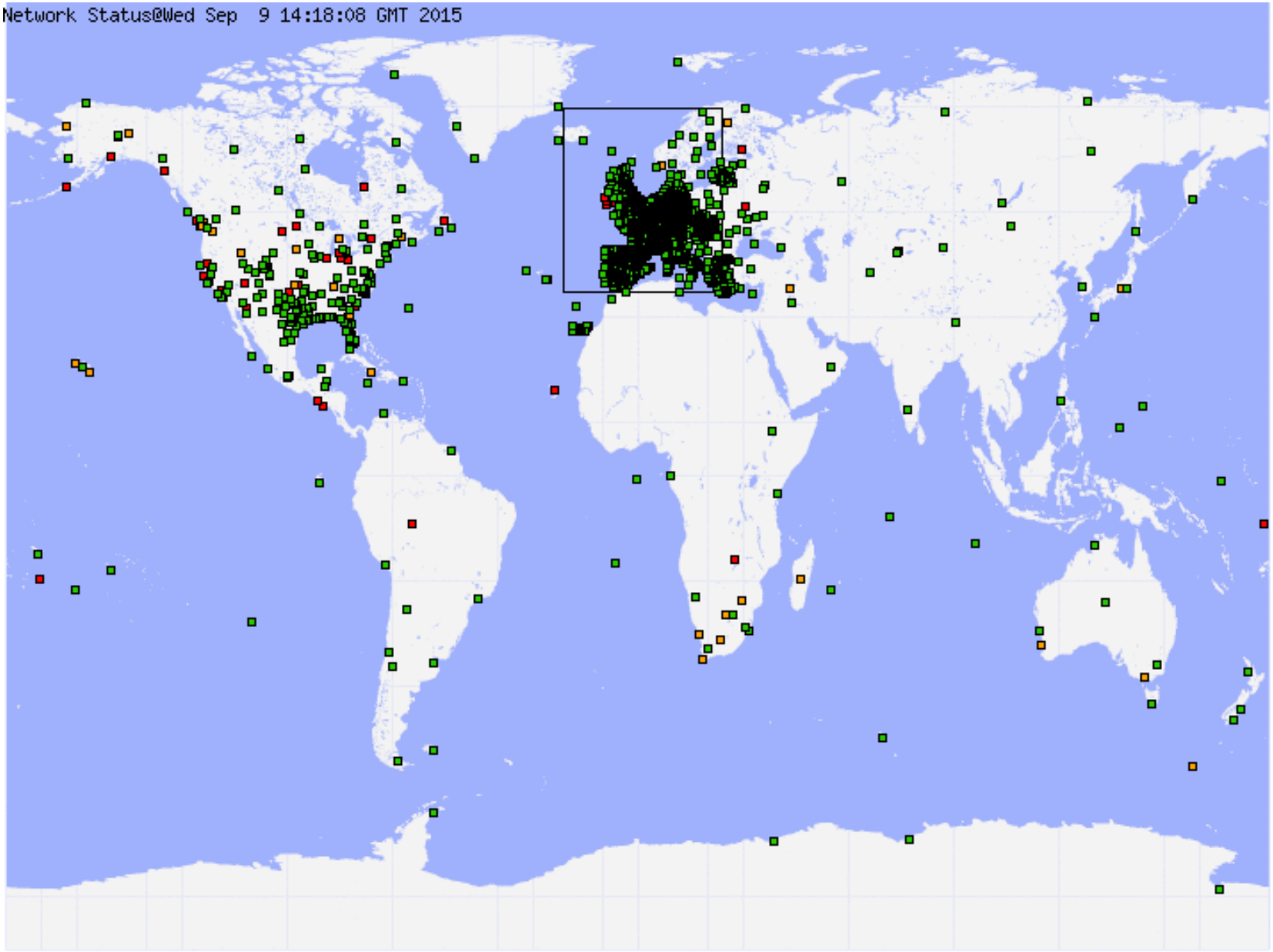
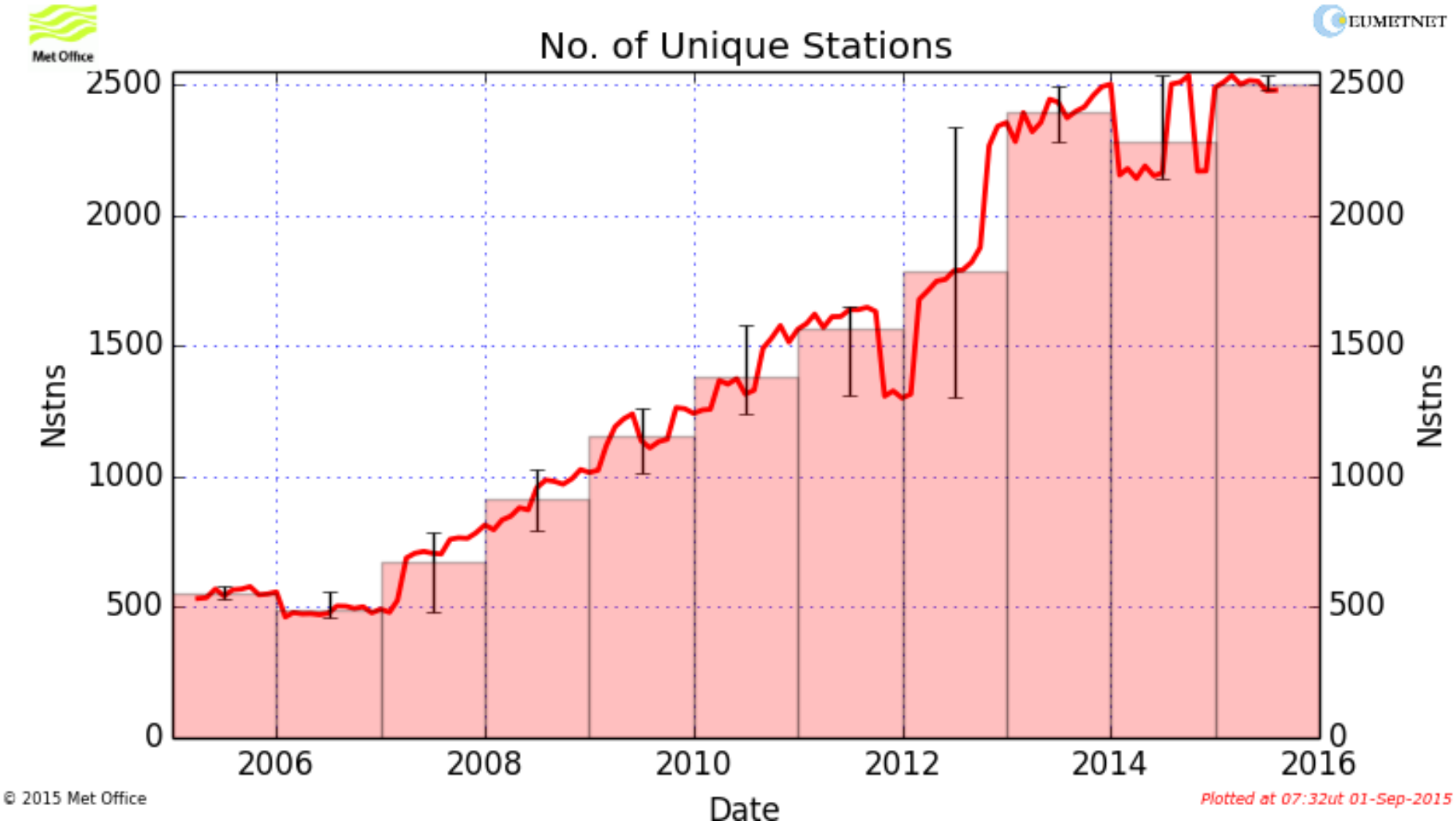
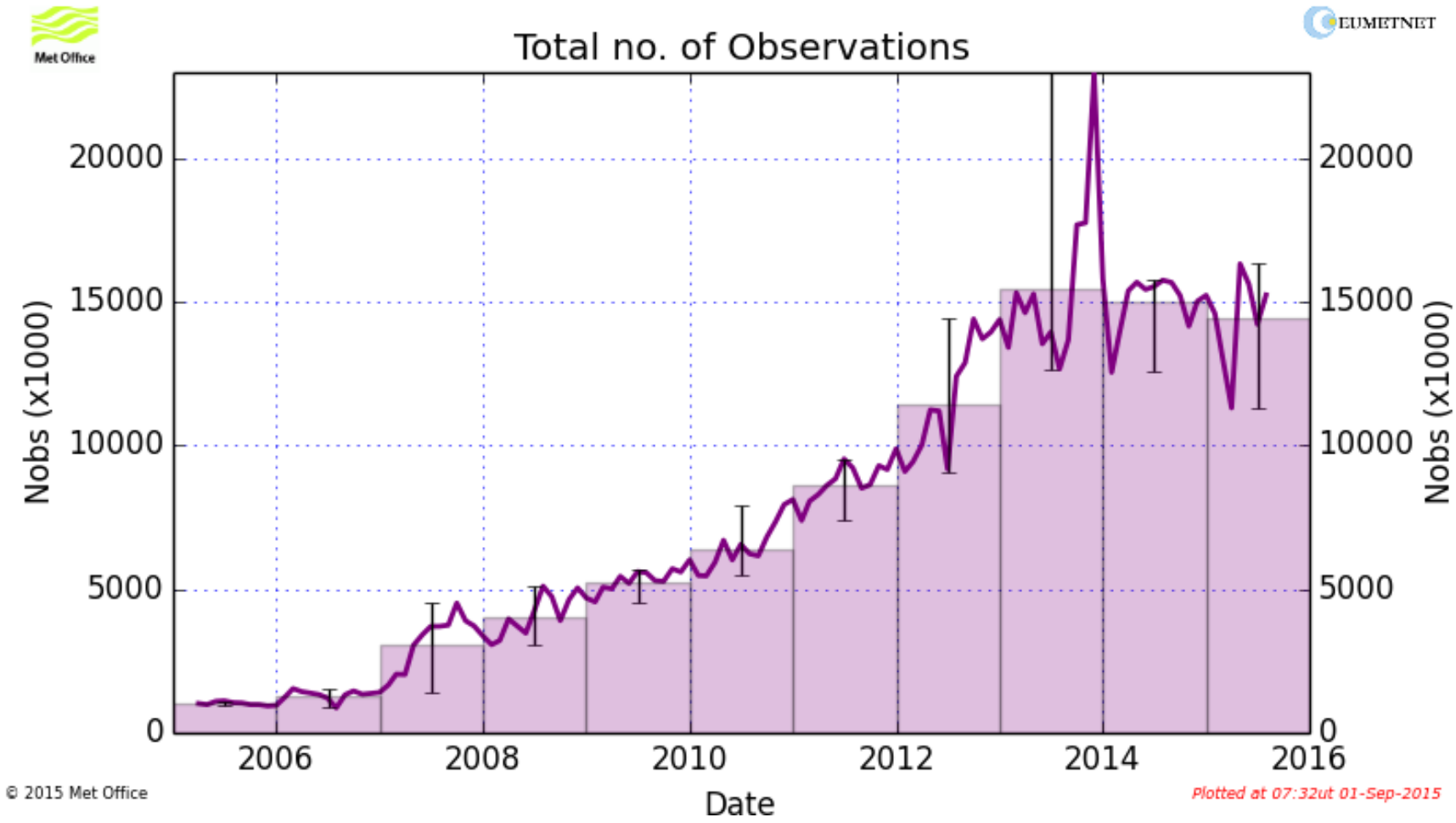
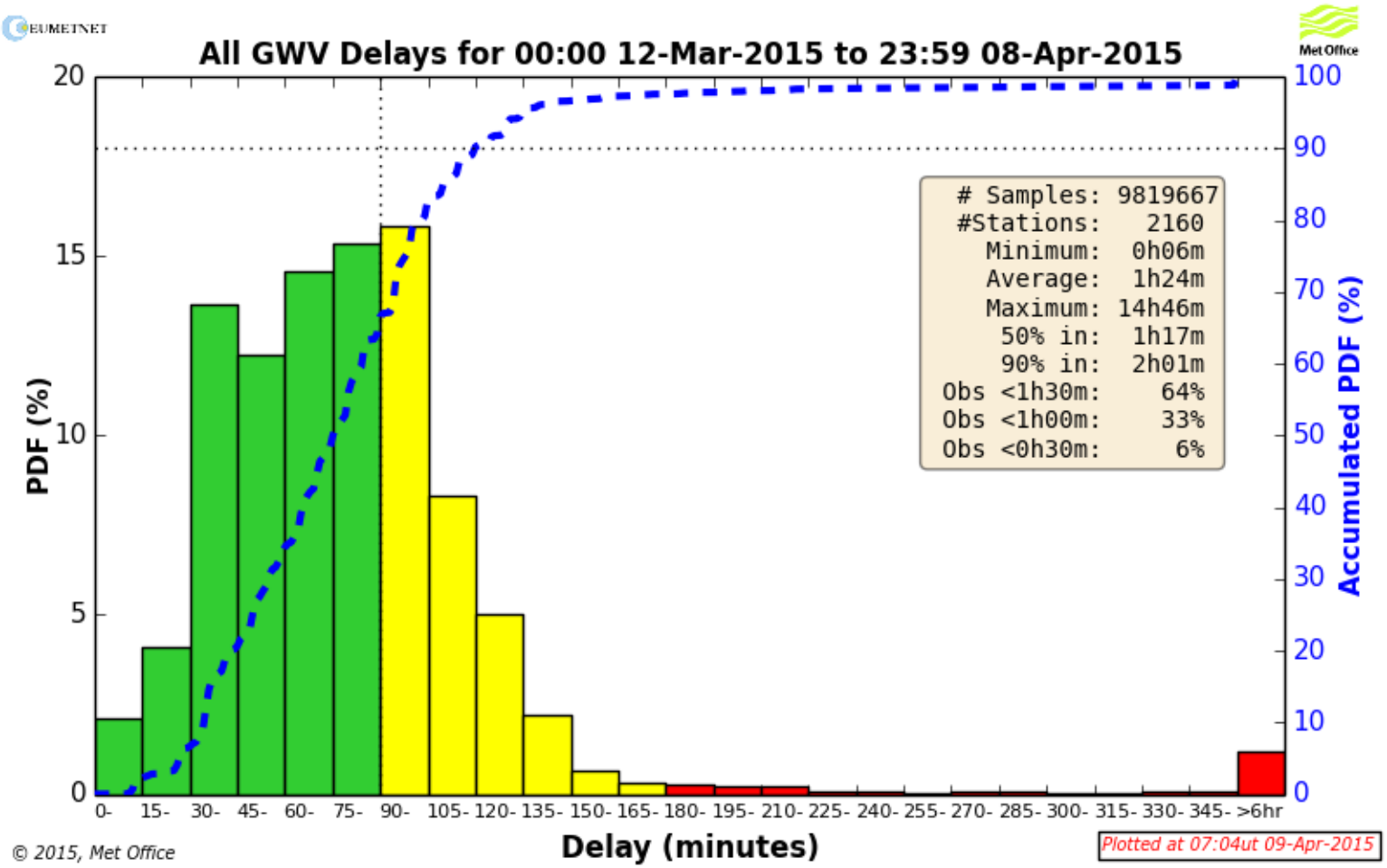


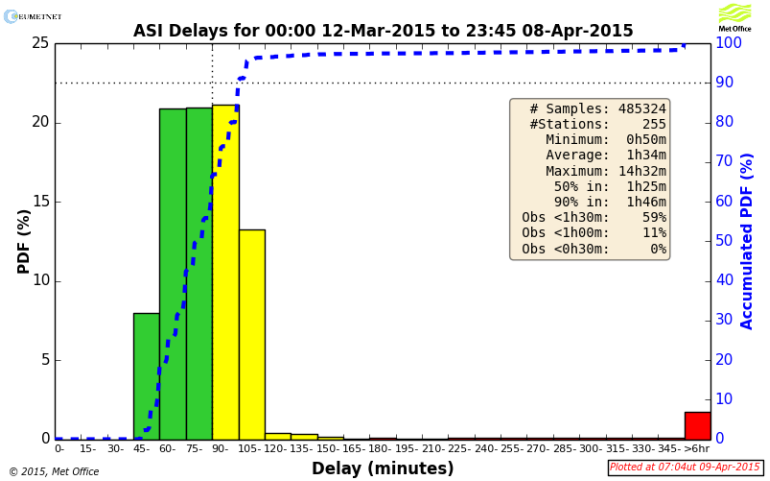


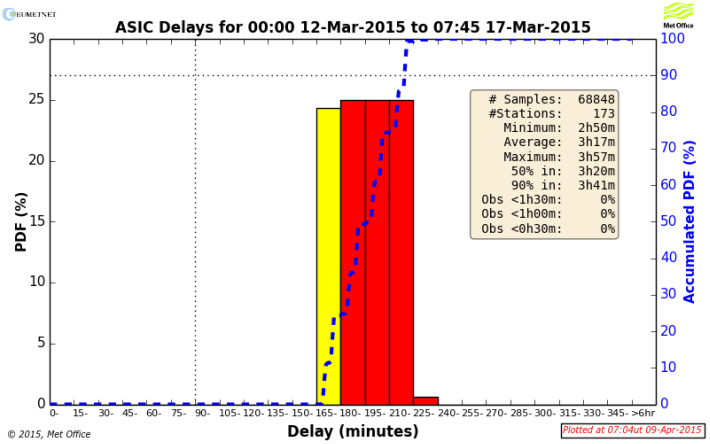
Number of unique GNSS sites versus time.


Met Office
EUMETNET
Total no. of Observations
Nobs (x1000)
20000
15000
10000
5000
0
2006
2008
2010
2012
2014
2016
Date
© 2015 Met Office
Plotted at 07:32ut 01-Sep-2015

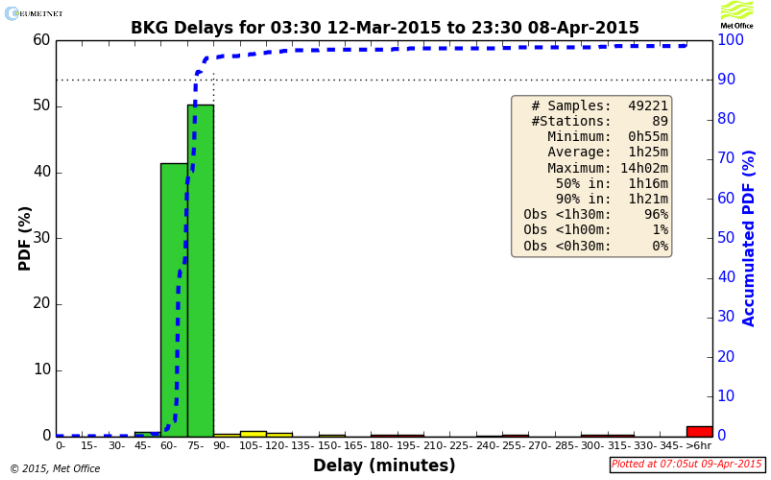


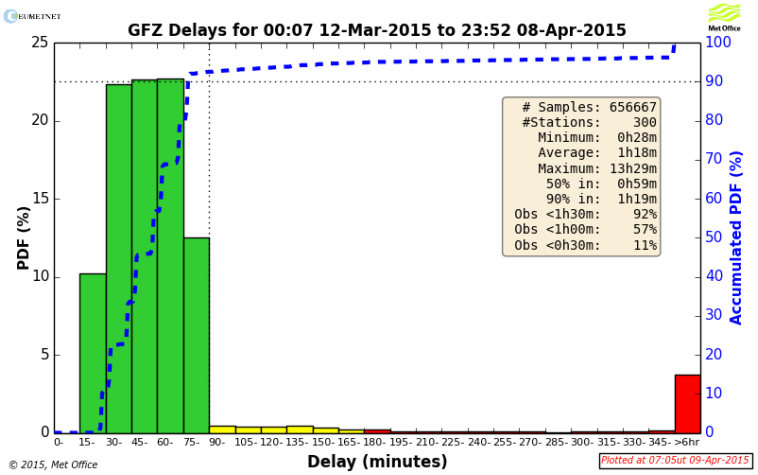
Timeliness: Age of observations when arriving in UKMO database,
counted in 15 min bins.





(ASIC is a ”combined” solution, made by combining the other, used for quality control)





Observations Programme
Status report

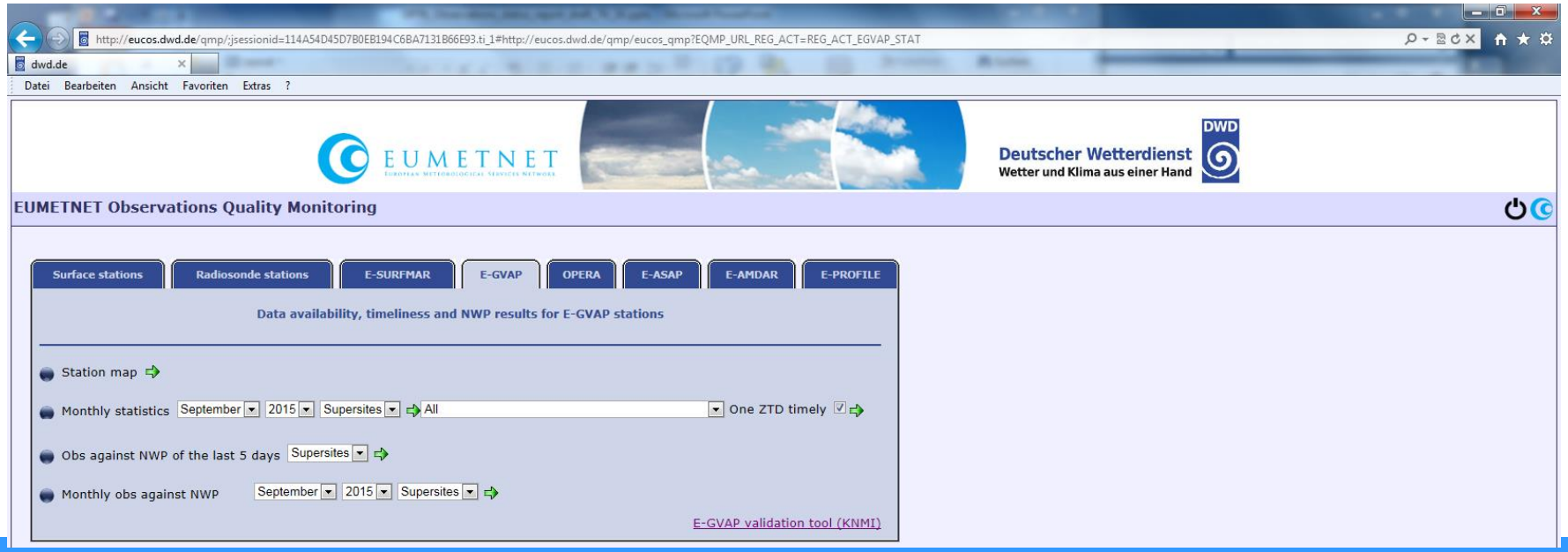
OPT6 Meeting, Agenda item 4.1
14th and 15th September 2015

OBS Programme Management Team:
Stefan Klink, Sabine Hafner, Tanja Kleinert

EUCOS QMP

Finalisation of development work on EUCOS QMP in 2015, almost finalised:

- Monitoring tools for BUFR data have been added
- Separating the networks to allow external users access
- The snap shot shows the front page as it is now



Access to QM portal

- Access to particular networks of the EUCOS QMP only (e.g. Geodetic institutes to E-GVAP) has been implemented
- When the new release of EUCOS QMP is available (in October) Obs PMT will circulate the E-GVAP user logins to E-GVAP OSM for further distribution

Contact Details

Stefan Klink
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GIE/EIG EUMETNET

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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.

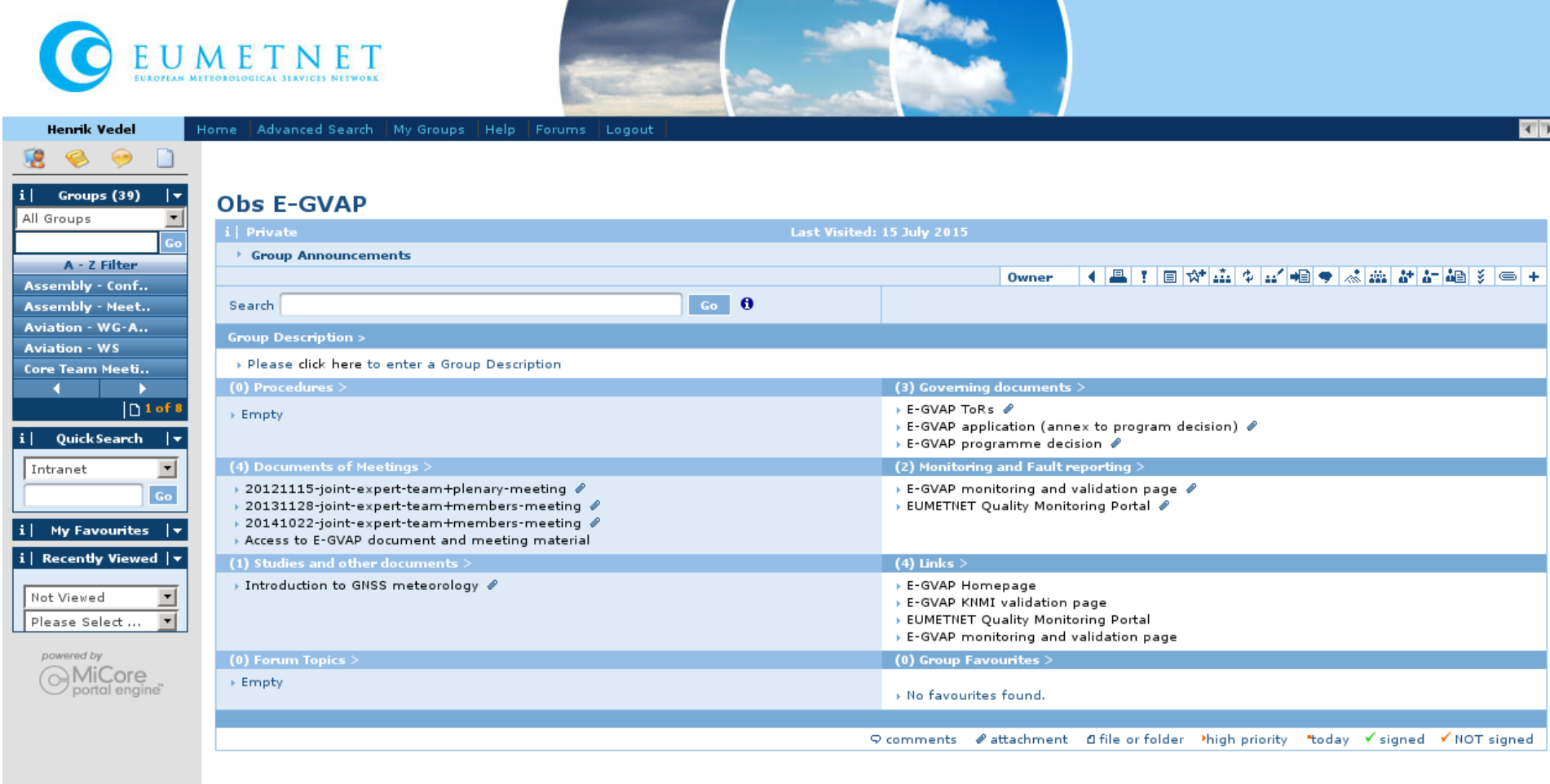
The EUMETNET QMP includes a ”one observation timely” monitoring. Timeliness is relative to arrival at DWD database.

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?!



EUMETNET portal

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.

Please use new naming scheme when making any changes to your AC uploads.

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.**
- **For AC´s uploading data to E-GVAP, we kindly ask them to check the list for eventual name clashes, and adjust accordingly.**

- **Planning to move Dave Offilers tool to an operational server.**

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

With the many new AC´s and paralllel test solutions being uploaded to in ”test” mode on the egvap-server, a simple scheme for deciding a solution is mature to be moved to the operational stream becomes necessary. How to do that?

Comparison against operational ZTDs from supersites sites and/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. But only after alerting users in proper time.

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, robustness, etc.)

On “alerting users about changes”

From Klaus Stefan, DWD:

- **Regarding "updates rules" a sufficient time for testing and adopting bias correction should be taken into account.**
- **We think that at least 2 month of parallel data would be necessary for this.**

- **Of course the new solution should be in the same level of quality or even better.**
- **This has to be proven by AC before providing the parallel data.**

- **A notification of such new data one month in advance, would be appreciated.**

- **At DMI the proper notification period should rather be two months.**

- **Changes of formats require longer notification, for users to implement and test the necessary software in their data assimilation system.**
- **The main problem is not the time the work and tests take, but that staff works on many other things as well, and cannot attend the problem on short notice.**

Notifications to E-GVAP people

E-GVAP has several maillists (see homepage). The most important are:

egvap_operational@dmi.dk Use this for distribution of information of importance to operational users of gb GNSS data.
egvap_users@dmi.dk A more general list. Use for distribution of information of broad interest to gb GNSS community.

egvap_processing_wg@dmi.dk Members of the E-GVAP expert team on data processing.
egvap_user_wg@dmi.dk Members of the E-GVAP expert team on data usage.

egvap_members@dmi.dk The responsible contact persons at each member institute. Often a chief or manager in observing department.

egvap_gts@dmi.dk Reaches institutes obtaining E-GVAP data via GTS

- **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.

- **E-GVAP expert teams and members meeting, October 22-23. 2014, UK Metoffice, Exeter**
- **EUMETNET PM meeting, December 2014**
- **Obs PM meeting, Offenbach, February 2015**
- **ESAT meeting, ECMWF, April 2015**
- **EGU, Vienna, April 2015**
- **Working meeting on formats, E-GVAP+IGS+EUREF, Vienna, April 2015**
- **GNSS4SWEC workshop and working group meetings, May 2015, Greece.**
- **EUREF annual symposium, Leipzig, June, 2015**
- **GNSS4SWEC working group meetings, Wroclaw, Poland, 28 Sept – 1 Oct.**
- **E-GVAP expert teams and members meeting, Wroclaw, Poland, October 1-2**

- **GNSS4SWEC summer school, 19-21/9 2016, Potsdam**
- **GNSS4SWEC working group and MC meeting, 22-23/9 2016 Potsdam**

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

Norman Terfele, UL01, University of Luxemburg, Luxemburg

Jaroslaw Bosy, WUEL, Poland

Jonathan Jones, Siebren de Haan, Henrik Vedel.

Responsible person: Jonathan Jones.

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>.**

Update User Requirements?

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

- **List of cut off times at NWP centres**

- **EUMETNET introducing ”Table of risks”**

EU INSPIRE directive

Implications for meteorology, geodesy, and E-GVAP?!

INSPIRE
Infrastructure for Spatial Information in Europe

D2.8.III.13-14 Data Specification on Atmospheric Conditions and Meteorological Geographical Features – Technical Guidelines

Title	D2.8.III.13-14 INSPIRE Data Specification on *Atmospheric Conditions and Meteorological Geographical Features* – Technical Guidelines
Creator	INSPIRE Thematic Working Group *Atmospheric Conditions and Meteorological Geographical Features*
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Subject	INSPIRE Data Specification for the spatial data theme *Atmospheric Conditions and Meteorological Geographical Features*

Interoperability of Spatial Data Sets and Services – General Executive Summary

The challenges regarding the lack of availability, quality, organisation, accessibility, and sharing of spatial information are common to a large number of policies and activities and are experienced across the various levels of public authority in Europe. In order to solve these problems it is necessary to take measures of coordination between the users and providers of spatial information. The Directive 2007/2/EC of the European Parliament and of the Council adopted on 14 March 2007 aims at establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) for environmental policies, or policies and activities that have an impact on the environment.

INSPIRE is based on the infrastructures for spatial information that are created and maintained by the Member States. To support the establishment of a European infrastructure, Implementing Rules addressing the following components of the infrastructure have been specified: metadata, interoperability of spatial data sets (as described in Annexes I, II, III of the Directive) and spatial data services, network services, data and service sharing, and monitoring and reporting procedures.

INSPIRE does not require collection of new data. However, after the period specified in the Directive[2] Member States have to make their data available according to the Implementing Rules.

Interoperability in INSPIRE means the possibility to combine spatial data and services from different sources across the European Community in a consistent way without involving specific efforts of humans or machines. It is important to note that "interoperability" is understood as providing access to spatial data sets through network services, typically via Internet. Interoperability may be achieved by either changing (harmonising) and storing existing data sets or transforming them via services for publication in the INSPIRE infrastructure. It is expected that users will spend less time and efforts on understanding and integrating data when they build their applications based on data delivered in accordance with INSPIRE.

2.2.1 Definition of the mandatory and recommended data sets

Recommendation 1	The data made available should include, but not be limited to, the following parameters, spatial coverage and resolution, temporal coverage and resolution.

List of mandatory parameters

- wind speed and direction
- temperature
- relative humidity
- evaporation amount
- precipitation amount

Spatial coverage and resolution

- Data observed at the Regional Basic Synoptic Network (RBSN), which is a WMO-managed observing network aiming at assisting in defining the state of the atmosphere at least on a scale of the order of 200 km in the horizontal and six to 12 hours in time (ref. WMO Resolution 40, Cg XII).

Temporal coverage and resolution

- Past and present data as available
- Wind, temperature and humidity: 6-hourly data
- Evaporation and precipitation: daily data, 24-hour accumulated

List of recommended parameters

Meteorological data

- wind speed and direction
- wind gust speed
- temperature
- relative humidity
- evaporation amount
- precipitation amount
- precipitation rate
- precipitation type
- total snow depth
- pressure reduced to mean sea level
- total cloud cover
- visibility
- global solar radiation
- long-wave radiation
- short-wave radiation

OUTLOOK

Main themes,

- **Continuation of E-GVAP data processing and distribution**
- **Reports from E-GVAP expert teams and the E-GVAP team**
- **Midterm review**

In addition

- **Scheme for when to move uploaded ZTD data from “test” to “operational”**
- **Monthly statistics for quality monitoring**
- **Active quality control, AQC.**
- **More GNSS sites.**
- **More sub-hourly uploads.**
- **Clarification of eventual INSPIRE implications.**

- SINEX Tropo

Next meeting?

Any other matter?

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