

# EIG EUMETNET GNSS Water Vapour Programme E-GVAP

## E-GVAP Status and outlook

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# What is E-GVAP?

- EIG EUMETNET GNSS Water Vapour Programme.
- EUMETNET = organisation of European national meteorological offices. Not all are members, EUMETNET is gradually enlarging.
- E-GVAP is a separate observing programme under EUMETNET.
- Not all EUMETNET members are members of E-GVAP (currently 16).

## Purpose of E-GVAP

- To provide ground based GNSS delay and integrated water vapour data (ZTDs and IWVs) in **near real-time** (NRT), for use in **operational** numerical weather prediction (NWP) models and in now-casting to the participating EUMETNET members.
- To improve on the NRT GNSS ZTD data quality and enlarge data coverage
- To assist users in utilising the data for weather forecasting.

# Method

**Collaboration with geodesy.**

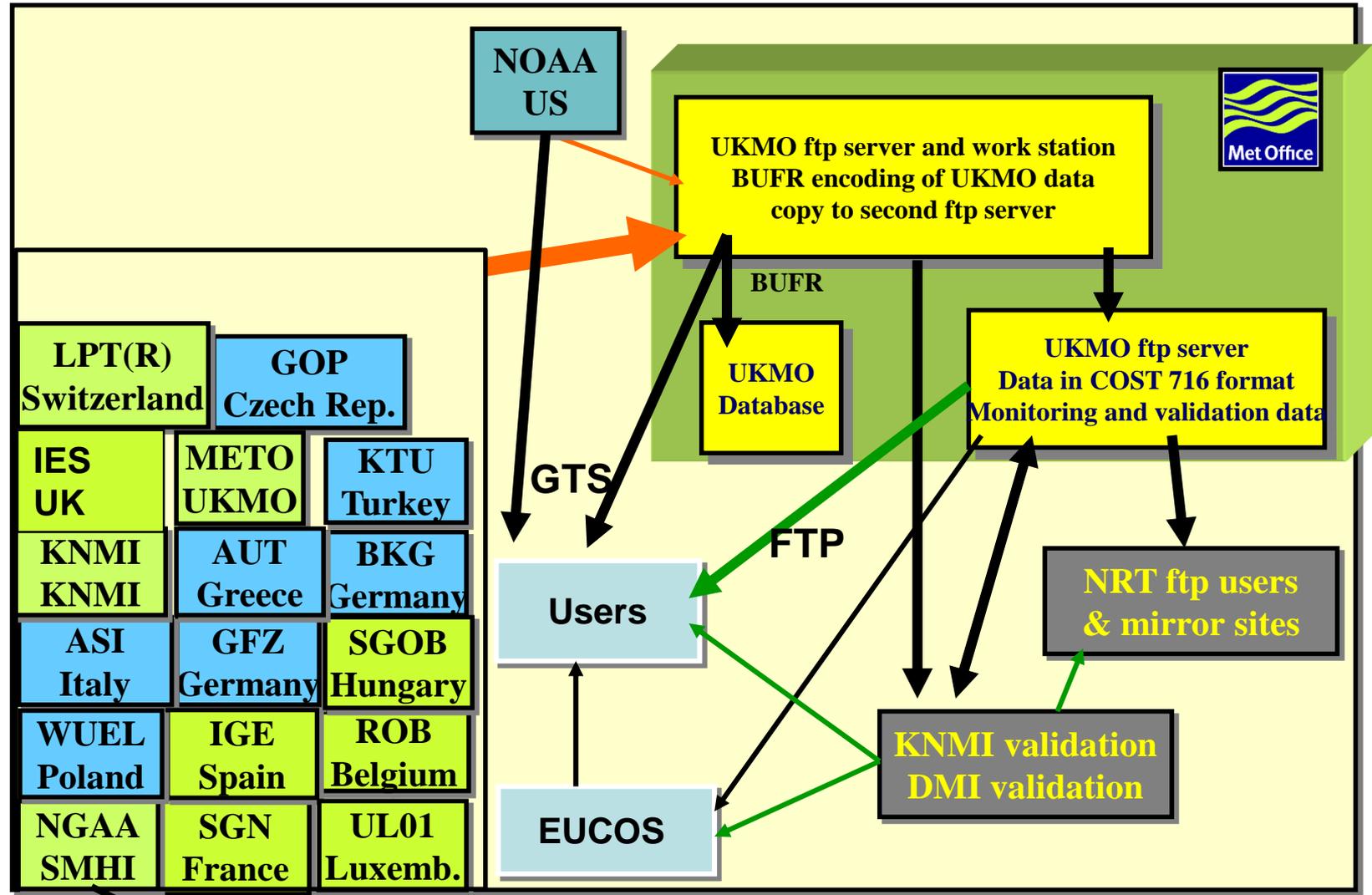
**It is "geodesy" at large, that owns the GNSS receivers and has the expertise to process the GNSS data.**

**MoUs, stating the dedication to collaborate, are in place between EUMETNET and both EUREF and EUPOS.**

**The majority of the E-GVAP analysis centers (ACs), making ZTD estimates for E-GVAP, are geodetic institutions. A few ACs are located at metoffices, set up with help from geodetic experts.**

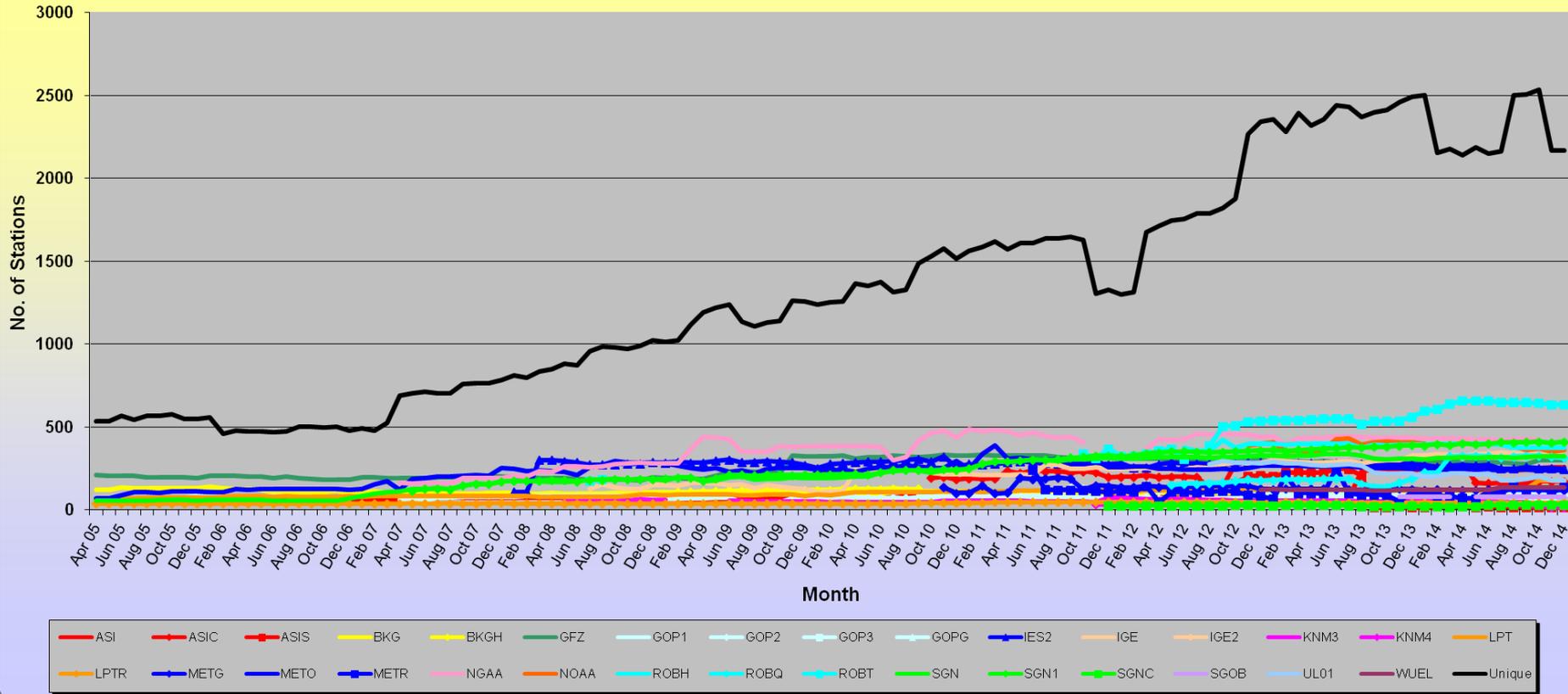
| AC   | Institution  |     |
|------|--|-----|
| ASI  | e-geos/Telespazio, Italy   |     |
| AUT  | Aristotle University of Thessaloniki, Greece                     | NEW |
| BKG  | Federal Agency for Cartography and geodesy, Germany              |     |
| GFZ  | Helmholz Centre Potsdam, GFZ German 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 | Norrköping 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 |     |

## NRT GNSS ZTD data flow



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

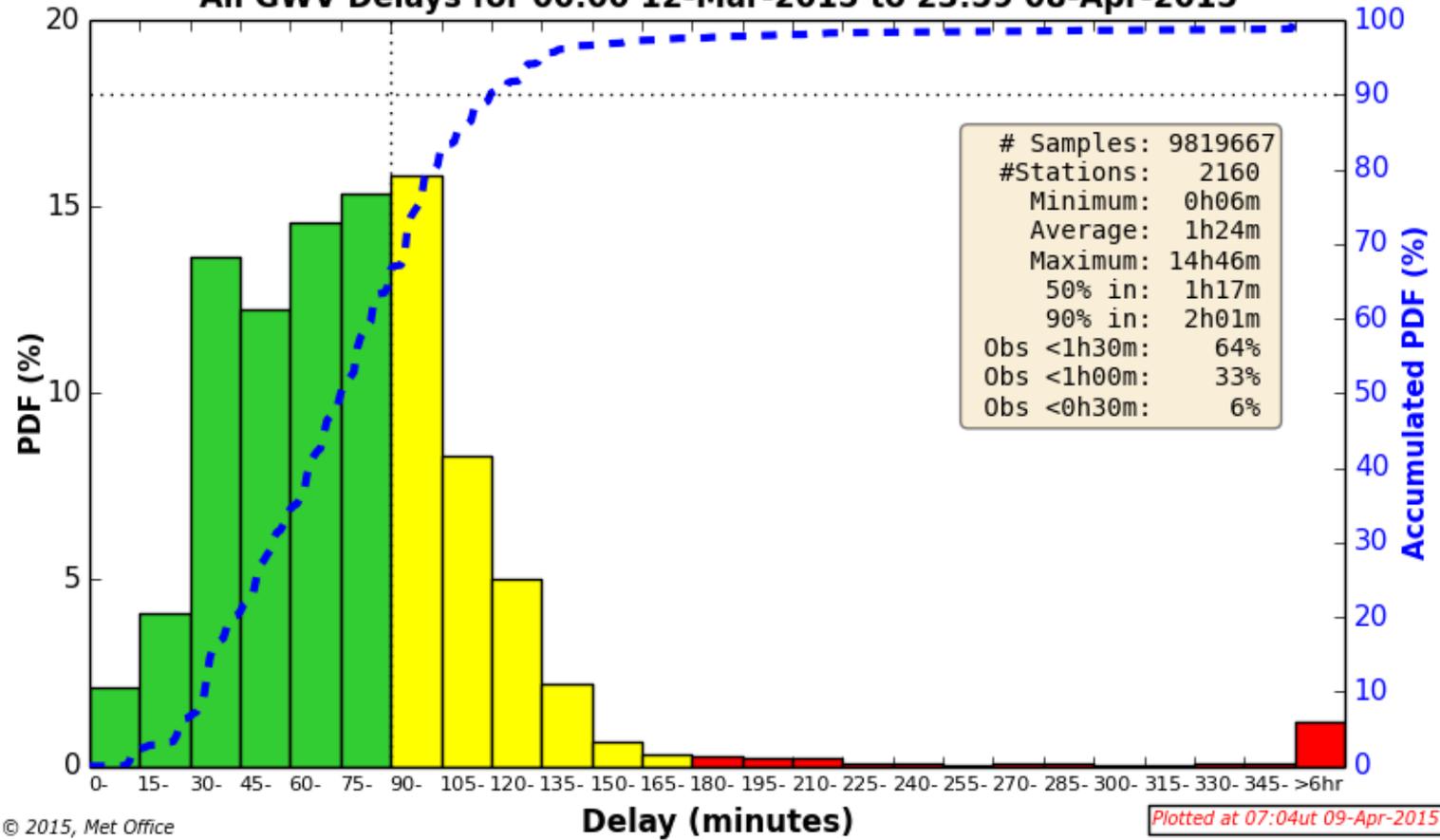
## Number of NRT Stations



## Number of GNSS sites in E-GVAP data distribution versus time.

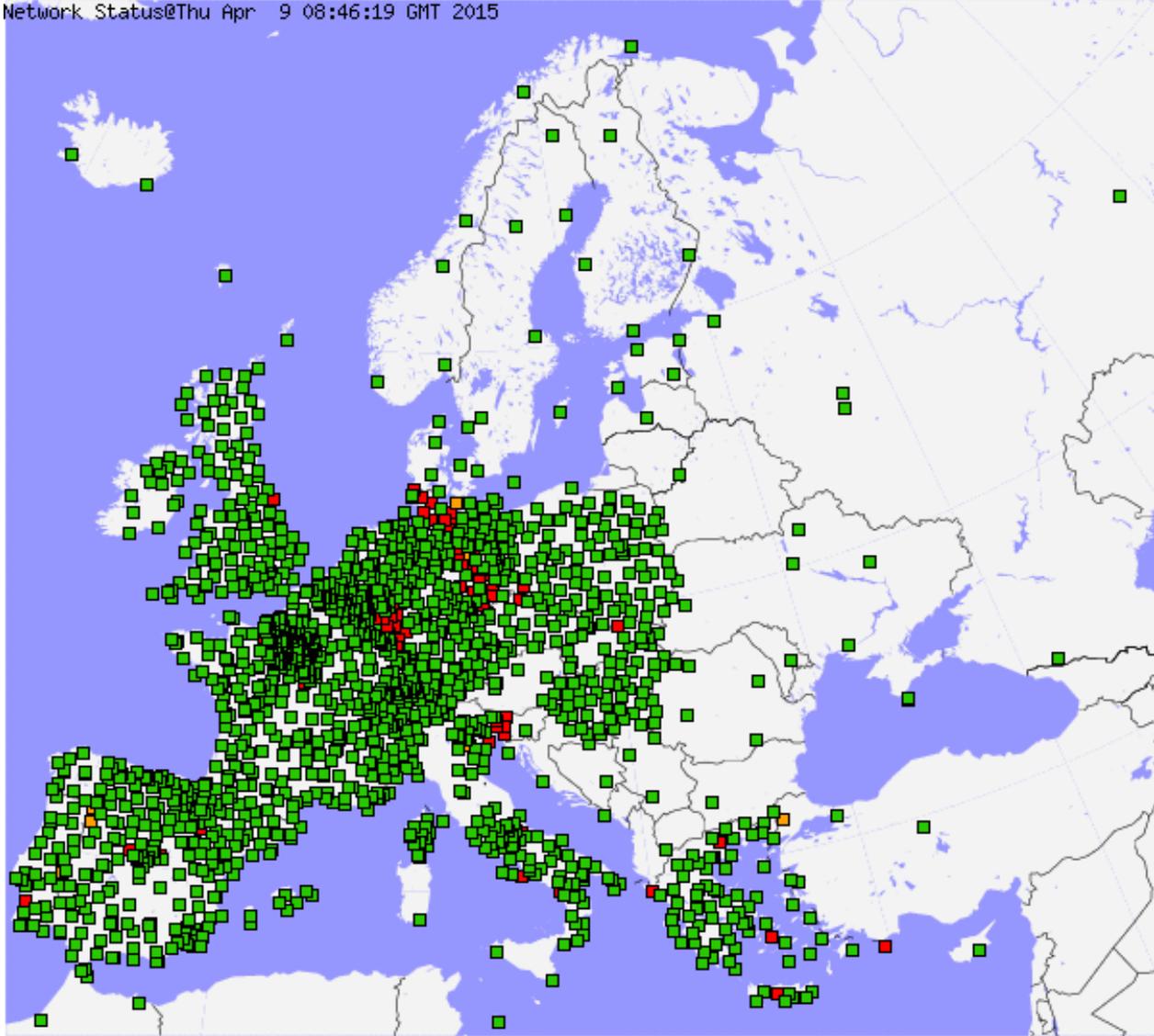
The drop mid 2014 was due to lack of NOAA (North American) data. The drop starting end of 2014 is due to lack of NGAA (Nordic) data. NGAA processing is being restructured to improve ZTD quality.

**All GWV Delays for 00:00 12-Mar-2015 to 23:59 08-Apr-2015**



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

Network Status@Thu Apr 9 08:46:19 GMT 2015

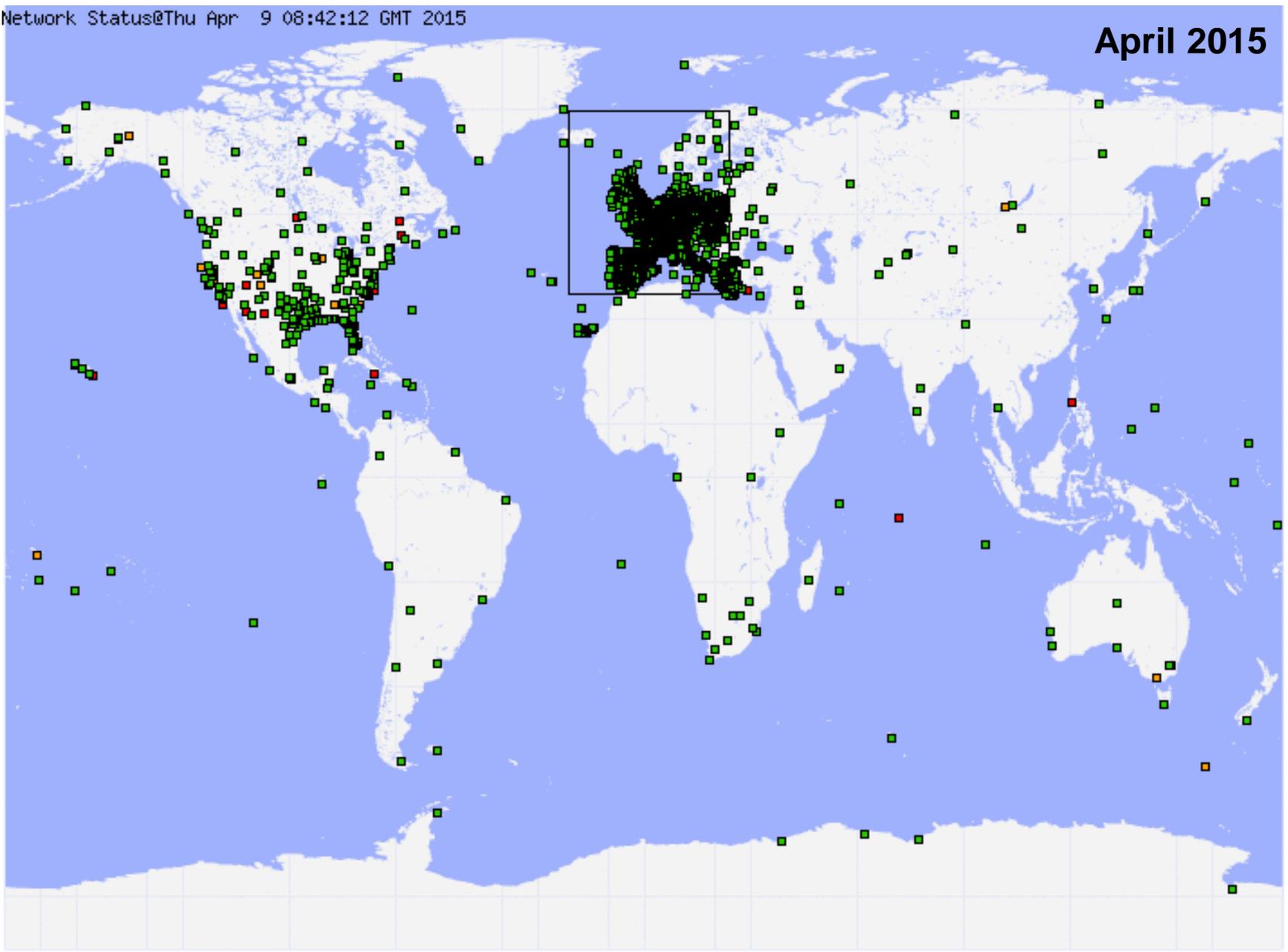


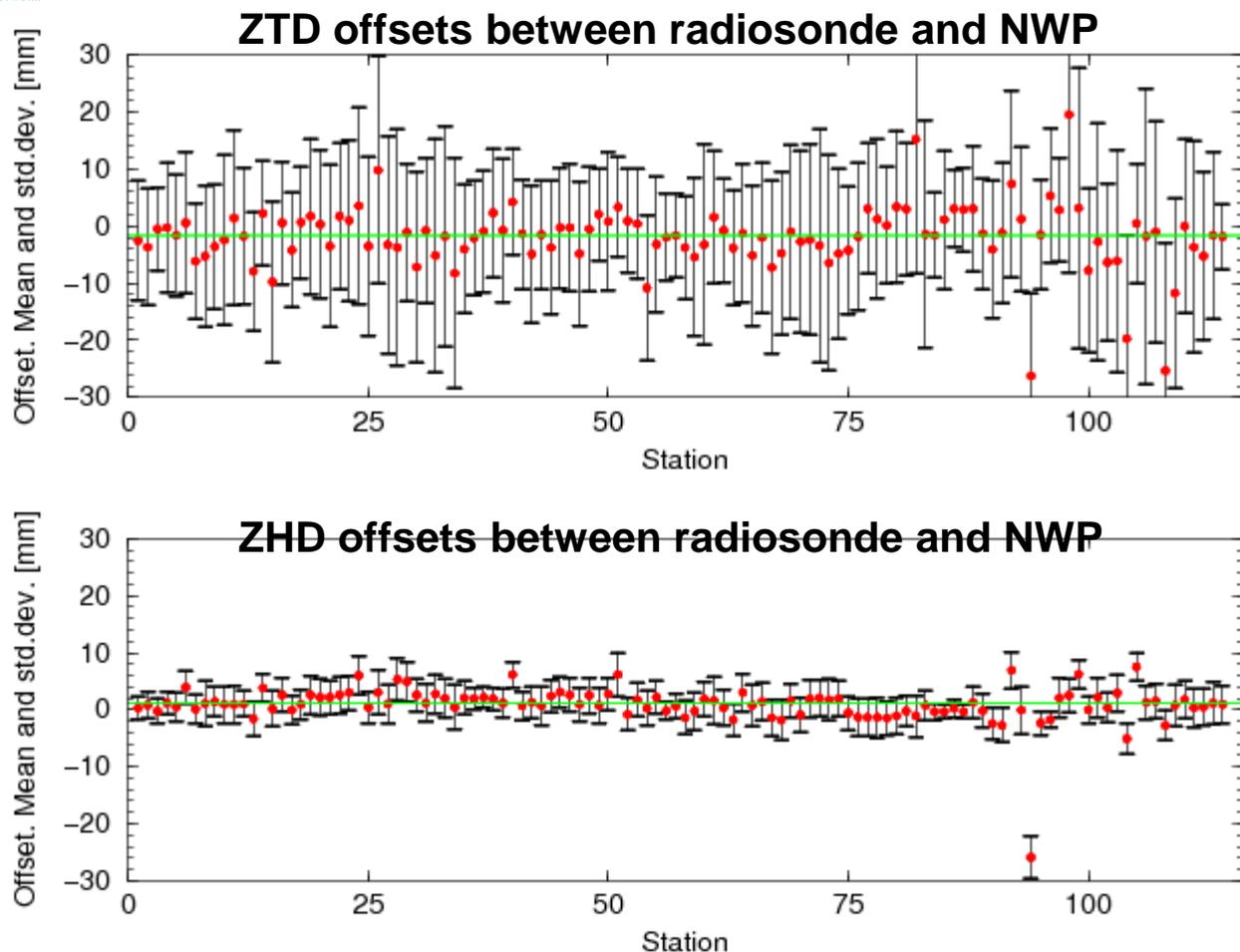
# Coverage

## April 2015

Network Status@Thu Apr 9 08:42:12 GMT 2015

## April 2015

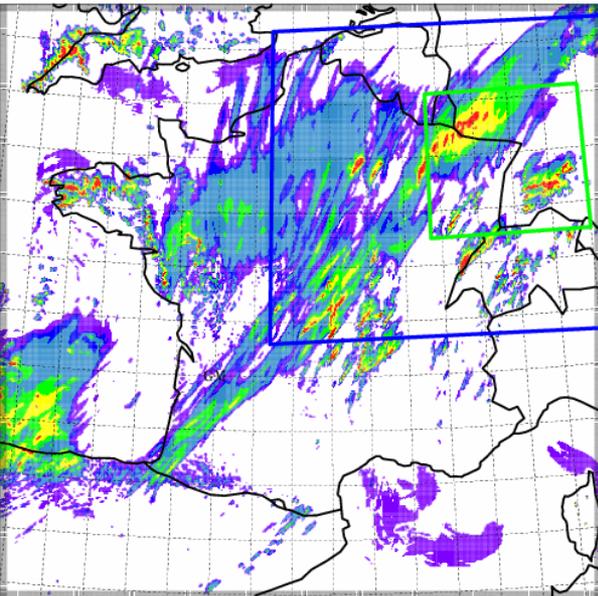




- Because NWP is better in estimating ZHD than ZTD, the ZTD provides in reality mainly information about water vapour, when assimilating ZTD into NWP.
- Use NWP surface pressure (proportional to ZHD) in GNSS data processing instead of climatology?

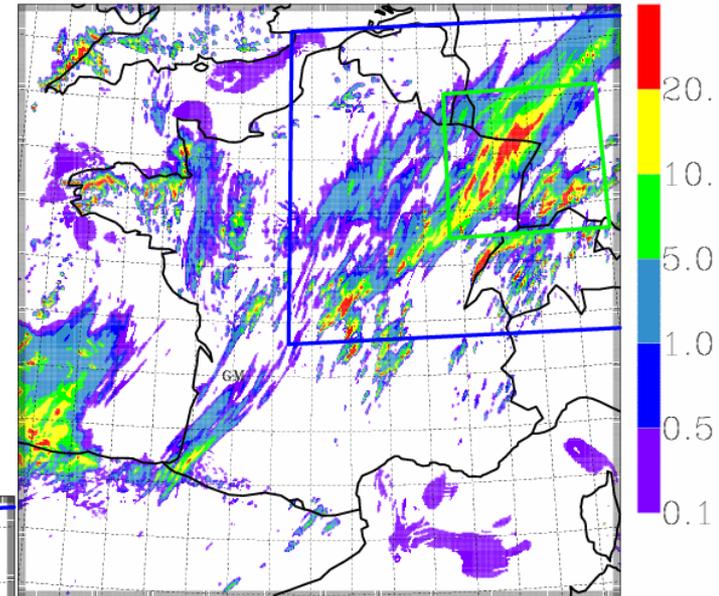
# Impact on AROME forecast (OSE experiment)

AROME, 15h forecast starting from the 00UTC analysis, 19 July 2008

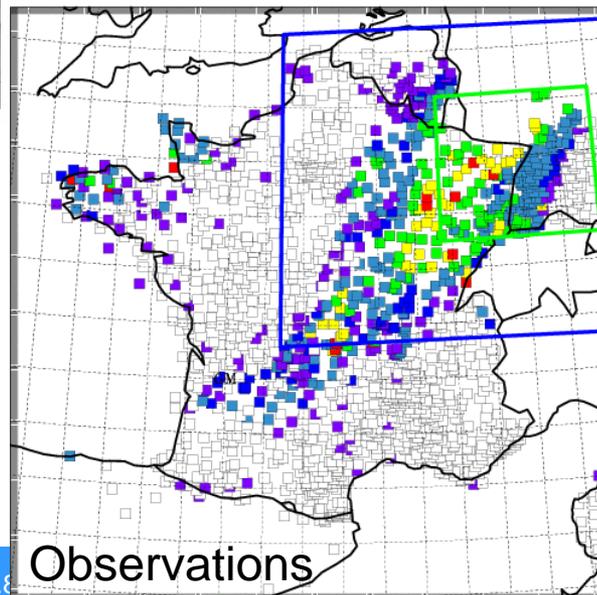


**WITHOUT ZTD** data assimilation

Cumulated rainfall  
between 03UTC and  
15UTC, 19 July 2008



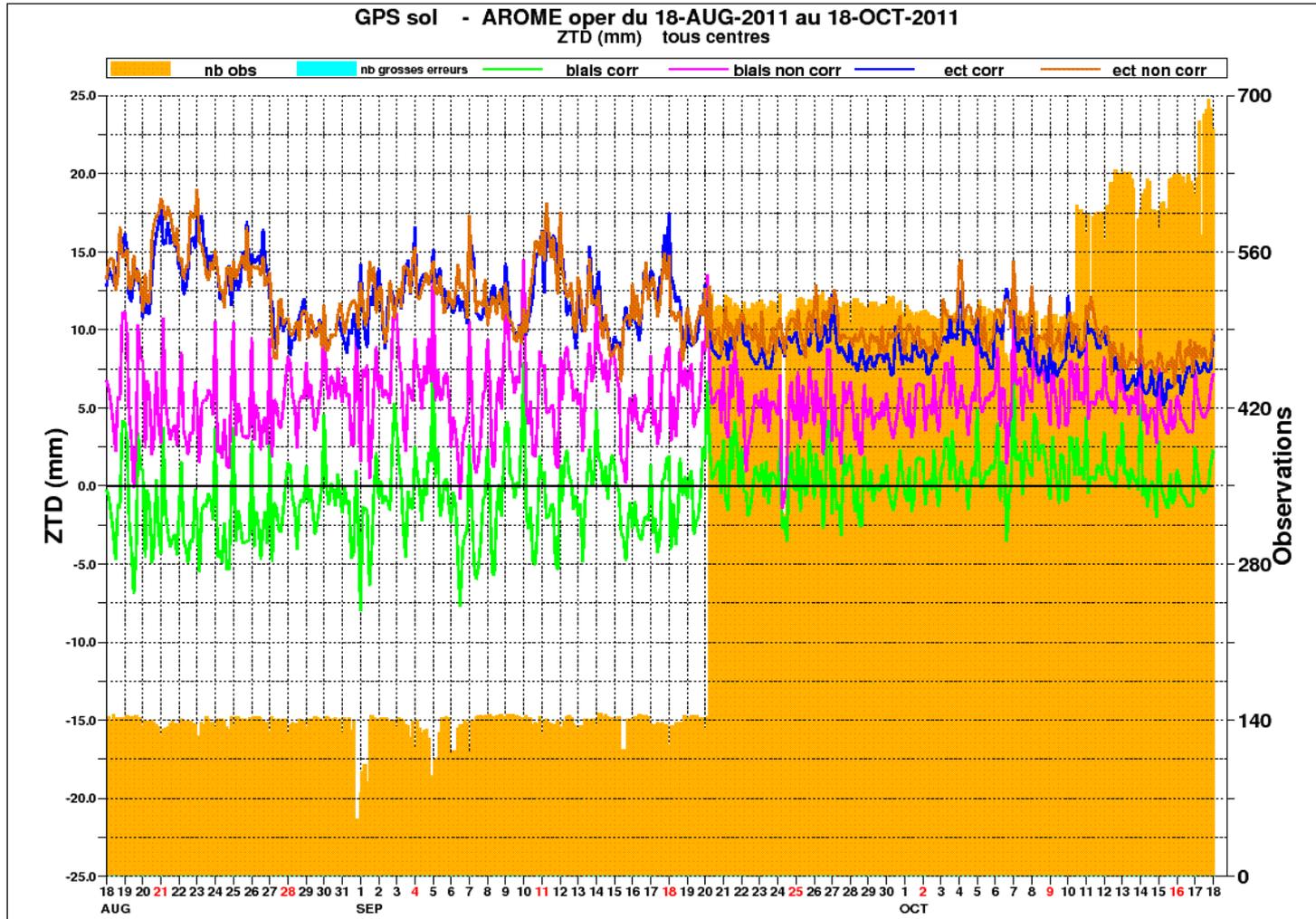
**WITH ZTD** data assimilation



Observations

Slide from Patrick Moll  
Meteo France

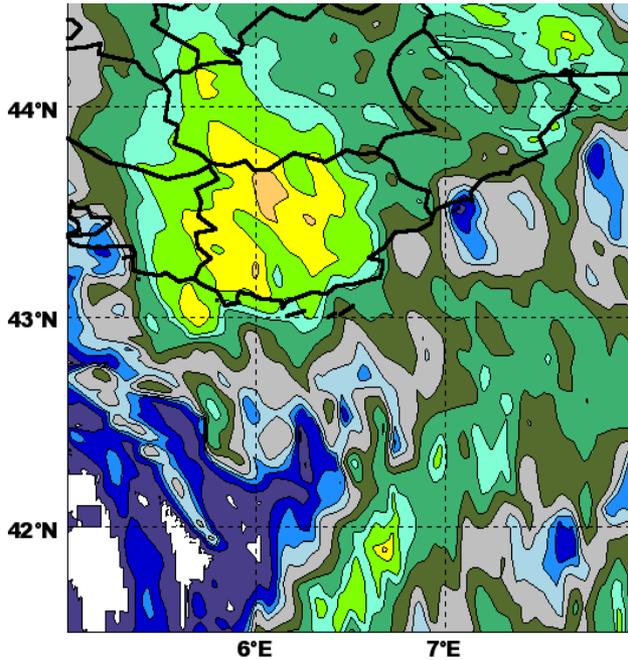
# Monitoring example (time-series)



DPREVI/COMPAS

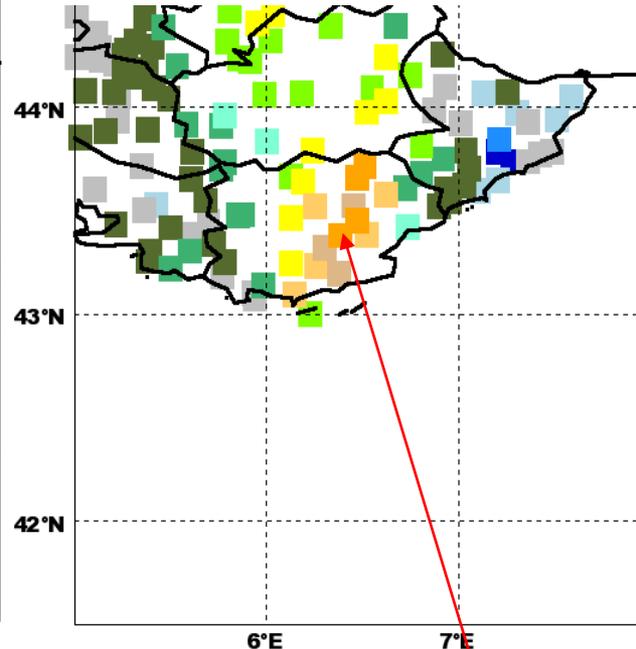
15/06/2010 – 09UTC

AROME\_WMED (D031)



Old white list

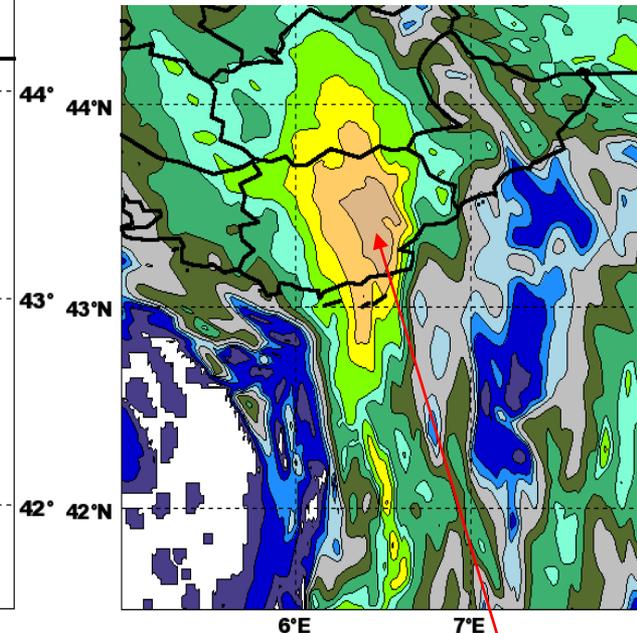
OBS (6h Accumul.)



Rain gauges obs

195mm/6hr

AROME\_WMED (D03Q)



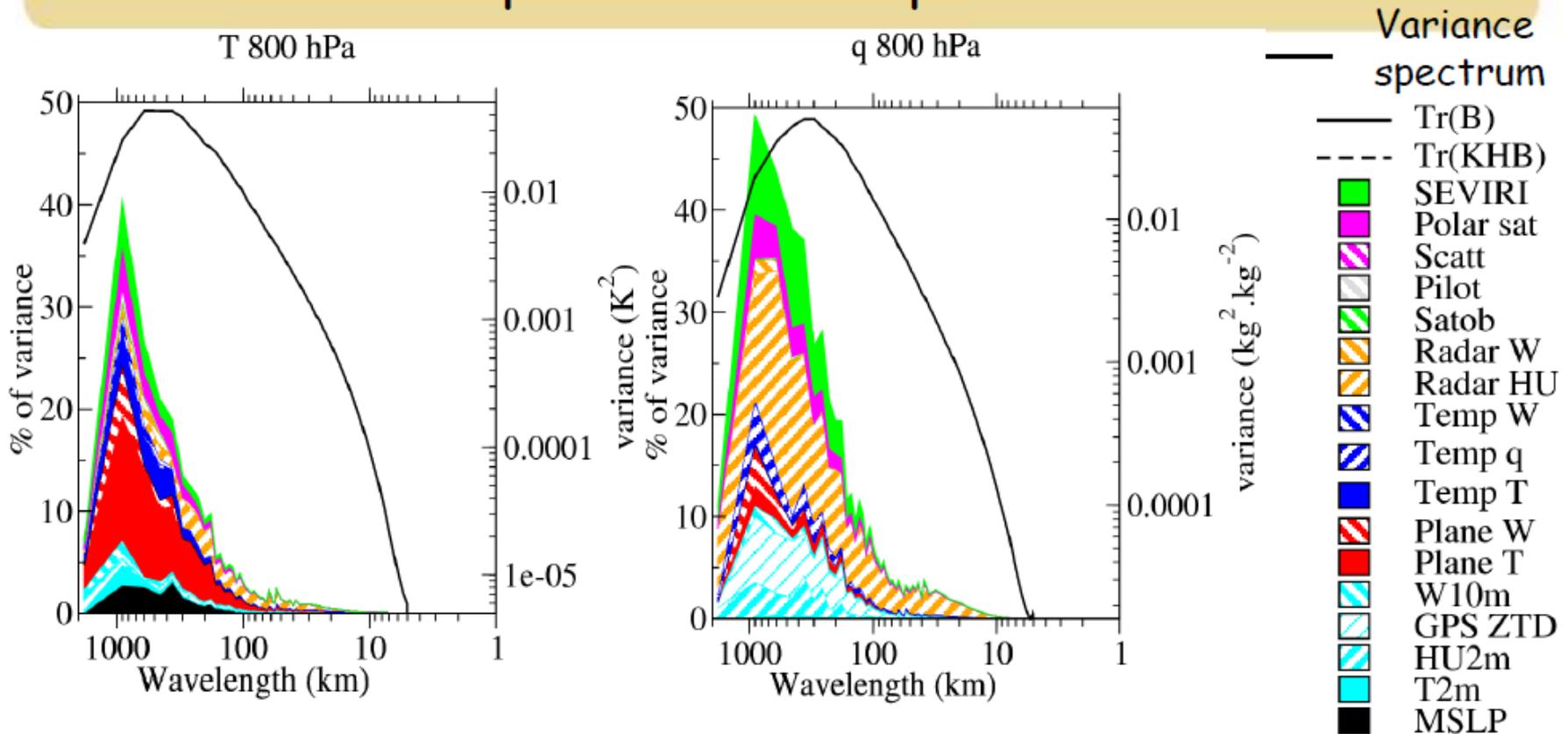
New white list

130mm/6hr

**Conclusion:**

**More GNSS data (denser network) improves the Arome forecasts**

# Spectral decomposition



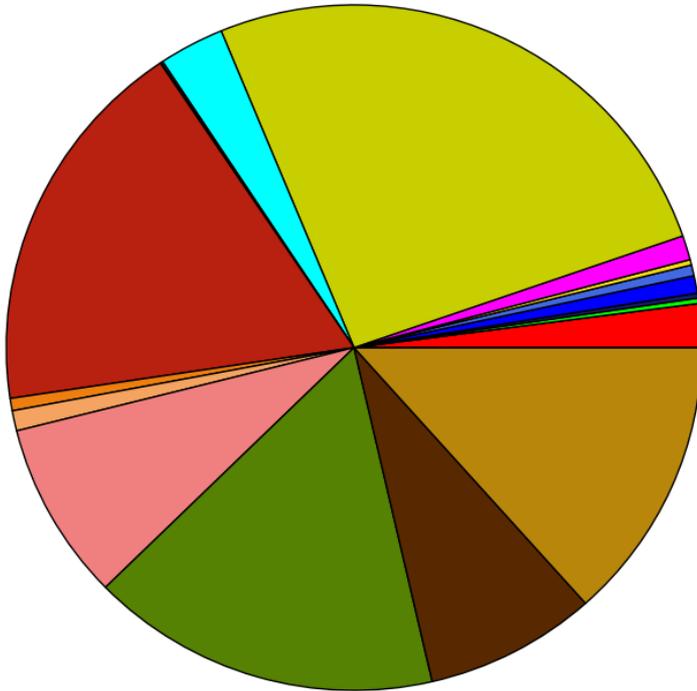
- Higher reduction of variance error for wavelengths corresponding to the higher values of variance spectra
- For wavelengths shorter than :
  - 200 km, only radar and plane measurements for temperature ( GPS for specific humidity) contribute to the variance reduction
  - 100 km, the variance reduction reach only 5% of the error variance and it is only provided by radar observations

Slide from Pierre Brousseau, Météo France

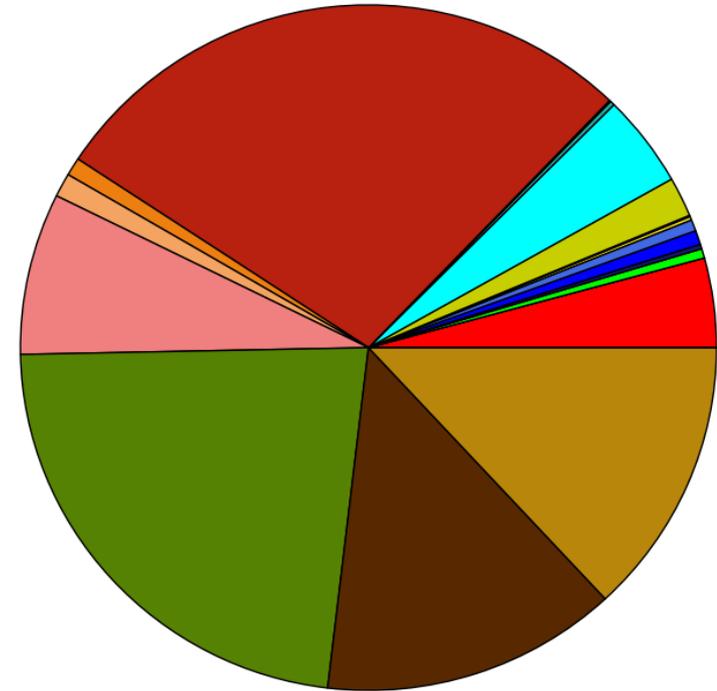
# Arome DFS (rainy days)

Proportions des nombres d'observations utilisées par type d'obs  
 analyses cut-off AROME - AROME France oper  
 observations conventionnelles et satellites  
 cumul du nombre d'observations utilisées sur la période 2012101100 - 2012101121 : 281

Part des DFS par type d'obs  
 analyses cut-off AROME - AROME France oper  
 observations conventionnelles et satellites  
 cumul du DFS sur la période 2012101100 - 2012101121 : 100548



|              |       |                    |        |           |        |
|--------------|-------|--------------------|--------|-----------|--------|
| GPS ground   | 2.06% | AIRS               | 1.15%  | PILOT/PRF | 0.95%  |
| GPS sat      | 0.00% | IASI               | 25.96% | TEMP      | 8.42%  |
| SATOB        | 0.25% | SEVIRI             | 3.04%  | AIRCRAFTS | 16.28% |
| ATOVS HIRS   | 0.23% | SCATT              | 0.09%  | RADAR Vr  | 7.99%  |
| ATOVS AMSU-A | 0.82% | BUOY               | 0.04%  | RADAR Hur | 13.40% |
| ATOVS AMSU-B | 0.51% | SYNOP/SYNOR/RADOME | 17.96% | BOGUS     | 0.00%  |
| SSMIS        | 0.26% | SHIP               | 0.58%  |           |        |



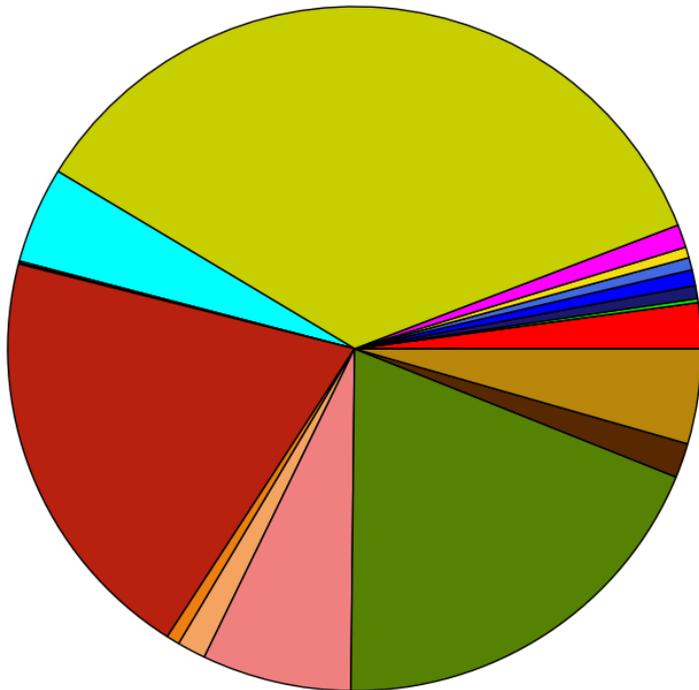
|              |       |                    |        |           |        |
|--------------|-------|--------------------|--------|-----------|--------|
| GPS ground   | 4.21% | AIRS               | 0.06%  | PILOT/PRF | 1.12%  |
| GPS sat      | 0.00% | IASI               | 1.87%  | TEMP      | 7.62%  |
| SATOB        | 0.44% | SEVIRI             | 4.36%  | AIRCRAFTS | 22.81% |
| ATOVS HIRS   | 0.22% | SCATT              | 0.21%  | RADAR Vr  | 13.78% |
| ATOVS AMSU-A | 0.67% | BUOY               | 0.07%  | RADAR Hur | 13.09% |
| ATOVS AMSU-B | 0.54% | SYNOP/SYNOR/RADOME | 27.90% | BOGUS     | 0.00%  |
| SSMIS        | 0.17% | SHIP               | 0.85%  |           |        |

**From Patrick Moll, Meteo France**

# Arome DFS (dry days)

Proportions des nombres d'observations utilisées par type d'obs  
 analyses cut-off AROME - AROME France oper  
 observations conventionnelles et satellites

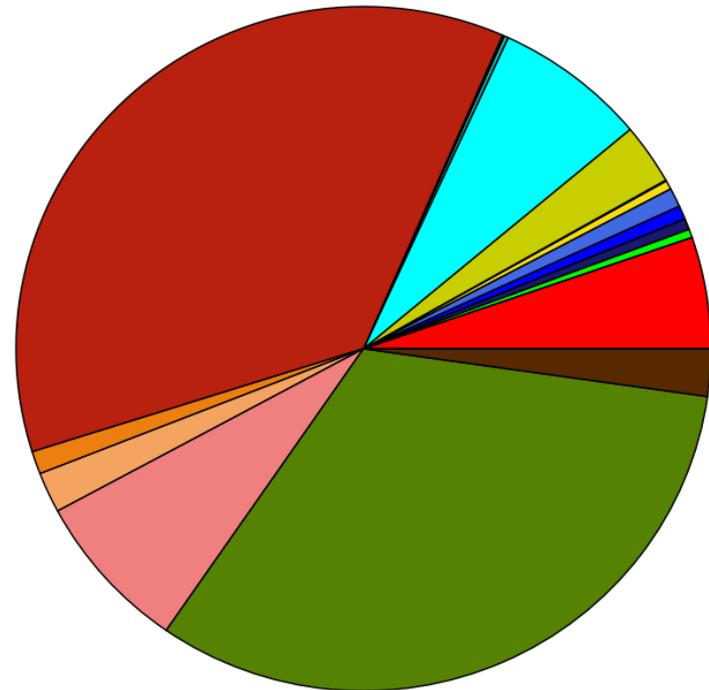
cumul du nombre d'observations utilisées sur la période 2012100500 - 2012100521 : 25



|              |       |                    |        |           |        |
|--------------|-------|--------------------|--------|-----------|--------|
| GPS ground   | 2.16% | AIRS               | 1.08%  | PILOT/PRF | 1.33%  |
| GPS sat      | 0.00% | IASI               | 35.44% | TEMP      | 6.96%  |
| SATOB        | 0.19% | SEVIRI             | 4.55%  | AIRCRAFTS | 19.05% |
| ATOVS HIRS   | 0.62% | SCATT              | 0.09%  | RADAR Vr  | 1.63%  |
| ATOVS AMSU-A | 0.75% | BUOY               | 0.05%  | RADAR Hur | 4.49%  |
| ATOVS AMSU-B | 0.58% | SYNOP/SYNOR/RADOME | 19.91% | BOGUS     | 0.00%  |
| SSMIS        | 0.51% | SHIP               | 0.62%  |           |        |

Part des DFS par type d'obs  
 analyses cut-off AROME - AROME France oper  
 observations conventionnelles et satellites

cumul du DFS sur la période 2012100500 - 2012100521 : 76214



|              |       |                    |        |           |        |
|--------------|-------|--------------------|--------|-----------|--------|
| GPS ground   | 5.28% | AIRS               | 0.05%  | PILOT/PRF | 1.92%  |
| GPS sat      | 0.00% | IASI               | 7.53%  | TEMP      | 7.53%  |
| SATOB        | 0.40% | SEVIRI             | 2.87%  | AIRCRAFTS | 32.37% |
| ATOVS HIRS   | 0.52% | SCATT              | 0.20%  | RADAR Vr  | 2.23%  |
| ATOVS AMSU-A | 0.65% | BUOY               | 0.08%  | RADAR Hur | 0.00%  |
| ATOVS AMSU-B | 0.90% | SYNOP/SYNOR/RADOME | 36.42% | BOGUS     | 0.00%  |
| SSMIS        | 0.42% | SHIP               | 1.08%  |           |        |

**From Patrick Moll, Meteo France**

**The GNSS ZTDs estimated and distributed under the MoUs between EUREF+EUPOS and EUMETNET are used in operational meteorology, and do improve weather forecasting.**

**To further improve the impact, the plan is to**

- Continue to enlarge and densify the network (more sites)**
- Gradually move toward faster, subhourly processing where possible (of importance to forecasting of heavy local convective precipitation, which can occur rapidly and has short predictability).**
- Streamlining of E-GVAP monitoring and validation, to ease handling of many ACs and different products (hourly, sub-hourly, real-time).**
- Collaborate with EU Cost action GNSS4SWEC to stimulate production and usage of "next generation" GNSS data (ZTD gradients, slant total delays), as well as of meteorological data for usage in GNSS real-time position estimation.**
- An attempt has been made to cut this presentation to 10 min, and hand over the remaining 5 min to the next presentation on GNSS4SWEC**



**Fin**

# Contact Details

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