

E-GVAP

The EUMETNET GPS Water Vapour Programme

5th plenary meeting
Météo France, Toulouse

Agenda, E-GVAP 5'th plenary meeting

9:30 Start of meeting

3. Welcome, practicalities
4. Information about E-GVAP work and programme from the E-GVAP team.
5. Information about the GPS meteorological status in each member country by each member representative.
6. Discussion of the results for E-GVAP of the PB-OBS user questionnaire about EUMETNET programmes.
7. Discussion of status and plans for next period
8. Discussion of the future of E-GVAP (beyond next period)
9. Next meeting(s)
10. Other matters

16:00 End of meeting.

Highlights

- A memorandum of understanding has been made between EUREF and E-GVAP/EUMETNET
- Météo-France and DHMZ have become new members 2007.
- A significant increase in the number of included observing sites, in particular in the Nordic countries, France and Ireland.
- E-GVAP observations are now used operationally at 2 European met centres, giving a positive impact on NWP forecast scores.
- Introduction of "supersites" and upgrade in monitoring.
- Upgrade in IWV films for now-casting.

Timeline and members

E-GVAP started 2005-04-01, runs for 4 years, from April 2005 to March 2009.

Age is now 2 years and 9 ½ months.

Initially 11 members, since this period 13 members.

Belgium, Croatia, Denmark, Iceland, Ireland, Finland, France, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom

E-GVAP economy

The yearly budget (so far unchanged from year to year)

•Project manager 0.5 year per year	43.0 k€	DMI
•Contract to support hub/central processing	25.5 k€	UK Metoffice
•Contract to quality control facility	25.5 k€	KNMI
•Project Travel	10.0 k€	
•Liaison group meetings	15.0 k€	
•Expert Team meetings	10.0 k€	
•Total	129.0 k€	

Travelmoney not all spent. About 27 k-euro has been paid out, about 5 k-euro are being processed, and an estimated 20 k-euro can be claimed for travels already made, but which have not been invoiced to E-GVAP for whatever reason, leaving about 53 k-euro.

Propose to keep the travel savings for payment of similar post during remainder periods. Question: Consider to use some of the money for the workshop (requires a yes from above, PB-OBS) and/or to assist "poor" processing centres workin on best effort basis, by buying equipment (pc's) for them?

Propose to keep budget unchanged for next period.

Budget breakdown, 2007-2008 and 2008-2009 terms. Amounts in euro.

Country	Entry fee	Ann fee	Total 2007	Ann fee 2008
Belgium	0	4643	4643	5903
Croatia	376	374	750	476
Denmark	0	3130	3130	3980
Finland	0	2426	2426	3084
France	27153	27014	54167	34341
Iceland	0	151	151	192
Ireland	0	1842	1842	2342
Netherlands	0	7609	7609	9673
Norway	0	3403	3403	4325
Spain	0	12529	12529	15927
Sweden	0	4450	4450	5657
Switzerland	0	5259	5259	6686
UK	0	28644	28644	36414
Total	27529	101474	129003	129000

EGVAP project team

- **Management.**

Danish Meteorological Institute (DMI), Henrik Vedel.

Email: hev@dm.dk

- **Data processing and database.**

UK Met Office (MetO), Jonathan Jones, John Nash, and Dave Offiler.

Email: jonathan.jones@metoffice.gov.uk

- **Validation.**

Royal Netherlands Meteorological Institute (KNMI), Siebren de Haan.

Email: siebren.de.haan@knmi.nl

- **Daily team:**

Henrik, Jonathan, and Siebren.

Email: egvap@dm.dk (goes to all three)

E-GVAP primary contact and information points

- Email address: egvap@dmi.dk
- Web address: <http://egvap.dmi.dk>
- Uid and pw at website: egvap, gps2user. Site links to validation site and datasever.
- Access to database is institute specific password protected. Contact Jonathan Jones for access.

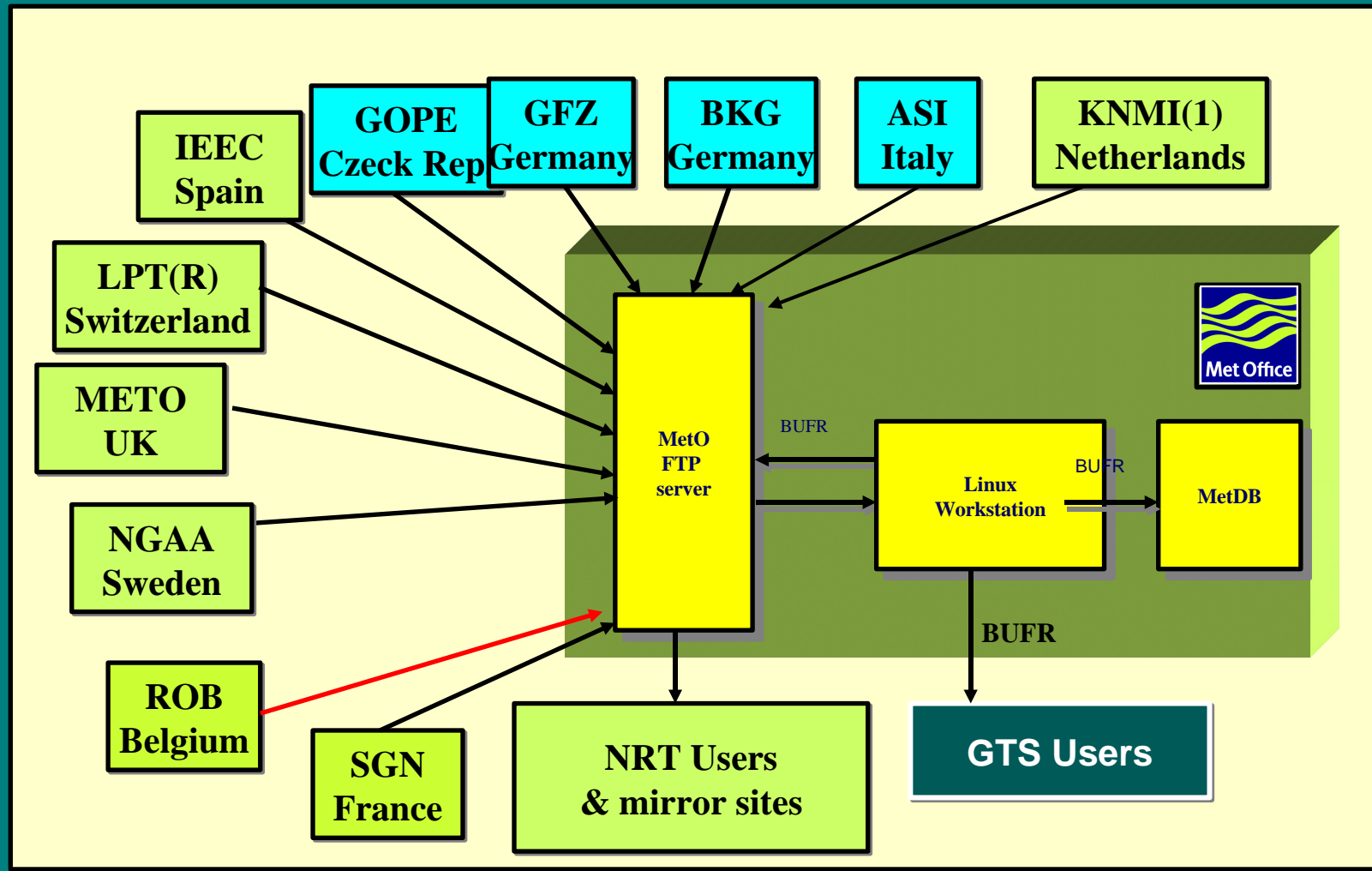
E-GVAP work in past period

- Establishing and maintaining contacts with relevant people on both meteorological and geodetic side.
- Updates of validation software and validation site.
- Updates of homepage.
- Preparation and partaking in meetings.
- Update, expansion and running processing of GPS data at UK MetO.
- Plenary meetings, PB-OBS meetings, Council meetings
- Expert groups on data processing and expert group on data usage.
- MoU between EUREF and E-GVAP/EUMETNET.
- Assisting NMSES to make agreements with national GNSS data providers.

Meetings in past year and near future

- E-GVAP 3rd plenary meeting, January 2007.
 - E-GVAP expert team on use of GPS data in operational meteorology, February 2007.
 - (HIRLAM workweek on data assimilation, March 2007)
 - (HIRLAM ALADIN workshop on data assimilation, March 2007.)
 - (Council meeting, April 2007, final acceptance/declarance of DHMZ and Meteo France entry)
 - EUREF annual symposium June 2007 – signing of MoU.
 - E-GVAP 4th plenary meeting June 2007, INM, Barcelona, Spain.
 - PB-OBS meeting June 2007, Vedur, Reykjavik, Iceland.
 - Expert team on data processing, Sept. 2007, ASI, Matera, Italy
 - Expert team on data usage, Nov. 2007, KNMI, de Bildt, Holland.
 - PB-OBS + central data hub (under EUCOS), Nov. 2007, DHMZ, Dubrovnik, Croatia
-
- E-GVAP 5th plenary, Jan. 2008, Météo France, Toulouse, France
 - Expert teams on both data processing and data usage, May 6-7, 2008, Potsdam, Germany
 - EUREF symposium, primo June, 2008 ?
 - PB-OBS, ultimo June, 2008, Austria

NRT GPS Processed Data Flow



Green = nation member of E-GVAP. Blue = nation not member of E-GVAP.

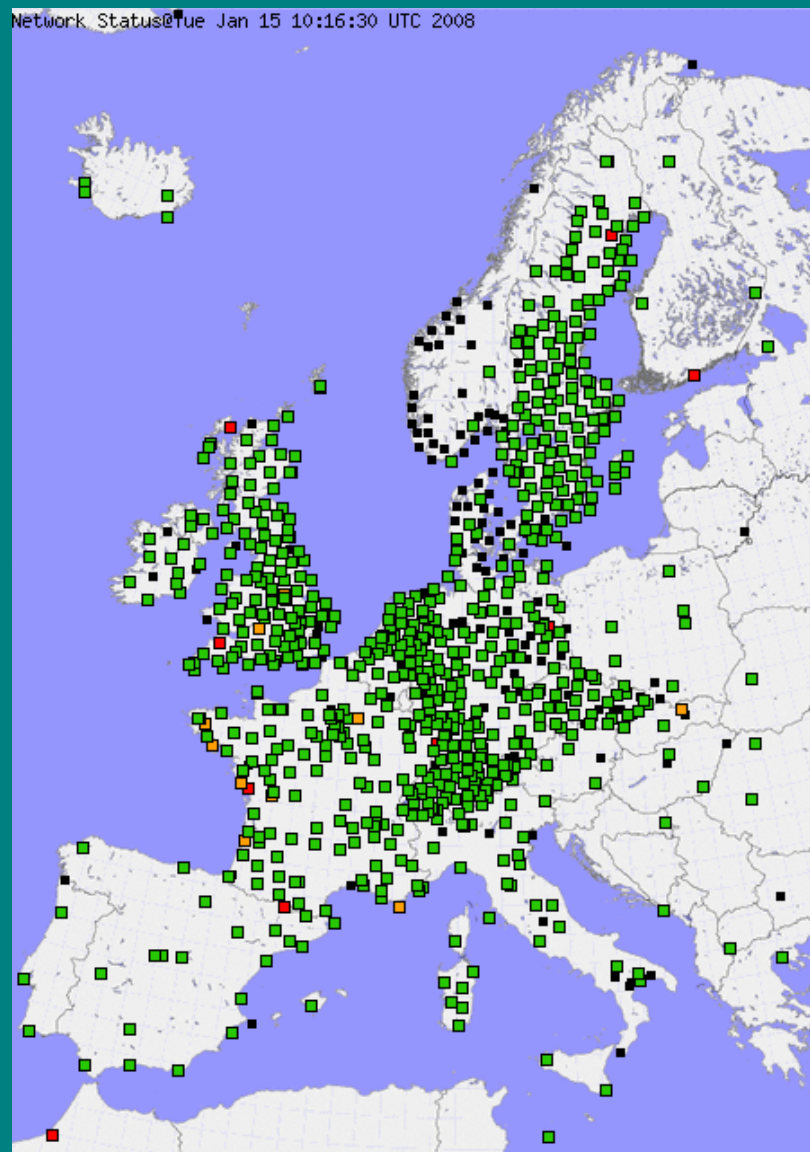
DATA COVERAGE

Status map from 20080115 from the E-GVAP validation site.

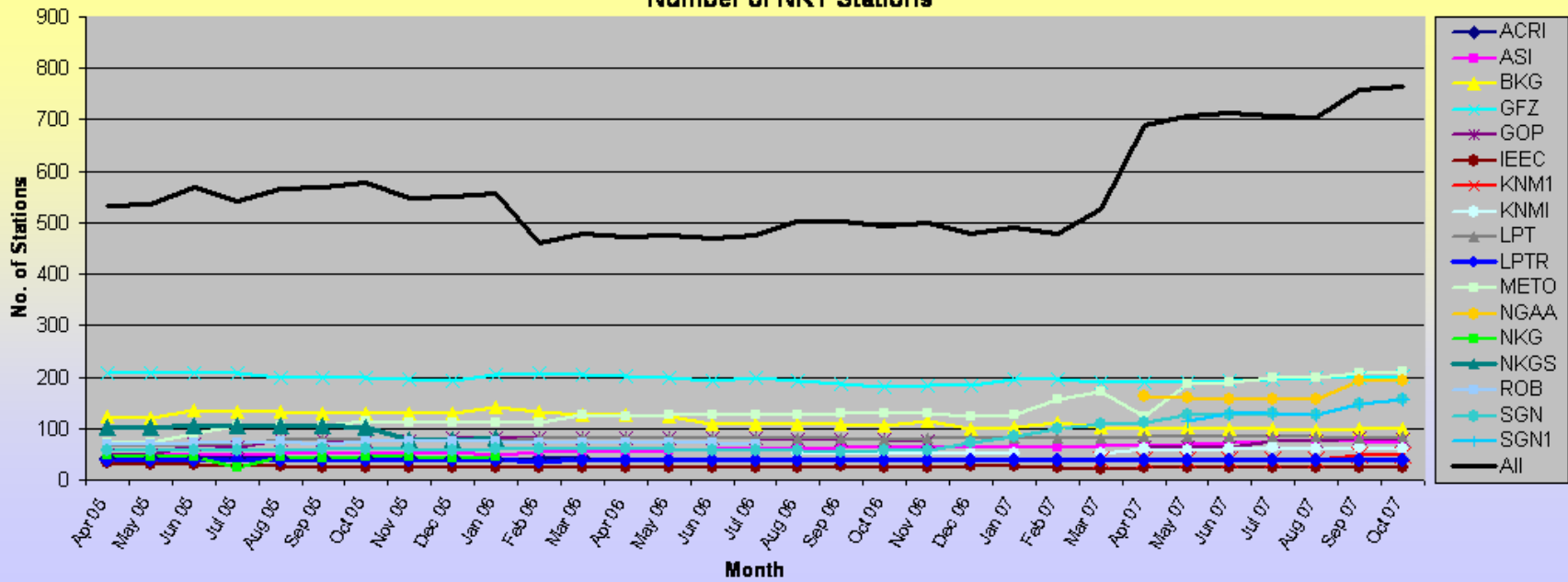
Data available at ftp-server at MetO: [ftp.meto.gov.uk](ftp://ftp.meto.gov.uk)

Validation statistics and graphs are created automatically and shown via click at each square representing a GPS

Made and run by Siebren de Haan.



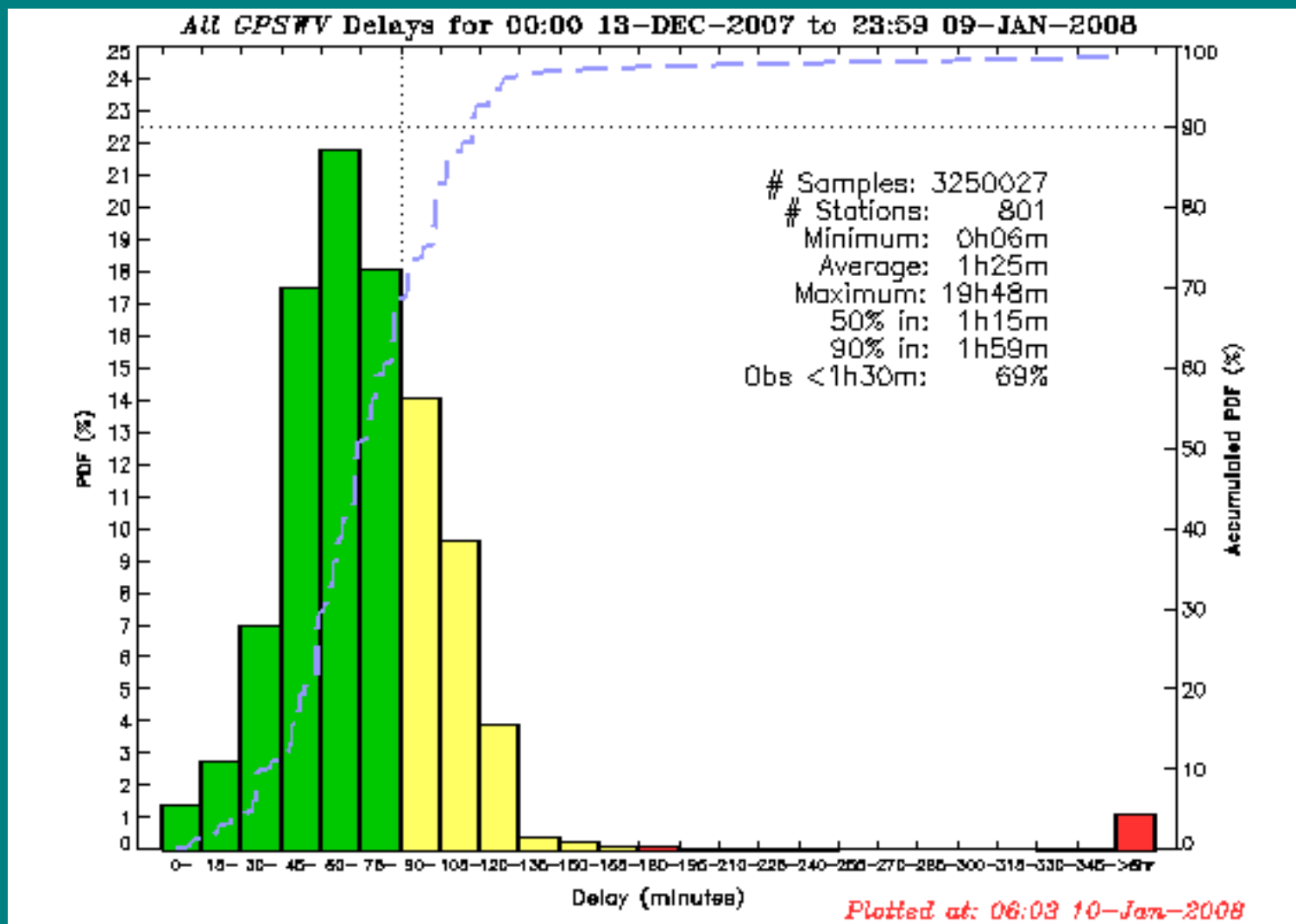
Number of NRT Stations



By Dave Offiler. Available via validation link on E-GVAP website

Mark more clearly on server and validation site which are **operational** and which are **experimental**?

17/12 2007 – 13/1 2008 data from 801 stations in 3275583 samples.

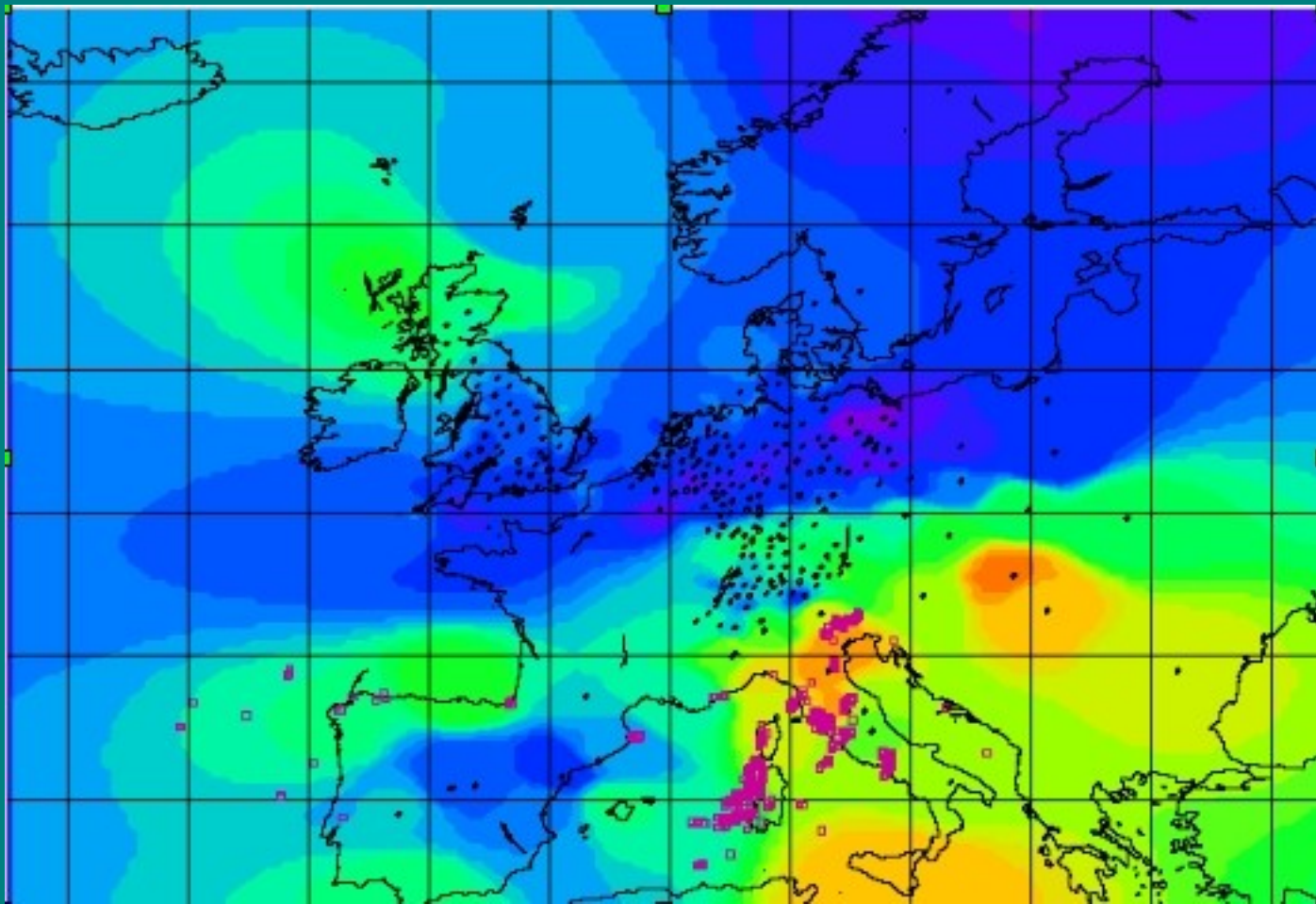


17/12 2007 – 13/1 2008 data from 801 stations in 3275583 samples.
 By Dave Offiler, UK MetO.

Value adding. Statistics and IWV maps

- Statistics is compiled for the KNMI-HIRLAM NWP - GPS offsets and presented at the KNMI validation site.
- Based on nearest SYNOP pressures and temperatures the ZTD observations are converted to IWV. The IWV point “measurements” are combined into 3 different maps: Europe, German + Netherlands, and UK.
- The map includes also wind directions (currently from a limited number of wind profilers) and locations with lightning. This is done every hour. The maps are combined into a film, covering the past 24 hours, which can be viewed via the egvap homepage. We expect such maps to be useful in now-casting. But this requires experience, which has first to be gained. We encourage forecasters to check these maps regularly and report to us suggestions for improvement.

IWV films



By Jonathan Jones and Siebren de Haan.

Data distribution policy

Former plenary meeting decisions:

Continue with 'free access'= access for all interested meteorological institutes, for institutes receiving GTS data, and for individuals declaring their use of the data is for scientific purposes.

Reconsider if mis-used.

Propose to keep unchanged.

Now making standard "Conditions of use" for agreements about data usage between E-GVAP and third parties (scientific use by third parties).

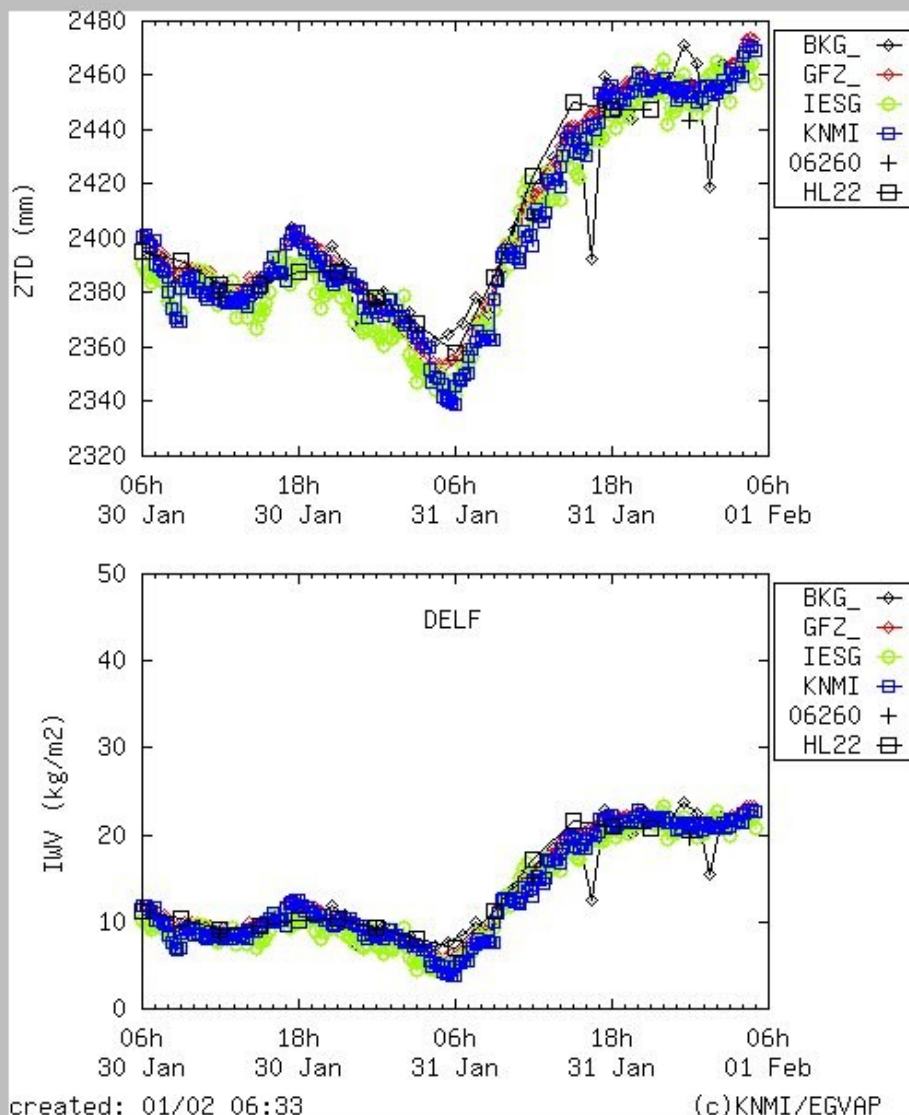
Expert team on data processing

Rosa Pacione/Francesco Vespe, ASI, Italy.
Jan Dousa, GOP, Czech Rep.
Etienne Orliac, Univ. Nottingham, UK.
Elmar Brockmann, Swisstopo, Switzerland.
Galina Dick, GFZ, Germany.
Jan Johansson, Chalmers Tech. Univ., Sweden.
Thierry Duquesnoy/Jacques Beilen, IGN, France.
Jonathan Jones, UK Metoffice, UK
Siebren de Haan, KNMI, Netherlands.
Henrik Vedel, DMI, Denmark
Responsible person: Jonathan Jones.

Include more people, e.g. from Belgium?

Expert processing team meetings

- Met September 2006 in Payerne (thanks to Dominique Ruffuex, MeteoSwiss)
- Met September 2007 (thanks to Rosa Pacione (Telespazio) and Francesco Vespe (ASI))
- Introduction of **Super-sites** = sites at which GPS receivers co-exist with radiosonde site and/or WVR site.
- All processing centres to include super-sites in their processing.
- Super-sites serve several purposes:
 - Continuous inter-comparison of PCs, for fast detection of certain types of single PC processing problems
 - Long term inter-comparison between PCs, against post processed data and against meteorological data (RS, WVR, and NWP) for identification of superior processing techniques.
- Recommendation to use same "clocks and orbits", where applicable.
- Contact to IGS to update orbit determinations/predictions more frequently – currently main product is from GFZ.



HIRLAM(KNMI) AN - GPS ZTD

7day stat. 2007/01/25 - 2007/01/31

AC	num	bias	RMS	stddev
BKG	53	-0.1	8.0	8.0
GFZ	55	-3.7	7.7	6.7
IESG	53	2.4	9.4	9.0
KNMI	56	-0.8	7.5	7.5

Notes

- Statistics are updated daily
- GPS ZTD are interpolated to NWP analysis time

HIRLAM(KNMI) FC - GPS ZTD

Latest Obs. vs NWP-forecast

AC	Obs.time	FC.time (sec)	HIRLAM-GPS
IESG	07:00	3600	5.6
KNMI	07:00	3600	1.7
GFZ	07:07	4020	-1.7
KNMI	07:14	4440	0.8
IESG	07:15	4500	10.4
GFZ	07:22	4920	-0.6
KNMI	07:29	5340	0.5
IESG	07:30	5400	8.6
BKG	07:30	5400	-4.7
GFZ	07:37	5820	-1.4
KNMI	07:44	6240	2.1
IESG	07:45	6300	6.9

By Siebren de Haan. Available via
E-GVAP homepage under "validation"

Liaison group(s)

Inter European scale (EUREF)

- Joao Agria Torres, Chairman of EUREF.
- Elmar Brockmann, Swisstopo
- Hans van der Marel, Tech. Univ. Delft.
- 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 both above geodesists.

Particular close contact between Elmar and Henrik.

ECOMET Discussions with Ton Donker, KNMI.

Liaison group(s)

National scale.

- E-GVAP team.

Responsible person: Henrik Vedel.

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

Best arranged how to develop in "poor" countries?

- 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, and from the liaison group one it has been formed. Currently the situation is very different from country to country, and it will be a gradual process and a central part of E-GVAP to achieve good coverage in all countries.

MoU between EUREF and EUMETNET

- The MoU has been approved by the TWG of EUREF (January 2007)
- The MoU has been approved by the EUMETNET Council (April 2007)
- The MoU has been signed on behalf of E-GVAP/EUMETNET, by the Chairman of EUMETNET Fritz Neuwirth. (May 2007)
- The MoU has signed by the Chairman of EUREF, Joao Agrio Torres (June 2007)

Reason for making an MoU for the inter European level, between EUREF and E-GVAP/EUMETNET

- To strengthen the collaboration between EUREF and E-GVAP, to further collaboration also on the national level. the making of an MoU was initiated in connection with the EUREF Annual Symposium in Vienna 2005.
- The MoU was made by people in the **liaison group between EUREF and E-GVAP**.
- Peter Aakjær, Niels Jørgen Pedersen, and Jean-Pierre Chalon has been helpful along the way.

Content of the MoU (extract)

- EUREF will provide to E-GVAP/EUMETNET free access to the EPN raw data for the determination of ZTD, IWV and other meteorological applications. The data and conditions of use are more precisely specified in annex 1.
- E-GVAP/EUMETNET will provide to EUREF free access to meteorological data for GNSS data processing, analysis, and validation. The data and conditions of use are specified more precisely in annex 1.
- EUREF and E-GVAP/EUMETNET will create common guidelines for the exchange of data.

Content of the MoU (extract, cont.)

- EUREF will contact the European GNSS network operators inviting them to collaborate with European national meteorological institutes on co-located observations (GNSS and meteorological observations) and support GNSS data processing from dense national networks to contribute to meteorological applications.
- E-GVAP/EUMETNET will contact the European national meteorological institutes inviting them to collaborate with the responsible for national GNSS networks and/or EPN stations to provide the necessary meteorological data for GNSS data processing and analysis.
- Use of data exchanged under this MoU for publications must be acknowledged by citation to the relevant data providing party (EUREF or EUMETNET).

Conditions of use of exchanged data

A: EUREF use of meteorological data

- The meteorological data will be used for GNSS data processing, validation of GNSS processing and products, and for scientific studies.

The meteorological data will not be sold or used for any direct economical gain or profit, nor forwarded to third parties, unless a separate written agreement has been made to the contrary.

Conditions of use of exchanged data

B: Meteorological use of GNSS data

Raw GNSS data (RINEX format) will not be forwarded to third parties unless specifically agreed with EUREF in advance.

The data will be used solely with the purpose of estimation of atmospheric GNSS delays and further computation of atmospheric water vapour. Actual positions determined in connection with the delay estimation will not be distributed. The GNSS delays will be utilised in numerical weather prediction models and IWV used to assist forecasters to monitor the weather. The goal is to enhance the skill of the meteorological forecasts.

GNSS delay data and associated error estimates will be distributed free of charge within the meteorological community (including EUREF if required) for use in weather forecasting and climate monitoring. The distribution between E-GVAP and the meteorological community will take place via the Global Telecommunication System and password restricted ftp.

The GNSS delays derived from EUREF data or provided by EUREF will not be sold or used for any direct commercial gain or profit unless a separate written agreement has been made to the contrary.

Annex 1, extract

Responsibilities

EUREF will provide to E-GVAP/EUMETNET free access to the EPN raw data (hourly and daily satellite observation files in RINEX format) for the determination of ZTD, IWV and other meteorological applications.

E-GVAP/EUMETNET will provide to EUREF the following data:

Hourly

Observations of pressure, T2m, and RH2m from the **nearest SYNOP site** to the EUREF GNSS stations. From essential data + additional data from institutes on Annex 2 list.

Daily

Observations of pressure, T2m and RH2m from SYNOP sites, with a time resolution of 3 hours. From essential data + additional data from institutes on Annex 2 list.

Radiosonde observations of pressure, temperature and humidity from radiosondes within 50 km of a EUREF GNSS site. From essential data.

Water vapour radiometer data from sites located within 50 km of GNSS receiver. Pending agreement with data owner in each case.

Annex 1, extract

The **Annex 2** of the *MoU between EUREF and E-GVAP/EUMETNET* is a list of meteorological institutes that have agreed that for extraction of the data mentioned below their *additional data* may be used.

Met.no has stopped discriminating between essential and additional data from Norway and now declares all their data as essential. Therefore signing of annex 2 is not relevant for met.no

Annex 2, signing

From E-GVAP we have asked all members of EUMETNET to consider signing Annex 2.

Note: From E-GVAP we **do not** plan to ask for additional data from members not already providing additional data. However, the acceptance for members currently providing additional SYNOP data to DMI, KNMI and UK Metoffice to sign Annex 2 will significantly ease the work in E-GVAP, as the information about whether data are essential or additional is unfortunately not stored when observational data are transferred from the GTS to the meteorological databases for observational data.

Next important steps (from plenary meeting presentation June 2007)

- The EUREF TWG will now write a letter to all EUREF members, urging them to seek collaboration with the national meteorological counterparts, and describing the type of collaboration reached in a set of countries where close collaboration has already been achieved.
- GNSS processing centres working for E-GVAP already have access to EPN data.
- Access for EUREF to meteorological data will be set up within a few months.
- It is foreseen that access will be provided via password restricted, institute specific ftp.

Another issue for EUREF E-GVAP discussions:

- Naming (of GNSS sites) policy (for meteorological databases the name must be unique).

MoU, recent developments

- Some met. institutes have been hesitant signing annex 2. This creates problems for the data extraction, because "essential" and "additional" data can not be discriminated in the databases at DMI, KNMI, and UK Metoffice.
- The main problem is that according to EU and some national legislation there must be equal access to the meteorological data for different firms. Currently private met agencies in some countries take nat. metoffices to courts whenever they believe this rule is broken.
- In particular in regi of ECOMET, which controls much of the selling of met data to private met agencies, this is important.

MoU, recent developments

- After discussions with an ECOMET expert a solution has been found: Each EUREF institute wishing to download met data will be presented a document detailing that the data are only for scientific use and must not be used commercially. Notice: This is slightly tighter than the text in the MoU, which speaks about "direct gain or profit", not excluding in-direct.
- This approach has been accepted by our EUREF contact.
- Very recently Météo France has requested that the above be done so that the document in question is send/emailed to the EUREF institute requesting data access, the institute must add the name and contact details of a responsible person, and send/email the document back to E-GVAP.
- This approach will hopefully (probably) be accepted by our EUREF friends as well.
- We are in the process of setting up the data exchange. The main thing remaining is to decide on data file formats.

Expert team on GPS observation usage

Purpose: To further the use of gb GPS 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.

Members:

Adrian Jupp/Dave Officer, UK MetO,
Daniel Leuenberger, MeteoSwiss,
Jana Sanchez Arriola, INM,
Paul Poli, Meteo-France,
Maria Tomassini, DWD (new member)
Henrik Vedel, DMI and E-GVAP
Jonathan Jones, UK Met Office and E-GVAP
Siebren de Haan, KNMI and E-GVAP.

Responsible person: Henrik Vedel.

Meetings financed by E-GVAP. Met February 2007 and November 2007.

Next meeting May 6-7, 2008 together with expert team on data processing.

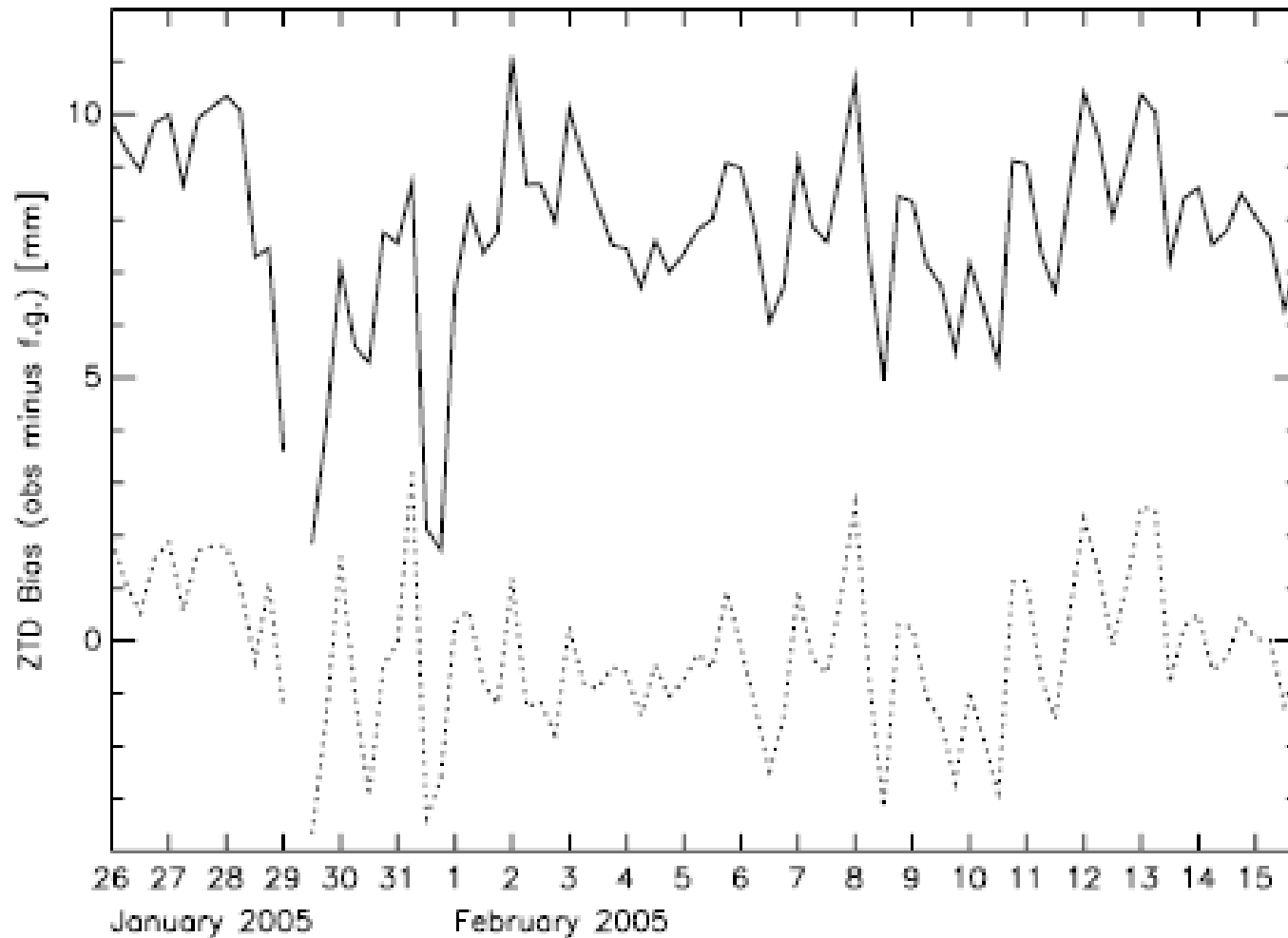
Operational status:

- Currently two institutes, UK Met Office and Meteo France, assimilate E-GVAP data in their operational models.
- Both institutes report a positive impact from the use of the E-GVAP data.
- Both institutes assimilate NRT ZTD using variational data assimilation systems (3 and 4DVar). Besides that there are significant differences in their approach.
 - MF uses a white list for selection of sites&processing centres to be included in the data assimilation. The list is determined based on the O-B statistics. Site&processing centre specific bias correction (from month long offset averages) and observation errors.
 - MetO uses available data from a subset of the E-GVAP processing centres. Bias correction based on month long offset averages.
- In both cases the screening is very heavy compared to screening of other types of observations. In some cases sites are left out due to data thinning or due to large differences between model orography and real altitude of GPS site, but mainly the screening is meant to remove sites-processing centre combinations that are not producing ZTD data of constant good quality based on O-B offset statistics.

Expert team on GPS observation usage, 2

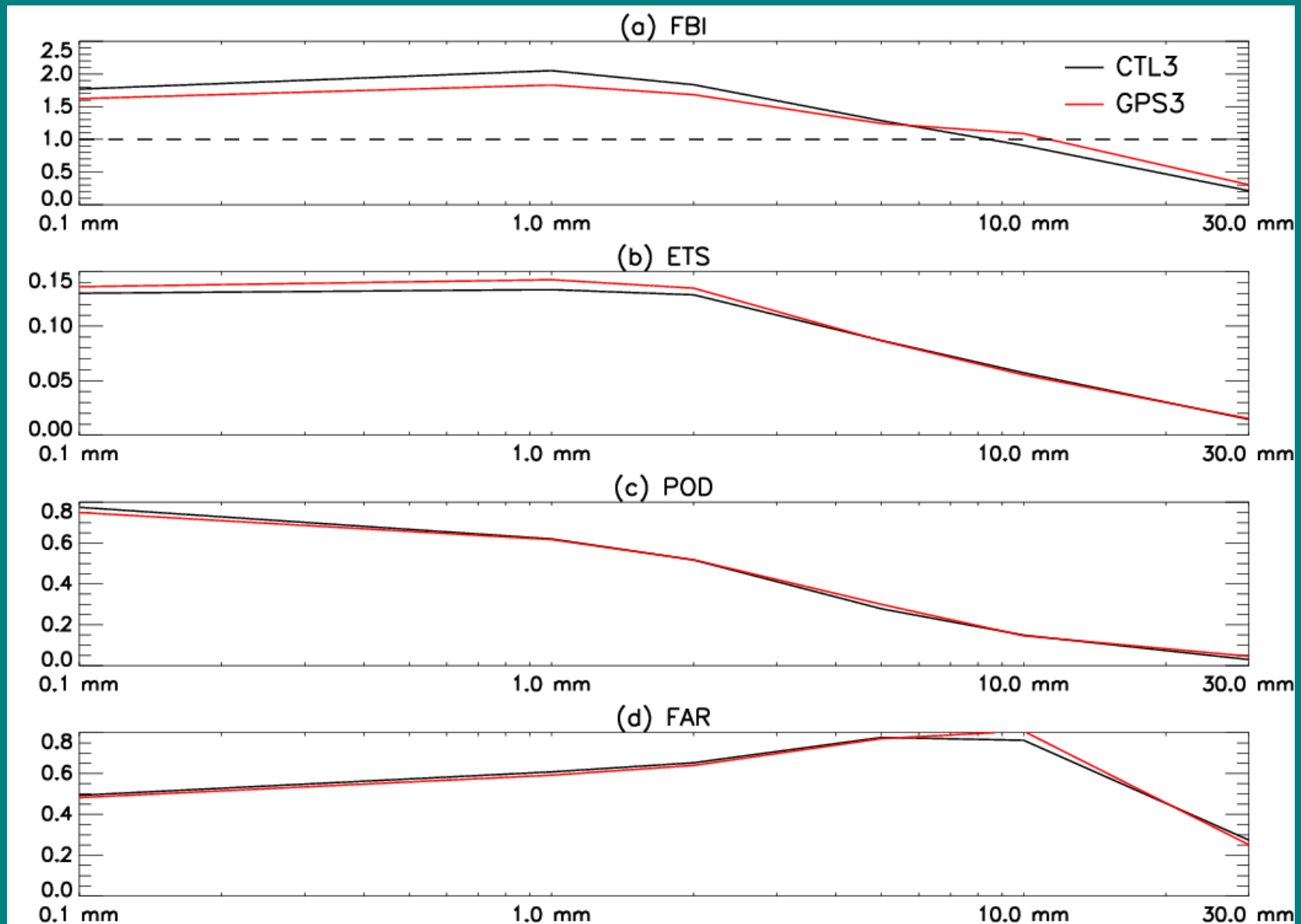
- Conclusion. Positive results obtained in operational NWP from use of E-GVAP data.
- However, important aspects to improve in order to make **all** data useful and to limit the risk of forecasts degrading due to abrupt changes in data processing.
 - Homogeneity of data quality a main issue. Significant differences between ACs.
 - Stability in processing a main issue, ie not change anything at AC without some type of notice (warning ahead when reason to consider important, notification in log file and via version number in COST file otherwise).
- Meeting of the two expert teams found to be important to discuss and resolve such issues. Therefore next meeting will be a joint meeting.

Example from impact study (Poli et al, Meteo-France)

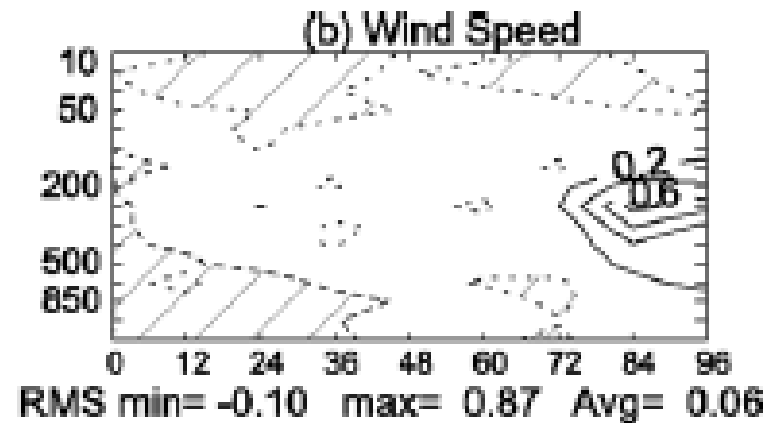
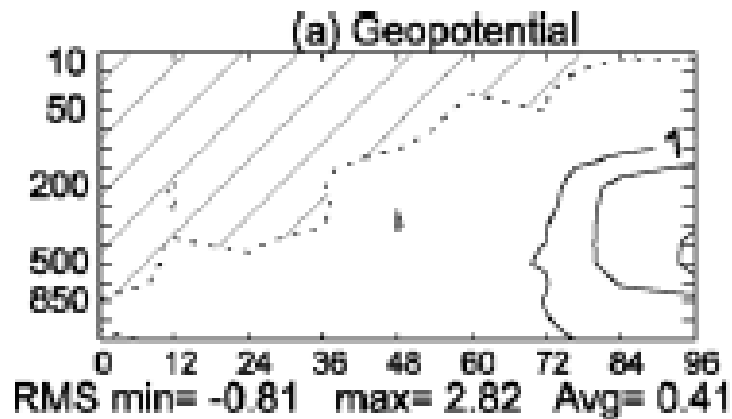


Before and after bias correction against Meteo-France NWP model.

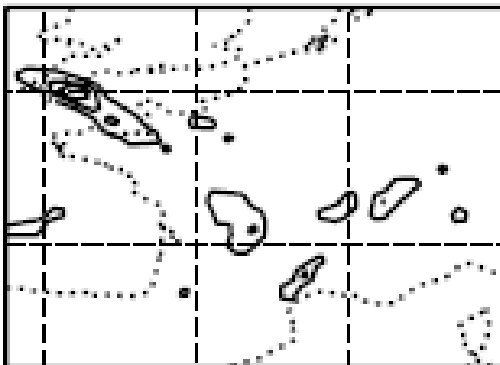
Example of impact (Poli et al, Meteo-France)



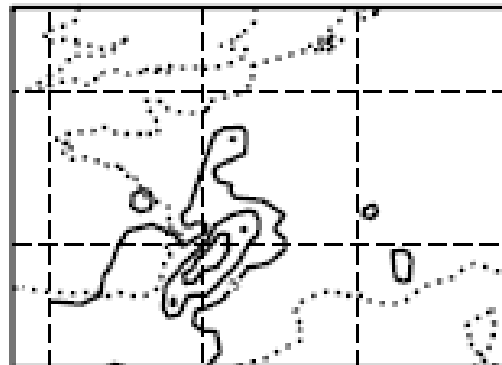
Example of impact



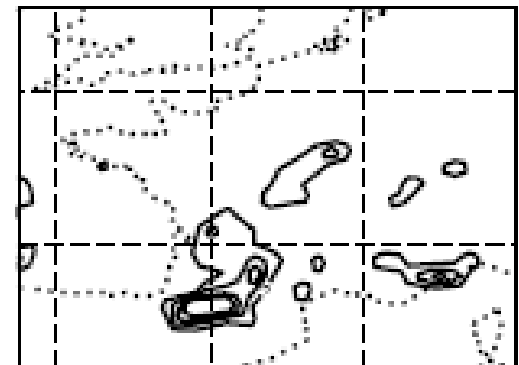
(d) CTL2
2005/04/24 00H-06H Precip



(e) RAIN GAUGES (FRANCE ONLY)
2005/04/24 00H-06H Precip



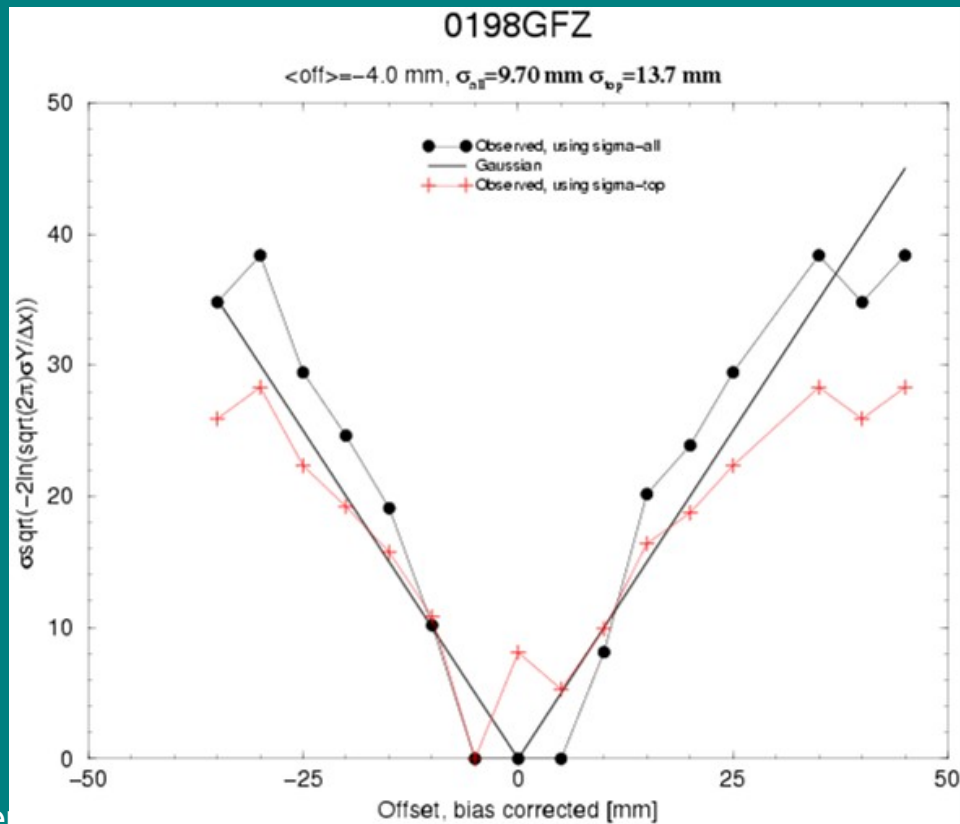
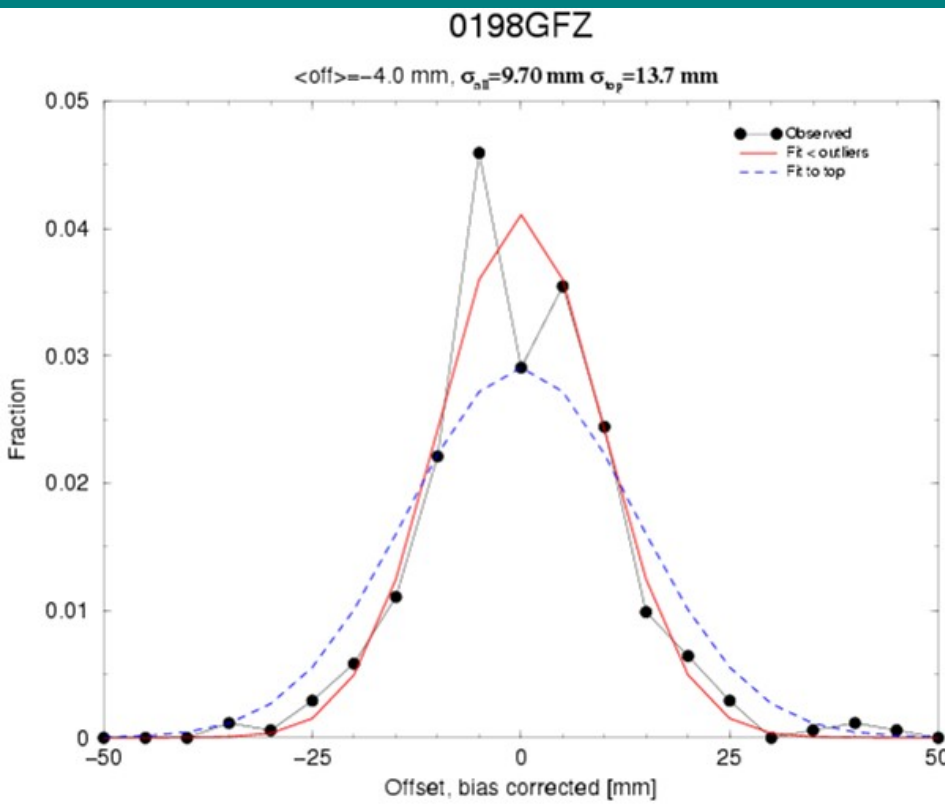
(f) GPS2
2005/04/24 00H-06H Precip



From Poli et al, 2006.

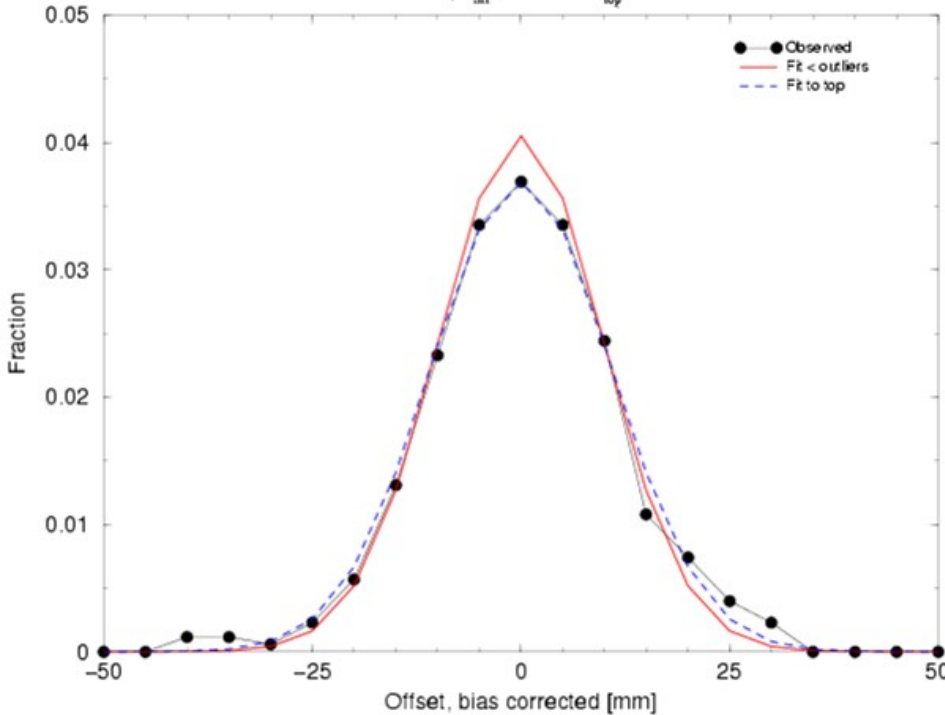
- Many HIRLAM countries are preparing assimilation (DMI, KNMI, INM, SMHI?).
- At DMI we have done
 - "passive assimilation since July 07.
 - an impact experiment for July 2007, neutral impact.
 - want to start a "parallel" assimilation experiment to compare with our operational models. Have for a time been awaiting more stable quality for the NGAA NRT ZTDs.
 - In research department strategy to include gb GPS in operational models during 2008.
- At INM
 - Passive Assimilation.
- At KNMI
 - Siebren.
- DWD re-starting, since ultimo 2007, work on use of gb GPS data in NWP.

The O-B distribution for site 0198 processed by GFZ



0897GFZ

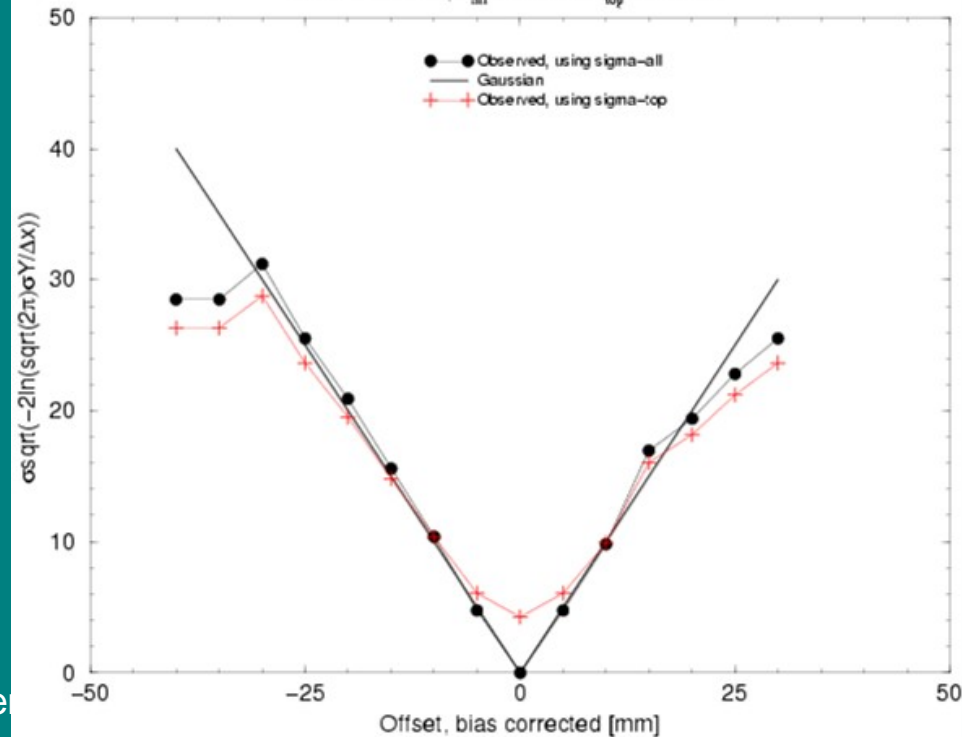
$\langle \text{off} \rangle = 0.62 \text{ mm}$, $\sigma_{\text{all}} = 9.84 \text{ mm}$ $\sigma_{\text{top}} = 10.8 \text{ mm}$



The O-B distribution for site 0897 processed by GFZ

0897GFZ

$\langle \text{off} \rangle = 0.62 \text{ mm}$, $\sigma_{\text{all}} = 9.84 \text{ mm}$ $\sigma_{\text{top}} = 10.8 \text{ mm}$



Making a white list, determining observation errors for NWP

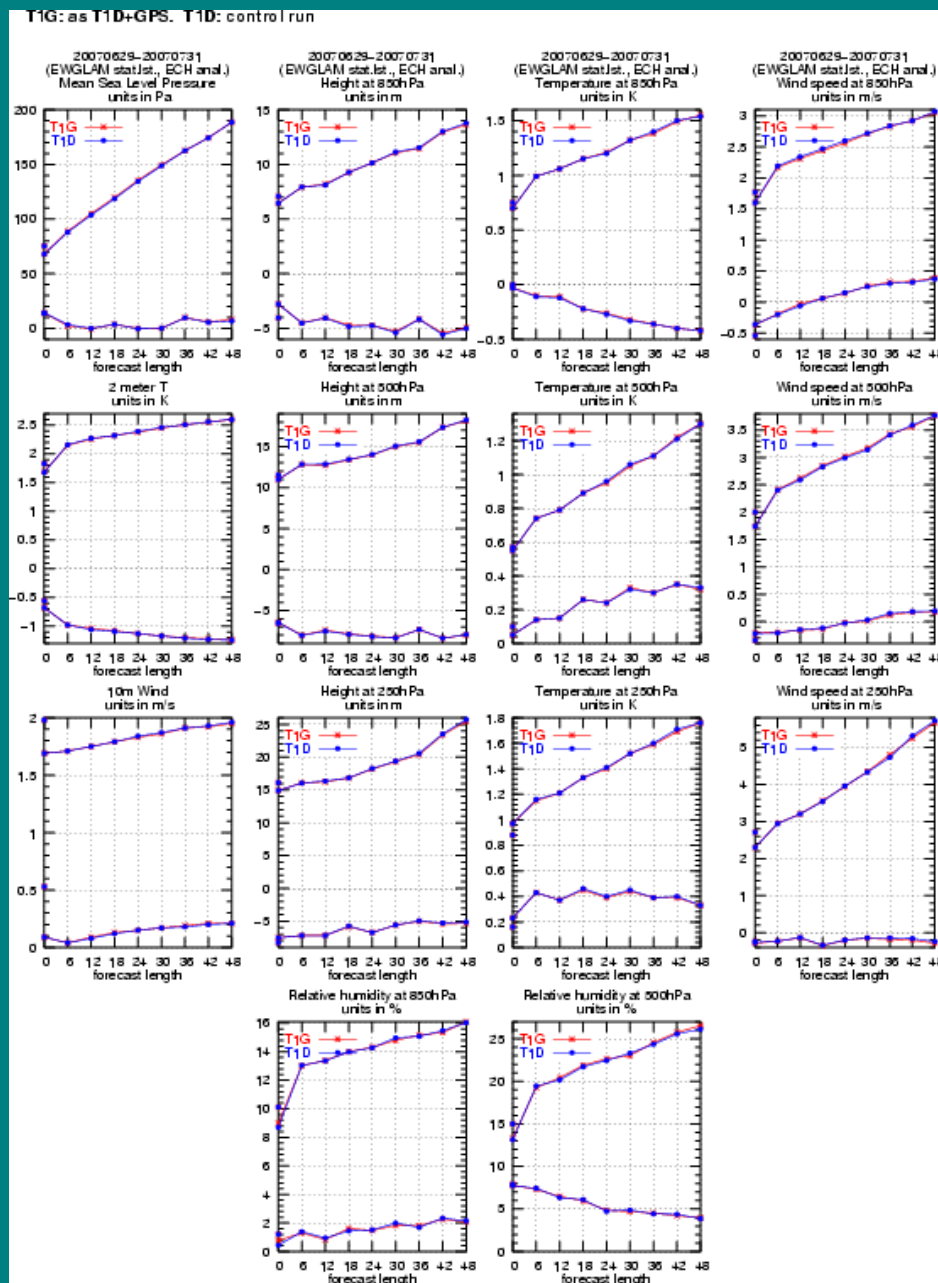
0198GFZ -0.004374 0.010571 423 11 11.402 9.402
0.061 0.259 0.000 0.000 0.105 0.546 3.338

0779GFZ -0.005044 0.010363 438 9 9.394 9.394
0.927 0.927 0.000 0.070 0.889 0.200 1.140

0897GFZ 0.000395 0.010853 435 9 9.974 9.974
0.957 0.957 0.000 0.137 0.286 0.069 2.511

Impact experiment for July 2007. With and without GPS data added to the observations used in our operational runs.

Note: Setup includes re-assimilation 4 times a day, including both late observations and ECMWF analyses, leading to improved first guesses and consequently less impact of new observations.



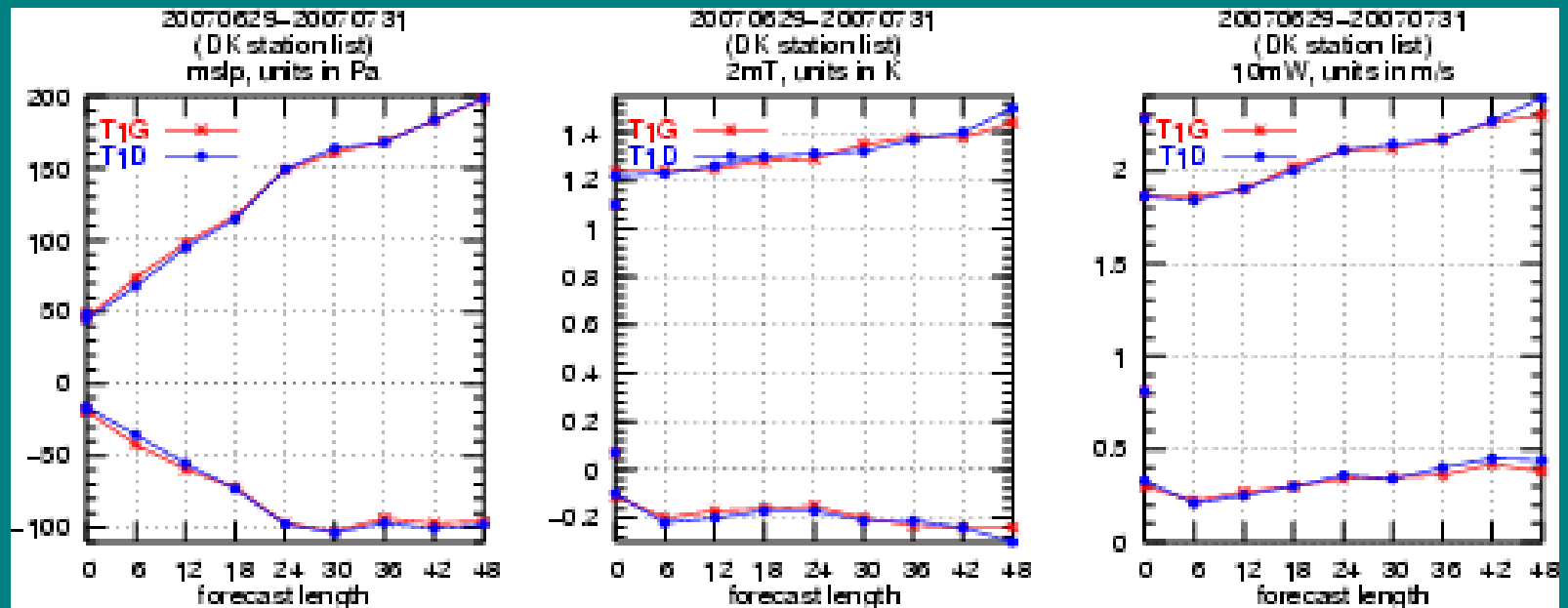


Table 1: Contingency table(s) for 0707 (6–18 h forecasts). Danish station list.													
T1G 0707 (64.5 %)							T1D 0707 (64.4 %)						
$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum	$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum
F1	610	38	24	5	5	682	F1	601	38	25	7	5	676
F2	152	56	36	12	4	260	F2	176	67	41	9	4	297
F3	155	81	132	44	22	434	F3	145	78	139	56	29	447
F4	30	23	52	43	25	173	F4	24	19	38	36	19	136
F5	3	13	26	25	45	112	F5	4	9	27	21	44	105
sum	950	211	270	129	101	1661	sum	950	211	270	129	101	1661
%FO	64	27	49	33	45	53	%FO	63	32	51	28	44	53

Table 2: Contingency table(s) for 0707 (18–30 h forecasts). Danish station list.													
T1G 0707 (58.9 %)							T1D 0707 (60.3 %)						
$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum	$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum
F1	538	42	20	6	6	612	F1	540	39	24	8	7	618
F2	189	49	50	12	5	305	F2	184	44	37	6	2	273
F3	171	84	114	58	17	444	F3	167	92	122	56	17	454
F4	40	24	51	33	24	172	F4	41	23	58	40	23	185
F5	12	12	35	20	49	128	F5	18	13	29	19	52	131
sum	950	211	270	129	101	1661	sum	950	211	270	129	101	1661
%FO	57	23	42	26	49	47	%FO	57	21	45	31	51	48

Table 3: Contingency table(s) for 0707 (30–42 h forecasts). Danish station list.													
T1G 0707 (57.6 %)							T1D 0707 (57.6 %)						
$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum	$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum
F1	515	41	31	14	6	607	F1	505	44	29	19	6	603
F2	218	53	54	14	6	345	F2	214	58	56	23	4	355
F3	172	91	119	49	31	462	F3	178	84	121	38	28	449
F4	33	15	50	42	29	169	F4	40	12	42	35	29	158
F5	12	11	16	10	29	78	F5	13	13	22	14	34	96
sum	950	211	270	129	101	1661	sum	950	211	270	129	101	1661
%FO	54	25	44	33	29	46	%FO	53	27	45	27	34	45

Year 1 milestones

- *Successful setup of liaison group and the two expert groups and first years reports from those. Achieved.*
- *Successful setup of hub to receive GPS meteorological data, distribute them and archive them. Achieved.*
- *Start of quality measurements/report facility. Achieved*
- *An agreement with EUREF about use of GPS data. MoU made, transfer of met data being set up, final details on met side regarding annex 2. No problems with EUREF at any time.*
- *Recommendations for design of regional/national networks for water vapour determination. Final TOUGH report on this has been made, based on input from most of the experts in the E-GVAP expert team. UK Met Office document on installation of GPS sites.*

Year 2 milestones

- *Formal arrangements with national organisations assuring delivery of GPS data to hub for a multi-year period. Either via NMS or directly with E-GVAP. **Achived for some countries, starting in some, missing in some.***
- *Operation of quality measurement/report facility. Quality measured against NWP, radiosonde an dother available meteorological data. Reported quarterly. **Achived, reported on web.***
- *Workshop on the production and use of GPS data (possibly in connection with project meeting). **Workshop postponed after agreement at plenary meetings. No final day decided yet.** To be made in connection with other meeting?! Any good ideas?*

Year 3 milestones

- *Formal arrangements with facility which can process "raw" GPS data which might become available in Europe, but are not processed already by current GPS processing centres for whatever reason. **Not achieved yet. Exploiting EUCOS "central data hub", but that turned out to be sometime into the future.***
- *Functioning automated quality control of GPS meteorological data against GPS meteorological data from nearby stations, other GPS networks with common stations, and against NWP data and other meteorological observations. Automated near real time feedback to owners of problematic stations and processing centres processing the station(s) in question. Periodic feedback to all involved parties. **Automated quality control in place. Automated feedback not. Question: What should result in feedback and to whom?***
- *Organised support for expansion of network in regions with poor coverage, and for GPS sites collocated with radiosonde sites, airport (AMDAR), and other meteorological sites. **MoU between EUREF and EUMETNET supports site sharing as an important form of EUREF EUMETNET collaboration. Supersites.***

Year 4 milestones

- Ongoing processing of ground based GPS data from an increasing European GPS network.
- Review of processing, utilisation, and impact of ground based GPS data at European meteorological services.
- A review/discussion of the future route for European ground based GPS observations for meteorology.

Other central work in period as defined at plenary meeting a year ago.

- 1 Making of MoU between EUREF and "us" acceptable to PB-OBS and EUMETNET Council (and EUREF). *Signed, but met data exchange not running, due to hesitation on met side.*
- 2 Development of GPS observing system in "poor" E-GVAP countries. There is a particular wish to help densify and solidify the Spanish GNSS observing network. *Not solved, but agreement that Spanish GPS data can be processed at UK Metoffice, or that E-GVAP experts can help set up processing at INM.*
- 3 E-GVAP and Meteo-France collaboration. *Done. Also DHMZ now a member*
- 4 Review of **User Requirements**, data formats, and data distribution with the goal of a future update. *Discussed at expert team on data usage meetings, but no strong wish for an update.*
- 5 Decide on long term archiving strategy (e.g. for climate research). *A UK institute has expressed its willingness to archive the E-GVAP data, but should NRT delay/IWV data be used for climate studies?*

National reporting

Finland

Received from Reima Eresmaa:

- Observations from four receiver stations has been in operational processing at the Nordic processing centre for some time. These receiver stations are operated by the Finnish Geodetic Institute (FGI). FGI operates in total of 13 receiver stations. As far as I know, there has been no recent progress in order to include the remaining nine receiver stations in operational NRT processing.
- Negotiations have taken place in order to include the network of the private company Geotrim in the processing. Their network consists of 86 receiver stations providing a fairly uniform coverage over the whole of Finland. At the moment, the data from about 10 receiver stations from this network is transferred every two hours into an FTP server at FMI. The Nordic processing centre at SMHI has access to this FTP server. I have not been informed about how soon the processing centre will start to make use of this data.

The facilities of Geotrim limit the amount of data that can be transferred in NRT into FMI. This is the reason why only a small part of the Geotrim data is currently transferred. FMI will provide a new FTP server to Geotrim in near future such that the data from the remaining (about 75) receiver stations could also be transferred to the server at FMI, without disturbing the other activities of Geotrim and their customers.

Finland

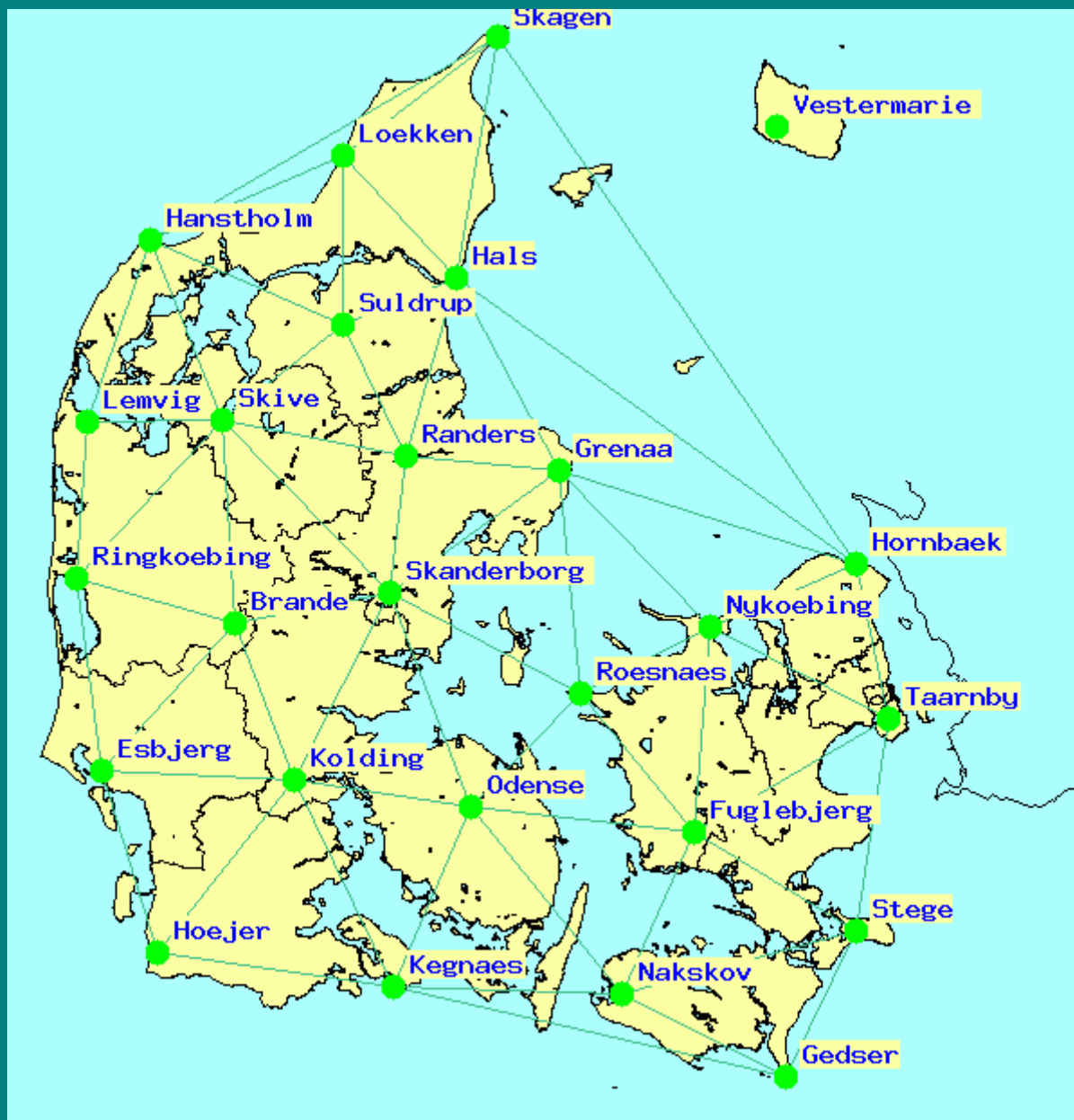
- Research on the use of the GPS data in NWP goes on. The current development tasks focus on the bias correction methods, in particular on application of the Variational Bias Correction in the framework of the Hirlam 3D-Var data assimilation system. This method is expected to be relevant for both ZTD and slant delay observations. Moreover, impact studies with ZTD data are planned for 2008 in the framework of the HIRLAM model, together with the other institutes involved in the consortium.
- At the moment, there are no detailed plans for making impact studies with slant delay observations. There is a general lack of slant delay observations in Europe. This limits our interest and capabilities to conduct impact studies with the methodology that has been developed within the TOUGH project. We are aware that the currently known slant delay data processing methods have limitations. Anyway, we would appreciate if raw GPS measurements from dense and large receiver networks were archived somewhere such that these could be re-processed later in case there is progress in the processing methods. This would increase the possibilities to conduct reasonable impact studies later. We are not aware if there already exists systematic archiving of the raw GPS data.

Denmark

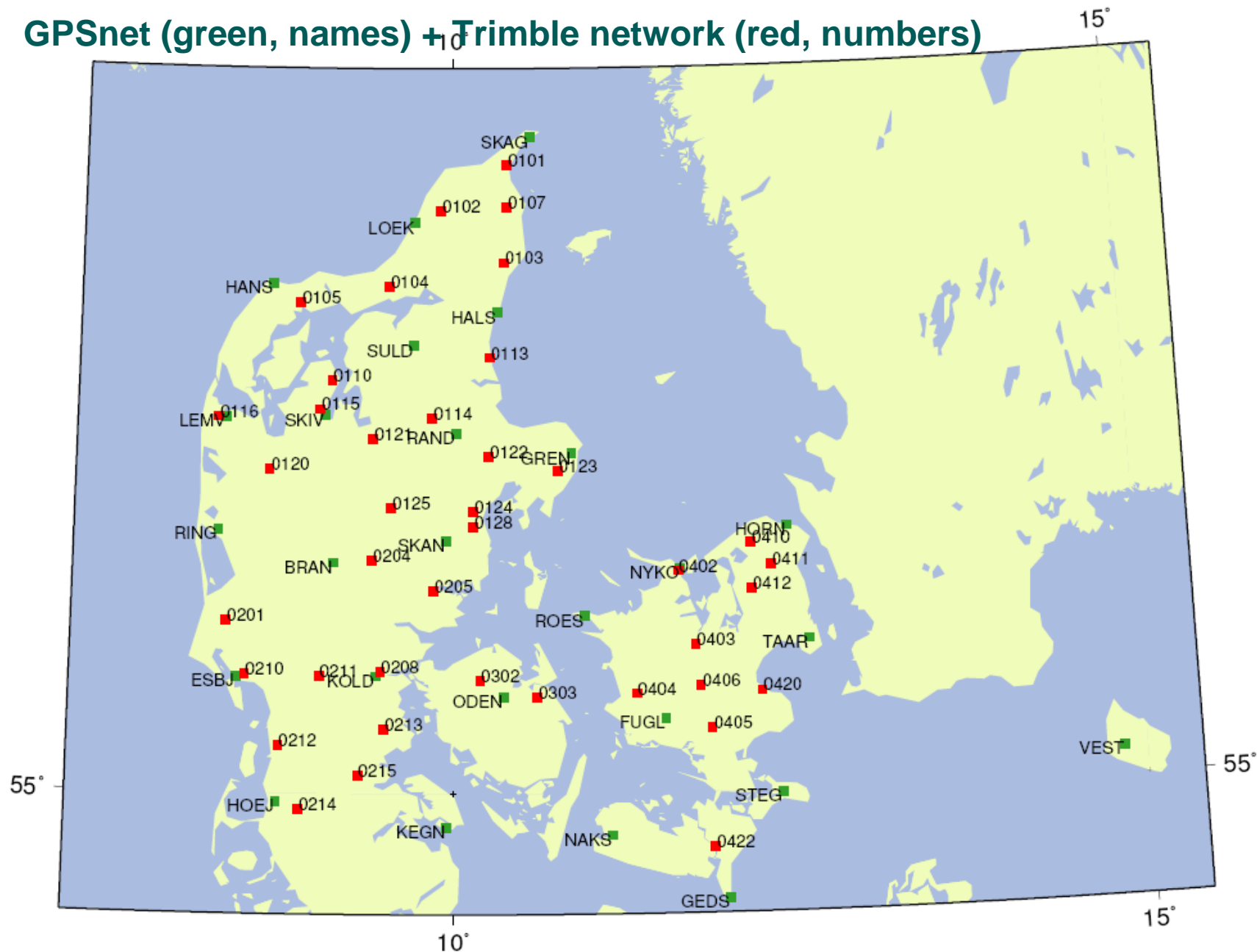
GB GPS data. Access and procesing.

- DMI is colaborating with the NRT GPS processing centre at SMHI, such that Danish GPS data are processed at SMHI.
- The Danish GPS data come from 2 sources:
 1. The national Danish mapping agency.
 2. A private network called GPSnet.
- The access is based on an old non formal agreement between the data providers and Chalmers Space Observatory.
- Potential for more Danish data, as a second private network operator exits.
- Currently there is no direct interaction between DMI and the two private networks, but a formal agreement is obviously to be made.

GPSnet



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



Denmark

Use of gb GNSS data at DMI

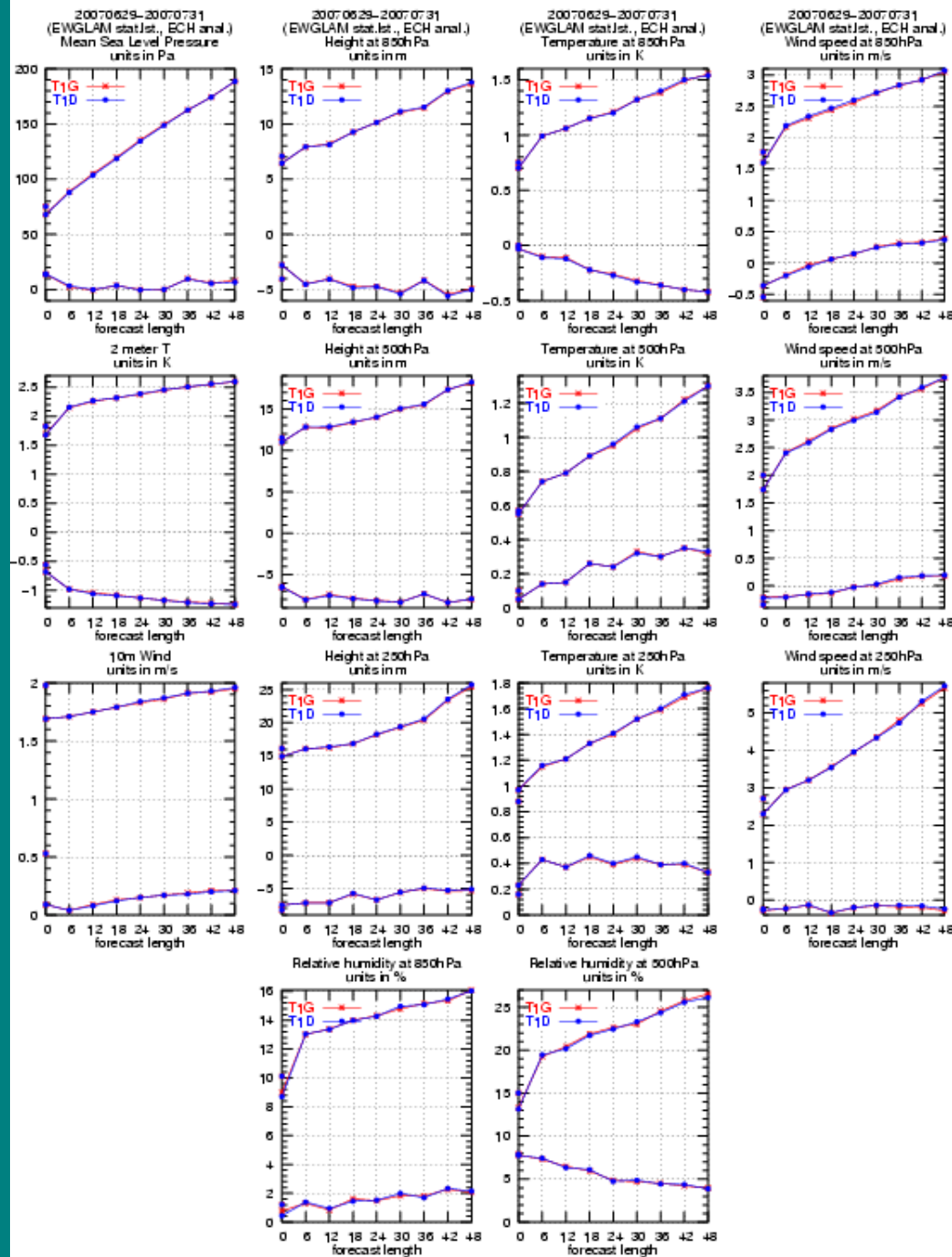
- DMI is involved in validation, verification and assimilation of ground based GPS data since 1996. Including the projects NewBaltic, MAGIC, COST716, and TOUGH. In addition significant work is carried out on GPS RO, with a current deep involvement in the GRASSAF for METOP.
- Download GPS data from egvap database is operational, done via ftp, once per hour. We (still) use the ascii format data files.
- The HIRLAM data assimilation system, HIRVDA, does currently not handle GPS data in BUFR format.
- Operational validation/verification against DMI-HIRLAM is now operational via passive data assimilation.
- The statistics for validation/verification will be made available to others via egvap homepage. Inclusion in "E-GVAP" official statistics and NRT monitoring and feedback, including automatic feedback, possible.

Denmark, 2, cont.

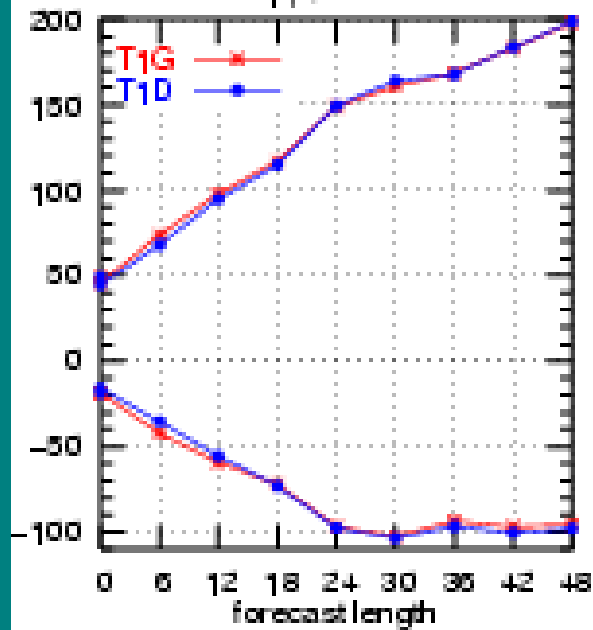
- Software for calculation of the offset statistics necessary for active assimilation and for creation of white lists, bias corrections, etc., based on "Gaussianity" and error sizes has been made and tested.
- Using this a case study has been performed for July 2007. This is the first study at DMI in which we use heavy screening (white list) and bias correction (month long average O-B offset). The impact is found to be neutral. The control experiment included "re-analysis" with blending of ECMWF analyses into the HIRVDA analysis, a setup which is for any observing system very hard to improve.
- We are ready to start a parallel impact study, but have so far been postponing it due to the transient quality problems with the NGAA data.

Other DMI GNSS:

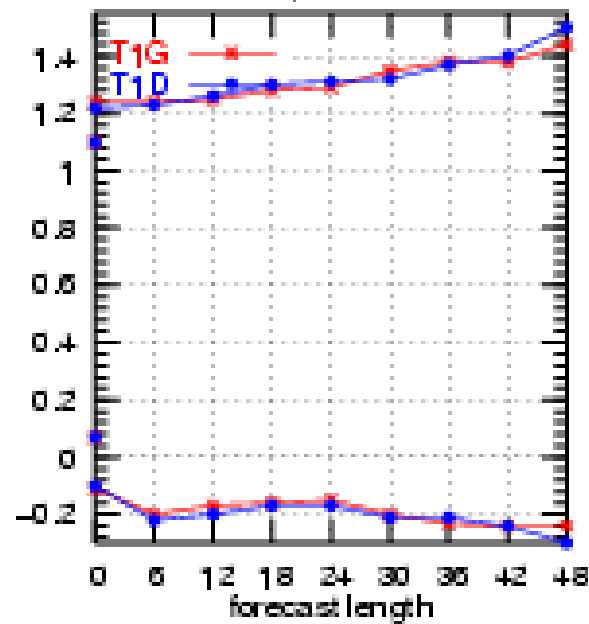
- EUMETSAT fellowship on assimilation of GPS RO started by September 2007.
- Ongoing contacts to GRASSAF to find out whether/when EUMETSAT ground segment for Metop will be of value (near enough to NRT) to E-GVAP processing centres.



20070629-20070731
(DK station list)
mslp, units in Pa



20070629-20070731
(DK station list)
2mT, units in K



20070629-20070731
(DK station list)
10mW, units in m/s

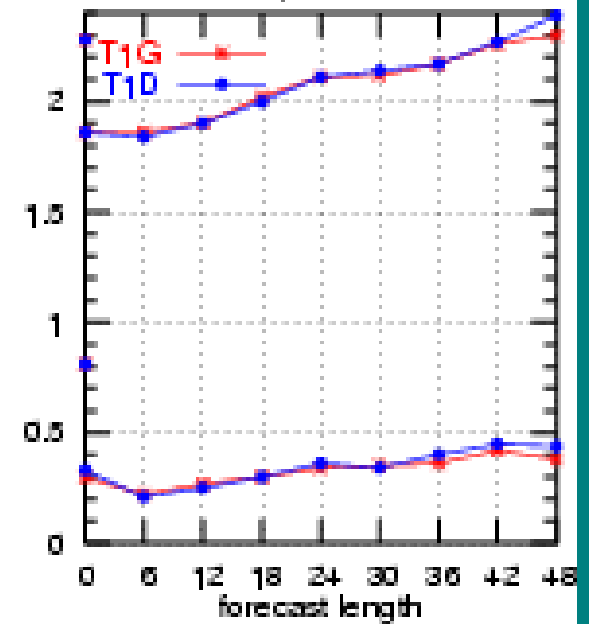


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F5	3	13	26	25	45	112	F5	4	9	27	21	44	105
sum	950	211	270	129	101	1661	sum	950	211	270	129	101	1661
%FO	64	27	49	33	45	53	%FO	63	32	51	28	44	53

Table 2: Contingency table(s) for 0707 (18–30 h forecasts). Danish station list.

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F4	33	15	50	42	29	169	F4	40	12	42	35	29	158
F5	12	11	16	10	29	78	F5	13	13	22	14	34	96
sum	950	211	270	129	101	1661	sum	950	211	270	129	101	1661
%FO	54	25	44	33	29	46	%FO	53	27	45	27	34	45

Table 4: Contingency table(s) for 0707 (6–18 h forecasts). EWGLAM station list.

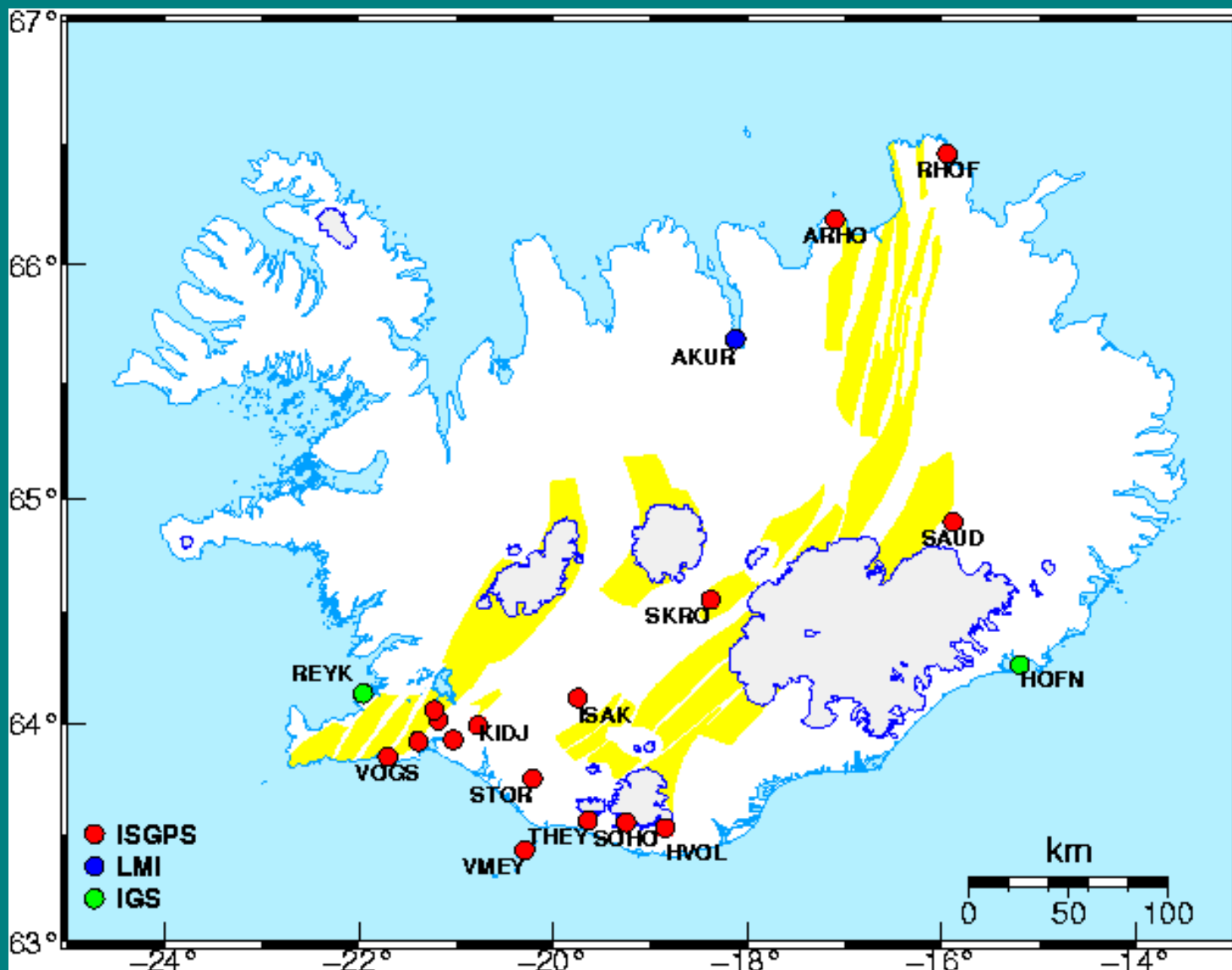
T1G 0707							T1D 0707						
$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum	$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum
F1	10142	343	170	40	23	10718	F1	10168	331	180	42	24	10745
F2	1442	463	357	61	35	2358	F2	1462	485	348	61	34	2390
F3	920	609	939	344	161	2973	F3	889	616	931	318	160	2914
F4	108	101	306	225	139	879	F4	108	86	322	254	156	926
F5	61	50	132	164	259	666	F5	46	48	123	159	243	619
sum	12673	1566	1904	834	617	17594	sum	12673	1566	1904	834	617	17594
%FO	80	30	49	27	42	68	%FO	80	31	49	30	39	69

Table 5: Contingency table(s) for 0707 (18–30 h forecasts). EWGLAM station list.

T1G 0707							T1D 0707						
$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum	$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum
F1	9978	348	231	52	45	10654	F1	9973	332	207	42	42	10596
F2	1522	462	344	83	51	2462	F2	1471	437	353	85	40	2386
F3	970	589	911	334	154	2958	F3	1023	646	898	348	167	3082
F4	131	113	278	209	141	872	F4	137	99	308	194	147	885
F5	72	54	140	156	226	648	F5	69	52	138	165	221	645
sum	12673	1566	1904	834	617	17594	sum	12673	1566	1904	834	617	17594
%FO	79	30	48	25	37	67	%FO	79	28	47	23	36	67

Table 6: Contingency table(s) for 0707 (30–42 h forecasts). EWGLAM station list.

T1G 0707							T1D 0707						
$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum	$\frac{\text{obs} \rightarrow}{\downarrow \text{for}}$	O1	O2	O3	O4	O5	sum
F1	9906	343	229	73	50	10601	F1	9911	361	254	74	53	10653
F2	1590	452	377	103	43	2565	F2	1580	453	396	88	44	2561
F3	935	621	877	337	199	2969	F3	944	581	842	372	182	2921
F4	134	104	268	194	152	852	F4	134	123	269	163	151	840
F5	108	46	153	127	173	607	F5	104	48	143	137	187	619
sum	12673	1566	1904	834	617	17594	sum	12673	1566	1904	834	617	17594
%FO	78	29	46	23	28	66	%FO	78	29	44	20	30	66



Discussion of status and plans for next period

- Milestones for years 1 to 4.

Other action items:

- Spanish network.
- Croatian GPS data?
- Setup of met data transfer facility to serve EUREF institutes.
- User requirements, data formats, data exchange (ftp/BUFR/?). Balance between decentralisation in data delivery and central quality control. Next expert meeting.
- Workshop, when and where.
- EUCOS. When. Central server facility apparently not clear soon.
- Automated quality checking running. Automated feedback: Report what to whom? Determined by expert teams?
- Clearer marking between operational and experimental data at E-GVAP server.
- Attempt to make MoU with GFZ and BKG? Yes, in connection with the expert meeting in Potsdam, May 2008.
- Attempt expanding network in non E-GVAP countries?

6: Future of E-GVAP, beyond next period.

- According to plan E-GVAP ends by March 31, 2009.
- By that time the E-GVAP ground based GNSS observing system should be mature and continue within EUCOS.
- Other EUMETNET programmes and EUCOS runs financially from January 1st to December 31st.
- EUCOS will in the present period have difficulties with its operations due to lack of funding (some EUMETNET partners have not paid their contributions to EUCOS).
- Some aspects of E-GVAP where it would be beneficial with a little more time
- Propose to ask for a 9 month prolongation of E-GVAP, in order to
 - Bring E-GVAP in sync with the other EUMETNET programmes
 - Give more time for implementation of E-GVAP into EUCOS
 - Give more time for E-GVAP observing system to mature prior to EUCOS overtake.

6: Future of E-GVAP, beyond next period.

Previously WINPROF have had a 8 month prolongation.

The scheme for a prolongation would consist of:

4. Proposal of prolongation to PB-OBS, June 2008. Could be made by E-GVAP team and based on completely similar setup as now, except scaled with 9/12 as regards economy. Presented to PB-OBS by Henrik.
5. PB-OBS to recommend/dismiss proposal at PB-OBS in November 2008.
6. Council to accept/dismiss proposal at meeting in December 2008.

In E-GVAP we have to discuss and decide whether we think it is beneficial to the observing system that we are developing to start this procedure. Other, higher, people will decide whether it is acceptable economically and otherwise.

Next meeting = 6'th plenary meeting

- EUREF symposium primo June, 2008
- PB-OBS meeting ultimo June, 2008.
- Meeting before/after summer?
- Ultimo May or mid June.
- September.

7'th plenary meeting

- January 2009

Workshop

-

Other matters

Fin

- Many thanks for your participation.
- In particular thanks to Michel and his local co-workers for organising the meeting.

An example of data quality and validation problems

