E-GVAP

Meteorology and geodesy synergy

E-GVAP

The EUMETNET GPS Water Vapour Programme

Purpose

The main purpose of EGVAP is to provide ground based GPS delay data in near real time (NRT) for use in operational numerical weather prediction (NWP) models and in now-casting to the participating EUMETNET members.

Important requirements to meteorological data used operationally.

- Reliable: Contineous quality checking and validiation.
- Homogeneous: Quality not (too strongly) depending on site or region.
- Contineous: Problems with data delivery or quality are reported upstream and cured…

Why do we want ground based GPS delay data?

GPS delays are related to water vapour!

In fact

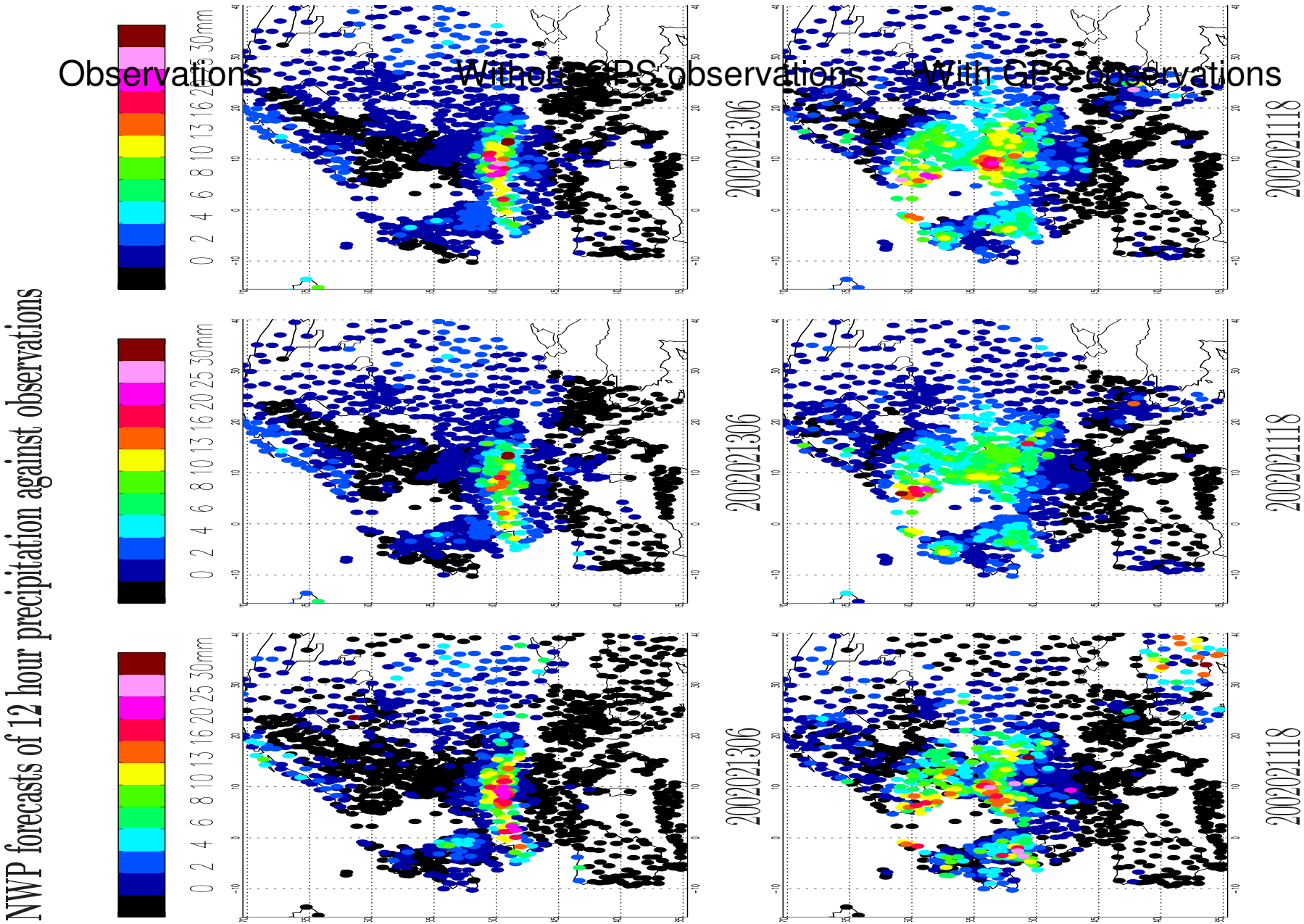
- ZTD = ZHD + ZWD
  (Total = ’dry’ + wet delay)
  2.3m= 2.0m + 0.3m
- ZHD is proportional to local pressure
- ZWD is proportional to the amount of water vapour above the GPS site

- NWP models predict ZHD with much higher accuracy than ZWD!
- Our measurements of pressure (ZHD) are much better than of water vapour.

Water vapour is an extremely important ingredient of the atmosphere.

- Water vapour plays a key role in the transfer of energy to and in the atmosphere.
- Water vapour is crucial in forecasting precipitation and important to atmospheric dynamics.
- Water vapour is the most important and most variable greenhouse gas.
- The current water vapour measurements are very coarse in time and space. Quality problems are not on-common, some of them systematic.
- We are neither capable at observing nor modelling water vapour in sufficient detail.

But, can we acutally utilise ground based GPS data?



Impact study from TOUGH project, by Vedel & Huang, DMI

- Many impact studies indicate that assimilation of gb GPS data improves NWP model skill, in particular forecasting of medium to heavy precipitation.
- Studies indicate that gb GPS data can improve now-casting in certain sitatuations
- Gb GPS data can help identify poor radiosondings if sites are near enough.

- Statistical confirmation weak, but strengthening.
- Problems with GPS data quality/homogeneity apparent.

EGVAP is started now (2005-04-01), rather than tomorrow, to build on and further the COST 716 results and collaboration.

COST 716 itself has ended, but the NRT processing and collection of gb GPS delays is continuing, in part via other projects (e.g. TOUGH) and in part by independent contributions.

COST 716 NRT demonstration project

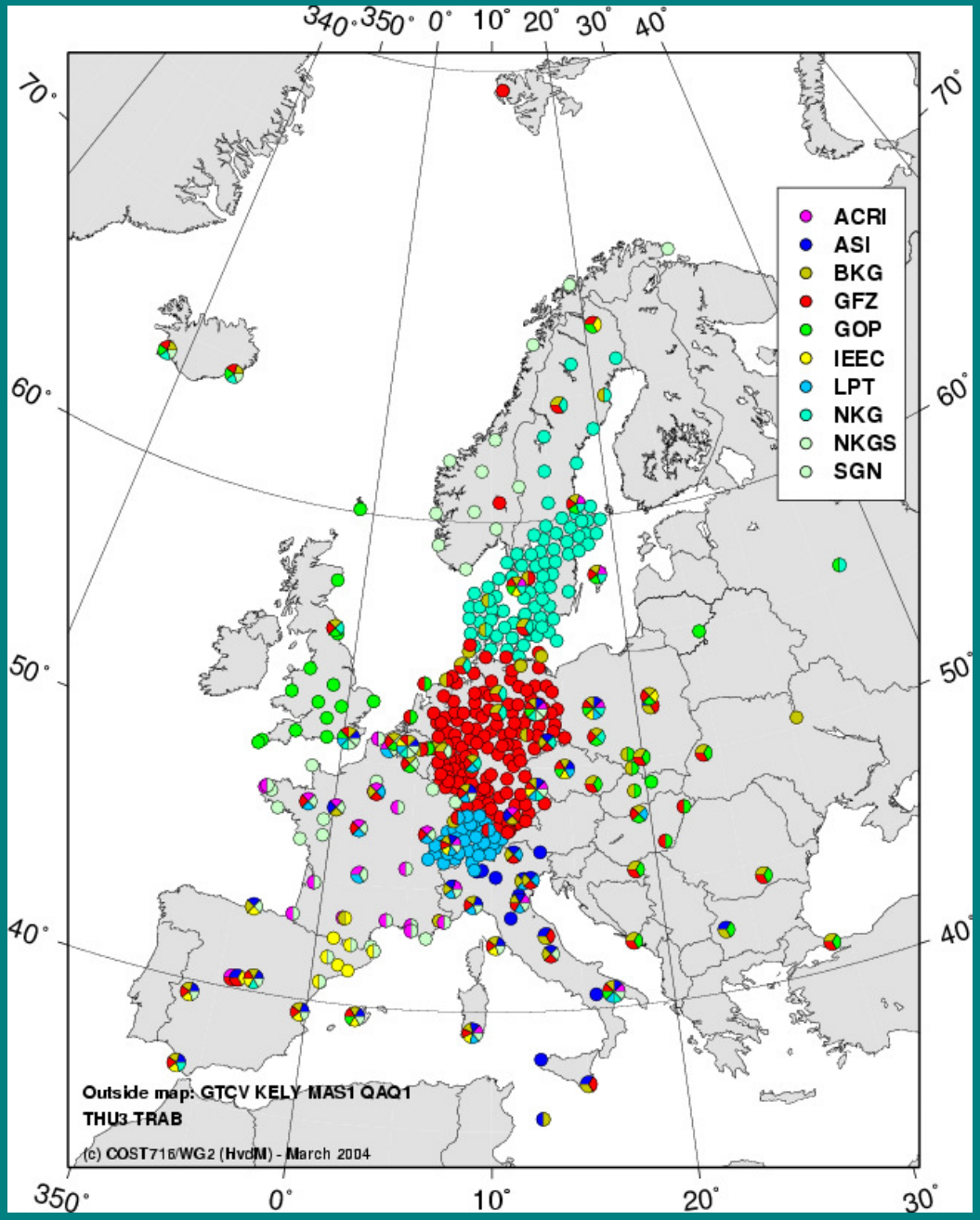
Started March 2001.

Status March 2004:

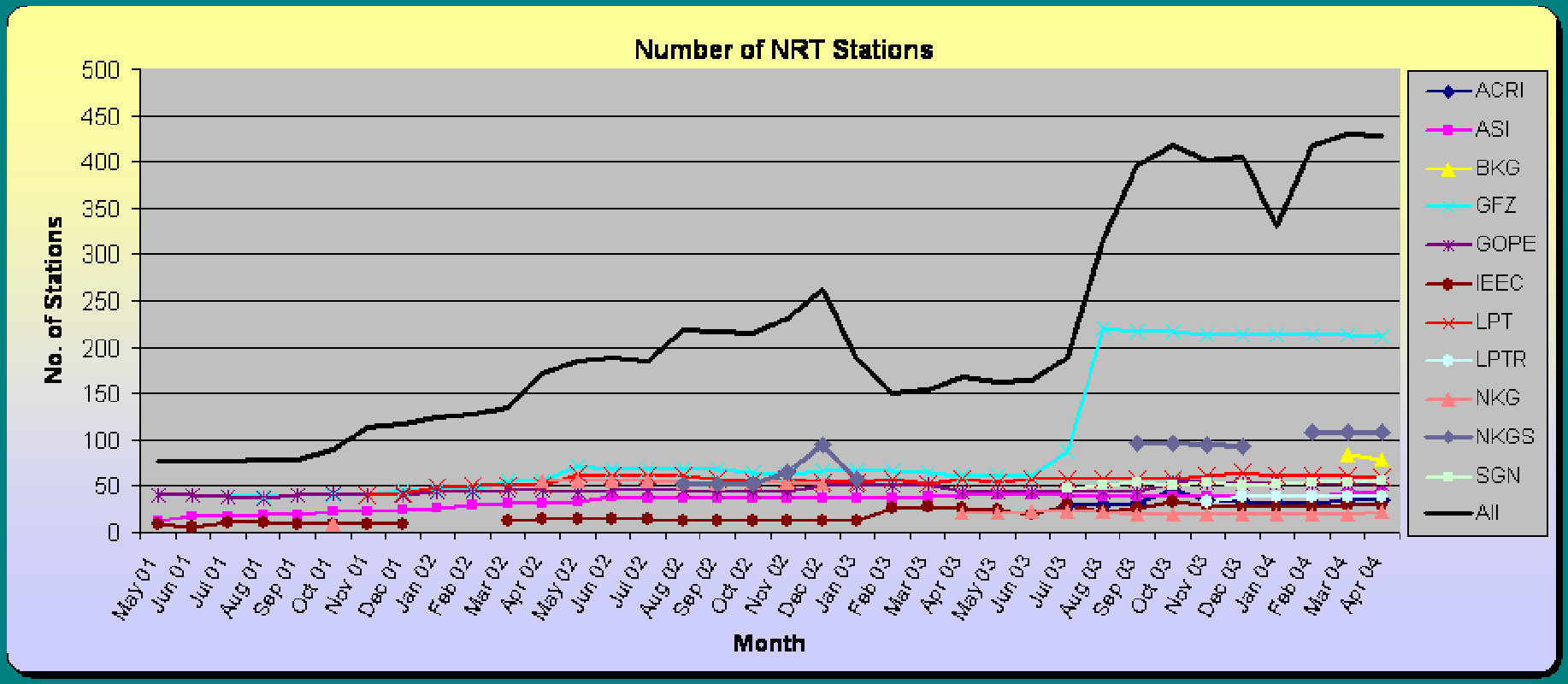
- 428 stations
- 10 operational GPS processing centres:

GFZ, GOPE, IEEC, ASI, LPT, NKG, NKGS, ACRI, SGN, BKG

http://www.knmi.nl/samenw/cost716.html



Time development of NRT GPS water vapour data in COST 716



COST 716 ended spring 2004

E-GVAP programme setup

- Manager (responsible member). Setup and running of programme, reporting, connections to third parties.
- Database and processing centre. NRT gb GPS delays database, processing of some gb GPS data.
- Validation centre. Quality checking and validation. Moving toward automatisation with feedback to processing centres and GPS sites/site owners.
- Operational liason group. Collaboration between E-GVAP and geodetic community
- Expert team on data processing. Improving data quality and homogeneity, through better processing.
- Expert team on using GPS water vapour data. Assisting members in using GPS water vapour data

EGVAP project team

- Management. Danish Meteorological Institute (DMI), Henrik Vedel.
Email:egvap@dmi.dk
- Database and processing. UK Met Office (MetO), Jonathan Jones, Adrian Jupp, John Nash, and Dave Offiler.
Email:dave.offiler@metoffice.gov.uk
- Validation. Royal Netherlands Meteorological Institute (KNMI), Siebren de Haan.
Email:Siebren.de.Haan@knmi.nl

EGVAP countries

1. Belgium
2. Denmark
3. Finland
4. Iceland
5. Ireland
6. Netherlands
7. Norway
8. Spain
9. Sweden
10. Switzerland
11. United Kingdom

E-GVAP economy

Project management	43k€
Liaison group meetings	15k€
Expert Team meetings	10k€
Data hub/processing centre	25.5k€
Validation centre	25.5k€
Project Travel	10k€
Total per year	129k€
Total over four years	516k€

- Formally it is the responsibility of each national met service in EGVAP to establish a collaboration with the national GPS station owners and eventual national processing centre. EGVAP central can be involved in setting this up.
- On the GPS data owner and processing side there are important countries, currently providing many data to the COST716 dataserver, whose met service is currently not in EGVAP. In EGVAP, however, we want to further from COST 716 the collaboration with those despite the current (in most cases likely transient) lack of interest nationally.

Nature of E-GVAP

- EGVAP is not a programme in which everything is expected to be running and formalised from day one.
- The focus is on a gradual tightening of the GPS – meteorological collaboration, toward something which on the one hand satisfies the needs of operational meteorology, in terms of data availability, reliability, amount, and on the other hand is beneficial also to the geodetic community.

What do we expect we can provide the geodetic community?

Meteorological data.

1. Observations, e.g. radiosonding data
2. NWP model data

Both useful for validation currently, in the future likely also for processing, e.g. improving on the ’a priori Niell map. fct.’, or providing a forecasted a priori estimate of the atmospheric delays in different directions. Speedup in positioning.

Monitoring and validation. In EGVAP automated monitoring and validation with feedback will be set up.

Cost sharing.

The national meterological agencies controls many little pieces of land, nicely equipped with power, data links, fence, and regular visits for maintainance. It would be natural to place some of the future GPS stations at such sites.

In addition to the cost sharing this will make validation against other observations or use of other observations in the processing more straight forward.

…

Conclusion

E-GVAP has been started in April 2005 to enable and coordinate collection and distribution of European near real time ground based GPS water vapour measurements to EUMETNET members for operational meteorology.

We look forward to a tightening collaboration with the geodetic community, both GPS station owners and data processing centres.

The ’liason group’ and the ’expert teams’ will soon be formed, establishing new links between meteorology and geodesy.

Conclusion, cont.

The EGVAP people responsible nationally for the EGVAP geodetic collaboration will soon be apointed.

In non EGVAP countries with strong GPS-meteorological activitivies, e.g. Germany, France, Italy, and others, we hope that contacts can be made directly between the GPS processing centres and the EGVAP team. (We expect that later many of those countries will join EGVAP.)

Further information

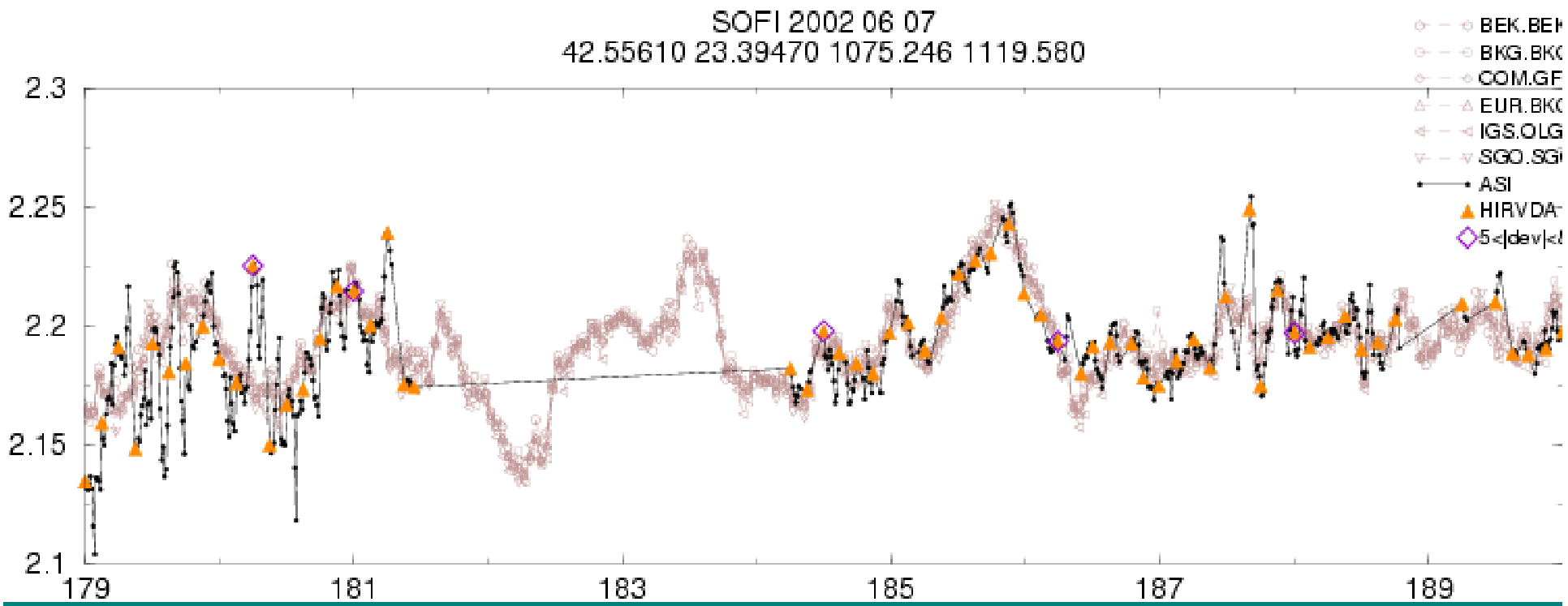
- http://egvap.dmi.dk
- Email: egvap@dmi.dk

- http://tough.dmi.dk

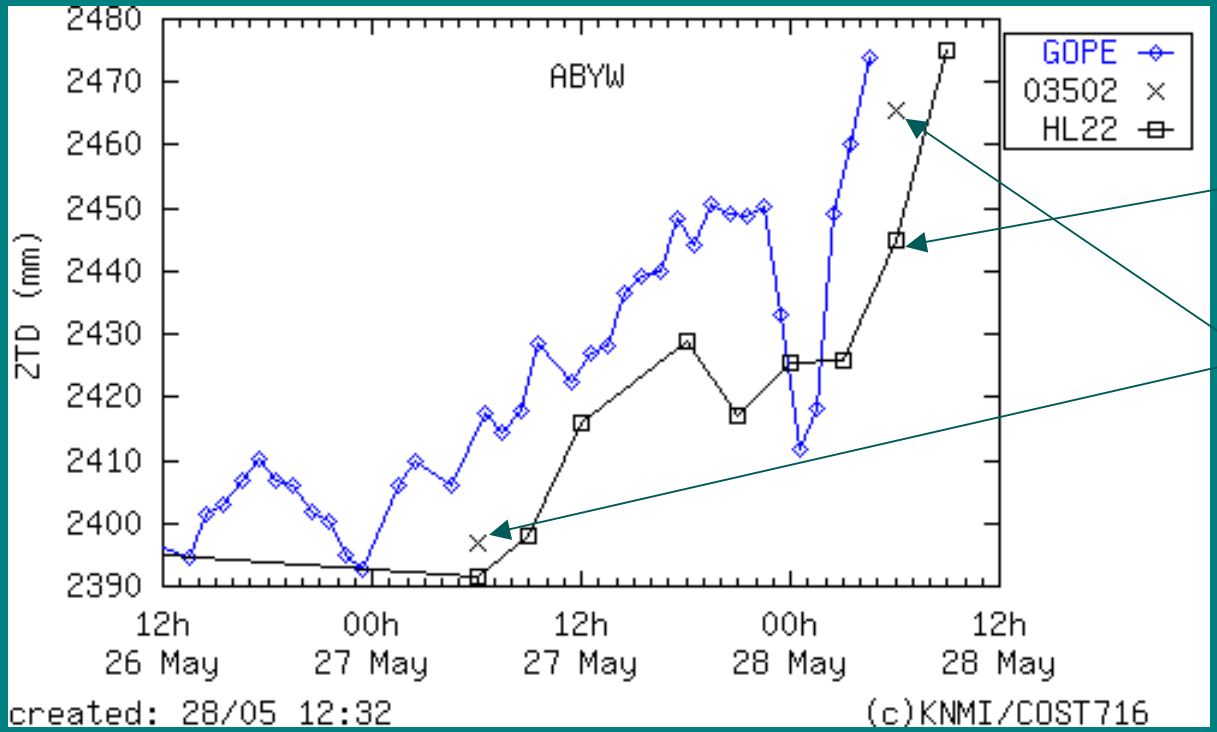
(with link to COST716 homepage)

Note: TOUGH workshop on GPS-meteorology, presenting TOUGH results, on Friday, September 30, at UK Met Office.

An example of data quality and validation problems



Validation example



Validating model equivalents

Validating radiosonde observations

Nature of GPS water vapour measurements

- GPS measurements are sensitive to atmospheric mass, in particular to water vapour, which delays the GPS signals (noise in GPS positioning).
- Determination of delays in NRT require data from a set of GPS receivers with a certain geographical coverage.
- Extremely stable in time and not significantly degraded by some types of weather, contrary to radiosondes.
- The frequency of observations is very high, currently 15 to 30 minutes.
- Compared to radiosondes the horisontal resolution is high while the vertical resolution is poor.

- Many GPS receivers have already been installed, by national mapping agencies, private companies, etc.

- The task is to aquire the data, and to get them processed properly and forwarded to meteorological users in near real time. And to get new stations in regions with poor coverage.

NRT GPS data providers

GPS data providers in COST 716:

- International GPS Service (IGS)
- EUREF Permanent GPS Network (EPN)
- National Mapping Agencies
- National Meteorological Services
- Universities and research networks
- Private companies

GPS data collection is handled by the analysis centres, these centres will often have access to unique sources of data which are otherwise not available to the public.

Purpose of E-GVAP

- Enable and coordinate collection and distribution of European near real time ground based GPS water vapour measurements to EUMETNET members for operational meteorology.
- Work to gradually increase quality, amount, and geographical coverage of GPS water vapour data.
- Assist members in utilising GPS water vapour data.

E-GVAP objectives (1)

- Prepare and coordinate future operational processing of GPS water vapour on both European and national scales.
- Transfer from research funding to operational service as far as possible in liaison with the geodetic community.
- Establish a data hub for GPS ZTD, and a quality monitoring facility with feedback to data GPS data processing centres and data providers.

E-GVAP objectives (2)

- In collaboration with geodetic community establish a long term policy for processing operational GPS water vapour measurements.
- Coordinate national/regional processing efforts to ensure availability and homogeneity of data from the whole of Europe.
- Help improve meteorological collaboration with operators of national GPS sensor networks,
  - e.g. sharing facilities for reducing operational costs (common sites, data transfer)
  - e.g. providing feedback of meteorological data (various validation, possibly later forecast of mapping functions)

E-GVAP objectives (3)

- Review data processing strategies to improve data quality.
- Assist members in utilizing GPS humidity data by writing of documentation and reporting on the use of GPS water vapour data in NWP, now-casting, and verification.

The way ahead…

- Operational EUMETNET project proposed at COST final workshop. Tackles the challenge of coordination between voluntary organisations (IGS, EUREF,..), private companies, and operational meteorology.
- Geodetic interface to the EUMETNET project*)
  - Task given to group of four geodetics by the COST 716 MC
  - Suggested to contact EUREF and IGS first
  - Letter of COST 716 chair to EUREF/TWG chair
- GPS meteorology research continued in EU project TOUGH (2003-2006)

**) the mandate is a little broader: the complete meteorological community*