# GPS Meteorology in Europe

## COST716, EUREF and EUMETNET

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# Issues addressed

- What can GPS geodesy do for meteorology? The COST716 results.
- The organisation of meteorology
- A proposal to tackle the challenge of co-ordination between voluntary co-operations (EUREF, IGS) and operational public meteorology

# GPS meteorology: results from COST716

- Voluntary network for near real time exchange of atmospheric GPS data
- Meteorological GPS network requirements
  - Example: requirements for regional Numerical Weather Prediction (NWP)
- Applications development
  - Operational forecasting (nowcasting)
  - Numerical Weather Prediction
  - Climate monitoring and research

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# NRT Demonstration

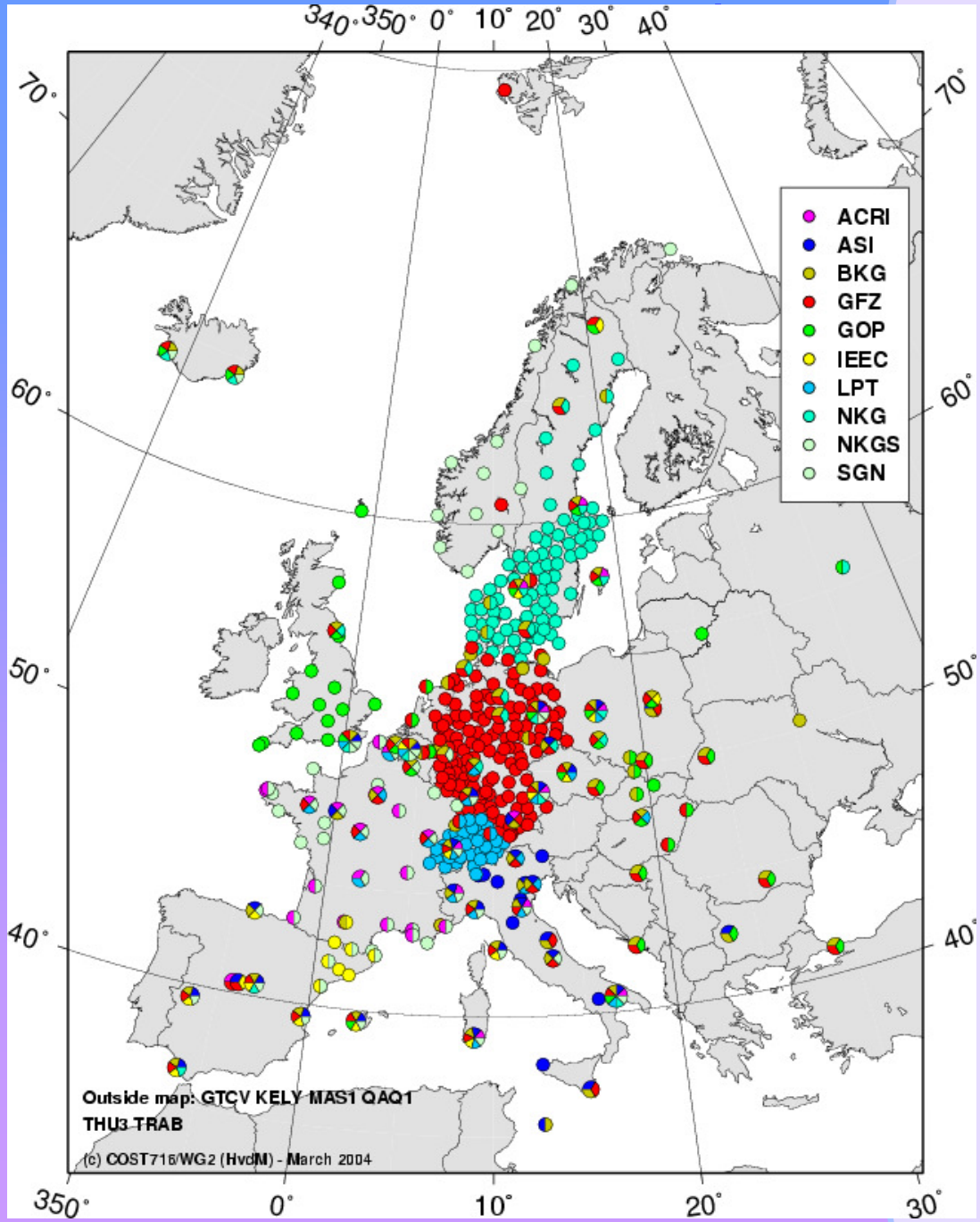
Started March 2001

Status March 2004:

- 428 stations
- 10 operational ACs:

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

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



# NRT GPS data providers

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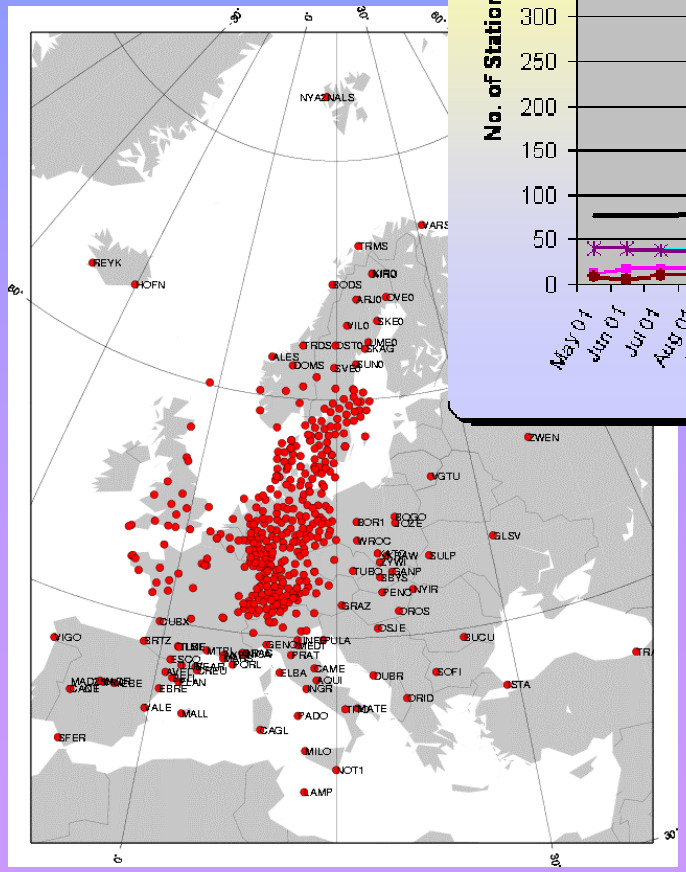
GPS data providers which contribute to the NRT demonstration are:

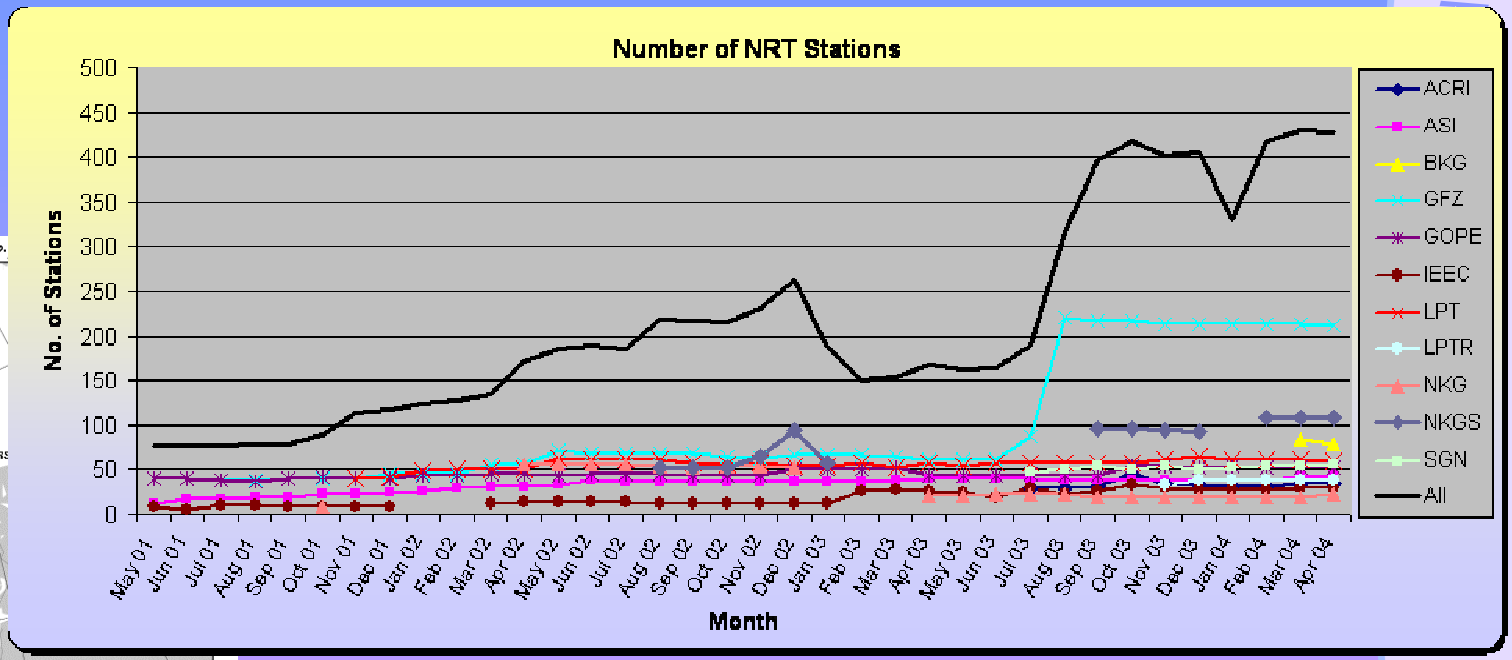
- International GPS Service (IGS)
- EUREF Permanent GPS Network (EPN)
- National Mapping Agencies (OS, BKG, SAPOS, SWEPOS, NMA, LPT, …)
- National Meteorological Services (Met.Office, DWD, …)
- Universities and research networks
- Private companies

GPS data collection is handled by the analysis centers:

- uses IGS and EPN data centers, completed with several local data centers, resulting in a dense network
- analysis centers often have access to unique sources of data which are otherwise not available to the public

# Development of NRT GPS meteorology





# Meteorological Requirements for NWP

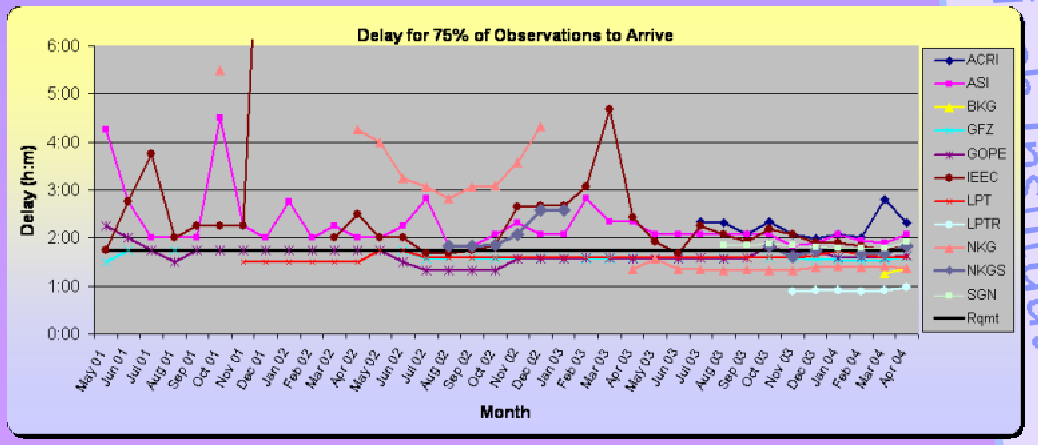
| | ZTD | |
|---|---|---|
| | target | threshold |
| Hor. domain | Regional | |
| Hor. distance | 30 km | 100 km |
| Rep. cycle | 15 ‘ | 60 ‘ |
| Integr. time | MIN(15’, Rep.cyc.) | |
| Accuracy | 3 mm | 10 mm |
| Timeliness | 30 ‘ | 90 ‘ |

} network design

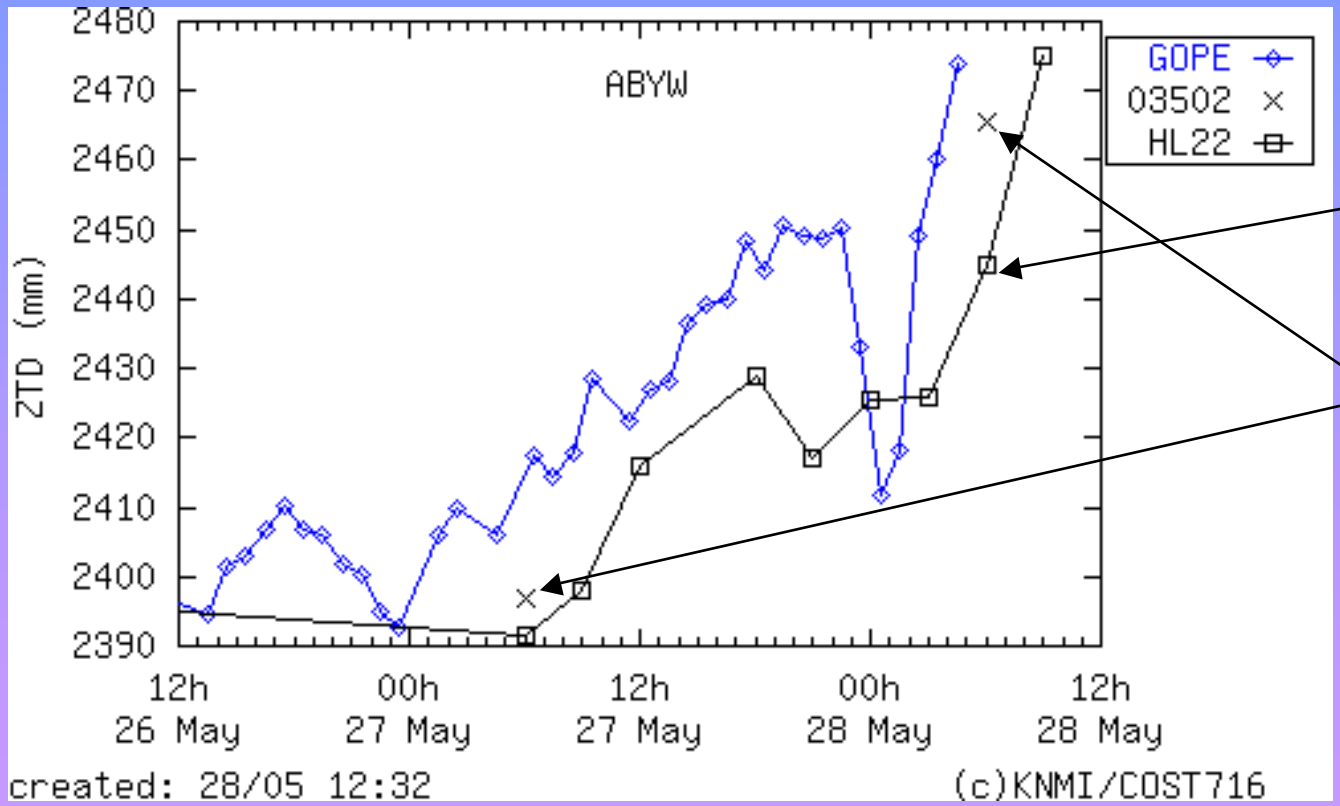
} processing strategy

→ See next slide or climate slide

Delay time in which 75% of obs have arrived →



# Validation example




Validating model equivalents

Validating radiosonde observations

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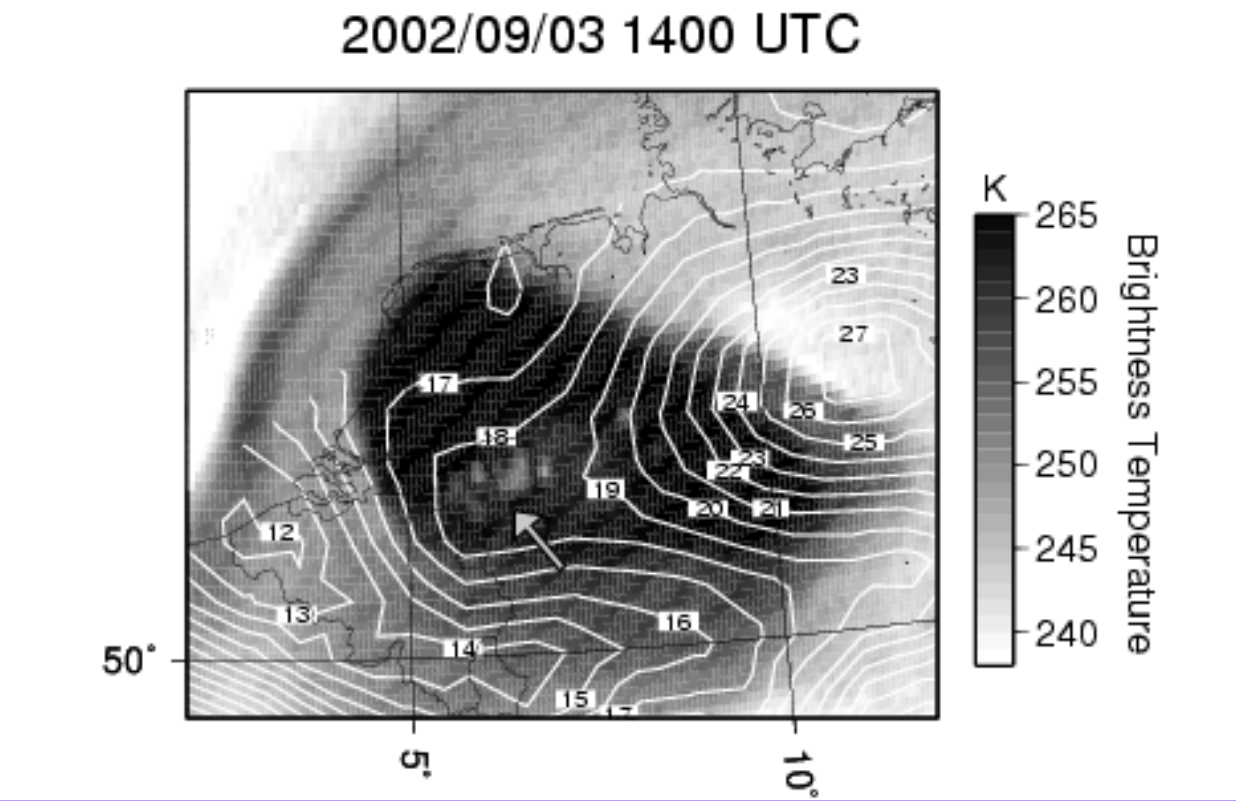
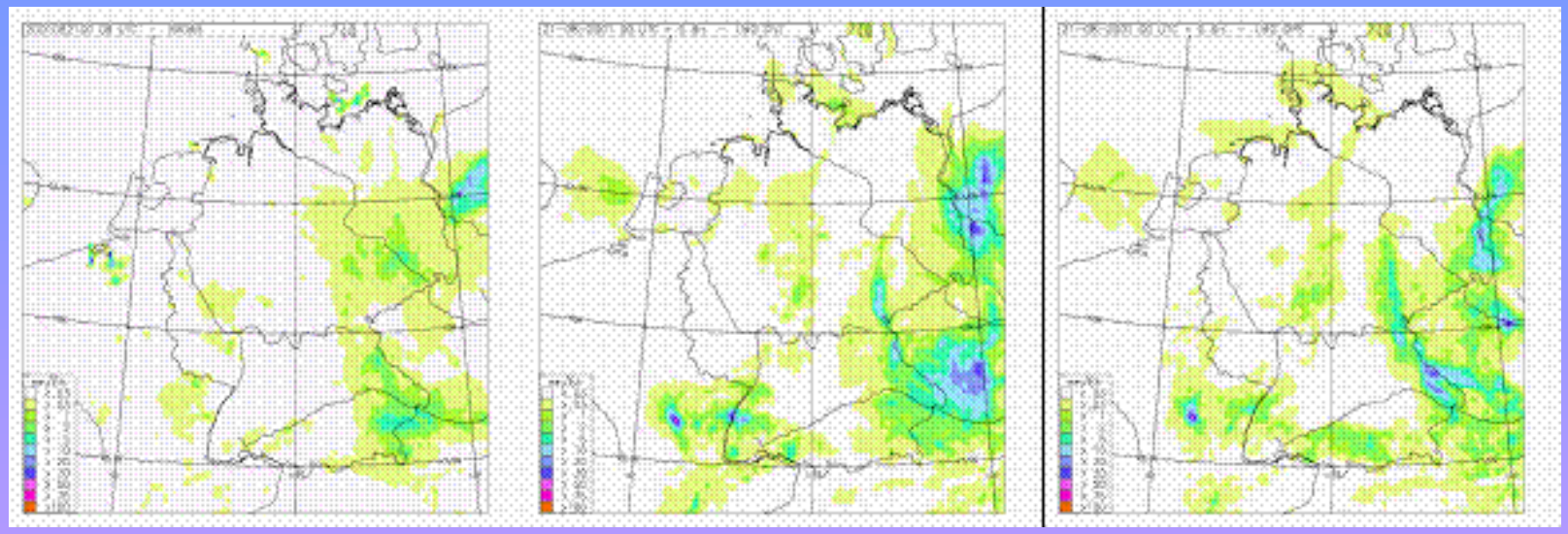
# Applications: Nowcasting



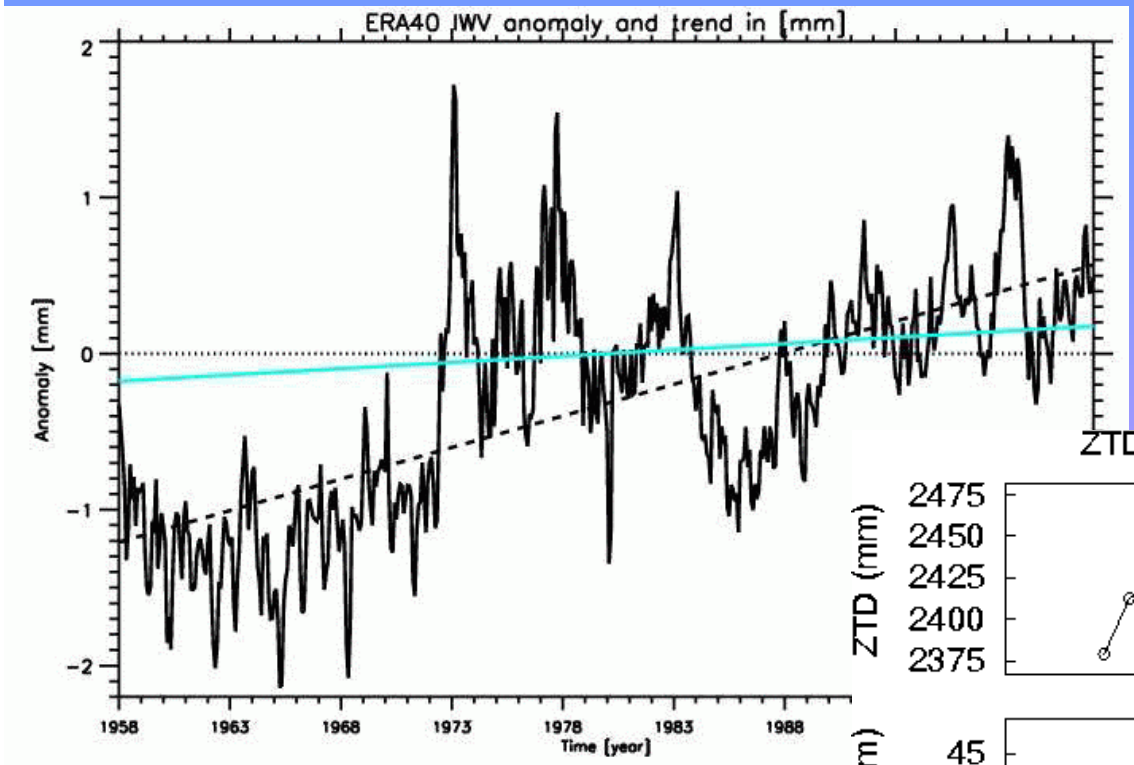

Thunderstorm development over the Netherlands
in conditions with ‘dry’ upper tropospheric eye (Meteosat image)
overlying higher lower level humidity (GPS contours)

# Applications: NWP



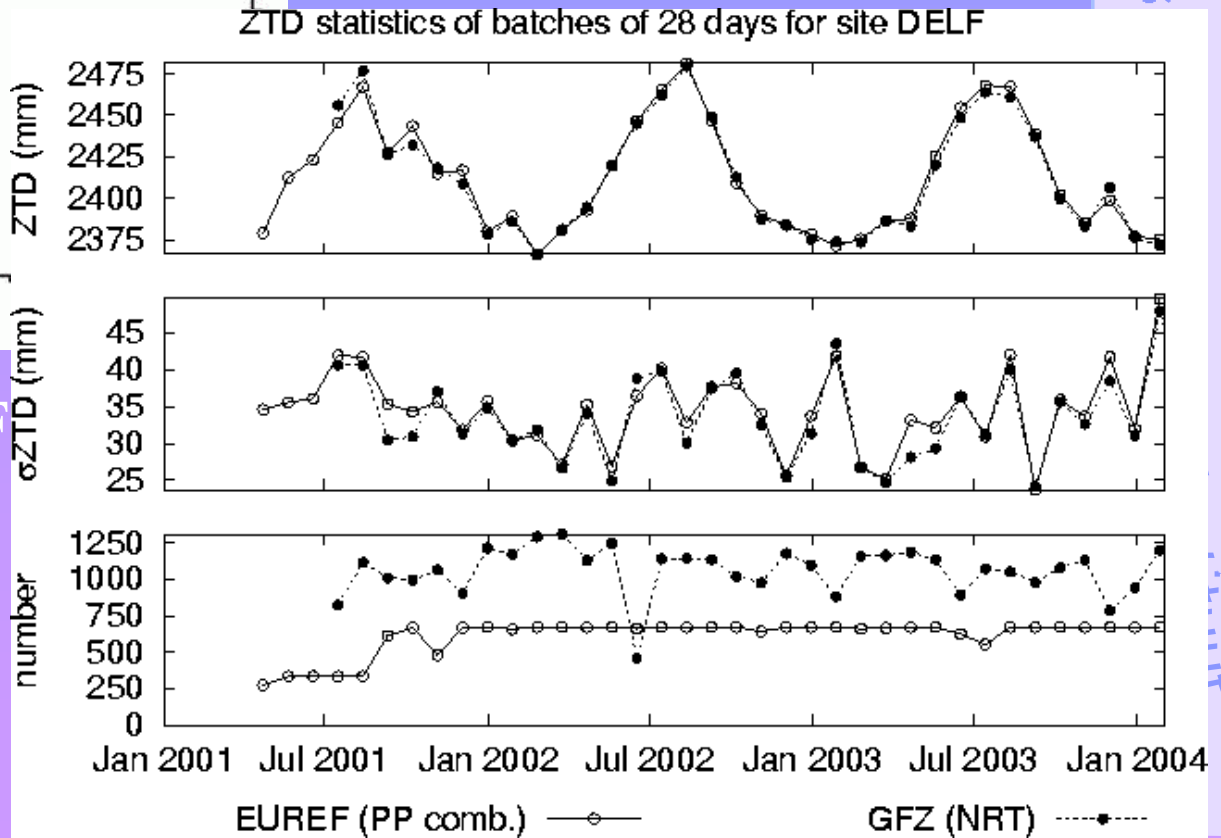
From left to right:
Radar rain observations
NWP forecast without use of GPS observations in analysis phase
NWP forecast with GPS

# Applications: Climate




The signal we must look for: IWV trend in re-analysed data is ± 0.05kg/m2/yr (blue line)

Differences between EUREF PP solutions and GFZ NRT Solution for Delft

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# The way ahead…

- Research continued in TOUGH (2003-2006)
- EUMETNET project proposed at COST final workshop
  - Organisation of National Meteorological Services
  - Special project proposed to take actions to prepare the European GPS water vapour network to function operationally
  - Proposal written by John Nash (Met.Office)
  - 3 year project to be started in 2005
- Geodetic interface to the EUMETNET project*)
  - Task given to Hans van der Marel, Elmar Brockmann, Hans-Peter Plag and Gerd Gendt by the COST 716 MC
  - Suggested to contact EUREF and IGS first
  - Letter of COST 716 chair to EUREF/TWG chair

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

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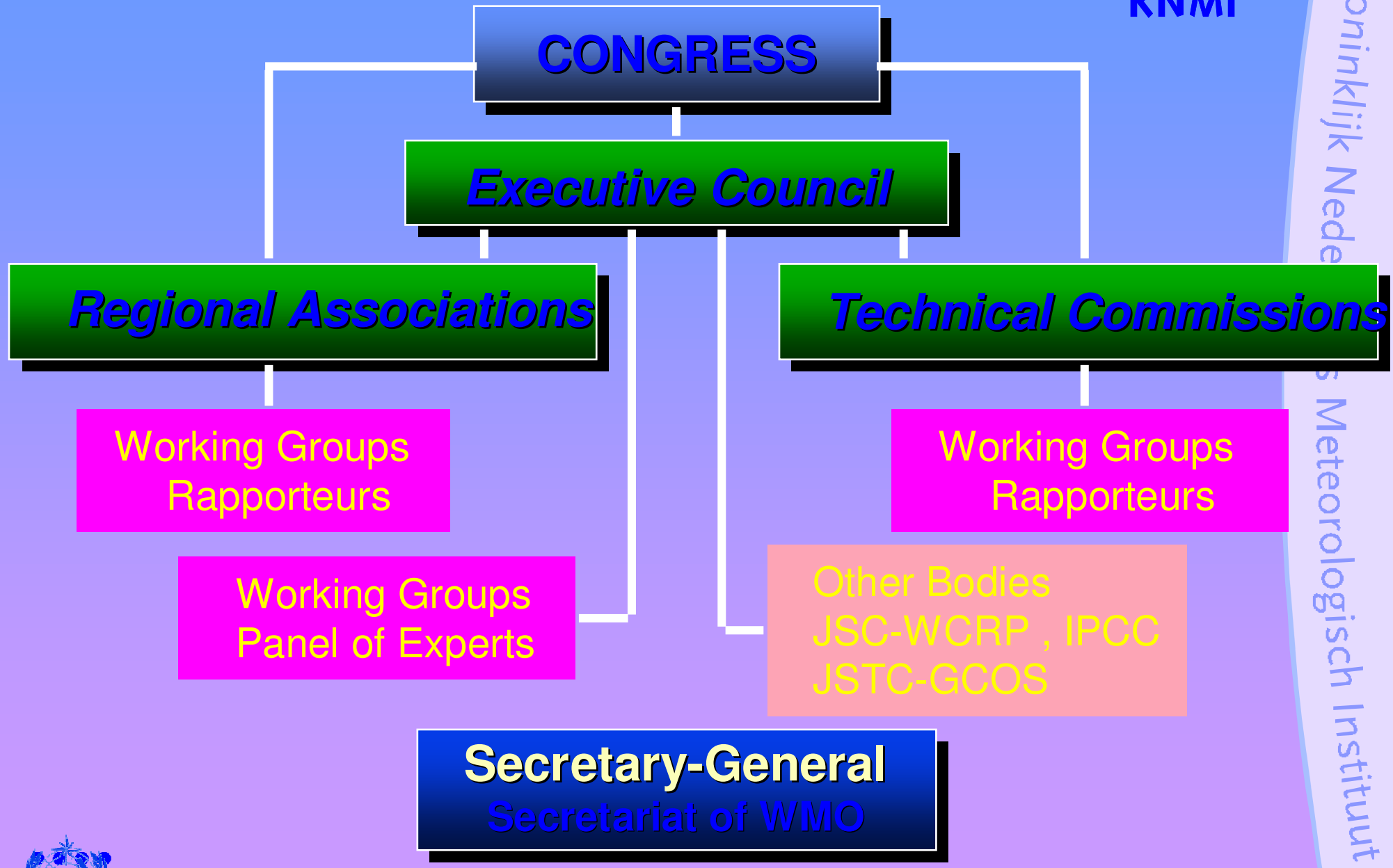
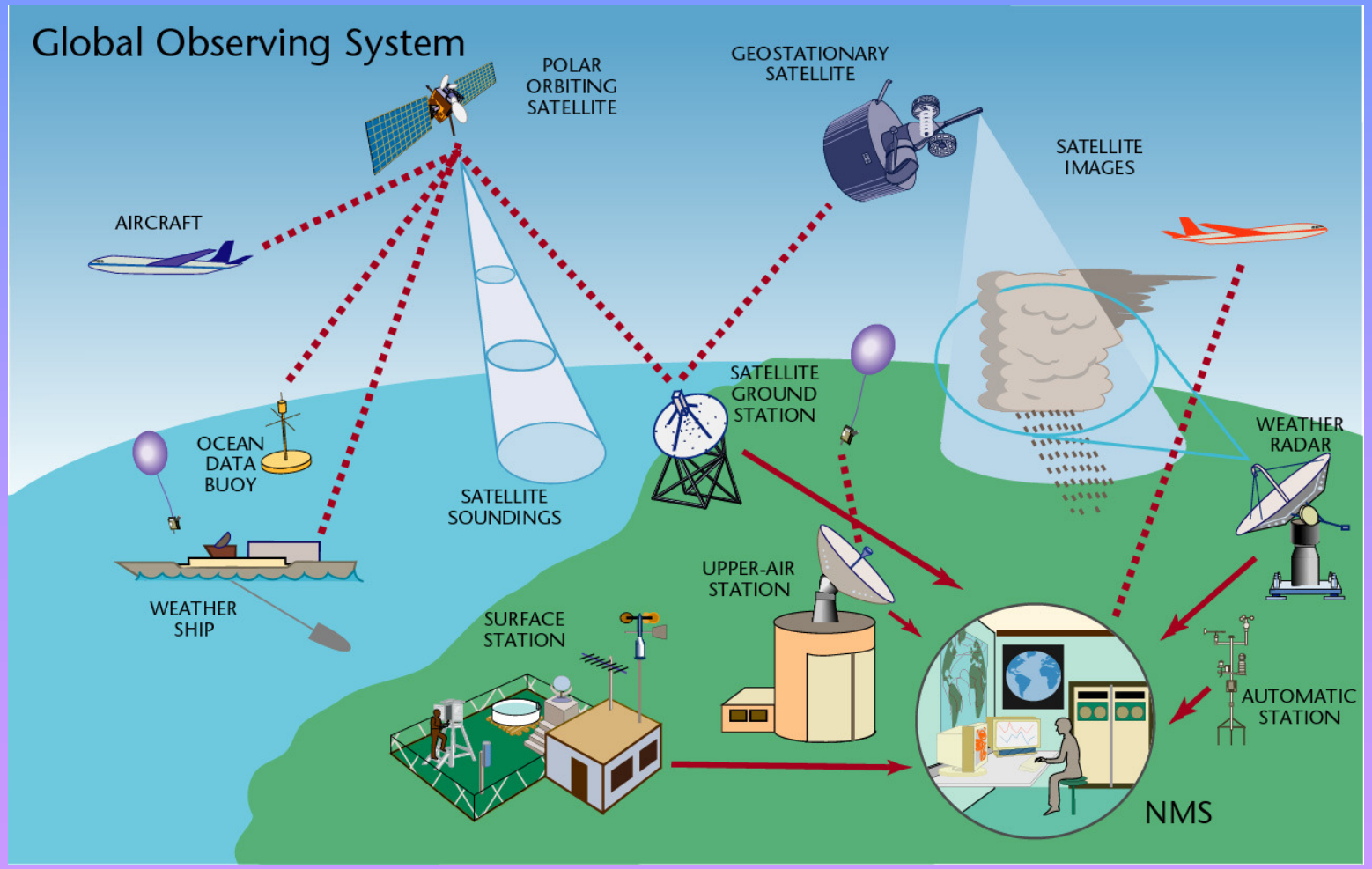
# Organisation of meteorology

- **World** Meteorological Organisation
  - Based on voluntary co-operation, but highly structured
- **European** organisations:
  - European Centre for Medium-range Weather Forecasts (**ECMWF,** global NWP)
  - European Organisation for the Exploitation of Meteorological Satellites (**EUMETSAT**)
  - European Meteorological Network (**EUMETNET**)
- **National** organisations
  - National Weather Services (governmental institutions)
  - Commercial Service Providers (companies)

# Structure of the World Meteorological Organisation



# World Weather Watch Programme
# GOS system



# EUMETNET, a conference of 19 European Meterological Services


- Scope of co-operation:
  - Obs systems
  - Data
  - Forecasting
  - R&D
  - Training/education
  - and <TBD> by council
- through:
  - Core programmes (GNI %)
  - Optional programmes
- structure:
  - Governed by Council (CEO's)
  - Guided by Co-ord. Office

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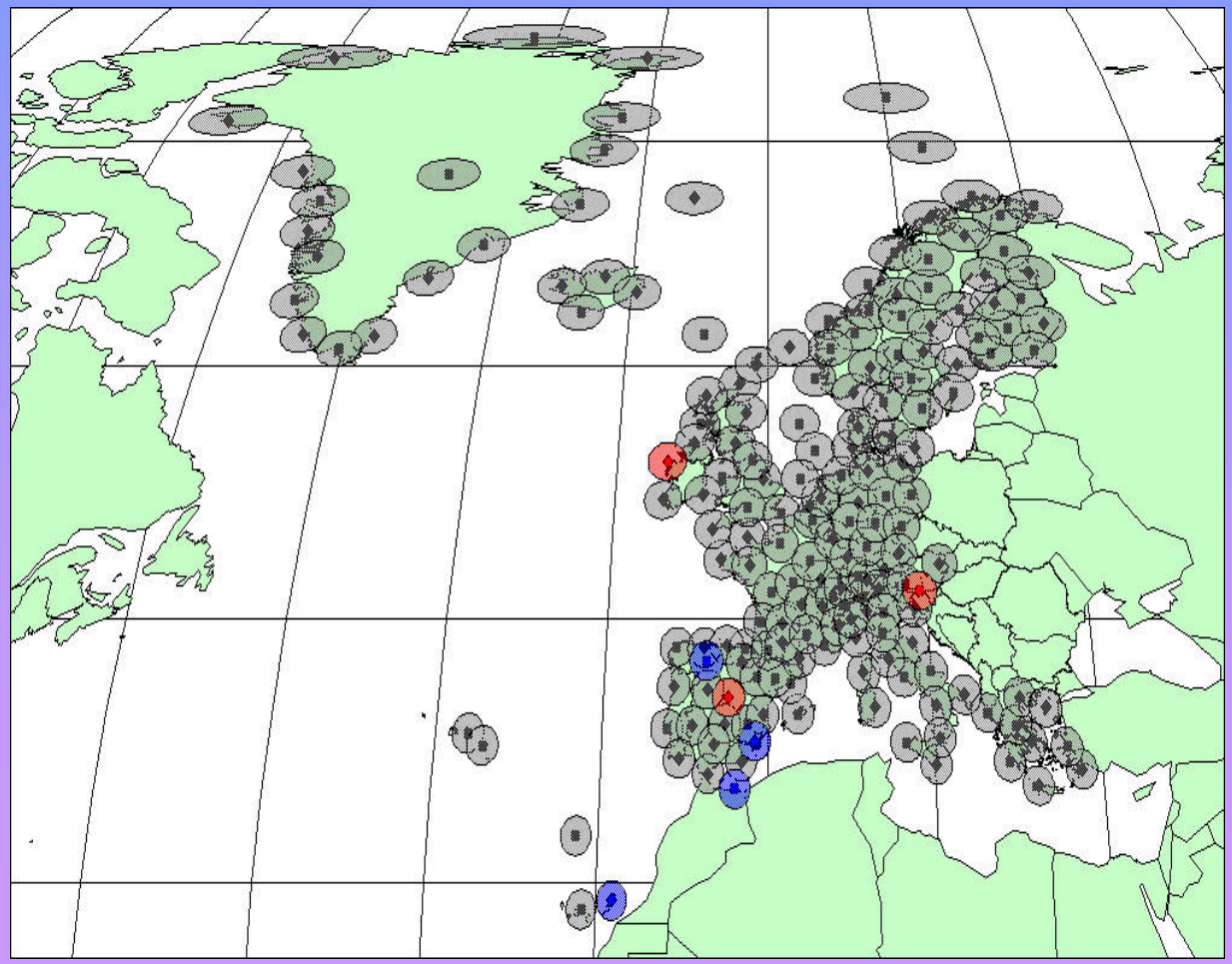
# EUMETNET programmes and projects

- Programme Board for Observations (PB-OBS) recommends a proposed new activity to Council (proposal commented by PB-OBS)
- Council decides on the new activity's scope and budget
- CO calls for responsible members using the proposed activity's description (proposal+ amendments), and time and budget constraints
- CO guides the selection process
- Council selects a responsible member
- Responsible member manages contracts (plus budgets) with others

# Project examples

EUCOS design (Eumetnet Composite Observing System) Surface obs component



Sensor studies and intercomparisons
Reports and guidelines

# A EUMETNET GPS programme

- Responsible member (manager) and 3 expert teams:
- Operational liason group
  - Ensure continuity of the European network
  - Promote cost/benefit sharing between parties
  - Liaise with geodetic community (data providers and processing centres)
  - Establish data processing policies
- Expert team on data processing
  - Review user requirements
  - Monitor (progress in) data quality
- Promote applications
  - Provide support and documentation
  - Review progess in applications

# EUMETNET (E-GVAP) Objectives

- Prepare and coordinate future operational processing of GPS water vapour on both European and national scales
- Transfer from research funding to operational service as fas as possible in liaison with the geodetic community
- Establish a data hub for GPS ZTD and quality monitoring facility
- Activities will be designed to improve meteorological collaboration with operators of national GPS sensor networks,
  - by sharing facilities for reducing operational costs
  - by providing feedback of meteorological data
- Liaise with geodetic data processing centers to establish a long term policy for processing operational GPS water vapour measurements, and to co-ordinate national/regional processing efforts to ensure availability of data from the whole of Europe
- Promotion, standards, etc.

# Potential benefits for GPS community

- Cost sharing
  - Common stations
  - Communications
- NRT quality monitoring hub
- Use of meteorological products
  - Atmospheric loading effects, a-priori ZTD for GPS processing
  - Mapping functions from numerical weather models
  - Atmospheric delay corrections for Network RTK
- Use of meteorological services
  - Calibration of pressure sensors
  - Management of meteo equipment at GPS sites by NMS