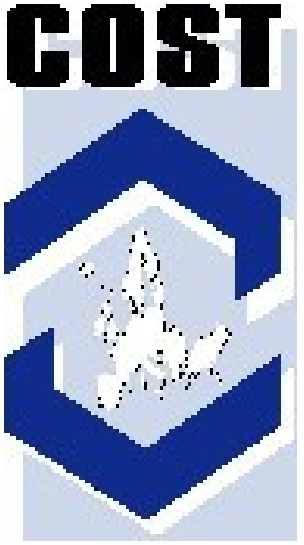


COST Action ES0702

Working Group on Data Assimilation (WG 2)

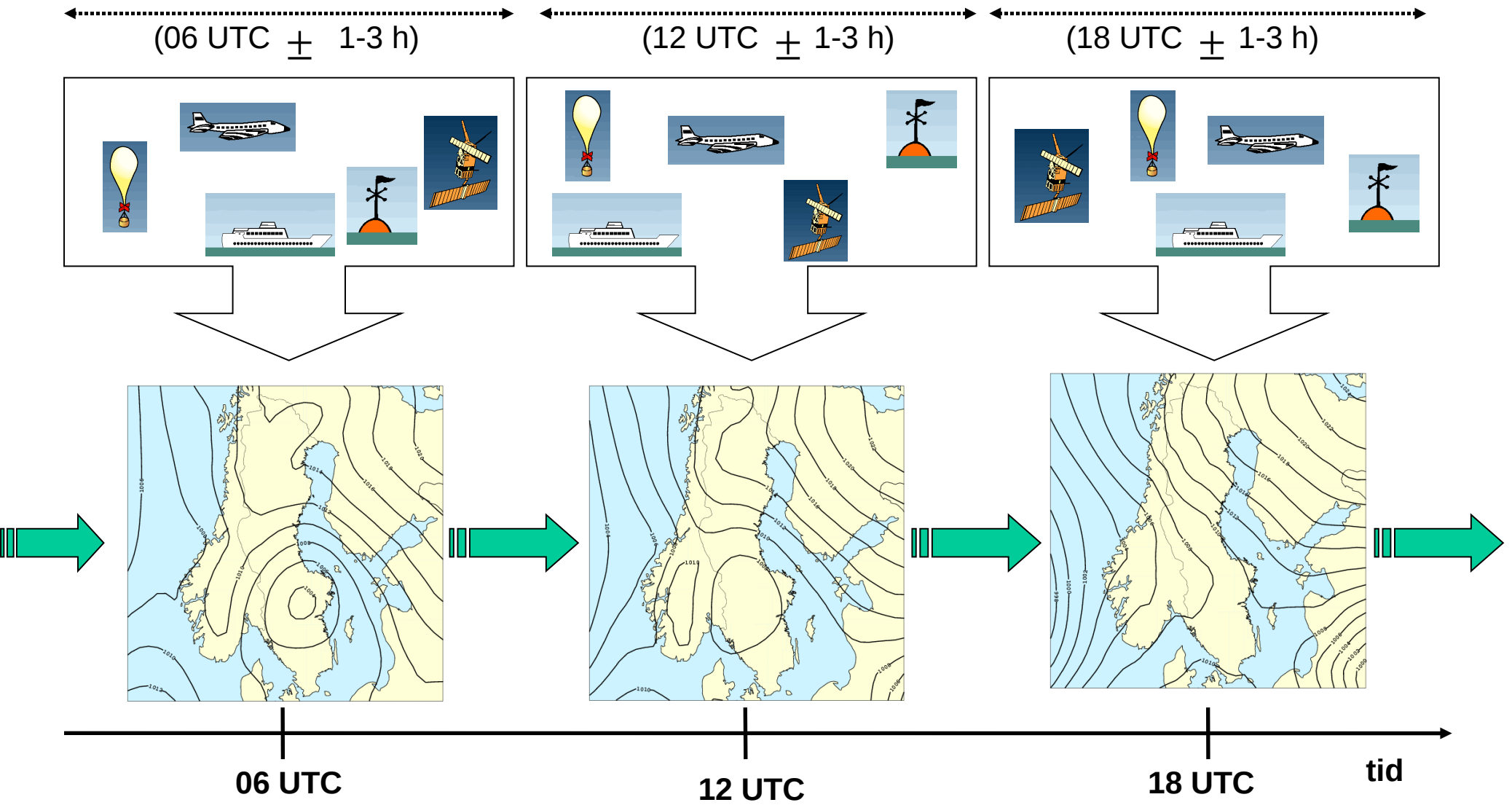
Chair: Per Undén

Goals of the action

- Develop Data Assimilation to fully exploit observations for
  - Weather forecasting at high spat/temp resolution
  - Validation of forecasts and observations
  - Evaluation of climate models
    - Model validation, detailed vertical structure, clouds
- Ground based observation of atmospheric essential climate variables

- Data assimilation goals
  - Identify impact at small scales, horizontal as well as
  - High temporal resolution
  - Analyse vertical profiles (better)
  - Error characteristics should be better known
  - Data assimilation results to be used for analysis of testbed exps and
  - To Quantify usefulness and cost-effectiveness ? (previous WG4 tasks?)
    - Difficult from OSEs alone to quantify
    - NOTE: EUCOS interest for this – but on European scale
    - We should concentrate on meso-scale impacts (~2 km) and push for EUCOS too...

Intermittent data assimilation

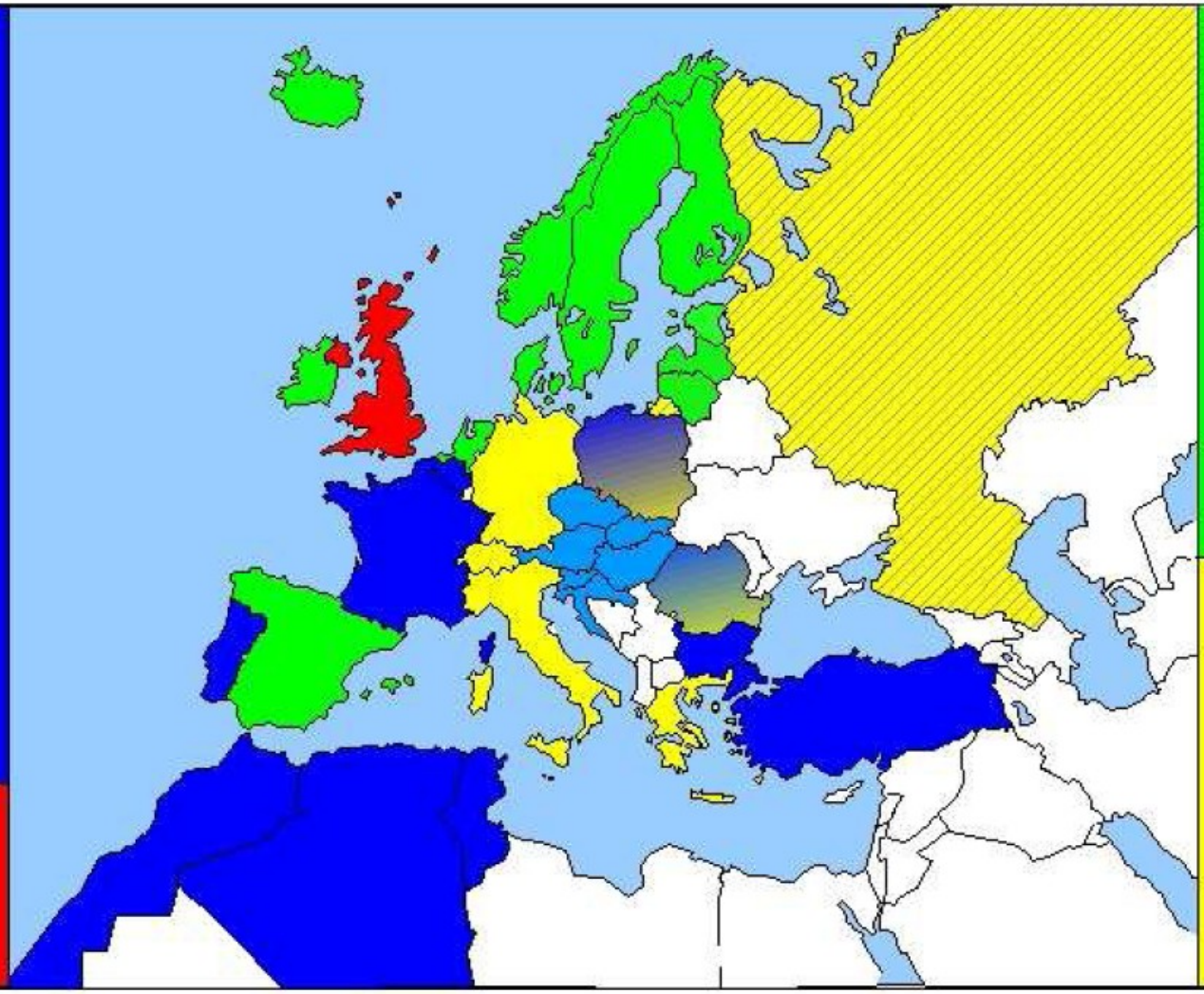


Data assimilation activities

- Test Different assimilation techniques ?
  - Variational methods, many differences in implementations still
  - Nudging method
  - EKF methods coming on line – important for fine scales where balances not explicitly known (model error structures)
  - Capability of (forecast) models:
    - Large(r) impact of modifying micro-physics
    - Difficult to assimilate directly
    - Models are nowadays advanced enough to represent microphysics, a pre-requisite for doing assimilation at all!

- Test Different assimilation techniques II
  - 1D techniques allow extra observations and local observations -
    - A test of instruments and tecniques
    - Cloud base and cloud top etc.
    - PBL height, inversion

SRNWP Consortia in Europe



ALADIN
Algeria
Belgium
Bulgaria
France
Morocco
Poland
Portugal
Tunisia
Turkey

Austria
Croatia
Czech Rep.
Hungary
Romania
Slovakia
Slovenia
LACE

UKMO
United Kingdom

HIRLAM
Denmark
Estonia
Finland
Iceland
Ireland
Netherlands
Norway
Spain
Sweden
(Latvia)
(Lithuania)

COSMO
Germany
Greece
Italy
Poland
Romania
Switzerland
(Russia)

Regional Assimilation techniques operational in SRNWP (Nov 2007)

- None (21 models)
- Surface only (3 models)
- Nudging (6 models)
- 3DVAR (16 models)
- 3DVAR-FGAT (4 models)
- 4DVAR (1 model)
- EnKF (0 models)

Compare different analysis systems?

- Most assimilation systems similar – but not set up in any comparible way – not scientifically meaningful to compare in ordet to find “best” system

Plan of WG2

- Survey of DA systems/algorithms and pros and cons
  - COST 731 survey to be extended and combined
  - General overviews to be prepared
  - Concentrate on observational exploitation
  - STATUS: started in COST731/702?

COST-731 DA inter-comparison project (FoUa, FoUp, …)

COST-731 MoU: *… building on the experiences from COST-717, investigate and compare different approaches to the assimilation of radar data in models of grid-length O(1km) - O(10km), possibly including 4D Var and Ensemble Kalman Filter …*

- possible framework for an DA inter-comparison project: WWRP project COPS (Convective and Orographically-induced Precipitation Study, www.cops2007.de) → DA test bed?
- possible candidates: ALADIN & AROME (FI, FR?, SE), COAMPS (PL), COSMO (CH, DE, IT), HIRLAM (FI, SE), Meso-NH (FR?), MM5 (DE, ES), UM (UK?), WRF (CY, HU), and the JMA model.
- time frame: 2008 - 2010

Data assimilation activities

- Error characteristics
  - Representativeness (error) more important than instrument errors
  - Model representativeness depending on resolution
  - Need to filter observations (R vs B matrix)
  - High resolution exps , 100s m and PBL t
  - Diagnostics from operational DA (innovations)
  - And from fitting best member ensemble forecast

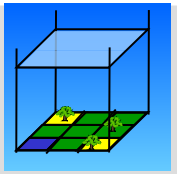
- Kalman filter analogue

- $X_a - X_b = \mathbf{B}H^t (H\mathbf{B}H^t + \mathbf{R})^{-1})(Y - HX_b)$

Young scientist group at Hamburg

OBS

Synthesis of Observations and Models

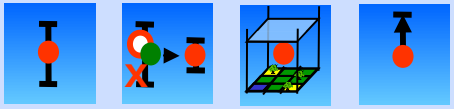


Model

Methods

„How to make models and observations comparable?“

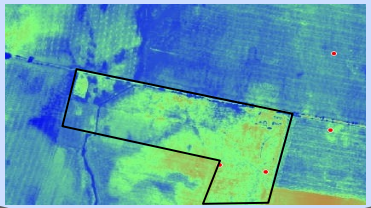
- Error models
- Comparison of „OBS-to-model“ and „model-to-OBS“ approach



Experimental

„How representative are (point-)measurements?“

- Wireless Sensor Networks (WSN)



Application

„Are our models physical consistent?“

- Multivariate Verification of the hydrological cycle

Felix Ament

Plan of WG2 IV

- Survey of obs operators and development of new ones where needed
- Include and revise error structures
  - Filtering of observations
  - Low level winds , necessary in order to be able to use them

Data assimilation activities II

- Direct use of observations or pre-retrievals ?
  - Some complicated operators or combinations of observations may warrant a pre-step
    - e.g more complicated drop size distributions not yet in models can be dealt with in 1D-VAR and retrieval error passed to 3D scheme
  - Different processing in different countries
    - Less preprocessing? Or necessary or beneficial?

Joint activities

- Impact studies - yes
- Testbeds - ?
  - Large effort to set up DA systems for new domains and observation streams – need to be warranted – good quality, representative, areal coverage etc.
  - Or: use DA results to validate testbeds and intercompare relative importance

HIRLAM impact studies in connection with development of observation operators

- AMSU-A over sea
- AMSU-A over land and sea ice
- AMSU-B
- HIRS
- Scatterometer winds
- MODIS wind
- MODIS water vapour
- SEVIRI water vapour channel radiances
- Radar radial winds
- Radar VAD wind profiles
- Wind profilers
- GPS zenith delays
- GPS slant delays

HIRLAM impact studies for EUCOS; met.no

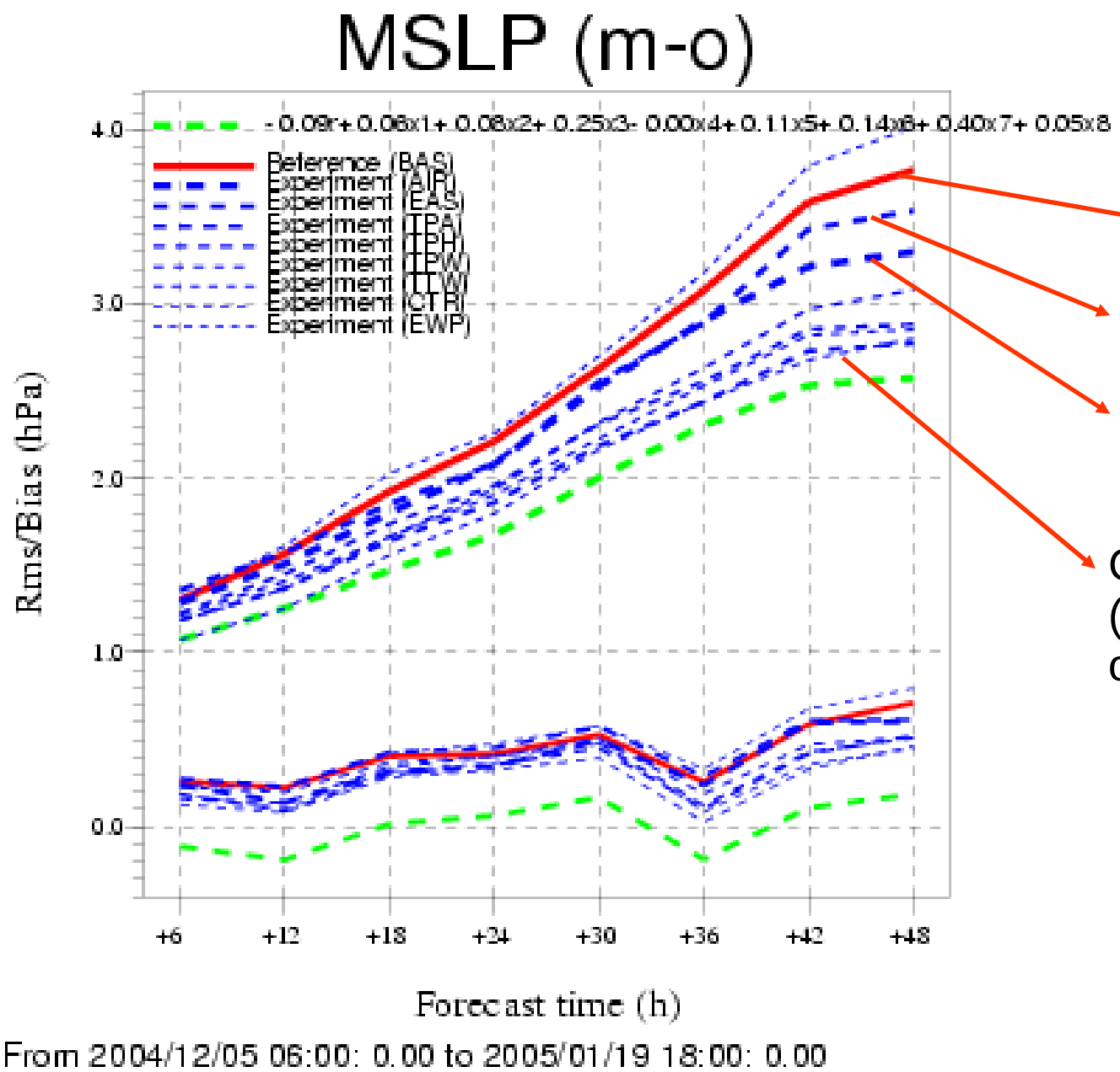
Scenario	GUAN+GSN Buoy, QScat ATOVS,AMV	All RSONDE Wind	All RSONDE Temp.	All RSONDE Hum.	AIREP	EWP	E-ASAP	Other conv. obs.
1 BAS	X							
2 AIR	X				X			
3 TPW	X	X						
4 TTW	X	X	X					
5 EWP	X					X		
6 TPA	X	X	X		X			
7 TPH	X	X	X	X				
8 CTR	X	X	X	X	X	X	X	X
9 EAS	X						X	

Table 1: Overview of experiment characteristics

Extra

- Studies performed at DMI and met.no, observation scenarios specified from EUCOS
- Two periods: December 2004-January 05 (storms passing Northern Europe), August 2005
- HIRLAM 3D-Var with AMSU+Scatt+Meteosat AMV

Results – all scenarios, winter period



Baseline scenario

Add E-ASAPs

Add AIREPs

Control Scenario (all available in-situ observations)

EUCOS studies met.no; conclusions

- Conventional observations have large positive impact in our system
- TEMPs dominating factor for analysis quality in precense of satellite data, wind more than temperature (but developments ongoing towards more use of satellite: AMSU over land, advanced sounders, …)
- No significant effect of adding moisture information (could also be seen as an assimilation algorithm problem)
- Aicraft data complement TEMPs (positive impact of adding aircraft in the presence of sondes), but to much larger degree in winter (by chance?)
- Negative impact from EWP: revising QC and data selection did not help (more work needed?)
- Significant positive impact from E-ASAP network (also excluding Mike+Ekofisk)

HIRLAM Summer time convection CIS

Select a summer month, based on data availability (radar radial wind data)
European area with 10 km hor. resolution (5 km later)
Observations as in the Atlantic scale CIS + Radar radial winds + Groundbased GPS zenith delays + SEVIRI cloud-free water vapor radiance data

(To be prepared and to be run soon)

Regional impact studies: overview

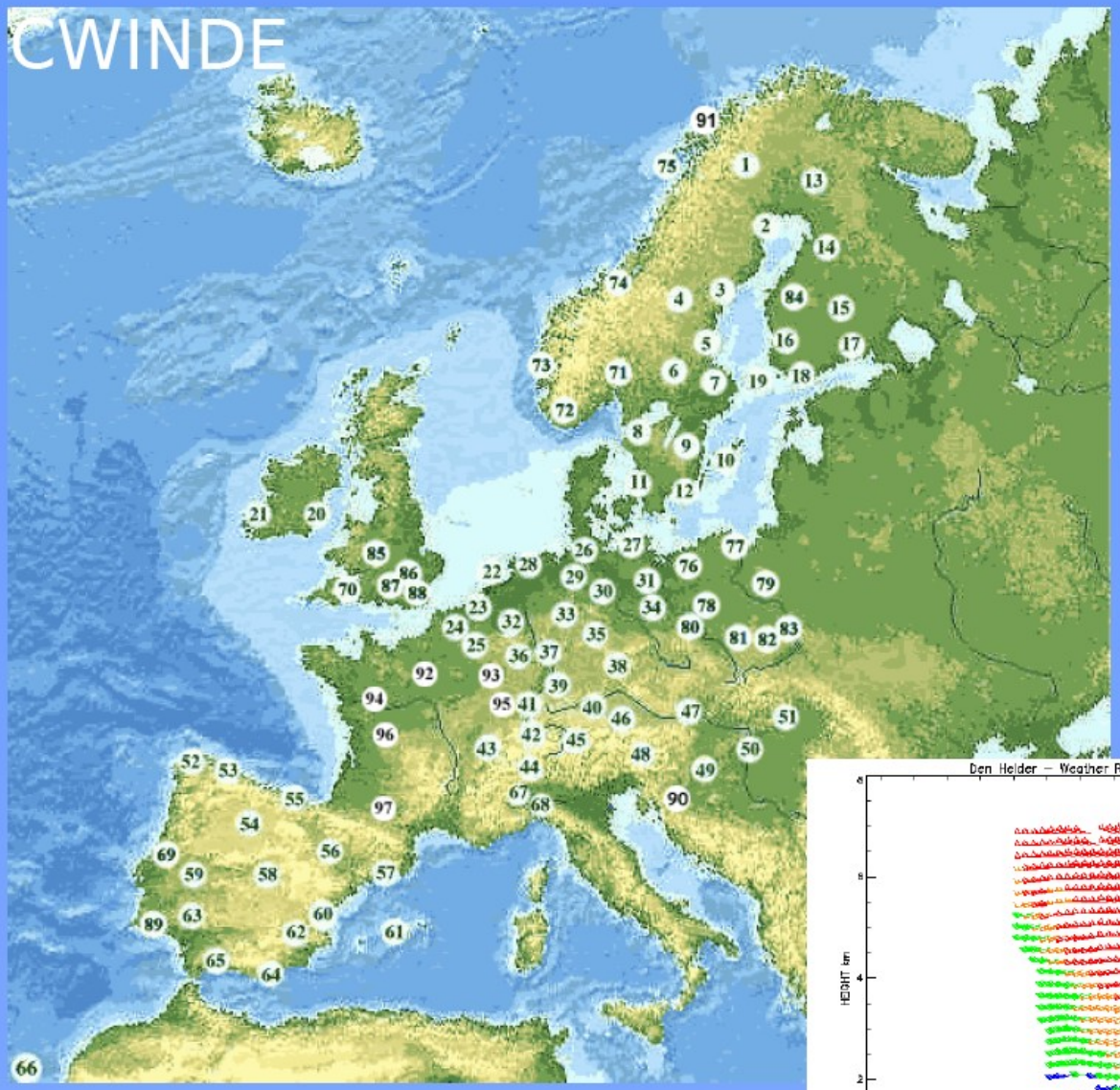
- Radiosondes are relatively more important for regional models than for global models; isolated profiles of wind and temperature (from radiosondes, AMDAR?) are crucial for NWP.
- Radiances from geostationary satellites are used in several regional systems with a small positive impact: there is still a lot of potential to improve the use of this type of data.
- Wind profilers have shown neutral impact on average: slightly positive in some impact studies, slightly negative in others => somewhat disappointing ? => Quality control and screening procedures in data assimilation are issues which affect the results and should be further studied.
- Radar data and GPS surface observations have demonstrated their positive impacts on regional assimilation systems, and on some occasions also on global systems.

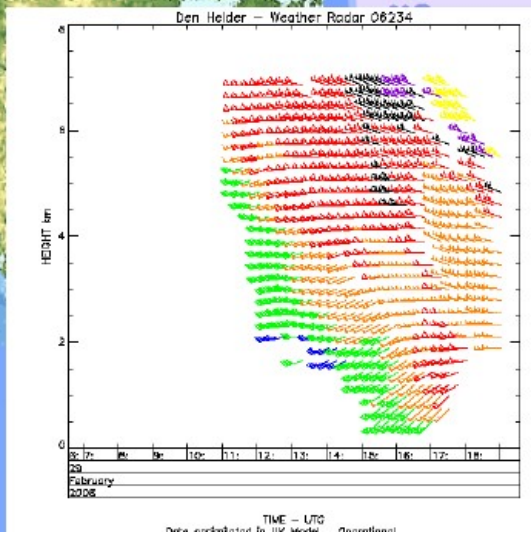
Plan of WG2 III

- Concentrate on list of observations, use and problems

OPERA and WINPROF

- OPERA and WINPROF worked on radar wind profiles
- Increase of availability ~ 100 sites
- Harmonization of GTS headers, format, and content
- EUCOS upper-





Koninklijk Nederlands Meteorolo

Assimilate radial winds in HIRLAM

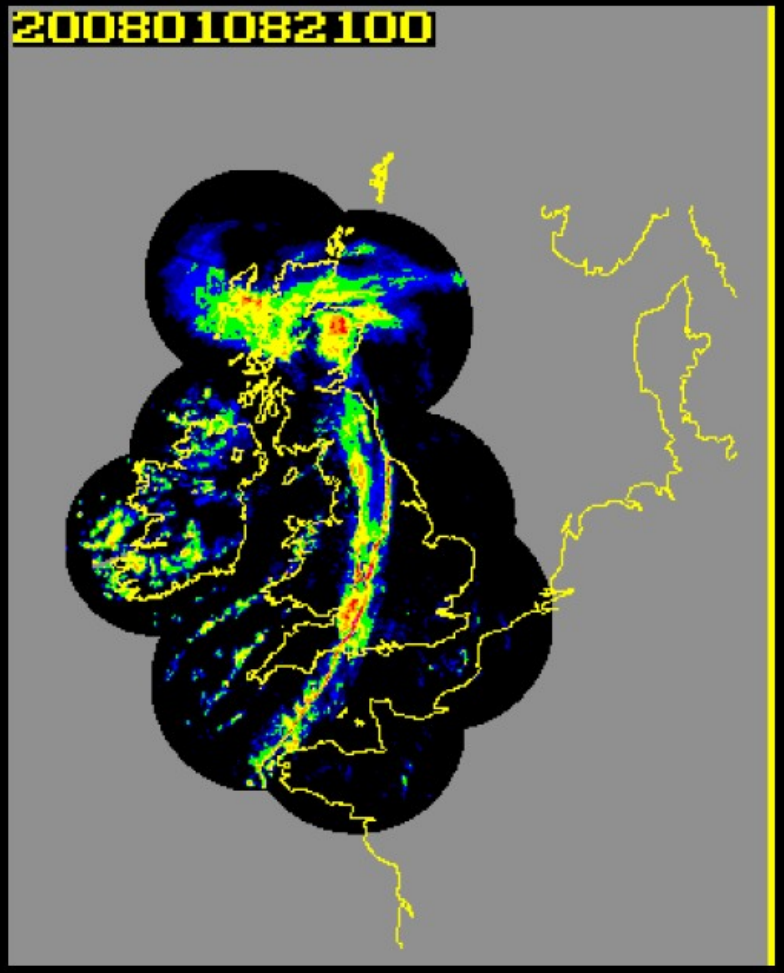
Kirsti Salonen, FMI

Towards the operational use of radial winds

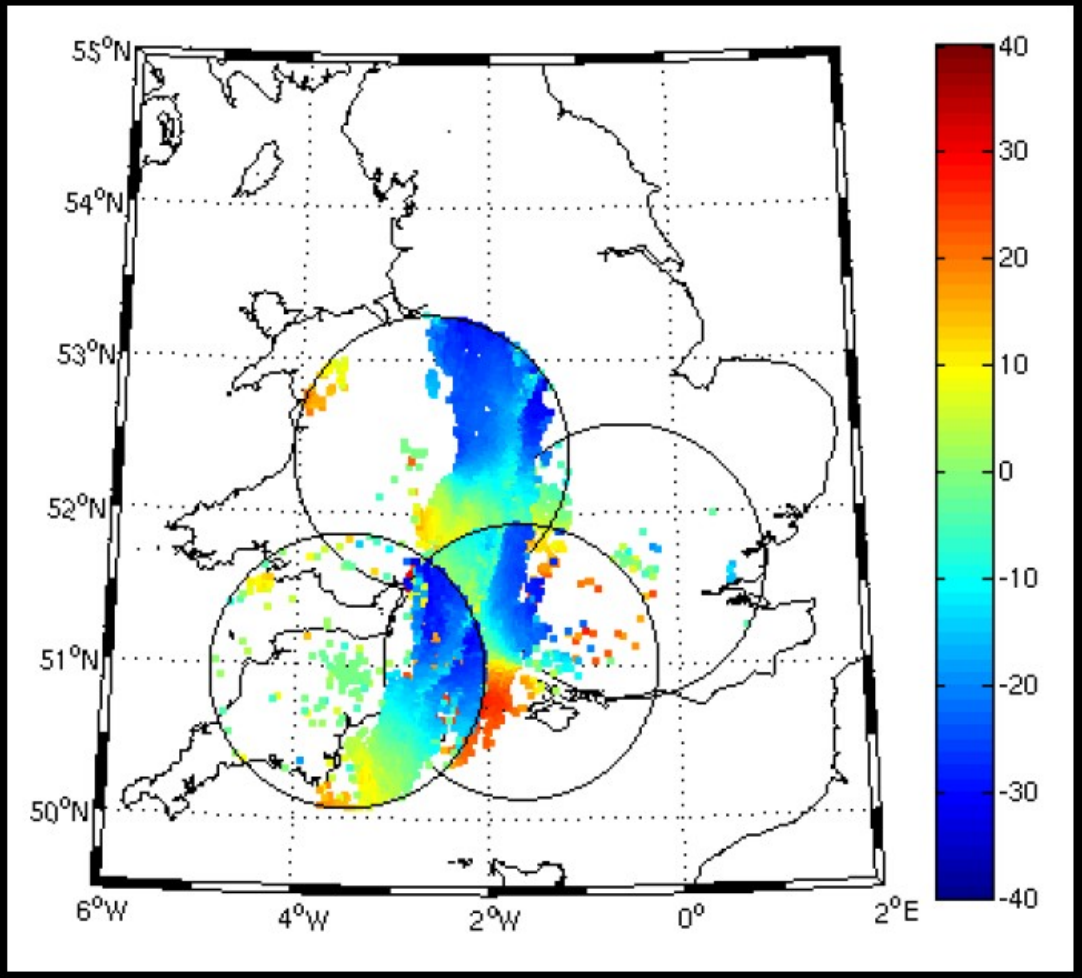
- Accurate and computationally feasible observation operator is available in the HIRLAM reference system.
- HIRLAM strategy is to use super-observations, spatial averages, of the raw observations. This decreases the impact of random errors.

Use of Novel observation types
- Radar Doppler Winds – David Simonin

Radar rain rates 08/01/08 21UTC



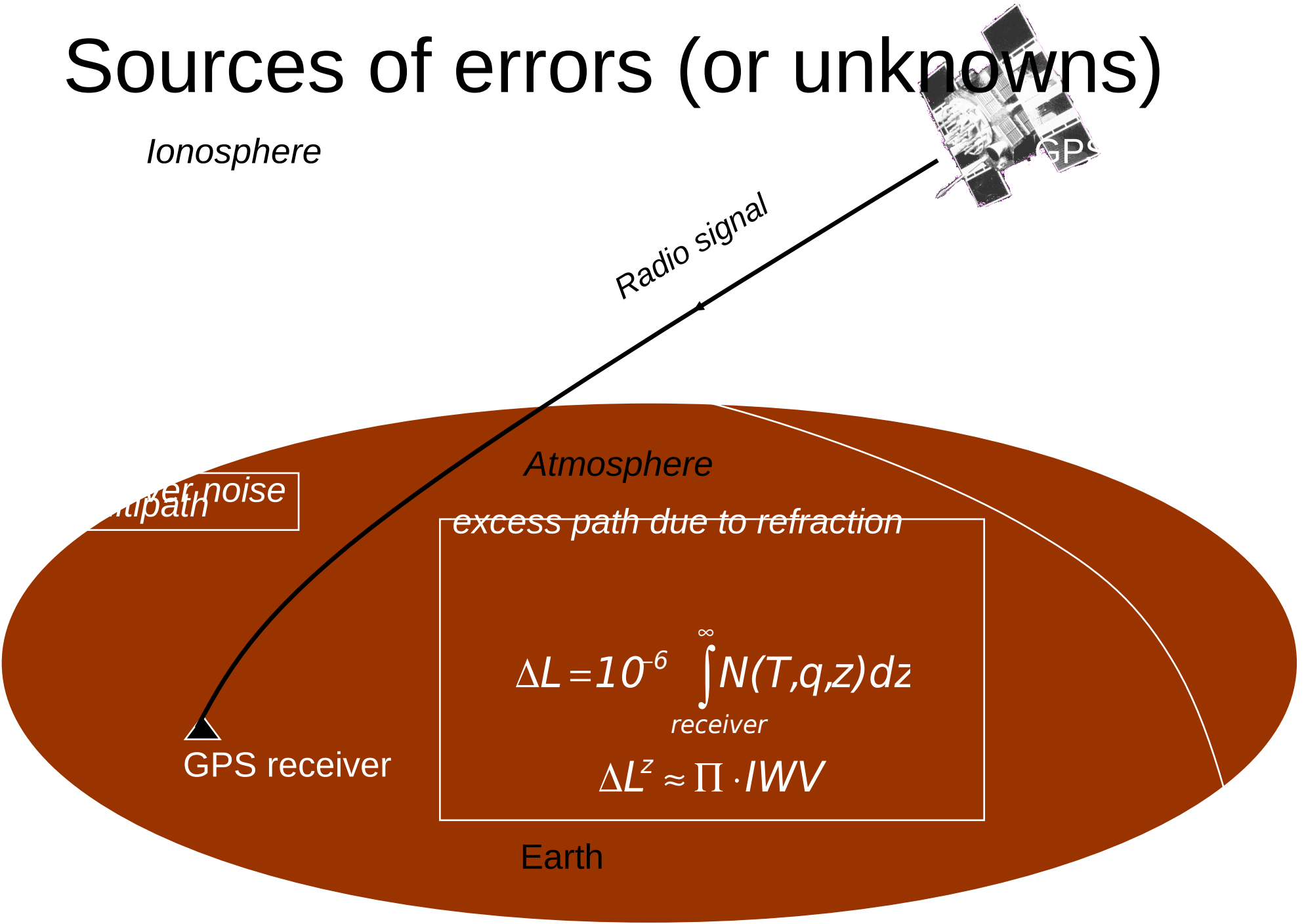
Radar doppler winds



Progress

- Weather radar
  - Wind profiles : calibration and error structures, KNMI
  - Implementation in HIRLAM and impact runs running
  - Radial winds : monitoring and super-observations running (FMI)
  - Impact studies have been done and next talk (KS)
  - Preparations for CIS 4D-VAR and pre-processing
  - Convective scale 4D-VAR carried out (Met Office)
  - Reflectivity : UNIVAQ under test !

Sources of errors (or unknowns)



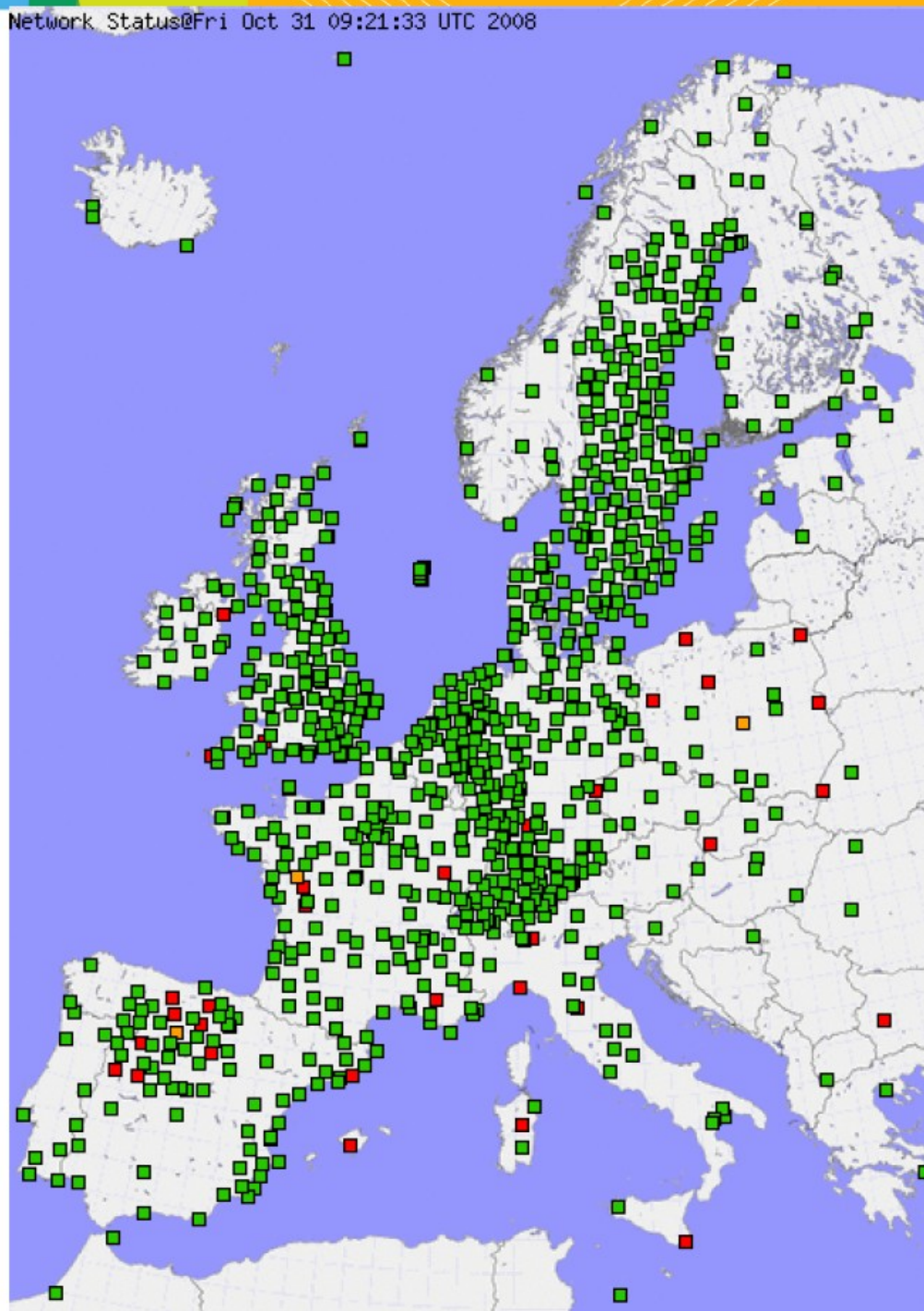
GPS data

Observing system status

The observing system consists of ground-based receiver networks that are specific to each country

Increasing number (~800-900 at the moment) of receiver stations is included in near real time processing

The processing is done at ~10 processing centres, including both geodetic and meteorological institutes

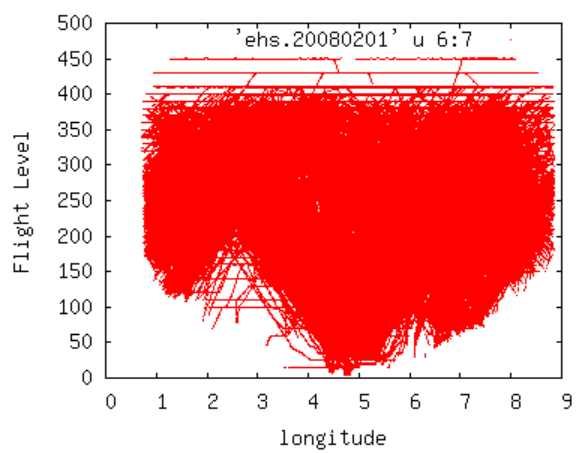


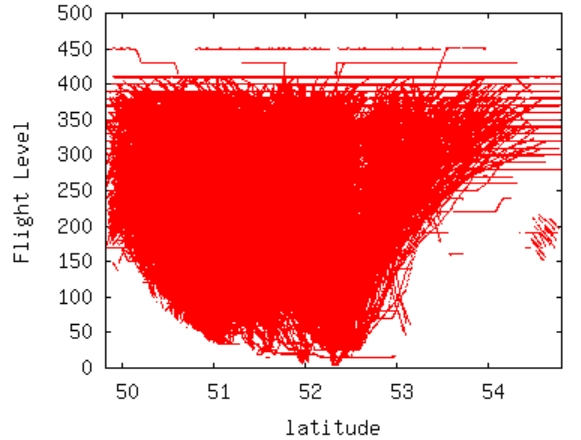
GPS (ZTD)

- ZTD
  - HIRLAM obs operator corrected
  - Impact studies (next talk)
  - Preparations for summer time CIS
  - UNIAQ has carried out 3D-VAR and nudging

High resolution temperature and wind observations : Mode-S

- Inferred from Air Traffic Control tracking radar data at Schiphol
- Mode-Selective
- Every aircraft responds automatically
- Full scan every 4 seconds
- 1 581 287observations T,ff,dd per day
- Quality close to AMDAR





Radar (cont)

- Mode-S
  - Monitored and running at KNMI in short cut-off cycle

1D-profiles

- Wind lidar
  - Lyon airport, MF
- Cabauw 1D columnt
  - KNMI
- Radiometers
  - Not started yet

Conclusions

- Data assimilation systems – various ones
- Survey of systems and use of observations
- Error characteristics will be worked on
- Impact studies in the Consortia
- A list of observation are worked on and assimilated
- New observations, testbed data from WG1,3 ?