European Ground-based observations of essential variables for CLImate and operational METeorology

EG-CLIMET

ES-0702

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Prepared by Met Office

John Nash (DPhil),
Observation Development,
President CIMO (WMO),
4 previous COST Actions.

Catherine Gaffard (PhD),
Upper Air Senior Scientist,
Leader of COST720 Integration Work Package,
CIMO ET on Upper Air System Intercomparisons
Data assimilation at ECMWF (1993-96).

Tim Hewison,
PHD on Microwave Radiometry including assimilation tests, completed 2007
Upper Air Senior Scientist,

Main Objective of EG-CLIMET

The specification, development and demonstration of cost-effective

ground –based integrated profiling systems

for future networks providing essential atmospheric observations for

both climate and weather.

Proposal Background

- Proposal agreed with colleagues from 17 European countries and widened to ensure results are relevant to all areas of Europe.
- About half from National Meteorological Services and half from European Universities with interest from manufacturers to ensure effective scientific and technical collaboration between industry, climate and meteorological operations.
- Primary authors authorised to prepare the proposal since the aims are in line with Met Office strategies for observing networks, as also in Meteo France.
- Plans for this type of testing to merge insitu and remote sensing in operational networks endorsed by WMO Executive Council in 2007 and also GCOS/WCRP plans for reference Upper Air network sites [GRUAN] in 2007.
- Substantial investment in instruments and scientific effort is required but this has already started. The need is to coordinate efforts between the various countries and scientific specialisations.

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Motivation [1]

Co-ordinated development of insitu upper air measurements and ground-based remote sensing

with the emphasis on providing
new operational networks

This action would promote cross-fertilisation between

- Instrumentation experts including manufacturers for
  - wind profilers,
  - atmospheric lidars,
  - integrated profiling systems,
  - radiosondes,
  - GPS water vapour,
  - Cloud radars,
  - weather radars,
  - aircraft sensing

- Experts at introducing new systems into operation

and

- Scientists specialising in the generation of outputs from the measurements of these systems ,

especially in the context of data assimilation into numerical weather prediction models.

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Motivation [2]

The remote sensing observing systems are now sufficiently mature to make it worthwhile:-

1. To improve the **temporal and spatial resolution of weather observing networks** using remote sensing systems to deliver the potential for improved societal benefits.

2. To **develop the data assimilation techniques** that will allow the observations to be effectively used in Numerical Weather Prediction (NWP) and hence deliver the essential outputs producing the improved societal benefits.

3. To exploit the new remote sensing measurements in **studying atmospheric processes for climate prediction**.

4. To combine *in situ* and remote sensing to **provide a stable observing system for climate monitoring.**

5. To design an observing network where **climate and weather observations are complementary**, and hence also more cost effective than at present.

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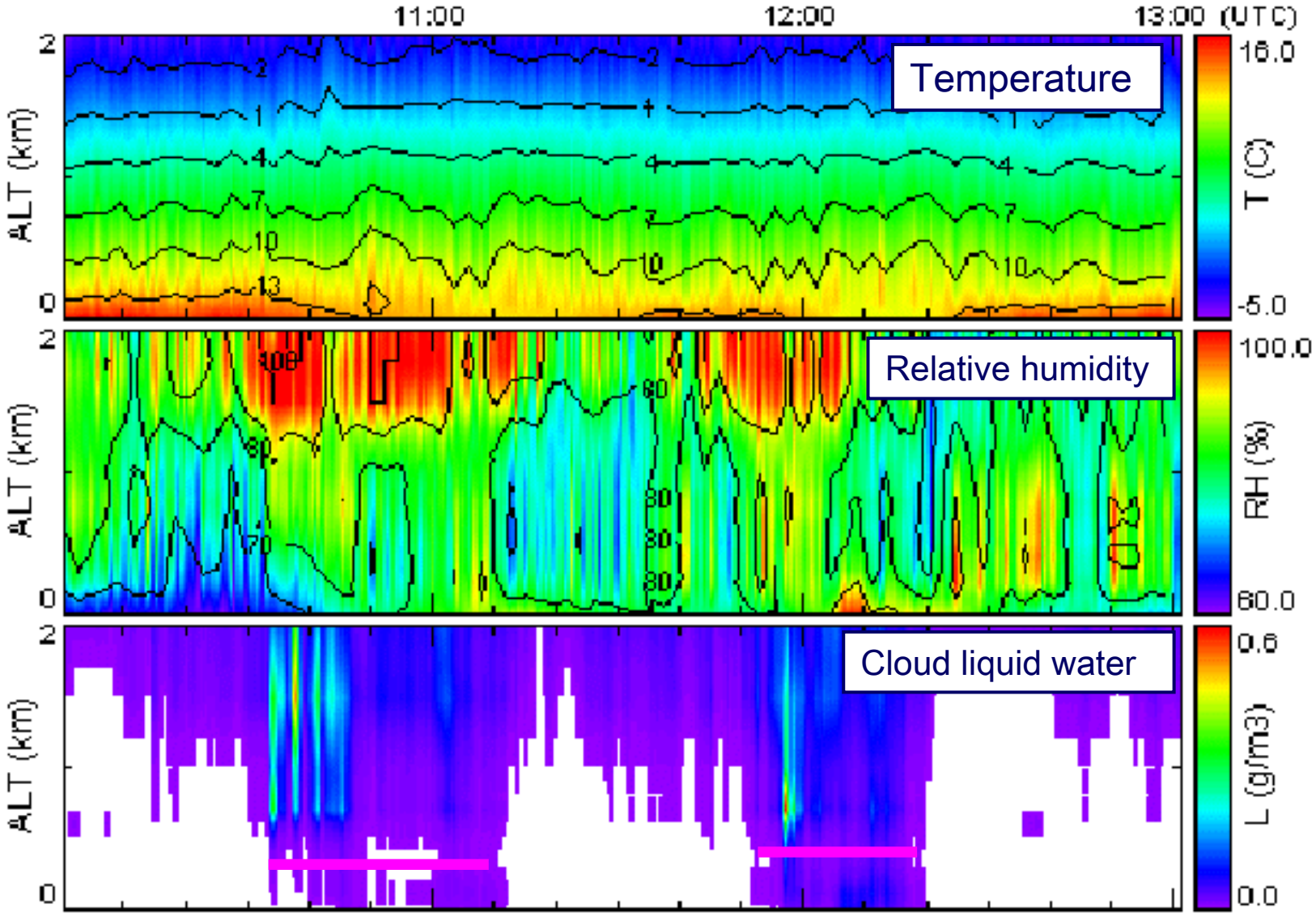
Time series of 3 hours of independent profiles of temperature, relative humidity and cloud liquid water, at high temporal resolution



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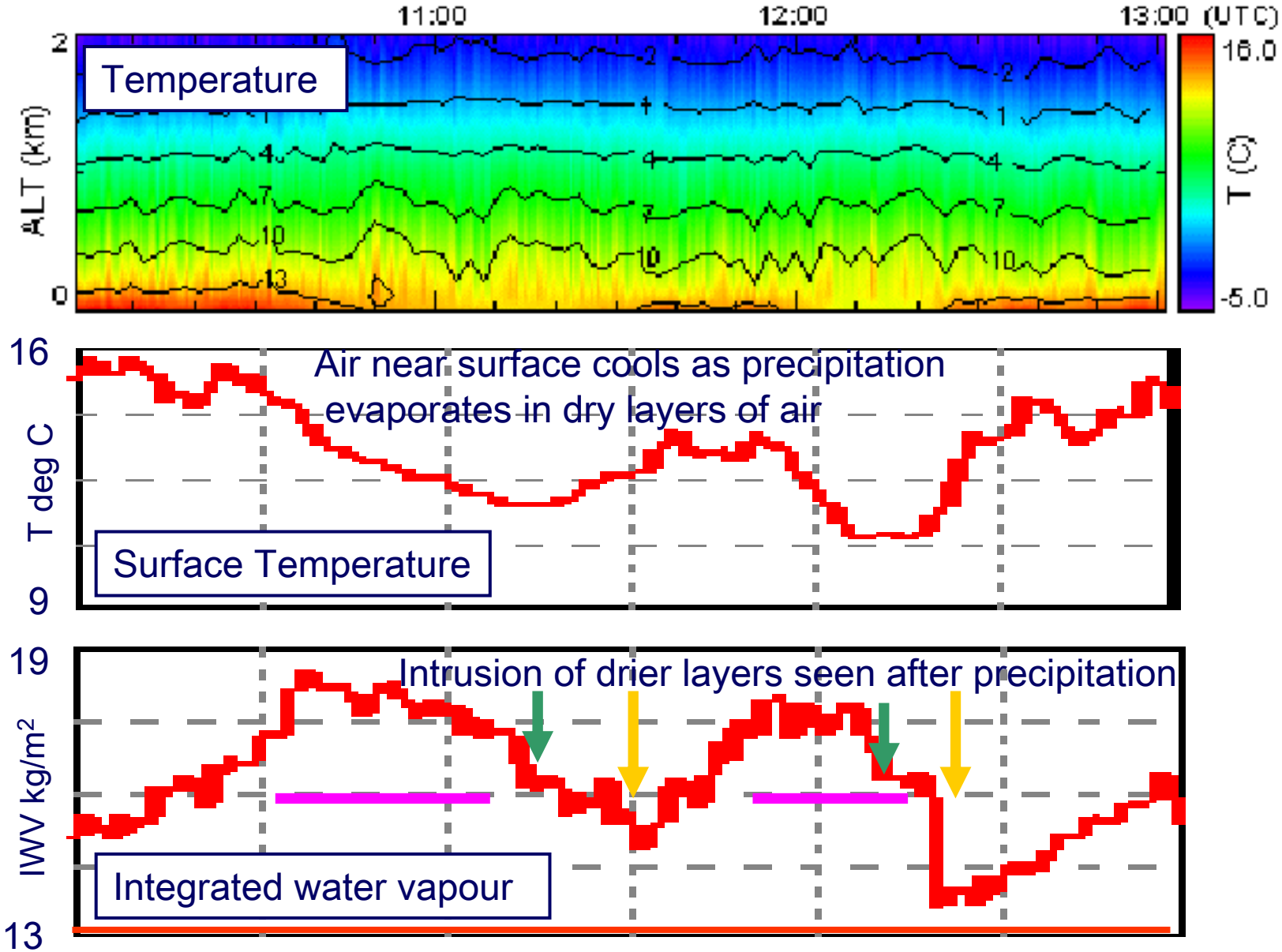
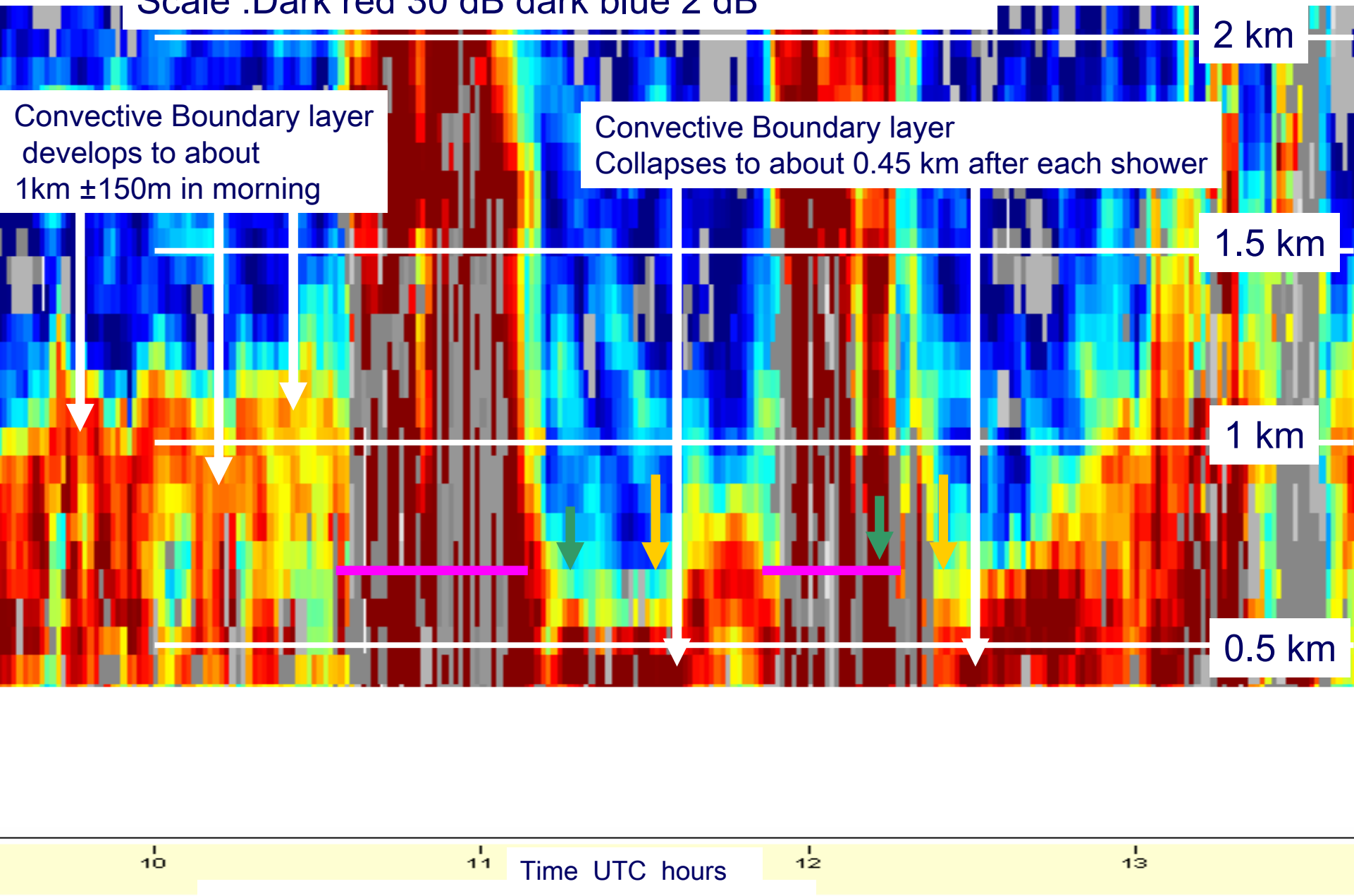
Time series of 3 hours of independent profiles of temperature, surface temperature and integrated water vapour, at high temporal resolution



Wind profiler signal to noise, 25/08/05. Linkenholt

Scale :Dark red 30 dB dark blue 2 dB



Measurements by a microwave radiometer in 2005

- Measurements not made at this temporal resolution in earlier years
- Instrumentation that has applications in both climate and weather observing networks and also able to observe small scale atmospheric changes
- Significant advances in the commercially available systems took place during and after COST 720.

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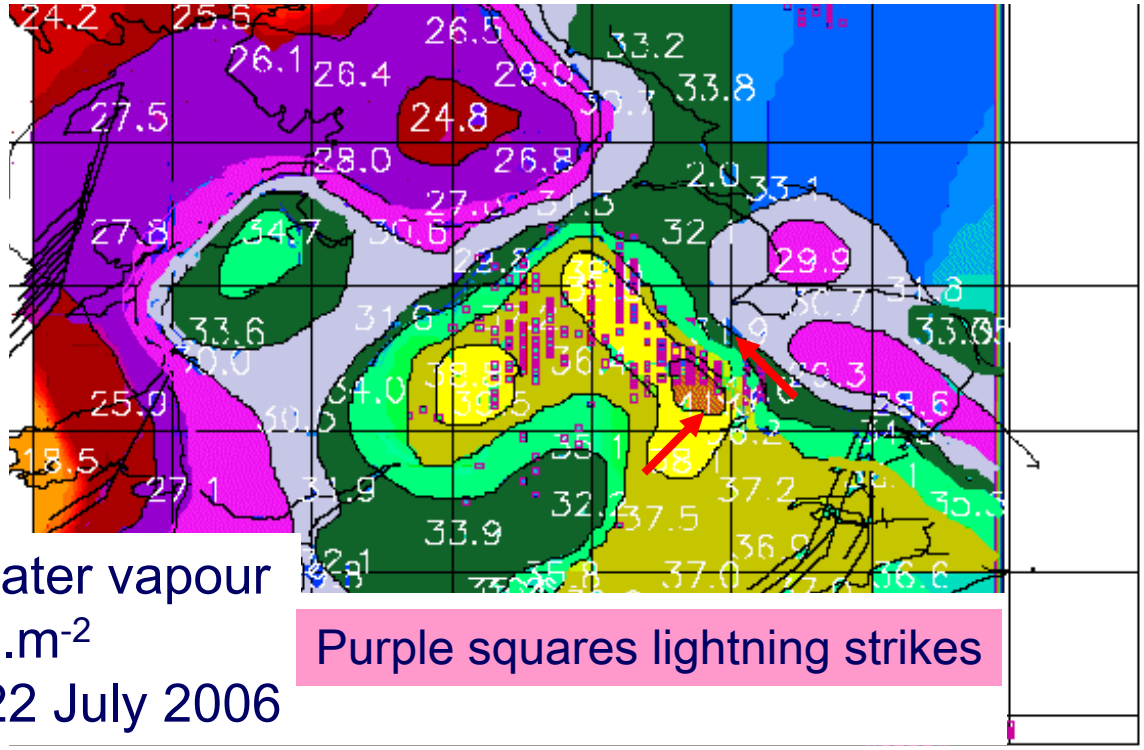
Dimensions of a dangerous
Mesoscale storm over England identified
with GPS water vapour measurements
combined with wind profiler winds and
Lightning location data
Red arrows show wind directions
from research wind profiler



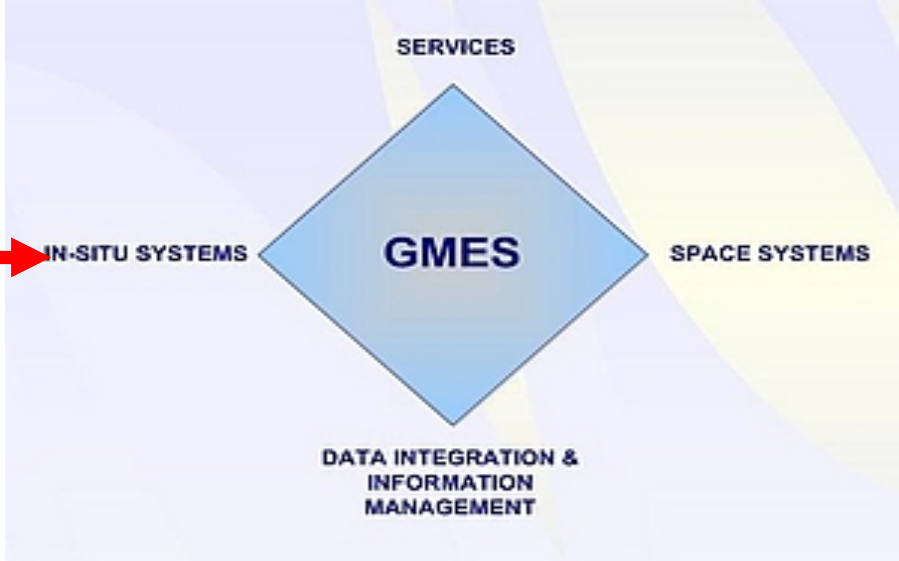
Integrated water vapour
In Kg.m^{-2}
at 14.00 on 22 July 2006

Purple squares lightning strikes

Relationship to Global monitoring for Environment and Security, GMES

"The development of a non-satellite atmospheric monitoring must make best co-ordinated use of what exists" GMES-GATO

+
ground based
remote
sensing



Reliable measurements of fundamental atmospheric variables on a smaller scale than currently available are clearly required for early warning and real-time natural hazard management requiring different operational networks combining insitu and ground based remote sensing

Atmospheric corrections for most GMES earth observation remote sensing require reliable measurements of water vapour in the lower troposphere, as well as aerosol and ozone.

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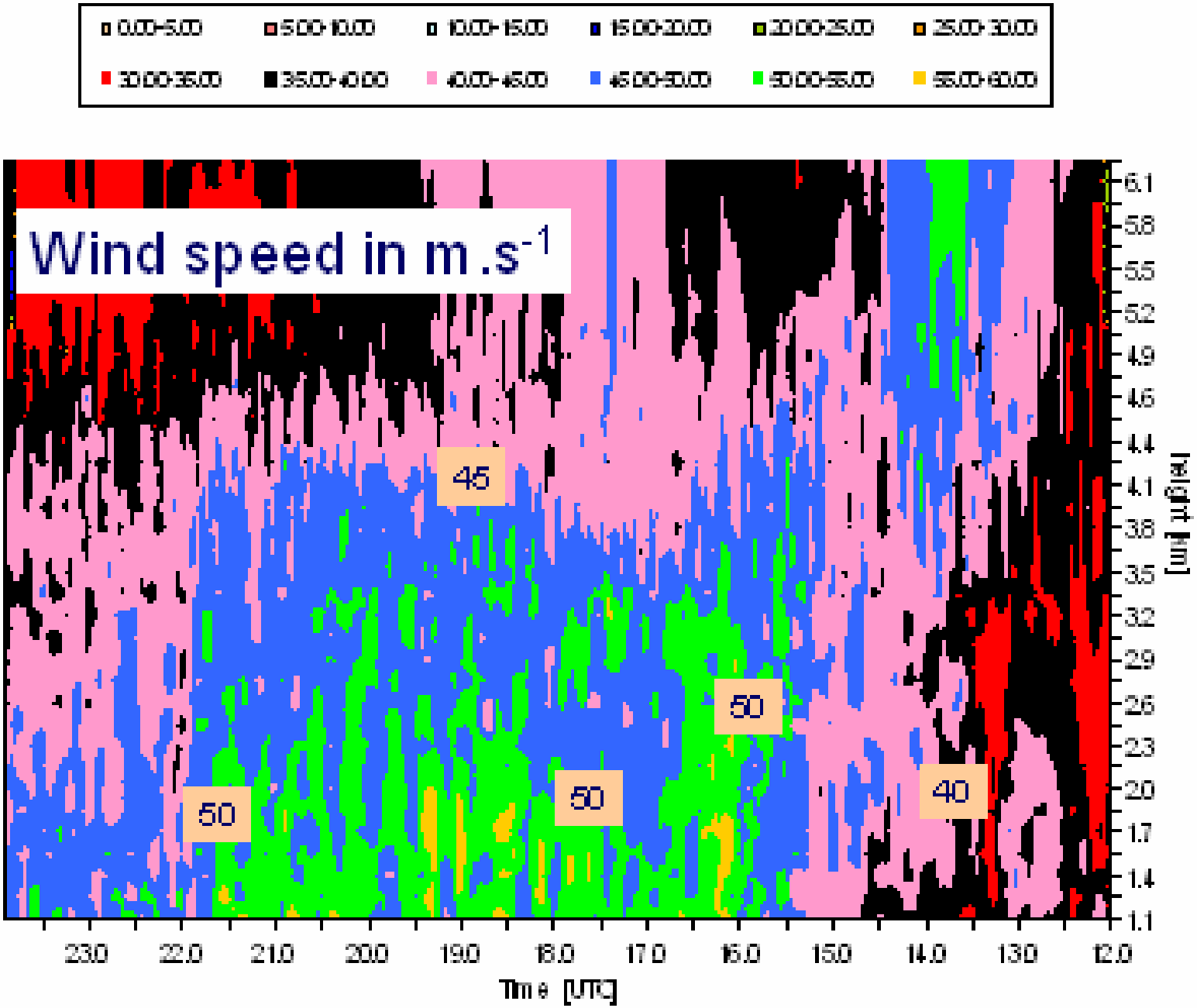
South Uist wind profiler,64 MHz;

operational since October 2004

Development benefited from earlier COST Actions
But up till now temporal resolution of system not properly exploited because of limitations in data assimilation techniques

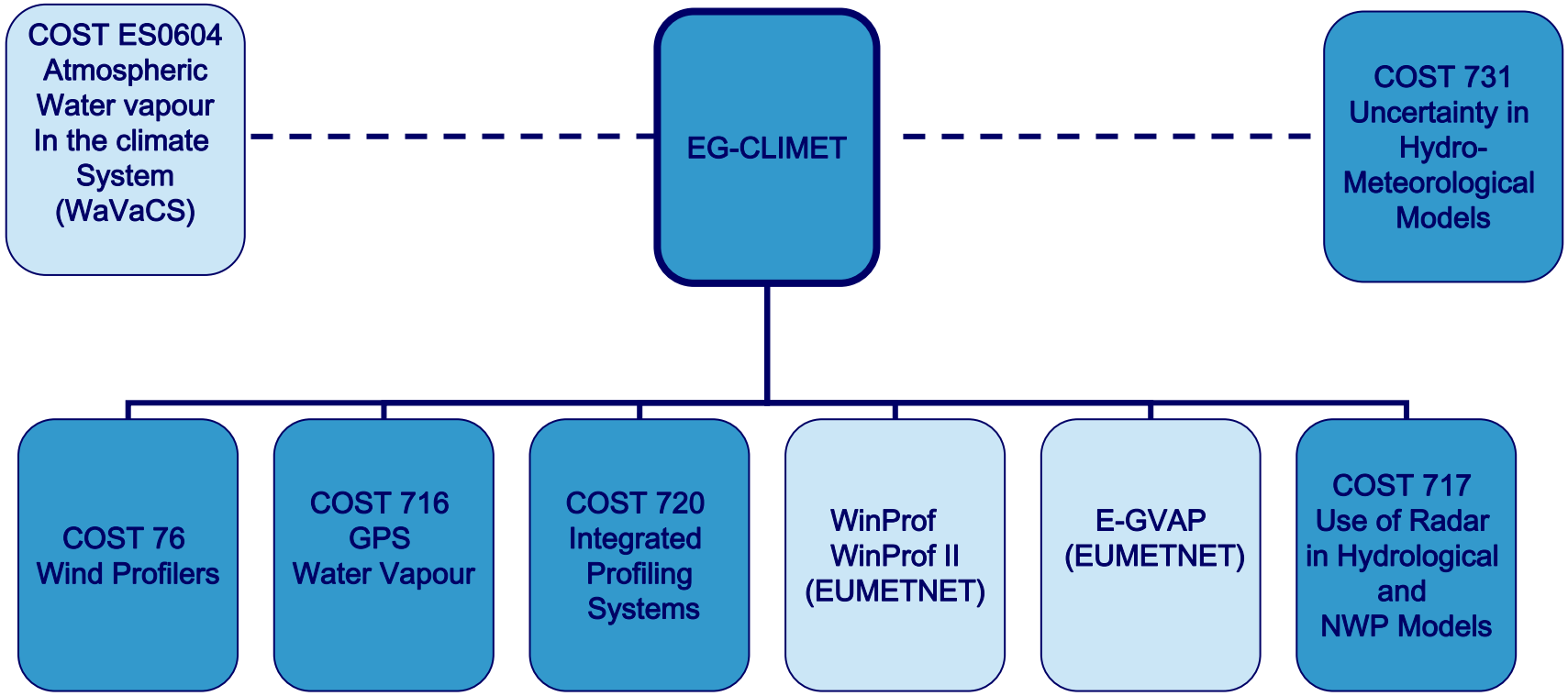
System operated throughout the most severe storm observed in recent years in the UK– January 11 2005

Independent wind profile measurements more than ten times per hour



Relationship to other European Actions

EG-CLIMET Proposal
Builds on Outputs of previous COST Actions and EUMETNET programmes



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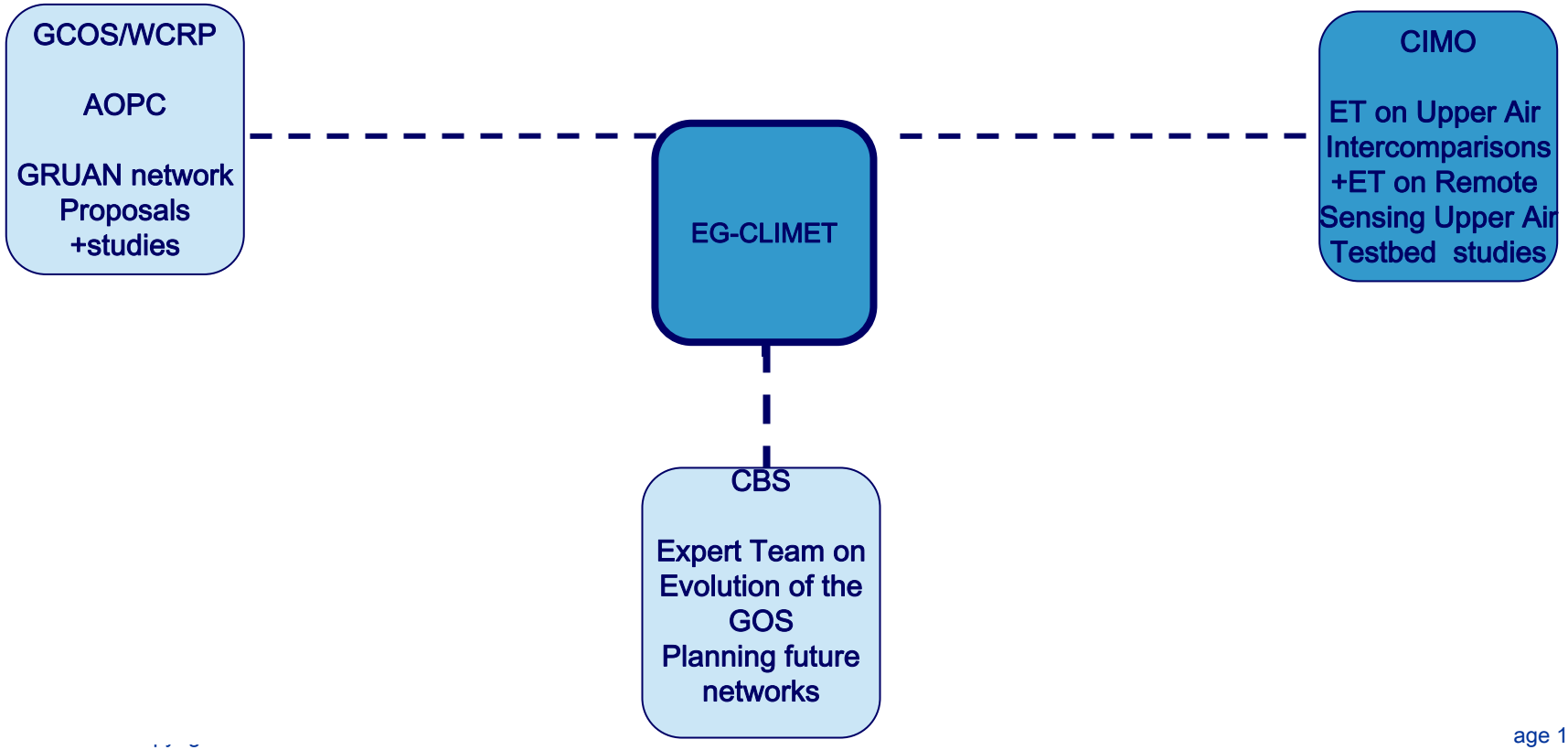
Relationship to WMO expert teams

EG-CLIMET Proposal
is in line with WMO Policy for a WMO Integrated Global Observing System [WIGOS]



Emphasis of Proposal

- Emphasis on boundary layer and troposphere
- Improved wind observations with temperature and water vapour
- Improved cloud observations
- Complements satellite capability
- Validate models of atmospheric processes for Climate prediction
- Impact on short-range forecasts
- Using 4D assimilation in convective scale models
- Defining international network across Europe as regional pilot study for WMO networks

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Scientific Programme Tasks Overview

1. Further develop of remote sensing for operational networks.

2. Improve integration from groups of systems.

3. Design techniques to assimilate observations or vertical profiles.

4. Deploy Integrated Observing Systems in *Testbeds*.

5. Analyse Observing System Experiments.

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Working Groups

1. Instrumentation
   - Covering Tasks 1 and 2
2. Assimilation
   - Covering Tasks 3
   - Input from instrument experts + data assimilation scientists
3. Observing Experiments
   - Covering Tasks 4
4. Data Evaluation

- Flexibility to manage some activities by combinations of joint working groups

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Task 1 Examples for Wind Profiler

- Specify Wind Profiler for Integrated Profiling:
  - Beamwidth, power, advanced signal processing to estimate spectral moments
- For:
  - Reliable measurement of vertical velocity
  - Improved height coverage (Better signal to noise)
  - Better turbulence measurements (spectral width)

UFAM 1290 MHz Degreane Wind Profiler at Aberystwyth

Antenna array for 46.5 MHz NERC MST

Radar can be seen in the background

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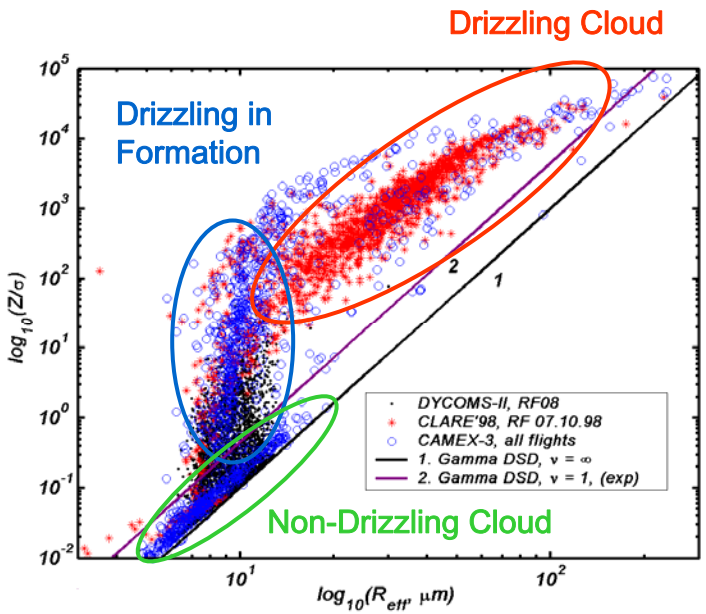
Task 2 Example - Improve Cloud Products

- Classification algorithms
  - Combining cloud radar and ceilometer
  - To improve cloud profiles
    - e.g. as pre-processing step for other retrievals
  - Need to understand underlying physics
  - To use adequate physical description
  - For example ⇒ Combining signal from ceilometer and cloud radar to classify clear/cloud/drizzle



Simulated radar-lidar ratio versus the effective radius. Both plots are based on in-situ data taken during the CLARE 98, DYCOMS-II, and CAMEX - 3 campaigns

[Krasnov and Russchenberg, 2006, Chapter 5, COST720 Final Report]

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Task 3 Set-up Data Assimilation

- Benefit of *integrated observing networks only realised if data assimilation techniques improve.*
- Specify *forward model* and error characteristics for each obs.
- Conduct trials assimilating data (over extended periods)
  - into high-resolution operational NWP models
  - including raw observations and/or retrieved profiles
  - from real proto-type operational systems
  - or synthetic observations

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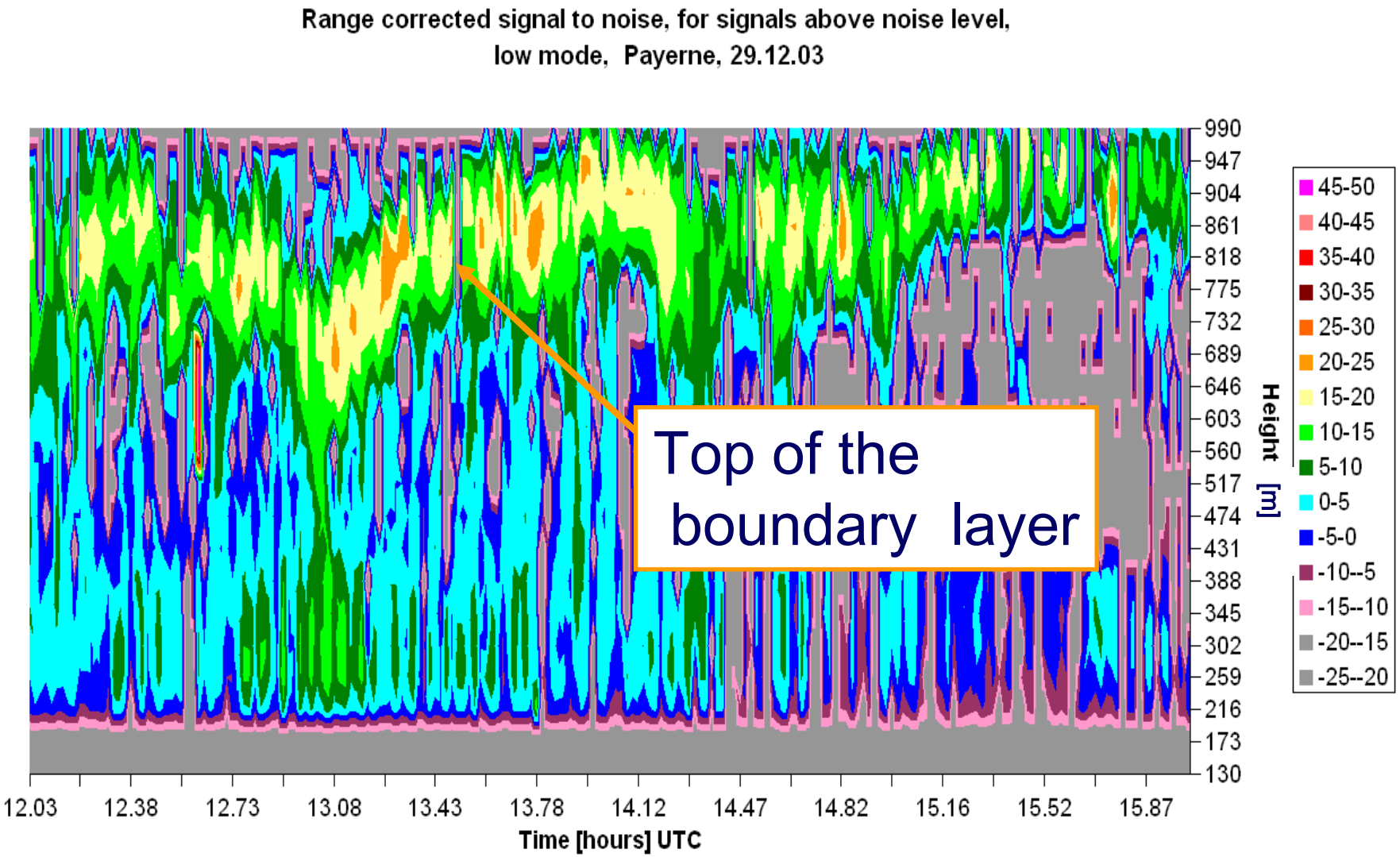
Assimilating level data is now a problem, but height of boundary layer is fundamental for many applications

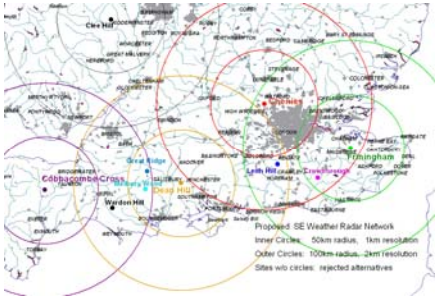


Planned Testbed Experiments

- Helsinki Testbed
- Coordinated by FMI
- ongoing

- GRUAN studies
- Coordinated by DWD
- Lindenberg

- Integrated Profiling Test
- Coordinated by Met Office
- 2008-2011
- SE England



- Dedicated experiment for EG-CLIMET?
- Extension of others?
- France/Netherlands/ Italy/Switzerland

?

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Proposed Milestones for Working group activities [1]

- <u>WG1 Instrumentation for Integration</u>

  Complete plans for collaboration with instrument manufacturers and instrument scientists +0.7 year

  Agree work plans and assign responsibilities for integration work packages [including possible designation of expert teams] +0.7 year

  Review instrument performance from initial testbed experiments +2.5 years

  Review performance of integration packages in initial test bed experiments +3.5 years

  Develop prototype network management facilities [including quality control] +4.5 years

  Deliver prototype operational integration packages +4.5 years

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Proposed Milestones for Working group activities [2]

- <u>WG2 Assimilation</u>

  Complete review of current data assimilation capabilities and then agree plans and assign tasks for necessary development +0.7 year

  Report on initial data assimilation experiments from testbed experiments +3 years

  Develop prototype operational data assimilation schemes +4.5 years

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Proposed Milestones for Working group activities [2]

- <u>WG2 Assimilation</u>

  Complete review of current data assimilation capabilities and then agree plans and assign tasks for necessary development +0.7 year

  Report on initial data assimilation experiments from testbed experiments +3 years

  Develop prototype operational data assimilation schemes +4.5 years

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Proposed Milestones for Working group activities [3]

- <u>WG3 Observing Experiments</u>

Complete planning of testbed experiments and assign responsibilities and priorities

+0.5 years

Complete initial testbed experiments

+2.0 years

Report on initial testbed experiments and agree further testing

+3.0 years

Complete further testing

+4.0 years

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Proposed Milestones for Working group activities [4]

- <u>WG4 Data Evaluation</u>

  Review evidence on usefulness of different measuring systems from earlier European observing experiments +0.9 years

  Report on the results of tests and studies based on initial testbed experiments, especially when observing significant weather. +3.0 years

  Report on impact assessments and evaluation of information content of different combination of systems. +4.0 years

  Provide recommendations for cost effective solutions for future observing networks. +4.5 years

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Workshops proposed

- Workshop 1 +0.9 years
  Refinement of Testbed plans, data assimilation plans [data delivery plus archiving] and data evaluation plans

- Workshop 2 +2.5 year

  Review initial results from first testbed experiments and earlier European observing experiments.

- Workshop 3 +4.5 year
  Final project workshop, reporting on progress achieved and plans for future

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Conclusions

- The proposed work for this Action is well suited for a COST project, since it requires coordination between a wide range of groups of activities which are being initiated at this time.
- The Actions of the scientific programme would be the first design of an integrated [remote sensing +in situ measurements] observing network for a WMO region.
- The Action is designed to allow a wide range of contributors from a wide range of countries, thus facilitating crossfertilisation between a very wide range of groups .
- This allows the possibility of encouraging gender balance and the development of younger scientists.
- As there is already high level commitment in many countries and in WMO to the aims of this Action, progress will be made. The details of the primary work areas will be made clear as soon as possible, if the Action is initiated.

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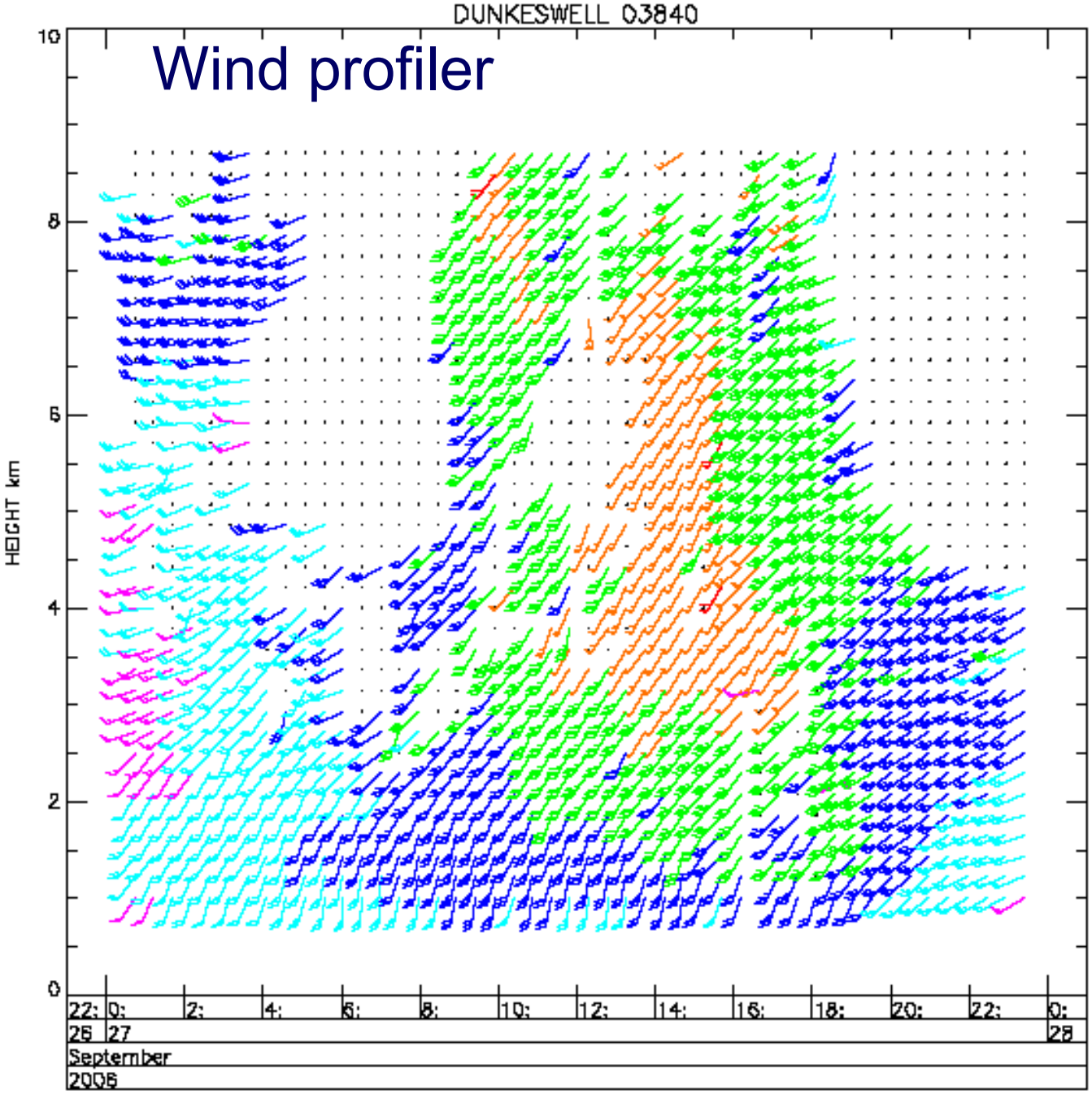
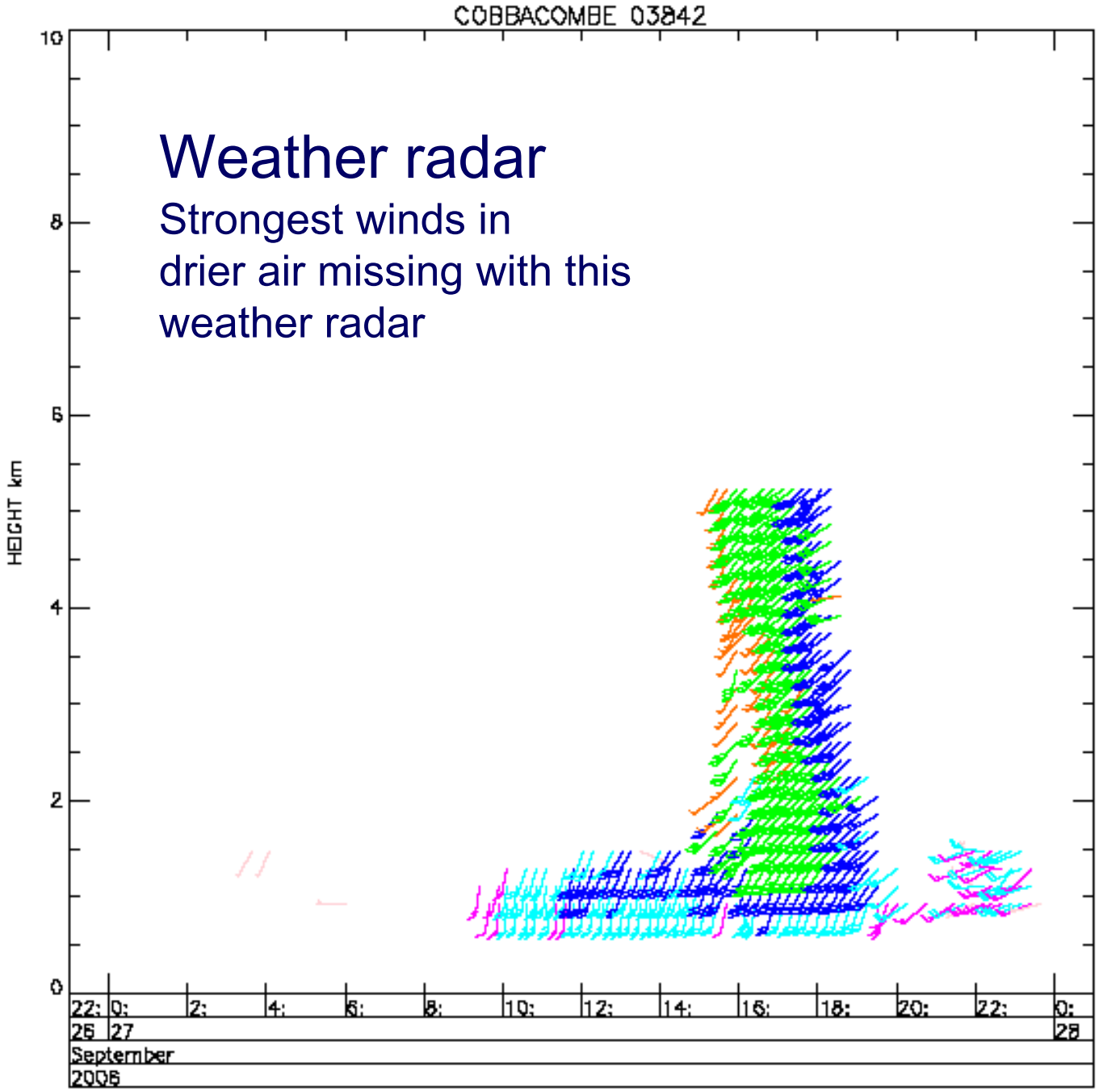
Wind profiler



Weather radar

Strongest winds in drier air missing with this weather radar