40th Anniversary of the Cabauw Observatory

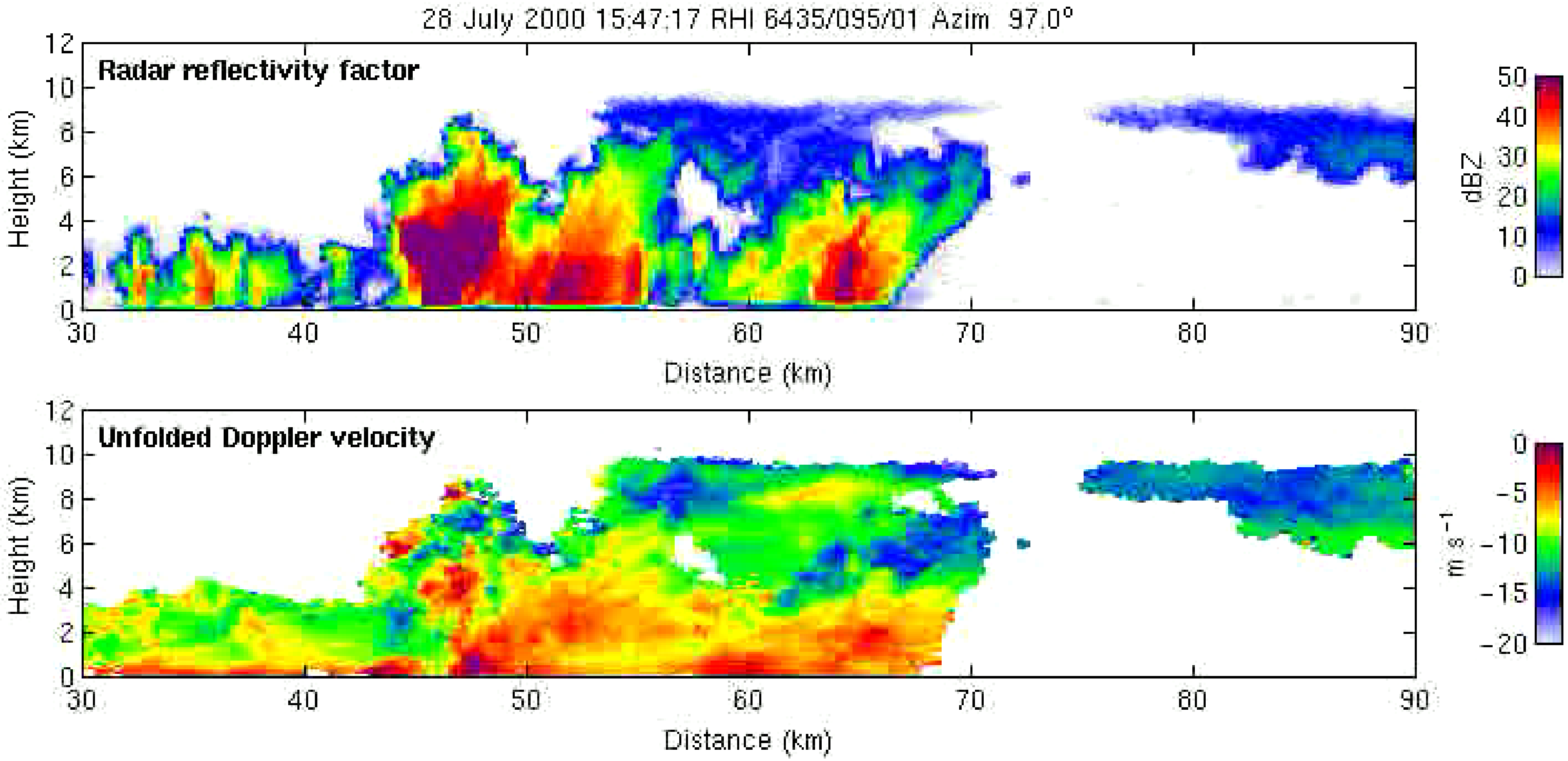
REMINISCENCES OF AN ANCIENT ATMOSPHERIC PROFILER

Anthony Illingworth
Dept of Meteorology
Univ of Reading, UK

26 Oct 2012

More modern instruments

Animation of reflectivity and Doppler wind velocity over 1 hour



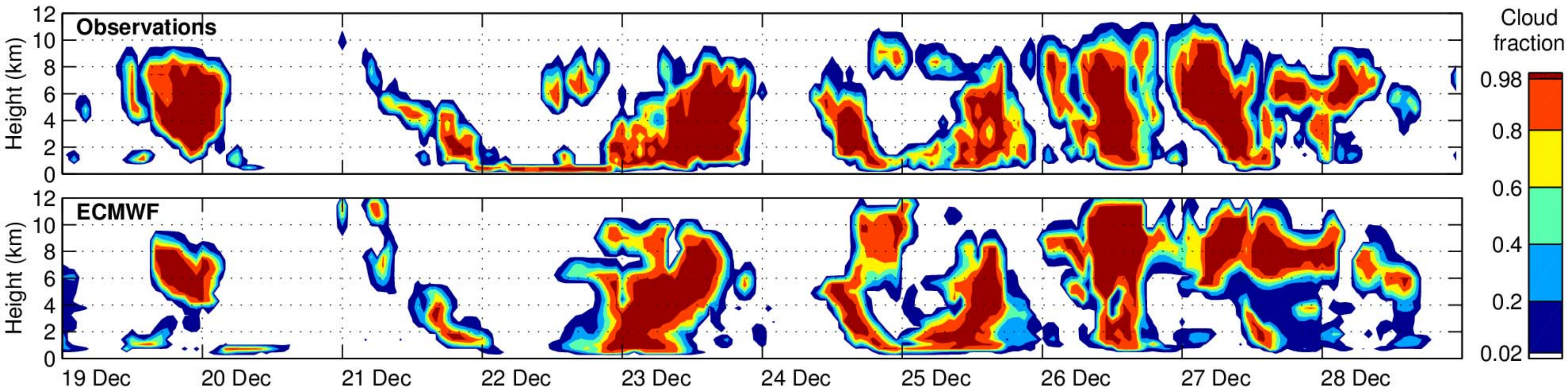
←Red towards radar Blue away from radar→

Our dream….

Where Reading meteorologists used to experience the weather "up close and personal"


SELECT
GENERAL WASTE ONLY

Cloud fraction: 10 day comparison with ECMWF model

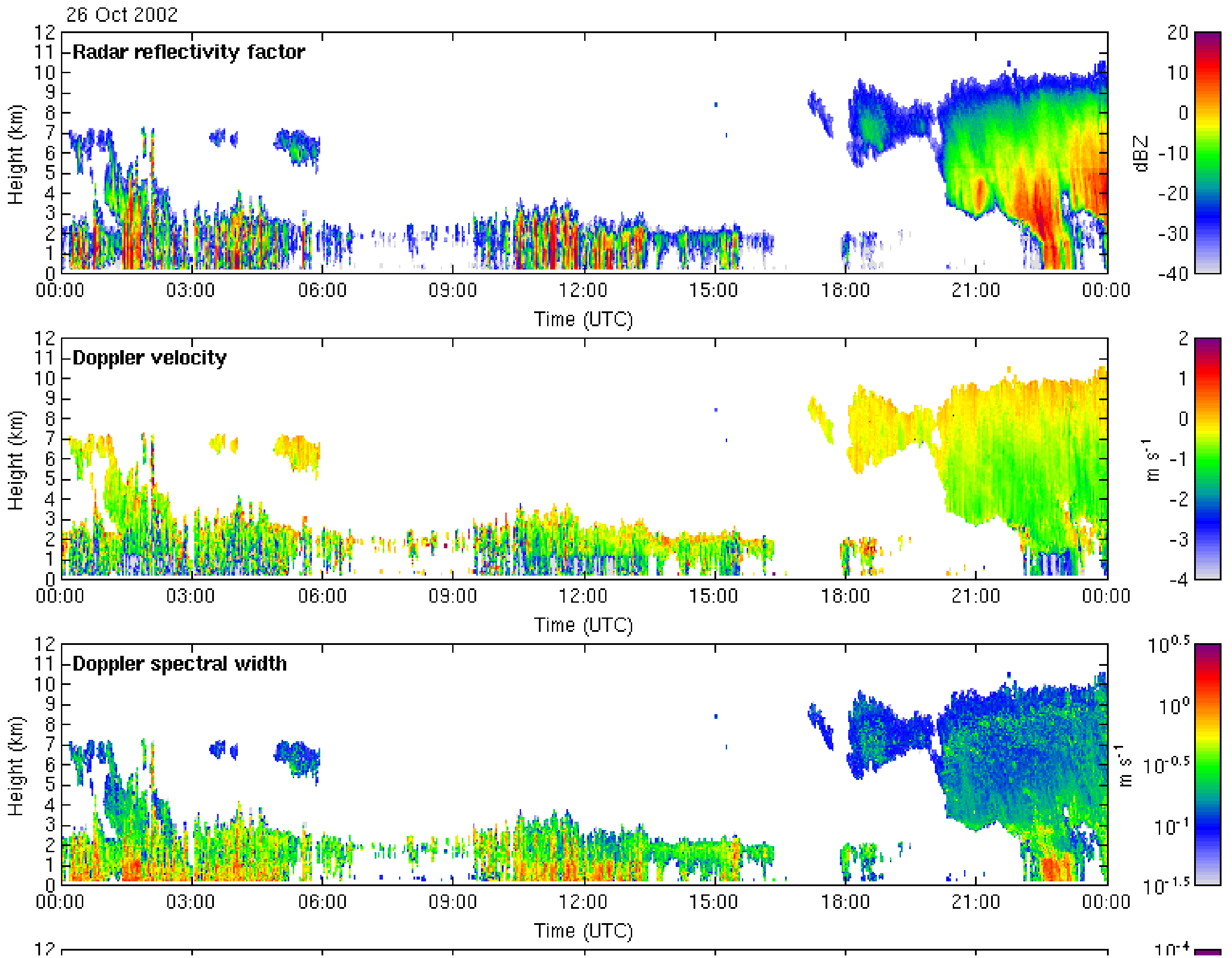


- Initial comparison suggests that clouds are very well represented by the ECMWF model
- Remember that for 20 m/s wind, one day of data is equivalent to 1700 km of cloud, so very large scale features are being compared here!

WHAT IS A CLOUD?

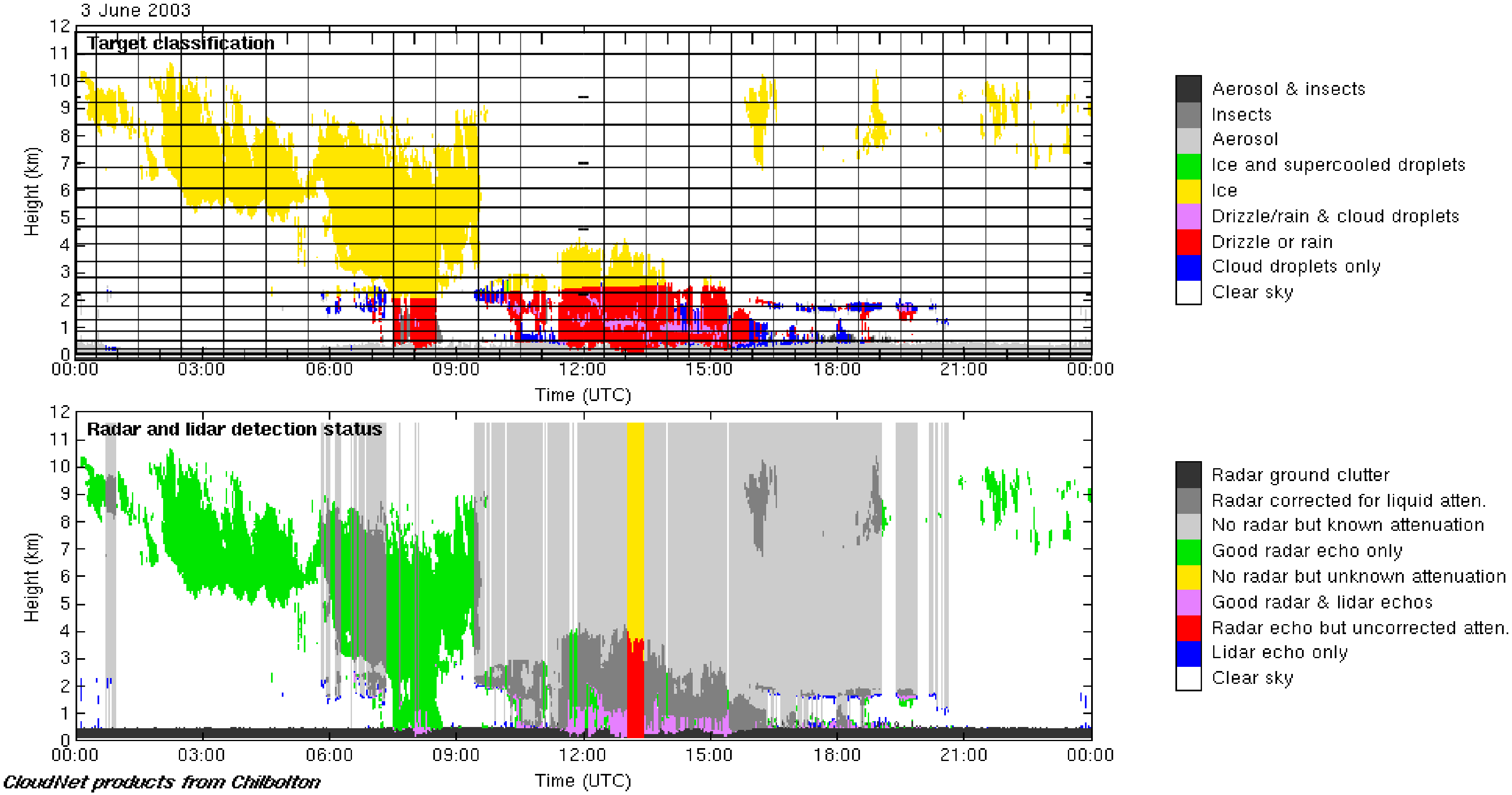
More sensitive radar sees more

CABAUW OBSERVATIONS   26 OCTOBER 2002

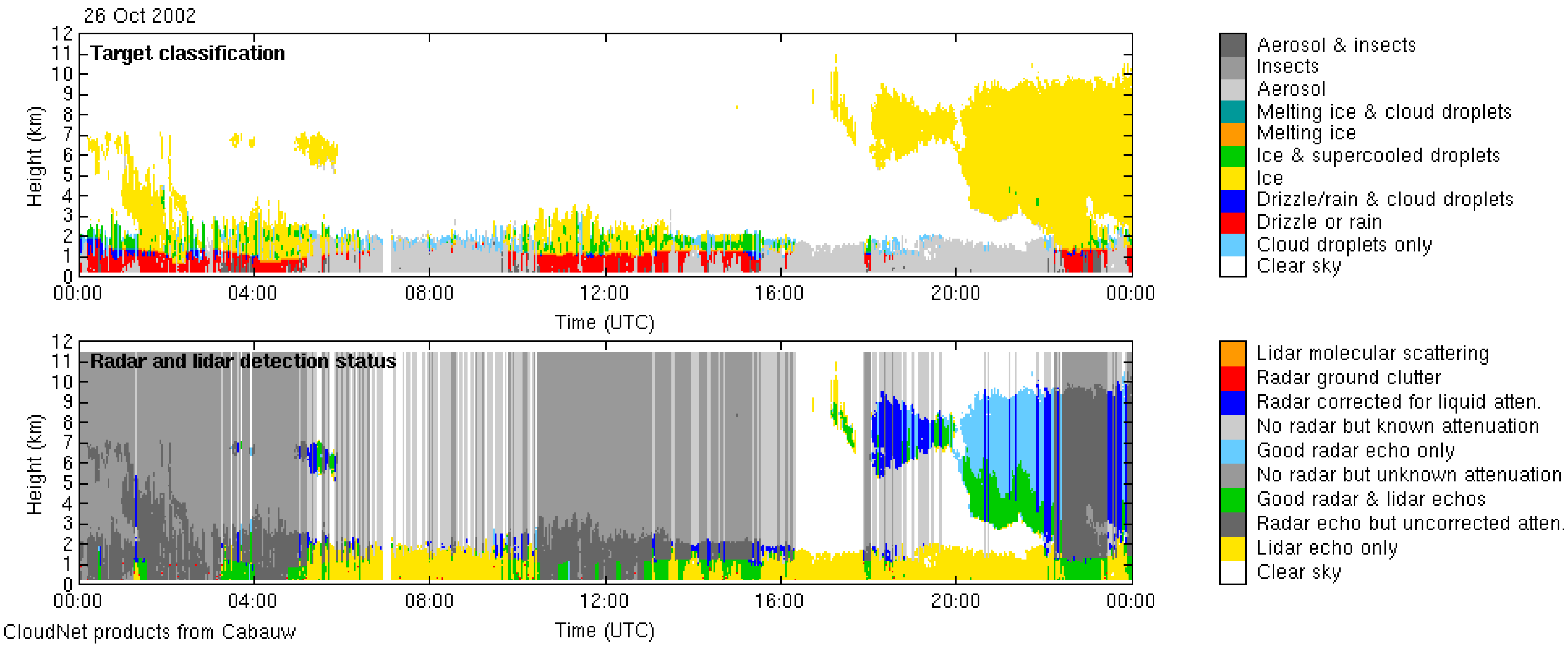


Target categorization

- Combining radar, lidar and model allows the
- type of cloud (or other target) to be identified
- From this can calculate cloud fraction in each model gridbox

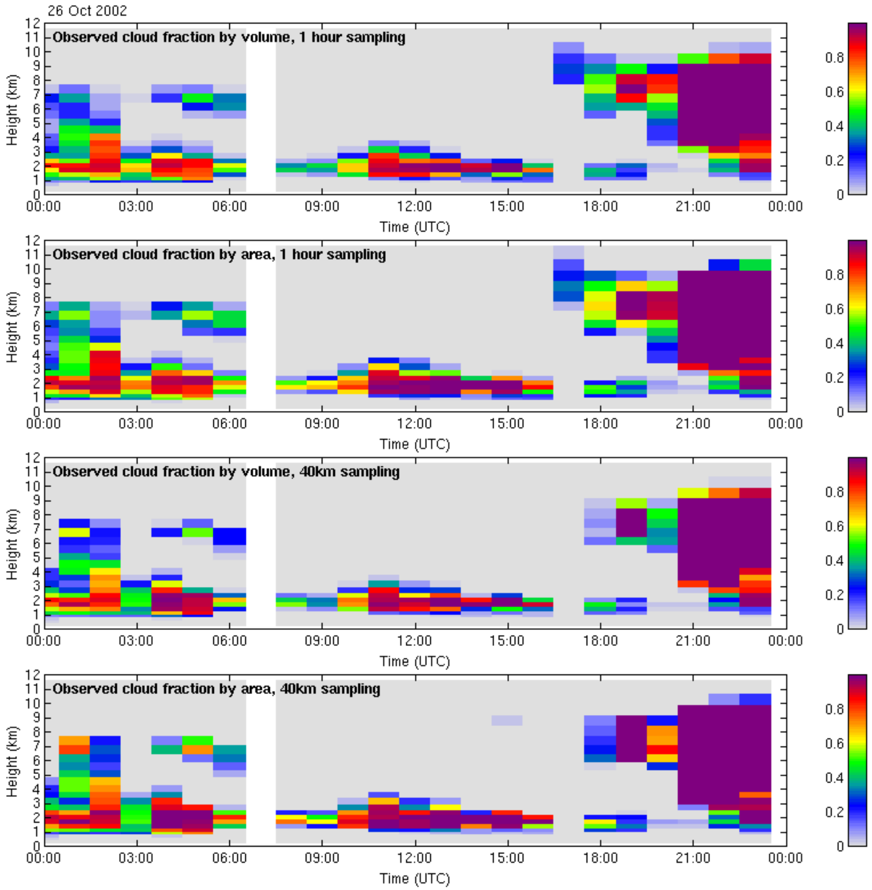


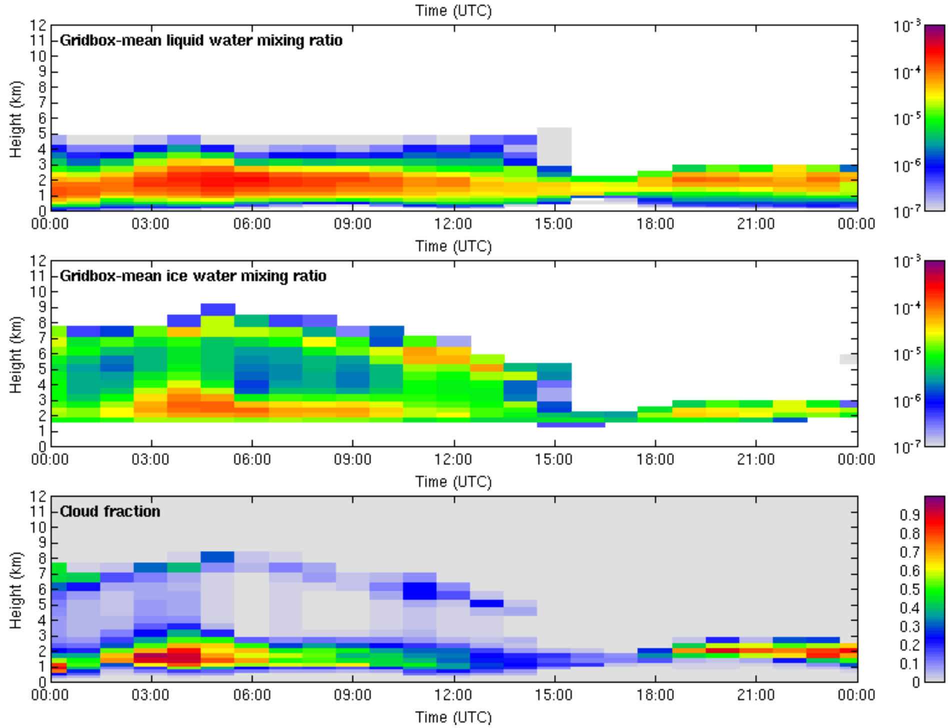
CLOUDNET ANALYSIS FROM 26 OCT 2002

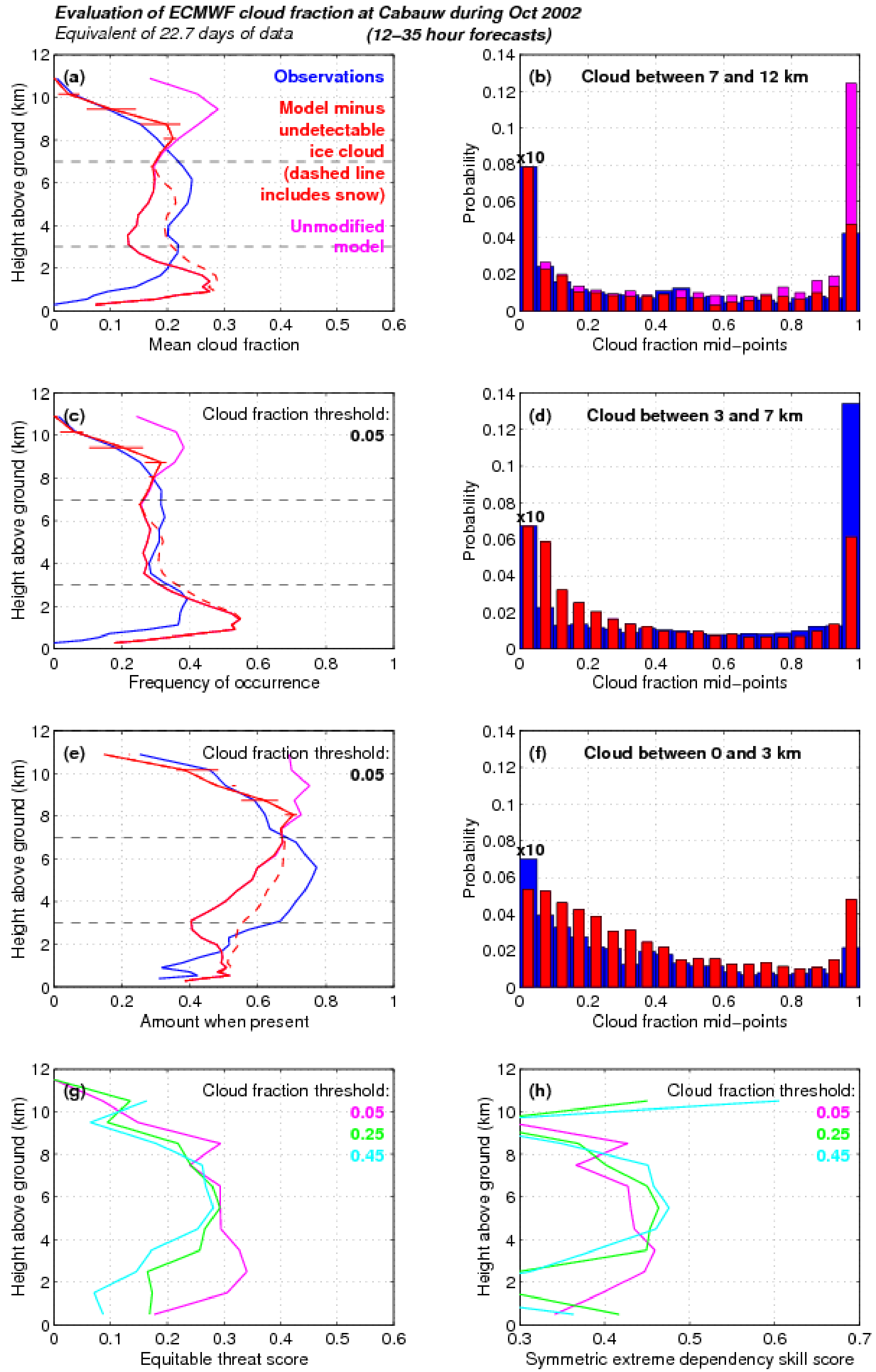


Cloudnet analysis of Cabauw data on the ECMWF model grid

ECMWF ANALYSIS/FORECAST

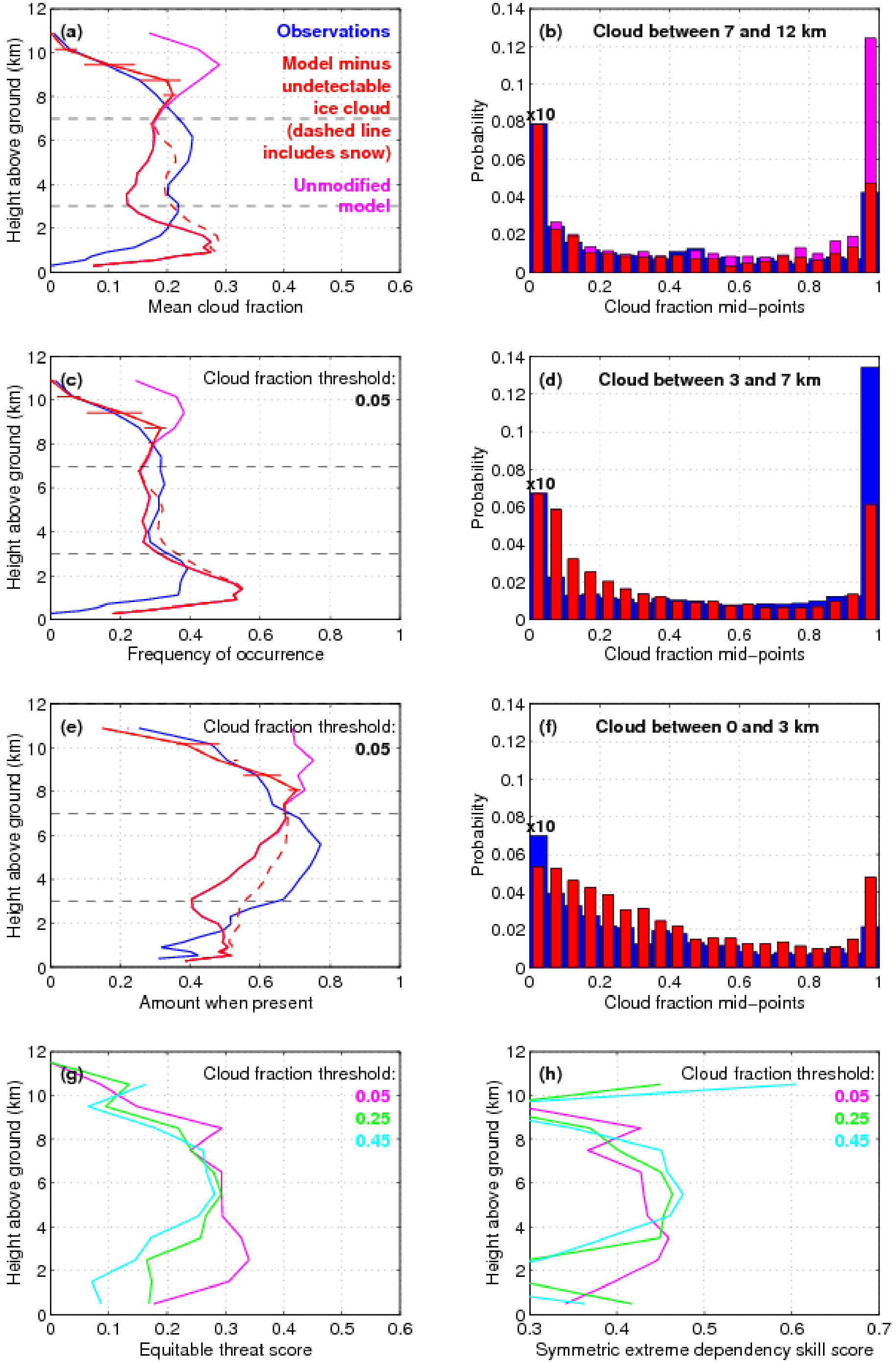




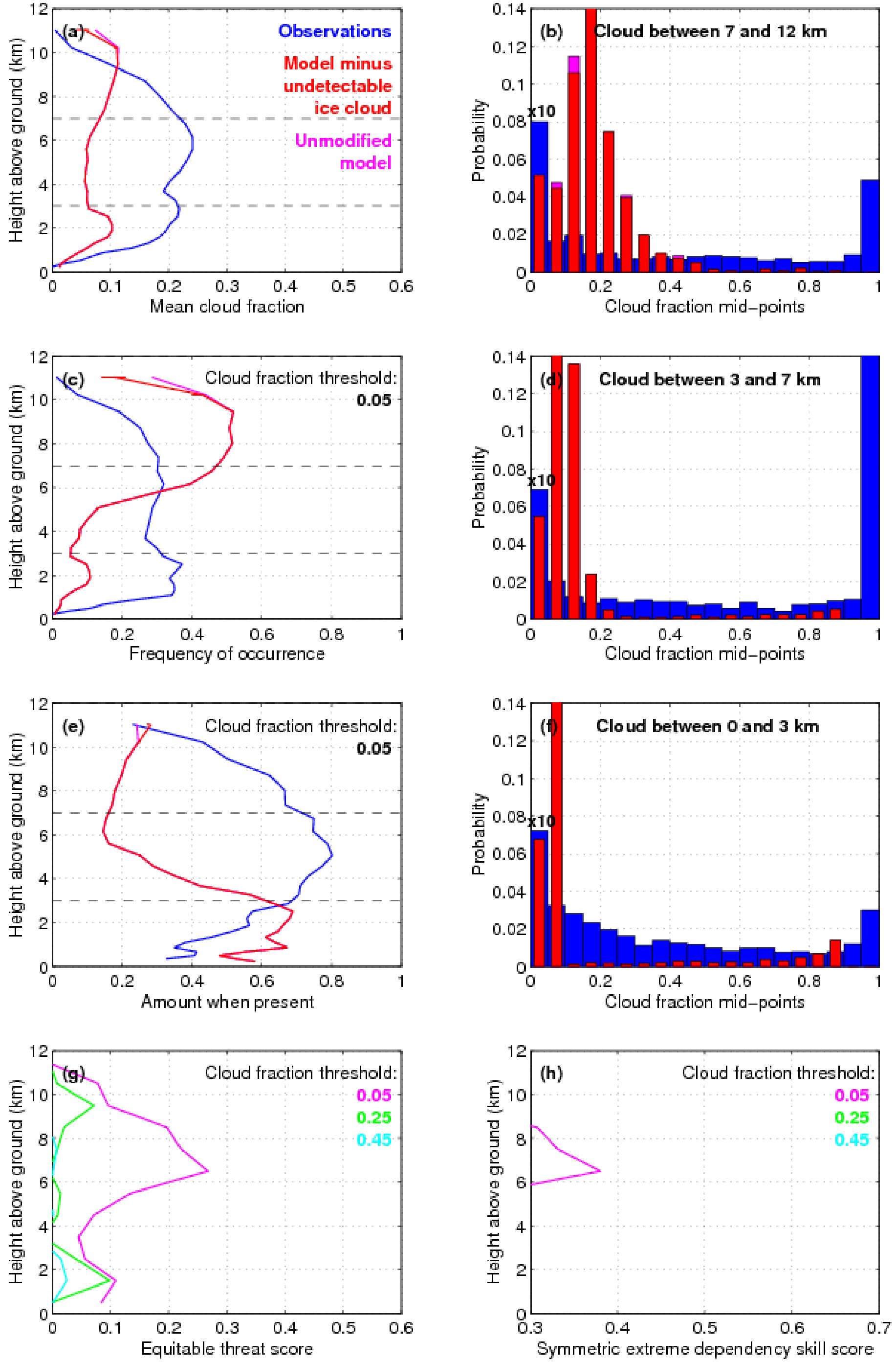


ECMWF
Oct 2002
CLOUD FRACTION
SKILL SCORES

Evaluation of ECMWF cloud fraction at Cabauw during Oct 2002
Equivalent of 22.7 days of data ***(12–35 hour forecasts)***



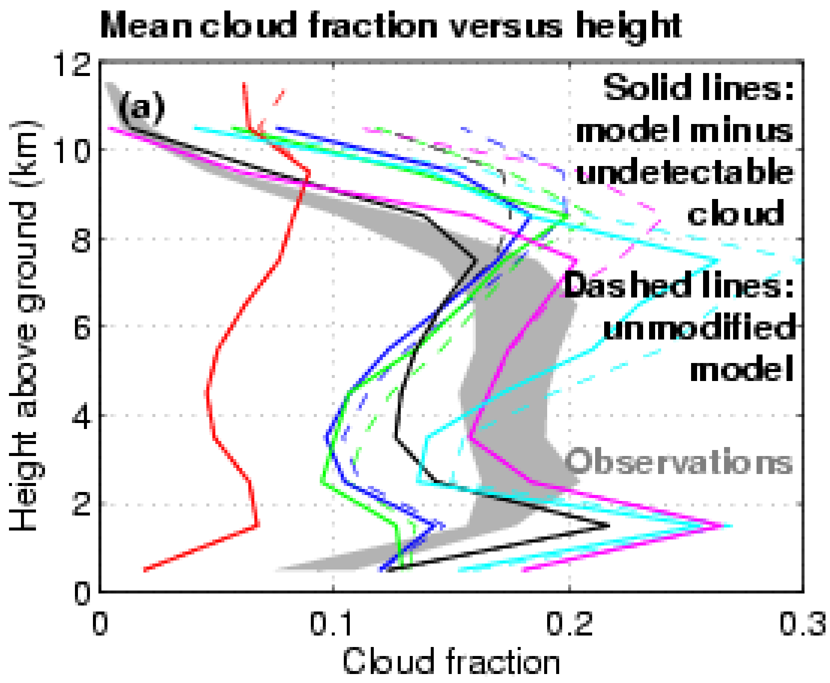
Evaluation of Meteo France cloud fraction at Cabauw during Oct 2002
Equivalent of 22.7 days of data ***(12–35 hour forecasts)***

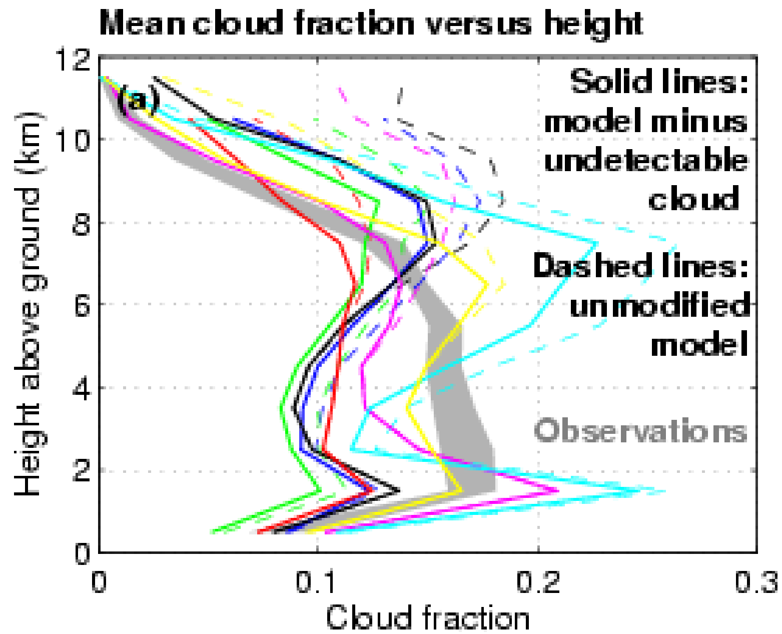


Model performance: Cloud fraction

2002

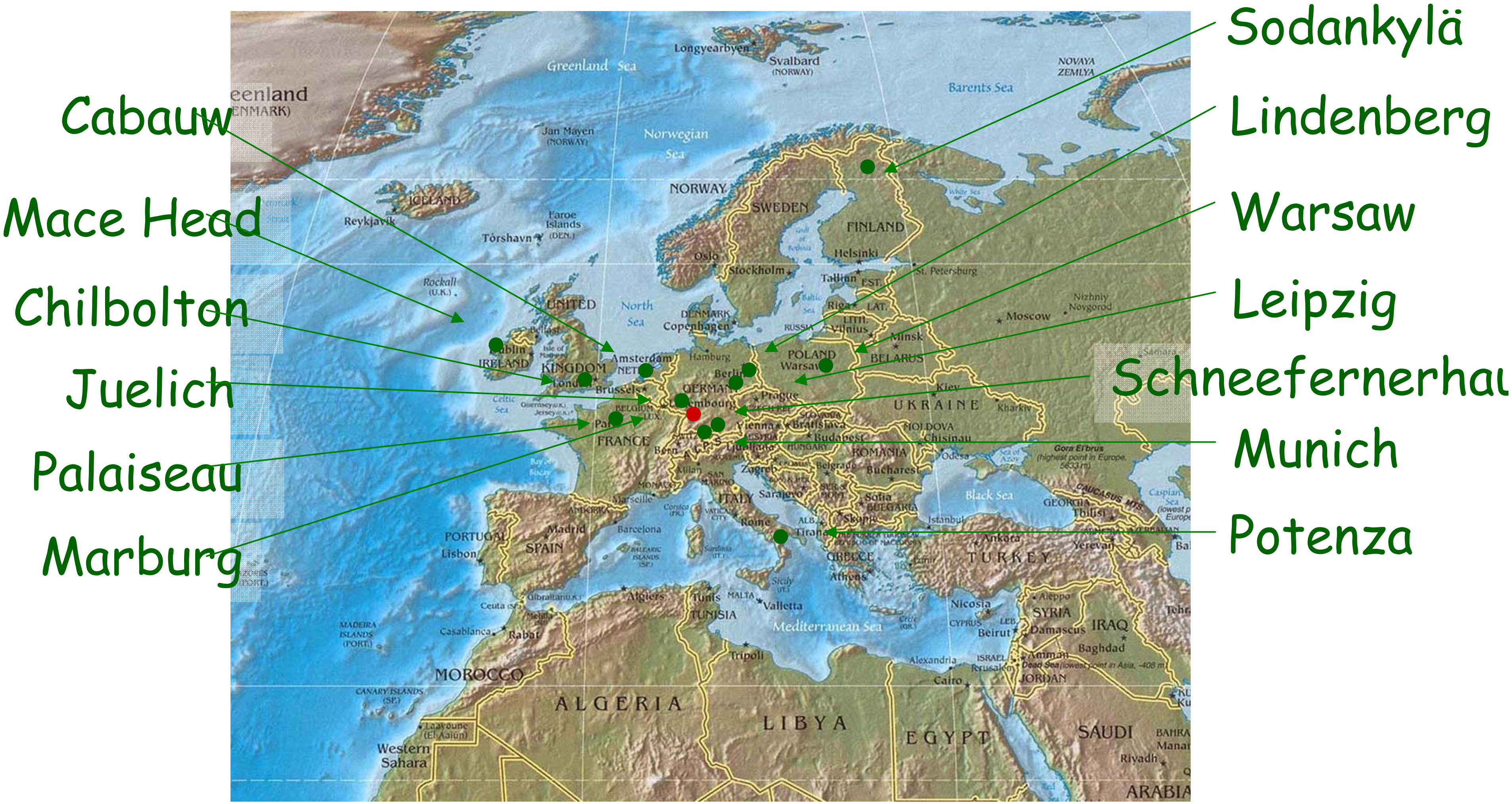
2004





BIG IMPROVEMENT, BUT SINCE THEN BL CLOUDS BETTER OTHERWISE ON A PLATEAU

ACTRIS – Cloud profiling sites

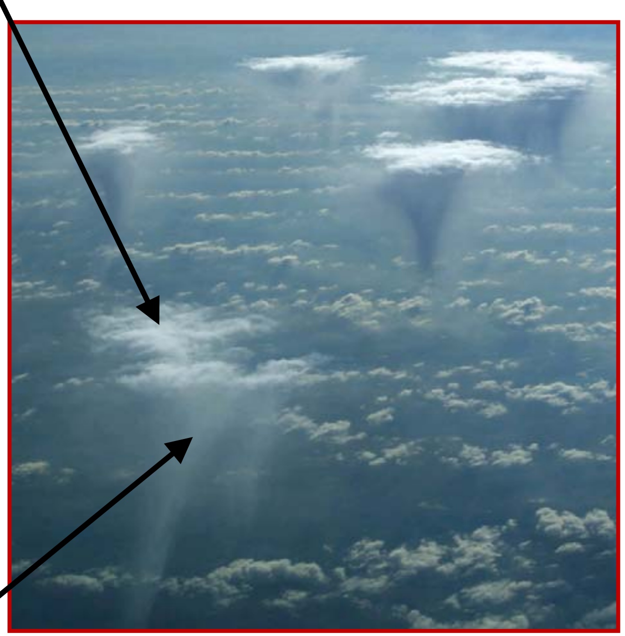


- Cloudnet Sites
- ARM Mobile Facility

Mixed-phase altocumulus clouds

Small supercooled liquid cloud droplets

- Low fall speed
- Highly reflective to sunlight
- Often in layers only 100-200 m thick



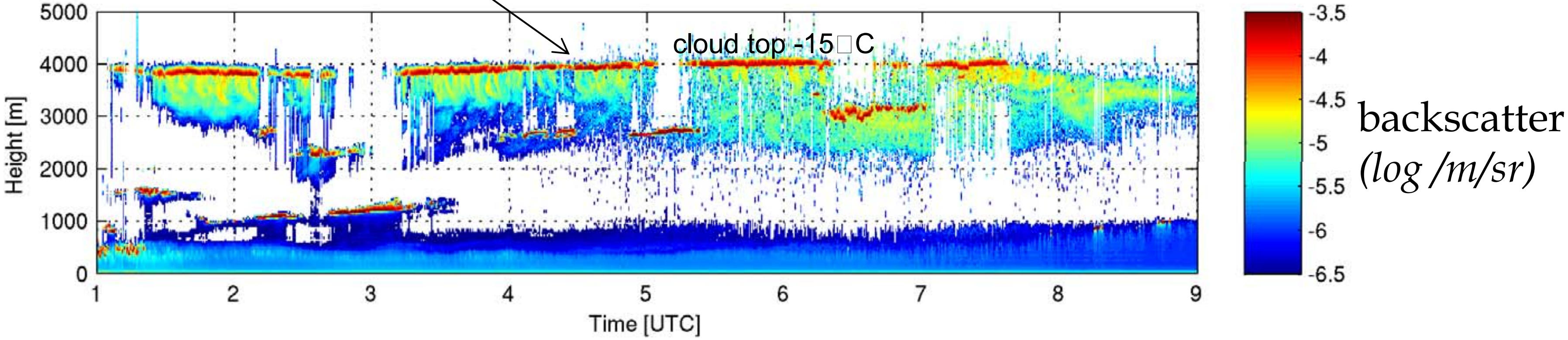
Large ice particles

- High fall speed
- Much less reflective for a given water content

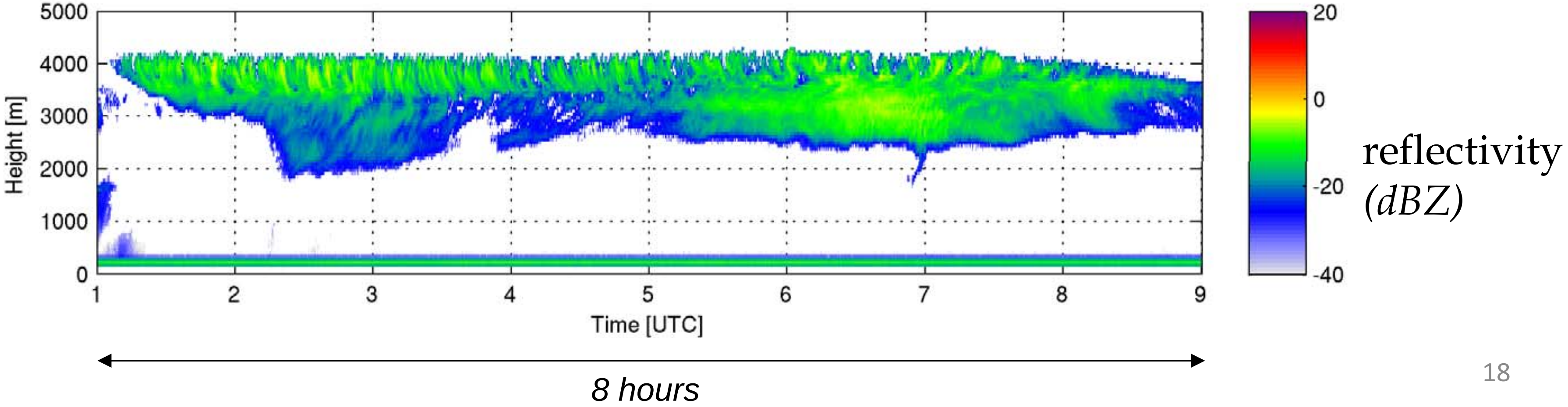
Radar & lidar are a powerful tool to observe these clouds

- 0.9µm lidar and 8.6mm radar at Chilbolton Observatory, Hampshire, UK
- vertically pointing, sample whatever drifts overhead
- operates 24/7.   EXAMPLE 18 MAY 2008

Lidar time series: thin layers of very high reflectivity = liquid droplets (large concentration)

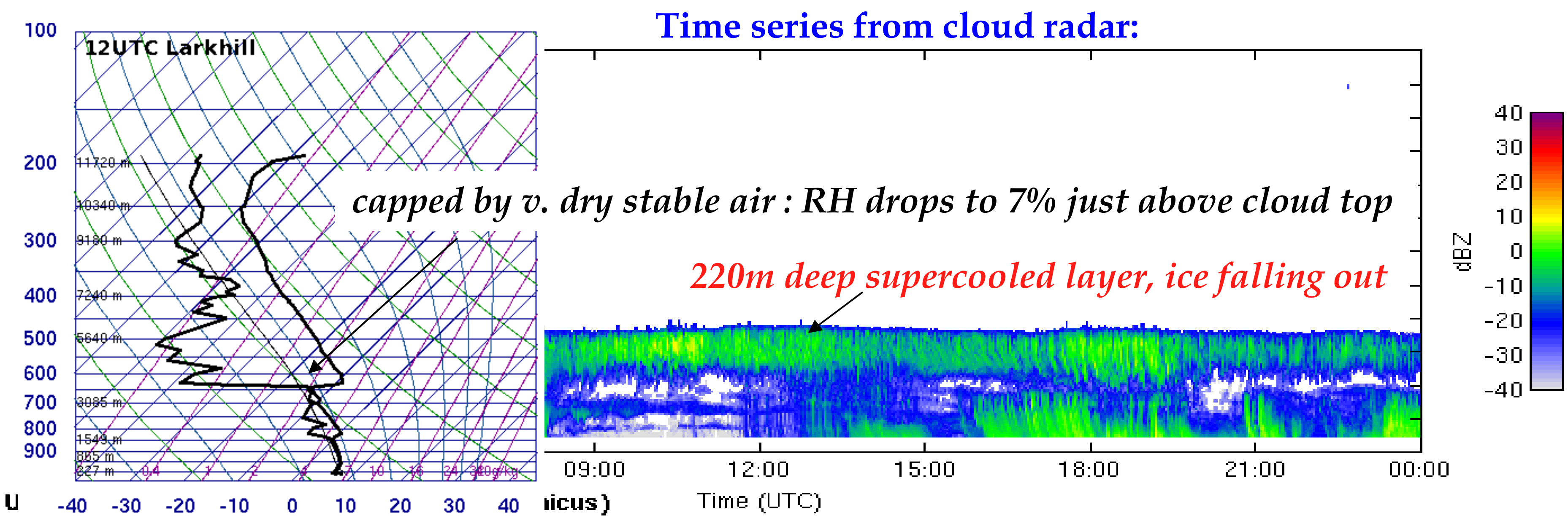


Radar: dominated by much heavier ice crystals (radar scattering ∝ particle volume²)



IN–SITU AIRCRAFT OBSERVATIONS OF CLOUD PARTICLES

- Case study from 18 Feb 2009 **APPRAISE-CLOUDS** campaign
- Based around Chilbolton - coincident aircraft sampling with radar/lidar
- Synoptic situation: quasi-stationary front, widespread mid-level cloud
- Cloud top -12°C



OBSERVATIONAL CHALLENGES 1

1. Liquid clouds – drizzle affects Z, lidar attenuated.

   Get lwp from microwave radiometer, not LWC profile.

   Difficult to get droplet size and concentration profiles

2. Ice cloud – radar and lidar better, IWC not too bad

3. Mixed phase clouds – very difficult/impossible to get lwc when ice is present within deep clouds.

4. Thin mixed layer clouds OK – penetrate by lidar

5. Has cloud cover changed over the past 50 years?

   How define a cloud. Natural variability.

6. Ice nuclei and glaciation of clouds – crudely modelled

OBSERVATIONAL CHALLENGES 2

7. Aerosol size – dual wavelength lidar (colour ratio) helps.

8. Speciation and mass loading more difficult.

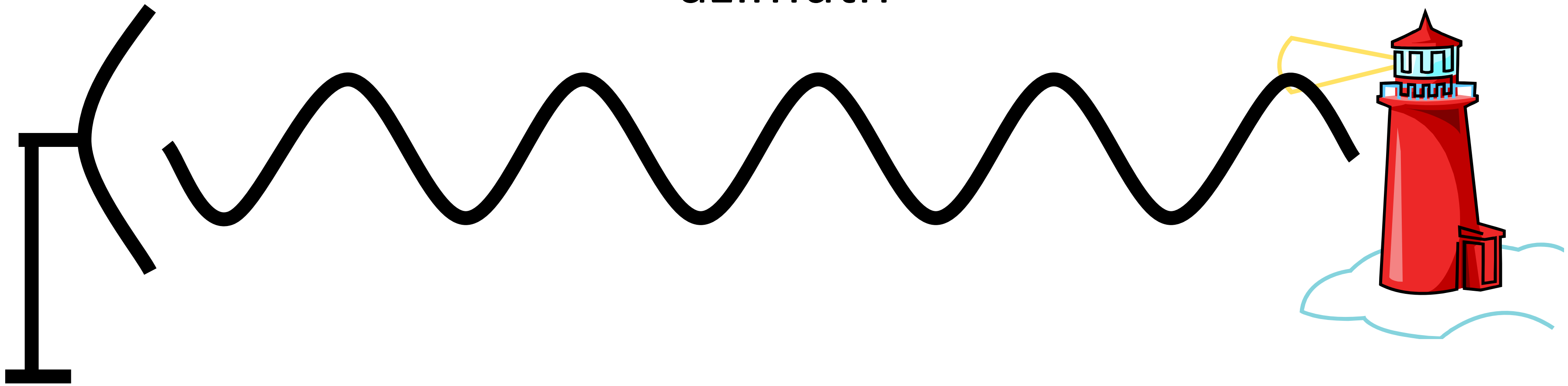
9. Identify cloud-aerosol interaction – does it really suppress or increase rainfall/ change cloud lifetime?

10. But what about the effect of aerosols on ice clouds?

11. Can we remotely profile relative humidity – Raman lidar no good in clouds. GPS tomography?

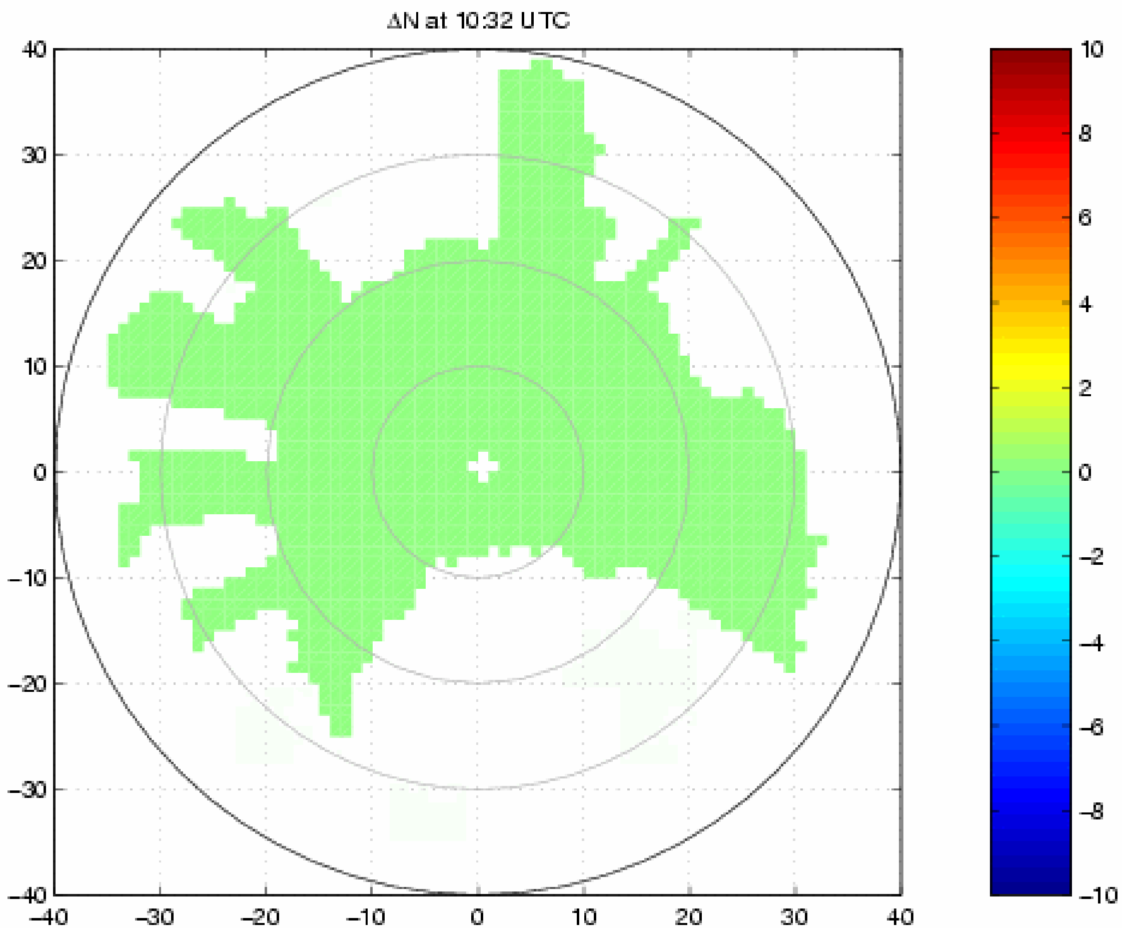
New technique: low level refractivity (humidity) using radar ground clutter.

MAPS OF REFRACTIVITY:
Measure phase of stationary targets along same azimuth



Change in humidity alters the refractive index → Causes change in phase of return signal

Thousands of good ground clutter targets within 30km of Chilbolton - map of change in refractivity, N, for 21 May 2004



+10% RH
MOIST

-10% RH
DRY

1ppm change in N is about 1% change in RH at 20C

Recently Oklahoma measurements show big problems on cool nights – ponding of air – affects propagation.

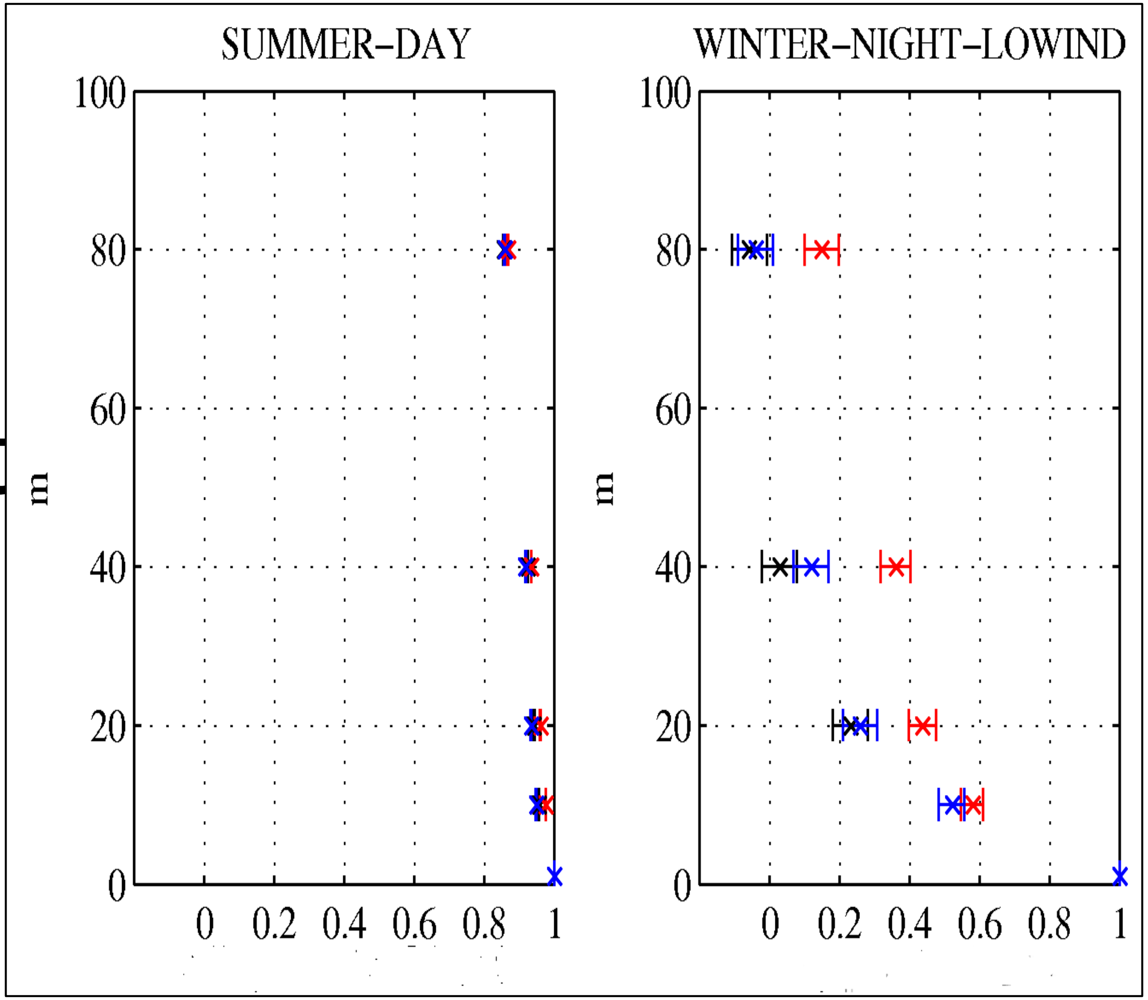
Aim: see convergence of humidity on showery days - to predict where showers/storms will break out.

Need to show that on showery days hourly change in refractivity, ΔN, at the ground is representative of changes throughout the boundary layer.

Cabauw tower to the rescue. See if ΔN at the ground is correlated with ΔN at 100m ht.

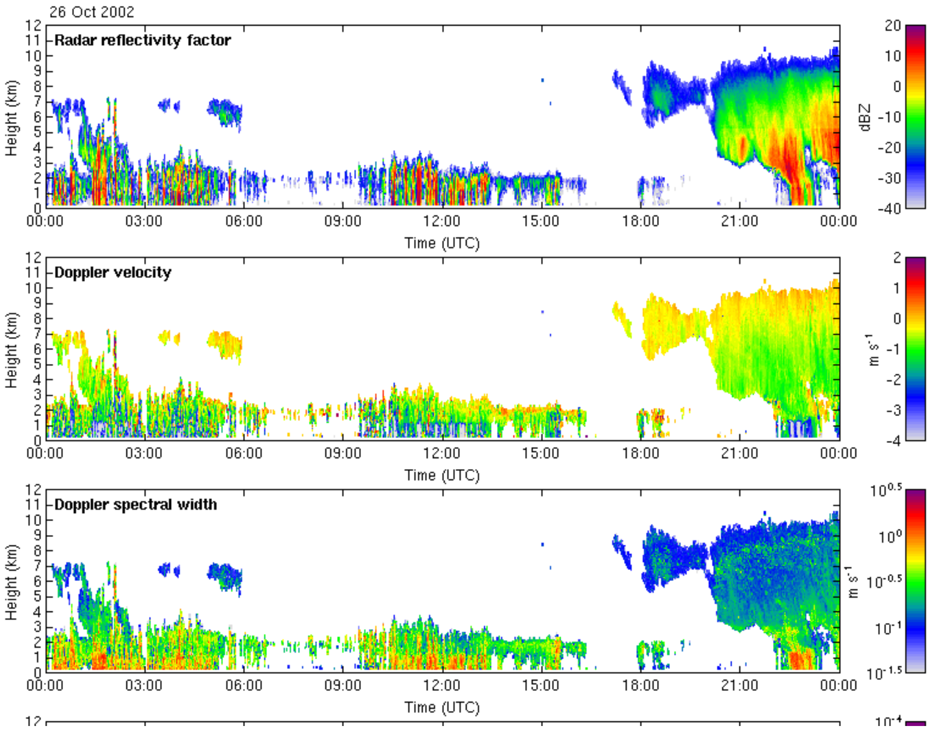
Correlation of hourly ΔN at the ground with ΔN at various heights

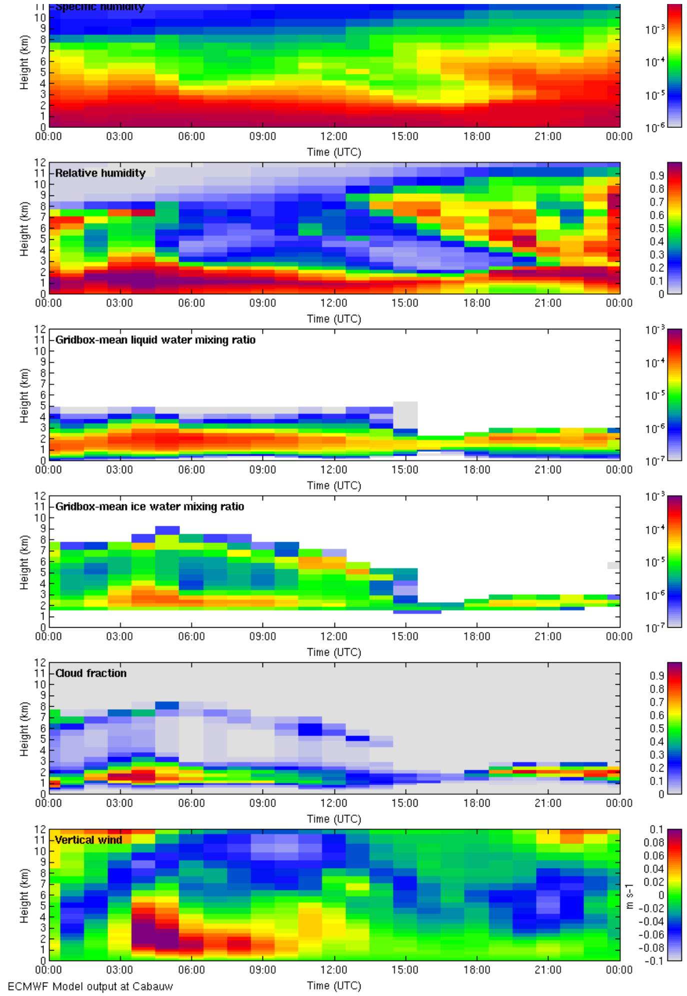
Height
In m



Correlation

CABAUW OBSERVATIONS 26 OCTOBER 2002





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