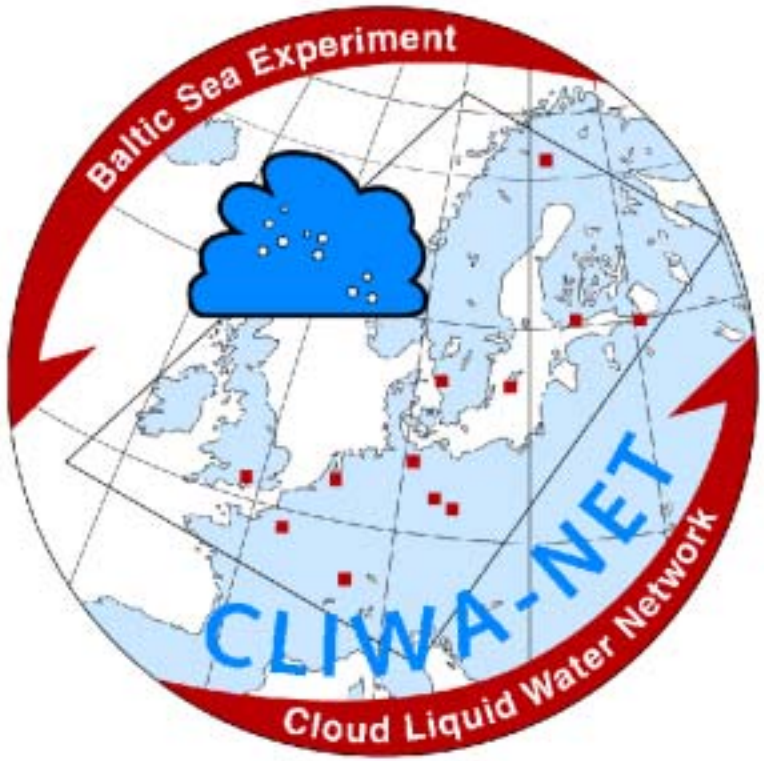
Modelling component of the CLIWA-Net project: Workpackage 4000

Erik van Meijgaard, KNMI, De Bilt, The Netherlands



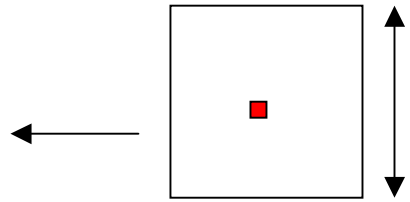
Combined EUROCS/CLIWA-Net Final Workshop,
Madrid, 16 December 2002

Model Evaluation/Parameterisations

- Model evaluation of cloud parameters with focus on Liquid Water Path
  - Evaluation with time series of ground-based measurements
  - Comparison with satellite inferred LWP spatial distributions
- Aspects of Horizontal resolution (range 10 - 1 km)
- Parametric issues of cloud processes
  - …
  - Cloud overlap assumptions
  - Diurnal cycle of cloud parameters
  - Effect of vertical resolution

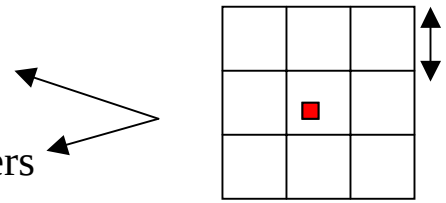
Towards comparisons between model outputs and observations during the CNN campaigns of CLIWA-NET

✓ *Models involved :*



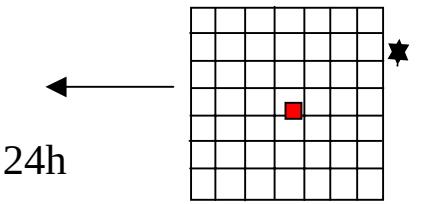
Global model

- ECMWF : spatial resolution : 55 km, 60 layers
  time step : 30 min - Semi-Lagrangian



Regional models

- KNMI/RACMO : spatial resolution : 18 km, 24 layers
  time step : 2 min - Eulerian
  initialized from ECMWF every 24 h
- Rossby Center/ RCA-HIRLAM: spatial resolution : 18 km, 24/40/60 layers
  time step : 7 min 30 - Semi-Lagrangian
  initialized from ECMWF every 24 h



- DWD/ Lokal Modell: spatial resolution 7 km, 35 layers
  time step : 40 s - Eulerian
  initialized from the DWD analysis every 24h

✓ *Observations :*

- Ground-based : 12 Stations
  - Microwave radiometer
  - Infrared radiometer
  - Lidar ceilometer
  - Cloud radar (at 3 sites)

→ continuous temporal information

- Satellite:
  - NOAA/AVHRR (Vis/IR)

→ snapshots with spatial information

Specifications of Model Output

(File Format is ASCII)_

General Information

- Name participating institute, model and experiment
- Reference date [yyyymmdd]
- Reference time [hhmn]
- Name CLIWANET station
- Longitude grid point [decimal]
- Latitude grid point [decimal]
- Surface Geopotential grid point [m2/s2]

Single-level parameters:(averaged/accumulated)

- Verifying date [yyyymmdd]
- Verifying time [hhmn]
- Surface Pressure [Pa] (instantaneous)
- Sensible heat flux at surface [W/m2] (ave)
- Latent heat flux at surface [W/m2] (ave)
- Momentum flux at surface [Pa] (rho <u'w'>) (ave)
- Downward SW-flux at surface [W/m2] (ave)
- Upward SW-flux at surface [W/m2] (ave)
- Downward LW-flux at surface [W/m2] (ave)
- Upward LW-flux at surface [W/m2] (ave)
- Downward SW-flux at TOA [W/m2] (ave)
- Upward SW-flux at TOA [W/m2] (ave)
- Upward LW-flux at TOA [W/m2] (ave)
- Precipitation Convective [m/s] (acc)
- Precipitation Large Scale [m/s] (acc)
- Precipitative Fraction in GridBox [0..1] (ave)
- Total Cloud Cover [0..1] (ave)

Multi-level parameters: (instant./averaged)

- Verifying date [yyyymmdd]
- Verifying time [hhmn]
- Model layer value
- Pressure [Pa] (instant.)
- Temperature [K] (instant.)
- Zonal wind component [m/s] (instant.)
- Meridional wind component [m/s] (instant.)
- Vertical wind speed [Pa/s] (instant.)
- Turbulent Kinetic energy [m2/s2] (instant.)
- Specific Humidity [kg/kg] (instant.)
- Specific Liquid Water [kg/kg] (instant.)
- Specific Ice Content [kg/kg] (instant.)
- Cloud fraction [0..1] (instant.)
- Short Wave In-Cloud Optical Thickness [..]
- Long Wave In-Cloud Emissivity [0..1]
- Liquid Precipitative Flux [W/m2] (ave)
- Solid Precipitative Flux [W/m2] (ave)

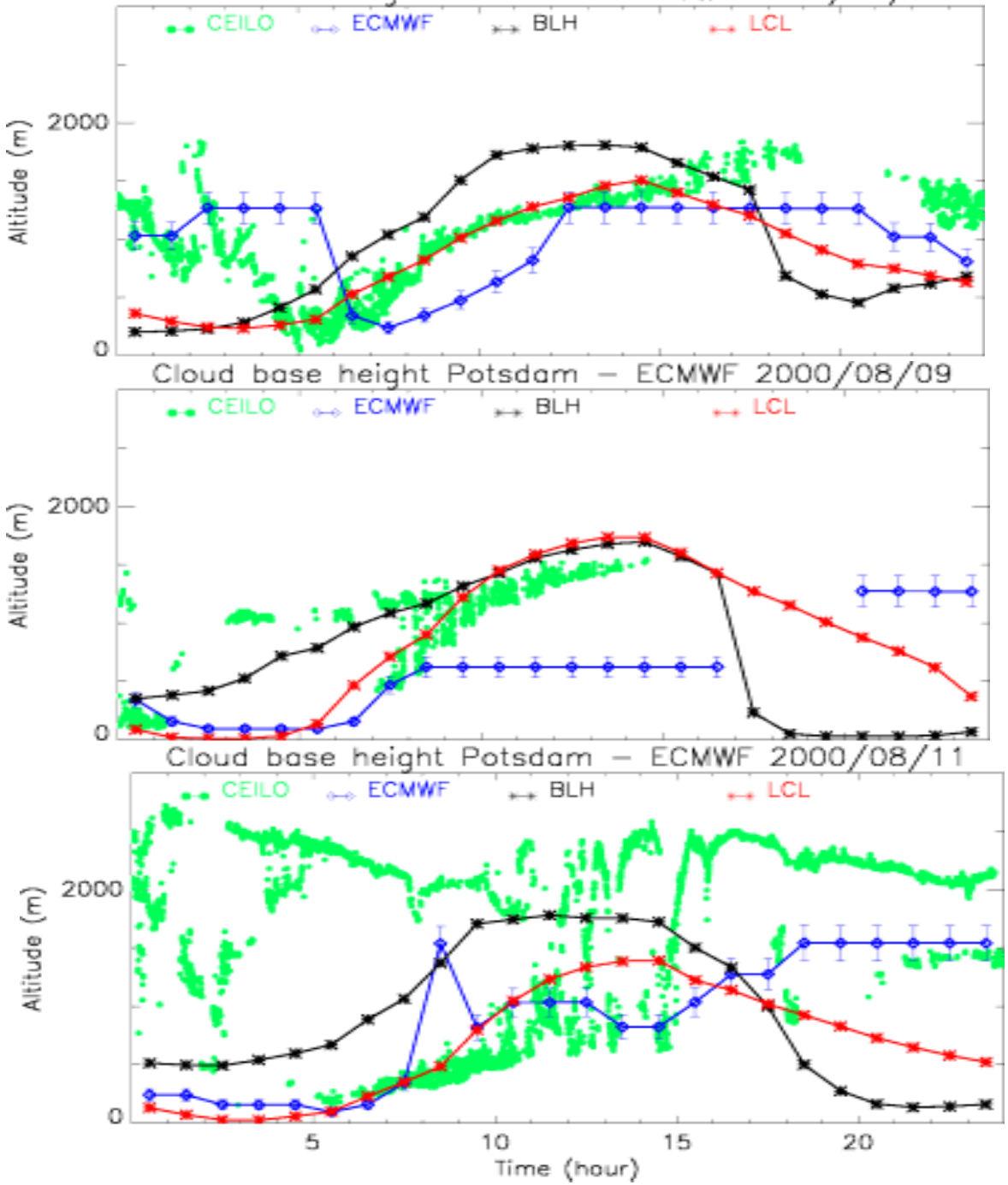
KNMI

Model evaluation

- Cloud base height predictors

Lidar ceilometer cloud base height series at Potsdam.

ECMWF series of
- cloud base height
- PBLH (dry)
- LCL

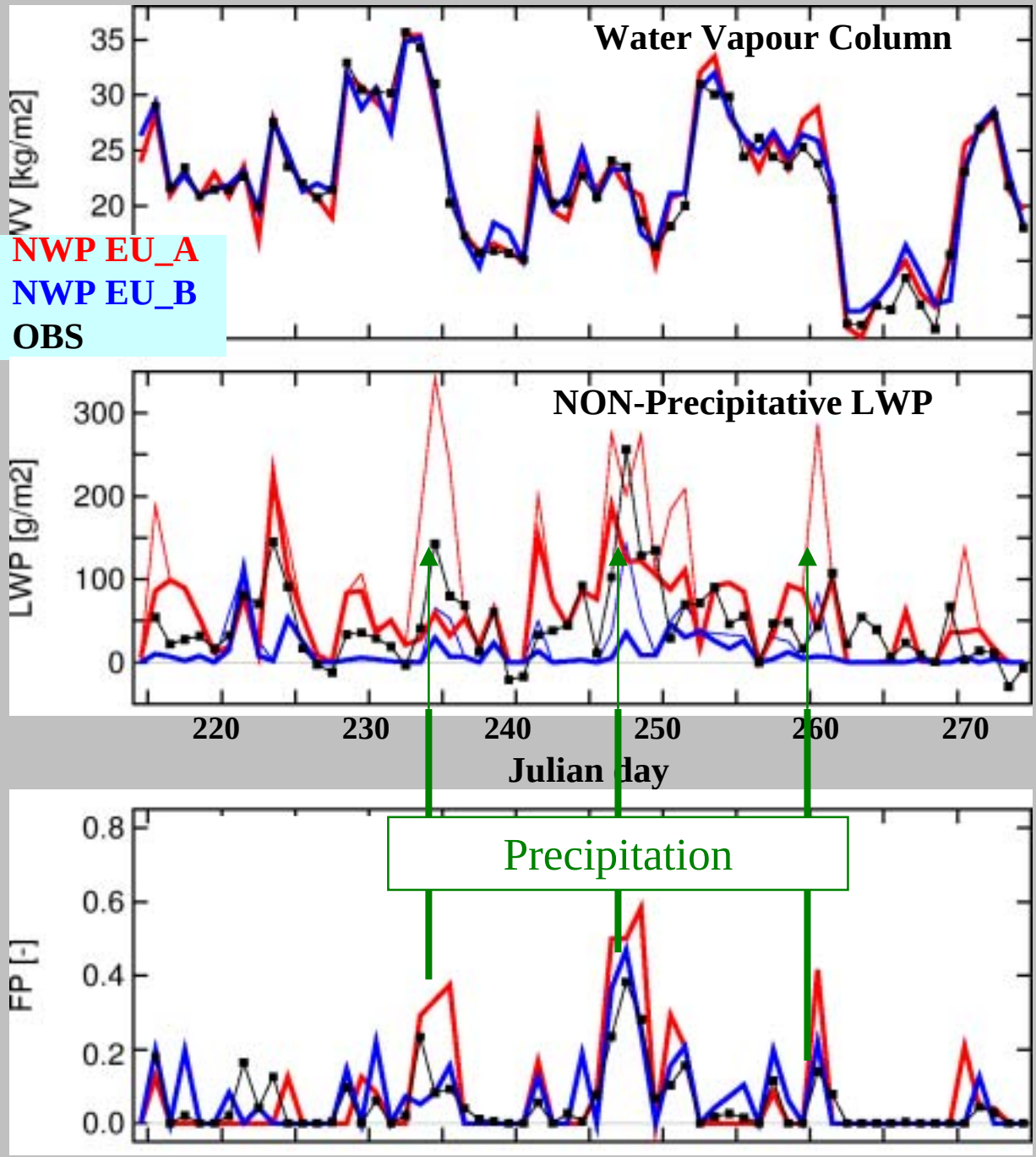


KNMI

Model evaluation

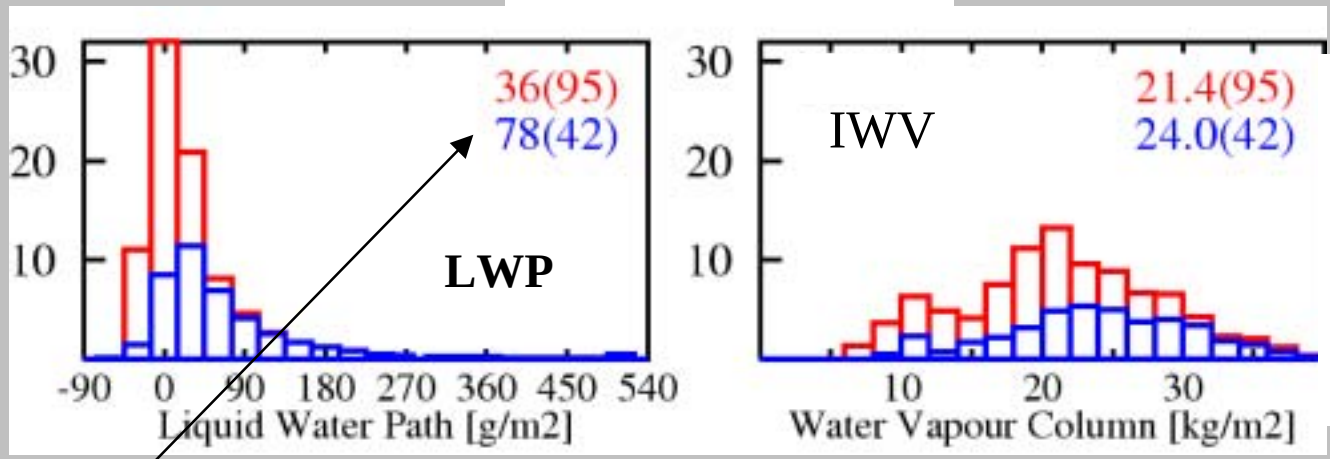
- Frequency Distributions of Liquid Water Path

Time series of LWP and IWV at Lindenberg during CNN1



CNNI-Distributions of LWP and IWV at Lindenberg (time of operation : 90%)

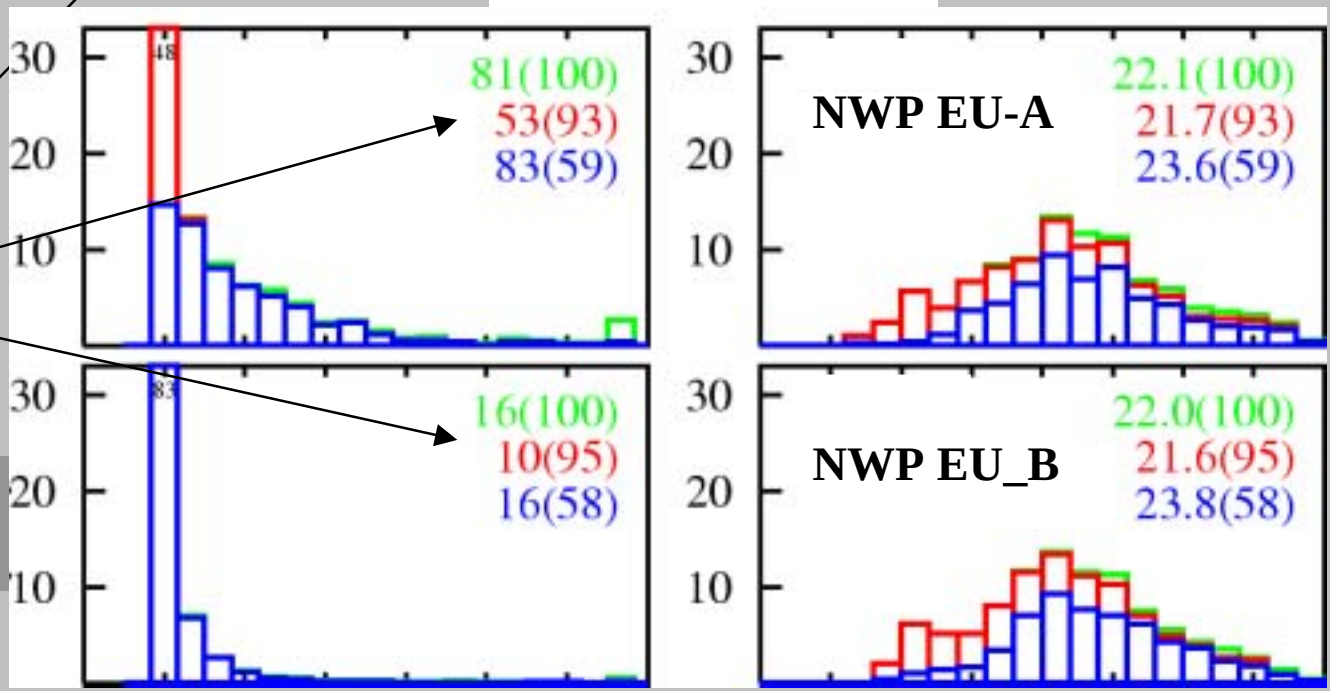
OBSERVATIONS



BLUE:
Non-raining liquid water clouds

RED:
All non-raining events (clouds+clear)

MODEL



Mean(%)

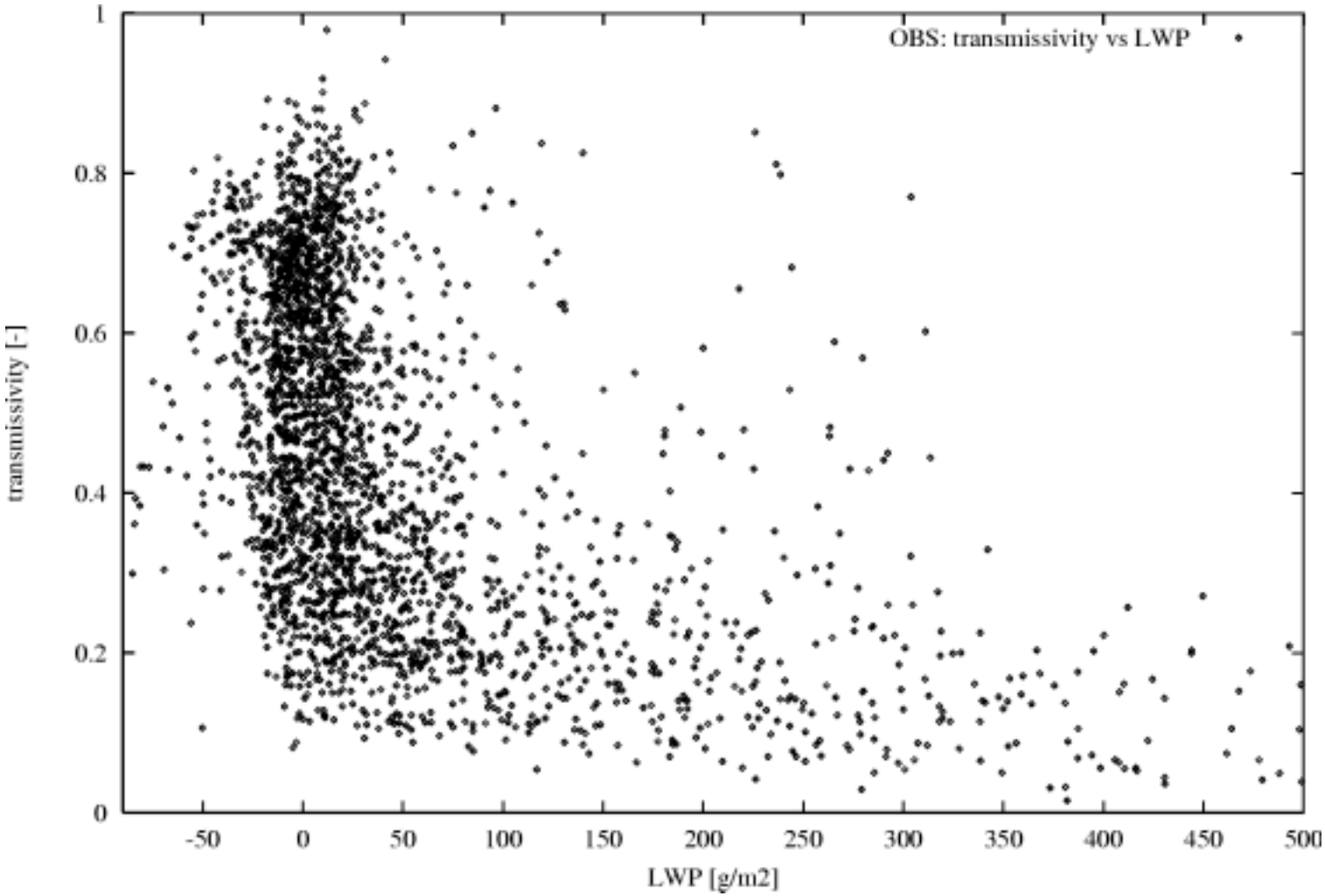
GREEN: (only models)
All events.

KNMI

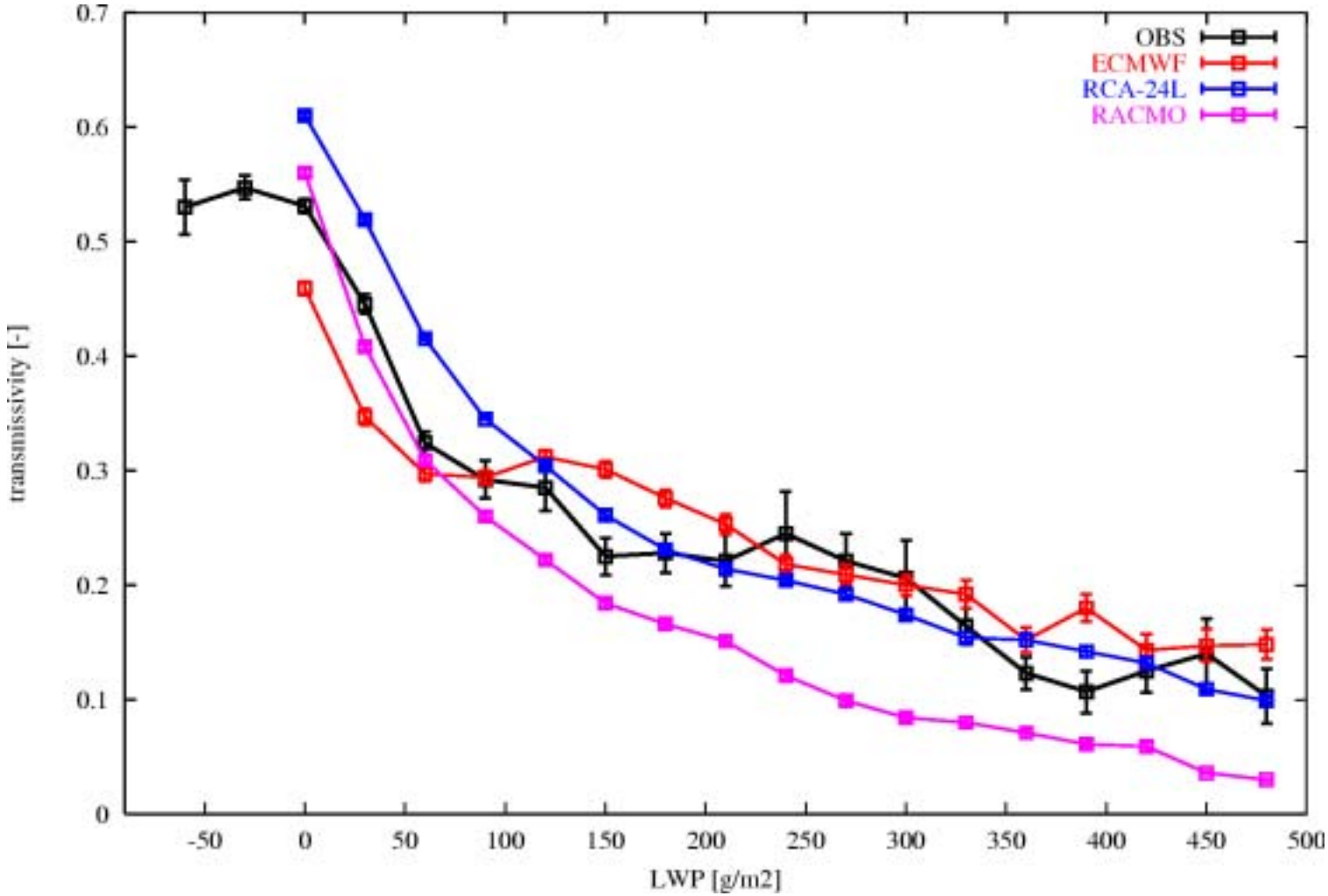
Model evaluation

- Short-wave transmissivity versus Liquid Water Path

BBC-Cabauw : Observed transmissivity versus LWP



BBC-Cabauw : Observed and Model predicted transmissivity versus LWP

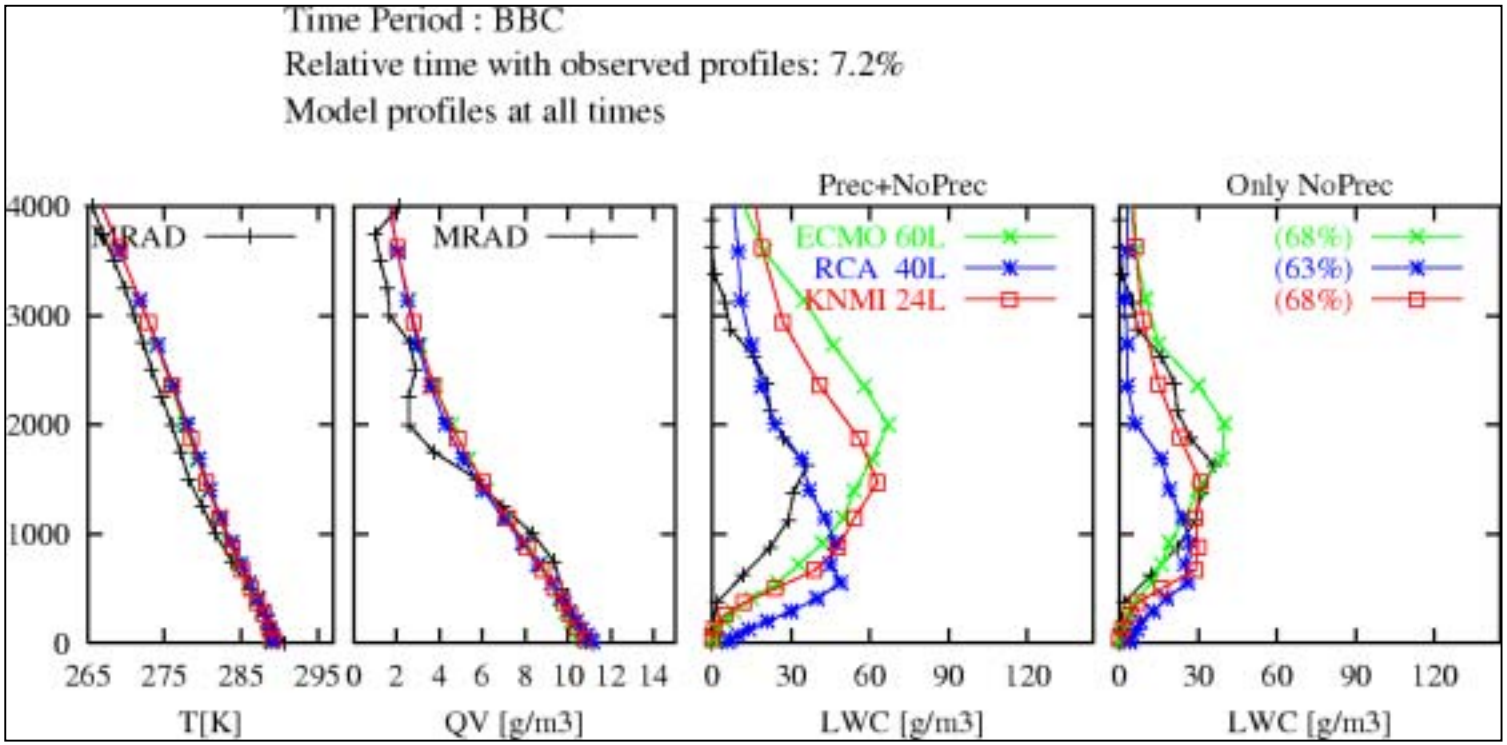


KNMI

Model evaluation

- Vertical distribution of Liquid Water Content

BBC-Cabauw: Microwave Radiometer inferred and Model predicted Vertical distribution of Liquid water Content



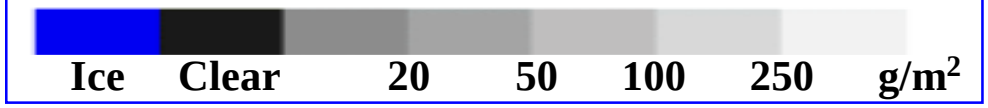
KNMI

Satellite processing

- Retrieval of the horizontal distribution of LWP from AVHRR validated by ground-based measurements.

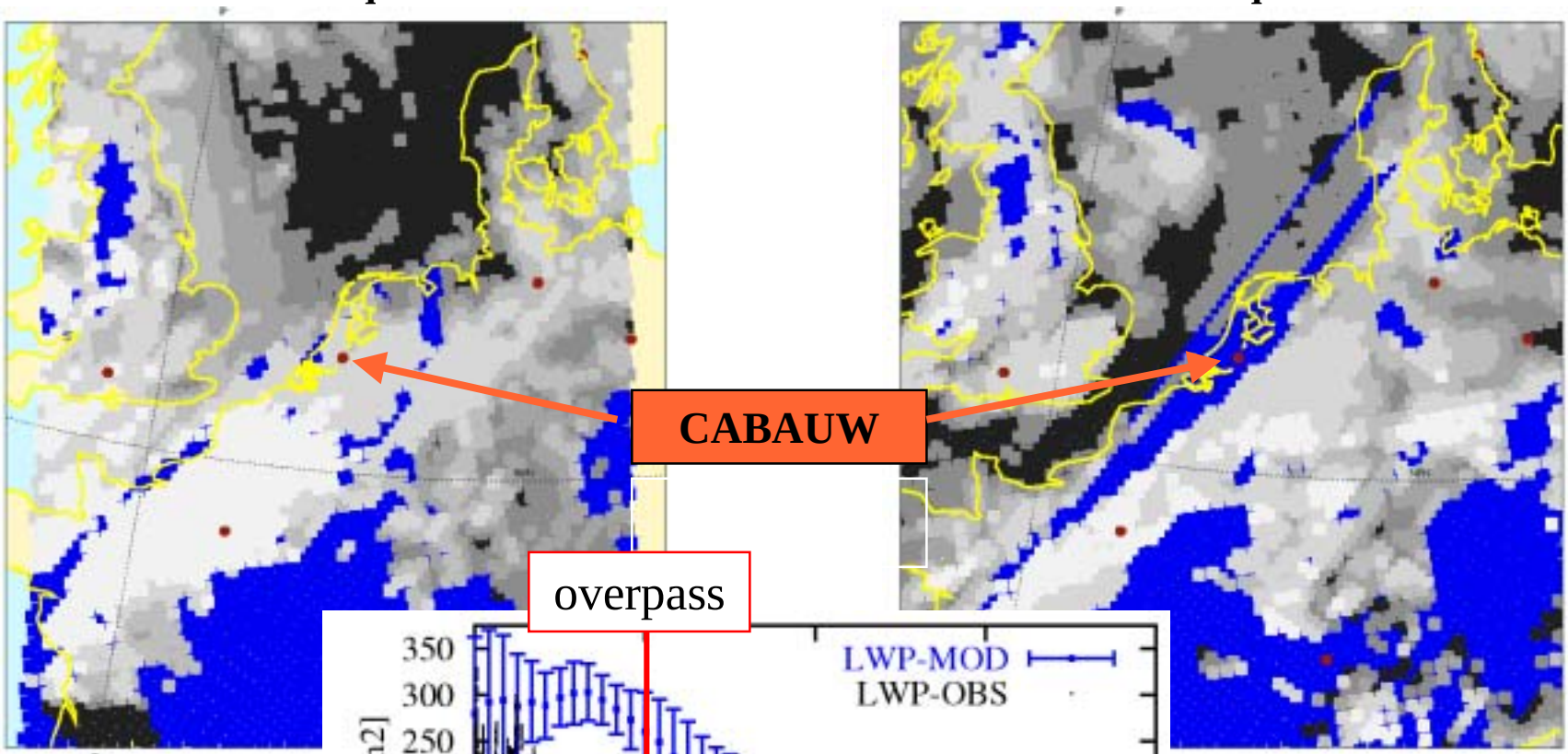
  (KLAROS: KNMI's Local implementation of APOLLO Retrieval in an Operational System

- Comparison of model predicted LWP fields with AVHRR inferred distributions.

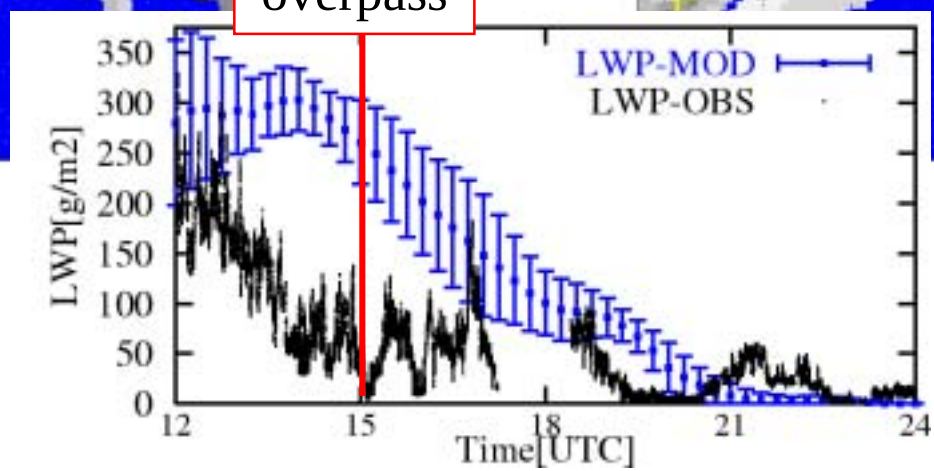


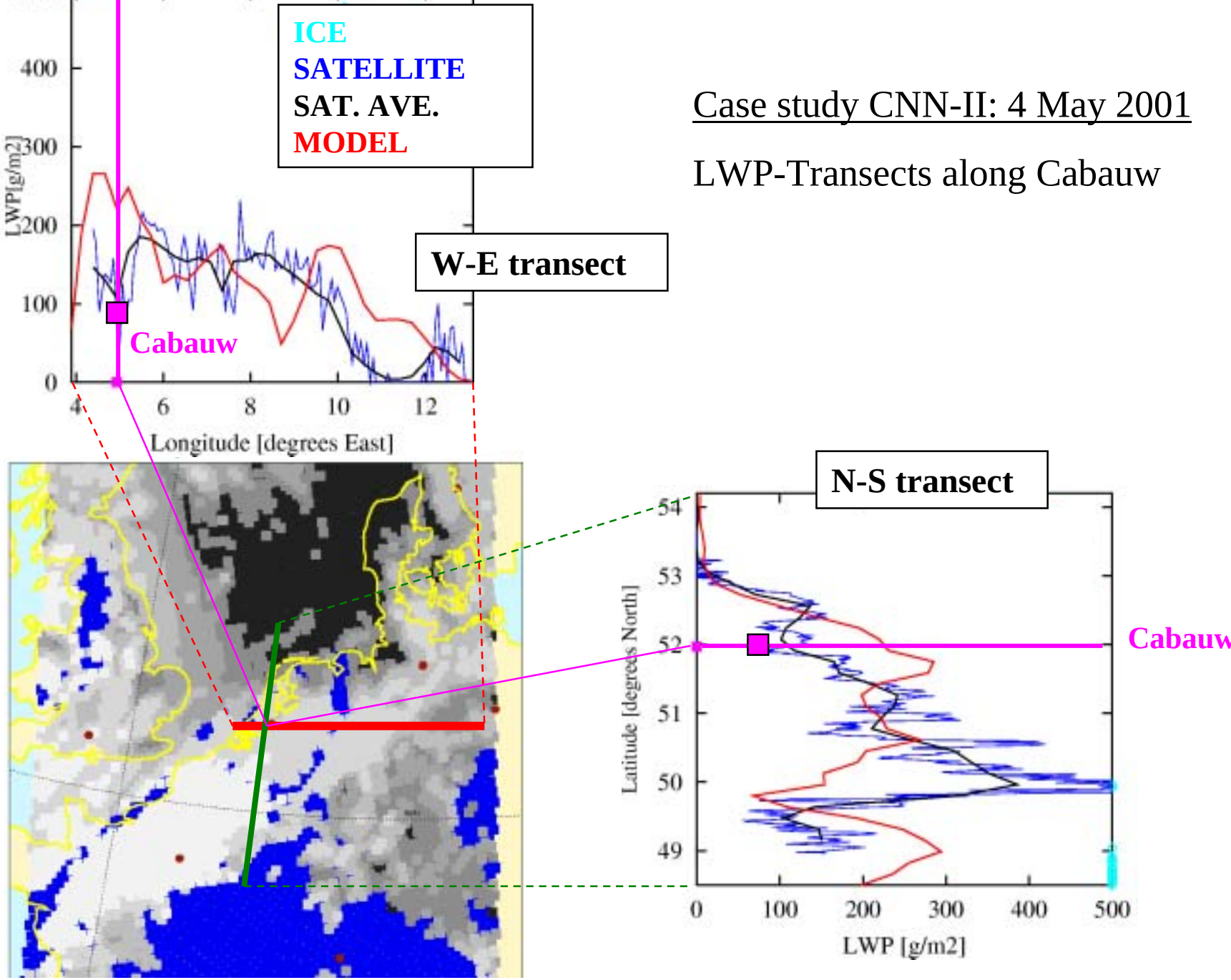
AVHRR inferred Liquid Water Path

Model Predicted Liquid Water Path



overpass

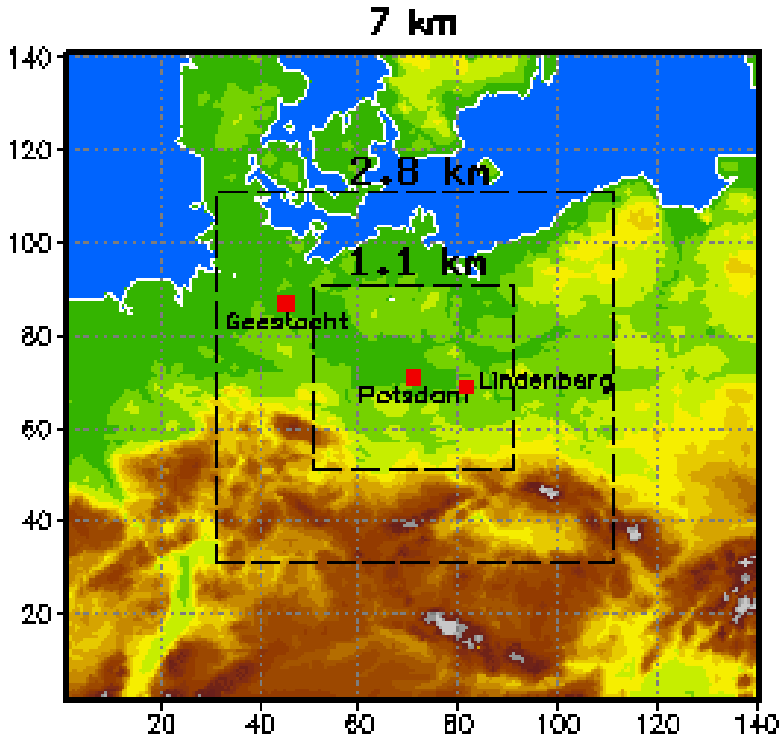




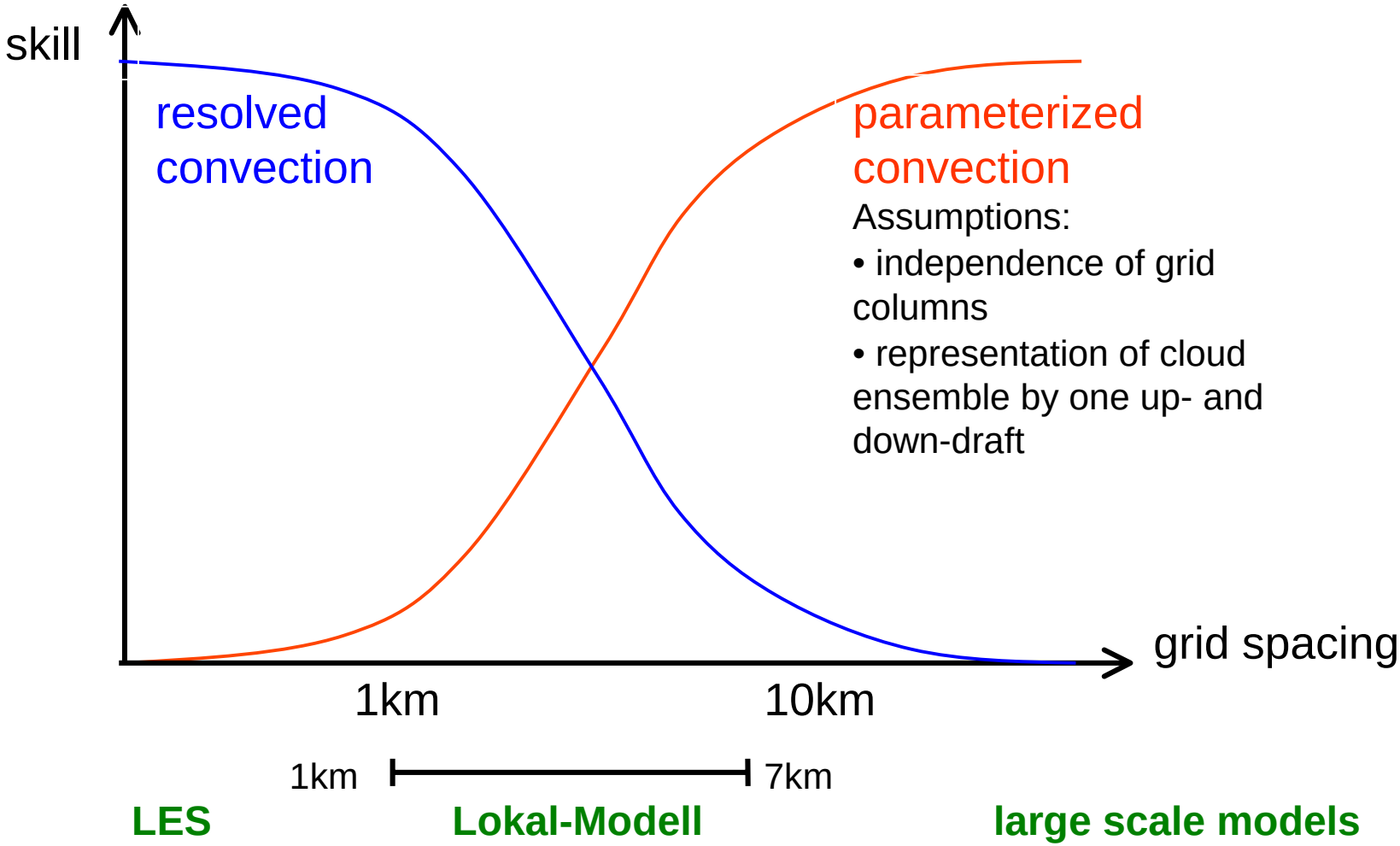
Case study CNN-II: 4 May 2001

LWP-Transects along Cabauw

Horizontal domain Local Modell

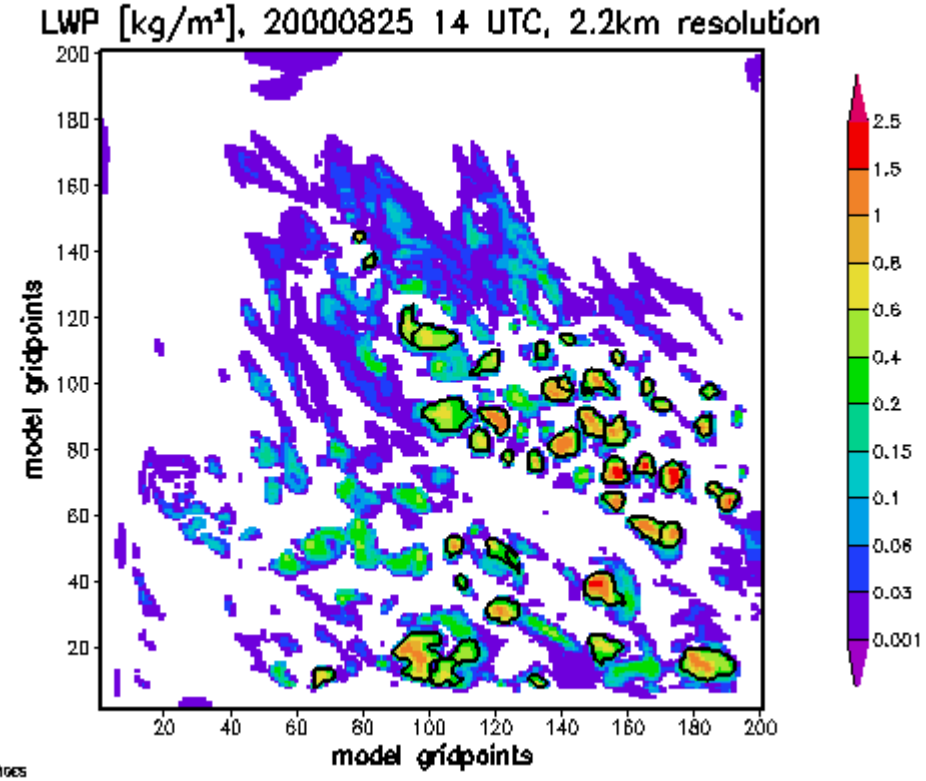


Motivation

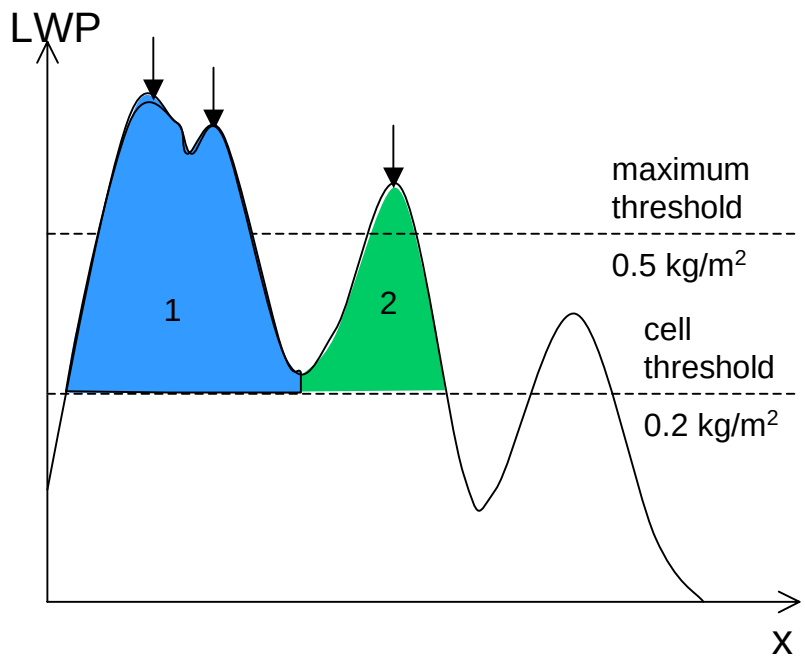

skill
resolved convection
parameterized convection
Assumptions:
• independence of grid columns
• representation of cloud ensemble by one up- and down-draft
grid spacing
1km
10km
1km
7km
LES
Lokal-Modell
large scale models

Detection of „convective“ cells

Example:

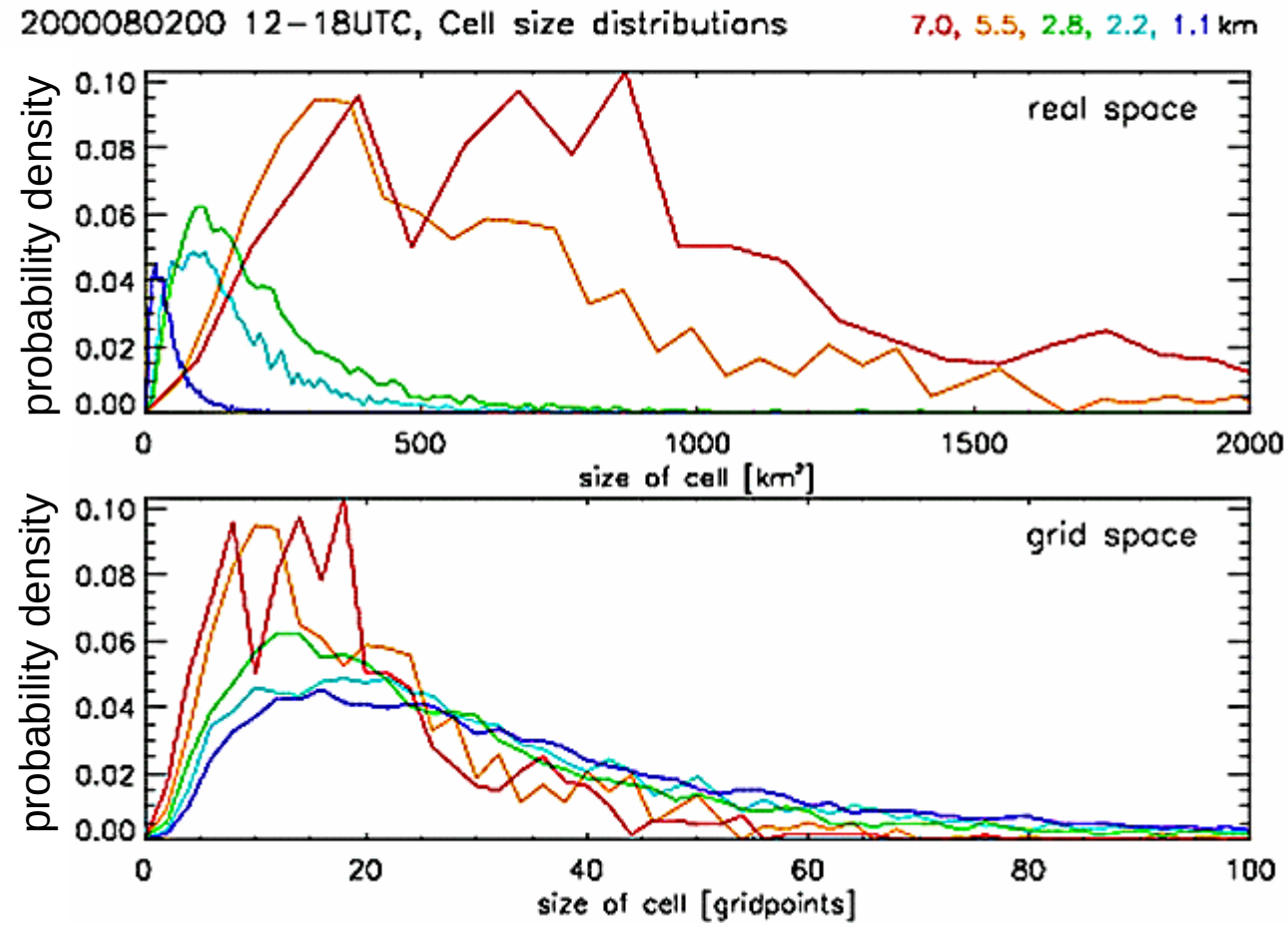


Scheme of threshold algorithm:

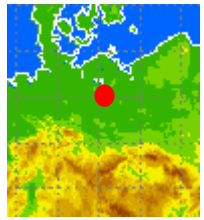


Cell size distributions

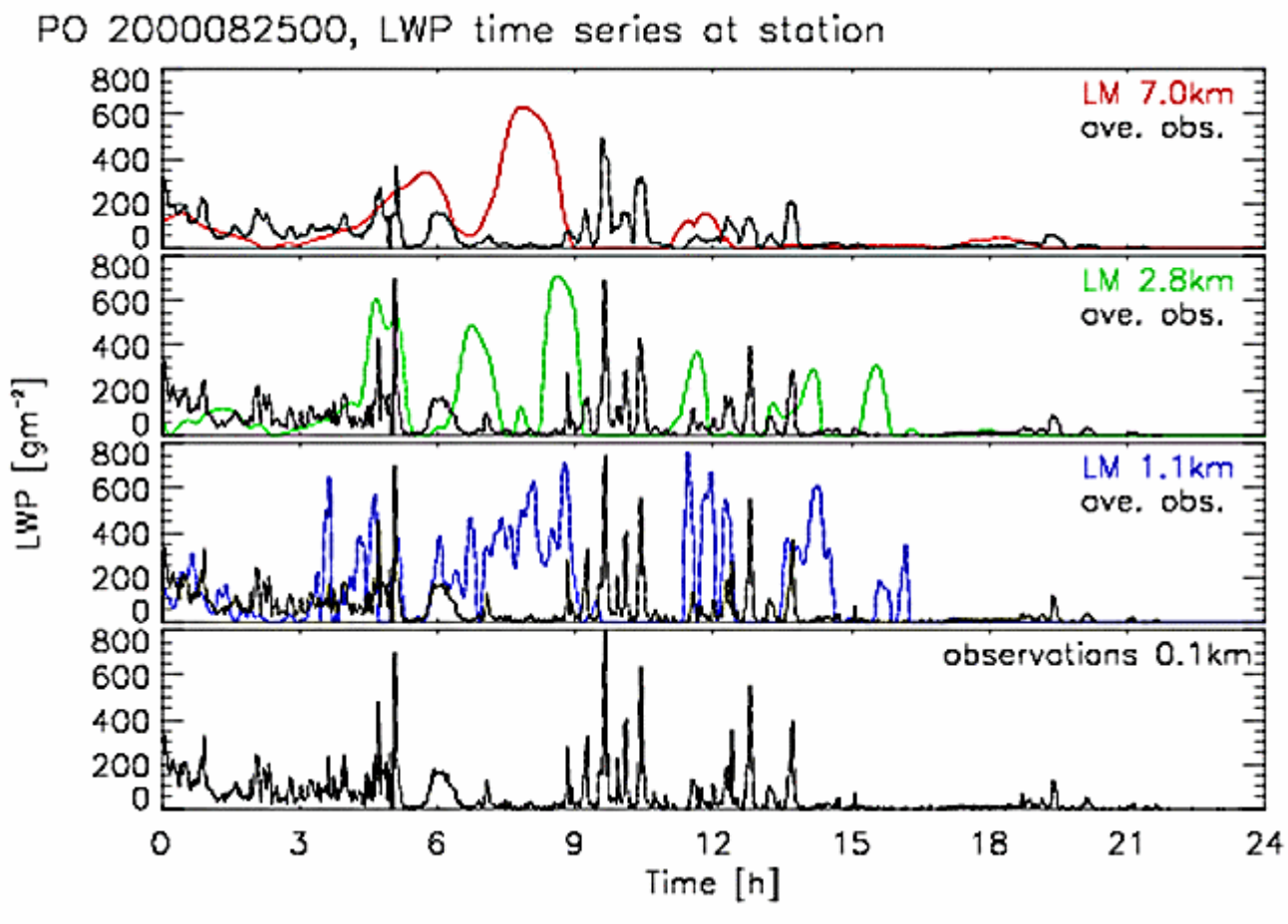
(averaged over domain and 6h forecast time)



Comparison of LWP time series



microwave radiometer - model output



⇒ no better match, <u>but</u> statistic is improved!

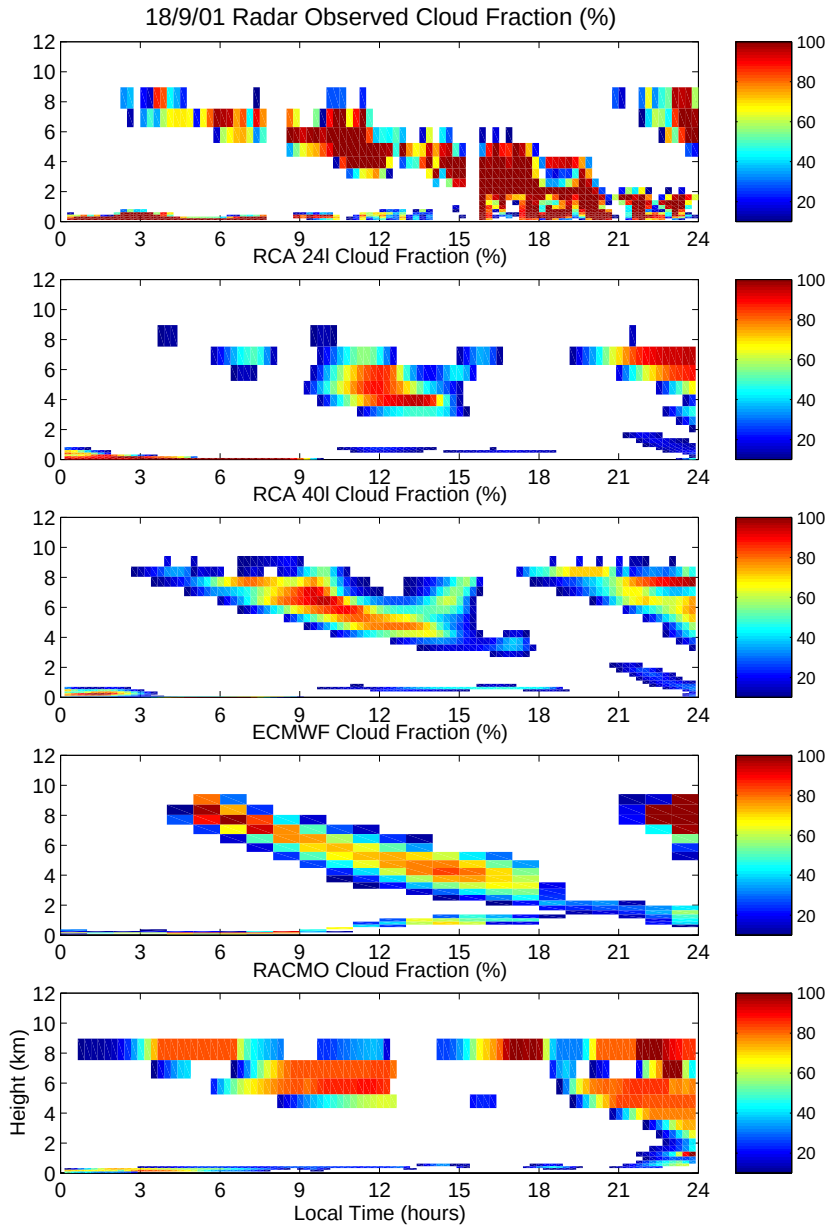
Parametric issues of cloud processes

- …
- Diurnal cycle of cloud parameters
- 2D cloud fraction distribution
- Effect of vertical resolution
- …

The effect of vertical resolution:

Cloud fraction at Cabauw (BBC) on 18/09/2001from cloud radar and model predictions.

(by Ulrika Willén, Rossby Center)



Conclusions

- Evaluation of model predicted LWP with ground-based measurements is only sensible if rainfall events (rain at the surface) can be discriminated. Ground-based retrieved LWP seems to provide a lower limit.

- Models put maximum in LWC (liquid water content) at different altitudes. When model events with precipitation are ignored, maximum values in LWC compare reasonably well with those inferred from measurements.

- A qualitative comparison between model predicted and satellite retrieved spatial LWP-distributions looks promising. More cases are needed to make quantitative statements.

- In refining the grid of the LM, the effective size of the resolved "convective cells" reduces in proportion, no convergence at scales larger than 1km ; domain averaged quantities (LWP,rain,fluxes) are robust.

- Increased vertical resolution proves beneficial in representing vertical cloud structure.