High-Resolution Model Simulation of Deep Convection in the Black Forest during COPS

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Bad Orb, 2007

Outline

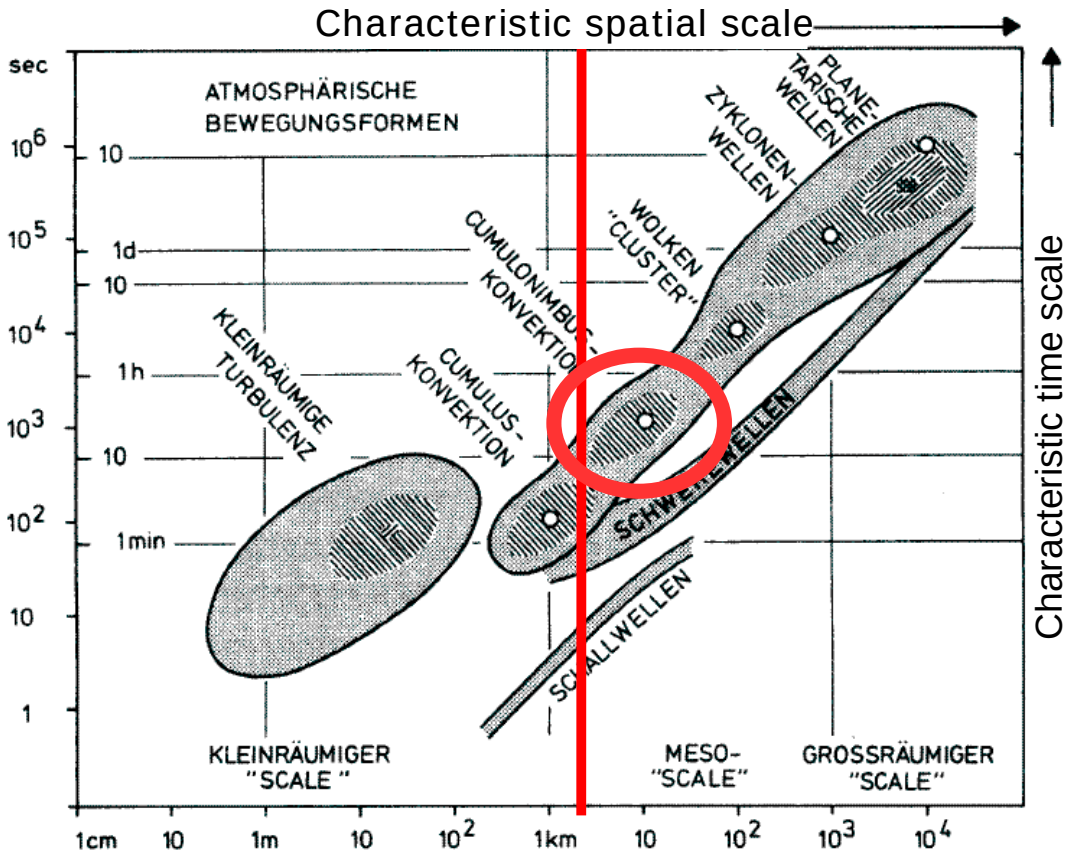
1. General remarks
2. COSMO-Model / COPS field campaign
3. Simulations with COSMO-Model
4. Summary and Outlook

General remarks

Conditions for deep convection

- Conditional Instability
- Initiation
  - by lifting
  - by reaching the convective temperature
- Sufficient Humidity at lower levels

General remarks



COSMO-DE(2,8km)

Interaction between the scales:

- Humidity is generally determined by large scales
- Initiation by small scales

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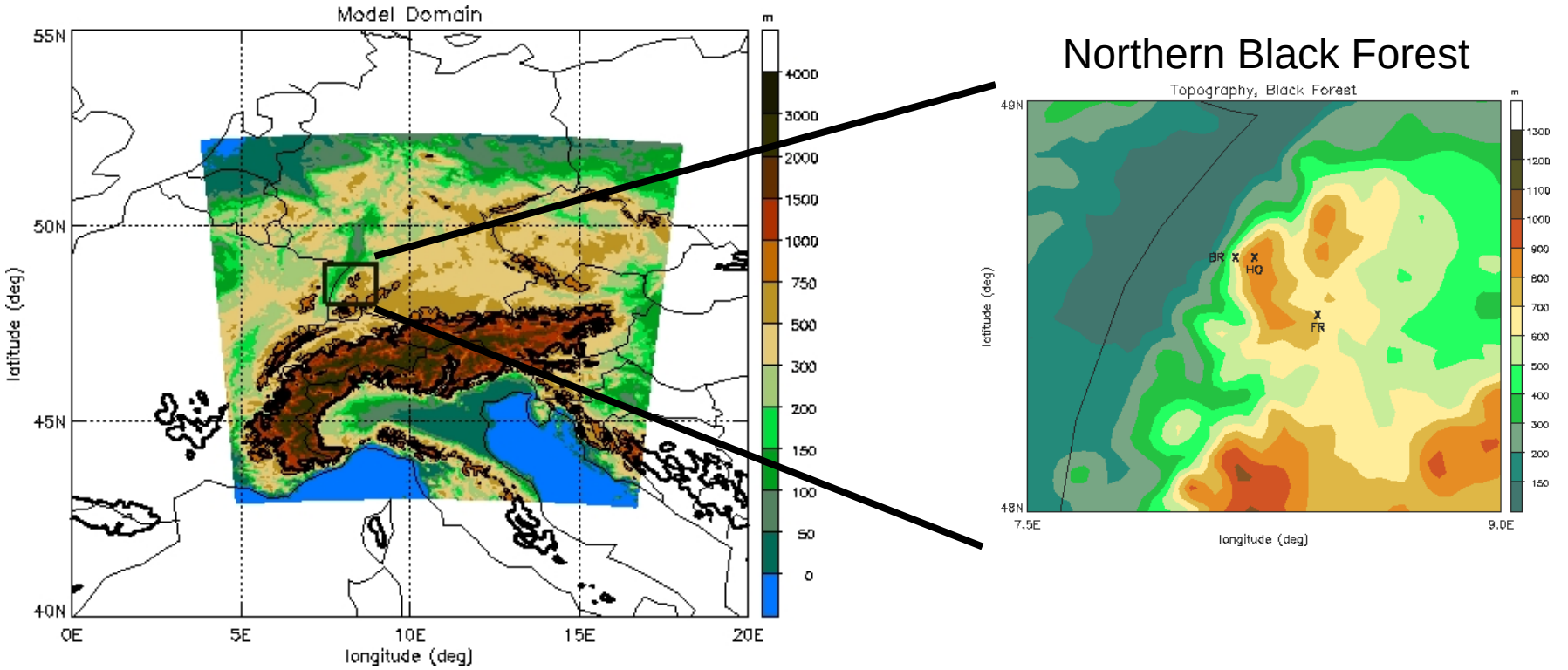
COSMO-Model setup

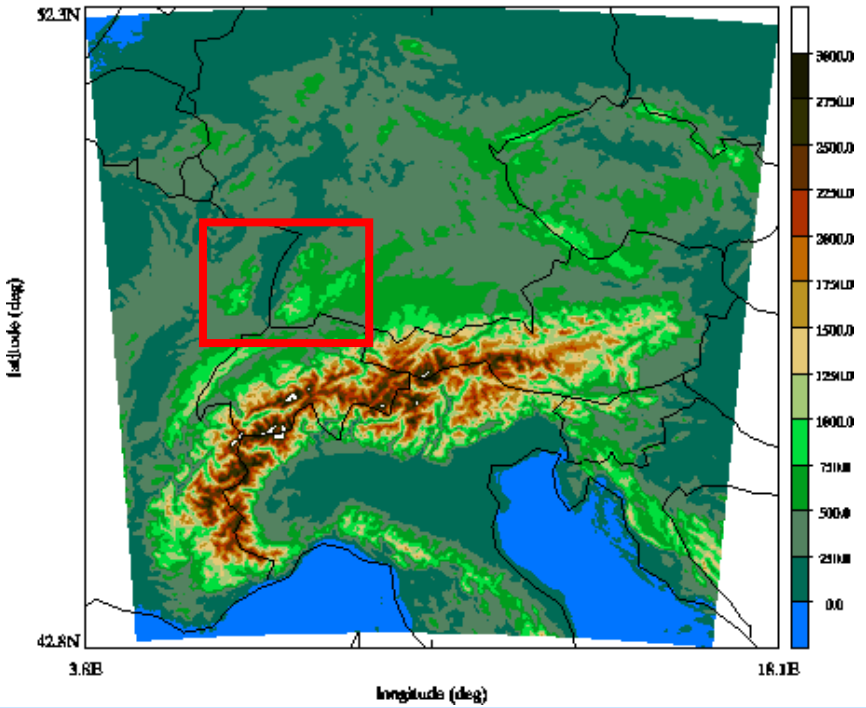


- Operational numerical weather prediction model
- Grid point distance: approx. 2.8 km
- No parameterisation of deep convection, main motions/processes of deep convection are considered explicitly
- Hourly boundary conditions from COSMO-EU Analysis

COPS field campaign

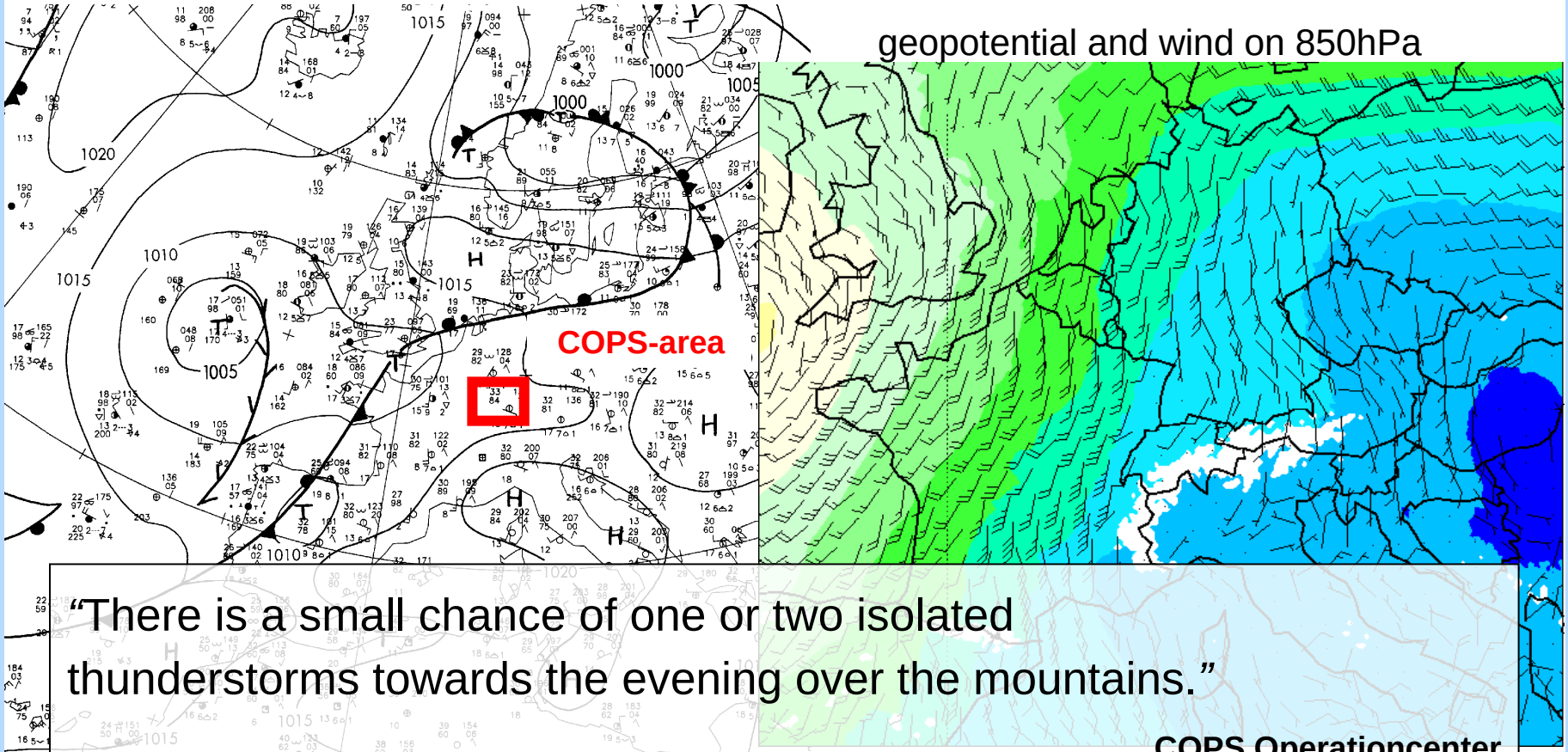
Convective and Orographically-induced Precipitation Study / Summer 2007

- Area: south-western Germany/ eastern France
- Period: June 1st - August 31th



COPS field campaign

Overview of the synoptic situation on July 15th

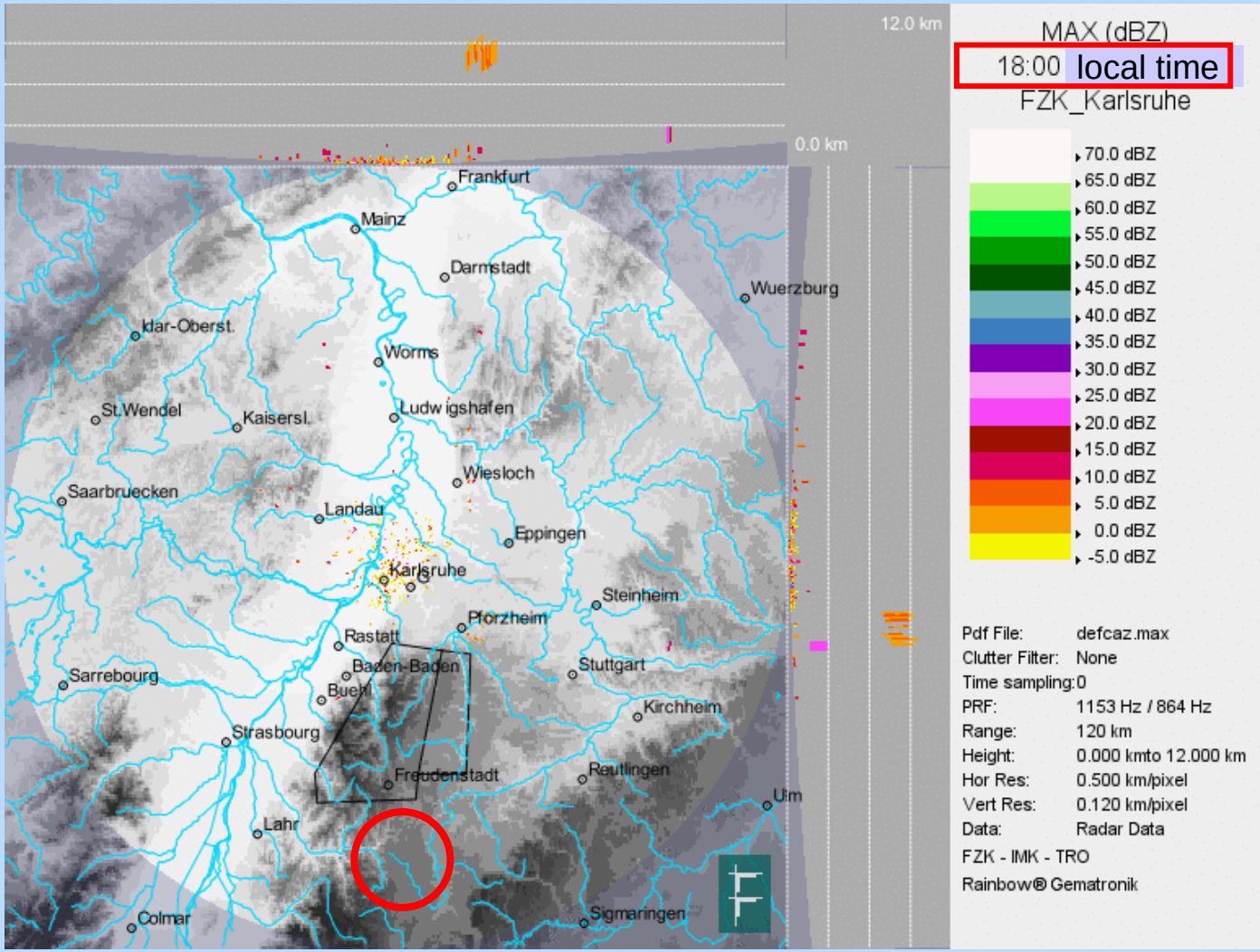


"There is a small chance of one or two isolated thunderstorms towards the evening over the mountains."

COPS Operationcenter

COPS field campain

14:20-16:00 UTC



Forschungszentrum Karlsruhe

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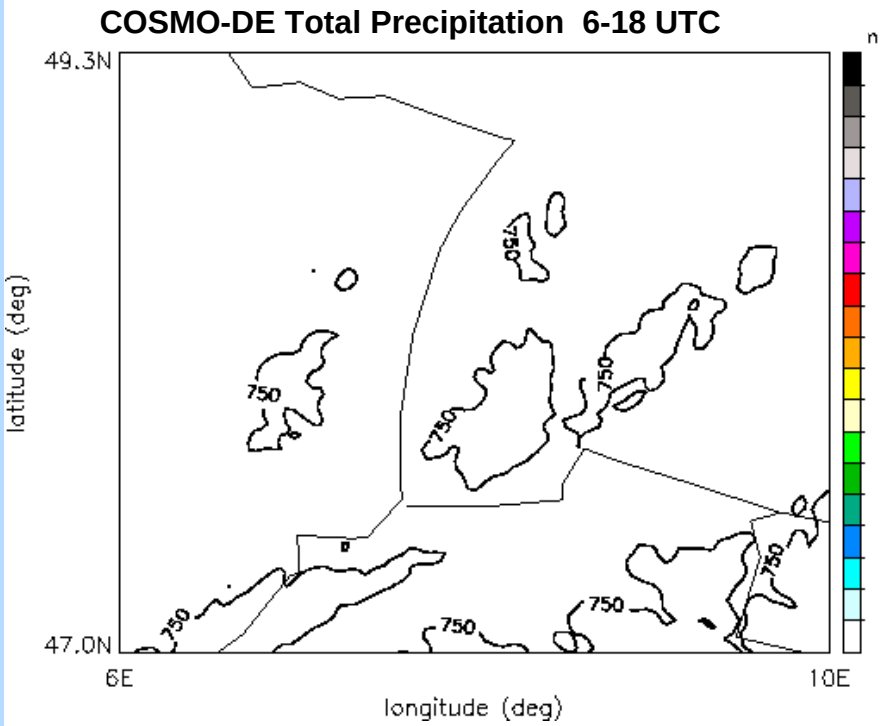
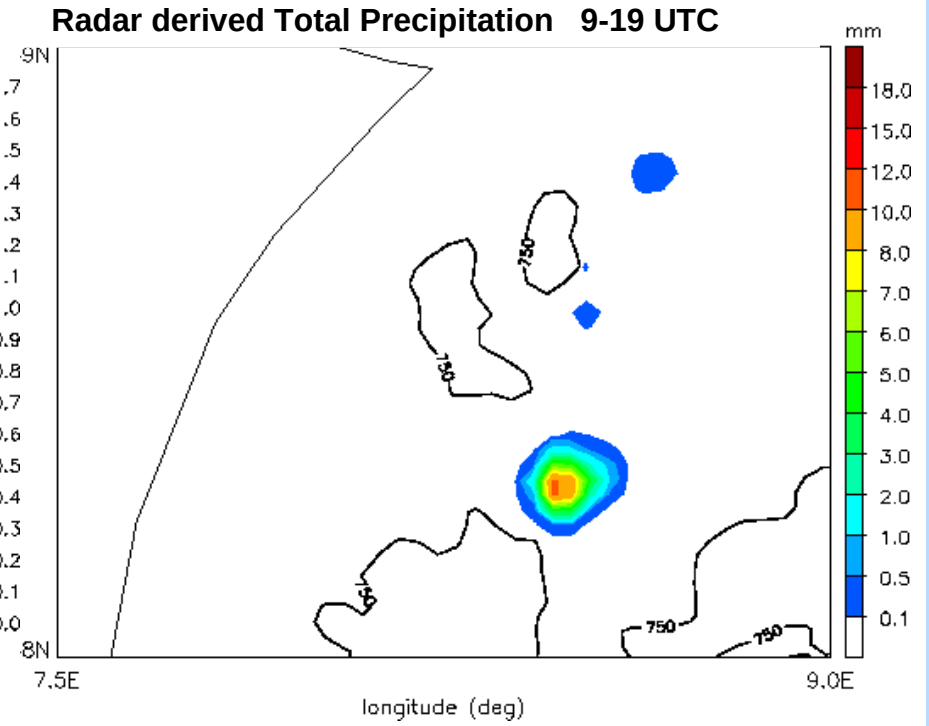
Simulations with COSMO-Model

Operational forecast of COSMO-DE

Observation





COSMO-Model

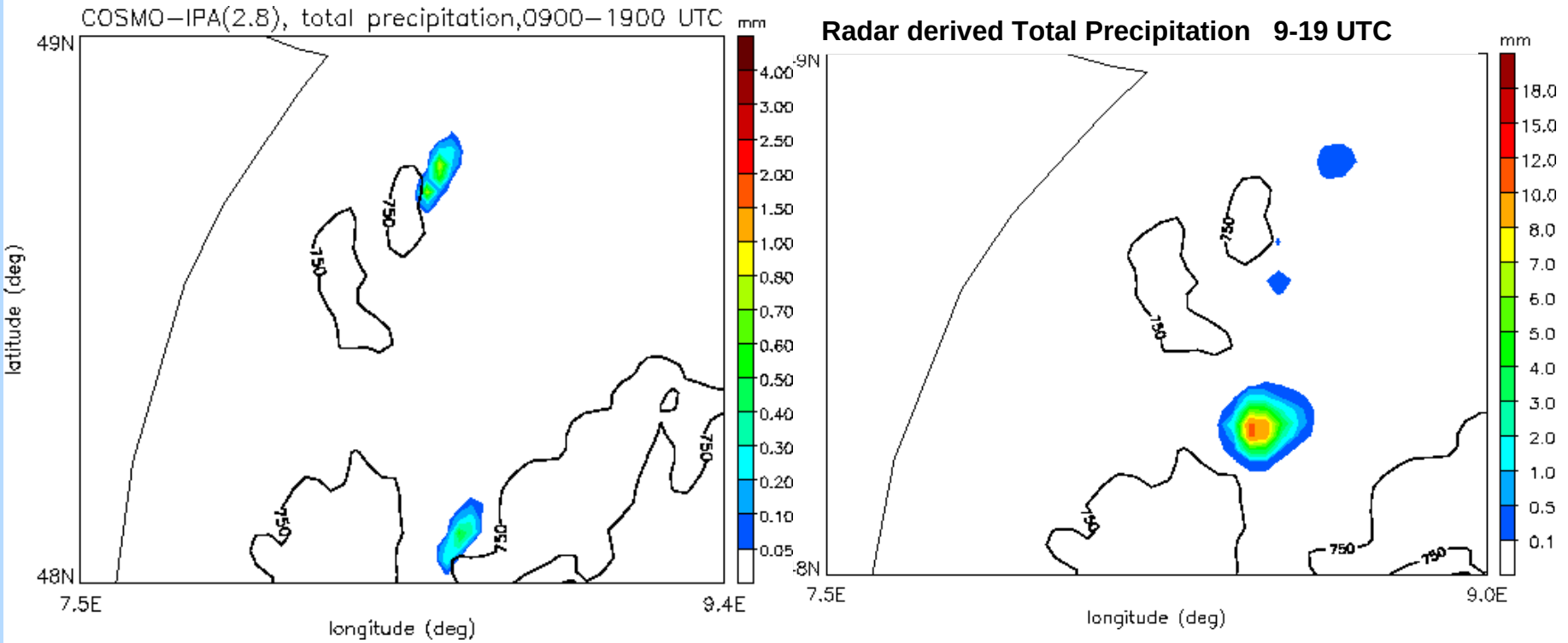
Setting used for Simulations

number of run	turbulence-lenght	parametrization of shallow convection	starting time	soil moisture	**precipitation**
operational	500	TRUE	6 UTC	Default	No
14	250	TRUE	7 UTC	Default	No
15	500	FALSE	7 UTC	Default	No
16	50	TRUE	7 UTC	Default	Yes
19	50	FALSE	7 UTC	Default	Yes
21	50	TRUE	5 UTC	Default	No
22	50	TRUE	7 UTC	-25%	Yes
25	50	TRUE	7 UTC	25%	No
34	50	TRUE	10 UTC	Default	No
35	50	TRUE	12 UTC	Default	Yes
…					

Simulations with COSMO-Model

Simulation

Observation

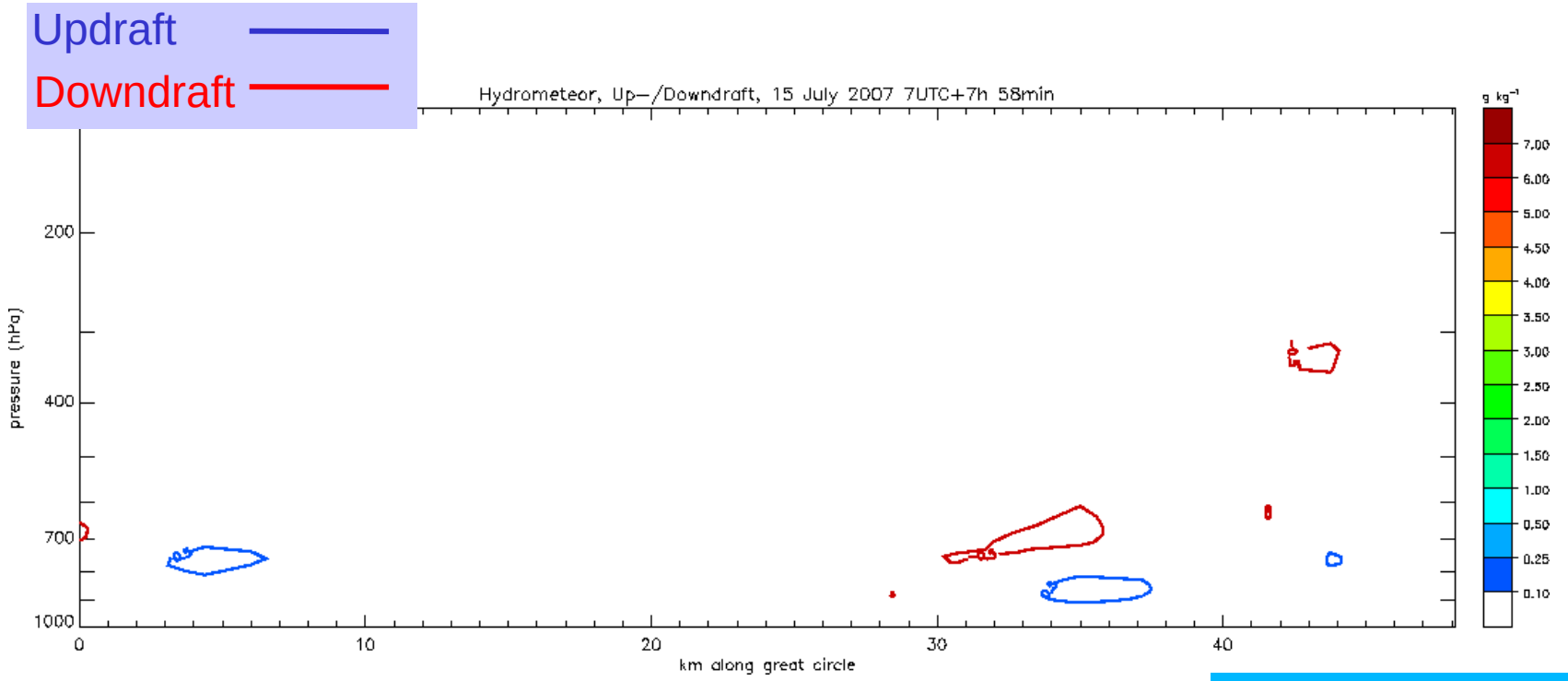


The simulation with the "best" result not optimal

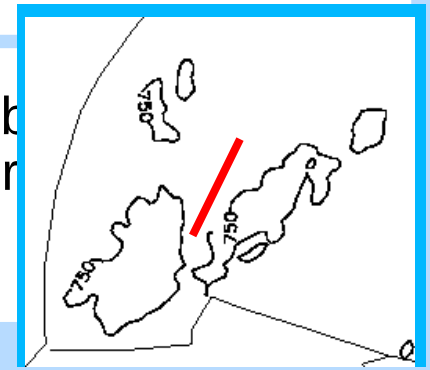
- Intensity underestimated
- Location not well simulated

Simulations with COSMO-Model

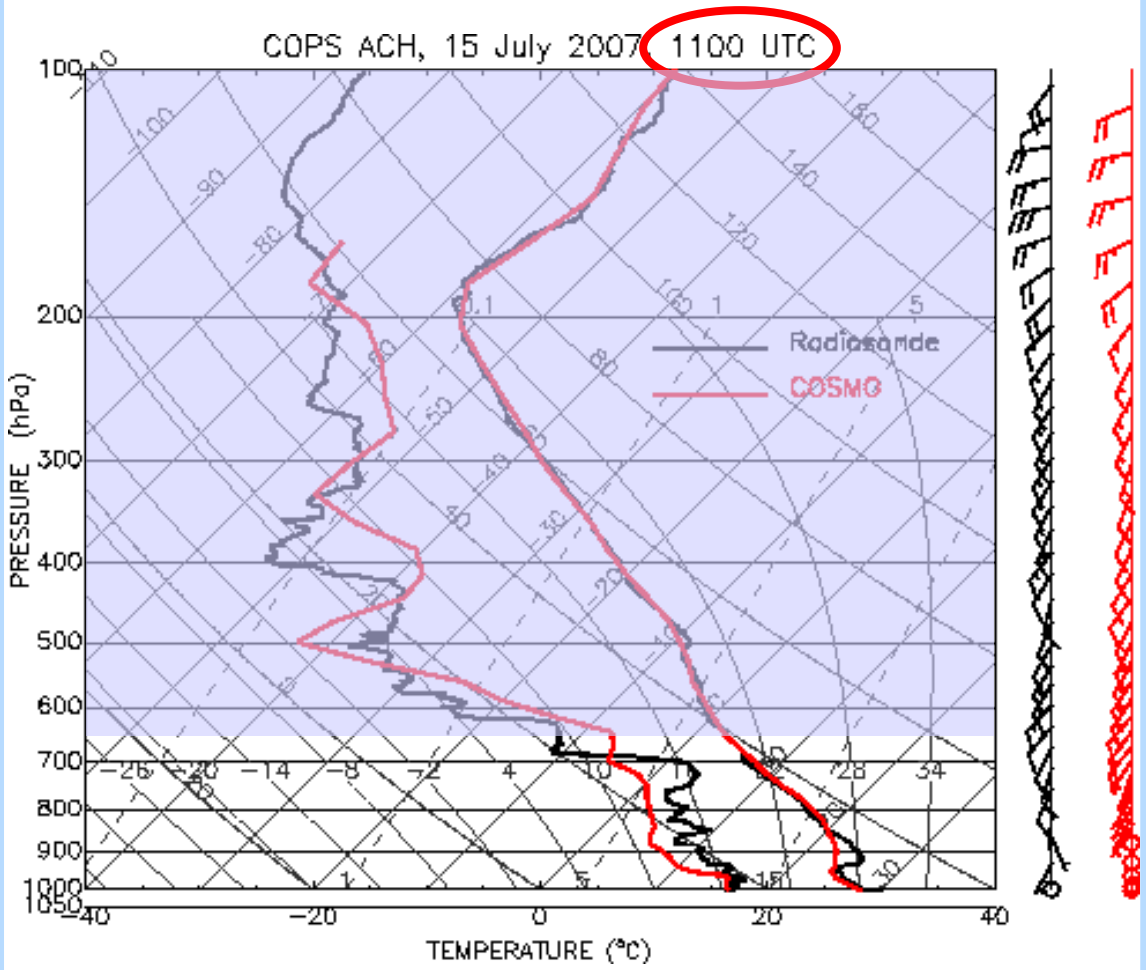
Vertical cross-section in steps of one minute



- Lifetime and speed of evolution are realistic for a Cb
- Up- and Downdrafts shows characteristic behaviour



Simulations with COSMO-Model



Observed and simulated sounding in Achern

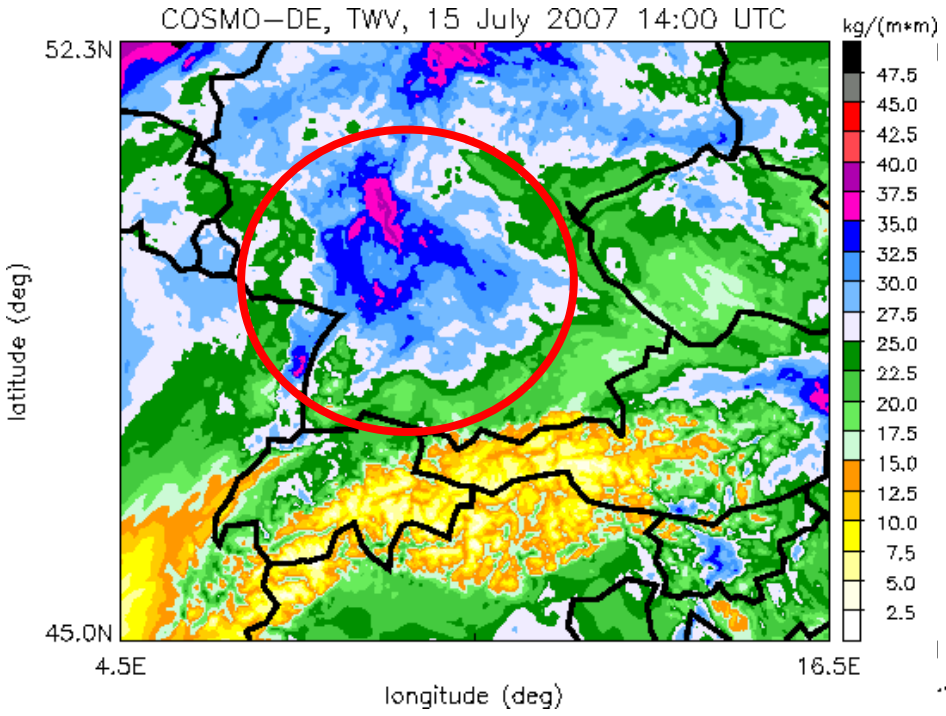
(~30km to observed cell)

Model underestimates humidity in boundary layer

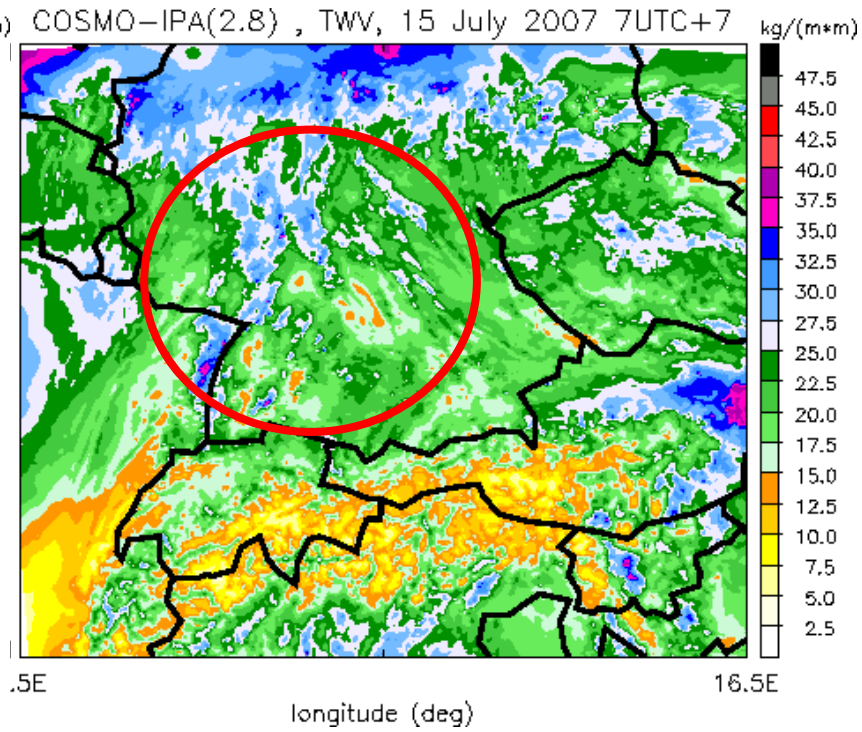
Simulations with COSMO-Model

Total integrated water vapor

COSMO-DE Analysis at 14 UTC

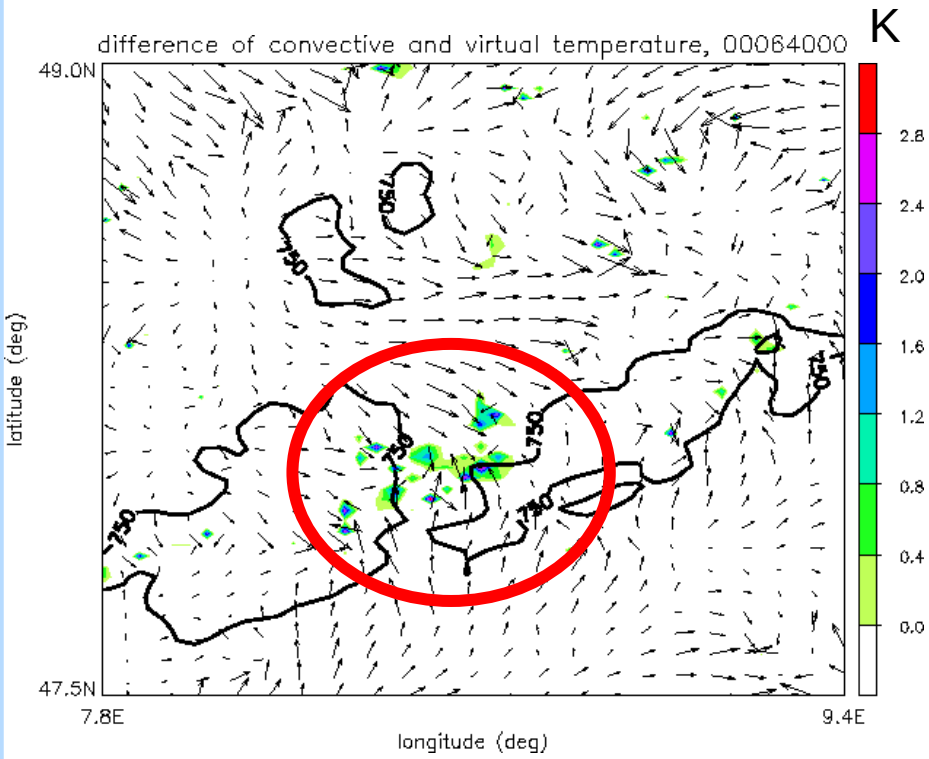


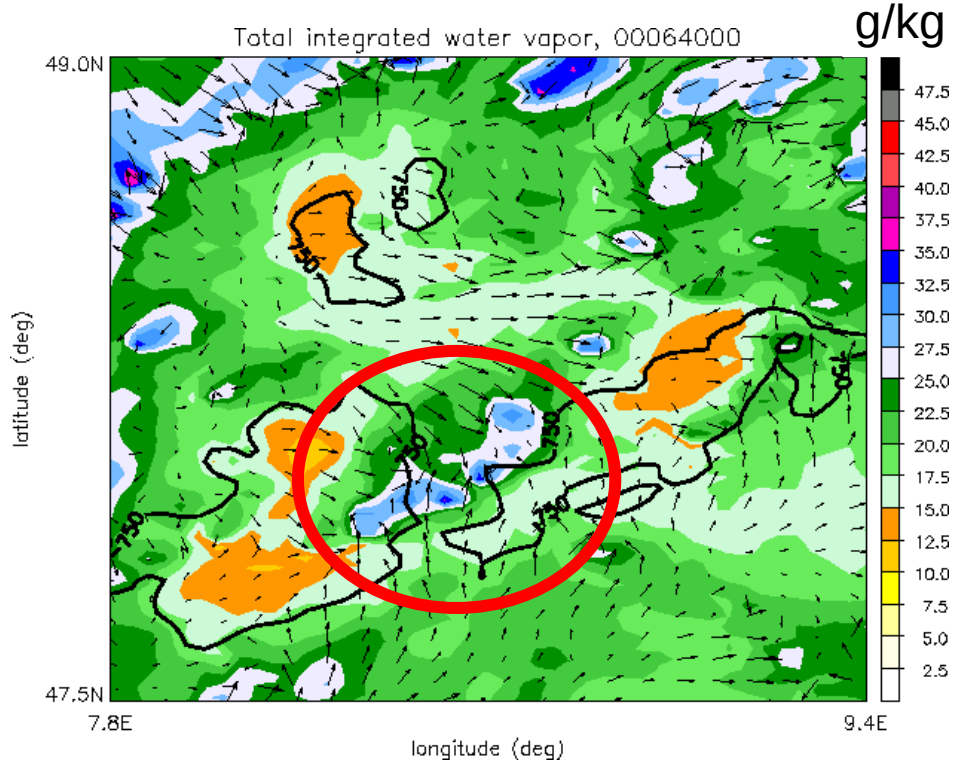
COSMO-IPA(2.8) 7 UTC+7h



Simulations with COSMO-Model

Situation before initiation





- Convective temperature has been reached
- strong wind convergence
- local concentration of humidity

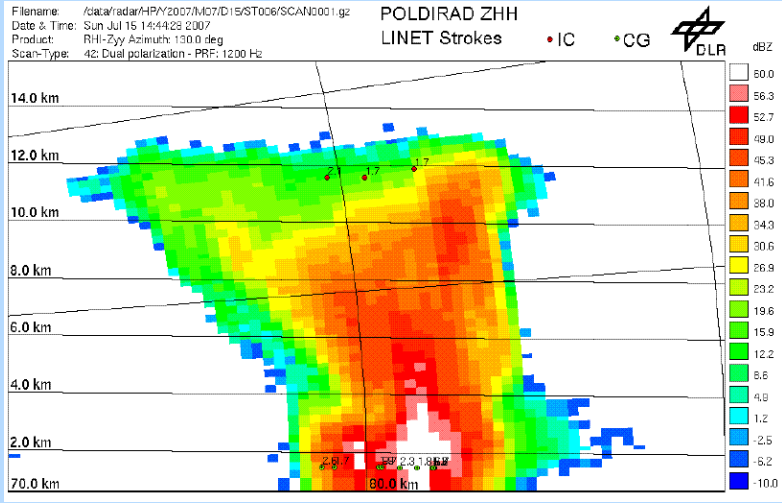
Summary

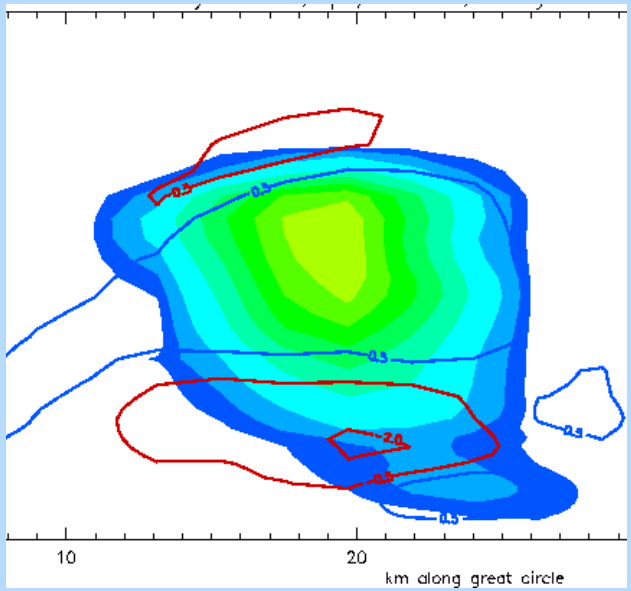
- A COPS case study of a single deep convective event was investigated with the COSMO-Model.
- The operational COSMO-DE did not reproduce this convective event. Different settings of model parameters were tested, some simulations resulted in convective precipitation.
- In one setup, a cumulonimbus cloud was simulated at the right time but on a slightly different location than the observed one.
- The simulated convective cell shows realistic properties of the observed deep convection, like characteristic lifecycle and dynamic structure.
- The simulations underestimate the humidity in the area.

Outlook

- Further investigations on the evolution of the humidity in the boundary layer using data collected during the COPS campaign
- Quantification of the conditions for the initiation of deep convection
- High-resolution simulations with 1km grid

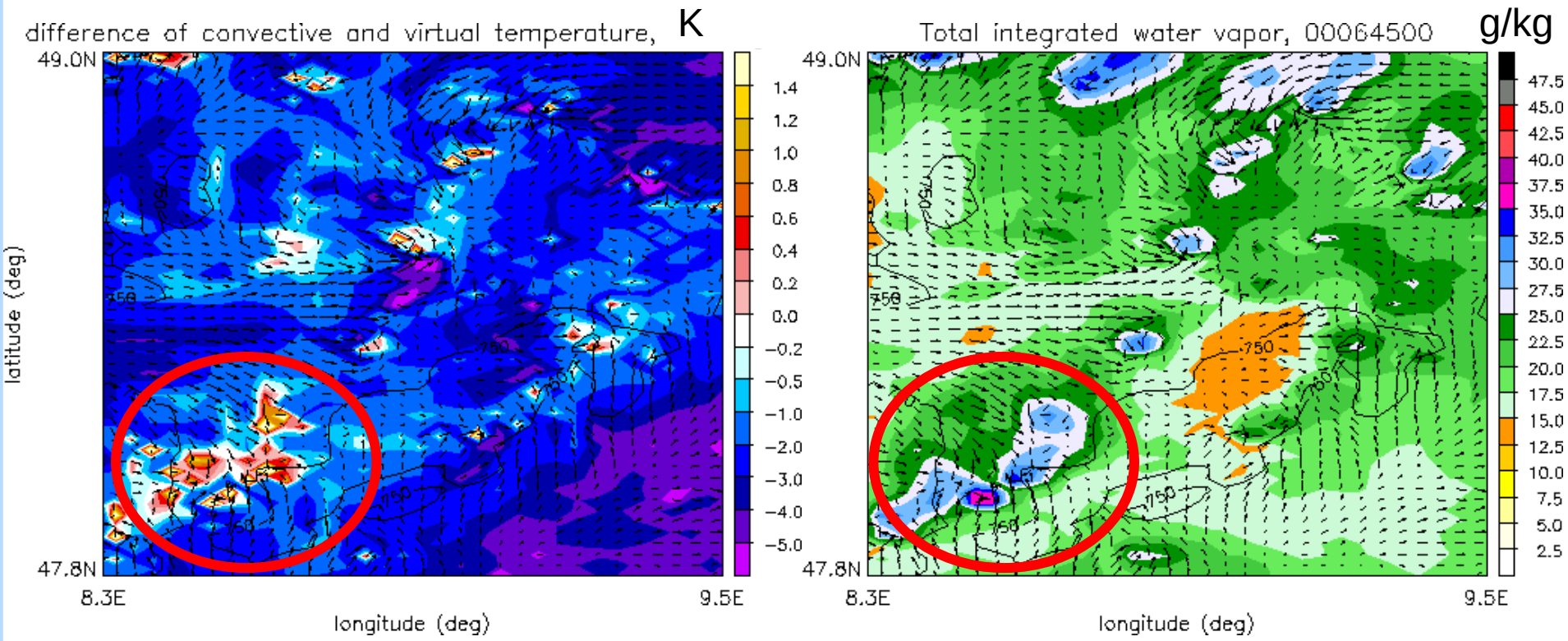
Thank you for your attention





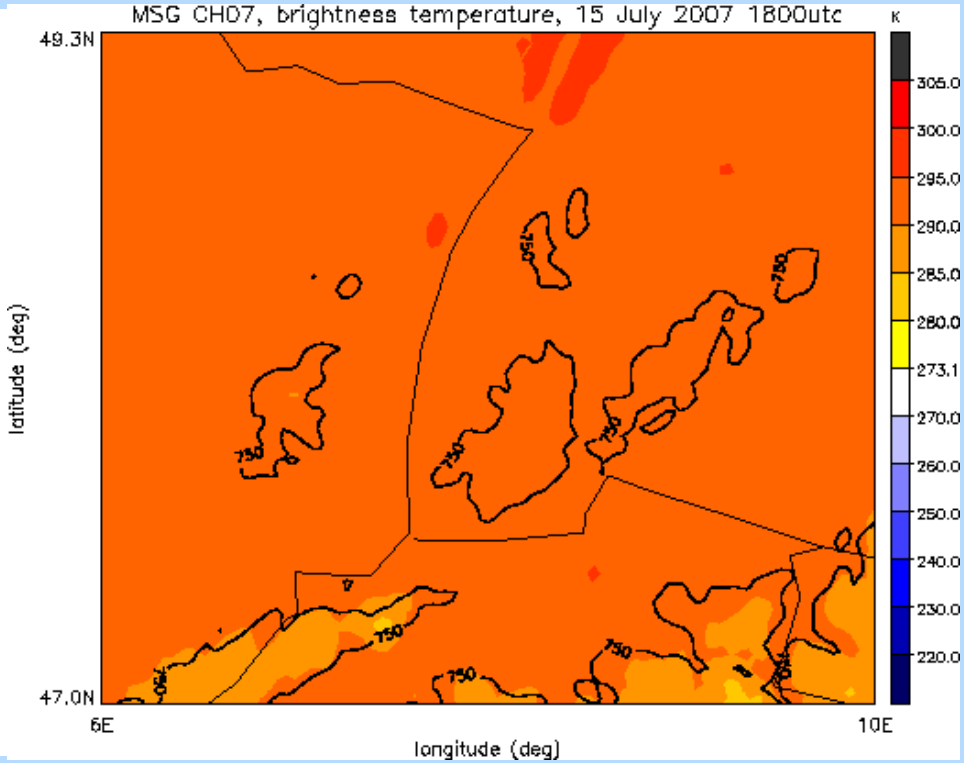
Simulations with COSMO-Model

Situation before initiation

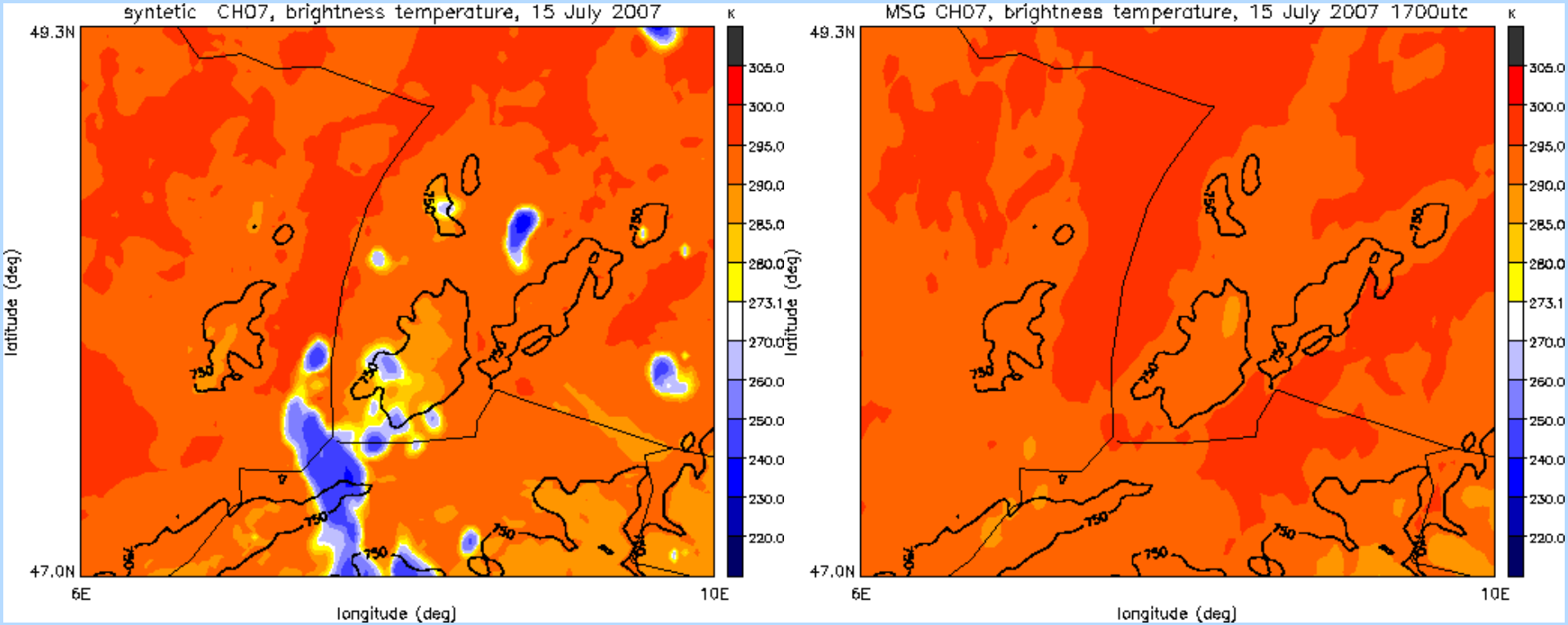


- Convective temperature hab been reached
- strong konvergence of wind
- Konzentration of humidity

Simulations with COSMO-Model



Simulations with COSMO-Model



Entwicklung der Grenzs