Working Group "Initiation of Convection"

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University of Hohenheim

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A presentation with contributions of:

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- ✓ **Cathérine Meißner, FZK-IMK**
- ✓ **Michael Kunz, FZK-IMK**
- ✓ **Andreas Wieser, FZK-IMK**
- ✓ **Gerhard Adrian, DWD**
- ✓ **Tammy Weckwerth, NCAR-ATD**

Participants of the WG „Convection Initiation“ (1st COPS Workshop):

Jens Bange,
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Shane Mayor,
Heinke Schluenzen,
Heini Wernli,

Three processes are responsible for CI

Local CI

- ✓ differential soil and vegetation moisture
- ✓ differences in surface heating (land use and orography)
- ✓ resulting in secondary circulations over complex terrain

Meso scale CI

- ✓ temperature fronts
- ✓ wind/flow field (gust fronts, convergence lines)
- ✓ moisture fronts

***Large scale CI* (upper tropospheric forcing, triggering of pot. instability)**

- ✓ upper level troughs causing large scale positive vorticity advection (PVA)
- ✓ cold air advection causing increase of CAPE and deep convection

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Key science questions and hypotheses (1)

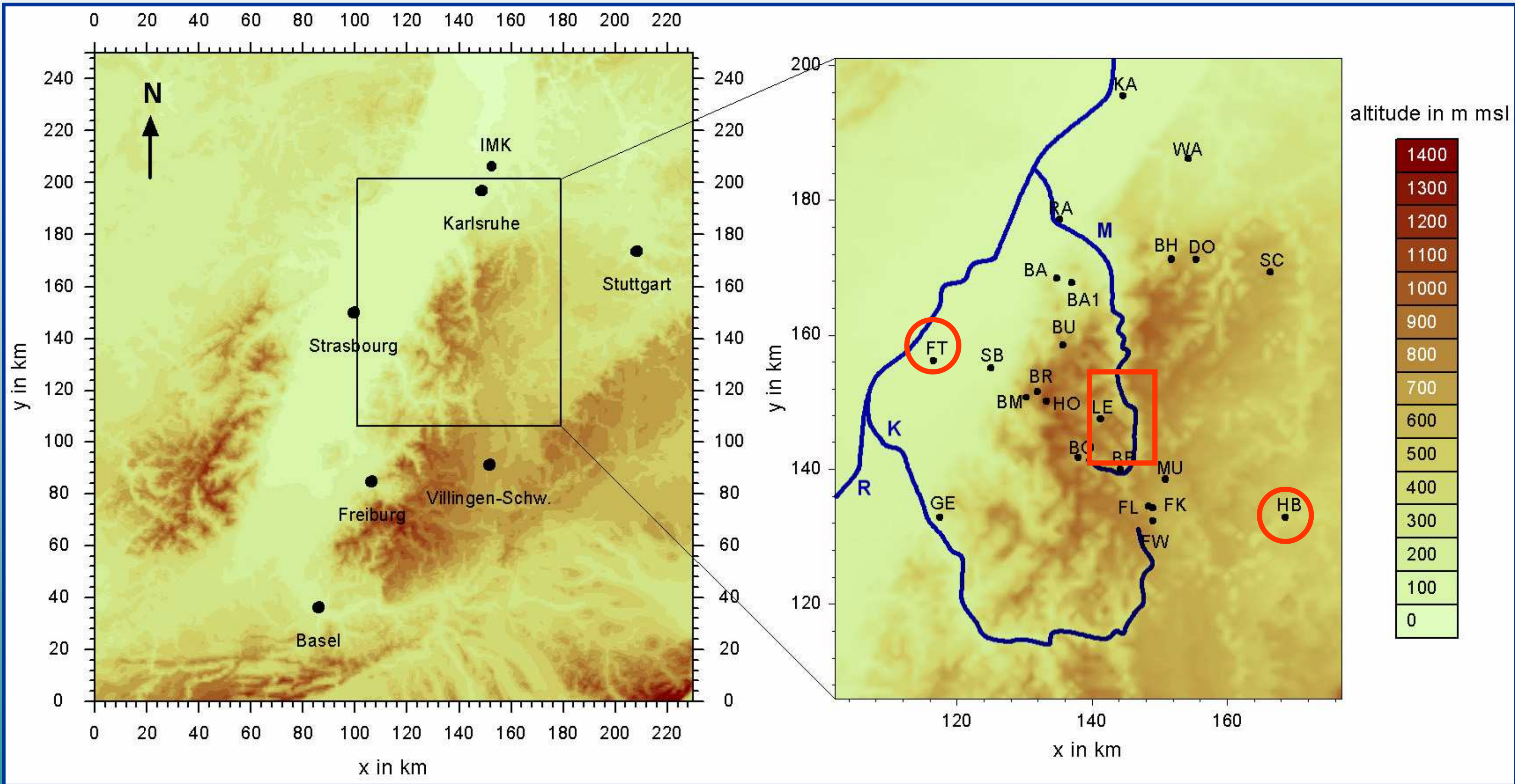
- ✓ **What are the characteristic differences for precipitation events which result from the different processes? (precipitation pattern, duration, intensity, onset)**
- ✓ **What is the diurnal cycle of CI (processes at the surface and in the PBL)? Why is the diurnal cycle of CI not represented correctly in the models?**
- ✓ **How decisive is the flow in complex terrain? How do secondary circulations influence convection? Do the models represent these flow patterns? What model resolution is necessary (horizontal and vertical)?**
- ✓ **How well are initial fields characterized in the models? What is the small scale inhomogeneity of humidity, temperature, and wind in complex terrain? How decisive are mesoscale/small scale initial errors of the models? What is the impact of targeted observations on the mesoscale (e.g. inflow at valleys)?**

Key science questions and hypotheses (2)

- ✓ What causes the heterogeneity in PBL fields? Are there specific causes for different onsets and intensity of convection?
- ✓ What is the spatial and temporal structure of latent and sensible heat fluxes?
- ✓ To which extend do cities as sources of heat and aerosols influence CI (WG2)?
- ✓ To which extend does cirrus cloud shading inhibits CI (WG2)?
- ✓ To which extend do gravity waves/mountain waves inhibit/initiate CI?
- ✓ How predictable are CI processes in complex terrain?

Initialisation of Deep Convection over Low Mountain Ranges

The VERTIKATOR Case Study of June 19, 2002



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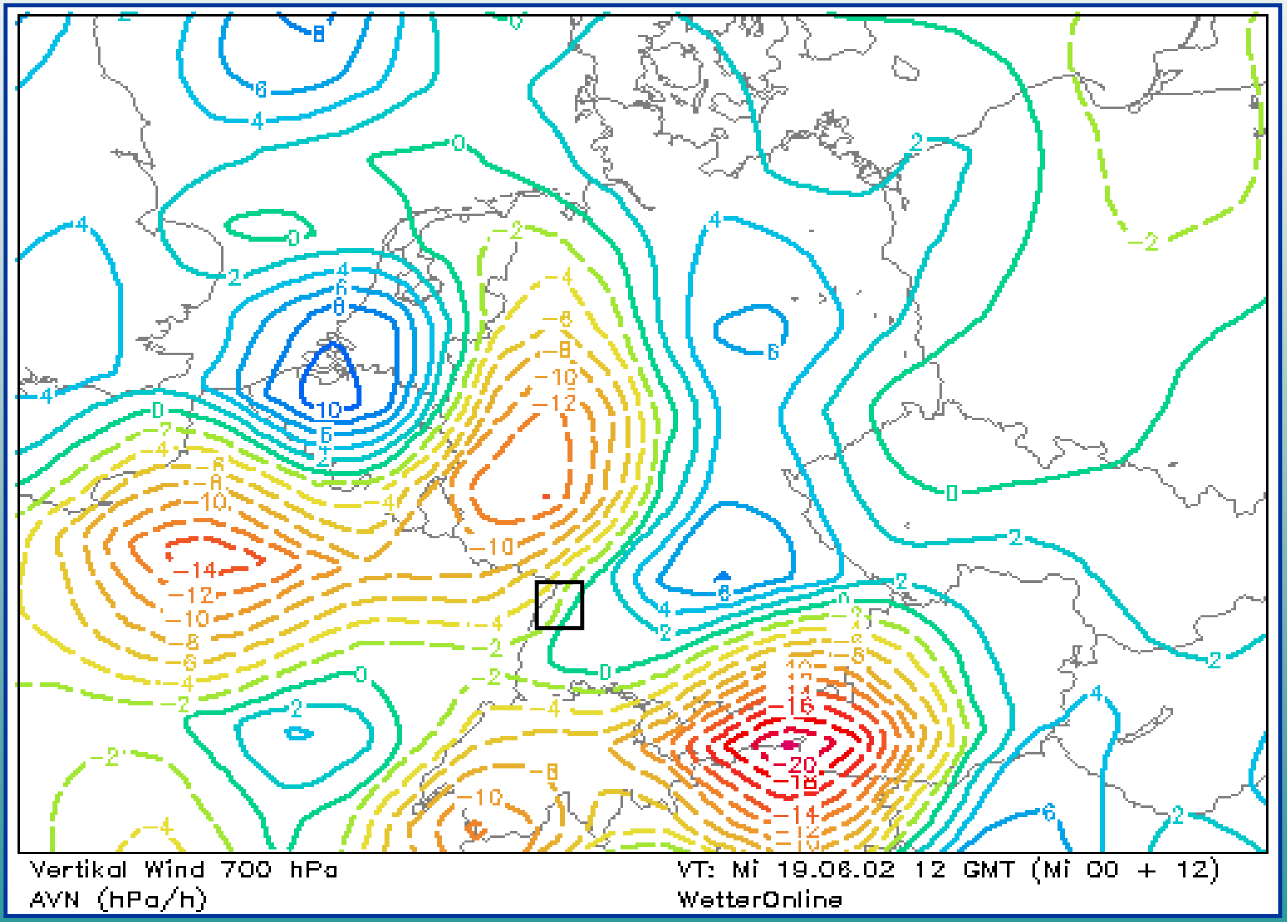
Lifting in hPa h^{-1} at the 700 hPa-level on 19 June 2002 at 13 MEZ



Source: www.wetteronline.de

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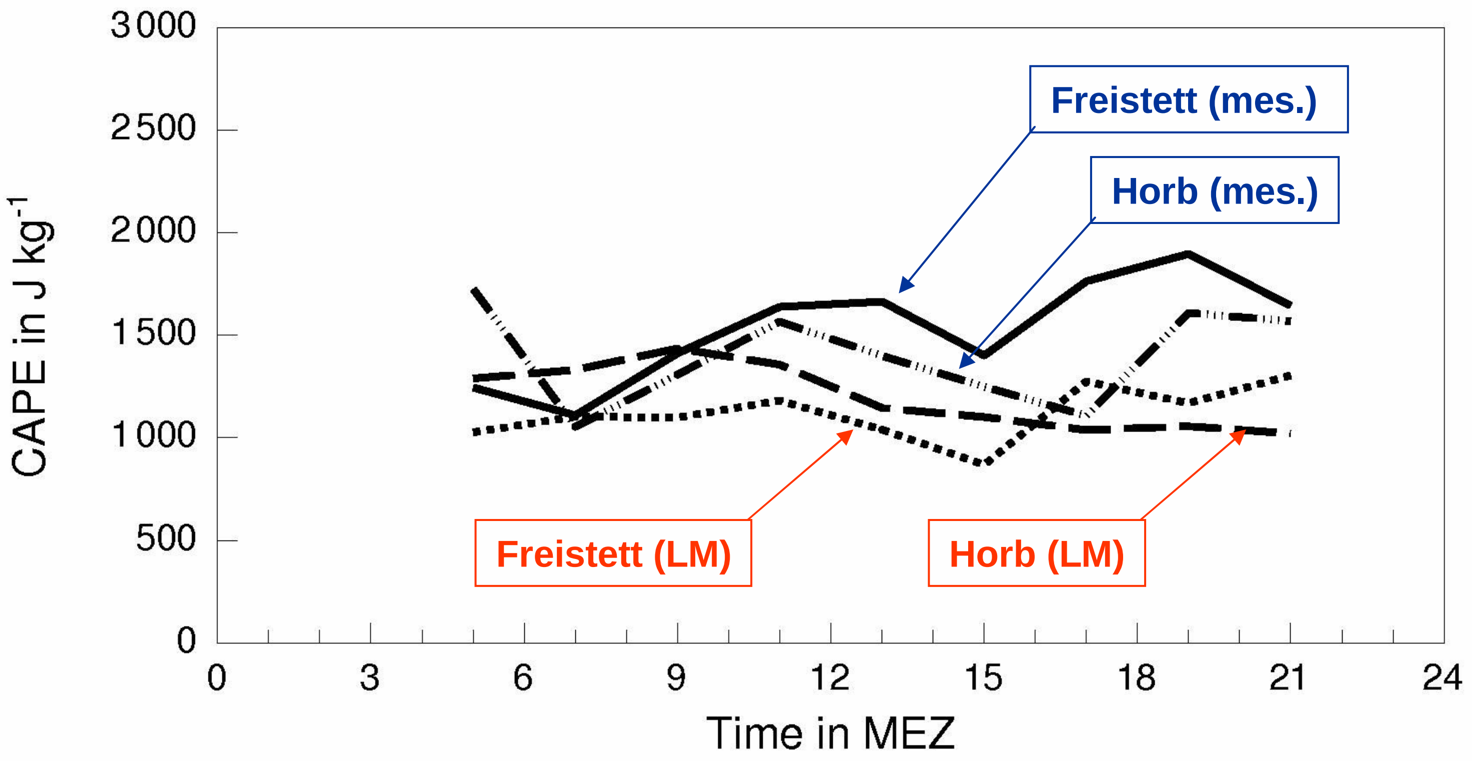
Diurnal cycle of CAPE on 19 June 2002



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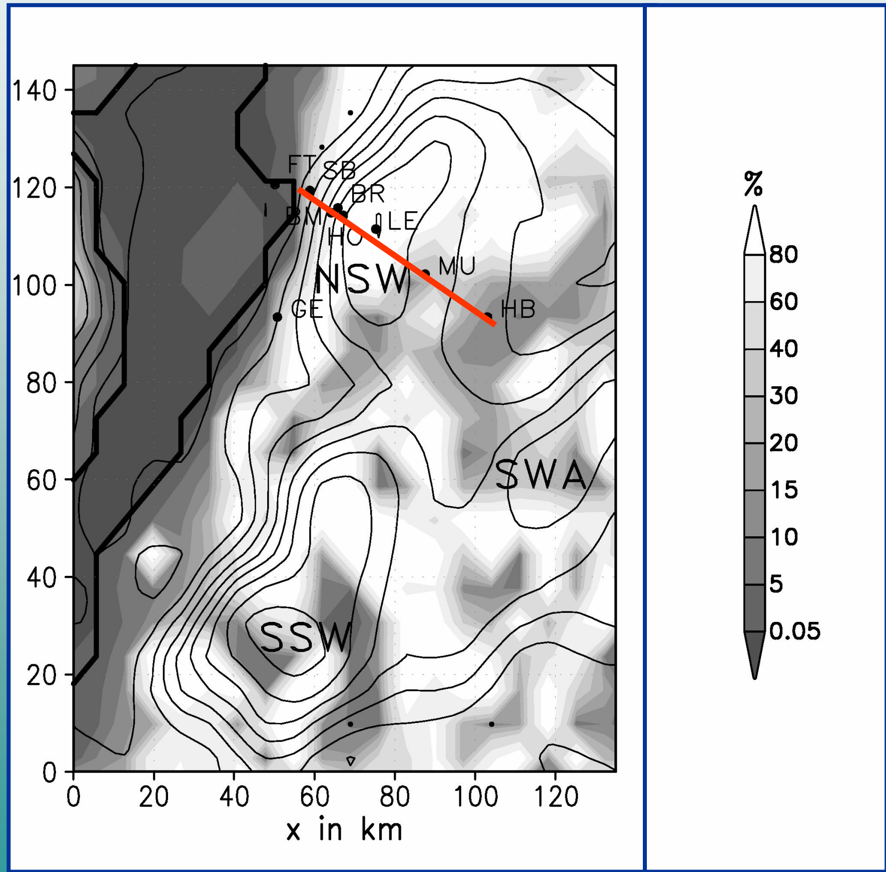
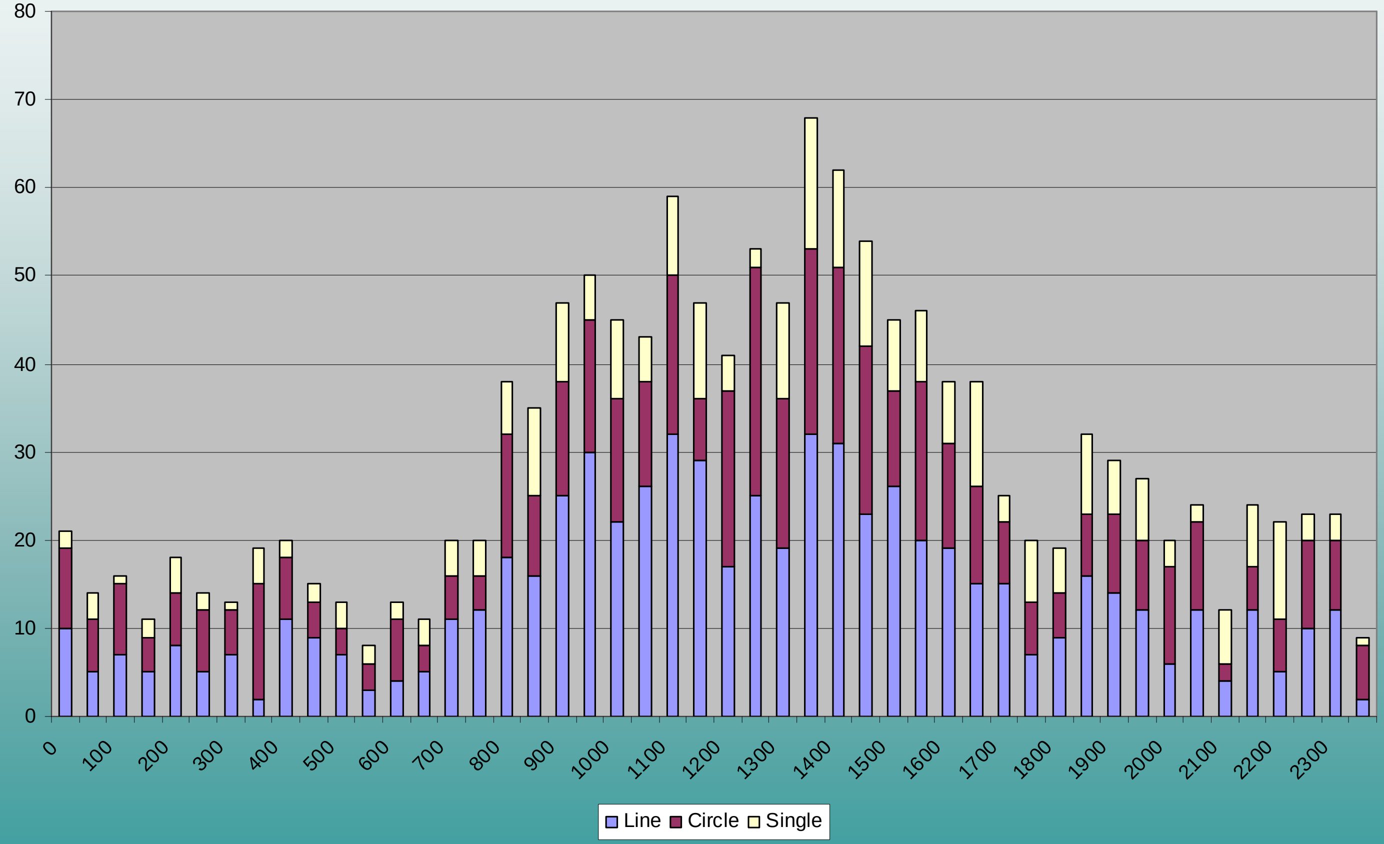
NOAA image at 13:26 MEZ

LM cloud cover in percent of the total grid area at 13 MEZ



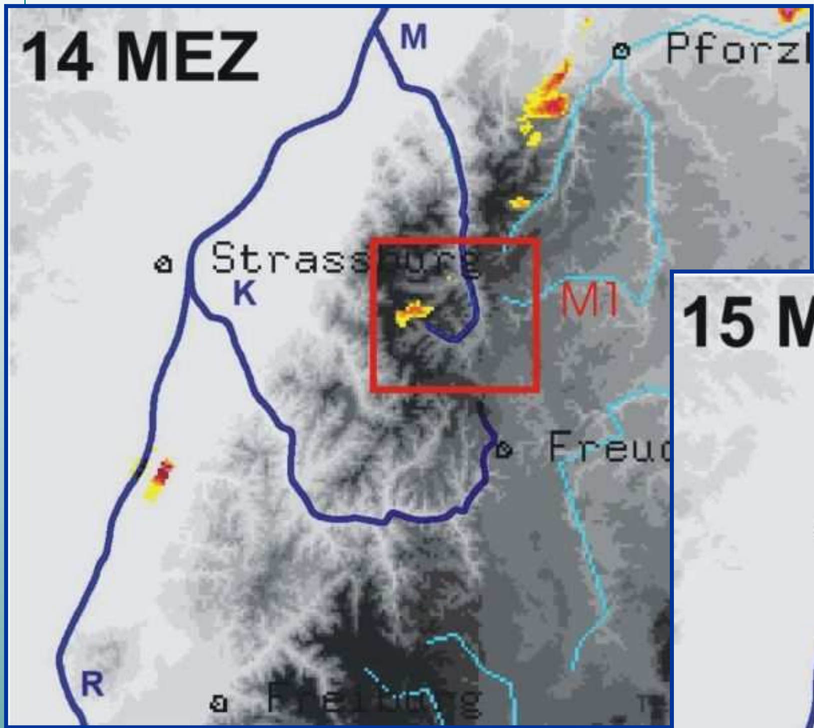
Diurnal variation of precipitation initiation for JJA, 2003 and 2004

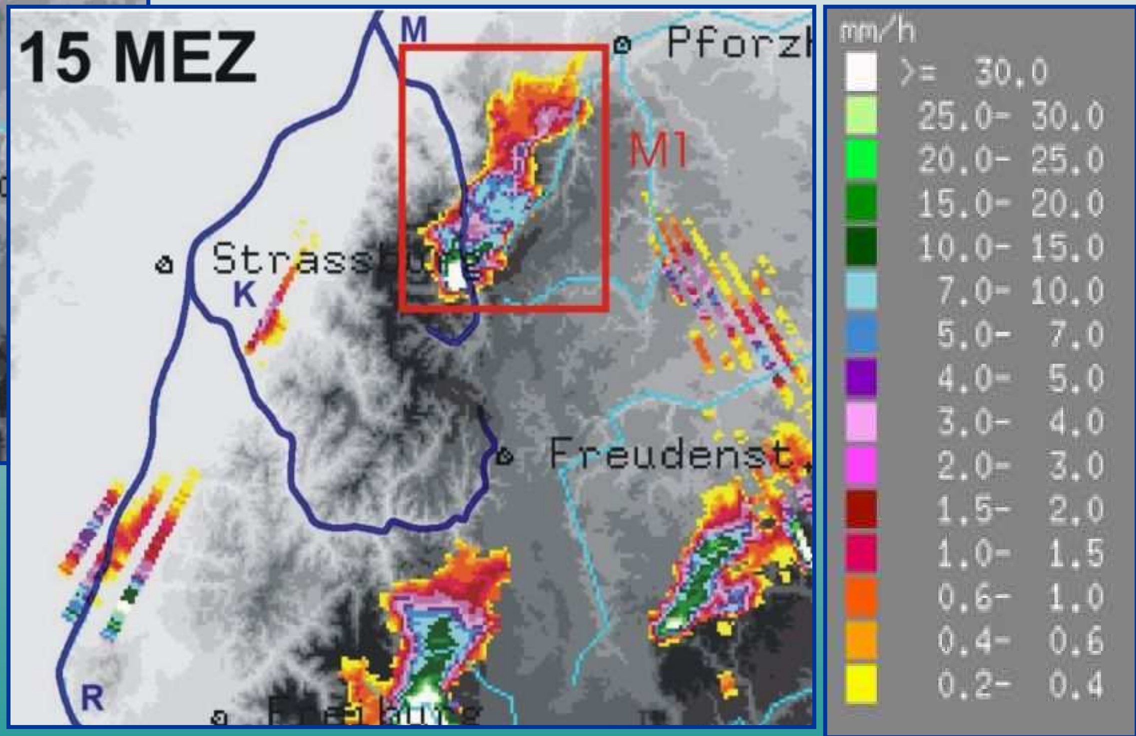


Blue indicates linearly-organized convection; maroon is convection occurring in a cluster and yellow is single-cell initiation

Courtesy of Tammy Weckwerth

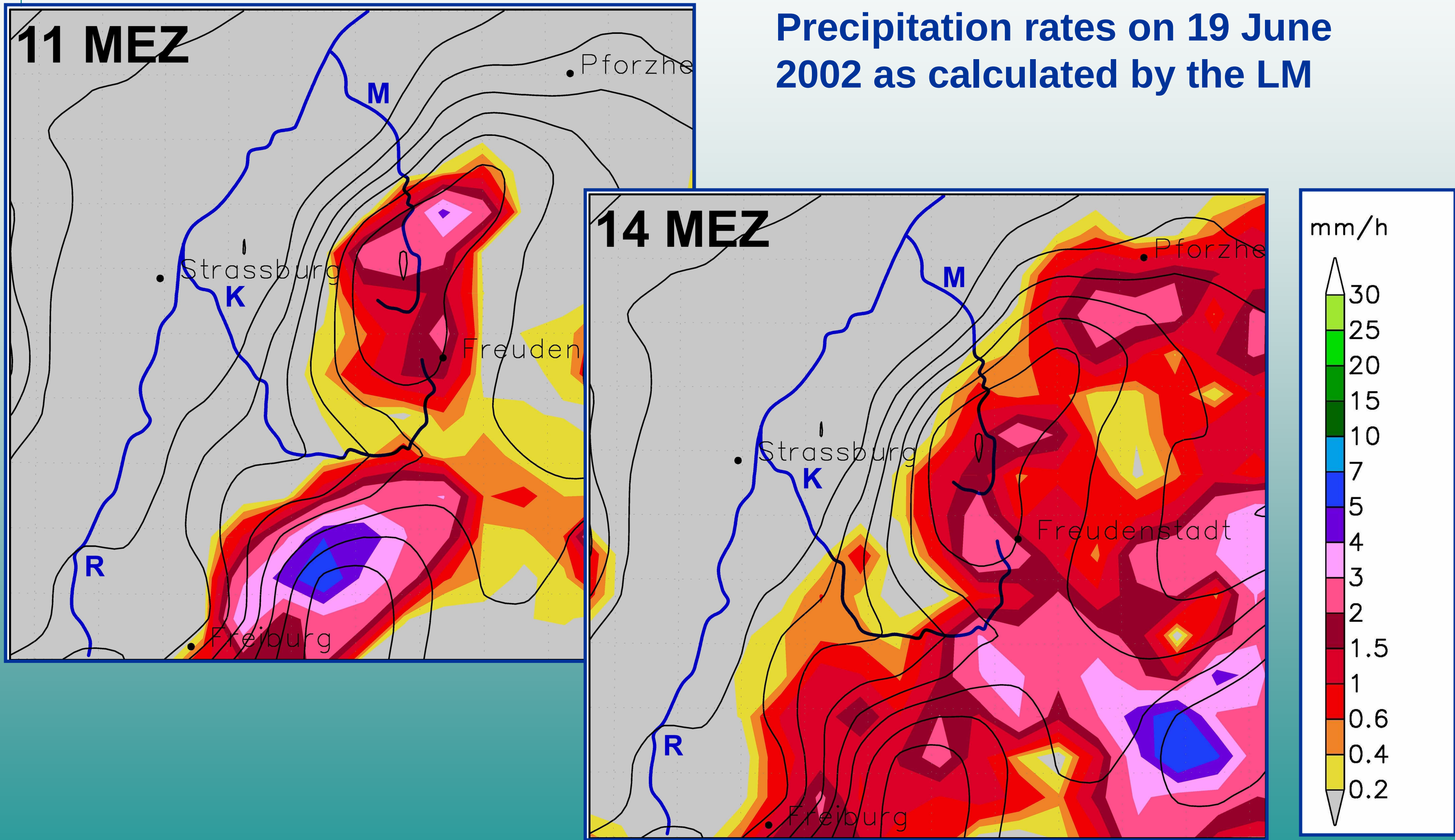
Precipitation rates on 19 June 2002 as calculated by the IMK C-band radar located at Karlsruhe





Courtesy of Jan Handwerker

Precipitation rates on 19 June 2002 as calculated by the LM



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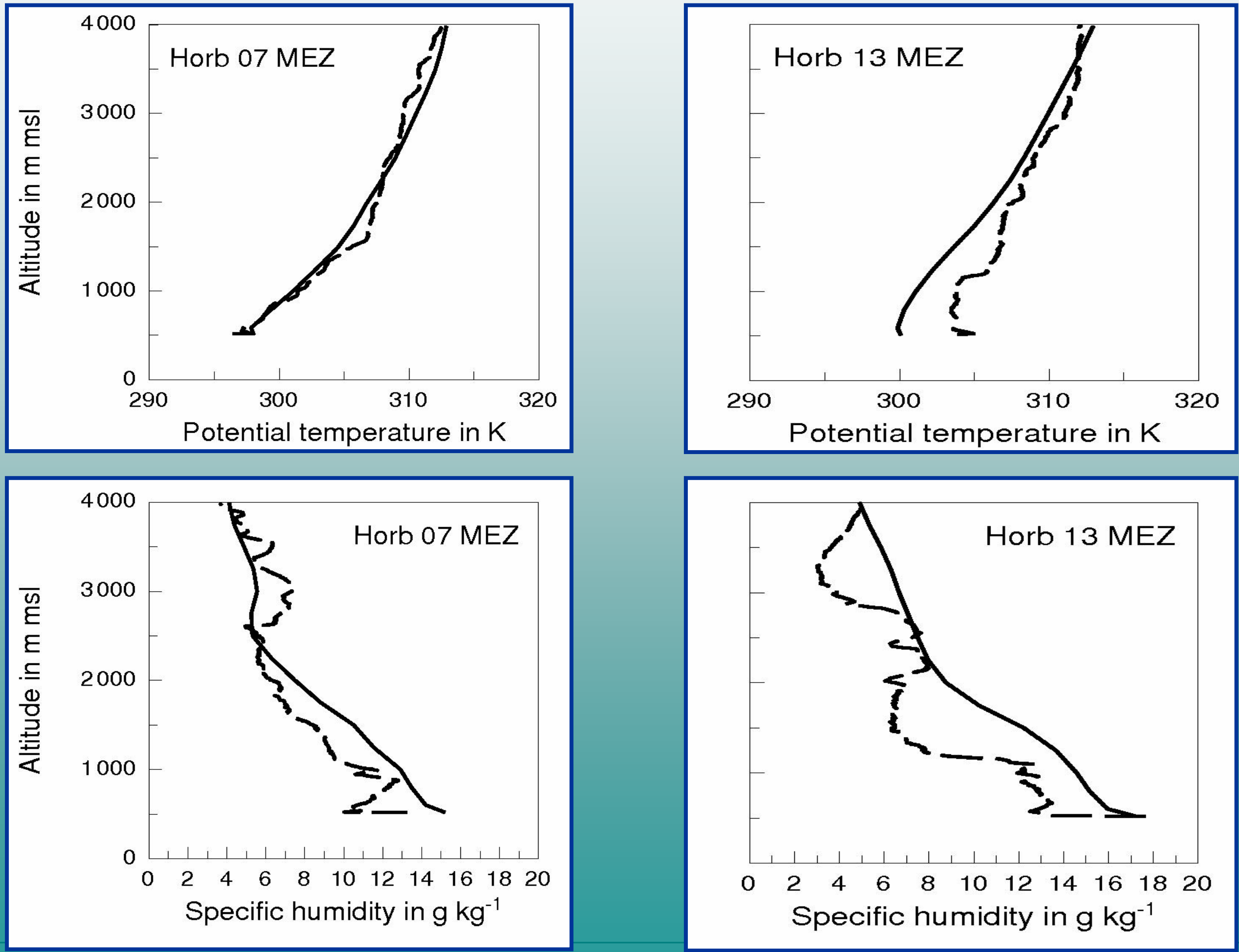
Comparison of measured (dashed) and simulated (solid) profiles of potential temperature and specific humidity at 7 and 13 MEZ at Horb



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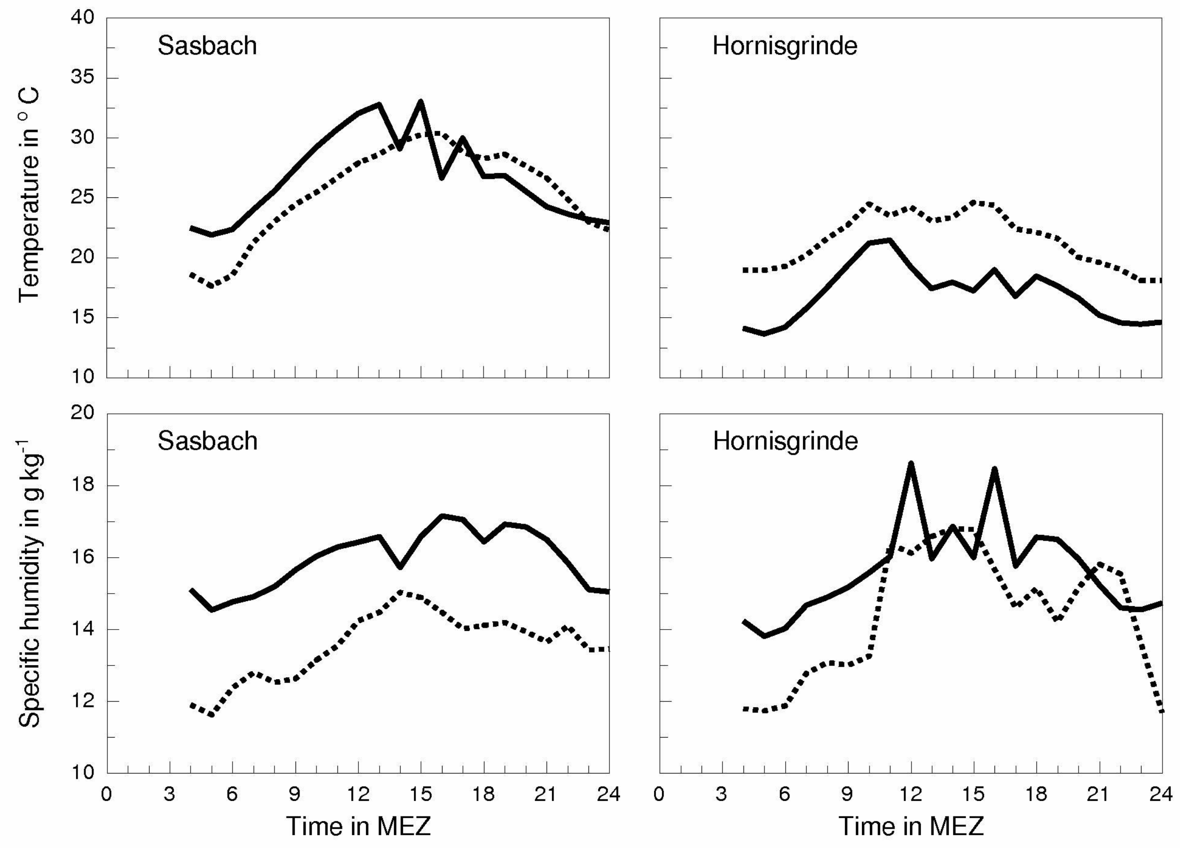
Comparison of measured (dashed) and simulated (solid) diurnal cycles of temperature and specific humidity at Sasbach and Hornisgrinde



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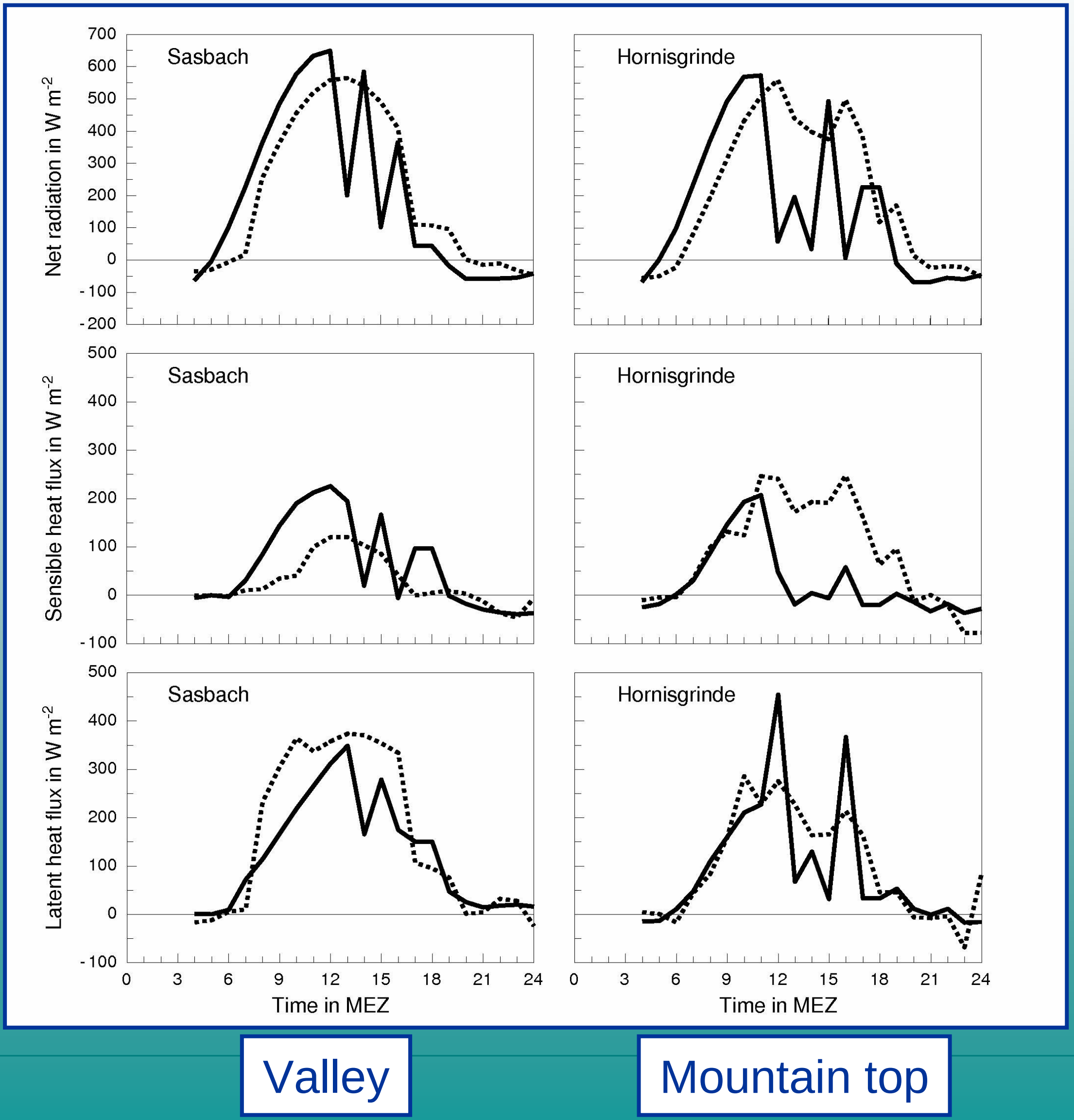

Comparison of the diurnal cycles of net radiation, sensible, and latent heat flux at Sasbach and Hornisgrinde.

Measurements dashed lines and simulations solid lines.

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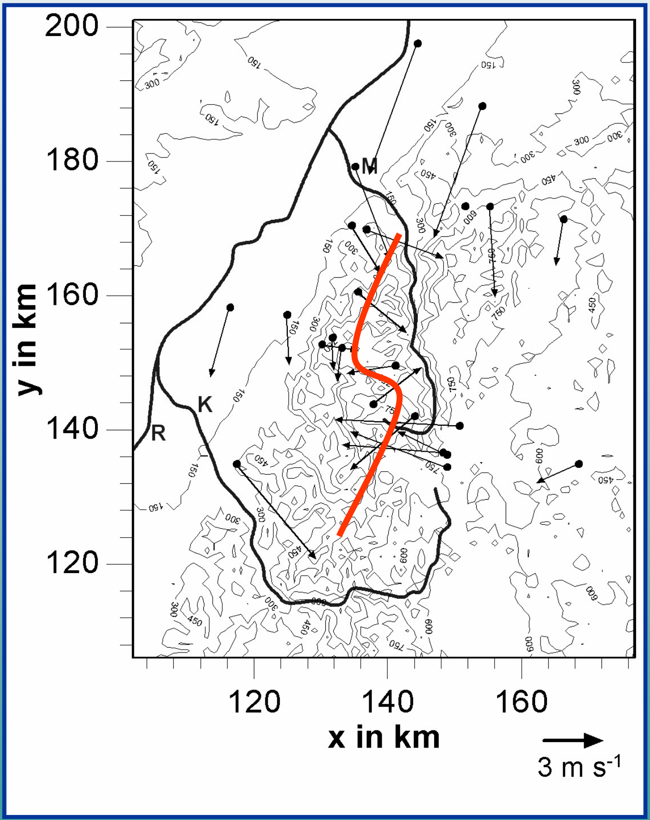
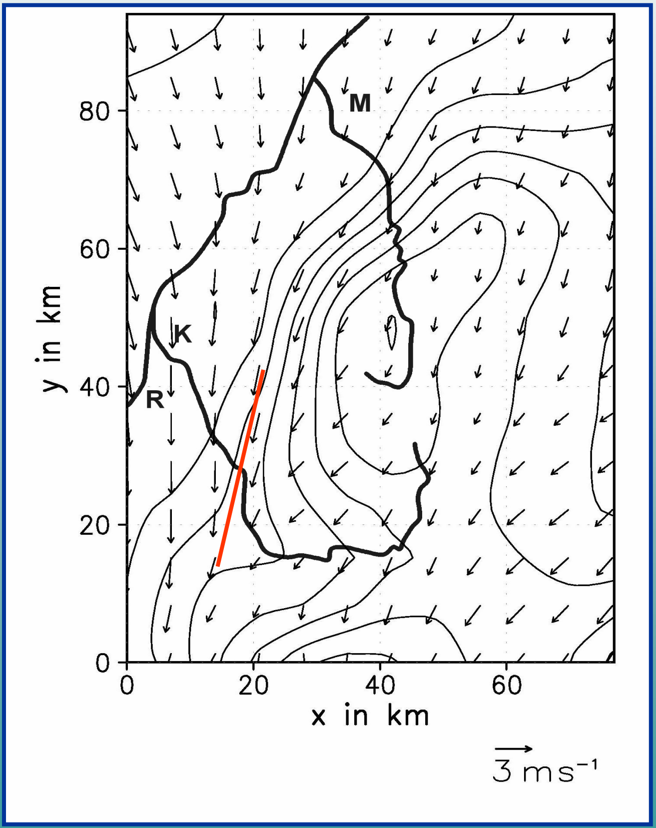
Measured (left) and modelled (right) surface wind field at 13 MEZ





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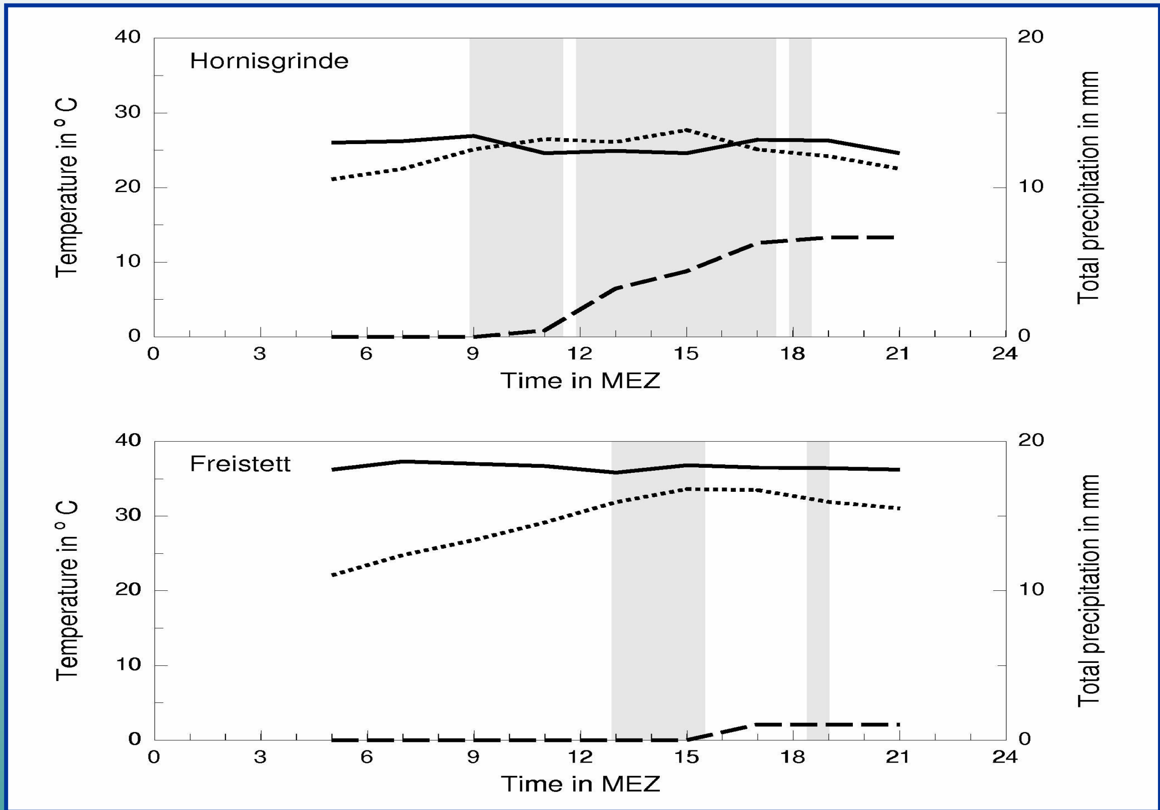
Convective temperature (solid) and virtual air temperature (dotted) calculated from measurements at Hornisgrinde and Freistett



The period, the LM convection parameterisation scheme is activated, is highlighted.
The accumulated precipitation simulated by LM is displayed by the dashed line.

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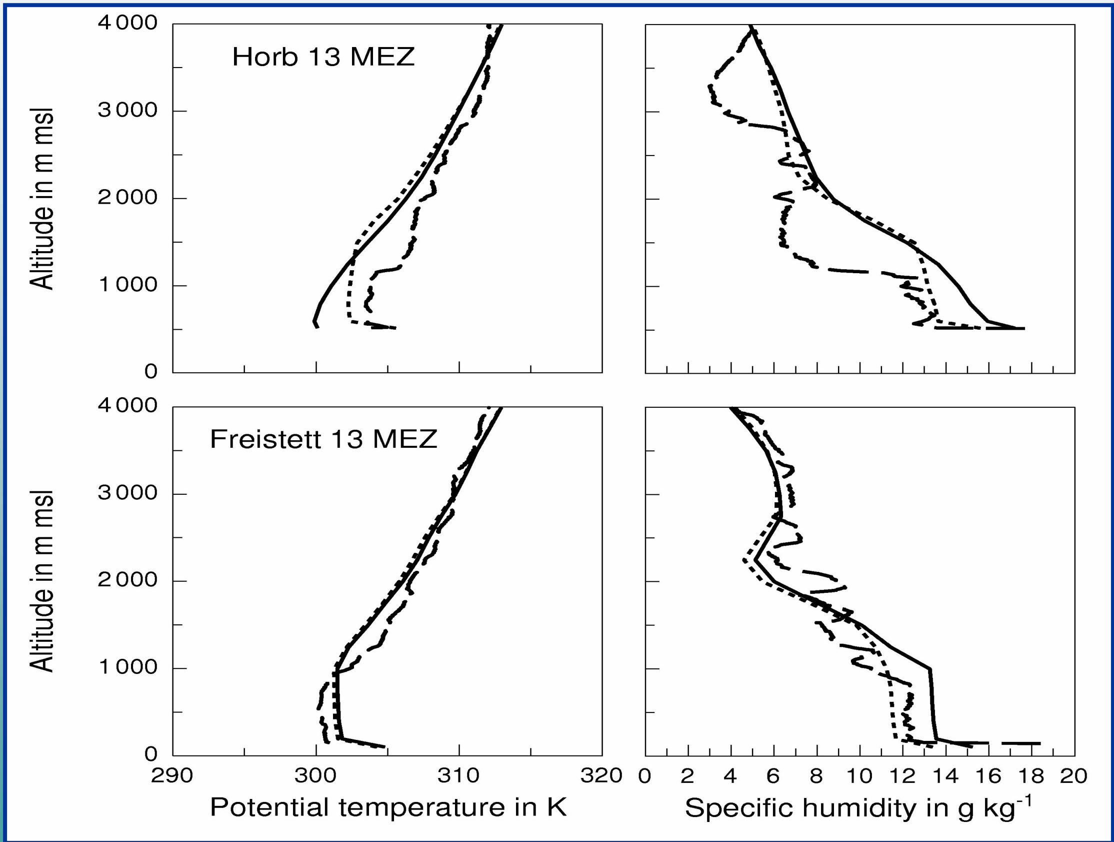
Measured and simulated profiles of potential temperature and specific humidity at 13 MEZ at Horb and Freistett



The measured profiles are dashed, the modelled profiles of the LM reference run are solid, and the LM simulation starting with reduced humidity up to 2 km height as initialisation conditions are displayed by dotted lines.

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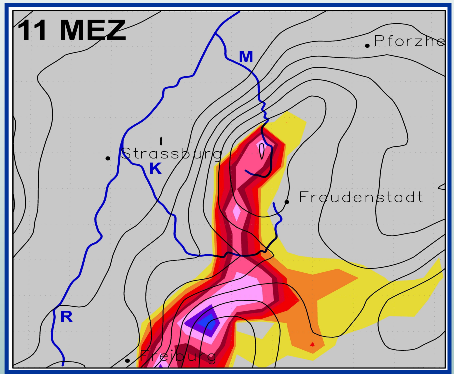
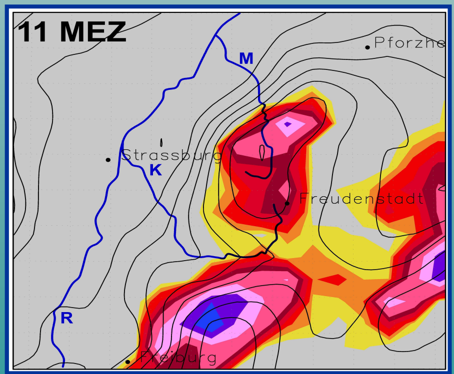
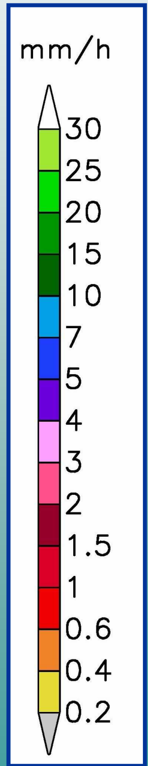
Simulated precipitation rates on 19 June 2002 and accumulated precipitation between 1 and 19 MEZ.

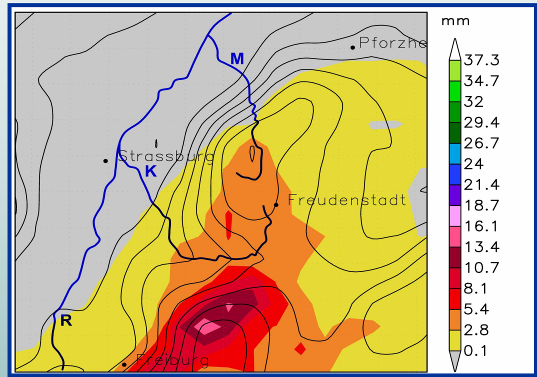


modified



operational





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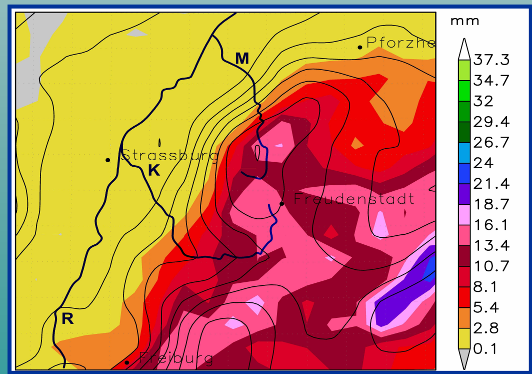

operational

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Conclusions

Morning:

- ✓ slope and valley winds developed
- ✓ higher evapo-transpiration in the valleys was measured
- ✓ convergence zones of humid air over the mountain ridges were formed
- ✓ lifting over the mountain tops started

Afternoon:

- ✓ high CAPE and large scale lifting resulted in deep convection

Simulation:

- ✓ LM could not resolve small scale thermally induced winds
- ✓ consequently right location of convergence zones were missing
- ✓ rain started too early and too widespread, amount of rainfall was wrong
- ✓ too high humidity in the Rhine valley caused rainfall at wrong locations
- ✓ adjustment of humidity profiles did not result in significant improvements

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Required instruments and strategy for operation

✓ Data of the existing networks (DWD, Meteo France, MeteoSwiss, Floot Prediction Center BW, private weather companies etc).

✓Supersites with continuous observations to derive parameters from the combined set of data and to ensure the data quality by comparisons.

✓Supersites near locations of highest probability for CI; as an advantage of low-mountainous regions, the locations of initiation of convection are more confined.

✓Scanning multi-wavelength remote sensing instruments of water vapor, wind, temperature, … combined with energy balance stations and near-by radiosonde launching stations.

✓Airborne observations (in-situ and remote sensing instruments). Different types of aircrafts to cover different scales and focus on specific parameters/altitude regions.

✓Operational radar network complemented with additional radars at supersites to achieve dual Doppler capability.

✓Additional stationary and mobile radiosonde stations and drop-sonde launches.

✓Satellite remote sensing instrumentation.

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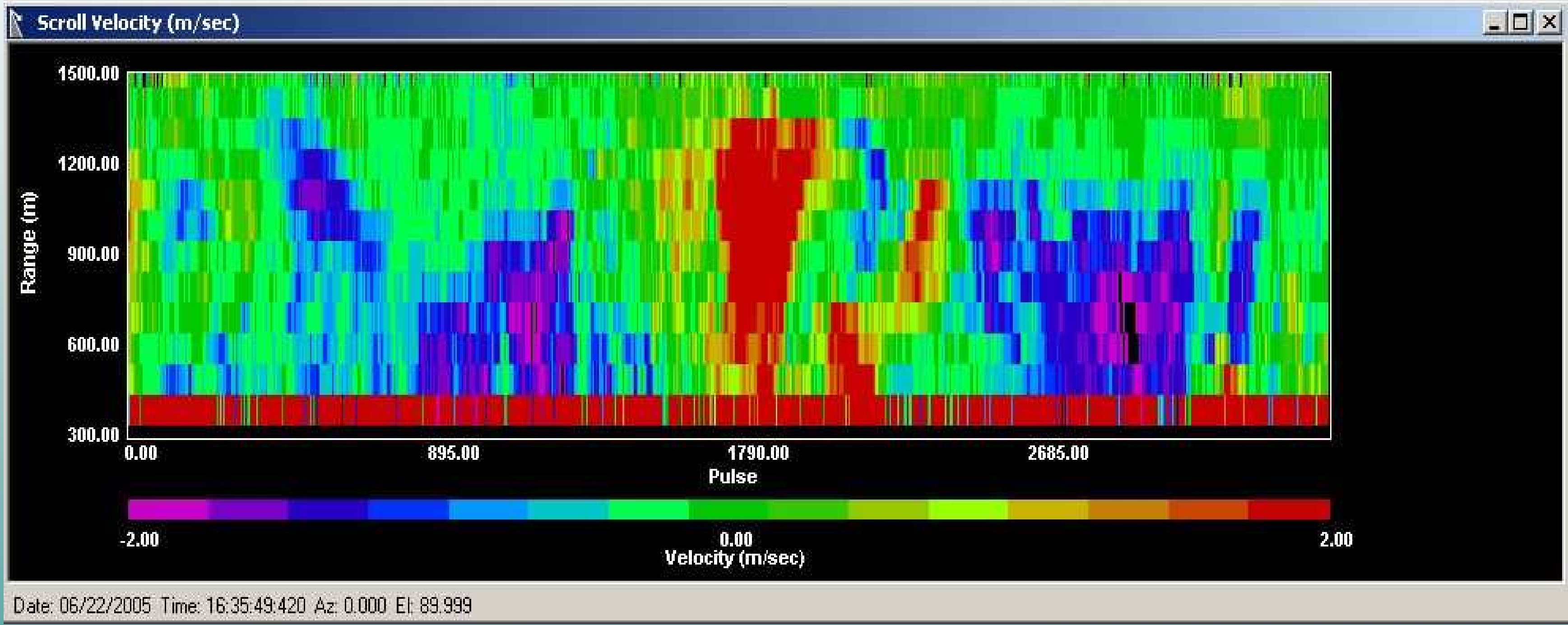
Instrumentation probably provided by IMK

- ✓ **Research aircraft DO 128 (Meteorology, Chemistry)**
- ✓ **Drop sondes (30 pieces per flight), *alternatively***
- ✓ **Drop-up-sondes (30 pieces/launched ad 5 mobile locations)**
- ✓ **Radiosonde stations (2, mobile)**
- ✓ **Tethered sondes (2, mobile)**
- ✓ **Precipitation radar (IMK)**
- ✓ **Cloud radar (mobile)**
- ✓ **Wind lidar (mobile)**
- ✓ **Sodar (2, mobile)**
- ✓ **Energy balance stations (2, mobile)**
- ✓ **Automatic weather stations (9, mobile)**
- ✓ **MMM (4, mobile met. towers)**
- ✓ **Soil moisture instrumentation**

CSIP example for convection initiation detection: June 22, 2005



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