Working Group „Precipitation Processes“

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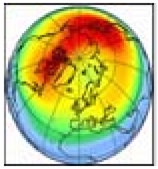
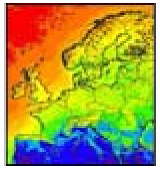
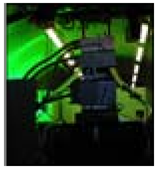
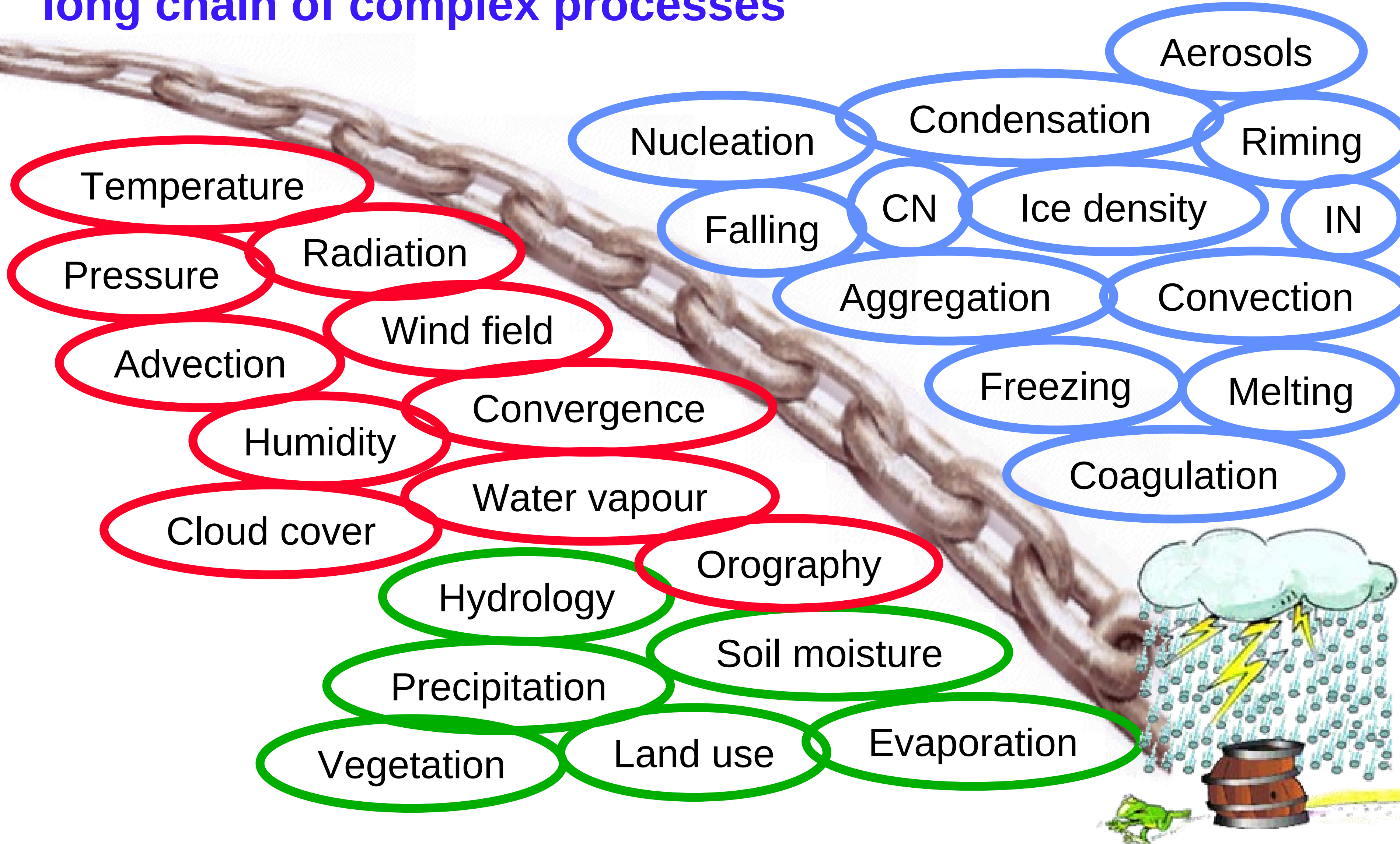






Precipitation observed at ground is the result of a long chain of complex processes



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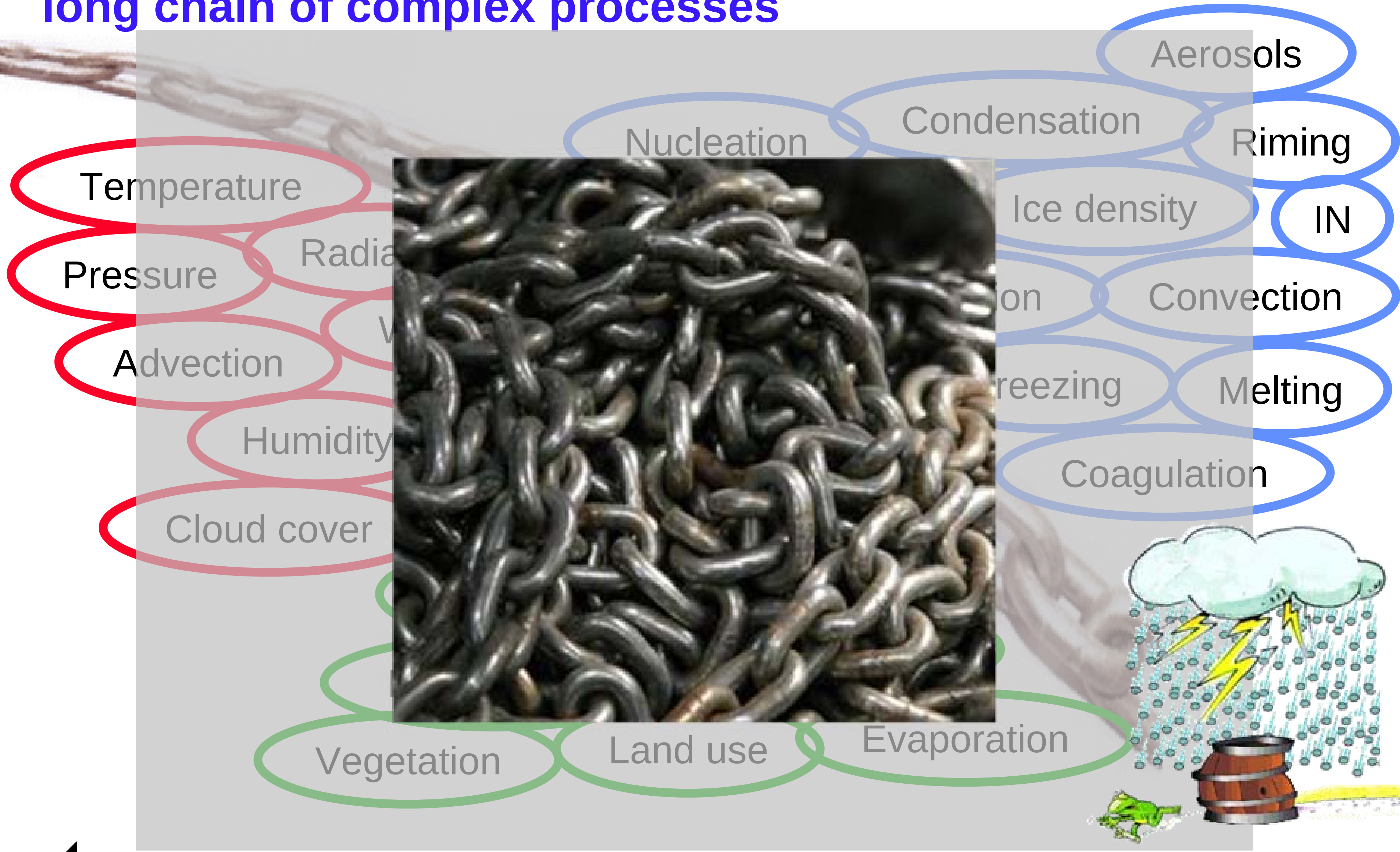


Precipitation processes

High importance of precipitation processes.

Requires input from:

- Initiation of convection (WG 1)
- Aerosol and cloud microphysics (WG 2)

provide the environment favourable for the generation of precipitation.

Output (real-time) for data assimilation (WG 4)

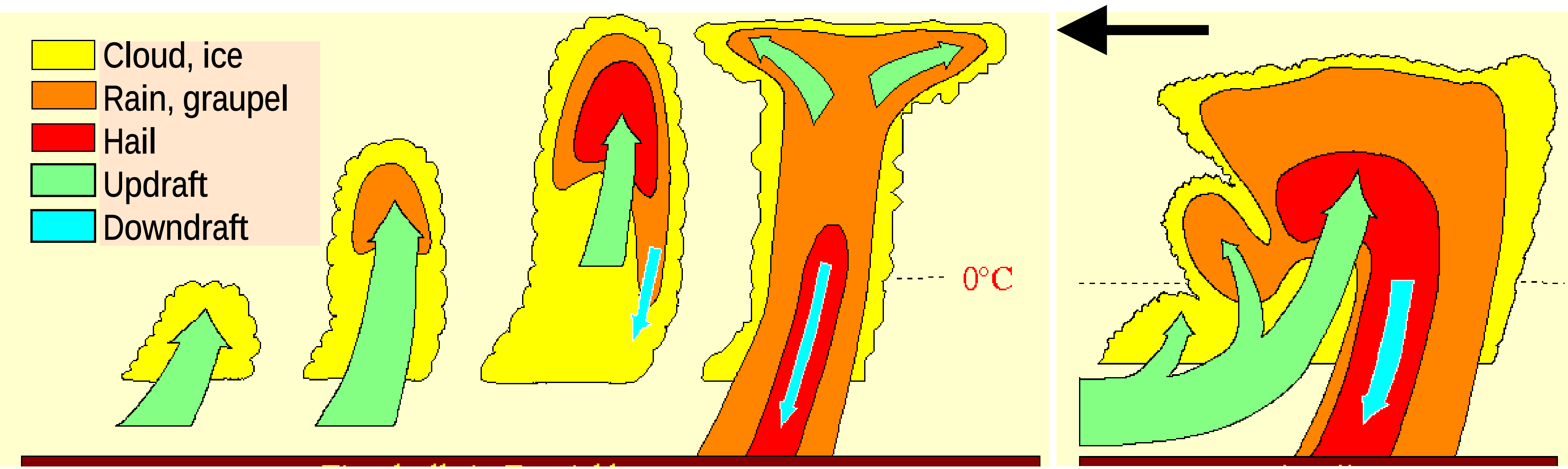
Generally, forecast quality is measured only through the final product:

→ precipitation observed at ground

State of the art: Life cycle of convective precipitation

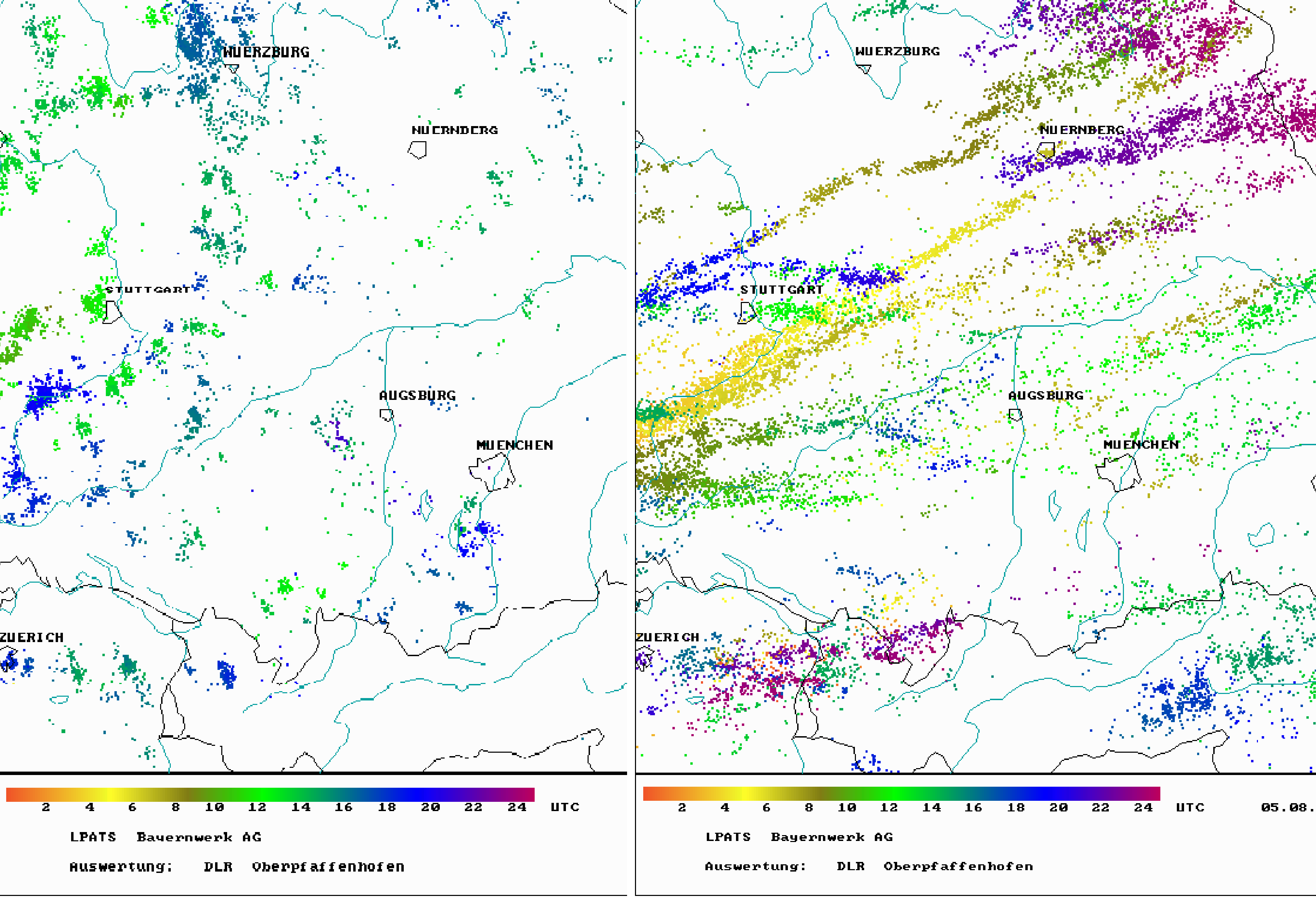
The microphysics of precipitation and the life cycle of convective precipitation are fairly well understood.

Single cell (½ - 1 h) Multi cell (hours)



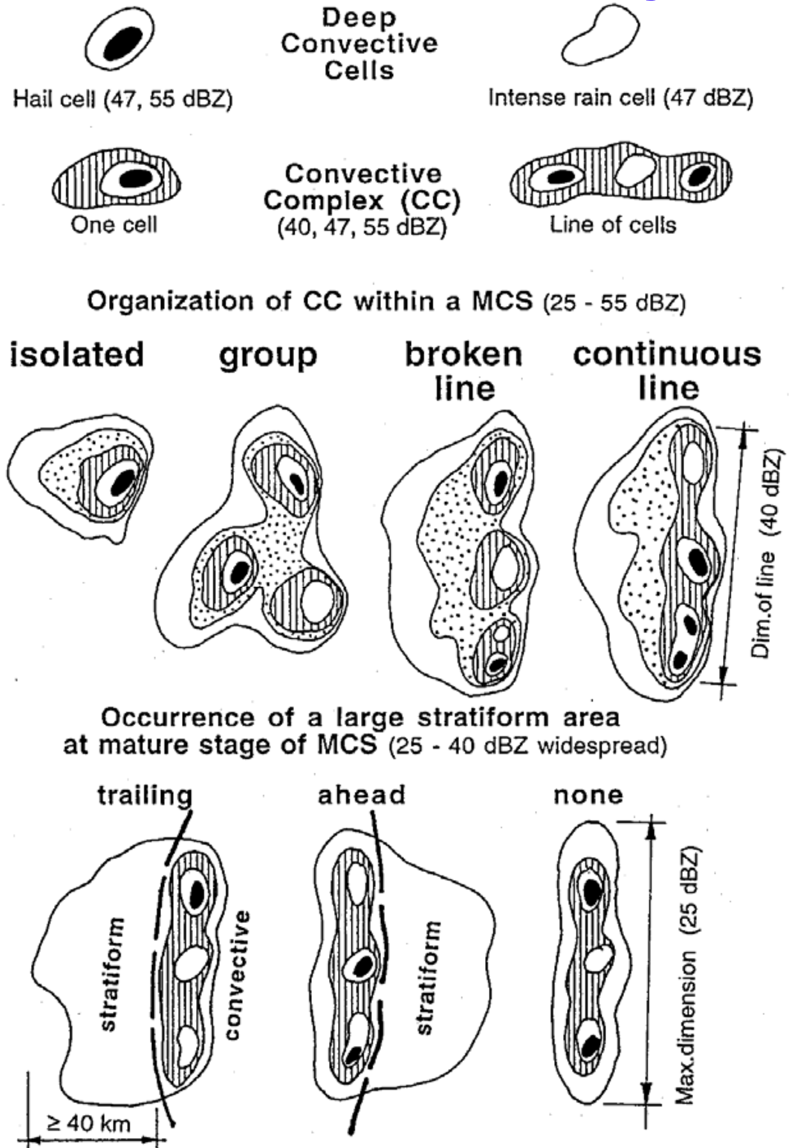
The life cycle of deep convection is controlled by the instability of the air and the wind shear in the lower troposphere.

Höller, 1994

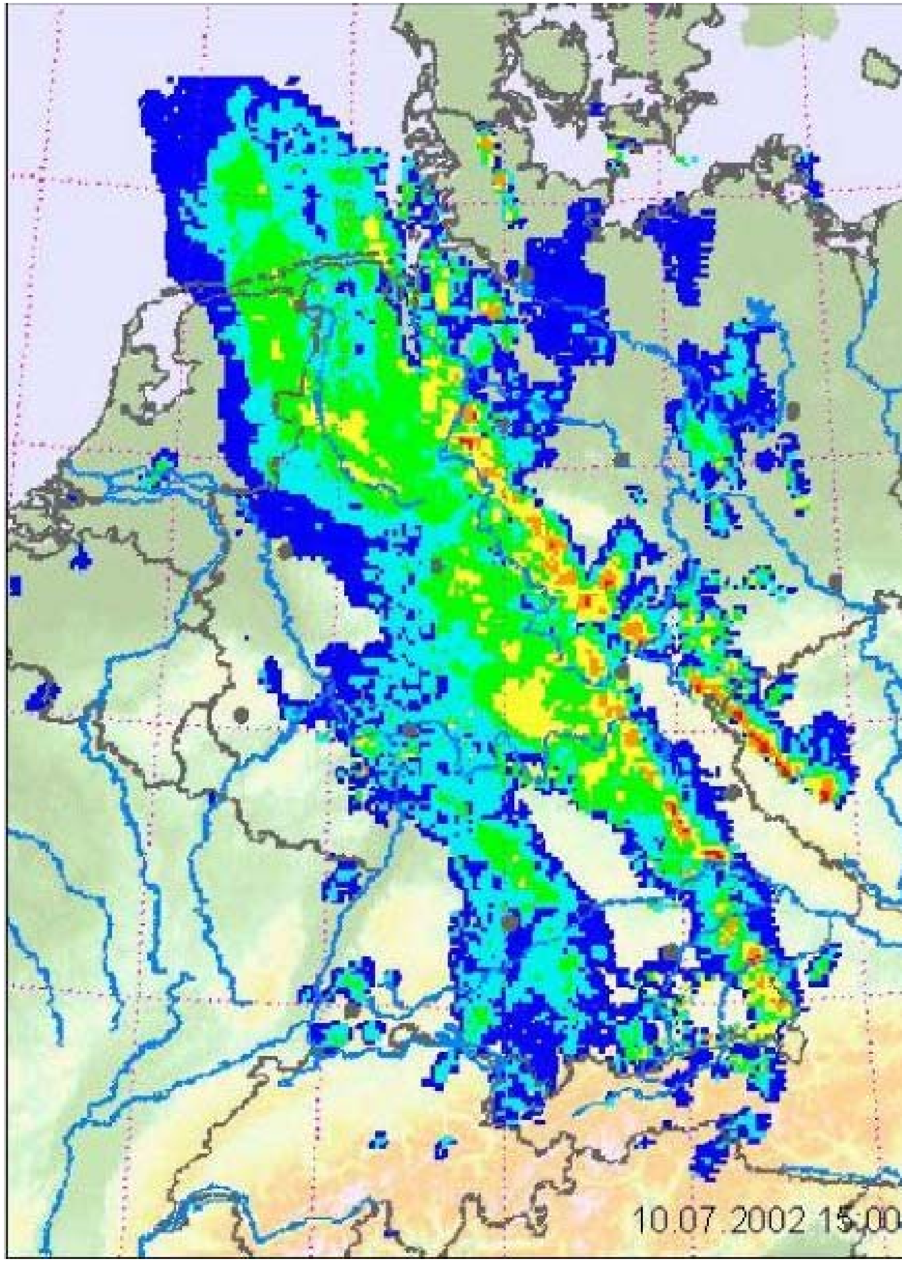


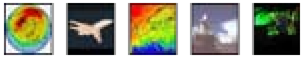
Hagen et al., 1999

Mesoscale convective systems



Houze et al., 1993





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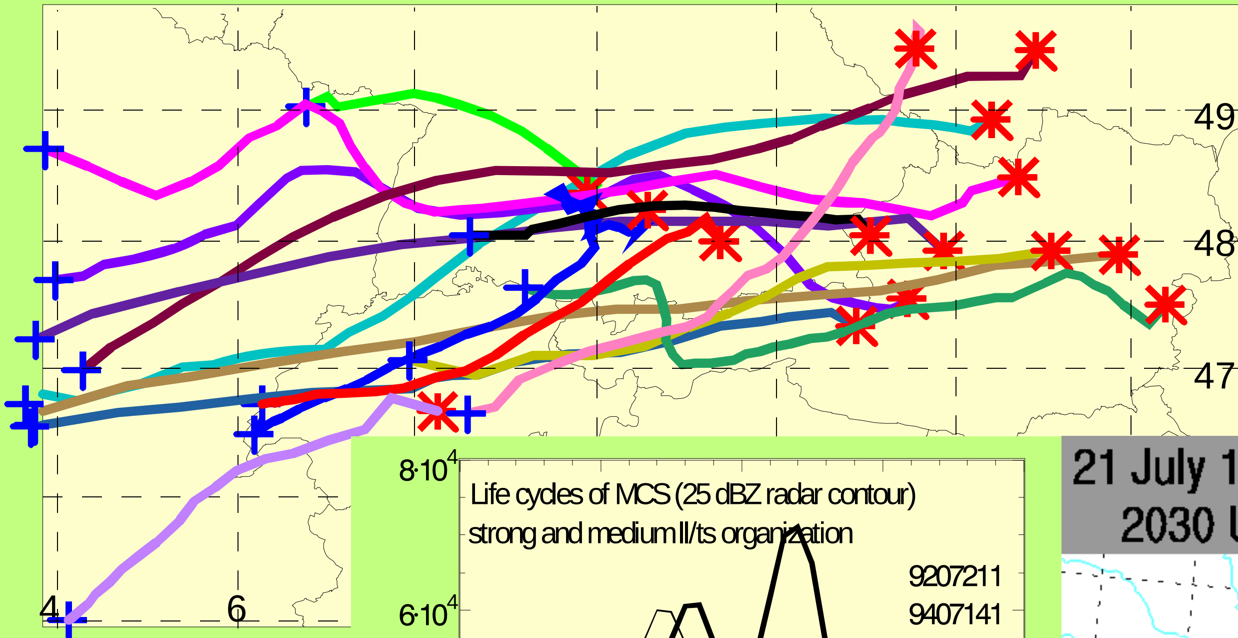
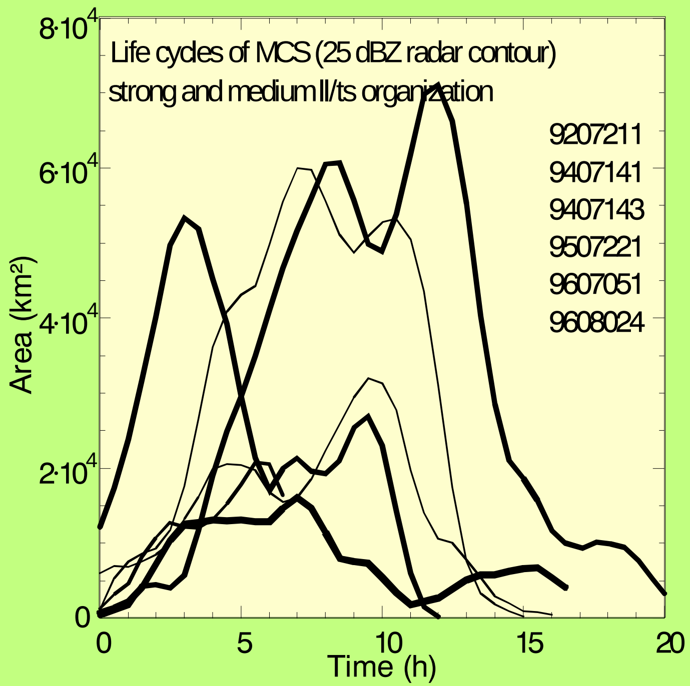
Mesoscale convective systems

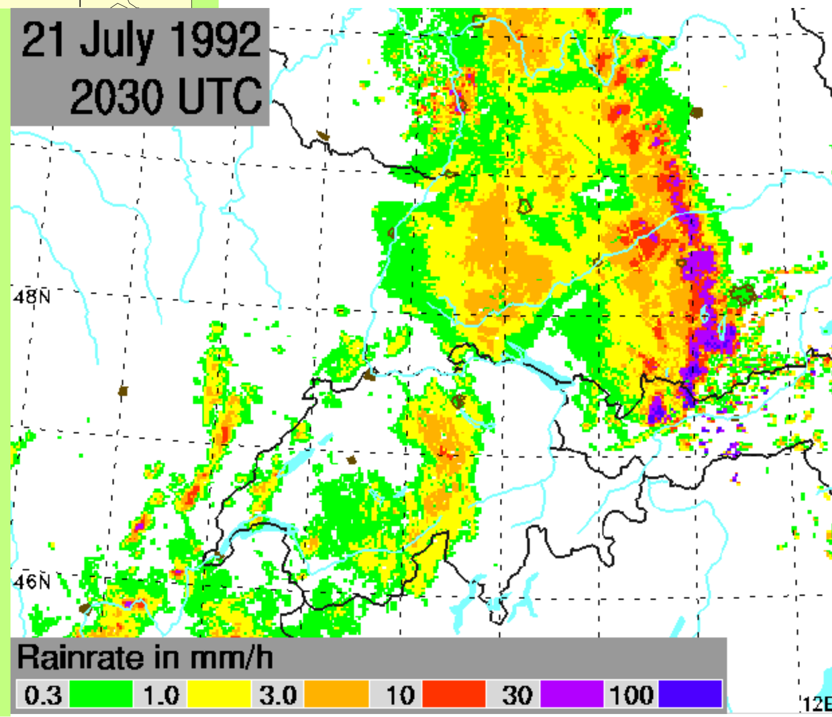
Trajectories of MCS in Central Europe



Life time up to 20 hours.

Travelling distance up to 1000 km.





Hagen et al., 2000

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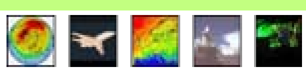


Instruments

Polarimetric Doppler weather radar

- operational Doppler radars (high resolution volume, networking)
- additional polarimetric radars (fixed, mobile, airborne)
- cloud radars (fixed, mobile, airborne)

Disdrometer

- ground based
- vertical pointing Doppler radars

Rain gauge

- operational networks
- additional gauges

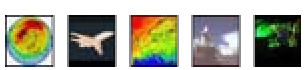
Microwave radiometers

Lightning detection network

- operational networks
- high resolution network with vertical location capabilities

Satellite observations (MSG, ...)

Instrument synergy (e.g. radar – cloud radar; radar – lidar; radar – mwr; ...)



Operational Doppler radars

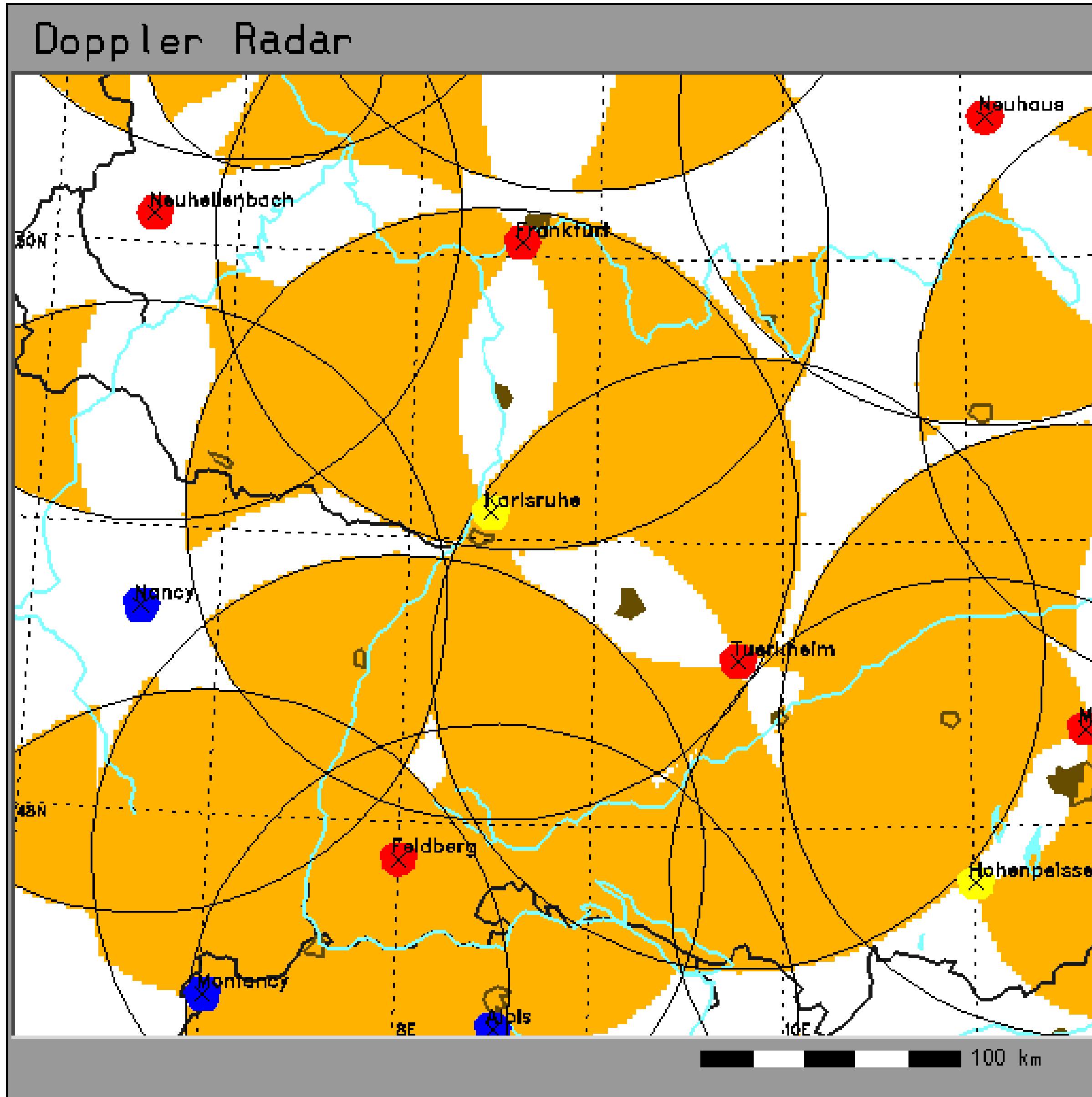
DWD
IMK Karlsruhe

Meteo Swiss

Meteo France

complete coverage
with 125 km range
orange: dual-Doppler area

all Dopplerized
none is polarimetric
(except Montancy, ’06)



added after discussion:
Nancy will not be polarimetric

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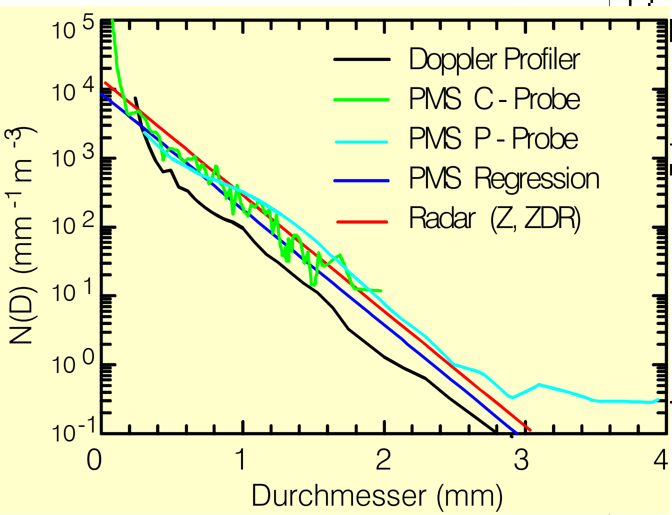
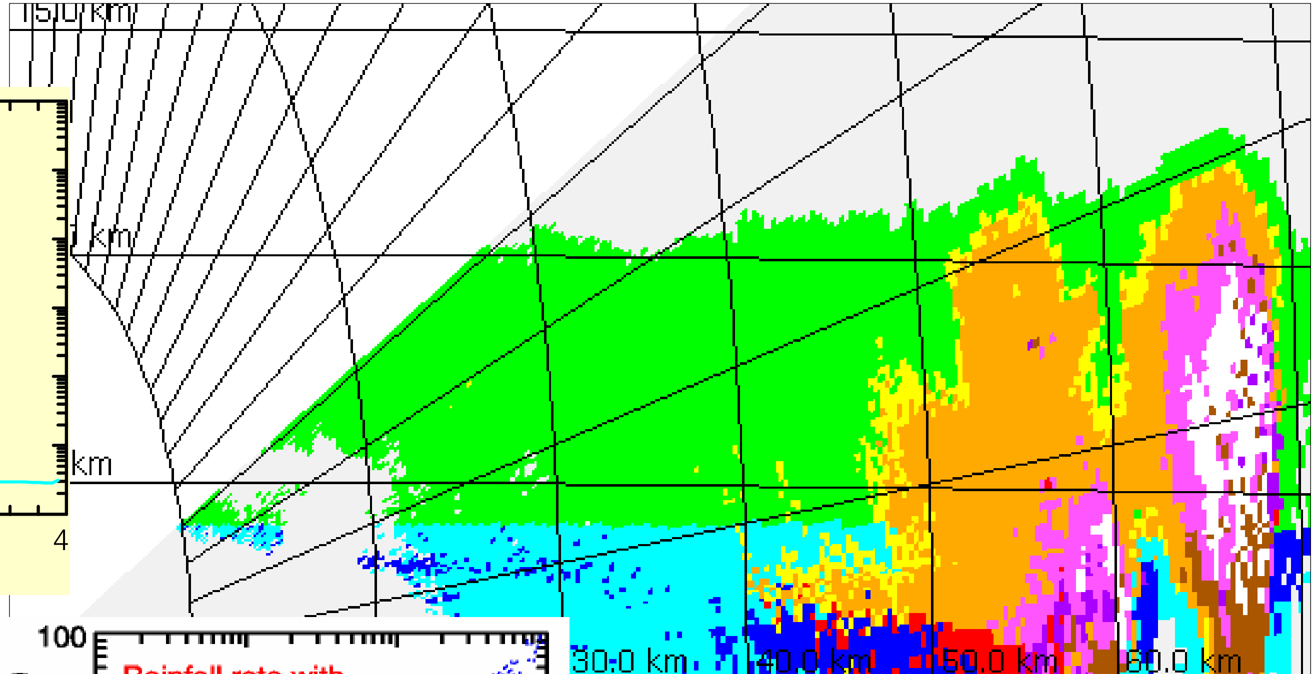
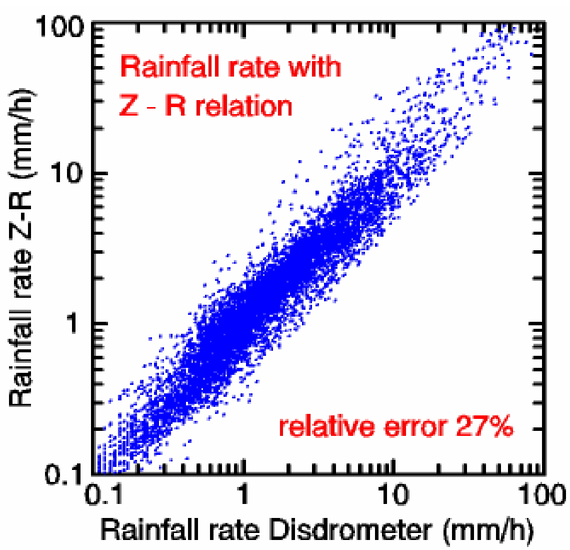
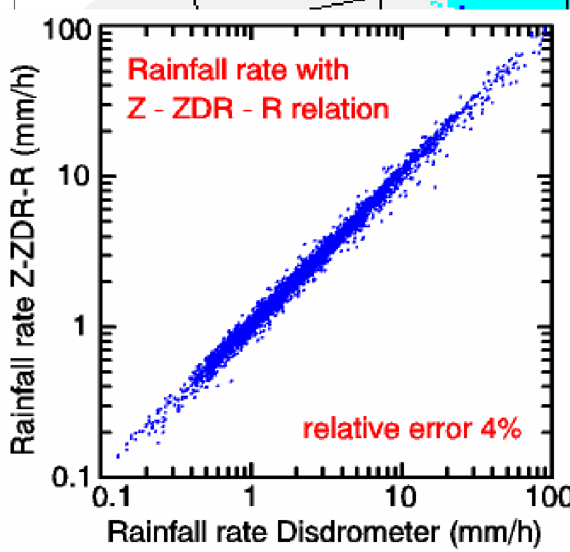
Rain rate estimation (DSD) and Hydrometeor classification by polarimetric radar

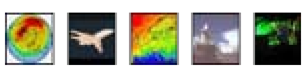




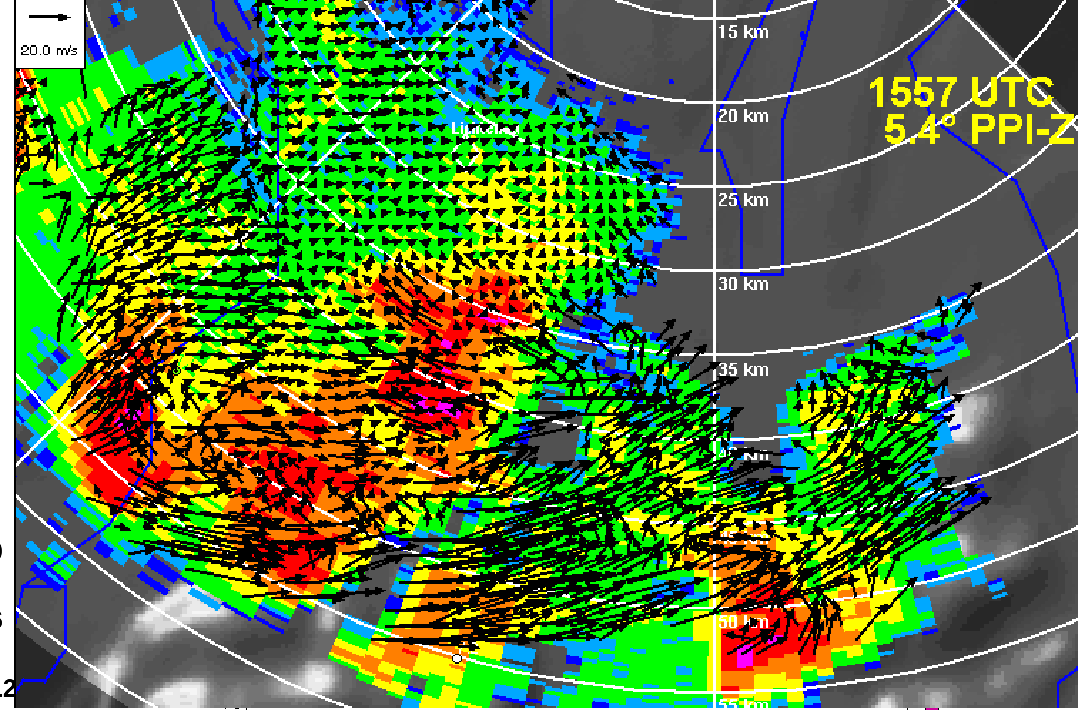


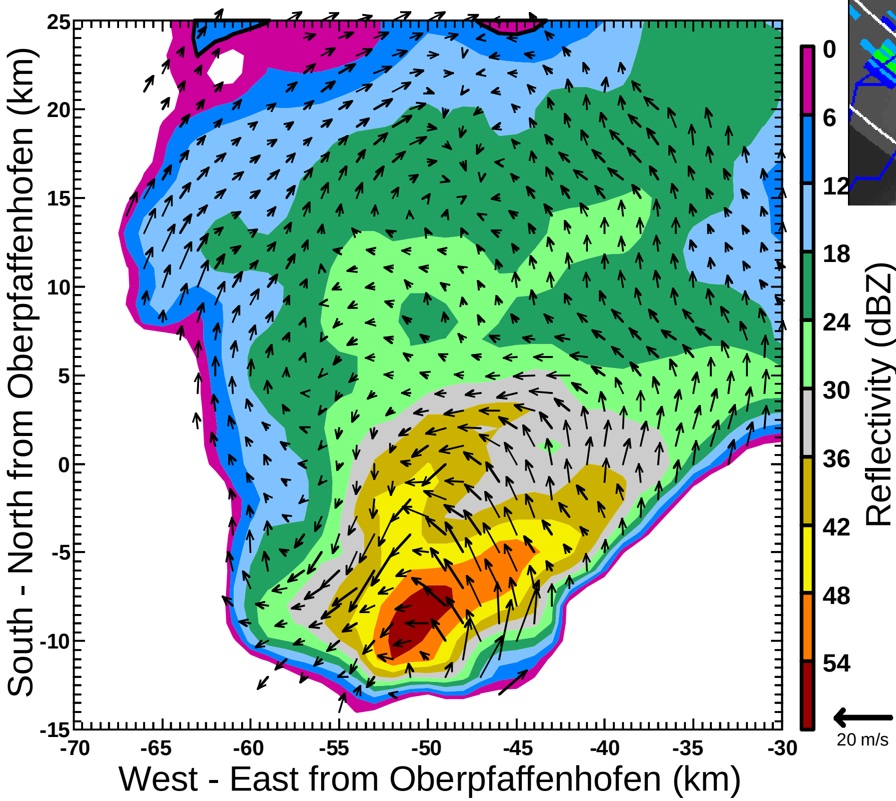


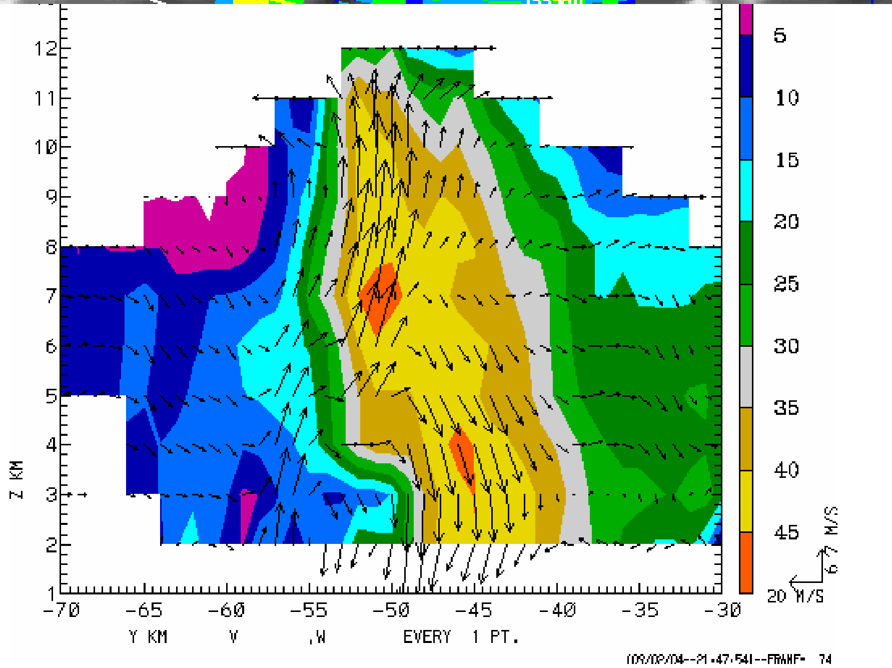
- small raindrops
- large raindrops
- dry hail
- wet hail
- wet hail, water shell
- small graupel
- wet graupel
- spongy wet hail
- rain + small hail
- rain + large hail
- no hydrometeor classification possible



Dynamic features by multiple Doppler observations







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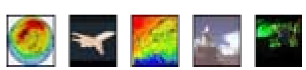
COPS Hypotheses

1. Knowledge of large-scale conditions is a prerequisite for improving QPF.
2. Understanding and modelling of the orographic controls of convection such as embedded convection in convergence lines, secondary circulations is essential.
   1+2: Requires 4-D observations
3. Initiation of convection depends mainly on the structure of the humidity field in the PBL.
   <> Orographic forcing has a strong impact
4. Continental and maritime aerosol type clouds develop differently over mountainous terrain, but ice formation and precipitation from convective clouds do not depend on measurable aerosol properties.
   How to validate this ?
5. Instrumentation synergy can be designed in such a way that critical parameterizations improved.
   New microphysical parameterization is required.
6. Real-time data assimilation is routinely possible and improves QPF.
   -



Open questions

Orography can trigger the development of cells, however, it is open whether convection is suppressed in the subsiding flow in the lee of hills.

The life cycle of single cells can be modulated by orography, but it is open whether orography like Vosges Mountains or Black Forest can have a significant influence on the formation and propagation of multi- or super-cells or even mesoscale convective systems.

How significant is this influence if the cells have been already formed before they interact with orography?

Can embedded convection be triggered by topography. Formerly stably stratified precipitation may be destabilized by the forced uplift through mountains.

Role of WG “Precipitation life cycle and processes”

Define measurement strategy
(for precipitation related instruments).

Coordinate observations,
provide data (real-time ?) to WG 4.

Develop new instrument synergy to evaluate the transition from non-precipitating to precipitating cloud systems.

Provide observations to investigate in new microphysical parameterization schemes.