Status-quo of COPS' Scientific Preparation, Candidate Instrumentation, Workshop Overview

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Thunderstorms 24/25 June 2005

Tagesschau:

„Sintflutartiger Regen über Deutschland“

„The Deluge over Germany“

„Festivalgäste bei Unwetter verletzt“

„Festival guests injured by Thunderstorm“

„Bangen vor dem Siebenschläfer“

„People afraid of Siebenschläfer (27 June)“

The weather on 27 June is said to determine that of the next seven weeks (St Swithin's Day)

DWD:

46 mm/(30 minutes) in Metzingen

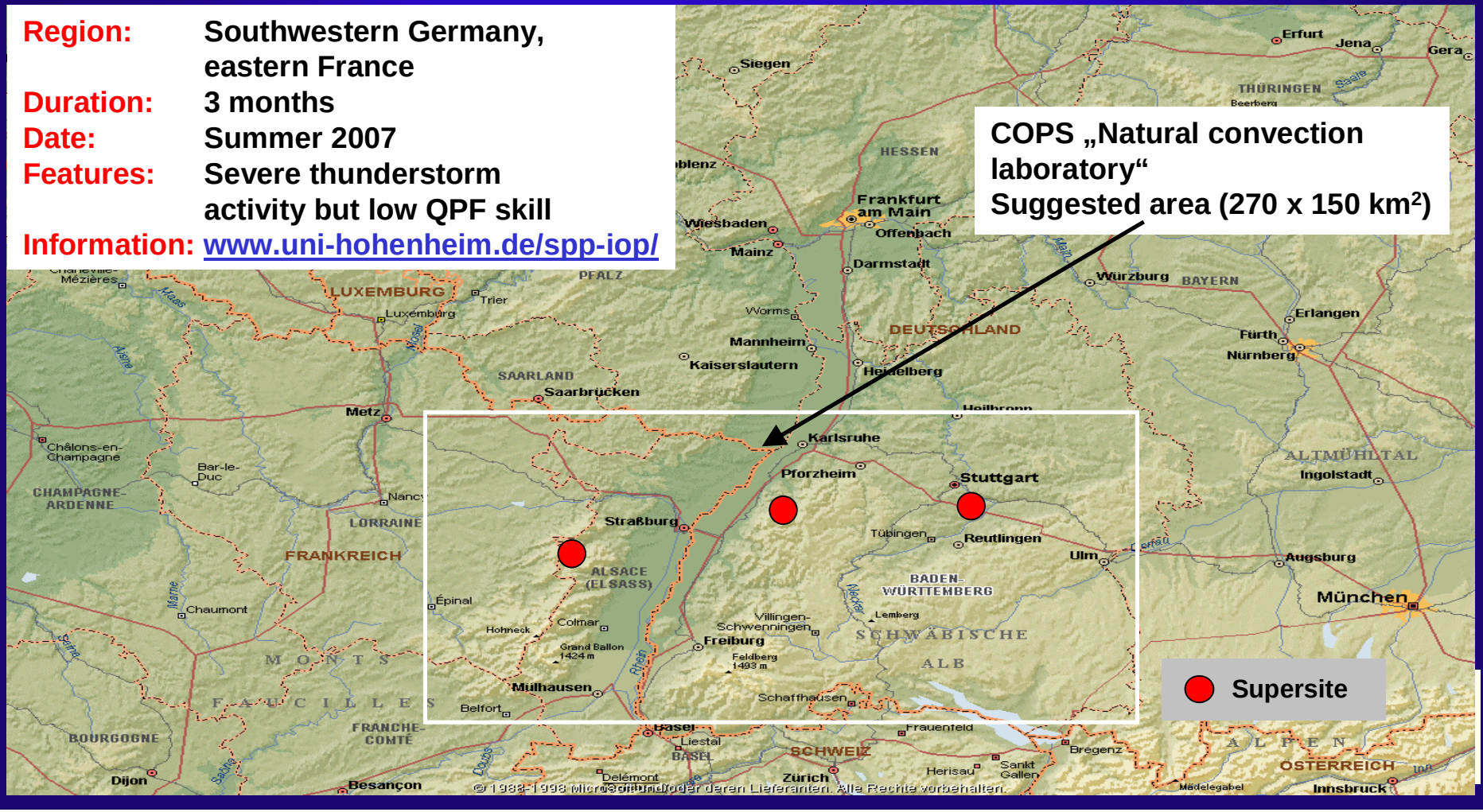
„strongest rain in Germany“

COPS (Convective and Orographically-induced Precipitation Study)

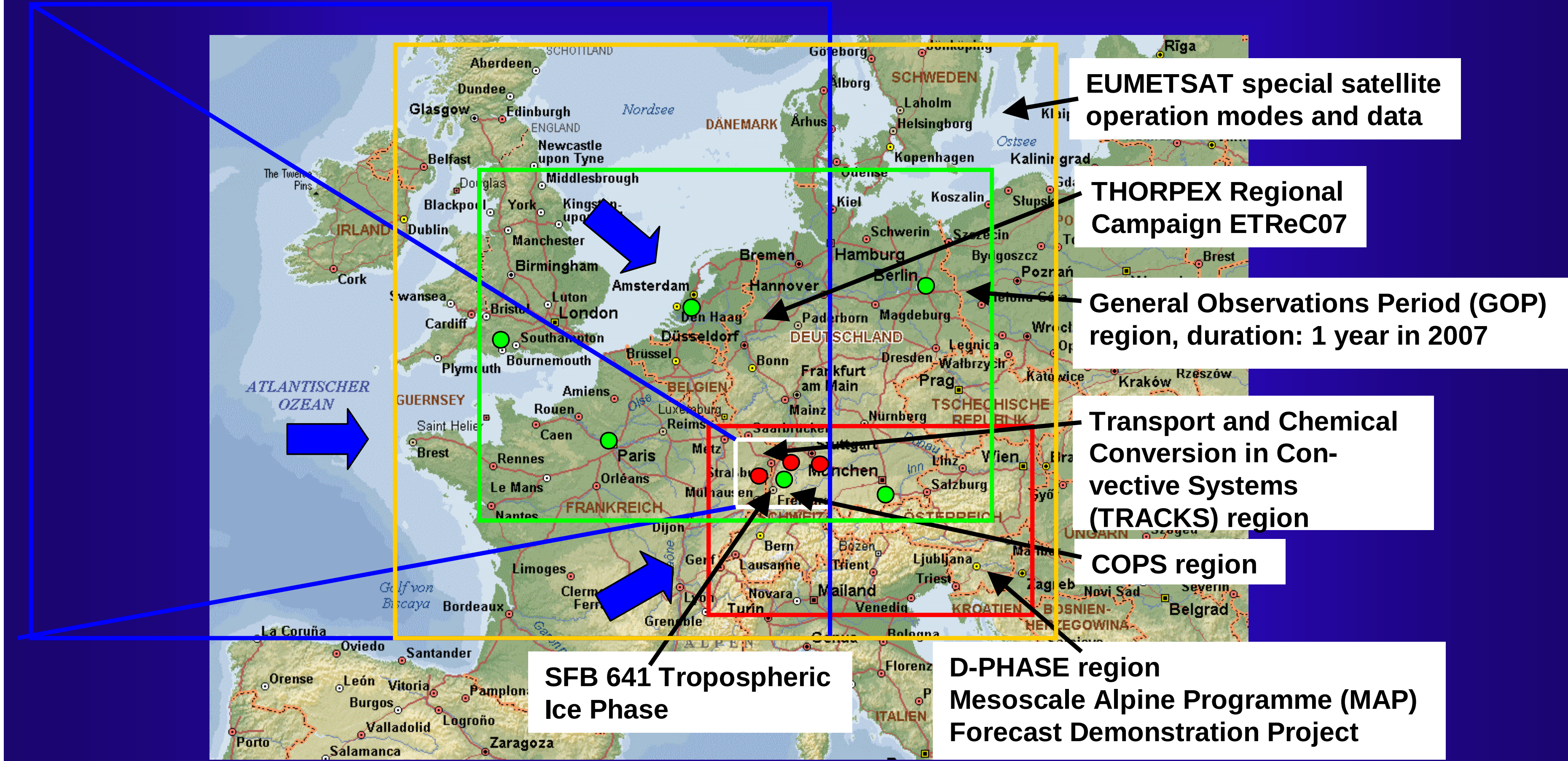
A field experiment within the Priority Program 1167 PQP

Goal: Advance the quality of forecasts of orographically-induced convective precipitation by 4D observations and modeling of its life cycle

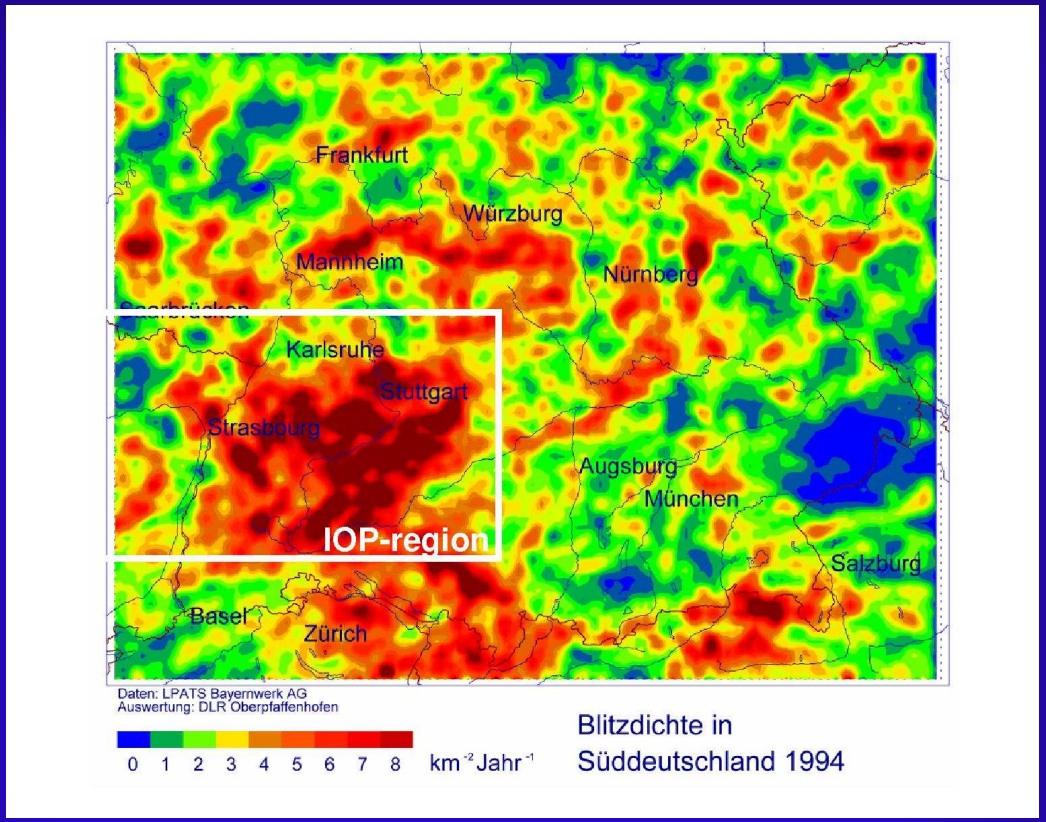
Region: Southwestern Germany, eastern France
Duration: 3 months
Date: Summer 2007
Features: Severe thunderstorm activity but low QPF skill
Information: www.uni-hohenheim.de/spp-iop/



International Collaboration Within COPS

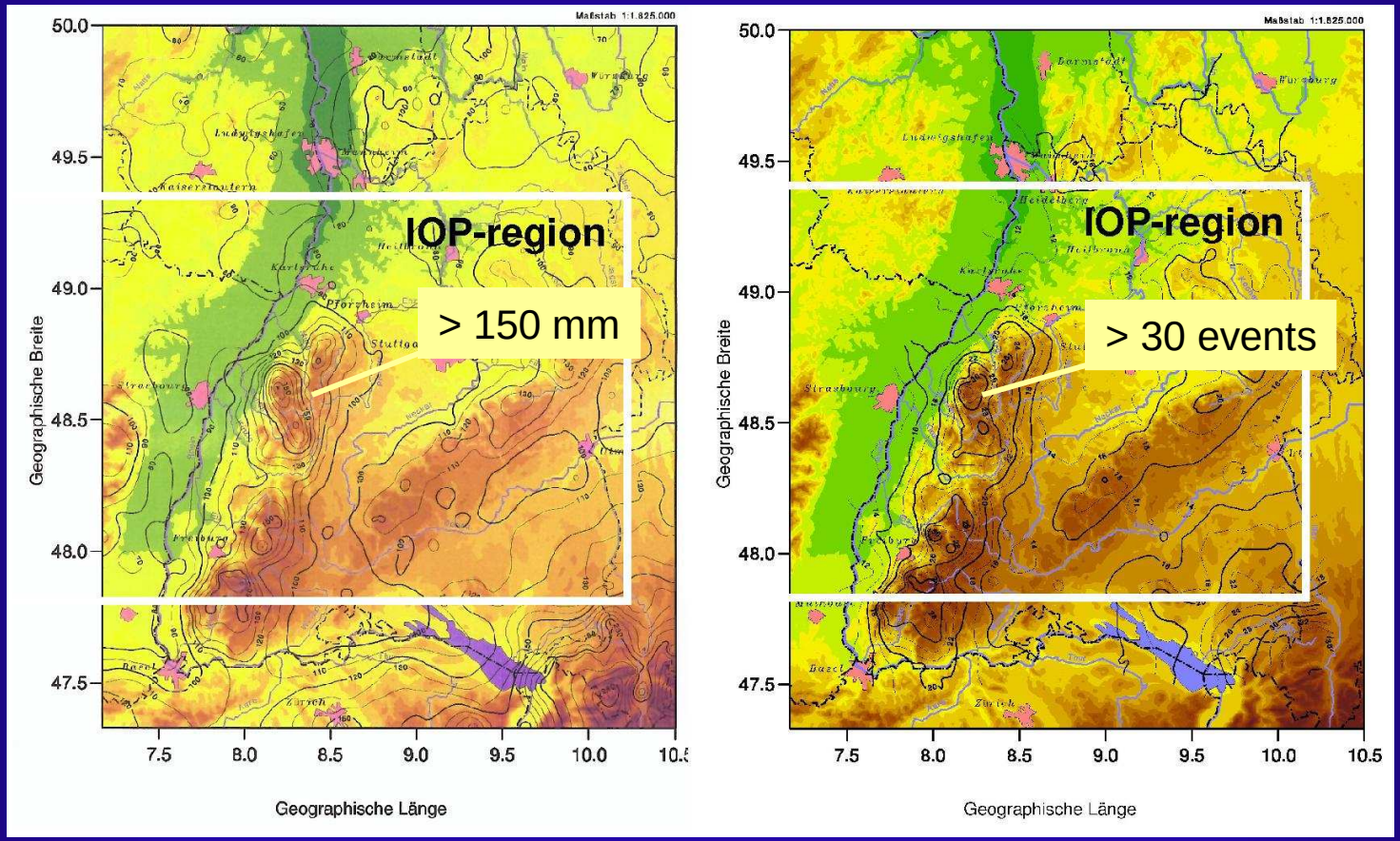


Lightening climatology in the COPS area



Areas with largest convective activity and thunderstorm development in Germany.

Precipitation climatology in the COPS area

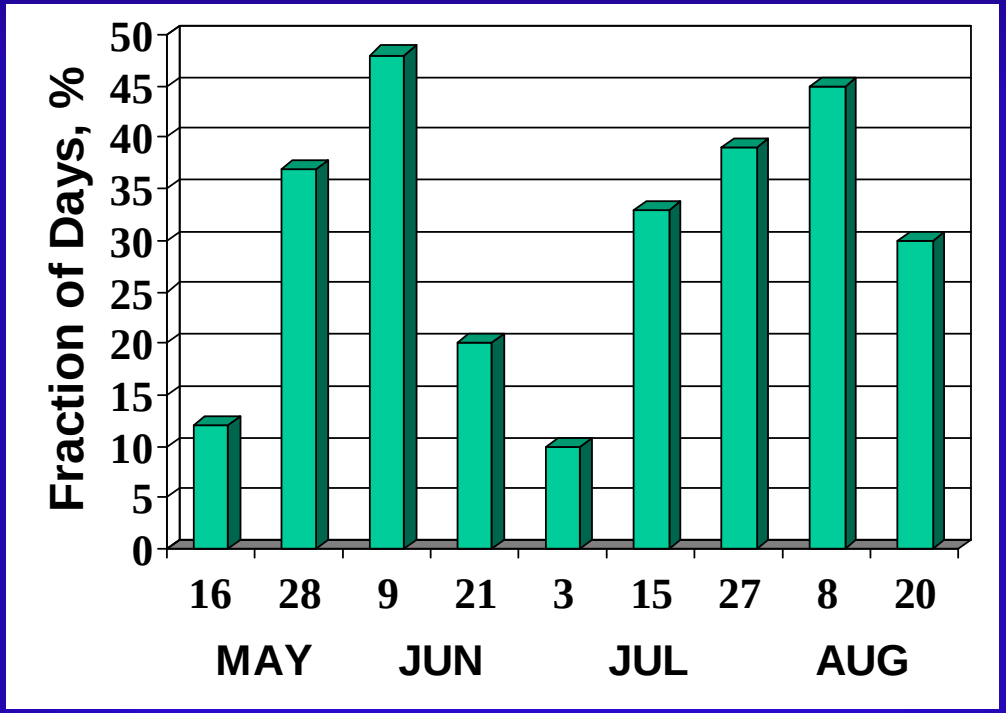


(Mühr, 1999)

Mean Precipitation in June **Events > 10 mm/day, Apr – Sep**

Precipitation on > 60 % of days in summer.

Initiation of Precipitation over the Black Forest



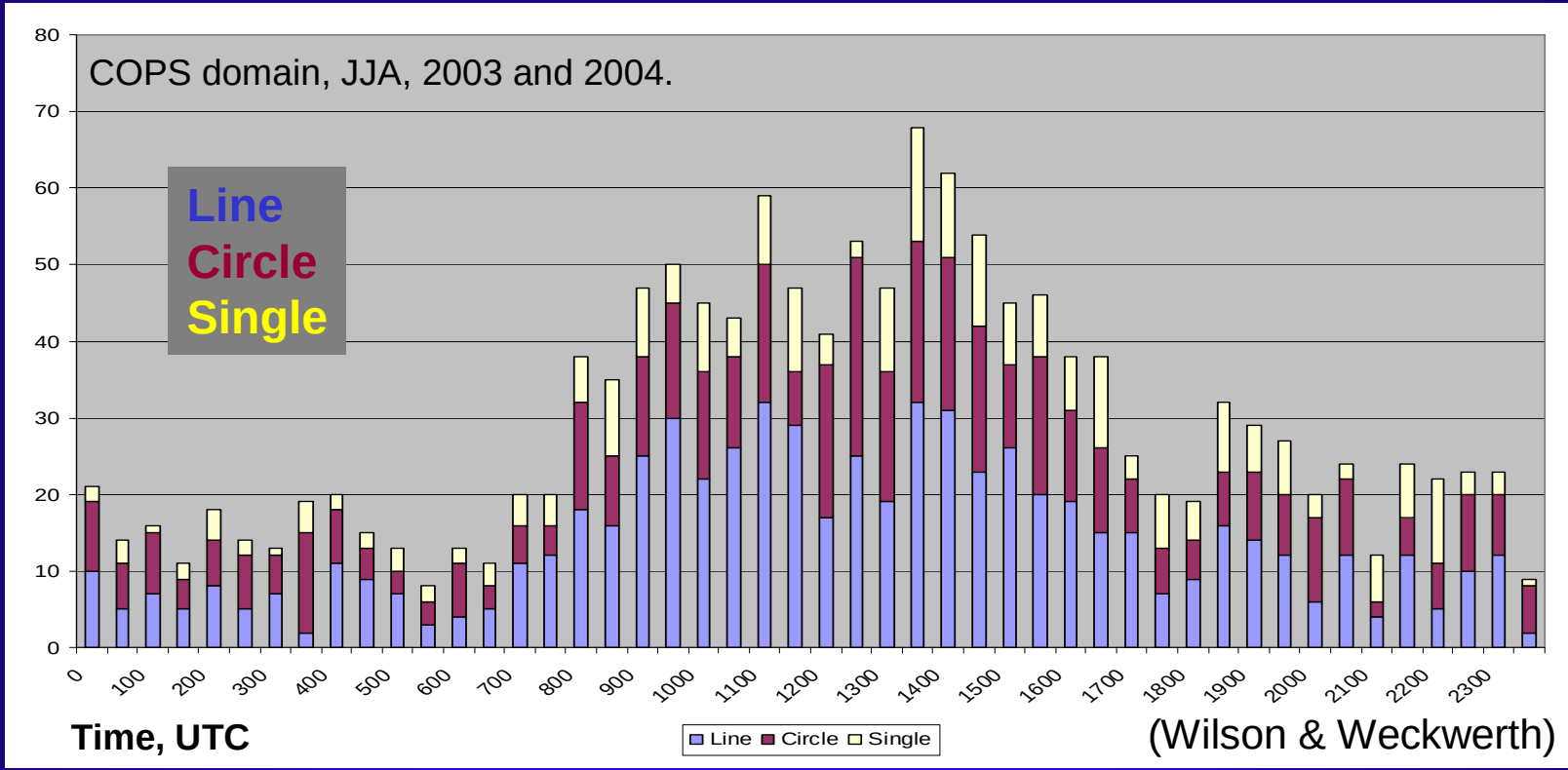
(Wilson & Weckwerth)

16 May – 31 Aug, 2000 - 2004

Large fraction of days with initiation of precipitation.

Mean: ~25 % of days in summer.

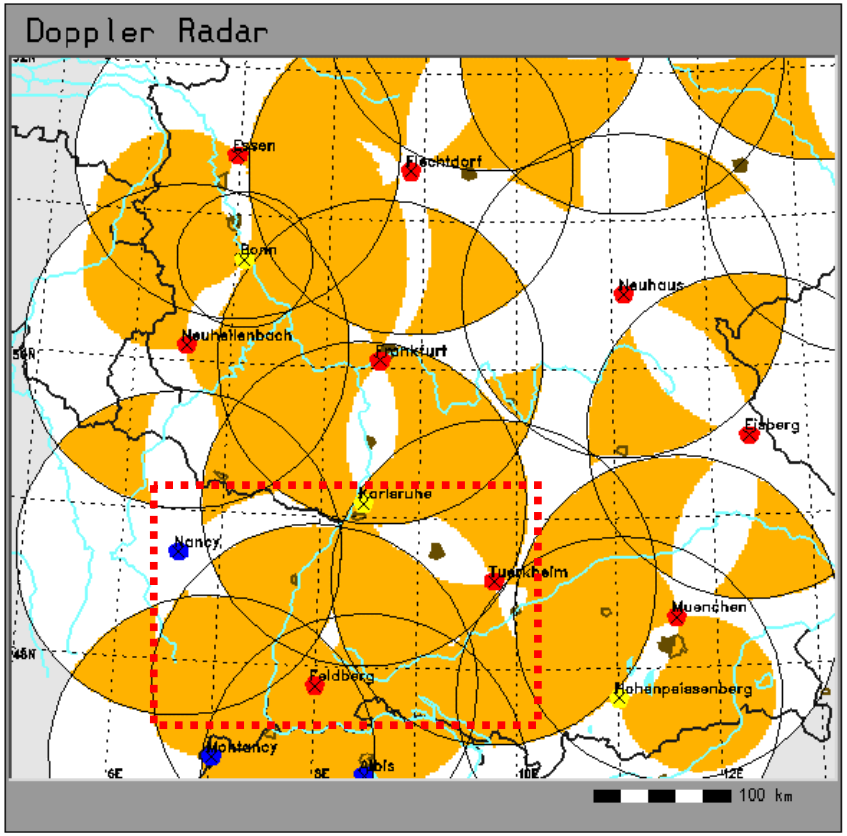
Diurnal Variation of Initiation of Precipitation



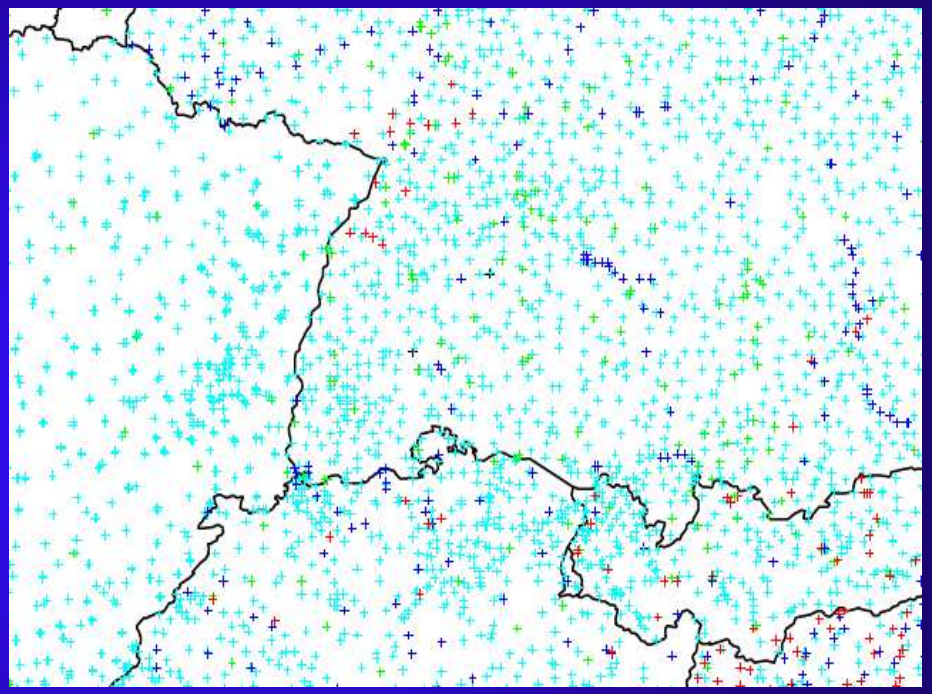
- Why is linear convection the dominant organization?
- Why do new storms also often initiate in clusters?
- What role does the orography play in the organization of convection?
- Why does the maximum initiation frequency occur on the gradients in slope?

Dense Operational Networks in COPS Region

Radar Network



Rain gauges



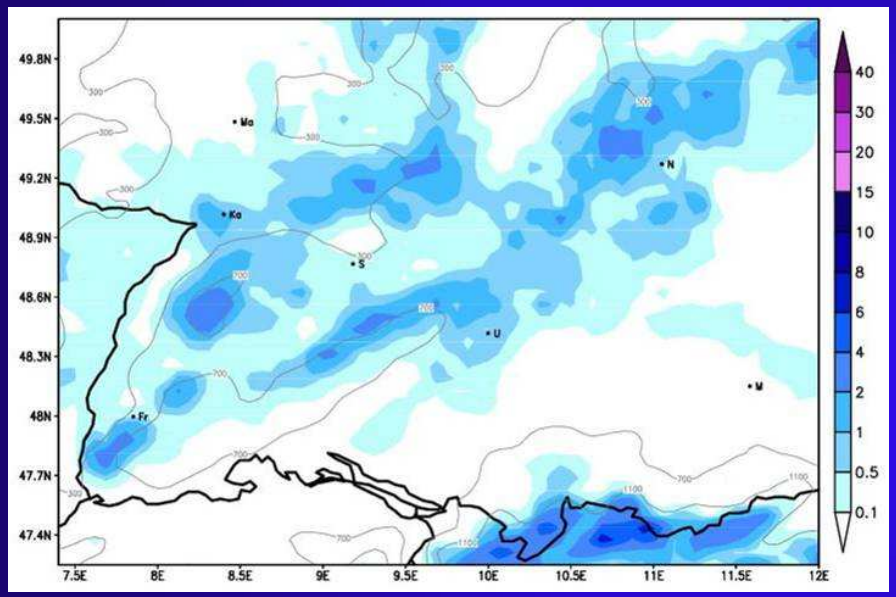
(Frei and Schär, 1998)

Orange: areas with at least dual-Doppler capability
(orographical shading not considered here)
• DWD, • MeteoFrance & MeteoSwiss, • Research

Typical Model Deficiencies

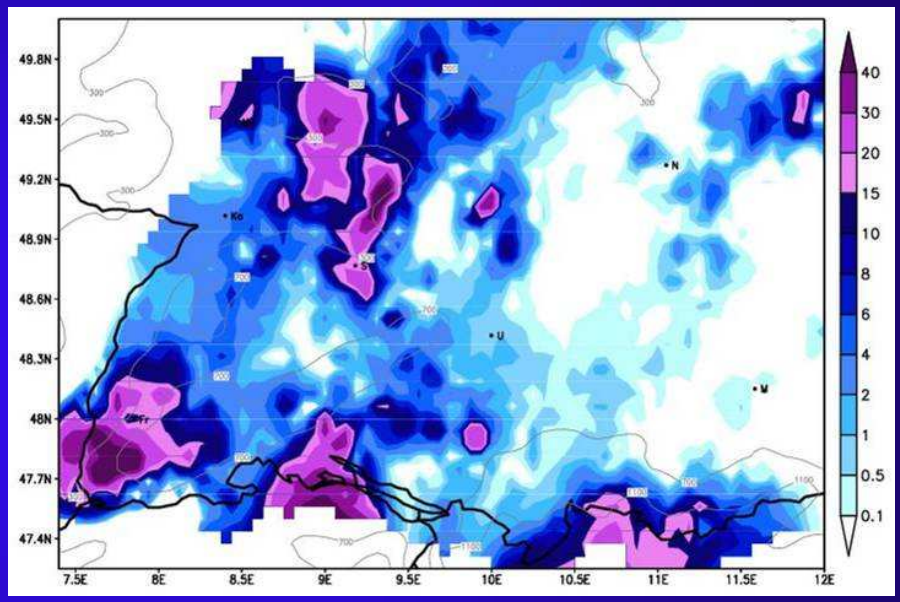
Case study VERTIKATOR:
24-hour precipitation between 19 June 2002 06 UTC and 20 June 2002 06 UTC.

LM, 7 km



Forecast 19 June 2002 00 UTC.

Observations



895 rain gauges

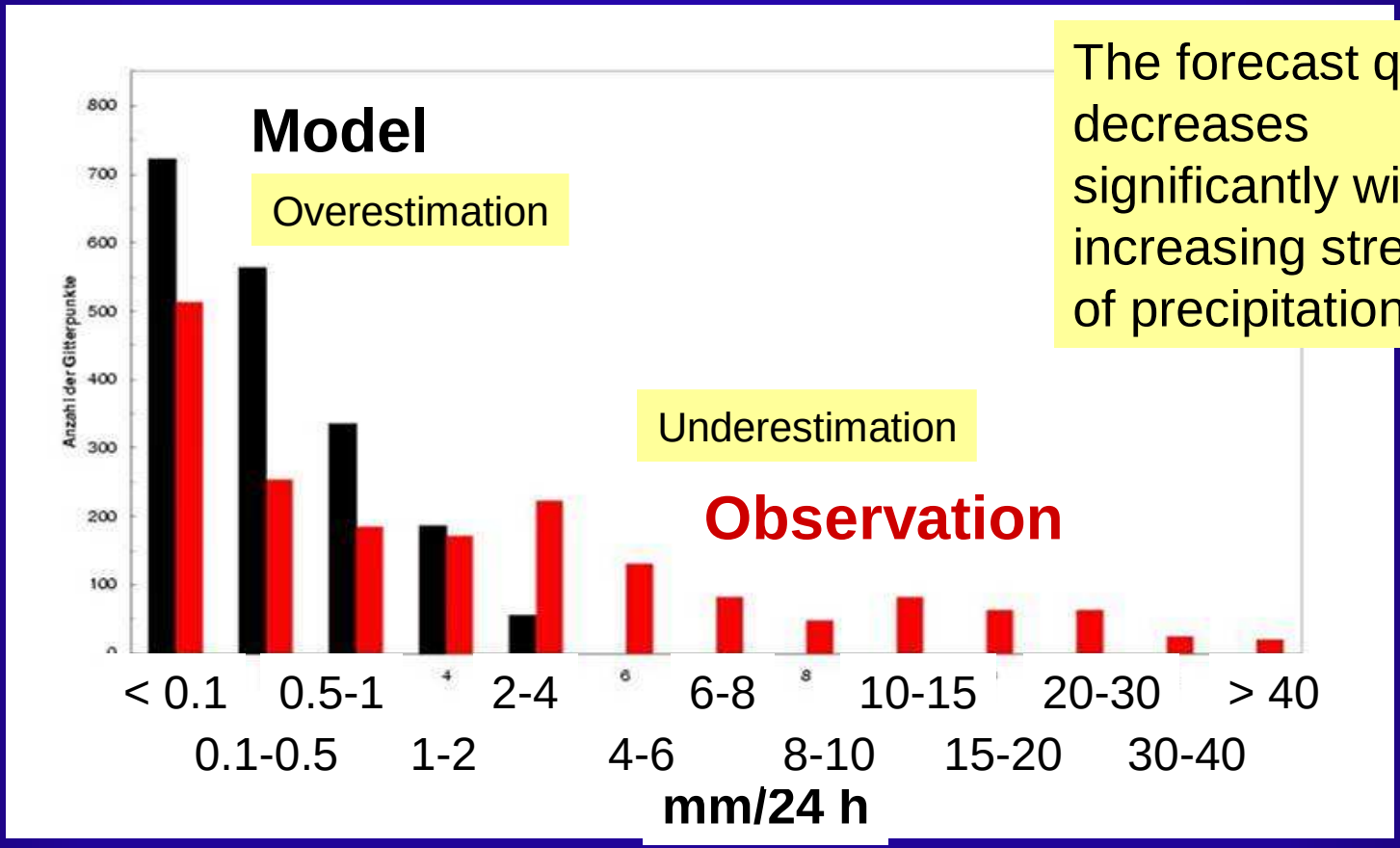
Typical forecast errors:

- **intensity distribution too smooth (in both space and time)**
- **Luv/lee effects**
- **CI too early (2-3 h)**

(Eisenmann, 2004)

Typical Model Deficiencies

24-hour precipitation between 19 June 2002 06 UTC and 20 June 2002 06 UTC.

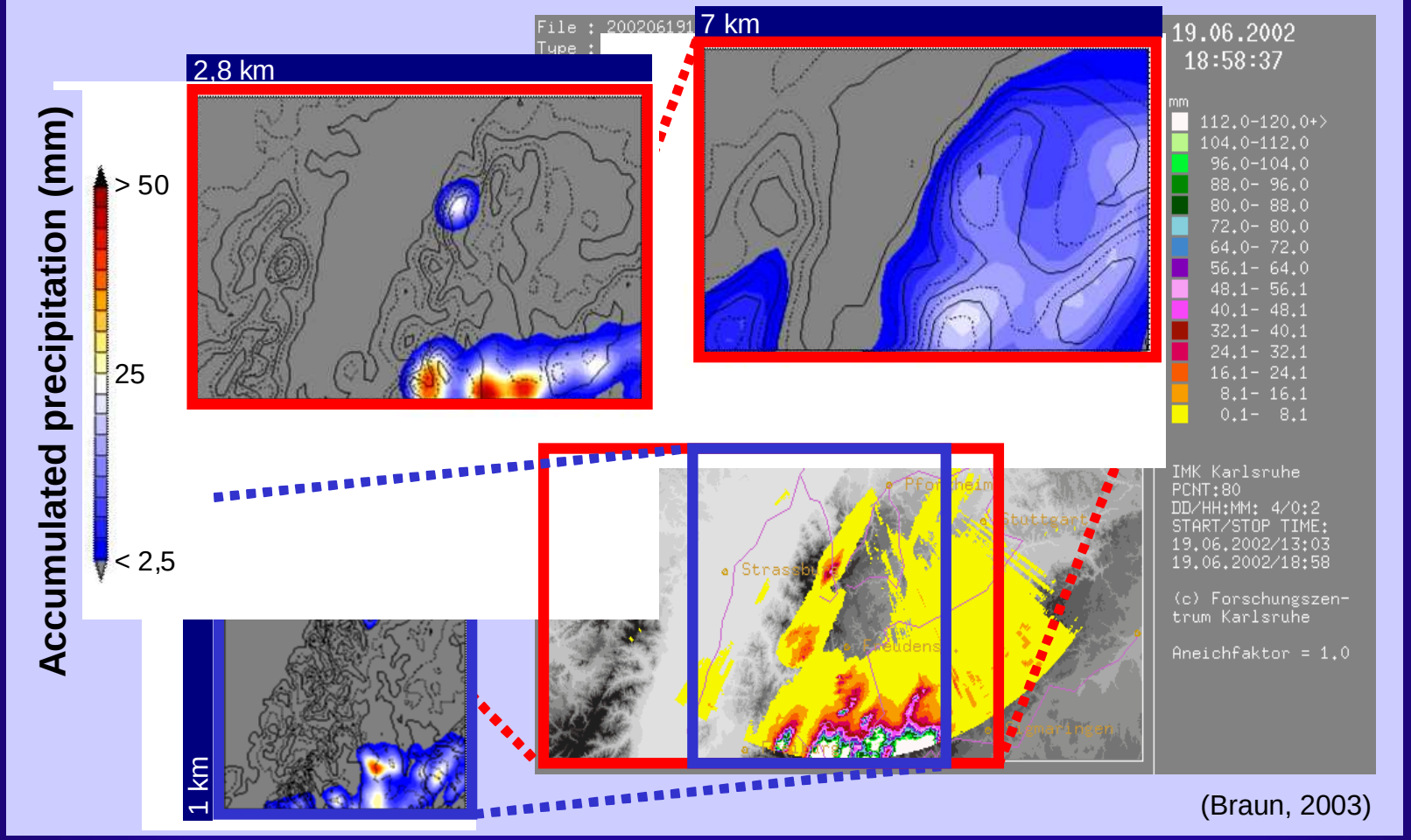


The forecast quality decreases significantly with increasing strength of precipitation!

(Eisenmann, 2004)

Typical Model Deficiencies

Precipitation forecasts with different Lokalmodell (LM) versions 19 June 2002



(Braun, 2003)

„With higher model resolutions better forecast of CI location and time but still large deviations in precipitation location and amount.“

COPS Science Hypotheses

... to be refined.

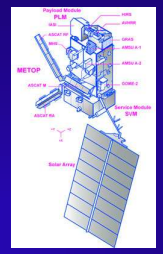
- **Detailed knowledge of the large-scale conditions is a prerequisite for improving QPF in orographic terrain.**
- **Better understanding and high-resolution modeling of the orographic controls of convection is essential.**
- **Initiation of convection depends mainly on the structure of the humidity field in the PBL.**
- **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.**
- **Novel instrumentation during COPS can be designed so that parameterizations of sub-grid processes in complex terrain can be improved.**
- **Real-time data assimilation of key prognostic variables such water vapor and dynamics is routinely possible and leads to a significant better short-range QPF.**

Instrumentation

... partly applied for the first time

11 aircrafts, helicopter, Zeppelin NT
4 airborne H2O lidars
4 airborne wind lidars
3 airborne cloud radars

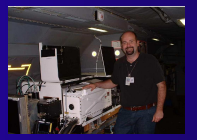
> 100 Letters of interest



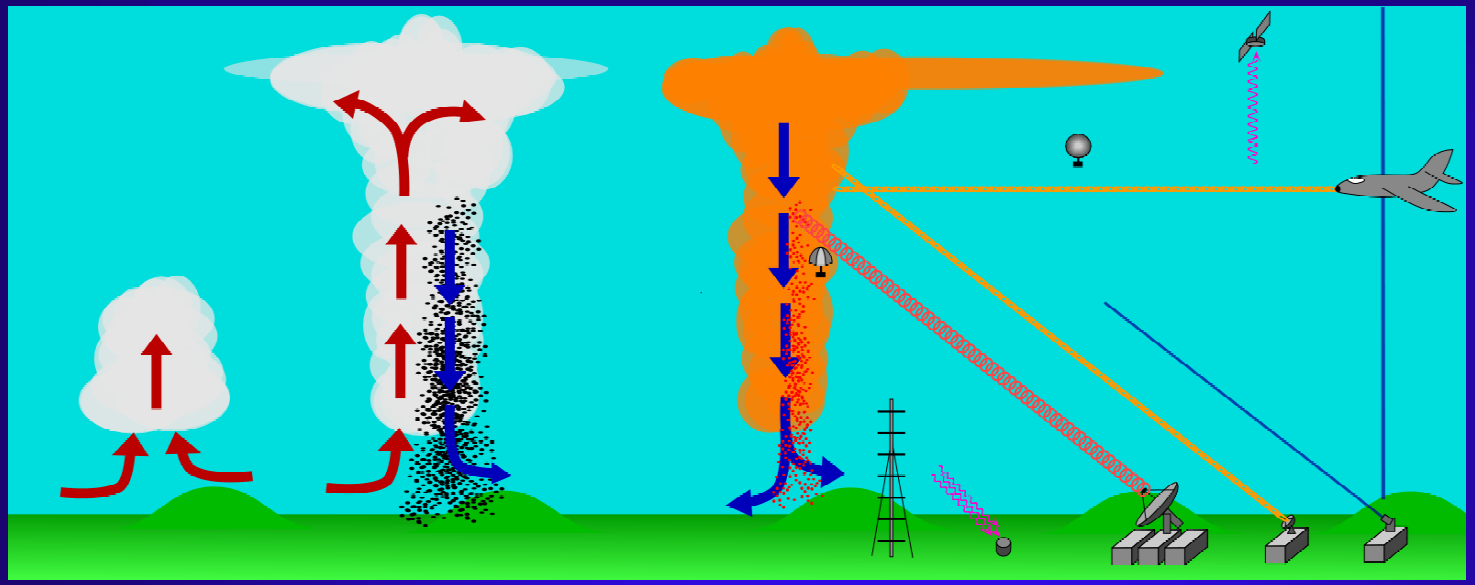





Large suite of in-situ sensors on different platforms
Aerosol and cloud microphysics instrumentation
Large suite of ground-based instruments
New space borne sensors (e.g. IASI, Cloudsat/CALIPSO, MSG)
and new platforms (e.g. HIAPER)

Proposed synergy of observing systems



Weather radars

X-, C- or S-band,
$\lambda \approx 3$–10 cm, $\nu \approx 10$–3 GHz,
⇨ Reflectivity, velocity, refractivity

Cloud radars

Ka- or W-band
$\lambda \approx 3$–9 mm, $\nu \approx 100$–35 GHz
⇨ Reflectivity, velocity in clouds, depolarization δ

Lidars

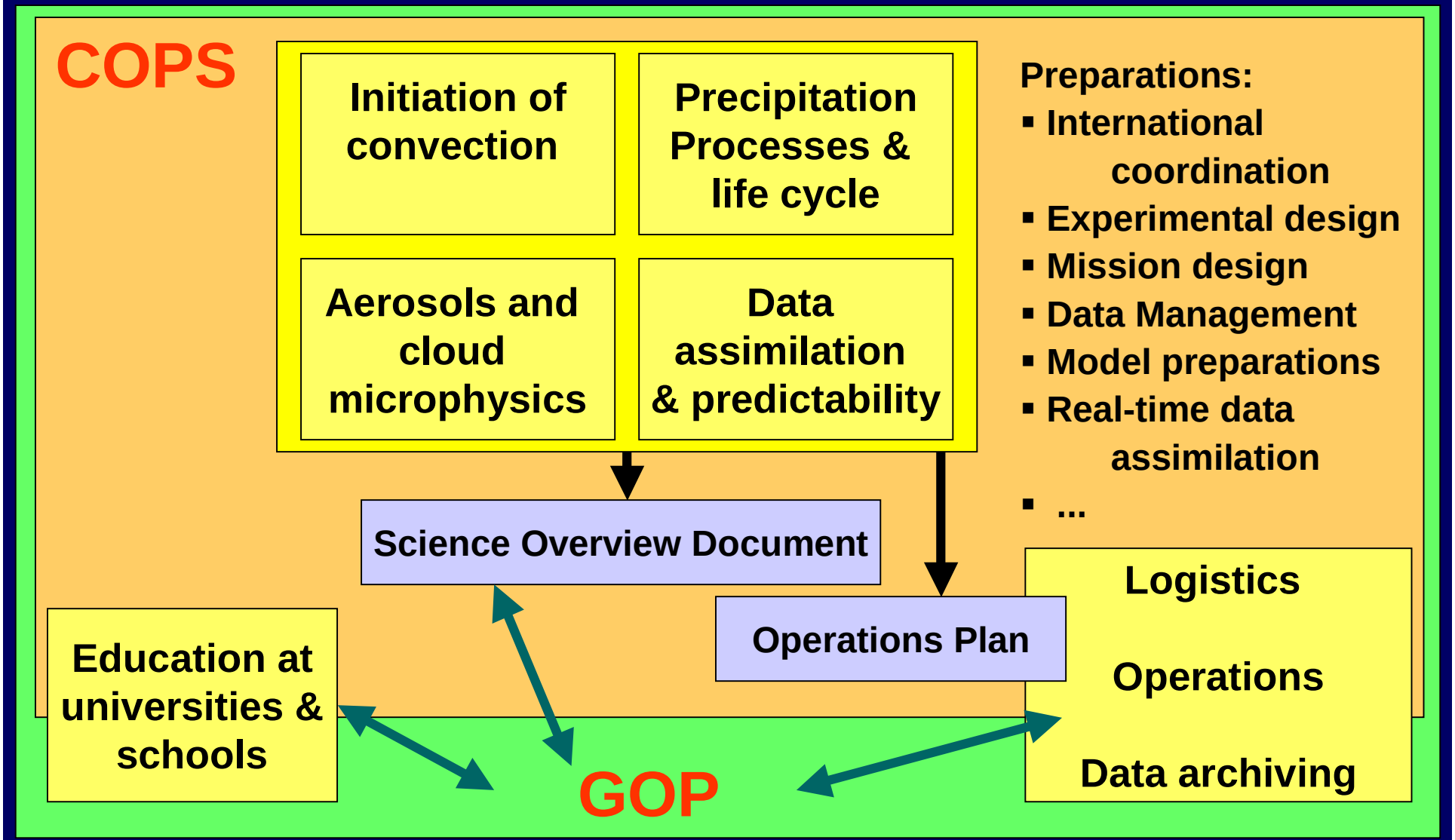
$\lambda \approx 0.3$–2 μm, $\nu \approx 10^{15}$–1.5×10^{14} Hz
⇨ α_{par}, β_{par}, depol. δ, q, T, velocity in clear air, properties of aerosols and thin clouds

Microwave and FTIR radiometers

⇨ LWC, q, T, ...

The full potential of synergetic measurements is not explored yet, e.g.:
- R_{eff} in clouds using lidar and cloud radar (Donovan et al. 2001)
- Cloud condensation nuclei using lidar, cloud radar and microwave radiometer (Feingold et al. 1997)

Suggestion for Structure of „COPS & GOP“ Proposal to be Submitted at DFG



COPS visions

If the proposals will be funded, we can:

- **Understand the 3-d development of convection**
- **Separate model errors due to initialization and parameterization**
- **Improve the skill of short-range QPF, e.g. for applications in hydrology**
- **Investigate the predictability of convective precipitation**

Significant step forward for the understanding of precipitation processes.