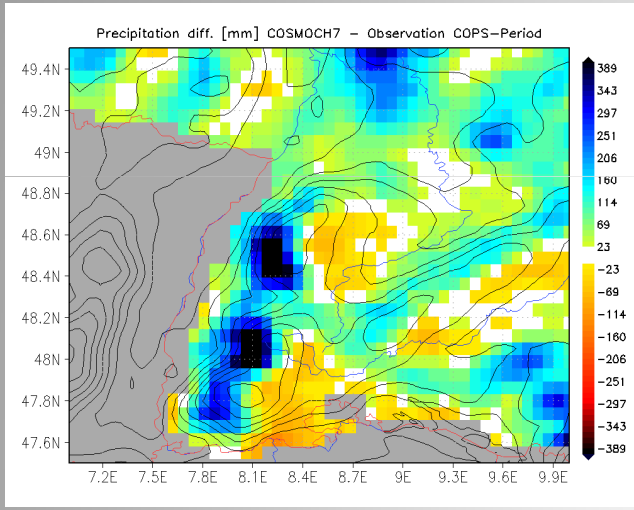
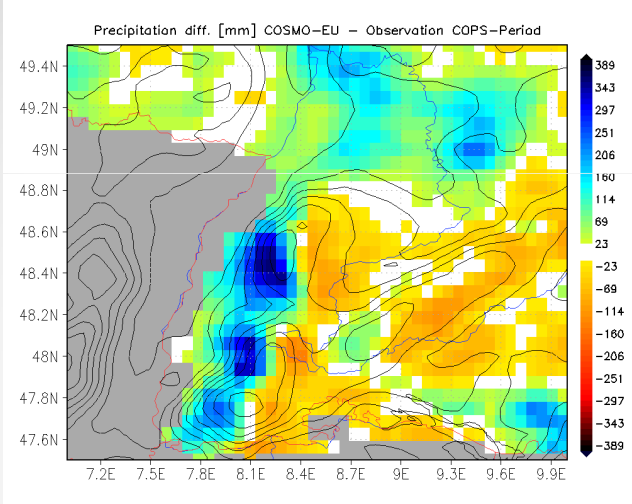
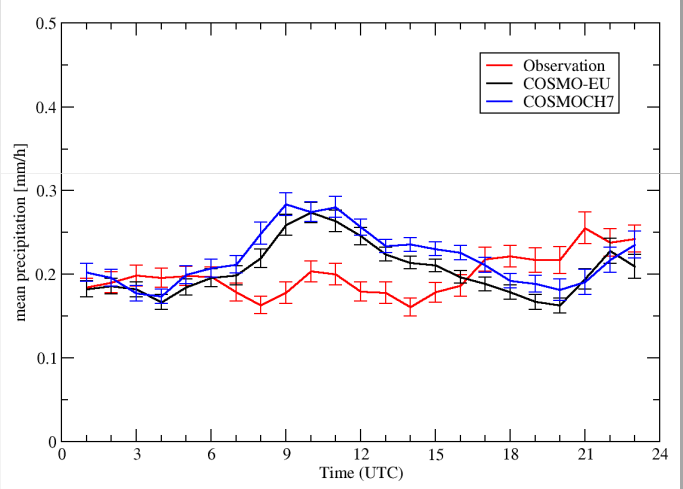
# One Year After COPS:
# The Paramount Scientific Issues



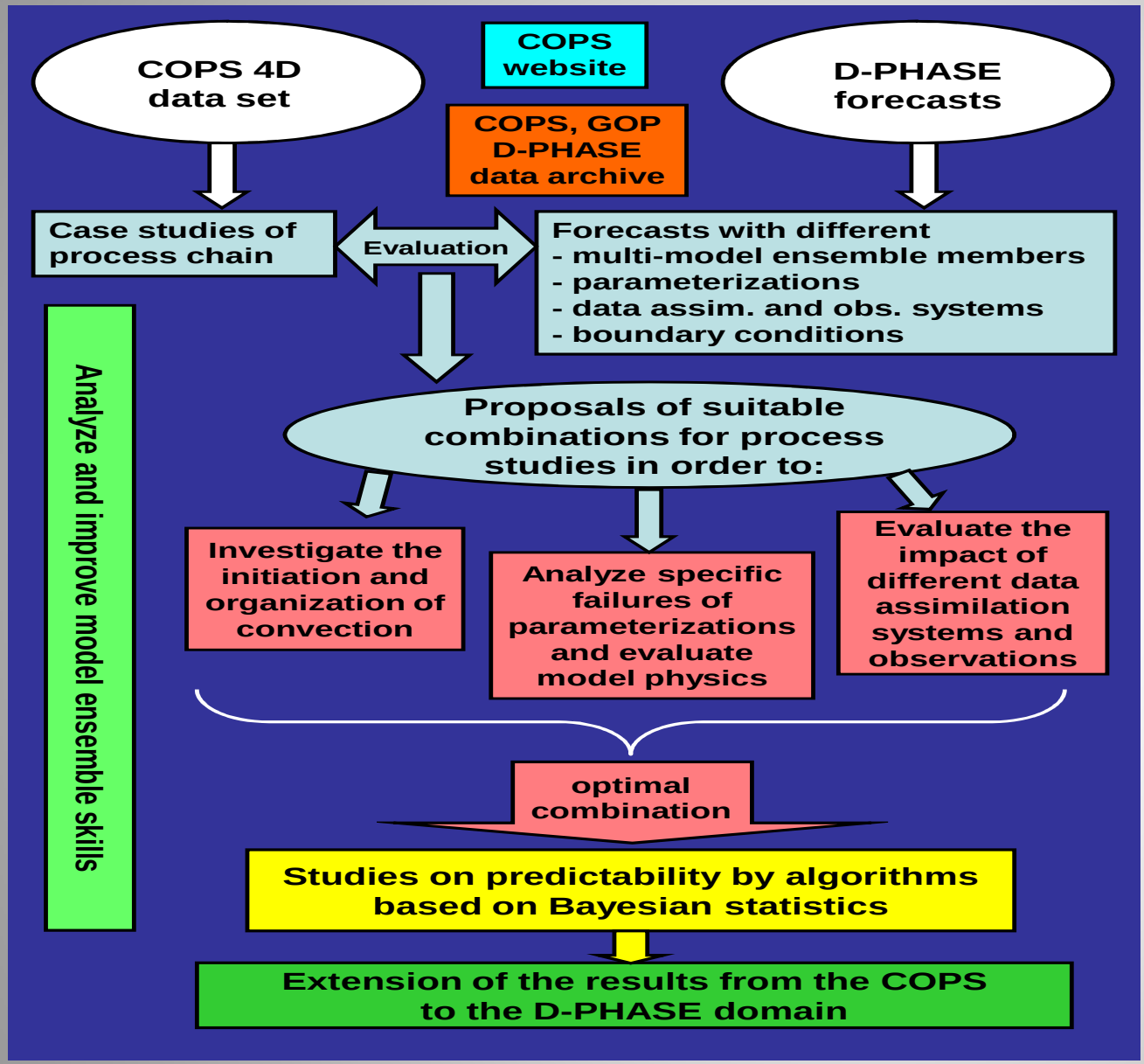




**Task of COPS: Identify and separate errors due to resolution and numerics, model physics, and initial conditions**

- **Overarching research strategy**
- **First highlights**
- **COPS science questions**
- **Suggestions and outlook**

# Overarching Research Strategy

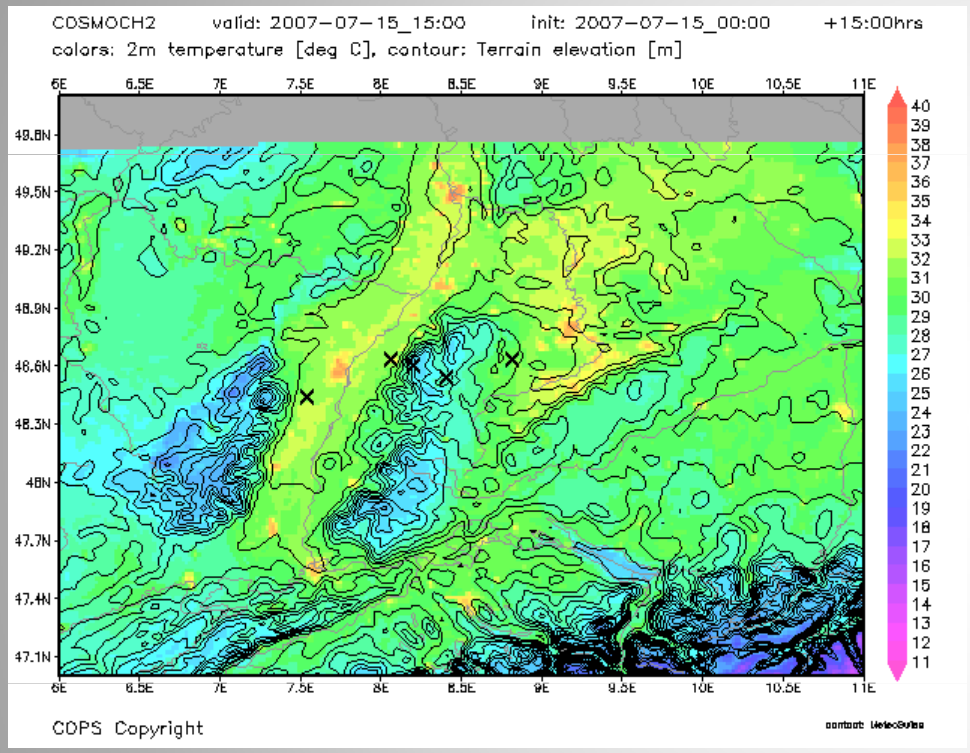


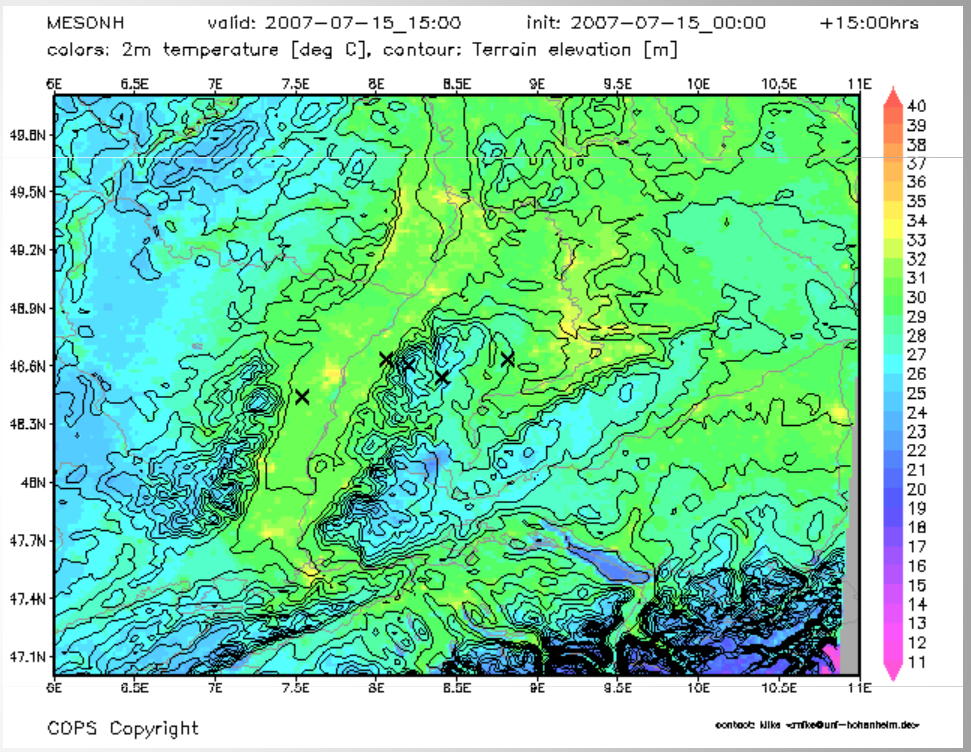

## Key aspects:

- Unique data set for studying the process chain
- Interplay between case studies and evaluation of (pre)operational models
- Demonstrate positive impact of improved process understanding and/or data assimilation efforts on QPF
- Define and quantify predictability

# Improved Process Understanding Based on Case Studies

## IOP 8b, surface temperature, 15 UTC, COSMO-2 and MESO-NH

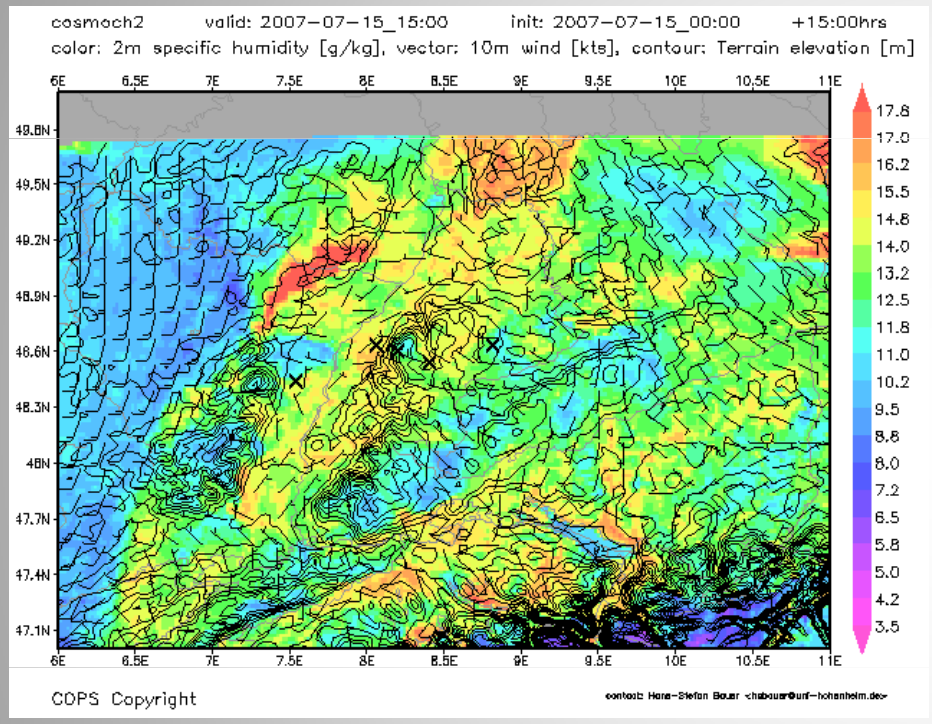


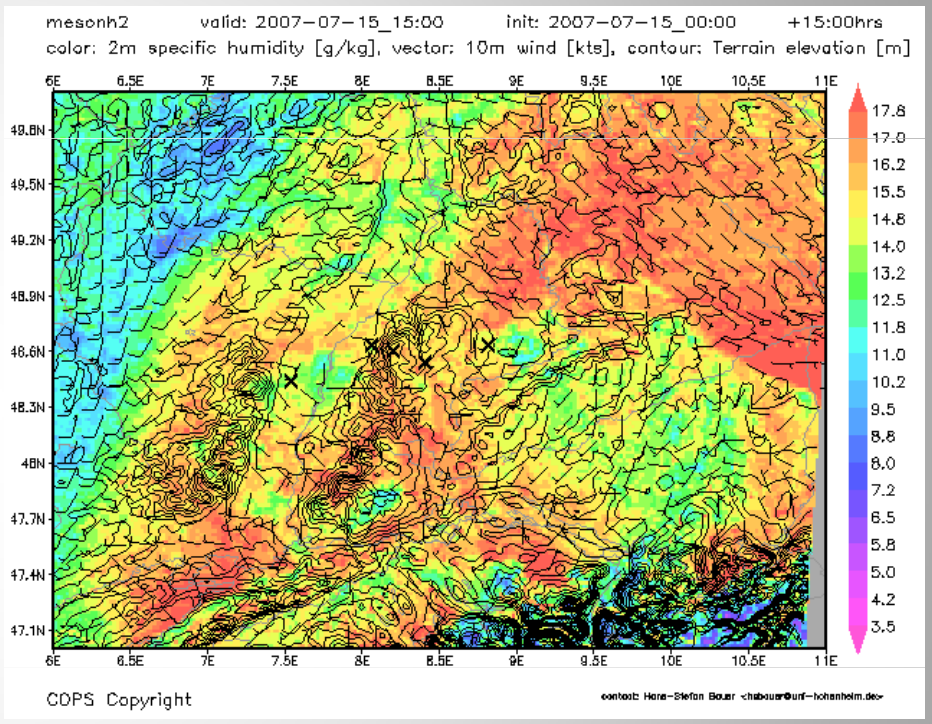




- Significant differences also seen in surface fluxes and soil moisture
- Important impact on resulting thermally induced slope flows

# Improved Process Understanding Based on Case Studies

## IOP 8b, water-vapor and wind fields, 15 UTC

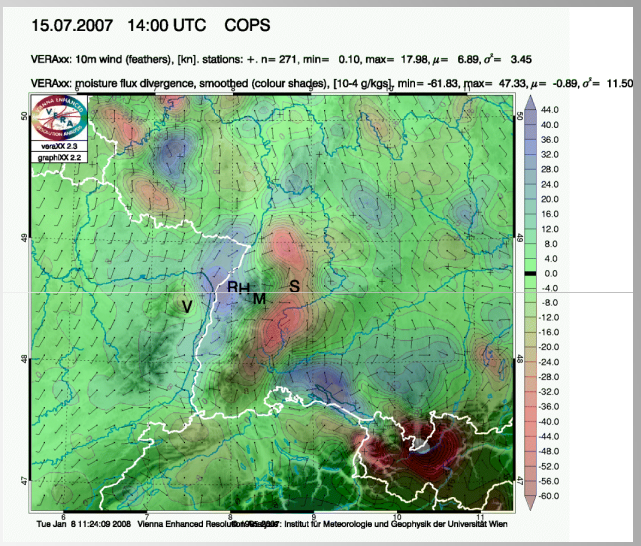



**Huge difference in moisture fields but generally high-resolution models too moist in ABL (see also GOP results)**

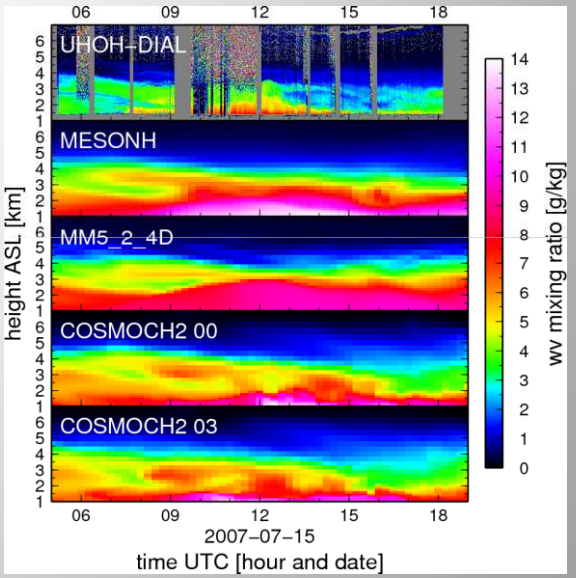
# Key Results on CI

- Thermally induced slope flows and resulting orographically induced convergence very critical.
- Important role of vertical exchange over valleys.




However, more comprehensive picture needs to be developed by synergetic use of observations and analysis tools.

- Simulation of water cycle still a key problem in mesoscale modeling.

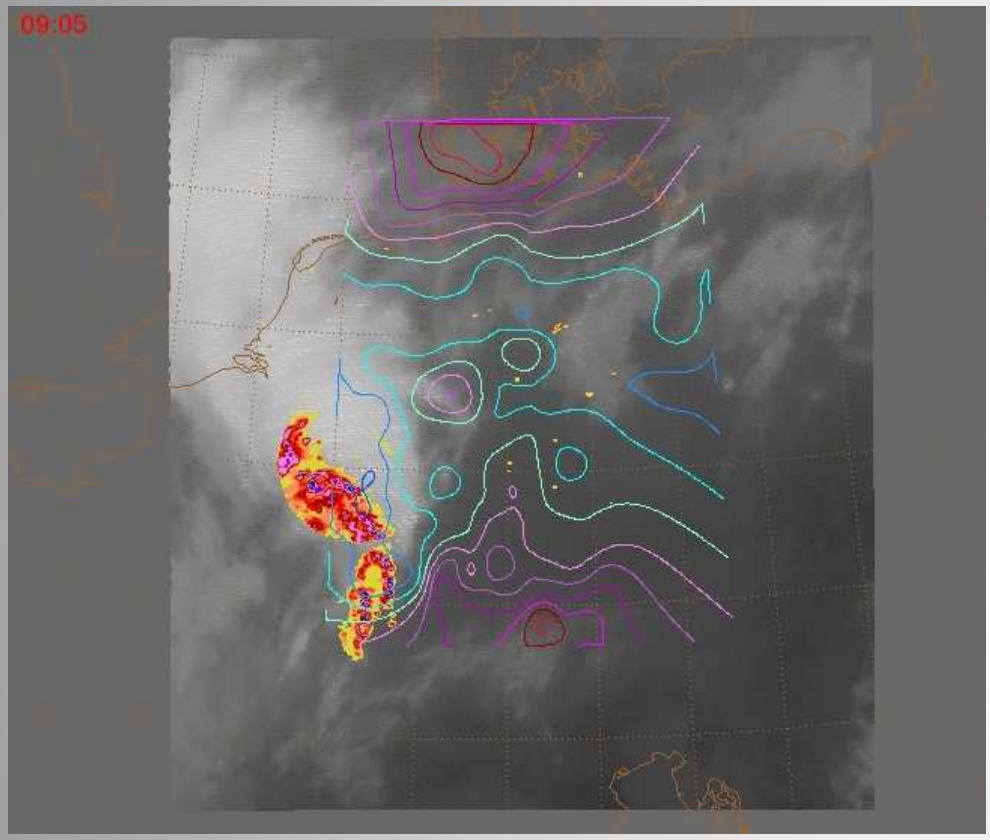


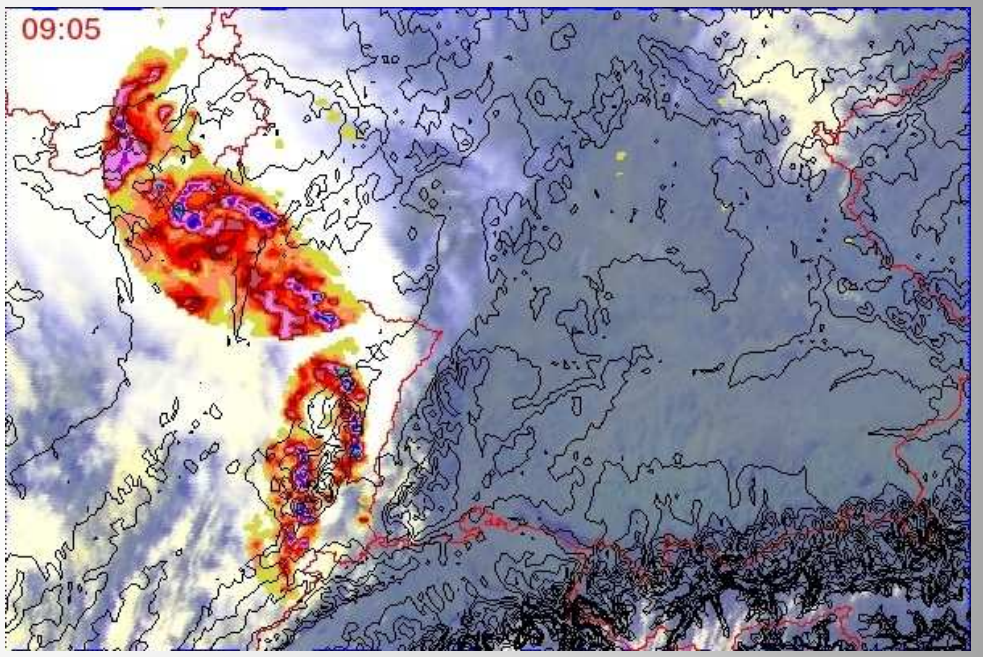

Wind observations, GPS, lidar, and soundings need to be combined for more detailed studies.

It needs to be quantified how accurate the detected processes are simulated and how critical these processes are for improving QPF.

# Important Data Sets and Tools

**Data overlays, e.g., IOP 9c**

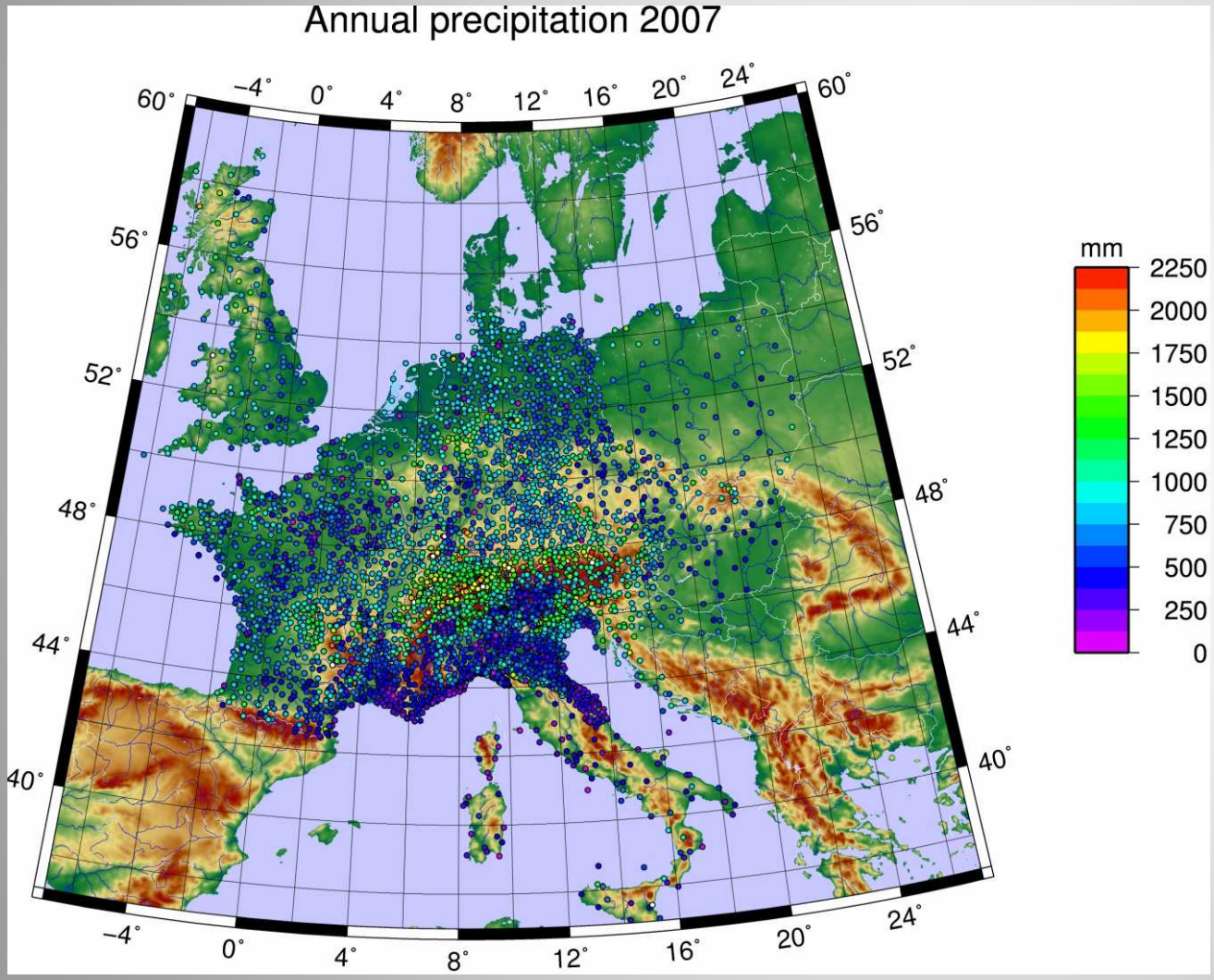


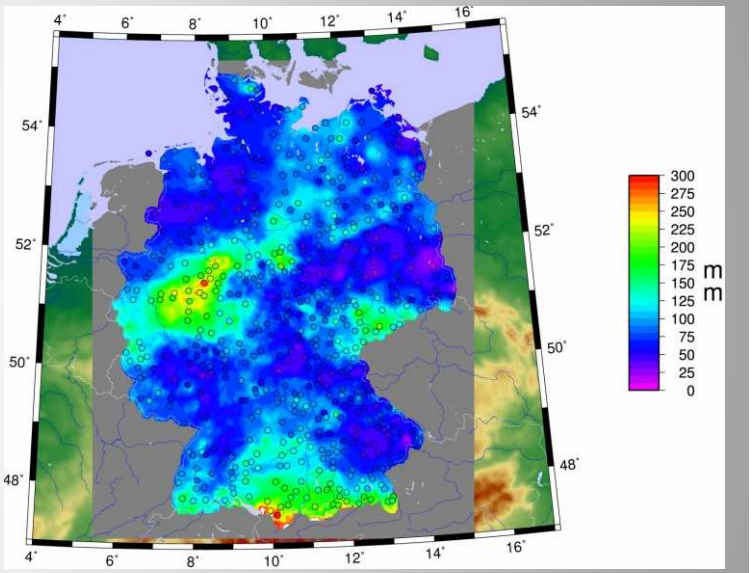




**Data sources: GPS IWV, MSG all channels, radar reflectivity composites, VERA in comparison with D-PHASE model outputs.**

# Important Data Sets and Tools

## The COPS-D-PHASE precipitation data set



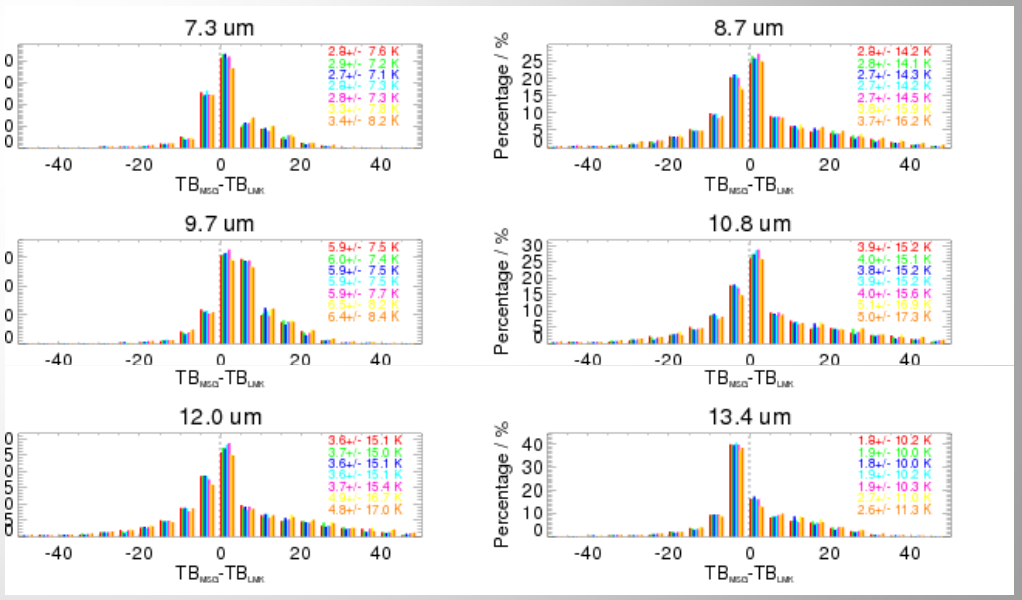



# Key Results on ACM and PPL

- Model evaluation with AMF, airborne data, and ground-based remote sensing data ongoing.
- New methodologies and sensor synergy demonstrated.
- Significant deviations in cloud base (COSMO-DE) detected.
- Strong differences between radiative and microphysical properties found.

Sensor synergy and exploitation of data at different sites required.

**Impact on QPF needs to be quantified.**



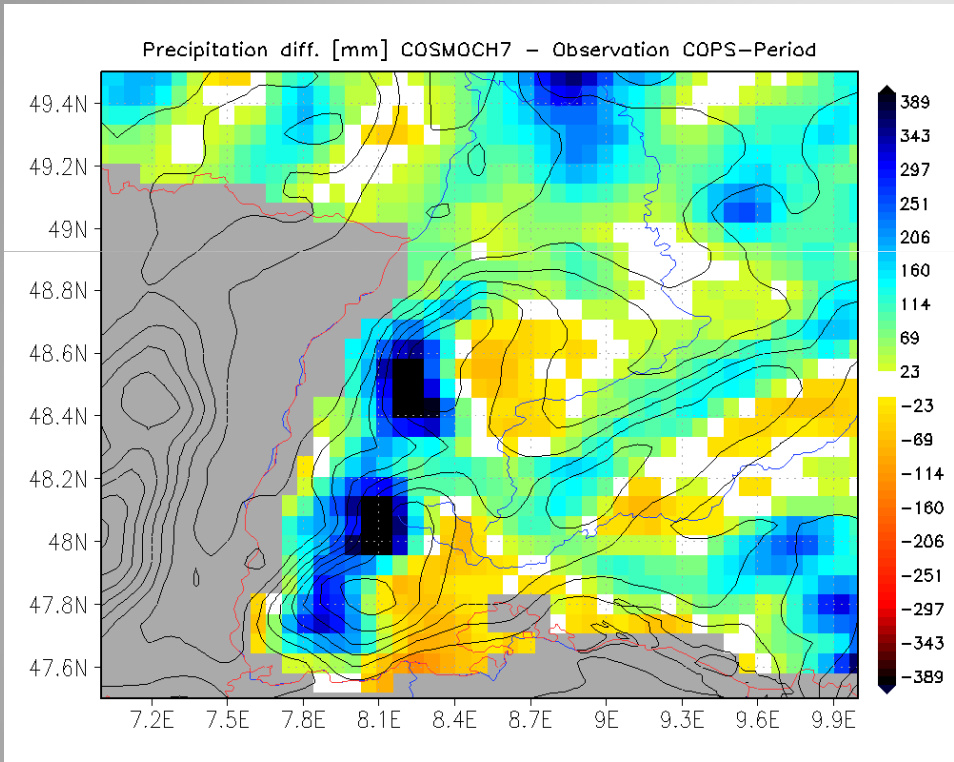

Models need to be applied which are able to simulate aerosol-cloud-precipitation microphysics.

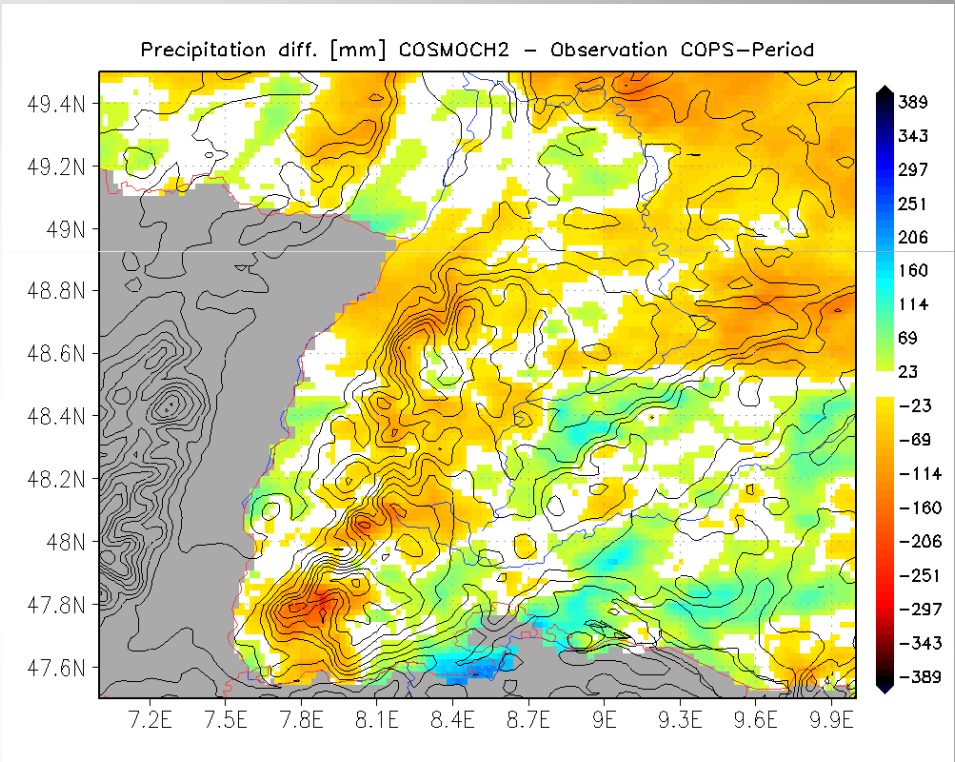
# Key Results on DAP

- Clear improvement of QPF by assimilation of GPS and radar data using
  - latent heat nudging,
  - 3DVAR,
  - and 4DVAR.

- There large room for improvement of QPF by optimizing initial conditions.
- COPS/D-PHASE data assimilation testbed required in order to compare different techniques on the convection-permitting scale.

# Model Evaluation




**Reduction of windward/lee effort in all convection permitting models, improvement of diurnal cycle of precipitation.**

**Focus should be set on airmass convection and organization of convection.**

**Separation between effects of initial conditions and model physics necessary.**

# The COPS Science Questions

? • Upper tropospheric features play a significant but not decisive role for convective-scale QPF in moderate orographic terrain.

☑ • Accurate modeling of the orographic controls of convection is essential and only possible with advanced mesoscale models having a resolution of the order of a few kilometers.

? • Location and timing of the initiation of convection depends critically on the structure of the humidity field in the planetary boundary layer.

? • Continental and maritime aerosol type clouds develop differently over mountainous terrain leading to different intensities and distributions of precipitation.

? • Novel instrumentation during COPS can be designed so that parameterizations of sub-grid scale processes in complex terrain can be improved.

☑ • Real-time data assimilation of key prognostic variables such as water vapor and dynamics is routinely possible and leads to a significant better short-range QPF.

# Suggestions and Outlook

- Joint coordinated work on IOPs through the whole process chain.
- Intensify communication between research groups.
- Use most comprehensive data sets.
- Share tools and methodologies.
- Model toolbox required for sensitivity studies?
- Quantify the impact of upper-tropospheric features and large-scale effects in collaboration with ETReC07 and TIGGE.
- Develop strategies for studying parameterizations with the COPS data set.

Duration of most COPS projects: summer 2010

Continue scientific work on international level (e.g., ESF)
or by a combination of national activities?