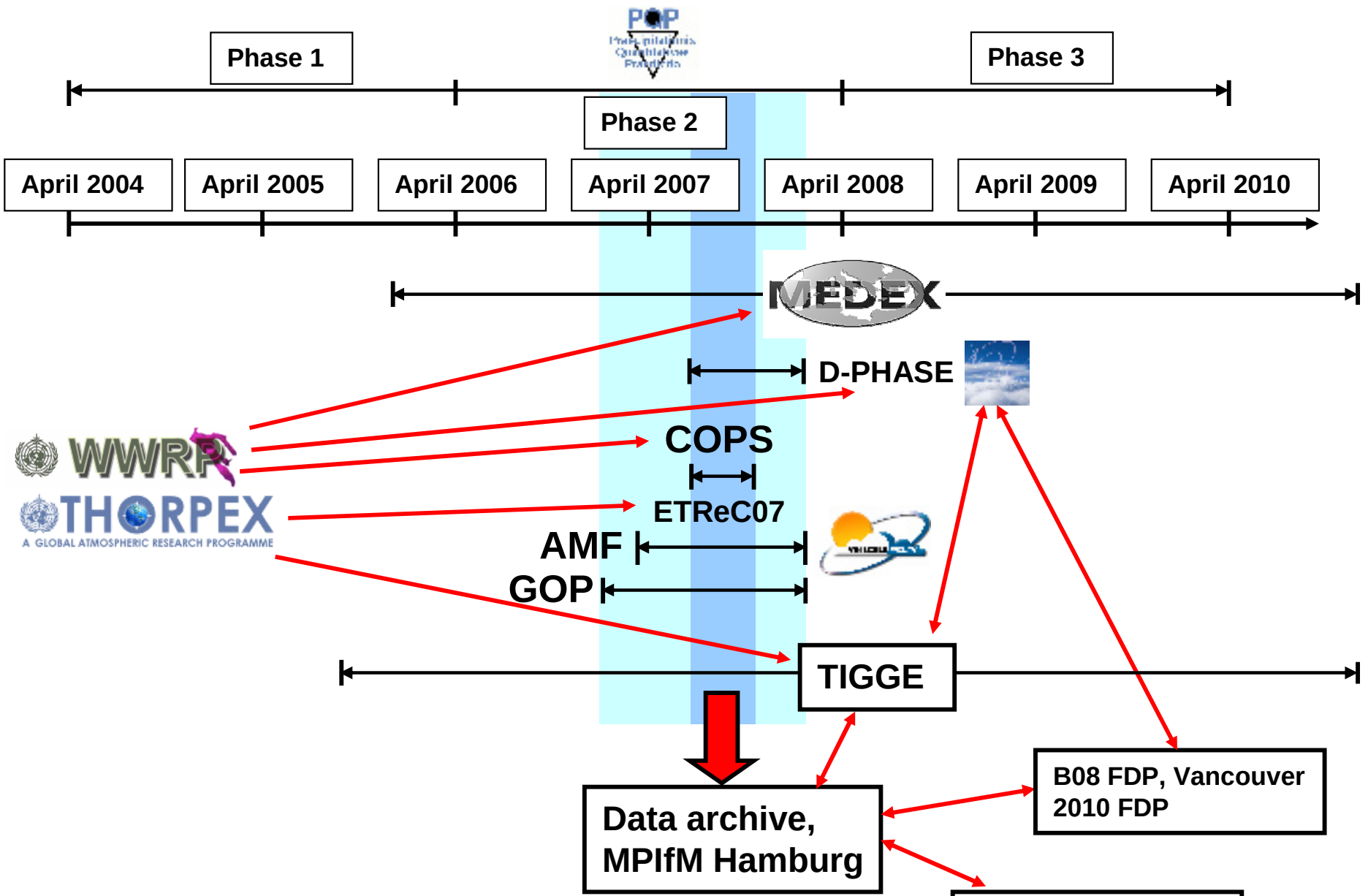
COPS Status

Volker Wulfmeyer and Andreas Behrendt
Institute of Physics and Meteorology (IPM)
University of Hohenheim, Stuttgart, Germany
and the COPS ISSC and WG Chairs

With updates.
AB, 11 October 2006

- **International collaboration**
- **Experimental design**
- **Mission design**
- **Operations**
- **Expectations**

Coordination of QPF Research Programs



EUMETSAT

MeteoSchweiz

METEO FRANCE

DWD

ECMWF

ARM

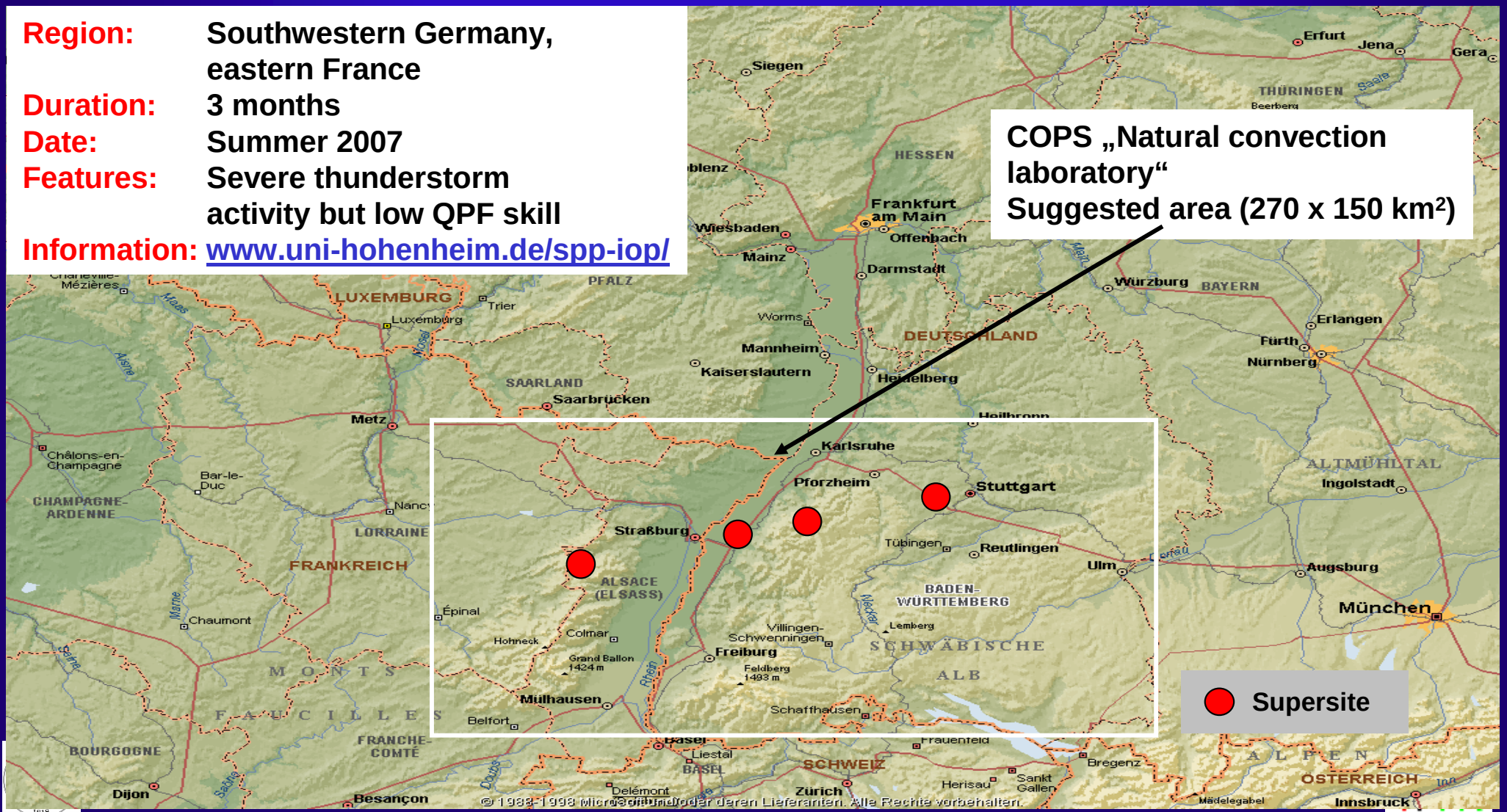
COPS (Convective and Orographically-induced Precipitation Study)

A field experiment within the German QPF Program PQP

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

PQP Praecipitationis Quantitativae Praedictio

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/



COPS Preparation

Example: MM5 high-resolution modeling study of June 19, 2002 (6-18 UTC)

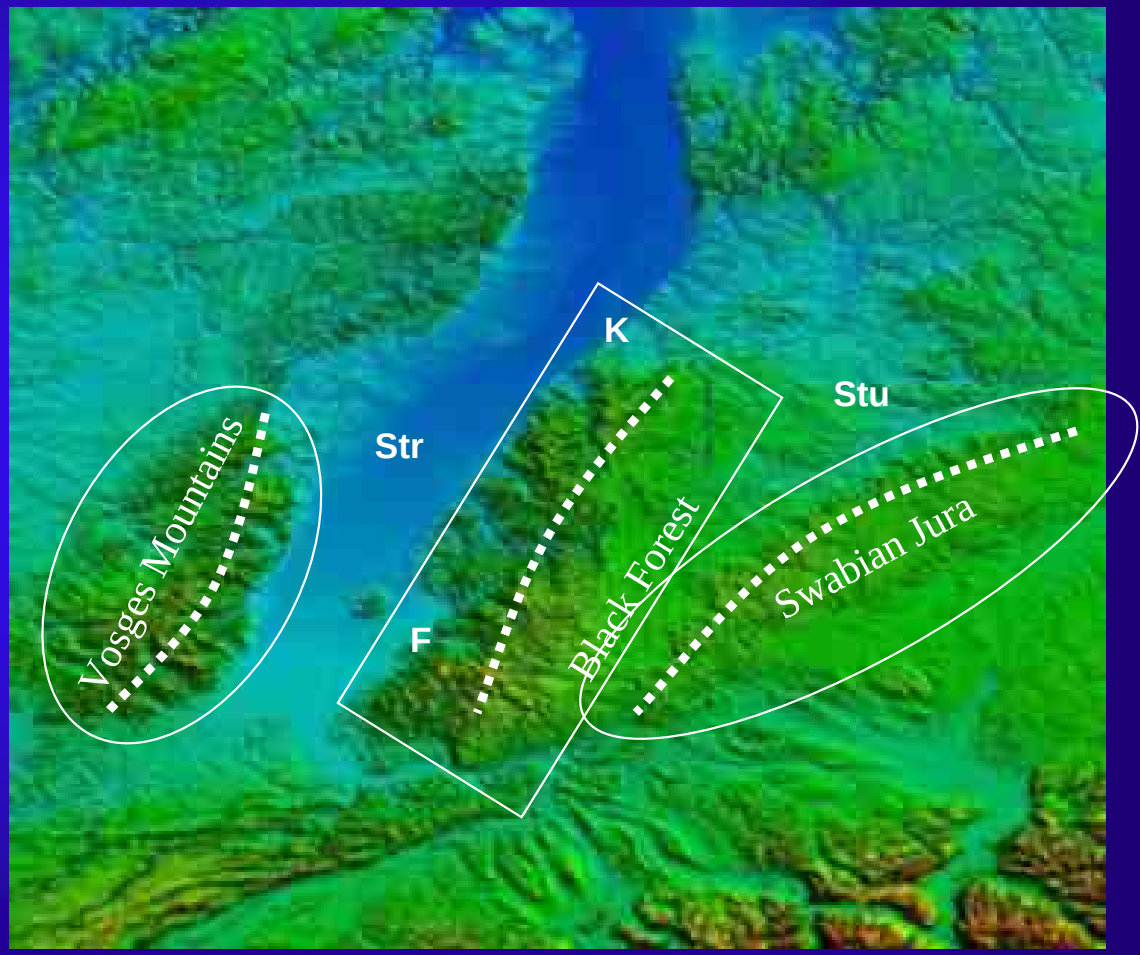
Events with large amounts of precipitation are mainly

- forced/frontal: Convection imbedded in frontal line

- forced/non-frontal: synoptic-scale ascent, but no surface front

- air mass convection (non-forced/non-frontal)

Example: forced/non-frontal



COPS Preparation

Example: MM5 high-resolution modeling study of June 19, 2002 (6-18 UTC)

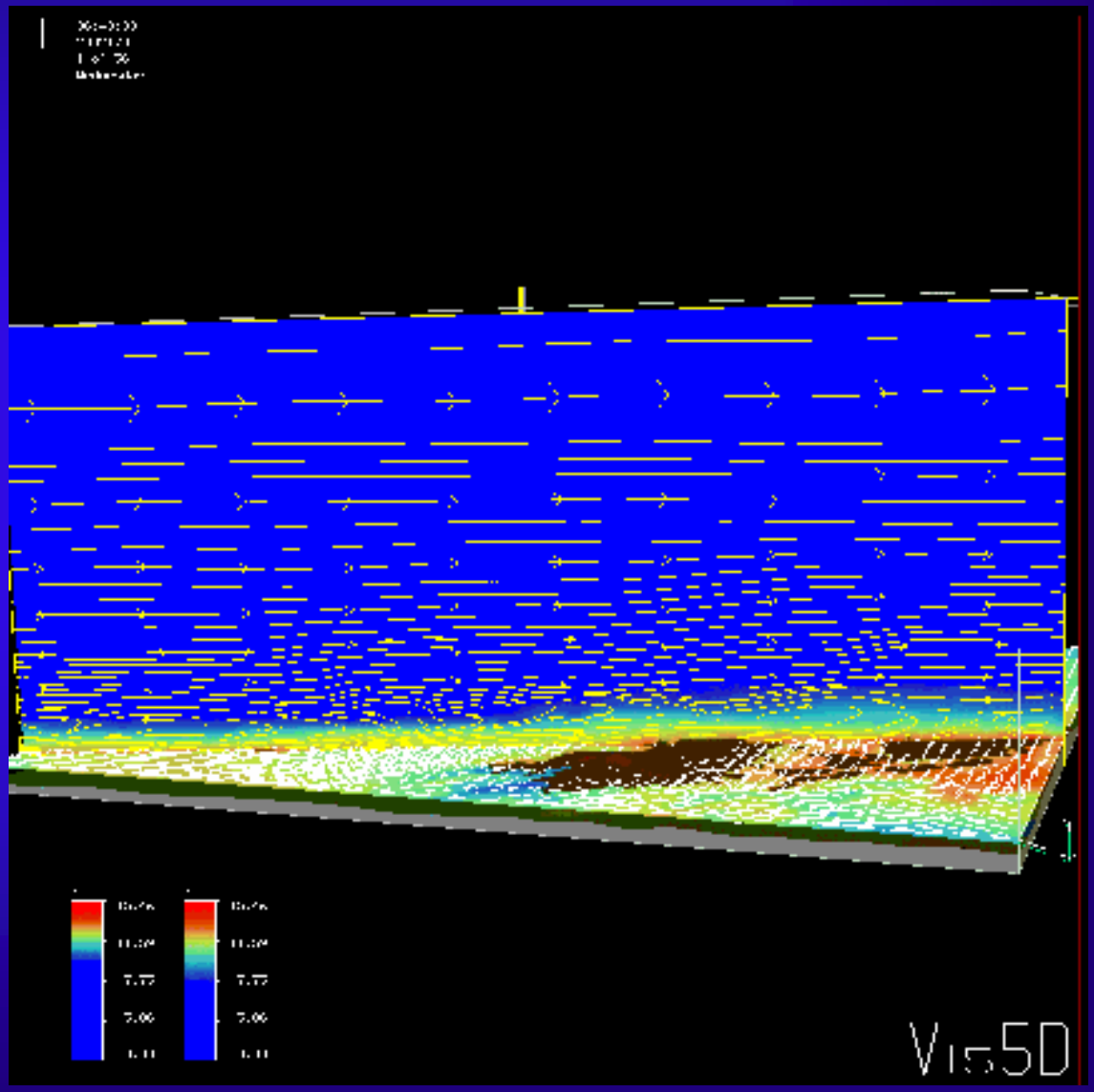
Phase 1: Pre-convection

Phase 2: Convection initation, cloud formation considering aerosol-cloud interaction

Phase 3: Development of convection, onset of precipitation

Phase 4: Maintenance and decay of precipitating system

Simultaneous large-scale and small-scale synergetic 4D observations of key variables.



Boundary layer temperature, water-vapor mixing ratio, wind, cloud, and precipitation fields.

Observing strategy

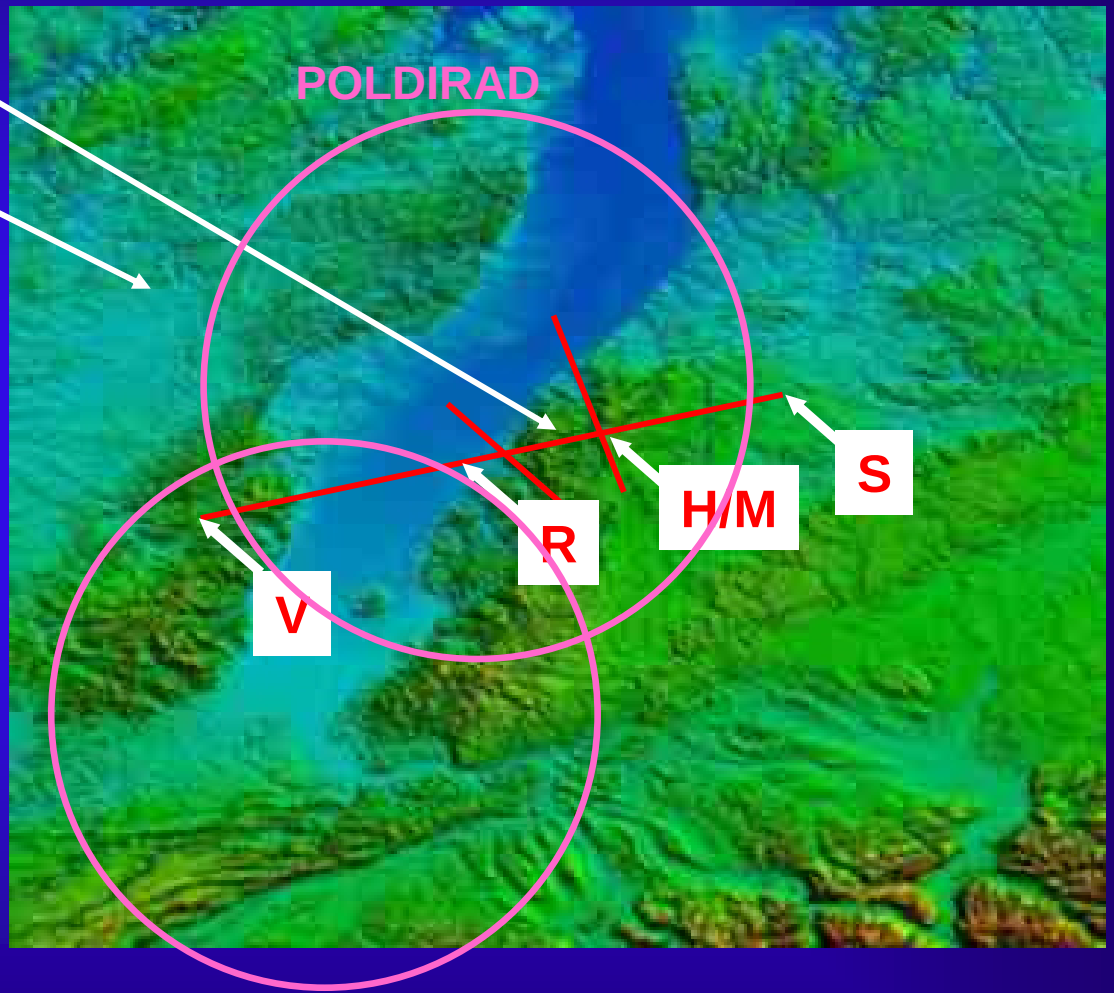
Transect with supersites

Optimization of radar coverage

Large-scale and mesoscale observations provided by DLR Falcon aircraft.

Regional observations between supersites performed by Do-128 and Safire F20.

Cloud microphysics with UK BAE 146.



S-POLKa Proposal Situation

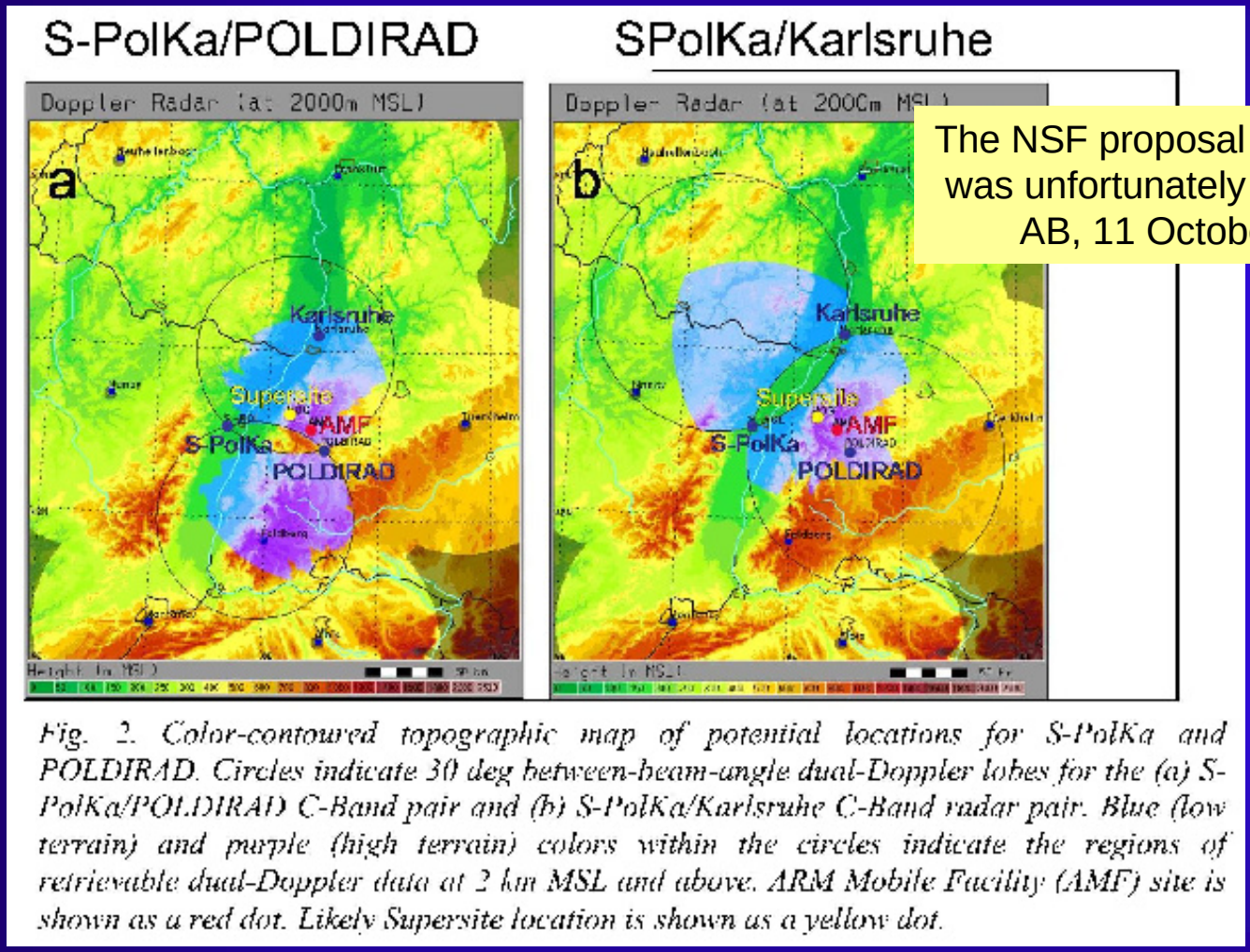
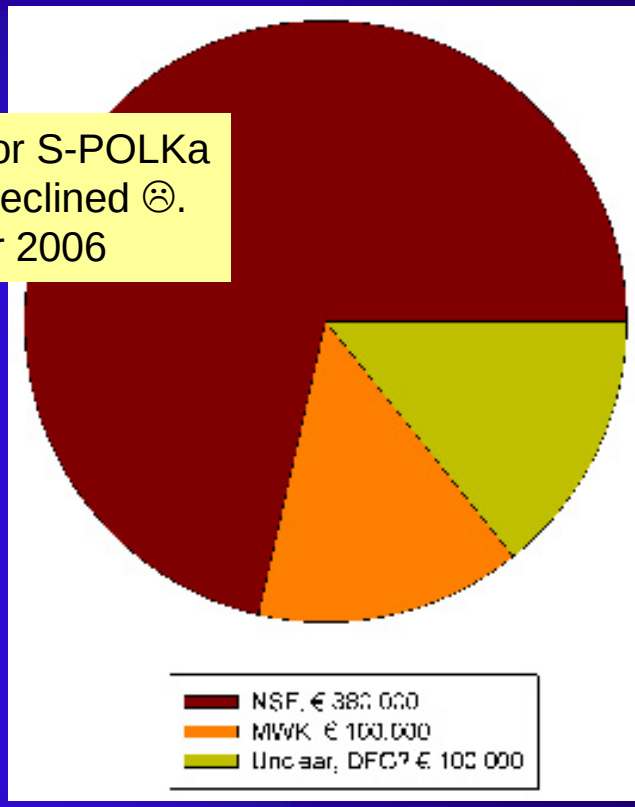


Fig. 2. Color-contoured topographic map of potential locations for S-PolKa and POLDIRAD. Circles indicate 30 deg between-beam-angle dual-Doppler lobes for the (a) S-PolKa/POLDIRAD C-Band pair and (b) S-PolKa/Karlsruhe C-Band radar pair. Blue (low terrain) and purple (high terrain) colors within the circles indicate the regions of retrievable dual-Doppler data at 2 km MSL and above. ARM Mobile Facility (AMF) site is shown as a red dot. Likely Supersite location is shown as a yellow dot.

The NSF proposal for S-POLKa was unfortunately declined ☹.
AB, 11 October 2006



Supersites

Lidars
Cloud radars
Precip. radars
Radiometers
Radiosondes
Sodars

M

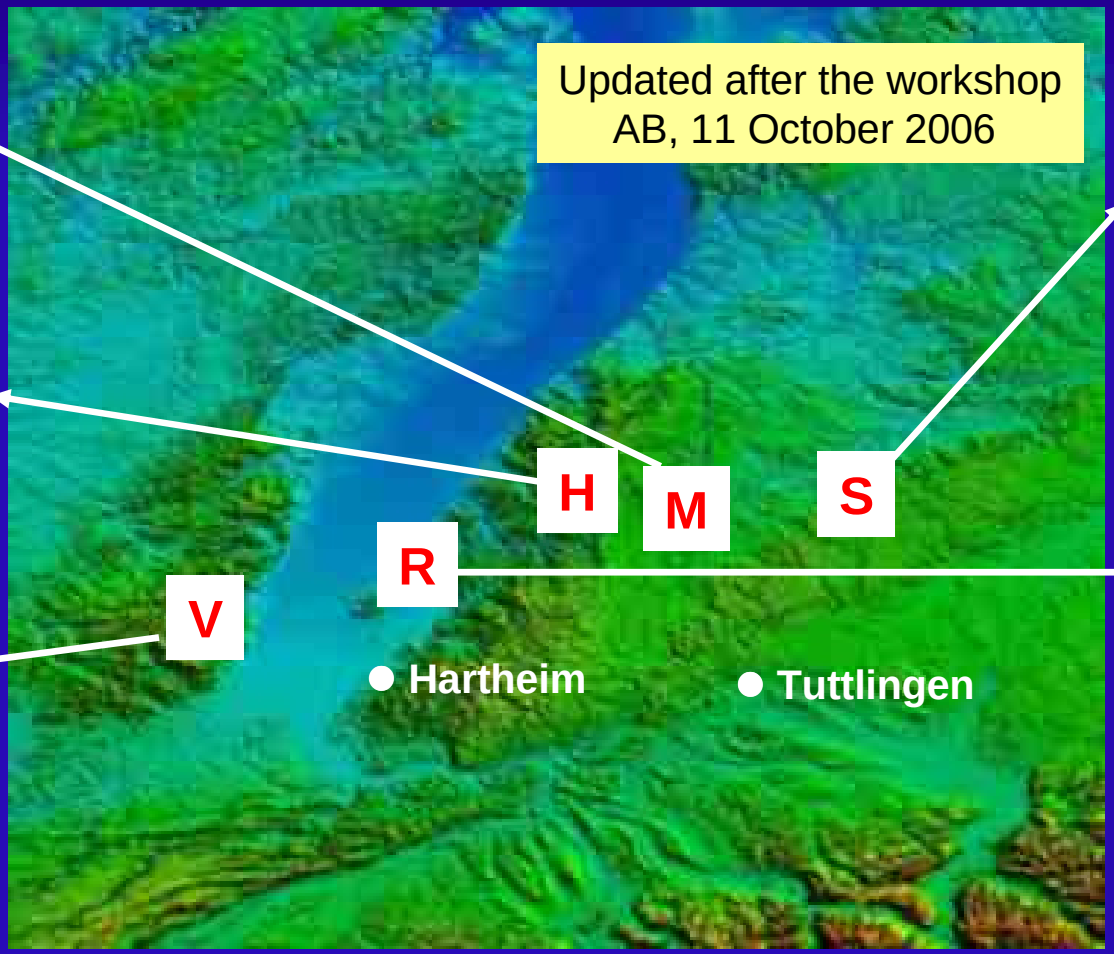
- AMF
  RS, MWR, AERI, RWP, WACR, aerosol in-situ analysis
- HATPRO
- 90/150 GHz
- IfT MWL
- IfT WILI
- UHH MRR

H

- UHOH WV DIAL (scanning)
- UHOH RR Lidar (scanning)
- FZK WindTracer (scanning)
- FZK Cloud Radar (45°scan)
- UHOH X-Band (vertical)
- UK Radiosondes
- UK aerosol in-situ analysis

V

- CNRS WV Raman lidar
- CNRS TRESS =
  Aerosol Raman Lidar
  IR radiometer, sun ph.
- LaMP X-Band (scanning)
- LaMP K-Band (vertical)
- MF Radiosondes
- MF Surf. Flux Stations (3)
- MF soil moisture (1-3)
- MF UHF prof., sodar



S

- FZK WTR
- UV MRR
- UV Radiosondes
- UV Tethersonde
- CNS MW radiometer
  (or at V?)
- UK Doppler (or at V?)

R

- UNIBAS Raman lidar
- UK Doppler lidar
- UK radiometer
- UHH cloud radar
- TARA
- UK Radiosondes
- UK sodar

Black-Forest valley entrances

- FZK and UBT Sodars (entrance of Murg and Kinzig V.)
- UF Sodar (entrance of Rench V.)
- 2 UK sodars (entrance of Nagold V., center of Murg V.)

Transect of MRRs from E to W (UHH)

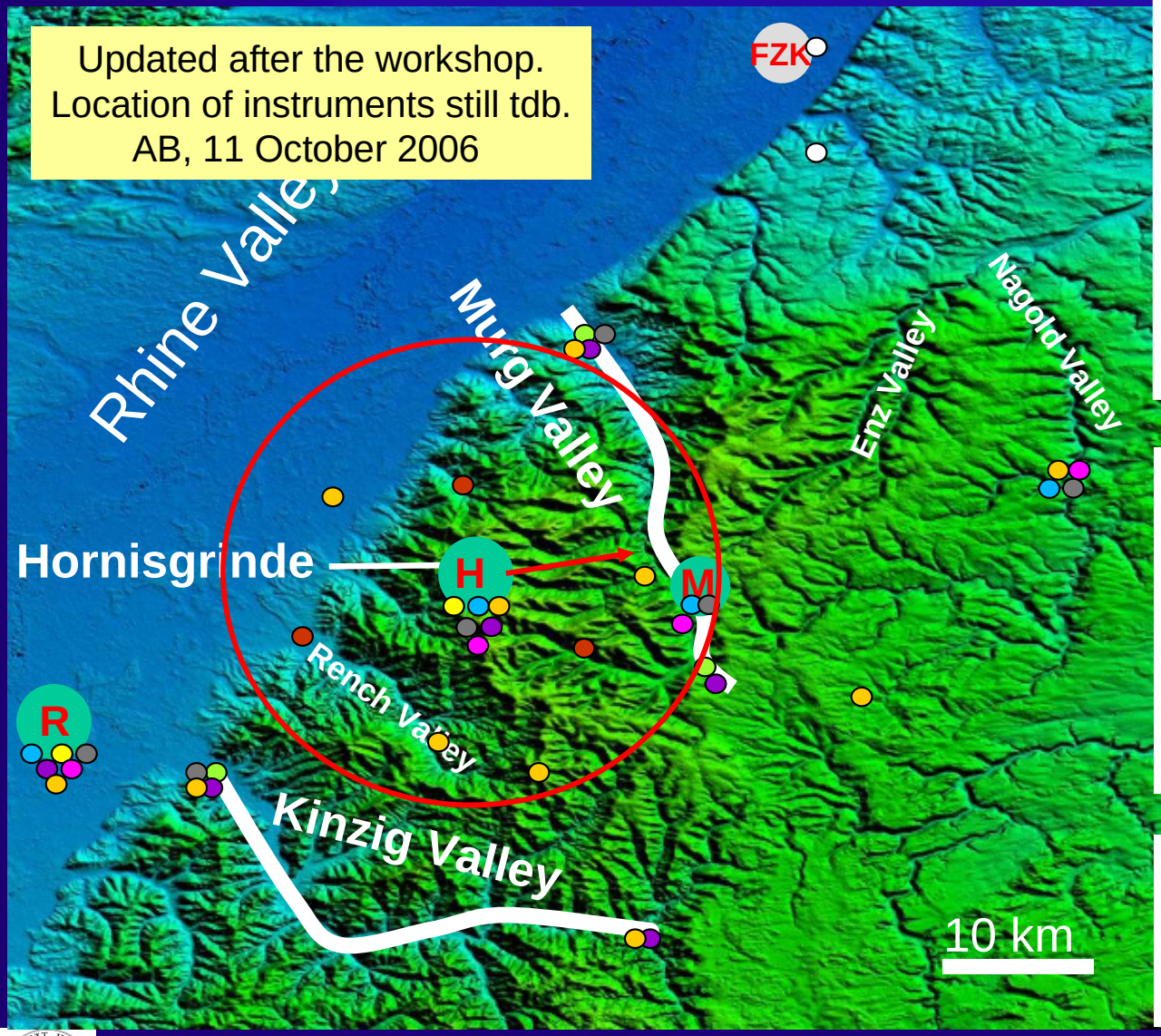
Between S1 and S3

- FZK RS station (mobile)

Rhine valley

- FZK RS station (mobile)

Zoom in view in Northern Black Forest



- Energy balance stations
- Flux stations (turb. towers)
- Radiation turbulence clusters
- Soil moisture sensors
- Mesonet
- Radiosonde stations (RS)
- Sodars
- MRRs
- GPS

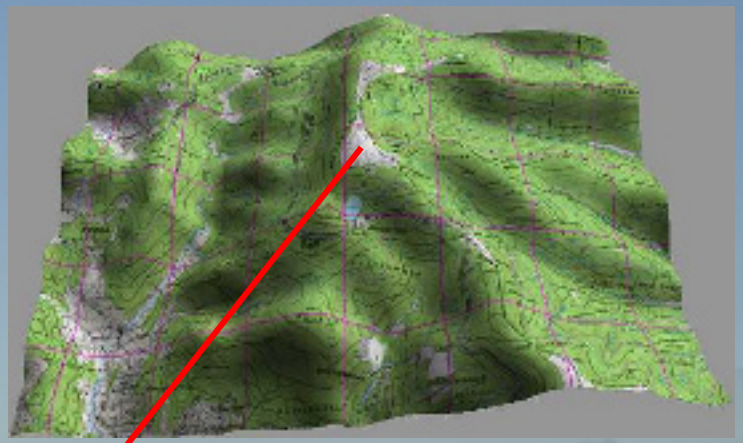
H

UHOH WV DIAL
UHOH RR Lidar
Windtracer
UHOH X-band
FZK cloud radar

M

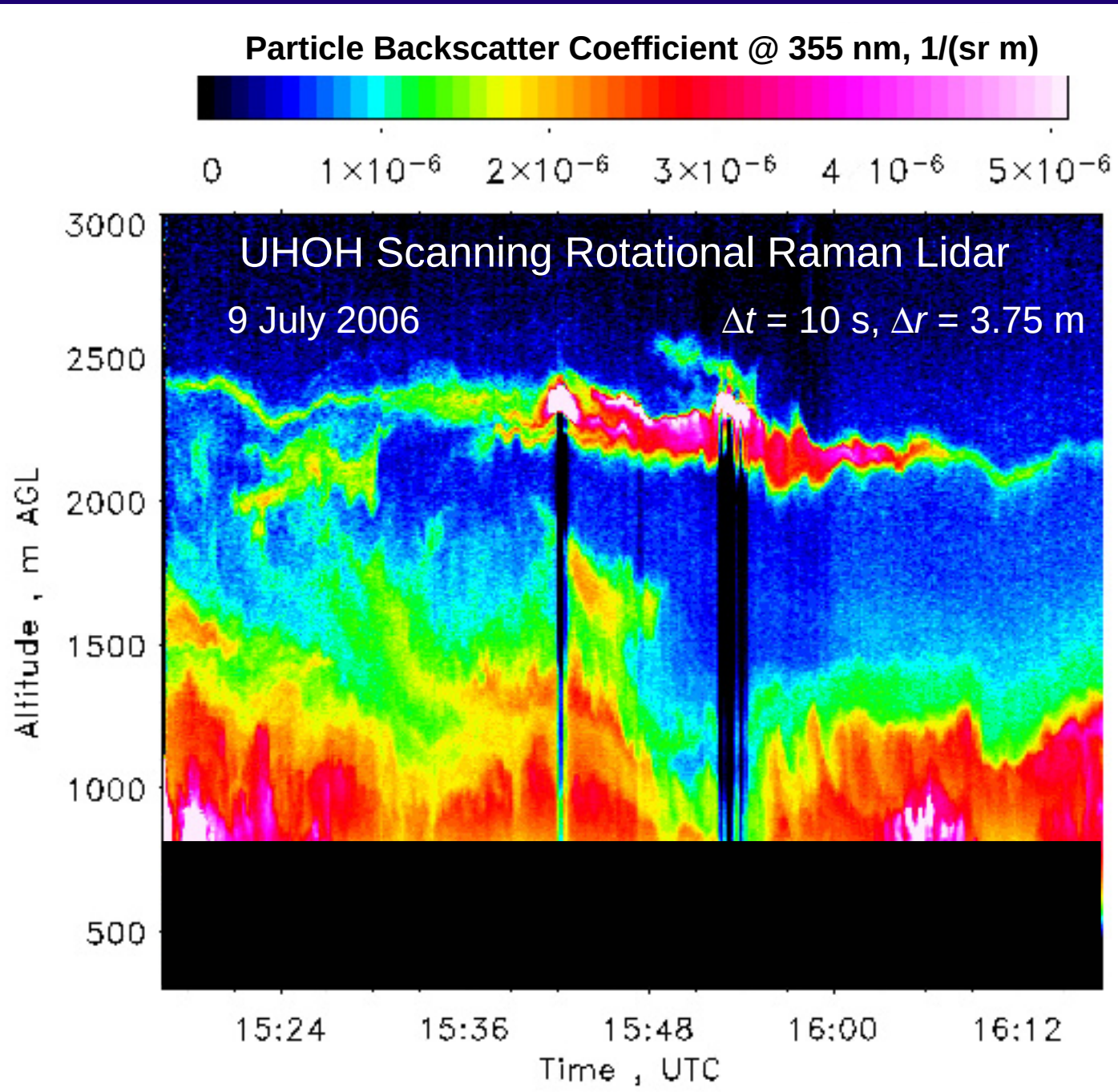
AMF
HATPRO + 90/150 GHz
MWL & WiLi

PRINCE (*PR*ediction, *I*dentification and tracki*N*g of *C*onvective c*E*lls), 6. 7. 2006 – 19. 7. 2006

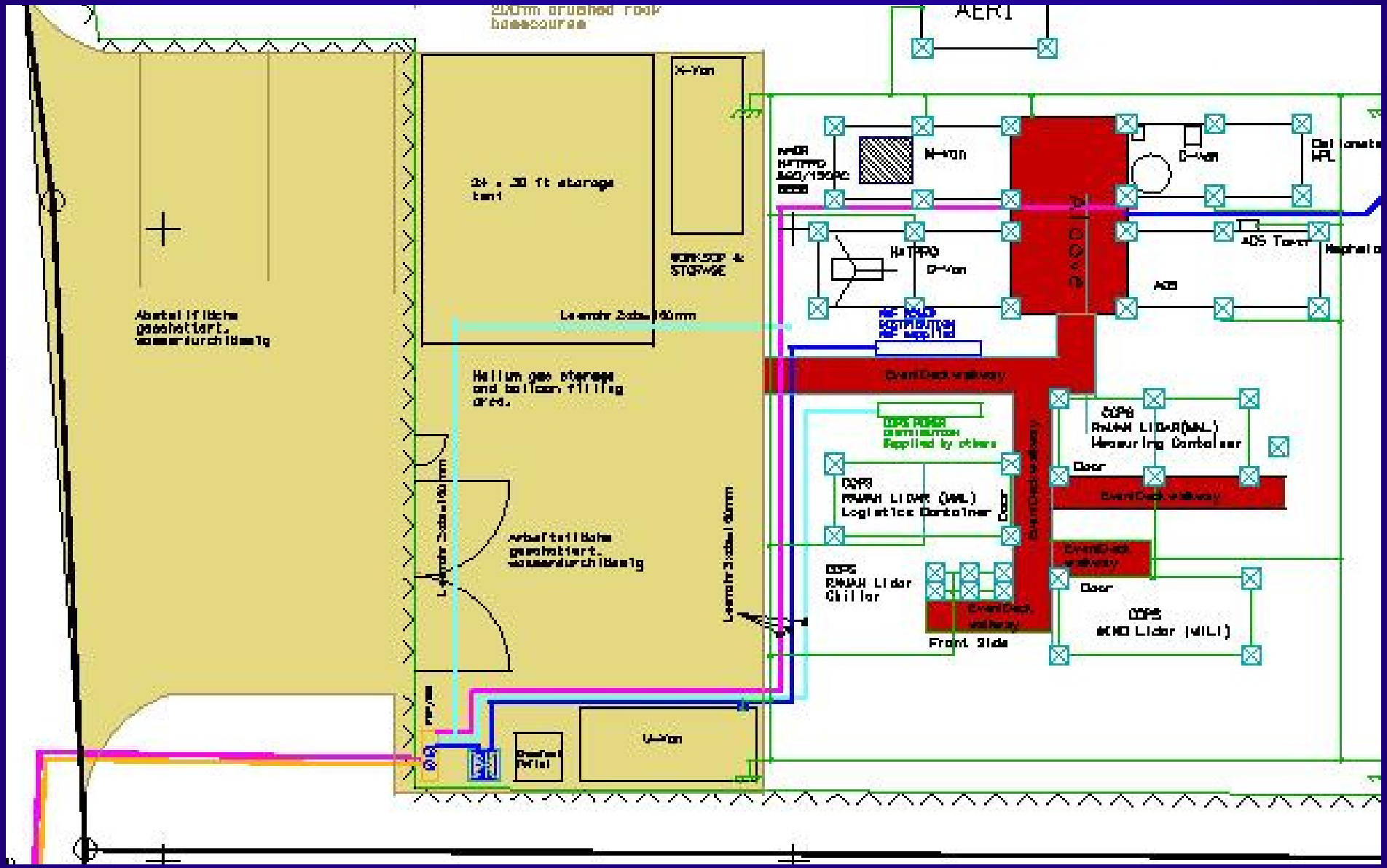


Instruments at Hornisgrinde during PRINCE:

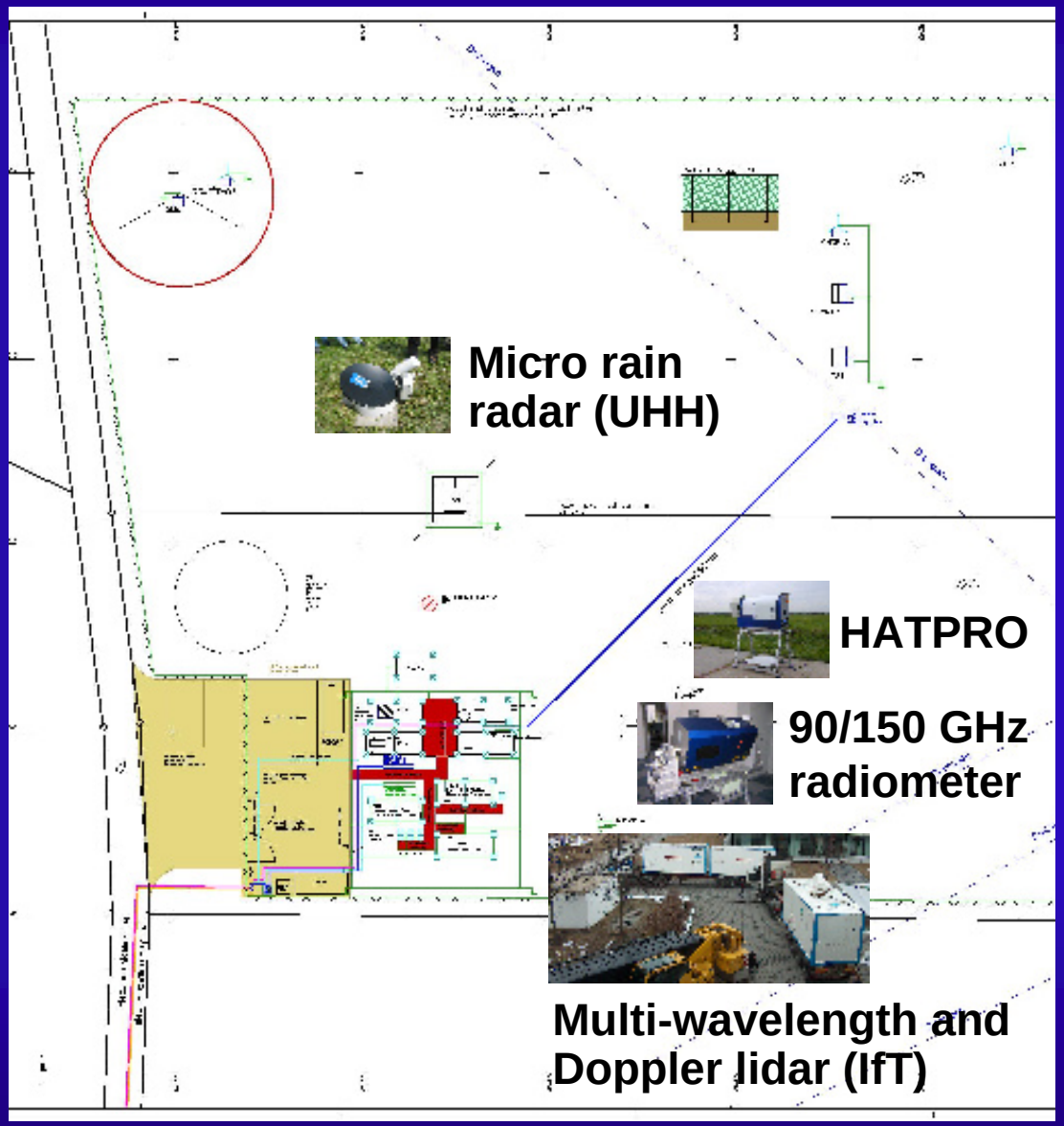
UHOH Scanning Rotational Raman Lidar
FZK WindTracer
FZK Cloud Radar
UHOH X-Band Radar


Particle Backscatter Coefficient @ 355 nm, 1/(sr m)
0
1×10⁻⁶
2×10⁻⁶
3×10⁻⁶
4 10⁻⁶
5×10⁻⁶
UHOH Scanning Rotational Raman Lidar
9 July 2006
Δt = 10 s, Δr = 3.75 m
Altitude , m AGL
3000
2500
2000
1500
1000
500
15:24
15:36
15:48
16:00
16:12
Time , UTC

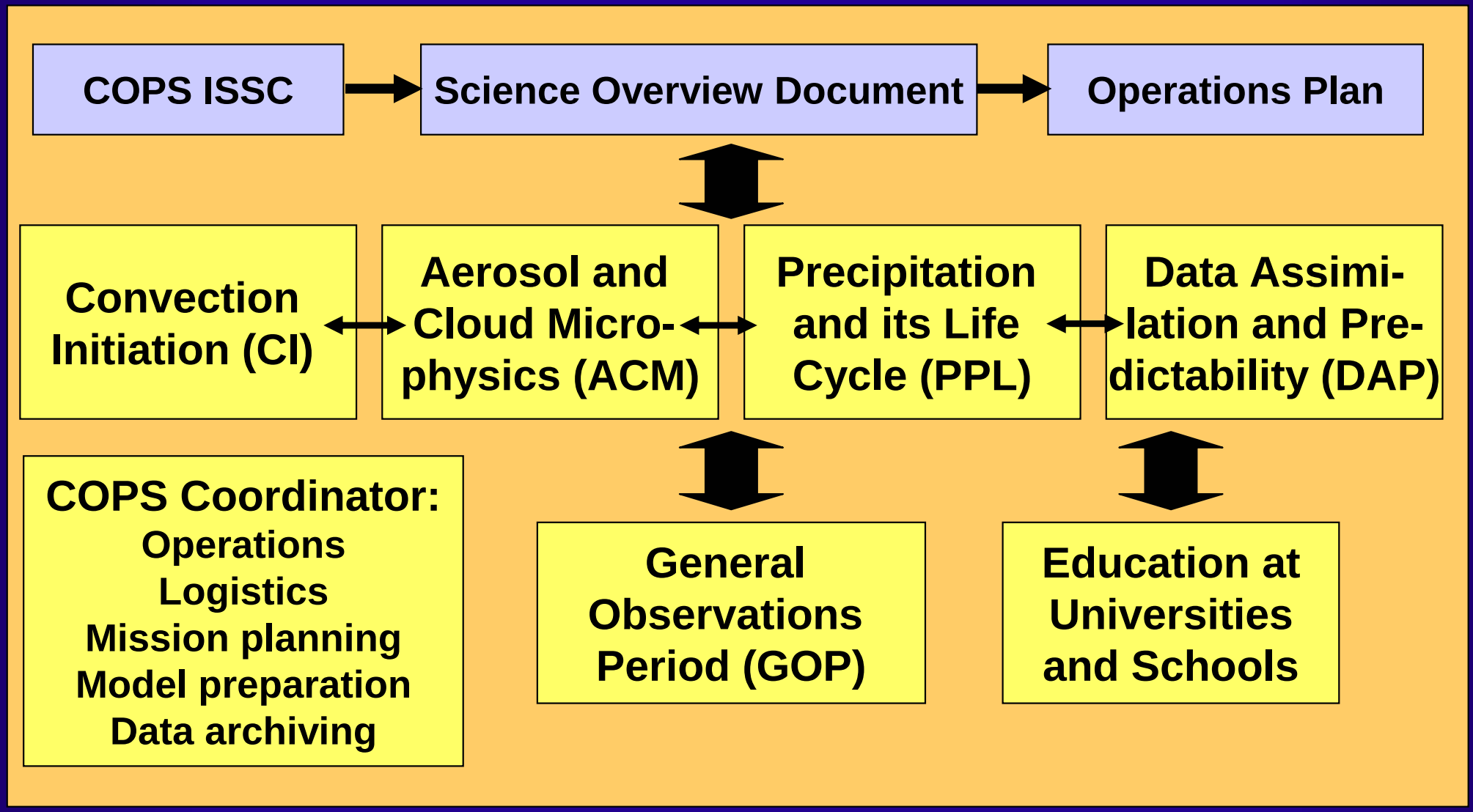
AMF Supersite in the Murg Valley



AMF Supersite in the Murg Valley



PQP field programs organizational structure



COPS science hypotheses

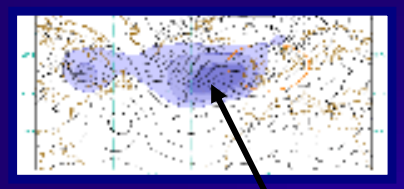
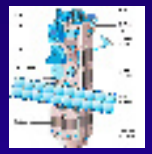
- Upper tropospheric features play a significant but not decisive role for convective-scale QPF in moderate orographic terrain. ⇒ ETReC07, COPS, GOP
- Accurate modeling of the orographic controls of convection is essential and only possible with advanced mesoscale models having a resolution of the order of a few kilometers ⇒ D-PHASE, COPS
- Location and timing of CI depends critically on the structure of the humidity field in the planetary boundary layer ⇒ COPS, GOP
- Continental and maritime aerosol type clouds develop differently over mountainous terrain leading to different intensities and distributions of precipitation ⇒ TRACKS, SFB 641, COPS
- Novel instrumentation during COPS can be designed so that parameterizations of sub-grid scale processes in complex terrain can be improved (ALL)
- 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 (COPS, GOP)

AMF proposal science questions

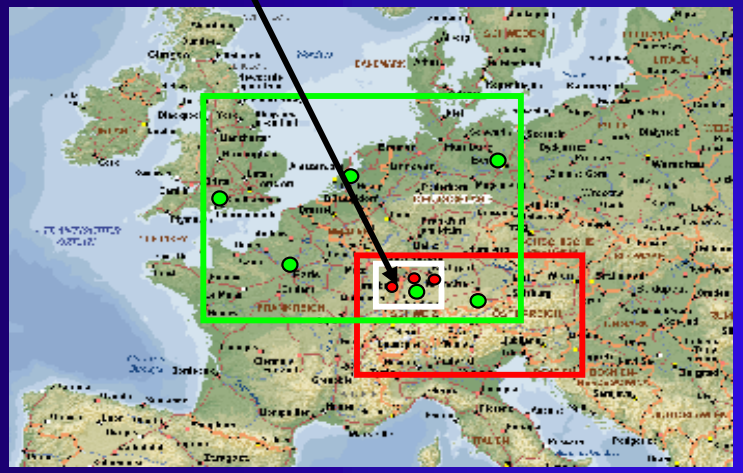
- What are the processes responsible for the formation and evolution of convective clouds in orographic terrain?
  CI + ARM + D-PHASE + PQP scientists

- What are the microphysical properties of orographically induced clouds and how do these depend on dynamics, thermodynamics, and aerosol microphysics?
  ACM + ARM + GOP + PQP scientists

- How can convective clouds in orographic terrain be represented in atmospheric models based on AMF, COPS, and GOP data?
  Coordination of all efforts





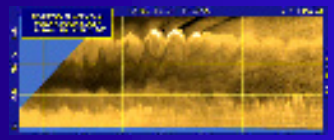
Vision of mission performance

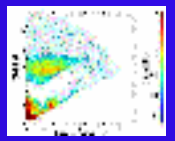
1. Pre-convection:

- Targeted observation within a TReC
- Dedicated measurements of upstream flow

→ Boundary-layer measurements using a synergy of 3-d scanning instrumentation

→ Turbulence closure in heterogeneous terrain



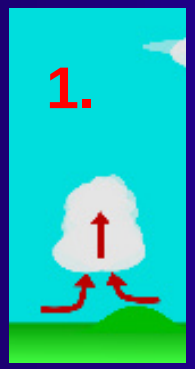
2. CI and 3. Dev. of CI, onset of precip:

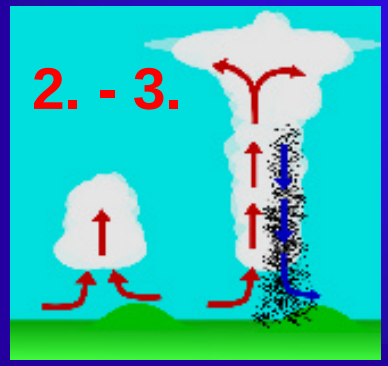
- Dedicated measurements of upstream flow
- Impact of targeted observations

→ Investigation of the interaction between large- and small-scale processes

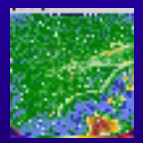
- Adaptation of scanning modes

→ Investigation of the development and parameterization of convection

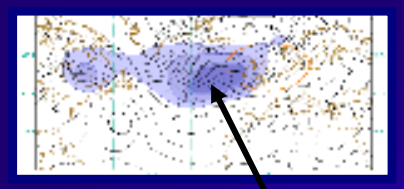
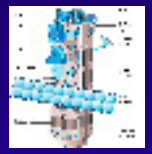








Vision of mission performance

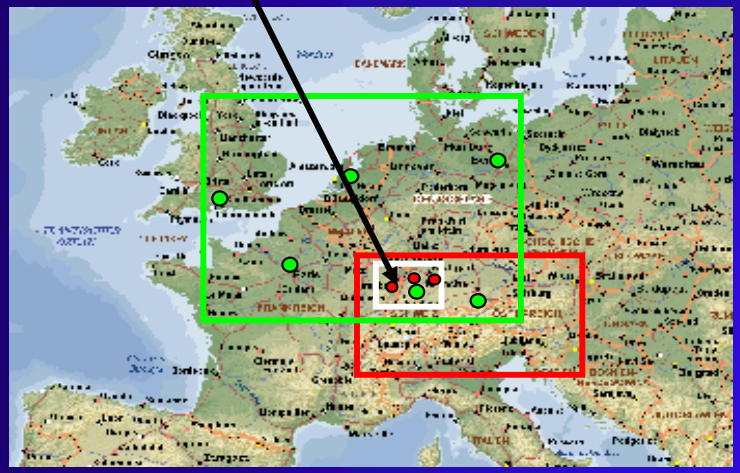

4. Maintenance and decay of precip:

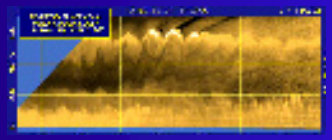
- **Aircraft tracking, radar observations**

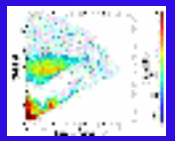
→ **Investigation of cloud and precipitation dynamics and microphysics**

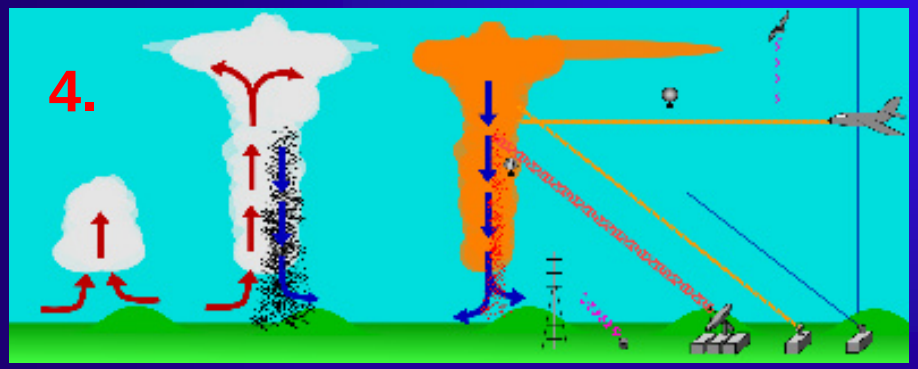
→ **Impact of targeted observations**

→ **Investigation of the interaction between large- and small-scale processes**

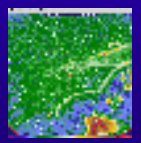


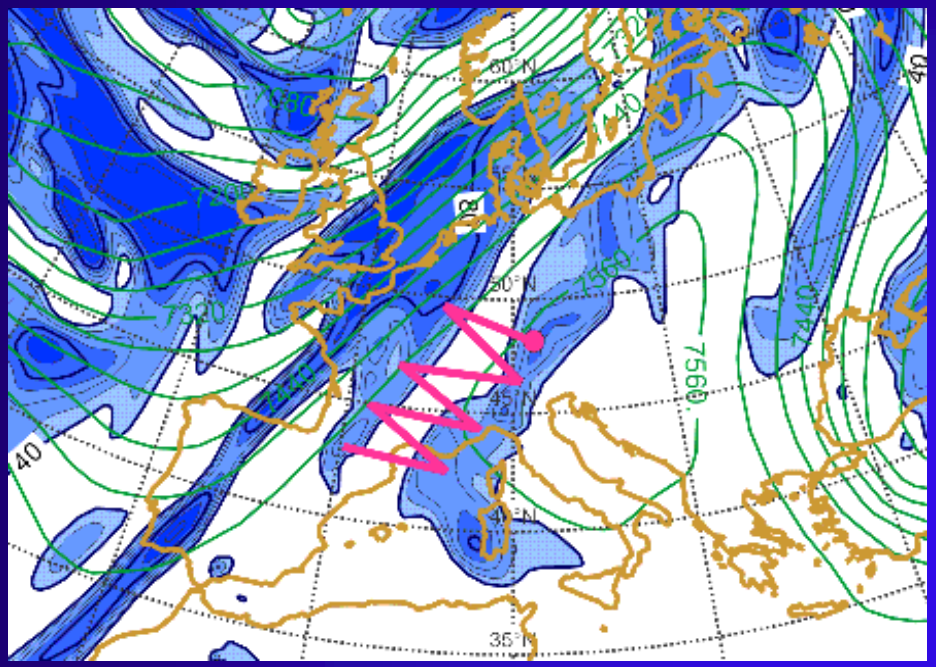




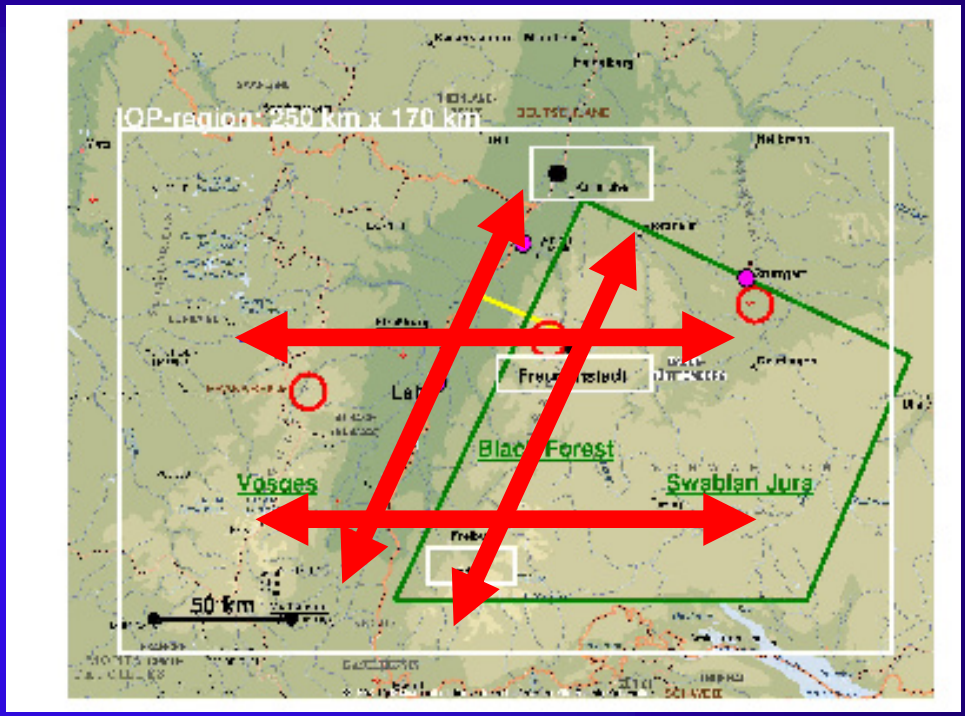




Example, weakly-forced conditions



ECMWF analysis for 19 June 2002, 6 UTC, with contours of geopotential height and specific humidity (color coded) in 400 hPa, overlaid with a DLR Falcon flight route for mapping the stratospheric intrusion.

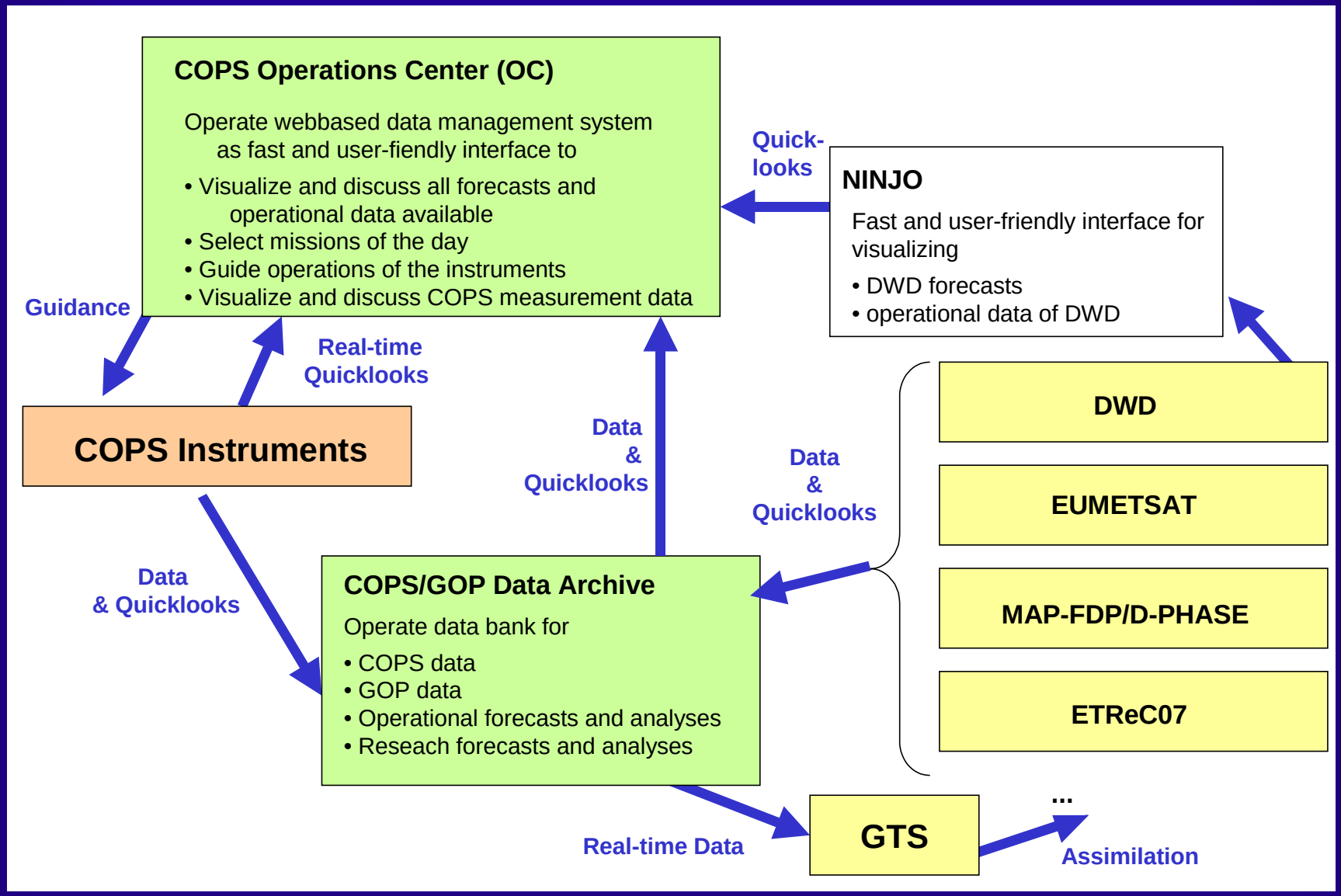


Met. situation: instability and deep convection forecasted; heterogeneity of pre-convective wind and moisture fields expected

Suggestions for mission planning

- Intercomparisons and validation efforts before first and in combination with COPS special observation periods (SOPs)
- During an SOP, the mission comprises the intertwining topics of all working groups
- Missions should be categorized with respect to the meteorological conditions: Strongly forced (SF), weakly forced (WF), no forcing (NF) (see DFG proposal)
- Key is the coordination between adaptive systems: aircraft, ground-based scanning, mobile systems
- Can the observations be used for improving parameterizations?

COPS/GOP Performance and Data Archiving



COPS Operations Center

- Location
- Infrastructure
- Communication
- Mission preparation: data products from models, satellites, and nowcasting systems
- Mission guidance (real-time quicklooks from radar and satellites)
- Decision process
- Operations

Expectations from this workshop

- Refinement of instrument locations
- Preparation of required instrument logistics
- Draft missions
- Preparation of Operations Center
- Organization of access to model and satellite data for mission planning
- Refinement of data management
- Set up of operations plan
- Include education and outreach
- Clear time schedule with action items and distribution of responsibilities