COPS Status

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

With updates.
AB, 11 October 2006
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

**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/](http://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 initiation, 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.
The NSF proposal for S-POLKα was unfortunately declined 😞. AB, 11 October 2006

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.
Supersites

Hartheim
- 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

Tuttlingen
- 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

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

Between S1 and S3
- FZK RS station (mobile)

Rhine valley
- FZK RS station (mobile)

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)

Updated after the workshop AB, 11 October 2006
Zoom in view in Northern Black Forest

Updated after the workshop. Location of instruments still tdb.
AB, 11 October 2006

- 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

10 km

4th COPS Workshop, Hohenheim, 25 – 26 September 2006
PRINCE (Prediction, Identification and tracking of Convective Cells), 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)

Δt = 10 s, Δr = 3.75 m

9 July 2006

UHOH Scanning Rotational Raman Lidar

Altitude, m AGL

Time, UTC

4th COPS Workshop, Hohenheim, 25 – 26 September 2006
AMF Supersite in the Murg Valley
AMF Supersite in the Murg Valley

- Micro rain radar (UHH)
- HATPRO
- 90/150 GHz radiometer
- Multi-wavelength and Doppler lidar (IfT)
PQP field programs organizational structure

COPS ISSC → Science Overview Document → Operations Plan

Convection Initiation (CI) ← Aerosol and Cloud Microphysics (ACM) ← Precipitation and its Life Cycle (PPL) ← Data Assimilation and Predictability (DAP)

COPS Coordinator:
Operations Logistics
Mission planning
Model preparation
Data archiving

General Observations Period (GOP)
Education at Universities and Schools
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
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 (OC)
Operate web-based data management system as fast and user-friendly interface to
• Visualize and discuss all forecasts and operational data available
• Select missions of the day
• Guide operations of the instruments
• Visualize and discuss COPS measurement data

NINJO
Fast and user-friendly interface for visualizing
• DWD forecasts
• Operational data of DWD

COPS Instruments

COPS/GOP Data Archive
Operate data bank for
• COPS data
• GOP data
• Operational forecasts and analyses
• Research forecasts and analyses

DWD

EUMETSAT

MAP-FDP/D-PHASE

ETReC07

GTS

Real-time Data

Assimilation
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