The field programs COPS and GOP 2007: Possibilies for model improvement

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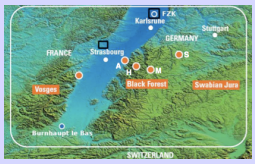
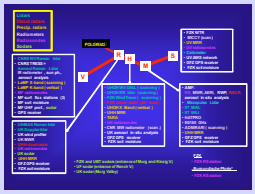
Objectives

- Within the German Priority Program **on Quantitative Precipitation Forecasting (PQP)** two experimental efforts were performed to gather a comprehensive data set suitable for testing hypotheses and new model developed within the PQP.
- The **Convective and Orographically-induced Precipitation study (COPS)** was performed from 1 June to 31 August 2007 in southwestern Germany and Eastern France to study the initiation and the lifetime of convective precipitation systems over low mountains (Black Forest and Vosges Mountains). ➔ **process orientated**
- The longterm **general observation period (GOP)** covers central Europe with increasing focus towards the COPS region to provide long-term information in that area. The GOP philosophy includes and optimized exploitation of existing instrumentation within Germany and the neighboring countries
- Within the GOP a routine model evaluation environment is created (http://gop.meteo.uni-koeln.de). Forecasts by DWD's operational COSMO-DE and COSMO-EU models are matched with observations and routinely compared. ➔ **statistically orientated**

COPS Setup

- COPS region is characterized in summer by severe thunderstorm activity with low forecast skill
- Five **supersites** (V, R, H, M, S) with advanced instrumentation including scanning remote sensors and radiosonde launch stations
- **Surface networks** (soil moisture, energy blance, GPS), polarimetric radar, 2 Doppler on wheels, mobile radiosonde teams
- In total 9 **aircraft** and one airship (Zeppelin) were operated for detailed boundary layer observations and large scale mapping.
- During COPS 18 **intensive observation periods (IOP)** covering 35 days were conducted. They were categorized into
  - air mass or high pressure convection
  - weakly forced convection
  - forced convection



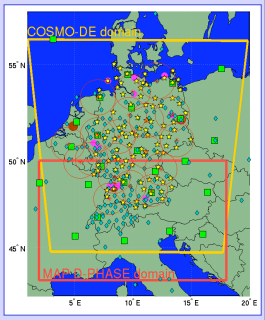


GOP Setup

GOP Observations
cover precipitation properties and environmental conditions

- GOP-1: Rain gauges
- GOP-2: Weather Radar
- GOP-3: Drop Size Distribution
- GOP-4: Lidar
- GOP-5: GPS
- GOP-6: Lightning networks
- GOP-7: Satellites
- GOP-8: Meteorological stations

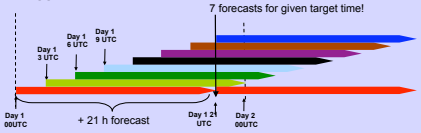
Radiosonde
Cloudnet
Micro Rain Radar
GPS
Ceilometer
Wetterradar



DWD's Routine Models

- **COSMO-DE**: 2.8 km mesh size, permitting explicit convection on grid scale
- **COSMO-EU:** 7 km mesh size, parameterized (Tiedtke) convection

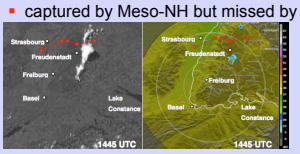
Forecasts started every 3 h:
Lagged forecast ensemble



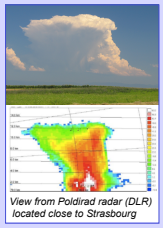
COPS IOP examples

IOP 8b 15 July 2007

- **isolated thunderstorm**
- local convection triggered by effects of complex terrain
- captured by Meso-NH but missed by most models



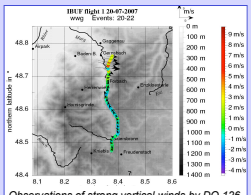
Microphysical observations by BAE 146 (Blyth et al.)



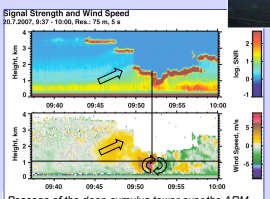
View from Poldirad radar (DLR) located close to Strasbourg

IOP 9c 15 July 2007:

- **Convection initiation in a ridge-trough system**
- strong gust front and convergence line



Observations of strong vertical winds by DO 126 (Corsmeier et al.)



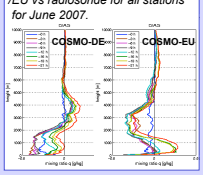
Passage of the deep cumulus tower over the ARM site observed by Doppler lidar (Engelmann et al.)

Humidity statistics

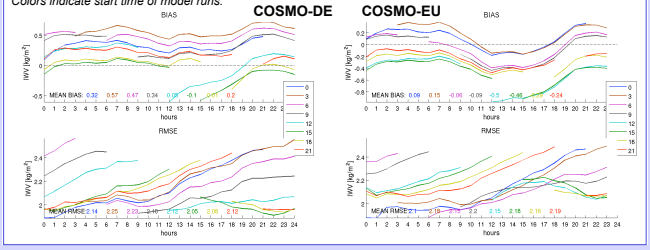
- **GPS** observations show that
  - COSMO-EU is drier than COSMO-DE
  - the diurnal cycle is better reproduced in COSMO-DE
  - RMSE increases with forecast lead time
- Model runs started at 12, 15, 18 UTC are significantly drier due to the assimilation of 12 UTC **radiosondes** having a "dry bias" than others

  ➔ drier model runs gain moisture with time
- When latent heat nudging is included in COSMO-DE the vertical error structure differs from COSMO-EU

Mixing ratio bias of COSMO-DE /EU vs radiosonde for all stations for June 2007.



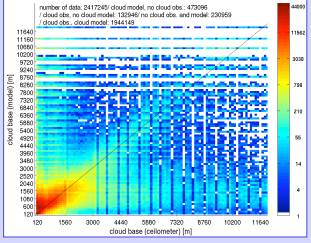
Diurnal cycle of IWV Bias and RMSE of COSMO-DE/EU vs GPS for all stations from 1 February to 30 September 2007 Colors indicate start time of model runs.



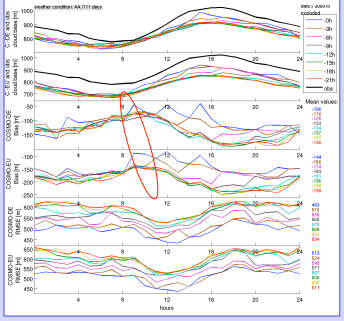
Cloud statistics

- DWD's **ceilometer network** consisting of about 100 stations offers a new opportunity for evaluating cloud base height
- Determination of model cloud base height is ambiguous (cloud fraction vs. scaled clouds) ➔ threshold changes mainly result in constant bias

Two-dimensional frequency distribution of COSMO-DE model vs ceilometer-observed cloud base height. Full year 2007.



Diurnal cycle of cloud base height (1% cloud fraction) from 4 September – 2 April 2007 for 111 anticyclonic days. Colors indicate start time of model runs.



- Few cases (as in Dec.2007) with low stratus or fog in observation (but not in simulation) can dominate monthly statistics
- Classifications into **weather regimes** helps to isolate deficiencies
- During anticyclonic conditions COSMO-DE clouds start to rise earlier after sunrise than COSMO-EU clouds