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# Initiation of deep convection over the Black Forest mountains during COPS IOP 8b: A multi-model approach

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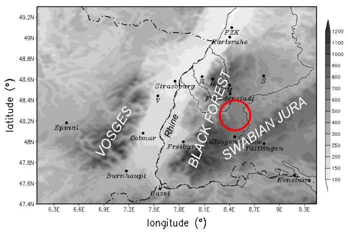
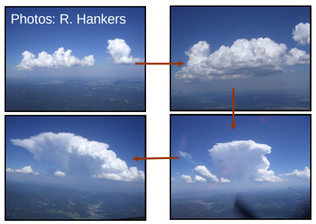
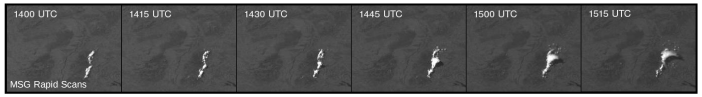
## Introduction

- The Convective and Orographically induced Precipitation Study (COPS) was performed in summer 2007 in southwestern Germany and eastern France in order to improve QPF by 4D observations and numerical modelling (Wulfmeyer et al., 2008).
- Deep convection developed east of the Black Forest crest on July 15 (IOP 8b) although CAPE was moderate and CIN was high:



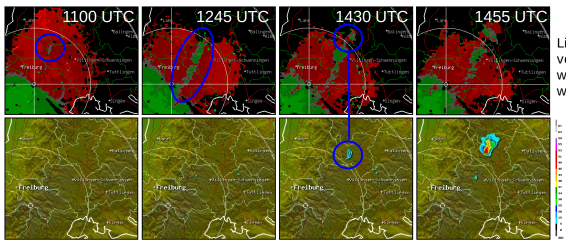




- Model performance quite variable → intercomparison
- find the reason(s) why some models provide better results than others, good forecast for the wrong reason?
- determine the processes which have to be well represented in the models to initiate deep convection at the right place and time

### *Observational results:*

- Convection was initiated by a PBL convergence line (Kalthoff et al. 2009, Barthlott et al., 2010)




Line-of-sight Doppler velocity (green: towards Radar, red: wind away from Radar)

Radar reflectivity

## *Numerical simulations:*

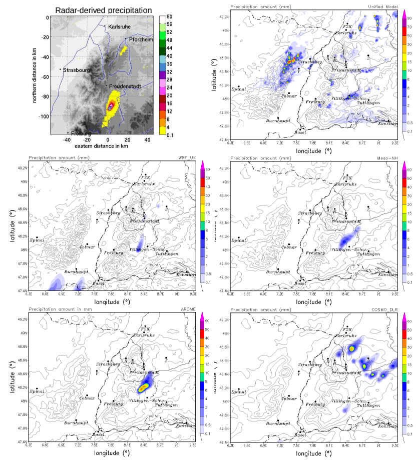
- 8 different model runs from five non-hydrostatic models:

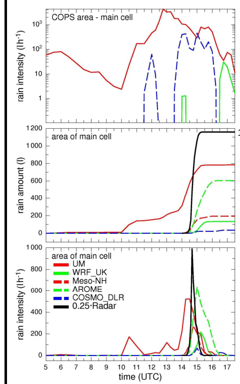
| Name | Affiliation | Model | Initial and boundary data outer domain(s) | Inner domain (init. Time 0Z July 15) | # hor. grid points | # verti. levels |
|---|---|---|---|---|---|---|
| UM | Department of Meteorology, Univ. Reading, UK | UM v6.1 | 30 h global model run using Met Office global reanalysis 12Z July 14 → 12 km run init. at 0Z July 15 → 4 km run | 1 km | 300x190 | 76 |
| WRF_UK* | NCAS, Leeds, UK | WRF V3.1 | 24 h run with 3.6 km using GFS analyses every 6 h init. at 0Z July 15 | 1.2 km | 300x240 | 50 |
| WRF_DE | IPM, University of Hohenheim | WRF V3.1 | 24 h run with 3.6 km using ECMWF analyses every 6 h init. at 0Z July 15 | 1.2 km | 250x250 | 50 |
| Meso-NH* | LA, CNRS et Universite de Toulouse, France | Meso-NH | 30 h run with 32 km using ECMWF analysis+forecasts init. at 0Z July 15 → 8 km run | 2 km | 192x180 | 50 |
| AROME | Meteo France, Toulouse, France | AROME | 10 km ALADIN-France | 2.5 km | 400x320 | 41 |
| COSMO_DLR | IPA-DLR, Oberpfaffenhofen, Germany | COSMO v4.8 | 7 km COSMO-LEPS forecast (nested on selected members of ECMWF EPS) | 2.8 km | 421x461 | 50 |
| COSMO_IPA | IPA, University of Mainz, Germany | COSMO v4.3 | 7 km COSMO forecast based on ECMWF analyses 18Z July 14 | 2.8 km | 351x375 | 50 |
| COSMO_IMK | IMK, KIT, Karlsruhe, Germany | COSMO v4.0 | 7 km COSMO-EU analyses | 2.8 km | 421x461 | 50 |

*Feedback between nests: 2-way, rest: 1-way

## Results

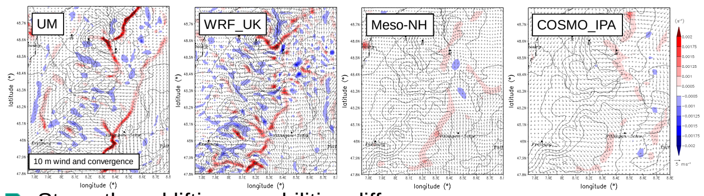
- 5 models simulate precipitation, but only WRF_UK, Meso-NH, and AROME simulate reasonably well the convective activity:



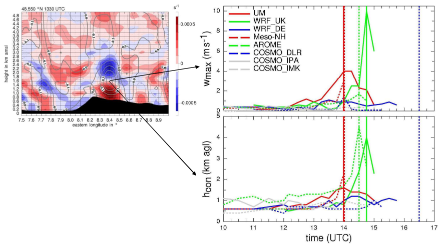




- Successful models seem to have somewhat different mechanisms which initiate convection: Meso-NH humid PBL, AROME thermal forcing more important
- All successful models share a combination of high CAPE and modest CIN, but trigger mechanism is needed

- All models are capable of reproducing the convergence line roughly at the right place and time, 4 examples at 1315 UTC:




- Strength and lifting capabilities differ:

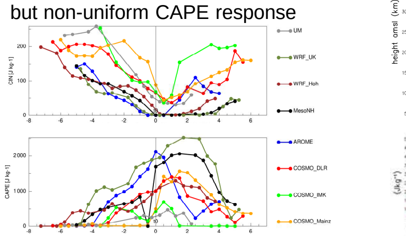



Common feature of successful models:

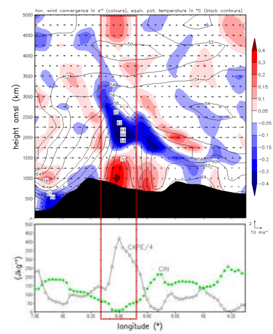
- Largest vertical extent of convergence line (2.3 - 4.5 km agl)
- Highest vertical wind speeds induced by lifting

- Passage of convergence line in the models is accompanied by
  - Pressure minimum
  - Wind speed minimum
  - Turning of wind direction
  - CIN minimum (T_trig exceeded)

  but non-uniform CAPE response




COSMO IMK 1300 UTC:




## Discussion

- Variety of numerical findings a result of different configurations (hor./vert. grid resolution, physical schemes, initial data,…)
- Besides accurate specification of thermodynamic and kinematic fields, low-level convergence lines and their ability to lift parcels up to the LFC need to be well represented in NWP models
- Multi-model approach reflects forecast uncertainties

More details: **Barthlott et al. (2011)**; Simulations of same IOP: **Richard et al. (2011)**, **Hanley et al. (2011)**.

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