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Predictability of convection in COPS: high resolution ensemble forecasts

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Introduction

Atmospheric predictability at the convective storm scale is limited by the sensitivity of convection to the errors inherent in numerical models. Mesoscale uncertainties in the large-scale conditions that drive limited-area NWP models cause variability in the convective potential and the strength of the vertical motions that are required to trigger storm cells. Additionally, many of the small-scale features that initiate individual convective cells are either completely unresolved (e.g. boundary layer thermals) or highly uncertain (e.g. land surface fluxes), even in today's highest-resolution models.

Aims

- Use data from the COPS campaign to study the role of complex terrain in regulating the storm scale predictability of convection.
- Use the UK Met Office Unified Model to perform high resolution (1km) ensemble simulations over the COPS region. Initial and boundary data will be obtained from the Met Office Global and Regional Ensemble System (MOGREPS).
- Evaluate the role of different sources of uncertainty that reduce predictability e.g. mesoscale dynamics, variability in surface forcing.

IOP 9c, 20th July 2007

- A mesoscale convective system moves across the COPS region and convection initiates along a gust front and within a thermally-induced convergence zone.

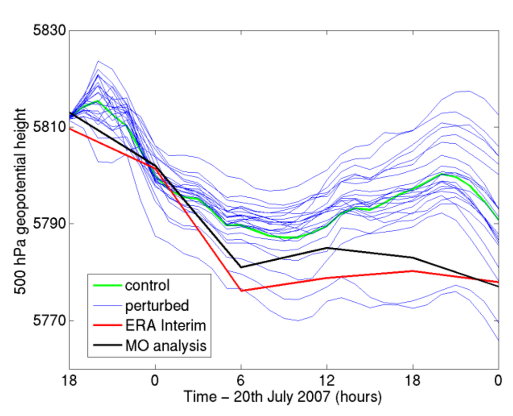

Figure 6. 500 hPa geopotential height at 48.5N 8E from MOGREPS.

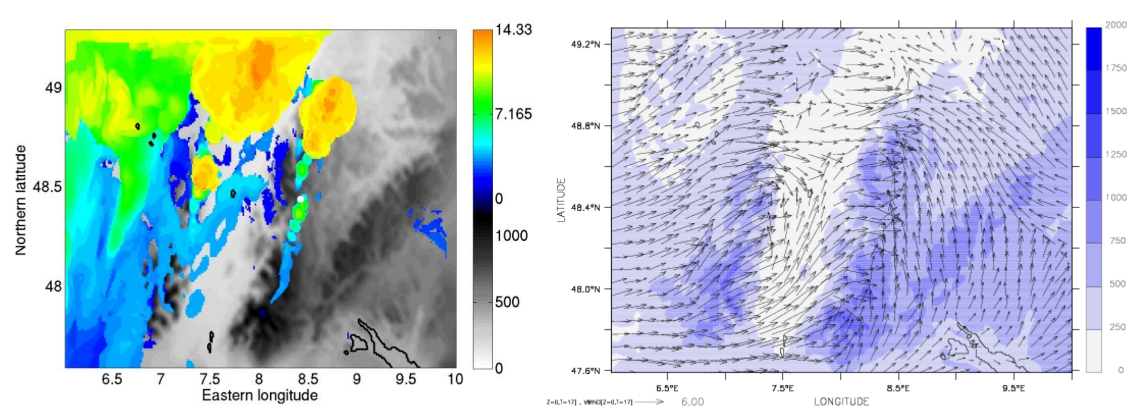

Figure 7. Cloud top height and 10 m wind vectors at 12 UTC for the high resolution control simulation.

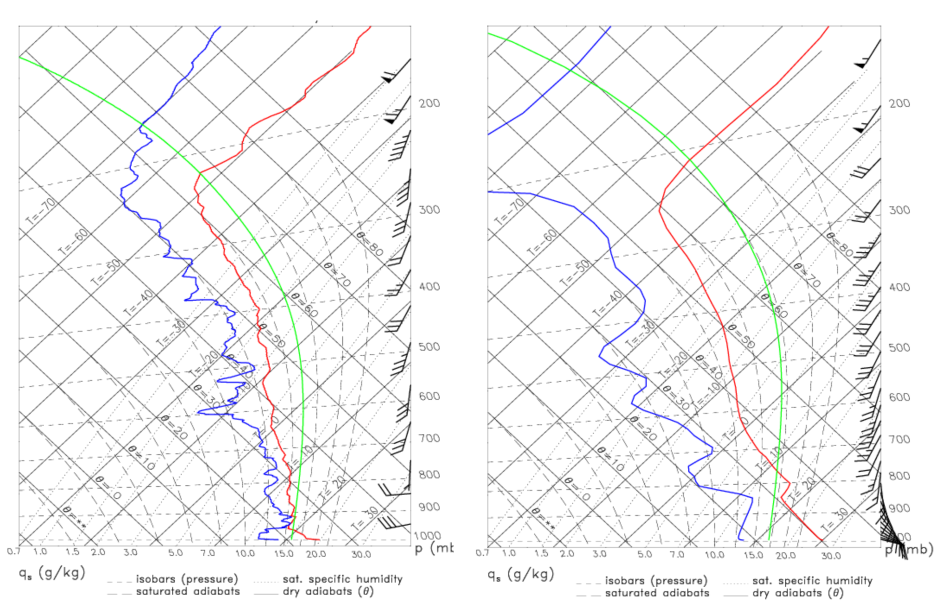

Figure 8. Vertical profiles from Karlsruhe at 11 UTC from the COPS data (left) and from the high resolution control simulation (right).

References

1. Kottmeier , C. et al (2008):Mechanisms initiating deep convection over complex terrain during COPS, *Meteorol. Z.*

Acknowledgements

- COPS data used in this study was obtained from WDCC .UK Met Office data was obtained from NCAS-CMS.

IOP 8b, 15th July 2007

- Weak synoptic forcing over the COPS region. A line of convective clouds break out over the Northern Black Forest between 13.00 and 16.00 UTC due to surface convergence.

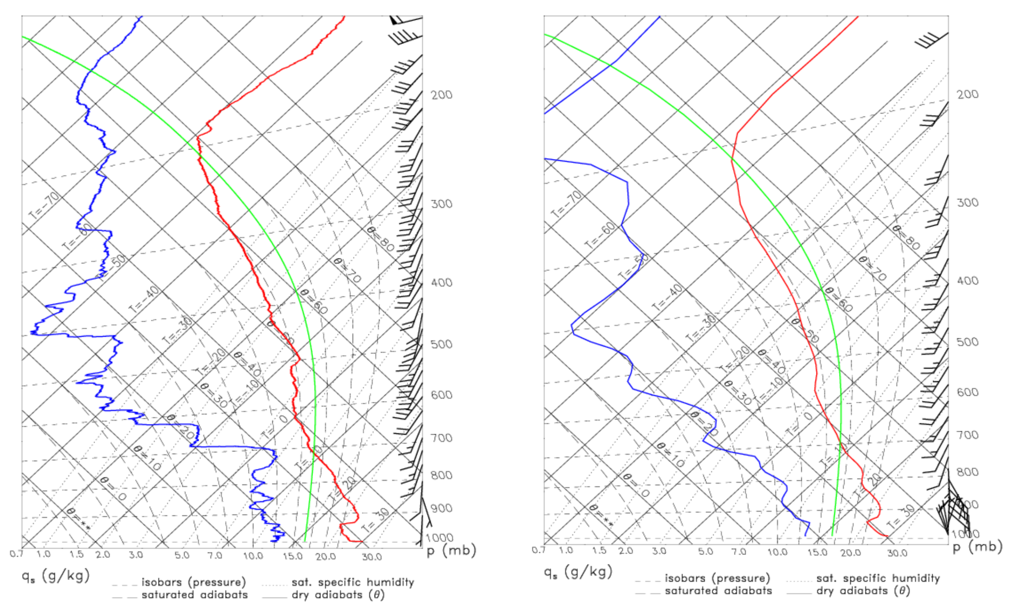

Figure 1. Vertical profiles from Achern (48.6N, 8.1E) at 11 UTC from COPS data (left) and the UM 1km resolution control simulation (right).

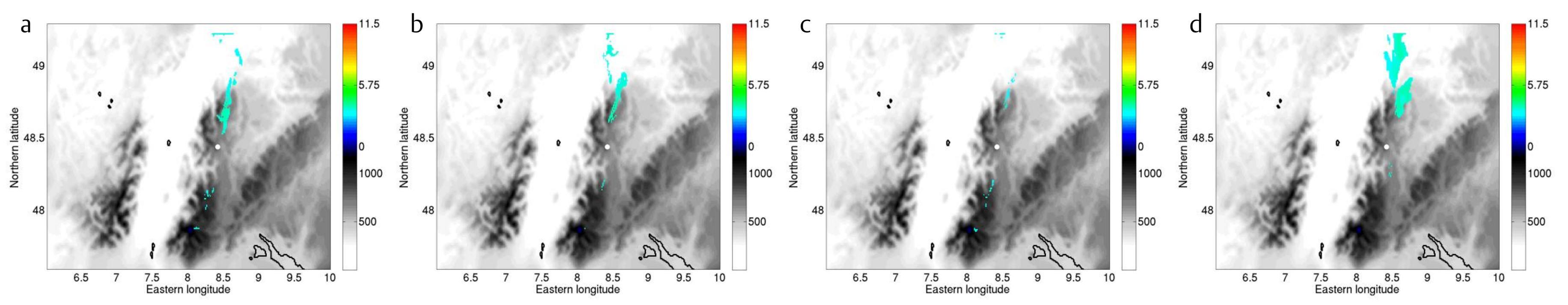

Figure 2. Cloud top height in km at 16 UTC for a) the 1km control simulation, b) 5th c) 12th and d) 21st perturbed forecast. Orography shown in greyscale.

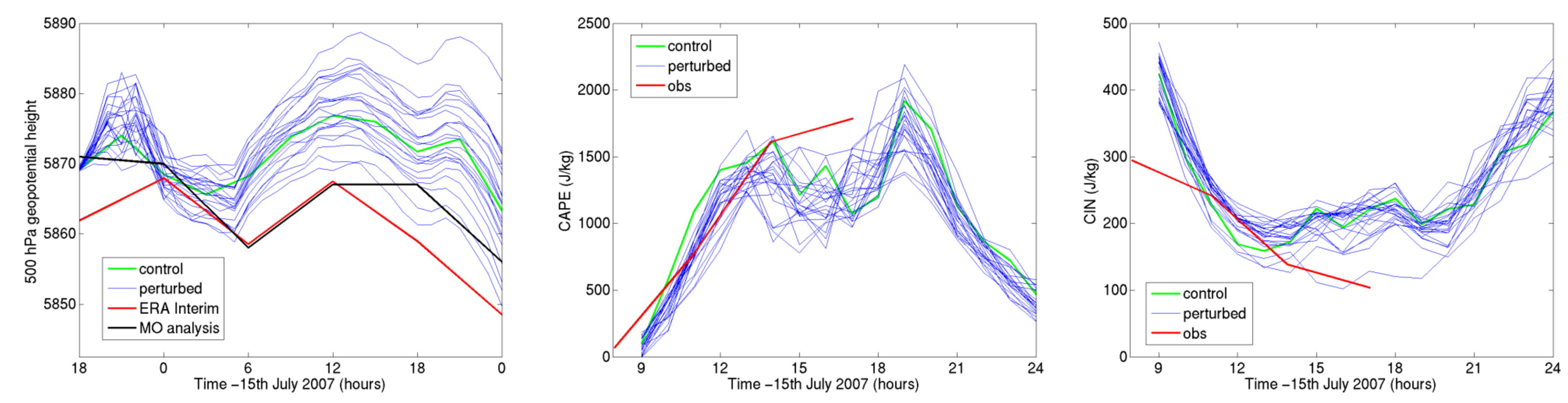

Figure 3. Ensemble spread of 500 hPa geopotential height from the MOGREPS-Regional ensemble, and CAPE and CIN from the high resolution ensemble.

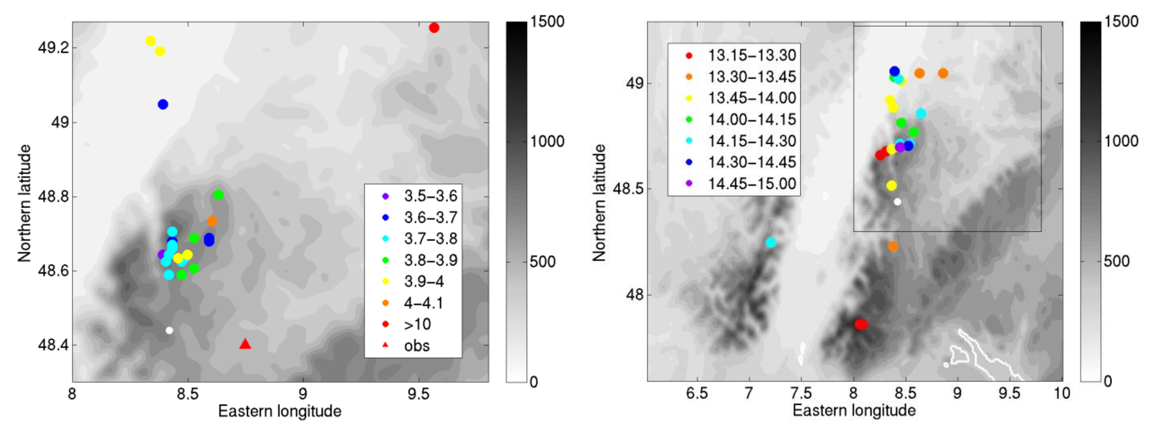

Figure 4. Maximum cloud top height in km and time of convective initiation for the high resolution ensemble. The white dot indicates Freudenstadt.

Varying parameters

- MOGREPS provides the synoptic-scale uncertainty but not the uncertainty in surface forcing & physical parameterisations.
- Investigate the sensitivity to the soil moisture content and the subgrid horizontal diffusion coefficient, c.

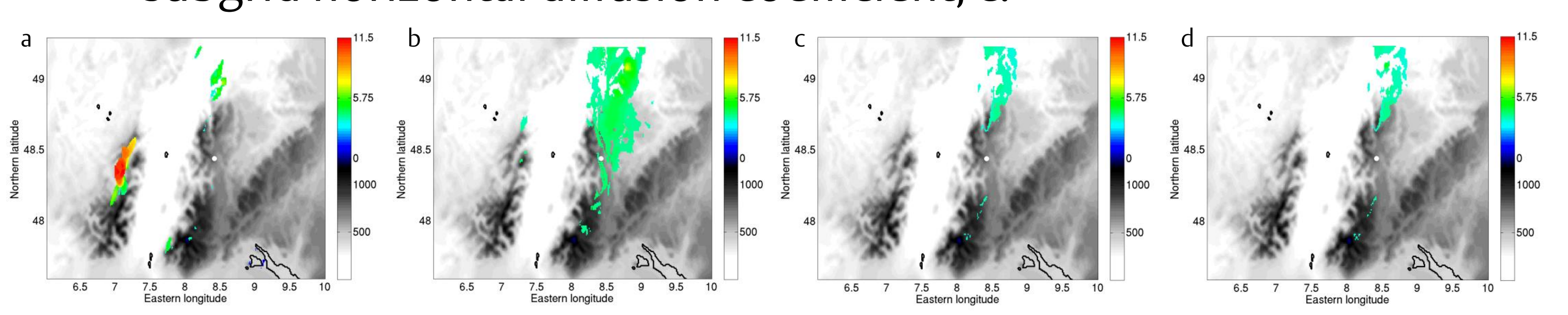

Figure 5. Cloud top height in km at 15 UTC 15th July for the control simulation with a) horizontal diffusion switched off, b) soil moisture halved, c) soil moisture reduced by 20% uniformly across the domain and d) soil moisture reduced by 20% and c = 0.1.

Conclusions

For a case with weak synoptic forcing the ensemble spread from MOGREPS is small. This case shows a strong sensitivity to parameters such as soil moisture & horizontal diffusion showing that it is also important to capture the uncertainty in the surface forcing and the parameterisations. In contrast, for a synoptically-driven case MOGREPS produces an ensemble that encompasses the observations.