Meeting report: Convection workshop

The discussion at the workshop, which took place during the Royal Meteorological Society conference in Reading, was centred on four invited talks, which covered a broad spectrum of themes.

Prof David Schultz (Universities of Helsinki and Manchester, Finnish Meteorological Institute) discussed "Slantwise convection", starting by looking at the review by Schultz and Schumacher (1999) ten years on. As recommended by the review, later authors have generally adopted potential vorticity as a way of diagnosing symmetric instability. Also, later research has shown that banded convection does not require the presence of symmetric instability. Four main questions for research were identified:

- How often does slantwise convection occur and what is its climatology?
- Does it need to be parametrised in models? Given that it can only be resolved in high-resolution numerical weather prediction (NWP) models, vertical resolution can still be an issue.
- What is the best way to set up idealised simulations of slantwise convective systems?
- How can a single band versus multiple banding be forecast?.

Dr Alison Stirling (Met Office) discussed "Current problems in parametrising deep convection":

- The basic requirements for a deep convective parametrisation: to remove convective instability, start at the right time, end at the right time and give reasonable transports of heat, water vapour and momentum in between were reviewed. Systematic biases of timings of convection in global models show that these basic requirements are not met.
- Entrainment rates based on cloud resolving model studies can improve these timings, e.g. with the parametrisation currently being tested at the Met Office, using an entrainment rate that depends on cloud-size, which itself is parametrised as a function of convective boundary-layer depth.
- Major outstanding issues that were identified included: non-equilibrium behaviour, stochastic parametrisations, parametrising convective cold-pool outflows, couplings with sub-grid processes (e.g. fluxes and orography) and interactions of convection with larger scales.

Prof Tom Choularton (University of Manchester) reviewed "The effects of aerosols on deep convection", discussing:

- Observational evidence that in low sulphate loadings sulphates can be internally mixed with organic aerosols, giving numerous efficient cloud condensation nuclei (CCN), even for low sulphate concentrations.
- Recent observations of high loadings of organics of biological origin in ice residues. Organic particles may play an important role in nucleating ice at temperatures as warm as -6 ^{o}C.
- Results from modelling "Hector" storms over the Tiwi islands (Australia) where CCN concentrations appear to have significant effects on the timing of precipitation, although not on the total amounts. Intermediate CCN concentrations give maximum updraught strengths in models and perhaps observations.

- Observations of frozen haze droplets in anvils from convective clouds acting as centres for the growth of bullet rosette crystals, where multiple columnar crystals grow outwards from a single point.

The source and properties of atmospheric ice nuclei, the effects of aerosol on deep convective clouds, aerosol effects on secondary ice and the origin of aerosol in cirrus anvils were identified as major areas for future work.

Dr Glenn Shutts (Met Office) gave a talk entitled "Upscale impacts of deep convection", discussing:

- The physical basis for parametrisation, noting that now model grid-boxes (spacings < 50km) often no longer contain a large ensemble of clouds. This has led to the development of stochastic physics parametrisations, which it has now been shown can improve ensemble forecasts (but tropical regions are still challenging).
- Coarse-graining of simple convection plume simulations to examine the efficacy of different parametrization strategies (e.g. heating or explicit mass forcing)
- Recent idealised cloud-resolving model experiments over domains of 1000s of km showing the role of convection in further warming already warm regions.

Many areas requiring further research were identified, including: whether we should modify existing parametrisations or make new ones, how we should develop parametrisations for ensemble prediction, why NWP models appear to have insufficient gravity wave energy sources on scales of 100km and how well global models capture mesoscale convective.

Throughout the workshop, and indeed the conference, it was noted that we are still lacking fundamental understanding of many convective processes, and that this, as well as the modelling of convection, limits many aspects of atmospheric science.