“Convection permitting models” – setting the scene

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Hand et al 2004 examined UK 20th century extreme flood events and found that “more than half of the 50 events identified were short-period convective storms.” We’ve seen plenty in recent years!

Regional Climate Models (100 – 12km grid) can’t represent convective storms, therefore we can’t really say anything useful about possible future changes in rainfall produced by convective storms. That’s a big omission.

Now we have the capability to do what is now done in weather forecasting and run so called “convection permitting” or “kilometre scale” models for climate studies.

What benefit does this give us? Take a look at the weather forecasting experience.
Operational “convection permitting” forecast models

Simulate the atmosphere by splitting it into chunks – the smaller the chunks the greater the precision

Computer power has allowed this – more difficult for long climate simulations of course
What does a kilometre scale model do that a 12 km model can’t?

Much more detailed topography and land surface characteristics

Much better representation of local storm triggers – e.g. uplift from flow associated with hills, coasts and air-mass boundaries

Ability to represent the evolution, structure and secondary development of convective storms

More accurate orographic rainfall
Convection-permitting model development

2003  Non-hydrostatic Unified Model – allows convection-permitting resolutions

2005  4 km UK model

2009  1.5 km UK model (UKV)  CONVEX

2012  2.2 km UK ensemble system (MOGREPS-UK)


Types of convective storm organisation
Heavy rain x long duration = high total

Mesoscale Convective System
- Fast moving
- Intense rainfall

Repeating storms
- E.g. Boscastle

Back building
- 1
- 2
Types of convective storm organisation

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Mesoscale Convective System

- Intense rainfall
- Typically fast moving

Repeating storms

- E.g. Boscastle

Back building

- E.g. Back-building Mesoscale convective system
- Partly broken stationary band ....

Near stationary bands

Slow progression

More exotic storms

- E.g. rotating Supercell
More pixels = more realism!

Grid point storm
Not good!
More pixels = more realism!

Convection scheme
Bit of rain everywhere!
More pixels = more realism!

Dynamical structure represented
1.5 km forecast from 06 UTC for 20th July 2007

Which is radar and which is the forecast?

Simulation courtesy of Peter Clark
The Boscastle flood
16th August 2004

Radar accumulations
12 to 18 UTC 16/08/04

(a)

(b)
Flooding in London
3rd August 2004

Displayed on a 5 km grid
Flooding in London
3rd August 2004
Summary

Convection-permitting models have brought a step change in forecasting capability (greater realism & skill, new products)

Storm structures, evolution and rainfall amounts can be represented with remarkable realism

Realism is vital, but is only part of the picture for climate modelling – also need to test for statistical agreement with observed rainfall

Note of caution – these models are impressive but are far from perfect. Some processes are still not properly resolved and any RCM also depends on the quality of the driving GCM. Further R&D is essential.
Forecasts of 16-hour rainfall accumulations

11-12th October 2000
13 UTC  29th July 2002

Storm

> 32 mm /hour

1 km

13 UTC
The Boscastle flood
16th August 2004

Radar accumulations
12 to 18 UTC 16/08/04

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