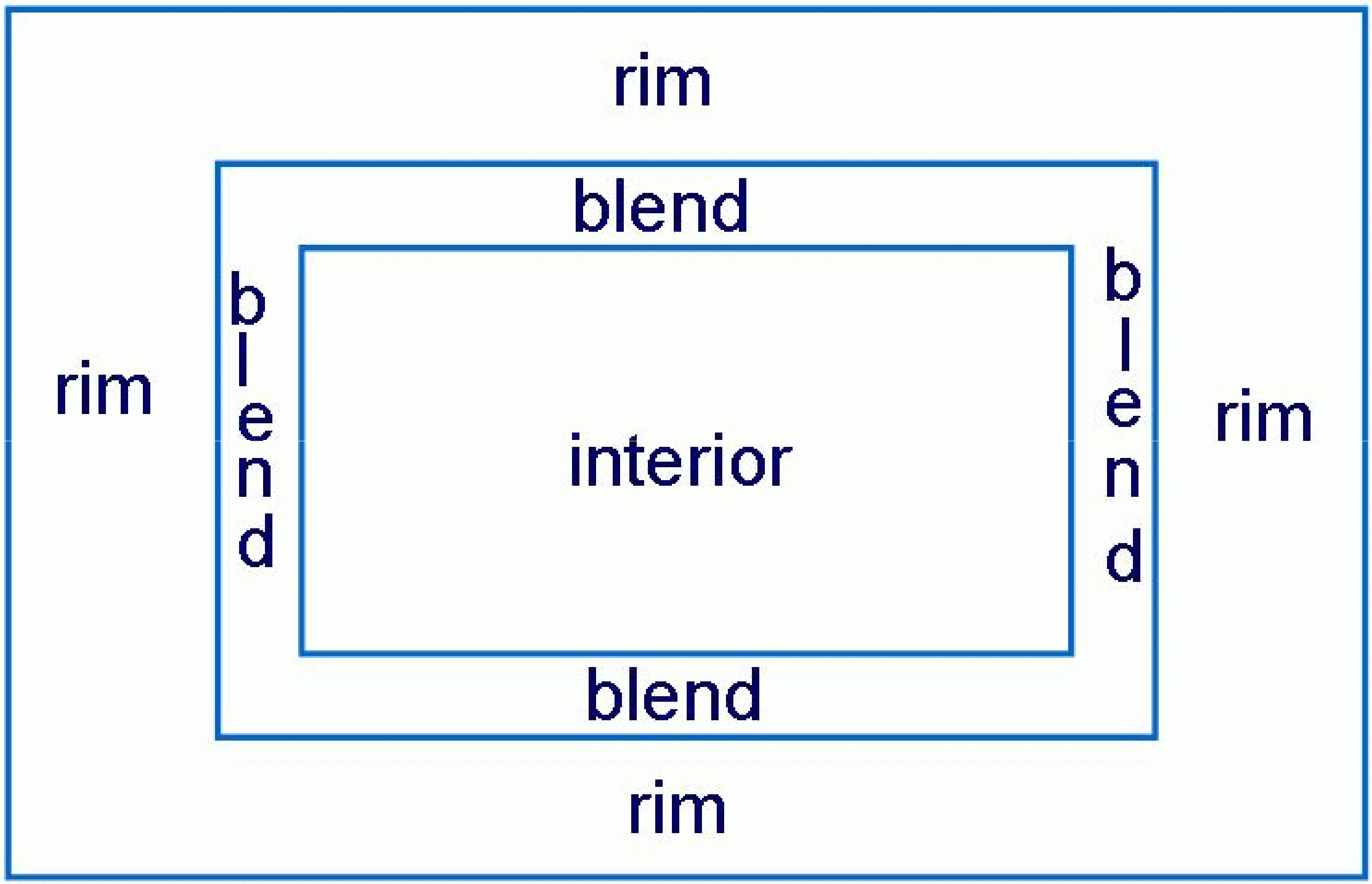
Lateral boundary conditions AND variable resolution

Terry Davies Dynamics Research

Lateral boundaries

- **To run variable resolution LAM will still need lbcs.**
- **Current lbcs use standard blending technique (Davies)**
- **Semi-Lagrangian predictor applies lbcs naturally using time level n**
- **Apply appropriate lbcs to Helmholtz equation**
- **Need to filter small-scale outflow information**



LAM domain

Lateral boundaries

Semi-Lagrangian predictor applies lbcs naturally

- **Up-winding scheme so lbcs only applied at in-flow (if departure point is inside domain then lateral boundaries are not used)**
- **Departure points outside domain obtained from lateral boundaries but use time-level n information, not time-level n+1 (time-level n+1/2 used for trajectories)**

Lateral boundaries

- **Apply appropriate lbcs to Helmholtz equation**
- **LBC only applied to (Exner) pressure correction ($\Pi' = \Pi^{n+1} - \Pi^{n}$) at one point around edge of domain – well-posed Dirichlet problem**
- **For mpp, lateral boundary files do not need external halos – can use a rim (>1 to allow for flow Courant number >1) around inner edge of domain**

Lateral boundaries

- **Blending of lbcs still useful to match mass/pressure fields of driving and nested models**
- **Blending upsets geostrophic adjustment**
- **If no blending of lbcs then will need to filter small-scale outflow information otherwise reflection at the boundary (loss of transparency)**

LBCs test set up

- Regional model (NAE-type) .44/.22/.11 degrees (48/24/12km)
- LAMs over UK .44/.22/.11
- Variable resolution LAMs with same fixed area as LAMs
- LAMs with same number of points as variable resolution LAMs
- Run LAMs using lbcs supplied by NAEs. Change frequency of lbcs.
- Main test is to drive LAMs using lbcs from .11NAE and differencing against the .11 NAE forecast.

T+0

.11 deg

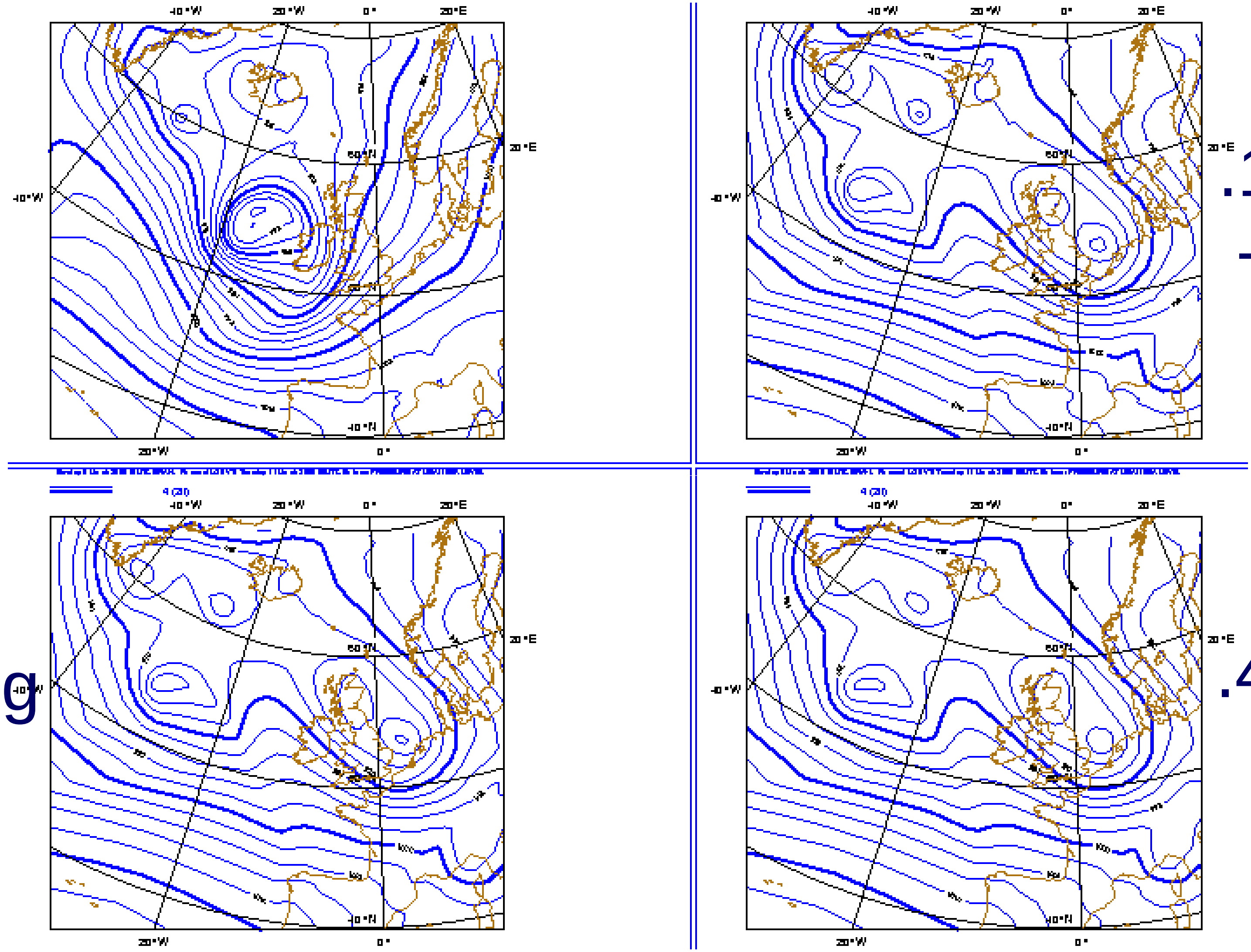
T+24

.22 deg

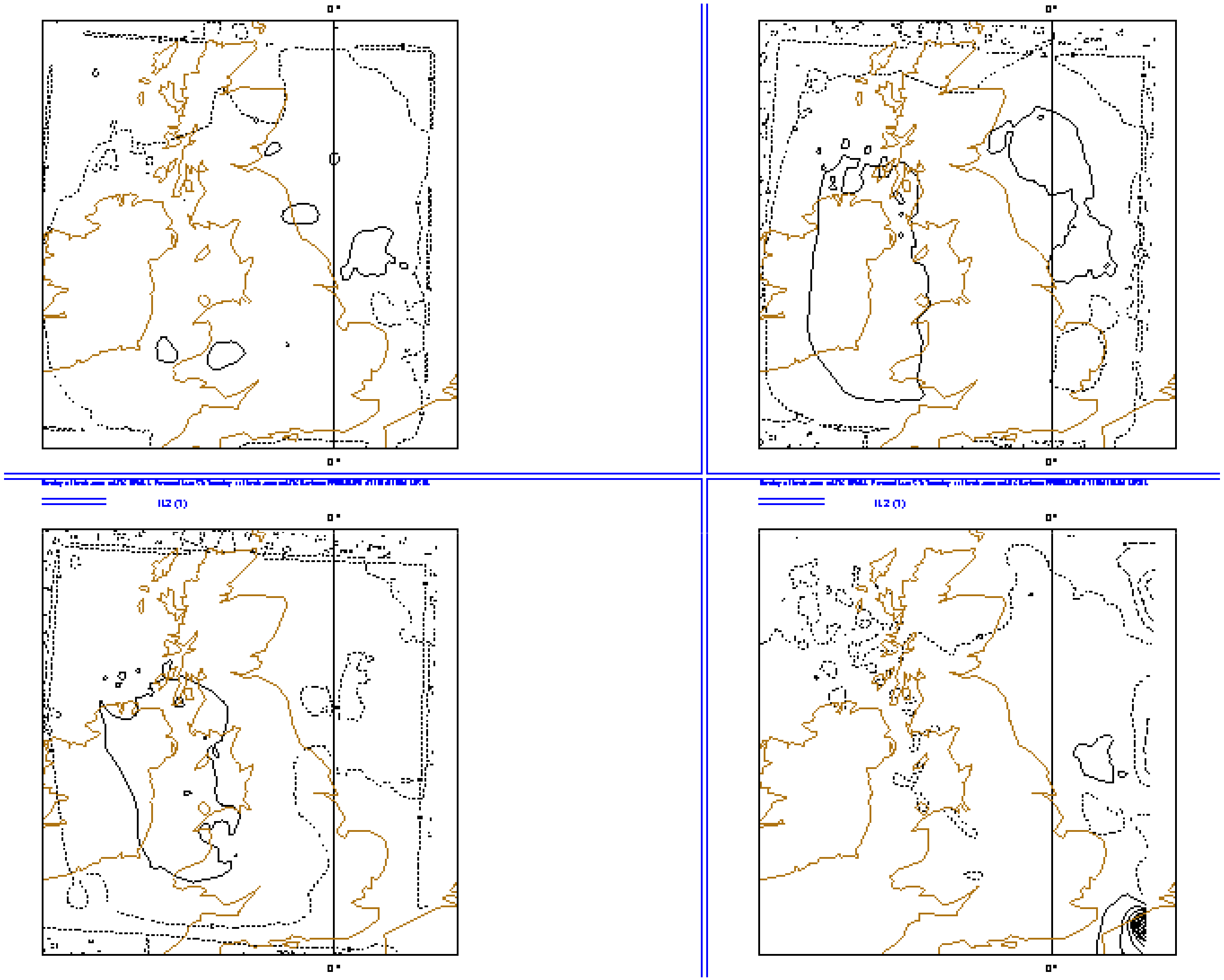
T+24

.44 deg

T+24



NAE

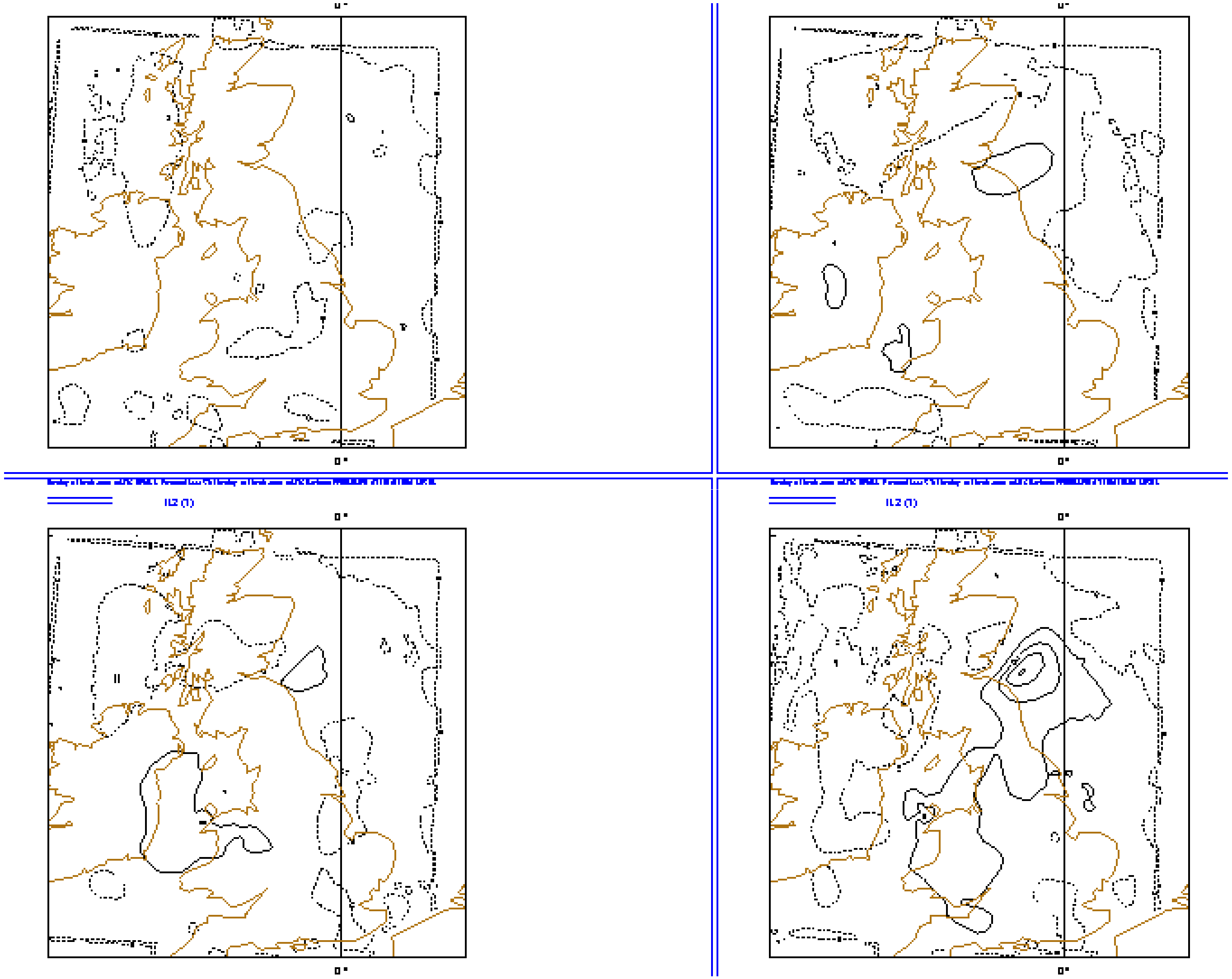


T+24 PMSL differences 0.2hPa

T+18 PMSL differences 0.2hPa

5min lbcs

10min lbcs



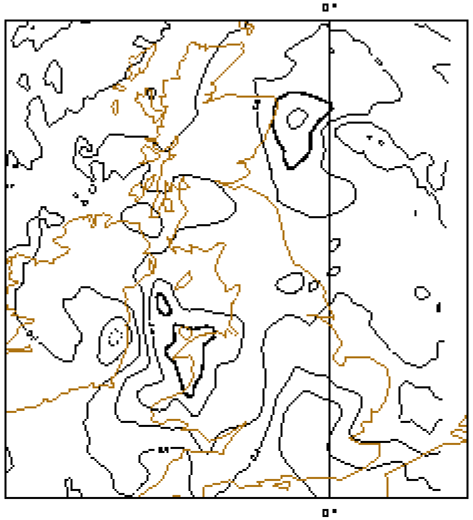
15min lbcs

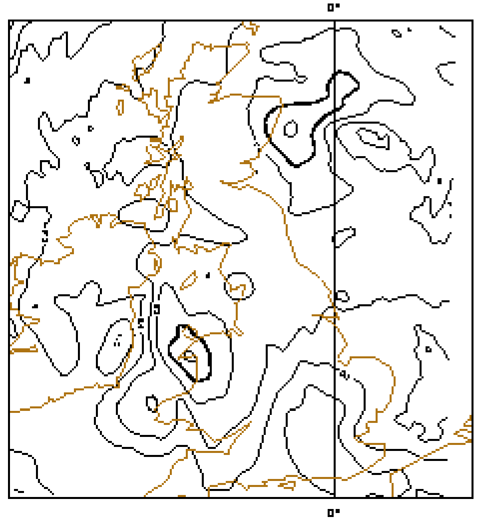
30min lbcs

.11degree LAM and lbcs

Var LAMsT+18 –NAE.11

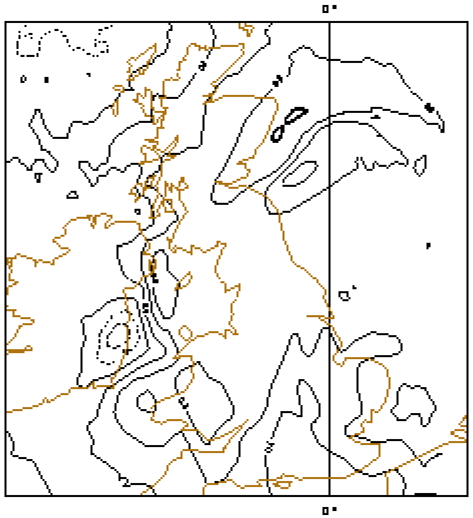
5min
10%

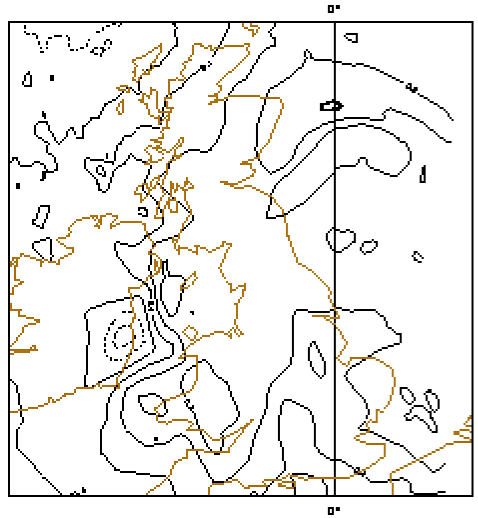




10min
10%

5min
5%





10min
5%

.2hPa interval

Forecasting precipitation from severe convection

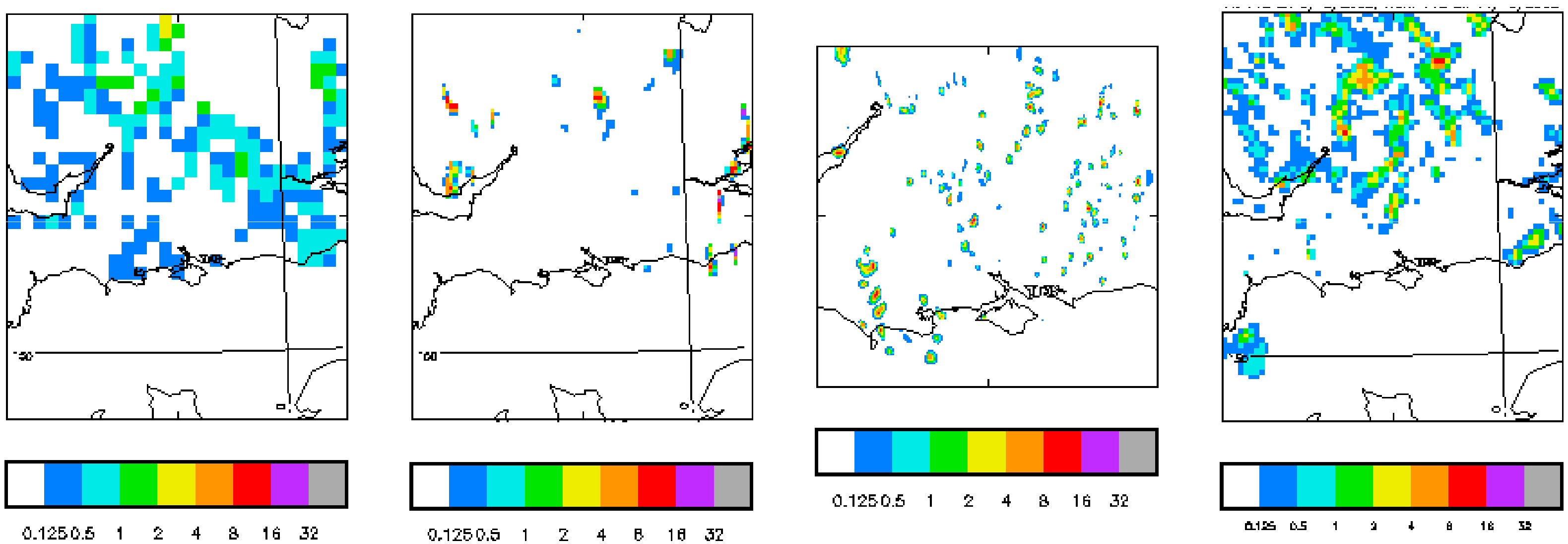
- Parametrized convection – limited success
- Very high resolution models (over a small domain), with detailed controlling factors, such as surface forcing and orography – promising
- Nesting -- typically 3 - 5:1
  - Requires a smooth transition
  - Mismatch of grids and model physics (e.g. coarse resolution model does not explicitly represent convection).
  - Possible solution: variable resolution ?

3rd May 2002 case

- **May 3 2002 case is a scattered convection case.**
- **To compare 1 km to 4 km variable resolution to a 1 km model nested inside a 4 km model .**
- **First, the conventional nested model.**

May 3 2002 Case
----- Nested model

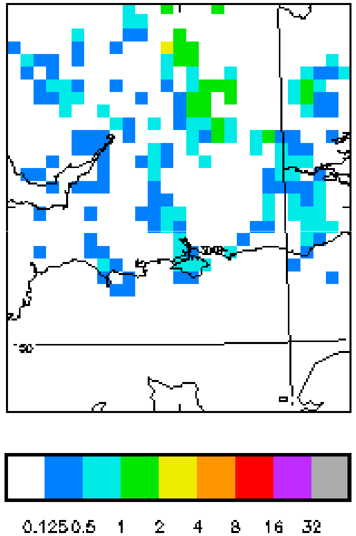
12 km | 4 km | 1 km | Radar

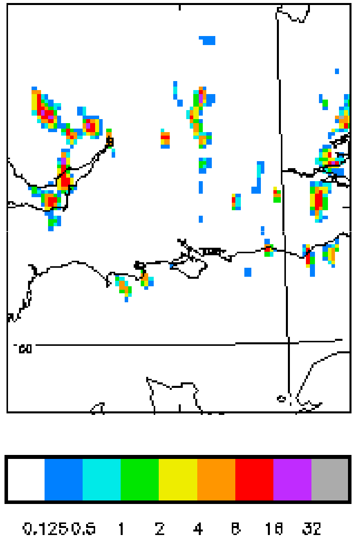


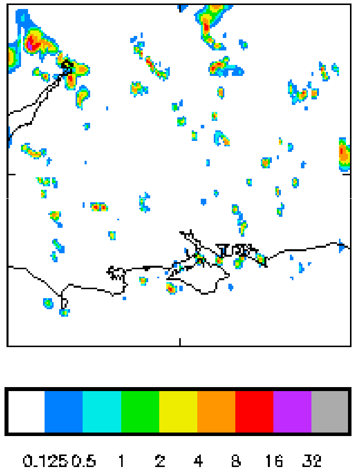
1 km high resolution nested model and radar rainfall at 14 UTC

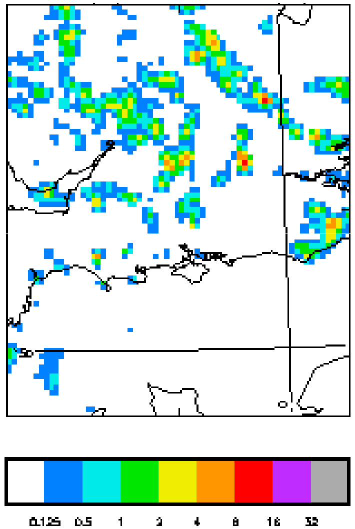
May 3 2002 Case
----- Nested model

12 km	4 km	1 km	Radar









1 km high resolution nested model and radar rainfall at 15 UTC

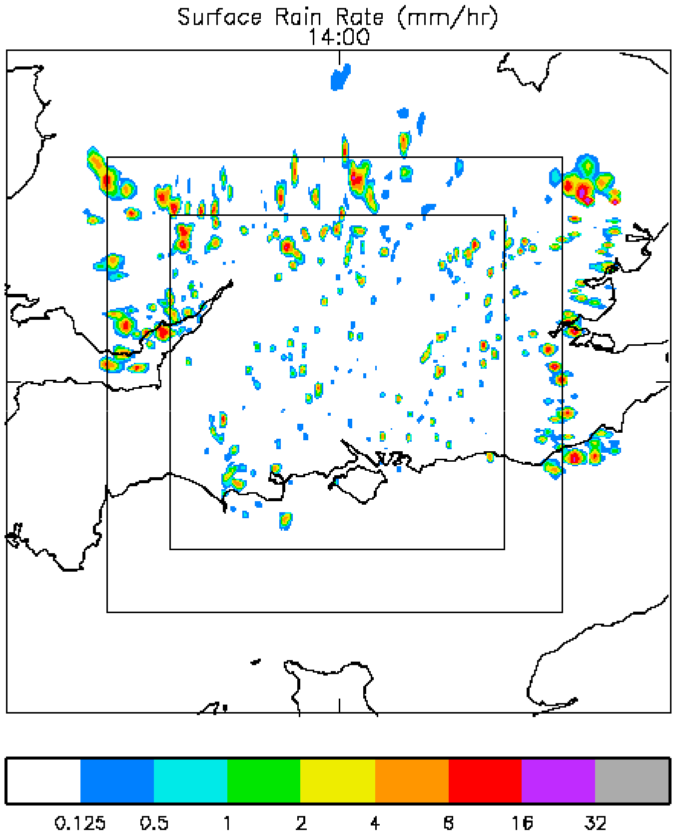
Summary of nested model result

3rd May 2002 case

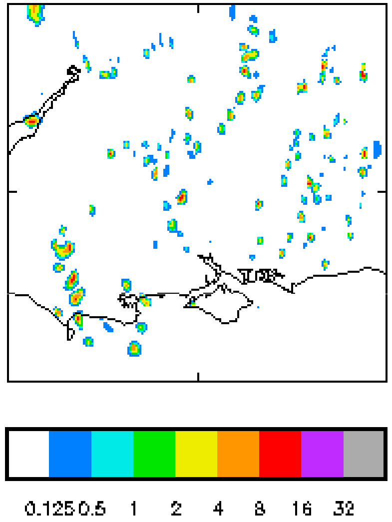
- Nested models suffered two major problems:
  - Spin up problem: at the inflow boundaries (northern) the nested model is too slow to produce convection.
  - Transition problem: at the end of the run when finally the large convection cells are being advected in from the 4 km model, they remain as large cells in the north.

- How well will variable resolution model do ?

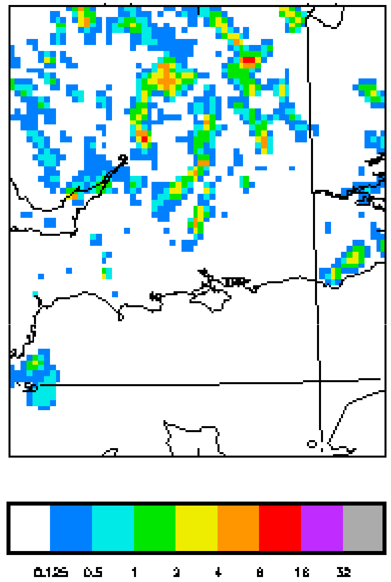
May 3 2002 Case
----- variable resolution model



1km

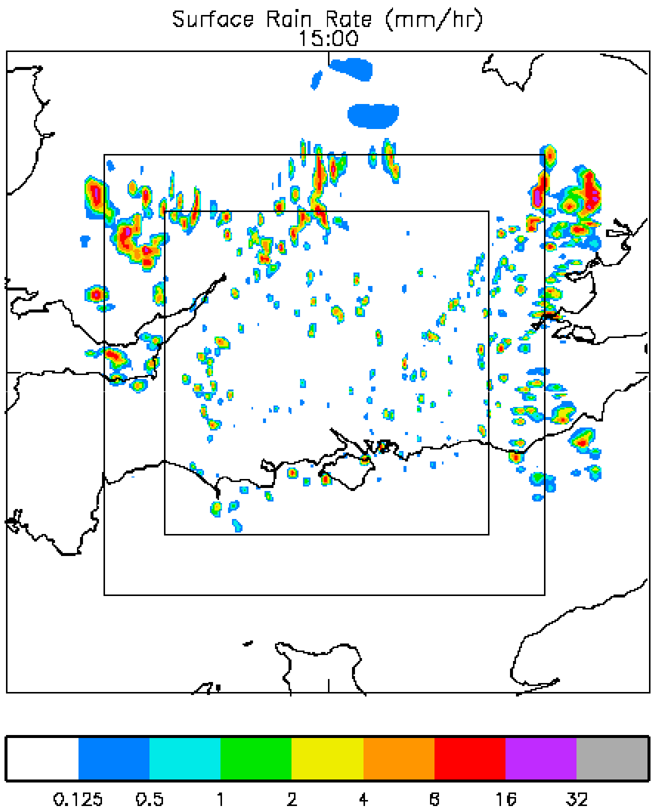


Radar

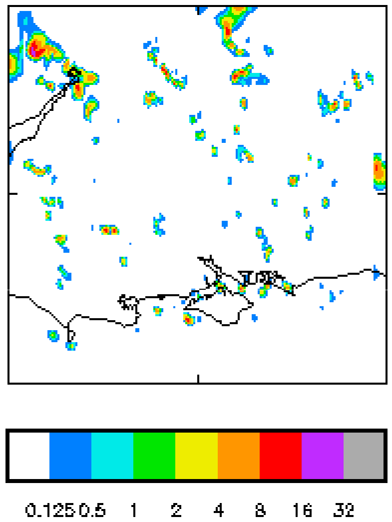


Rainfall at 14 UTC. The three regions of the variable resolution domain are also shown

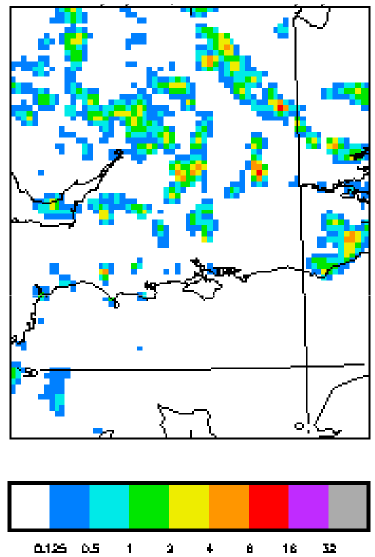
May 3 2002 Case
----- variable resolution model



1km



Radar



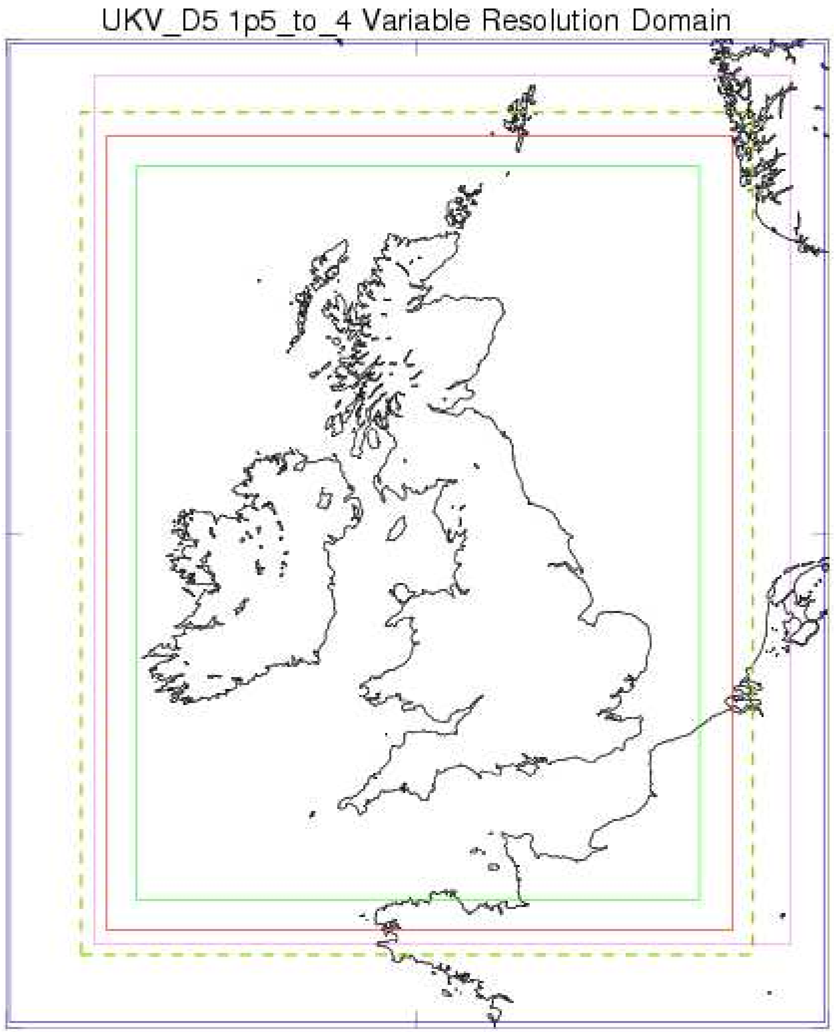
Rainfall at 15 UTC. The three regions of the variable resolution domain are also shown

Summary

- **In the variable resolution model, when the ratio of the minimum and maximum grid is the same as a conventional nesting ratio of 1 : 4, it performs better in resolving convective scale storms. In particular it has overcome the problems of spin up and transition, highlighted in the nested model.**

- **Further study is needed on the physical parametrization schemes if ratio > 4.**

UK 1.5 km domain



1.5km UK model plan

- **1.5km fixed resolution over UK with outer variable rim to 4km (*perhaps 12km*)**
- **3D VAR mainly over 1.5 km area**
- **Testing on new IBM starting January / March**
- **Parallel suite starts end of April (daily in May, 4x day July)**
- **Operational end-of-May (3DVAR August)**

The End