Storm-permitting Ensemble

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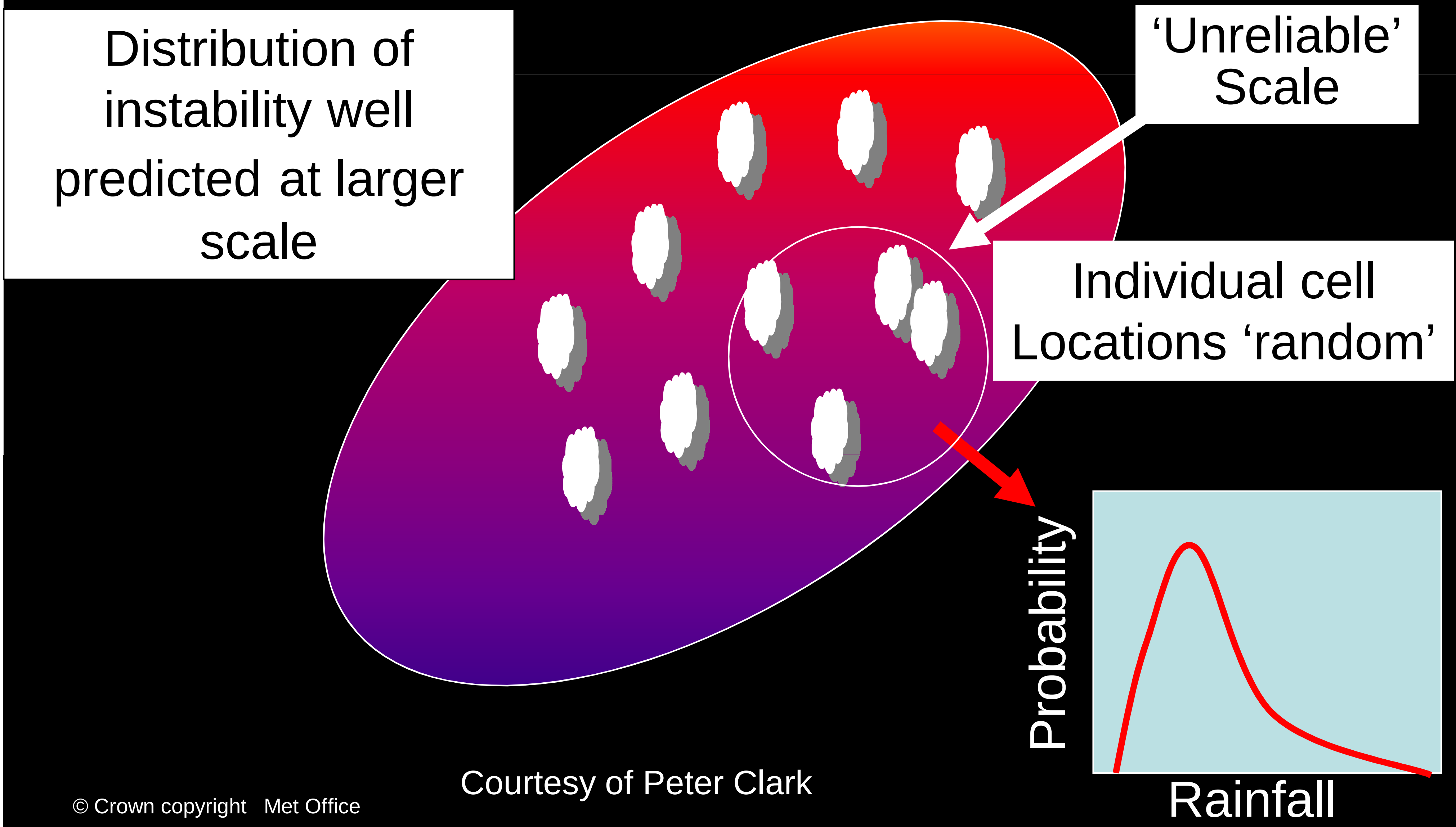
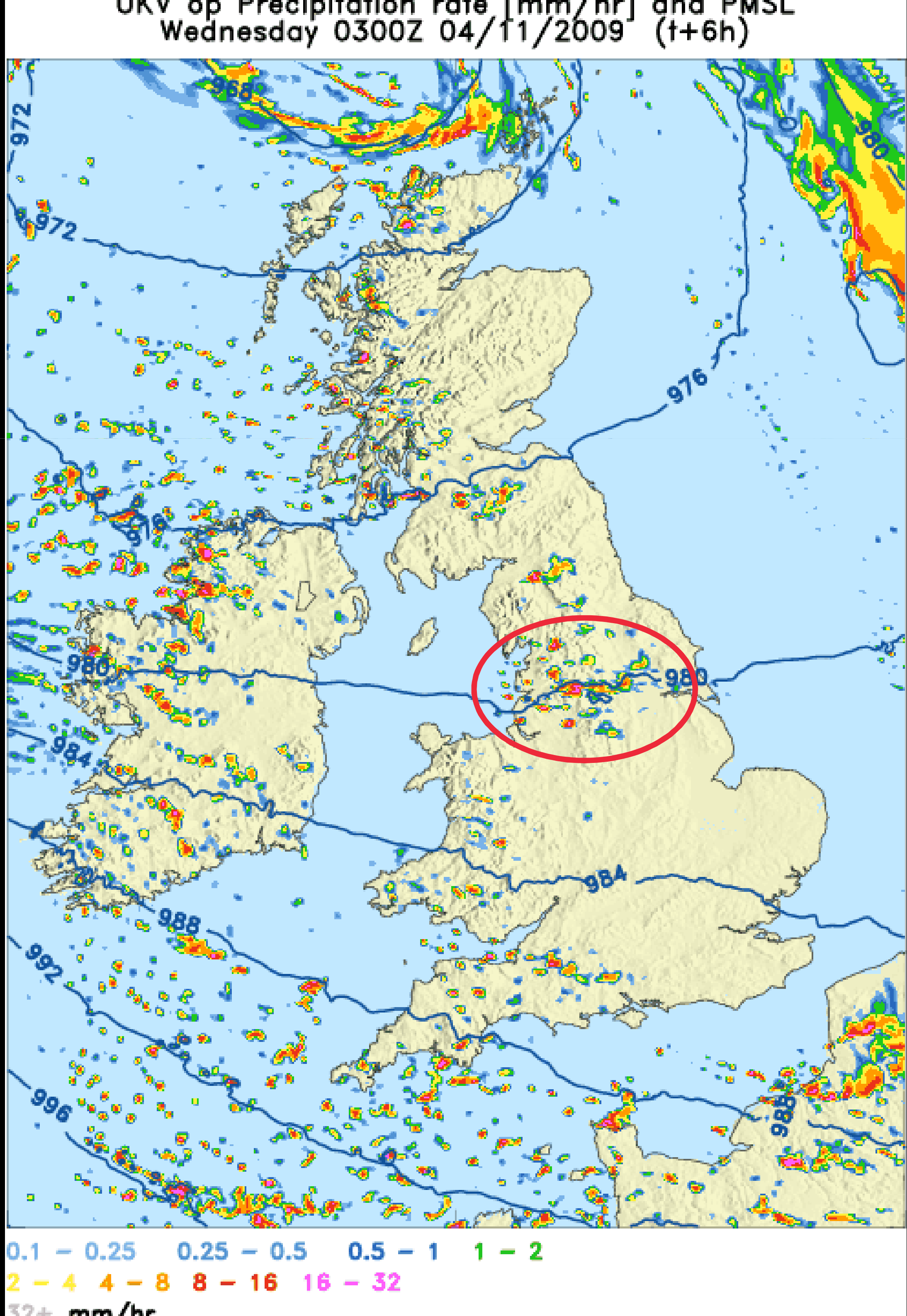
Joint Centre for Mesoscale Modelling, Readin g

We shouldn't believe high-resolution at face value (at or near the grid scale)



Courtesy of Peter Clark

Met Office


UKV op Precipitation rate [mm/hr] and PMSL
Wednesday 0300Z 04/11/2009 (t+6h)
972
972
976
976
980
980
980
984
984
988
988
992
996
0.1 – 0.25
0.25 – 0.5
0.5 – 1
1 – 2
2 – 4
4 – 8
8 – 16
16 – 32
32+ mm/hr

Consequence of uncertainty in forecasting local weather (e.g. pdf for showers)

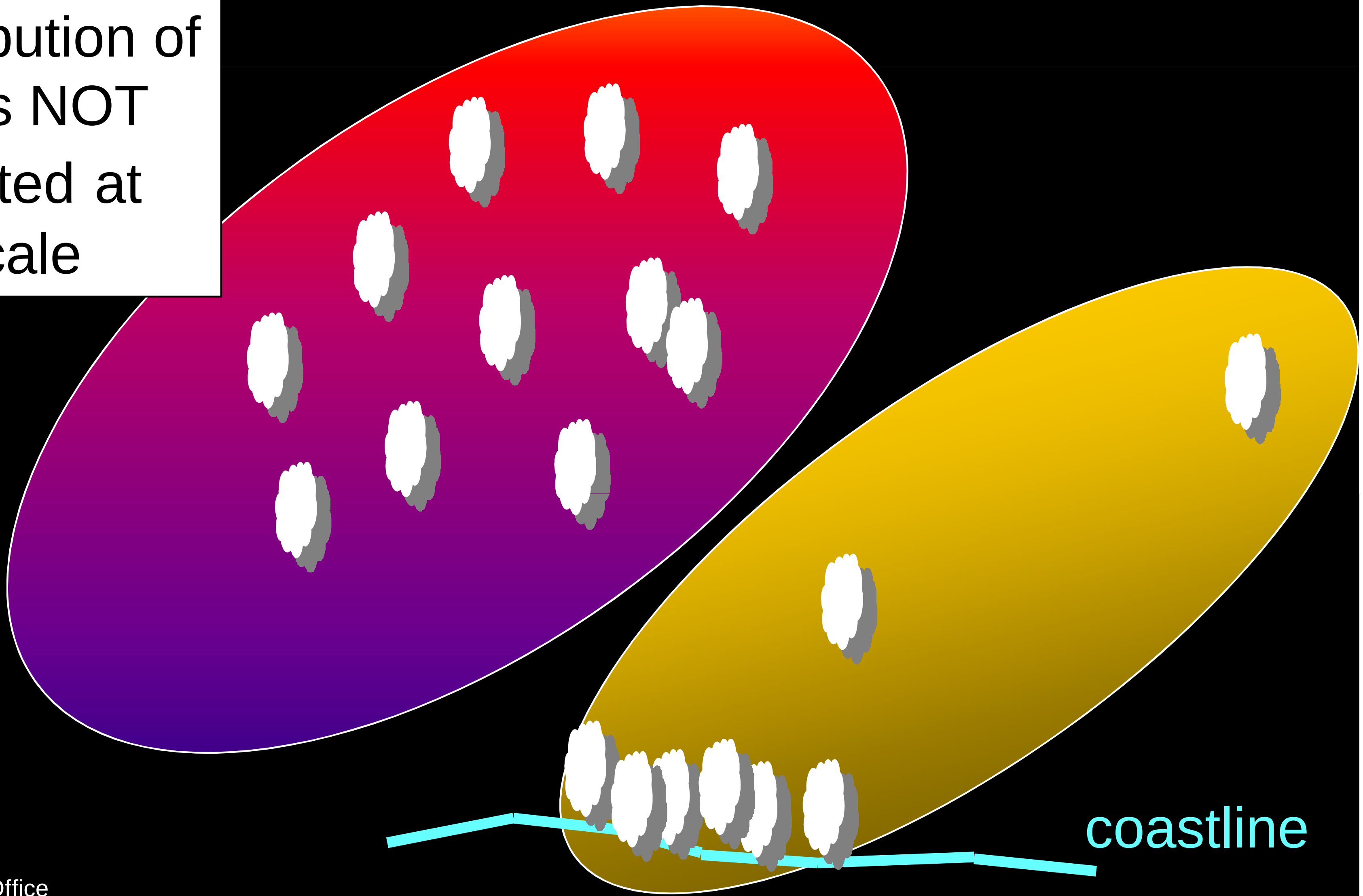
We don’t need an ensemble to produce a probability forecast

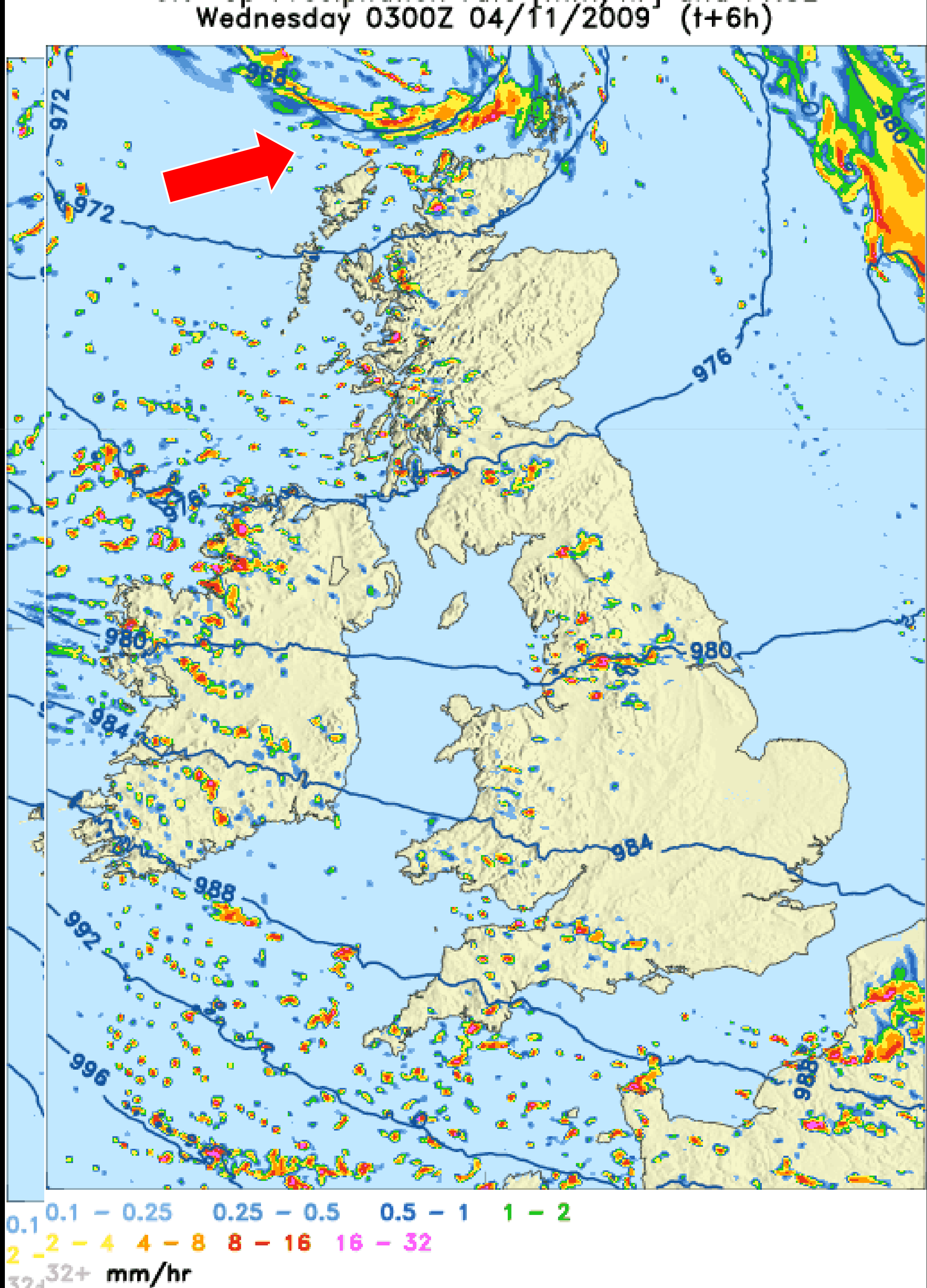
Nearby grid squares provide plausible alternative scenarios – and can therefore be treated as ensemble members

The so called ‘neighbourhood’ approach. Can work well.

We shouldn’t believe high-resolution at face value

What if distribution of instability is NOT well predicted at larger scale

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0.1 – 0.25   0.25 – 0.5   0.5 – 1   1 – 2
2 – 4   4 – 8   8 – 16   16 – 32
32+ mm/hr

Convective-scale Ensemble

Plan to routinely run a 2.2 km ensemble from 2012, embedded within MOGREPS-R (18 km -> 12 km) ensemble.

36-hour forecasts

12 members

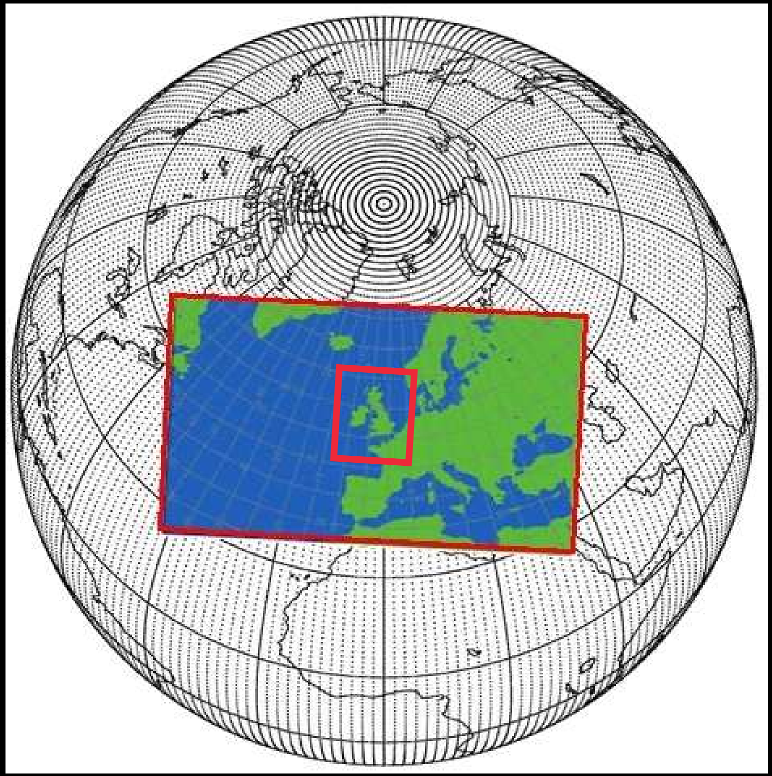
6-hour cycling

No high-res perturbations initially

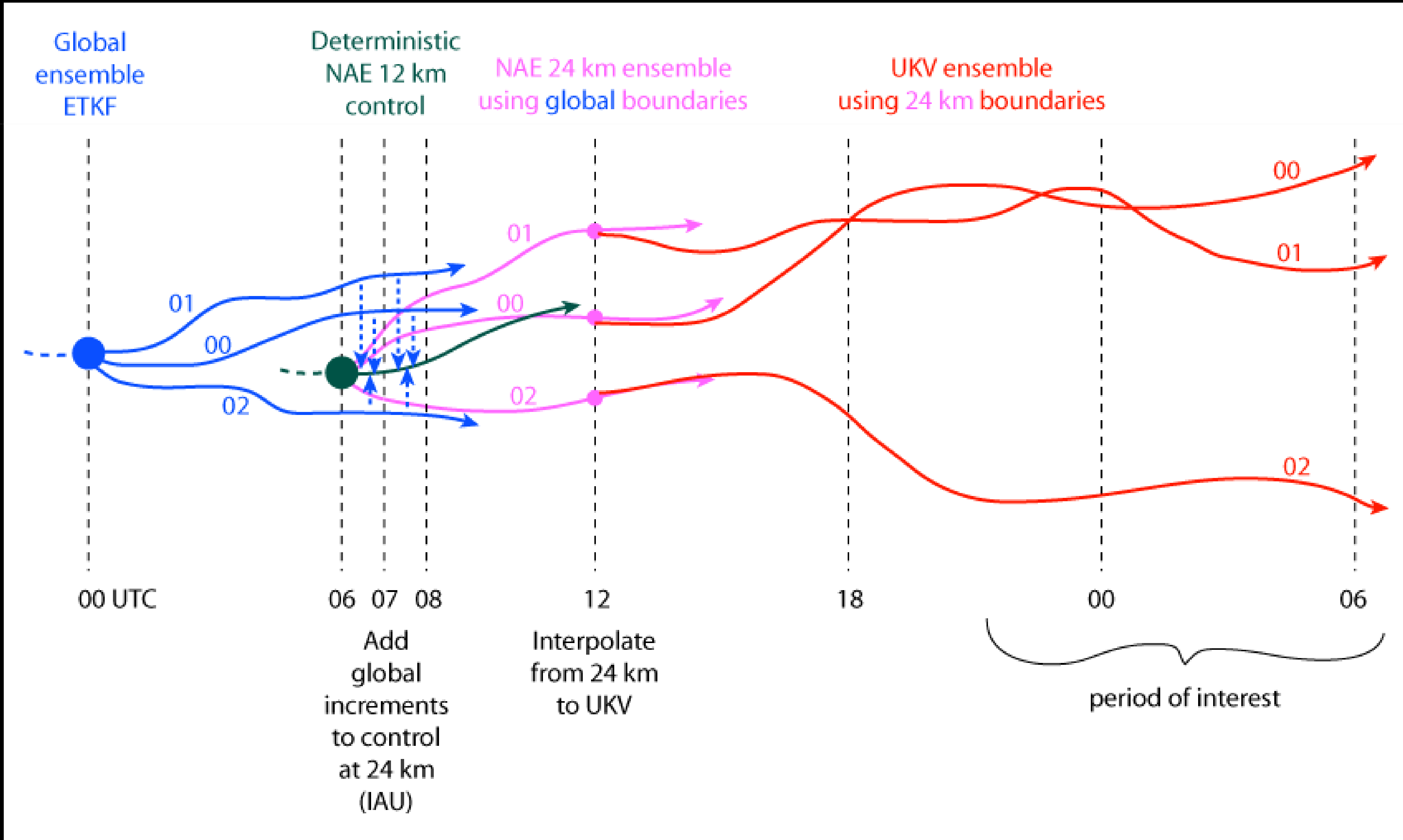
Initial experiments

Cases 24 members 1.5 km

Towards 3-6 members 1.5 km



How the UKV ensemble was run



Thanks to Neill Bowler and Changgui Wang

Met Office

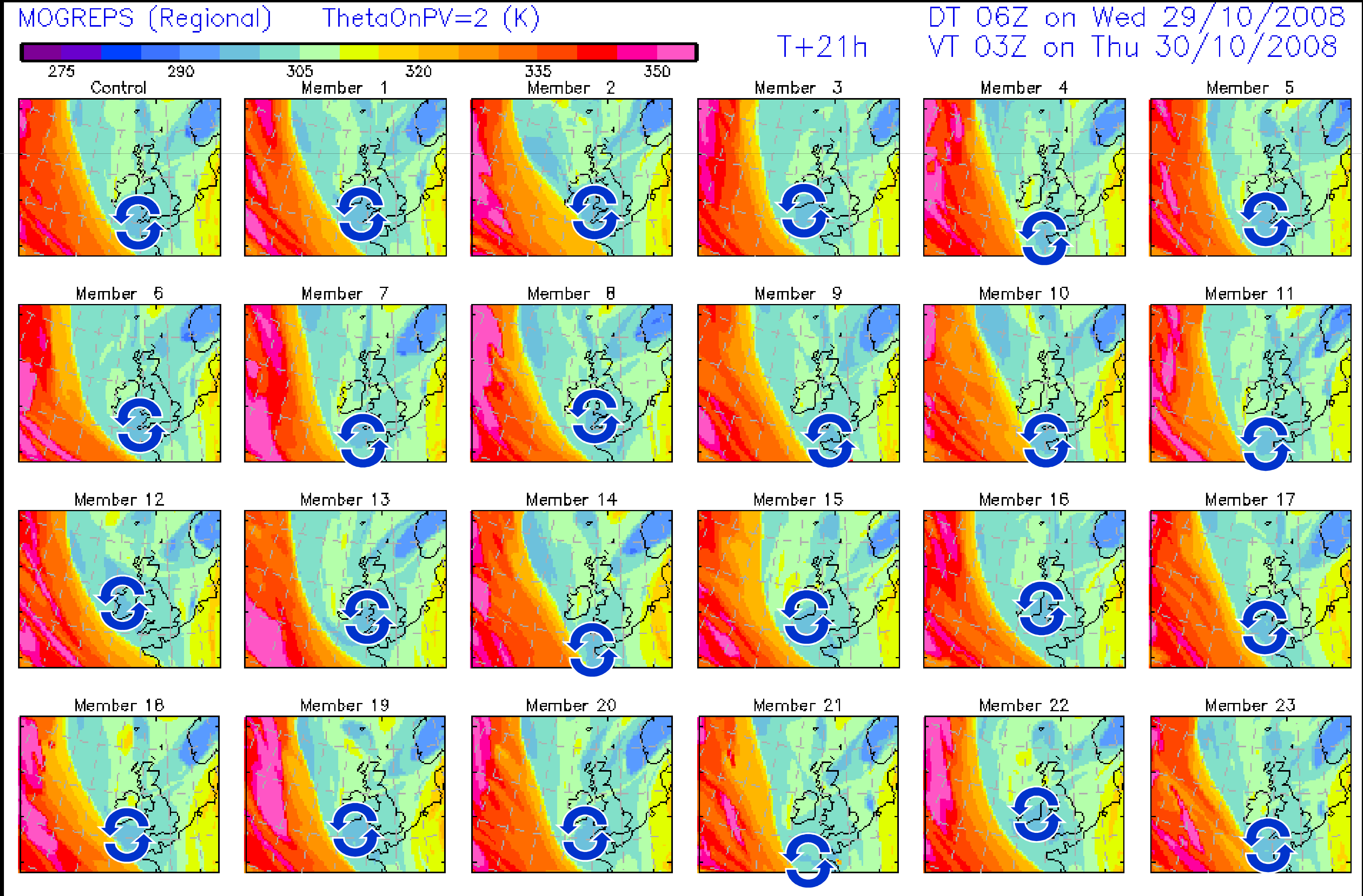
First case
Hailstorm in Ottery

Dramatic thunderstorm
Very localised
Flash floods in Otter Valley

Courtesy of Ken Mylne

MOGREPS-R (24 km) output

Mesoscale variability, NO large precipitation totals

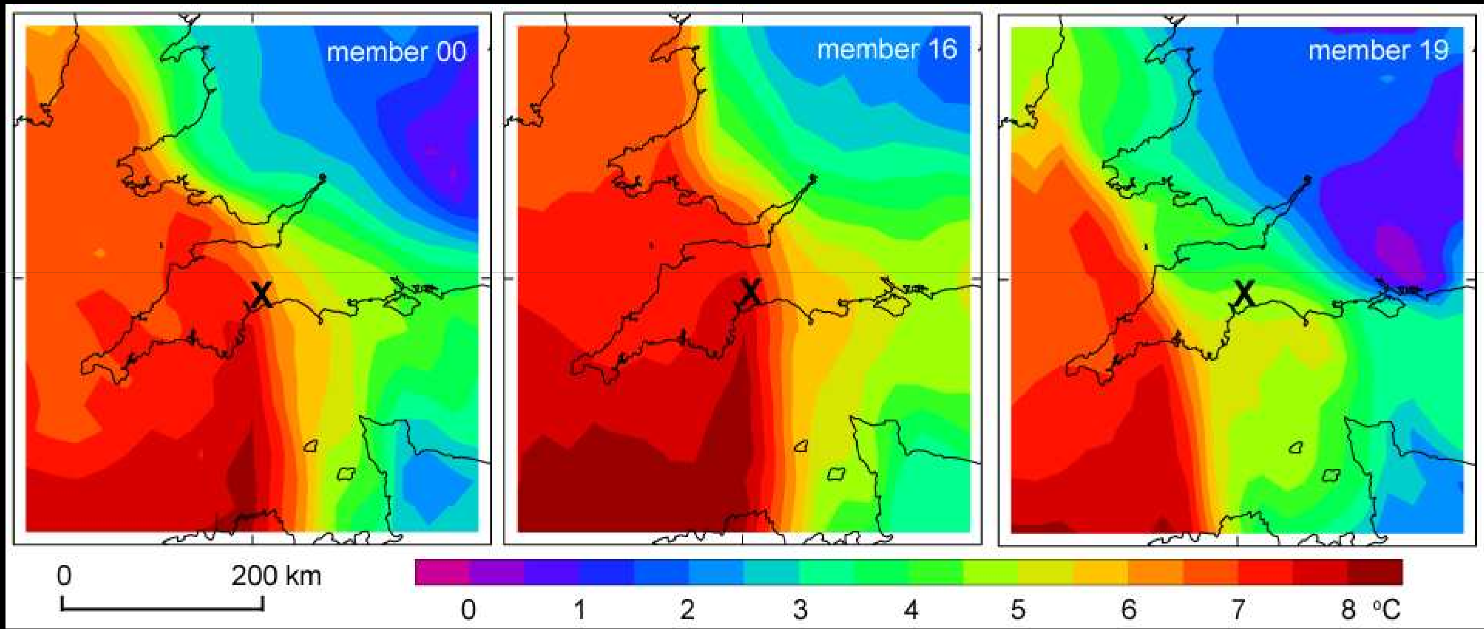


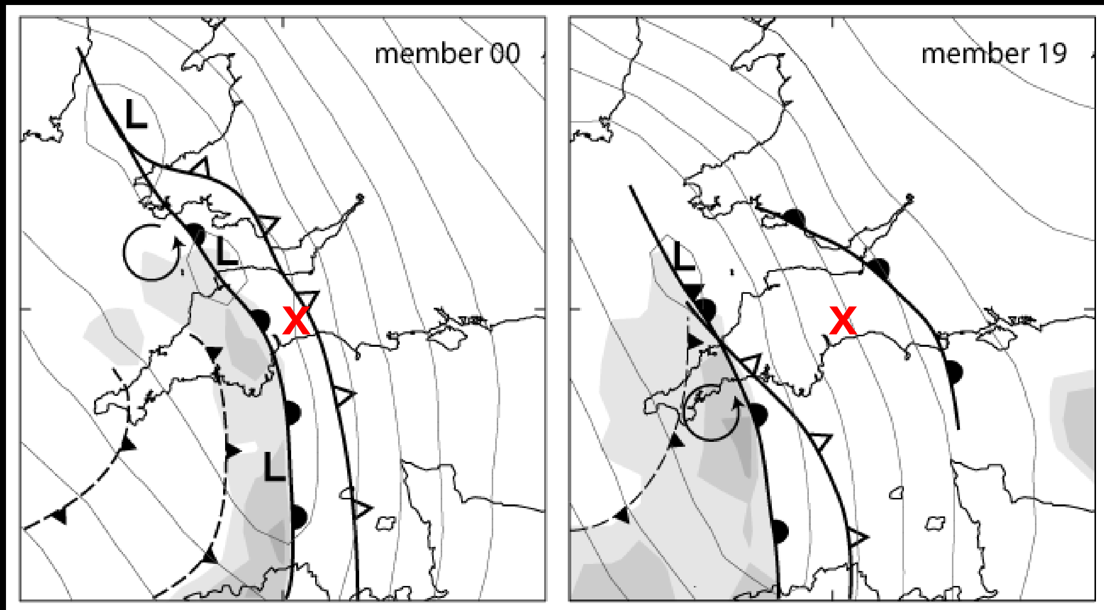
Courtesy of Caroline Jones

MOGREPS output 00 UTC 30/10/08
T+18 - selected members

θ_w

950 hPa





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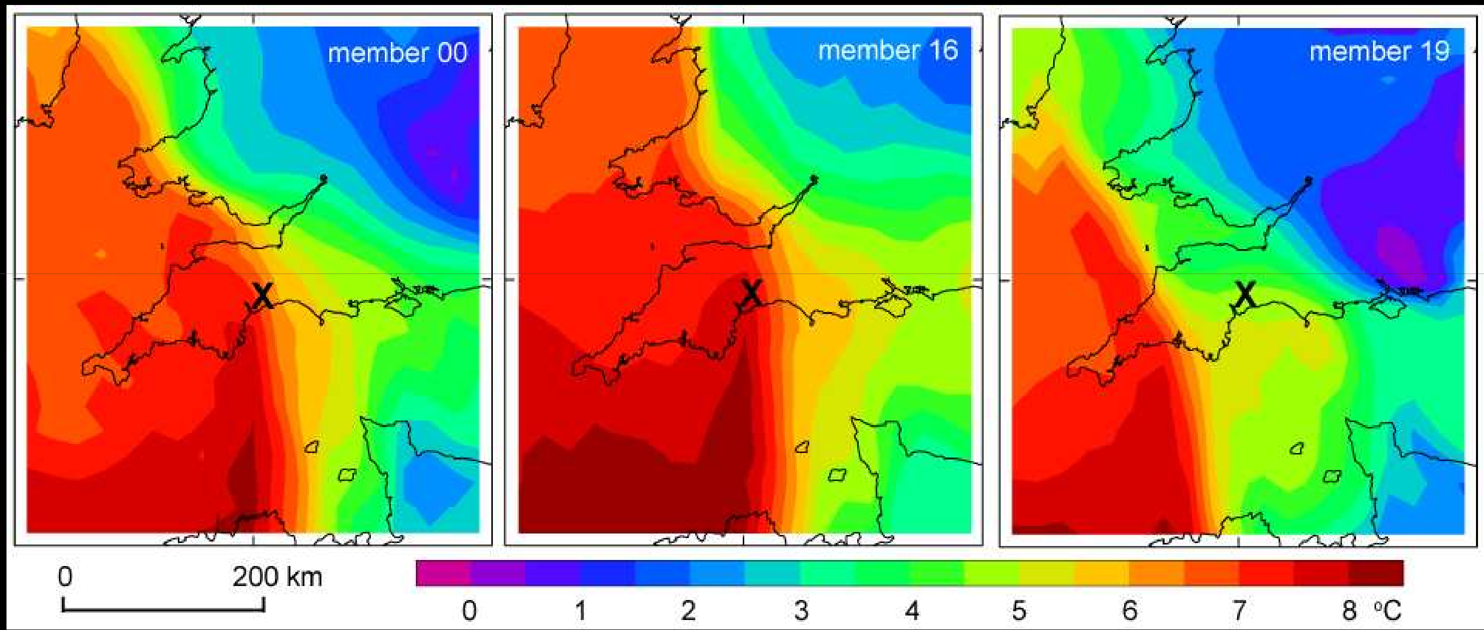
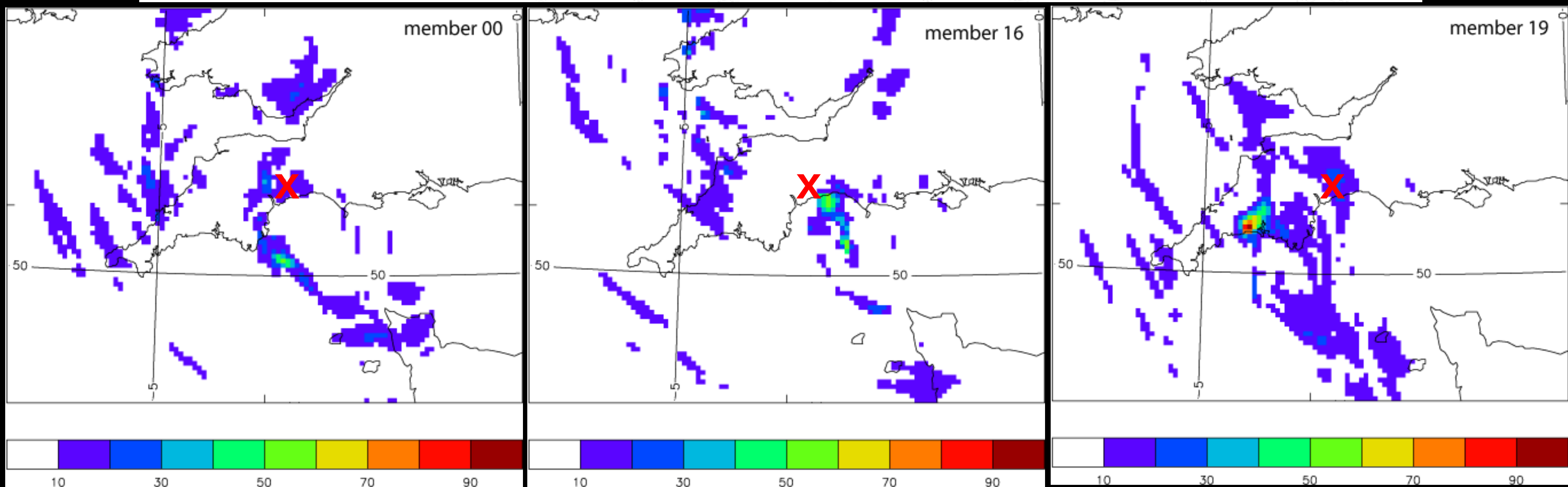
MOGREPS output 00 UTC 30/10/08 (top)
UKV 6-hour accumulations (bottom)



Highest
6-hour totals



55 mm 55 mm 96 mm

Computed on 4.5km grid – Changgui Wang

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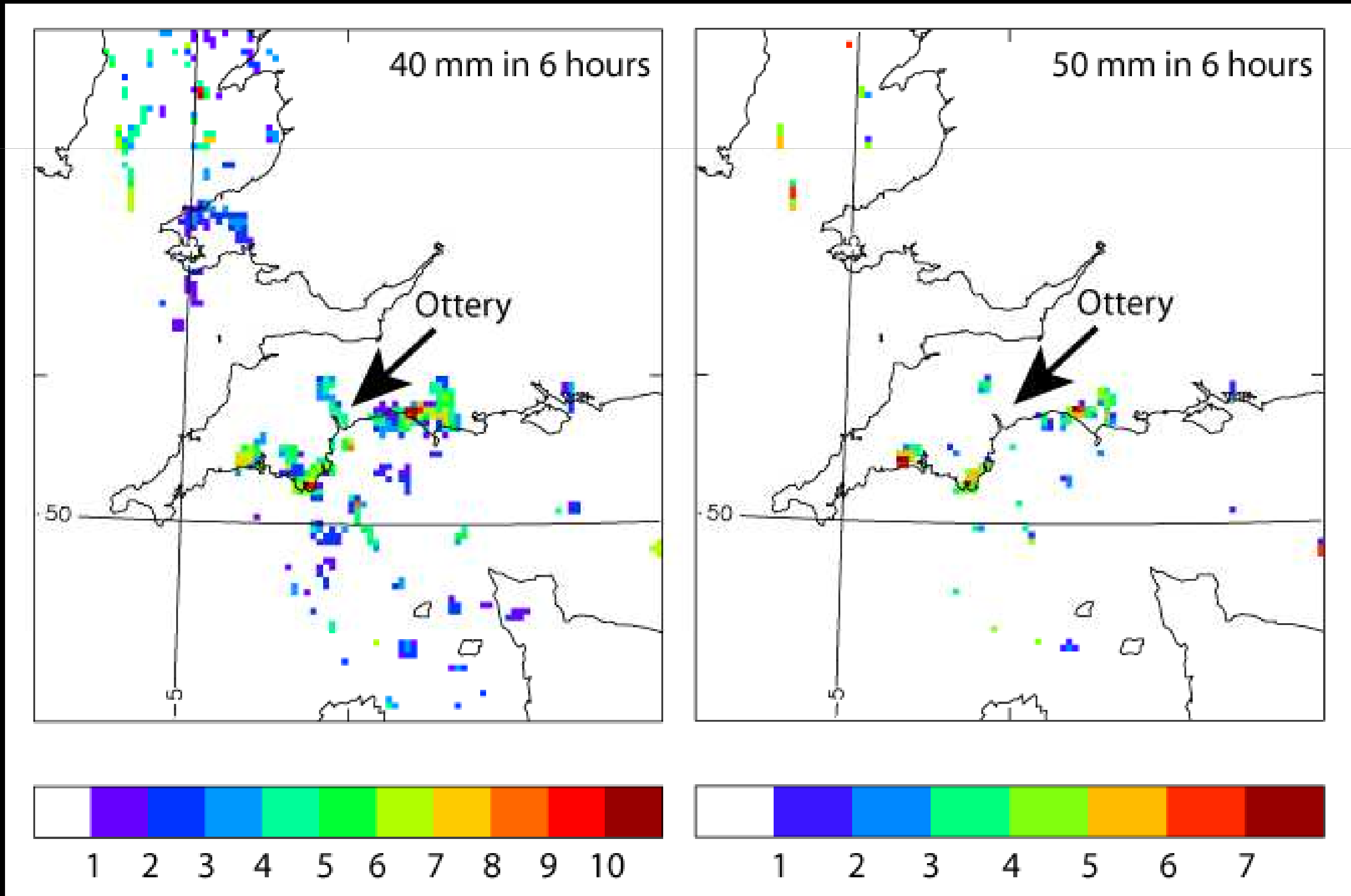
All pixels exceeding critical thresholds

‘Extreme’ threshold for surface water flooding

1 in 10 years

1 in 30 years



Computed on 4.5km grid – Changgui Wang

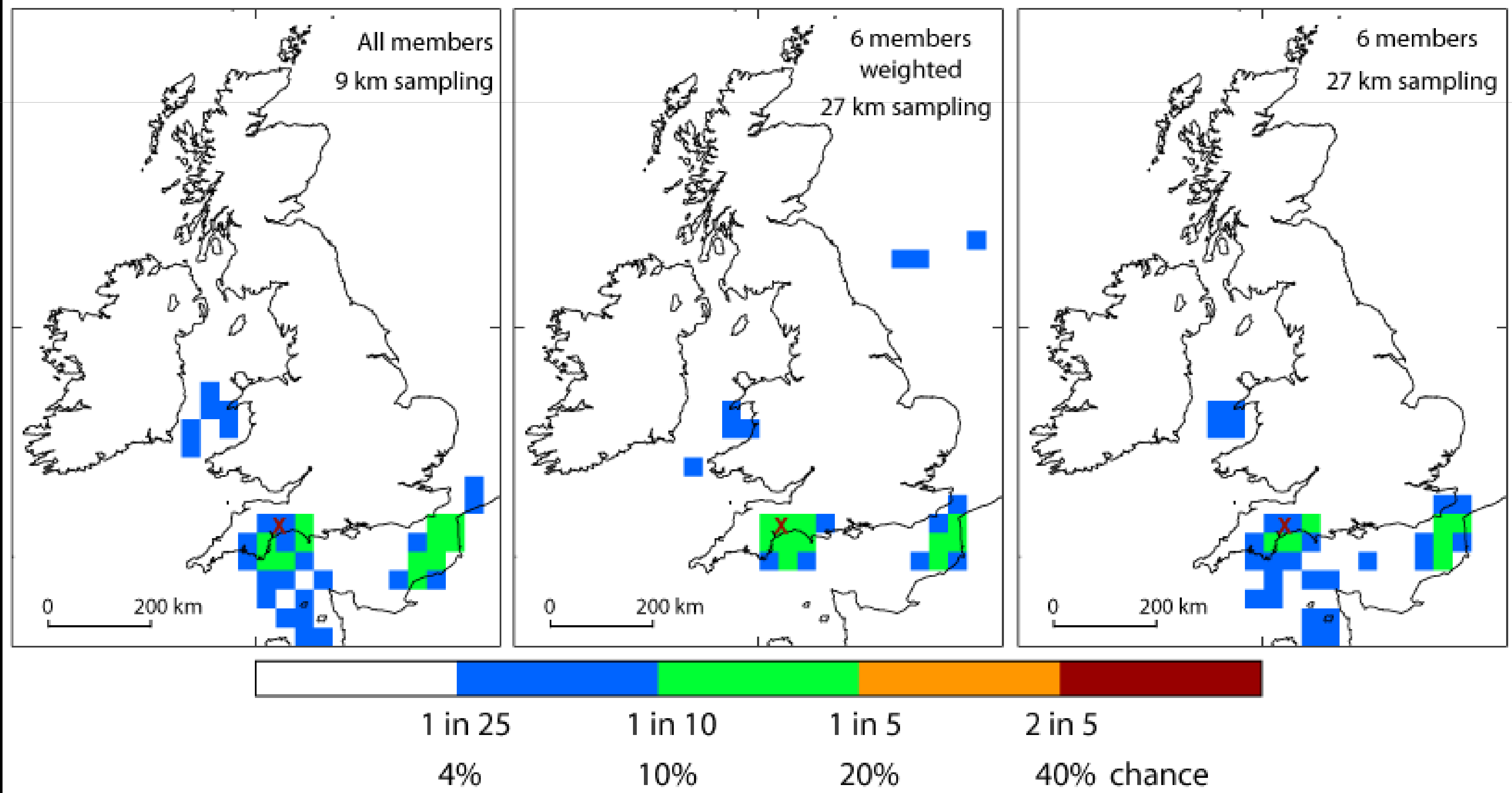
The question of ensemble size

24 members at 1.5 km is too expensive!

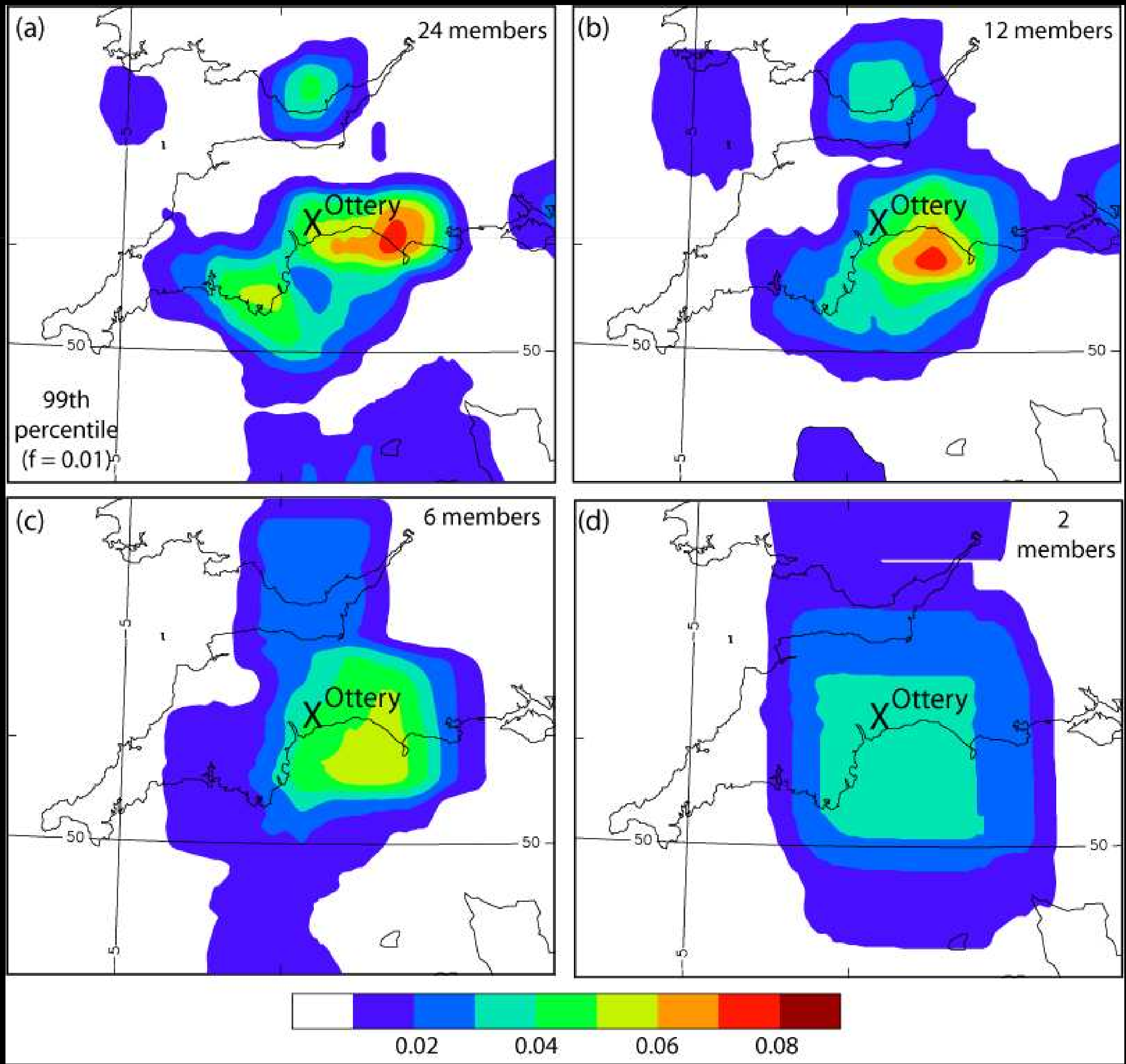
How good is a smaller ensemble?

Probability of an 'extreme' event within 36x36km squares

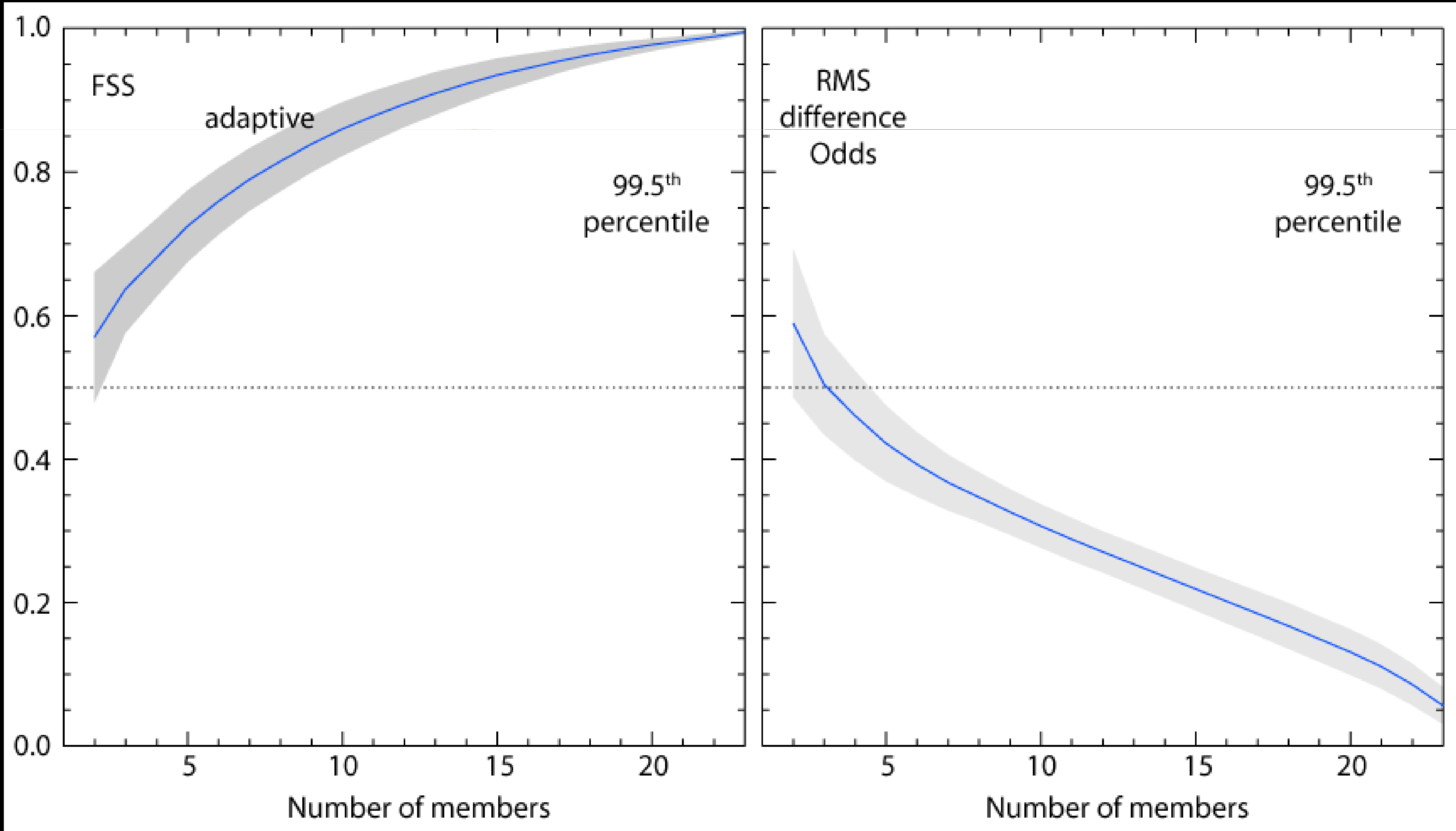
Traditional clustering method found wanting – weighted sampling should be better



Adaptive neighbourhood processed probabilities



Comparison of ensemble sizes



What about model grid spacing?

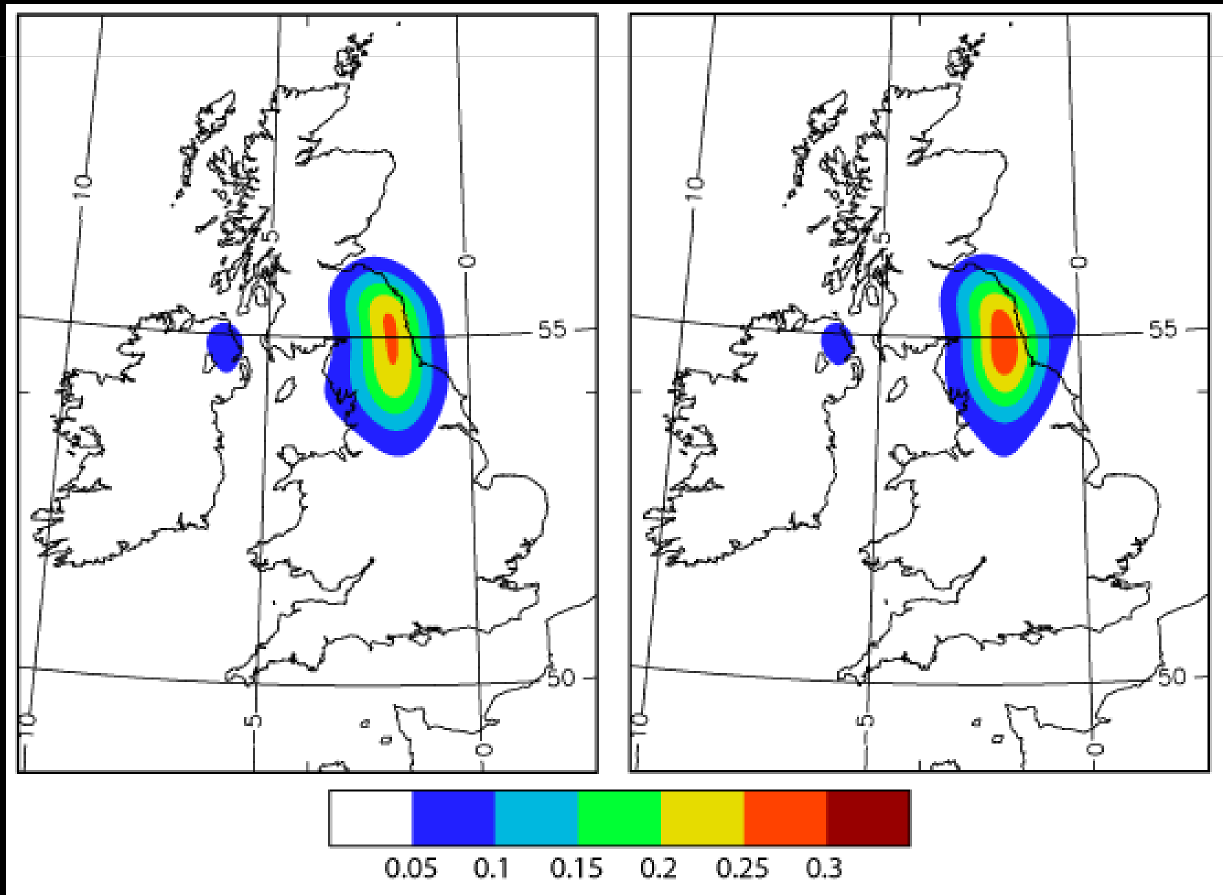
24 members at 1.5 km is too expensive!

Coarser resolution buys more members

Morpeth flood event 5-6 Sept 2008

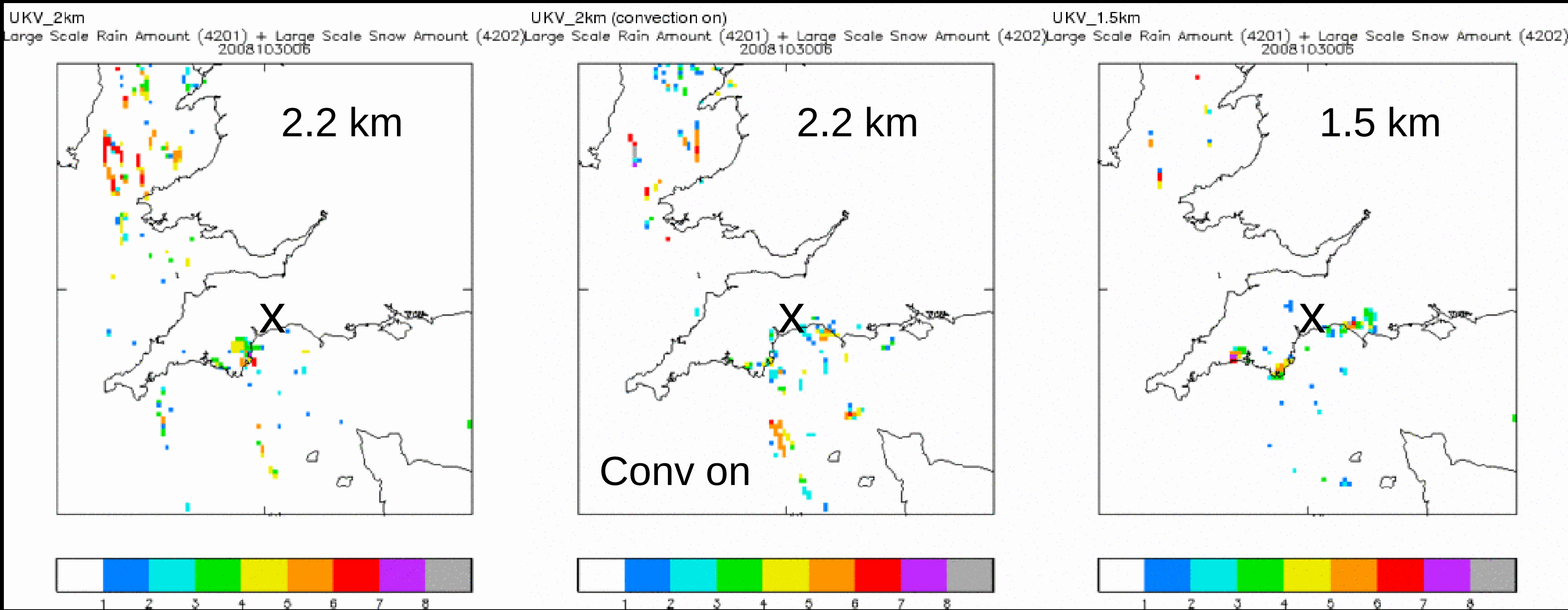
Probability of exceeding 50mm in 17 hours

UKV 24 members   2.2km 24 members



2.2 km compared to 1.5 km

Focus of convection is moved from coastal strip to over the sea

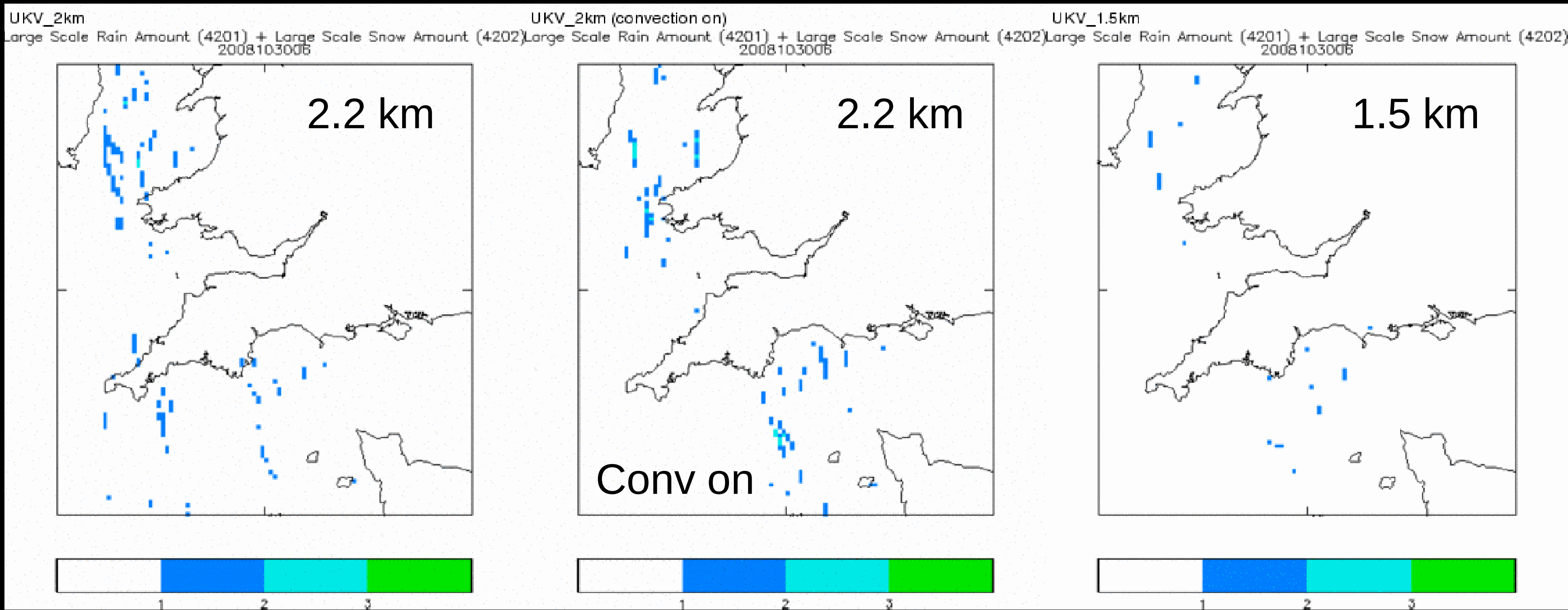


Number of pixels exceeding the ‘extreme’ threshold 50mm in 6 hours from all 24 members

Thanks to Changgui Wang

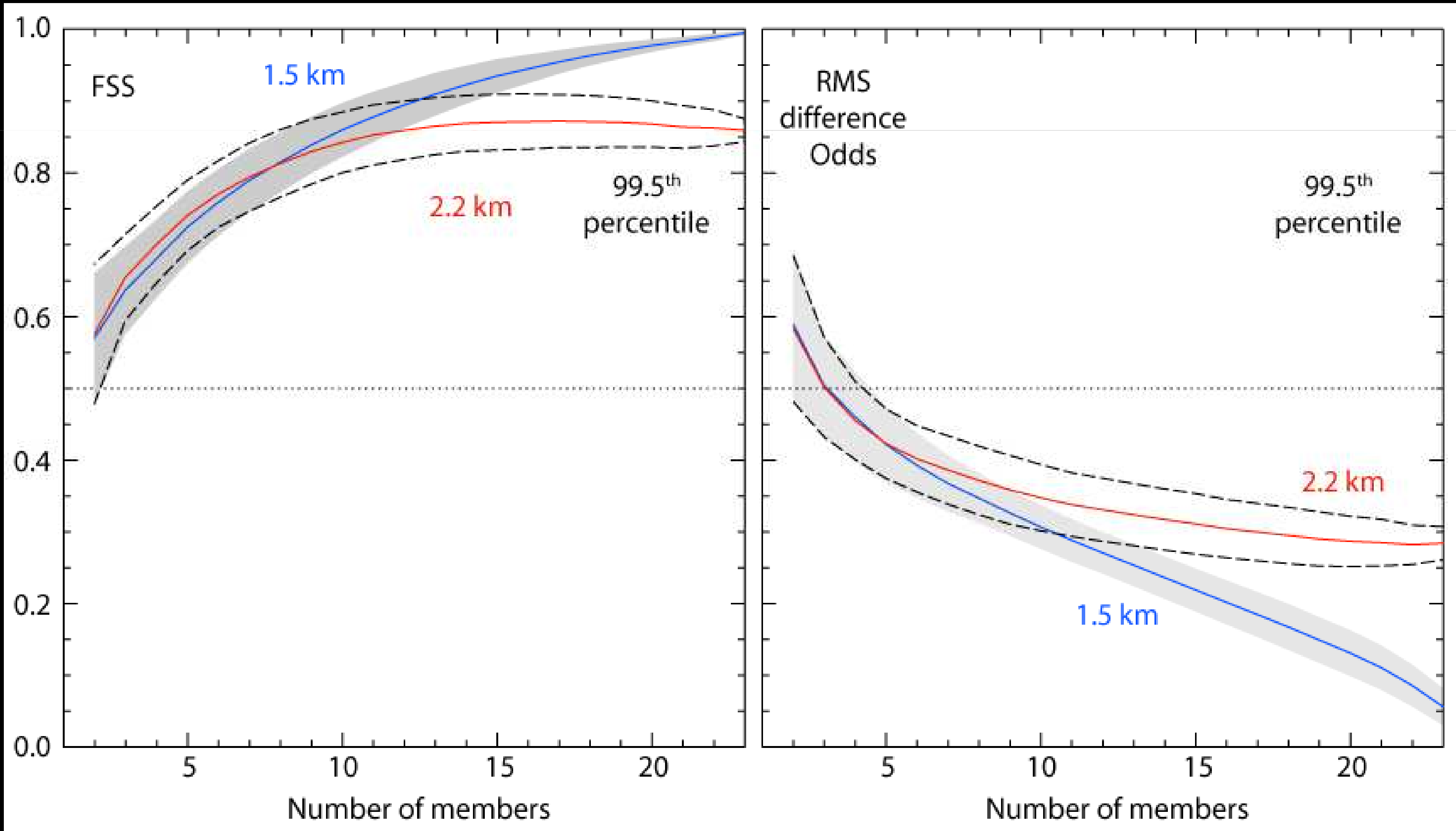
2.2 km compared to 1.5 km

Focus of convection is moved from coastal strip to over the sea

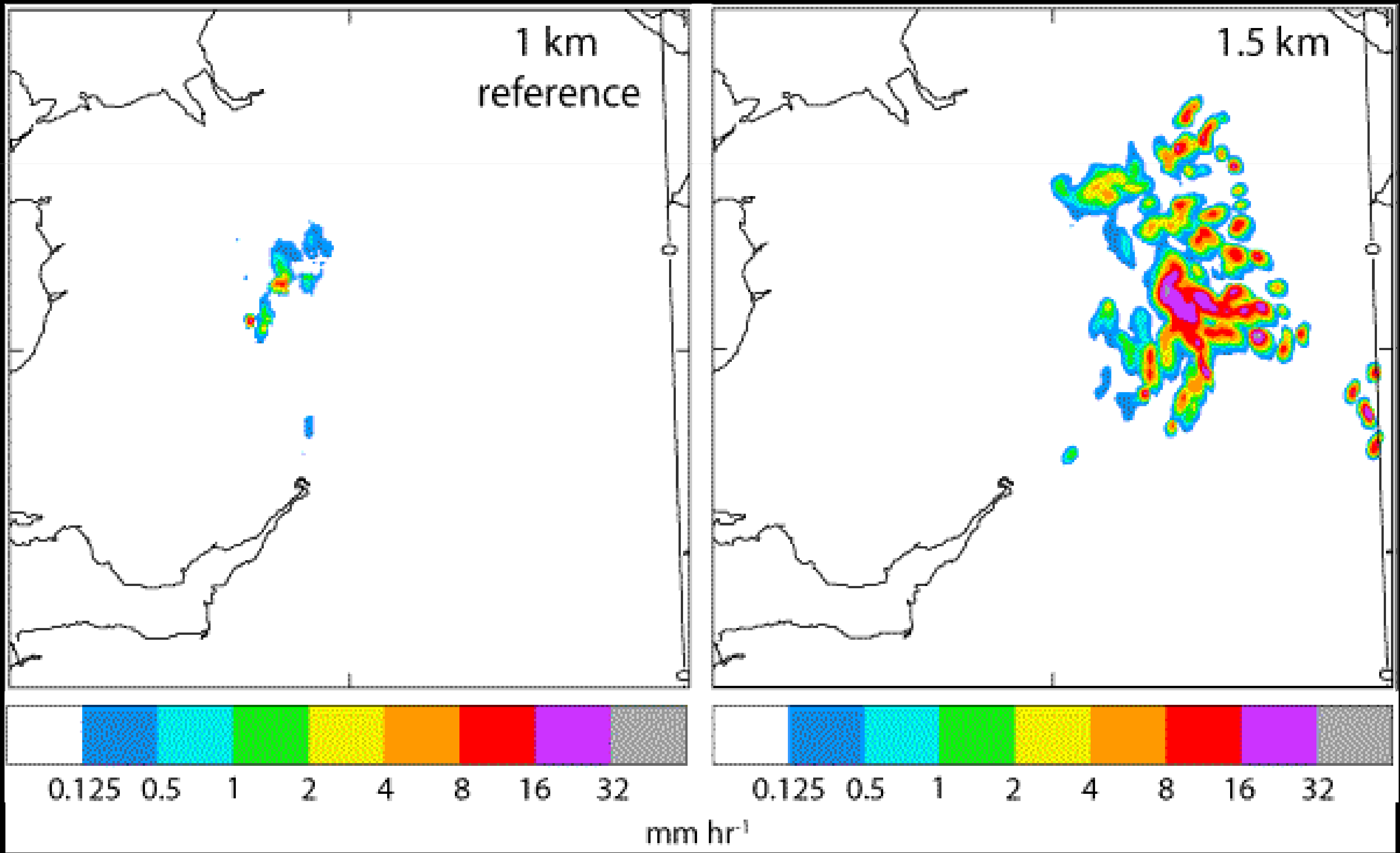


Number of pixels exceeding the ‘extreme’ threshold 30mm in 1 hour from all 24 members. Short-lived very heavy rain only over the sea in forecasts

Comparison of ensemble sizes and resolution

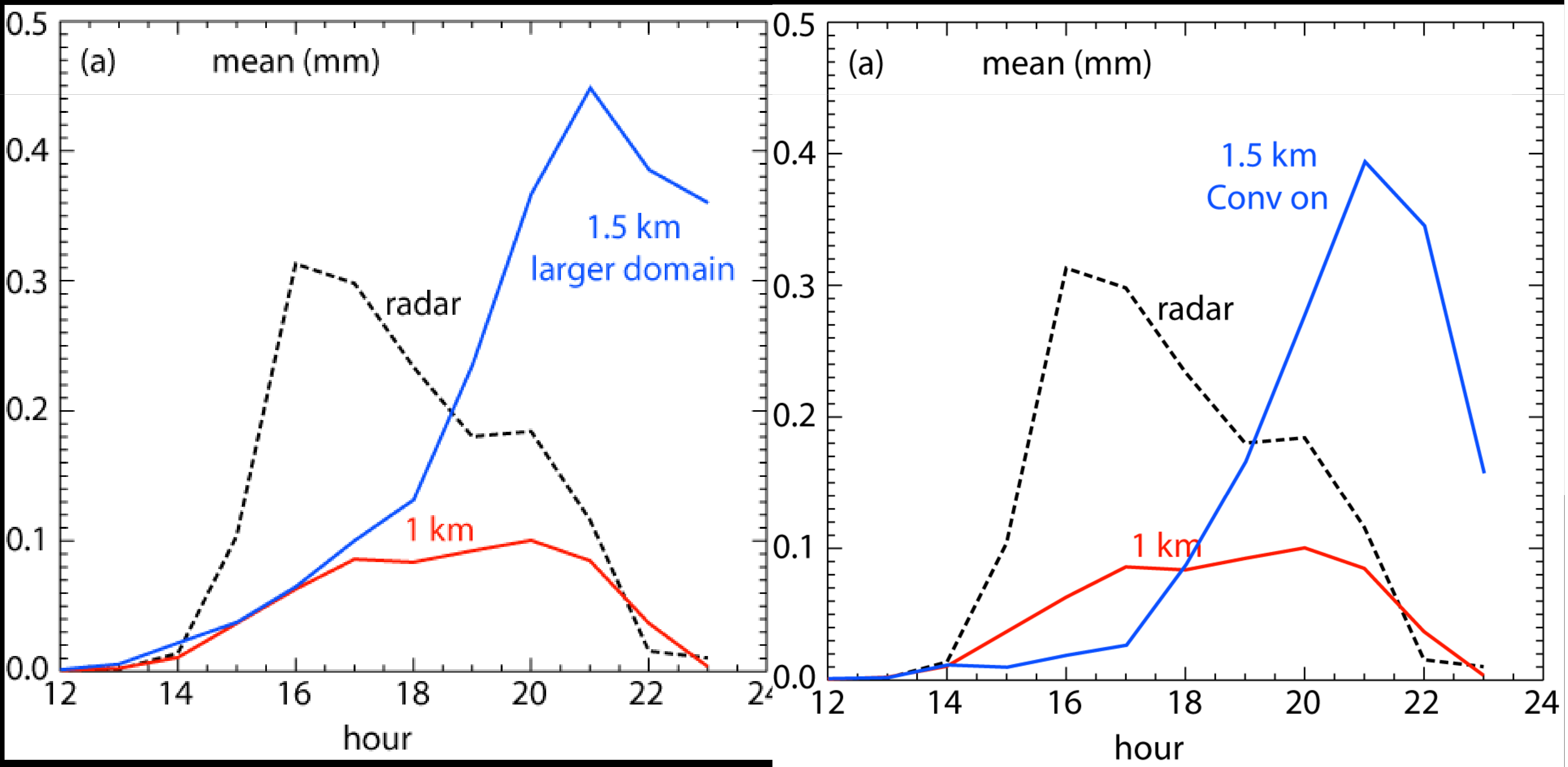


Another case



Nonlinear storm feedbacks are resolution sensitive

Updraft strength, turbulence, microphysics, lid, warmth, humidity, flow ….



Storm-permitting ensemble - findings

High resolution crucial for predicting high-impact local weather

Important to represent mesoscale uncertainty (larger-scale flow)

Neighbourhood processing can effectively increase ensemble size and represent small-scale uncertainty

Neighbourhood processing can adapt to ensemble spread and scales of uncertainty

Ensemble size – a small ensemble can do a reasonable job if processed intelligently

Model resolution – 12-member 2.2 km ensemble is comparable or better than 6-member 1.5 km ensemble (except perhaps for most extreme situations)

Beware – resolution dependence can be crucial in some situations. Need to understand biases. Incorporate physics uncertainties.

Met Office

Thanks for listening.