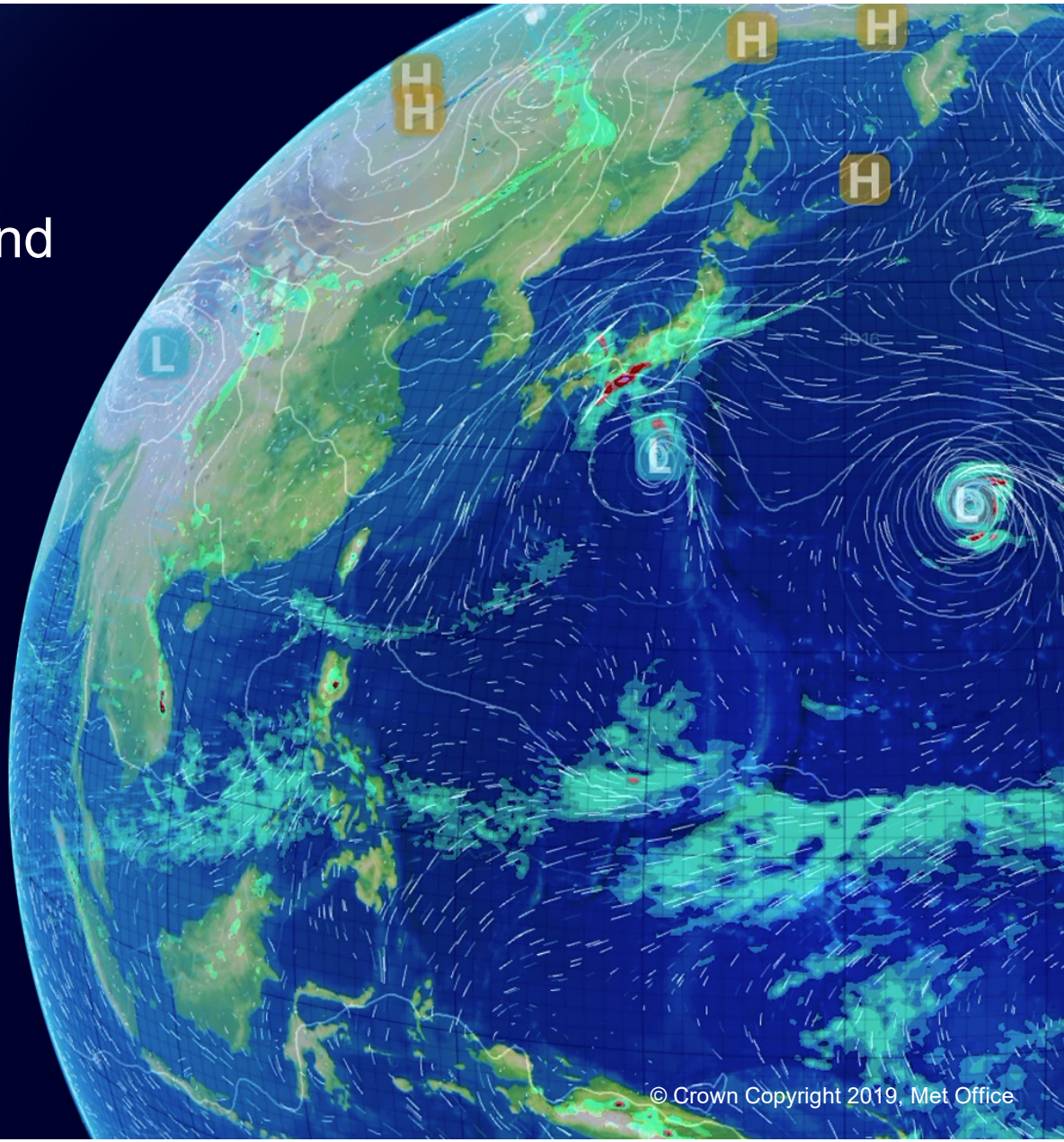
Convection-permitting ensembles and neighbourhoods for extreme events

Nigel Roberts



Thinking about extremes

Not all rare events are extreme!

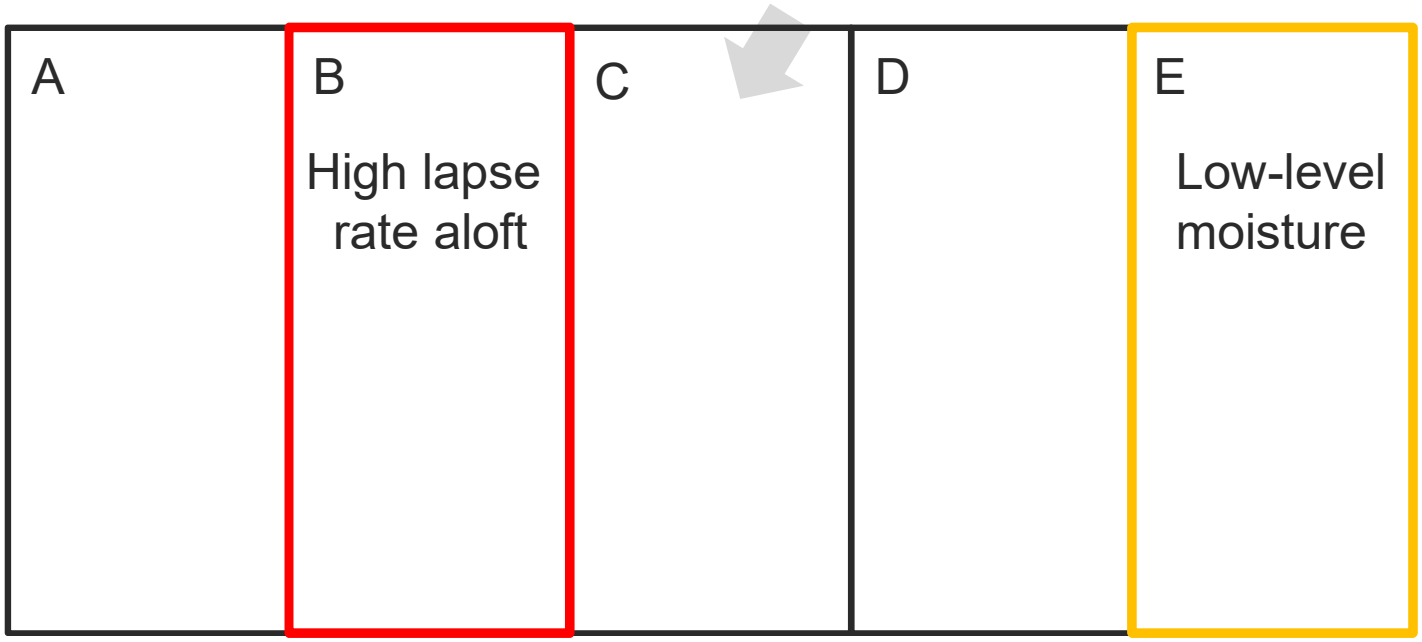
30 average temperatures in a row may be rare but isn't extreme

Not all extreme events are extreme!

If the conditions are favourable an extreme event may not be a surprise

What is extreme for a location may happen quite often in a wider area

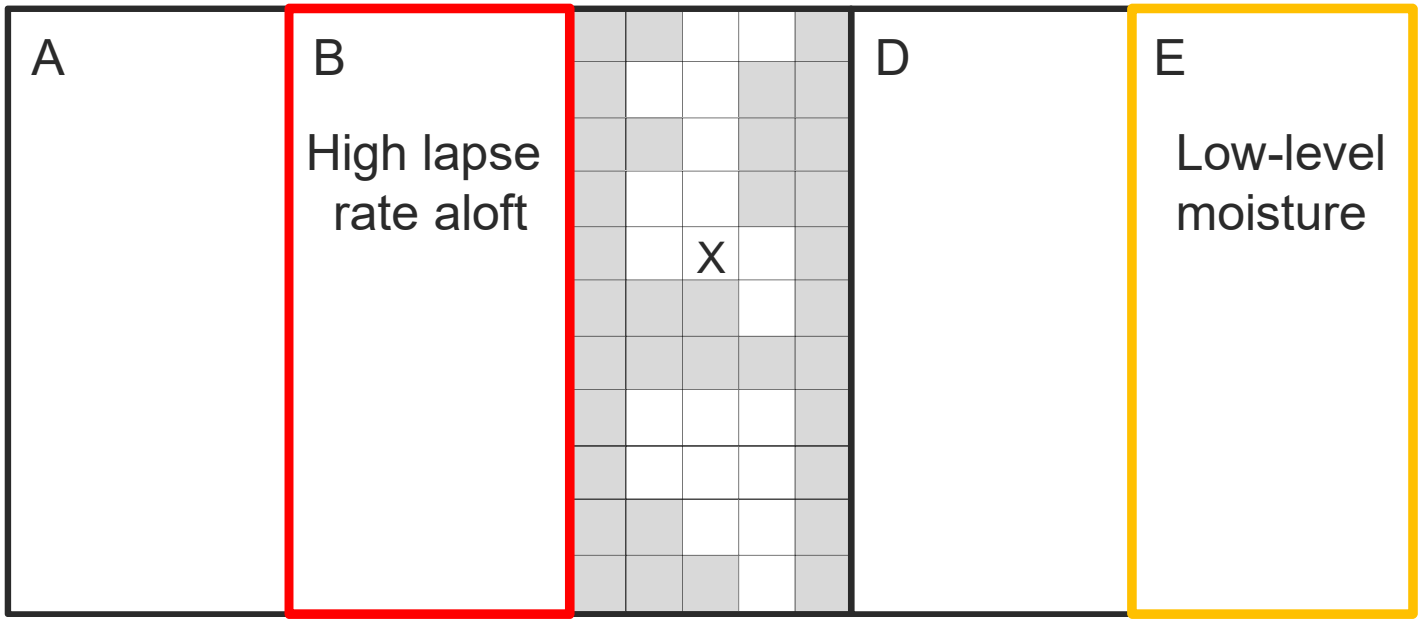
What's the chance of an extreme event?



Chance of required conditions coinciding = 1/5

Chance of required conditions coinciding in region C = 1/25

What's the chance of an extreme event?

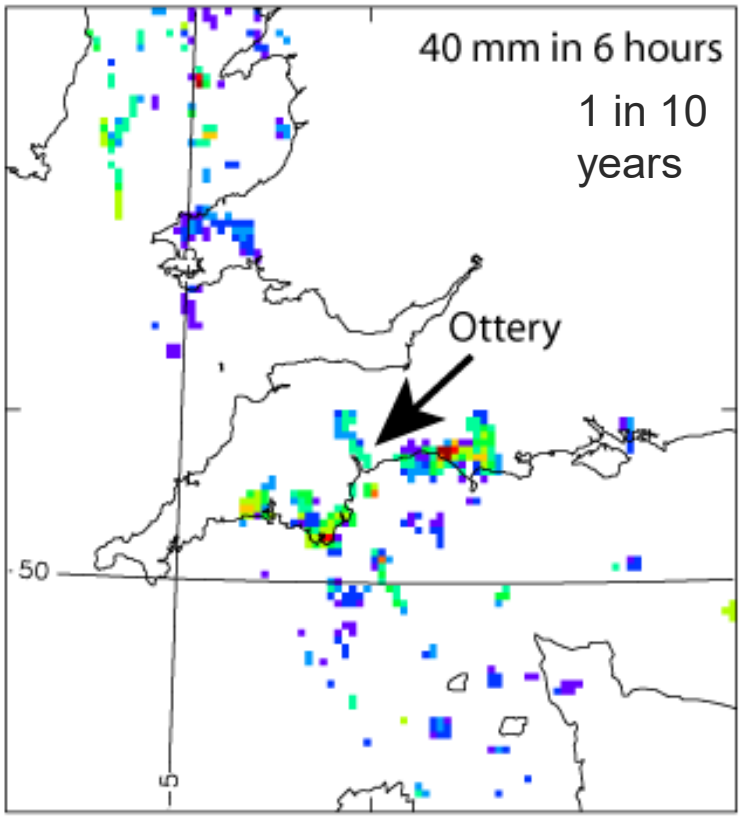


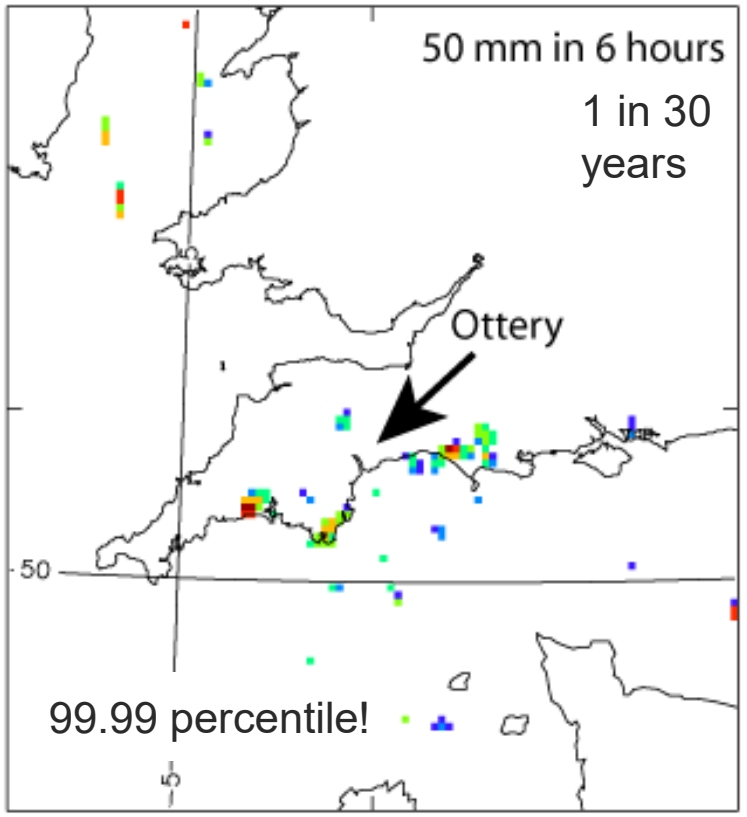
Chance of required conditions coinciding = 1/5

Chance of required conditions coinciding in region C = 1/25

Chance of the storm occurring in local area X = 1/500

Example extreme event





24-member ensemble

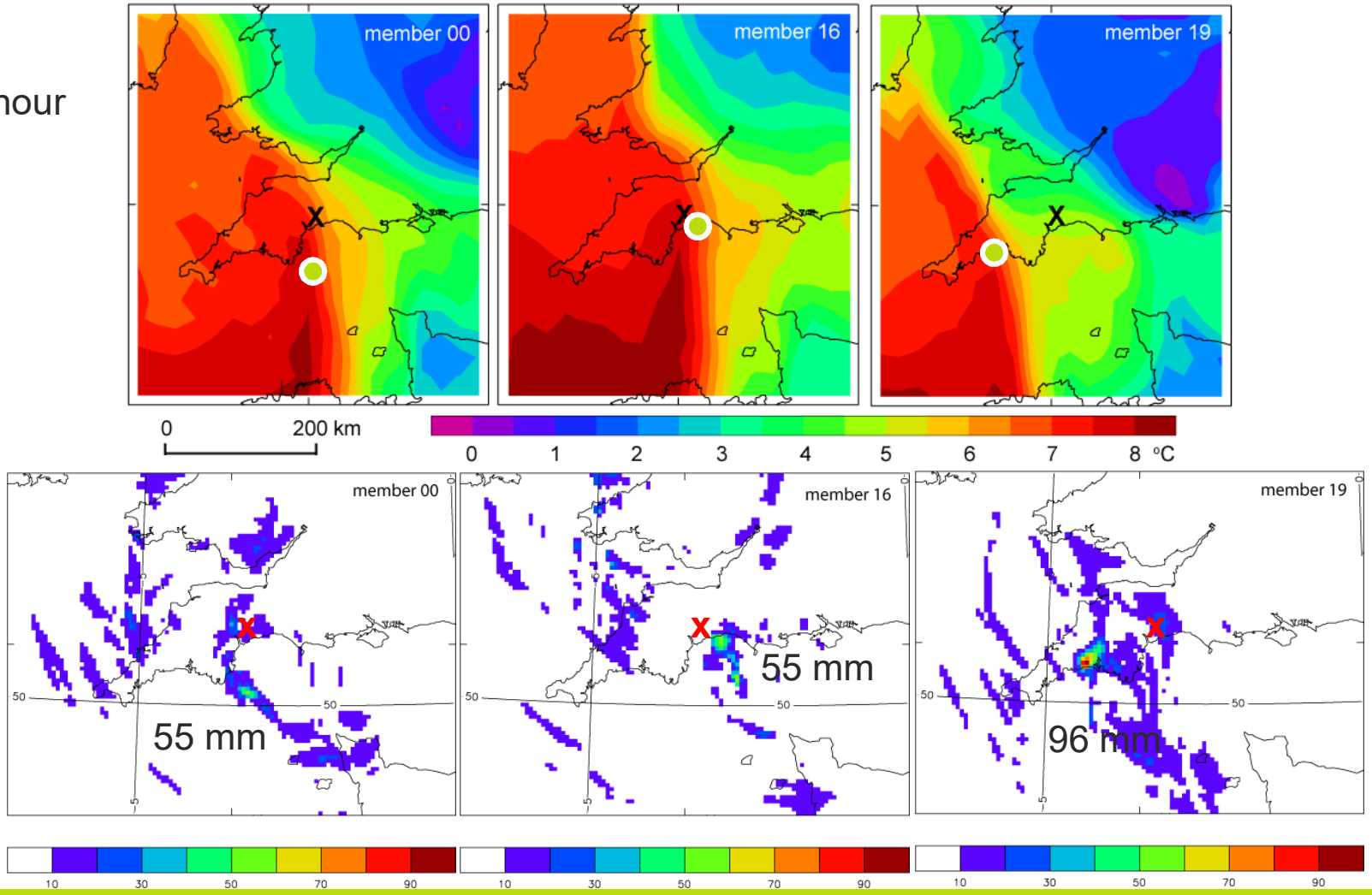
Good signal for a high-impact event

No storms in correct place

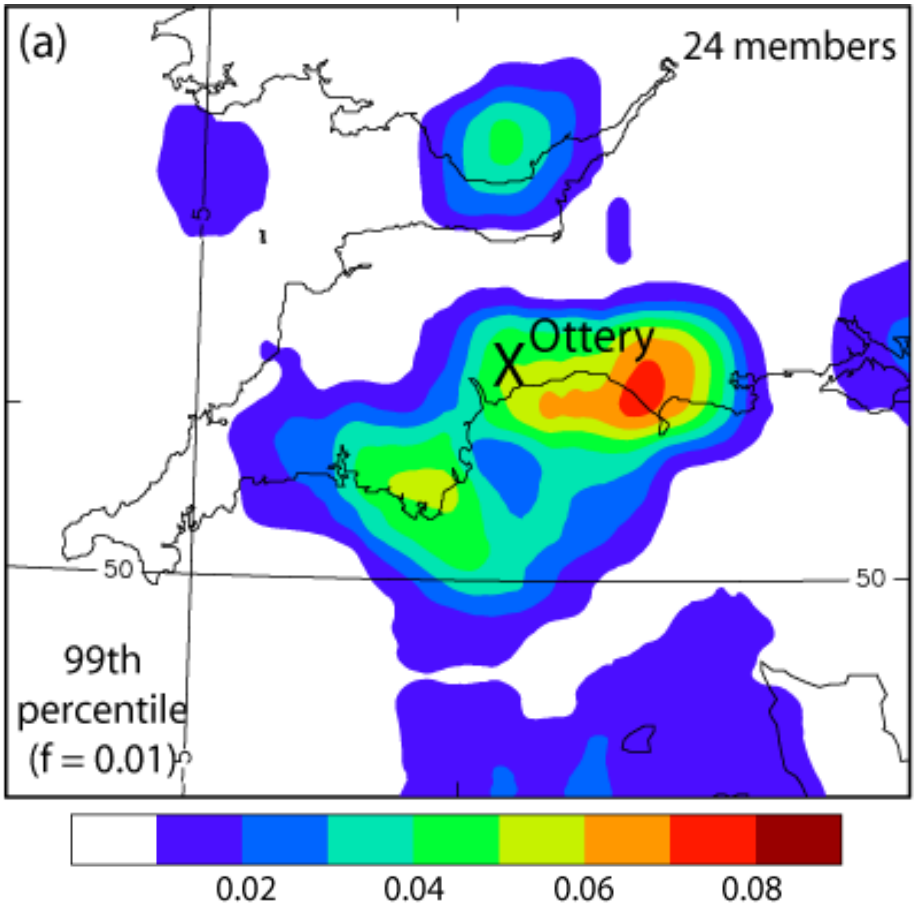
Need neighbourhood processing

Example members

Highest 6-hour totals



Using a neighbourhood

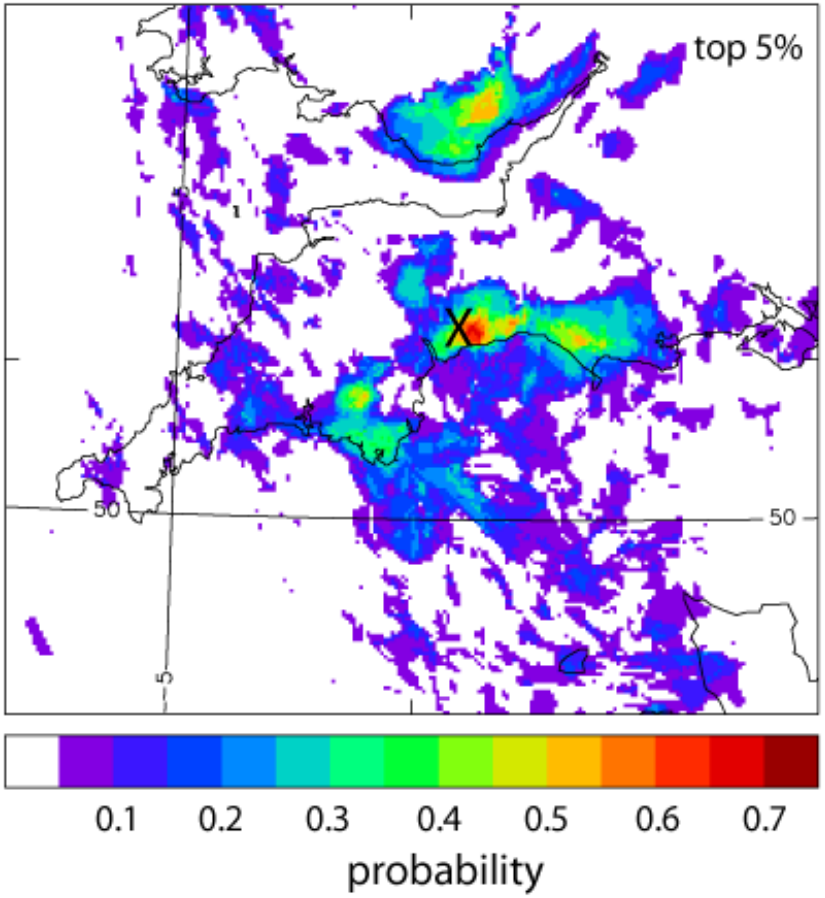


Now a non-zero probability for storm location

BUT the probabilities are very small

- and this percentile represents a much lower (non-extreme) accumulation

Signal from a non-extreme percentile

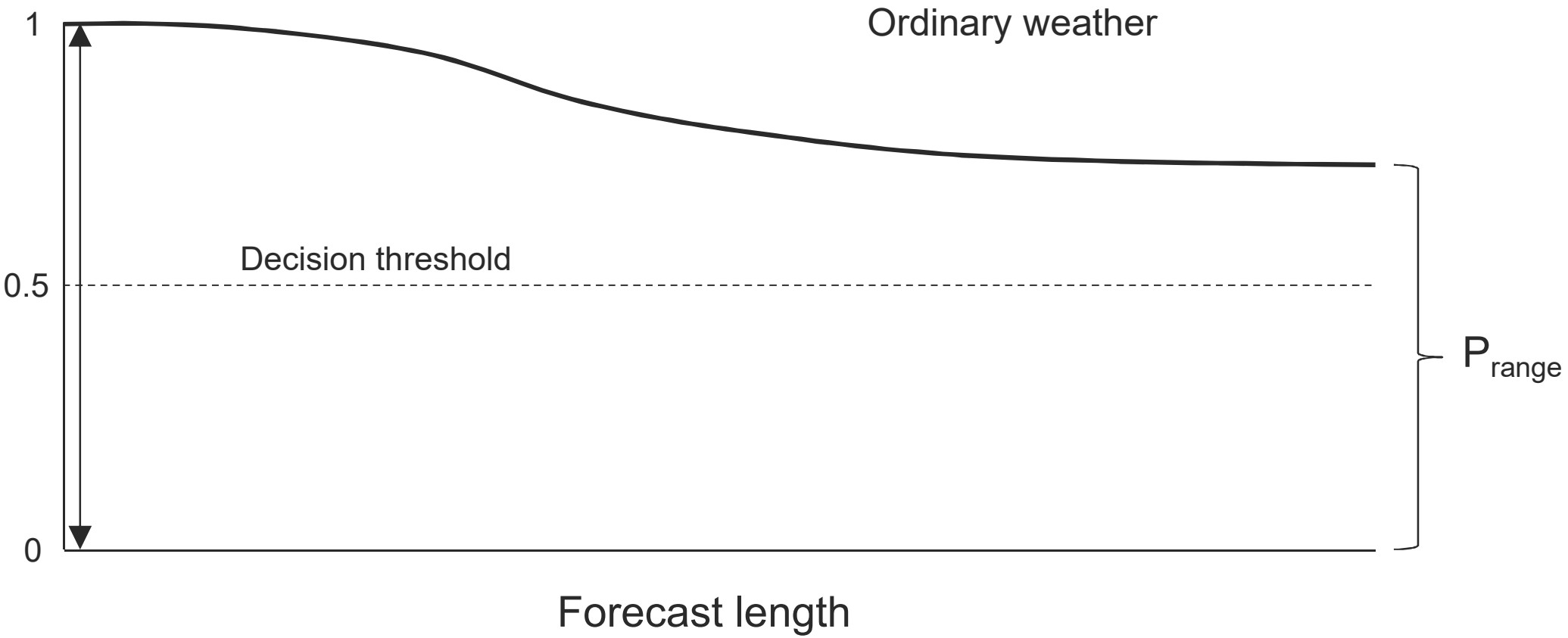


Use of a much lower percentile gives a very good indication of the area at risk.

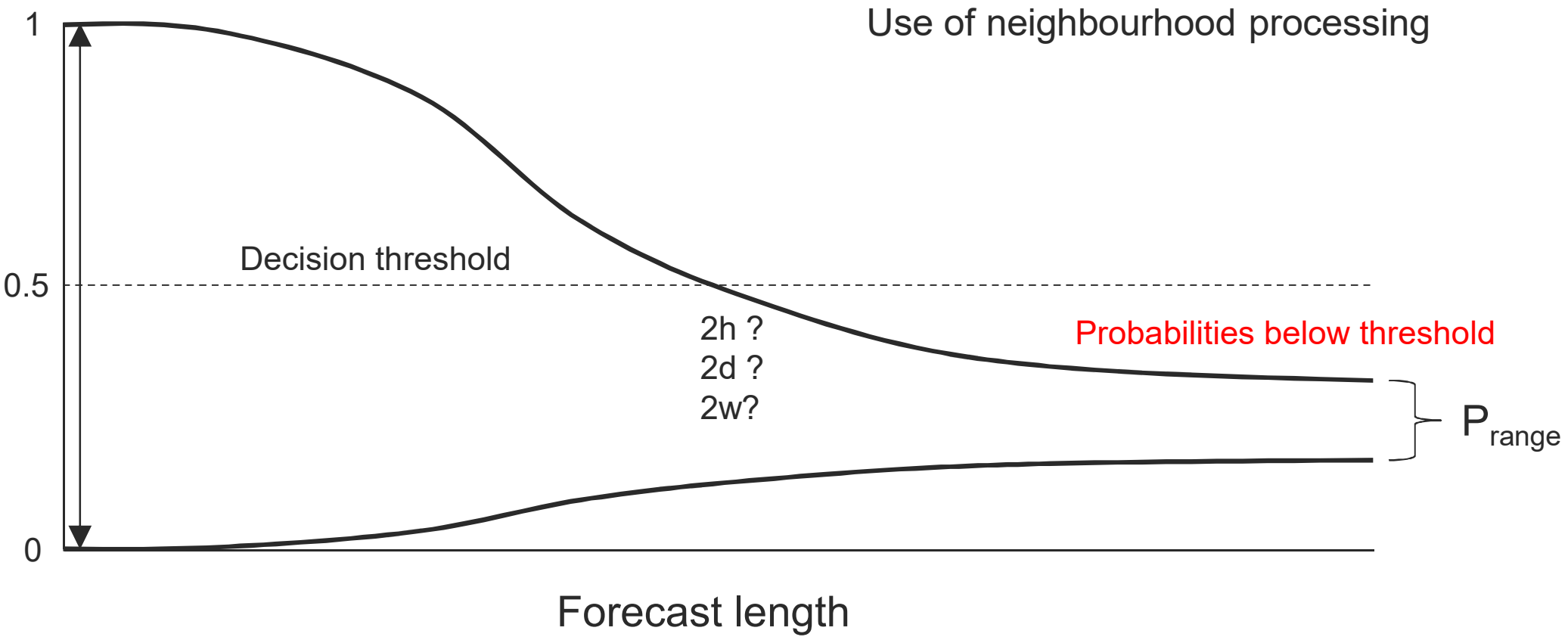
Is this just a coincidence? Don't know!

Can we use lower percentiles as an indicator of risk area or to constrain neighbourhood for higher percentiles? Don't know!

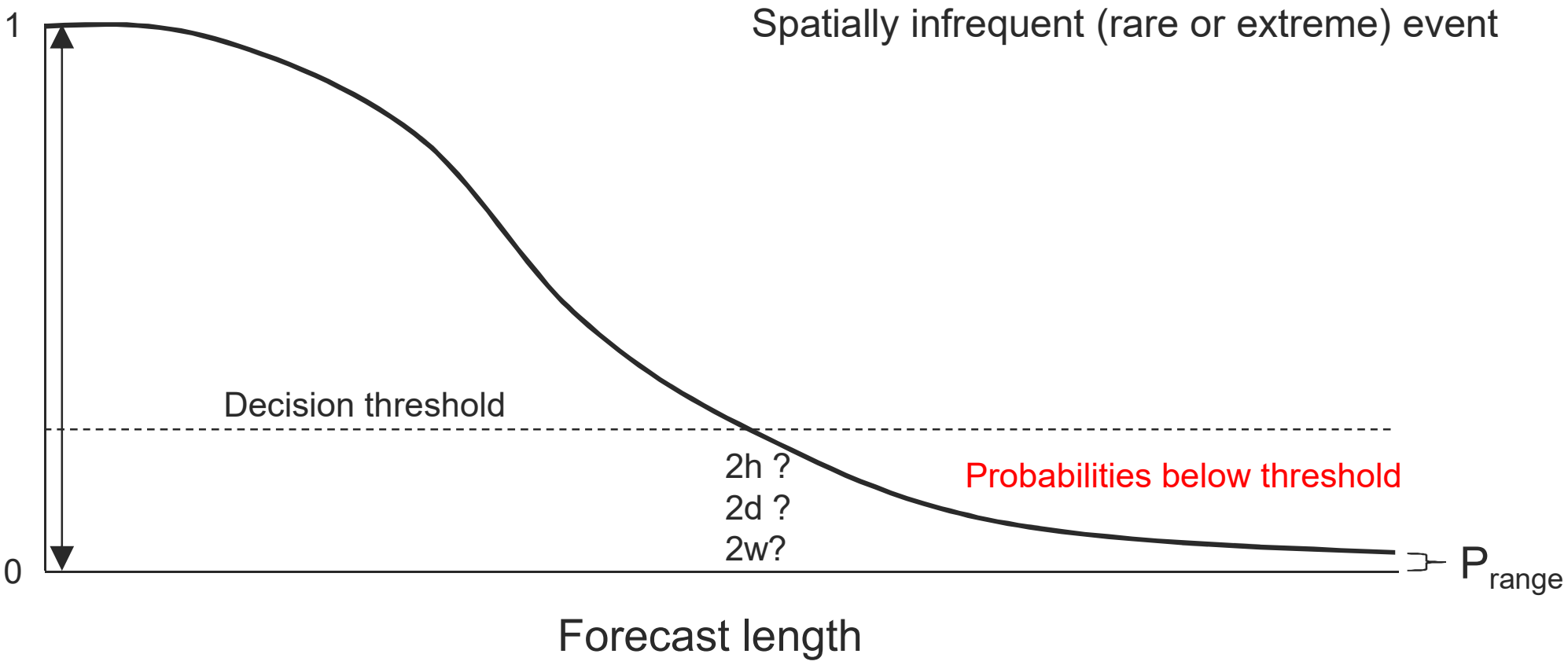
Probability range



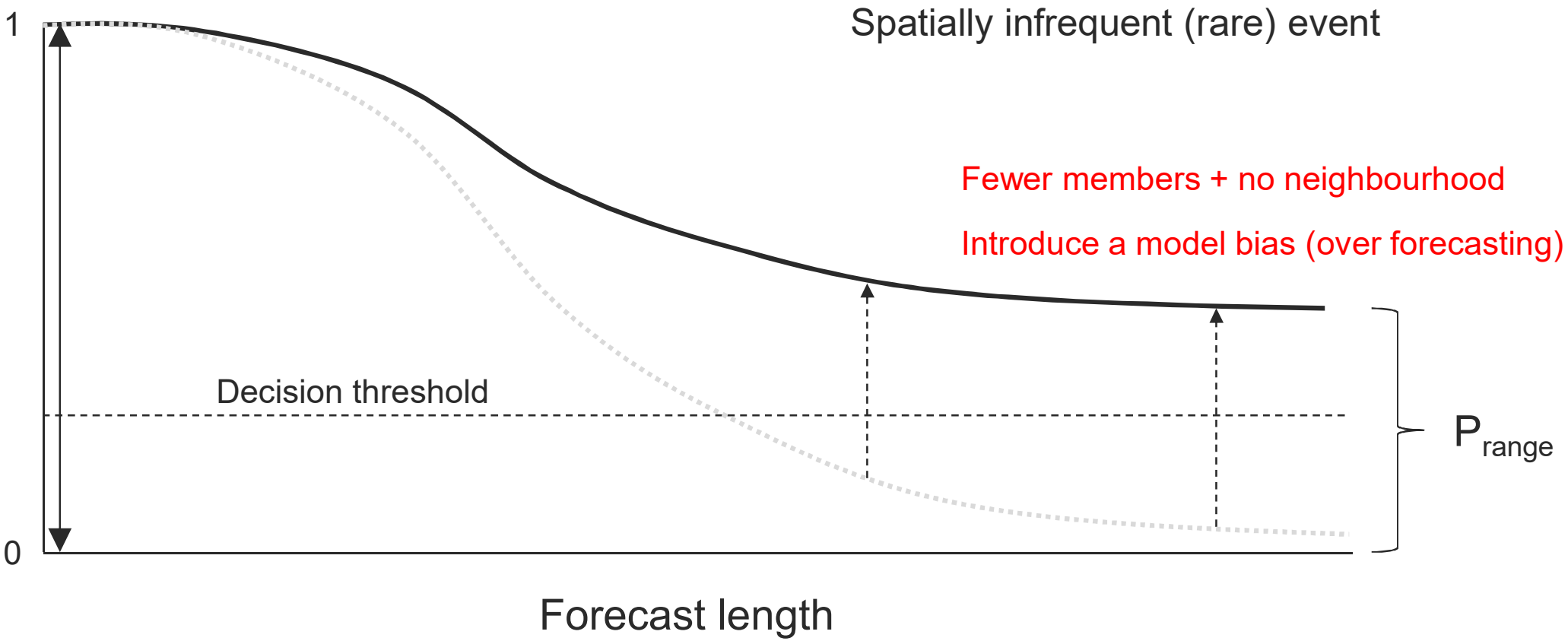
Probability range



Probability range



Probability range

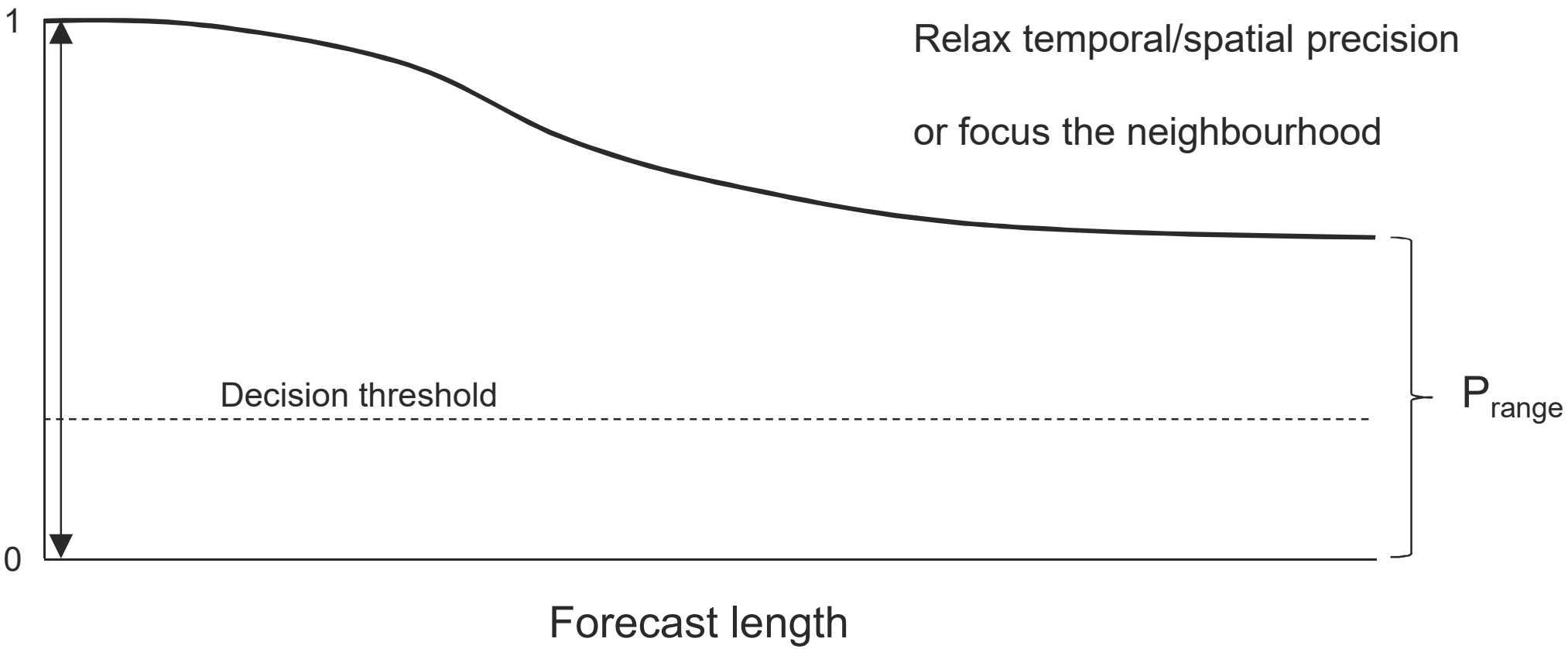


Probability range

Spatially infrequent (rare) event

Relax temporal/spatial precision

or focus the neighbourhood



Two sorts of neighbourhood

(1) defines the area(s) of concern (doesn't deal with spatial uncertainty)

Occurrence in an area, occurrence within a distance, maximum in an area

Size/length/shape should depend on spatial/temporal predictability and user requirements (to allow decision making)

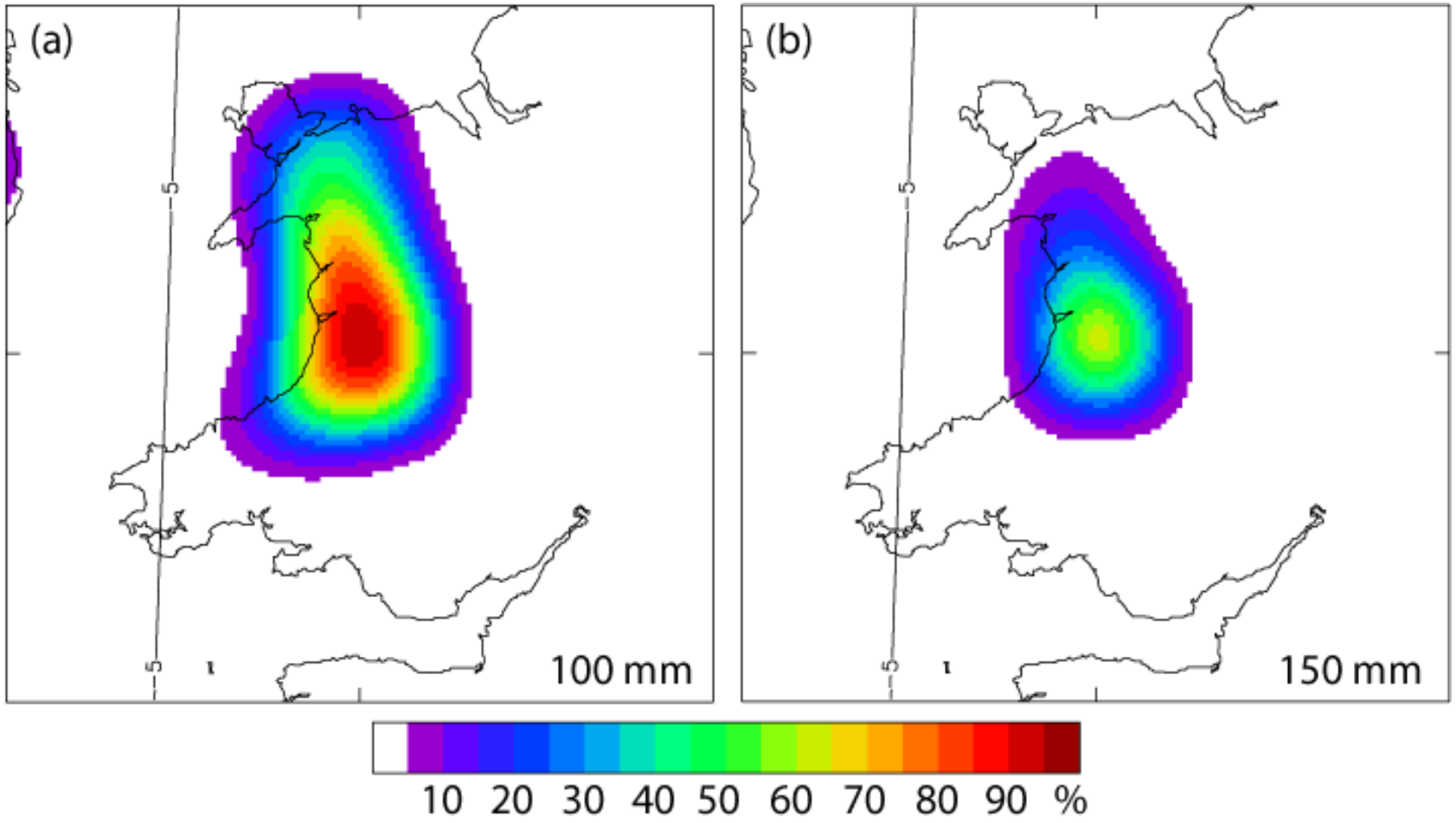
(2) takes into account the spatial uncertainty in the individual forecasts

Fraction in an area - probability given spatial uncertainty, effective additional members to account for under-sampling (smoothing effect)

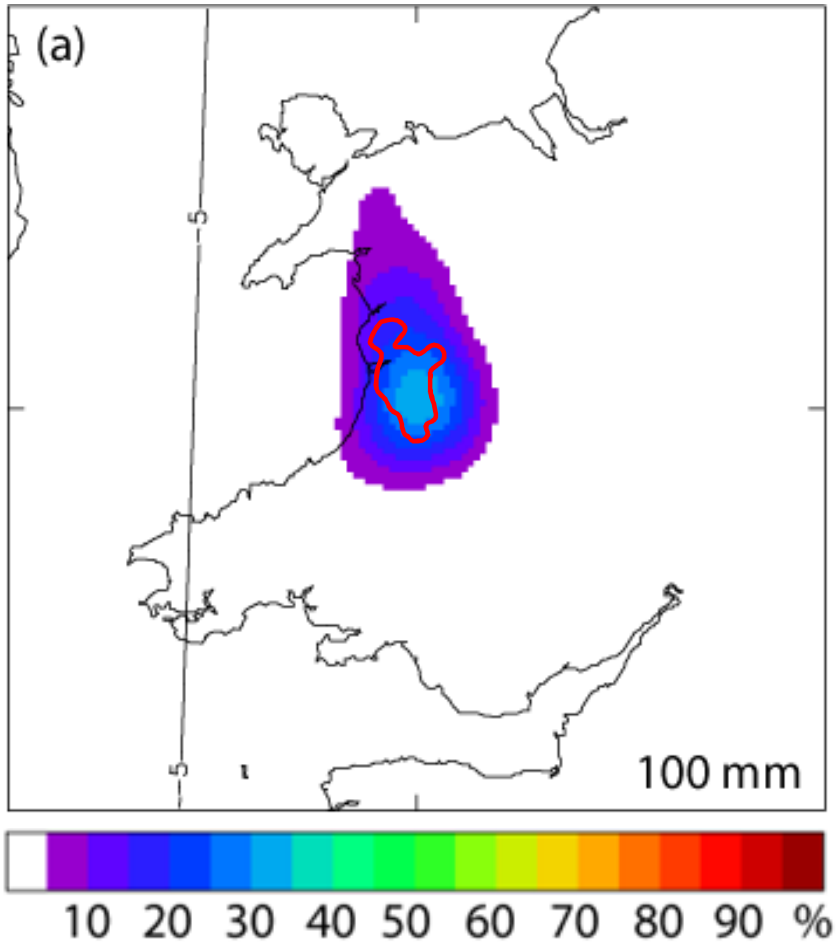
Size/shape should depend on ensemble size, spatial dispersion and/or topographical/meteorological constraints

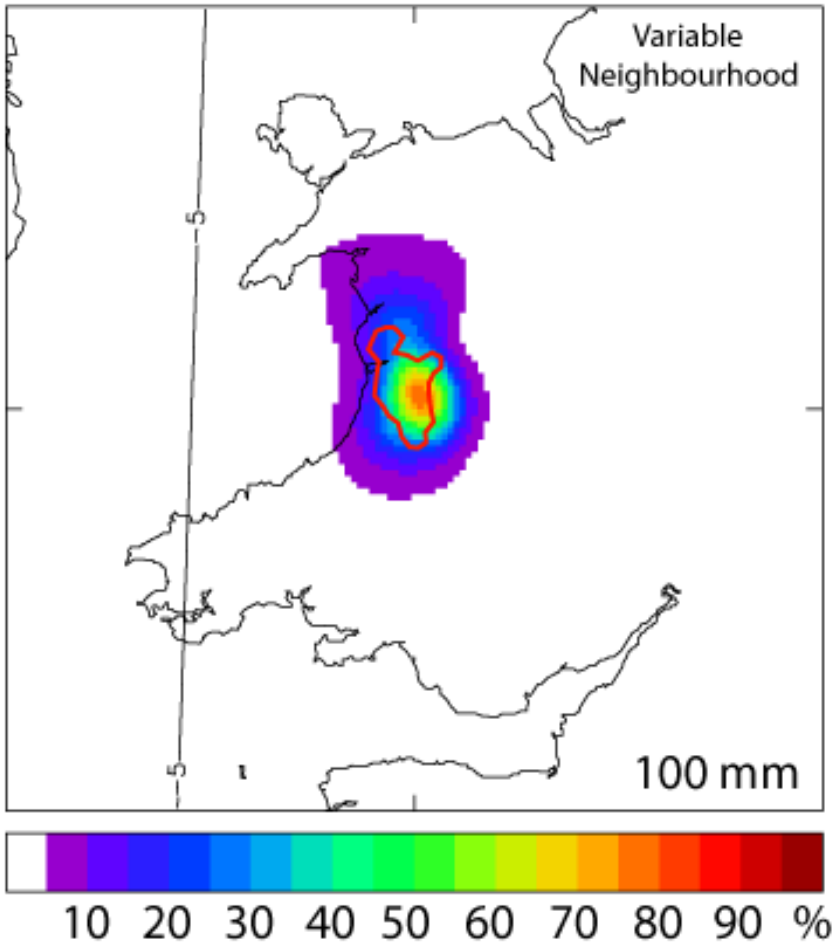
Schwartz and Sobash 2018

Probability within a distance



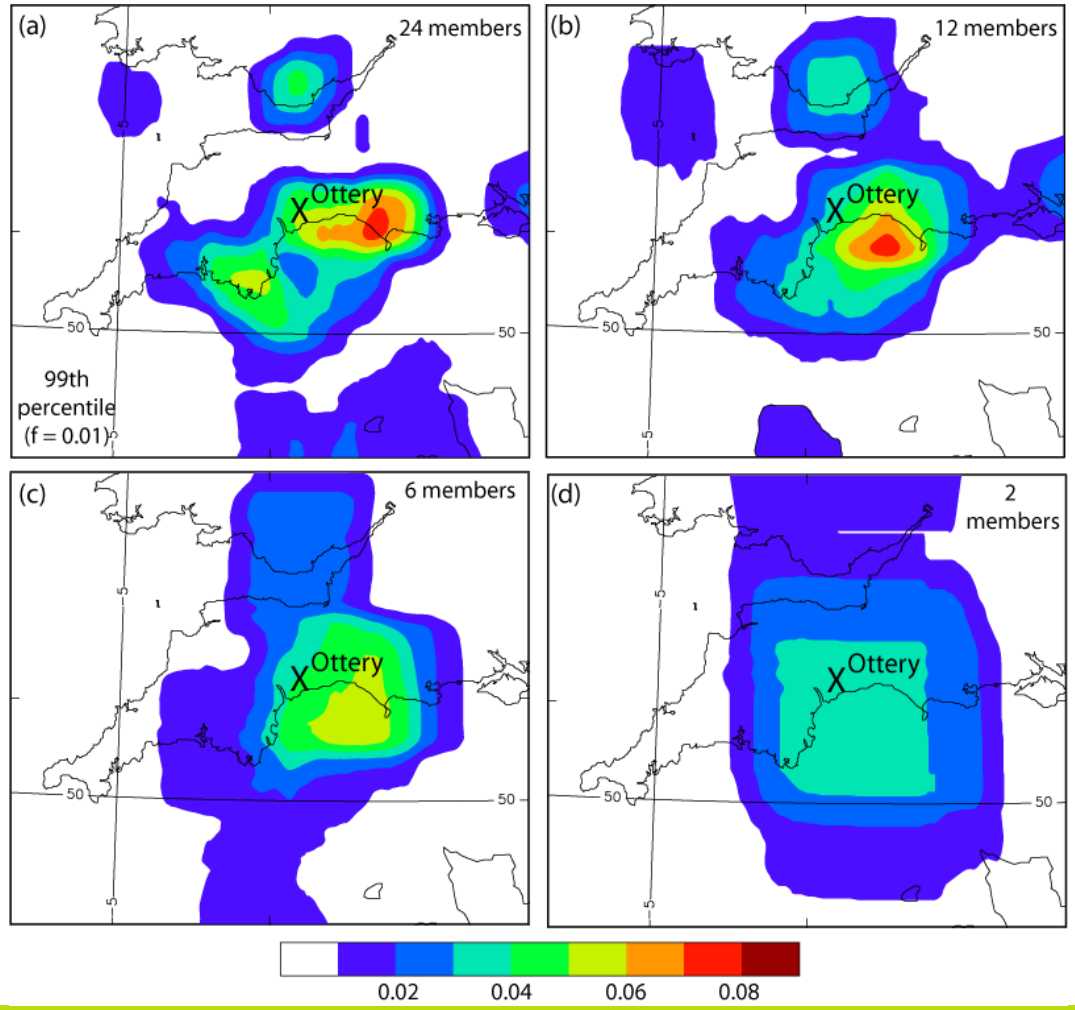
An adaptive neighbourhood – focusses probabilities





What about ensemble size?

Neighbourhood probabilities using fewer members



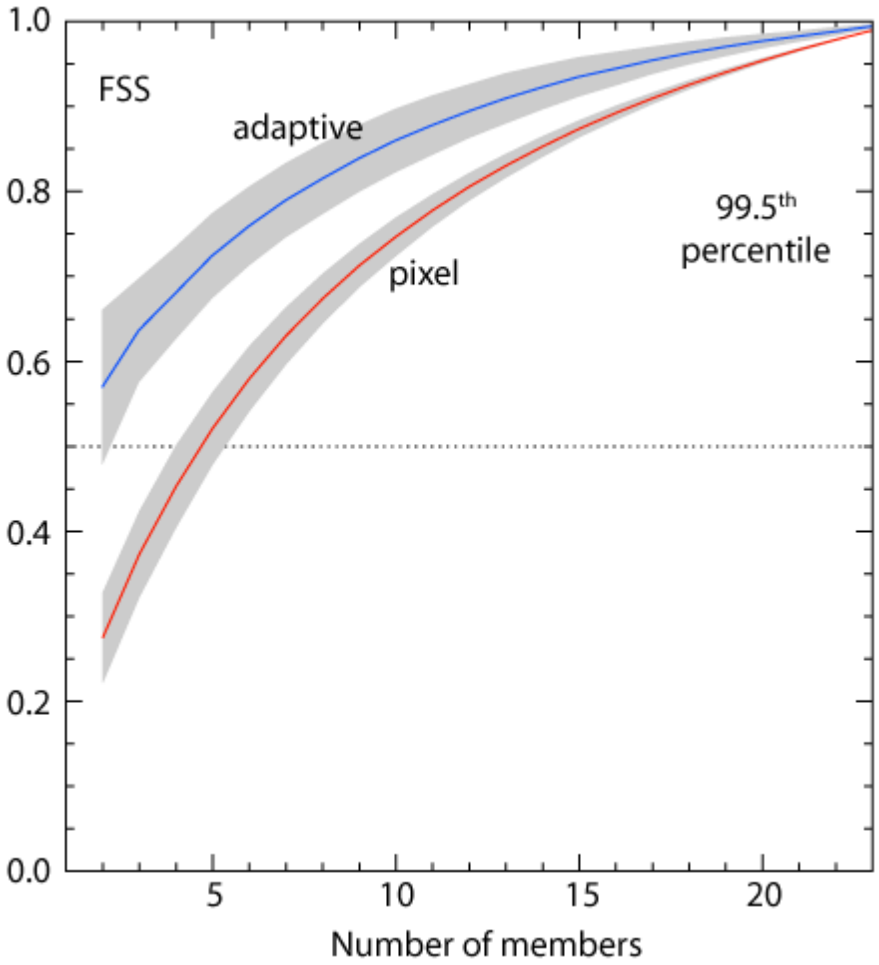
Sub-sampling from 24 members

Select members at random

Use of a spatially adaptive neighbourhood to generate probabilities

Repeat a large number of times for each ensemble size

Agreement between smaller ensembles and full ensemble



Neighbourhood processing "gains" 4-5 members

12 members gives 90% agreement with 24 members

Need 17 members without neighbourhood processing

Same effect for other cases.

Gain is greater for higher percentiles (rare events)

CP-ensembles and extreme

Probabilities are small – may need to relax spatial/temporal constraints

Need to determine what scales maintain predictability at different lead times?

Can larger-scale information be used to constrain neighbourhoods?

Use neighbourhoods that adapt to the ensemble spatial spread

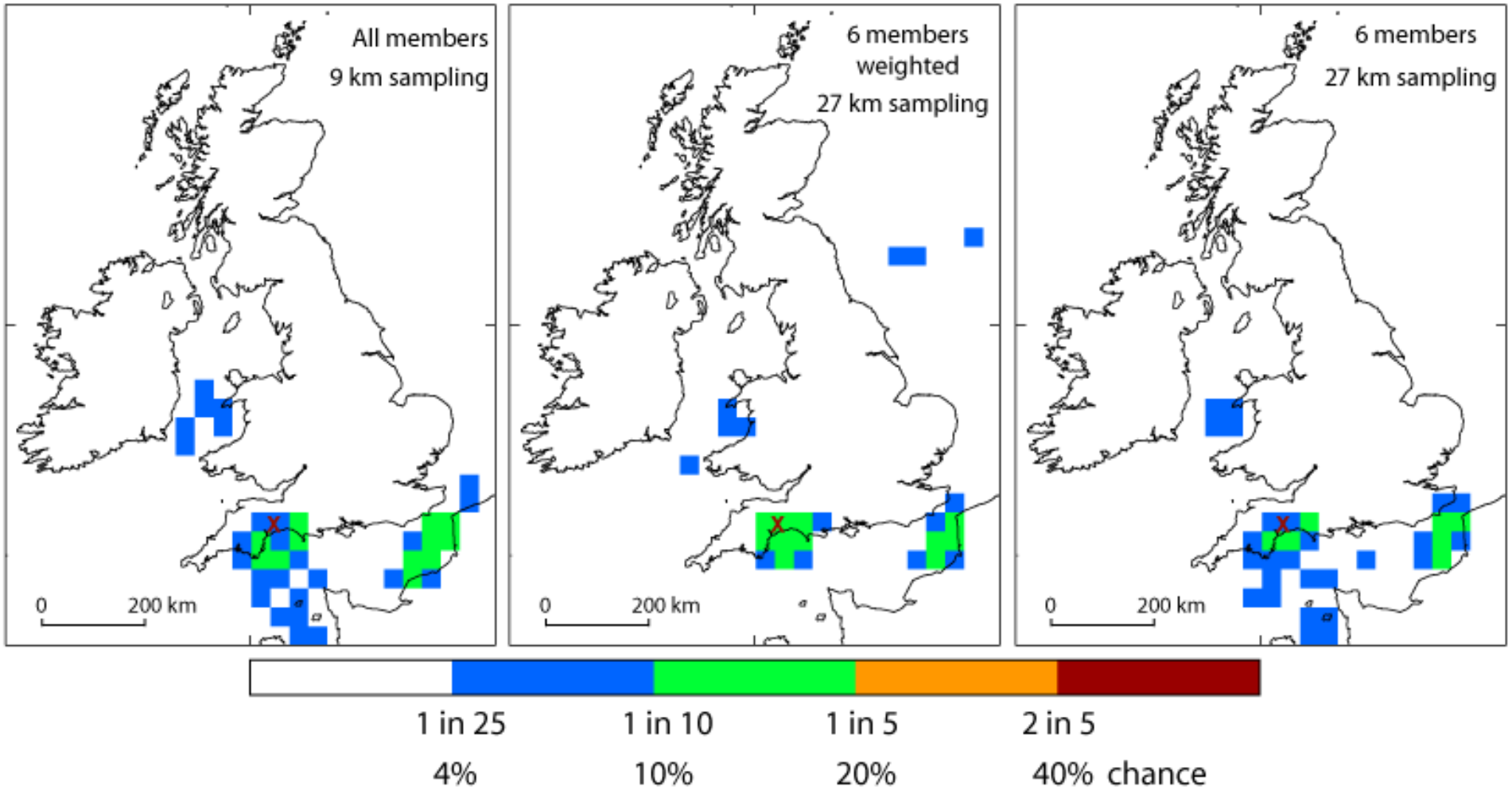
How to extract “storylines” (clusters or outliers) from CP-ensembles (neighbourhoods may help extract signal from noise)

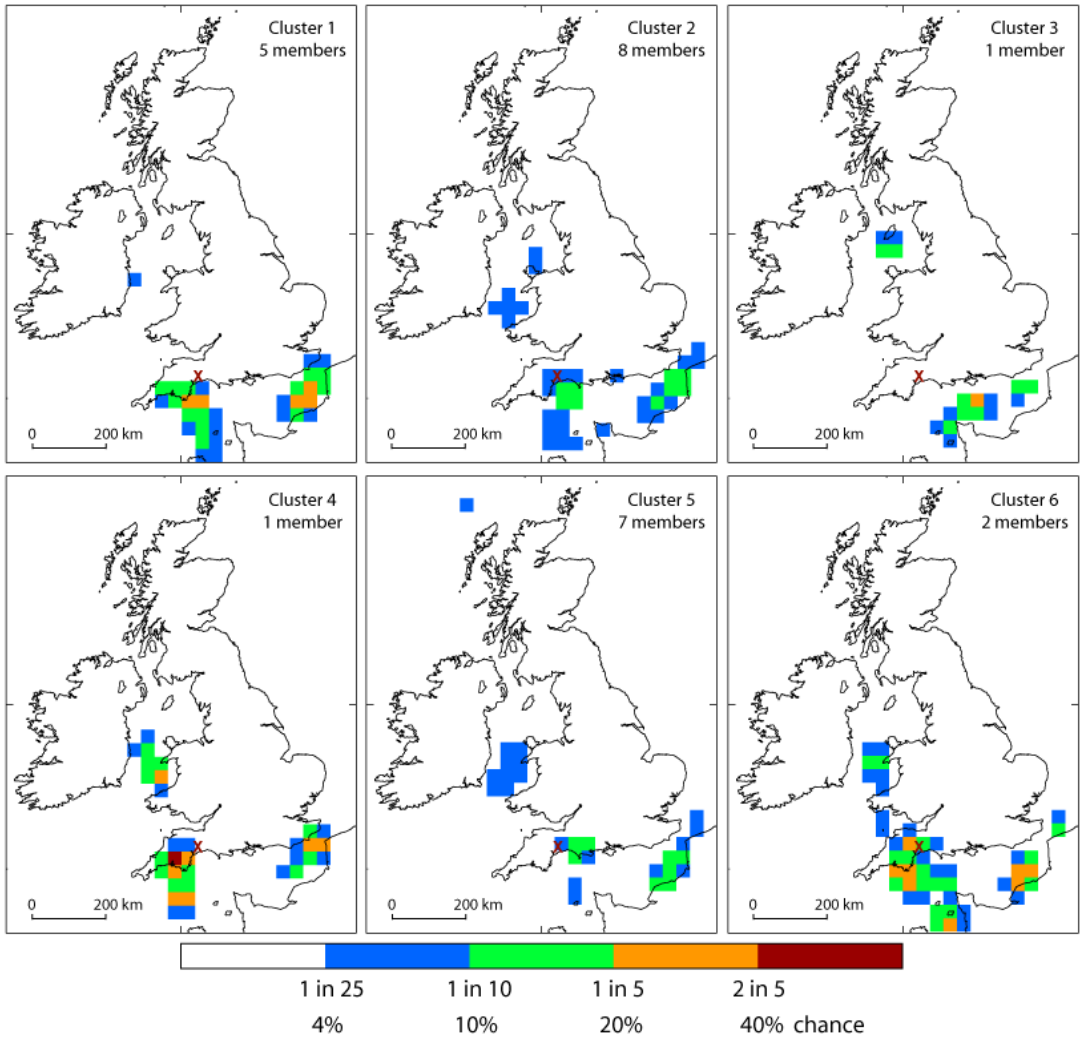
What about “subsetting” – removing “wrong members”? (again – signal-noise)

Users may want “plausible worst case” scenarios

Use logarithmic scale (odds) when probabilities are small

Met Office





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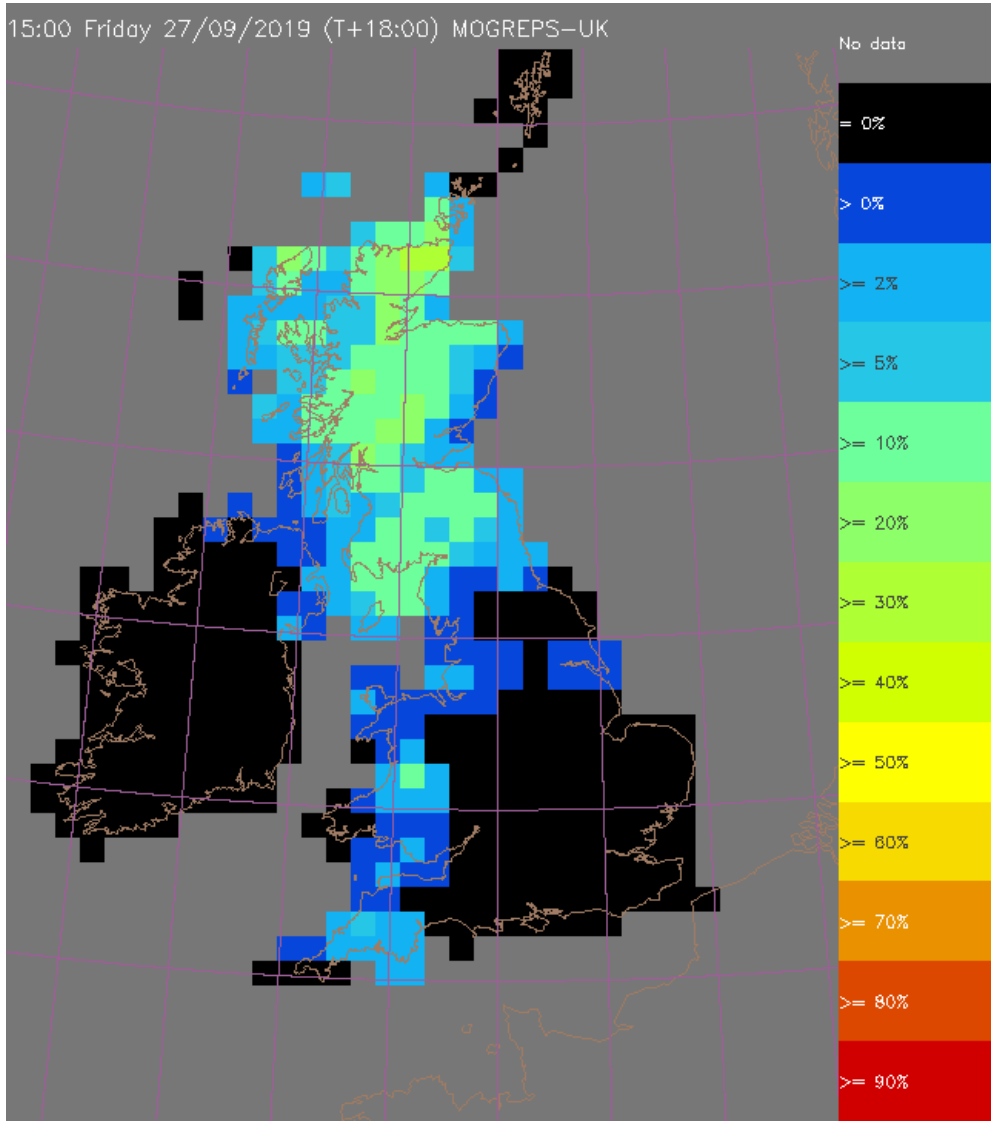

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