Ensemble spatial verification

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Convection-permitting ensembles

Used to forecast local and high-impact weather

What is a good forecast when small scales are not predictable ?

Insufficient ensemble members to represent small-scale uncertainty (in precipitation)

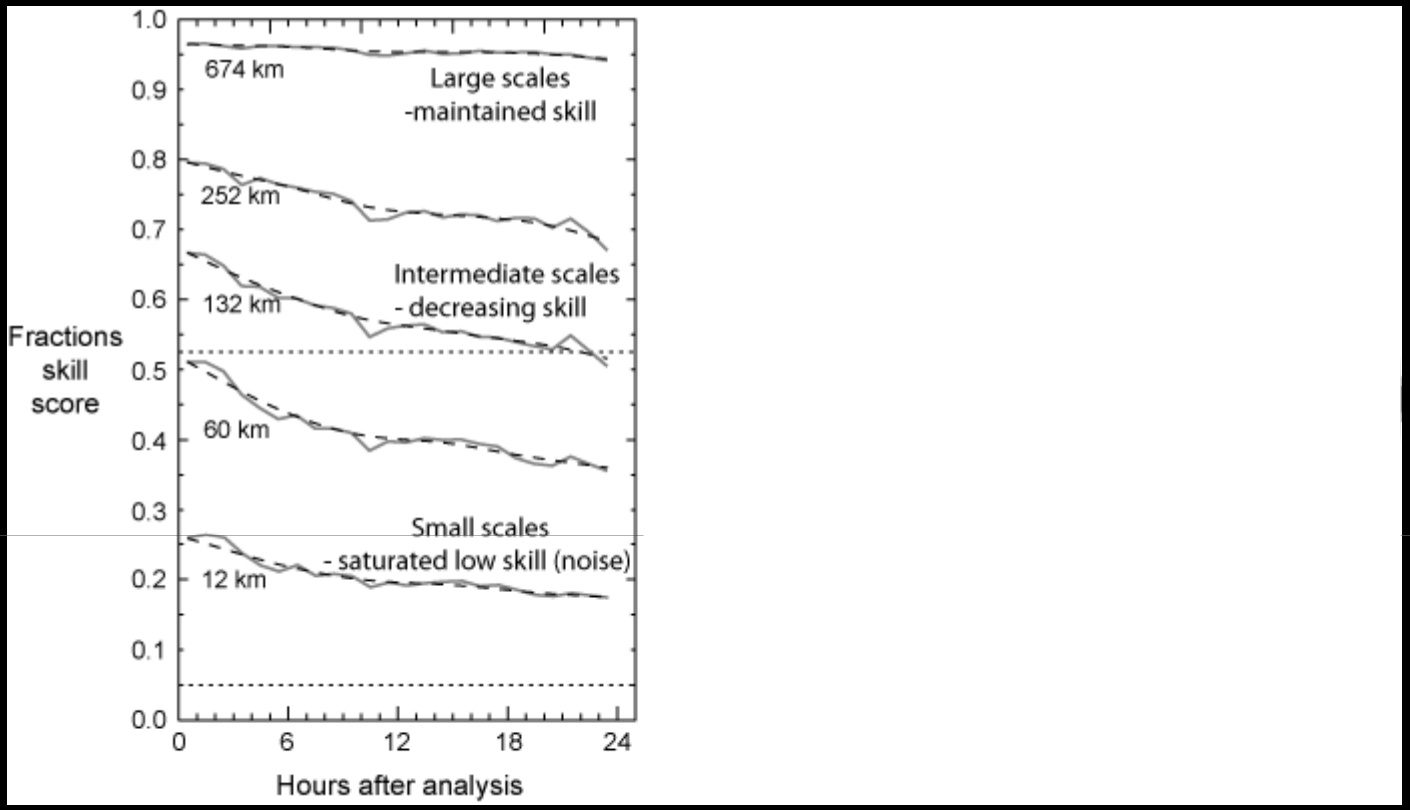
Need to artificially increase ensemble size

How do we measure ensemble skill and spread ?

Evolution of skill with scale

1 year

12-km forecasts



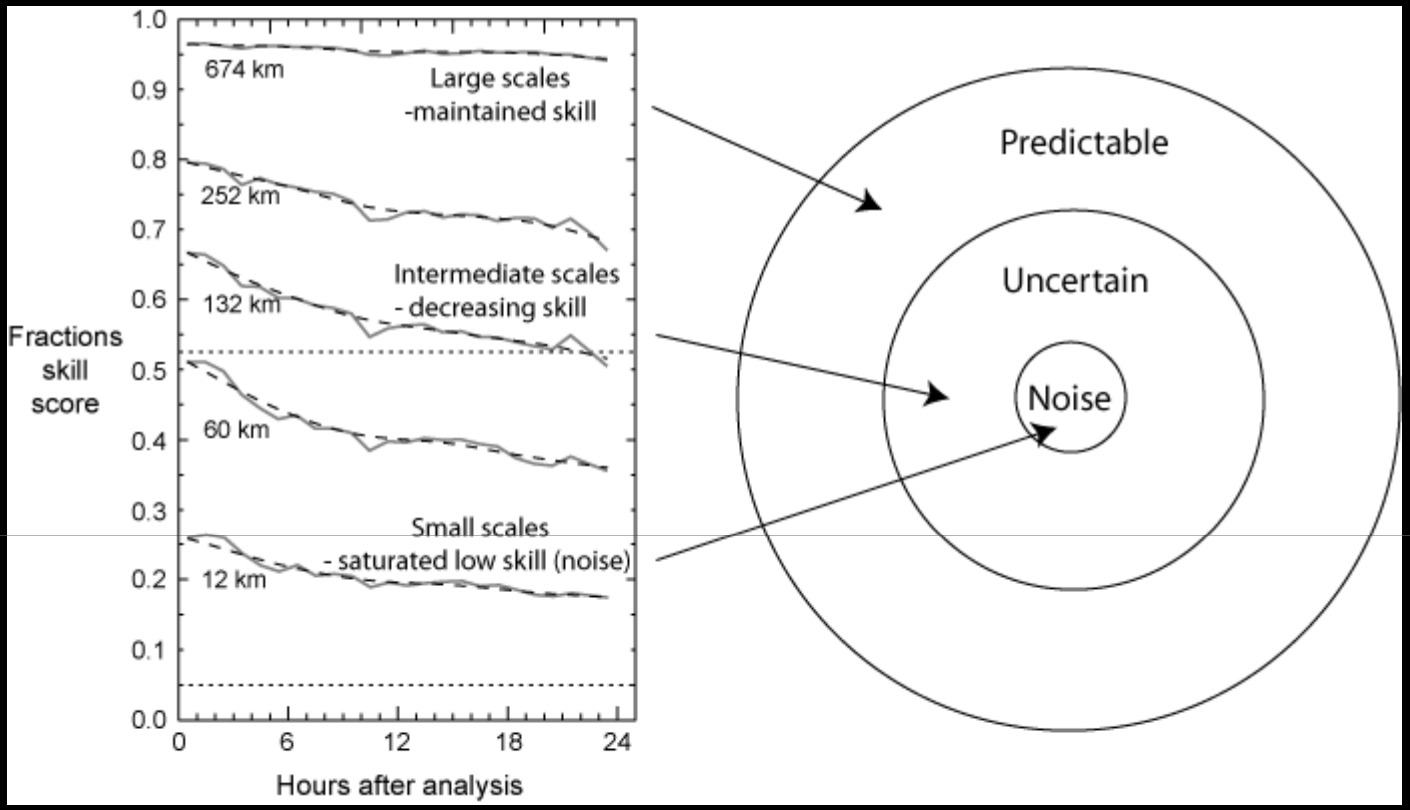
Roberts 2008 Met Apps

Fractions Skill Score (FSS) Roberts and Lean 2008 MWR

Spatial verification

1 year

12-km forecasts



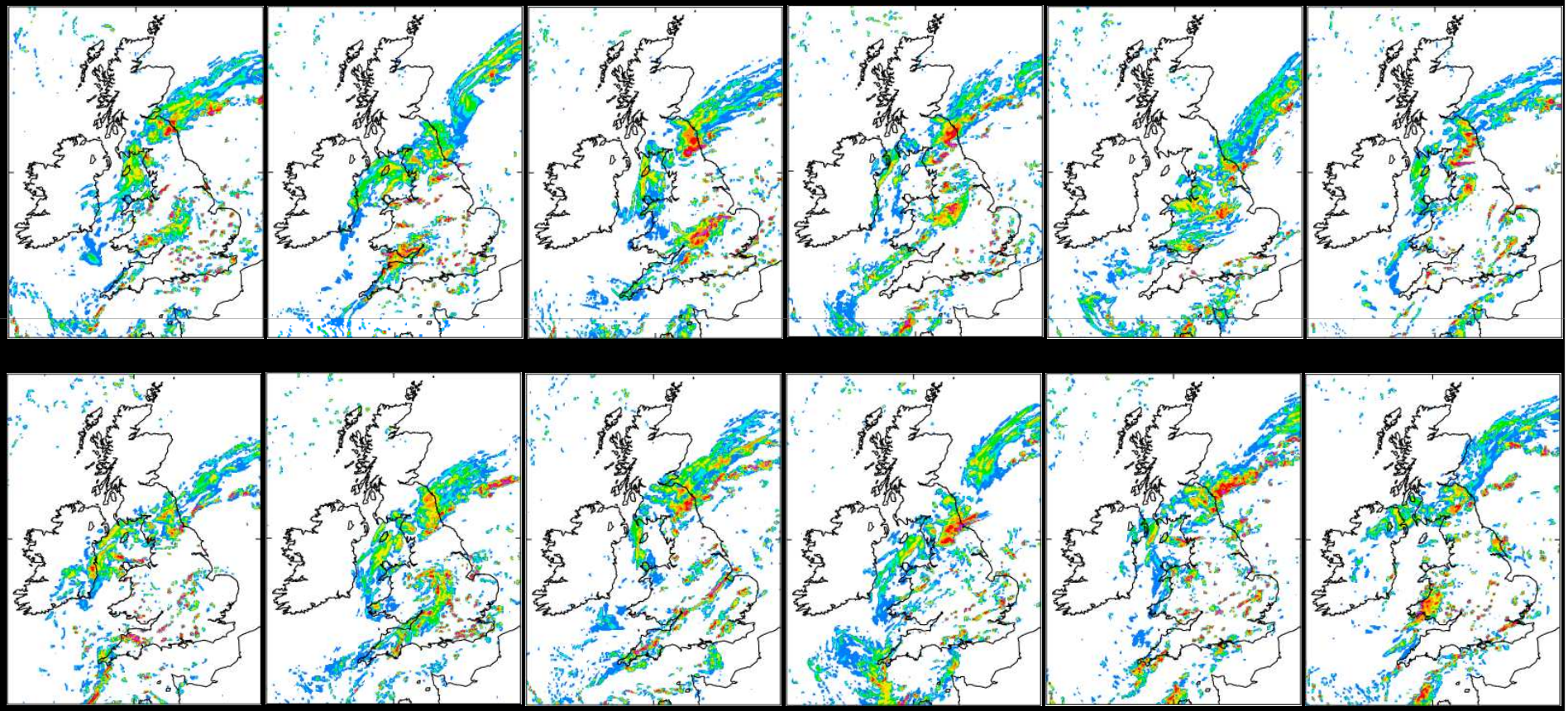
Predictable scales (large synoptic) – no need for an ensemble

Uncertain scales (mesoscale) – ensemble needed

Noise (individual showers) – neighbourhood processing with ensemble

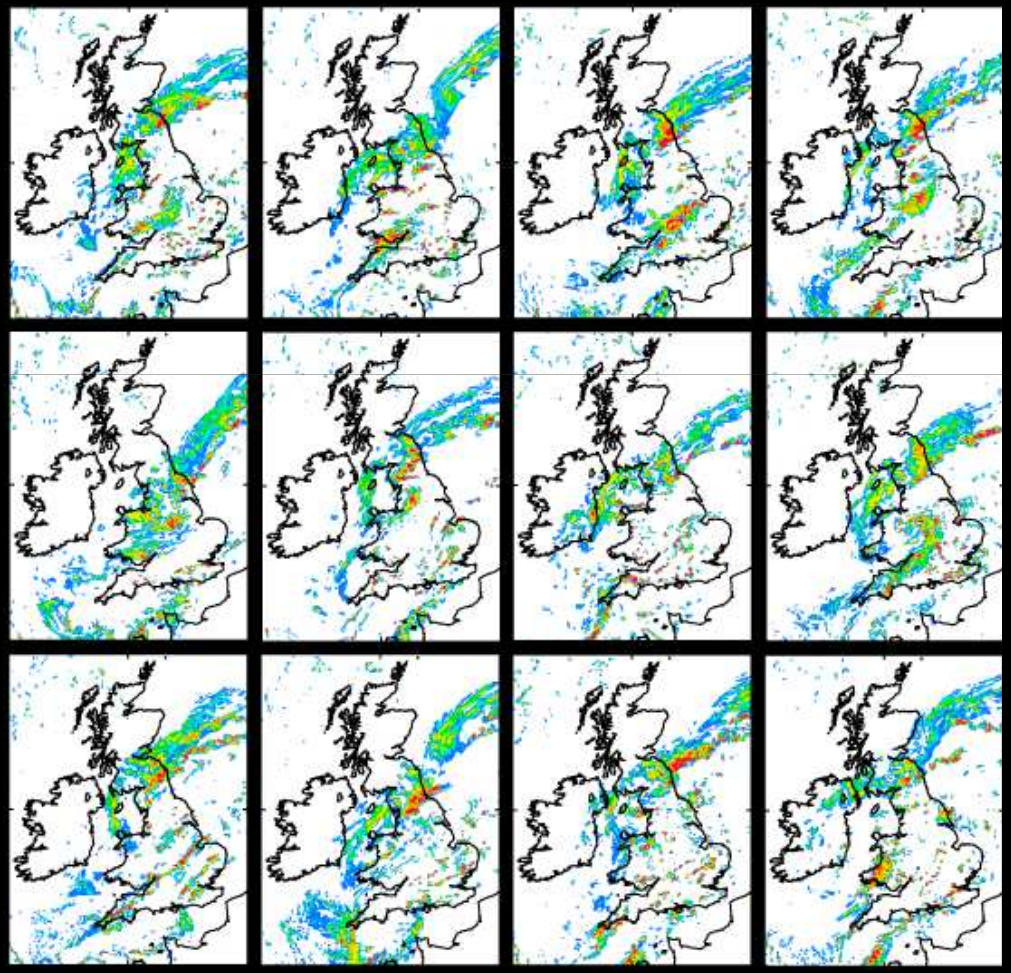
Convection-permitting ensemble example

MOGREPS-UK

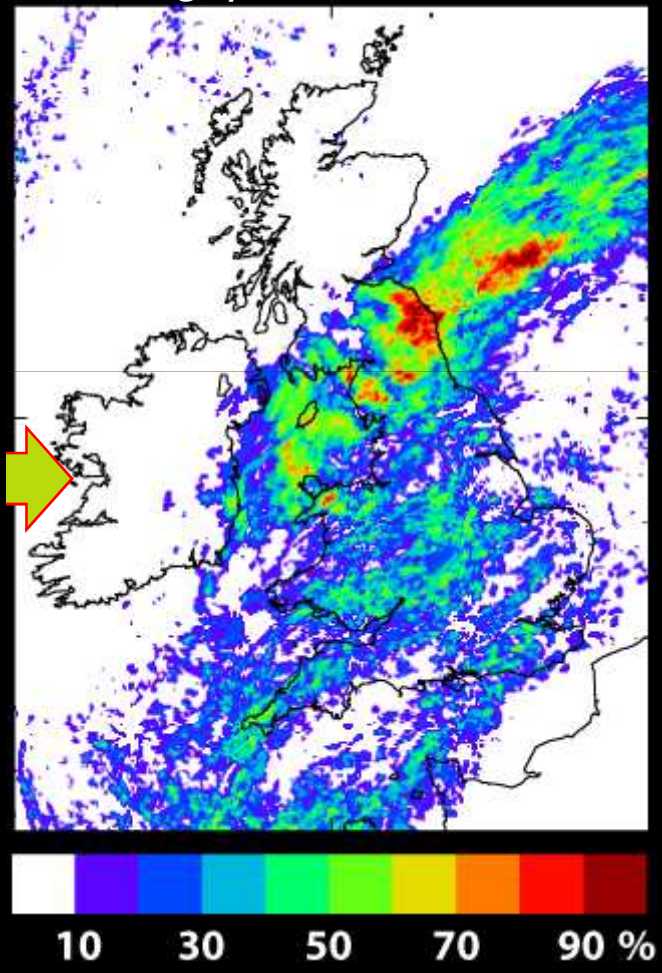


Is it possible to represent uncertainty in local weather with only 12 members (and a marginally convection resolving model) ?

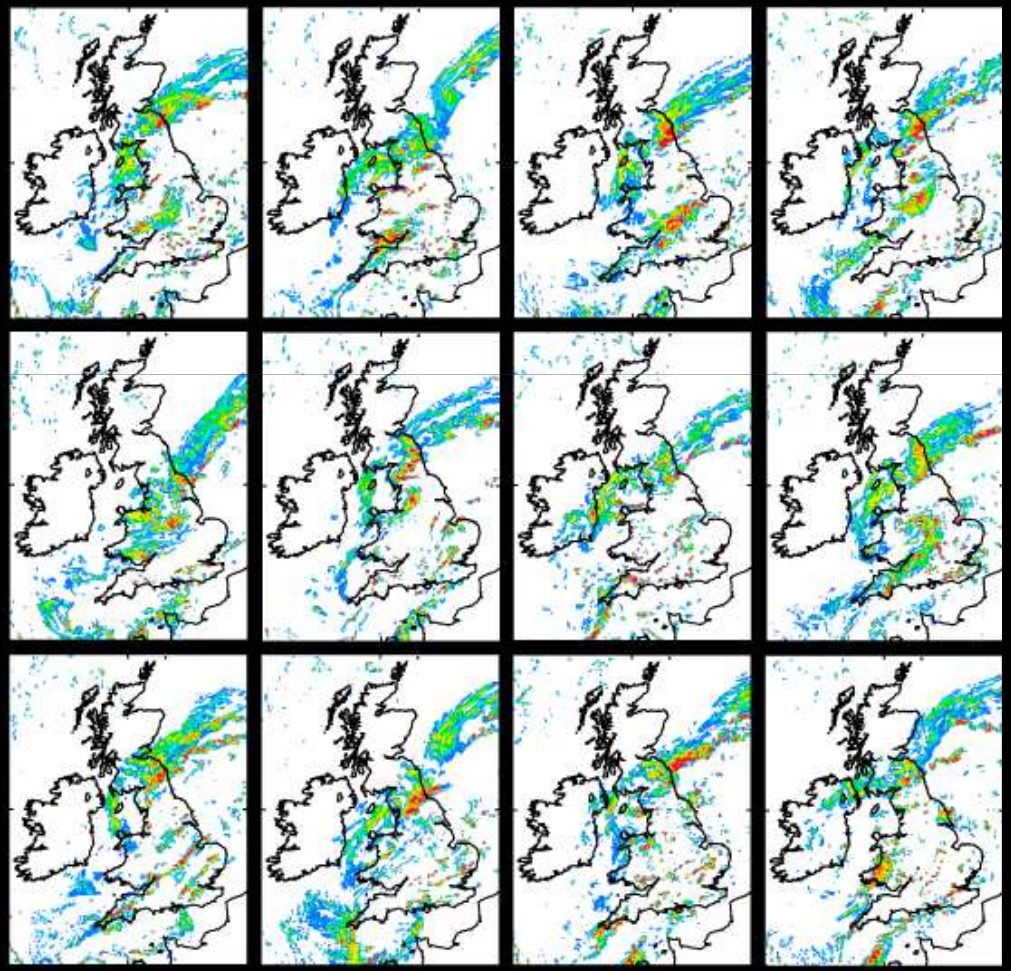
Constructing a probability forecast



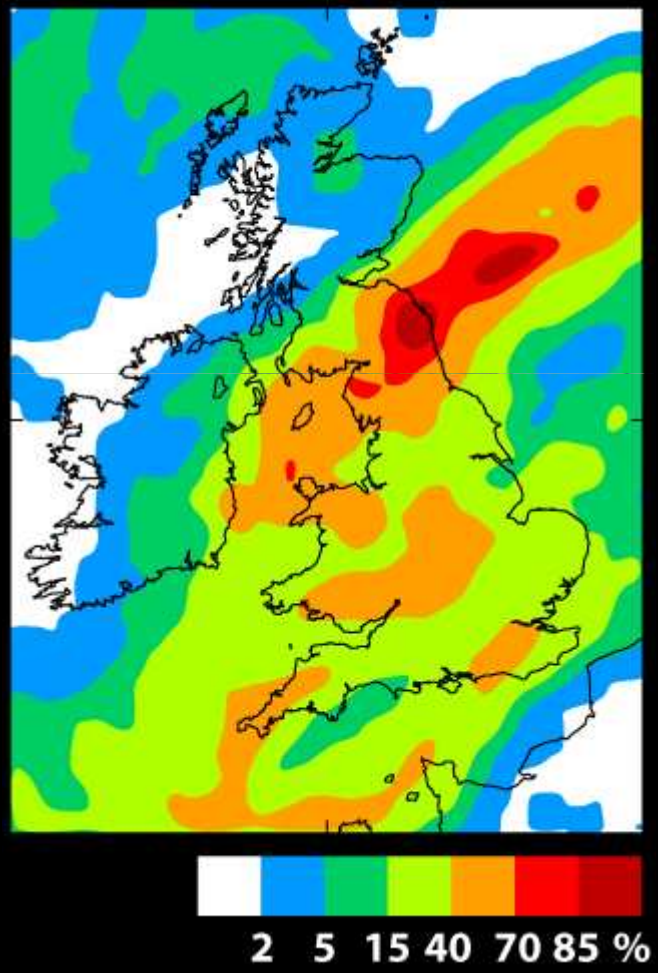
Insufficient ensemble size leaves gaps



Constructing a probability forecast



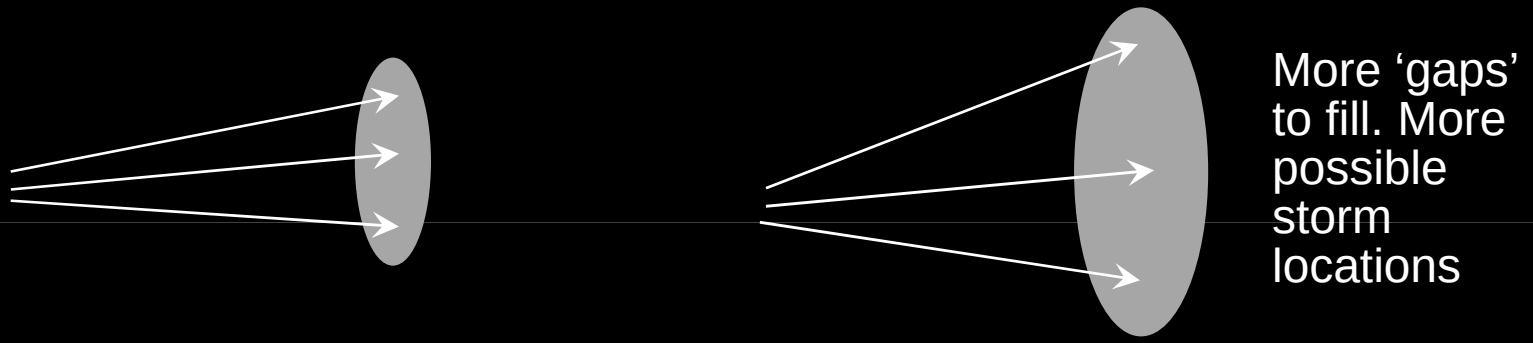
Probability of rain in period around the time of interest



Neighbourhood processing

How large should the neighbourhood be?

The neighbourhood size should depend on the spatial ensemble spread



More ‘gaps’ to fill. More possible storm locations

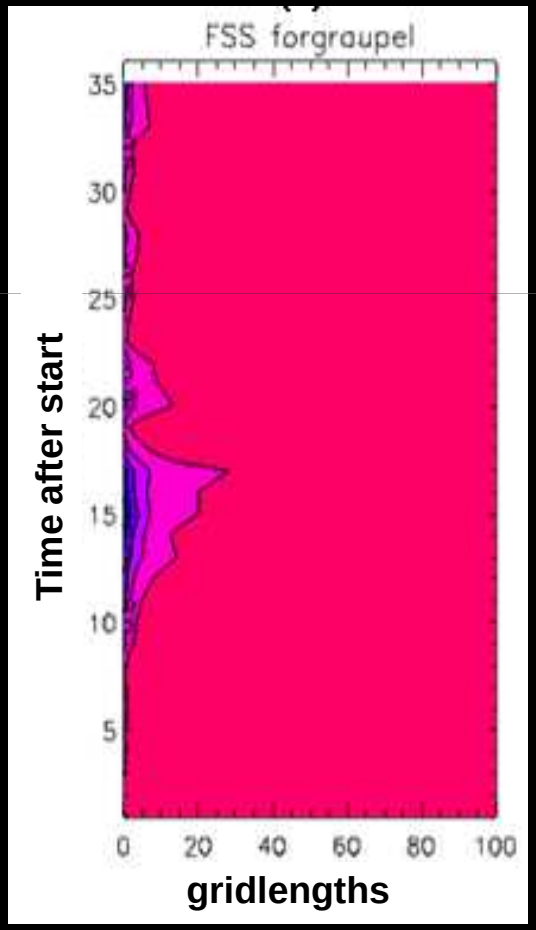
Provided that driving ensemble (MOGREPS-R in our case) has appropriate spread at larger scales (spans the grey area).

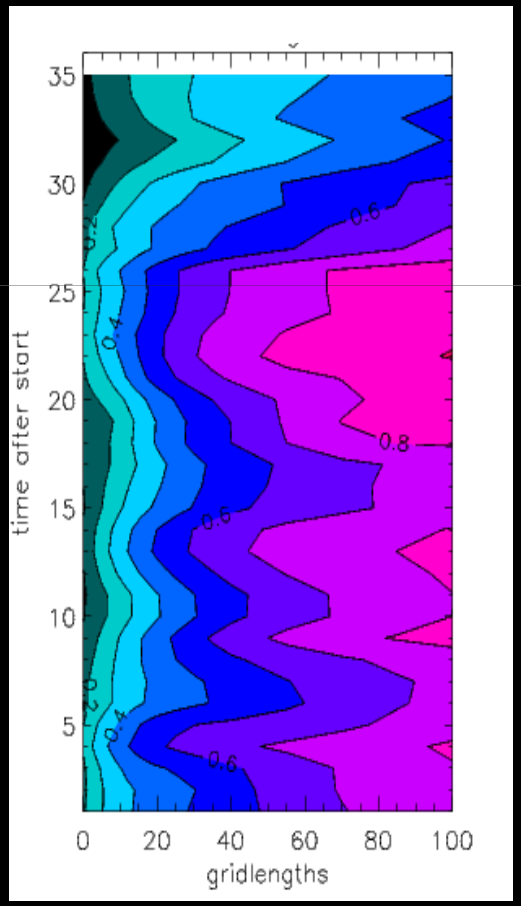
Use the Fractions Skill Score (FSS) spatial verification method (Roberts and Lean MWR 2008) to compute the spatial differences between members and radar.
Gives spatial ensemble spread and skill. Use to define scale for post processing

Use - Physics vs. boundaries

Seonaid Dey

FSS for precipitation hourly accumulations





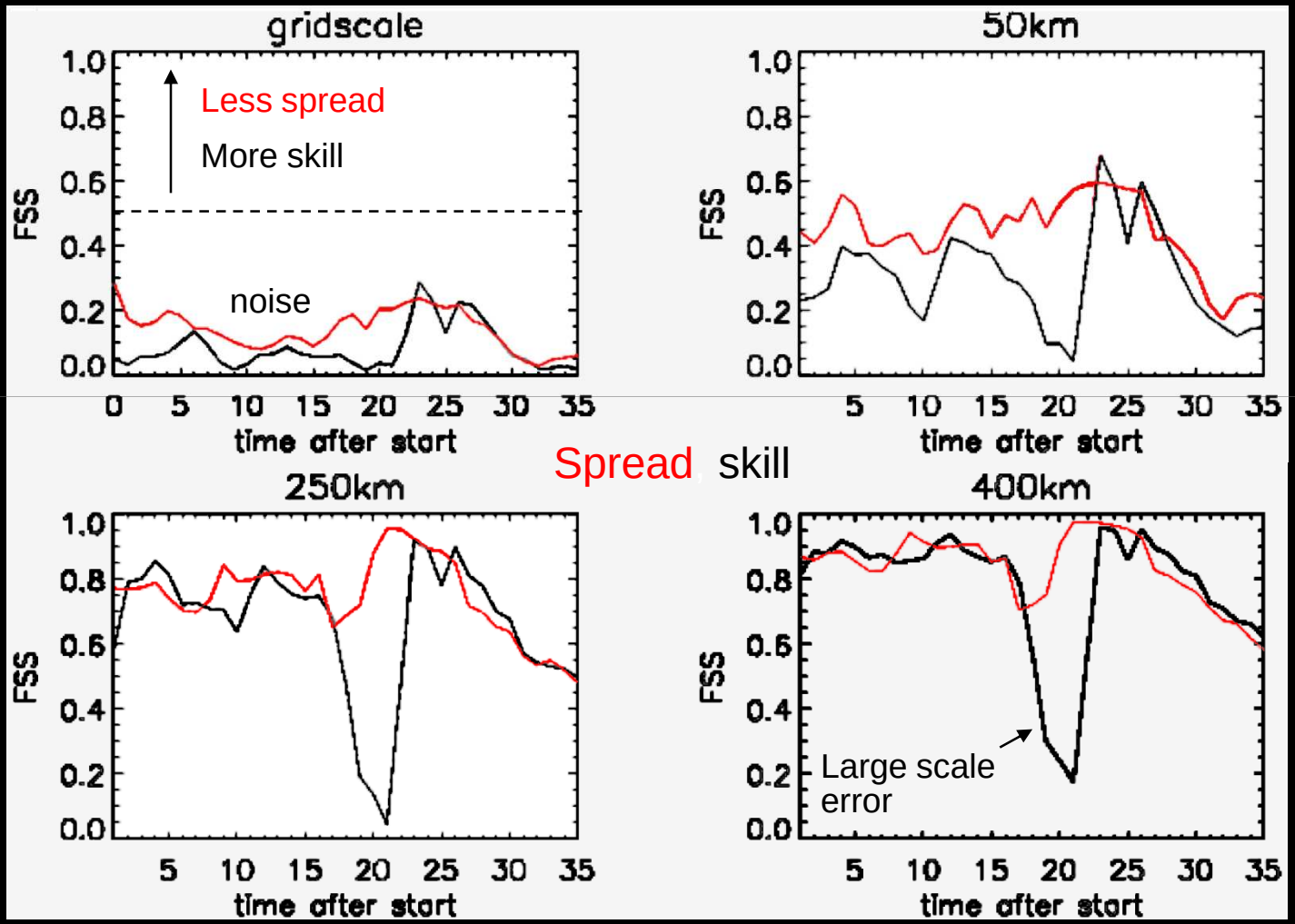
FSS

- Values 0-1
- 1 = ‘perfect match’

  0 = ‘totally different’
- Contours every 0.1, colours **black at 0.0** to **red at 1.0**
- Graupel / convection scheme / timestep had little effect at reliable scales

Spatial skill-spread using the FSS

99th percentile, hourly accumulations



Convection-permitting ensembles

Small scales are not predictable (precipitation)

Insufficient ensemble members

Spread at or near the grid scale is meaningless (for precipitation)

Possible to determine spatial spread and error

Use to define suitable scales over which to post process or utilise

Coarser-resolution ensembles no different – just longer spatial and temporal scales

The Fractions Skill Score (FSS) for comparing fractions with fractions

Mean square error for the fractions – variation on the Brier score

$$\underset{\text{(Fractions Brier Score)}}{FBS} = \frac{1}{N}\sum_{j=1}^{N}(p_j - o_j)^2$$

$0 \leqslant p_j \leqslant 1$ forecast fractions

$0 \leqslant o_j \leqslant 1$ radar fractions

N number of points

Skill score for fractions/probabilities - Fractions Skill Score (FSS)

$$FSS = 1 - \frac{FBS}{\frac{1}{N}\left[\sum_{j=1}^{N}(p_j)^2 + \sum_{j=1}^{N}(o_j)^2\right]}$$

Compute fractions within different sized squares to get variation of FSS with scale

Thanks for listening