A critical look at the verification of “flash” Warnings

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4th International Verification Methods Workshop, Helsinki 8-10 June 2009

Flash warnings
Issued for local authority regions

Type	Criteria
Severe Gales	Repeated gusts of 70 mph or more over land areas *ie 2 or more gusts of 70 mph or more at separate hours within the period of the warning*
Heavy rain	Heavy rain expected to persist for at least 2 hours and to give at least 15mm in 3 hours *Or a period of rainfall of sufficient intensity to cause flooding on already saturated ground*
Must also be at least 80% confident (ie FAR < 0.2)	

Scores

		Observed		
		Event	No event	Total
Forecast	Event	a=hits	b=false alarms	a+b=B*(a+c)
	No event	c=misses	(d=correct no)	
	Total	a+c		

$$\text{Hit rate}, H = \frac{a}{a+c} \quad \text{False alarm ratio}, FAR = \frac{b}{a+b}$$

$$\text{Threat}, TS = \frac{a}{a+b+c} \quad \text{Bias}, B = \frac{a+b}{a+c}$$

Deterministic limit (Hewson 2006)

- More forecasts correct than either missed or false alarms

$$a > (b + c)$$

$$2a > (a + b + c)$$

$$a/(a + b + c) = TS > 0.5$$

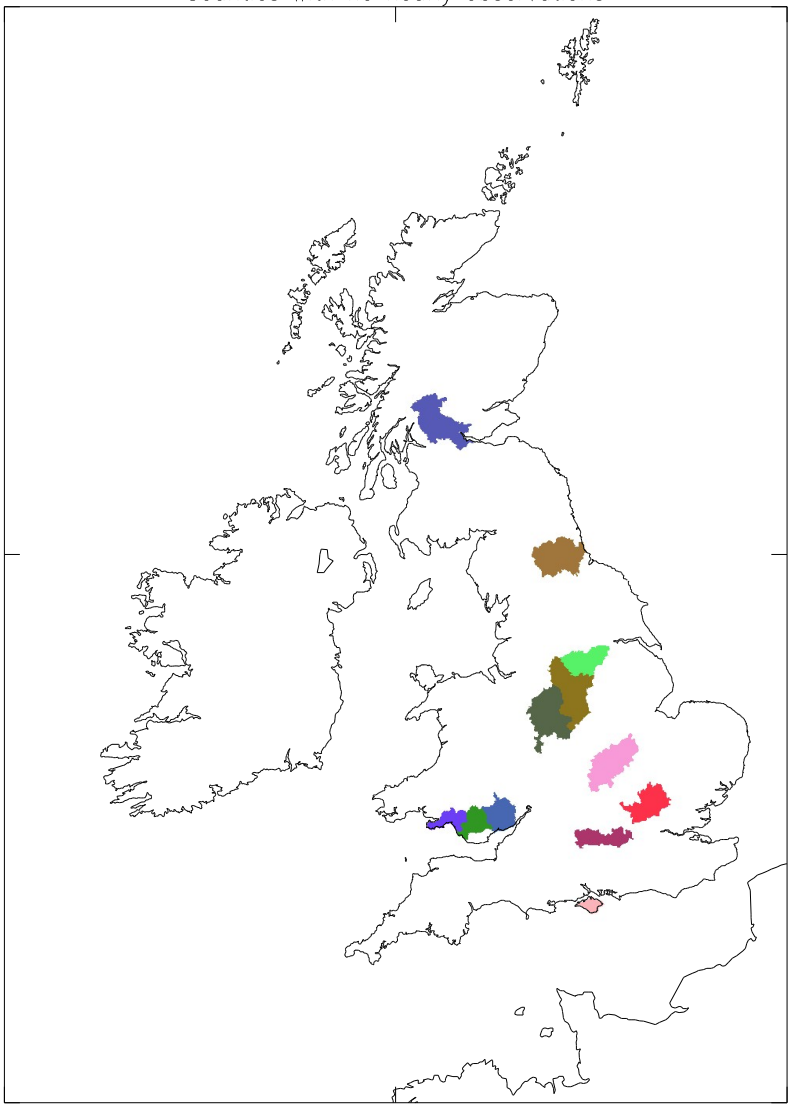
Verification regions & Truth types

- Amalgamate some small areas into 65 “county” regions
- Must have criteria for gale or heavy rain exceeded for *at least one location*
- Truth:
  - Observations
    - Some counties have none or few
  - Virtual observations
    - UKPP= post-processed UK4 model+radar (2km)
    - Locally adjusted UKPP for site location
    - At least 2 per region
  - Nimrod (nowcast) analyses (15km grid)
  - UKPP analyses (nominally 2km grid)

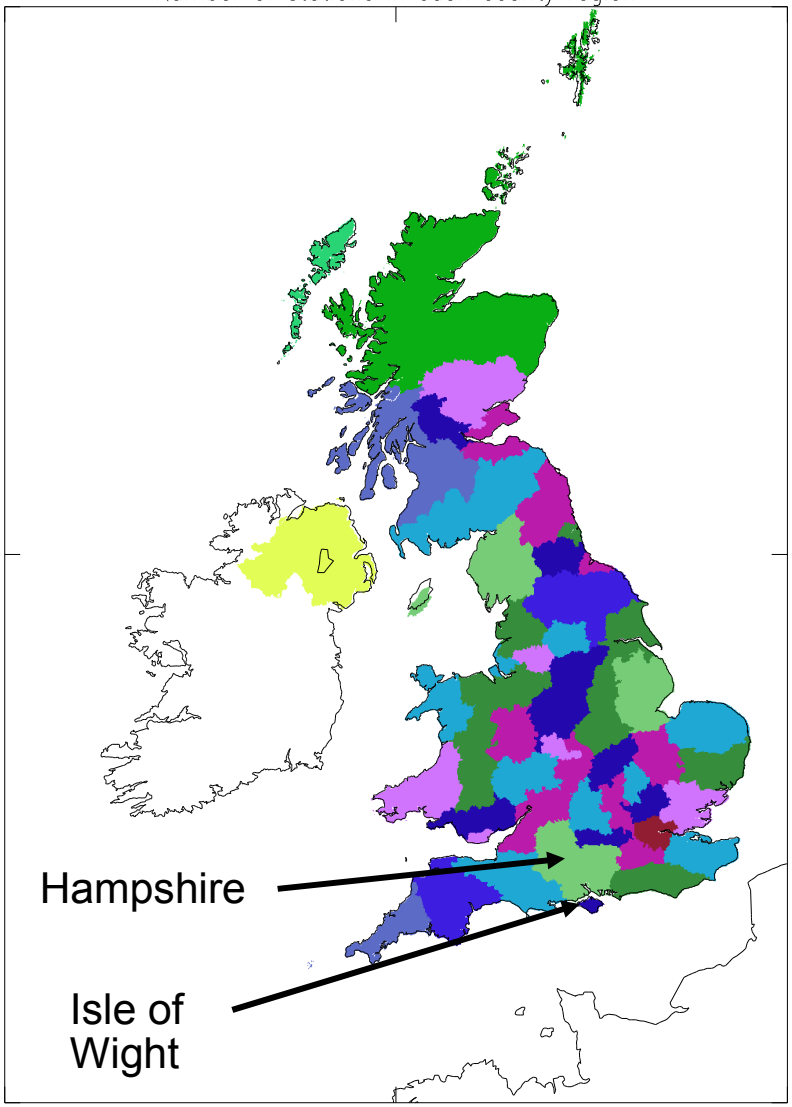
Verification - Truth types

Truth type	Comments
Station Observations	Some counties few or none
“Virtual” observation	UK 4km postprocessed to 2km Local adjustment At least 2 per region
Nimrod (nowcast)	Radar composite 15km resolution
UKPP	2km resolution radar composite Wind analyses

Counties with no hourly observations



Number of stations in each county region



Variation with H and FAR

$$H = \frac{a}{a+c} \Rightarrow c = a\frac{(1-H)}{H}$$

$$FAR = \frac{b}{a+b} \Rightarrow a+b = \frac{a}{1-FAR}$$

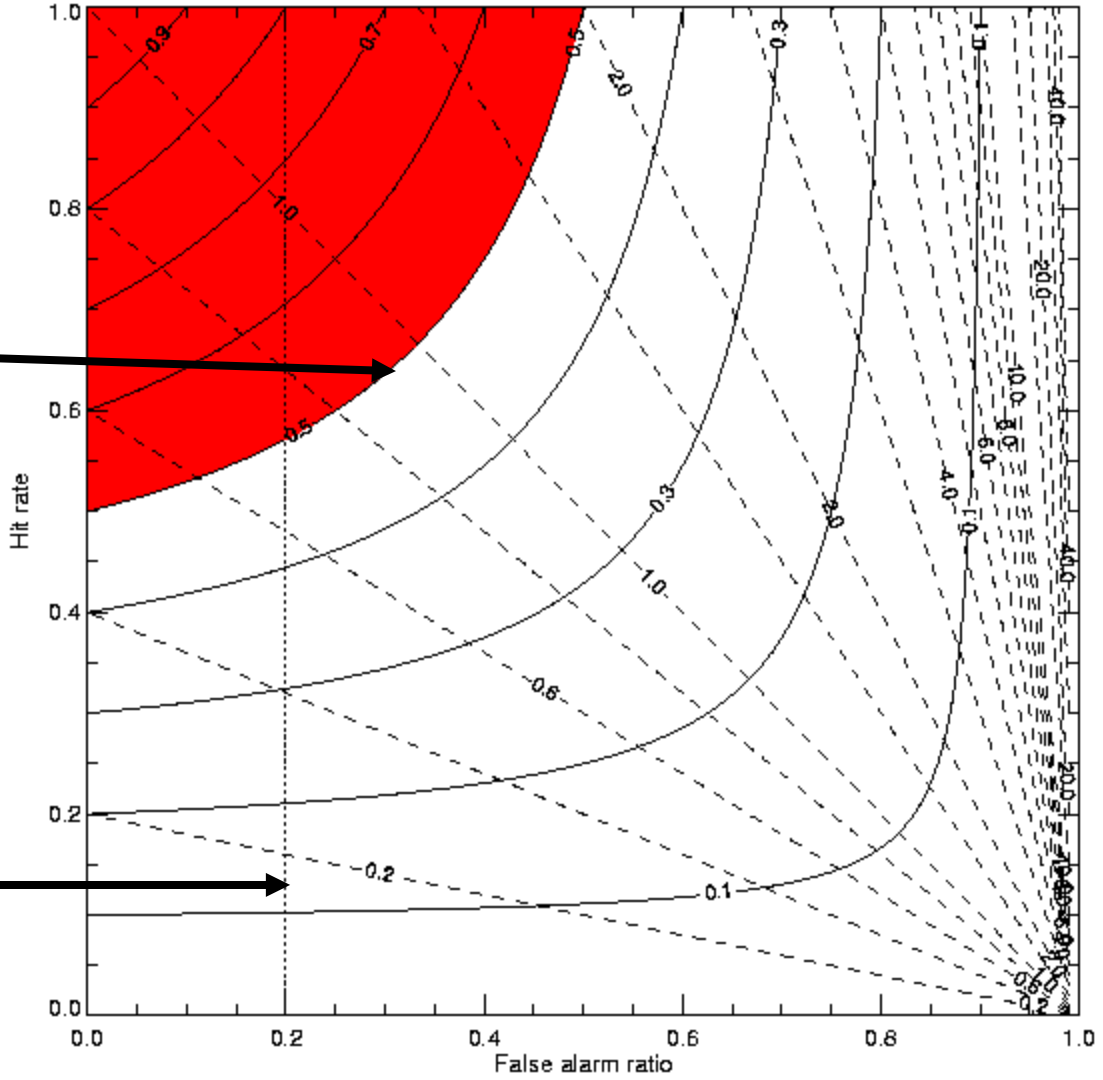
$$TS = \frac{(1-FAR)H}{1-FAR(1-H)}$$

$$B = \frac{H}{1-FAR}$$

Hit rate v False alarm ratio-cf Roebber – WAF, 2009

Deterministic limit

Confidence limit



Heavy Rain - forecasters

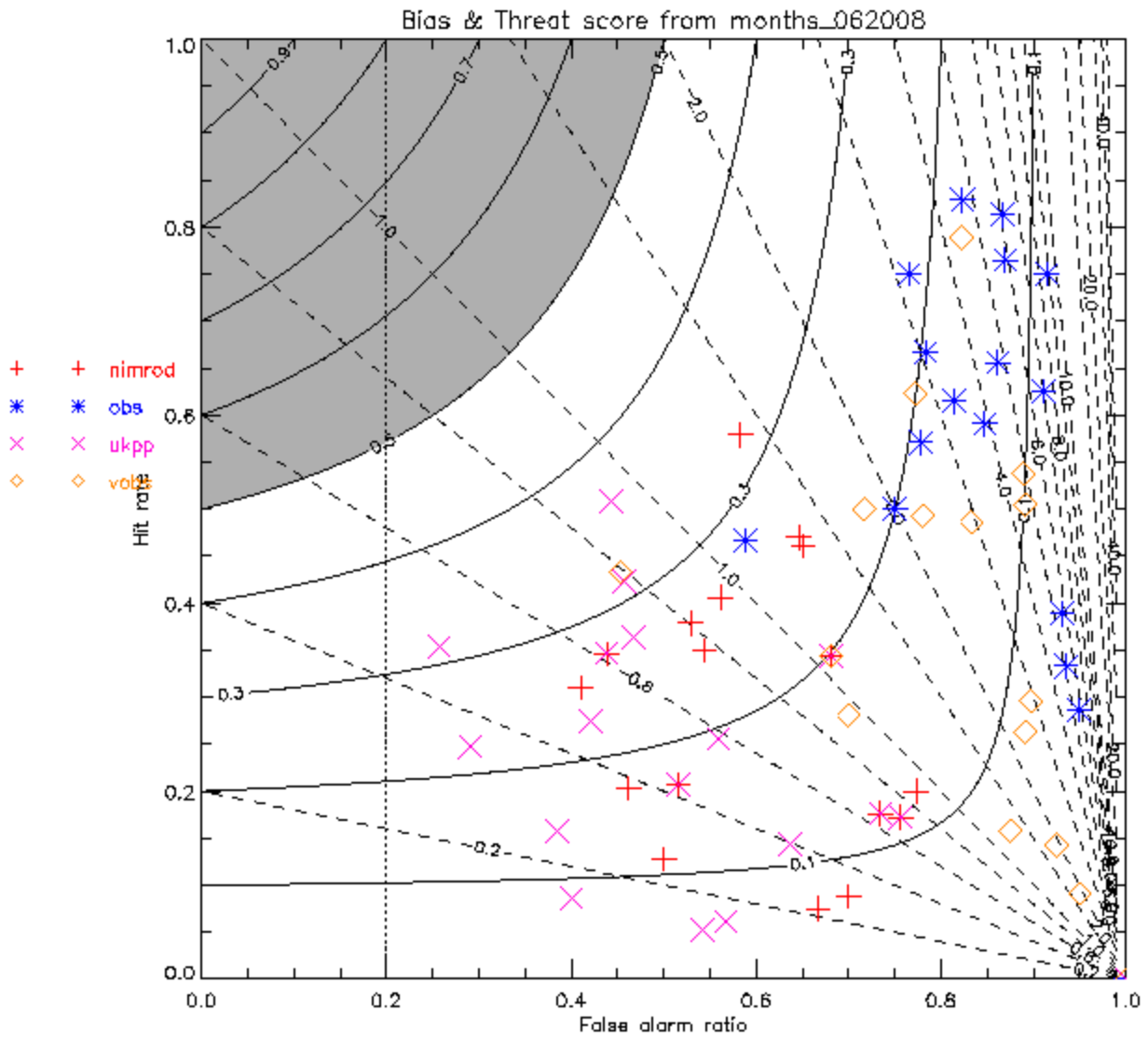
Nimrod

Obs

UKPP

Virtual Obs

monthly



Heavy Rain - forecasters

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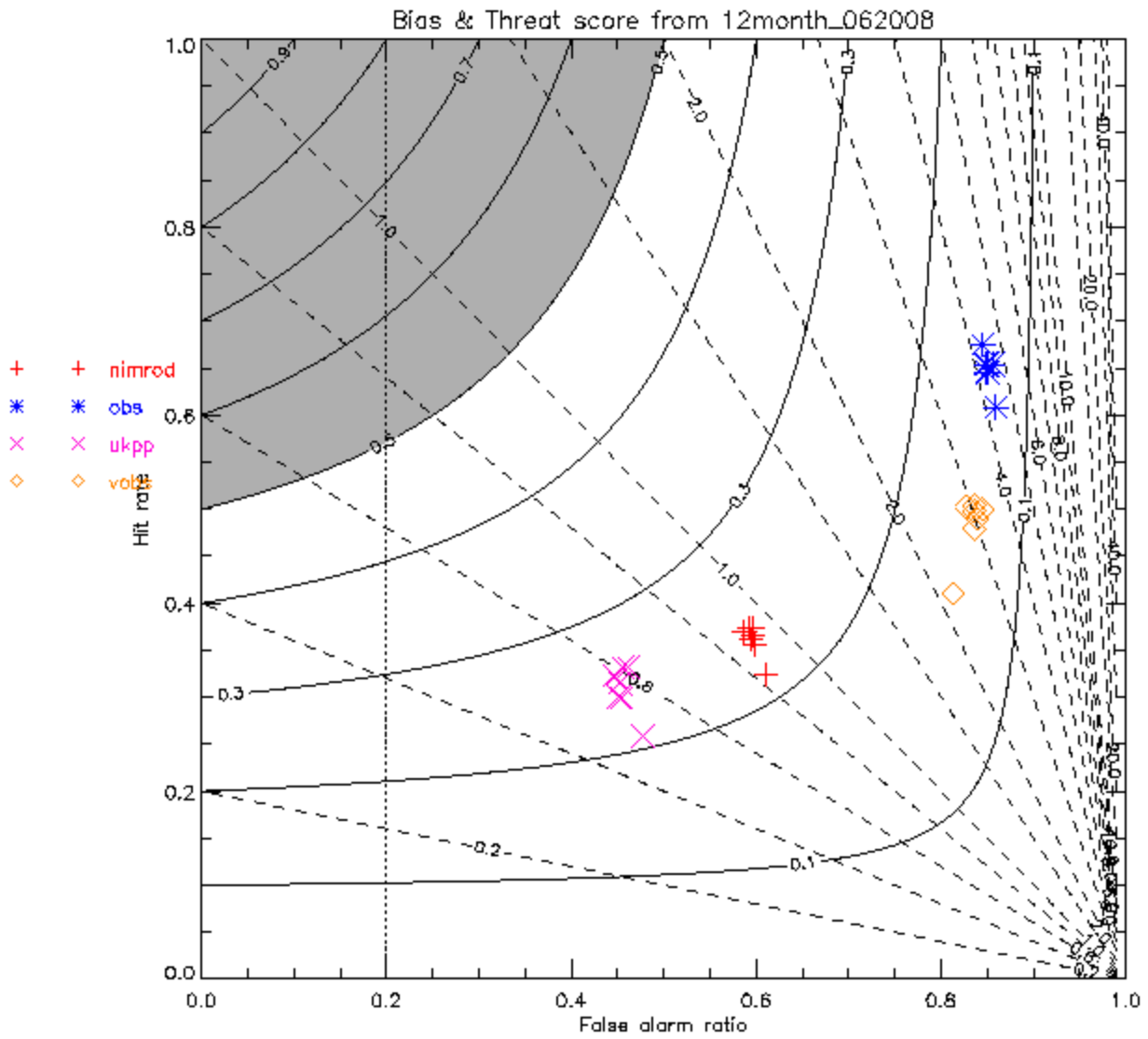


12-monthly

Severe gales - forecasters

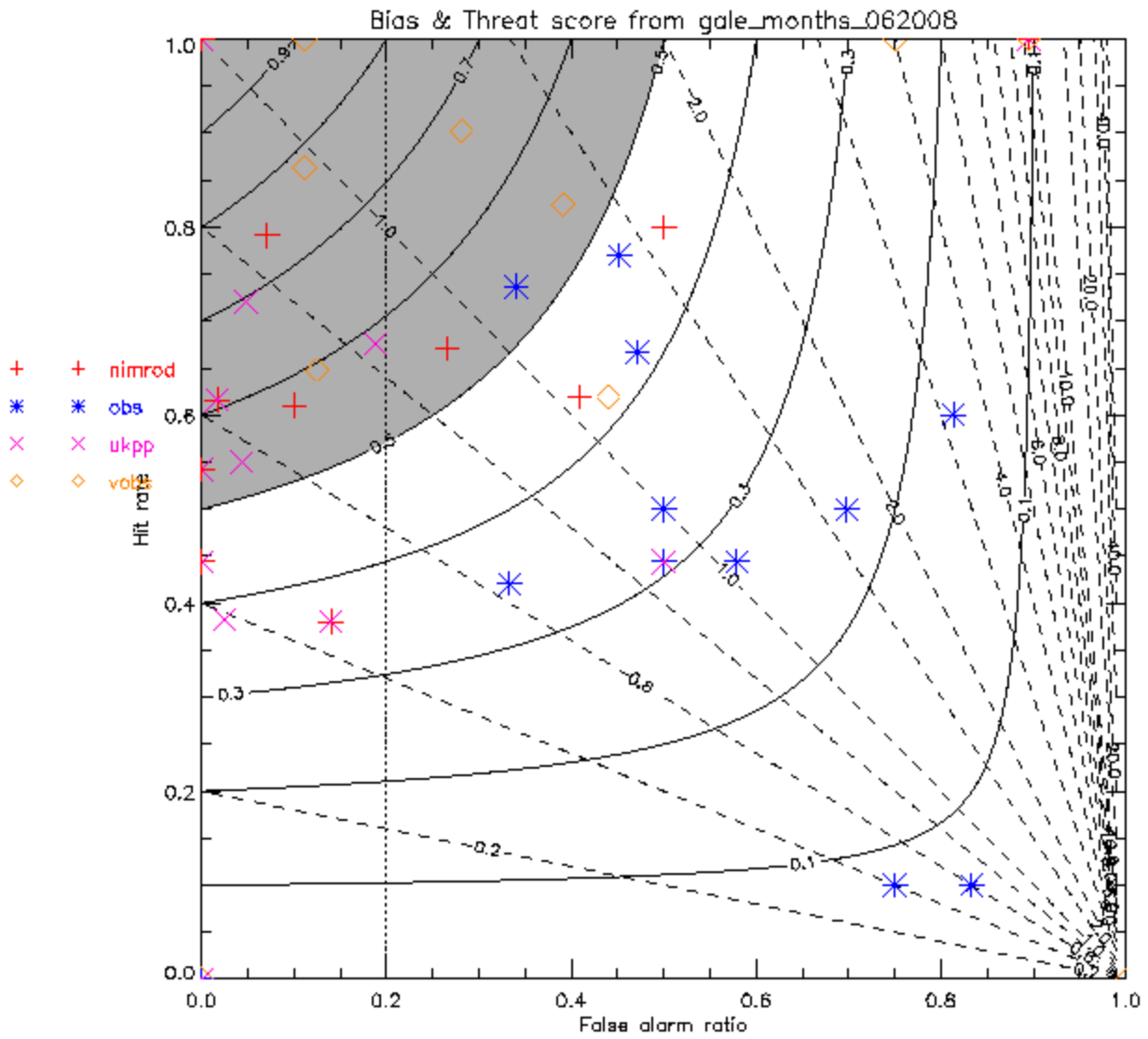
Nimrod

Obs

UKPP

Virtual Obs

monthly



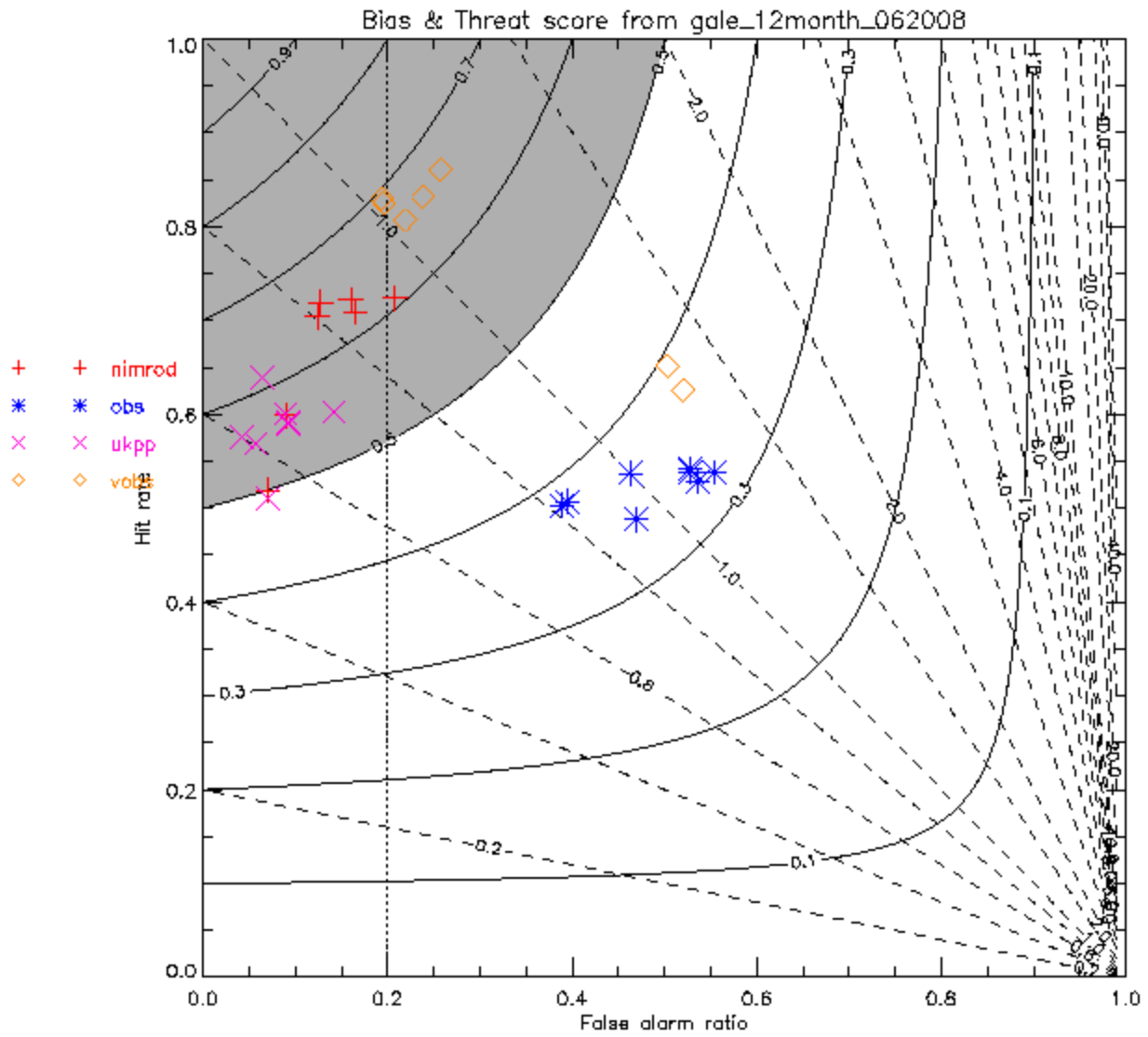
Severe gales - forecasters

Nimrod

Obs

UKPP

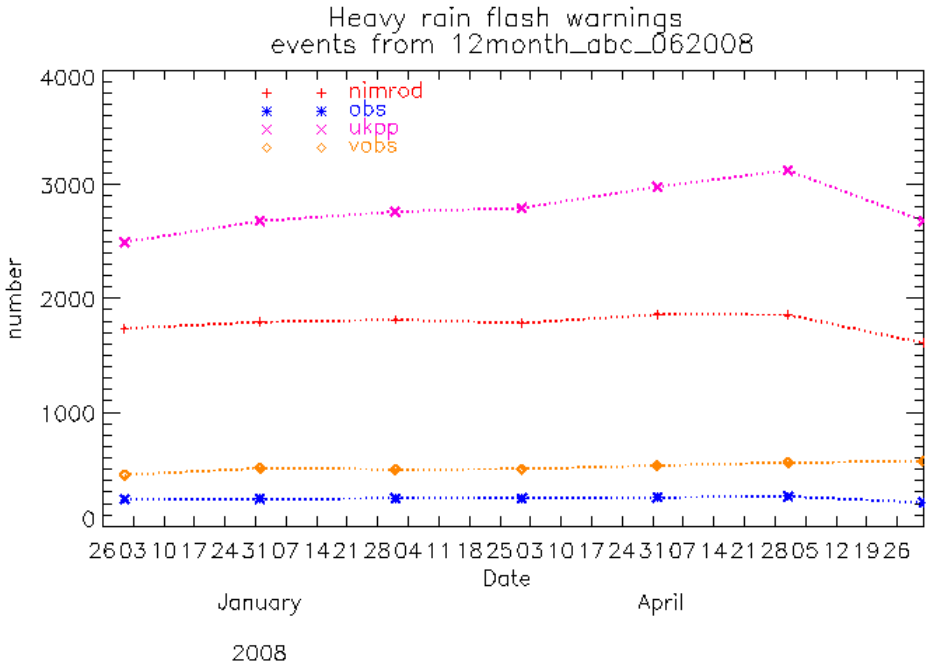
Virtual Obs



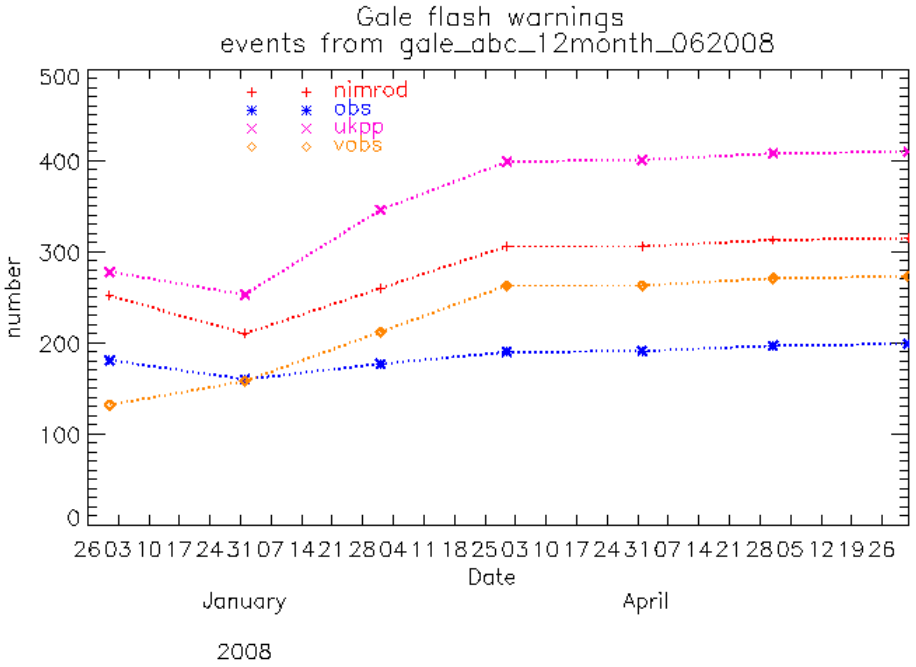
12-monthly

Detection of events

Heavy rain

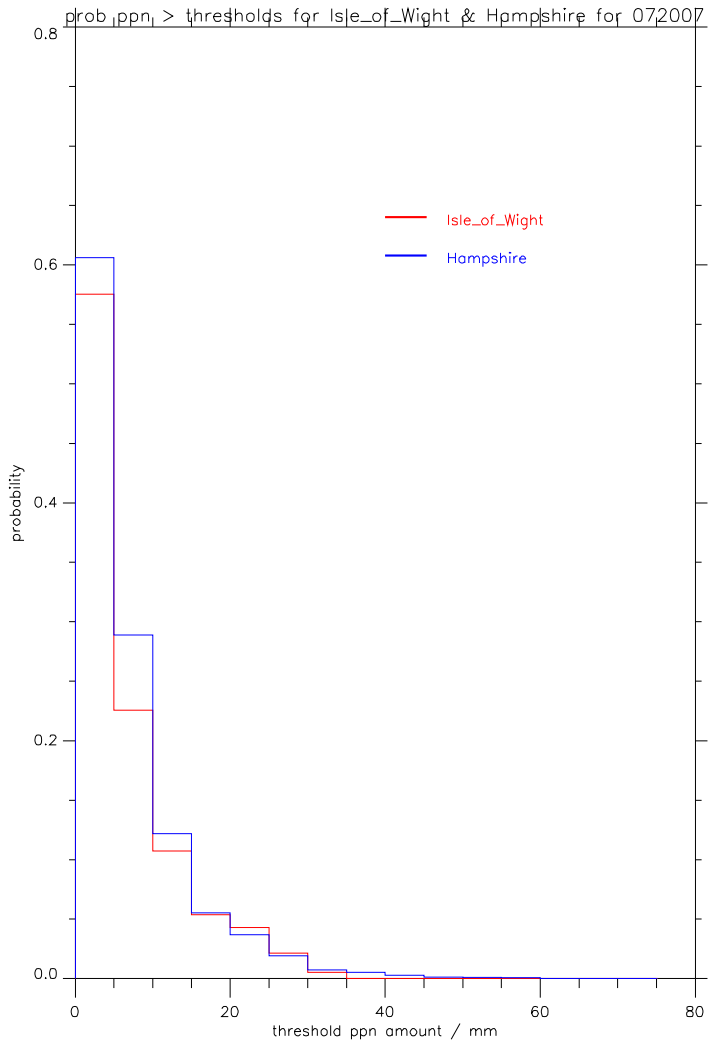


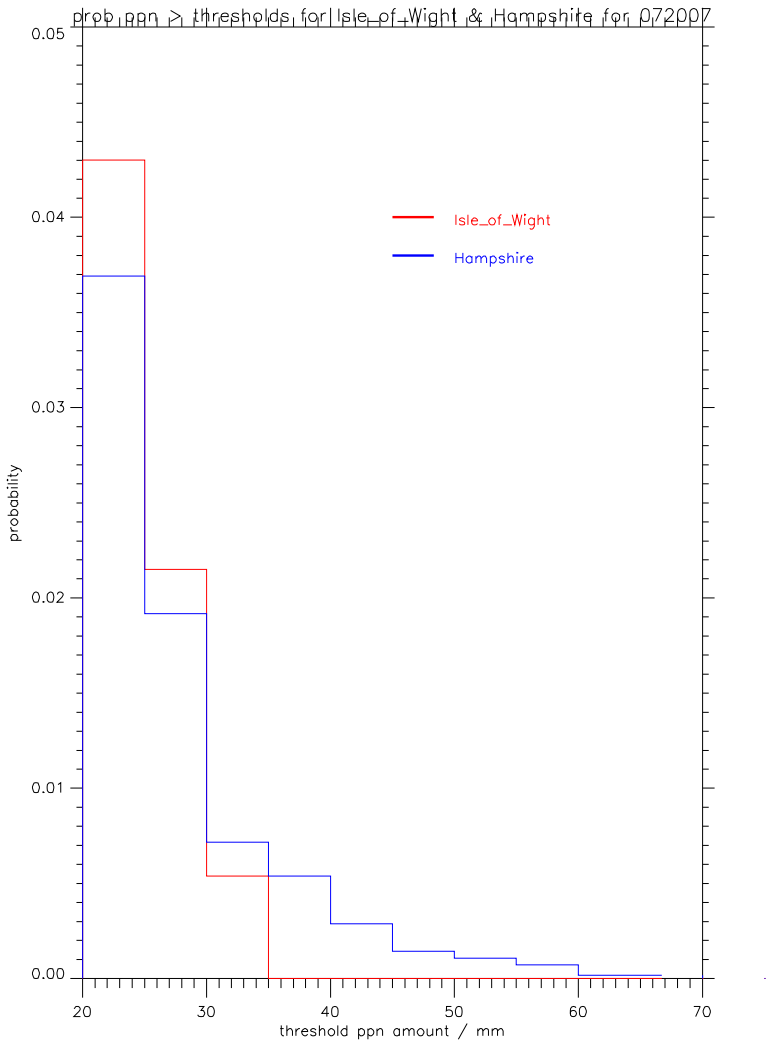
Gales



Obs
UKPP
Virtual Obs

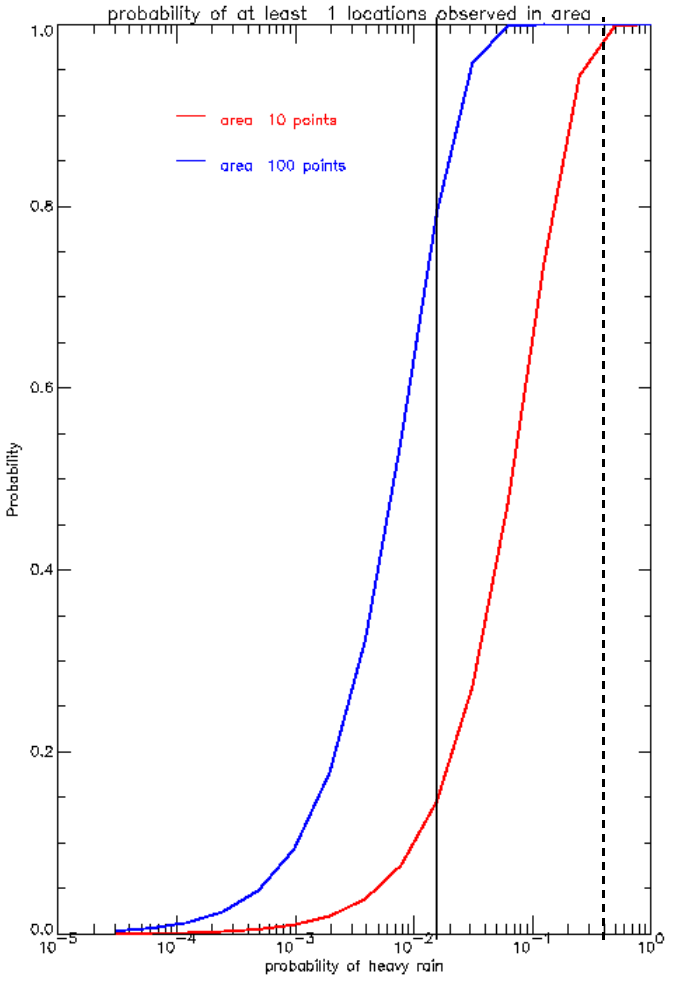
Probability of heavy rain depends on region size – daily precipitation, July 2007





Variation of detecting heavy rain at 1 location with base rate probability

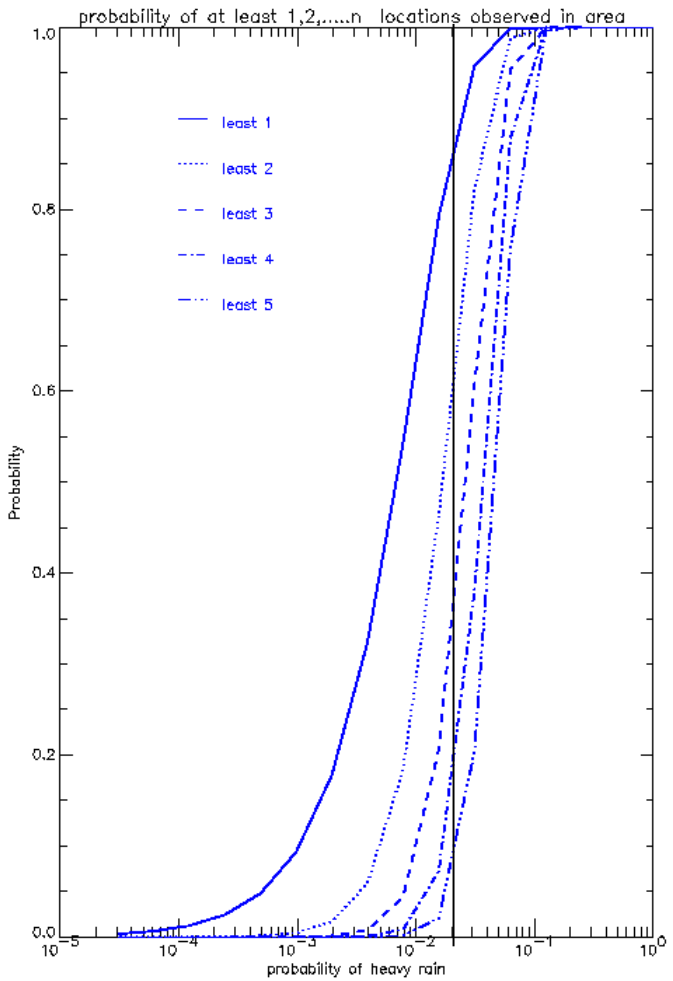
- 2 regions
  - 10 grid points
  - 100 grid points
  - Same base rates p
  - 6-10x more likely to detect for larger region with typical p



Base rate, p

Variation of probability of detecting heavy rain at more than 1 point

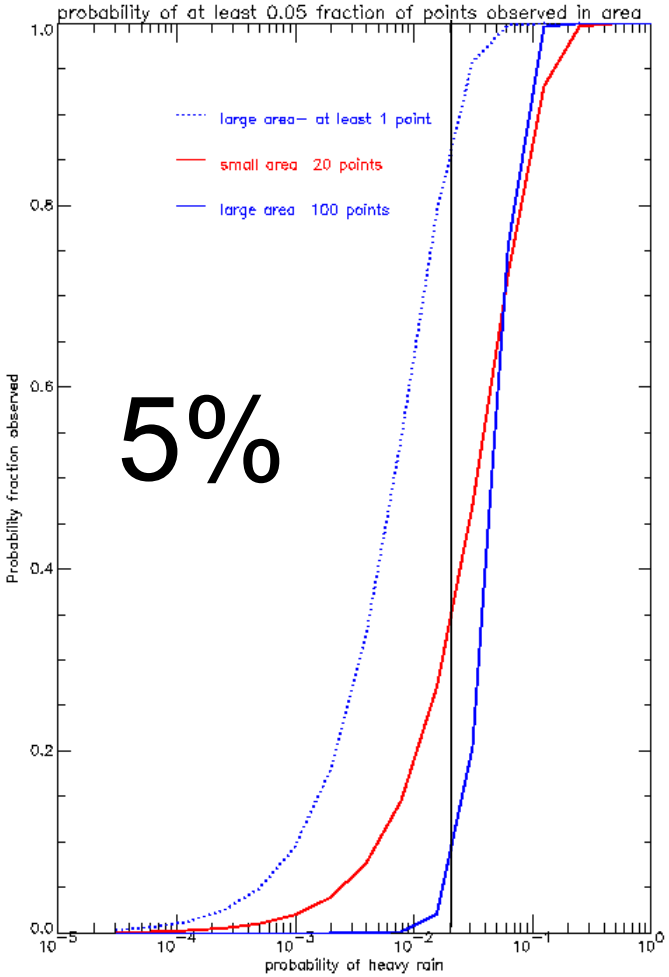
- 1 region
  - 100 grid points
  - base rate p
  - At least 1,2,3,4,5 locations simultaneously



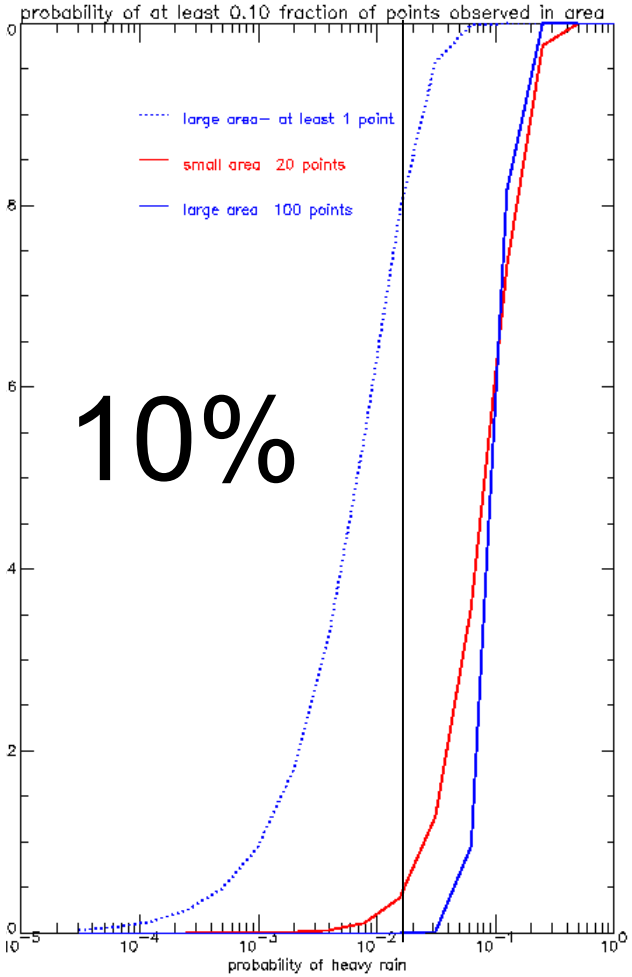
Base rate, p

Probability of detecting a fixed %age of points per county region

More likely to detect over smaller area for rare events

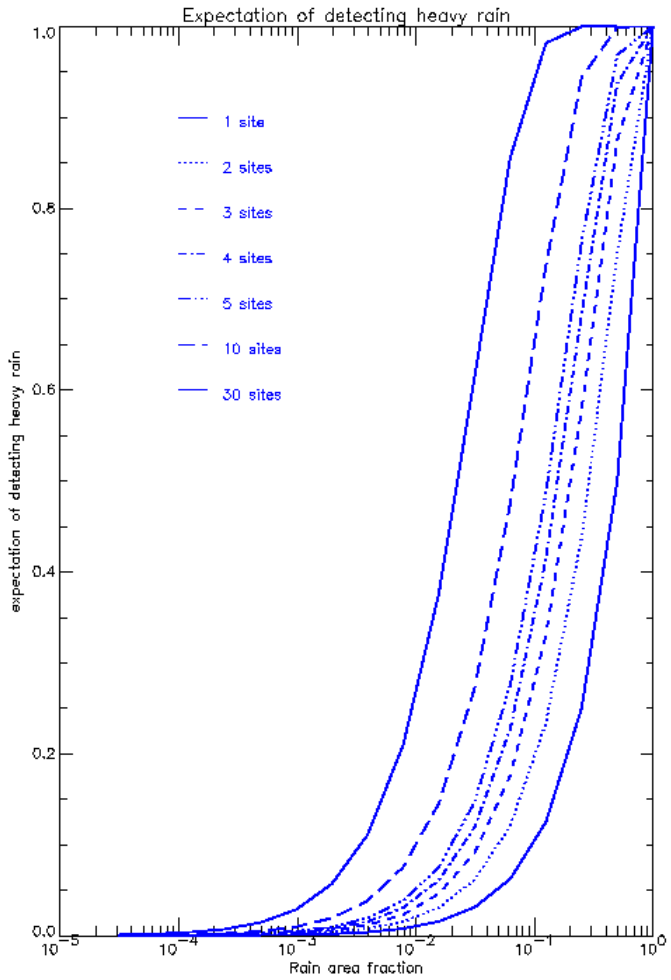


Base rate, p

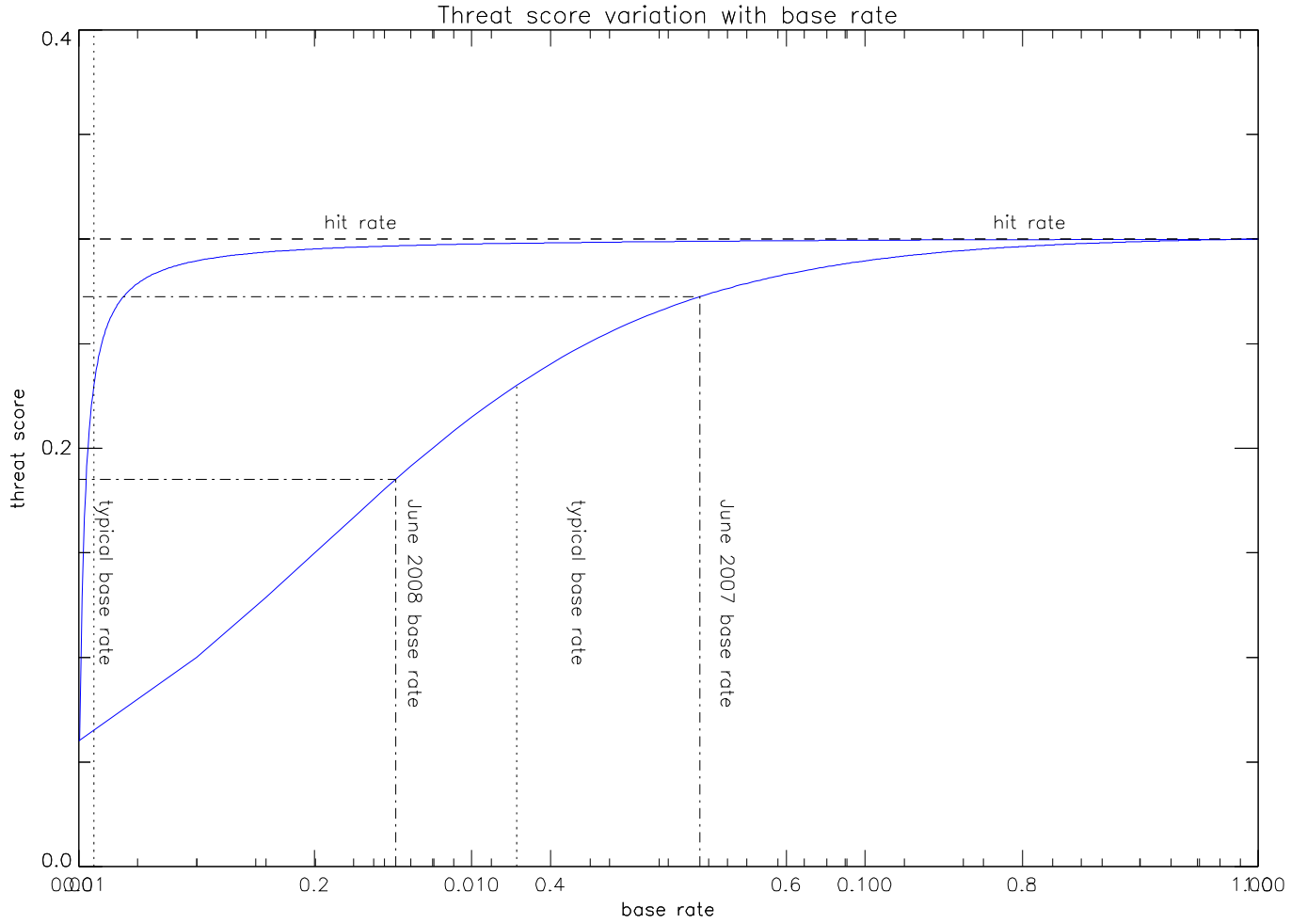


Base rate, p

Expected detection rate for at least one observation with varying number of sites

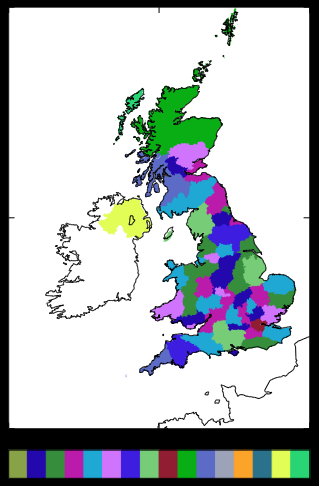


Variation of threat score for heavy rain with base rate

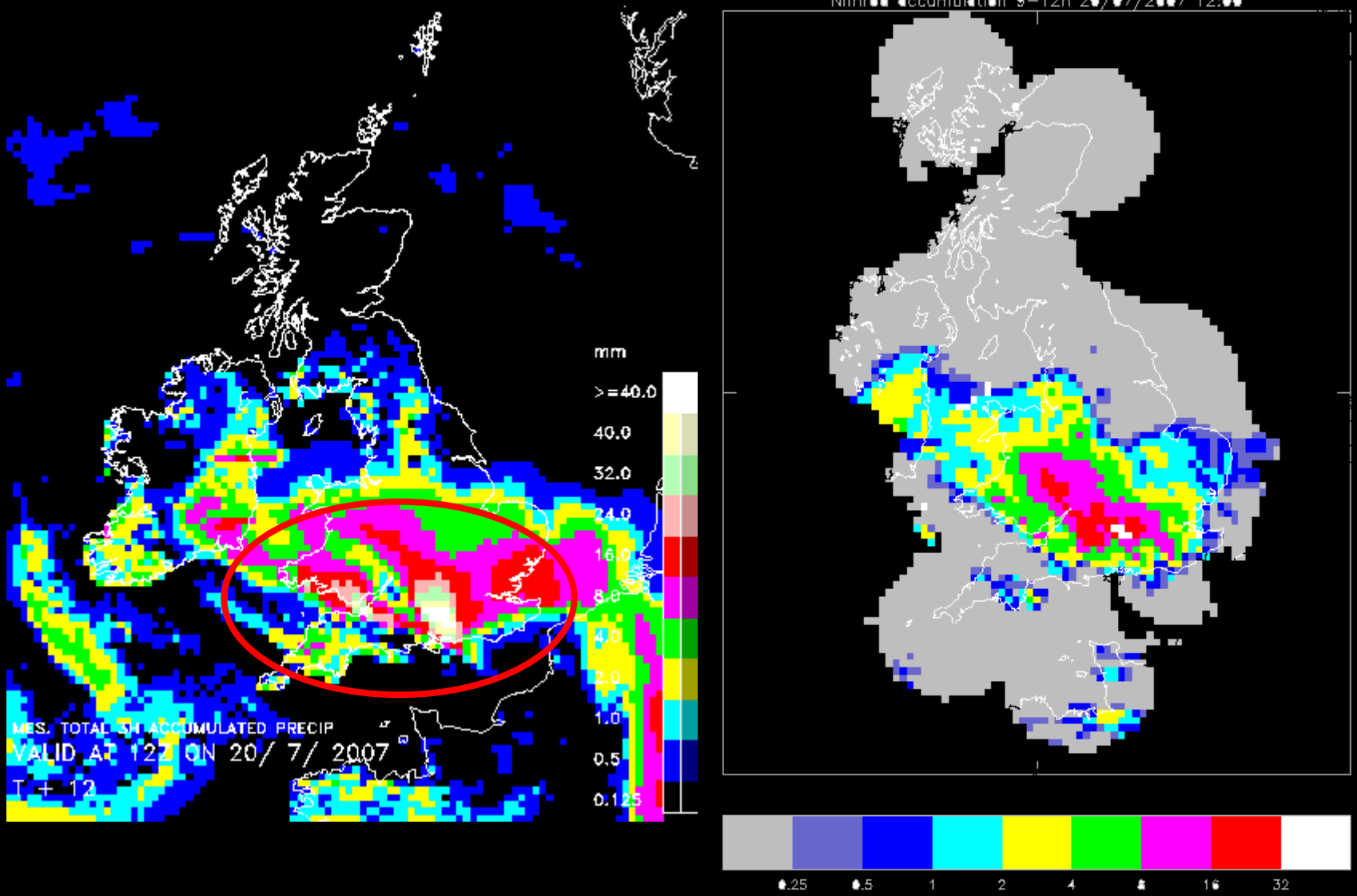


Model forecasts for heavy rain flash (15mm/3h)

- NAE (12km) and UK4 4km forecasts over UK for July 2007
- Compared to radar composites (5km)
- Verified at all 3h periods 0-3, 1-4, 2-5 … 33-36
- Model forecasts verified at 12km and 5km (UK4)
- thresholds 5mm, 10mm, 15mm (/3h)
- Verified
  1. At all grid points with radar ppn
  2. for “county regions”
  3. Mostly verified at 12km radar



Radar 3h accumulation on 12km grid

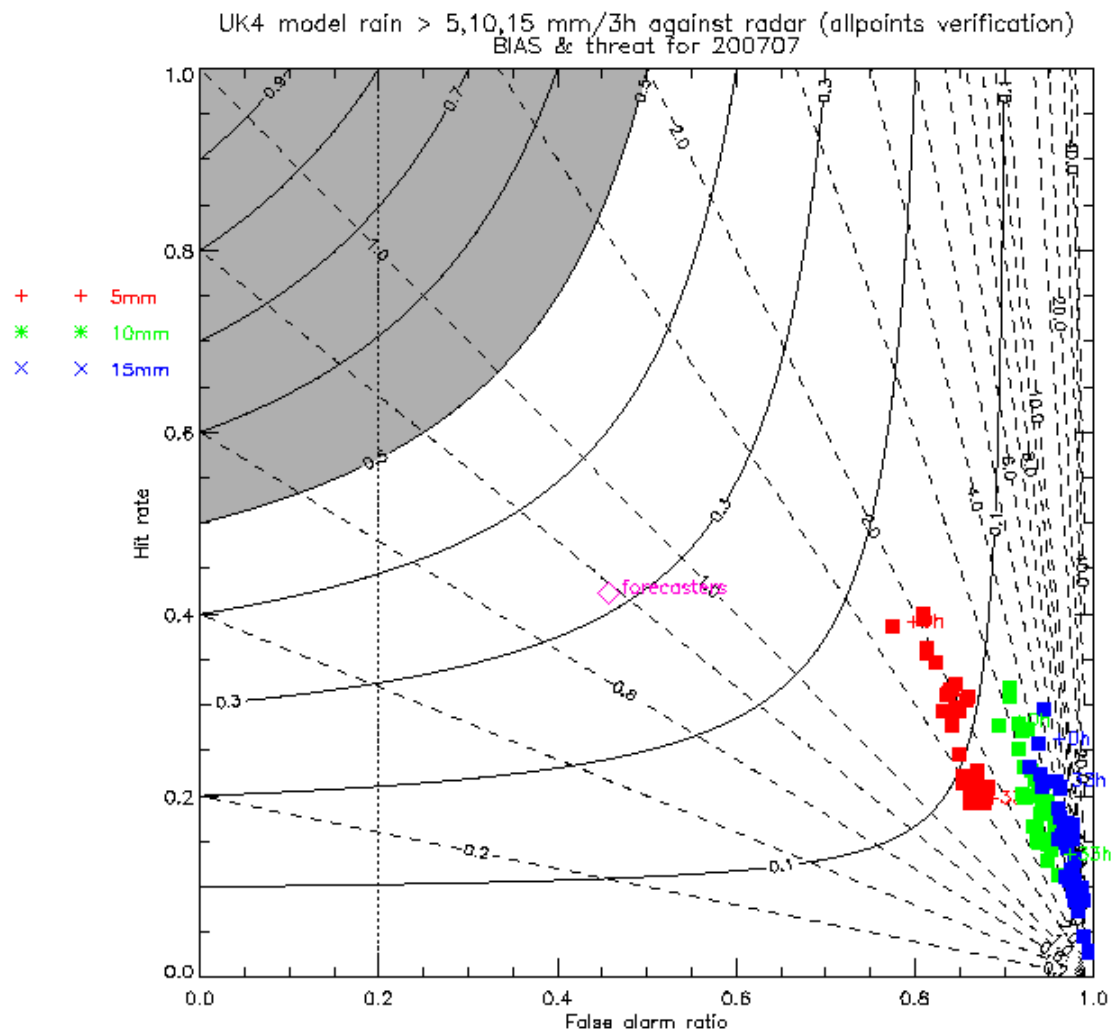


NAE(12km) & UK 4km models (12km grid verification) July 2007

NAE

12km

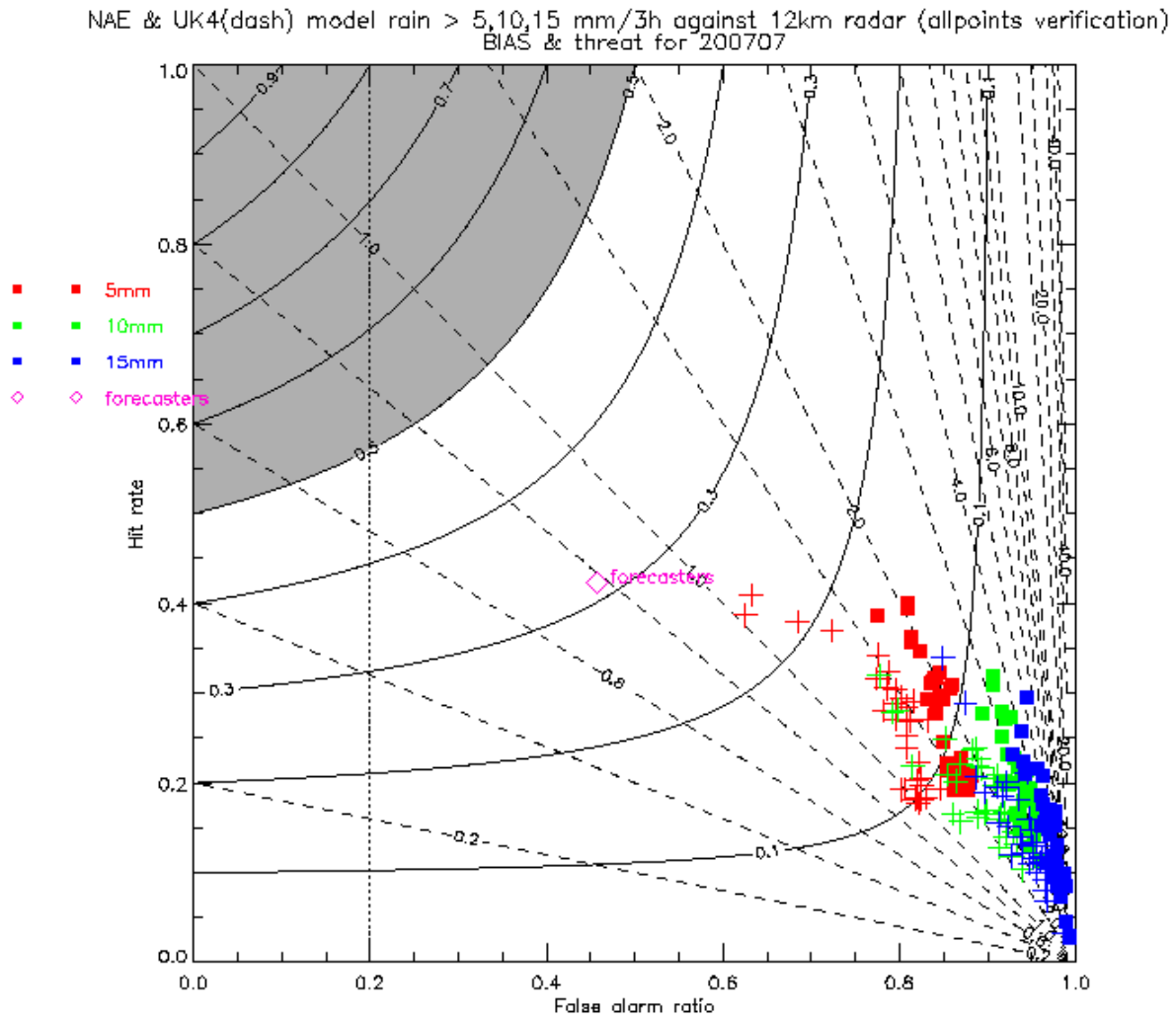
4km



NAE(12km) & UK 4km models (12km grid verification) July 2007

12km +

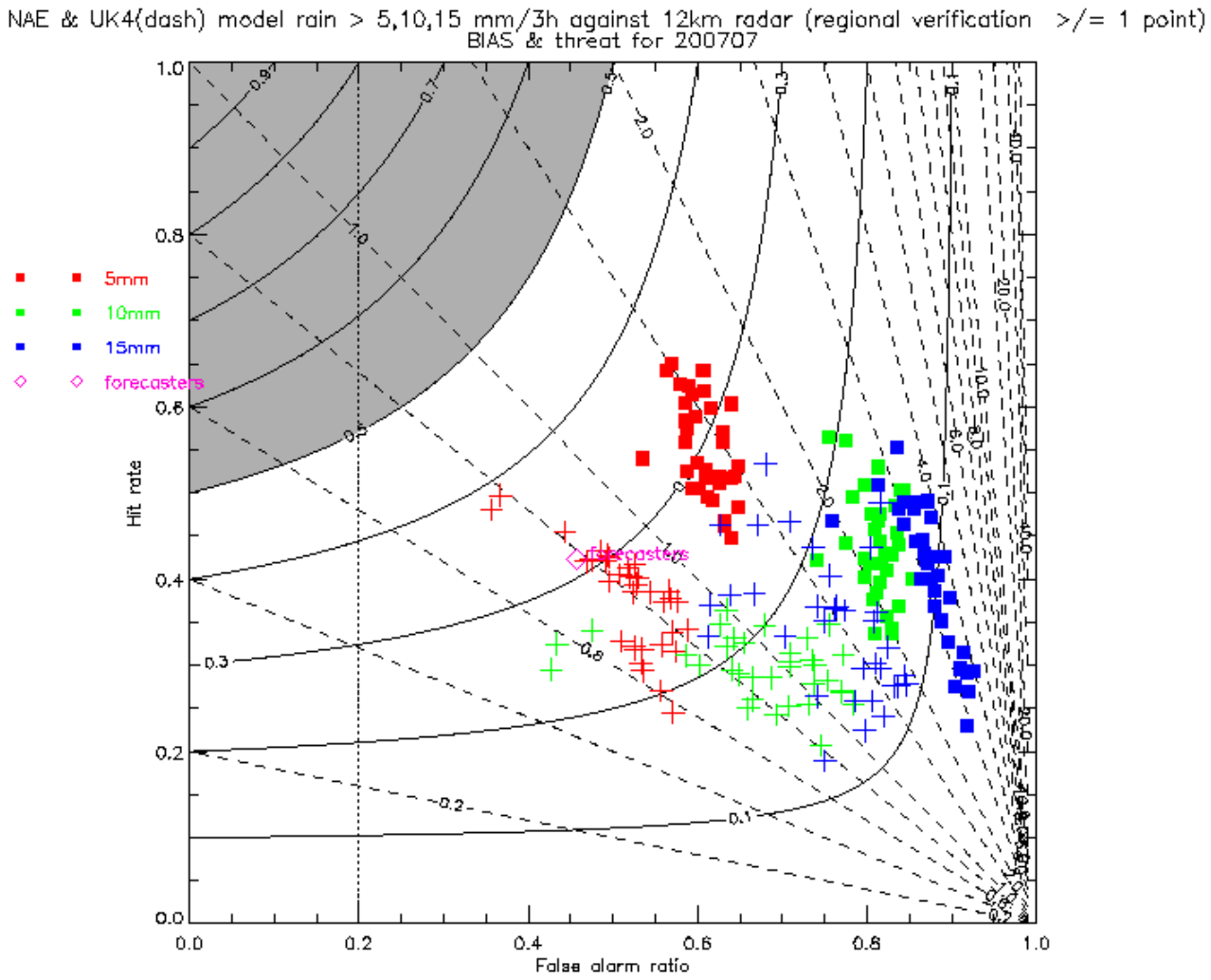
4km ■



NAE(12km) & UK 4km models (regional verification) July 2007

12km +

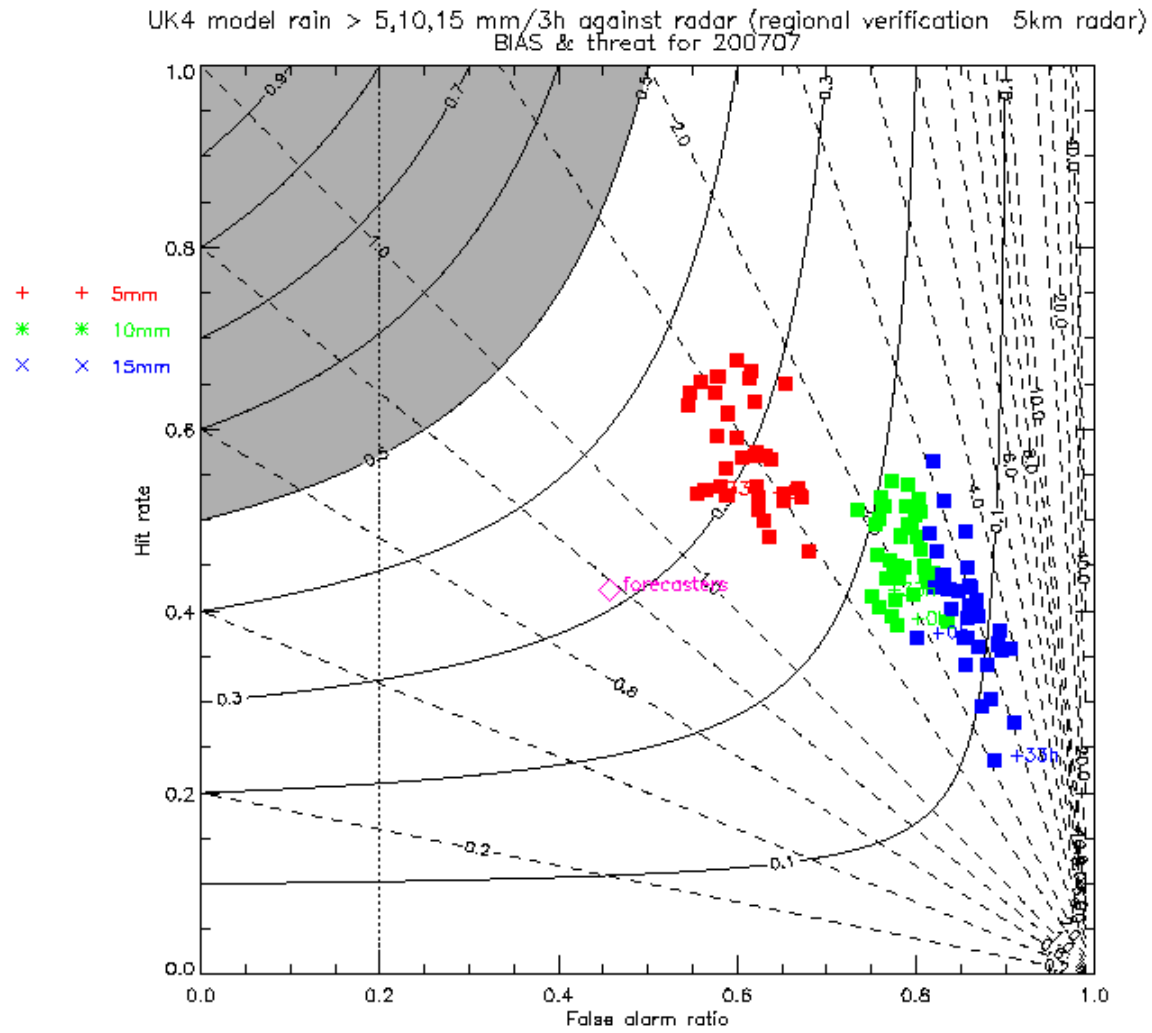
4km ■



UK 4km model (regional verification) v 12km & 5 km radar July 2007

12km radar

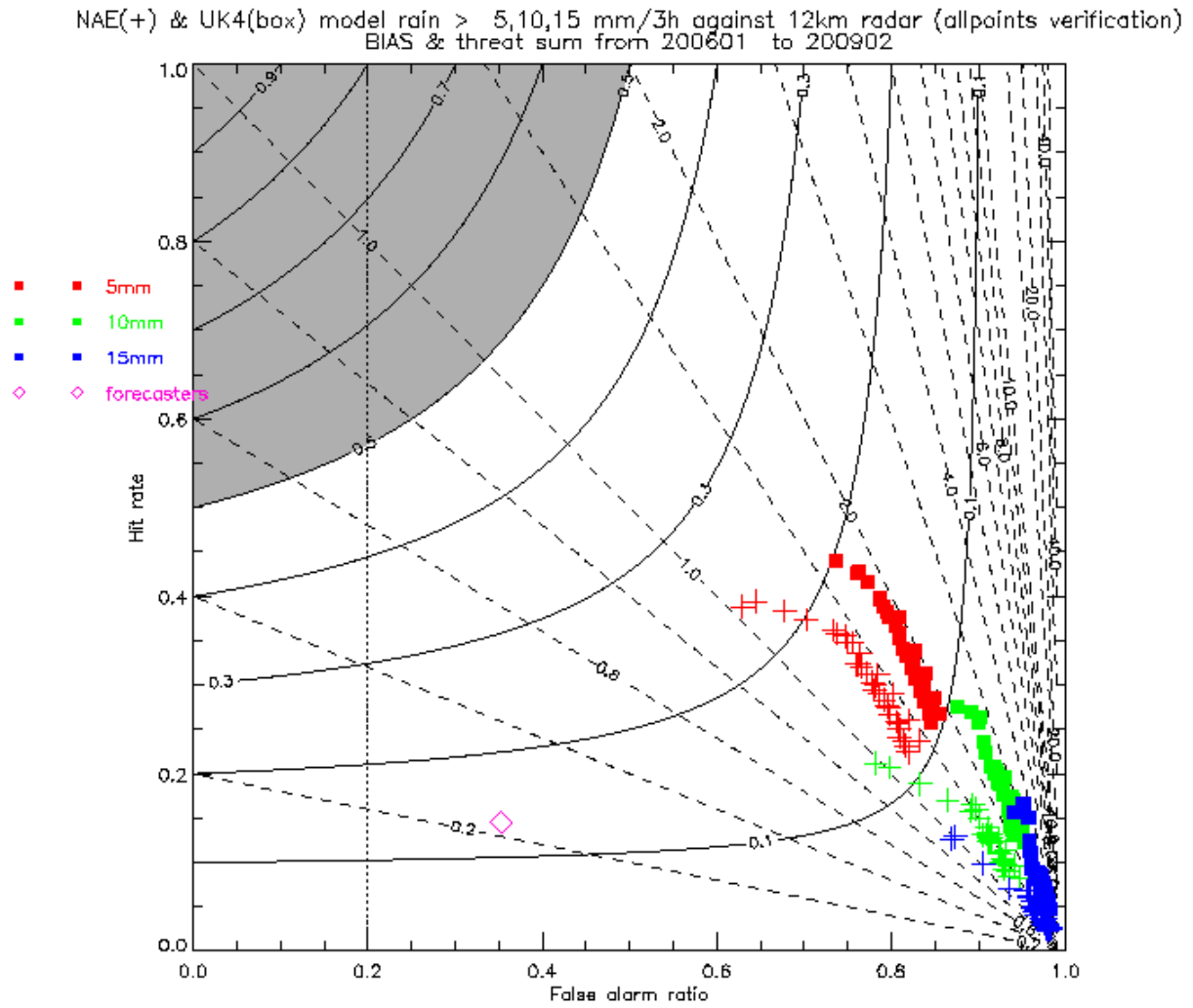
5km radar



NAE(12km) & UK 4km models (12km radar verification) 200601-200902

12km +

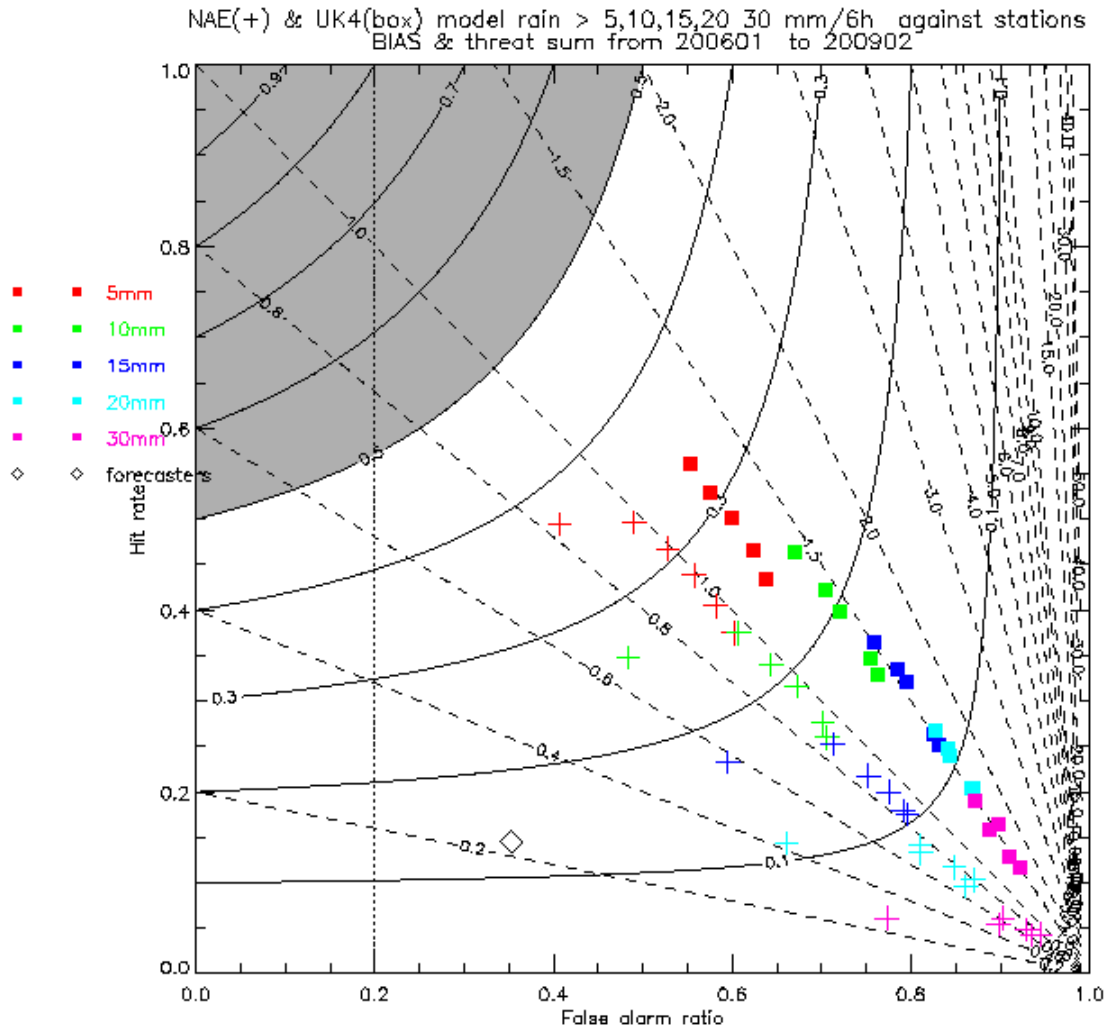
4km ■



NAE(12km) & UK 4km models (Nearest point to station verification) 200601-200902

12km +

4km ■



Conclusions -1

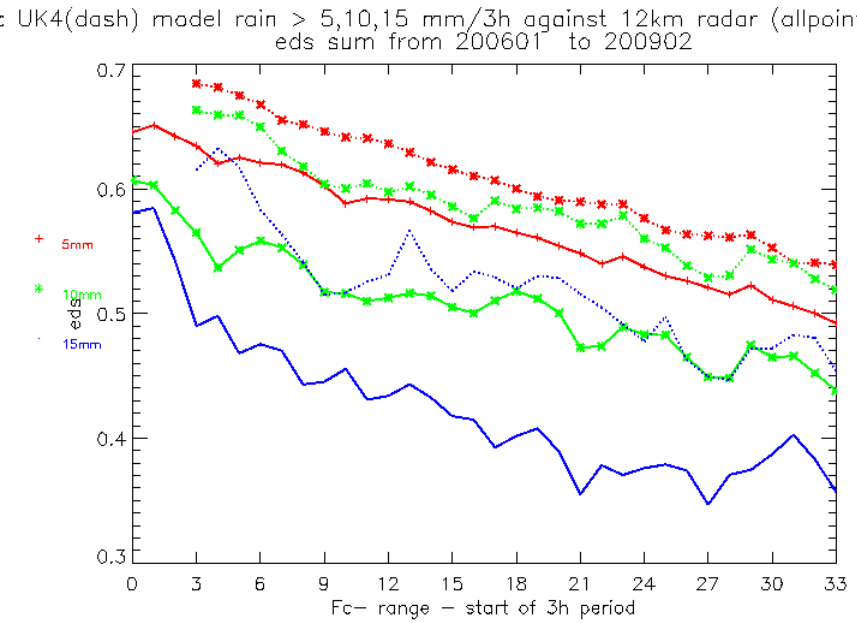
- Useful summary plots
  - Hit rate v False alarm ratio with Bias, threat score contours
- Single (threat) score inadequate
- Always show bias – scores may be hedged
- Scores depend on “truth” type
- Regional verification problems
  - Variation in area
  - Obs missing
  - Detection depends on no. of locations for event & frequency

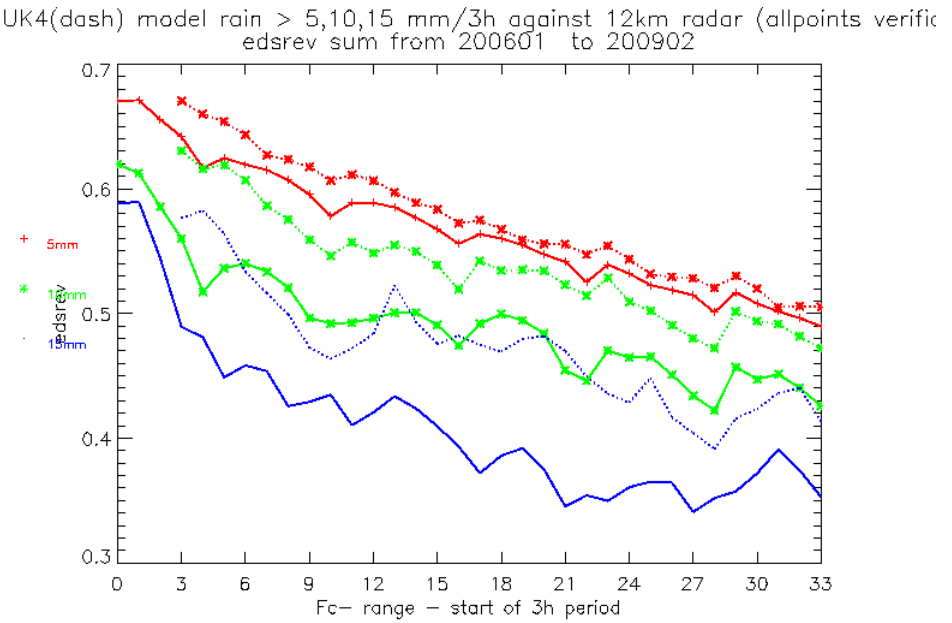
Conclusions -2

- Confidence (80%) generally not achieved by forecasters
- Deterministic limit – not generally satisfied
- Forecasters improve on raw model guidance
  - nowcasting
- Threat score very dependent on base rate
  - Perhaps use Extreme dependency score (EDS) -need “d”
- Models – heavy rain
  - Better performance July 2007 than July 2008
    - Larger base rate
  - UK 4km better than NAE 12km?
    - Higher hits & sometimes threat – but larger bias

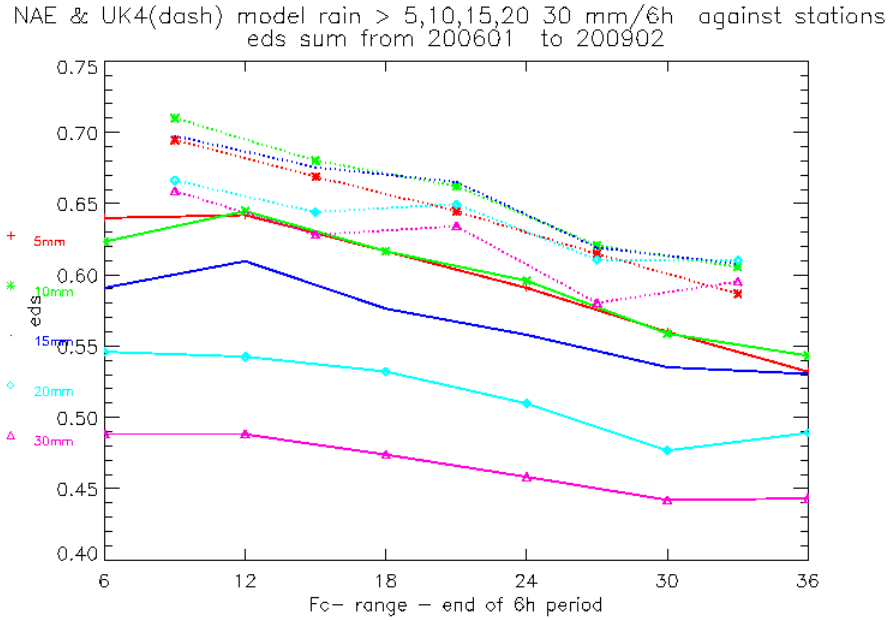
Questions ?

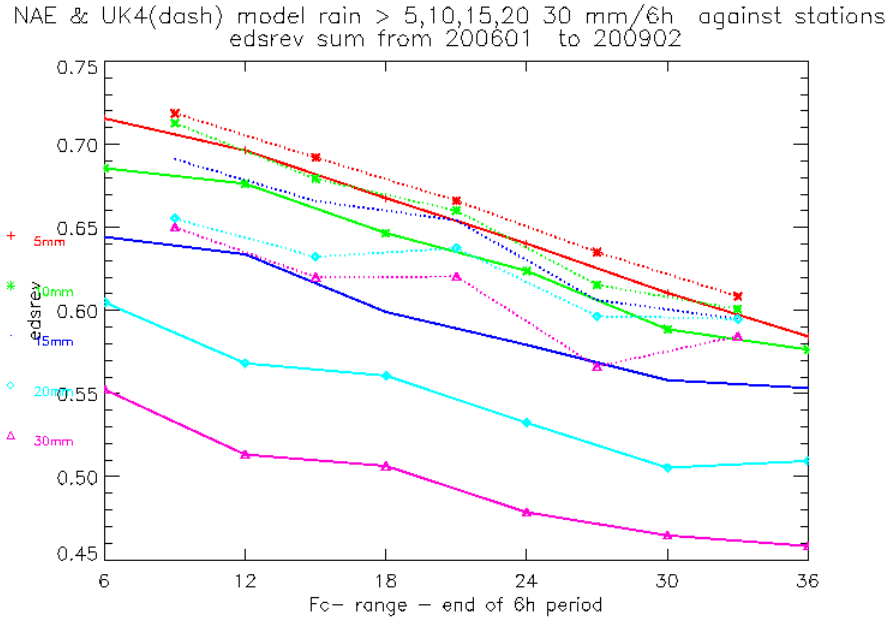
EDS scores
(12km radar verification)
200601-200902





EDS scores
(Nearest point to station verification) 200601-200902





Contents

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  - Different “truths”
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- Model “warnings”
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- Conclusions

Public Weather Service warnings – web site guidance

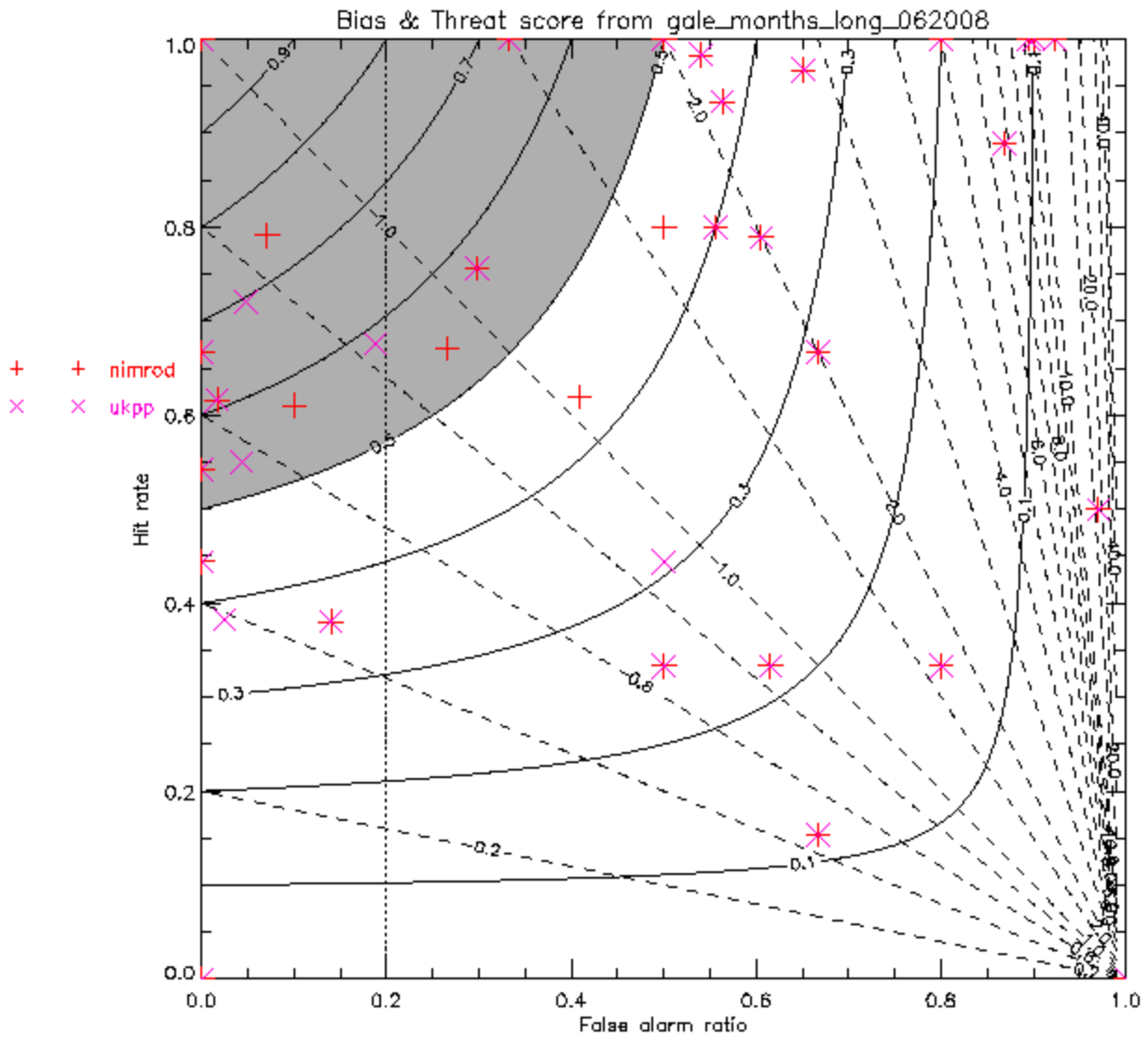
Colour and risk levels for severe weather events (can often occur, particularly in winter)					
	Green		**Yellow**	**Amber**	
Warning	None		Advisory	Early	Flash
Risk	Very low <20%	Low ≥20% <40%	Moderate ≥40% <60%	High ≥60% <80%	Very high >80%
Headline	No severe weather expected		Moderate risk of severe weather	High risk of severe weather	Severe weather is imminent or is occurring
Impact			Moderate risk of some damage to infrastructure and local disruption	High risk that there will be some damage to infrastructure and local disruption	Very high risk that there will be some damage to infrastructure and local disruption
Advice			Ensure you access the latest weather forecast	Remain vigilant and ensure you access the latest weather forecast	Ensure you access the latest weather forecast and take precautions where possible

Severe Gales 36-month

Nimrod

UKPP

Monthly



Severe Gales 36-month

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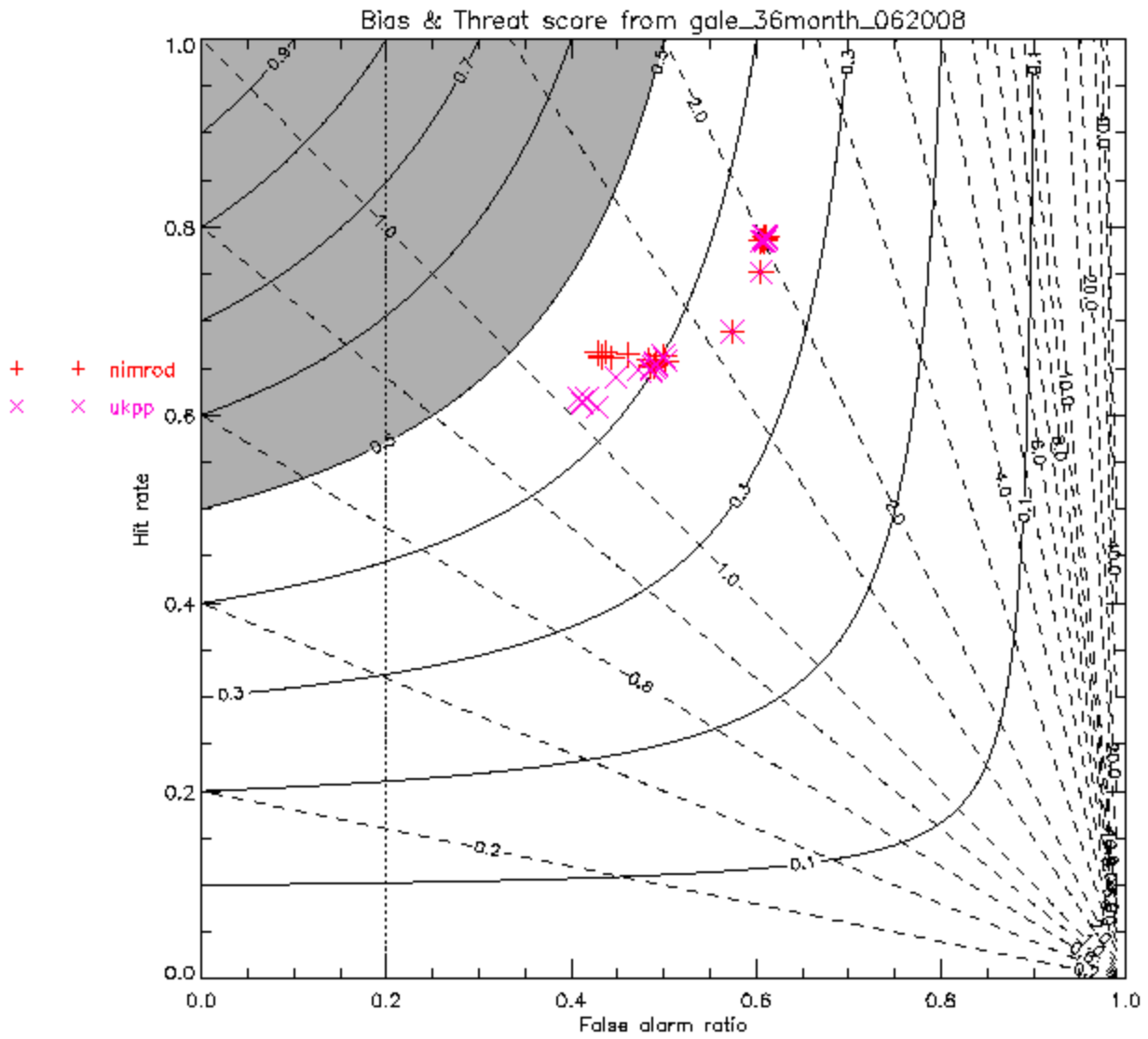
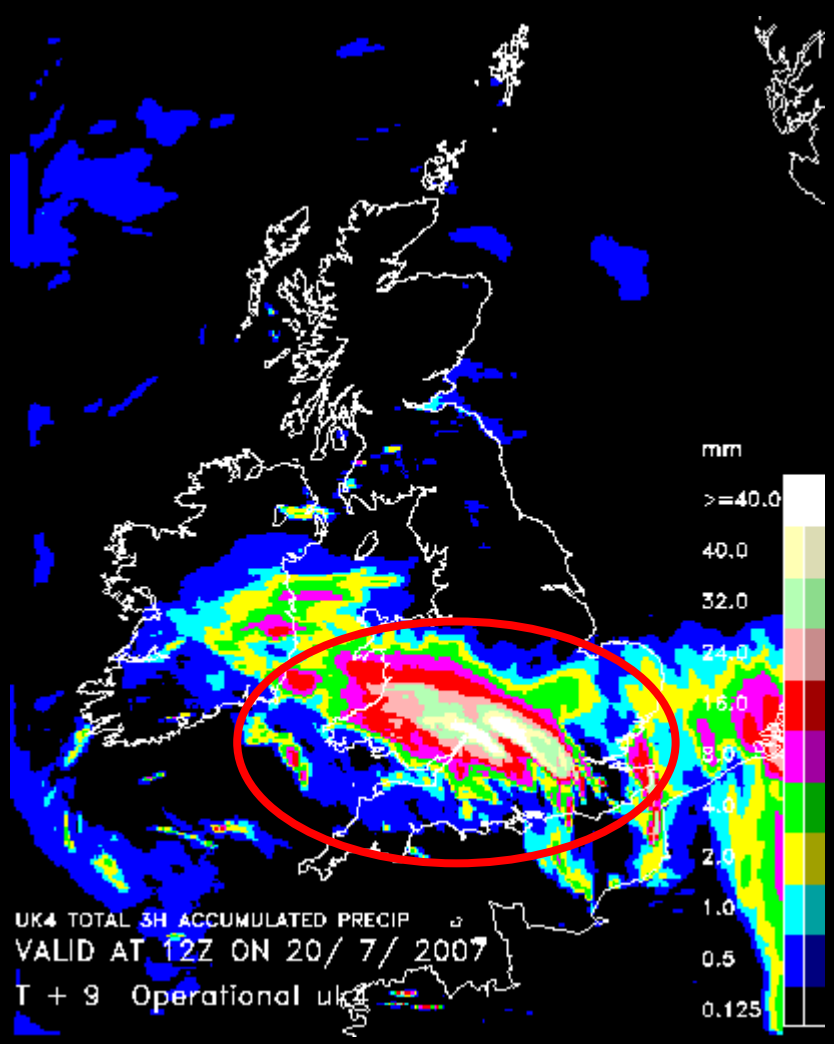
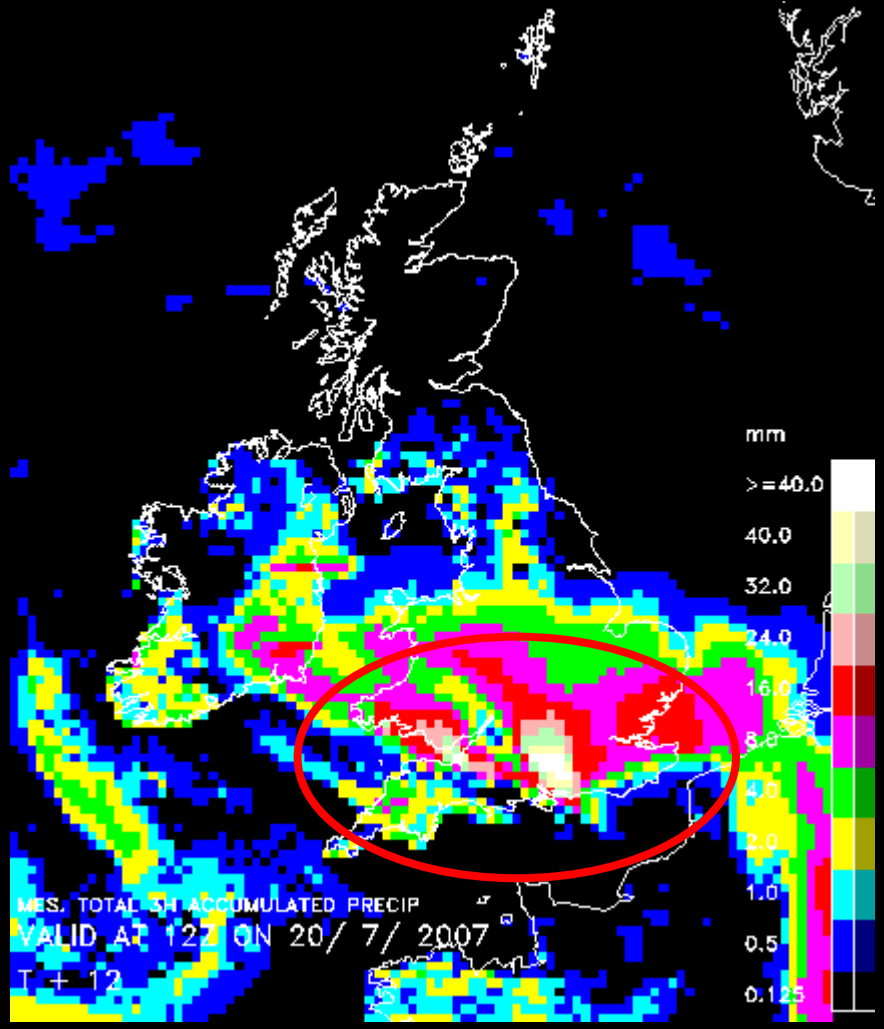


36-monthly

3h accumulations -20 July 12Z

4km (6-9h) 12km (9-12h)

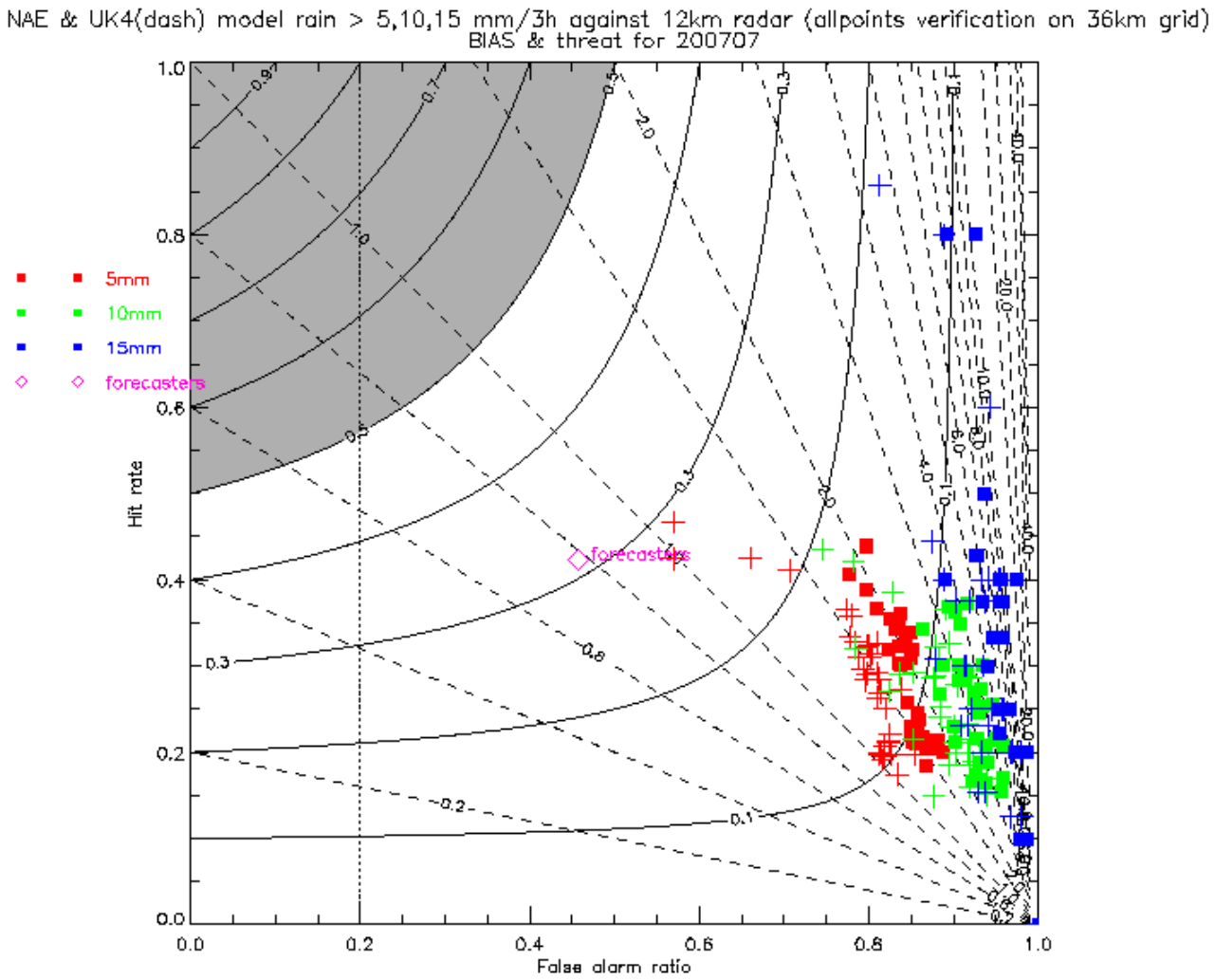




NAE(12km) & UK 4km models (36km grid verification) July 2007

12km +

4km ■



NAE(12km) & UK 4km models (36km grid verification) 200601-200902