# The Challenge of Verifying Severe Weather Warnings

Dr Michael Sharpe

4th International Verification Methods Workshop, Helsinki, Finland, June 2009

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# National Severe Weather Warnings - Introduction

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# NSWWs - Introduction

- What is a NSWW?

Part of the UK Met Office's remit is:

*"The provision of ... weather related warnings that enable the UK public to make informed decisions ... and contribute to the protection of life, property and basic infrastructure."*

- Two types: Early and Flash Warnings
  - Flash: lead time 2 - 6 hours length 2 - 24 hours
  - Heavy Rain, Gales, Snow, Fog, freezing rain, temperature
  - 84% of the public find NSWWs 'useful' (3530)

# Current Verification System

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# Current Verification System

- split UK into counties

- wind gust and 3 hour rain accumulation maximums are calculated in each UK county every hour

- Real observations are not available in every county so a Nowcast model is used – grid resolution 2Km

- Nowcast conditions are available every hour

- **BUT** cannot verify every hour as:

    – No requirement that severe weather persists throughout warning period

    – and severe gale warnings require <u>repeated</u> gusts > 70 mph

# Current Verification System

- Therefore **events** are verified – how?

- The maximum hourly Nowcast model condition in each county is compared against each warning
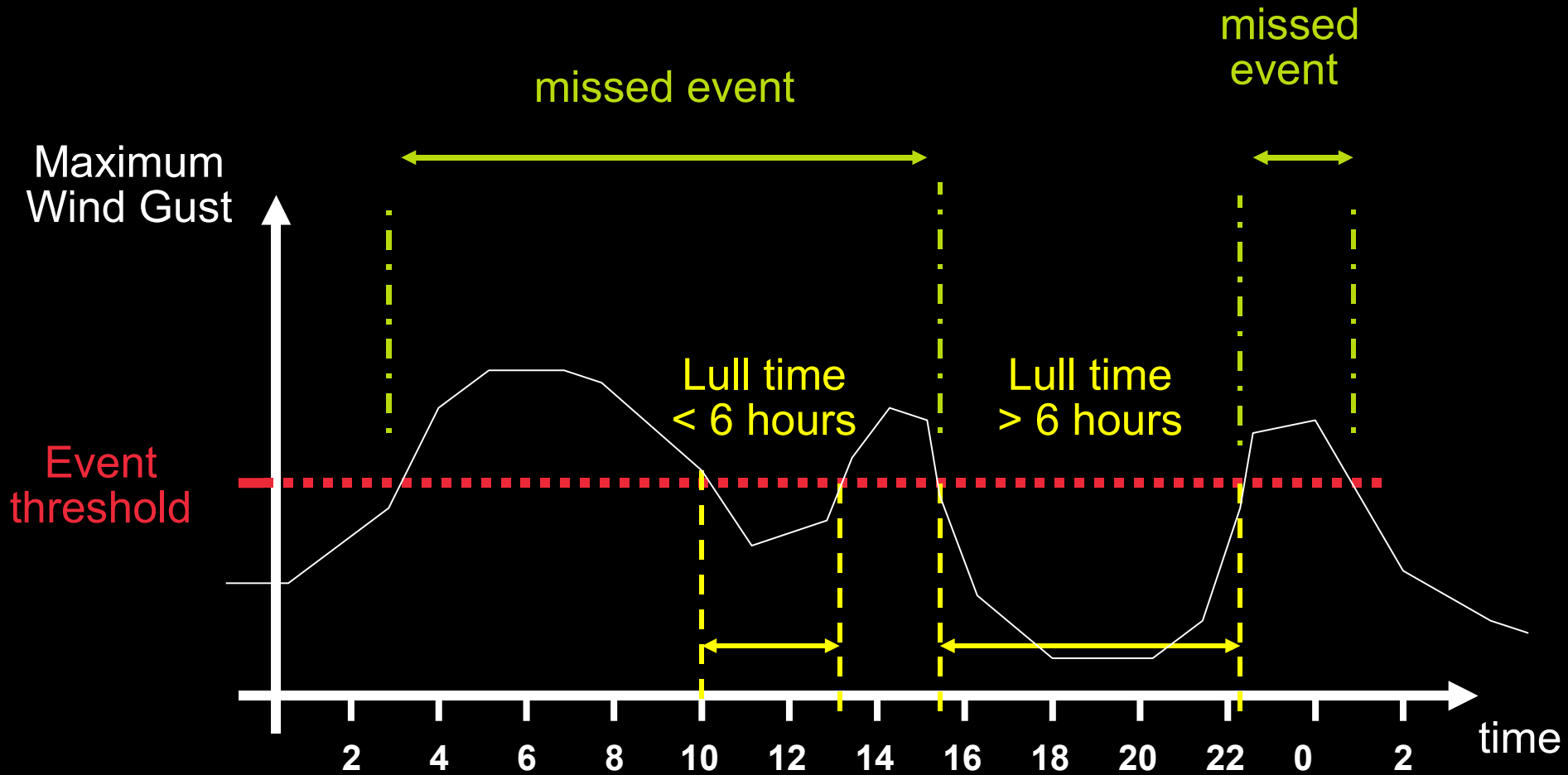
| Maximum hourly condition | Score | |
|---|---|---|
| | Warning | No Warning |
| > event threshold | HIT | MISS |
| < event threshold | FALSE ALARM | NON-EVENT |

- NON-EVENTs: length is hard to calculate so ignored

- Missed events must be separated by conditions < event threshold, this is a '*lull time*', currently 6 hours
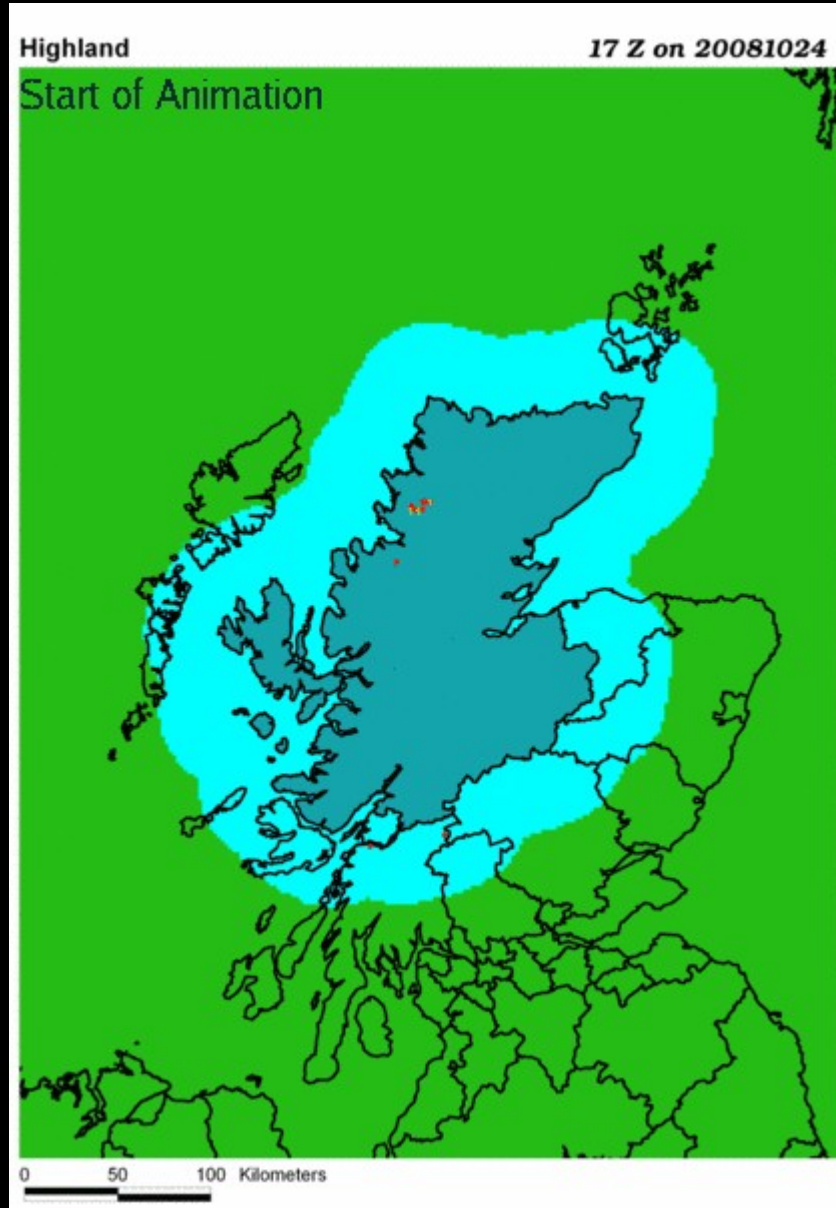
# Current Verification System

## Lull time example:

# Heavy Rain Warning in the Highlands



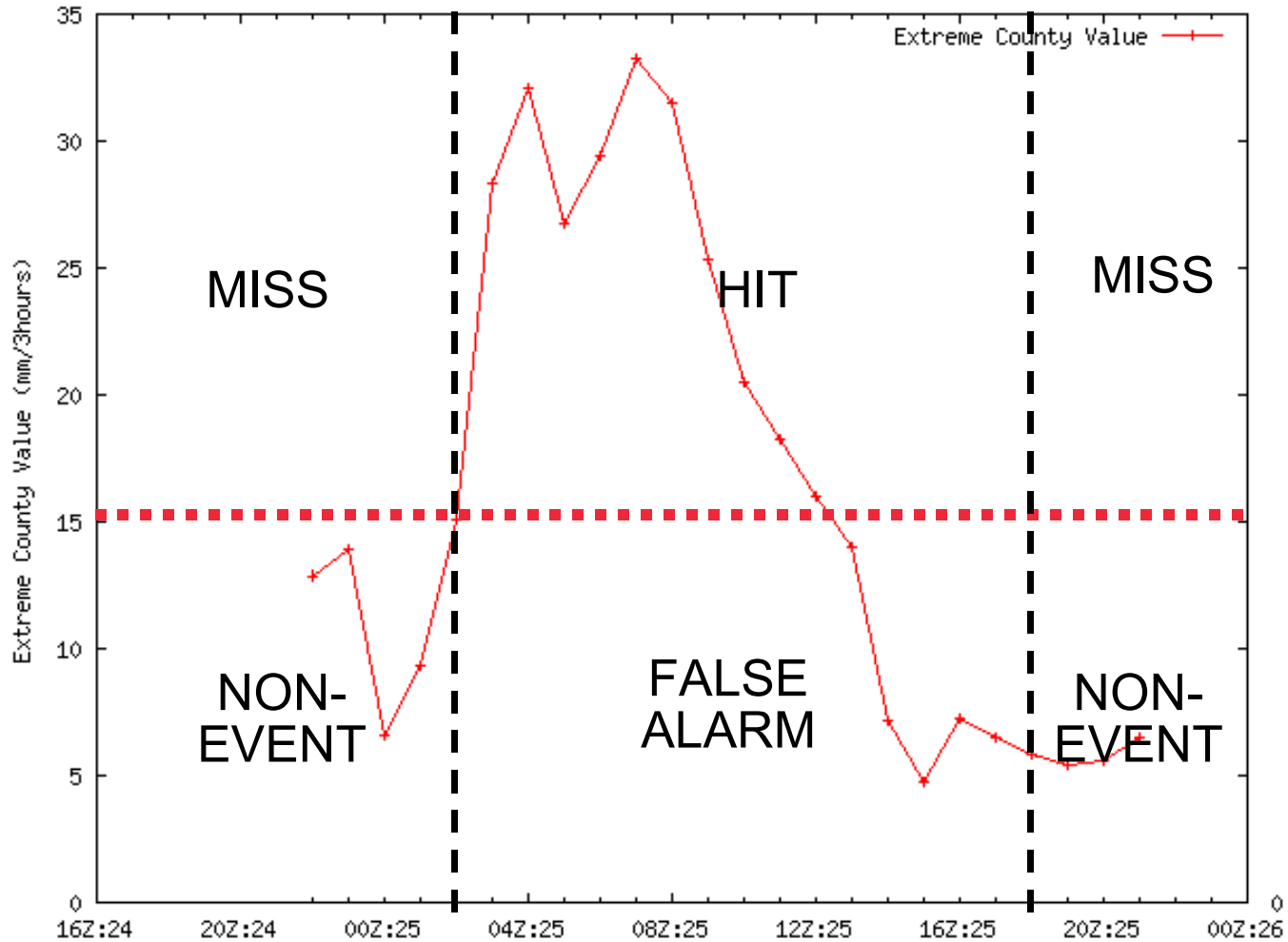Warnings issued
for most of
Scotland.

Highland Warning:
a HIT

## Result: HIT



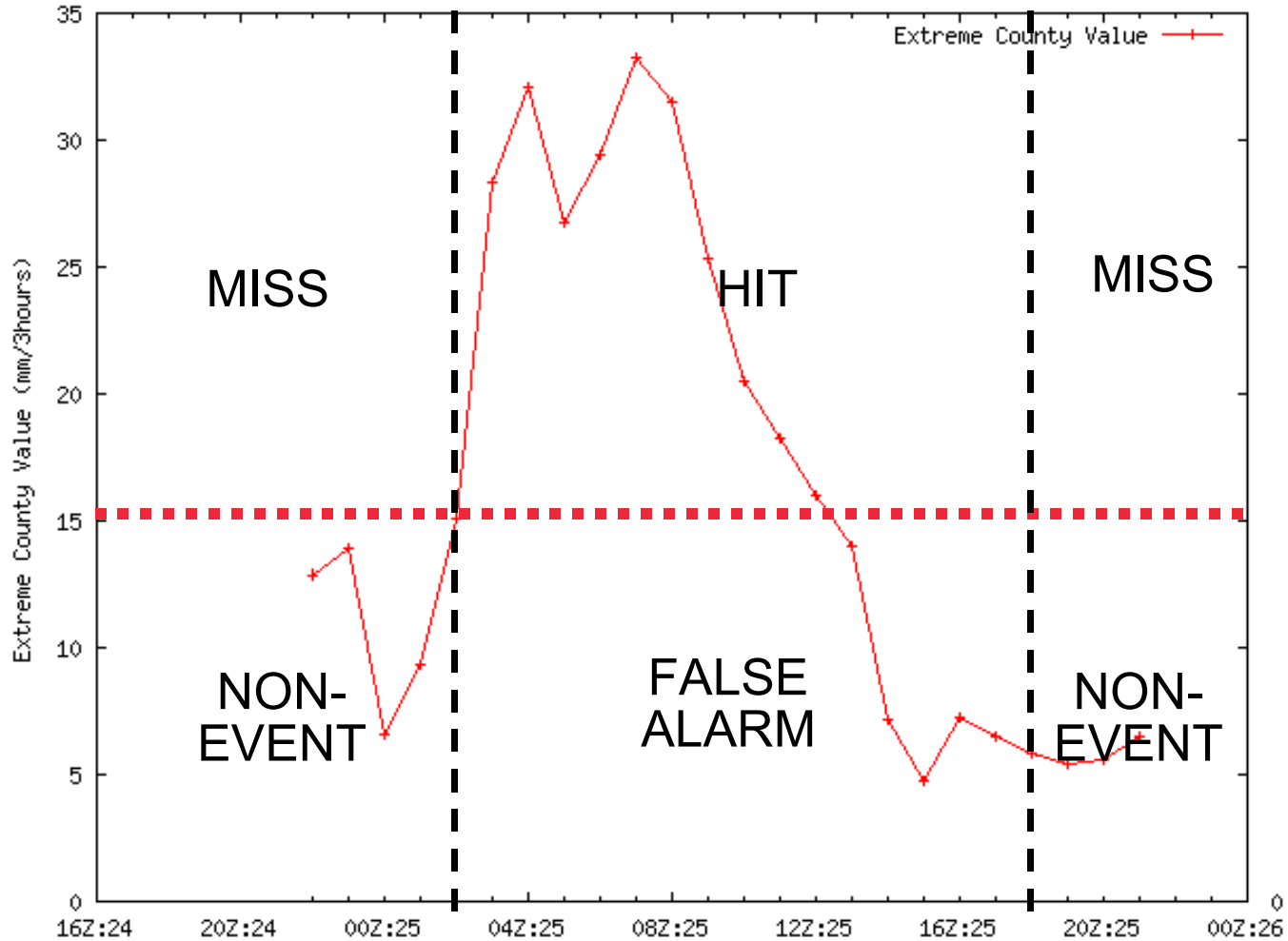HIGHLAND HeavyRain Warning: issue 2008102423, start 2008102502, end 2008102518

Event threshold

MISS

HIT

MISS

NON-EVENT

FALSE ALARM

NON-EVENT

Extreme County Value

← Warning Period →

## Results: Miss, Hit and Miss



Event threshold

HIGHLAND HeavyRain Warning: issue 2008102423, start 2008102502, end 2008102518

MISS

HIT

MISS

NON-EVENT

FALSE ALARM
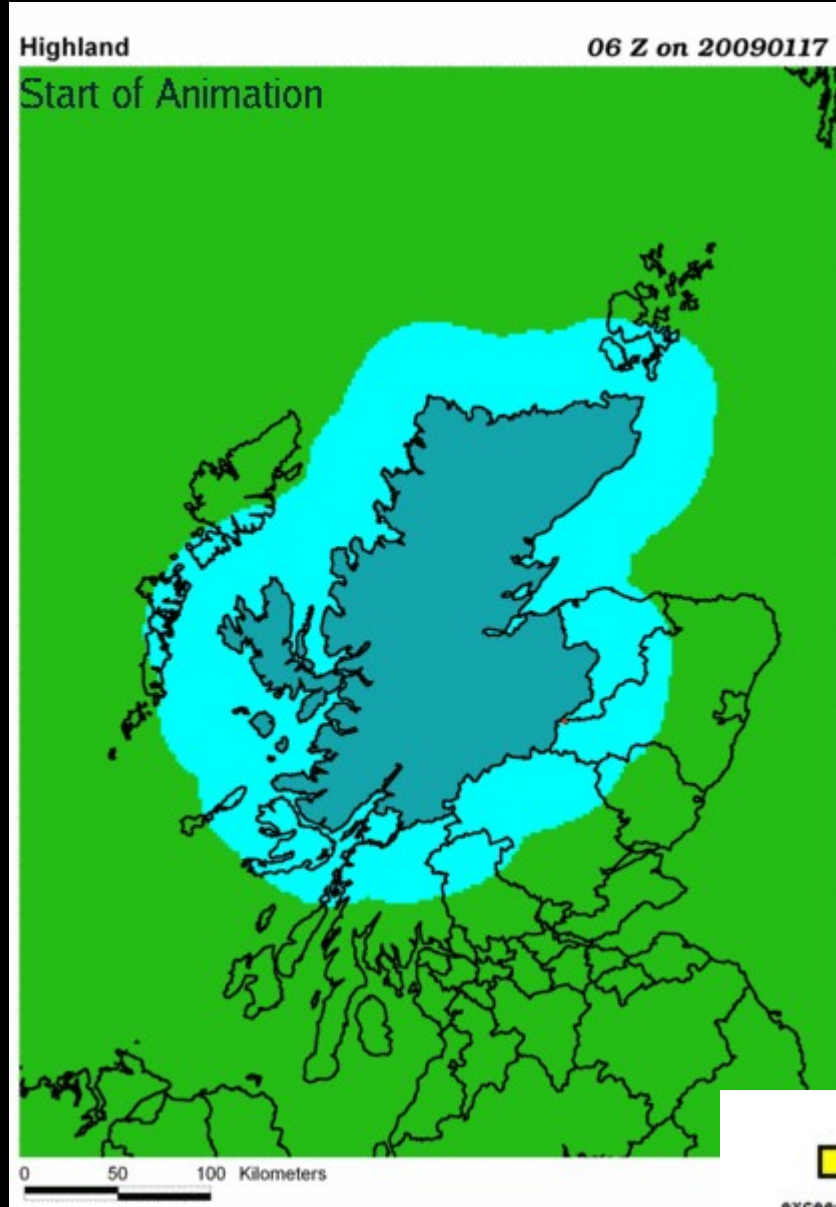
NON-EVENT

Warning Period

# Gale Warning in the Highlands



Severe winds begin **before** start time

AND

**continue** into warning period

Require more flexibility in event definitions…

Result:

Hit & Miss

Highland                    06 Z on 20090117

Start of Animation

0    50    100 Kilometers

(High ground removed)

exceeds lower threshold → exceeds event threshold

# New Verification System

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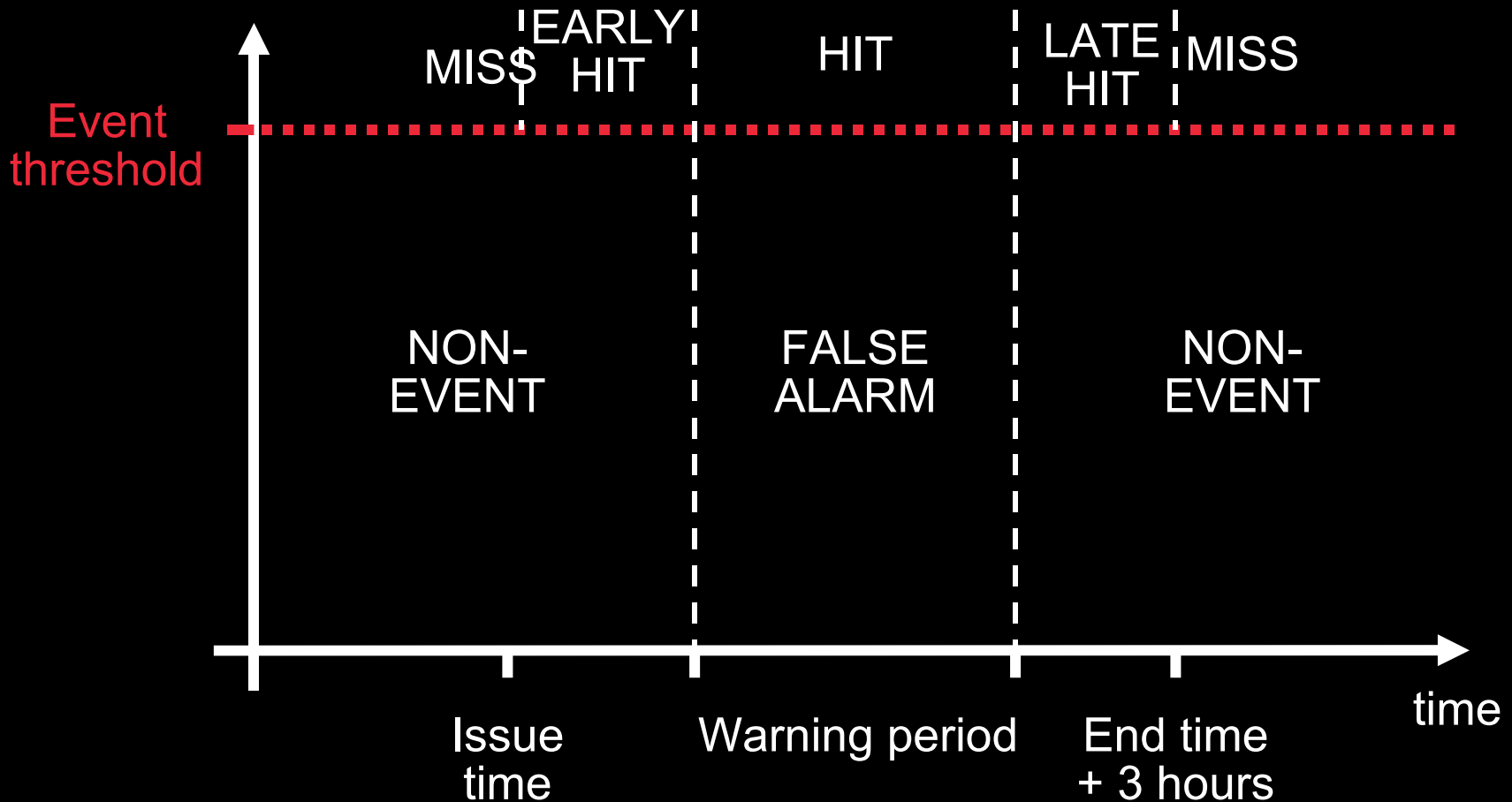
# New Verification System

New system introduces:

- Temporal flexing

# New Verification System

Temporal flexing

Event threshold

MISS | EARLY HIT | HIT | LATE HIT | MISS

NON-EVENT | FALSE ALARM | NON-EVENT

time

Issue time | Warning period | End time + 3 hours

# New Verification System
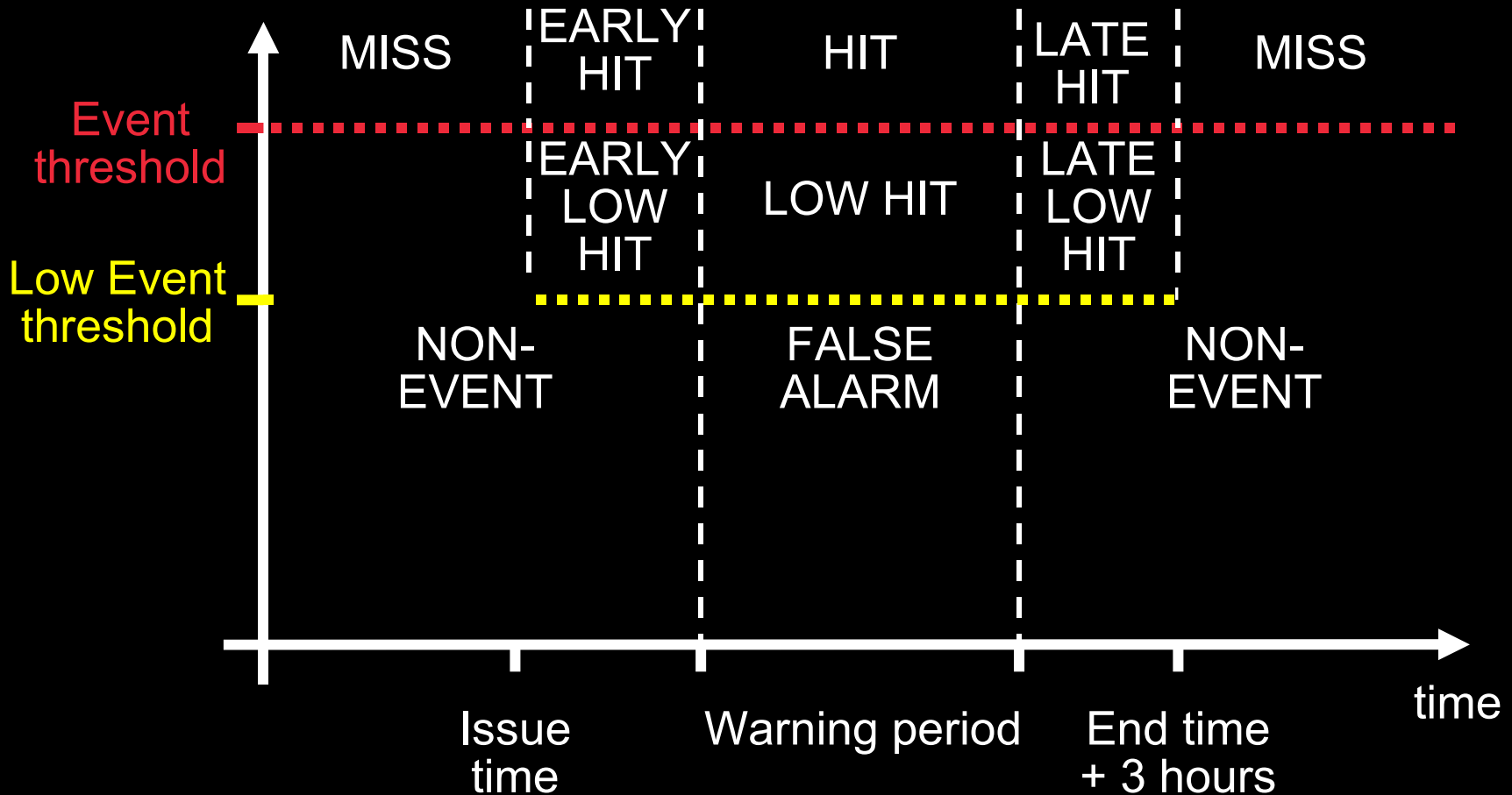
New system introduces:

- Temporal flexing

  Quantitative flexing

# New Verification System

Quantitative flexing

# New Verification System

New system introduces:

- Temporal flexing

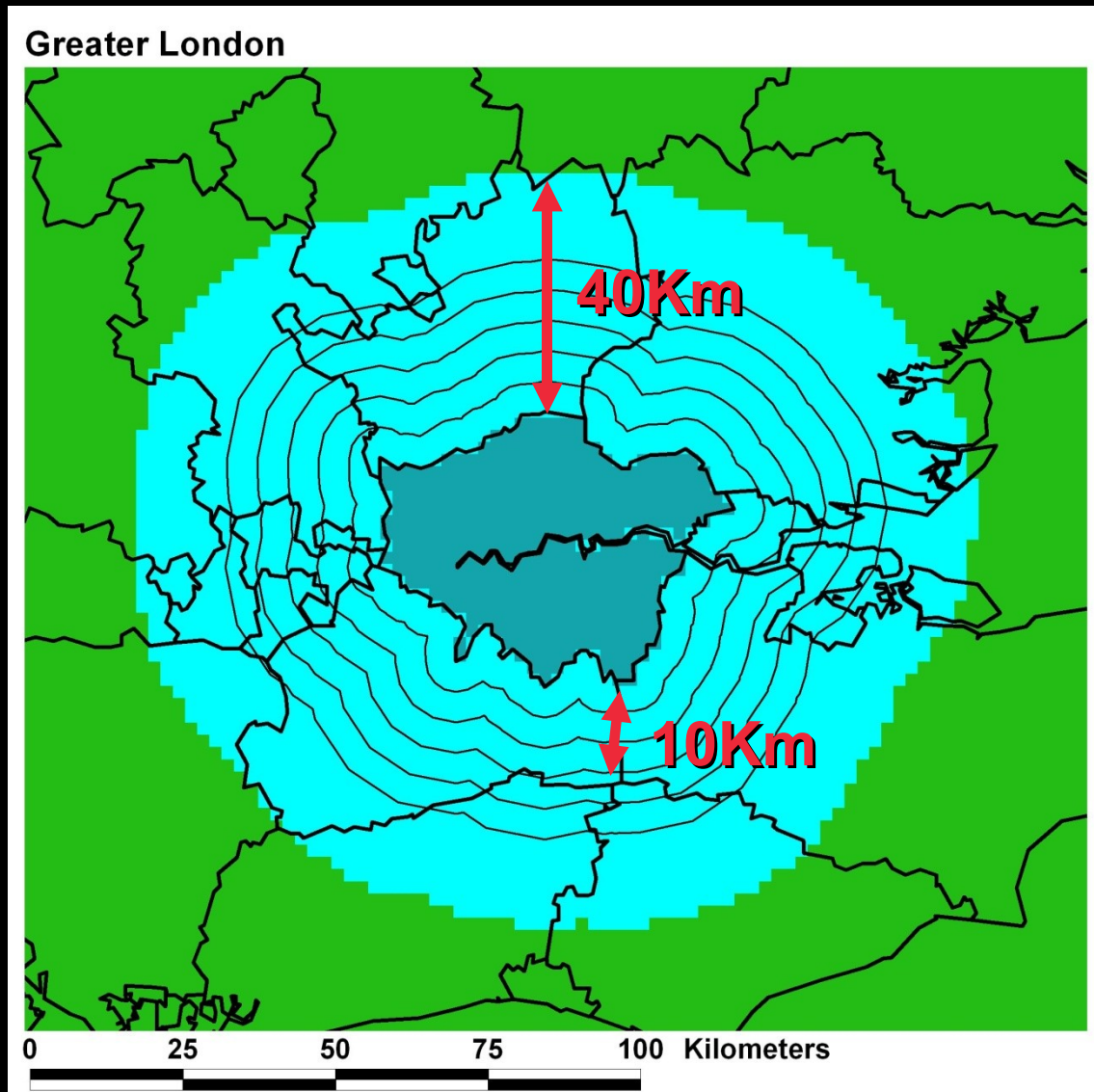- Quantitative flexing

   Spatial flexing

# New Verification System

Spatial flexing

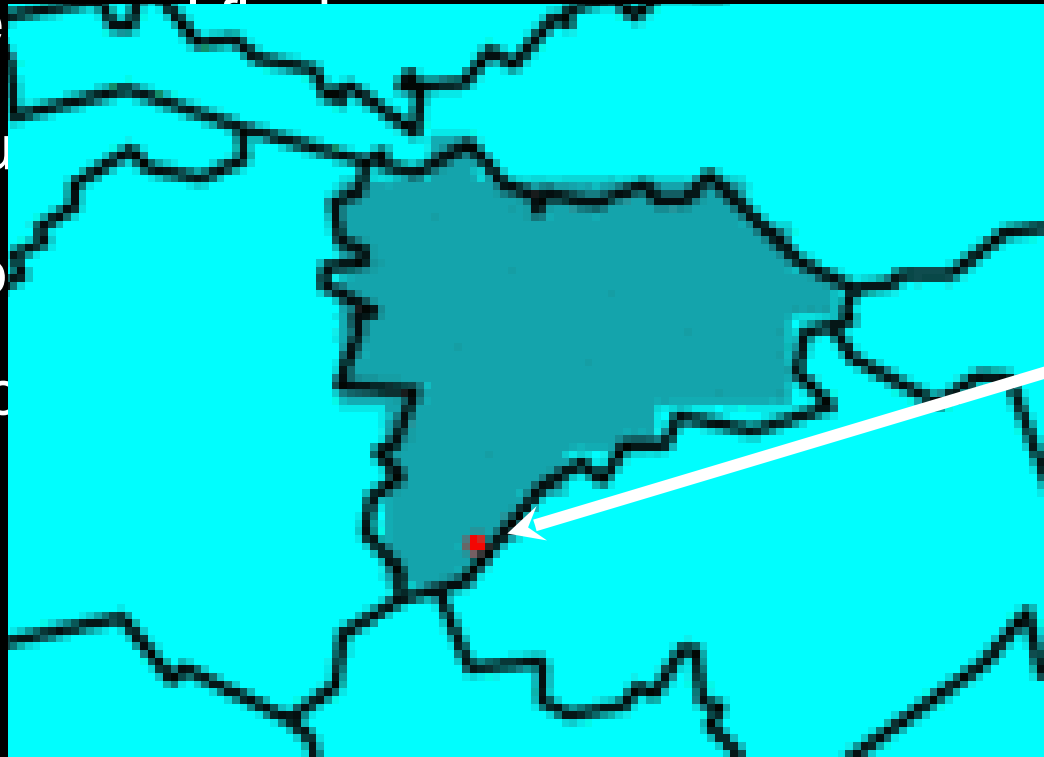If severe weather didn't occur in the county did it occur near by?



Greater London

40Km

10Km

| 0 | 25 | 50 | 75 | 100 Kilometers |

# New Verification System

Heavy Rain missed event 8am – 9am 23/04/09 :

New system introduces:

- Te...
- Qu...
- Sp...

  Pro...

1 grid point

**Is this enough to be sure that heavy rain actually occurred?**

# New Verification System

- Nowcast model not 100% accurate

- *Phantom* events possible, typically at a small number of grid points

- Eliminate *Phantom* events by introducing a threshold on the number of points > event threshold

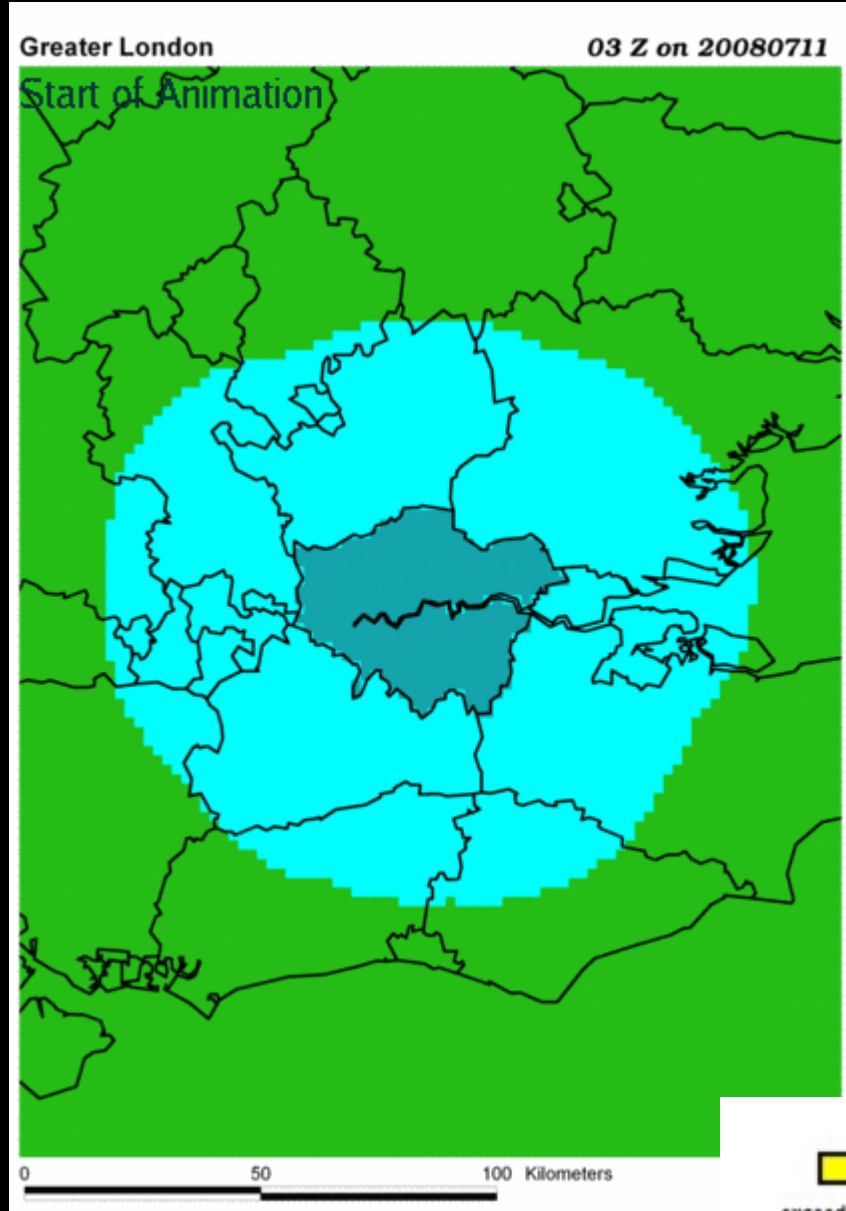| County | 2Km grid points | 5% grid point threshold |
|---|---|---|
| Edinburgh | 66 | 4 |
| Greater London | 393 | 20 |
| Cambridgeshire | 766 | 39 |
| Highlands | 6583 | 330 |

- Grid point thresholds increase the confidence that an event actually occurred

# Heavy Rain Warning in Greater London

- Rain in London almost = event threshold

- Rain > event threshold close to London



Greater London      03 Z on 20080711

Start of Animation

0     50     100 Kilometers

| area | Grid point threshold | |
|---|---|---|
| | 0% | 5% |
| county | Low Hit | False Alarm |
| county + 10Km | Hit | Low Hit |

exceeds lower threshold    →    exceeds event threshold

# The Scoring Problem

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# The Scoring Problem

- The introduction of new categories should help forecasters improve

- Can these new categories be used to measure performance? How?

- Traditionally an event is binary:

  - occurs (1 Hit)

  - doesn't occur (0 Hits)

- I propose basing a skill score on non-binary hit events

# The Scoring Problem

- simplest non-binary Hit scores on which to base a skill score are:

| Event Category | Score | Extended county score |
|---|---|---|
| Hit | 1 | ½ |
| Early/Late Hit | ½ | ¼ |
| Low Hit | ½ | ¼ |
| Early/Late Low Hit | ¼ | $\frac{1}{8}$ |

- other ideas and discussion welcome

# Questions and answers

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