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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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 repeated 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

<table>
<thead>
<tr>
<th>Maximum hourly condition</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; event threshold</td>
<td>HIT</td>
</tr>
<tr>
<td>&lt; event threshold</td>
<td>FALSE ALARM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Warning</td>
</tr>
<tr>
<td>MISS</td>
</tr>
<tr>
<td>NON-EVENT</td>
</tr>
</tbody>
</table>

- 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:

- Missed event
- Lull time < 6 hours
- Lull time > 6 hours
- Missed event

Maximum Wind Gust

Event threshold
Heavy Rain Warning in the Highlands

Warnings issued for most of Scotland.

Highland Warning: a HIT
Current Verification System

Result: HIT

Warning Period
Current Verification System

Results: Miss, Hit, Miss, Miss

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

Event threshold

Warning Period

Extreme County Value (mm/3hours)

MISS
HIT
FALSE ALARM
NON-EVENT
NON-EVENT
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
New Verification System

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New Verification System

New system introduces:

• Temporal flexing
New Verification System

Temporal flexing

- **Event threshold**
  - **Earliest** MISS
  - **Miss** HIT
  - **HIT**
  - **Late** HIT
  - **Miss**

- **Warning period**
  - **Non-event**
  - **False alarm**

- **Issue time**
  - **End time + 3 hours**

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New Verification System

New system introduces:

• Temporal flexing

  Quantitative flexing
New Verification System

Quantitative flexing

Event threshold

Low Event
threshold

MISS

EARLY HIT

HIT

LATE HIT

MISS

EARLY LOW HIT

LOW HIT

LATE LOW HIT

NON-EVENT

FALSE ALARM

NON-EVENT

Issue time

Warning period

End time + 3 hours

time
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?
New Verification System

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

New system introduces:

- Temporal flexing
- Quantitative flexing
- Spatial flexing
- Proportional flexing

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

<table>
<thead>
<tr>
<th>County</th>
<th>2Km grid points</th>
<th>5% grid point threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edinburgh</td>
<td>66</td>
<td>4</td>
</tr>
<tr>
<td>Greater London</td>
<td>393</td>
<td>20</td>
</tr>
<tr>
<td>Cambridgeshire</td>
<td>766</td>
<td>39</td>
</tr>
<tr>
<td>Highlands</td>
<td>6583</td>
<td>330</td>
</tr>
</tbody>
</table>

- 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
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:

<table>
<thead>
<tr>
<th>Event Category</th>
<th>Score</th>
<th>Extended county score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hit</td>
<td>1</td>
<td>½</td>
</tr>
<tr>
<td>Early/Late Hit</td>
<td>½</td>
<td>¼</td>
</tr>
<tr>
<td>Low Hit</td>
<td>½</td>
<td>¼</td>
</tr>
<tr>
<td>Early/Late Low Hit</td>
<td>¼</td>
<td>1/₈</td>
</tr>
</tbody>
</table>

- other ideas and discussion welcome
Questions and answers

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