“Although it is not yet possible to achieve 100 % accuracy, we will continue to give 100 % in trying.“

Shanghai weather bureau, December 2008
Approaches to process- and event-oriented verification of warnings

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Major issue in warning verification:

How do you match warnings and observations?
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warning verification

„process oriented“

„user oriented“

time

value

space

hourly

obs_{threshold} = warning_{threshold}

county

user: operational control („single voice“)
Area wide observations of thunderstorms:
• Siemens-BLIDS lightning detection system

Verification:
• hourly
• at county level
• summer 2006

7. August 2008

500 hPa geopotential + sea level pressure

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500 hPa geopotential + sea level pressure
Verification of thunderstorm warnings against lightning observations  YES / NO

<table>
<thead>
<tr>
<th>Observation</th>
<th>Warning</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>NO</td>
<td>correct NO</td>
</tr>
<tr>
<td>YES</td>
<td>moderate</td>
<td>hit</td>
</tr>
<tr>
<td></td>
<td>strong</td>
<td>false alarm</td>
</tr>
<tr>
<td></td>
<td>severe</td>
<td>miss</td>
</tr>
</tbody>
</table>
false alarm ratio
proportion of false alarms on all YES forecasts
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Relative frequency in %

- 0-1 h Vorlauf

0-1 h Vorlauf

Relative Häufigkeit in %

- HA 0-1
- PD 0-1
- EM 0-1
- LZ 0-1
- OF 0-1
- SU 0-1
- MS 0-1
- ALLE 0-1

2006

thunderstorm warning duration in hours

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daily cycle of ...

- **Figure 1**: Graph showing the daily cycle of observations and warnings for the years 2003/04 and 2005/06.

  - **Observations**: Light blue line (solid) and turquoise line (dashed).
  - **Warnings**: Red line (solid) and orange line (dashed).

  - **Time (UTC)**: x-axis
  - **Number**: y-axis

  - **Key Points**:
    - **Observations**: 03/04, 05/06
    - **Warnings**: 2003/04, 2005/06
Frequency bias

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Bias

2003+04 2005+06

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Summary for process oriented verification

- Thunderstorm warnings on a small spatial and temporal scale can be skillful.

- Greatest improvements in the quality have and will come from the reductions in false alarms.

- "Simple" organisational measures can improve forecasts already substantially.
Motivating (user) “event – oriented” warning verification

• Users are not interested in the ups and downs of the weather during a severe event (within certain limits) → event should be verified en bloc.

• An „event“ comprises homogenised observations and / or warnings.

• Evaluation of the intensity of a warning should be somewhat tolerant.
Warning verification

„process oriented“

time/events

1. warning
2. obs intervals

value

hit
false alarm

delta_{intensity} = 0

delta_{intensity} > 0

user: emergency services

„(user) event oriented“

space

radius

region

user: media

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Choice of parameters for verification of thunderstorms YES / NO

1. Warning YES/NO against lightning measurements
2. False alarm:
   • No lightning during warning
   • additionally: at least 3 consecutive hours without lightning, i.e. considerably too long
   • Required lead times for a hit: 0 or 1 hours
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#### Process and Event Oriented Warning Verification

<table>
<thead>
<tr>
<th>Time</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
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<tbody>
<tr>
<td>Observation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warning</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of Issue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

- **Hit**
  - 1 hit
  - 3 false alarms

- **Miss (too late)** or **Hit (still useful)**
  - 1 miss (or hit)
  - 2 false alarms

- **Hit + False Alarm (too long)**
  - 1 hit
  - 2 false alarms (including 1 false alarm)
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- **Forecasted events 2008**
  - Hits: 69
  - False alarms: 91

- **Forecasted events 2003**
  - Hits: 83
  - False alarms: 178

- **Observed events 2008**
  - Hits: 69
  - Misses: 31

- **Observed events 2003**
  - Hits: 83
  - Misses: 17

Number of events per 100 observed events:

- Hits
- Misses
- False alarms
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number of events per 100 observed events

pure hits  | hit + too long | completely missed | miss + warned
---|---|---|---
misses 2008 | 7 | 24 |
misses 2003 | 10 | 7 |
hits 2008 | 51 | 19 |
hits 2003 | 4 | 79 |
“bad” = completely missed + false alarm

“good” = perfect + just useable

“just useable” = late warning + hits, but too long

“perfect” = hit with a short warning

Zahl Ereignisse je 100 beobachtete Ereignisse

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Summary for event oriented verification

• warnings have become spatially and temporarily detailed
• there have been only few events, which were completely unwarned
• half of the warnings were perfect
• excessive warning has been substantially reduced
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Thunderstorms

base rate 1/hour

bias

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relative frequency of thunderstorms in a county