Probabilistic Forecasts of Winter Thunderstorms around Schiphol Airport using Model Output Statistics

MSc thesis by Aimée Slangen (Wageningen University)
Supervisor: Maurice Schmeits (KNMI)

Outline
- Introduction
- Methodology
- Results
- Conclusion
Introduction

- Thunderstorms in winter: quite rare
- Problems to aviation

A forecast system is developed:
- Runs 4 times a day
- Forecast times: 0-6 h and 6-12 h
- 4 regions of 80 x 90 km around Schiphol Airport
- For October 16th to April 15th

AIL per season

Strikes to commercial jets over Japan, 1980-1991 (Murooka, 1992)

⇒ Landing and take-off problematic during winter
MOS: Model Output Statistics

- MOS uses numerical weather prediction (NWP) variables to create and perform a statistical weather forecast
- Advantage: Makes forecasts for variables that are not in the direct model output
- Disadvantage: Large dataset needed, preferably of unchanged model

Predictand for winter thunderstorms

- Probability of >= 1 lightning discharge in a 6-hour period (03-09, 09-15, 15-21 or 21-03 UTC) in a 90x80 km² region.
- Data used: October 16th 2004 – April 15th 2007, winter half-years only.
Selection of predictors: Logistic regression

\[
p_i = \frac{1}{1 + \exp[5.161 - (0.009 \cdot t_{p6e3})]}
\]

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Process of predictor selection

- ECMWF Predictors (25)
- HIRLAM Predictors (51)
- RADAR and Lightning advection (only +6h) (15)

Binary predictand:
No discharges = 0
≥ 1 discharge = 1

Logistic regression on pooled set (all regions together)

Small set of predictors (max 5)
per time period and forecast time

Logistic regression per region

32 Forecast equations
RADAR and lightning advection

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### Selected predictors

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Nr. of times used</th>
<th>Formula/ explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIRLAM Boyden Index</td>
<td>27</td>
<td>$0.1 \cdot (z_{700} - z_{1000}) - T'_{700} - 200$</td>
</tr>
<tr>
<td>ECMWF RTCP</td>
<td>24</td>
<td>Square root of convective precipitation over 3 or 6 hours</td>
</tr>
<tr>
<td>HIRLAM CAPE</td>
<td>14</td>
<td>$\int_{\text{environment}}^{\text{parcel}} T_i(z) dz$</td>
</tr>
<tr>
<td>RADAR advection</td>
<td>7</td>
<td>Square root of the precipitation above a certain threshold, over 6 hours, max of the radar advection ensemble</td>
</tr>
<tr>
<td>ECMWF Others</td>
<td>2</td>
<td>• Max. temperature anomaly at 1000hPa</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Relative vorticity-advection at 500hPa</td>
</tr>
</tbody>
</table>

### An example

<table>
<thead>
<tr>
<th>6-12h forecast probability (%)</th>
<th>0-6h forecast probability (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31</td>
<td>97</td>
</tr>
<tr>
<td>56</td>
<td>10</td>
</tr>
<tr>
<td>97</td>
<td>92</td>
</tr>
<tr>
<td>10</td>
<td>26</td>
</tr>
</tbody>
</table>
The predictors in the MOS system for winter thunderstorms are:

1. HIRLAM Boyden Index
2. ECMWF Convective precipitation sum
3. HIRLAM CAPE
4. Radar advection Precipitation sum over 6 hours
5. ECMWF Max. temperature anomaly at 1000hPa and Relative vorticity-advection at 500hPa

Verification shows that the forecast equations are skilful. However, more verification is needed.
Thank you!

Questions?

Slangen, A., Probabilistic forecasts of winter thunderstorms around Schiphol Airport using Model Output Statistics
http://www.knmi.nl/publications/fulltexts/tr300.pdf