AN OBJECTIVE METHOD OF THE STABILITY - SEGMENTED WIND ROSES CONSTRUCTION IN COMPLEX TERRAIN

Josef Keder, Jiri Bubnik, Jan Macoun, Hana Skachova
Czech Hydrometeorological Institute
Overview

• Motivation
• Wind roses used in SYMOS´97
• Method, input data, choice of testing stations
• Results, comparison with expert estimate and real data
• Conclusions, proposals for further work
Motivation

• Reference model for the regulatory purposes prescribed by the Czech environmental legislation – SYMOS Gaussian model (see e.g. Model Documentation System, http://etc-acc.eionet.eu.int/databases/mds.html)

• Among others, a stability-segmented wind rose used as a standard model input

• Wind rose from the nearby airport or meteorological station commonly used

• Owing to complex orography of the Czech Republic territory this approach is inapplicable over the majority of the country area-representativeness

• Roses should be modified by qualified expert with respect to the distinguished structures of the terrain shape

• Unbiased approach to the wind roses construction needed, objective method prospected
Wind roses used in SYMOS´97

- 8 main wind direction sectors: N, NE, E, etc.
- 3 wind speed classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Range [m.s⁻¹]</th>
<th>Class representant [m.s⁻¹]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak wind</td>
<td>0.5 to 2.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Moderate wind</td>
<td>2.6 to 7.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Strong wind</td>
<td>over 7.5</td>
<td>11</td>
</tr>
</tbody>
</table>

- 5 stability classes according to temperature gradient

<table>
<thead>
<tr>
<th>Class</th>
<th>Gradient [°C/100 m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>I super stable</td>
<td>γ &lt; -1.6</td>
</tr>
<tr>
<td>II stable</td>
<td>-1.6 ≤ γ &lt; 0.7</td>
</tr>
<tr>
<td>III isothermal</td>
<td>-0.7 ≤ γ &lt; 0.6</td>
</tr>
<tr>
<td>IV neutral</td>
<td>0.6 ≤ γ ≤ 0.8</td>
</tr>
<tr>
<td>V convective</td>
<td>0.8 &lt; γ</td>
</tr>
</tbody>
</table>
Method

• Well known CALMET preprocessor
  ([http://earthtec.vwh.net/download/calmet.pdf](http://earthtec.vwh.net/download/calmet.pdf)) applied and tested for this purpose
• 2 meteorological stations providing hourly data of good quality, located in non-uniform or in complex terrain, chosen as testing points
• These data not used as a model input, for validation only
• Input data
  → one-year time series of hourly data from the neighbouring meteorological stations
  → upper-level data from the Czech radio-sounding stations
  → detailed digital terrain model of the testing station surroundings
• For the each grid point covering the area, CALMET provides a one-year series of hourly wind and temperature data in suitably set of height levels
• Vertical temperature gradients evaluated, the modeled wind data arranged according to SYMOS stability classes
• Stability-structured wind roses for three wind speed categories can be derived from the wind direction class-frequencies
Testing stations

Tušimice
Long 13.3281° E
Lat 50.3764° N

Přerov
Long 17.4078° E
Lat 49.4242° N
Testing station Tušimice – terrain and rose 2002
Testing station Přerov – terrain and rose 2002
Results – rose Tušimice 2002

Measured
Calmet
Expert

9th Harmonisation Conference
9th Harmonisation Conference
Garmisch-Partenkirchen

Harmo 9, GaPa, 1.-4.6.2002
Results – rose Přerov 2002

Measured
Calmet
Expert

CALM N NE E SE S SW W NW

Frequency [%]

Wind sector

Harmo 9, GaPa, 1.-4.6.2002

9th Harmonisation Conference

Garmisch-Partenkirchen
Results – roses Tušimice, split by stability
Superstable and stable class

Calmet and expert assessment compared only, stability data for Tušimice not yet completed (RASS?)

Superstable

Stable
Results – roses Tušimice, split by stability
Isothermal, neutral and convective class

Isothermal

Neutral

Convective

Harmo 9, GaPa, 1.-4.6.2002
Conclusions and scope of future work

- Objective method of stability-segmented wind roses proposed, based on Calmet preprocessor
- Tested on the data from stations located in non-uniform terrain
- The method provides reasonable results, not worse if compared with expert assessment applied so far (for roses without stability splitting)
- Significant differences between expert and model results determined in Tušimice for particularly for stability classes III and IV – who is right?
- Further tests on measured data and method improvements prepared
- Final stage – sw package for wind roses construction