Performance of waterspout forecasting method using high resolution numerical weather model

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Waterspout (AMS, cited 2017)

• In general, any tornado over a body of water.
• In its most common form, a nonsupercell tornado over water.
Introduction

- evenly distributed along Adriatic coast
- equal number of thunderstorm related and non-thunderstorm waterspouts in eastern Adriatic (Renko et al., 2016)
- instability indices are not very useful as standalone indicators for recognizing the environments in which waterspouts will occur
- waterspouts can form in various conditions, which makes forecasting quite difficult
Szilagyi Waterspout Nomogram (SWN)

- empirical forecasting technique
- instability parameters:
  a) water-850 hPa temperature difference ($\Delta T = SST - T850$)
  b) convective cloud depth ($\Delta Z = EL - LCL$)
- wind constraint: 850 hPa wind speed ($W850 < 20$ m/s)
Szilagyi Waterspout Index (SWI)

- a stability index derived directly from the waterspout nomogram
- it quantifies the likelihood of waterspout occurrence
- values range from -10 to +10, waterspouts occur when SWI ≥ 0
Table 1. Date, time, location, geographical coordinates, lightning, synoptic/weather type and SWI ("yes" if the conditions were favorable or "no" if otherwise) for selected waterspout events along the Croatian coast.

<table>
<thead>
<tr>
<th>No.</th>
<th>DATE</th>
<th>TIME (UTC)</th>
<th>LOCATION</th>
<th>LAT (°)</th>
<th>LONG (°)</th>
<th>LIGHTNING</th>
<th>WEATHER TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28.08.2013.</td>
<td>08:00</td>
<td>Dubrovnik</td>
<td>42.64</td>
<td>18.08</td>
<td>no</td>
<td>SW/SWT</td>
</tr>
<tr>
<td>2</td>
<td>28.08.2013.</td>
<td>08:00</td>
<td>Pula</td>
<td>44.84</td>
<td>13.80</td>
<td>yes</td>
<td>SW</td>
</tr>
<tr>
<td>3</td>
<td>30.06.2014.</td>
<td>08:00</td>
<td>Novigrad</td>
<td>45.32</td>
<td>13.55</td>
<td>yes</td>
<td>LW</td>
</tr>
<tr>
<td>4</td>
<td>15.08.2014.</td>
<td>10:15</td>
<td>Ližnjan</td>
<td>44.79</td>
<td>13.98</td>
<td>yes</td>
<td>SW</td>
</tr>
<tr>
<td>5</td>
<td>24.09.2015.</td>
<td>07:00</td>
<td>Hvar</td>
<td>43.17</td>
<td>16.41</td>
<td>yes</td>
<td>CLOSED</td>
</tr>
<tr>
<td>6</td>
<td>25.09.2015.</td>
<td>12:30</td>
<td>Dubrovnik</td>
<td>42.64</td>
<td>18.08</td>
<td>yes</td>
<td>CLOSED</td>
</tr>
<tr>
<td>7</td>
<td>06.01.2016.</td>
<td>14:50</td>
<td>Split</td>
<td>43.51</td>
<td>16.44</td>
<td>yes</td>
<td>SW</td>
</tr>
<tr>
<td>8</td>
<td>13.01.2016.</td>
<td>08:30</td>
<td>Murter</td>
<td>43.81</td>
<td>15.58</td>
<td>yes</td>
<td>LW</td>
</tr>
<tr>
<td>9</td>
<td>14.01.2016.</td>
<td>09:15</td>
<td>Komiža</td>
<td>43.03</td>
<td>15.95</td>
<td>no</td>
<td>SWT</td>
</tr>
<tr>
<td>10</td>
<td>11.02.2016.</td>
<td>13:00</td>
<td>Mali Lošinj</td>
<td>44.53</td>
<td>14.40</td>
<td>no</td>
<td>SWT</td>
</tr>
</tbody>
</table>
Data and Method

WRF model setup

• 4 domains: Δx = 9 km, 4.5 km, 1.5 km and 0.5 km
• 97 vertical levels (terrain-following)
• lowest level at 5 m, 25 levels in first 1 km
• initial and boundary conditions from ECMWF

METHOD: pseudo-soundings were extracted from sea grid points; necessary parameters for SWI were calculated
Parameters that are needed for SWI calculation are:

1. sea surface temperature (SST), temperature at 850 hPa ($T_{850}$) – for $\Delta T$ calculation
2. equilibrium level (EL) and lifting condensation level (LCL) – for convective cloud depth ($\Delta Z$) calculation

The following were also calculated: CAPE, CAPE03, CIN, BS01, BS03, BS06

- **Pseudo soundings 1 hour before the event were used as an input for open-source sounding analysis program SHARPpy (Marsh and Hart 2012)**
- **Only 20 pseudo soundings from fine grid (D) model domain in the vicinity of waterspout location were used.**
BS01 & BS06
ΔZ & ΔT
Summary
Thank you for your attention!

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photo by Sandro Puncet