Vertically Integrated Ice – A New Lightning Nowcasting Tool

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Motivation and Methodology

➢ Lightning is a frequent and dangerous phenomenon, especially in the summer along the Gulf Coast.
➢ Despite its dangers, only a few techniques exist to accurately nowcast lightning.
➢ Vertically integrated ice (VII), was developed and tested on 10 years of Houston, TX radar data to determine its viability in lightning nowcasting.

VII Equation

\[ VII = 1000 \pi H \rho_i N_0^{\frac{1}{7}} \int_{0}^{H_{40}} \frac{Z}{H^{\frac{3}{2}}} dH \]

• \(H_{10}\) and \(H_{40}\) indicate the heights of the -10 and -40 °C environmental levels in meters, respectively.
• \(\rho_i\) is the density of ice (917 kg m\(^{-3}\))
• \(N_0\) is the intercept parameter (\(4 \times 10^6\) m\(^{-4}\)) of an exponential size distribution of precipitation-sized ice.

Results

<table>
<thead>
<tr>
<th>Percentile</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII (kg m(^{-2}))</td>
<td>0.25</td>
<td>0.42</td>
<td>0.58</td>
<td>0.74</td>
<td>0.91</td>
<td>1.09</td>
<td>1.29</td>
<td>1.50</td>
<td>1.73</td>
<td>1.99</td>
<td>2.57</td>
<td>3.33</td>
<td>4.42</td>
<td>6.35</td>
</tr>
</tbody>
</table>

Graphical Results

- **Distribution of VII Values for First CG Flashes**
- **Critical Success Index**
- **Lead Time to First CG Flash**

Best Practices

<table>
<thead>
<tr>
<th>Desired Result</th>
<th>Forecast Criteria</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximize POD</strong></td>
<td>Use a low (10th percentile or less) value, such as 0.1 kg m(^{-2})</td>
<td>98% POD using 0.25 kg m(^{-2}) (5th percentile)</td>
</tr>
<tr>
<td><strong>Minimize FAR</strong></td>
<td>Use a high values (above 50th percentile)</td>
<td>Less than 15% FAR after 2.00 kg m(^{-2})</td>
</tr>
<tr>
<td><strong>Maximize CSI</strong></td>
<td>Use a lower percentiles (35th percentile or less)</td>
<td>Greater than 0.60 CSI for percentiles less than 35th percentile</td>
</tr>
<tr>
<td><strong>Maximize Lead Time</strong></td>
<td>Use a low value (10th percentile or less)</td>
<td>13.5 min lead time using 0.25 kg m(^{-2}) (5th percentile)</td>
</tr>
</tbody>
</table>

VII in AWIPS

Download Convert and Create VII raw level 2 process radar netCDF Import into AWIPS Display via D2D

Examples

Airport Weather Warning at DFW Airport
• Issued when lightning is expected within 10 nm of the airport

| Max VII 2.4 | Max VII 7.0 | Max VII 12.0 |
| ~15 min lead time | (0.05/0.15/0.60) | (0.04/0.01/0.04) |

Strong Updraft Identification

- POI
- FAR
- CSI
- Lead Time