Hail climatology for Brisbane derived from single-polarization radar and insurance data

Rob Warren\textsuperscript{1}

Justin Peter\textsuperscript{2}, Steve Siems\textsuperscript{1}, Hamish Ramsay\textsuperscript{1}

\textsuperscript{1}School of Earth, Atmosphere and Environment, Monash University
\textsuperscript{2}International Centre for Applied Climate Sciences, University of Southern Queensland
Location, location, location
<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Radar</th>
<th>$\omega$ (°)</th>
<th>$r_{\text{max}}$ (km)</th>
<th>$\Delta r$ (m)</th>
<th>$N_\theta$</th>
<th>$T$ (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>66</td>
<td>Mt Stapylton</td>
<td>Meteor1500S</td>
<td>1.0</td>
<td>150</td>
<td>250</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>50</td>
<td>Marburg</td>
<td>WSR74S</td>
<td>1.9</td>
<td>256</td>
<td>1000</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>28</td>
<td>Grafton</td>
<td>WSR74S</td>
<td>1.9</td>
<td>256</td>
<td>1000</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>08</td>
<td>Gympie</td>
<td>DWSR8502S</td>
<td>2.0</td>
<td>300</td>
<td>500</td>
<td>14</td>
<td>10</td>
</tr>
</tbody>
</table>
Radar Calibration

\[ \Delta t \leq 5 \text{ mins} \]
Maximum for oversampled points
Interpolation otherwise (nearest neighbour in range direction, bilinear in azimuth-elevation plane)

\[ w = w_{\text{remap}} \times w_{\text{mosaic}} \times w_t \]

\[ w_{\text{mosaic}} = \exp(-r/r_{\text{scale}}) \]

\[ r_{\text{scale}} = \sqrt{\frac{4V}{\pi \omega^2 \Delta r_0}} \quad V = 1 \text{ km}^3 \]
\[ \Delta r_0 = 1 \text{ km} \]
Hail Kinetic Energy Flux:
\[ \dot{E} = 5 \times 10^{-6} W_Z 10^{0.084Z} \]

Severe Hail Index:
\[ \text{SHI} = 0.1 \int_{z_0}^{z_t} W_T \dot{E} \, dz \]

Maximum Expected Size of Hail:
\[ \text{MESH} = 2.54 (\text{SHI})^{0.5} \]

\( z_0 \) = freezing level height
\( z_t \) = storm top (18 dBZ threshold)
\( W_T \) = temperature weight
\( W_Z \) = reflectivity weight
\( Z \) = reflectivity

Insurance data

• Home and contents insurance data provided by Suncorp Group Ltd. for a total of 19 known hail days

• Entries consist of address and lat–lon coordinates of property, claim flag, amount claimed, and total sum insured

• Used to create daily “damage indicator” fields – grid boxes assigned one of the follow values:
  • Damage if # claims ≥ 3
  • No Damage if # claims = 0 and # contracts ≥ 3
  • Unknown otherwise

• Total of 521 Damage grid boxes, but 258 of these from a single day (27/11/2014)
Example Hail Event: 27/11/2014
Choosing an optimum MESH threshold

\[ \text{Hit Rate} = \frac{a}{a + c} \]
\[ \text{False Alarm Ratio} = \frac{b}{b + d} \]
\[ \text{Critical Success Index} = \frac{a}{a + b + c} \]

\( a = \text{Hit} \)
\( b = \text{False Alarm} \)
\( c = \text{Miss} \)
\( d = \text{Correct Null} \)
Choosing which days to process

Storm day criterion:
$\geq 50$ lightning strikes in domain

Data availability criteria:
Marburg data essential
Maximum no. missing times $< 12$
Maximum no. missing times in $1 \text{ h} < 3$
Hail climatology

Damaging Hail Count

Maximum MESH
Comparison with Soderholm et al. (2016)
Future Work

• Explore methods of improving skill of MESH
• Extend climatology back to 2006 (if possible) and forward to 2016
• Examine seasonal and diurnal variations in hail occurrence
• Investigate the large-scale and local environments characterising hail days using reanalyses and soundings
• Repeat analysis for Sydney region

Would be interesting to perform high-resolution simulations of SEQ storms and their interactions with the sea breeze...