Hail climate for Brisbane, Australia, derived from single-polarization radar and insurance data

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Introduction

- Severe hail storms are a significant hazard along the central east coast of Australia, with previous events causing billions of dollars’ worth of damage.
- Knowledge of the spatial distribution of these storms is thus relevant both to forecasters and the insurance industry.
- Here, the hail hazard in the vicinity of Brisbane (Fig. 1) is quantified using the frequencies from four single-polarization radars and home and contents insurance data provided by Suncorp Group Ltd.

Radar Data

- Archived data from four single-polarization S-band radars (Table 1; Fig. 1) extracted for the period 2008–2015

Table 1: Details of the four single-polarized S-band radars used in this study

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Range</th>
<th>PRT</th>
<th>PRF</th>
<th>Azimuth</th>
<th>Elevation</th>
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<td>08</td>
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<td>300</td>
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<td>14</td>
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</table>

- To deal with calibration errors, reflectivity values compared against those from the Ku-band radars on board the Tropical Rainfall Measurement Mission (TRMM) and Global Precipitation Measurement (GPM) satellites

Merging Radars

- Reflectivity data from individual radars merged onto a common three-dimensional grid with 1 km spatial resolution
- Domain is 300 x 300 x 20 km, centred just southwest of Brisbane, and includes several major population centres (Fig. 1b), with a total population of around 3.3 million (~15 % of the entire country)
- Minimum radar beam height is < 3 km over almost the entire domain (Fig. 1c) which is below the freezing level during the warm season (~4 km) when virtually all major hail storms occur
- Values extracted for all points with damage/no damage and non-zero MESH values and used to construct 2 x 2 contingency tables for MESH thresholds ranging from 0 to 8 cm in 1 mm increments
- Hit Rate (HR), False Alarm Rate (FAR), and Critical Success Index (CSI) plotted as a function of MESH threshold (Fig. 5)
- CSI peaks at just under 0.2 for MESH = 4.8 cm (with HR = 0.42 and FAR = 0.01); low skill in part reflects spatial offset noted in Fig. 4
- 617 storm days identified for seven-year period 2008/09–2015 based on strike counts from the Global Positioning and Tracking Systems (GPATS) lightning detection network (Fig. 6)
- Of these, 220 rejected due to missing radar scans (most in the first 12 months), leaving 397 to analyse

Identifying Damaging Hail

- Home and contents insurance claim and exposure data obtained from Suncorp for a total of 29 days with known hail events
- Using merged radar product and soundings from Brisbane Airport, daily accumulations of the maximum expected size of hail (MESH; Witt et al. 1998) produced for each of these days (e.g. Fig. 4a)
- These were compared against grids showing whether or not damage occurred based on the insurance data (e.g. Fig. 4b) – points with at least three claims [no claims and at least three contracts] were labelled as having damage [no damage]

Future Work

- Explore methods for improving skill of MESH (e.g. tilted integrations, optimal shift, dilution)
- Examine seasonal and diurnal variations in hail occurrence
- Examine large-scale and local environments characterising hail days
- Use high-resolution numerical simulations to explore interactions between convective storms and the sea breeze in Southeast QLD

References

- Justin Peter, Roger Stone

Figure 1. (a) Map of Australia showing the location of the region of interest (black square). (b) Map of region of interest showing topography height (m; colours), location of radars (black diamonds) and their maximum range (black circles), sounding location (white star), regions of high population density (black lines) and MESH values (white shading) for each of 2014.

Figure 2. Time series of calibration errors for the Mt Stapylton radar in 2014. Circles and diamonds show the mean errors for individual radars and merged radars respectively, with t-test vertical lines indicating the standard deviation. Vertical lines indicate the sampling size for each radar.

Figure 3. Various forms of calibration errors for the Mt Stapylton radar in 2014. Extreme and diamonds show the mean errors for individual radars and merged radars respectively, with t-test vertical lines indicating the standard deviation. Vertical lines indicate the sampling size for each radar.