An extended hail climatology for Sydney, Australia, derived from a storm database, reanalysis, volumetric radar and sounding data

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Introduction

- Hailstorms are one of the costliest natural disasters on Australian East Coast. 20th December 2018 Hailstorm official estimate $871 Million (Insurance Council Australia[1])
- NSW is the most hail prone state in Australia, representing 81% of total national insurance losses (Leslie et al, 2008)[2]. Sydney is the most densely populated and one of the most hail prone cities in Australia
- Limited understanding of hailstorm spatiotemporal distribution, and mechanisms of formation in Sydney basin
- **AIMS:**
  - Develop an extended hail climatology for the Sydney basin
  - Identify critical meteorological parameters for local hailstorm development in Sydney

Fig 1. Sydney Hailstorm 20th December 2018. (Photo: Ajamian, C., 2018)

Methods

Extended climatology from observational data:

- Observation range 1950 – 2018
- **Bureau of Meteorology (BOM) Severe Storm Archive Database:** 197 Hail Events
  - Storm Spotter network established early 1990's
- **Hybrid Hail Database (Risk Frontiers and BOM hybrid):** 790 Hail Events
- Data bias due to spatial and temporal discontinuity

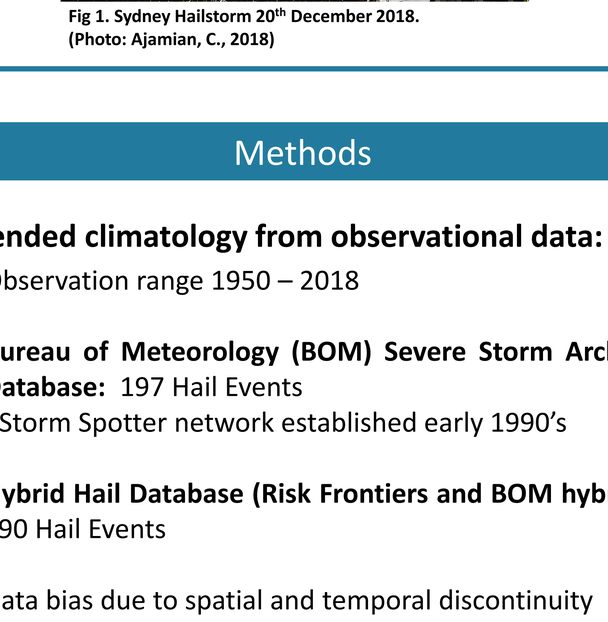

Fig 2. Spatial distribution of hail according to size using BOM database

Analysis of Environmental Parameters:

- Pseudo – proximity soundings using the **Regional NSW and ACT Regional Climate Modelling (NARCliM) project**.
  - Generated by 4 GCMs downscaled by 3 RCMs (WRF with different physics)
  - Resolution of the RCMs 10km
- Rawinsonde soundings will be used for verification of NARCliM reanalysis

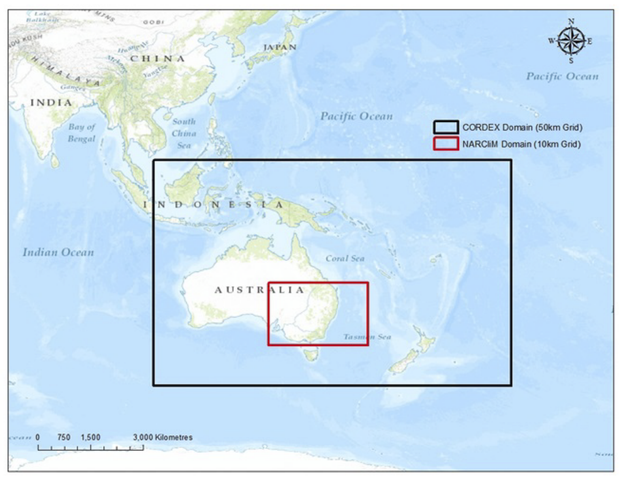

Fig 3. NARCliM domain[3]

Preliminary Results & Discussion

Hailstorm Database:

- Average number of hailstorms per year in Sydney
  - **BOM DB:** 2.94 ± 2.53
  - **Hybrid DB:** 11.43 ± 4.84
- Increase in observational data from ~1985
  - Likely due to storm spotter network establishment
  - Or possible increase in hailstorm activity?
- Database shows high inter-annual variability

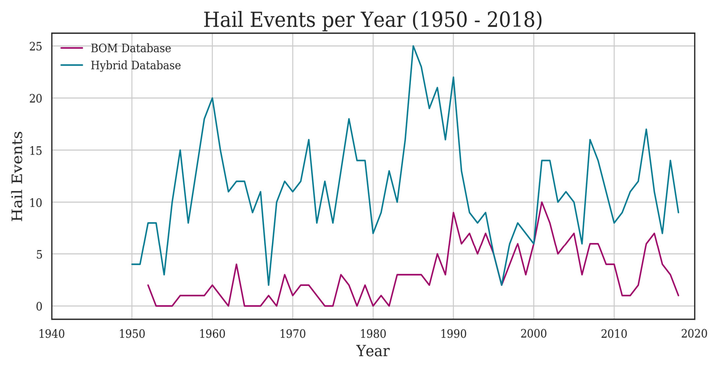

Fig 4. Timeseries of BOM and Hybrid Hail database from 1950 - 2018

- Higher frequency and variability of hailstorms during the Australian warm seasons (Oct – Mar) in both datasets. Peak in winter (Aug)

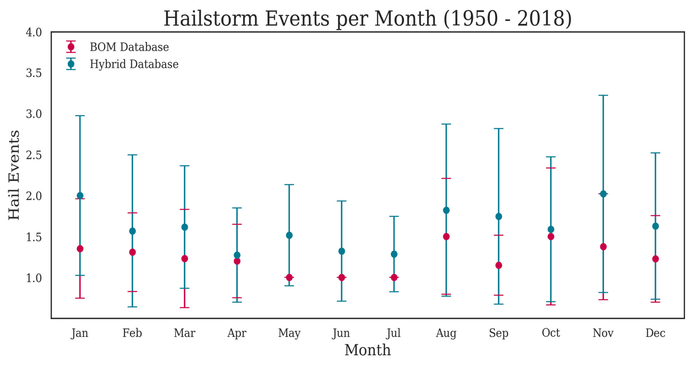

Fig 5. Monthly frequency analysis of hailstorm days. Round markers depict means, while bar caps depict respective standard deviations

- High temporal variability, with most hailstorms occurring from 2pm until 8pm Sydney time
- Potential role of sea breeze in initiation of hailstorms as seen in other Australian east coast studies (Soderholm et al, 2016)[4]

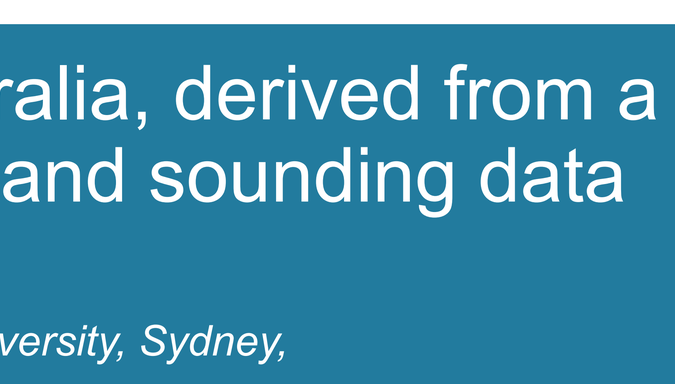

Fig 6. Temporal analysis of BOM hailstorm days

NARCliM downscaled Reanalysis

- Analysis conducted for the greater Sydney region only
- Trend of increasing CAPE and 0-6km vertical wind shear (S06) ~1975 – 1990's
- **Unexpected results**
  - MU CAPE mean much lower than observed soundings (average annual cape ~ 240 J Kg^{-1})

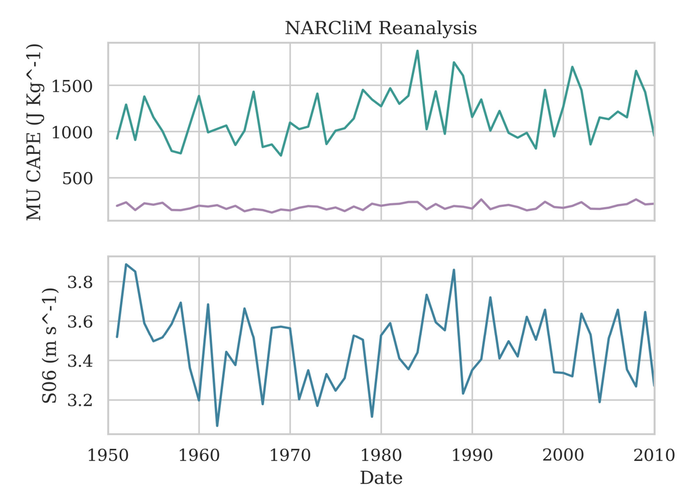

Fig 7. Preliminary analysis of mean & max CAPE and mean S06 produced from NARCliM reanalysis for Sydney

Future Work

- Reanalysis requires further work to obtain values that are more relevant to storm development
- Analyse the correlation between CAPE and S06, and calculate metric for Australian severe thunderstorm environments:

$$CAPE\ x\ S06^{x} \geq y$$

with x and y more suitable for Sydney storms (Allen et al., 2011)[5]

- Investigate further environmental parameters to determine their relevance to hailstorms in the Sydney region such as those in the Storm Prediction Center
- Investigate the potential influence of mesoscale (eg. sea breeze and cold front), and larger scale climate phenomena (eg. ENSO)

References & Acknowledgements

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