Estimating Severe Windstorm Occurrence Across Australia Using Bayesian Modelling

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INTRODUCTION

• Research Goal:
  To develop a stochastic event-based modelling approach that simulates an extended period of convective windstorm activity over Australia

• Broken down into four steps:
  1. Create a spatially complete convective windstorm climatology
  2. Generate and track convective events
  3. Model ground-level wind fields for each event
  4. Develop wind hazard maps for a range of return periods

• The work presented here focuses on developing the convective windstorm climatology:
  - Observational data (i.e. Bureau of Meteorology’s (BoM) Severe Storm Archive (SSA), Global Position and Tracking System (GPATS) lightning detection data), aggregation, and inference methods are used to determine storm frequency in areas where reliable information is available
  - Spatial probability information is used, along with reanalysis data sets (ERA-Interim), to infer windstorm occurrence frequency in areas where observational data is limited

METHODS

• Bayesian statistical modelling is used to infer relationships between severe weather indices (SWI) and the observed number of lightning events following the methods outlined by Cheng et al. (2015)

• The model is outlined as follows:

  \[
  \log(\lambda) = a_0 + a_1^{SWI1} + a_2^{SWI2} + a_3^{SWI3} + \text{CAR},
  \]

  - \(\lambda\) - gridcell-specific rate of event occurrence
  - CAR - gridcell-specific conditional autoregression terms

  Output parameters values:
  \(a_0, a_1, a_2, a_3, \text{CAR}\)

  Average SWI

  Output:
  Solve for \(\lambda\) for 1990-2015

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FUTURE WORK

• Future work will involve expanding the current Bayesian model to specifically look at determining the severe windstorm climatology across Australia

• This involves:
  1. Developing a relationship between the occurrence of lightning storms and severe weather events
  2. Adding a conditional probability to determine the type of severe weather event (i.e. wind, rain, hail, or tornado)
  3. Systematically distinguishing between severe winds that originate from convective storms versus synoptic weather events

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