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Estimating severe windstorm occurrence across Australia using Bayesian modelling

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The starting point for any climatological analysis is a long-duration (i.e. multi-decadel) data set. Unfortunately, severe weather event records (including wind gusts) in the Australian Bureau of Meteorology's Severe Storm Archive (SSA) are incomplete and contain biases. These biases occur because of differences in population density and reporting practices over space and time, and affect the overall completeness of the SSA.

Severe weather parameters (i.e. Convective Available Potential Energy and 0-6 km wind shear) are increasingly being used by climate researchers to either compliment or replace poor observational records of severe weather events. The parameters chosen to do this, though, are not typically tailored for use in specific climate regions or for estimating the occurrence of different storm types. A Bayesian hierarchical framework may facilitate such tailoring and this work explores the use of such a model to estimate the probability of severe wind events occurring in different parts of Australia.

The hierarchical Bayesian model used in this study couples population density estimates and severe weather parameters to correct for biases in the SSA event counts. Combinations of different severe weather parameters are examined to determine which indices provide the most explanatory power for severe wind occurrence. The spatiotemporal variability of the underlying factors inherent to severe weather formation (e.g. instability, moisture, wind shear) are also examined to better determine the expected number of severe wind events across different seasons and climate regions of Australia. Model estimates of 'true' storm occurrence counts are compared with quality controlled SSA severe wind event counts and a nation-wide climatology of severe windstorm occurrence developed.