Future climate projections of severe convective wind events from a convection-permitting regional climate model

Lead author profile and publications

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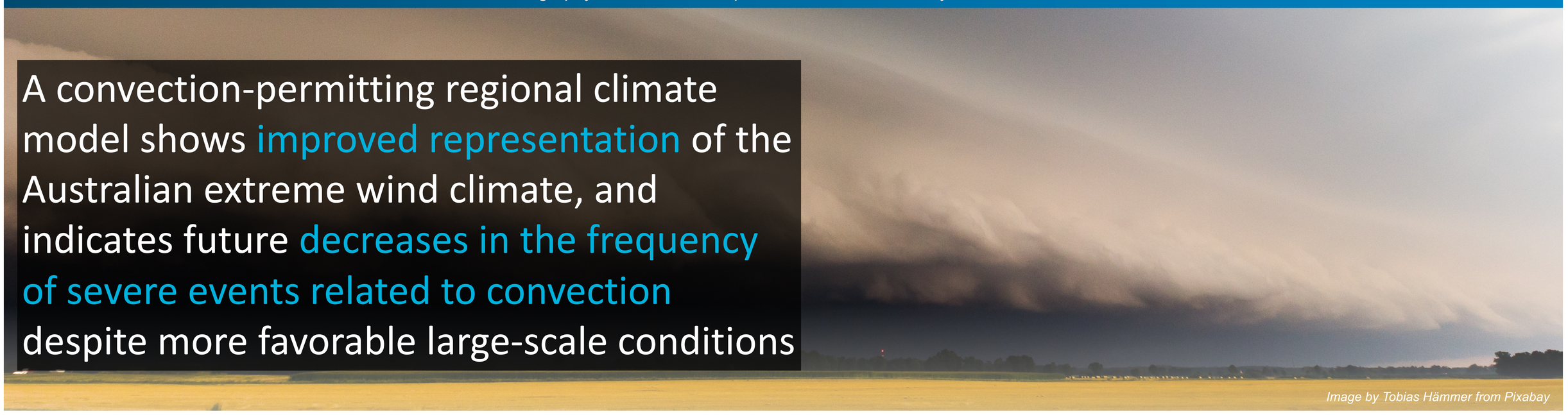
A convection-permitting regional climate model shows improved representation of the Australian extreme wind climate, and indicates future decreases in the frequency of severe events related to convection despite more favorable large-scale conditions



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Background

The frequency and intensity of severe wind gusts (3-second average wind 25+ m/s) associated with convection (severe convective winds, SCWs) have been projected to change in future climate due to global warming (Brown and Dowdy 2021, Prein 2023), but the sign and magnitude of change in south-eastern Australia is uncertain. This is investigated using a convection-permitting regional climate model to simulate different types of SCWs under historical and future climate scenarios.

Types of severe convective wind events

Severe convective wind events in Australia occur in three types of large-scale environments, that are also associated with different parent storm types

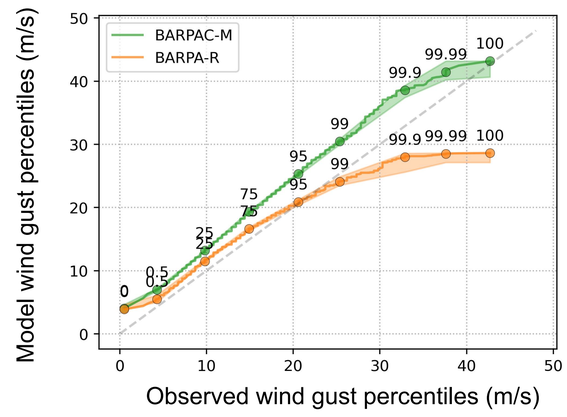
Strong background wind
Steep lapse rate
High moisture

Figure adapted from Brown et al. (2023)

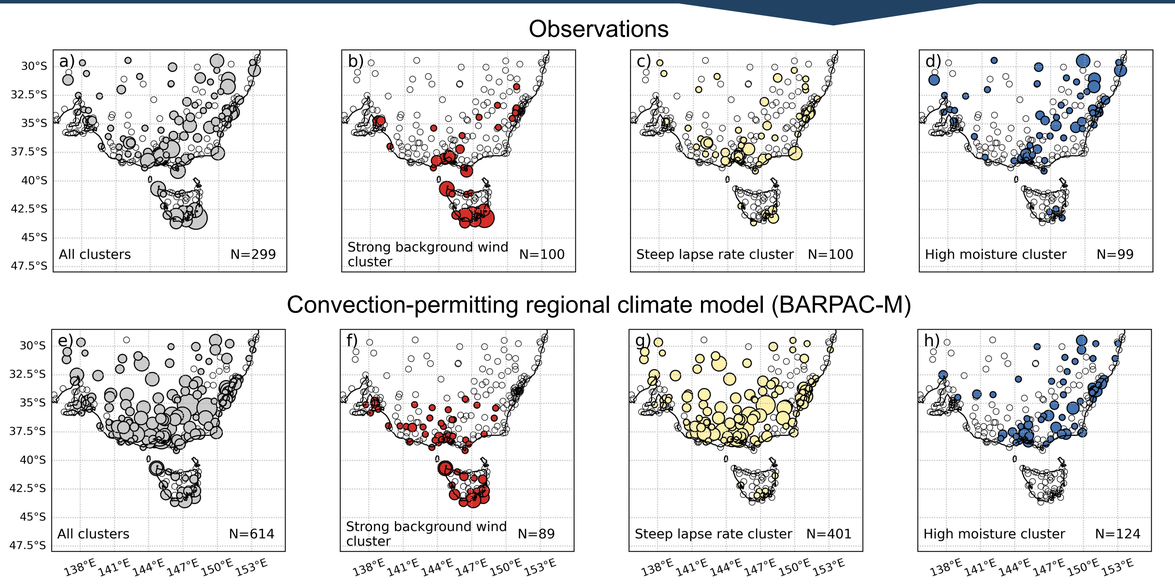
Model framework and evaluation

The modelling framework used here is the Bureau of Meteorology Atmospheric Regional Projections for Australia (Su et al. 2021) with a convection-permitting configuration (BARPAC-M, dx=2.2 km) and a regional configuration (BARPA-R, dx=12 km). A nested hindcast using these configurations is forced with the ERA-Interim reanalysis for December-February (Austal summer) and compared with station wind observations over a 2005-2015 period

Severe daily maximum convective wind gusts are better represented by a convection-permitting model compared with a model that parameterises convection



The convection-permitting regional climate model can broadly simulate the spatial separation of severe convective wind event types, but produces too many steep lapse rate events

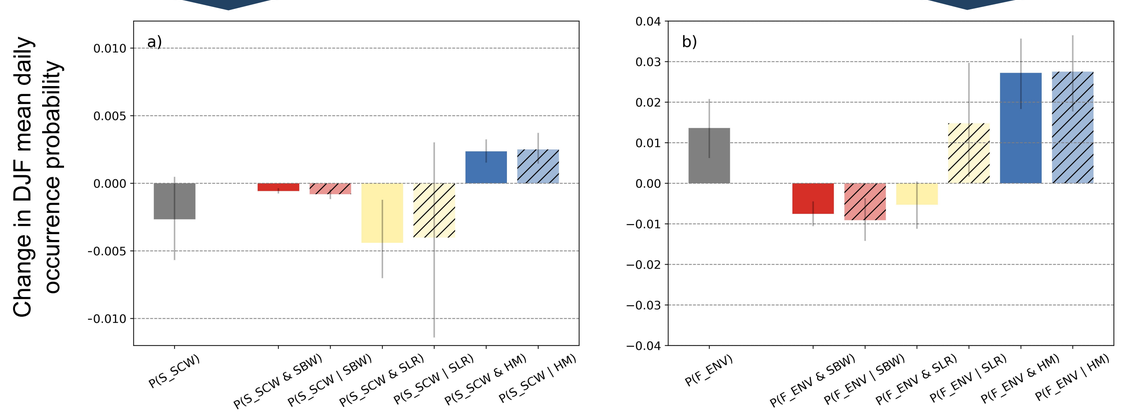


Future climate projections

- We compare the probability of a simulated SCW occurrence between historical (1985-2005) and future (2039-2059, RCP8.5) BARPAC-M experiments, forced by the ACCESS1-0 global climate model.
- A future decrease in probability is suggested, driven by a decrease in simulated steep lapse rate events, noting significant biases in historical event frequency.
- These results are compared with an environmental proxy applied to BARPA-R, that uses statistical regression to relate large-scale conditions to the probability of an observed SCW event (Brown and Dowdy, 2021).
- This approach indicates an increase in probability, driven by an increase in favourable high moisture environments (related to increasing convective instability).
- The relationship between the anomalous monthly number of favourable SCW environments and simulated events becomes less correlated in future climate (r=0.347) compared with the historical climate (r=0.613).

Future decrease in simulated SCW probability from **BARPAC-M**

Future increase in favourable SCW environments from **BARPA-R**



Acknowledgements
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