Extreme Weather Event Real-time Attribution Machine (EWERAM) - An overview

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Overview

Motivation

- In the immediate aftermath of an extreme weather event (EWE), the public wants to find out to what extent **anthropogenic climate change** has contributed to the event.
- This question is not straightforward to answer.

Waiho Bridge, Westcoast, May 2019
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Motivation

- Nevertheless, attribution questions have been answered for some EWEs in the scientific literature (e.g. Herring et al., 2015).
- But, the wider public does typically not read the scientific literature.
- EWERAM conducts the research necessary to develop a tool that provides scientifically defensible data to inform quantitative statements about the role of climate change in both the **severity** and **frequency** of the specific event.
- EWERAM is an MBIE Smart Ideas project which started in 2018 and runs for three years.

The EWERAM team

The EWERAM project brings together scientists from 5 institutions within New Zealand.

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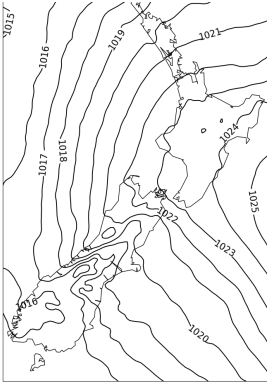
The attribution questions addressed in EWERAM

The project has two parts which are addressing distinct attribution questions that the wider public may be interested in, i.e.

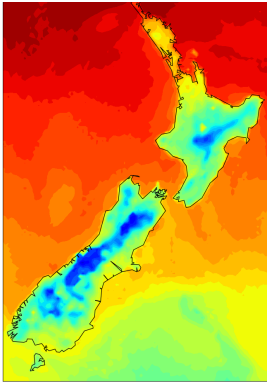
1. The analysis of **severity** will answer the question: How much more severe (stronger) was the specific extreme weather event due to anthropogenic climate change?
2. The analysis of **frequency** will answer the question: How did the frequency of a class of events change due to anthropogenic climate change? Should we expect more such events than in the past?

Changes in the Severity of EWEs

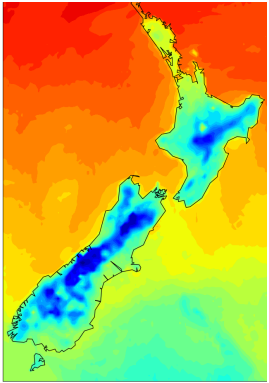
To study changes in the severity of EWEs, we assume the same synoptic situation (same dynamics) with changes in **thermodynamics** (e.g. Trenberth et al., 2015).



(a) Pressure



(b) Temp antropogenic



(c) Temp preindustrial

Changes in the Severity of EWEs

To study te changes in the severity of EWEs, EWERAM will:

- Run the Weather Research and Forecast (WRF) model in two distinct set-ups under the same synoptic conditions, i.e.
  1. Using fields from the global GFS model for nowadays conditions, i.e. temperatures, humidity etc. as observed/modelled on the specific day.
  2. Using pre-industrialised conditions, i.e. taking the same GFS fields as in 1., but apply difference fields to subtract the influence of anthropogenic climate change in e.g. sea surface temperature, vertically resolved temperature/humidity.

The delta fields are calculated from CMIP5[1] model output for anthropogenic and pre-industrial simulations (Stone and Pall, 2019).

[1] Coupled Model Intercomparison Project Phase 5

Changes in the Frequency of EWEs

However, studying changes of the thermodynamics alone is not sufficient, as NZ may also experience changes in the **dynamics** which could make specific events more or less likely. EWERAM will:

- Define classes of events.
- Find and count all events of a specific class in anthropogenic and pre-industrial ensembles of weather@home and CMIP6.
- For extreme heat events, this is reasonably straightforward as warm temperatures occur on a large scale.
- For extreme rainfall, which can be very localised, defining and counting the events can be much more challenging based on the large grid size of CMIP6 and weather@home $\rightarrow$ see **Leroy Bird's poster**.

The intended outcome of this project

- The main goal of this project is to do the science required to answer the question of how the frequency and severity of an EWE has been influenced by anthropogenic climate change.
- The process will be semi-automated to provide answers within days after an EWE occurred in NZ.
- This information can then be used to inform NZ's public to gain an understanding of the effect that anthropogenic climate change has on their every day life.

References I

Herring, S., Hoerling, M. P., Kossin, J. P., Peterson, T. C., and Stott, P. A. (2015). Explaining extreme events of 2014 from a climate perspective. *Bulletin of the American Meteorological Society*, 96(12):S1–S172.

Stone, D. A. and Pall, P. (2019). A benchmark estimate of the effect of anthropogenic emissions on the ocean surface. *Submitted to International Journal of Climatology*.

Trenberth, K., Fasullo, J., and Shepherd, T. (2015). Attribution of climate extreme events. *Nature Climate Change*, 5(August):725–730.

EWERAM - It's nothing to do with sheep!

New Zealand's Extreme Weather Event Realtime Attribution Machine (EWERAM)