The Extreme Weather Event Real-time Attribution Machine (EWERAM) – An Overview

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Goals of EWERAM – Providing attribution statements to the public

- 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 **frequency** and **severity** of the specific event.
- As every EWE has a contribution from natural variability as well as an anthropogenic contribution resulting from climate change, this question is not straightforward to answer.
- EWERAM conducts the research necessary to develop a tool that, **within days after an EWE**, provides scientifically defensible data to inform quantitative statements about the role of climate change in both the severity and frequency of the specific event.

Figure 1: Waiho Bridge, Westcoast New Zealand, May 2019.
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Severity attribution

- The analysis of severity will answer the question: How much more severe (stronger) was the specific EWE due to anthropogenic climate change?
- To study changes in the severity of EWEs, we assume the same synoptic situation (same dynamics) with changes in thermodynamics[5], as illustrated below.

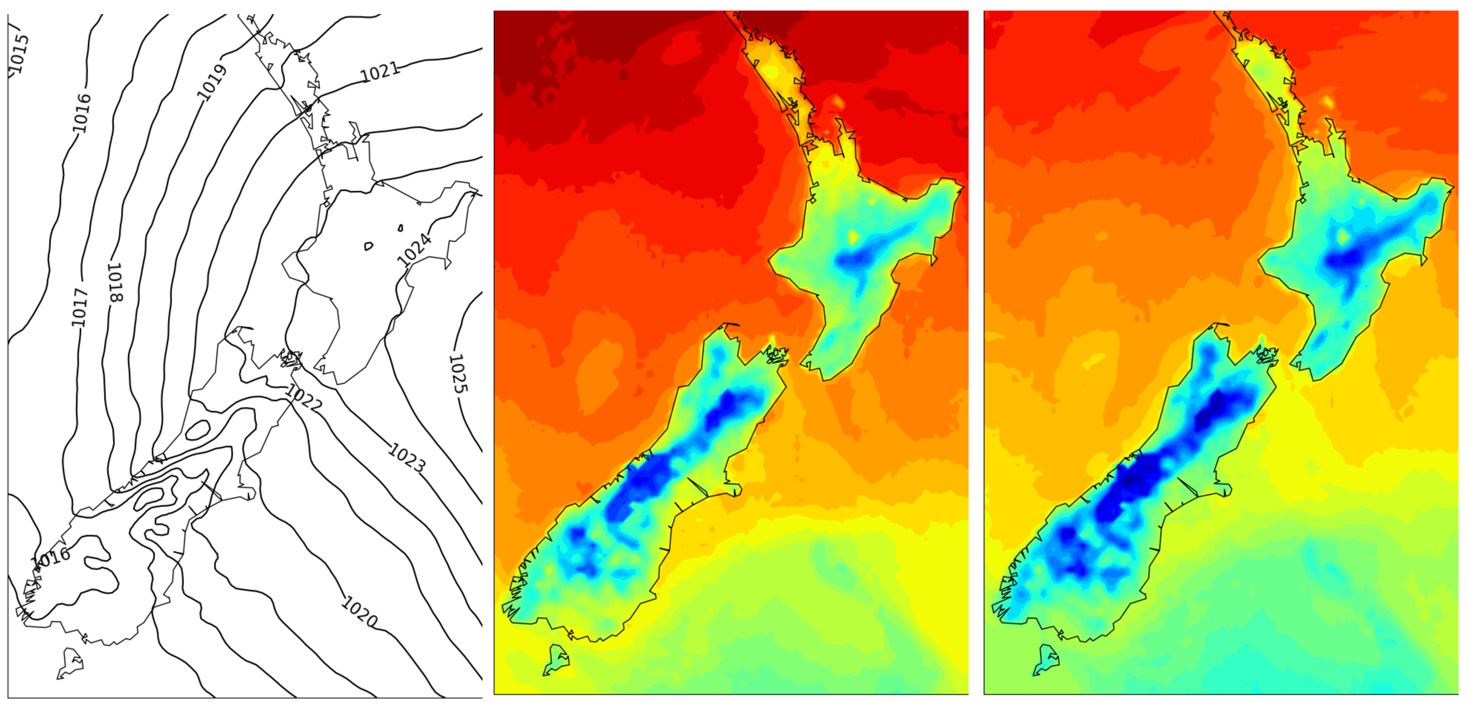

Figure 2: Illustration of concept. Mean sea level pressure (left), associated temperature field (middle), "pre-industrialised" temperatures (right).

- EWERAM will run the Weather Research and Forecast (WRF) model in two distinct set-ups under the same synoptic conditions:

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.

- The delta fields are calculated from CMIP5 model output for anthropogenic and pre-industrial simulations[4].
- However, studying changes in thermodynamics is not sufficient, as New Zealand is also affected by changes in the dynamics which could affect the frequency of specific EWEs.

Frequency attribution

- The analysis of frequency will answer the question: How did the frequency of a class of events change due to anthropogenic climate change?
- To study changes in the frequency/return period of EWEs, EWERAM will:
- Define classes/thresholds that define an EWE.
- Account for biases between WRF and climate model output using return periods to set a new threshold of e.g. extreme temperature or rainfall.
- Find and count all events of a specific class/exceeding a threshold in anthropogenic and pre-industrial ensembles of weather@home[2] and CMIP6[3].
- For extreme temperature and large-scale rain events, this is reasonably straightforward as they occur on a large scale.
- For localised events that occur on a subgrid-scale of climate simulations, this is challenging. EWERAM is exploring the use of machine learning methods to infer probabilities of EWEs occurring on a sub-grid scale[1].

The EWERAM team and its initial results

- EWERAM involves researchers from five New Zealand institutions:

Initial severity/frequency attributions have been performed with promising results.

WRF runs stably using "pre-industrialised" input fields and it reproduces EWE under investigation.

We will work towards providing the attribution within days after EWE occurred.

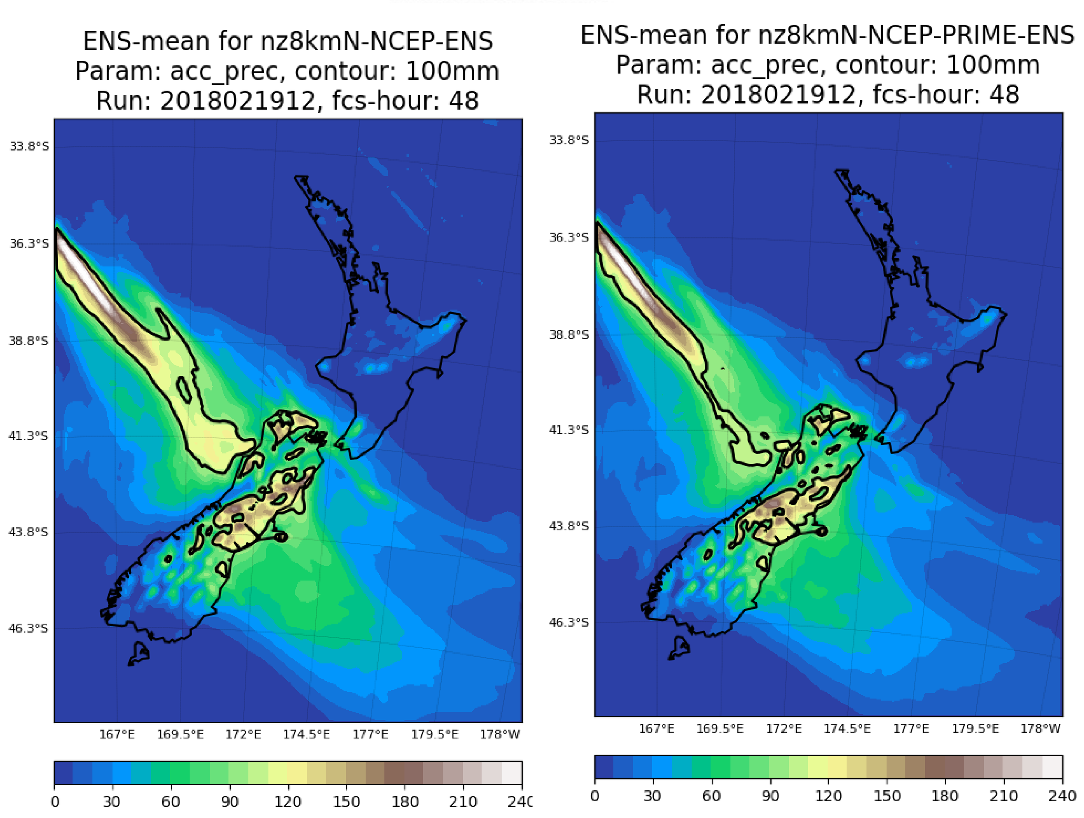

Figure 3: WRF rain forecast for Cyclone Gita under current (left) and pre-industrial (right) conditions.

References

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