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

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Overview

Motivation

- New Zealand is strongly affected by extreme weather events (EWEs), specifically by precipitation extremes and heat extremes.
- Almost every time there is an EWE in New Zealand, the media and/or the public ask whether it was caused or affected by anthropogenic climate change.
- This question is not straight forward to answer as typically both internal variability and climate change play a role in an EWE.

Motivation

- There have been studies analysing specific EWEs (e.g. the yearly BAMS issue "Explaining Extreme Events from a Climate Perspective"), but the wider public does not typically read the scientific literature which becomes available long after the event.
- To inform the debate, New Zealand would benefit from knowing, soon after an extreme event, whether climate change had any influence on it.
- 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[1] Smart Ideas project which started in 2018 and runs for three years.

[1] Ministry for Business, Innovation and Employment

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 **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?

2. The analysis of **severity** will answer the question: How much more severe (stronger) was the specific EWE due to anthropogenic climate change?

Globally there is a growing EWE attribution community and we are looking towards them to learn and to collaborate. This includes World Weather Attribution, the UK Met Office and others.

Changes in the Frequency of EWEs

New Zealand is affected by changes in the **dynamics** and **thermodynamics** of the climate. We study these changes based on well-established approaches (e.g. World Weather Attribution).

- Define classes of events, e.g. based on a threshold for a variable such as temperature or based on the synoptic pattern.
- Use return period space to avoid biases of the model against reality.
- Find and count all events of a specific class in anthropogenic (ANT) and natural-world (NAT) ensembles of weather@home and CMIP6 (Coupled Model Intercomparison Project Phase 6).

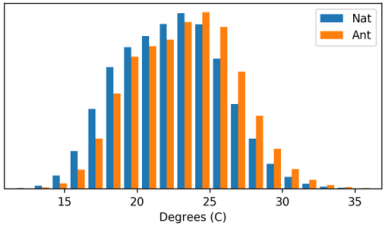
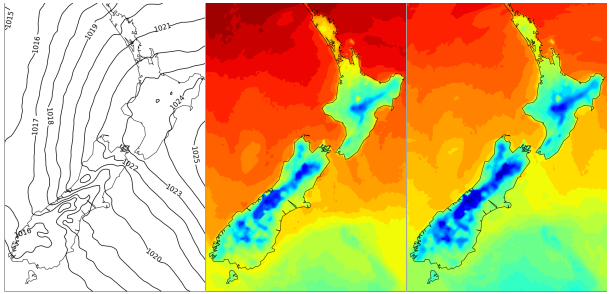


Figure 1: Distribution of weather@home ANT and NAT January 2015 daily maximum temperatures in Gisborne, New Zealand.

Changes in the Severity of EWEs

In addition to the approach outlined above, we analyse changes in severity of EWEs, by assuming the same synoptic situation (same dynamics) with changes in **thermodynamics**.

- Think about the same pressure system, but different fields of thermodynamic variables.
- This will provide information about how the strength of an event would differ between an anthropogenic (ANT) world and a world without human influence (NAT).



(a) Pressure (b) Temp ANT (c) Temp NAT

Figure 2: Schematic presentation of the concept.

Changes in the Severity of EWEs

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

- Run the Weather Research and Forecast (WRF) model in three 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 naturalised 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.
  3. Using conditions as in 1., but add the influence of anthropogenic climate change to test for consistency in the results.

The delta fields were calculated from CMIP5[2] model output for anthropogenic and natural simulations within the Climate of the 20th Century Plus Detection and Attribution project.

[2] Coupled Model Intercomparison Project Phase 5

The intended outcome of this project

- The main goal of this project is to do the science required to provide some answers to the question of how the frequency and severity individual EWEs in New Zealand has been influenced by anthropogenic climate change.
- Eventually, we intend to use the information to inform New Zealand's public about the influence that anthropogenic climate change has on EWEs which also affect their every day life. But, first we'll need to work hard on getting there.

The next steps within EWERAM

- We still have a lot to learn and to improve and am hoping to collaborate closely with the international community.
- The EWERAM process will be semi-automated to provide output within days after an EWE occurred in New Zealand.
- Once we have have the WRF simulations and statistics from the analysis of climate models, the EWERAM team will develop attribution statements.
- We will start now to internally perform attribution analysis for EWEs as they occur to learn from the analysis of those events.


Thank you for your attention!