

# NASEM EEA IMPACTS WORKSHOP

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# A bit about me.

## Climate scientist with a keen interest in heatwaves

- How they are measured
- Underpinning physical mechanisms
- Changes in the observational record
- Future projections from physical climate models

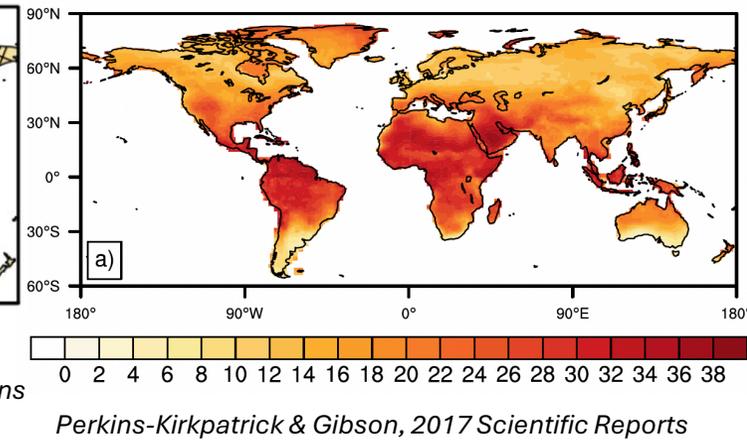
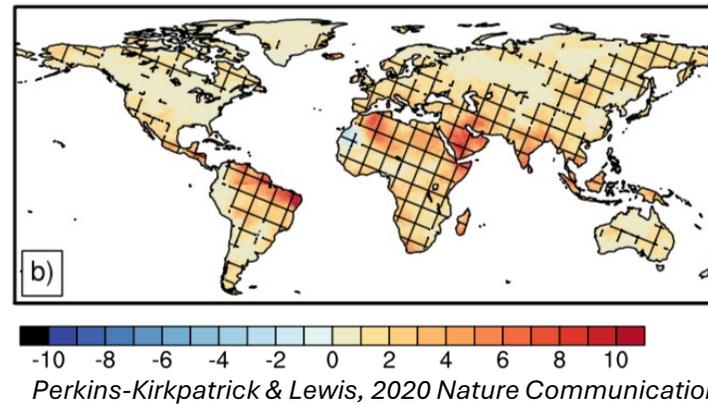
## Also interested in detection and attribution

- Finding the role of climate change behind observed events
- Extreme event attribution
- Impact attribution

## And in the health impacts of heatwaves

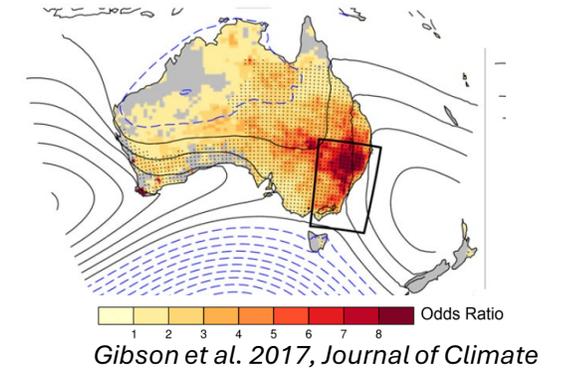
- heat + humidity
- Liveability vs survivability
- Challenging the  $T_w$  35°C threshold

Historical changes in heatwave days/decade      Changes in heatwave days/°C global warming

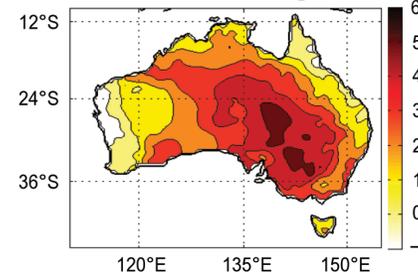


**My interest in attribution is generally around extreme heat and corresponding health impacts**

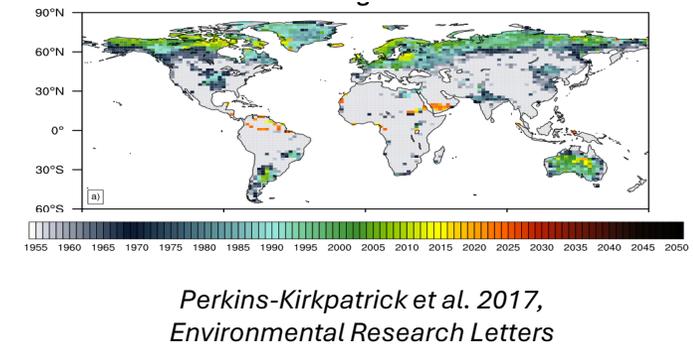
Interaction of heatwave mechanisms



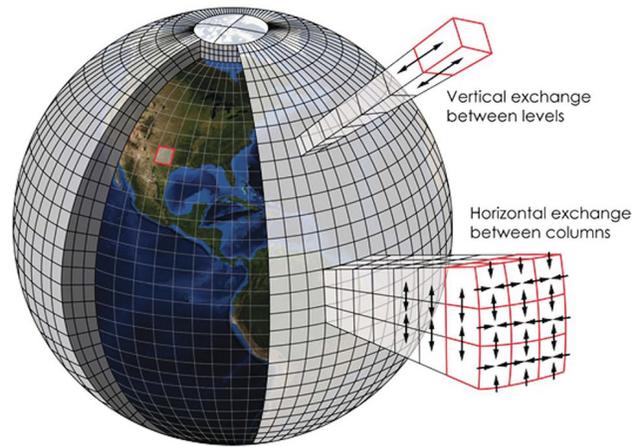
Attributing heatwaves to climate change



When do heatwave trends become unprecedented?



# Impact attribution is interdisciplinary at its core

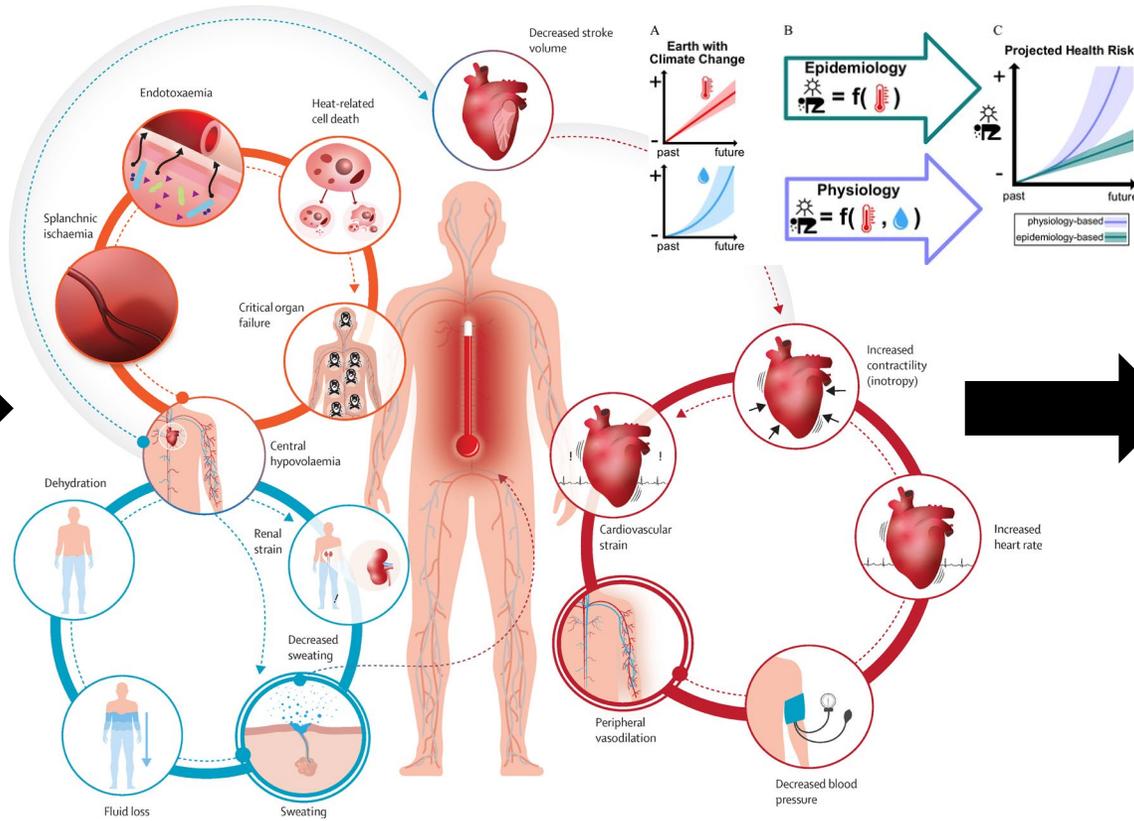
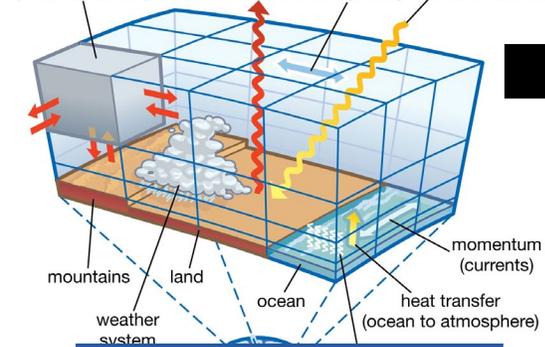


*Ebi et al 2021 Lancet*

*Baldwin et al 2023 Environ. Health. Persp.*

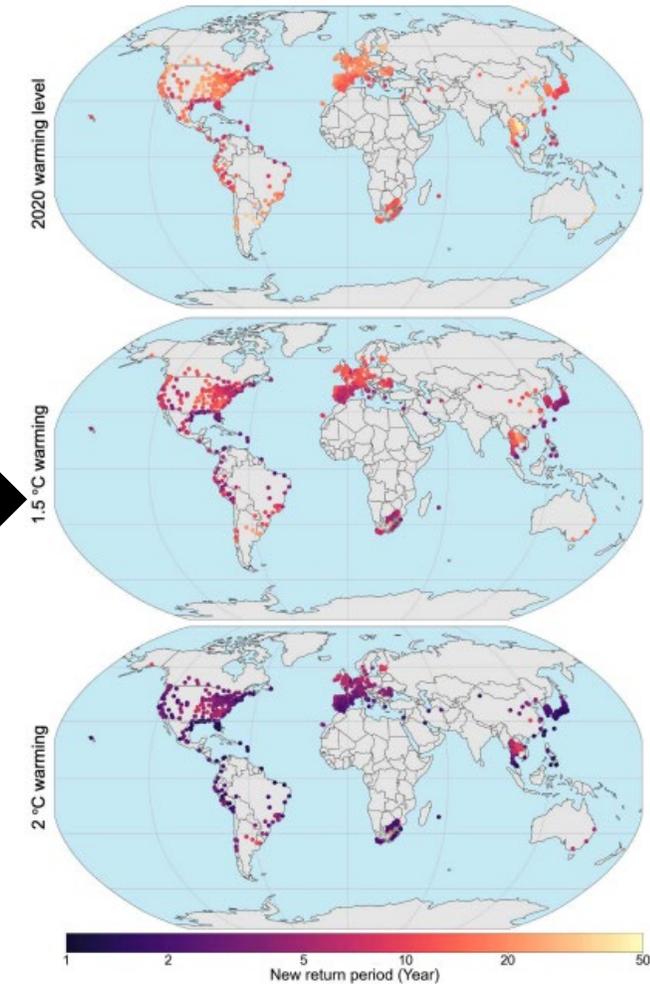
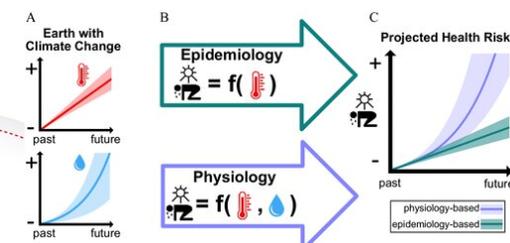
*Luthi et al 2023 Nature Climate change*

**Concept diagram of climate modeling**  
3-D grid box (CO<sub>2</sub>, dust, H<sub>2</sub>O)



**BUT**

Interdisciplinary research is not straightforward



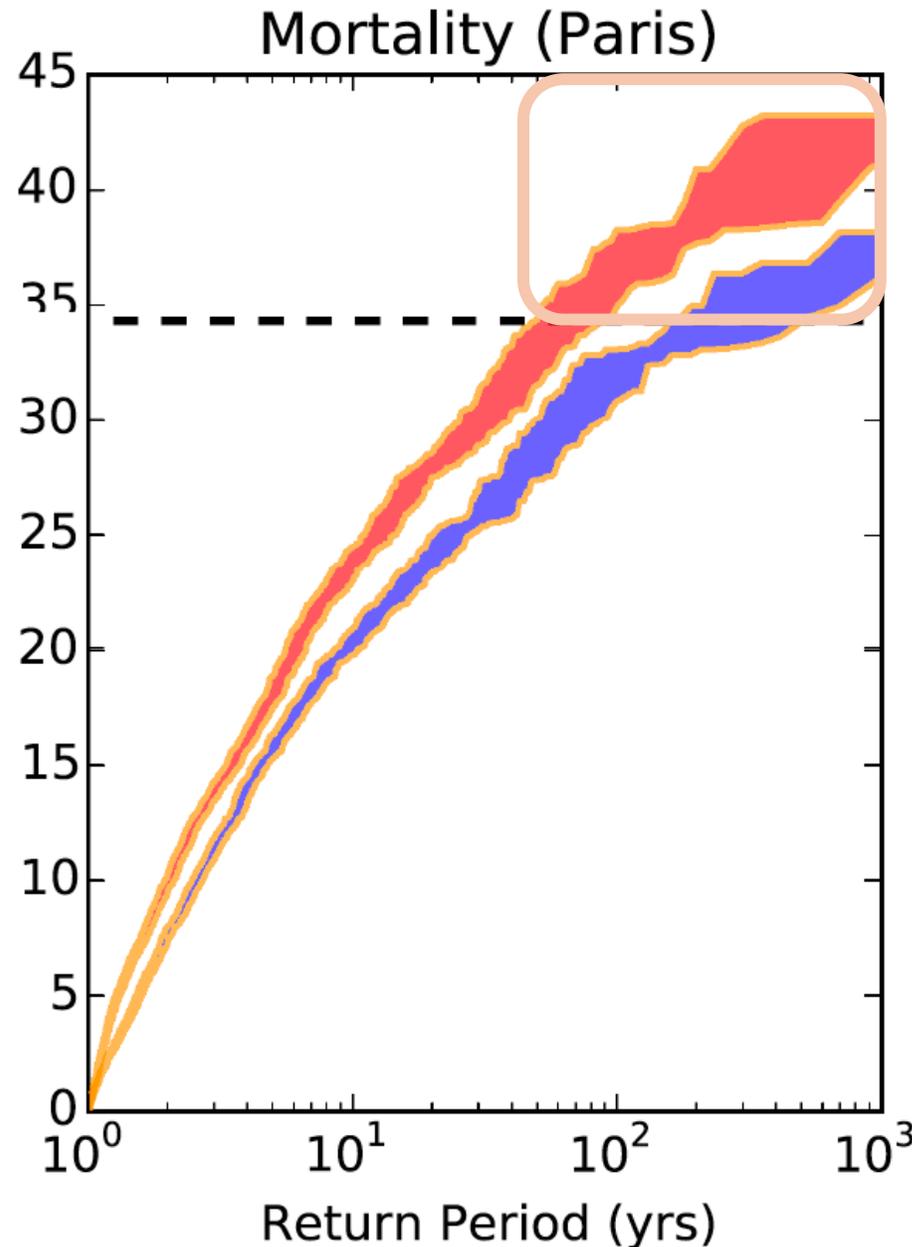
# Fraction of attributable risk not appropriate for impact of a *specific* event

$$FAR = 1 - (P_{nat} / P_{all})$$

$$RISK = P_{all} / P_{nat}$$

FAR measures the change in likelihood of an event **at least as big as the observed event of interest**, and not specifically for that event only

Therefore, cannot directly fit FAR to measure how the impact of a **specific event** was altered due to climate change

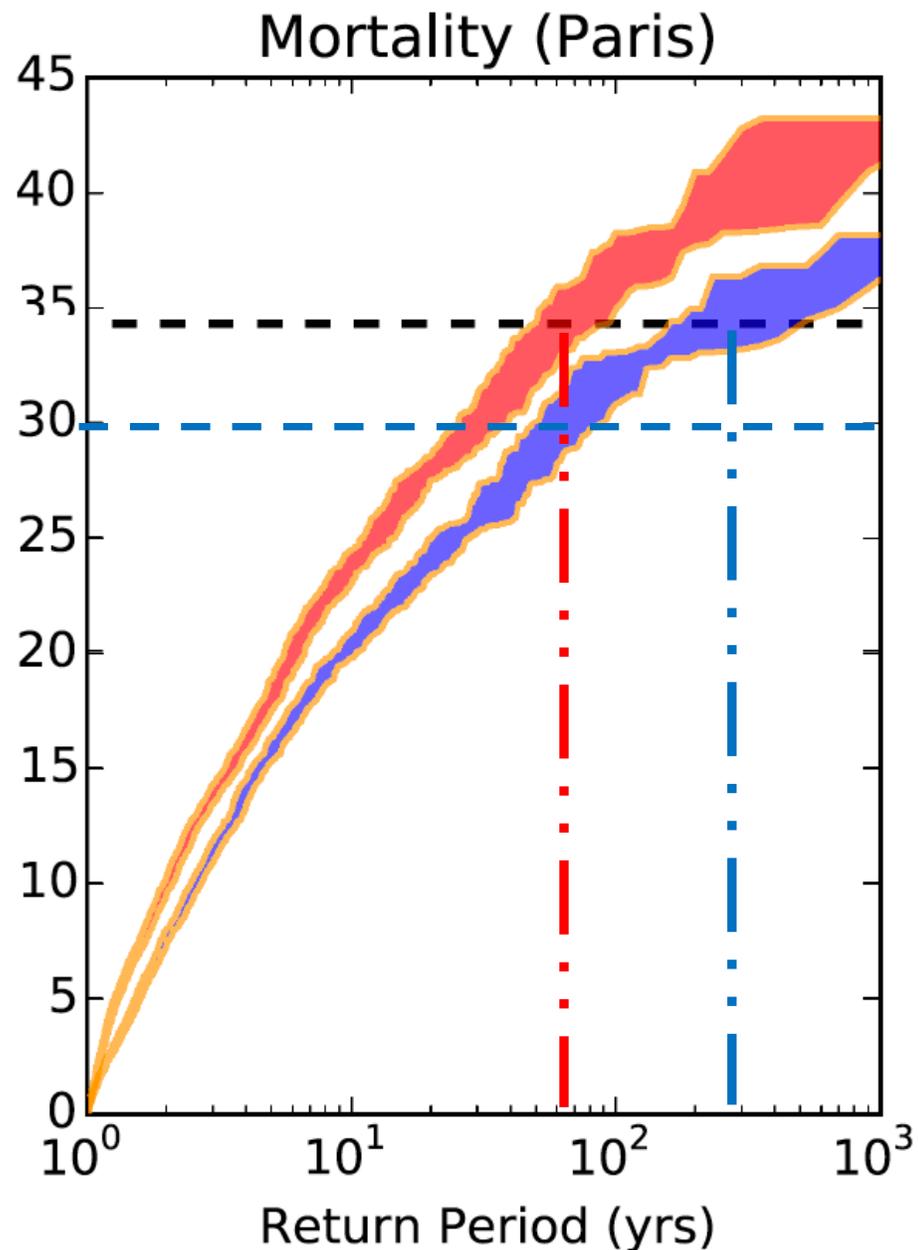


FAR = 0.7  
for **all** heat-related  
mortality events  
above 34 per  
100,000

# We proposed a different approach

Underpinning input is still the same:

- A pre-defined method that appropriately links the event and an impact
- Mapping the impact of interest to climate data
- **Factual** & **counterfactual** climate model simulations



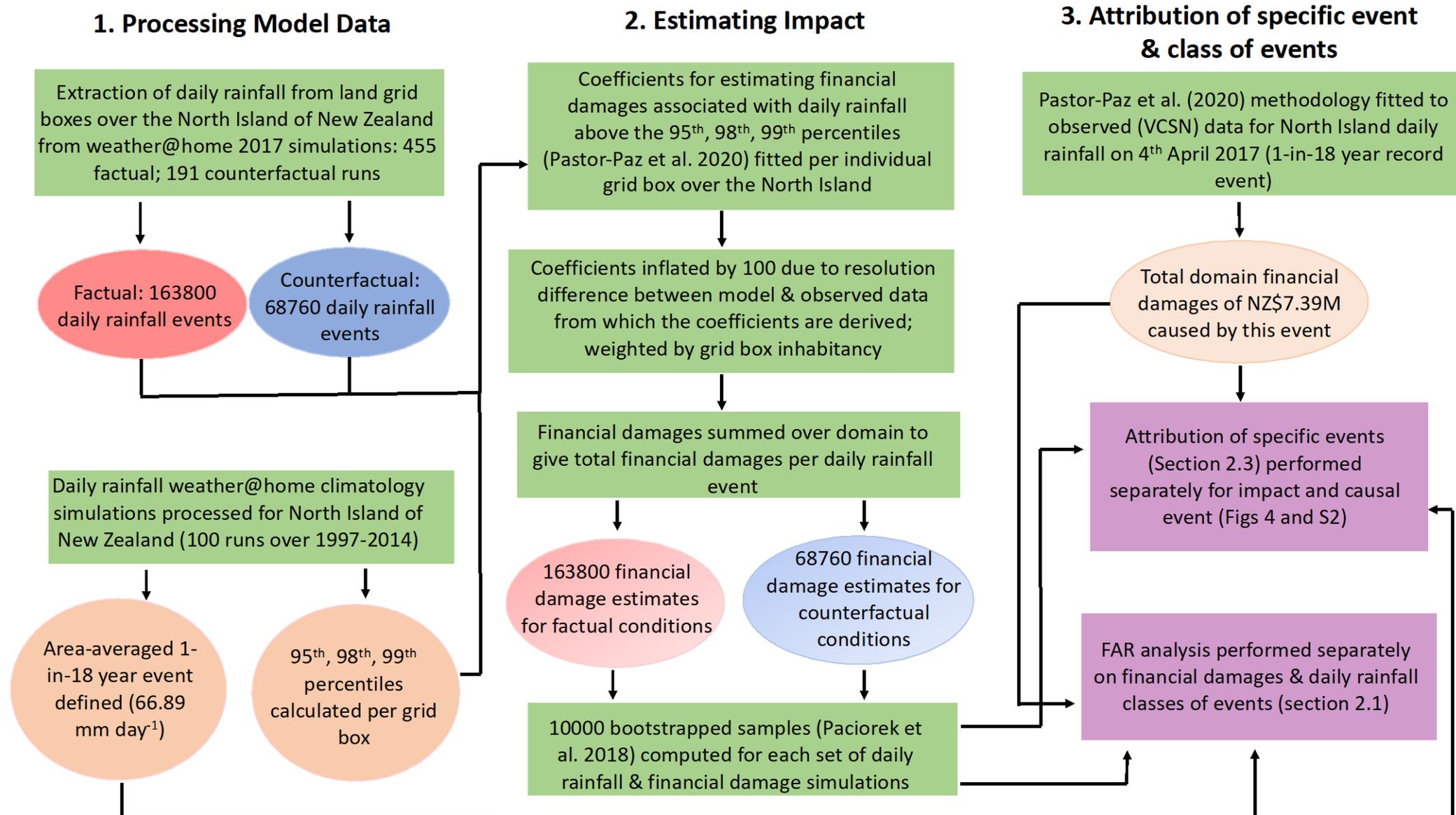
In the **factual world**, a mortality rate of 34 deaths/100000 is a 1-in-70 year event

In the **counterfactual world**, the death rate with ***the same return period*** is 30 deaths/100000

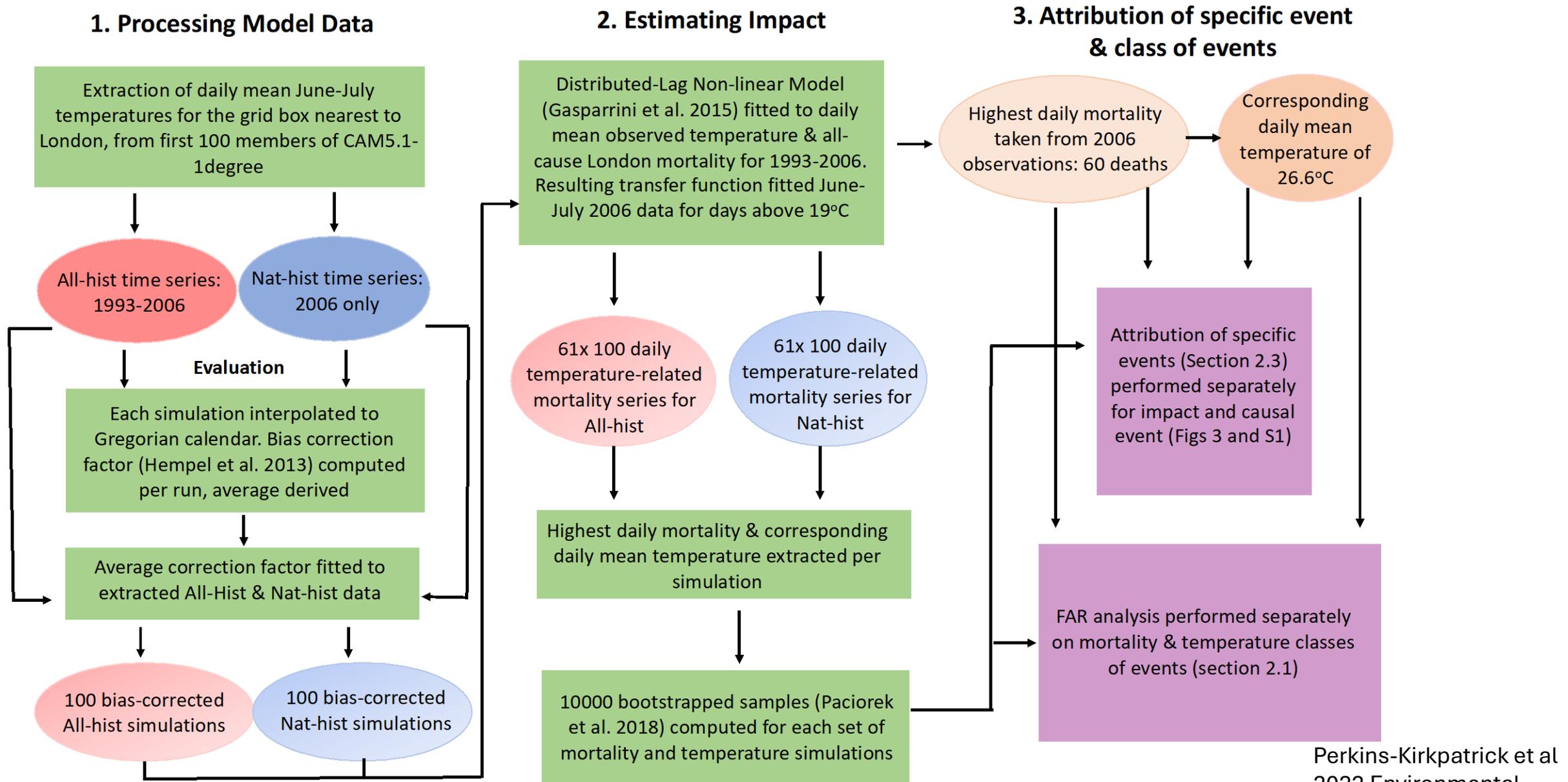
Therefore 4 deaths/100000 during *this specific event* can be attributed to climate change

Also, the waiting time of 34 deaths/100000 has *reduced* by 130 years

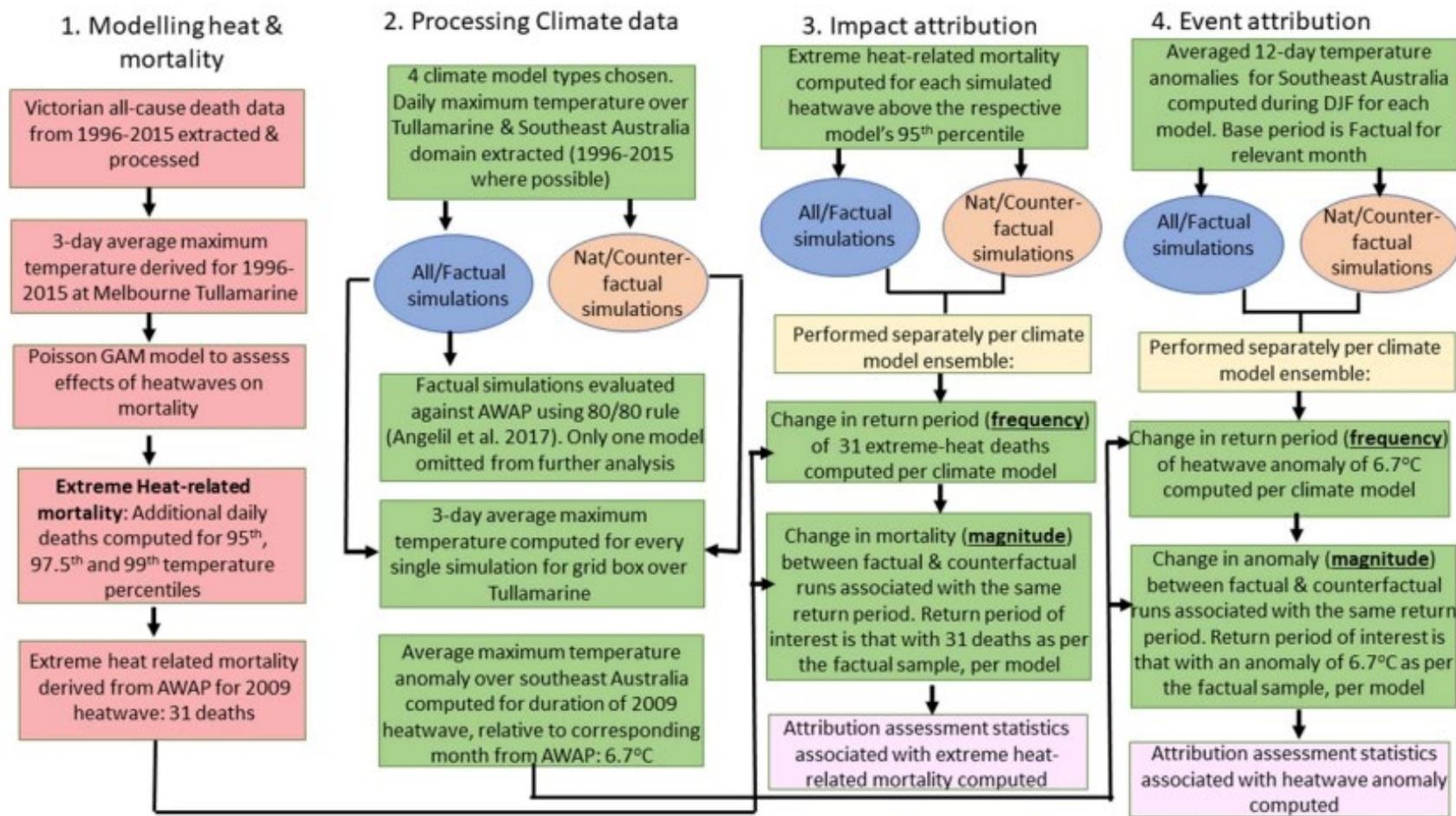
# Case study: NZ rainfall & Financial Damage



# Case Study: London Heat and Mortality



# Application to 2009 Southeast Australian Heatwave



Looked at **extreme heat-related mortality** ONLY

Employed 8 different climate models

strength in signal different across models

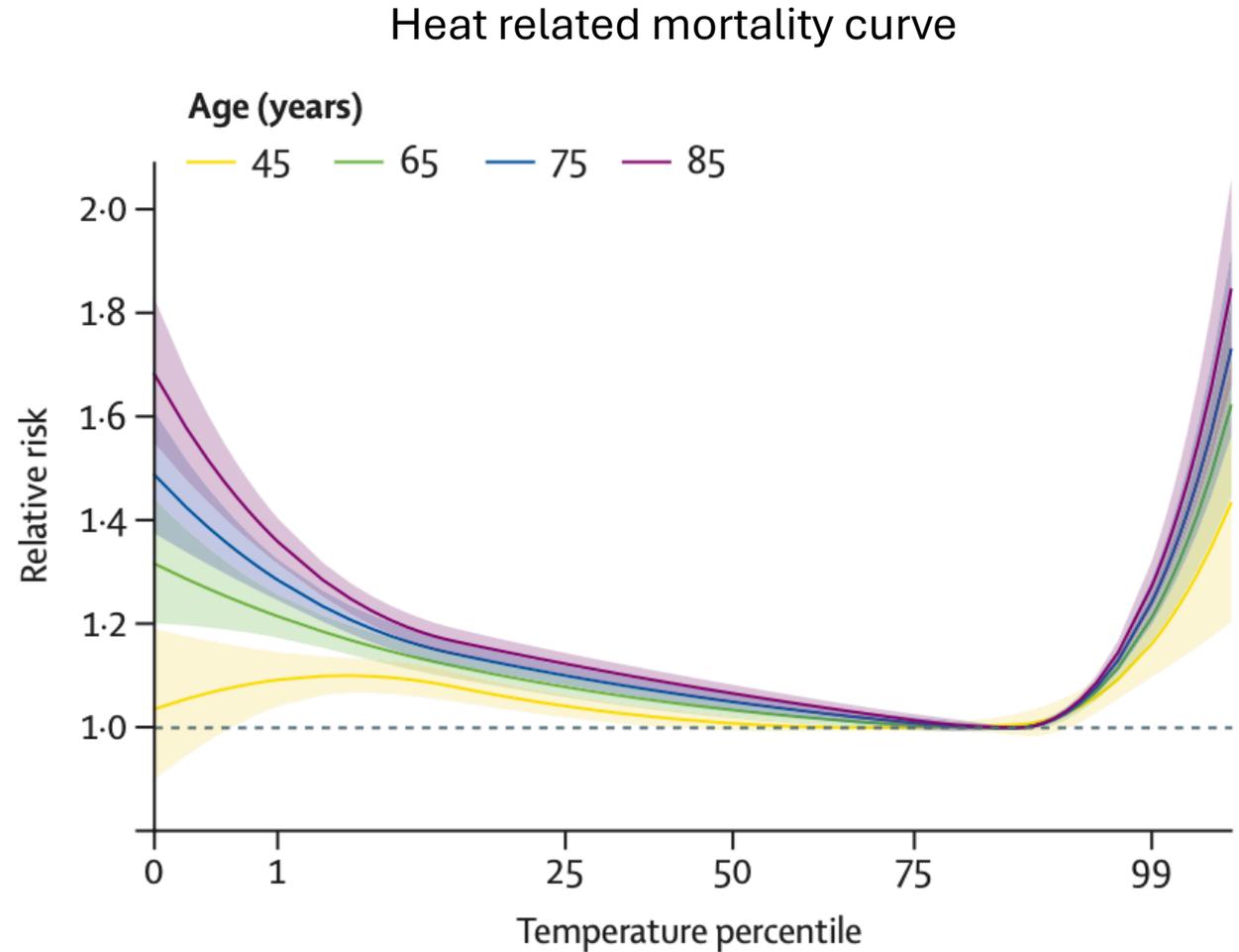
Collectively, provides a robust estimate of the influence of climate change

BUT, how impact is defined matters A LOT!

(374 all-caused deaths vs 31 extreme heat-related deaths)

# A (potentially major) caveat:

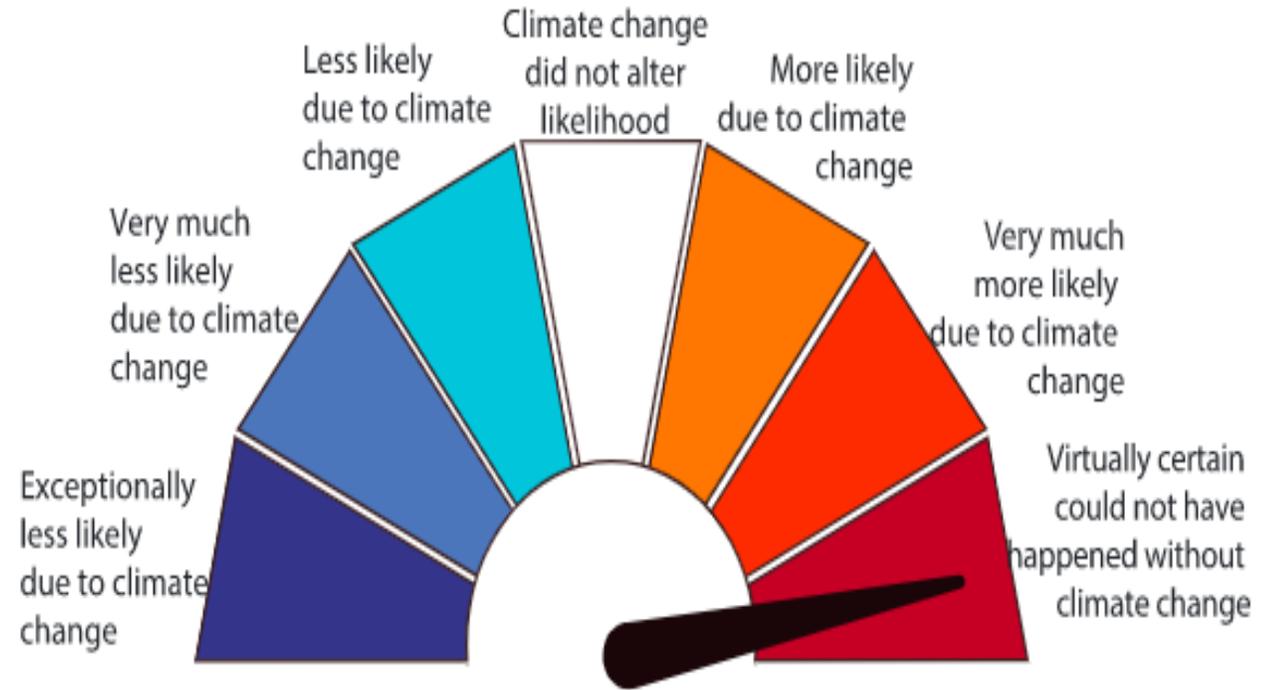
- Attributable mortality figure *a lot* lower than deaths specific to the event
- BUT, we need an impact function to “model” *expected* deaths from heatwaves simulated by climate models
- Also – *extreme heat* related deaths was the focus, NOT all-cause mortality or even *heat related* mortality
- Need to be extremely clear. No easy task, even amongst experts



Masselot et al 2023 the Lancet Planetary Health

# There is strength in:

- Multiple approaches
- Multiple methods
- Multiple tools
- Using quantitative data to inform qualitative statements



Lewis et al 2019 Earth's Future

# Golden rules for impact attribution

1. The attribution of the causal weather event and impact should always be separated (even if the underpinning tools are related)
2. FAR is for class of events, even for impacts. Never for a specific event
3. An appropriate impact/damage function is crucial, and only possible through interdisciplinary collaboration
4. Need to be *VERY* clear about the impact you are assessing – incredibly nuanced



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