University of BRISTOL

Increasing mitigation ambition to meet the Paris Agreement's goals avoids substantial heat-related mortality in U.S. cities

Eunice Lo

Dann Mitchell, Peter Frumhoff, Antonio Gasparrini, Kris Ebi

bristol.ac.uk

@EuniceLoClimate
eunice.lo@bristol.ac.uk

Climate change

"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased."

— Intergovernmental Panel on Climate Change, 2013

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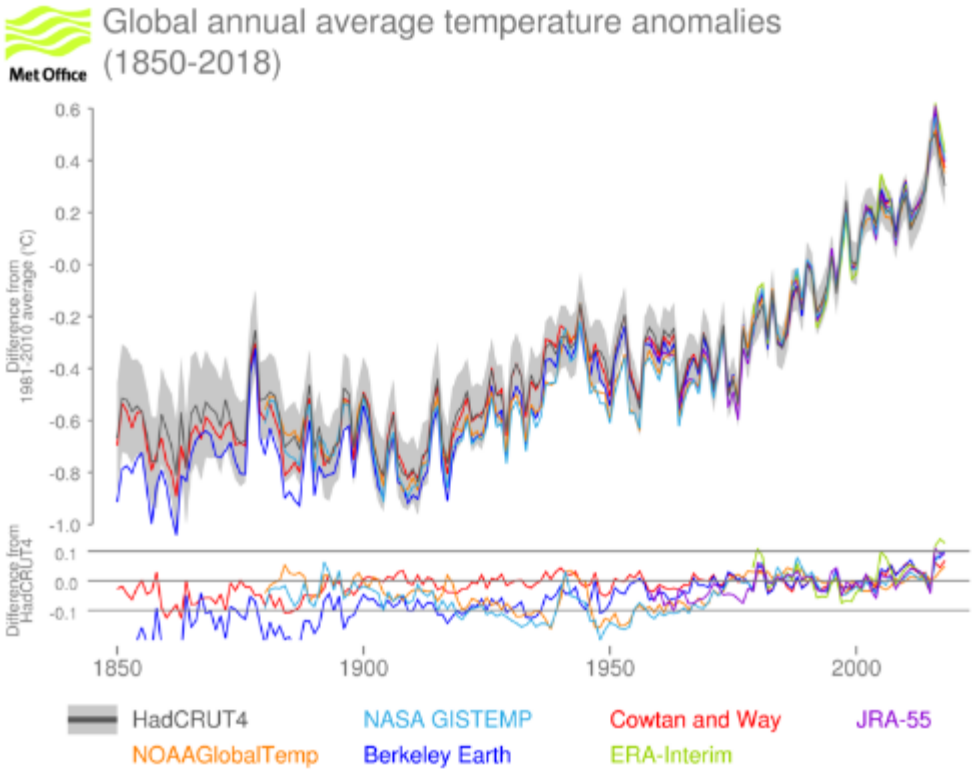
Climate change



2015, 2016, 2017 and 2018 are the four warmest years on record in all surface temperature data sets.

(UK Met Office, 2019)

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We have made heatwaves more likely

- Tenfold increase in the re-occurrence frequency of summer as hot as the 2003 European heatwave between 1990s and 2003–2012:
  - Return time in the 1990s: 52 years *(Christidis, et al., 2014)*
  - Return time in 2003–2012: 5 years
  - Return time without human influence: >1000 years

- Human-induced climate change increased the risk of heat-related mortality in Central Paris by 70% and by 20% in London *(Mitchell et al., 2016)*

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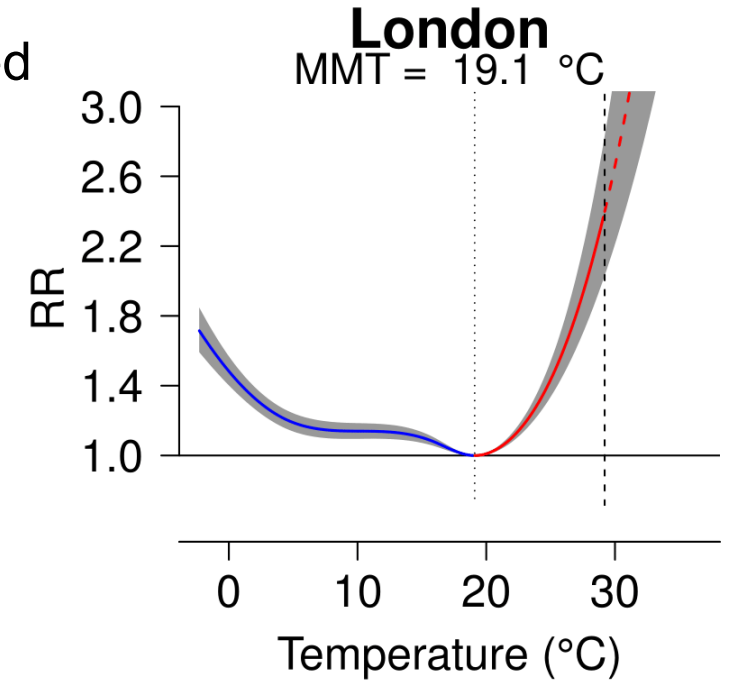
Heat and health

- High ambient temperatures are associated with increased mortality risks
- Heat-related health risks:
  - Heat exhaustion
  - Heat stroke
  - Coronary heart disease
- The relationship between low temperatures and mortality is less direct



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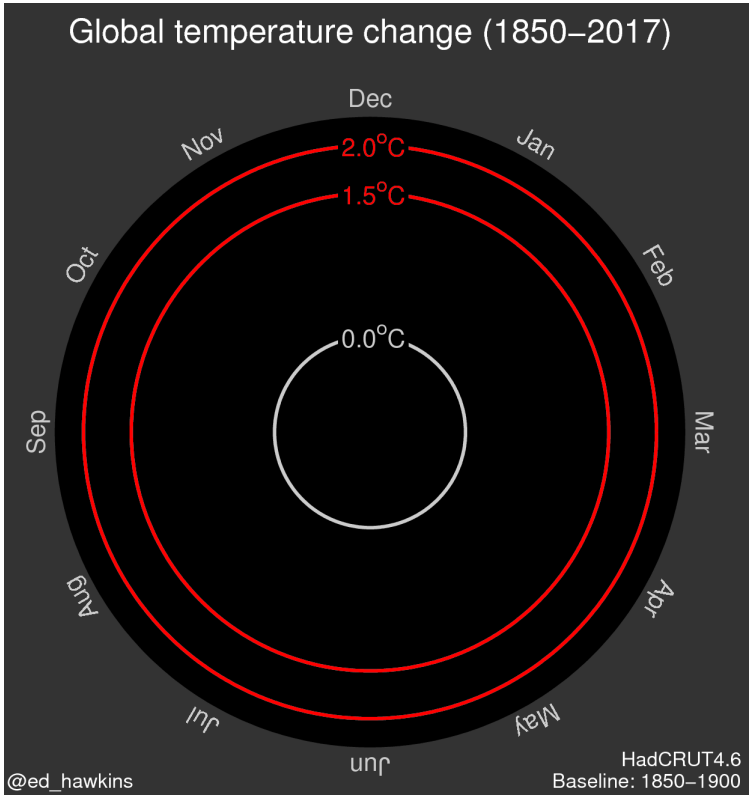
The Paris Agreement

"Keep a global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C."



(Ed Hawkins/Climate Lab Book)

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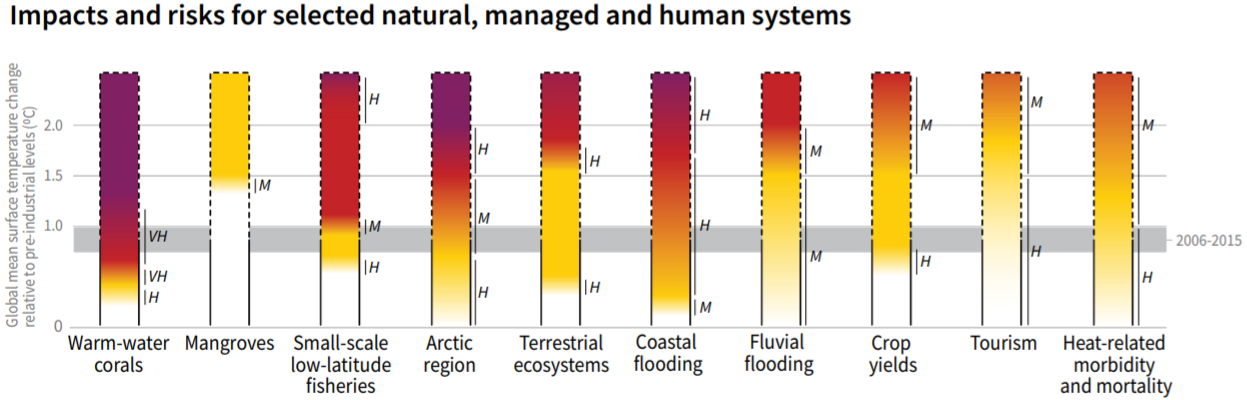
The Paris Agreement & current trajectory

- "Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate" *(IPCC Special Report, 2018)*
- Nations' current climate pledges imply a median warming of ~3ºC by 2100 *(Rogelj et al., 2016)*



(IPCC Special Report on 1.5ºC Warming, 2018)

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eunice.lo@bristol.ac.uk

15 cities covering a wide range of regions

(Carbon Brief)

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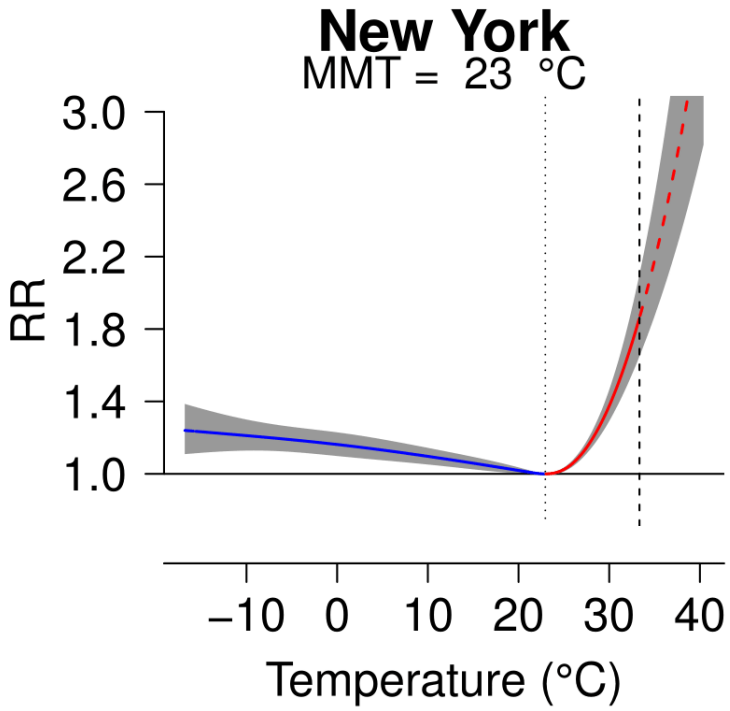
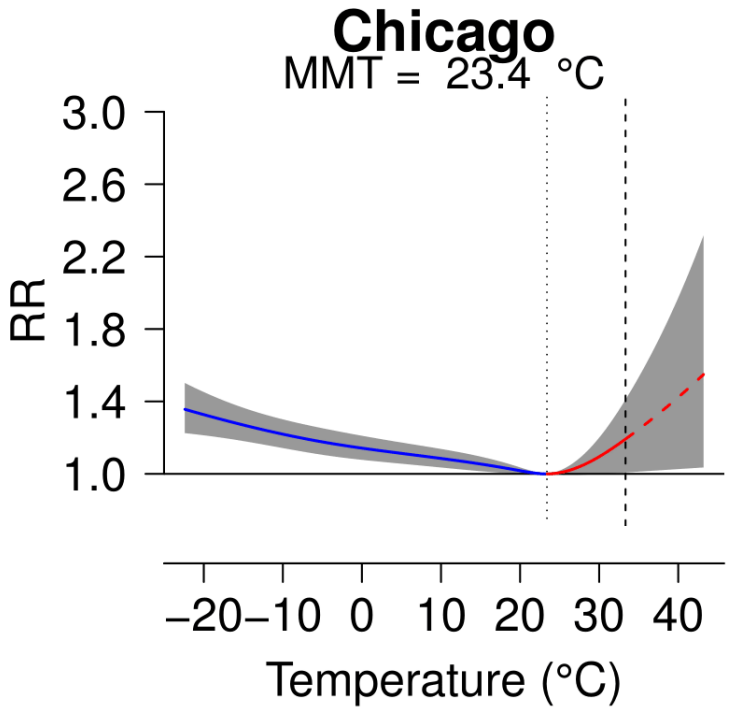
Temperature and mortality





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(Lo et al., Science Advances 2019)

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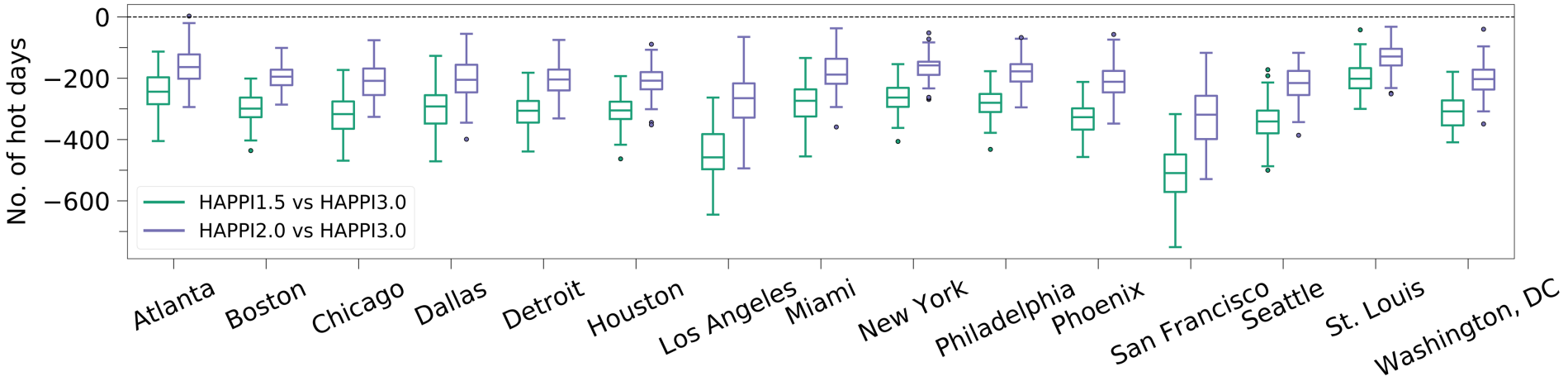
Paris targets = fewer hot days

- 1.5°C vs 3°C; 2°C vs 3°C (global warming)



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The 1995 Chicago heatwave

- 514 deaths *(Whitman et al., 1997)*

"On the first day of the heat wave, July 13, the temperature hit 106 ℉ (~41℃)… Hundreds of young people were hospitalized with heat-related illnesses. But the elderly, and especially the elderly who lived alone, were most vulnerable to the heat wave." *(Eric Klinenberg "Heat Wave")*

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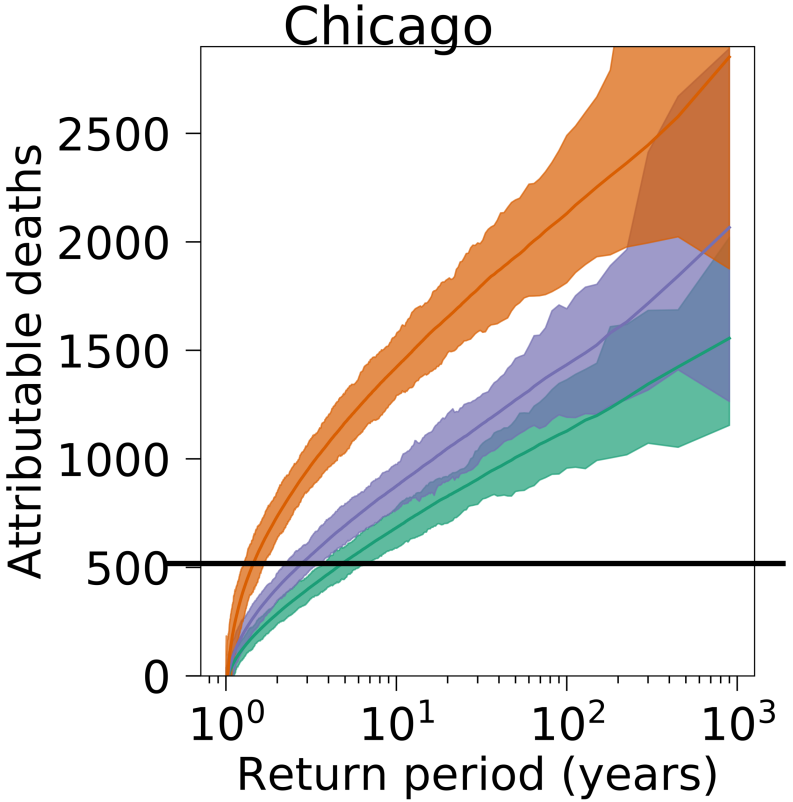
The 1995 Chicago heatwave

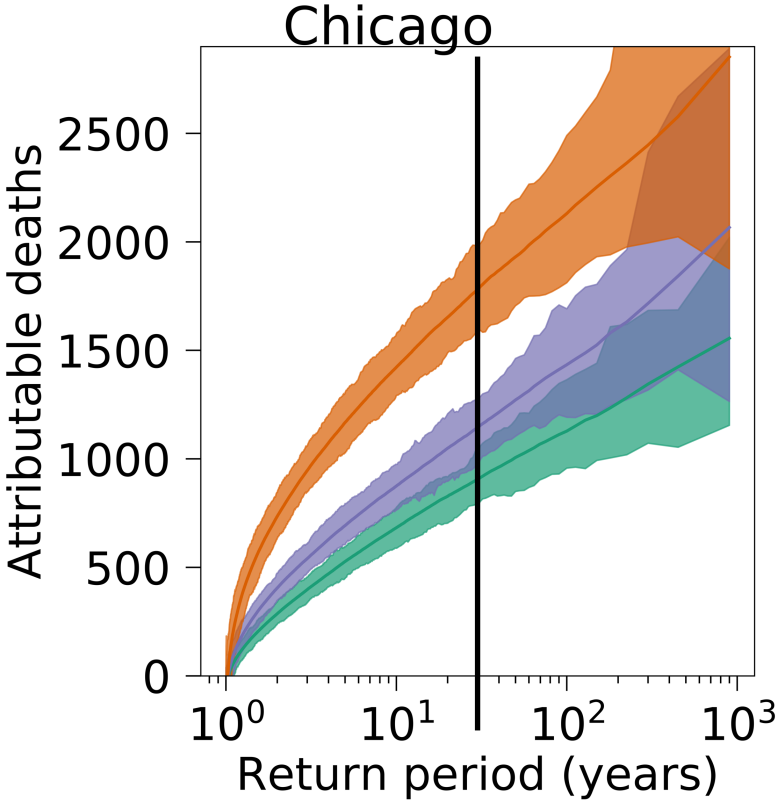
Reoccurrence of this mortality event:

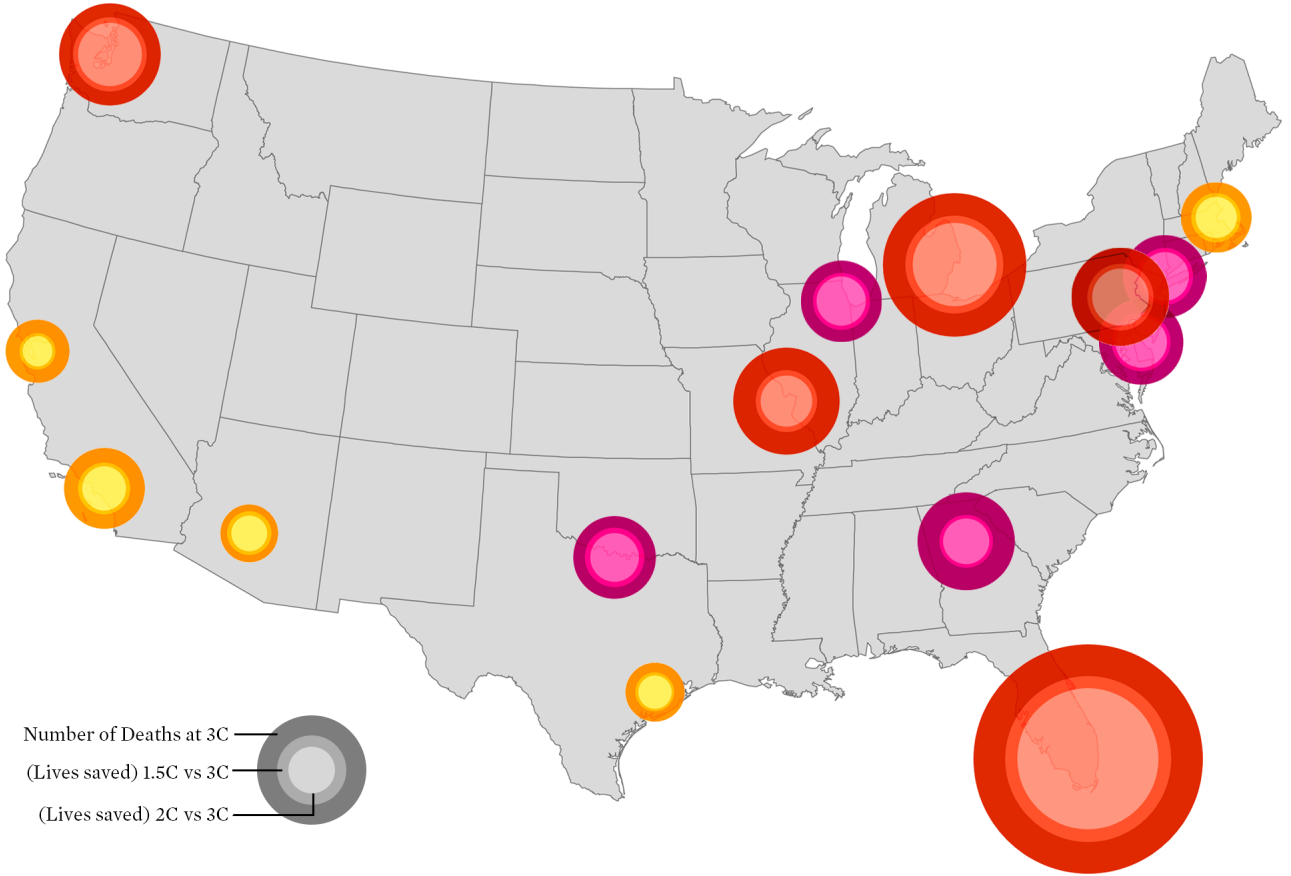
- Every ~1.5 years in 3°C warming
- Every ~ 3 years in 2°C warming
- Every ~ 5 years in 1.5°C warming
- Every 28 years in current climate



1-in-30-year mortality

- Annual number of people dying from heat where that year is the warmest in 30 years
- 1781 deaths in 3°C warming
- 1145 deaths in 2°C warming
- 906 deaths in 1.5°C warming
- 650 deaths in current climate
- Chicago population: 2.7M





Per 100,000 People	Miami	Detroit	St. Louis	Seattle	Philadelphia
Number of Deaths at 3C	520	204	113	103	95
(Lives saved) 1.5C vs 3C	272	95	38	54	44
(Lives saved) 2C vs 3C	197	69	26	40	32

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Other factors that affect future mortality

- A growing population
- An aging population
- Urbanization
- Municipal adaptation
- Acclimatization

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Summary

- We used present-day temperature-mortality relationships and climate simulations to estimate how much heat-related mortality could be avoided in 15 U.S. cities if their current population were exposed to 1.5 or 2°C warming instead of 3°C
- Limiting temperature rise to 2°C would reduce heat-related mortality in most studied cities
- Limiting temperature rise to 1.5°C would be substantially more beneficial than 2°C in relation to heat-health
- Strengthened climate action is needed!

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Thank you

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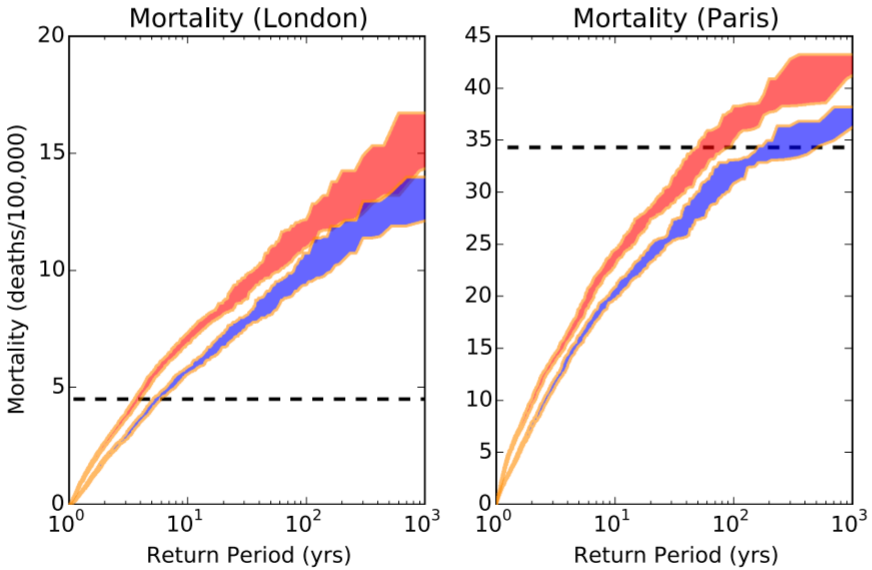
Human influence increased mortality risk

In summer 2003, human-induced climate change increased the risk of heat-related mortality in Central Paris by 70% and by 20% in London



(Mitchell et al., 2016)

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eunice.lo@bristol.ac.uk

The Paris Agreement and extreme heat

- 1.5°C global warming is better than 2°C regarding heat exposure and heat-related mortality:
  - 73 million fewer people in Europe would experience unprecedented heat extremes warmer than those during 1950-2017 (King et al., 2018);
  - The likelihood of a mortality event like the 2003 European heatwave would be 2.4 times lower in London and 1.6 times lower in Paris (Mitchell et al., 2018);
  - Heat-related mortality impacts would decrease by 0.11−2.13% in most countries (Vicedo-Cabrera et al., 2018).

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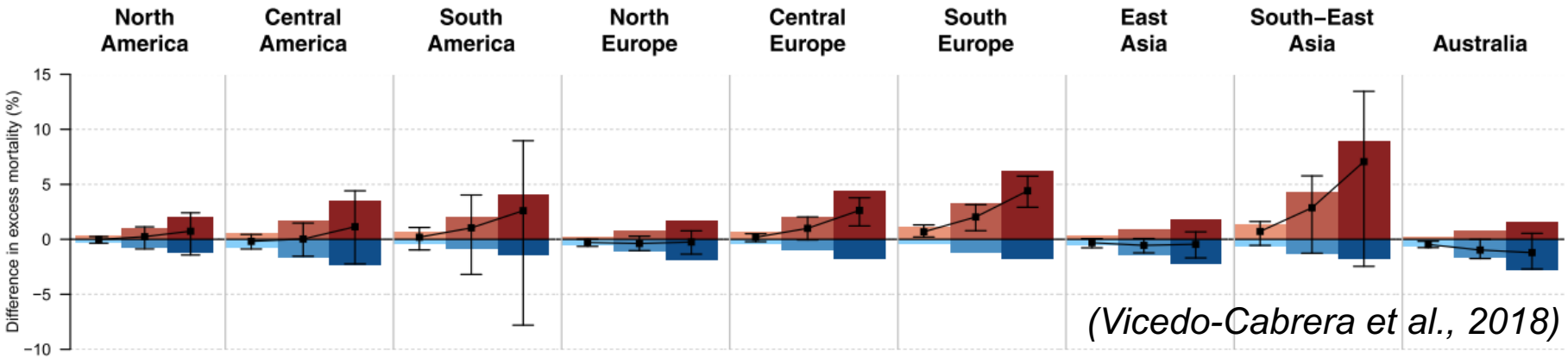
Temperature-mortality in 1.5, 2, 3°C



- Substantial rise in heat-related mortality due to global mean warming in all studied regions
- Assumption: no changes in demographic distribution and vulnerability

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eunice.lo@bristol.ac.uk

Exposure-response relationships

- Present day relationships between daily mean temperature and all-cause mortality.
- 1987-2000 data from the National Morbidity, Mortality, and Air Pollution Study (NMMAPS).
- Distributed lag non-linear models (DLNMs) (Gasparrini et al., 2015)
- Assumption: the relationship obtained for each city does not change with global warming or time.

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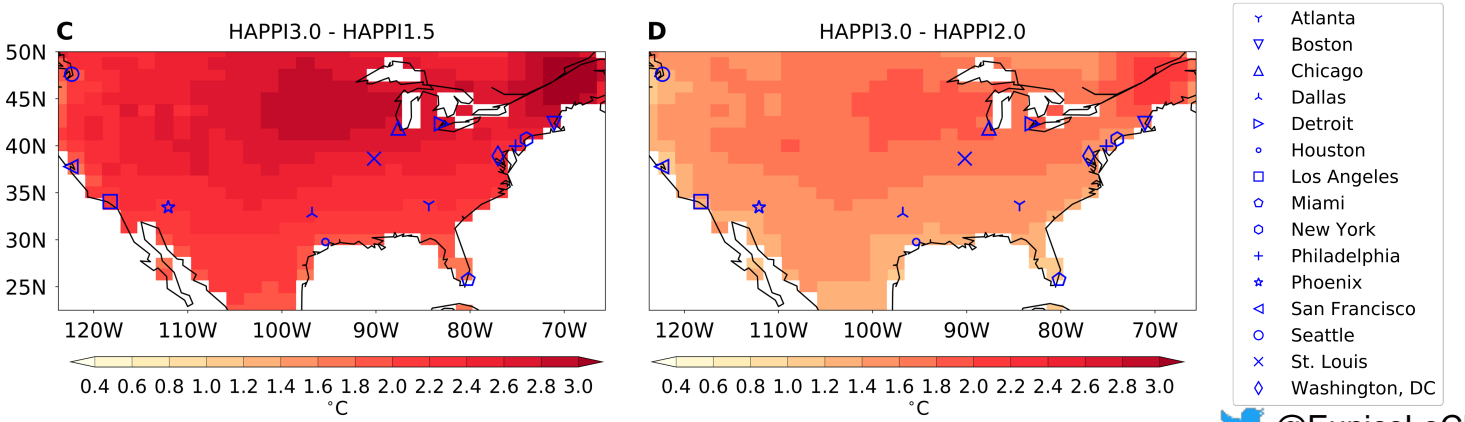
eunice.lo@bristol.ac.uk

Targeted warming scenarios

- Half a degree Additional warming, Prognosis and Projected Impacts (Mitchell et al., 2017, 2018).
- HAPPI1.5, 2.0 & 3.0 (new): stabilization scenarios at 1.5 °C, 2°C and 3°C above pre-industrial levels. Bias corrected.



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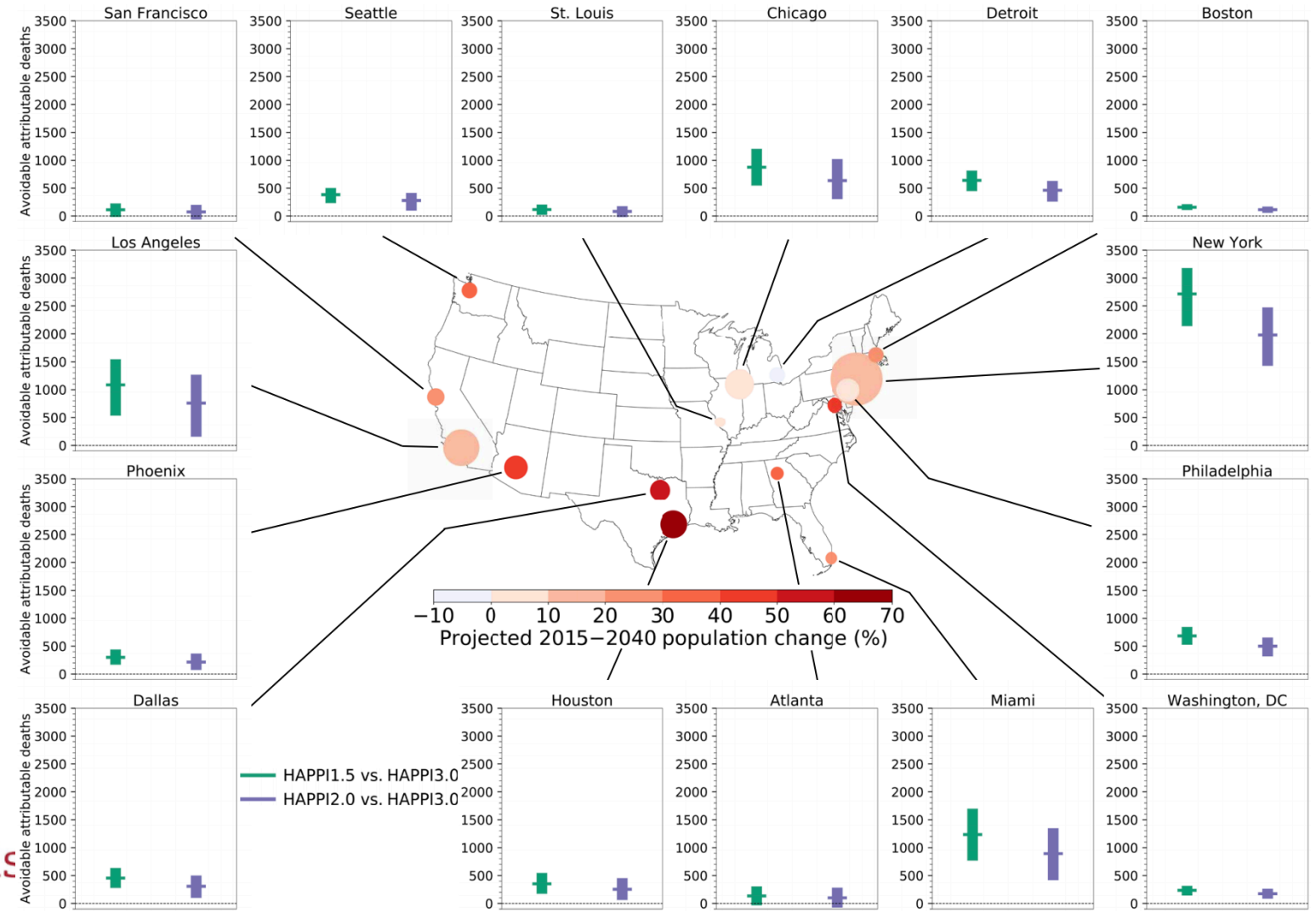
San Francisco
Seattle
St. Louis
Chicago
Detroit
Boston
Los Angeles
New York
Phoenix
Philadelphia
Dallas
Houston
Atlanta
Miami
Washington, DC
Avoidable attributable deaths
0
500
1000
1500
2000
2500
3000
3500
−10
0
10
20
30
40
50
60
70
Projected 2015−2040 population change (%)
HAPPI1.5 vs. HAPPI3.0
HAPPI2.0 vs. HAPPI3.0