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Global, regional and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019

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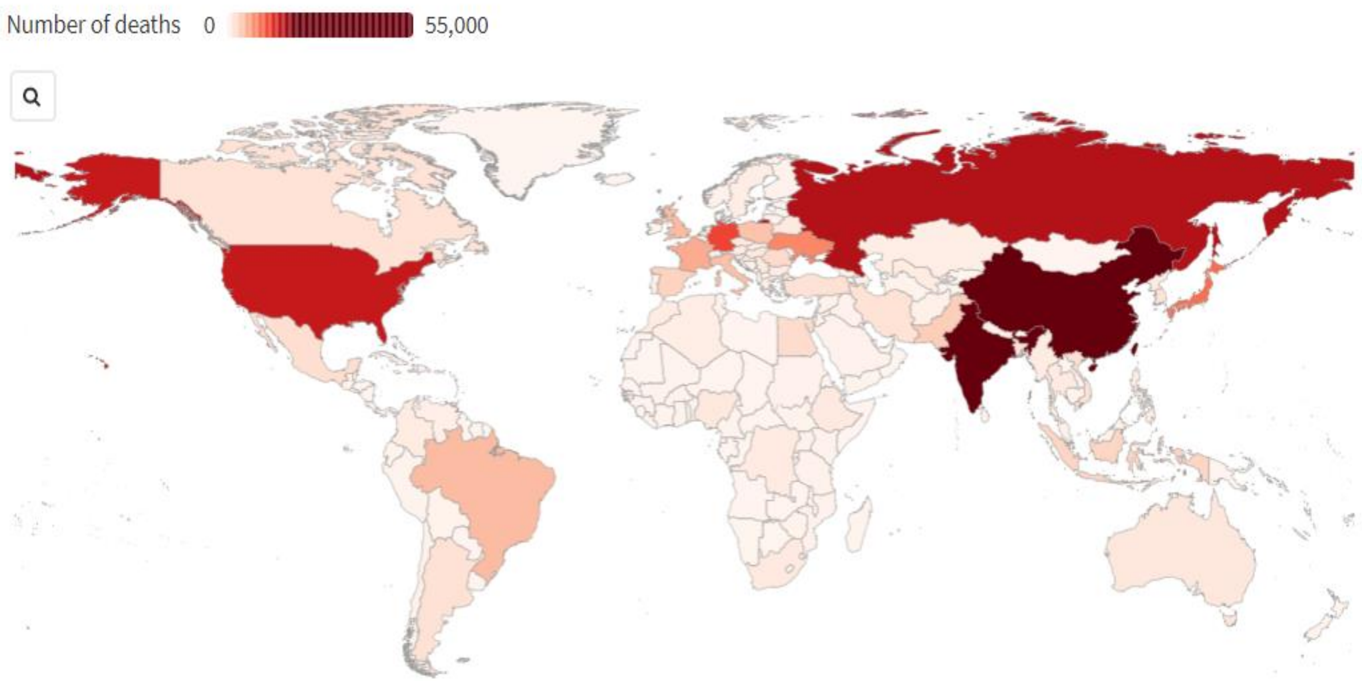
2021.01.13

Background

- Example: Global estimation of heat-related excess deaths



Excess deaths due to heat (2014-2018 average)

The 2020 Report of the Lancet Countdown

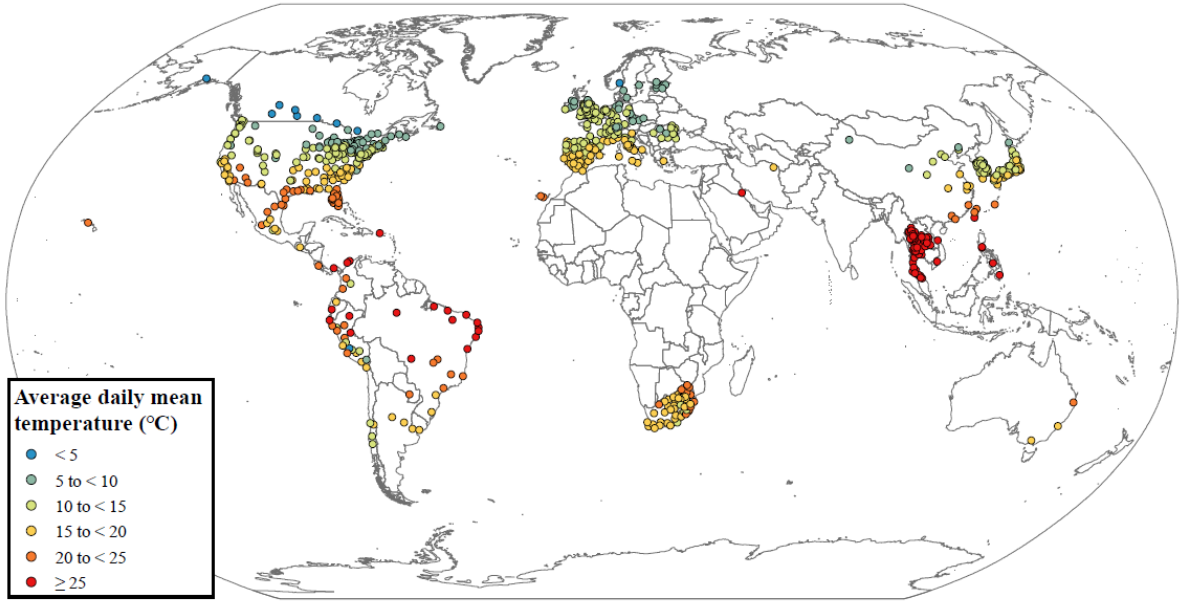
Limitations in GBD estimation:

- Only 12 mortality causes' data from 8 countries (6 in Americas) in use
- Ignorance of spatio-temporal variation in the exposure-response curves
- Only estimation at the global and national levels (low resolution)

Background

- Solution: **Big data analysis**

The Multi-Country Multi-City (MCC) Collaborative Research Network since 2014



Advantages in global estimation:

- Data from 750 locations in 43 countries/regions (46.3% of the world's population)

Research aims

- To estimate the global mortality burden associated with sub-optimal temperature using MCC database

Spatial resolution

Global: 0·5°×0·5°

Temporal resolution

2000-2019

Outcome indicators

Excess deaths number

Excess deaths ratio (%)

Excess deaths per 100,000 residents

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Materials and methods

- 1. Main data sources

Data	Variables	Source
1. Location-specific time-series data (750 locations from 43 countries)	Daily counts of deaths (>130 million); weather conditions	MCC network.
2. Weather data (0·5˚×0·5˚)	Daily minimum, mean and maximum temperatures between 2000–2019	Climate Prediction Center Global Gridded Temperature
3. Socioeconomic data (0·5˚×0·5˚)	GDP, population, GDP per capita between 2000–2019	ISIMIP
4. Mortality rate	Annual mortality rate per country in 2010	World bank
5. Others	Climatic zones……	

Materials and methods

- 2. Statistical analysis: A three-stage meta-analytic approach

➢ Stage 1: modelling location-specific temperature-mortality association (750 locations)

$Y_{it} \sim poisson\ (\mu_{it})$

$Log\ (\mu_{it}) = \alpha + cb(Temp_{it}, lag = 21) + \mathrm{ns}(Time_i, \mathrm{df} = 8/\mathrm{year}) + \beta DOW_{it}$ [1]

➢ Stage 2: Building a meta-regression model between location-specific association and five location-specific meta-predictors, i.e. the continent, climate zone, GDP per capita, and average and range of daily mean temperature.

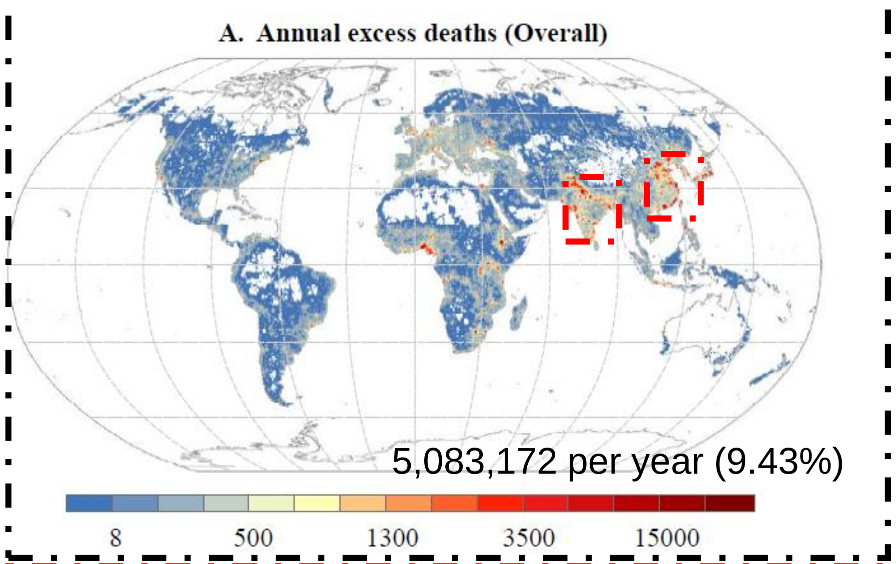
➢ Stage 3: Predicting cell-specific temperature-mortality association (0·5°×0·5°) using the model in stage 2 and cell-specific meta-predictors.

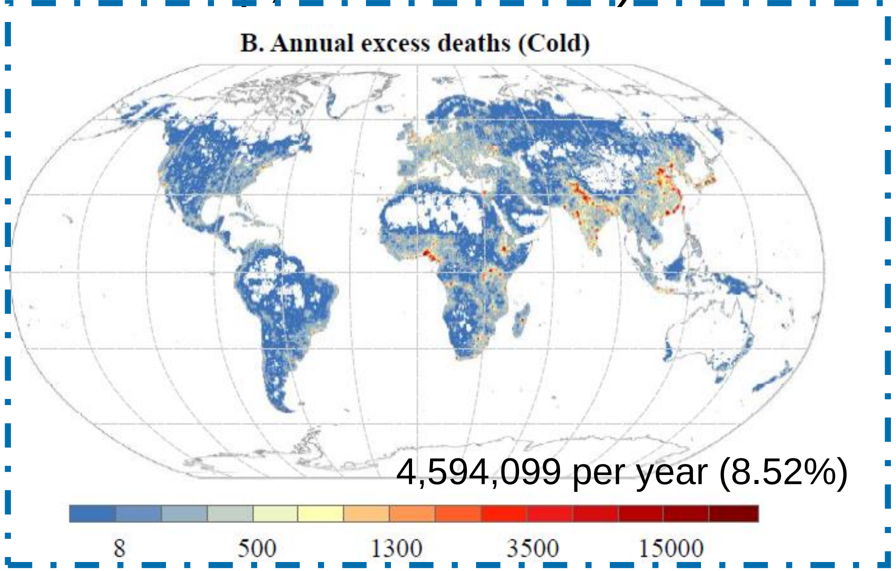
➢ Extended stage 3: Calculating daily excess deaths (number, ratio and rate per 100,000 residents) (0·5°×0·5°) using cell-specific association and daily deaths.

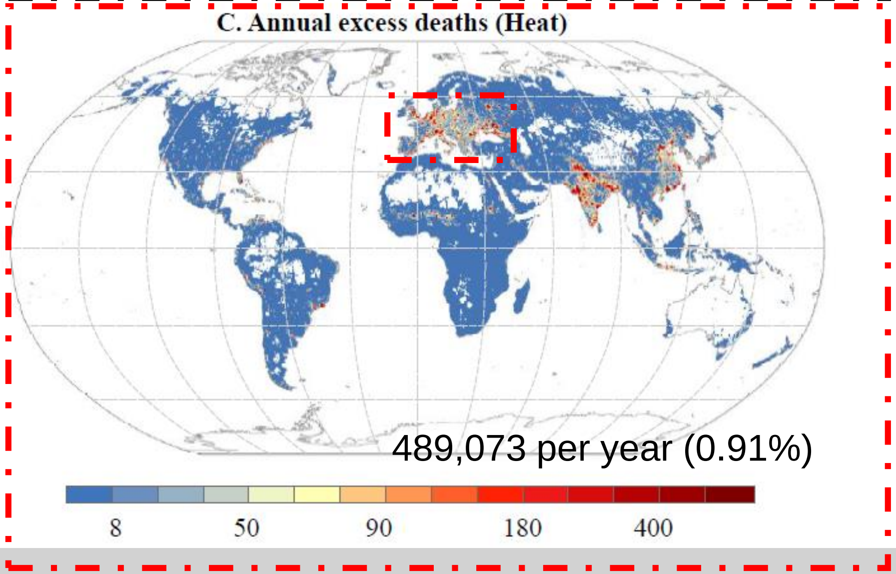
$ED_{it} = (RR_{it} - 1) \times D_i$ [2]

Findings

- 1. Annual excess deaths (due to all non-optimum temp, cold and heat) between 2000-2019



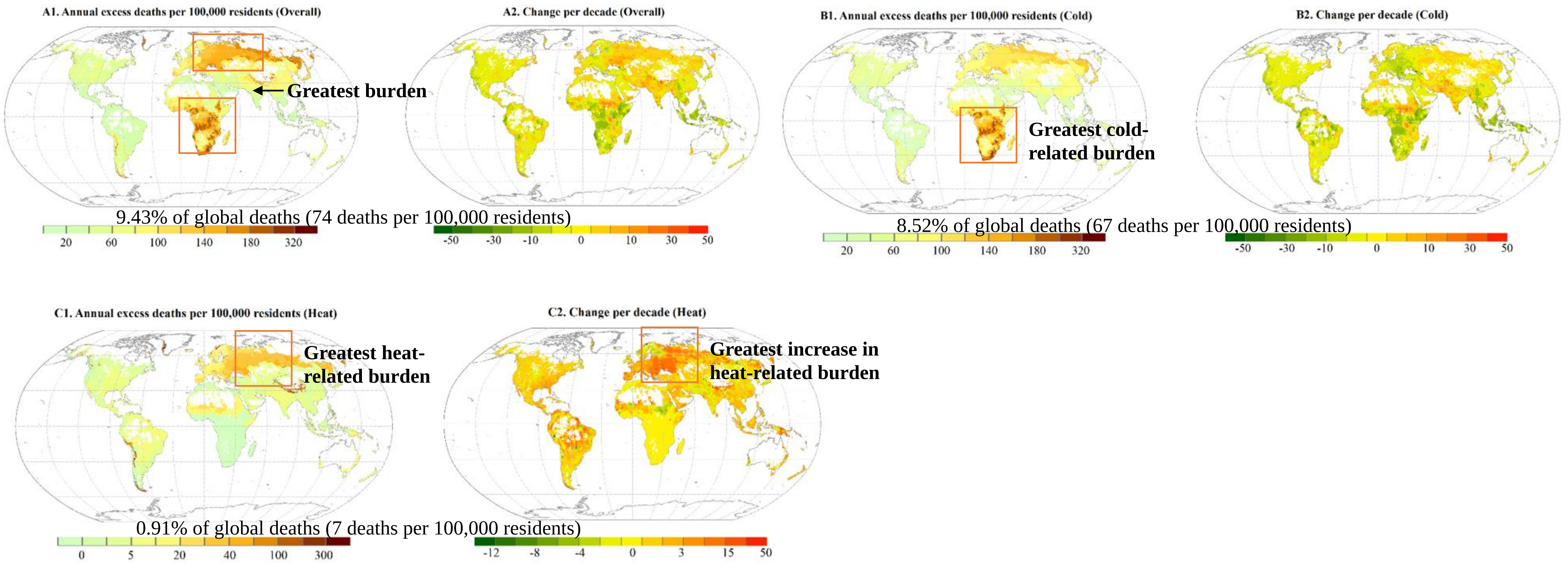




Continent	%
Asia	51.5
Africa	23.9
Europe	16.4
America	7.7
Oceania	0.5

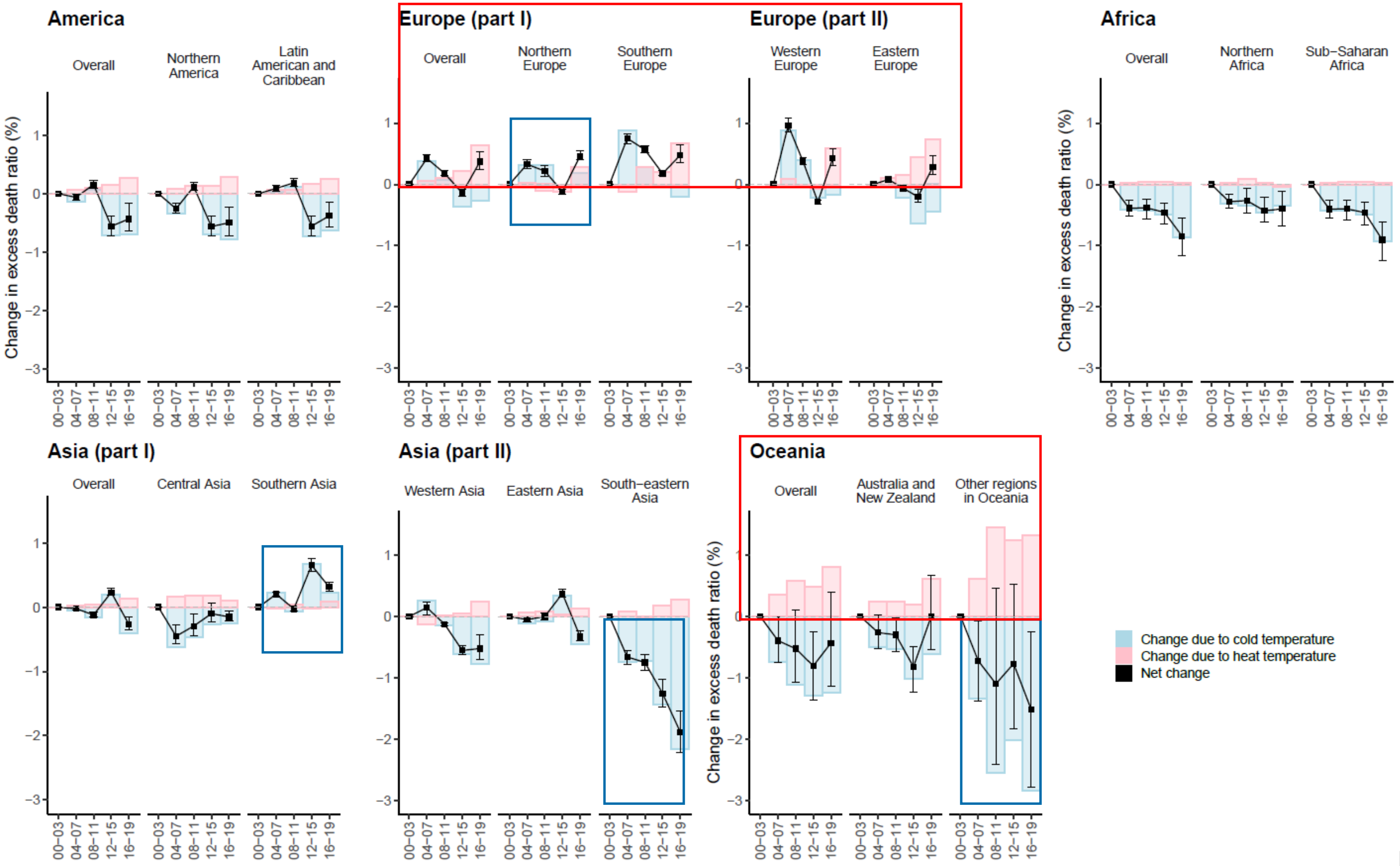
Findings

- 2. Annual excess deaths rate per 100,000 residents and change per decade



Findings

- 3. Regional variation in change in excess death ratio (%) compared with 2000-2003



From 2000–2003 to 2016–2019

- Cold-related ratio: -0·51%
- Heat-related ratio: 0.21%
- Net change: -0.3%

Conclusion

- Complicated geographic patterns in temperature-related excess mortality

1. Over half of excess deaths occurred in Asia.

2. East Europe and Sub-Saharan Africa had the highest excess death rates for heat and cold exposures, respectively.

3. The global net temperature-related burden decreased slightly over the past 20 years (although this pattern may shift in the near future.)

4. The largest decline occurring in South-east Asia.

Thank You

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