Attributing climate impacts to specific emitters

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With thanks to co-authors Sol Hsiang, Noah Diffenbaugh, Mustafa Zahid

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Rapid scientific advances in impact attribution

Key pieces include improved understanding of

1. how outcomes *y* respond to local changes in climate variable *c*
2. how anthropogenic emissions alter global climate, and in turn *c*

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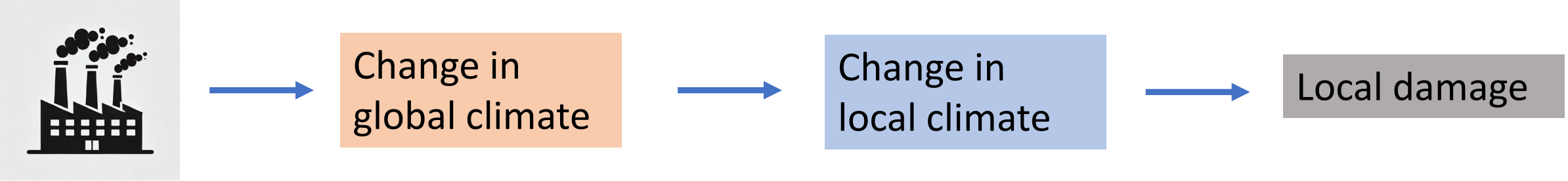
Some implications and key points:

1. Doing this credibly often does not involve saying anything about extremes specifically
2. Because GHGs are well mixed, can now fairly credibly link (some) specific damages to specific emissions/ emitters

Playbook for specific emissions → specific damages:



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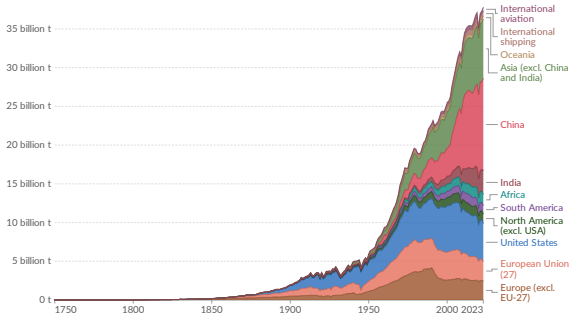
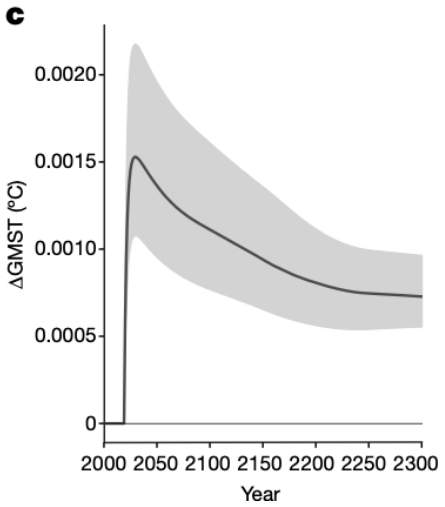
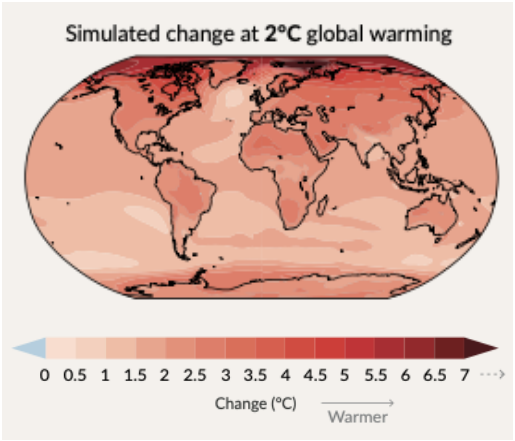


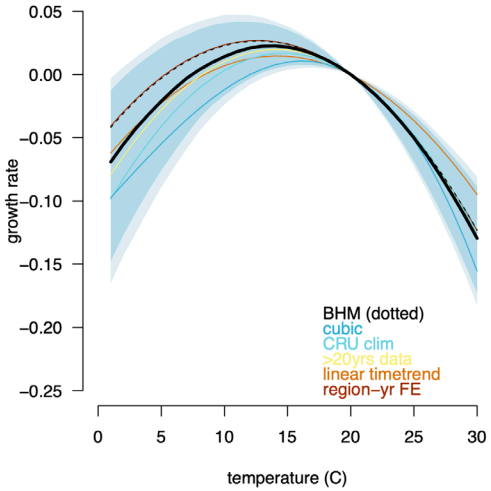
Change in global climate



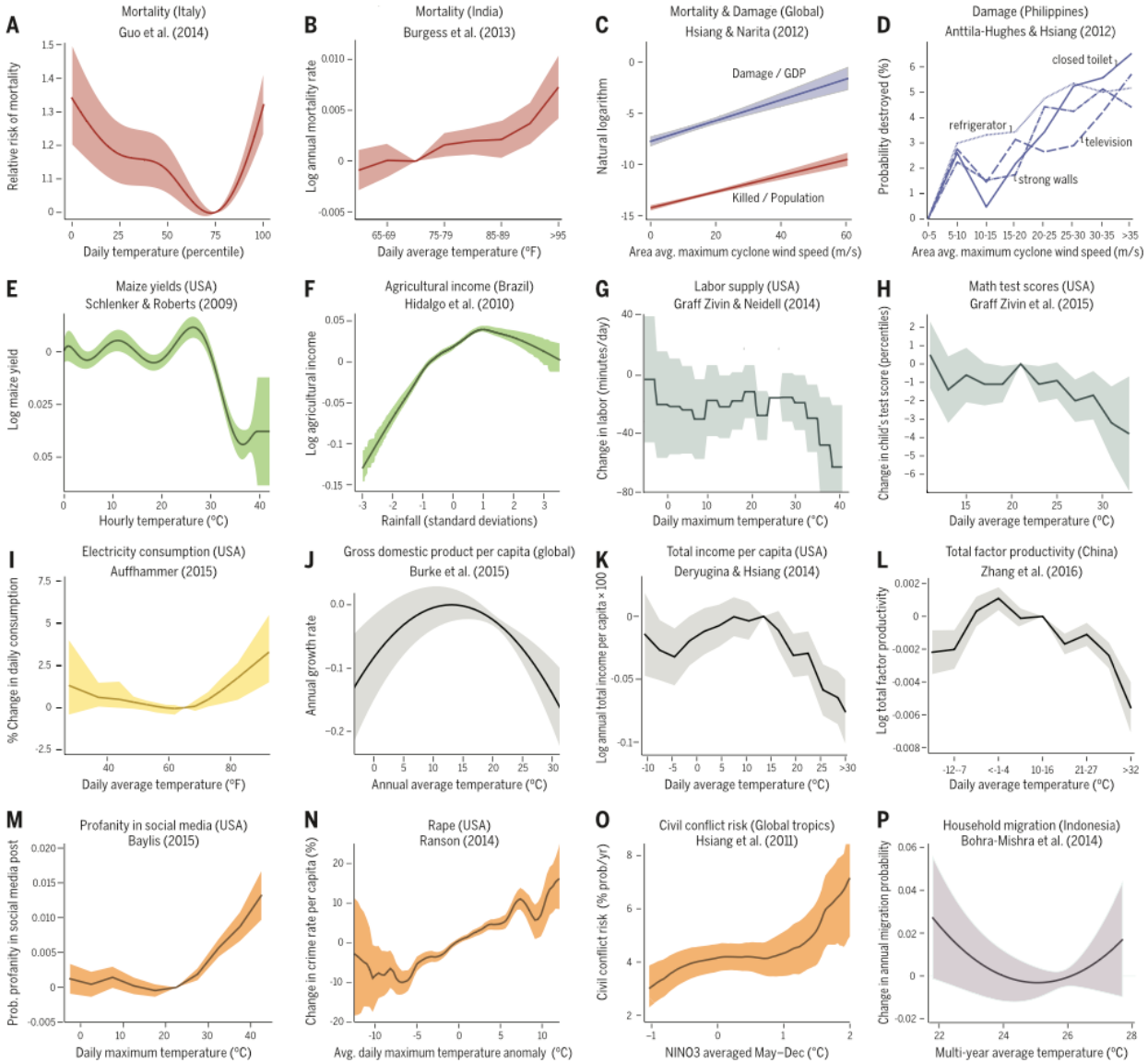
Change in local climate



Local damage



“Damage functions” well estimated for many sectors, outcomes



Carleton & Hsiang 2016

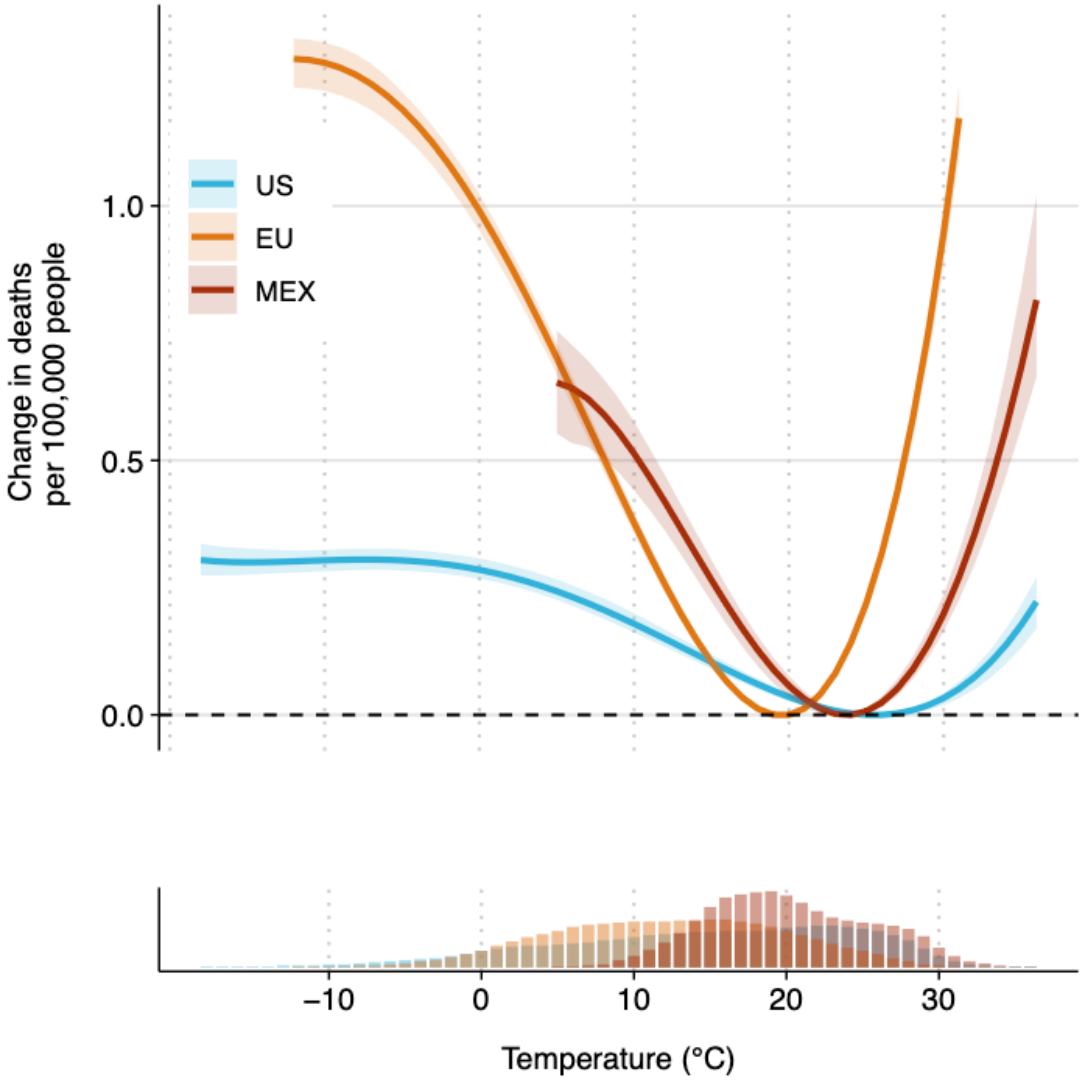
Estimation uses causal inference techniques that exploit longitudinal data

Areas where we know a lot:

Ag = f(temperature, drought)
Health = f(temperature, TCs)
Violence = f(temperature)
Energy use = f(temperature)
Economic output = f(temp, rainfall, TCs)

Example: temperature and mortality

Well-established U-shaped relationship



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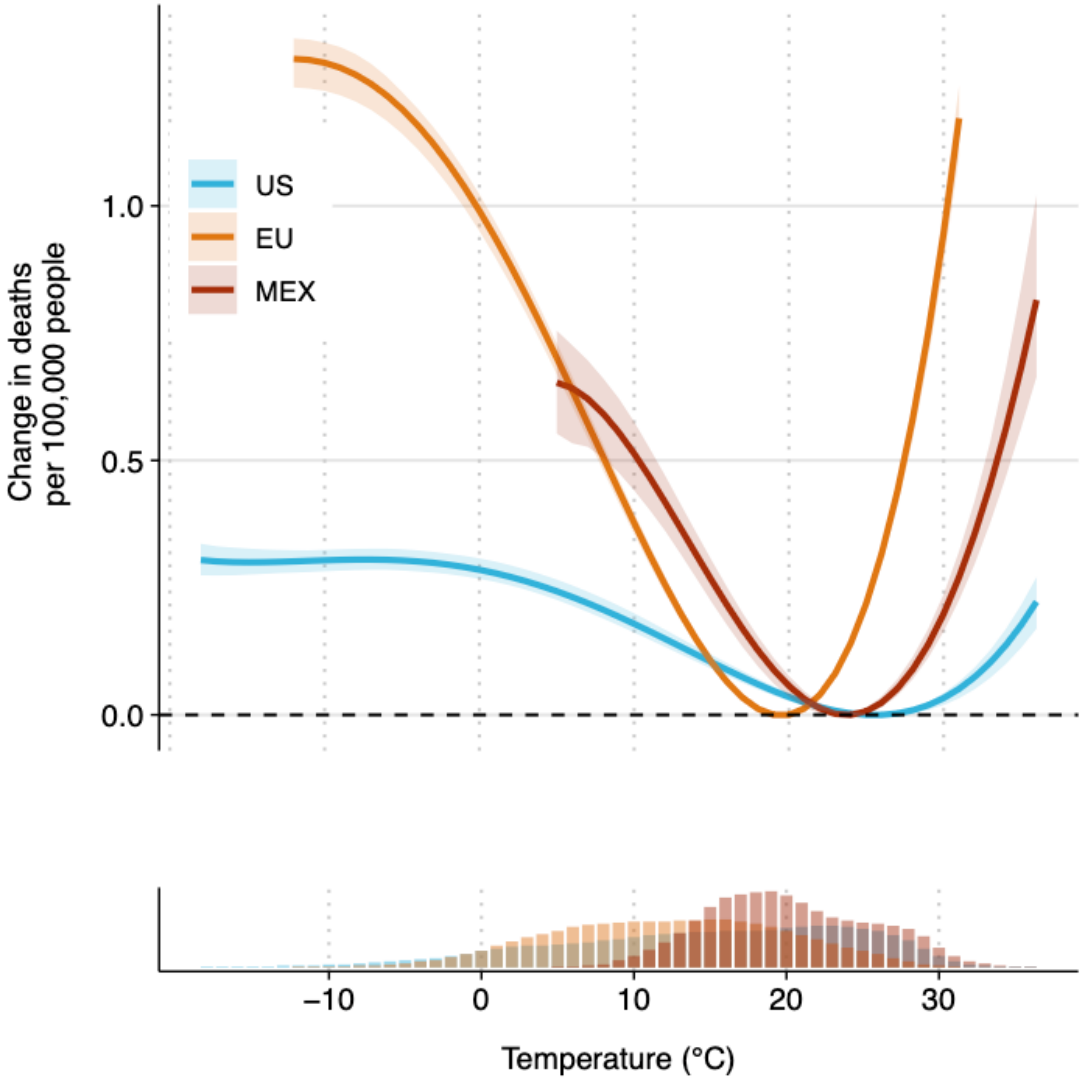
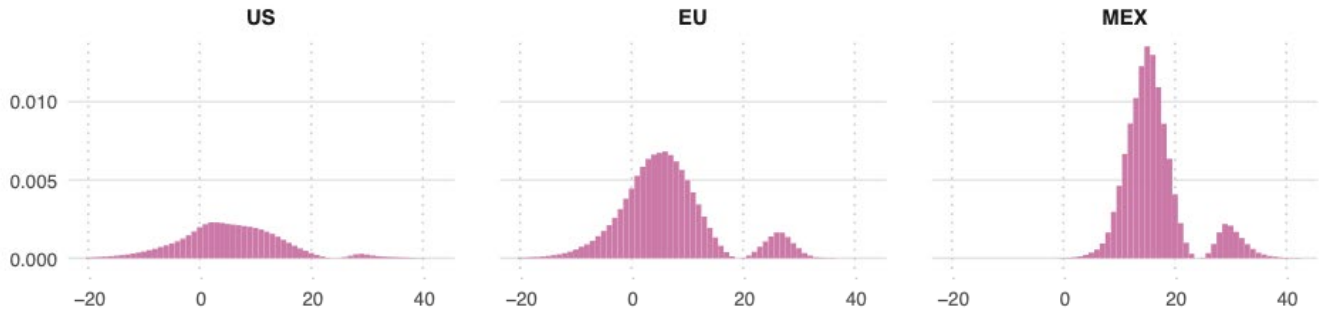


The vast majority of temperature-attributed deaths happen at moderate cold or heat



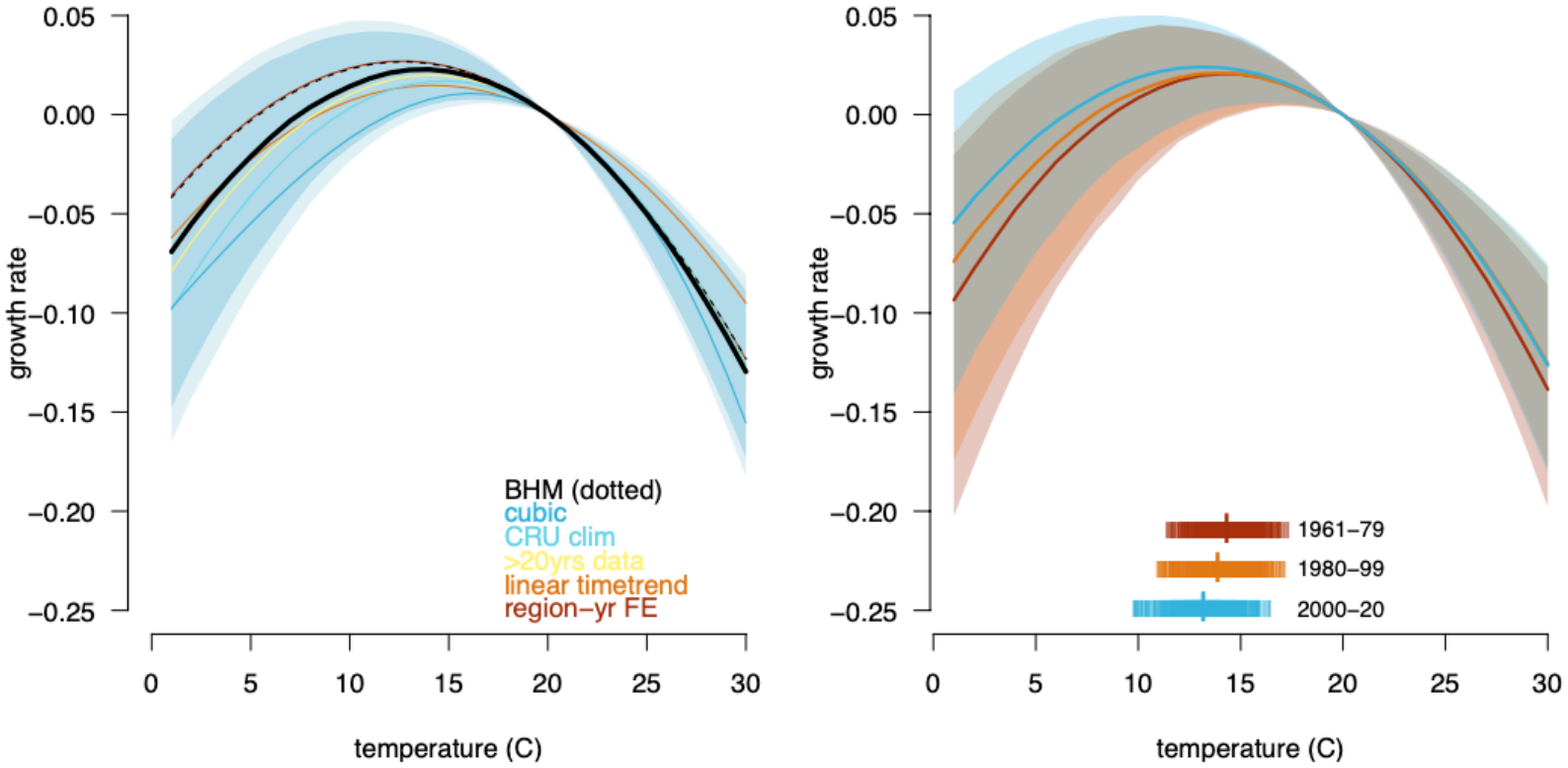
Extreme days are more deadly but WAY less common.

Overall impacts are then driven mainly by changes in moderate days.

Burke, Wilson et al *in prep*

Example: temperature and output

Well-established inverted-U-shaped relationship



Extremes (# hot days, temperature variance, extreme rainfall) add a bit of extra explanatory power, but signal dominated by annual average temperature

This is very well mapped to emissions!

Burke et al 2024, 2018, 2015

Example: Effect of US emissions since 1990 on the Brazilian economy through 2020

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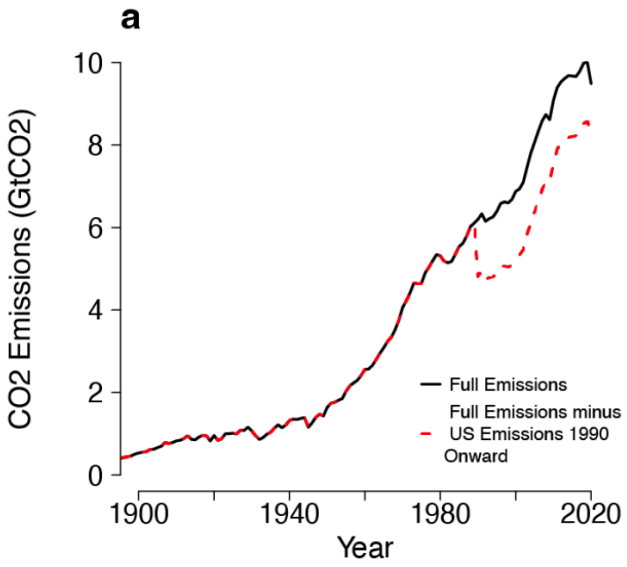

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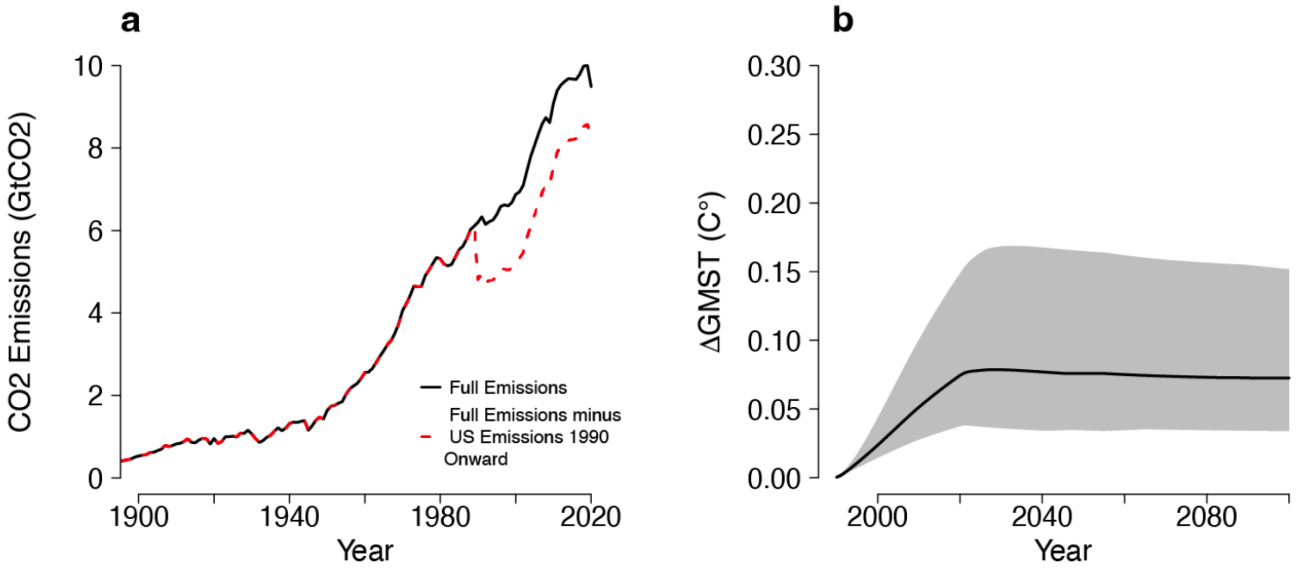

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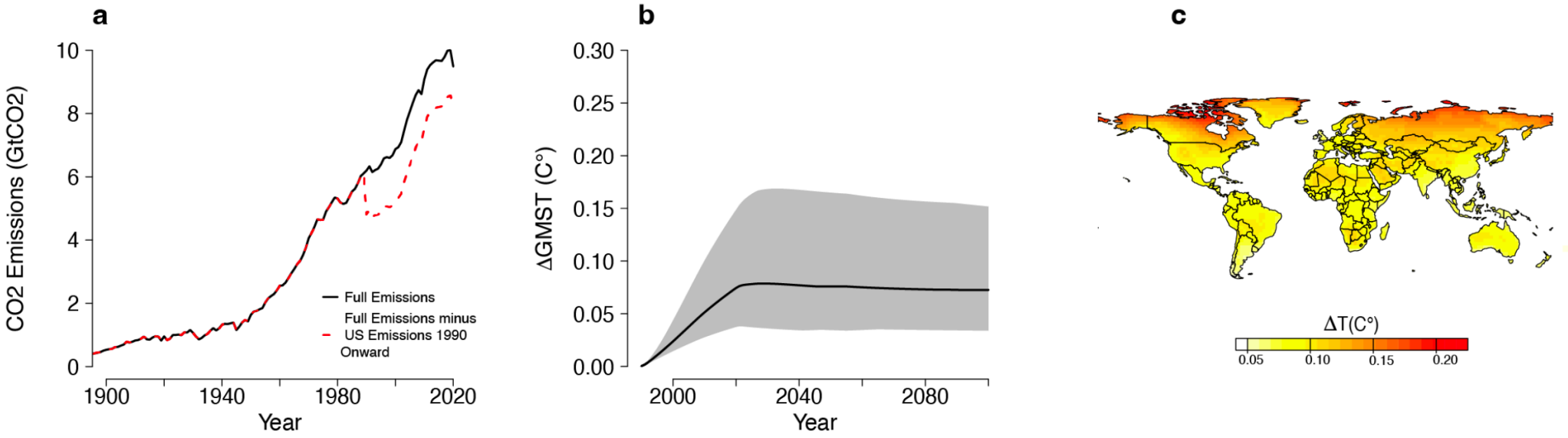

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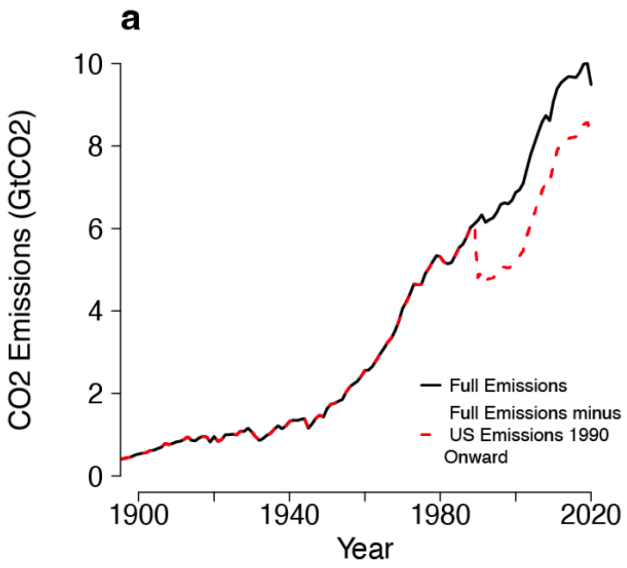

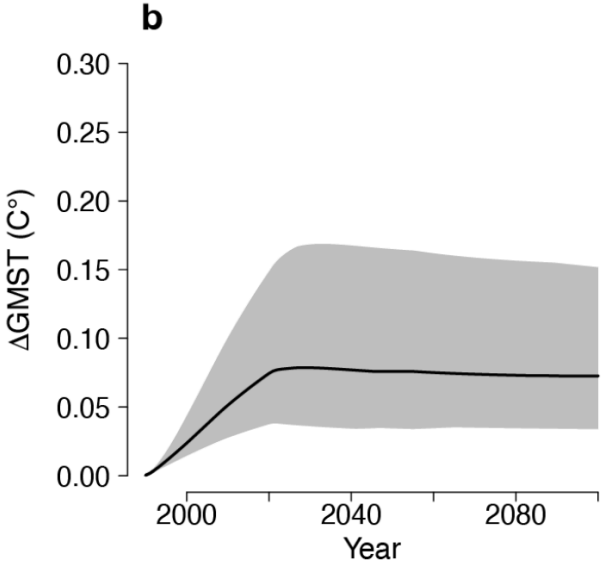

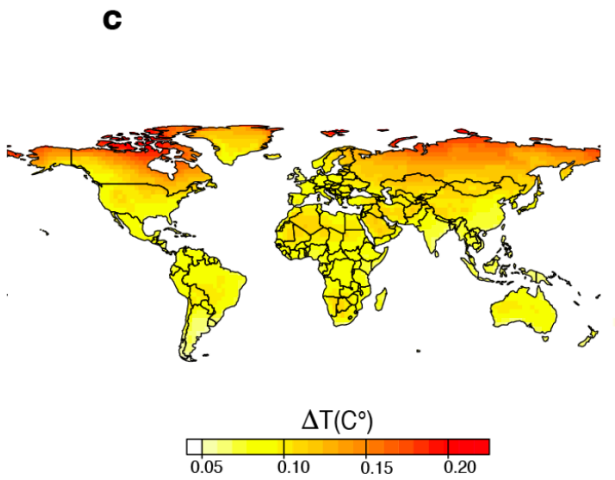

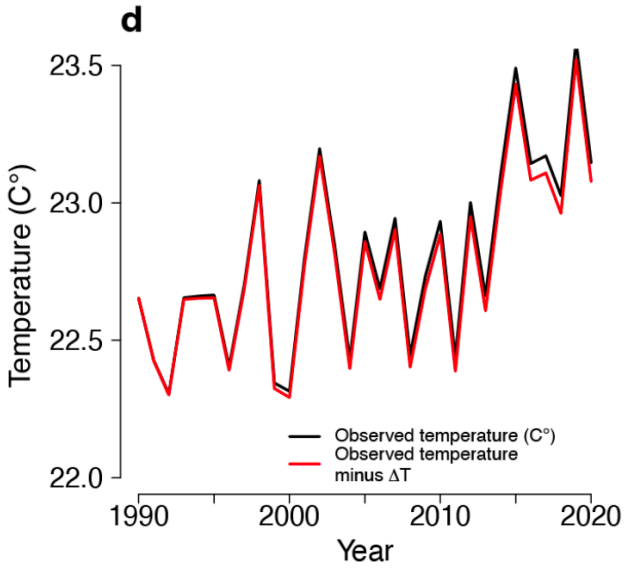

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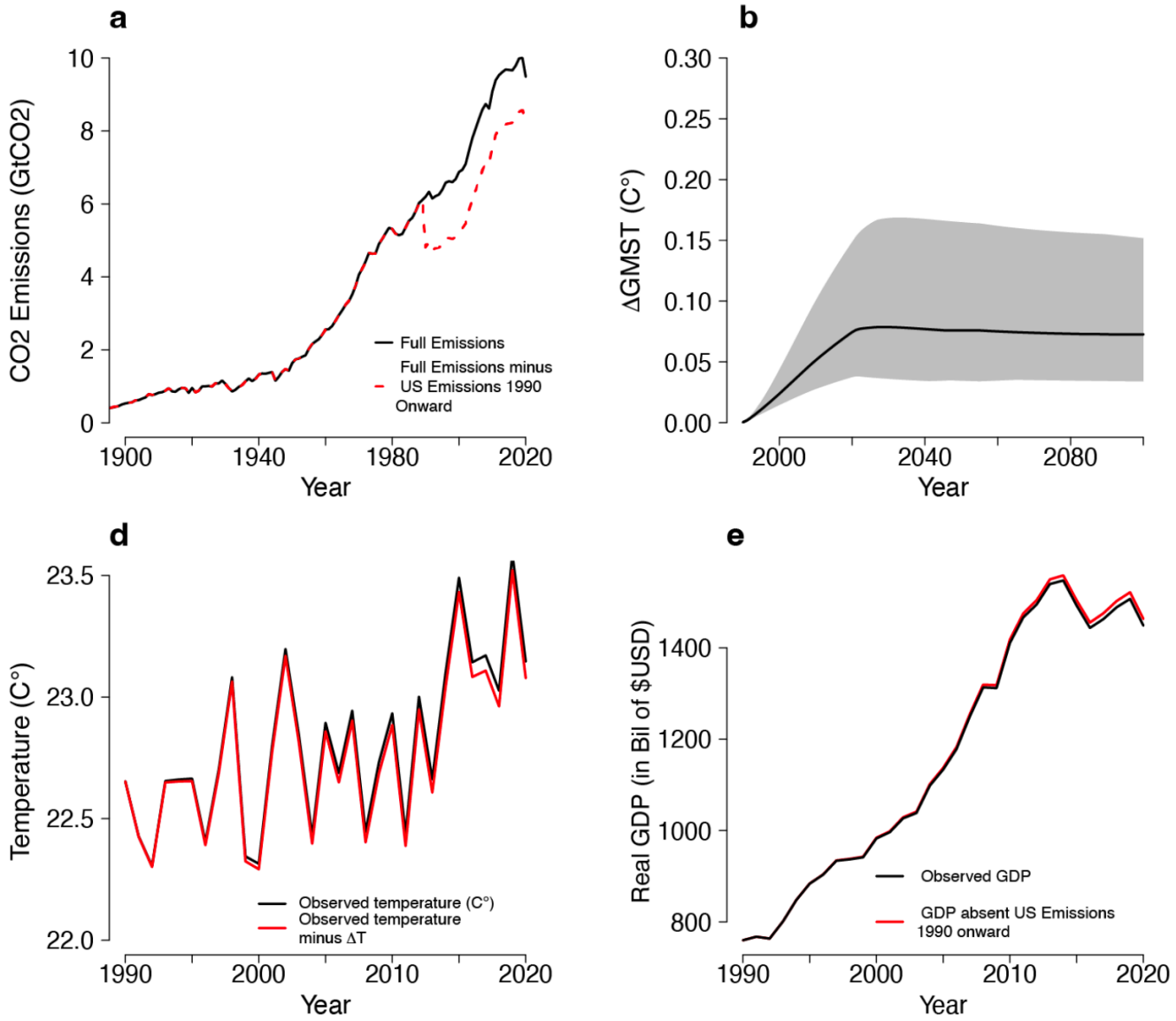

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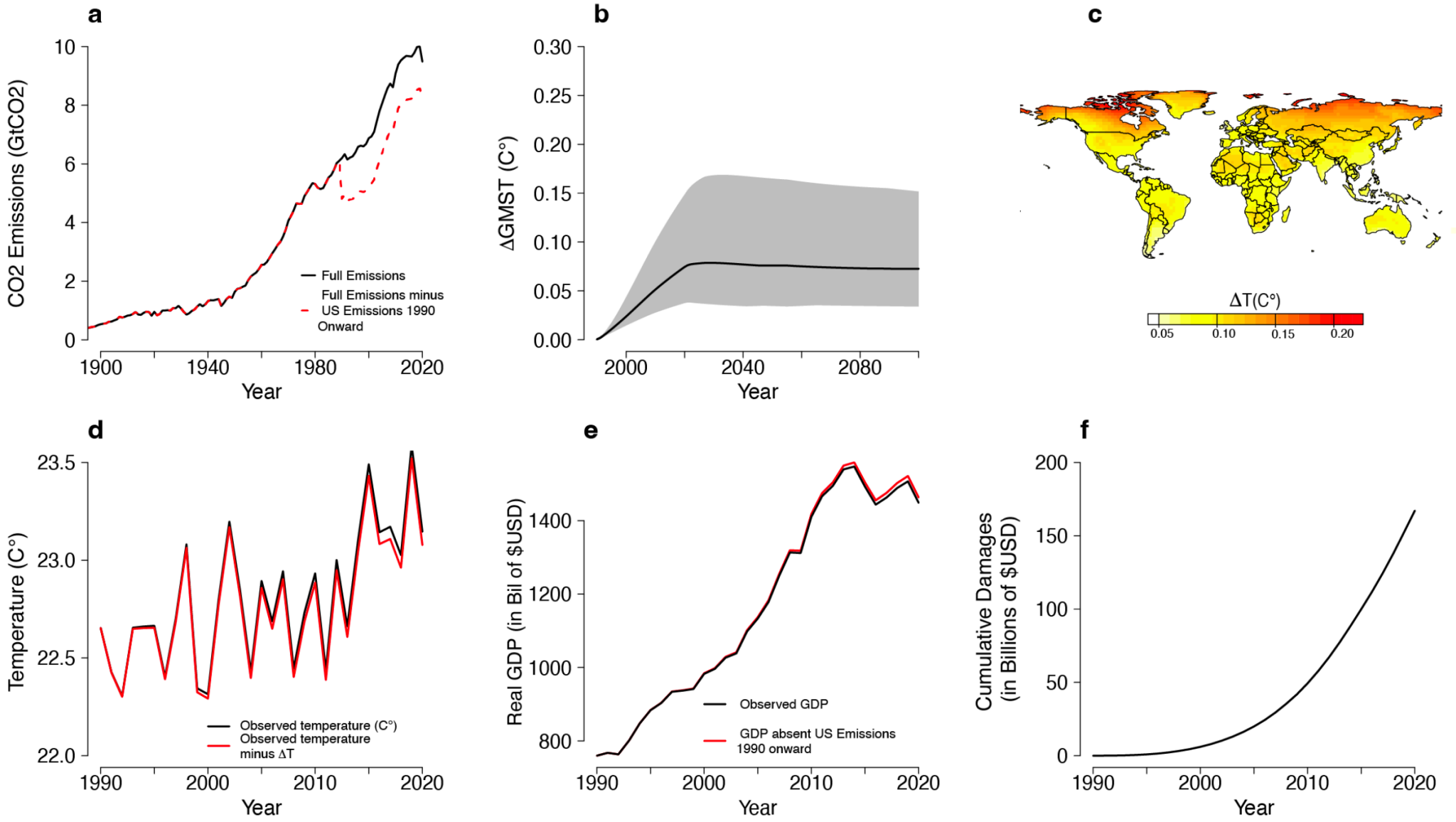
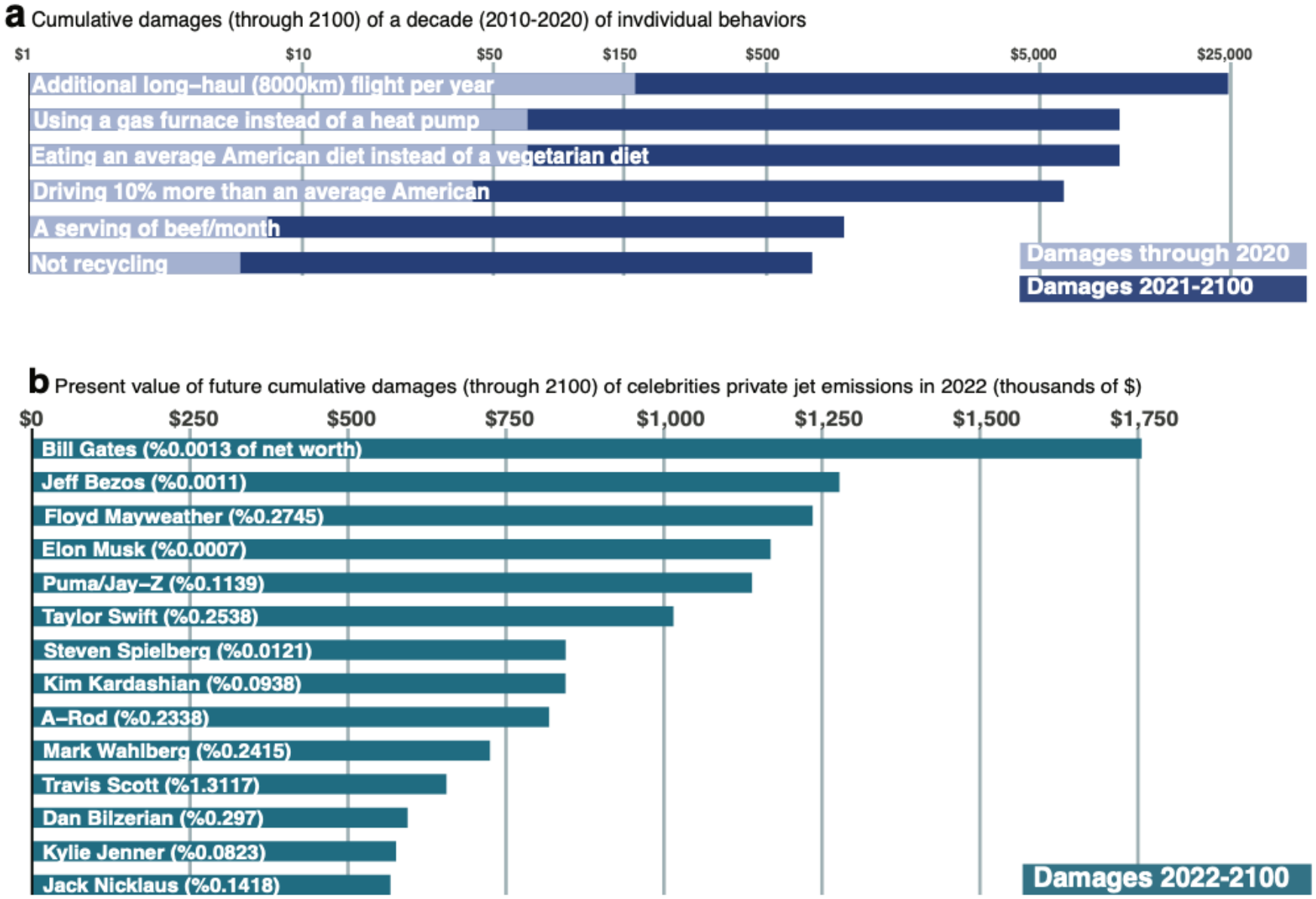


Can do damages from individual emissions as well:



Some key challenges

- We lack comprehensive damage functions for important exposures
  - In particular: floods, storms where “indirect” impacts are likely very important
- The more local you want to go on impacts, the less confident we will be in the attribution
  - Get statistical power from pooling across lots of units