The cost of climate inaction: Some statistical evidence

Marshall Burke
Dept. of Earth System Science, Stanford University
National Bureau of Economic Research

European Commission, March 2021

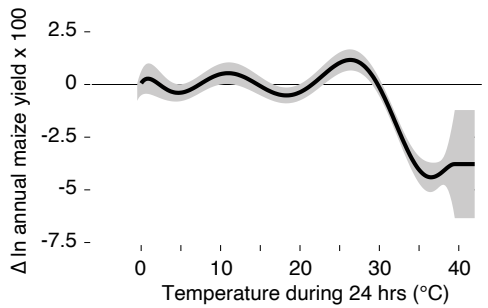
[*with thanks to Sol Hsiang, Ted Miguel, Noah Diffenbaugh, Matt Davis, Vincent Tanutama*]

We know a lot at the “micro” level

We know a lot at the "micro" level

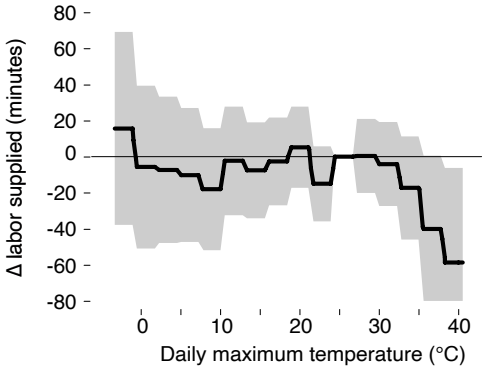
Agriculture

Schlenker and Roberts 2009



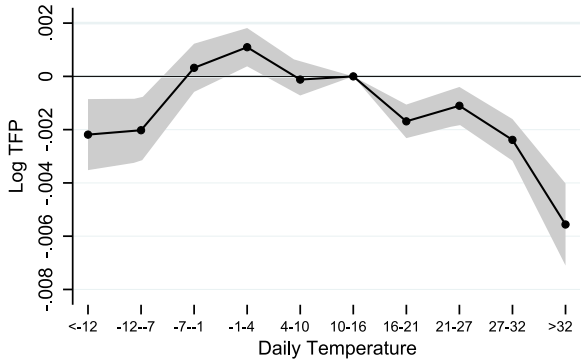
Labor supply

Graff Zivin and Niedell 2014



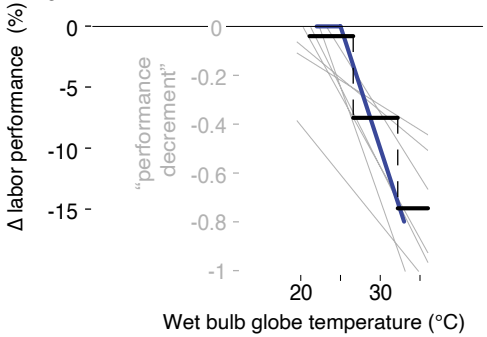
Plant-level TFP

Zhang Meng Deschenes Zhang 2017



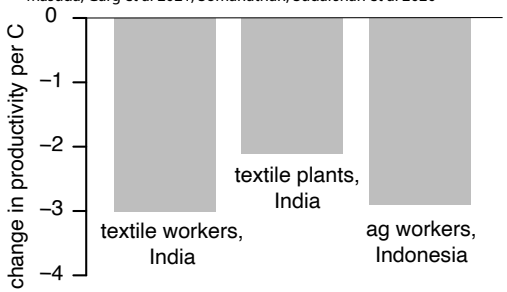
Ergonomics

Hsiang 2010



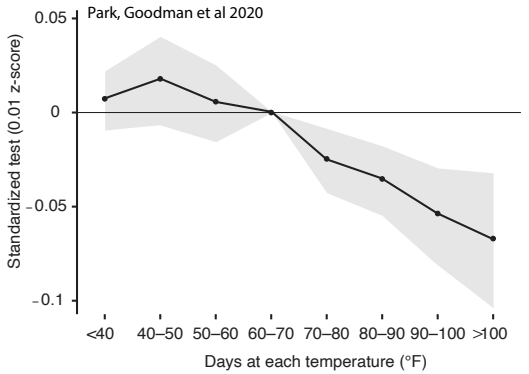
Labor productivity

Masuda, Garg et al 2021; Somanathan, Sudarshan et al 2020



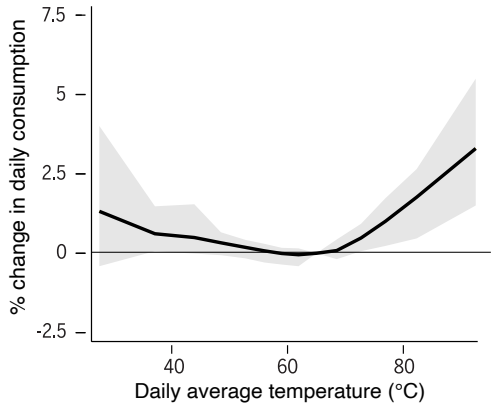
Test scores

Park, Goodman et al 2020



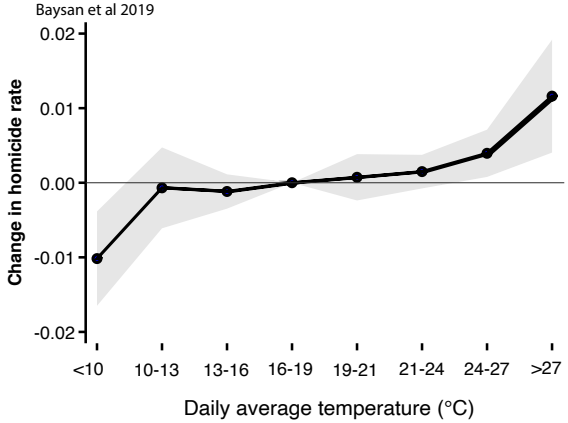
Electricity consumption

Auffhammer 2015



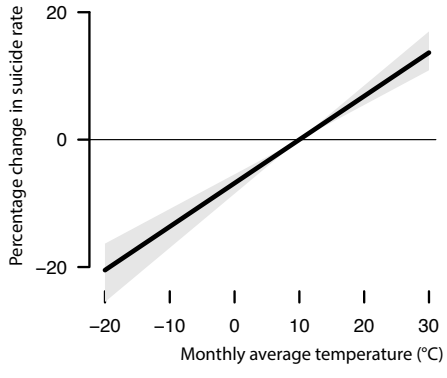
Homicide

Baysan et al 2019



Suicide

Burke et al 2018



But how do these effects aggregate?

Two approaches to generate an aggregate "damage function"

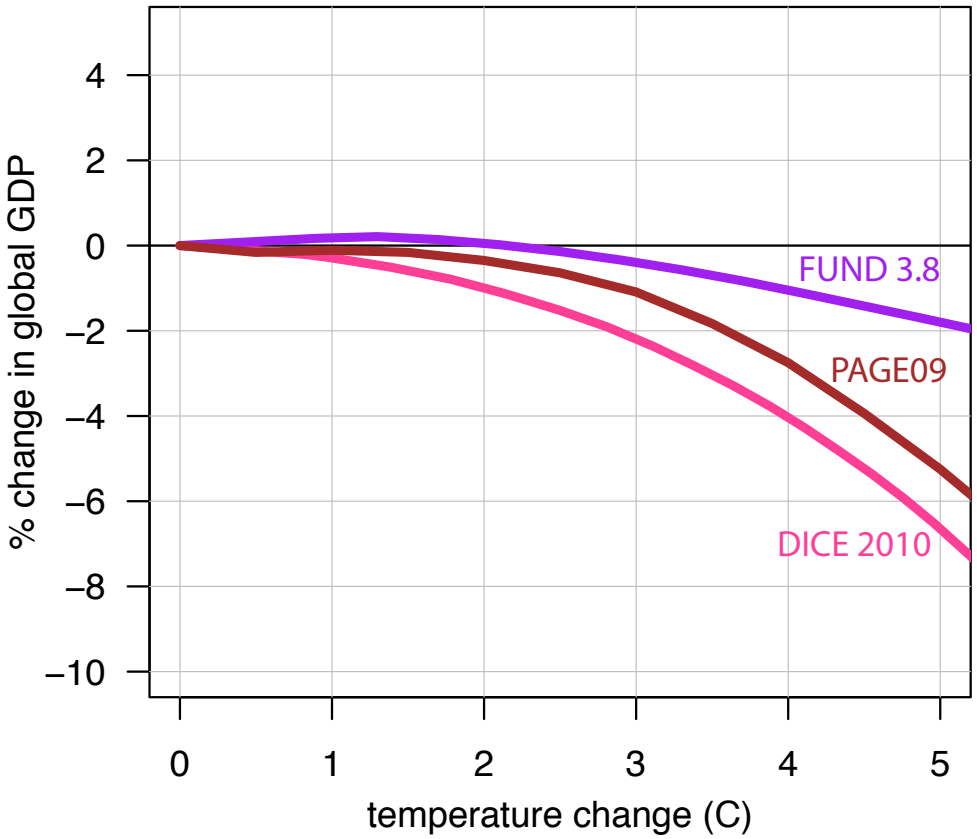
1. **Bottom up**: convert micro estimates to $, add them up

But how do these effects aggregate?

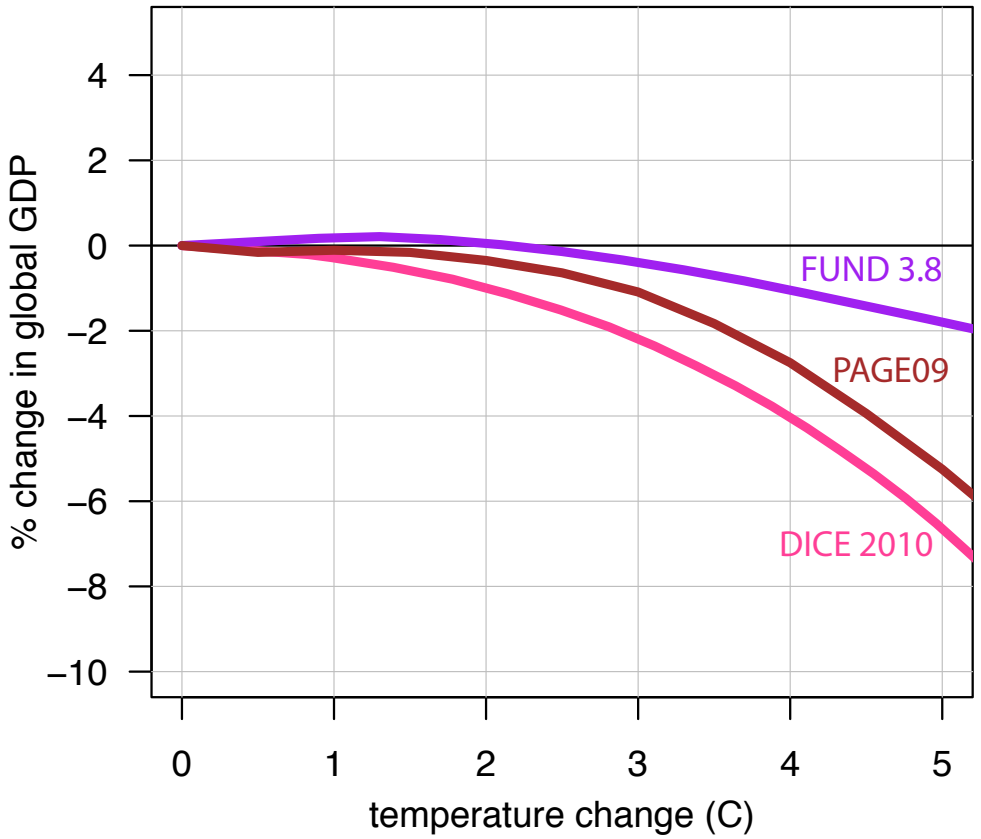
Two approaches to generate an aggregate "damage function"

1. **Bottom up**: convert micro estimates to $, add them up
2. **Top down**: let economy do adding up for you, study effect on economic aggregates (e.g. GDP)

Damage functions we have known



Damage functions we have known



- Pindyck (JEL, 2013): *"The damage functions used in most IAMs are completely made up, with no theoretical or empirical foundation."*
- Revesz, Arrow, Goulder et al (*Nature*, 2014): *"The models should be revised more frequently to accommodate scientific developments."*

Burke et al *Nature* (2015, 2018)

Approach: study effect of temperature on aggregate economic outcomes using country-level data (165 countries, 50 years).

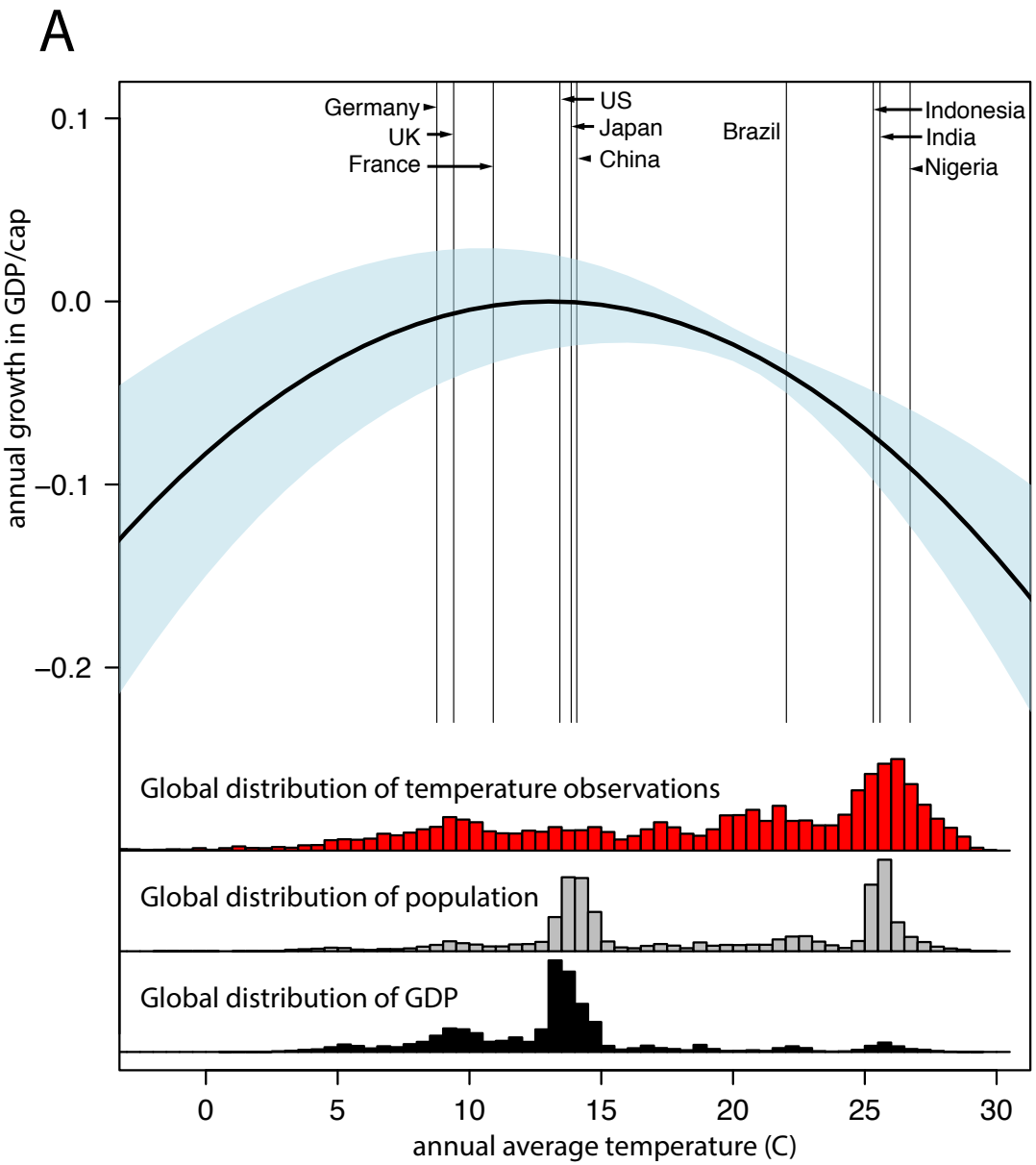
Burke et al *Nature* (2015, 2018)

Approach: study effect of temperature on aggregate economic outcomes using country-level data (165 countries, 50 years).

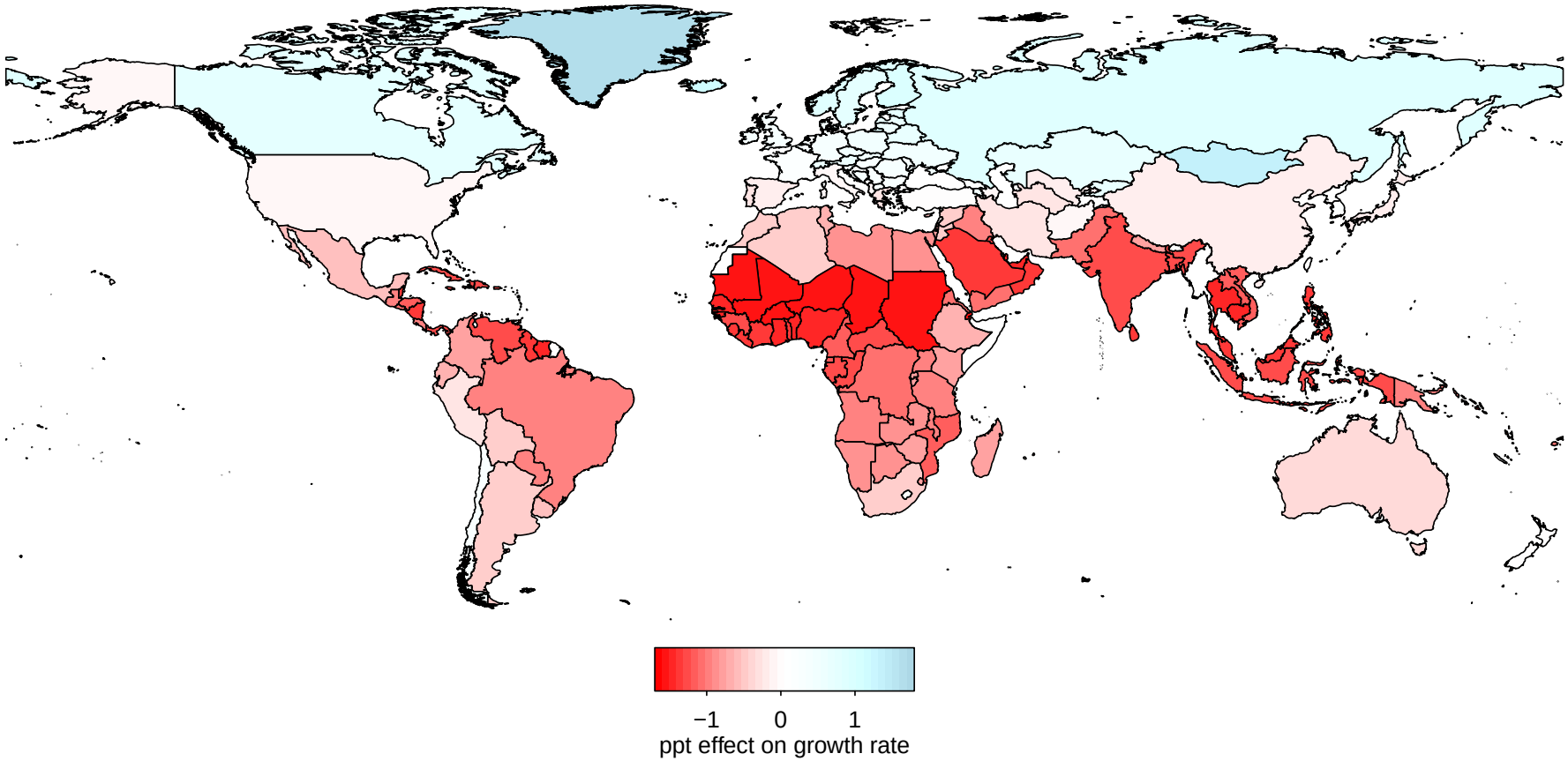
Goals:

- Identify *causal* effect of temperature on economic aggregates
- Empirically evaluate some conventional wisdoms:
  1. Temperature has level effects, not growth effects
  2. Wealth insulates you from the effects of climate
  3. Ag is sensitive to climate, but other sectors aren't
  4. We've become less sensitive over time

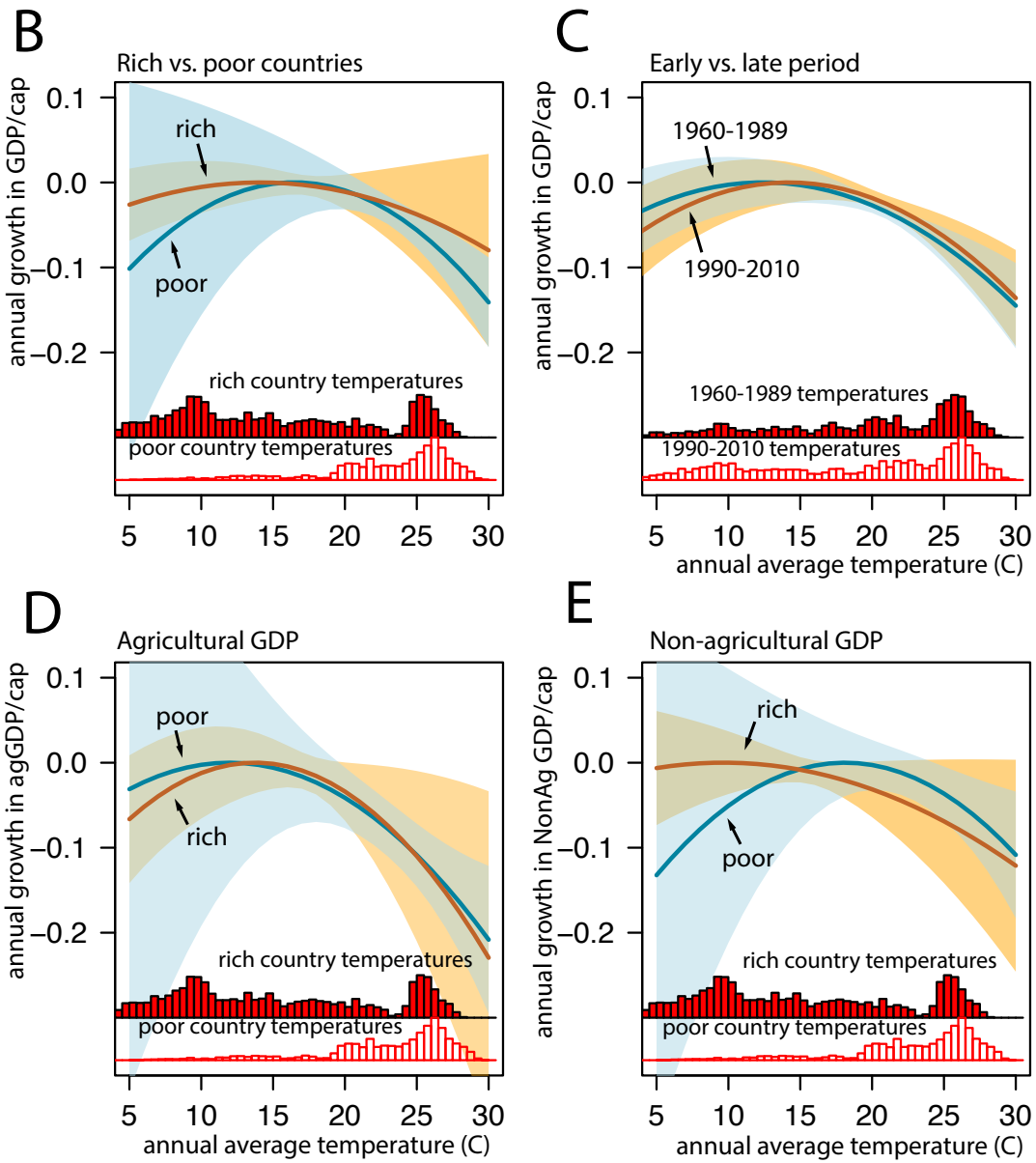
Last half-century: global non-linear response



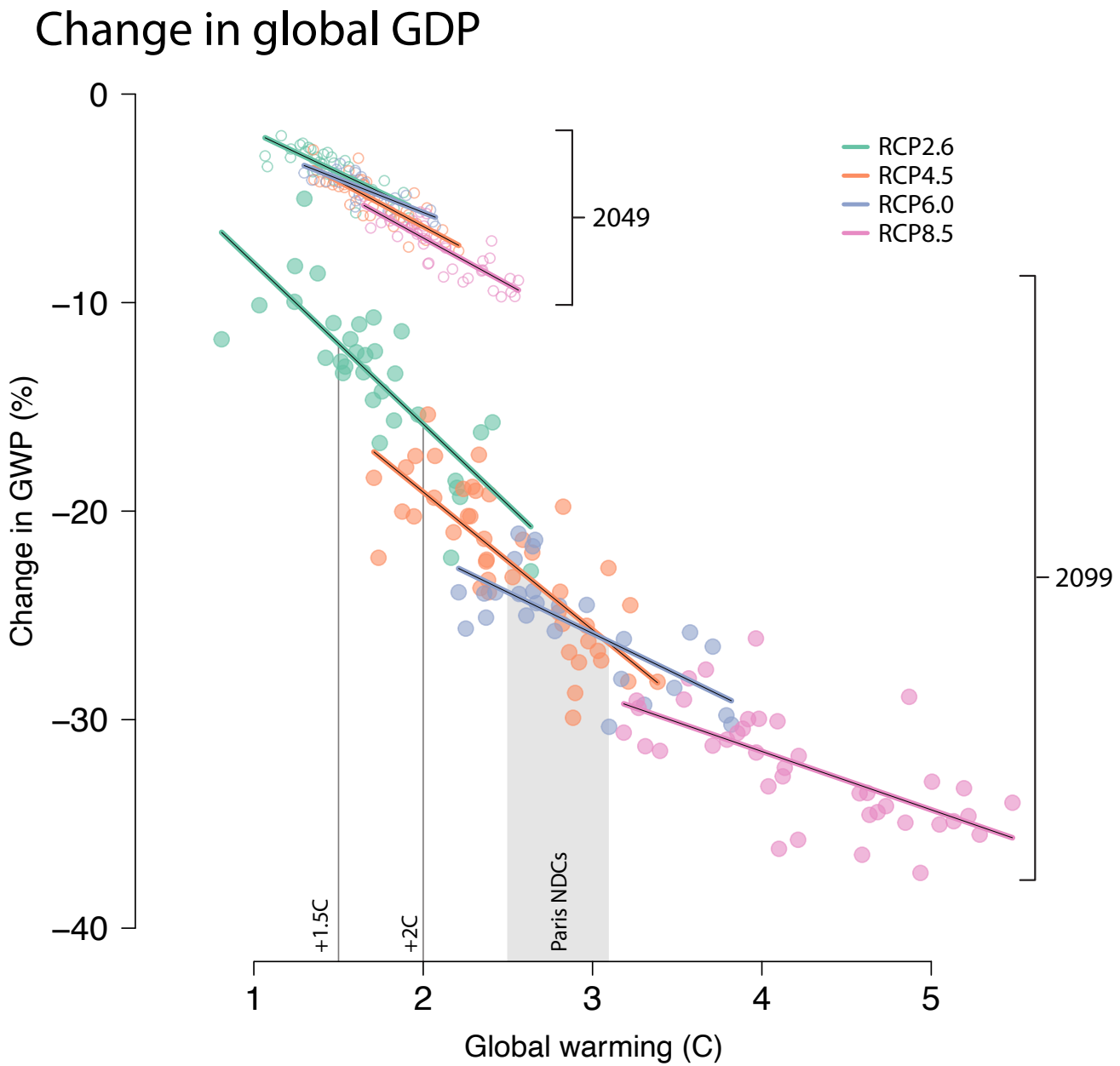
Historical effect of +1C warmer temperatures



Differences over space or time?



Now run the world forward



Can this be right??

Estimates are 5-10x larger that IAM damage estimates.

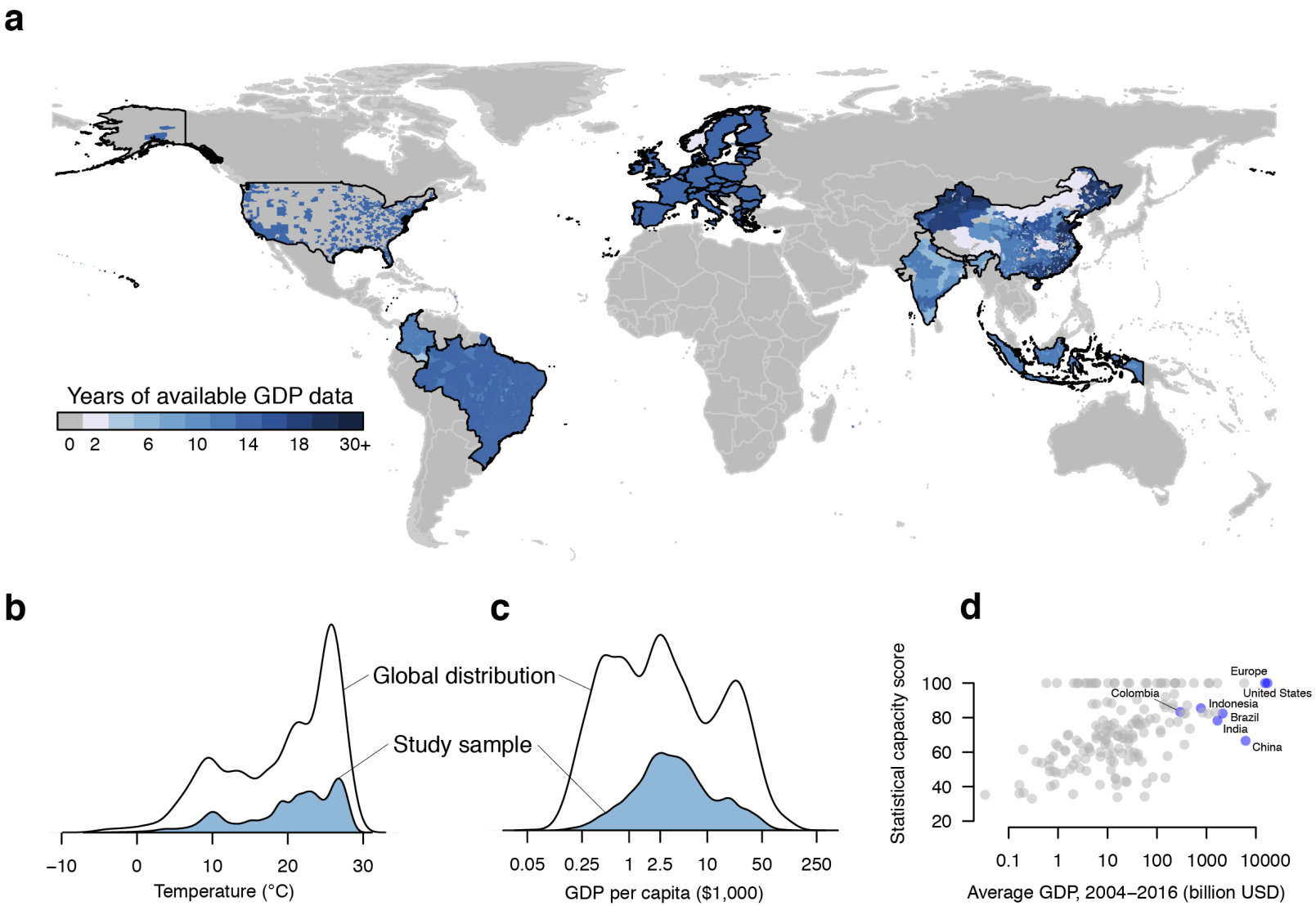
Can this be right??

Estimates are 5-10x larger that IAM damage estimates.

Some common complaints:

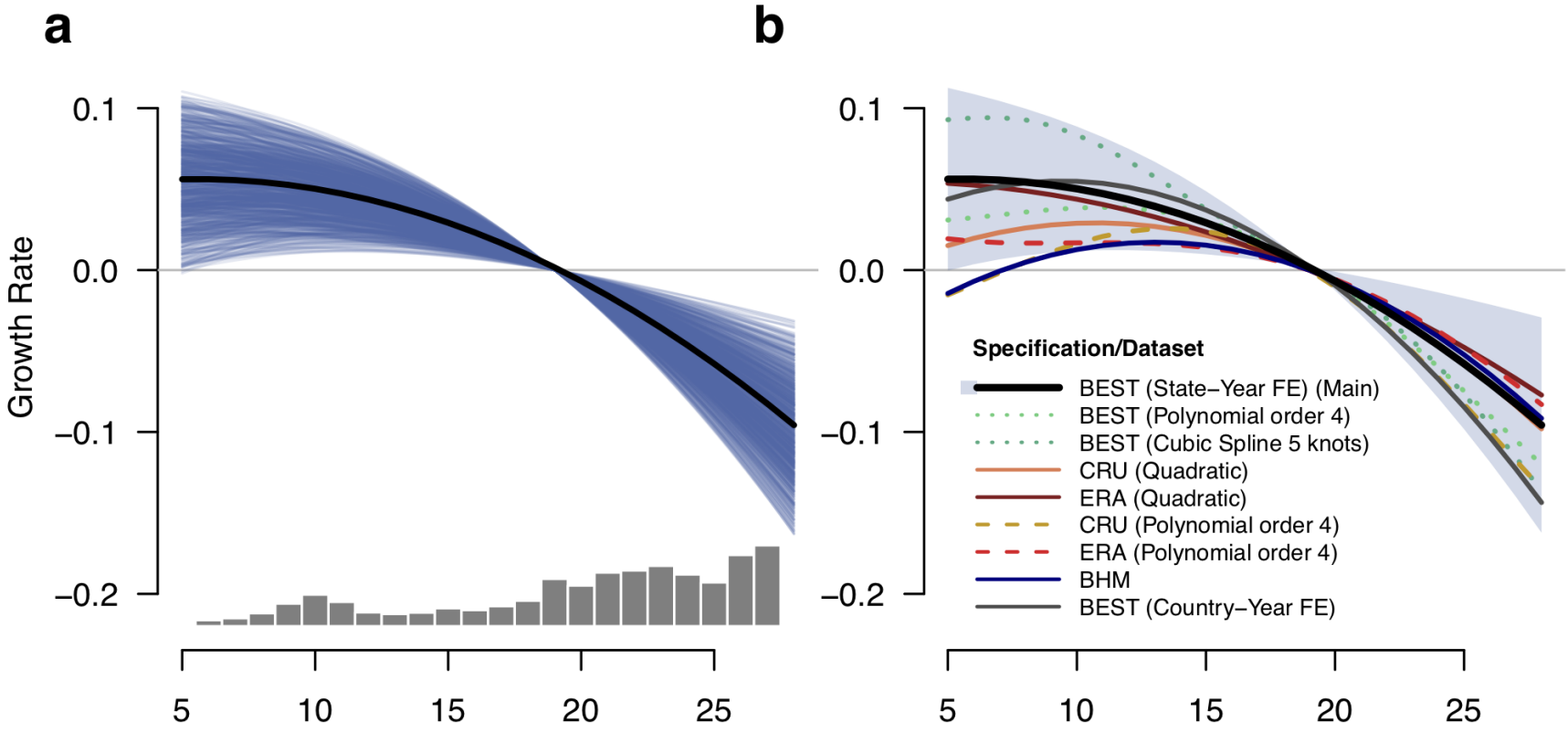
- Not convinced growth rates are affected
- We can't trust national accounts data from lots of places
- Effects could differ within countries as well as between them
- You're still leaving out a lot of bad stuff

Let's try it with subnational output data

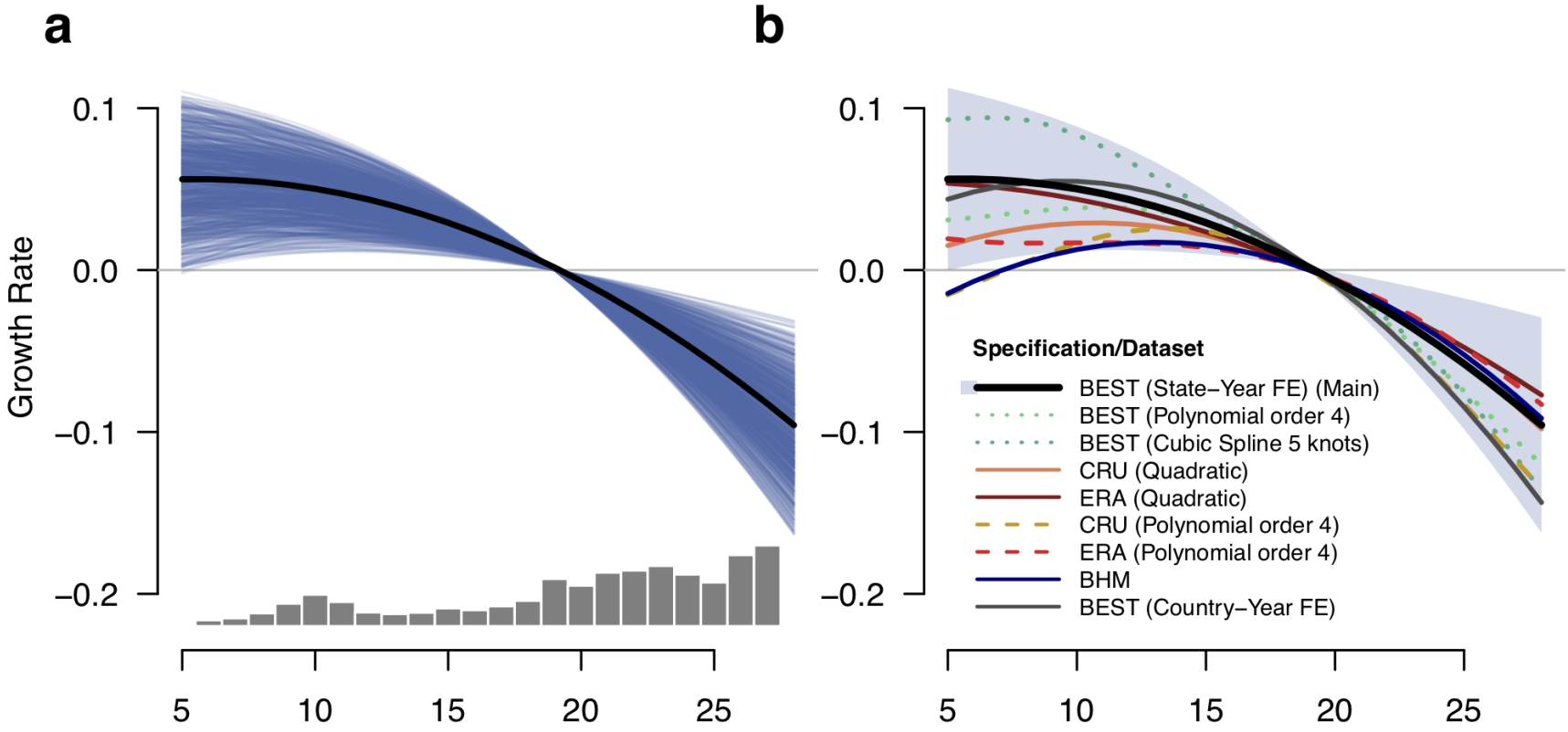


11,669 districts, n=162,256 total district-year obs

Pooled response, all districts

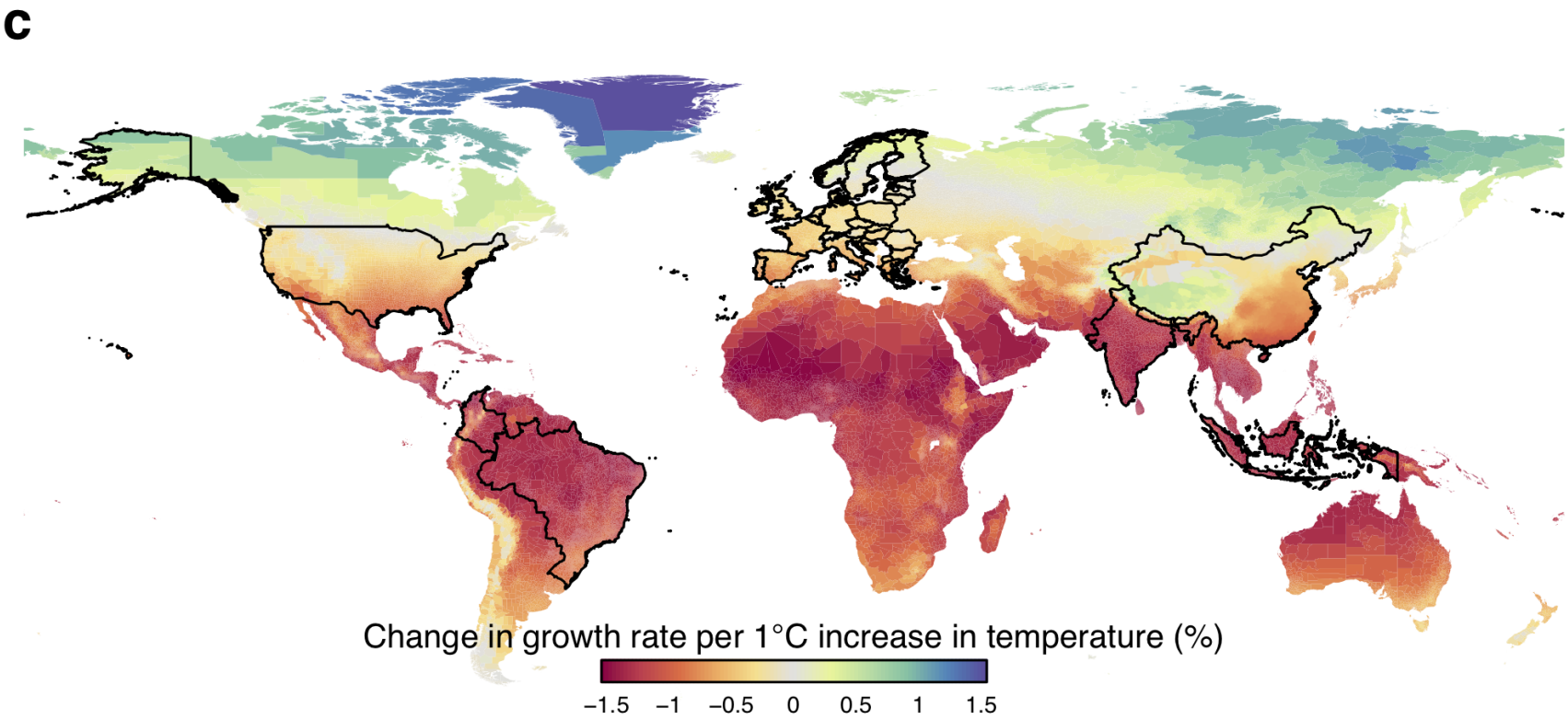


Pooled response, all districts

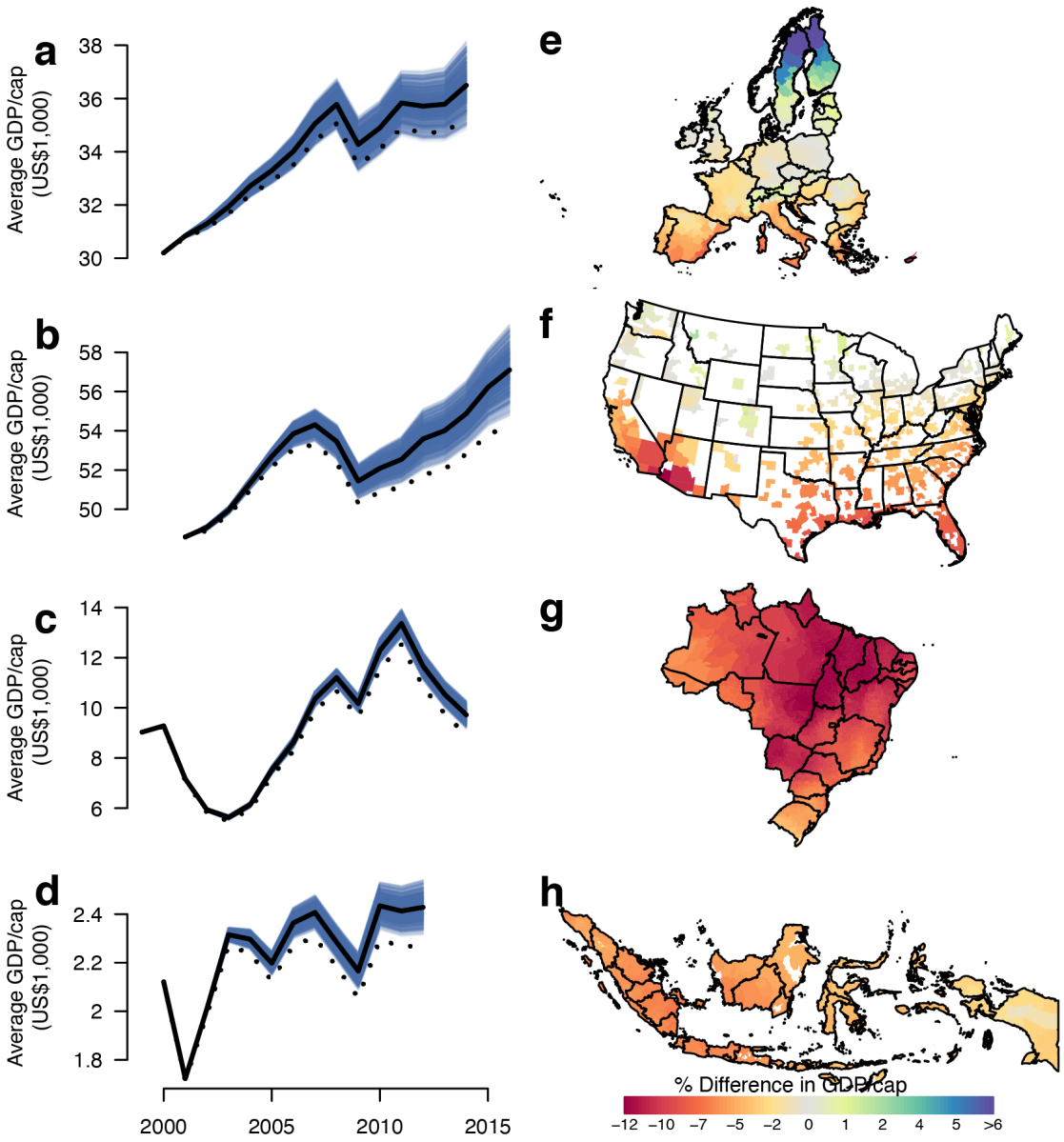


Estimated optimum is ∼5C (compare 13C in Burke et al 2015, 2018).

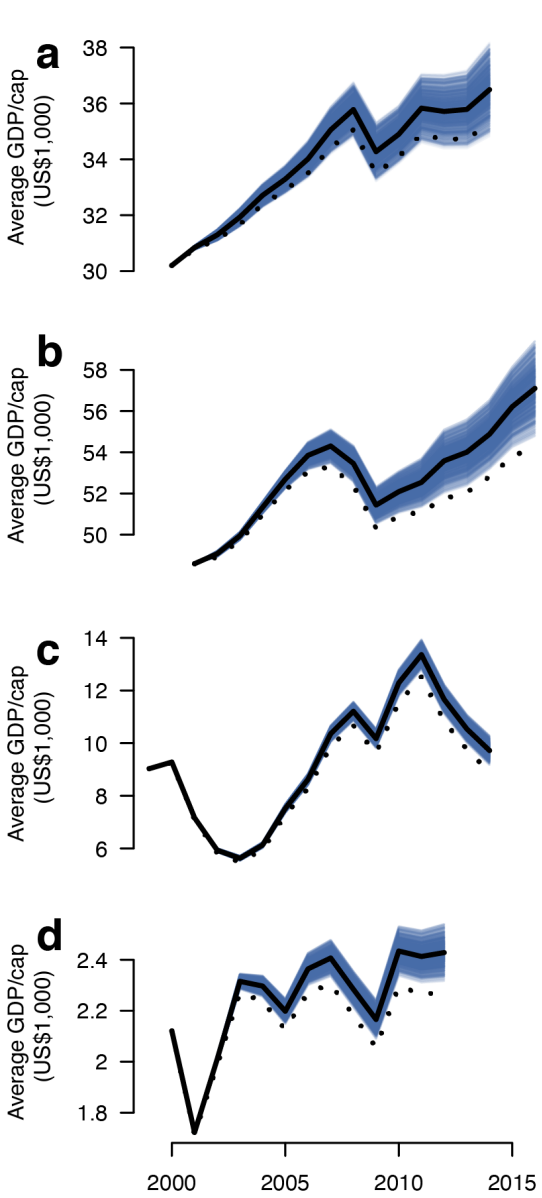
Implies that most of world harmed by warming

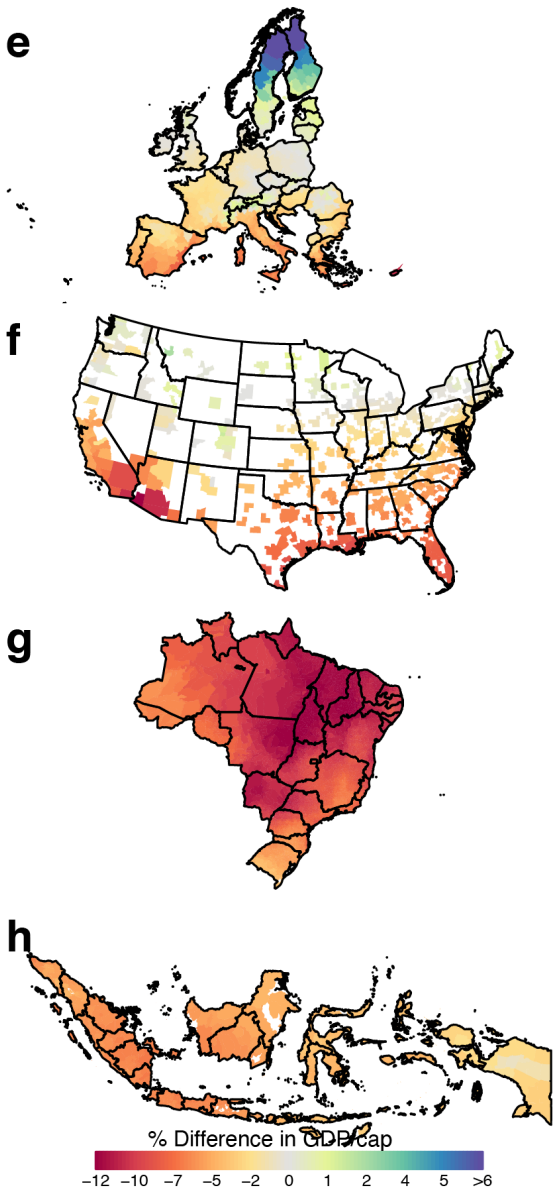


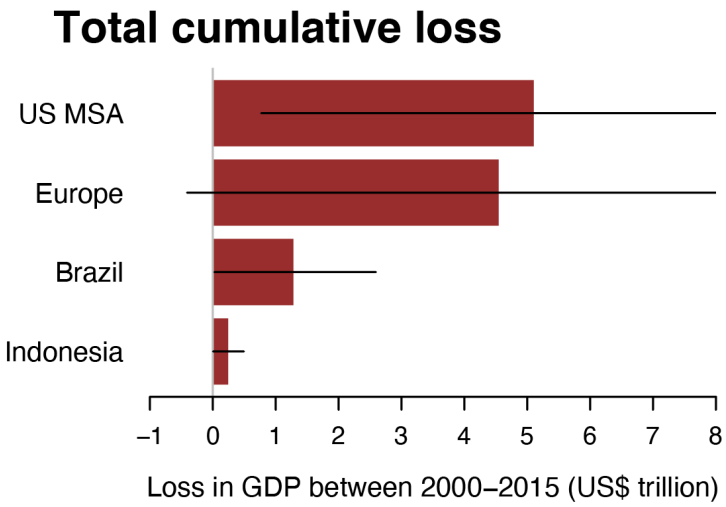
Can calculate cost of warming since 2000



Can calculate cost of warming since 2000







Conclusions

1. **Non-linear effect of temperature on historical output**
   - No strong evidence that structure of economy mitigates these effects
   - No evidence of adaptation over time
   - Similar response in national and subnational data

2. **High likelihood of substantial losses under future climate change**
   - Loss estimates are much larger than in existing damage functions, 5-10x
   - This is just from taking historical aggregate data seriously

3. **Recent warming already had damaging effects**
   - Trillions of $ in cumulative losses over last 2 decades