# 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*
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Some implications and key points:

- 1. Doing this credibly often does <u>not</u> 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  $\rightarrow$  specific damages:



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Year

## "Damage functions" well estimated for many sectors, outcomes



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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#### Well-established U-shaped relationship

## 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**





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!









С







#### Can do damages from individual emissions as well:

 \$1
 \$10
 \$50
 \$150
 \$500
 \$5,000
 \$25,000

 Additional long-haul (8000km) flight per year
 Using a gas furnace instead of a heat pump
 Image: starting an average American diet instead of a vegetarian diet

 Driving 10% more than an average American
 Image: starting an average American
 Image: starting an average American

 A serving of beef/month
 Image: starting an average American
 Image: starting an average American

 Not recycling
 Image: starting an average American
 Image: starting an average American

**a** Cumulative damages (through 2100) of a decade (2010-2020) of invdividual behaviors

D Present value of future cumulative damages (through 2100) of celebrities private jet emissions in 2022 (thousands of \$)

0	\$250	\$500	\$750	\$1,000	\$1,250	\$1,500	\$1,750
Bill	Gates (%0.0013 of net v	vorth)					
Jeff	Bezos (%0.0011)						
Flo	d Mayweather (%0.274	5)					
Elo	n Musk (%0.0007)						
Pur	na/Jay-Z (%0.1139)						
Tay	lor Swift (%0.2538)						
Ste	ven Spielberg (%0.0121)	)					
Kin	Kardashian (%0.0938)						
A-F	lod (%0.2338)						
Mai	k Wahlberg (%0.2415)						
Trav	/is Scott (%1.3117)						
Dar	Bilzerian (%0.297)						
Kyli	e Jenner (%0.0823)						
Jac	k Nicklaus (%0.1418)						Damages 20

# 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