Unequal Climate Impacts in the State of California

Developing a Climate Vulnerability Metric

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Climate Impact Lab

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Project Overview

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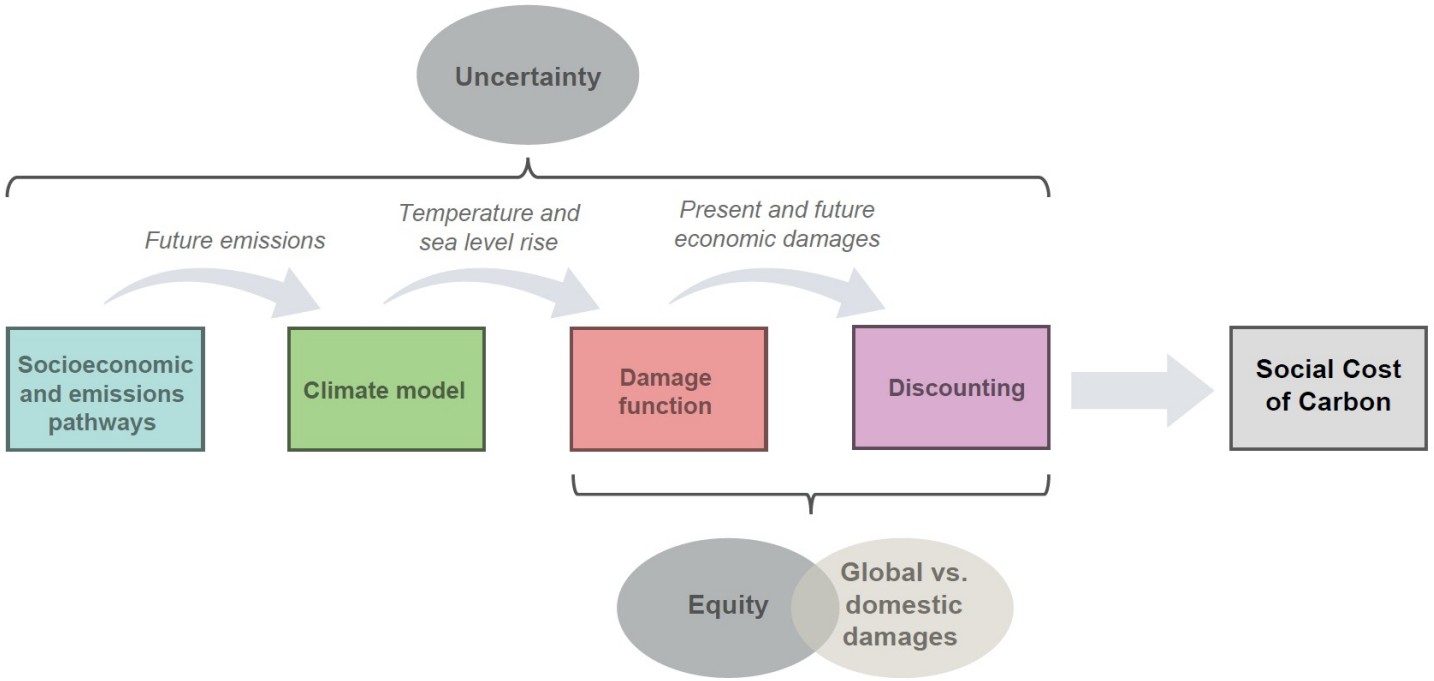
Climate Impact Lab research motivation

The Social Cost of Carbon (SCC) - the external social cost imposed by emitting one ton of carbon-dioxide.



The Climate Impact Lab is producing **evidence-based, hyperlocal climate impact information** that can be used to estimate the SCC.

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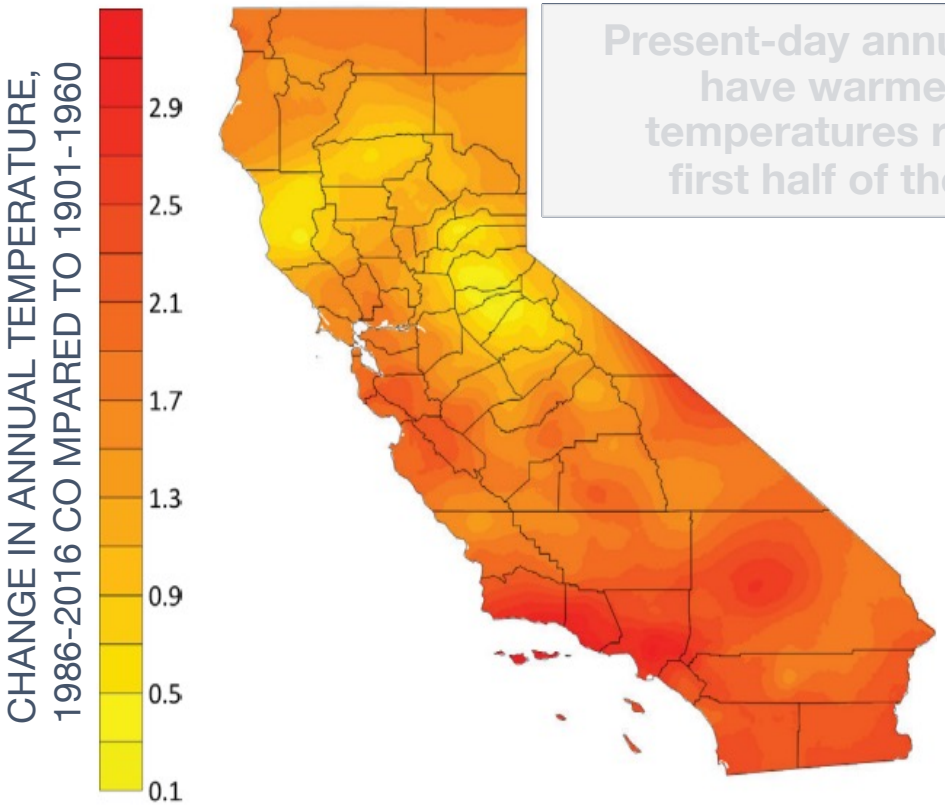
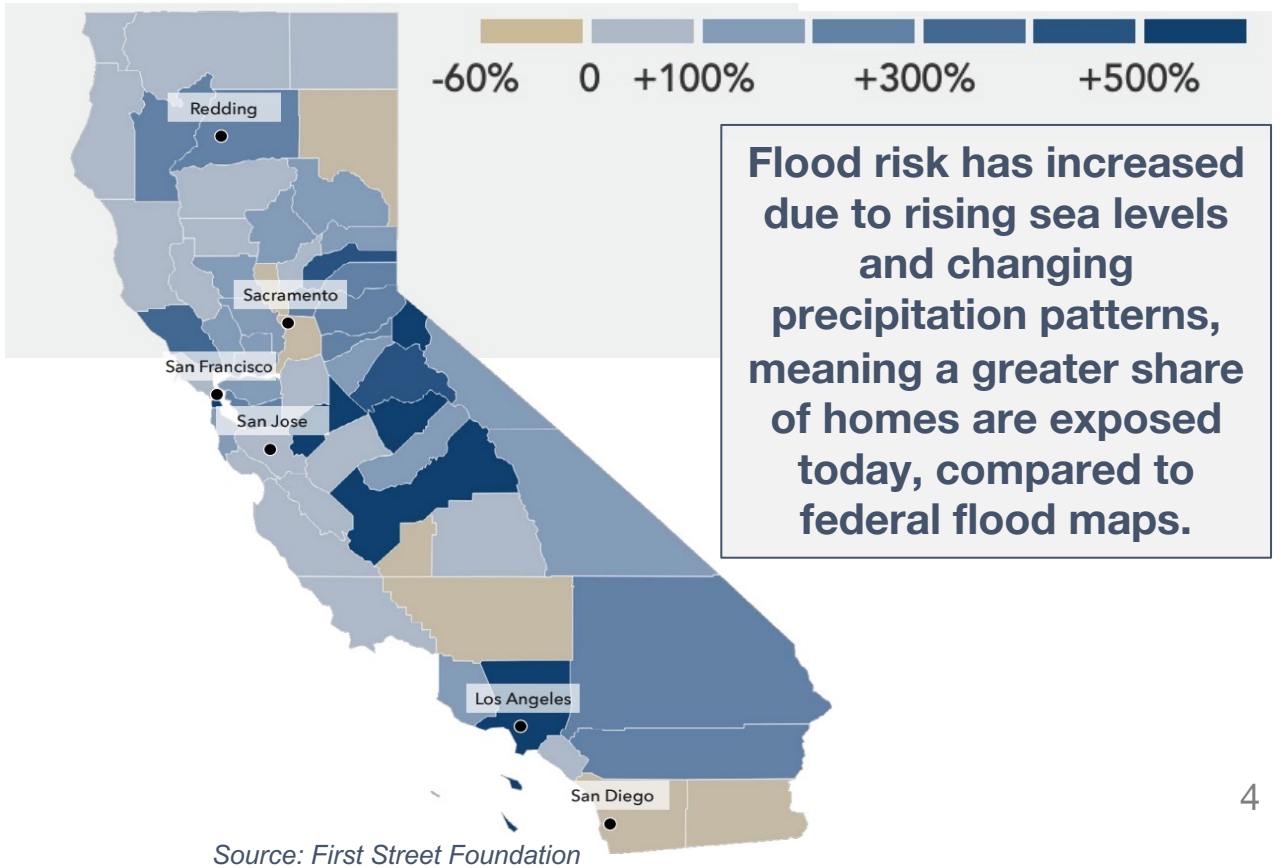
Evidence that California's climate is changing is undeniable…



Present-day annual temperatures have warmed 1°F above temperatures recorded in the first half of the 20th century

Source: CA 4th Climate Change Assessment



Flood risk has increased due to rising sea levels and changing precipitation patterns, meaning a greater share of homes are exposed today, compared to federal flood maps.

Source: First Street Foundation

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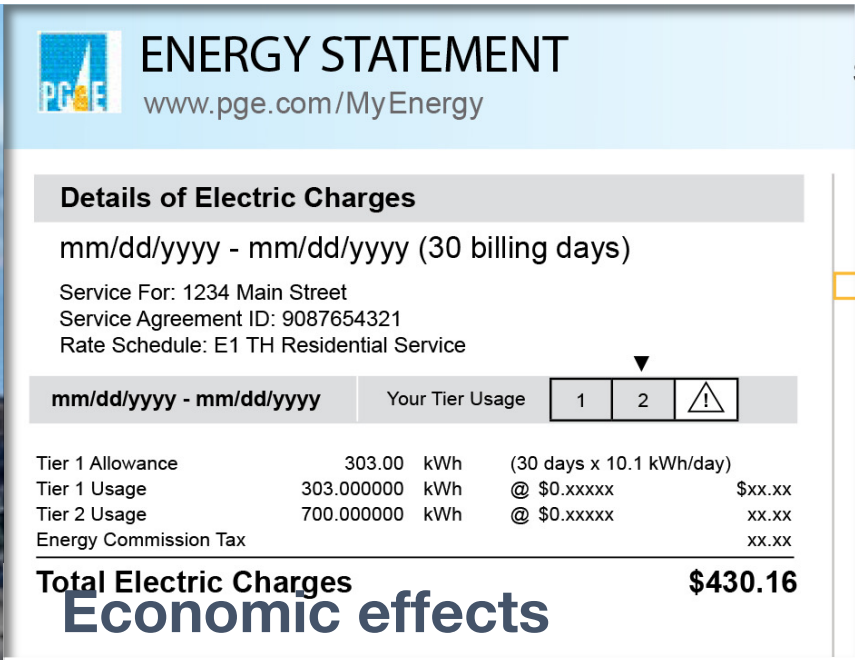
…but less is known about how these physical hazards impact human welfare.

Health outcomes

Coastal infrastructure



ENERGY STATEMENT
www.pge.com/MyEnergy

Details of Electric Charges

mm/dd/yyyy - mm/dd/yyyy (30 billing days)

Service For: 1234 Main Street
Service Agreement ID: 9087654321
Rate Schedule: E1 TH Residential Service

mm/dd/yyyy - mm/dd/yyyy	Your Tier Usage	1	2	⚠

Tier 1 Allowance	303.00	kWh	(30 days x 10.1 kWh/day)	
Tier 1 Usage	303.000000	kWh	@ $0.xxxxx	$xx.xx
Tier 2 Usage	700.000000	kWh	@ $0.xxxxx	xx.xx
Energy Commission Tax				xx.xx
Total Electric Charges				**$430.16**

Economic effects

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Existing framework for measuring vulnerability does not account for different communities to have different responses

- EPA's 2021 report on Climate Change and Social Vulnerability in the U.S. used a two-step process:
  1. Estimate the impact of climate change on human welfare assuming all populations are uniformly vulnerable to physical hazards (e.g., extreme temperatures, flooding)
  2. Estimate how likely socially vulnerable groups are to live in regions exposed to the highest physical hazards
- Recent climate-economic research shows that impacts of physical hazards on human welfare are not uniform
- **Measuring differential vulnerability is critical**

CLIMATE CHANGE AND SOCIAL VULNERABILITY IN THE UNITED STATES

A Focus on Six Impacts

Source: U.S. EPA

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Project Goals

- Quantify significant climate impacts affecting Californians

- Develop a **Climate Vulnerability Metric (CVM)** for the state that will:
  1. Assess climate change's impacts on human welfare across multiple categories
  2. Quantify the impacts of climate change - as measured through increased warming - on California communities
  3. Develop a metric that can be used to compare impacts across communities in California

- Make CVM **data and findings public** for use in local, state and federal policy application

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California's existing resources that quantify climate impacts on human welfare

- Wide array of California climate change assessments exist

- These quantify impacts such as:
  - changes in mortality rates caused by extreme heat
  - energy costs from additional air conditioning
  - loss in hours worked by laborers exposed to heat

- Geographic granularity is limited. Policy experts have suggested that **census tracts** could provide the correct scale for analysis of climate impacts to disadvantaged populations at the local level

Source: California's 4th Climate Change Assessment

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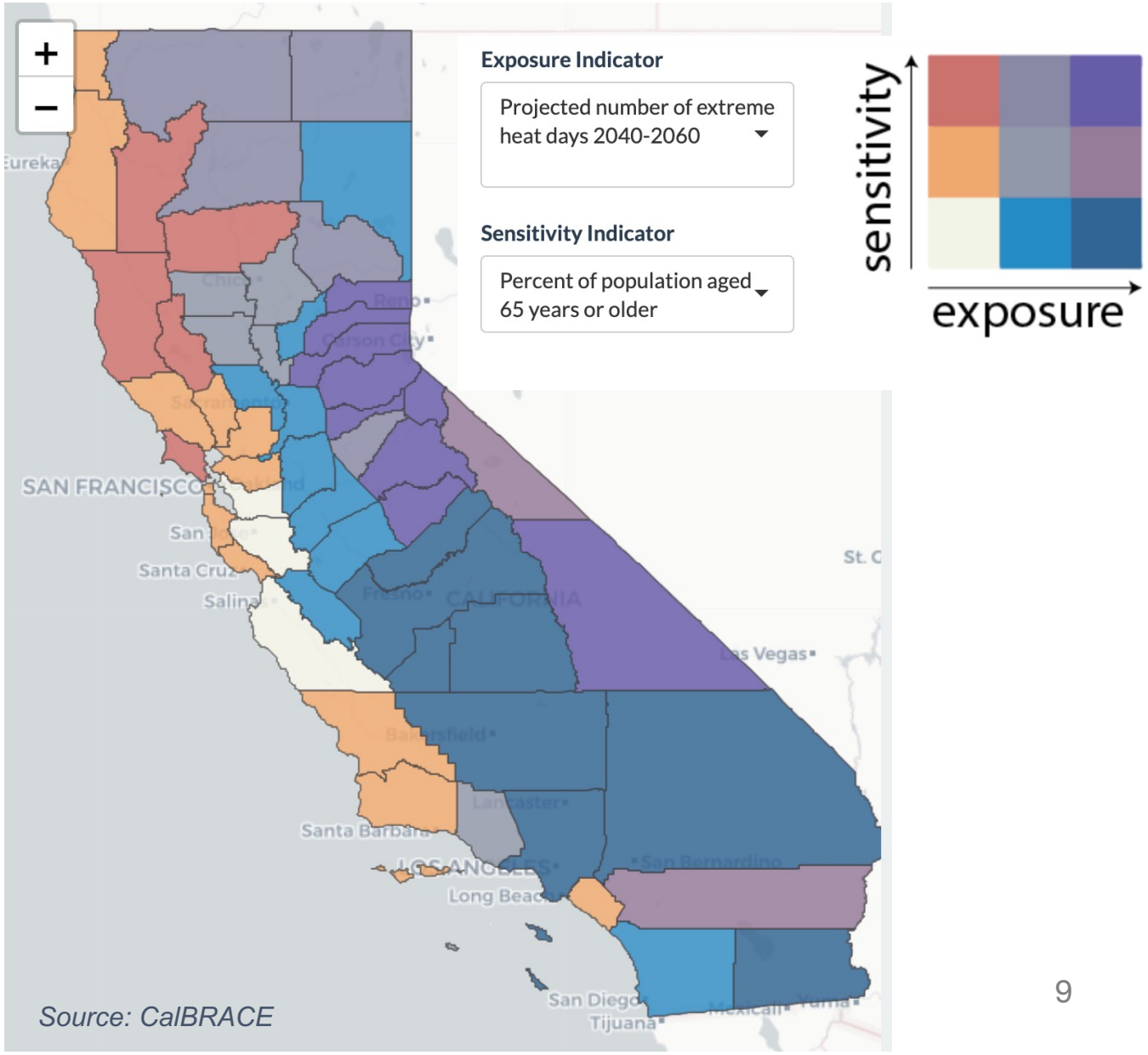
California's existing tools for assessing climate vulnerability

- Existing tools show **physical hazard projections** at local level (i.e. extreme heat days, wildfire risk)
- **Overlay** physical hazards with social vulnerability indicators
  - Population of children/elderly, % of pop. without health insurance, poverty rate
  - Advanced features include adaptive capacity, such as air conditioning
- **Do not quantify how the impacts of physical climate hazards vary across different communities**



Source: CalBRACE

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Gaps the CVM aims to fill

- **Capture differences among diverse populations:** Incorporate the fact that individuals and communities differ in their capacity to respond to physical hazards. Ensure climate impacts estimates reflect lived experiences.
- **Provide localized climate risk information:** Assess climate impacts at census tract level to identify the climate vulnerability within neighborhoods and other community boundaries.
- **Support targeted resiliency and adaptation policies:** Inform efforts to make California's diverse populations more resilient to climate change and reduce and prevent disparities through targeted funding for climate adaption.

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Principles for Developing a CVM

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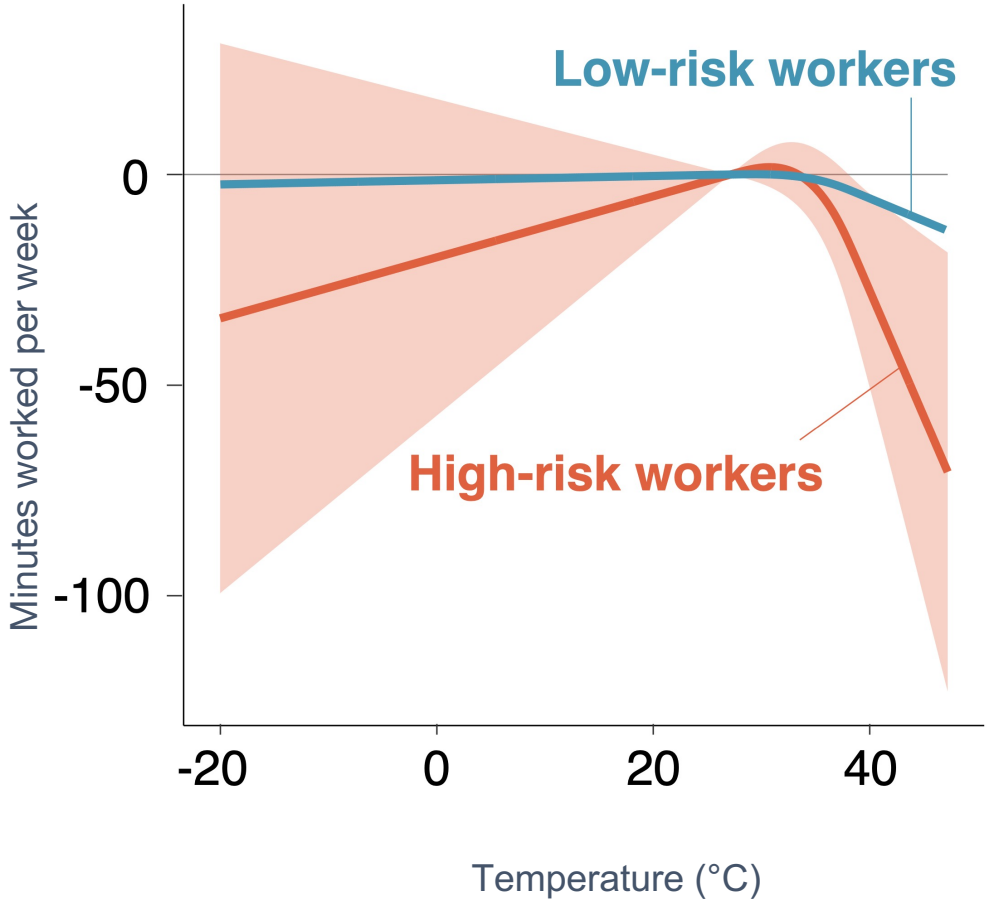
1. Account for different responses based on population characteristics

- Our approach:
  - Estimate **"dose-response" relationship** between physical hazards and human welfare outcomes using historical data
  - Use **high-resolution climate models** to project outcomes in future years under climate change
- Account for data-driven estimates of **differential vulnerability** by socioeconomic, demographic, and climate conditions



Source: Rode et al. (2022)

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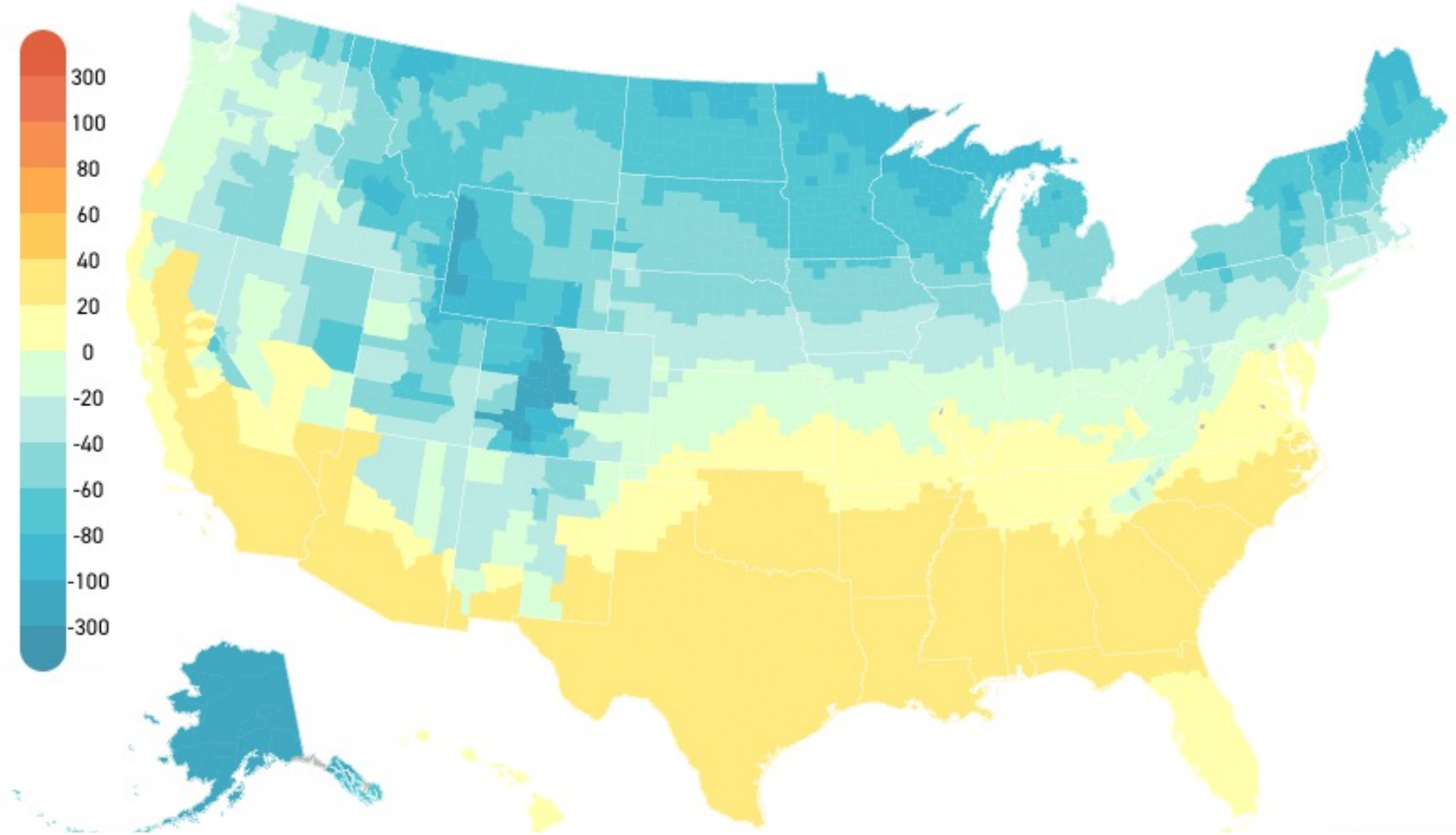
1. Account for different responses based on population characteristics

Change in death rates (per 100,000 population) caused by changes in climate. Median outcomes in mid-century time period (2040-2059) under a moderate emissions scenario (RCP 4.5) median.



Source: Carleton et al. (2022)

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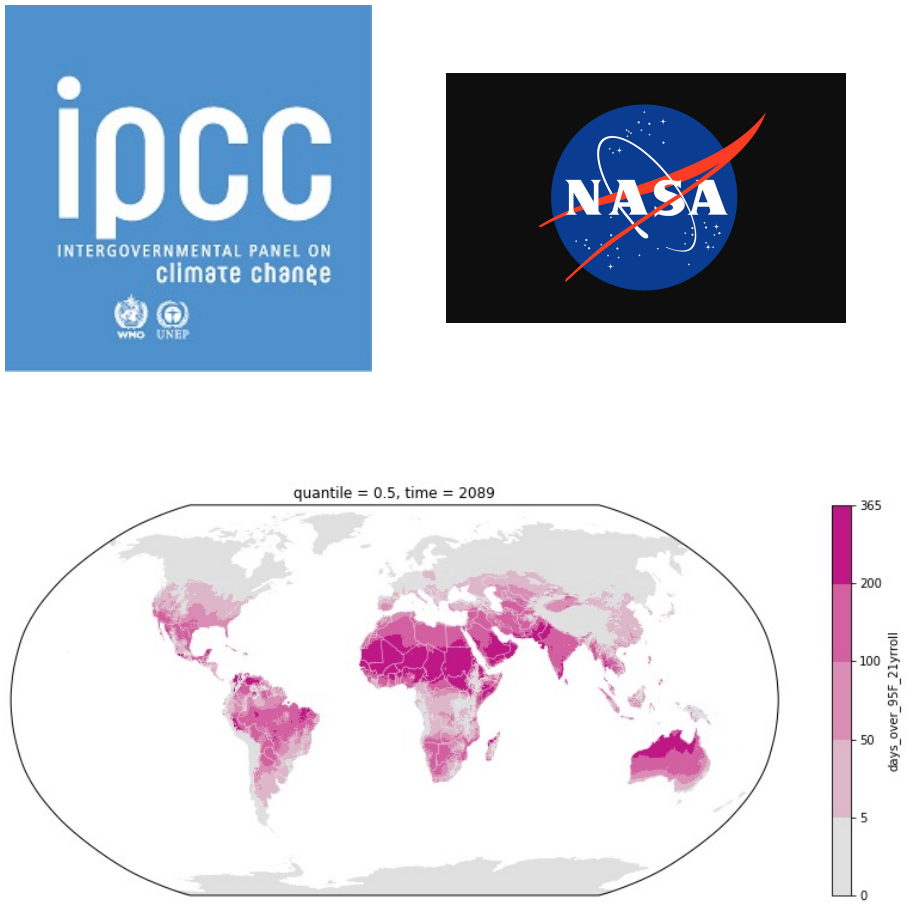
2. Capture daily climate conditions

- Probability distributions of high-resolution daily climate including:
  - 21 climate models from IPCC's Fifth Assessment Report bias-corrected to historical observations and downscaled to ~25km resolution by NASA's Global Daily Downscaled Project
  - 12 "surrogate" climate models to provide full coverage of the tails of climate sensitivity uncertainty (Rasmussen et al. 2016)
- Daily maximum surface air temperature, daily average surface air temperature
- Aggregated to census tract



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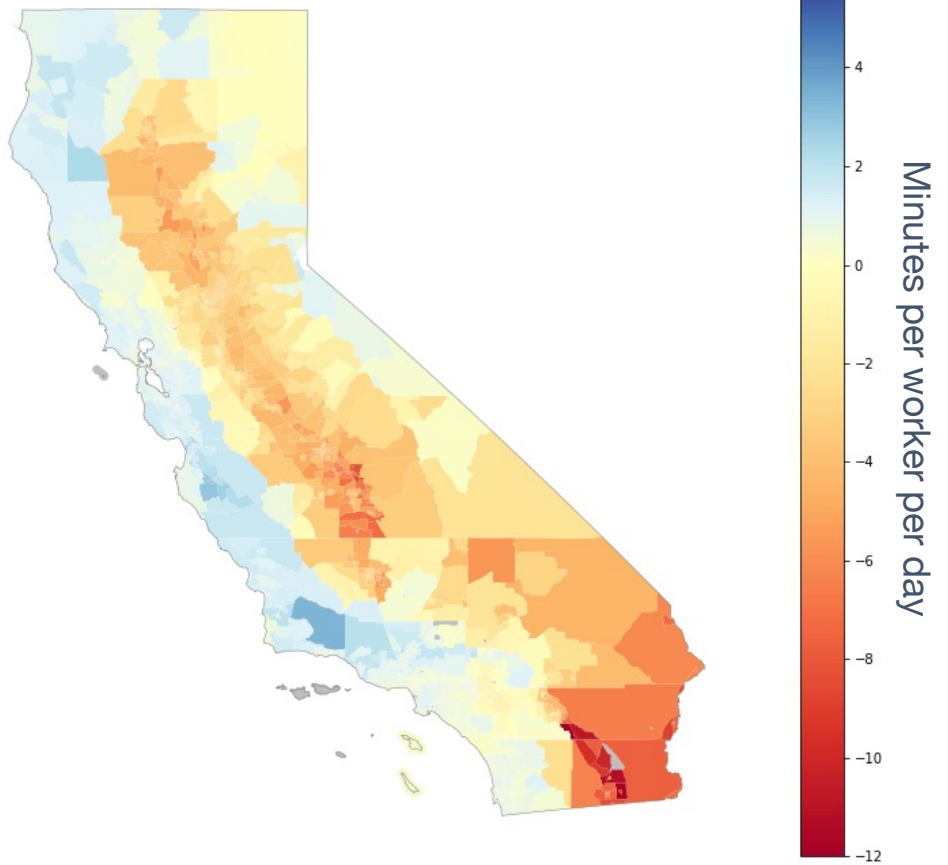
3. Report climate impacts that are geographically comprehensive and granular

- Intended to **augment California's existing resources** for understanding physical hazards
- Combine historical climate data with socioeconomic data to identify the effect of specific daily events on outcomes
- Develop "dose-response" functions for each census tract and combine with climate projections to estimate future impacts
- Will account for local social and economic conditions that will influence the ability of communities to cope with physical hazards in each census tract

Estimated impacts of climate change on labor supply in 2050 (moderate emissions, RCP4.5)



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Project Next Steps

- **Reviewing climate economics literature** for categories of significant impacts where research has advanced enough to allow for quantification at the census tract level
- Developing a method for **combining impacts across categories**
- Identifying the most likely **emissions scenario** for forecasting climate impacts and time period
- **Collecting public comments** on proposed methodology and data inputs

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