Nexus of extreme heat, air quality, climate, and health

Susan Anenberg, PhD

NOAA CPO ESSM Workshop
Climate Research to Enhance Resilience to Extreme Heat
November 19, 2019

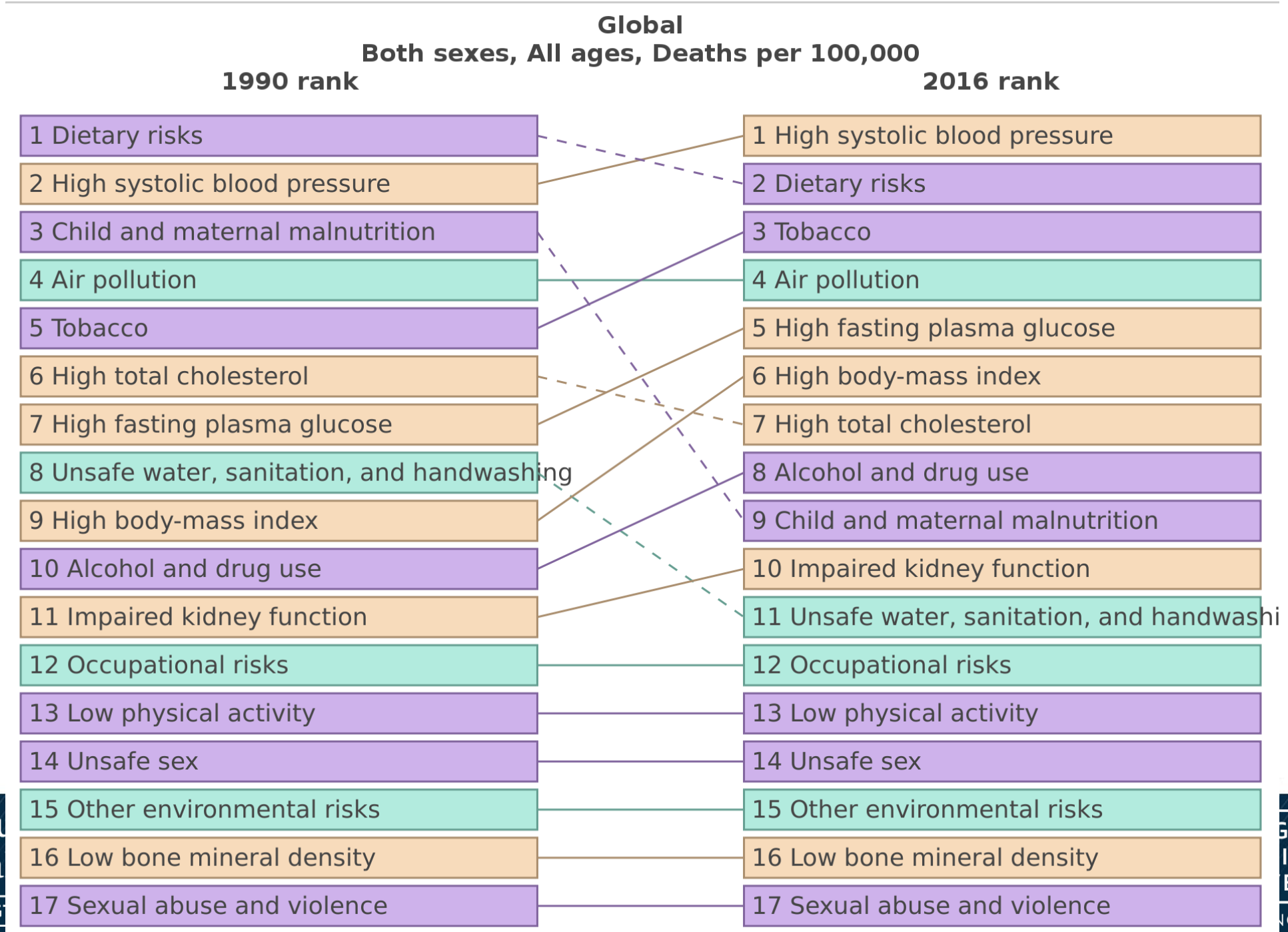
Milken Institute School of Public Health
THE GEORGE WASHINGTON UNIVERSITY

Overview

- Air pollution is among the leading public health risk factors globally
- Climate change is an increasingly important driver of air pollution and associated health outcomes
  - Wildfire $PM_{2.5}$
  - Airborne dust
- Modeling framework for estimating air quality and health impacts of climate change
- Final thoughts
  - Climate, air quality, and human health interactions are complex
  - Long wish list of data/model needs
  - Collaborations between climate scientists and health researchers

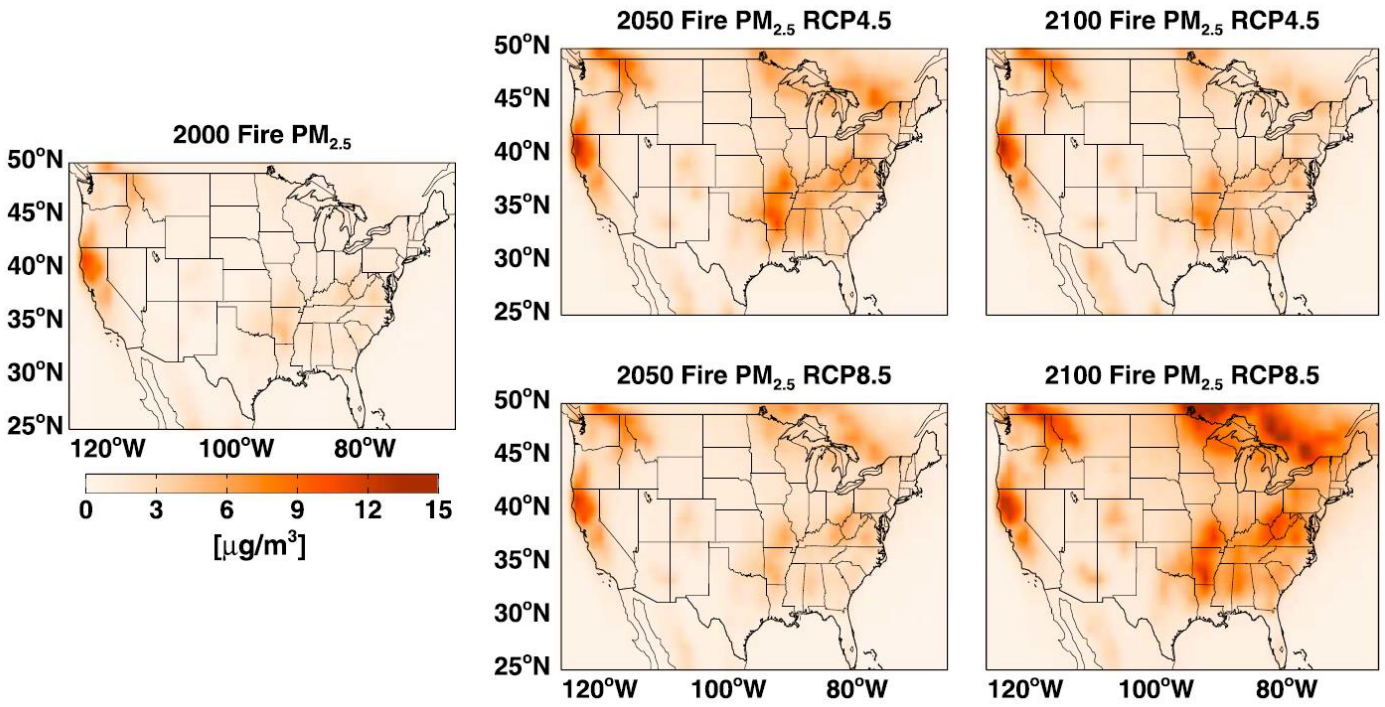
Air pollution is the "…world's largest single environmental health risk"

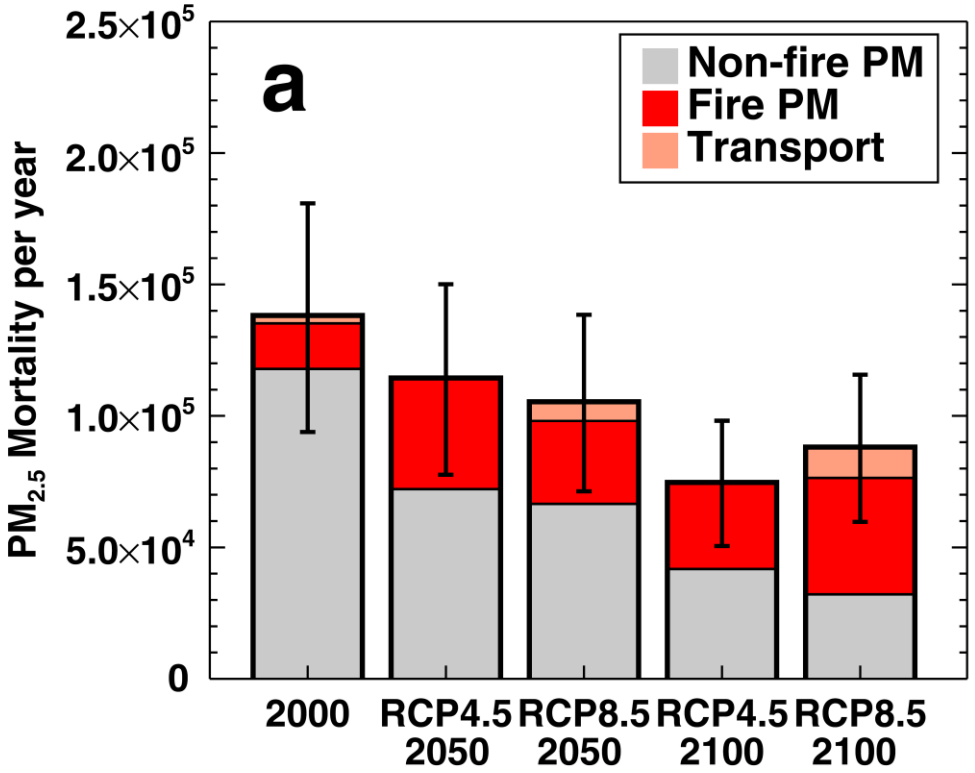
- 68th World Health Assembly Agenda Item 14.6 (May 2015)



Institute for Health Metrics and Evaluation, 2017

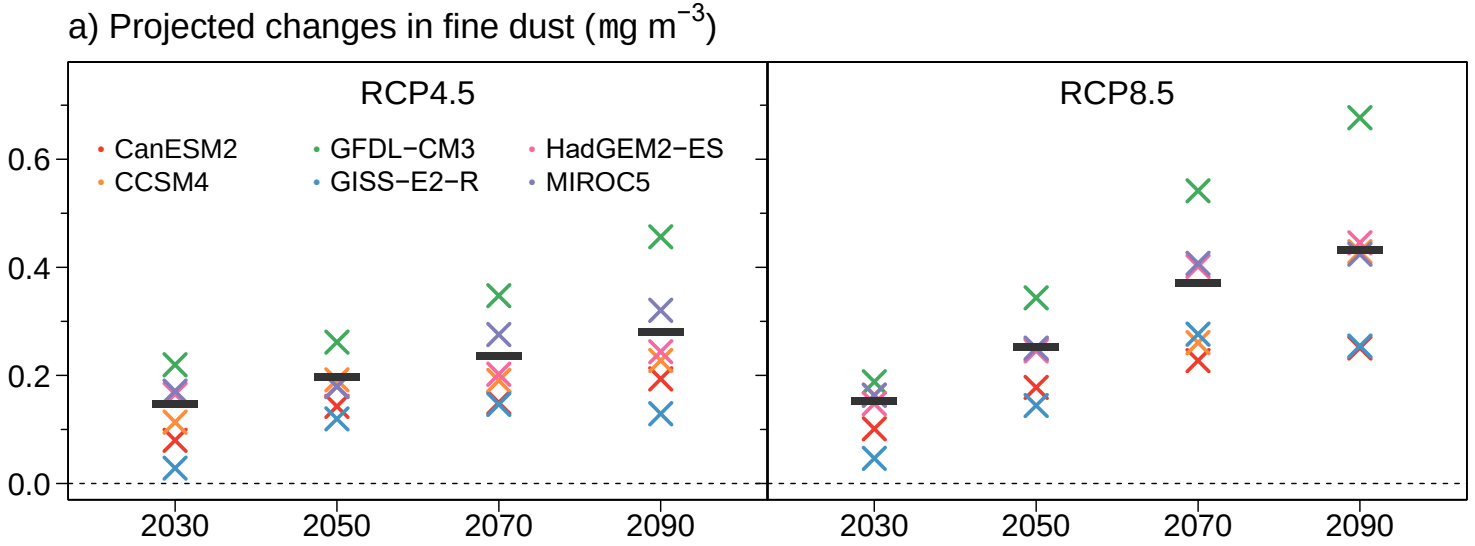
Wildfire $PM_{2.5}$ may become dominant contributor to $PM_{2.5}$ and associated mortality in the U.S.





Ford et al. GeoHealth, 2018

How will dust levels in the U.S. Southwest change due to projected drought conditions for each season, model, and RCP scenario (relative to 1986-2005)?

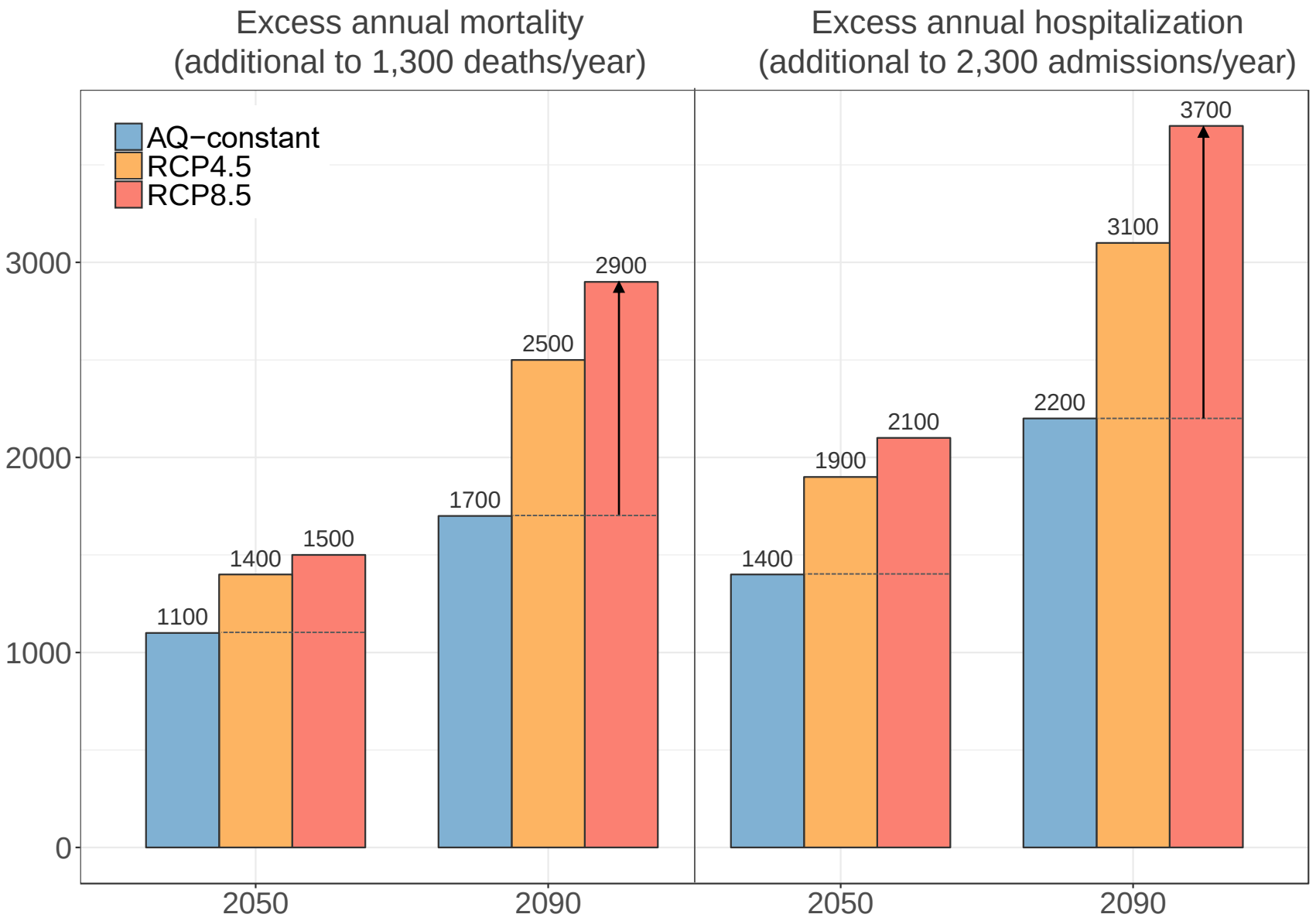


Projected decreases in soil moisture could **increase fine dust levels by 57% and coarse dust levels by 38%** over the US Southwest in 2090 under RCP8.5.

Under RCP8.5 relative to RCP4.5, increases in dust concentrations are 30% larger in 2050 and 60% larger in 2090.

Achakulwisut et al. 2019

What are the magnitudes and economic values of the health impacts attributable to dust exposure?

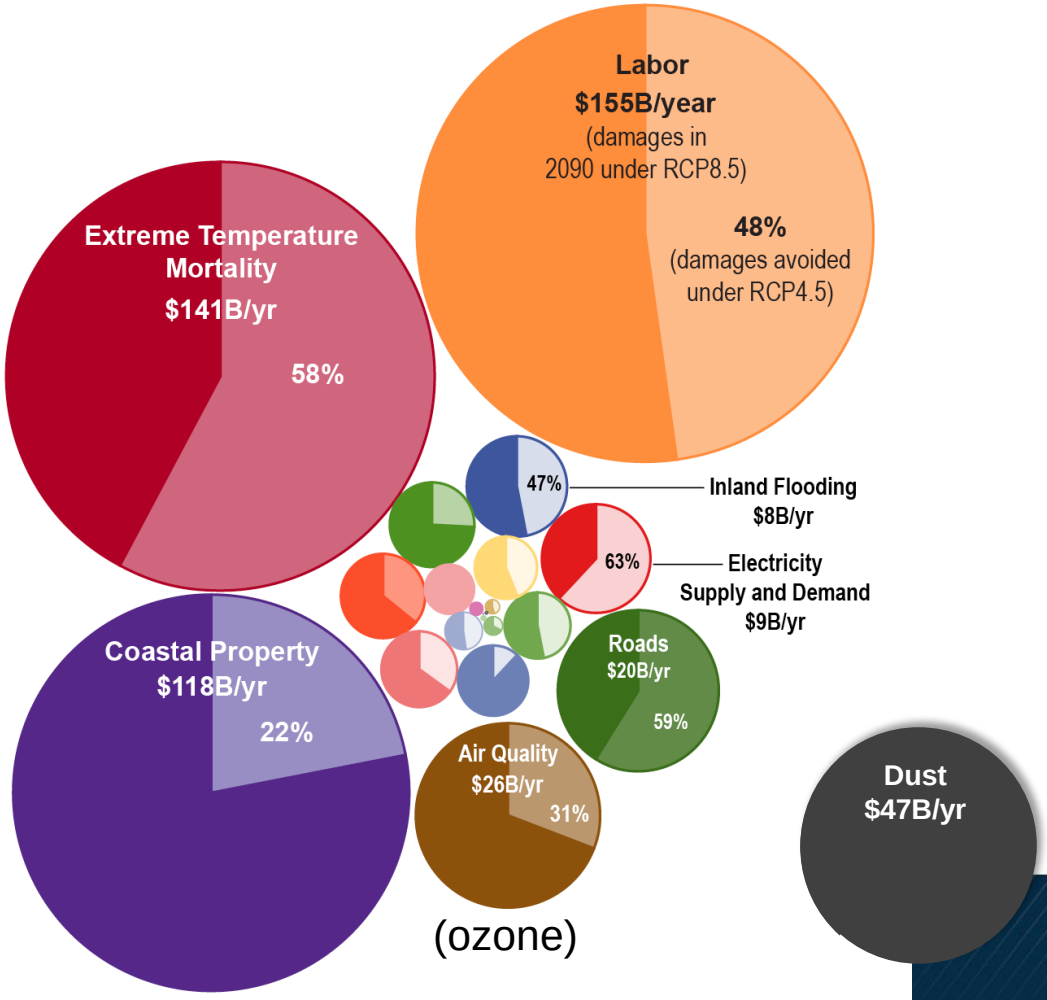


In 2090, dust-attributable mortality could increase by 220% and morbidity by 160% due to rises in dust, population, and baseline disease rates.

Climate-driven changes in dust concentrations alone can account for ~40% of these increases.

Achakulwisut et al. 2019

The EPA's Climate Change Impacts and Risk Analysis (CIRA) framework quantifies damages across different US sectors using consistent greenhouse gas concentration and socioeconomic scenarios

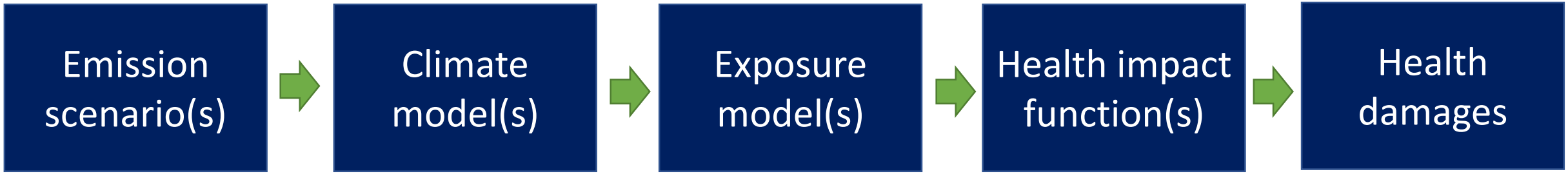


The Fourth National Climate Assessment reported that climate change is expected to cause substantial damages to multiple US sectors, with the largest risks in 2090 related to extreme temperature mortality, labor productivity decline, and coastal property loss.

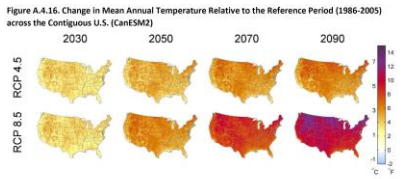
Compared to these projected national-scale climate impacts, **our estimated dust-related health damages of $47 billion/year for four southwestern states rank 4th**, and is ~2 times larger than ozone-related health impacts.

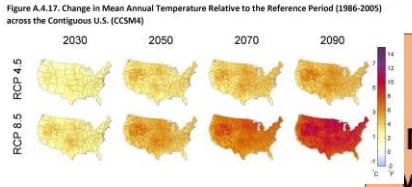
USGCRP, 2018 (NCA4 Vol II)

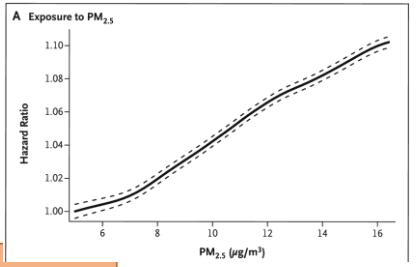
Modeling health impacts of climate change



Modeling air pollution-attributable health impacts of climate change: Example of wildfires







Meteorological variables from 5 LOCA GCMs

Fuel load database of US Forest Service; BC and OC emission factors (Andreae and Merlet 2001)

Present-day meteorology and emissions from all other sources

Concentration-response functions ($PM_{2.5}$ and wildfire-specific); ICLUS v2 demographics

Species	Tropical Forest
OC	5.2 ± 1.5
BC	0.66 ± 0.31

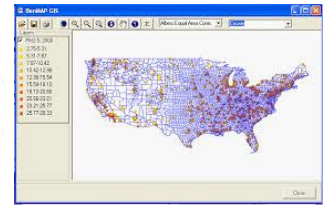
$$\ln(AB) = \begin{cases} \alpha \cdot T \cdot (1.0 - RH/100)^2 \\ T_t \cdot (R + 0.2) \end{cases}$$

Fire area burned model (Yue et al. 2013, 2014)

GEOS-Chem

GEOS-Chem

BenMAP-CE

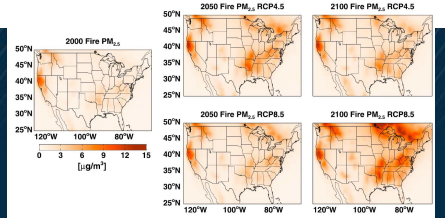


1. Project future fire area burned

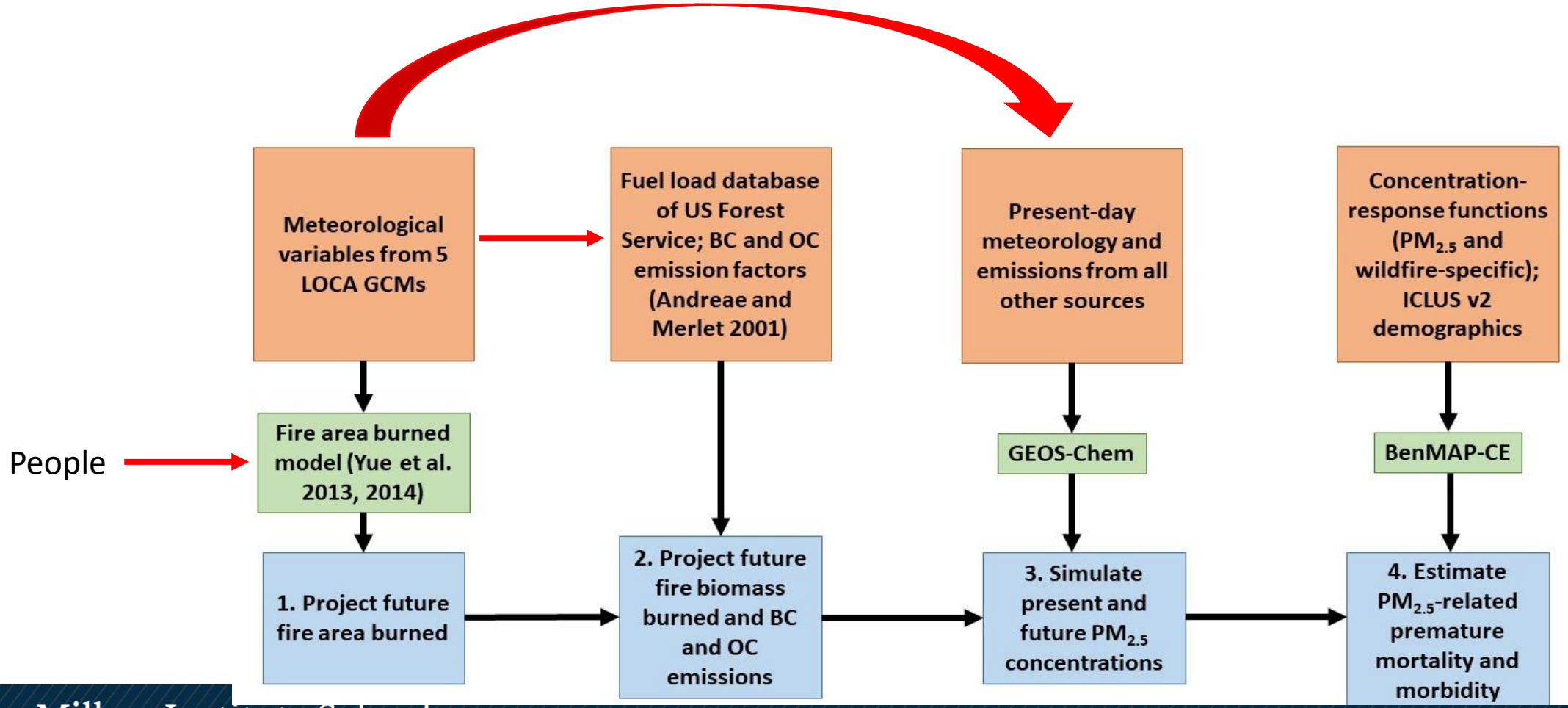
2. Project future fire biomass burned and BC and OC emissions

3. Simulate present and future $PM_{2.5}$ concentrations

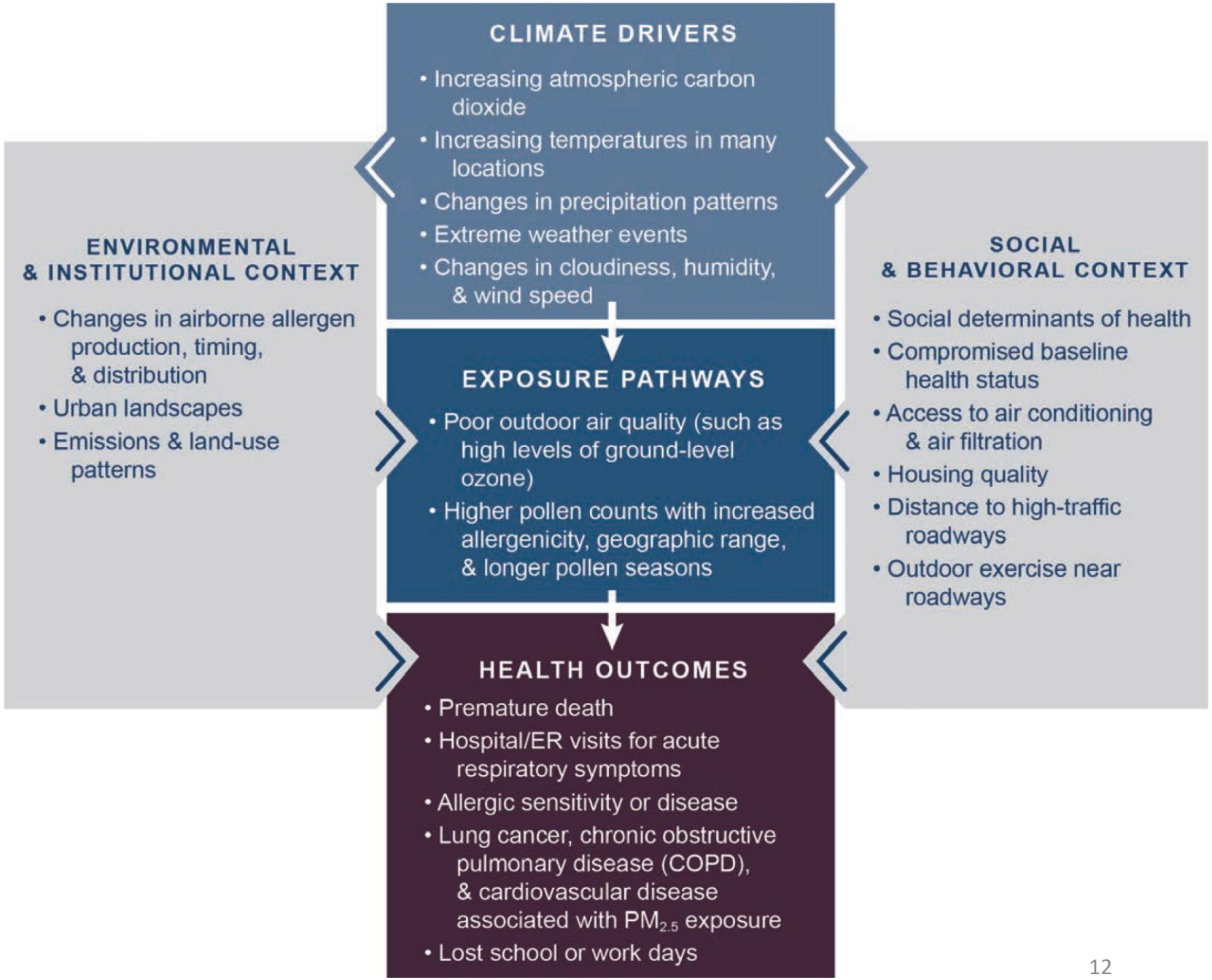
4. Estimate $PM_{2.5}$-related premature mortality and morbidity



Modeling air pollution-attributable health impacts of climate change: Example of wildfires



Climate change and health – a complex system



USGCRP 2016

Final thoughts

- Impacts of climate change on global air pollution (and other health risks) remain unknown, yet may become dominant in some areas in the future
- Heat/cold included in next Global Burden of Disease cycle, but no other climate health connections
- Wish list: Information on drivers of air pollution emissions and exposure
  - Future temp, precipitation, humidity, wind speed projections globally (past 2100!)
  - Incorporate urban heat island effect to capture population exposure
  - Soil aridity and wildfire potential to capture dust and fire smoke
  - Climate influence on land use (expansion/contraction/movement of wildland, desert)
  - Interactions between people, climate, and natural systems
  - Consider adaptation
- Collaborations between climate scientists and health researchers important

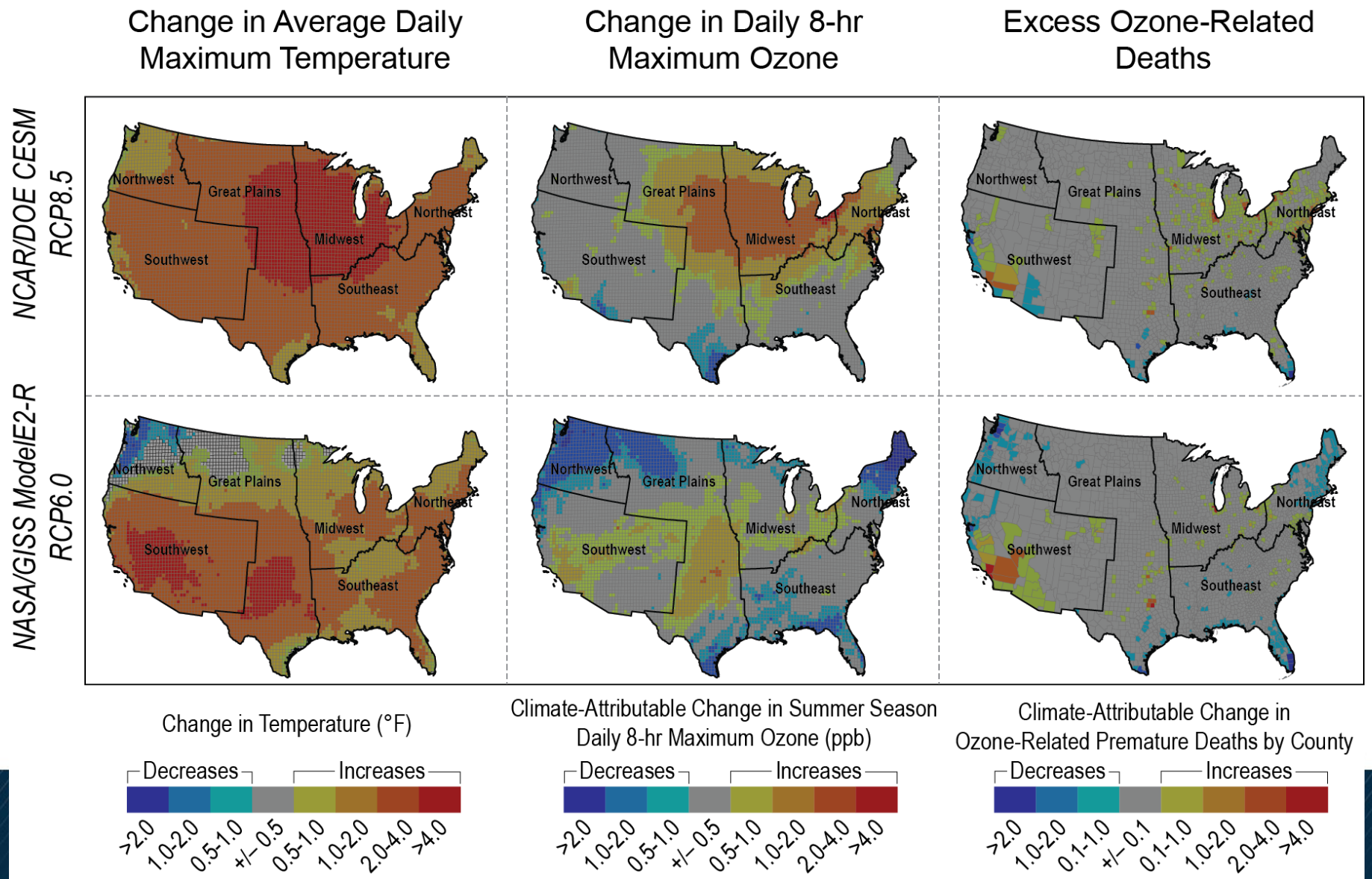
sanenberg@gwu.edu

THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

Ozone penalty

Projected Changes in Temperature, Ozone, and Ozone-Related Premature Deaths in 2030



USGCRP Climate and Health Assessment 2016