

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)



Global Both sexes, All ages, Deaths per 100,000 1990 rank 2016 rank

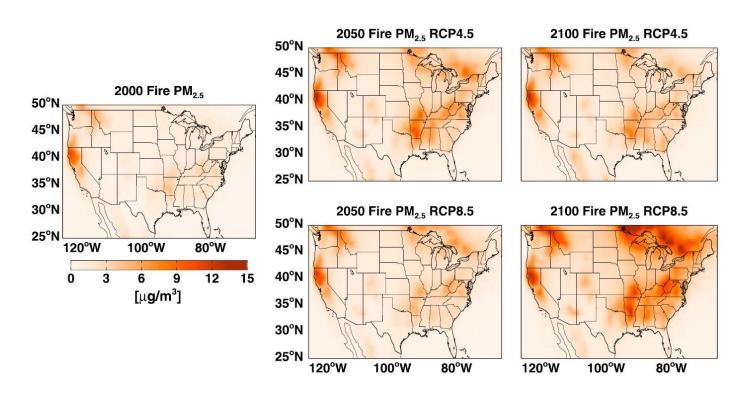
1 Dietary risks 1 High systolic blood pressure 2 High systolic blood pressure 2 Dietary risks 3 Child and maternal malnutrition 3 Tobacco 4 Air pollution 4 Air pollution 5 Tobacco 5 High fasting plasma glucose 6 High total cholesterol 6 High body-mass index 7 High total cholesterol 7 High fasting plasma glucose 8 Alcohol and drug use 8 Unsafe water, sanitation, and handwashing 9 Child and maternal malnutrition 9 High body-mass index 10 Alcohol and drug use 10 Impaired kidney function 11 Impaired kidney function 11 Unsafe water, sanitation, and handwashi 12 Occupational risks 12 Occupational risks 13 Low physical activity 13 Low physical activity 14 Unsafe sex 14 Unsafe sex 15 Other environmental risks 15 Other environmental risks GEORGE INGTON 16 Low bone mineral density 16 Low bone mineral density **ERSITY** 17 Sexual abuse and violence 17 Sexual abuse and violence

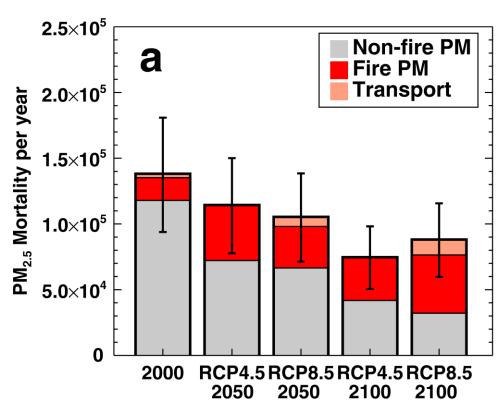
IGTON, DC

Institute for Health Metrics and Evaluation, 2017

> Milken Institu of Public Hea

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





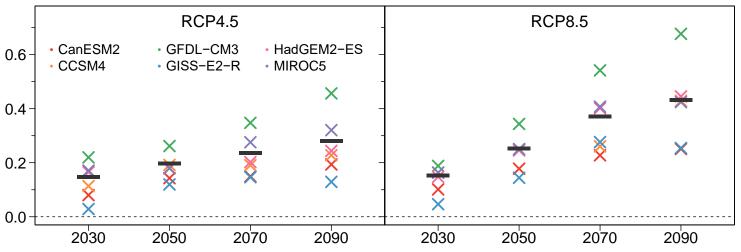
Ford et al. GeoHealth, 2018

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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.

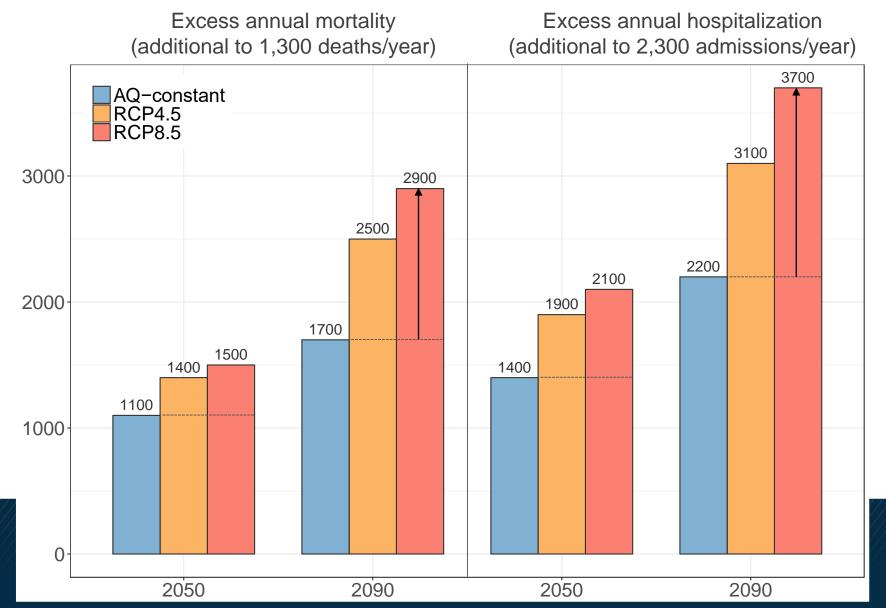
Under RCP8.5 relative to RCP4.5, increases in dust concentrations are 30% larger in 2050 and 60% larger in 2090.

Achakulwisut et al. 2019





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



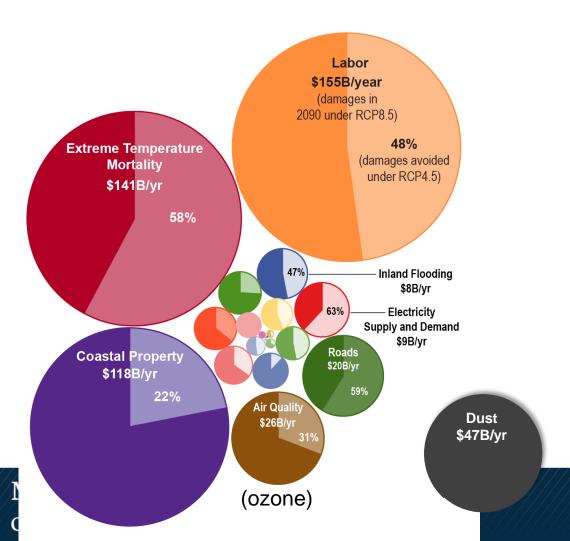
In 2090, dust-attributable mortality could increase by 220% and morbidity by 160% due to rises in dust, population, and baseline disease rates.

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)



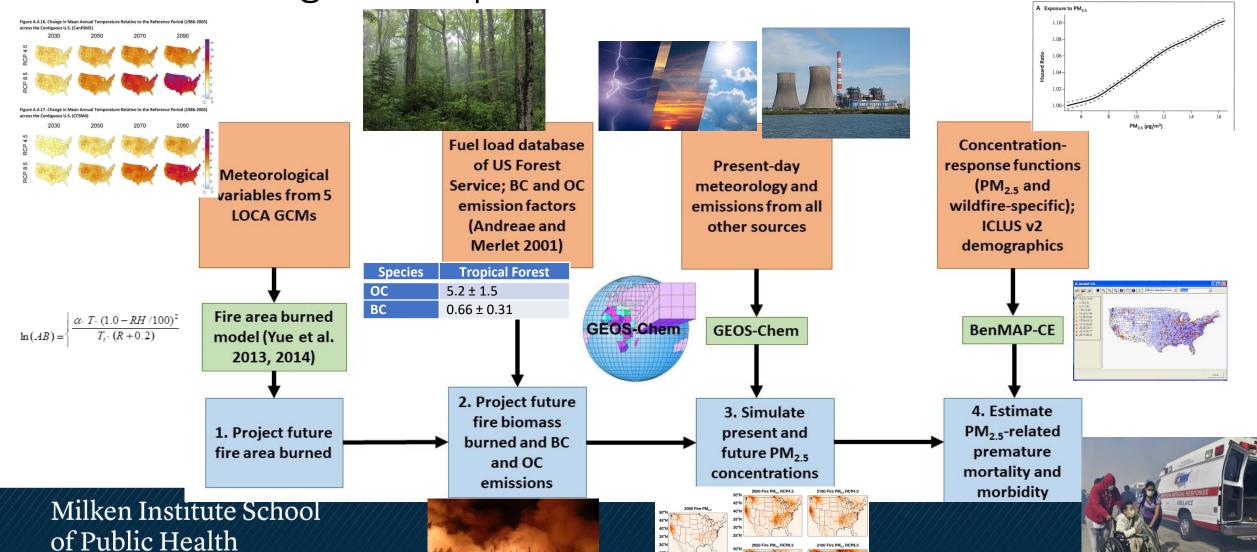
Modeling health impacts of climate change





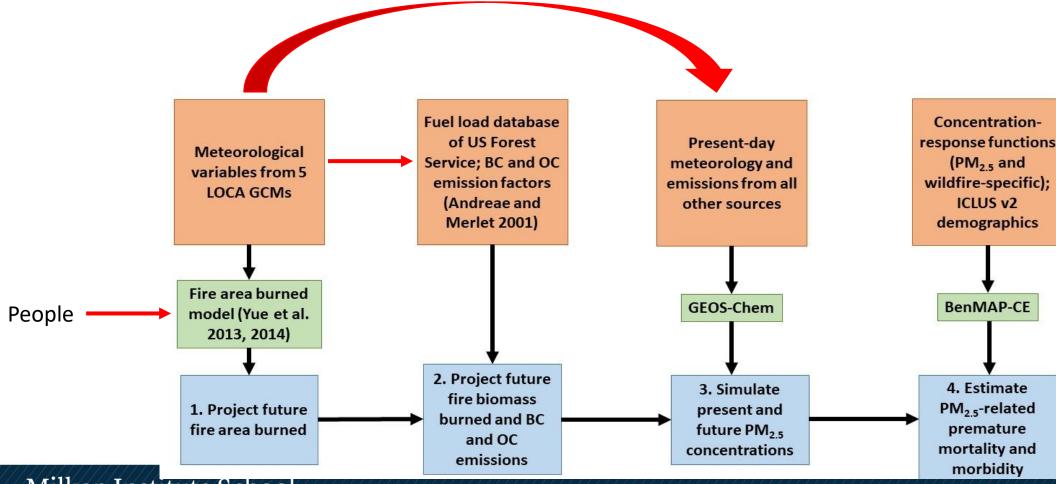


Modeling air pollution-attributable health impacts of climate change: Example of wildfires



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



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Climate change and health – a complex system

ENVIRONMENTAL & INSTITUTIONAL CONTEXT

- Changes in airborne allergen production, timing, & distribution
- Urban landscapes
- Emissions & land-use patterns

CLIMATE DRIVERS

- Increasing atmospheric carbon dioxide
- Increasing temperatures in many locations
- Changes in precipitation patterns
- Extreme weather events
- Changes in cloudiness, humidity,
 & wind speed

EXPOSURE PATHWAYS

- Poor outdoor air quality (such as high levels of ground-level ozone)
- Higher pollen counts with increased allergenicity, geographic range,
 & longer pollen seasons

SOCIAL & BEHAVIORAL CONTEXT

- · Social determinants of health
- Compromised baseline health status
- Access to air conditioning & air filtration
- Housing quality
- Distance to high-traffic roadways
- Outdoor exercise near roadways

HEALTH OUTCOMES

- · Premature death
- Hospital/ER visits for acute respiratory symptoms
- Allergic sensitivity or disease
- Lung cancer, chronic obstructive pulmonary disease (COPD),
 & cardiovascular disease associated with PM_{2.5} exposure
- Lost school or work days

USGCRP 2016

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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

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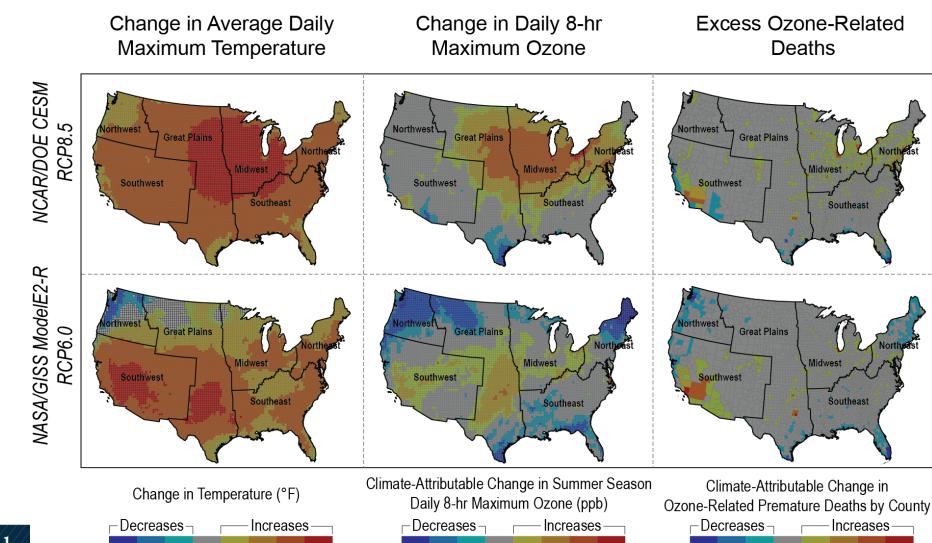


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Ozone penalty

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



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USGCRP Climate and Health Assessment 2016

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