

Air Pollution, Health Impacts, and Disparities in Exposure

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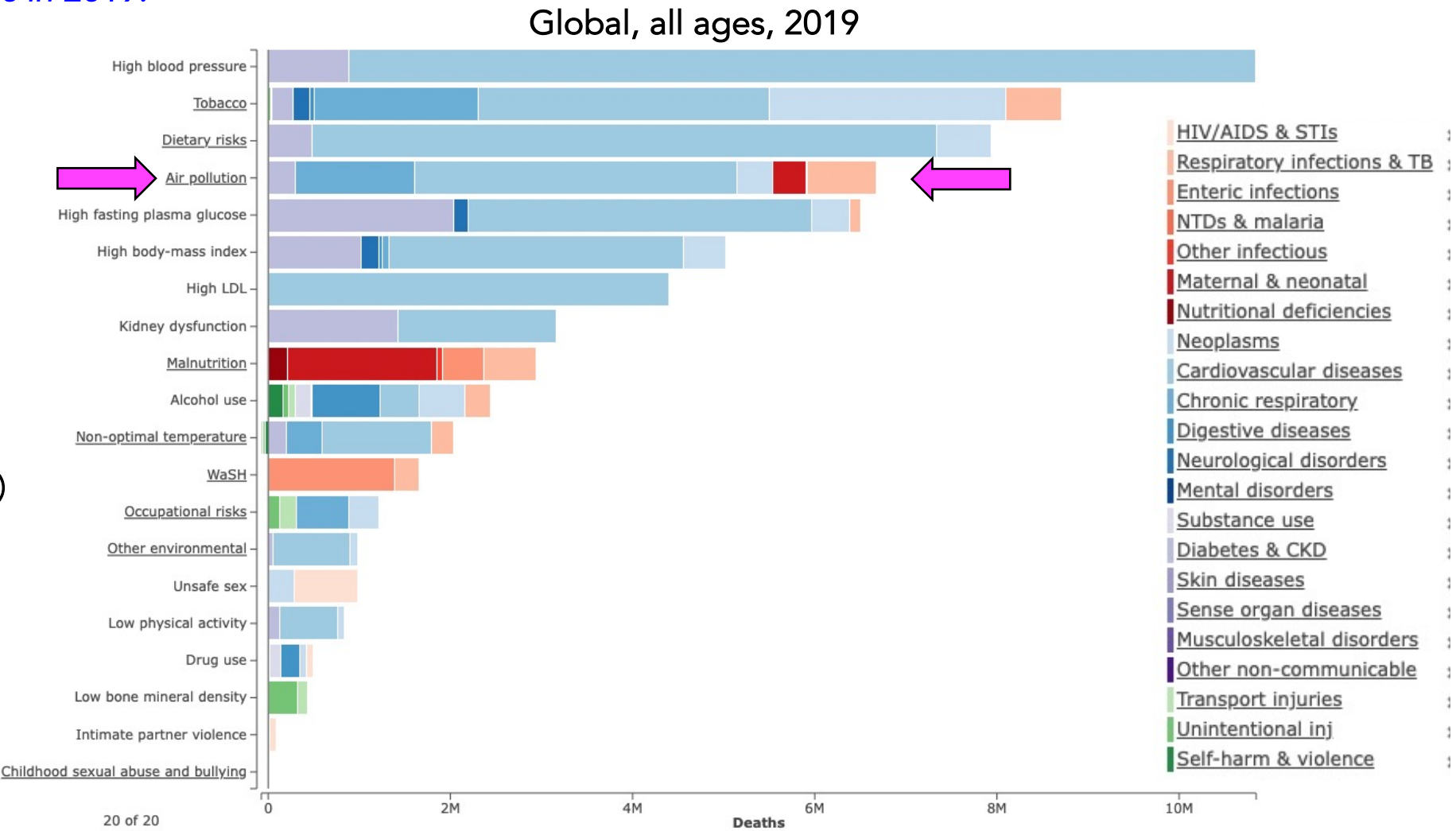


UNIVERSITY OF MINNESOTA

Air pollution is a major public health issue and a leading cause of mortality

The Lancet, vol. 396, 2020

Deaths attributed to top risk factors in 2019:



GLOBALLY:
>6.6M deaths/y from indoor
+ outdoor air pollution

For comparison
HIV/AIDS + malaria + TB combined:
~3.6M deaths/y globally in 2020 (WHO)

Combined effects of indoor + outdoor air pollution estimated to account for 6.6M deaths annually

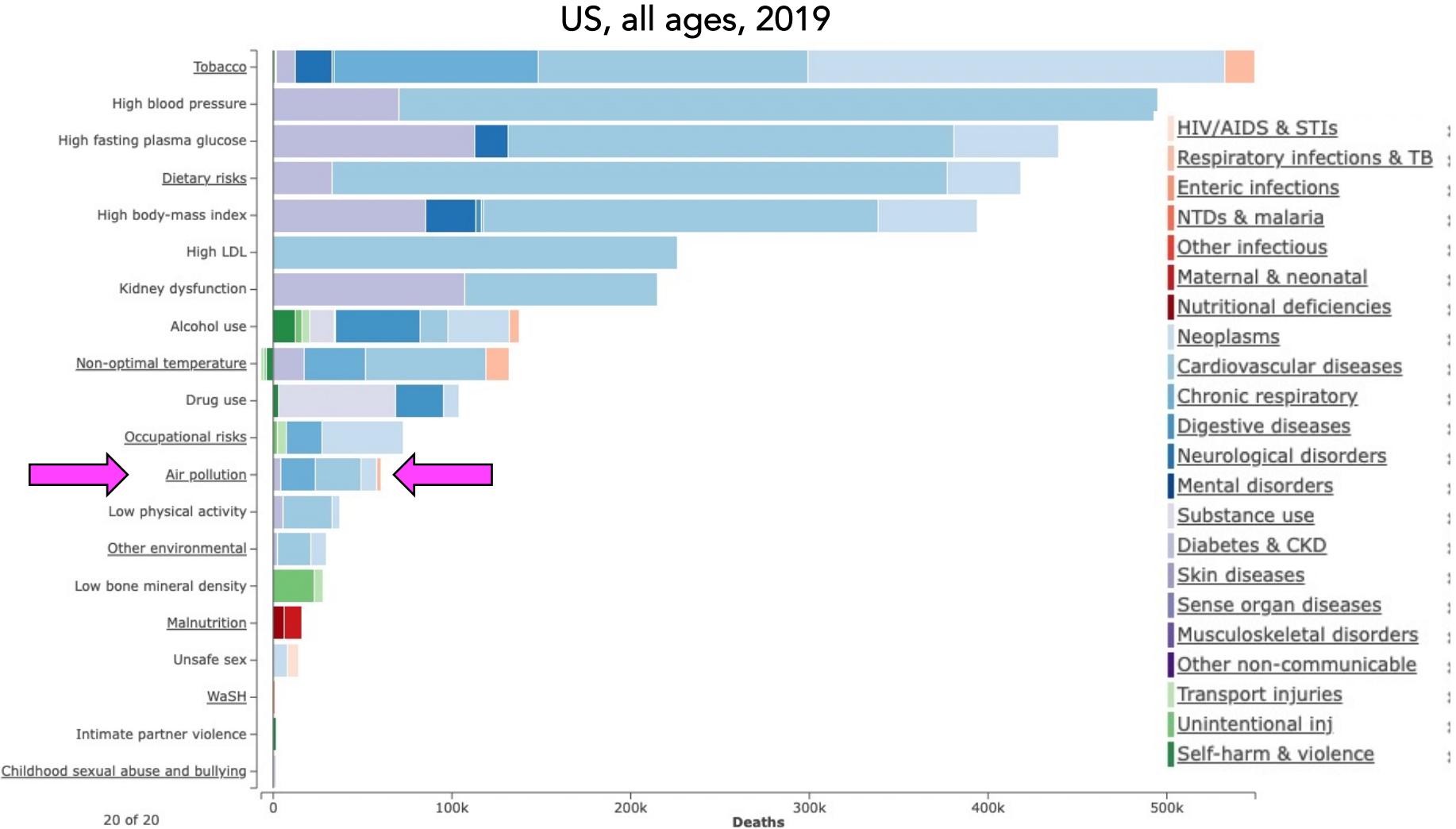
Air pollution is a major public health issue and a leading cause of mortality

The Lancet, vol. 396, 2020

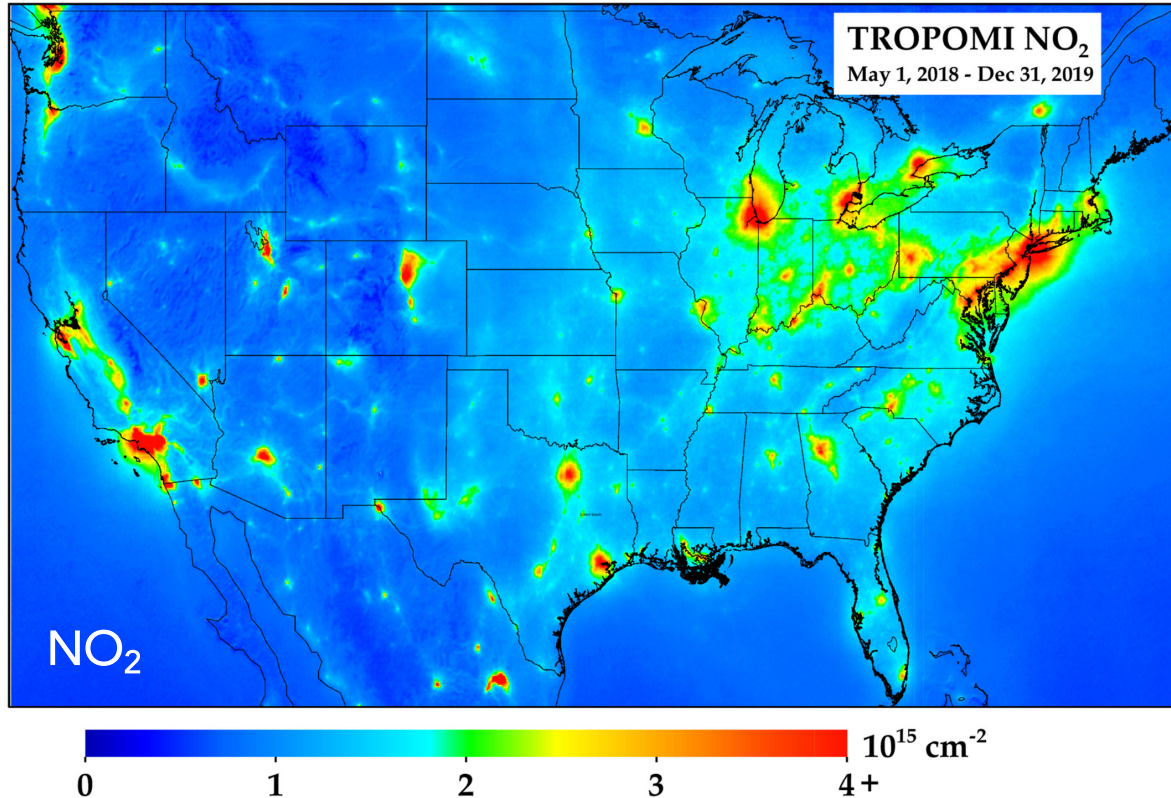
Deaths attributed to top risk factors in 2019:

US:
>60,000 deaths/y from indoor
+ outdoor air pollution

For comparison
US traffic deaths:
36,000 in 2019



Our exposure to air pollution depends on where we live

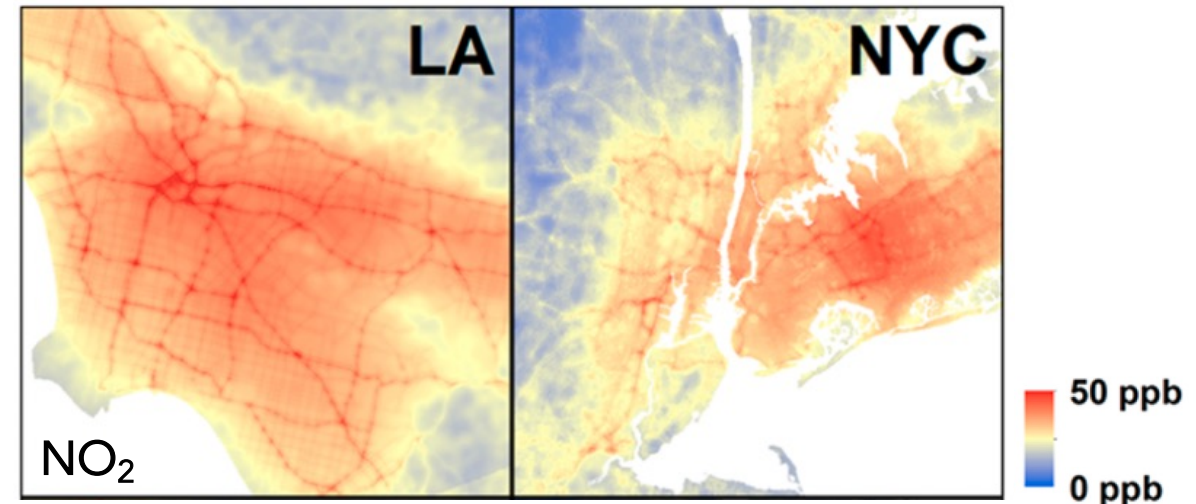


...between cities...

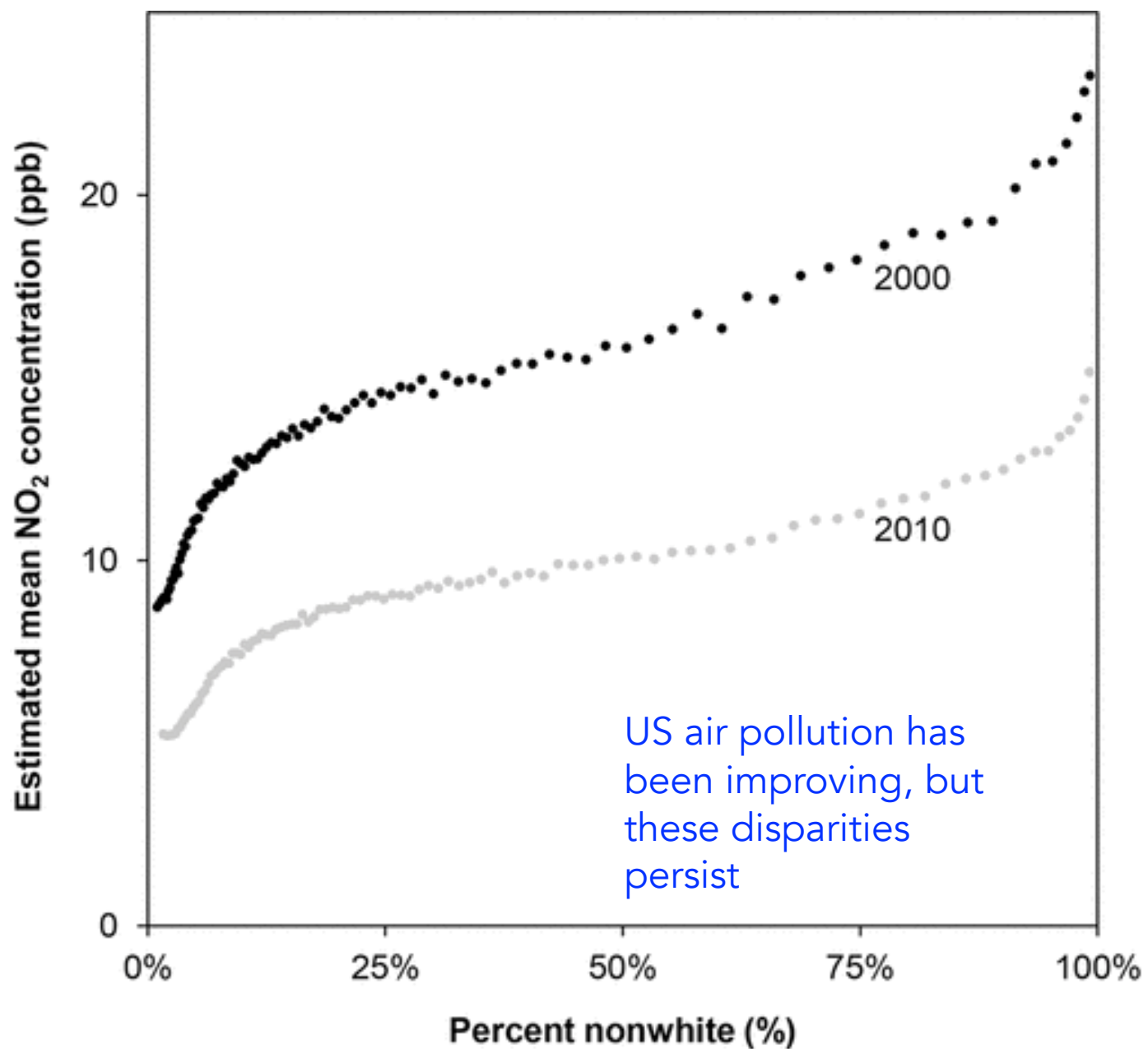
Goldberg et al. (2021)

...and within cities.

Bechle, Millet, and Marshall (2015)

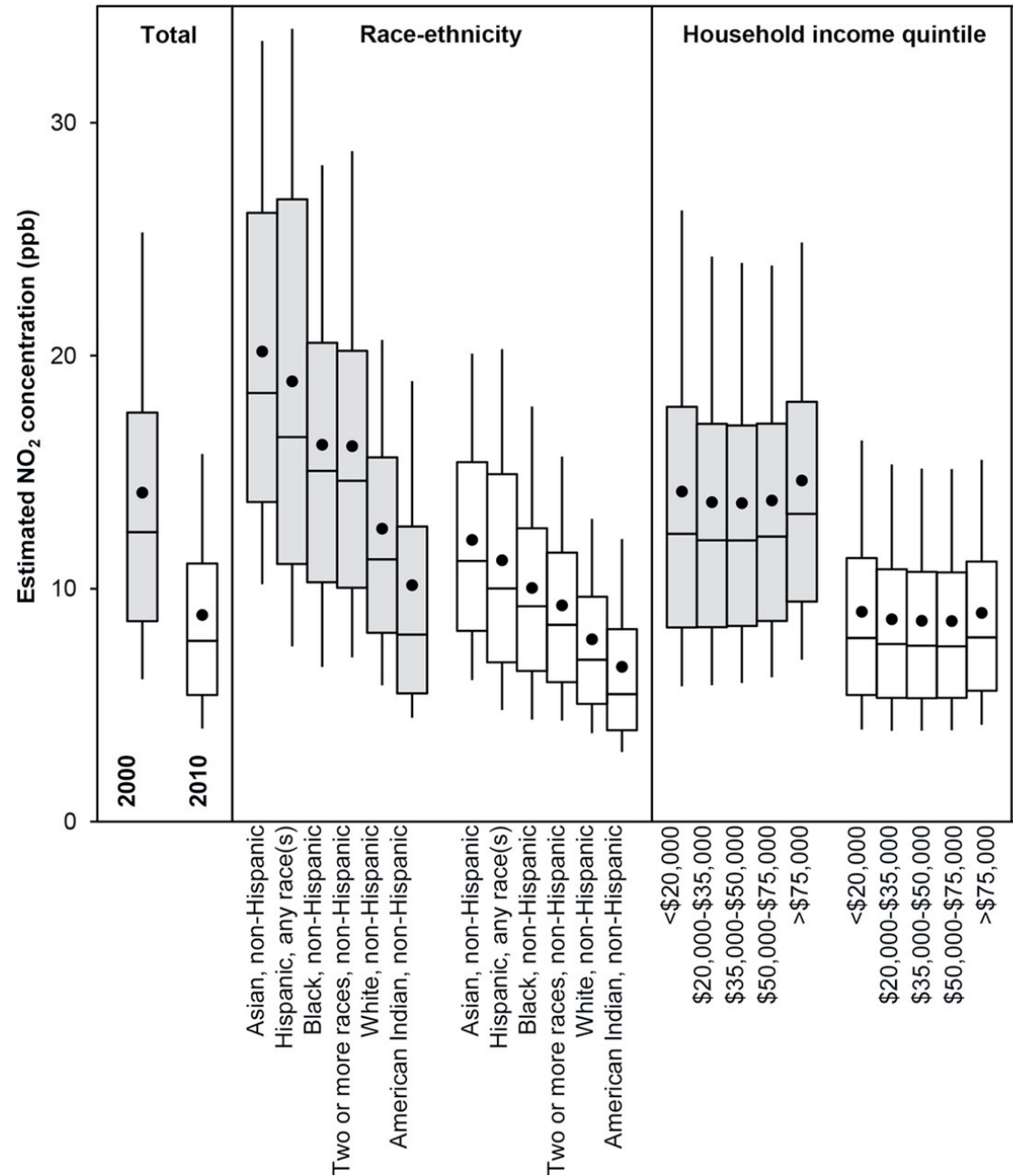


On average, non-white people are exposed to more air pollution in the US



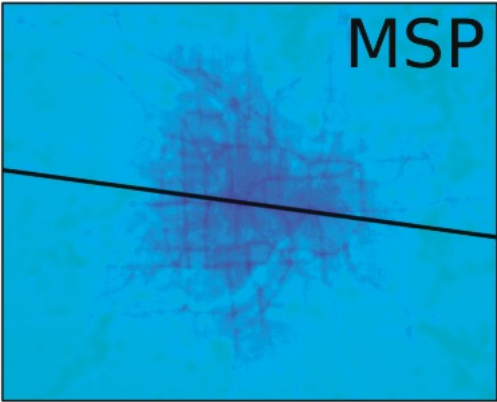
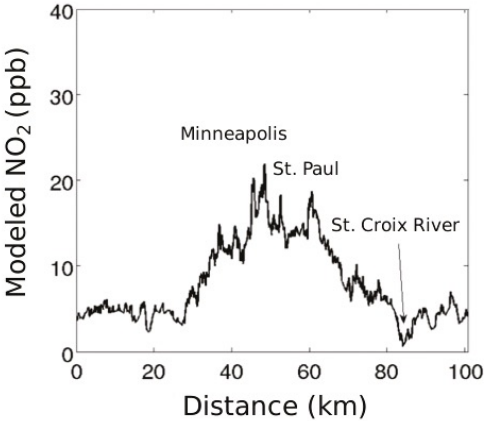
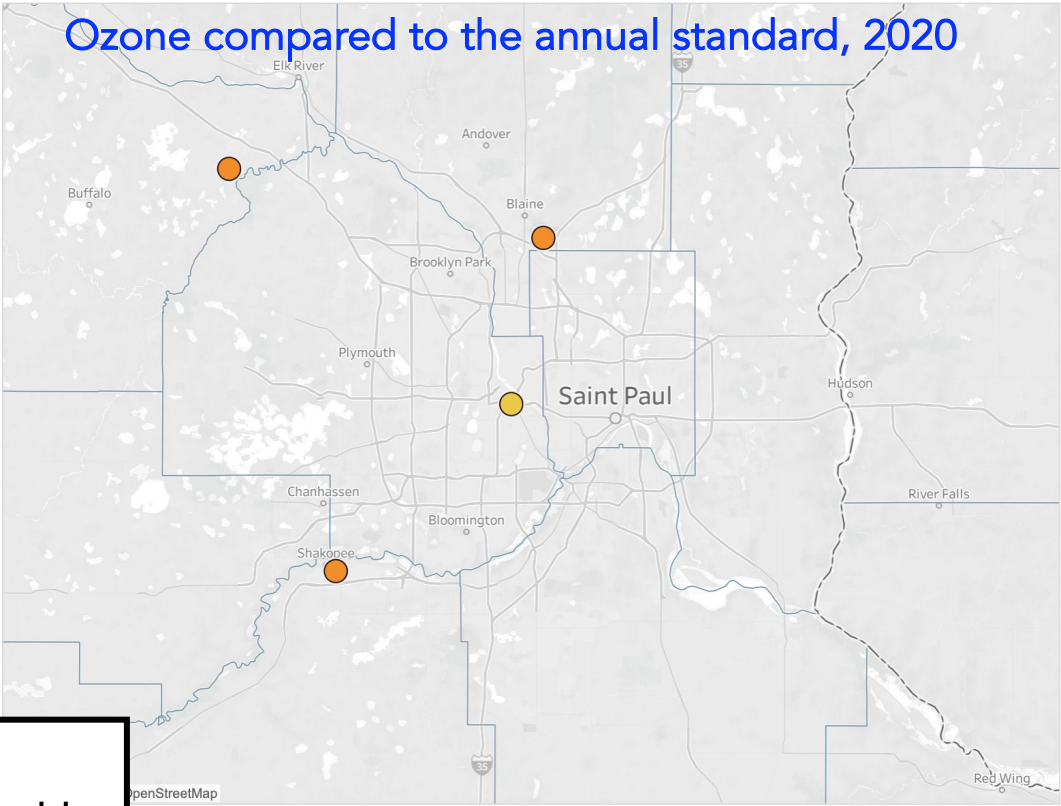
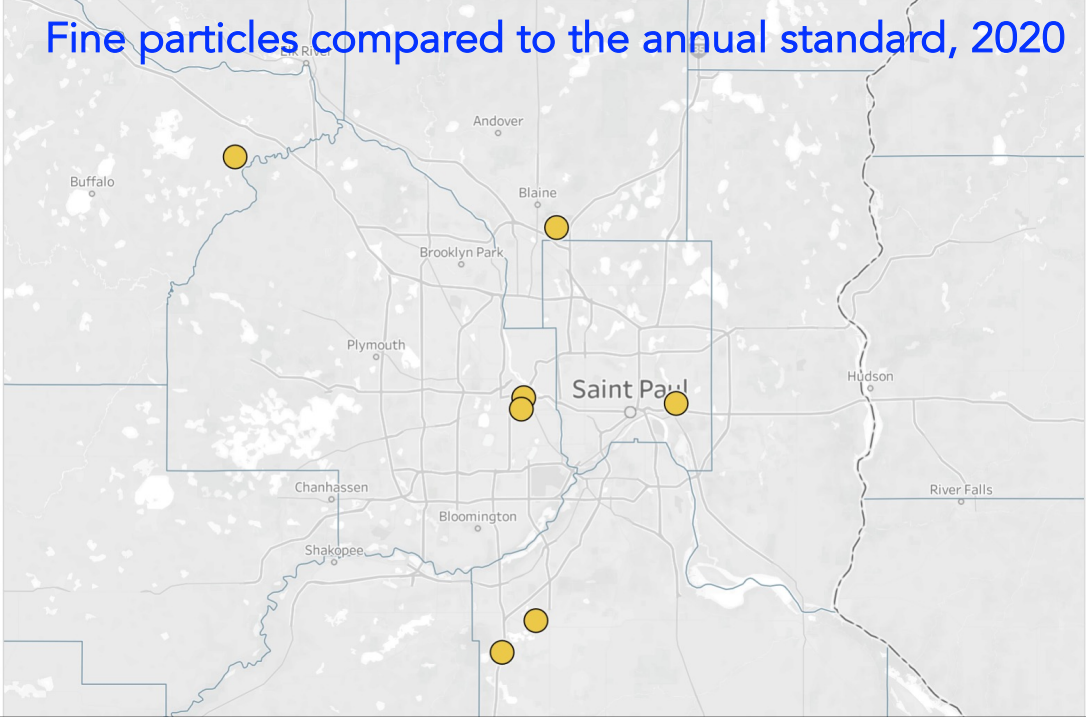
US air pollution has been improving, but these disparities persist

Air pollution disparities by race are much greater than by income

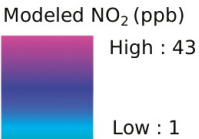


Within the US, there is greater inequality for exposure to NO₂ (a traffic-related air pollutant) than there is for income.

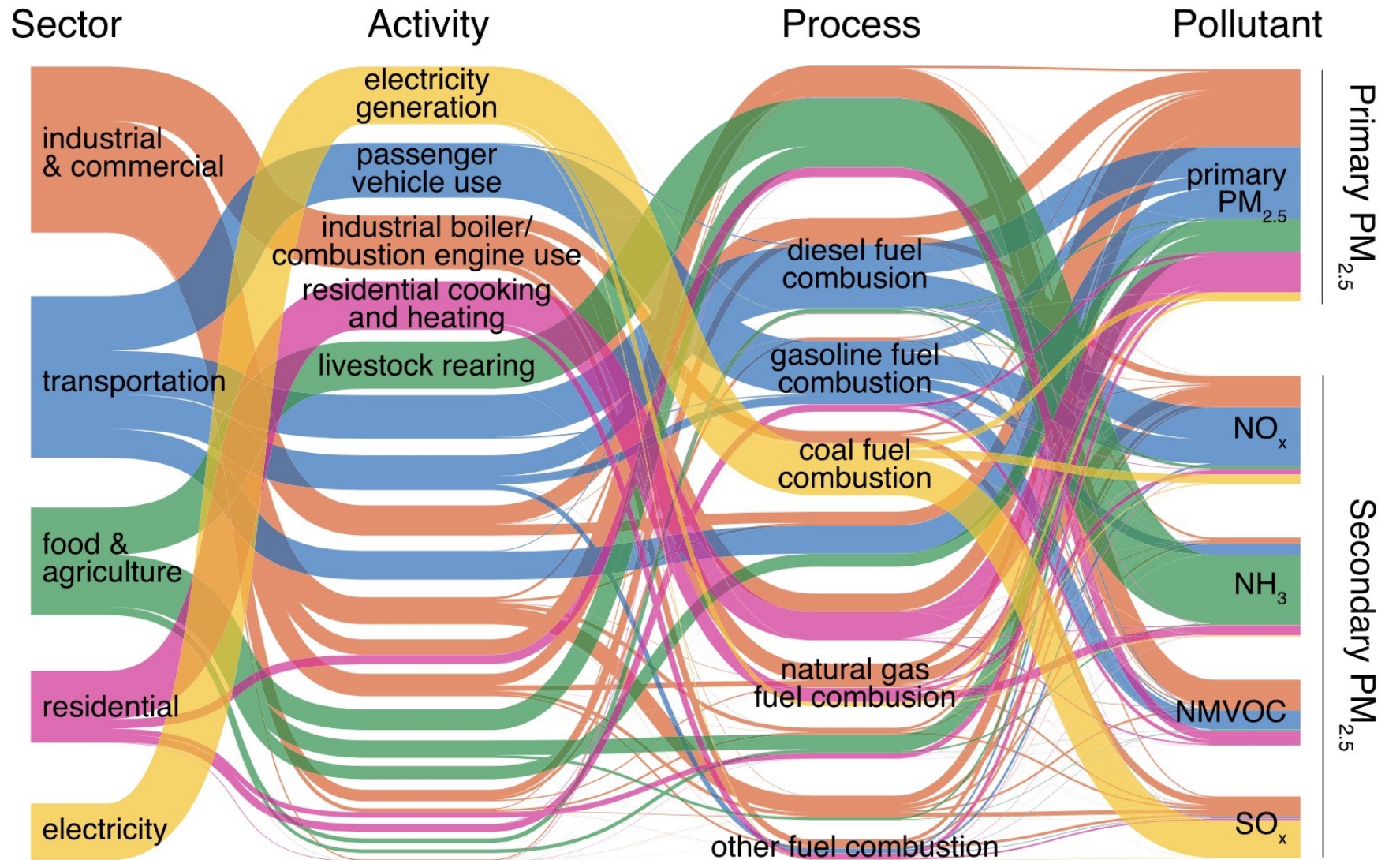
Understanding these disparities, and how they are getting better or worse over time, is challenged by the sparse measuring network



Novotny, Bechle, Millet, and Marshall (2011)



Of the 100,000 deaths
in the United States
each year associated
with exposure to
human-caused,
domestic emissions of
PM_{2.5}-related pollution...



...all five sectors are
major contributors
and no single
sector dominates.

...around half are
attributable to just
five activities, all in
different sectors.

...around half are
attributable to fossil
fuel combustion.

...both primary and
secondary PM_{2.5} are
important, including from
unregulated pollutants.

Study: Farms' air pollution causes 17,000 deaths yearly

Animal agriculture accounts for bulk of such fatalities, research finds

BY SARAH KAPLAN

The smell of hog feces was overwhelming, Elsie Herring said. The breezes that wafted from the hog farm next to her mother's Duplin County, N.C., home carried hazardous gases: methane, ammonia, hydrogen sulfide.

"The odor is so offensive that we start gagging, we start coughing," she told a congressional committee in November 2019. Herring, who died last week, said she and other residents developed headaches, breathing problems and heart conditions from the fumes.

Now, a first-of-its-kind study shows that air pollution from Duplin County farms is linked to roughly 98 premature deaths per year, 89 of which are linked to emissions directly caused by hogs. Those losses are among more than 17,000 annual deaths attributable to pollution from farms across the United States, according to research published today in the Proceedings of the National Academy of Sciences.

Animal agriculture is the worst emitter, researchers say, responsible for 80 percent of deaths from



ALEX WROBLEWSKI/BLOOMBERG NEWS

Floodwaters surround a hog farm in a photo taken above Vanceboro, N.C. Emissions tied to animal agriculture now account for more annual deaths than pollution from coal power plants, research published in the Proceedings of the National Academy of Sciences shows.

according to the American Lung Association.

"You go through the central valley and it's just this thick layer of gray," said Almaraz, who is the program manager for the Working Lands Innovation Center at the University of California at Davis.

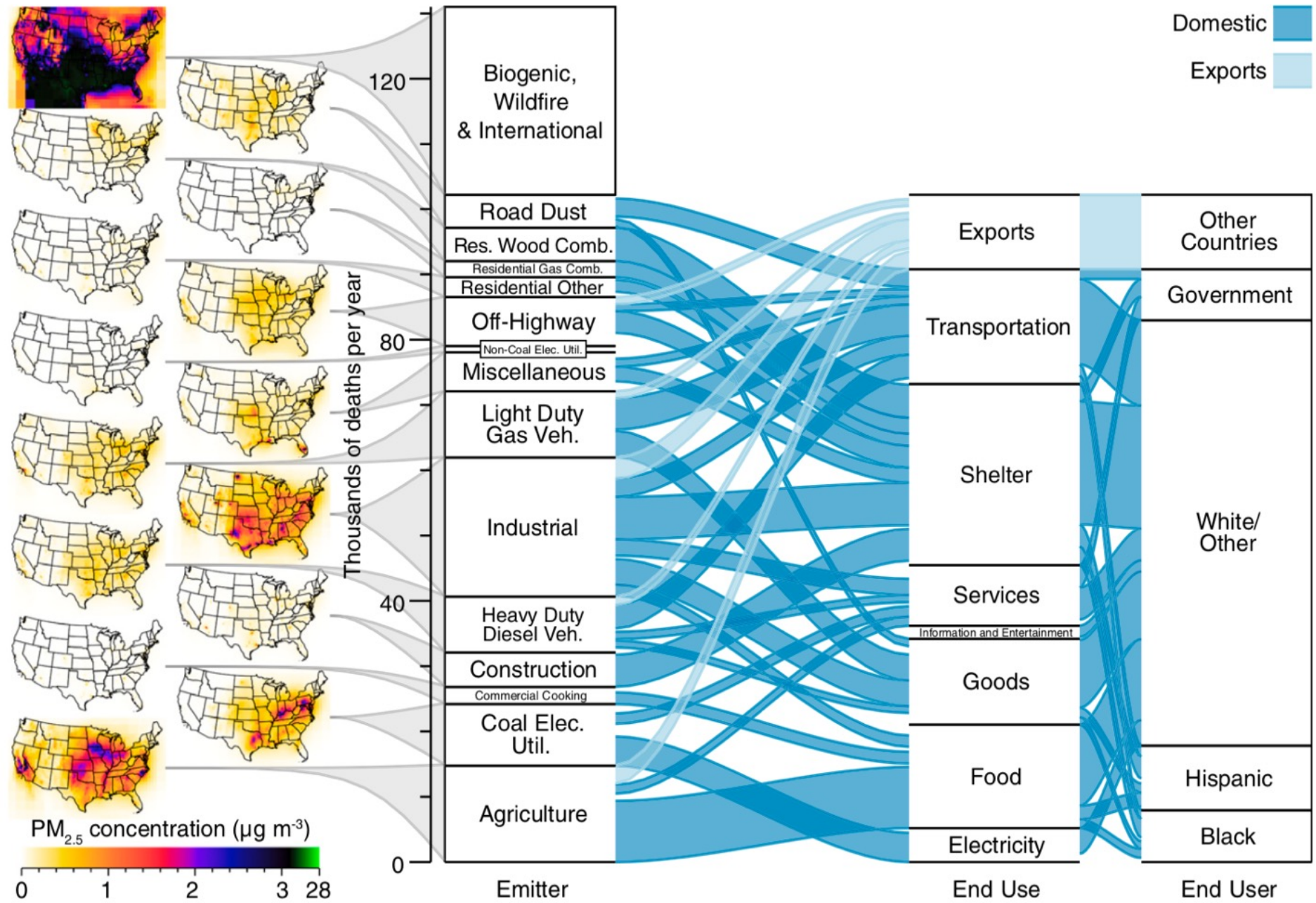
Although California has some of the country's strictest air-quality standards for cars and smokestacks, she said, "we're not really doing anything at a regulatory standpoint to decrease emissions coming from farms."

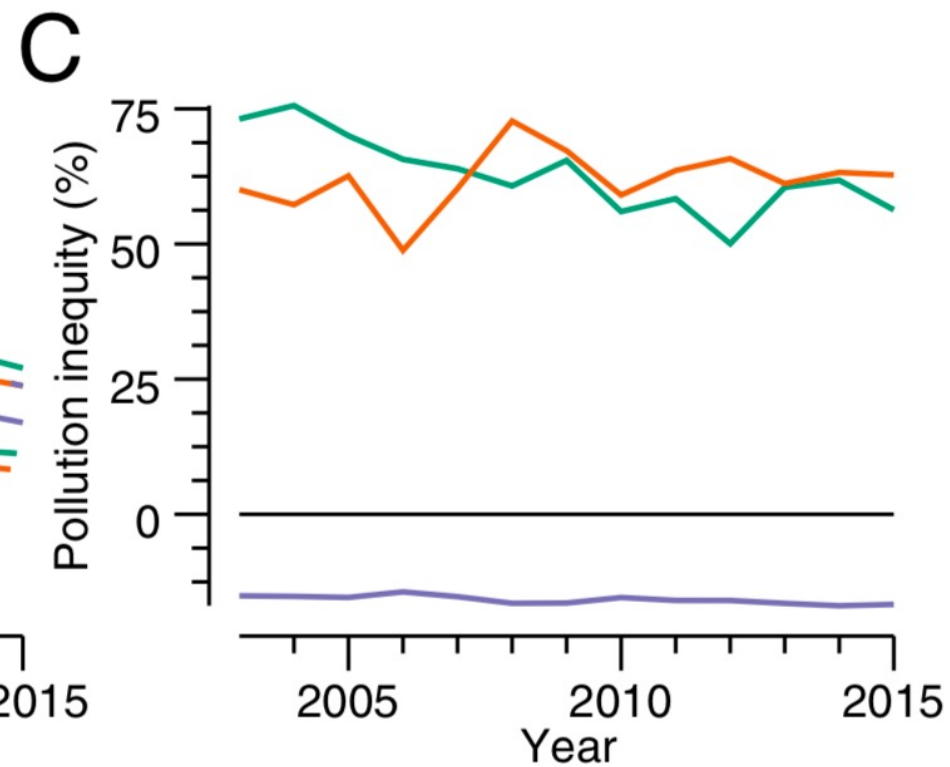
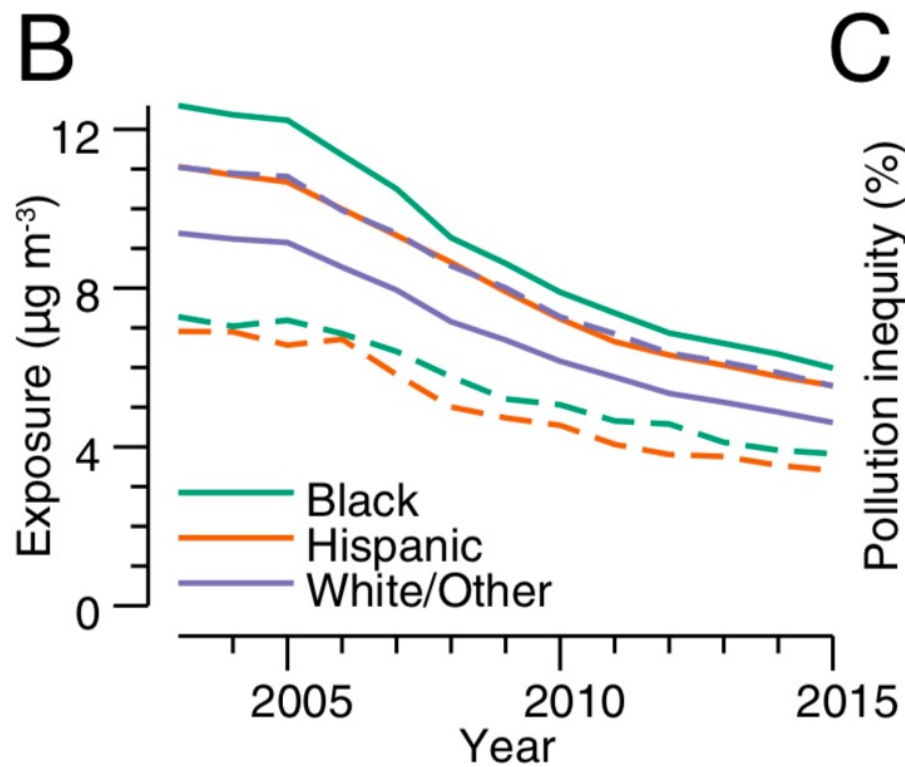
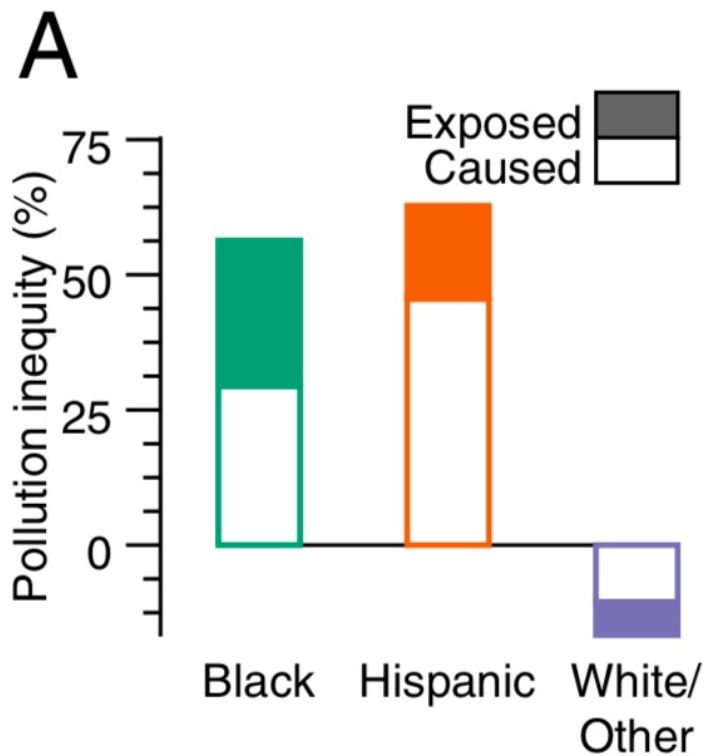
"But recognizing these sources really provides mitigation opportunities," she added. "Now that we know this is an important source, what can we do about it?"

Hill and his colleagues found that farmers could halve the number of air-pollution deaths from food production by changing their practices. Instead of leaving manure to decompose in lagoons, they could incorporate it into soil as fertilizer. Covering lagoons, separating urine from feces, and controlling the acidity and temperature of lagoons would also reduce ammonia emissions.

"We know the technology is there," said Devon Hall, an environmental justice advocate who co-founded REACH in Duplin County. "And we would hope that the industry would do the right thing."

Targeted fertilizer applications would reduce the amount of am-



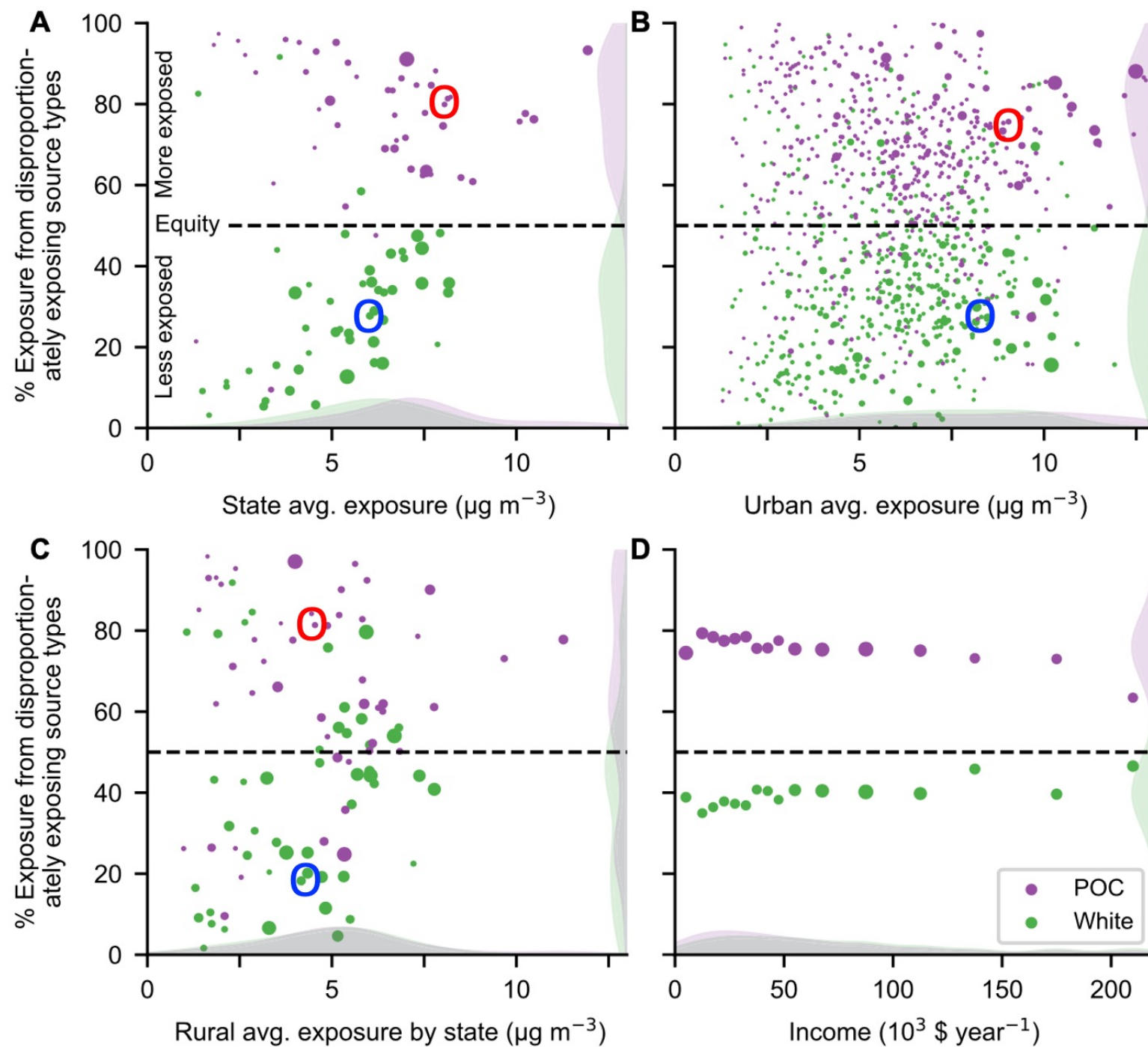


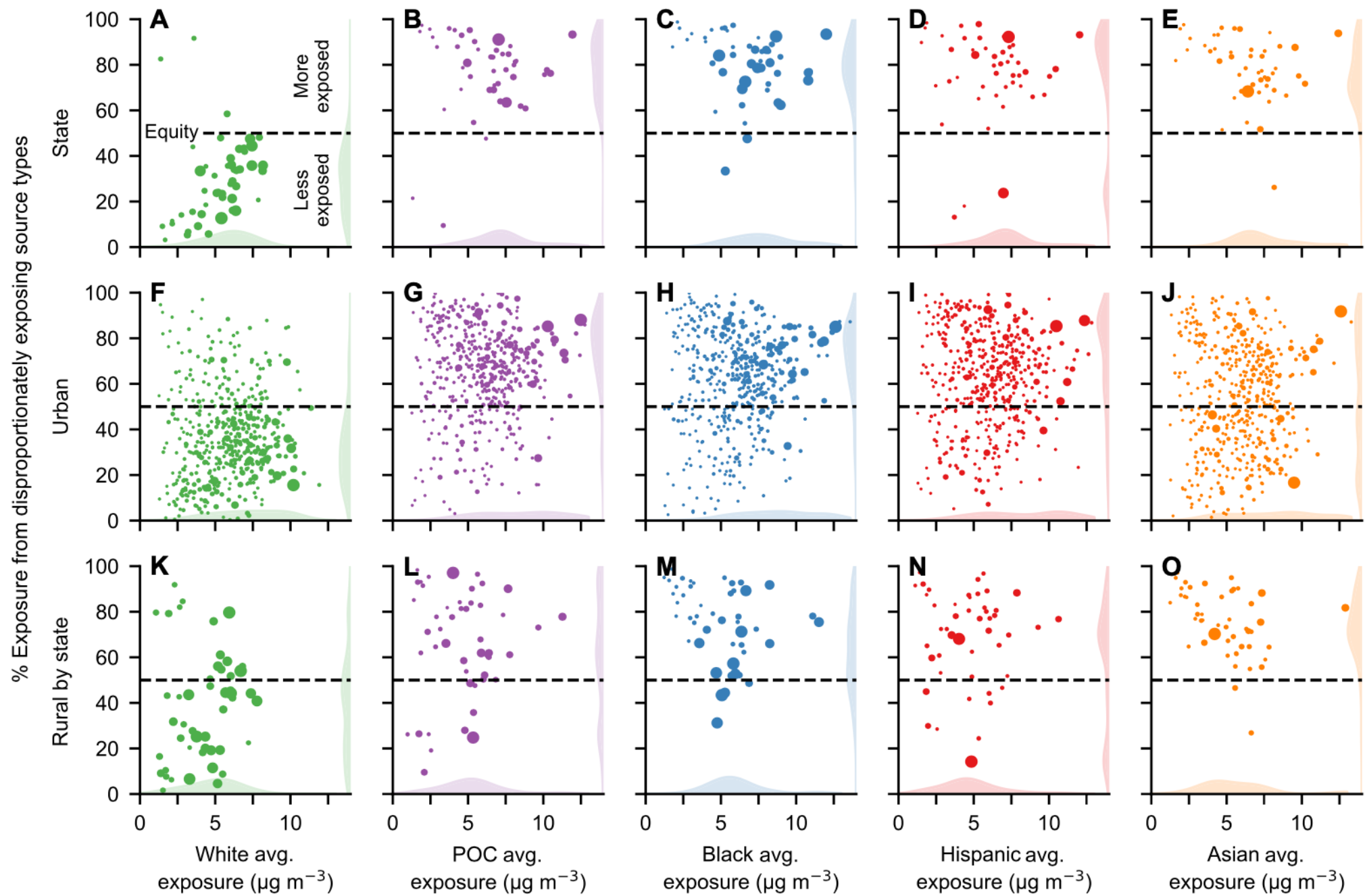
SCIENCE POLICY

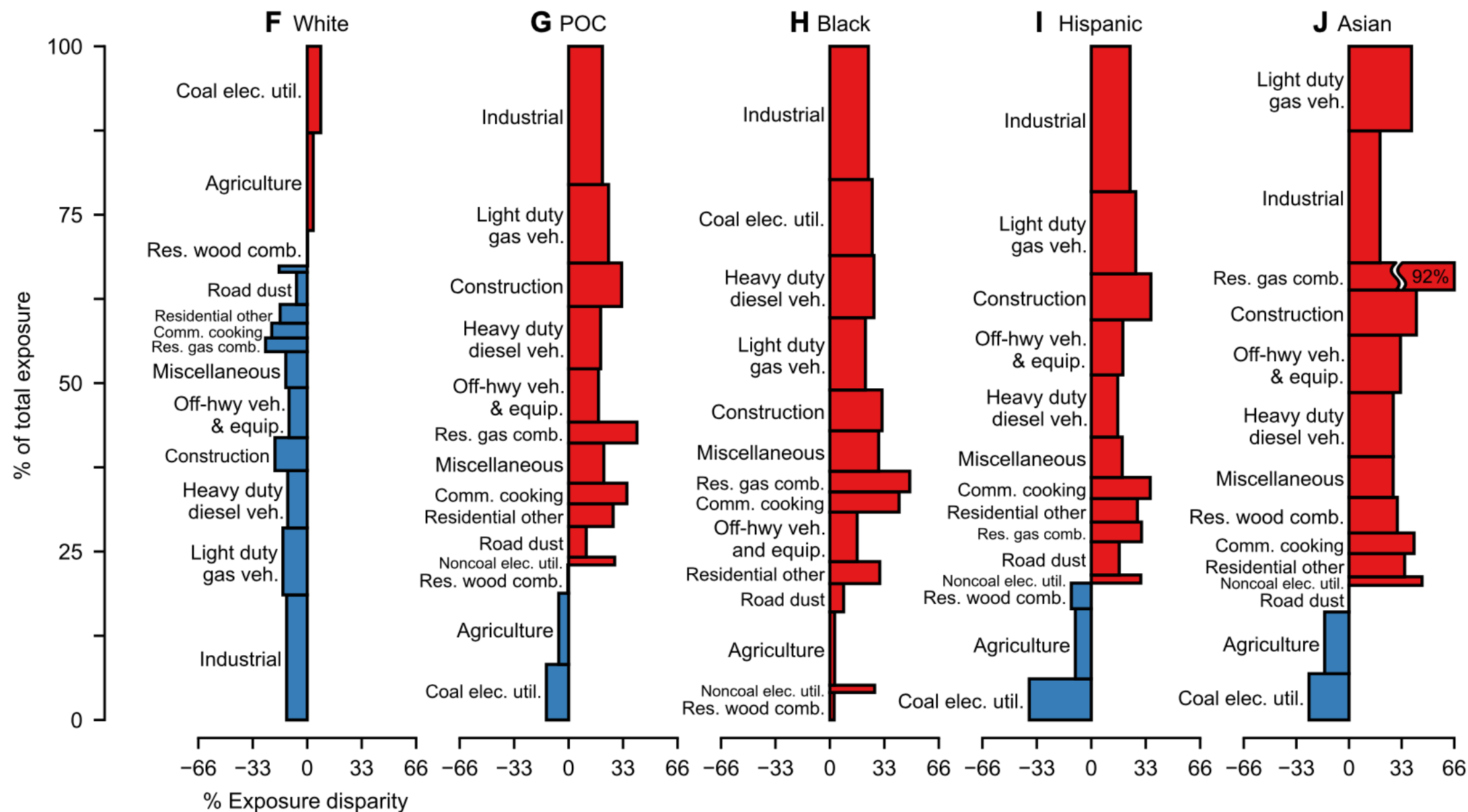
PM_{2.5} polluters disproportionately and systemically affect people of color in the United States

Christopher W. Tessum^{1*}, David A. Paoletta^{2†}, Sarah E. Chambliss³, Joshua S. Apte^{4,5}, Jason D. Hill⁶, Julian D. Marshall²

Racial-ethnic minorities in the United States are exposed to disproportionately high levels of ambient fine particulate air pollution (PM_{2.5}), the largest environmental cause of human mortality. However, it is unknown which emission sources drive this disparity and whether differences exist by emission sector, geography, or demographics. Quantifying the PM_{2.5} exposure caused by each emitter type, we show that nearly all major emission categories—consistently across states, urban and rural areas, income levels, and exposure levels—contribute to the systemic PM_{2.5} exposure disparity experienced by people of color. We identify the most inequitable emission source types by state and city, thereby highlighting potential opportunities for addressing this persistent environmental inequity.





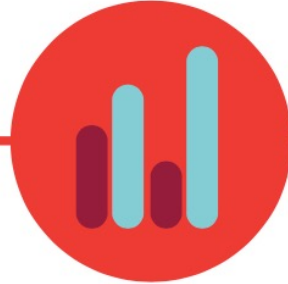


InMAP methodology



1 emissions

InMAP reads annual total emissions from an arbitrary shapefile and allocates them to the model grid.



2 concentrations

InMAP calculates annual average changes in $PM_{2.5}$ concentrations caused by the input emissions.



3 exposure

InMAP estimates changes in human $PM_{2.5}$ exposure caused by the input emissions using census data.



6 environmental justice

InMAP calculates how different demographic groups are exposed to $PM_{2.5}$ even when the groups live in adjacent neighborhoods.



5 economic damage

Optionally, health damages can be converted to economic damages using a Value of Statistical Life metric.



4 health impacts

Using epidemiological concentration-response functions, InMAP calculates the health impacts of the emissions.



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