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Air Pollution from Cars, Trucks, and Buses in the US: Everyone is Exposed, But the Burdens are not Equally Shared

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Air pollution has significant impacts to public health and the cars, trucks, and buses on America's roads contribute to this problem. While we are all exposed to this pollution, there are significant differences in the average exposure to this air pollution by different racial groups in the U.S. and exposure also varies greatly depending on where in the U.S. you live.

Earlier this year, UCS modeled the exposure to vehicular air pollution in California and the Northeast and Mid-Atlantic region. We've now looked at the contiguous U.S. and we find similar trends for which people are most burdened by the most prevalent and harmful type of air pollution, fine particulate matter (known as $PM_{2.5}$). Our model results show that Asian Americans are, on average, exposed to 34 percent higher levels of $PM_{2.5}$ from vehicles than the average for the total U.S. population. Other groups also have higher than average exposure: African Americans are burdened with 24 percent higher than average exposure, and Latinos

have 23 percent higher exposure. On the other hand, exposure of whites to $PM_{2.5}$ from vehicles is, on average, 14 percent lower than the average exposure for everyone.

What is $PM_{2.5}$ air pollution and why is it bad?

Exposure to $PM_{2.5}$ (particulate matter smaller than 2.5 micrometers in diameter) is linked to increased illness and death, primarily from heart and lung diseases. But this air pollution can also cause many other ill effects, including cancers, cognitive disorders, and low birthweights. These microscopic particles are small, as the largest are 20 times smaller than the diameter of fine human hair and can be much smaller. This means they can penetrate deeply into the lungs, and the smallest particles can even enter the bloodstream. While $PM_{2.5}$ is not the only air pollutant that adversely affects health, it is estimated to be responsible for approximately 95 percent of the global public health impacts from air pollution. Long-term exposure to $PM_{2.5}$ causes increased death rates attributed to cardiovascular diseases, including heart attacks, and has been linked to other adverse impacts such as lung cancer. Chronic exposure to $PM_{2.5}$ in children has also been linked to slowed lung-function growth, development of asthma, and other negative health impacts.

On-road vehicles like cars, trucks, and buses are a significant source of harmful air pollutant emissions. The burning of fossil fuels such as gasoline and diesel has multiple negative effects: it both produces climate-changing emissions such as carbon dioxide and pollution that reduces air quality and leads to health impacts.

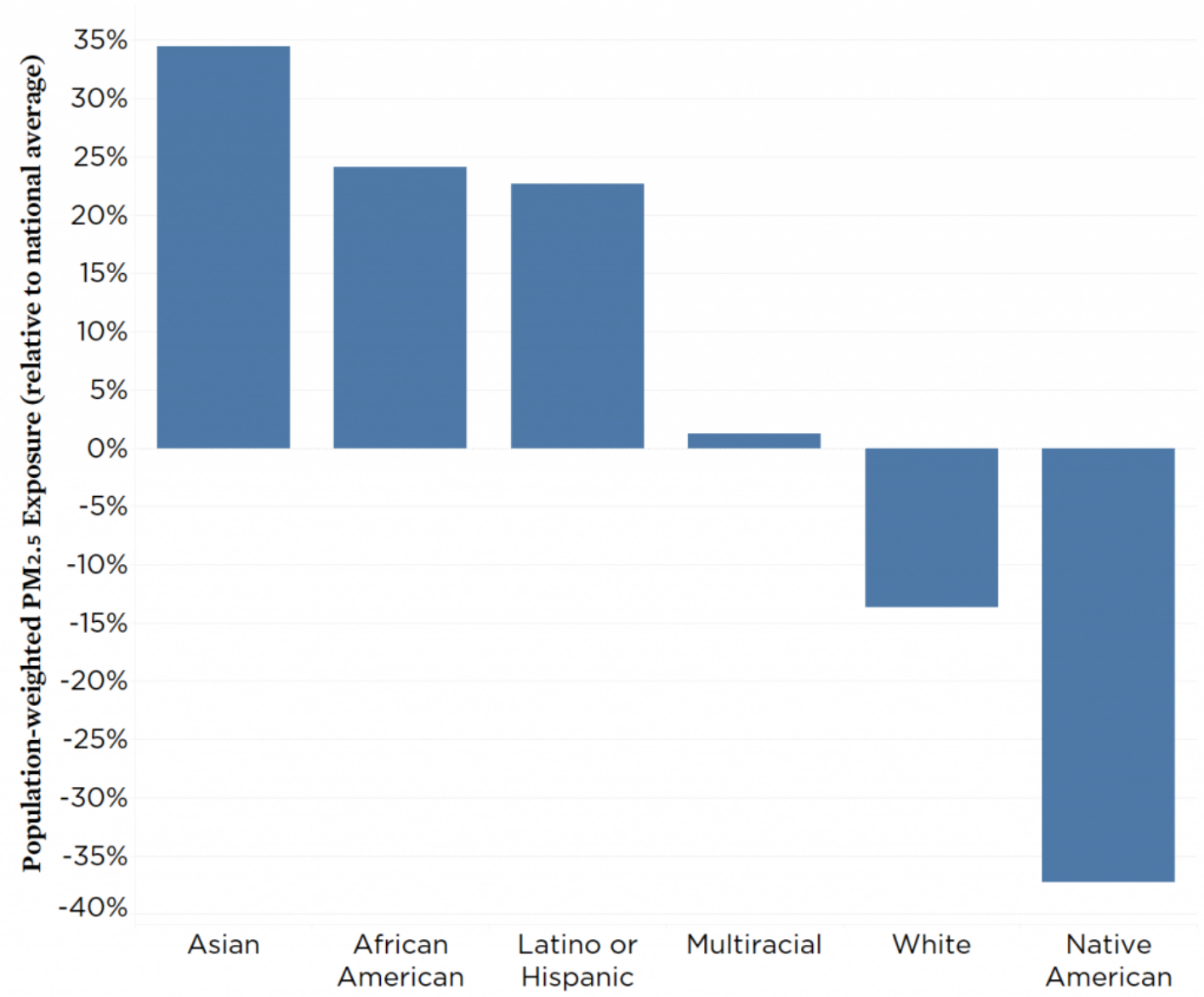
Some $PM_{2.5}$ pollution forms directly during combustion and is present in vehicle exhaust. Additional $PM_{2.5}$ particles are generated by brake and tire wear. However, much of the $PM_{2.5}$ forms indirectly through the reactions of pollutant gases in the atmosphere, often in combination with sunlight. These pollutant gases that can lead to particle formation include ammonium, nitrogen oxides, sulfur oxides, and volatile organic compounds. Most of these pollutants are emitted in vehicle exhaust, though volatile organic compounds also come from the evaporation of gasoline during refueling and from leaks in vehicles' fuel tanks and lines.

This means that the total exposure to $PM_{2.5}$ pollution (from both direct and indirect sources) at any location depends on several variables. These include the location of the $PM_{2.5}$ and precursor $PM_{2.5}$ -forming emissions from tailpipes and refueling locations. Weather patterns and geography play a role in the generation of secondary $PM_{2.5}$ particles from other air pollutants and these factors also determine the movement of $PM_{2.5}$ pollution once it is generated. Exposure itself depends on the location of both the pollution and the people inhaling the pollution.

We estimated exposure to particulate matter air pollution using a recently developed model from the University of Washington and data from the US EPA and US Census Bureau. This model lets us calculate how vehicle tailpipe and refueling emissions ultimately lead to ground-level pollution exposure so we can understand how exposure to $PM_{2.5}$ varies among groups and locations. The model takes into account where emissions occur, the formation of additional pollution, and how that pollution moves across the U.S. Note that because limitations of the input data, the data shown is for the 48 contiguous states (excluding Alaska and Hawaii).

Greater Exposure to $PM_{2.5}$ Pollution for Asians, Latinos, and African Americans

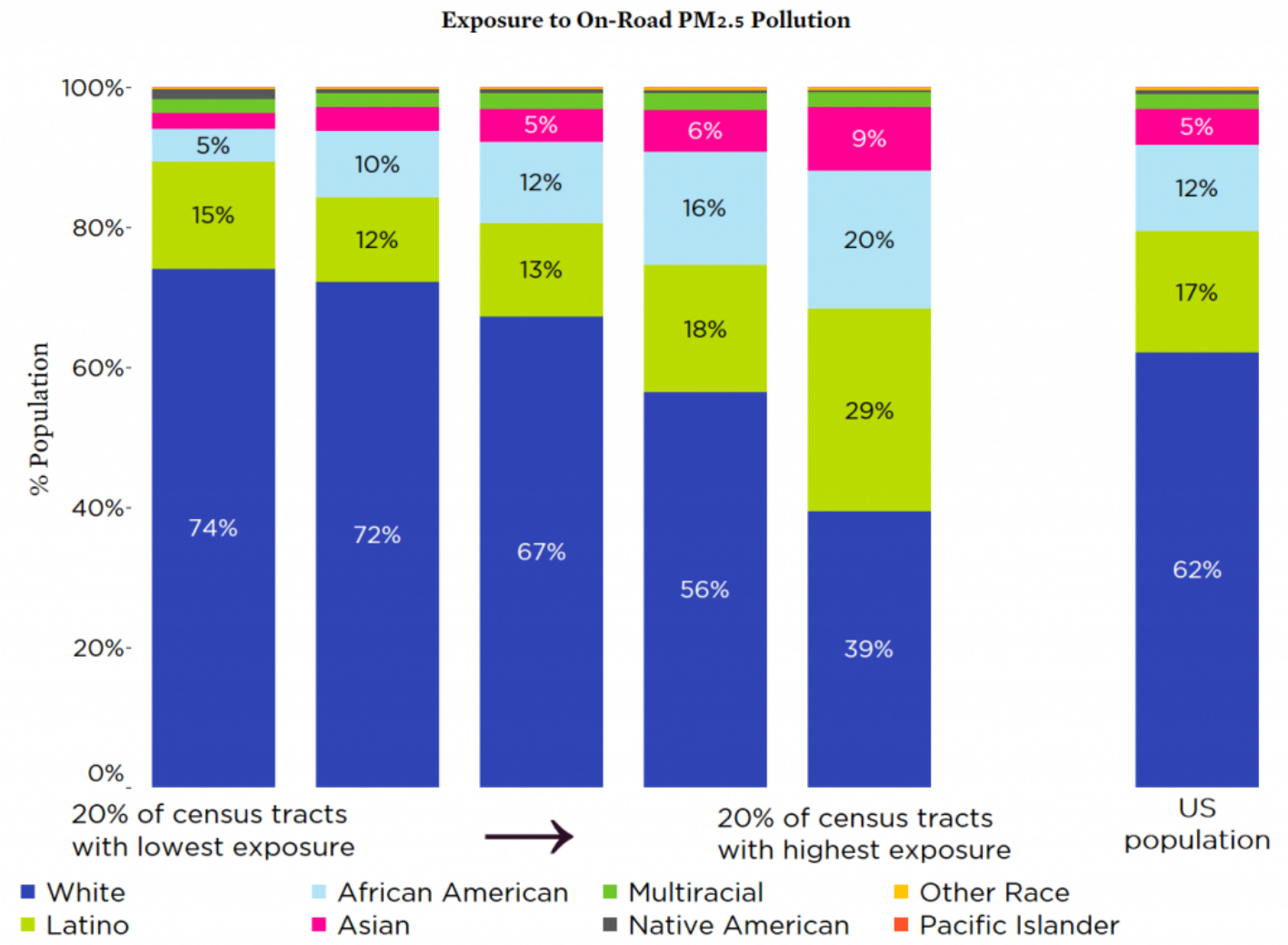
The results of our analysis are clear: $PM_{2.5}$ pollution burden from cars, trucks, and buses is inequitable when looking at the exposure experienced by racial groups. Asian Americans are, on average, exposed to 34 percent higher $PM_{2.5}$ concentrations than the average person in the U.S., and African Americans experience concentrations 24 percent higher than average. Latinos (defined as those identifying as Hispanic or Latino) have exposure 23 percent higher than the US population as a whole. Whites have average exposure that is 14 percent lower than the average for the nation. This means that, on average, Asian American and African Americans are exposed to $PM_{2.5}$ pollution that is 56 and 44 percent higher, respectively, than whites.



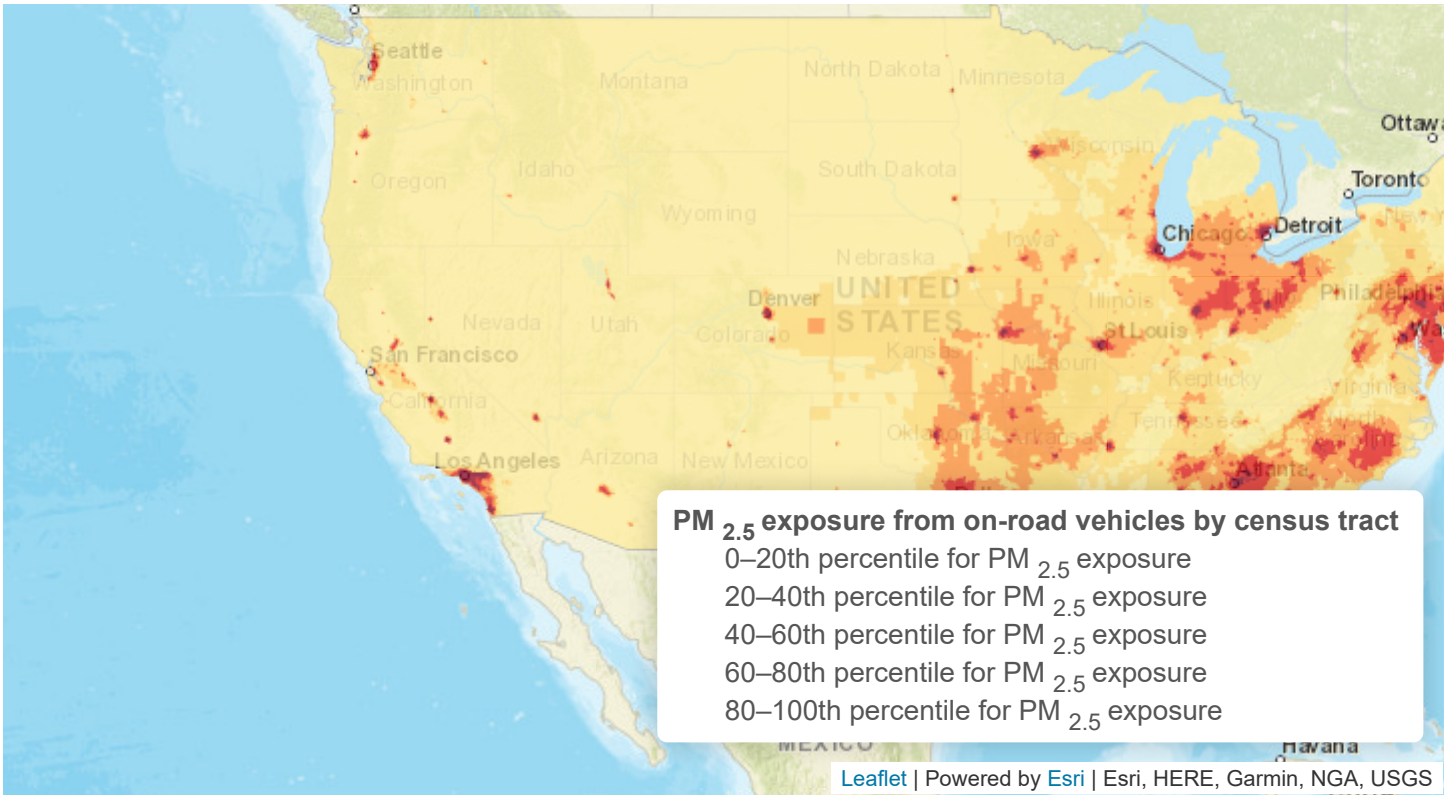
Asian American, African American and Latinos are exposed to higher than average levels of $PM_{2.5}$ pollution from cars, trucks and buses. The average exposure of Native Americans to $PM_{2.5}$ pollution from on-road sources is lower than the US average and reflects communities that are in rural areas with lower concentration of vehicle traffic.

Unequal pollution burdens can also be seen at the community level. In the 20 percent of census tracts with the lowest average annual $PM_{2.5}$ concentrations (i.e. the 'cleanest' areas in terms of vehicular pollution), whites make up 74 percent of the population, while only constituting 62 percent of the total population in the U.S. In contrast, the most polluted census tracts in our analysis have a higher proportion of people of color. In the 20 percent of census tracts with the highest exposure to $PM_{2.5}$ pollution from cars, trucks, and buses, the population is 29 percent Latino or Hispanic, compared with 17 percent for the entire country. Similarly, 20 percent of

the population in these areas are African American, which is much higher than the 12 percent of the population nationwide. The inequities and disparities in exposure to this pollution are clear.



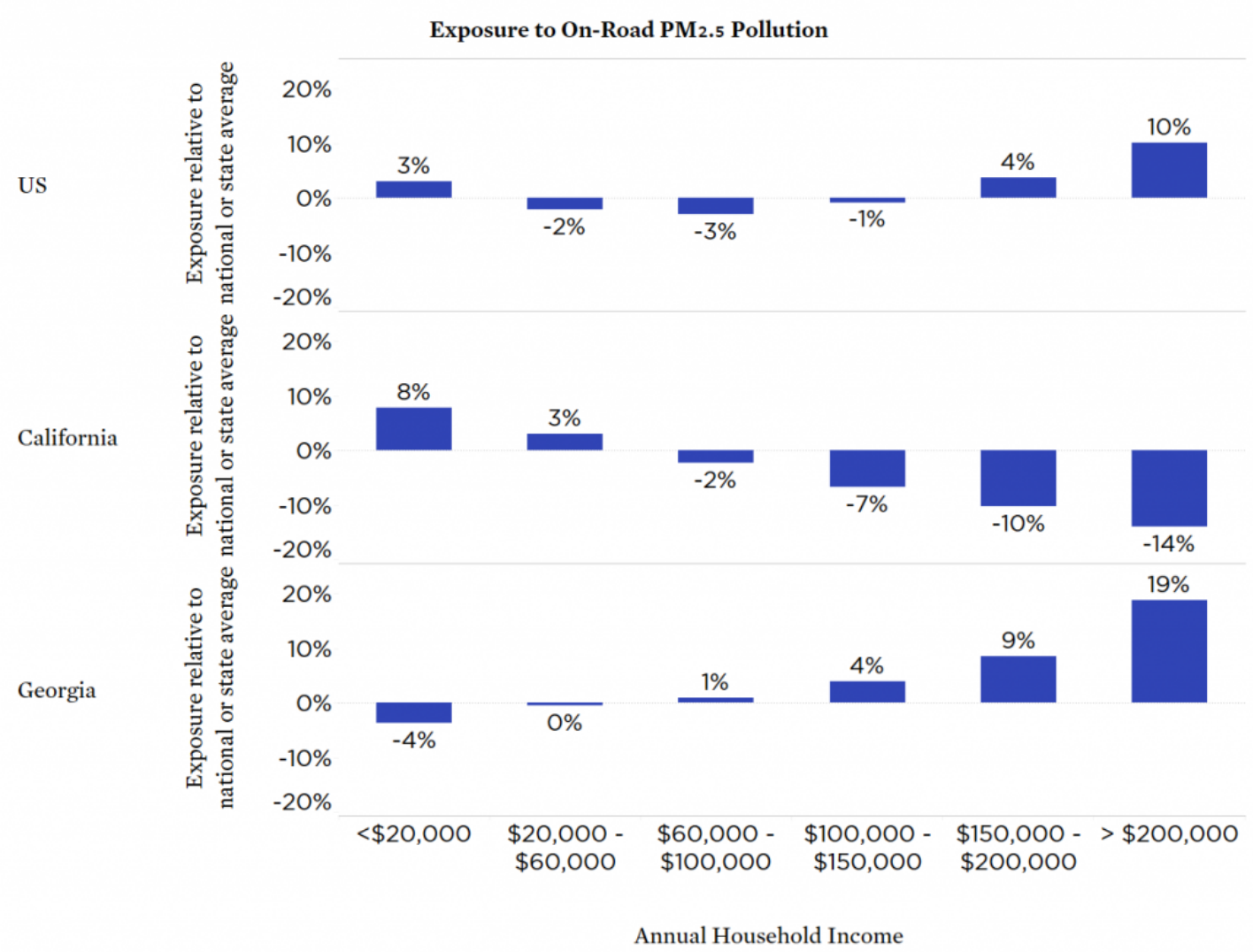
Dividing census tracts into quintiles based on $PM_{2.5}$ exposure reveals significant differences in the racial demographics between the areas with lowest exposure and highest exposure. In the census tracts with highest exposure to particulate matter from on-road vehicles, Latino, African American, and Asian Americans are overrepresented while in the cleanest census tracts, the population has a higher fraction of white residents than the US as a whole.



Income is less of a factor for exposure at the national level

For the U.S. overall, there is not a clear trend linking household income to on-road vehicular $PM_{2.5}$ exposure. Both the lowest-income (less than $20,000 per year household income) and highest-income (greater than $150,000 per year household income) households are exposed to higher levels of $PM_{2.5}$ pollution from on-road vehicles than the average for the U.S. Households with incomes between $20,000 and $150,000, on average, show slightly lower exposure.

However, some states do show a correlation between income and exposure. For example, in California, lower-income households are exposed to higher levels of pollution while more affluent households experience lower than average exposure. In Georgia, this trend is reversed, as lower-income households are exposed to slightly lower concentrations of air pollution from vehicles and higher-income are have more exposure.



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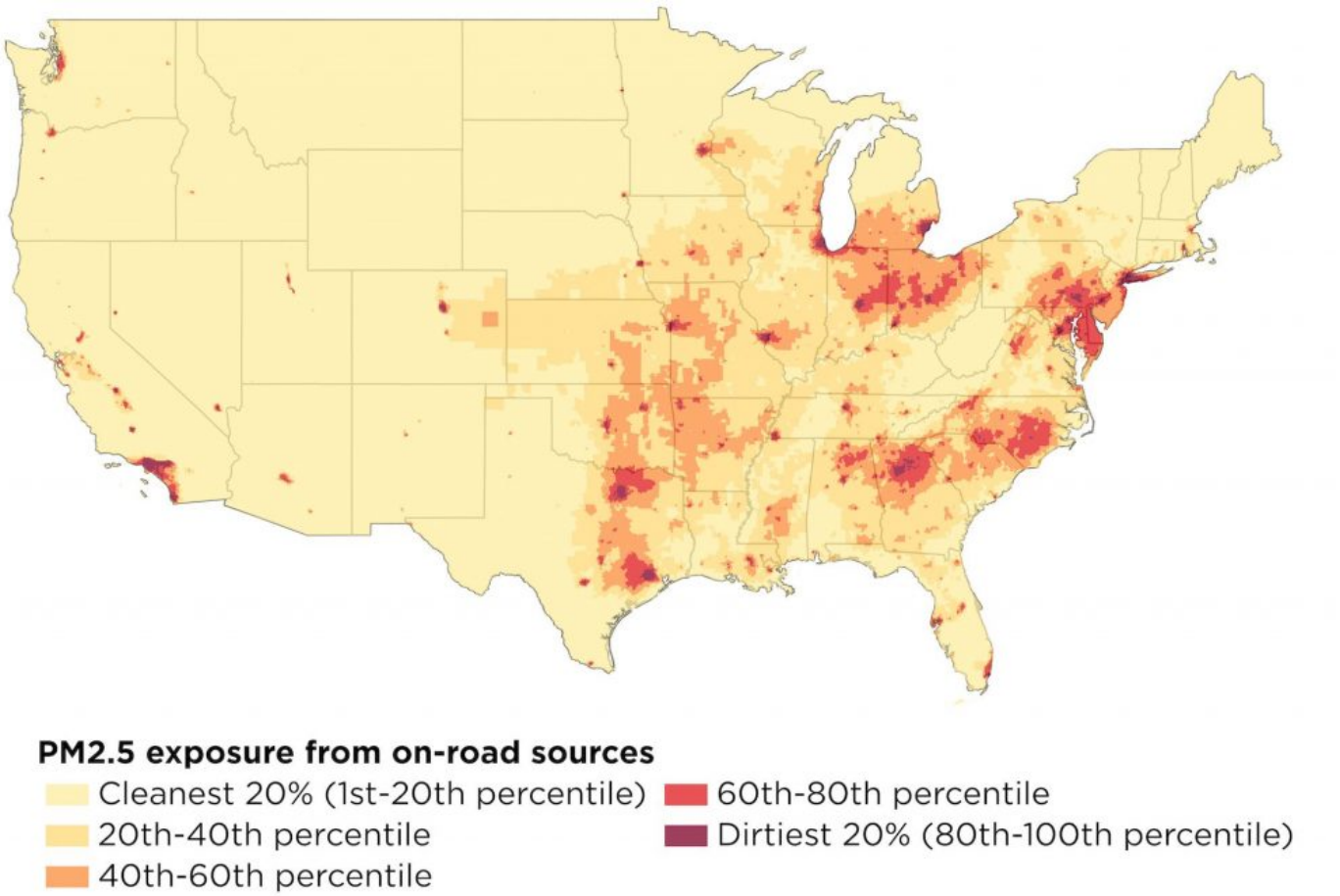
PM2.5 Exposure from Cars and Trucks Varies Greatly Across the U.S.

The exposure to $PM_{2.5}$ pollution from cars, trucks, and buses varies greatly across the U.S. Overall, pollution exposure is highest in densely populated, urban areas and places downwind from those areas.

It's important to note that these estimates of exposure to on-road vehicle pollution are just one portion of people's exposure to air pollution. Other pollutants like

ground-level ozone and coarse particulate matter (PM_{10}) also have detrimental effects on public health. More importantly, these results do not show the impact of industrial, agricultural, construction, or off-road transportation sources of air pollution (such as aircraft and trains). People are exposed to pollution from sources like oil refineries, ports, and power plants that is not captured in this analysis. However, these results do highlight a particular source of harmful pollution exposure where we currently have solutions to reduce or eliminate this pollution altogether.



$PM_{2.5}$ exposure from vehicle use varies greatly across the U.S. This map shows the census tracts, shaded by exposure to $PM_{2.5}$ from on-road sources. Note: Alaska and Hawaii were not evaluated due to data limitations.

We Can Reduce Air Pollution from Vehicles

Particulate matter air pollution from on-road transportation places significant health burdens on people in the U.S., and those burdens are inequitably distributed. However, there are opportunities to greatly reduce the exposure to $PM_{2.5}$ by reducing tailpipe and refueling emissions, making much of this burden avoidable.

Electrification of vehicles, both passenger and freight, could greatly reduce emissions. Battery-electric and hydrogen fuel cell vehicles in particular have no tailpipe emissions and completely avoid the need for, and emissions associated with, gasoline refueling. Electricity generation and hydrogen production can produce emissions; however, when comparing emissions from using conventional and electric drive vehicles, the emissions from electric vehicles are generally lower. And as we increase electricity generation from clean, renewable sources and close coal-fired power plants, the emissions benefit from switching from petroleum to electricity will grow.

While we can make a difference at the personal level by buying cleaner vehicles, much of the pollution comes from sources outside an individual's direct control, like heavy-duty trucks and buses. The US government, along with the states, need to continue to move forward on regulations, incentives, and other policies to reduce vehicle emissions. We need to continue to make progress on reducing emissions and also should prioritize actions that reduce the inequity of the air pollution burden. Incentives to help retire older, polluting cars, building charging infrastructure, and making electric vehicles available in the most impacted communities are examples of ways the states can help, but clearly more can and should be done to address the problem of harmful air pollution in the U.S.

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