Union of Concerned Scientists

FACT SHEET

Inequitable Exposure to Air Pollution from Vehicles in the Northeast and Mid-Atlantic

Who Bears the Burden?

HIGHLIGHTS

This analysis explores the significant contribution of cars, trucks, and buses to particulate matter air pollution in the Northeast and Mid-Atlantic and its disproportionate impact on communities of color. Clean transportation policies—such as those that encourage vehicle electrification, cleaner fuels, and reduced driving—will help lower these emissions. Additionally, policymakers should evaluate investments in clean transportation and other clean transportation solutions for their ability to reduce inequities in exposure to vehicular air pollution. Quantitative evidence of such inequities in the region's air pollution helps to inform such evaluations.

In the Northeast and Mid-Atlantic region, transportation is a significant source of both global warming emissions and air pollution (EPA 2019). The region contains four of the 20 US metropolitan areas that are most polluted by year-round fine particulate matter.[1] This air pollution has a significant impact on the health of the region's residents, and varies greatly geographically and across different types of community. This analysis from the Union of Concerned Scientists (UCS) quantifies the formation of fine particulate matter from on-road vehicles in the Northeast and Mid-Atlantic, covering the District of Columbia and 12 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia. The analysis identified the locations and populations most exposed to fine particulate matter by measuring its annual average concentration using a 2014 estimate of emissions as input data (EPA 2014).

Research links exposure to particulate matter smaller than 2.5 micrometers in diameter ($PM_{2.5}$)—20 times smaller than even fine human hair—to increased illnesses and deaths, primarily from heart and lung diseases. The use of vehicles that burn fossil-based fuels in the Northeast and Mid-Atlantic directly produces $PM_{2.5}$, and, at the same time, produces gases that lead to the formation of additional $PM_{2.5}$.

The UCS analysis of annual average $PM_{2.5}$ concentrations due to cars, trucks, and buses in the Northeast and Mid-Atlantic finds that:

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Millions of residents in the Northeast and Mid-Atlantic live near major highways and urban centers, and are exposed to high levels of vehicular air pollution; in certain New York City neighborhoods, pollution levels are 3.7 times higher than the regional average. People of color are disproportionately exposed to more of this pollution.

- The average concentrations of exposures for Latino residents are 75 percent higher, and for Asian American residents they are 73 percent higher, than they are for white residents. Exposures for African American residents are 61 percent higher than for white residents.
- White residents comprise 85 percent of people living in areas with the lowest $PM_{2.5}$ pollution from on-road vehicles. In these areas, pollution is less than half the statewide average.
- About 6.5 million African American residents, 6.1 million Latino residents, and 3.7 million residents of other races (Asian American, Pacific Islander, Native American, multiracial, and residents who self-identify with other racial groups) live in areas with $PM_{2.5}$ pollution higher than the average of the state where they live.
- Exposure to $PM_{2.5}$ from cars, trucks, and buses is distributed unequally across the region. Residents in the most polluted census tracts breathe air that is significantly worse than the regional average. In New York State's most polluted areas, $PM_{2.5}$ concentrations are 3.7 times higher than the regional average. The highest concentrations in Pennsylvania are three times higher than the regional average.

New clean technologies, such as electric trucks, buses, and passenger vehicles, have the potential to eliminate the use of diesel fuel and gasoline for on-road vehicles, avoiding some of these local transportation emissions. A number of strategies are available for reducing both air pollution and climate-damaging carbon emissions—for example, electrifying vehicles, using cleaner fuels, reducing miles driven, improving public transportation, improving the infrastructure for walking and biking, and increasing the supply of affordable housing in communities close to transit.

As the Northeast and Mid-Atlantic region moves to create clean, modern transportation, states and the District of Columbia can address the inequity of $PM_{2.5}$ exposure by targeting clean technology deployment to benefit the most affected communities. They should seek input from the communities that currently bear the greatest burden from on-road $PM_{2.5}$ exposure about which solutions and investments would be most effective, and should prioritize investments that will directly benefit these communities.

Why Particulate Matter Air Pollution Is a Problem

Some $PM_{2.5}$ pollution forms directly during combustion, from sources such as fires, power plant emissions, and vehicle exhaust. Additional $PM_{2.5}$ comes from sources such as road and construction dust. However, much of the $PM_{2.5}$ forms indirectly through reactions of pollutant gases in the atmosphere (Fine, Sioutas, and Solomon 2008). These gases include ammonia, nitrogen oxides, sulfur oxides, and volatile organic compounds. Most of these pollutants come from vehicle exhaust, although volatile organic compounds also come from the evaporation of gasoline during refueling and from leaks in vehicles' fuel tanks and lines.

[$PM_{2.5}$ is estimated to be responsible for about 95 percent of the global public health impacts from air pollution.]

Exposure to $PM_{2.5}$ has significant negative health impacts. The particles are small enough to penetrate deeply into the lungs; the smallest can even enter the bloodstream (Donaldson et al. 2013). It has been estimated that fine particulate air pollution is responsible for almost all of the 3 million to 4 million annual deaths attributed to air pollution worldwide. $PM_{2.5}$ is estimated to be responsible for about 95 percent of the global public health impacts from air pollution, even if it is not the only air pollutant that affects health (Landrigan et al. 2018; Lelieveld et al. 2015). In the United States, it is the largest environmental health risk factor, responsible for 63 percent of deaths from environmental causes (Tessum et al. 2019; Tessum, Hill, and Marshall 2014).

Both acute and chronic exposures to $PM_{2.5}$ have been linked to illness and death (Guo et al. 2018; Pagalan et al. 2018; Achilleos et al. 2017; Brook et al. 2010). Short-term exposure to elevated levels of $PM_{2.5}$ can exacerbate lung and heart ailments, cause asthma attacks, and lead to both increased hospitalizations and mortality from cardiovascular diseases (Orellano et al. 2017; Pope and Dockery 2006). Chronic exposure to $PM_{2.5}$ also increases death rates attributed to cardiovascular diseases, including heart attacks, and has been linked to lung cancer and other impacts (Fine, Sioutas, and Solomon 2008). Chronic exposure to $PM_{2.5}$ in children has been linked to slowed lung-function growth and the development of asthma, among other negative health impacts (ALA 2018; Gehring et al. 2015; Gauderman et al. 2004).

$PM_{2.5}$ air pollution varies greatly across the Northeast and Mid-Atlantic, leading to disparities in exposure linked to race and, to a lesser extent, income. The UCS analysis

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Investing in public transit, deploying more electric vehicles in our car and truck fleets, and reducing the need to drive are all solutions to reduce transportation-related emissions. Policymakers must ensure that these clean, modern solutions are prioritized in communities most burdened by vehicle pollution.

quantifies the documented, lived experiences of communities of color.

Analysis of $PM_{2.5}$ Pollution from On-Road Transportation

The concentration of $PM_{2.5}$ at any particular 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 also play a role in the generation of secondary $PM_{2.5}$ from other air pollutants, and determine the movement of $PM_{2.5}$ pollution. Exposure itself depends on the location of both the pollution and the people inhaling it.

To estimate the average annual exposure and health impacts of particulate matter air pollution from cars, trucks, and buses, UCS modeled $PM_{2.5}$ concentrations in the Northeast and Mid-Atlantic due to emissions from vehicle tailpipes and vehicle refueling (Tessum, Hill, and Marshall 2014).[2] We estimated ground-level pollution exposure for each census tract, then combined that information with population and demographic data to understand how exposure to $PM_{2.5}$ varies across groups and locations.[3]

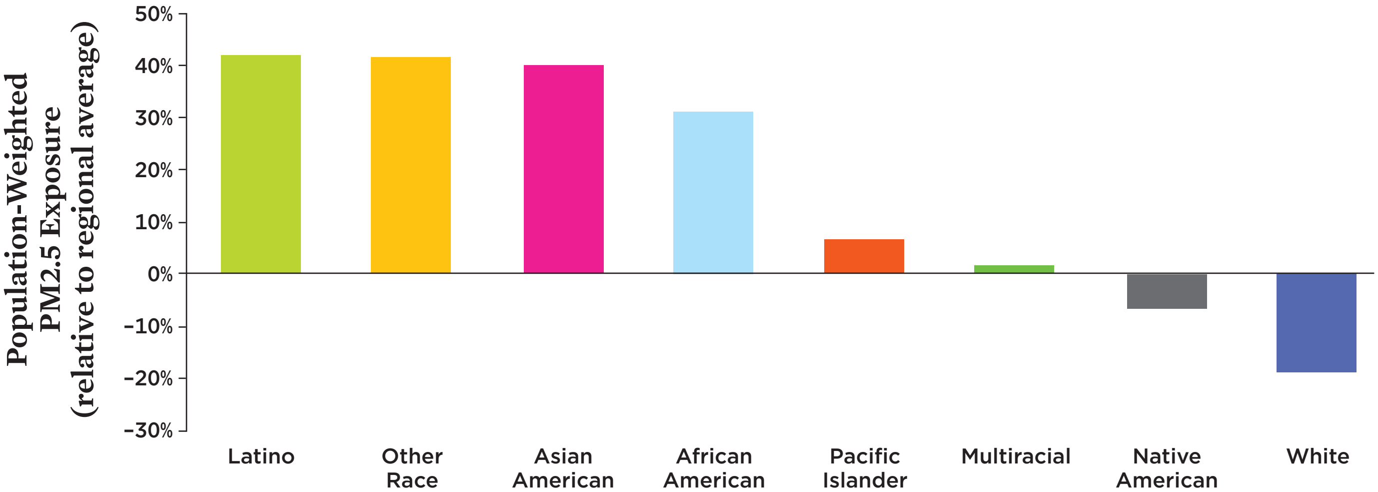
The health impacts from $PM_{2.5}$ pollution depend not only on the concentration of pollution but also on the number of people exposed. Elevated $PM_{2.5}$ levels in densely populated regions of a state will have a greater overall impact on public health than the same pollution concentration in unpopulated areas. Therefore, to compare $PM_{2.5}$ levels among regions and among demographic groups, we used population-weighted $PM_{2.5}$ concentrations. For example, to determine the average exposure for a resident of a particular county, we multiplied the concentration in each of the county's census tracts by the population in each tract. We then divided the sum of these values for the county by the county population to determine the average exposure for a resident. A similar process yields the average exposure for demographic groups within each state and in the region as a whole.

These estimates do not include $PM_{2.5}$ exposure from other modes of transportation, such as airplanes, marine vessels, or trains. The $PM_{2.5}$ concentration and exposure modeling also excludes operations at freight facilities and ports, along with emissions from power plants and other stationary sources. Such emissions, which would add to the on-road exposures estimated in the UCS analysis, also cause significant health impacts. Those impacts especially affect people who live closest to such facilities, leading to well-documented environmental justice concerns (Hricko 2008). While the contributions of on-road vehicles to local $PM_{2.5}$ exposure are less well known, they affect a great many communities in the region.

$PM_{2.5}$ Exposure from Cars, Trucks, and Buses Causes Significant Health Impacts

Across eight states of the Northeast and Mid-Atlantic,[4] the combined health and climate costs attributable to the passenger vehicle fleet were about $21 billion in 2015. Estimates of

FIGURE 1. Disproportionately High Exposure for People of Color in the Northeast and Mid-Atlantic



Latino residents, residents of other races, and Asian American residents have 42, 42, and 40 percent higher exposure to $PM_{2.5}$ concentrations, respectively, relative to the regional average. African American residents have 30 percent higher exposure. However, white residents have 19 percent lower exposure.

Note: This analysis uses the following US Census Bureau–defined racial groups: White; Black or African American; American Indian or Alaska Native; Asian; Native Hawaiian or Other Pacific Islander; Hispanic; Latino; and Some Other Race. In the chart above, Latino includes census respondents who select Hispanic, Latino, or both; Other Race includes respondents who select Some Other Race as their only race.

SOURCES: US CENSUS BUREAU 2018; EPA 2014.

the health costs—about two-thirds of this total—include premature deaths, heart attacks, asthma attacks, emergency room visits, and lost work days resulting from breathing pollution associated with passenger cars. The combined health and climate costs ranged from $313 million in Vermont to $4.6 billion in New Jersey and $7.9 billion in New York State (Holmes-Gen and Barrett 2016).

In Maryland, communities surrounding the Port of Baltimore, such as Curtis Bay, are exposed to high levels of air pollution and experience elevated rates of respiratory illness, cardiovascular disease and cancer. In 2010, Baltimore's rate of asthma-related hospitalizations was almost three times higher than the US average and more than twice the average for Maryland, and recent data indicate that this trend has not changed (Pinto de Moura 2018; Kelly and Burkhart 2017).

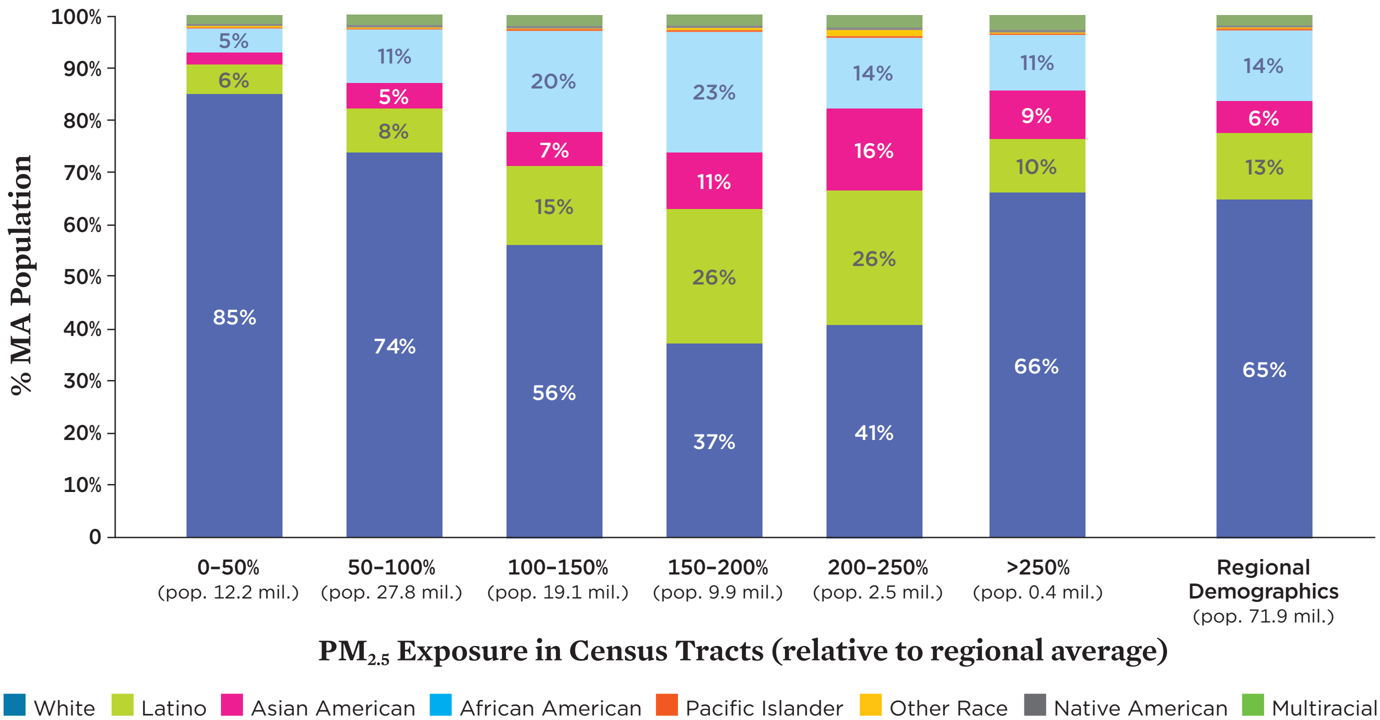
In New York City, exposure to fine PM air pollution from vehicles contributes an estimated 320 premature deaths each year due to cardiovascular disease, heart attacks, and other illnesses (Kheirbek et al. 2016). Pollution from trucks and buses accounts for more than half of these deaths. By way of comparison, 292 homicides and 222 traffic fatalities were reported in New York City in 2017 (NYC 2018; NYPD 2017).

Greater $PM_{2.5}$ Pollution for Latino, Asian American, and African American residents

The $PM_{2.5}$ pollution burden from cars, trucks, and buses is inequitably distributed among the region's racial groups (Figure 1). On average, exposures to $PM_{2.5}$ concentrations are 42 percent higher for the region's Latino residents and 40 percent higher for Asian American residents than those for the average resident. For African American residents, the concentrations are 31 percent higher than for the average resident. However, for white residents, the average exposure is 19 percent lower than for the average resident. Thus, Latino and Asian American residents are, on average, burdened with 75 percent and 73 percent more $PM_{2.5}$ pollution, respectively, than are white residents; African American residents bear a 61 percent higher burden than do white residents.

Pollution inequity also appears at the community level (Figure 2). In census tracts with low pollution and cleaner air (where average annual $PM_{2.5}$ concentrations are less than half of the state average), white residents make up 85 percent of the total population, although they constitute less than two-thirds of the total population in the Northeast and Mid-Atlantic. In contrast, more people of color live in census tracts where pollution is more than one and a half times the state average. In these areas, people of color constitute slightly more

FIGURE 2. $PM_{2.5}$ Exposure in Census Tracts, Relative to Regional Average



In areas where $PM_{2.5}$ exposure is low, the fraction of white residents is high. As the analysis looks at more polluted areas, this fraction decreases. In the highest pollution areas, which correspond to urban centers with heavy traffic, the fraction of white residents is higher. However, these are averages; inequities exist within urban areas as well, such as in the Bronx in New York City.

Notes: Each column refers to census tracts in areas with similar $PM_{2.5}$ pollution concentrations. The columns show the fraction of people belonging to each of eight racial groups living in those areas. The least polluted areas are on the left and the most polluted on the right. The 0–50% area refers to census tracts where $PM_{2.5}$ pollution is less than half the regional average, the 50–100% area refers to tracts where pollution is from half the regional average to the regional average, etc. The column at the far right shows the region's racial composition.

This analysis uses the following US Census Bureau–defined racial groups: White; Black or African American; American Indian or Alaska Native; Asian; Native Hawaiian or Other Pacific Islander; Hispanic; Latino; and Some Other Race. In the chart above, Latino includes census respondents who select Hispanic, Latino, or both; Other Race includes respondents who select Some Other Race as their only race.

SOURCES: US CENSUS BUREAU 2018; EPA 2014.

than 60 percent of the population, compared with about 35 percent of the regional population. The most polluted census tracts in New York are in Morris Heights, in the West Bronx at the intersection of I-95 and I-87. There, 70 percent of the population are Latino residents and 29 percent are African American residents. The most polluted census tracts in Pennsylvania are in downtown Philadelphia and Pittsburgh. The most polluted census tract in New Jersey is in Camden County, where 71 percent of the population are Latino residents.

Further, the UCS analysis shows that exposure inequities are more pronounced between racial and ethnic groups than between income groups. Disparities based on income are not significant because the fractions of people in each income bracket are distributed fairly evenly over areas with different pollution levels.

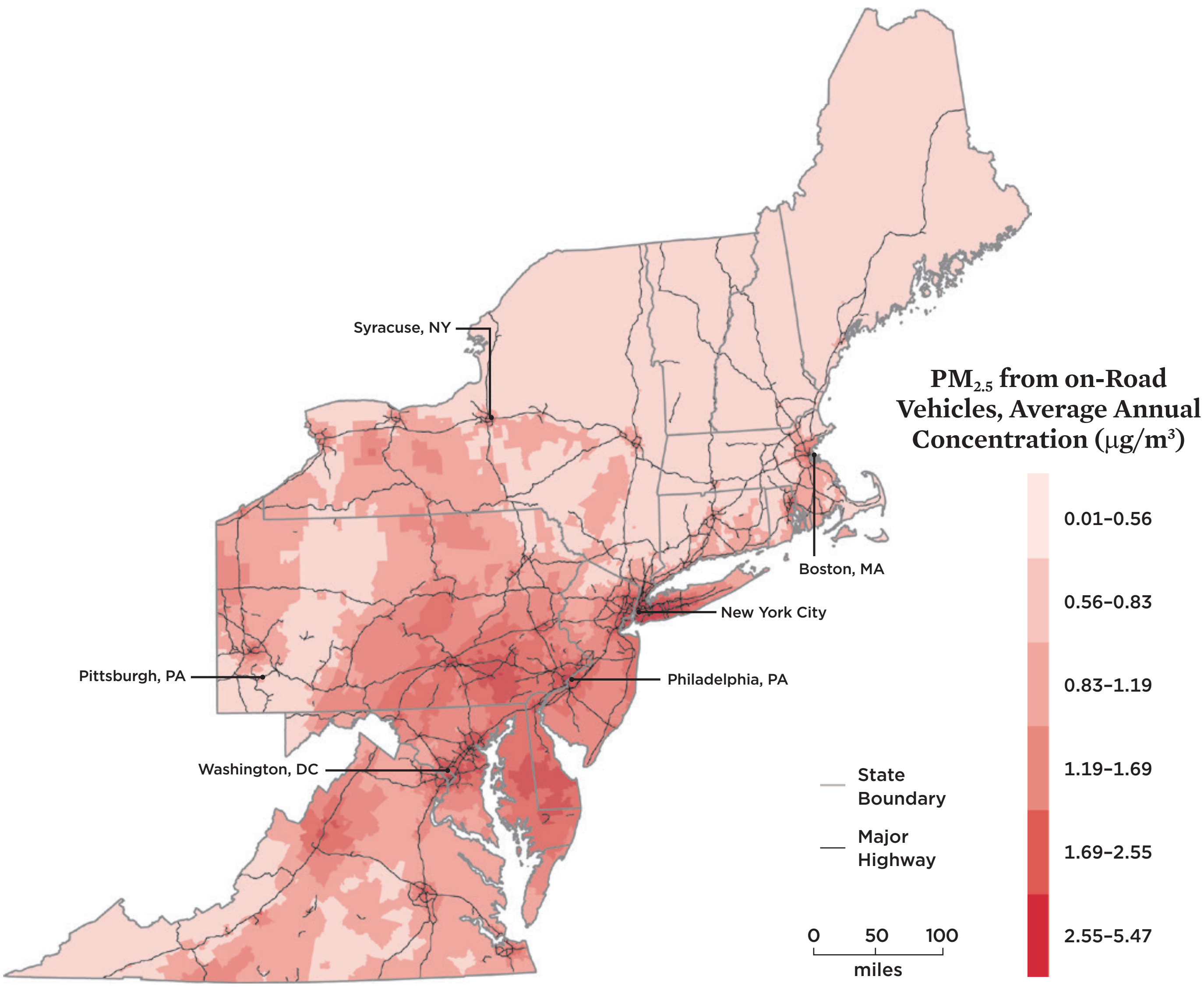
$PM_{2.5}$ Exposure from Cars and Trucks Varies Greatly Across the Region

The District of Columbia ranks highest in the region in average $PM_{2.5}$ concentration from on-road vehicles, followed by New York State (Figure 3, p. 6 and Figure 4, p.7). However, the range of $PM_{2.5}$ concentrations within each state varies significantly, so that even if a state average is low, very high concentrations afflict some areas, many of which are located near highways. For example, New York State has the census tracts with the highest $PM_{2.5}$ concentrations in the entire region. These tracts are in the Bronx, Queens, and Manhattan. The Philadelphia area also has very high $PM_{2.5}$ concentrations compared with the Pennsylvania average: pollution in the state's dirtiest census tracts is more than three times as high as Pennsylvania's average. On the other hand, Washington, DC, an urban area, has a higher average than New York State's, but the most polluted air in the District of Columbia is only about two-thirds the concentration of the most polluted areas in New York State.

New Jersey, New York, and Pennsylvania, the region's most populous states with a total of 41.4 million people, have higher $PM_{2.5}$ averages than the other states. In other words, almost 58 percent of the region's population live in states where the average pollution from on-road vehicles ranges from 94 percent to almost 150 percent of the regional $PM_{2.5}$ average.

Almost one-fifth of the region's 72 million people live in census tracts where $PM_{2.5}$ pollution levels are more than one-and-a-half times the average of the whole state; more than 60 percent of the residents of those tracts are people of color. In New York State, one-third of the population experiences $PM_{2.5}$ pollution levels that are more than

FIGURE 3. $PM_{2.5}$ Exposure Varies Greatly across the Northeast and Mid-Atlantic



Metropolitan areas in the District of Columbia, Maryland, New Jersey, New York, Pennsylvania, and Rhode Island have many areas with $PM_{2.5}$ pollution at least twice as high as the regional average. There is much variability between exposure in urban and rural areas of all states.

SOURCES: US CENSUS BUREAU 2018; EPA 2014.

150 percent of the state average. Because New York is the region's most populous state, this higher level of pollution affects 6.3 million people, almost 70 percent of whom are people of color.

These results are for a specific subset of pollution sources (on-road vehicles) and for one class of air pollutants ($PM_{2.5}$). They do not indicate the total impacts of air pollution in a region or for a demographic group. For example, in Allegheny County, Pennsylvania, the highest annual average $PM_{2.5}$ concentration is 2.5 micrograms per cubic meter (μg/m^3) (EPA 2018). Yet the Environmental Protection Agency classifies the county as a non-attainment area, signifying it did not meet the National Ambient Air Quality Standards because it was above the threshold of 12 μg/m^3 (annual average) specified by the standard.[5] The difference between on-road and overall $PM_{2.5}$ concentrations results from other stationary sources of pollution in the Pittsburgh area, such as manufacturing and electricity generation, as well as from off-road transportation such as warehouse equipment, trains, and aviation.

One limit of the UCS analysis is the one-square-kilometer precision of the air quality model results. This is precise enough to reveal pollution differences within a city. However, it cannot yield estimates of $PM_{2.5}$ concentration at busy intersections or near shipping facilities, so hyperlocal $PM_{2.5}$ concentration measurements could very easily be higher than shown in this analysis.

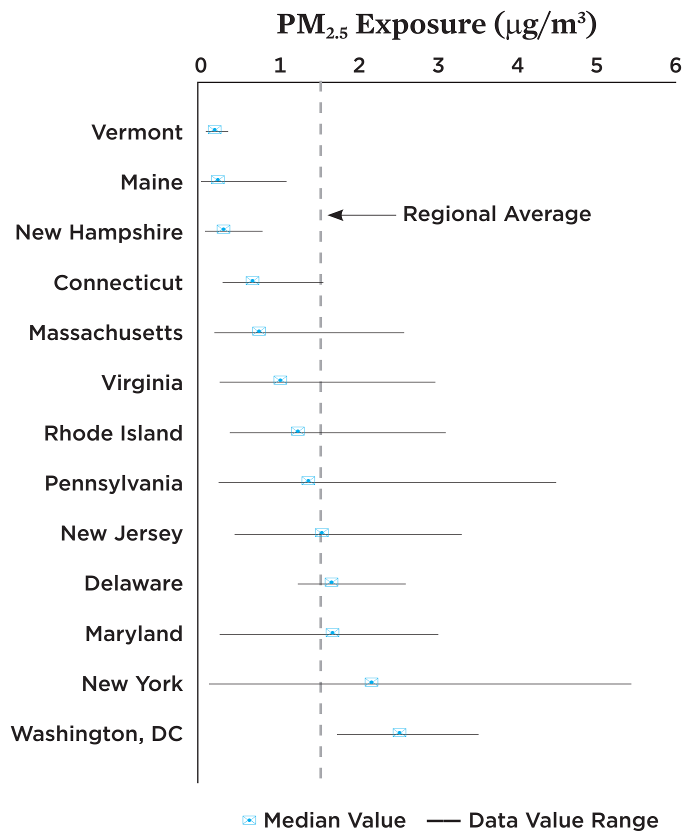
Opportunities to Reduce the Harmful Impacts of Vehicle Use

Particulate matter air pollution from on-road transportation such as diesel and gasoline vehicles places significant, inequitable health burdens on residents of the Northeast and Mid-Atlantic. This inequity reflects decades of local, state, regional, and national decisions about transportation, housing, and land use. Decisions concerning where to place highways, where to invest in public transportation, and where to build housing have all contributed to a transportation system that concentrates emissions in communities of color. In many cases, transportation policies have left those communities with inadequate access to public transportation, divided by highways, and exposed to air polluted by congested highways serving suburban commuters.

We have the tools and the technologies to transform our transportation system away from diesel and gasoline and toward clean, modern, equitable solutions. With targeted actions in electrification and clean fuels, the region can save more than $30 billion by 2050 and save thousands of lives (Lowell, Saha, and Van Atten 2018).

Electrification of vehicles, both passenger and freight, could greatly reduce emissions. Battery-electric and fuel cell

FIGURE 4. $PM_{2.5}$ Pollution Concentrations from On-Road Vehicles for the Northeast and Mid-Atlantic



Four states and the District of Columbia have average $PM_{2.5}$ exposure levels above the regional average. The District of Columbia, which is entirely urban, has the highest average. New York and Pennsylvania have the largest ranges in $PM_{2.5}$ pollution; both are large states with much pollution variability between rural and urban areas.

SOURCES: US CENSUS BUREAU 2018; EPA 2014.

vehicles have no tailpipe emissions.[6] Further, these vehicles avoid the need for fuels, eliminating emissions associated with refueling. The electricity used to charge the vehicle can produce some emissions, but these emissions are lower than those of an average gasoline car and vary depending on the location where the vehicle is charged (Reichmuth 2017). However, in the Northeast and Mid-Atlantic, the Regional Greenhouse Gas Initiative (RGGI), along with investments in solar, wind, and other renewable electricity resources, has greatly reduced emissions from electricity generation (RGGI 2019).[7]

Making clean transportation technologies available to everyone will require significant up-front investments, yet the communities most affected by transportation pollution often have the fewest available resources. Significant new funding

States should seek input from communities disproportionately burdened by transportation pollution and ensure that equity is a key consideration in both design processes and future investment decisions.

is necessary to expand access to clean transportation in these communities, as are strong regulations that limit transportation emissions and put a price on carbon pollution.

In December 2018, nine states in the region and the District of Columbia agreed to create a regional, market-based program that would limit transportation emissions and invest in clean transportation.[8] They plan to use funds raised from pollution permits to make strategic investments in clean transportation. States should seek input from communities disproportionately burdened by transportation pollution and ensure that equity is a key consideration in both design processes and future investment decisions.

Specific investments that could reduce inequities include:

- Investments in electric buses, with a priority on serving communities exposed to the highest levels of gasoline and diesel emissions
- Expansion of electric vehicle rebate programs to provide financing assistance and larger rebates to low- and moderate-income residents
- Utility investments in electric vehicle charging infrastructure, with a priority on serving communities exposed to the highest levels of gasoline and diesel emissions
- State programs that provide aid to municipalities to support clean transportation, with a priority on serving communities exposed to the highest levels of gasoline and diesel emissions

While residents of the region can make a difference by choosing cleaner vehicles and driving less, much of today's air pollution comes from sources outside the direct control of individuals. States need regulations, incentives, and other policies to reduce vehicle emissions, with equity and the meaningful involvement of affected communities as key considerations in designing policies and strategies to reduce pollution from vehicles.

States need to continue to reduce emissions, placing a high priority on actions that reduce the inequitably distributed burden of air pollution in the Northeast and Mid-Atlantic. This analysis provides evidence of the need for and importance of such programs, and it can help inform and shape future actions to reduce pollution exposure and environmental inequities in the region.

Maria Cecilia Pinto de Moura *and* ***David Reichmuth*** *are senior engineers in the UCS Clean Vehicles Program.*

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Organizational affiliations are listed for identification purposes only. The opinions expressed herein do not necessarily reflect those of the organizations that funded the work or the individuals who reviewed it. The Union of Concerned Scientists bears sole responsibility for the report's contents.

ENDNOTES

1. *The metropolitan areas are Pittsburgh, Philadelphia, and Reading in Pennsylvania, and Camden in New Jersey (ALA 2018).*
2. *Details on the modeling approach can be found at* www.ucsusa.org/air-quality-methodology.
3. *The average population of a census tract is 4,000.*
4. *Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Rhode Island, and Vermont.*
5. *The Clean Air Act requires the Environmental Protection Agency to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. For $PM_{2.5}$, the primary standard for public health is an annual mean of 12 $\mu g/m^3$. Allegheny County was classified as a non-attainment area in 2019.*
6. *There are minor amounts of $PM_{2.5}$ emissions from tire and brake wear.*
7. *Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont participate in RGGI. Virginia is preparing to join in 2020, and Pennsylvania is considering joining. New Jersey left RGGI in 2012 but is on track to rejoin in 2020. Partially because of RGGI, the region has reduced its emissions by about 40 percent relative to 2005 levels.*
8. *Six of the original nine RGGI states signed the agreement: Connecticut, Delaware, Maryland, Massachusetts, Rhode Island, and Vermont. The District of Columbia, New Jersey, Pennsylvania, and Virginia have also signed. Maine, New Hampshire, and New York have not signed, but Maine and New York are likely to join soon. It is unclear if New Hampshire will join.*

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