Trouble in the Air

Millions of Americans Breathed Polluted Air in 2018

Environment Florida Research & Policy Center

Florida PIRG Education Fund

Frontier Group

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Winter 2020

Acknowledgments

Environment Florida Research & Policy Center and Florida PIRG Education Fund thank the following individuals for their review of drafts of this document, as well as their insights and suggestions:

- Bruce Bekkar, M.D., Climate Activist/Speaker; Co-chair, Public Health Advisory Committee and Board Member, Climate Action Campaign; and Climate for Health Leadership Circle, ecoAmerica;
- Robert Laumbach, M.D., of the Rutgers School of Public Health;
- Sarah Spengeman, Ph.D., Associate Director, Climate and Health Program, Health Care Without Harm, U.S. and Canada; and
- Neelima Tummala, M.D., M.S., physician and clinical assistant professor of surgery, George Washington University School of Medicine and Health Sciences.

Thank you to reviewers who provided guidance and feedback on previous versions of this report. Thanks also to Susan Rakov, Tony Dutzik, Abigail Bradford, and Adrian Pforzheimer of Frontier Group for editorial support.

The authors bear responsibility for any factual errors. The recommendations are those of Environment Florida Research & Policy Center and Florida PIRG Education Fund. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided review.

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Executive summary

People across America regularly breathe polluted air that increases their risk of premature death, and can also trigger asthma attacks and other adverse health impacts.

In 2018, 108 million Americans lived in areas that experienced more than 100 days of degraded air quality. That is equal to more than three months of the year in which ground-level ozone (the main ingredient in smog) and/or particulate pollution was above the level that the EPA has determined presents "little to no risk." These Americans live in 89 large and small urban areas,* and in 12 rural counties. Millions more Americans are exposed to damaging levels of air pollution, but less frequently.

Policymakers can protect public health by strengthening air quality protections, reducing reliance on fossil fuels that contribute to air pollution, and cutting global warming pollution that will exacerbate future air quality problems.

Each year, millions of Americans suffer from adverse health impacts linked to air pollution, and tens of thousands have their lives cut short.

- Fine particulate matter from sources such as vehicles and power plants was responsible for an estimated 107,000 premature deaths in the U.S. in 2011.[1]
- Air pollution is linked to health problems including respiratory illness, heart attack, stroke, cancer and mental health problems. Research continues to reveal new health impacts. For example, maternal exposure to air pollution such as fine particulates ($PM_{2.5}$) and ozone is associated with a higher risk of low birth weight, pre-term birth and stillbirth.[2] For older adults, long-term exposure to particulate pollution has been associated with an increased risk of Alzheimer's disease and other forms of dementia.[3]
- Air pollution's effects are pronounced among vulnerable populations, including children, pregnant women and the elderly. Research has found that children exposed to particulate pollution can suffer from lung development problems and long-term harm to lung function.[4]
- Levels of air pollution that meet current federal air quality standards can be harmful to health, especially with prolonged exposure. Researchers can detect negative health impacts, such as increased premature deaths, for people exposed to pollution at levels the EPA considers "good" or "moderate."[5] Current federal standards are less stringent than those recommended by the World Health Organization.[6] Moreover, the EPA cautions that unusually sensitive people may experience health effects at "moderate" levels. For these reasons, the analysis in this report includes air pollution at or above the level the EPA labels "moderate," corresponding with a rating yellow or higher in its Air Quality Index.

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* Throughout this report, our mention of "large and small urban areas" includes metropolitan areas (population above 50,000) and micropolitan areas (which have a population of 10,000 to 50,000 people).

Global warming will make air pollution worse.

- The U.S. Global Change Research Program's *Fourth National Climate Assessment* warns that unless the nation acts to improve air quality, "climate change will worsen existing air pollution levels. This worsened air pollution would increase the incidence of adverse respiratory and cardiovascular health effects, including premature death."[7]
- Climate change will worsen air pollution in several ways, including:
    - Rising temperatures will speed up the formation of ozone. According to one study, people in the Northeast, Midwest and Southwest will experience three to nine more days of ozone pollution at or above the level the U.S. EPA considers "unhealthy for sensitive groups" annually by 2050 compared to 2000 because of higher temperatures.[8]
    - Hotter, drier weather will increase the frequency and severity of wildfires, which create particulate pollution, contribute to smog, and can spread air pollution for hundreds of miles.

Millions of Americans live in urban and rural areas that experience frequent ozone and/or particulate pollution.

- 108 million Americans lived in the 89 large and small urban areas and 12 rural counties that experienced more than 100 days of degraded air quality in 2018. (See Table ES-1.)
- Another 157 million Americans resided in the 264 large and small urban areas and 61 rural counties that faced 31 to 100 days – a month or more – of elevated ozone and/or particulate pollution. The communities included major urban areas such as the District of Columbia and Miami and smaller communities such as Racine, Wisconsin, and Columbia, Missouri.

People in every state face health risks from ground-level ozone pollution.

- Thirty-eight urban areas and rural counties, which are home to more than 21 million people, experienced more than 100 days of ozone pollution in 2018. Such frequent ozone pollution affected people living in

Table ES-1. Ten most populated metropolitan areas with more than 100 days of elevated air pollution in 2018

Metropolitan area	Number of days in 2018 when half or more monitoring locations reported elevated ozone and/or $PM_{2.5}$	2018 population
Los Angeles-Long Beach-Anaheim, CA	156	13,291,486
Chicago-Naperville-Elgin, IL-IN-WI	113	9,498,716
Dallas-Fort Worth-Arlington, TX	106	7,539,711
Houston-The Woodlands-Sugar Land, TX	110	6,997,384
Atlanta-Sandy Springs-Roswell, GA	114	5,949,951
Phoenix-Mesa-Scottsdale, AZ	153	4,857,962
Riverside-San Bernardino-Ontario, CA	227	4,622,361
Detroit-Warren-Dearborn, MI	118	4,326,442
San Diego-Carlsbad, CA	160	3,343,364
Denver-Aurora-Lakewood, CO	131	2,932,415

Note: This count includes air pollution at or above the level the EPA labels "moderate," indicated in yellow or worse in its Air Quality Index.

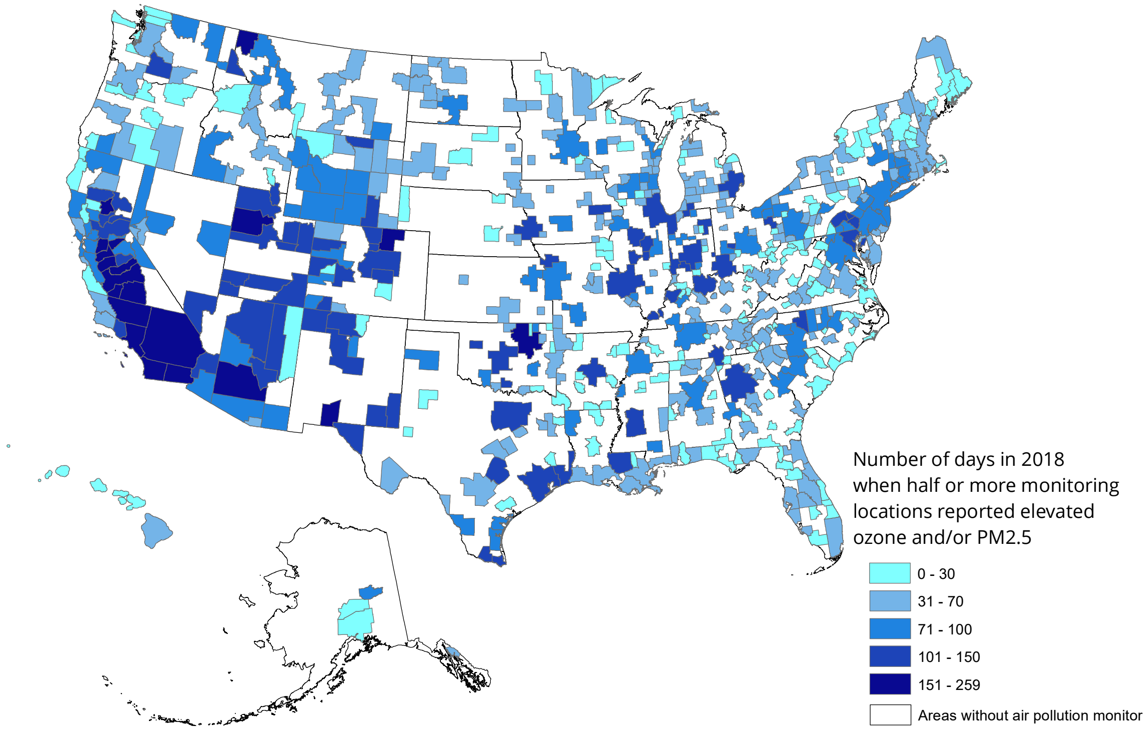


Figure ES-1. Both urban and rural areas experienced frequent ozone and/or particulate pollution in 2018

communities in California, New Mexico, Arizona, Utah, Colorado and Wyoming. Table ES-2 shows the most populated metropolitan areas that experienced more than 100 days of elevated ozone levels.

- Residents of another 228 large and small urban areas and rural counties encountered air with elevated levels of ozone pollution on 31 to 100 days in 2018. That means that for one to three months in 2018, up to 170

Table ES-2. Ten most populated metropolitan areas with more than 100 days of ozone pollution in 2018

Metropolitan area	Number of days in 2018 when half or more monitoring locations reported elevated ozone	2018 population
Phoenix-Mesa-Scottsdale, AZ	110	4,857,962
Riverside-San Bernardino-Ontario, CA	166	4,622,361
Las Vegas-Henderson-Paradise, NV	132	2,231,647
Salt Lake City, UT	111	1,222,540
Fresno, CA	137	994,400
Albuquerque, NM	123	915,927
Bakersfield, CA	178	896,764
Colorado Springs, CO	119	738,939
Ogden-Clearfield, UT	108	675,067
Provo-Orem, UT	104	633,768

Table ES-3. Ten most populated metropolitan areas with more than 100 days of particulate pollution in 2018

Metropolitan area	Number of days in 2018 when half or more monitoring locations reported elevated $PM_{2.5}$	2018 population
Los Angeles-Long Beach-Anaheim, CA	135	13,291,486
Riverside-San Bernardino-Ontario, CA	154	4,622,361
San Diego-Carlsbad, CA	138	3,343,364
Cincinnati, OH-KY-IN	111	2,190,209
Austin-Round Rock, TX	108	2,168,316
Fresno, CA	157	994,400
Tulsa, OK	146	993,797
Bakersfield, CA	110	896,764
McAllen-Edinburg-Mission, TX	115	865,939
Stockton-Lodi, CA	183	752,660

million Americans were exposed to elevated ozone pollution. Those rural counties and urban areas were located in 45 different states, plus the District of Columbia.

Particulate pollution is widespread, exposing millions of Americans to potential health damage. 34 million people lived in areas with more than 100 days of elevated fine particulate pollution in 2018. (Table ES-3 shows the most populated metropolitan areas that experienced frequent fine particulate pollution.)

Air pollution already harms the health of millions of Americans around the country and cuts short tens of thousands of lives each year. Climate change will make it worse. Many solutions that address the climate challenge will also improve air quality. Policymakers at the federal, state and local levels should look to implement policies that:

- Reduce emissions from transportation, the largest source of global warming pollution in the U.S. and a major source of air pollution in many communities.[9] Policies to reduce global warming and air pollution include expanded use of zero-emission vehicles, regional programs to cap pollution from transportation, and support for active transportation such as walking and biking.
- Move the country away from fossil fuels – which are a major source of climate pollution in transportation, electricity generation and buildings – and toward the use of clean, renewable energy like wind turbines and solar panels.
- Strengthen, and strongly enforce, emission and air quality standards to fully protect human health.

Introduction

Air pollution and climate change are "two sides of the same coin," according to the United Nations Environment Program.[10] Climate change will make air pollution worse, while some air pollutants can exacerbate global climate change.

Higher atmospheric temperatures worsen air quality in multiple ways. Hotter temperatures speed up the formation of ground-level ozone (often known as "smog") and increase evaporation of volatile organic compounds (VOCs) that are among the precursors of ozone.[11] Higher temperatures, combined with drought, will increase the frequency and severity of wildfires that produce huge amounts of particulate pollution that threaten public health.[12]

At the same time, air pollution such as black carbon, a form of particulate pollution, exacerbates global warming. Black carbon in the air readily absorbs sunlight, increasing the temperature of the atmosphere.[13] When black carbon lands on snow or ice, it absorbs heat and hastens melting. This can lead to greater warming, as open water and bare ground retain more heat from the sun than do snow or ice. Production of natural gas is a major source of VOCs, which contribute to ozone, and also releases methane, a powerful global warming pollutant that traps more than 80 times as much heat as carbon dioxide over 20 years.[14]

Just as air pollution and global warming share some common causes, and are linked together in a self-reinforcing cycle, so too do they share another characteristic: scientific alarm about their threats to the environment and public health is growing.

New research has documented that an increase in even low levels of air pollutants like particulates is associated with an increase in the number of people who die prematurely.[15] And scientists are increasingly discovering that air pollution has impacts on the human body far beyond the lung and cardiovascular problems that have long been the focus of scientific attention. For example, research is increasingly finding links between air pollution and decreased cognitive functioning, including possible links to diseases such as Alzheimer's.[16]

At the same time, scientific concerns about rising global temperatures are also becoming more urgent. Numerous studies – including a headline-grabbing analysis by the Intergovernmental Panel on Climate Change – have estimated how steeply global temperatures are likely to rise in the coming decades unless we take action to reduce emissions dramatically.[17] Many of these analyses have also calculated the severe potential consequences of higher temperatures on human health and planetary wellbeing.

Fortunately, action to reduce air pollution can help slow global warming, while many of the solutions to prevent the worst impacts of climate change over the long run can also protect our health and make the air safer to breathe right away.

This report shows that air pollution remains a widespread problem for the nation. Though the skies over most cities are less visibly smoggy than they were in the 1990s and 2000s, millions of Americans breathe levels of pollution that can put their health at risk. By cutting the emissions that cause air pollution and contribute to global warming, we can protect public health today, while minimizing the warming that threatens our future. The benefits of taking such action now are clear. And as the following analysis shows, the costs of waiting are steep.

Air pollution threatens public health

Photo: T. H. Painter, Snow Optics Laboratory, JPLCaltech via Flickr CC BY 2.0.

Particulate pollution can harm human health and also add to global warming. Here, dust and black carbon have coated snow and ice, causing them to absorb more heat from the sun.

Americans breathe air polluted with a variety of contaminants, including particulate matter (PM), ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, volatile organic compounds, and many other toxic or hazardous substances. This pollution, which comes from burning fossil fuels, agricultural activity, wildfires, and other sources, creates significant risks to public health. Each year, millions of Americans suffer from adverse health impacts linked to air pollution, and tens of thousands have their lives cut short.

Two pollutants of special concern are **particulate matter** and **ozone**. Fine particulate pollution smaller than

2.5 micrometers ($PM_{2.5}$) poses especially high health risks because it can be deposited deep in the lungs.[18] Ozone that forms near the ground is the main ingredient in smog and is associated with adverse health impacts (as opposed to ozone in the high atmosphere, which blocks harmful solar ultraviolet rays from reaching the earth).

Air pollution – including but not limited to $PM_{2.5}$ and ozone – damages many aspects of health and wellbeing.

Premature death. Globally, ozone and fine particulate matter are estimated to cause 470,000 and 2.1 million deaths each year, respectively, by damaging the lungs and respiratory system.[19] A study published in the *Proceedings of the National Academy of Sciences* estimated that in the U.S. fine particulate matter generated by human activities was responsible for more than 107,000 premature deaths in 2011.[20]

Small changes in pollution levels affect death rates. A 2019 study published in the *New England Journal of Medicine* found that when the concentration of fine particulate matter ($PM_{2.5}$) increased by 10 micrograms (μg) per cubic meter, daily mortality in the U.S. increased by 1.58 percent. A 1.58 percent increase in daily mortality equals an additional 122 deaths in the U.S. on a day when fine particulate pollution increased by 10 μg per cubic meter.[21] When coarse particulate matter (PM_{10}) increased by 10 micrograms (μg) per cubic meter, daily mortality rose 0.79 percent.[22]

A 2009 study compared U.S. metropolitan areas across decades and found that a 10 μg per cubic meter decrease in fine particulate matter concentrations was associated with an increase in average life expectancy of approximately 0.6 years.[23]

Damage to respiratory and cardiovascular systems. In weeks with elevated ozone or particulate matter pollution, hospital emergency rooms see more patients for breathing problems.[24] A 2019 study published in *JAMA* (the Journal of the American Medical Association) found that higher levels of pollutants including ozone and particulate matter in the air are associated with increased risk of emphysema.[25] Air pollution, especially traffic-related air pollution, not only worsens asthma but may also cause more people to develop asthma.[26] Research also shows strong associations between air pollution and cardiovascular diseases including stroke.[27] Particulate pollution is associated with increased risk of hospitalization for heart disease.[28]

Worsened mental health and functioning. A 2019 study published in *PLOS Biology* found that poor air quality, including higher levels of particulate matter and ozone, was associated with increases in bipolar disorder.[29] Long-term exposure to particulate pollution has also been associated with increased risk of Alzheimer's disease and other forms of dementia.[30]

Decreased fertility and harm to pregnancies. Exposure to air pollution has been associated with difficulty in having children, and increased risk of low birth weight and premature deliveries.[31] A 2019 study of women in Italy found that higher levels of particulate matter (both $PM_{2.5}$ and PM_{10}) and nitrogen dioxide are associated with lower levels of ovarian reserve, a marker of female fertility.[32] A 2013 study found "short-term decreases in a couple's ability to conceive" associated with higher levels of $PM_{2.5}$ and nitrogen dioxide.[33] Maternal exposure to $PM_{2.5}$ or ozone is associated with a higher risk of low birth weight, pre-term birth and stillbirth.[34] One study estimated that in 2010, up to 42,800 preterm births in the U.S. and Canada were related to women's exposure to $PM_{2.5}$, accounting for up to 10 percent of preterm births.[35]

Increased cancer risk. Exposure to air pollution can cause lung cancer and other cancers.[36] The International Agency for Research on Cancer (IARC), part of the World Health Organization, has found that outdoor air pollution generally, and particulate matter specifically, are carcinogenic to humans.[37] The IARC determined that "exposures to outdoor air pollution or particulate matter in polluted outdoor air are associated with increases in genetic damage that have been shown to be predictive of cancer in humans." In 2010, 223,000 lung cancer deaths globally were attributed to exposure to $PM_{2.5}$.[38]

Harm to children. Children are particularly vulnerable to air pollution because their bodies are developing, and also because they tend to spend more time outside.[39] Children are also exposed to higher levels of air pollution because they walk or are pushed in strollers closer to the height of vehicle exhaust pipes.[40] Particulate pollution can harm lung development in children and impair lung function in the long-run.[41] Prenatal exposure to air pollution is also associated with impaired lung function and impaired lung development in childhood.[42]

Air pollution is harmful at some levels the EPA considers safe

Air pollution likely poses health threats even at levels the EPA considers safe.

The EPA communicates potential health risks to the public using its Air Quality Index (AQI), which classifies levels of different pollutants into the color-coded risk categories of "Good," "Moderate," "Unhealthy for Sensitive Groups," "Unhealthy," "Very Unhealthy," and "Hazardous." (See Table 1 for details and colors.)

Photo: xavigm via iStockphoto

Children are particularly vulnerable to air pollution.

Air quality classified as "Good," for example, poses "little or no risk," according to the EPA.[44] "Moderate" pollution is described by the EPA as only presenting "a moderate health concern for a very small number of people who are unusually sensitive to air pollution."[45]

Table 1. U.S. EPA air quality index values and colors[43]

Air Quality Category	Air Quality Index Values	Color	Ozone Readings (ppb)	$PM_{2.5}$ Readings (μg/m³)
Good	0-50	Green	0-54	0-12
Moderate	51-100	Yellow	55-70	12.1-35.4
Unhealthy for Sensitive Groups	101-150	Orange	71-85	35.5-55.4
Unhealthy	151-200	Red	86-105	55.5-150.4
Very Unhealthy	201-300	Purple	106-200	150.5-250.4
Hazardous	301-500	Maroon	201+	250.5+

Higher levels of pollution create a health threat more quickly and for a larger share of the population.

The AQI is linked to the National Ambient Air Quality Standards (NAAQS), which are periodically reviewed and adjusted based on the latest research on the links between pollution and public health. For example, currently the EPA has concluded that ozone levels above 70 parts per billion for eight hours or more are unhealthy for sensitive people, and when ozone exceeds that level, the EPA warns that children, older adults and people with lung disease should consider limiting their exposure.[46] The EPA has concluded that sensitive people are at risk when levels of fine particulates (particulate matter of 2.5 microns or less, $PM_{2.5}$) average 35 micrograms per cubic meter of air (µg/m3) over 24 hours.[47]

However, research suggests that "moderate" air quality can, in fact, pose broad threats to public health, and a variety of medical and public health organizations have recommended tighter air quality standards that are more protective of public health.

The World Health Organization (WHO), for example, recommends lower ozone and particulate pollution standards than are currently in place in the United States. The WHO published air quality guidelines in 2006 that recommended an ozone pollution standard equal to 51 parts per billion over eight hours.[48] In comparison, the current U.S. ozone standard is 70 parts per billion.[49] The WHO recommended that fine particulates be limited to 25 µg/m3 over 24 hours, which is more protective than the current U.S. standard of 35 µg/m3. The American Thoracic Society, the American Lung Association and other health associations support the same standard for fine particulates as the WHO.[50]

Beyond what the WHO and other health organizations have recommended, a growing body of evidence supports the conclusion that even very low levels of pollution can affect health.

- In response to new data about deaths linked to particulate pollution, a 2019 editorial in the *New England Journal of Medicine* noted that "Even high-income countries, such as the United States, with relatively good air quality could still see public health benefits from further reduction of ambient PM concentrations (i.e., below the current [pollution standards])."[51]
- A 2019 analysis of the impact of $PM_{2.5}$ on dementia rates concluded that particulate pollution continues to have an impact at levels "below the current regulatory thresholds."[52]

In fact, there may not be a minimum threshold at which air pollution should be considered safe. For example:

- In a 2017 study, researchers examined more than 22 million deaths in the Medicare population from 2000 to 2012 and found that a 10-parts-per-billion rise in warm-season ozone pollution increased the daily mortality rate by 0.5 percent, regardless of how low pollution levels had been initially.[53] The authors concluded that there is "no evidence of a threshold" below which ozone or particulate pollution is safe.
- Even when concentrations of ozone are at levels considered by the EPA to be "good" or "moderate," a 2006 study found that an increase in ozone pollution results in more premature deaths.[54]
- In 2006, the WHO concluded that there is no documented safe level of exposure to particulate pollution.[55]

Fossil fuel combustion is a major source of air pollution

Air pollution comes from a variety of sources, both human and natural. Gasoline, diesel, natural gas, coal and other fossil fuels burned for transportation, electricity generation, industrial processes, heating and other purposes are major sources of NO_x and VOC emissions. These create ground-level ozone and also can turn into particulate pollution. Fossil fuel combustion, fires and dust are major contributors to particulate pollution. These sources create particulates directly and, in addition, some produce precursor chemicals that combine into particulates.

Ozone

Ozone, the main component of smog, is formed by chemical reactions between nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight.[56] Fossil fuels – both their combustion and production – are major sources of NO_x and VOC emissions.

The majority of NO_x emissions come from the combustion of fossil fuels for transportation and electricity generation. (See Figure 1.)

- In 2014, transportation and other mobile sources produced more than 60 percent of NO_x emissions. Highway vehicles – including passenger cars and SUVs, freight trucks and delivery vans – accounted for more than one third of total NO_x emissions from human activities. Commercial marine vessels and railroads accounted for 9 percent and 5 percent of emissions, respectively.[58]

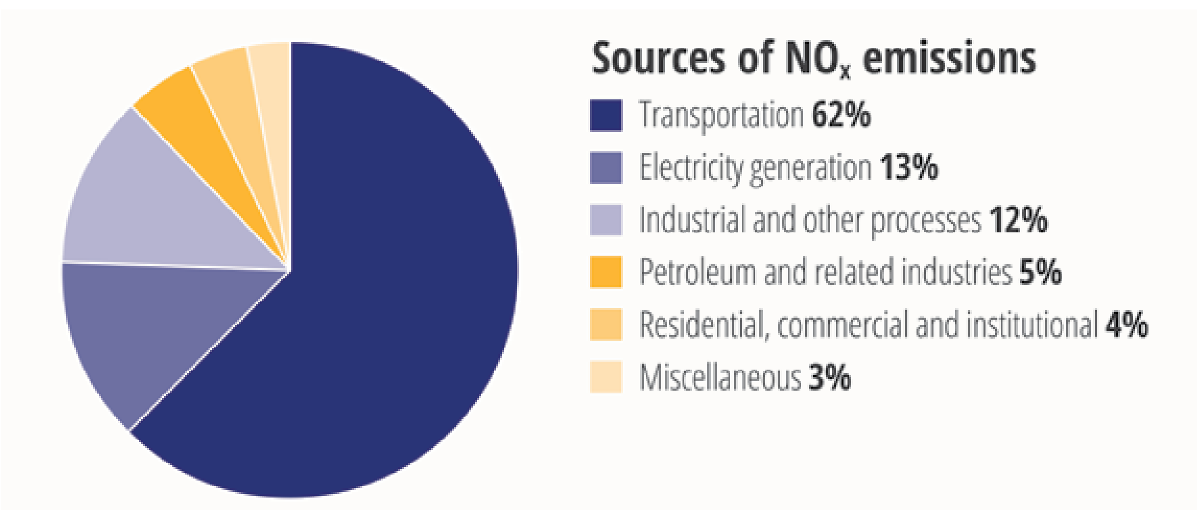


Figure 1. Sources of nitrogen oxide (NO_x) pollution in 2014 (excluding NO_x from vegetation)[57]

- In 2014, coal combustion for electricity generation by utilities accounted for 11 percent of NO_x emissions from human activities, with oil and gas adding more pollution.
- Industrial activities accounted for 12 percent of NO_x emissions.
- Oil and gas production, refining and related activities produced 5 percent of the nation's total NO_x emissions from human activities in 2014.

Wildfires, transportation, and oil and gas production are the biggest sources of VOC emissions in the United States (excluding VOCs released by plants). (See Figure 2.)

- Wildfires and planned burning created 26 percent of VOCs from human activities and fires in 2014.[60]
- Transportation accounted for one-quarter of all VOC pollution from human activities and fires in 2014. Passenger cars and SUVs accounted for nearly half of VOC emissions from transportation.[61]
- In 2014, oil and gas production was responsible for nearly one fifth (19 percent) of VOC emissions (excluding emissions from vegetation), with significant impacts in areas where oil and gas production is prevalent.[62] Oil and gas production in northeastern Colorado, for example, has been found to be a major contributor to ozone in the area. According to a researcher who headed one study, as quoted by *Phys.org*, "If conditions are right, emissions from oil and gas can contribute up to 20-30 parts per billion (ppb) on bad ozone days and could lead to exceedances of the Environmental Protection Agency standards."[63]
- Solvents such as those used in consumer products, pesticides, graphic arts, architectural applications and other activities created 19 percent of VOCs (excluding VOCs from plants).
- Trees and other plants are also a major source of VOCs. VOC emissions from plants can contribute to ground-level ozone when they react with pollution from human sources.[64]

Particulate matter

Particulate matter consists of solid or liquid particles that can be emitted directly from a source or that can form in the air from chemicals such as VOCs, sulfur dioxide, ammonia and NO_x.[65] Fine particulates smaller than 2.5 micrometers ($PM_{2.5}$) pose elevated health risks as they can

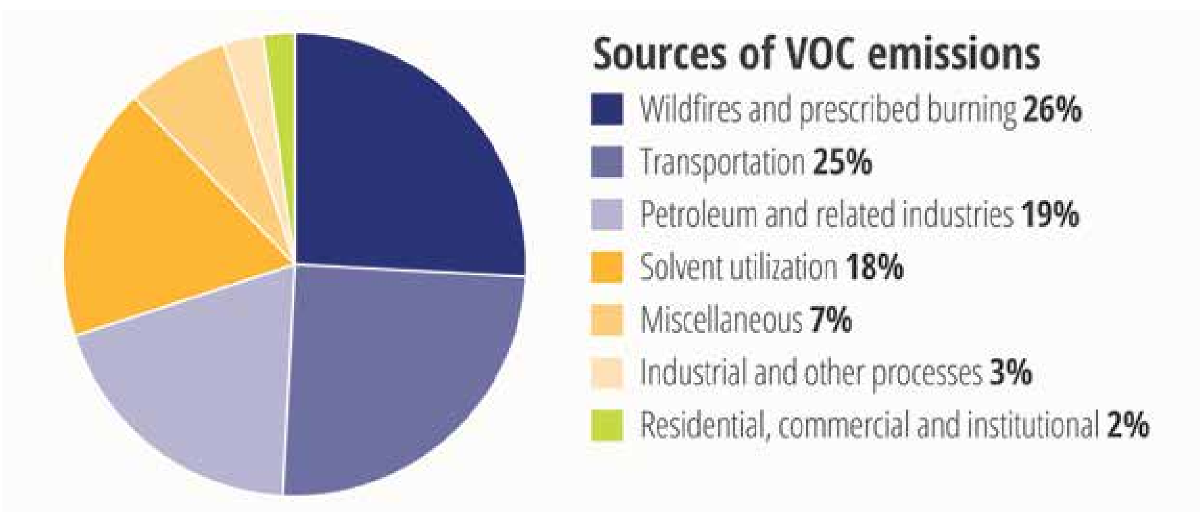


Figure 2. Sources of volatile organic compound (VOCs) pollution in 2014 (excluding VOCs from vegetation)[59]

be absorbed deep into the lungs.[66] The impact of $PM_{2.5}$ is further increased by the fact that it is so lightweight that it remains in the air for a long time and can travel hundreds of miles from its source.[67]

Primary particulate matter is created by a variety of sources, including fossil fuel combustion; dust from roads, agriculture and construction; wildfires; and wood burned for heating.[68] On average across the U.S., the majority of the particulate pollution in the atmosphere is secondary particulate pollution, which forms through a chemical reaction.[69] Secondary $PM_{2.5}$ can be created from sources including sulfur dioxide emitted by burning coal and other fossil fuels for electricity generation and industrial power; nitrogen oxides from fossil fuel combustion; and ammonia from fertilizer and manure.[70]

Mobile sources (including cars, trucks and other on-road vehicles and also off-road vehicles) accounted for 20 percent of both primary and secondary $PM_{2.5}$, according to one 2004 study.[71] Mobile sources may have disproportionately larger impacts on health compared to other sources, because mobile sources are generally in closer proximity to people. A 2019 study estimated that transportation emissions were associated with more than a quarter of U.S. deaths caused by fine particulate matter created by human activity.[72]

In addition to combustion emissions, cars, trucks and other on- and off-road vehicles play a role in producing other particulate pollution. In 2014, dust from paved and unpaved roads accounted for 16 percent of primary fine particulate emissions.[73] Vehicle braking also produces particulate pollution, which can contain heavy metals such as zinc and copper that may elevate health risks.[74]

Electricity generation is also a major source of $PM_{2.5}$ pollution, especially in eastern states.[75] Power plants produce large amounts of sulfur dioxide, which can turn into $PM_{2.5}$. According to a 2019 study, sulfur dioxide from coal-fired power plants accounts for 11 percent of the total health damage from $PM_{2.5}$.[76]

Agriculture is also a major source of particulate pollution. Dust from crop and livestock operations accounted

Cars, light-trucks and other vehicles contribute to both particulate pollution and ozone pollution.

for 18 percent of primary $PM_{2.5}$.[77] Agriculture is also responsible for 80 percent of national ammonia emissions, which can react in the atmosphere to form secondary particulate matter.[78] Agricultural ammonia emissions, which are emitted from sources including animal waste and fertilizer, are responsible for a significant percentage of human mortality attributed to $PM_{2.5}$.[79]

Air toxics

Fossil fuel combustion also releases toxic air contaminants such as benzene, formaldehyde and 1,3-butadiene that contribute to ozone and particulate pollution, and that are also hazardous on their own.[80] These pollutants can cause cancer, and some, such as formaldehyde, increase the risk of asthma.[81] Exposure to air toxics creates additional health threats above and beyond the threats highlighted in this report related to particulate matter and ozone.

Global warming will make air pollution worse

Climate change has begun to affect air quality, and air pollution will become a greater problem as climate change further warms the planet, alters weather patterns, and triggers other shifts. According to the U.S. Global Change Research Program's *Fourth National Climate Assessment*, "climate change will worsen existing air pollution levels" without additional efforts to improve air quality. "This worsened air pollution would increase the incidence of adverse respiratory and cardiovascular health effects, including premature death," according to the report.[82]

Global warming is already harming air quality.

- Higher temperatures have already resulted in increased ozone, despite lower emissions of the chemicals that create ozone. In the central U.S. in the summer of 2012, for example, higher temperatures caused higher levels of ozone than in the years before and after.[83]
- The American Lung Association found that ozone was higher in the 2014 to 2016 period than in previous recent three-year study periods, and attributed the increase to higher temperatures.[84]

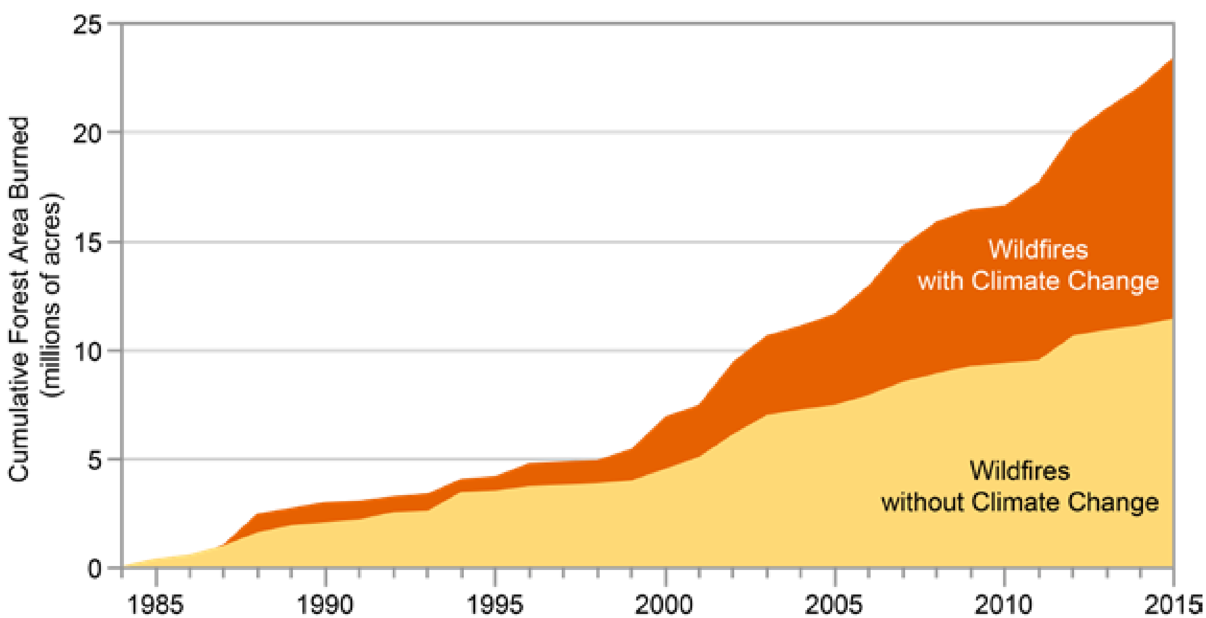


Figure 3. Climate change has increased the area burned in wildfires[87]

- Hotter, drier conditions have increased wildfires, which create particulate pollution as well as VOCs and nitrogen oxides that contribute to ozone formation. By one estimate, global warming nearly doubled the total acreage that burned in western states from 1984 to 2015, compared to a scenario in which the climate had not changed.[85] (See Figure 3.) Wildfires also burn for longer, causing more prolonged and widespread exposure to pollutants. The typical large wildfire now burns for more than seven weeks, compared to less than a week in the 1970s.[86]

In the years to come, climate change will make air pollution even worse:

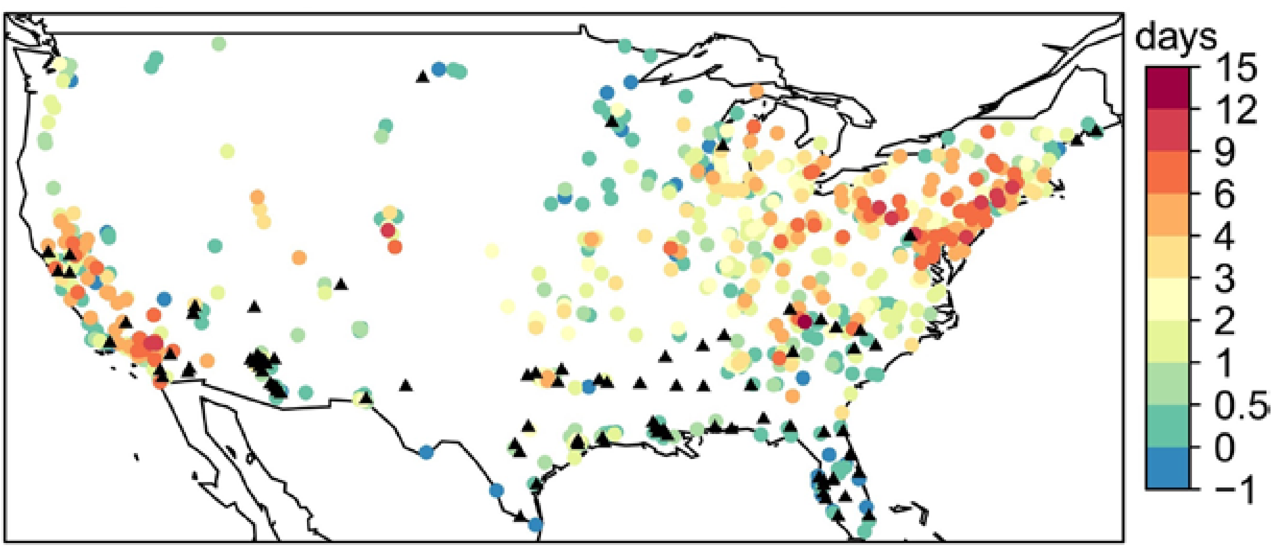
- Rising temperatures will result in more ozone formation.[88] According to an analysis by researchers at Harvard and the National Center for Atmospheric Research, people in the Northeast, Midwest and Southwest will have experienced an additional three to nine days of ozone pollution of above 75 ppb annually by 2050 compared to 2000 because of higher temperatures predicted as a result of global warming.[89] (See Figure 4.) Ozone concentrations at that level are in the range the EPA considers "unhealthy for sensitive groups."[90]

- With higher temperatures throughout the year, unhealthy levels of ozone may become more common in the spring and fall, in addition to the summer ozone problems that are common today.[92]

- Higher temperatures may also exacerbate the health effects of exposure to any given amount of ozone, as higher temperatures are associated with an increased risk of ozone-related premature death.[93]

- Changed wind patterns may increase the number of days with stagnant air, keeping pollution from being diluted. Decreased air circulation may already be worsening air quality by trapping pollution precursors and pollution near the ground.[94] Multiple days of stagnant air can lead to especially high levels of pollution.

- Climate change will increase the frequency and severity of wildfires, as a result of hotter temperatures and more droughts.[95] According to the *Fourth National Climate Assessment*, resulting wildfires will "diminish air quality, increase incidences of respi-



Black triangles indicate locations where higher temperatures will not have an impact on ozone formation.

Figure 4. Estimated change in days with elevated ozone levels in 2050[91]

ratory illness from exposure to wildfire smoke, impair visibility, and disrupt outdoor recreational activities."[96]

- Global warming is projected to cause severe droughts in the southwestern U.S., increasing dust pollution. A 2019 study found that droughts could increase dust levels in the region, increasing deaths and hospitalizations attributable to fine dust by 230 percent and 360 percent, respectively.[97] Reduced rainfall caused by global warming may also increase air pollution levels because rainfall removes particulate matter from the atmosphere.[98]
- Higher temperatures could increase evaporative emissions of volatile organic compounds, precursors to ozone.[99]

One study estimates global warming will increase the number of air pollution-related premature deaths if no measures are implemented to counteract global warming's impact on air quality. The analysis, published in 2017, estimates that an additional 1,130 Americans may die prematurely in the year 2030 from smog pollution under a scenario where global warming emissions are high and unchecked.[100] The study also estimates that particulate pollution worsened by global warming could cause an extra 6,900 premature deaths in 2030.

The U.S. Global Change Research Program has concluded that global warming will make it more difficult to control ozone pollution, and that maintaining current pollution levels in a warmer world will require reduced emissions of the chemicals that form ozone.[101]

In many cases, the activities that cause air pollution also contribute to global warming. Efforts to reduce our reliance on fossil fuels, which contribute to global warming, have the potential to help reduce ozone and particulate pollution as well.

Air pollution was widespread in the United States in 2018

Degraded air quality affects residents of every state in the country. In the summer, ozone pollution is a widespread problem. Throughout the year, many areas suffer from particulate pollution. Even a single day of elevated air pollution represents a threat to public health.

Number of days with elevated ozone and/or particulate pollution

In 2018, air pollution affected people across the nation. 108 million Americans lived in 89 large and small urban areas and in 12 rural counties that experienced more than 100 days of degraded air quality in 2018.

About This Analysis

Hundreds of air quality monitors in both urban and rural areas across the nation sample air pollution levels multiple times each hour. Based on this information and computer modeling, the U.S. Environmental Protection Agency (EPA) communicates present and forecasted air quality conditions using its Air Quality Index (AQI).

This report estimates the number of days of degraded air quality experienced in 2018 by people in various locations based on the number of days when air quality monitors reported an AQI of 51 or higher. This includes days that the EPA coded as moderate, unhealthy for sensitive groups, unhealthy, very unhealthy and hazardous. Air pollution data were grouped regionally, primarily by metropolitan and micropolitan areas. A relatively small number of rural counties also have air pollution monitors and were included.

In areas that contain more than one monitoring location, days in which half or more of the monitoring locations in the area reported an air quality problem were included in the tally of days with degraded air quality. People who live close to individual air pollution monitors may experience worse air pollution than indicated by this measure. However, counting every elevated reading from individual air pollution monitors runs the risk that a high reading from one or a handful of monitors may overstate the extent of the air pollution problem in a geographically dispersed metropolitan area.

This report presents the number of days with elevated ground-level ozone pollution and with elevated particulate pollution, which present different types of threats to health. It also presents the number of days when ozone and/or particulate pollution were elevated, a measure of how often residents have to breathe polluted air.

That is equal to more than three months of the year in which ozone and/or fine particulate pollution was above the level that the EPA has determined presents "little to no risk." (See Table 2.) These communities experienced more than 100 days with elevated ozone pollution, elevated fine particulate pollution, or some combination of both.

Another 157 million Americans resided in 264 large and small urban areas and in 61 rural counties that faced 31 to 100 days – a month or more – of elevated ozone and/or particulate pollution. Those places include the New York City region, with nearly 20 million residents, and other major urban areas such as the Washington, D.C., Miami, and San Francisco regions. (See Table 3.)

Table 2. Ten most populated metropolitan areas with more than 100 days of elevated air pollution in 2018

Metropolitan area	Number of days in 2018 when half or more monitoring locations reported elevated ozone and/or $PM_{2.5}$	2018 population
Los Angeles-Long Beach-Anaheim, CA	156	13,291,486
Chicago-Naperville-Elgin, IL-IN-WI	113	9,498,716
Dallas-Fort Worth-Arlington, TX	106	7,539,711
Houston-The Woodlands-Sugar Land, TX	110	6,997,384
Atlanta-Sandy Springs-Roswell, GA	114	5,949,951
Phoenix-Mesa-Scottsdale, AZ	153	4,857,962
Riverside-San Bernardino-Ontario, CA	227	4,622,361
Detroit-Warren-Dearborn, MI	118	4,326,442
San Diego-Carlsbad, CA	160	3,343,364
Denver-Aurora-Lakewood, CO	131	2,932,415

Note: This count includes air pollution at or above the level the EPA labels "moderate," indicated in yellow or worse in its Air Quality Index.

Table 3. Ten most populated metropolitan areas with 31 to 100 days of elevated air pollution in 2018

Metropolitan area	Number of days in 2018 when half or more monitoring locations reported elevated ozone and/or $PM_{2.5}$	2018 population
New York-Newark-Jersey City, NY-NJ-PA	71	19,979,477
Washington-Arlington-Alexandria, DC-VA-MD-WV	86	6,249,950
Miami-Fort Lauderdale-West Palm Beach, FL	42	6,198,782
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	85	6,096,372
Boston-Cambridge-Newton, MA-NH	33	4,875,390
San Francisco-Oakland-Hayward, CA	88	4,729,484
Seattle-Tacoma-Bellevue, WA	62	3,939,363
Minneapolis-St. Paul-Bloomington, MN-WI	74	3,629,190
Tampa-St. Petersburg-Clearwater, FL	58	3,142,663
Orlando-Kissimmee-Sanford, FL	43	2,572,962

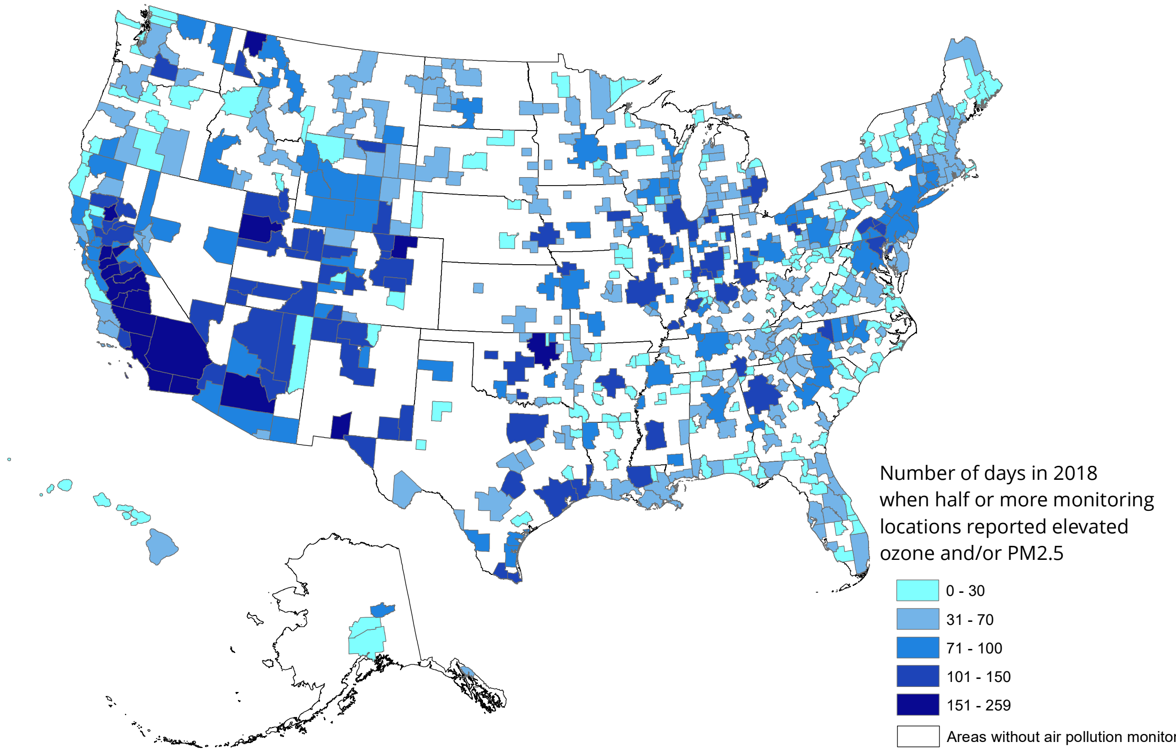


Figure 5. Both urban and rural areas experienced frequent ozone and/or particulate pollution in 2018

Smaller communities that experienced a month or more of elevated air pollution include Racine, Wisconsin; Columbia, Missouri; and Billings, Montana.

Number of days with elevated ozone pollution

Thirty-two large and small urban areas and six rural counties – home to more than 21 million people – experienced more than 100 days of ozone pollution in 2018. Frequent ozone pollution affected major urban areas such as Phoenix, Arizona; Riverside, California; Las Vegas, Nevada; and Salt Lake City, Utah. Smaller communities plagued by frequent ozone pollution include Fort Collins and Boulder, Colorado, and Laramie, Wyoming.

Pollution from transportation is a major contributor to ozone. In Phoenix, for example, vehicles, including cars and light trucks, are the largest source of the pollution that turns into ozone.[102] In Colorado, pollution from transportation has the biggest impact on ozone formation in the Boulder and Denver areas.[103] (Denver had 99 days of elevated ozone pollution.)

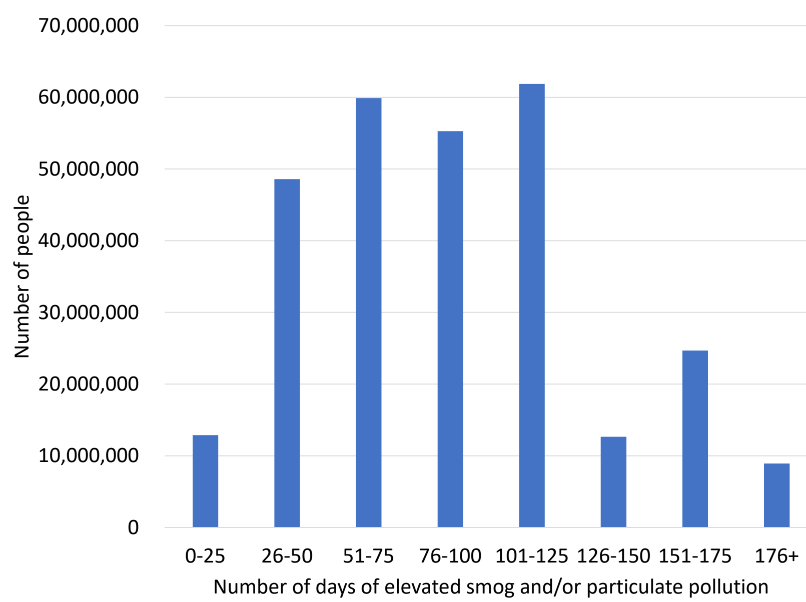


Figure 6. Number of people living in communities that experienced elevated air pollution at various frequencies in 2018

Table 4. Ten most populated metropolitan areas with more than 100 days of elevated ozone pollution in 2018

Metropolitan area	Number of days in 2018 when half or more monitoring locations reported elevated ozone	2018 population
Phoenix-Mesa-Scottsdale, AZ	110	4,857,962
Riverside-San Bernardino-Ontario, CA	166	4,622,361
Las Vegas-Henderson-Paradise, NV	132	2,231,647
Salt Lake City, UT	111	1,222,540
Fresno, CA	137	994,400
Albuquerque, NM	123	915,927
Bakersfield, CA	178	896,764
Colorado Springs, CO	119	738,939
Ogden-Clearfield, UT	108	675,067
Provo-Orem, UT	104	633,768

Note: This count includes ozone pollution at or above the level the EPA labels "moderate," indicated in yellow or worse in its Air Quality Index.

Oil and gas operations also have a major impact on air quality in some areas. For example, in the area from Boulder to Fort Collins, oil and gas operations produce more ozone-forming pollution than other any other source.[104]

Another 228 large and small urban areas and rural counties experienced 31 to 100 days with elevated levels of ozone pollution in 2018. That means that for one to three months in 2018, up to 170 million Americans were exposed to elevated ozone pollution. Those rural counties, small communities and urban areas were located in 45 different states, plus the District of Columbia.

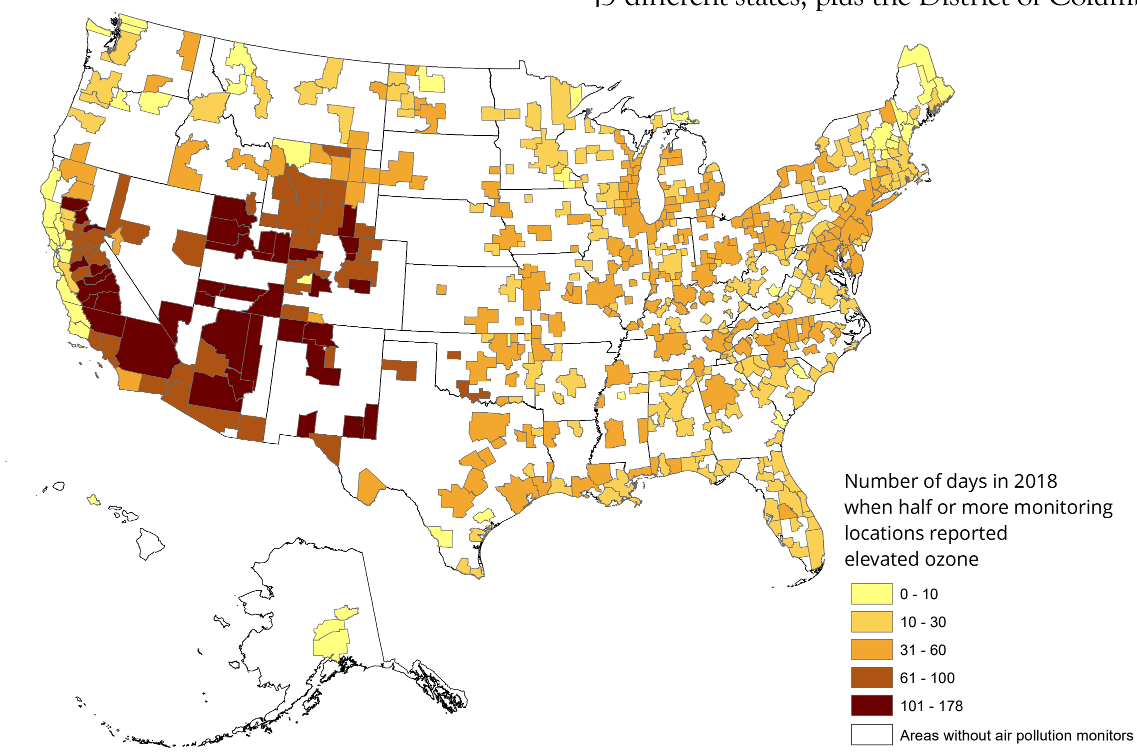


Figure 7. Frequency of ozone pollution in 2018

Table 5. Ten most populated metropolitan areas with more than 100 days of elevated particulate pollution in 2018

Metropolitan area	Number of days in 2018 when half or more monitoring locations reported elevated $PM_{2.5}$	2018 population
Los Angeles-Long Beach-Anaheim, CA	135	13,291,486
Riverside-San Bernardino-Ontario, CA	154	4,622,361
San Diego-Carlsbad, CA	138	3,343,364
Cincinnati, OH-KY-IN	111	2,190,209
Austin-Round Rock, TX	108	2,168,316
Fresno, CA	157	994,400
Tulsa, OK	146	993,797
Bakersfield, CA	110	896,764
McAllen-Edinburg-Mission, TX	115	865,939
Stockton-Lodi, CA	183	752,660

Number of days with elevated particulate pollution

Particulate pollution was a problem for more than 100 days in 26 large and small urban areas that were home to 34 million people during 2018. (See Table 5.)

Wildfires spread smoke across many western states in 2018, contributing to the high number of days with elevated fine particulate pollution in California, Washington, Idaho and Montana.[105] Oklahoma and Texas also experienced very active wildfire seasons in 2018.[106]

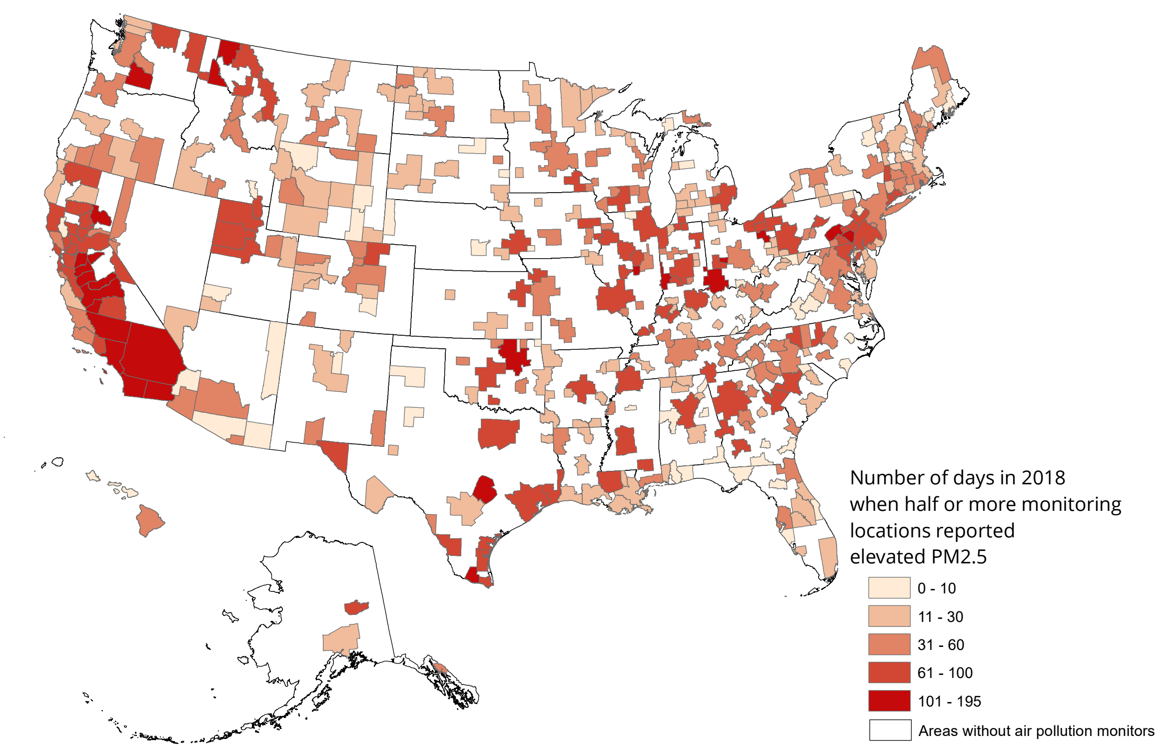
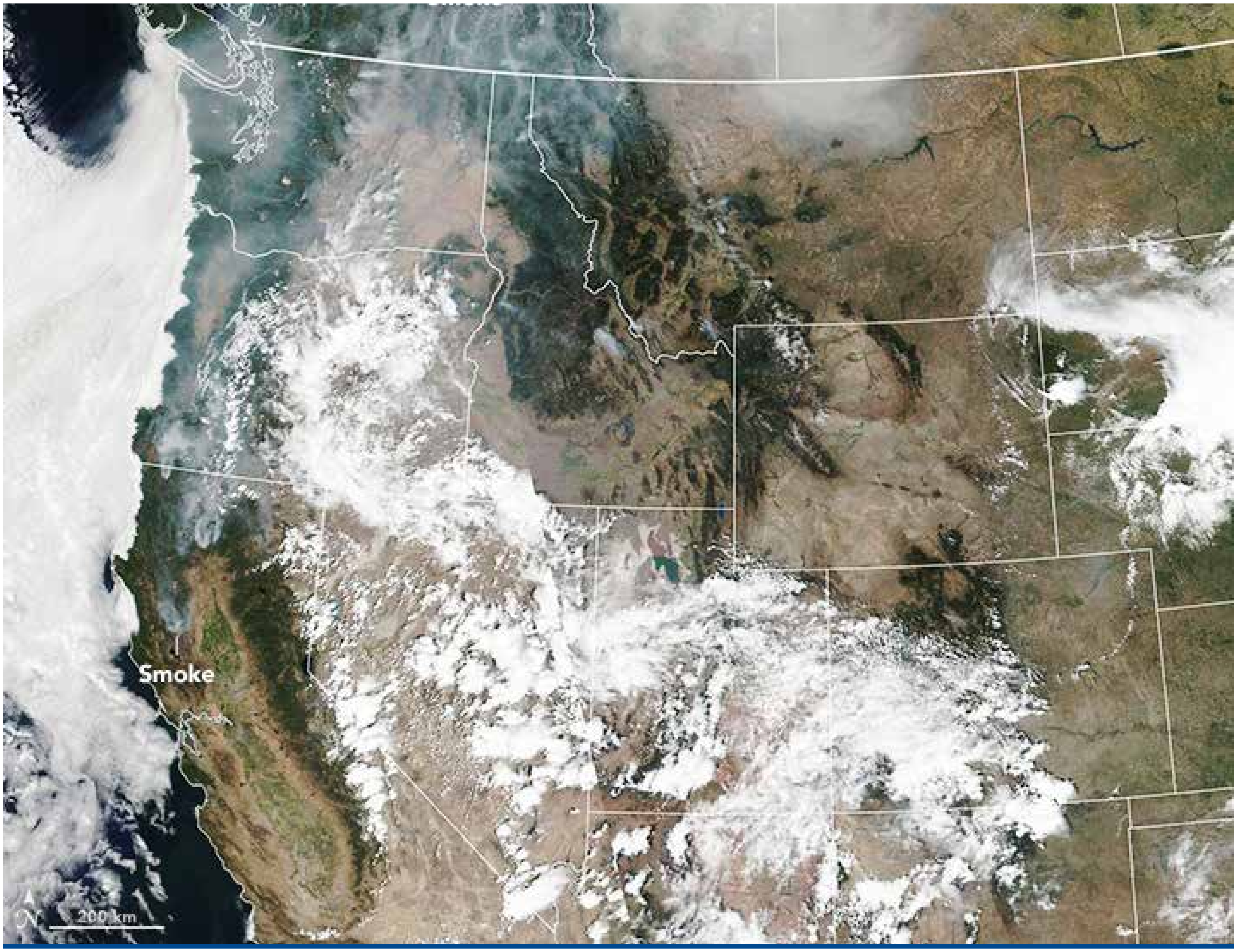


Figure 8. Frequency of fine particulate pollution in 2018

Photo: NOAA



Plumes of smoke from wildfires spread across the western U.S. in this image from August 2018.

Communities in Illinois, Indiana, Ohio and Pennsylvania also experienced more than 100 days of high particulate pollution in 2018.

An additional 188 large and small urban areas and 20 rural counties, home to a total of 180 million Americans, experienced 31 to 100 days of elevated particulate pollution in 2018. The urban areas affected include many of the nation's largest metropolitan areas, such as the New York, Chicago, Dallas-Fort Worth, and Houston regions, where diesel trucks, industrial activity, and other combustion sources produce particulate pollution and its precursors. Particulate pollution was frequently elevated in a number of smaller communities, where wildfire smoke and wintertime wood-burning for heat result in particulate pollution.

Progress on air pollution has stalled

Though air quality in the U.S. has improved over the decades, in recent years that progress has slowed. The U.S. Environmental Protection Agency calculates that the average level of ozone pollution dropped by 31 percent from 1980 to 2018 and that fine particulate pollution dropped by 34 percent from 2000 to 2018.[107] However, the agency's analysis of elevated ozone and particulate pollution in 35 major cities shows that the number of days of pollution was higher in each of the years from 2015 through 2018 than it was in 2013 or 2014.[108] Furthermore, the agency's data show that 2018 had more days of pollution than each of the previous five years.

The data analysis for this report reveals that the increase in days of elevated air pollution means that millions more Americans lived in areas with polluted air in 2018 than in 2016.[109]

- More Americans lived in areas experiencing more than 100 days of elevated pollution: In 2016, 56 large and small urban areas and four rural counties, home to 73 million Americans, experienced more than 100 days of degraded air quality.[110] In 2018, 89 large and small urban areas and 12 rural counties, home to 108 million Americans, had elevated pollution for this many days.

- More Americans dealt with frequent ozone pollution: In 2018, more than 21 million people lived in areas where smog pollution was elevated for more than 100 days. That is up from more than 8 million people living in such areas in 2016.

- Frequent particulate pollution also affected more communities: while 21 communities, home to 21 million Americans, experienced more than 100 days of elevated particulate pollution in 2016, the number rose to 26 communities, home to 34 million people, in 2018.

The snapshot comparison of data we analyzed for 2016 versus 2018 is not robust enough to indicate a long-term trend in air quality in the U.S. Combined with analysis by the EPA, however, it suggests progress on air quality has stalled.

Conclusion and recommendations

Air pollution plagues metropolitan areas and rural counties across the country. Millions of Americans regularly breathe air that contains ozone or particulate pollution, which creates a risk to their health, including by damaging the lungs, raising the risk of heart attack, and increasing the risk of premature death. It also endangers the health of new generations of children from birth onward.

Evidence suggests that many aspects of air pollution will be exacerbated by climate change. The problems are intimately connected: The combustion of fossil fuels is a leading cause of both climate change and air pollution. For example, transportation is the largest source of greenhouse gas emissions in the United States and also the largest source of nitrogen oxide pollution that causes ozone.[111] A variety of solutions that improve air quality will also help prevent the worst impacts of global warming.

To protect air quality and the health of all Americans, and to reduce climate emissions and prevent the worst impacts of global warming, policymakers should reduce emissions from transportation, support a broad transition to clean energy, and raise standards for air quality. Opportunities for doing so include:

Reducing emissions from transportation. Highway vehicles are a major source of air pollution. Pollution from vehicles is also especially harmful, as vehicle emissions often occur in densely populated urban areas. Specifically, policymakers should:

- **Support zero-emission vehicles.** Eleven states – California, Colorado, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island and Vermont – already have electric vehicle sales requirements.[112] Elected officials in other states should establish a goal of having all new passenger vehicles sold be electric vehicles by 2035 or sooner. States should also support the development of infrastructure needed to recharge those vehicles. Transit agencies and school districts should replace buses powered by fossil fuels with electric buses and consider adopting goals to repower entire fleets with electricity over one replacement cycle. Policies to encourage electrification of heavy-duty trucks and nonroad equipment would help to further reduce air pollution and limit global warming pollution. Both New York City and the state of California have committed to replacing all transit buses with electric buses by 2040.[113]
- **Create a strong regional program to reduce transportation emissions under the Transportation and Climate Initiative (TCI) in northeastern and mid-Atlantic states.** The Transportation Climate Initiative (TCI) is a proposed regional, cap-and-invest program intended to reduce carbon pollution from transportation. Policymakers in affected states should support a strong program that includes:
    - Setting a cap to reduce transportation-sector emissions by at least 25 percent by 2032, incorporating all transportation fuels.

- Requirements to auction 100% of allowances and reinvest auction revenue in programs to reduce carbon pollution from the transportation sector.
- Measures to ensure the integrity of the program and prevent loopholes.

- **Ensure that states can adopt and strengthen pollution standards for passenger vehicles.** The federal Clean Air Act allows California to establish tighter pollution standards for passenger vehicles, an acknowledgment of the state's severe air pollution problems and long history of air quality regulation. These clean car standards help to reduce global warming emissions and health-threatening air pollution from cars and trucks and have helped drive technological advances that have then led to strengthening of federal air quality standards. Federal law allows other states with air pollution problems to adopt California's clean car standards instead of federal standards. Thirteen other states, plus the District of Columbia, have done so.[114] These standards have been highly effective in reducing pollution and are one reason cars, light trucks and other passenger vehicles today are 98 to 99 percent cleaner than vehicles sold in the 1960s.[115]
  - The federal government should not jeopardize the ability of states to protect public health. The Trump administration is attempting to revoke California's ability to establish strong pollution standards for cars and light trucks.[116] The administration should not take away the ability of states to develop policies that have been so important in addressing pollution from passenger vehicles.
  - Additional states that suffer from poor air quality should adopt the clean car standards to better protect the health of their citizens.

- **Maintain strong federal fuel economy and global warming pollution standards for transportation.** The Trump administration has announced its intention to reconsider standards that, when fully phased in, would avoid emissions of 6 billion metric tons of global warming pollution over the lifetime of cars sold from 2012 to 2025.[117] These standards should be implemented as planned and strengthened for subsequent model years.

- **Support policies that can reduce driving and increase walking, biking and the use of transit.** These forms of transportation can help lower both air pollution and global warming pollution, while providing additional proven health benefits associated with increased physical activity. Efforts to improve facilities for walking and biking can make it safer and more appealing, helping to encourage people to drive less. Frequent, reliable transit service can attract more riders. For example, expanded light rail options and revamped bus service in Seattle have helped boost transit ridership, even as ridership has declined in many other cities.[118] To expand active transportation and transit use, states and cities should increase funding for walking, biking and transit, shift funding away from new road construction, and support development patterns that allow people to travel easily without a car.

- **Reduce pollution from all forms of transportation**, including medium- and heavy-duty vehicles, airplanes, railroads and marine vessels. Provide incentives and mandates for zero- and reduced-emissions technologies.

Supporting clean, renewable energy. Policymakers at all levels of government should work to support the rollout of renewable energy sources such as wind and solar power that can reduce air pollution emissions from the production, transportation and burning of fossil fuels. Efforts should include enforceable commitments to achieving high levels of renewable energy, commitments to improve energy efficiency and reduce energy use, and support for emerging technologies including energy storage and offshore wind power. Already, eight states and many cities and counties have adopted commitments to obtain all of their energy from clean sources in the coming decades.[119]

Expanding transit service and replacing diesel buses with electric buses, such as this electric bus in New York City, can help reduce air pollution and global warming impacts.

Protecting and building upon progress achieved under the Clean Air Act. The Clean Air Act has reduced air pollution and improved public health across the nation since its enactment more than four decades ago. In 2010, air quality improvements made possible by regulations under the Clean Air Act Amendments of 1990 helped prevent more than 160,000 early deaths, 130,000 non-fatal heart attacks, and 41,000 hospital admissions.[120] America should not relinquish any of this progress. Specifically, policymakers should:

- **Maintain the gains already achieved under implementation of the Clean Air Act** and seek to ensure that air quality rules are enforced in such a way as to protect public health.
- **Strengthen ozone and particulate matter standards.** Ozone and particulate matter standards should be brought in line with what science says is necessary to minimize adverse effects on human health.
- **Ensure strong enforcement of the Clean Air Act**, including by seeing that enforcement agencies:
    - Issue timely, health-based air quality permits that are maximally protective of public health.
    - Take timely, aggressive enforcement action to hold polluters accountable.
    - Expand and improve air quality monitoring.

Protecting and expanding urban tree cover. Trees help reduce air pollution by filtering fine particulates and ozone from the air.[121] They also help address multiple aspects of global warming by storing carbon pollution, lowering urban temperatures and reducing energy used for cooling, and by making walking and biking more pleasant. Cities and states can adopt policies to expand urban forests, including by providing greater funding for tree planting and maintenance, adopting requirements for trees in new developments, and adopting tree protection policies.

Methodology

This report estimates the number of days of degraded air quality experienced in 2018 by people living across the country, based on the number of days when air quality monitors for $PM_{2.5}$ or ozone reported an AQI of 51 or higher. Particulate matter and ozone are among pollutants that the World Health Organization considers to have the "strongest evidence for public health concern."[122] (See "Air pollution threatens public health," page 9, for more descriptions and details.) The report also presents the number of days with elevated ozone and/or particulate pollution, a measure of how often residents have to breathe polluted air.

Air pollution data were grouped regionally, primarily by metropolitan and micropolitan areas. A relatively small number of rural counties also have air pollution monitors and were included.

In areas that contain more than one monitoring location, days in which half or more of the monitoring locations in the area reported an air quality problem were included in the tally of days with degraded air quality. People who live closer to emission sources may experience worse air pollution than indicated by this measure, and people living further away from sources may experience less air pollution.

Air pollution data for 2018 are from U.S. Environmental Protection Agency, Air Data, Pre-Generated Files, accessed at https://aqs.epa.gov/aqsweb/airdata/download_files.html, 21 August 2019. The relevant files are the daily summary data for ozone and daily summary data for $PM_{2.5}$ measured with FRM/FEM mass methods.

Those files include a daily EPA-calculated Air Quality Index (AQI) score from 0 to 500 for each monitoring station and for each pollutant. Per the EPA, an AQI score of 51 to 100 is moderate (yellow), 101 to 150 is unhealthy for sensitive groups (orange), a score of 151 to 200 is unhealthy (red), a score of 201 to 300 is very unhealthy (purple), and a score of 301 to 500 is hazardous (maroon).[123]

The geographic units included in this analysis were core-based statistical areas (CBSA) (metropolitan and micropolitan urban areas identified by the federal Office of Management and Budget), and counties that are not part of a CBSA but that include one or more air quality monitoring locations. Each CBSA or county may have more than one monitoring location, and each location may have multiple monitors or air quality reports daily.

The method for each pollutant was as follows:

1. Identify the highest (worst) 8-hour AQI score for ozone or 24-hour AQI score for $PM_{2.5}$ from each monitoring location for each day to obtain a single reading per location.

2. Count the number of those with an AQI above 50.

3. Divide that by the total number of monitoring locations that reported an AQI that day.

4. Tally the number of days on which half or more reporting locations in each CBSA or county reported an AQI above 50.

2018 population data for CBSAs came from U.S. Census Bureau, *Metropolitan and Micropolitan Statistical Areas Population Totals: 2010-2018*, downloaded 28 September 2019 from https://census.gov/. 2018 population for counties came from U.S. Census Bureau, *County Population Totals and Components of Change: 2010-2018*, downloaded 28 September 2019 from https://census.gov/.

The populations for five geographic areas were not included in these two sources.

- Estimated 2018 population for Bishop, CA, came from U.S. Census Bureau, American FactFinder, *Bishop City, California*, accessed 1 October 2019 at https://census.gov.
- The estimated 2018 population for Macon, Georgia, was assumed to be that of Macon-Bibb County, Georgia, obtained from U.S. Census Bureau, QuickFacts, *Macon-Bibb County, Georgia*, accessed 1 October 2019 at https://www.census.gov/quickfacts/maconbibbcountygeorgia.
- The estimated 2018 population for Rockland, Maine, was obtained from U.S. Census Bureau, QuickFacts, *Rockland City, Maine*, accessed 1 October 2019 at https://www.census.gov/quickfacts/fact/table/rocklandcitymaine/PST045218.
- The estimated 2018 population for Española, New Mexico, was obtained from U.S. Census Bureau, QuickFacts, *Española, New Mexico*, accessed 1 October 2019 at https://www.census.gov/quickfacts/fact/table/espanolacitynewmexico/PST045218.
- The estimated 2018 population for Walterboro, South Carolina, was obtained from U.S. Census Bureau, QuickFacts, *Walterboro City, South Carolina*, accessed 1 October 2019 at https://www.census.gov/quickfacts/fact/table/walterborocitysouthcarolina/PST045218.

The data assessed may miss certain threats. For example, averaging pollution data over eight hours for ozone and 24 hours for particulate pollution, as is the case for the AQI data used in this report, may mask short-term spikes in pollution that can damage health.[124] Some results not counted as degraded air quality in this analysis also likely pose a threat to health. See "Air pollution is harmful at some levels the EPA considers safe" on page 11 for details.

Sources of air pollution

Data on sources of pollution comes from U.S. Environmental Protection Agency, *2014 National Emissions Inventory*, 14 February 2018, downloaded from ftp://newftp.epa.gov/air/nei/2014/tier_summaries/. For purposes of categorization in Appendix B and Figures 1 and 2, pollutant sources were aggregated based on the EPA's "Tier 1" source categorization as follows:

Tier 1 category	New categorization
Chemical & Allied Product Mfg	Industrial and other processes
Fuel Comb. Elec. Util.	Electricity generation
Fuel Comb. Industrial	Industrial and other processes
Fuel Comb. Other	Residential, commercial and institutional
Highway Vehicles	Transportation
Metals Processing	Industrial and other processes
Miscellaneous	Miscellaneous
Off-Highway	Transportation
Other Industrial Processes	Industrial and other processes
Petroleum & Related Industries	Petroleum & related industries
Solvent Utilization	Miscellaneous
Storage & Transport	Miscellaneous
Waste Disposal & Recycling	Miscellaneous

For VOCs, additional categorizations were applied as follows:

- Sources with an original Tier 1 source category of "solvent utilization" were categorized by the same name.
- Sources with original Tier 3 source categories of "prescribed burning" or "forest wildfires" were categorized as "wildfires and prescribed burning."

Appendix A – Days with elevated ozone, particulates and total pollution, by geographic area, 2018

This count includes air pollution at or above the level the EPA labels "moderate," and indicated in yellow or worse in its Air Quality Index. N/A indicates the location does not have a monitor for the type of pollution in question.

Air pollution data are listed by state. Results for urban areas are listed first, in alphabetical order, followed by results for rural counties that are not part of a metropolitan or micropolitan area. Many rural counties do not have any air pollution monitors and therefore do not appear here. Metropolitan and micropolitan areas that extend into more than one state are listed multiple times, once for each state.

Table A1. Days with elevated ozone, particulates and total pollution, by geographic area, 2018

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Alabama	Birmingham-Hoover, AL	30	81	92	1,151,801
	Columbus, GA-AL	27	65	79	305,451
	Daphne-Fairhope-Foley, AL	22	5	26	218,022
	Decatur, AL	28	12	37	152,046
	Dothan, AL	18	10	28	148,245
	Florence-Muscle Shoals, AL	12	15	26	147,149
	Fort Payne, AL	27	9	34	71,385
	Gadsden, AL	28	12	37	102,501
	Huntsville, AL	36	13	44	462,693
	Mobile, AL	33	12	41	413,757
	Montgomery, AL	21	12	31	373,225
	Tuscaloosa, AL	23	10	32	243,575
	Clay County, AL	N/A	7	7	13,275
	Sumter County, AL	14	N/A	14	12,691
Alaska	Anchorage, AK	0	27	27	399,148
	Fairbanks, AK	0	74	74	98,971
	Juneau, AK	N/A	46	46	32,113
	Denali Borough, AK	3	N/A	3	2,059
Arizona	Flagstaff, AZ	121	N/A	121	142,854
	Nogales, AZ	N/A	55	55	46,511
	Payson, AZ	136	N/A	136	53,889
	Phoenix-Mesa-Scottsdale, AZ	110	50	153	4,857,962
	Prescott, AZ	73	N/A	73	231,993
	Show Low, AZ	104	N/A	104	110,445
	Sierra Vista-Douglas, AZ	74	6	80	126,770
	Tucson, AZ	81	10	91	1,039,073
	Yuma, AZ	70	44	100	212,128
	Apache County, AZ	N/A	1	1	71,818
	La Paz County, AZ	100	7	101	21,098

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Arkansas	Arkadelphia, AR	19	N/A	19	22,061
	El Dorado, AR	N/A	20	20	39,126
	Fayetteville-Springdale-Rogers, AR-MO	43	22	61	549,128
	Fort Smith, AR-OK	21	20	38	282,318
	Harrison, AR	21	N/A	21	45,285
	Hot Springs, AR	N/A	22	22	99,154
	Jonesboro, AR	N/A	19	19	132,532
	Little Rock-North Little Rock-Conway, AR	30	91	104	741,104
	Memphis, TN-MS-AR	36	65	87	1,350,620
	Texarkana, TX-AR	N/A	13	13	150,242
	Arkansas County, AR	N/A	20	20	17,769
	Ashley County, AR	N/A	15	15	20,046
	Jackson County, AR	N/A	15	15	16,811
	Polk County, AR	28	16	41	20,049
California	Bakersfield, CA	178	110	226	896,764
	Bishop, CA	96	50	115	3,746
	Chico, CA	118	84	160	231,256
	Clearlake, CA	4	6	10	64,382
	Crescent City, CA	N/A	14	14	27,828
	El Centro, CA	77	126	171	181,827
	Eureka-Arcata-Fortuna, CA	0	16	16	136,373
	Fresno, CA	137	157	228	994,400
	Hanford-Corcoran, CA	146	195	259	151,366
	Los Angeles-Long Beach-Anaheim, CA	73	135	156	13,291,486
	Madera, CA	118	133	196	157,672
	Merced, CA	98	157	191	274,765

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
California	Modesto, CA	109	169	205	549,815
	Napa, CA	3	88	91	139,417
	Oxnard-Thousand Oaks-Ventura, CA	63	92	120	850,967
	Red Bluff, CA	108	69	138	63,916
	Redding, CA	57	11	62	180,040
	Riverside-San Bernardino-Ontario, CA	166	154	227	4,622,361
	Sacramento--Roseville--Arden-Arcade, CA	64	93	124	2,345,210
	Salinas, CA	0	23	23	435,594
	San Diego-Carlsbad, CA	40	138	160	3,343,364
	San Francisco-Oakland-Hayward, CA	0	88	88	4,729,484
	San Jose-Sunnyvale-Santa Clara, CA	13	84	88	1,999,107
	San Luis Obispo-Paso Robles-Arroyo Grande, CA	10	46	54	284,010
	Santa Cruz-Watsonville, CA	2	34	34	274,255
	Santa Maria-Santa Barbara, CA	0	43	43	446,527
	Santa Rosa, CA	4	35	38	499,942
	Sonora, CA	94	N/A	94	54,539
	Stockton-Lodi, CA	81	183	209	752,660
	Truckee-Grass Valley, CA	101	41	114	99,696
	Ukiah, CA	3	75	75	87,606
	Vallejo-Fairfield, CA	6	97	97	446,610
	Visalia-Porterville, CA	175	62	204	465,861
	Yuba City, CA	96	88	142	174,848
	Amador County, CA	76	N/A	76	39,383
	Calaveras County, CA	95	189	216	45,602
	Colusa County, CA	14	78	85	21,627
	Glenn County, CA	20	N/A	20	28,047
	Mariposa County, CA	132	N/A	132	17,471
	Mono County, CA	N/A	73	73	14,250
	Plumas County, CA	N/A	130	130	18,804
	Siskiyou County, CA	34	92	96	43,724

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Colorado	Boulder, CO	120	39	143	326,078
	Colorado Springs, CO	119	24	132	738,939
	Craig, CO	69	N/A	69	13,188
	Denver-Aurora-Lakewood, CO	99	51	131	2,932,415
	Durango, CO	87	35	103	56,310
	Fort Collins, CO	102	40	126	350,518
	Glenwood Springs, CO	78	20	82	77,720
	Grand Junction, CO	92	28	109	153,207
	Greeley, CO	100	89	164	314,305
	Montrose, CO	71	N/A	71	42,214
	Pueblo, CO	N/A	6	6	167,529
	Archuleta County, CO	33	N/A	33	13,765
	Delta County, CO	2	18	20	30,953
	Gunnison County, CO	111	N/A	111	17,246
	Montezuma County, CO	98	N/A	98	26,158
	Rio Blanco County, CO	109	44	123	6,336
Connecticut	Bridgeport-Stamford-Norwalk, CT	54	69	99	943,823
	Hartford-West Hartford-East Hartford, CT	29	59	71	1,206,300
	New Haven-Milford, CT	41	75	89	857,620
	Norwich-New London, CT	25	17	32	266,784
	Torrington, CT	32	18	43	181,111
	Worcester, MA-CT	22	41	56	947,866
Delaware	Dover, DE	35	30	56	178,550
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	43	65	85	6,096,372
	Salisbury, MD-DE	46	28	70	409,979
District of Columbia	Washington-Arlington-Alexandria, DC-VA-MD-WV	37	60	86	6,249,950

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Florida	Cape Coral-Fort Myers, FL	29	25	48	754,610
	Crestview-Fort Walton Beach-Destin, FL	27	N/A	27	278,644
	Deltona-Daytona Beach-Ormond Beach, FL	25	11	34	659,605
	Gainesville, FL	21	5	24	288,212
	Jacksonville, FL	21	39	53	1,534,701
	Lake City, FL	22	N/A	22	70,503
	Lakeland-Winter Haven, FL	32	11	40	708,009
	Miami-Fort Lauderdale-West Palm Beach, FL	15	28	42	6,198,782
	Naples-Immokalee-Marco Island, FL	18	N/A	18	378,488
	North Port-Sarasota-Bradenton, FL	23	9	32	821,573
	Ocala, FL	23	N/A	23	359,977
	Orlando-Kissimmee-Sanford, FL	30	18	43	2,572,962
	Palm Bay-Melbourne-Titusville, FL	28	1	29	596,849
	Panama City, FL	22	N/A	22	201,451
	Pensacola-Ferry Pass-Brent, FL	32	10	39	494,883
	Port St. Lucie, FL	20	N/A	20	482,040
	Sebastian-Vero Beach, FL	28	N/A	28	157,413
	Sebring, FL	14	N/A	14	105,424
	Tallahassee, FL	29	10	36	385,145
	Tampa-St. Petersburg-Clearwater, FL	25	42	58	3,142,663
	Holmes County, FL	18	N/A	18	19,477
	Liberty County, FL	11	N/A	11	8,457

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Georgia	Albany, GA	N/A	64	64	153,009
	Americus, GA	22	N/A	22	34,969
	Athens-Clarke County, GA	24	55	70	211,306
	Atlanta-Sandy Springs-Roswell, GA	36	98	114	5,949,951
	Augusta-Richmond County, GA-SC	23	87	97	604,167
	Brunswick, GA	14	2	15	118,456
	Chattanooga, TN-GA	39	86	106	560,793
	Columbus, GA-AL	27	65	79	305,451
	Dalton, GA	29	N/A	29	143,983
	Douglas, GA	N/A	4	4	43,093
	Gainesville, GA	N/A	40	40	202,148
	Macon, GA	26	43	53	153,095
	Savannah, GA	8	47	50	389,494
	Summerville, GA	21	N/A	21	24,790
	Valdosta, GA	N/A	9	9	146,174
	Warner Robins, GA	N/A	58	58	193,835
	Washington County, GA	N/A	11	11	20,386
Hawaii	Hilo, HI	N/A	50	50	200,983
	Kahului-Wailuku-Lahaina, HI	N/A	2	2	167,295
	Kapaa, HI	N/A	0	0	72,133
	Urban Honolulu, HI	1	0	1	980,080

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Idaho	Boise City, ID	51	28	71	730,426
	Idaho Falls, ID	46	N/A	46	148,904
	Jackson, WY-ID	59	25	73	34,721
	Logan, UT-ID	85	88	130	140,794
	Pocatello, ID	N/A	8	8	87,138
	Twin Falls, ID	N/A	33	33	110,096
	Benewah County, ID	N/A	79	79	9,226
	Idaho County, ID	20	N/A	20	16,513
	Lemhi County, ID	N/A	33	33	7,961
	Shoshone County, ID	N/A	123	123	12,796
Illinois	Bloomington, IL	36	91	117	188,597
	Champaign-Urbana, IL	35	50	82	239,643
	Chicago-Naperville-Elgin, IL-IN-WI	40	83	113	9,498,716
	Davenport-Moline-Rock Island, IA-IL	27	67	91	381,451
	Decatur, IL	33	103	124	104,712
	Effingham, IL	31	N/A	31	34,208
	Fort Madison-Keokuk, IA-IL-MO	N/A	22	22	58,741
	Mount Vernon, IL	35	53	78	37,820
	Paducah, KY-IL	34	100	121	96,647
	Peoria, IL	34	80	110	368,373
	Quincy, IL-MO	17	N/A	17	75,546
	Rockford, IL	41	5	46	337,658
	Springfield, IL	40	81	111	207,636
	St. Louis, MO-IL	45	67	101	2,805,465
	Clark County, IL	22	N/A	22	15,596
	Jo Daviess County, IL	22	N/A	22	21,366
	Randolph County, IL	30	47	74	32,106

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Indiana	Bloomington, IN	35	82	108	167,762
	Chicago-Naperville-Elgin, IL-IN-WI	40	83	113	9,498,716
	Cincinnati, OH-KY-IN	50	111	134	2,190,209
	Columbus, IN	35	43	75	82,753
	Elkhart-Goshen, IN	24	63	78	205,560
	Evansville, IN-KY	38	89	113	314,672
	Fort Wayne, IN	33	97	122	437,631
	Huntington, IN	21	N/A	21	36,240
	Indianapolis-Carmel-Anderson, IN	28	91	109	2,048,703
	Jasper, IN	N/A	23	23	54,975
	Kokomo, IN	31	47	72	82,366
	Lafayette-West Lafayette, IN	23	60	80	221,828
	Louisville/Jefferson County, KY-IN	40	87	113	1,297,301
	Michigan City-La Porte, IN	47	11	57	110,007
	Muncie, IN	24	18	41	114,772
	New Castle, IN	N/A	16	16	48,271
	Seymour, IN	20	N/A	20	44,111
	South Bend-Mishawaka, IN-MI	37	97	117	322,424
	Terre Haute, IN	34	102	123	169,725
	Vincennes, IN	46	N/A	46	36,895
	Wabash, IN	47	N/A	47	31,280
	Perry County, IN	26	N/A	26	19,102
	Spencer County, IN	N/A	25	25	20,327

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Iowa	Cedar Rapids, IA	36	88	116	272,295
	Clinton, IA	21	32	52	46,518
	Davenport-Moline-Rock Island, IA-IL	27	67	91	381,451
	Des Moines-West Des Moines, IA	32	49	81	655,409
	Fort Madison-Keokuk, IA-IL-MO	N/A	22	22	58,741
	Iowa City, IA	N/A	55	55	173,401
	Muscatine, IA	N/A	68	68	42,929
	Omaha-Council Bluffs, NE-IA	34	77	106	942,198
	Sioux City, IA-NE-SD	33	29	61	169,045
	Waterloo-Cedar Falls, IA	21	22	42	169,659
	Montgomery County, IA	26	10	36	10,003
	Palo Alto County, IA	30	15	44	8,929
	Van Buren County, IA	31	13	44	7,020
Kansas	Kansas City, MO-KS	47	36	80	2,143,651
	St. Joseph, MO-KS	58	62	105	126,490
	Topeka, KS	27	73	93	232,594
	Wichita, KS	37	25	58	644,888
	Neosho County, KS	38	15	51	15,951
	Trego County, KS	44	28	65	2,793

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Kentucky	Bowling Green, KY	23	22	41	177,432
	Cincinnati, OH-KY-IN	50	111	134	2,190,209
	Clarksville, TN-KY	31	55	76	292,264
	Elizabethtown-Fort Knox, KY	34	19	51	153,378
	Evansville, IN-KY	38	89	113	314,672
	Huntington-Ashland, WV-KY-OH	23	36	52	352,823
	Lexington-Fayette, KY	35	21	54	516,697
	Louisville/Jefferson County, KY-IN	40	87	113	1,297,301
	Middlesborough, KY	18	9	25	26,569
	Owensboro, KY	30	66	87	119,114
	Paducah, KY-IL	34	100	121	96,647
	Somerset, KY	27	13	39	64,623
	Carter County, KY	15	7	22	27,004
	Morgan County, KY	25	N/A	25	13,345
	Perry County, KY	23	4	26	26,092
	Pike County, KY	14	26	39	58,402
	Simpson County, KY	31	N/A	31	18,529
	Washington County, KY	33	N/A	33	12,084
Louisiana	Alexandria, LA	N/A	17	17	153,044
	Baton Rouge, LA	31	93	105	831,310
	Hammond, LA	N/A	15	15	133,777
	Houma-Thibodaux, LA	27	11	37	209,136
	Lafayette, LA	37	18	50	489,364
	Lake Charles, LA	28	16	41	210,080
	Monroe, LA	11	15	25	176,805
	New Orleans-Metairie, LA	24	19	39	1,270,399
	Shreveport-Bossier City, LA	44	41	77	436,341

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Maine	Augusta-Waterville, ME	13	2	15	122,083
	Bangor, ME	7	19	26	151,096
	Lewiston-Auburn, ME	8	17	24	107,679
	Portland-South Portland, ME	7	40	45	535,420
	Rockland, ME	10	N/A	10	7,146
	Aroostook County, ME	4	42	44	67,111
	Hancock County, ME	19	6	23	54,811
	Oxford County, ME	8	36	44	57,618
	Washington County, ME	9	N/A	9	31,490
Maryland	Baltimore-Columbia-Towson, MD	50	77	102	2,802,789
	Cambridge, MD	46	19	59	31,998
	Hagerstown-Martinsburg, MD-WV	34	49	74	268,049
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	43	65	85	6,096,372
	Salisbury, MD-DE	46	28	70	409,979
	Washington-Arlington-Alexandria, DC-VA-MD-WV	37	60	86	6,249,950
	Garrett County, MD	29	15	42	29,163
	Kent County, MD	50	29	69	19,383
Massachusetts	Barnstable Town, MA	21	N/A	21	213,413
	Boston-Cambridge-Newton, MA-NH	14	27	33	4,875,390
	Greenfield Town, MA	14	29	40	70,963
	Pittsfield, MA	2	74	75	126,348
	Providence-Warwick, RI-MA	25	31	43	1,621,337
	Springfield, MA	40	45	72	631,761
	Vineyard Haven, MA	27	N/A	27	17,352
	Worcester, MA-CT	22	41	56	947,866

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Michigan	Adrian, MI	42	16	56	98,266
	Ann Arbor, MI	47	20	65	370,963
	Bay City, MI	N/A	16	16	103,923
	Cadillac, MI	31	9	40	48,579
	Detroit-Warren-Dearborn, MI	35	99	118	4,326,442
	Flint, MI	36	31	66	406,892
	Grand Rapids-Wyoming, MI	29	29	55	1,069,405
	Holland, MI	36	20	54	117,327
	Kalamazoo-Portage, MI	35	22	54	340,318
	Lansing-East Lansing, MI	32	19	50	481,893
	Ludington, MI	26	N/A	26	29,100
	Muskegon, MI	37	N/A	37	173,588
	Niles-Benton Harbor, MI	37	N/A	37	154,141
	Sault Ste. Marie, MI	3	40	42	37,517
	South Bend-Mishawaka, IN-MI	37	97	117	322,424
	Traverse City, MI	32	N/A	32	149,914
	Huron County, MI	28	N/A	28	31,166
	Manistee County, MI	17	12	28	24,528
	Schoolcraft County, MI	18	4	22	8,068
	Tuscola County, MI	32	N/A	32	52,516

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Minnesota	Bemidji, MN	N/A	25	25	46,847
	Brainerd, MN	15	34	48	94,408
	Duluth, MN-WI	13	19	32	278,799
	Fargo, ND-MN	18	27	43	245,471
	La Crosse-Onalaska, WI-MN	17	48	65	136,808
	Marshall, MN	13	19	32	25,629
	Minneapolis-St. Paul-Bloomington, MN-WI	22	56	74	3,629,190
	Red Wing, MN	25	N/A	25	46,403
	Rochester, MN	8	62	69	219,802
	St. Cloud, MN	21	34	55	199,801
	Becker County, MN	18	19	36	34,371
	Cook County, MN	N/A	12	12	5,393
	Lake County, MN	8	13	21	10,658
Mississippi	Cleveland, MS	42	48	75	31,333
	Grenada, MS	N/A	8	8	21,055
	Gulfport-Biloxi-Pascagoula, MS	32	45	66	397,261
	Hattiesburg, MS	N/A	75	75	149,414
	Jackson, MS	31	98	110	580,166
	Memphis, TN-MS-AR	36	65	87	1,350,620
	Meridian, MS	31	N/A	31	100,948
	Tupelo, MS	17	N/A	17	140,552
	Yalobusha County, MS	7	N/A	7	12,392

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Missouri	Columbia, MO	37	N/A	37	180,005
	Fayetteville-Springdale-Rogers, AR-MO	43	22	61	549,128
	Fort Madison-Keokuk, IA-IL-MO	N/A	22	22	58,741
	Jefferson City, MO	34	N/A	34	151,520
	Joplin, MO	45	N/A	45	178,902
	Kansas City, MO-KS	47	36	80	2,143,651
	Quincy, IL-MO	17	N/A	17	75,546
	Springfield, MO	39	37	71	466,978
	St. Joseph, MO-KS	58	62	105	126,490
	St. Louis, MO-IL	45	67	101	2,805,465
	Cedar County, MO	32	57	79	14,165
	Monroe County, MO	29	N/A	29	8,664
	Perry County, MO	37	N/A	37	19,150
	Sainte Genevieve County, MO	35	N/A	35	17,888
Montana	Billings, MT	N/A	46	46	171,677
	Bozeman, MT	N/A	28	28	111,876
	Butte-Silver Bow, MT	N/A	55	55	34,993
	Helena, MT	27	63	81	80,797
	Kalispell, MT	6	85	88	102,106
	Missoula, MT	2	81	83	118,791
	Fergus County, MT	22	24	39	11,113
	Lincoln County, MT	N/A	162	162	19,794
	Phillips County, MT	14	21	32	4,074
	Powder River County, MT	40	52	74	1,716
	Ravalli County, MT	N/A	51	51	43,172
	Richland County, MT	43	18	57	10,913
	Rosebud County, MT	12	28	31	9,063

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Nebraska	Grand Island, NE	N/A	7	7	85,088
	Lincoln, NE	20	15	35	334,590
	Scottsbluff, NE	N/A	8	8	37,906
	Sioux City, IA-NE-SD	33	29	61	169,045
	Knox County, NE	29	N/A	29	8,419
Nevada	Carson City, NV	92	33	95	55,414
	Fallon, NV	76	N/A	76	24,440
	Fernley, NV	58	N/A	58	55,808
	Gardnerville Ranchos, NV	N/A	47	47	48,467
	Las Vegas-Henderson-Paradise, NV	132	23	140	2,231,647
	Reno, NV	75	35	85	469,764
	White Pine County, NV	91	N/A	91	9,475
New Hampshire	Berlin, NH-VT	40	N/A	40	37,839
	Boston-Cambridge-Newton, MA-NH	14	27	33	4,875,390
	Claremont-Lebanon, NH-VT	7	23	29	217,215
	Concord, NH	10	N/A	10	151,132
	Keene, NH	6	26	31	76,493
	Laconia, NH	7	7	14	61,022
	Manchester-Nashua, NH	21	7	26	415,247
New Jersey	Allentown-Bethlehem-Easton, PA-NJ	41	76	99	842,913
	Atlantic City-Hammonton, NJ	19	25	38	265,429
	New York-Newark-Jersey City, NY-NJ-PA	32	60	71	19,979,477
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	43	65	85	6,096,372
	Trenton, NJ	48	54	82	369,811
	Vineland-Bridgeton, NJ	17	52	60	150,972

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
New Mexico	Albuquerque, NM	123	16	137	915,927
	Carlsbad-Artesia, NM	149	N/A	149	57,900
	Española, NM	116	N/A	116	10,050
	Farmington, NM	122	N/A	122	125,043
	Hobbs, NM	115	38	138	69,611
	Las Cruces, NM	122	46	154	217,522
	Santa Fe, NM	88	0	88	150,056
	Taos, NM	N/A	19	19	32,835
New York	Albany-Schenectady-Troy, NY	26	59	77	883,169
	Buffalo-Cheektowaga-Niagara Falls, NY	38	19	50	1,130,152
	Corning, NY	18	16	34	95,796
	Ithaca, NY	26	N/A	26	102,793
	Jamestown-Dunkirk-Fredonia, NY	42	15	50	127,939
	New York-Newark-Jersey City, NY-NJ-PA	32	60	71	19,979,477
	Rochester, NY	32	37	60	1,071,082
	Syracuse, NY	34	18	47	650,502
	Utica-Rome, NY	12	N/A	12	291,410
	Watertown-Fort Drum, NY	22	N/A	22	111,755
	Essex County, NY	20	2	21	37,300
	Hamilton County, NY	11	N/A	11	4,434

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
North Carolina	Asheville, NC	33	32	57	459,585
	Charlotte-Concord-Gastonia, NC-SC	41	53	79	2,569,213
	Cullowhee, NC	N/A	9	9	43,327
	Durham-Chapel Hill, NC	38	65	90	575,412
	Fayetteville, NC	41	34	65	387,094
	Greensboro-High Point, NC	59	36	80	767,711
	Greenville, NC	31	2	32	179,914
	Hickory-Lenoir-Morganton, NC	39	55	86	368,416
	Kinston, NC	29	N/A	29	55,976
	Morehead City, NC	19	N/A	19	69,524
	Myrtle Beach-Conway-North Myrtle Beach, SC-NC	18	N/A	18	480,891
	Oxford, NC	40	N/A	40	60,115
	Raleigh, NC	39	50	75	1,362,540
	Rocky Mount, NC	24	N/A	24	146,021
	Sanford, NC	28	N/A	28	61,452
	Virginia Beach-Norfolk-Newport News, VA-NC	16	13	27	1,728,733
	Wilmington, NC	18	5	21	294,436
	Winston-Salem, NC	54	81	107	671,456
	Avery County, NC	25	N/A	25	17,505
	Caswell County, NC	34	N/A	34	22,698
	Graham County, NC	32	N/A	32	8,484
	Macon County, NC	16	N/A	16	35,285
	Martin County, NC	28	N/A	28	22,671
	Mitchell County, NC	N/A	16	16	15,000
	Montgomery County, NC	19	16	35	27,271
	Swain County, NC	19	38	54	14,245
	Yancey County, NC	41	N/A	41	17,903

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
North Dakota	Bismarck, ND	36	58	81	132,678
	Dickinson, ND	30	20	40	30,997
	Fargo, ND-MN	18	27	43	245,471
	Minot, ND	7	26	32	75,934
	Williston, ND	25	31	53	35,350
	Burke County, ND	32	14	41	2,100
	Dunn County, ND	26	18	40	4,332
	McKenzie County, ND	29	23	46	13,632
	Mercer County, ND	31	20	44	8,267
Ohio	Akron, OH	34	72	91	704,845
	Ashtabula, OH	37	N/A	37	97,493
	Athens, OH	N/A	6	6	65,818
	Canton-Massillon, OH	42	105	123	398,655
	Cincinnati, OH-KY-IN	50	111	134	2,190,209
	Cleveland-Elyria, OH	38	76	98	2,057,009
	Columbus, OH	35	47	81	2,106,541
	Dayton, OH	40	70	97	806,548
	Huntington-Ashland, WV-KY-OH	23	36	52	352,823
	Lima, OH	38	19	57	102,663
	Marietta, OH	29	N/A	29	60,155
	Mount Vernon, OH	37	N/A	37	61,893
	Portsmouth, OH	N/A	9	9	75,502
	Springfield, OH	35	104	118	134,585
	Toledo, OH	38	24	57	602,871
	Washington Court House, OH	27	N/A	27	28,666
	Weirton-Steubenville, WV-OH	35	25	52	117,064
	Wheeling, WV-OH	34	17	46	140,045
	Wilmington, OH	43	N/A	43	42,057
	Youngstown-Warren-Boardman, OH-PA	36	66	87	538,952
	Harrison County, OH	N/A	3	3	15,174
	Noble County, OH	23	N/A	23	14,354

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Oklahoma	Ardmore, OK	67	63	112	48,177
	Bartlesville, OK	0	3	3	51,843
	Durant, OK	45	N/A	45	47,192
	Fort Smith, AR-OK	21	20	38	282,318
	Lawton, OK	65	27	88	126,198
	McAlester, OK	37	55	80	43,877
	Miami, OK	19	5	24	31,175
	Oklahoma City, OK	57	78	116	1,396,445
	Ponca City, OK	24	47	66	44,161
	Tulsa, OK	41	146	162	993,797
	Adair County, OK	28	N/A	28	22,082
	Choctaw County, OK	18	N/A	18	14,668
	Dewey County, OK	77	48	104	4,894
	Jefferson County, OK	70	N/A	70	6,123
	Mayes County, OK	34	N/A	34	41,107
	Nowata County, OK	36	56	80	10,218
Oregon	Eugene, OR	13	26	38	379,611
	Grants Pass, OR	N/A	20	20	87,393
	Hermiston-Pendleton, OR	8	N/A	8	88,888
	Klamath Falls, OR	N/A	51	51	67,653
	Medford, OR	42	44	75	219,564
	Portland-Vancouver-Hillsboro, OR-WA	11	50	57	2,478,810
	Prineville, OR	N/A	29	29	23,867
	Salem, OR	15	N/A	15	432,102
	The Dalles, OR	2	N/A	2	26,505
	Harney County, OR	N/A	32	32	7,329
	Lake County, OR	N/A	26	26	7,879

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Pennsylvania	Allentown-Bethlehem-Easton, PA-NJ	41	76	99	842,913
	Altoona, PA	24	50	66	122,492
	Chambersburg-Waynesboro, PA	11	N/A	11	154,835
	DuBois, PA	22	N/A	22	79,388
	East Stroudsburg, PA	26	10	36	169,507
	Erie, PA	18	78	85	272,061
	Gettysburg, PA	36	44	71	102,811
	Harrisburg-Carlisle, PA	29	102	114	574,659
	Indiana, PA	33	N/A	33	84,501
	Johnstown, PA	10	60	66	131,730
	Lancaster, PA	36	105	119	543,557
	Lebanon, PA	27	91	105	141,314
	New Castle, PA	29	N/A	29	86,184
	New York-Newark-Jersey City, NY-NJ-PA	32	60	71	19,979,477
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	43	65	85	6,096,372
	Pittsburgh, PA	39	72	90	2,324,743
	Reading, PA	43	66	96	420,152
	Sayre, PA	20	27	46	60,833
	Scranton--Wilkes-Barre--Hazleton, PA	19	50	58	555,485
	Somerset, PA	27	N/A	27	73,952
	St. Marys, PA	26	N/A	26	30,169
	State College, PA	20	61	77	162,805
	Williamsport, PA	18	N/A	18	113,664
	York-Hanover, PA	36	79	96	448,273
	Youngstown-Warren-Boardman, OH-PA	36	66	87	538,952
	Greene County, PA	27	11	37	36,506
	Susquehanna County, PA	N/A	7	7	40,589
	Tioga County, PA	22	18	37	40,763

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Rhode Island	Providence-Warwick, RI-MA	25	31	43	1,621,337
South Carolina	Augusta-Richmond County, GA-SC	23	87	97	604,167
	Charleston-North Charleston, SC	14	21	30	787,643
	Charlotte-Concord-Gastonia, NC-SC	41	53	79	2,569,213
	Columbia, SC	21	61	75	832,666
	Florence, SC	9	13	22	204,961
	Greenville-Anderson-Mauldin, SC	14	46	56	906,626
	Myrtle Beach-Conway-North Myrtle Beach, SC-NC	18	N/A	18	480,891
	Seneca, SC	27	15	39	78,374
	Spartanburg, SC	28	42	63	341,298
	Walterboro, SC	6	N/A	6	5,468
	Chesterfield County, SC	28	3	30	45,754
South Dakota	Aberdeen, SD	N/A	7	7	43,191
	Brookings, SD	34	8	42	35,232
	Pierre, SD	N/A	15	15	22,064
	Rapid City, SD	42	30	64	148,749
	Sioux City, IA-NE-SD	33	29	61	169,045
	Sioux Falls, SD	35	20	54	265,653
	Watertown, SD	N/A	33	33	28,015
	Jackson County, SD	36	18	45	3,307

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Tennessee	Athens, TN	N/A	40	40	53,285
	Chattanooga, TN-GA	39	86	106	560,793
	Clarksville, TN-KY	31	55	76	292,264
	Cookeville, TN	N/A	33	33	112,669
	Dyersburg, TN	N/A	31	31	37,320
	Jackson, TN	N/A	30	30	129,209
	Kingsport-Bristol-Bristol, TN-VA	44	32	62	306,616
	Knoxville, TN	34	46	68	883,309
	Lawrenceburg, TN	N/A	24	24	43,734
	Memphis, TN-MS-AR	36	65	87	1,350,620
	Morristown, TN	42	N/A	42	118,581
	Nashville-Davidson--Murfreesboro--Franklin, TN	41	50	76	1,930,961
	Sevierville, TN	48	N/A	48	97,892
	Claiborne County, TN	20	N/A	20	31,756
	DeKalb County, TN	18	N/A	18	20,138
Texas	Amarillo, TX	97	3	97	265,947
	Austin-Round Rock, TX	33	108	124	2,168,316
	Beaumont-Port Arthur, TX	32	95	107	409,526
	Brownsville-Harlingen, TX	12	99	111	423,908
	Corpus Christi, TX	12	69	79	452,950
	Corsicana, TX	44	N/A	44	49,565
	Dallas-Fort Worth-Arlington, TX	47	80	106	7,539,711

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Texas	Eagle Pass, TX	N/A	48	48	58,485
	El Paso, TX	86	91	149	845,553
	Houston-The Woodlands-Sugar Land, TX	32	96	110	6,997,384
	Killeen-Temple, TX	45	N/A	45	451,679
	Kingsville, TX	N/A	96	96	31,571
	Laredo, TX	9	67	75	275,910
	Longview, TX	35	N/A	35	219,417
	Lubbock, TX	N/A	9	9	319,068
	Marshall, TX	20	11	28	66,726
	McAllen-Edinburg-Mission, TX	11	115	124	865,939
	Odessa, TX	N/A	18	18	162,124
	San Antonio-New Braunfels, TX	34	16	49	2,518,036
	Texarkana, TX-AR	N/A	13	13	150,242
	Tyler, TX	40	N/A	40	230,221
	Victoria, TX	9	N/A	9	99,619
	Waco, TX	31	N/A	31	271,942
	Brewster County, TX	42	17	51	9,267
	Polk County, Texas	18	N/A	18	50,031
Utah	Cedar City, UT	106	10	107	52,775
	Logan, UT-ID	85	88	130	140,794
	Ogden-Clearfield, UT	108	76	147	675,067
	Price, UT	134	N/A	134	20,269
	Provo-Orem, UT	104	76	146	633,768
	Salt Lake City, UT	111	76	152	1,222,540
	St. George, UT	125	21	140	171,700
	Vernal, UT	115	28	123	35,438
	Duchesne County, UT	128	42	144	19,964
	Garfield County, UT	105	N/A	105	5,080
	San Juan County, UT	102	N/A	102	15,449

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Vermont	Bennington, VT	12	22	32	35,631
	Berlin, NH-VT	40	N/A	40	37,839
	Burlington-South Burlington, VT	14	28	41	221,083
	Claremont-Lebanon, NH-VT	7	23	29	217,215
	Rutland, VT	7	54	59	58,672
Virginia	Blacksburg-Christiansburg-Radford, VA	40	N/A	40	184,029
	Charlottesville, VA	24	12	35	235,232
	Harrisonburg, VA	19	9	26	135,277
	Kingsport-Bristol-Bristol, TN-VA	44	32	62	306,616
	Lynchburg, VA	N/A	6	6	263,353
	Richmond, VA	21	44	59	1,306,172
	Roanoke, VA	26	10	35	314,172
	Virginia Beach-Norfolk-Newport News, VA-NC	16	13	27	1,728,733
	Washington-Arlington-Alexandria, DC-VA-MD-WV	37	60	86	6,249,950
	Winchester, VA-WV	12	15	25	139,810
	Madison County, VA	29	N/A	29	13,295
	Prince Edward County, VA	19	N/A	19	22,950
	Rockbridge County, VA	10	N/A	10	22,752
	Wythe County, VA	30	N/A	30	28,754
Washington	Bellingham, WA	4	21	24	225,685
	Bremerton-Silverdale, WA	N/A	15	15	269,805
	Ellensburg, WA	N/A	44	44	47,364
	Kennewick-Richland, WA	32	N/A	32	296,224
	Mount Vernon-Anacortes, WA	0	20	20	128,206
	Olympia-Tumwater, WA	11	N/A	11	286,419
	Port Angeles, WA	6	N/A	6	76,737
	Portland-Vancouver-Hillsboro, OR-WA	11	50	57	2,478,810
	Seattle-Tacoma-Bellevue, WA	27	44	62	3,939,363
	Spokane-Spokane Valley, WA	33	83	92	573,493
	Yakima, WA	N/A	111	111	251,446
	Okanogan County, WA	N/A	87	87	42,132

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
West Virginia	Charleston, WV	22	46	63	211,037
	Clarksburg, WV	N/A	13	13	92,822
	Fairmont, WV	N/A	12	12	56,097
	Hagerstown-Martinsburg, MD-WV	34	49	74	268,049
	Huntington-Ashland, WV-KY-OH	23	36	52	352,823
	Morgantown, WV	23	7	30	140,259
	Parkersburg-Vienna, WV	11	13	21	90,033
	Washington-Arlington-Alexandria, DC-VA-MD-WV	37	60	86	6,249,950
	Weirton-Steubenville, WV-OH	35	25	52	117,064
	Wheeling, WV-OH	34	17	46	140,045
	Winchester, VA-WV	12	15	25	139,810
	Gilmer County, WV	14	N/A	14	8,026
	Greenbrier County, WV	10	N/A	10	34,786
	Tucker County, WV	27	N/A	27	6,955

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Wisconsin	Appleton, WI	31	39	68	237,524
	Baraboo, WI	27	35	62	64,249
	Beaver Dam, WI	34	53	87	87,847
	Chicago-Naperville-Elgin, IL-IN-WI	40	83	113	9,498,716
	Duluth, MN-WI	13	19	32	278,799
	Eau Claire, WI	25	59	83	168,669
	Fond du Lac, WI	31	N/A	31	103,066
	Green Bay, WI	46	32	76	321,591
	Janesville-Beloit, WI	29	N/A	29	163,129
	La Crosse-Onalaska, WI-MN	17	48	65	136,808
	Madison, WI	29	65	94	660,422
	Manitowoc, WI	36	N/A	36	79,074
	Milwaukee-Waukesha-West Allis, WI	39	59	90	1,576,113
	Minneapolis-St. Paul-Bloomington, MN-WI	22	56	74	3,629,190
	Platteville, WI	N/A	55	55	51,554
	Racine, WI	49	N/A	49	196,584
	Sheboygan, WI	52	N/A	52	115,456
	Watertown-Fort Atkinson, WI	34	N/A	34	85,129
	Wausau, WI	27	N/A	27	135,428
	Whitewater-Elkhorn, WI	35	N/A	35	103,718
	Ashland County, WI	16	11	27	15,600
	Door County, WI	26	N/A	26	27,610
	Forest County, WI	31	12	43	8,991
	Taylor County, WI	24	34	58	20,412
	Vilas County, WI	19	21	40	21,938

continued

State	Metropolitan area or rural county	Number of days in 2018 when half or more monitoring locations reported elevated levels of this pollutant			2018 population
		Ozone	$PM_{2.5}$	Ozone and/or $PM_{2.5}$	
Wyoming	Casper, WY	70	12	76	79,115
	Cheyenne, WY	63	14	68	98,976
	Evanston, WY	75	N/A	75	20,299
	Gillette, WY	37	14	44	46,140
	Jackson, WY-ID	59	25	73	34,721
	Laramie, WY	104	6	108	38,601
	Riverton, WY	90	19	94	39,531
	Rock Springs, WY	68	12	75	43,051
	Sheridan, WY	69	45	102	30,233
	Big Horn County, WY	37	N/A	37	11,881
	Carbon County, WY	75	N/A	75	14,971
	Converse County, WY	44	0	44	13,640
	Johnson County, WY	33	N/A	33	8,460
	Park County, WY	2	9	10	29,324
	Sublette County, WY	77	40	93	9,813
	Weston County, WY	46	N/A	46	6,967

Appendix B – Sources of pollutants that contribute to ozone and particulate pollution, by state, 2014

Data are from the EPA's 2014 National Emissions Inventory. "Transportation" includes on- and off-road vehicles. "Industrial and other processes" include fuel combustion for industrial purposes, chemical and related product manufacturing, metals processing, and other industrial processes.

Table B1. Share of nitrogen oxides from various emission sources, 2014

Percentages represent share of total emissions minus vegetation. Selected emission sources are the top four national emission sources for nitrogen oxides. The category of "Other, from human activity" includes residential, commercial, institutional and miscellaneous sources, but excludes vegetation.

State	Transportation	Electricity generation	Industrial and other processes	Petroleum & related industries	Other, from human activity
Alabama	53%	15%	22%	3%	7%
Alaska	43%	13%	27%	2%	16%
Arizona	76%	14%	5%	0%	5%
Arkansas	55%	15%	19%	3%	7%
California	77%	1%	9%	1%	12%
Colorado	50%	16%	15%	14%	4%
Connecticut	70%	3%	6%	0%	22%
Delaware	73%	7%	13%	0%	6%
District of Columbia	75%	0%	7%	0%	18%
Florida	73%	13%	7%	0%	7%
Georgia	67%	11%	11%	0%	11%
Hawaii	40%	42%	4%	0%	14%
Idaho	76%	0%	11%	0%	13%
Illinois	65%	10%	12%	2%	10%
Indiana	55%	28%	12%	1%	5%
Iowa	67%	16%	10%	0%	7%

continued

State	Transportation	Electricity generation	Industrial and other processes	Petroleum & related industries	Other, from human activity
Kansas	48%	9%	14%	22%	5%
Kentucky	53%	31%	8%	4%	4%
Louisiana	47%	11%	28%	10%	4%
Maine	64%	3%	22%	0%	12%
Maryland	74%	10%	6%	0%	11%
Massachusetts	67%	4%	10%	0%	20%
Michigan	57%	15%	15%	3%	10%
Minnesota	61%	12%	18%	0%	10%
Mississippi	66%	13%	15%	0%	6%
Missouri	65%	20%	9%	0%	6%
Montana	66%	17%	7%	4%	6%
Nebraska	76%	15%	6%	0%	3%
Nevada	76%	12%	6%	0%	6%
New Hampshire	60%	8%	18%	0%	13%
New Jersey	74%	4%	3%	1%	18%
New Mexico	53%	12%	12%	20%	3%
New York	69%	5%	8%	0%	17%
North Carolina	70%	14%	11%	0%	5%
North Dakota	46%	27%	3%	21%	4%
Ohio	58%	21%	12%	1%	8%
Oklahoma	39%	11%	24%	21%	5%
Oregon	69%	3%	9%	0%	18%
Pennsylvania	48%	25%	15%	4%	8%
Rhode Island	80%	2%	4%	0%	14%
South Carolina	69%	9%	16%	0%	6%
South Dakota	74%	16%	4%	0%	6%
Tennessee	72%	7%	13%	0%	7%
Texas	52%	10%	14%	21%	3%
Utah	53%	27%	7%	10%	4%
Vermont	72%	2%	7%	0%	19%
Virginia	67%	7%	16%	4%	6%
Washington	77%	4%	7%	0%	12%
West Virginia	31%	38%	12%	14%	6%
Wisconsin	69%	10%	13%	0%	9%
Wyoming	40%	26%	18%	14%	1%

Table B2. Share of volatile organic compounds from various emission sources, 2014

Percentages represent share of total emissions minus vegetation. Selected emission sources are the top four national emission sources for volatile organic compounds. The category of "Other, from human activity" includes residential, commercial and institutional sources; industrial and other processes; electricity generation; and miscellaneous sources excluding vegetation.

State	Wildfires and prescribed burning	Transportation	Petroleum & related industries	Solvent utilization	Other, from human activity
Alabama	44%	25%	5%	14%	12%
Alaska	89%	5%	5%	1%	1%
Arizona	30%	37%	0%	24%	8%
Arkansas	46%	20%	4%	14%	15%
California	56%	16%	8%	11%	9%
Colorado	7%	28%	34%	14%	17%
Connecticut	0%	41%	0%	40%	18%
Delaware	2%	58%	1%	23%	16%
District of Columbia	0%	46%	0%	48%	6%
Florida	32%	35%	0%	23%	10%
Georgia	9%	39%	0%	27%	26%
Hawaii	46%	24%	3%	16%	11%
Idaho	63%	17%	0%	12%	8%
Illinois	7%	38%	7%	31%	17%
Indiana	5%	38%	6%	33%	18%
Iowa	17%	32%	0%	23%	28%
Kansas	21%	17%	34%	15%	12%
Kentucky	27%	24%	10%	18%	20%
Louisiana	47%	15%	14%	8%	16%
Maine	2%	57%	0%	21%	20%
Maryland	6%	49%	0%	30%	14%
Massachusetts	1%	40%	0%	41%	19%
Michigan	2%	48%	7%	29%	15%
Minnesota	18%	38%	0%	18%	25%
Mississippi	33%	30%	2%	16%	20%
Missouri	44%	27%	0%	19%	10%

continued

State	Wildfires and prescribed burning	Transportation	Petroleum & related industries	Solvent utilization	Other, from human activity
Montana	40%	16%	27%	7%	10%
Nebraska	18%	36%	0%	29%	17%
Nevada	27%	35%	0%	25%	13%
New Hampshire	0%	54%	0%	28%	18%
New Jersey	12%	36%	0%	35%	18%
New Mexico	9%	13%	64%	8%	6%
New York	1%	40%	2%	41%	16%
North Carolina	11%	38%	0%	34%	18%
North Dakota	5%	4%	86%	3%	2%
Ohio	3%	39%	4%	38%	16%
Oklahoma	23%	14%	41%	9%	13%
Oregon	74%	13%	0%	9%	5%
Pennsylvania	2%	29%	25%	31%	14%
Rhode Island	0%	43%	0%	41%	16%
South Carolina	25%	32%	0%	22%	20%
South Dakota	41%	20%	3%	25%	10%
Tennessee	15%	35%	1%	29%	20%
Texas	7%	13%	58%	13%	9%
Utah	8%	22%	53%	12%	5%
Vermont	1%	44%	0%	22%	33%
Virginia	16%	37%	4%	25%	18%
Washington	58%	19%	0%	15%	8%
West Virginia	17%	15%	51%	8%	9%
Wisconsin	5%	53%	0%	25%	17%
Wyoming	7%	7%	78%	2%	7%

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