State of the Science FACT SHEET

Air Quality

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION • UNITED STATES DEPARTMENT OF COMMERCE

Air pollution has significant health, economic and ecological consequences. The U.S. spends tens of billions of dollars each year to reduce air pollution in order to protect public health and the environment. For more than 50 years, industrial nations have been reducing harmful air pollutants generated primarily by power plants, transportation, industry and agriculture. Large improvements have occurred in U.S. air quality over the last few decades. However, poor air quality still contributes to tens of thousands of premature deaths from cardiovascular and respiratory diseases across the Nation annually. NOAA provides air quality forecasts and critical science that support development of effective policies and strategies for air quality management.

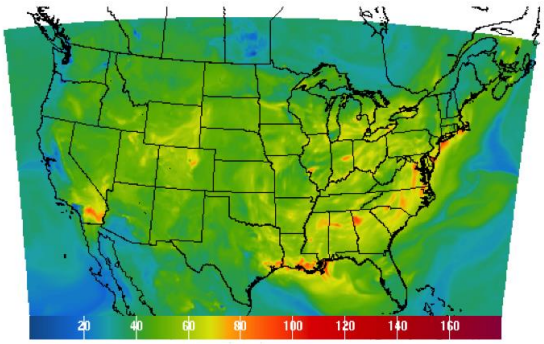
What Is Air Quality?

Air quality is determined by the quantities and types of gaseous and particulate pollutants in the air we breathe. Pollutants are both directly emitted and formed by chemical reactions in the atmosphere. Critical pollutants affecting U.S. air quality are:

Ground-level ozone: A gas produced from other air pollutants reacting in the presence of sunlight. Ozone is a major constituent of smog and has harmful effects on human health.

Fine particulate matter ($PM_{2.5}$): Small particles (with a diameter of 2.5 microns or less) emitted into the air or formed by atmospheric reactions of other gaseous pollutants such as sulfur and organic compounds. Sources include dust from Earth's surface and smoke from wildfires and other biomass burning. Because health effects are associated primarily with small particles, $PM_{2.5}$ is a research and policy focus of NOAA and the Environmental Protection Agency (EPA).

Other air pollutants: Certain compounds containing mercury, sulfur and nitrogen are pollutants that also impact ecosystems. These compounds are released into the air primarily from burning fossil fuels. Additional sources of nitrogen-bearing pollutants include fertilizers and animal waste.



Sample operational air quality forecast guidance. Predicted ground-level ozone concentrations (averaged over 8 hours, in parts per billion) show unhealthy levels of ground-level ozone in warmer colors (orange, red). Current predictions are available at airquality.weather.gov.

Improving Air Quality: What Are NOAA's Roles and the Benefits to the Nation?

NOAA research builds the foundation of scientific information and understanding needed by regulators and stakeholders in decision making regarding the Nation's air quality. In building this foundation NOAA researchers collaborate and interact with others in government agencies, academia and the private sector.

Roles: Deliver operational air quality predictions to the public and air quality management agencies as the basis for health warnings and individual actions to limit exposure to poor air quality. Deliver operational satellite-derived aerosol and trace gas products for air quality monitoring and forecasts. Improve the accuracy of air quality predictions through research and development.
Benefit: The public can adjust their daily activities to limit exposure to poor air quality, responsible for as many as 200,000 premature deaths each year. People with access to air quality forecasts have less exposure to pollutants as documented, for example, in reductions of hospital admissions for asthma.

Role*:* Provide decision makers with the understanding of how physical and chemical atmospheric processes contribute to poor air quality.
Benefit*:* Federal and state agencies can develop and implement policies that will be most effective in improving air quality. For example, a NOAA-led air quality assessment in 2012-2014 in Utah's extensive oil and gas production region identified high emissions of volatile organic compounds as the key factor in local episodes of high ozone production during winter. The findings enabled the State of Utah to tailor very specific new regulations that will improve air quality.

Role: Quantify trends in air quality and deposition of pollutants.
Benefit: Air quality decision makers can assess whether policies and regulatory actions have achieved the desired outcome and whether new approaches are needed to protect public health and the environment.

How Does Poor Air Quality Affect the Nation?

Air pollution affects human health, the economy and the environment through multiple pathways. People inhale pollutants. Crops and forests are also exposed to air pollution. Some air pollutants make their way into the aquatic and terrestrial food chains and ultimately into humans. The impacts of air pollutants include:

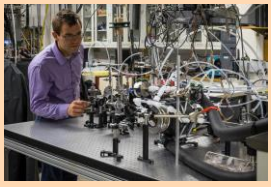
- Ground-level ozone and $PM_{2.5}$ cause respiratory and cardio-vascular problems. It is estimated that current regulations will prevent 230,000 deaths in 2020, for example, valued at $1.8 trillion. Today, almost 44 percent of the people in the U.S. live

in areas that do not meet the health-based air quality standards established by the U.S. EPA.

- Ground-level ozone damages crops and forests, causing billions of dollars in losses annually.
- Volatile organic compounds (VOCs) and methane are emitted from oil and gas extraction activities, resulting in episodes of high summer and winter ozone production and increased climate forcing, respectively.
- $PM_{2.5}$ reduces visibility, posing risks to aviation safety and limiting vistas in national parks and other protected areas, thereby impacting tourism.
- Consuming seafood contaminated with high levels of mercury can harm the brain and other organs, especially during in-utero and early childhood development.
- Acidic and nitrogen-containing compounds deposit onto watersheds and water surfaces. These compounds can degrade water quality, impair ecosystem health and reduce commercial and recreational use of these areas.
- Many air pollutants, including ground-level ozone and $PM_{2.5}$, contribute to, and are influenced by, climate change.

NOAA's Research and Development Capabilities

NOAA employs a comprehensive set of capabilities to advance understanding of air quality.



Laboratory investigations characterize and quantify fundamental properties of atmospheric chemical compounds.

Observational studies use advanced instrumentation–deployed on the ground, on board aircraft and ships and on satellites–to gather data on atmospheric composition and processes. These data support model evaluation and improvements, guide new laboratory investigations, and inform policies and strategies for controlling air quality.

Air quality model improvements lead to more accurate and reliable predictions.

What Are the Priorities for NOAA Research?

Effective air quality management and prediction depend on knowing the sources of pollutants and their transport and chemical transformation in the atmosphere. NOAA's research serves to evaluate and understand the factors affecting the Nation's present and future air quality. NOAA's research priorities include:

- Improving understanding of the processes that control $PM_{2.5}$ abundance and composition, especially formation from organic compounds.
- Improving the accuracy of air quality predictions, especially next-day $PM_{2.5}$ and ozone predictions out to several days.
- Improving rapid projections of emissions by using real-time satellite data, especially for intermittent emission sources such as wildfires and dust storms.
- Improving the understanding of the roles of regional and intercontinental transport of air pollution on U.S. air quality.
- Developing a detailed and quantitative understanding of interactions between air quality and climate and how these interactions affect future air quality and climate projections.
- Investigating the role of U.S. and global wildfires on air quality and climate.
- Understanding the influence of changes in $PM_{2.5}$ on climate change.
- Studying the emissions from gas and oil fields and their chemical transformations that result in record high winter ozone episodes.
- Resolving significant gaps in understanding the sources of high levels of mercury in fish.
- Reducing uncertainties in sources of airborne nitrogen compounds and their rates of air-surface exchange.

Participating NOAA Organizations

Office of Oceanic and Atmospheric Research (OAR)/Air Resources Laboratory – Investigates the exchange of pollutants between the air and surface; improves air quality forecast models; and enhances the understanding of the sources, fate, and transport of mercury, nitrogen compounds, dust, and other potentially harmful atmospheric constituents by development and use of advanced observation techniques and models. www.arl.noaa.gov

OAR/Earth System Research Laboratory – Investigates the chemical processes that form and transform air pollutants; improves regional and global predictive models for air quality and pollutant transport; and develops fast-response and compound-specific sensors for the study of air quality. www.esrl.noaa.gov

OAR/Geophysical Fluid Dynamics Laboratory – Provides modeling analysis on the linkages between climate and air quality, and estimates of contributions to U.S. air quality from long-range transport and other background sources. www.gfdl.noaa.gov

OAR/Pacific Marine Environmental Laboratory – Conducts research on aerosol processes and their contribution to air quality in coastal areas. http://saga.pmel.noaa.gov

National Environmental Satellite, Data, and Information Service (NESDIS)/Center for Satellite Applications and Research (STAR) – Transfers satellite observations of air quality from scientific research and development into routine operations, and provides state-of-the-art data, products and services to decision makers. www.star.nesdis.noaa.gov/star

National Weather Service (NWS) – Develops, tests and implements NOAA's operational air quality predictions. Development and testing is conducted by a team of scientists in the Office of Science and Technology Integration, the National Centers for Environmental Prediction (NCEP), OAR, and NESDIS. www.nws.noaa.gov/ost/air_quality