The New York City Community Air Survey:

Neighborhood Air Quality 2008-2018

Summary

In 2007, the New York City Department of Health and Mental Hygiene established the New York City Community Air Survey (NYCCAS), the **largest ongoing urban air monitoring program** of any U.S. City. NYCCAS, which began collecting data in December 2008, is a collaboration between the Health Department and Queens College of the City University of New York and provides data to:

- Help inform the City's sustainability plan, OneNYC
- Track changes in air quality over time
- Estimate exposures for health research

This report:

- Provides a summary of key findings (#Findings), the air monitoring program (#Methods), monitoring site selection (#Sites), and descriptions of the pollutants measured (#Pollutant_Description)
- Describes the trends in air pollutant levels (#Pollutant_Sources) from **a decade's worth of data** between winter 2008-2009 through fall 2018 for fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), nitric oxide (NO), black carbon (BC), wintertime sulfur dioxide (SO_2) and summertime ozone (O_3)
- Presents maps of neighborhood air pollution levels (#Pollutant_Maps) by year
- Identifies the local sources (#Pollutant_Predictors) that contribute to high levels of these pollutants in NYC neighborhoods

Key Findings

Citywide, annual average levels of four key pollutants have gone down between the first year of monitoring, 2009, and the most recent year of data, 2018

Fine particles ($PM_{2.5}$)	-32%
Nitrogen Dioxide (NO_2)	-29%
Nitric Oxide (NO)	-47%
Black Carbon (BC)	-33%

Air quality improved significantly after the city required building owners to convert to cleaner heating oils by 2015

Since the first winter of monitoring, average levels of sulfur dioxide (SO_2) have declined by **95%**. In 2018, only 17 of our 60 core sites detected any SO_2, and the levels at those sites were similar to SO_2 levels measured on Whiteface Mountain in

the Adirondack Mountains, demonstrating the success of the clean heating oil requirements.

Air quality changes with location

$PM_{2.5}$, NO_2, NO, and BC are highest in:

- Areas of higher traffic density
- Areas with higher density of buildings with heat and hot water boilers
- Industrial areas

Ozone levels are highest in:

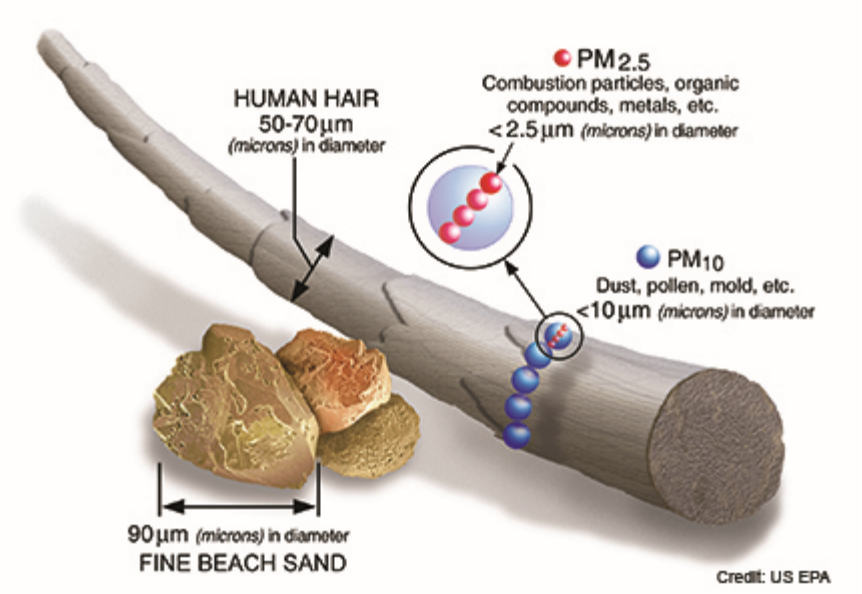
- The outer boroughs
- Areas that are downwind of high NOx emissions
- Areas with fewer combustion emissions

Pollutants Measured by NYCCAS: Health Effects and Sources

Fine Particles

Fine particles ($PM_{2.5}$) are tiny airborne solid and liquid particles less than 2.5 microns in diameter. $PM_{2.5}$ is the most harmful urban air pollutant. It is small enough to penetrate deep into the lungs and enter the bloodstream, which can worsen lung and heart disease and lead to hospital admissions and premature deaths. $PM_{2.5}$ causes cancer.

$PM_{2.5}$ can either be directly emitted or formed in the atmosphere from other pollutants. Fuel combustion in vehicles, boilers in buildings, power plants, construction equipment, marine vessels and commercial cooking are all common sources of $PM_{2.5}$. Between 30% to 40% of the $PM_{2.5}$ in New York City's air comes from sources in areas upwind from the city, such as coal-burning power plants in the Midwest.



Black Carbon

Nitrogen Dioxide and Nitric Oxide

Ozone

Sulfur Dioxide

NYCCAS Methods

The Health Department designed NYCCAS to understand how average air pollution levels vary from place to place within New York City. The New York State Department of Environmental Conservation also has a network of nineteen air quality monitors in New York City that are required by the Federal government, but they are mounted on building roofs. We placed our air samplers at street level to measure pollution where people spend time, and where traffic-related pollution levels are usually higher.

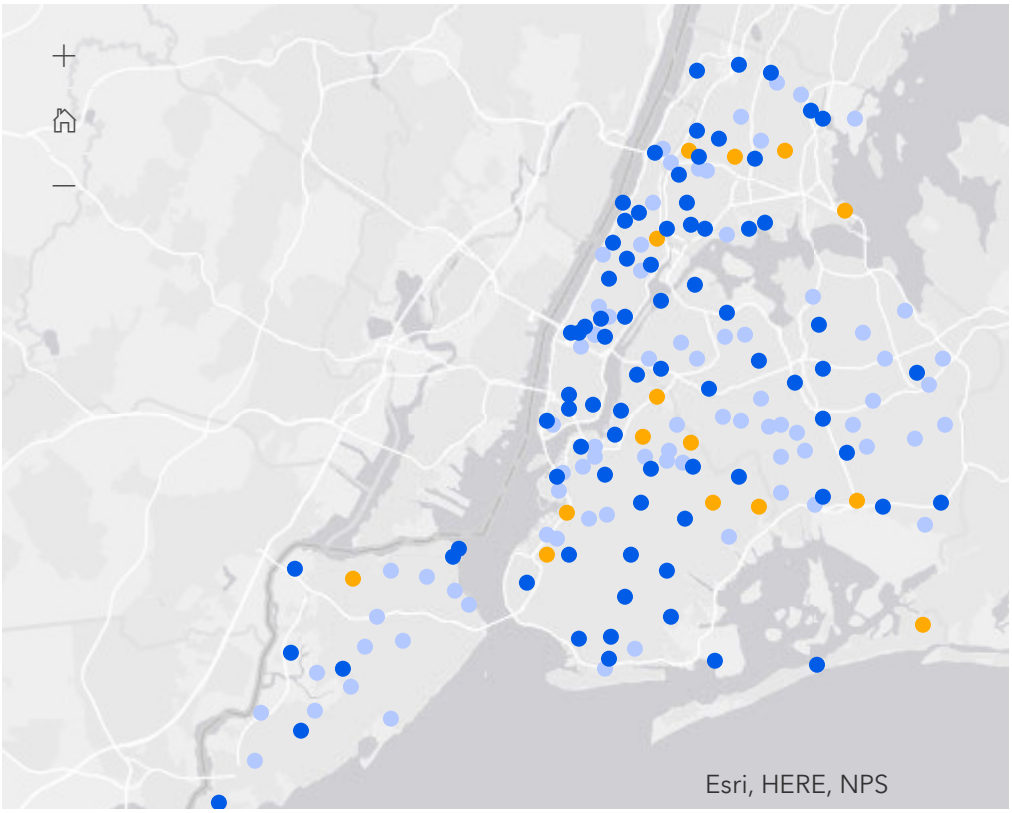
NYCCAS staff mount samplers on street light poles 10 to 12 feet off the ground along residential and commercial streets and in parks. The monitors use a small battery-powered pump and filters to collect air samples. Our air samplers are

deployed at each NYCCAS site once each season and collect data for a two-week period. Samples are collected in all seasons for NO, NO_2, $PM_{2.5}$ and BC; in the summer for O_3; and in the winter for SO_2. For more details on sample collection methods, see Appendix 1 (PDF) (/besp-report-stage/web/sites/default/files/NYCCAS-appendix/Appendix1.pdf).

NYCCAS Sites

The monitoring locations represent a wide variety of New York City environments – sidewalks, busy streets, parks and quiet neighborhood roads. Most of the sites (80%) were chosen by the Health Department at random to ensure representation in all types of neighborhoods, including residential, commercial and industrial areas. The remaining sites were selected because they are near potentially high-emission locations that were not captured in the random assignment. These include Times Square, the Port Authority Bus Terminal and the entrance to the Holland Tunnel. The locations vary in tree canopy and in the density of traffic and buildings. The number of sites has changed over the years as we have learned about air quality in our city. In 2018, we monitored 78 routine

locations and an additional 15 sites in low-income neighborhoods that would benefit from additional monitoring to understand potential sources of emissions. We refer to these as Environmental Justice Sites on the map.



Pollutant Maps

Since it is impossible to sample the air in every location in New York City, we monitor representative sites to determine how pollution levels vary in relation to traffic, buildings, trees and other neighborhood factors. We use NYCCAS monitoring data along with data on land use, traffic, building emissions and other neighborhood factors around the monitors to build a land-use regression (LUR) model. We then used the associations from these models to estimate the seasonal average air pollution levels at locations across the city, including places where no NYCCAS measurements were collected. For more details on emission source

data, see Appendix 1 (PDF) (/nyccas2020/web/sites/default/files/NYCCAS-appendix/Appendix1.pdf). For more details on the analysis methods, see NYCCAS Scientific Publications (https://www1.nyc.gov/site/doh/data/data-publications/air-quality-nyc-community-air-survey.page#nyccas-pubs).

In the maps below, you can select a pollutant to see how air pollution is distributed throughout the city and how it has changed over time. Winter and summer average maps for BC, NO_2, NO and $PM_{2.5}$ are available in Appendix 2 (PDF) (/nyccas2020/web/sites/default/files/NYCCAS-appendix/Appendix2.pdf).

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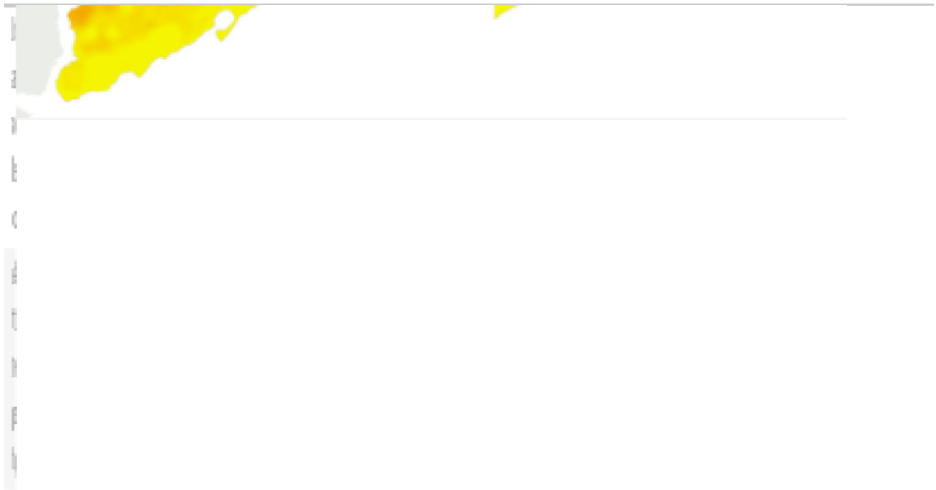
Citywide, annual average levels of black carbon (BC) declined by 33% between 2009 and 2018, an average of 0.05 absorbance units (abs) per year.

Across the ten-year period, higher levels were consistently seen at sites in industrial areas (reflecting increased truck traffic density) and in areas of high traffic emissions.

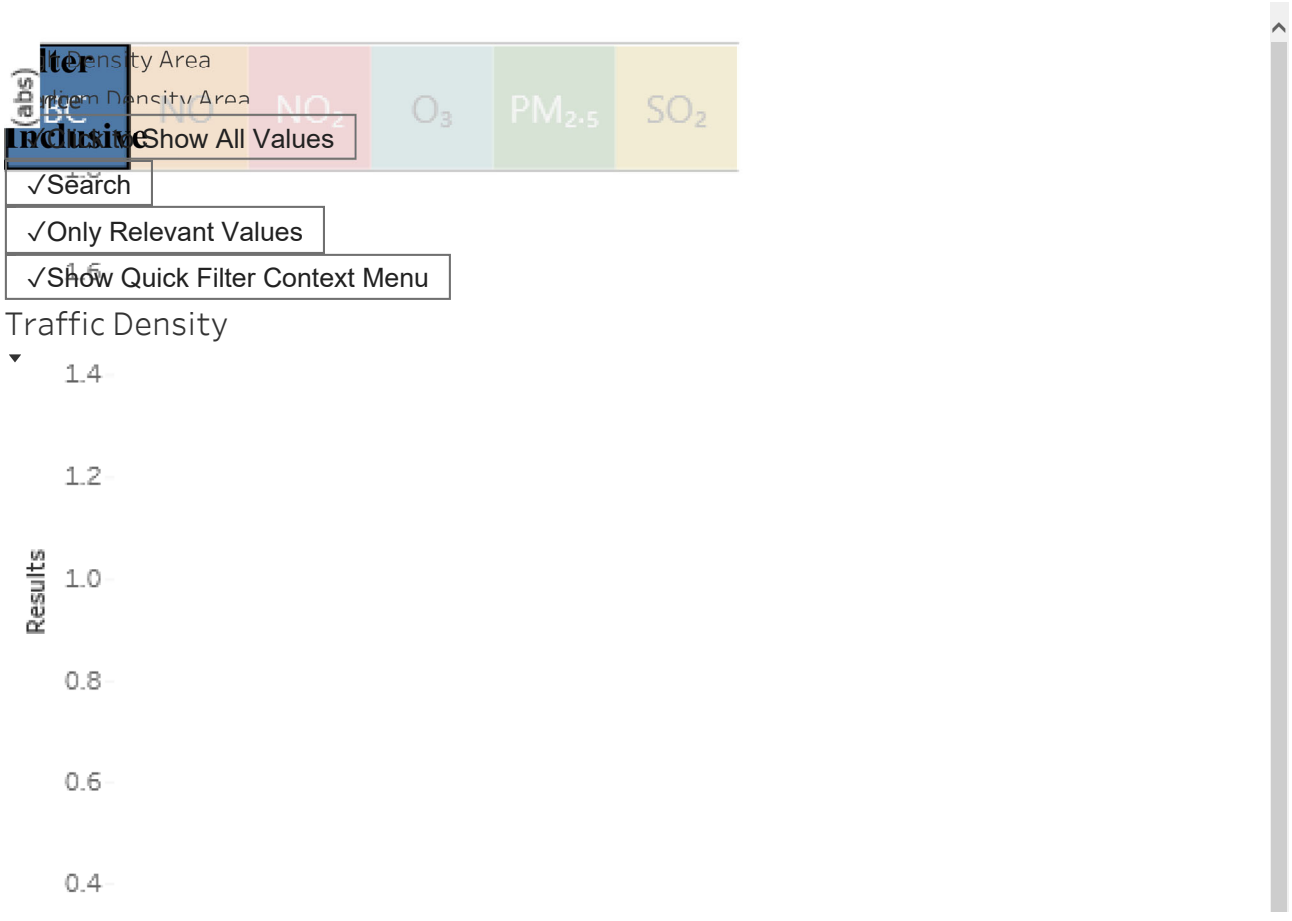
In 2018, seasonal average BC concentrations across NYCCAS monitoring sites ranged from 0.3 to 2.3 abs.



Pollutant Sources

Since monitoring began in winter 2008-2009 in New York City, we have seen a decrease in most of the air pollutants we measure. However, the concentration of each of these pollutants continues to be higher in industrial areas, as well as areas of higher traffic and building density. Air pollution changes not only by neighborhood, but also by season. Some pollutants are highest in certain seasons of the year because of either weather patterns or emissions sources. For example, SO_2 mainly comes from big buildings burning No. 6 (the dirtiest) fuel oil for heat and hot water. We only monitor SO_2 in the winter when heating demand is highest. SO_2 levels have gone down dramatically since Local Law 43 of 2010 (https://www1.nyc.gov/assets/dep/downloads/pdf/air/local-law-43-biodiesel-fuel-requirement.pdf) prohibited the burning of heavy fuel oil (No. 6) in New York City buildings.

The figure below illustrates how the levels of each air pollutant change by season from winter 2008-2009 to fall 2018. We break out locations with high, medium and low densities of the most common sources of each. In winter 2017-18 there were too few sites with SO_2 values above the detection limit for us to include it in this chart.

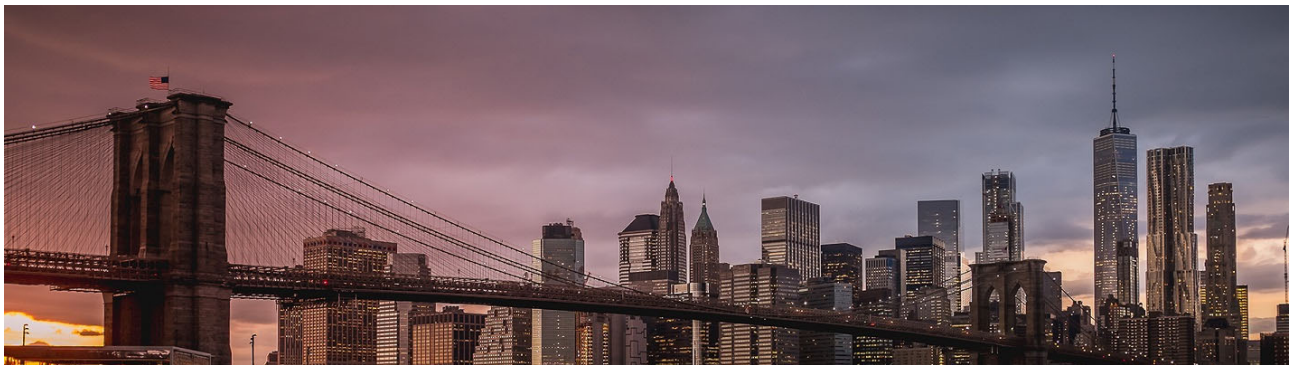


Pollutant Predictors

NYCCAS data were analyzed using a land-use regression (LUR) model. LUR models estimate associations among pollution levels, average traffic, building emissions, land use and other neighborhood factors around the monitoring sites. The pollution sources that contribute most to differences in concentrations of NO, NO_2, BC, and $PM_{2.5}$ across NYC are listed in the table below. SO_2 is now so low in NYC that it is not possible to build a LUR model for the most recent years of data.

BC	NO	NO_2	O_3	$PM_{2.5}$	ssociated Sources and Interpretation
Percent impervious road surface within 250 m					Emissions from motor vehicles on paved road
Area of industrial land use within 1,000 m					Diesel exhaust particles from trucks idling and through industrial areas and industrial combu equipment
$PM_{2.5}$ emissions from heat and hot water boilers in buildings within 1,000 m					Combustion of heating oil and natural gas
Traffic density, weighted by relative $PM_{2.5}$ emissions rates by					$PM_{2.5}$ emissions from all on-road motor vehic on vehicle miles and the relative emissions ra

Conclusion



This report underscores the importance of emissions reduction efforts over the past decade and highlights the continued need to reduce emissions citywide. The City's sustainability plan, OneNYC (http://www1.nyc.gov/html/onenyc/index.html), and its roadmap to reduce greenhouse gas emissions, 80x50 (http://www1.nyc.gov/site/sustainability/codes/80x50.page), have already and will continue to improve air quality and provide important public health benefits to all New Yorkers. These strategies and measures include:

- Transitioning to more efficient, less polluting light-duty and heavy-duty vehicles
- Reducing motor vehicle use by shifting to more sustainable modes of transportation
- Creating more efficient freight networks and expanding truck retrofit and replacement programs
- Reducing fossil fuel combustion in buildings.

Additionally, reducing emissions from other widely distributed sources of pollution, such as BC and $PM_{2.5}$ from commercial charbroiling, will contribute to improved air quality in the future.

More Information:

- New York Community Air Survey: current and past reports (http://www.nyc.gov/health/nyccas)
- Appendix 1 (PDF) (/nyccas2020/web/sites/default/files/NYCCAS-appendix/Appendix1.pdf) : Sampling Methodology and Data Sources for Emissions Indicators.
- Appendix 2 (PDF) (/nyccas2020/web/sites/default/files/NYCCAS-appendix/Appendix2.pdf) : Seasonal Average Pollutant Maps.
- Appendix 3 (PDF) (/nyccas2020/web/sites/default/files/NYCCAS-appendix/Appendix3.pdf) : Community District Average Pollution Levels
- Environment & Health Data Portal (http://a816-dohbesp.nyc.gov/IndicatorPublic/publictracking.aspx) : Neighborhood-level data and neighborhood air quality reports
- The Public Health Impacts of $PM_{2.5}$ from Traffic Air Pollution data story. (http://a816-dohbesp.nyc.gov/IndicatorPublic/Traffic/index.html)
- NYCCAS Air Pollution Rasters on NYC OpenData (https://data.cityofnewyork.us/Environment/NYCCAS-Air-Pollution-Rasters/q68s-8qxv).