# Epi Data Brief

New York City Department of Health and Mental Hygiene April 2017, No. 88

## Tracking Air Quality across New York City, 2008-2015

Air quality in New York City (NYC) has improved over the past several decades due to expansive legislation, such as the federal Clean Air Act, and regulations written in response to it and other federal, state and local air quality laws. However, concentrations of common urban pollutants are still harmful to public health.[1] Exposure to fine particulate matter ($PM_{2.5}$) increases risk of cardiovascular disease, respiratory disease – including lung cancer[2] – low birth weight, and premature death.[3] It is estimated that $PM_{2.5}$ exposures are associated with thousands of respiratory and cardiovascular disease emergency department visits, hospitalizations, and deaths in NYC each year.[4] Exposure to nitrogen dioxide ($NO_2$), sulfur dioxide ($SO_2$), and ground level ozone ($O_3$) can exacerbate asthma and other respiratory diseases. Older adults, children, and those with cardiovascular and respiratory diseases are most vulnerable.[3]

In 2008, the Health Department established the New York City Community Air Survey (NYCCAS) to monitor neighborhood variation in air quality. It is the largest ongoing urban air monitoring program in the United States, and is used to track changes in air quality over time, inform policy and study health effects.

### Common air pollutants in NYC

**Fine particulate matter ($PM_{2.5}$)** refers to tiny airborne solid and liquid particles less than 2.5 microns in diameter (i.e., less than a tenth of the diameter of a human hair). The particles are made up of constituents that are small enough to penetrate deep into the lungs and enter the bloodstream.

**Nitrogen dioxide ($NO_2$) and nitric oxide (NO)** are part of a group of air pollutants called oxides of nitrogen ($NO_x$). $NO_x$ can also react with compounds in the atmosphere to form $PM_{2.5}$ and ozone. We limit findings in this report to $NO_2$ and note that patterns of NO pollution are similar.

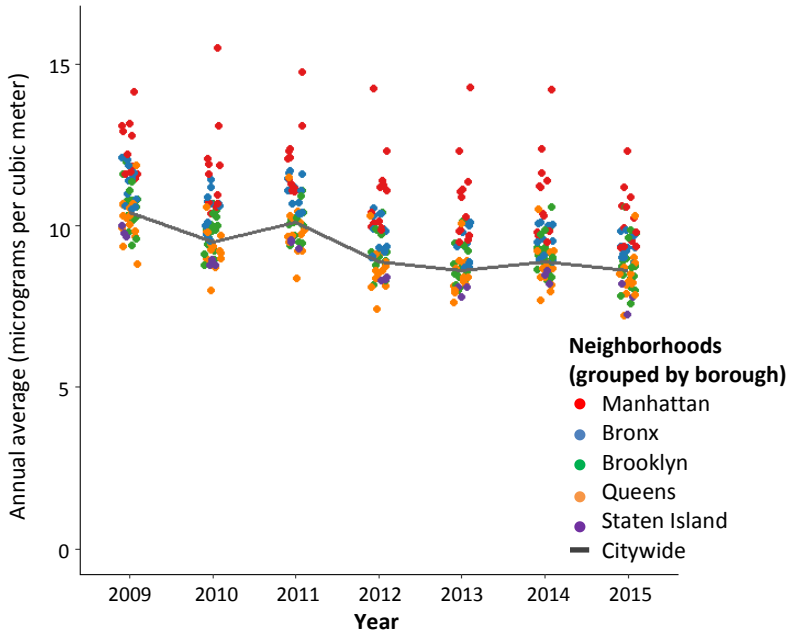
**Sulfur dioxide ($SO_2$)** in NYC is typically generated from burning high-sulfur fuel, which was commonly used in older boilers for heat until recently. It can also react with other compounds in the atmosphere to form $PM_{2.5}$.

**Ozone ($O_3$)** is formed at ground level when $NO_x$ emissions react with volatile organic compounds (VOCs) in the presence of sunlight. Ground-level $O_3$ is the primary constituent of smog, and is to be distinguished from the $O_3$ that forms the ozone layer in the stratosphere. All data reported here represent ground-level $O_3$.

## Fine particulate matter ($PM_{2.5}$)

- The most important local sources of $PM_{2.5}$ emissions in NYC are building boilers, commercial cooking, traffic, and construction and other industrial equipment.
- Citywide levels have declined 18% since 2009 due to regional and local legislative and regulatory efforts to meet requirements of the Clean Air Act, the NYC Air Code and citywide sustainability plans. The transportation, building and power sectors have been targets of local initiatives.[5,6]
- From 2009 to 2015, the majority of the most polluted neighborhoods were in Manhattan, although levels in some of these neighborhoods declined as much as 24%.

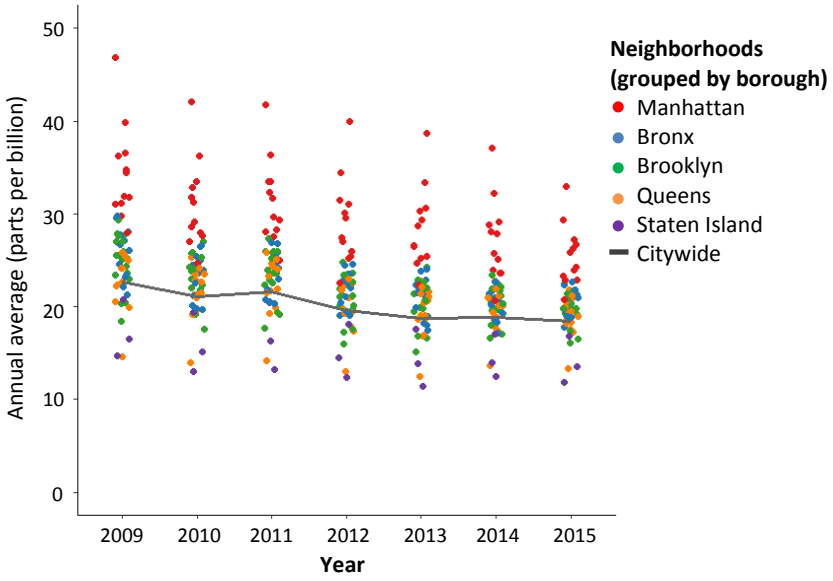
### Distribution of annual average neighborhood $PM_{2.5}$ levels by borough, New York City, 2009-2015




*Source: New York City Community Air Survey, 2009-2015*

## Nitrogen dioxide ($NO_2$)

### Distribution of annual average neighborhood $NO_2$ levels by borough, New York City, 2009-2015



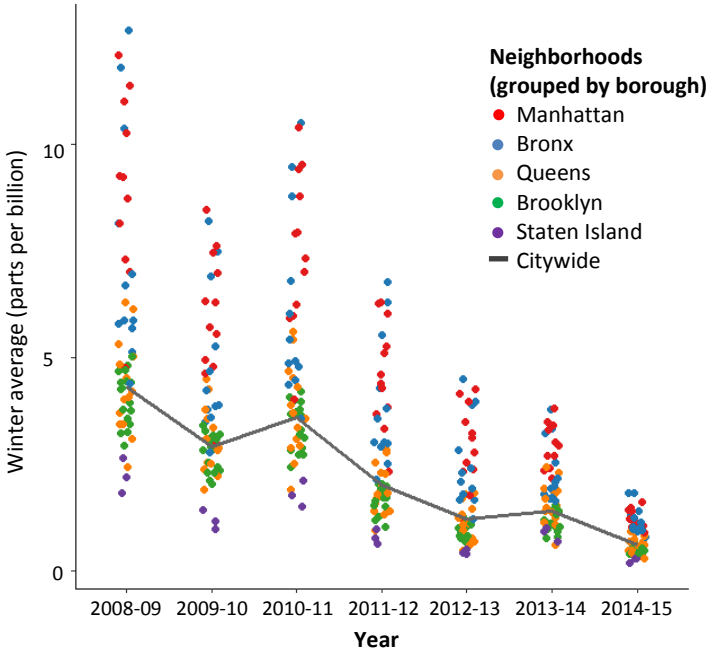

*Source: New York City Community Air Survey, 2009-2015*

- The most important local sources of $NO_2$ emissions in NYC are traffic, building boilers, construction and other industrial equipment, and marine vessels.
- Citywide levels have declined 23% since 2009 as buildings and vehicle fleets have become more efficient and power plant emissions have declined, but current exposure levels can still adversely affect health.
- Like $PM_{2.5}$, the majority of the most polluted neighborhoods were in Manhattan, where levels dropped as much as 30% from 2009 to 2015, but were still higher than in other boroughs.

## Sulfur dioxide ($SO_2$)

- The remaining important sources of $SO_2$ emissions in NYC are building boilers and power plants that have not phased out use of high-sulfur fuel. Marine vessels also use high sulfur fuel oil and are a local source of emissions.
- Between 2009 and 2015, wintertime $SO_2$ levels declined 84% citywide due to state and local legislation to reduce sulfur content of heating oil, and local regulations requiring phase-out of boilers that use the most polluting residual oil. Increased production and declining cost of natural gas has also provided an economic incentive for power and heating sectors to switch from using high sulfur oil to low sulfur natural gas.
- Disparities in $SO_2$ levels across neighborhoods have also gotten smaller. The difference between the most and least polluted neighborhoods dropped from over 10 parts per billion (ppb) in winter 2008-2009 to about 1 ppb in winter 2014-2015.

### Distribution of wintertime neighborhood $SO_2$ levels by borough, New York City, 2008-2015




*Source: New York City Community Air Survey, 2008-2015*

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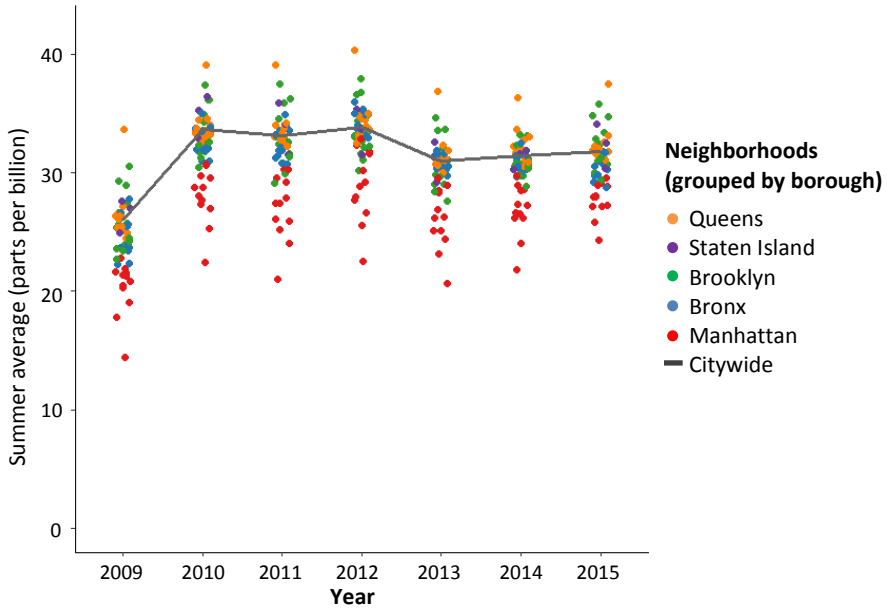
# Ground-level Ozone ($O_3$)

## Distribution of summertime neighborhood $O_3$ levels by borough, New York City, 2009-2015




*Source: New York City Community Air Survey, 2009-2015*

- $O_3$ is highest on warm sunny days, because it is formed through reactions in the atmosphere involving $NO_2$ or other oxides of nitrogen ($NO_x$) and volatile organic compounds (VOCs) in the presence of sunlight. Accordingly, summer weather and temperature influence $O_3$ concentrations year-to-year.
- Since a relatively cool summer that contributed to lower levels in 2009, summertime average $O_3$ levels in NYC were relatively stable from 2010 to 2015.
- The outermost neighborhoods in Queens, Staten Island, and Brooklyn had the highest levels of $O_3$.

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### Other Definitions:

**Volatile Organic Compounds (VOCs)** are also pollutants mentioned, but not described in this report. Motor vehicles are one important source of VOCs in NYC.

### Data Source:

**New York City Community Air Survey (NYCCAS), 2008-2015:** Field teams sample air at up to 150 monitoring sites across NYC neighborhoods once per season (winter, spring, summer and fall). Monitoring results are analyzed using a land-use regression model that estimates associations between pollution levels and their predictors. Traffic, density of buildings (or boilers), and land use around the monitoring sites are among the most important predictors of local variation in pollution. The model-based estimates of associations between predictors and air pollution concentrations are used to estimate seasonal average pollutant levels across NYC – even at locations where no measurements were taken. The neighborhood-level air quality estimates presented in this publication have been generated by land use regression models; the estimates of changes in air pollution levels citywide come directly from 60 monitors that have remained in the same location year-to-year.

### Suggested citation:

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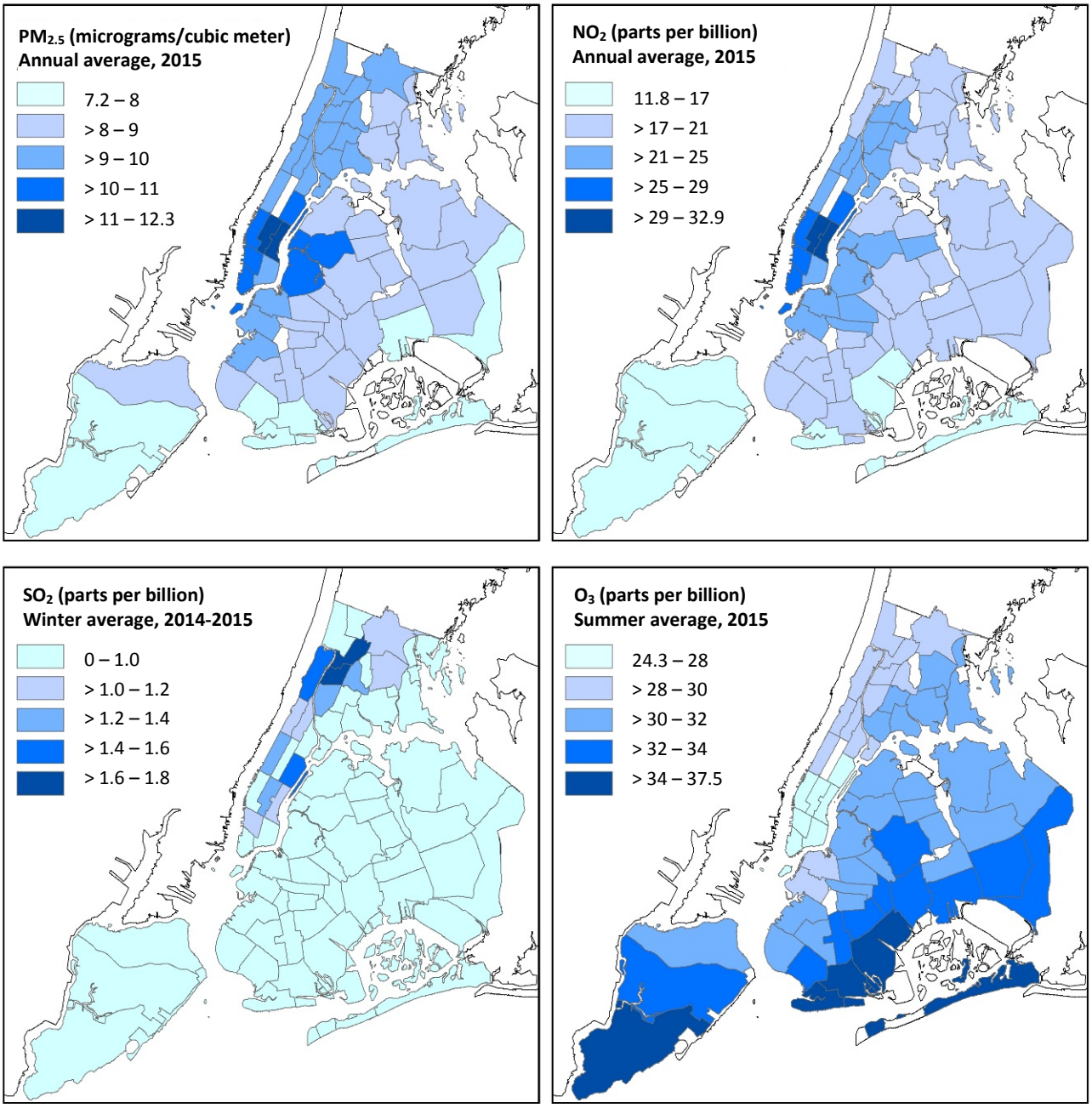
### References:

1. Environmental Protection Agency (EPA) 2015. Air Quality – Cities and Counties. Available at: epa.gov/air-trends/air-quality-cities-and-counties. Accessed Apr 7, 2017.
2. World Health Organization: International Agency for Research on Cancer. 2013. Q & As on outdoor air pollution and cancer. Available at: iarc.fr/en/media-centre/pr/2013/pdfs/pr221_Q&A.pdf. Accessed Apr 7, 2017.
3. Environmental Protection Agency (EPA) Integrated Science Assessments. Available at: epa.gov/isa. Accessed Mar 30, 2017.
4. New York City Trends in Air Pollution and Its Health Consequences. 2013 Available at: nyc.gov/assets/doh/downloads/pdf/environmental/air-quality-report-2013.pdf. Accessed Mar 30, 2017.
5. One New York: The Plan for a Strong and Just City. 2015. Available at: nyc.gov/html/onenyc/downloads/pdf/publications/OneNYC.pdf. Accessed Apr 7, 2017.
6. New York City Administrative Code - Air Code. Available at: legistar.council.nyc.gov/LegislationDetail.aspx?ID=1709613&GUID=AD9DEF6D-EF0C-455A-BF53-0639A32F2E0D&Options=ID|Text|&Search=38. Accessed Apr 7, 2017.

## Patterns of air pollution across New York City neighborhoods, 2015

- $PM_{2.5}$ and $NO_2$ levels were highest in the densely populated and highly trafficked neighborhoods of Manhattan, but they were also relatively high in many densely populated areas of the other boroughs.
- State and local legislation requiring use of low sulfur fuels and phase-out of use of residual heating oil in NYC led to large declines in $SO_2$, but levels remain higher in Manhattan and the Bronx than in other boroughs.
- $O_3$ was highest in the Rockaways and other outer borough areas downwind of precursors to its formation (for example, $NO_2$ and VOCs).
  - However, patterns of $O_3$ pollution in NYC are more complex, because nitric oxide can also react with $O_3$ to reduce its concentration. The inverse association between $O_3$ and areas of high $NO_x$ in the maps below is likely due in part to this process.

### Levels of common air pollutants ($PM_{2.5}$, $NO_2$, $SO_2$, and $O_3$) across Community Districts in New York City, 2015




*Source: New York City Community Air Survey, 2015*