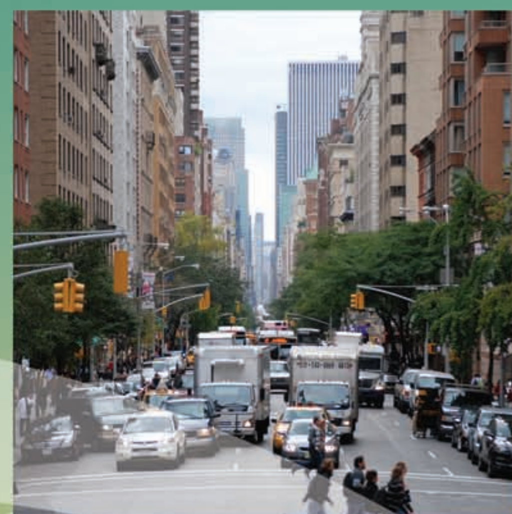
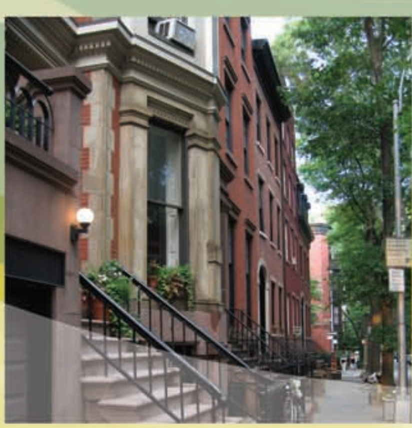
The New York City Community Air Survey

Results from Years One and Two: December 2008–December 2010





NYC Health

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For more information about the Department of Health and Mental Hygiene's New York City Community Air Survey, visit nyc.gov/health/nyccas.

For additional data and information on New York City's environment, sustainability and health outcomes, visit nyc.gov/health/tracking.

Suggested Citation:

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Background

New York City launched its first comprehensive environmental sustainability plan, PlaNYC, in 2007 to protect and improve the City's environment and quality of life while addressing the challenges posed by population growth, climate change, aging infrastructure, and an evolving economy. The original plan and the 2011 update launched many initiatives to improve New York City air quality. One such initiative is the New York City Community Air Survey (NYCCAS), the city's first comprehensive assessment of street-level air quality and the largest urban air pollution monitoring program of its kind in the country.

The program is designed to understand how average air pollution levels vary from place to place within the city.

This report summarizes the first two years of NYCCAS monitoring for five pollutants: fine particles ($PM_{2.5}$), nitrogen dioxide (NO_2), nitric oxide (NO), sulfur dioxide (SO_2) and ozone (O_3). The results reinforce major findings of previous reports:

- Concentrations of pollutants vary widely in different parts of the city during summer and winter seasons.
- Boilers burning residual fuel oil (grade #4 and #6 heating oil) continue to be major sources of air pollution in New York City, especially in neighborhoods where there are many large buildings.
- Traffic emissions also contribute to higher pollution in some neighborhoods and near busy roadways across the city.

These findings have already helped to spur laws, regulations and building owner actions to phase out the use of the most polluting heating fuel. The anticipated air quality improvements will prevent hundreds of premature deaths in the coming years. Data summarized in the current report provide a baseline from which to track these air quality improvements over time. NYCCAS data will continue to guide city efforts to further reduce emissions and achieve the PlaNYC goal of achieving the cleanest air of any large U.S. city.

Methods

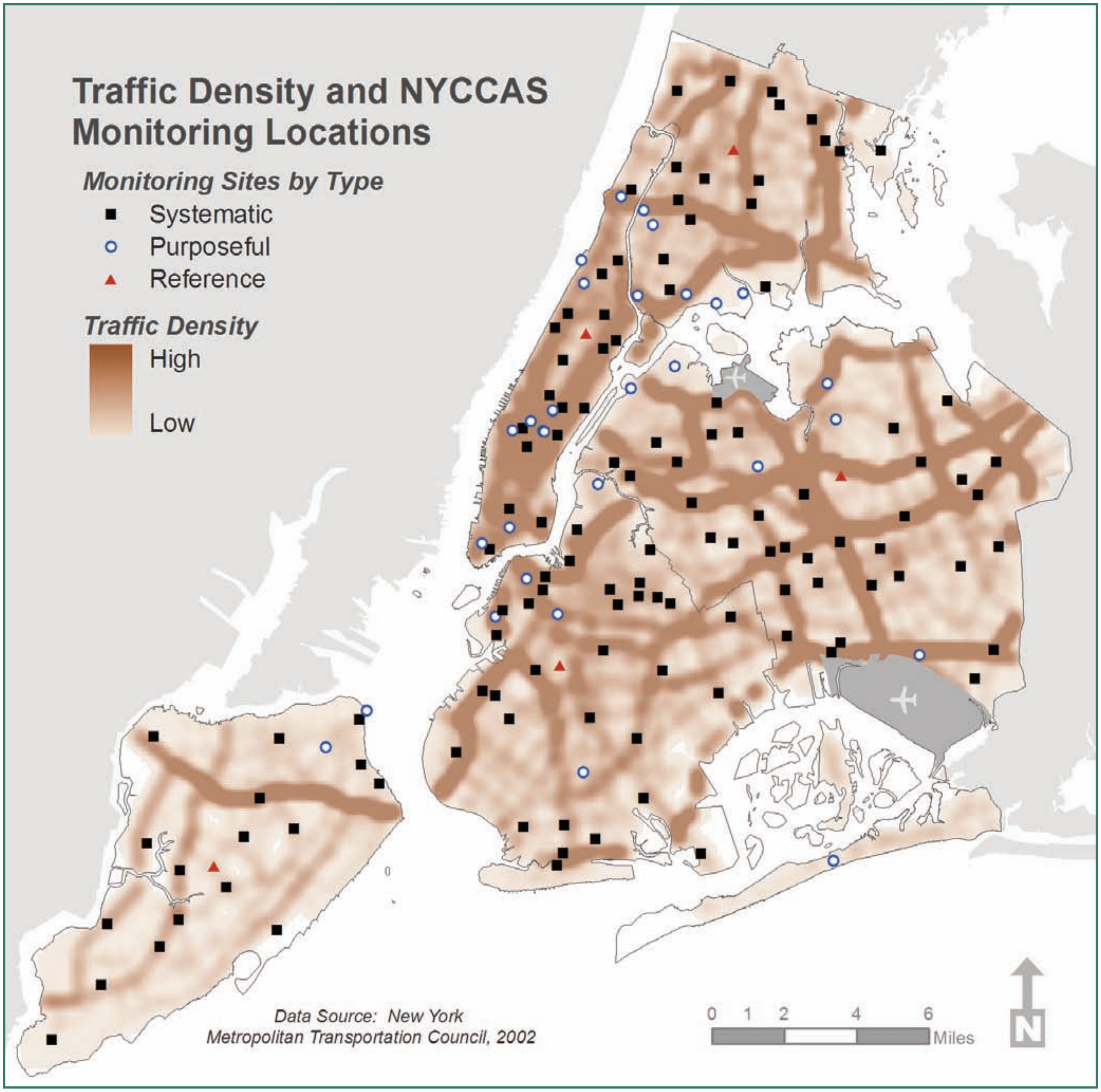
In the two years following its December 2008 launch, the Community Air Survey measured street-level air pollution at 150 locations across the city over every season of the year (Figure 1), gathering data on common air pollutants that affect public health such as fine particles, black carbon, oxides of nitrogen and ozone (summer only), sulfur dioxide (winter only) and certain metals.

NYCCAS uses an established modeling approach known as land-use regression (LUR) to provide air pollution estimates for unmonitored locations. Land-use regression has been used to study air pollution exposure and health effects in other urban areas. The method examines how measured pollution levels vary in relation to traffic, buildings, ground cover and other neighborhood factors near the NYCCAS monitor locations. Using the relationship between sources and levels of air pollutants at monitored locations, a statistical model estimates air pollution levels throughout city neighborhoods, including locations where no measurements were taken.

NYCCAS investigators used computerized databases that map features associated with combustion emissions and land cover to identify factors contributing to air pollution patterns. Using additional data sources and several dozen variables, they identified a small subset for each pollutant that best explained how its concentration varied from place to place.

Although the statistical models reasonably predict pollution concentrations at most monitoring locations, in some areas the model under- or over-estimated pollution measurements. Therefore, as a final modeling step, we statistically identified areas where the model over- or under-estimated pollution measures and adjusted the model estimates accordingly. Further statistical methods were used to smooth the estimates for mapping purposes. More detail on the land-use regression analysis and data sources used to identify factors contributing to air pollution patterns are available online at nyc.gov/health/nyccas. Because ozone is not emitted directly from sources such as tailpipes or boilers, but is produced by chemical reactions involving sunlight and oxides of nitrogen near ground level, a modified modeling method was applied for predicting ozone levels based on estimated nitrogen dioxide (NO_2) concentrations.

Figure 1. New York City Community Air Survey monitoring locations



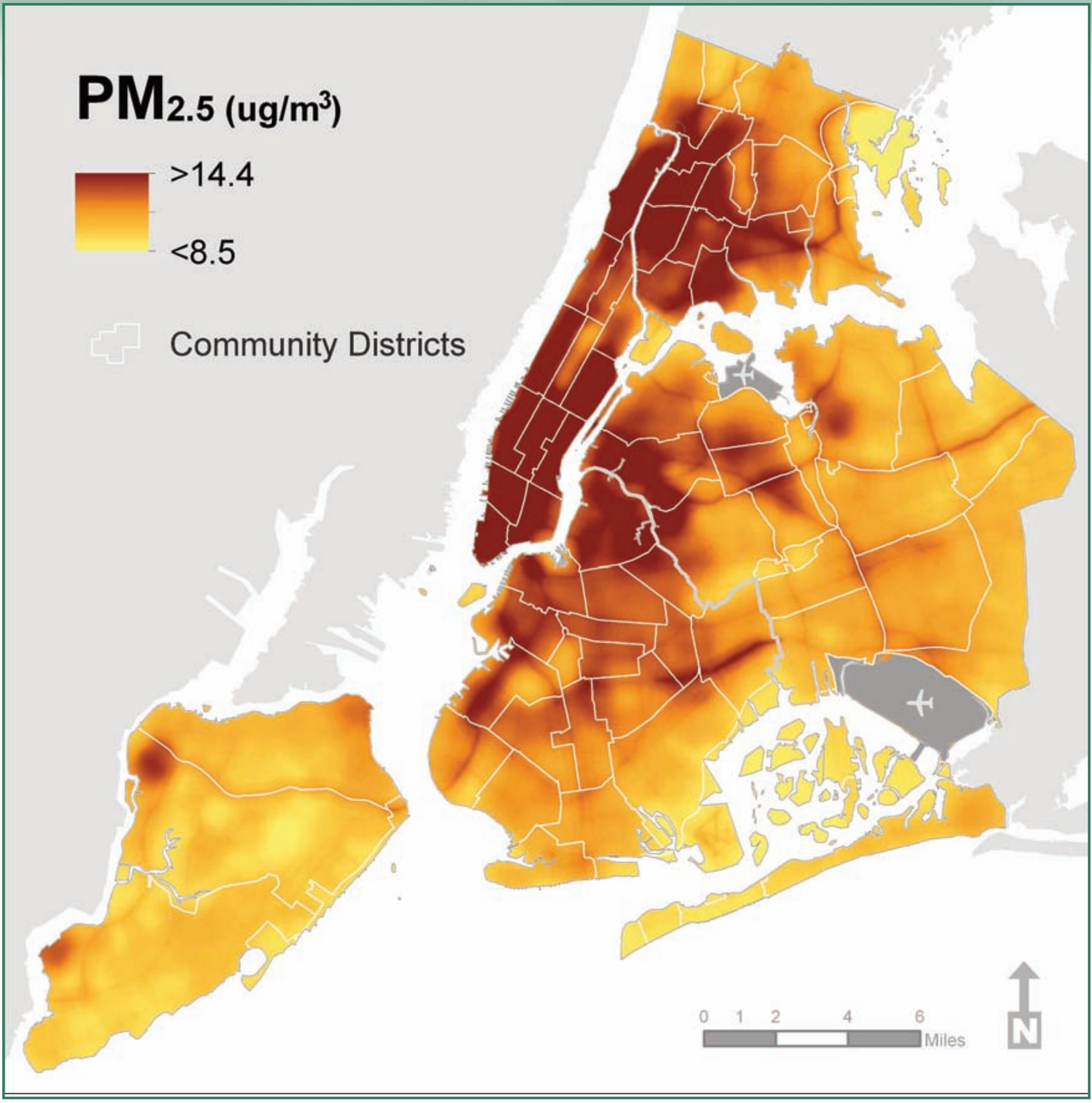
Results

Air pollution levels measured at NYCCAS locations during the second full year of NYCCAS (from December 2009 to December 2010) strongly correlated with year one measurements. This means that the same locations tended to have higher than average pollution levels in each of the two years, reflecting fairly consistent patterns of pollution sources like traffic and buildings. The two-year maps provide estimates based on the combined measurements taken during the first two years of NYCCAS. Below each map, a table lists the emission source indicators that were important predictors of air pollution concentrations in land use regression models. The time trend charts show the average concentrations at NYCCAS monitoring locations for different levels (high, medium and low) of traffic density and building density across the first two years of NYCCAS.

Consistent with prior published NYCCAS reports, the maps show higher concentrations of fine particles **(Figure 2)** and oxides of nitrogen **(Figures 5 and 8)** in midtown and lower Manhattan, and along busy freeways in sections of the Bronx, Brooklyn, Queens and Staten Island. Areas with a convergence of major emission sources, such as buildings and traffic, had the highest pollution levels. Also consistent with year one data, winter sulfur dioxide levels **(Figure 11)** are higher where large buildings are concentrated; they are not associated with traffic. While pollutant concentrations vary by year, because of weather and overall changes in emissions, these charts show that air quality is consistently worse in locations with a concentration of emission sources.

An exception to the pattern is ozone **(Figure 13)**, a secondary pollutant, which forms through chemical reactions of other pollutants (oxides of nitrogen and volatile organic compounds) in the presence of sunlight. In locations with high concentrations of oxides of nitrogen from “fresh” emissions (those directly emitted from a tailpipe or other source), ozone is rapidly consumed through a process known as scavenging. As a result, ozone concentrations are often highest in downwind, suburban areas with less traffic.

Figure 2. Map of estimated two year average $PM_{2.5}$ concentrations, December 2008-December 2010



In a land-use regression model,[1] the following source indicators were important predictors of the two year average $PM_{2.5}$ concentrations at NYCCAS monitoring sites (in order of importance):

Indicator	Associated Sources and Interpretation
Estimated $PM_{2.5}$ emissions from large building boilers within 1000 meters	Combustion of heating oil and natural gas
Area of industrial land use within 1000 meters	Diesel exhaust particles from trucks and idling and traveling in industrial areas, industrial combustion equipment
Nighttime population within 450 meters	Combustion of heating fuel
Truck traffic within 200 meters	Diesel exhaust particles from motor vehicles
Road surface area within 50 meters	Road dust that becomes airborne, emissions from motor vehicles

[1] See appendix for a list of indicator sources.

Figure 3. Seasonal average $PM_{2.5}$ concentrations at NYCCAS sites, by traffic density[2]

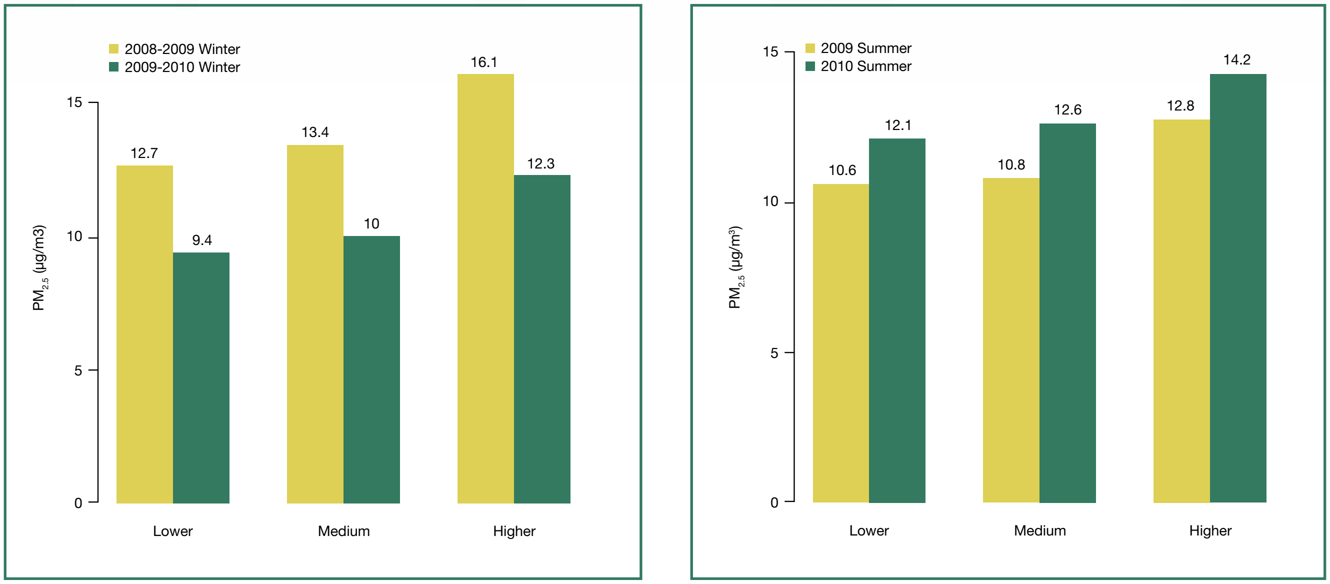
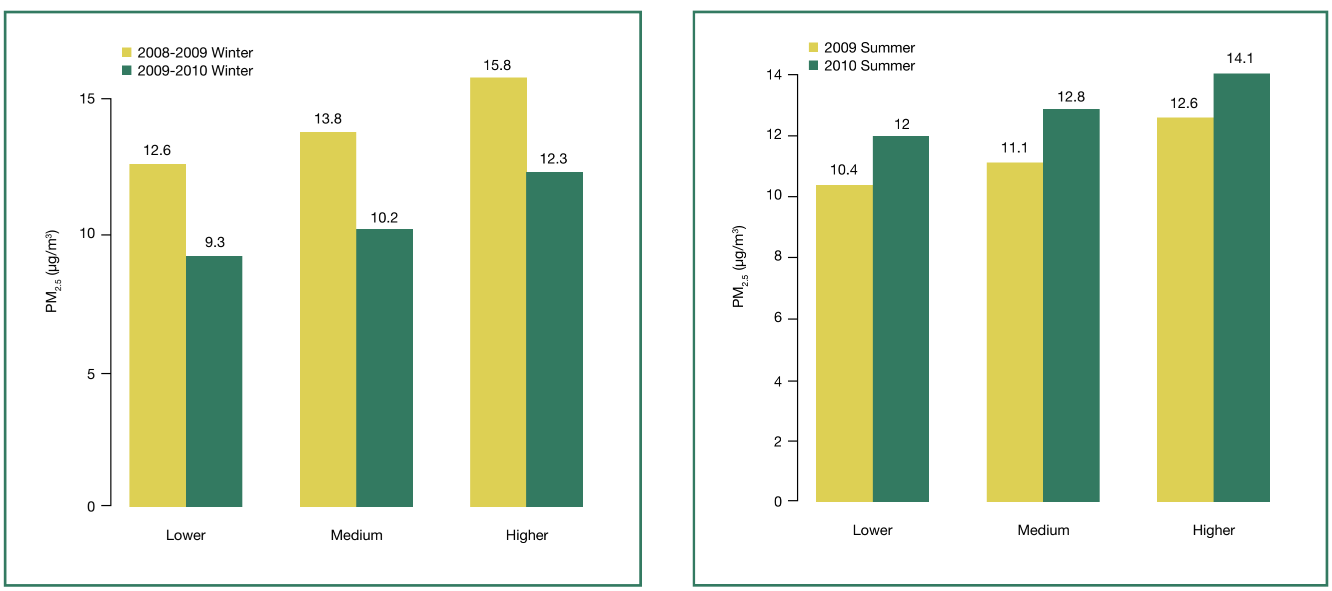


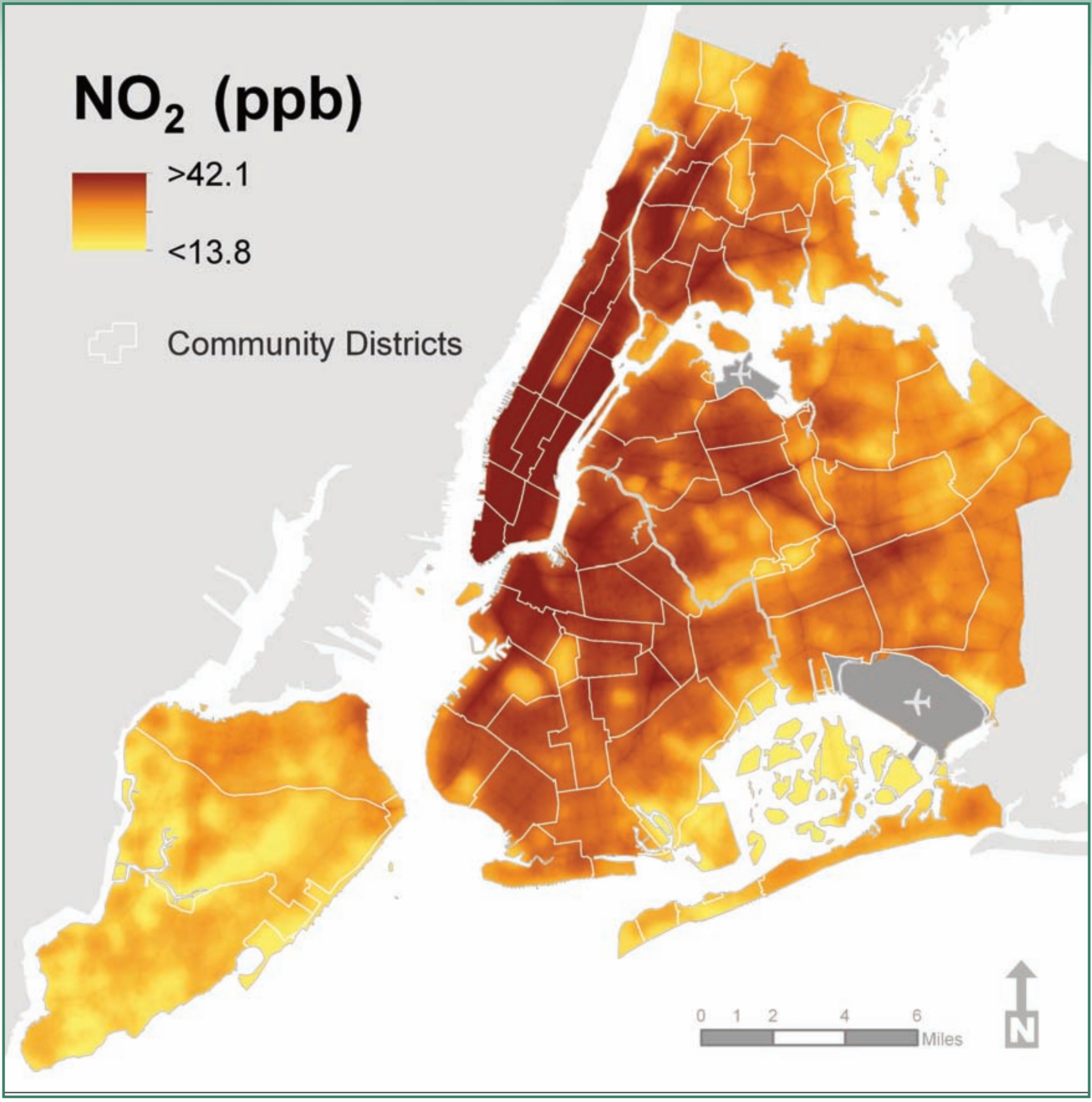
Figure 4. Seasonal average $PM_{2.5}$ concentrations at NYCCAS sites, by building density[3]



[2] Nearby traffic is estimated within 1 km of sampling location. Each category (lower, medium, and higher) includes one-third of sampling sites, with a weighted traffic density of low, 126-11160; medium, 11160-21294; and high, 21294-43257 vehicle-kilometers per hour. Data source: New York Metropolitan Transportation Council.

[3] Building density is estimated as total interior built space within 900m. Each category includes one-third of sampling sites, with total interior built space area of low, 0-1.1; medium, 1.1-2.5; and high, 2.5-21.7 square kilometers. Data source: New York City Planning Map PLUTO buildings data.

Figure 5. Map of estimated two year average nitrogen dioxide (NO_2) concentrations, December 2008-December 2010



In a land-use regression model,[4] the following source indicators were important predictors of the two year average NO_2 concentrations at NYCCAS monitoring sites (in order of importance):

Indicator	Associated Sources and Interpretation
Area of interior built space within 1000 meters	Combustion of heating oil and natural gas
Area of impervious surface within 100 meters	Emissions from motor vehicles
Location on a bus route	Emissions from buses and other vehicles on busy roads, traffic congestion
Traffic density within 100 meters	Emissions from motor vehicles

[4] See appendix for a list of indicator sources.

Figure 6. Seasonal average NO_2 concentrations at NYCCAS sites, by traffic density[5]

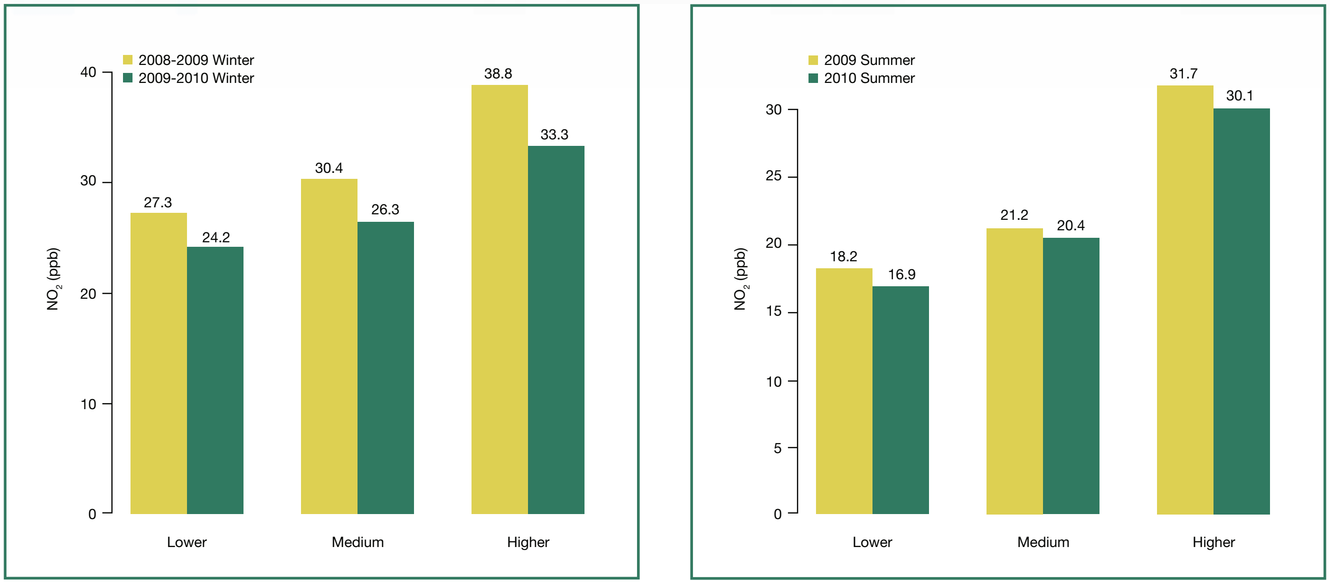
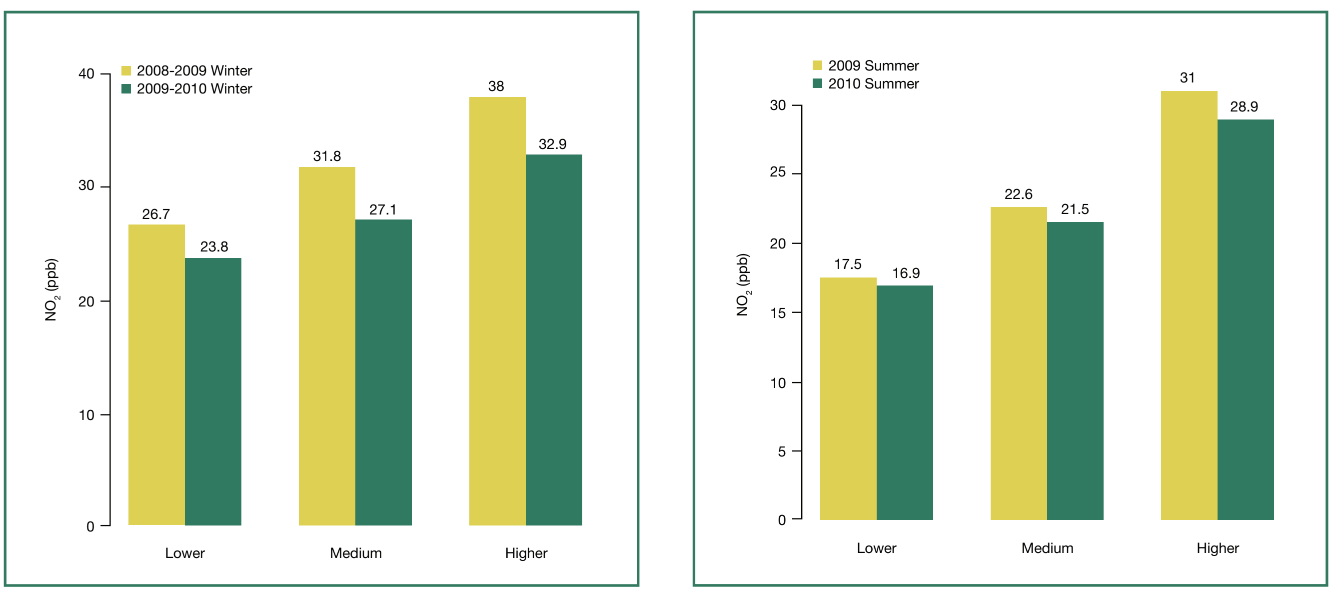


Figure 7. Seasonal average NO_2 concentrations at NYCCAS sites, by building density[6]

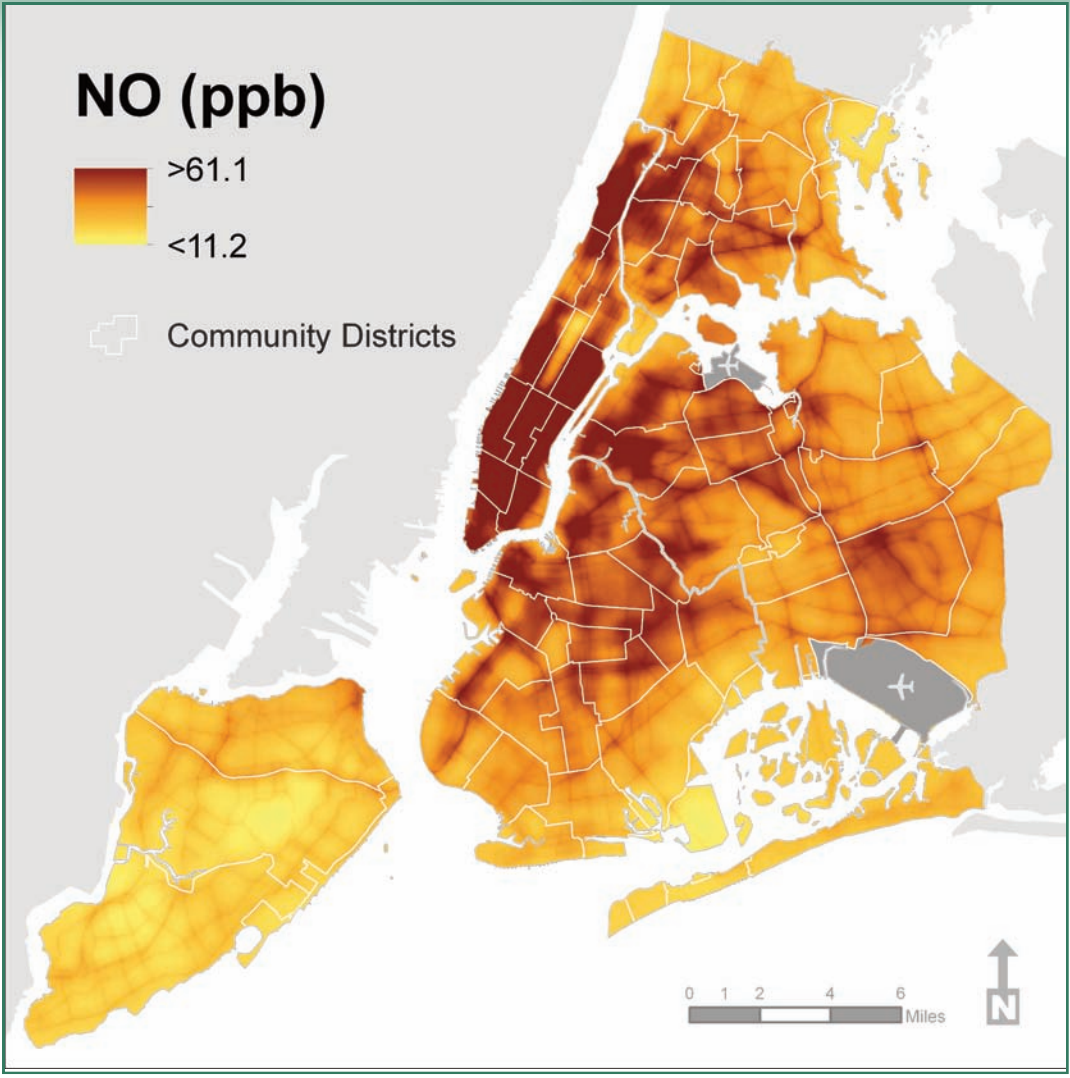


[4] See appendix for a list of indicator sources.

[5] Nearby traffic is estimated within 1 km of sampling location. Each category (lower, medium, and higher) includes one-third of sampling sites, with a weighted traffic density of low, 126-11160; medium, 11160-21294; and high, 21294-43257 vehicle-kilometers per hour. Data source: New York Metropolitan Transportation Council.

[6] Building density is estimated as total interior built space within 900m. Each category includes one-third of sampling sites, with total interior built space area of low, 0-1.1; medium, 1.1-2.5; and high, 2.5-21.7 square kilometers. Data source: New York City Planning Map PLUTO buildings data.

Figure 8. Map of estimated two year average nitric oxide (NO) concentrations, December 2008-December 2010

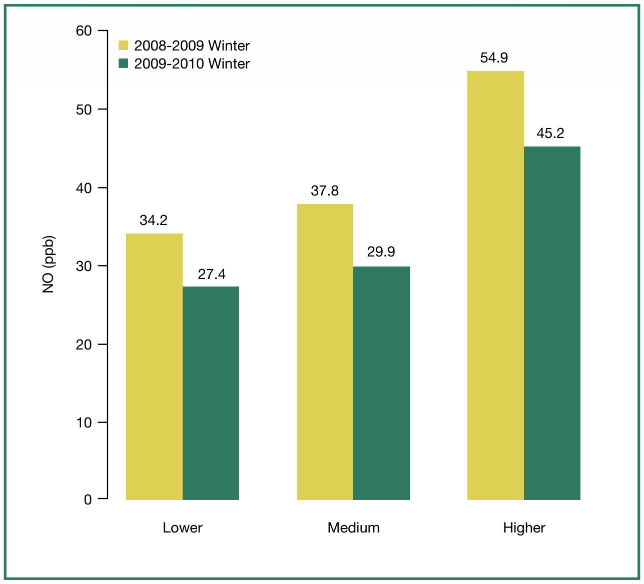


In a land-use regression model,[7] the following source indicators were important predictors of the two year average NO concentrations at NYCCAS monitoring sites (in order of importance):

Indicator	Associated Sources and Interpretation
Number of building boilers within 250 meters	Combustion of heating oil and natural gas
Length of truck route within 50 meters	Emissions from trucks and other vehicles on busy roads
Bus traffic density within 100 meters	Emissions from buses and other vehicles on busy roads, traffic congestion
Number of signaled intersections within 150 meters	Emissions from motor vehicles, traffic congestion
Traffic density within 100 meters	Emissions from motor vehicles
Modeled impact of large electricity generating units on nitrogen oxide concentrations	Emissions from power generation

[7] See appendix for a list of indicator sources.

Figure 9. Seasonal average NO concentrations at NYCCAS sites, by traffic density[8]



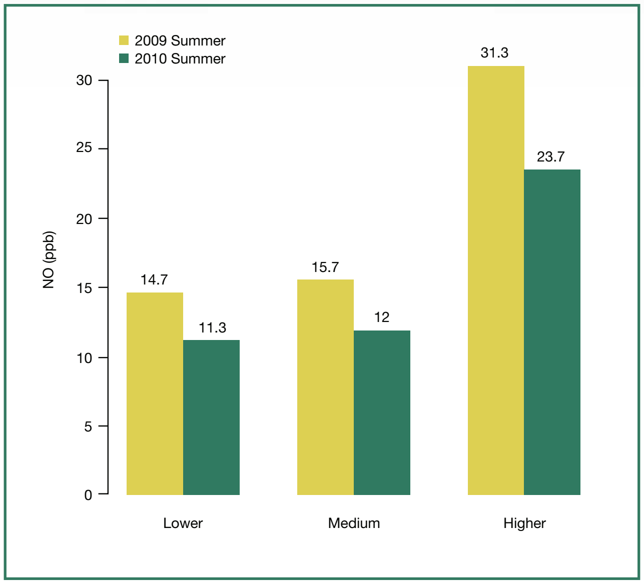
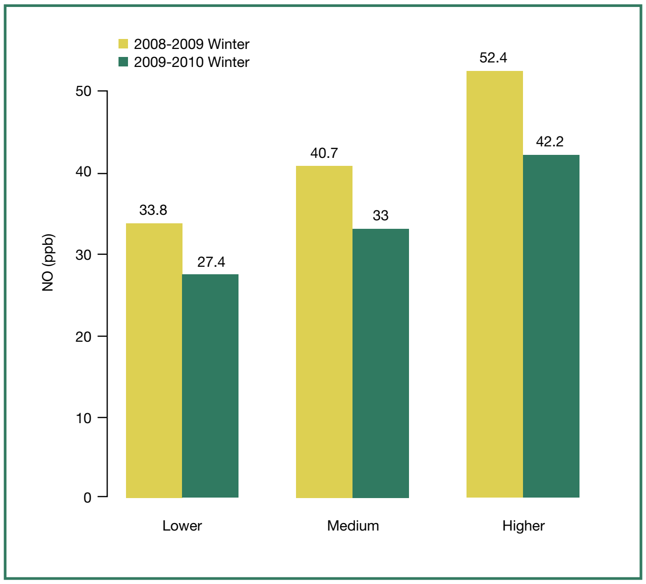
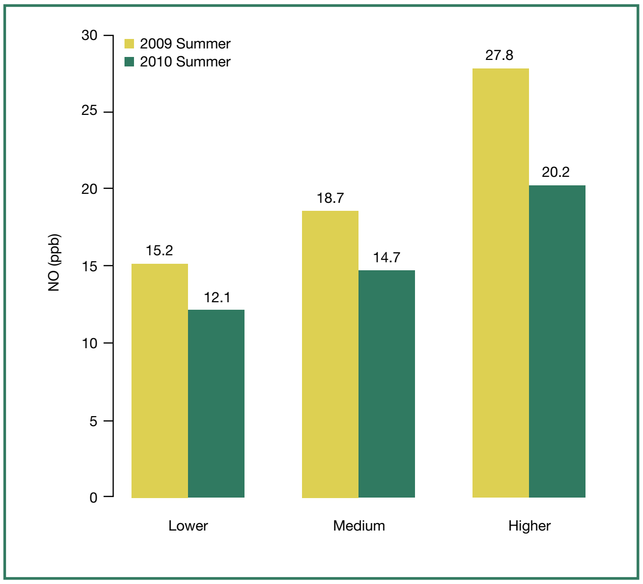


Figure 10. Seasonal average NO concentrations at NYCCAS sites, by building density[9]

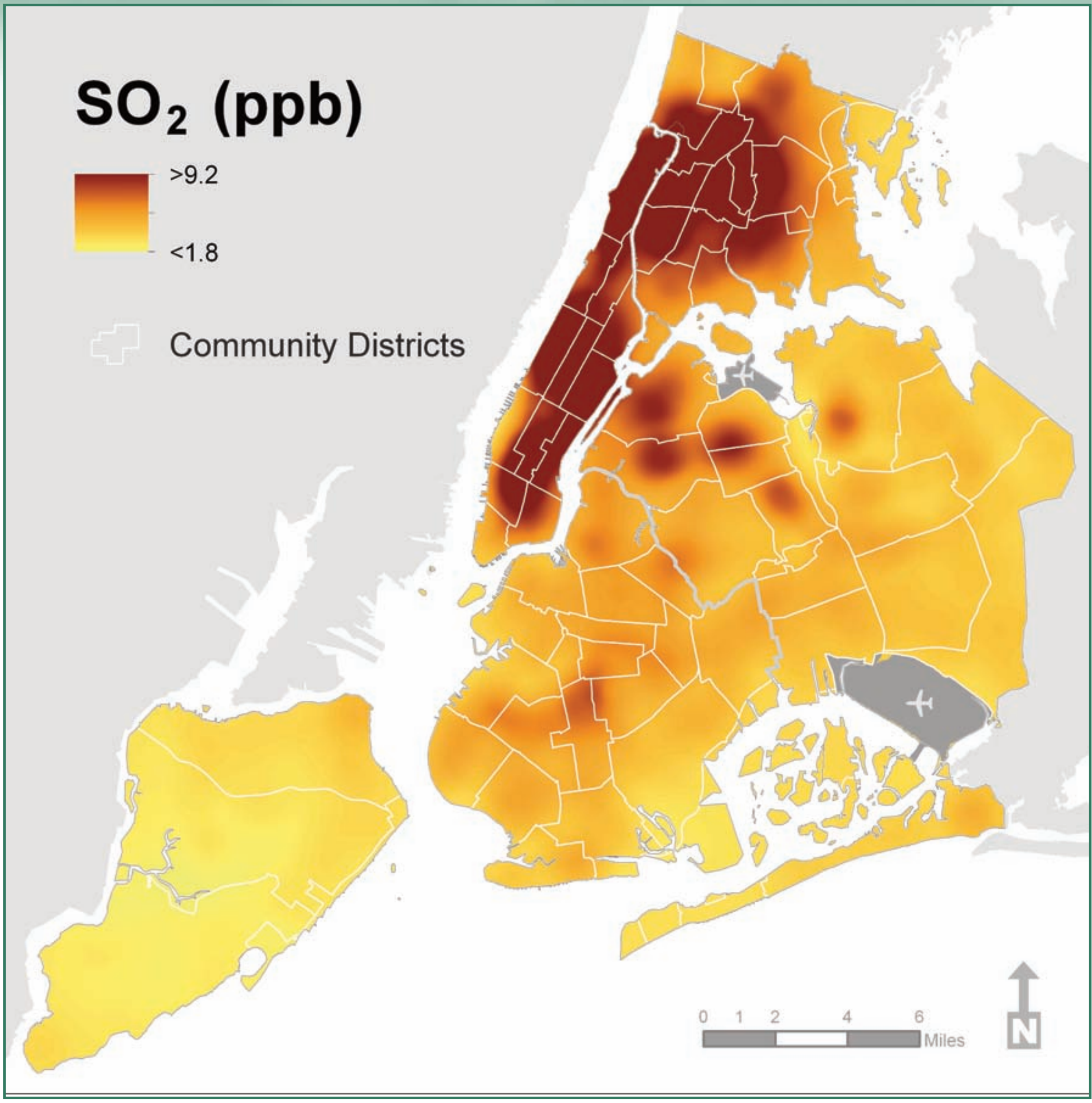




[8] Nearby traffic is estimated within 1 km of sampling location. Each category (lower, medium, and higher) includes one-third of sampling sites, with a weighted traffic density of low, 126-11160; medium, 11160-21294; and high, 21294-43257 vehicle-kilometers per hour. Data source: New York Metropolitan Transportation Council.

[9] Building density is estimated as total interior built space within 900m. Each category includes one-third of sampling sites, with total interior built space area of low, 0-1.1; medium, 1.1-2.5; and high, 2.5-21.7 square kilometers. Data source: New York City Planning Map PLUTO buildings data.

Figure 11. Map of estimated winter average sulfur dioxide (SO_2) concentrations, December 2008-December 2010

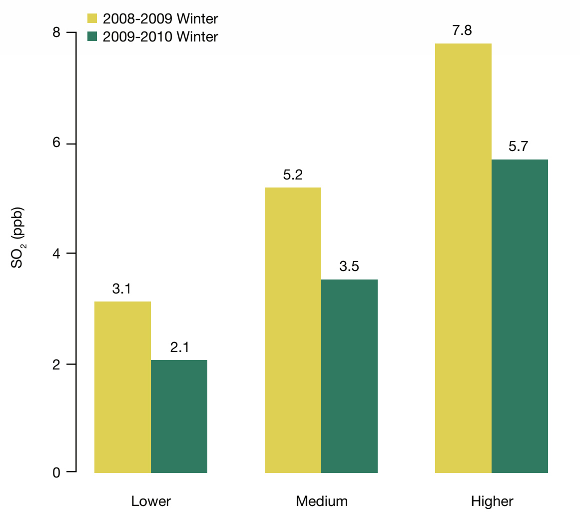


In a land-use regression model,[10] the following source indicators were important predictors of the two year average SO_2 concentrations at NYCCAS monitoring sites (in order of importance):

Indicator	Associated Sources and Interpretation
Number of building boiler burning residual fuel oil within 1000 meters	Combustion of #4 and #6 heating oil
Nighttime population within 1000 meters	Combustion of heating fuel

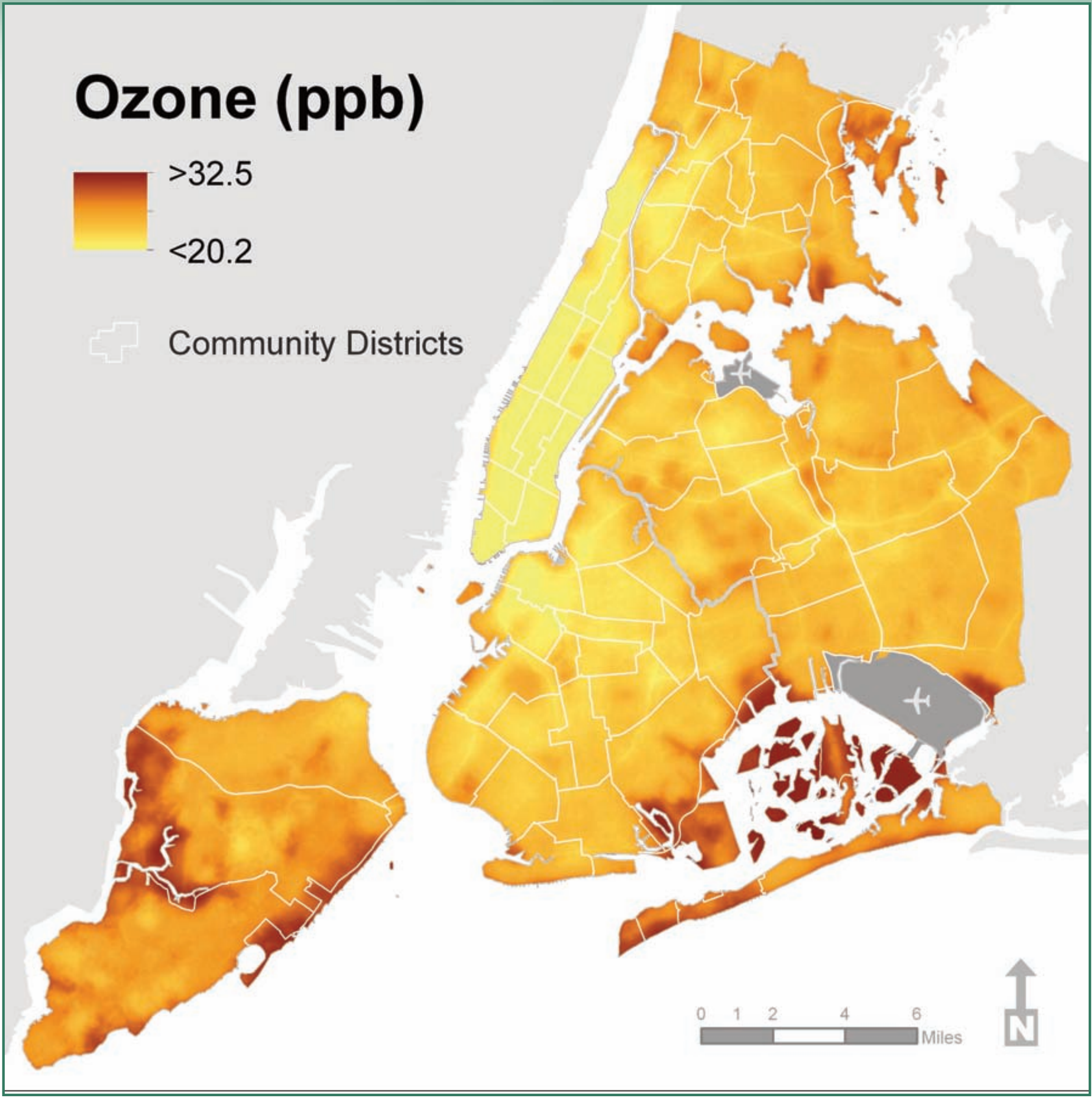
[10] See appendix for a list of indicator sources.

Figure 12. Seasonal average SO_2 concentrations at NYCCAS sites, by building density[11]



[11] Building density is estimated as total interior built space within 900m. Each category includes one-third of sampling sites, with total interior built space area of low, 0-1.1; medium, 1.1-2.5; and high, 2.5-21.7 square kilometers. Data source: New York City Planning Map PLUTO buildings data.

Figure 13. Map of estimated summer average ozone (O_3) concentrations, December 2008-December 2010

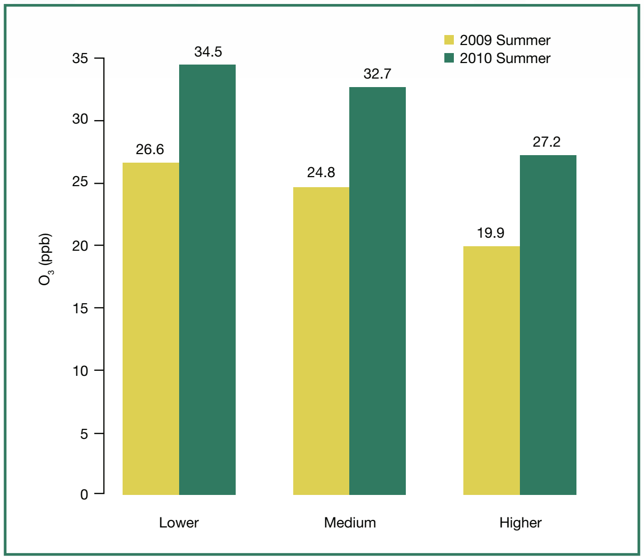


Indicator	Associated Sources and Interpretation
Level of NO_2 measured at the same location	Nitrogen oxides at elevated concentrations react with ozone and reduce levels
Tree cover within 50 meters	Reduced levels through reactions of ozone with leaf surfaces

In a land-use regression model,[12] the following source indicators were important predictors of the two year average O_3 concentrations at NYCCAS monitoring sites (in order of importance):

[12]See appendix for a list of indicator sources.

Figure 14. Seasonal average O_3 concentrations at NYCCAS sites, by traffic density[13]



[13]Nearby traffic is estimated within 1 km of sampling location. Each category (lower, medium and higher) includes one-third of sampling sites, with a weighted traffic density of low, 126-11160; medium, 11160-21294; and high, 21294-43257 vehicle-kilometers per hour. Data source: New York Metropolitan Transportation Council.

Discussion

The first two years of data from NYCCAS document consistent neighborhood differences in air pollution and establish a baseline for monitoring these differences over time. While we anticipate major improvements in the most polluted neighborhoods as the "dirtiest" heating fuels are phased out, NYCCAS data demonstrate the need for continuing and expanding measures to reduce harmful emissions from traffic and other sources within our city. For more information on PlaNYC air quality initiatives and progress, visit PlaNYC.

For neighborhood level air pollution estimates and other environmental, health and sustainability indicators, visit the Environmental Public Health and Sustainability Tracking Portal.

Appendix

Data sources for emission source indicators

Pollutant	Indicator	Associated Sources and Interpretation
$PM_{2.5}$	Estimated $PM_{2.5}$ emissions from large building boilers within 1000 meters	NYC Department of Environmental Protection (DEP) permit data, 2008
	Area of industrial land use within 1000 meters	PLUTO™ data, 2007
	Truck traffic within 200 meters	NYMTC traffic data, 2005
	Road surface area within 50 meters	NYC Department of Parks and Recreation Land Cover Map, 2010
NO_2	Area of interior built space within 1000 meters	PLUTO™ data, 2007
	Area of impervious surface within 100 meters	USGS, 2001
	Location on a bus route	NYC Department of Transportation (DOT)
	Traffic density within 100 meters	NYMTC traffic data, 2005
NO	Number of building boilers within 250 meters	NYC Department of Environmental Protection (DEP) permit data, 2008
	Length of truck route within 50 meters	NYC Department of Transportation (DOT)
	Bus traffic density within 100 meters	NYMTC traffic data, 2005
	Number of signaled intersections within 150 meters	NYC Department of Transportation (DOT)
	Traffic density within 100 meters	ALIS network; MPSI TrafficMetrix™ data
	Modeled impact of large electricity generating units on oxides of nitrogen concentrations	EPA 2005 National Emissions Inventory modeled using the CALPUFF dispersion model (AKRF)
SO_2	Number of building boilers burning residual fuel oil within 1000 meters	NYC Department of Environmental Protection (DEP) permit data, 2008
	Nighttime population within 1000 meters	Oak Ridge National Laboratory LandScan™ data, 2001
O_3	Level of NO_2 measured at the same location	NYCCAS monitoring data
	Tree cover within 50 meters	NYC Department of Parks and Recreation Land Cover Map, 2010

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