New York City Community Air Survey: Spatial Variation of Fine Particle Vanadium and Ship Emissions in New York City

Since its launch in 2008, the New York City Community Air Survey (NYCCAS), a PlaNYC initiative, has provided data to the public and to local policy-makers on how average levels of common air pollutants vary throughout the City and the sources that contribute to these differences. NYCCAS monitors a variety of common air pollutants with known health effects, one of which is fine particles ($PM_{2.5}$). Fine particles come from a variety of different sources, and the chemical components of $PM_{2.5}$ can vary by source.

In a recent study, the Health Department analyzed 16 chemical components of $PM_{2.5}$ filters from 150 NYCCAS monitor sites. To link the chemical components of $PM_{2.5}$ with their source, the Health Department also collected extensive source indicator variables for eight categories of major source types (e.g., traffic density, the number of boilers burning residual oil, etc.) at 15 levels of buffers (50m to 1000m) from the NYCCAS air quality monitors.[1,2]

Marine traffic, especially traffic at ports, can be a source of air pollution. The port of New York and New Jersey is the third largest port in the United States, and it is the largest port on the East Coast.[3] Ship vessels that unload at ports are of concern because they burn residual oil, ("bunker" fuel), which is more viscous (i.e., longer carbon chains) and contains higher levels of metals than distillate fuel types such as diesel fuel (Figure 1).

To explore the impact of marine traffic on air pollution, the Health Department obtained data from the NYC Office of Emergency Management on the NY Harbor navigation channels and shipping anchorages as well as port berth volume from the National Transportation Atlas Database Ports 2010. Using these data, the Health Department created estimates of marine traffic for the ports in the New York/New Jersey Harbor and the channels within and around New York City and related these to specific chemical constituents from the $PM_{2.5}$ measures.

Of the sixteen elements detected in the $PM_{2.5}$ filters and the various indicator variables, vanadium exhibited the strongest and unique association with the indicator for marine vessels. This finding is consistent with findings of other studies.[4] The spatial distribution of marine traffic explains the spatial distribution of the vanadium detected in the $PM_{2.5}$ filters (Figure 2).

The findings of this study indicate that New Yorkers residing for long periods in close proximity to areas of high marine traffic volumes may be exposed to higher levels of vanadium and other pollutants associated with ship emissions. Assessment of the health impacts of exposure to these emissions warrants further research.[5] Continuing and expanding efforts to monitor air quality will inform policy to reduce population exposure to air pollutants from specific emission sources within the City.

[1] Matte TD, Ross Z, Kheirbek I, Eisl H, Johnson S, Gorczynski JE, Kass D, Markowitz S, Pezeshki G, Clougherty JE. 2013. Monitoring intraurban spatial patterns of multiple combustion air pollutants in New York City: Design and implementation. Journal of Exposure Science and Environmental Epidemiology, 23: 223-231.

[2] Clougherty JE, Kheirbek I, Eisl HM, Ross Z, Pezeshki G, Gorczynski JE, Johnson S, Markowitz S, Kass D, Matte T. 2013. Intra-urban spatial variability in wintertime street-level concentrations of multiple combustion-related air pollutants: The New York City Community Air Survey (NYCCAS). Journal of Exposure Science and Environmental Epidemiology, 23:232-240.

[3] http://www.panynj.gov/port/about-port.html

[4] Agrawal H, Eden R, Zhang X, Fine PM, Katzenstein A, Miller W, Ospital J, Teffera S, Cocker DR. 2009. Primary particulate matter from ocean-going engines in the Southern California air basin. Environmental Science and Technology, 41(14): 5398-5402.

[5] California Environmental Protection Agency. Office of Environmental Health Hazard Assessment, Integrated Risk Assessment Section. Used oil in bunker fuel: A review of potential human health implications. By Mazur L, Milanes C, Randles K and C Salocks. December, 2004.

Some of these policies and efforts are already under way through PlaNYC and include actions to reduce marine emissions by retrofitting ferries, promoting the use of low-sulfur fuels, and collaborating with the Port Authority of New York and New Jersey (PANYNJ) to implement their Clean Air Strategy.[6,7] For example, PlaNYC is working with PANYNJ, the US EPA, the New York Power Authority, and Carnival Cruise Lines to make the Brooklyn Cruise Terminal shore-power capable, which will reduce emissions from cruise ships that are docked in this terminal.[6] NYCCAS monitoring will help track improvements in air quality from these efforts to reduce marine emissions.

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[6] The City of New York. Office of Long-Term Planning and Sustainability. PlaNYC Full Report, April 2011.
http://s-media.nyc.gov/agencies/planyc2030/pdf/planyc_2011_planyc_full_report.pdf
Accessed May 28, 2014.
[7] The Port Authority of New York and New Jersey. A Clean Air Strategy for the Port of New York & New Jersey: 2013 Implementation Report. December, 2013.
http://www.panynj.gov/about/pdf/CAS_Implementation_Report.pdf
Accessed May 28, 2014.

Figure 1. Photographic comparison of diesel fuel vs. bunker fuel
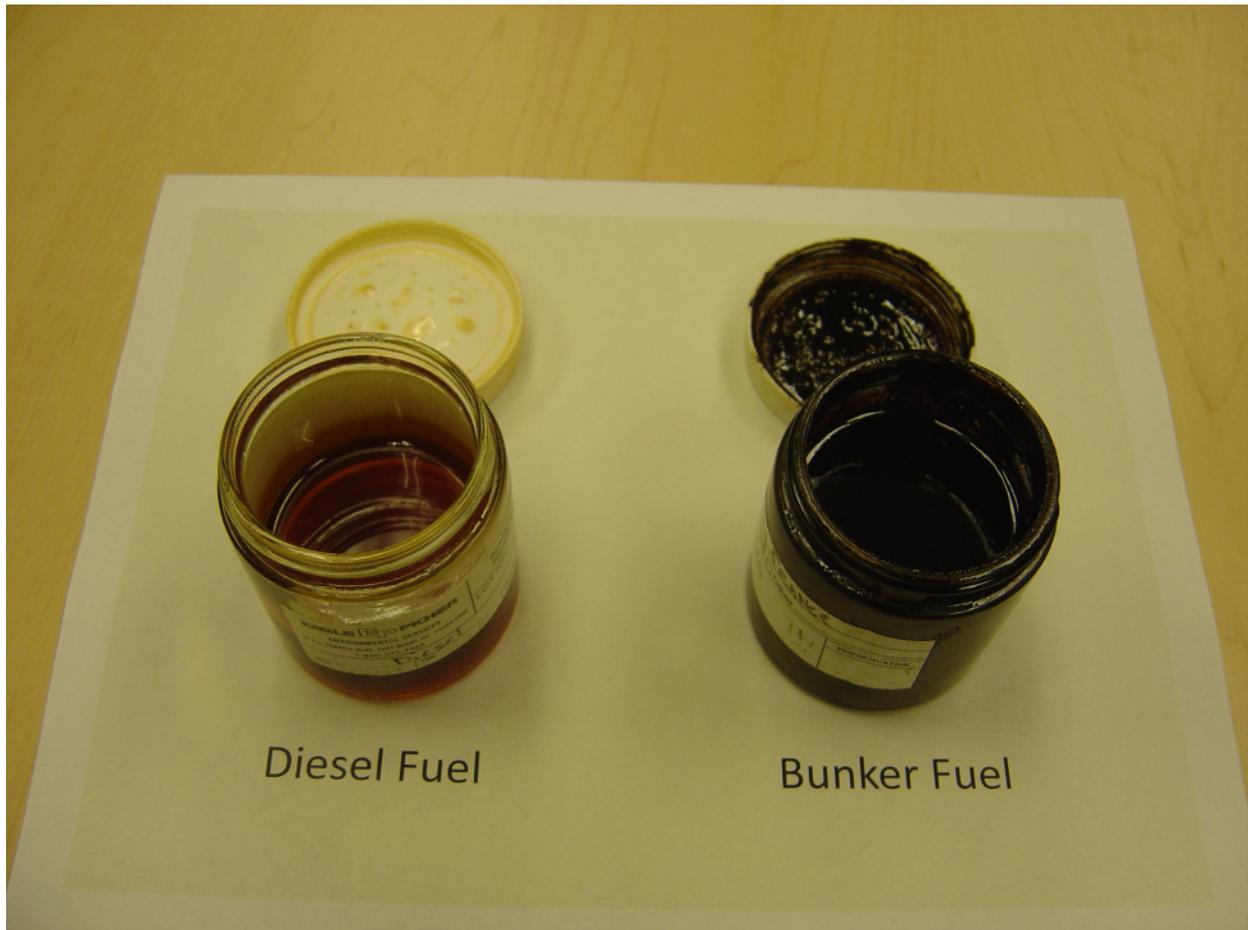
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[8] National Oceanic and Atmospheric Administration, Office of Response and Restoration. NOAA's Office of Response and Restoration Blog, *What's in the Oil from the Deepwater Horizon Spill? What's in ANY Oil?* http://usresponserestoration.wordpress.com/2011/07/22/whats-in-oil-deepwater-horizon/ Accessed April 28, 2014.

Figure 2. Comparison of vanadium concentrations and Marine Traffic Indicator values at NYCCAS monitoring locations.
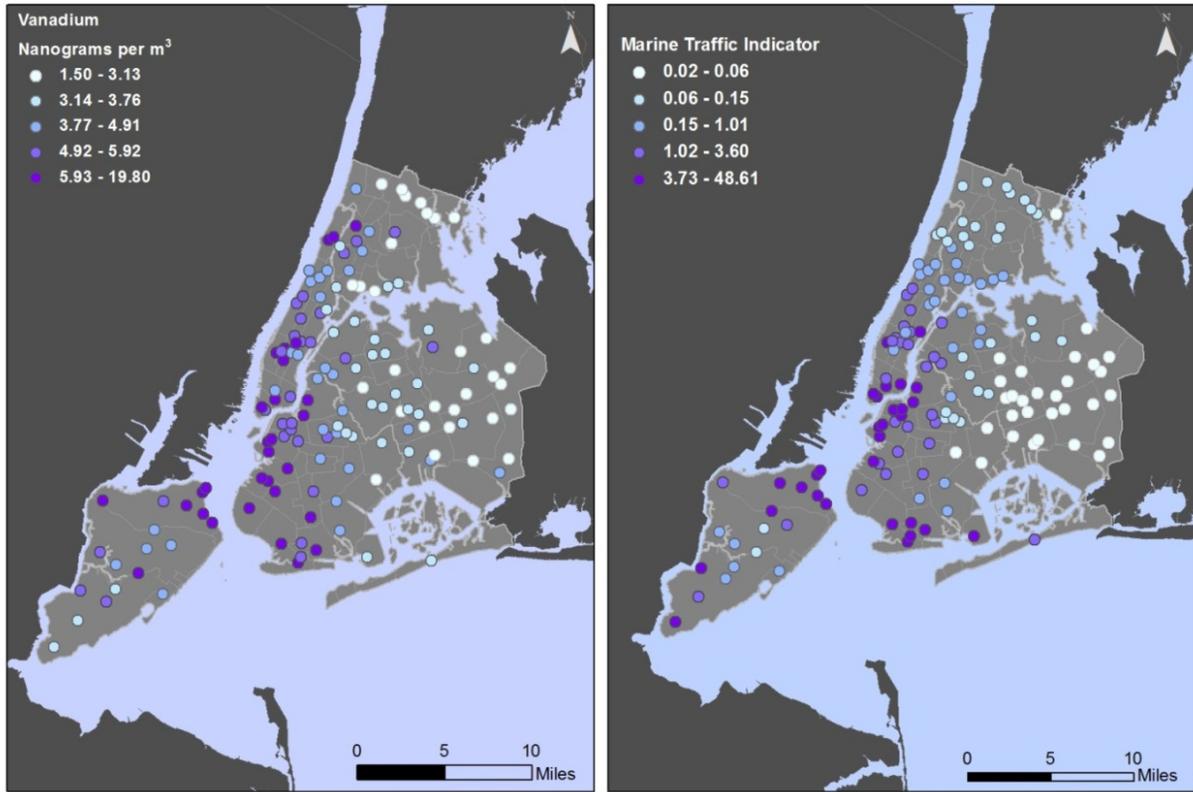
Marine Traffic Indicator: Inverse-distance to navigation channel weighted by associated port berths

Vanadium data were sampled December 2008- November 2009. Source indicator for ship emissions is highly spatially correlated with vanadium concentration.