Characterization and Variability of Pollutant Concentrations for the Las Vegas Implementation of the National Near-Road Mobile Source Air Toxics Study

Control #: 556

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INTRODUCTION

EPA, in collaboration with FHWA, has been involved in a large-scale monitoring research study in an effort to characterize highway vehicle emissions in a near-road environment[1]. The pollutants of interest include particulate matter with aerodynamic diameter less than 2.5 microns ($PM_{2.5}$), mobile source air toxics (MSATs), black carbon, and regulated gaseous pollutants.

Two of the objectives of the National Near-Road Mobile Source Air Toxics Study are to (1) identify the existence and extent of elevated air pollutants near roads; and (2) determine how vehicle operations and local meteorology influence near-road air quality for criteria and toxic air pollutants.

The most unique features of this project is that it has been a year-long study allowing an analysis of long-term trends, while most other near-road studies have been or are short-term (less than 6-month) intensives. The study design, based on a detailed monitoring protocol that was developed to ensure a uniformity of measurements across study cities, calls for consecutive year-long studies to be conducted in three cities (Las Vegas, NV; Detroit, MI; and tentatively Raleigh, NC). The first study city is Las Vegas, NV, with data covering December, 2008-December, 2009. Samples are collected at various distances from the roadway in order to determine relative concentrations as distance from the roadway increases.

METHODS

Critical Measurements

Critical measurements as shown in Table 1 included the following: MSATs (1,3-butadiene, benzene, acrolein, formaldehyde, acetaldehyde); continuous gaseous and particulate monitoring (CO, NO_X, carbon black, PM_{10}, $PM_{2.5}$, PM-coarse); and a full suite of meteorological instruments. The Nevada Department of Transportation provided the traffic data (vehicle count, vehicle speed, vehicle length). Moreover, enhancements to the protocol include (1) continuous particle counters; (2) SO_2 analyzers, (3) semi-continuous GCs; (4) EC/OC analyzer and (5) nephelometer.

Table 1. Summary of Measurements Conducted at Each Monitoring Site.

Measurements	10 Meters@ Roadside	100 Meter Downwind	300 Meter Downwind	100 Meter Upwind
TO-15 Canister sampling[2]	X	X	X	X
TO-11A Cartridge sampling[3]	X	X	X	X
Semi-continuous GC	X	X	X	X
DNSH Sampling (acrolein)[4,5,6]	X	X	X	X
Continuous gas monitoring (CO, NO_x)	X	X	X	X
Continuous gas monitoring (SO_2)		X		X
Continuous black carbon monitoring (Aethalometer)	X	X	X	X
Continuous fine particle (TEOM)	X	X	X	X
Integrated $PM_{2.5}$ (FRM)	X	X	X	X
Condensation Particle Counters (TSI, 6nm – 3µm)	X	X	X	X
TSI Ultra-fine Particulate (UFP) Monitor	X		X	
CO_2 Monitors		X		X
Wind speed/wind direction	X	X	X	X
Meteorological monitoring (temp, RH, etc.)		X		
Nephelometer				X
Sound Meter	X	X		
Video Camera	X	X		X
Cut Section Monitoring (3-CO & 3-Aethalometers)	X			

Traffic data (Figure 1) indicates a tri-modal traffic distribution as opposed to a bi-modal distribution. This is believed to be the result of several factors: (1) Las Vegas is not typical commuter city; 2) Las Vegas is a recreation destination for many travelers; (3) shift changes in Las Vegas are later or earlier in the day depending on the employer; (4) study site is along an interstate that carries both inter- and intra- state traffic; and (5) I-15 is a North American Free Trade (NAFTA) corridor.

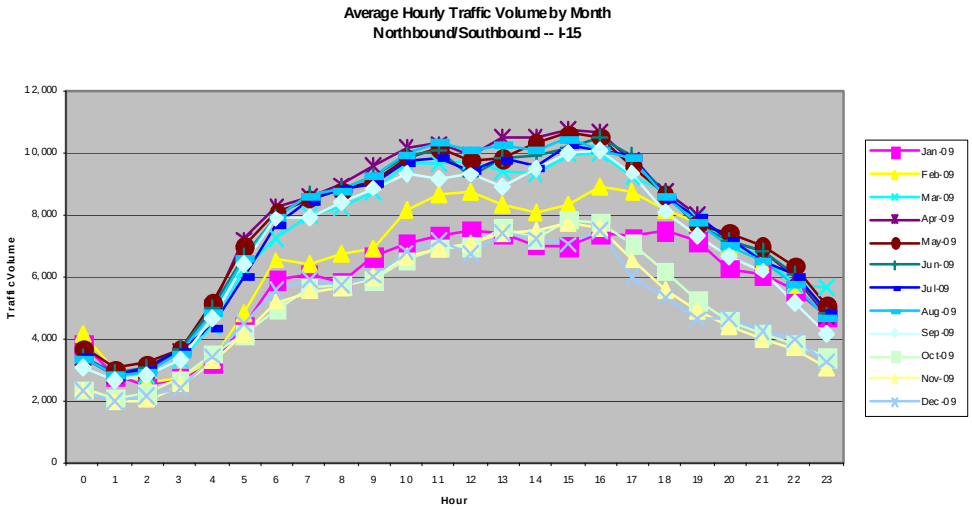

Figure 1. Average Hourly Traffic Volume by Month.

RESULTS

Example pollution rose plots shown in Figures 2, 3 and 4 provide an indication of black carbon, nitrogen dioxide, and carbon monoxide pollutant concentrations at the I-15 site. Figures 5 and 6 provide an indication of the 24-hour variability of nitrogen dioxide and carbon monoxide pollutant concentrations at the I-15 site.

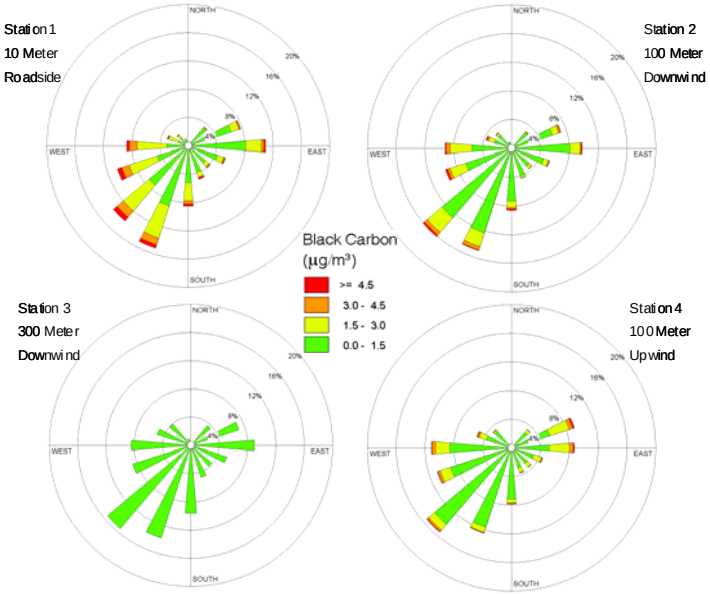

Figure 2. Pollution Rose for Black Carbon.

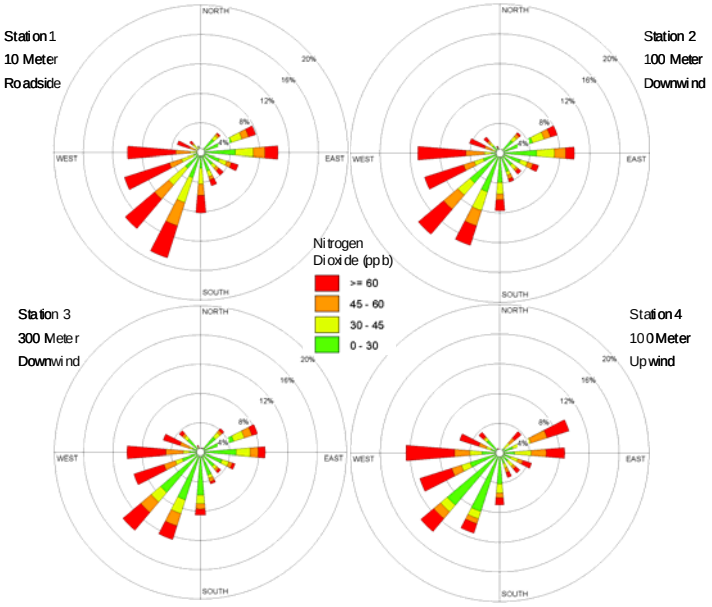

Figure 3. Pollution Rose for Nitrogen Dioxide.

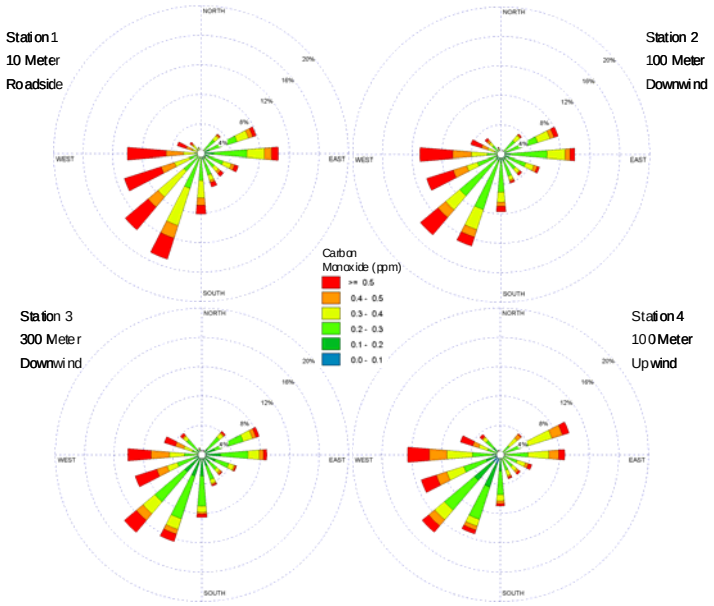

Figure 4. Pollution Rose for Carbon Monoxide.

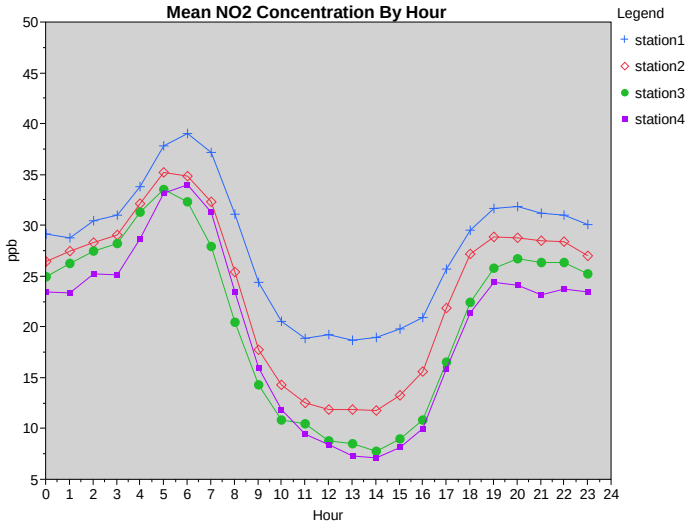

Figure 5. Mean NO_2 Concentrations by Hour.

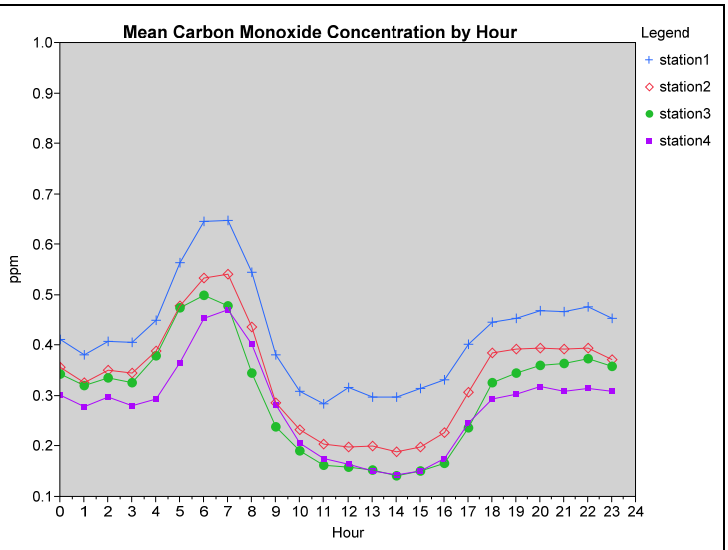

Figure 6. Mean CO Concentrations by Hour.

SUMMARY

This paper provides a summary of a field study conducted in Las Vegas, NV from mid-December, 2008 through mid-December, 2009. The objective of this research study has been to determine criteria pollutant concentrations and variations in concentrations as a function of distance from the highway and to establish relationships between MSAT concentrations as related to highway traffic flows including traffic count, vehicle types and speeds, and meteorological conditions such as wind speed and wind direction. Preliminary results include the following:

- Concentration gradients are observed for gaseous pollutants and black carbon associated with distance from roadway, however more analysis is required.
- Elevated concentrations of measured pollutant are directly proportional with traffic volume, as indicated by average hourly traffic counts.

- Effect of wind speed appears to be a factor with regard to concentration gradient (e.g., dilution effect) and needs to be investigated further.
- Non I-15 sources may be larger contributors than previously expected, for example
    - the impact of a near-by parking lot may be a factor at the 100 meter and 300 meter downwind sites.

Preliminary results of this study provide indications that highway vehicle emissions impact near-road air quality. Known highway vehicle pollutants such as CO, carbon black, NO, and $PM_{2.5}$ have elevated concentrations in a near-road environment and decrease as one moves away from the road. Additional analysis of the data is needed to more accurately assess the effect of wind speed as well as other near-road effects.

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KEYWORDS: NEAR-ROAD, AMBIENT MONITORING, MSAT, SITE SELECTION.