Smog Summit 2005

SUMMARY: Pre-Summit Air Quality Sampling Exercise
June 7, 2005 Media Conference

Background to May 30 Sampling Exercise:

- Smog is formed by a mixture of particulate matter and chemical pollutants.

- Sampling with measurement equipment is an established method of identifying particulate levels: it generally indicates that locations near busy roads with heavy traffic have greater levels of particulate matter and chemical pollutants.

- Sampling shows that when a car does a hard acceleration, it releases a spike of particulate matter. Therefore, stop-and-go traffic can increase particle concentrations.

- Particulate matter is one of the components of smog associated with air-quality negative health effects.

- The public is not generally aware that particulate matter affects health and the environment all year round. We literally “see” the effects more in summer, in combination with the sun, as smog.

May 30 Sampling:

- The sampling exercise involved five municipal politicians, assisted by engineering students and supervised by Dr. Greg Evans from the University of Toronto. It focused on measuring a one-day (May 30) sampling of the number and concentration of two types of particulate; ultrafine particles ($PM_{0.1}$) and fine particulate ($PM_{2.5}$), resulting from vehicle emissions.

Highlights of the Sampling Exercise:

- Ultrafine particulate matter ($PM_{0.1}$) is highly influenced by local variations; that is, community traffic volume and patterns.

- $PM_{2.5}$ levels tend to be more consistent locally and reflect the movement of air pollution across the region from various sources, primarily vehicle and industry, beyond the community.

- The exercise illustrated that local air pollution from vehicle emissions typically rises during the morning rush hour, in combination with the sun.

- On May 30, these 5 communities experienced levels of $PM_{2.5}$ that were lower than average because of wind direction: a northwest wind typically brings cleaner air.

Comments

- Relying on favourable winds to limit smog is a regressive and unhealthy way to live in our communities.

- Local communities have a specific and powerful role to play in reducing levels of particulate matter all year round, through reducing or eliminating vehicle use: this is an area most immediately within their control.

CONTACT:

Prof. Greg Evans,
Department of Chemical Engineering and Applied Chemistry
University of Toronto
416-978-1821
evansg@chem-eng.utoronto.ca

Eva Ligeti
Clean Air Partnership
416-392-1220
416-567-0924 (cell)

THE SAMPLING EXERCISE IN MORE DETAIL:

Introduction

In order to stimulate awareness of air quality issues in preparation for the Smog Summit on June 8th 2005, politicians Mayor Marolyn Morrison from the Town of Caledon, Mayor John Gray from the City of Oshawa, Regional Councillor Brenda Hogg from the Town of Richmond Hill, Councillor John Filion from the City of Toronto, and Regional Councillor Joyce Frustaglio from the City of Vaughan participated in a sampling exercise within their communities. The politicians used hand held instruments to take measurements of air pollutants, following a simple script designed to highlight air quality issues within the GTA. The politicians were assisted by Environmental Engineering students from the research group of Prof. Greg Evans from Faculty of Applied Science and Engineering at the University of Toronto.

The intent of the exercise is to raise awareness of air quality issues and provide to the politicians and public an example of the contribution of vehicle emissions to air quality within GTA municipalities. This exercise was not a scientific study and the measurements collected were not intended to allow any definitive conclusions on their own.

Methodology and Instrumentation

Measurements for ultrafine particles and $PM_{2.5}$ were taken using real-time portable instruments, P-Trak and D-Trak, within each participating municipality. Ultrafine particle concentration and $PM_{2.5}$ concentration measurements were taken near traffic, away from traffic and near an idling car to illustrate the effects of vehicle emissions on particle concentrations

P-Trak

A P-Trak was used to measure the number of ultrafine particles, particles less than 0.1 micron in diameter. This instrument works by first pumping air into a chamber in a fine continuous stream. The particles are then grown to a measurable size by contacting them with alcohol vapour, which condenses onto the particles. These droplets are then passed through a laser and light flashes are produced. A photodetector counts the light flashes and determines the concentration of ultra-fine particles. This concentration is reported in particles per cubic centimetre (particles/cm^3).

Dust Trak

The Dust Trak measures the mass based concentration of particulate matter smaller than of 2.5 microns in diameter. The instrument works by first pumping air into a chamber in a fine continuous stream. A laser light is scattered by these particles, with the intensity of the scattered light depending on the size (or mass) of the particle. A lens then focuses the light onto a photodetector. The detection circuitry converts the light into voltage. The voltage is proportional to the scattering of light by all the particles within the chamber, which is proportional to the $PM_{2.5}$ concentration in the air sample. The concentrations are expressed in micrograms per cubic meter (μg/m^3). The vast majority of particles in air are smaller than 0.1 micron in diameter. Hence these particles constitute almost the entire particle concentration on a number basis, which is the concentration measured by the P-Trak. However, since these particles are so small, they constitute very little of the respirable particle concentration on a mass basis, which is what is measured by the D-Track. It remains unclear which health effects associated with exposure to particles are more dependent on particle mass as compared to particle number concentration.

Results

The concentrations of ultrafine particulate matter showed more variation within each community than that of $PM_{2.5}$. The concentrations of ultrafine particulate matter measured in one of the communities are shown in Figure 1. These results are representative of the trends observed in all the communities: the baseline concentration was similar away from and close to traffic; however, frequent sharp "spikes" were evident due to vehicles. The concentration of ultrafine particles increased significantly near an idling car. Once the car was turned off, the concentrations returned close to the baseline concentration. When the instrument was taken to an area near traffic, the concentration increased dramatically when cars accelerated or when a truck passed by. Once the vehicles had passed, the concentrations again returned to the baseline concentration. Finally, on a road away from heavy traffic, the concentration remained fairly constant. The smaller peaks in this section corresponded to the passing of a single car.

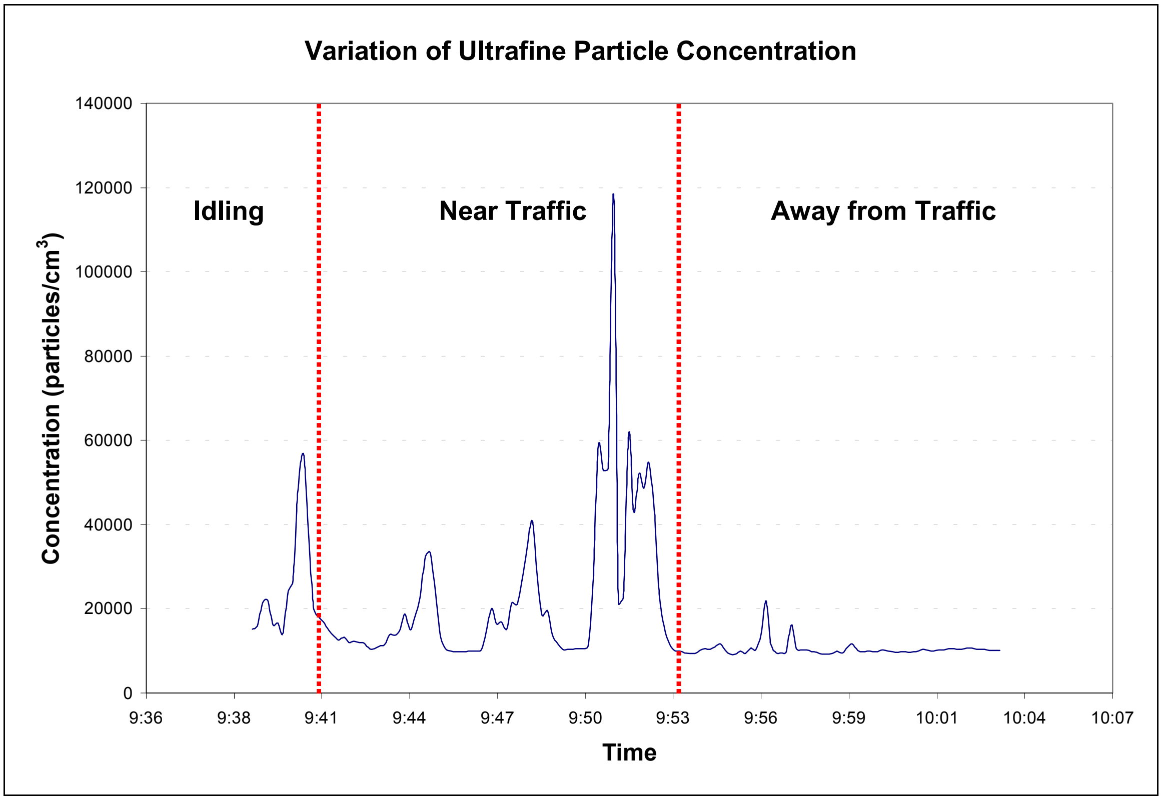

Figure 1 Depiction of typical measurements made in each municipality

The concentration of ultrafine particles increased during the day, as sampling progressed across the GTA from communities upwind to those down wind. On this day, the air mass was originating from the northwest. Wind from this direction typically brings clean air into the GTA. Figure A1 in the appendix illustrates the origin of the air that was arriving in the GTA on May 30. Figure 2 illustrates effect of travelling from upwind municipalities to those downwind.

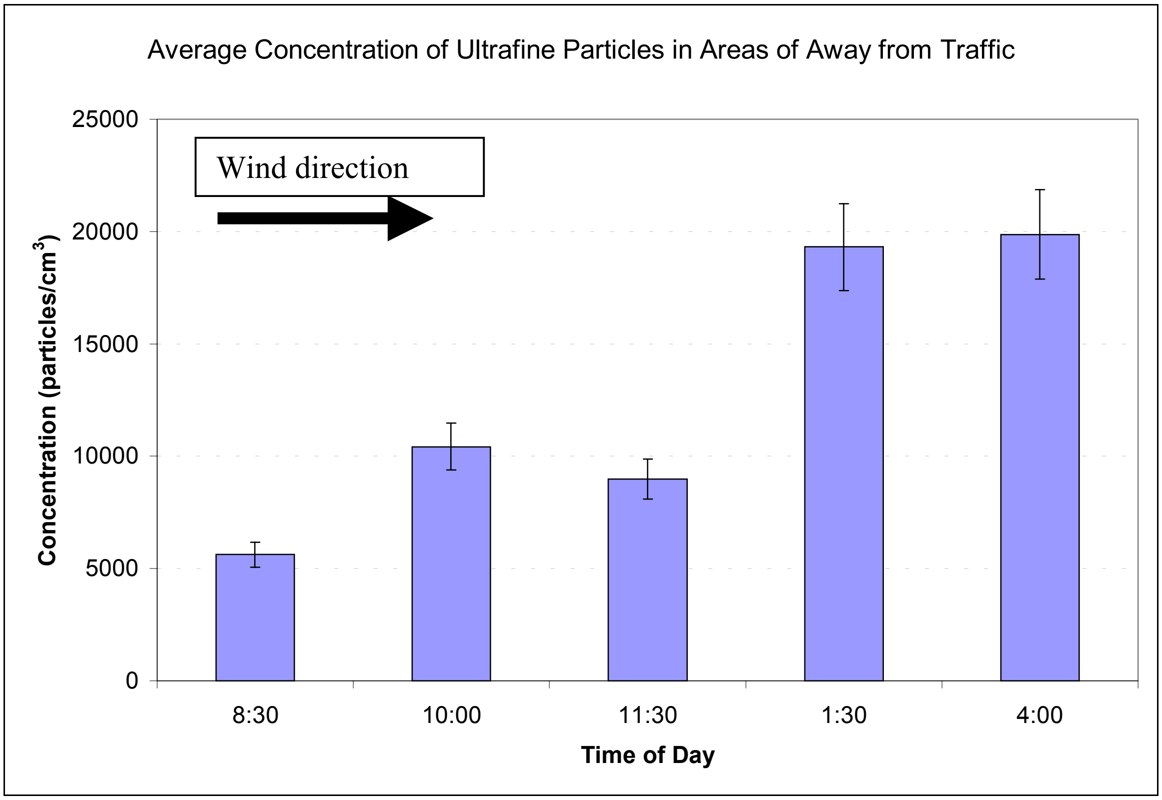

Figure 2 Depiction of ultrafine particle concentrations in areas away from traffic in each municipality

The rise in concentration was also a result of the diurnal trend typically observed in cities in which the baseline concentration of ultrafine particles increases sharply during the morning, coinciding with the morning rush hour, remains fairly constant until the evening, and decreases overnight. Figure A2 in the appendix illustrates the average diurnal trend for weekdays, based on measurements made in downtown Toronto throughout May 2005.

As a result of the spikes produced by vehicles, there was a significant difference between the average concentration of ultrafine particles near heavy traffic and away from traffic. Figure 3 illustrates the difference observed between areas near high traffic and areas away from traffic, averaged over the five municipalities. A smaller difference was also observed for $PM_{2.5}$, as expected. The concentration of $PM_{2.5}$ tend to be similar across areas larger than the GTA, whereas ultrafine particulate matter tends to be much more localised and show much greater spatial variation. However, it should be emphasised that over 40%, of $PM_{2.5}$ is associated with vehicle emission sources; $PM_{2.5}$ does not vary as much in concentration between different locations within the GTA as ultrafine particulate matter due to differences in the chemical processes associated with its formation and it's elimination.

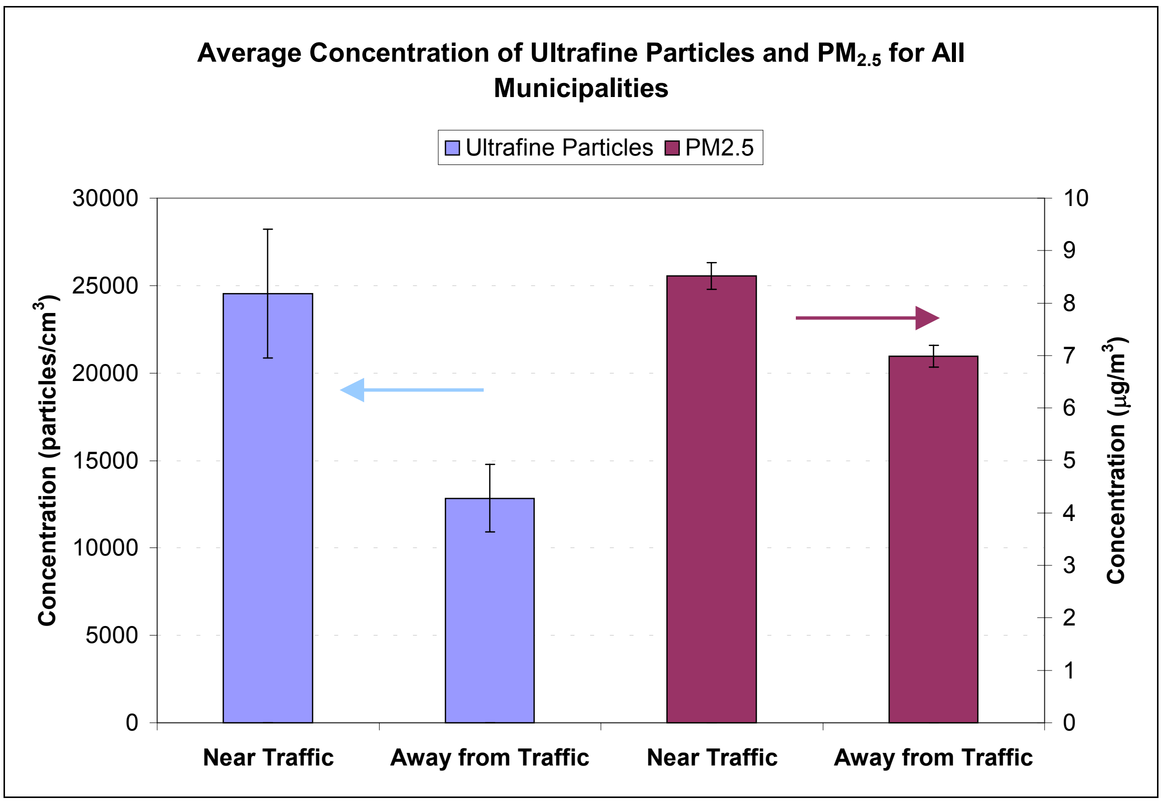

Figure 3 Comparison of concentrations of ultrafine particles and $PM_{2.5}$ in areas near and away from heavy traffic averaged for the five municipalities.

Appendix A: Background Information

<u>Back-trajectory for 500m</u>

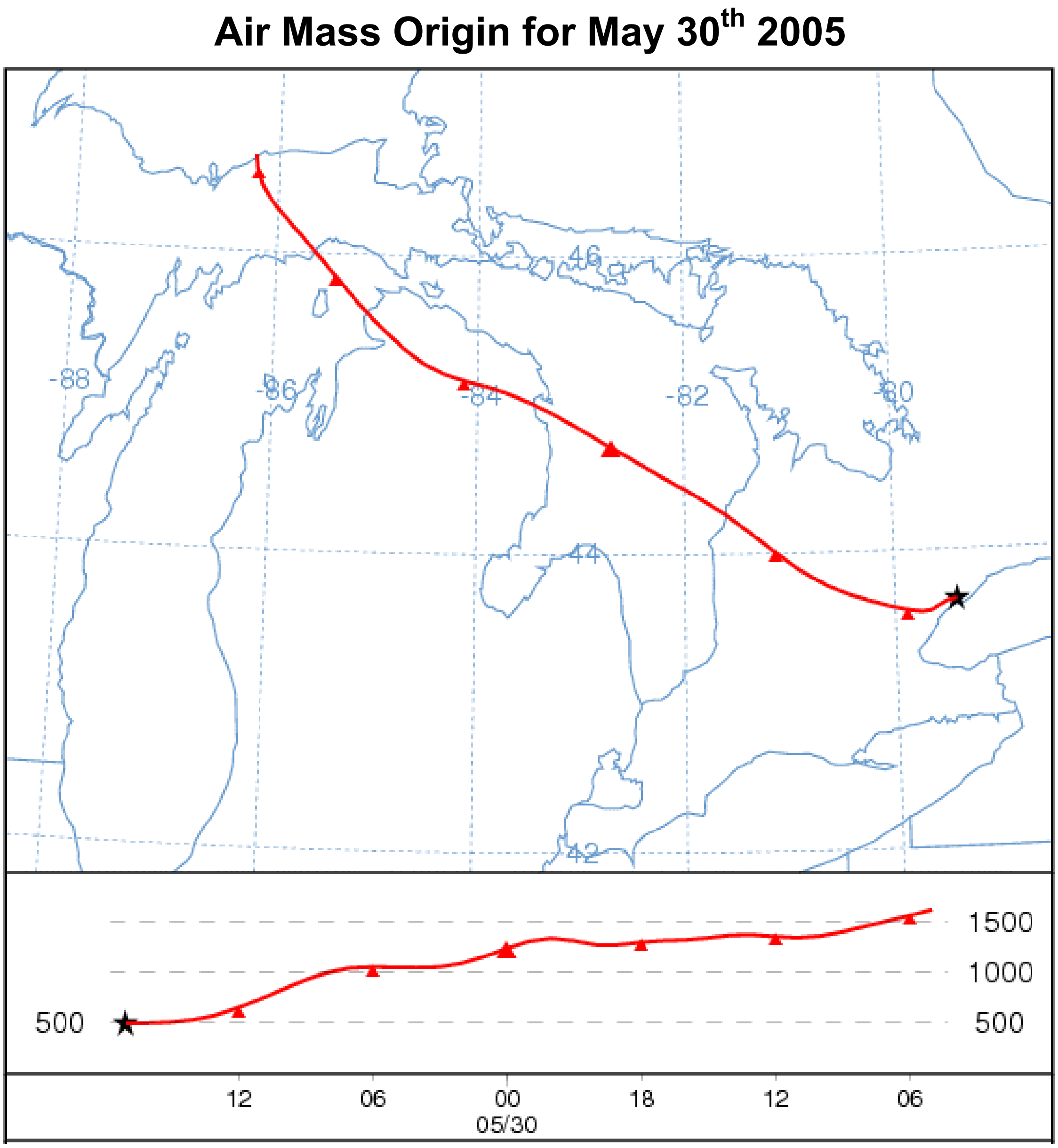

Figure A 1 Map depicting the origin of air mass in Toronto on May 30th 2005

The air mass originated from the northwest on May 30th. Air from this direction is typically less polluted with particulate matter than air that comes from the southwest. As a result, the measured $PM_{2.5}$ and the ultrafine particles were more likely generated locally from traffic sources.

The average temperature for the day was 15.8°C and the average wind speed was 12.3km/h. During the sampling time, the average temperature was 19.2 °C and the average wind speed was 13km/h.

Average Ultrafine Particle Concentration Measurements for May

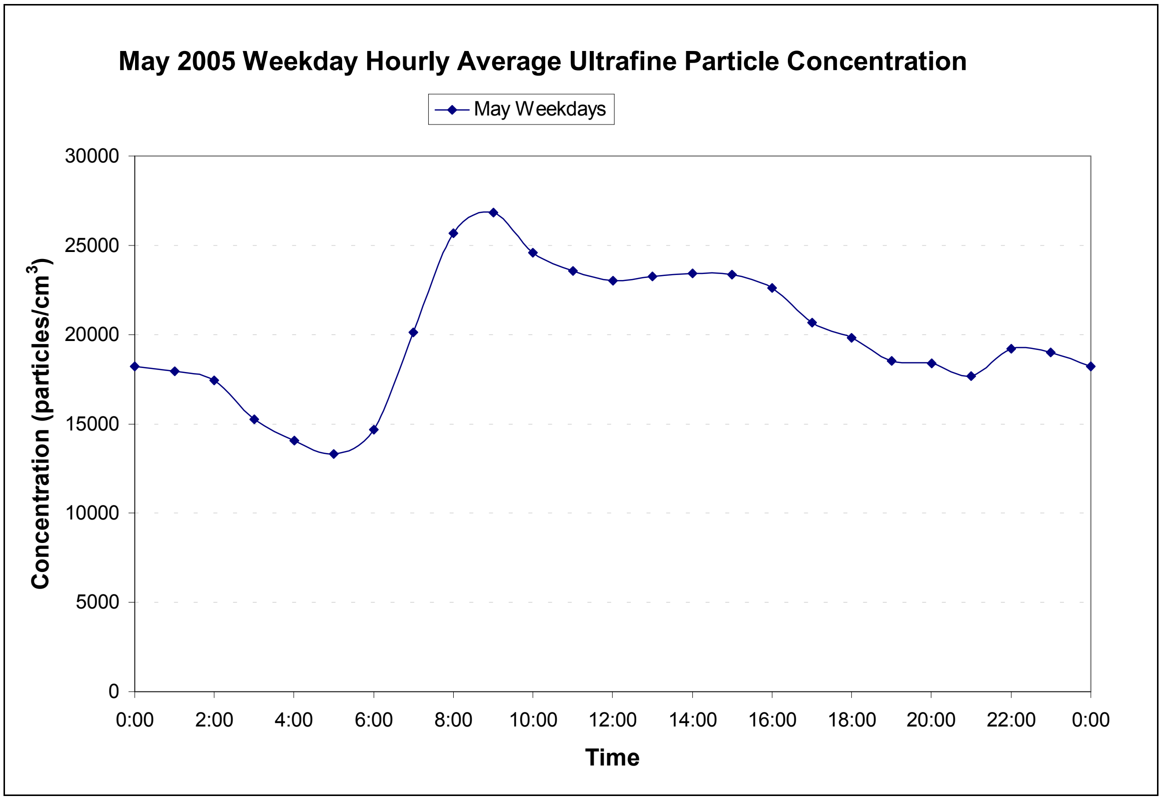

Figure A 2 Depiction of hourly average concentrations of ultrafine particles for weekdays in May 2005 measured at a central location in downtown Toronto.

The formation of ultrafine particles is heavily linked to traffic patterns. The first sharp increase corresponds to the morning rush hour and sunrise. The air is also much more stable in the morning so less mixing occurs. The concentrations decrease throughout the day is part because the amount of mixing increases. As a result, a second traffic peak is not typically observed in the afternoon rush hour.

Centralized $PM_{2.5}$ Measurements for May 30th 2005

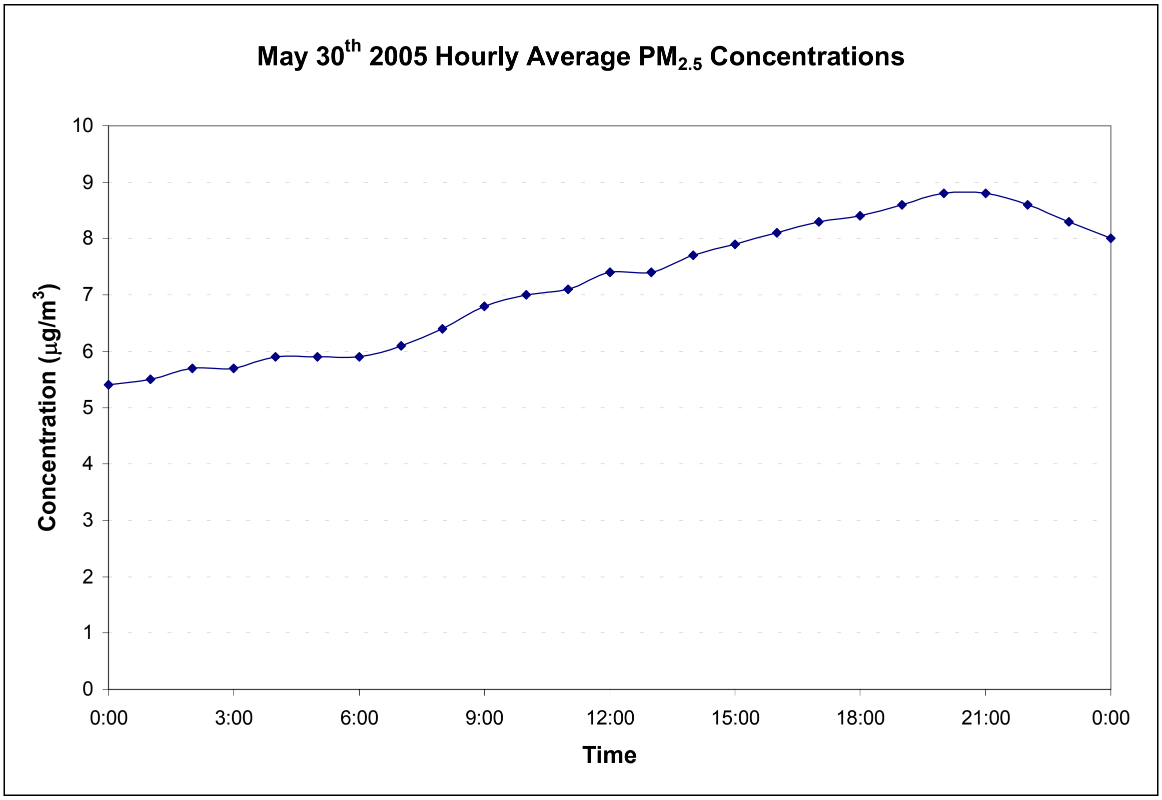

Figure A 3 Depiction of hourly average concentrations of $PM_{2.5}$ on May 30th measured at a central location

The concentration of $PM_{2.5}$ for the air sampled on College Street in Toronto steadily increased throughout the day on May 30th. These concentrations were below average for GTA, mostly due to the prevailing wind direction.

-30-

CONTACT:
Prof. Greg Evans,
Department of Chemical Engineering and Applied Chemistry
University of Toronto
416-978-1821
evansg@chem-eng.utoronto.ca

Eva Ligeti
Clean Air Partnership
416-392-1220
416-567-0924 (cell)