Year One Project Report
To Meadowlands Environmental Research Institute
The NJ Meadowlands Commission

(07/27/07)

TITLE: **Characterization of Atmospheric Nitrogen Oxides over the Meadowlands**

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PERIOD: Year1: 11/01/06 – 08/31/07
(Approved Project Period: 11/01/06 – 10/31/08)

BUDGET: Year1: $40,500
(2 Year Total: $81,000)

STATEMENT OF THE PROBLEMS

Nitrogen oxides (NO_x) are highly reactive gases in the ambient air, such as NO and NO_2 which are precursor molecules for the production of ground-level ozone (O_3). The O_3 production rate strongly depends on the concentrations of NO and NO_2. High concentrations of O_3 in the ambient air can trigger serious respiratory and other health-related problems. Therefore, an adequate knowledge of the characteristics of NO_x in the ambient air is crucial for the assessment of O_3 pollution and air quality.

According to the EPA data, the major anthropogenic source of NO_x in the ambient air in the United States is motor vehicles emissions, accounting for ~55% of the total emissions. Additional sources of NO_x include electric utilities (~22%) and other industrial, commercial, and residential sources. Nitrogen oxides form from fossil fuel burning at high temperature, as in a combustion process. Therefore, high concentrations of NO_x are often found in the areas heavily impacted by traffic and power plants, although they can also come from natural sources and be transported over long distances by prevailing winds.

Despite the critical role of NO_x in air quality, the concentration levels and temporal variations of NO_x over the Meadowlands District have not been monitored, and this represents a serious data gap in air quality assessment in the District. With the heavy transportation and the existence of power plants and landfills in the region, the emissions of NO_x and the production of O_3 in the

District could be substantial. Therefore, the measurements of NO_x in the ambient air in the region are critically needed.

GOAL AND OBJECTIVES

The research effort under this plan aims at generating new data on the ambient levels of NO_x over the Meadowlands District, and this new research will complement the on-going air quality monitoring at Meadowlands Environmental Research Institute (MERI). The ultimate goal of this project is to contribute to the understanding and control of air pollution in the District, maintaining the health of the Meadowlands. Within this context, the specific objectives are:

(1) To install a new NO_x analyzer at MERI and to initiate atmospheric nitrogen monitoring at this location,

(2) To measure the concentrations of atmospheric NO_x in order to assess the current levels of NO_x in the ambient air,

(3) To generate temporal variation, in particular seasonal trends of NO_x under ambient environmental conditions.

ACTIVITIES ACCOMPLISHED DURING YEAR ONE PERIOD

A brief summary of the accomplishment toward the goals in the year1 period is as follows:

(1) A new NO_x analyzer (Model 42i, Thermal Electron Corp.) was purchased based on the selection made by the PI, and it was installed on site in a laboratory at MERI in December 2006. The instrument calibration was completed in January 2007 with the assistance from MERI staff.

(2) Routinely measuring NO_x in the ambient air at the MERI site has been on since February 2007.

Besides the above targeted gas-phase measurement activities, additional efforts that are not in the original research plan were made on aerosol nitrate during this period to strengthen the project, which includes:

(1) Particulate N sampling was made for a period of three months from February to May 2007 on a daily basis. Sample collection was carried out through the use of an in-house-built aerosol sampler assembled at the PI's lab that is primarily composed of a ChemComb cartridge, mass flow meter, and vacuum pump.

(2) Aerosol sampling structure was constructed on the roof of MERI building to support daily aerosol sample collection.

(3) Analyses of all air samples for particulate nitrate and nitric acid vapor have been performed through a DIONEX ion chromatograph analyzer at the PI's lab.

In addition to the efforts on aerosol nitrate, a new ozone analyzer was installed at the MERI site and has been up running for data collection, which is also not in the original research plan. Although this O_3 analyzer has generated tremendous data that requires more time for data process, the O_3 data will strengthen this project and help interpret NO_x data. Therefore we have included extra O_3 data processing in our current efforts.

PRELIMINARY RESULTS

Summary: Table 1 shows a brief summary of the concentrations of the gas-phase NO, NO_x, O_3, aerosol nitrate and HNO_3 vapor observed at the MERI site. During the measurement period of February – May 2007, the concentrations of NO, NO_x and NO_3^- in the ambient air decreased with time, while the O_3 concentration increased with time. The HNO_3 gas concentration showed less variation.

Diurnal Patterns: Figure 1 shows the diurnal patterns of the concentrations of NO, NO_x, and O_3 based on the hourly averages of data collected on the minute basis. The O_3 concentration showed an opposite variation compared with those of NO and NO_x. The concentration peaks of NO and NO_x appeared at 6:00am-8:00am, while the O_3 concentration peak appeared in early afternoon hours. There are about 8 hours of lag between the NO_x peak and O_3 peak.

Daily Patterns: The daily variation of O_3 was less than those of NO and NO_x and mostly opposite to those of NO and NO_x, as shown in Figure 2. These plots were made based on daily average concentrations that were converted from minute/hourly data. Figure 3 shows the daily concentration patterns of aerosol nitrate and HNO_3 vapor. Compared to the HNO_3 gas, aerosol nitrate showed greater daily variation. In earlier spring, NO_3^- also showed more variation and higher values in the ambient concentration; however, HNO_3 gas showed less variation in earlier spring compared with the late spring.

YEAR-2 EFFORTS

The efforts under this project in Year 2 starting in September 2007 should include:

(1) To continue the measurements of NO_x and O_3 for a full year in order to get the seasonal patterns. By now, the measurements of NO_x and O_3 have been made for 7 months (Feb – July, 2007). Therefore, the measurements should be continued to February 2008;

(2) To continue and finish the remaining IC chemical analyses for aerosol samples;

(3) To perform data analyses and interpretation of all species (NO, NO_2, O_3, NO_3^-, HNO_3);

(4) To generate a publication on atmospheric nitrogen over the Meadowlands and final project report.

Table 1. Springtime Concentrations of Atmospheric NO, NO_x, O_3, Aerosol Nitrate and HNO_3 Vapor over the Meadowland in Central New Jersey

Month 2007	NO (ppb)	NO_x (ppb)	O_3 (ppb)	NO_3^{-1} ($\mu g\ m^{-3}$)	HNO_3 ($\mu g\ m^{-3}$)
February	25.4	50.7	20.5	3.08	1.28
March	16.8	41.2	25.6	2.42	1.10
April	9.36	25.1	31.8	1.39	1.16
May	5.26	19.1	34.4	1.06	1.50
Average	16.4	34.0	28.1	1.26	1.99

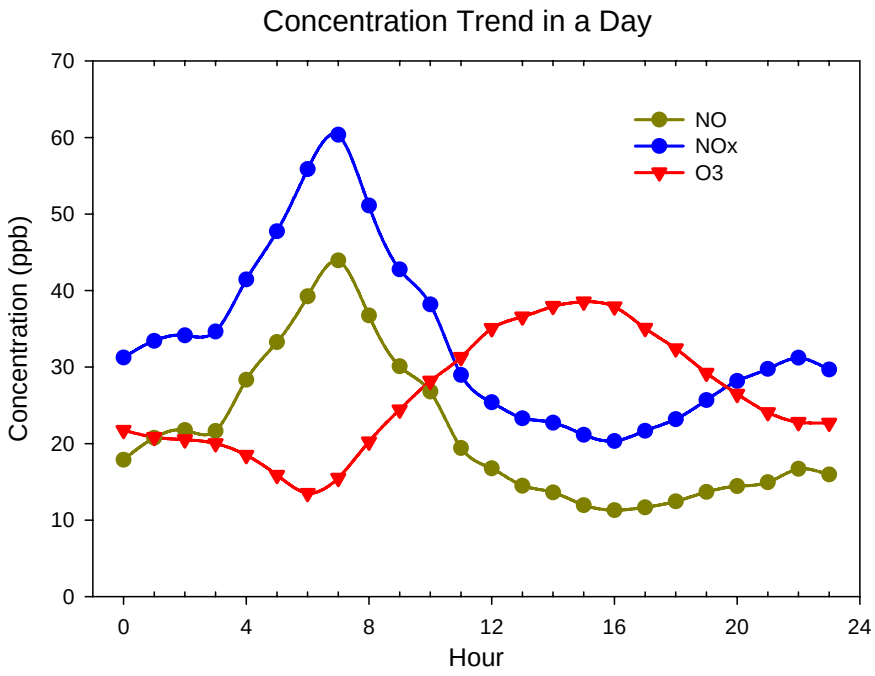

Figure 1. Averaged diurnal variations of NO, NO_x and O_3 during Feb – May 2007.

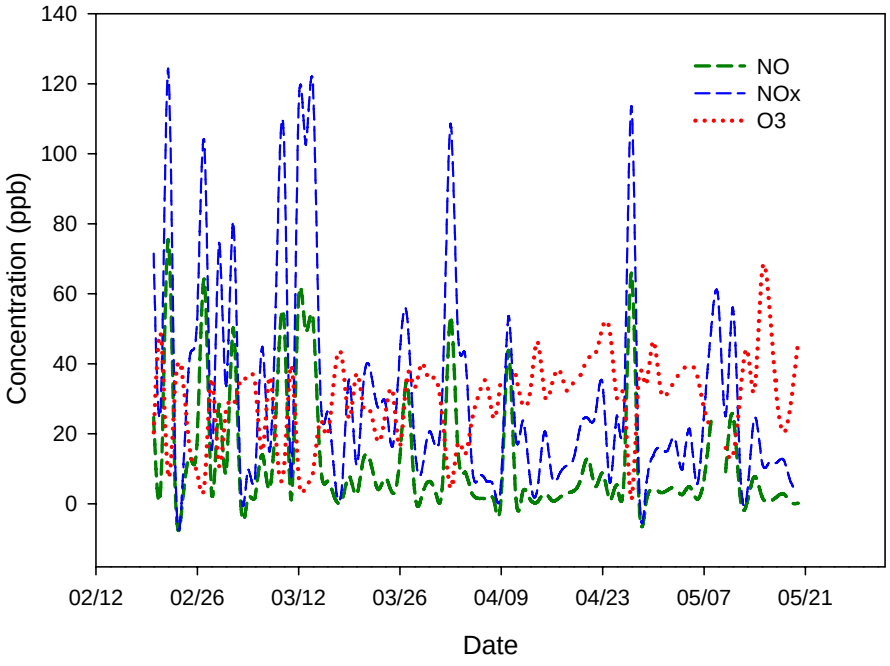

Figure 2. Daily Variations of NO, NO_x and O_3 during Feb – May 2007.

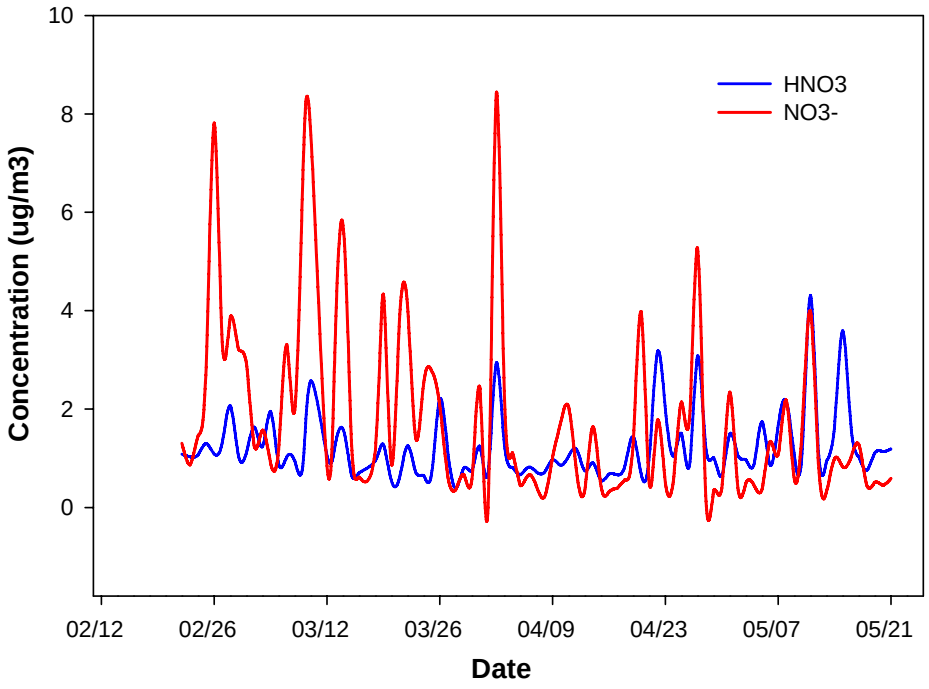

Figure 3. Daily Variations of NO_3^- and HNO_3 vapor from February to May 2007.