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Abstract

ROELLE, PAUL ANDREW. Chemically Reactive Nitrogen Trace Species in the Planetary Boundary Layer. (Under the direction of Viney Pal Aneja.)

Although there have been methods in place to control Ozone (O_3) for the past 30 years, there are still periods when O_3 levels exceed levels dictated by the Environmental Protection Agency as safe. The Southeast U.S. currently maintains 40% of the non-attainment areas in the U.S. Nitric Oxide (NO) plays a significant role in the production of ozone, however the biogenic contribution of this critical trace gas is not clearly understood.

Utilizing a dynamic flow-through chamber system and a mobile laboratory, measurements were made for a continuous four week period in spring 1995, near Plymouth, NC, located in the Lower Coastal Plain of NC. This research was part of a larger research effort called Project NOVA (**N**atural emissions of **O**xidant precursors: **V**alidation of techniques and **A**ssessment). Project NOVA is a multi-scientific agency project in which different flux methodologies are compared side-by-side. The site for Project NOVA 1995 was characterized by an addition of nitrogen (N) fertilizer at the midpoint of the experimental period enabling us to study the effects of N fertilizer on NO flux. The average NO flux prior to the addition of N fertilizer was 31.5 ± 10.1 ng N m^{-2} s^{-1} and more than doubled to 77.7 ± 63.7 ng N m^{-2} s^{-1} after the addition of the N fertilizer. Side-by-side comparisons of the two different chamber techniques used at Project NOVA 1995 did not reveal any statistically significant differences in the NO flux results.

Additionally, measurements of NO_Y and NO_2 revealed that less than 7% of the total reactive nitrogen compounds being emitted from the soil are unaccountable.

Although there is debate as to the actual percentage of biogenic NO to the entire NO budget (anthropogenic + biogenic), the contribution from anthropogenic sources has been well documented. A case study was conducted in an urban area of NC (Raleigh), where there are large sources of anthropogenic NO_X being emitted, in order to determine if biogenic emissions are a significant contributor to the total NO_X budget. Our results concluded that less than 1% of the total NO_X budget in Raleigh, NC is emitted by biogenic processes.

NO measurements were also conducted on various soil and crop types throughout different physiographic regions of NC in an attempt to relate the flux of NO to certain physio-chemical properties of soils which could than be extrapolated to similar soil types throughout the Southeast U.S. Although we were able to detect some relationships between certain variables, we did not see any consistent trends across all of the measurement sites. Our results suggest that the nature of an observational based study is limiting when trying to compare dynamic soil processes at different points in space and time.

CHEMICALLY REACTIVE NITROGEN TRACE SPECIES IN THE PLANETARY BOUNDARY LAYER

by

PAUL ANDREW ROELLE

A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Degree of
Master of Science

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Biography

Paul Andrew Roelle [redacted]. The son of an Air Force Master Sergeant, Paul moved with his family from the Philippines to Ohio, and then to Northern Virginia. Paul graduated from Lake Braddock Secondary School in Burke, Virginia in 1987.

In 1987, Paul was awarded an Air Force ROTC scholarship and entered the AFROTC program at the Pennsylvania State University. While at Penn State, Paul was involved with the University Student Government (USG) as a Fraternity Senator and was a member of the Phi Delta Theta Fraternity. During his junior year, Paul attended the U.S. Army Parachute school at Ft. Benning, Georgia, where he earned his parachute wings in August of 1990.

Paul earned a Bachelor's of Science degree in Meteorology in May of 1991, and accepted a commission in the United States Air Force as a Second Lieutenant. While waiting to enter the active duty Air Force, Paul met his future wife and spent three months traveling throughout Europe and Northern Africa.

At his first assignment in Ft. Polk, Louisiana, Paul served as the Staff Weather Officer to both an Infantry Division and an Armored Cavalry Regiment. In the fall of 1994, Paul began graduate study in air quality at the North Carolina State University.

Paul, a Captain in the U.S. Air Force, and his wife Cynthia currently live in Cary, North Carolina. Upon Paul's completion of the Masters of Science program, Paul and Cindy will be stationed at Hanscom Air Force Base, Massachusetts.

Acknowledgments

I would like to recognize the following people for their unending support and guidance throughout my course work, research efforts, and thesis preparation.

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Chapter I. Plymouth, NC Nitric Oxide Emissions (May-June 1995).

Abstract

Biogenic soil emissions of Nitric Oxide (NO) were measured from an intensively managed agricultural row crop (corn, Zea mays) during a four week period (May 15 through June 9, 1995). The site was located in Washington County, near the town of Plymouth, which is in the Lower Coastal Plain of North Carolina. Soil NO flux was determined using a dynamic flow-through chamber technique. The measurement period was characterized by two distinguishing features: an application of nitrogen (N) fertilizer at the midpoint of the experiment and a non-typical rainfall pattern. Average NO flux prior to the application of N fertilizer was 31.5 ± 10.1 ng N m^{-2} s^{-1}, and more than doubled (77.7 ± 63.7 ng N m^{-2} s^{-1}) after the application of a sidedressing of N fertilizer. Average soil extractable nitrogen values did not change significantly following application of the sidedressing of N fertilizer. We attribute this failure to detect a significant difference in soil extractable nitrogen following N fertilization to the method in which the fertilizer was applied, the subsequent rainfall pattern, and the mechanics of our sampling system. NO flux followed the same diurnal trend as soil temperature, with maximum NO emissions coinciding with maximum soil temperature, and minimum NO emissions coinciding with minimum soil temperature. NO flux was found to increase exponentially with soil temperature, but only after fertilization. Due to sub-surface irrigation practices employed by the farmer, changes in soil water content were minimal and no relation could be drawn between soil water content and NO flux. Fluxes of NO_Y and NO_2 were also calculated to ascertain the balance of nitrogen species being emitted.

Simultaneous NO flux measurements made by a closed box flux technique, at the same site, revealed no statistically significant differences between the two different methodologies for measuring NO flux.

Introduction

NO plays an important role in tropospheric photochemistry. Increasing NO emissions, in the presence of hydrocarbons and sunlight, are thought to be the cause of increased regional levels of tropospheric ozone and other photochemical oxidants (Logan, 1985; Penkett, 1988). Yienger and Levy (1995) developed an empirically based model to estimate soil NO_X emissions on a global scale. They have reported that anthropogenic land use is having a significant impact on global soil NO_X emissions and that soil emissions can account for up to 75% of the total NO_X budget depending on location and time of year.

Although there have been many experiments conducted that have measured NO emissions from various soil types (Slemr and Seiler, 1984; Johansson and Granat, 1984; Williams et al, 1988; Johansson and Sanhueza, 1988; Kaplan et al., 1988; Williams and Fehsenfeld, 1991; Hutchison and Brams, 1992; Kim et al., 1994, Aneja et al., 1995), relatively few have included intensively managed agricultural soils, or continued measurements for substantial periods of time (Anderson and Levine, 1987; Williams et al., 1988; Shepherd, Barzetti, and Hastie, 1991; Skiba et al., 1992; Valente and Thornton, 1993; Sullivan et al., 1996). Previous measurements of soil emissions from other research groups confirm that there is great spatial and temporal variability in NO flux. For example, Sullivan et al. (1996) and Aneja et al. (1995) reported average summertime

NO fluxes of 21.9 ng N m^{-2} s^{-1} and 8.1 ng N m^{-2} s^{-1}, respectively, for corn planted at the same location for two years in a row in the Upper Coastal Plain of North Carolina. Additionally, Johansson and Sanhueza (1988) reported that soil NO emission rates can vary by a factor of 2-3 within a 50 m^2 plot.

In the Southeast U.S., which is NO_X ($NO+NO_2$) limited, an increase in NO_X emissions is believed to produce a corresponding increase in O_3 levels (Southern Oxidant Study, 1993). O_3 negatively affects human health, as well as ecological systems, such as crop yield. Studies show that prolonged exposure to high ozone levels causes persistent functional changes in the gas exchange region of the lungs. Additionally, ozone plays a critical role in controlling the chemical lifetimes and the reaction products of many atmospheric species (National Research Council, 1991). Gaseous nitric acid (HNO_3), the end product of NO reactions in the atmosphere, combines with either aerosols or water in the atmosphere, and is removed via rain, snow, or other deposition processes, as acidic deposition.

The primary objective of this study was to characterize NO flux from an intensively managed row crop (corn) in the Lower Coastal Plain of North Carolina and to attempt to relate this flux to environmental parameters such as soil temperature, soil extractable nitrogen, and soil water content. This research site was also the site of Project NOVA 1995 (**N**atural emissions of **O**xidant precursors: **V**alidation of techniques and **A**ssessment) (Aneja, 1994). This multi-scientific agency project was designed to conduct side-by-side comparisons of different NO flux methodologies, namely chamber techniques and micrometeorological techniques. This paper will also present the results of an intercomparison of soil NO flux values as measured via the NC State University Air Quality Groups' dynamic flow-through chamber and the NASA Langley Research Center, Hampton, Virginia, Groups' static chamber. The knowledge gained from this site will help to further characterize biogenic soil emissions from the southeast U.S., and may help to explain elevated O_3 concentrations in this region.

Methods and Materials

Physiographic Location

Flux measurements were made on the Michael Boyd property located in Washington County, in the Lower Coastal Plain region of North Carolina. The research site is located in the southwest corner of Washington County, NC, approximately 20 km southwest of Plymouth, NC and 120 km from the Atlantic Ocean. Washington County is situated between two major river basins, the Roanoke River basin and the Pungo River basin, and has a level topography, ranging from 5 to 50 feet above sea level. A naturally high water table inhibits drainage, slows the mineralization of soil organic matter, and leaves the surface layer black as compared to lighter colored soils which are well drained and dominated by mineral matter. There were three soil types at the research site: the Conaby muck, the Arapahoe fine sandy loam, and the Portsmouth fine sandy loam. The primary soil type sampled during our measurement period was the Portsmouth fine sandy loam soil (black fine sandy loam, weak medium granular structure, very friable, Tant, 1981).

Farming in this region is made possible by a series of ditches and canals that are interconnected and drain into Albemarle Sound. Most farmland is drained by a network of parallel ditches, 1 m deep and 50 m apart, that drain into larger canals, which in turn empty into several main canals. Most major highways follow these main canals. Beginning in the late 1970's, flash-board risers were installed at exit points on most farms to prevent field runoff via ditches and smaller canals from emptying directly into the main canals and thus into Albemarle Sound. This measure has proven successful in limiting nutrient loading into the Sound, and has also been used by individual farmers as a means of sub-surface irrigation. During periods of moisture stress, water from deep wells is pumped into the ditch-canal system on individual farms, eventually raising the water table.

The research site itself consisted of approximately 136 hectares of continuous cropland (corn, Zea mays), 1,067 meters wide and 1,280 meters long. The site is accessible by a canal road off NC Route 99/45, which lies approximately 2 km to the northeast. Measurements using our technique were confined to the northeast edge of the field. Sub-surface irrigation by the farmer was used once during our measurement period.

Planting and Fertilization

The corn crop was planted on April 12th, 1995. The land was treated with a pre-emergent herbicide and then the corn seed was drilled into the soybean stubble (no-till planting). The crop was fertilized at planting with 73 kg Nitrogen (N) per hectare. Approximately 9 kg N per hectare was applied at planting, 5 centimeters below the seed. The remainder was applied as a 30% N solution, containing equal parts of urea, ammonia, and nitrate, that was broadcast across the field after planting. The final addition of fertilizer, 102 kg N per hectare, was applied on May 20, 1995, also as a 30% N solution of equal parts urea, ammonia, and nitrate. This final sidedressing was applied as a thin (approximately 2 cm) liquid band down the center of the interrow. A portion of the cornfield was not fertilized with the additional N fertilizer to allow comparison of NO flux from fertilized and un-fertilized areas.

Sampling Scheme

The daily sampling scheme consisted of measuring ambient concentrations of NO, NO_Y, and NO_2, at ground level and after the sample exited the dynamic flow-through chamber. A daily experiment consisted of placing the chamber on the stainless steel collar, which had been inserted into the soil the previous evening. The chamber was placed on the collar at approximately 5:30 AM and flushed with ambient air for at least one hour before data collection began at 6:30 AM. This technique ensured that the concentrations within the chamber reached steady state prior to any data acquisition and allowed for the instruments to undergo their daily calibrations. Daily experiments ended at approximately 6:00 PM and the stainless steel collar was relocated to a random location within a 10 m radius of the mobile laboratory, in preparation for the next days experiment. This procedure allowed a minimum of 12 hours for any effect on soil NO flux due to soil disturbance with insertion of the stainless steel collar to dissipate.

Dynamic Flow-Through Chamber

A dynamic flow-through chamber lined with five millimeter thick fluorinated ethylene propylene (FEP) teflon was used to measure NO, NO_2, and NO_Y concentrations emitted from the soil. The translucent chamber, 27 cm in diameter, and 42 cm high (a volume equal to 24.05 liters), fits inside of a stainless steel metal ring, which is driven into the ground to a depth of ~10 cm (See Figure 1.1). Ambient air, which is used as a carrier gas, is pumped through the chamber at a constant flow rate (approximately 4 lpm). The air inside the chamber is mixed by a variable-speed, motor driven teflon impeller. The sample exiting the chamber travels through teflon tubing (1/4" outside diameter, 1/8" inside diameter) to the detection instruments. The entire measuring system, from the inlet port on the chamber to the point where the stream is analyzed in the instrument, is coated by either teflon, stainless steel or gold to minimize further chemical reactions with the sample stream. The sample lines do not exceed 10 meters. The NO detection instruments drew 1 lpm, which resulted in a sample residence time in the sample lines of approximately 5 seconds.

Experiments were conducted to determine if the mixing speed of the teflon impeller altered soil NO flux measurements. Varying the speed between 20 and 100 revolutions per minute (rpm) did not produce any significant changes in the calculated NO flux. The impeller was set to 70 rpm for the remainder of the experiment. Outlets in the chamber ensured that there were no substantial pressure differences between the outside atmosphere and the air within the chamber. Research conducted on similar chambers using a tilting water manometer indicate that pressure differences were below detection limits (0.2 mm H_2O) (Johansson, and Granat, 1983). The condensation of water vapor in the sample lines leading to the detection instruments was one complication with using ambient air as a carrier gas. Condensation occurred the most often during the afternoon hours. To combat this problem, the sample lines were disconnected at both the detection instrument and the chamber and flushed with zero grade air. Although the

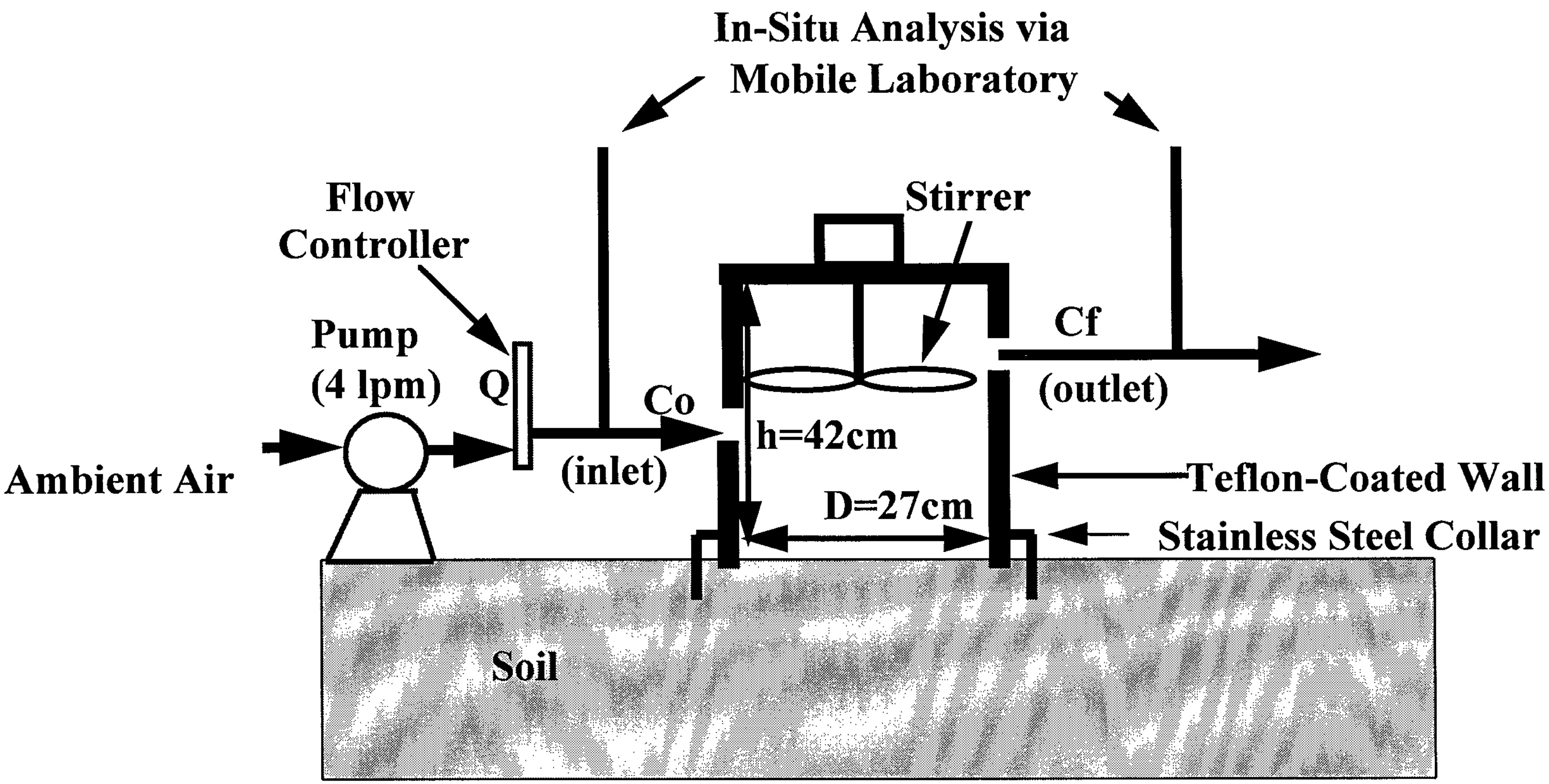

Figure 1.1. Schematic of dynamic flow-through chamber. The chamber fits inside of a stainless steel collar which is placed in the soil the previous day to minimize soil disturbances.

process took only 4-5 minutes, concentration measurements were delayed approximately 30 minutes to allow the system to reach steady state. Condensation within the sample lines was no longer a problem after the instruments were converted to measure NO_Y concentrations in addition to NO. The instrument conversion involved moving the molybdenum converter, which is heated to 325 oC, to the exit port of the chamber. This step effectively minimized condensation of water in the sample lines. All measurements after May 25th were taken with the converted instruments.

Temperature Controlled Mobile Laboratory

All instrumentation was housed in a temperature controlled mobile laboratory. The mobile system consisted of a modified Ford Aerostar van with a 13,500 BTU air conditioning unit. The temperature inside the van was maintained at or below the operating range of the instruments. Power for the air conditioning and all of the detection instruments was standard 110 volt AC commercial power.

NO Detection Instrumentation

Nitric Oxide (NO) concentrations were measured using a Thermo Environmental Instruments Incorporated (TECO) Model 42S chemiluminescence, low level NO analyzer (Thermo Environmental Instruments, Inc., 1992). The principle behind the operation of the NO instrument is the gas phase reaction between ozone (O_3) and NO ($NO + O_3 \rightarrow NO_2 + O_2 + h\nu$). Light emissions from the decay of NO_2 to lower energy states is proportional to the concentration of nitric oxide. This decay is detected in a photomultiplier tube and converted to a concentration measurement after calibration with known standards.

A multipoint calibration was conducted prior to, and at the midpoint of, the measurement period. Each day, zero and span checks were conducted according to the operator manuals. A cylinder of .109 ppmV NO in N_2 (Scott Specialty gases) and zero grade air (National Welders) were used for zeroing, spanning, and calibrating the TECO instruments.

NO_Y Detection Instrumentation

The reactive nitrogen compounds (NO_Y) were measured using a modified TECO Model 42S. The TECO 42S uses a molybdenum converter, heated to approximately 325°C, which converts oxides of nitrogen to NO. The NO is then measured by the same reaction processes described previously. However, a complication arises with the molybdenum converter housed in the instrument up to 10 m away from the chamber. Nitrogen compounds, such as nitric acid, deposit in the sample lines, never reaching the measuring instrument. With the assistance of the North Carolina Department of Environmental Health and Natural Resources (DEHNR-Air Quality Division), the instruments were modified so that the molybdenum converter was relocated from inside the instrument to the sample exit port on the dynamic chamber. After modification, the same TECO 42S instrument could measure both NO and NO_Y. DEHNR protocols were used for zeroing, spanning, and calibrating the NO_Y channel.

NO_2 Detection Instrumentation

Nitrogen Dioxide (NO_2) concentrations were measured with a Unisearch Associates Incorporated LMA-3 chemiluminescence NO_2 instrument. This system uses a fabric wick that is saturated with a luminol based solution. The NO_2 in the airstream, when drawn across the wick, oxidizes the luminol and produces a characteristic chemiluminescence. The LMA-3 measures the chemiluminescence directly via a photomultiplier tube.

The instruments were calibrated prior to and at the midpoint of the experiment, according to written protocols (Scintrex Ltd., 1987). Additionally, zero and span checks were performed prior to each set of measurements. The same mixture that was used to calibrate the NO instruments (.109 ppmV NO in N_2 - Scott Specialty Gases) was used to calibrate the NO_2 instruments. A TECO 146, Dynamic Calibration System was used to titrate a mixture of NO with an abundance of ozone. Using the reaction: $NO + O_3 \rightarrow NO_2 + O_2 + h\nu$, a known quantity of NO_2 was delivered to the LMA-3.

Automated Data Collection

A Toshiba laptop computer and Labview software (National Instruments), were used as an automated data acquisition system. The system recorded 60-second, rolling average concentration measurements, and then binned and averaged these values every 15 minutes. The 15-minute, binned averages were stored and used later in all flux calculations. At frequent intervals, we recorded the concentrations from the LED readout on the front panel of the instruments. These recorded values were checked against computer recorded values to ensure the systems' accuracy. No significant discrepancies were noted between the instrument display and the computer stored values.

Flux Calculations

The NO and NO_Y fluxes were calculated from a mass balance equation (Kaplan et al., 1988; Kim et al., 1994). The mass balance equation is:

$$\frac{dC}{dt} = (\frac{q[C_{air}]}{V} + \frac{J}{h}) - (\frac{L}{h} + \frac{q}{V})[C] \qquad (1)$$

where

h = internal height of the chamber (42 cm)

J = emission flux per unit area (ng N m^{-2} s^{-1})

L = total loss in the chamber per unit area assumed first order in [NO] (cm s^{-1})

q = flow rate through the chamber (lpm)

V = volume of the chamber (24.05 liters)

C = NO concentration in the chamber (ppbV)

C_{air} = NO concentration in the ambient air immediately adjacent to the chamber (the inlet of the chamber) (ppbV)

Assuming the chamber is well mixed, the concentration [C] measured can be assumed to be the same everywhere within the chamber. Additionally, at steady state conditions, the change of concentration, with respect to time, will be zero. Equation (1) reduces to

$$\frac{J}{h} = (\frac{L}{h} + \frac{q}{V})C_{eq} - \frac{qC_{air}}{V} \qquad (2)$$

(C_{eq}) is the concentration measured at the outlet of the chamber. During most of the measurements, the NO concentrations in the ambient air (C_{air}) adjacent to the chamber were less than 1 ppbV.

In equation (2), the total loss term (L) is the sum of the loss of NO through reactions with the chamber walls and chemical reactions of NO with existing oxidants in the carrier gas, such as ozone and peroxy radicals (Kim et al., 1994; Aneja et al., 1995). The total loss term was determined empirically (five experiments were conducted throughout the day and night) utilizing a method developed by Kaplan et al., 1988. This method plots the value of $-\ln\frac{C_{eq}-C}{C_{eq}-C_o}$ against time (t). C_0 is the NO concentration in the chamber when NO reaches the first equilibrium state at an initial flow rate. C_{eq} is the NO concentration in the chamber after the flow rate is reduced and allowed to reach a second equilibrium. From the linear relationship between the value of $-\ln\frac{C_{eq}-C}{C_{eq}-C_o}$ and time during the experiment, the slope is found to represent $(\frac{L}{h}+\frac{q}{V})$. The total loss in the chamber was estimated to be 0.924 cm minute^{-1} from the linear regression between the value of $-\ln\frac{C_{eq}-C}{C_{eq}-C_o}$ and time (t) with a constant flow rate. The value of L/h (=.022 minute^{-1}) agrees with those found by Kim et al. (1994), and is directly used in equation (2) to calculate the NO flux during the experimental period.

Soil Temperature and Soil Analysis

Soil temperature was recorded every 15 minutes using a Fischer Scientific temperature probe inserted 5 cm into the soil, adjacent to the chamber. Comparisons were made during the first week of the experimental period to see if there were any significant temperature differences between the soil inside the chamber and the soil outside the chamber. Temperature differences were negligible, which agrees with results obtained by other researchers (Kim, 1994; Sullivan, 1995).

A soil sample was taken from the center of the dynamic flow-through chamber footprint at the end of each measurement period (approximately 1 sample per day). Samples were taken with a bucket auger which removed a soil core to a depth of 20 cm. Soil properties for the research site, such as Percent Water Filled Pore Space (%WFPS), pH, and Total Extractable Nitrogen, were obtained from the bucket auger samples. %WFPS is an expression of soil water content and can be expressed as the percentage of pore spaces in the soil filled with water.

Soil bulk density, which is the weight of the soil solids per unit volume of total soil, and soil particle density, are used to determine the %WFPS of the soil (Troeh and Thompson, 1993). The core method (345 cm^3) was used to determine the soil bulk density for the research site (Blake and Harge, 1986). The standard particle density is 2.65 g/cm^3 for most soils, however particle densities will differ from this value if the soils have high organic matter content or are high in heavy minerals such as hydrous oxides of iron. The organic soils of the North Carolina Lower Coastal Plains research site had particle densities of 2.3 g/cm^3.

The total extractable nitrogen was calculated by summing the extractable fractions of ammonium (NH_4^+) and nitrate (NO_3^-) determined from the soil samples. Extractable NH_4^+ and NO_3^- were determined using a 1 M KCL soil extract (expressed on a weight basis) (Keeney and Nelson, 1982) and standard autoanalyzer techniques (Lachat Instruments, 1990). The total soil water content was calculated as:

[initial weight - oven dry weight (105 ^{o}C)] / oven dry weight(105 ^{o}C).

Results and Discussion

Site Characterization

All soil flux measurements reported here were conducted between May 15, and June 9, 1995. Rainfall patterns during this period were marked by the passage of the remnants of Hurricane Allison over the site on June 5th. Prior to this event, there had been limited rainfall with thunderstorms occurring on May 19, and June 3. Neither of these events left any standing water in the field, as opposed to the heavier rains (12 cm of rainfall) which occurred on June 5, leaving portions of the field flooded for up to two days. The only significant deviation in the soil water content of the field, which can be expressed as Percent Water Filled Pore Space (%WFPS), occurred after the passage of the remnants of the hurricane. The average %WFPS for the entire measurement period was 35.2 % ± 6.3 % (Table 1.1). The measured %WFPS increased to 49.7 % two days after passage of the remnants of the hurricane. During the remainder of the measurement period, the site was dominated by high pressure systems with southerly winds.

Extractable nitrogen (1 M KCL) was present in the soil throughout the measurement period, and, although N fertilizer was applied to the field at the midpoint of the experiment, there was not a corresponding increase in the amount of extractable N (Table 1.1). The lack of a discernible difference in extractable nitrogen after fertilization, as would be expected, is due to a combination of three factors: method of fertilizer application, rainfall distribution, and our soil NO flux measurement technique. The fertilizer was applied as a thin concentrated liquid band (2 cm wide) down the center of

	Soil Temperature (^{o}C)	Total Extractable Nitrogen (mg N / kg dry soil^{-1})	% WFPS	NO Flux (ng N m^{-2} s^{-1})
Corn (All measurements)				
Average	24.2	51	35.2	50.8
Standard Deviation	3.2	26	6.3	47.7
Minimum	16.4	23	27.9	4.2
Maximum	34.2	116	49.7	264.7
Corn (Before sidedressing)				
Average	23.5	49	34.7	31.5
Standard Deviation	3.7	21	6.0	10.1
Minimum	16.4	27	27.9	7.6
Maximum	32.7	94	43.4	41.9
Corn (After sidedressing)				
Average	24.8	52	35.7	77.7
Standard Deviation	2.3	31	7.0	63.7
Minimum	20	23	27.9	4.2
Maximum	34.2	116	49.7	264.7

Table 1.1 Data Summary for the Plymouth, NC (May 15 - June 9, 1995) measurement period. All NO flux data, and soil temperature data were computed from 15 minute binned averages. The total extractable N, and %WFPS were computed from the daily soil samples collected from the center of the chamber footprint at the end of each experimental period.

the interrow (1 m width). During application, the applicator nozzles would drag across the soil surface, sometimes being deflected from the center of the interrow. As a result, the concentrated fertilizer band could not be assumed to always be present in the center of the interrow. Once the liquid band dried, it was not possible to determine where the band was located at a particular sampling position. The fertilizer applied as the liquid band remained on the soil surface for a week following application due to a lack of any measurable rainfall. The first substantial rainfall event following fertilization, however, flooded portions of the field and part of the N fertilizer, in the relatively higher elevations of the field, was transported to the lower lying areas due to surface runoff. Since the chamber footprint (27 cm diameter) was less than half the width of the interrow, random placement of the chamber meant that it was possible to miss the portion of the interrow that had received the additional N fertilizer. The situation was further compounded as the chamber was moved to other portions of the field (of differing relative elevation) through the remainder of the measurement period. The extractable N values in Table 1.1 for the period after application of the N fertilizer suggest that many of the flux measurements recorded were from portions of the field not directly impacted by the additional application of N fertilizer.

Soil temperatures during the experiment ranged from 16.4 to 34.2 ^{o}C with an average of 24.2 ± 3.2 ^{o}C (Table 1.1). Daily average soil temperatures increased throughout the research period, with all values between the 15-35 ^{o}C optimum range for NO emissions proposed by Williams and Fehsenfeld (1992). The crop remained in a vegetative growth stage throughout the experiment and ranged in height from 58 cm to 173 cm.

NO Flux

Measured soil NO flux ranged from 4.2 to 264.7 ng N m^{-2} s^{-1}. The overall average of the 15 minute NO flux measurements for the experimental period was 50.8 ± 47.7 ng N m^{-2} s^{-1} (Table 1.1). Figure 1.2 displays a cumulative frequency plot for all of the composite hourly averaged NO flux values. This plot shows that, although there were periods when the flux exceeded 200 ng N m^{-2} s^{-1}, these relatively extreme values represent less than 3% of all observations. The plot further reveals that 80% of the observations were below 67 ng N m^{-2} s^{-1} and 50% of the observations were below 37 ng N m^{-2} s^{-1}. Additionally, over 65% of the observation fell between 15 and 50 ng N m^{-2} s^{-1}.

The average NO flux increased dramatically after the final sidedressing of N fertilizer on May 20, 1995. The average NO flux prior to this sidedressing was 31.5 ± 10.1 ng N m^{-2} s^{-1} with a range of 7.6 to 41.9 ng N m^{-2} s^{-1} (Table 1.1). The average flux from those portions of the field which received the sidedressing of fertilizer was 77.7 ± 63.7 ng N m^{-2} s^{-1} with a range of 4.2 to 264.7 ng N m^{-2} s^{-1}. A shift in the overall population distribution of NO flux values from before fertilization to after fertilization can be seen in Figure 1.3. Both measurement periods contained approximately the same percentage of observations between 0-30 ng N m^{-2} s^{-1} (~ 30%), although for the period prior to N fertilization the majority (72.6%) of the measurements fell between 30-45 ng N m^{-2} s^{-1} and for the period after N fertilization the majority (52.3%) of the measurements were greater than 45 ng N m^{-2} s^{-1}. Some of the variation present in the NO flux within

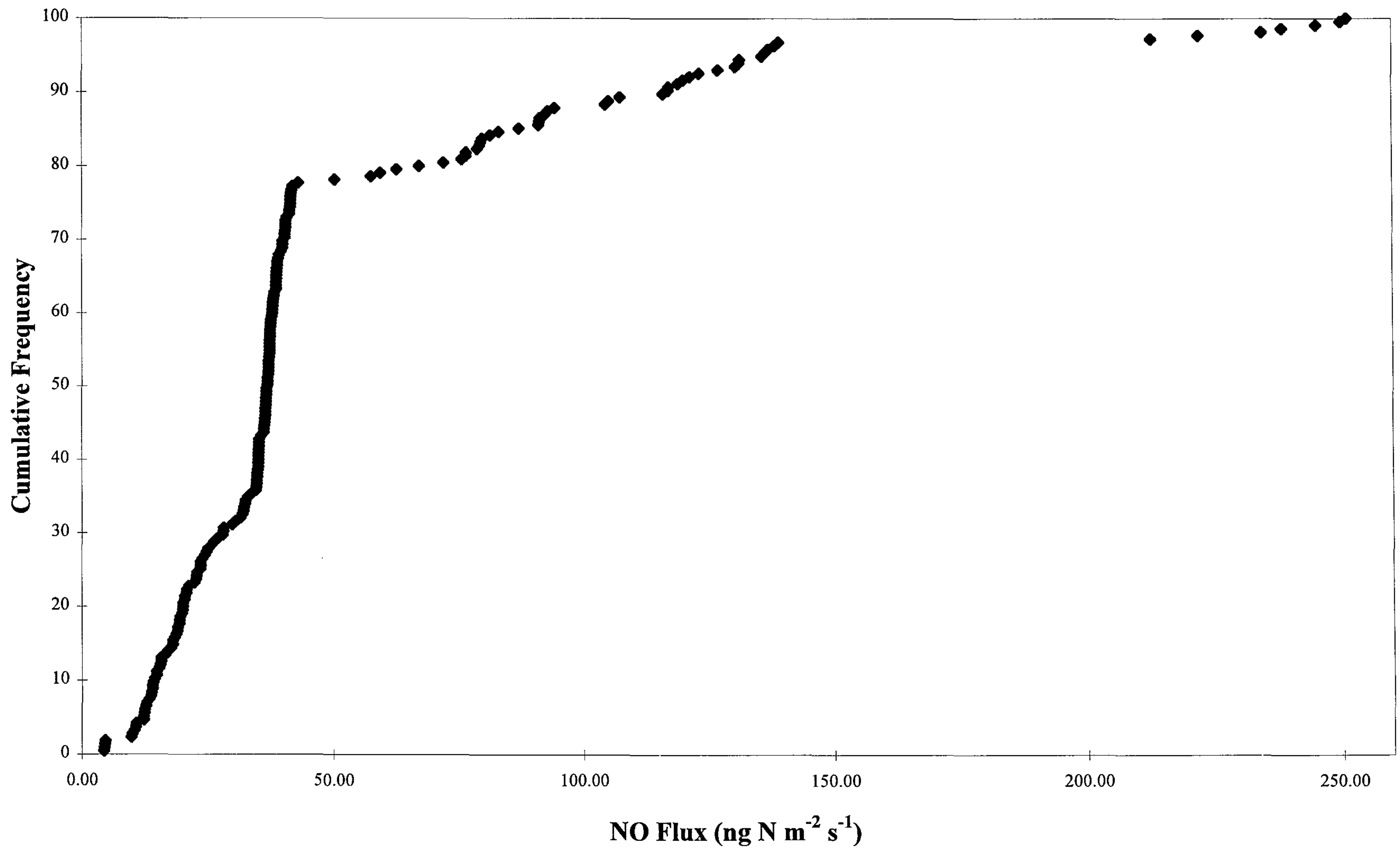

Figure 1.2. Frequency plot of the composite hourly averaged NO flux measurements.

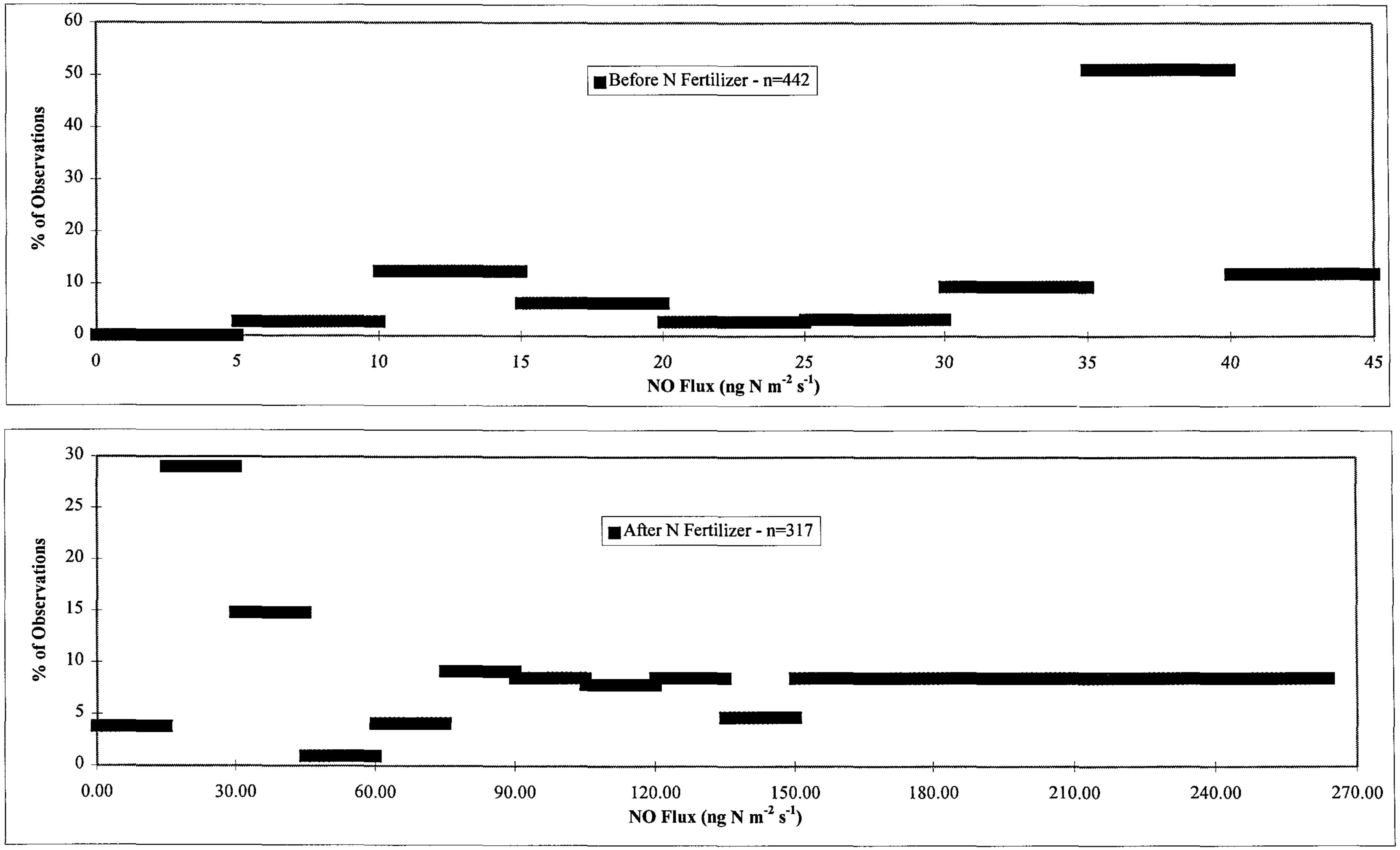

Figure 1.3. Population distribution of 15 minute NO flux measurements for 8 day period prior to N fertilizer (top) and 8 day period after N fertilizer (bottom).

each measurement period can be explained by Figure 1.4, which is a graph of the daily average NO flux (9:00 AM - 5:00 PM) throughout the entire research period. As indicated by the data in Figure 1.4, daily soil NO flux measured prior to application of the band of N fertilizer was essentially constant, except for the passage of a thunderstorm on May 19th which decreased soil NO emissions. Daily soil NO flux after application of the additional N fertilizer are much more variable, with one day (May 30th) accounting for the majority of measured NO flux values greater than 150 ng N m^{-2} s^{-1} (Figure 1.2 & 1.4). The data in Figure 1.4 also suggest that surface application of N fertilizer resulted in NO flux becoming much more susceptible to daily changes in other parameters as noted by the decline in NO flux on succeeding days as compared to daily NO flux measured prior to May 26th. The two peaks in daily soil NO flux after May 26th are consistent with the passage of rain events and the conclusion by Yienger and Levy (1995) that "pulses" of soil NO flux induced by rain events can account for more than 20% of total soil NO emissions. However, we are not certain as to why no such peaks were observed prior to May 26th. The decrease in soil NO emissions due to the heavy rains on June 5th and 6th is consistent with the results of other researchers who have reported a decrease in soil NO emissions due to reduced diffusivity of NO through the water-logged soil pores (Cardenas et al., 1993).

The difference in soil NO flux before and after fertilization can also be seen in Figure 1.5 which is a graph of the composite hourly averaged flux for periods prior to and after the application of fertilizer. The range of NO flux observed during the duration of this study coincides with values reported by other researchers. Table 1.2 lists values of

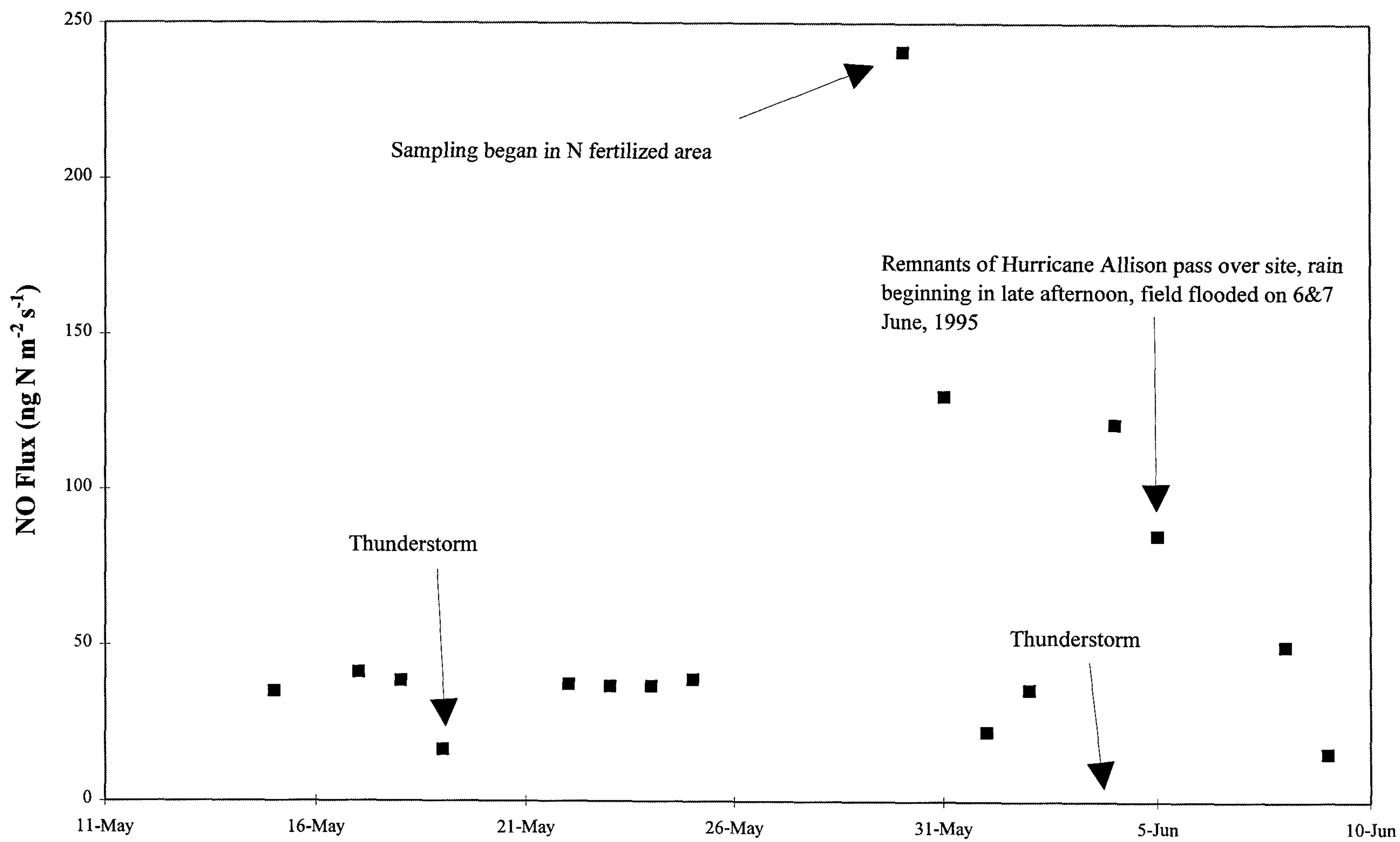

Figure 1.4. Daily average NO flux (9:00 AM - 5:00 PM) versus day of experiment.

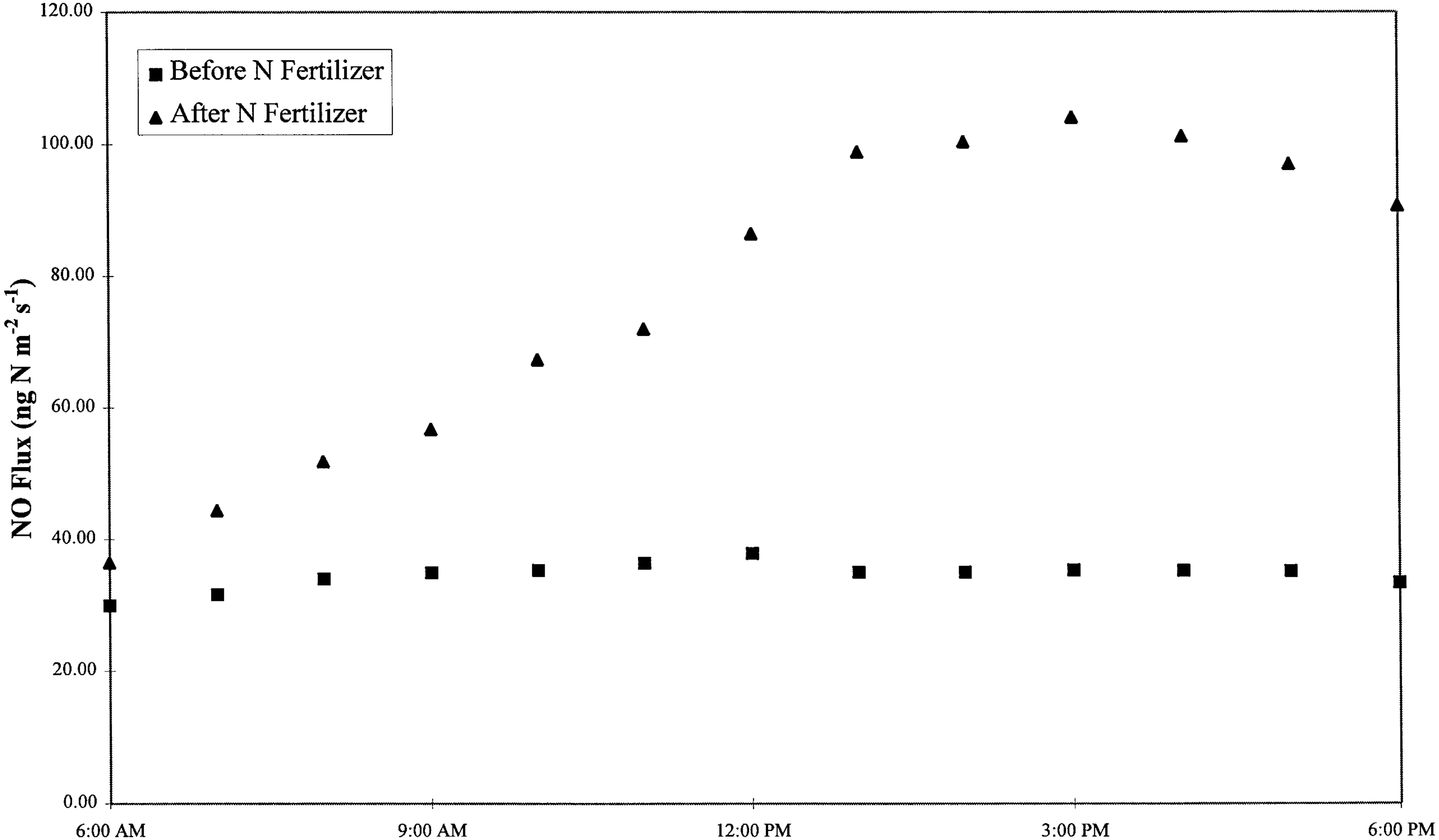

Figure 1.5. Hourly averaged flux values for the time periods prior to and after the final application of nitrogen fertilizer.

Flux (ng N m^{-2} s^{-1})	Source
5.56 - 239	Williams et al. (1987)
5.84 - 67	Anderson and Levine (1987)
-0.5 - 106.2	Aneja et al. (1995)
7.1 - 106.2	Sullivan et al. (1995)
8 - 188	Valente and Thorton (1993)
36.4 - 54.7	Jambert et al. (1994)
This paper	
4.2 - 264.7	Range for entire research period
7.6 - 41.9	Range before fertilizer sidedressing
4.2 - 264.7	Range after fertilizer sidedressing

Table 1.2. NO emissions obtained by various research groups using chamber techniques. All measurements were made from corn crops.

NO flux reported by other researchers who measured NO emissions from corn using chamber techniques.

A diurnal trend, in which NO emissions peaked in the afternoon and diminished throughout the evening hours, was evident throughout the experiment (Figure 1.6). The rise in NO flux during the morning hours coincided very well with the increase in soil temperature as did the gradual decline in soil NO flux with the gradual decline in soil temperature during the late afternoon and evening hours. This strong relationship between NO flux and temperature has been reported by other researchers (Johansson and Granat, 1984; Johanson, 1984; Williams et al., 1988; Shepherd et al., 1991; Slemr and Seiler, 1991; Valente and Thorton, 1993; Sullivan et al., 1996).

NO_Y Flux

Soil NO_Y flux was measured during the latter half of the experimental period, from May 30 to June 9, 1995. The same diurnal trend which appeared in the NO emission profile was evident in the NO_Y profile. NO_Y is important because it consists of the reactive atmospheric nitrogen compounds ($NO + NO_2 + NO_3^- + HNO_3 + HNO_2 +$ PAN + organic nitrates + HO_2NO_2) (Fehsenfeld et al., 1987). The range of the calculated NO_Y fluxes during this period was 2.09×10^{-10} to 2.16×10^{-8} mol NO_Y m^{-2} s^{-1}. NO_Y was measured in conjunction with NO and NO_2 in order to determine if any other reactive nitrogen compounds were being emitted by biogenic soil processes.

Figure 1.7 is a graph of the composite daytime averaged flux of NO and NO_Y versus time of day. The composite average flux of NO represents 86% of the composite average flux of NO_Y. Measurements of NO_2 concentrations made during this period

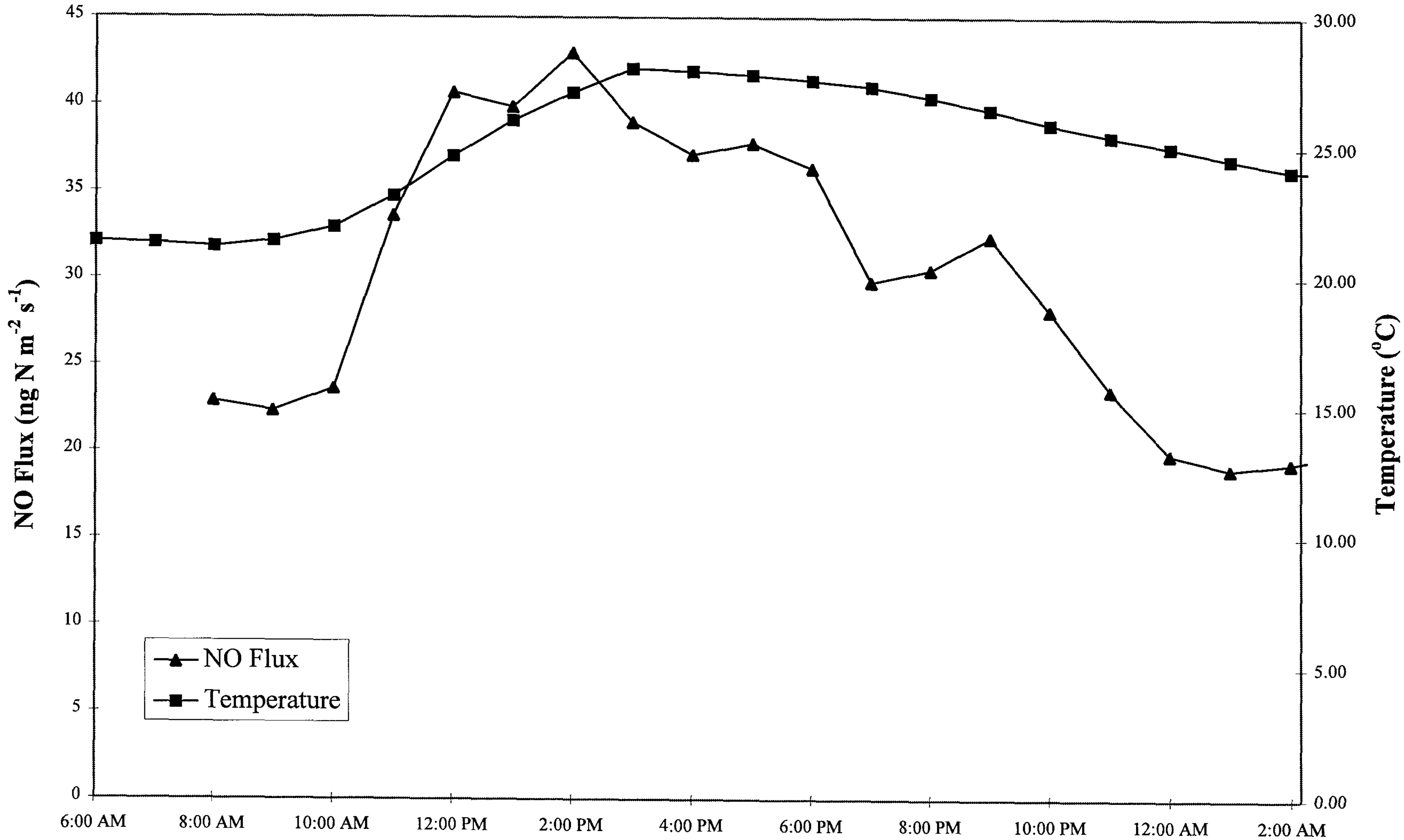

Figure 1.6. NO flux versus time of day and temperature for diurnal experiment conducted on June 2, 1995.

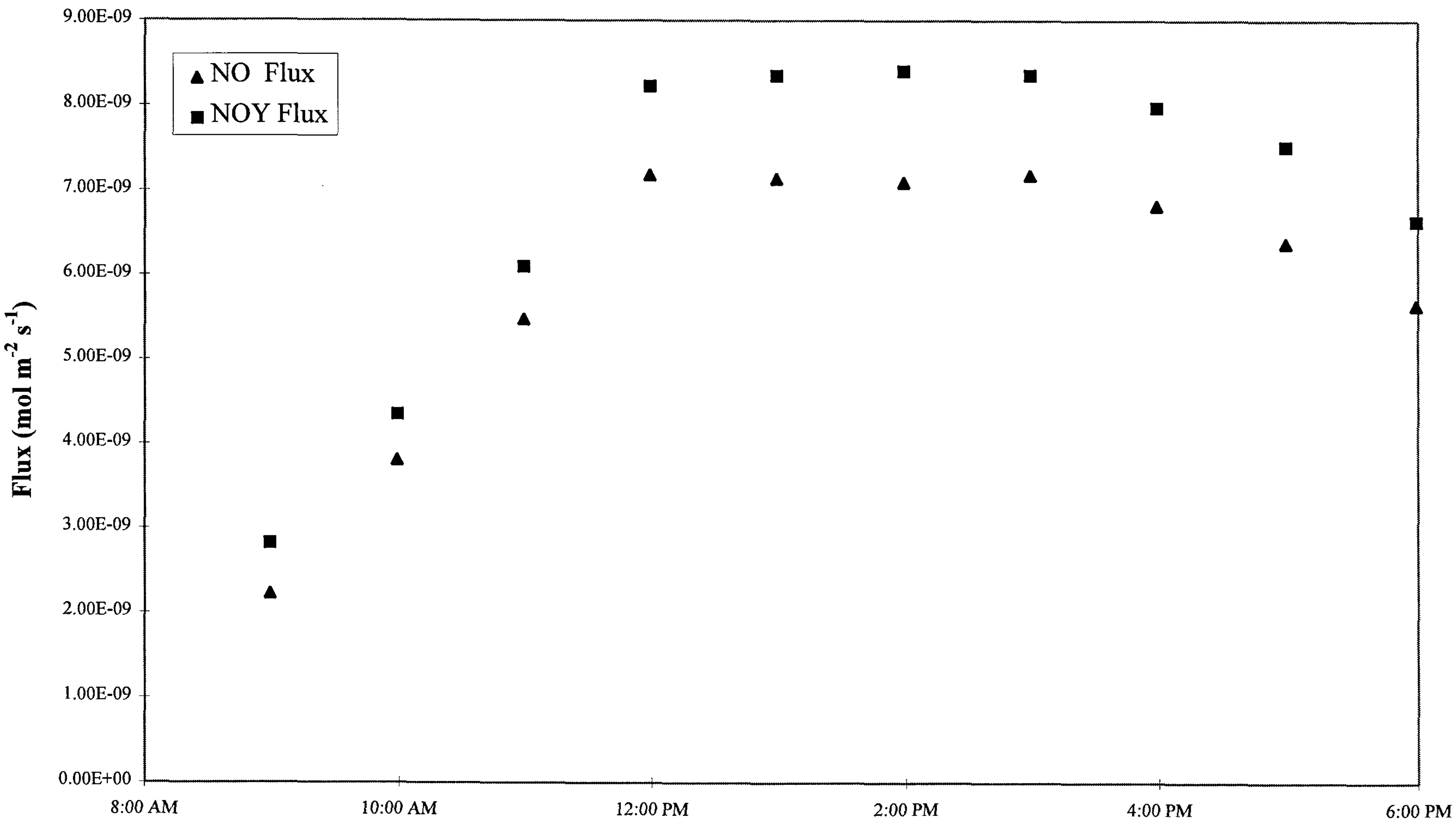

Figure 1.7. Composite daytime hourly averaged flux of NO and NO_Y versus time of day.

indicate a flux range from 0 to 15.73 ng N m^{-2} s^{-1}, with an average flux of 6.19 ng N m^{-2} s^{-1} which is approximately 8.7% of the total NO emitted and agrees with other reports that <10% of the NO_X (NO+NO_2) emitted by the soil is in the form of NO_2 (National Research Council, 1991). The average NO emissions during this time period was 71.56 ng N m^{-2} s^{-1}. The results for this research site indicate that 86% of NO_Y is made up of NO and 8.7% is present in the form of NO_2, leaving 5.3% of the emitted NO_Y unaccountable. Our results can not confirm or deny whether this unaccounted NO_Y is due to instrument uncertainty or if there are other reactive nitrogen compounds, other than NO_X, being emitted from the soil (i.e., NO_3^-, HNO_3, HNO_2, PAN, organic nitrates, or HO_2NO_2).

Figure 1.8 shows the apparent relationship between NO and NO_Y at night. Although this graph only represents one diurnal experiment, it appears that the two graphs begin to converge during the late evening/early morning hours. This suggests that the unaccounted reactive nitrogen compounds being emitted during the day, drop to a minimum at night.

Environmental Controls on NO Flux

Temperature

The results presented in Figure 1.6 show a strong temperature dependence of soil NO flux on soil temperature. However, the overall relationship between soil temperature and soil NO flux, when summarized on a daily scale was essentially non-existent for soil NO flux measured prior to N fertilizer application (R^2 = 0.10; Fig. 1.9). After N fertilizer application, the exponential dependence on soil temperature improved (R^2 = 0.34).

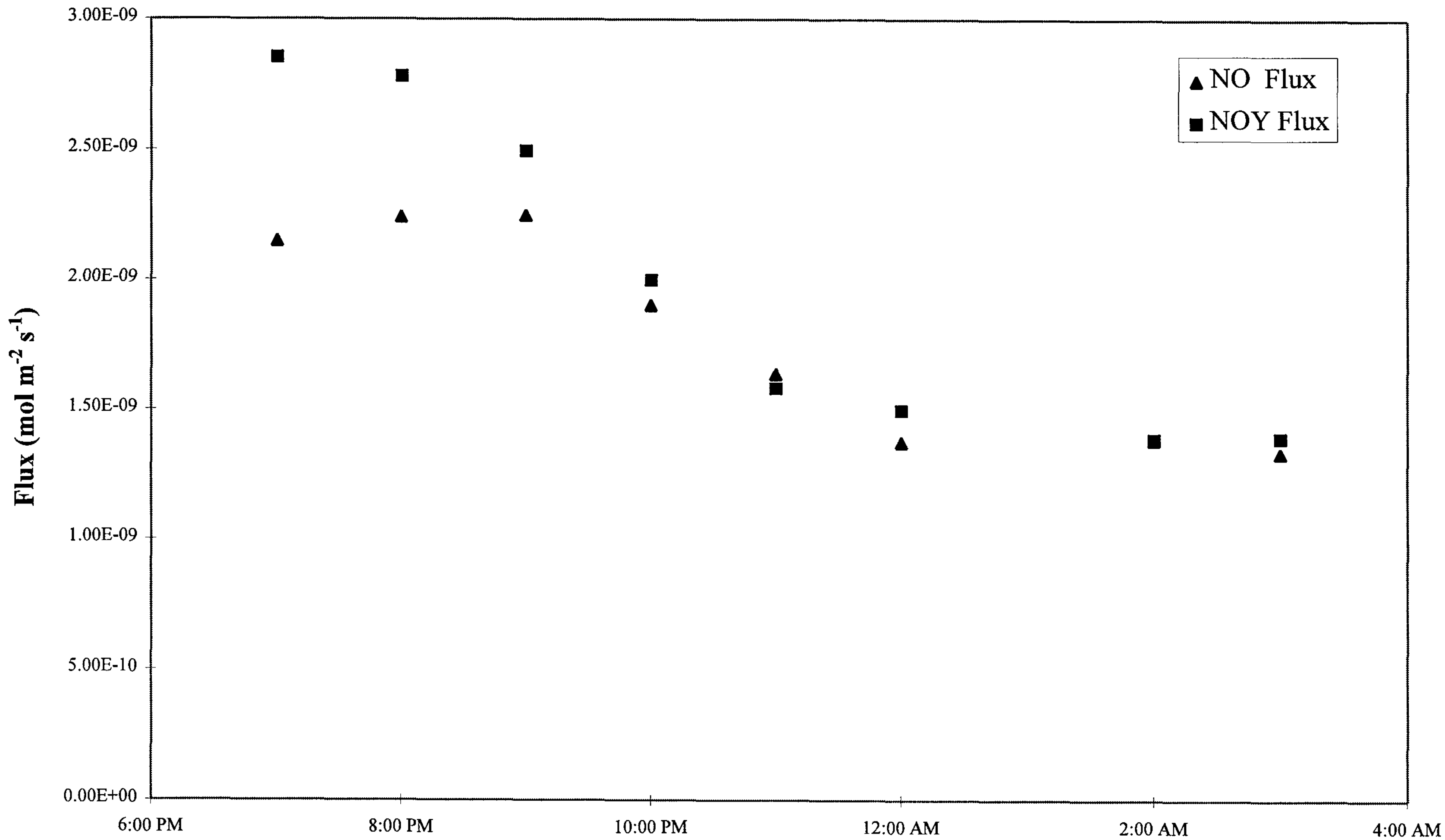

Figure 1.8. Composite nighttime hourly averaged NO flux of NO and NO_Y versus time of day.

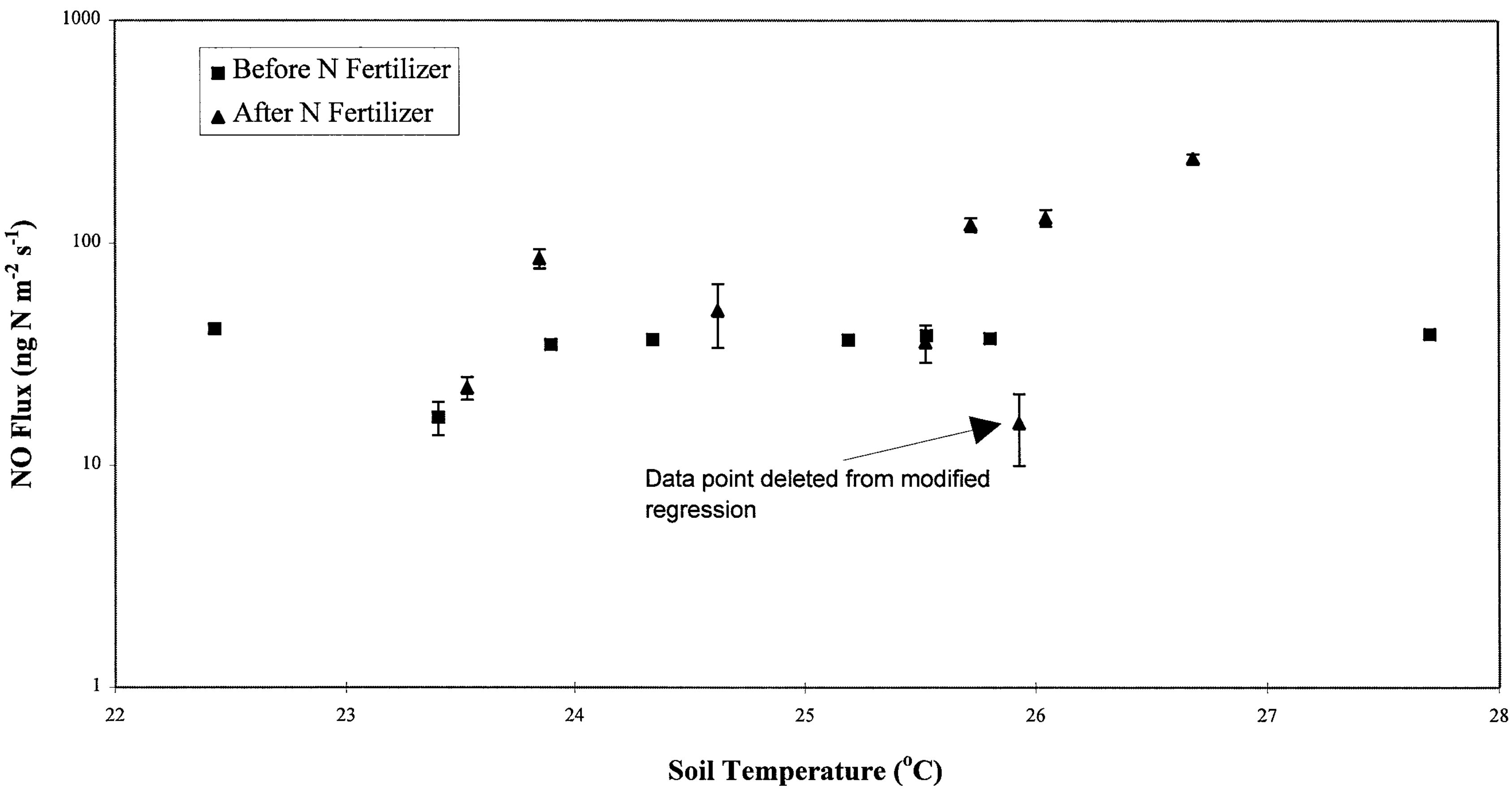

Figure 1.9. Daily average NO flux (9:00 AM - 5:00 PM) versus daily average soil temperature. Data was segregated into periods before and after N fertilizer application. Vertical lines indicate one standard deviation of NO flux. $R^2 = 0.58$ for the time period after the N fertilizer was applied to the field (neglecting the one marked data point).

However, when we removed one data point from the regression, which occurred during the period when the field was flooded by the passage of the remnants of the hurricane, we found an even stronger exponential dependence on soil temperature ($R^2 = 0.58$), which is consistent with the observations of other investigators (Williams et al., 1988; Sheperd et al., 1991; Slemr and Seiler, 1991; Williams and Fehsenfeld, 1991; Stocker et al., 1993; Sullivan et al., 1996). The lack of a relationship between soil NO flux and soil temperature prior to the addition of N fertilizer may be due to other factors, such as optimum soil water content in the surface soil horizon. Our data suggest that the exponential dependence of soil NO flux on soil temperature may only be observed in intensively managed agricultural row crops when excess amounts of extractable N are present in the top few centimeters of soil. In the future, soil sampling schemes to estimate extractable N may need to be altered in order to measure the distribution of extractable N with depth in the top 20 cm of the soil.

Total Extractable Nitrogen and Soil Moisture

Figure 1.10 is a graph of the daily averaged NO flux versus %WFPS and total soil extractable nitrogen, segregated into periods before and after the N fertilizer was applied. Although the organic and inorganic nitrogen content of soils has been shown to affect the emissions of NO, a relationship between extractable N and soil NO flux is not evident in our data (Slemr and Seiler, 1984; Anderson and Levine, 1987; Williams et al., 1987; Davidson, 1992; Hutchison and Brams, 1992; Hutchison, 1993). In fact, the highest soil NO fluxes were obtained from soil with the lowest content of extractable N. This suggests that some other parameter was controlling soil NO flux. Within the range of

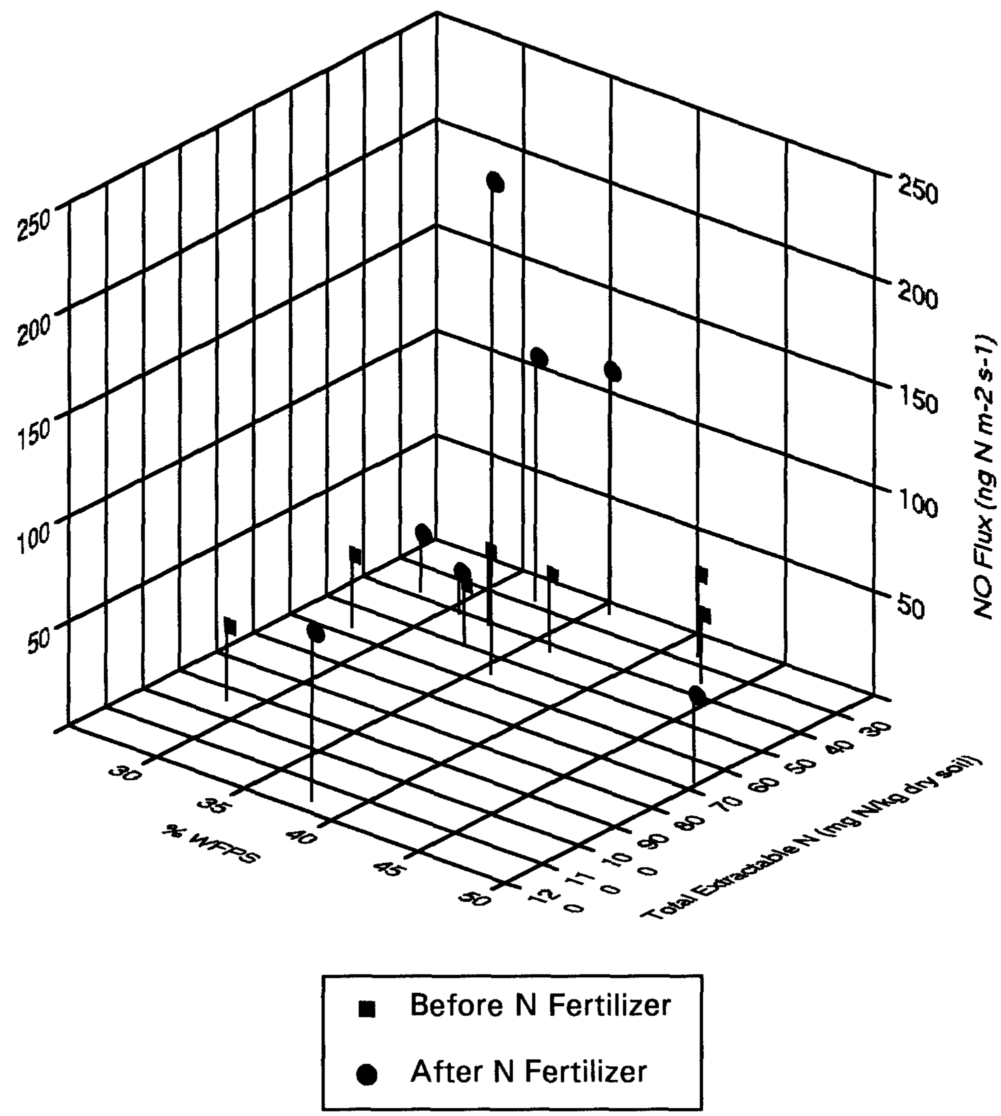

Figure 1.10. Daily averaged NO flux (9:00 AM - 5:00 PM) versus percentage water filled pore space and total extractable nitrogen. Soil data is from the 20 cm soil core taken from the center of the chamber footprint at the end of each experimental period.

optimum soil water content for soil NO flux, reported to be between 30% and 70% WFPS, changes in %WFPS are not expected to produce a significant change in the NO flux (Linn and Doran, 1984; Davidson and Swank, 1986; Parton et al., 1988; Davidson, 1991). There were only three days in which the %WFPS existed outside this optimum range, precluding any statistical corroboration of the impact of %WFPS on soil NO flux using our data set.

Intercomparison

The research conducted in Washington County, North Carolina was part of a larger research effort known as Project NOVA 1995 (**N**atural emissions of **O**xidant precursors: **V**alidation of techniques and **A**ssessment). The North Carolina State University Air Quality Group and NASA Langley Research Center, Hampton, Virginia, both participants of Project NOVA, measured NO emissions from the soil using two different chamber techniques.

The NASA research group used a closed box flux technique, in which NO fluxes were calculated using the mixing ratio of NO (ppbV) versus Time (Anderson, and Levine, 1987). Their measurement technique consisted of placing the chamber collars in the soil, several days prior to the experiment. The collars were arranged in groups of four, approximately one meter apart, in a square pattern in two adjacent interrows. There were four of these groupings positioned throughout the field. Whereas the NASA Group primarily sampled from the same sites throughout the measurement period, the NC State University Air Quality Group sampled from a different position in the field each day. A typical measurement period for the NASA group involved one hour at 3-4 of the sites, sampling from each of the 4 collars at the individual sites. Nighttime measurements, between 6:00 PM and 6:00 AM, were also conducted so that diurnal comparisons could be made between the two chamber techniques. Experimental constraints limited nighttime comparisons to 60 of the total 460 simultaneous measurements. Therefore, we have chosen to neglect these nighttime measurements in the statistical analysis due to the limited number of data points. However, the limited data during the nighttime period does show that the NASA group measured NO flux consistently higher than the NC State Air Quality Group.

Figure 1.11 is a difference plot of the composite averaged fluxes calculated by the NCSU Air Quality Group and the NASA Research Group versus Time. Differences between the 400 measurements were calculated and the resulting Δflux's were analyzed with the SAS statistical package. Due to time series activity in the data, a procedure called PROC ARIMA (Autoregressive Integrated Moving Average) was used to model the data and test the hypothesis that the mean of these differences was zero meaning that both chamber methods yield statistically identical values (SAS User's Guide, 1988). The statistical model which best fit the data consisted of a mean parameter and two auto regressive parameters. The SAS output produced a T-Ratio = 0.15 for MU, the mean of the differences. This value indicates that there is not enough statistical evidence to reject the hypothesis that the mean of the differences is zero. Therefore, as the hypothesis fails to be rejected, the conclusion must be that there was no statistical difference between soil NO flux as measured using the two chamber methods at the Plymouth, North Carolina research site.

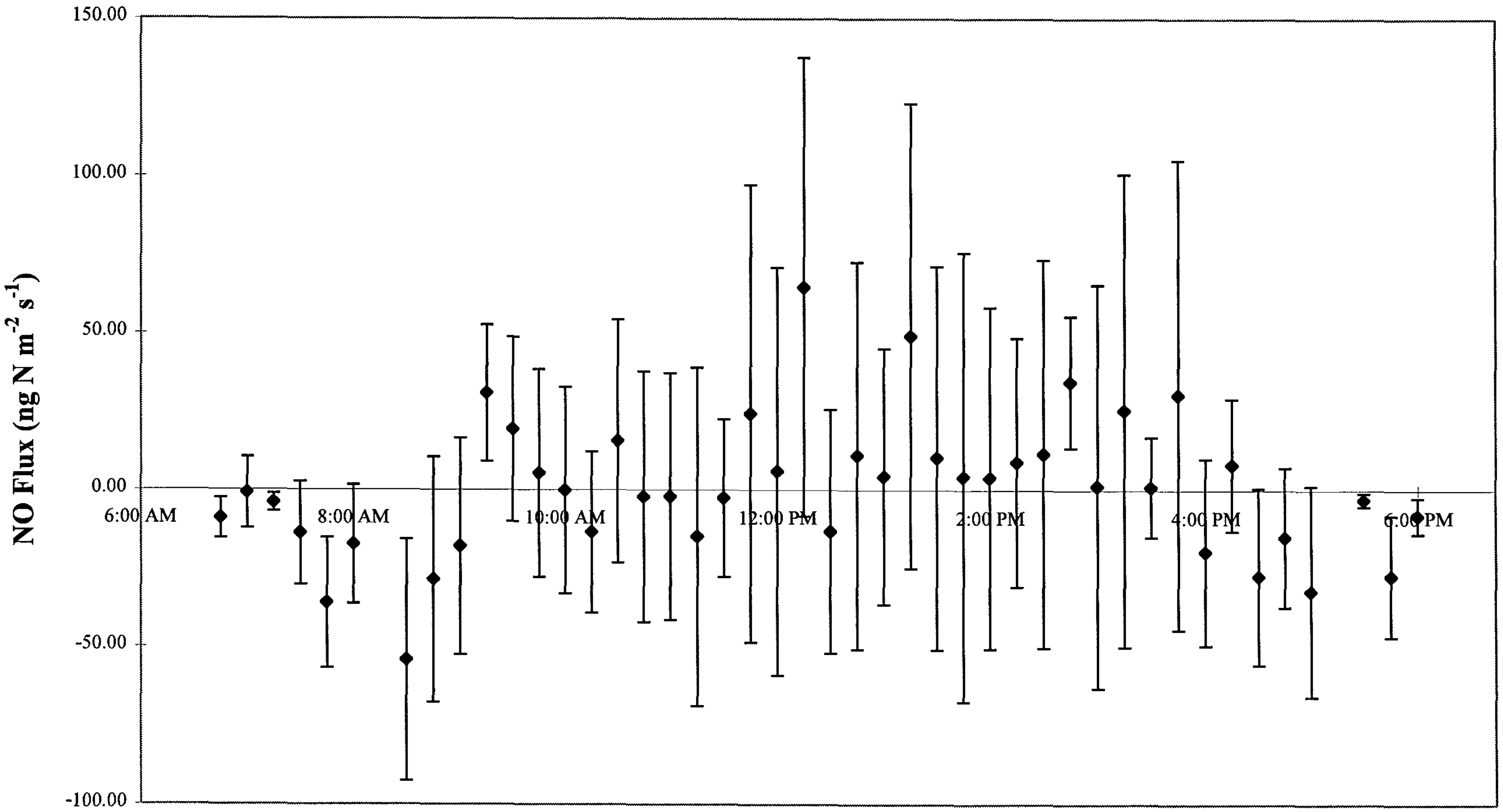

Figure 1.11. Difference of NO flux between two chamber techniques (NCSU Air Quality Group - NASA Group) versus time of day. Vertical lines indicate one standard deviation of the NO flux measurements made from both chamber techniques.

Conclusions and Recommendations

The research conducted at a corn field in Plymouth, NC provided an opportunity to measure NO emissions and the environmental variables which may control them, for a continuous 4 week period. During this measurement period we were also able to investigate how the application of N fertilizer affects NO emissions. Utilizing a dynamic flow-through chamber technique to measure NO emissions, the average flux was found to be 31.5 ± 10.1 ng N m^{-2} s^{-1} before the N fertilizer was applied and 77.7 ± 63.7 ng N m^{-2} s^{-1} after the N fertilizer was applied. Although NO flux did follow the same diurnal pattern of soil temperature throughout the research period, we were only able to detect the exponential relationship between NO flux and soil temperature, as observed by other researchers, for the period after sidedressing with N fertilizer. We believe that the addition of N fertilizer was responsible for the increased levels of NO flux from this agricultural field. However, the fact that average extractable nitrogen values did not change significantly between before and after fertilization brings into question the exact location of the biogenic processes responsible for soil NO emissions. Our hypothesis is that the processes responsible for NO emissions are concentrated in the top few centimeters of the soil surface. Our current soil sampling method, which removes a soil core 20 cm deep, could have diluted the concentration of extractable nitrogen present near the soil surface. Future research should consist of 5, 10, 15 and 20 cm deep soil cores so that the dilution effect can be analyzed, and therefore weaken or solidify the relationship between N fertilizer and NO emissions.

The intercomparison conducted between the two chamber flux methodologies revealed, as other researchers have also found, that there is great spatial variability in soil emissions and the quantification of these emissions is complicated by the high spatial variability exhibited by many microbial processes (Parkin, 1993; Sullivan et al., 1996). Although individual data points between the two chamber techniques can differ substantially depending on the location within the field, the hypothesis is that many observations of randomized locations in an agricultural field will produce a statistically equivalent average flux value between the two methodologies. In fact, through a statistical intercomparison we have confirmed this hypothesis for NO flux measurements at Plymouth, NC.

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Chapter II. Contribution of Biogenic Nitric Oxide in Urban Ozone: Raleigh, NC as a Case Study.

Abstract

Anthropogenic emissions from industrial and automotive sources within the confines of the city of Raleigh, NC have been documented by the North Carolina Department of Environment, Health and Natural Resources - Division of Environmental Management, but no direct biogenic emissions of nitric oxide (NO) from soils has yet been measured. In this study, emissions of NO were measured in Raleigh, NC, and its surrounding suburbs, in an attempt to determine the portion of the total NO_x ($NO + NO_2$) budget which can be attributed to biogenic sources. Residential and commercial lawns, and golf courses receiving normal fertilizer applications were chosen as the primary biogenic source of NO. Soil NO fluxes were measured using a dynamic chamber technique from 11 sites and ranged in value (hourly averages calculated from 15 minute readings) from 1.24 to 23.7 ng N m^{-2} s^{-1}. These hourly averages were then combined with estimates of lawn acreage within the city proper, and in the surrounding suburbs, in order to develop a budget for biogenic NO emissions in Raleigh. This budget was then compared to the budget used in the Environmental Protection Agency's (EPA) Regional Oxidant Model (ROM) for photochemical modeling. Results from this comparison suggest that less than 1% of the total NO_x budget for Raleigh, NC is emitted by natural processes, and that approximately 1.2% of the nitrogen applied as fertilizer is lost via soil NO emissions. Thus the effects of biogenic NO may be neglected in the development of a reliable plan for reducing ozone in the urban atmosphere.

Introduction

NO_x ($NO + NO_2$) is a critical component in the photochemistry of the troposphere (World Meteorological Organization (WMO), 1985; Slemr and Seiler, 1991; Trainer et al., 1991; Aneja et al., 1996). Increasing emissions of NO_x are of great concern because NO reacts with hydrocarbons in the atmosphere, in presence of sunlight, to produce ozone (O_3). NO_x in the lower troposphere is emitted from six predominant sources (Yienger and Levy, 1995). The descending order of importance of these sources are: fossil fuel combustion (>20 T_g N/yr; Logan, 1983; Hameed and Dignon, 1988; Levy and Moxim, 1989), soil-biogenic emissions, and biomass burning (4-20 T_g N/yr; Hao et al., 1990; Davidson et al., 1991; Levy et al., 1991); lightning discharge (<10 T_g N/yr; Penner et al., 1991); and upper troposphere aircraft emission, and stratospheric intrusion (<1 T_g N/yr; Levy et al., 1980; Kasibhatla et al., 1991; Kasibhatla, 1993).

Efforts to reduce O_3 in the urban atmosphere must account for both NO_x and hydrocarbon emissions, including emissions from natural sources (Chameides et al., 1988). For example, results published by Lindsay et al. (1989) for the city of Atlanta, Georgia, document continued exceedances of the National Ambient Air Quality Standard for O_3 (>0.12 ppmV) despite sizable reductions in anthropogenic emissions of hydrocarbons. This data strongly suggests that in urban environments like Atlanta, Georgia, emissions of natural hydrocarbons are not negligible, and that anthropogenic hydrocarbon emissions are not the dominant source of O_3-producing hydrocarbons. Failure to account for natural hydrocarbon emissions may be a serious flaw in the current national O_3 abatement control strategy, and may in part be related to the apparent lack of success in the U.S. to reduce O_3 in many urban areas.

A number of studies have now shown that in rural areas, natural emissions of NO can be just as significant as anthropogenic emissions in influencing the chemistry of the atmosphere (Anderson and Levine, 1987; Slemr and Seiler, 1991). However, we are not aware of any studies that have attempted to document biogenic NO emissions from within the confines of moderate to large cities. It is unknown, therefore, whether such emissions have the same potential to influence O_3 formation as do emissions of natural hydrocarbons. In this study, we focus on a relatively large urban center in the Southeast U.S. and the contribution of biogenic emissions to the total (biogenic + anthropogenic sources) NO budget in order to evaluate the extent to which such sources should be considered in photochemical modeling for ozone control.

Methods and Materials

Physiographic Location

Soil NO flux measurements were made in Raleigh, NC and the surrounding suburbs during the summer and fall of 1995. Raleigh, the capitol and the second largest city in North Carolina (35.52°N, 78.47°W, ~127 MSL), has a population of 250,000 people and is situated in the north central portion of the state, 150 km west of the Atlantic Ocean and 90 km south of the Virginia border. Raleigh is located in Wake County which has a population of approximately 500,000 people and is located along the geologic border between the Piedmont and Upper Coastal Plain regions of North Carolina.

Raleigh is accessible by I-40 from the northwest and southeast, US 64 from the east, and US 1 from the northeast and the south. I-440 is the major thoroughfare in Raleigh, which is a beltline encircling the city. The city is currently experiencing rapid growth in both population and number of businesses moving into the city and surrounding areas.

Sampling Scheme

Soil NO flux was measured on a daily basis using a dynamic flow-through chamber technique. Urban areas, which have more vehicular traffic than rural locations, will typically have fluctuating levels of ambient NO concentrations. Determining the loss term for the flux calculation, in an urban environment, would be difficult due to the fluctuating concentrations of ambient NO. In order to compensate for this problem of fluctuating ambient NO concentrations, zero grade air was used as the carrier gas in the chamber. Figure 2.1 is a schematic diagram of the dynamic flow-through chamber system utilizing zero grade air as the carrier gas. The use of zero grade air eliminates reactions within the chamber, except wall loss (Parrish et al., 1987; and Sullivan et al., 1996), from all subsequent calculations.

NO concentrations within the chamber were measured every 15 minutes, usually from 9:00 AM until 4:00 PM. The chamber was flushed with zero grade air for approximately 45 minutes prior to the first measurement to allow the system to reach a steady state. The stainless steel collar was relocated in the evening after each experiment, which attempted to remove a potential bias from soil NO flux due to soil disturbance generated by insertion of the stainless steel collar into the soil. Eleven sites were chosen for the collection of this data, nine which represented average fertilized lawn areas, and

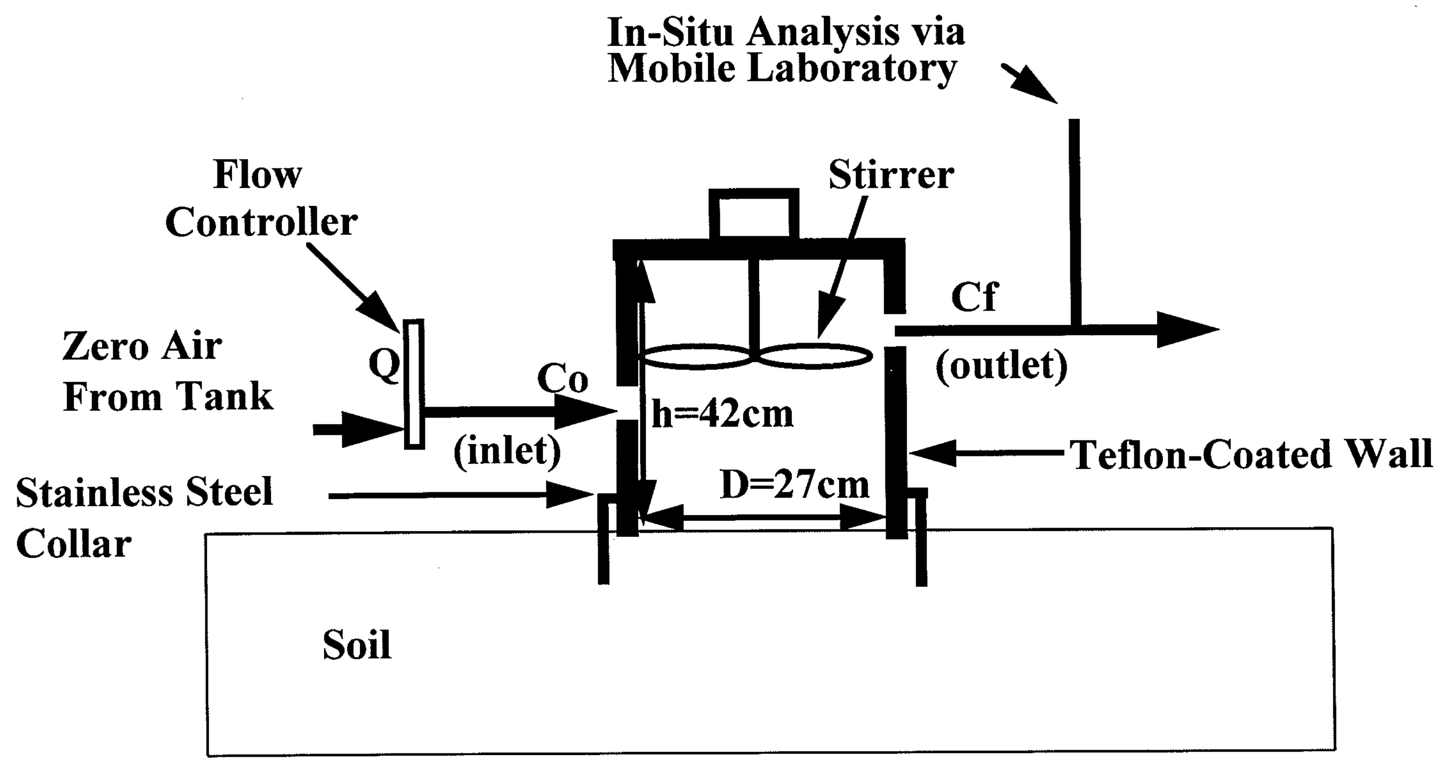

Figure 2.1. Schematic of dynamic flow-through chamber. The chamber fits inside of a stainless steel collar which is placed in the soil the previous day to minimize soil disturbances.

two which represented golf courses. Figure 2.2 shows the approximate locations of these 11 sites with Site 2 and Site 5 being the two golf course sites.

Flux Calculation

The NO flux was calculated from a mass balance equation (Kaplan et al., 1988; Kim et al., 1994). The mass balance equation is:

$$\frac{dC}{dt} = \left(\frac{q[C_{air}]}{V} + \frac{J}{h}\right) - \left(\frac{L}{h} + \frac{q}{V}\right)[C] \qquad (1)$$

where:

h = internal height of the chamber (42 cm)

J = emission flux per unit area (ng N m^{-2} s^{-1})

L = loss by chamber wall per unit area assumed first order in [NO] (cm s^{-1})

q = flow rate through the chamber (lpm)

V = volume of the chamber (24.05 liters)

C = NO concentration in the chamber (ppbV)

C_{air} = NO concentration in the stream entering the chamber (ppbV)

Assuming the chamber is well mixed, the concentration [C] which is measured can be assumed to be the same everywhere within the chamber. Additionally, at steady state conditions, the change of concentration with respect to time will be zero. Because zero grade air was used as the carrier gas, equation 1 can be further simplified. In the presence of zero grade air, the loss term (L) only represents losses due to the reaction of

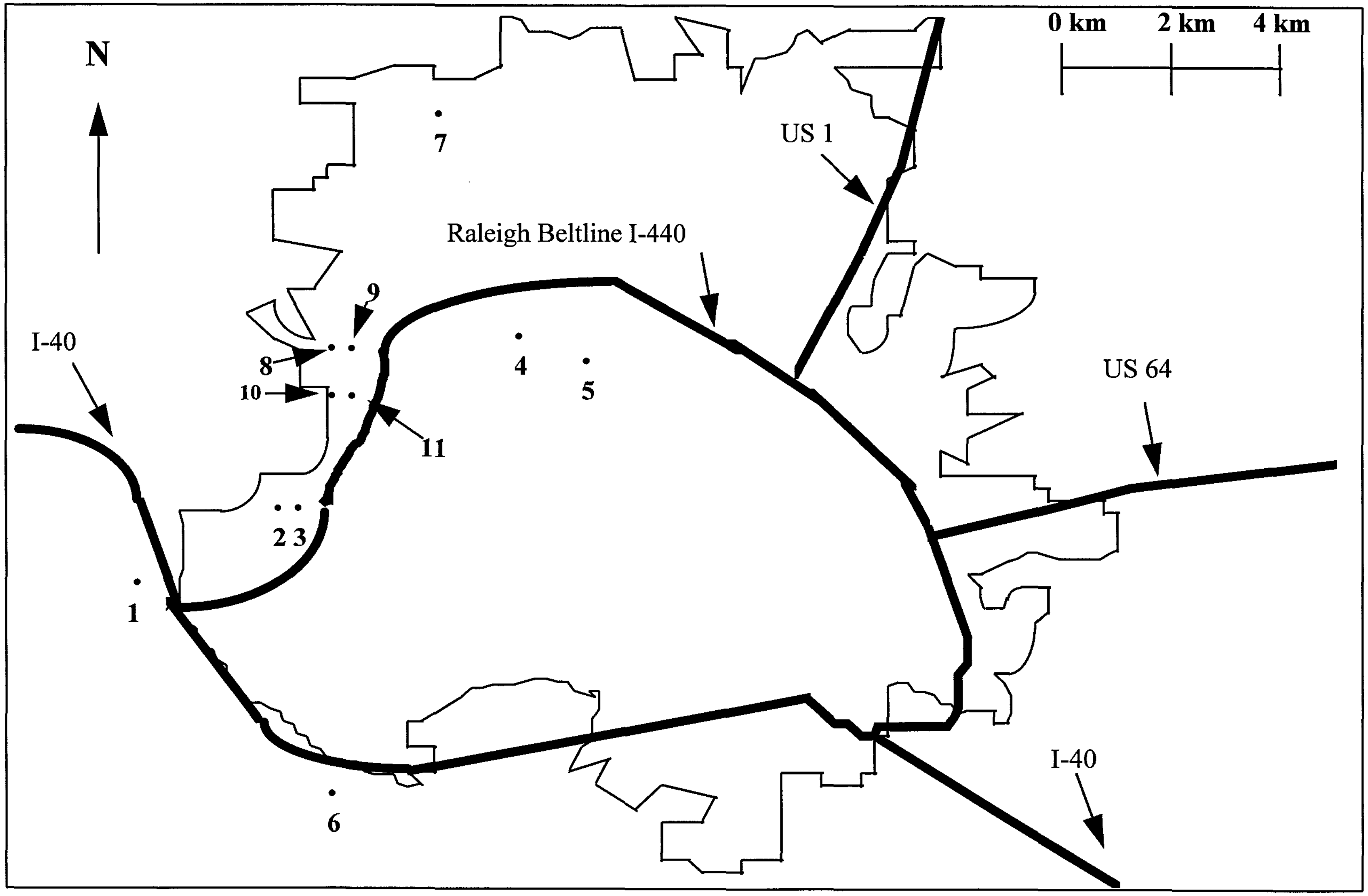

Figure 2.2 Map of Raleigh, NC with NO measurement sites indicated by numbers.

NO with the chamber wall (no other reactions resulting in production or destruction of NO should be occurring in the chamber).

$$\frac{J}{h} = \left(\frac{L}{h} + \frac{q}{V}\right) C_{eq} \tag{2}$$

where C_{eq} is the NO concentration measured at the outlet of the chamber after steady state is reached. For this study, the wall loss term L was assumed to have a value of 0.02 cm/sec as proposed by Kaplan et al. (1988).

Results and Discussion

Calculation of Raleigh Fertilized Lawn Area

In order to determine a NO budget for Raleigh, it was critical to determine the amount of land within the city limits that is capable of emitting NO. For example, we wanted to know how much land was paved and built on, versus how much land was grass and forested areas. Although areas which are not fertilized for many years will emit some NO (Williams et al., 1992; Kim et al., 1994), it has been found that the application of fertilizer can dramatically increase the emissions of NO (Slemr and Seiler, 1991; Jambert et al., 1994; Sullivan et al., 1996; Aneja et al., 1996). Therefore, the contribution from the fertilized acreage will be used to determine the biogenic NO_X budget and the non-fertilized acreage will only be considered when trying to calculate a budget using the most extreme scenario.

The City of Raleigh Planning Department provided the acreage for the following nine land use areas: Vacant, Open Space, Recreational, Industrial, Institutional, Office, Retail, Single, and Multi-Family dwellings. The Raleigh Department of Taxation provided figures on total homes, total apartment complexes, businesses, and approximate acreage for these respective properties. The City Planning Department and Geographical Information Systems Office was unable to provide data on the percentage of lawn area, as opposed to driveway, sidewalk, forest or building area. For the purpose of this study we assumed that 50% of all the land use areas were covered by lawns (personal communication with the North Carolina State University Forestry Department). Table 2.1 lists these nine different land use categories and their respective acreage, estimated lawn acreage and estimated fertilizer acreage.

Assuming that the only fertilized land use areas are those lawns in the industrial, institutional, office, retail, golf courses, multi-family, and single-family home areas, an estimate can be obtained for the land area which will emit the majority of biogenic NO. We assumed that approximately 90% of the industrial, institutional, office, retail, and multi-family land use areas use commercial lawn care. Using statistics provided by the National Gardening Survey, approximately 45% of the single-family home areas use fertilizer (see section on Calculation of Nitrogen Fertilizer Applied). Additionally, the lawn areas of the three golf courses in Raleigh were added, bringing the total to 6,961 hectares (ha) of fertilized lawn area in Raleigh, NC.

Calculation of Anthropogenic Emissions

The total anthropogenic NO_X budget for the Raleigh, NC area was calculated from a report provided by the North Carolina Department of Environment, Health and Natural Resources (DEHNR), Division of Environmental Management - Air Quality

Use	Total Acreage	Lawn Acreage	Estimated Fertilized Acreage
Vacant	15,204.94 ha	N/A	N/A
Open Space	4,886.33 ha	N/A	N/A
Recreational	3,866.15* (255) ha	127.48 ha	127.48 ha
Industrial	1,645.44 ha	822.73 ha	740.45 ha
Institutional	1,766.05 ha	883.03 ha	794.73 ha
Office	1,252.17 ha	626.08 ha	563.48 ha
Retail	2,901.93 ha	1,451.0 ha	1,305.87 ha
Multi-Family	2,200.47 ha	1,100.23 ha	495.11 ha
Single-Family	13,042.63 ha	6,521.31 ha	2,934.59 ha
Totals	**46,766.12 ha**	**11,531.83 ha**	**6,961.70 ha**

* The only acreage which is considered in this land use category is from the golf courses, listed in parenthesis.

ha = hectare

Source: City of Raleigh - Planning Department

Table 2.1. Land use categories in Raleigh, NC and associated acreage. The manner in which grass acreage and fertilized acreage was determined can be found in the section: Calculation of Raleigh Fertilized Lawn Area.

Section. This report (North Carolina Inventory - Tons/Day) contains all of the counties in North Carolina and an emissions inventory, by county, for the following categories: NO_X Point, defined as those facilities/plants/activities for which individual records are maintained in the inventory; NO_X Mobile, defined as a source which can travel on roads; NO_X Non Road (NR) Mobile, defined as vehicles which do not travel on roads, for example tractors, railroad locomotives, and aircraft; NO_X Area, defined as sources that are too small and/or too numerous to be handled individually in the point source inventory; and NO_X Biogenic, defined as tree, crop and vegetation species (EPA-450/4-91-016; Mobile Source Inventory, Charlotte Maintenance Plan). It is the sum of the first four of these sources which make up the anthropogenic sources.

Although these figures represent the entire Wake County, they were refined to be representative of only Raleigh. NO_X Area and Point sources, according to the report, emitted 2,449 kg and 1,633 kg per day, respectively. These values needed to be reduced to represent only the City of Raleigh. A separate report, also provided by DEHNR, lists all facilities in Raleigh and their NO_X emissions. The total of all the facilities in Raleigh summed to 272,486 kg of NO_X emitted per year. The total for the entire County of Wake was 1,490,076 kg of NO_X emitted per year (2,449.4 and 1,633.0 kg NO_X per day * 365 days per year). This suggests that Raleigh emits approximately 18% of all the area and point sources of NO_X for Wake County. The Area and Point source emissions, in Raleigh, for the 43 day period from August 22 to October 3, 1995 totaled 32,096.7 kg of NO_X.

The total NO_X emissions from both mobile and non-road mobile sources, in Raleigh, for the 43 day period were 1,123,131 kg. This value was obtained from the following calculation provided by DEHNR-Division of Environmental Management:

$$\frac{\text{Total Wake County mobile and non - road mobile sources}}{\text{Wake County Population}} * \text{Raleigh Population}$$

Summing both estimates (Area and Point Source emissions + mobile and non-road mobile Source emissions) brings the total to 1,155,228 kg of NO_X emitted by anthropogenic sources during the time period under investigation (Aug 22 - Oct 3, 1995).

Calculation of Nitrogen Fertilizer Applied

The total Nitrogen (N) fertilizer that was applied in Raleigh, NC was calculated by using the 1994 North Carolina Fertilizer Tonnage Report and through personal communication with both the Fertilizer Institute and the Professional Lawn Care Association of America. The total amount of N fertilizer that was shipped to Wake County between July 1, 1993 and June 30 1994 was 3,339,403 kg.

In order to estimate the amount of N fertilizer applied to the average lawn, we spoke with various lawn care companies which operate in Raleigh, NC. The spokespersons for these companies agreed that, on average, 1.36 kg of N per 92.94 square meters per year are applied to the average maintained lawn (TruGreen Chemlawn, Raleigh, NC; Barefoot Grass Lawn Service, Raleigh, NC, personal communication). This total is distributed through 3-4 applications throughout the year with the heaviest dose of nitrogen being applied in the fall. Additionally, the Professional Lawn Care

Association of America in Marietta, Georgia, provided the most recent National Gardening Survey. The city of Raleigh, NC falls into a demographic region where approximately 45% of the households are estimated to apply fertilizer to their yards. Applying this average (1.36 kg/N per 92.94 square meters) to the total fertilized lawn acreage translates to 1,019,692 kg of N applied in Raleigh, which represents approximately 30% of the 3,339,403 kg which was shipped to Wake County.

Biogenic NO Budget Using Data from Urban Measurements

The budget that we calculated represents only the period during which the measurements were made (Aug 22 - Oct 3, 1995). The total acreage for the lawn area (Industrial, Institutional, Office, retail, multi-family, and single-family) assumed to be fertilized in typical quantities (1.36 kg N per 92.94 square meters per year) is 6,834 ha. The average flux from the nine measurement locations representative of these land-use areas was 5.66 ng N m^{-2} s^{-1}. Applying this average to the total acreage for the 43 day period produces 1,433 kg of N. It should be noted that this estimate may slightly overestimate NO emissions, because we obtained our daily average flux from measurements between 9:00 AM and 4:00 PM and previous studies have shown that soil NO emissions tend to follow soil temperature with afternoon maximum and a daytime minimum values (Williams et al., 1988; Shepherd et al., 1991; Valente and Thorton, 1993; Sullivan et al., 1996). Experimental constraints precluded diurnal experiments. Table 2.2 lists the average NO flux from the 11 different measurement sites.

Site	Date	Average NO Flux ($ng\ N\ m^{-2}\ s^{-1}$)
1	Aug 22, 1995	8.69
2 (Golf Course)	Aug 24, 1995	5.64
3	Aug 25, 1995	3.74
4	Aug 29, 1995	4.39
5 (Golf Course)	Aug 30, 1995	16.29
6	Aug 31, 1995	3.50
7	Sept 26, 1995	18.10
8	Sept 28, 1995	1.43
9	Sept 29, 1995	3.59
10	Oct 2, 1995	2.73
11	Oct 3, 1995	3.77

Table 2.2. The average flux at the 11 different sites which were measured during the Raleigh, NC urban study. See Figure 2.2 for the location of these sites.

The total fertilized acreage for the lawn areas at the three golf courses located in Raleigh, NC is 127 ha. The average flux for the two measurement locations representative of this land-use area was 10.9 ng N m^{-2} s^{-1}. Applying this average to the total golf course acreage produces 51.7 kg of N for the 43 day period. Therefore, the total NO budget from fertilized lawns in Raleigh, NC is 1,485 kg of N for the period during which the measurements were made.

Biogenic NO Budget Used in the EPA Regional Oxidant Model (ROM)

The Regional Oxidant Model (ROM) (Pierce and Novak, 1991) is used by the Environmental Protection Agency (EPA) in order to estimate natural sources of nitrogen oxides (NO_X) and nonmethane hydrocarbon (NMHC). The model uses an algorithm developed by Williams, 1991, to assess the emissions of NO due to microbial processes in the soil. The equation used to calculate the flux is:

$$\text{Flux (ng N m}^{-2}\text{ s}^{-1}) = C * \text{Exp}(.071 * T_S)$$

where:

C = experimentally derived coefficient for each land-use category

T_S = soil temperature (°C), which is derived from functional relationships with air temperature

Table 2.3 lists all the land use categories in the algorithm, their respective C values and the functions for calculating soil temperature.

For urban areas, the EPA assumes that 20% of the acreage is grass ($C = 0.9$) and a corresponding temperature function ($T_S = 0.67*T_A + 8.8$) to model NO emissions. Table 2.4 lists air temperature, and soil temperature, as calculated by the soil temperature

Land Use	C	Function For Computing Soil Temperature (T_S ^0C) From Air Temperature (T_A ^0C)
Grasslands and Pasture	.9	$T_S = .67 * T_A + 8.8$
Forest	0.07	$T_S = .84 * T_A + 3.6$
Wetlands	0.004	$T_S = .92 * T_A + 4.4$
Agriculture		
Upper Bound	9.0	$T_S = .72 * T_A + 5.8$
Lower Bound	0.2	$T_S = T_A + 2.9$

Table 2.3. Land use categories and their respective C values and soil temperature functions (Source: Williams, Parish and Fehsenfeld, 1990; Pierce and Novak, 1991).

Date	Average Air Temp (^{o}C)	Average Soil Temp (^{o}C)	Average* NO Flux (ng N m^{-2} s^{-1})	EPA ROM Average Flux (ng N m^{-2} s^{-1})
Aug 22	30.28	29.09	8.69	7.10
Aug 24	28.61	27.97	5.64	6.56
Aug 25	29.17	28.34	3.74	6.73
Aug 29	25.69	26.01	4.39	5.70
Aug 30	28.06	27.60	16.29	6.39
Aug 31	27.92	27.51	3.50	6.35
Sept 26	21.67	23.32	18.10	4.71
Sept 28	21.11	22.94	1.43	4.59
Sept 29	20.42	22.48	3.59	4.44
Oct 2	24.03	24.90	2.73	5.27
Oct 3	24.03	24.90	3.77	5.27

*This study.

Table 2.4. The air temperature, as recorded at the Raleigh-Durham International Airport, and the soil temperature as calculated by the temperature algorithm used in the EPA Regional Oxidant Model are listed for the 11 urban sites which were measured. The average NO flux calculated using a mass balance equation and the NO flux calculated using the Regional Oxidant Model are also listed.

function. Additionally, the table displays side by side comparisons of daily average NO fluxes using our mass balance approach and the NO flux algorithm used in the ROM. Except for the two high fluxes which occurred on Aug 30 and on Sept 26, 1995, the algorithm tended to slightly overestimate biogenic emissions. Using the estimates generated by the ROM and applying them to the fertilized land areas in Raleigh (see section on Calculation of Raleigh Fertilized Land Area) for the 43 day period produces a total NO budget of 1,487 kg of N.

Conclusions and Recommendations

The urban measurements of NO conducted in Raleigh, NC suggest that biogenic emissions make up a minor portion of the overall NO_X budget. The 11 sites measured, in addition to land estimates, show that for the 43 day period from Aug 22 - Oct 3, 1995 approximately 1,485 kg of N are emitted from the fertilized soils. This estimate represents less than 1% of the anthropogenic emissions emitted in Raleigh for the same time period. The most liberal estimate would be to assume that all of the vacant and open space land use areas were lawn (total acreage = 31,623 ha) and that all these acres emitted at the highest flux calculated (18.1 ng N m^{-2} s^{-1}). Using these values would produce 21,273 kg of N emitted which is still less than 2% of the anthropogenic emissions emitted in Raleigh from Aug 22 - Oct 3, 1995.

Comparing the estimates obtained using the urban measurements (1,485 kg of N emitted during the 43 day period) and the algorithm used in the Regional Oxidant Model (1,487 kg of N emitted during the 43 day period) shows no significant differences.

However, there is a difference in the methods used for estimating the amount of lawn area in the urban centers. The comparisons made between the two techniques were conducted using identical lawn acreages. Through communication with the EPA, it became evident that we were not making the same assumptions of lawn acreage. The EPA model assumes that 20% of all the acreage in urban areas is grassland whereas we assumed 50% of certain land use categories are grassland. There is no way to substantiate either claim without a detailed land analysis. However, the results suggest that biogenic emissions, which account for such a small fraction of the total NO_X budget, makes any differences in the lawn acreage's inconsequential.

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Chapter III. Biogenic Nitric Oxide Source Strengths in North Carolina.

Abstract

Emissions of nitric oxide (NO) were measured during the summer of 1995 from 4 crops, located at three different sites throughout North Carolina. These sites were chosen to represent major physiographic regions of the Southeast U.S., in an effort to compare fluxes from different agriculturally managed soils. Emission rates were determined using a dynamic flow-through chamber system. In order to understand the NO flux from the different soil and crop types, measurements were made on corn and soybean crops in the coastal region, tobacco in the piedmont region, and corn in the upper piedmont region of North Carolina. Average NO fluxes were 5.5 ± 2.2 ng N m^{-2} s^{-1}, 20.7 ± 19.2 ng N m^{-2} s^{-1}, 4.1 ± 1.4 ng N m^{-2} s^{-1}, and 8.5 ± 4.9 ng N m^{-2} s^{-1} respectively for corn and soybean in the coastal region, tobacco in the piedmont region, and corn in the upper piedmont region. We were only able to detect an exponential dependence of NO flux on soil temperature at two of the locations. The composite data of all the research sites revealed a general trend of increasing NO flux with soil water content or increasing extractable nitrogen in the soil, however, the day to day variations within each site did not reveal the same trends. We feel that acquisition of a soil NO flux data set in this fashion, which consists of observations collected over different points in both space and time, makes attempts to model soil NO flux in terms of different soil parameters very difficult.

Introduction

Ozone photochemistry in the troposphere is regulated by oxides of nitrogen (NO_X = $NO + NO_2$). Currently, the only known pathway for the production of ozone is the photolysis of NO_2 ($NO_2 \rightarrow NO + O(^3P)$), which further reacts with O_2 to produce ozone (O_3) by the reaction $O(^3P) + O_2 \rightarrow O_3$. In a pseudo-photostationary environment, the O_3 produced would react with the NO that was generated via the photolysis of NO_2 in the following reaction: $NO + O_3 \rightarrow NO_2 + O_2$. Hence, there is no net production of O_3. However, in the real atmosphere, hydroxyl radicals combine with volatile organic compounds (VOC's) to produce new radicals which preferentially react with NO, allowing a net O_3 accumulation. Regions such as the southeast U.S. are classified as NO_X limited and increased emissions of NO into the troposphere are likely to produce increased O_3 concentrations (SOS, 1993). In a region which currently maintains 40% of the ozone non-attainment areas of the U.S., the Southeast must develop a better understanding of these ozone precursors in order to more successfully develop control strategies for the emissions of ozone precursors.

The strongest sources of NO_X are known to be anthropogenic and located in confined geographical areas, such as the combustion of fossil fuels from power plants and automotive exhaust (Logan, 1983; Hameed and Dignon, 1988; Levy and Moxim, 1989). Being confined to known areas, these anthropogenic sources can be well quantified and modeled. In contrast, biogenic emissions are not as clearly understood. Recent studies have estimated that soil emissions can be 50% of the NO_X budget in remote agricultural areas of the U.S., and even exceed 75% of the NO_X budget during certain months of the year (Yienger and Levy, 1995). Researchers have found that obtaining accurate estimates by computer modeling is difficult to achieve due to the extremely high variability of biogenic soil NO emissions. Seemingly homogeneous soils have been shown to differ by more than a factor of 10 between adjacent sites (Williams and Fehsenfeld, 1991). Although the apparent spatial variability of soil NO emissions would appear to limit attempts to model soil NO flux, there are some environmental parameters which have been shown to have a reasonably consistent relationship with NO flux. These include soil temperature, soil water content and the nitrogen content of the soil (Anderson and Levine, 1984; Davidson, 1991; Slemr and Seiler, 1991; Hutchison and Brams, 1992; Sullivan et al., 1996).

The objective of this study was to measure NO emissions from several different physiographic regions in the southeast U.S., in an attempt to relate NO flux to different physical and chemical properties of soil. Further, these relationships could then be extrapolated to similar physiographic regions of the southeast U.S. to better model emissions of NO from biogenic processes within soils.

Methods and Materials

Sampling Sites and Crop Characterizations

NO flux measurements were made on three different crop types (corn, soybean, tobacco) at three different research sites during Summer of 1995. The research sites were located in Lenoir County, NC, approximately 5 km northeast of Kinston, NC; Granville County, NC, approximately 5 km west of Oxford, NC; and Rockingham County, NC, approximately 10 km southwest of Reidsville, NC. All three of these sites were operated by the North Carolina Department of Agriculture using management practices typical for their respective crops and physiographic locations. The agricultural fields at the Kinston, NC research facility were dominated by a soil type classified as Rains fine sandy loam.

The dominant soil types of the Oxford, NC and Reidsville, NC research sites were classified as Vance sandy loam and Pacolet sandy loam respectively. The location of these research sites can be seen in Figure 3.1.

NO flux measurements at the Kinston, NC research site were conducted on both corn and soybean fields. The corn crop was planted in early April, and the seed was drilled directly into soybean stubble (no-till planting) from the preceding year. The corn crop received a total of 190 kg N per hectare. The corn crop, which was in a mature growth stage, had fully developed ears and had reached an approximate height of 183 cm. The soybean crop at Kinston was planted during the first week of June, 1995. The soybean seed was planted directly into the residue of wheat (no-till planting), which was harvested a few days prior to the soybeans being planted. Although the wheat crop received approximately 157 kg N per hectare during the month of February, 1995, the soybean crop did not receive any N fertilizer. The soybean crop, which was in a vegetative growth stage, was approximately 10 cm tall at the beginning of our measurement period and grew to a height of approximately 25 cm at the conclusion of our measurement period.

The research conducted in Oxford, NC was on a tobacco crop. The tobacco plants were initially grown in tobacco plant beds and transplanted to the growing field in early May, 1995, when the individual plants were approximately 13 cm tall. The tobacco plants were planted in raised beds, which were spaced approximately 1 meter apart. After transplanting, the tobacco crop received a total of 70 kg N per hectare. During our measurement period, the tobacco crop was in a mature growth stage, reaching an

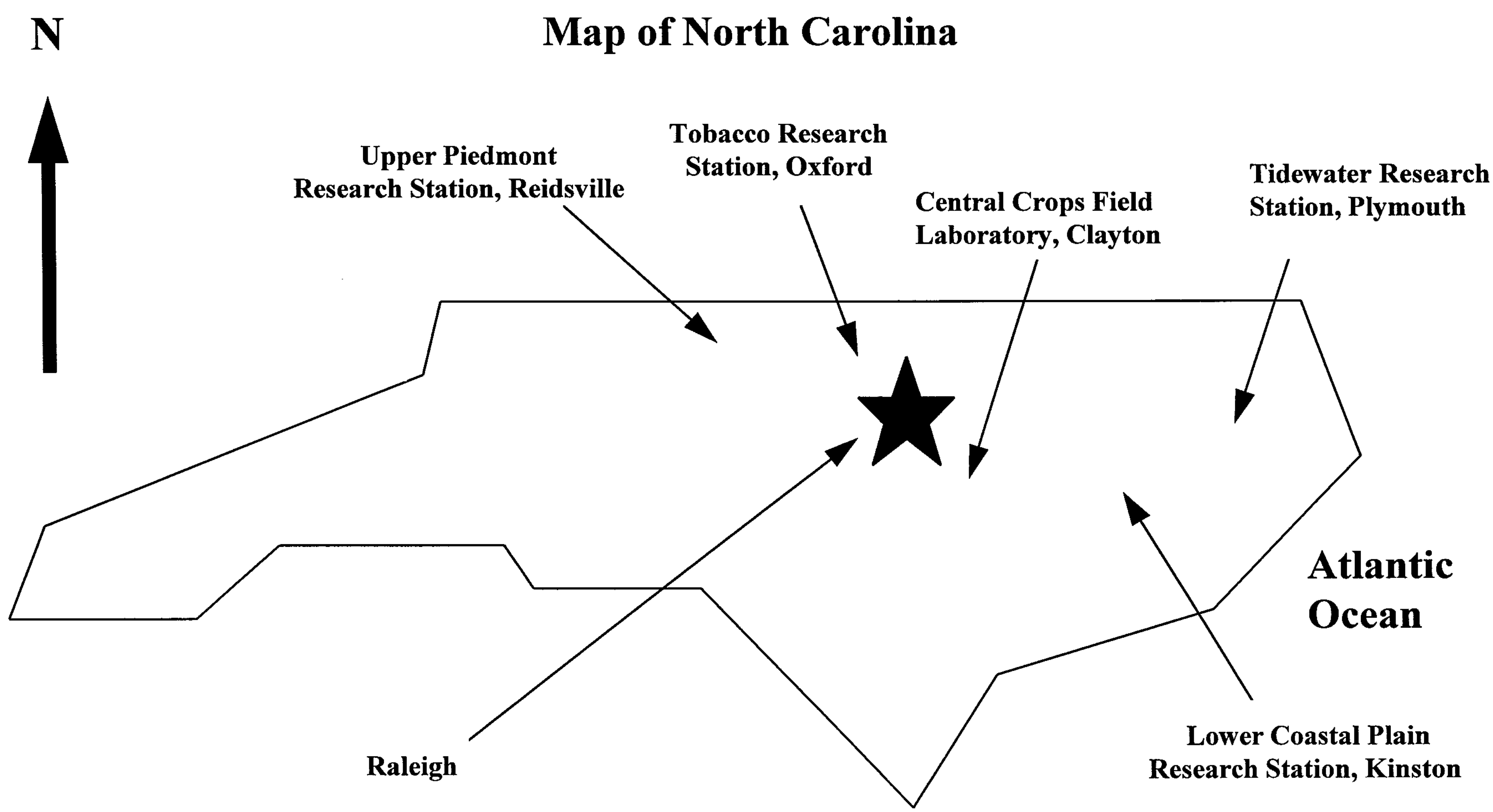

Figure 3.1. Location of NO flux measurement sites in various physiographic regions of North Carolina.

approximate height of 145 cm. Leaves from these tobacco plants were being harvested throughout our measurement period.

The research conducted in Reidsville, NC was on a corn crop that was planted in early April, 1995. The corn seed was drilled directly into stubble (no-till planting), from corn planted the preceding year, and received a total of 197 kg N per hectare. This crop was in a mature growth stage, and had reached an approximate height of 289 cm, which was attributed to the large amounts of rain during the early part of the growing season. Portions of the crop were being harvested during our measurement period.

Sampling Scheme

The sampling scheme of the multi-site experiment was to measure concentrations of Nitric Oxide (NO) at ground level at three distinctively different physiographic locations in North Carolina. The methodology of how each experimental day was conducted is detailed in Chapter I, Sampling Scheme. Measurements were conducted for a minimum of four days at each site with at least one continuous 24-hour experiment conducted at each location.

The measurement campaign began in Kinston, NC from June 30 until July 13, 1995. Typically only one crop was measured at each of the sites, however this site had two different crops planted side-by-side facilitating NO flux measurements on both corn and soybean, with one week being spent at each crop. Oxford, NC was the second site of the measurement campaign, with NO flux measurements made on a tobacco crop from July 20 until July 27, 1995. The measurement campaign concluded in Reidsville, NC with NO flux measurements made on a corn crop from August 1 until August 10, 1995.

Instrumentation and Flux Calculation

All instrumentation to measure NO emissions, and equations to calculate NO flux are discussed in Chapter I. See Chapter I, Flux Calculation and Temperature Controlled Mobile Laboratory for any questions concerning the NO flux calculation or instrumentation used throughout the research period.

Temperature and Soil Analysis

Soil and air temperature were recorded every 15 minutes in conjunction with NO flux measurements. Soil and air temperatures were recorded and stored in a laptop computer using Fascinating Electronics software and temperature probes. The temperature probe was inserted 5 cm into the soil, adjacent to the chamber, while the air temperature probe was positioned at a height of 1 m, shielded from direct sunlight.

A soil sample was taken from the center of the dynamic flow-through chamber footprint at the end of each experimental period (approximately 1 sample per day). Samples were taken with a bucket auger which removed the top 20 cm of soil. Soil parameters, such as total extractable nitrogen, moisture content, and pH for the various research sites were determined for each soil sample collected. Nitrate (NO_3^-) and ammonium (NH_4^+) in a 2 M KCL soil extract (Keeney and Nelson, 1982) were determined using standard autoanalyzer techniques (Lachat Instruments, 1990).

Results and Discussion

NO Flux

The intersite comparison revealed that measured soil NO flux was heavily dependent on location and crop type (Table 3.1). The highest average NO flux, 20.7 ± 19.2 ng N m^{-2} s^{-1}, occurred from a soybean field in Kinston, NC, although it should be noted that the average NO flux from this soybean crop would have been 12.8 ± 5.2 ng N m^{-2} s^{-1} if we neglected one day of measurements after a rain event. We observed the largest amount of NO flux from the soybean crop, unlike what has typically been observed by other researchers (Aneja et al., 1995; Sullivan et al., 1996). However, the different sampling periods of the various crops should be taken into consideration when trying to account for this apparent anomaly. We were sampling the soybean crop within 4 weeks of the seed being drilled directly into the wheat stubble. This method of planting left the root system of the wheat crop undisturbed. The subsequent decomposition of the wheat roots may have provided an abundant nitrogen source explaining the higher than expected NO flux values.

The diurnal variation in which NO flux increases in the afternoon, coinciding with the rise in soil temperature throughout the afternoon, can be seen in Figure 3.2, which shows the average NO flux (6:00 AM - 6:00 PM) for each of the crops sampled. Figure 3.2 also reveals a morning peak of NO emissions, between 6:00 AM - 10:00 AM, which seems to be fairly consistent among all physiographic locations and crop types. Similar result were observed by Holbrook (1994), and the hypothesis which was proposed was that the roots of the plants exude organic compounds during the morning hours. These

		Soil Temp. (^oC)	Total Extractable N (mg N kg dry soil^{-1})	% Soil Moisture (dry weight)	NO Flux (ng N m^{-2} s^{-1})
Site: Kinston, NC	Average	24.8	10	12.6	5.5
Crop: Corn	Standard Deviation	2.4	2	1.5	2.2
Growth Stage: Maturity	Minimum	19.3	8	10.7	3.0
Date: June 30 - July 5, 1995	Maximum	32.5	12	14.5	14.4
Site: Kinston, NC	Average	25.7	14	12.8	20.7
Crop: Soybean	Standard Deviation	3.0	3	0.8	19.2
Growth Stage: Vegetative	Minimum	21.5	11	11.6	6.1
Date: July 10 - July 14, 1995	Maximum	31.9	19	13.4	80.0
Site: Oxford, NC	Average	27.3	8	5.6	4.1
Crop: Tobacco	Standard Deviation	2.1	2	2.3	1.4
Growth Stage: Maturity	Minimum	23.5	6	2.7	1.7
Date: July 20 - July 27, 1995	Maximum	32.5	13	8.1	8.0
Site: Reidsville, NC	Average	22.6	13	11.3	8.5
Crop: Corn	Standard Deviation	2.3	12	2.4	4.9
Growth Stage: Maturity	Minimum	19.7	4	10.0	1.9
Date: August 2 - August 11, 1995	Maximum	29.0	32	15.6	20.5

Table 3.1. Data Summary for Kinston, Oxford, and Reidsville, NC (Summer 1995). All NO flux data and soil data were calculated from the 15 minute binned averages. The total extractable N and % soil moisture content were calculated from the soil sample collected from the center of the chamber footprint at the end of each measurement period.

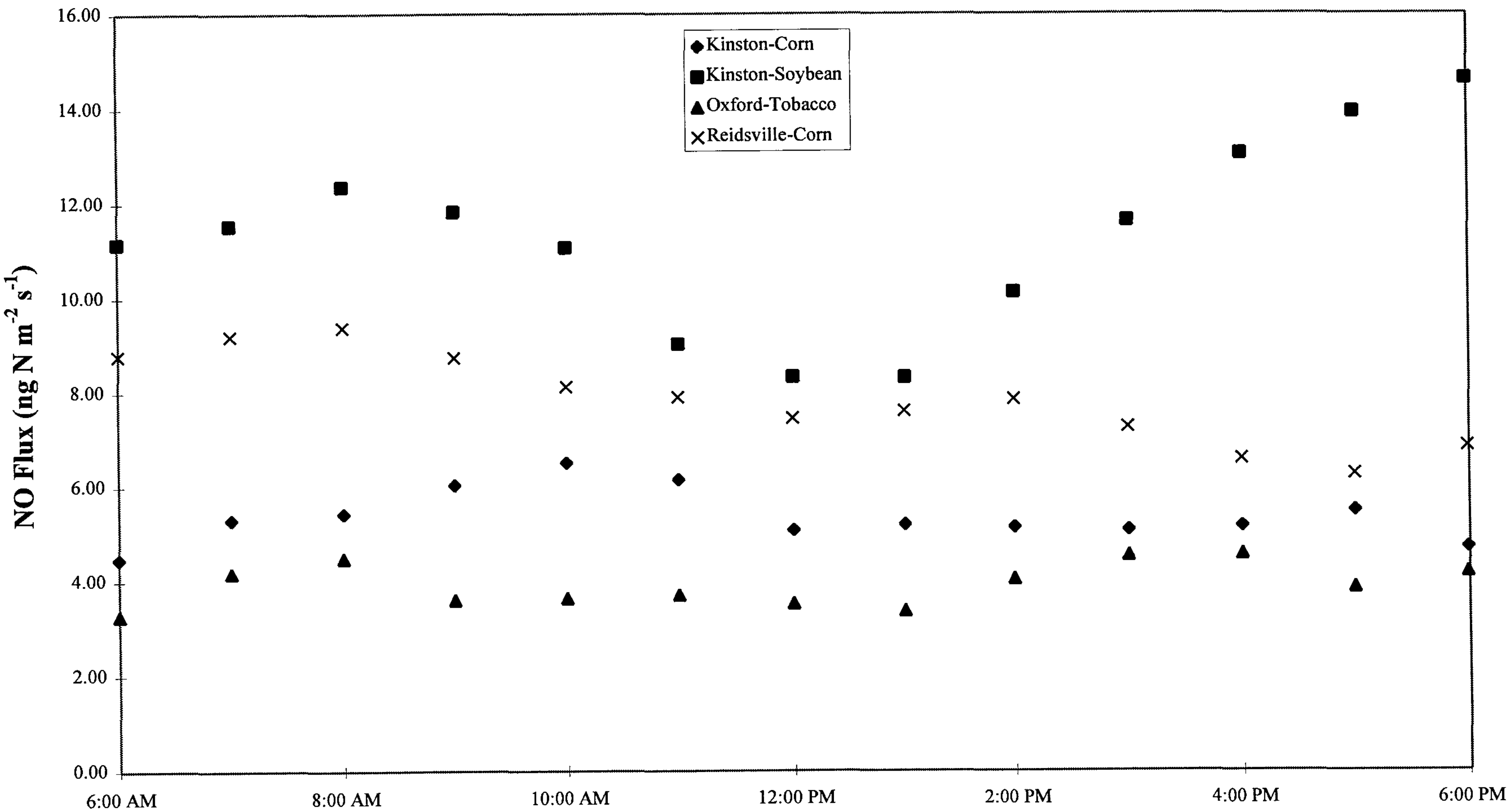

Figure 3.2. The composite hourly averaged NO flux (6:00 AM - 6:00 PM) for the three research sites and the 4 crops. Note: The plot of soybean at Kinston does not contain the data from measurements conducted on the day following a thunderstorm.

organic compounds are then utilized by denitrifying bacteria which reduce NO_3^- generating emissions of NO greater than would be predicted by soil temperature.

Another possible explanation of this morning peak in NO flux is that it is an effect caused by the high volume of vehicular traffic during morning rush hour. NO is a product of combustion processes, therefore the increased vehicular traffic will generate increased ambient NO concentrations. The NO rich ambient air is then pumped into the chamber as the carrier gas. The loss term used in the equation to calculate NO flux is determined by allowing the chamber to reach an equilibrium concentration at different flow rates (See Flux Calculations, Chapter 1). The experiments to determine the loss term were conducted during the afternoon and during the nighttime. The large fluctuations in NO flux due to vehicular traffic during the morning hours would likely generate a different loss term and therefore a different flux value. Typically, O_3, which tends to destroy NO via the reaction $NO + O_3 \rightarrow NO_2 + O_2$, is at a minimum throughout the night and early morning hours. Therefore, it is possible that the excess NO produced from the rush hour traffic is not consumed as rapidly, causing the loss term to be smaller than it would be in the afternoon. A smaller loss term in the flux calculation would effectively reduce the morning peak of NO. We did not detect this peak at the Plymouth, NC site (Chapter 1), which was essentially isolated from vehicular traffic. The research sites located in Kinston, Oxford, and Reidsville, NC were all influenced, to some degree, by nearby roadways or farm traffic.

The plot for soybean in Figure 3.2 contains three of the four sample days, because the NO flux which we recorded on 11 July 1995 was an order of magnitude larger than the rest of the sampling days, and we felt this was unrepresentative of average NO emissions at this site. The increased NO flux for this particular day, evident by the change in scale of the y-axis in Figure 3.3 can be attributed to rainshowers that occurred the previous evening, which is consistent with a process referred to as "pulsing" by Yienger and Levy (1995). These pulse fluxes, which occur as the result of a rain event, can be 10-100 times background values and have been observed to last for a few days to a few weeks (Stocker et al., 1993; Valente and Thornton, 1993; Williams et al., 1987; Williams and Fehsenfeld, 1991). The duration of the increased flux will vary depending on the moisture condition of the field prior to the rain event and the amount of rain. We observed 1 day of increased NO flux immediately after the rainshower and the NO flux returned to pre-rain event values on July 12, 1995.

Each crop received different amounts of N fertilizer (Kinston - Corn, 190 kg N per hectare; Kinston - Soybean, 0 kg N per hectare; Oxford - Tobacco, 70 kg N per hectare; Reidsville - Corn, 197 kg N per hectare). By taking a ratio of the average summertime flux of NO to the amount of total N fertilizer applied to each crop, we can estimate the amount of N fertilizer returned to the atmosphere, during the summer months, via NO flux. For each of the crops which were fertilized, the percentage of nitrogen applied as fertilizer which was returned to the atmosphere via NO flux was less than 1%.

Soil Temperature

Strong relationships between NO flux and soil temperature, in which NO flux doubles for each 10 °C increase in soil temperature, has been observed by several researchers (Williams et al., 1988; Williams and Fehsenfeld, 1991; Kim et al., 1994).

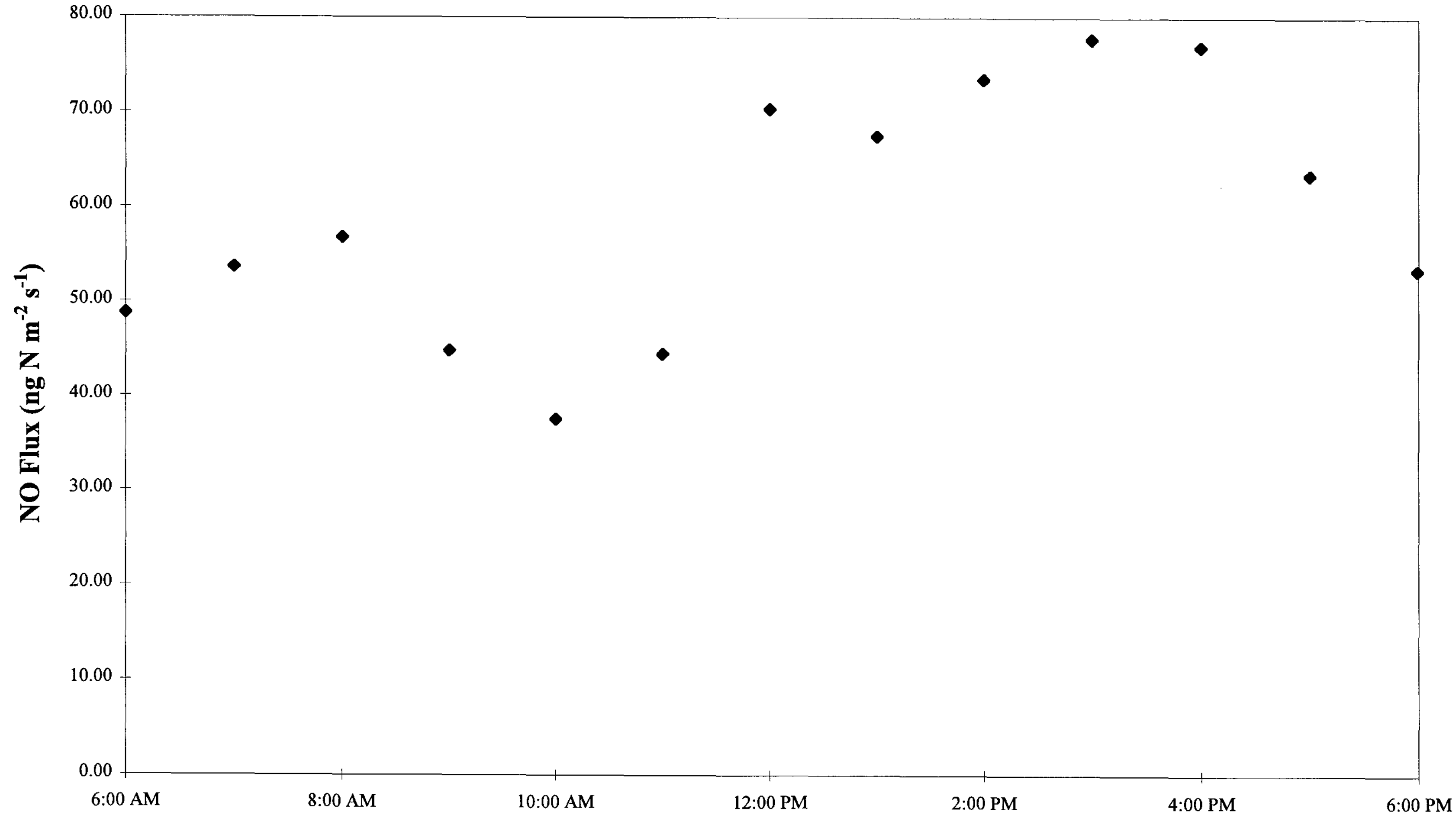

Figure 3.3. Hourly averaged NO flux (6:00 AM - 6:00 PM) for the soybean crop in Kinston, NC after a thunderstorm.

Unlike most of these researchers who were sampling from fairly uniform and stable forest and grassland systems, our research was conducted from intensively managed, dynamic agricultural soils. Although we occasionally detected this same relationship between soil temperature and NO flux, we were not surprised that our results were not consistent across the three different soil and crop types. Figure 3.4 is a graph of daily average NO flux, plotted on a log scale, versus daily average soil temperature (9:00 AM - 5:00 PM) at the tobacco crop located in Oxford, NC. This graph displays the strongest relationship between soil temperature and NO flux that we detected in our multi-site experiment (R^2=0.54). The soybean crop in Kinston, NC (excluding the day after the rain event) also showed some relation between soil temperature and NO flux (R^2=0.35), however the two corn crops sampled in Kinston and Reidsville showed virtually no NO flux dependence on soil temperature (R^2=0.01 for both sites). These results from Kinston and Reidsville, which were sampled approximately two months after the last N fertilizer application, are consistent with some of the results of the data that we collected from a corn crop located in Plymouth, NC. Research at Plymouth, NC was segregated into two time periods, which were before and after the final application of N fertilizer. The Plymouth, NC site revealed no NO flux dependence on soil temperature until immediately after the field was fertilized. The fact that no relationship between soil temperature and NO flux was detectable until excess amounts of N were present in the top few centimeters of the soil surface suggests that NO flux is also being controlled by the application of N fertilizer.

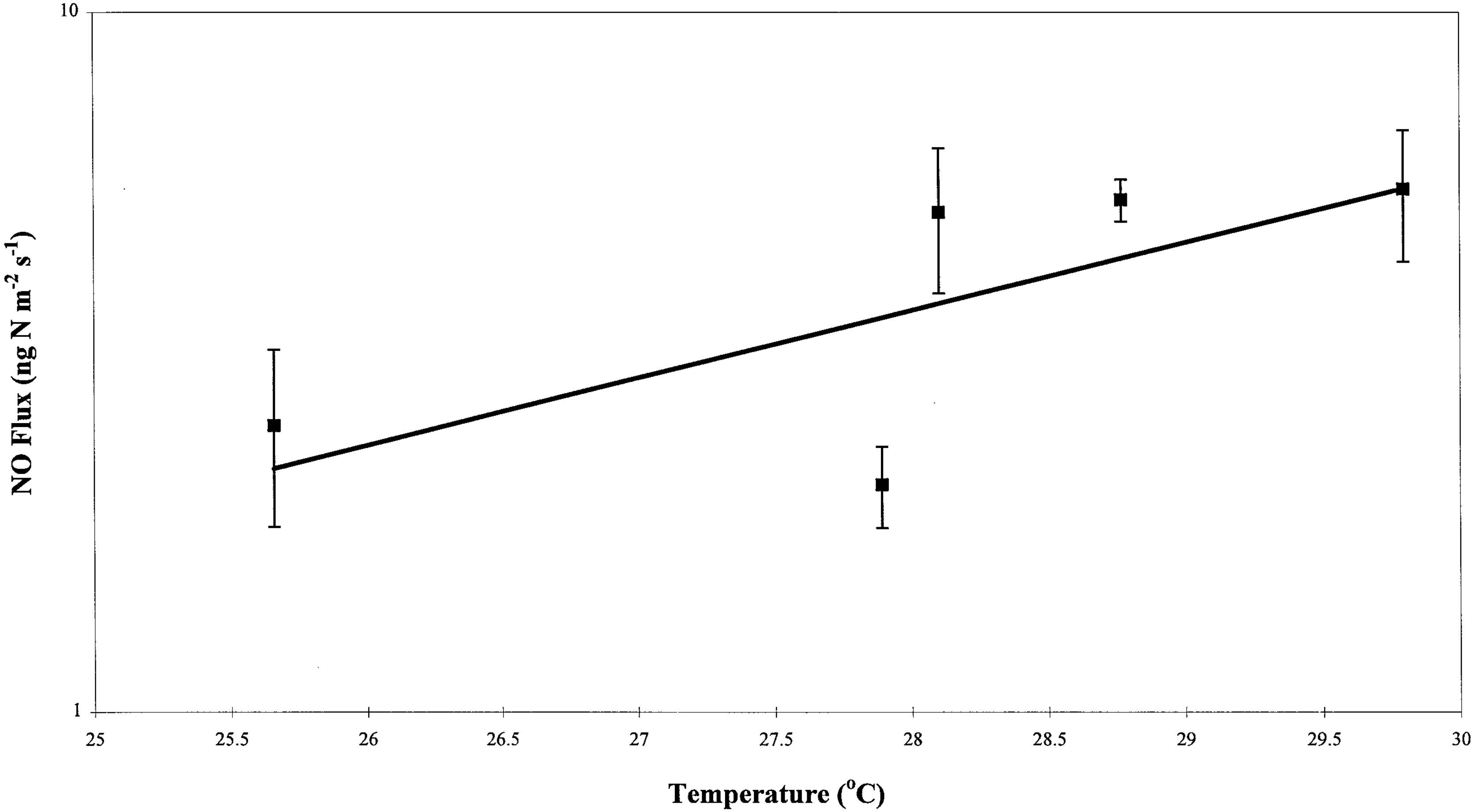

Figure 3.4. Daily averaged NO flux versus daily averaged soil temperature (9:00 AM - 5:00 PM) plotted on a logarithmic scale. Vertical bars indicate one standard deviation of the average NO flux. This plot represents data collected from a tobacco crop in Oxford, NC.

Total Extractable Nitrogen and Soil Moisture

Nitrogen enters the biosphere predominantly by bacterial nitrogen fixation (Warneck, 1988). This process involves living biomass incorporating N_2 and reducing it into forms which the plant can use to satisfy its energy needs. NH_4^+ and NO_3^- are two forms of nitrogen which are utilized by soil microbes and can lead to the release of NO gas in soils. The total extractable nitrogen ($NH_4^+ + NO_3^-$) present in the soil, therefore should give an indication of NO flux. Figure 3.5 is a graph of NO flux versus total extractable N for the different measurement sites. The general trend among all of the data points is an increase in NO flux as total extractable N increases, however within each crop type, the relationship is not as evident. This graph reveals, as other researchers have also reported, that a change in extractable nitrogen, by itself, does not lead to increased NO flux (Williams and Fehsenfeld, 1991; Cardenas et al., 1993; Sullivan et al., 1996).

Although we have seen NO emissions follow changes in soil temperature, and to some degree follow changes in extractable nitrogen content, the correlation's are further complicated by the interactions of soil moisture. Researchers have shown that biogenic NO emissions can take place over a wide range of soil moisture conditions as long as the soils are not stressed by a lack of water or are not water saturated (Slemr and Seiler, 1984; Williams et al., 1986; Anderson and Levine, 1987; Johansson et al., 1988; Williams and Fehsenfeld, 1993). A model has been proposed by Davidson (1993) which shows no effect of soil moisture on NO flux, as long as the field is in an optimum range, meaning it is neither water stressed nor water logged. The optimum range of soil moisture for any given field will differ due to soil and crop type. The range of soil

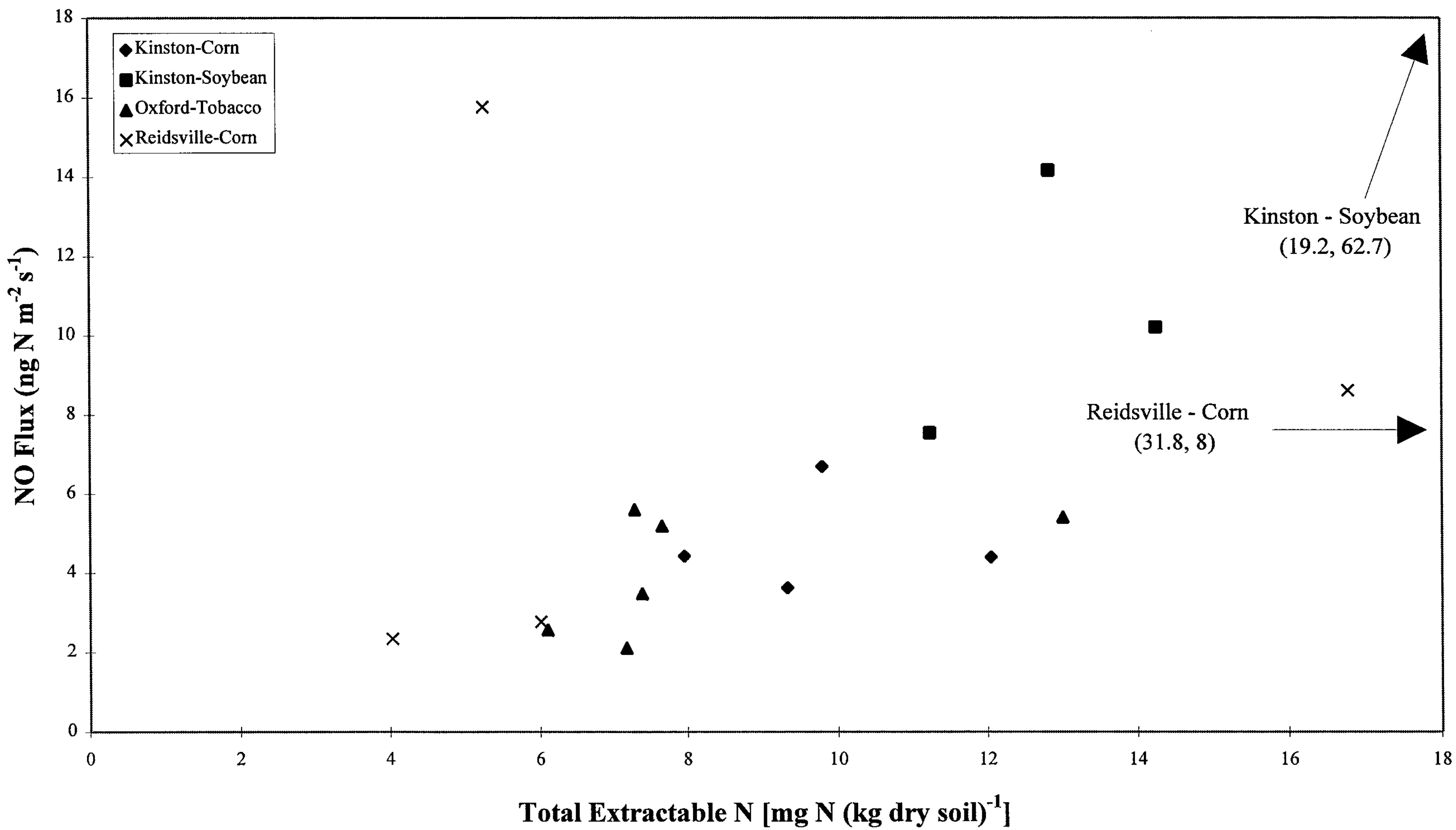

Figure 3.5. Daily averaged NO flux (9:00 AM - 5:00 PM) versus total extractable N. The arrows indicate two data points located off of the scale.

moisture (dry weight) that we observed from our multi-site experiment ranged from 2.9 - 15.7 %, however our data does not specify the optimum range of soil moisture for the individual fields. Looking at the individual research sites in Figure 3.6, there does not appear to be any relationship between soil moisture and NO flux, which is consistent with what has been proposed by Davidson (1993), if we assume that all of the soils were neither water stressed nor water logged. Further inspection of Figure 3.6 reveals that there is an overall trend among all the data points of increasing NO flux with increasing % soil moisture. However, we can not infer from this graph alone that increasing soil moisture will generate increased emissions of NO. The nature of an observational based study is that we had to accept the environmental conditions as we encountered them. The hypothesis that NO emissions were the lowest in Oxford due to this site having the lowest soil moisture could not be tested because we did not experience any rain events during the measurement period at this location.

Figure 3.7 is a three dimensional plot of NO flux versus % soil moisture and total extractable nitrogen. This graph shows that there is a range of soil moisture (between 10-14%) and a range of total extractable nitrogen (8-13 mg N kg dry soil^{-1}) which produce fairly consistent levels of NO emissions. When soil conditions varied from these ranges we saw corresponding deviations in NO flux, however not in any predictable manner. Researchers have attempted to model these deviations in soil conditions. Most recently Yienger and Levy (1995) modeled the effect of soil moisture and the effect of nitrogen fertilization which they refer to as "pulsing" and "nitrogen fertilizer stimulation" respectively. Depending on existing environmental conditions, increasing either of these

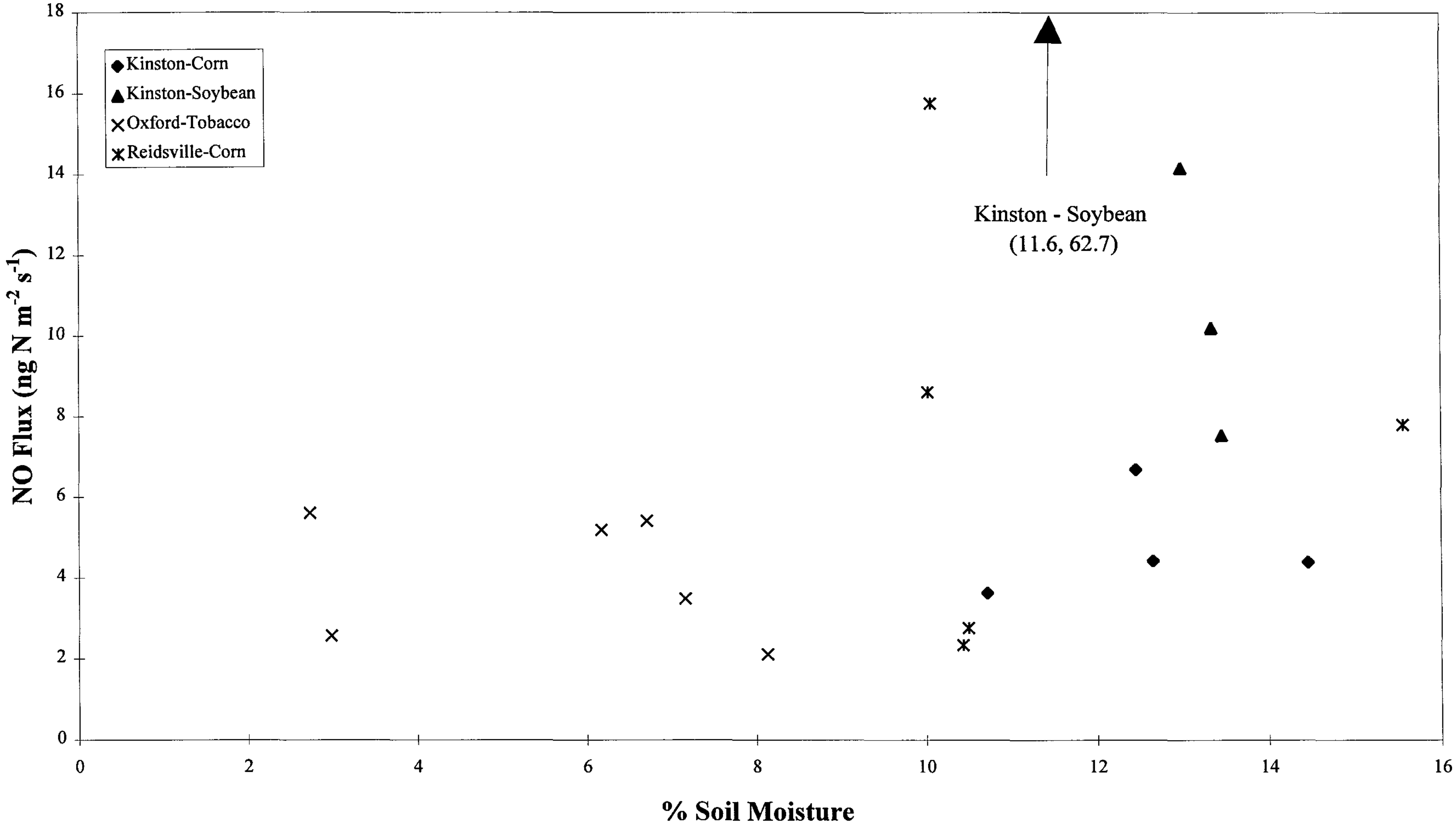

Figure 3.6. Daily averaged NO flux (9:00 AM - 5:00 PM) versus % soil moisture (dry weight). The arrow indicates a data point located off of the scale.

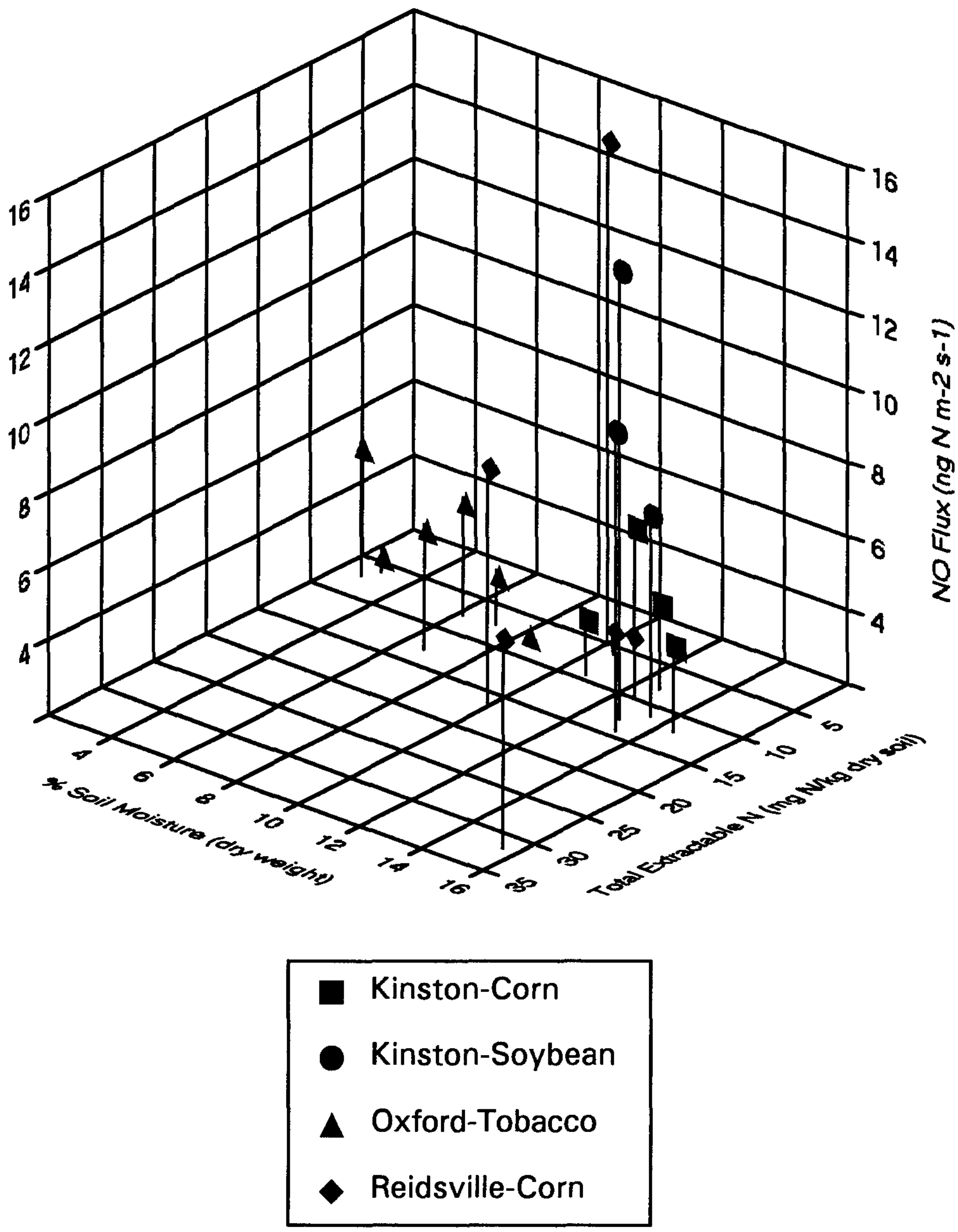

Figure 3.7. NO flux (9:00 AM - 5:00 PM) flux versus % soil moisture (dry weight) and total extractable nitrogen. NO flux represents the daily average value (9:00 AM - 5:00 PM) and soil data is from the 20 cm soil core taken from the center of the chamber footprint at the end of each experimental period.

variables, within certain ranges, is expected to produce increased NO flux. We observed these effects in our extended study at one site in Plymouth, NC, however we were unable to observe these same trends during our short duration at the various sites.

Data Set Bias

Sanchez et al., 1985 recognized two types of data sets for studying soil dynamics. A Type I data set is one in which changes in soil properties are monitored with time at the same site. An example of a Type I data set, although confined to a relatively short period of time, is the 4 day measurement period at each of the individual research sites (Kinston, Oxford, Reidsville). A Type II data set is one in which several soils of nearby sites are sampled at the same time. Type I data, when conducted over extensive periods of time, best characterizes a soil system. However, obtaining this type of data is both costly and time consuming, and therefore not readily available. Type II data sets produce results quickly and are more readily available, however they suffer from the inherent problem that the initial conditions of the research site and the initial soil properties are unknown. Therefore, differences among the research sites may be the result of different initial soil properties, or crop management techniques, and not necessarily the current physical or chemical properties of the soil system. The data we collected, which would be classified as Type II data, came from physiographic regions in North Carolina which represent different crop and soil types. Although we know the dates of planting, and the amount of N fertilizer applied, we can not assume that the soils were all identical in their potential to produce NO during the measurement period used in this study.

The variability inherent in our measurement sites makes it difficult to see simple trends in the data. We were unable to detect some of the same relationships that other researchers have identified, at relatively stable ecosystems such as pastures and fallow fields, between NO flux and total extractable nitrogen, % soil moisture or soil temperature (Slemr and Seiler, 1984; Johansson and Granat, 1984; Williams et al., 1988; Johansson and Sanhueza, 1988; Kaplan et al., 1988; Williams and Fehsenfeld, 1991; Hutchison and Brams, 1992; Kim et al., 1994; Aneja et al., 1995). In order to see a simple two dimensional relationship between NO flux and total extractable nitrogen, % soil moisture or temperature, requires that the other variables be at optimum conditions for the production of NO, or not important in terms of NO production. The fact that we were unable to detect consistent trends between NO flux and the environmental variables suggests that agricultural soil systems are too dynamic to apply simple environmental dependence functions.

Conclusions and Recommendations

NO flux from intensively managed agricultural soils displayed variations from one physiographic location to another. Relationships between environmental variables and NO flux were found to exist at some locations but no one relationship was consistent throughout all of the sites. Although it has been shown that increasing levels of applied N fertilizer leads to increased NO flux, we did not observe this same trend. The soybean crop yielded the highest NO flux, while corn yielded the next highest NO flux and tobacco produced the least NO flux. We feel this observation was a result of the sampling dates of our research. Unlike the corn and tobacco crops which were close to being harvested, the soybean was just recently planted in a nitrogen rich source of decaying wheat roots. Temperature seemed to be a fairly good indicator of NO flux at two of the sites (Kinston-soybean, Oxford-tobacco), but not at others. We noticed an unusual peak in NO emissions at all of the sites which occurred during the morning hours. Possible explanations are that there is microbial activity occurring just after sunrise or we are observing this peak due to increased vehicular traffic during the morning rush hour, in conjunction with ambient air used as the carrier gas. Future research should consist of zero air being used as the carrier gas instead of ambient air to eliminate this possible source of contamination.

This observational based study consisted of sampling for a limited period of time (approximately 4 days) during the changing conditions of the crops growth cycle. Additionally, the sampling occurred from different crop types in physiographically different regions of the state of N.C. Sanchez et al., (1985) elucidated this problem when he described two different types of data sets used in studying soil dynamics. Our data, which is considered a Type II data set, is plagued by not knowing initial soil conditions, and only observing the site for a short period of time. Future work should consist of controlled field experiments where some of these soil conditions can be controlled and remove some of the uncertainty inherent in studies conducted at different crops in space and time.

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Appendices

Appendix A

Data from May 15, 1995 to June 9, 1995 at the Boyd property in Plymouth, NC
%WFPS = Percent Water Filled Pore Space
Total Extractable Nitrogen (TEN) = mg N (kg dry soil)$^{-1}$
nm = not measured
Ambient air as carrier gas
Each 15 minute measurement represents the binned averages of the previous 15 minutes
lpm = liter per minute

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
15-May-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 43.4	7:45 AM	nm	46.14	19.3	23.3	34.79
TEN = 35	8:00 AM	nm	46.27	19.4	23.7	34.88
Flow Rate = 4 lpm	8:15 AM	nm	46.35	19.6	24.0	34.94
Loss Term = 0.02 cm sec^{-1}	8:30 AM	nm	46.34	19.9	25.0	34.94
	8:45 AM	nm	46.41	20.0	24.8	34.99
	9:00 AM	nm	46.45	20.2	27.1	35.02
	9:15 AM	nm	46.43	20.5	26.4	35.00
	9:30 AM	nm	46.55	20.7	28.5	35.09
	9:45 AM	nm	46.48	20.8	30.4	35.04
	10:00 AM	nm	45.97	21.0	31.1	34.66
	10:15 AM	nm	45.64	21.6	31.5	34.41
	10:30 AM	nm	45.57	21.8	30.0	34.36
	10:45 AM	nm	45.68	21.2	30.8	34.44
	11:00 AM	nm	45.73	22.3	31.4	34.48
	11:15 AM	nm	45.84	22.6	31.9	34.56
	11:30 AM	nm	45.95	22.8	31.3	34.64
	11:45 AM	nm	46.23	23.0	30.7	34.85
	12:00 PM	nm	47.27	23.5	29.5	35.64
	12:15 PM	nm	46.97	23.7	28.0	35.41
	12:30 PM	nm	46.88	23.9	29.1	35.34
	12:45 PM	nm	46.30	24.1	25.4	34.91
	1:00 PM	nm	46.44	24.3	28.1	35.01
	1:15 PM	nm	46.69	24.4	27.9	35.20
	1:30 PM	nm	46.88	24.5	27.6	35.34
	1:45 PM	nm	46.54	24.8	31.7	35.09
	2:00 PM	nm	46.72	25.1	32.1	35.22
	2:15 PM	nm	46.04	25.3	27.5	34.71
	2:30 PM	nm	47.48	25.5	29.1	35.80
	2:45 PM	nm	46.29	25.6	35.2	34.90
	3:00 PM	nm	46.35	25.3	28.1	34.94
	3:15 PM	nm	46.41	25.8	26.4	34.99
	3:30 PM	nm	46.53	26.0	28.4	35.08
	3:45 PM	nm	46.88	26.2	27.9	35.34
	4:00 PM	nm	46.95	26.5	29.3	35.40
	4:15 PM	0.30	46.77	26.5	29.3	35.06
	4:30 PM	0.08	47.14	26.5	29.5	35.49
	4:45 PM	nm	47.20	26.3	30.0	35.58
	5:00 PM	nm	47.23	26.3	30.0	35.64

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
17-May-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 41.5	6:30 AM	nm	53.60	19.0	19.7	40.41
TEN = 27	6:45 AM	nm	53.50	19.1	20.1	40.33
Flow Rate = 4 lpm	7:00 AM	nm	53.70	19.0	20.0	40.48
Loss Term = 0.02 cm sec^{-1}	7:15 AM	0.35	53.50	19.2	20.5	40.29
	7:30 AM	0.59	53.60	19.1	20.4	40.34
	7:45 AM	0.51	53.70	19.3	20.8	40.42
	8:00 AM	0.56	53.70	19.4	21.3	40.41
	8:15 AM	0.48	53.60	19.5	22.0	40.35
	8:30 AM	0.54	53.50	19.7	21.7	40.27
	8:45 AM	0.57	53.50	19.7	22.5	40.26
	9:00 AM	0.41	53.50	19.8	23.0	40.28
	9:15 AM	0.36	53.70	20.0	23.7	40.44
	9:30 AM	0.57	53.30	20.5	25.5	40.11
	9:45 AM	0.46	53.50	20.3	25.7	40.28
	10:00 AM	0.36	53.20	20.5	25.7	40.06
	10:15 AM	0.39	54.50	20.9	25.9	41.04
	10:30 AM	0.55	54.50	21.2	26.8	41.02
	10:45 AM	0.44	54.60	21.3	26.5	41.11
	11:00 AM	0.34	54.70	21.4	26.3	41.20
	11:15 AM	0.16	54.80	21.6	26.3	41.29
	11:30 AM	0.37	54.50	21.7	26.7	41.04
	11:45 AM	0.50	54.60	21.9	26.8	41.10
	12:00 PM	0.69	54.90	22.0	27.0	41.30
	12:15 PM	0.37	54.80	22.1	26.5	41.27
	12:30 PM	0.48	54.80	22.3	24.5	41.25
	12:45 PM	0.45	55.10	22.3	28.3	41.48
	1:00 PM	0.48	55.50	23.0	27.6	41.78
	1:15 PM	0.66	54.30	23.0	27.6	40.85
	1:30 PM	0.73	55.20	23.1	29.1	41.52
	1:45 PM	0.59	55.00	23.4	29.5	41.39
	2:00 PM	0.51	55.00	23.6	30.0	41.40
	2:15 PM	0.67	55.40	23.7	28.2	41.68
	2:30 PM	0.53	55.50	23.8	28.8	41.78
	2:45 PM	0.58	55.40	23.7	29.5	41.69
	3:00 PM	0.13	55.60	23.7	28.4	41.90
	3:15 PM	0.16	55.70	23.8	27.7	41.97
	3:30 PM	0.18	55.40	23.8	27.5	41.74
	3:45 PM	0.50	54.40	23.6	28.0	40.95
	4:00 PM	0.50	55.00	23.6	28.8	41.40
	4:15 PM	0.38	55.00	23.6	28.9	41.42
	4:30 PM	0.38	55.30	23.6	28.9	41.64
	4:45 PM	0.16	54.50	23.8	27.8	41.07
	5:00 PM	1.04	54.90	23.6	27.6	41.26
	5:15 PM	0.19	55.30	23.6	26.8	41.67
	5:30 PM	0.48	55.40	23.5	26.4	41.71
	5:45 PM	0.75	54.90	23.4	26.6	41.30
	6:00 PM	0.56	55.00	23.3	25.8	41.39

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
18-May-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 36.2	7:15 AM	nm	50.40	21.6	25.0	38.00
TEN = 42	7:30 AM	nm	50.40	21.8	25.3	38.00
Flow Rate = 4 lpm	7:45 AM	nm	50.40	21.8	25.6	38.00
Loss Term = 0.02 cm sec^{-1}	8:00 AM	nm	50.40	21.9	27.1	38.00
	8:15 AM	nm	50.20	22.0	27.1	37.85
	8:30 AM	0.38	50.40	22.1	27.1	37.74
	8:45 AM	0.64	50.50	22.2	28.5	37.65
	9:00 AM	0.11	50.40	22.3	28.6	37.92
	9:15 AM	0.23	50.60	22.5	29.0	37.99
	9:30 AM	0.62	50.70	22.8	29.3	37.81
	9:45 AM	0.24	50.80	23.0	30.0	38.14
	10:00 AM	0.21	51.00	23.2	30.0	38.31
	10:15 AM	0.27	51.10	23.3	30.6	38.34
	10:30 AM	0.54	51.00	23.6	31.5	38.09
	10:45 AM	0.57	51.20	23.8	31.5	38.22
	11:00 AM	0.70	51.30	24.0	31.1	38.21
	11:15 AM	0.36	51.30	24.2	31.8	38.44
	11:30 AM	0.09	51.20	24.7	31.5	38.54
	11:45 AM	0.48	51.50	24.8	32.5	38.51
	12:00 PM	0.39	51.50	25.0	32.3	38.57
	12:15 PM	0.09	51.70	25.2	32.6	38.92
	12:30 PM	0.73	51.60	25.3	31.8	38.41
	12:45 PM	0.39	51.70	25.6	32.8	38.72
	1:00 PM	0.29	51.50	25.8	33.0	38.63
	1:15 PM	0.25	51.40	26.0	33.4	38.58
	1:30 PM	0.22	51.30	26.2	33.0	38.53
	1:45 PM	0.15	51.30	26.4	32.9	38.58
	2:00 PM	0.08	51.40	26.8	32.7	38.70
	2:15 PM	0.02	51.40	26.8	32.5	38.74
	2:30 PM	0.00	51.30	27.1	32.4	38.68
	2:45 PM	-0.30	51.20	27.2	32.2	38.80
	3:00 PM	0.03	51.40	27.2	32.3	38.73
	3:15 PM	0.06	51.30	27.2	32.6	38.64
	3:30 PM	0.36	51.20	27.3	32.7	38.36
	3:45 PM	0.76	51.40	27.3	33.9	38.24
	4:00 PM	0.18	51.80	27.4	34.0	38.93
	4:15 PM	0.16	51.60	27.5	33.7	38.80
	4:30 PM	0.16	51.20	27.6	33.2	38.49
	4:45 PM	0.00	51.10	27.6	33.6	38.52
	5:00 PM	0.21	51.30	27.7	33.8	38.54
	5:15 PM	-0.21	52.20	27.7	33.8	39.49
	5:30 PM	0.34	52.00	27.7	33.1	38.98
	5:45 PM	0.16	51.70	27.7	31.6	38.87
	6:00 PM	0.46	51.70	27.6	31.8	38.67

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
19-May-95	(hr/min)	(ppb)	(ppb)	(^{o}C)	(^{o}C)	ng N m^{-2} s^{-1}
%WFPS = 32.4	6:45 AM	nm	23.42	21.9	23.9	17.66
TEN = nm	7:00 AM	nm	24.56	22.0	23.8	18.52
Flow Rate = 4 lpm	7:15 AM	nm	23.64	22.1	23.8	17.82
Loss Term = 0.02 cm sec^{-1}	7:30 AM	nm	23.86	22.2	24.2	17.99
	7:45 AM	0.68	24.04	22.3	24.7	17.67
	8:00 AM	0.34	24.42	22.4	24.7	18.18
	8:15 AM	1.01	24.92	22.5	25.6	18.11
	8:30 AM	1.63	26.01	22.7	25.6	18.52
	8:45 AM	1.05	26.57	22.9	26.1	19.33
	9:00 AM	1.18	27.15	23.1	27.2	19.68
	9:15 AM	0.80	27.80	23.3	28.0	20.43
	9:30 AM	1.18	29.33	23.9	27.8	21.33
	9:45 AM	1.00	29.00	24.1	27.3	21.20
	10:00 AM	0.77	28.15	24.2	28.8	20.71
	10:15 AM	1.32	27.94	24.6	28.5	20.18
	10:30 AM	0.34	26.98	24.6	28.0	20.11
	10:45 AM	0.73	27.18	24.6	25.7	20.00
	11:00 AM	nm	nm	nm	nm	nm
	11:15 AM	nm	nm	nm	nm	nm
	11:30 AM	nm	nm	nm	nm	nm
	11:45 AM	nm	nm	nm	nm	nm
	12:00 PM	nm	nm	nm	nm	nm
	12:15 PM	nm	nm	nm	nm	nm
	12:30 PM	0.03	20.59	22.3	19.1	15.50
	12:45 PM	0.29	19.08	22.2	19.5	14.19
	1:00 PM	0.50	18.16	22.2	20.2	13.36
	1:15 PM	0.86	18.49	22.2	20.2	13.37
	1:30 PM	0.52	17.86	22.2	20.1	13.12
	1:45 PM	0.32	17.86	22.3	19.8	13.25
	2:00 PM	0.41	17.93	22.3	20.5	13.24
	2:15 PM	0.30	18.14	22.4	20.8	13.48
	2:30 PM	0.27	19.34	22.8	23.5	14.40
	2:45 PM	0.54	20.48	23.1	23.5	15.08
	3:00 PM	0.36	20.90	23.4	23.3	15.52
	3:15 PM	0.27	21.50	23.6	23.0	16.03
	3:30 PM	0.81	20.77	23.6	23.3	15.12
	3:45 PM	0.51	21.23	23.6	23.4	15.67
	4:00 PM	0.59	21.04	23.7	23.4	15.47
	4:15 PM	0.54	21.14	23.7	23.9	15.58
	4:30 PM	0.48	21.18	23.8	23.8	15.65
	4:45 PM	0.54	21.50	26.2	23.4	15.85
	5:00 PM	0.54	21.86	23.9	23.6	16.12
	5:15 PM	0.36	20.40	23.9	23.4	15.14
	5:30 PM	0.36	19.74	23.8	22.9	14.64
	5:45 PM	0.89	20.21	23.6	22.1	14.64
	6:00 PM	0.65	18.41	23.4	22.0	13.45
	6:15 PM	0.75	17.96	23.2	21.7	13.04
	6:30 PM	0.30	17.94	22.9	21.1	13.33
	6:45 PM	0.31	18.50	22.7	21.0	13.74
	7:00 PM	0.33	19.16	22.6	20.8	14.22

7:15 PM	0.33	19.33	22.3	20.5	14.35
7:30 PM	0.66	19.45	22.1	20.2	14.22
7:45 PM	0.45	19.37	22.0	19.8	14.30
8:00 PM	0.00	19.34	21.7	19.3	14.58
8:15 PM	0.21	19.21	21.6	19.1	14.34
8:30 PM	0.42	18.78	21.5	19.0	13.88
8:45 PM	0.24	18.61	21.3	18.6	13.87
9:00 PM	0.83	18.54	21.2	18.8	13.42
9:15 PM	0.15	17.89	21.0	19.0	13.39
9:30 PM	0.36	17.85	20.9	18.8	13.22
9:45 PM	0.15	17.50	20.9	18.1	13.09
10:00 PM	0.24	16.44	20.7	17.9	12.23
10:15 PM	0.62	15.15	20.7	17.8	11.01
10:30 PM	0.18	15.24	20.5	17.5	11.37
10:45 PM	0.47	14.83	20.1	17.3	10.87
11:00 PM	0.15	14.87	19.8	17.3	11.11
11:15 PM	0.21	13.35	19.8	17.3	9.92
11:30 PM	0.41	13.62	19.8	17.3	9.99
11:45 PM	0.35	13.70	19.7	17.2	10.10
12:00 AM	0.24	13.85	19.6	17.1	10.28
12:15 AM	0.86	13.55	19.5	16.7	9.64
12:30 AM	0.86	13.55	19.3	16.0	9.64
12:45 AM	0.68	13.52	19.1	15.8	9.74
1:00 AM	0.74	13.64	19.0	15.6	9.79
1:15 AM	0.48	13.61	18.9	15.3	9.94
1:30 AM	0.89	13.74	18.8	14.9	9.77
1:45 AM	0.71	14.92	18.6	14.7	10.77
2:00 AM	0.92	14.95	18.5	14.5	10.66
2:15 AM	1.31	14.87	18.4	14.0	10.34
2:30 AM	1.37	16.82	18.2	13.6	11.77
2:45 AM	3.50	19.59	18.0	12.6	12.43
3:00 AM	5.34	20.76	17.9	11.8	12.09
3:15 AM	5.56	21.75	17.7	12.0	12.69
3:30 AM	10.09	23.55	17.6	12.5	11.02
3:45 AM	3.36	20.86	17.4	12.4	13.49
4:00 AM	3.45	21.00	17.3	12.3	13.53
4:15 AM	2.21	18.89	17.1	12.0	12.77
4:30 AM	4.40	19.27	17.0	11.7	11.59
4:45 AM	3.76	18.17	16.9	10.9	11.19
5:00 AM	2.79	20.89	16.7	10.5	13.89
5:15 AM	7.07	22.46	16.7	10.3	12.22
5:30 AM	9.56	25.27	16.6	10.7	12.68
5:45 AM	2.53	18.51	16.6	11.1	12.27
6:00 AM	1.72	16.95	16.4	11.5	11.63

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
22-May-95	(hr/min)	(ppb)	(ppb)	(^{o}C)	(^{o}C)	ng N m^{-2} s^{-1}
%WFPS = 32.3	7:00 AM	nm	47.99	17.8	14.0	36.18
TEN = 40	7:15 AM	nm	47.82	18.0	16.5	36.05
Flow Rate = 4 lpm	7:30 AM	nm	48.12	18.2	19.2	36.28
Loss Term = 0.02 cm sec^{-1}	7:45 AM	nm	48.49	18.2	19.7	36.56
	8:00 AM	nm	48.19	18.4	21.3	36.33
	8:15 AM	1.27	48.23	18.7	23.0	35.51

8:30 AM	0.71	48.28	19.0	23.8	35.93
8:45 AM	0.94	48.47	19.8	29.2	35.92
9:00 AM	0.40	48.64	19.6	25.5	36.40
9:15 AM	0.48	48.86	20.0	29.0	36.52
9:30 AM	0.58	49.18	20.6	29.7	36.69
9:45 AM	0.64	49.97	21.0	28.3	37.25
10:00 AM	0.61	50.30	21.6	29.3	37.51
10:15 AM	0.20	50.10	21.1	31.0	37.64
10:30 AM	0.79	50.00	22.5	29.3	37.17
10:45 AM	0.76	50.00	22.9	31.3	37.19
11:00 AM	0.53	50.00	23.3	32.1	37.34
11:15 AM	0.73	50.10	23.9	30.7	37.28
11:30 AM	0.94	50.20	24.2	33.1	37.22
11:45 AM	0.54	50.30	24.5	33.2	37.56
12:00 PM	1.20	50.30	24.8	33.8	37.12
12:15 PM	0.94	50.20	25.0	34.3	37.22
12:30 PM	0.99	50.10	25.3	32.8	37.11
12:45 PM	0.46	50.20	25.7	30.5	37.54
1:00 PM	0.36	50.10	25.7	33.0	37.53
1:15 PM	0.37	50.20	26.0	32.5	37.60
1:30 PM	0.39	50.30	26.5	32.1	37.66
1:45 PM	0.40	50.30	26.9	31.8	37.65
2:00 PM	0.39	50.40	27.5	31.4	37.74
2:15 PM	0.41	50.50	27.9	30.7	37.80
2:30 PM	0.42	50.60	28.4	30.1	37.87
2:45 PM	0.42	50.60	29.2	29.8	37.87
3:00 PM	0.43	50.70	30.0	29.4	37.94
3:15 PM	0.43	50.70	30.1	29.0	37.94
3:30 PM	0.58	50.50	30.0	29.0	37.69
3:45 PM	0.82	50.10	29.8	30.0	37.22
4:00 PM	0.85	50.10	29.7	28.8	37.20
4:15 PM	0.88	50.00	29.6	27.4	37.11
4:30 PM	0.86	49.85	29.5	27.1	37.01
4:45 PM	0.90	49.84	29.4	26.5	36.97
5:00 PM	0.92	49.80	29.3	26.4	36.93
5:15 PM	0.95	49.79	29.2	25.9	36.90
5:30 PM	0.99	49.77	29.2	25.7	36.86
5:45 PM	1.02	49.77	29.1	25.6	36.84
6:00 PM	1.07	49.76	29.0	25.6	36.80

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
23-May-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 27.9	6:45 AM	3.82	47.01	17.5	14.5	32.89
TEN = 57	7:00 AM	8.63	48.64	17.5	13.9	30.91
Flow Rate = 4 lpm	7:15 AM	7.91	47.30	17.4	16.0	30.38
Loss Term = 0.02 cm sec^{-1}	7:30 AM	5.41	47.85	17.6	18.2	32.47
	7:45 AM	3.41	48.21	17.8	20.5	34.07
	8:00 AM	1.54	48.89	18.0	21.9	35.83
	8:15 AM	0.95	49.54	18.1	22.5	36.72
	8:30 AM	0.48	50.00	18.1	23.8	37.38
	8:45 AM	0.39	50.30	18.4	24.0	37.66
	9:00 AM	0.77	49.77	18.7	24.4	37.01
	9:15 AM	0.38	49.49	20.0	24.8	37.06

9:30 AM	0.93	49.17	20.4	25.1	36.45
9:45 AM	0.90	49.00	19.4	25.7	36.34
10:00 AM	0.58	49.01	19.8	26.1	36.56
10:15 AM	0.58	48.96	20.2	26.5	36.52
10:30 AM	1.04	48.93	20.7	28.7	36.20
10:45 AM	0.46	48.73	20.9	30.4	36.43
11:00 AM	0.29	48.82	21.3	29.6	36.61
11:15 AM	0.73	49.19	21.5	29.8	36.60
11:30 AM	0.93	49.19	21.8	30.0	36.46
11:45 AM	0.76	49.04	22.1	30.5	36.46
12:00 PM	0.90	49.02	22.4	30.6	36.36
12:15 PM	0.46	49.09	22.4	29.8	36.70
12:30 PM	0.46	49.09	22.8	30.8	36.70
12:45 PM	1.03	49.22	23.0	30.8	36.42
1:00 PM	1.03	49.47	23.4	30.3	36.61
1:15 PM	0.91	49.49	24.1	30.6	36.70
1:30 PM	0.85	49.51	24.9	30.9	36.76
1:45 PM	0.76	49.53	25.8	31.5	36.83
2:00 PM	0.68	49.55	26.5	31.8	36.90
2:15 PM	0.59	49.57	27.2	31.9	36.98
2:30 PM	0.55	49.59	28.0	32.4	37.02
2:45 PM	0.49	49.61	28.9	32.8	37.07
3:00 PM	0.48	49.64	29.7	33.0	37.10
3:15 PM	0.47	49.66	30.7	33.3	37.13
3:30 PM	0.74	49.63	31.3	30.3	36.92
3:45 PM	0.89	49.76	31.6	30.8	36.92
4:00 PM	0.71	49.75	31.8	30.3	37.03
4:15 PM	0.39	49.77	32.2	29.8	37.26
4:30 PM	1.02	49.84	32.5	30.0	36.89
4:45 PM	0.51	49.86	32.6	29.6	37.25
5:00 PM	0.33	49.69	32.7	31.1	37.24
5:15 PM	0.24	49.85	32.7	32.3	37.42
5:30 PM	0.98	49.82	32.5	32.5	36.91
5:45 PM	0.66	49.74	32.4	32.3	37.06
6:00 PM	0.60	49.77	32.2	31.2	37.12

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
24-May-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 28.6	6:45 AM	nm	46.45	19.3	12.6	35.02
TEN = 94	7:00 AM	nm	46.43	19.2	13.7	35.00
Flow Rate = 4 lpm	7:15 AM	nm	46.62	19.2	15.0	35.15
Loss Term = 0.02 cm sec^{-1}	7:30 AM	nm	46.31	19.2	17.7	34.91
	7:45 AM	nm	46.95	19.2	18.7	35.40
	8:00 AM	nm	46.94	19.2	22.5	35.39
	8:15 AM	1.48	47.11	19.3	22.8	34.53
	8:30 AM	-0.46	47.47	19.4	26.0	36.09
	8:45 AM	-0.84	48.06	19.7	26.7	36.79
	9:00 AM	-0.86	47.80	20.0	27.0	36.61
	9:15 AM	-0.89	48.00	20.2	27.2	36.78
	9:30 AM	-1.00	47.60	20.2	27.4	36.55
	9:45 AM	-1.01	47.89	20.5	27.5	36.78
	10:00 AM	-0.77	47.87	20.6	27.6	36.60
	10:15 AM	-0.98	47.88	21.0	25.0	36.75

10:30 AM	-0.53	48.13	21.2	27.0	36.64
10:45 AM	-0.03	48.18	21.5	33.0	36.34
11:00 AM	-0.20	48.55	21.8	32.5	36.74
11:15 AM	-0.70	48.51	22.1	32.5	37.04
11:30 AM	-0.19	48.66	22.5	33.6	36.81
11:45 AM	-0.67	48.86	22.8	35.2	37.28
12:00 PM	-0.95	48.91	23.0	33.3	37.51
12:15 PM	-1.18	48.88	23.3	33.7	37.64
12:30 PM	-1.10	48.80	23.9	29.3	37.52
12:45 PM	-1.23	48.79	23.9	29.3	37.60
1:00 PM	-1.00	48.67	24.3	33.5	37.36
1:15 PM	-0.70	48.92	25.2	31.7	37.35
1:30 PM	-0.40	49.19	25.2	31.7	37.35
1:45 PM	-0.10	49.23	26.0	29.2	37.18
2:00 PM	0.02	49.27	26.2	28.1	37.13
2:15 PM	0.77	49.07	26.5	30.8	36.48
2:30 PM	0.15	48.93	26.8	30.0	36.79
2:45 PM	0.39	49.07	27.0	31.1	36.73
3:00 PM	0.46	49.00	27.2	32.0	36.63
3:15 PM	0.35	48.85	27.2	31.6	36.60
3:30 PM	0.46	49.23	27.3	31.6	36.81
3:45 PM	0.41	48.75	27.4	30.8	36.48
4:00 PM	0.78	49.80	27.6	30.8	37.02
4:15 PM	0.12	49.14	27.6	30.6	36.97
4:30 PM	0.51	48.50	27.7	30.0	36.22
4:45 PM	0.67	48.69	27.8	29.8	36.26
5:00 PM	0.41	48.63	27.8	29.6	36.39
5:15 PM	0.25	48.81	28.1	29.3	36.63
5:30 PM	0.02	49.28	28.2	28.6	37.14
5:45 PM	0.53	49.63	28.3	27.8	37.06
6:00 PM	-0.13	49.84	28.3	27.2	37.66
6:15 PM	0.26	49.87	28.3	26.1	37.42
6:30 PM	0.10	49.96	28.2	26.0	37.60
6:45 PM	0.05	50.20	28.1	25.9	37.81
7:00 PM	0.15	43.00	28.0	25.8	32.32
7:15 PM	-0.18	40.91	27.7	24.5	30.96
7:30 PM	-0.15	39.52	27.5	24.0	29.89
7:45 PM	-0.12	37.30	27.3	23.2	28.20
8:00 PM	-0.02	35.69	27.0	22.5	26.92
8:15 PM	0.15	35.64	26.8	22.0	26.77
8:30 PM	0.07	35.15	26.6	21.5	26.45
8:45 PM	0.00	35.35	26.3	20.6	26.65
9:00 PM	0.00	35.30	26.0	20.3	26.61
9:15 PM	0.02	37.27	25.7	20.0	28.08
9:30 PM	0.08	39.15	25.5	19.2	29.46
9:45 PM	0.10	42.25	25.1	18.8	31.79
10:00 PM	0.25	43.00	24.8	18.0	32.25
10:15 PM	0.45	45.25	24.7	17.6	33.81
10:30 PM	0.92	46.59	24.6	17.2	34.51
10:45 PM	3.41	48.33	24.4	16.8	34.16
11:00 PM	7.84	47.77	24.2	16.2	30.79
11:15 PM	10.82	47.82	24.0	15.8	28.84
11:30 PM	3.48	47.79	23.9	15.8	33.71

11:45 PM	5.14	47.89	23.7	16.0	32.68
12:00 AM	9.29	47.21	23.5	14.7	29.40
12:15 AM	3.15	48.02	23.4	15.0	34.10
12:30 AM	11.03	48.09	23.2	15.6	28.90
12:45 AM	18.01	47.64	23.1	15.3	23.90
1:00 AM	16.95	47.68	22.9	14.8	24.64
1:15 AM	12.75	47.75	22.7	14.6	27.50
1:30 AM	17.69	47.70	22.6	14.6	24.16
1:45 AM	24.93	47.39	22.5	14.3	19.10
2:00 AM	30.13	47.14	22.3	14.1	15.44
2:15 AM	39.69	47.52	22.2	13.8	9.35
2:30 AM	39.93	47.61	22.0	13.7	9.26
2:45 AM	39.31	47.61	21.9	13.7	9.68
3:00 AM	34.00	47.59	21.8	13.7	13.20
3:15 AM	38.00	47.45	21.6	13.4	10.43
3:30 AM	33.74	47.32	21.5	13.0	13.17
3:45 AM	30.48	47.44	21.4	13.2	15.44
4:00 AM	29.70	47.58	21.3	13.5	16.06
4:15 AM	31.92	47.53	21.0	13.1	14.54
4:30 AM	27.68	47.43	21.1	12.6	17.30
4:45 AM	42.19	47.43	21.0	12.0	7.62
5:00 AM	nm	nm	20.8	12.2	nm
5:15 AM	nm	nm	20.7	12.1	nm
5:30 AM	nm	nm	20.6	1212.5	nm
5:45 AM	nm	nm	20.5	13.2	nm
6:00 AM	21.39	46.90	20.3	13.0	21.09

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
25-May-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 32.9	6:15 AM	20.18	46.55	20.3	14.0	21.64
TEN = 49	6:30 AM	14.85	46.72	20.2	14.2	25.32
Flow Rate = 4 lpm	6:45 AM	12.85	42.70	20.2	14.7	23.62
Loss Term = 0.02 cm sec^{-1}	7:00 AM	1.00	41.02	20.2	16.3	30.26
	7:15 AM	0.00	40.32	20.1	16.9	30.43
	7:30 AM	0.00	42.33	20.1	18.0	31.97
	7:45 AM	0.28	46.32	20.1	20.1	34.73
	8:00 AM	0.00	47.54	20.1	20.9	35.84
	8:15 AM	0.00	47.74	20.2	21.5	36.29
	8:30 AM	0.00	47.60	20.2	24.0	36.55
	8:45 AM	0.00	47.62	20.3	26.1	36.57
	9:00 AM	0.00	47.75	20.5	27.0	36.67
	9:15 AM	0.00	47.82	20.0	29.7	36.62
	9:30 AM	0.00	47.71	20.2	30.3	36.24
	9:45 AM	0.00	49.15	21.5	31.5	37.29
	10:00 AM	0.00	50.00	22.9	32.9	37.84
	10:15 AM	0.00	51.50	23.6	33.8	38.83
	10:30 AM	0.25	51.80	24.1	35.2	38.89
	10:45 AM	0.85	52.10	24.3	35.9	38.71
	11:00 AM	0.70	52.00	24.5	36.0	38.74
	11:15 AM	0.73	51.00	24.8	34.7	37.96
	11:30 AM	0.76	52.20	25.0	33.3	38.85
	11:45 AM	0.65	52.10	25.1	34.0	38.85
	12:00 PM	0.57	52.10	25.3	35.2	38.90

12:15 PM	0.63	52.10	25.4	35.9	38.86
12:30 PM	0.77	52.00	26.0	33.8	38.69
12:45 PM	0.23	52.50	26.9	35.7	39.43
1:00 PM	0.36	52.70	28.0	37.0	39.49
1:15 PM	1.07	52.90	29.8	36.4	39.17
1:30 PM	0.78	52.90	30.4	36.2	39.36
1:45 PM	0.65	53.00	30.9	36.0	39.52
2:00 PM	0.55	53.30	32.0	36.1	39.82
2:15 PM	0.59	53.10	32.0	36.5	39.64
2:30 PM	0.45	53.50	32.2	37.1	40.03
2:45 PM	0.38	53.00	32.4	37.5	39.70
3:00 PM	0.45	53.70	32.5	38.0	40.18
3:15 PM	0.67	53.40	32.6	38.2	39.81
3:30 PM	0.55	53.80	32.3	38.3	40.19
3:45 PM	0.46	53.40	32.2	37.9	39.95
4:00 PM	0.78	53.10	32.0	36.4	39.51
4:15 PM	0.85	53.80	31.8	35.4	39.99
4:30 PM	0.65	54.10	31.4	34.6	40.35
4:45 PM	0.54	54.20	30.8	33.3	40.50
5:00 PM	0.37	54.00	30.8	32.5	40.46

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
30-May-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 35.7	11:30 AM	3.44	138.00	25.5	36.2	264.71
TEN = 56	11:45 AM	4.15	130.10	26.1	36.1	247.85
Flow Rate = 11.26 lpm	12:00 PM	3.45	130.40	26.6	36.9	249.76
Loss Term = 0.02 cm sec^{-1}	12:15 PM	3.50	126.40	27.0	36.2	241.80
	12:30 PM	4.05	124.00	27.3	35.0	236.05
	12:45 PM	5.24	125.50	27.7	32.7	236.77
	1:00 PM	5.01	126.00	28.0	35.5	238.18
	1:15 PM	4.89	127.70	28.3	38.4	241.75
	1:30 PM	4.72	128.00	28.3	38.8	242.66
	1:45 PM	4.35	128.50	28.4	38.9	244.33
	2:00 PM	4.04	129.00	28.6	39.0	245.90
	2:15 PM	3.86	129.50	28.7	38.4	247.22
	2:30 PM	3.65	130.00	28.8	37.9	248.59
	2:45 PM	3.43	130.80	28.8	37.4	250.58
	3:00 PM	3.88	131.10	28.9	36.2	250.32
	3:15 PM	2.28	129.30	28.8	36.8	249.79
	3:30 PM	3.89	126.10	28.7	33.3	240.48
	3:45 PM	3.02	121.50	28.7	34.0	233.07
	4:00 PM	2.85	123.10	28.7	35.2	236.54
	4:15 PM	3.17	118.40	28.6	33.6	226.70
	4:30 PM	3.84	120.30	28.6	33.0	229.18
	4:45 PM	2.75	114.50	28.6	34.0	219.83
	5:00 PM	2.54	114.00	28.6	32.5	219.24
	5:15 PM	2.38	113.60	28.6	31.6	218.75
	5:30 PM	3.80	111.90	28.5	30.9	212.75
	5:45 PM	2.79	112.40	28.4	32.3	215.63
	6:00 PM	2.19	108.40	28.3	32.1	208.89

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
31-May-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 32.4	6:45 AM	nm	105.70	19.9	18.0	79.69
TEN = 28	7:00 AM	nm	101.40	19.8	19.1	76.45
Flow Rate = 4 lpm	7:15 AM	nm	105.90	19.8	18.6	79.84
Loss Term = 0.02 cm sec^{-1}	7:30 AM	nm	110.80	19.9	20.8	83.53
	7:45 AM	5.48	113.90	19.9	23.1	82.22
	8:00 AM	4.90	121.50	20.0	23.5	88.33
	8:15 AM	4.70	128.90	20.0	24.0	94.04
	8:30 AM	5.30	135.60	20.5	24.5	98.70
	8:45 AM	3.90	140.10	20.9	25.1	103.02
	9:00 AM	4.00	145.80	21.0	26.0	107.25
	9:15 AM	4.30	150.90	21.5	26.8	110.90
	9:30 AM	4.21	155.60	21.9	27.5	114.50
	9:45 AM	4.65	159.80	22.4	28.3	117.37
	10:00 AM	5.00	168.60	22.6	29.5	123.77
	10:15 AM	4.83	175.80	22.8	30.4	129.32
	10:30 AM	4.41	181.40	23.0	31.0	133.82
	10:45 AM	8.63	184.30	23.5	28.2	133.19
	11:00 AM	5.02	189.90	23.9	32.9	139.82
	11:15 AM	2.73	199.50	24.4	32.9	148.58
	11:30 AM	2.94	186.70	24.7	33.0	138.79
	11:45 AM	3.11	179.90	25.1	33.2	133.55
	12:00 PM	4.98	189.80	25.4	30.8	139.77
	12:15 PM	4.70	183.30	25.9	34.7	135.06
	12:30 PM	4.41	193.30	26.3	33.2	142.79
	12:45 PM	4.12	184.70	26.6	35.2	136.50
	1:00 PM	3.77	178.10	26.9	37.3	131.76
	1:15 PM	1.74	178.60	27.2	36.9	133.49
	1:30 PM	1.21	175.00	27.4	37.1	131.13
	1:45 PM	2.05	191.40	27.7	32.3	142.93
	2:00 PM	1.71	176.50	27.9	36.6	131.92
	2:15 PM	2.40	182.50	28.1	34.4	135.99
	2:30 PM	2.54	186.70	28.2	34.6	139.06
	2:45 PM	3.58	188.00	28.4	36.0	139.35
	3:00 PM	2.47	189.40	28.4	34.9	141.14
	3:15 PM	3.89	179.30	28.5	35.2	132.58
	3:30 PM	2.09	178.30	28.6	34.6	133.03
	3:45 PM	2.04	177.00	28.7	36.1	132.08
	4:00 PM	2.38	173.00	28.7	37.3	128.84
	4:15 PM	3.00	174.90	28.7	34.2	129.86
	4:30 PM	4.36	153.80	27.8	30.9	113.04
	4:45 PM	1.36	151.20	28.7	31.3	113.08
	5:00 PM	2.14	138.10	28.7	32.4	102.69
	5:15 PM	2.32	134.80	28.8	30.5	100.08
	5:30 PM	2.69	126.50	28.7	29.9	93.58
	5:45 PM	3.91	123.90	28.6	30.5	90.80
	6:00 PM	4.04	121.00	28.5	28.9	88.53

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
1-Jun-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 30.6	6:45 AM	0.00	33.34	19.7	16.2	25.14
TEN = 41	7:00 AM	0.00	31.18	19.6	16.3	23.51
Flow Rate = 4 lpm	7:15 AM	0.00	30.82	19.6	18.5	23.23
Loss Term = 0.02 cm sec^{-1}	7:30 AM	3.94	29.92	19.7	20.8	19.93
	7:45 AM	1.33	26.43	19.8	22.3	19.03
	8:00 AM	1.05	27.57	20.0	23.0	20.09
	8:15 AM	1.00	28.81	20.4	24.1	21.06
	8:30 AM	0.88	30.03	20.6	25.2	22.05
	8:45 AM	0.80	30.43	20.7	26.4	22.41
	9:00 AM	0.73	31.24	20.8	27.0	23.06
	9:15 AM	0.71	31.60	20.9	27.8	23.35
	9:30 AM	0.62	31.46	21.1	28.9	23.31
	9:45 AM	0.59	34.44	21.4	33.1	25.58
	10:00 AM	1.07	35.86	21.6	34.0	26.32
	10:15 AM	1.43	38.17	21.8	31.3	27.82
	10:30 AM	1.48	33.03	22.1	28.6	23.91
	10:45 AM	0.00	29.11	22.3	28.1	21.94
	11:00 AM	1.14	28.51	22.4	33.7	20.73
	11:15 AM	0.63	33.16	22.6	35.6	24.58
	11:30 AM	0.54	31.59	22.8	30.8	23.46
	11:45 AM	0.77	34.20	23.0	32.9	25.27
	12:00 PM	0.84	34.28	23.2	35.0	25.29
	12:15 PM	0.72	34.09	23.5	36.5	25.22
	12:30 PM	0.24	34.03	23.9	37.1	25.49
	12:45 PM	1.00	34.45	23.9	37.5	25.31
	1:00 PM	0.45	32.89	23.8	30.7	24.49
	1:15 PM	0.67	30.49	23.8	30.7	22.54
	1:30 PM	1.35	29.39	24.0	30.5	21.25
	1:45 PM	0.47	28.37	24.0	34.9	21.07
	2:00 PM	1.94	29.16	24.0	30.6	20.69
	2:15 PM	0.51	26.97	24.0	29.3	19.99
	2:30 PM	1.50	27.60	24.2	29.1	19.81
	2:45 PM	1.01	26.31	24.3	29.7	19.16
	3:00 PM	1.03	25.47	24.3	30.3	18.51
	3:15 PM	2.10	26.14	24.2	33.7	18.31
	3:30 PM	0.12	27.98	24.1	32.6	21.02
	3:45 PM	0.57	27.87	25.5	33.1	20.64
	4:00 PM	1.01	27.81	25.6	33.2	20.30
	4:15 PM	1.60	27.75	25.7	33.5	19.86
	4:30 PM	2.25	27.71	25.8	33.7	19.39
	4:45 PM	1.84	27.59	25.9	33.2	19.58
	5:00 PM	2.00	27.08	26.0	30.2	19.08
	5:15 PM	0.72	26.43	26.1	32.1	19.44
	5:30 PM	2.71	23.97	26.2	29.0	16.27
	5:45 PM	1.55	23.42	26.1	29.7	16.62
	6:00 PM	2.08	23.76	26.2	27.6	16.53

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
2-Jun-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 27.9	8:00 AM	0.00	30.62	21.2	23.9	23.09
TEN = 38	8:15 AM	0.00	30.16	21.3	25.8	22.74
Flow Rate = 4 lpm	8:30 AM	0.00	29.53	21.4	27.7	22.26
Loss Term = 0.02 cm sec^{-1}	8:45 AM	0.00	30.97	21.4	29.9	23.35
	9:00 AM	1.07	31.17	21.6	28.8	22.78
	9:15 AM	1.06	28.64	21.7	28.4	20.89
	9:30 AM	2.20	29.03	21.9	30.5	20.41
	9:45 AM	1.30	30.70	22.0	30.5	22.28
	10:00 AM	3.29	33.39	22.2	32.3	22.98
	10:15 AM	4.73	42.32	22.6	34.2	28.75
	10:30 AM	3.02	42.97	23.0	34.5	30.38
	10:45 AM	1.25	44.28	23.3	34.8	32.55
	11:00 AM	1.26	45.57	23.7	34.6	33.51
	11:15 AM	1.64	51.81	24.0	35.0	37.97
	11:30 AM	1.95	59.14	24.6	35.6	43.29
	11:45 AM	1.23	54.70	24.9	35.7	40.42
	12:00 PM	2.37	55.20	25.2	35.9	40.03
	12:15 PM	2.49	53.89	25.6	35.9	38.97
	12:30 PM	3.17	53.68	25.9	38.3	38.36
	12:45 PM	1.94	55.10	26.2	36.1	40.24
	1:00 PM	4.68	56.11	26.5	38.7	39.18
	1:15 PM	5.36	59.95	26.7	40.8	41.62
	1:30 PM	0.00	59.04	27.0	40.2	44.51
	1:45 PM	1.30	58.74	27.3	38.6	43.42
	2:00 PM	1.46	58.13	27.5	33.7	42.85
	2:15 PM	0.40	54.90	27.7	2.0	41.12
	2:30 PM	1.48	53.79	27.8	34.3	39.56
	2:45 PM	1.00	53.89	27.9	34.9	39.96
	3:00 PM	2.94	53.08	28.8	33.2	38.06
	3:15 PM	2.29	52.98	28.0	33.1	38.41
	3:30 PM	2.69	51.76	28.0	32.9	37.23
	3:45 PM	0.98	50.95	27.9	32.6	37.76
	4:00 PM	0.86	48.69	27.9	31.3	36.13
	4:15 PM	0.97	50.55	27.9	32.8	37.47
	4:30 PM	0.80	49.54	27.8	31.1	36.82
	4:45 PM	0.79	49.73	27.8	31.7	36.97
	5:00 PM	1.52	52.37	27.7	1.6	38.47
	5:15 PM	2.27	53.58	27.7	32.6	38.88
	5:30 PM	6.39	55.20	27.6	30.8	37.35
	5:45 PM	0.14	50.65	27.6	29.4	38.10
	6:00 PM	0.17	47.60	27.5	28.9	35.77
	6:15 PM	0.72	45.93	27.5	28.7	34.14
	6:30 PM	3.15	40.60	27.4	27.9	28.51
	6:45 PM	2.24	41.49	27.3	27.4	29.79
	7:00 PM	0.61	40.64	27.2	26.9	30.23
	7:15 PM	0.26	41.02	27.1	26.4	30.75
	7:30 PM	1.79	40.84	27.0	26.3	29.60
	7:45 PM	2.15	41.64	26.9	26.1	29.96
	8:00 PM	2.68	43.47	26.8	25.9	30.99
	8:15 PM	3.63	45.03	26.7	25.5	31.53
	8:30 PM	4.20	47.52	26.6	25.0	33.02

8:45 PM	4.60	49.43	26.4	24.0	34.20
9:00 PM	4.97	44.02	26.2	23.8	29.87
9:15 PM	5.27	47.59	26.1	23.5	32.36
9:30 PM	3.22	41.88	26.0	23.7	29.42
9:45 PM	2.74	41.34	25.9	23.4	29.34
10:00 PM	5.98	48.14	25.7	23.5	32.31
10:15 PM	7.09	34.74	25.6	23.3	21.46
10:30 PM	3.04	33.79	25.5	23.1	23.44
10:45 PM	7.99	32.10	25.4	22.7	18.87
11:00 PM	10.37	46.40	25.3	22.4	28.07
11:15 PM	5.48	36.32	25.2	22.5	23.72
11:30 PM	4.56	31.94	25.1	22.6	21.04
11:45 PM	4.56	31.88	25.0	22.5	20.99
12:00 AM	8.27	32.72	24.9	22.3	19.15
12:15 AM	6.82	30.33	24.7	22.3	18.32
12:30 AM	6.34	30.18	24.6	22.4	18.52
12:45 AM	4.57	28.96	24.5	22.5	18.78
1:00 AM	2.77	27.83	24.5	22.5	19.14
1:15 AM	2.74	28.32	24.3	22.4	19.52
1:30 AM	3.15	29.16	24.2	22.3	19.88
1:45 AM	3.37	28.96	24.1	22.3	19.58
2:00 AM	3.55	28.36	24.0	22.3	19.01
2:15 AM	4.79	29.32	24.0	22.2	18.91
2:30 AM	5.31	31.20	24.0	22.1	19.98
2:45 AM	7.72	31.05	24.0	21.8	18.26
3:00 AM	18.86	45.38	24.0	22.0	21.63
3:15 AM	2.73	29.36	23.9	22.5	20.31
3:30 AM	7.49	25.82	23.8	21.8	14.47
3:45 AM	5.99	27.72	23.8	21.3	16.90

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
4-Jun-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 35.7	7:45 AM	1.21	118.19	22.2	24.5	88.30
TEN = 24	8:00 AM	1.29	121.72	22.3	24.6	90.91
Flow Rate = 4 lpm	8:15 AM	1.52	126.27	22.3	25.0	94.18
Loss Term = 0.02 cm sec^{-1}	8:30 AM	1.65	131.73	22.3	25.7	98.22
	8:45 AM	1.57	135.47	22.5	26.4	101.09
	9:00 AM	1.22	143.97	22.5	27.4	107.73
	9:15 AM	1.86	147.71	22.5	28.4	110.12
	9:30 AM	1.63	157.11	22.8	30.0	117.36
	9:45 AM	1.68	165.50	23.0	31.2	123.65
	10:00 AM	1.59	182.08	23.2	33.1	136.22
	10:15 AM	1.55	192.19	23.5	35.4	143.86
	10:30 AM	1.52	196.94	23.7	37.0	147.46
	10:45 AM	1.73	nm	23.9	34.0	nm
Switched Flow Rate	11:00 AM	1.51	103.32	24.1	39.9	118.53
New Flow Rate = 6.45 lpm	11:15 AM	1.75	111.11	23.9	39.8	127.33
	11:30 AM	1.14	111.31	24.1	37.6	128.22
	11:45 AM	1.70	109.19	24.3	39.6	125.15
	12:00 PM	2.16	112.73	24.7	41.4	128.77
	12:15 PM	1.65	109.19	25.0	41.9	125.21
	12:30 PM	1.38	102.01	25.4	40.6	117.15
	12:45 PM	2.25	102.01	25.7	42.2	116.22

1:00 PM	1.75	103.22	26.1	36.3	118.16
1:15 PM	2.34	102.11	26.4	41.3	116.23
1:30 PM	2.15	101.71	26.8	40.5	115.96
1:45 PM	0.00	0.00	27.0	38.3	0.00
2:00 PM	1.46	101.91	27.1	35.5	116.95
2:15 PM	1.26	99.68	27.3	36.6	114.57
2:30 PM	2.42	105.75	27.4	39.3	120.37
2:45 PM	2.91	100.09	27.6	41.1	113.27
3:00 PM	1.73	107.57	27.7	37.1	123.24
3:15 PM	3.14	108.48	27.8	35.2	122.78
3:30 PM	3.01	104.94	27.9	35.5	118.80
3:45 PM	1.41	102.21	28.0	35.1	117.35
4:00 PM	2.63	104.94	27.9	35.0	119.21
4:15 PM	1.04	104.23	27.9	34.1	120.10
4:30 PM	1.95	102.31	27.9	33.4	116.88
4:45 PM	4.70	102.92	27.9	34.0	114.63
5:00 PM	6.84	107.77	27.8	33.1	117.97
5:15 PM	7.12	108.48	27.8	32.6	118.50
5:30 PM	5.33	109.49	27.7	33.5	121.60
5:45 PM	3.82	108.18	27.7	31.7	121.69
6:00 PM	2.42	110.60	27.6	32.1	126.02

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
5-Jun-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 38.1	7:00 AM	2.07	109.59	22.6	20.8	81.24
TEN = 116	7:15 AM	1.81	96.45	22.5	21.4	71.51
Flow Rate = 4 lpm	7:30 AM	2.27	98.17	22.6	21.8	72.50
Loss Term = 0.02 cm sec^{-1}	7:45 AM	2.08	96.05	22.5	22.3	71.02
	8:00 AM	1.01	96.75	22.5	23.0	72.27
	8:15 AM	1.71	96.75	22.5	23.0	71.80
	8:30 AM	1.36	98.57	22.5	23.8	73.40
	8:45 AM	1.09	102.01	22.6	25.8	76.18
	9:00 AM	0.79	105.14	22.7	27.2	78.74
	9:15 AM	1.12	103.63	22.8	26.3	77.38
	9:30 AM	1.53	101.91	22.8	26.3	75.81
	9:45 AM	1.15	101.30	22.9	26.1	75.60
	10:00 AM	1.69	103.83	23.0	26.2	77.15
	10:15 AM	1.45	119.20	23.1	26.7	88.90
	10:30 AM	1.49	120.92	23.2	26.6	90.17
	10:45 AM	1.41	123.34	23.3	27.1	92.05
	11:00 AM	1.29	125.47	23.3	28.5	93.73
	11:15 AM	1.13	127.28	23.4	28.3	95.21
	11:30 AM	1.14	126.17	23.5	28.2	94.36
	11:45 AM	1.18	126.38	23.6	28.1	94.49
	12:00 PM	1.41	125.97	23.7	28.0	94.03
	12:15 PM	1.47	125.67	23.8	27.9	93.76
	12:30 PM	1.32	122.13	23.9	27.8	91.19
	12:45 PM	1.31	124.96	24.0	27.7	93.33
	1:00 PM	1.30	123.34	24.1	27.6	92.12
	1:15 PM	1.29	123.24	24.2	27.5	92.05
	1:30 PM	1.28	123.14	24.2	27.4	91.98
	1:45 PM	1.42	120.81	24.3	27.3	90.14
	2:00 PM	1.32	121.93	24.4	27.1	91.04

2:15 PM	1.27	122.94	24.5	27.0	91.84
2:30 PM	1.85	118.49	24.5	27.2	88.10
2:45 PM	1.91	117.98	24.5	26.7	87.67
3:00 PM	2.41	113.94	24.5	24.4	84.29
3:15 PM	2.71	88.87	24.6	23.3	65.19
3:30 PM	1.15	96.15	24.4	22.9	71.72
3:45 PM	2.67	103.73	24.4	22.7	76.42
4:00 PM	2.31	104.94	24.4	22.4	77.58
4:15 PM	2.05	103.12	24.4	21.7	76.38
4:30 PM	1.17	103.53	24.3	21.9	77.27
4:45 PM	3.31	105.65	24.2	22.8	77.44
5:00 PM	2.28	108.18	24.1	22.9	80.04
5:15 PM	1.78	110.20	24.2	22.8	81.89
5:30 PM	1.67	107.27	24.1	22.4	79.76
5:45 PM	0.92	112.02	24.1	22.9	83.84
6:00 PM	2.08	115.15	24.1	22.9	85.43

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
8-Jun-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
%WFPS = 49.7	7:15 AM	0.00	24.37	23.0	23.0	18.37
TEN = 67	7:30 AM	0.00	34.82	23.0	23.7	26.25
Flow Rate = 4 lpm	7:45 AM	0.75	41.88	23.0	24.5	31.07
Loss Term = 0.02 cm sec^{-1}	8:00 AM	nm	nm	22.9	25.4	nm
	8:15 AM	0.82	52.67	22.9	26.2	39.16
	8:30 AM	nm	nm	22.9	27.3	nm
	8:45 AM	1.22	20.60	22.9	28.7	14.72
	9:00 AM	nm	nm	22.9	31.0	nm
	9:15 AM	1.93	21.37	22.9	29.7	14.82
	9:30 AM	nm	nm	22.9	31.9	nm
	9:45 AM	1.39	46.09	23.0	33.7	33.82
	10:00 AM	nm	nm	23.0	34.6	nm
	10:15 AM	1.28	48.12	23.1	35.6	35.43
	10:30 AM	nm	nm	23.1	36.7	nm
	10:45 AM	0.09	51.16	23.2	37.3	38.50
	11:00 AM	nm	nm	23.3	38.9	nm
	11:15 AM	0.39	59.75	23.4	39.9	44.79
	11:30 AM	nm	nm	23.5	39.2	nm
	11:45 AM	0.41	74.92	23.6	40.9	56.21
	12:00 PM	nm	nm	23.7	40.9	nm
	12:15 PM	0.99	78.55	23.8	41.1	58.57
	12:30 PM	nm	nm	24.0	42.7	nm
	12:45 PM	0.28	85.03	24.1	42.8	63.91
	1:00 PM	nm	nm	24.3	41.2	nm
	1:15 PM	0.15	93.01	24.5	41.9	70.02
	1:30 PM	nm	nm	24.7	41.3	nm
	1:45 PM	0.57	48.33	24.9	43.6	36.06
	2:00 PM	nm	nm	25.1	42.2	nm
	2:15 PM	0.52	85.83	25.4	42.7	64.36
	2:30 PM	nm	nm	25.6	40.7	nm
	2:45 PM	0.61	81.79	25.9	38.4	61.26
	3:00 PM	nm	nm	26.1	42.7	nm
	3:15 PM	0.00	75.93	26.3	41.4	57.25
	3:30 PM	nm	nm	26.4	39.2	nm

	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
	3:45 PM	0.22	83.00	26.5	36.8	62.43

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
9-Jun-95	(hr/min)	(ppb)	(ppb)	(^{o}C)	(^{o}C)	ng N m^{-2} s^{-1}
%WFPS = nm	6:45 AM	0.73	6.69	24.2	23.4	4.56
TEN = nm	7:00 AM	0.27	nm	24.2	24.4	nm
Flow Rate = 4 lpm	7:15 AM	0.42	6.51	24.2	25.1	4.63
Loss Term = 0.02 cm sec^{-1}	7:30 AM	0.47	nm	24.2	25.6	nm
	7:45 AM	0.69	6.26	24.1	26.4	4.26
	8:00 AM	0.20	nm	24.1	26.8	nm
	8:15 AM	0.36	6.15	24.1	27.9	4.40
	8:30 AM	0.31	nm	24.1	28.5	nm
	8:45 AM	0.82	6.33	24.1	29.7	4.22
	9:00 AM	0.30	nm	24.1	30.6	nm
	9:15 AM	0.42	6.60	24.1	31.4	4.70
	9:30 AM	0.47	nm	24.2	30.5	nm
	9:45 AM	0.48	16.63	24.2	30.2	12.22
	10:00 AM	0.29	nm	24.2	32.1	nm
	10:15 AM	0.63	18.22	24.3	34.4	13.31
	10:30 AM	0.45	nm	24.3	34.6	nm
	10:45 AM	0.18	16.13	24.4	36.5	12.04
	11:00 AM	0.29	20.77	24.5	37.7	15.46
	11:15 AM	0.09	nm	24.6	39.1	nm
	11:30 AM	0.39	nm	24.7	39.9	nm
	11:45 AM	-0.07	24.71	24.8	38.7	18.68
	12:00 PM	0.14	nm	24.9	35.1	nm
	12:15 PM	0.10	nm	25.0	36.8	nm
	12:30 PM	0.62	28.26	25.2	38.1	20.89
	12:45 PM	0.48	nm	25.3	36.1	nm
	1:00 PM	0.49	nm	25.5	36.9	nm
	1:15 PM	0.40	28.94	25.7	35.1	21.56
	1:30 PM	0.10	nm	25.7	35.9	nm
	1:45 PM	0.57	nm	25.8	37.8	nm
	2:00 PM	0.45	27.45	25.9	35.9	20.39

Appendix B

Data from August 22, 1995 to October 3, 1995 urban study conducted in Raleigh, NC
nm = not measured
Zero grade air used as carrier gas
Each 15 minute measurement represents the binned averages of the previous 15 minutes
lpm = liter per minute
Ambient air temperature was measured at Raleigh-Durham International Airport

Urban site	Time	NO Out	Ambient Air	NO Flux
22-Aug-95	(hr/min)	(ppb)	(°C)	ng N m^{-2} s^{-1})
Flow Rate = 4 lpm	8:00 AM	nm	22.78	nm
Loss Term = 0.02 cm sec^{-1}	8:15 AM	2.25	nm	1.8
	8:30 AM	2.48	nm	1.9
	8:45 AM	2.09	nm	1.6
	9:00 AM	1.92	nm	1.5
	9:15 AM	1.89	nm	1.5
	9:30 AM	1.99	nm	1.6
	9:45 AM	2.09	nm	1.6
	10:00 AM	2.23	nm	1.7
	10:15 AM	2.39	nm	1.9
	10:30 AM	2.53	nm	2.0
	10:45 AM	2.67	nm	2.1
	11:00 AM	2.87	30.56	2.2
	11:15 AM	3.10	nm	2.4
	11:30 AM	3.33	nm	2.6
	11:45 AM	3.65	nm	2.8
	12:00 PM	4.68	nm	3.7
	12:15 PM	6.17	nm	4.8
	12:30 PM	8.85	nm	6.9
	12:45 PM	10.67	nm	8.3
	1:00 PM	nm	nm	nm
	1:15 PM	nm	nm	nm
	1:30 PM	nm	nm	nm
	1:45 PM	nm	nm	nm
	2:00 PM	nm	33.89	nm
	2:15 PM	nm	nm	nm
	2:30 PM	nm	nm	nm
	2:45 PM	25.04	nm	19.6
	3:00 PM	26.76	nm	20.9
	3:15 PM	26.06	nm	20.4
	3:30 PM	26.02	nm	20.3
	3:45 PM	26.95	nm	21.1
	4:00 PM	27.15	nm	21.2
	4:15 PM	27.36	nm	21.4
	4:30 PM	28.04	nm	21.9
	4:45 PM	30.09	nm	23.5
	5:00 PM	nm	33.89	nm

	Time	NO Out	Ambient Air	NO Flux
Urban site	Time	NO Out	Ambient Air	NO Flux
24-Aug-95	(hr/min)	(ppb)	(°C)	ng N m^{-2} s^{-1})
Flow Rate = 4 lpm	8:00 AM	nm	22.22	nm
Loss Term = 0.02 cm sec^{-1}	8:15 AM	nm	nm	nm
	8:30 AM	nm	nm	nm
	8:45 AM	nm	nm	nm
	9:00 AM	nm	nm	nm
	9:15 AM	nm	nm	nm
	9:30 AM	nm	nm	nm
	9:45 AM	nm	nm	nm
	10:00 AM	nm	nm	nm
	10:15 AM	14.79	nm	11.6
	10:30 AM	13.44	nm	10.5
	10:45 AM	10.77	nm	8.4
	11:00 AM	10.76	28.89	8.4
	11:15 AM	8.84	nm	6.9
	11:30 AM	9.32	nm	7.3
	11:45 AM	8.94	nm	7.0
	12:00 PM	9.99	nm	7.8
	12:15 PM	7.39	nm	5.8
	12:30 PM	5.97	nm	4.7
	12:45 PM	4.99	nm	3.9
	1:00 PM	4.59	nm	3.6
	1:15 PM	4.86	nm	3.8
	1:30 PM	4.08	nm	3.2
	1:45 PM	3.90	nm	3.0
	2:00 PM	4.01	30.56	3.1
	2:15 PM	4.22	nm	3.3
	2:30 PM	4.64	nm	3.6
	2:45 PM	4.43	nm	3.5
	3:00 PM	4.39	nm	3.4
	3:15 PM	nm	nm	nm
	3:30 PM	nm	nm	nm
	3:45 PM	nm	nm	nm
	4:00 PM	nm	nm	nm
	4:15 PM	nm	nm	nm
	4:30 PM	nm	nm	nm
	4:45 PM	nm	nm	nm
	5:00 PM	nm	32.78	nm

	Time	NO Out	Ambient Air	NO Flux
Urban site	Time	NO Out	Ambient Air	NO Flux
25-Aug-95	(hr/min)	(ppb)	(°C)	ng N m^{-2} s^{-1})
Flow Rate = 4 lpm	8:00 AM	nm	23.33	nm
Loss Term = 0.02 cm sec^{-1}	8:15 AM	nm	nm	nm
	8:30 AM	nm	nm	nm
	8:45 AM	nm	nm	nm
	9:00 AM	nm	nm	nm
	9:15 AM	5.45	nm	4.3
	9:30 AM	5.68	nm	4.4
	9:45 AM	5.38	nm	4.2
	10:00 AM	5.06	nm	4.0
	10:15 AM	4.86	nm	3.8
	10:30 AM	4.72	nm	3.7

10:45 AM	4.66	nm	3.6
11:00 AM	4.69	30.56	3.7
11:15 AM	4.80	nm	3.8
11:30 AM	4.84	nm	3.8
11:45 AM	4.96	nm	3.9
12:00 PM	4.92	nm	3.8
12:15 PM	4.84	nm	3.8
12:30 PM	4.70	nm	3.7
12:45 PM	4.67	nm	3.6
1:00 PM	4.74	nm	3.7
1:15 PM	4.81	nm	3.8
1:30 PM	3.99	nm	3.1
1:45 PM	4.66	nm	3.6
2:00 PM	4.65	31.67	3.6
2:15 PM	4.67	nm	3.6
2:30 PM	4.72	nm	3.7
2:45 PM	4.68	nm	3.7
3:00 PM	4.74	nm	3.7
3:15 PM	4.71	nm	3.7
3:30 PM	4.60	nm	3.6
3:45 PM	4.53	nm	3.5
4:00 PM	4.52	nm	3.5
4:15 PM	4.62	nm	3.6
4:30 PM	4.75	nm	3.7
4:45 PM	nm	nm	nm
5:00 PM	nm	31.11	nm

Urban site	Time	NO Out	Ambient Air	NO Flux
29-Aug-95	(hr/min)	(ppb)	(°C)	ng N m^{-2} s^{-1})
Flow Rate = 4 lpm	6:45 AM	7.16	nm	5.6
Loss Term = 0.02 cm sec^{-1}	7:00 AM	6.99	nm	5.5
	7:15 AM	6.74	nm	5.3
	7:30 AM	6.42	nm	5.0
	7:45 AM	6.16	nm	4.8
	8:00 AM	6.02	19.44	4.7
	8:15 AM	5.96	nm	4.7
	8:30 AM	5.81	nm	4.5
	8:45 AM	5.74	nm	4.5
	9:00 AM	5.73	nm	4.5
	9:15 AM	5.69	nm	4.4
	9:30 AM	5.67	nm	4.4
	9:45 AM	5.69	nm	4.4
	10:00 AM	5.66	nm	4.4
	10:15 AM	5.59	nm	4.4
	10:30 AM	5.80	nm	4.5
	10:45 AM	8.84	nm	6.9
	11:00 AM	5.06	25.56	4.0
	11:15 AM	4.72	nm	3.7
	11:30 AM	4.63	nm	3.6
	11:45 AM	4.60	nm	3.6
	12:00 PM	4.55	nm	3.6
	12:15 PM	4.55	nm	3.6
	12:30 PM	4.60	nm	3.6

12:45 PM	4.61	nm	3.6
1:00 PM	4.62	nm	3.6
1:15 PM	4.82	nm	3.8
1:30 PM	5.05	nm	4.0
1:45 PM	5.34	nm	4.2
2:00 PM	nm	28.33	nm
2:15 PM	nm	nm	nm
2:30 PM	nm	nm	nm
2:45 PM	nm	nm	nm
3:00 PM	nm	nm	nm
3:15 PM	nm	nm	nm
3:30 PM	nm	nm	nm
3:45 PM	nm	nm	nm
4:00 PM	nm	nm	nm
4:15 PM	nm	nm	nm
4:30 PM	nm	nm	nm
4:45 PM	nm	nm	nm
5:00 PM	nm	29.44	nm

Urban site	Time	NO Out	Ambient Air	NO Flux
30-Aug-95	(hr/min)	(ppb)	(°C)	ng N m^{-2} s^{-1})
Flow Rate = 4 lpm	8:00 AM	19.27	21.67	15.1
Loss Term = 0.02 cm sec^{-1}	8:15 AM	15.17	nm	11.9
	8:30 AM	13.61	nm	10.6
	8:45 AM	13.13	nm	10.3
	9:00 AM	13.08	nm	10.2
	9:15 AM	13.31	nm	10.4
	9:30 AM	13.63	nm	10.7
	9:45 AM	14.06	nm	11.0
	10:00 AM	15.16	nm	11.8
	10:15 AM	18.81	nm	14.7
	10:30 AM	20.37	nm	15.9
	10:45 AM	21.11	nm	16.5
	11:00 AM	20.97	28.89	16.4
	11:15 AM	21.36	nm	16.7
	11:30 AM	22.21	nm	17.4
	11:45 AM	23.02	nm	18.0
	12:00 PM	23.99	nm	18.8
	12:15 PM	25.01	nm	19.6
	12:30 PM	25.72	nm	20.1
	12:45 PM	26.00	nm	20.3
	1:00 PM	26.73	nm	20.9
	1:15 PM	27.18	nm	21.2
	1:30 PM	17.23	nm	13.5
	1:45 PM	30.36	nm	23.7
	2:00 PM	26.33	31.11	20.6
	2:15 PM	24.86	nm	19.4
	2:30 PM	23.86	nm	18.7
	2:45 PM	23.06	nm	18.0
	3:00 PM	25.89	nm	20.2
	3:15 PM	nm	nm	nm
	3:30 PM	nm	nm	nm
	3:45 PM	nm	nm	nm

4:00 PM	nm	nm	nm
4:15 PM	nm	nm	nm
4:30 PM	nm	nm	nm
4:45 PM	nm	nm	nm
5:00 PM	nm	30.56	nm

Urban site
31-Aug-95
Flow Rate = 4 lpm
Loss Term = 0.02 cm sec^{-1}

Time (hr/min)	NO Out (ppb)	Ambient Air (°C)	NO Flux ng N m^{-2} s^{-1})
7:15 AM	3.74	nm	2.9
7:30 AM	3.80	nm	3.0
7:45 AM	3.88	nm	3.0
8:00 AM	4.03	21.67	3.1
8:15 AM	4.01	nm	3.1
8:30 AM	4.06	nm	3.2
8:45 AM	3.91	nm	3.1
9:00 AM	3.95	nm	3.1
9:15 AM	4.05	nm	3.2
9:30 AM	4.18	nm	3.3
9:45 AM	4.23	nm	3.3
10:00 AM	4.36	nm	3.4
10:15 AM	4.54	nm	3.6
10:30 AM	4.67	nm	3.7
10:45 AM	4.73	nm	3.7
11:00 AM	4.89	27.78	3.8
11:15 AM	5.00	nm	3.9
11:30 AM	5.08	nm	4.0
11:45 AM	4.95	nm	3.9
12:00 PM	4.81	nm	3.8
12:15 PM	4.68	nm	3.7
12:30 PM	4.46	nm	3.5
12:45 PM	4.51	nm	3.5
1:00 PM	4.50	nm	3.5
1:15 PM	4.52	nm	3.5
1:30 PM	4.63	nm	3.6
1:45 PM	4.61	nm	3.6
2:00 PM	4.72	31.11	3.7
2:15 PM	4.81	nm	3.8
2:30 PM	4.86	nm	3.8
2:45 PM	nm	nm	nm
3:00 PM	nm	nm	nm
3:15 PM	nm	nm	nm
3:30 PM	nm	nm	nm
3:45 PM	nm	nm	nm
4:00 PM	nm	nm	nm
4:15 PM	nm	nm	nm
4:30 PM	nm	nm	nm
4:45 PM	nm	nm	nm
5:00 PM	nm	31.11	nm
5:15 PM	nm	nm	nm
5:30 PM	5.07	nm	4.0
5:45 PM	4.87	nm	3.8
6:00 PM	4.69	nm	3.7
6:15 PM	4.63	nm	3.6

	6:30 PM	4.47	nm	3.5

Urban site	Time	NO Out	Ambient Air	NO Flux
26-Sep-95	(hr/min)	(ppb)	(°C)	ng N m^{-2} s^{-1})
Flow Rate = 6.45 lpm	8:00 AM	15.98	16.67	19.0
Loss Term = 0.02 cm sec^{-1}	8:15 AM	15.51	nm	18.5
	8:30 AM	15.18	nm	18.1
	8:45 AM	15.16	nm	18.0
	9:00 AM	15.09	nm	18.0
	9:15 AM	14.97	nm	17.8
	9:30 AM	14.87	nm	17.7
	9:45 AM	14.85	nm	17.7
	10:00 AM	14.66	nm	17.5
	10:15 AM	14.54	nm	17.3
	10:30 AM	14.77	nm	17.6
	10:45 AM	14.58	nm	17.4
	11:00 AM	14.37	21.11	17.1
	11:15 AM	14.17	nm	16.9
	11:30 AM	14.24	nm	16.9
	11:45 AM	14.18	nm	16.9
	12:00 PM	14.54	nm	17.3
	12:15 PM	14.32	nm	17.0
	12:30 PM	14.02	nm	16.7
	12:45 PM	14.12	nm	16.8
	1:00 PM	14.46	nm	17.2
	1:15 PM	14.11	nm	16.8
	1:30 PM	14.55	nm	17.3
	1:45 PM	15.03	nm	17.9
	2:00 PM	14.83	24.44	17.7
	2:15 PM	15.45	nm	18.4
	2:30 PM	15.21	nm	18.1
	2:45 PM	14.78	nm	17.6
	3:00 PM	15.40	nm	18.3
	3:15 PM	16.06	nm	19.1
	3:30 PM	16.21	nm	19.3
	3:45 PM	16.03	nm	19.1
	4:00 PM	15.72	nm	18.7
	4:15 PM	16.47	nm	19.6
	4:30 PM	17.26	nm	20.5
	4:45 PM	18.13	nm	21.6
	5:00 PM	17.78	24.44	21.2
	5:15 PM	16.26	nm	19.4

Urban site	Time	NO Out	Ambient Air	NO Flux
28-Sep-95	(hr/min)	(ppb)	(°C)	ng N m^{-2} s^{-1})
Flow Rate = 4 lpm	8:00 AM	nm	13.89	nm
Loss Term = 0.02 cm sec^{-1}	8:15 AM	nm	nm	nm
	8:30 AM	nm	nm	nm
	8:45 AM	nm	nm	nm
	9:00 AM	nm	nm	nm
	9:15 AM	nm	nm	nm
	9:30 AM	nm	nm	nm
	9:45 AM	nm	nm	nm

10:00 AM	nm	nm	nm
10:15 AM	1.59	nm	1.2
10:30 AM	1.65	nm	1.3
10:45 AM	1.79	nm	1.4
11:00 AM	1.97	21.67	1.5
11:15 AM	1.88	nm	1.5
11:30 AM	1.79	nm	1.4
11:45 AM	1.71	nm	1.3
12:00 PM	1.70	nm	1.3
12:15 PM	1.73	nm	1.3
12:30 PM	1.70	nm	1.3
12:45 PM	1.67	nm	1.3
1:00 PM	1.75	nm	1.4
1:15 PM	1.75	nm	1.4
1:30 PM	1.83	nm	1.4
1:45 PM	1.94	nm	1.5
2:00 PM	1.98	25.00	1.6
2:15 PM	1.99	nm	1.6
2:30 PM	1.99	nm	1.6
2:45 PM	2.07	nm	1.6
3:00 PM	2.10	nm	1.6
3:15 PM	nm	nm	nm
3:30 PM	nm	nm	nm
3:45 PM	nm	nm	nm
4:00 PM	nm	nm	nm
4:15 PM	nm	nm	nm
4:30 PM	nm	nm	nm
4:45 PM	nm	nm	nm
5:00 PM	nm	23.89	nm

Urban site	Time	NO Out	Ambient Air	NO Flux
29-Sep-95	(hr/min)	(ppb)	(^{o}C)	ng N m^{-2} s^{-1})
Flow Rate = 4 lpm	8:00 AM	nm	13.89	nm
Loss Term = 0.02 cm sec^{-1}	8:15 AM	nm	nm	nm
	8:30 AM	nm	nm	nm
	8:45 AM	nm	nm	nm
	9:00 AM	3.52	nm	2.8
	9:15 AM	3.37	nm	2.6
	9:30 AM	3.15	nm	2.5
	9:45 AM	4.00	nm	3.1
	10:00 AM	4.00	nm	3.1
	10:15 AM	4.09	nm	3.2
	10:30 AM	4.32	nm	3.4
	10:45 AM	4.41	nm	3.4
	11:00 AM	5.17	20.00	4.0
	11:15 AM	5.26	nm	4.1
	11:30 AM	5.08	nm	4.0
	11:45 AM	5.83	nm	4.6
	12:00 PM	6.16	nm	4.8
	12:15 PM	6.25	nm	4.9
	12:30 PM	nm	nm	nm
	12:45 PM	nm	nm	nm
	1:00 PM	nm	nm	nm

1:15 PM	nm	nm	nm
1:30 PM	nm	nm	nm
1:45 PM	nm	nm	nm
2:00 PM	nm	23.89	nm
2:15 PM	nm	nm	nm
2:30 PM	nm	nm	nm
2:45 PM	nm	nm	nm
3:00 PM	nm	nm	nm
3:15 PM	nm	nm	nm
3:30 PM	4.33	nm	3.4
3:45 PM	nm	nm	nm
4:00 PM	nm	nm	nm
4:15 PM	nm	nm	nm
4:30 PM	nm	nm	nm
4:45 PM	nm	nm	nm
5:00 PM	nm	23.89	nm

Urban site	Time	NO Out	Ambient Air	NO Flux
2-Oct-95	(hr/min)	(ppb)	(^{o}C)	ng N m^{-2} s^{-1})
Flow Rate = 4 lpm	8:00 AM	nm	14.44	nm
Loss Term = 0.02 cm sec^{-1}	8:15 AM	nm	nm	nm
	8:30 AM	nm	nm	nm
	8:45 AM	nm	nm	nm
	9:00 AM	nm	nm	nm
	9:15 AM	2.74	nm	2.1
	9:30 AM	2.40	nm	1.9
	9:45 AM	2.38	nm	1.9
	10:00 AM	2.62	nm	2.0
	10:15 AM	2.81	nm	2.2
	10:30 AM	2.88	nm	2.2
	10:45 AM	2.98	nm	2.3
	11:00 AM	3.09	23.89	2.4
	11:15 AM	3.23	nm	2.5
	11:30 AM	3.46	nm	2.7
	11:45 AM	3.60	nm	2.8
	12:00 PM	3.82	nm	3.0
	12:15 PM	3.77	nm	2.9
	12:30 PM	3.79	nm	3.0
	12:45 PM	3.83	nm	3.0
	1:00 PM	3.84	nm	3.0
	1:15 PM	3.85	nm	3.0
	1:30 PM	3.91	nm	3.1
	1:45 PM	3.85	nm	3.0
	2:00 PM	3.77	28.89	2.9
	2:15 PM	3.78	nm	3.0
	2:30 PM	3.89	nm	3.0
	2:45 PM	3.83	nm	3.0
	3:00 PM	3.86	nm	3.0
	3:15 PM	3.80	nm	3.0
	3:30 PM	3.87	nm	3.0
	3:45 PM	3.81	nm	3.0
	4:00 PM	3.73	nm	2.9
	4:15 PM	3.94	nm	3.1

	4:30 PM	3.61	nm	2.8
	4:45 PM	nm	nm	nm
	5:00 PM	nm	28.89	nm

Urban site	Time	NO Out	Ambient Air	NO Flux
3-Oct-95	(hr/min)	(ppb)	(°C)	ng N m^{-2} s^{-1})
Flow Rate = 4 lpm	8:00 AM	nm	17.22	nm
Loss Term = 0.02 cm sec^{-1}	8:15 AM	nm	nm	nm
	8:30 AM	nm	nm	nm
	8:45 AM	nm	nm	nm
	9:00 AM	nm	nm	nm
	9:15 AM	nm	nm	nm
	9:30 AM	nm	nm	nm
	9:45 AM	nm	nm	nm
	10:00 AM	nm	nm	nm
	10:15 AM	nm	nm	nm
	10:30 AM	4.98	nm	3.9
	10:45 AM	5.01	nm	3.9
	11:00 AM	5.21	24.44	4.1
	11:15 AM	5.07	nm	4.0
	11:30 AM	4.95	nm	3.9
	11:45 AM	4.91	nm	3.8
	12:00 PM	4.84	nm	3.8
	12:15 PM	4.69	nm	3.7
	12:30 PM	4.89	nm	3.8
	12:45 PM	5.35	nm	4.2
	1:00 PM	5.80	nm	4.5
	1:15 PM	5.83	nm	4.6
	1:30 PM	5.67	nm	4.4
	1:45 PM	5.08	nm	4.0
	2:00 PM	4.84	27.78	3.8
	2:15 PM	4.79	nm	3.7
	2:30 PM	4.47	nm	3.5
	2:45 PM	4.14	nm	3.2
	3:00 PM	3.84	nm	3.0
	3:15 PM	3.55	nm	2.8
	3:30 PM	3.52	nm	2.7
	3:45 PM	nm	nm	nm
	4:00 PM	nm	nm	nm
	4:15 PM	nm	nm	nm
	4:30 PM	nm	nm	nm
	4:45 PM	nm	nm	nm
	5:00 PM	nm	26.67	nm

Appendix C

Appendix C contains measurements from the Summer 1995 campaign conducted at Kinston, Oxford, and Reidsville, NC.

Data from June 30, 1995 to July 13, 1995 at Kinston, NC
% Moisture = Expressed as a percentage of moisture per dry soil weight
Total Extractable Nitrogen (TEN) = mg N (kg dry soil)$^{-1}$
nm = not measured
Ambient air as carrier gas
Each 15 minute measurement represents the binned averages of the previous 15 minutes
lpm = liter per minute

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
30-Jun-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 14.5	8:15 AM	0.00	3.37	21.8	24.1	3.87
TEN = 12.05	8:30 AM	0.00	4.52	21.9	25.0	5.18
Flow Rate = 4 lpm	8:45 AM	0.00	4.98	22.2	27.3	5.71
Loss Term = 0.08 cm sec^{-1}	9:00 AM	0.00	6.26	22.6	27.9	7.18
	9:15 AM	0.00	6.49	22.9	28.9	7.44
	9:30 AM	0.00	5.90	23.2	33.0	6.76
	9:45 AM	0.00	5.35	23.5	34.0	6.13
	10:00 AM	0.00	4.94	23.7	33.6	5.66
	10:15 AM	0.00	4.11	23.8	35.7	4.71
	10:30 AM	0.00	3.40	23.9	34.4	3.89
	10:45 AM	0.00	3.43	24.0	36.6	3.93
	11:00 AM	0.00	3.29	24.0	38.2	3.77
	11:15 AM	0.00	3.18	24.2	38.9	3.65
	11:30 AM	0.00	2.98	24.3	36.7	3.41
	11:45 AM	0.00	3.13	24.4	33.5	3.58
	12:00 PM	0.00	3.29	24.5	36.0	3.78
	12:15 PM	0.00	3.33	24.5	38.1	3.82
	12:30 PM	0.00	3.00	24.6	36.4	3.44
	12:45 PM	0.00	3.20	24.7	31.5	3.67
	1:00 PM	0.00	5.49	24.7	31.0	6.29
	1:15 PM	0.00	4.20	24.7	33.8	4.82
	1:30 PM	0.00	4.23	24.9	37.1	4.86
	1:45 PM	0.00	3.92	25.5	34.7	4.49
	2:00 PM	0.00	3.42	26.0	38.7	3.92
	2:15 PM	0.00	3.31	26.5	36.3	3.80
	2:30 PM	0.00	3.07	26.9	35.5	3.52
	2:45 PM	0.00	2.91	27.1	31.8	3.34
	3:00 PM	0.00	2.86	27.1	34.4	3.28
	3:15 PM	0.00	3.07	27.2	39.8	3.52
	3:30 PM	0.00	3.16	27.6	40.3	3.62
	3:45 PM	0.00	3.36	28.2	38.5	3.85
	4:00 PM	0.00	3.52	28.6	39.8	4.04
	4:15 PM	0.00	3.76	28.8	35.1	4.32
	4:30 PM	0.00	3.73	28.6	35.0	4.27
	4:45 PM	0.00	3.48	28.5	34.3	4.00
	5:00 PM	0.00	3.63	28.3	31.2	4.16
	5:15 PM	0.00	3.51	28.2	34.8	4.02

	5:30 PM	0.00	3.68	28.0	35.7	4.22
	5:45 PM	0.00	3.83	28.0	34.3	4.39
	6:00 PM	0.00	3.73	28.1	33.6	4.28

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
01-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = nm	6:30 AM	1.31	2.58	23.3	21.2	2.09
TEN = nm	6:45 AM	1.41	3.42	23.2	21.4	2.98
Flow Rate = 4 lpm	7:00 AM	2.25	5.00	23.2	21.9	4.23
Loss Term = 0.08 cm sec^{-1}	7:15 AM	2.03	7.92	23.3	23.0	7.72
	7:30 AM	1.66	11.63	23.2	22.8	12.23
	7:45 AM	1.54	15.26	23.2	23.2	16.48
	8:00 AM	1.23	18.38	23.2	23.8	20.26
	8:15 AM	0.98	20.18	23.3	29.6	22.49
	8:30 AM	1.01	14.76	23.3	32.2	16.25
	8:45 AM	1.09	7.81	23.4	31.3	8.23
	9:00 AM	1.06	6.94	23.5	31.9	7.25
	9:15 AM	0.98	6.65	23.7	35.0	6.97
	9:30 AM	1.01	8.15	23.8	35.4	8.67
	9:45 AM	0.95	10.88	24.0	34.1	11.84
	10:00 AM	0.91	12.71	24.1	34.2	13.97
	10:15 AM	0.88	13.10	24.3	36.1	14.44
	10:30 AM	0.87	12.66	24.5	35.8	13.94
	10:45 AM	0.86	12.71	24.6	38.2	14.01
	11:00 AM	0.36	9.77	24.9	35.8	10.97
	11:15 AM	0.38	5.77	25.0	33.9	6.37
	11:30 AM	0.45	5.60	25.1	33.5	6.12
	11:45 AM	0.88	5.46	25.2	32.4	5.67
	12:00 PM	0.41	5.25	25.3	34.0	5.75
	12:15 PM	0.37	5.79	25.5	36.3	6.39
	12:30 PM	0.36	6.27	25.7	35.0	6.95
	12:45 PM	0.21	5.92	25.8	35.9	6.65
	1:00 PM	0.18	5.30	25.9	37.6	5.95
	1:15 PM	0.27	5.53	26.1	36.3	6.17
	1:30 PM	0.90	6.01	26.4	37.4	6.29
	1:45 PM	0.25	6.64	26.8	37.8	7.45
	2:00 PM	0.18	7.01	27.3	39.4	7.92
	2:15 PM	0.20	7.15	27.7	38.7	8.07
	2:30 PM	0.21	7.69	28.2	33.5	8.68
	2:45 PM	0.23	7.86	28.2	31.4	8.86
	3:00 PM	0.24	8.01	28.0	29.7	9.02
	3:15 PM	0.40	8.09	27.8	27.4	9.01
	3:30 PM	0.18	8.29	27.6	25.7	9.38
	3:45 PM	0.19	7.74	27.1	24.9	8.76
	4:00 PM	0.14	5.68	26.8	23.7	6.41
	4:15 PM	0.20	5.66	26.6	23.8	6.36
	4:30 PM	0.27	6.57	26.3	24.1	7.36
	4:45 PM	0.27	7.30	26.2	24.1	8.19
	5:00 PM	0.37	7.60	26.0	24.1	8.47
	5:15 PM	0.40	9.23	25.8	24.1	10.31
	5:30 PM	0.43	19.52	25.7	24.5	22.10
	5:45 PM	0.51	26.38	25.7	24.3	29.91
	6:00 PM	0.37	29.46	25.6	24.0	33.54

	6:15 PM	0.43	32.70	25.5	23.5	37.22

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
02-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 12.4	6:45 AM	0.25	5.33	22.9	22.1	5.95
TEN = 10	7:00 AM	0.28	4.73	23.0	22.3	5.24
Flow Rate = 4 lpm	7:15 AM	0.33	5.13	23.0	22.5	5.66
Loss Term = 0.08 cm sec^{-1}	7:30 AM	0.35	6.32	22.9	22.8	7.02
	7:45 AM	0.25	6.51	22.9	22.4	7.30
	8:00 AM	0.29	6.54	23.0	22.6	7.31
	8:15 AM	0.36	6.87	22.9	24.5	7.64
	8:30 AM	0.34	6.88	23.0	25.4	7.67
	8:45 AM	0.32	6.84	23.0	27.1	7.64
	9:00 AM	0.27	6.87	23.3	26.0	7.70
	9:15 AM	0.27	6.71	23.2	26.4	7.52
	9:30 AM	0.23	6.05	23.4	25.6	6.79
	9:45 AM	0.22	5.95	23.8	25.6	6.68
	10:00 AM	0.26	5.99	48.7	27.9	6.70
	10:15 AM	0.22	6.17	48.7	30.4	6.93
	10:30 AM	0.22	6.06	48.6	29.3	6.80
	10:45 AM	0.21	6.11	25.8	28.3	6.86
	11:00 AM	0.21	6.19	25.3	30.6	6.96
	11:15 AM	0.18	6.07	25.4	28.5	6.84
	11:30 AM	0.18	5.98	25.3	28.0	6.75
	11:45 AM	0.17	5.99	25.1	27.4	6.76
	12:00 PM	0.17	6.08	25.0	30.9	6.85
	12:15 PM	0.17	5.85	25.1	30.1	6.59
	12:30 PM	0.17	5.44	25.1	31.3	6.13
	12:45 PM	0.16	6.11	25.3	33.0	6.90
	1:00 PM	0.14	5.87	25.4	34.3	6.64
	1:15 PM	0.18	4.99	26.2	32.2	5.61
	1:30 PM	0.15	5.39	27.2	35.3	6.09
	1:45 PM	0.18	5.63	28.2	33.0	6.34
	2:00 PM	0.16	nm	28.0	33.9	nm
	2:15 PM	0.21	nm	28.7	32.6	nm
	2:30 PM	0.19	nm	28.1	33.1	nm
	2:45 PM	0.21	nm	28.4	32.3	nm
	3:00 PM	0.15	nm	28.1	32.0	nm
	3:15 PM	0.19	nm	28.3	33.5	nm
	3:30 PM	0.16	nm	28.3	31.1	nm
	3:45 PM	0.16	nm	27.9	33.0	nm
	4:00 PM	0.15	6.25	27.6	32.7	7.07
	4:15 PM	0.15	5.78	27.7	33.3	6.52
	4:30 PM	0.18	5.64	27.8	34.5	6.35
	4:45 PM	0.15	5.73	27.8	33.8	6.47
	5:00 PM	0.16	5.69	27.5	31.9	6.42
	5:15 PM	0.15	5.50	27.3	33.2	6.21
	5:30 PM	0.15	5.62	27.2	32.1	6.35
	5:45 PM	0.16	5.67	27.1	33.1	6.40
	6:00 PM	0.16	5.71	27.0	32.7	6.44

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
03-Jul-95	(hr/min)	(ppb)	(ppb)	(^{o}C)	(^{o}C)	ng N m^{-2} s^{-1}
% Moisture = 10.7	7:00 AM	5.75	15.58	21.4	20.7	14.03
TEN = 9	7:15 AM	7.75	17.62	21.4	21.9	15.04
Flow Rate = 4 lpm	7:30 AM	1.36	8.01	21.4	22.9	8.28
Loss Term = 0.08 cm sec^{-1}	7:45 AM	0.58	4.33	21.5	24.3	4.58
	8:00 AM	0.60	3.76	21.7	24.0	3.91
	8:15 AM	1.77	4.71	21.8	28.1	4.22
	8:30 AM	1.67	6.41	22.0	29.3	6.24
	8:45 AM	0.51	3.87	22.1	26.9	4.10
	9:00 AM	0.45	3.48	22.4	30.4	3.69
	9:15 AM	0.32	3.24	22.5	29.9	3.50
	9:30 AM	0.37	3.33	22.7	34.5	3.57
	9:45 AM	0.30	3.31	23.0	31.4	3.59
	10:00 AM	0.28	3.30	23.2	32.8	3.60
	10:15 AM	0.31	3.34	23.3	32.9	3.63
	10:30 AM	0.36	3.45	23.6	37.8	3.72
	10:45 AM	0.42	3.86	24.0	38.1	4.15
	11:00 AM	0.30	3.84	24.2	38.7	4.21
	11:15 AM	0.21	3.61	24.4	38.8	4.00
	11:30 AM	0.22	3.67	24.7	38.1	4.07
	11:45 AM	0.18	3.86	24.9	39.1	4.31
	12:00 PM	0.18	3.87	25.0	37.4	4.31
	12:15 PM	0.19	3.65	25.1	38.2	4.06
	12:30 PM	0.15	3.49	25.5	38.0	3.90
	12:45 PM	0.18	3.43	25.7	36.6	3.81
	1:00 PM	0.19	3.38	26.1	38.3	3.75
	1:15 PM	0.16	3.37	26.7	36.6	3.75
	1:30 PM	0.15	3.14	27.2	39.4	3.51
	1:45 PM	0.17	3.09	27.8	38.5	3.43
	2:00 PM	0.17	3.19	28.6	40.5	3.54
	2:15 PM	0.16	3.19	29.6	41.1	3.55
	2:30 PM	0.17	3.12	30.0	36.7	3.47
	2:45 PM	0.18	3.14	29.3	33.9	3.48
	3:00 PM	0.21	3.17	28.8	31.0	3.49
	3:15 PM	0.31	3.31	28.0	26.2	3.59
	3:30 PM	0.28	2.98	27.2	26.9	3.23
	3:45 PM	0.29	2.94	26.9	28.4	3.17
	4:00 PM	0.27	2.89	26.8	26.3	3.13
	4:15 PM	0.29	2.85	26.5	26.5	3.08
	4:30 PM	0.30	2.90	26.3	26.7	3.12
	4:45 PM	0.29	2.79	26.1	26.2	3.01
	5:00 PM	0.27	2.82	25.8	26.7	3.06
	5:15 PM	0.25	2.83	25.7	26.8	3.08
	5:30 PM	0.22	2.73	25.6	26.1	2.98
	5:45 PM	0.25	2.77	25.5	25.9	3.01
	6:00 PM	0.23	2.73	25.3	26.6	2.98

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
05-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 12.6	7:00 AM	0.35	8.13	21.1	21.7	9.09
TEN = 8	7:15 AM	0.55	6.71	21.2	22.3	7.33
Flow Rate = 4 lpm	7:30 AM	0.54	5.12	21.2	22.5	5.52
Loss Term = 0.08 cm sec^{-1}	7:45 AM	0.59	4.35	21.3	22.8	4.60
	8:00 AM	0.61	4.50	21.3	23.1	4.75
	8:15 AM	0.52	4.24	21.4	28.2	4.51
	8:30 AM	0.65	4.61	21.4	29.2	4.86
	8:45 AM	0.52	4.41	21.6	30.5	4.71
	9:00 AM	0.52	4.29	21.7	32.6	4.57
	9:15 AM	0.47	4.24	22.0	34.3	4.54
	9:30 AM	0.36	3.91	22.1	35.0	4.24
	9:45 AM	0.35	3.80	22.4	35.4	4.12
	10:00 AM	0.35	3.76	22.7	35.8	4.07
	10:15 AM	0.37	3.78	23.0	36.4	4.09
	10:30 AM	0.37	3.83	23.6	36.5	4.15
	10:45 AM	0.38	3.88	24.0	36.5	4.20
	11:00 AM	0.56	4.14	24.3	37.6	4.37
	11:15 AM	0.57	nm	24.5	38.0	nm
	11:30 AM	0.32	4.31	25.0	38.1	4.73
	11:45 AM	0.23	nm	25.2	38.9	nm
	12:00 PM	0.20	3.96	25.3	33.7	4.41
	12:15 PM	0.25	nm	25.4	38.6	nm
	12:30 PM	0.27	4.08	25.7	38.1	4.50
	12:45 PM	0.22	nm	26.0	38.1	nm
	1:00 PM	0.25	4.11	26.6	38.9	4.55
	1:15 PM	0.18	nm	27.8	40.0	nm
	1:30 PM	0.19	4.18	29.0	39.1	4.67
	1:45 PM	0.22	nm	29.7	38.6	nm
	2:00 PM	0.15	3.77	29.9	39.3	4.22
	2:15 PM	0.16	nm	30.7	40.4	nm
	2:30 PM	0.17	4.12	31.5	40.3	4.62
	2:45 PM	0.18	3.62	32.1	42.0	4.03
	3:00 PM	0.29	4.13	32.6	41.0	4.53
	3:15 PM	0.17	4.27	32.5	41.1	4.79
	3:30 PM	0.17	3.96	32.5	41.5	4.42
	3:45 PM	0.19	nm	32.1	40.9	nm
	4:00 PM	0.18	nm	31.5	35.9	nm
	4:15 PM	0.17	nm	31.3	38.6	nm
	4:30 PM	0.19	nm	30.9	34.2	nm
	4:45 PM	0.18	4.54	30.3	36.6	5.08
	5:00 PM	0.22	nm	29.9	35.6	nm
	5:15 PM	0.18	4.71	29.7	38.2	5.28
	5:30 PM	0.20	nm	29.8	35.9	nm
	5:45 PM	0.16	4.63	29.5	34.5	5.21
	6:00 PM	0.28	4.96	29.4	35.6	5.50

Soybean Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
10-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 13.4	5:45 AM	1.08	9.58	22.5	19.6	10.34
TEN = 11	6:00 AM	2.27	9.07	22.5	19.7	8.95
Flow Rate = 4 lpm	6:15 AM	2.05	8.43	22.3	19.8	8.37
Loss Term = 0.08 cm sec^{-1}	6:30 AM	2.67	9.66	22.3	20.2	9.38
	6:45 AM	7.41	15.73	22.2	20.3	13.23
	7:00 AM	5.02	15.29	22.1	20.9	14.31
	7:15 AM	3.20	12.37	22.1	21.6	12.16
	7:30 AM	1.49	8.69	22.1	23.4	9.04
	7:45 AM	1.71	8.29	22.1	25.6	8.43
	8:00 AM	1.57	8.34	22.1	25.6	8.58
	8:15 AM	2.03	8.88	22.2	27.1	8.90
	8:30 AM	2.26	9.85	22.2	29.6	9.86
	8:45 AM	1.80	9.18	22.4	30.4	9.39
	9:00 AM	1.55	9.05	22.5	32.2	9.41
	9:15 AM	0.65	6.74	22.7	32.8	7.35
	9:30 AM	0.74	6.80	23.0	33.0	7.35
	9:45 AM	0.82	7.03	23.3	30.8	7.57
	10:00 AM	0.69	6.66	23.6	32.2	7.23
	10:15 AM	0.69	6.57	23.9	34.6	7.13
	10:30 AM	0.50	6.21	24.2	33.4	6.84
	10:45 AM	0.33	5.83	24.6	34.6	6.52
	11:00 AM	0.27	5.49	24.9	34.6	6.16
	11:15 AM	0.26	5.45	25.3	35.9	6.12
	11:30 AM	0.24	5.63	25.7	36.5	6.34
	11:45 AM	0.26	5.73	26.1	36.3	6.45
	12:00 PM	0.21	5.46	26.5	34.8	6.17
	12:15 PM	0.23	5.56	26.8	32.9	6.26
	12:30 PM	0.24	5.83	27.0	37.7	6.57
	12:45 PM	0.21	6.09	27.2	38.9	6.90
	1:00 PM	0.20	5.85	27.6	37.5	6.62
	1:15 PM	0.22	5.69	28.1	36.7	6.42
	1:30 PM	0.24	6.02	28.4	41.3	6.80
	1:45 PM	0.25	6.75	28.7	37.9	7.63
	2:00 PM	0.20	6.58	29.0	39.0	7.47
	2:15 PM	0.22	nm	29.3	39.8	nm
	2:30 PM	0.18	nm	29.6	39.6	nm
	2:45 PM	0.21	nm	29.9	40.6	nm
	3:00 PM	0.22	7.53	30.2	36.1	8.55
	3:15 PM	0.27	7.49	30.3	34.8	8.47
	3:30 PM	0.26	7.54	30.3	33.4	8.54
	3:45 PM	0.24	7.66	30.2	37.1	8.69
	4:00 PM	0.24	7.50	30.3	37.4	8.50
	4:15 PM	0.27	8.07	30.4	31.2	9.13
	4:30 PM	0.21	8.15	30.4	30.2	9.27
	4:45 PM	0.27	7.86	30.3	29.7	8.90
	5:00 PM	0.32	7.91	30.2	28.3	8.92
	5:15 PM	0.20	7.94	30.0	28.2	9.03
	5:30 PM	0.22	7.74	29.8	26.2	8.79
	5:45 PM	0.26	8.40	29.6	25.9	9.52
	6:00 PM	0.24	8.40	29.2	26.2	9.54

6:15 PM	0.24	7.90	28.9	25.9	8.97
6:30 PM	0.24	7.64	28.6	24.5	8.66
6:45 PM	0.22	7.30	28.4	24.3	8.28
7:00 PM	0.23	7.26	28.1	24.2	8.24
7:15 PM	0.22	7.22	27.8	23.7	8.20
7:30 PM	0.27	7.13	27.6	23.2	8.05
7:45 PM	0.32	7.56	27.3	22.7	8.51
8:00 PM	0.29	7.28	27.0	22.3	8.21
8:15 PM	0.42	7.84	26.8	21.7	8.77
8:30 PM	0.43	8.04	26.5	21.6	9.00
8:45 PM	0.39	7.80	26.3	22.1	8.75
9:00 PM	0.46	7.73	26.1	21.8	8.62
9:15 PM	0.59	nm	25.9	21.6	nm
9:30 PM	0.60	nm	25.7	21.7	nm
9:45 PM	0.57	nm	25.5	21.8	nm
10:00 PM	0.34	nm	25.4	22.1	nm
10:15 PM	0.46	nm	25.2	21.6	nm
10:30 PM	0.65	7.12	25.1	21.1	7.79
10:45 PM	0.83	7.71	24.9	21.2	8.35
11:00 PM	0.79	7.56	24.8	20.9	8.20
11:15 PM	0.92	7.51	24.7	20.8	8.06
11:30 PM	0.78	7.51	24.5	20.7	8.15
11:45 PM	0.72	6.78	24.4	20.5	7.35
12:00 AM	0.56	7.14	24.3	20.3	7.87
12:15 AM	0.93	7.41	24.1	20.3	7.94
12:30 AM	0.80	7.56	24.0	20.1	8.20
12:45 AM	1.06	7.73	23.9	20.0	8.22
1:00 AM	0.65	7.55	23.8	19.8	8.28
1:15 AM	0.97	7.33	23.6	19.8	7.81
1:30 AM	0.90	7.68	23.5	19.5	8.27
1:45 AM	0.56	7.42	23.4	19.6	8.19
2:00 AM	1.52	7.79	23.3	19.7	7.98
2:15 AM	1.20	8.61	23.2	19.5	9.15
2:30 AM	1.31	8.36	23.1	19.5	8.77
2:45 AM	1.50	8.56	23.0	19.2	8.89
3:00 AM	1.01	8.34	22.9	19.3	8.96
3:15 AM	1.24	8.13	22.8	19.0	8.56
3:30 AM	1.46	8.12	22.7	19.3	8.41
3:45 AM	1.71	8.46	22.6	19.2	8.63
4:00 AM	1.71	8.83	22.5	19.1	9.05
4:15 AM	1.70	9.30	22.4	19.1	9.60
4:30 AM	1.26	9.03	22.3	19.4	9.59
4:45 AM	0.88	7.72	22.3	19.2	8.33
5:00 AM	1.80	9.00	22.2	19.1	9.19

Soybean Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
11-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 11.6	6:45 AM	3.37	44.15	21.8	20.6	48.74
TEN = 19	7:00 AM	2.03	44.29	21.7	21.2	49.80
Flow Rate = 4 lpm	7:15 AM	2.16	55.21	21.6	21.8	62.32
Loss Term = 0.08 cm sec^{-1}	7:30 AM	3.06	50.86	21.7	22.3	56.70
	7:45 AM	3.77	52.40	21.7	22.7	58.00
	8:00 AM	3.14	51.82	21.7	22.7	57.75

8:15 AM	1.16	48.03	21.8	22.6	54.70
8:30 AM	0.53	42.16	21.8	22.6	48.34
8:45 AM	0.50	39.28	21.9	22.6	45.03
9:00 AM	0.63	26.30	21.9	22.4	29.96
9:15 AM	0.40	37.32	21.9	21.7	42.84
9:30 AM	0.36	34.41	21.8	21.0	39.49
9:45 AM	0.51	33.35	21.8	20.9	38.17
10:00 AM	0.41	32.26	21.8	20.8	36.98
10:15 AM	0.34	30.91	21.7	21.0	35.47
10:30 AM	0.40	31.55	21.6	21.4	36.18
10:45 AM	0.54	32.71	21.6	24.0	37.42
11:00 AM	1.01	40.68	21.7	29.1	46.31
11:15 AM	0.79	50.55	22.0	29.6	57.85
11:30 AM	3.01	61.56	22.5	31.2	69.09
11:45 AM	2.63	68.16	22.9	31.7	76.96
12:00 PM	2.57	71.95	23.5	32.1	81.39
12:15 PM	1.65	47.65	23.9	33.0	53.94
12:30 PM	1.25	52.66	24.4	34.1	59.98
12:45 PM	0.70	60.17	24.9	36.3	69.03
1:00 PM	0.50	nm	25.4	38.5	nm
1:15 PM	0.43	78.40	25.9	37.1	90.26
1:30 PM	0.35	nm	26.4	37.4	nm
1:45 PM	0.41	83.30	26.8	35.9	95.93
2:00 PM	0.36	nm	27.2	36.9	nm
2:15 PM	0.29	84.00	27.6	37.0	96.82
2:30 PM	0.32	nm	27.9	36.4	nm
2:45 PM	0.28	79.20	28.2	34.5	91.29
3:00 PM	0.31	nm	28.3	37.8	nm
3:15 PM	0.32	69.39	28.6	35.9	79.93
3:30 PM	0.25	69.12	28.7	39.2	79.67
3:45 PM	0.29	69.52	28.9	36.2	80.09
4:00 PM	0.28	65.95	28.9	35.0	75.98
4:15 PM	0.36	62.59	28.9	35.1	72.05
4:30 PM	0.25	58.77	28.8	34.0	67.71
4:45 PM	0.28	54.92	28.7	33.5	63.24
5:00 PM	0.32	53.64	28.6	32.6	61.74
5:15 PM	0.36	53.07	28.5	32.9	61.05
5:30 PM	0.29	50.12	28.5	32.9	57.69
5:45 PM	0.28	46.48	28.5	32.8	53.50
6:00 PM	0.29	44.97	28.4	32.0	51.74
6:15 PM	0.23	44.05	28.3	31.8	50.73
6:30 PM	0.27	47.78	28.2	31.2	55.00

Soybean Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
12-Jul-95	(hr/min)	(ppb)	(ppb)	(^oC)	(^oC)	ng N m^{-2} s^{-1}
% Moisture = 13.3	6:30 AM	1.38	8.45	22.3	21.5	8.84
TEN = 14	6:45 AM	2.71	8.89	22.3	21.7	8.46
Flow Rate = 4 lpm	7:00 AM	4.05	10.64	22.3	22.0	9.59
Loss Term = 0.08 cm sec^{-1}	7:15 AM	3.91	10.50	22.3	22.4	9.52
	7:30 AM	4.77	13.13	22.3	22.8	11.98
	7:45 AM	4.34	12.58	22.3	24.0	11.64
	8:00 AM	9.16	17.26	22.4	26.8	13.82
	8:15 AM	5.21	15.69	22.4	28.3	14.64

8:30 AM	4.25	14.30	22.5	29.2	13.68
8:45 AM	4.46	14.30	22.7	29.2	13.55
9:00 AM	3.52	13.10	22.8	31.2	12.78
9:15 AM	4.20	13.52	23.0	32.0	12.81
9:30 AM	2.38	12.00	23.2	32.4	12.27
9:45 AM	2.23	10.66	23.4	32.1	10.83
10:00 AM	1.74	9.45	23.7	33.5	9.75
10:15 AM	2.09	9.48	24.0	33.8	9.56
10:30 AM	1.78	9.55	24.4	34.9	9.85
10:45 AM	0.68	8.21	24.7	34.2	9.02
11:00 AM	0.50	7.36	25.1	33.4	8.17
11:15 AM	0.45	7.09	25.5	34.6	7.89
11:30 AM	0.46	7.08	25.9	34.5	7.87
11:45 AM	0.41	7.03	26.3	34.7	7.85
12:00 PM	0.48	7.17	26.7	35.9	7.97
12:15 PM	0.49	7.53	27.2	35.8	8.37
12:30 PM	0.42	7.70	nm	nm	8.61
12:45 PM	0.35	7.80	28.0	35.6	8.77
1:00 PM	0.39	8.33	28.4	38.2	9.36
1:15 PM	0.42	8.63	28.7	36.2	9.69
1:30 PM	0.39	8.77	29.1	36.5	9.87
1:45 PM	0.42	8.76	29.5	34.6	9.83
2:00 PM	0.38	8.35	29.7	37.8	9.39
2:15 PM	0.42	9.10	29.9	32.4	10.23
2:30 PM	0.35	9.25	30.0	36.9	10.44
2:45 PM	0.34	9.20	30.0	34.6	10.39
3:00 PM	0.36	9.38	30.1	37.2	10.59
3:15 PM	0.36	8.96	30.2	37.5	10.11
3:30 PM	0.31	9.35	30.4	38.0	10.58
3:45 PM	0.39	9.81	30.6	36.8	11.08
4:00 PM	0.36	10.49	30.8	37.6	11.87
4:15 PM	0.37	11.00	31.0	37.4	12.45
4:30 PM	0.33	11.51	31.1	38.2	13.08
4:45 PM	0.36	11.54	31.2	36.5	13.09
5:00 PM	0.29	11.06	31.2	35.5	12.58
5:15 PM	0.32	11.81	31.2	36.4	13.42
5:30 PM	0.34	11.80	31.1	33.9	13.40
5:45 PM	0.46	11.02	31.0	34.5	12.42
6:00 PM	0.37	11.24	30.9	34.0	12.73
6:15 PM	0.38	10.64	30.7	33.2	12.03

Soybean Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
13-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 13.0	6:30 AM	22.79	36.25	21.7	19.2	26.67
TEN = 13	6:45 AM	9.30	29.18	21.7	19.8	27.49
Flow Rate = 4 lpm	7:00 AM	5.96	17.58	21.7	20.5	16.33
Loss Term = 0.08 cm sec^{-1}	7:15 AM	10.14	21.15	21.6	21.5	17.67
	7:30 AM	3.51	17.72	21.6	22.5	18.13
	7:45 AM	3.40	14.44	21.5	23.3	14.41
	8:00 AM	2.81	13.88	21.6	24.8	14.15
	8:15 AM	2.26	12.71	21.6	27.2	13.18
	8:30 AM	2.54	13.19	21.7	28.3	13.54

8:45 AM	3.09	13.43	21.9	28.7	13.45
9:00 AM	3.76	13.31	22.1	29.1	12.87
9:15 AM	3.39	14.36	22.3	30.0	14.32
9:30 AM	2.96	14.14	22.5	30.9	14.36
9:45 AM	2.45	14.07	22.8	30.6	14.62
10:00 AM	0.80	12.36	23.1	30.6	13.75
10:15 AM	0.62	10.50	23.4	31.2	11.71
10:30 AM	0.61	9.66	23.7	31.4	10.75
10:45 AM	0.58	9.65	24.0	33.9	10.76
11:00 AM	0.48	9.85	24.3	33.5	11.06
11:15 AM	0.51	10.24	24.7	33.7	11.48
11:30 AM	0.54	10.68	25.1	34.6	11.97
11:45 AM	0.48	10.09	25.5	32.8	11.33
12:00 PM	0.48	9.57	25.9	35.0	10.74
12:15 PM	0.49	7.38	26.4	35.5	8.20
12:30 PM	0.51	1.75	26.8	33.7	1.67
12:45 PM	0.50	7.43	27.2	35.8	8.25
1:00 PM	0.54	9.41	27.6	36.3	10.50
1:15 PM	0.47	10.11	28.1	37.8	11.36
1:30 PM	0.48	10.97	28.7	37.9	12.35
1:45 PM	0.52	11.87	29.3	38.2	13.37
2:00 PM	0.49	12.94	29.7	36.6	14.61
2:15 PM	0.51	13.54	30.1	36.9	15.29
2:30 PM	0.49	12.79	30.3	37.2	14.45
2:45 PM	0.37	15.22	30.6	40.4	17.33
3:00 PM	0.47	15.71	31.0	37.0	17.83
3:15 PM	0.40	16.35	31.3	37.6	18.61
3:30 PM	0.36	16.42	31.6	40.0	18.73
3:45 PM	0.34	16.96	31.8	36.5	19.36
4:00 PM	0.36	17.48	31.8	39.9	19.95
4:15 PM	0.41	17.15	31.9	38.7	19.53
4:30 PM	0.39	18.06	31.9	37.2	20.60
4:45 PM	0.36	17.63	32.0	38.0	20.11
5:00 PM	0.35	16.96	31.9	38.2	19.35
5:15 PM	0.40	nm	31.9	37.2	nm
5:30 PM	0.43	nm	31.8	33.0	nm
5:45 PM	0.58	nm	31.5	31.9	nm
6:00 PM	0.45	nm	31.2	34.1	nm
6:15 PM	0.52	25.24	31.0	31.7	28.80
6:30 PM	0.59	21.18	30.7	31.8	24.07
6:45 PM	0.48	20.50	30.5	30.3	23.35
7:00 PM	0.78	20.53	30.2	29.6	23.19
7:15 PM	0.68	18.97	29.9	29.0	21.45
7:30 PM	0.98	20.34	29.6	28.7	22.84
7:45 PM	1.24	20.86	29.4	27.8	23.27
8:00 PM	2.40	21.44	29.1	26.7	23.16
8:15 PM	3.20	21.49	28.9	25.8	22.69
8:30 PM	4.16	21.97	28.6	25.2	22.60
8:45 PM	3.20	21.84	28.3	24.7	23.09
9:00 PM	4.39	21.00	28.1	24.2	21.33
9:15 PM	2.24	19.09	27.9	24.0	20.56
9:30 PM	4.66	19.37	27.7	23.8	19.26
9:45 PM	5.67	21.57	27.4	23.5	21.13

10:00 PM	1.65	18.39	27.2	23.5	20.13
10:15 PM	2.30	17.49	27.0	23.3	18.66
10:30 PM	2.36	16.90	26.8	23.3	17.94
10:45 PM	1.27	15.84	26.6	23.7	17.45
11:00 PM	0.68	15.54	26.4	24.4	17.49
11:15 PM	0.53	16.30	26.2	24.5	18.48
11:30 PM	1.19	14.28	26.0	23.8	15.70
11:45 PM	1.28	13.16	25.9	23.4	14.35
12:00 AM	2.86	14.88	25.7	22.6	15.28
12:15 AM	3.75	15.99	25.5	22.5	15.96
12:30 AM	2.64	15.56	25.4	22.5	16.22
12:45 AM	3.42	15.41	25.3	22.5	15.52
1:00 AM	6.54	18.94	25.1	22.2	17.51
1:15 AM	10.04	22.68	25.0	21.9	19.50
1:30 AM	10.84	24.56	24.8	21.8	21.13
1:45 AM	7.02	21.15	24.7	21.9	19.75
2:00 AM	7.79	21.58	24.6	21.8	19.73
2:15 AM	8.32	22.73	24.4	21.9	20.70
2:30 AM	5.34	17.87	24.3	21.5	17.07
2:45 AM	5.16	19.72	24.2	21.5	19.34
3:00 AM	4.63	18.11	24.1	21.4	17.83
3:15 AM	9.60	20.67	24.0	21.1	17.47
3:30 AM	11.74	23.82	23.9	20.8	19.68
3:45 AM	5.08	20.96	23.7	21.3	20.82
4:00 AM	7.88	20.19	23.7	20.8	18.07
4:15 AM	12.11	24.02	23.5	20.7	19.66
4:30 AM	16.18	30.05	23.5	20.6	23.91
4:45 AM	9.27	23.46	23.4	20.6	20.91
5:00 AM	15.52	24.38	23.2	20.4	17.81
5:15 AM	14.14	28.02	23.2	20.3	22.93
5:30 AM	14.75	28.04	23.1	20.4	22.55
5:45 AM	10.00	23.57	22.9	20.6	20.55
6:00 AM	10.79	22.75	22.9	20.6	19.07
6:15 AM	10.64	22.55	22.8	20.2	18.95
6:30 AM	10.32	22.65	22.6	20.5	19.27
6:45 AM	13.68	24.62	22.5	20.5	19.31
7:00 AM	13.20	24.63	22.4	21.6	19.64
7:15 AM	15.85	25.54	22.4	26.6	18.93
7:30 AM	11.96	26.12	22.3	28.7	22.20
7:45 AM	10.24	23.42	22.4	30.8	20.22
8:00 AM	10.39	26.16	22.4	31.4	23.28

Data from July 20, 1995 to July 27, 1995 at Oxford, NC
% Moisture = Expressed as a percentage of moisture per dry soil weight
Total Extractable Nitrogen (TEN) = mg N (kg dry soil)$^{-1}$
nm = not measured
Ambient air as carrier gas
Each 15 minute measurement represents the binned averages of the previous 15 minutes
lpm = liter per minute

Tobacco Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
20-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 2.7	12:30 PM	0.02	5.09	28.1	38.4	5.27
TEN = 7	12:45 PM	0.14	9.60	28.4	38.8	9.87
Flow Rate = 4 lpm	1:00 PM	0.12	12.60	29.0	39.3	13.00
Loss Term = 0.06 cm sec^{-1}	1:15 PM	0.12	12.53	29.7	37.9	12.94
	1:30 PM	0.12	11.43	30.1	36.2	11.78
	1:45 PM	0.11	10.01	30.2	35.3	10.32
	2:00 PM	0.13	7.81	30.2	36.2	8.03
	2:15 PM	0.11	6.50	30.4	36.8	6.68
	2:30 PM	0.14	6.43	30.5	36.9	6.59
	2:45 PM	0.09	6.19	30.5	35.2	6.37
	3:00 PM	0.09	5.98	30.3	36.6	6.15
	3:15 PM	0.12	5.77	30.1	36.4	5.91
	3:30 PM	0.14	5.67	30.1	37.1	5.80
	3:45 PM	0.09	5.57	30.0	37.1	5.73
	4:00 PM	0.11	5.43	30.0	37.0	5.56
	4:15 PM	0.16	4.38	29.9	35.2	4.44
	4:30 PM	0.12	4.10	29.7	34.5	4.17
	4:45 PM	0.13	3.89	29.6	33.0	3.95
	5:00 PM	0.09	3.72	29.4	31.9	3.80
	5:15 PM	0.13	3.69	29.1	31.9	3.75
	5:30 PM	0.12	3.55	28.9	30.2	3.61
	5:45 PM	0.20	3.35	28.7	27.7	3.35
	6:00 PM	0.33	3.62	28.3	29.1	3.54
	6:15 PM	0.48	4.10	28.2	29.8	3.94
	6:30 PM	0.51	4.06	28.0	30.8	3.87
	6:45 PM	0.44	4.15	27.9	30.6	4.02
	7:00 PM	0.35	4.18	27.8	30.0	4.10
	7:15 PM	0.34	3.96	27.7	30.5	3.88
	7:30 PM	0.32	4.12	27.6	30.4	4.06
	7:45 PM	0.38	4.20	27.5	29.5	4.11
	8:00 PM	0.54	4.66	27.4	28.6	4.48
	8:15 PM	0.33	4.55	27.2	27.7	4.51
	8:30 PM	0.23	4.48	27.1	27.1	4.49
	8:45 PM	0.20	4.41	27.0	27.0	4.45
	9:00 PM	0.23	4.10	27.0	27.0	4.10
	9:15 PM	0.31	4.04	27.0	27.0	3.99
	9:30 PM	0.37	4.07	27.0	27.0	3.98
	9:45 PM	0.34	4.02	27.0	27.0	3.95
	10:00 PM	0.32	4.36	27.0	27.0	4.32
	10:15 PM	0.38	4.40	27.0	27.0	4.32
	10:30 PM	0.51	4.77	27.0	27.0	4.61
	10:45 PM	0.69	5.32	27.0	27.0	5.06
	11:00 PM	0.48	5.39	27.0	27.0	5.28

11:15 PM	0.33	4.89	27.0	27.0	4.86
11:30 PM	0.26	4.52	27.0	27.0	4.52
11:45 PM	0.28	4.23	27.0	27.0	4.21
12:00 AM	0.27	4.19	27.0	27.0	4.17
12:15 AM	0.34	4.33	27.0	27.0	4.27
12:30 AM	0.37	4.48	27.0	27.0	4.41
12:45 AM	0.25	4.17	27.0	27.0	4.17
1:00 AM	0.25	4.20	27.0	27.0	4.19
1:15 AM	0.21	4.28	27.0	27.0	4.31
1:30 AM	0.23	4.35	27.0	27.0	4.36
1:45 AM	0.22	4.38	27.0	27.0	4.40
2:00 AM	0.20	4.43	27.0	27.0	4.46
2:15 AM	0.25	4.55	27.0	27.0	4.56
2:30 AM	0.26	4.66	27.0	27.0	4.67
2:45 AM	0.32	4.70	27.0	27.0	4.66
3:00 AM	0.25	4.52	27.0	27.0	4.53
3:15 AM	0.26	4.39	27.0	27.0	4.38
3:30 AM	0.33	4.52	27.0	27.0	4.47
3:45 AM	0.26	4.48	27.0	27.0	4.47
4:00 AM	0.21	4.60	27.0	27.0	4.64
4:15 AM	0.22	4.62	27.0	27.0	4.66
4:30 AM	0.26	4.69	27.0	27.0	4.70
4:45 AM	0.35	4.74	27.0	27.0	4.69
5:00 AM	0.34	4.88	27.0	27.0	4.84

Tobacco Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
21-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 3.0	6:00 AM	0.55	3.26	27.0	27.0	3.02
TEN = 6	6:15 AM	0.36	3.27	27.0	27.0	3.15
Flow Rate = 4 lpm	6:30 AM	0.58	3.46	23.6	24.0	3.21
Loss Term = 0.06 cm sec^{-1}	6:45 AM	0.89	3.75	23.5	24.3	3.30
	7:00 AM	1.11	4.01	23.5	24.5	3.43
	7:15 AM	1.29	4.09	23.5	25.2	3.38
	7:30 AM	1.61	4.38	23.5	25.6	3.48
	7:45 AM	1.92	4.49	23.6	25.9	3.38
	8:00 AM	2.12	4.31	23.6	27.8	3.06
	8:15 AM	2.18	4.26	23.7	28.2	2.98
	8:30 AM	2.38	4.54	23.7	29.8	3.13
	8:45 AM	2.31	4.41	23.8	29.5	3.04
	9:00 AM	2.25	4.42	23.9	32.1	3.09
	9:15 AM	1.97	4.29	24.0	32.6	3.14
	9:30 AM	1.81	5.43	24.2	33.2	4.43
	9:45 AM	1.06	4.06	24.3	30.9	3.51
	10:00 AM	nm	nm	nm	nm	nm
	10:15 AM	nm	nm	24.5	33.5	nm
	10:30 AM	nm	nm	24.7	33.5	nm
	10:45 AM	nm	nm	nm	nm	nm
	11:00 AM	nm	nm	nm	nm	nm
	11:15 AM	nm	nm	25.1	32.2	nm
	11:30 AM	1.22	2.39	25.3	32.2	1.67
	11:45 AM	1.36	2.55	25.5	33.2	1.74
	12:00 PM	1.22	2.56	25.6	31.9	1.84

12:15 PM	1.18	2.40	25.5	30.8	1.70
12:30 PM	0.95	2.63	25.5	30.8	2.10
12:45 PM	1.25	2.83	25.4	26.9	2.10
1:00 PM	1.45	3.25	25.3	27.4	2.41
1:15 PM	1.69	3.28	25.2	28.9	2.28
1:30 PM	1.55	3.07	25.2	29.3	2.16
1:45 PM	1.76	3.13	25.2	32.2	2.08
2:00 PM	1.72	3.49	25.5	33.5	2.48
2:15 PM	1.51	3.37	25.8	34.0	2.49
2:30 PM	1.42	3.05	26.0	35.0	2.22
2:45 PM	1.60	3.16	26.2	35.7	2.22
3:00 PM	1.58	3.20	26.4	35.5	2.28
3:15 PM	1.47	3.28	26.7	36.4	2.42
3:30 PM	1.49	3.13	26.8	36.3	2.25
3:45 PM	1.44	nm	26.9	36.2	nm
4:00 PM	1.51	nm	27.0	34.5	nm
4:15 PM	1.35	4.89	27.0	34.8	4.18
4:30 PM	1.47	4.09	27.0	36.0	3.27
4:45 PM	1.66	4.17	27.0	34.3	3.23
5:00 PM	1.59	3.85	27.0	34.2	2.94
5:15 PM	1.80	3.99	27.1	35.8	2.94
5:30 PM	1.98	4.38	27.1	35.8	3.23
5:45 PM	2.11	5.27	27.2	35.5	4.06
6:00 PM	1.88	4.87	27.2	34.6	3.81

Tobacco Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
24-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 7.2	7:15 AM	0.63	3.12	nm	nm	2.82
TEN = 7	7:30 AM	0.92	4.17	nm	nm	3.72
Flow Rate = 4 lpm	7:45 AM	0.73	4.04	nm	nm	3.71
Loss Term = 0.06 cm sec^{-1}	8:00 AM	0.75	3.89	nm	nm	3.55
	8:15 AM	0.87	4.04	nm	nm	3.61
	8:30 AM	1.01	4.23	nm	nm	3.72
	8:45 AM	1.05	4.28	nm	nm	3.75
	9:00 AM	1.18	4.30	nm	nm	3.68
	9:15 AM	1.14	4.26	nm	nm	3.66
	9:30 AM	1.04	4.03	nm	nm	3.49
	9:45 AM	1.00	3.96	nm	nm	3.44
	10:00 AM	0.77	3.71	nm	nm	3.34
	10:15 AM	0.67	3.59	nm	nm	3.28
	10:30 AM	0.59	3.46	nm	nm	3.19
	10:45 AM	0.50	3.25	nm	nm	3.04
	11:00 AM	0.43	3.20	nm	nm	3.04
	11:15 AM	0.40	3.18	nm	nm	3.04
	11:30 AM	0.35	3.22	nm	nm	3.11
	11:45 AM	0.30	3.07	nm	nm	2.99
	12:00 PM	0.38	3.27	nm	nm	3.14
	12:15 PM	0.41	3.31	nm	nm	3.16
	12:30 PM	0.46	3.43	nm	nm	3.25
	12:45 PM	0.52	3.36	nm	nm	3.15
	1:00 PM	0.61	3.67	nm	nm	3.40
	1:15 PM	0.59	3.76	nm	nm	3.51
	1:30 PM	0.49	3.53	nm	nm	3.34

1:45 PM	0.35	3.57	nm	nm	3.48
2:00 PM	0.35	3.76	nm	nm	3.67
2:15 PM	0.24	3.86	nm	nm	3.85
2:30 PM	0.27	3.99	nm	nm	3.96
2:45 PM	0.28	3.92	nm	nm	3.89
3:00 PM	0.23	3.88	nm	nm	3.88
3:15 PM	0.16	3.93	nm	nm	3.98
3:30 PM	0.06	4.13	nm	nm	4.25
3:45 PM	0.16	3.93	nm	nm	3.98
4:00 PM	0.04	3.56	nm	nm	3.67
4:15 PM	0.04	3.46	nm	nm	3.57
4:30 PM	0.20	3.48	nm	nm	3.48
4:45 PM	0.09	3.50	nm	nm	3.58
5:00 PM	0.25	3.56	nm	nm	3.53
5:15 PM	0.57	4.36	nm	nm	4.15
5:30 PM	0.70	4.31	nm	nm	4.01
5:45 PM	0.66	4.28	nm	nm	4.01
6:00 PM	0.60	4.51	nm	nm	4.28
6:15 PM	0.51	3.89	nm	nm	3.70

Tobacco Crop
25-Jul-95
% Moisture = 8.1
TEN = 7
Flow Rate = 4 lpm
Loss Term = 0.06 cm sec^{-1}

Time (hr/min)	NO Before (ppb)	NO After (ppb)	Soil (^oC)	Ambient Air (^oC)	NO Flux ng N m^{-2} s^{-1}
7:00 AM	3.23	3.71	nm	nm	1.70
7:15 AM	6.39	6.99	24.6	22.6	2.99
7:30 AM	4.35	6.46	24.6	22.6	3.81
7:45 AM	2.84	4.91	24.9	23.3	3.20
8:00 AM	2.98	4.50	24.6	24.3	2.68
8:15 AM	2.94	4.37	24.7	24.8	2.58
8:30 AM	1.58	3.25	24.8	25.7	2.32
8:45 AM	1.47	2.89	24.9	26.4	2.03
9:00 AM	1.39	2.84	25.1	27.4	2.02
9:15 AM	1.18	2.75	25.3	28.0	2.07
9:30 AM	0.83	2.49	25.4	28.8	2.04
9:45 AM	0.65	2.33	25.5	29.5	1.99
10:00 AM	0.62	2.19	25.6	29.9	1.86
10:15 AM	0.56	2.17	25.7	30.2	1.88
10:30 AM	0.78	2.45	25.8	31.1	2.02
10:45 AM	1.22	3.01	26.0	31.7	2.31
11:00 AM	1.29	2.99	26.1	32.3	2.25
11:15 AM	1.77	3.51	26.3	32.8	2.47
11:30 AM	1.25	3.30	26.6	33.3	2.59
11:45 AM	0.87	2.77	26.8	33.3	2.30
12:00 PM	0.67	2.56	27.1	33.2	2.21
12:15 PM	0.55	2.35	27.2	34.0	2.07
12:30 PM	0.43	2.24	27.5	34.1	2.04
12:45 PM	0.43	2.15	27.8	34.0	1.94
1:00 PM	0.48	2.17	28.0	34.2	1.93
1:15 PM	0.27	2.25	28.1	34.2	2.16
1:30 PM	0.22	2.26	29.0	35.0	2.20
1:45 PM	0.29	2.41	29.0	35.4	2.31
2:00 PM	0.35	2.62	29.0	35.4	2.49
2:15 PM	0.41	2.54	29.4	35.0	2.37

2:30 PM	0.37	2.45	29.5	34.8	2.30
2:45 PM	0.31	2.40	29.5	34.7	2.28
3:00 PM	0.35	2.30	29.7	33.3	2.16
3:15 PM	0.39	2.27	29.7	36.3	2.10
3:30 PM	0.45	2.18	29.8	35.6	1.96
3:45 PM	1.91	2.20	30.0	35.5	1.02
4:00 PM	1.05	2.22	30.0	35.1	1.61
4:15 PM	0.68	2.68	30.0	34.7	2.33
4:30 PM	0.49	2.36	29.9	34.3	2.12
4:45 PM	0.28	2.24	29.9	33.9	2.14
5:00 PM	0.21	2.28	30.0	33.7	2.22
5:15 PM	0.20	2.22	29.9	33.4	2.18
5:30 PM	0.20	2.28	29.9	33.1	2.24
5:45 PM	0.24	2.15	30.0	33.0	2.08
6:00 PM	0.22	2.17	30.0	32.5	2.11

Tobacco Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
26-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 6.2	7:00 AM	0.61	5.05	25.0	22.1	4.84
TEN = 8	7:15 AM	0.67	4.99	25.0	22.4	4.74
Flow Rate = 4 lpm	7:30 AM	0.97	5.30	25.0	23.0	4.86
Loss Term = 0.06 cm sec^{-1}	7:45 AM	0.63	5.21	25.0	23.8	4.99
	8:00 AM	0.59	4.35	25.0	25.2	4.12
	8:15 AM	0.57	3.84	24.9	25.6	3.61
	8:30 AM	0.83	3.88	25.0	26.0	3.48
	8:45 AM	0.60	3.73	25.0	26.8	3.47
	9:00 AM	0.58	3.75	25.1	27.4	3.51
	9:15 AM	0.58	3.74	25.1	28.0	3.49
	9:30 AM	0.63	3.81	25.2	28.7	3.54
	9:45 AM	1.76	4.49	25.2	29.4	3.48
	10:00 AM	2.49	5.39	25.3	29.7	3.94
	10:15 AM	2.64	5.70	25.4	30.1	4.16
	10:30 AM	2.19	5.39	25.6	30.6	4.13
	10:45 AM	2.46	5.57	25.7	31.5	4.14
	11:00 AM	2.18	5.70	25.8	31.8	4.46
	11:15 AM	1.94	5.64	26.0	32.4	4.57
	11:30 AM	2.35	6.08	26.1	33.3	4.75
	11:45 AM	2.19	6.51	26.3	33.6	5.31
	12:00 PM	1.17	5.45	26.5	33.0	4.88
	12:15 PM	0.95	5.12	27.0	33.7	4.68
	12:30 PM	0.78	5.13	27.7	33.6	4.81
	12:45 PM	0.56	5.00	27.7	33.6	4.82
	1:00 PM	0.54	4.98	28.3	34.5	4.81
	1:15 PM	0.92	5.09	28.6	34.7	4.67
	1:30 PM	0.53	4.79	28.8	34.9	4.62
	1:45 PM	0.74	5.37	29.0	35.0	5.08
	2:00 PM	1.30	6.33	29.5	35.1	5.71
	2:15 PM	0.87	6.36	30.0	35.2	6.02
	2:30 PM	0.47	6.23	30.0	35.8	6.16
	2:45 PM	0.48	7.01	30.5	36.0	6.96
	3:00 PM	0.49	7.26	30.6	35.4	7.22
	3:15 PM	0.53	7.32	30.8	34.2	7.24
	3:30 PM	0.55	7.12	30.8	34.9	7.02

3:45 PM	0.52	7.04	30.8	34.4	6.96
4:00 PM	0.53	6.92	30.9	34.8	6.83
4:15 PM	0.42	6.55	30.9	35.1	6.52
4:30 PM	0.49	6.42	30.8	35.4	6.34
4:45 PM	0.47	nm	30.7	33.8	nm
5:00 PM	0.47	nm	30.6	35.1	nm
5:15 PM	0.53	nm	30.5	33.1	nm
5:30 PM	0.46	6.02	30.4	33.0	5.95
5:45 PM	0.52	6.19	30.2	33.2	6.08
6:00 PM	0.30	5.89	30.0	33.0	5.92

Tobacco Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
27-Jul-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 6.7	6:45 AM	1.44	6.97	25.0	23.5	6.27
TEN = 13	7:00 AM	1.82	7.20	25.0	23.7	6.27
Flow Rate = 4 lpm	7:15 AM	14.00	14.95	25.0	23.8	6.19
Loss Term = 0.06 cm sec^{-1}	7:30 AM	11.01	15.37	25.0	23.9	8.62
	7:45 AM	10.25	15.39	25.0	24.3	9.15
	8:00 AM	4.13	10.44	25.0	24.5	8.09
	8:15 AM	3.65	8.68	25.0	24.6	6.58
	8:30 AM	2.42	7.30	25.0	24.7	5.97
	8:45 AM	1.99	6.67	25.1	26.0	5.60
	9:00 AM	1.69	6.48	25.2	27.4	5.60
	9:15 AM	1.81	6.32	25.3	27.6	5.36
	9:30 AM	1.68	6.25	25.4	28.0	5.37
	9:45 AM	1.78	6.25	25.5	28.4	5.31
	10:00 AM	1.77	6.22	25.6	28.8	5.28
	10:15 AM	1.59	6.05	25.8	29.6	5.22
	10:30 AM	1.27	5.82	26.0	29.6	5.20
	10:45 AM	1.26	5.82	26.2	29.7	5.20
	11:00 AM	0.89	5.73	26.4	29.9	5.36
	11:15 AM	0.88	5.32	26.6	30.1	4.93
	11:30 AM	0.00	5.50	26.8	32.7	5.71
	11:45 AM	0.00	5.65	27.1	32.8	5.87
	12:00 PM	0.42	5.68	27.4	32.9	5.62
	12:15 PM	0.48	5.25	27.8	32.3	5.13
	12:30 PM	0.47	nm	27.9	33.0	nm
	12:45 PM	0.00	nm	28.0	34.1	nm
	1:00 PM	0.00	4.77	28.8	33.3	4.95
	1:15 PM	0.27	4.44	29.1	33.8	4.43
	1:30 PM	0.00	4.48	30.5	33.9	4.65
	1:45 PM	0.00	4.90	32.2	34.0	5.08
	2:00 PM	0.18	5.08	32.5	34.2	5.15
	2:15 PM	0.33	5.15	32.3	33.9	5.12
	2:30 PM	0.00	5.35	32.0	33.9	5.56
	2:45 PM	0.00	5.63	31.6	34.0	5.85
	3:00 PM	0.27	5.69	31.4	34.2	5.73
	3:15 PM	0.29	5.65	31.3	35.1	5.67
	3:30 PM	0.33	5.61	29.5	32.6	5.60
	3:45 PM	0.31	5.69	31.1	33.3	5.71
	4:00 PM	0.30	5.78	31.0	32.9	5.81
	4:15 PM	0.26	5.69	30.9	32.6	5.74
	4:30 PM	0.00	5.51	30.8	32.9	5.73

4:45 PM	0.00	5.73	30.7	32.0	5.95
5:00 PM	0.00	5.57	30.6	31.5	5.78
5:15 PM	0.00	5.82	30.5	31.1	6.04
5:30 PM	0.20	5.36	30.3	31.6	5.43
5:45 PM	0.00	5.20	30.2	30.7	5.41
6:00 PM	0.18	5.48	30.1	31.2	5.57
6:15 PM	0.00	5.54	30.0	30.4	5.75

Data from August 2, 1995 to August 10, 1995 at Reidsville, NC
% Moisture = Expressed as a percentage of moisture per dry soil weight
Total Extractable Nitrogen (TEN) = mg N (kg dry soil)-1
nm = not measured
Ambient air as carrier gas
Each 15 minute measurement represents the binned averages of the previous 15 minutes
lpm = liter per minute

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
02-Aug-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 10.0	6:45 AM	2.12	11.39	24.1	21.3	10.92
TEN = 17	7:00 AM	4.13	12.44	24.1	21.9	10.72
Flow Rate = 4 lpm	7:15 AM	5.86	13.71	24.1	22.2	10.94
Loss Term = 0.07 cm sec^{-1}	7:30 AM	6.07	14.84	24.1	22.7	12.03
	7:45 AM	4.24	12.81	24.1	23.1	11.04
	8:00 AM	4.33	12.66	24.1	23.8	10.82
	8:15 AM	3.73	11.94	24.1	24.5	10.44
	8:30 AM	3.27	11.53	24.1	25.6	10.30
	8:45 AM	2.65	10.35	24.2	26.2	9.44
	9:00 AM	2.39	10.12	24.3	27.0	9.36
	9:15 AM	2.23	9.86	24.4	27.8	9.19
	9:30 AM	2.14	9.93	24.5	28.2	9.32
	9:45 AM	1.53	9.74	24.6	28.6	9.52
	10:00 AM	1.38	9.84	24.7	29.1	9.73
	10:15 AM	1.18	9.73	24.9	29.2	9.74
	10:30 AM	1.24	9.56	25.1	29.3	9.52
	10:45 AM	1.03	9.32	25.2	29.9	9.41
	11:00 AM	0.97	9.38	25.3	30.7	9.51
	11:15 AM	0.80	9.91	25.4	31.0	10.20
	11:30 AM	0.62	9.85	25.4	31.9	10.26
	11:45 AM	0.56	9.41	25.5	32.8	9.81
	12:00 PM	0.62	9.29	25.6	33.2	9.64
	12:15 PM	0.57	9.12	25.7	32.6	9.49
	12:30 PM	0.63	8.79	25.8	31.1	9.10
	12:45 PM	0.54	8.17	25.9	33.9	8.49
	1:00 PM	0.46	7.63	26.1	33.7	7.96
	1:15 PM	0.44	7.93	26.2	32.0	8.29
	1:30 PM	0.48	7.68	26.2	32.6	7.99
	1:45 PM	0.37	7.57	26.3	33.7	7.95
	2:00 PM	0.41	7.64	26.4	34.1	8.00
	2:15 PM	0.39	7.99	26.5	33.1	8.39
	2:30 PM	0.39	7.84	26.5	33.5	8.22
	2:45 PM	0.43	7.85	26.5	33.2	8.21
	3:00 PM	0.46	7.65	26.5	33.1	7.98
	3:15 PM	0.41	7.42	26.6	34.7	7.76

3:30 PM	0.37	7.35	26.7	30.0	7.71
3:45 PM	0.40	6.99	26.7	31.2	7.29
4:00 PM	0.44	6.91	26.6	31.1	7.19
4:15 PM	0.40	7.04	26.7	33.2	7.35
4:30 PM	0.42	6.76	26.7	33.1	7.04
4:45 PM	0.40	6.90	26.8	33.3	7.20
5:00 PM	0.36	6.96	27.1	33.7	7.29
5:15 PM	0.34	6.89	27.1	3.1	7.23
5:30 PM	0.36	6.76	27.0	32.8	7.08
5:45 PM	0.35	6.84	27.0	32.5	7.17
6:00 PM	0.38	6.85	27.0	32.8	7.17

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
03-Aug-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 15.6	6:15 AM	1.20	9.09	24.5	20.8	9.04
TEN = 32	6:30 AM	1.01	9.14	24.5	20.8	9.22
Flow Rate = 4 lpm	6:45 AM	1.45	10.32	24.4	20.7	10.21
Loss Term = 0.07 cm sec^{-1}	7:00 AM	6.83	14.50	24.4	21.2	11.14
	7:15 AM	9.63	17.09	24.4	21.4	12.08
	7:30 AM	9.48	18.01	24.5	21.6	13.18
	7:45 AM	9.22	18.56	24.5	22.0	13.95
	8:00 AM	10.99	21.02	24.5	22.9	15.43
	8:15 AM	13.46	23.87	24.5	24.1	16.87
	8:30 AM	8.65	20.43	24.6	24.6	16.35
	8:45 AM	6.25	16.80	24.7	25.8	14.02
	9:00 AM	3.63	13.31	24.7	26.3	11.99
	9:15 AM	4.15	12.32	24.8	26.3	10.57
	9:30 AM	2.90	12.14	24.9	26.2	11.21
	9:45 AM	1.27	10.39	25.0	26.3	10.40
	10:00 AM	1.25	10.41	25.1	27.0	10.44
	10:15 AM	1.20	11.29	25.3	27.6	11.42
	10:30 AM	1.16	12.48	25.5	28.4	12.74
	10:45 AM	1.12	13.56	25.7	29.3	13.93
	11:00 AM	1.11	13.09	26.0	29.6	13.43
	11:15 AM	0.89	11.22	26.1	29.9	11.55
	11:30 AM	0.72	9.04	26.3	30.3	9.31
	11:45 AM	0.67	7.48	26.4	30.7	7.65
	12:00 PM	0.55	5.98	26.5	31.0	6.11
	12:15 PM	0.93	6.12	26.7	31.2	6.01
	12:30 PM	0.36	5.61	26.8	33.4	5.83
	12:45 PM	0.42	5.48	27.0	33.1	5.65
	1:00 PM	0.41	5.42	27.2	32.1	5.60
	1:15 PM	0.33	5.41	27.6	32.6	5.64
	1:30 PM	0.31	5.45	28.0	33.1	5.69
	1:45 PM	0.32	5.89	28.2	33.0	6.16
	2:00 PM	0.30	5.52	28.4	32.8	5.78
	2:15 PM	0.29	5.30	28.4	33.4	5.55
	2:30 PM	0.22	5.35	28.3	33.4	5.65
	2:45 PM	0.26	5.40	28.5	33.1	5.67
	3:00 PM	0.30	5.47	28.7	32.7	5.72
	3:15 PM	0.23	5.30	29.0	32.8	5.59
	3:30 PM	0.39	nm	28.8	32.6	nm
	3:45 PM	0.32	nm	28.9	33.7	nm

4:00 PM	0.30	nm	29.0	32.7	nm
4:15 PM	0.25	6.02	29.0	32.7	6.35
4:30 PM	0.36	5.86	28.9	33.0	6.10
4:45 PM	0.29	5.75	28.9	33.1	6.03
5:00 PM	0.25	5.20	28.8	34.6	5.46
5:15 PM	0.36	5.30	28.7	32.8	5.50
5:30 PM	0.37	5.45	28.7	31.3	5.65
5:45 PM	0.30	5.34	28.6	31.6	5.58
6:00 PM	0.27	5.00	28.6	32.0	5.23

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
07-Aug-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 10.5	6:45 AM	0.00	3.04	22.2	22.1	3.29
TEN = 6	7:00 AM	0.49	3.11	22.2	21.9	3.04
Flow Rate = 4 lpm	7:15 AM	nm	nm	22.1	21.5	nm
Loss Term = 0.07 cm sec^{-1}	7:30 AM	2.48	3.38	22.1	21.2	2.01
	7:45 AM	1.72	3.98	22.1	21.7	3.16
	8:00 AM	2.10	4.31	22.1	22.0	3.26
	8:15 AM	2.11	4.23	22.0	22.8	3.18
	8:30 AM	2.35	4.75	22.1	22.8	3.58
	8:45 AM	2.44	4.96	22.0	22.4	3.75
	9:00 AM	5.24	6.52	22.0	24.0	3.57
	9:15 AM	2.15	4.68	22.0	25.0	3.63
	9:30 AM	2.60	5.38	22.0	24.0	4.09
	9:45 AM	1.99	5.01	22.0	25.7	4.10
	10:00 AM	1.57	4.39	22.0	26.1	3.70
	10:15 AM	1.50	3.69	22.1	25.3	3.00
	10:30 AM	1.97	3.66	22.0	26.2	2.65
	10:45 AM	2.58	4.15	22.0	26.5	2.77
	11:00 AM	2.26	3.79	22.1	28.4	2.60
	11:15 AM	5.01	5.26	22.1	28.2	2.35
	11:30 AM	1.79	3.87	22.1	27.5	3.00
	11:45 AM	1.54	3.43	22.1	30.7	2.69
	12:00 PM	1.52	3.34	22.2	29.3	2.60
	12:15 PM	1.34	3.45	22.2	32.1	2.84
	12:30 PM	1.03	3.15	22.3	31.3	2.73
	12:45 PM	1.05	3.14	22.3	30.7	2.70
	1:00 PM	0.97	3.09	22.3	30.3	2.70
	1:15 PM	1.13	3.16	22.3	30.8	2.67
	1:30 PM	0.96	3.12	22.4	30.7	2.74
	1:45 PM	1.72	3.50	22.4	28.4	2.64
	2:00 PM	0.98	3.13	22.4	30.9	2.73
	2:15 PM	1.89	3.96	22.4	27.1	3.03
	2:30 PM	0.72	2.94	22.4	27.8	2.70
	2:45 PM	0.71	2.81	22.4	27.5	2.56
	3:00 PM	0.71	2.67	22.4	26.9	2.42
	3:15 PM	0.75	2.71	22.4	27.0	2.43
	3:30 PM	0.68	2.45	22.4	27.3	2.20
	3:45 PM	0.75	2.57	22.4	29.2	2.28
	4:00 PM	0.74	2.54	22.4	29.2	2.26
	4:15 PM	0.69	2.54	22.4	27.8	2.28
	4:30 PM	0.77	2.49	22.4	28.0	2.18
	4:45 PM	0.71	2.45	22.4	26.8	2.18

5:00 PM	0.87	2.57	22.4	25.5	2.20
5:15 PM	0.94	2.69	22.4	25.4	2.29
5:30 PM	5.49	5.24	22.3	26.7	2.01
5:45 PM	5.59	6.85	22.3	26.8	3.69
6:00 PM	4.41	5.58	22.3	25.0	3.10

Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
09-Aug-95	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 10.4	6:15 AM	0.70	2.21	19.9	18.1	1.93
TEN = 4	6:30 AM	1.66	2.28	19.8	18.3	1.36
Flow Rate = 4 lpm	6:45 AM	0.70	2.25	19.8	18.4	1.98
Loss Term = 0.07 cm sec^{-1}	7:00 AM	1.29	2.62	19.8	18.5	1.97
	7:15 AM	1.45	2.98	19.8	18.5	2.26
	7:30 AM	1.59	2.76	19.8	18.8	1.92
	7:45 AM	3.26	5.07	19.7	19.3	3.31
	8:00 AM	1.78	3.27	19.7	19.7	2.35
	8:15 AM	3.29	5.62	19.7	20.1	3.89
	8:30 AM	3.45	4.40	19.7	20.7	2.46
	8:45 AM	2.95	5.50	19.7	21.3	3.99
	9:00 AM	1.91	4.09	19.8	22.1	3.15
	9:15 AM	1.79	3.62	19.8	22.7	2.73
	9:30 AM	2.00	3.64	19.8	23.5	2.60
	9:45 AM	1.86	3.64	19.8	24.5	2.70
	10:00 AM	2.11	3.83	19.9	24.8	2.74
	10:15 AM	1.70	3.12	19.9	25.4	2.24
	10:30 AM	1.66	2.93	19.9	27.0	2.07
	10:45 AM	2.05	3.23	20.0	28.3	2.13
	11:00 AM	2.16	3.43	20.1	29.6	2.27
	11:15 AM	2.62	3.91	20.1	29.3	2.48
	11:30 AM	2.32	3.69	20.3	30.2	2.45
	11:45 AM	1.95	3.42	20.3	30.6	2.41
	12:00 PM	1.59	3.02	20.4	32.0	2.21
	12:15 PM	1.59	3.15	20.5	33.2	2.34
	12:30 PM	2.01	3.42	20.7	34.8	2.36
	12:45 PM	1.71	3.47	20.8	36.3	2.62
	1:00 PM	1.02	2.94	20.9	32.7	2.51
	1:15 PM	0.83	2.93	21.0	36.0	2.62
	1:30 PM	0.74	3.09	21.2	36.4	2.85
	1:45 PM	0.55	2.72	21.3	32.0	2.57
	2:00 PM	0.44	2.31	21.4	31.7	2.21
	2:15 PM	0.36	2.15	21.5	36.3	2.09
	2:30 PM	0.30	2.13	21.6	38.8	2.11
	2:45 PM	0.39	2.24	21.8	35.2	2.17
	3:00 PM	0.18	2.19	21.9	33.4	2.26
	3:15 PM	0.19	2.08	22.0	32.5	2.13
	3:30 PM	0.21	2.06	22.0	33.8	2.08
	3:45 PM	0.23	1.96	22.0	31.5	1.97
	4:00 PM	0.20	1.96	22.0	34.8	1.99
	4:15 PM	0.17	1.98	22.1	31.6	2.03
	4:30 PM	0.28	2.01	22.1	31.1	1.99
	4:45 PM	0.20	2.00	22.1	31.4	2.03
	5:00 PM	0.25	2.09	22.1	29.9	2.09

Corn Crop
10-Aug-95
% Moisture = 10.0
TEN = 5
Flow Rate = 4 lpm
Loss Term = 0.07 cm sec^{-1}

Time (hr/min)	NO Before (ppb)	NO After (ppb)	Soil (°C)	Ambient Air (°C)	NO Flux ng N m^{-2} s^{-1}
6:30 AM	0.00	15.89	20.4	20.4	17.20
6:45 AM	0.00	16.19	20.4	20.4	17.53
7:00 AM	2.35	16.86	20.4	20.6	16.69
7:15 AM	3.24	16.78	20.4	20.7	16.01
7:30 AM	2.37	14.15	20.4	20.9	13.74
7:45 AM	3.94	17.15	20.4	21.1	15.94
8:00 AM	10.51	19.82	20.4	21.3	14.45
8:15 AM	9.24	21.00	20.4	21.6	16.57
8:30 AM	11.71	21.60	20.3	22.2	15.58
8:45 AM	11.18	20.64	20.4	22.9	14.89
9:00 AM	12.49	20.20	20.4	23.0	13.54
9:15 AM	9.74	17.78	20.4	23.5	12.75
9:30 AM	9.22	16.83	20.4	23.8	12.07
9:45 AM	8.19	16.62	20.4	24.4	12.54
10:00 AM	5.43	15.40	20.4	24.7	13.06
10:15 AM	9.16	22.06	20.5	26.2	17.78
10:30 AM	4.89	14.22	20.5	27.1	12.13
10:45 AM	5.89	14.48	20.5	27.9	11.74
11:00 AM	6.86	15.09	20.6	27.5	11.76
11:15 AM	5.32	15.04	20.7	32.8	12.74
11:30 AM	1.97	14.22	20.8	33.9	14.09
11:45 AM	2.75	15.07	20.9	32.0	14.48
12:00 PM	2.08	15.45	21.0	34.1	15.34
12:15 PM	0.45	15.24	21.1	36.2	16.20
12:30 PM	0.22	16.08	21.2	33.0	17.26
12:45 PM	0.20	16.68	21.3	36.2	17.92
1:00 PM	0.02	17.43	21.4	37.6	18.86
1:15 PM	0.00	18.85	21.5	39.3	20.41
1:30 PM	0.24	19.09	21.7	40.0	20.51
1:45 PM	0.55	18.87	21.9	39.1	20.06
2:00 PM	0.50	18.48	22.0	39.0	19.68
2:15 PM	0.30	19.03	22.2	40.3	20.41
2:30 PM	0.62	18.87	22.4	35.7	20.02
2:45 PM	0.26	17.02	22.5	35.9	18.26
3:00 PM	0.00	15.36	22.5	37.6	16.63
3:15 PM	0.00	15.19	22.6	35.7	16.44
3:30 PM	0.33	14.64	22.6	37.0	15.64
3:45 PM	0.00	14.26	22.7	38.6	15.44
4:00 PM	0.00	13.90	22.7	33.2	15.05
4:15 PM	0.05	13.29	22.7	31.0	14.35
4:30 PM	0.19	13.12	22.7	31.0	14.09
4:45 PM	0.55	13.71	22.7	33.1	14.48
5:00 PM	0.04	12.87	22.7	30.8	13.91
5:15 PM	0.23	13.12	22.7	31.6	14.05
5:30 PM	0.93	13.81	22.7	31.7	14.33
5:45 PM	0.14	13.14	22.7	31.8	14.13
6:00 PM	0.60	13.67	22.7	32.3	14.41
6:15 PM	0.25	13.13	22.7	34.6	14.05
6:30 PM	1.55	12.83	22.7	33.1	12.85
6:45 PM	0.66	11.34	22.8	32.4	11.83
7:00 PM	0.22	10.42	22.8	31.5	11.13

7:15 PM	0.45	9.99	22.8	30.7	10.52
7:30 PM	0.17	9.83	22.7	29.4	10.52
7:45 PM	0.00	9.61	22.7	26.9	10.40
8:00 PM	0.00	9.44	22.7	24.9	10.22
8:15 PM	0.53	9.47	22.6	23.6	9.91
8:30 PM	3.58	11.73	22.5	22.7	10.31
8:45 PM	0.61	10.06	22.5	22.3	10.49
9:00 PM	0.00	9.59	22.4	22.2	10.38
9:15 PM	0.18	9.97	22.3	21.8	10.68
9:30 PM	0.45	10.04	22.3	21.4	10.57
9:45 PM	0.10	10.11	22.2	21.0	10.88
10:00 PM	0.28	10.28	22.1	20.7	10.94
10:15 PM	0.43	10.76	22.1	20.6	11.37
10:30 PM	0.02	10.89	22.0	20.6	11.78
10:45 PM	0.33	nm	22.0	20.4	nm
11:00 PM	0.58	nm	21.9	20.3	nm
11:15 PM	0.69	10.66	21.9	20.4	11.08
11:30 PM	0.35	10.52	21.8	20.4	11.16
11:45 PM	0.50	11.12	21.7	20.3	11.70
12:00 AM	0.28	11.35	21.7	20.1	12.10
12:15 AM	1.38	11.86	21.7	20.4	11.92
12:30 AM	1.59	12.29	21.6	20.2	12.25
12:45 AM	1.60	11.60	21.6	20.2	11.50
1:00 AM	1.61	11.86	21.5	20.0	11.77
1:15 AM	1.07	11.39	21.5	20.7	11.62
1:30 AM	0.78	10.94	21.4	20.8	11.33
1:45 AM	0.40	10.77	21.4	20.7	11.40
2:00 AM	0.12	10.68	21.4	20.9	11.48
2:15 AM	0.00	10.48	21.3	21.0	11.35
2:30 AM	0.29	10.81	21.3	21.1	11.51
2:45 AM	0.42	10.74	21.3	21.2	11.34
3:00 AM	0.28	10.75	21.3	21.3	11.45
3:15 AM	0.52	10.76	21.3	21.3	11.30
3:30 AM	0.28	10.48	21.2	21.3	11.16
3:45 AM	0.47	10.32	21.2	21.3	10.86
4:00 AM	0.48	10.41	21.2	21.3	10.95
4:15 AM	0.51	10.43	21.2	21.3	10.95
4:30 AM	0.81	9.60	21.2	21.1	9.86
4:45 AM	1.09	9.85	21.1	21.2	9.93
5:00 AM	0.38	9.82	21.1	21.2	10.38
5:15 AM	0.64	9.54	21.1	21.3	9.90
5:30 AM	0.93	9.50	21.1	21.2	9.67
5:45 AM	0.80	9.65	21.0	21.3	9.92
6:00 AM	0.46	9.67	21.0	21.2	10.16
6:15 AM	0.69	9.82	21.0	21.2	10.18
6:30 AM	1.47	10.54	21.0	21.1	10.43
6:45 AM	1.11	10.47	20.9	21.2	10.59
7:00 AM	1.87	11.39	20.9	21.2	11.08
7:15 AM	3.09	11.92	20.9	21.4	10.85
7:30 AM	3.20	12.92	20.9	21.6	11.85
7:45 AM	5.23	13.96	20.9	21.9	11.63
8:00 AM	6.35	14.49	20.9	22.1	11.45
8:15 AM	6.84	14.69	20.8	22.3	11.35

8:30 AM	9.14	20.61	20.8	23.4	16.22
8:45 AM	7.45	15.21	20.8	24.0	11.49
9:00 AM	3.95	13.40	20.8	24.3	11.88
9:15 AM	3.55	12.80	20.9	26.6	11.49
9:30 AM	2.60	11.94	20.9	27.9	11.19
9:45 AM	2.37	11.22	20.9	27.5	10.57
10:00 AM	2.14	11.52	21.0	32.6	11.04

Appendix D

Appendix D contains measurements from the Spring 1996 campaign conducted at Plymouth, Kinston, Oxford, and Reidsville, NC.

Data from April 11, 1996 to April 14, 1996 at Plymouth, NC
% Moisture = Expressed as a percentage of moisture per dry soil weight
Total Extractable Nitrogen (TEN) = mg N (kg dry soil)$^{-1}$
nm = not measured
Ambient air as carrier gas
Each 15 minute measurement represents the binned averages of the previous 15 minutes
lpm = liter per minute

Plymouth, NC						
Wheat Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
11-Apr-96	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 23.8	6:30 AM	4.76	18.76	5.5	7.1	16.01
TEN = 14	6:45 AM	5.02	18.82	5.6	7.3	15.90
Flow Rate = 4 lpm	7:00 AM	4.88	18.65	5.5	6.9	15.82
Loss Term = 0.06 cm sec^{-1}	7:15 AM	4.96	19.11	5.7	7.5	16.23
	7:30 AM	5.02	19.22	5.8	7.8	16.31
	7:45 AM	3.99	19.76	5.9	8.1	17.55
	8:00 AM	4.01	20.01	6.1	8.7	17.79
	8:15 AM	4.05	21.24	6.3	9.2	19.02
	8:30 AM	4.31	22.00	6.4	9.9	19.62
	8:45 AM	4.30	22.54	6.5	10.4	20.18
	9:00 AM	4.56	21.86	6.8	10.8	19.31
	9:15 AM	4.44	22.78	6.8	11.3	20.33
	9:30 AM	4.06	23.00	7.4	13.5	20.81
	9:45 AM	4.39	23.34	7.9	14.0	20.94
	10:00 AM	4.22	27.42	8.3	14.7	25.22
	10:15 AM	4.19	29.00	8.8	14.8	26.86
	10:30 AM	3.29	31.56	9.3	14.9	30.08
	10:45 AM	3.02	nm	10.0	16.4	nm
	11:00 AM	2.75	33.84	10.5	16.5	32.77
	11:15 AM	2.65	37.00	11.0	16.6	36.07
	11:30 AM	2.61	37.56	11.4	16.9	36.67
	11:45 AM	2.68	38.10	12.1	17.1	37.17
	12:00 PM	2.54	38.33	12.6	17.8	37.50
	12:15 PM	2.31	38.65	13.0	17.4	37.98
	12:30 PM	2.05	39.14	13.8	18.0	38.66
	12:45 PM	2.01	40.05	14.1	18.3	39.61
	1:00 PM	1.81	38.76	14.4	18.5	38.43
	1:15 PM	1.44	39.51	14.5	18.7	39.44
	1:30 PM	1.17	40.38	14.8	19.2	40.51
	1:45 PM	1.33	38.96	15.0	19.5	38.95
	2:00 PM	1.75	38.63	15.3	19.8	38.34
	2:15 PM	1.34	39.34	15.4	20.0	39.33
	2:30 PM	1.14	40.38	15.7	20.1	40.53
	2:45 PM	1.17	41.90	15.9	20.9	42.07
	3:00 PM	1.04	42.70	16.0	21.7	42.97
	3:15 PM	1.03	42.29	15.9	21.8	42.56

3:30 PM	1.55	44.05	16.0	21.7	44.01
3:45 PM	1.09	43.56	16.1	21.5	43.82
4:00 PM	1.32	41.08	15.9	20.6	41.13
4:15 PM	0.82	39.32	15.8	20.1	39.66
4:30 PM	0.67	38.74	15.8	20.1	39.17
4:45 PM	1.18	39.83	15.8	20.0	39.94
5:00 PM	1.05	40.21	15.8	19.8	40.42
5:15 PM	1.21	39.86	15.8	19.7	39.95
5:30 PM	1.07	40.02	15.7	19.8	40.21
5:45 PM	1.29	38.79	15.6	19.7	38.81
6:00 PM	0.98	39.31	15.6	19.6	39.54

Plymouth, NC
Wheat Crop
12-Apr-96
% Moisture = 23.6
TEN = 5
Flow Rate = 4 lpm
Loss Term = 0.06 cm sec^{-1}

Time (hr/min)	NO Before (ppb)	NO After (ppb)	Soil (°C)	Ambient Air (°C)	NO Flux ng N m^{-2} s^{-1}
6:30 AM	0.91	3.43	8.8	10.7	2.90
6:45 AM	0.82	3.87	8.8	10.9	3.41
7:00 AM	0.84	3.65	8.9	11.5	3.17
7:15 AM	0.91	3.21	9.0	11.8	2.68
7:30 AM	0.87	4.41	9.1	12.5	3.93
7:45 AM	0.80	4.86	9.2	12.7	4.44
8:00 AM	0.89	4.67	9.2	13.4	4.18
8:15 AM	1.02	5.90	9.2	14.1	5.35
8:30 AM	1.23	3.98	9.4	14.7	3.24
8:45 AM	1.43	4.48	9.8	15.0	3.63
9:00 AM	1.59	4.95	10.0	15.5	3.99
9:15 AM	1.49	5.31	10.2	16.1	4.43
9:30 AM	1.56	5.64	10.4	16.8	4.72
9:45 AM	1.74	6.02	10.5	17.0	5.00
10:00 AM	1.93	6.52	10.6	17.2	5.38
10:15 AM	1.92	6.76	10.8	17.6	5.64
10:30 AM	1.93	7.12	10.8	18.0	6.00
10:45 AM	2.10	7.55	10.9	18.1	6.32
11:00 AM	1.95	8.00	11.1	18.7	6.88
11:15 AM	1.80	8.88	11.3	18.8	7.88
11:30 AM	1.77	9.39	11.3	19.0	8.42
11:45 AM	1.76	9.92	11.5	19.2	8.97
12:00 PM	1.49	10.10	11.7	19.7	9.34
12:15 PM	1.21	10.32	11.9	20.5	9.75
12:30 PM	0.94	9.95	12.1	20.8	9.55
12:45 PM	0.77	9.79	12.3	20.9	9.50
1:00 PM	0.57	9.56	12.4	21.0	9.40
1:15 PM	0.47	9.23	12.5	21.6	9.12
1:30 PM	0.44	9.33	12.6	22.0	9.25
1:45 PM	0.36	9.47	12.8	22.5	9.44
2:00 PM	0.29	9.34	13.0	23.0	9.36
2:15 PM	0.31	9.11	13.4	23.9	9.11
2:30 PM	0.27	9.50	14.0	24.1	9.54
2:45 PM	0.20	9.53	14.5	24.9	9.61
3:00 PM	0.27	9.66	14.7	25.0	9.70
3:15 PM	0.32	9.52	14.8	25.1	9.53
3:30 PM	0.28	9.38	14.8	25.4	9.41
3:45 PM	0.26	9.47	14.9	25.8	9.51

4:00 PM	0.24	9.63	15.0	26.5	9.68
4:15 PM	0.27	9.73	15.1	26.9	9.77
4:30 PM	0.21	8.94	15.3	27.0	9.00
4:45 PM	0.22	8.64	15.5	27.5	8.69
5:00 PM	0.26	8.48	15.5	27.6	8.50
5:15 PM	0.22	8.05	15.5	27.3	8.08
5:30 PM	0.24	8.01	15.6	26.8	8.03
5:45 PM	0.25	7.98	15.6	26.5	7.99
6:00 PM	0.22	7.88	15.5	26.4	7.91

Plymouth, NC						
Wheat Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
13-Apr-96	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 21.3	6:30 AM	0.65	117.50	11.2	12.4	119.72
TEN = 12	6:45 AM	0.82	118.10	11.3	13.2	120.22
Flow Rate = 4 lpm	7:00 AM	1.01	119.20	11.5	13.4	121.22
Loss Term = 0.06 cm sec^{-1}	7:15 AM	1.05	118.70	11.6	3.9	120.68
	7:30 AM	0.91	118.90	11.7	14.7	120.98
	7:45 AM	0.87	119.50	11.9	15.5	121.62
	8:00 AM	0.79	119.90	12.1	16.1	122.08
	8:15 AM	0.65	120.10	12.2	16.9	122.38
	8:30 AM	0.68	121.80	12.2	17.5	124.10
	8:45 AM	0.77	120.60	12.3	18.1	122.81
	9:00 AM	0.74	121.50	12.3	18.6	123.75
	9:15 AM	0.70	122.20	12.5	19.2	124.49
	9:30 AM	0.88	122.80	12.6	19.8	124.99
	9:45 AM	0.50	127.50	12.8	20.3	130.05
	10:00 AM	0.53	131.30	13.1	20.9	133.91
	10:15 AM	0.42	139.60	13.4	21.5	142.47
	10:30 AM	0.25	145.80	13.7	22.3	148.93
	10:45 AM	0.43	152.80	14.0	22.7	155.97
	11:00 AM	0.40	158.80	14.2	22.8	162.12
	11:15 AM	0.45	163.00	14.7	23.0	166.38
	11:30 AM	0.20	164.20	14.8	23.2	167.78
	11:45 AM	0.19	165.40	15.0	23.5	169.01
	12:00 PM	0.23	165.00	15.5	24.4	168.57
	12:15 PM	0.20	164.10	16.3	25.0	167.67
	12:30 PM	0.11	160.90	16.9	25.2	164.46
	12:45 PM	0.17	162.10	17.2	25.0	165.65
	1:00 PM	0.08	160.80	17.4	24.9	164.38
	1:15 PM	0.15	160.50	17.5	25.5	164.03
	1:30 PM	0.00	160.30	17.6	26.0	163.92
	1:45 PM	0.44	164.40	17.7	26.3	167.82
	2:00 PM	0.26	166.00	17.7	26.3	169.58
	2:15 PM	0.05	169.20	17.7	27.5	172.99
	2:30 PM	0.29	169.80	17.6	28.1	173.44
	2:45 PM	0.12	168.70	17.5	27.9	172.43
	3:00 PM	0.26	171.90	17.5	27.9	175.61
	3:15 PM	0.18	169.90	17.6	27.7	173.62
	3:30 PM	0.19	167.10	17.6	27.4	170.75
	3:45 PM	0.26	166.80	17.7	27.3	170.39
	4:00 PM	0.30	165.00	17.7	27.3	168.53
	4:15 PM	0.28	nm	17.5	26.8	nm

4:30 PM	0.21	nm	17.4	26.3	nm
4:45 PM	0.06	nm	17.4	26.0	nm
5:00 PM	0.18	nm	17.4	26.3	nm
5:15 PM	0.20	147.10	17.3	26.1	150.29
5:30 PM	0.15	147.00	17.2	26.2	150.22
5:45 PM	0.10	139.80	17.2	25.6	142.89
6:00 PM	0.16	140.00	17.1	25.4	143.06
6:15 PM	0.21	141.50	17.0	25.4	144.56
6:30 PM	0.18	139.60	16.9	25.5	142.63
6:45 PM	0.16	139.40	16.9	25.4	142.44
7:00 PM	0.10	139.10	16.8	24.7	142.18
7:15 PM	0.05	137.50	16.8	24.5	140.57
7:30 PM	0.03	138.20	16.8	24.3	141.30
7:45 PM	0.00	137.40	16.9	24.3	140.50
8:00 PM	0.04	136.40	16.8	24.3	139.45
8:15 PM	0.08	136.70	16.8	24.1	139.73
8:30 PM	0.21	137.00	16.7	24.1	139.95
8:45 PM	0.23	136.20	16.6	23.9	139.12
9:00 PM	0.31	135.10	16.6	23.8	137.95
9:15 PM	0.32	134.20	16.6	23.5	137.02
9:30 PM	0.09	133.90	16.5	23.5	136.86
9:45 PM	0.07	130.20	16.4	23.4	133.09
10:00 PM	0.21	129.50	16.4	22.5	132.29
10:15 PM	0.25	131.50	16.3	22.1	134.30
10:30 PM	0.13	129.40	16.2	22.1	132.24
10:45 PM	0.11	128.40	16.2	22.0	131.23
11:00 PM	0.12	127.60	16.1	21.9	130.40
11:15 PM	0.04	124.30	16.1	21.7	127.08
11:30 PM	0.20	122.60	16.1	21.7	125.24
11:45 PM	0.07	123.80	15.9	21.6	126.55
12:00 AM	0.07	121.90	15.8	21.5	124.61
12:15 AM	0.00	122.00	15.8	19.8	124.76
12:30 AM	0.08	123.50	15.7	19.8	126.24
12:45 AM	0.04	123.70	15.7	20.1	126.47
1:00 AM	0.17	121.50	15.6	19.5	124.13
1:15 AM	0.16	121.70	15.5	19.4	124.34
1:30 AM	0.21	122.00	15.5	19.3	124.62
1:45 AM	0.23	123.70	15.5	19.2	126.34
2:00 AM	0.24	122.60	15.4	19.1	125.21
2:15 AM	0.23	121.70	15.4	19.0	124.30
2:30 AM	0.19	121.70	15.3	18.7	124.32
2:45 AM	0.18	121.50	15.2	18.8	124.12
3:00 AM	0.13	121.40	15.2	18.6	124.06
3:15 AM	0.34	119.40	14.9	18.5	121.87
3:30 AM	0.32	118.40	14.8	18.4	120.86
3:45 AM	0.09	117.40	14.7	18.4	119.99
4:00 AM	0.23	115.30	14.4	18.4	117.75
4:15 AM	0.51	118.80	14.3	18.5	121.14
4:30 AM	0.21	118.50	14.3	18.4	121.04
4:45 AM	0.27	118.10	14.2	17.6	120.59
5:00 AM	0.31	121.40	14.1	17.7	123.94
5:15 AM	0.22	116.40	13.9	17.7	118.88
5:30 AM	0.06	116.90	13.7	16.7	119.50

	5:45 AM	0.00	117.30	13.6	16.8	119.95
	6:00 AM	0.17	115.20	13.6	15.9	117.69

Plymouth, NC Wheat Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
14-Apr-96	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 22.0	6:45 AM	1.48	8.05	13.2	15.8	7.24
TEN = 6	7:00 AM	1.54	8.36	13.3	15.9	7.52
Flow Rate = 4 lpm	7:15 AM	1.63	8.49	13.3	16.1	7.59
Loss Term = 0.06 cm sec^{-1}	7:30 AM	1.41	8.85	13.4	16.1	8.11
	7:45 AM	1.59	8.86	13.5	16.5	8.00
	8:00 AM	1.38	8.78	13.6	16.8	8.06
	8:15 AM	1.47	9.05	13.8	16.9	8.27
	8:30 AM	1.65	9.10	14.0	18.0	8.21
	8:45 AM	1.27	9.09	14.3	18.8	8.45
	9:00 AM	1.39	9.31	14.3	18.5	8.59
	9:15 AM	1.60	9.25	14.3	19.9	8.39
	9:30 AM	1.58	10.00	14.7	20.5	9.17
	9:45 AM	1.32	10.29	15.1	21.2	9.64
	10:00 AM	1.17	10.87	15.4	21.8	10.34
	10:15 AM	1.19	11.21	15.5	22.2	10.67
	10:30 AM	1.08	12.05	15.7	22.8	11.60
	10:45 AM	0.98	12.87	15.9	23.4	12.51
	11:00 AM	0.80	13.26	16.1	23.5	13.03
	11:15 AM	0.78	13.68	16.1	23.6	13.47
	11:30 AM	0.88	13.97	16.1	23.5	13.70
	11:45 AM	0.91	14.09	16.4	24.5	13.80
	12:00 PM	0.95	15.12	16.8	25.0	14.83
	12:15 PM	1.01	16.53	17.1	25.2	16.23
	12:30 PM	0.99	18.61	17.3	26.1	18.37
	12:45 PM	1.06	20.01	17.5	26.8	19.76
	1:00 PM	1.11	20.22	17.7	27.1	19.94
	1:15 PM	1.27	20.47	17.8	27.5	20.09
	1:30 PM	1.35	21.70	17.8	27.6	21.29
	1:45 PM	1.40	23.20	17.8	27.7	22.79
	2:00 PM	1.05	24.18	18.0	26.9	24.03
	2:15 PM	0.48	25.41	18.2	26.2	25.66
	2:30 PM	0.87	27.89	18.3	28.4	27.94
	2:45 PM	1.13	31.09	18.5	29.1	31.04
	3:00 PM	0.89	29.43	18.6	30.7	29.50
	3:15 PM	0.49	31.79	18.9	28.5	32.18
	3:30 PM	0.93	32.93	19.1	26.6	33.05
	3:45 PM	0.27	30.73	19.2	27.9	31.24
	4:00 PM	0.49	29.05	19.1	29.0	29.38
	4:15 PM	0.58	28.96	19.1	28.5	29.23
	4:30 PM	0.63	27.75	19.1	27.0	27.96
	4:45 PM	0.66	nm	19.1	26.8	nm
	5:00 PM	0.79	27.39	19.1	26.5	27.48
	5:15 PM	0.41	26.53	19.1	26.4	26.86
	5:30 PM	0.58	26.50	18.9	26.1	26.71
	5:45 PM	0.43	26.22	18.8	26.3	26.53
	6:00 PM	0.32	25.40	18.8	26.0	25.76

Data from April 17 to April 20, 1996 at Kinston, NC.
nm = not measured
Ambient air as carier gas
Each 15 minute measurement represents the binned averages of the previous 15 minutes
lpm = liter per minute

Kinston, NC

Wheat Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
17-Apr-96	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 11.8	6:30 AM	2.47	6.32	9.5	8.9	7.86
TEN = 4	6:45 AM	2.81	7.53	9.8	9.6	9.45
Flow Rate = 4 lpm	7:00 AM	2.46	6.91	9.9	10.0	8.75
Loss Term = 0.15 cm sec^{-1}	7:15 AM	3.05	7.49	10.1	10.3	9.23
	7:30 AM	2.89	7.54	10.4	10.5	9.41
	7:45 AM	2.91	6.85	10.7	11.9	8.36
	8:00 AM	4.05	8.96	11.0	12.4	10.77
	8:15 AM	3.15	7.81	11.3	13.1	9.64
	8:30 AM	2.96	7.58	11.4	13.4	9.42
	8:45 AM	4.12	10.12	11.8	13.7	12.47
	9:00 AM	3.82	8.78	11.9	14.5	10.66
	9:15 AM	4.12	8.43	12.2	13.8	9.93
	9:30 AM	4.35	8.49	12.4	13.8	9.87
	9:45 AM	5.61	8.53	12.6	13.4	9.09
	10:00 AM	4.81	8.55	12.8	13.6	9.65
	10:15 AM	4.81	8.56	12.9	14.0	9.66
	10:30 AM	2.42	9.02	13.1	14.1	11.95
	10:45 AM	2.84	9.01	13.6	16.0	11.66
	11:00 AM	2.56	9.05	14.2	17.1	11.90
	11:15 AM	3.29	9.00	14.7	18.0	11.34
	11:30 AM	2.84	8.59	15.1	18.5	11.02
	11:45 AM	2.01	7.85	15.7	18.9	10.46
	12:00 PM	1.59	7.05	16.0	19.1	9.54
	12:15 PM	0.80	6.54	16.3	19.7	9.30
	12:30 PM	1.97	8.01	16.7	19.9	10.73
	12:45 PM	3.25	8.76	17.0	20.1	11.01
	1:00 PM	4.19	9.89	17.4	20.3	12.08
	1:15 PM	6.13	11.46	17.9	20.5	13.15
	1:30 PM	4.05	10.99	18.2	21.9	13.83
	1:45 PM	2.62	10.52	18.5	22.5	14.07
	2:00 PM	2.79	10.48	18.7	22.6	13.90
	2:15 PM	3.01	10.96	18.8	22.8	14.47
	2:30 PM	3.84	11.01	18.9	22.9	14.00
	2:45 PM	3.99	11.09	19.2	23.0	14.02
	3:00 PM	5.15	11.40	19.4	23.2	13.71
	3:15 PM	4.87	11.09	19.4	23.1	13.43
	3:30 PM	4.02	10.88	19.1	23.0	13.68
	3:45 PM	3.07	10.46	19.2	23.2	13.68
	4:00 PM	2.54	10.34	18.9	23.1	13.86
	4:15 PM	2.09	10.02	18.6	22.8	13.67
	4:30 PM	1.85	9.68	18.2	21.5	13.32
	4:45 PM	1.27	8.78	18.0	19.6	12.36
	5:00 PM	1.57	8.94	17.9	20.0	12.40
	5:15 PM	1.73	9.01	17.8	19.9	12.40

	5:30 PM	1.65	8.57	17.8	22.5	11.79
	5:45 PM	1.49	7.95	17.6	22.3	10.96
	6:00 PM	1.87	8.04	17.5	21.4	10.84

Kinston, NC Wheat Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
18-Apr-96	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 10.9	11:15 AM	13.91	19.40	15.1	16.8	19.91
TEN = 3	11:30 AM	9.88	15.43	15.2	17.1	16.61
Flow Rate = 4 lpm	11:45 AM	6.95	13.05	15.3	17.8	15.00
Loss Term = 0.15 cm sec^{-1}	12:00 PM	5.47	11.47	15.8	18.1	13.60
	12:15 PM	3.19	9.24	16.5	18.9	11.77
	12:30 PM	1.52	7.40	16.7	19.4	10.11
	12:45 PM	1.19	6.91	16.9	19.9	9.59
	1:00 PM	0.25	5.77	17.5	20.7	8.50
	1:15 PM	0.25	5.50	17.9	20.9	8.11
	1:30 PM	0.09	5.50	18.4	21.8	8.21
	1:45 PM	-0.29	5.24	18.7	22.6	8.07
	2:00 PM	0.30	5.66	18.9	23.6	8.31
	2:15 PM	0.15	5.50	19.4	23.8	8.17
	2:30 PM	0.43	5.55	19.6	24.9	8.06
	2:45 PM	-0.10	5.48	19.9	25.8	8.30
	3:00 PM	1.48	6.90	20.3	26.7	9.39
	3:15 PM	0.26	5.87	20.5	27.1	8.66
	3:30 PM	1.01	5.61	20.7	27.5	7.77
	3:45 PM	0.09	6.02	20.7	27.9	8.99
	4:00 PM	0.21	5.85	20.8	28.0	8.66
	4:15 PM	0.23	4.34	20.9	28.7	6.37
	4:30 PM	0.54	5.02	21.0	29.6	7.19
	4:45 PM	0.31	4.96	21.1	29.7	7.25
	5:00 PM	0.04	5.03	21.1	30.2	7.54
	5:15 PM	0.02	4.81	21.2	30.3	7.22
	5:30 PM	0.11	4.78	21.3	29.8	7.11
	5:45 PM	0.83	4.37	21.5	29.7	6.02
	6:00 PM	0.54	4.55	21.5	29.8	6.48

Kinston, NC Wheat Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
19-Apr-96	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 8.6	6:15 AM	1.09	3.61	13.5	15.0	4.70
TEN = 2	6:30 AM	1.84	4.09	13.5	14.8	4.92
Flow Rate = 4 lpm	6:45 AM	1.71	3.87	13.6	14.7	4.68
Loss Term = 0.15 cm sec^{-1}	7:00 AM	1.39	3.91	13.8	14.9	4.95
	7:15 AM	1.45	4.04	13.9	15.8	5.11
	7:30 AM	1.75	3.98	14.1	16.7	4.82
	7:45 AM	2.16	4.09	14.2	17.8	4.71
	8:00 AM	2.01	4.51	14.4	18.6	5.44
	8:15 AM	1.84	4.87	14.7	20.0	6.10
	8:30 AM	1.37	5.01	14.8	18.7	6.62
	8:45 AM	1.85	4.82	14.8	19.0	6.01
	9:00 AM	1.69	4.92	14.9	19.6	6.27
	9:15 AM	1.58	5.61	15.0	20.9	7.38
	9:30 AM	1.36	6.28	15.1	21.2	8.54

9:45 AM	1.09	7.20	15.3	21.6	10.10
10:00 AM	1.25	6.81	15.4	21.5	9.41
10:15 AM	1.48	4.59	15.7	21.5	5.92
10:30 AM	1.38	4.51	15.8	21.7	5.86
10:45 AM	1.07	4.36	15.9	21.9	5.84
11:00 AM	1.00	4.14	16.1	22.2	5.56
11:15 AM	1.07	4.25	16.2	22.4	5.68
11:30 AM	1.12	4.39	16.4	22.7	5.85
11:45 AM	1.29	4.87	16.5	23.1	6.46
12:00 PM	1.35	5.22	16.5	23.2	6.95
12:15 PM	1.41	5.19	16.6	23.4	6.86
12:30 PM	1.27	5.34	16.7	23.5	7.18
12:45 PM	1.59	5.85	17.0	23.7	7.74
1:00 PM	1.85	6.05	17.2	23.9	7.86
1:15 PM	2.50	6.84	17.5	24.1	8.62
1:30 PM	2.32	6.00	17.7	24.3	7.48
1:45 PM	2.41	6.51	17.9	24.7	8.18
2:00 PM	2.60	6.49	18.1	25.0	8.03
2:15 PM	2.27	6.44	18.2	25.2	8.17
2:30 PM	2.15	6.32	18.4	24.6	8.07
2:45 PM	2.76	6.98	18.5	25.1	8.66
3:00 PM	2.88	7.43	18.7	24.3	9.25
3:15 PM	1.99	nm	18.8	24.5	nm
3:30 PM	2.08	nm	18.7	24.2	nm
3:45 PM	2.67	nm	18.6	24.4	nm
4:00 PM	2.41	6.79	18.6	24.6	8.60
4:15 PM	1.87	6.01	18.7	24.1	7.79
4:30 PM	1.05	5.83	18.7	23.8	8.07
4:45 PM	0.64	5.29	18.7	23.2	7.53
5:00 PM	1.08	5.06	18.3	22.8	6.89
5:15 PM	1.67	4.98	18.1	21.9	6.38
5:30 PM	1.45	4.76	17.8	21.7	6.19
5:45 PM	2.02	5.01	17.7	21.5	6.19
6:00 PM	2.58	4.21	17.6	21.1	4.61

Kinston, NC

Wheat Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
20-Apr-96	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 6.3	6:15 AM	2.06	5.01	14.8	16.5	6.16
TEN = 3	6:30 AM	1.95	4.42	14.8	16.6	5.35
Flow Rate = 4 lpm	6:45 AM	2.21	4.81	14.9	17.1	5.76
Loss Term = 0.15 cm sec^{-1}	7:00 AM	2.38	3.89	15.1	17.2	4.26
	7:15 AM	3.02	4.65	15.3	17.8	4.98
	7:30 AM	1.75	4.29	15.4	17.9	5.28
	7:45 AM	1.89	4.31	15.4	18.4	5.22
	8:00 AM	1.97	4.75	15.4	18.4	5.83
	8:15 AM	2.01	4.85	15.5	18.5	5.95
	8:30 AM	1.84	5.94	15.9	17.8	7.71
	8:45 AM	1.58	6.28	15.7	18.4	8.39
	9:00 AM	1.26	7.39	15.6	19.0	10.27
	9:15 AM	1.37	7.57	15.7	19.3	10.47
	9:30 AM	1.48	7.88	15.8	19.8	10.86
	9:45 AM	1.52	7.91	15.9	20.1	10.88

10:00 AM	1.68	8.02	16.1	20.3	10.94
10:15 AM	1.51	8.10	16.2	20.9	11.17
10:30 AM	0.99	7.99	16.5	21.7	11.36
10:45 AM	0.87	8.21	16.7	22.1	11.77
11:00 AM	0.42	8.30	16.7	22.5	12.20
11:15 AM	1.55	8.35	16.8	22.2	11.52
11:30 AM	0.71	7.96	17.4	24.6	11.50
11:45 AM	0.68	8.01	17.9	26.8	11.59
12:00 PM	0.59	8.05	18.3	28.5	11.71
12:15 PM	0.61	7.81	18.5	28.8	11.34
12:30 PM	0.54	6.92	18.8	28.8	10.05
12:45 PM	0.84	8.08	18.8	28.0	11.59
1:00 PM	1.16	7.72	20.0	27.8	10.84
1:15 PM	1.44	7.78	20.4	27.4	10.74
1:30 PM	1.51	7.94	20.6	27.0	10.93
1:45 PM	0.98	nm	20.7	26.8	nm
2:00 PM	0.87	nm	20.8	26.0	nm
2:15 PM	0.81	8.71	21.5	27.2	12.56
2:30 PM	0.76	8.87	21.5	27.6	12.83
2:45 PM	0.62	9.22	21.4	28.0	13.45
3:00 PM	0.64	9.45	21.4	28.1	13.78
3:15 PM	0.52	8.86	21.4	28.0	12.98
3:30 PM	0.49	9.01	21.4	27.9	13.22
3:45 PM	0.41	8.82	21.3	27.7	12.99
4:00 PM	0.64	8.26	21.3	25.0	11.99
4:15 PM	0.85	8.79	21.3	24.8	12.65
4:30 PM	0.74	8.88	21.1	24.5	12.86
4:45 PM	0.69	8.65	20.9	24.1	12.55
5:00 PM	1.05	8.21	20.8	23.8	11.65
5:15 PM	1.21	7.96	20.8	22.7	11.16
5:30 PM	1.32	8.00	20.5	22.5	11.15
5:45 PM	1.06	7.75	20.4	21.8	10.95
6:00 PM	0.85	7.42	20.3	21.0	10.59

Data from April 24 to April 28, 1996 at Oxford, NC.
nm = not measured
Ambient air as carier gas
Each 15 minute measurement represents the binned averages of the previous 15 minutes
lpm = liter per minute

Oxford, NC						
Wheat Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
24-Apr-96	(hr/min)	(ppb)	(ppb)	(°C)	(°C)	ng N m^{-2} s^{-1}
% Moisture = 6.7	6:45 AM	1.46	2.51	10.7	9.0	1.63
TEN = 2	7:00 AM	1.96	2.36	10.8	9.1	1.14
Flow Rate = 4 lpm	7:15 AM	1.81	2.48	11.1	9.5	1.37
Loss Term = 0.06 cm sec^{-1}	7:30 AM	2.01	2.51	11.4	9.8	1.27
	7:45 AM	1.65	2.69	11.6	10.2	1.69
	8:00 AM	1.81	2.65	11.8	10.6	1.55
	8:15 AM	1.41	2.87	12.1	11.1	2.04
	8:30 AM	1.35	3.05	12.5	11.6	2.27
	8:45 AM	1.51	2.95	12.8	12.1	2.06
	9:00 AM	1.41	3.19	12.9	12.6	2.37

9:15 AM	1.30	3.70	13.0	13.0	2.98
9:30 AM	1.46	3.98	13.1	13.1	3.16
9:45 AM	1.66	4.03	13.3	14.0	3.08
10:00 AM	1.64	5.58	13.4	14.7	4.70
10:15 AM	1.50	5.32	13.6	14.5	4.53
10:30 AM	1.62	4.88	13.7	15.0	3.99
10:45 AM	1.43	5.00	13.9	15.4	4.24
11:00 AM	1.39	4.60	14.0	15.8	3.85
11:15 AM	1.79	4.99	14.2	16.5	3.99
11:30 AM	1.82	5.13	14.3	17.8	4.11
11:45 AM	1.91	5.22	14.6	17.9	4.15
12:00 PM	2.05	4.96	14.8	18.1	3.78
12:15 PM	2.01	5.38	15.0	18.2	4.25
12:30 PM	1.87	5.98	15.1	18.6	4.96
12:45 PM	1.65	5.76	15.3	18.5	4.88
1:00 PM	1.96	5.84	15.4	18.5	4.76
1:15 PM	2.77	7.13	15.8	18.7	5.56
1:30 PM	7.50	10.09	16.2	18.9	5.48
1:45 PM	12.85	14.61	16.4	19.3	6.60
2:00 PM	10.16	13.51	16.6	19.6	7.26
2:15 PM	11.62	15.42	16.9	20.8	8.27
2:30 PM	6.50	12.06	17.2	21.9	8.19
2:45 PM	5.26	8.81	17.6	20.8	5.64
3:00 PM	6.32	10.29	17.9	20.0	6.47
3:15 PM	3.05	6.64	17.9	20.4	4.86
3:30 PM	2.48	5.19	18.0	20.7	3.74
3:45 PM	0.83	3.39	18.3	20.2	2.97
4:00 PM	0.75	3.27	18.3	20.2	2.90
4:15 PM	0.16	2.70	18.7	23.4	2.70
4:30 PM	0.00	2.46	19.0	26.0	2.56
4:45 PM	0.16	2.28	18.7	24.4	2.26
5:00 PM	0.08	2.35	18.6	3.8	2.39
5:15 PM	0.12	2.39	18.6	23.6	2.40
5:30 PM	0.16	1.96	18.5	22.5	1.93
5:45 PM	0.05	2.25	18.4	21.4	2.30
6:00 PM	0.01	2.18	18.4	20.8	2.26

Oxford, NC
Wheat Crop
25-Apr-96
% Moisture = 6.3
TEN = 2
Flow Rate = 4 lpm
Loss Term = 0.06 cm sec^{-1}

Time (hr/min)	NO Before (ppb)	NO After (ppb)	Soil (°C)	Ambient Air (°C)	NO Flux ng N m^{-2} s^{-1}
6:30 AM	3.49	8.76	12.5	11.6	6.77
6:45 AM	4.28	7.85	12.5	11.8	5.30
7:00 AM	3.76	6.99	12.5	12.9	4.75
7:15 AM	2.88	5.85	12.6	12.9	4.16
7:30 AM	5.17	8.61	12.7	13.1	5.49
7:45 AM	6.54	9.23	12.7	13.6	5.22
8:00 AM	5.88	8.76	12.9	13.9	5.18
8:15 AM	6.21	9.06	13.0	14.1	5.27
8:30 AM	6.96	10.02	13.3	14.3	5.76
8:45 AM	7.01	10.78	13.4	14.6	6.52
9:00 AM	6.99	11.78	13.5	14.7	7.57
9:15 AM	7.05	11.12	13.6	15.8	6.85
9:30 AM	7.95	13.49	13.7	16.9	8.71

9:45 AM	8.65	14.55	13.8	18.7	9.34
10:00 AM	4.42	10.34	14.0	18.2	7.79
10:15 AM	1.90	6.98	14.1	18.6	5.98
10:30 AM	2.11	6.52	14.2	19.1	5.36
10:45 AM	0.59	5.64	14.4	19.7	5.46
11:00 AM	0.00	4.59	14.5	20.1	4.77
11:15 AM	0.00	4.10	14.8	20.4	4.26
11:30 AM	0.00	3.28	14.8	20.9	3.41
11:45 AM	0.00	3.18	15.0	21.1	3.30
12:00 PM	0.00	3.07	15.2	21.3	3.19
12:15 PM	0.00	3.01	15.4	21.6	3.13
12:30 PM	0.00	2.86	15.6	21.9	2.97
12:45 PM	0.00	2.78	15.8	22.0	2.89
1:00 PM	0.00	1.68	16.0	22.5	1.74
1:15 PM	0.00	1.74	16.4	23.4	1.81
1:30 PM	0.00	1.46	16.7	23.8	1.52
1:45 PM	0.00	1.77	17.0	23.9	1.84
2:00 PM	0.00	1.89	17.4	24.0	1.96
2:15 PM	0.00	2.01	17.6	24.6	2.09
2:30 PM	0.00	2.15	17.8	25.0	2.23
2:45 PM	0.00	2.36	17.9	24.8	2.45
3:00 PM	0.00	2.58	17.8	24.5	2.68
3:15 PM	0.00	2.88	17.7	24.2	2.99
3:30 PM	0.00	2.77	17.7	24.3	2.88
3:45 PM	0.00	2.71	17.7	24.5	2.81
4:00 PM	0.00	2.60	17.8	23.1	2.70
4:15 PM	0.00	2.35	17.8	23.3	2.44
4:30 PM	0.00	1.99	17.8	23.5	2.07
4:45 PM	0.00	2.01	17.8	23.1	2.09
5:00 PM	0.00	2.24	17.7	22.8	2.33
5:15 PM	0.00	1.98	17.7	22.6	2.06
5:30 PM	0.00	2.17	17.6	21.4	2.25
5:45 PM	0.00	2.07	17.6	21.3	2.15
6:00 PM	0.00	2.31	17.5	21.0	2.40

Oxford, NC
Wheat Crop
27-Apr-96
% Moisture = 8.7
TEN = 1
Flow Rate = 4 lpm
Loss Term = 0.06 cm sec^{-1}

Time (hr/min)	NO Before (ppb)	NO After (ppb)	Soil (°C)	Ambient Air (°C)	NO Flux ng N m^{-2} s^{-1}
6:30 AM	1.45	1.41	12.5	12.3	0.50
6:45 AM	1.31	1.38	12.6	12.4	0.56
7:00 AM	1.26	1.45	12.7	12.5	0.67
7:15 AM	1.51	1.76	12.8	12.6	0.82
7:30 AM	1.41	1.65	13.0	12.8	0.77
7:45 AM	1.37	1.41	13.2	12.9	0.55
8:00 AM	1.29	1.38	13.3	13.1	0.57
8:15 AM	1.30	1.41	13.4	13.6	0.60
8:30 AM	1.21	1.39	13.6	13.8	0.64
8:45 AM	1.16	1.67	13.8	14.2	0.96
9:00 AM	1.31	1.81	13.9	14.5	1.01
9:15 AM	1.30	1.50	13.9	14.7	0.69
9:30 AM	1.28	1.47	13.8	15.0	0.67
9:45 AM	1.36	1.95	13.8	15.5	1.12
10:00 AM	1.27	1.50	13.8	15.7	0.71

10:15 AM	1.25	1.58	13.9	15.8	0.81
10:30 AM	1.19	1.92	14.0	16.9	1.20
10:45 AM	1.21	1.92	14.1	18.2	1.19
11:00 AM	1.41	1.73	14.2	18.2	0.86
11:15 AM	1.13	1.80	14.3	18.3	1.12
11:30 AM	1.06	1.34	14.3	18.0	0.68
11:45 AM	1.09	1.51	14.3	17.4	0.84
12:00 PM	1.13	1.61	14.5	17.9	0.92
12:15 PM	1.17	1.69	14.7	18.5	0.97
12:30 PM	1.29	1.78	14.9	19.3	0.99
12:45 PM	1.32	1.85	15.3	19.6	1.04
1:00 PM	1.40	1.90	15.5	20.1	1.04
1:15 PM	3.22	4.11	15.7	21.0	2.12
1:30 PM	22.68	18.25	16.0	21.5	3.83
1:45 PM	24.10	24.24	16.5	22.0	9.10
2:00 PM	26.08	29.65	16.7	22.3	13.40
2:15 PM	40.15	42.47	17.1	22.4	17.33
2:30 PM	16.52	35.21	17.5	22.4	25.55
2:45 PM	14.11	30.21	17.5	21.8	21.97
3:00 PM	8.71	9.65	17.5	21.1	4.21
3:15 PM	2.96	5.96	17.6	20.6	4.22
3:30 PM	2.50	3.36	17.6	20.6	1.82
3:45 PM	0.69	1.30	17.6	20.6	0.89
4:00 PM	1.38	2.23	17.7	22.6	1.40
4:15 PM	0.88	nm	17.7	22.4	nm
4:30 PM	2.46	3.02	17.8	22.3	1.50
4:45 PM	0.69	1.98	18.0	22.3	1.60
5:00 PM	0.68	2.01	18.1	22.3	1.63
5:15 PM	1.01	2.22	18.1	22.2	1.63
5:30 PM	1.21	2.31	18.0	21.9	1.59
5:45 PM	0.97	1.96	18.1	21.7	1.39
6:00 PM	0.88	1.85	17.9	21.6	1.33

Oxford, NC
Wheat Crop
28-Apr-96
% Moisture = 5.8
TEN = 2
Flow Rate = 4 lpm
Loss Term = 0.06 cm sec^{-1}

Time (hr/min)	NO Before (ppb)	NO After (ppb)	Soil (°C)	Ambient Air (°C)	NO Flux ng N m^{-2} s^{-1}
6:15 AM	1.56	1.55	10.9	11.8	0.57
6:30 AM	1.38	1.41	11.1	13.1	0.54
6:45 AM	1.41	1.36	11.1	13.6	0.47
7:00 AM	1.56	1.21	11.3	13.9	0.22
7:15 AM	1.51	1.41	11.5	14.1	0.46
7:30 AM	1.78	1.65	11.6	14.3	0.53
7:45 AM	1.84	1.44	12.0	16.1	0.27
8:00 AM	1.80	1.31	12.1	16.5	0.16
8:15 AM	1.61	1.22	12.3	17.1	0.19
8:30 AM	1.59	1.13	12.5	17.6	0.11
8:45 AM	1.99	1.22	12.8	17.8	0.00
9:00 AM	1.98	1.18	13.1	18.1	0.00
9:15 AM	1.88	1.12	13.2	18.2	0.00
9:30 AM	2.00	1.16	13.3	18.6	0.00
9:45 AM	1.64	0.45	13.3	18.9	0.00
10:00 AM	1.23	0.00	13.6	19.1	0.00
10:15 AM	0.77	0.00	13.9	20.4	0.00

10:30 AM	0.60	0.00	14.2	20.8	0.00
10:45 AM	0.51	0.00	14.4	21.0	0.00
11:00 AM	0.23	0.00	14.5	21.1	0.00
11:15 AM	0.51	0.00	14.7	22.1	0.00
11:30 AM	0.19	0.00	15.0	22.4	0.00
11:45 AM	0.14	0.00	15.2	2.8	0.00
12:00 PM	0.20	0.00	15.6	24.1	0.00
12:15 PM	0.17	0.00	15.9	25.6	0.00
12:30 PM	0.26	0.00	16.1	26.1	0.00
12:45 PM	0.06	0.00	16.8	26.2	0.00
1:00 PM	0.10	0.00	17.0	26.3	0.00
1:15 PM	0.13	0.00	17.3	26.1	0.00
1:30 PM	0.03	0.00	17.6	25.6	0.00
1:45 PM	0.00	0.00	17.9	25.8	0.00
2:00 PM	0.12	0.00	18.3	26.1	0.00
2:15 PM	0.10	0.00	18.6	26.3	0.00
2:30 PM	0.20	0.00	18.6	26.5	0.00
2:45 PM	0.20	0.00	18.6	26.6	0.00
3:00 PM	0.17	0.00	18.6	26.7	0.00
3:15 PM	0.16	0.00	18.6	26.8	0.00
3:30 PM	0.14	0.00	18.7	27.1	0.00
3:45 PM	0.13	0.00	18.7	27.1	0.00
4:00 PM	0.08	0.00	18.8	27.2	0.00
4:15 PM	0.00	0.00	18.8	27.0	0.00
4:30 PM	0.06	0.00	18.8	26.8	0.00
4:45 PM	0.03	0.00	19.0	26.8	0.00
5:00 PM	0.03	0.00	19.2	26.9	0.00
5:15 PM	0.11	0.00	19.2	26.5	0.00
5:30 PM	0.06	0.00	19.3	26.2	0.00
5:45 PM	0.12	0.00	19.3	26.3	0.00
6:00 PM	0.08	0.00	19.3	26.2	0.00

Data from May 14 to May 18, 1996 at Reidsville, NC.
nm = not measured
Ambient air as carier gas
Each 15 minute measurement represents the binned averages of the previous 15 minutes
lpm = liter per minute

Reidsville, NC						
Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
14-May-96	(hr/min)	(ppb)	(ppb)	(^oC)	(^oC)	ng N m^{-2} s^{-1}
% Moisture = 22.2	8:00 AM	1.81	130.70	11.0	8.5	98.38
TEN = 10	8:15 AM	1.90	131.50	11.1	8.7	98.93
Flow Rate = 4 lpm	8:30 AM	1.57	132.60	12.0	9.5	99.98
Loss Term = 0.02 cm sec^{-1}	8:45 AM	1.61	133.40	12.2	10.1	100.57
	9:00 AM	1.75	135.70	12.4	11.2	102.23
	9:15 AM	1.64	138.90	12.6	11.9	104.74
	9:30 AM	1.69	135.40	12.8	13.6	102.04
	9:45 AM	1.79	139.70	13.6	13.8	105.25
	10:00 AM	2.17	140.30	13.8	14.0	105.45
	10:15 AM	1.64	150.10	14.2	13.7	113.27
	10:30 AM	2.01	160.50	14.4	13.5	120.95
	10:45 AM	2.60	219.00	14.5	13.1	165.13

	11:00 AM	2.89	nm	14.7	14.3	nm
Switched Flow Rate	11:15 AM	3.05	104.60	14.9	14.6	118.36
Flow Rate = 6.45 lpm	11:30 AM	3.01	115.80	15.0	16.2	131.43
	11:45 AM	2.97	121.70	15.3	17.8	138.34
	12:00 PM	1.63	130.90	15.6	19.0	150.48
	12:15 PM	1.65	131.60	15.9	19.1	151.27
	12:30 PM	1.84	130.50	16.3	19.3	149.79
	12:45 PM	2.04	132.70	16.6	19.5	152.13
	1:00 PM	2.09	133.80	16.8	19.6	153.35
	1:15 PM	2.36	131.70	17.3	19.4	150.62
	1:30 PM	2.45	129.30	17.5	18.7	147.73
	1:45 PM	1.96	135.40	17.6	20.6	155.35
	2:00 PM	1.84	139.70	17.8	22.8	160.48
	2:15 PM	1.61	136.70	18.0	21.7	157.24
	2:30 PM	1.47	133.10	18.2	20.8	153.21
	2:45 PM	0.99	148.40	18.6	19.9	171.52
	3:00 PM	0.86	165.80	18.8	19.5	191.89
	3:15 PM	0.99	157.60	18.8	23.7	182.22
	3:30 PM	1.15	152.90	18.9	25.0	176.58
	3:45 PM	1.85	147.80	19.0	22.6	169.89
	4:00 PM	2.74	142.70	19.1	19.7	163.01
	4:15 PM	1.95	153.80	19.2	18.5	176.76
	4:30 PM	1.90	162.90	19.3	17.1	187.40
	4:45 PM	1.75	153.70	19.2	18.6	176.86
	5:00 PM	1.61	141.40	19.2	19.1	162.71
	5:15 PM	1.51	138.10	19.0	18.4	158.98
	5:30 PM	1.88	114.70	18.8	17.1	131.37
	5:45 PM	1.68	110.30	18.6	16.6	126.47
	6:00 PM	1.41	102.60	18.3	16.0	117.80

Reidsville, NC						
Corn Crop	Time	NO Before	NO After	Soil	Ambient Air	NO Flux
15-May-96	(hr/min)	(ppb)	(ppb)	(^oC)	(^oC)	ng N m^{-2} s^{-1}
% Moisture = 19.8	7:15 AM	2.01	11.15	12.2	8.4	7.15
TEN = 9	7:30 AM	2.67	11.22	12.4	8.6	6.77
Flow Rate = 4 lpm	7:45 AM	3.22	12.23	12.9	9.0	7.17
Loss Term = 0.02 cm sec^{-1}	8:00 AM	3.45	13.01	13.3	9.1	7.61
	8:15 AM	6.87	13.87	13.7	9.3	5.99
	8:30 AM	8.75	13.96	14.0	9.7	4.80
	8:45 AM	4.39	15.27	14.2	9.9	8.70
	9:00 AM	4.06	15.33	14.3	9.9	8.97
	9:15 AM	3.95	15.68	14.5	10.1	9.31
	9:30 AM	4.54	17.64	14.6	10.3	10.41
	9:45 AM	5.44	20.92	14.6	10.5	12.31
	10:00 AM	4.82	23.33	14.6	10.7	14.56
	10:15 AM	3.92	23.68	14.7	11.0	15.43
	10:30 AM	3.31	21.31	14.8	11.1	14.02
	10:45 AM	3.41	20.85	4.8	11.3	13.61
	11:00 AM	3.21	19.49	15.0	11.5	12.71
	11:15 AM	4.17	19.95	15.1	11.6	12.42
	11:30 AM	6.66	23.44	15.2	11.5	13.42
	11:45 AM	7.62	25.22	15.4	12.0	14.13
	12:00 PM	3.86	21.11	15.3	12.5	13.50

12:15 PM	3.43	18.55	14.9	12.9	11.84
12:30 PM	3.29	18.74	14.9	12.9	12.08
12:45 PM	3.50	19.44	14.8	13.3	12.48
1:00 PM	3.55	19.68	14.7	13.6	12.63
1:15 PM	3.19	18.89	14.6	13.7	12.27
1:30 PM	3.45	19.33	14.6	14.0	12.43
1:45 PM	3.70	19.34	14.6	14.5	12.27
2:00 PM	4.34	20.91	14.6	14.7	13.03
2:15 PM	5.07	23.01	14.6	15.1	14.15
2:30 PM	4.54	23.81	14.6	15.1	15.11
2:45 PM	3.07	22.65	14.6	14.9	15.21
3:00 PM	2.32	20.93	14.6	14.7	14.40
3:15 PM	2.16	20.49	14.6	14.4	14.17
3:30 PM	2.01	18.33	14.6	14.2	12.62
3:45 PM	1.38	16.36	14.6	14.1	11.54
4:00 PM	1.17	15.51	14.6	13.6	11.04
4:15 PM	1.42	15.69	14.6	13.3	11.01
4:30 PM	1.55	15.33	14.5	12.9	10.65
4:45 PM	1.83	15.33	14.5	12.7	10.46
5:00 PM	1.32	14.11	14.4	12.6	9.87
5:15 PM	1.30	13.73	14.3	12.5	9.59
5:30 PM	1.21	13.65	14.3	12.0	9.59
5:45 PM	1.07	13.21	14.3	11.6	9.35
6:00 PM	0.98	12.97	14.1	11.0	9.23

Reidsville, NC
Corn Crop
17-May-96
% Moisture = 24.9
TEN = 37
Flow Rate = 4 lpm
Loss Term = 0.02 cm sec^{-1}

Time (hr/min)	NO Before (ppb)	NO After (ppb)	Soil (°C)	Ambient Air (°C)	NO Flux ng N m^{-2} s^{-1}
7:00 AM	3.89	19.34	16.1	18.7	12.14
7:15 AM	4.66	21.65	16.4	19.0	13.39
7:30 AM	3.21	25.31	16.5	19.1	17.14
7:45 AM	5.02	20.61	16.8	19.8	12.36
8:00 AM	4.58	22.15	17.3	20.1	13.82
8:15 AM	2.32	23.68	17.5	20.6	16.50
8:30 AM	4.01	29.72	17.6	21.1	19.97
8:45 AM	3.65	24.95	17.7	22.4	16.57
9:00 AM	4.02	27.27	17.8	23.1	18.10
9:15 AM	3.41	32.03	18.0	23.8	22.12
9:30 AM	1.94	36.31	18.3	24.0	26.37
9:45 AM	2.03	44.67	18.5	24.8	32.68
10:00 AM	1.34	55.10	18.7	25.7	41.09
10:15 AM	0.72	63.01	19.1	15.1	47.53
10:30 AM	0.68	80.43	19.3	26.4	60.83
10:45 AM	0.53	101.47	19.7	26.5	76.96
11:00 AM	0.49	109.27	20.0	27.0	82.93
11:15 AM	0.40	110.68	20.3	27.3	84.06
11:30 AM	0.47	49.30	20.7	27.5	37.25
11:45 AM	0.70	46.34	21.0	27.7	34.84
12:00 PM	0.60	57.72	21.3	30.3	43.57
12:15 PM	0.59	36.63	21.5	31.1	27.51
12:30 PM	0.65	25.74	21.6	30.5	19.18
12:45 PM	0.37	24.71	22.0	29.6	18.58
1:00 PM	0.38	24.78	22.6	28.8	18.63

1:15 PM	0.59	26.23	22.6	28.8	19.60
1:30 PM	0.20	nm	23.0	32.1	nm
1:45 PM	0.17	nm	23.3	29.7	nm
2:00 PM	0.61	nm	23.5	28.6	nm
2:15 PM	0.56	26.25	23.5	31.7	19.63
2:30 PM	0.43	27.82	23.5	32.7	20.91
2:45 PM	0.82	26.12	23.8	32.3	19.35
3:00 PM	0.63	25.35	24.1	32.0	18.89
3:15 PM	0.21	26.35	24.2	31.9	19.94
3:30 PM	0.25	27.77	24.2	31.2	20.99
3:45 PM	0.78	28.14	24.4	29.9	20.92
4:00 PM	1.04	28.55	24.5	28.8	21.06
4:15 PM	11.65	39.21	24.5	29.9	22.11
4:30 PM	13.43	56.50	24.5	30.6	34.09
4:45 PM	7.03	49.72	24.6	30.3	33.19

Reidsville, NC
Corn Crop
18-May-96
% Moisture = 20.0
TEN = 23
Flow Rate = 4 lpm
Loss Term = 0.02 cm sec^{-1}

Time (hr/min)	NO Before (ppb)	NO After (ppb)	Soil (°C)	Ambient Air (°C)	NO Flux ng N m^{-2} s^{-1}
7:30 AM	0.63	44.96	19.1	25.4	33.84
7:45 AM	0.74	45.08	19.3	26.1	33.85
8:00 AM	0.96	46.05	19.6	26.5	34.45
8:15 AM	1.08	46.31	19.7	27.0	34.56
8:30 AM	1.01	46.92	19.7	27.3	35.08
8:45 AM	0.75	47.74	9.9	27.3	35.87
9:00 AM	0.80	47.91	20.1	27.7	35.97
9:15 AM	0.78	53.90	20.8	28.9	40.55
9:30 AM	0.92	54.60	21.1	29.7	40.99
9:45 AM	0.80	55.80	21.3	32.3	41.98
10:00 AM	0.72	58.20	21.5	30.7	43.86
10:15 AM	0.34	59.40	22.0	31.7	45.03
10:30 AM	0.11	60.10	22.5	32.5	45.72
10:45 AM	0.08	61.50	23.0	33.6	46.81
11:00 AM	0.03	62.30	23.3	34.1	47.45
11:15 AM	0.10	62.30	23.9	34.8	47.40
11:30 AM	0.18	62.40	24.1	35.1	47.42
11:45 AM	0.49	61.00	24.7	34.9	46.15
12:00 PM	0.43	61.20	24.8	34.5	46.34
12:15 PM	0.00	58.00	25.1	36.6	44.19
12:30 PM	0.10	59.20	25.9	36.4	45.04
12:45 PM	0.08	60.10	26.3	36.0	45.74
1:00 PM	0.15	64.80	26.4	34.5	49.27
1:15 PM	0.53	nm	26.6	34.2	nm
1:30 PM	0.23	nm	26.9	34.3	nm
1:45 PM	0.56	64.20	27.1	34.1	48.54
2:00 PM	0.32	65.60	27.4	36.0	49.77
2:15 PM	0.38	65.70	27.6	35.9	49.81
2:30 PM	0.32	65.70	27.8	35.8	49.85
2:45 PM	0.15	69.00	28.0	35.8	52.47
3:00 PM	1.10	nm	28.1	35.6	nm
3:15 PM	1.91	61.10	28.2	34.2	45.28
3:30 PM	1.25	63.20	28.2	35.2	47.32
3:45 PM	1.51	67.60	28.2	34.2	50.50

4:00 PM	0.79	63.90	28.3	33.9	48.16
4:15 PM	0.05	62.10	28.3	33.2	47.28
4:30 PM	0.10	60.60	28.3	33.5	46.11
4:45 PM	0.23	59.50	28.4	33.1	45.18
5:00 PM	0.06	61.30	28.4	32.5	46.67
5:15 PM	0.24	59.70	28.3	31.7	45.33
5:30 PM	0.28	58.70	28.3	32.6	44.54
5:45 PM	0.31	58.60	28.3	32.0	44.44
6:00 PM	0.25	59.50	28.4	31.2	45.17