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STATE OF ILLINOIS
Pollution Control Board

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF:	)	
PROPOSED AMENDMENTS TO 35 ILL.ADM.CODE 217,	)	R 01-16
SUBPART V, ELECTRICAL POWER GENERATION	)	(Rulemaking- Air)

TESTIMONY OF ROBERT J. KALEEL

Qualifications

My name is Robert J. Kaleel. I am the Manager of the Modeling Unit, Air Quality Planning Section, Division of Air Pollution Control, at the Illinois Environmental Protection Agency ("Agency"), Springfield, Illinois. I have a Bachelor of Science degree in meteorology from Northern Illinois University. I have worked at the Agency for almost twenty years, and have been in my present position since 1989. I have also worked as a private consultant as a specialist in air quality modeling. As Manager of the Modeling Unit, my responsibilities include oversight of staff in the Unit who perform air quality modeling to evaluate the impact of various control measures on ambient air quality. I have been involved with the development of the ozone attainment demonstrations for both the Metro-East/St. Louis and the Lake Michigan ozone nonattainment areas.

The purpose of my testimony is to summarize the results of the modeling conducted to support the 1-hour ozone attainment demonstration for the Metro-East/St. Louis nonattainment area. The attainment demonstration for this area relies on the NOx control measures that are the subject of this rulemaking.

Background

I will begin my testimony by describing the progress made to date in improving ozone air quality in the Metro-East/St. Louis ozone nonattainment area. The level of the one hour National Ambient Air Quality Standard ("NAAQS") for ozone is 0.12 parts per million ("ppm") or 124 parts per billion ("ppb"). Since the form of the ozone NAAQS allows up to three exceedances of the standard over a three year period, the fourth highest value at a given location is the called the design value. If the measured design value at a given monitoring site exceeds the level of the NAAQS, then that location is considered to be in violation of the standard. Figure 1 illustrates the changes in observed ozone design values for the 1987-89 versus the 1997-99 periods in the Metro-East/St. Louis ozone nonattainment area. As shown in the figure, the spatial extent and magnitude of ozone violations has decreased considerably over the past 10 years. In the Metro-East/St. Louis nonattainment area, there were 13 monitoring sites that violated the 1-hour ozone NAAQS in 1987-89 (see Figure 1), but only two sites violated the NAAQS in 1997-99. The maximum design value in the area has been reduced from 156 ppb in 1987-89 to 131 ppb in 1997-99. However, violations of the NAAQS are still observed, and attainment will not be achieved without further emission reductions.

UAM-V Photochemical Modeling System

The 1990 Clean Air Act Amendments established specific planning requirements for ozone nonattainment areas, including the need for a demonstration of attainment based on photochemical modeling. In general, an attainment demonstration relies on the use of air quality simulation models to show how a nonattainment area will achieve the air quality standard by its attainment date and the emission control measures necessary to achieve attainment. The modeling supporting the Metro-East/St. Louis attainment demonstration was performed with the Urban Airshed Model, Version V ("UAM-V"). This is the same model used by the Ozone Transport Assessment Group ("OTAG") in formulating its recommendations, and by the U.S. EPA in support of the NOx SIP Call.

The Agency has worked cooperatively with the State of Missouri to develop a state-of-the-art modeling system for the Metro-East/St. Louis region. The modeling for the Metro-East/St. Louis area utilized the same model, the same modeling domain, and two of the same ozone episodes, July 1991 and July 1995, developed for the Midwestern subregion by the Lake Michigan Air Directors' Consortium, or LADCO, a group comprised of the air directors from states in the Lake Michigan area; i.e., Illinois, Indiana, Michigan, and Wisconsin.

There are three key inputs to the UAM-V photochemical modeling system: emissions, meteorology, and boundary conditions. UAM-V requires a regional inventory of hourly emissions estimates for volatile organic compounds (VOCs), nitrogen oxides

(NOx), and carbon monoxide (CO). Emissions inputs were derived using the Emission Modeling System ("EMS-95"). The EMS-95 model was designed to produce model-ready emissions inputs for the UAM-V, including point and area source emission estimates, on-road and off-road mobile source emission estimates (based on U.S. EPA's mobile source emissions model, Mobile5b), and biogenic emissions. Biogenic emissions, which occur naturally from biological activity and vegetation, are derived from U.S. EPA's BEIS2 model. Once estimates are obtained for each of these emission categories, the EMS-95 model spatially distributes, temporally allocates, and speciates emissions for input into the UAM-V photochemical model. Emissions were prepared for the 1996 base year, and future-year scenarios representing the area's attainment deadline (2003).

Meteorology is the second key input to the UAM-V photochemical modeling system. Inputs for meteorology were developed through prognostic meteorological modeling using the RAMS3, a model developed by Colorado State University. UAM-V requires 3-dimensional hourly values of winds, temperatures, pressure, water vapor, turbulence and, for some episodes, clouds and precipitation. RAMS3a is a prognostic meteorological model based on the dynamic equations that govern atmospheric motion. Meteorological data fields were developed for the two ozone episodes, July 1991 and July 1995, using RAMS3a.

Boundary conditions, the third key input, are used in the model to represent ozone and precursor emissions entering the modeling domain from areas upwind of the domain. The modeling domain, which is referred to as Grid M (see Figure 2), was established based on consideration of the location of upwind sources expected to contribute to transported ozone in St. Louis. For the subject attainment demonstrations, boundary conditions were developed using the UAM-V over an even larger domain (called the OTAG coarse-grid domain) as shown in conjunction with Grid M in Figure 2. Emissions data were prepared for the larger OTAG domain to represent both base and future year scenarios.

A thorough evaluation of the model's performance (i.e., its ability to replicate observed ozone concentrations for historical ozone episodes) was conducted prior to the performance of future year control strategy modeling. The model was executed using the 1996 emissions inventory and the model's performance was evaluated by comparing observed and modeled ozone concentrations. The model was shown to meet U.S. EPA's acceptance criteria before any future-year strategy evaluations were performed.

UAM-V Modeling Results

A series of UAM-V simulations were performed to evaluate various future year control scenarios. The goal of this process was to develop a control strategy that would demonstrate attainment of the 1-hour ozone NAAQS by the appropriate attainment year (2003 for St. Louis). The conclusion that attainment has been adequately demonstrated by the modeled results is based on application of specific criteria, or "tests", established by U.S. EPA. Numerous future year scenarios were developed and tested with the model for the two nonattainment areas. The modeling results for the following scenarios are relevant to the purpose of today's hearing:

1. CAA controls (including States' 15% and ROP measures, reformulated gasoline, enhanced vehicle inspection and maintenance, etc)

2. CAA controls + a rate based limit of 0.25 lb NOx/mmbtu on utilities

3. CAA controls + NOx SIP Call (0.15 lb NOx/mmbtu emissions cap on utilities + SIP Call reductions for non-utilities)

The projected emissions in the Grid M modeling domain for these scenarios are summarized in Figure 3. The first, future year projection, or scenario, evaluated using the UAM-V anticipates implementation of all control measures currently required by the CAA by 2003. From Figure 3, the net effect of growth and CAA controls is a reduction of VOC emissions of about 2,100 tons per day in the Grid M domain, and a reduction of NOx emissions of about 2,400 tons per day compared to the 1996 base year emissions. The second future-year scenario assumed a reduction of NOx emissions from electric generating utilities in Midwestern states to a control level of 0.25 lbs NOx/mmbtu. This control level represents a reduction of NOx emissions in the Grid M modeling domain of about 2,000 tons per day compared to the Clean Air Act control level. The final scenario simulates the effects of the NOx SIP Call controls. For this scenario, it is estimated that a reduction of NOx emissions in Grid M of an additional 1,600 tons per day can be expected compared to the previous modeling scenario, 0.25 lb NOx/mmbtu, or a reduction of about 3,600 tons of NOx per day compared to CAA controls.

The peak 1-hour ozone concentrations predicted by the model for each scenario are shown in Figure 4. Results are shown for a single episode day, July 18, 1991, as an example of the results obtained for the many episode days modeled. The results shown in Figure 4 indicate that substantial reductions in ozone concentrations can be expected from implementation of mandated CAA control measures relative to the 1996 basecase. Additional ozone air quality benefits are indicated from the results of the 0.25 lb NOx/mmbtu scenario, relative to the CAA scenario. Application of the control measures contained in the NOx SIP Call provides some additional, air quality benefits (generally 1-3 ppb) in the Metro-East/St. Louis area, relative to the 0.25 lb NOx/mmbtu scenario. The control level represented by the 0.25 lb NOx/mmbtu scenario is considered adequate to demonstrate attainment of the 1-hour NAAQS in Metro-East/St. Louis by 2003. Implementation of the NOx SIP Call in 2004 should help to maintain ozone levels in the years after the area's 2003 attainment date.

Figure 5 depicts the results of the future year scenarios, relative to the current, monitored design value in the Metro-East/St. Louis area. The ozone design value for an area is the highest of the fourth highest hourly peak ozone concentrations observed at any air quality monitor in that area over a three-year period. U.S. EPA has released guidance (May 1999) that provides a means for using the monitored design values in concert with model-generated data. Rather than comparing modeled peaks in an absolute way to the NAAQS, this approach uses the modeled results in a relative way, by determining the percentage change in the model's overall response across all episode days. The percent change between modeled scenarios, called the "relative reduction factor," is applied to the observed design value to derive the "adjusted design value." To show attainment, the adjusted design value must be below the ozone NAAQS. From Figure 5, the adjusted design value for the Metro-East/St. Louis area does not meet the NAAQS for the CAA scenario, but meets the NAAQS using the 0.25 lb NOx/mmbtu. The NOx SIP Call scenario provides greater benefits with adjusted design values 1-3 ppb less than the NAAQS.

Summary

In summary, I have described the photochemical modeling analyses performed to support the updated 1-hour ozone attainment demonstrations for the Metro-East/St. Louis nonattainment area. The Metro-East/St. Louis attainment demonstration was submitted to U.S. EPA in October 1999, and supplemented in February 2000. The model, as applied to this area, was shown to perform adequately to support regulatory applications.

The modeling analyses show that Clean Air Act controls will reduce ozone concentrations, but do not, by themselves, provide for attainment of the 1-hour NAAQS in the Metro-East/St. Louis area. A control strategy requiring a NOx limit of 0.25 lb/mmbtu on electric generating units in conjunction with CAA control measures is sufficient to demonstrate attainment in Metro-East/St. Louis.

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Figure 1
Comparison of 1987-1989 and 1997-1999
1-hour Ozone Design values within the St. Louis NAA

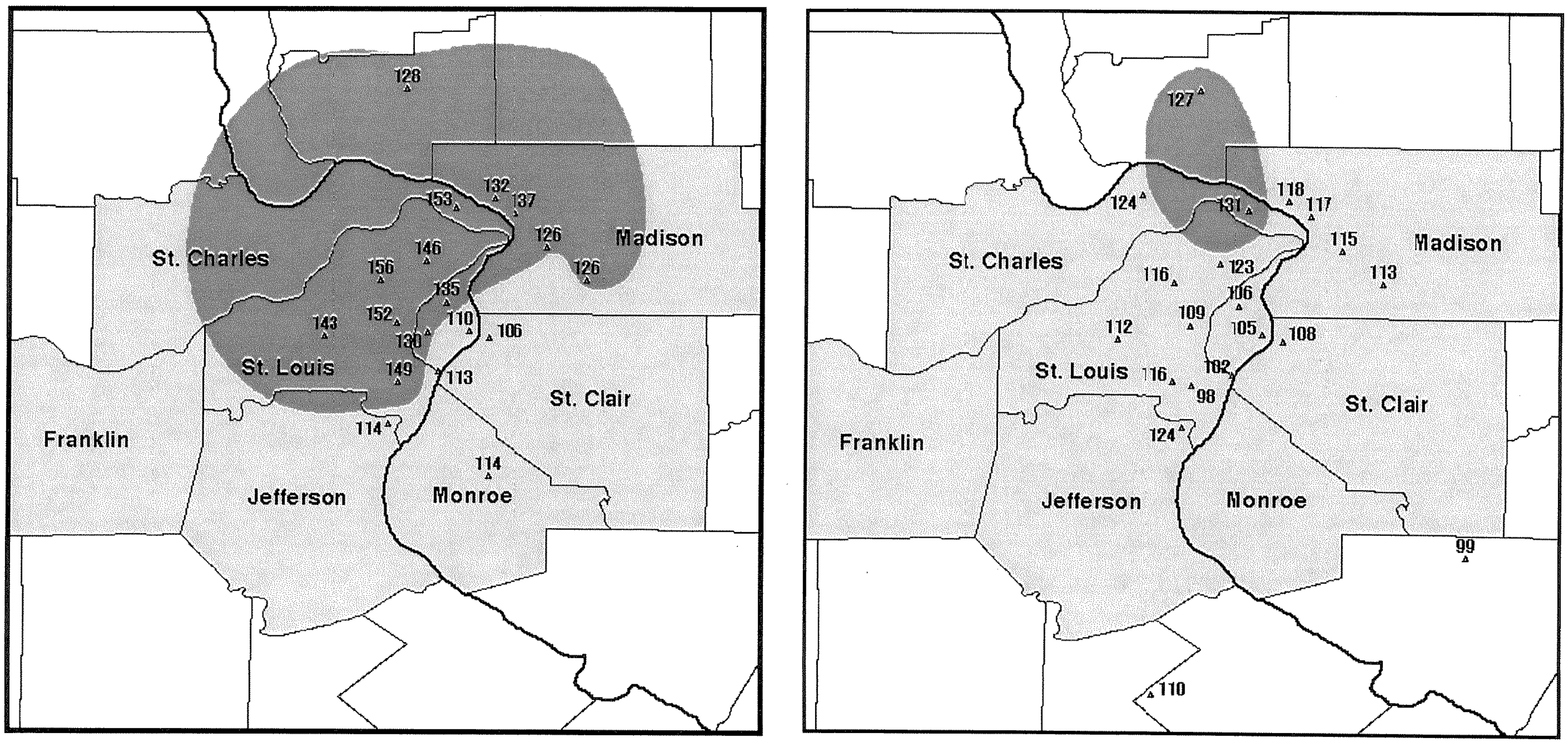


Figure 2
Midwest Modeling Domain
"Grid M"

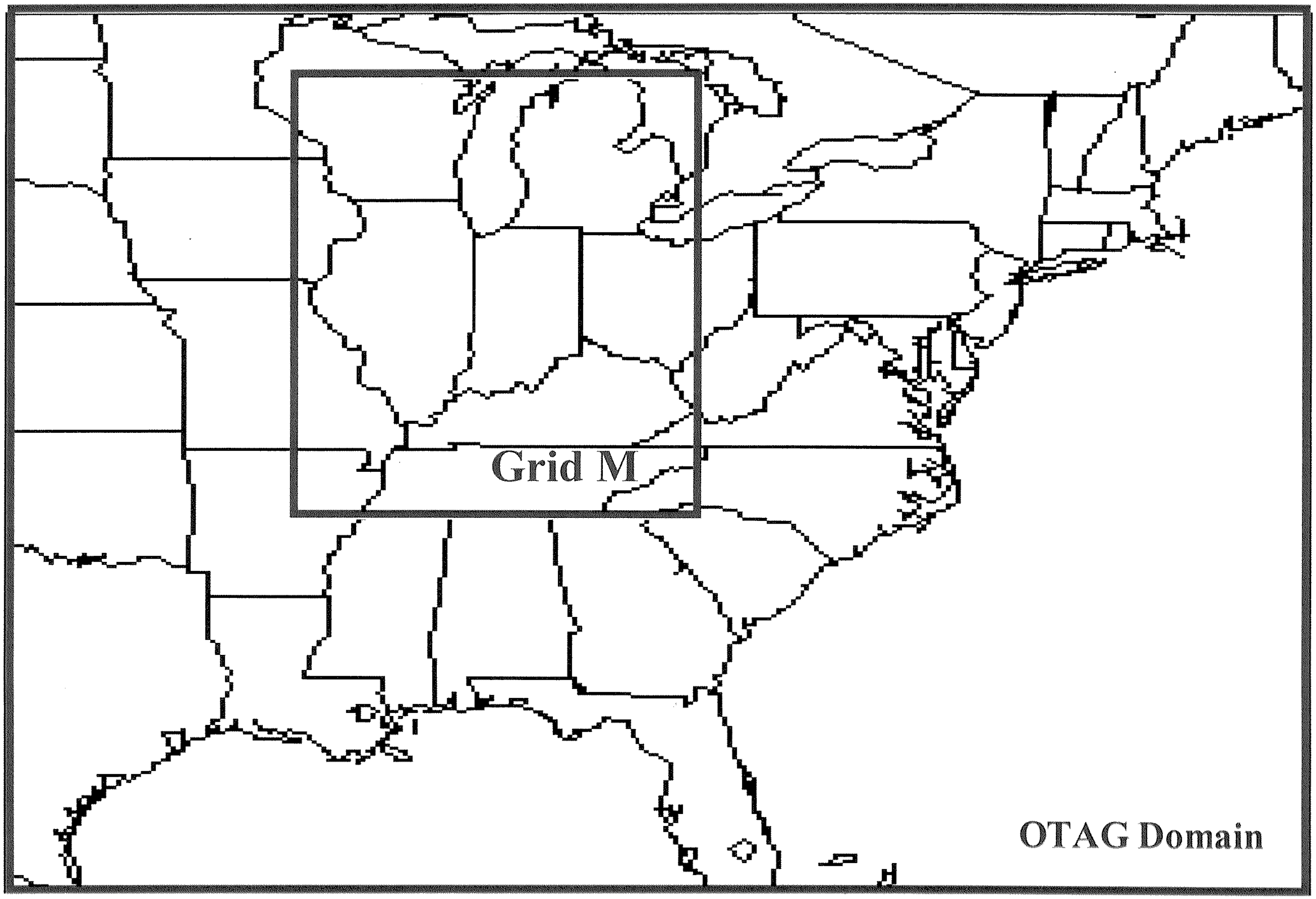
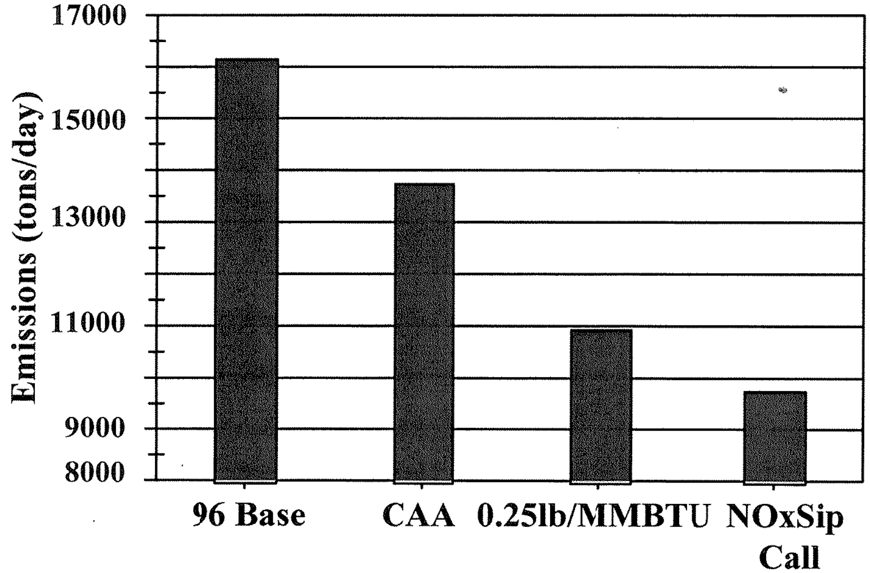


Figure 3
Domain-wide Total Anthropogenic Emissions
(tons per day)

NOx Emissions



VOC Emissions

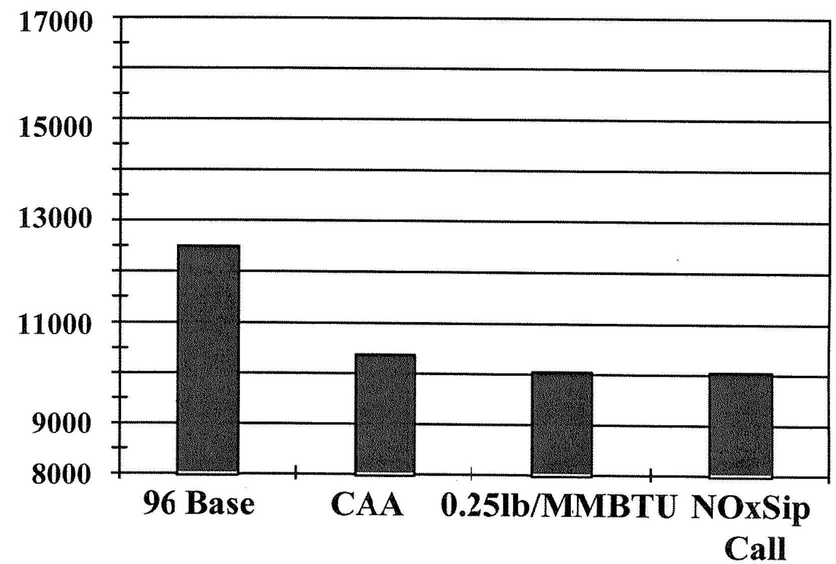


Figure 4
Peak 1-Hour Ozone Concentrations
July 18, 1991 - St. Louis Area

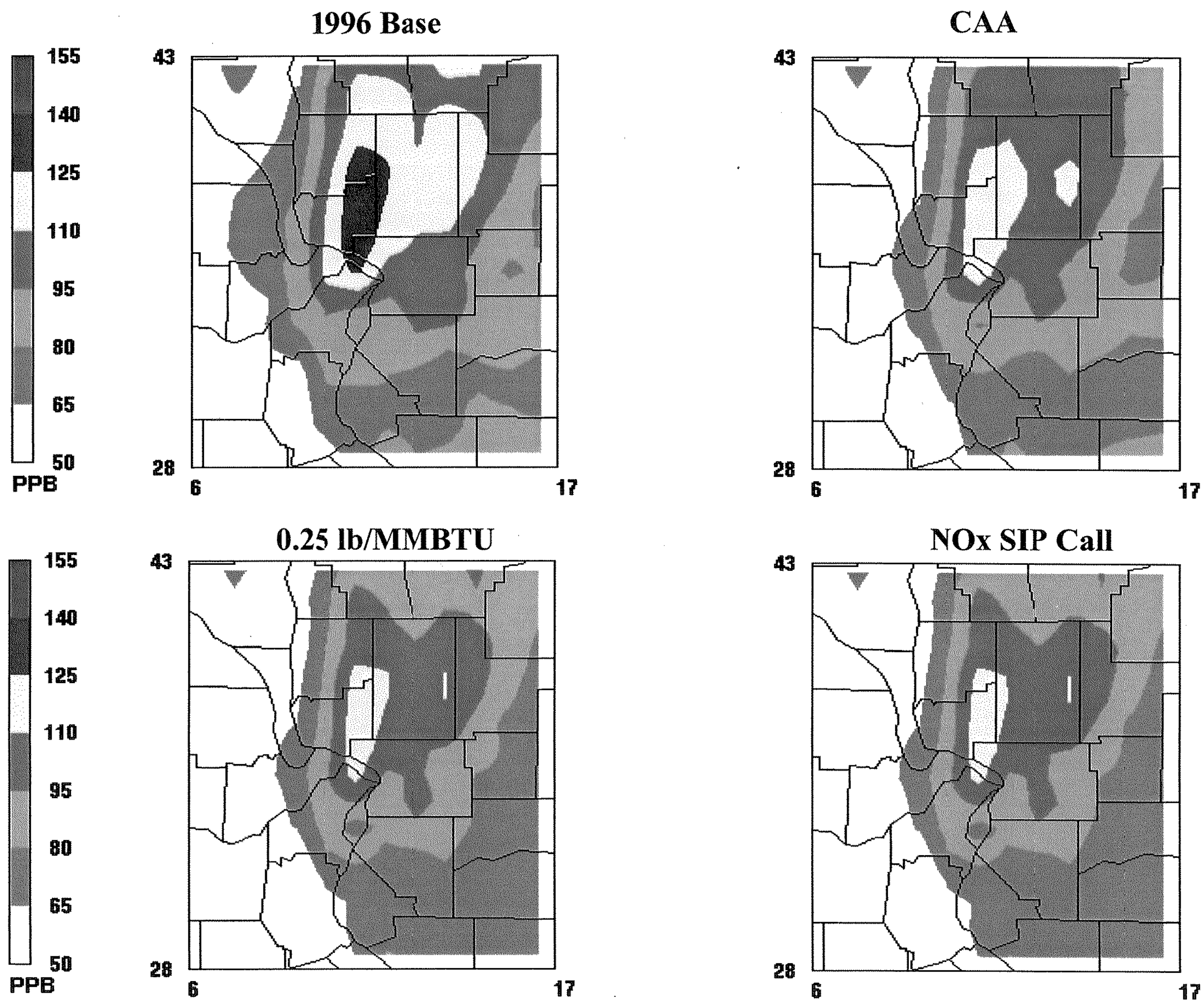


Figure 5
Attainment Strategy Modeling Results
Lake Michigan Region