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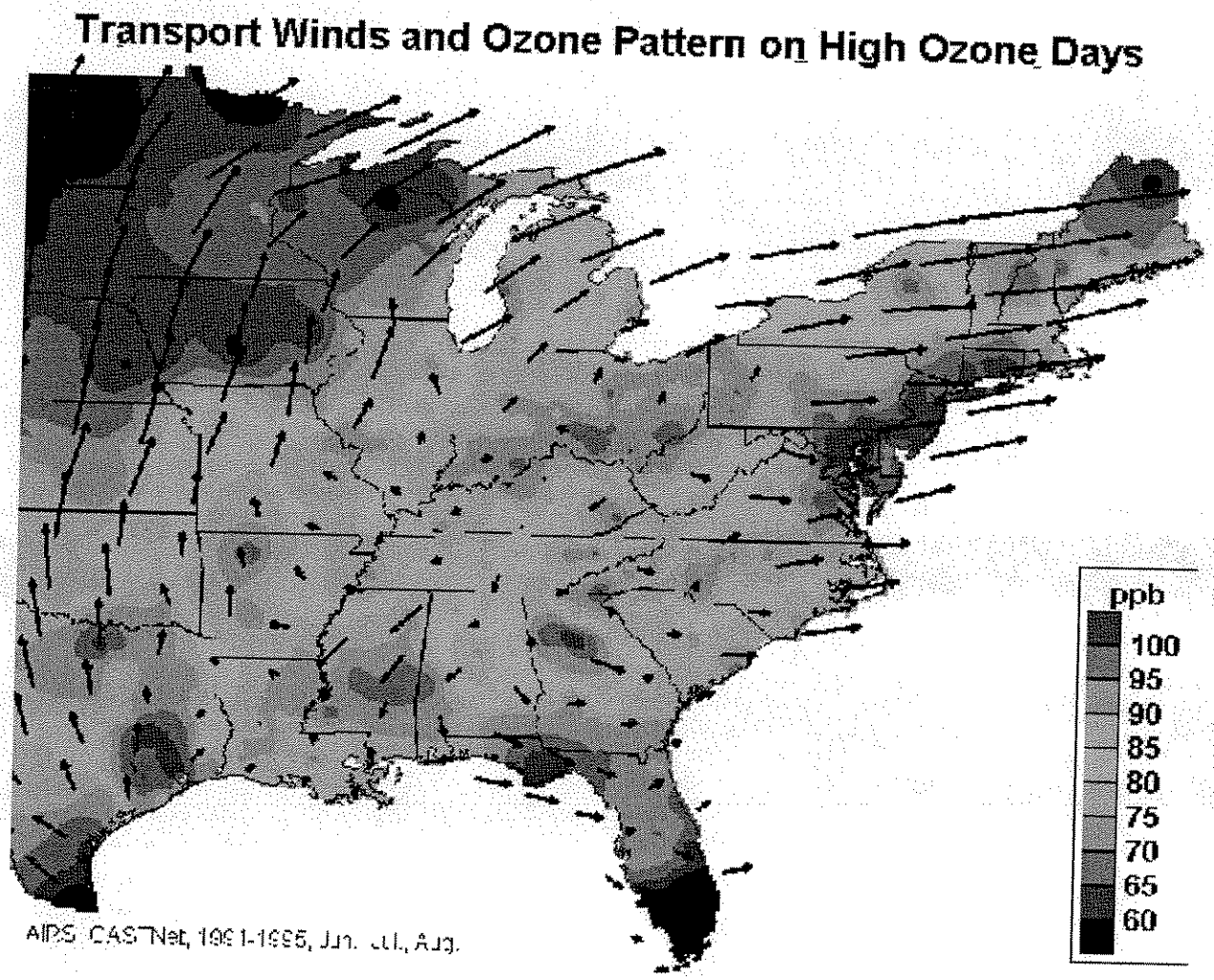
Control Region Options

- Statewide Default in NOx SIP Call
- Three smaller area options under evaluation:
  - Alt 1 - SE 21 Counties encompassing ozone problem areas and emissions concentration
  - Alt 2 - Elec Supply Region (NERC) deliniation splitting MAIN [WE,WPL,MGE] & MAPP [NSP, DLP]
  - Alt 3 - 44 Degree Latitude (OTAG Fine Grid)
- Demo of "No AQ Detriment" Critical for any Alternative
- Linked Zone and Phasing Approach may be most Supportable in final SIP Package (1999)

Telling the OTAG Ozone Story with Data



Final Report, Vol. I: Executive Summary

OTAG Air Quality Analysis Workgroup

Dave Guinnup and Bob Collom, Co-chair

June 2, 1997

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Is there evidence that precursor emission changes cause ozone concentration changes? *

Do air quality data suggest high-leverage means for controlling ozone? *

Recommendations to Foster Future AQ Analyses *

Cover image: Superposition of ozone concentration contours and resultant transport winds during the high 90^{th} percentile ozone conditions.

Abstract

This report was prepared by the OTAG Air Quality Analysis (AQA) Workgroup to aid the deliberations of the OTAG Policy Group with policy-relevant information. The ozone problem addressed by the Workgroup stems from the existence of nonattainment areas in the OTAG domain and that some nonattainment areas are experiencing considerable influx of ozone across their boundaries.

The analysis of more than 600 monitoring stations' data, shows that the highest average daily maximum ozone concentrations (60-80 ppb) within the domain roughly coincide with the highest emission densities of anthropogenic NO_x and VOC: near major metropolitan areas and along the industrial Ohio River Valley. The O_3 levels at the edges of the OTAG domain correspond to the tropospheric background range of 30-50 ppb. Ten-year trend analysis shows a decline of 120 and 80 ppb exceedances in the Northeast. However, the reductions of these exceedances over the entire domain is less pronounced, particularly if one disregards the anomalous high ozone year of 1988.

Low wind speeds, <3m/sec, cause ozone accumulation near local source areas. High winds, >6m/sec reduce the concentrations, but contribute to the long-range transport of ozone. The average range of ozone transport implied from an array of diverse methods is between 150 and 500 miles. The transport of ozone manifests itself differently at the local, sub-regional and regional scales. In general, local (30-150 miles) transport contributes most to the non attainment of the 120 ppb standard. Beyond 100 - 200 miles the ozone concentrations tend to decrease with increasing transport distances However, the perceived range, depends whether one considers the average concentrations (300-500 miles) or peak concentrations (tens of

miles at 120 ppb). The relative importance of ozone transport for the attainment of a new 8-hour standard is likely to be higher due to the closer proximity of nonattainment areas.

The modeling results have been evaluated based on model performance and the representativeness of the selected modeling periods compared to climatological conditions. The model simulations have captured the large-scale features of each episode. However, there was a tendency to under-predict (10-20 ppb) the regional daily maximum ozone concentrations in the North and over-predict in the South. The transport wind fields as well as the average ozone concentration pattern during the four episodes (36 days), are representative for OTAG domain-wide episodes that occur 3-8 times a year. Stagnation over multi-state areas, followed by swift transport is an important characteristic of such O_3 episodes that are prevalent over the central portion of the OTAG domain, where the NO_x emissions are also high. The modeling periods are not representative of the highest ozone concentrations occurring locally. In particular, high O_3 events over the Gulf states are under-represented in the modeling periods.

The anthropogenic ozone in the OTAG domain originates from within the domain and therefore it is controllable with measures inside the domain. The strong weekly cycle of peak ozone concentrations along with the observed parallel 10-year trends of ambient ozone and precursor emissions in some sub-regions suggests that ozone reductions are feasible. Urban areas contribute to their own ozone problems and VOC controls appear to be effective for 'peak shaving' of the 120 ppb standard. NO_X emission reductions are likely to be effective for regional ozone reductions. Emissions in the central part of the OTAG domain along the industrial-urban Ohio River Valley appears to be associated with many regional-scale ozone episodes. Reductions in that area would benefit many receptor areas downwind.

The Workgroup has recommended preserving the OTAG AQA infrastructure and the stakeholder-based approach. Future monitoring and assessment programs should set as further goals the quantification of ozone source attribution, flow across political boundaries and routine evaluation of photochemical models.

Introduction

The Air Quality Analysis (AQA) Workgroup of OTAG has been formed to provide assessments of air quality and meteorological data relevant to the mission of OTAG. The Workgroup placed special emphasis on ozone transport since some nonattainment areas are experiencing considerable influx of ozone across their boundaries and they cannot demonstrate attainment by local measures only. Specifically, the workgroup's purpose statement reads:

> ***The Air Quality Analysis Workgroup shall identify, characterize, compare, and assess observational data and studies including but not limited to air quality trends analysis, overflight data, and meteorological studies for the purpose of evaluating the effects of the transport of ozone and its precursors on ozone nonattainment in the eastern United States.***

The Workgroup process has entailed the development of individual work products, presentation of results at Workgroup meetings, followed by open review by the group. The Workgroup has collectively developed policy-relevant summaries and subjected these to repeated group review. This process has been greatly facilitated by the early development of an interactive Internet website which has been used to communicate data sets, analytical tools, results, interpretations, and critical feedback.

The Workgroup members were affiliated with the EPA, state agencies, industry (power, transportation) consultants and academia. The specific activities undertaken by this group have included reviewing existing air quality studies and analyses; developing analyses and visualizations of air quality and meteorological data to help in the understanding of ozone formation and transport; comparing modeling results against available air quality data; and integrating air quality analyses and modeled results into conceptual interpretations of ozone transport for use in policy development. The multiple types of analyses included: spatial and temporal pattern and trend analysis, trajectory and residence time analysis, correlation and cluster analysis, detailed evaluations of intensive field studies, (SOS and NARSTO-NE) and comparison of model results with the data.

The efforts of the Modeling and Air Quality Analysis Workgroups are intended to provide complementary input to support the OTAG policy development. The modeling effort evaluates the effects of future control strategies using photochemical grid modeling for specified episode periods. On the other hand, the air quality analysis results assess the ozone problem using long-term measurements from monitoring networks. A comparison of the modeling results for the four modeling episodes with corresponding observations as well as with climatological values provides a good indication of the strengths and weaknesses of photochemical grid modeling, including simulation performance and representativeness.

The air quality assessments help to "set the stage" for the Policy Group by providing broader perspectives on the current ozone problem and its characteristics. While modeling is uniquely suited for evaluating the consequences of future emission scenarios, the complexities of the ozone problem are such that comparisons with data are a necessity. The combination of modeling and AQ analysis results can help to improve confidence for, and identify uncertainties in, the outcome of future control scenarios.

The paragraphs below present the major policy-relevant results, conclusions and recommendations from the AQA Workgroup. The summary falls into the following major categories:

- *Origins and patterns of the ozone problem in the OTAG domain.*
- *Ozone transport in the OTAG domain.*
- *Air quality comparisons to UAM-V episodic model results.*
- *Air quality management implications of the data analysis results.*

In each major category a set of policy-relevant technical questions are posed, followed by and brief statement of pertinent results. The supporting materials for this Volume I - Executive Summary, can be found in Volume II - Summary and Integration of Results and in Volume III - Summaries of Individual Analyses, all accessible through the AQAWG website, http://capita.wustl.edu/OTAG.

Origins and Patterns of the Ozone Problem in the OTAG Domain

What is the OTAG Ozone Problem?

Recent health and ecological studies suggest that adverse biological effects can result from ozone exposures at any level above natural background. All sections of the OTAG region periodically experience ozone higher than the natural background, and share a common interest in addressing the ozone problem. However, the severity, frequency and duration of high ozone events exhibit complex patterns and source receptor relationships, such that the most efficient strategies to reduce local or regional ozone exposures are not obvious.

Control strategies depend directly on how the OTAG ozone problem is defined. Current federal health standards focus on peak 120 ppb, 1-hour concentrations; proposed health standards focus on 80 ppb, 8-hour averages; ecological effects result from chronic exposures accumulated over the entire growing season.

The spatial pattern of the current (1993-1995) exceedances (120 ppb, 1 hr) shows that the Washington-New York corridor, Chicago, Atlanta, Dallas-Ft. Worth, Houston, St. Louis, are the major metropolitan areas that exceed the current standard (Figure 1). However, there are other metropolitan areas throughout the OTAG region which remain in nonattainment with the current standard.

Virtually all areas where exceedances of the current standard occur are confined to the near vicinity (<150 miles) of metropolitan areas. In contrast, areas exceeding the proposed 8-hour 80 ppb ozone standard are more numerous, extend further from metropolitan areas and include a large portion of the central OTAG domain. The distances between nonattainment areas projected under this proposed standard are significantly shorter than those under the current standard and therefore there is more likelihood that one area influences the exceedances in its neighboring nonattainment areas.

What is the pattern of ozone precursor emissions?

Ozone precursors are volatile organic compounds (VOC) and nitrogen oxides (NOx) from area and point sources. Anthropogenic area sources of both VOC and NOx are most dense in large urban metropolitan areas (e.g., the Washington-New York corridor, Chicago, Atlanta, Dallas-Ft. Worth, Houston, St. Louis). The largest, elevated point sources of (predominantly) NOx emissions are prevalent in industrial regions including the Ohio River Valley (Figure 2). Anthropogenic NOx area sources tend to have a strong diurnal and weekly cycle, while point sources typically vary less in time. VOC emissions from both anthropogenic and biogenic sources are heavily influenced by sunlight and temperature, and so tend to exhibit stronger

diurnal and seasonal variations than NOx emissions.

What are the spatial patterns of ozone?

The Workgroup has evaluated the regional ozone concentration patterns using a comprehensive set of over 600 monitoring stations from routine EPA and research networks. The entire data set includes 102 urban sites, 259 suburban sites, and 238 rural or remote sites (13 sites in the network are not classified).

During the summer ozone season, the OTAG domain is periodically ventilated by air coming from outside the domain where ozone concentrations average ranges between 30 and 50 ppb, corresponding to typical tropospheric background levels measured in the northern hemisphere (Figure 3). It is reasonable to assume that in the absence of anthropogenic emissions, the average summertime ozone concentration would be about 30-50 ppb throughout the OTAG domain. Thus, with the notable exception of the Canadian border along the Windsor-Quebec corridor, there are no significant external source impacts on the domain, at least on a regional scale. Large sections of the domain experience average daily maximum ozone levels of 60 to 80 ppb, double the tropospheric background. The highest average concentrations are observed near major metropolitan areas and in a large central sub-region of the of OTAG domain along the Ohio River (Figure 3).

What is the range of ozone concentrations?

Ozone exhibits strong day-to-day variation that can be quantified by examining "cleaner" and "dirtier" days across the domain (Figure 4). The urban impact is virtually undetectable during cleaner, low-ozone days (i.e., the lowest 10th percentile of all measured ozone concentrations). However, even these cleanest days exhibit a broad area of higher average ozone (>40 ppb) from Illinois to Pennsylvania relative to the rest of the OTAG domain. During the dirtier, high-ozone days (the 90th percentiles) the urban influence is very pronounced but confined to about one or two hundred miles from major metropolitan areas. It is therefore observed that urban areas are making substantial local contributions to the highest 1-hour daily maximum ozone concentrations as well as exhibiting the highest range in ozone concentration as measured by difference between 90th and 10th percentiles.

How does ozone vary in time?

Ozone exhibits temporal variability over hourly, diurnal, synoptic (3-5 days), weekly, seasonal, and long-term (5-20 years) time scales. The ozone changes on weekly and long-term scales are caused primarily by anthropogenic emission changes, while changes at the hourly, diurnal, synoptic and seasonal scales are also influenced by meteorology.

Ten year trends show that the number of 120 ppb, 1-hr exceedances has declined markedly over the past decade in areas like the northeastern Ozone Transport Region (Figure 5a) and Southern California. The percentage reductions of the 80 ppb, 8-hr exceedances were less.

These areas have also experienced substantial emissions reductions of both VOC and NO_x. For the OTAG region as a whole, improvements have been much less dramatic (Figure 5b). If 1988 is considered an anomalous ozone year, the OTAG region has experienced relatively small changes in the number of 120 ppb and 80 ppb exceedances and OTAG-wide average ozone concentration over the past 10 summers (Figure 5b). Evidently, historical reductions of VOC and NOx emissions have been successful at reducing peak ozone levels on a local or sub-regional scale. However, broader control approaches may be necessary to reduce the more regionally distributed 80 ppb, 8-hr average ozone levels.

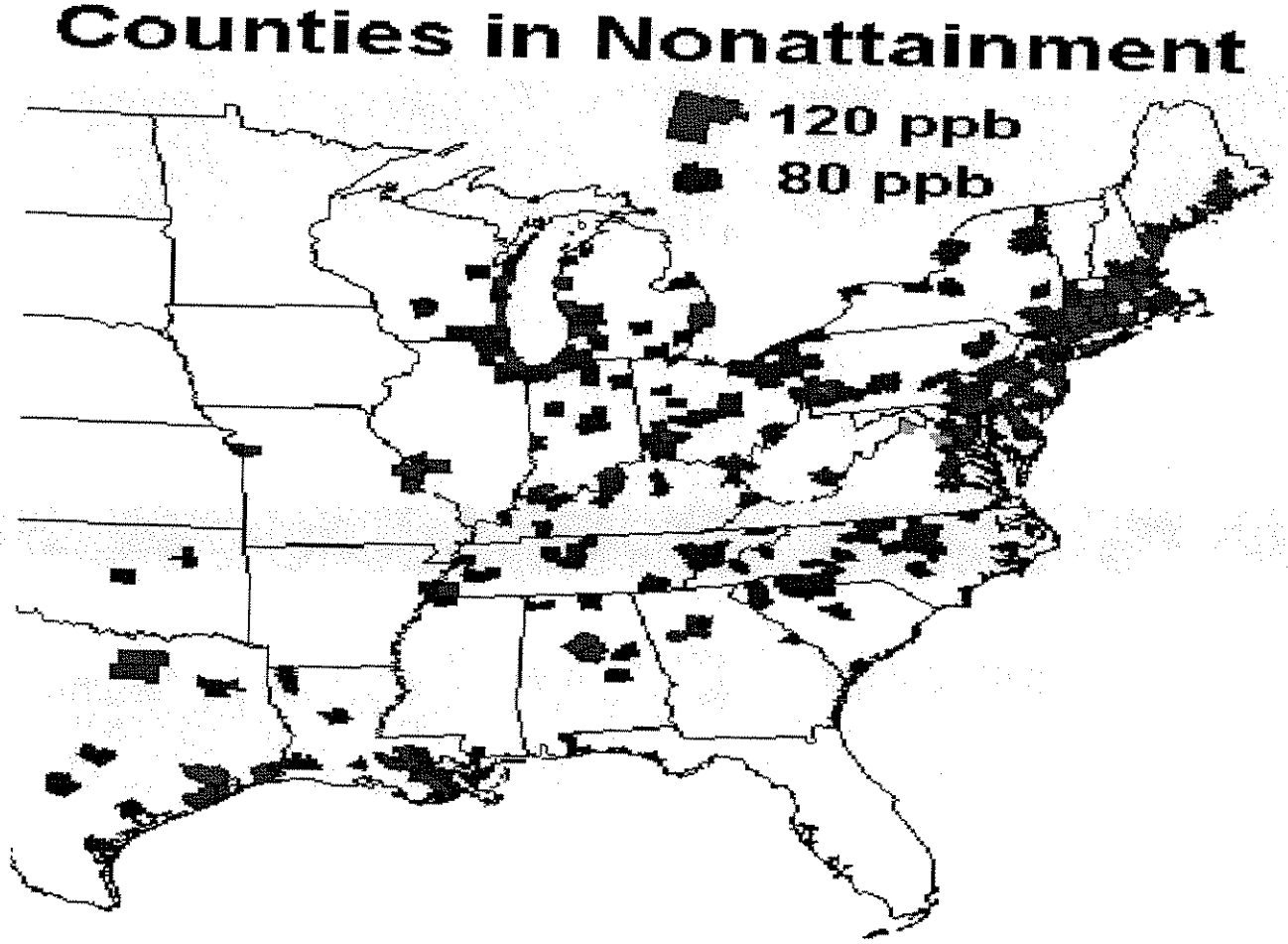


Figure 1. Counties not meeting the 0.12 and 0.08 ppm standard according to EPA.

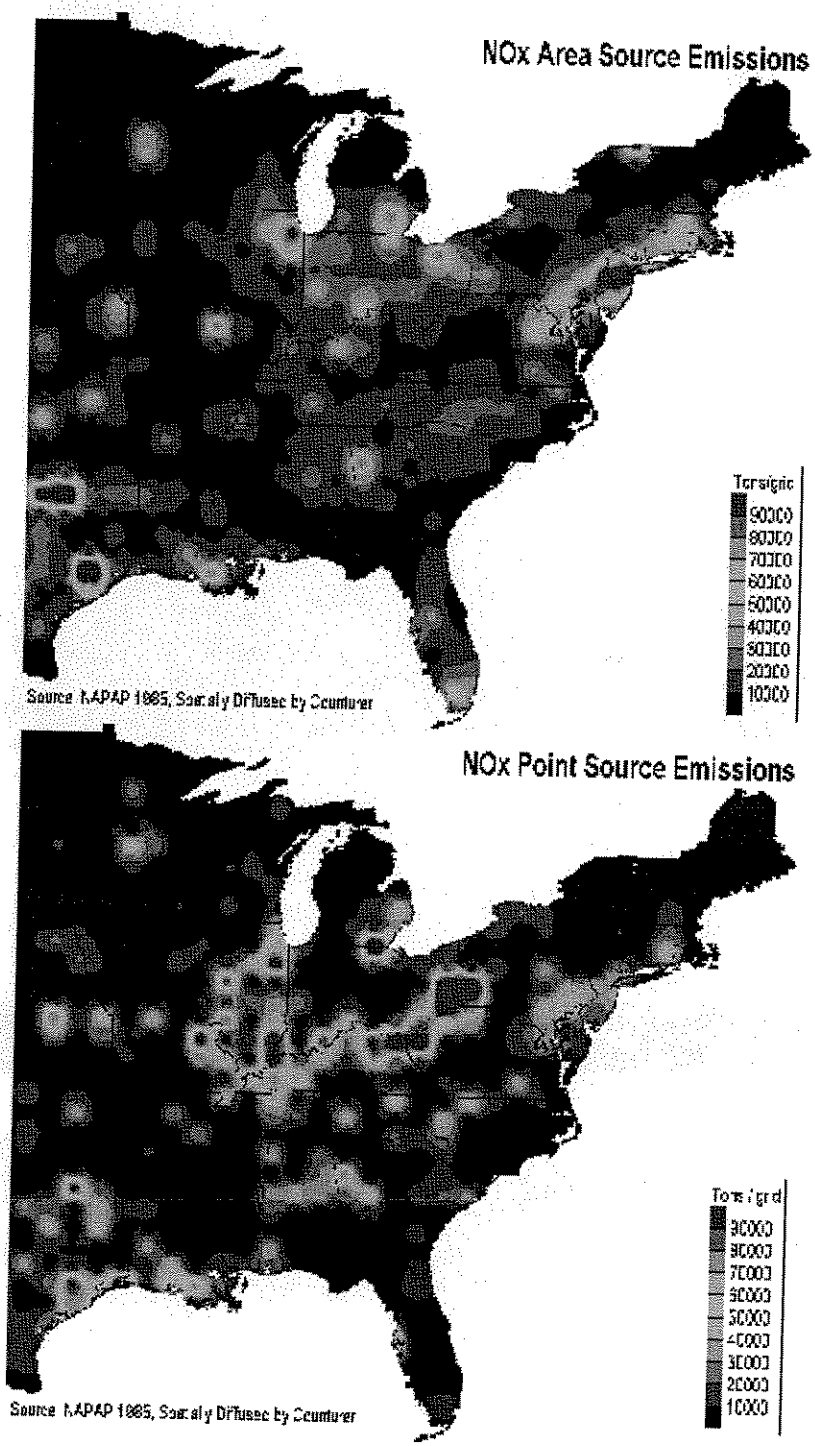
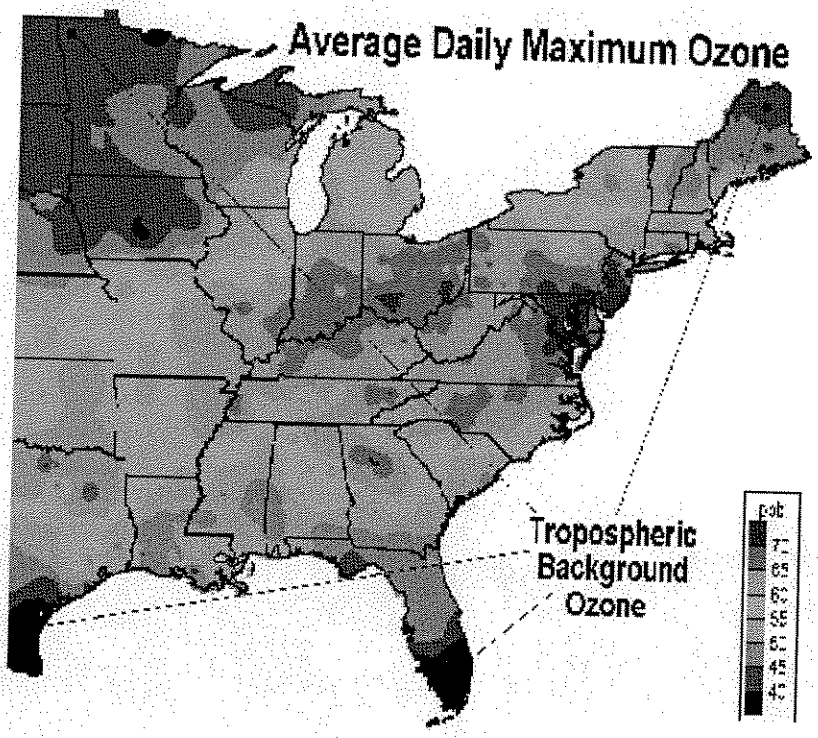


Figure 2. a) Area source emissions densities for NOx. The high emission densities are located in the vicinity of urban-metropolitan areas.

Figure 2. b) Point source emission densities for NOx. The major emission regions are located along the Ohio River Valley.



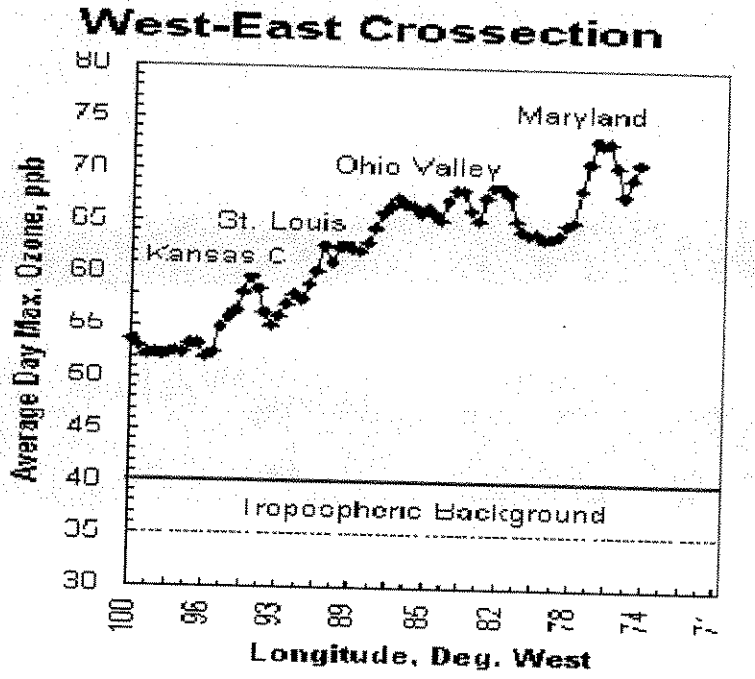


Figure 3. a) Average 1-hour daily maximum ozone concentration in the OTAG region. All four corners have about 30-50 ppb ozone, corresponding to the tropospheric background entering the region.

Figure 3. b) The crossection through the center of the OTAG domain indicates a general increase of ozone from west to east.

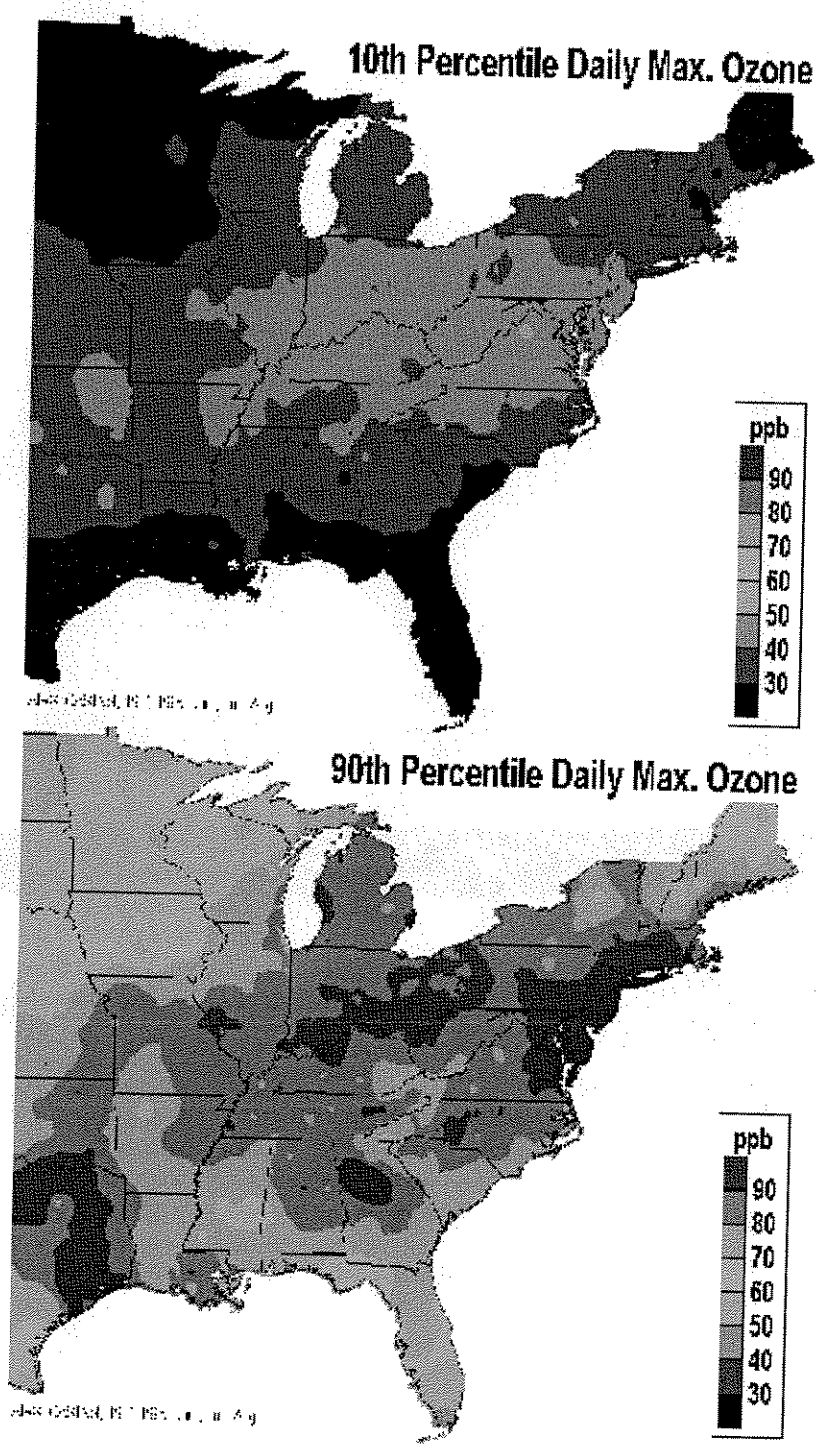
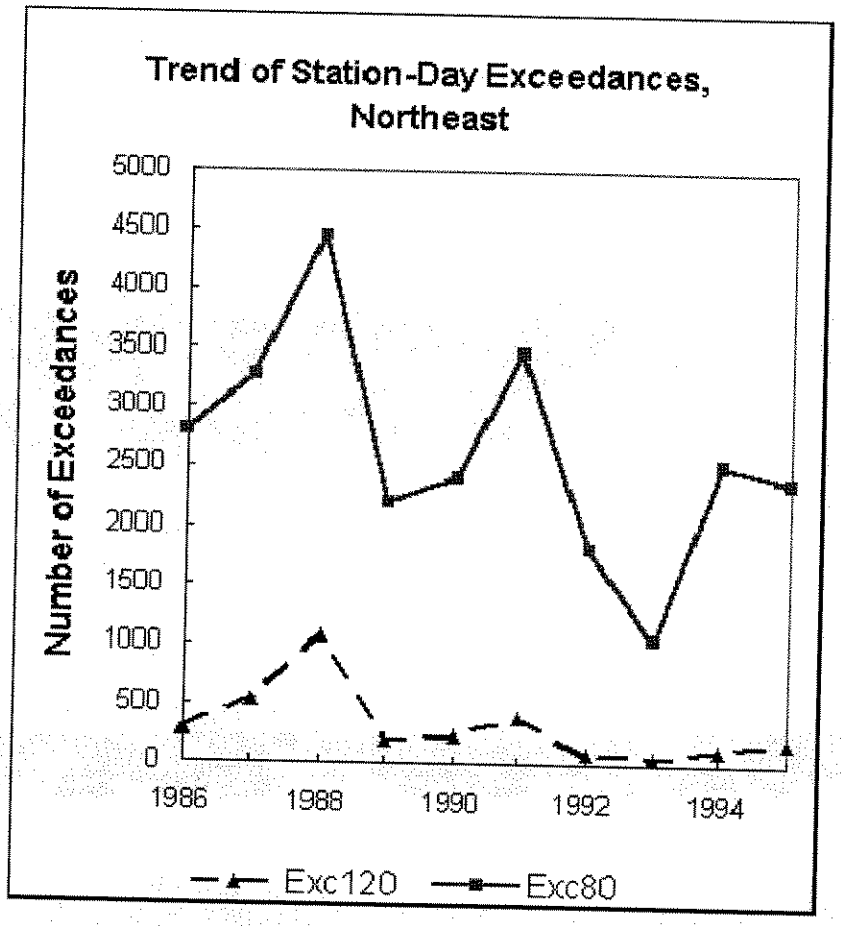


Figure 4. a) Spatial pattern of the 10th percentile of daily maximum ozone. Elevated ozone concentrations are evident throughout the central OTAG region.

Figure 4. b) Spatial pattern of the 90th percentile of daily maximum ozone. The highest ozone concentrations occurs near major metropolitan areas.



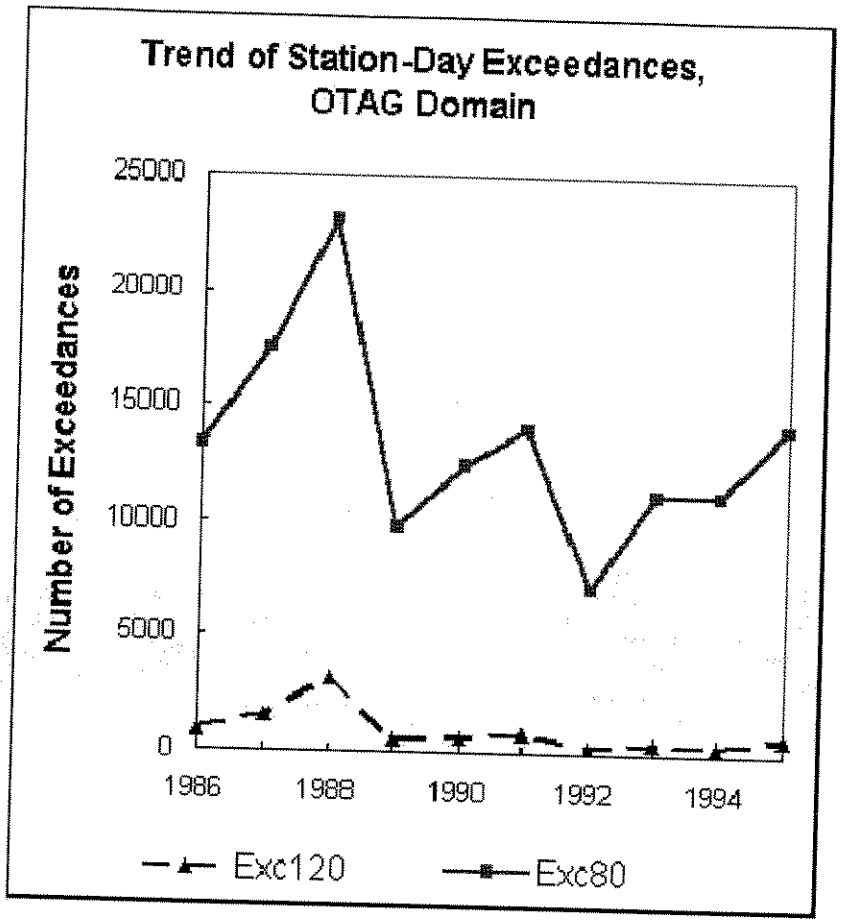


Figure 5. a) Exceedance trends over the Northeast.

Figure 5. b) Trend of the yearly 120 and 80 ppb exceedances for the 1986-95 period; over the OTAG domain.

Ozone transport in the OTAG Domain

Ozone transport: beneficial or harmful?

Atmospheric conditions can exert a powerful influence on the distribution of pollutant concentrations in space and time. Low wind speeds lead to the buildup of high local pollutant concentrations (Figure 6a). Strong ventilation with high wind speeds prevents the local build-up near the sources (Figure 6b), but contributes to long-range transport and regional ozone particularly during directionally persistent wind conditions. For southern urban areas, where episodes are caused by local stagnation, ozone levels decline rapidly with increasing wind speed (Figure 7a). In northern cities, more heavily influenced by transport, ozone levels decrease much less rapidly, with increasing wind speeds.

Vertically, ozone transport takes place in synoptic (>800m), channeled (200-800m) and near surface (<200m) flow regimes (Figure 7b). The potential for transport from elevated (>100m) emission sources is substantially higher than for low-level sources, due to higher wind speeds aloft, particularly at night during channeled, 'nocturnal jet' conditions.

Examination of dispersion conditions during locally high-ozone days (90 th percentile), shows that dispersion in the Southeast is typically poor due to stagnating air masses (Figure 8a). However, the western and northern sections of the domain experience stronger and more persistent southerly and westerly winds, respectively. This supports the notion that ozone exceedances in the central and southeastern areas are predominantly "homegrown," while exceedances in other sections of the OTAG domain are also influenced by regional transport. In contrast, on low-ozone days, the transport is predominantly from the outside (e.g., Canada and the Gulf of Mexico) into the OTAG domain (Figure 8b).

The widespread, regional-scale ozone transport episodes result from several days of stagnation over the central portion of the OTAG domain, **followed** by strong unidirectional flow, generally to the northeast. Three (88, 91, 95) out of four episodes chosen for OTAG modeling were such stagnation-followed-by-transport regional episodes.

In summary, the "good news" about transport is that it can disperse, or clean up, the ozone formed in an area during a stagnation event. The central and southeastern portions of the OTAG domain, which experience relatively more stagnation, can benefit from this aspect of transport. The "bad news" about transport is that it can carry significant ozone concentrations from one portion of the domain to another, causing influx of regional ozone across the boundaries of the nonattainment areas, particularly over the midwestern and northeastern portions of the domain.

AQA WG researchers have assessed the transport issue based on examination of meteorological data, trajectory analyses and field observations of ozone and ozone precursors. These analyses have not estimated ozone transport at future times.

What are the implied ranges of ozone transport?

The distance of O3 transport between the precursor emissions and O3 removal is in the range of 150 to 500 miles (Figure 9a). The transport of ozone manifests itself differently at the local, sub-regional and regional scales. In general, local (30-150 miles) transport contributes most to the non attainment of the 120 ppb standard. Beyond 100 - 200 miles the ozone concentrations tend to decrease with increasing transport distances.

Statistical correlation analyses of the regional ozone pattern suggest ozone transport distances of up to 300-500 miles, but it is not clear to what extent this actually represents transport of ozone and/or precursors, or is a meteorological correlation. Time-lagged correlation analyses also suggest linkages between ozone concentrations separated in time by one to two days. Interpretation of such a time lagged correlation as an ozone lifetime of one to two days corresponds to a transport distance of about 400 miles.

While an estimate of ozone impact distance based on any single method is rather uncertain, the coinciding range of the various methods increases confidence in the accuracy of these estimated ozone transport distances.

The perceived distance of ozone impact can vary considerably depending on the measures used to describe

the ozone impact. In general, the spatial scale of perceived ozone transport decreases rapidly with an increasing concentration threshold (or increasing percentiles of the ozone distribution). For example, the average daily maximum ozone has a scale of impact of hundreds of miles, while ozone exceedances of 1-hour, 120 ppb thresholds may extend only to tens of miles. This finding underscores the notion that an 8-hour, 80 ppb ozone standard will implicate larger areas and longer transport scales, than the 120 ppb 1-hour standard.

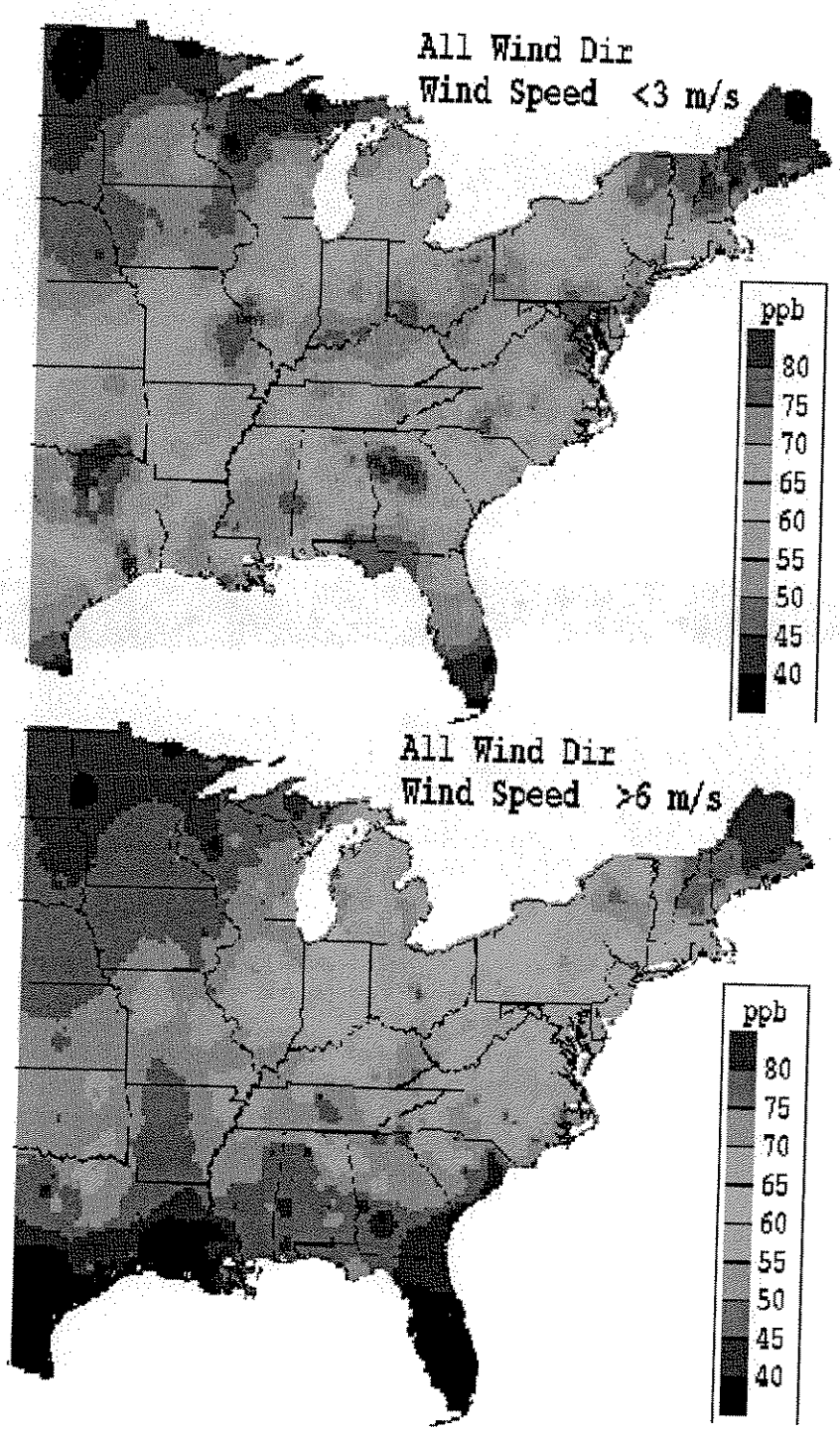
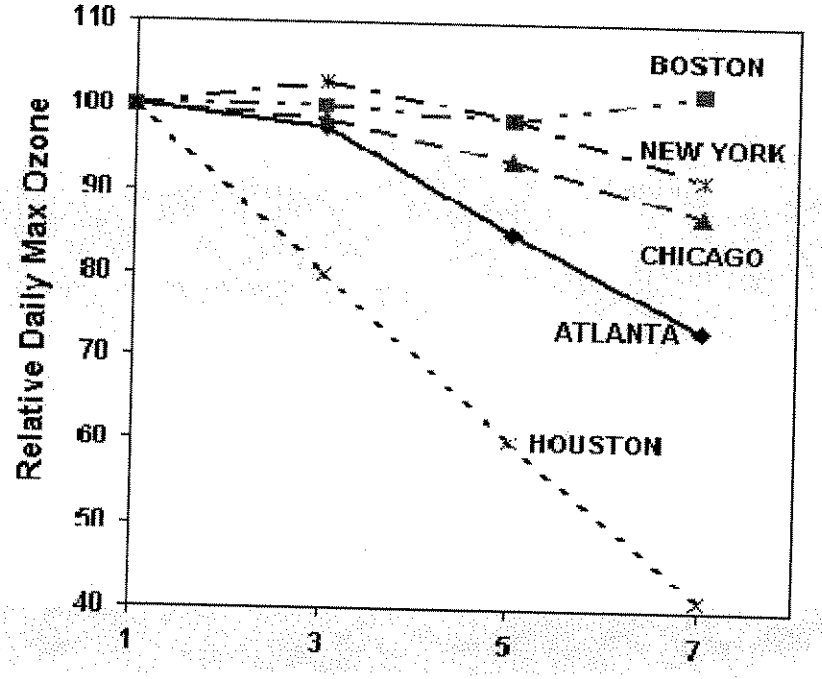


Figure 6. a) Average ozone concentration during low (< 3 m/s) wind speed conditions. Low wind speeds cause ozone to accumulate near the source areas.

Figure 6. b) Average ozone concentration during high (>6 m/s) wind speed conditions. Higher wind speeds cause more regional ozone transport.



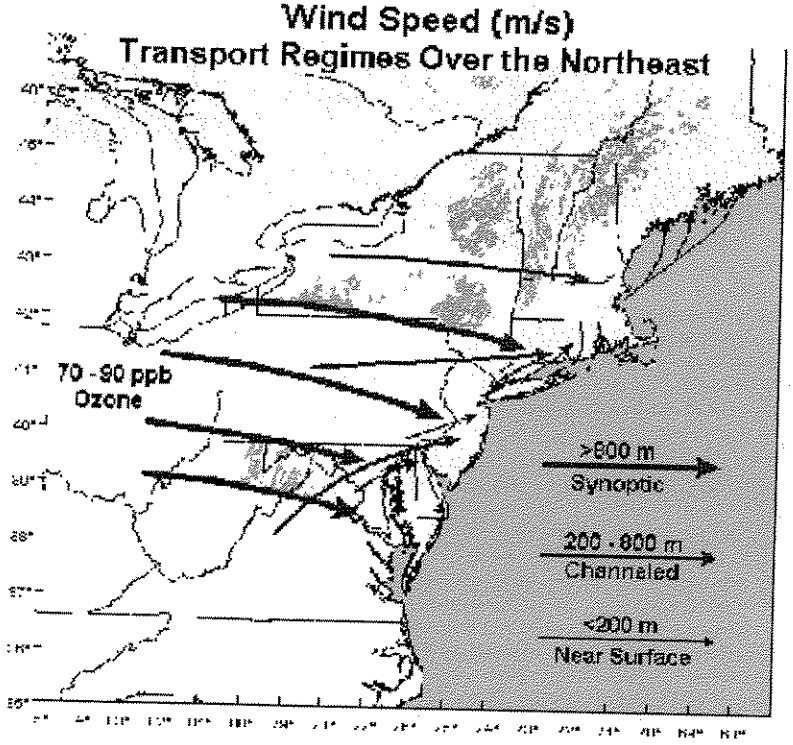
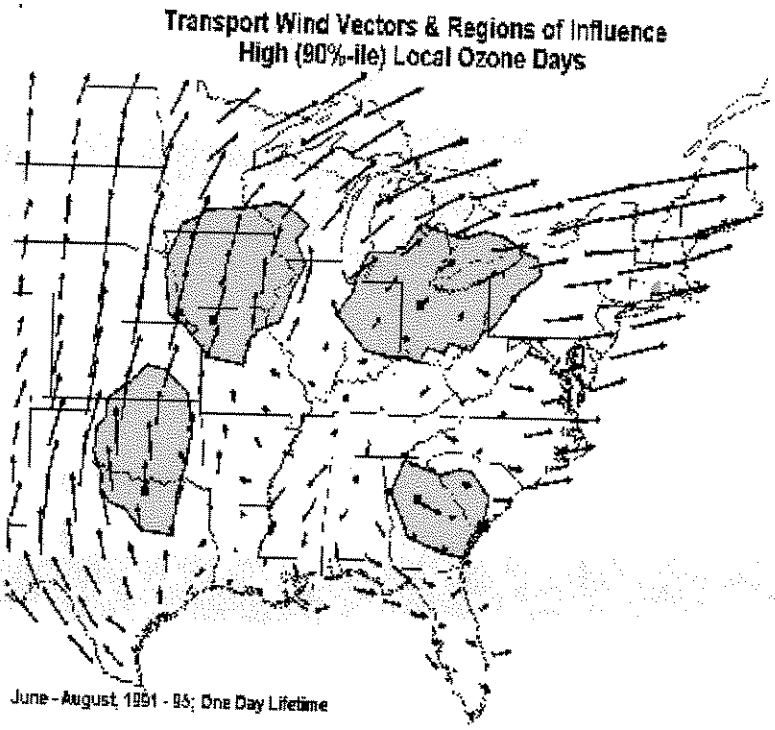


Figure 7 .a) Relative change of ozone concentration with wind speed of different cities. In the South, higher local wind speed diminishes ozone, in the North it does not.

Figure 7 .b) Schematics of transport regimes in the Northeast. Ozone transport occurs in synoptic, channeled, and near surface flow regimes.



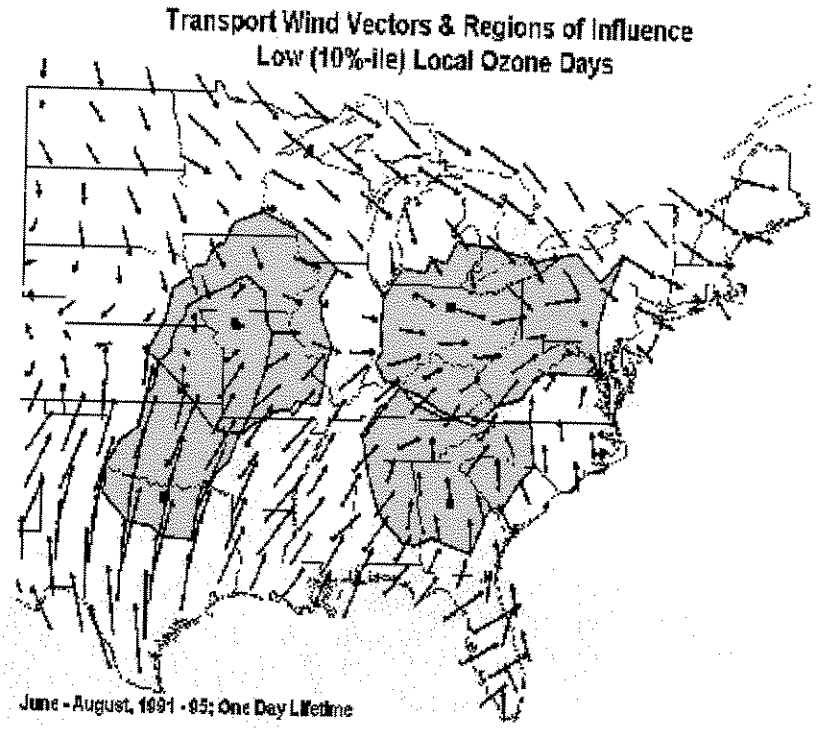


Figure 8. a) Transport winds during high (90%-ile) local ozone days. High ozone in the central OTAG domain occurs during slow transport winds. In the north and west, high ozone is associated with strong winds.

Figure 8. b) Transport winds during low (10%-ile) local ozone days. Low ozone occurs on days with transport from outside the region. The regions of influence (yellow shaded areas) are also higher on low ozone days.

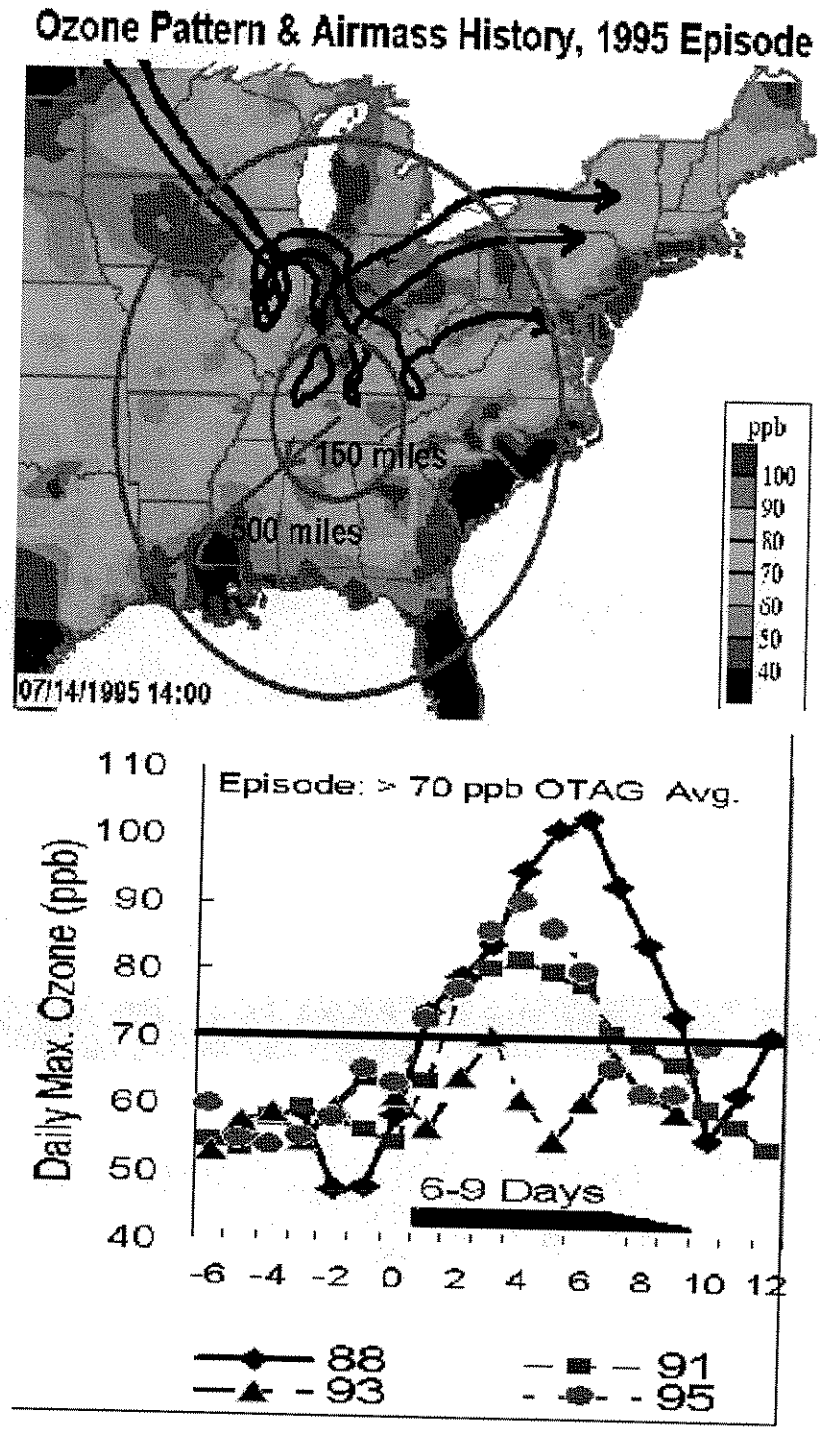


Figure 9. a) Ozone pattern and air mass histories during the 1995 episode.

Figure 9. b) Daily maximum ozone averaged over the OTAG domain. Regional episodes above 70 ppb have a duration of up to nine days.

Air Quality Comparisons to UAM-V Episodic Model Results

How do model results compare to measured concentrations?

From the point of view of AQA, the utility of modeling results as a basis of policy making can be evaluated based on two criteria: model performance during the selected (36 day) episodes, and secondly the representatives of these episode conditions for "typical" or climatological conditions.

Visual comparison of maps of measured and modeled ozone values shows that the simulations capture the large-scale dynamic and spatial features of each episode. Although not seen in every episode, there appear to be tendencies for the model to underpredict daily maximum ozone levels in the northern portion of the domain by 10-20 ppb (Figure 10a, 10b, 11a), where high ozone is frequently associated with strong, synoptic-scale flows. The model tends to overpredict the ozone for the southern portion of the domain where high ozone is typically associated with local stagnation. Further, aircraft measurements in the Northeast for a few simulation days indicate that ozone levels above the surface layer (>200m) may be underpredicted by the model. One possible interpretation of these observations (although not the only one) is that transport impacts may be understated by the model. This, and the generally longer scales of transport indicated by the climatological air quality analyses should be kept in mind when interpreting model results regarding transport distances.

Comparison of model predictions to ozone precursor data, while limited by the availability of measurements, shows marginal to poor agreement, especially for isoprene from biogenic VOC emissions. In addition, comparison of modeled and observed CO (a tracer of automotive emissions) shows poor agreement for the 1995 episode. Comparison of ozone to total reactive nitrogen ratios in non-urban locations tends to agree with model predictions.

Based on the ability of the model to capture the large-scale features of the ozone concentration patterns and non-urban ozone to total reactive nitrogen ratios, it is suggested that the UAM-V model is a useful tool for evaluating the general features of future large-scale control options. However, the limitations of model applications, such as those suggested by these analyses, reinforce the notion that modeling results should be interpreted not as definitive or absolute, but rather as one part of a full assessment. The full assessment, relative to the mission of OTAG, would thus include modeling, air quality analysis, and information relating to control strategy feasibility and cost.

How does transport during modeling episodes compare to episodes in general?

The transport conditions during the selected OTAG modeling episodes are similar to the transport during OTAG domain-wide regional ozone episodes in general (Figure 12a). Such episodes are characterized by slow meandering transport over Kentucky, Tennessee, and West Virginia, with a strong clockwise transport

around this region of stagnation.

However, the transport during OTAG modeling periods differs significantly from the conditions of highest local ozone concentrations (Figure 12b). The main difference is that the net transport speeds are mostly higher during the OTAG modeling episodes, and the direction of net transport over the Illinois-Pennsylvania corridor is from the west, rather than the typical southwesterly flow.

What kind of episodes do model results represent?

Within the OTAG domain, high ozone concentration, above 80 or 120 ppb, can occur during regional, sub-regional, or local episodes. The OTAG domain-wide regional episodes are caused by slow-moving or recirculating airmasses over the center of the OTAG domain (Figure 9a). Coincidentally, the central Ohio River Region is a high NOx emissions area (Figure 2). A regional episode is defined here as the condition when the daily maximum ozone concentration averaged over all the OTAG domain monitoring sites, exceeds 70 ppb (Figure 9b). All four periods selected for OTAG modeling are regional. During the 1988 episode, the OTAG domain average ozone exceeded 70 ppb for 9 consecutive days with an OTAG domain average peak of 103 ppb. The 1991 and 1995, episodes lasted for about 6 days with peaks between 80-90 ppb. The 1993 episode is best characterized as a subregional episode over the Southeast, since the OTAG domain-average ozone barely exceeded 70 ppb on one day.

The pattern of average measured ozone concentration (Figure 10a) shows that during the four modeling episodes ozone is high over the industrial Midwest, as well as over Pennsylvania and New Jersey and low along the Gulf Coast.

The OTAG domain-scale regional episodes occur about 3 (1993) to 8 (1988) times, covering about 10% of the April-September ozone season. Multi-day ozone accumulation causes about half of the OTAG-wide recorded 120 ppb exceedances to occur during these regional episodes. However, these episodes account for only 30% of the 80 ppb exceedances. Hence, their role for the proposed new standard is diminished, compared to the old standard.

air matters

Spring 1998 Wisconsin Department of Natural Resources • Bureau of Air Management

What EPA's NO_x SIP Call Means to Wisconsin

By Larry Bruss, Bureau of Air Management

Wisconsin would need to reduce statewide emissions of nitrogen oxides by over one-third during the five-month ozone season, according to a recent proposal by the United States Environmental Protection Agency (EPA).

On November 7, 1997, EPA proposed a program to reduce ground level ozone or smog throughout the eastern United States. EPA's proposal identifies inadequacies in air quality plans in 22 eastern states, including Wisconsin, and the District of Columbia—areas which, EPA says, emit ozone precursors in amounts that "significantly contribute" to ozone nonattainment problems in downwind states.

EPA's proposal calls for the affected states to make significant reductions in nitrogen oxides (NO_x) emissions, a principal precursor to ozone formation. The results of this action will be very beneficial to Wisconsin, as the proposal provides flexibility for states, addresses many of our concerns about ozone transport, and should result in significant reductions in ozone concentrations if implemented.

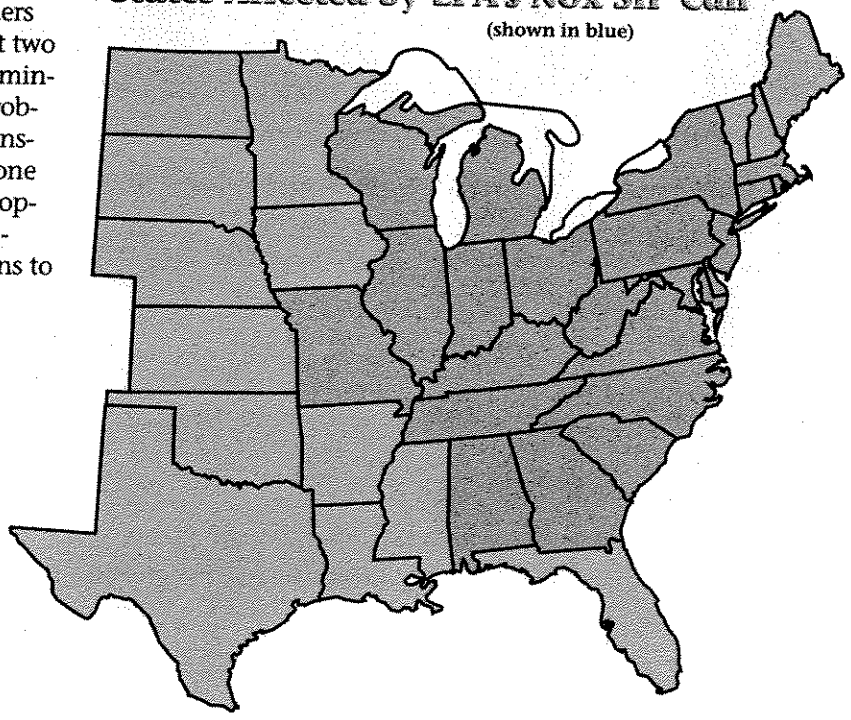
Why NO_x control matters

Ozone is formed when volatile organic compounds (VOCs) react with NO_x compounds on hot sunny days. Historically, the approach to controlling ozone has been to control VOC emissions in urban areas. While this has been effective at reducing concentrations within and immediately downwind of ozone nonattainment areas, VOC control alone will not be enough to bring many large urban areas into attainment. NO_x control over a large geographic region is much more effective at reducing ozone concentrations over a large area, and hence a more effective control for interstate transport. A significant reduction in transported ozone and ozone precursors is the only way for areas like southeastern Wisconsin to achieve attainment of the ambient air quality standards.

EPA's November 1997 proposal is the first step in implementing recommendations made by OTAG—the Ozone Transport Assessment Group, a consortium of 37 states and hundreds of stakeholders that spent two years examining the problem of transported ozone and developing recommendations to solve the problem.

EPA gets its authority under section 110 of the Clean Air Act to propose regulations for sources that significantly contribute to downwind nonattainment problems. With essentially millions of ozone precursor sources in the eastern United States contributing to the problem, it is difficult to determine "significant contributors." Therefore, EPA aggregated emissions from groups of sources or groups of states and found that these states or groups of sources significantly contribute to downwind ozone nonattainment problems. The agency applied a weight of evidence approach to determine which areas should be subject to emission reduction requirements. They looked at the amount of

States Affected by EPA's NOx SIP Call
(shown in blue)



DNR outreach and public input on NOx issues

Two advisory groups, the Clean Air Act Task Force and the NOx Technical Advisory Group, are providing input to the Bureau of Air Management on NOx issues. The Clean Air Act Task Force, originally formed in 1990, will be restructured to reflect the key interests that need to be heard to address broad NOx issues such as the future of the NOx waiver (see above), NOx versus VOC emissions budgets, NOx reduction budgets for large stationary, area and mobile sources, and the geographic area covered by emission budgets. The NOx Technical Advisory Group advises the bureau on specific cost evaluations and the technical merits and feasibility of NOx emission reduction options.

Public forums on NOx issues will be held intermittently between April and August 1998. For information about dates and locations of these meetings, check the "Meetings, Notices and News" page of the DNR's website (http://www.dnr.state.wi.us/news/), or call Anne Bogar at 608-266-3725.

emissions, emissions density, ambient effects, cost and cost effectiveness as criteria for determining which states should be subject to the NO_x control requirements.

NO_x budget

The proposal establishes a five month seasonal budget, effective May through September. EPA calculated the budget from five budget components—electric utilities, non-utility point sources (industrial and commercial operations), highway vehicles, off-road equipment and area sources. EPA's proposal calls for Wisconsin to reduce NO_x emissions statewide by about 50,000 tons during the five month summer period. This represents about a 35% reduction from a projected 2007 base emission level. Each state is free to choose the most appropriate method for obtaining the reductions. However, most states will have to seriously consider major NO_x emission reductions at electric utilities and other large fuel burning installations.

In developing its NO_x reduction strategy, the Bureau of Air Management is using a number of avenues to get public input into the process, including the Clean Air Act Task Force, NO_x Technical Advisory Group, discussions with other state agencies, and town meetings, as well as other outreach efforts (see sidebar above).

EPA expects to finalize its rule in September 1998. EPA's proposal requires the affected states to submit a plan that demonstrates compliance with the final rule by September 1999. This includes having fully adopted rules in place. EPA has suggested a time frame between September 2002 and September 2004 for a final compliance date. This date is a critical concern among affected entities in Wisconsin. It will be much easier to comply with the rule if EPA provides affected entities enough time to adequately plan and implement significant operational changes at their facilities.

Geography, cost and other issues

The OTAG recommendations indicated that reductions of ozone precursor emissions in northern Wisconsin, north of 44 degrees, were not effective in reducing ozone concentrations in downwind nonattainment areas. However, EPA's proposal includes emission reductions for the entire state. This is an obvious source of concern for the State of Wisconsin and for potentially regulated entities in northern Wisconsin.

The DNR is in the process of more closely examining this issue with the use of several air quality modeling tools. We are concerned about the emission reduction requirement in northern Wisconsin, but we are also concerned about emissions from other states that have the potential to adversely affect our ozone nonattainment areas. Those areas include Iowa and other states which are not among the 22 states identified in EPA's proposed SIP call. (See map on page 1.)

The average cost of the NO_x control program nationally may approach about $2,000 per ton of NO_x removed. If this is the case, the final control costs will be about $100 million annually for Wisconsin. However, the DNR expects that effective emissions trading programs could greatly reduce control costs.

There are several outstanding issues associated with this important air quality improvement proposal. First, the timing of the final control programs is important. Pushing the control program along too quickly could lead to poor planning and wasted effort and could hamper the reliability of the state's electric generating capacity. Reliability of the electrical generating capacity is a concern, especially during the period when control equipment is being installed. A longer compliance timeframe also allows the electric utility companies to consider other air quality issues in their planning, such as greenhouse gases, mercury and fine particulate matter.

In 1995 several ozone nonattainment counties in eastern Wisconsin received a waiver from implementing NO_x emission reductions through Reasonably Available Control Technology (RACT) under Section 182(f) of the Clean Air Act. At that time, it appeared that NO_x emission reductions in that area would not be effective at reducing, and might possibly increase, local ozone concentrations. However, EPA's proposal deals with NO_x reductions over a large area to address regional transport of ozone and its precursors. Sources in these ozone nonattainment areas will not automatically have the exemption from NO_x control afforded by Section 182(f). To more closely examine this issue, the Wisconsin DNR, in concert with Michigan, Indiana and Illinois, will conduct additional analyses using an updated model. These refined analyses will provide technical support regarding whether NO_x RACT should be pursued in all or part of the Lake Michigan ozone area.

FACE Up to It: Study Examines Forest Impacts of CO_2 Plus Ozone

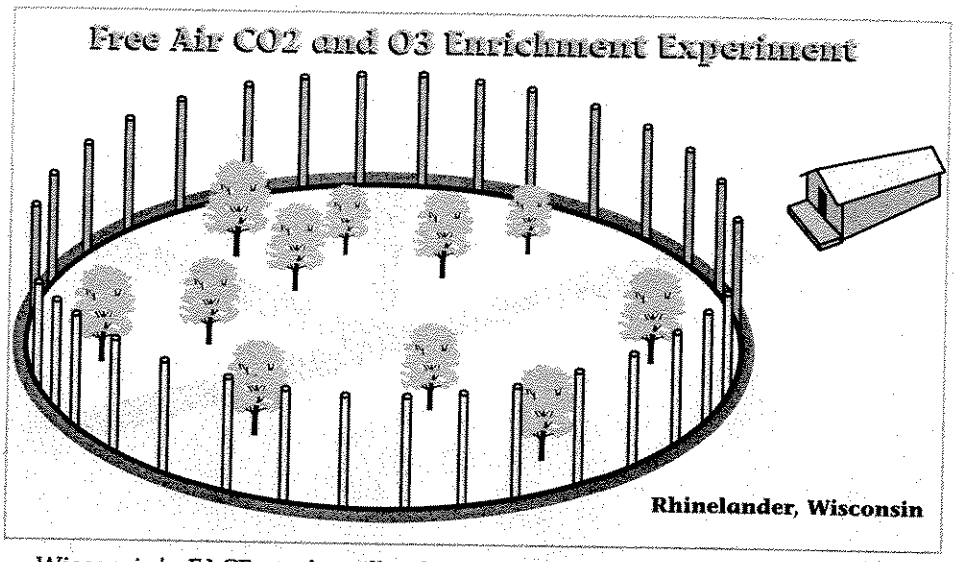
By Ed Jepsen,
Bureau of Air Management

Wisconsin's north woods is home to one of the most advanced air pollution study sites in the world. The year-old project, called the Northern Hardwoods FACE Study, is being conducted at the Harshaw Forestry Research Farm in Oneida County (part of the U.S. Forest Service North Central Experimental Station) in cooperation with Michigan Technological University.

FACE stands for Free Air Carbon Dioxide Enrichment. The study's state of the art facility for exposing plants to air pollutants opened in 1997 and will bring national and international scientists together to evaluate how interactions between elevated carbon dioxide and ozone affect forest growth and competition. The researchers will conduct studies ranging from cellular biochemical processes to plant level competition.

Big commitment, unique approach

A FACE study involves a long-term commitment to examining carbon dioxide and ozone effects on natural systems. This type of study is crucial because most of the carbon dioxide enrichment studies to date have been done on tree seedlings or crops and other plants not native to northern climates and no information is currently available on carbon dioxide enrichment on forest development. Most importantly, the work will be done here in Wisconsin on economically and ecologically important northern hardwood species such as trembling aspen, sugar maple and paper birch. Construction of the FACE system will cost in excess of $2 million, and annual carbon dioxide purchases alone will cost over $55,000. Various aspects of the study, such as the development of stand and soil characteristics, will take five to 10 or even 20 years to complete.



Wisconsin's FACE study will address a variety of serious questions about the effects of elevated carbon dioxide and ozone on forest productivity and diversity: Will elevated carbon dioxide ameliorate the adverse effects of ozone on plants? How will increasing carbon dioxide concentrations affect the growth of dominant northern forest tree species such as maple, aspen and birch? Will the species composition of our forests change over time? Which insect and disease interactions are likely to change? How will the storage of carbon in the forest change? Will nutrient dynamics shift subtly or dramatically?

How FACE works

The FACE system uses computer controlled valves to release carbon dioxide and/or ozone to a 30 meter-diameter circular test plot through a ring of vertical vent pipes (see graphic). The computer adjusts for wind speed and direction so that gases are released only from the upwind vent pipes and are then carried across the plot by the wind.

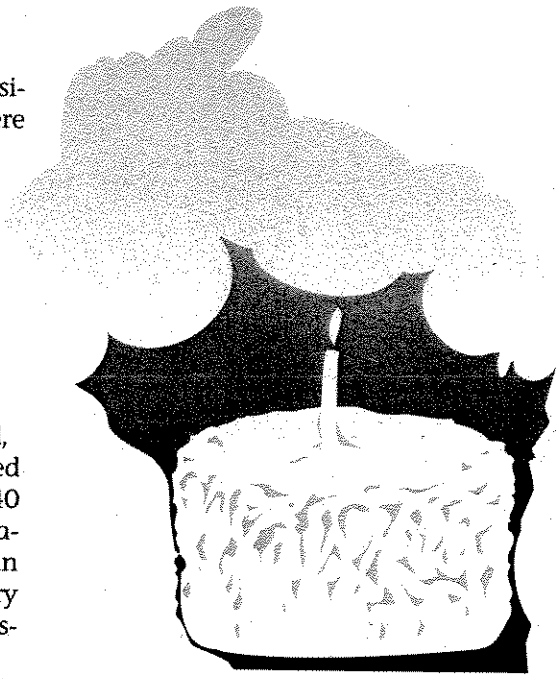
The Harshaw facility will have 12 study rings using carbon dioxide and ozone singly or in combination. Because fumigation occurs outdoors, the test plants are exposed to natural climatic and biological conditions missing from earlier chamber and greenhouse studies. This approach will provide the most realistic exposures to enable scientists, policy makers and the public to assess the impacts of ozone and increasing levels of carbon dioxide on forests.

Wisconsin's Air Management program has been monitoring ozone concentrations at the Harshaw site since 1994 in collaboration with the biomonitoring staff. A local controversy about the ozone fumigations has prompted the Air Monitoring section to lend the Forest Service five ozone monitors for the duration of the study. Staff from the central office, the monitoring shop and the regions are contributing by assisting the researchers in the design and implementation of the monitoring program to assess dissipation of ozone drifting from the study site. Air Monitoring staff will also be performing critical audits to ensure ozone measurements are accurate. In addition, the FACE study involves the same varieties of aspen trees as the biomonitoring group is using in their studies on ozone effects in southern Wisconsin. This cooperation and collaboration underscores Air Management's commitment to understanding the effects of air pollutants on our environment.

Wisconsin Partners for Clean Air Program Celebrates its First Year

By Melissa Cook, DNR Southeast Region Air Program

A little over a year ago, key business and community leaders were instrumental in forming a steering committee to direct a coalition of businesses, community organizations, and government agencies which would take an innovative approach to improving air quality in southeastern Wisconsin—the Wisconsin Partners for Clean Air program. During the year since it was formed, the program has evolved and earned nationwide respect. To date, over 240 public and private sector organizations have pledged to participate in this program, which seeks voluntary reductions of ozone causing emissions.



Wisconsin Partners for Clean Air celebrated the program's voluntary commitment to reduce air emissions at its first annual meeting on November 18, 1997. A strong business and community turn-out complemented the attendance of high level state and federal environmental officials, including Secretary George Meyer of the Department of Natural Resources; David Kee, Director of Air and Radiation for EPA Region 5; and Deputy Secretary Terry Mulcahy from the Wisconsin Department of Transportation. Over 50 people attended the meeting.

The first part of the meeting focused on accomplishments of the Partners program during the year. Kris McKinney, principal environmental strategist for the Wisconsin Electric Power Company, spoke of the successful efforts of the Point and Area Source Work Group in developing a form for reporting voluntary emission reductions from industrial sources. David Kee expressed EPA's support and interest in using voluntary efforts such as the Partners program to reduce mobile source emissions.

A major portion of the meeting was dedicated to discussing important strategic issues for the future. The Partners Steering Committee recently committed to developing a strategic plan for the program. The planning process will identify key issues and challenges for the program and will assist in developing an action plan to assure achievement of the goals and objectives. The plan intends to integrate the needs of program participants and create a clearer direction for the program as it expands in the years ahead. The annual meeting served as the kick-off for this planning process. The Partners Steering Committee will be involved in the strategic planning process through the winter and spring of 1998, and will include a variety of stakeholders as well as Partners.

While regulatory efforts have contributed to substantially improving air quality, a voluntary program now stands a chance of becoming part of Wisconsin's official plan for further improvements. We hope that as you plan for the year ahead, you include support for the Wisconsin Partners for Clean Air program, so that it may truly have an opportunity to be a successful voluntary effort. If you would like additional information or your organization is interested in joining the Wisconsin Partners for Clean Air program, please call Melissa Cook at 414-263-8751.

New Exhibit Focuses on Ozone Formation

A new, permanent exhibit at the Museum of Science & Industry in Chicago will focus on the role of mobile source emissions and personal actions in the formation of ozone pollution.

The Tour of the Environment exhibit opens May 20, 1998, and will include an interactive learning device to explain and illustrate the relationship between meteorology and ozone. The exhibit will highlight Ozone Action Days and include ozone maps showing ozone formation and transport. It will also include information on acid rain, global climate change and stratospheric ozone depletion.

The Illinois Environmental Protection Agency (IEPA) was awarded a grant by the U.S. Environmental Protection Agency to plan the exhibit in concert with the Museum of Science & Industry. For more information contact IEPA staffers Terry Sweitzer at 217-782-7438 or Brian Urbashevski at 312-814-1028.

Final Round of Permitting Continues

By Lynda Cutts, Bureau of Air Management

The Operation Permit Program is continuing to accept applications in its final round of permitting. Smaller sources of air pollution which are not exempt from permitting have been submitting State Operation Permit (SOP) applications since July 1997 (see Air Matters, Fall 1997). Any business which paints, coats, glues, prints, heats, cleans, sands or grinds may need a permit.

Operation permit applications for larger sources needing Federal Operation Permits (FOPs) and Federally Enforceable State Operating Permits (FESOPs) were due in 1994 and 1995. Due dates for SOP applications are staggered by county. All applications must be submitted by December 1, 1998 (see sidebar).

A one-time extension of up to 60 days may be granted upon written request. Requests may be sent to Renee Lesjak Bashel at Wisconsin DNR, Bureau of Air Management, PO Box 7921 (AM/7), Madison, WI 53707-7921. Specific questions about the SOP program may be directed to Cindy Brandt at the DNR's Peshtigo office at 715-582-5021.

Workshops underway

The Bureau of Air Management and the Small Business Clean Air Assistance Program (SBCAAP) in the Wisconsin Department of Commerce have been collaborating on half-day workshops called "Clearing the Air on Air Permits." Registration is free for affected facilities.

Workshops have already been held in Stevens Point, Rice Lake, Green Bay, Menomonie, Platteville, Milwaukee, Tomahawk, Waukesha and Superior, and participants have found them "very useful." Another workshop is planned for May or June in the Madison area. To register for that workshop or get more information, call Pam Christenson at SBCAAP at 608-267-9214 or Lynda Cutts at 608-266-0244.

Counties with upcoming permit application deadlines

June 1, 1998
Milwaukee, south of Wisconsin Avenue

July 1, 1998
Brown, Dodge, Green Lake, Marathon and Marquette

August 1, 1998
Bayfield, Chippewa and Douglas

September 1, 1998
Milwaukee, north of Wisconsin Avenue

October 1, 1998
Winnebago

November 1, 1998
Dane and La Crosse

December 1, 1998
Waukesha, and portable sources located anywhere throughout the state

Where's the Air? CD-ROM Debuts

By Jennifer Gundry, DNR Bureau of Communications & Education

An interactive CD-ROM kit on air quality called *Where's the Air?* is now available from the Wisconsin Department of Natural Resources.

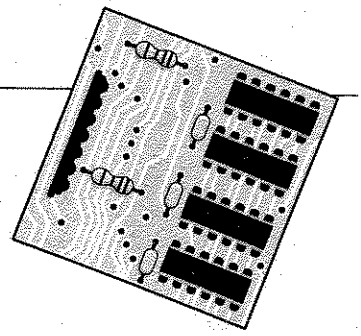
Developed in collaboration with the Wisconsin Department of Transportation, *Where's the Air?* was created for educators and their students ages 10 and up. Activities and resources in the kit will help students investigate stratospheric ozone, tropospheric (ground-level) ozone, biomonitoring, and other air quality issues. The CD-ROM includes two interactive games that allow students to make choices that have a positive or negative impact on air quality. In addition to the CD-ROM, the kit includes a poster, teacher's activity guide and other supplemental study materials.

The Department's educational website, Environmental Education for Kids!—EEK! (**http://www.dnr.state.wi.us/eek/**), will also feature supplementary air quality material this spring.

To find out how to order *Where's the Air?* contact: Air Education, CE/6, PO Box 7921, 101 S. Webster St., Madison WI, 53707-7921, phone 608-266-6790, fax 608-264-6293. You may also send an e-mail to Sara Burr at **burrs@dnr.state.wi.us.**

Technology Review:

Changed Assembly Process, New Glue Mean Fewer Emissions for Green Bay Manufacturer



By Anne Urbanski, Bureau of Air Management

Innovation is one of the keys to both pollution prevention and cost savings. Thanks to its innovative approach to reducing several types of air emissions, Krueger International (KI) recently merited a Prevention/Environment/Prosperity (P/E/P) award from the Wisconsin Department of Natural Resources.

Established in Aurora, Illinois, in 1941, to manufacture folding chairs, KI now produces complex office furniture systems; office chairs; seating for airports, universities and theaters; and dollies for storing tables and stacking chairs. The company employs over 3,000 people at several facilities in the United States and abroad.

KI's corporate culture stresses environmental responsibility, and company management became concerned about emissions of volatile organic compounds and hazardous air pollutants as well as potential employee exposure to hazardous materials. The company also wanted to redirect time and money away from personal protective equipment, training, industrial hygiene monitoring and cleanup of air and waste discharges and toward other environmental, safety and health concerns.

The company decided that reducing its air emissions would require changing the assembly process and commissioning its glue supplier, H.B. Fuller Co., to formulate a new, environmentally friendly glue. Five different solvent-based glues were replaced with a water-based glue called Hydrophuse. Some of KI's products had required pretreatment of plastic parts with a flex primer before applying the old glues. The new glue eliminates the need to pretreat plastic parts as well as the need to use petroleum-based solvents for cleanup.

KI's old solvent-based glues dried as a result of solvent evaporation. Now the company uses two processes, depending on the needs of the product and process, to drive water out of the assembled product. The new glue and new processes required KI to install infrared ovens and vacuum presses to drive water out of the glue, as well as new stainless-steel piping and pumping systems to convey the glue and 10 new ventilation systems to properly capture and control the new adhesive.

Overall benefits of new system

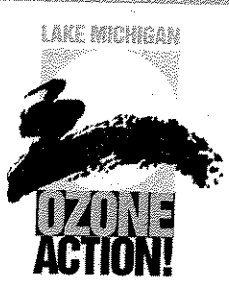
The new system enabled KI to avoid almost $1.5 million in installation and startup costs for new equipment to control emissions of volatile organic compounds. The new system also reduced VOC emissions almost 82% between 1994 and 1996. This resulted in reducing the company's emission fees as well as changing its emission status from "major source" to "synthetic minor source." During the same period, KI's hazardous air pollutant emissions dropped 92.4% while particulate matter emissions dropped almost 74%.

While the company has incurred higher labor costs for training and maintenance, it has significantly reduced operating costs for waste handling and transportation as well as for VOC emission control equipment. KI also recycles its process water in several ways, which reduced its water consumption over 50% in just three years. The company estimates its overall cost savings at over $821,000 per year, following initial capital costs of about $223,000.

KI's technology is transferable and is currently being used by other businesses throughout the United States and abroad. The new glue, while developed for KI, is now available for a broader market and is being used by six other Wisconsin firms as well as several on the west coast and in Europe.

To obtain a copy of the DNR's pollution prevention case study on Krueger International (publication CO-084-98) contact the DNR Bureau of Cooperative Environmental Assistance, PO Box 7921, Madison, WI 53707, phone 608-267-9700. For more information about KI's operations, contact Dan Schmidt, Environmental Health and Safety Engineer, Krueger International, PO Box 8100, Green Bay, WI 54308-8100, phone 920-468-8100, ext. 2401. ❖

Summer is right around the corner



On Ozone Action Days, try to:

- ❖ carpool or take the bus to work,
- ❖ fill your gas tank after 6 p.m.,
- ❖ postpone lawn mowing, and
- ❖ reduce travel.

Every little bit counts—please do your share for cleaner air!

Air Rules Update

By Robert Park,
Bureau of Air Management

Since the Winter 1998 issue of Air Matters three rules have been added to the Rules Calendar. These rules have to do with the new federal ambient air quality standard for fine particulates ($PM_{2.5}$), an increase in fees for air permits, and new federal test methods for measuring capture efficiencies in the control of volatile organic compound emissions from surface coating operations. The volume and complexity of the work associated with updating the hazardous air pollutant rules has caused this rule package to be postponed until next year.

Air Management Rules Calendar

As of MARCH 23, 1998

Devel. Rank	Wis. Admin. Code, NR	Subject	Hearing Authorization	Public Hearing	Board Adoption	Effective Date
1	445	Update of hazardous pollutant rules	4/99	6/99	10/99	3/2000
2	400,423	Update of perchloroethylene rules	10/98	1/99	4/99	9/99
3	404	Fine particulates ($PM_{2.5}$)	10/98	1/99	3/99	8/99
4	466	MACT for printing & publishing industry*	(30 day notice procedure)		10/98	5/99
5	410	Fees revision	6/98	9/98	12/98	5/99
6	439	Capture efficiency test methods	6/98	8/98	10/98	3/99
7	400-499	NR 400 series cleanup changes	6/98	8/98	10/98	3/99
8	487	Clean Fuel Fleet Program implementation delay	1/98	4/98	6/98	11/98
9	485	I/M final emission limit revision	10/97	11/97	5/98	10/98

The rules listed above are currently under development at the Department of Natural Resources, Bureau of Air Management. Rules are ranked in order of progress to promulgation, higher numbers indicating further development. Dates not printed in blue, bold-faced type are projected dates, subject to change. To obtain a copy of a particular proposed rule and supporting documents when prepared as a Natural Resources Board item ("green sheet") or a copy of the public hearing notice, contact Robert Park, Air Program Rules Coordinator, at 608-266-1054, or via Internet e-mail at **parkr@dnr.state.wi.us**. Some of the draft rules are also available for downloading from the Environmental Programs section of the DNR Gopher on the Internet.

* Rule to meet federal Clean Air Act requirements.

It's Coming Soon...Will It Affect You??

By Jerry Medinger,
Transportation Section
DNR Southeast Region

Yes, it's coming soon. And it's getting closer. The year 2000? The new Milwaukee Brewers stadium?? Yes to both. But the real answer is—the Clean Fuel Fleets Program, which is required in certain areas by the federal Clean Air Act Amendments of 1990.

The Clean Fuel Fleets program affects all public and private fleets that have 10 or more vehicles below 26,000 pounds Gross Vehicle Weight Rating (GVWR) that are capable of being fueled at a central location and that are used in any of six southeastern Wisconsin counties (Kenosha, Racine, Milwaukee, Waukesha, Washington or Ozaukee). While certain types of vehicles are exempt from program requirements—law enforcement, emergency vehicles and rental agency fleets, to name a few—the new rule may have an impact on your organization's future plans for acquiring fleet vehicles. Beginning with model year 1999, a certain percentage of all new covered fleet vehicles acquired through purchase or lease must be clean fuel vehicles.

To find out if the Clean Fuel Fleet program applies to your operation, or to learn about upcoming informational workshops, contact Jerry Medinger at the DNR Southeast Region office, phone 414-263-8643, or e-mail

meding@dnr.state.wi.us

or Muhammed Islam, DNR Bureau of Air Management, phone 608-264-9219 or e-mail

islamm@dnr.state.wi.us

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This newsletter is available upon request in alternate formats for visually impaired persons. Please call Anne Urbanski at 608-267-0573 to request an alternate format.

The Wisconsin Department of Natural Resources provides equal opportunity in its employment, programs, services and functions under an Affirmative Action Plan. If you have any questions, please write to: Equal Opportunity Office, U.S. Department of the Interior, Washington, DC 20240.

May is Clean Air Month

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