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1980 Ambient Assessment-Air Portion

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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

The Air Portion focuses on three principal categories--current air quality status and trends for the major pollutants, the new air monitoring strategy, and a detailed analysis of the pollutant ozone. The current air quality status and trends chapter (Chapter 2) deals with the major pollutants: total suspended particulates (TSP), sulfur dioxide (SO_2), carbon monoxide (CO) and nitrogen dioxide (NO_2). Ozone is treated in greater depth in Chapter 4. The report is limited to dealing with the criteria pollutants only and does not address acid deposition, toxic chemicals, and other air pollutants of concern. The principal reason for this is the recommendation in last year's report that comprehensive, multi-pollutant, environmental reports are not necessary more than once every three years. Reports in intermediate years should focus on a comprehensive analysis of particular pollutants or information problems of primary interest to the Agency. Since last year's Administrator's Report was comprehensive, covering many pollutants, this report falls within an intermediate year and follows this recommendation.

The statistical analyses which have been undertaken in Chapter 2, Current Air Quality Status and Trends, and Chapter 4, An Examination of Ozone, comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators. The Task Force was established in January 1980 to recommend standardized air quality indicators and statistical methodologies for presenting air quality status and trends. Its members represent the EPA Offices of Air, Noise, and Radiation; Planning and Management; and Research and Development; as well as EPA Region 5. Also participating were representatives from the President's Council on Environmental Quality, the Office of Water and Waste Management, and EPA Region 4. Statistical summaries of pollutant-specific analyses are presented in Appendix A and in the text of Chapter 4.

1.2 MAJOR FINDINGS

The major findings of the Air Portion of the Report on Ambient Monitoring are summarized by chapter as follows:

o CURRENT AIR QUALITY, STATUS AND TRENDS FOR MAJOR POLLUTANTS

Total Suspended Particulate (TSP) - Ambient levels of TSP decreased 32 percent during the 20-year period from 1960 to 1979. From 1970 to 1979, particulate emissions decreased 50 percent due to the control of industrial emissions. Actual measurements of air quality during this period did not show the same rate of improvement, however. The difference is attributed to low-level fugitive emissions from industry and to windblown dust.

Sulfur Dioxide (SO_2) - Levels in SO_2 in the Nation's urban areas decreased 67 percent between 1964 and 1979. Improvement was most rapid between 1966 and 1971 due to an increased use of cleaner burning fuels in the residential, commercial, and industrial sectors of most urban areas. Local and state air pollution regulations led to a switch from coal and high sulfur oil to natural gas and low sulfur oil. Between 1970 and 1979 national average ambient SO_2 levels dropped 44 percent, with a corresponding 7 percent decrease in sulfur oxide emissions during this time. The greater improvement in ambient SO_2 levels reflects SO_2 trends in urban areas, where most of the emission reductions have taken place. Emission reductions in urban areas were offset with new sources, such as large fossil fuel power stations, located in rural areas.

Carbon Monoxide (CO) - Nationally, ambient CO levels in center-city locations showed a steady decline of approximately 6 percent per year or an overall reduction of 36 percent between 1972 and 1979. In contrast, CO emissions show only a 7 percent decrease since 1972. The smaller reduction in CO emissions is largely due to a 35 percent increase in total vehicles miles travelled since 1970. The improvement in average CO concentrations is greater than the reduction in CO emissions because the trend reflects levels at traffic-saturated monitoring sites in the center-city.

Nitrogen Dioxide (NO_2) - Ambient NO_2 levels increased 15 percent between 1975 and 1979 at 180 sites, corresponding to a 12 percent increase in emissions. The increase in emissions is due to an increase in emissions from motor vehicles and electric utility generating plants. While this trend is cause for concern, it is important to realize that only 3 percent of the nitrogen dioxide measurements at 933 sites with acceptable data exceeded the health-related standard in 1979.

o IMPROVING THE AIR MONITORING STRATEGY

The existing criteria pollutant air monitoring strategy will vastly improve the quality and representativeness of ambient monitoring data being collected by State and local air pollution control agencies. By January 1981, over 95 percent of the National Air Monitoring Stations (NAMS) will be fully adhering to the Part 58 monitoring regulations with respect to network design, siting, and quality assurance. Additional efforts, however, are needed to improve the way data are used by EPA and State officials in decision making.

The technical basis for establishing attain/nonattainment boundaries needs to be strengthened to minimize inconsistencies which result among States and Regions. More refined data analysis techniques must be developed and used in determining air quality trends and progress in attaining NAAQS. The following specific actions are being pursued:

Expand Data Base in One to Three Urban Areas - The purpose is to establish an enhanced long-term data base (air quality, emissions, and meteorology) to be used in pinpointing the effects of source control and for refining and validating diffusion models. EPA would provide funds to participating state or local agencies to purchase and operate monitors necessary to supplement the established NAMS/SLAMS network and to periodically update the emission inventory. State or local agencies would be direct participants with EPA in the design of the studies and share in the analysis and interpretation of monitoring information. The anticipated benefits of the cooperative effort would be a more sound technical basis for using and interpreting air quality and modeling information and improved NAAQS reviews.

Expand Program to Improve Models

- Continue a program of formal review of air quality simulation models by the scientific and air quality management communities. The objectives of the review are to insure that the models are founded on sound scientific bases and function in an efficient, cost-effective manner to insure that appropriate new and superior models are promptly incorporated into the analytical system. As models are developed which adhere to accepted theoretical and objective measures of performance, they will be incorporated into guidelines for models and in regulations.

- Develop performance standards and performance measures for dispersion models to provide an objective method of determining model reliability for specific applications.

Expand Guidance for Interpreting and Using Monitoring/Modeling Data - To reduce inconsistency in the uses of monitoring and modeling data and to improve the technical bases for decision-making, additional guidance will be developed. The guidance will focus on when and how to use monitoring and modeling data to arrive at conclusions on attainment/nonattainment, on establishing emission control targets to achieve NAAQS and in reviewing the impact of sources. Additional emphasis will be given to developing and improving data analysis and the use of probability concepts in decision-making.

Improve Monitoring Modeling Coordination

- SAMWG has been reestablished as a vehicle for identifying and resolving technical and administrative problems involving the use of monitoring data. SAMWG will assume an important role in developing and reviewing workable monitoring and data interpretation guidelines for air program managers at the Federal, state, and local levels.

-EPA Regions will be asked to participate more fully in developing and implementing monitoring policies.

Develop a Non-Criteria Air Pollutant Air Monitoring Strategy - The strategy will summarize the state of knowledge about monitoring methods and quality assurance practices and outline a plan for monitoring specific pollutants, sources, and geographic areas. A draft strategy report will be available by February 1981.

o AN EXAMINATION OF OZONE

Monitoring Status

- In 1979, ozone monitors at 475 sites in 282 counties across the nation collected at least 50 percent of the possible days in the ozone season. The majority of these counties are in major metropolitan areas. Approximately 111 million people live in the 282 counties or 54 percent of the 1970 total U.S. population. Of these people, 81 million (73%) live in counties where ozone levels were above the standard in 1979.

- Seventy-seven of the 282 counties did not violate the ozone standard over the 4-year period 1976-1979.

- A comparison of counties east and west of the Mississippi River in 1979 shows 110 of 188 counties (59%) exceeding the standard in the East and 45 of 94 counties (48%) exceeding the standard in the West.

Air Quality and Emission Trends

- While no long-term nationwide ozone trend is revealed in the 6-year period, 1974-1979, a short-term decrease of 5 percent is observed between 1978 and 1979.

- Most of the decrease took place in the Midwest, principally the EPA Region 5 states (Ohio, Indiana, Illinois, Wisconsin, Minnesota and Michigan). The median percent change in the EPA Region 5 states was 11.1 percent. The large improvement in ozone levels in Regions 5 appears to be due to a combination of factors: more conducive meteorological conditions for ozone formation in 1978, calibration changes, changes in quality assurance procedures, and reductions in emissions.

- Outside Region 5 there appears to be no difference between the groups of sites where calibration was or was not a factor. The overall median percent change for the non-Region 5 sites is 3.1 percent, a value consistent with the 2.5 percent decrease in estimated nationwide VOC emissions.

Technical Issues Associated with Ozone SIP's

- In July 1982, 37 nonattainment areas that sought an extension to 1987 to attain the ozone standard will be required to submit revised SIP's. States are currently in the process of collecting a good data base to develop SIP's.

- Because of the complex nature of ozone, it has been difficult to develop the technical tools needed to fully implement the air resource management approach, which is prescribed by the Clean Air Act for SIP development.

- For various reasons, ozone models are limited and not widely accepted. High priority Agency efforts have resulted in an improved model (e.g., the Empirical Kinetic Modeling Approach (EKMA) having been recently proposed by EPA for use in 1982 ozone SIP development.

- Validated photochemical dispersion models are generally believed to be theoretically superior to other ozone models. However, photochemical dispersion models are data intensive and their results are affected by errors inherent in the data input required by the model.

- The Northeast Regional Modeling Project (NERMP) is a multi-year, multi-million dollar effort designed to better define the ozone transport problem in the North East Corridor, and to develop control strategies to provide for attainment. The data collection phase of the project is currently underway. Modeling results are projected to be available by 1986.

2. CURRENT AIR QUALITY STATUS AND TRENDS FOR MAJOR POLLUTANTS

This chapter focuses on the current air quality status and trends of the major pollutants: total suspended particulate (TSP), sulfur dioxide (SO_2), carbon monoxide (CO) and nitrogen dioxide (NO_2). Ozone is treated in greater depth in Chapter 4. The report deals with these criteria pollutants only and does not address acid rain, toxic chemicals, carcinogens, and other air pollutants which are now of mounting environmental concern.

The following sections discuss the current air quality and emission trends by pollutant, their significance in terms of health, and the effectiveness of various pollution abatement programs.

2.1 TOTAL SUSPENDED PARTICULATES

Total suspended particulate matter is the general term for particles found in the atmosphere. In addition to soot and dust, particulates are composed of organic matter and compounds containing sulfur, nitrogen, and metals. Since particles are formed in the air as a result of various chemical and physical processes, the chemical composition of particulates varies widely according to location and time of year.

Ambient levels of total suspended particles decreased 32 percent during the 20-year period from 1960 to 1979, an improvement of about 2 percent per year. From 1970 to 1979, particulate emissions decreased 50 percent due to the control of industrial emissions. Actual measurements of air quality during this period did not show the same rate of improvement, however. The difference is attributed to low-level fugitive emissions from industry and to windblown dust, factors which are difficult to quantify and do not usually appear in emission inventories. Dust levels remain fairly stable over time.

Some sections of the country show more improvement than others. The Northeast, Great Lakes, and Southern states show high rates of improvement, while Western states show little change. In the West, agricultural and natural sources continue to be major contributors of windblown particulates.

Despite the improvements, total suspended particulates remain a problem. Approximately 21 percent of the Nation's population live in areas where the annual standard is exceeded. Although there has been a nationwide decrease in levels of total suspended particulate matter, there is evidence that atmospheric levels of particulates in some size ranges are increasing. This is indicat-

ed by the increasing levels of small particulates such as sulfates, and the deterioration of visibility in the Southwest and non-urban areas of the East. These patterns are consistent with the growth of emission sources outside large metropolitan areas.

2.1.1 NATIONAL TREND IN AVERAGE PARTICULATE LEVELS, 1960-1979

Figure 2-1 shows year-by-year changes in average ambient particulate levels based on measurements taken throughout the country. Nationally, ambient particulate levels measured in 95 urban areas with a long history of data dropped dramatically between 1960 and 1971. This was followed by a more gradual decline from 1972 to 1979, as measured at more than 3000 monitoring sites. The rapid improvement in the late 1960's was largely due to the emission control programs of state and local air pollution control agencies. The improvement in air quality during the 1970's is due mainly to control of traditional particulate sources such as fuel combustion, solid waste disposal operations, and industrial process emissions. The slight reversal in the downward trend in 1976 is believed to be due to an increase in windblown dust caused by abnormally dry weather.

2.1.2 NATIONAL TREND IN PARTICULATE EMISSIONS, 1970-1979

The dramatic 50 percent reduction in particulate emissions from 1970 to 1979 (Figure 2-2) results largely from installation of control equipment on industrial processes, reduced coal burning by non-utility users, installation of control equipment by electric utilities that burn coal, and a decrease in the burning of solid waste.

2.1.3 COMPARISON OF PARTICULATE LEVELS

Currently, 395 counties (or county equivalents) are classified as nonattainment for TSP. Of the 45 urbanized areas with populations above 500,000 that monitored TSP, 33 (73%) exceeded the NAAQS for TSP in 1979 (Figure 2-3). Five of these urbanized areas had annual average TSP concentrations exceeding 150 $\mu g/m^3$ (double the NAAQS level of 75 $\mu g/m^3$).

2.2 SULFUR DIOXIDE

Sulfur dioxide (SO_2) is one of a number of sulfur-containing compounds found in the atmosphere. Although SO_2 enters the air primarily from the burning of coal and oil, it is also produced by various other industrial processes.

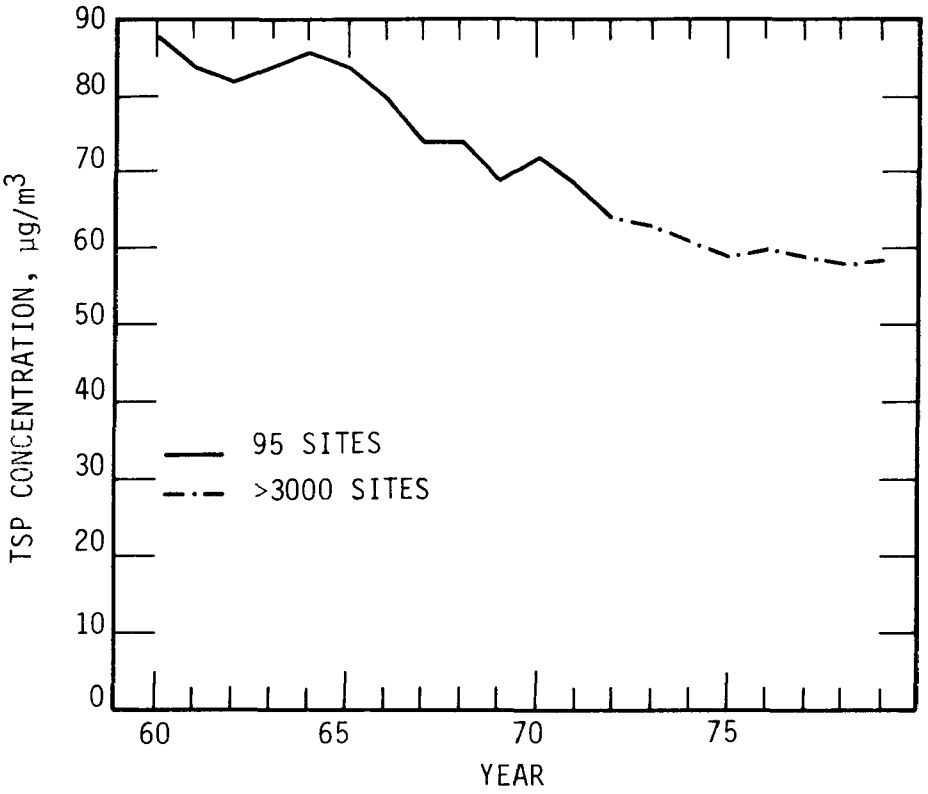

Figure 2-1. National trend in average particulate levels, 1960-1979.

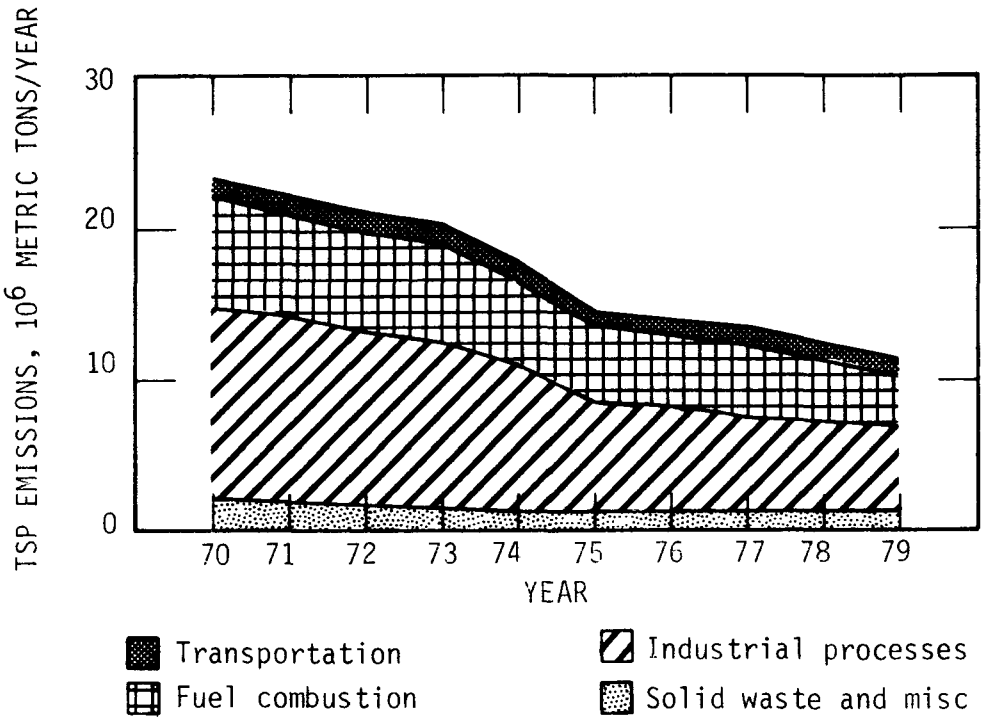

Figure 2-2. National trend in particulate emissions, 1970-1979.

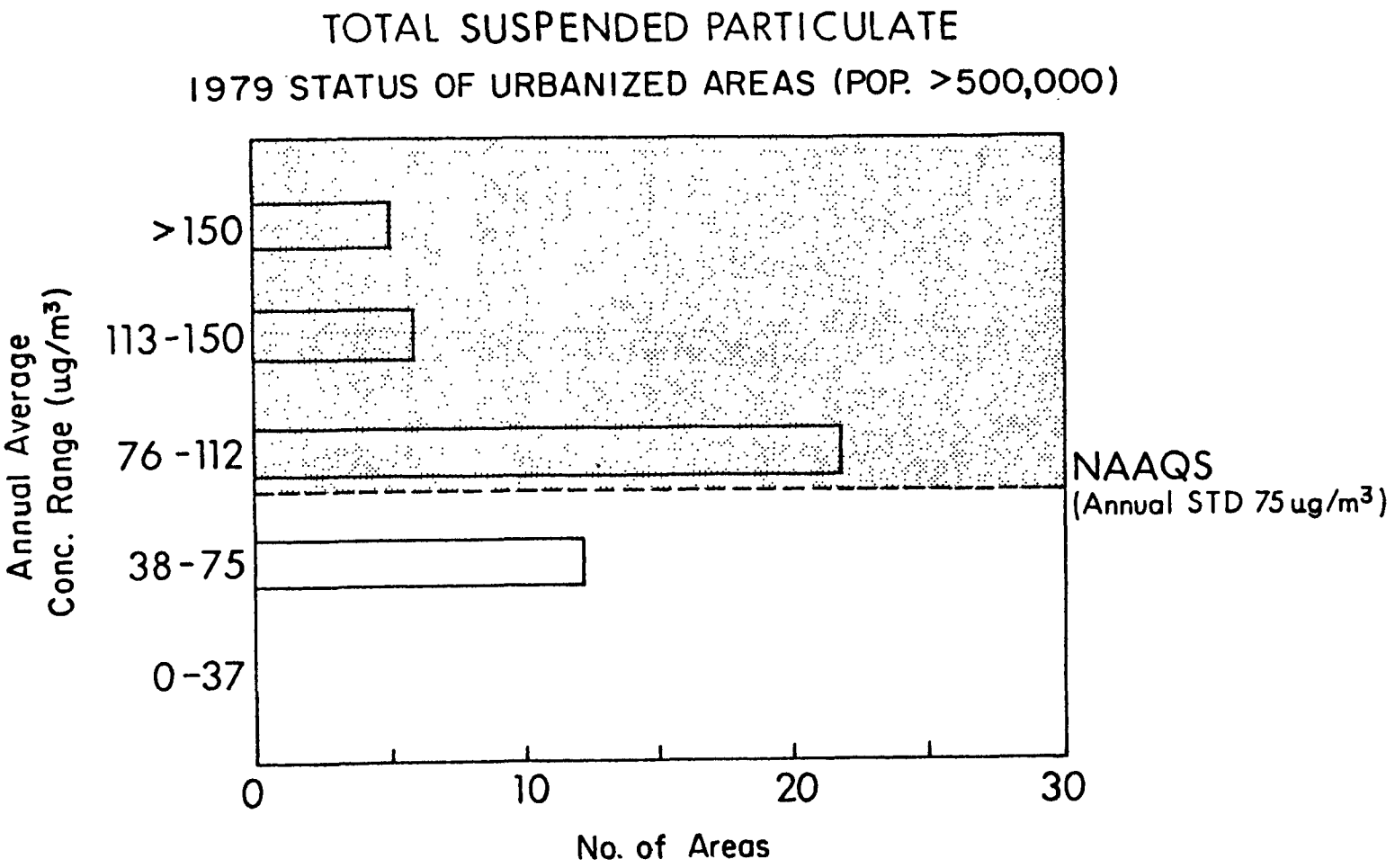

Figure 2-3. Comparison of 1979 particulate levels in urban areas with populations greater than 500,000.

Levels of SO_2 in the air over the Nation's urban areas decreased by 67 percent from 1964 to 1979. Improvement was most rapid from 1966 to 1971 because of an increased use of cleaner burning fuels in the residential, commercial, and industrial sectors of most urban areas. Local and state air pollution regulations led to a switch from coal and high sulfur oil to natural gas and low sulfur oil. Between 1970 and 1979 the improvement continued with the national average SO_2 levels dropping 44 percent. A corresponding 7 percent decrease in sulfur oxides emissions was observed between 1970 and 1979. The greater improvement in ambient levels reflects SO_2 trends in urban areas, where most of the emission reductions have taken place. Partially offsetting the emission reductions in the urban areas was the location of new sources, such as fossil fuel power stations, in rural areas.

Nationally, the urban SO_2 problem has diminished to the point that only a small number of urban areas now exceed the air quality standard. Some regions outside major urban areas continue to have high SO_2 because of single sources, such as non-ferrous smelters. Today, these individual sources pose the greatest obstacle to the attainment of air quality standards for SO_2.

2.2.1 NATIONAL TREND IN AVERAGE SULFUR DIOXIDE LEVELS, 1965-1979

Nationally, annual average SO_2 levels measured at 32 urban locations declined significantly from 1966 to 1971. This was followed by a more gradual decline from 1972 to 1979 as measured at more than 1000 monitoring sites (Figure 2-4). The improvement in air quality during the first half of this period is due mainly to (1) the change from coal with a high sulfur content to natural gas, electricity, and low sulfur oils for residential and commercial space heating; (2) strict local emission regulations, which caused the reduction in sulfur content of coal and fuel oil or required the installation of control equipment to remove sulfur; and (3) the location of major new sources, such as fossil-fuel burning power plants, away from urban areas. In recent years, most urban areas have attained the SO_2 standards and are now working to maintain these lower levels rather than reduce sulfur oxide emissions further.

2.2.2 NATIONAL TREND IN EMISSION OF SULFUR OXIDES, 1970-1979

Sulfur oxides emissions declined 7 percent from 1970 to 1979 (Figure 2-5). The moderate decline in emissions corresponds to a considerable reduction in SO_2 levels in urban areas. This difference between emission and air quality

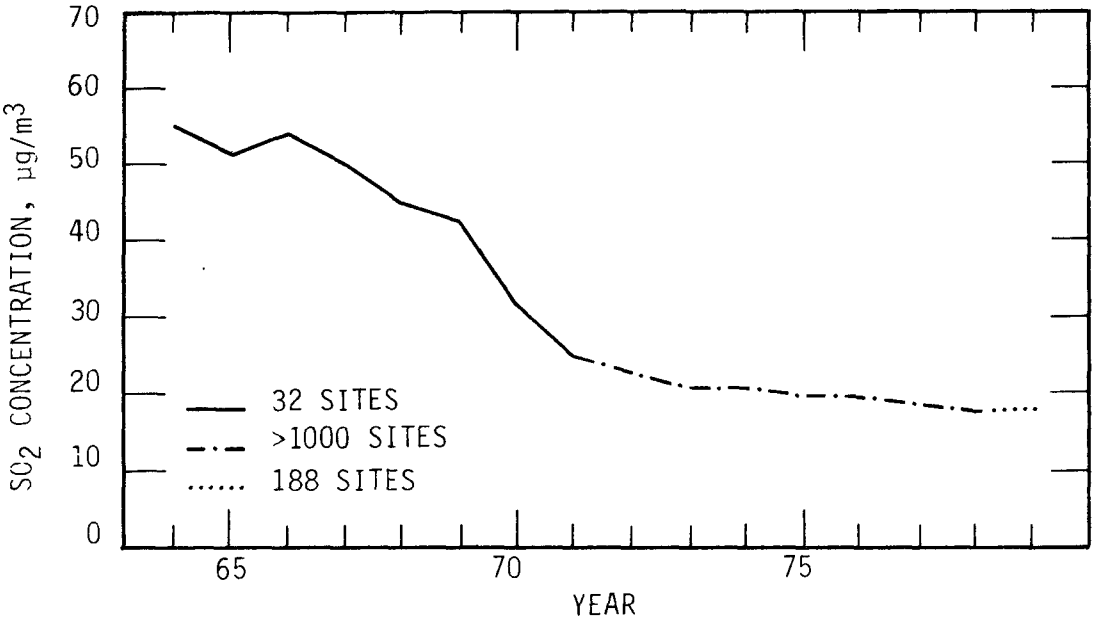

Figure 2-4. National trend in average sulfur dioxide levels, 1964-1979.

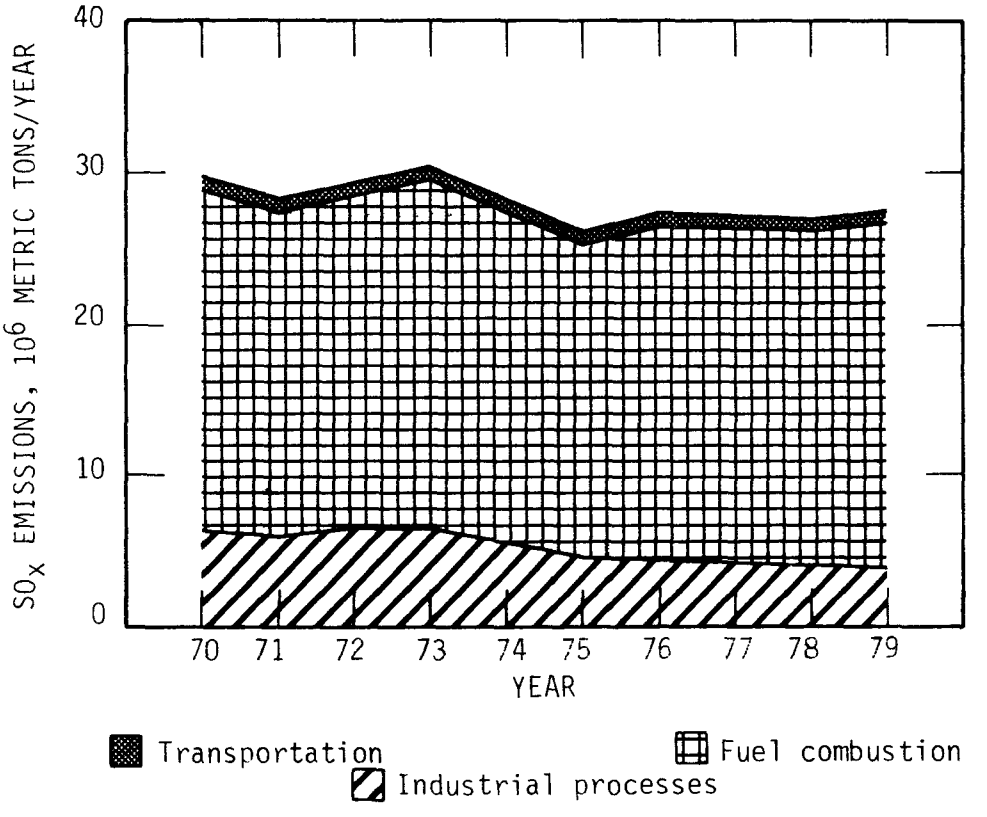

Figure 2-5. National trend in emissions of sulfur oxides, 1970-1979.

trends arises because the use of high sulfur fuels has shifted from urban areas to a growing number of sources outside of densely populated areas where there are few other sources.

2.2.3 COMPARISON OF SULFUR DIOXIDE LEVELS

There are 97 counties (or county equivalents) which are currently classified as nonattainment for SO_2. Of the 45 urbanized areas with populations above 500,000 that monitored SO_2, only 6 (13%) exceeded the 24-hr NAAQS of 365 $\mu g/m^3$ in 1979 (Figure 2-6). Peak 24-hour average values of 182 $\mu g/m^3$ or less were recorded in 20 (44%) of the urbanized areas.

2.3 CARBON MONOXIDE

Carbon monoxide (CO) is a byproduct of the incomplete burning of fuels-mostly by cars and trucks. CO is also released by some industrial processes. In some urban areas, automobiles and other modes of transportation are responsible for over 99 percent of these emissions, although any city with heavy traffic may have a potential problem from CO. In some cases, the problem is highly localized with only a few street corners experiencing high CO levels. In other cases, the problem is spread throughout the center-city area and along major commuter corridors.

Nationally, ambient CO levels in center-city locations have shown a steady decline. From 1972 to 1979 CO levels dropped at a rate of 6 percent per year with an overall reduction of about 36 percent. The greatest improvements occurred at sites traditionally having the worst CO problem. Estimates of nationwide CO emissions from highway vehicles, in contrast, show only a 7 percent decrease since 1972. The smaller reduction in CO emissions is largely due to a 35 percent increase in total vehicle miles travelled since 1970. The improvement in average concentrations is greater than the reduction in CO emissions, because the trend reflects levels at traffic-saturated monitoring sites in the center city. These sites have recorded little or no change in vehicle miles travelled. Therefore, the ambient CO trend reflects the reduction in emissions from new cars brought about by federal standards on vehicle emissions.

2.3.1 NATIONAL TREND IN AVERAGE CARBON MONOXIDE LEVELS, 1972-1979

Figure 2-7 shows year-by-year changes in annual average CO levels at 221 urban sites over the 8 year period, 1972-1979. Carbon monoxide levels

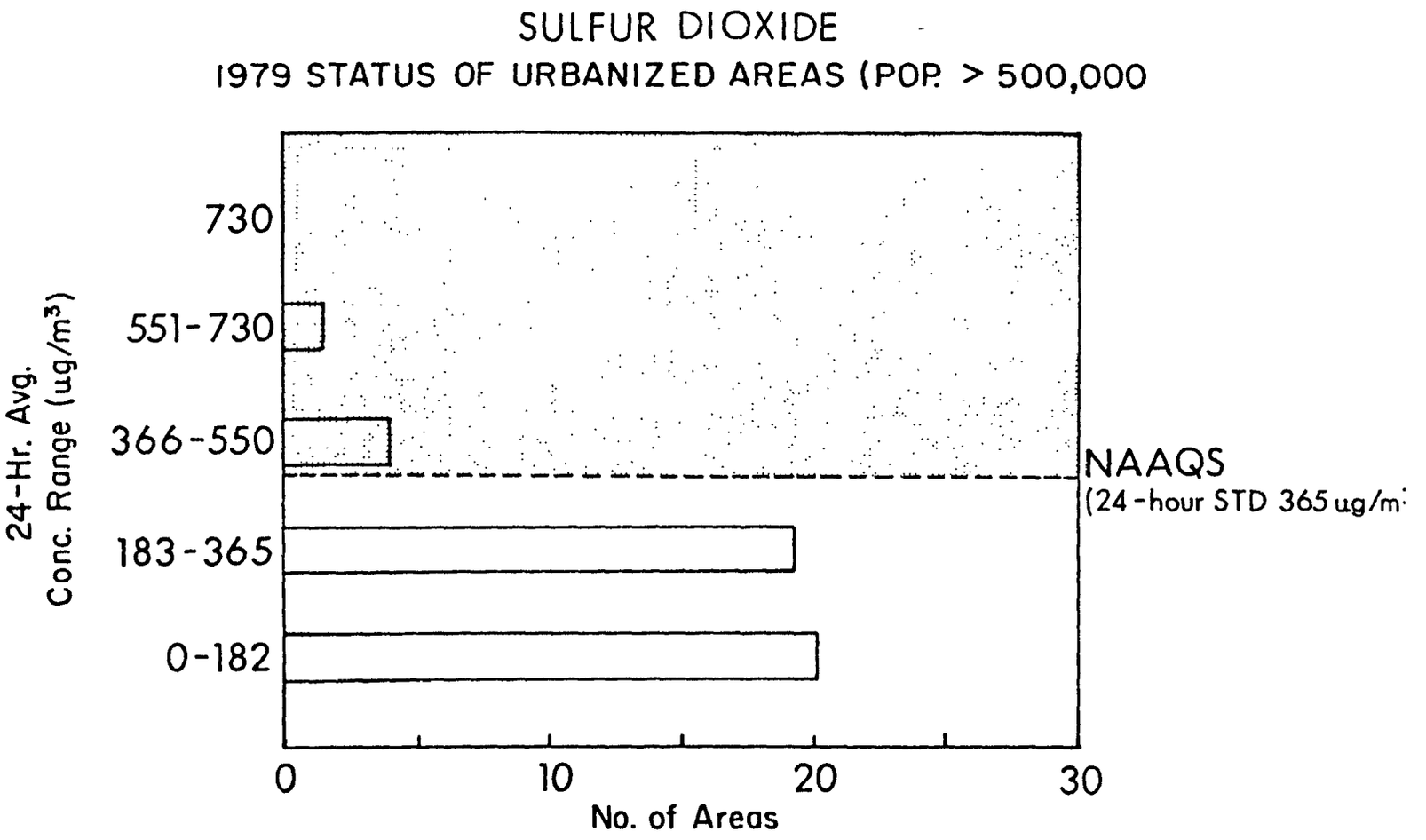

Figure 2-6. Comparison of 1979 sulfur dioxide levels in urban areas with populations greater than 500,000.

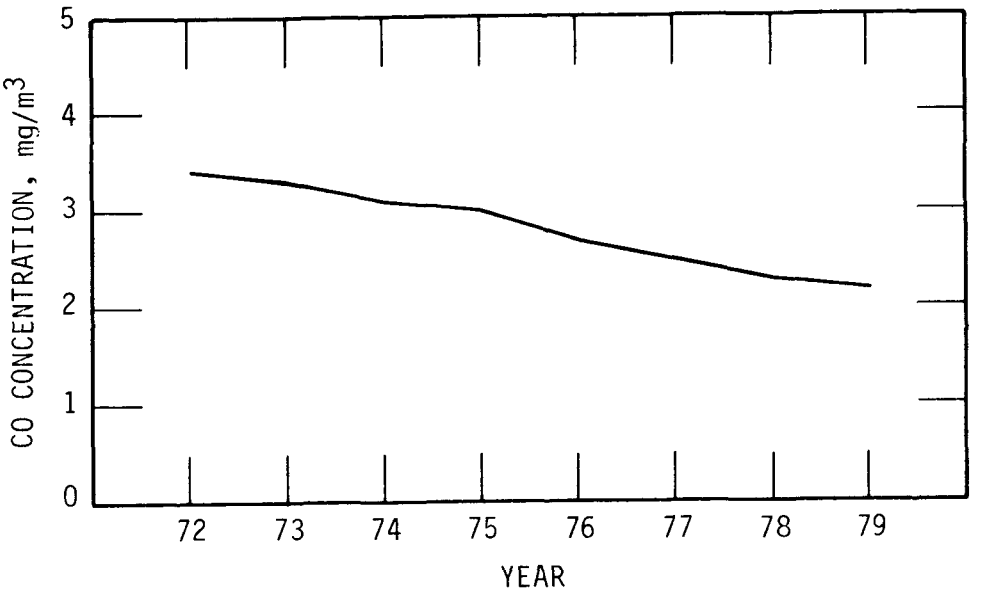

Figure 2-7. National trend in average carbon monoxide levels, 1972-1979.

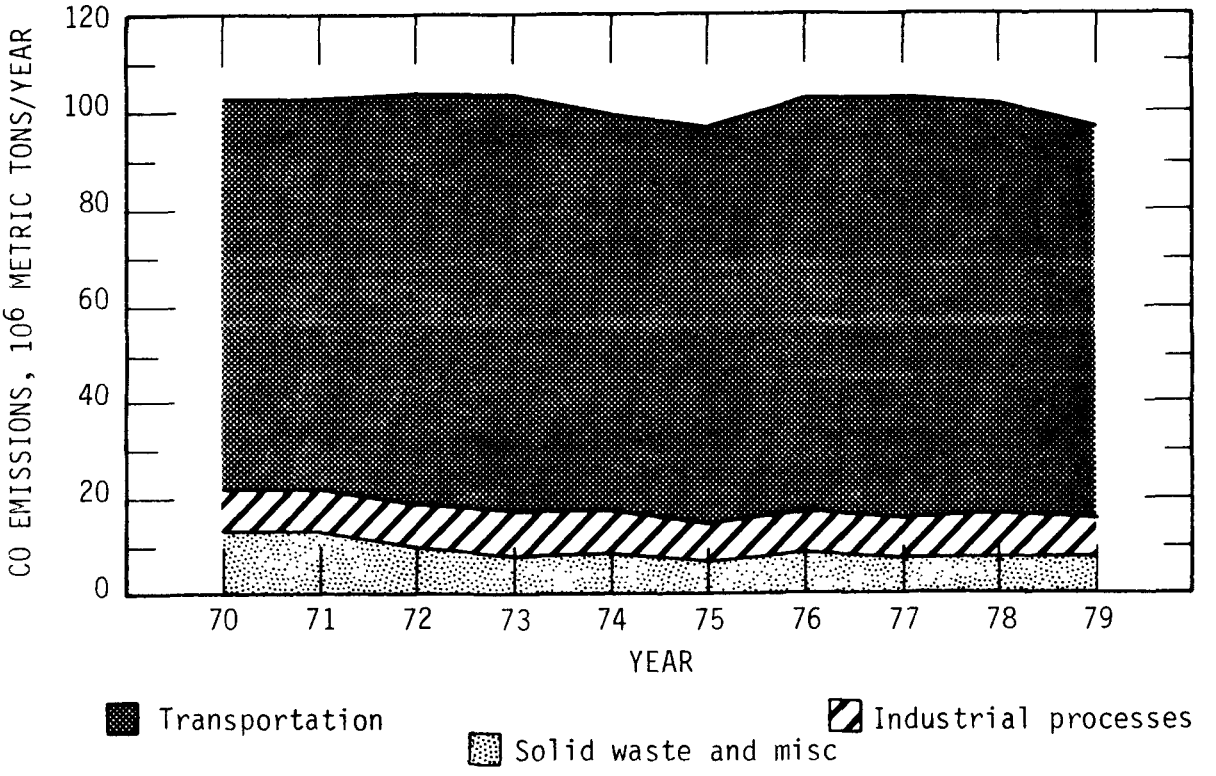

Figure 2-8. National trend in emissions of carbon monoxide, 1970-1979.

improved at a rate of 6 percent per year with an overall reduction of about 36 percent. The improvement reflects levels at traffic-saturated monitoring sites in the center-city. Since these sites have experienced little or no change in the number of vehicles in their vicinity, the improvement in CO levels reflects the reductions in emissions from new cars brought about by federal standards on vehicle emissions.

2.3.2 NATIONAL TREND IN EMISSIONS OF CARBON MONOXIDE, 1970-1979

Carbon monoxide emissions in 1979 were 7 percent lower than in 1972 (Figure 2-8). Highway vehicles are the main source of this pollutant, and there was an increase of 35 percent in total vehicle miles travelled during this period. The increase in traffic offset the decrease in emissions per car achieved by recent pollution control measures. Outside transportation, relatively small reductions in CO emissions were observed in the solid waste disposal and agricultural burning categories.

2.3.3 COMPARISON OF CARBON MONOXIDE LEVELS

Currently, 161 counties (or county equivalents) are classified as nonattainment for CO. In 1979, 45 urbanized areas with populations above 500,000 monitored CO; of these, 28 (61%) exceeded the 8-hour NAAQS (Figure 2-9). Five urbanized areas recorded peak 8-hour average values exceeding 18 ppm (double the NAAQS level of 9 ppm).

2.4 NITROGEN DIOXIDE

Nitrogen dioxide (NO_2) is one of a family of nitrogen oxides. The oxides important to air pollution control usually come from high-temperature combustion. Nitrogen dioxide plays a major role in the atmospheric reactions which produce photochemical oxidants (smog) and is primarily responsible for smog's yellow-brown color.

From 1975 to 1979, NO_2 levels increased about 15 percent at 180 trend sites while emissions for the same period were up 12 percent. In 1979, only 3 percent of the NO_2 measurements at 933 sites with acceptable data exceeded the health-related ambient air quality standard.

Most of the increase in NO_2 emissions came from motor vehicles and electric utility generating plants. Although the emission rates for motor vehicles and generating plants have been steadily reduced, increased demands for trans-

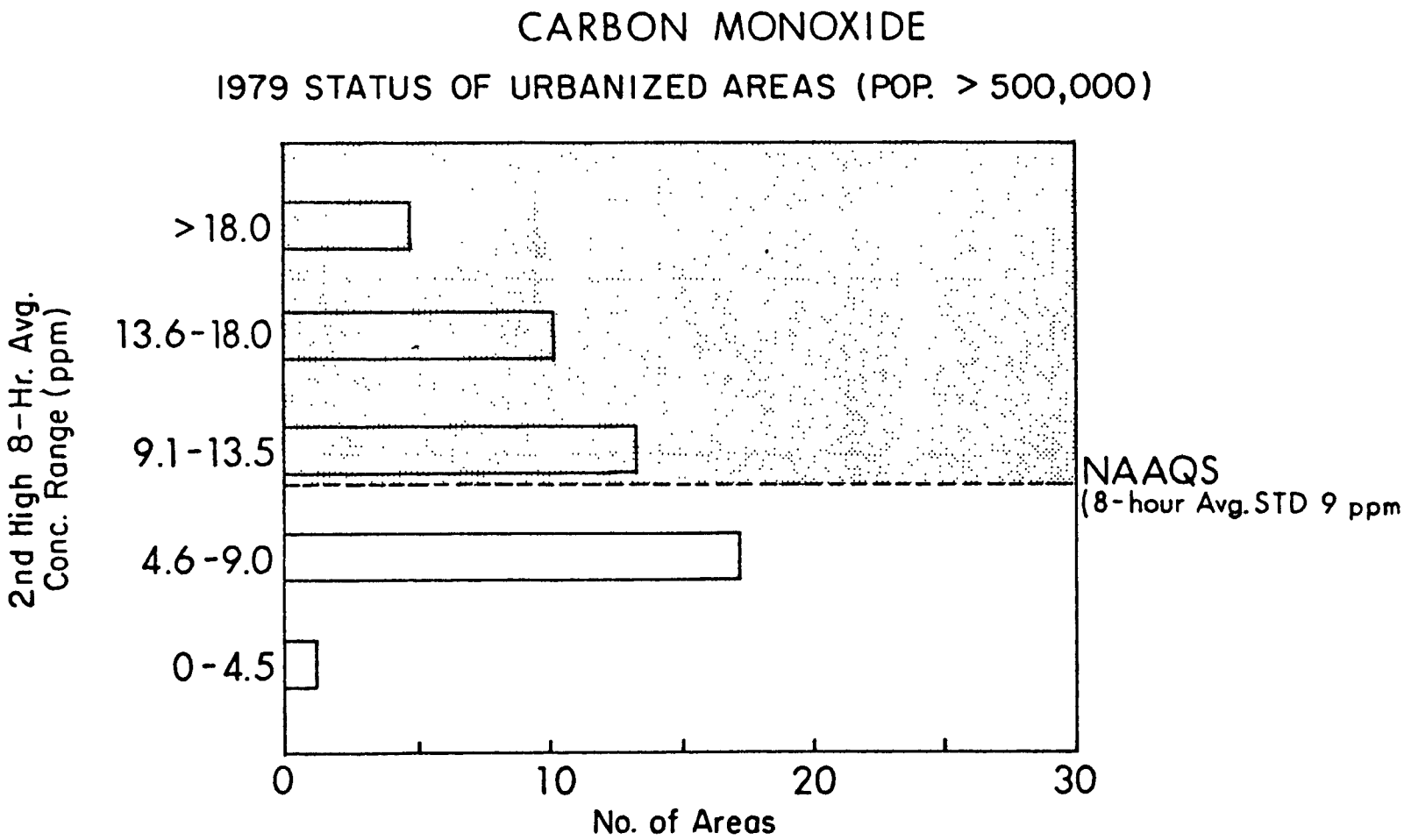

Figure 2-9. Comparison of 1979 carbon monoxide levels in urban areas with populations greater than 500,000.

portation and power have more than offset the reductions. During the 1975-1979 period the number of miles travelled by all types of motor vehicles increased substantially and higher electricity demands caused utilities to burn more fuel.

2.4.1 NATIONAL TREND IN AVERAGE NITROGEN DIOXIDE LEVELS, 1974-1979

Figure 2-10 shows year-by-year changes in average NO_2 levels based on measurements obtained at 180 sites. There is an increasing trend from 1975 to 1979 with NO_2 levels rising 15 percent. The increase in NO_2 levels corresponds to increases in nitrogen oxides emissions from transportation and from fuel combustion in stationary sources.

2.4.2 NATIONAL TREND IN EMISSIONS OF NITROGEN OXIDES, 1970-1979

Nitrogen oxides emissions increased 18 percent from 1970 to 1979 (Figure 2-11). The increase in nitrogen oxides emissions resulted primarily from increased fuel use by stationary sources and increased highway motor vehicle travel. Vehicle miles driven increased 35 percent over the decade. During this same period industrial process emissions remained relatively constant, while solid waste and miscellaneous emissions decreased.

2.4.3 COMPARISON OF NITROGEN DIOXIDE LEVELS

In 1979, NO_2 was monitored in 45 urban areas which had populations greater than 500,000. As Figure 2-12 indicates, 6 (13%) of these urbanized areas recorded annual average values which exceed the NAAQS level of 0.050 ppm. The majority of the urbanized areas recorded annual average values between 0.026 ppm and 0.050 ppm. Only 7 counties (or county equivalents) are currently classified as nonattainment for NO_2.

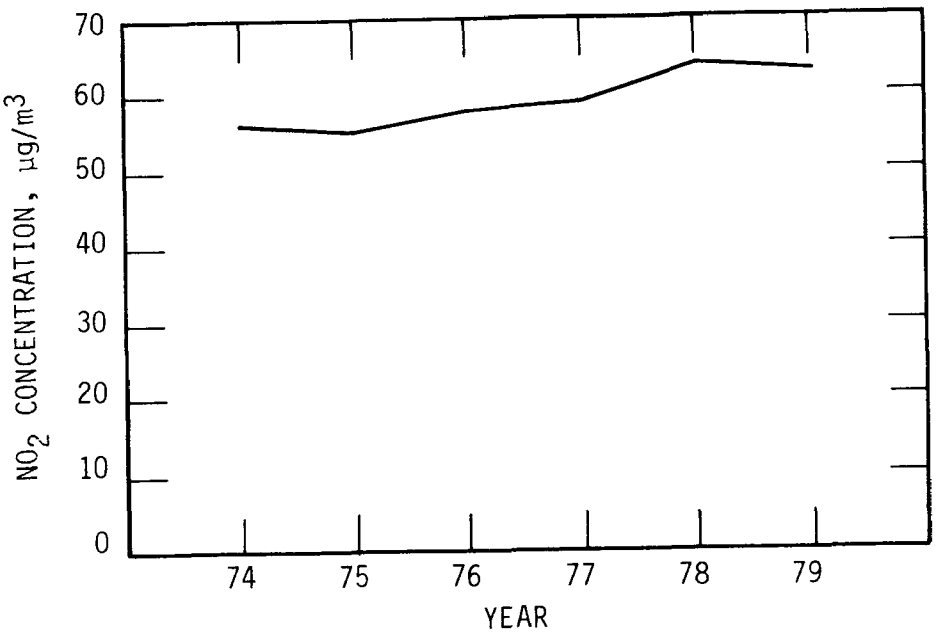

Figure 2-10. National trend in average nitrogen dioxide levels, 1974-1979.

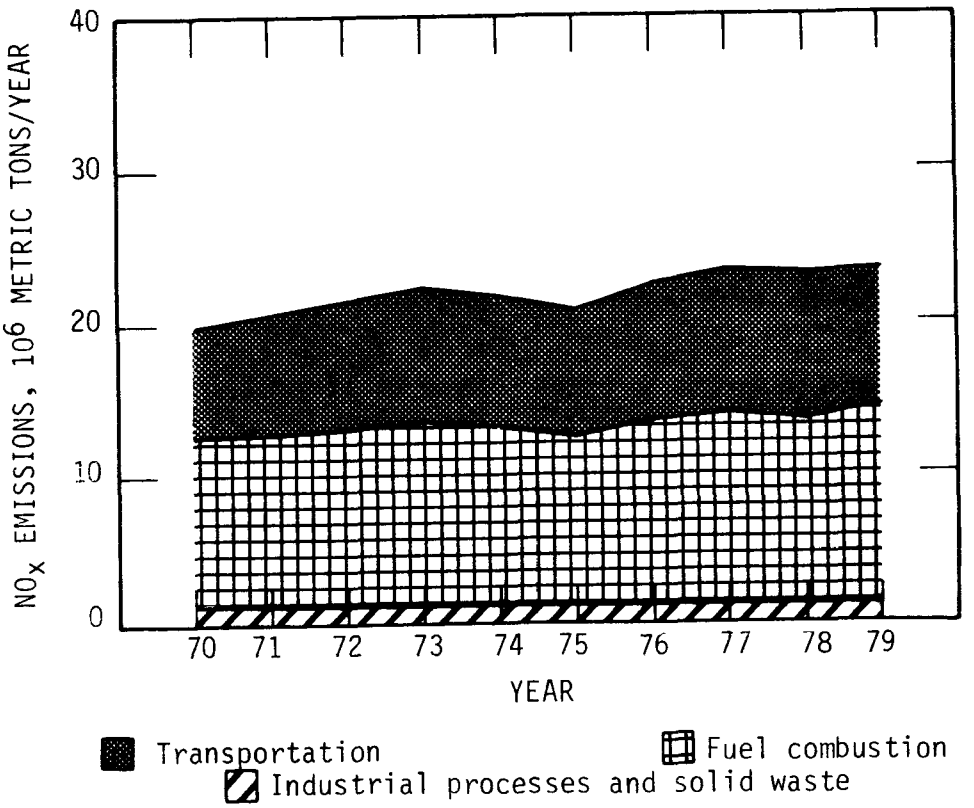

Figure 2-11. National trend in emissions of nitrogen oxides, 1970-1979.

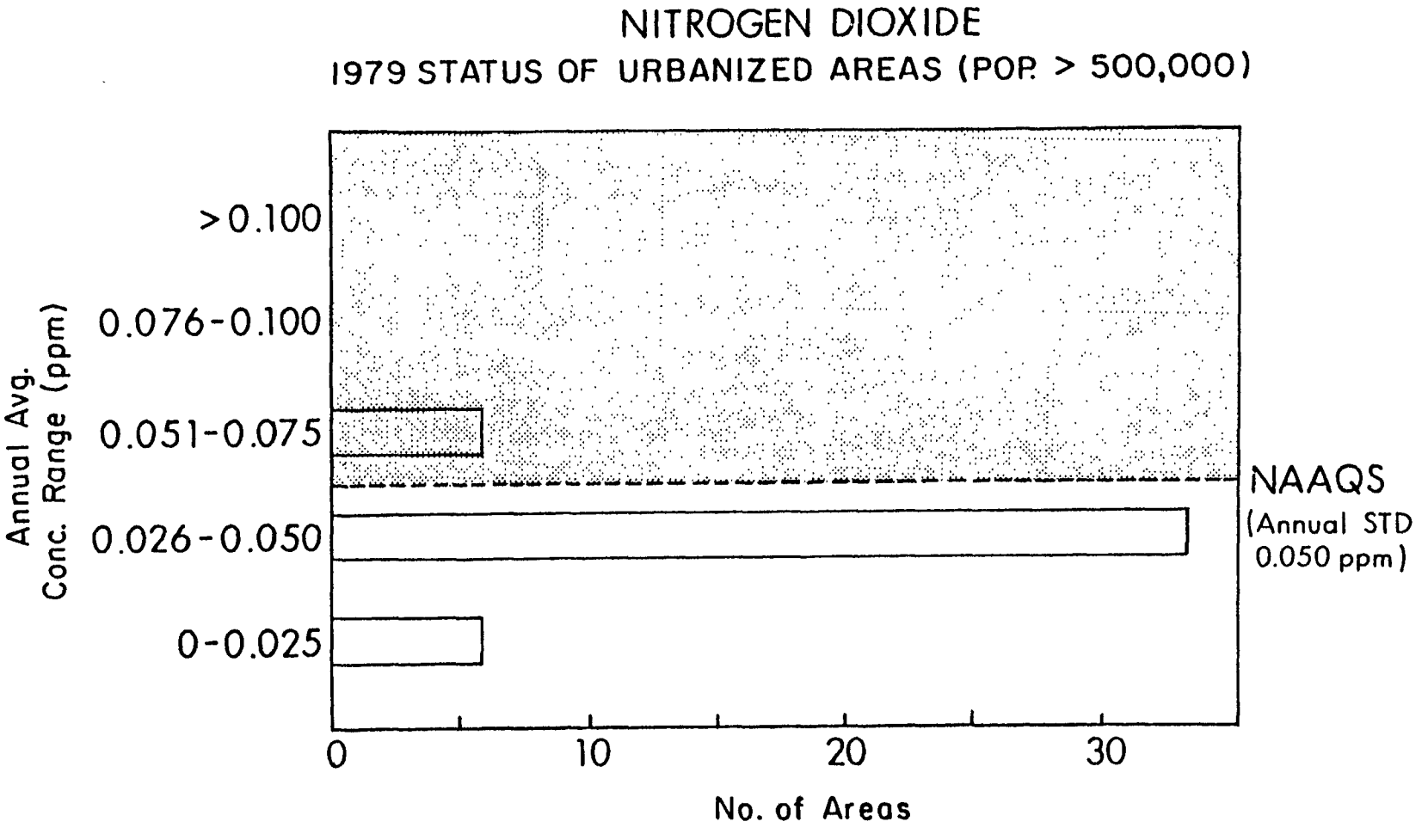

Figure 2-12. Comparison of 1979 nitrogen dioxide levels in urban areas with populations greater than 500,000.

3. AIR MONITORING STRATEGY

In October 1975, a Standard Air Monitoring Work Group (SAMWG) composed of Federal, State and local air pollution control officials was established. SAMWG developed an ambient air monitoring strategy that was approved in June 1977.[1] This strategy is now being implemented through air monitoring regulations promulgated on May 10, 1979.[2] These regulations require the states to:

- Establish requirements for a refined national monitoring network in areas with high population and pollutant concentrations to provide a sound data base for assessing national trends.

- Give the States flexibility to use resources freed from unnecessary monitoring work to meet their own needs.

- Establish uniform criteria for siting, quality assurance, equivalent analytical methodology, sampling intervals, and instrument selection to assure consistent data reporting among the States.

- Establish a standard national pollutant reporting index and require its use for major metropolitan areas.

- Require the submission of precision and accuracy estimates with air quality data to enable better interpretation of data quality.

These changes should result in a streamlined, high-quality, more cost-effective, national air monitoring program.

The States are required to establish a network of stations to monitor pollutants for which National Ambient Air Quality Standards (NAAQS) have been established. Each network is to be designed so that stations are located in all areas where the State and the EPA Regional Office decide that monitoring is necessary. The stations in the network are termed State and Local Air Monitoring Stations (SLAMS).

Data from the network will be condensed and reported annually to EPA. Data from a subset of SLAMS to be designated as National Air Monitoring Stations (NAMS) will be reported quarterly to EPA.

3.1 NETWORK DESCRIPTION

3.1.1 THE SLAMS NETWORK

The SLAMS network will be designed to meet a minimum of four objectives:

- To determine the highest concentrations expected in each area covered by the network;

o To determine representative concentrations in areas of high population density;

o To determine the impact on ambient pollution levels from significant sources or source categories; and

o To determine background concentrations.

Each monitoring site is required to be identified by location and type of surroundings as well as by monitoring objective and spatial scale of representativeness. The spatial scale of representativeness is described in terms of the physical dimensions of the air parcel sampled by the monitoring station throughout which actual pollutant concentrations are reasonably similar; the scale adjectives are micro, middle, neighborhood, urban, and regional.

3.1.2 THE NAMS NETWORK

The NAMS stations are selected from the SLAMS network to emphasize urban and multisource areas. The primary objective for NAMS is to monitor areas where pollutant levels and population exposure are expected to be highest, consistent with the averaging time of the NAAQS. Accordingly, NAMS fall into two categories:

o Stations in area(s) of expected maximum concentrations; and

o Stations with poor air quality and high population density but not necessarily in area(s) of expected maximum concentrations.

3.2 IMPROVING THE CRITERIA POLLUTANT AIR MONITORING STRATEGY

The February 8, 1980 memorandum from the Administrator to the Assistant Administrators of EPA requested that they prepare a monitoring strategy for their respective programs. In April 1980, the air program and SAMWG began a review of the existing monitoring strategy to determine if any deficiencies remained to be resolved. Four principal issues were identified:

3.2.1 EXPAND THE DATA BASE IN SELECTED URBAN AREAS

EPA will investigate the feasibility of establishing a continuing intensive monitoring program in one or more cities representing different emission patterns to provide a comprehensive data base for dealing with new issues and issues unresolved because of inadequate data. Establishing data intensive efforts in these representative cities would provide a long-term data base for

studying a variety of pollutant-specific issues, such as the extent of nonattainment, determining the impact of specific source categories and causes of air quality trends.

Over several years, a history of pollutant concentration levels and gradients, meteorological characteristics, and emission patterns could be developed within each special study area. The result would be a comprehensive and cooperatively-used data base that could replace the continuing need for special short-term monitoring programs and would be responsive to a variety of national as well as state and local data needs. Although the program would be costly in the beginning, significant resources might be saved in the long run, since resource-intensive special studies could be minimized. Once established, the data base would serve as a reference for future special studies, and it could replace the need for continually establishing special monitoring programs with limited applications.

3.2.2 IMPROVE THE TECHNICAL BASIS FOR POLICY AND REGULATORY DECISIONS

The relationship of the technical and nontechnical aspects of monitoring and modeling to the decision-making process must be better understood before improved guidance can be issued. Specific items to be accomplished are listed below:

- Develop performance standards and performance measures for air quality monitoring. Such standards and measures are needed to provide an objective method of assessing the representativeness of monitoring.

- Develop performance standards and performance measures for dispersion models. These standards and measures will provide an objective method of determining model reliability for specific applications.

- Continue the program of formal review of air quality simulation models by the scientific and air quality management communities. The objectives of the review are to ensure that the models are founded on sound scientific bases and function in an efficient, cost-effective manner and to ensure that appropriate new and superior models are promptly incorporated into the analytical system.

3.2.3 EXPAND AND STRENGTHEN DATA ANALYSIS CAPABILITIES

Data analysts are exploring ways to use statistical and probability analysis to improve the rationale for using monitoring data and model outputs in decision-making. Such analysis will receive greater administrative attention as

a priority item in the budgeting process. Specific actions for expanding and strengthening data analysis include the following:

o Continue to explore the feasibility of using a probability approach as the basis for reviewing the impact of new sources.

o Maintain the Intra-Agency Task Force for Air Quality Indicators as the vehicle for establishing statistically sound and consistent approaches for analyzing air quality data and trends.

o Establish priorities for exploratory data analysis that would include:

(a) Representativeness of monitoring and model estimates - extent of nonattainment.

(b) Technique development - time series analysis, factor analysis, probability models and Markov process applications.

(c) Trends analysis - Areawide indicators, statistical significance of observed air quality changes.

(d) Data validation and consistency - detection of data anomolies.

3.2.4 IMPROVE THE COORDINATION AND MANAGEMENT OF MONITORING AND MODELING ACTIVITIES

SAMWG has identified critical problems in managing EPA's air monitoring program. It has provided the perspective of air program managers at the Federal, state, and local levels. This is a key element in planning, because the strategy must address the real problems that will occur at any of those levels to be successful. Accordingly, SAMWG is being maintained to provide continual review of the overall air monitoring strategy and to insure that data users' viewpoints are properly addressed. SAMWG will be asked to develop and review issues related to how monitoring/modeling data should be used to make control-related decisions.

Mid-level managers within the Regional Offices are being asked to play a greater role in implementation of the NAMS network through RO/HQ NAMS workshops and troubleshooting work groups.

3.3 NON-CRITERIA AIR POLLUTANT MONITORING STRATEGY

A forthcoming report, will include a description of current monitoring programs for measurement of non-criteria air pollutants, the status of monitoring techniques as well as quality assurance procedures. In addition, data

needs will be identified and a proposed future monitoring program will be discussed. A draft of this report should be available in 1981.

3.4 REFERENCES

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2. Federal Register, Vol. 44, May 10, 1979, pp 17558-27604.

4. AN EXAMINATION OF OZONE

Unlike the other criteria pollutants, ozone is not emitted directly by specific sources. Instead, it is formed in the air by chemical reactions between nitrogen oxides and volatile organic compounds, such as the vapors of gasoline, chemical solvents, and the combustion products of various fuels. Since these reactions are stimulated by sunlight, ozone reaches peak levels in most parts of the country during the summer. This type of pollution first gained attention in the 1940's as Los Angeles "smog." Since then, photochemical smog has been observed frequently in many other cities.

This chapter examines the current status of ozone monitoring and recent trends in ozone levels based on data available on EPA's National Aerometric Data Bank (NADB). VOC emission trends are also presented based on data in the National Emission Data System (NEDS).

The second part of the chapter is concerned with the development of the 1982 State Implementation Plan (SIP) data base, particularly the effort to collect emissions, air quality, and meteorological data within the Northeast Corridor (Washington, D.C. to Boston, Massachusetts) and other urban areas.

The chapter ends with a discussion on efforts to standardize and improve ozone air quality models. Results from the preliminary application of the airshed model are discussed.

4.1 MONITORING STATUS AND TRENDS

During the 1970's the number of ozone/oxidant monitors increased considerably.[1,2] In 1970, there were one ozone monitor and 56 oxidant monitors in use; by 1979, there were 475 ozone monitors reporting at least 50 percent of the possible days in the ozone season, May through October.

An examination of the ozone levels recorded at these sites shows that many areas across the country are not violating the new ozone standard of 0.12 parts per million (ppm). In fact, 77 of 282 counties did not report violations of the ozone standard over the 4-year period 1976-79. A comparison of counties east and west of the Mississippi River in 1979 shows 110 of 188 counties (59%) exceeding the standard in the East and 45 of 94 counties (48%) exceeding the standard in the West. Therefore, while the ozone problem is widespread, it is not universal.

Nationwide, ozone air quality levels decreased approximately 5 percent between 1978 and 1979. Most of the decrease took place in the Midwest,

principally the EPA Region 5 states--Ohio, Indiana, Illinois, Wisconsin, Minnesota, and Michigan. The decrease appears to be due to a combination of factors. Meteorology was more conducive to ozone formation in 1978 than 1979. In addition, there were changes in the way ozone monitors were calibrated,[3,4] and there were regionwide changes in quality assurance procedures. Most monitors outside Region 5 showed a small decline in ozone levels.

4.1.1 MONITORING STATUS

In February 1979, the EPA adopted a new ozone standard[3] requiring that the expected number of days per calendar year with daily maximum hourly ozone concentrations exceeding 0.12 parts per million (ppm) be less than or equal to 1. The expected number of exceedances (the statistical indicator used in monitoring summaries) is further discussed in an EPA guideline on interpretation of ozone standards[5] and in a paper by Curran and Cox.[6]

Only sites reporting sufficient data for at least 50 percent of the possible 184 days in the ozone season were considered in this analysis. The criterion for a valid day was either 75 percent of the hours between 9:01 a.m. and 9 p.m. (9 of the 12 hours) or one recorded hour in exceedance of the standard; this completeness criterion is reasonable for determining whether sites and/or counties are exceeding the new ozone standard.

Nationwide Summary

In 1979, ozone monitors at 475 sites in 282 counties across the Nation collected at least 50 percent of the possible days in the ozone season (Figure 4-1). Exceedances of the standard were reported at 155 (55%) of the counties. The majority of these counties are in major metropolitan centers. The approximately 110 million people living in the 282 counties account for about 54 percent of the total 1970 U.S. population; of these, 81 million people or 73 percent were exposed to ozone levels above the standard in 1979.

4.1.2 OZONE TRENDS

4.1.2.1 Long-Term Trend, 1974-1979

Measurements of ozone taken over a 6-year period, 1974-1979, show no significant change in ambient levels. This is consistent with the trend in ozone precursor emissions (volatile organic compounds). Emissions from transportation have decreased despite an 18 percent increase in vehicle miles driven

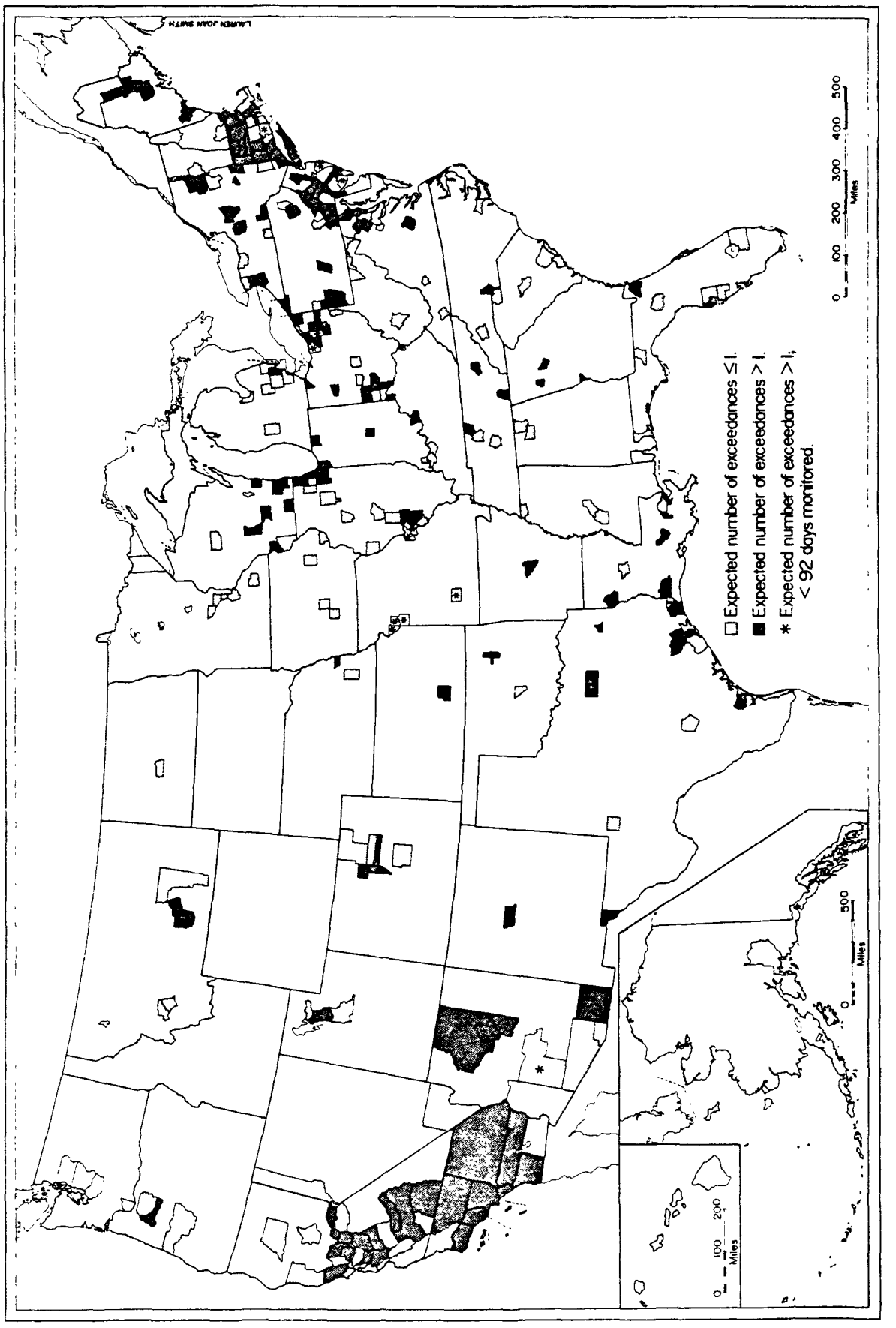

Figure 4-1. Ozone status by county, 1979.

between 1974 and 1979, because of the increasing effectiveness of emissions controls. Emissions from industrial sources have increased because of growth or increased industrial production.

Figure 4-2 shows year-by-year changes in the composite May through October average of daily maximum hour ozone values of 230 urban sites over the 6-year period, 1974-1979. The data reveal no long-term trend, which is consistent with a similar lack of change in volatile organic compound emissions (Figure 4-3).

4.1.2.2 Short-Term Trend, 1978-1979

The long-term nationwide analysis has been supplemented with a short-term 2-year (1978-79) analysis to examine the short-term decline in ozone levels between 1978 and 1979. The completeness criterion for trend analysis was more restrictive than that used for the monitoring summaries (Section 4.1.1)--75 percent of the possible days of data had to be available during the May through October period. One hundred and fifty seven sites met this criterion for 1978 and 1979.

Ozone sites meeting the 75 percent completeness criterion showed a 5 percent decrease in the May through October average of the daily maxima from 1978 to 1979. A partial factor in the overall decrease in ozone levels may have been the 2.5 percent decrease in estimated VOC emissions from 27.8 million metric tons in 1978 to 27.1 million metric tons in 1979. Between 1978 and 1979, VOC emissions from industrial processes remained relatively unchanged, while VOC emissions from motor vehicles dropped, largely due to increased emission control and decreased motor vehicle miles travelled.[7]

Other possible causes for the decline in ozone levels between 1978 and 1979 are the effects of meteorology, calibration change and regional differences. Most of the decreasing trends are in the Midwest, principally EPA Region 5 states - Ohio, Indiana, Illinois, Wisconsin, Minnesota and Michigan. These decreases appear to be due to a combination of three factors. First, meteorology was more conducive to ozone formation in 1978 than 1979 in the Midwestern states (see Appendix B). Secondly, as in other regions there were changes in the way ozone monitors are being calibrated. Third, estimated nationwide volatile organic compound emissions decreased between 1978 and 1979. Finally, the Region 5 office applied uniform auditing procedures to all ozone

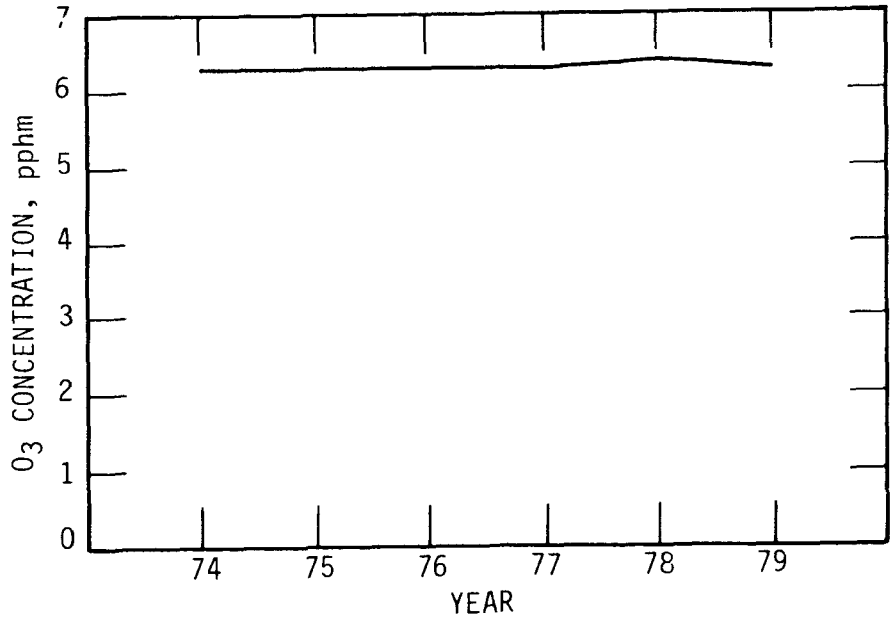

Figure 4-2. National trends in daily maximum ozone levels for May through October, 1974-1979.

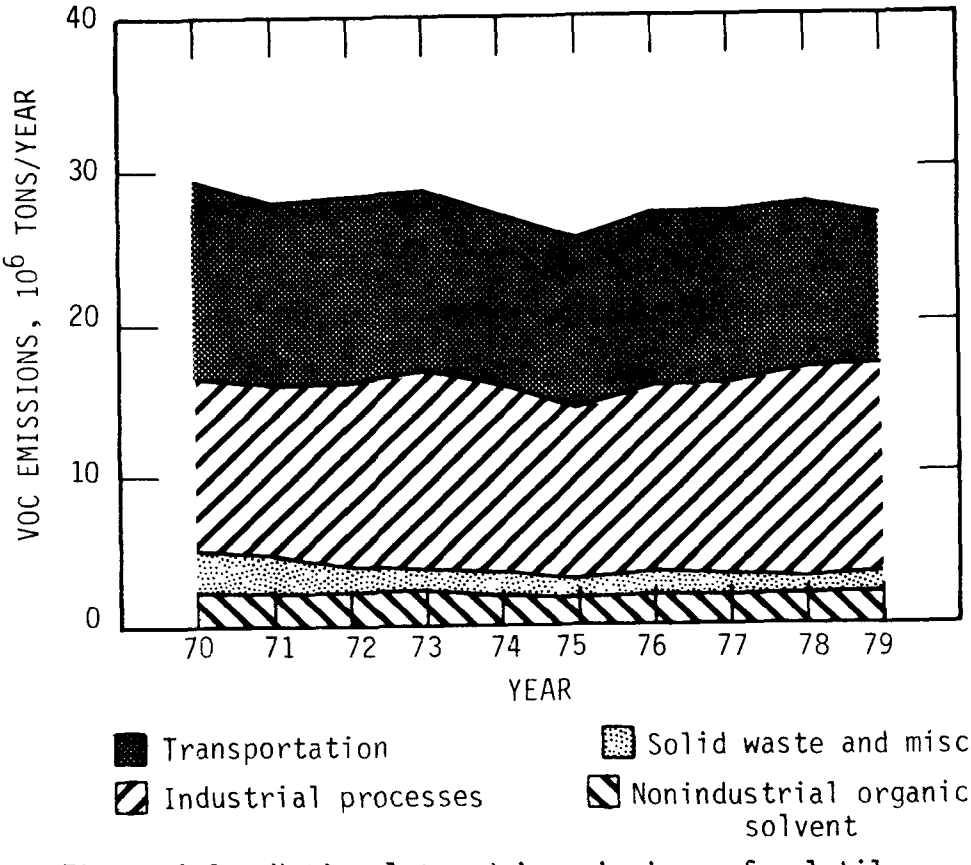

Figure 4-3. National trend in emissions of volatile organic compounds, 1970-1979.

monitors in the Region 5 states for the first time. A paper by Hunt, et. al. examines these factors in depth.[8]

4.1.2.3 Trend Conclusion

While no statistically significant long-term trend is apparent, a statistically significant short-term decreasing trend (1978-1979) has been found. Most of the decrease occurs in the EPA Region 5 states, although a statistically significant decrease of 3 percent is observed for the non-Region 5 sites. Several general conclusions also emerge:

- Since VOC emission decreases are gradual, ozone trends are difficult to determine and probably will not emerge until 10 or 15 years of data are available.

- Analytical techniques are steadily improving but will not lead to a significantly improved capability for detecting ozone trends in the near future.

4.2 TECHNICAL ISSUES ASSOCIATED WITH THE DEVELOPMENT OF OZONE SIP'S

Revised State Implementation Plans (SIP's) are to be submitted by July 1982 for each of the 37 ozone nonattainment areas that sought an extension to attain the standard. These SIP's are to contain the regulatory and legislative measures that are needed to attain the ozone standard. Currently, the States are collecting the environmental data base needed to develop the SIP's.

4.2.1 FACTORS AFFECTING THE FORMATION OF OZONE

Ozone is a pollutant formed in the atmosphere when ambient concentrations of nonmethane organic compounds (NMOC) and oxides of nitrogen (NO_x) react in the presence of sunlight during meteorological conditions typical of summertime (i.e., high temperature and strong sunlight intensity). Of critical importance in ozone formation is the ambient ratio of nonmethane organic compounds to oxides of nitrogen ($NMOC/NO_x$). NMOC reductions are most effective in reducing ozone levels when the ambient ratio of $NMOC/NO_x$ is less than about 10:1, as it is in most urban areas. In remote areas, where $NMOC/NO_x$ ratios are about 30:1 or above increases or decreases in ambient NMOC concentrations may have an insignificant impact on ozone concentrations.

Ozone is unlike most of the other criteria pollutants in many respects. For example:

a. Peak ozone concentrations occur a number of hours after precursor emissions are emitted. Higher levels of ozone are frequently measured in rural areas downwind from urban areas than in the urban areas themselves. This is due to transport from the urban area rather than from sources located in the rural area.

b. The formation of ozone is dependent upon the emissions of two pollutants--volatile organic compounds and oxides of nitrogen (NO_x). It is widely believed that control of (VOC) sources of volatile organic compounds is more effective, especially when the cost and technology limitations associated with NO_x control are considered.

c. Volatile organic compounds from stationary sources are emitted from a wide range of industrial and commercial sources as well as from consumer products. Stationary sources of VOC emissions are so diffuse that no one stationary source category is likely to emit more than a small fraction of the total emissions. The ubiquitous nature of stationary sources of VOC makes the development and enforcement of VOC control regulations more difficult than for most other criteria pollutants.

While there is general agreement with respect to the technical issues discussed above, there are other issues which are more controversial and which can be misleading unless the available information is presented in proper perspective. For example:

a. While upwind sources may contribute to ozone concentrations measured in a downwind city, in most cases the city itself is primarily responsible for the peak ozone concentrations measured further downwind. All too often attention is focused on the contribution from upwind sources, while the city's own contribution to peak ozone concentrations is deemphasized.

b. It is frequently stated that the magnitude of VOC emissions from vegetative sources is greater than those from man-made sources. Although there is uncertainty in such estimates, various studies have indicated that natural sources of VOC emit 3 to 5 times the amount of emissions from man-made sources. However, in raising this issue, many fail to mention the more important fact that the contribution of natural emissions to ambient ozone concentrations has been estimated to be small. Emissions from vegetation tend to be widely dispersed geographically, whereas emissions from man-made sources tend to be concentrated in urban areas. In addition, scientific evidence suggests that the major vegetative emissions, terpenes, are a major sink for ozone.

4.2.2 THE TECHNICAL DATA BASE NEEDED FOR OZONE SIP'S

The Clean Air Act prescribes the use of the air resource management approach in developing SIP's. The air resource management approach essentially requires: (a) that emission sources be identified and quantified; (b) that ambient air quality concentrations be determined; and (c) that a model, which

simulates the relationship between emissions and air quality, be available. The purpose of the model is to estimate the impact of control strategies on future ambient ozone concentrations.

4.2.3 AIR MONITORING DATA AND SIP DEVELOPMENT

More specialized air quality data are needed for the development of the ozone SIP's than for other pollutants. Ambient measurements of three pollutants--ozone, oxides of nitrogen, and nonmethane organic compounds are needed. Monitoring networks must be designed to account for the transport phenomenon associated with ozone. For example, additional monitors must be located upwind of the city (to measure incoming transport) and downwind (to measure peak ozone concentrations produced by the city). Because there is no continuous, reliable method to measure ambient nonmethane organic compounds, particularly at concentrations below 0.5 parts per million carbon (ppmc), specialized research procedures must be used. These procedures are more reliable, but are also more resource intensive, and more technically complicated. To minimize these and other problems the Agency has undertaken an active program to provide financial and other assistance to the States so that a good data base can be collected for the 1982 ozone SIP's. A major effort is underway in the Northeast Corridor to collect a good data base for SIP development.

Two recent developments will improve the overall quality of the ozone air quality data base. These developments are (1) the recent change in the Agency's recommended ozone calibration technique and (2) the implementation of the national air monitoring strategy.

The national monitoring strategy has been discussed in earlier chapters of this report. The quality assurance program required by the strategy should eliminate the use of faulty air quality data in regulatory decisions. Also, adherence to monitor siting guidance should provide a national network of similarly-sited ambient monitors located where one would expect maximum ozone impact. Analysis of data from these sites should result in more meaningful intercity comparisons of data than previously possible.

The national monitoring strategy will result in an increase in the number of ozone monitors currently operated in some cities. In other cities, some existing monitors may be relocated to areas where peak ozone concentrations are more likely to occur. Consequently, ozone levels higher than those currently

being recorded are likely to be measured, particularly in medium and smaller sized cities where the monitoring networks are likely to be more deficient than in larger cities (e.g., New York and Los Angeles).

The modification to the ozone calibration technique will eliminate the 5 to 20 percent positive bias that has existed in the Agency's recommended ozone calibration procedure. As a result, peak ozone concentrations should be consistently 5 to 20 percent lower than previously reported. There continues to be a $\pm$15 percent error associated with the ozone monitoring procedure that will not be affected by the change in the calibration procedure. At the current level of the ozone standard (0.12 ppm, 1-hour standard), this results in a probable $\pm$0.02 ppm error. This generally recognized error is typically ignored when making regulatory decisions since the measured value is the best estimate of the true value available.

4.2.4 EMISSION INVENTORY DATA

Another requirement for the effective implementation of the air resource management approach is an inventory of emission sources. Emission data are needed for two pollutants (VOC and NO_x). Unlike air quality data, which are direct measurements, an emission inventory is a compilation of a series of estimates. Consequently, there are inherent errors associated with any inventory. The magnitude of the error is greatest when emission estimates are attempted for a single source. More confidence is attached to estimates of total emissions for an urban area as random errors associated with individual estimates cancel each other to some degree producing a more reasonable estimate of total emissions.

It is generally believed that inventories for VOC emissions are less reliable than those for other criteria pollutants. Emission inventory procedures for stationary sources were originally developed to estimate emissions from particulate matter and sulfur dioxide sources. As new pollutants were inventoried, existing inventory procedures were applied to these pollutants without much change. In some cases, this was appropriate (e.g. oxides of nitrogen). However, due to the nature of VOC sources, the historical procedures have been found to be generally insufficient. Improved procedures have recently been developed to more completely account for emission from the ubiquitous sources of VOC emissions.

4.2.5 AVAILABLE MODELING PROCEDURES FOR OZONE

The development of a technically sound and widely accepted model has been a difficult task. For the 1979 ozone SIP's, the Agency allowed States to use any one of a number of modeling techniques to relate source emissions to air quality since it was not possible to determine which of the available ozone modeling procedures was best.

Since that time, considerable progress has been made to develop and validate the Empirical Kinetic Modeling Approach (EKMA). As a result of preliminary validation efforts, the Agency recently proposed that the States use EKMA for the development of 1982 ozone SIP's. However, because of the inherent errors in the data base and with model estimates, it is anticipated that the estimates of control provided by EKMA may be used as a guide to determine the general level of control needed to attain the standard. Despite recent efforts, there continues to be uncertainty associated with ozone model results. The best we can do today is to implement a control strategy, measure the effect on the ambient ozone and later make appropriate adjustments to the control strategy as required.

4.2.6 THE POTENTIAL OF PHOTOCHEMICAL DISPERSION MODELS

Unlike EKMA, which is a relatively simplified model, urban photochemical dispersion models are sophisticated, detailed mathematical representations of the chemical and meteorological phenomena associated with the photochemical process. Since such models represent the state-of-the-science, the development of a validated photochemical dispersion model is viewed as a valuable tool for improving the Agency's credibility with respect to its ozone control program. Advantages of a validated photochemical dispersion model include:

1. the ability to demonstrate the appropriateness of the Agency's current strategy for ozone control;

2. the ability to determine the potential effectiveness of new strategies, and to determine the most cost-effective strategy to attain standards;

3. the capability to provide decision-makers with pertinent information to allow them to make reasonable and supportable decisions.

On the other hand, model results may be limited for the following reasons:

a. Photochemical dispersion models are data and resource intensive. The cost to obtain the emission, air quality, and meteorological data for one

city often exceeds $1 million and may take 2 to 4 years to complete the data collection-model application process.

b. A photochemical dispersion model cannot be expected to produce accurate and unquestioned results if the input data contain significant errors. Consequently, the results from photochemical dispersion models will be limited in credibility due to the inherent errors in the data bases needed to operate the model and the implicit assumptions in model formulation.

Efforts are currently underway to validate a photochemical dispersion model. Detailed data bases have been assembled for St. Louis, MO and Tulsa, OK and data collection efforts are underway in Philadelphia. A comprehensive testing protocol has been formulated for St. Louis, which requires the evaluation of model performance of 50 separate days of varying air quality and meteorological conditions. Less rigorous, but nevertheless comprehensive testing is underway on the Tulsa data base. These validation efforts are scheduled to be completed by the end of FY 81.

While limited results are available concerning the performance of photochemical dispersion models, a sensitivity study was recently conducted to evaluate the impact of various input parameters on model predictions. Noteworthy results, which should be considered preliminary at this time (since the model has not yet been validated) include the following:

a. Errors in peak ozone predictions from photochemical dispersion models appear to be directly related to errors in emission input data. In other words, an error of 10 percent in emission estimates could have as much as a 10 percent error in ozone prediction.

b. Sensitivity tests indicate that peak ozone concentrations are not very sensitive to the spatial distribution of emissions. These results suggest that either the model or ambient ozone formation itself is not sensitive to the spatial distribution of emissions. If ozone formation is not particularly sensitive to such changes, this would question the air quality benefits to be gained from implementing various transportation and land use strategies that are designed primarily to relocate rather than reduce emissions.

In summary, while photochemical dispersion models are believed to have the capability of providing more theoretically sound results, the extent of the data bases required by the model and their inherent errors may limit the usefulness of the results from such models. Efforts are continuing to validate these models in a number of cities. Only limited use of sophisticated photochemical dispersion models for the development of 1982 ozone SIP's is anticipated.

Summary: Technical Issues Associated with Ozone SIP's

- In July 1982, 37 nonattainment areas that sought an extension to attain the ozone standard will be required to submit revised SIP's. States are currently in the process of collecting a good data base to develop SIP's.

- Because of the complex nature of ozone, it has been difficult to develop the technical tools needed to fully implement the air resource management approach, which is prescribed by the Clean Air Act for SIP development.

- Available ozone models are limited and not widely accepted. High priority Agency efforts have resulted in an improved model i.e., the Empirical Kinetic Modeling Approach (EKMA) having been recently proposed by EPA for use in 1982 ozone SIP development.

- Photochemical dispersion models are generally believed to be superior to other ozone models and efforts are underway to validate such models. However, the results from photochemical dispersion models will be limited in credibility due to the inherent errors in the data bases needed to operate the model and the implicit assumptions in model formation.

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16. ABSTRACT

This report presents national ambient air quality and emission trends through 1979 for total suspended particulate, sulfur dioxide, carbon monoxide, nitrogen dioxide and ozone. Ozone is treated in greater depth focussing on monitoring states as well.

17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Trends --- Air Pollution Emission Trends Air Monitoring Carbon Monoxide Nitrogen Dioxide Ozone Sulfur Dioxide Total Suspended Particulates		

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