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AEROSOL RESEARCH BRANCH, ANNUAL REPORT FY 1976/76A

Federal Interagency Energy/Environment Research and Development Program

Interagency Energy-Environment Research and Development Program Report

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AEROSOL RESEARCH BRANCH
ANNUAL REPORT FY 1976/76A
Federal Interagency Energy/Environment Research and Development Program

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ENVIRONMENTAL SCIENCES RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

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ABSTRACT

The research program of the Aerosol Research Branch includes research grants and contracts at institutions in many parts of the United States, in addition to an intramural program. The purpose of these projects is to study the chemical and physical properties of aerosols, identify the mechanisms of aerosol formation and removal, and conduct experiments to measure these rates.

The results of the research are being used (1) to establish the contribution of the various sources to the ambient atmospheric aerosol loading, (2) to characterize urban, natural, and primary and secondary aerosols, (3) to develop quantitative descriptions of the generation and removal rates associated with each major aerosol source and sink, (4) to quantify the effects of aerosol on atmospheric chemical reactions, and (5) as a scientific basis for recommending regulatory actions concerned with air quality improvements.

In addition to base funding through EPA's Office of Research and Development, the Aerosol Research Branch (ARB) also receives funds from the Federal Interagency Energy/Environment Research and Development Program. This program is coordinated by the Office of Energy, Minerals, and Industry, Dr. Steven Gage, Deputy Assistant Administrator. The tasks conducted by ARB under this program relate to the transport and fate of pollutants associated with energy sources.

Tasks funded by the base program are not described in this report but are listed by title and principal investigator. The FY 1976/76A annual report of the base program is found in EPA Report 600/3-77-080.

CONTENTS

ABBREVIATED FUNCTIONAL STATEMENTS

The Environmental Sciences Research Laboratory (ESRL) conducts research programs in the physical sciences to detect, define, and quantify the effects of air pollution on urban, regional, and global atmospheres, and the subsequent impact on air and water quality and land use. ESRL is responsible for the planning, implementation, and management of research and development programs designed to quantitate the relationships between emissions of pollutants from all types of sources, air quality, and atmospheric effects. ESRL also plans, implements, and manages a research and development program to provide needed techniques and instrumentation for the measurement and characterization of pollutants in the ambient air and in the emissions from all types of sources. ESRL's research and development program consists of grants, contracts, and in-house work.

The Atmospheric Chemistry and Physics Division (ACPD) conducts research programs (1) to characterize the chemical and physical properties of ambient air pollutants and (2) to relate quantitatively the chemical and physical properties of emissions from mobile, stationary, and natural sources to the effects on air and water quality and land use. ACPD also develops techniques and instrumentation for the measurement and characterization of gaseous and aerosol pollutants.

The Aerosol Research Branch (ARB) studies the chemical and physical properties of aerosols, identifies the mechanisms of aerosol formation and removal, and conducts experiments to measure these rates. The properties of atmospheric aerosols are related to health and welfare effects for the purpose of selective control of pollutant sources.

ACKNOWLEDGEMENTS

The program of the Aerosol Research Branch is under the scientific direction of A.P. Altshuller, Director, Environmental Sciences Research Laboratory. EPA funds are provided through OALWU, Thomas Murphy, DAA (Transport and Transformation Program) and OHEE, Delbert Barth, DAA (Catalyst Program). Federal Interagency Energy/Environment Research and Development Program funds (Project MISTT) are provided through OEMI, Steven Gage, DAA. We also thank Robert Papetti and Deran Pashayan, OALWU, and Greg D'Alessio, OEMI, for management support.

INTRODUCTION

The Aerosol Research Branch (ARB), as part of the Environmental Sciences Research Laboratory of the U.S. Environmental Protection Agency, administers an extramural research program consisting of grants and contracts at institutions in many parts of the United States. In addition to the extramural program, ARB conducts a modest in-house program. Since the major responsibility of ARB is to conduct an extramural research program, the in-house program is designed to support the extramural program. It has three major functions: 1) to provide rapid-response capability to respond to agency needs, 2) to test out concepts prior to establishing extramural programs, and 3) to maintain the scientific competence of the EPA project officers. It is considered extremely important that the scientific competence and reputation of ARB's project officers be such that grant and contract principal investigators consider them as scientific peers rather than funding clerks.

This progress report presents results of tasks which were active during fiscal years 1976 and 1976A and funded through the Federal Interagency Energy/Environment Research and Development Program. This work represents a portion of ARB's program as shown in the Summary of Aerosol Research Branch Fiscal 1976 Program by Project. ARB tasks funded through the base program are listed by Title and Principal Investigator in the Appendix.

SUMMARY OF AEROSOL RESEARCH BRANCH
FISCAL YEAR 1976 PROGRAM BY PROJECT

Project MISTT (Midwest Interstate Sulfur Transformation and Transport)

A study of pollutant transformations and removal during atmospheric transport over various scale lengths.

Urban scale (50 km): Tracer and portable chamber studies.
Power plant plumes (250 km): Aircraft measurements.
Urban plumes (500 km): Aircraft and ground measurements.
Blobs (2000 km): Weather Service visibility reports and a ground network of 14 stations extending from eastern Kansas to New England.
Model Development and Data Analysis.

Funded by the Federal Interagency Energy/Environment Research and Development Program through USEPA, ORD, OEMI. Program Element 1NE625.

Auto-Exhaust Catalyst Program

Determination of chemical and physical properties of sulfuric acid aerosol produced by automobile catalysts.

Funded by USEPA, ORD, OHEE. Program Element 1AA601.

Atmospheric Processes and Effects

Aerosol Formation, Growth and Removal. Identification of physical and chemical mechanisms for aerosols processes in the atmosphere, measurement of important rate constants, and development of models for formation, growth and removal of atmospheric aerosols.

Aerosol Characterization and Sources. The utilization of physical properties, elemental and chemical analyses, and microscopy for the characterization of atmospheric aerosols and the use of this information to determine the primary and secondary source contributions to urban pollution.

Visibility and Radiation Effects. Measurement of pertinent aerosol properties and determination of relationships between concentration, composition, size and effects.

Heterogeneous Reactions. Measurement of the rates and mechanisms of reactions involving gases with surfaces or condensed phases.

Technique Development. Development of new instruments or techniques required for the aerosol research program.

Funded by USEPA, ORD, OALWU. Program Element 1AA603 and 1AD712.

PROJECT MISTT
(Midwest Interstate Sulfur Transformation and Transport)

A study of pollutant transformations and removal during atmospheric transport over various scale lengths.

Urban scale (50 km): Tracer and portable chamber studies.
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Model Development and Data Analysis.

Funded by the Federal Interagency Energy/Environment Research and Development Program through USEPA, ORD, OEMI. Program Element 1NE625.

1. Task Title: Direction of MISTT Field Studies

2. Objective:

To provide on site EPA technical direction to insure integration of the ten groups involved in the field study phase of MISTT: Washington University, St. Louis - field director, data manager, communications aircraft, instrumented aircraft; University of Minnesota - aircraft-aerosol-size distribution, ground-mobile laboratory; Meteorology Research, Inc. - fully instrumented aircraft; Environmental Quality Research - pilot ballons, forecasting; Rockwell International-pilot ballons; Environmental Monitoring, Inc. - SO_2 burden with ground and airborne correlation spectrometer; Stanford Research Institute - ground mobile lidar; Washington State University, Pullman - detailed hydrocarbon analysis; Argonne National Laboratory - boundary layer studies, dry deposition; EPA - Las Vegas - helicoptor measurements, aircraft lidar; EPA-RTP - calibration, quality control, data reduction.

3. Institution: ARB, ESRL, ORD, EPA
Investigators: William E. Wilson, Jack Durham

4. EPA Project Officer: William E. Wilson

5. Progress:

Three successful field studies were conducted - a four-week study during summer - 1975, a two-week study during winter-1976, and a six-week study during summer 1976. Measurements were made of power plant and urban plumes. During the summer-1976 study the ERDA-funded, DaVinci ballon was used as an air mass marker to measure the St. Louis plume in a LaGrangian manner. During the last week a prototype study of a "big blob" was made to determine optimum flight patterns for studying the development of secondary pollutants in stagnating anticyclones.

6. Presentations, Publications, and Thesis: None

7. Plans:

Jack Durham will serve as EPA field manager for a winter-1977 field study of an oil-fired plume.

7. Plans:

1. An oil-fired plume will be studied during FY 77.

2. The major emphasis during FY 77 will be on data analysis and reporting. An investigator's meeting will be held during the winter of FY 77. Results will be presented at the June 1977 FIE/E Meeting and the Dubrovnik Conference, "Sulfates in the Atmosphere" during September 1977.

1. Task Title: Management of Project MISTT

2. Objective:

To plan and direct Project MISTT, an integrated, multidisciplinary program to study the transformation and fate of sulfur compounds during transport.

3. Institution: ARB, ESRL, EPA
Investigator: William E. Wilson

4. EPA Project Officer: W.E. Wilson

5. Progress:

A critical review of plume studies was completed. The study pointed out the necessity of studying plumes in four dimensions, time as well as space. Measurements must be made as a function of time of day as well as distance from the plume source. Conversion rates must be determined from differences in mass flow rates. Techniques used previously are inadequate. The S^{32}/S^{34} isotope ratio technique cannot be used because of the variety of reaction mechanisms involved; the particulate sulfur/total sulfur ratio cannot be used because of surface removal of gaseous sulfur dioxide.

Field studies were planned and implemented in the St. Louis area during summer-1975, winter-1976, and summer-1976. Results from the summer-1975 study were summarized and presented at the June 1976 Federal Interagency Energy/Environment Meeting and the June 1976 APCA meeting. Numerous presentations of Project MISTT were made to scientific organizations.

6. Publications, Presentations, and Thesis:

1. Wilson, W.E. Transformation and Transport of Energy Related Pollutants. Presented at: EPA-OEMI Health Environ. Effects and Control Tech. Aspects of Energy Research and Development Symp.

2. Wilson, W.E., R.J. Charlson, R.B. Husar, K.T. Whitby, and D. Blumenthal. Sulfates in the Atmosphere. Presented at: 69th Annual Meeting of APCA, June 27 - July 1, 1976, Portland, Oregon.

3. Project MISTT: Presentation to Maryland Academy of Sciences.

4. Wilson, W.E., R.B. Husar, K.T. Whitby, and D. Blumenthal. Sulfate Formation in Power Plant Plumes. Presented at: 7th International Tech. Meeting on Air Pollution Modeling and Its Application, Sept. 7-10, 1976, Airlie, VA.

5. Wilson, W.E. Sulfate Formation in Power Plant Plumes. A Critical Review. To be published.

Comparison flights were performed with the correlation spectrometer of Environmental Measurements, Inc., Washington University's sampling aircraft, and the instrumented balloon of ERDA's Project DaVinci.

The plume was sampled regularly by the MISTT sampling team to distances greater than 150 km and, on occasion, to 300 km. The Labadie plume was found to be transported long distances at night with little dilution in layers which were separated from the ground. SO_2 concentrations of 0.75 ppm were observed on one occasion at night at a distance of 50 km. Preliminary indications are that the sulfate formation rate in the plume varies with air mass characteristics.

6. Publications, Presentations and Theses:

1. White, W.H., D.L. Blumenthal, J.A. Anderson, R.B. Husar, and W.E. Wilson, Jr. Ozone Formation in the St. Louis Urban Plume. In: Proc. of the International Conference on Photochemical Oxidant Pollution and Its Control, Raleigh, NC, September 1976.

2. White, W.H., J.A. Anderson, D.L. Blumenthal, R.B. Husar, N.V. Gillani, S.B. Fuller, K.T. Whitby and W.E. Wilson, Jr. Formation of Ozone and Light-Scattering Aerosols in the St. Louis Urban Plume. In: Proc. of the Div. Environ. Chem., 171st National ACS Meeting, New York, NY, April 1976.

3. White, W.H., J.A. Anderson, D.L. Blumenthal, R.B. Husar, N.V. Gillani, J.D. Husar and W.E. Wilson, Jr. 1976. Formation and Transport of Secondary Air Pollutants: Ozone and Aerosols in the St. Louis Urban Plume. Science. 194:187-189.

4. White, W.H., D.L. Blumenthal, J.A. Anderson, R.B. Husar and W.E. Wilson, Jr. Formation and Transport of Light-Scattering Aerosols in the St. Louis Urban Plume. In: Proc. of the Symposium on Radiation in the Atmosphere, Garmisch-Partenkirchen, Germany, August 1976.

5. White, W.H. Photochemistry in Power Plant Plumes: A Comparison of Theory with Observation. Submitted to: Environ. Sci. and Tech.

6. Husar, J.D., R.B. Husar, and E.S.Macias, W.E. Wilson, Jr., J.L. Durham, W.K. Shepherd and J.A. Anderson. 1976. Particulate Sulfur Analysis: Application to High Time-Resolution Aircraft Sampling in Plumes Atmos. Environ. 10:591-595.

7. Whitby, K.T., B.K. Cantrell, R.B. Husar, N.V. Gillani, J.A. Anderson, D.L. Blumenthal and W.E. Wilson, Jr. Aerosol Formation in a Coal-Fired Power Plant Plume. In: Proc. of the Div. Environ. Chem., 171st National ACS Meeting, New York, NY, April 1976.

8. Husar, R.B., N.V. Gillani and J.D. Husar. Particulate Sulfur Formation in Power Plant, Urban and Regional Plumes. Presented at: Symposium on Aerosol Science and Technology, 82nd National Meeting of AIChE, Atlantic City, NJ, August-September 1976.

9. Wilson, W.E. Jr., R.B. Husar, K.T. Whitby, D.B. Kittleson, W.H. White. Chemical Reactions in Power Plant Plumes. In: Proc. of the Div. Environ. Chem., 171st National ACS Meeting, New York, NY, April 1976.

10. Wilson, W.E. Jr., R.J. Charlson, R.B. Husar, K.T. Whitby and D.L. Blumenthal. Sulfates in the Atmosphere. In: Proc. of the 69th Annual Meeting of APCA, Portland, OR, June 1976.

11. Husar, R.B., J.D. Husar, N.V. Gillani, S.B. Fuller, W.H. White, J.A. Anderson, W.M. Vaughan, and W.E. Wilson, Jr. Pollutant Flow Rate Measurement in Large Plumes: Sulfur Budget in Power Plant and Area Source Plumes in St. Louis Region. In: Proc. of the Div. Environ. Chem., 171st National ACS Meeting, New York, NY, April 1976.

12. White, W.H., J.A. Anderson, W.R. Knuth, D.L. Blumenthal, J.C. Hsuing, and R.B. Husar. Mapping Large Pollutant Plumes by Instrumented Aircraft: Support for Project MISTT, 1974. Final Report to USEPA on Contract No. 68-02-1919 1976.

13. Meterology Research, Inc., Altadena, California. Aircraft Monitoring Support for an Aerosol Characterization Study in St. Louis-1976 MISTT Program; Volume I, 1976 MISTT Sampling Summary. 1975; Volume II, 1975 MISTT Data Volume. 1976.

14. Wilson, W.E., Jr., R.B. Husar, N.V. Gillani, S.B. Fuller, W.H. White, J.A. Anderson, and D.L. Blumenthal. Characterization of Urban Plumes. In: Proc. of the Third Symposium on Atmospheric Turbulence, Diffusion and Air Quality, Raleigh, NC, October 1976.

15. Gillani, N.V. and R.B. Husar. Mesocscale Model for Pollutant Transport, Transformation and Ground Removal. In: Proc. of the Third Symp. on Atmos. Turbulence, Diffusion and Air Quality, Raleigh, NC, October 1976.

7. Plans:

1. Sulfate flow rates will be calculated and used to estimate $SO_2 \rightarrow SO_4^=$ conversion rates. Data on hydrocarbon composition and aerosol composition and size distribution will be studied for clues to conversion mechanisms.

2. The impactor samples will be analyzed for trace elements to document the characteristics of the plume aerosol. Detailed meteorological analysis will be performed to document the long range trajectories of the air masses sampled and to document the age of the plume for each pass on selected days.

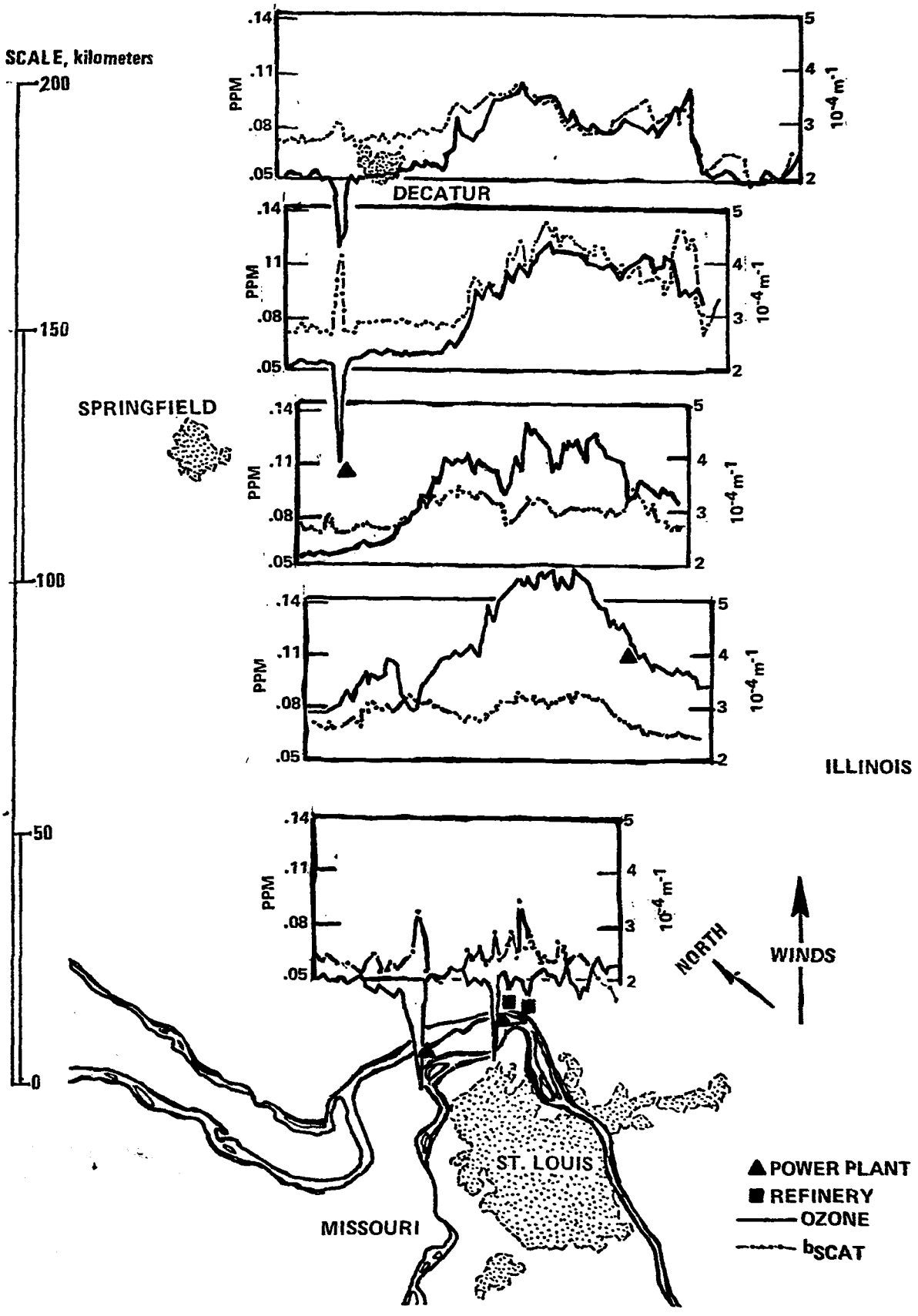


Figure 1. Ozone concentration and light-scattering coefficient, b_{scat}, downwind of St. Louis on July 18, 1975. Data are taken from horizontal traverses by MRI's instrumented aircraft. Graph baselines show sampling paths; note that baseline concentrations are not zero.

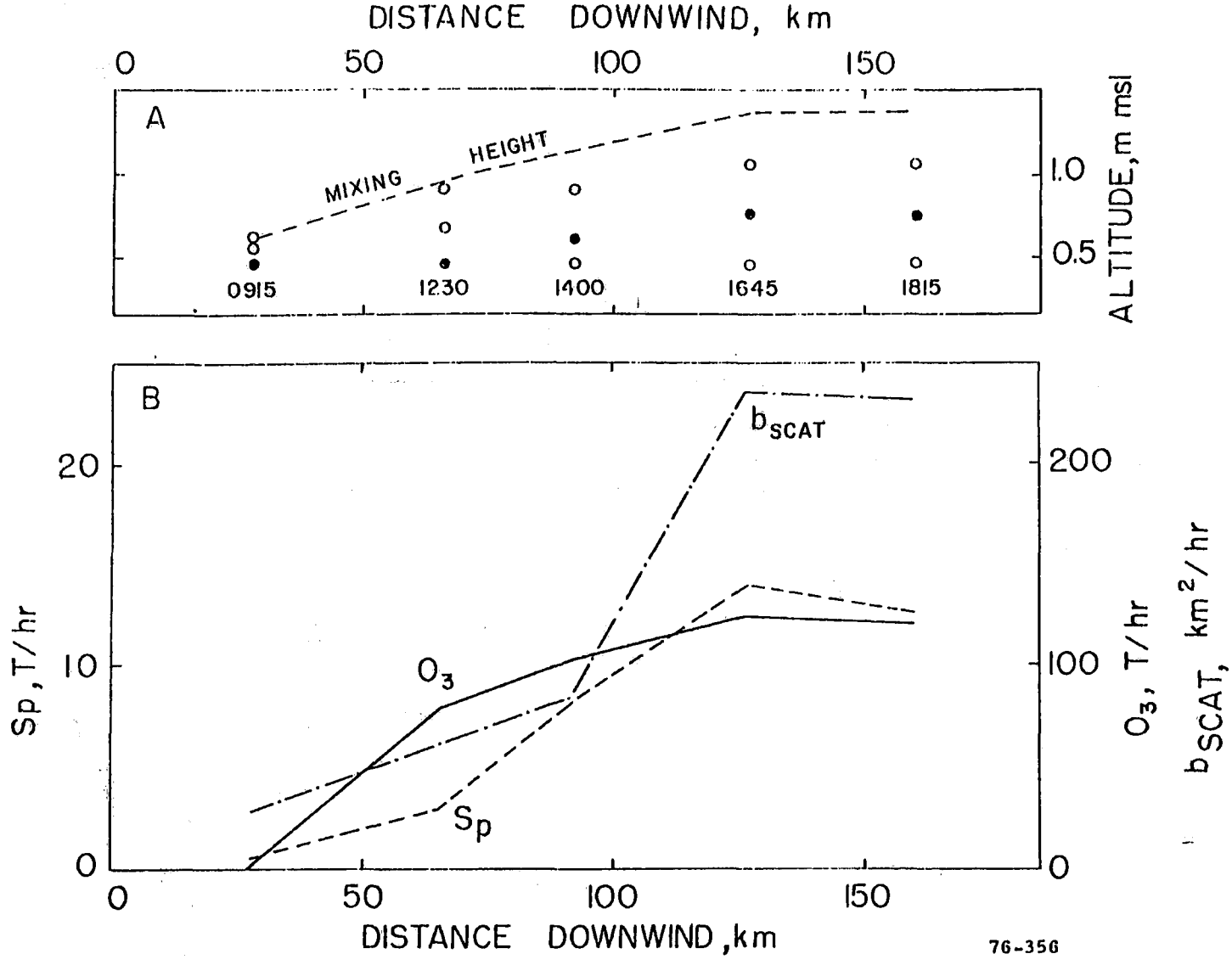


Figure 2. Traverse altitudes and pollutant flow rates in St. Louis urban plume on July 18, 1975. Data are plotted against distance downwind of the St. Louis Gateway Arch. (a) Location of horizontal traverses; solid dots correspond to traverses shown in Figure 1. Mixing heights were determined from aircraft soundings. Approximate time (CDT) of sampling is shown at bottom. (b) Flow rates (in excess of background) of ozone (O_3), light-scattering coefficient (b_{scat}), and particulate sulfur (S_p).

1. Task Title: Aircraft Monitoring and Analysis for an Aerosol Characterization Study in St. Louis, Missouri.

2. Objective:

To study the transport and the transformations undergone by sulfur dioxide and other pollutants in urban and power plant plumes.

3. Institution: Meteorology Research, Inc. (MRI), Altadena, California
Investigator: W.H. White, D.L. Blumenthal, J.A. Anderson

4. EPA Project Officer: W.E. Wilson

5. Progress:

As part of Project MISTT (Midwest Interstate Sulfur Transformation and Transport), MRI has used an instrumented aircraft to characterize the three-dimensional flow of aerosols and trace gases in the St. Louis area. The aircraft, a modified Cessna 206, was equipped for continuous monitoring of gas concentrations (SO_2, O_3, NO, NO_x), aerosol indices (condensation nuclei count, electrical chargeability, light-scattering coefficient), and meteorological characteristics (temperature, relative humidity, dew point, and turbulent energy dissipation). A sequential filter system collected high time-resolution samples for sulfate analysis, while an array of four cascade impactors obtained size-differentiated aerosol samples for chemical and microscopic analysis. An onboard electrical mobility analyzer/optical particle counter system determined the in situ size distributions of grab samples, and evacuated canisters collected air samples for hydrocarbon analysis.

Sampling flights were carried out on a total of thirty-nine days during the July 15 - August 15, 1975 and July 1 - 31, 1976 study periods. Flight patterns were designed to characterize cross-wind sections of large pollutant plumes at discrete distances downwind from their sources (Figure 1). These cross-sectional concentration fields were then combined with data on winds aloft, to calculate mass flow rates through each cross section (Figure 2). Changes in the flow rate of a given pollutant with increasing distance from the source reveal the effects of the chemical and physical transformations occurring in the atmosphere.

The 1975 experimental program documented the existence, under steady meteorological conditions, of a well-defined "urban plume" downwind of metropolitan St. Louis. This plume was mapped in detail out as far as 160 km downwind of St. Louis and was characterized at long distances by reduced visibilities and, during the daytime, by excess ozone. Analysis of aerosol and sulfate flow rates indicated that most of the excess light-scattering aerosol in the plume was sulfate of secondary origin. Sulfate concentrations in excess of 60 $\mu g/m^3$ were measured during one overnight flight.

The 1976 experimental program characterized the plume from the 2200 MW coal-fired power plant at Labadie, MO. Measurements were made under a variety of meteorological conditions during all phases of the diurnal cycle. Instrumental calibration procedures were tightened this year, with calibrations by EPA personnel of the gas monitors before and after each sampling mission, and cross-calibration of the aircraft and RAPS systems. An improved hydrocarbon sampling technique eliminated difficulties encountered in the 1975 program.

1. Task Title: Project MISTT Field Program

2. Objective:

To design, direct and implement a field program, based primarily on aircraft sampling of precursor gases and secondary aerosols, for the study of transport, transformation and ground removal of atmospheric sulfur.

3. Institution: Washington University (WU), St. Louis, Missouri
Investigators: R.B. Husar, N.V. Gillani, J.D. Husar.

4. EPA Project Officer: W.E. Wilson, Jr.

5. Progress July 1975 - October 1976:

A primary objective of Project MISTT (Midwest Interstate Sulfur Transformation and Transport) is to investigate the in situ formation and distribution of sulfates in large urban power plant plumes. The design of the field program, conducted in St. Louis during the summers of 1975 and 1976, called for a systematic deployment of several sampling and communications aircraft, as well as mobile ground-based sampling and meteorological support units. The experimental program was designed to provide a data base to determine the total mass flow rate (Q) of each measured pollutant across vertical planes normal to plume flow at a number of increasing downwind distances from the source. The downwind range covered was well beyond the mesoscale (100 km). The rates of change of Q for gaseous and particulate sulfur during plume transport permit the estimation of overall rates of SO_2 conversion and removal (see report on Project MISTT Data).

Two primary instrumented sampling aircraft have been used in the field program: a twin-engine Aero-Commander instrumented and operated by WU; and a single-engine Cessna 206 instrumented and operated by Meteorology Research, Inc. With some variations, these aircraft were equipped for continuous monitoring of gaseous (SO_2, NO, NO_x, O_3), aerosol (light scattering, charge, condensation nuclei count), meteorological (temp., R.H., dew point, turbulence), and aircraft position (altitude, VOR, DME) parameters. These data were recorded digitally at 1 or 2 sec. intervals on magnetic tapes. High time resolution collection of segregated fine and coarse particles was performed by a sequential two-stage filter tape sampler developed at WU. The filter samples were subsequently analyzed on the ground by a flash vaporization/flame-photometric detection method. The specific chemical forms of the sulfates were also determined by a thermal analysis technique. Other co-ordinated pollutant measurements were made from separate mobile sampling platforms on the ground (sulfur, b_{scat}, aerosol charge and correlation spectrometer [COSPEC] for SO_2 and NO_2) or in the air (COSPEC). Ground meteorological support was provided by three mobile pilot balloon (PIBAL) units, as well as a trained meteorologist on duty at the operations headquarters (OHQ). Aerosol size-distribution measurements were made with the MRI aircraft using an electrical aerosol analyzer and an optical particle counter.

All field operations were directed from a stationary OHQ, by WU via constant radio communication through a system which also interlinked the field units themselves. The complex communications link was facilitated by a radio-relay aircraft, whose presence was vital during flights ranging beyond 100 km. The OHQ also maintained a well-equipped command post to receive and translate real-time data into graphic plots, and, with the help of these and continually updated meteorological reports, provided on-line direction of the entire operation.[1]

Alternative flight patterns were devised depending on the availability of one or two sampling aircraft. In 1975, the MRI aircraft was the principal sampling unit, and was aided by a WU scout/relay aircraft. The latter, equipped more sparsely than the former for sampling, performed plume searching and similar scouting work ahead of the MRI aircraft in order to save valuable sampling time. In that year, the urban plume of St. Louis was studied (Figure 1) out to distances of over 160 km during daytime, and over 200 km at night. The sampling aircraft performed detailed cross-sectional mapping of the plume at each of a number of downwind distances by making horizontal plume traverses at several elevations within the plume, and augmenting these by vertical soundings. In 1976, the emphasis was placed on mapping the Labadie power plant plume with both sampling aircraft operating. The two aircraft were used to perform sampling at alternating downwind distances in a leapfrog fashion, thereby permitting a better spatial coverage and a closer approximation of the desired Lagrangian mode of plume sampling. With an ultra-sensitive sulfur analyzer aboard the WU aircraft, the Labadie plume was clearly tracked down to 300 km! During 1976, a long-range flight was also made providing air support for the flight of ERDA's instrumented balloon DaVinci. The field program was extended by one week to conduct three long-range test flights aimed at investigating synoptic scale hazy air masses and plume transport in the Ohio River valley region.

These field studies have yielded much valuable data in addition to the development of a sophisticated operational methodology of detailed plume studies over a long range. The aircraft studies have provided indirect estimates of overall SO_2 ground removal rates during plume transport. Direct local measurements of SO_2 dry deposition have also been performed over a variety of ground cover, under different meteorological conditions during day and at night, and during summer as well as winter.

6. Publications and Presentations:

1. Husar, R.B., N.V. Gillani, J.D. Husar, S.B. Fuller, W.H. White, J.A. Anderson, W.M. Vaughan and W.E. Wilson, Jr. Pollutant Flow Rate Measurement in Large Plumes: Sulfur Budget in Power Plant and Area Source Plumes in the St. Louis Region. In: Proc. 171st National ACS Meeting, Div. Environ. Chem., New York, NY, April 1976.

2. Husar, R.B., N.V. Gillani and J.D. Husar. Particulate Sulfur Formation in Power Plant, Urban and Regional Plumes. Presented at: Symp. Aerosol Sci. & Tech., 82nd. National Meeting of AIChE, Atlantic City, NJ Sept. 1976.

3. Wilson, W.E., Jr., R.J. Charlson, R.B. Husar, K.T. Whitby and D. Blumenthal. Sulfates in the Atmosphere. Presented at: 69th Annual Meeting, APCA, Portland, OR, June 1976.

4. White, W.H., J.A. Anderson, D.L. Blumenthal, R.B. Husar, N.V. Gillani, J.D. Husar and W.E. Wilson, Jr. 1976. Formation and Transport of Secondary Air Pollutants: Ozone and Aerosols in the St. Louis Urban Plume. Science 194:187-189.

5. Vaughan, W.M., R. Sperling, N.V. Gillani and R.B. Husar. Horizontal SO_2 Mass Flow Rate Measurements in Plumes: A Comparison of Correlation Spectrometer Data with a Dispersion and Removal Model. Presented at: 68th Annual Meeting, APCA, Boston, MA, June 1975.

6. Husar, J.D., R.B. Husar and P.K. Stubits 1975. Determination of Submicrogram Amounts of Atmospheric Particulate Sulfur. Anal Chem. 47:2062.

7. Husar, J.D., R.B. Husar, E.S. Macias, W.E. Wilson, J.L. Durham, W.K. Shepherd and J.A. Anderson 1976. Particulate Sulfur Analysis: Application to High Time Resolution Aircraft Sampling in Plumes. Atm. Environ. 10:591.

8. Macias, E.S. and R.B. Husar, 1976. Atmospheric Particulate Mass Measurement with Beta Attenuation Mass Monitor. Environ. Sci. & Tech. 10:904.

9. R.B. Husar, 1976. Thermal Analysis of Aerosols. J. Thermal Anal. 10:2.

10. Dannevik, W., S. Frisella, L. Granat and R.B. Husar. SO_2 Deposition Measurements in the St. Louis Region. In Preprint: 3rd Symp. on Atm. Turb., Diff., and Air Quality, AMS, Raleigh, NC, October 1976.

11. Husar, R.B. Determination of Ambient H_2SO_4 and its Ammonium Salts by in situ Aerosol Thermal Analysis. Presented at: Symp. on Radiation in the Atm., Garmisch-Partenkirchen, Germany, August 1976.

12. Husar, R.B., N.V. Gillani, J.D. Husar. A detailed report describing the field program of Project MISTT is presently being prepared.

7. Plans:

1. Aircraft instrumentation must include meteorological and NO_x measurements. The high sensitivity Meloy SA-285 Sulfur Analyser is currently being calibrated for continuous in situ monitoring of particulate sulfur, with possible on-line in situ thermal analysis of the aerosol.

2. The field operation may be improved by real-time input of telemetered data into the computer to yield graphics in near real-time. Efforts to further co-ordinate all the sampling units to better attain Lagrangian plume sampling will be made in future programs.

3. Longer range flight designs will be seriously considered.

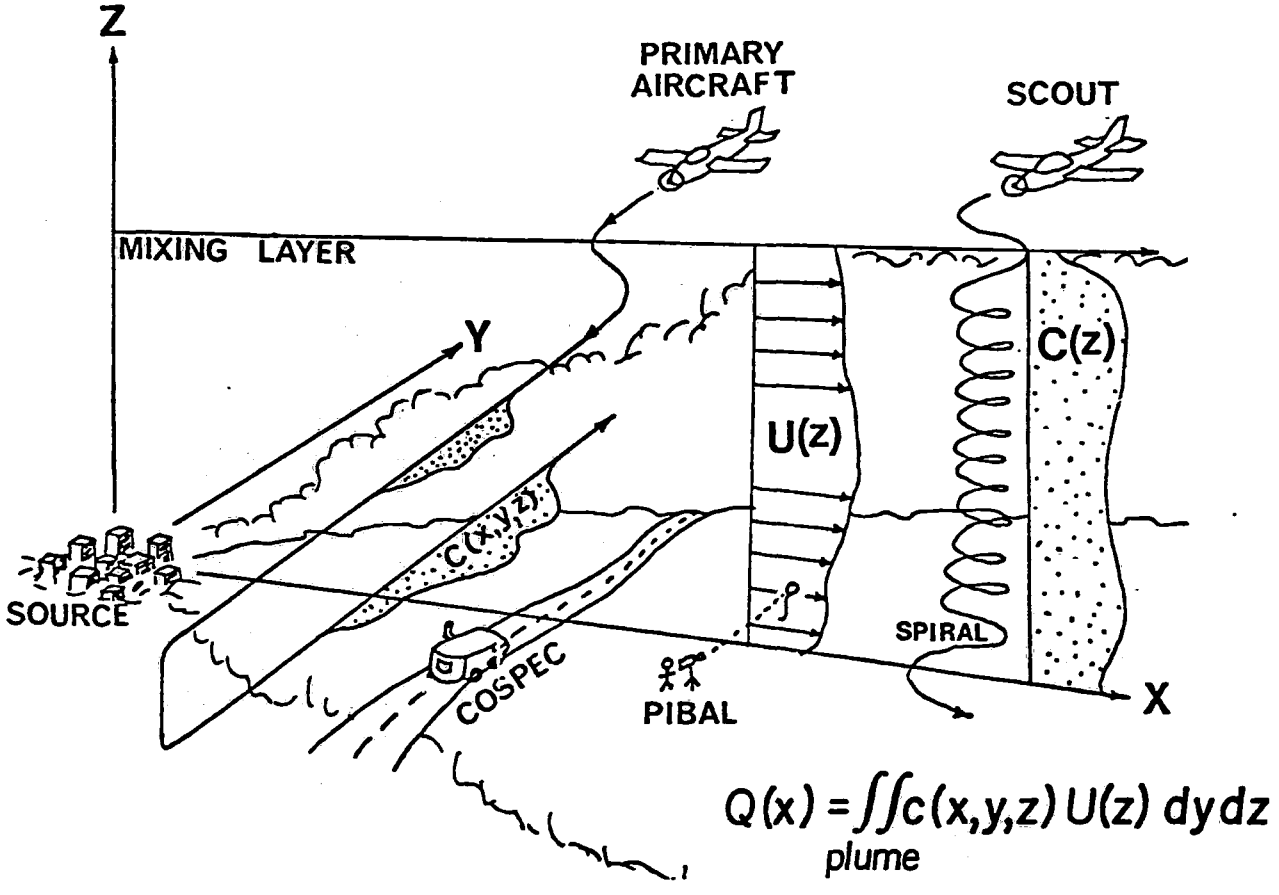


Figure 1. Field program components and methodology - urban-industrial plume.

1. Task Title: Formation of Atmospheric Aerosols - Aerosol Characteristics Measured at Glasgow, MO. and in the St. Louis Urban Plume during the summer of 1975.

2. Objective:

To characterize the aerosol in the St. Louis urban plume using the EPA mobile van located 160 km north of St. Louis.

To characterize the urban plume using an instrument package aboard the MRI aircraft.

3. Institution: University of Minnesota, Minneapolis, Minnesota
Investigator: K.T. Whitby

4. EPA Project Officer: W.E. Wilson

5. Progress:

Aerosol size distributions measured in the St. Louis urban plume can be characterized by a single log-normal mode with $\sigma_g = 2.2 \pm 0.2$ and a volume mean size of 0.45 ± 0.06 μm. There is little contribution from a nuclei mode except near ground sources such as the Wood River Refinery.

Calculated concentrations of aerosol sulfur in the urban plume using measured aerosol volume concentrations and assuming sulfur in the form of H_2SO_4, yield values about 75% of those obtained by J. Husar using a filter collection method.

Most of the submicron aerosol measured by the EPA van at Glasgow in 1975 can be characterized by a single log-normal mode with $\sigma g = 1.78 \pm 0.07$ and volume mean size of about 0.30 ± 0.06 μm. This accumulation mode accounts for most of the particles measured by the Aitken nuclei counter and the optical properties of the aerosol.

Two peak ozone periods observed on August 8 and August 9 show a significant difference in both the amount of visibility reduction and the distribution of the associated aerosols. Table I presented the pertinent parameters for the accumulation mode on both days. Visibility reduction is correlated more closely with relative humidity and mean aerosol size (volume weight) than SO_2 or O_3. The high b_{scat} during the second episode is explained by a shift in the mean size of the accumulation mode rather than the amount of aerosol present.

Making the assumption that sulfur in the aerosol measured in situ by the MAAS is in the form H_2SO_4, average sulfur content of the aerosol was calculated for both days and agrees with amounts measured on August 8 using filter collection techniques (J. Husar, 1975). For August 9, however, the calculated average amount is only 63% of the measured amount. This could imply either different sources or different conversion processes for the two days (Table II.)

6. Publications, Presentations, Theses: None

7. Plans:

1. Gas calibration constants for this data have been received recently and the problem of reading the aircraft tapes has been solved. Work on the data from 1975 will be completed as soon as the Los Angeles roadway study is completed in October, 1976.

Table I

Date	Typical Dist. Time of Measurement	Accumulation Mode Characteristics $\int V$ $\mu m^3/cc$	$\bar{D}_v$ μm	$\sigma_g v$	RH %	b_{scat} ($x10^{-4} m^{-1}$)	Particulate Sulfur $S < 1 \mu m$ $\mu g/m^3$	Gas Concentrations O_3 ppm	Sulfur ppm
Aug. 8,	19:00 - 20:00	48.5	0.254	1.85	51.6	2.91	7.0	0.104	0.027
Aug. 9,	20:00 - 21:00	78.2	0.367	1.8	70.0	13.2	14.0	0.106	0.018

Table II

Day	Average Measured $S < 1 \mu m$ $\mu g/m^3$	Average Calculated S (accumulation mode) $\mu g/m^3$
August 8	4.75	4.81
August 9	8.71	5.52

1. Task Title: Formation of Atmospheric Aerosols - Coal Fired Power Plant Plume Studies in St. Louis, summer, 1976.

2. Objective:

To furnish, calibrate, and reduce data from an in situ aerosol analyzing system aboard the MRI Cessna 206.

To furnish, operate, and reduce the data from a special mobile van that was operated on the ground under the power plant plumes being studied by the aircraft.

3. Institution: University of Minnesota, Minneapolis, Minnesota
Investigator: K.T. Whitby

4. EPA Project Officer: W.E. Wilson

5. Progress:

Aerosol size distributions at the Labadie power plant plume were obtained with an instrumented aircraft and the University of Minnesota's van. The intial examination of the aerosol size distributions shows significant formation of ultrafine aerosols in the size range smaller than 0.01μm. Typical nuclei mode sizes are 0.006 to 0.009μm with concentrations being in the 40,000 to 100,000 cm range. Even though significant numbers of nuclei are being formed, most of the aerosol mass being formed in the plume is being deposited directly into the accumulation mode (Figure 1).

6. Publications, Presentations, Theses: None

7. Plans:

1. To reduce and report data by spring 1977.

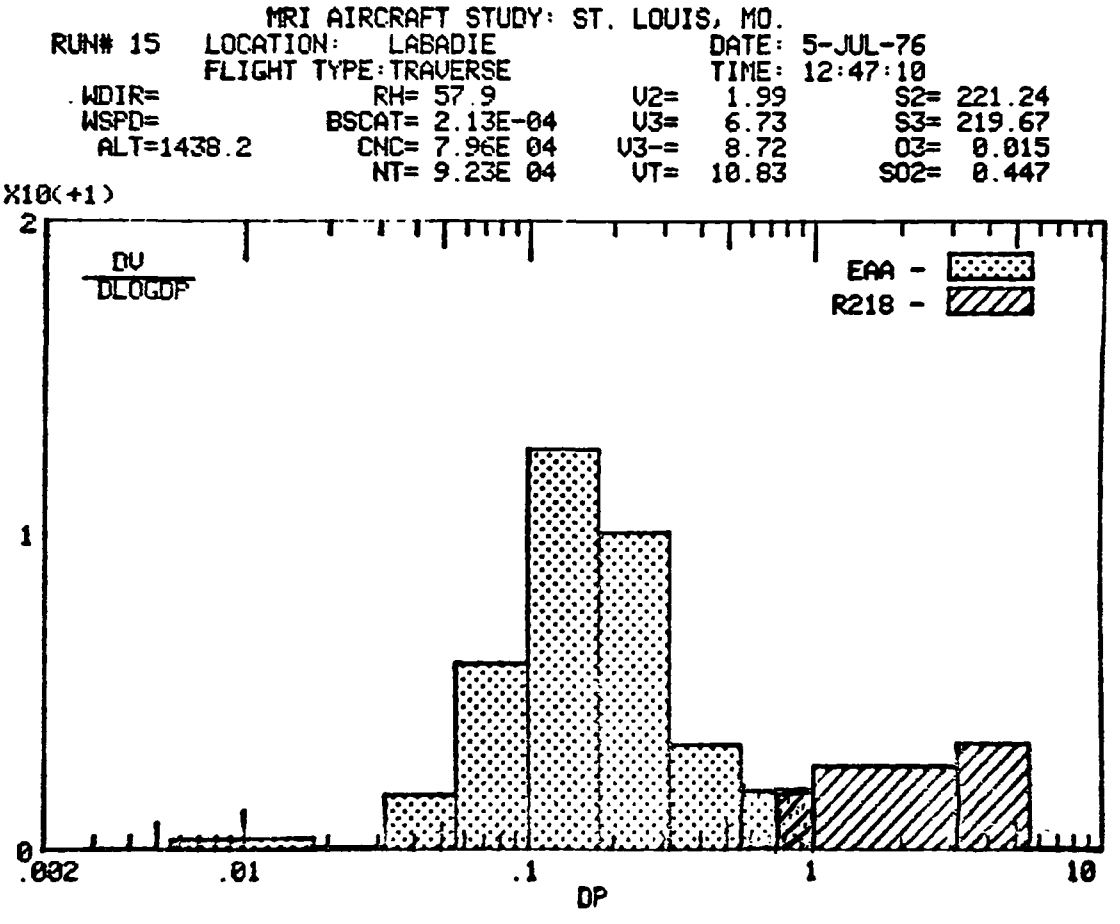


Figure 1. Typical aerosol volume size distribution measured at a distance of 6 Km from the Labadie coal fired power plant near St. Louis, Mo. on July 5, 1976. The condensation nuclei count in the plume is 80,000 cm^3 as compared to about 8,000 cm^3 outside of the plume, indicating significant nuclei formation in the plume.

1. Task Title: Project MISTT - Synoptic Scale Haziness and Air Pollution

2. Objective:

To investigate using the national visibility data, the spatial extent, temporal behavior, secondary pollution content, and variability of synoptic scale hazy air masses ('blobs') in the U.S.

3. Institution: Washington University (WU), St. Louis, Missouri
Investigators: R.B. Husar, N.V. Gillani, J.D. Husar.

4. EPA Project Officer: W.E. Wilson, Jr.

5. Progress July 1976 - October 1976:

Recent observations of high background sulfate and ozone levels over wide rural areas of eastern U.S. have raised concern about the long range transport and interaction of effluents from many sources. Project MISTT field studies have already evidenced the in situ formation and transport of aerosols and ozone in St. Louis plumes over a range of about 200 km, and the associated reduction of visibility over the exposed areas. The study of synoptic scale air pollution is hampered by the absence of an adequate national data base for secondary pollution. This study investigates the suitability of national visibility data as an effective surrogate for regional scale secondary pollution data.

Ground level visual range observations are made hourly at hundreds of airport stations operated by the National Weather Service (NWS). The data become immediately available via long-line telephone service, generally on paper or paper-tape output, and are also stored on magnetic tapes for subsequent delivery to the user. The spatial density of data permits meaningful computer contour plotting of visibility or light extinction. A comprehensive package of computer software has been developed which may be driven by hourly real-time input, or stored magnetic tape input of an entire month's data. Within minutes, the computer yields graphic visibility contour plots, as well as surface wind plots. The programs also perform differential shading of different visibility regions.

A detailed case study has been made of a synoptic scale air pollution episode affecting various parts of the eastern U.S. over a period of nearly two weeks during Summer 1975. The formation and long range transport of a synoptic hazy 'blob' were documented for this episode using sequential visibility plots (Figure 1), surface winds, long-range post-facto air parcel trajectories, national weather maps and detailed local air quality data. It was observed that a stagnant meteorological condition, persisting for more than two days over the high sulfur emission region of the Ohio River valley, led to the accumulation of large amounts of aerosols and visibility reduction to less than 6 miles over a synoptic region. Subsequent circulatory air motion associated with a high-pressure cell in the region caused the motion of the 'blob' westward to Kansas, then up through Iowa and Minnesota, and back to the southern Great Lakes region. At that time, the hazy blob (<6 mile visibility) extended up to 2000 km. A subsequent rapid southward movement of a cold Canadian front swept the blob to Florida within two days.

The motion of the blob as seen from visibility plots was consistent with long-range air parcel trajectories. Satellite pictures also substantiated the existence and scale of the haziness. Local air pollution data in Missouri and Illinois verified the temporal behavior of the blob motion and were consistent with its synoptic dimensions. Aerosol light scattering as measured by nephelograms, and daily ozone data in St. Louis showed remarkably good correlation with light extinction based on visibility data. In St. Louis, 40% of the aerosol mass in the blob was measured as sulfuric acid. Finally, hand contour plots of ozone and sulfates for days of available data, Figure 2) showed the existence of synoptic ozone and sulfate blobs of high concentrations coinciding closely with the hazy blobs. A limited analysis was also performed to show the predominance of pollution over water content as the source of haziness for R.H. <70%.

The utility of visibility reduction data as an excellent qualitative surrogate for aerosol mass has been demonstrated. The use of this very convenient tool in visualizing synoptic scale pollution has important implications and should be exploited.

6. Publications and Presentations:

1. Husar, R.B., N.V. Gillani, J.D. Husar, C.C. Paley. Large Scale Haziness over Midwestern and Eastern U.S. Presented at: Symp. on Radiation in the Atm., Garmisch-Partenkirchen, Germany, August 1976.

2. Husar, R.B., N.V. Gillani, J.D. Husar. A Study of Long Range Transport from Visibility Observations, Trajectory Analysis and Local Air Pollution Monitoring Data. Presented at: NATO/CCMS 7th Tech. Meeting on Air Pollution Medeling and its Applications. Airlie, VA , September 1976 (Proc. to be issued).

3. Husar, R.B., D.E. Patterson, C.C. Paley, N.V. Gillani. Ozone in Hazy Air Masses. Presented at: EPA Intl. Conf. on Photochemical Oxidant and its Control, Raleigh, NC , September 1976 (Proc. to be issued).

4. Husar, R.B., N.V. Gillani, J.D. Husar, C.C. Paley, P.N. Turcu. Long Range Transport of Pollutants Observed Through Visibility Contour Maps, Weather Maps and Trajectory Analysis. In Preprint: 3rd Symp. on Atm. Turb., Diff. and Air Quality, Amer. Met. Soc., Raleigh, NC, October 1976.

5. Gillani, N.V. and R.B. Husar. Synoptic Haziness Over the Eastern U.S. and its Long Range Transport. Invited Paper: 4th National Conf. on Fire and Forest Meteorology, Soc. Amer. Foresters/Amer. Met. Soc., St. Louis, MO, November 1976 (Proc. to be issued).

7. Plans:

1. Further automation will permit direct input of real-time data from weather telephone service terminal into computer memory.

2. Visibility plots will be prepared at fixed intervals daily to provide a larger scale pollution perspective, as well as to signal the onset of blob conditions.

3. To collect data for a second detailed case study of a suspected blob episode relative humidity and visibility reduction during the single episode period.

4. To assess the role of relative humidity in light extinction and visual range reduction.

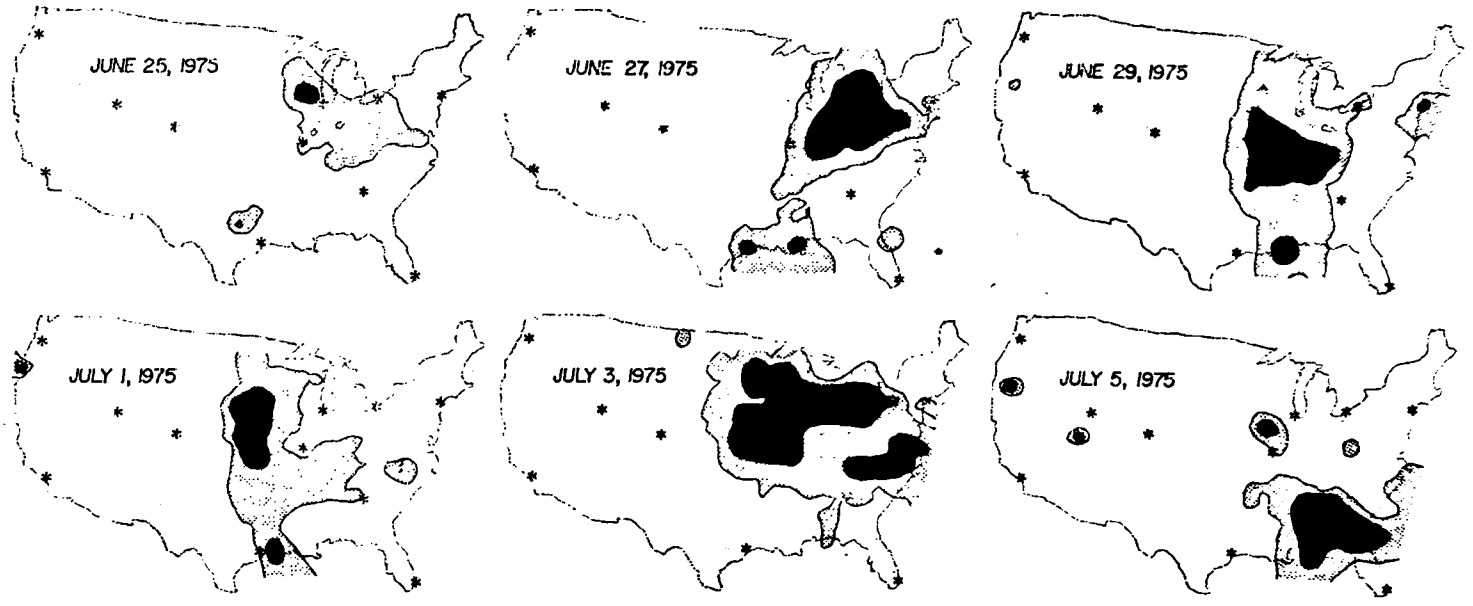


Figure 1. Sequential computer contour plots for noon ground visibility: solid black, <4 miles; shaded grey, 4-6 miles.

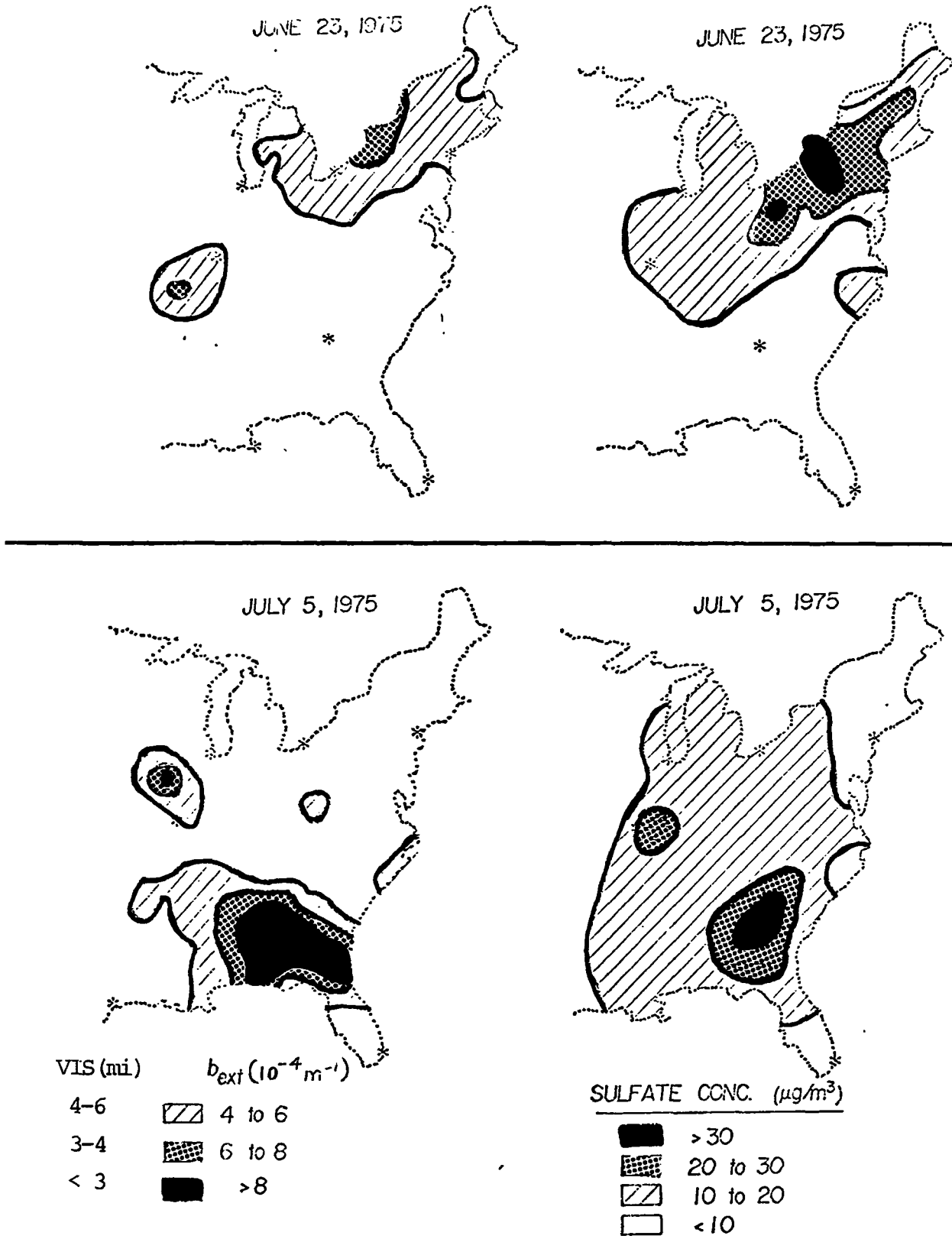


Figure 2. Comparison of noon visibility (left) and 24-hour sulfate concentration (right) for two days.

1. Task Title: Processing and Analysis of Project MISTT Data

2. Objectives:

To develop and implement an interactive, graphics-oriented computer software package for rapid processing of aircraft data.

To design the basic strategy for data analysis, and provide guidelines for the design of an appropriate field program.

To determine rates and mechanisms of SO_2-to-sulfate conversion and pollutant removal by dry deposition.

3. Institution: Washington University (WU), St. Louis, Missouri
Investigators: R.B. Husar, N.V. Gillani, J.D. Husar

4. EPA Project Officer; W.E. Wilson, Jr.

5. Progress July 1975 - October 1976:

The data processing objective has been fully achieved with great success. A comprehensive and versatile minicomputer software package has been developed which permits systematic processing, and basic analysis of the data logged on magnetic cassettes aboard aircraft, (WU, MRI) or instrumented ground vehicles (EMI, roadway study). Particulate sulfur (S_p) data are merged into the permanent data files as soon as filter sample analyses are completed. A special feature of the software is the rapid initial turnaround of the data within hours of the sampling mission. This processing includes data transfer to computer memory, calibration and instrument response time corrections, data averaging, and production of hard copies of graphical data displays in engineering units. It provides immediate data quality check, indicates sampling instrument malfunctions, and provides a basis for daily interaction between the scientists and the field crew. Meteorological data (pibals, visibility, etc.) are processed simultaneously. User-oriented interactive data display-edit-integration procedures have also been developed and used. A new software package, designed for highly-automated production of hard copy graphics for the data volume, is nearing completion.

The field program, as well as data analysis, are based on the mass flow rate (Q) approach. ΔQ values for SO_2 and S_p at successive downwind sections permit the evaluation of SO_2 loss-to-conversion and to other forms of scavenging. The application of our dispersion-transformation-removal model then permits the estimation of overall rates of conversion and of removal, consistent with the observed changes in Q. The measurements also permit the determination of pollutant ratios (e.g. SO_2/sulfate). The analysis based on Q is viewed as the more rational approach for non-conservative species. These basic concepts have been used in a field program designed to provide detailed pollutant measurements, as well as a completely co-ordinated meteorological data base.

Project MISTT data analyzed so far have indicated a substantial loss of SO_2 to the ground in the mesoscale transport of low-level plumes (e.g. urban-industrial). Tall stack emissions remain airborne for longer distances (Figure 1). The data for both types of plumes on hot, sunny, summer days tend to implicate the presence of ozone, (either from in situ formation in the plume (Fig. 2a), or from entrainment of the background air (Fig. 2b)) as being conducive to in situ aerosol formation. The highest observed aerosol and sulfate concentrations ($b_{scat} > 10 \times 10^{-4} m^{-1}$ and $[SO_4] > 60\ \mu g/m^3$) were under nighttime conditions, with no direct evidence of ozone participation in the reactions forming the aerosols. Data of this type are rich in information regarding rates as well as mechanisms. Furthermore, both urban-industrial and power plant plumes have been tracked downwind to 300 km (1976), with detailed data of direct possible significance in regional models.

A mesoscale parametrized dispersion model has been developed to include the effects of dry deposition, as well as pseudo-first order gas-to-particle conversion and precipitation scavenging. The conversion rate is allowed to depend on plume transport time, thus permitting simulation of changing plume composition. The model also permits free interaction between meteorology and chemistry in a non-homogeneously turbulent atmosphere. Comparison of model results with measured pollutant flow rates have yielded realistic overall rates of conversion and removal.

6. Publications and Presentations:

1. Gillani, N.V. 1975. Data Processing, Management and Analysis Related to Project MISTT, 1975. Report submitted to EPA Project Officer.

2. Husar, R.B., N.V. Gillani, J.D. Husar, S.B. Fuller, W.H. White, J.A. Anderson, W.M. Vaughan and W.E. Wilson, Jr. Pollutant Flow Rate Measurement in Large Plumes: Sulfur Budget in Power Plant and Area Source Plumes in the St. Louis Region. In: Proc. 171st National ACS Meeting, Div. Environ. Chem., New York, NY, April 1976.

3. Husar, R.B., N.V. Gillani and J.D. Husar. Particulate Sulfur Formation in Power Plant, Urban and Regional Plumes. Presented at: Symp. Aerosol Sci. & Tech., 82nd National Meeting of AIChE, Atlantic City, NJ, September 1976.

4. Wilson, W.E., Jr., R.J. Charlson, R.B. Husar, K.T. Whitby and D. Blumenthal. Sulfates in the Atmosphere. Presented at: 69th Annual Meeting, APCA, Portland, OR, June 1976.

5. White, W.H., J.A. Anderson, D.L. Blumenthal, R.B. Husar, N.V. Gillani, J.D. Husar and W.E. Wilson, Jr. 1976. Formation and Transport of Secondary Air Pollutants: Ozone and Aerosols in the St. Louis Urban Plume. Science. 194:187-189.

6. Vaughan, W.M., R. Sperling, N.V. Gillani and R.B. Husar. Horizontal SO_2 Mass Flow Rate Measurements in Plumes: A Comparison of Correlation Spectrometer Data with a Dispersion and Removal Model. Presented at: 68th Annual Meeting, APCA, Boston, MA, June 1975.

7. Whitby, K.T., B.C. Cantrell, R.B. Husar, N.V. Gillani, J.A. Anderson, D.L. Blumenthal and W.E. Wilson, Jr. Aerosol Formation in a Coal Fired Power Plant Plume. In: Proc. Div. of Environmental Chemistry, Amer. Chem. Soc., NY, April 1976.

8. Wilson, W.E., Jr., R.B. Husar, K.T. Whitby, D.B. Kittleson and W.H. White. Chemical Reactions in Power Plant Plumes. In: Proc. Div. of Environmental Chemistry, Amer. Chem. Soc., NY, April 1976.

9. Gillani, N.V. and R.B. Husar. Analytical-Numerical Model for Mesoscale Transport, Transformation and Removal of Air Pollutants. Presented at: NATO/CCMS 7th Tech. Meeting on Air Pollution Modeling and its Applications, Airlie, VA, September 1976 (Proc. to be issued).

10. Gillani, N.V. and R.B. Husar. Mesoscale Model for Pollutant Transport, Transformation and Ground Removal. Presented at: 3rd Symp. on Atm. Turb., Diff. and Air Quality, Amer. Met. Soc., Raleigh, NC, October 1976.

11. Husar, J.D., R.B. Husar, E.S. Macias, W.E. Wilson, J.L. Durham, W.K. Shepherd and J.A. Anderson. 1976. Particulate Sulfur Analysis: Application to High Time Resolution Aircraft Sampling in Plumes. Atm. Environ. 10:591.

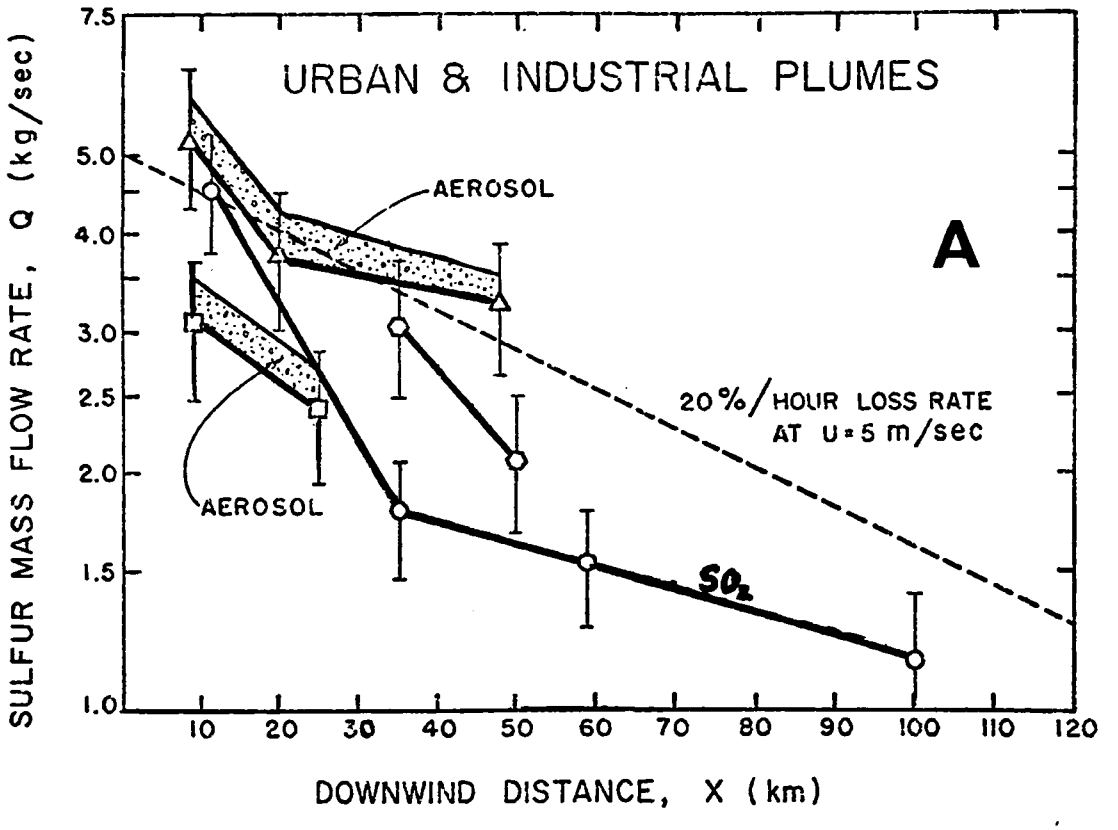
7. Plans:

During the past year analysis of aircraft data has been quite limited. However, it will be the area of major emphasis and effort in the next year.

1. The production of detailed data volumes will be completed for all 1975, 1976 field data collected by WU, MRI, Univ. of Minnesota and EMI. These packages will consist of edited, averaged data in engineering units on magnetic tape storage; tape format documentation; data volumes of hard copy graphical displays with integrations, flight logs, sampling and meteorological summaries, and pibal data.

2. Mass flow rates, appropriate pollutant ratios, meteorological analyses, and model calculations and comparisons will be performed for all appropriate data of 1975 and 1976 field programs with the following principal objectives: a) extraction of SO_2-to-sulfate conversion rates and SO_2 removal rates; b) determination of dominant factors governing the conversion rates; c) quantitative relationships between conversion rates and incluencing factors (i.e. models of mechanisms).

3. The main mathematical model will be extended to include: temporal variability, full utilization of meteorological data, and non-linear conversion processes.



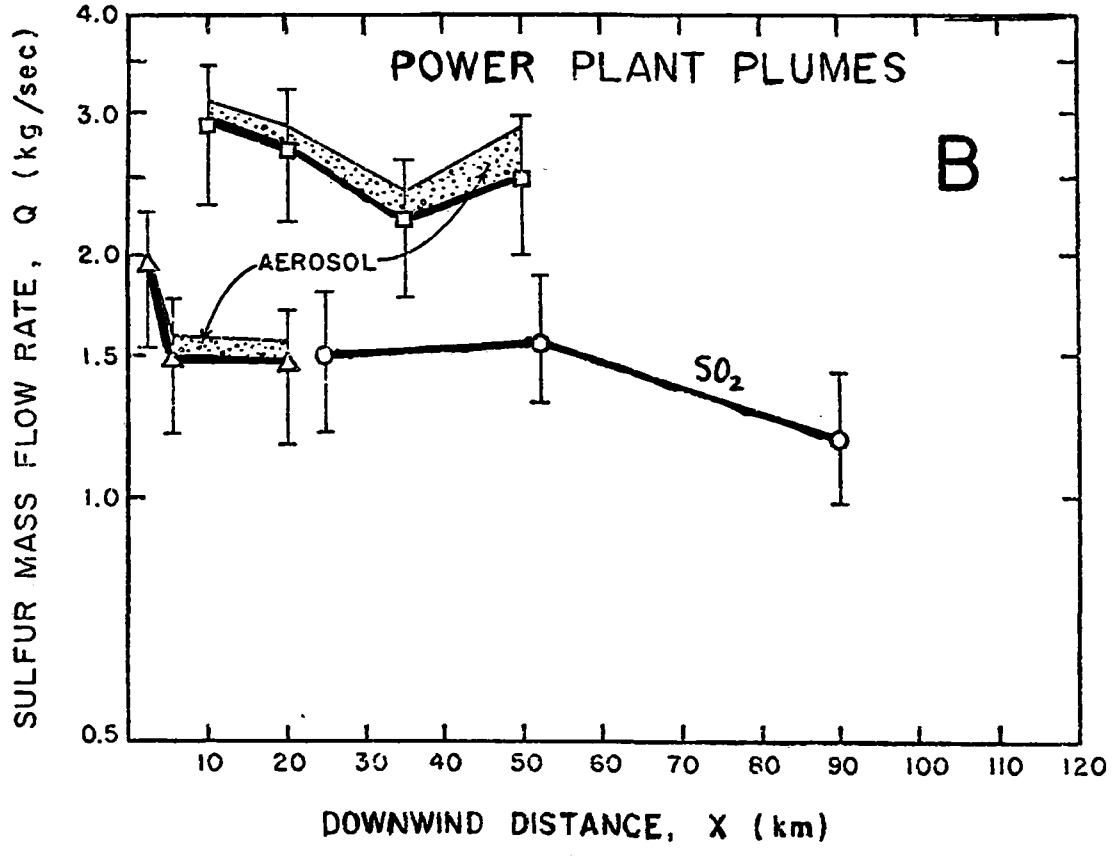


Figure 1. Mesoscale depletion of sulfur mass flow rate in large plumes.
a) Rapid ground loss from urban-industrial plumes.
b) Slow depletion from power plant plumes.

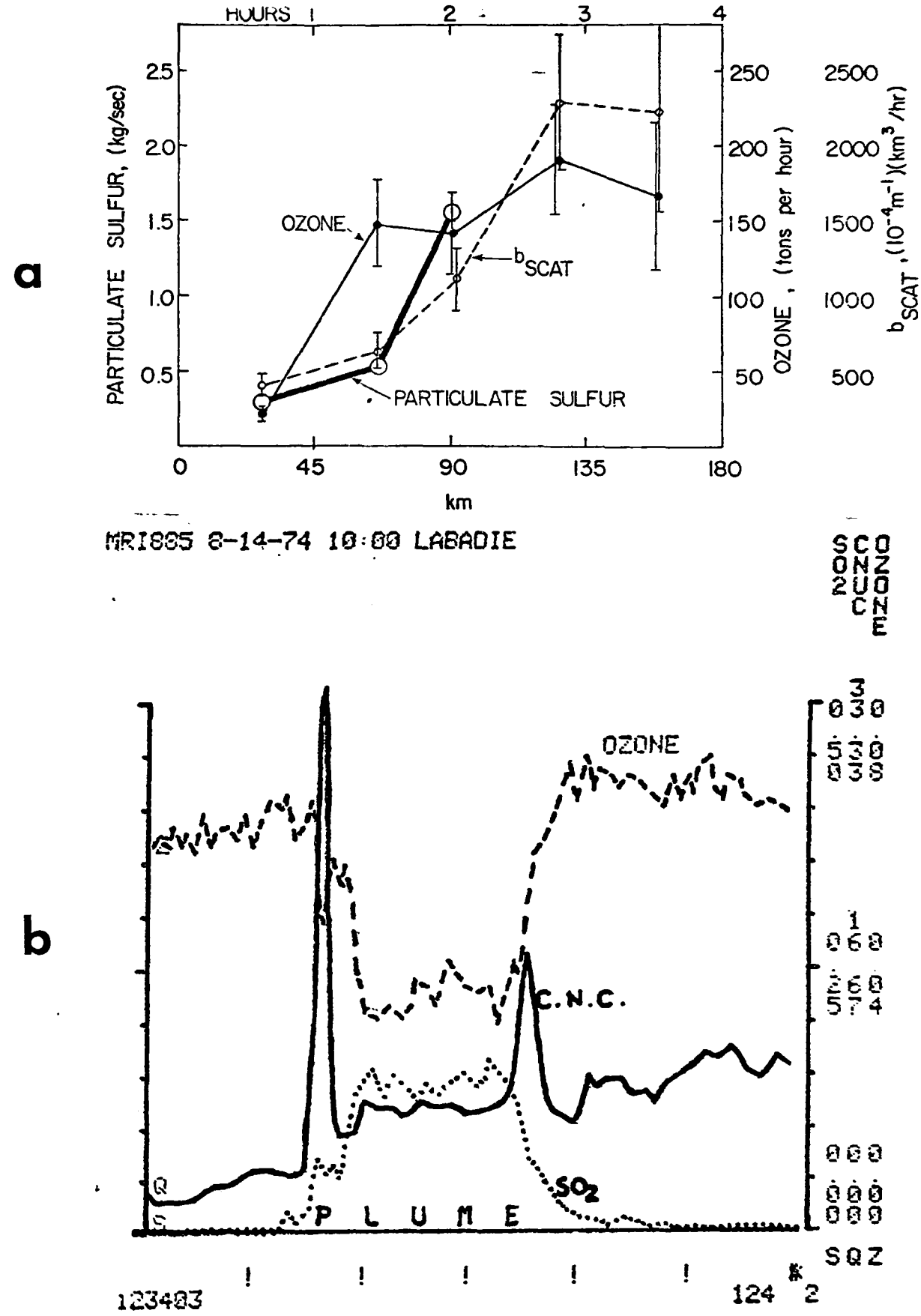


Figure 2. Indication of role of ozone in plume aerosol formation.
a) In situ ozone and aerosol formation in St. Louis urban plume, 7/18/75.
b) Possible homogeneous nucleation processes (increase in Condensation Nuclei Count) by entrainment of background ozone at plume edges, Labadie, 8/14/74.

1. Task Title: St. Louis Plume Study - Halocarbon and Hydrocarbon Measurements

2. Objective:

To make continuous halocarbon and hydrocarbon measurements at a rural site 100 km northwest of St. Louis in order to identify the source and age of the air mass. This information will be used, in conjunction with EPA measurements of pollutants and Argonne measurements of meteorological parameters, to study the transformation of pollutants during transport.

To examine ozone concentrations in terms of the source, age, and hydrocarbon concentrations, natural and anthropogenic, of the air mass.

3. Institution: Washington State University
Investigator: R.A. Rasmussen

4. EPA Project Officer: W.E. Wilson

5. Progress:

In July and August of 1975, Washington State University carried out an intensive measurement program to determine the species of hydrocarbons and their concentrations in a clearly rural location that was often influenced by emissions from the St. Louis urban area as well as other more distant pollutant sources. An instrumented field laboratory was operated at the field site near Glascow, Ill. for thirty days.

Real-time quantitative analyses of the following halocarbons were conducted using an automated electron capture gas chromatograph: CCl_3F (F-11), CCl_2F_2 (F-12), $CHCl_3$, CH_3CCl_3 and CCl_4. Detailed C_2-to-C_5 and C_3-to-C_{12} hydrocarbon analysis were performed at two-hour intervals on a 24 hr. basis, seven days a week. The intent was to discriminate natural from anthropogenic hydrocarbons and to apply this understanding to the involved chemistry that results in hydrocarbon oxidation products such as ozone and aerosols.

A data report for use by other investigators was provided. An interpretive report concentrating on the general character of the hydrocarbons measured at the rural site and on the oxidant behavior in the air masses that passed over the study site was also prepared. From the data at this one site, four distinct situations illustrating the interplay of meteorology and chemistry in the photolysis of urban and rural hydrocarbons, and the consequent production of elevated rural ozone levels can be recognized:

1) Remote or background air: unambiguously clean and therefore accepted as characteristic of air unaffected by any discernable urban contamination;

2) Young plumes: urban pollutant plumes with easily measurable levels of primary pollutants still reacting in transit over the rural study site;

3) Old plumes: clearly marked fluorocarbon plumes, with most of the reactive hydrocarbons consumed;

4) Regional pollution: no plumes noticeable, but clear evidence of photochemical oxidation of hydrocarbons and elevated oxidant.

Fluorocarbon-11, hydrocarbon, and weather data were used to identify and describe these situations and to interpret the observed concentrations of hydrocarbons and oxidant resulting from local photochemistry and transport.

6. Publications, Presentations, Theses:

1. Robinson, E. and R.A. Rasmussen. Identification of Natural and Anthropogenic Rural Ozone for Control Purposes. Presented at: APCA Speciality Conference on Ozone/Oxidants: Interactions with the Total Environment, March 10-12, 1976, Dallas, TX.

2. Rasmussen, R.A., D.J. Pierotti, and J.P. Krasnec. Analysis of Halocarbons in the Atmosphere. Presented at: 69th Annual Meeting APCA, June 27-July 1, 1976, Portland, OR.

3. Chatfield, R. and R.A. Rasmussen. An Assessment of the Continental Lower Tropospheric Ozone Budget. To be published in: Proc. of OCED-EPA Inter. Conf. on Photochemical Oxidant Pollution and Its Control, Raleigh, NC, September 12-17, 1976.

4. Rasmussen, R.A. Atmospheric Halocarbon Monitoring Techniques. Presented at: WMO Technical Conference on Atmospheric Pollution Measurement Techniques, Gottenburg, Sweden, October 11-15, 1976.

5. Rasmussen, R.A. 1976. Surface Ozone Observations in Rural and Remote Areas. J. of Occupational Medicine. 18(5):346-349.

6. Rasmussen, R.A., R.B. Chatfield and M.W. Holden Transport of Hydrocarbon and Oxidant Chemistcies Observed at a Rural Mid-West Site. Presented at: "Non-Urban Tropospheric Composition." Symposium, Miami Beach, FL, November 10-12, 1976.

7. Plans

This task has been completed.

1. Task Title: Application of Statistical and Mathematical Methods to Air Pollution Problems

2. Objective:

To determine the feasibility of using the IBM Model to simulate tracer experiments.

3. Institution: Northrup Technical Services
Investigator: J.H. Overton

4. EPA Project Officer: W.E. Wilson

5. Progress:

A diffusion model developed by IBM for EPA has been modified and used to simulate the results of SF_6 tracer experiments carried out in St. Louis during August of 1975. Initially, the input/output parts of the IBM model computer program had to be modified to make it useful for the SF_6 simulations. These modifications allow for minute-by-minute input of source strengths, and minute-by-minute output of concentrations at specified locations. The results of four SF_6 tests, tests #1, 3, 4, and 5 have been simulated (Figure 1 and Table 1). During the tests SF_6 was released at a location, at a constant rate, for a given period of time. Meanwhile, an automobile traveling at a constant rate downwind of the release point collected air samples at equal distance intervals. The samples were later analyzed for SF_6. The plots are of concentration versus distance along the collecting automobile's path.

Test #1 was a low level release 100 feet above RAMS site 111. In test #3, the SF_6 was released from the KETC TV tower 1000 feet above the ground.

The relationship between the release sites and the traverse routes (highway 40 for the data in Figure 1) is indicated in Figure 2.

In addition to the collection of SF_6 on the road, hourly averages were obtained at RAMS sites. Table 1 lists the experimental and simulated values of hourly averages at those sites. There is a general lack of agreement between simulated and experimental values for test #1, the low-level release. In most cases the simulated values are far too large. Better results were obtained for the high-level release, test #3.

An attempt was made to obtain better results by varying the release height, source location and the mixing height. The results were not significant; thus indicating that the effects of other parameters, such as eddy diffusivity should be investigated.

6. Publications, Presentations, Theses:

1. Overton, J.H. B.K. Lamb and F.H. Shair. A Dual Tracer Study for Validation of Models with Respect to High and Low Altitude Sources. Presented at: The 7th Inter. Technical Meeting on Air Pollution Modeling, Aulie, VA, September 8, 1976.

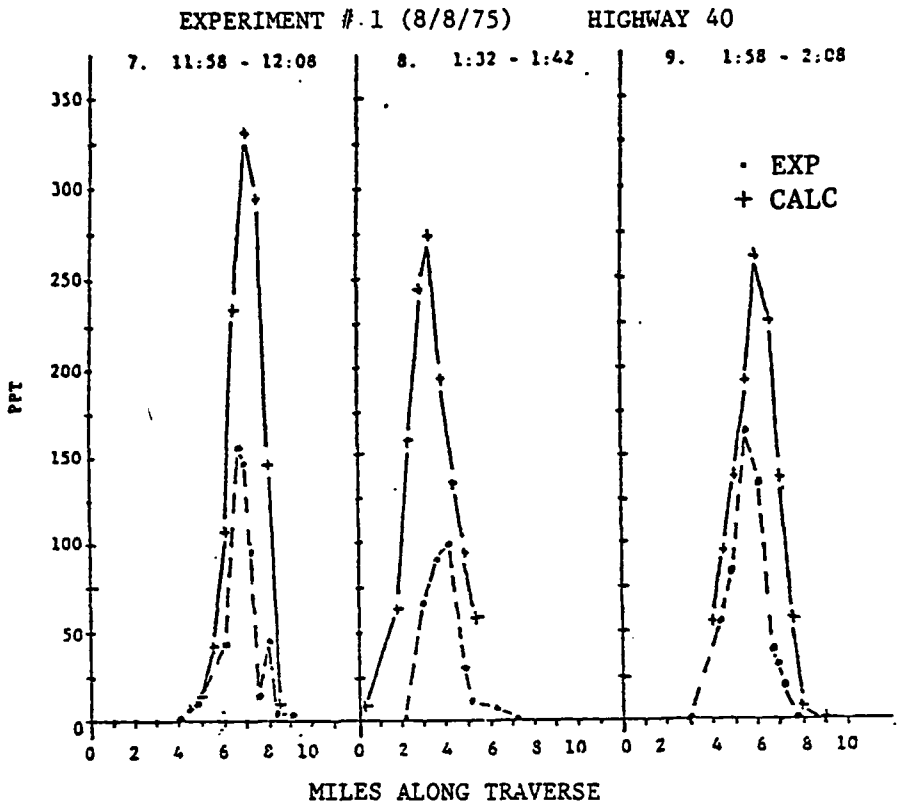
7. Plans:

Project completed.

TABLE 1. COMPARISON OF CALCULATED AND MEASURED Concentrations of SF_6 (ppt)

	Test #1 (8/8/75) Time of Day - CDT				Test #3 (8/11/75) Time of Day - CDT			
Station Number	11-12	12-1	1-2	2-3	11-12	12-1	1-2	2-3
101	0	2/0	0	-	0/1	2/7	0/1	0
102	-	6/0	0	0	0	0/17	26/17	8/4
103	-	0	0	0	0	0/4	0	0
104	0	0	0	0	0	0/0	0	0
105	4/0	0	5/0	-	0/1	0/1	0	0
106	12/279	13/206	4/79	0/32	0/8	27/26	6/11	7/1
109	5/0	-	1/0	-				
110	0	2/0	0	0				
112	6/9	36/65	63/172	46/189				
113	0	-	1/0	2/0	0	0	9/6	7/21
114	0	0	0	0	5/0	0	7/12	13/29
115	0	0	0	-	0	0	0/3	0
116	0	0	0	-	0	0	0	0
117	0	0	0	0				
118	0	0	4/0	0	0	0	0	0
119	0	0	0	0	6/15	22/18	18/22	44/18
120	-	-	-	-	0	0	0	0
121	0	0	0/2		0	0	0	0

Single entry: Both calculated and experimental concentrations are the same. Double entry: Experimental/calculated. Stations not included either had faulty data, no sample taken or a value of zero.



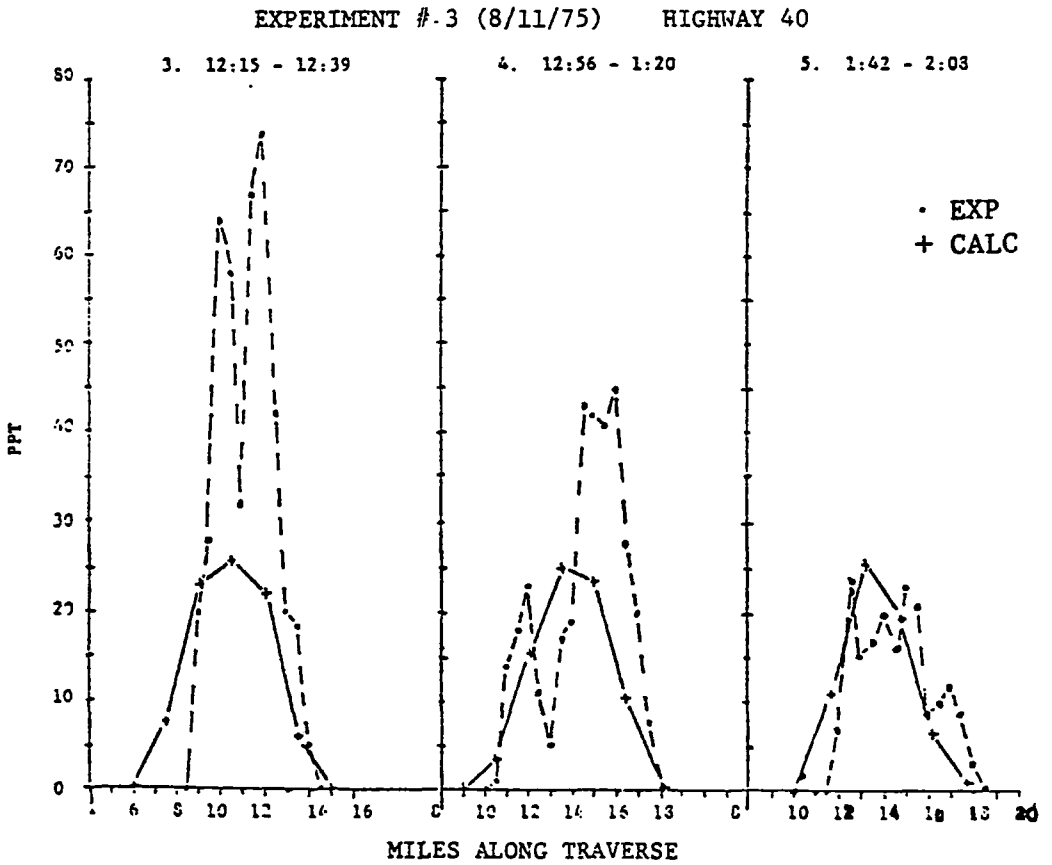
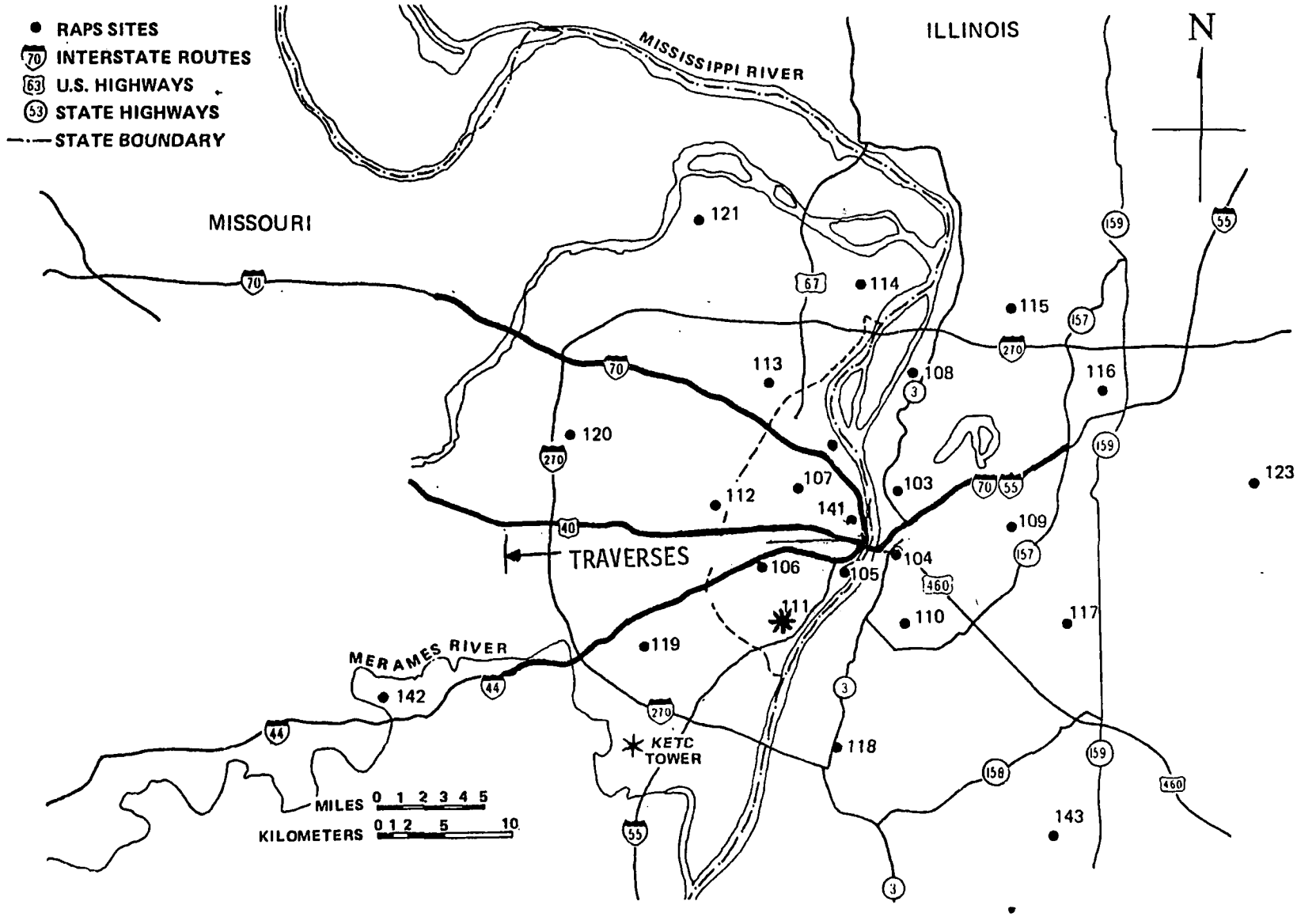


Figure 1. Calculated and experimental concentrations of SF_6.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U.S. HIGHWAYS
STATE HIGHWAYS
STATE BOUNDARY
MISSISSIPPI RIVER
ILLINOIS
N
MISSOURI
121
114
115
113
108
116
120
107
103
112
141
123
109
TRAVERSES
106
104
105
111
110
117
MERAMES RIVER
119
142
118
KETC TOWER
143
MILES 0 1 2 3 4 5
KILOMETERS 0 1 2 5 10

Figure 2

1. Task Title: Atmospheric Boundary Layer Measurements in Project MISTT
Atmospheric Boundary Layer Measurements in Project MISTT-II.

2. Objective:

To investigate the transport and dispersive properties of the Planetary Boundary (PBL), for the purpose of improving numerical simulations of pollutant distribution downwind of emission sources.

3. Institution: Atmospheric Physics Section, Radiological and Environmental Research Division, Argonne National Laboratory (ANL).
Investigator: B. Hicks

4. EPA Project Officer: W.E. Wilson and G. Holzworth.

5. Progress:

From July 15 to August 15, 1975, three Divisions of ANL (Chemical Engineering, Energy and Environmental Systems, and Radiological and Environmental Research) cooperated in a research effort to detect pollutants emanating from the St. Louis industrial complex at a range of 100 km, and to observe and document those atmospheric planetary boundary layer phenomena that influence pollutant transport over such distances.

The six-part 1975 Sangamon experiment was conducted over relatively flat farming country near Auburn, Illinois, in order to investigate the evolution of the PBL capping inversion between the hours of 0400-1200. To do this, hourly radiosonde (or pibal) ascents were tracked by a digitized, double theodolite system, the WHAT System, to give wind and temperature profiles. Measurements made at the Galesburg, Champaign, and Auburn stations to determine the geostrophic and thermal winds were supplemented by hourly air-ways reports from the National Weather Service. Also, a network of four acoustic sounders measured the mesoscale variations in refractive index fluctuations near the inversion at Glasgow, Palmyra, Waverly, and Auburn.

Supporting micrometeorological data were gathered over the maize and soybean crops grown in that area. These data included continuous measurements of wind, temperature, dewpoint, ozone gradients, and net radiation. Direct measurements of momentum and sensible heat fluxes were made by the eddy correlation technique over both crops. In addition, line-of-sight remote sensing of the wind field and the heat and moisture fluxes were made near the surface by laser scintillation and optical blurring methods.

A third part of the experiment involved measurements from a kytoon. These measurements gave high resolution profiles of wind speed and temperature in the lowest 100m. Although slow balloon motions created unwanted noise in the low frequencies, the high-frequency portion of the kinetic energy spectrum was evaluated at various heights in the lowest 100m. Air samples were obtained at heights above and below the inversion at different times during the morning hours.

Besides monitoring the concentration of ozone, sulfur dioxide, nitrogen dioxide, hydrocarbons, etc., and performing the analysis of the air samples taken from the kytoon system, measurements were made of particulates, sulfate specification, and oxygen-isotope ratios. An air-chemistry network was also established, with stations at Glasgow, Auburn, and near St. Louis.

Finally, measurements were made of turbidity by comparing the direct and indirect components of the solar radiation. A network of stations located at St. Louis, Glasgow, Waverly, Famersville, Hillsboro and Auburn were deployed for this purpose.

The 1976 Sangamon experiment was conducted from July 13 to August 5, at the same site near Auburn as the 1975 PBL experiment. The second field experiment was to describe the diurnal cycle of the structure of the atmospheric mixed layer, particularly in the late afternoon and evening conditions of inversion formation. The following details will concern only those parts of the experiment that differed significantly from the 1975 exercise.

Automatic acoustic sounding equipment was operated over a 3/4 km triangular array in order to record spatial variations in the behavior and evolution of the mixed layer of the atmosphere. These sounders indicated the presence of decoupled, stable layers aloft, and provided information on the behavior of gravity waves on the inversion layers. The breaking of such waves near the top of inversions is a potential mechanism for the transfer of both pollutant materials and thermal energy through these stable layers.

Instead of kytoon-borne sampling equipment, the second Sangamon experiment benefited from the participation of aircraft from both Battelle Pacific Northwest Laboratories and the EPA. Other cooperative ventures resulted in experimental programs addressing the surface fluxes of small particles (in cooperation with the University of Minnesota) and of ozone (University of Michigan).

During February 1976, related cooperative study (in collaboration with Washington University of St. Louis and Environmental Quality Research, Incorporated) was performed downwind of the Wood River refinery complex. This investigation resulted in the first successful measurement of the vertical turbulent flux of small particles. The measurements of particle flux, obtained as a result of coupling a fast-response particle detector to the eddy-correlation apparatus, showed deposition velocities that are not substantially different from those which might be predicted for SO_2 flux. This casts some doubt on the advisability of assuming greatly dissimilar values for these two cases.

6. Publications and Presentations:

1. Wesely, M.L., B.B. Hicks, W.P. Dannevik, S. Frisella, and R.B. Husar. An Eddy-Correlation Measurement of Particulate Deposition from the Atmosphere. Submitted to: Atmos. Environ.

2. Hicks, B.B. and C.M. Sheih. Some Observations of Eddy Fluxes within a Maize Canopy. Submitted to: Boundary-Layer Meteorology.

7. Plans:

1. Further intensive studies of PBL behavior are being planned in conjunction with several other cooperating organizations.

2. To complete a series of field experiments measuring deposition velocities in natural circumstances.

3. To test the parameterizations developed in PBL programs over larger spatial and temporal scales.

1. Task Title: Field Sampling and Analysis of Airborne Particulate Material in Conjunction with Project MISTT.

2. Objective:

To determine the frequency of occurrence of acidic sulfate on a regional basis and to attempt to identify those temporal and spatial relationships that may exist in its occurrence.

3. Institution: Argonne National Laboratory, Argonne, Illinois.
Investigator: P.T. Cunningham

4. EPA Project Officer: W.E. Wilson

5. Progress:

The Chemical Engineering Division of Argonne National Laboratory has developed techniques for collecting time-resolved, size-fractionated samples of airborne particulate matter using Lundgren impactors and subsequent chemical analysis by Fourier Transform infrared spectroscopy (FTS). The analysis is quantitative for sulfate and nitrate ions. It also provides qualitative information on the relative amounts of acidic sulfate (the observation of bisulfate ion and/or sulfuric acid) and other chemical species found in the samples.

Previous studies have shown ammonium sulfate to be a major constituent of submicrometer-size ambient aerosol particles. Acidic sulfate has also been shown to occur frequently in the Chicago, IL area. During the MISTT project, these techniques were applied for the first time on a regional basis in order to help elucidate the long-range transport and transformation of sulfur compounds in the air. The frequency, extent and magnitude of acidic sulfate episodes were to be evaluated and correlated with other data coming from the MISTT project.

Sampling sites were established approximately 100 km apart at St. Louis, MO; Glasgow, IL; and Auburn, IL. By using Lundgren impactors, size- and time-resolved samples of airborne particulate matter were collected almost continuously at these sites from July 15, 1975 to August 11, 1975. The samples were collected with two-hour time resolution and with four size fractions which had nominal 50% cut-points of 10 μm, 3 μm, 1 μm, and 0.3 μm for impaction stages I, II, III and IV, respectively.

Analysis of the submicrometer-size stage IV samples, which represent the secondary particulate matter, has been completed and some qualitative assessments have been made. Ammonium sulfate was found in varying amounts in all stage IV samples. Widespread acidic sulfate episodes were observed to have occurred twice during the sampling period (Fig. 1). The time correlation for the occurrence of acidic sulfate at the three sites suggests strongly that such occurrences are regional in nature. The apparent diurnal variations in the degree of acidity associated with the acidic sulfate episodes appear to be related more to the onset of mixing associated with breakup of the nocturnal inversion than to an increase in photochemical activity.

6. Publications, Presentations and Theses:

1. Yang, R.T., P.T. Cunningham, W.I. Wilson and S.A. Johnson. 1975. Kinetics of the Reaction of Half-Calcined Dolomite with Sulfur Dioxide Adv. in Chem. Ser. 139:149-157.

2. Hubble, B.R., S. Siegel and P.T. Cunningham. 1975. On the Feasibility of the $CaSO_4$-Gas REaction for Regeneration of Sulfated Dolomite or Limestone in Sulfur Dioxide Pollution-Control Processes. J. Air Poll. Control Assoc. 25(12):1256.

3. Cunningham, P.T. and S.A. Johnson. 1976 Spectroscopic Observation of Acid Sulfate in Atmospheric Particulate Samples. Science. 191:77-79.

4. Cape, T.W., V.A. Maroni, P.T. Cunningham and J.B. Bates. 1976. Raman and I.R.-Emission Studies of Some Tungstate- and Molybdate-Containing Melts. Spectro. Acta 32A:1219-1223.

5. Holt, B.D., A.G. Engelkemeir, S.A. Johnson and P.T. Cunningham. Oxygen Isotopy in the Formation of Sulfate Aerosols. Second International Conference on Stable Isotopes, October 20-23, 1975, Oak Brook, Illinois. (In Press).

6. Cunningham, P.T. and B.D. Holt. Stable Isotope Ration Measurements in Atmospheric Sulfate Studies. International Symposium on the Development of Nuclear-based Techniques for the Measurement, Detection, and Control of Environmental Pollutants, March 15-19, 1976, Vienna, Austria. In Press .

7. Holt, B.D., P.T. Cunningham and A.G. Engelkemeir. Application of Oxygen-18 Analysis to the Study of Atmospheric Sulfate Formation. International Conference on Stable Isotopes, August 4-6, 1976, Lower Hutt, New Zealand. In Press.

8. Hubble, B.R., S. Siegel, L.H. Fuchs, H.R. Hoedstra, B.Tani and P.T. Cunningham. 1976. The Formation of $Mg_3Ca(SO_4)_4$ During the Sulfation Reaction of Dolomite. Submitted to J. Air Poll. Control Assoc.

7. Plans:

1. Data analysis, including quantification of the neutral sulfate and correlation with other data, will be completed for the stage IV samples.

2. The acidic sulfate episodes will be examined.

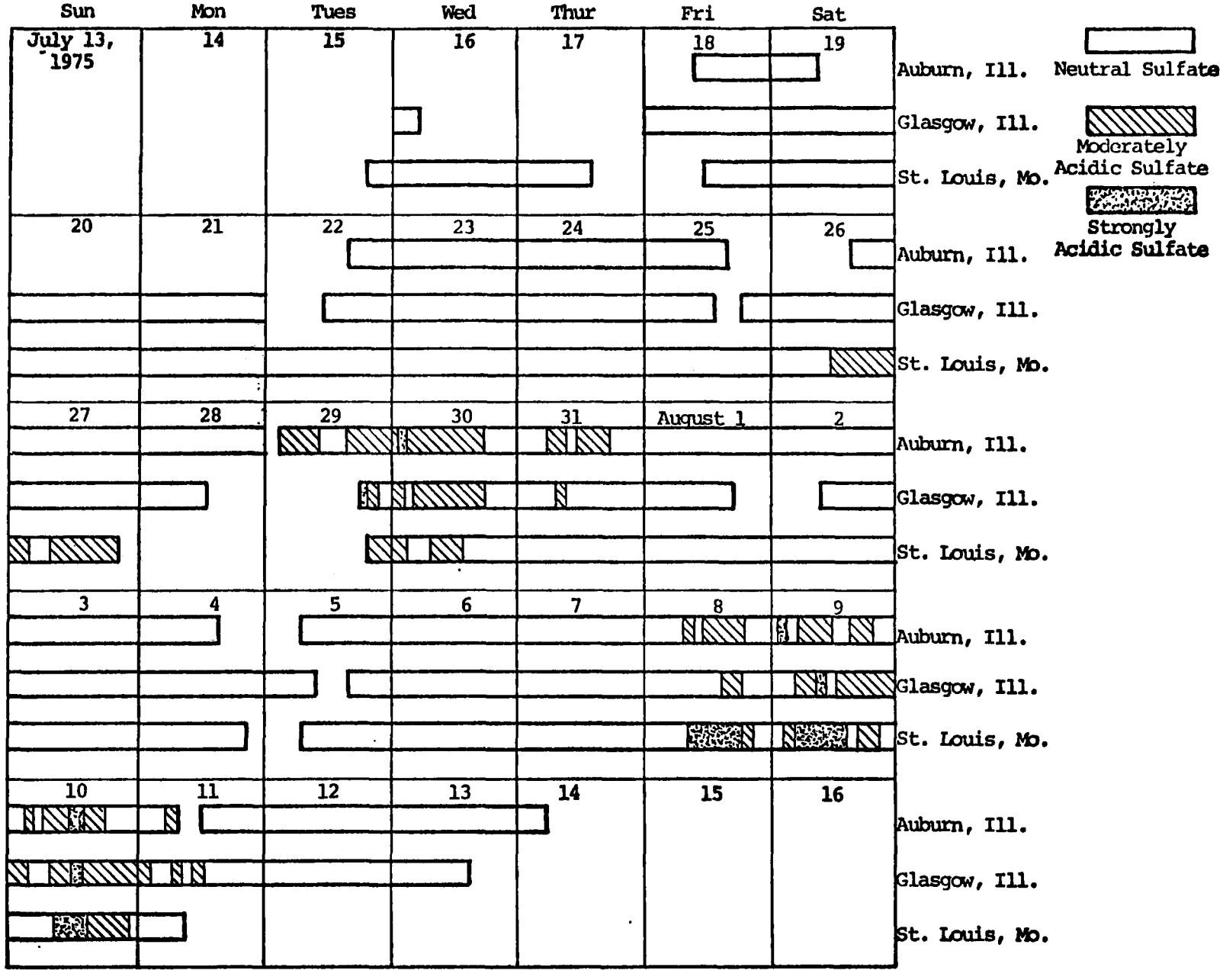

Figure 1. **Sampling Periods and Acidic Sulfate Episodes during Project MISTT.**

1. Task Title: Formation of Atmospheric Aerosols - Aerosols Produced by Combustion.

2. Objective:

To study the size distribution and concentration of primary aerosols produced by relatively clean combustion sources operated in compliance with air pollution emission standards.

3. Institution: University of Minnesota, Minneapolia, Minnesota
Investigator: K.T. Whitby

4. EPA Project Officer: W.E. Wilson

5. Progress:

Barsic has studied the interaction of fresh combustion aerosols with filtered and unfiltered humid air surrounding a premixed propane-air flame. Two modes were observed in the fine particle size range (Fig. 1). Both modes are in the Aitken nuclei size range. The smallest mode, AN1 mode, is more strongly affected by humidity. Experiments in which the sulfur content of the fuel was varied suggest that the AN1 mode consists of sulfur compounds.

More aerosols were produced when unfiltered air was used around the flame (Table 1).

From particle size distribution measurements made on highly dilute diesel exhaust aerosols at idle, 1/4 load, and full load, Dolan found size distributions showing systematic variations in the mean size of the combustion nuclei and accumulation modes. At full load the accumulation mode dominated, at 1/4 load both were apparent, and at idle the nuclei mode of increased size dominated.

Verrant has developed an improved system for sampling and rapidly diluting diesel aerosols. Using this system, aerosol size distributions on a single cylinder Onan diesel were found to be very similar to those measured 9 m behind a Peugeot diesel on the GM test track in Milford, MI. These size distributions have a single mode in the volume distribution at 0.2 μm.

6. Publications, Presentations, Theses:

1. Barsic, N.J. Size Distribution and Concentration of Fine Particles Produced by Propane-Air Combustion in a Controlled Humidity Environment. Ph.D. Thesis. Mechanical Engineering Department, University of Minnesota, MN. Estimated completion, January, 1977.

2. Dolan, D.F., D.B. Kittelson and K.T. Whitby. Measurement of Diesel Exhaust Particle Size Distributions. ASME Preprint #75-WA.APC-5. Presented at: The American Society of Mechanical Engineers Annual Meeting, November 30 - December 4, 1975.

3. Verrant, J.A. Development of a Dilution System for Measuring Diesel Exhaust Particulate Matter. M.S. Thesis. Mechanical Engineering Department, University of Minnesota, MN, September, 1976.

4. Verrant, J.A. Sampling and Physical Characterization of Diesel Exhaust Aerosols. Submitted to: Society of Automotive Engineers. 1976.

5. Whitby, K.T., D.B. Kittelson, B.K. Cantrell, N.J. Barsic and D.F. Dolan. Aerosol Size Distributions and Concentrations Measured During the General Motors Proving Grounds Sulfate Study. Presented at: The Division of Environmental Chemistry, American Chemical Society, San Francisco, CA, August, 1976.

7. Plans:

1. The sampling and size distribution techniques developed will be applied to the study of other clean sources of combustion aerosol.

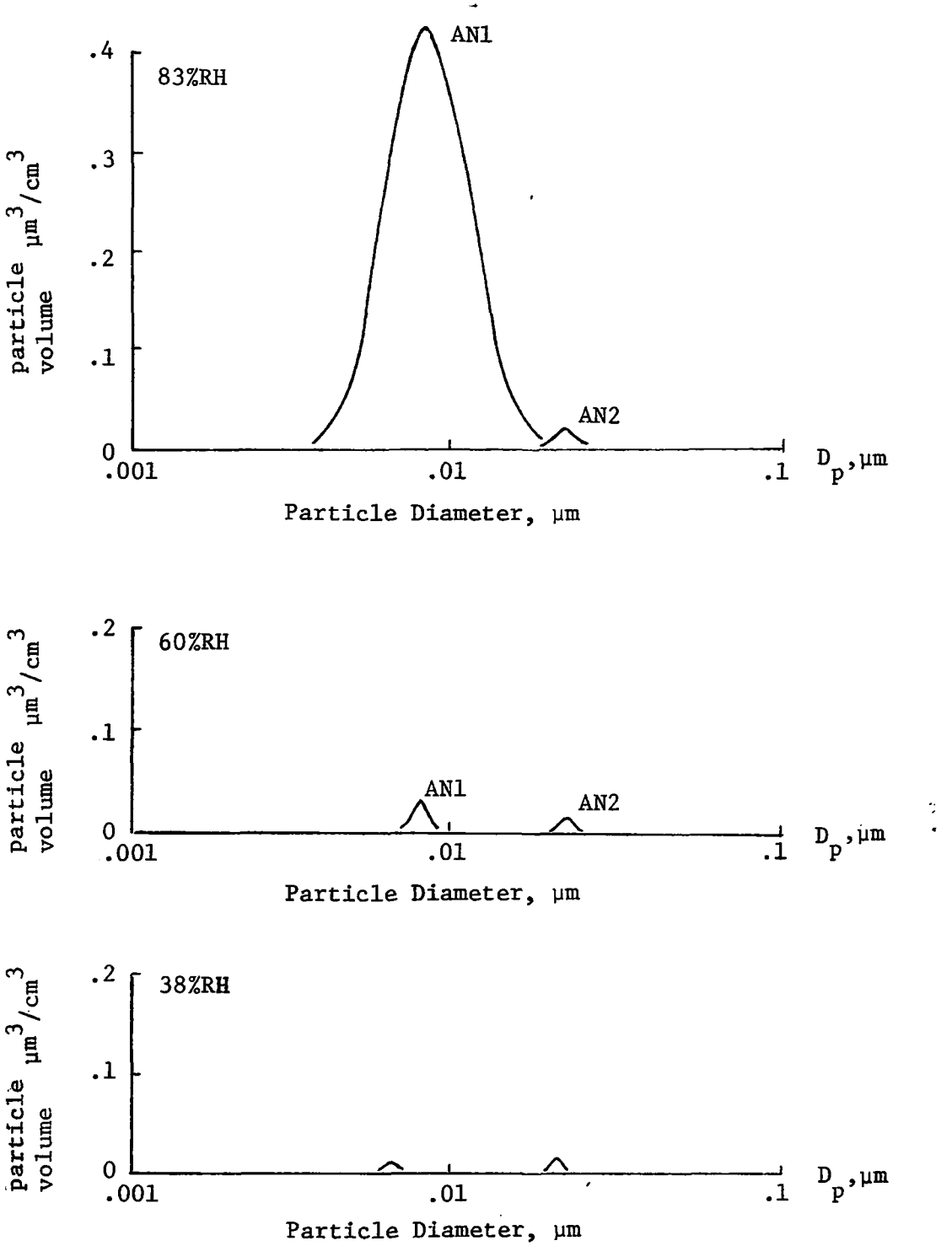

Figure 1. Aitken nuclei mode volume distributions for fuel-rich combustion aerosols diluted (30:1) with filtered, humidity controlled air. Since all three distributions are to the same scale, and $\Delta V/\Delta \log D_p$ is plotted vs. $\log D_p$, the area under each curve is proportional to the volume of aerosol produced. Volume distributions for lean and stoichiometric flames are similar in the AN1 mode but do not have the AN2 mode. The AN1 mode may be due to sulfates, while the AN2 mode probably consists of carbon.

Table I

%RH	Particle volume ($\mu m^3/cm^3$) filtered air	Particle volume ($\mu m^3/cm^3$) unfiltered air	Number Mean Diameter (μm) filtered air	Number Mean Diameter (μm) unfiltered air
40	.003	.015	.0030	.0026
90	.12	.23	.0050	.0050

1. Task Title: Aerosol Formation and Removal in Plumes.

2. Objective:

To develop comprehensive models to account for dispersion, precursor formation, and aerosol dynamics in plumes. To carry out experimental measurements of dry deposition and especially the effects of charge on deposition.

3. Institution: University of Texas, Austin, Texas
Investigators: J.R. Brock, P.B. Middleton, and K. de Bower

4. EPA Project Officer: J.L. Durham

5. Progress:

The adverse effects of the atmospheric aerosol are related to the many and complex rate processes which determine the characteristics of the suspended particles. Development of rational control strategies, which seek to relate ambient concentrations to primary and secondary sources, requires models which deal with these complexities.

This project is seeking to develop useful models of the various processes which determine the size and composition distribution of the atmospheric aerosol. These various processes are summarized in a general rate equation:

$$\left\{\begin{array}{l}\text{rate of change in}\\ \text{composition or}\\ \text{size distribution}\end{array}\right\} = - \left\{\begin{array}{l}\text{rate of change}\\ \text{due to advection}\end{array}\right\}$$

$$+ \left\{\begin{array}{l}\text{rate of change}\\ \text{due to dispersion}\end{array}\right\} + \left\{\begin{array}{l}\text{rate of change}\\ \text{due to coagulation}\end{array}\right\} + \left\{\begin{array}{l}\text{rate of change}\\ \text{due to condensation}\end{array}\right\}$$

$$+ \left\{\begin{array}{l}\text{rate of change due to}\\ \text{homogeneous nucleation}\end{array}\right\} \left\{\begin{array}{l}\text{rate of primary due to}\\ \text{primary sources}\end{array}\right\}$$

$$+ \left\{\begin{array}{l}\text{rate of change due to}\\ \text{sedimentation}\end{array}\right\}$$

Processes occurring at surfaces, such as deposition, appear as boundary conditions. These rate relationships are coupled to rate equations for the various chemical species participating in the aerosol growth processes.

A numerical model, called EPOSOD, has been developed to provide a real time simulation of aerosol size and composition. As a preliminary effort in developing a model for secondary aerosol formation in plumes, EPOSOD has been used to study the interaction of a plume containing a high NO concentration with ambient levels of ozone (Figures, 1, 2, 3).

Instrumentation is being assembled to determine the deposition rates of aerosols.

6. Publications, Presentations, Thesis:

   1. K. de Bower. A Method of Modelling Chemically Reactive Plumes. M.S. Thesis, University of Texas, Austin, TX, August 1976.

7. Plans

   1. Improve efficiency and stability of current numerical models.

   2. Carry out dry deposition studies using high speed particle size analyzer.

   3. Carry out concurrent measurements of atmospheric electrical parameters for direct measurement of dry deposition.

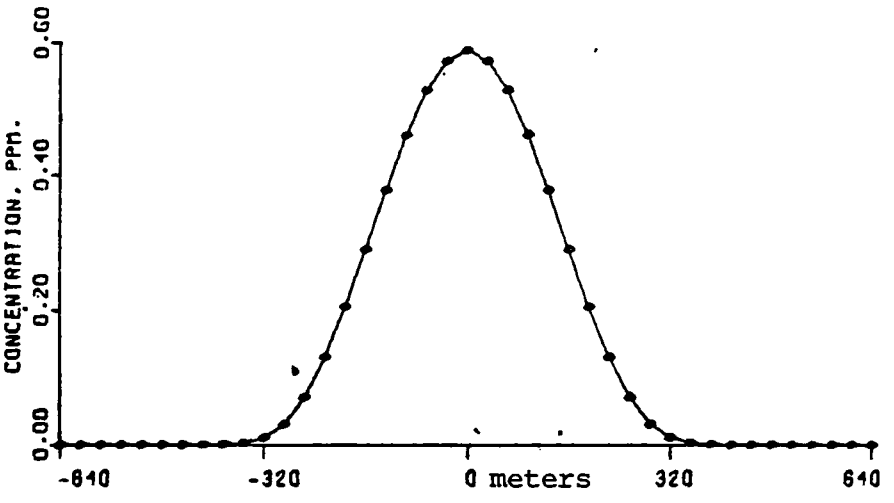

Figure 2. Simulated concentration profile of NO for traverse through plume center at 2.3 km downwind of point source of NO.

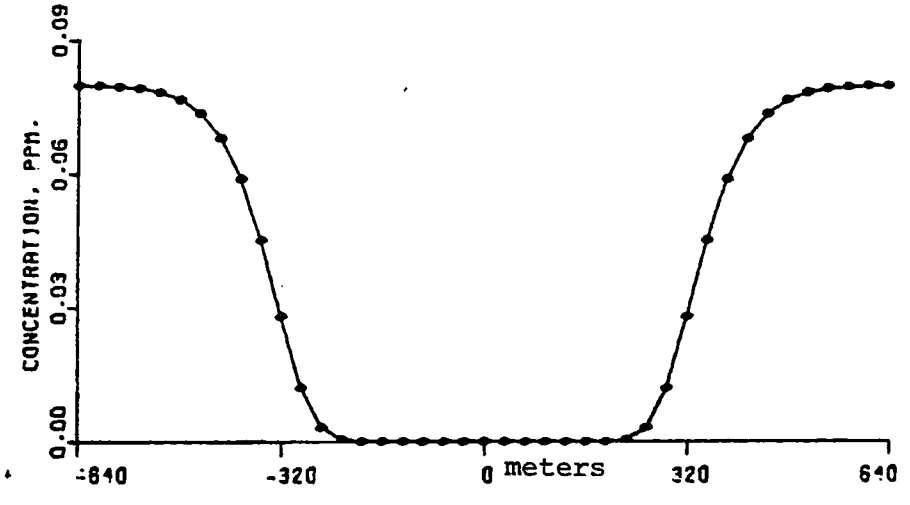

Figure 3. Simulated concentration profile of O_3 for traverse through plume center at 2.3 km downwind of point source of NO.

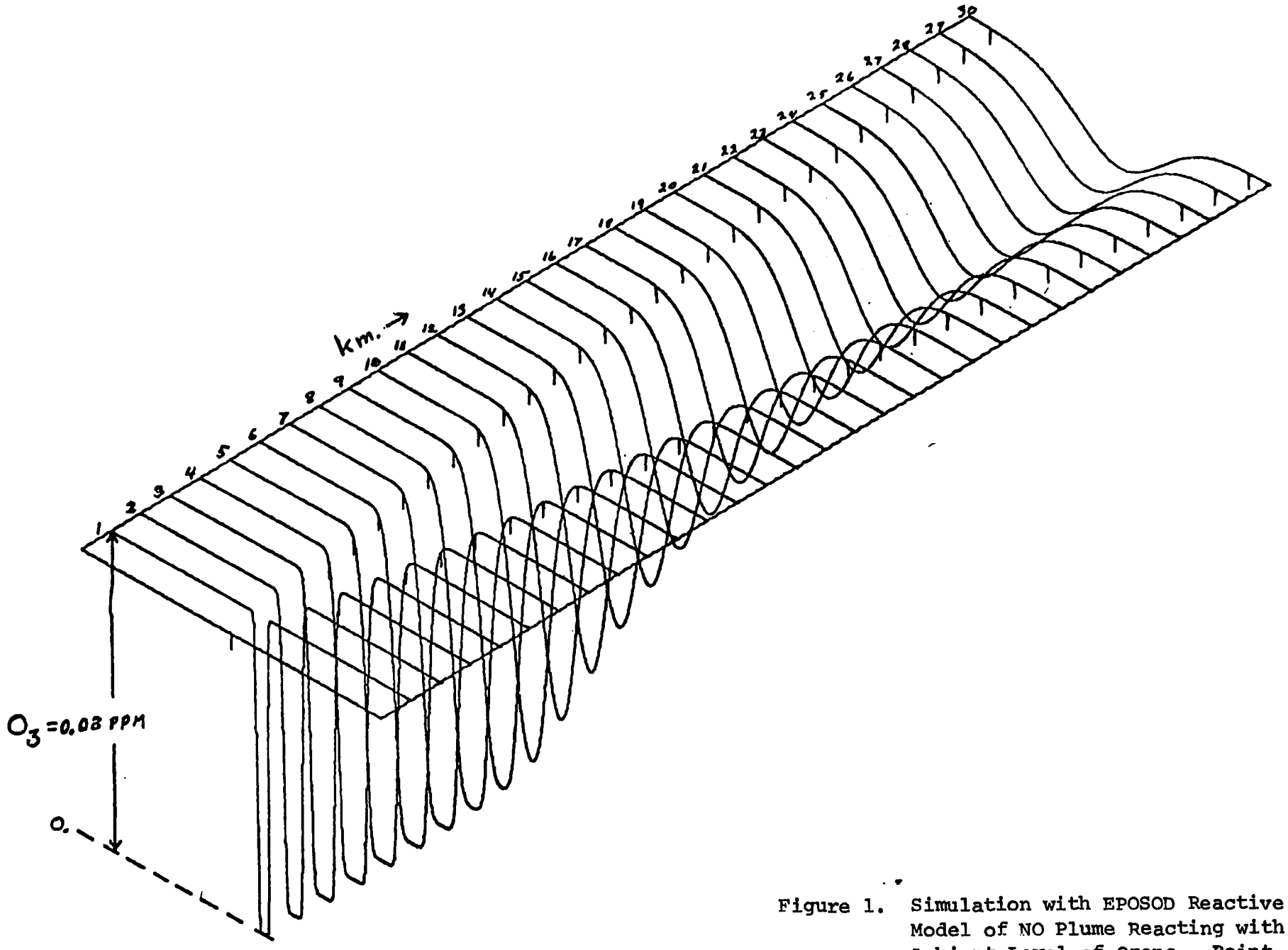

Figure 1. Simulation with EPOSOD Reactive Plum Model of NO Plume Reacting with Ambient Level of Ozone. Point Source of NO Located at 0 KM. Ambient Level of Ozone Assumed as 0.08 ppm.

1. Task Title: Mobile Laboratory Operations in Support of Project MISTT, July-August 1975

2. Objective:

To collect aerosol samples, pollutant gas concentrations, and meteorological data at a site 100 km north of St. Louis, MO.

3. Institution: EPA-ERC, ESRL-ARB
Investigators: T. Ellestad; D. Dale, G. DeJong, K. Fuchs, M. Garneau, G. Shelton (student aids).

4. EPA Project Officer: W.E. Wilson

5. Progress

Thirteen days of intensive data were collected on schedule, with frequent local instrument calibrations and two cross-calibrations with the St. Louis-based group. Aerosol size distribution reduction is in progress at the University of Minnesota; gas, filter, and meteorological data reduction is in progress at EPA. Student aids performed about 50% of gas calibrations, 70% of data acquisition system operation, and 80% of routine instrument operation.

5. Presentations, Publications, Theses:

Preliminary summary given at the November 4, 1975, MISTT meeting at RTP, NC.

6. Plans:

Issue a verified data volume in December 1977.

1. Task Title: Gas Calibration Support for 1976 MISTT Summer Field Program, July 1976.

2. Objective:

To provide accurate and traceable gas calibrations for pollutant gas analyzers on board several mobile sampling platforms.

3. Institution: EPA-ERC, ESRL-ARB
Investigators: T. Ellestad, R. Speer, M. Parrish, M. Bourke, J. Durham G. Shelton (Student Aide)

4. EPA Project Officer: W.E. Wilson

5. Progress:

Calibration systems for delivering NBS-traceable concentrations of SO_2, O_3, NO and NO_x were assembled and verified. Calibration services were provided for the MRI Cessna 206, the Washington University Grand Commander, and the University of Minnesota Mobile Van on a demand basis, generally after each flight or trip. In addition to verifying analyzer performances and monitoring minor instrument drifts, the frequent calibrations uncovered several serious analyzer malfunctions, which were quickly corrected. Two cross-calibrations with the RAPS Mobile Calibration Van were performed during the month. Student aids were responsible for about 35% of the work.

5. Publications, Presentations, Theses: None.

6. Plans:

None, project complete.

1. Task Title: Data Processing Support for 1976 MISTT Summer Field Program, July 1976

2. Objective:

To process aircraft data tapes within hours of landing so that instrument problems can be identified before the next flight.

3. Institution: EPA-ERC, ESRL-ARB
Investigator: K. Fuchs (student aid).

4. EPA Project Officer: W.E. Wilson

5. Progress:

Aircraft cassettes were read on schedule with the ARB data processing system, gas calibration constants were entered, and 10:1 averaging of the data was performed. Copies of the data were made for Meteorology Research, the University of Minnesota, and ARB-ESRL-EPA. Student aids were responsible for 100% of the effort.

6. Publications, Presentations, Theses: None

7. Plans:

None, project complete.

1. Task Title: Relationships among Ground-level Sulfate Concentrations, Visibility Reduction, and Meteorological Conditons.

2. Objective:

To determine if a high sulfate episode in Wheeling, W. Va. (50 - 80 $\mu g/m^3$, July 6-8, 1974) was due to local sources or long range transport.

3. Institution: ARB, ESRL, ORD, EPA and University of North Carolina
Investigators: D. Fondario, H. Jeffries, J. Saunders, and William E. Wilson.

4. EPA Project Officer: William E. Wilson.

5. Progress:

Results from Phase I of the Sulfate Regional Experiment (SURE), sponsored by the Electric Power Research Institute (EPRI), indicated a high sulfate episode at Wheeling, W. Va. Daily, 24-hour, high volume sampler measurements showed sulfate concentrations in excess of 30 $\mu g/m^3$ from June 5-9, 1974 with a peak June 8 of 80 $\mu g/m^3$. An analysis was undertaken to determine whether this was due to local sources or long range transport. Data utilized included long range trajectories (24-hour and 5-day), surface weather, visibility distances, mixing heights, and emissions. The analysis indicated that a stagnant, high pressure system in a high emission region upwind of Wheeling accumulated pollutants which were then transported to Wheeling by air motion. Thus it was concluded that the high sulfate measured in Wheeling was the result of pollutant transformations during long range transport.

6. Presentations, Publications, and Thesis:

1. D. Fondario, Master's Thesis: Explanations for a High Sulfate Episode at Wheeling, W. Va., June 5-9, 1974. 1976.

7. Plans:

The thesis will be rewritten with additional long range trajectories, published as an EPA report, and submitted for journal publication.

1. Task Title: Mesoscale Sulfate Concentration Study

2. Objective:

To obtain 2-hour measurements of particulate sulfur and other elements over a large geographic area for one year.

To analyze this data in terms of sulfur transformation and transport.

3. Institution: Florida State University, Tallahassee, Florida
Investigators: W. Berg, W. Nelson, J. Winchester.

4. EPA Project Officer: R. Patterson

5. Progress:

Sample collection from a 14-station network, ranging from Kansas to New Hampshire, began in early June, 1976 and will be continued until June, 1977. Some 800 separate week-long "streaker" sample records will be collected. A portion of these will be analyzed for sulfur and other heavy elements with 2-hour time resolution by PIXE(Proton Initiated X-Ray Emission). Some test samples have been analyzed.

6. Plans:

Several sets of streaker samples will be analyzed and the data interpreted in terms of sources and weather patterns.

The network will be modified to include the SURE Class I stations during summer - 1977.

7. Publications, Presentations, and Thesis: None

APPENDIX A

A. ATMOSPHERIC PROCESSES AND EFFECTS

1. Aerosol Formation, Growth, and Removal

2. Aerosol Characterization and Sources

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. RECIPIENT'S ACCESSION NO.
EPA-600/7-77-076		

4. TITLE AND SUBTITLE	5. REPORT DATE
AEROSOL RESEARCH BRANCH, ANNUAL REPORT FY1976/76A Federal Interagency Energy/Environment Research and Development Program	August 1977 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) W.E. Wilson and C. Danskin, editors	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Sciences Research Laboratory - RTP, NC Office of Research and Development U.S. Environmental Protection Agency Research Triangle Park, NC 27711	10. PROGRAM ELEMENT NO. 1NE-625 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Environmental Sciences Research Laboratory - RTP, NC Office of Research and Development U.S. Environmental Protection Agency Research Triangle Park, NC 27711	13. TYPE OF REPORT AND PERIOD COVERED Final 14. SPONSORING AGENCY CODE EPA/600/09

15. SUPPLEMENTARY NOTES A complementary report, EPA-600/3-77-080, describes research activities funded by EPA's base program.

16. ABSTRACT

The research program of the Aerosol Research Branch includes research grants and contracts at institutions in many parts of the United States, in addition to an intramural program. The purpose of these projects is to study the chemical and physical properties of aerosols, identify the mechanisms of aerosol formation and removal, and conduct experiments to measure these rates.

The results of the research are being used (1) to establish the contribution of the various sources to the ambient atmospheric aerosol loading, (2) to characterize urban, natural, and primary and secondary aerosols, (3) to develop quantitative descriptions of the generation and removal rates associated with each major aerosol source and sink, (4) to quantify the effects of aerosol on atmospheric chemical reactions, and (5) as a scientific basis for recommending regulatory actions concerned with air quality improvements.

The research projects totally or partially funded by the Federal Interagency Energy/Environment Research and Development Program are described.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
*Air pollution *Aerosols *Research projects		13B 07D

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