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FISCAL YEAR 1983 SUMMARY REPORT OF NOAA METEOROLOGY DIVISION SUPPORT TO THE ENVIRONMENTAL PROTECTION AGENCY

Air Resources Laboratory
Rockville, Maryland
July 1984

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Herbert J. Viebrock, Editor

Meteorology Division
Research Triangle Park, North Carolina

Air Resources Laboratory
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UNITED STATES DEPARTMENT OF COMMERCE

Malcolm Baldrige, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

John V. Byrne, Administrator

Environmental Research Laboratories

Vernon E. Derr Director

NOTICE

PREFACE

The work reported herein for FY-1983 was funded by the Environmental Protection Agency (EPA) under agreement EPA-DW930036-01-01 between the EPA and the National Oceanic and Atmospheric Administration (NOAA). The Meteorology Division (MD), staffed with both NOAA and EPA personnel, serves as the vehicle for implementing the agreement. This relationship was established in 1955 and has continued since that time.

The MD performs and manages a research, development, and operational effort in air pollution meteorology. Research activities define, describe, and study the meteorological factors important to air pollution control activities; operational support activities apply meteorological principles to assist the EPA in the evaluation and implementation of air pollution abatement and compliance programs. Research activities, which are sponsored by the EPA Environmental Sciences Research Laboratory, and other EPA groups, are conducted within the MD and through contract and cooperative agreement activities. The MD provides technical information, observational and forecasting support, and consultation on all meteorological aspects of the air pollution control program to many offices, including the EPA Office of Air Quality Planning and Standards and various Regional Offices, as appropriate.

Any inquiry on the research or support activities outlined in this report should be directed to the Director, Meteorology Division, MD-80, Environmental Research Center, Research Triangle Park, NC 27711.

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ABSTRACT

The Meteorology Division provided research and meteorological support to the Environmental Protection Agency. Basic meteorological support consisted of the application of dispersion models and the conduct of dispersion studies and evaluations. The primary research effort was in the development and evaluation of air quality simulation models using numerical and physical techniques supported by field studies. Modeling emphasis was on the dispersion of photochemical oxidants on urban and regional scales, dispersion in complex terrain, atmospheric processes in the boundary layer, and atmospheric processes related to the acid deposition problem.

Activity highlights included performance of the Small Hill Impaction Study #2 at Hogback Ridge, near Farmington, New Mexico; statistical testing of the VALLEY, COMPLEX I, COMPLEX II and CTDM; documentation of VALMET and MELSAR; conduct of tracer experiments at the Boulder Atmospheric Observatory to study diffusion under convective conditions; continued development of the Regional Oxidant Model; and completion of a model for simulating transport, diffusion, and chemical reactions of pollutants on and immediately downwind of roadways.

Laboratory studies were conducted on the stratified flow over triangular-shaped ridges to obtain data on lee-wave structure, interactions between leewaves and the near-wake recirculating region, and the height of the dividing streamline (below which fluid moves around, instead of over, a body). Also a laboratory study was conducted to examine concentration distributions on a hill surface resulting from plumes impinging from upwind sources under neutral and very stable flow conditions.

UNAMAP (Version 5) containing 31 air quality simulation models and test data was prepared and released through NTIS. Work was performed on the preparation of user's guides for air quality models; a comparison of sigma schemes for estimating plume dispersion, and the preparation of meteorological data for use in routine dispersion calculations.

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1. INTRODUCTION

During Fiscal Year 1983, the Meteorology Division continued to provide meteorological research and support to the Environmental Protection Agency. Meteorological support was provided by the Air Policy Support Branch and Environmental Operations Branch to various EPA offices, including the Office of Air Quality Planning and Standards and the Regional offices. This work is discussed in sections 2.5 and 2.6.

The primary effort of the Division was the conduct of research in the basic processes affecting the dispersion of atmospheric pollutants, and to model the dispersion on all temporal and spatial scales. The major modeling emphasis was on oxidant dispersion on the urban and regional scales, particulate dispersion on the regional scale, disperison in complex terrain, and acid precipitation related processes. Work on the study and modeling of boundary layer processes continued. A major field study was conducted at Hogback Ridge, New Mexico, early in the fiscal year. The Fluid Modeling Branch conducted physical modeling experiments on the flow in complex terrain, building downwash, and the effects of automobile wakes. The research work is described in sections 2.1, 2.2, 2.3, and 2.4.

2. PROGRAM REVIEW

2.1 Atmospheric Modeling Branch

The Atmospheric Modeling Branch is responsible for the development, evaluation, and validation of analytical, statistical, and numerical models used to describe the relationships between air pollutant source emissions and resultant air quality, to estimate the distribution of air quality, and to describe and predict the state of the planetary boundary layer. Model scales range from local to global. Studies are conducted to describe the physical processes affecting the transport, diffusion, transformation, and removal of pollutants in and from the atmosphere.

2.1.1 Northeast Regional Oxidant Study (NEROS)

Northeast Regional Oxidant Study (NEROS) field programs were conducted during 1979 and 1980 in support of the development and evaluation of the Regional Oxidant Model (ROM). The field programs were designed to obtain pollutant and meteorological data for initialization and evaluation of the ROM as well as an improved description of physical and chemical processes to be simulated by the ROM, e.g., nocturnal wind shear, nighttime chemistry, urban plume dynamics, and venting of pollutants from the boundary layer by cumulus clouds.

The data base was completed in 1983 and consists, for example, of aircraft and fixed-site sampling for ozone and ozone precursors on a regional scale, characterization of the physical and chemical properties of the Baltimore and Columbus urban plumes (from aircraft and surface platforms), temporally enhanced (4/day) radiosonde observations for the Northeast, and aircraft ozone flux measurements at the surface and in the vicinity of clouds.

The quality and availability of the data for each experimental period were evaluated. Mission summaries were prepared describing the experimental scenarios, meteorological conditions, and platform deployment for each day. More detailed presentations and evaluations were carried out for potential candidate days (based on quality and quantity of data) for model evaluation runs. These analyses consisted of a chemical and meteorological description of the air mass or plume being sampled and included local and air mass trajectories, wind and temperature profiles, mixing heights, transport winds, the temporal and spatial location of urban plumes, and the chemical composition and variability of the plumes and air masses.

Several papers have been prepared on analyses of specific aspects of the data base. Clarke and Ching (1983) presented a case study which shows that oxidants and precursors are transported on regional scales exceeding twelve hours. Clark and Clarke (1983) described and analyzed results of Lagrangian sampling of the Baltimore urban plume into southeastern Connecticut. The analyses indicated both enhancement and scavenging of the Baltimore plume by interacting downwind plumes depending on the time of interaction. In another analysis, twelve NEROS tetroon tracks were compared with three trajectory calculation schemes (Clarke et al. 1983a). The results show the standard deviation of the difference between model-predicted and tetroon-positions data increased with travel time and was 200 km after 21 hours of travel by the best model run. An overview of the NEROS field program, analyses and data base was presented at the 14th International Technical Meeting on Air Pollution Modeling and its Applications, Clarke et al. (1983b). The data base is being made available to the scientific community for further analyses and model evaluation programs.

Convective clouds have long been known to redistribute heat and moisture, and recently, the need to examine the vertical transport of pollutants between the mixed layer and the free troposphere have been required when regional scale transport modeling is attempted. Inclusion of cloud transport processes into models is not straightforward. Two methodologies have been proposed for use in the NEROS Regional Oxidant Model (ROM) by Ritter (1983). These approaches both utilize a framework common to the Arakawa-Shubert scheme (1974), but differ in the manner in which the cloud fields are forced. One approach utilized the moist static energy distribution as determined from rawinsonde and radiative cooling data. However, realizing that cumulus elements are subsynoptic in scale, a second approach utilizes satellite data in a data assimilation mode to determine the cloud forcing function required. These approaches then provide values of cloud base mass flux and therefore pollutant mass flux. Ritter (1983) also indicates concentration increases in the free troposphere due to cumulus venting can be as, if not more important than, in-situ production for some pollutant species.

2.1.2 Regional Oxidant Model

The Regional Oxidant Model is intended for simulation of pollutant episodes on scales of 2-3 days and 1000 km (Lamb, 1983). The design of the network of processors that drives the regional model was completed and all but one of the processors has been built and tested. In the development of the processor network a multitude of design problems was encountered. The most difficult of these was the treatment of lateral boundary conditions in one of the processors that solves the 2-D shallow water equations. A similar boundary problem is faced in mesoscale meteorological models but no generally valid solution to this problem exists. An approximate solution was developed that proved to satisfy the needs and it may be of value in meteorological models as well.

Concurrent with the processor network development, the regional model was subjected to a series of tests designed to evaluate the accuracy of individual components of the model as well as the accuracy of the model overall. These tests consisted of the application of the model to a sequence of meteorological/emissions scenarios whose associated concentration fields are known exactly. The results of the tests showed that the accuracies of the individual techniques that were built into the model to treat chemistry, transport and vertical material fluxes equal or exceed the accuracies of the best available alternatives. Results of the test scenarios that involved the steady emissions of pollutants from small, isolated urban areas showed that up to travel times of 50 hours, the predicted peak concentrations of ozone in each plume are within ±10% of the correct value.

An effort parallel to the regional model development work is underway to assess the predictability of air pollutant concentrations. This work has shown that models can predict only the probabilities of concentrations rather than the concentration that will actually occur at a given site and time. Guided by this study the processor has been designed to generate the flow fields for the regional model to produce an ensemble of flows from which the regional model can generate concentration probabilities and averages. Advanced methods of generating the flow field ensemble are presently being developed for future application.

2.1.3 Studies on Tall Stack Dispersion on Regional Scales

Dispersion and long-range transport of an elevated point source plume are controlled by the diurnal variation of the mean and turbulent structure of the planetary boundary layer. Few comprehensive measurement programs exist which document both plume dispersion and the temporal and spatial variations of the relevant mean and turbulent fields. Perhaps the most comprehensive experimental program conducted on this scale was the U.S. Environmental Protection Agency's August 1978 Tennessee Plume Study (TPS). Briefly, this program's objectives were to parameterize plume dispersion and compositional change over the diurnal cycle of the plume from TVA's Cumberland coal fired power plant located about 25 km southwest of Clarksville, TN. Aircraft and ground sampling of the plume and its environment were complemented by a boundary layer turbulence program.

In this program, Ching, et al. (1983a) found that maximum turbulence intensities and length scales occur during the early afternoon when convective heating was greatest. Vertical time sections of turbulence intensities show situations when the decay of turbulence propagates downward from upper levels of the PBL starting in the mid-afternoon. The ramifications of this are explored; in particular, it is expected that an elevated plume would decouple from the lower layers earlier than expected from surface turbulence measurements alone. Data from a mobile lidar support this contention.

Considerable variability of the horizontal and vertical velocity variances was observed as a function of land use type. The variability is attributed to large heat flux differences that are associated with the various land uses in the region and shown to be consistent with recent free convective similarity scaling. Vertical profiles of dimensionless velocity variances show the same behavior as results from other experimental and laboratory data. Lagrangian-Eulerian time scale relationships to parameterize plume dispersion were analyzed and reported by Clarke et al., (1983c).

Lagrangian integral time scales, t_L, for the convective period of the day were derived with the Taylor diffusion equation from tracer measurements of plume width to 400 km downwind of the TVA Cumberland, TN, power plant. Time scales derived from aircraft sampling of the plume were about 250 s, while those from automobile traverses of the plume were about 800 s. The longer time scales for the ground-level sampling are believed to be due to the longer time required to traverse the plume. The time scale generally increased with the ratio of the height of the mixed layer, z_i, to the standard deviation of the lateral wind component σ_v.

Eulerian integral time scales, t_ε, were derived from aircraft gust probe and tower measurements of the lateral turbulent velocity component. The ratio $t_L/t_\varepsilon = B$ ranged from 1.5 to 19. The temporal variation of t_ε, σ_v and the lateral exchange coefficient, $K_y = \sigma_v^2 t_L$, in the convective boundary layer are presented. While t_ε and σ_v peak near midday, the effective K_y (value required to describe the plume growth) increased from 200 m^2/s at 1000 CDT to 1100 m^2/s at 1800 CDT.

A simple parameterization of t_L based on cz_i/σ_v in the Taylor diffusion equation generally explained much of the day to day variation of the measured plume widths with z_i being the dominant factor. The coefficient c, however, was not the same for aircraft and automobile derived plume widths.

2.1.4 Boulder Tower Experiment

The field experiment begun last year, Convective Diffusion Observed with Remote Sensors (CONDORS), was completed in its experimental phase during September 1983. The purpose is to test in the atmosphere some diffusion modeling results from a laboratory tank and from a numerical model that are at odds with standard Gaussian models. These results should apply to sunny, low wind speed conditions (convective). They show the height of maximum averaged concentrations from a ground source lifting off the ground at several hundred meters downwind and rising to the upper half of the convective mixing layer. For elevated sources, they show maximum averaged concentrations descending to the ground, then behaving much like those produced by ground sources. Standard models assume that maximum concentrations remain at the effective source height, whether it is elevated or near the surface.

In the CONDORS field experiment, there were 3 fully successful run-days last year during a trial run period, and 8 successful run-days in September 1983. Each two hour release was made near midday when skies were clear and the wind was light to moderate. The site was NOAA's Boulder Atmospheric Observatory (BAO), operated by the Wave Propagation Laboratory. Oil fog was released and detected by a lidar sited 4 km north of the BAO, and a metallic chaff was released and detected by X-band radar sited 3 km east of the BAO.

This siting set a requirement for easterly winds for successful plume scanning, but such winds are dominant at this site during convective conditions, due to the development of thermal upslope winds on the east front of the Rocky Mountains. The oil fog and chaff could be detected independently and both mapped in 3 dimensions. On 5 days they were released side-by-side for direct comparison, and on 6 days the chaff source was elevated while the oil fog was released from the ground. The 300-m tower at the BAO provided both a convenient release point for elevated releases and high quality meteorological measurements. Winds, temperatures, and humidity to 3000 m were obtained from 4 or 5 rawinsondes each day, and mixing heights were monitored by acoustic sounder and lidar. In addition to oil fog and chaff, two conservative passive gases were released in 1983, and detected by an arc of surface samplers about 1.2 km from the sources. Processing and analyzing of the data and writing of the final report is expected to take about one year.

2.1.5 Planetary Boundary Layer (PBL) Modeling

The goal of the PBL modeling effort has been to develop a model which treated the PBL as a layer of surface based mixing. Results from this effort in the form of diurnal values of mixing depth, surface heat flux, and surface friction velocity show that the main features of PBL physics are correctly modeled (Binkowski, 1983). Considering the use of a constant geostrophic forcing flow, even the transport winds are reasonable. Further efforts on this task will concentrate on how this approach can be used in regional scale numerical weather prediction models. No real progress on the problem of long range transport of air pollution can be expected until the regional scale models include realistic physics. The present approach is a compromise between the use of high resolution for the PBL which is expensive, and the use of a bulk PBL representation which is crude but inexpensive. Further work will also include the addition of a moisture variable, and a simple plant canopy as a lower surface.

2.1.6 Acid Deposition Model Development and Evaluation

In March 1983, the National Center for Atmospheric Research (NCAR) completed a comprehensive survey of acid deposition processes and modeling procedures for the U.S. EPA. This was the first step in initiating a major program in modeling the acid deposition problem, one which has important societal and economic ramifications. Scientifically, it is characterized by a rich variety of physical and chemical phenomena. Therefore, it is essential for any serious mathematical modeling effort in this field to recognize that all possible scientific completeness and rigor must be sought, and that practical applications of the model will ensue.

A well-constructed acid deposition model should, in its maturity, embody all relevant physical and chemical phenomena and thus serve to integrate results from the full spectrum of acid rain research. The model could then serve as a primary assessment tool in the identification of future mitigation studies by defining source-receptor relationships on a regional scale.

The key conclusions of the NCAR study were as follows:

- There are fundamental weaknesses in existing models of regional acid deposition, particularly in upper-air transport and dispersion, omissions of detailed chemical reactions, cloud physics, and the treatment of terrain and surface effects.
- Marked improvements are now possible due to recent advances in mesoscale meteorology and tropospheric chemistry; the construction of a comprehensive regional acid deposition model is now feasible.
- The development of such a comprehensive model requires a clearly focused, multidisciplinary group effort under strong scientific leadership.
- The Eulerian framework is most suitable for representing the essential physical and chemical processes in regional acid deposition.

NCAR proposed that the modeling system be based on an established, proven, mesoscale meteorological model, use fundamental chemical process equations to predict the relevant transformations, and incorporate the details of both wet and dry deposition. Further, effort would be focused on analyzing the sensitivity of model predictions to uncertainties in chemical initialization and parameterizations and also on the proper statistical interpretation of the model predictions in the context of regional climatology. A user-oriented post-processor would facilitate the interpretation and application of the model results. The system would be modular and highly flexible and would thus allow the easy incorporation of new research results.

As a specific proposal, NCAR found a suitable meteorological framework in a hydrostatic model (Anthes and Warner, 1978) with grid size 30-60 km and 10-15 vertical levels. A chemistry module with gas and aqueous phase reactions, including OH, H_2O_2 and O_3, would have possibly 100 reactions involving 20 gas phase species, 15 liquid phase species, 6 aerosols, metals, carbon and a liquid droplet size distribution. The model will be executed on selected cases representing synoptic weather types: winter storm precipitation (5 cases), summer convective precipitation (5 cases), and summer fair weather stagnation (2 cases). A user oriented microprocessor system for analysis of results would be developed.

In July 1983, NCAR agreed to build and test a model over a four year period. That program is now underway with an NCAR research team of about 20 members and support for module development and data management coming from three National Laboratories. Supporting activities are mentioned in other sections of this report.

2.1.7 Dry Deposition Modeling of Acidic Matter

An important aspect of acid deposition process research is the empirical studies and theoretical investigations leading to the development of parameterization of deposition velocities of acidifying substances. This task is being accomplished primarily by Argonne National Laboratory (ANL) through an Interagency Agreement. The objective of this program will be the development of a module to be used with the RADM (Regional Acid Deposition Model) so that dry deposition can be determined according to chemical species, surface conditions, and meteorological conditions. ANL's progress during the year is discussed below.

The dry deposition velocity for submicron particulate sulfur has been reparameterized. Formulations are suitable for computing deposition velocity maps in the Northeast and for use in the numerical module to be constructed for the RADM model.

Improved parameterizations of sulfate and sulfur dioxide deposition velocities were utilized to generate deposition velocity maps (actually matrices of values). Preliminary daily averages of sulfate deposition velocities over inland areas during midsummer, for example, were found to be 0.24 cm s^{-1}.

Measurements of the dry deposition of NO and NO_2 were obtained over grass during a dry deposition monitoring comparison experiment at ANL in August. Preliminary estimates of NO_2 fluxes are rather large but variable.

2.1.8 Horizontal and Vertical Transport Processes in Acid Deposition Research

Convective clouds remove pollutants from the mixed into the free troposphere. The inflow into the clouds is believed rooted within the near surface emission layer. Experimental field studies have been conducted by Pacific Northwest Laboratory (PNL) and by Argonne National Laboratory (ANL) through Interagency Agreements. In particular, the ANL objectives were (1) to develop quantitative relationships among the factors that affect the rates of flow into clouds whether they be controlled by surface heating and/or be self-induced by the cloud elements, (2) develop useful parameterizations of planetary boundary layer processes that influence transport and dispersion necessary for regional-scale acid deposition models. The efforts by PNL were to (1) determine the physical and chemical modification of acidic compounds in non-precipitating cumulus clouds, (2) determine the net vertical flux, if any, of cumulus elements and acidic pollutants through the tops of convective clouds, (3) examine relationships between cloud-related circulations and mixed layer structure as a function of convection and phase of the diurnal cycle; and (4) develop schemes for parameterizing cloud transport and chemical transformations for use in the Regional Acid Deposition Model.

During the past year Argonne's major effort was devoted to participation in the Boundary Layer Experiment-1983 (BLX83) near Chickasha, Oklahoma. In cooperation principally with the University of Wisconsin, the National Severe Storms Laboratory, and NCAR, detailed investigations into the evolution and influence of fair weather cumulus clouds and their impact upon the developing convective boundary layer were conducted. Vertical velocities and related statistics obtained by Argonne are being combined with plume and cloud statistics derived from University of Wisconsin lidar and NSSL radar information on the same portion of the atmosphere. A full contingent of surface layer measurements, including deposition velocities, were made by ANL to acquire accurate boundary layer measurements during the experiment.

In the course of this study, ANL developed and implemented a two-camera time-lapse photography system to continuously monitor cloud position and development relative to the vertical movements of volumes of air being measured by their doppler sodar. The digitization and initial software development has been completed in a highly successful manner such that a semi-continuous time series of cloud position above the sodar in a 2 x 2 km area is available for comparison and use with the remote sensor data.

A field study was performed by PNL during July and August 1983 in the vicinity of Lexington, KY to study the impact of non-precipitating cumulus clouds on the vertical transport and modification of acidic substances. The flow of acid substances from near the ground into clouds and beyond were tracked by release of SF_6 tracers. Parameters measured on board fixed-wing aircraft include temperature, dew-point temperature, turbulence, O_3, SO_2, NO_x, aerosol light scattering, particle size distributions, altitude, and location. Filters were exposed for later analyses for trace metals, elemental carbon, detailed ionic composition, SO_2, and HNO_3. Some sulfuric acid size-distribution measurements were also made, using the ironoxide/impactor/spot technique.

Analysis is proceeding to find average rates of conversion of NO_x and SO_2 to nitrate and sulfate aerosols over the flight areas covered by cumulus clouds. Further, the change in aerosol size distribution during the formation and dissipation stage of the clouds will be examined.

2.1.9 Acid Deposition Modeling Support Activities

Several tasks have been initiated at Brookhaven National Laboratory (BNL) to support various aspects of modeling on small and large scales. The first task is an effort to adapt an existing air quality model to predict ambient sulfur dioxide and sulfate concentrations for use in materials damage screening. The approach is to stratify the meteorological inputs so that the predicted concentrations are available by humidity class interval. The question of local urban contribution to acid rain will be attacked by a field study measuring the chemical content of rain upwind and downwind of Philadelphia, PA during frontal situations. Both of these tasks are well underway.

The use of tracers such as "tagged" sulfur is a very attractive method of determining the impact of particular sources upon sensitive receptors. Various isotopes of sulfur are being considered in a study to determine the feasibility of using such tracers in field experiments on the fate of emissions from a given source area. Long range pollutant transport calculations are very strongly dependent upon the advection-diffusion algorithms chosen for the calculation. A comparison study considering two methods, a pseudo-spectral method and a biquintic upstream method has shown a clear preference for the biquintic method. Finally, all of the relevant data sets for the research effort will be located at Brookhaven. A prime function for BNL will be to supply all data, properly formatted, for the Regional Acid Deposition Model being developed at NCAR.

2.1.10 Eastern North American Model of Air Pollution (ENAMAP)

The extramural development of the final version of the sulfur and nitrogen model, ENAMAP-2, has been completed. The model code, final report

(Endlich et al., 1983), and user's guide have been received. The final report describes the three-layer long-range sulfur and nitrogen model. Differences between this version and the previous one-layer version, ENAMAP-1, are discussed. This report also contains maps of model-calculated and measured ambient concentrations of SO_2 and sulfate for two months of 1977. In addition, maps of model-calculated sulfur depositions and depositions and concentrations of five nitrogen compounds are presented.

This model has been adapted to run on the UNIVAC computer. The results of the first model application compared very favorably with the results generated by the contractor on their computer. Since a few technical errors were found in the delivered code, a task has just been started to identify further errors, if any, in the parameterizations and coding. Further, since the model code possesses some machine-specific features, which will make it difficult for others to use the model, these features will be replaced by more universal features.

Meanwhile, the ENAMAP-1 model has been applied to assess changes in statewide ambient sulfate concentrations and sulfur depositions resulting from emission reduction scenarios proposed by the Administration, Congress, and the National Governors' Association. A sensitivity study was conducted in-house to assess the effects on the concentration and deposition fields of the uncertainties in the model input data (Clark and Coventry, 1983).

2.1.11 Sulfur Deposition Model Intercomparison/Evaluation Study

In conjunction with the Atmospheric Environment Service of Environment Canada, an international group of sulfur deposition modelers has been assembled to apply models to a standardized set of processed 1980 meteorological and sulfur emissions data. The data have been acquired and processing by the Brookhaven National Laboratory has begun.

The modelers, from the U.S., Canada, Great Britian, Norway, Sweden, Finland, and Denmark, will deliver their model outputs by the spring of 1984. The results of the model intercomparisons and evaluations will be presented at a planned acid deposition symposium in Muskoka, Ontario in the fall of 1985. Results will also be published in the open literature.

2.1.12 Spatial Variability in the Evolution of the Urban Mixing Height

A realistic and practical method of predicting the time-dependent growth of the mixing height after sunrise is an important component of urban oxidant and dispersion models, as model results are highly sensitive to variations in the evolution of mixing height. In urban areas, significant spatial differences exist and rapid temporal changes in the mixing height occur during the morning period. A paper describing the morning evolution of the mixing height and erosion of the overlying nocturnal inversion layer at one urban site and a nearby nonurban location has been prepared for publication. Mixing height observations were derived from high resolution temperature profiles obtained during intensive summer experimental studies as part of the Regional Air Pollution Study (RAPS) in St. Louis, Missouri. The mixing height evolved in a nonlinear manner at both sites. Consequently, best fit empirical curves were derived by fitting the observations with a least-squares quadratic regression. The urban mixing height was consistently higher than the nonurban mixing height during the morning, although the difference decreased with time because the mixing height growth rate was greater at the nonurban site. Advection of relatively cold air and lower mixing heights from the upwind nonurban environment was attributed for the slower growth rate of the mixing height at the urban site. Statistical results revealed that the growth rate increased nearly linearly with time, which substantiated the second order evolution found from the regression analysis, and the mean nonurban mixing height growth rate was indeed greater. A rise in the inversion top height after sunrise was believed to be due to lifting of the entire inversion layer by urban-induced upward motions. This mechanism contributed to an increase in the mixing height growth rate at both sites.

Statistical, regression and analytical methods have been applied to the larger data base of observations obtained at numerous other sites in the urban area in order to examine spatial mixing height differences and variability in mixing height growth. Statistical results revealed that mean mixing height increased with distance from the upwind boundary of the urban area. Mean mixing heights at sites downwind of the urban heat island center were higher and their growth rates were slightly greater due to warm air advection from the central city. Results of evaluating the governing equation for temperature with the profile measurements from several case studies indicated that the horizontal temperature advection term had an important role in modulating the mixing height growth rate within the urban area, although its impact decreased as the urban heat island steadily weakened with time. The results of this research will be presented at an AMS Specialty Conference in November 1983 on the nonhomogeneous urban boundary layer and will be included in a meteorological monograph with other conference papers.

2.1.13 Urban Boundary Layer Studies

Two major data bases of turbulence measurements were collected by the Meteorology Division to support air quality and plume dispersion modeling. Extensive urban boundary layer data were collected during the U.S. EPA Regional Air Pollution Study (RAPS) from 1975 to 1977. The data from the Tennessee Plume Study (TPS) offer a unique data base to evaluate tall stack dispersion with concurrent PBL turbulence measurements of the transport environment.

Current research on the RAPS data include the analyses of the spatial and temporal variability of the energy fluxes and turbulence statistics at the surface and within the mixed layer on urban and suburban or land use scales in the presence of non-stationary, nonhomogeneous conditions characteristic of urban meteorology. Ching et al., (1983b) discussed the modulation of sensible heat flux in urban area by advection on these scales. In this analysis, a measurement methodology was presented that prescribes a mininum upwind fetch to height of heat flux measurement requirement and that smaller scales contributing to that heat flux are unresolvable at that height. Cold air advection was found to significantly enhance a sensible heat flux output, and under these conditions, convective scaling laws for velocity variances developed from experiments under relatively homogeneous, rather ideal conditions are inapplicable (Ching et al. 1983c). Aircraft measurements of fluxes and turbulence is currently under examination. Preliminary results reveal positive, urban heat fluxes two to four times larger than rural counterparts. Bowen ratios greater than one for urban areas are larger than rural areas by a factor of five to ten. Strong thermal land-water contrasts associated with the Mississippi River induced a minimum in heat flux; consequently conventional convective scaling laws do not apply. Everywhere else including the urban area the scaling laws appear applicable to within a 10% variability.

Preliminary results on analysis of land use variability of turbulence from three tower measurements are presented in Clarke et al. (1982). They find that departures from similarity theory were observed in the data for urban sites. For example, the normalized velocity variances were smaller than expected from recent empirical verification of similarity theory for ideal sites.

The integral length scale of the vertical velocity fluctuations is suggested as a surrogate for the mixing length and is used in the evaluation of the turbulent kinetic energy budget for the three sites. For neutral stratification, the mechanical production and dissipation terms are essentially in balance. For unstable stratification, a large residual term representing a net loss of energy was associated with the urban sites. The residual is apparently site specific being associated with urban mesoscale and local advective effects.

An analysis to determine the diurnal variability of surface energy fluxes was performed for three contrasting land use surfaces: concrete, blackened concrete to simulate asphalt, and grassed over soil surfaces. Observations include net radiation, surface and subsurface temperature and soil moisture data obtained during a spring period from the subsurface heat flux project of the St. Louis Regional Air Pollution Study (RAPS). In particular, the study examined how G, the subsurface heating rate, so difficult to measure practically, relates to F_n, the net radiation, a relatively easy parameter to measure. A model of the diurnal variation of the ratio $G/F_n = \lambda$ was obtained for each of the three surfaces under undisturbed weather conditions. The models for a spring period was very similar to models for a summer period.

Strong day-night differences in λ were observed for all surfaces. Nighttime values were greater than 1.0 for all surfaces. The soil surface showed a distinct daytime trend. The diurnal patterns for concrete and blacktop were nearly identical. The moisture content and its vertical distribution is found to be critical to an accurate determination of the heating rate of the soil layer. The study also indicates that the diurnal energy budget behavior is strongly affected by the distinct heterogeneous vertical layering of materials, (e.g., concrete asphalt over soil). Implications of these results for urban modeling are also discussed.

2.1.14 Photochemical Model Evaluation -- Urban Scale

A multi-year project to develop and evaluate several urban photochemical air quality simulation models (PAQSM's) for O_3 predictions using the RAPS - St. Louis data base was completed in late FY-82. Recently there has been some discussion of setting a 1-h or 24-h National Ambient Air Quality Standard (NAAQS) for NO_2. There is currently only an annual standard in effect which states that the annual average concentration should not exceed 0.053 ppm.

Therefore the EPA Office of Air Quality Planning and Standards (OAQPS) requested a report analyzing the ability of short-term urban PAQSM's to predict NO_2 concentrations. The objective of this task was to reanalyze the results of the 20 simulations conducted with each model during the O_3 evaluation task to elucidate the models' ability to predict 1-h NO_2 concentrations.

The models included in the study are the Photochemical Box Model (PBM), developed in-house, the Lagrangian Photochemical Model (LPM), developed by Environmental Research and Technology, Inc., and the Urban Airshed Model (UAM), developed by Systems Applications Inc. The data set includes 20 days selected from the 1975 and 1976 summer periods of the RAPS project in St. Louis, MO. The days were primarily chosen for their high measured levels of O_3 and other photochemical species of interest.

Prior to evaluating model performance, the NO and NO_2 measurements from the RAPS data base were characterized to assess the adequacy of evaluation data. The most striking aspect of this characterization relating to model evaluation is the absence of sufficient numbers of high NO_2 concentration data values. Isolating only the daily maximum 1-h NO_2 values observed at each monitoring station over the two-year period, it was seen that only about 5% were greater than 0.10 ppm and only 4 of the 25 monitoring stations reported maximum values exceeding 0.06 ppm on at least 10% of the days. These values may be contrasted with the present NAAQS for annual average NO_2 concentrations of 0.053 ppm and California's 1-h standard of 0.25 ppm, which was rarely exceeded during the entire RAPS data record. Another significant aspect of the NO_2 characterization was that the strength and frequency of peak RAPS NO_2 measurements occurring in the evening period (after 1800h) were significantly greater than those of peaks occurring at any other time of the day.

Results from the data base analysis preclude a definitive evaluation of the models for NO_2 predictions. Nonetheless, within the limits of the available data some statements may be made concerning model performance for NO_2 on the RAPS data base. The PBM generally underpredicted the domain average peak NO_2 concentrations. Over the sample of 20 days modeled, the PBM's average underprediction was 17%. The simplistic treatment of point source emissions, which includes a substantial fraction of the total NO_x emissions, in the PBM and its large volume size, prevent this model from giving strict NO_2 point estimates. It may be most useful as a screening model for a more complex photochemical model. Simulations with the LPM were conducted along the air parcel trajectories leading to the monitoring station recording the highest 1-h O_3 value. The trajectory did not necessarily coincide with that for the highest NO_2 values for that day and this posed some additional problems in evaluating the LPM for NO_2. The elevated average residual concentration over the sample of days modeled for NO_2 with the LPM was nearly zero with a large variance among the residuals; those for ground-level showed substantial overpredictions. The UAM showed serious underpredictions of maximum 1-h NO_2 values over the 20 test days. The average value was a 37% underprediction but individual cases were as high as 78%.

The three models tested here cannot yet be endorsed as effective tools for assessing short-term NO_2 concentrations in urban areas. While the PBM may be applicable as a screening model, the LPM and UAM would need further testing and refinement to qualify as useful models in assessing short-term NO_2, especially if more serious consideration is given to promulgating a

NAAQS short-term standard. At the very least, a data base should be used for model evaluation that includes a substantial number of values above the proposed standard.

2.1.15 Photochemical Modeling -- Numerical Advection Schemes

While working with the Urban Airshed Model, a grid-type photochemical air quality simulation model, during the urban O_3 model evaluation task it became clear that the component of the model responsible for advection produced an unacceptably large amount of artificial diffusion. The purpose of this task was to study several candidate methods of numerical advection as potential replacements for the existing one in the urban grid model.

Two of the methods studied are from the general category of flux-corrected transport, first proposed by Boris and Book (1973) and later generalized by Zalesac (1979). The earlier technique is known as SHASTA (sharp and smooth transport) and the later one as FCT (flux-corrected transport). In addition, a new scheme developed by Lamb (1983) based on a biquintic polynomial (BIQUINTIC) was studied. The tests of these schemes involved the advection of an element of mass through a 25 x 25 cell two-dimensional grid. In one case the mass element had a rectangular block shape and in the other it was a shape with elliptical cross-sections. Tests were performed with three different flow fields for advection: 1-D linear flow, 2-D linear flow, and rotational flow. In addition a test with a constant mass field and an analytically non-divergent flow field was included as a check for convergence zones in the solution.

Results from the flux-corrected techniques, including SHASTA and FCT, tend to distort a peaked distribution in the direction of a top-hat distribution. While the SHASTA technique is faster than FCT, it is counterbalanced by the large amount of attendent numerical diffusion. In air quality simulation applications where the peak values are of greatest interest, this places the SHASTA method in a poor light. A logical alternative lies in FCT which is a multidimensional generalization of SHASTA, does not require time- splitting in the solution process, and preserves the peak values in a mass distribution better than SHASTA does. The penalty for use of FCT is a longer execution time but its higher accuracy balances this cost.

The relatively long execution time required for the BIQUINITIC algorithm apparently places it as the least attractive of the methods tested. There are however many features of this technique that more than compensate for its longer execution time and may indeed prove the BIQUINTIC method to be preferable in many applications. It maintains the integrity of a peaked mass distribution better during transport than the other methods tested. In an actual simulation of fluid flow there are other advantages. For one, it solves the diffusion component simultaneously with advection while most other techniques must do this in a separate step. It is also capable of solving a small portion of the computational grid at a time, thus, saving a vast amount of computer storage. Lastly, and most significantly, the BIQUINTIC technique is independent of Courant number which would otherwise dictate a prohibitively small time-step with the large grid cell dimensions in regional-scale air quality modeling work.

Based on the conclusions of this study a fourth-order version of the FCT scheme has been integrated into the Urban Airshed Model. This method was shown to preserve peak areas of concentration quite well during numerical transport and was intermediate in time requirements between the SHASTA and BIQUINTIC methods.

2.2. Fluid Modeling Branch

The Fluid Modeling Branch conducts physical modeling studies of the air flow and pollutant dispersion in complex terrain, near buildings and near roadways. The Branch operates a Fluid Modeling Facility consisting of large and small wind tunnels, and a large water channel/towing tank. The large tunnel has an overall length of 38 m with a test section 18.3 m long, 3.7 m wide, and 2.1 m high. It has an airflow speed range of 0.5 to 10 m/s. The water channel/towing tank has an overall length of 35 m with a test section 25 m long, 2.4 m wide, and 1.2 m high. It has a speed range of 0.1 to 1 m/s and the towing carriage a range of 1 to 50 cm/s.

2.2.1 Characterization of Dispersion in Automobile Wakes

Wind tunnel concentration measurements have been made in the wakes of block-shaped and scale-model vehicles in a moving-floor wind tunnel. This is an extension of previous measurements of the wake structure by Eskridge and Thompson (1982). The concentration measurements were used to determine vertical and horizontal scaling functions for the eddy diffusion coefficients in a previously developed mathematical model called ROADWAY. This model has been modified and is currently being validated against the General Motors and Long Island tracer data. The ROADWAY model has been used (Eskridge and Rao, 1983) to show that measured velocity variances near a highway are due, in part, to a nondiffusive wake-passing effect. It is also being used to investigate how vehicle speeds affect pollutant concentrations near a highway.

2.2.2 Complex Terrain Studies

In conjunction with the Complex Terrain Model Development Project, the Fluid Modeling Branch conducted three separate modeling studies. The first was a fundamental study wherein the objective was to examine theoretically and experimentally the proper similarity criteria and techniques to be used in simulating flow and dispersion of atmospheric pollutants over terrain features using a stratified towing tank. Specifically, the towing tank has rigid boundaries and a free surface and, when the model width approaches the width of the towing tank, blocking can occur and columnar disturbance modes can progate upstream that have no counterpart in a free or unbounded atmosphere. A general derivation, based on energy constraints, shows that if a fluid parcel originates upstream at a height $z<H_D$ (where H_D is the dividing-streamline height), then it cannot pass over the hill top. For three-dimensional terrain, these parcels can pass around the sides of the model, but for two-dimensional hills (or models with cross-wind width approaching that of the towing tank), such parcels will be blocked. Experimental observations show that, under these conditions, non-steady-state conditions ensue as the lower-level fluid is "squashed" between the obstacle and the end-gate of the tank. The theoretical derivations and preliminary results were presented by Eskridge, Thompson and Lawson (1983). Additional

work which casts doubt on the validity of previous laboratory experiments on the flow over ridges with small gaps are contained in Snyder et al (1983). Further work examining in specific detail the flow fields over truncated ridges of varying cross-wind aspect ratio were discussed by Castro, Snyder and Marsh (1983). Finally, observations of upstream columnar disturbances, which manifiest themselves in upstream blocking and "squashing", are described by Castro and Snyder (1983).

The second study conducted in conjunction with the Complex Terrain Model Development Project involved the simulation of a particular case hour as observed in the field studies conducted at Cinder Cone Butte. This was a period of essentially neutral atmospheric conditions and was simulated using a deep boundary layer in the meteorological wind tunnel. Measurements of vertical profiles of wind speed and lateral, vertical and ground-level concentration profiles were made. A report on this work (Thompson, Snyder and Lawson, 1983), describing the conduct of the study and a comparison between the field and laboratory measurements as well as additional observations of the laboratory study, was prepared for inclusion as an appendix to the (Environmental Research and Technology (ERT) Third Milestone Report (Lavery et al, 1983). The concentrations measured on the surface of the model hill reproduced the values reported for the field experiment to within a factor of 2 for 43% of the sample locations. Concentrations measured on the upwind face of the hill compared closely with flat-terrain Gaussian plume predictions. The vertical and horizontal plume widths above the hill compared well with Pasquill-Gifford values for flat terrain.

The third study also involved the simulation of a particular case hour as observed in the field studies at Cinder Cone Butte, but in this case the stability was moderately stable, and the stratified towing tank was used. The atmospheric data were divided into 6 ten-minute periods and 6 tows were made in the tank, matching the wind direction and dividing-streamline height for each of the ten-minute periods. The surface concentrations observed in the field showed relative maxima in three areas on the lee side of the hill, with the absolute maximum occurring at the base. Laboratory measurements showed the same three areas of maximum concentration, but the absolute maximum was in a different place. The maximum observed in the laboratory was 25 percent larger than that observed in the field. The conclusion was that the laboratory experiments reproduced the field data with a good degree of fidelity (Eskridge, Lawson and Marsh, 1983).

A summary of the results of recent wind-tunnel and towing-tank studies that were designed to obtain basic understanding of flow and diffusion in complex terrain, to provide guidance on locating sources in complex terrain, and to provide "rules of thumb" for estimating concentrations when a source is located in complex terrain was presented by Snyder (1983).

A paper on towing-tank and wind-tunnel measurements of concentration distributions on the surface of a hill when a plume impinges from an upwind source was prepared by Snyder and Hunt (1983). The stability was varied between very stable and neutral. The results were compared with the potential flow models developed in an earlier paper by Hunt, Puttock and Snyder (1979). The comparison showed that the basic physics of the earlier models was correct.

2.2.3 Building Downwash Studies

In the building-downwash area, a paper was published on a wind-tunnel study of the downwash of plumes from short stacks adjacent to rectangular-shaped buildings (Huber and Snyder, 1982), a two-part paper was published on a wind-tunnel investigation of dispersion downwind of two standard-design nuclear power plants (Payne et al, 1982a, 1982b), and a report was published on a demonstration study to be used as an example to be followed by fluid modeling organizations in the conduct of good-engineering-practice stackheight determinations to meet the requirements of EPA regulations promulgated in January 1982 (Lawson and Snyder, 1983).

2.2.4 North Carolina State University Studies (NCSU)

Through a cooperative agreement with the Department of Marine, Earth and Atmospheric Sciences, NCSU, a number of studies were conducted. A twopart paper by Pendergrass and Arya (1983a, 1983b) described the flow and dispersion over a step change in surface roughness (smooth to rough). Part I described the mean flow and turbulence structure in the internal boundary layer and Part II described the dispersion of plumes released at the juncture of the two surfaces. These papers show that the dispersion from tall stacks is not governed by the local roughness in the vicinity of the stack, but rather by the roughness far upstream.

A paper was published describing the effects of stable stratification on turbulent diffusion and the decay of grid turbulence (Britter et al, 1983). These results have strong implications for predicting diffusion in the nighttime stable boundary layer, e.g., that the vertical growth of a plume reaches predictable asymptotic limits even though the turbulence does not cease, and that horizontal dispersion is largely unaffected by the stratification.

A paper was presented describing a preliminary analysis of velocity measurements to examine vortex development over two-dimensional escarpments with slopes ranging from 14° to 90° (Pendergrass and Arya, 1983c). This work will be extended under an agreement with the Atmospheric Turbulence and Diffusion Division (ATDL), Oak Ridge, TN to include effects of three-dimensionality as well as dispersion from upwind sources.

Three projects are under way by Master's-degree candidates. One project involves the measurement and analysis of the wake structure and dispersion from point sources within the wakes of two conical hills of different slope. A second involves the comparison of mathematical-model predictions of concentrations on a two-dimensional escarpment with previous wind tunnel measurements. A third attempts to evaluate the effectiveness of wind screens in reducing fugitive dust emissions from storage piles; primary variables include screen porosity, screen height, placement, and pile shape.

2.3 Data Management Branch

The Data Management Branch is responsible for the coordination of all ADP activities within the Meteorology Division, including the design, procurement, and implementation of data base management, computer systems analysis, and ADP studies. It provides data management and programming services; this is done primarily through ADP service contracts monitored by the Branch.

2.3.1. Regional Oxidant Model Development

The implementation of a network of 20 processors which are an integral part of the first generation Regional Oxidant Model (ROM) has been completed and final testing is being performed. Meteorological, emissions, air quality, land use and topography data are manipulated by these processors which apply mathematical descriptions of the various physical and chemical processes to prepare the appropriate composite matrix and vector elements required by the numerical solvers in the models. Both the first generation ROM and associated network of processors, originally developed on a UNIVAC 1100/82 mainframe, have been converted to a VAX 11/780 minicomputer. A general Input/Output software package has been developed to provide maximum flexibility of data interface among the processors and model.

The ROM has also been installed and optimized on a CRAY-1 computer at Los Alamos National Laboratory. The powerful capability of executing the ROM on a CRAY computer was developed to provide an efficient mechanism for model evaluation and application. The ROM has been implemented so as to minimize hardware dependencies and maximize 1) ease of transfer to different computer systems, 2) flexibility of updating or replacing process descriptions, and 3) ability to modify model framework for similar regional scale modeling applications.

2.3.2 Regional Oxidant Model Emission Inventory Support

A software system which provides a realistic estimate of biogenic hydrocarbon emissions has been implemented. Isoprene and monoterpene emissions have been calculated for each grid cell in the Regional Oxidant Model (ROM) domain. Emission estimates are based on the product of a specie emission factor, biomass and area coverage of each specie in each cell. Calculations are performed for all predominant tree and agricultural crop species, surface water and leaf-litter. Preliminary total emission estimates compare favorably with those found in the literature. Biogenic hydrocarbon emissions estimates will be used in conjunction with the anthropogenic emissions in ROM studies to determine their relative contribution to ozone formation.

A program - PSPLIT - has been developed to automate a method for generating hydrocarbon speciation factors for any specified chemistry mechanism or specie classification scheme. PSPLIT computes the factors which are used to disaggregate total hydrocarbon emissions as received from the States into selected groups of volatile organic compounds consistent with the chemistry mechanism of the ROM. The Regional Model Data Handling System (RMDHS) performs the temporal, spatial and VOC species allocations on annual point and area source emissions to produce major point source and gridded area source hourly emissions for up to 10 pollutant species classes.

The 1976 Canadian emissions inventory has been converted to the Emission Inventory Subsystem/Point Source and Area Source (EIS/PS & AS) formats to provide consistent and complete hourly gridded emissions for the entire ROM domain. Spatial allocation factors have been developed using Canadian census data, waterport and airport locations, and land use information.

2.3.3 Support of the National Crop Loss Assessment Network (NCLAN)

Estimates of crop exposure to ozone for the period 1978-1982 were made. A description of the data, station selection criteria, statistical methodology, and averaging time relationships and results are contained in a status report to the NCLAN Steering Committee and is to be a chapter in the NCLAN annual report. In summary, ozone data available from the SAROAD system were retrieved and set up in an annual file format. If there were sufficient data a seasonal average based on the 7-hour daily mean corresponding to the NCLAN crop exposure periods was calculated for each acceptable monitoring station. The "kriging" interpolation technique was used to estimate the average exposure at the center of each grid square, 1/2 degree latitude by 1/2 degree longitude, across the continental U.S. subject to at least 5 stations within 500 kilometers. A comparison of the 7-hour seasonal average with other statistics was made at each monitoring station and summarized across all stations.

Future work calls for exploring the averaging time with the other NCLAN experimentalists and attempting to incorporate into this what is known for major crops about the critical dose patterns. A compilation of the NCLAN Field data into a unified structure is to be started. An extensive review of the literature on kriging will be made to improve the model specifications. This includes station selection criteria for interpolation, distance limitations for station inclusion, and the possibility of construction of standard variograms which are used in the distance - variance weighting function inherent in kriging. Testing of the compartmental limitations such as the continental divide and Applachians will be done.

2.4 Terrain Effects Branch

The Terrain Effects Branch conducts research studies into the effects of complex irregular terrain and man-made surface features on ambient pollutant dispersion, on both an intramural and extramural basis; establishes mathematical relationships among air quality, meteorological parameters, and physical processes affecting the air quality; and conducts research in the areas of air pollution climatology and acidic deposition.

2.4.1 Dispersion Model Development for Sources in Complex Terrain

The complex terrain model development program is designed to produce atmospheric disperison models that are useful in regulatory applications for large pollutant sources located in complex terrain, that have a demonstrated higher degree of reliability than exisitng models, and that are reasonable to apply in terms of required computer input parameters (Lavery et al., 1983a; Schiermeier et al., 1983b). As the first priority, the modeling effort was designed to focus on the one-hour average, ground-level concentrations that result from stable plume impaction on elevated terrain obstacles. To this end, small hill impaction studies were designed to use mobile sources emitting oil fog and tracer plumes to impact on isolated terrain features, features small enough to permit sampling over much of their surfaces.

The Small Hill Impaction Study #1 was conducted on the 100-meter tall Cinder Cone Butte near Boise, Idaho, during October and November 1980. Participants in this study included the EPA contractor, Environmental Research

& Technology (ERT), and the NOAA Wave Propagation Laboratory (WPL). During FY-81, detailed meteorological and tracer gas measurements from the Small Hill Impaction Study #1 were used by ERT to evaluate existing dispersion models (Valley, Complex I, Complex II, and Potential Flow Model) and to aid in the development of two new models (Neutral and Impingement) for defining stable plume impaction in complex terrain. During FY-82, ERT continued utilizing this data base by performing case study analyses of various plume interactions with Cinder Cone Butte (Hanna, 1983). Results of these analyses were used to further refine the Neutral and Impingement models into the Lift and Wrap models, respectively.

The Small Hill Impaction Study #2 was performed on the 100-meter-tall Hogback Ridge near Farmington, New Mexico, during October 1982. This study was designed to expand the applicability of the complex terrain dispersion models developed for Cinder Cone Butte to the case of a two-dimensional ridge with attendant blocked and drainage flows. The Small Hill Impaction Study #2 consisted of quantitative measurements of stable plume impaction and associated flow structures using tracer releases, flow visualization techniques, and meteorological documentation. Eleven tracer experiments were performed during which 86 hours of dual-tracer concentrations were detected on the ridge surface.

In addition to the management of the study by ERT, the NOAA Wave Propagation Laboratory (WPL) participated by operating a lidar to measure particulate plume dimensions prior and during plume impaction (Eberhard, 1983). WPL also operated one Doppler acoustic sounder, one tethersonde, two acoustic echo sounders, two sonic anemometers, and three optical anemometers. A second tethersonde and an experimental optical plume digitization device were operated by the NOAA Atmospheric Turbulence and Diffusion Laboratory (ADOD).The NOAA Air Resources Laboratory Field Research Division (ARLFRD) had primary responsibility for performing the oil fog release and accompanying plume photography, for conducting the tracer release/sampling/analyses, and for providing the real-time data collection and archival system. A description of the Small Hill Impaction Study #2 has been published (Lavery et al., 1983b).

Analyses of the Cinder Cone Butte and Hogback Ridge data bases suggest that the concept of a critical dividing streamline height is appropriate for stable flows toward elevated terrain obstacles (Venkatram et al., 1983). Tracer gas released below the dividing streamline dispersed in a highly variable, blocked flow and produced relatively large ground-level concentrations on the windward faces of the butte and the ridge. Tracer gas emitted above the dividing streamline dispersed in flows that traveled over the obstacles and produced peak ground-level concentrations near the crests and on the lee sides. These conclusions are leading toward a complex terrain modeling system with two major flow components, differentiated by the height of the critical dividing streamline. Currently, testing continues on the newly-developed Complex Terrain Dispersion Model (CTDM) which incorporates the Lift and Wrap components for flow above and below the dividing streamline, respectively (Strimaitis et al., 1983).

A Full Scale Plume Study is planned for the fall of 1984 to provide measurements for validation of the complex terrain models developed on the basis of smaller terrain obstacles. Preliminary tests will be conducted at the Tracy Power Plant near Reno, Nevada, during November 1983 to ensure a reasonable degree of certainty of experiencing stable plume impaction on elevated topographic features during performance of the 1984 Full Scale Plume Study. In addition to management by ERT and participation by NOAA WPL and NOAA ARLFRO, the Electric Power Research Institute (EPRI) has joined in this preliminary study by sponsoring supplemental tracer and lidar measurements.

2.4.2 Green River Ambient Model Assessment

Because of the proposed development of the Green River Oil Shale Formation encompassing the areas of southwestern Wyoming, northeastern Utah, and northwestern Colorado, the EPA Region VIII office in Denver has the need for development of site-specific air quality diffusion models. Accordingly, the Green River Ambient Model Assessment (GRAMA) project was initiated in 1980 to provide models for evaluating permit applications in the oil shale development area. The project is being conducted by the Battelle Memorial Institute, Pacific Northwest Laboratories (PNL).

The main objective of this project is to develop improved air quality models for analyzing the impacts of the oil shale industry. The effort consists of several components, depending on whether emissions are constrained within valley circulations or whether they are carried by convective processes into the prevailing synoptic flow. The components include local, mesoscale and regional flow models as well as local and mesoscale air quality models.

During this fiscal year, the preliminary version of the combined local flow and air quality model was completed. The model, termed VALMET, simulates the effects on pollutant transport and dispersion of meteorological processes within well-defined deep mountain valleys. A technical report (Whiteman and Allwine, 1983a) on the VALMET model was completed. MELSAR is a mesoscale Lagrangian puff model for predicting pollutant concentrations within a 500 km by 450 km domain. A technical report (Allwine and Whiteman, 1983) on the MELSAR model was submitted. Model testing, evaluation, and revisions to both VALMET and MELSAR are continuing.

A paper (Schiermeier et al., 1983a) summarizing the GRAMA project was presented at the NATO/CCMS Fourteenth International Technical meeting. A paper (Whiteman and Allwine, 1983b) on aspects of the VALMET model was presented at the AMS Sixth Symposium on Turbulence and Diffusion. A published note by Whiteman (1983) further explains his earlier publication (Whiteman, 1982) on observations of the breakup of temperature inversions in deep mountain valleys.

A Drake (1983) report was completed which identifies meteorological and air quality data sources for the oil shale areas of southwestern Wyoming, northeastern Utah, and northwestern Colorado. The information and bibliography identified in this report are not complete or exhaustive, but consist of the materials assembled during 1980-1982 as part of the GRAMA project. These materials were collected with three criteria in mind; generic information applicable to the oil shale area, general information for the Rocky Mountain west, and information specific to the oil shale areas. Analyses of tracer and meteorological measurements collected during the August 1982 joint EPA and DOE-ASCOT field study of nighttime drainage flow in Brush Creek Valley, Colorado, continued during this fiscal year. Plans for a 1984 field study to evaluate the interaction of the valley flow with mesoscale flow are being considered.

2.4.3 United States/Canadian Memorandum of Intent

The Atmospheric Sciences and Analysis Work Group 2 was one of five work groups established under the Memorandum of Intent on Transboundary Air Pollution, signed by the governments of Canada and the United States on August 5, 1980. The objectives of the work groups were to synthesize available knowledge about the causes and effects of transboundary air pollution, with initial emphasis on acidic deposition, for use by the governments of the two countries in negotiating a bilateral air quality agreement. A Terrain Effects Branch representative served as the United States Co-Chairman of the Work Group 2 Regional Modeling Subgroup.

Eight linear regional-scale models developed by Canadian and United States scientists were applied by the Regional Modeling Subgroup using standardized 1978 emissions and precipitation input data sets. Model results were evaluated with currently-available January, July, and annual 1978 observational data sets. Concentrations and depositions of sulfur compounds as well as source-receptor relationships (transfer matrices) were calculated by the eight long-range transport models using simplified formulations. The results of the model evaluations are described in the Regional Modeling Subgroup Final Report (Schiermeier and Misra, 1982) and are summarized in a recent paper (Schiermeier and Misra, 1983).

For the 1978 data set, most of the models appeared to perform relatively better in predicting the deposition of sulfur in precipitation than in predicting sulfate concentrations in ground-level air. Based on available 1978 wet deposition measurements, the models were able to reproduce the correct order of magnitude of the large time and space-scale features of measured wet sulfur deposition patterns. In the construction of unit transfer matrices, the models examined by the Regional Modeling Subgroup predicted generally similar relative impacts on ecologically sensitive receptor regions in terms of ranked order of importance, although variations existed among models in the absolute magnitudes of the transfer matrix elements.

During the model evaluation process, it became evident that the model results were associated with considerable uncertainty. These uncertainties arose from our current lack of understanding of the physical processes responsible for long-range transport and deposition of atmospheric pollutants, from the parameterizations of these processes in available regional-scale transport models, and from the temporal and spatial scales of applicability of these models. Consequently, a cooperative agreement has been awarded to the American Meteorological Society (AMS) to conduct a workshop in early 1984 to recommend methods for quantifying model uncertainties for use by decision makers. Because of the mutual national interest, the workshop may be jointly sponsored by Canada through the Canadian Meteorological and Oceanic Society (CMOS). Approximately 35 leading scientists from both the United States and abroad would be invited to participate, with workshop results to be summarized in a report.

2.4.4 National Acid Precipitation Assessment Program

The national effort aimed at seeking solutions to the acidic deposition problem is centered in the inter-agency National Acid Precipitation Assessment Program (NAPAP). The Division monitors work under Workgroup C - Atmospheric Processes. A Terrain Effects Branch representative serves as the Project Manager for Atmospheric Processes within the EPA funded portion of the program, with the Project C effort divided into the following sub-projects:

A. Acid Deposition Model Development and Evaluation

B. Precipitation Scavenging Studies and Modeling

C. Precipitation Precursors and Chemical Transformations

D. Dry Deposition Modeling of Acidic Matter

E. Horizontal and Vertical Transport Processes

F. Comprehensive Field Studies and Support Efforts

Five of these sub-projects are administered by four NOAA Sub-Project Managers within the Meteorology Division while responsibility for the sixth (Precipitation Precursors and Chemical Transformations) resides in an EPA Division.The four NOAA Sub-Project Managers are assisted by four other NOAA personnel who are responsible for particular aspects of the sub-projects. Altogether, nine Meteorology Division personnel are directly involved in the research effort for Project C - Atmospheric Processes. The report on Precipitation Scavenging Studies and Modeling as well as the report on Comprehensive Field Studies and Support Efforts will be described as part of this Branch's activities.

The Manager of Project C has no direct responsibilities for administering extramural tasks, but instead serves as a coordinator of the various subproject efforts. Planning, reporting, and peer review meetings in which the Project C Manager must participate are held frequently because of the attention focused on the acid deposition program by the agencies involved.

2.4.5 Precipitation Scavenging Studies and Modeling

The basic purpose of this portion of the NAPAP effort, being carried out by Battelle Pacific Northwest Laboratories (PNL), is the development of a precipitation scavenging module, based on theoretical and field studies, for use in the Eulerian regional acid deposition model. This work is being coordinated with the model development contained in (A) above. The module development was begun under the MAP3S and is continuing under the NAPAP. In the present state of knowledge about the different methods for describing precipitation scavenging in terms of scavenging rates, ratios, or efficiencies, there are different kinds and levels of uncertainty. Initial efforts are being made to define the major sources of uncertainty in modeling scavenging and to estimate the consequences in the Eulerian code.

Work continued on the analysis of data collected during two field studies performed under MAP3S: the Oxidation and Scavenging Characteristics of April

Rains (OSCAR) and the Transboundary Pollution Inflow Project. OSCAR involved a high density sequential precipitation sampling network in Indiana, the MAP3S network in the northeastern United States, and measurements of atmospheric chemistry and cloud characteristics by aircraft. PNL was responsible for the activities related to the high density network. Other participants included Argonne National Laboratory and Brookhaven National Laboratory. The Transboundary Pollution Inflow Project involved the acquisition of pollutant and meteorological data on a series of flights to study the impact of anticyclonic weather patterns in the northeastern United States on air pollutant flow into the southeastern coastal region.

During the period July 18 to August 26, 1983 a field study was conducted near Lexington, KY, with aircraft sampling conducted in and above the convective boundary layer and in the vicinity and through nonprecipitating cumulus clouds.During fifteen flight days, both air quality and meteorological parameters were measured. The data are being analyzed.

PNL, under the previous MAP3S, developed a one-dimensional reactive scavenging model, PLUVIUS. Developmental work continued on the model with PLUVIUS Mod 4.0 now including upgraded aqueous phase chemistry, and PLUVIUS Mod 5.0 using a new compact finite differencing scheme which is being tested.

2.4.6 Comprehensive Field Studies and Support Efforts

Rather than relying completely on physico-chemical models for obtaining the relationships among pollutant source areas and acidic deposition areas, it is desirable to also obtain direct empirical relationships. Such relationships are intended to provide additional guidance for formulating source control scenarios and evaluating the performance of regional acidic deposition predictive models. Thus the goal of this project is to develop a comprehensive plan for the approach, organization, and performance of a field investigation to quantify source-receptor relationships of acidic atmospheric pollutants, and subsequently to perform the field investigation to obtain the experimental data base.

To prepare for the potential extended multi-state and international field experiment that would be funded and managed by a number of governmental and other agencies, proposals for a comprehensive plan to relate acidic deposition to precursor emissions were requested. Proposals were received from ten bidders and were evaluated and ranked by a panel. Award of a contract to develop the plan, and optionally to test some of the areas of uncertainty of the design plan, is expected before the end of calendar 1983.

2.4.7 PEPE/NEROS Field Study

In July and August, 1980, a major field study was carried out with the principal objective to characterize Persistent Elevated Pollution Episodes (PEPE's) from development through translocation and/or dissipation. This study was performed in conjunction with the Northeast Regional Oxidant Study (NEROS). The conduct of the study, with field headquarters in Columbus, Ohio has been described by Vaughan et al. (1982). The contract team was responsible for the overall operations, and operated three aircraft, a helicopter, a mobile sampling van, a lidar van, and two mobile sounding units that obtained meteorological profiles with minisondes and Doppler acoustic devices.The NASA also participated in the study, using a large plane equipped with two downward-looking lidar systems to make overflights of the study area, as well as operating a smaller plane to make laser-based total ozone column measurements, and a plane equipped to make pollutant measurements to support the remote measurements of the other two aircraft.

Small tetroons were released by the NOAA ARLFRD team and tracked locally with mobile radars, and a smaller number of larger tetroons equipped with aircraft transponders were tracked using the FAA-ARTC radars. The EPA-Las Vegas airborne dual-wavelength lidar made overflights of the regions being sampled by the other aircraft to obtain data on aerosol backscatter to indicate the depth and variations of the mixed layer. A number of other participants also took part, making measurements of surface deposition flux, of detailed aerosol characterization, cloud chemistry, turbulence, and vertical profiles of pollutant and meteorological variables, as well as making detailed hydrocarbon and other chemical measurements at sites in the Columbus area, and multi-wavelength sun photometer measurements at a network of sites over the greater northeastern United States.

In support of the study, another contractor collected meteorological wire service data, facsimile charts and satellite data in digital form during the study performance. These data together with ozone and sulfate data from EPA's data archive were analyzed to yield two reports (Lyons and Calby, 1983a,b).The first report is a daily narrative of the synoptic weather, together with descriptive summaries of the evolution of episodes of increased ozone and haze over the eastern United States. The second is a case study of a mesoscale convective complex that developed over the central east coast states, and resulted in a large area of depleted ozone and haze the following day. This area was readily seen extending eastward over the Atlantic on the GOES visible imagery. Reduction and analysis of the measurements obtained by the contract team was delayed by funding problems, but this work was resumed during the current year. Data volumes from all mobile platforms have been received, and descriptive case study analyses have begun.

2.4.8 Cold Weather Plume Study

In February, 1981, a two-week study was conducted of dispersion and pollutant transformations of a plume from a power plant in central Illinois during winter conditions. The study was a cooperative project with the Electric Power Research Institute (EPRI), with both EPRI and EPA funding separate contract teams to perform the study. In addition, the EPA-Las Vegas airborne dual-wavelength lidar was operated to obtain transects of aerosol backscatter to document plume geometry for use in later analyses, and, in real time, to guide the contractor-operated aircraft to the plume position in three-dimensional space.

Reduction, quality control, and archiving of data collected by the EPA-supported contract team were completed during the year, and an exchange of data with the EPRI-supported team was made. Analyses of the joint data base were begun by both contract teams.

2.4.9 Archiving Field Study Data

To ensure the availability of data collected during past field studies for future use, a modest effort was begun to obtain such data and to archive it on the EPA computer facility at Research Triangle Park. The data bases to be archived are from the Midwest Sulfur Transformation and Transport (MISTT) study conducted in the St. Louis area in 1975-76 in conjunction with the RAPS, from the Tennessee Plume Study conducted in central Tennessee and Kentucky in 1978, and from the two studies described above, the PEPE/NEROS study and the Cold Weather Plume Study.

Data from the two more recent studies appear to be in reasonably good shape, and will not require much effort except to prepare a data manual to describe the content, format, and accessing procedures for the stored data. Some problems have been encountered with data from the earlier studies which are currently being worked on. The principal problem to date is with "geography," in that navigational data are often of such poor quality that the recorded data cannot be used to determine position, so estimates must be derived from other sources such as instructions and operator logs. This work is coordinated with the Data Management Branch to ensure no duplication of effort.

2.4.10 Plume Dispersion in the Wake of Surface Obstacles

A simple method for estimating enhanced dispersion resulting from the overall effect of buildings was evaluated (Huber, 1983). The method is based on the results of earlier analyses of wind tunnel studies (Huber and Snyder, 1982). Huber (1983) presents a framework for applying the method to general plume dispersion modeling problems. The Gaussian plume equation was modified to incorporate building wake-enhanced dispersion parameters, and the resulting ground-level centerline concentration estimates were compared to ten sets of field measurements. The results indicate that the method can provide a good correction for the overall effect of adjacent buildings.

The evaluation concludes that better measurements of plume height and vertical spread of the plume are needed to resolve some issues. The effect of building influences on plume rise and the determination of plume centerline requires vertical profile measurements. Also, the effect of wind speed should be considered. The cases with the highest wind speed have been observed to behave somewhat extraordinarily for several of the studies. Also, the possible effect of vortices should be more fully investigated. Additional data are needed to fully examine building wake effects. However, in lieu of sitespecific information, the method presented in this report should provide an approximate correction to estimated ground-level centerline concentrations. Additional inhouse wind tunnel studies of building wake effects are planned for FY-84.

2.4.11 Air Pollution Climatology

At the request of the volume editor at Indiana State University, a major article entitled "Air Pollution Climatology" was prepared during FY-83 for inclusion in an Encyclopedia of Climatology (Holzworth, 1983). The Encyclopedia is one volume in the Encyclopedia of Earth Science Series to be published by Hutchinson Ross Publishing Company of Stroudsburg, Pennsylvania. The article reviews fundamental meteorological factors that are involved in the occurrence of undesirable ambient pollutant concentrations. It discusses the background for the topic and describes the effects of wind, stability, diffusion, stagnation, and other factors. Examples of pertinent climatic data are presented in tables and charts for locations in the contiguous 48 states. The article presents 27 references many of which contain their own extensive bibliographies.

2.4.12 Meteorological Influences on Human Mortality

A paper was completed describing results of a project that was conducted in FY-82. The paper entitled, "A Mortality Standard for Heat Wave and Cold Wave Episodes", was presented at the Sixth Conference on Biometeorology and Aerobiology (Truppi, 1983). The study indicated the full effect on human mortality by heat and cold wave episodes in the United States cannot be determined until standards of expected mortality are derived against which observed numbers can be compared. Standards of daily mortality were derived for states east of the Rocky Mountains and then applied to heat wave episodes in 1966 and 1973 and to cold wave episodes in 1966 and 1973. These comparisons of reported mortality with derived standard values revealed increased mortalities of 4,632 and 2,720 for the 1966/1973 heat waves, along with 573 and 898 for the 1966/1973 cold waves.

2.4.13 Synoptic Climatology of Stagnating Anticyclones

Julius Korshover of NOAA Air Resources Laboratory has conducted a study of stagnating high pressure systems in the eastern two-thirds of the United States for the forty-year period of 1936-1975 (Korshover, 1975). Areas of stagnation that persisted for four days or more were delineated by grid points at latitude/longitude intervals of two degrees. The record of dates and associated grid points are resident in a computer data base at the EPA National Computer Center under the supervision of personnel in the Terrain Effects Branch.Since Korshover routinely analyzes daily weather maps to keep the stagnation data current, the data base was supplemented during FY-83 with the inclusion of seven additional years of data (1976-1982). Copies of the updated data base were forwarded to Korshover in the forms of magnetic tape and computer listings. The data are readily available to interested persons for further analyses and applications.

2.5 Environmental Operations Branch

The Environmental Operations Branch improves, adapts, and evaluates new and existing air quality dispersion models, makes them available for use, and consults with users on their proper application. The research work of the branch consists of two major projects: (1) UNAMAP (Users' Network for Applied Modeling of Air Pollution) which makes models available to users (sections 2.5.1 to 2.5.4), and (2) the improvement of plume modeling techniques (sections 2.5.5 to 2.5.7).

2.5.1 Averaging-Time Model

A single air quality data analysis system is needed for interrelating air pollutant effects, air quality standards, air quality monitoring, dispersion calculations, source-reduction calculations, and emission standards. Two and three-parameter averaging-time mathematical models (expressing air pollutant concentration as a function of averaging time and frequency) were developed to meet some of the needs of such a single system. Using these models, computer techniques were developed and used to compare present and potential future National Ambient Air Quality Standards and the concentration reductions needed to meet those standards.

One project is the effort to develop an acute-chronic two pollutant leaf injury model. O'Gara published the first air pollutant plant injury model 61 years ago, in 1922. Over the years others, including Heck and Tingey, improved O'Gara's model. Larsen, Heagle, and Heck (1983) developed and published a leaf injury model that differs completely from O'Gara's. In a comparative study, the H-T model explained an average of 51 percent of the variance in leaf injury for six plant species. The L-H-H model explained 86 percent of the variance, leaving only one-third as much variance unexplained (14 percent) as the H-T model left unexplained (49 percent).

Previous leaf injury models were applicable only to acute exposures (less that 8 hours) to an air pollutant. The L-H-H model also can be used for chronic exposures (Figure 1), including hour by hour concentrations for as long as the entire growing season of a plant.

Previous leaf injury models dealt with only one pollutant at a time, not with the interactive effect on plants exposed to two ambient pollutants simultaneously.The L-H-H model allows one to estimate cumulative injury expected from simultaneous ambient exposures to two pollutants for an acute exposure (Figure 2) or for an entire growing season. This approach was applied, for instance, to soybean plants exposed over a growing season to ambient concentrations of ozone and sulfur dioxide near coal-burning power plants.

2.5.2 Handbook for Preparing User's Guide

The "Handbook for Preparing User's Guides for Air Quality Models," (Petersen et al., 1983) developed as an aid to preparing documentation for models and processors, was published in May 1983. This addresses the structure and content of user's guides, and presents a review of coding techniques designed to assist in documentation.

2.5.3 UNAMAP

Air quality simulation models continue to be made available to the modeling community through the UNAMAP (User's Network for Applied Modeling of Air Pollution) System. For EPA users UNAMAP (Version 5) became operational on the EPA computer at Research Triangle Park on July 20, 1983. The magnetic tape containing the FORTRAN source codes for the models as well as test input and printed output from running the tests became available from the National Technical Information Service (NTIS) on August 25, 1983, as accession number PB83-244 368. Ten models were added to the 21 previously available bringing the total to 31.

The additional models are:

MPTDS -- A modification of MPTER to account for gravitational settling and/or deposition loss of a pollutant.

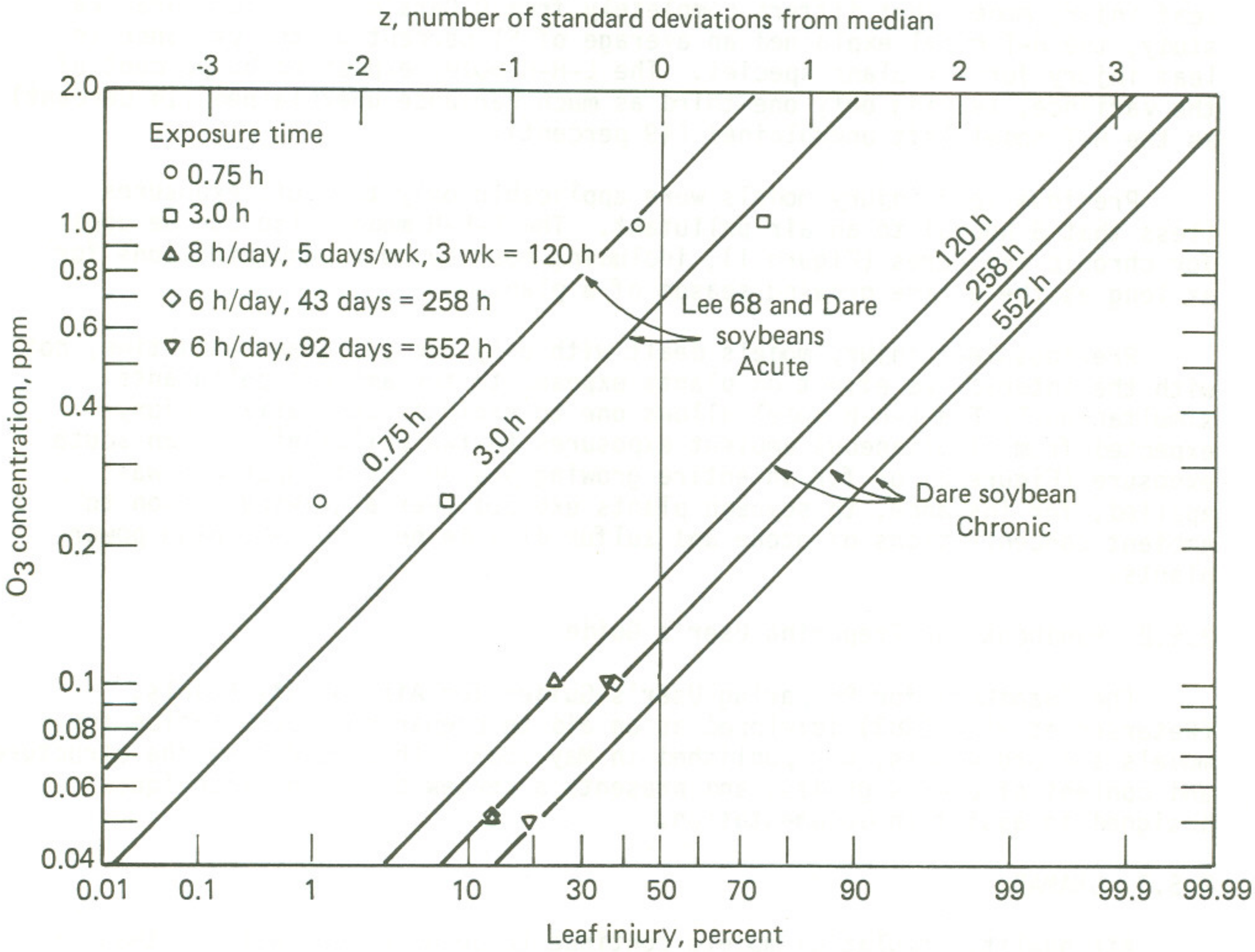

Figure 1. Percent leaf injury in Lee 68 and Dare soybeans exposed acutely (0.75-3.0 h) and Dare soybean exposed chronically (120-552 h) to O_3.

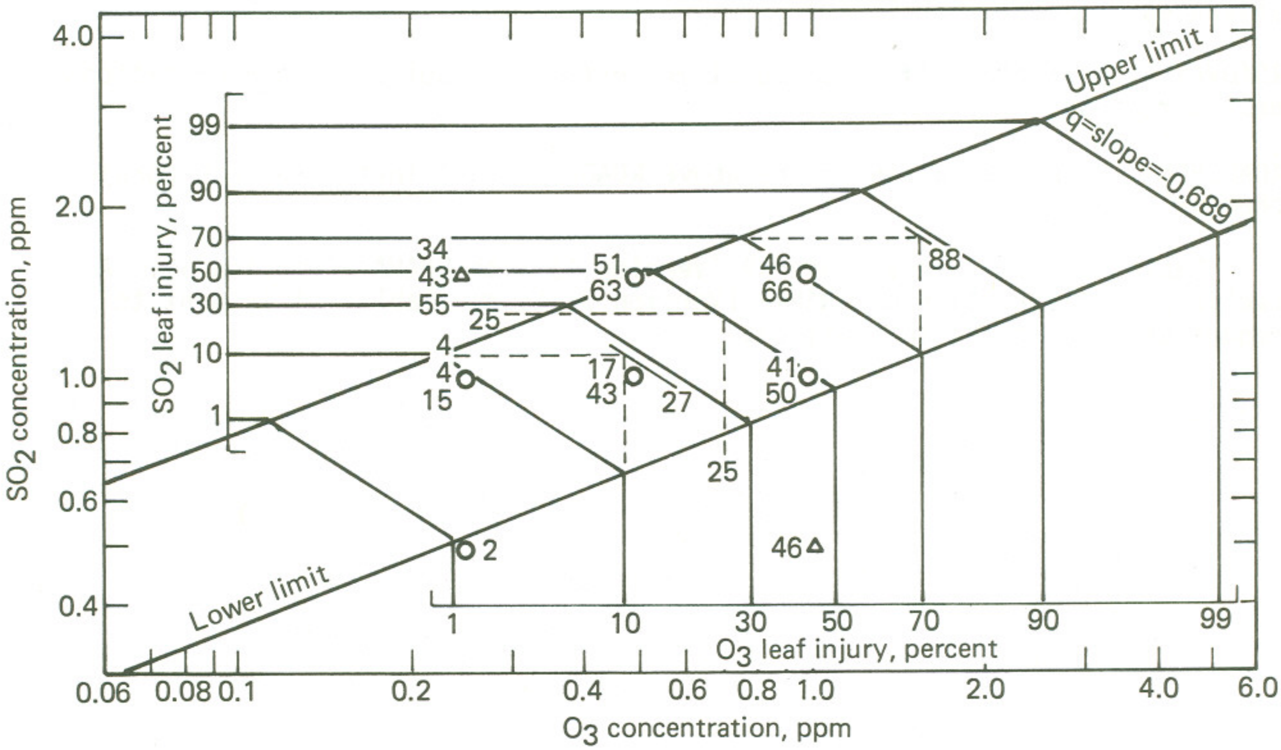

Figure 2. Percent leaf injury in Lee 68 and Dare soybeans exposed for 0.75 h to SO_2, O_3, or both.

PALDS -- A modification of PAL to account for gravitational settling and/or deposition loss of a pollutant.

APRAC3 -- An updated urban carbon monoxide code.

SHORTZ -- A short-term (1 hour and longer) model applicable to multiple sources in flat or complex terrain.

LONGZ -- A long-term (seasonal and/or annual) model applicable to multiple sources in flat or complex terrain.

COMPLEX/PFM -- A complex terrain model that includes an option for potential flow calculations.

MESOPUFF -- A variable-trajectory regional-scale Gaussian puff model.

MESOPLUME -- A segmented or "bent" Gaussian plume model for use over long distances (greater than 50 km).

ROADWAY -- A finite difference model for estimating pollutant concentrations near a roadway.

ROADCHEM -- A modification of the above ROADWAY model that also incorporates chemical reactions.

Tables 1 and 2 compare UNAMAP (Version 4) with UNAMAP (Version 5). A twelve page discription of UNAMAP (Version 5) is available and is sent to requesters asking for information.

TABLE 1. COMPARISON OF UNAMAP (VERSION 4) WITH UNAMAP (VERSION 5)

	UNAMAP (VERSION 4)	UNAMAP (VERSION 5)	CHANGE %
NUMBER OF MODELS	21	31	+48
NUMBER OF PROGRAM LINES	50,475	95,619	+89
TOTAL LINES	69,000	172,048	+149
COST TO USERS			
NORTH AMERICAN	$ 840	$ 1,115	+33
OTHERS	$ 1,360	$ 1,795	+32

TABLE 2. UNAMAP COSTS -- COMPARISONS BETWEEN VERSION 4 AND VERSION 5

		NORTH AMERICAN	OTHERS
COST TO USERS	UNAMAP-4	$ 840	$ 1360
	UNAMAP-5	$ 1115	$ 1795
$ PER MODEL	UNAMAP-4	$ 40	$ 64.8
	UNAMAP-5	$ 36.0	$ 57.9
PROGRAM LINES PER $	UNAMAP-4	60.1	37.1
	UNAMAP-5	85.8	53.3
TOTAL LINES PER $	UNAMAP-4	82.1	50.7
	UNAMAP-5	154.3	95.8

2.5.4 The Relation of Urban Model Performance to Stability

Several studies have been made using data collected in the Regional Air Pollution Study (RAPS) in St. Louis to evaluate the urban model RAM. These studies indicated that although the model overestimated concentrations for some measurement stations and underestimated concentrations for other stations, for the network as a whole, there appeared to be little bias. In this study (Turner and Irwin, 1983), the modeled and measured SO_2 concentrations were stratified by stability to determine the nature of any systematic bias.

For each stability, the average concentration and the maximum concentration for both the model estimates and the measurements were selected for analysis. These data were graphed in various ways, Figure 3 is an example.

It was seen that for both low and high wind speed categories, the model yields lower average concentrations for the most unstable category A, with a slight trend to higher values for the stable categories E-G. The trend toward higher values during stable categories is more apparent in the results for the low wind speed groups than the results for the high wind speed groups.

The measurements generally exhibit higher average concentrations during stable conditions. This trend is in contrast to that seen for the model results.As with the model results, the trends are more easily seen for the low wind speed groups than for the high wind speed groups.

The trends seen in the model estimates for peak 1-hour concentrations are quite similiar to the trends seen in the average estimated concentrations. Typically, the model yields lower peak concentrations during A stability than during stable conditions.

The peak measured concentrations are generally lower for the extremes in stability (very unstable or very stable) with the highest values occurring during B through F stability.

To further examine these data, each stability category was assigned a rank of 1 to 8, according to the ranking of the concentrations. For example, for station 108, for peak measurements at high wind speeds stability E has a rank of 1, category A a rank of 8. These ranks were then averaged for each stability category over the 13 stations. These results are displayed in Figure 4. Examination of Figure 4 reveals quite different model behavior from that of the measurements. It is speculated that the stability-related bias may result from several causes: building downwash, plume penetration of stable layers, and/or partitioning of the emissions between point and area categories.Although the exact causes are not determined, the fact that the bias was seen to be an apparent function of stability is considered a significant advance.

2.5.5 Estimating Plume Dispersion

"Estimating Plume Dispersion -- A Comparison of Several Sigma Schemes" (Irwin, 1983a) was published in the January 1983 issue of the Journal of Climate and Applied Meteorology. This summarized the performance of schemes using turbulence intensities of wind fluctuations at plume level and concluded

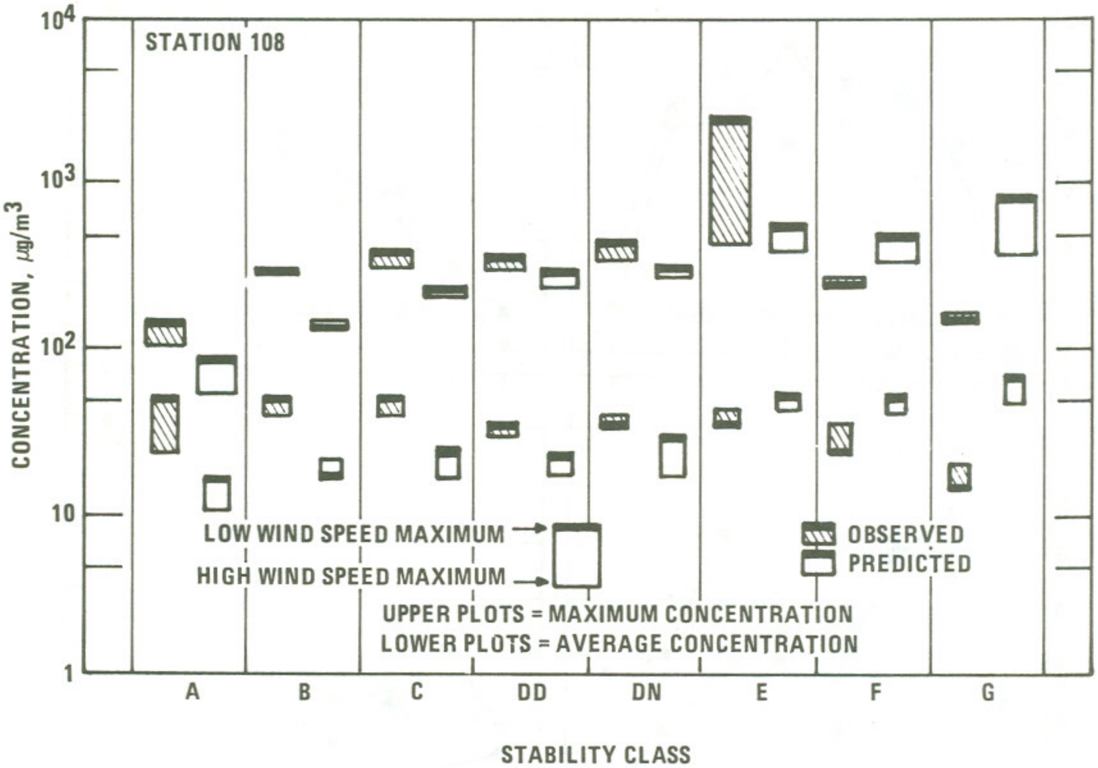

Figure 3. Maximum and average SO_2 concentrations for each stability wind speed category for station 108.

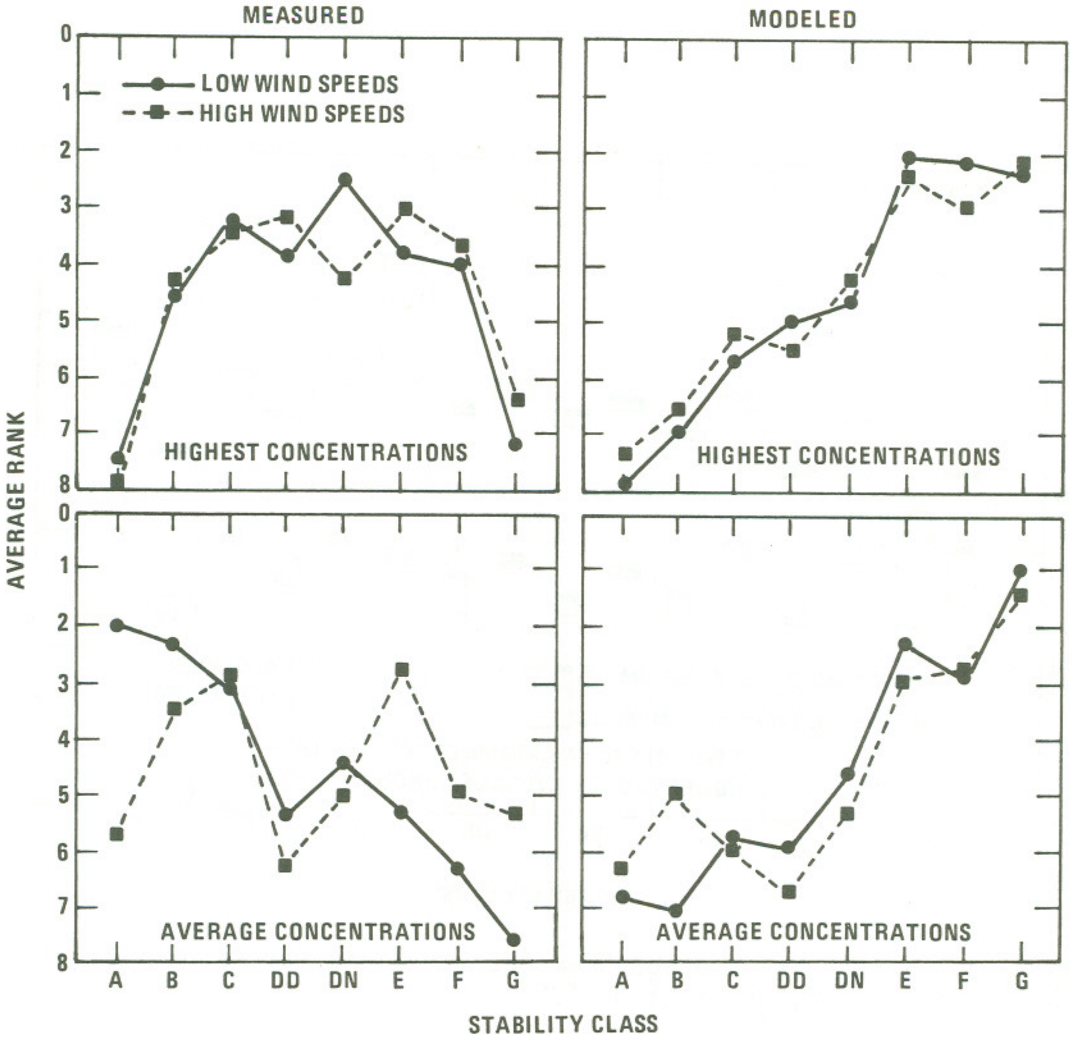

Figure 4. Mean rankings of maximum and average concentrations over the 13 stations for each stability-wind speed category (solid lines for low wind speeds, dashed lines for high wind speeds).

that usefulness of such schemes over currently employed Pasquill plume parameter methods is contingent on proper characterization of the turbulence intensities at plume level.

2.5.6 Workgroup Summary Report

A discussion workgroup (Irwin, 1983b) outlined methods for preparing meteorological data for routine use in air quality simulation of dispersion. The goal of the workgroup was to initially accommodate Gaussian plume modeling techniques, and to expand the meteorological variable list, as needed in the future, to accommodate other dispersion estimation techniques. Methods were suggested for estimating the vertical profiles of wind velocity, temperature, and the variances of the vertical and lateral wind speed fluctuations. Procedures were suggested for estimating the mixing height and the surface layer scaling parameters, including the Monin-Obukhov stability length. Coupled with near-surface measurements from a fully instrumented low-level meteorological tower, the winds, turbulence intensities, and temperatures are estimated using empirical formulations of the vertical profiles of these variables, defined in terms of mixing height and stability.

The model formulation of concentration estimates is viewed as a combination of several separate processors (Figure 5). The dispersion model characterizes the transport and dispersion for the pollutants based on the information it receives about the meteorological conditions and emission characteristics, which are typically specified hourly. The meteorological and emissions processors are referred to as preprocessors, as their tasks need to be accomplished before the dispersion model processor can accomplish its task. If the meteorological and emissions data are measured directly, these processors do little more than format the data for input to the dispersion model. If the required input data are not measured, then procedures are employed to derive or estimate the required input from other available information. As the quality and completeness of the meteorological data will vary from one application to the next, it is desirable to provide alternate methods for specifying each of the input variables to the dispersion model. For analyses involving an existing source, having only a limited meteorological measurement program onsite, the winds and turbulence intensities aloft might be estimated using empirical formulations of the vertical profiles of these variables coupled with near-surface measurements of wind velocity and turbulence intensity. The vertical profiles, derived either from field data or from numerical simulations of the planetary boundary layer (PBL), might be defined in terms of PBL properties, such as mixing height and stability. For large facilities, where measurements might be made routinely of the vertical profiles of the meteorological conditions, the extrapolation schemes could be employed for time periods where direct measurements are missing.

2.5.7 Formation of International Workgroup

An international workgroup was formed for the purpose of reviewing and evaluating methods for processing meteorological data for use in routine studies of air pollution dispersion and transport. Scientists from Denmark, Norway, The Netherlands and the U.S. met for one week during September 1983. The conclusions and recommendations from the workgroup will form the basis for the construction of a meteorological processor for use in computer simulation of dispersion.

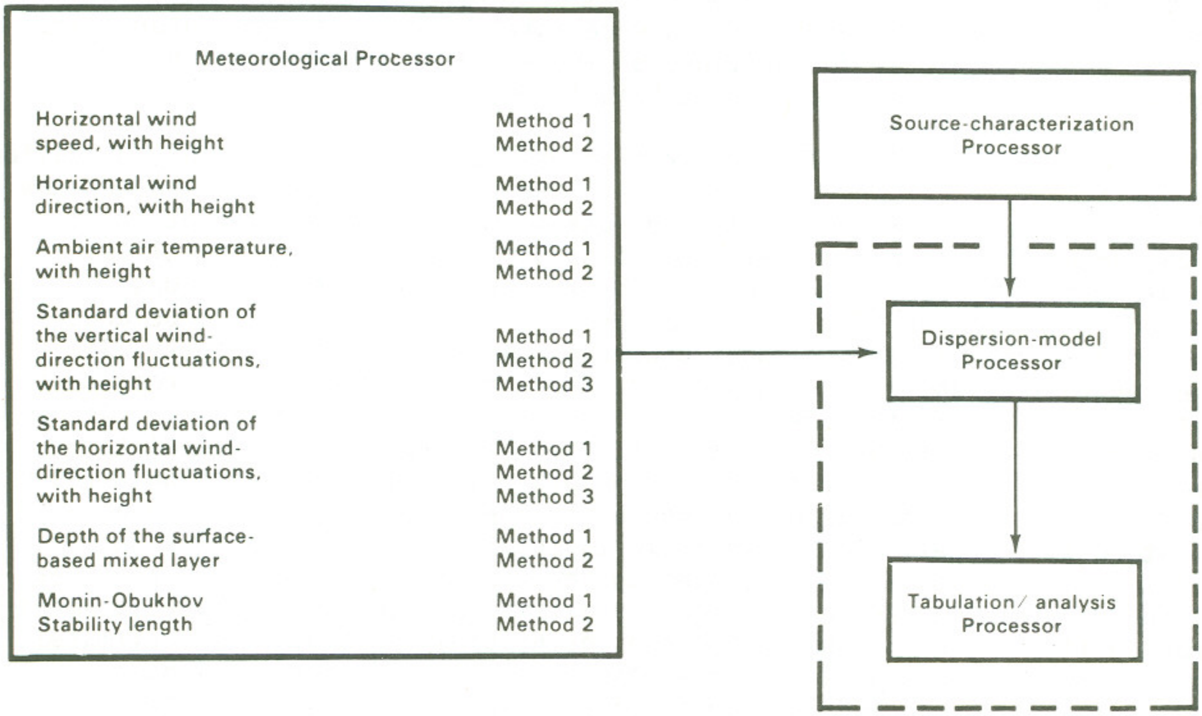

Figure 5. A depiction of the processors employed in formulating concentration estimates. Optimally, the meteorological processor has several methods to derive the required variables; the number depicted is for illustration purposes only. Many of the routine air quality dispersion models combine the functions of the estimation of the dispersion and the tabulation and analysis of the concentration estimates.

2.6 Air Policy Support Branch

The function of the Air Policy Support Branch (APSB) is to support activities of the Office of Air Quality Planning and Standards.

General APSB responsibilities include: (1) evaluating, modifying and improving atmospheric disperison and related models to ensure adequacy, appropriateness and consistency with established scientific principles; (2) preparing guidance on applying and evaluating models and simulation techniques that are used to assess, develop or revise national, regional and local air pollution control strategies for attainment/maintenance of ambient air quality standards; (3) organizing and directing aerometric field studies for improving the technical basis of the air quality management approach to air pollution control; and (4) providing meteorological assistance and consultation to support OAQPS's broad responsibilities for development and enforcement of Federal regulations and standards and assistance to Regional Offices.

APSB meteorologists are typically involved in interdisciplinary team efforts which include engineers, chemists, statisticians, computer specialists and other technical staff. Thus, it should be noted that most of the projects discussed in this report required such team efforts and the input of other technical staff.

2.6.1 Northeast Corridor Regional Modeling Project (NECRMP)

A report describing the design and operation of the 1980 urban field studies was finalized and distributed to the NECRMP participants during FY 83.The urban studies were conducted from July through mid-September 1980 in Washington, DC, Baltimore, New York City, and Boston. Specific information on (1) surface monitoring networks for ozone, oxides of nitrogen, hydrocarbons, and meteorological variables, (2) upper air meteorological soundings, (3) hydrocarbon species measurements, and (4) aircraft monitoring flights is included in the report. Also described are the quality assurance programs for each monitoring component and the availability of measured data.

An analysis was initiated to evaluate the representativeness of meteorological conditions and ozone concentrations in the Northeast during the 1980 NECRMP field study. Thus far, 1980 ozone concentrations have been compared to adjacent years, 1979 and 1981. The procedures for this analysis included identifying the daily maximum surface ozone concentrations of each year from June through August for 18 cities and towns from Ohio to the East Coast. Frequency distributions of the number of days ozone exceeded 125 ppb (the level of the ozone NAAQS) and 150 ppb indicate that the number of such high ozone days was significantly greater in 1980 across most of the central and eastern portion of the modeling domain. However, in Ohio, 1979 had the greatest frequency of high ozone days.

Because of historical changes in monitoring networks and the shift in ozone calibration procedure, comparisons of 1980 to ozone measurements prior to 1979 may be misleading. Thus, our effort is focusing on the development of a meteorological index which reflects the potential for high ozone concentrations in the major Northeast cities. In view of the completeness and consistency of National Weather Service records, compared to available ozone data, it is believed that analysis of historical variations in such an index (or indices) will provide a more meaningful indication of the representativeness of the 1980 ozone season.

2.6.2 Model Clearinghouse

The FY-83 activities for the Model Clearinghouse included:

1. Responding to EPA Regional Office requests for review of non-guideline models proposed for use.

2. Reviewing "special action" SIP submittals.

3. Documenting Clearinghouse decisions and discussions.

4. Summarizing Clearinghouse activities at various meetings.

5. Issuing periodic information (newsletter) on models and data base usage.

During FY-83 there were a total of 140 modeling issues referred to the Model Clearinghouse from all 10 Regional Offices. Sixteen of these issues required a written response and 53 issues were resolved orally or were outside the purview of the Clearinghouse. Fourteen issues, all involving the use of nonguideline models or choices between guideline models, were considered controversial and required a considerable amount of attention. A total of approximately 13 person-months was required to respond to these issues.

During FY-83 the Clearinghouse conducted or participated in a number of activities that can be categorized as coordination and information exchanges with the Regional Offices. One of the first activities was to prepare and distribute to the Regional Offices in October a Clearinghouse report, which served as a "newsletter," informing Clearinghouse users about the issues and responses which occurred in FY-82. This included a summary of 12 major responses by the Clearinghouse to Regional Offices as well as a listing of other issues the Clearinghouse addressed.

In response to a suggestion from the Regional Offices, at the beginning of FY-83 the Clearinghouse began sending copies of all of its written responses (along with the incoming requests) to all the Regional Offices. In this way the Regional Offices are made aware, in a timely fashion, of decisions made that may affect some of their modeling activities.

2.6.3 Guideline on Air Quality Models

A plan, submitted to EPA Headquarters by the Office of Air Quality Planning and Standards (OAQPS) in November 1982, for the development of the regulatory package required to revise the Guideline on Air Quality Models was approved shortly after the first of the year. This plan commits OAQPS to complete the revisions to the guideline and the associated regulatory changes according to the schedule specified in the plan. A workgroup was formed to provide advice and to cover the concerns of various offices who may be affected by changes in the guidance. Five NOAA Meteorology Division meteorologists participate in the workgroup activities. The first three workgroup meetings were held to discuss responses to the comments on the 1980 proposed revisions and to resolve several important issues. Following those meetings, work began on the guideline revisions and a first draft for workgroup review was distributed in August. A second draft incorporating the workgroup comments from a late August meeting has been completed and distributed for review to Federal agencies, State agencies and EPA Regional Offices.

Several briefings were held concerning the Development Plan and our progress on the guideline. Separate briefings were held in July and August for the Office of Research and Development, for Regional Office of Air Programs representatives and for interested Federal and State agency representatives.

The plan calls for EPA Headquarters review to be completed by late spring 1984 with a public hearing on the proposal (guideline plus regulatory changes) to take place in conjunction with the Third Conference on Air Quality Modeling in mid-1984. The final document is expected to be published in mid-1985.

2.6.4 Regional Meteorologists Workshop

A workshop for information exchange with the Regional Meteorologists and Modeling Contacts, as well as personnel active in modeling, was held at Research Triangle Park, NC in May 1983. The workshop met three objectives: (1) in-depth discussion of the new models that now appear in UNAMAP Version 5; (2) briefings on Division research programs in progress; and (3) discussion of special regulatory modeling topics together with status reports on OAQPS regulatory activities. Staff who either developed or were most familiar with the new or substantially updated models in UNAMAP gave detailed presentations on the models and also answered questions likely to be raised by the user community. Research plans, programs and outputs were discussed with the attendees by the respective Meteorology Division Branch Chiefs and selected staff members. The special topics discussed were chosen primarily to present progress in resolving action items from previous Workshops such as procedures for handling calms, background, building wakes and cavities, GEP stack height credits and on-site meteorological data. Time was also devoted to discussion of Region-specific modeling issues and problems being faced by the meteorologists/modeling contacts. Material presented included: (1) Model Clearinghouse activities; (2) status of State modeling guidelines; (3) modeling in conjunction with emissions trades (bubbles); (4) performance evaluations of models and (5) the schedule for revision the Guideline on Air Quality Models.

One outcome of these workshops that have now been held for several years is the report entitled "Regional Workshops on Air Quality Modeling: A Summary Report". First formalized in April 1981 the report has been updated to reflect consensus on issues reached during succeeding workshops. Its purpose is to clarify those procedures that are not specifically defined in the April 1978 Guideline on Air Quality Models and are left to the discretion of each Regional Office. The report does not establish any new modeling policy. EPA published the latest workshop report in December 1982 as EPA 450/4-82-015; the NTIS accession number is PB 83 150573. The report is updated by means of addenda following each workshop and the latest addendum is now under review the the Regional Offices prior to 1983 publication by OAQPS.

2.6.5 Interim Procedures for Evaluating Air Quality Models

In 1981 APSB personnel developed the "Interim Procedures for Evaluating Air Quality Models." The intent of this document was to provide a general framework for deciding whether a proposed model, not specifically recommended in the "Guideline on Air Quality Models", is acceptable on a case-by-case basis for a specific regulatory application. At that time it was recognized that the concepts described in these procedures were relatively new and untested and that, after a period of time during which experience is gained and problems are identified, there would be a need to update and revise the procedures.

During the 1981-1983 period considerable experience was gained on the application of the interim procedures through the development of an example problem and through several cases where the procedures were applied to select a regulatory model for a specific situation. Based on this experience an in-house effort was initiated during FY-83 to revise the procedures.

The major effort during FY-83 involved revisions of the procedures for calculating certain performance measures and for applying the performance statistics in a decision scheme. Specifically the concept of data sets was introduced and criteria for the selection of the appropriate data sets and related performance measures were suggested. A revised scheme for weighting the various performance measures for quantifying the relative performance of the proposed model versus the reference model have now been incorporated into the document.

During FY-84 it is planned to complete the revisions to the Interim Procedures for Evaluating Air Quality Models. The overall structure of the document will be revised in order to more closely tie the performance evaluation to the technical evaluation and the requisite data bases.

2.6.6 National Air Pollution Background Network (NAPBN)

An analysis of ozone measurements from the eight NAPBN sites was conducted to quantify summer background ozone concentrations (natural plus anthropogenic contributions due to long range transport) and compare the frequency of high ozone episodes among remote locations in five geographic regions: the Northeast, Southeast, Midwest, Northern Rockies, Southwest, and Pacific Northwest. The ozone data base used in the analysis extended from 1977 through 1981. Overnight measurements were excluded to avoid site-to-site variations in nighttime ozone scavenging. The analysis indicates that summer background ozone concentrations range from 32 to 59 ppb with a mean value of 46 ppb. Most (67 percent) of the summer seasons had mean ozone values between 40 and 50 ppb and no consistent geographic variation was noted from the data. However, examination of short-term, daily fluctuations in ozone concentrations, indicates a distinct geographical difference between eastern (Northeast, Southeast and Midwest) and western (Northern Rockies, Southwest and Pacific Northwest) sites. At the eastern sites, relatively large amplitude cycles occur during which ozone concentrations rise and decline over a multiday period. At western sites, the temporal distributions are fairly irregular, without any well-defined multiday cycles. Episodes with daily maximum ozone concentrations at or exceeding 80 ppb occurred in all areas except the two sites in the Northern Rockies and the Pacific Northwest. Major episodes at eastern sites were often coincident with episodes in urban areas within the same geographic region. The results of this effort are being used by EPA in evaluating the impact of ambient ozone concentrations on vegetation.

2.6.7 Arsenic--National Emission Standard for Hazardous Air Pollutants (NESHAP)

In response to a request for support of the NESHAP regulatory process, a study was initiated to identify the most appropriate model to estimate long-term average concentrations of ambient arsenic levels in the vicinity of the ASARCO-Tacoma smelter. Once identified, this model will be applied to a base case, corresponding to 1982 emissions from the smelter, and an "after control" case(s) corresponding to estimated smelter emissions after the application of Best Available Technology (BAT).

In 1980, arsenic was listed as a hazardous pollutant under Section 112 of the Clean Air Act. In support of this listing, in 1981 an in-house analysis was performed to estimate the ambient levels of arsenic in the base case and the BAT case for the largest source of airborne arsenic in the country, the ASARCO-Tacoma smelter. This analysis involved the application of the ISC model using the readily available model inputs on emissions and meteorology. Since that time a number of events/considerations have taken place leading to the identification of the need to conduct a much more thorough investigation of the ambient arsenic picture near the smelter:

1. Risk analyses utilizing the 1981 model estimates showed a significant residual cancer risk after application of BAT.

2. Further reduction of this risk would likely necessiate closure of the smelter.

3. This case is the first test of a new proposed EPA policy where risk analyses associated with NESHAPS regulations is given a much higher level of importance than in the past.

4. The terrain in the vicinity of the ASARCO-Tacoma smelter is such that ISC, as applied to the problem, may not lead to the most accurate estimates that could be made.

5. Observed ambient levels of arsenic in the vicinity of the smelter suggest that the 1981 estimates may be too high.

6. The 1981 modeling did not include an acquisition/analysis of all of the existing meteorological data to determine the most appropriate model inputs.

7. The 1981 modeling did not include considerations of the temporal affect on arsenic emissions caused by operation of the supplementary control system (SCS) at the smelter.

8. A court ordered proposal of the arsenic emission standards was published in July 1983.

Based on these facts a contractual study was initiated to select, evaluate, and apply appropriate air quality simulation models. The contract has four phases:

1. A background study where the appropriate emissions (taking into account the affect of the SCS), meteorology, and air quality data are identified.

2. A model selection study where candidate models are identified.

3. A model testing study where the candidate model estimates are compared to ambient measurements from certain historical periods.

4. A model application phase where the best model, identified from testing, is applied to a base case and the BAT case.

At the close of FY-83 the background and model selection phases are nearing completion. Final model selection and application will take place in FY-84.

2.6.8 Evaluating Model Performance

Eight categories of air quality models are being evaluated in a program that consists of several major tasks. APSB staff members serve as advisors and Project Officers on several specific tasks in this program.

Work on one task, Report on Model Accuracy, was completed this fiscal year. This task was performed under contract by Systems Applications, Inc., (SAI) with an APSB Project Officer. In this task, SAI proposed a set of aggregate statements of model performance which reflect the performance measures recommended by the American Meteorological Society (AMS) SAI reviewed model evaluation studies for the recommended EPA air quality models and those models which were submitted to EPA by private developers for possible inclusion in the Guideline on Air Quality Models. Where possible, the statistics reported in those studies were recast in a form consistent with the AMS recommendations. The final report, entitled "A Survey of Statistical Measures of Model Performance and Accuracy for Several Air Quality Models," EPA-450/4-83-001, has been published. The NTIS accession number is PB 83 260810.

A second task, Evaluation, Selection, and Installation of Data Bases for Complex Terrain Models, was completed with the accession of The Cinder Cone Butte data base and the Westvaco data base. An APSB staff member served as Project Officer on this task.

A third task is the performance evaluation of the complex terrain models. The protocol for the evaluation of each of the eight models in this category has been developed. The evaluation itself is in progress with an APSB meteorologist serving as an advisor to the EPA Project Officer.

2.6.9 Emissions Trading Policy (Bubbles)

EPA's Emissions Trading Policy, commonly referred to as the "bubble policy", was proposed in the Federal Register on April 7, 1982. Until a final policy is promulgated, principles contained in the proposal are to be used to evaluate trading activities which become ripe for decision.

The Emissions Trading Policy states that emission increases and decreases within the bubble should result in ambient air quality equivalence. Two levels of analysis are defined for establishing this equivalence. In a Level I analysis the source configuration and setting must meet certain limitations (defined in the policy and clarification to the policy) that ensure ambient equivalence; no modeling is required. In a Level II analysis a modeling demonstration of ambient equivalence is required but only the sources involved in the emissions trade are modeled. The resulting ambient estimates of net increases/decreases are compared to a set of significance levels to determine if the bubble can be approved.

The Emissions Trading Policy also allows States to adopt generic regulations for processing bubbles. However, an added requirement is that the modeling procedures contained in any generic regulation must be replicable such that there is no doubt as to how each individual bubble will be modeled.

The Emissions Trading Policy left unclear a number of details on how the modeling for an individual bubble was to be carried out. As a consequence the APSB expended considerable resources in developing the requisite modeling methodologies. Specifically APSB personnel developed a technique whereby refined models could be applied to Level II bubbles. The procedure involves sequential modeling, considering both emission increases and decreases within a facility, such that one can establish whether the significant levels are met both temporally and spatially, i.e., at all receptors for each time period throughout the year. APSB personnel established that for generic bubbles the States must prespecify the models, model options, data bases and procedures for applying the models in their regulation in order to meet the replicability requirement. APSB personnel also established that bubbles for sources located in complex terrain and certain industrial sources, where judgements must be made on source characterization, cannot be handled generically because of the replicability requirement.

2.6.10 Model Review

Five models were submitted for review during FY-83. All passed the initial screening requirements for adequacy of coding and documentation in a user's guide as well as the review for technical adequacy.

The Maryland PPSP Dispersion Model is a Gaussian model applicable to point sources with tall stacks. Although similar to the CRSTER model, it differs in four ways: (1) daytime stability is based on convective scaling; (2) Brigg's dispersion curves for elevated releases are used; (3) Briggs' plume rise equations for convective conditions are included; and (4) Briggs' model for plume penetration of elevated stable layers is incorporated. ERT Inc. submitted PLUMSTAR, a photochemical trajectory model designed for urban scale and mesoscale applications involving reactive hydrocarbon, NO_x and SO_x emissions. The model produces short-term concentration estimates of O_3, NO_2, HNO_3, PAN, SO_2, and sulfate. ERT, Inc. also submitted an updated version of the Rough Terrain Dispersion Model (RTDM) for review. SAI, Inc. submitted the Reactive Plume Model (RPM-II), designed to estimate short-term concentrations of primary and secondary pollutants from point and area source emissions. The Regional Transport Model (RTM-II) was also submitted by SAI, Inc. This version contains updates and improvements to a previous submission.

2.6.11 Particulate Matter Impact Due to Surface Coal Mines

Additional work to characterize emissions, particle deposition and pit retention, together with preparation of a protocol for further evaluation of the ISC Model, is being carried out through a contract managed by an EPA Project Officer in Cincinnati with assistance from APSB staff. The contractor's work plan is comprised of two parts. First, a draft report entitled "Plan for Performance Evaluation of the ISC Dispersion Code Applied to Fugitive Dust Emissions From Western Surface Coal Mines" was submitted in March, 1983. The report contains the essentials for conducting an evaluation of the entire air quality impact predictive process, i.e, emissions, monitoring and modeling. The plan could be followed by any group concerned with surface mine emissions and interested in evaluating the performnce of a model that provides estimates of particulate matter air quality. In this case, the Air Quality Committee of the National Coal Association (NCA) is currently reviewing the plan but has not yet submitted comments. However, NCA has expressed interest in cooperative efforts to apply the plan at a surface coal mine operated by a member company, providing funds are available to do so.

Second, the contractor conducted a week-long field study at each of four Western surface coal mines during July 1983. Daytime smoke releases within four types of pits were recorded on video tape concurrent with meteorological data and other related observations. The objective is to document the dispersion behavior of particles that are generated within coal mine pits or trenches under a variety of meteorological conditions. There were 740 smoke release cases recorded on 16 video tapes in VHS format and 350 hours of recorded meteorological data.

The contractor has submitted a draft report entitled "Studies Related to Retention of Airborne Particulates in Coal Mine Pits, Data Collection Phase." The report contains a description of the smoke study program as it was conducted at the Colorado Yampa Coal Mine in Colorado, the Caballo Mine in Wyoming, the Spring Creek Coal Mine in Montana and the Rosebud Mine in Wyoming. Four appendices contain the procedures utilized and a copy of the documentation forms, still camera photographs from the study sites, a listing of the smoke data and the meteorological data listing. In FY-84 a separate OAQPS contract managed by an APSB meteorologist, will focus on the analysis and interpretation of this data base. The goal will be to produce a technique for treating analytically the in-put releases of particulate matter so that quantitative concentration estimates at downwind locations can be made.

To close out an item from FY-82, the report prepared by PEDCo Environmental, Inc. and TRC Environmental Consultants entitled "Characterization of PM_{10} and TSP Air Quality Around Western Surface Mines" was printed in early 1983 as EPA 450/4-83-004.

2.6.12 Task Team on Probabalistic Modeling

Prior to disbanding the task team that had been assembled to look at probabalistic modeling concepts, the contract investigating the stochastic treatment of meteorology was completed. A final report "The Temporal Representativeness of Short-Term Meteorological Data Sets: Implications for Air Quality Impact Assessments" has been submitted by Systems Applications, Inc. for review.

This work included development of a new technique that uses repeated random sampling of a short-term data set (e.g., one or five years) to estimate whether the short-term set is representative of a longer term (e.g., 20- or 30-year climatic period). SAI integrated the technique into the Expected Exceedances (ExEx) modeling method and applied it to a coal-fired power plant. The study concludes that emission limits calculated from a single year's data show significant variability from year to year. Thus, regulatory decisions, based on a single year's data, may contain a high degree of uncertainty. Emission limits based on five years of meteorological data show far less variability.

In addition, SAI began investigation of a statistical procedure to incorporate meteorological variability into the ExEx methodology. Preliminary results indicate that "standard" ExEx (emissions treated statistically) and "stochastic" ExEx (emissions and meteorology treated statistically) produce results which are not greatly different. More work is necessary before the impact of statistically treating meteorology, as reflected by variations in χ/Q, can be adequately determined.

2.6.13 Technical Assistance to OECD and NATO/CCMS

During FY-83 technical assistance was provided to the Organization of Economic Cooperation and Development, Environment Directorate in their effort to pursue the development and application of a long range transport photochemical model for Europe. At their request, a paper was prepared in conjunction with other Meteorology Division personnel on the regional chemical and meteorological measurements obtained during the 1979 and 1980 Northeast Regional Oxidant studies. The paper provided OECD with information on the magnitude of data needed to apply a regional oxidant model and the scope of field programs conducted to obtain the ambient data base.

A similar paper was also prepared in conjunction with other Meteorology Division staff for presentation at a NATO/CCMS sponsored conference. However, this paper focused more on the monitoring aspects of the field studies. Also included were interim results from the interpretation of case studies to quantify long range and interurban ozone and precursor transport in the Northeast, and the effects of mesoscale processes, such as cloud venting, on the vertical distribution of pollutants.

2.6.14 Technical Consultation

On the average, approximately one quarter of each APSB meteorologist's time is devoted to responding to telephone requests for technical assistance. At least half of these requests come from outside the Agency and frequently address both the technical and policy aspects of modeling for different agency program requirements. Requests often come from lawyers and managers as well as private consultants and technical experts. Immediate response concerning the application of modeling techniques to programmatic requirements means all meteorologists must keep abreast of the latest technical information and policy changes. For example, one APSB meteoroloigst is the contact person for questions on meteorological monitoring in the context of ambient monitoring requirements in the PSD regulations. Another meteorologist has attended several meetings of EPA's Standing Committee on Emissions Trades (bubbles) to present advice and recommendations on modeling techniques for specific cases. Modeling guidance was written to accompany the regulatory package for the proposed revisions to the TSP ambient air quality standard. Updates were supplied for the modeling techniques used to demonstrate attainment of the quarterly lead (Pb) ambient standard. Assistance was provided on the use of Multi-point Rollback techniques for setting emission limits and demonstrating compliance by smelters with the SO_2 ambient standard. A comprehensive review of two meteorological training courses that resulted in substantial upgrading of technical quality was provided to the Air Pollution Training Institute early in the fiscal year. Finally, APSB staff provide assistance to EPA contract project officers on meteorological aspects of their work plans, sensitivity studies, field programs, analysis of data and technical reviews of reports.

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5. METEOROLOGY DIVISION STAFF FISCAL YEAR 1983

All personnel are assigned to the Environmental Protection Agency from the National Oceanic and Atmospheric Administration, except those designated (EPA) = Environmental Protection Agency employees or (PHS) = Public Health Service Commissioned Corps personnel.

Office of the Director

Dr. Kenneth L. Demerjian, Physical Scientist, Director
Herbert J. Viebrock, Meteorologist, Assistant to the Director
Marc Pitchford, Meteorologist (Las Vegas, NV)
Evelyn Poole-Kober (T) (EPA), Technical Information Clerk
Michelle Richardson (Student) (EPA), Clerk-Typist

Atmospheric Modeling Branch

Dr. Jack H. Shreffler, Physical Scientist, Chief
Dr. Francis Binkowski, Meteorologist
Dr. Gary Briggs, Meteorologist
Dr. Jason Ching, Meteorologist
Terry Clark, Meteorologist
Dr. John Clarke, Meteorologist
James Godowitch, Meteorologist
Dr. George Griffing, Physical Scientist (until July 1983)
Dr. Robert Lamb, Meteorologist
Kenneth Schere, Meteorologist
Orren Bullock (Student), Meteorologist (until June 1983)
Mark Shipham (Student), Meteorologist (until August 1983)
Bess Flowers, (PT) (EPA), Secretary

Fluid Modeling Branch

Dr. William H. Snyder, Physical Scientist, Chief
Roger Thompson, (PHS), Environmental Engineer
Dr. Robert Eskridge, Meteorologist
Robert Lawson, Physical Scientist
Robert Chalfant, Electronics Technician
Lewis Knight, Electronics Technician
Joseph Smith, Mechancial Engineering Technician
Ralph Soller, Meteorological Technician
Judith Haden (Student), Engineering Aid
Eileen Ward (Student) (EPA), Clerk-Typist

Data Management Branch

Joan H. Novak, Computer Systems Analyst, Chief
James Reagan (PHS), Statistician
Adrian Busse, Computer Specialist
Dale Coventry, Computer Systems Analyst
Alfrieda Rankins, Computer Programmer
John Rudisill, Meteorological Technician
William Amos (EPA), Computer Programmer
Barbara Hinton (PT) (EPA), Secretary

Terrain Effects Branch

Francis A. Schiermeier, Meteorologist, Chief
Dr. Francis Pooler, Jr., Meteorologist
Lawrence Truppi, Meteorologist
Alan Huber, Meteorologist
George Holzworth (T), Meteorologist
Hazel Hevenor (EPA), Secretary

Environmental Operations Branch

D. Bruce Turner, Meteorologist, Chief
Dr. Ralph Larsen (PHS), Environmental Engineer
William Petersen, Meteorologist
John Irwin, Meteorologist
Dr. Peter Finkelstein, Meteorologist (Assigned to Environmental Monitoring Systems Laboratory)
Everett Quesnell, Meteorological Technician (Assigned to Environmental Monitoring Systems Laboratory)
Thomas Asbury (Student), Meteorologist
Valentine Descamps, Meteorologist (Boston, MA)
Alan Cimorelli, Meteorologist (Philadelphia, PA)
Lewis Nagler, Meteorologist (Atlanta, GA)
Richard Fisher, Meteorologist (Denver, CO)
Joan Emory (EPA), Secretary

Air Policy Support Branch

James L. Dicke, Meteorologist, Chief
Charlotte Hopper, Meteorologist
Dean Wilson, Meteorologist
Russell Lee, Meteorologist
Norman Possiel, Jr., Meteorologist