Abstract

The Eighth Joint Conference on Applications of Air Pollution Meteorology with the Air and Waste Management Association was held in conjunction with the AMS 74th Annual Meeting in Nashville, Tennessee, on 23–28 January 1994. Sessions at the meeting covered a broad range of topics including the dispersion environment, meteorology in emissions determination, long-range and mesoscale pollutant transport and fate, meteorology and photochemistry, advanced dispersion models and modeling systems, model evaluation, complex flows affecting dispersion near structures, and coastal and complex terrain issues. Papers followed some recurrent themes but many reported applications of new technology that provide new opportunities to see atmospheric characteristics and complexities for the first time. Innovative techniques were described in data analysis and presentation and modeling.

1. Introduction

The Eighth Joint Conference on Applications of Air Pollution Meteorology with the Air and Waste Management Association was held in conjunction with the AMS 74th Annual Meeting in Nashville, Tennessee, on 23–28 January 1994. Since the last conference in 1991, changes have occurred on how research in air pollution and applied studies in air pollution meteorology are conducted. In contrast to the seventh conference with its summary of the 10-year National Acid Precipitation Assessment Program, few papers addressed acid deposition issues. A cooling of the economic climate and uncertainties in the regulatory environment associated with evolving 1990 Clean Air Act Amendments (CAAA) have also limited studies related to more traditional local-scale dispersion issues. Rather, the CAAA have turned our view toward a broader set of issues for which regulations and guidance are now being developed.

The CAAA title on nonattainment has brought renewed interest in the pairing of complex dynamical meteorological models with photochemical air quality models. Requirements that future attainment to regulations be demonstrated with these models invites a new look at model evaluation. The CAAA titles addressing airborne toxic chemicals have brought renewed interest in near-source dispersion and deposition of toxic chemicals with needs related to residual health risk assessments and coastal waters chemical loading. Studies are also required to address the transport and fate of toxic chemicals after accidental releases. CAAA titles related to acid deposition and operating permits have rekindled interest in plume rise and the atmosphere’s vertical structure, particularly on the small scale with dispersion near structures, on local scales in areas of complex terrain, and on the mesoscale for air quality assessments. These issues were addressed by the conference contributors with sessions on the dispersion environment, meteorology in emission determination, long-range and mesoscale pollutant transport and fate, meteorology and photochemistry, advanced models, model evaluation, complex flows near structures, and coastal and complex terrain issues.
2. Summaries

a. Session 1: The dispersion environment

The conference began with a session devoted to summarizing recent developments in characterizing how the environment or meteorology affects air pollution. Papers concentrated on observations and their use in representing wind fields and dispersion in the atmosphere. Additional papers discussed comparisons among different atmospheric turbulence and profiling techniques and their role in interpreting observations for use in analysis and modeling.

S. Hanna set the stage for the session in his invited paper, “Random Variability in Mesoscale Wind Observations and Implications for Dispersion Models.” The paper was timely with the current focus on air pollution studies on urban and mesoscale meteorological and dispersion modeling to address ozone, visibility, and other secondary air pollutant issues. Hanna noted that horizontal diffusion is characterized by turbulent fluctuations in horizontal winds over a wide range of timescales and space scales. That is, no matter how long the sampling time, the wind observations will always contain significant fluctuations on timescales that are of the same order as the sampling time. Current models using constant eddy diffusivities, or “K’s,” do not adequately represent this observed feature. Improvements in K theory models are required to provide different values of the constant K’s for the timescale of each application. Similarly, oversmoothing by prognostic wind field models does not capture the full spectrum of horizontal turbulent wind fluctuations, and therefore the models are unable to adequately simulate diffusion. Hanna suggested that incorporation of subgrid-scale models for turbulence is required for prognostic meteorological models.

Several papers presenting wind measurement comparisons from different advanced systems supported the conclusions of Hanna. R. Paine, J. Martini, and D. Murray presented observations from wind measurement systems, balloons, towers, and acoustic sounders in an attempt to uncover the relationships in observations among these systems. It was clear from observations presented that longer averaging periods produced better agreement among systems. That is, the smoothing of smaller-scale eddies by averaging reduces the importance of spatial separations and variability and improves the comparisons.

Papers by Y. Ping and W. Angevine introduced data from relatively new radar profiling systems. The systems provide observations over a greater depth in the atmosphere than towers and acoustic sounders. They also have the advantage of providing semi-continuous observations as an improvement over the “snapshots” from balloon-borne sounding systems.

b. Session 2: Meteorology in emissions determination

The information derived from the systems was related to wind speed profiles, mixing depths, and their effects on plume rise and dispersion.

P. Welsh presented an interesting diagnostic display of boundary-layer data through the use of computer graphic videos. These developmental displays were rich in content, but still required user familiarity to fully interpret the analyses. The promising concept deserves further study.

T. Coulter, B. Bowen, and D. Holland each presented papers on methods for determining appropriate stability categories for use in current Environmental Protection Agency (EPA) regulatory dispersion models. Each presenter showed method comparisons but stopped short of presenting an evaluation of model results using the techniques through comparisons to tracer data or other measurements of dispersion.

D. Murray provided results of a study in Valdez, Alaska, that provided tracer data that could be used in model comparisons as well as chemical exposure measurements. A unique aspect of the study was the use of individual exposure monitors by workers and the local populace in their daily activities. These provided direct measurements of exposure to replace estimates inferred from point measurements. The study was important in allocating exposure to benzene from local emission sources and oil-loading facilities across the fjord due to the unusual orographic wind patterns found in the area.

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points within the circulations. Perry conducted dispersion simulations using the EPA Industrial Source Complex (ISC) model with a modified area source to represent the pit emissions. The source configuration injected the most significant emission on the upwind edge of the pit.

G. Emmitt reported results from a project involving another aspect of coal operations, that is, storage and handling at port facilities. He and his coworkers addressed the potential nuisance of large particle emissions by constructing a system to estimate off-site particulate concentrations resulting from wind erosion and coal handling. The system allows the effects of controls to be evaluated. It is composed of a CO_2 scanning lidar and data acquisition system, a meteorological data system, and a dispersion model. The lidar system provides a means of dynamically calibrating a version of the ISC model by providing information on the temporal variability of emissions and the near-source concentrations.

R. Ormerod dealt with another nuisance, odor from cattle feedlots. His approach was to construct a model of odor fluxes. These are dependent on some operational factors as well as wind speed turbulence level and pad moisture. The latter parameter is simulated with a hydrological model incorporating rainfall and evaporation. It is also dependent on stocking density, time of year, and cleaning frequency to account for urine input. Time is used to account for surface crusting, bacterial growth, and the suppressive effect of newly fallen rain. Fluxes can be used in appropriate dispersion models.

The last paper of the session, presented by R. Perry, examined the temporal variability in emissions from cement kilns in estimating concentrations and therefore health risk to the maximally exposed individual near facilities. Results of Monte Carlo simulations showed that neglect of temporal variability in dispersion models resulted in excessive overestimates of pollutant concentrations. In addition, the spatial pattern of long-term concentrations is significantly altered by assumptions of time-invariant emissions.

c. Session 3: Long-range and mesoscale pollutant transport and fate

Session 3 provided a collection of papers on mesoscale and long-range pollutant transport issues. The session was limited in scope over previous meetings as less emphasis is now placed on studies of acidic deposition. S. Dorling presented a cluster analysis of back trajectories from three United Kingdom and Norwegian sites to explain the variance in their wet deposition measurements. A composite surface pressure pattern was computed for each cluster to classify the meteorological environment. Taken with precipitation amount, the clusters could account for up to 35% of the deposition variance in the measurements from the United Kingdom sites. Less of the variance was explained by the clusters at Norwegian sites, which he attributes to a larger orographic influence on precipitation patterns. Dorling proposed that use of global circulation model results with the clustering analysis could provide estimates of climatic effects of air pollution.

J. Stout also examined trajectories but those of falling particles through a layer represented by a power-law or logarithmic wind profile. Stout did this by solving the equations of particle motion. Results of sensitivity tests showed that small or light particles quickly adjust to local flow velocities. In future studies this result will be reexamined to simulate more realistic deposition patterns by adding a turbulent component to the model.

W. Lyons, providing a substitute paper, presented findings to support his contention that large convective clouds complexes characterized by mass fluxes on the order of 10^{14} g s^{-1} effectively remove boundary layer pollutants. Observations presented illustrated a clear area remaining after an embedded mesoscale convective complex formed and decayed during an East Coast haze episode. Simulation results by a dynamical model [Regional Atmospheric Modeling System (RAMS)] supported his theory that the pollutants were ejected into the upper troposphere or stratosphere in the anvil outflow rather than eliminated through wet deposition.

M. Moran, in an invited paper titled “Delayed Shear Enhancement in Mesoscale Atmospheric Dispersion,” discussed the role of wind shear in enhancing mesoscale horizontal dispersion. The mechanism was initially suggested by Pasquill (1962). When pollutants are released in a region of vertical shear in the horizontal wind, they are transported at different speeds and directions at different levels. Subsequent vertical mixing then results in pollutant mixing over a much larger volume than would be the case in the absence of shear. Moran used tracer data from the Great Plains and CAPTEX (Cross Appalachian Transport Experiment) experiments, which were conducted over 600–800 km to provide examples of this process. Simulations of these experiments using the RAMS model in conjunction with a particle dispersion model supported this process of enhanced dispersion due to the interaction of differential horizontal advection and vertical mixing.

M. Ullasaz described a series of particle simulations being conducted for the MOHAVE (Measurement of Haze and Visual Effect) Project. Daily output fields for a year will be extracted from a series of 36-h simulations of the RAMS dynamical model. These will be
used to provide data in particle simulations. To speed computations, horizontal diffusion, a process of secondary importance, was neglected in the particle simulations. A unique feature of the dispersion model is the ability to compute conventional source-based concentrations as well as receptor-based influence functions.

Addressing another mesoscale issue, J. Vimont tested different meteorological preprocessors for regulatory modeling. The analysis focused on the ability to compute mixing heights and wind fields from the MESOPAC-II, METDWN, and CALMET preprocessors. Demonstrations showed that MESOPAC-II had problems over large domains. These were characterized by discontinuities resulting from the use of the nearest-station data for each grid point. METDWN produced better wind field predictions using a mass consistent formulation and terrain inputs but produced unrealistic mixing height estimates. CALMET outputs appeared to be most realistic due to use of a diagnostic wind field model that included terrain and a more complete parameterization for mixing heights over both land and water.

d. Session 4: Meteorology and photochemistry

Recently, much attention has been given to overcoming nonattainment of ambient oxidant standards. Numerous conferences and symposia have addressed issues related to photochemical oxidant models and their validity as demonstrated in field measurement programs. Six papers were presented in the meteorology and photochemistry session, five of which addressed how oxidant models respond to changes in meteorological and emissions inputs and parameters. The remaining paper attempted to identify pollutant source regions for a high oxidant episode in the Great Smoky National Park.

P. Dolwick presented sensitivity test results for the Lake Michigan Ozone Study (LMOS) CAL-RAMS/UAM-V (Regional Atmospheric Modeling System/Urban Airshed Model) modeling system. Response to varying emission scenarios was examined in an attempt to quantify the effects of emission inventory bias. Preliminary results showed marginal performance with domainwide oxidant concentration underpredictions for all episodes studied. This was attributed to an underestimate in the emissions inventory. W. Lyons reviewed applications of the same CAL-RAMS model as the meteorological driver for the LMOS modeling system. Lyons demonstrated using four episodes in which modeling with fine horizontal and vertical resolution nested grids was critical in adequately describing the shallow lake breezes (approximately 250 m) found in the Lake Michigan area. Results also showed that soil moisture was an important parameter in regional-scale results from the meteorological model. Meteorological results were generally comparable to observed values.

R. Bornstein also examined the UAM model from the aspect of sensitivity to input winds. Using wind fields from the Regional Oxidant Model and URBMET/TVM (Urban Meteorological/Total Vorticity Advection Model) models, his results for a 1988 high-ozone episode were more favorable using the latter model due to its improved ability to simulate local circulations and low wind speed conditions. S. T. Rao presented sensitivity test results for the UAM model comparison of spatially varying mixing height profiles formulations to spatially invariant profiles. Rao studied a high oxidant concentration episode (June 1988) in the New York City air shed. Peak ozone concentrations between the two cases ranged from a few parts per billion (ppb) to approximately 40 ppb with mixing height assumptions affecting elevated sources differently than low-level emission sources. This result would imply that NOx-based control strategies appear more effective if a spatially invariant mixing height assumption is used and that volatile organic compound-focused controls appear more effective if a spatially varying mixing height formulation is used.

C. Walcek presented results of a more basic study on how meteorological parameter variations affect the ozone formation rates in current chemical submodels for oxidant modeling systems. His results showed that there is substantial sensitivity with a 5-K increase in temperature resulting in a 10%–20% increase in ozone formation rates, a 10% enhancement in the photolysis rate leading to a 10%–15% increase in the ozone formation rate, and a 10% increase in relative humidity resulting in a 5%–10% increase in the ozone formation rate.

S. Mueller presented an exploratory study of whether back trajectory techniques were adequate to identify source regions of high oxidant concentration episodes in Great Smoky National Park. Although nearby urban sources were implicated, he concluded that the analysis technique was inadequate by itself to provide a clear source attribution. This finding is similar to the findings of acid deposition and visibility studies: that is, other “secondary” pollutants.

e. Session 5: Advanced dispersion models and modeling systems

The fifth session of the meeting was devoted to discussion of advanced atmospheric dispersion models. Nine papers were presented during this session beginning with an invited presentation by A. Venkatram titled “Recent Developments in Air Quality Modeling.” In his discussion, Venkatram noted that advances in regulatory dispersion models have been slow with the
result that applied, user-friendly air quality models, having consistent parameterizations of the governing equations, still do not exist. Current models are frequently patched together with “if statements” arbitrarily based on factors such as time of day as a replacement for consistent parameterizations. In contrast to the slow pace of applied model development, Venkatram stated that advances have been made in the parameterization of micrometeorological processes. He cited boundary layer formulations using $L$, $u$, $w$, and $z/H$ rather than simple stability categorizations as examples of these advances. Some of these advances are only now beginning to appear in applied models—for example, in the model resulting from the AMS/EPA Regulatory Model Improvement Committee. Finally, Venkatram listed several improvements that he thought were important in advancing modeling. Among these were incorporation of probability distribution functions of turbulent velocity fluctuations, consistency in planetary boundary layer parameterizations, and elimination of arbitrary changes of parameterizations based on time of day, stability class, etc.; linking of meteorological and dispersion models without creating “monsters”; and simplified chemistry for use in ozone screening models.

M. Capuano and coauthors described a mesoscale dispersion model developed for the U.S. Department of the Interior Minerals Management Service as an alternative to the existing Offshore Coastal Dispersion Model and the Environmental Protection Agency’s SCREEN model. The Short-Range Layered Atmospheric Model (SLAM) is part of the Offshore Modeling System and runs on a UNIX workstation. The modeling system includes interfaces to access near-real-time weather data, a weather data processor, SLAM, graphical weather data displays, and graphical model output displays.

Presentations by R. Karpovich and P. Catizone addressed preparation of data for use in the EPA’s regulatory CTDMPLUS (Complex Terrain Dispersion Model Plus Algorithms for Unstable Simulations) model. Their papers indicate that appropriate regulatory use of the model can be both costly and time consuming. R. Karpovich and coauthors concentrated on the hardware and software requirements of CTDMPLUS. They noted an inconsistency in formats between recent data obtained from the National Climatic Data Center (NCDC) and model input requirements. Specifically, the observation time for recent upper-air data is the hour closest to the actual observation, while CTDMPLUS requires the nominal observation time, either 0000 or 1200 UTC. They described their correction for this problem and NCDC delays in making observations available after observation. The authors also compared several methodologies for generating needed terrain input from currently available U.S. Geologic Service Digital Elevation Model (DEM) or Defence Mapping Agency (DMA) files and discussed file and data management techniques for dealing with the large amount of model output.

P. Catizone and coauthors concentrated more on issues associated with collection of on-site meteorological data for use in CTDMPLUS. They described enhancements to an existing meteorological system required to provide data for CTDMPLUS. Their estimate of planning and installation costs for an adequate measurement system is likely to exceed $300,000. At least 18 months is required to plan and implement a measurement program and to collect sufficient data for modeling.

H. Lee described an efficient semi-Lagrangian advection scheme for use in regional numerical dispersion models. Spatial interpolation in the algorithm is accomplished using a combination of Fourier modes plus a fifth-order polynomial for the nonperiodic components. The results of several advection test problems were presented to demonstrate the numerical properties of this advection scheme. The method appears to be stable and robust for a wide range of Courant numbers and exhibits very low numerical diffusion.

A presentation by R. Petersen discussed a hybrid modeling approach to estimate toxic gas concentrations in the vicinity of buildings. The hybrid model approach involves the use of wind tunnel simulations to establish dispersion parameters within the downwind zone affected by buildings and a numerical model to describe diffusion farther downwind. Petersen compared the predictions of the hybrid model with predictions of the same numerical models without the adjustment of parameters using the wind tunnel input. The comparison indicates that the hybrid modeling approach improves model predictions.

In his presentation, C. Matthias described a dense gas diffusion model for continuous releases. The model consists of three components describing entrainment regimes for the gas as it disperses. The first component gives the lateral spread of the plume by gravitational spreading and limited vertical growth due to entrainment. The second component describes diffusion in a stably stratified regime, and the final component describes diffusion of a passive tracer. Comparison of dense gas model predictions of centerline concentrations with the experimental data shows that the dense gas model yields generally reasonable results.

R. Yamartino presented a dispersion modeling methodology based on a synthetic turbulence representation also known as kinematic simulation. In this approach, sinusoidal-like fields of eddies provide an
explicit subgrid-scale flow field for Lagrangian particles to follow. The amplitudes and phases of these eddies evolve according to Langevin equations so that the fixed-wavelength Fourier components smear out to yield realistic, smooth energy spectra. Successful application of the method to an atmospheric tracer experiment conducted under stable conditions was presented to show that the approach could realistically simulate atmospheric dispersion.

The final paper of the session was presented by C. Tremback. He described an Emergency Response Dose Assessment System being developed for the U.S. Air Force Space Systems Division. The system contains a prognostic mesoscale meteorological model based on the Colorado State University RAMS model and will contain a particle dispersion model to facilitate evaluation of hazardous material releases and rocket launch aborts under the complex meteorological conditions often found at the Kennedy Space Center. The modeling system will run on RISC workstations.

f. Session 6: Topics in model evaluation

Conference presentations on model evaluation covered all types of models from plume dispersion, to Lagrangian puff, to Eulerian grid, with no dominant theme indicated for the types in models evaluated. The papers ranged from guidance on model evaluation approaches, particularly related to plume dispersion, and to interpretative studies of Eulerian grid model performance through the use of statistical protocols and sensitivity studies. J. Weil, the invited speaker of the session, presented a paper on plume model evaluation titled "Evaluation of Plume Dispersion Models: Expanding the Practice to Include Model Dispersion." In it he argued that evaluation of a model's formulation or physics should be given equal weight to operational or performance evaluations of the models. The validity of the model formulations is frequently ignored. Weil presented illustrations of the two elements of a model physics evaluation, namely, assessment of the scientific formulation and evaluation using field or laboratory measurements. R. Dennis expanded this interpretive theme by showing that, for grid models, factors in design and application such as grid size can affect model performance in unexpected ways. The result is often a misinterpretation of model results. Examples were shown and suggestions made for approaches to check for design-induced differences such as contrasting data, use of additional data, and model sensitivity analyses.

Recently defined needs for regulatory air quality studies are modeling techniques for applications for distances at which assumptions such as steady-state, straight-line pollutant transport and no chemical or depositional losses are not valid. J. Scire discussed evaluation results from studies designed to address these needs by examining diagnostic wind fields of (DWM) that are used to produce spatially varying wind fields and dispersion and/or deposition models with the ability to use these fields. J. Vimont presented a related paper in session 3. Evaluations were performed for three diagnostic wind field models using raw observations, coarse-grid dynamical model (MM4-FDDA) outputs, and simple interpolated wind fields from the larger-scale dynamical model. Results indicated that use of coarse-grid dynamical model wind fields as input to DWMs improved their performance with CALMET (California Meteorological Model) providing the most favorable performance. Simple interpolation of the coarse-grid dynamical model outputs also produced results nearly as favorable as the best DWM. Dispersion modeling results showed that the CALPUFF (California Puff Model) model enhanced with a selection of regulatory defaults, a near-sources area source algorithm, an area source plume rise algorithm, and use of the MM4/CALMET couple provided results consistent with observations. The CALMET model when run under steady-state conditions could also reproduce straight-line plume model results.

J. Ciolek described a statistical protocol developed to allow the state of Colorado to judge the performance of emergency response models. Part of the protocol consisted of developing a composite model performance score. The study examined an emergency response model for the Rocky Flats Plant, the subject of numerous field and modeling studies described at the meeting. The protocol was implemented using two wind field models as part of the modeling system. Results followed on those of Weil and Dennis, indicating that interpretation of the individual performance scores—that is, the whys of model performance—proved to be more beneficial than use of the composite score.

J. Ramsdell presented results of a study in which he used sensitivity testing of parameters in a Lagrangian puff climatological dispersion model to determine how the model efficiency could be improved without loss of accuracy. Parameters studied included numbers of puffs released, minimum time steps, puff radius, and method of puff consolidation. Results suggested that these parameters could be modified to greatly reduce model running time with little impact on modeled concentrations. J. Paumier also used sensitivity study techniques but with the objective of determining how hourly design concentrations produced by the regulatory Industrial Source Complex model, version 2 (ISC2), were affected by differences in hourly mixing heights.
generated using the RAMMET versus METPRO input data processors. He showed that while the average ratio of design concentrations between the two processors had a value near 1, RAMMET could generate extremely small mixing heights and therefore the potential for unusually high estimated concentrations.

g. Session 7: Complex flows affecting dispersion near structures

Seven session papers reported use of field measurements, physical modeling, and mathematical techniques to study the complex flow and dispersion patterns surrounding structures. An additional paper presented an objective technique for developing building dimension inputs for EPA regulatory modeling.

The first paper of the session, authored by an invited speaker, L. Schulman, was titled “The EPRI Plume Rise and Downwash Modeling Project: Preliminary Findings.” This modeling project is designed to develop a better understanding and mathematical models of plume rise and dispersion near structures. Emphasis in this ongoing project is on short stacks with hot exhaust and significant momentum, that is, combustion turbines. The project consists of wind tunnel modeling studies, a field measurement and data interpretation task, and model development. Preliminary evaluation results showed significant differences between measured values and those predicted in present mathematical models.

Papers by W. Snyder, M. Ohba and R. Lawson, and W. Hoydysh examined flows in the vicinity of buildings using wind tunnel models. Snyder used measurements of velocity to examine the effects of building height, width, length, and angle to the wind on streamline patterns upwind, downwind, and immediately adjacent to buildings. A significant finding of the study suggests that the streamline patterns in the wake or “cavity” differed significantly from those previously described (e.g., Hunt 1978). Lateral flow in the cavity is inward rather than outward, and the flow in the center plane appears to spiral out from a node inside the cavity and reattaches to the downwind face of the structure. A comprehensive dataset was developed that will be useful for development of realistic models for concentration predictions in building wakes and cavities. Ohba and Lawson, provided two complementary papers addressing flow and pollutant concentrations around twin high-rise buildings adjoined by terraces using wind tunnel models. The cases studied included realistic configurations for urban complexes in Japan by varying tower heights and separation distances. The primary effect of the upwind tower was to retard flow separation on the top and sides of the downwind tower. The degree of retarding is a function of the separation distance to building height for ratios greater than 1.0. Flow patterns suggested that emission sources near the base of either building would contribute significantly to concentrations on the downwind building face. Concentration data showed higher concentrations in the wake of the downstream building than would be expected for an isolated building. Also, the elevation of the sources in the downwind building wake was not a significant determinant in the magnitude of maximum concentrations. However, moving the source position downwind at a constant release height resulted in an overall maximum concentration decrease and a more rapid concentration decrease with source–receptor separation.

In a different application, H. Ginzburg examined the exhaust plume emanating from a tunnel portal. The sensitivity of various parameters including vehicle speed, ventilation rates, wind conditions, and portal configurations were examined providing a direct application of using physical models in a wind tunnel to address siting and design problems.

W. Hoydysh presented a wind tunnel study designed to evaluate the wake and plume structure in the lee of bluff bodies (i.e., nuclear power plant models) using video imaging and tracer gas measurements. Results showed downwashed plumes to be well mixed with correspondingly smaller peak-to-mean concentration ratios. Results also indicated that the video imaging analysis techniques used provided good agreement with concentration measurements made in the wind tunnel.

L. Genikhovich and W. Snyder used wind tunnels to evaluate a new Gaussian-type mathematical model to simulate dispersion near buildings. The model, MDNB (Model for Dispersion Near Buildings), incorporates concepts of a Russian regulatory model with those of recent studies. Results indicate that the model provides improved results over the EPA ISC model when actual plume height data were input. A future objective is the addition of a distance-dependent plume rise algorithm. The ISC model was also addressed in a paper by P. Eckhoff that described a preprocessor incorporating standardized techniques to input building dimensions for the ISC2 dispersion model. The program, the Building Profile Input Program, incorporates EPA guidance and is currently available for review on the EPA SCRAM bulletin board. It facilitates input of wind direction–dependent building parameters including those for multistory and multiple structure configurations.

h. Session 8: Coastal and complex terrain issues evaluation

The last session addressed air pollution issues in complex terrain and coastal settings. In an invited paper, “The Role of the ASCOT Program in Dispersion
Studies in Complex Terrain," J. C. Doran summarized research carried out during the 15-year history of the U.S. Department of Energy’s Atmospheric Studies in Complex Terrain (ASCOT) Program by addressing three topics. First, he emphasized advances in instruments and meteorological measurement systems made during the program. For example, 1979–1981 field experiments at the Geyers in California marked the first use of Doppler sodars to observe vertical wind profiles. Similarly, field experiments at Brush Creek, Colorado, marked the first use of lidars to provide cross sections of wind fields. These and other techniques were heavily represented in conference papers on the dispersion environment (session 1) and in subsequent papers in this session. Doran’s second topic emphasized advances in methods of data analysis and interpretation including the first detailed descriptions of drainage flows, pressure-driven channeling, and elevated jets in complex terrain. Last, Doran dealt with advances in tracer studies, based on field experiments particularly at the Geyers, Brush Creek, and at the Rocky Flats Plant. Although these studies addressed energy applications including geothermal development, oil shale extraction, and emergency response relative to a nuclear fuels program, their contributions were perhaps greatest in advancing our understanding of complex flows. Transport and dispersion models were developed in the program that successfully described the rise of tracers up valley sidewalls, as well as downslope transport. The future plans of the program are directed toward the use of diagnostic and prognostic meteorological models to drive Lagrangian particle dispersion models and to improve our understanding of surface energy balances in complex terrain.

J. Fast presented a paper on one component of the ASCOT program, namely, modeling transport and dispersion form the Rocky Flats Plant. He applied the RAMS prognostic meteorological model with data assimilation to an evening tracer experiment. Wind field predictions agreed qualitatively with observations. Predicted tracer patterns were shown to be in fair agreement with observations (i.e., ±30° or less differences in plume direction, and a factor of ±4 or less differences in concentrations).

J. Ciolek in a companion paper reported results of an ASCOT tracer study conducted at the Rocky Flats Plant. This complex site is located on a mesa abutting the wall of foothills marking the beginning of the Rockies. The paper reported a tracer release in easterly (upslope) surface winds that resulted in the concentration both downwind (upslope) and, more importantly, upwind (downslope) of the release point. Such unconventional behavior, which was thought to result from a mountain-induced recirculation zone, points out the difficulty in using simplistic models to predict transport direction and downwind concentrations in such complex terrain settings.

Complex terrain can affect dispersion rates as well as flow patterns. R. Hauser presented results from the Navajo Generating Station Winter Visibility Study that operated a data collection network of thirteen 10-m towers in a large area surrounding the plant. Using scalar and vector average wind speeds along with σv, results showed considerable differences between ridge-top, open-exposure, and sheltered locations, but the analysis indicated some site-specific consistency in the data—for example, the tendency of the product of the vector average wind and σv to yield a function dependent on elevation, site exposure, stability, and strength of the overlying flow. This suggests that dispersion parameters could be mapped over a fairly large region using data from a small number of appropriately selected measurement sites.

A series of five papers dealt with meteorology and dispersion in coastal settings. K. Hiraga presented results of a tracer study of overwater diffusion, finding lateral and vertical dispersion coefficients (σx and σz) in the overwater regime to be 50% of their expected overland values. D. Sailor applied prognostic meteorological models to the coastal Los Angeles Basin, concluding that predicted afternoon mixing heights decreased by about 100 m and temperatures decreased about 2°C when relative humidity in the mixed layer increased by 20% or when the surface albedo increased by 20%. R. Caiazzo investigated the effects of Lake Ontario on observed shoreline atmospheric stability, finding that the major influence of the lake occurs with strong onshore flow. Results from experiments with remote sensors were presented in a paper by J. McElroy, who examined airborne lidar observations in coastal complex terrain in southern California, and in a paper by C. Lindsey, who examined a network of 915-MHz sounders in and around the Gulf of Mexico. McElroy showed how elevated pollutant layers could be formed due to upslope wind and convergence in complex terrain. Lindsey’s observations demonstrated that periods with high-ozone observations in the Houston area were generally coincident with periods characterized by flow reversals from onshore flows to offshore flows and back again.

In July and August 1993, a study was conducted by a team of Canadian and U.S. scientists of ozone concentrations in the vicinity of Vancouver, British Columbia, a region affected in both sea- and valley-breeze regimes. L. Oliver reported preliminary results from CO2 Doppler lidar measurements intended to document transport of high-ozone air and to understand the effects of valley flows in Vancouver and the Lower Fraser Valley. Results show the importance of
both sea breezes and valley circulations with complexities in connecting valleys. The intensity of ozone events was also shown to be strongly coupled to meteorology.

Determining the spatial and temporal variations in mixing depth over regions of varying surface characteristics and topography is a continuing problem in air quality modeling. This information is not available in standard meteorological observations but rather is the product of special filed programs that have been conducted in few locations. Promising results in obtaining these data are expected from boundary layer wind profilers, and a paper presented by J. Gaynor describes results using a Radio Acoustic Soundings Systems-equipped 915-MHz profiler to deduce mixing depths in complex terrain. The complex problem of extracting mixing depth information from RASS and wind profiler data was accomplished with a new algorithm proposed to be applicable over a wide range of conditions. Mixing depths are easiest to define in the daytime convective boundary layer, and several daytime observing periods were reported. The profiler-deduced depths appeared shallower than results expected by several conferees in the audience. These differences will need to be resolved with more experience using these new techniques.

Another continuing modeling problem in source permitting is the issue of plume impact on neighboring terrain under stable conditions. R. Petersen reported wind tunnel tests of two screening models [RTDM (Rough Terrain Dispersion Model) and VALLEY] and CTDMPPLUS, the EPA model recommended for use when simple screening models indicate a possibility of concentrations in excess of goals. Similarity analyses showed that wind tunnels can be used to simulate near-source dispersion for a number of practical situations, particularly simulations of stable flows. The principal shortcoming in these applications is a tendency in the wind tunnels to underestimate $\sigma_y$. This renders estimates of surface concentrations that are higher than actual for plume impact studies. In the application reported, for a plume impact on an idealized two-dimensional ridge, the wind tunnel simulations showed that all three models overestimated concentrations by a factor of 2–3. This would lead to use of overly restrictive emissions limits.

3. Conclusions

Issues drive research, and research summaries such as this conference highlight technical areas at issue. Papers at the conference identified some recurrent themes. New technology provides new opportunities to see atmospheric characteristics for the first time. The wealth of data calls for innovative techniques in data analysis and presentation. What these measurements show is atmospheric complexity. This suggests that modeling must reach for improvements through new boundary layer parameterizations, methods to address atmospheric inhomogeneities, and use of dynamical models to fully address real atmospheric variability. Progress in meteorological aspects of air pollution meteorology requires well-crafted interpretations of data and both physical and analytical models to produce useful assessments. The research represented at the conference contributes to this progress.

References
