U.S. DEPARTMENT OF COMMERCE/ National Oceanic and Atmospheric Administration

OFCM

OFFICE OF THE FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

PROCEEDINGS OF THE WORKSHOP ON MULTISCALE ATMOSPHERIC DISPERSION MODELING WITHIN THE FEDERAL COMMUNITY

June 6-8, 2000
Town Center Hotel
Silver Spring, Maryland

OFFICE OF THE

FEDERAL COORDINATOR
FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH

8455 Colesville Road, Suite 1500
Silver Spring, Maryland 20910

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JUNE 6-8, 2000

TOWN CENTER HOTEL
SILVER SPRING, MARYLAND

Washington, DC
August 2000

FOREWORD

The Workshop on Multiscale Atmospheric Dispersion Modeling within the Federal Community, sponsored by the Office of the Federal Coordinator for Meteorology, was held on June 6-8, 2000, at the Town Center Hotel, Silver Spring, Maryland. The workshop was attended by over fifty participants who represented nine federal agencies involved in dispersion modeling. The requirements for dispersion modeling within the federal government are derived from various agency missions including emergency response, national security, public health, and transportation safety that respond to events with both natural and human causes. Such events as volcanic ash, chemical, biological and nuclear releases, pollution, and smoke from forest fires, to name a few, represent potential threats to the health and well being of the population and are of concern to both emergency managers and government officials. These concerns were exemplified by the recent train derailment near Eunice, Louisiana, that involved a variety of chemicals and caused the evacuation of residents surrounding the accident scene.

The goal of the workshop was to bring users and developers of dispersion models together to improve the coordination in the development and operational use of dispersion models. The objectives of the workshop were to state requirements and capabilities; describe methods for the validation, verification, and approval of models; address technical barriers to model development; begin a process to establish subsets of models for specific applications; and to identify opportunities for leveraging model development. This workshop provided an opportunity to assess the current state of dispersion modeling and to identify barriers that need to be overcome in order to meet the wide range of requirements.

This document summarizes the requirements and capabilities for dispersion modeling, presents the results of the sessions on technical barriers, model subsets, model verification and presents the next steps needed to maintain the momentum toward improved dispersion modeling.

In conclusion, I would like to express my appreciation to the agency participants whose presentations and involvement contributed to a successful workshop. I would also like to thank the OFCM staff and the members of the Joint Action Group for Atmospheric Transport and Diffusion (JAG/ATD) for their support and active involvement in the workshop.

Samuel P. Williamson
Federal Coordinator for Meteorological Services
and Supporting Research

PROCEEDINGS

of the

Workshop on Multiscale Atmospheric Dispersion Modeling
Within the Federal Community

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PRESENTATIONS

SESSION I

USER REQUIREMENTS FOR DISPERSION MODELING

Chair: Mr. Rickey Petty, Department of Energy
Rapporteur: Mr. Roger Stocker, Fleet Numerical Meteorology and Oceanography Center

Synopsis

During Session I, agencies addressed current requirements for dispersion modeling, described how the current requirements are being met, and presented new and/or unmet requirements. A wide range of application scenarios for dispersion modeling resulting from both natural and human activities were described by the agencies. These included ash released from volcanic eruptions and its impact on air travel; the release of radioactive material from nuclear reactor accidents/incidents and its impact on operators and surrounding populations; the release of smoke from forest fires and other materials from industrial sources and the subsequent impact on air quality and human health; the release of chemical/biological agents and their impact on populations especially in the urban environment; and the release of various toxic material through spills resulting from surface transportation accidents and its impact on populations. Also highlighted was the requirement of a wide range of spatial and temporal scales ranging from meters to thousands of kilometers and from minutes to days. Generally speaking, the diverse requirements for dispersion modeling are being met by existing models and agencies are addressing new/unmet requirements through modest investments in research and development, with a special focus on the urban environment.

The following snapshot of requirements was derived from the agency presentations: Within the Department of Defense (DOD), the requirements for dispersion models are driven by the need for immediate response to the threat of chemical and biological attacks as well as the development of concepts of operation. In keeping with the mission of the National Oceanic and Atmospheric Administration (NOAA), the protection of life and property and providing reliable information to decision makers, as well as environmental concerns, dictate dispersion modeling requirements. These requirements include forecasting in urban, coastal, and complex terrain environments; injecting descriptions of stochastic behavior into deterministic models; and assessing the skill of predictive schemes. For the Department of Energy (DOE), application users, as well as research and development, drive the requirements. The application users apply models for prediction, assessment and strategic purposes associated with routine facility operational emissions and to support emergency response activities when an accidental or terrorist release occurs. For the Environmental Protection Agency (EPA), air quality concerns are of primary interest with model applications focused on contingency modeling, accidental releases and short term assessments. The Federal Emergency Management Agency (FEMA) highlighted the need for a tiered approach to modeling similar to the graded modeling approach mentioned by the DOE. Under this approach, initial responses with preliminary impacts are based on less sophisticated models. As better meteorology and better source characteristics become available, more sophisticated models are used. The Nuclear Regulatory Commission (NRC) cited areas of need dealing with power plant design, control room habitability, incident response, cost/benefit analyses, high level waste disposal, and facility decommissioning. The Department of Agriculture (USDA) Forest Service (FS) focused on three areas: (1) smoke/fire emissions, (2) wilderness air quality related values, and (3) carbon management. The impacts of smoke on air quality and the acidification of alpine watersheds drive requirements for the Forest Service. The Department of Transportation (DOT) highlighted volcanic ash and other airborne hazardous materials as key concerns for air transportation. Accurate transport and diffusion forecasts of these hazards are required for safe flight in the National Airspace System. The DOT also relies on dispersion modeling to support assessments based on federal hazardous material transportation laws for flammable and poisonous materials. The Department of Interior (DOI) U.S. Geological Survey (USGS) discussed its role in volcano monitoring and emphasized the importance for space-based systems for observing parameters used to initialize dispersion models. The requirements of the U. S. Air Force's Eastern and Western Ranges are driven by the need for predictions to support long range planning, launch operations, and emergency response in order to protect populations and to comply with federal and local exposure guidelines.

From the agency presentations on requirements for dispersion modeling, a number of cross-cutting issues emerged. These included:

- The need for credible dispersion forecasts applicable to complex terrain, coastal regions, and especially urban areas.

- The need for model verification to establish the bounds of uncertainty for the intended application.

- The need to conduct field studies to verify models and model products under the same circumstances for which the models are to be applied.

- The need for probabilistic forecasts of dangerous concentrations of hazardous materials.

- The need for improved understanding of the loading, properties and transport of atmospheric aerosols in relation to sources.

- The need to use a graded modeling approach to increase modeling complexity commensurate with the complexity of the problem. The models must handle the urban environment and be valid over a wide range of meteorological conditions.

•The need to correctly represent the source term in the models.

•The need for model output to be understandable and readily accessible to emergency managers through the use of self-evident graphics/tables provided via the Internet or on backup PC’s.

•The need for model users/regulators and model researchers/developers to interact during model development.

For information on the Session I presentations, see Appendix C.

PRESENTATIONS

SESSION II

AGENCY DISPERSION MODELING CAPABILITIES

Chair: Mr. Jeffrey McQueen, NOAA Air Resources Laboratory
Rapporteur: Mr. David Weinbrenner, National Centers for Environmental Prediction

Synopsis

During Session II, agencies presented their dispersion modeling capabilities to meet current requirements. Model evaluation, model output, types of users, and research and development to meet unmet needs were also presented by some of the agencies. The EPA presented a broad range of models categorized as screening models, regulatory models, other models (non-regulatory), models under public review, and non-EPA models. The screening models are geared to provide a simple tool to determine compliance with regulations. Examples of models in this category are SCREEN3, TSCREEN, CTSCREEN, and RTDM. Regulatory models are more sophisticated tools for determining compliance and include such models as ISCST3, UAM, CTDMPLUS, and OCD. Models classified as other models and models under public review are those which have not undergone the procedures required to be classified as regulatory. The EPA's Support Center for Regulatory Air Models (SCRAM) maintains a website (www.epa.gov/ttn/scram/) which includes information on model availability, training, and answers general questions about the state of regulatory modeling.

Presentations from the DOD included the Army Research Laboratory, Defense Threat Reduction Agency, Air Force Research Laboratory, and the U. S. Navy's Naval Surface Warfare Center. The Army Research Laboratory highlighted capabilities in both transport and diffusion models. These included transport models with varying scales from mesoscale to microscale; domains from a few square km's to several hundred square km's; grids from 50m to 10km; and with surface layer hi-resolution terrain and morphology effects. Capabilities in diffusion modeling included gaussian plume over flat terrain, gaussian puff over complex terrain, gaussian puff over canopies/buildings, and secondary surface evaporation. Currently, meteorological transport models such as HRW and CCSL and a diffusion code, RIMPUFF, are being combined as an integrated transport and diffusion simulation capability. The Army's operational models include D2-PC, SCIPUFF for diffusion and MM-5 for transport. The Defense Threat Reduction Agency's primary capability is the Hazard Prediction & Assessment Capability (HPAC). This is a transport and diffusion system that is forward deployable and is used for counterproliferation, counterforce and counter-terrorism purposes against weapons of mass destruction (WMD) for both DOD and civil support. HPAC has multiple users from the DOD and also from civilian agencies including the DOE, Department of State, Department of Justice and FEMA. Continued research and development activities are focused on meeting requirements particularly in the area of urban modeling.

The Air Force Research Laboratory described its capabilities in the area of atmospheric chemistry and emphasized that this is a key piece to completing the total picture of dispersion modeling. Atmospheric chemistry has relevance to dispersion modeling with respect to the transformations of volatile organic compounds and the effects of chemical composition and concentration within the dispersion plume. The U. S. Navy's Naval Surface Warfare Center presented their capabilities in modeling and simulation for chemical/biological (CB) defense. The presentation focused on VLSTRACK which is the DOD standard model for CB attacks; MESO-NEXT GENERATION which deals with more complex flow and planetary boundary layers; and CFX which is a computational fluid dynamics code for CB warfare and provides hazard assessment for ships, port facilities, urban regions, and air bases.

For the DOE, dispersion modeling activities are performed within the Environmental Meteorology Program (EMP) and the Atmospheric Chemistry Program (ACP) and within the Office of Emergency Operations' Chemical and Biological Nonproliferation Program. (CBNP). The EMP focuses on the transport of energy-related materials through the atmosphere and the ACP focuses on the chemical transformation of tropospheric energy-related materials on regional, continental, and global scales. The web address for EMP is <gonzalo.er.anl.gov/ACP/> and the web address for EMP is <www.pnl.gov/VTMX/>. Most of the work in these programs is research oriented using models to understand the physics. In the EMP, research work is being done using Large Eddy Simulation (LES) and Direct Numerical Simulation (DNS) to resolve small scale turbulence. The DOE Atmospheric Sciences Program has also conducted several field experiments as part of their research and development work in dispersion and atmospheric chemistry. An active research and development program is ongoing to evaluate and improve topography in meso models, to evaluate sub-grid scale turbulence parameterizations, and to compare simulated turbulence with observed turbulence. The DOE CBNP effort is focused on the development of a suite of multi-scale transport and fate models for chemical and biological agent releases within the urban environment. Both interior (buildings and subways) and exterior dispersion models are being developed. The exterior models include computational fluid dynamics (CFD) models with the ability to resolve individual buildings as well as regional models that rely on urban parameterizations. The CBNP has also initiated a large-scale urban dispersion experimental program to provide field data for model evaluation. The DOE Office of Emergency Operations has developed a response capability that is based on a graded approach where the model complexity used for a particular emergency response application is commensurate with the complexity or scale of the incident. These capabilities include the HOTSPOT health physics codes which can be deployed to emergency response personnel; an atmospheric dispersion and consequence prediction capability which is based on the AIRRAD radionuclide fallout and ERAD high explosive dispersal models and is deployed with an expert; and the National Atmospheric Release Assessment Center (NARAC) which utilizes the ADAPT diagnostic windfield code, the COAMPS mesoscale meteorology model, the KDFOC fallout code and the LODI regional dispersion model, and also provides reach-back capability to the national center's expert staff.

NOAA uses a number of operational models to meet current requirements. These requirements include guarding people/property, improving quality/timeliness of dispersion forecasts, reducing costs of property damage, and reducing the vulnerabilities of the public to hazardous concentrations of materials dispersed from various sources. The NOAA Air Resources Laboratory issues daily predictions for elements such as ozone concentrations. The Air Resources Laboratory as well as the National Weather Service and the National Ocean Service also cover emergencies such as radiological releases, volcanic ash, smoke from forest fires, and hazardous material spills. NOAA conducts various model evaluations, has a wide range of users, and conducts extensive research and development in areas such as coupling dispersion models with meteorological and chemical models, air-surface exchange and deposition, and assimilation of plume predictions with surface observations and satellite imagery.

As stated in Session I, the NRC's requirements for dispersion modeling are driven by site suitability studies, incident response and cost/benefit analyses. For waste repository site suitability studies, where the accident of interest is volcanic eruption for the post-closure period, the NRC's capability rests with the Suzuki model. For plant design and plant site suitability evaluations, chi/Q met analyses are used. For incident response, severe accidents, and cost/benefit analyses, the Gaussian plume is used.

At both the USAF Eastern and Western Ranges there is a considerable capability for forecasting toxic hazards in support of space and missile operations. These capabilities include the Hybrid Particle and Concentration Transport (HYPACT) Model, the Ocean Breeze/Dry Gulch (OB/DG) Model, the Air Force Toxic Chemical Dispersion Model (AFTOX), and the Rocket Exhaust Effluent Diffusion Model (REEDM).

The Department of Transportation described its capability with the Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE). The objective of ARCHIE is to provide a set of hazard and consequence analysis tools applicable to hazardous materials. This capability is applicable to planners and emergency responders in developing response plans and in managing risk associated with the release of a hazardous material.

For information on Session II presentations, see Appendix C.

PANEL

SESSION III

TECHNICAL BARRIERS TO DISPERSION MODELING

Moderator: Mr. Ronald Cionco, Army Research Laboratory
Rapporteur: Mr. Robert Lawson, Environmental Protection Agency

Synopsis

The panel, consisting of representatives from both developers and users of dispersion models, addressed five areas considered to be technical barriers (knowledge gaps) for dispersion modeling. These areas had been selected and agreed upon by the OFCM staff and the Joint Action Group for Atmospheric Transport and Diffusion prior to the workshop. The areas addressed by the panel were:

Turbulence and the Stable Boundary Layer: There is a need to better understand turbulence processes and turbulence exchange parameters under stable conditions as well as within and immediately above urbanized and forested areas.

Air-Surface Exchange: There is a need to better characterize air-surface exchange, pollutant deposition and other near-surface processes which relate not only to source and sink characterization, but also to human exposure assessment.

Probabilistic Modeling: There is need for better understanding of the use of deterministic models to simulate stochastic processes.

Mesoscale and Surface Layer Transport: There is a need for better understanding of the dynamics and interfacing between mesoscale and surface layer transport within these models.

Neighborhood Scale Processes: There is a need to characterize surface morphological features with adequate resolution in order to develop models which reflect the effects of local-scale features (important for urban areas and neighborhood-scale applications). Additionally, methods for assimilation of additional data sources need to be developed at all spatial scales of interest.

There was general agreement by the panel members that these areas represent key challenges or knowledge gaps faced by model developers and that further research work needs to be done particularly in the boundary layer under stable conditions, within the urban environment, and at smaller scales in order to better understand the processes taking place. A summary of the key points and recommendations from the panel session follows on pages 2-3 through 2-5.

Panel Membership:

Dr. Ray Hosker, Director, Atmospheric Turbulence & Diffusion Division, Air Resources Laboratory
Mr. Paul Bryant, Federal Emergency Management Agency
Mr. Jim Bowers, Dugway Proving Ground, Department of the Army
Mr. Alan Cimorelli, Environmental Protection Agency
Dr. Jerome Fast, Pacific Northwest National Laboratory, Department of Energy

Summary of Technical Barriers Panel

•Questions:

-What are the knowledge gaps which limit the performance of models?
-What is impeding your research or restricting progress on model development?

•Anticipated Results:

-Do you accept this as a barrier?
-How do we satisfy this deficiency?
-Identify which agencies are clearly addressing this barrier.

Turbulence and the Stable Boundary Layer (SBL): **Barrier**? Yes

•Need simultaneous meteorology measurements and dispersion data; need higher resolution measurements - scales of a few meters (being addressed by the Army and DOE laboratories).
•The SBL in coastal areas (in addition to urban and forested areas) needs more attention due to the location of power plants and cities near coasts.
•It's important to link chemistry and meteorology in the SBL.
•Need to be observers before we can be modelers.
•There are minimal observations available to verify and improve SBL parameterizations.
•Need information on the vertical structure of the SBL; not just surface-based measurements.
•Need to probe the SBL with multiple radars or sounders to establish the structure of the SBL. Need to combine technologies to get a better observation capability.
•How do we distinguish true dispersion from low frequency meandering?
•What is the limit to vertical mixing in the SBL?
•Should consider empirically correlated local phenomena with larger-scale phenomena.
•Should examine non-Gaussian models for the SBL.
•Pacific Northwest Laboratory is planning a field study in Salt Lake City to examine the SBL in an urban environment.

Agencies: DOE, NOAA, ARL, DOD

Air-Surface Exchange: **Barrier**? Yes

•This is the most important driving mechanism for models because it represents the lower boundary condition.
•There is a lack of data and observations on which to base parameterizations.
•There is a need for higher spatial resolution measurements of sensible and latent heat fluxes which appear to be the key to driving mesoscale models.
•Pollutant characterization is complicated by chemical and biological effects and their relation to micrometeorology.
•Need to consider the effects of precipitation - tends to move materials to lowest areas.

•Need for better understanding of acid deposition and nitrogen deposition to estuaries - multimedia processes.
•Need for deposition velocities and solubilities for toxic pollutants as well as better data for dry deposition in general.

Agencies: DOD, EPA, NOAA

Probabilistic Modeling: **Barrier**? Yes and No

•Probabilistic modeling requires educating the decision makers - "let the user know the consequences".
•To achieve probabilistic results requires that the models perform to a higher level than required for deterministic models.
•Probabilistic modeling techniques need to be applied to chemistry as well as meteorology. •These models are difficult to evaluate.
•Approaches:
- -Conventional model with variance
- -2-particle Lagrangian stochastic models
- -SCIPUFF-type model
- -Ensemble of runs with conventional models

Agencies: NRC, FEMA, DOD

Mesoscale and Surface Layer Transport: **Barrier**? Yes

•Important to recognize that the microscale process drives the mesoscale processes.
•Knowledge gaps exist because we don't have measurements at the scale needed to parameterize the process (being addressed by Army Research Laboratory).
•Current understanding of canopy models (urban and vegetative) has not been transferred to mesoscale models (being addressed by Army Research Laboratory).
•New instruments may show promise.
- -Special-purpose aircraft
- -Remote automated weather stations

•Coupling/decoupling of meso/micro scale models is not well understood. The mesoscale parameterization of the surface layer is problematic.
•Current model resolution is not adequate for surface layer phenomena.
•Need better understanding of energy budgets and spatial variability of sensible and latent heat fluxes.
•As the vertical resolution is improved, may require different closure schemes for models.

Agencies: DOE, DOD, NOAA

Neighborhood-Scale Processes: **Barrier**? Yes

•New instrumentation techniques and standards promise to provide very high resolution measurements of near-surface properties.
•Characterization of the morphological features of urban areas at high resolution is in progress by FEMA and Army Research Laboratory.
•CFD models for flow around buildings is improving, but still need wind tunnel modeling as well as field studies with greater data density.
•DOE's CBNP has upcoming field studies to address scales down to building scale - VTMX experiment in Salt Lake City; long term goal is to do full-scale urban experiment (2002).
•Need to include interstate highways as a large line source - may not be properly included in current models.
•Does the urban heat island effect need to be included?
•Models must resolve problems with local sources of particulates and with fenceline issues for toxics.

Agencies: DOE, EPA, FEMA, DOD

Recommendations:

-Follow up with scientific meeting.
-Invite more hands-on scientists.
-Probe deeper into these problems.
-Begin coordination in regard to future field studies.
-Explore sharing modeling products.

SESSION IV

BREAKOUT ONE

METHODS FOR VALIDATION, VERIFICATION AND APPROVAL (VV&A) OF MODELS

Co-Chairs: Mr. William Peterson, Environmental Protection Agency
Mr. Tim Bauer, Naval Surface Warfare Center
Rapporteur: Ms. Marcia Carpentier, Environmental Protection Agency

Synopsis

The goal of Breakout One was to describe existing methods of validation, verification and approval used within the agencies and to begin developing a common framework for the verification and inter-comparison of models. Although model evaluation is going on within the agencies, current methods vary from the formal regulatory process used by the EPA to a less formal, self-imposed process by the DOE. The DOD is developing a process which will be part of the formal system acquisition procedures. The NOAA uses a continuous process which compares new models against existing models. Although there was general agreement that model evaluation is needed, a number of issues were raised that complicate the process. These included the need to evaluate models for the application of intended use, the cost and time for field studies, the availability and sharing of data sets, the fact that models predict mean values and not point values, and the difficulty of decoupling model evaluation from model acceptance by the user. It was also mentioned that the process being developed by the DOD and the guidelines developed by the American Society for Testing and Materials (ASTM) might serve as models for a more rigorous process for model evaluation. A summary from Breakout One follows on pages 3-2 and 3-3.

Summary of VV&A Breakout Session

Model Evaluation = Verification and Validation

•Elements:

- -Operational testing or sensitivity analysis.
- -Independent methodology evaluation or peer review.
- -Comparison against measured data.

Approval involves sponsor/user concluding that model should be used for a specified range of applications.

•Current Procedures

- -DOE: self-imposed; no formal process.
- -DOD: being developed; formal acquisition procedure for EMIS/D2PC and MIDAS-AT.
- -EPA: formal regulatory approval process including public review and comment.
- -NOAA: comparison of new against existing as continuous process.
- -FEMA: same as NOAA.

•More on EPA process

- -Defined regulatory "niches".
- -One guideline model for each niche but many models submitted.
- -1980 solicitation for new models to allow technological advances.
- -Modeling clearinghouse established to evaluate model applications.
- -Potential problem with inertia (slow process).

•ASTM Standard Guide for Evaluation of Dispersion Models

- -ASTM develops widely varying standards.
- -Several federal organizations represented in D-22 subgroup (meteorologists).
- -Covers basic procedures but not specifics such as statistics (general philosophy).

•Issues

- -Difficulty in decoupling evaluation from acceptance (model must meet user's needs).
- -Evaluation process quite expensive.
- -Woods Hole: too many statistics.
- -Who is the audience for the evaluation?
- -Lack of database or data exchange - need lots of data to determine model accuracy.
- -Models predict means, we measure observations.

•Summary and Recommendations

- -Model evaluation seems impossible but still gets done (Hanna dense gas models).
- -Recommend staying involved with ASTM subgroup - may adopt guidelines.
- -Facilitate data sharing between organizations.

BREAKOUT TWO

ESTABLISHING SUBSETS OF MODELS TO MEET DISPERSION APPLICATIONS

Co-Chairs: Dr. K.S. Rao, Air Resources Laboratory
LTC Todd Hann, USA, Defense Threat Reduction Agency
Rapporteur: Mr. Ron Meris, Defense Threat Reduction Agency

Synopsis

The objective of Breakout Two was to propose a process for establishing model subsets for specific applications. After considerable discussion, it was decided to identify types of models for different applications rather than specific models by name. A set of model characteristics shown on page 3-5 was used to begin the process. During this session, the focus was on identifying types of models with time scales of minutes to weeks and spatial scales from building size to thousands of kilometers. An initial assessment of production time and identification of applicable agencies was also made. This process has much further to go, and the need for a follow-on meeting was identified as a recommended action. A summary from Breakout Two follows on pages 3-5 through 3-7.

Summary of Subsets Breakout Session

•Many model characteristics need to be considered.
- -Time and space scales
- -Frame of Reference (Eulerian or Lagrangian)
- -Steady state or time dependent
- -Pollutant properties (gas/particle) and chemical reactions
- -Plume behavior (buoyant/dense; downwash)
- -Turbulence parameterization
- -Topography and removal processes
- -Treatment of uncertainty
- -Numerical solution method

•Established a framework to identify types of models appropriate to various applications.
•Concentrated on time and space scales to get started.
•Much more detail needed to fill in the framework.

<u>Subsets Based on Space and Time Scales</u>

•Space scale: inside a building
•Time scale: few minutes to 1 hour
•Model types:
- -CFD - good for low speed, auditorium type
- -Multizonal good for energetic flow with multiple rooms

•Production time (within 1 hour of "cold start") - multizonal only
•Agencies with capability: DOE, EPA, DOD, NIST

•Space scale: single building - 10m x 100m
•Time scale: few minutes
•Model types:
- -CFD
- -Parameterized Gaussian
- -Physical modeling

•Production time: planning tool only, no model for immediate response
•Agencies with capability: DOE, DOD, EPA, NOAA

•Space scale: neighborhood, 2 x 5 km horizontal, sfc - 100m vertical
•Time scale: 30 minutes to days
•Model types:
  -Particle (near field)
  -CFD (mixed, large eddy simulation [LES])
  -Modified Gaussian
  -Puff trajectory with mass consistent winds
•Production time: 20 min for modified Gaussian and Puff
•Agencies with capability: DOE, DOD, EPA, NOAA

•Space scale: micro scale, 20 x 20 km horizontal, sfc to BL vertical
•Time scale: convective 10-15 mins, advective 1 hr
•Model types:
  -Trajectory
  -Gaussian Plume or Puff
  -CFD particle
•Production time: within 20 min for all Gaussian, CFD particle and trajectory types; requires more fine scale meteorology to meet regulatory considerations
•Agencies with capability: ALL

•Space scale: mesoscale, 50 x 1000 km horizontal, sfc to BL vertical
•Time scale: Hours to 24 hours
•Model types:
  -Gaussian Puff or Particle
  -Eulerian
  -Hybrid Eulerian and Lagrangian
•Production time: within 20 min for all model types.
•Agencies with capability: DOD, DOE, NOAA, EPA, NASA

•Space scale: continental, 3000 x 4000 km
•Time scale: several days
•Model types:
  -Lagrangian puff
  -Transport key; not diffusion
•Production time: within 20 min for all model types.
•Agencies with capability: NOAA, DOE, DOD, NSF, EPA, NASA

•Space scale: global
•Time scale: weeks
•Model types:
    -Numerical Weather Prediction (NWP) is key
    -Lagrangian particle trajectory
•Production time: within 20 min
•Agencies with capability: DOD, DOE, NSF, NASA, NOAA

•Recommended Actions:
    -Conduct follow-on meetings.
    -Conduct scientific reviews/discussion.

WORKSHOP SUMMARY/ACTION PLAN/NEXT STEPS

SESSION V

Background: The goal of the workshop was to bring agency representatives together to present requirements and capabilities, to address technical barriers and to foster coordination in the development and operational use of dispersion models. Specific objectives included (1) stating current modeling requirements and capabilities, (2) specifying new requirements and unmet needs, (3) describing existing methods for the validation, verification and approval of current models, (4) describing a process for establishing model subsets for specific applications, (5) finding solutions to agency identified technical barriers, and (6) identifying opportunities for leveraging model development and model validation, verification and approval methods.

Results: The workshop highlighted the wide range of requirements for dispersion modeling and also the wide range of capabilities that exists within the federal agencies. It also highlighted the need for continued coordination between the agencies to ensure that resources earmarked for modeling research and development are applied effectively so key technical barriers or knowledge gaps are overcome. Additionally, the breakout sessions on model verification and model subsets made progress in meeting their objectives, however more work needs to be done to complete the process. The model verification group described current methods used in the agencies but further work is needed on developing a common framework. The model subsets breakout session proposed a process for classifying models based on a set of model characteristics but again more work is needed in order to complete the process. Both model verification and model subsets should be addressed further by the Office of the Federal Coordinator for Meteorology (OFCM) and the Joint Action Group for Atmospheric Transport and Diffusion (JAG/ATD).

Cross-Cutting Concerns: A number of cross-cutting issues and concerns were identified during the workshop including the need for:

- Improved temporal and spatial resolution.

- Improved urban modeling capabilities.

- Taking a probabilistic approach to dispersion modeling since uncertainty cannot be eliminated.

- Improved source term estimates.

- Improved handling of the lower boundary condition which is a complex problem and is hampered by the sparsity of data.

•Training to create a sophisticated user who can interpret probabilistic model output.

•Tailored model verification and choosing the right model to cover a spectrum of applications from immediate response to planning and design.

•Transition technology to operations and avoid duplication through leveraging, collaboration, and a systematic exchange of agency activities.

Action/Next Steps: In addition to the above issues and concerns, the following actions/next steps are considered necessary in order to continue the momentum generated as a result of this forum:

•Publish proceedings of the workshop in August 2000. (OFCM)

•Report the results of the workshop to the Committee for Environmental Services, Operations and Research Needs (C/ESORN) at their August meeting. (JAG/ATD)

•Report the results of the workshop to the Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR) at their next meeting. (JAG/ATD)

•Continue exploration of relevant requirements and capabilities using the Joint Action Group for Atmospheric Transport and Diffusion. (OFCM, JAG/ATD)

•Develop plans for addressing the scientific issues associated with technical barriers as well as model verification and model subset methods based on the recommendations of the panel and breakout sessions. (JAG/ATD, September 2000)

•Determine how the guidelines developed by the Department of Defense and Subgroup D-22 of the American Society for Testing and Materials (ASTM) may be applicable to model verification. (JAG/ATD)

•Conduct a follow-on workshop in the January-March 2001 timeframe to focus on specific scientific issues seen as barriers to model development. (OFCM)

•Invite participation by the stakeholders who attended the workshop in the activities of the JAG/ATD. (OFCM)

It was also recommended when the Model Directory (FCM-I3-1999) is updated, that consideration be given to incorporating a model classification scheme similar to the one begun during the breakout session on model subsets. Also, it was recommended that a listing of available data sets be included in the Directory. The inclusion of data set references would be useful for model evaluations.

APPENDIX A- AGENDA

Workshop on Multiscale Atmospheric Dispersion Modeling Within the Federal Community

June 6-8, 2000, Town Center Hotel,
8727 Colesville Road, Silver Spring, MD

Tuesday, June 6, 2000

7:00 - 8:00 a.m. **REGISTRATION AND CONTINENTAL BREAKFAST**

8:00 - 8:20 a.m. **WELCOME AND KICKOFF**

Mr. Samuel P. Williamson, Federal Coordinator for Meteorology
Dr. Darryl Randerson, Director, Special Operations and Research Division, Air Resources Laboratory

8:20 - 11:30 a.m. **SESSION I - USER REQUIREMENTS FOR DISPERSION MODELING**

Session Chair: Rickey Petty, Department of Energy
Rapporteur: Roger Stocker, Fleet Numerical Meteorology & Oceanography Center

8:30-8:50 **Department of Defense**

Captain David Martin, USN, Military Assistant for Environmental Sciences, Office of the Deputy Under Secretary of Defense, Science and Technology

8:50-9:10 **National Oceanic and Atmospheric Administration**

Bruce Hicks, Director, Air Resources Laboratory
Tom Renz, Lead Meteorologist, Alaska Aviation Weather Unit

9:10-9:30 **Department of Energy**

Dr. Peter Lunn, Program Director, Atmospheric Sciences Program
Dr. Don Ermak, Program Leader, Atmospheric Release Assessment Programs, Lawrence Livermore National

Laboratory

9:30-9:50	**<u>Environmental Protection Agency</u>**
	Philip Campagna, Chemist, Environmental Emergency Response Center Mark Evangelista, Chief, Air Quality Support Branch, Office of Air Quality and Planning Standards
9:50-10:00	**<u>Federal Emergency Management Agency</u>**
	Clifford Oliver, Chief, Building Sciences and Risk Assessment
10:00-10:30	**Break**
10:30-10:40	**<u>Nuclear Regulatory Commission</u>**
	Jocelyn Mitchell, Senior Technical Advisor, Office of Research
10:40-10:50	**<u>Department of the Interior</u>**
	Marianne Guffanti, Coordinator, Volcano Hazards Program, U.S. Geological Survey
10:50-11:00	**<u>Department of Agriculture</u>**
	Dr. Allen Riebau, National Program Lead for Atmospheric Science Research, Forest Service
11:00-11:20	**<u>Department of Transportation</u>**
	Steven Albersheim, Aviation Weather Requirements, Federal Aviation Administration Dr. Steven Hwang, Chemical Engineer, Research and Special Programs Administration
11:20-11:30	**<u>Air Force Range Safety</u>**
	Carlton “Bud” Parks, Senior Meteorologist, Air Force Range Safety
11:30 - 12:50	**Lunch On Your Own**

12:50 - 5:00 p.m. **SESSION II - AGENCY DISPERSION MODELING CAPABILITIES**

Session Chair: Jeffery McQueen, NOAA Air Resources Laboratory
Rapporteur: David Weinbrenner, National Centers for Environmental Prediction

1:00-1:45 **<u>Environmental Protection Agency</u>**

Dennis Atkinson, Meteorologist, Office of Air Quality and Planning Standards
Alan Cimorelli, Lead Meteorologist, EPA Region 3
Mark Evangelista, Chief, Air Policy Support Branch, Office of Air Quality and Planning Standards

1:45-2:45 **<u>Department of Defense</u>**

Ronald Cionco, Research Meteorologist, US Army Research Laboratory
Ronald Meris, Physical Scientist, Defense Threat Reduction Agency
Mike Henley, Research Chemist, Air Force Research Laboratory
Tim Bauer, Program Manager, Modeling and Simulation, Naval Surface Warfare Center Dahlgren Division

2:45-3:15 **Break**

3:15-3:45 **<u>Department of Energy</u>**

Dr. Jerome Fast, Senior Research Scientist, Pacific Northwest National Laboratory
Dr. Don Ermak, Program Leader, Atmospheric Release Assessment Programs, Lawrence Livermore National Laboratory

3:45-4:15 **<u>National Oceanic and Atmospheric Administration</u>**

Dr. Darryl Randerson, Chief, Special Operations and Research Division, Air Resources Laboratory
Dr. Jerry Galt, Chief, Hazardous Materials Response Division, National Ocean Service

4:15-4:30	**<u>Nuclear Regulatory Commission</u>**
	Jocelyn Mitchell, Senior Technical Advisor, Office of Research
4:30-4:45	**<u>Air Force Range Safety</u>**
	Carlton "Bud" Parks, Senior Meteorologist, Air Force Range Safety
4:45-5:00	**<u>Department of Transportation</u>**
	Dr. Steven Hwang, Chemical Engineer, Research and Special Programs Administration

Wednesday, June 7, 2000

7:30 - 8:30 a.m.	**CONTINENTAL BREAKFAST**
8:30 - 12:00 Noon	**SESSION III - TECHNICAL BARRIERS TO DISPERSION MODELING PANEL**
	Moderator: Ronald Cionco, Army Research Laboratory **Rapporteur**: Robert Lawson**,** Environmental Protection Agency
	Panel Members: Dr. Ray Hosker, Director, Atmospheric Turbulence & Diffusion Division, Air Resources Laboratory Paul Bryant, Federal Emergency Management Agency Jim Bowers, Dugway Proving Ground Jocelyn Mitchell, Nuclear Regulatory Commission Alan Cimorelli, Environmental Protection Agency Dr. Jerome Fast, Pacific Northwest National Laboratory
8:30-10:00	Panel members address technical issues identified by agencies (15 minutes each)
10:00-10:30	**Break**
10:30-12:00 Noon	Open Discussion
12:00 Noon - 1:30 p.m.	**Lunch On Your Own**

1:30-4:00 p.m. **SESSION IV- MODEL VALIDATION, VERIFICATION AND APPROVAL AND MODEL SUBSET BREAKOUTS (CONCURRENT)**

Breakout One- Methods for Validation, Verification and Approval of Models

Co-Chairs: William Petersen, EPA, National Exposure Research Laboratory
Tim Bauer, Naval Surface Warfare Center, Dahlgren
Rapporteur: Marcia Carpentier, Environmental Protection Agency

Breakout Two- Establishing Subsets of Models to Meet Dispersion Applications

Co-Chairs: Dr. K.S. Rao, Air Resources Laboratory, Oak Ridge
LTC Todd Hann, USA, Defense Threat Reduction Agency
Rapporteur: Ron Meris, Defense Threat Reduction Agency

2:30-3:00 **Break**

Thursday, June 8, 2000

8:00 - 9:00 a.m. **BREAKFAST (Cambridge Cafe)**

9:00 - 10:45 a.m. **SESSION V- SUMMARY AND WRAP-UP**

Session Chair: Dr. Darryl Randerson

9:00-10:30 **Summary**

Panel Report: Ronald Cionco
Breakout One Report: William Petersen, Tim Bauer
Breakout Two Report: Dr. K.S. Rao, LTC Hann, USA

10:30-10:45 **Workshop Wrap-up/Closing Remarks**
Mr. Samuel P. Williamson, Federal Coordinator for Meteorology

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APPENDIX C- PRESENTATIONS

Due to the volume of presentations and to take advantage of web technology, the Session I & II presentations are available on the OFCM website under Special Projects.

The URL is <http://www.ofcm.gov>.

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