OFFICE OF THE
FEDERAL COORDINATOR
FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH
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Defense Threat Reduction Agency-Sponsored

Seventh Annual George Mason University Conference

on

Transport and Dispersion Modeling

OFCM Special Session

Atmospheric Transport and Dispersion Modeling Support for Homeland Security

June 19, 2003

George Mason University (GMU)
Fairfax, VA

FOREWORD

On June 19, 2003, the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) conducted a special session on Atmospheric Transport and Dispersion Modeling Support for Homeland Security at the Defense Threat Reduction Agency (DTRA)-sponsored George Mason University 7th Annual Conference on Transport and Dispersion Modeling. The purpose of the OFCM special session was to begin building upon the work and recommendations of the OFCM Joint Action Group for the Selection and Evaluation of Atmospheric Transport and Diffusion modeling (JAG/SEATD), which were published in the report, *Atmospheric Modeling of Releases from Weapons of Mass Destruction: Response by Federal Agencies in Support of Homeland Security*.

To begin the discussion on the current state of the science in transport and dispersion modeling, the Department of Homeland Security representative provided an excellent summary of the activities of the Radiological Dispersal Device (RDD)/Improvised Nuclear Device (IND) Working Group and the Consequence Management, Site Restoration and Clean-up (CMS) Plume Modeling Task Group. The presentation and subsequent panel session helped to better define the homeland security requirements for transport and dispersion modeling systems and serves as valuable input as the OFCM Federal coordinating infrastructure documents its plans for meeting these requirements.

Next, representatives from the Committee on Atmospheric Dispersion of Hazardous Material Releases of the National Research Council's Board on Atmospheric Sciences and Climate (BASC) presented the results of their recently published report, *Tracking and Predicting the Atmospheric Dispersion of Hazardous Material Releases: Implications for Homeland Security*. After the presentation, a panel session was conducted on atmospheric transport and dispersion research needs and priorities. Representatives from the public, private, and academic sectors participated and provided a community-wide assessment of what improvements in capability were possible to achieve in the near-term and what longer-term challenges are faced. The results of the panel session will help the lay the groundwork OFCM-sponsored Federal research and development plan for atmospheric dispersion modeling and prediction.

Finally, the third panel session dealt with developing a common framework for model evaluation. This topic will become increasingly significant to the Federal agencies that are working together to provide an integrated and coordinated response to homeland security requirements for environmental support. This challenging topic requires much additional work and is a part of the longer-term effort at OFCM.

I want to thank the Defense Threat Reduction Agency and George Mason University for allowing us to take part in this very important event, and we look forward to continuing our mutually beneficial collaboration in the future. I also wish to extend my deepest appreciation to the panelists, moderators, rapporteurs, and attendees whose lively involvement, interaction, discussion, and interest made our session and the overall conference a big success.

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

OFCM Special Session

Atmospheric Transport and Dispersion Modeling Support for Homeland Security

AGENDA

INTRODUCTION

PANEL DISCUSSION

Panel 1: Operational Requirements and the Current State of the Science

Moderator: CAPT Frank Garcia, Jr., *Military Assistant for Environmental Sciences, Office of the Deputy Undersecretary for Defense (Science and Technology), Department of Defense*

Dr. Paula Davidson, *Environmental Hazards Planning Lead, Office of Science and Technology, National Weather Service, National Oceanic and Atmospheric Administration*

Mr. Mark Miller, *CAMEO Program Manager, Office of Response and Restoration, National Ocean Service, National Oceanic and Atmospheric Administration*

Mr. Ronald G. Meris, *Program Manager, HPAC/CATS, Defense Threat Reduction Agency*

Dr. Stephen A. McGuire, *Office of Nuclear Security and Incident Response, Nuclear Regulatory Commission*

Mr. William Petersen, *Meteorologist, NOAA Air Policy Support Branch, Office of Air Quality Planning and Standards, Environmental Protection Agency*

Dr. Walter Chrobak, *Department of Energy (NA-42)* and Mr. Ron Baskett, *National Atmospheric Release Advisory Center (NARAC), Lawrence Livermore National Laboratory*

Panel 2: Atmospheric Transport and Dispersion Research Needs and Priorities

Moderator: Dr. Walter Bach, *Program Manager, Engineering Sciences Directorate, Army Research Office, United States Army*

Dr. Jay Boris, *Chief Scientist and Director Laboratory for Computational Physics, Naval Research Laboratory, United States Navy*

Mr. Walter Schalk, *Special Operations and Research Division, Air Resources Laboratory, National Oceanic and Atmospheric Administration*

Mr. John Pace, *Urban Dispersion Modeling Program Manager, Defense Threat Reduction Agency, Department of Defense*

Ms. Jocelyn Mitchell, *Senior Level Technical Advisor, Office of Research, Nuclear Regulatory Commission*

Dr. David Bacon, *Director, Center for Atmospheric Physics, Science Applications International Corporation*

Dr. Zafer Boybeyi, *School of Computational Sciences, George Mason University*

Panel 3: Developing a Common Framework for Model Evaluation

Moderator: *Dr. Paul Try, Science and Technology Corp., Office of the Federal Coordinator for Meteorology*

Dr. Steven Hanna, *Adjunct Associate Professor of Environmental Health Department of Environmental Health, Harvard School of Public Health*

Dr. James Ellis, *National Atmospheric Release Advisory Center, Lawrence Livermore National Laboratory*

Dr. Jeffrey C. Weil, *Cooperative Institute for Research in Environmental Sciences, University of Colorado*

Dr. Priscilla A. Glasow, *Mitre Corp., JEM Program's Accreditation Agent, Naval Surface Warfare Center Dahlgren Division*

Mr. Bruce Hicks, *Director, Air Resources Laboratory, National Oceanic and Atmospheric Administration*

WRAP-UP

INTRODUCTION

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

Welcome

After welcoming the participants to the special session, Mr. Williamson provided background information on the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM). The OFCM works through an infrastructure of program councils, standing committees, working groups, and short-term joint action groups to facilitate cooperation among the Federal agencies that make up the Federal meteorological community.

The OFCM Federal coordinating infrastructure has been involved in atmospheric transport and diffusion (ATD) modeling for over two decades. Most recently, in the aftermath of September 11, 2003, the participating Federal departments and agencies conducted a study of the nonproprietary ATD modeling systems in use by the Federal operational modeling centers. The resultant report of the Joint Action Group for the Selection and Evaluation of Atmospheric Transport and Dispersion modeling (JAG/SEATD) is titled, *Atmospheric Modeling of Release from Weapons of Mass Destruction: Response by Federal Agencies in Support of Homeland Security*.

The session that the OFCM is conducting, in conjunction with the DTRA-sponsored George Mason University 7th Annual Conference on Transport and Dispersion Modeling, is a first step in addressing the JAG/SEATD recommendations. The objectives of the special session are to:

- Identify and refine the requirements for ATD modeling support/plume forecasts and develop a concept of operations to support those requirements.
- Refine, prioritize (if possible), and document the community's research and development needs.
- Develop a common model evaluation framework that supports our customers' needs and requirements.

Upon completing the special session the next steps are to:

- Develop an environmental support concept of operations in support of Homeland Security that is consistent with the new National Response Plan and that will form the basis for the Homeland Security Environmental Support Plan.
- Develop an R&D plan and pursue interagency support, including DHS.
- Complete the development and implementation of a common framework for model evaluation among the Federal agencies.

The Federal Coordinator concluded his remarks and introduced the invited speaker, Mr. Craig Conklin, Director, Technical Services Division, Office of National Preparedness, Directorate of Emergency Preparedness and Response, (EP&R/FEMA), Department of Homeland Security.

INVITED SPEAKER

Mr. Craig Conklin leads the Technical Services Division, Office of National Preparedness, FEMA within the Department of Homeland Security's (DHS) Directorate for Emergency Preparedness and Response (EP&R) and is Chairperson for the Consequence Management, Site Restoration/Clean-up (CMS) Subgroup under the Working Group for Radioactive Dispersal Device (RDD)/Improvised Nuclear Device (IND) Preparedness, which was formed in September 2002 .

Mr. Conklin described some of the lessons learned from the Top Officials 2 (TOPOFF 2) Exercise. As a result of TOPOFF 2 experiences, the Plume Modeling Subset of the CMS Subgroup was formed in June 2003 to address the following issues with expect to atmospheric dispersion of hazardous material releases:

- Summarize the roles and responsibilities of Federal agencies for detecting, monitoring, and forecasting the extent of contamination from chemical, biological, radiological, and nuclear (CBRN) releases.

- Summarize existing programs and capabilities for detecting, monitoring, and forecasting the extent of contamination from CBRN releases to identify a single source for plume models.

- Identify priority actions necessary to address technical and policy gaps for detecting, monitoring and forecasting the extent of contamination from radiological, chemical and biological releases.

The Plume Modeling Subset of the CMS Subgroup consists of highly qualified subject-matter experts in atmospheric dispersion modeling and consequence assessments for radiological and nuclear releases as well as experienced senior managers with extensive experience with dispersion modeling programs and emergency operations. The following departments and agencies were represented: DHS/EPR, DHS/S&T, USDA, DOC/NOAA, DOC/NOAA/OFCM, DOE, DOD, EPA, NRC, NASA, and DOL/OSHA.

The members have reviewed both the OFCM and National Research Council reports which address the state-of-the science in atmospheric dispersion and have concluded that there is a large and diverse user community and a robust national capability for atmospheric dispersion prediction within the U.S. The reports recommend increased collaboration among agencies and funding for the most urgent research needs. The Plume Modeling Subset of the CMS Subgroup is working on a framework to address the question of how various agency capabilities for detecting, monitoring, and forecasting the extent of contamination from CBRN and other hazardous releases should be coordinated. The framework will also include the protocols and supporting technologies required. This framework is required to achieve a robust DHS capability for atmospheric dispersion prediction.

PANEL DISCUSSION

Panel 1: Operational Requirements and the Current State of the Science

Moderator: CAPT Frank Garcia , Jr., DOD/ODUSD (S&T)

Panelists: Dr. Paula Davidson, NOAA NWS
Mr. Mark Miller, NOAA NOS/ORR
Mr. Ronald G. Meris, DOD/DTRA
Dr. Stephen A. McGuire, NRC
Mr. William Petersen, EPA/NOAA
Dr. Walter Chrobak, DOE

Rapporteurs: Mr. Floyd Hauth, OFCM/STC
Mr. Tony Ramirez, OFCM/STC

Synopsis

This panel session followed the invited speaker. The invited speaker, Mr. Conklin, described the efforts within the Department of Homeland Security to establish an interagency framework for dispersion modeling and consequence assessment support of national homeland security operations. Collectively, the Panel 1 speakers provided an overview of some of the Federal capabilities that could contribute to the DHS framework.

The objective of Panel 1 was to identify and refine the requirements for atmospheric transport and diffusion (ATD) modeling support/plume forecasts and develop a concept of operations to support those requirements. Each speaker described the operational requirements that are the basis for the capabilities developed by their agency, and several speakers described the current state of the science in regards to satisfying those requirements. The speakers also described how the various agencies support other Federal agencies and also how they support the state and local authorities.

Dr. Davidson provided an overview of the National Oceanic and Atmospheric Administration (NOAA) capabilities including joint sponsorship (with EPA) of the CAMEO (ALOHA) system for first responders; a robust development program that provides CAMEO/ALOHA products to support first responders for localized hazardous releases, HYSPLIT for radiological emergencies exceeding a 10 km area and the HARM model which predicts dispersion of hazardous releases for selected sites; and a fully operational system for dispersion forecasts that is based on the existing network of 122 Weather Forecast Offices and the National Centers for Environmental Prediction (NCEP) that operate HYSPLIT.

Mr. Miller reported on NOAA NOS/ORR requirements for ATD modeling. The CAMEO

(ALOHA) modeling system is the primary model used operationally to support first responders during chemical incidents.

Mr. Meris described the Defense Threat Reduction Agency (DTRA) capabilities, including overviews of the Hazardous Prediction and Assessment Capability (HPAC) model, the Consequence Assessment Tools Set (CATS) model, and the Consequence Assessment Cell support for the 2002 Winter Olympics in Salt Lake City, Utah.

Dr. McGuire described the NRC's RASCAL modeling system. RASCAL couples the source term and dose with ATD models to provide a capability to accept input from the reactor or other analytical sources. The intent is to estimate the consequences of an event and provide information for early protective actions; e.g. evacuation or sheltering. Only the protective actions are used when briefing the decision maker.

Mr. Petersen described EPA's responsibilities for critical infrastructure protection which include preparedness, response, and recovery; communication and information; and protection of EPA personnel and infrastructure. Effective risk communications rely on rapid risk assessment and information provided to the public and first responders. Current operational capabilities include a GIS version of HYSPLIT. Future enhancements will include a near-field algorithm and the addition of an urban model.

Dr. Chrobak described DOE's plume modeling responsibilities, capabilities, and processes. He then introduced Mr. Ron Baskett who briefed the results from the TOPOFF 2 Exercise, which provided a major test of NARAC's support to multiple agencies.

The panel session concluded with a question and answer session.

National Oceanic and Atmospheric Administration
National Weather Service

Support for Homeland Security: ATD Modeling

Dr. Paula Davidson
Environmental Hazards Planning Lead
Office of Science and Technology
NOAA National Weather Service

ABSTRACT

Dr. Davidson addressed the structure, services, and cooperative aspects of NOAA/NWS support to homeland security. Services associated with ATD modeling include real-time and archived environmental data, long- and short-range environmental forecasts, dispersion forecasts, event-specific support, direct public dissemination, education and coordination, and focused research. Environmental support includes daily, weekly, monthly, and seasonal forecasts; warnings and forecasts in the range of hours to minutes for first responders and attack victims; and real-time surface observations. NOAA provides dispersion forecasts such as CAMEO/ALOHA products to support first responders for localized hazardous releases, HYSPLIT for radiological emergencies exceeding a 10 km area, and HARM model output that predicts dispersion of hazardous releases for selected sites. HYSPLIT is linked to the NCEP Eta-12, the highest resolution mesoscale model. For event-specific support, NOAA deploys incident meteorologists to event sites, HAZMAT scientific support coordinators to spill or release sites, and Air Resources Laboratory (ARL) support for FBI Nuclear Emergency Search Teams. NWS Weather Forecast Offices (WFO) provide on-site support and supply incident-specific WEB sites as requested. NOAA support to emergency managers consists of dispersion forecasts and dissemination of emergency warning information via NOAA Weather Radio, the Emergency Manager's Weather Information Network (EMWIN), NOAA Weather Wire Services, and NOAAPORT. THE WFOs also provide education, training, and coordination support to local and state officials. NOAA's efforts include data from the cooperative observer network, research for the improvement of dispersion models and fine-scale dispersion forecasts, and the development of new concepts for integrated weather and ATD support for homeland security.

National Oceanic and Atmospheric Administration
National Ocean Service
Office of Response and Restoration

Mr. Mark Miller
CAMEO Program Manager
Office of Response and Restoration
NOAA National Ocean Service

ABSTRACT

Mr. Miller reported on NOAA/ORR requirements for ATD modeling. Under the National Contingency Plan, NOAA/ORR provides scientific support for Federal on-scene coordinators for major spills of oil and other hazardous materials and is responsible for predicting atmospheric or marine pollutant movement and dispersion. NOAA/ORR also supports the Federal Response Plan and the joint EPA CAMEO program. Annually, there are approximately 100-120 spills of chemicals, oils, and other miscellaneous toxic substances. Of these, approximately 60 percent are oil, 30 percent chemical, and 10 percent miscellaneous. The CAMEO (ALOHA) model is the primary model used operationally. It is quick to set up and run in the field, and its output is easily interpreted. However, it is challenged by a data sparse environment and limited knowledge of uncertainties. It is also limited during certain atmospheric conditions, to include low wind speeds, stable atmospheric conditions, wind shifts and terrain steering effects, and concentrations of substances near the source. To ensure the reliability of results, sensitivity analysis, algorithm checking, usability testing, model comparisons, and field-data comparisons are required. It is imperative that the model be evaluated in the context in which it is to be used. The goal for continued development seeks to ensure that the focus is kept on the first responders by addressing, for example, multiple, simultaneous lines of communication, aqueous solutions, and enhanced network/web capabilities.

Department of Defense
Defense Threat Reduction Agency

Mr. Ronald G. Meris
Program Manager, HPAC/CATS
Defense Threat Reduction Agency

ABSTRACT

Mr. Meris described DTRA capabilities including overviews of the Hazardous Prediction and Assessment Capability (HPAC) model, the Consequence Assessment Tools Set (CATS) model, and the Consequence Assessment Cell support for the 2002 Winter Olympics in Salt Lake City, Utah. HPAC is required to predict collateral effects on civilian and military forces during military operations. It must be deployable, accurate, and user friendly for planning air, land, and sea missions. HPAC output can be applied to nuclear reactors and radiological weapons, chemical and biological facilities, nuclear weapons, and chemical and biological weapons. The meteorologist remains in the loop to interpret and apply the model output. CATS is a stand-alone, integrated system of tools, data, and analysis components (for effects on population, infrastructure, transportation, services, and public safety) and is based on GIS technology. Operational support for the 19th Winter Olympics consisted of a consequence management command and control scheme which included forward, stand-alone, and reach-back capabilities. HPAC and CATS are available to all U.S. Government Agencies and NATO nations.

Nuclear Regulatory Commission

Dr. Stephen McGuire
Office of Nuclear Security and Incident Response,
Nuclear Regulatory Commission

ABSTRACT

The NRC regulates the safety of commercial nuclear power plants and radioactive materials used in industry, research, and medical applications. Dr. McGuire emphasized that state and local governments are responsible for making protective action decisions and implementing those decisions. State and local governments near nuclear power plants are responsible for having an atmospheric dispersion/dose modeling capability. Nuclear power plant licensees are also required to have an atmospheric dispersion/dose modeling capability and to recommend protective actions to state and local decision makers. The NRC has developed the RASCAL model. RASCAL couples the source term and dose with ATD models to provide a capability to accept input from the reactor or other analytical sources. The intent is to estimate the consequences of an event and provide information for early protective actions; e.g. evacuation or sheltering. Before a release has occurred, the models determine the size, composition, and timing of the radionuclide release. The lead federal agency (LFA) speaks for the entire Federal government and modeling results should be released only by the LFA. However, Dr. McGuire concluded that plume plots should not be shown to decision makers as this can lead to misinterpretations. Interpretations and recommendations based on model output are what should be provided to the decision maker.

The NRC keeps other Federal agencies, the White House, Congress, news media, etc., advised on the status of the event. It also coordinates all non-radiological Federal assistance to state and local response agencies. For post-plume assessment, the NRC uses RASCAL for the first day. On the second day, the Federal Radiological Monitoring and Assessment Center (FRMAC) assumes the lead for plume modeling and dose assessment. FRMAC is supported by all agencies and operated by DOE. It provides radiological measurements and assessments to the LFA and state and local decision makers. The National Atmospheric Release Advisory Center (NARAC) is an important component of FRMAC. The NRC will be in contact with the NARAC as soon as NRC activates its Operations Center.

In conclusion, Dr. McGuire concluded that, rather that one ATD model or a better ATD model, a unified assessment of model results is what is most needed and only selected results should be shown to decision makers. Decision makers need interpretations and recommendations.

Environmental Protection Agency

Homeland Security Strategy

Mr. William Petersen
Meteorologist, NOAA Air Policy Support Branch
Office of Air Quality Planning and Standards
Environmental Protection Agency

ABSTRACT

EPA responsibilities for critical infrastructure protection include preparedness, response and recovery, communication and information, and protection of EPA personnel and infrastructure. Effective and rapid risk assessment is dependent upon critical information systems and tools, such as timely and accurate hazard data and models which provide exposure and risk assessment. Risk estimation must cover variable threat scenarios and provide guidance to determine response levels. Effective risk communication relies on rapid risk assessment and information provided to the public and first responders. Current operational capabilities include a GIS version of HYSPLIT. Future enhancements will include a near-field algorithm and the addition of an urban model. The Los Alamos QWIC-URB model is a strong candidate for the urban model. The QWIC-URB model can simulate concentrations and flow stream around complex building clusters. The use of a meteorological wind tunnel using smoke observations measures turbulent velocities and tracer concentrations. This is leading to the further development of a model evaluation database for characterizing flow within complex urban areas and estimates of potential human exposure with tracer concentration fields. The challenges for these models include:

- The time required to set up and plan studies for research and development.
- How to use timely modeling and monitoring in communications during an emergency.
- The development of fast, inexpensive, and reliable models.

Department of Energy

Plume Modeling

Dr. Walter Chrobak
Department of Energy (NA-42)

ABSTRACT

Dr. Chrobak described DOE's plume modeling responsibilities, capabilities, and processes. Following a radiological event, the plume model is employed. Then, after real-time data collection from the Aerial Measuring System and the Radiological Assistance Program, the plume model is refined at the Federal Radiological Monitoring and Assessment Center (FRMAC). The two major model capabilities include the HPAC SCIPUFF model and the NARAC model. There are a myriad of challenges to plume modeling which range from sparse and infrequent observations, to errors in theory. To emphasize the inexactness of plume modeling science, Dr. Chrobak cited several accounts, highlighting the highly variable results in tracking wind direction, the inability of modeling to be precise enough to draw definitive conclusions, and model users being unaware of such constraints and equating precision computer output as an accurate forecast. He concluded by stating that overlapping modeling responsibilities will be resolved based on the situation, and it is doubtful that a single model will be used for all incidents. He further proposed the possibility of a decision matrix to define which Federal plume model will receive priority for a specific set of circumstances.

National Atmospheric Release Advisory Center
Lawrence Livermore National Laboratory

TOPOFF 2 Exercise

Mr. Ron Baskett
National Atmospheric Release Advisory Center
Lawrence Livermore National Laboratory

ABSTRACT

Mr. Baskett summarized results from the TOPOFF 2 Exercise, which provided a major test for several agencies. This exercise took place May 12-15, 2003, and involved emergency personnel from the City of Seattle, State of Washington, King County, and 19 Federal agencies, including the Department of Homeland Security and the Department of State. It was the largest terrorism exercise undertaken since the terrorist attacks of September 11, 2001. The National Atmospheric Advisory Center (NARAC) via their Local Integration of NARAC with Cities (LINC) provided real-time plume predictions to the Seattle Fire Department and the emergency operations center. The HAZMAT team and Incident Commander used wireless communications and laptop-based NARAC client software to access NARAC predictions. There were also Web-based distributions of NARAC plume predictions to all responding agencies in real time. Officials including the Seattle Mayor, DHS Secretary, and the White House were briefed using NARAC predictions. NARAC simulation model output was used to define protective action guidelines including evacuation and relocation areas.

The exercise proved the utility of NARAC tools and services and found that users and decision makers need predefined sets of scenarios to select from based on minimal information and observable evidence. Executive displays should provide easily interpreted and summarized products, faster incorporation of field monitoring data, and operational capabilities to predict indoor-outdoor exchange of agents.

Panel 1: Question and Answer (Q&A) and Comments Session

- **Question:** Does the National Weather Service expect to increase or improve the number of sensor suites which are more suited to the models? **Answer:** Yes, there are plans and research activities that will focus on better sensors to measure wind fields and turbulence.

- **Question:** Does Doppler technology exist which has the capability to detect and monitor the micro- level? **Answer:** There are plans to leverage other radars and related research activities where possible.

- **Question:** What are some of the differences in detonations which occur aloft vice at ground level? **Answer:** For munition detonations which occur at ground level, the effects primarily remain near ground level. However, if detonations are aloft, the effects are transported for longer periods and over a wider area.

- **Question:** What are some of the plans for protecting populations and minimizing the dosages to people? **Answer**: For nuclear power plant accidents, when there is enough time to evacuate, evacuation is preferred. In other cases, sheltering might be preferred. **Follow-up:** Does this also hold true for terrorist events? **Answer**: No. Not necessarily. **Further comment**: ALOHA estimates toxic plume leakage into buildings by providing a concentration dose estimate, and NARAC is tied into the new weather information dissemination system. The real question is how to use this information. The interpretation of the model output is the most critical part of the response process.

- **Question:** Using the 3-Mile Island incident as a case study, how would the NRC protective actions have changed ahead of the 3-Mile Island disaster rather than after? **Answer:** As the result of 3-Mile Island, we made a lot of improvements. One of the key elements was automating the decision-making process so that when things happen we can very quickly make the decision. If we had 3-Mile island today, we would have recognized the core damage early on and would have immediately recommended protective action and evacuation.

- **Question:** The TOPOFF Experiment showed that people are not dealing with disasters every day and, in talking with first responders, they make a point that unless you use simulations and exercises constantly, you are not going to have good reactions. As a National policy, how will we go about ensuring that all of the population centers across the Nation have the right tools/skills for the next disaster. **Answer:** Regional offices should be working with the states. All regional offices have on-site coordinators, and state offices must work with regional offices and national offices. **Follow-up Comment**: Training is critical on statewide basis; states must work hard to become smarter and better in response to disasters. They must be aware of the tools, training, and procedures to deal with disasters. National Weather Service field offices should participate in this training. **Follow-up Comment:** For whatever the reasons, states don't trust the Federal government to lead and provide guidance effectively. There needs to be a lot of work done to ensure that coordinated responses by Federal and state government agencies are effective. This does not mean that Federal regulations and procedures need to manage responses down to the checklist level. That would not be helpful. **Follow-up Comment:** In DOE, 28 percent of lab guidance is right which means the remainder is wrong. When asked who has the best system, DOE cannot recommend by brand name for proprietary reasons.

- **Comment:** In response to the comment that all responses should be local, and first responders (e.g. Chicago) want to be able to use the same tool for fire, toxic leaks, and a variety of common accidents and disasters. They want to use the same tool, day in and day out, to provide that training. It would make a lot of sense to make tools multi-purpose where possible.

PANEL DISCUSSION

Panel 2: ATD Research Needs and Priorities

Moderator: Dr. Walter Bach, USA/ARO

Panelists: Dr. Jay Boris, Navy/NRL
Mr. Walter Schalk, NOAA/ARL
Mr. John Pace, DOD/DTRA
Ms. Jocelyn Mitchell, NRC
Dr. David Bacon, SAIC
Dr. Zafer Boybeyi, GMU

Rapporteurs: Ms. Margaret McCalla, OFCM
Ms. Mary Cairns, OFCM

Synopsis

The objective of Panel 2 was to refine, prioritize (if possible), and document the community's research and development needs. Each speaker identified research or development needs that require additional attention. Dr. Boris briefed the group on the Contaminant Transport (CT) Analyst system (CT-Analyst TM) developed at the U.S. Naval Research Laboratory. The source of the largest remaining errors in the full-spectrum 3D CFD airflow solver and dispersion model is uncertainty in boundary conditions (i.e. the wind fluctuations and morphology). Fluctuations in wind amplitude and direction are especially important in an urban area. The primary cause of contaminant spreading is vortex shedding off of the buildings as augmented by wind gusts. Mr. Walter W. Shalk, NOAA OAR/ARL, described some of the challenges facing the dispersion modeling community, including: presentation of credible threat information to the public in a useable format, the need for continued study of dispersion processes from local to regional scales, the need to increase efforts to couple mesoscale atmospheric models with dispersion models, and the use of increasingly available in-situ observational data. Mr. John Pace, DTRA, addressed two areas where additional research is required: (1) understanding the urban wind, turbulence, and dispersion effects on dispersion modeling and (2) the integration of data from agent sensors into dispersion modeling systems.

Ms. Jocelyn Mitchell, NRC, acknowledged the efforts of the Joint Action Group for the Selection and Evaluation of Atmospheric Transport and Diffusion Models (JAG/SEATD), which resulted in a report that included a list of research needs. She described the additional need for quick-running, easy-input codes that are good enough for making whatever decisions are necessary immediately after a release. Highly parameterized versions of models of complex effects are required, but the code must meet the requirements of the decision maker in regards to timeliness, accuracy, and ease of use. Dr. David Bacon, SAIC, made the two points that characterize the problem of dispersion modeling in urban areas: (1) it is necessary to understand all scales up to and including those at the spatial scale of the problem and (2) elements are introduced that aid and hinder our analysis of the threat. In strongly forced situations, the physical geometry severely limits the degrees of freedom for the flow, resulting in an easier problem. In weak forcing, however, the dispersion is driven by competing thermal and mechanical forcings, which is a very tough problem that requires understanding. Another key issue is the number of observations required for solution. It is necessary to understand the minimal observation set that is required and to implement an analysis system that can extend the in-situ measurements, documenting an instant in time, into the four-dimensional space that governs the evolution of the hazard. Dr. Zafer Boybeyi, GMU, described the need to improve the accuracy of atmospheric flows within the planetary boundary layer (PBL). Although the turbulent nature of the unstable boundary layer and its dispersion properties have been studied extensively, the properties and behavior of the stable boundary layer (SBL) and the transition into and out of such periods have not been. The study of the PBL in coastal areas in addition to urban and forested areas also needs more attention due to the location of power plants and major cities near coasts. There is a strong need for simultaneous meteorology and dispersion data both in the vertical and horizontal directions. There is a research need for better understanding of energy budgets and spatial variability of surface fluxes. There is also a need to validate the current parameterization schemes. The panel session concluded with questions and answers.

United States Navy
Naval Research Laboratory

Contaminant Transport Analyst System

Dr. Jay Boris
Chief Scientist and Director Laboratory for Computational Physics
Naval Research Laboratory
United States Navy

ABSTRACT

Dr. Boris briefed the group on the Contaminant Transport (CT) Analyst system (CT-Analyst TM) developed at the U.S. Naval Research Laboratory. CT-Analyst is an airborne emergency assessment system that is based on a set of pre-calculations using a full spectrum 3D CFD airflow solver and dispersion model for areas where building and terrain morphology are important. In this way, accuracy approaching the input 3D data sets can be made available to a user in milliseconds rather than minutes. The CT-Analyst
pre-computation stage also permits functions not available in other CFD and lumped-parameter plume modeling systems, such as sensor fusion and instantaneous backtrack to an unknown source location. Dr. Boris described some of the physically reasonable simplifications to the transport and dispersion of contaminants in an urban area that enable this approach. CT-Analyst features include:

- Urban Coverage Areas: high resolution areas (5 meter resolution) for 2 km by 2 km downtown areas (D.C. and Chicago). Also CT-Analyst was used to model transport and dispersion over Baghdad at 10-meter resolution for an area of 11 km by 8.5 km. CT-Analyst is not designed to give comparable accuracy for transport and dispersion at large spatial scales (i.e. greater than 50).

- For the highest resolution modeling, the CFD FAST3D-CT code must be pre-run. CT-Analyst treats three types of objects: sources, sites, and sensors. Individual 3D calculations are typically run for 12 sources and 18 wind directions to generate the compressed Dispersion Nomograph TM tables used by CT-Analyst.

- The source of the largest remaining errors is uncertainty in boundary conditions (i.e. the wind fluctuations and morphology). Fluctuations in wind amplitude and direction are especially important in an urban area. The primary cause of contaminant spreading is vortex shedding off of the buildings as augmented by wind gusts. The underlying FAST3D-CT model includes fluctuating winds, a large eddy simulation turbulence model, boundary conditions, land use, solar radiation, etc.

- The CFD data from FAST3D-CT runs are compressed in tables (structures) called Dispersion Nomographs. These data structures, compressed about 10,000 to 1, are used as a data base to drive the zero-latency CT-Analyst software tool. Dr. Boris also described how the weather modeling/measurement community can help.

Dr. Boris demonstrated the CT-Analyst emergency assessment tool, including its capabilities to

simulate sensor fusion and instantaneous backtrack to a source location. CT-Analyst is useful as a response tool because it computes and displays effective evacuation routes and can help make shelter-in-place decisions. Often the best course of action is to walk perpendicular to the wind direction away from the centerline of the plume. This is often much safer than sheltering in place and has the advantage of getting people away from the impacted area.

National Oceanic and Atmospheric Administration
Atmospheric Research Laboratory

Mr. Walter W. Shalk
Special Operations and Research Division
NOAA Air Resources Laboratory

ABSTRACT

Since the events of September 11th and the increased awareness/vigilance of terrorist threats, ATD activities have moved more into the spotlight both publicly and politically. It falls upon our community to conduct responsible research to aid in safeguarding our people and property.

Conveyance of Threat: How do we define the threat meteorologically? Many variables are involved with the threat including the material involved, area affected, and population affected. The presentation of credible information in a useable format is essential to protecting people and property. Graphics are definitely flashy, colorful, and memorable, but, are they useful/credible to an incident commander/decision maker. However, a definitive line "good"/"bad" line is drawn. Textual information can appear boring and has potential for technical jargon (not good for the public or politicians). Would the graphic presentation of probabilities be useful?

Continued study of local to regional scales: With the increased study in smaller and smaller flow regimes (i.e. building interiors) lately, it is important to not forget the importance of the regional scale. The current OKC experiment is a great example of this. This experiment will provide scientists a wealth of new information to study, evaluate, or revise older theories and develop new ones.

Mesoscale models/Dispersion model coupling: As computing center, desktop, and laptop computers increase in speed and storage capability, mesoscale models will be able to further increase resolution and better drive dispersion models. Organizations are already doing this, but work needs to continue to support and validate the increased detail of the data generated. In addition, this also requires the need for more detailed higher resolution data for input to these models. This leads to another question of observations versus model data. There appears to be a general shift from observational data to model data. My organization has continually supported the importance and use of on-scene meteorology. It IS what is happening, not predicted to happen. Armed with one of today's powerful laptop computers, on-scene weather observations, and on-scene dispersion codes, a Consequence Assessment "Army of One" can interact directly with Incident Commanders.

The "pressing needs" are a by-product of the current politics and perceived pertinent issues and are variable based on the state of the world. I believe we need to pursue the conveyance issue sooner rather than later, and education is a definite component. I think we have a better handle on the two latter issues than the first. Collaboration and coordination issues need to focus on the science.

Department of Defense
Defense Threat Reduction Agency

Mr. John Pace
Urban Dispersion Modeling Program Manager
Defense Threat Reduction Agency

ABSTRACT

My discussion will highlight two areas in which research is needed. The first area is urban wind, turbulence, and dispersion effects. Current urban models range in complexity from simple scaling relationships through empirical models to full-scale computational fluid dynamics models. All these models require data for validation, and the empirical models require data to develop the relationships underlying the model predictions. The presentation will highlight areas in which further research is needed in this area.

The second area in which ATD research is needed is the integration of data from agent sensors into dispersion modeling systems. This combination can provide a better prediction of agent dispersion and more confidence in the sensor readings. A useful analogy is the example of weather data assimilation into weather prediction models. Weather analyses are not done using weather observations alone, because the spatial and temporal coverage of weather observations is not complete, and because a combined system is more accurate than weather observations alone. Similarly, a combination of agent sampler data with dispersion model output can potentially provide a more complete and accurate depiction of dispersed materials. This is a nearly-new area of technology development, and much more research is needed to learn how to blend agent sensor data, with a range of false positive and false negative characteristics, with dispersion models which have considerable uncertainty.

Nuclear Regulatory Commission

Ms. Jocelyn Mitchell
Senior Level Technical Advisor
Office of Research, Nuclear Regulatory Commission

ABSTRACT

Discussions of research needs by experts in atmospheric transport and dispersion (ATD) usually center around efforts to acquire knowledge about and to develop models for detailed evaluation of local effects. For the long-term evaluation of the impacts of a release of hazardous material into the atmosphere, this is entirely appropriate. In the aftermath of a real release, people will want to have full confidence that evaluations of their likely exposures are accurate enough for them to make decisions about their own well-being. People must also be able to have confidence that a prediction of no exposure is likewise accurate. It is entirely appropriate, therefore, for experts to include as many of the various effects as possible within the state of computational art. A long list of needs was developed by a Task Action Group supported by OFCM in August 2002.

What is often given little attention is the need for quick-running, easy-input codes that are good enough for making whatever decisions (usually evacuation or sheltering) are necessary in the immediate aftermath of a release. The time scale for running these codes is minutes. Therefore, highly parameterized versions of models of complex effects are highly desirable. But the designer must take into account the desires of the decision makers about the direction that the simple models are likely to fail. That is, does the decision maker want the result of a calculation to over-predict or under-predict airborne and ground concentrations or to predict too-wide or too-narrow a plume in most situations. The answer is likely to be different in different situations. Most modelers are unable to make such decisions, because they see so clearly the complexities of the situation that would not be captured.

Science Applications International Corporation

Dr. David Bacon
Director, Center for Atmospheric Physics
Science Applications International Corporation

ABSTRACT

Understanding atmospheric dispersion is critical to being able to respond to the accidental or intentional release into the atmosphere of a hazardous chemical, biological, or radiological material. Unfortunately, this inherently multiscale problem is often treated piecemeal. While the thrust is now on the urban problem, it is important to recognize that this problem is driven by larger scales. Accordingly, it is necessary to understand all scales up to and including those at the spatial scale of the problem or at the temporal scale of the problem.

The urban problem introduces elements that aid and hinder our analysis of the threat. In strongly forced situations, the physical geometry severely limits the degrees of freedom for the flow, resulting in an easier problem. Dispersion, however, is like politics: always driven by local events. So it is also necessary to understand the details of the urban environment to correctly understand the potential hazard. In weak forcing, however, which in most cities is the dominant condition, the dispersion of the hazard is driven by competing thermal and mechanical forcings which is a very tough problem that requires understanding not just the physical geometry, but also the radiative and thermal properties of the surface (e.g., albedo, heat capacity, thermal conductivity).

Finally, a key issue is the number of observations required for solution. It is impossible to implement an observational network that is sufficiently dense to treat all possible release scenarios for all cities in the US. Thus it is necessary to understand the minimal observation set that is required and to implement an analysis system that can extend the in-situ measurements, documenting an instant in time, into the four-dimensional space that governs the evolution of the hazard.

George Mason University

Dr. Zafer Boybeyi
School of Computational Sciences
George Mason University

ABSTRACT

In recent years, the potential for the release into the atmosphere of hazardous materials is an increasing problem in this technological age. Hazardous releases can occur due to industrial accidents such as that seen in Bhopal, India in 1984, Chernobyl nuclear disaster seen in Ukraine in 1986, or as the unintentional result of military actions, such as the U.S. destruction of weapons, in Kamisiyah, Iraq, in 1991. More recently, modern military conflicts and terrorist activities are occurring with increasing regularity in urban settings such as the events of September 11th. This is a cause for concern because the exposure of large populations to military and terrorist activities presents the possibility of mass casualties when weapons of mass destruction are used.

Given the irrefutable fact that we live in a highly technological world, with increasing potential for accidental releases from chemical or nuclear facilities, and given the fact that terrorist access to hazardous materials is also getting easier, increasing the potential for intentional use in times of conflict, it is imperative that this research area receives much more attention than it has previously. Particularly in recent years, national security concerns have expanded beyond nuclear to include chemical, biological, and radiological releases. Potential scenarios range from a wide spectrum of accident response to countering urban terrorism threats.
In order to improve the accuracy of the transport and dispersion of hazardous materials, it is necessary to improve the accuracy of atmospheric flows within PBL. The fundamental problem in PBL modeling has been turbulence. Turbulent nature of unstable boundary layer and its disperse properties have been studied extensively to some extent successfully. It is, however, questionable whether the properties and behavior of the stable boundary layer (SBL) and the transition into and out of such periods are amenable to similar treatment. The PBL in coastal areas in addition to urban and forested areas also needs more attention due to the location of power plants and major cities near coasts. For a better understanding of PBL processes and model evaluation studies, there is a strong need for simultaneous meteorology and dispersion data both on the vertical and horizontal direction (the OKC experiment is a good example of this).

Mesoscale models are being used as a valuable option to further increase grid resolution and better drive dispersion models. There is a research need for better understanding of energy budgets and spatial variability of surface fluxes. As we refine the grid resolution of mesoscale models to local scale features, there is a need to validate the current parameterization schemes. Despite numerous applications of numerical modeling for air quality studies, the uncertainty of mesoscale meteorological modeling, and its impact on air pollution transport and dispersion modeling, still remains largely an unknown quantity. The uncertainties should be estimated in output parameters of mesoscale meteorological models (e.g., boundary-layer wind fields, mixing depths, stability, etc.) that are primary inputs to transport and dispersion models.

Panel 2 Question and Answer (Q&A) and Comments Session

After the presentations, the audience offered the following comments:

- There is a significant need for ATD research, however, it should be remembered that the ultimate goal of the ATDs is to positively impact decision making. If the model is not used by the decision maker for any number of reasons (e.g., model takes too long to run, model output is not user-friendly, etc.), then improvements to ATDs will still not positively impact the decision maker.

- There is room for improvement in the models, therefore more collaboration is needed among model developers. It is proposed that a workshop on ATDs be held to share common capabilities and needs for improvement. No one model has full capabilities to accommodate the full range of scenarios. Therefore, it is important to have more than one model.

- Another aspect of model assessment is to have a common evaluation standard for intercomparison. This common standard will allow decision makers and modelers to collaborate more effectively and efficiently.

- There is inherent uncertainty in the models. Acknowledging and communicating uncertainty to decision makers should be a priority. Model uncertainty includes such factors as source dispersion, orography, model initialization, and data assimilation.

- More model sensitivity studies should be completed. For example, sensitivity studies could examine such factors as boundary layer parameterization, range of wind conditions, and interactions between scales (synoptic scale, mesoscale, and microscale)

- The leading challenge is to develop probabilistic forecasts. Probabilistic forecasts will aid the decision maker in generating a response to a hazardous event.

- There is a need to prioritize observational requirements and consider the impact that these priority observations have. For example, wind information is of paramount importance. We need to better quantify wind-flow patterns (i.e., wind speed and direction).

PANEL DISCUSSION

Panel 3: Developing a Common Framework for Model Evaluation

Moderator: Dr. Paul Try, OFCM/STC

Panelists: Dr. Steven Hanna - GMU
Dr. James Ellis - LLNL/NARAC
Dr. Jeffrey C. Weil - CIRES/CU
Dr. Priscilla A. Glasow - Mitre Corp., JEM Program's Accreditation Agent
Mr. Bruce Hicks - NOAA OAR/ARL

Rapporteurs: Maj Brian Beitler - DTRA
Mr. Jim McNitt - OFCM/STC

Synopsis

The objective of Panel 3 was to start to develop a common model evaluation framework that supports our customers' needs and requirements.

Dr. Hanna, GMU, described the few common frameworks for air quality model evaluation that exist (all of the methods described use statistical performance measures) and stated that many agencies and research groups have their own specialized methods. Other aspects of model evaluation involve assessment of (1) the scientific components of the models and (2) study of user friendliness. Current evaluation methods need to be broadened to address CFD model predictions in urban areas. Further work on model acceptance criteria is needed for all models and for a range of scenarios and estimates of expected model uncertainties must be made and communicated to decisionmakers. Dr. Hanna recommended the collection and analysis of additional field data for evaluations, and he described the requirements for these data.

Dr. Ellis, LLNL/NARAC, described four key components to traditional plume model evaluation: (1) analytic comparison, (2) field experiments, (3) Operational testing, and (4) open literature publication and public availability of the code. There is also a need to evaluate a model more fully in its operational mode or environment. Dr. Ellis recommended the development of a number of baseline sites (e.g., city, coastal, mountain, high plains) as model test bed sites (e.g., the Atmospheric Radiation Measurement sites).

Dr. Weil, CIRES/CU stated that model evaluations usually have three main components: (1) an assessment of the model physics, (2) an "operational performance" evaluation with field data, and (3) a model-to-model comparison. Dr. Weil also stated that there are a number of existing frameworks for evaluating model performance. Although he warned that there should be room for additional novel measures of performance, he raised the possibility of developing a common framework for some evaluation measures. Dr. Weil described two major limitations of many field experiments and model evaluations: the vertical distribution of concentration and the random variability or inherent uncertainty in concentration.

Dr. Glasow, Mitre Corp, JEM Program's Accreditation Agent described the Joint Effects Model (JEM), how modeling and simulation (M&S) systems are evaluated in the Department of Defense, and the JEM Program Office's approach to model evaluation. In order to develop a common framework for model evaluation, an initial set of goals will have to be established.

The community will have to (1) understand the problem that needs to be resolved, (2) determine {the appropriate) use of M&S, focus accreditation criteria, scope the V&V, and contract to get what the program needs (include M&S and VV&A requirements in RFPs to get bids and estimated costs).

Other goals include building a consensus and commitment to developing and using credible models, securing adequate resources to conduct credible model evaluation efforts, and providing program incentives to those who are expected to perform model evaluations. Finally, Dr. Glasow recommended that programs use independent evaluators to obtain unbiased evaluation reports, institutionalize the use and reuse of models that have documented credibility, and establish standards for model evaluation performance to ensure quality and integrity of evaluation efforts.

Mr. Hicks, NOAA OAR/ARL described the elements of successful model evaluation: (1) good housekeeping and (2) comparisons between model inputs and model ouputs and observational data. Good housekeeping includes internal examination and approval of code and external peer-review of code and documentation. Comparisons must be made between model outputs and observations. Tracer studies are crucial, in the area of intended application. Tests against data should involve observations that are independent of the data sets used to develop or refine the model. Plots of predicted versus observed concentrations are rarely rewarding, in the situations of current concern (primarily urban cases). To anticipate future needs, field studies should be suitable for use in evaluating future modeling systems, in addition to current systems, and the resulting data sets should be widely accessible. A forum is needed, where field studies and model evaluations are discussed and examined.

George Mason University

Dr. Steven Hanna
Adjunct Associate Professor of Environmental Health
Department of Environmental Health, Harvard School of Public Health

A few common frameworks for air quality model evaluation already exist. The most widely used air quality model evaluation tools in the U.S. are the EPA Model Evaluation Software (updated recently by Irwin et al. as an ASTM guide) and the Hanna et al. BOOT software. These methods use statistical performance measures. In addition, many agencies and research groups have their own specialized methods. Other aspects of model evaluation involve assessment of the scientific components of the models and study of their user friendliness. For example, sometimes a model can give the right answer because the errors of two scientific components cancel each other out. Recently, it has become evident that many emergency response models give significantly different answers when applied to the same scenario by different users.

Current evaluation methods need to be broadened to address CFD model predictions in urban areas. Further work on model acceptance criteria is needed for all models and for a range of scenarios. Connected to this topic, estimates of expected model uncertainties must be made and communicated to decision makers. These uncertainties will be much greater for scenarios where inputs are not well-known.

Additional field data are needed for evaluations. Most past data were taken using simple source scenarios during fair weather in ideal conditions. However, real accidents or terrorist events are seldom so straightforward. New field studies should include variable and non-standard sources, weather periods with rain and with time and space-variable conditions, and complex terrain (e.g., coastal cities with nearby mountains).

National Atmospheric Release Advisory Center
Lawrence Livermore National Laboratory

Dr. James Ellis
National Atmospheric Release Advisory Center
Lawrence Livermore National Laboratory

Plume models can be evaluated in a number of ways. We see the following key components.

- Analytic comparison with known mathematical solutions to test the numerical accuracy of the model.
- Field experiment comparison to test the model in real-world situations.
- Operational testing to evaluate the usability, efficiency, consistency, and robustness of the models under operational conditions.
- Open literature publication and public availability of the model to allow for scrutiny by the scientific and user communities.

In addition to the more traditional approach above, there is a need for a methodology to evaluate a model more fully in its operational mode or environment. The atmospheric transport and diffusion component of a plume modeling system may score high marks under controlled or well-defined laboratory and field conditions. However, the operational application of a model will most likely not score as highly because the present and predicted state of the atmosphere is usually not as well characterized as during experimental conditions. The user wants to know how well the plume modeling system is going to perform in any given real-world event.

Perhaps a number of baseline sites (e.g., city, coastal, mountain, high plains) could be constructed as model test bed sites (e.g., the Atmospheric Radiation Measurement sites). These sites would incorporate advanced observational platforms, which could "well" characterize the three-dimensional atmosphere components on an ongoing basis for evaluating ATD modeling systems. Plume modeling systems could be evaluated using both the complete data set, subsets of the data set, and predicted data sets. The subsets would replicate today's operational data sets. As the deployed operational observational networks improved, more data would be added to the data subsets.

University of Colorado

Dr. Jeffery C. Weil

Cooperative Institute for Research in Environmental Sciences
University of Colorado

Model evaluations usually have three main components: 1) an assessment of the model physics, 2) an "operational performance" evaluation with field data, and 3) a model-to-model comparison. The physics are assessed based on a scientific review and a model comparison with data from intensive field experiments as well as numerical and laboratory simulations. In the operational evaluation, the data can be from intensive experiments or routine monitoring networks. A central issue is how well can models be evaluated in the presence of a large natural variability in concentration due to atmospheric turbulence.

There are a number of existing frameworks for evaluating model performance. Most include statistical measures of the mean model bias, the random variability about the mean, the probability distribution of concentration, and the correlation between predictions and observations. It seems possible to develop a common framework for some evaluation measures although this may depend on the specific problem (e.g., instantaneous source), observational details, etc. However, there should be room for additional novel measures of performance since a rigid codification of the evaluation process stifles new ideas and perhaps a new enlightening performance measure.

From a scientific viewpoint, two major limitations of many field experiments and model evaluations are a lack of information on: 1) the vertical distribution of concentration, and 2) the random variability or inherent uncertainty in concentration. The first impedes our understanding of why models perform as they do, forcing one to speculate about the adequacy of the vertical dispersion treatment. The second, due to an insufficient number of experimental realizations, places bounds on how well a model can be expected to perform. These limitations can be overcome in some problems by numerical simulations of dispersion with a Lagrangian particle model driven by large-eddy simulations. Examples will be given showing how these simulations can be used to quantify the uncertainty in concentration.

United States Navy
Space and Naval Warfare Systems Command

Dr. Priscilla A. Glasow
Mitre Corp.
JEM Program's Accreditation Agent

ABSTRACT

Dr. Glasow described the Joint Effects Model (JEM). The Department of Defense (DOD) is building JEM to provide a single, common use hazard prediction modeling system for CBRN incidents/accidents. The JEM system will predict how hazardous material is transported and diffused in the atmosphere by incorporating components of three legacy systems in use within DOD. Ultimately, JEM will consolidate the "best of the best" of the legacy models into a single model. It will model the environment, including the weather, terrain, vegetation, and marine environment and will simulate interactions with other materials in the environment, such as how a material decays or binds with other materials. JEM's output includes the predicted hazard area, the estimated concentrations of the hazardous material, its lethality, direction of spread, etc. This output will be generated to overlay on maps within DOD command and control (C2) systems. It will be interoperable with C2 systems, and with warning and reporting systems. The JEM system's architecture will support seamless weather data transfer from multiple sources. Its development includes a full training package and sustainment through reach-back. An independent assessment of the functions of each of the legacy models was performed by Battelle Institute, and is being used as a guide to select which legacy model's code will be used in JEM.

Dr. Glasow described how modeling and simulation (M&S) systems are evaluated in the DOD. She described the basis for VV&A procedures and recommended practices for M&S systems. Dr. Glasow proposed that the problem may not be VV&A at all, but the way in which program managers use M&S. Experts within the T&E community have suggested the VV&A effort should be focused on reducing program risk. Dr. Glasow described the JEM Program Office's approach to model evaluation. It is based on DOD VV&A procedures and recommended practices for M&S systems, comparison metrics established by the IDA, and ASTM guidelines for statistical comparisons of dispersion codes.

In order to develop a common framework for model evaluation an initial set of goals will have to be established. The community will have to do the following: understand the problem that needs to be resolved, determine the appropriate use of M&S, focus accreditation criteria, scope the V&V, and contract to get what the program needs (include M&S and VV&A requirements in RFPs to get bids and estimated costs). Other goals include building a consensus and commitment to developing and using credible models, securing adequate resources to conduct credible model evaluation efforts, and providing program incentives to those who are expected to perform model evaluations. Finally, Dr. Glasow recommended that programs use independent evaluators to obtain unbiased evaluation reports, institutionalize the use and reuse of models that have documented credibility, and establish standards for model evaluation performance to endure quality and integrity of evaluation efforts.

National Oceanic and Atmospheric Administration
Air Resources Laboratory

Mr. Bruce Hicks
Director, NOAA Air Resources Laboratory

ABSTRACT

Mr. Bruce Hicks described the elements of successful model evaluation: (1) good housekeeping and (2) comparisons between model outputs and model inputs and observational data. Good housekeeping includes internal examination and approval of code and external peer-review of code and documentation.

Since agencies have different ways of conducting this, standardizing this part of the process might be a good idea. The intended application must be considered when designing model evaluation procedures. Comparisons must be made between model outputs and observations. Tracer studies are crucial, in the area of intended application. Tests against data should involve observations that are independent of the data sets used to develop or refine the model. Plots of predicted versus observed concentrations are scarcely rewarding, in the situations of current concern (primarily urban cases). Mr. Hicks suggested that model evaluators should evaluate the modeling system in terms understood by the end users and judge the performance of a model system by quantifying the proportion of people who receive incorrect guidance. The model that yields the minimum value would obviously garner some favor. As a first step, assume uniform population distributions.

To anticipate future needs field studies should be suitable for use in evaluating future modeling systems, in addition to current systems, and the resulting data sets should be widely accessible. A forum is needed, where field studies and model evaluations are discussed and examined. The Office of the Federal Coordinator is the official organization with relevant existing authority.

Panel 3 - Question and Answer (Q&A) and Comments Session

- **Question:** When comparing model data with observations how can the evaluator consider the difference in quantities of data so that there is no bias? **Answer:** Can use model averages over a volume and a statistical approach. Can apply confidence levels. Another issue to consider is that even if al the models agree in a specific situation what if the uncertainty associated with the meteorological inputs is large? **Comment:** ATP-145 is used by the military to encompass uncertainty by providing a relatively large hazard area. **Comment:** Part of the problem is deterministic and part of it is stochastic. For every grid there is a subgrid. Want to evaluate the deterministic part, but the stochastic part will give a spread to make a comparison that is bounded. Variability is real, and it is stochastic. Could be simulated by CFD code.

- **Question:** LES CFD codes can simulate conditions that vary with time by running the code for the same location several times. For winds, this can take 4 or 5 realizations. Typically, the LES CFD code generates few data points outside of the range of the averaged values. How should developers display these reults? **Answer:** Users seem to like color-filled contours.

- **Comment:** What is needed are standard benchmarks for comparing model performance. **Response:** Standards that evolve with time aren't standards, but there are probably ways to measure performance so that the developer can move to a new model.

- **Comment:** Another need is a body or forum within which to endorse code.. **Response:** Peer review can work well for data sets. **Comment:** Another need is a reference atmosphere that exercises the physics in the dispersion code.

WRAP-UP

Mr. Bob Dumont wrapped up the open session by describing the partnership between OFCM and GMU as successful and stating the OFCM intent to hold the session again next year. The Federal concept of operations will mature as the DHS CMS Subgroup completes its work. Once approved the CONOPS will be integrated with the OFCM's Homeland Security Environmental Support Plan. OFCM will also coordinate a R&D plan for dispersion modeling