Dr. Kathie L. Olsen, Associate Director for Science
Office of Science and Technology Policy (OSTP)

Policy, Science, and Partnership Issues for the Complex Urban Environment

Dr. Olsen began her presentation by stating that by 2025, 60 percent of the world's population will live in cities. As a result, Dr. Olsen advised that:

(1) We need to understand hazards which could impact the urban zone.
(2) We need to be warned and know how to react.
(3) We need to be safe at home and at work.
(4) We need to recover quickly.

She next provided an overview of OSTP, noting that the office advises the President and the Offices of the President. Dr. Olsen also said that the OSTP leads the interagency effort to develop science and technology policies and budgets for all areas of science. Engaging in these activities requires OSTP to build strong partnerships among federal, state and local governments, other countries, industry, academia and scientific associations; develop clear, measurable goals and objectives for research and development programs; and assess Federal investments relative to the purposes of government.

Dr. Olsen articulated that the program decision process is both a top-down activity involving agency management, OSTP/OMB, and Congress and a bottom-up activity with input from academia, industry, etc. OSTP's program priorities are established using science priority criteria (e.g., science return, benefit to society, mandated program, partnership opportunity, technology readiness, program balance, cost/budget context, etc.) and implementation priority criteria. Using these criteria, Dr. Olsen shared with the Forum participants the FY 06 research and development priorities. These priorities include:

(1) Environment.

   (a) Climate change science & technology
   (b) Global observations
   (c) Water availability and quality
   (d) Hydrogen economy

(2) Biology of complex systems.

(3) Physical sciences.

(4) Research and development for Homeland Security.

(5) Networking and information technology.

(6) Nanotechnology

Dr. Olsen also gave an overview OSTP's components such as the National Science and Technology Council and the activities within the council's Committee on Environment and Natural Resources. Dr. Olsen concluded her presentation with a quote from Marshall McLuhan (1911 - 1980): "There are no passengers on spaceship earth. We are all crew."

A complete summary of the Forum, as well as Dr. Olsen's remarks, can be found on the OFCM web site: www.ofcm.gov.

Ms. Nancy Suski, Director
Department of Homeland Security
Emergency Preparedness and Response Portfolio, Science and Technology Directorate

Urban Meteorology for Homeland Security

Ms. Suski's presentation highlighted two areas:

(1) The broad spectrum of urban meteorology needs for Homeland Security and attendant requirements.

(2) On-going programs at the Department of Homeland Security.

With respect to urban meteorology needs for Homeland Security, Ms. Suski reminded the Forum participants that effectively simulating the environment requires an understanding of atmospheric phenomena that affect the transport, dispersion, and fate of threat agents in the atmosphere. Fast access to appropriate meteorological data, including archived, nowcast, and forecast data are required to adequately support these simulations. The data needs to be readily accessible and in a standard format that will allow access by multi-scale and diverse modeling systems. Ms. Suski also noted that the ability to provide early warning of atmospheric releases includes continuous 24/7/365 monitoring of urban areas (including critical facilities) as well as rapidly deployable, targeted monitoring of special events (such as national security special events, agricultural outbreaks, etc.). Support to these efforts involves characterizing the environment with the help of meteorological inputs.

Ms. Suski also highlighted the gaps in our understanding of the urban zone, which are relevant to Homeland Security. She stated that better and faster tools are needed to support incident characterization. She asserted that significant attention has been focused on prevention, interdiction, and providing an early warning that an atmospheric release has occurred. Less attention, however, has been focused on how incident characterization and response tools can be used to assess the extent of attack (e.g., the area contaminated and the people exposed). This type of information would provide decision makers with a better understanding of the scale of the event and provide tools so they can rapidly formulate and implement appropriate responses, including phasing of critical resources.

Ms. Suski turned her attention to the on-going research programs at the Department of Homeland Security. She articulated that "making our nation safer and more resilient to terrorist attacks is one of the key goals of the DHS research and development programs in atmospheric transport and dispersion." Two of the many programs which Ms. Suski highlighted included:

(1) The Interagency Modeling and Atmospheric Assessment Center – This center seeks to bring together the significant Federal capabilities for atmospheric hazard prediction for incidents of national significance. It will provide a single Federal hazards prediction to

be utilized by Federal, state, and local emergency responders, thereby eliminating confusing and conflicting hazard predictions.

(2) New York City Urban Dispersion Program – This program enhances New York City's emergency capabilities for addressing potential airborne releases of harmful materials. The program will advance understanding and characterization of the effects of urban processes on atmospheric dispersion in large cities, leading to improved and validated urban parameterizations for atmospheric dispersion models. It will also couple indoor and outdoor studies to further understanding and characterization of outdoor-indoor exchange.

Ms. Suski concluded her remarks by recognizing that meeting urban meteorology needs and the goals of the aforementioned programs will require a combined effort across many different agencies and at all levels of government.

A complete summary of the Forum, as well as Ms. Suski's remarks, can be found on the OFCM web site: www.ofcm.gov.

Mr. Eric Webster, Majority Staff Director
U.S. House of Representatives
Science Subcommittee on Environment, Technology and Standards

A Congressional Perspective on Urban Meteorology

Mr. Webster's stated that urban meteorology is a "confusing concept." He advised the Forum participants that laying out clear and attainable goals is important. He also noted that "Federal funding can be difficult." Playing the role of devil's advocate, Mr. Webster asserted that the goal of focusing on urban meteorology is to "save lives, help people, etc." Using that thesis, he argued that there are anecdotes about technology providing more and better information which will save lives, "but 35,000 people died in Europe last summer because they didn't have fans or air conditioning. Does it matter if we can predict the temperature more accurately by one or two degrees? The real issue is getting people fans, AC and the information they need to stay alive. We must look at the cost/benefit analysis – fans, AC – lives saved vs. technology, etc."

He also provided road weather research as another example of a cost/benefit analysis. He stated that road weather research saves lives through better weather information, mesoscale networks, road sensors, etc. Noting that researchers wanted tens of millions of dollars, he asked what are the real causes of deaths on the highways? He questioned whether it would be better to spend "a couple of million and have AMS work with AAA to teach teenagers/others how to drive in wet or snowy conditions." He also acknowledged that the Science Committee put in the provision to create a road weather research program. He ended this example by saying that "we are not against the research, [we] just want to put all of this in perspective."

Mr. Webster also articulated the need for a consistent message. Using plume modeling as an example, he stated that Congress get[s] mixed messages from agencies. He noted that "one week DOE tells us they do it. [The] next week it is DOD, then NOAA and now DHS." As an alternative he suggested that "what would make a real difference, is the whole system, program, research organized rationally, etc."

Mr. Webster then shifted to the work Congress is doing on NOAA's Organic Act legislation – legislation that would define the basic mission and functions of NOAA. Within that legislation, Mr. Webster wants to ensure that NOAA's research is better coordinated and that it eliminates "some of the stove pipe mentality in NOAA."

Mr. Webster concluded his remarks by exhorting the Forum participants to "develop a good, responsible, cost-effective plan."

A complete summary of the Forum can be found on the OFCM web site: www.ofcm.gov.

Dr. Ronald D. McPherson, Executive Director Emeritus
American Meteorological Society

Perspectives on the Interdisciplinary Scope and Approaches to Urban Meteorology

Dr. McPherson asserted that "We have to learn to communicate effectively among scientific disciplines, applications disciplines, and the lay public." With this charge in mind, the thrust of his remarks centered on four themes:

(1) Communication and the historical development of meteorology.

(2) Scientific disciplinary linkages in the urban zone.

(3) Applications disciplinary linkages in the urban zone.

(4) AMS contributions to enhanced interdisciplinary communications.

Dr. McPherson acknowledged that historically meteorologists communicate "fairly well communicating with each other, but with one major exception not so well when talking to persons in other scientific disciplines, or in the applications disciplines, or to members of the general public." He noted that there were so many first-order problems associated with the meteorological discipline that most linkages with other earth science disciplines were regarded as second-order or greater. These linkages were in many cases known or suspected, but were rarely explored or exploited.

He noted, however, the progress toward an interdisciplinary approach. He stated that "the problem of weather forecasting is certainly not solved, but very great progress has been made in the last few decades, and as a result increasing attention has been directed to the interaction of meteorology with other disciplines." He highlighted such examples as the flow of air over and through building, the contrasts of temperature due to differing responses to solar radiation and urban heat sources, and the introduction of pollutants to air and water as illustrating the complexity that involves meteorology, hydrology, atmospheric chemistry, and in coastal areas, air-sea interaction. These disciplines in turn interact with other scientific disciplines, such as physiology, ecology, and medicine Although in general meteorologists are beginning to reach out to other scientific disciplines, he noted the exception of professional meteorologist on television who "have done much over the last 50 years to familiarize the public with the tools and trade of modern meteorology … Television meteorologists are therefore an important asset in urban meteorology, and can be even more important in the interdisciplinary approach to communications between scientific disciplines, applications disciplines, and the public."

Dr. McPherson stated that scientific disciplines affect such decision makers as political leaders, law enforcement, emergency managers, business leaders, traffic managers, health care professionals, and utilities (e.g., water, sewer, energy, and communications) managers. However, he noted that these decision makers do not want to act as meteorologists. They prefer to receive meteorological advice which is relevant and in a

useful form. Thus Dr. McPherson asserted that the fact "that meteorologists do not wish to be, for example, traffic managers, and traffic managers do not wish to be meteorologists, is a major interdisciplinary communications problem for which a solution must be developed."

The AMS established a Board on the Urban Environment. It is deliberately interdisciplinary and responsible for organizing scientific conferences and workshops designed to focus attention on the urban environment, drawing together the various scientific disciplines engaged in the urban zone.

Lastly, Dr. McPherson shared his thoughts on the road ahead. In January 2005, the AMS will introduce a new program, the Certified Broadcast Meteorologist (CBM) program, to raise the standards [of broadcast meteorologists] even higher, and to encourage those who hold the CBM designation to equip themselves to cover a broader range of environmental issues. He asserted that "the CBMs will be a major asset for enhanced communications among the players in the urban environment."

A complete summary of the Forum, as well as Dr. McPherson's remarks, can be found on the OFCM web site: www.ofcm.com.

Dr. Gilbert Brunet, Associate Director
Environment Canada
Meteorological Research, Meteorological Services of Canada

The Regional and Urban Numerical Weather Prediction and Operational Long Range Plan for the Meteorological Service of Canada

Dr. Brunet's presentation emphasized four areas:

(1) A description of the Canadian Meteorological Centre and Meteorological Research Branch.

(2) Multi-scale meteorological modeling.

(3) NWP now, in one year, and ten years.

(4) Future research and development challenges.

Dr. Brunet stated that the Canadian Meteorological Centre and Meteorological Research Branch are the Canadian equivalent to NOAA/ NWS/ NCEP and the Navy's FNMOC for NWP and equivalent to Lawrence Livermore National Laboratory's National Atmospheric Release Advisory Center for multi-scale atmospheric transport and dispersion modeling. He next gave examples of multi-scale meteorological modeling endeavors. These examples included improvements to hurricane forecasting (e.g., full life-cycle modeling), precipitation rates on a global scale, and representation of urban surfaces.

Dr. Brunet highlighted modeling opportunities within the urban zone. He noted that in the higher resolution convective scale models which are on the verge of being operationally implemented at the Canadian Meteorological Centre, it will become increasingly important to correctly represent physical processes over urban surfaces. For example, in the case of the short- and medium-range weather forecast systems currently operational at the Centre, even large urban areas (e.g., 50 km x 25 km) have a negligible impact on the atmospheric circulations produced by the models. To remedy this situation, Dr. Brunet recommends that high-resolution topography as well as physics parameterization (e.g., town energy budgets) be incorporated into models. Dr. Brunet also noted that due to Canadian/Japanese collaboration a computer system which is 25 times more powerful than the IBM cluster currently used at the Centre's Earth Simulator Center will be available in the next 5 to 10 years. These new systems will be a factor in enhancing the Centre's urban zone predictive capabilities.

With respect to future research and development challenges, Dr. Brunet stated that for Calendar Years 2004-2005 the research and development strategy in collaboration with the Centre, regional weather services, and Canadian universities will include:

(1) Global NWP with a meso-global Global Environmental Multi-scale forecasting and modeling system (GEM) with a lid at the stratopause (.1mb) and with the regional GEM physics package.

(2) A four-dimensional variational analyses assimilation system with new asynoptic and satellite data.

(3) An Ensemble Prediction System (EPS) delivered with a comprehensive physics and initial condition perturbations approach. A comprehensive unified EPS Research and Development and Operational Long-range Plan has been initiated with the NWS. The "ribbon-tying" ceremony occurred 16-18 November, 2004, at NCEP in Camp Springs, MD.

A summary of the Forum, as well as Dr. Brunet's remarks, can be found on the OFCM web site: www.ofcm.gov.

Dr. Walter D. Bach, Jr., Program Manager
U.S. Army Research Office
Environmental Sciences Division, Engineering Sciences Directorate

Summary of the Report, "Federal Research and Development Needs and Priorities for Atmospheric Transport and Diffusion Modeling"

Dr. Bach stated that the purpose of the report was to present a research and development plan for providing the ATD modeling capabilities needed to meet established needs of the user communities, with special emphasis on enabling the National strategy for responding to domestic chemical, biological, radiological and nuclear incidents. The range of users included first responders, incident commanders, emergency managers, federal responders, emergency preparedness and response coordinators, as well as those concerned with military operations and air quality. Dr. Bach stated that from these users' perspectives, the desired information is "a workable answer [which is accurate] in the user's time frame."

Dr. Bach presented a schematic of a model for meeting the user's needs. Inputs to the model included observations, forecasts, and source terms (e.g., where, when, and how much). Outputs included health effects and environmental effects. While discussing the model, Dr. Bach touched on modeling uncertainty. He noted that the total model uncertainty is measured by the variance in the predicted and the observed quantity over a large number of events that have similar properties (an ensemble). Model uncertainty has three sources. The internal source consists of numerical approximations, modeling errors, and treatment of dynamical processes. Data errors in execution and evaluation, model parameterizations, and initial and boundary conditions make up the external contributions to model uncertainty. Lastly, the stochastic contribution to model uncertainty comes from the natural variability of the atmosphere.

Modeling and measurement research needs were the next topic in Dr. Bach's presentation. Among the needs which he articulated included:

(1) Bridging the gap from mesoscale to microscale models.

(2) Improving the characterization of surface boundary conditions in model parameterizations and in input data sets.

(3) Testing and refining the physical basis for sub-grid parameterizations.

(4) Developing methods and technologies for improving ensemble construction and implementation.

Dr. Bach concluded his presentation with a series of recommendations. The recommendations included, but were not limited to:

(1) Quantifying model uncertainties and interpreting their implications to users.
(2) Capturing and using existing data sets.

(3) Implementing ATD test beds.

(4) Improving the spatial and temporal scale interactions between meteorological and ATD models.

A complete summary of the Forum, as well as Dr. Bach's remarks, can be found on the OFCM web site: www.ofcm.gov.

Mr. Dave Jones, Founder, President and CEO
StormCenter Communications, Inc.
and President
Foundation for Earth Science

Raising the Environmental I.Q. of America through Innovative Agency and Media Partnerships

Mr. Jones began his presentation by articulating the goals of StormCenter (e.g., to apply environmental science in such a way as to engage Americans to increase their understanding of the environment, to utilize science information as a tool for improved public and agency decision making, and to increase public environmental awareness so better decision making can be made in times of crisis). He articulated that market research has found that weather "is the #1 reason people watch local news." Additionally, the research shows that people are in a learning mode when they watch the television weathercasts.

Mr. Jones also articulated the necessity and value of partnerships. He stated that most agencies have as part of their strategic plan a goal to communicate effectively with those whom they serve. Many agencies have valuable data sources but have not had a direct conduit to the public on a regular basis. Additionally, Mr. Jones asserted that excellent resources exist that should be tested for applications in media. As a result, StormCenter has established partnerships with such public and private organizations and institutions such as NASA, NOAA, Harvard University, the AMS, and National Aquarium in Baltimore.

The weathercasts and weathercasters of the future were also subjects of Mr. Jones's remarks. He stated that the television weathercasters are now looked upon as the station scientists. In that role, the weathercasters will address information on air and water quality (e.g., health risks), environmental hazards/pollution, toxic releases, forest fires, El Nino, climate change, urban meteorology issues, and more. He then presented images from television broadcasts to illustrate the range of environmental issues which weathercasters are now expected to bring forward to the viewing audience. He noted that the use of real-time information and imagery are critical to engaging and informing the public.

To further illustrate his point about the value of data, information, imagery, and partnership, Mr. Jones pointed to a number of StormCenter "firsts." For example, he provided to the Forum participants StormCenter's work with hurricane wind field modeling endeavors. This effort is based on the GFDL model which incorporates "land use [urbanization] into the model." Using this information, StormCenter developed a visualization of the official NHC forecast. This visualization provided storm path and intensity and was the "first time that the official NHC forecast was visualized as a high resolution wind field and delivered to media."

Mr. Jones ended his presentation, emphasizing that "by working together we can make a difference!"

A complete summary of the Forum, as well as Mr. Jones's remarks, can be found on the OFCM web site: www.ofcm.gov.

Dr. Richard D. Rosen, Assistant Administrator
DOC/NOAA
Office of Oceanic and Atmospheric Research

Research and Development to Meet Urban Weather and Climate Needs

Dr. Rosen's remarks addressed the question, "Why urban meteorology now?" He stated that the three overarching reasons for addressing meteorological aspects of the urban zone are:

(1) Technological advances.

(2) Homeland Security.

(3) Health and Safety.

With regard to technological advances, Dr. Rosen stated that NOAA is working toward an integrated observing system to take into account a myriad of observational data (e.g., satellite data, UrbaNet, private sector "Weather Nets", and buoys) and to optimize their use. He then provided examples of how technological advances in observing systems allow atmospheric scientists to discern conditions which impact the urban zone. For example, we can now detect with enhanced clarity dust and air pollution flowing from China and destined to reach the U.S. The UrbaNet site located atop the U.S. Commerce Department headquarters building in Washington, D.C. collects three-dimensional wind vector, temperature, pressure, relative humidity, and solar radiation data in 1-minute intervals and transfers summaries of those data every 15 minutes. He noted that the UrbaNet data are particularly valuable for dispersion applications.

With regard to Homeland Security, NOAA's Air Resource Laboratory is partnering with EPA in Research Triangle, NC to model lower Manhattan. The Hybrid Single Particle Legrangian Trajectory model is used to characterize plumes and predict trajectory end points at hour intervals. At small scales UrbaNet data are assimilated into this model and "can have significant impact" on the model's predictive capability, a capability which will support a system to orderly evacuate cities during hazardous events.

Dr. Rosen explained that NOAA's involvement in the Air Quality Program addresses health and safety issues. One of the program's objectives is to provide scientific advice for decision makers. For example, regional assessments will discover key atmospheric processes that contribute to poor air quality such as Houston, TX's refinery emissions and New England's nocturnal chemistry. The air quality forecasting component of the program has implemented an operational ozone forecast. "A broader range of significant pollutants" will follow. Dr. Rosen also noted that urban areas are especially vulnerable to high impact weather, because of the concentration of lives and property. Severe thunderstorms and tornadoes affect trees, power lines, and buildings. Heat waves are the direct cause of more deaths than all other weather conditions combined. Additionally,

winter weather impacts transportation and utility infrastructure. As a result, Dr. Rosen concluded that:

(1) The need for an urban focus was magnified by 9/11 attacks, but longstanding issues regarding health and safety continue to demand attention.

(2) New observing systems and improved models point the way forward for research.

(3) The complexity of urban meteorology issues demands that NOAA partner with the broader community to advance research and development.

A complete summary of the Forum, as well as Dr. Rosen's remarks, can be found on the OFCM web site: www.ofcm.gov.

Ms. Chris Elfring, Director
The National Academy of Sciences
Board on Atmospheric Sciences and Climate

Challenges in Making Weather and Climate Information Useful in Decision Making

Ms. Elfring began her presentation by providing the Forum participants with background on the National Academies and the Board on Atmospheric Sciences and Climate. She stated that the purpose of the National Academies is to serve as advisors to the Nation on science, engineering, and medicine. The role of the Board seeks to advance understanding of the atmospheric sciences, meteorology, and climate; foster application of this knowledge to benefit the public; and advise U.S. research programs so they are responsive to scientific opportunities and the needs of the nation.

Turning her attention to urban meteorology, Ms. Elfring stated that there are a number of reasons for focusing on urban meteorology. For example, there is "clear evidence of human and economic impacts" on the urban zone. Additionally, advances in science and technology now can support improved capabilities and improved integration of information. She also articulated urban meteorology's underlying needs to include:

(1) The need to understand the hazards and potential impacts within the urban zone.

(2) The need to be warned and know how to react appropriately.

(3) The need to be able to be safe during and after hazards.

(4) The need to be able to recover quickly (e.g., infrastructure, health, and cascading problems).

Ms. Elfring also noted that the challenges articulated by the keynote Forum speakers fell into two categories – research (e.g., "things we need to understand better") and usefulness (e.g., "things we need to do better to increase the impact of what we know"). She gave examples of both. In incident modeling she said that the research challenge is to improve the ability to provide early warning of atmospheric releases (including tools to detect incidents and tools to model and characterize the extent and impacts of those incidents). The usefulness challenge is to improve "the way to integrate scientific capabilities from different providers and distribute [them] in an organized and consistent way to users (e.g., IMAAC)." Ms. Elfring also illustrated the research and usefulness challenges associated with urban observations. The research challenge is to gain better, high resolution data; measure numerous variables; and assure data quality and accessibility. The usefulness challenge is to determine how best to collect reliable data, allow easy processing by users, communicate in ways that meet user needs, and make training available.

Ms. Elfring identified other challenges for urban meteorology. She stated that we need to accept the importance of addressing real problems, "go for 'low hanging fruit'", and set

and attack priorities (with an eye to cost-effectiveness). Other challenges which she rendered included:

(1) Paying attention to moving from research to operations.

(2) Packaging information in ways that are truly useful to different users.

(3) Developing more creative approaches to partnerships among academic, private, and public sectors.

Ms. Elfring ended her presentation with the following question for the Forum participants' consideration: "How do you facilitate coordination, priority setting, and a realistic approach in a large, diverse scientific community?"

A complete summary of the Forum, as well as Ms. Elfring's remarks, can be found on the OFCM web site: www.ofcm.gov.