Office of the Federal Coordinator for Meteorological Services and Supporting Research

Special Session, 18th Annual George Mason University (GMU) Atmospheric Transport and Dispersion Modeling Conference

Update on Governmental Atmospheric Transport and Dispersion Experiments, Modeling and Response

This document provides a summary of the OFCM-sponsored special session within the 18th Annual Atmospheric Transport and Dispersion Modeling Conference at George Mason University (GMU). The session was chaired and moderated by Mr. Jeff McQueen of National Weather Service/Environment Modeling Center, College Park, Maryland, and Dr. Daniel Melendez, OFCM and NWS. The conference was held on the GMU campus in Fairfax, VA, and the session was conducted on Wednesday June 25, 2014. This summary report has three sections, which are outlined as follows:

- **Section I - Overview**
  - Purpose and Theme
  - Objectives
- **Section II - Session Synopsis**
  - Opening Remarks and Presentations
  - Question-and-Answer (Q&A) Period
- **Section III – General Discussion**

I. OVERVIEW

Purpose and Theme:

The OFCM participates in the annual GMU modeling conference and routinely sponsors a session to inform attendees on the status and plans of the Federal government's atmospheric transport and dispersion (ATD) experimental, observational and modeling efforts. Accordingly, this year's session provided a forum for the responsible Federal agencies, together with representatives of the user communities, to review the Nation's ATD efforts and to make recommendations on future ATD model improvements, as well as improvements to services and products derived from ATD sensor and model data.

The theme of the session was *Update on Governmental Atmospheric Transport and Dispersion Experiments, Modeling, and Response.* Reflecting the strong partnerships built over many years, the session had over 75 attendees, including representatives from the following Federal agencies: Department of Commerce/National Oceanic and Atmospheric Administration (DOC/NOAA); the Department of Defense (DoD), including the U.S. Army, the Defense Threat Reduction Agency (DTRA) and the U.S. Air Force; the Department of Energy (DOE); and the Department

of Homeland Security (DHS). Attendees also came from academia, industry, State and local governments, and the emergency management community.

Objectives: The session was structured to address the following objectives:

1. Current status: Discuss federally-managed ATD field experiments, modeling, opportunities for collaboration, warning responsibilities, and governance; status of existing modeling capabilities; and the availability and use of model output by decision makers.
2. Advances: Highlight improvements made in the past year to models and processes as well as new experimental initiatives supporting model boundary conditions, initialization and data assimilation.
3. Gaps: Discuss high priority areas of basic and applied research, experimental design, model development, and other resource development.
4. Where we need to go: Discuss areas of concern the community should begin working or increase emphasis on.

II. SESSION SYNOPSIS

The session consisted of opening remarks by the session chair and nine presentations. A Q&A period followed each presentation. Slides from session presentations are available on the OFCM Web site.

1. **Session Opening Remarks:** Mr. Jeff McQueen, Meteorologist, DOC/NOAA/NWS/NCEP, College Park, MD, opened the session by stating that prior OFCM-sponsored interdepartmental efforts helped shape the session. It is a follow-on activity based on interdepartmental ATD modeling requirements captured in the OFCM publications *Atmospheric Modeling of Releases from Weapons of Mass Destruction: Response by Federal Agencies in Support of Homeland Security* and *Federal Research and Development Needs and Priorities for Atmospheric Transport and Diffusion Modeling*, published in 2002 and 2004, respectively, and an update of last year's special OFCM session.

2. **Presentations:**

   - **Mr. Jimmie Trigg,** Defense Threat Reduction Agency (DTRA) (J9-ISR), Technical Reachback, Ft. Belvoir, VA (slides).

     - The mission of the Interagency Modeling and Atmospheric Assessment Center (IMAAC) is to provide a single point for coordinating and disseminating Federal atmospheric modeling and hazard prediction products during actual or potential incidents among the various partner and member agencies.
     - The IMAAC is run by DTRA and staffed 24/7/365, can be activated by any public agency, and is the primary resource to respond to requests for information on chemical/biological/radiological/nuclear effects (CBRNE) incidents.
     - To illustrate how IMAAC supports incidents, Mr. Trigg recounted the January 2014 rubber fire in a plant in Waynesfield, Ohio, that makes mud flaps. The

incident was modeled as continuous-release oil fire. It continued for about 7 hours, during which time a front passed through the area necessitating several dispersion products and changing the population at risk. First responders used the IMAAC products to locate the command post, position monitoring stations, identify the specific hazard, close roads, and establish ingress/egress zones.

Question-and-Answer Period:

Q: How was plume touch down point determined?
A: From newscast reports.
Q: What liability do IMAAC products have?
A: Best intent and effort case law covers liability.

- **Dr. Ivanka Stajner**, Physical Scientist, DOC/NOAA/NWS/Office of Science & Technology, Silver Spring, MD (slides). Dr. Stajner's presentation highlighted recent experience in applying dispersion models in operational prediction of wildfire, smoke, dust, volcanic ash, and chemical/radiological events. She also discussed model improvements, model verification efforts, and model improvement requirements:

  - Described how weather observations are used by weather models such as NAM for subsequent support for the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model to predict smoke concentrations associated with wildfires. The previous model bias to over predict smoke concentrations has been much reduced, to some extent because the model now allows plumes to rise above the model boundary layer. Smoke dispersion forecast verification relies on GOES imagery.
  - Dust propagation employs the NWS WRF/NAM model along with post-processing feeding the HYSPLIT model with MODIS satellite climatology and real-time land moisture data. Verification is done with NESDIS/MODIS dust imagery.
  - Volcanic ash monitoring and prediction is done at three dedicated NOAA/NWS centers using HYSPLIT as "trained" on Iceland 2010 volcano satellite imagery.
  - NCEP is the WMO Regional Specialized Meteorological Center for US per International Atomic Energy Agency agreements. NOAA provided radiological particle transport simulations (including ocean deposition) in response to the Fukushima Dai-ichi nuclear power plant incident that is part of the 2013 UN Scientific Committee on the Effects of Atomic Radiation report to the General Assembly.
  - NOAA is implementing a radiological backtracking capability in support of the Comprehensive Test Ban Treaty Organization (CTBTO) under a State Department agreement. This was tested with Fukushima data, using HYSPLIT to estimate radiological source strength. Preoperational testing at NCEP is continuing through September, 2014.

  Question-and-Answer Period:
  Q: Where can one find dust source data?

A: Maps of potential dust source locations are available from Dr. Paul Ginoux from NOAA/GFDL and there is a paper by Draxler et al. about their use in NWS operational dust predictions.
Q: How are dust and smoke locations determined?
A: Smoke locations are provided by NOAA/NESDIS based on satellite imagery.
Q: What about ensembles?
A: This is being considered but not operational at this time.
Q: Are heat sources included in numerical fire prediction?
A: No.

- **Mr. Mark Miller**, Development Group Supervisor, DOC/NOAA/NOS/OR&R, Seattle, WA (slides). Mr. Miller briefed the combined ALOHA/HYSPLIT chemical release module, which just became operational. He provided background on the Computer-Aided Management of Emergency Operations (CAMEO) software suite, of which ALOHA is the air dispersion component. Mr. Miller discussed the latest upgrades to the system, reviewed model evaluation procedures and measures, and discussed completed and ongoing dispersion model integration efforts. His presentation included the following key points:

  - NOAA's ERD and ARL worked together to combine the source release estimation models of ALOHA to the mesoscale dispersion model HYSPLIT. As part of the transition to operational status seven training webinars were held for NWS personal who are the primary users for this enhanced chemical release module. NWS uses the ALOHA/HYSPLIT model to evaluate releases of hazardous chemical vapors by estimating the downwind dispersion of a chemical cloud, based on the toxicological/physical characteristics of the released chemical, atmospheric conditions, and specific circumstances of the release.
  - As previously reported, the ALOHA model has been successfully modified to simulate atmospheric dispersion resulting from fires and explosions.
  - CAMEO-ALOHA products require NOAA login but output can be shared for 48-hour periods through user-shareable protected web pages
  - ALOHA is being transitioned to a web-enabled model.

  Question-and-Answer Period:

  Q: Are technical documents for CAMEO-ALOHA updated?
  A: Yes, they reside in publicly accessible websites.

- **Mr. J. V. Ramsdell,** Ramsdell Environmental Consulting, briefed on the radiological dispersion and deposition (RASCAL) model in support of the Nuclear Regulatory Commission (NRC) (slides). Mr. Ramsdell focused on model improvements and challenges, including the following highlights:

  - RASCAL is a confirmatory code for NRC that was started around 1974. The code has modules for U.S. nuclear reactors, spent fuel facilities, and fuel cycle facilities. Gaussian puff and plume models are used for transport and dispersion. The

RASCAL dispersion modules treat effluents and small particles as gases and calculate early and late phase radiological doses to individuals. There is a separate module that treats UF6 releases from uranium fuel cycle facilities.

- Projections are made for 96 hours or less in a domain up to 100 miles (increased from 50 mi) and can run multiple co-located reactor sources.
- Dispersion calculations were based on 1960's data that are biased for high wind speeds. The experimental bias results from forecast uncertainty in wind directions when the speed is low. RASCAL applies a low wind speed correction to dispersion when the wind speed is less than 4 m/s. The Gaussian plume model is undefined for zero wind speed, so the puff model is substituted for the plume model when the wind speed approaches zero.
- RASCAL dispersion algorithms are based on boundary layer turbulence models described in texts by Panofsky and Dutton (1984) and Stull (1988).
- Dry deposition is based on a resistance model and is a function of surface roughness, wind speed, and stability. Wet deposition modules include washout for particles and scavenging of gases. Iodine is treated as 25% particles, 30% reactive gas (I2), and 45% non-reactive gas (CH3I) for deposition and dose calculations. Future development may include addition of uncertainty estimates.

Question-and-Answer Period:

Q: Is a Gaussian plume model still being used in RASCAL?
A: Yes, but NRC is also bringing in NOAA mesoscale model output and using it to improve results over observation-driven Gaussian modeling.

- **Dr. John Pace,** Meteorology Division, US Army Dugway Proving Ground, UT, discussed the use of the Granite Mountain Atmospheric Sciences Testbed (GMAST) (slides):

  - Established in 2009, GMAST is a meteorological testbed aimed at improving operations through customer-funded R&D addressing the gap of forecasting in complex terrain.
  - Has been used to support MATERHORN (to be discussed later), precision airdrop wind sensing and tracer tests, and gunship wind sensing applications.
  - Most densely instrumented site in the world with a wide variety of sensors, movable instrumentation, 2-m and 10-m towers, and C- and X-band radars.
  - Data is incorporated into Four Dimensional Weather (4DWX), and NCAR-developed advanced modeling system. The ensemble version of 4DWX runs on a high-performance computer at Dugway.

  Question-and-Answer Period:

  Q: What formatting is used for the data?
  A: Some of the data goes to the community in various formats.
  Q: What about short-term forecasts?
  A: 4DWX runs eight times per day out to two days at 1.1 km horizontal resolution.

- **Dr. Kirk L. Clawson,** NOAA Air Resources Laboratory, Field Research Division, Idaho falls, ID, briefed project Sagebrush (slides):

  - Updates short-range dispersion data from the classic 1956 Prairie Grass project using state-of-the-art tracer and sensor technologies. It is being conducted over several years at the NOAA facility on DOE's Idaho National Laboratory (INL) in partnership with INL and academia.
  - Meets ANSI 3.11 governing weather measurements in support of nuclear facilities relying on three-dimensional sonic anemometry in order to estimate turbulence.
  - The first phase of the test was conducted in 2013 in mostly neutral boundary conditions. Future phases will include stable atmospheric conditions and focus on vertical dispersion.
  - The five year study could be accelerated with additional funding partners.

  Question-and-Answer Period:

  Q: Do aircraft perturb plumes they sample?
  A: Yes, but they don't affect the results because concentrations downwind perpendicular to the flight path are not sampled again after the fly-through.
  Q: Was there convective data as part of the field experiment?
  A: No. During Phase 1 the PBL was neutral due to strong winds during the experiment.

- **Dr. John Pace,** Meteorology Division, US Army Dugway Proving Ground, UT, discussed the Mountain Terrain Atmospheric Modeling and Observations (MATERHORN) field campaign (slides):

  - Study of the interaction of large and small scale motions in complex terrain using the GMAST sensor array discussed earlier.
  - First two phases were conducted in October 2012 and May 2013 over the GMAST array. Another phase is being planned for other areas, including Salt Lake City.
  - Preliminary results presented at conferences and in papers address such topics as the "Dividing Streamline: concept, slope and valley interactions, lidar observations from aircraft, and contributions to modeling advancements.

- **Mr. Jeremy Rishel,** Pacific Northwest National Laboratory (PNNL), discussed METFETCH – Data Retrieval for Emergency Response (ER) Codes (slides):

  - METFETCH is an application, available since September 2013, that retrieves meteorological observations and forecasts for use in RASCAL
  - Observations are decoded from their native formats and encoded in Extensible Markup Language (XML); a quality flag is included along with standard meteorological elements.

- Forecasts are derived from the NWS National Digital Forecast Database and encoded into XML for consistency. Forecast resolution is 2.5 km by 3 hours out to 72 hours and 6 hours out to 168 hours.
- Future work on METFETCH may include a map-based station selection option (versus the current alphanumeric approach), increasing the number of networks from which data is available, and customizing the format for other emergency response codes.

Question-and-Answer Period:

Q: Includes rain data?
A: Yes, also forecast rain amount/type.
Q: Is bad data quality controlled? Updated?
A: Master list at reactor sites uses representative stations. Focus is on high fidelity data. Several quality control flags are automated and prevent further transmission to RASCAL input file.

- **Mr. Jeff McQueen,** Research Meteorologist/Principal Investigator at NOAA/National Center for Environmental Prediction, College Park, MD, discussed SMARTINIT status for NAM model downscaling:
  - NAM grids include Alaska, CONUS, Hawaii, Puerto Rico and Virgin Islands and runs at different domains hourly to drive dispersion modeling.
  - Downscales GFS (13 km) and NMMB/ARW to the AWIPS CONUS (2.5 km) in unified framework.
  - Boundary layer height retrievable from ceilometer data.
  - Study addresses the following questions:
    - Can dispersion be done with two-dimensional numerical model?
    - How adequate is NWS's ATD data?
    - Is government response good enough?

III. GENERAL DISCUSSION

Discussion centered around the possible application of multiple model outputs for several related reasons—to compare to select the best output for the particular application, to compare to help estimate and express the uncertainty of the results in particular situations, or to create an ensemble to perhaps select a composite or hybrid solution. This approach would help address concerns expressed during the session about the lack of error bars on the ATD model output. A participant reported that some effort is being made in Europe to create ATD ensembles, but results are not mature. Getting all model output into a compatible format would be very helpful in making comparisons, and would be essential to any ensembling effort. OFCM could explore this with IMAAC and other ATD output providers in the coming year to see sample interest, scope the effort, and project the potential for success.

Questions and comments on this report and the OFCM session in the GMU ATD conference may be address to Dr. Daniel Melendez at OFCM: daniel.melendez@noaa.gov; (301) 628-0046.