FEMA **TechNote**

U.S. Department of Homeland Security

SAVER

System Assessment and Validation for Emergency Responders

The Federal Emergency Management Agency (FEMA) established the System Assessment and Validation for Emergency Responders (SAVER) Program to assist emergency responders making procurement decisions.

The SAVER Program conducts objective operational tests on commercial equipment and systems and provides those results along with other relevant equipment information to the emergency response community in an operationally useful form. SAVER provides information on equipment that falls within the categories listed in the DHS Authorized Equipment List (AEL).

The SAVER Program is supported by a network of technical agents who perform assessment and validation activities. Further, SAVER focuses primarily on two main questions for the emergency responder community: "What equipment is available?" and "How does it perform?"

For more information on this and other technologies, please see the SAVER website or contact the SAVER Program Support Office.

Telephone: 877-347-3371
Fax: 443-402-9489
E-mail: FEMA.ASKTS@fema.gov
Website: https://saver.fema.gov

This SAVER TechNote was prepared by the Environmental Measurements Laboratory,

EML

Science and Technology Directorate
U. S. Department of Homeland Security,
New York, NY for the SAVER Program.

Urban Atmospheric Plume Models for Emergency Response

An atmospheric plume model is a computer tool that can be used for planning, emergency response, and assessment of consequences of releases of hazardous materials into the air from industrial, transportation, and terrorist activities. The atmospheric plume model can predict the concentration and the path that airborne contamination might take as it spreads in the atmosphere. In the event of a Chemical, Biological, Radiological, Nuclear or Explosive (CBRNE) release in an urban environment, a model including urban settings will be needed for predicting the distributions of resulting contamination. Emergency responders could communicate the model predictions to the public and use these predictions to assess the impacts of the release and help plan response operations and actions including the evacuation routes, sheltering in place and relocation areas.

Overview

Hazardous material released from a source or sources is quickly spread by various processes (Fig. 1) and eventually deposits in nearby regions. The toxic or radioactive debris inhaled in the respiratory tract or deposited on surfaces of land and reservoirs can greatly increase risks to public health and potentially harm the environment.

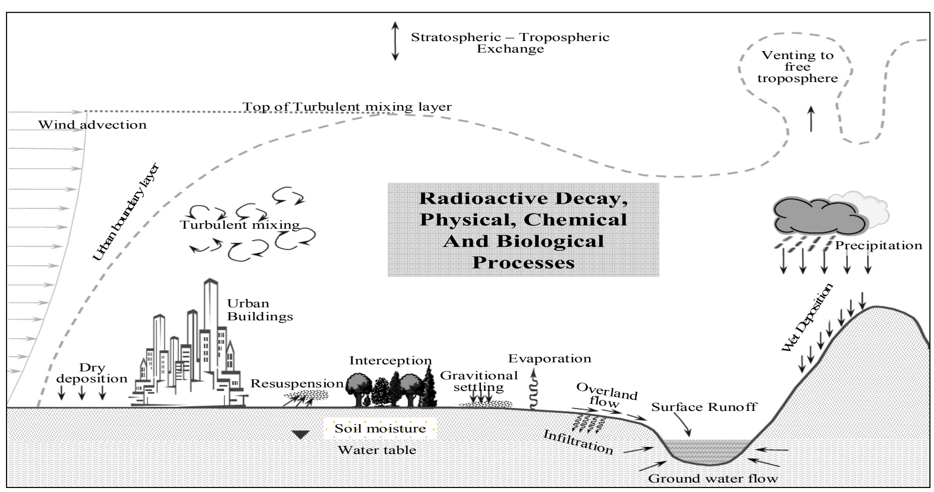

Figure 1. Schematic diagram of physical, chemical and biological processes influencing the cycles of transport of material.

In the event of a release in a city, the processes involving the transport and deposition of debris are complicated because tall buildings contribute to the fluctuations of urban winds and air turbulence that disperse the debris. Influence of turbulence on dispersion is large, but relatively little is known about the best way to model urban building induced turbulence to capture the features used in the dispersion calculations. An urban model including information about the height and width of buildings is needed for predicting a path that debris will spread around a city.

In the case of a CBRNE release in a city, the Interagency Modeling and Atmospheric Assessment Center (IMAAC) which was established in 2004 at the Department of Homeland Security/Science & Technology uses a suite of models for predictions and is responsible for producing, coordinating, and disseminating model predictions for airborne hazardous materials. Model inputs include real-time meteorological observational data and geographical data. It is important for state and local emergency responders to provide the field data (e.g., emission or concentration measured) to IMAAC for refining the model predictions during the event of attack.

Urban Models

A number of urban wind models have been developed for predicting the wind flows in an urban area. These urban wind flows are then used in urban dispersion models to predict the atmospheric concentrations of hazardous material released from a source or sources. Of urban models, the Computational Fluid Dynamic (CFD) model provides the highest fidelity predictions of urban plume distributions but is computationally expensive and slow to operate. The Urban Dispersion Model (UDM), and the Quick Urban and Industrial Complex (QUIC) model can be run quicker than the CFD model, but the predictions are less accurate. These models are applied to the studies of dispersion in few cities and are not yet used regularly in emergency response applications. Due to the complexities of urban models, IMAAC promotes continuous research and development to address plume model deficiencies in urban areas.

Model Limitations and Uncertainties

Some models have been designed for their ease of use and applicability to address specific problems that require special attention. Many models are applicable to the flat surface of terrain without any obstacles and buildings. These models are not valid for urban applications. There are a few models that are constructed for the calculations over a simple hill of terrain. Several models may be good for long range hazardous material transport prediction, but not for the short range - users need to be aware of the model limitations.

A model contains many processes that describe the transport and dispersion of hazardous material when released in the atmosphere. Generally, models do not produce perfect predictions. Model uncertainties are expected and vary with each model. The uncertainties may involve errors in modeling urban wind flows and turbulence, computational errors, and input errors in meteorological and building data. Particularly, uncertainties in the information about the state and the mass of hazardous material released per unit time at the source location can greatly increase the model uncertainty in predicting impacts from the hazardous material. Such source information is the key input to the model that predicts where the material is going and the concentration distribution in the atmosphere.

Model Validation and Evaluation

The inherent complexity of an urban environment and the relatively new field of urban meteorology are a challenge. Field and laboratory studies were conducted for improving the development of atmospheric plume models in urban areas. These studies used monitoring networks for measuring meteorological observations and the concentrations of non-toxic tracers released at the source location. Modelers were able to compare the model predictions with the measurements for assessing the performance and the accuracy of models. Intensive validation and evaluation of models against urban tests are the keys to the continuing improvement of UDM and QUIC for urban use in emergency.

Conclusions

Plume models are most effectively used to provide early estimates of potentially contaminated areas. Timeliness is the most important feature during an emergency for responders who need to know the areas where the plume has passed and the direction in which the plume is moving.

No single model captures all of the parameters inherent in comprehensively evaluating the urban wind flows and the extent of contamination after an attack. For the purpose of emergency response and recovery, models using a relatively simple, quick, but less accurate approach might be useful. Continuing improvements are needed in urban models, so that emergency responders are properly prepared for addressing airborne releases of harmful materials in an urban area.

Resources

"First Responders' Ability to Detect and Model Hazardous Releases in Urban Areas Is Significantly Limited", Report to Congressional Requesters, GAO-08-180, U. S. Government Accountability Office, June 2008, http://www.gao.gov/new.items/d08180.pdf

"Introduction to the IMAAC", LLNL, UCRL-PRES-208325 (2005) ,LLNL, UCRL-PRES-211992 (2005).