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TESTING AND DEVELOPMENT OF COMPREHENSIVE EVALUATION METHODOLOGIES FOR URBAN DISPERSION MODELS AND THEIR RELATIONSHIP TO USERS NEEDS REQUIREMENTS

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1. INTRODUCTION

There is a strong interest from several civil and military agencies in the U.S. and in Europe to improve existing model evaluation methodologies. This interest focuses mainly on model acceptance criteria, summaries of users needs, and preparation of data bases and software for use in model evaluation. In this paper we will discuss recent results obtained from a two-part study where we 1) test and develop comprehensive evaluation methodologies for urban dispersion models, and 2) investigate requirements of users needs for atmospheric transport tools

For the urban model evaluation component of the project, we have been acquiring models and field data sets for urban transport and dispersion. Also, a simple screening dispersion model has been developed and compared with the Salt Lake City tracer data.

The second part of this research assesses the needs of users of atmospheric transport and dispersion models for chemical or biological (CB) agent releases during an accidental release or a terrorist attack. During the course of this project a questionnaire was prepared and sent to atmospheric dispersion modelers to collect information for the final user needs assessment.

2. METHODOLOGIES

The study on the evaluation methodologies for urban dispersion models involves a set of comprehensive methodologies that is being developed along several tasks:

- Development and testing of scientific evaluation criteria. This involves the review of a model for its technical algorithms, physical assumptions, closure methods, and applicability to specific scenarios.
- Development and testing of statistical evaluation methods and criteria.
- Development of methods for communicating the model results and model uncertainties to decision-makers. This involves devising new methods to communicate the uncertainties of models and relating them to the model acceptance criteria mentioned above.
- Acquisition of field and laboratory data sets to prepare a standardized set of data bases to be used for model development and testing.
- Application of evaluation methods to a set of representative models and field data bases as a demonstration exercise.

For the 'Users Needs' project, we analyzed the responses to the questionnaire and interviewed selected model users.

3. RESULTS TO DATE

3.1 Urban Model Evaluation Methodologies Project

We have so far reviewed various model evaluation methodologies. We have also evaluated a number of models for their technical algorithms, physical assumptions, closure methods, and applicability to specific scenarios. We seek to develop a broad categorization of model types, and to provide generic critiques on each model type, by addressing issues such as scientific base, strengths and limitations, resource requirements, and typical application scenarios. Model acceptance criteria are being developed using statistical model performance measures across a range of scenarios.

We have acquired several urban transport and dispersion field data sets. Some of the data sets include (1) the European urban transport and dispersion data base COST-CITAIR (Fisher et al., 1999), (2) the data sets for street canyons analyzed by the European TRAPOS project (Berkowicz, 2001), (3) one day of data from the 2000 DOE VTMX/CBNP Salt Lake City experiments (Brown et al., 2001), (4) laboratory data sets of flow and dispersion within obstacle arrays, (5) the wind tunnel data used in the European Union EMU Computational Fluid Dynamic (CFD) model evaluation project (Daish et al., 1999), and (6) the PERF wind tunnel data (Hanna et al., 2001b) and the Kit Fox field data (Hanna et al., 2001a). These data sets range from single buildings to street canyons to urban metropolitan areas. The data are being analyzed in order to determine how existing urban boundary layer theories deviate from the data.

An urban screening dispersion model has been developed for use as a basis for comparison with more sophisticated urban models. This screening model is being compared with some preliminary data from the Salt Lake City tracer experiment. The results are encouraging and show an agreement within a factor of two.

The GMU BOOT model evaluation software has been upgraded. The software now implements the procedures adopted by the American Society for Testing and Materials (ASTM) Guide D6589-00 (ASTM 2000), as well as the single nomogram method suggested by

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K. Taylor (Taylor 2001). We are reviewing the areal coverage comparison method recently proposed by the Institute for Defense Analyses (Warner et al., 2000). The Cumulative Distribution Function (CDF) method developed by Lewellen, Sykes, and Parker (Lewellen et al., 1985) is also being tested using distributions of model residuals.

3.2 Users Needs Project

A questionnaire had been sent to a large number of model users, and the responses have been analyzed. Additionally, we have been conducting interviews with selected model users. The responses to the questionnaire are summarized below.

The availability of training time and materials is of high importance to secure prompt and easy solutions and to avoid misapplying the model. Most respondents prefer to learn how to run a new model in a period of one to four weeks, where comprehensive user's manual are highly desirable. Most respondents also prefer not to run simpler models, if available, for a specific scenario requires the appropriate model. Time is a critical factor in an operational or emergency environment. Meteorological and building morphology data, crucial for correct simulations, are often scarce. Additionally, in an operational environment when data are rare or missing the user must be able to modify the model default inputs. An emergency situation often requires the access to a remote central location where the model is run. In this situation clear guidance is crucial about an efficient and practical connection to e.g., a weather service. Effective real-time model simulations require accurate results by using current simple weather inputs, with short data download times and large detailed terrain/topography files on urban and mesoscale scales. Model results have to reflect the needs of the user. Desired information should be easily retrieved from output files and exported to other environments for timely interpretation. Concentration contour plots as well as times series of concentrations, and the animation of these plots, are important to obtain a complete information about the model scenario.

4. FUTURE OUTLOOK

For the urban model evaluation project, further scientific evaluations will be conducted for several general model categories. Additional, new field and laboratory data will be acquired as these field experiments are either just completed or currently underway. Further testing of the model evaluation methodologies will take place, with emphasis on several model categories.

The 'Users Needs' project has been completed and results are summarized in a report available to the sponsor and participants of the study.

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