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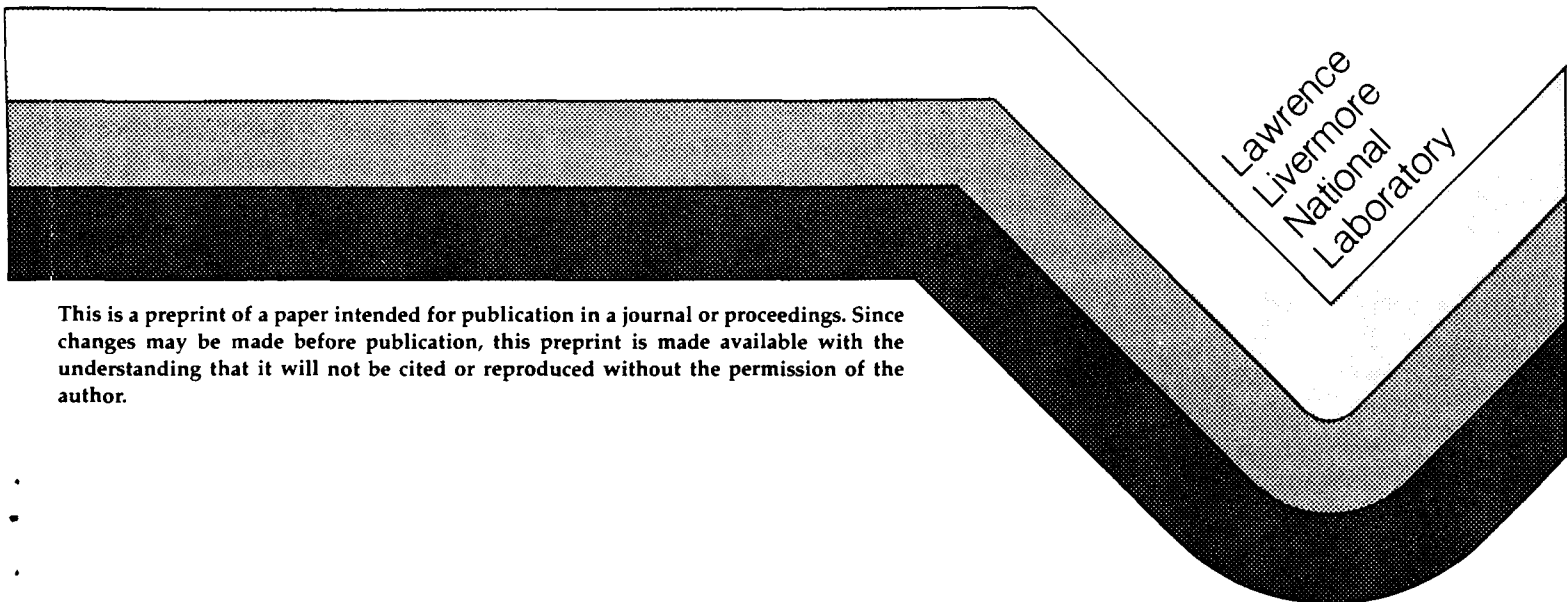
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PREPRINT

**EVALUATION OF AN EMERGENCY RESPONSE MODEL
WITH INSTANTANEOUS AIR CONCENTRATIONS
DURING STABLE CONDITIONS**

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SUMMARY

**Evaluation of an Emergency Response Model with Instantaneous
Air Concentrations during Stable Conditions**

Ronald L. Baskett and Connee S. Mitchell

INTRODUCTION

The STABLE project (STable Boundary Layer Experiment) is a multiyear research effort planned by the Department of Energy to study the effects of turbulence and diffusion on plumes in the stable boundary layer. Conducted by the Savannah River Laboratory (SRL) at Savannah River Plant (SRP), near Aiken, Georgia in April, 1988, the first STABLE field experiment provides a unique tracer data set for evaluating dispersion models. The unique aspect of the experiment was that instantaneous air concentrations were collected. When short-term toxicity is an issue in an accidental release, emergency response requires consideration of peak concentrations. The purpose of this paper is to show the comparison of the SRL STABLE data with Lawrence Livermore National Laboratory's (LLNL) Atmospheric Release Advisory Capability (ARAC) emergency response dispersion models.

DESCRIPTION OF THE EXPERIMENT

SRP is a nearly circular facility about 30 km across, located on the southeast coastal plain of the U.S. Several creeks cross the otherwise gently rolling, forested terrain, resulting in a few abrupt changes in elevation. Reference 1 provides an overview of the experiment. Sulfur hexafluoride tracer gas was released near the center of SRP through a 61-m stack during stable conditions on three nights. A continuous analyzer aboard SRL's mobile van

provided ground-level SF₆ concentrations once every five seconds on available roads 5–15 km downwind of the release stack. SRL had eight meteorological towers that measured the on-site wind speed and direction from biovanes at 61 m above ground. In addition, a 300-m TV tower, instrumented at 7 levels, gave wind and temperature measurements throughout the stable boundary layer 28 km northwest of the tracer release. Two nights of data were available for model evaluation. As discussed in Ref. 1, on the first night, 14 April 1988, the wind was from the southeast at about 4 m/sec during the 2:00–6:00 a.m. EDT release period. At the beginning of the period, it was from about 145 degrees. Between 3:15 and 4:15 a.m., it shifted counterclockwise 45 degrees. In addition, the plume crossed perpendicular to two creeks, resulting in sudden drops in the measured instantaneous air concentrations. On the third night of the experiment, 17 April 1988, the wind direction changed steadily from 200 to 310 degrees, and the speed decreased erratically from 5 to 2.5 m/sec during the 1:15–5:00 a.m. EDT release period (Ref. 1).

MODEL EVALUATION METHOD

Fifteen-minute-average meteorological data provided by SRL were used by LLNL as input to a mass-adjusted, three-dimensional wind field model (MATHEW). In the ADPIC model, advection and diffusion were treated using gradient theory and a particle-in-cell method. The model grid consisted of $40 \times 40 \times 14$ cells, each $500 \text{ m} \times 500 \text{ m} \times 20 \text{ m}$ in the north-south, east-west, and vertical directions, respectively. No special tuning of the model parameters or algorithms was done; the models were used as they would be to respond to an actual emergency. Instantaneous air concentrations computed by the MATHEW/ADPIC models were used for comparison with the measured concentrations averaged over 30 sec. Paring instantaneous air concentrations in space and time is one of the most rigorous tests of a dispersion model's accuracy. Data sets for the first and third nights were available for model evaluation.

RESULTS

Twenty percent of all the model calculations were within a factor of 2 of the measurements for the two nights, and 50 percent within a factor of 5. There was almost no bias toward over- or underprediction. While most of the peak values along cross-plume transects were underpredicted, MATHEW/ADPIC calculated well the reduced concentrations in the creek beds. During the periods when the wind direction was steadily shifting, the models' instantaneous value frequently changed by an order of magnitude over 15–30 min at three nearby locations (see Figure 1). Considerable improvement in model performance was achieved by assuming a ± 5 degree uncertainty in wind direction. Overall, the MATHEW/ADPIC models produced results comparable to previous evaluations against 30- to 60-min average tracer measurements taken in several other complex terrain settings (Ref. 2).

ACKNOWLEDGEMENTS

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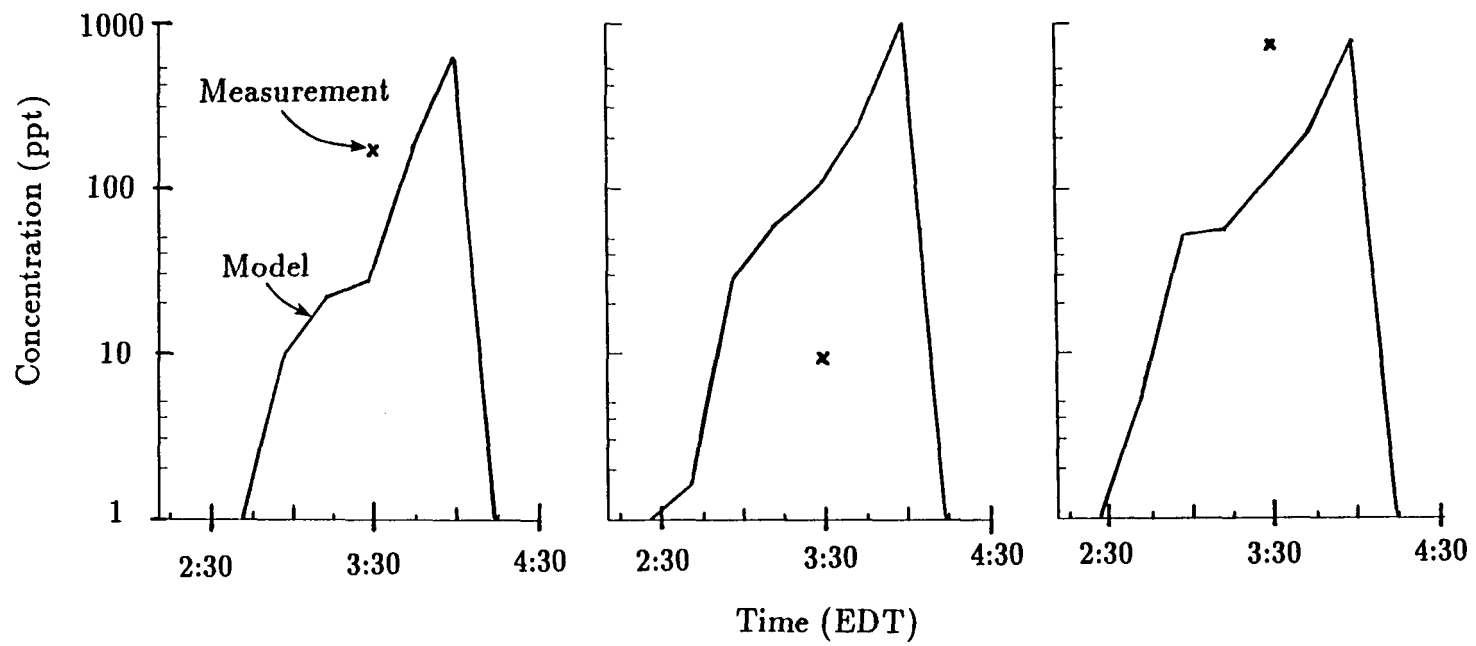


Figure 1. Example measurements taken at 3:30 a.m. on 14 April 1988 compared to model output.