URBAN 2000 SF_6 ATMOSPHERIC TRACER RESULTS FROM THE SUBURBAN EXPERIMENT DOMAIN

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1. INTRODUCTION

The threat of a terrorist releasing a toxic gas in an urban environment has taken on a new focus in recent months. The effort to model the effects of such a prospect has also been enhanced. It is clear that model results must be interpreted in light of the model's ability to accurately predict the real world. Model accuracy is determined through the model validation process, which relies primarily on data acquired from field trials such as atmospheric tracer tests.

URBAN 2000, an atmospheric tracer study, was conducted to establish a database that extends from the single-building scale, to the multi-building scale, to the urban scale, and ultimately to the suburban scale (6 km). The project has been described in detail by Allwine et al. (2002). The month-long field study was funded primarily by the by the U.S. Department of Energy's (DOE's) Chemical and Biological National Security Program. It involved researchers from several national laboratories, universities, and government agencies including the Field Research Division (FRD), making for a rather large experiment. Hence, this paper will focus on the results obtained from the six real-time mobile SF_6 analyzers that were used in six intensive observation periods (IOPs).

2. MATERIALS AND METHODS

URBAN 2000 consisted of six nighttime intensive experiments that were conducted in Salt Lake City, UT during October 2000. The IOPs involved several inert tracers and meteorological measurements. The tracer of interest in this paper, sulfur hexafluoride (SF_6), was disseminated in 18 one-hour releases at ground-level approximately 15 m south of the 35-m high Heber M. Wells Building . The Wells Building is located near the intersection of 400 South and 200 East. During the first four tracer IOPs (2, 4, 5 and 7), SF_6 was released at a rate of 1 g s^{-1} from a 30-m long line source for three 1-h periods from 0100-0200, 0300-0400 and 0500-0600 Mountain Daylight Time (MDT). For the last IOP (10), SF_6 was released from a point source rather than a line source. IOP 9 was conducted earlier in the night to better coincide with the expected higher winds through downtown SLC. The tracer was released at 2 g s^{-1} from a point source for three 1-h periods from 2200-2300, 0000-0100 and 0200-0300 MDT. The release rate of SF_6 was monitored throughout each experiment and was within 5% of the desired rate.

Atmospheric SF_6 tracer concentrations were monitored by mobile real-time analyzers. The FRD-built real-time mobile SF_6 analyzer makes measurements of atmospheric SF_6 concentrations with a response time of just under one second. The rapid response time and mobile nature of the analyzers make them ideally suited for measurements of plume widths and structure. They have been utilized in experiments measuring both across wind (e.g., Clawson et al, 2001) and along wind diffusion parameters (e.g. Bowers et al., 1994) commonly used in transport and dispersion models. The heart of the system is the TGA–4000 (Tracer Gas Analyzer) manufactured by Scientech Inc. of Pullman, WA.

The TGA-4000 real-time SF_6 analyzer is a fast response instrument designed specifically to measure the concentration of SF_6 in ambient air. The TGA–4000 uses an electron capture detector (ECD) to detect SF_6. The detection limit of the ECD is about 5 parts per trillion volume (pptv). The TGA-4000 signal along with real-time GPS position, instrument temperatures, and ambient pressure are collected by a laptop computer at the rate of 2 Hz. The computer stores the data for later

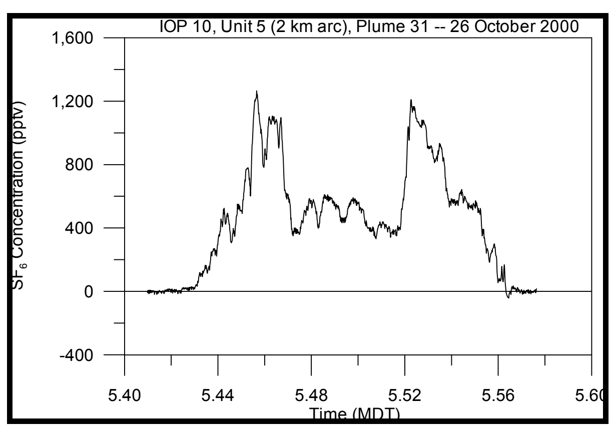

Figure 1. SF_6 concentration from plume traverse number 31 made during IOP 10 along the 2 km arc.

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post-processing and simultaneously displays the TGA-4000 signal for operator interpretation and control. Using this display, the operator determines the plume concentration and position by using software controls to “mark” the beginning and ending of the plume trace. Run time quality control (QC) outputs allow the operator to monitor the performance of the system.

Six real-time analyzers were deployed for the URBAN 2000 experiment. They were deployed along arcs of increasing distance downwind from the SF_6 tracer dissemination point. The arcs were approximately 1 and 2 blocks downwind, and 1, 2, 4 and 6 km downwind from the release site. The analyzers were mounted in vans that traversed the SF_6 plume in a nearly perpendicular manner, thereby measuring plume width, structure, and concentration.

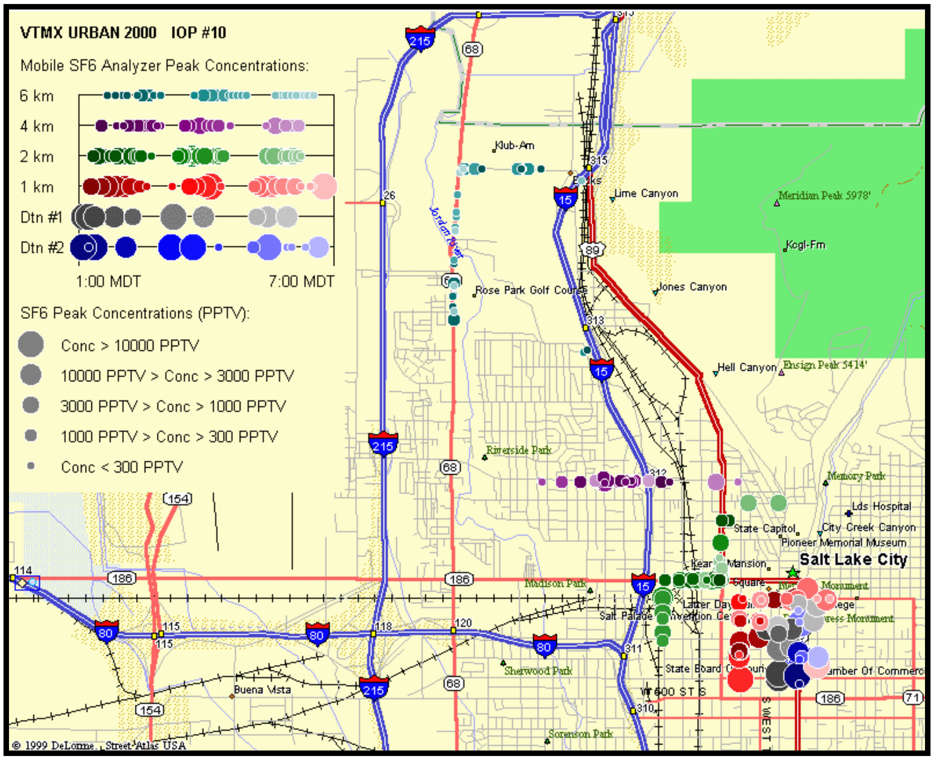

Figure 2. Maximum SF_6 concentration of each plume crossing during IOP 10 as a function of time (upper left). Size of dot increases with increasing concentration. Dots on map indicated the geographical location of each maximum concentration. Hue changes with increasing time.

3. RESULTS AND DISCUSSION

A typical SF_6 concentration trace from a traverse made by a real-time analyzer is shown in Fig. 1. The trace is from IOP 10, and was measured during the third release of the morning at about 0530 MDT. Although the traverse was nearly perpendicular to the plume trajectory, the trace is not Gaussian, but rather bimodal. The trace is indeed typical of the assemblage of all traverses made by all six mobile analyzers, which total 828. While some traces could be classified as Gaussian, most are not. It is in the ensemble average of the traces that the curve begins to approach Gaussian. This indicates that instantaneous exposures to toxic chemicals are not represented well by Gaussian dispersion models.

A summary graph of all the traverses made during each IOP was constructed to help determine plume concentrations and trajectories. The summary graph for IOP 10 is shown in Fig. 2. The figure describes the maximum concentration of every plume traverse in horizontal space and in time. In the upper left-hand corner of the figure is a graph of the maximum plume concentration for each plume traverse made by each mobile analyzer as a function of time. The various colors (blue, black, red, green purple, and aqua) represent each analyzer. The size of the dot is proportional to the concentration, as indicted in the legend below the graph. The color hue changes with time, becoming lighter as time increases. The same dots that appear on the graph also appear on the map, showing the geographical location of the maximum plume concentration on a base map.

It is readily apparent that the plume centerline meandered significantly at both the inner arcs as well as the outer arcs. Plume meander as much as 1.3 km was observed on the 1 km arc while plume meander as much as 2.4 km was observed at the 6 km arc during IOP 10. During other IOPs, plume meader was much larger, sometimes approaching a semi-circle on the 1 km arc.

4. REFERENCES

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