J5.3

Urban Near-Field Dispersion

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1. INTRODUCTION

The Joint Urban 2003 (JU2003) experiment was conducted in July 2003, principally supported by the Chemical and Biological National Security Program (CBNP, originally DOE and now DHS) and the Defense Threat Reduction Agency (DTRA). JU2003 was designed to obtain observations for evaluating and improving atmospheric dispersion models at scales from around a few buildings through the entire urban area. Sulfur Hexafluoride (SF6) was released at various locations within the central business district (CBD) of Oklahoma City and was measured in the near-field using real-time infrared spectrometry. Bag samples were also collected for later laboratory analysis. During the release, arrays of three-dimension and two-dimension ultra-sonic anemometers were deployed in the near-field of the release.

Dispersion in the near-field strongly depends on the small scale variation in the wind field and on the presence of buildings and other urban structures. Observations indicate that material disperses rapidly in the vertical when buildings are present. At several locations within a few city blocks of the SF6 release location, bag samplers were collocated at the ground and on rooftops.

2. NEAR FIELD SAMPLING STRATEGY

The building layout for releases during IOP1 and IOP2 is presented in Figure 1, where north is towards the top of the page. The releases of SF6 during IOP1 and IOP2 are described in Table 1. The sampling strategy for the bag samplers was to sample in a single bag for 5 minutes. During the continuous releases, the sampling was for 15 minutes per sample. Bag samplers were collocated at the ground and on rooftops at the points T (Corporate Tower Building), O (Okland Building), M (Main Street Parking garage), P(100 Park Avenue), C (Century Parking Plaza, north side), W (Westin Hotel), and CC (Convention Center).

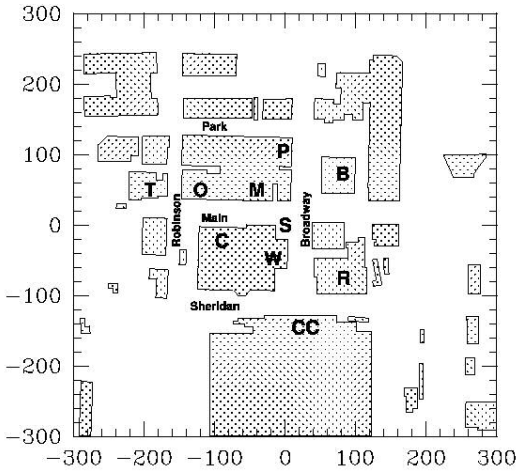

Figure 1. The source location is at the origin (0.,0.) and vertical sampling locations in the near field. Distances are in meters.

	Time	Type	Amount
IOP1	**0900**	**Puff**	**1000g**
	0910	**Puff**	**1000g**
	0920	**Puff**	**1000g**
	0930	**Puff**	**1000g**
	0945	**Puff**	**500g**
	1000	**Puff**	**500g**
	1100	**Continuous**	
	1300	**Continuous**	
IOP2	**0900**	**Puff**	**1000g**
	0920	**Puff**	**1000g**
	0940	**Puff**	**1000g**
	1000	**Puff**	**1000g**
	1100	**Continuous**	
	1300	**Continuous**	
	1500	**Continuous**	

Table 1. A summary of the releases for the first 2 IOPs.

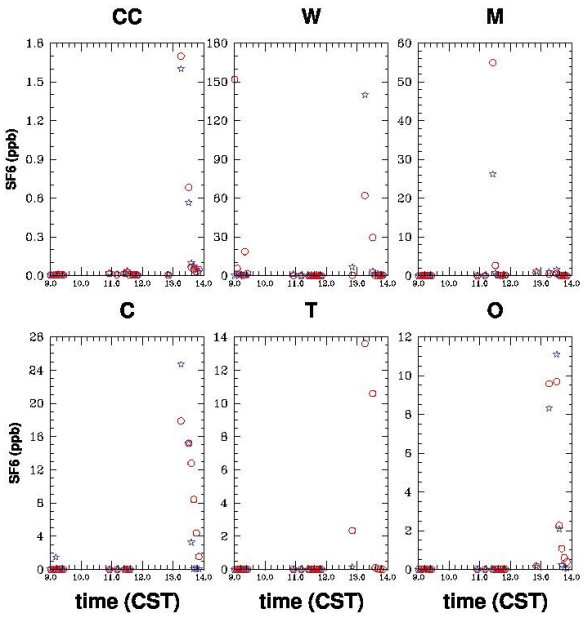

Figure 2. The blue stars are the concentration values at ground level, the red circles are the concentration values at the corresponding rooftop

3. OBSERVATIONS

3.1 IOP1

The observed concentrations for IOP1 at the sites depicted in Figure 1 are shown in Figure 2. Note that the Y-axis is self-scaling, so that each individual panel is a different scale; the units are parts per billion (ppb). The X-axis is time (Central Daylight Time).

At the convention center (CC), the concentrations are small but above the level of detection especially around 1330 and 1345, and the rooftop values are marginally above the ground values. However, they appear to represent a well-mixed environment. At the Westin Hotel, just to the west of the release point, there is a significant quantity of SF6 observed in the 5-minute rooftop sample of the first puff release, while very little is observed at ground level. Later during the continuous release at 1300, there appears to be evidence of non-well-mixed condition, with the rooftop values sometimes smaller and sometimes larger than the ground observations. At the Main Street garage (M) the rooftop observation is about a factor of 2 higher during the 1100 continuous release. Farther down the street and on the south side of the street at the Century Plaza structure, the rooftop observations are also generally greater than the ground observations, except for one time at about 1315. There were significant quantities of SF6 observed on the roof of the Corporate Towers (T), while very little is observed at ground level there. At the Okland Building (O), across the street from the Corporate Towers, but closer to the release point, SF6 is observed at both ground level and rooftop. The observations at O tend to move together, indicating that the air may be fairly well mixed at this location.

The wind field for IOP1 is shown in Figure 3. These observations were taken from the top level of the temporary tower crane deployed at 8th and Harvey, about 1 km northwest of the release point.

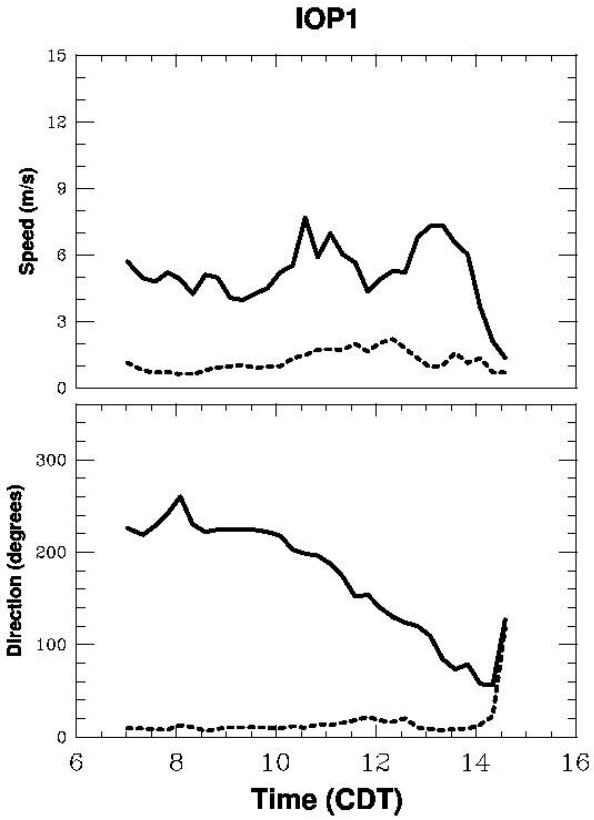

Figure 3. The wind speed and direction during IOP1 are shown. The top panel is the 15-minute mean wind speed (solid) line, and the standard deviation (dashed). The bottom panel are the mean and standard deviation for wind direction

The wind speed varies from about 4 to 8 meters per second, until near the end of the IOP when it became much smaller. The wind direction was southwesterly early in the IOP period, systematically shifted through south to southeast and eventually east and northeast. Standard deviations in the wind speed and direction are

estimates of turbulence intensity. The standard deviation of speed is approximately 1 m/s except from 1100 to 1230, when it is almost 2 m/s. A similar increase is observed in the standard deviation of the wind direction, while the mean wind speed decreases. This seems to indicate an increased transfer of kinetic energy from the mean wind to turbulence. Mixing should increase.

3.2 IOP2

The observations from IOP2 (Figure 4) also indicate that rooftop SF6 levels can be greater

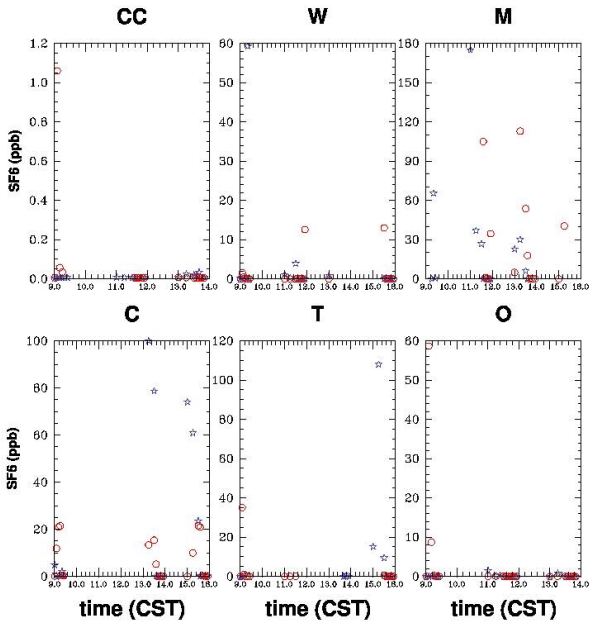

Figure 4. The blue stars are the concentration values at ground level, the red circles are the concentration values at the corresponding rooftop.

than those at the ground. This is particularly evident at the Main Street Parking garage (M), less than 50 meters from the release point. Farther along Main Street, at the Century Plaza Parking garage, the opposite is true; greater quantities of SF6 are consistently observed at ground level. At the Corporate Towers (T), significant quantities are observed at ground level, while very little is observed at rooftop during the 1500 continuous release. The samplers at the Okland building (O) malfunctioned during the last continuous release. However there were observed quantities of SF6 on the rooftop at O during the puff releases.

The wind field for IOP 2 is presented in Figure 5. In contrast to IOP2, the wind direction remained

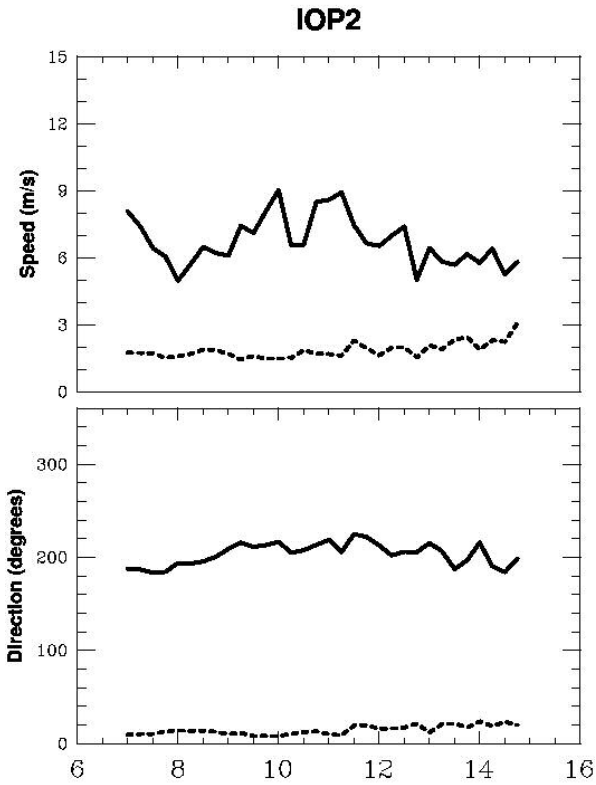

Figure 5. The wind speed and direction during IOP2 are shown. The top panel is the 15-minute mean wind speed (solid) line, and the standard deviation (dashed). The bottom panel are the mean and standard deviation for wind direction

mostly from the SSW, while the mean speed varied from about 5 to 9 m/s. The standard deviation of the wind speed is about 1.5 to 2m/s, possibly indicating higher levels of turbulence than in IOP1.

4 DISCUSSION

Observations of SF6 tracer gas at rooftop and at ground level indicate that rooftop concentrations, even at locations very near the release point, can be greater than ground level concentrations for ground level releases. It is difficult to discern a consistent pattern, reflecting the complexity of circulation in urban areas. Circulation patterns around individual buildings interact with the canyon-scale and urban scale circulation, creating the complexity. Future analysis will include examining the street level sonic anemometers and comparison to modeling results.

5. ACKNOWLEDGMENTS: This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.