J1.2 THE MUST FIELD EXPERIMENT: MEAN AND TURBULENT WIND FIELDS AT THE UPSTREAM EDGE OF A BUILDING ARRAY

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1. Introduction

The Mock Urban Settings Test (MUST) took place at the Dugway Proving Grounds (DPG) in Utah from Sept. 10-27, 2001 (Biltoft, 2001). This building array transport and dispersion experiment included a large number of continuous and puff releases and a high density of concentration and wind measurements (Biltoft et al, 2002). The MUST experiment, sponsored by the Defense Threat Reduction Agency and coordinated by the US Army DPG, was a multi-national collaborative effort. In this paper, preliminary analyses from one night of measurements of the wind and turbulence fields upstream and within the first canyon of a building array are presented.

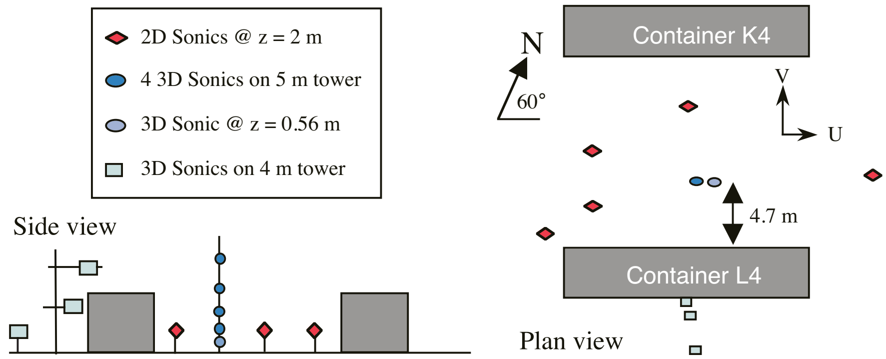

Figure 1. Side and plan views of sonic instrument layout. The "inflow" measurements were obtained about 30 m upstream of the building array.

2. Experimental Description

The building array, a 10 x 12 arrangement of shipping containers laid out on a regular aligned grid, was situated in flat terrain. Each shipping container was 12.2 m wide, 2.42 m deep, and 2.54 m high. They were aligned with the long face perpendicular to the mean climatological nightly wind (150°) coming out of the south-southeast. With 12 m spacing in the longitudinal and 6 m in the lateral, the plan area of the array was 0.13 and the height-to-width ratio was 0.2, the latter indicative of the isolated roughness flow regime.

Twelve sonic anemometers were placed around a single building near the center of the first row of buildings (Fig. 1). One 4m tower with two 3D sonic anemometers and one near-surface 3D sonic were placed close to the "upstream" side of the building. Five 2D sonics were placed in the canyon between the first and second row of buildings. Vertical information within the canyon was obtained from four 3D sonics placed on a 5m tower and a nearby near-surface 3D sonic (Fig. 2). The 2D sonics operated at 1 Hz, while the 3D sonics operated at 20 Hz. An upstream profile was obtained using a tethersonde, three tower-mounted 2D sonic anemometers, and one near-surface 3D sonic.

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3. Measurements

We have performed analyses of data from Sept. 24-25, a night with moderate winds coming out of the southwest to the southeast between 6 pm and 1 am (Fig. 3). Figure 4 shows the normal component of the wind (relative to the building's long side, see Fig. 1) at three downwind locations at nearly the same height. The velocity at the upstream edge of the building at z = 1.5 H is significantly reduced compared to the "upstream" position and tracks closely to the sensor downstream of the building in the first canyon.

Vertical velocity measurements show strong upward motion for much of the night for the 2 sonics at the "upstream" edge of the first building at z = 0.94 H and 1.5 H (Fig. 5). The vertical velocity time series also

Figure 2. Looking north at the 2D and 3D sonics in the first canyon of the MUST building array.

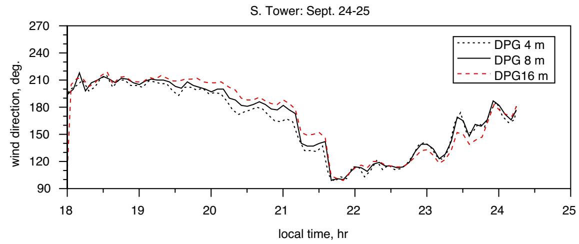

Figure 3. Wind direction time series (5 min. avg.) from the 2D sonics on the "upstream" South Tower. WD measured relative to true north; 150° is normal to the building array.

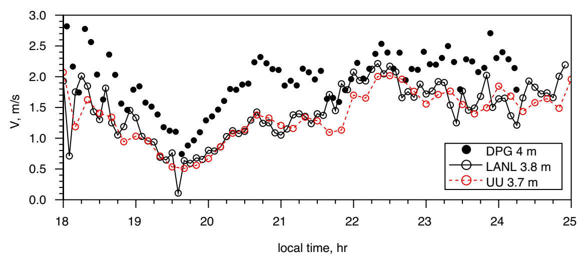

Figure 4. Normal component of wind velocity (relative to building array) at S. Tower (DPG), at upstream edge of first building (LANL), and in first canyon (UU).

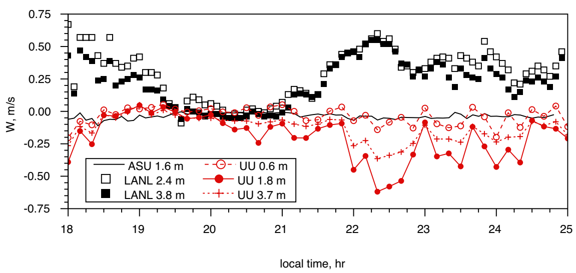

Figure 5. Vertical velocity at far upstream position (ASU), upstream edge of first building (LANL), and in first canyon (UU).

show downward motion for much of the night in the first canyon at z = 0.7 H and 1.46 H, while at the point closest to the ground (z = 0.24 H) there are periods of weak upward and downward motion. It appears that for V less than about 1 m/s, the vertical velocity induced by the buildings dies out.

Figure 6 shows 10 minute average vertical profiles of U, V, W, and σ_w within the first canyon at 1.9H down-wind of the back wall during a period when the winds were between 140° and 180°. One can see evidence of weak reverse flow near the ground with the cross-over (null) point at z/H = 0.4. This is similar to the z/H ≈ 0.5 value deduced from wind tunnel experiments for wide buildings (W=4H) (Snyder and Lawson, 1994). The vertical velocity profiles show downward motion throughout most of the depth of the profile. The cross-array velocity U is not negligible, and actually overwhelms the reverse flow in magnitude near the ground. The standard deviation of vertical velocity fluctuations appears to be fairly constant within the

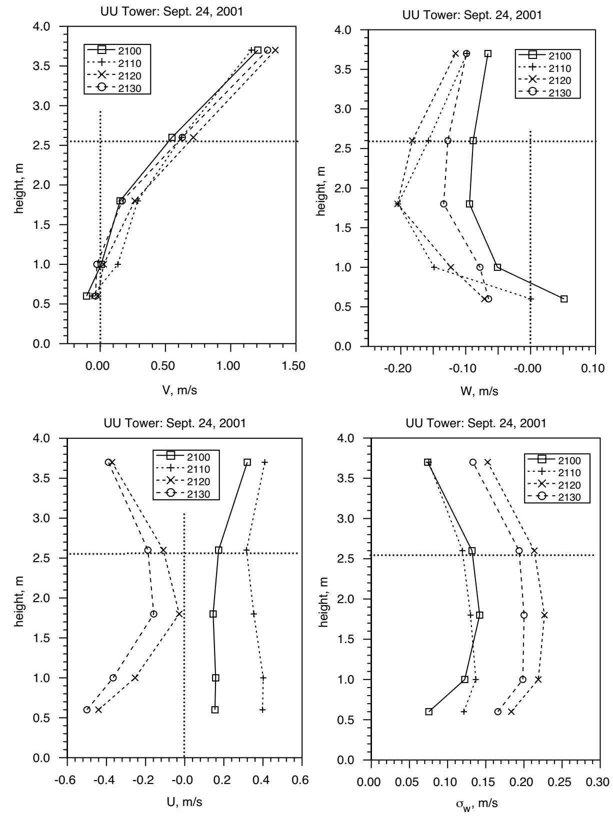

Figure 6. Vertical profiles of U, V, W, and σ_w within the first canyon for a period when the ambient winds were nearly perpendicular to the building array.

upper 2/3 of the canyon, decreasing above the canyon top and near the ground.

These analyses are literally our first look at the MUST velocity data. We intend to investigate this particular night more thoroughly and look at data from other nights. We will bin results by ambient wind direction and also look more closely at turbulence statistics. In addition, we will study nights when the prevailing wind is in the opposite direction, putting our sensors in the wake of the building array.

References

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