Observations of Localized Thunderstorm Outflow in an Urban Area

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1. INTRODUCTION

The Texas Tech University (TTU) Wind Science and Engineering (WISE) group has an established national program for research, modeling, and training related to threats from wind-borne hazards (Doggett et al., 2001). The release of chemical/biological (CB) agents or other toxic materials in an urban area, whether from an industrial accident or terrorist act, represents a real threat to large populations. A central issue for emergency planning, warning, and mitigation purposes is to understand how CB agents are physically transported in the urban boundary layer. As part of this program, mesoscale numerical models (MM5 and RAMS) and field observations will be used to simulate the transport and dispersion of CB agents in the boundary layer at resolutions approaching the urban scale.

A variety of field observation platforms at Texas Tech University will be used to gather data for analyses, model input, and verification. The West Texas Mesonet (Sickler and Doggett, 1998), which is comprised of twenty-eight surface data collection sites with a spatial resolution of approximately 50-km, will be used to provide background observational data. Specially designed mobile and portable surface layer platforms are being used to collect data with higher spatial and temporal resolution.

The objective of the TTU facilities is to provide a telescoping domain of data resolutions, so that winds on the scale of turbulent eddies can be explored in the context of the larger scale weather patterns. Vertical characterization of the boundary layer will be made through a combination of data from meteorological towers, atmospheric profilers, and soundings launched within the project domain.

Ultimately these platforms will be used to establish the horizontal and vertical scales of turbulence, growth of inner boundary layers, and the diurnal evolution of boundary layer winds. They will provide the basis for improving our understanding of the transport of hazardous airborne contaminants, including chemical and biological agents.

As a test of the mobile data collection platforms, an urban scale data collection project was undertaken on 24-25 June 2001. The goal of this project was to determine the scale of features that could be detected with these platforms and to produce a database for the testing of analysis techniques.

2. DATA COLLECTION AND PROCESSING

In order to sample temperature, humidity, and wind characteristics in an urban environment, a variety of the TTU platforms were utilized. Four mobile mesonet (MM) units were deployed in separated, predefined routes in and around the city of Lubbock, TX. The MM systems are rack mounted to standard automobiles. Using GPS technology, wind data can be retrieved so that data can be collected while the vehicle is in motion (Straka et al., 1996). In the current configuration, MM data is collected every three seconds and stored on a laptop in the vehicle so that the data may be viewed in real time. Data from the MM systems is collected at a height of between two to three meters.

To supplement the MM data, two portable three-meter towers were deployed on the periphery of the data collection domain. The two towers provide wind, temperature, dewpoint, and pressure measurements upstream of the urban environment. Three-second data are collected and stored on a Campbell Scientific 23X data logger and retrieved after the project was completed.

Lastly, data from several sites in the West Texas Mesonet were also utilized. Three sites within 25 miles of Lubbock were used to provide the rural ambient conditions both upstream and

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downstream of Lubbock. These sites were located near the towns of Abernathy, Slaton, and Reese Center. The mesonet sites provide wind information at both two and ten meter heights, and temperature, humidity, pressure information at two meters. In addition, solar radiation, precipitation, and soil measurements are also collected. The mesonet data has five-minute temporal resolution.

Data from each platform is quality controlled to remove erroneous data points and biases between the sensors on different platforms. The MM platforms were kept in close proximity for approximately 30 minutes before the start of data collection, to allow for these corrections. Once the processing of the raw data was completed, the data were sub-divided into twenty-minute blocks for analysis.

3. DATA ANALYSIS

For the first three hours of data collection, from approximately 21 UTC 24 June 2001 to 00 UTC 25 June 2001, conditions over Lubbock remained relatively quiescent. Just before 00 UTC 25 June, a strong thunderstorm began to develop directly over the city of Lubbock. The slow-moving thunderstorm produced heavy rains and strong winds before it dissipated.

The storm did not affect the entire urban domain, however, as it moved to the north and west over time. As a result, a well-defined cool outflow pool was left behind that persisted throughout the remainder of the data collection process. The cool pool was most evident in the northern and western portions of the city, while the environment to the east and south of the city quickly returned to ambient conditions.

In addition to the temperature and humidity variations measured across the outflow area, wind variations were also observed. These variations were subtler, and a more thorough examination of these data is needed to insure that the variations are not an artifact of the MM wind retrieval process.

4. CONCLUSIONS

The goal of this data collection project was to evaluate the capabilities of TTU mobile facilities for collecting data in an urban environment. The fortuitous occurrence of a strong but short-lived thunderstorm within part of the data domain facilitated the effort. The use of MM and portable fixed towers provided detailed information about variations in surface conditions across the city of Lubbock.

Further fieldwork needs to be competed to examine how less dramatic variations are observed. A similar project during the winter of 2001-2002 will be performed to investigate urban heat island properties of Lubbock. In addition, atmospheric sounding information also needs to be incorporated so that complete boundary layer properties can be investigated.

5. REFERENCES

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