7.1 THE IMPORTANCE OF MULTISCALE MEASUREMENTS FOR URBAN TEST BEDS

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1. INTRODUCTION

Urban boundary layers (UBL) are composites of intertwined multiple scale interactions between the atmosphere and the underlying surface. From the science view, describing the state of the UBL poses a significant challenge to represent a full spectrum of meteorological forcings and reactions in forms such as: heat islands; street canyon winds and turbulence; urban terrain; and transport and diffusion of hazardous substances. From the user viewpoint, the atmospheric states affect many diverse short- and long-term issues such as: emergency response to varied environmental, chemical, and public threats; public health issues due to episodic and chronic air and water quality hazards; urban flooding; school bus transportation; and wildland fire. Users also view planning and preparation for potential incidents or events as well as post-event consequence assessments as areas of interest. Measurements of the state and processes of the UBL are essential to understanding how the atmosphere connects events with consequences. The transition from science measurements to actionable information products for a particular user in a specific place has many extremely challenging, long-term tasks.

Supported by the Federal Committee for Meteorological Services and supporting Research (FCMSSR), Joint Action Groups [*](JAG) formed by the Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) have developed actionable reports on modeling capabilities for atmospheric dispersion to include, “Research and Development Needs and Priorities for Atmospheric Transport and Diffusion,” referred to in this paper as the JAG/ATD report. Additionally, the OFCM conducted an urban meteorology forum and published the “Proceedings of the Forum on Urban Meteorology: Meeting Weather Needs in the Urban Community.” The ideas and recommendations contained in these reports have been the genesis of the JAG for Joint Urban Test Beds (JAG/JUTB). This JAG is charged with developing a joint agency plan to implement, operate, and sustain test beds addressing the integration of multiple needs and desires of the science and user communities.

2. BACKGROUND

2.1 *Research and Development*

The JAG/ATD report clearly documents an urban scale (20 km to 20 m) gap in top-down operational forecast models and bottom-up research models of the atmospheric boundary layer (Figure 1). This gap encompasses the urban domain and presents a formidable obstacle to describing atmospheric processes at scales directly affecting people, their habits, their health, and the events of their daily lives. This gap further hinders modeling to develop and provide actionable information to the user community. At present, available operational models are far too coarse, and research models take too long to run.

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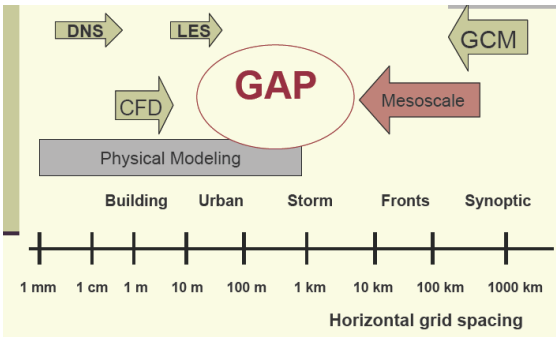

Figure 1. Horizontal grid spacings of modeling approaches.

A measurement gap accompanies the modeling gap at the same scales (Figure 2). This gap limits the ability of users to have current quantitative knowledge of the UBL conditions at time scales of the user interest and inhibits the ability of researchers to quantify the uncertainty of the model predictions and assess the validity of the modeling assumptions inherent to describing UBL states and processes. Of the routinely available observations in the UBL, almost all are at "people level" – below 10 m - which is the least predictable part of the atmosphere. Furthermore, detailed urban research meteorological data are primarily limited to short-term campaigns, focused on intensive periods, thought to "best represent" the experimental goals, usually in benign weather conditions. However, the users of urban atmospheric data must be able respond and operate in fair and foul weather conditions, where data may be scarce, conditions which are not wellrepresented by most present research efforts.

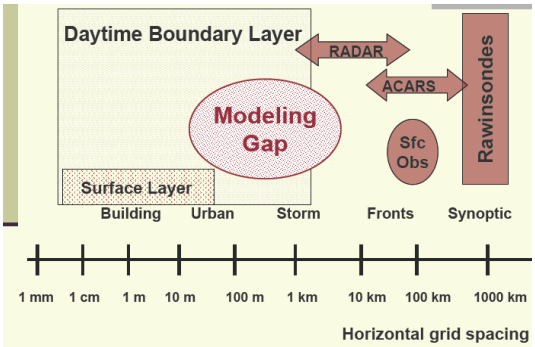

Figure 2. Horizontal grid spacings of routine meteorological measurements.

2.2 *User Communities*

A large and diverse user community of Federal, state, local, and industrial interests exists which has direct and indirect needs for meteorological data in the urban environment. User communities use urban environmental information and forecasts for numerous reasons. Their concerns span times of a few minutes to hours to years – often at a time or place not under their control. Some are focused on consequence assessments and/or emergency response actions. Others are more concerned with making actionable decisions to save lives and protect property. Still others use this information to improve their lifestyles and/or for socioeconomic benefits. The possibilities are numerous and vary based upon region along with associated weather regimes and climate. Frequently, users need actionable information in sporadic intervals, but due to the nature of the need, it is essential that detailed, useful data be available to them on demand, as conditions require.

2.3 User Interests

Events of user interest include those which are episodic and those which are chronic. Episodic events may include the release of hazardous materials, urban fires and smoke, or ice storms. Chronic events may include long-term industrial emissions, and those associated with public health, public safety, and urban planning. Regardless of the event, plans and procedures for response based on real scenarios provide training and readiness for various threats. After an event occurs, forensic inquiry as to event causes and resultant actions taken will require specific information about the atmospheric role in the event and outcome. Prior planning and training with real atmospheric conditions increases effectiveness of response in emergency conditions.

The development and implementation of urban test beds are intended to provide the meteorological backbone, enabling the connection of an incident to its consequences. For a successful Urban Test Bed, the user and research constituencies must come together to create an extensive observational network, apply their respective skills on the resultant data, and integrate

resultant knowledge into effective tools for the user community. It is expected that the user base will grow in size and diversity as successes are realized and communicated to others.

3. URBAN TEST BEDS

Several recent reports (Dabberdt, 2000; Dabberdt, 2003; OFCM 2004; OFCM 2005) have recommended establishing long-term test beds to examine and measure the atmospheric boundary layer to support research, development, and implementation of knowledge to address user needs at small time and space scales. The goal of the JAG/JUTB is to develop an operational concept for multifunctional joint urban test beds to provide services and data to model developers, test and evaluation personnel, and users. The objectives are to define the test bed capabilities required to meet users' needs for measurements, data assimilation and management, modeling and model evaluations, product generation and dissemination, and education, training, and outreach; develop criteria for joint urban test bed selection; define joint urban test bed infrastructure requirements; examine existing infrastructure that could be used; develop an operational concept that includes an implementation framework; describe how test beds can be used for risk management; and recommend next steps for Federal participating agencies.

3.1 *Definition*

An Urban Test Bed (UTB) is a multifunctional infrastructure that provides multiyear continuous measurement and archival of environmental data, across a metropolitan area and through the atmospheric boundary layer, supporting improvements in a range of activities from scientific research to user applications.

3.2 *Scope*

The UTB adopted the Oke description of the scales relevant to the urban climate (Figure 3). Consistent with the definition, the Meso-scale encompasses an area about 40 km radius about an urban core, through the depth of the boundary layer. Characterization of vertical profiles winds, temperature, and moisture, clouds, mixing height, and connections to the larger mesoscale processes and operational modeling are of interest. The Local scale is nested within the Mesoscale in multiple areas ~ 8 km radius and focused on the lower few hundred meters above the largest structures. Measurements of processes – fluxes, turbulence, energy balances – are distributed through these sub areas. The Microscale nests within the Local scale with a focus on the canopy-subcanopy flows, high gradient, and surface roughness characteristics of the near surface through sub-surface.

3.3 *Concepts*

UTBs are intended to serve many interconnected functions. At the Federal level, they will support functional areas of homeland security (such as DHS' Interagency Modeling and Atmospheric Assessment Center), severe weather, urban climate, air quality, and water quality. The UTB infrastructure provides Federal agencies with opportunity to share and leverage resources while developing and testing needs. The local stakeholders – public safety, planning boards, industry, and the general public – will be impacted through improved knowledge and capability, timeliness of warnings and actions, and accessibility to understand consequences, resulting from external actions or processes. However, the local stakeholder and the development personnel must work hand-in-glove to integrate the R&D with specific needs through long-term relationships.

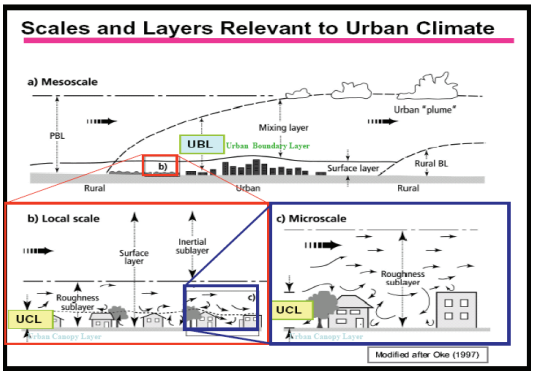

Figure 3. Scales and layers of urban climate.

3.4 *Benefits*

The ultimate, long-term benefit will primarily be to the stakeholders in test bed locals and in urban domains. In general, a UTB should lead to the protection of life, a healthier population, a more robust economy, protection of critical ecosystems, and hazard mitigation through better knowledge of the risks and consequences.

4. CONCLUSIONS

The JAG/JUTB continues its work to put forward a comprehensive concept of operations to the OFCM and its governing committees for their consideration and approval within the calendar year.

5. REFERENCES

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