CONCURRENT SESSION 5 – CHEMICAL AGENT DECONTAMINATION RESEARCH

Model Simulations of Contaminant Dispersion through an Irregular Building Array

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Urban areas create complex wind flow patterns that can affect contaminant dispersion downwind of a harmful release. This can result in challenging situations for local officials or emergency responders who must plan for or remediate infrastructure after major chemical, biological, or radiological (CBR) incidents. Fast-response dispersion models are frequently used to simulate the expected plume propagation following these incidents; however, results may fall short due to simplicity in model formulations, especially within complex environments. Field, laboratory, and computer modeling experiments that simulate these types of releases are critical in advancing characterizations in current dispersion models. This project leverages the configuration of buildings used in a full-scale, mock urban field study (Jack Rabbit II) to examine the concentrations of a neutrally buoyant tracer in a series of meteorological wind tunnel and Embedded Large Eddy Simulation (ELES) experiments. After demonstrating good comparisons between the wind tunnel and ELES via lateral and vertical concentration profiles, we show that the standard Gaussian plume equation, which is fundamental to most dispersion models, represents the profiles well despite the buildings and network of street canyons. The initial plume dispersion, however, depends strongly on the structures immediately adjacent to the release. Further ELES experiments show that slightly oblique incoming wind directions cause additional off-axis channeling of the plume, which demonstrates how building structures can cause considerable plume drift, especially under greater incoming wind obliquity. To represent the class of fast-running, Gaussian dispersion models, AERMOD was run to inform where these types of models may be usefully applied within urban areas or groups of buildings. Using an urban wind speed profile and other parameters that may be locally available after a release, AERMOD was shown to qualitatively represent the ground-level plume (albeit overestimating lateral plume spread) while somewhat underestimating peak concentrations. The addition of a turbulence profile (extracted from the ELES data) into AERMOD's meteorological input improved model estimates of lateral plume spread and centerline concentrations, although peak concentration values remained underestimated in the far field. Observations and suggestions for Gaussian dispersion modeling are then offered based on this mock urban modeling exercise.