Graphics Processing Unit (GPU) Large Eddy Simulation Contaminant Dispersion Modeling System for Urban Environments

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According to the 2010 United States (US) census, over 80% of the population resides in an urban area and surveys conducted and documented by Klepeis et al. (2001) suggest that as much as 86% of the day for an average person in the US is spent inside a structure or vehicle. These statistics highlight the need for air quality modeling capabilities that can resolve the complexities of the urban environment and the air exchanges that occur between indoor and outdoor spaces. Recent advances in atmospheric modeling have demonstrated that it is now possible to resolve the detailed interactions between the atmosphere and the outdoor urban environment (Lundquist et al. 2012 and Tomas et al. 2017) that are necessary for producing short time averaged, "single-realization", dispersion solutions. These single-realization dispersion solutions have been shown to be critical for atmospheric dispersion applications associated with air sampling network designs, pollutant measurement systems performance, and characterizing the impact of hazardous airborne materials on human health (Bieringer et al. 2014). In this presentation we will provide a description of a Large Eddy Simulation (LES) atmospheric model that has an immersed boundary method (IBM) lower boundary condition parameterization and has been coupled with an in-line atmospheric transport and dispersion (AT&D) modeling capability. This modeling capability has been implemented on a Graphics Processing Unit (GPU) computing platform which enables microscale (e.g. ~ 3m spatial resolution) urban air-flow and turbulence simulations to be produced on the order of 150 times faster than comparable simulations on a Central Processing Unit (CPU) based computer. Our presentation will include a description of the GPU-based urban dispersion modeling system, sample urban simulations, a preliminary evaluation of this modeling capability, and a live demonstration of the modeling technology .