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Multi-scale, model-based urban analyses, forecasts and climatologies

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The National Center for Atmospheric Research has developed and operationally implemented, for the Washington, DC area, a nested system of four data-assimilation and forecast models that resolve the mesoscale, the city scale, the neighborhood scale and the building scale weather conditions. On the largest scale, a version of the Penn State University/NCAR mesoscale model, version 5 (MM5) has an outer grid that spans the eastern U.S. Thirty-six-hour forecasts are produced. Within this MM5 grid is a four-dimensional Variational (4DVAR) Doppler Radar Assimilation and nowcasting System (VDRAS) that covers the city and suburbs. This model assimilates the radial-wind data from the U.S. National Weather Service's nearby WSR-88D Doppler radar. Other standard meteorological observations in the area are assimilated to produce analyses and 1-h forecasts of winds and other variables every 10 min on a 100 km x 100 km grid with a 1 km horizontal grid increment. Lateral boundary conditions are obtained from the MM5 model. Within the VDRAS domain is a similar 4DVAR system that has been adapted for use with Doppler lidar data, obtained here from a volume-scanning Coherent Technologies, Inc. *Windtracer*™ lidar, which is permanently installed on the roof of a building in the city. This Variational Lidar Assimilation System's (VLAS) 6 km x 6 km computational grid spans a significant fraction of the downtown area of the Capitol, and has a horizontal grid increment of 100 m. Both analyses of current conditions and 30-min forecasts are produced every 10 min. Within the VLAS area are embedded Computational Fluid Dynamic (CFD) models that have a grid increment of 2-10 m that represent the detailed structure of the airflow around buildings. The ambient flow field for the CFD models is obtained from VLAS. Urban climatologies can also be generated by embedding the CFD model in the MM5 model's data-assimilations system that is run for 20-40 years using archived large-scale anal-

yses for lateral-boundary conditions. This paper will summarize the modeling system and illustrate some of the three-dimensional properties of the urban boundary layer that are rendered by the lidar data and the VLAS data-assimilation system.