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The Influence of Land Surface Heterogeneities on Heavy Convective Rainfall in the Baltimore-Washington Metropolitan Area

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We perform numerical experiments using the Weather Research and Forecasting model to examine the influence of land surface heterogeneities on heavy convective rainfall in the Baltimore-Washington Metropolitan Area. Numerical experiments are carried out for a storm system (1-2 June 2012) in which heavy rainfall and severe weather were organized in the warm sector ahead of a rapidly moving cold front. As shown in previous studies, the environment is typical of flash flood producing storm systems for urban areas of the eastern US. The storm system produced rainfall accumulations exceeding 80 mm and major flash flooding in Baltimore watersheds. The study region is adjacent to the Chesapeake Bay and includes the second largest urban agglomeration in the eastern US. Numerical experiments examine urban impacts on rainfall using the Princeton Urban Canopy Model and the Noah Land Surface Model. We also examine the role of "Bay Breeze" circulations from the Chesapeake Bay for convective evolution. Rainfall distribution and amount are better represented for experiments using the more realistic urban canopy model. The Bay Breeze plays a central role in formation of convergence lines that are major determinants of convective evolution with the approaching line of convection. The Bay Breeze also interacts with heterogeneous surface fluxes from urban landscapes to determine moisture transport to evolving storm systems. The low-level convergence lines and water vapor transport that are induced and modified by land surface heterogeneities are crucial for the preferred locations of strong convective storms and heavy rainfall over the Baltimore Washington metropolitan area.