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Local deep convection in a megacity environment: A high-resolution modeling study with a rapid refresh system

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Due to a special underlying surface condition over Shanghai, a great deal of deep convection is locally developed. Because of its relatively small spatial scale, fast development and complicated movement, it's hard to monitor and predict such event in real-time by using the traditional observational network and forecast system. To forecast this kind of system, a rapid refresh cycling (1-hour) forecasting system was established based on the Weather Research and Forecasting (WRF) model and the ARPS Data Analysis System (ADAS), in which a 3-km grid size and the warm-start initialization technique are used. In this study, making use of high-resolution observations and the rapid refresh system, a deep convection weather event occurred in the afternoon of July 31, 2011 was simulated and the mechanism of initiation and development of this convective event was investigated.
In the morning, due to the urban heat island effects in city, boundary layer jet stream was maintained and weakened gradually, and in the meantime, a large amount of unstable energy was accumulated. By the afternoon, due to strong land-sea breeze near the Yangtze Estuary and Southeast coastal of Shanghai, abundant water vapor was brought into the lower atmosphere over the urban area. The interaction between land-sea breeze and urban heat island effects largely enhanced the boundary layer vertical wind shear, accelerated the accumulation of instability energy and strengthened the updrafts. While the southward intrusion of weaker cold air led to strong westerly wind in the boundary layer of inland, and at the same time, the powerful easterly land-sea breeze occurred, resulting in a meso-scale surface convergence line over the central area of Shanghai, which triggered the unstable energy releasing and deep convection formed. Our study found that a high-resolution and high-frequency rapid refresh cycling system is capable to predict this kind of local deep convective weather event if a proper data assimilation method was used with sufficient observational data.