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Nested High Resolution Modeling of the Impact of Urbanization on Regional Climate in Three Vast Urban Agglomerations in China

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In this paper, the Weather Research and Forecasting (WRF) model coupled to the Urban Canopy Model (UCM) is employed to simulate the impact of urbanization on the regional climate over three vast city agglomerations in China. Based on high resolution land use and land cover data, two scenarios are designed to represent the non-urban and current urban land use distributions. By comparing the results of two nested, high resolution numerical experiments, the spatial and temporal changes on surface air temperature, heat stress index, surface energy budget and precipitation due to urbanization are analyzed and quantified. Urban expansion increases the surface air temperature in urban areas by about 1 [U+2103] and this climatic forcing of urbanization on temperature is more pronounced in summer and nighttime than other seasons and daytime. The heat stress intensity, which reflects the combined effects of temperature and humidity, is enhanced by about 0.5 units in urban areas. The regional incoming solar radiation increases after urban expansion, which may be caused by the reduction of cloud fraction. The increased temperature and roughness of the urban surface lead to enhanced convergence. Meanwhile, the planetary boundary layer is deepened and water vapor is mixed more evenly in the lower atmosphere. The deficit of water vapor leads to less convective available potential energy and more convective inhibition energy. Finally, these combined effects may reduce the rainfall amount over urban area mainly in summer and change the regional precipitation pattern to a certain extent.