Numerical Simulation of Urban Heat Island in Sendai City with Land Use of the Potential Natural Vegetation, 1850s and 2000s

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This study examines the impact of urbanization over the past 150 years in Sendai City for three different land use cases: potential natural vegetation (PNV), 1850s, and 2000s. The Weather Research and Forecasting (WRF) model with 1 km horizontal resolution was used and the following results were obtained. Firstly, results of the control simulation were verified against observations. The WRF model reproduced well the observed temperatures in Sendai City and five additional locations in Miyagi prefecture. The bias is from -0.55 ºC to -1.30 ºC in August and from -0.02 ºC to -1.37 ºC in February. Secondly, impacts of urbanization were evaluated. The effect of urban heat island (UHI) in 1850s was almost not found even the existence of the small urban area of Sendai city. The sensitivity experiment, where the land use was replaced to PNV, was conducted and showed there was a slight temperature difference between 1850s and PNV. Thirdly, the simulated monthly mean temperature was compared between 1850s and 2000s land-use experimental cases. The results indicate that the monthly mean temperature in August (February) in 2000s is 1.4 ºC (1.5 ºC) higher than that in 1850s. Moreover, the considerable nocturnal temperature increase of 2.0 ºC (2.1 ºC) during the past 150 years was found in August (February).

Keywords: Urban heat island, urbanization, potential natural vegetation, land-use change

