Possible impact of urbanization on the surface air temperature in Sendai City in the past 150 years

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1. Introduction

Sendai City, known as the 'city of trees', is one of the greenest Japanese cities. Most other studies focused on cities with less vegetation. However, studies in cities with plenty of vegetation should not be ignored. Moreover, estimating the impact of past urbanization could contribute to better urban planning of Sendai City, particularly because it was damaged by the Great East Japan Earthquake of 2011.

We examine the impact of urbanization on surface air temperature in Sendai City during the past 150 year (1850s and 2000s cases). Moreover, we investigate the individual contributions between anthropogenic heat release and land-use changes.

2 Data and methodology

The numerical simulations were run for months of August from 2000 to 2009 using the WRF model with 27/9/3/1-km resolution domains. The initial and boundary conditions are obtained from the NCEP-FNL data set. We used the 1850s map created by Arizono (1995) and Himiyama (1995) (Fig. 1a) for the 1850s case. In addition, we use the land-use data for the 2000s case (Fig. 1b) which is provided by the Japanese National Land Numerical service.

3. Results and conclusions

The WRF model reasonably well reproduces the diurnal variation of the observed surface air temperatures in the 2000s case in Sendai City and five additional stations in the Miyagi prefecture. The model mean biases range from −0.29 to −1.18 °C in August (10-year average). Moreover,

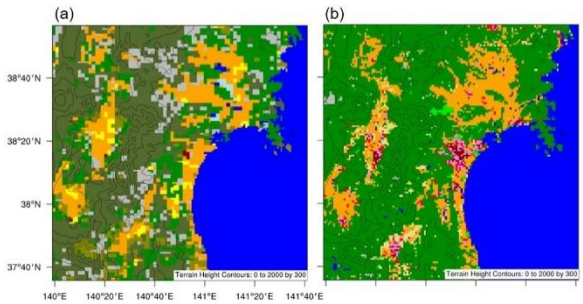

Fig. 1. Land-use around Sendai city for (a) 1850s and (b) 2000s cases. Red color means urban area.

we found that in the 1850s case, the urban heat island is negligible because of very small urban area of Sendai City. Comparing the simulated monthly mean surface air temperatures in the central part of Sendai City between the 1850s and 2000s cases, we found that the monthly mean temperature for August in the 2000s case is 1.30 °C higher than that in the 1850s. Similarly, we found considerable nocturnal (1800–0500 JST) average surface air temperature increases of 2.00 °C in August.

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