

Determining Urban Effects on Precipitation Patterns Utilizing Ensemble Climate Experiment Approach

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1. Introduction

Numerical experiment has been applied for rainfall events in the urban area on the idealized terrain or large plain in USA. In Japan, several numerical experiments have recently reported the positive impacts of urbanization on convective rainfall over the Tokyo metropolitan area (e.g., Moteki et al. 2005, Matheson and Ashie 2008). However, there is a remaining problem at least for the case of Tokyo. This is especially with regards to a place like Japan where the influence of the ocean and mountains easily outweigh the urban effects in controlling precipitation. As a result, a slight alteration of the land use may cause non-linear effects; i.e., Chaos, once the model produces rainfalls. In this case, it is difficult to determine if an increase in the rainfall amount is caused by the land use alteration or just by Chaotic nature. In this study, we discuss whether the standard sensitivity experiment is reliable in determining urban effects on a realistic convective rainfall event, analyzing several cases in the Tokyo Metropolitan area. Additionally, we propose alternative approaches and show the results from our study.

2. Results

Similar to previous studies, we first conduct the standard sensitivity experiment using the Weather Research and Forecasting (WRF) model for a typical rainfall event conducted by Matheson and Ashie (2008). The results show the positive impact of urbanization on the rainfall amount (Figure 1a). It seems that the existence of the urban areas enhances the rainfall intensity and increases the total rainfall amount. However, negative or neutral impacts have also been obtained when the experimental design had been marginally changed by adopting a different initial and boundary conditions (Figure 1b).

Furthermore, the enhancement of rainfall was unrelated to the location of the urban areas, i.e., the precipitation pattern seems to be unorganized. Our results indicated that the standard sensitivity experiment over the urban area surrounded by complex terrain is not reliable in determining the amount of precipitation due to the weak urban forcing and strong Chaos influence in rainfall simulation.

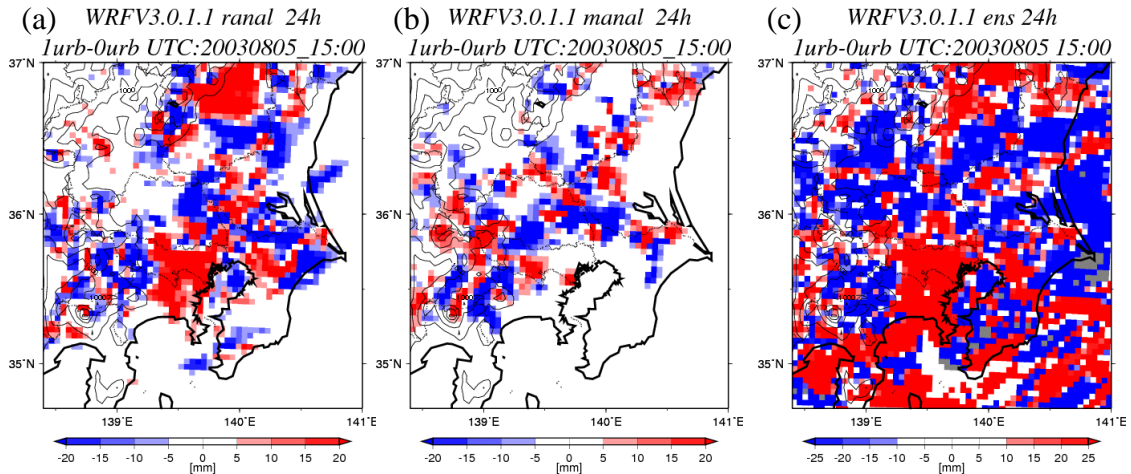


Fig. 1. Urban impact on the 24-hours precipitation on 1500 JST August 5, 2003. Experiments (a) RANAL and (b) MANAL. Red (blue) indicates urban areas increases (decreases) precipitation amount. (c) Percentage of precipitation amount increased by the urban areas. It is from four ensemble members, including Experiments RANAL, MANAL, JRA25, and FNL. Experiment RANAL means the sensitivity experiments using RANAL data set to create initial and boundary conditions.

Second, an approach similar to an ensemble (4 members), climate simulation (9 Augusts for 2001-2009) is attempted to decrease the characteristic of the initial value problem and instead strengthen the characteristic of the boundary value problem. Sensitivity experiments based on this method gives some indication of the possibilities of urban impact on the precipitation (Fig. is omitted). We will show you the results on the workshop.

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