P1.10 AN APPLICATION OF A SIMPLE URBAN CANOPY MODEL FOR MESO-SCALE SIMULATION (SUMM) TO TOKYO METROPOLITAN AREA

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1. Introduction

Air pollution still remains a serious issue at the center of Tokyo Metropolitan Area (TMA). Simulation accuracy of meso-scale meteorological model is important in coupling with air quality models. In this study, a Simple Urban canopy Model for Meso-scale simulation (SUMM) has been incorporated into a meteorological model (Regional Atmospheric Modeling System; RAMS), and the performance of RAMS-SUMM has been examined. GIS-based database of plane area index, frontal area index and mean building height has been established for the SUMM.

2. Method

The meso-scale model RAMS, which was originally developed by Colorado State University, has been used for meteorological simulation as basic software in this study. SUMM, which has been developed by Kanda et al. (2004), is a simple theoretical scheme analyzing radiation and heat balance for infinitely extending orderly array of evenly sized buildings.

Figure 1 shows a schematic view of physical parameters exchanged between RAMS and SUMM. SUMM produces term of energy balance using meteorological factors for the bottom layer of RAMS for meteorological field reproduction. The effects of buildings to meteorological field are taken into account in combination of RAMS and SUMM. This is an essential difference from slab models.

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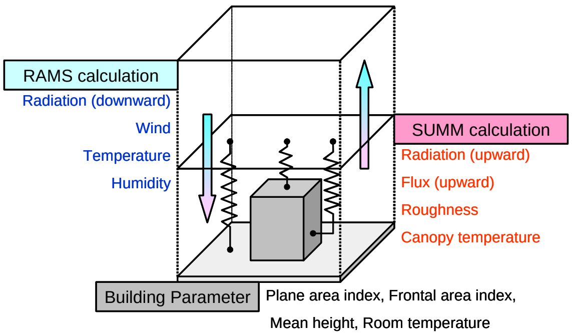

Figure 1 Physical parameters between RAMS and SUMM

For evaluation of the performance of SUMM, control-run with RAMS default setting ("RAMS Default" case) has been performed, and compared with that of RAMS with SUMM ("RAMS+SUMM" case). Although room temperature in "RAMS+SUMM" was assumed to be the same as the outdoor temperature, simulation under fixed room temperature at 20 degree C all day ("RAMS+SUMM_20" case) has also been made. Figure 2 shows the simulation area including TMA with 2km horizontal resolution. Early December 1999 has been set as simulation period, in which typical winter-time high air pollutant concentration episodes were observed.

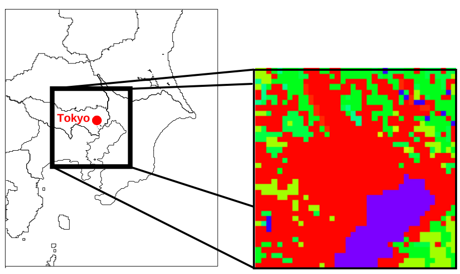

Figure 2 Simulation area of Tokyo Metropolitan Area.

Building parameter database, which is required for SUMM simulation, has been established using individual building information such as size, location, structure and application of buildings with approx. 300 m horizontal resolution at Tokyo metropolitan area. Figure 3 shows plane area index distribution in Tokyo metropolitan area. Plane area index of heavily dense building zone in Tokyo metropolitan area was approx. 0.8.

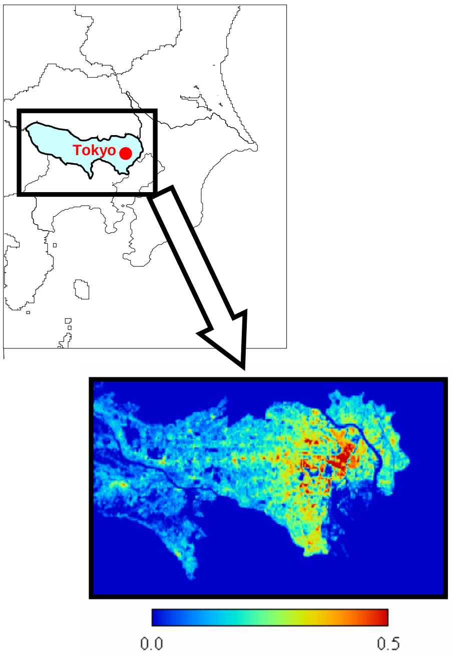

Figure 3 Example of plane area index distribution in Tokyo metropolitan area

3. Results and Discussion

Figure 4 shows time-series comparison of temperature, relative humidity and wind speed between simulation and observation results at the center of Tokyo metropolitan area. The simulated values are corrected by the altitude on which the meteorological measurement instruments were placed.

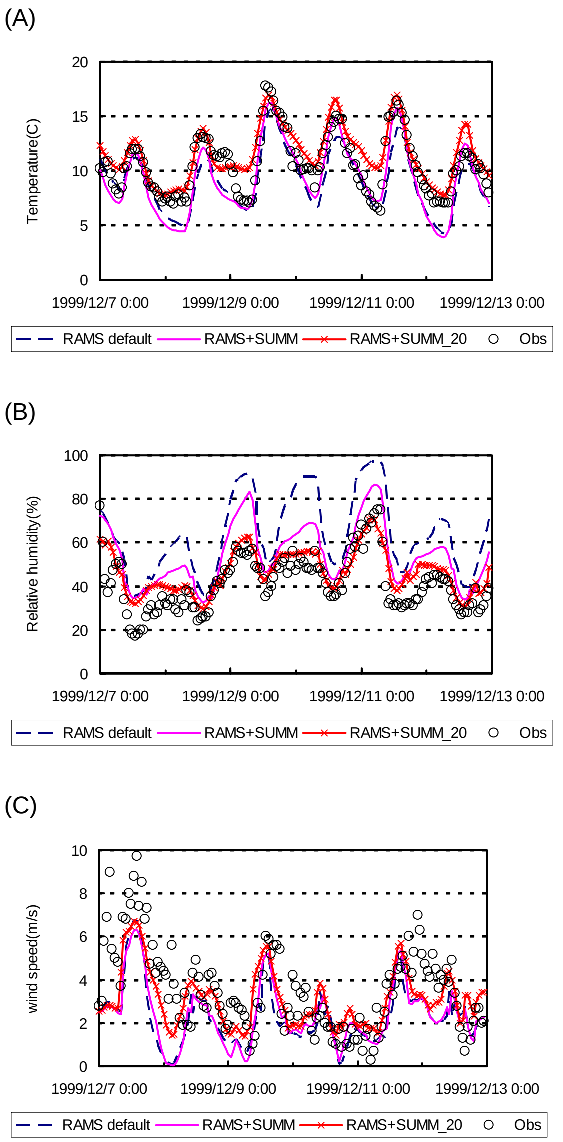

Figure 4 Time-series comparison between observed and simulated meteorological parameters of (A) temperature, (B) relative humidity and (C) wind speed at the center of Tokyo from December 7 to December 13, 1999

During daytime, temperature of RAMS default case was lower than other two cases; both were the cases of RAMS with SUMM incorporated. This phenomenon is caused by the effects of multi reflection of solar radiation and subsequent reduction in albedo within urban canopies, which are taken into account in SUMM. Night-time temperature is considerably sensitive to the room temperature setting and increases only in the case of RAMS+SUMM_20. Obviously this phenomenon results from heat storage specific to urban area, which is generated by temperature difference between inside and outside of the buildings, and indicates that specific setting and diurnal fluctuation of room temperature are required for further improvement in model reproducibility.

Remarkable improvement in time-series fluctuation of relative humidity as shown in Figure 4, is observed, which is resulted from improvement in temperature reproducibility stated above and evaporation efficiency that was determined from field measurement in urban area conducted by Kanda and Moriwaki (2002). Although little difference in simulated wind speed is observed among the three cases, "RAMS+SUMM_20" case shows different wind speed fluctuation tendency especially in night-time. The results suggest that room temperature setting also significantly affect the reproducibility of wind speed.

4. Conclusion

In this study SUMM was incorporated into RAMS and the effects of combination of these models are investigated. Also GIS-based database of building information required to SUMM simulation has been established. Simulation of RAMS with SUMM incorporated provides better results and shows considerably sensitive to the room temperature setting in reproducing meteorological parameters. Specific setting of room temperature is required for further improvement in SUMM-incorporated RAMS simulation.

5. Reference

Kanda, M., T. Kawai and K. Nakagawa, 2004: Simple Theoretical Radiation Scheme for Regular Obstacle Arrays, *Boundary Layer Meteorology (submitted)*

Kanda, M. and R. Moriwaki, 2002: Land surface parameters in a densely built-up residential area in Tokyo, *Fourth Symposium on the Urban Environment, American Meteorological Society.*