P3.3 OBSERVATIONS AND MODELING OF URBAN HEAT ISLANDS IN SHANGHAI, CHINA

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1. INTRODUCTION

As economic development, urbanization and population growth continue in China, the heat island phenomenon (UHI) has often been attributed to causing severe environmental problems in large cities, such as energy shortage, air pollution, and deterioration of living conditions. Particularly, Shanghai Meteorological Bureau noted (1998) "along with the development of the city, 'heat island effect' has become clearer and clearer, and has been the most prominent characteristic of Shanghai". The needs are acute to document and predict UHI in Shanghai, the largest commercial and industrial metropolitan city in China, in order to find effective methods to mitigate the impact of UHI.

UHI is just now beginning to be researched in large cities in developing countries (e.g., Deosthali, 1999; Jauregui, 1997; Klysik and Fortuniak, 1999). All these studies documented the long-term automated observations are needed to better understand and characterize UHI in those cities. In particular, in order to mitigate UHI effects quantitatively, numerical models for predicting UHI are required. However, there are difficulties in establishing and maintaining an adequate network of observations in developing countries because of the great cost. Developing cost-effective automatic observation systems are needed. In the other hands, there are more difficulties in constructing the urban database in those countries such as landuse database, building database and others for numerical simulations, because the details of the urban landscape information have not been provided. Moreover, due to the shortages of the urban database resources, there has not yet been a single case of successful modeling the urban environments in developing countries. Hence, the purpose of this study is to pursue a cost-effective approach to develop observations and modeling of UHI for developing countries, to focus on a case study in Shanghai, China.

In this paper, we first describe a cost-effective approach of monitoring and measuring UHI in Shanghai. Next we illustrate simulations on thermal environment around Shanghai using a mesoscale meteorological model, which has never been explored. Lastly, we make a comparison of the results between observations and simulations.

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2. METHODOLOGY

2.1 Monitoring and Measuring UHI

We established 5 automatic weather stations (DAVIS WEATHER LINK Automatic Observation System, made in USA) in Shanghai City (Fig. 1.), as long-term observation stations. The stations have provided real time weather data in 30-minute intervals from Shanghai. Through collaboration with an university in China, all data have been downloaded once a month and been sent to Keio University in Japan via the Internet. Additionally, we distributed 5 data-logger installations (ESPEC RS-11 thermal recorder, made in Japan) in Shanghai (Fig. 2.). Thermal recorder measures temperature and humidity every 15 minutes. The data have been downloaded once a month.

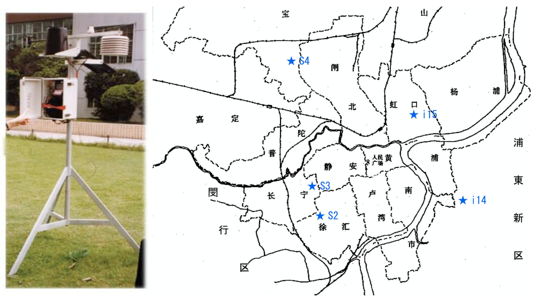

Fig. 1. Location of automatic weather stations

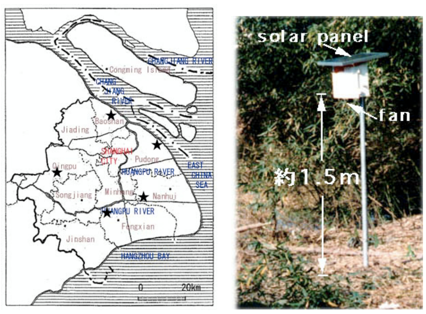

Fig. 2. Location of data-logger installations

2.2 *Numerical Simulations on UHI*

In our studies, the numerical simulation model is based on the Colorado State University Mesoscale Model (CSUMM) (Pielke, 1974) with the modifications of Ulrickson and Mass (1990), Kessler and Douglas (1992), and Uno (1995).

Models for predicting UIH require the requisite degree and detail of the urban landscape information. We identified an integrated approach that utilizes remote sensing (RS) data and statistical data to catalog and calibrate the input for numerical simulations. We have 1) obtained landuse database resource in current use from Landsat TM data, which have been calibrated or collated; 2) modified the modeling parameters through the use of the RS data; and 3) estimated anthropogenic heat emission from energy consumption statistics (Bai *et al.* 2000).

The numerical simulations were performed around Shanghai, covering the 140km × 124km areas divided by 2km grid cells (Fig. 3.).

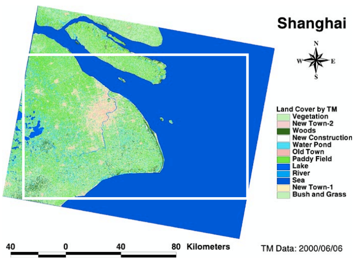

Fig. 3. Utilizing input from Landsat TM data (140km×124km areas divided by 2km grid cells)

3. RESULTS

The results of our observations indicated that UHI effects have become more evident, and the heat island intensity (_T) was higher in fall and winter in Shanghai (Fig. 4.). The mean heat island intensity in Shanghai might reach 4°C at 0:00 in winter days and 1.7°C at 0:00 in summer days in 1999.

Fig. 5. shows the result of simulations at 15:00 in summer. We attempt a comparison between observation temperat - ure and simulation temperature (Fig.6.). Additionally, based on our simulation results, we conclude that vegetation and energy savings are both helpful in mitigating UHI, with the former being more effective.

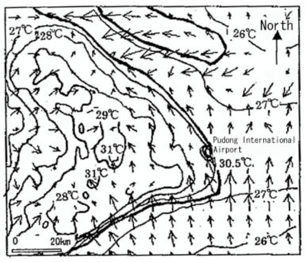

Fig. 5. Distribution of surface temperature and wind at 15:00 in summer

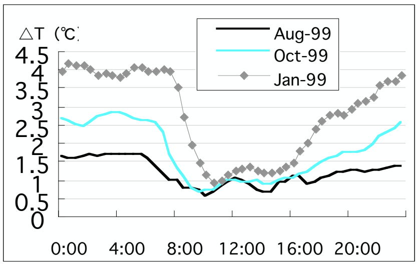

Fig. 4. The heat island intensity in Shanghai (1999)

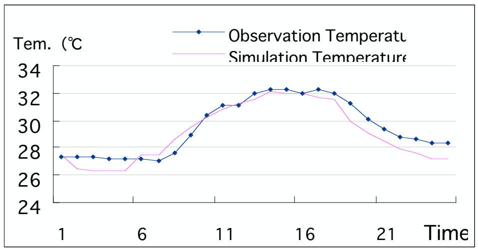

Fig. 6. Temperature comparison between observations and simulations

4. ACKNOWLEDGEMENTS

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