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Understanding of urban thermal environment in Hong Kong by data analysis and modeling

M. Xie (1,2) and Y. G. Li (1)

(1) Department of Mechanical Engineering, The University of Hong Kong, Hong Kong SAR, P R China, (2) School of Atmospheric Sciences, Nanjing University, Nanjing 21009, P R China

Urban Heat Island (UHI), the phenomenon that the air temperature in a metropolitan area is significantly higher than its surrounding rural areas, will affect the local meteorology and air quality in cities, especially the mega cities such as Hong Kong. To understand the forming of UHI and its effects on urban thermal environment in Hong Kong, we investigated the mechanism of the formation of UHI by integrating field observation data and air modeling exercises. Firstly, the observation meteorological data from 1970's till now at two Hong Kong weather sites, HKO and TKL, were analyzed. The results showed that the air temperature in the downtown of Hong Kong can be 2.4 ° warmer than the rural sites. Sometime, the difference can be over 10 °. In the past decade, there were more heat waves (air temperature exceeds 33 °) striking Hong Kong, and the daily minimum temperature in urban areas continuously increasing. This may seem to imply our city will get hotter and hotter. Secondly, with the aid of the meso-scale meteorological model WRF, some heat wave episodes and the contribution of UHI were studied. In the simulation, five nested domains were defined with the resolution of 1 km in the innermost domain, up-to-date and higher resolution landuse data were used, and the urban canopy models incorporated in WRF were adopted. We found that the meso-scale meteorological model WRF is a good assessment tool to study UHI and the urban canopy models can significantly improve the modeling results. Urban morphometry (building characteristics, etc.) and urban thermal parameters (emissivity, albedo, anthropogenic heat, etc.) played an important role in the formation of UHI, and therein they significantly influenced the modeling results: the more realistic landuse data improved the model output of ambient temperature by 1°; the temperature increased over 1 ° when the anthropogenic heat of 300 W/m^{2}was taken into account. Different surface heat budget in the urban and the rural area can explain the formation of UHI. The latent heat fluxes were much smaller at the urban site. The sensible heat fluxes were much larger. And the larger heat storage in the urban ground caused lower temperature in the daytime and higher at night in the city.