Urban Precipitation – How lower boundary conditions affect local characteristics of the flow

Christopher C. Holst *, Francis C. Y. Tam ^, Johnny C. L. Chan**#

Background
Heavy precipitation trends in Hong Kong have been found to behave differently in rural and urban areas (see presentation of Hilda Lam in the Croucher Workshop 2012). This raises an interesting fundamental question: What causes this divergence of the trends?

Methodology
We conducted numerical simulations of a heavy monsoon trough rainstorm on 7 June 2008 in Hong Kong and the PRD, using WRF ARW 3.5.1. By varying the surface anthropogenic heat flux (AH) and the spatial extent of urban area in the region (Figure 1), we simulated different degrees of urbanization and different urban development stages of the region.

Results
AH Impact on Local Precipitation Statistics
We find local intensification (urban grids) with increasing AH (Figure 2) which is intensity-dependent and can be connected to convective activity by comparing to the magnitude of changes buoyancy regimes (Figure 3).

Significance of Spatial Extend
When forcing the model with different boundary conditions (smaller or larger cities) and comparing the local statistics in smaller and larger sampling areas, we find that small cities have very small impacts on the local precipitation. If investigating large cities’ impact, we find that small regions surrounded by large areas of urban development are affected much more (Figure 4).

Remarks
We found in this simple experiment, that local convection and large scale systems interact with one another on local scales, if sufficient heat is released at the surface. Urban planners may consider, that their decisions potentially affect the local weather and their neighbours’ local weather.