

Effects of Urban Land Use Change and Anthropogenic Heat on temperature variation in Summer over Guangzhou-Shenzhen in South China by using WRF-Noah-UCM

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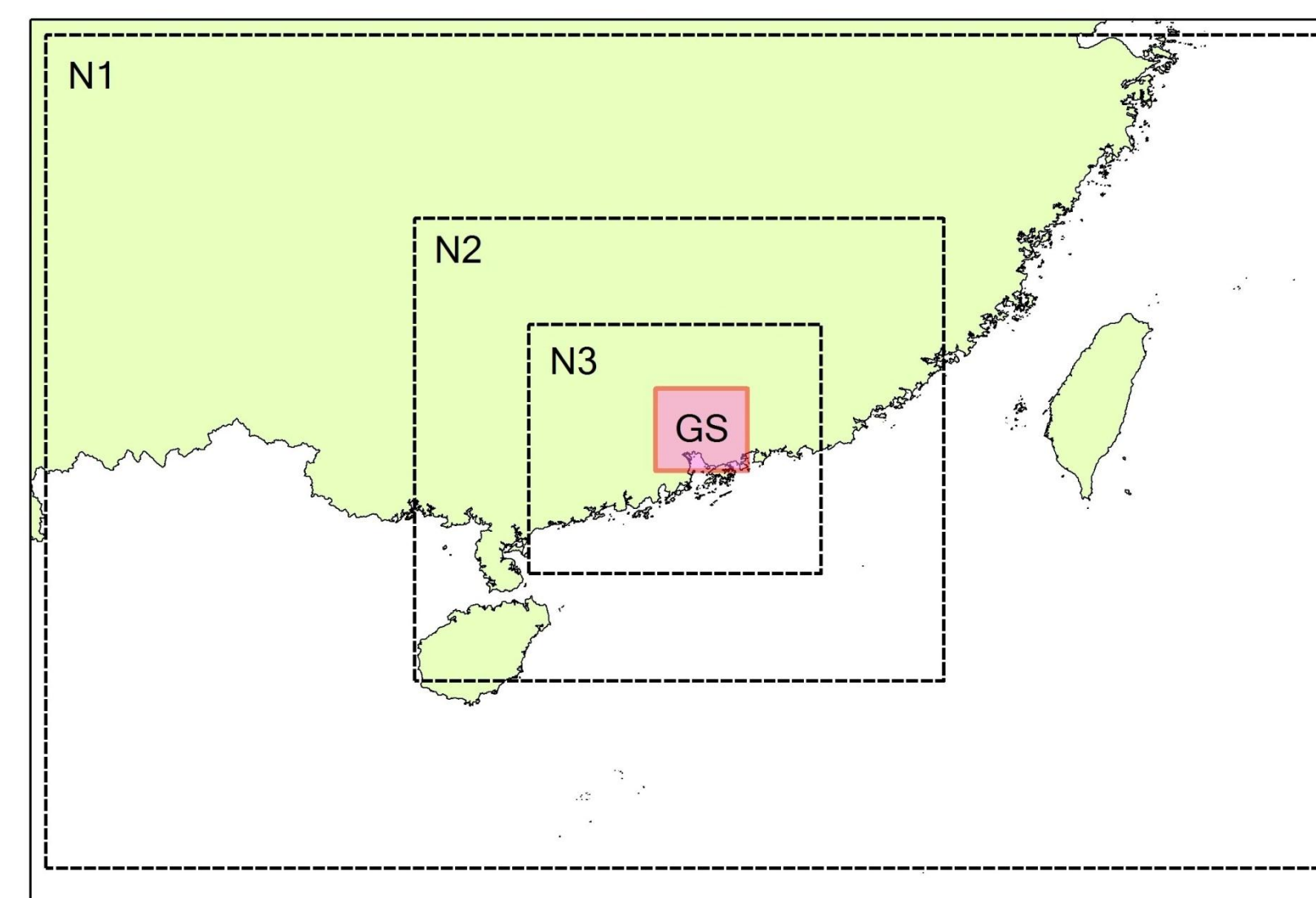
Background

The global urban population, that was 736,796 thousands in 1950 and 3,164,635 thousands in 2005, is projected to reach to 6.4 billions in 2050 (United Nations, 2007). Urbanization development has become one of the major factors that affect the local climate. Statistical Analysis on climate change in South China has revealed great urban influence on temperature increase in the cities of Guangzhou and Shenzhen, especially in recent three decades.

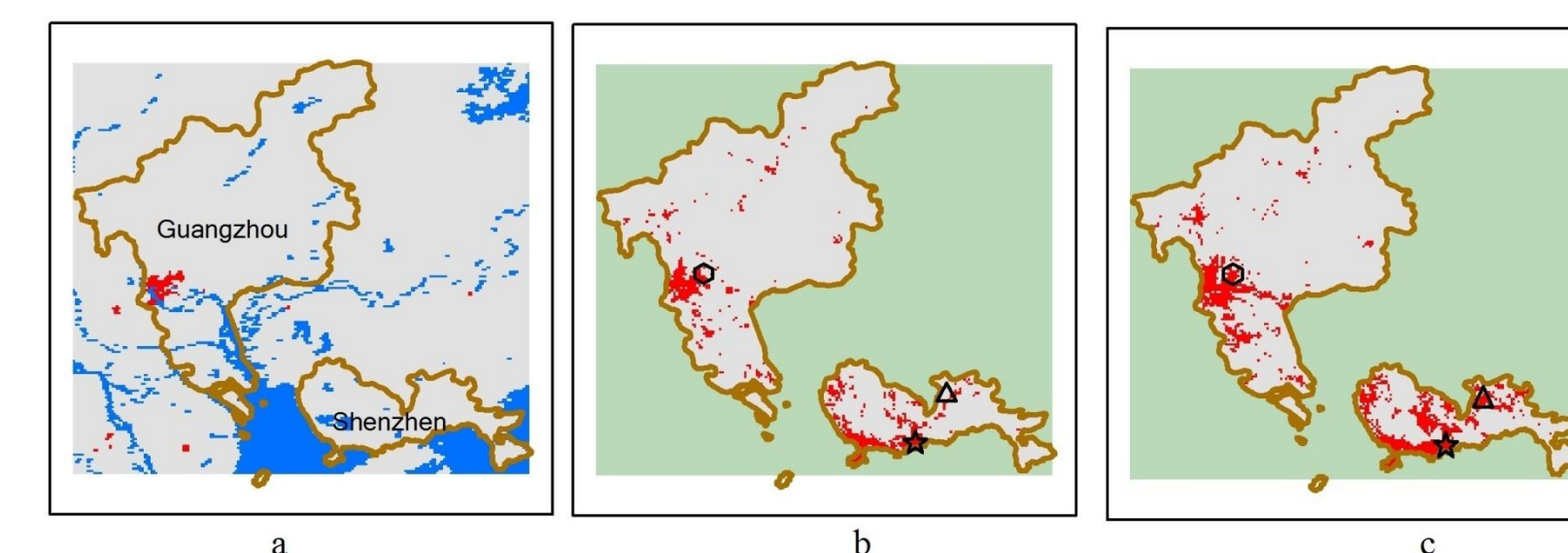
Objective

To quantify the influence of two urbanization factors: urban land expansion and anthropogenic heat (AH) increase, on temperature change in two megacities of Guangzhou and Shenzhen (GS) by using the Weather Research and Forecasting (WRF) model coupled with Noah Land Surface Model and Urban Canopy Model (WRF-Noah-UCM).

Model Setting and Data Source



The resolution of the three nests are: 27Km, 9Km and 3Km respectively



Inside N3, the GS box includes the two megacities

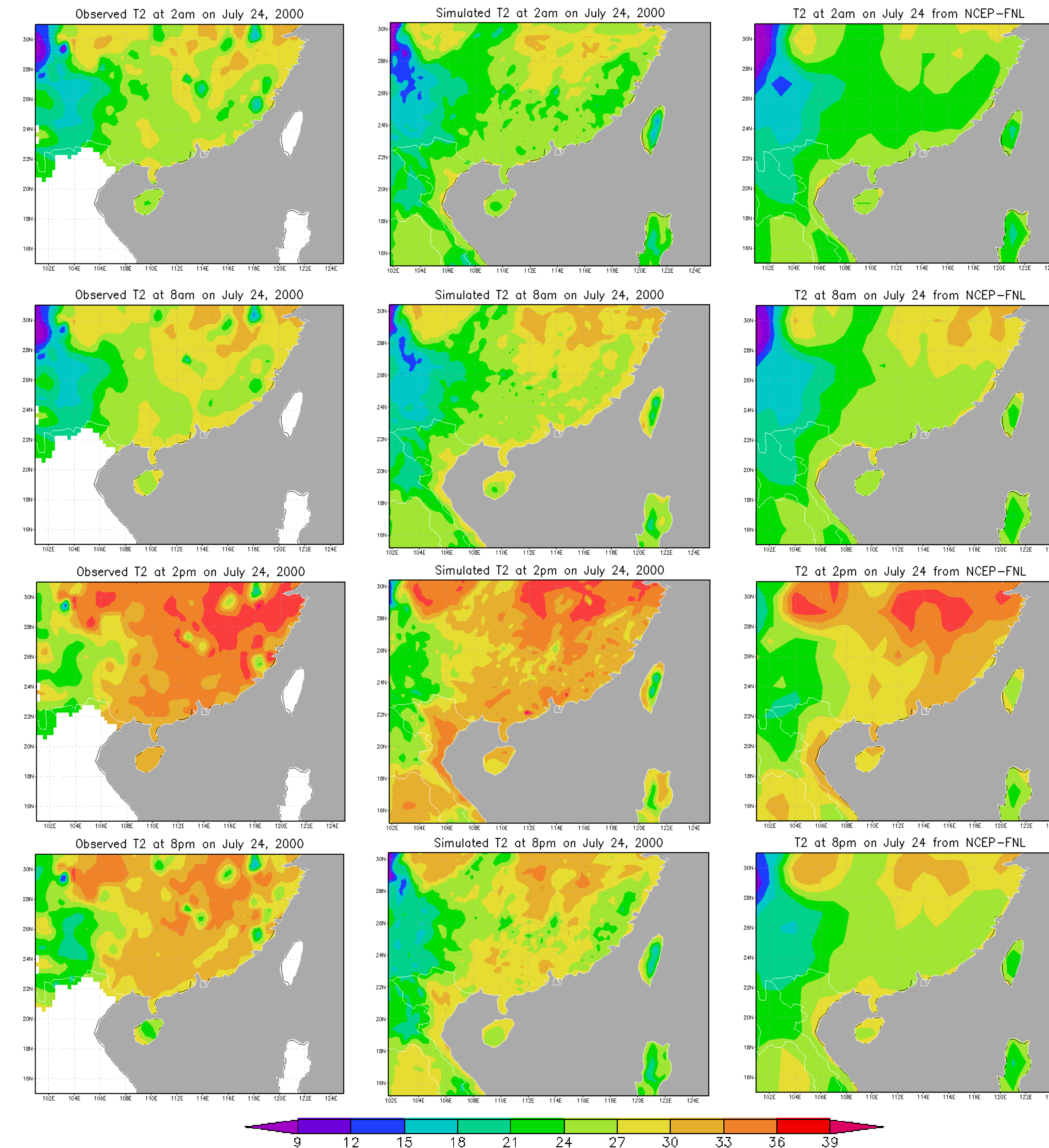
(a) Original land use in GS box in the WRF model provided by USGS with red part showing urban land use; (b) Actual urban land use data of Guangzhou and Shenzhen in 1980; (c) Actual urban land use data of Guangzhou and Shenzhen in 2000. The hollow hexagon point refers to GZ meteorological station; star refers to SZ station and triangular refers to SZLG. The urban land use data for (b) and (c) were obtained from Data Center for Resources and Environmental Sciences, Chinese Academy of Sciences.

The land use types over Guangzhou-Shenzhen administrative region are grouped into three categories

Grid category	Number
uu	73
ru	76
rr	1020

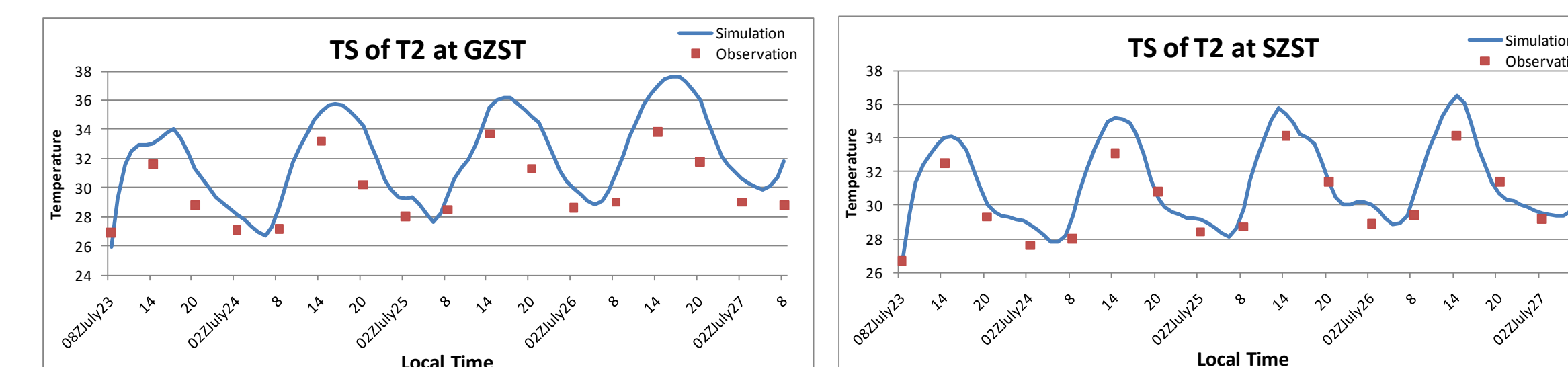
uu refers to land of urban in both 1980 and 2000;
ru refers to land of rural in 1980 and land of urban in 2000;
rr refers to land of rural in both 1980 and 2000.

Model Simulation Assessment



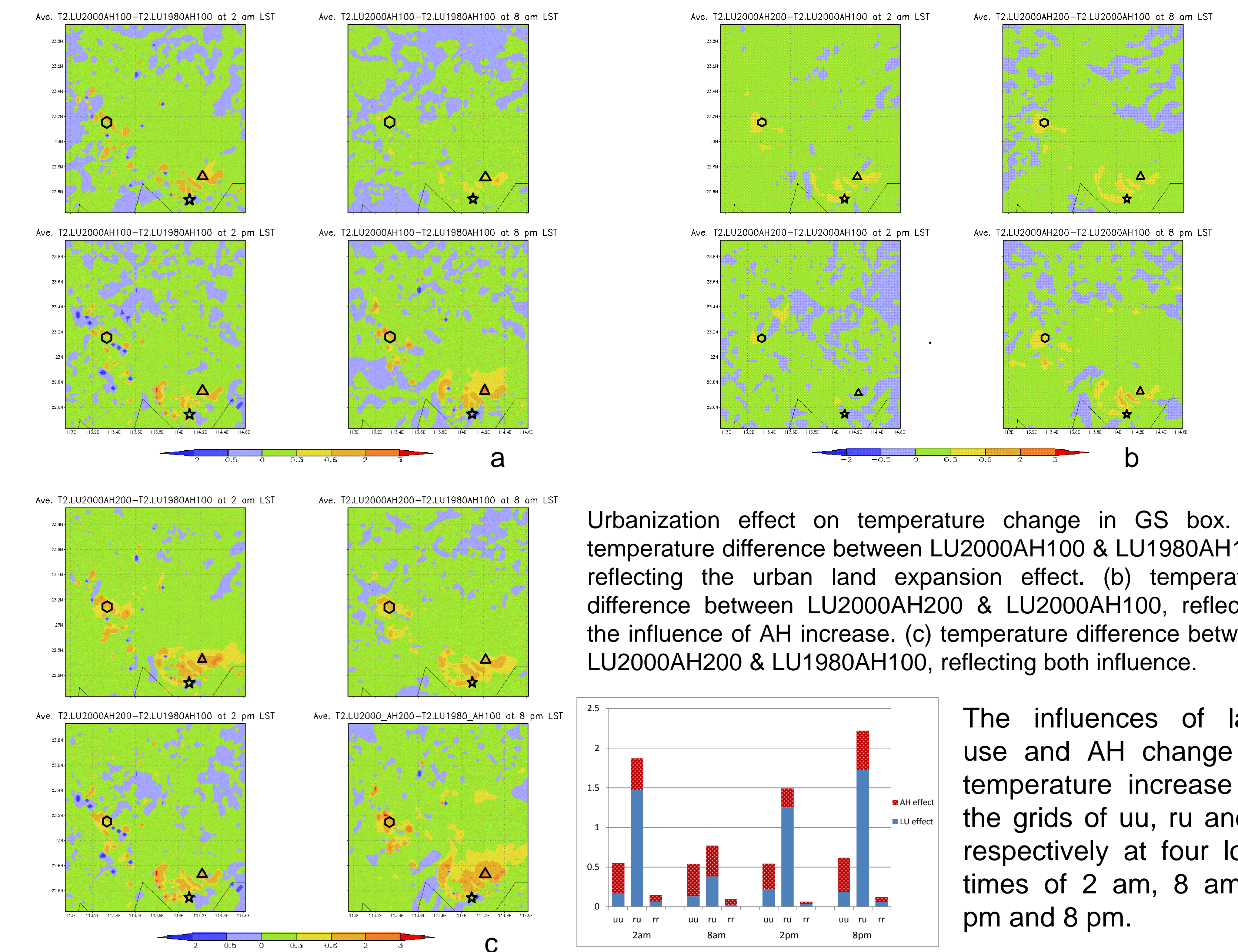
Daily observation at 2am, 8pm 14pm & 20pm → WRF downscaling at the same four local times → NCEP-FNL Data at the same four local times

Spatial comparison of the 2-m air temperatures between observations (left column) and simulations from WRF-Noah-UCM model (middle column) and NCEP-FNL reanalysis data (right column) in South China on July 24, 2000



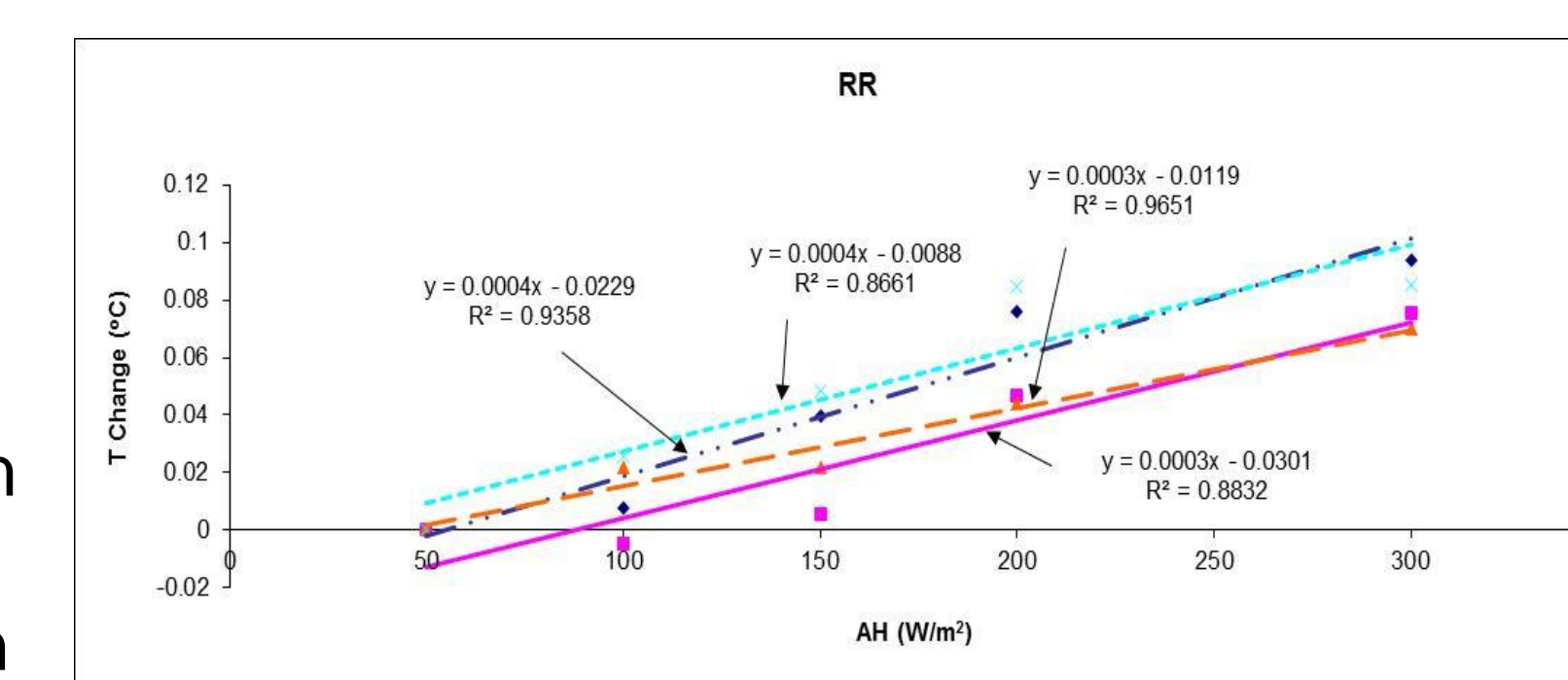
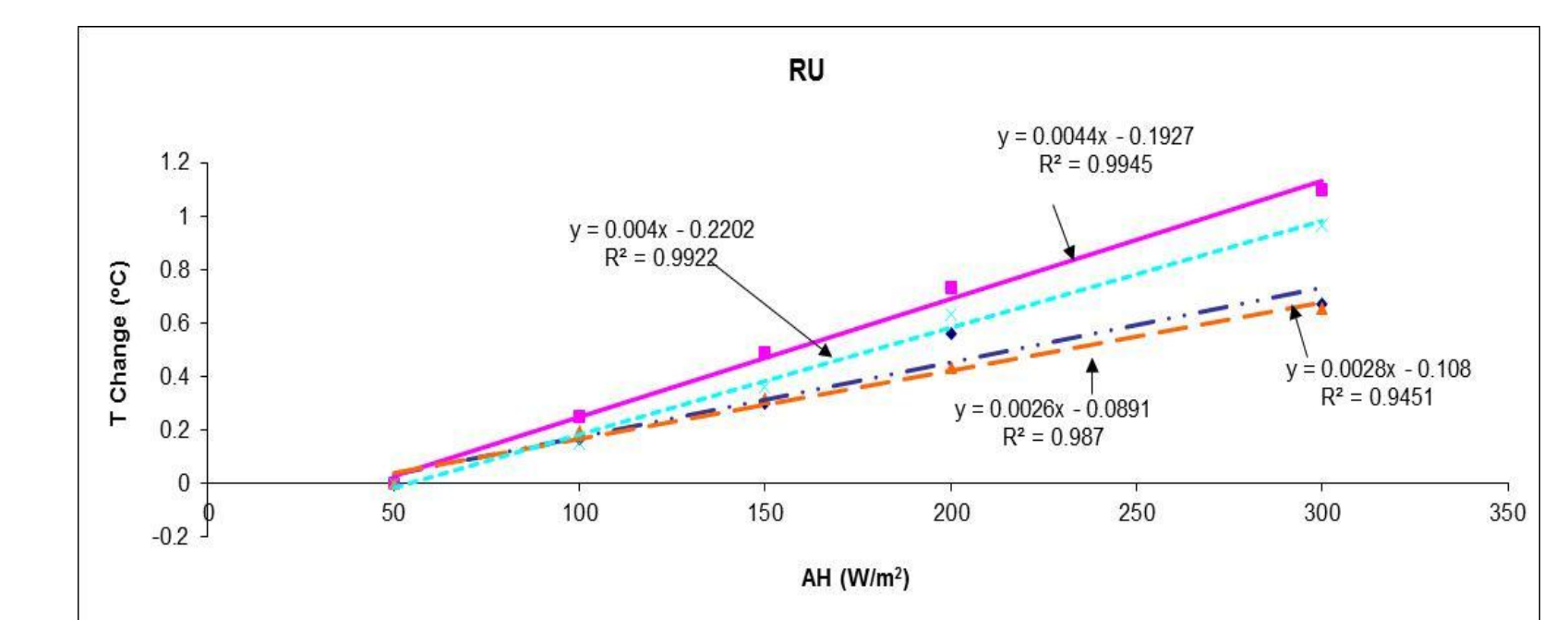
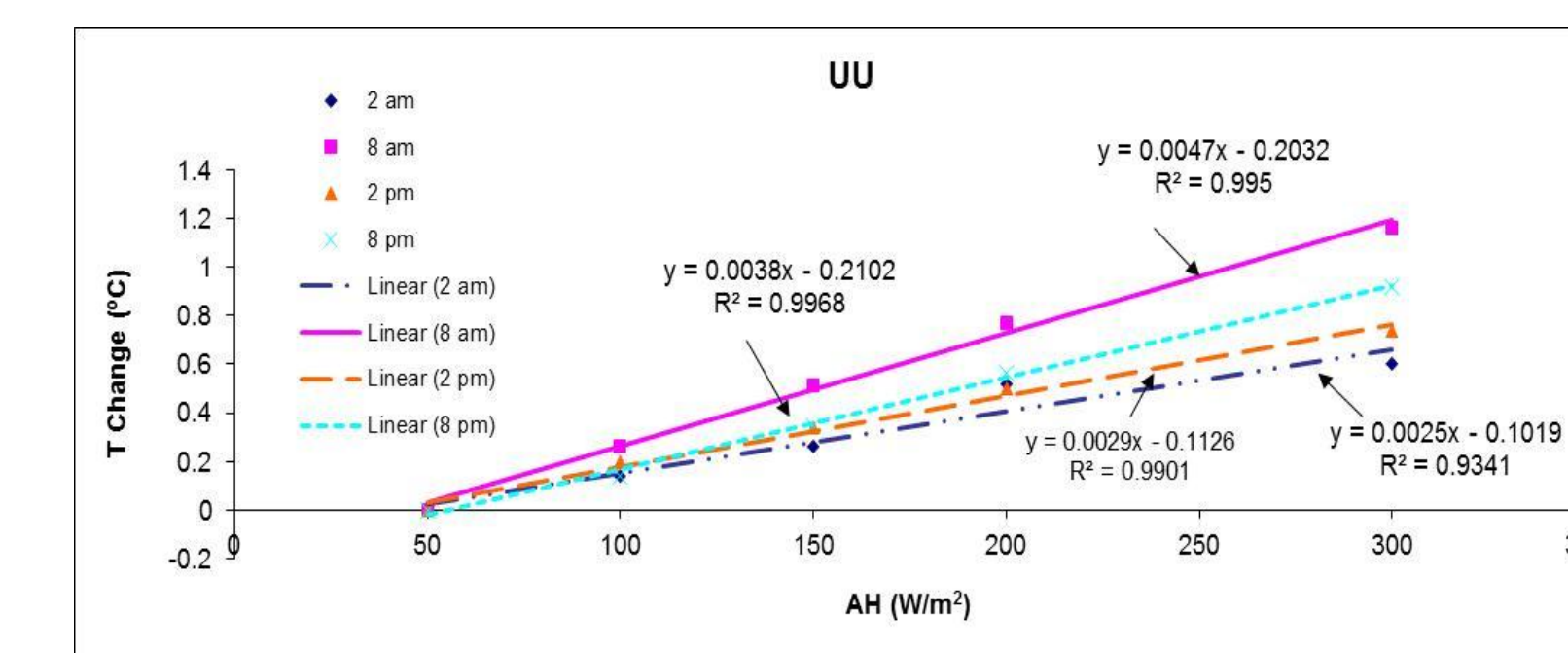
Temporal comparison of the 2-m air temperature between the model simulation and the observation at GZST and SZST from July 23 to 27, 2000.

Urban effect on temperature Change in GS box



Urbanization effect on temperature change in GS box. (a) temperature difference between LU2000AH100 & LU1980AH100, reflecting the urban land expansion effect. (b) temperature difference between LU2000AH200 & LU2000AH100, reflecting the influence of AH increase. (c) temperature difference between LU2000AH200 & LU1980AH100, reflecting both influence.

The influences of land use and AH change on temperature increase for the grids of uu, ru and rr respectively at four local times of 2 am, 8 am, 2 pm and 8 pm.



Linear regression between the average 2m temperature difference from the temperature of base scenario LU2000_AH50 and AH(x) (x refers to different AH value of 50, 100, 150, 200 and 300 Wm⁻²) at 2 am, 8 am, 2 pm and 8 pm respectively for uu grid; ru grid; rr grid.

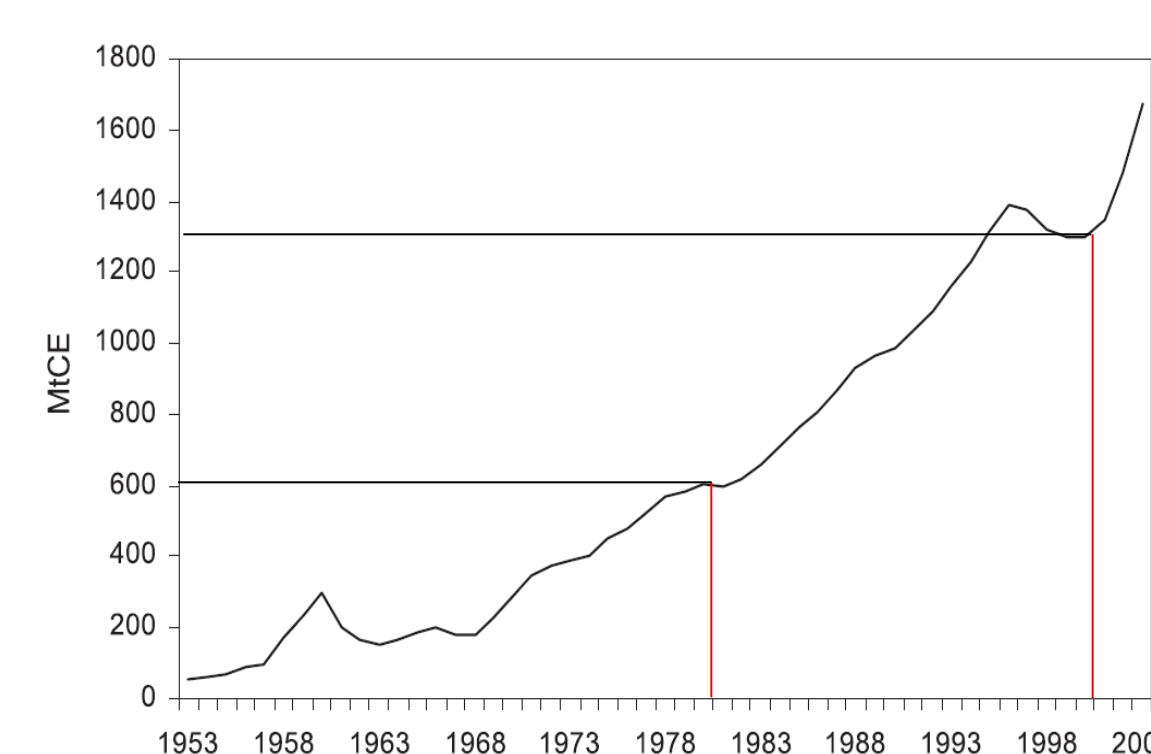
References

Crompton, P., Wu, Y. (2005). Energy consumption in China: past trends and future directions. *Energy Economics*, 27, 195-208.

Acknowledgement

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Total Energy Consumption in China



Energy consumption in 2000 is at least two times of the level in 1980. (Crompton and Wu, 2005)

MICE: Metric Tons Carbon Equivalent

Conclusions

This post presents the result of using WRF-Noah-UCM model to explore the urban effects on temperature change in summer:

- Both the land use change and anthropogenic heat change contribute to the urban warming in Guangzhou-Shenzhen area.
- Inside GS box, for the ru grids, where there is big urban land expansion (e.g. GZST and SZLG), more temperature increase is attributed to the urban land use change than to anthropogenic heat change (72% vs 28%). Among the four diurnal local times of 2 am, 8 am, 2 pm and 8 pm, the influence from urban land use change is the least at 8 am. For the rr and uu grids, where there is no urban land change (e.g. SZST), more temperature increase is attributed to anthropogenic heat change (57% for rr and 69% for uu) than to the urban land use change. Among the four diurnal local times, the influence from AH change is the least at 2 pm.
- The temperature increase in GS box (uu, ru and rr grids) at the four local 2 am, 8 am and 8 pm is positively linear correlated with anthropogenic heat. The influence on temperature at uu and ru grids is most significant at 8 am local time; the temperature would increase about 0.44-0.47 °C in urban area at this time when the anthropogenic heat release increases by 100 Wm⁻².