Assessing Impact of Landscape Characteristics on Urban Hydroclimate

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Introduction

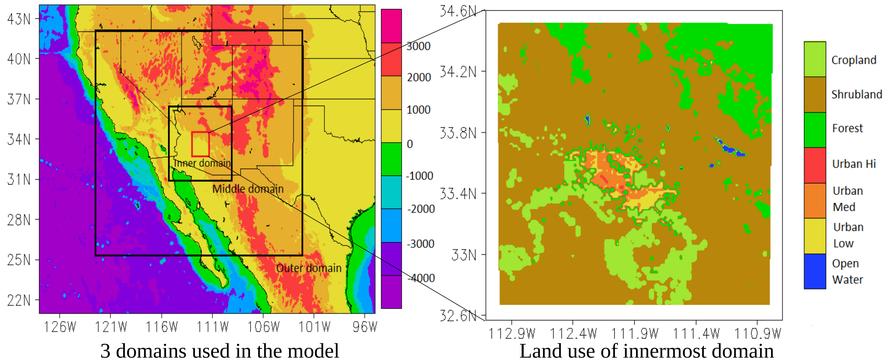
The land use and land cover (LULC) changes due to urbanization play a vital role in local climate change. The replacement of the natural surfaces with manmade structures modifies the surface energy and water budgets of the environment. This is responsible for the urban climate change of places like Phoenix which is one of the fastest growing cities in the U.S. To understand the underlying physics of urban climate modeling, in-depth knowledge is needed on the impact of various urban landscape characteristics on the urban climate.

For realistic representation of urban climate, Weather Research and Forecast (WRF) model with urban energy-water processes developed by Wang and Co-workers, based on the single layer urban canopy model (UCM) is used.

Methods

Application of WRF Simulation incorporating UCM:

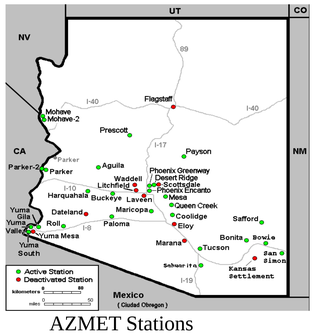
- Domains: 3 nested domains; 32km, 8km and 2km resolution
- Simulation Period: July, 2012
- LULC data: NLCD2006
- Innermost domain: Phoenix Metropolitan City



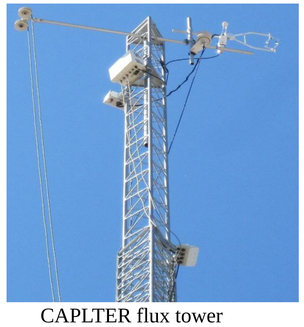
3 domains used in the model

Land use of innermost domain

- Rural sites: Buckeye, Desert Ridge
- Urban sites: Encanto, Greenway, Mesa



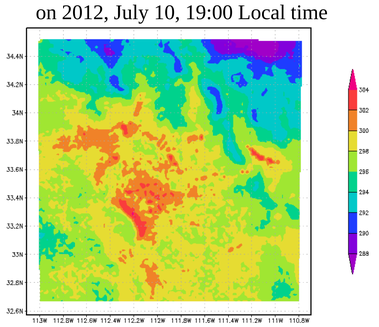
AZMET Stations



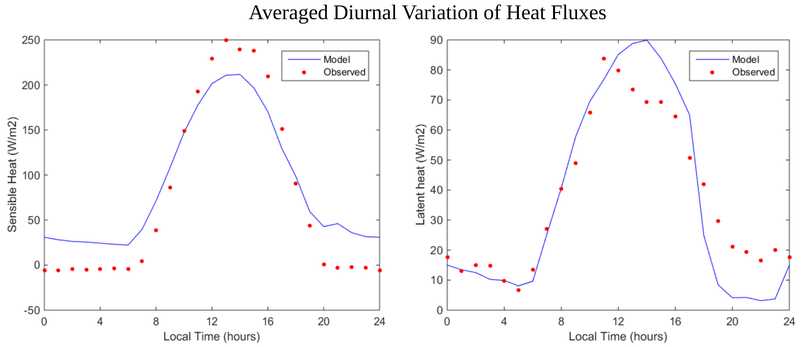
CAPLTER flux tower

Results

Air temperature at 2m for innermost domain on 2012, July 10, 19:00 Local time

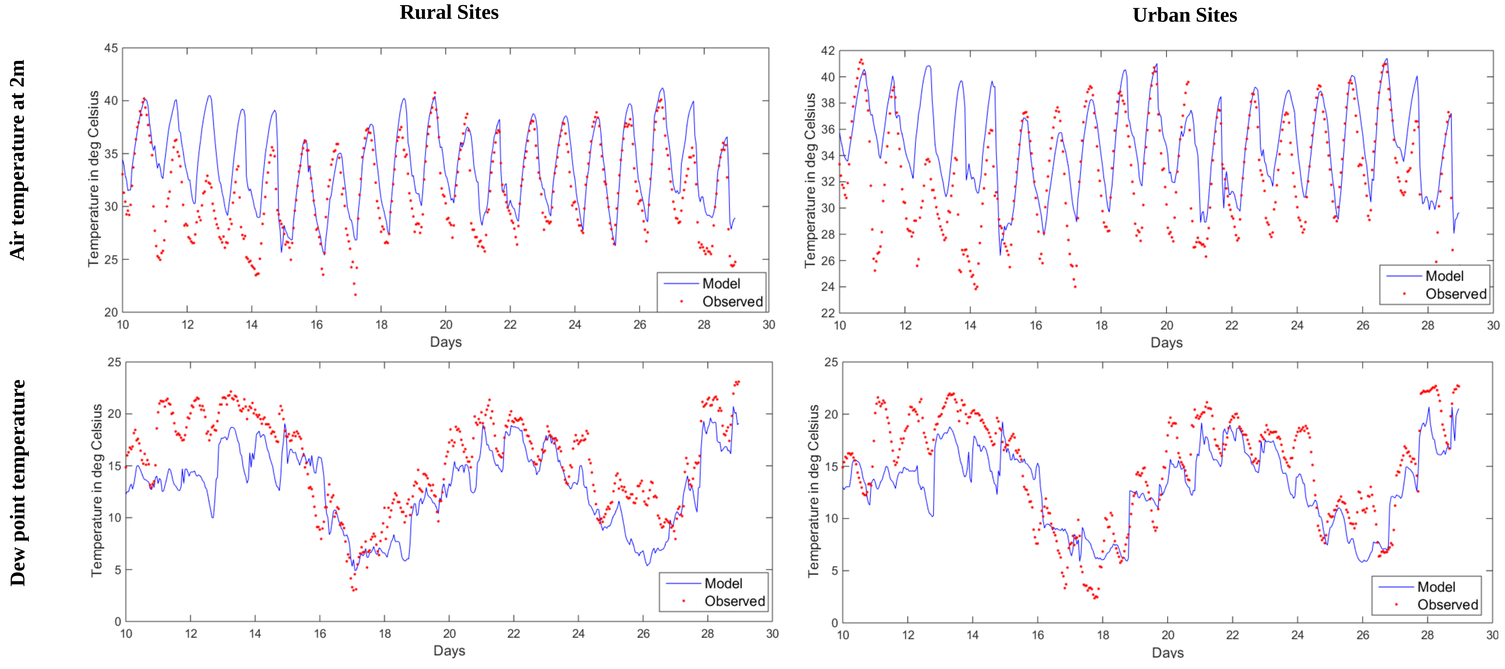


Averaged Diurnal Variation of Heat Fluxes



Calculated RMSE fro Model and Observed data

Parameters	RMSE
Sensible heat H(W/m^2)	60.8
Latent heat LE (W/m^2)	44.1
2-m temperature for rural sites (^{o}C)	3.0
2-m temperature for urban sites (^{o}C)	3.2
2-m dew point temperature for rural sites (^{o}C)	3.8
2-m dew point temperature for urban sites (^{o}C)	3.7



Conclusion

The results from model nearly approximates and follows the trend of observation data. The high differences between the observed data and result from model are the days with precipitation, which WRF hasn't simulated correctly. The comparison of air temperature between urban and rural sites show difference of approximately 1 unit. This comparison is based upon the different land use surrounding sites. Future works will include impacts of urban morphology and anthropogenic heat input in the urban climate.

References

Wang ZH*, Bou-Zeid E and Smith JA (2013) A coupled energy transport and hydrological model for urban canopies with evaluation using a wireless sensor network. *Quarterly Journal of the Royal Meteorological Society*, 139: 1643-1657. doi:10.1002/qj2032.

Yang J., Wang Z., Chen F., et al. (2015). Enhancing Hydrologic Modelling in the Coupled Weather Research and Forecasting–Urban Modelling System. *Boundary layer Meteorology*, 2014.