I. Introduction

Rapid urbanization in the Phoenix Metropolitan Area has transformed this region from a small agricultural center to a major metropolis through the fastest growth rates in the U.S. To mitigate the thermal stress resulting from urbanization in an arid area, green spaces are used extensively to provide cooling capacity through shading and enhanced evapotranspiration (ET). As a result, urban irrigation is extensively applied to maintain vegetated landscaping. Reliable and comprehensive assessment of the efficacy of urban irrigation requires an accurate prediction of ET and land surface temperature (LST). However, prior numerical modeling studies share limitations by using static and tabulated land surface parameters over a complex urban surface that can result in considerable errors in simulating the urban hydroclimate. In this work, we aim to improve the modeling of urban irrigation by integrating multiple remote sensing observations into an existing modeling framework.

II. Methodology

Model Setup:
Variable Infiltration Capacity (VIC) model
Release 5.1.

Remote Sensing Products:
Irrigation Extent
Urban Irrigation:
National Agricultural Imaging Program (1-m), USDA Aerial imagery, Object-based Classification
Cropland Data Layer (30-m), USDA, Landsat TM

Vegetation Phenology
Normalized difference vegetation index (NDVI)
MODIS, NASA

Climate Forcing Datasets:
Historical simulations
Gridded meteorological forcings
Precipitation, temperature and wind speed.

Simulation Period:
Year 2004-2013
1-km spatial resolution, hourly time step

Forcings:
Near-surface daily gridded meteorological data, disaggregated to 1-hr using MetSim model
Surface weather stations (bias-correction)

Observations used to test model performances:
Urban flux observation from eddy covariance tower LST from MODIS (1 km, daily)
LST from GOES (5 km, hourly)

III. Results

Fig. 1. (a) 30 m resolution DEM for the study domain, with the locations of FCDMC, AZMET stations and Urban flux tower for VIC model evaluation. (b) Land cover map of the study area based on NLCD 2011.

Good agreement of both ET and LST between VIC-IRR and observation.
VIC-IRR captures the spatial pattern of LST as compared to MODIS.

VIC-IRR captures the enhanced ET due to anthropogenic water use.

VIC-IRR model captures the enhanced ET due to anthropogenic water use.

Fig. 6 Simulated LST between VIC-IRR and VIC-NOIRR.
Croplands show lower LST than surrounding natural shrublands.
Cooling effect of irrigation has seasonal changes as amount varies.
VIC-IRR captures the cooling effect in both cropland and urban areas.

We found a good agreement of the irrigation water use in VIC-IRR with the annual government records of crop and urban irrigation.

IV. Conclusions

High-resolution remote-sensing observations are useful for capturing the spatial and temporal dynamics of irrigated vegetation.

With time-varying vegetation and irrigation parameters, VIC shows good agreement with LST observations from point to regional scales.
VIC-IRR can be used to investigate future climate and land use change impact on the urban thermal comfort and other applications.

V. Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant no. SES-1462086, DMUU: DCDC III: Transformational Solutions for Urban Water Sustainability Transitions. Summer funding and data from CAP-LTER project are also highly appreciated.