Urban Heat Island Impacts on Air and Water Quality in the Augusta Metropolitan Area

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Introduction

Due of increased heat storage in artificial surfaces, urban heat island (UHI) effects amplify temperatures in urban and built spaces. UHI effects are commonly felt at and near the surface but can influence temperatures in the air above (Barlow, 2014; Johnson and Shepherd, 2018) as well as in nearby streams (Zahn et al. 2021). These effects are commonly studied in larger urban areas (New York, Atlanta, Tokyo), but there is a knowledge gap for smaller and moderately-sized cities, such as Augusta.

Methods

To study Augusta's UHI impacts, we use a selection of observations, remotely-sensed data, as well as numerical models when needed. Surface and near-surface UHIs are studied more observationally, using Landsat satellite-derived temperatures and Automated Surface Observing Station (ASOS) 2-meter temperatures. Boundary layer UHI effects are simulated using the Weather Research & Forecasting (WRF) model, supplemented with radar-derived rainfall and satellite-estimated cloud cover. The hydrological UHI is studied using stream-gauge temperature data and will be further explored through use of SRNL's ALGE3D hydrological model.

Heat stored in Augusta's urban surface impacts **regional weather** as well as the **hydrology** of the Savannah River.

Surface

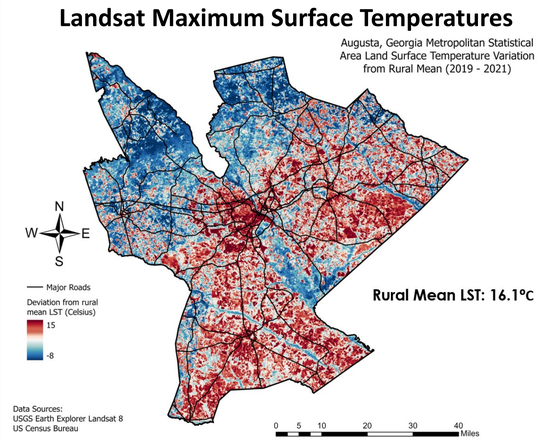
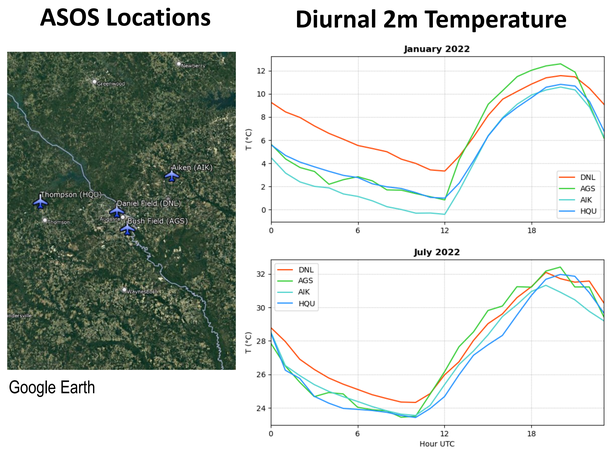
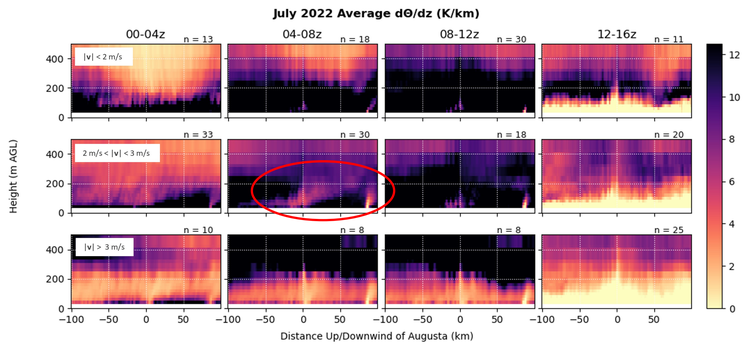


Figure Generated by Max Appelbaum from the University of Georgia

Canopy Layer (near-surface)



Boundary Layer



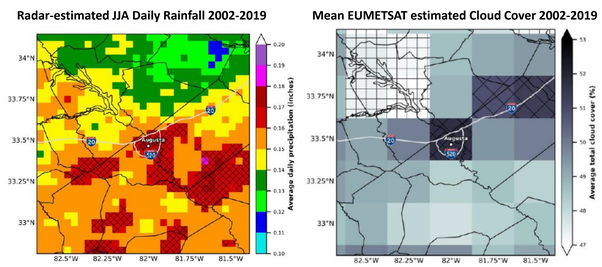
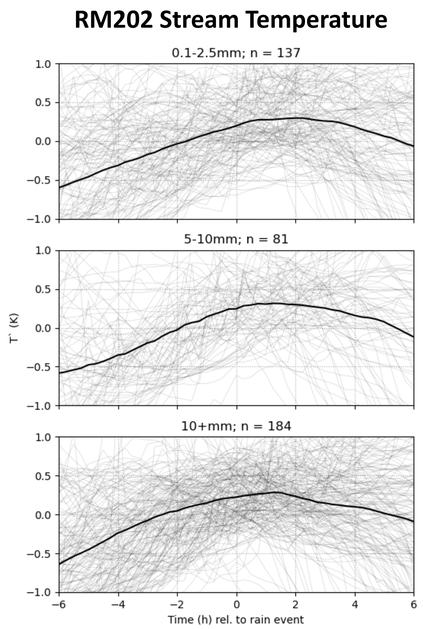
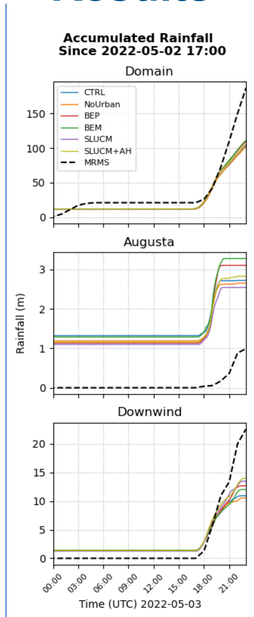


Figure Generated by Jordan McLeod from the University of South Alabama

Hydrologic

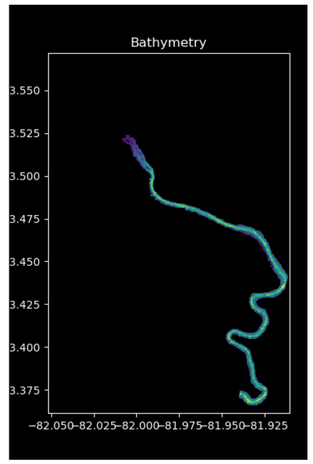


Results



In addition to discovering the different UHI effects that Augusta has on its environment, we found insights into how current models simulate rainfall events. In a case study for a rainfall event on May 3, 2022, we found that WRF model simulations initialized with different urban parameterizations (or lack thereof) will generate different rainfall estimates.

Through this LDRD, we have implemented the bathymetry of the Central Savannah River into SRNL's ALGE3D hydrological model, preparing it for more local operational applications.



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References

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Johnson, B.; Shepherd, J. M., An urban-based climatology of winter precipitation in the northeast United States. Urban Climate **2018**, 24, 205-220.

Zahn, E.; Welty, C.; Smith, J. A.; Kemp, S. J.; Baeck, M. L.; Bou-Zeid, E., The Hydrological Urban Heat Island: Determinants of Acute and Chronic Heat Stress in Urban Streams. Journal of the American Water Resources Association **2021**, 57 (6), 941-955.