American Meteorological Society Annual Meeting
February 1st 2024, Baltimore, MD

THE COMMUNITY RESEARCH ON CLIMATE AND URBAN SCIENCE (CROCUS) PROJECT

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Director of the Argonne Testbed for Multiscale Observational Science,
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Lead CROCUS Measurement Strategy Team
Argonne National Laboratory
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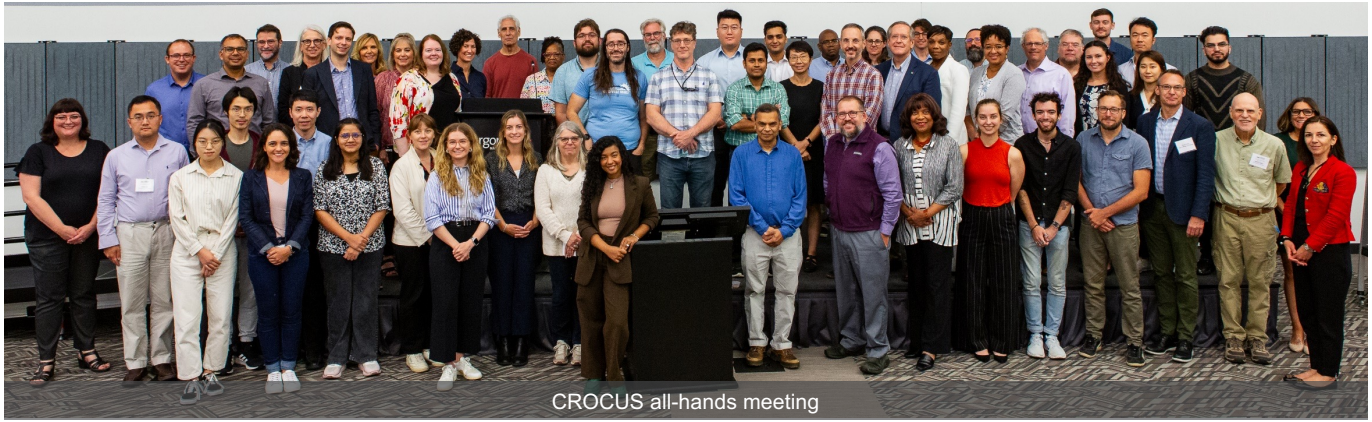
CROCUS
Community Research on
Climate & Urban Science

CROCUS: Pioneering community-driven science and climate learning in the Chicago area



CROCUS all-hands meeting

Argonne NATIONAL LABORATORY
BIG blacks in green
CHICAGO STATE UNIVERSITY
Ciemat
CITY COLLEGES of CHICAGO
GREATER Chatham INITIATIVE
Metropolitan Mayors Caucus
NORTH CAROLINA AGRICULTURAL AND TECHNICAL STATE UNIVERSITY
Northeastern ILLINOIS UNIVERSITY
Northwestern University
THE PUERTO RICAN Agenda
THE UNIVERSITY OF CHICAGO
UIC UNIVERSITY OF ILLINOIS CHICAGO
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN
UNIVERSITY OF NOTRE DAME
TEXAS The University of Texas at Austin
Washington University in St. Louis
WISCONSIN UNIVERSITY OF WISCONSIN–MADISON

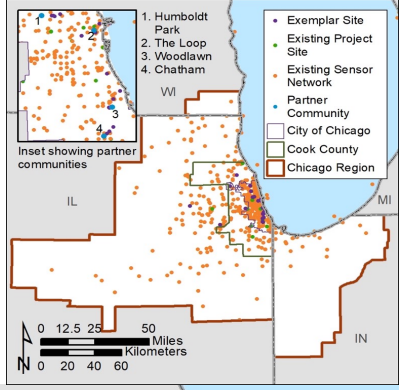
MOTIVATION AND CONTEXT

CROCUS
Community Research on Climate & Urban Science

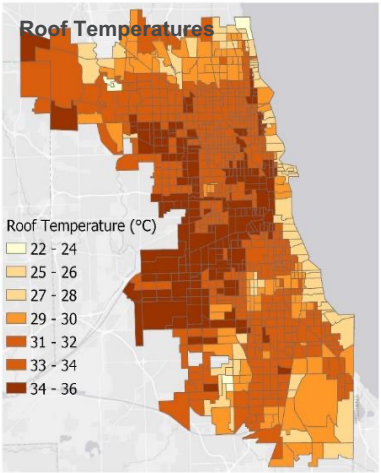
Urban climate science needs an integrated approach to evaluate physical and social drivers and community impacts of climate change

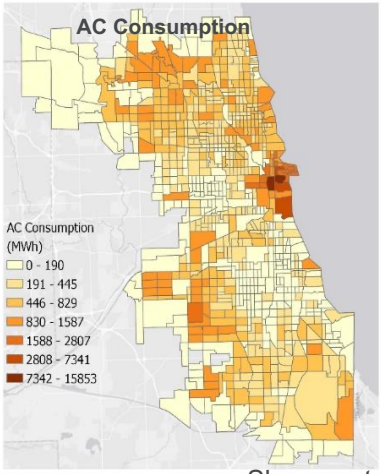
Chicago is 8th in income inequality among the Nation's largest cities.

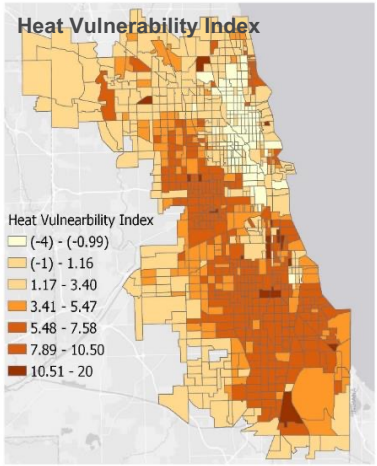
Today's inequalities in the region have old roots. These have pushed underrepresented communities into the most physically challenging areas with lower quality infrastructure.



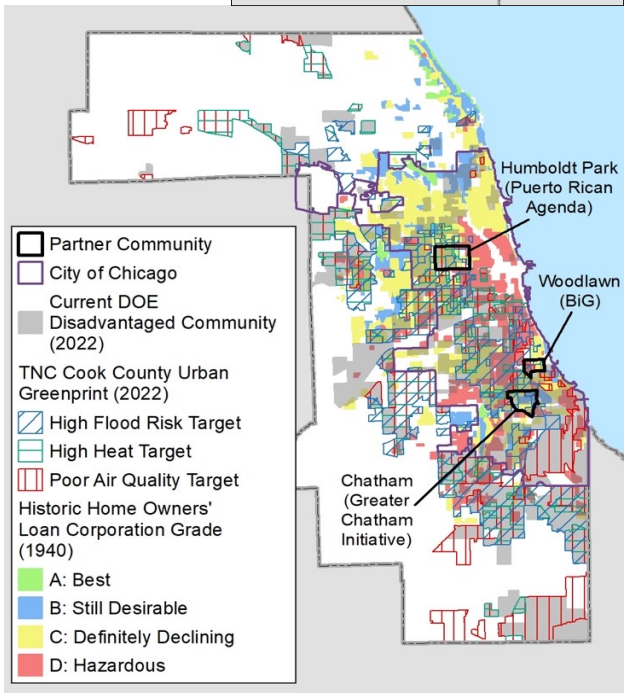
Flooding Heat Housing Marginalization Health Stress
Food security Extremes Tornadoes Gentrification Jobs
Green spaces Deterioration Variability



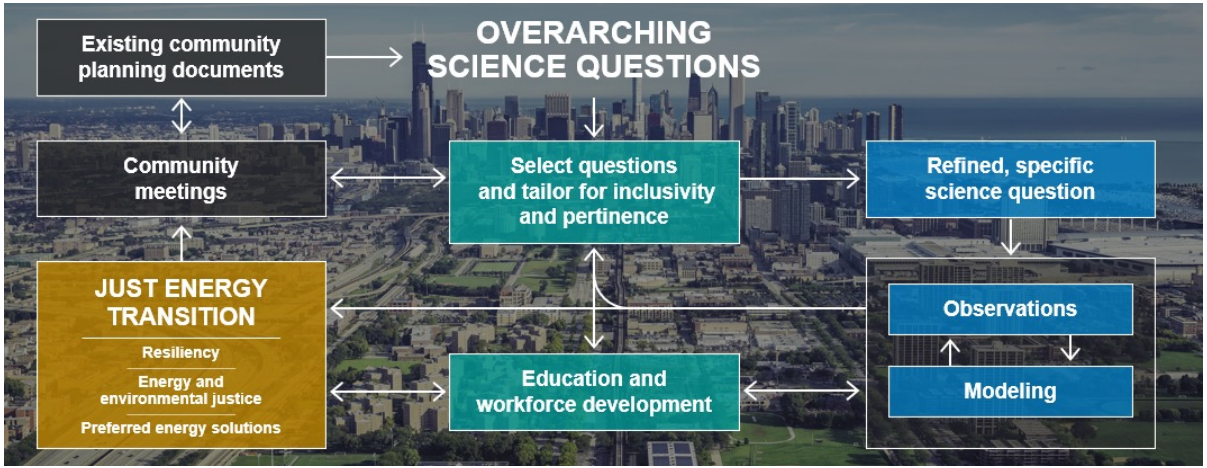




Sharma *et al.* (2018) *Env. Res. Lett.*



SCIENTIFIC AND COMMUNITY VISION COMING TOGETHER



SCIENCE GOALS

Understand the natural and human drivers and effects of environmental change in an urban area

URBAN DIGITAL TWIN FOR CLIMATE SERVICES

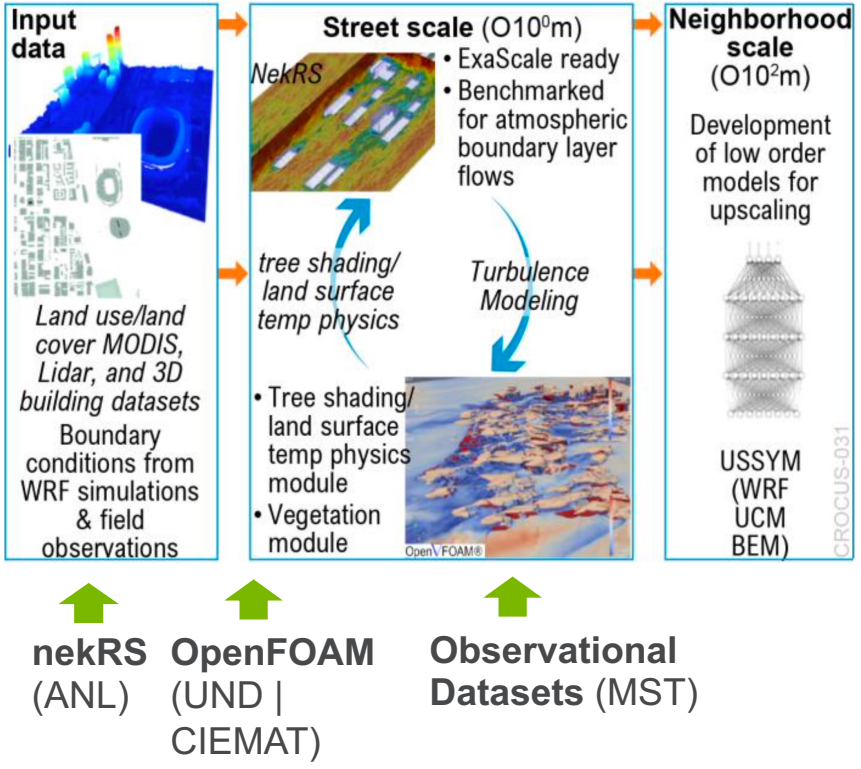
Scientifically advanced tools for decision making and stakeholder capacity building

SOCIETAL BENEFITS

Sustainable, resilient, and equitable solutions, with special attention to underserved communities

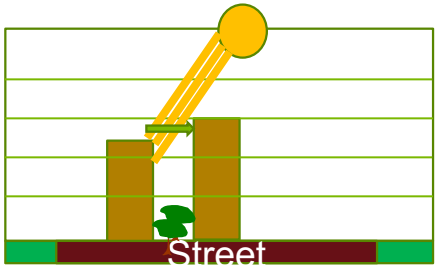
CROCUS MODELING PARADIGM

- Understating how the complex urban environment can interact with a changing climate requires a multi-scale modeling approach.
- This is part of the MODEX cycle.
- CROCUS deploys climate to regional to very high resolution models like nekRS (LES and RANS).
- CROCUS is leveraging AI for both observations and training of emulators for speed.



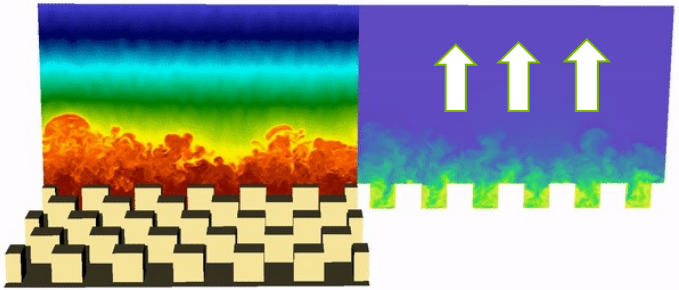
STREET-SCALE MODELING

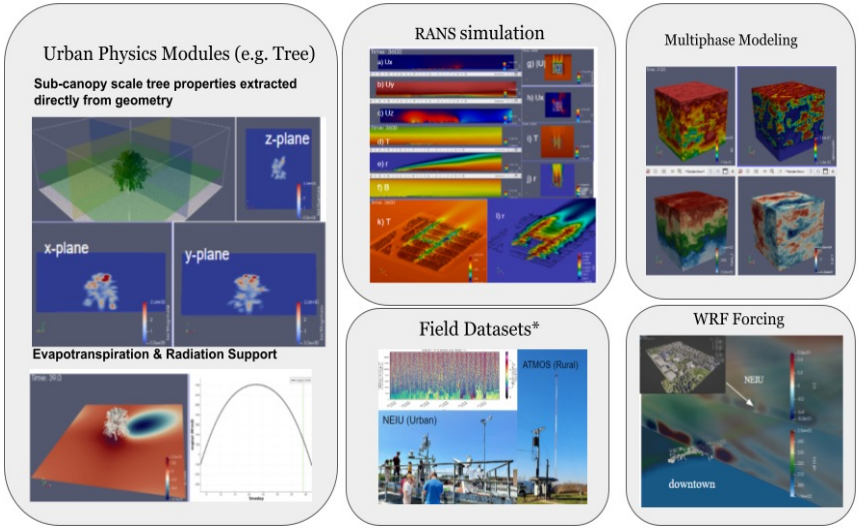
Micro-scale modeling to enhance the Building Effect Parameterization (BEP) schemes currently used in mesoscale models like WRF by incorporating these findings

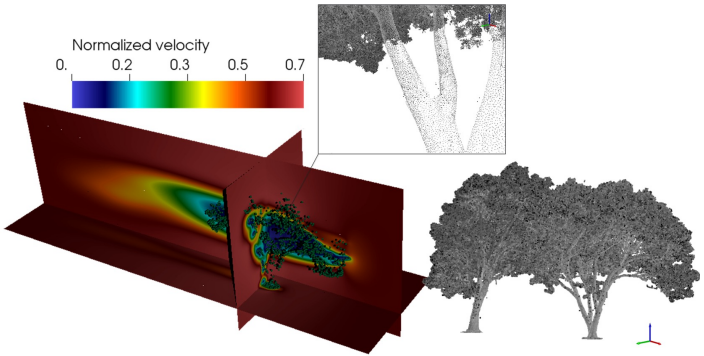


Source: Martilli, CIEMAT

Heat/moisture flux



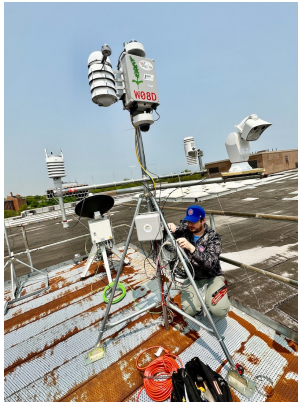




Source: D. Fytanidis, Argonne

MEASUREMENT STRATEGY

Four components: Micronet, field campaigns, public data & citizen science.



Chicago Micronet
Network of 21 observatories.

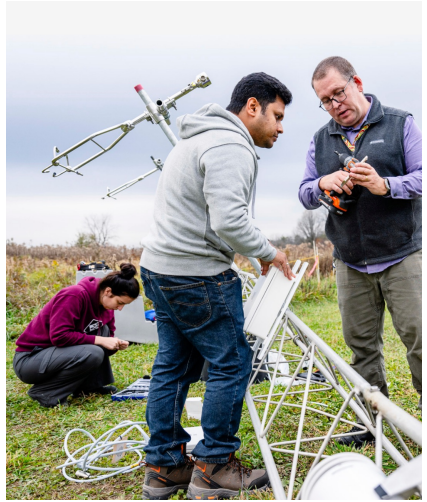
Field campaigns, bringing the most advanced instrumentation to Chicago.

Students involved throughout! Developing the diverse workforce of the future.

THE CHICAGO MICRONET

A network of 21 sites.

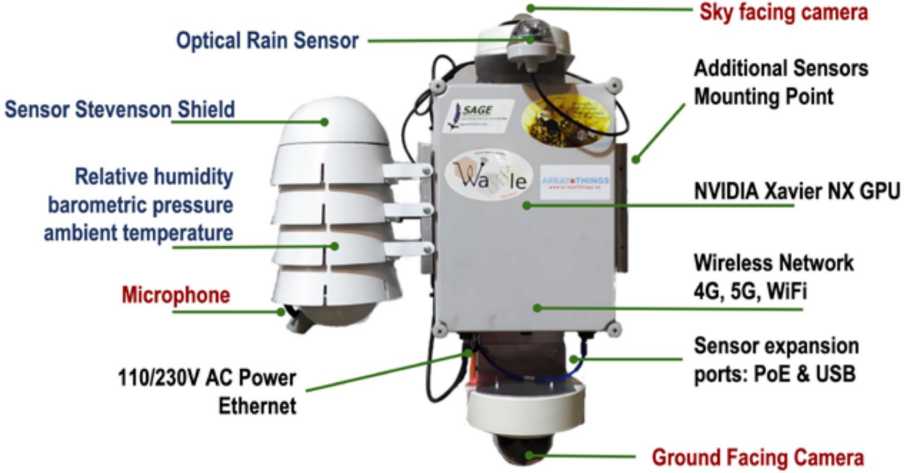
- Three levels of complexity. All have air quality and meteorology, four will have LIDARs giving vertical structure. Four will have towers with fluxes. Two will have radars for precipitation. Four ceilometers across the city.
- Work horse sensors at the Vaisala AQT and WXT. These have a serial interface and are calibrated. The AQT gives information about particulate matter and precursor gasses. The WXT gives high frequency meteorology up to 10Hz.



POWERED BY WAGGLE

Cyberinfrastructure that makes every CROCUS node extensible.

- Every one of the 21 nodes has a Waggle edge compute node.
- CROCUS benefits from the ”shovel ready” cyberinfrastructure in Waggle developed by the Sage project.
- Waggle acts as a ”beachhead” from where we can add new sensors as the network develops.
- By writing edge code repository plugins Sage acts is one conduit we have for sharing open science.



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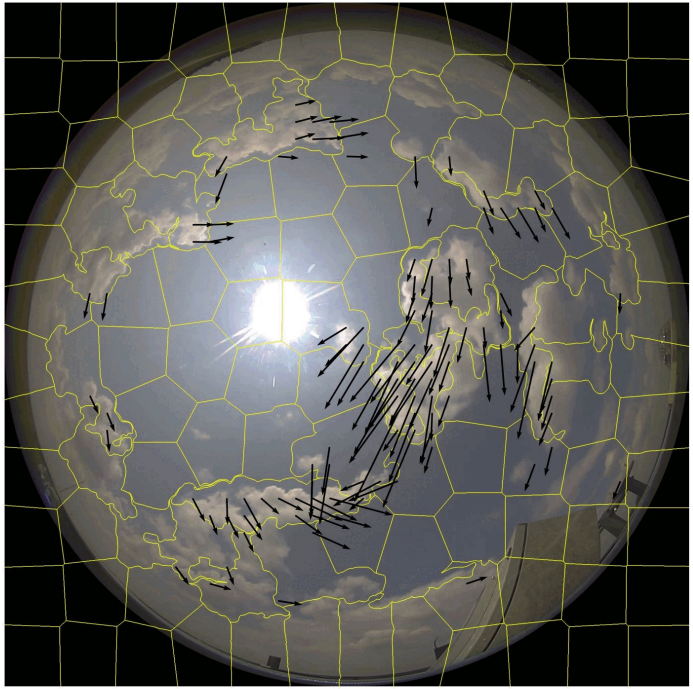


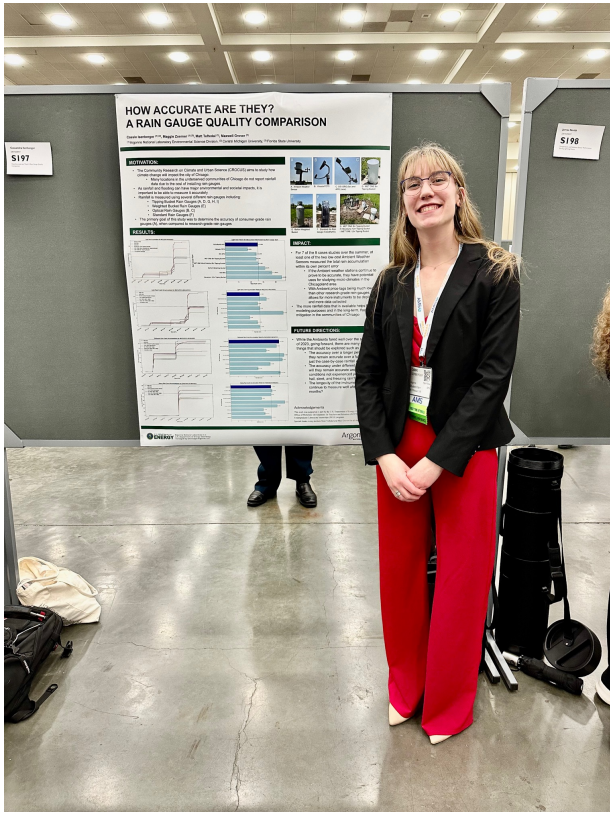
FIELD CAMPAIGNS

Four intensive observational periods.

- While the micronet will provide longer term (multiple seasons) observations several agile campaigns are needed to collect the data needed for the thematic group driven science questions.
- We will be bringing advanced remote sensing platforms, soundings, and sense temporary in-situ networks.

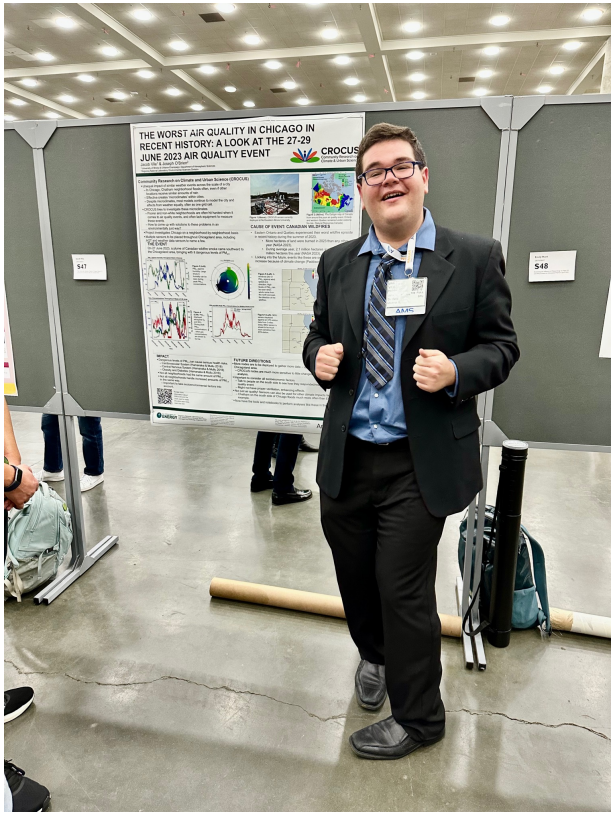
EARLY RESULTS AND LATEST UPDATES

2023 STUDENT COHORT



Cassie Isenberger
Central Michigan University

S197 - How Accurate are They? A Rain Gauge Quality Comparison



Jake Vile
University of Illinois Urbana-Champaign

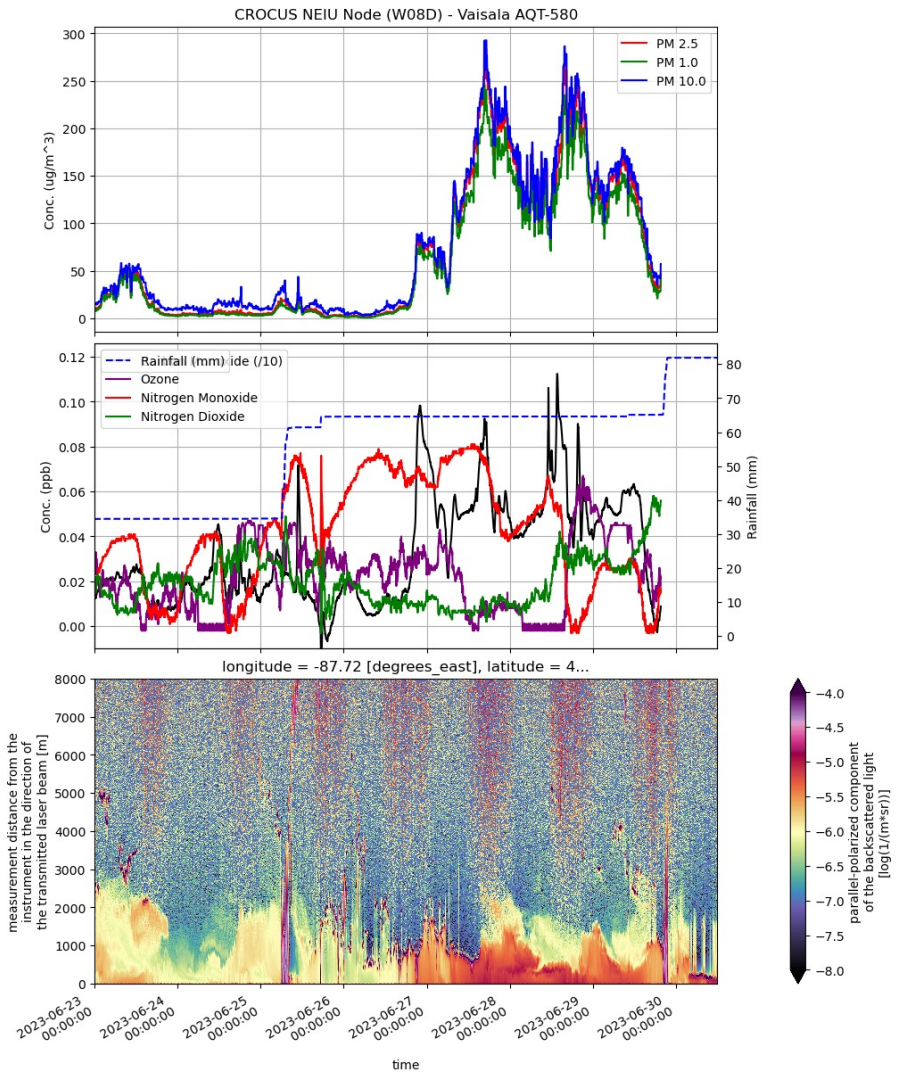
S47 - The Worst Air Quality in Recent Chicago History: A Look at the 27-29 June 2023 Air Quality Event

ON THE TOPIC OF AIR QUALITY

Working with EPA Region 5 to establish if this was the *worst* AQ

- Historic wildfires in Quebec and Ontario.
- Southward advection and subsidence plus a stout inversion led to some very bad air quality in Chicago.
- Air quality is a environmental justice issue as EPA's recommendation is to "stay indoors". Not all underserved citizens have AC.

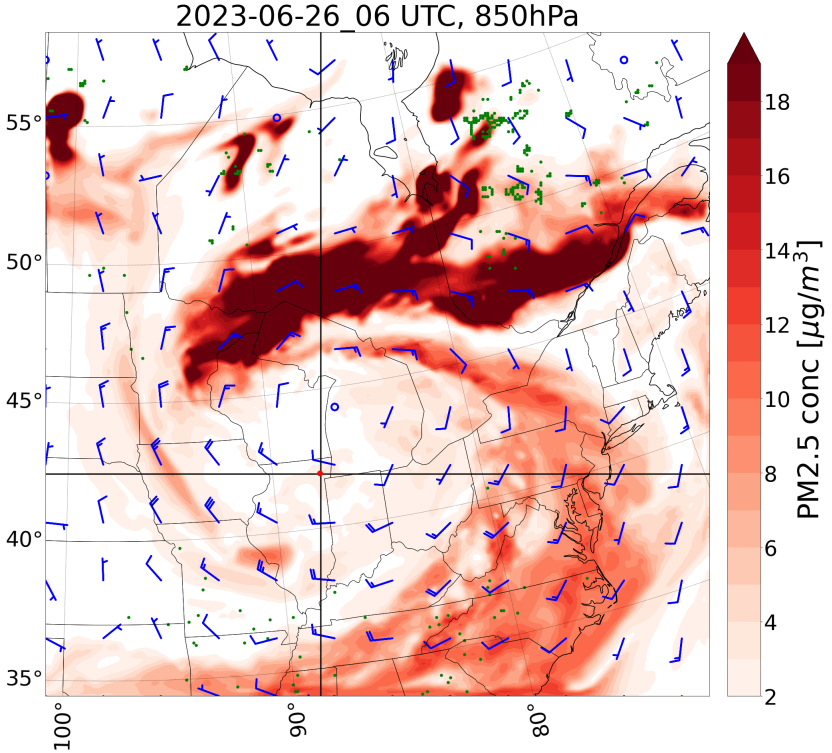
Manuscript in prep.



ON THE TOPIC OF AIR QUALITY

Initial modeling efforts are underway

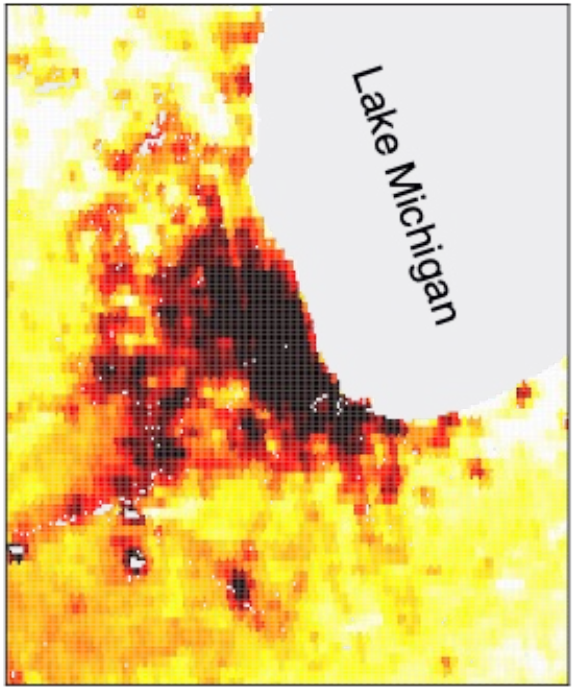
- Using WRF-Chem to model regional transport and processing from Canadian wildfires
- Investigating the role of local meteorology. Working theory (Based on ACAR data and ceilometer) that an inversion compounded bad AQ.
- Early example of U-IFL data being used as an observational target for model improvement.

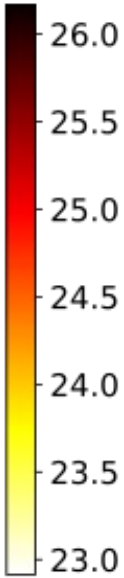


Sicheng Wu and Ashish Sharma

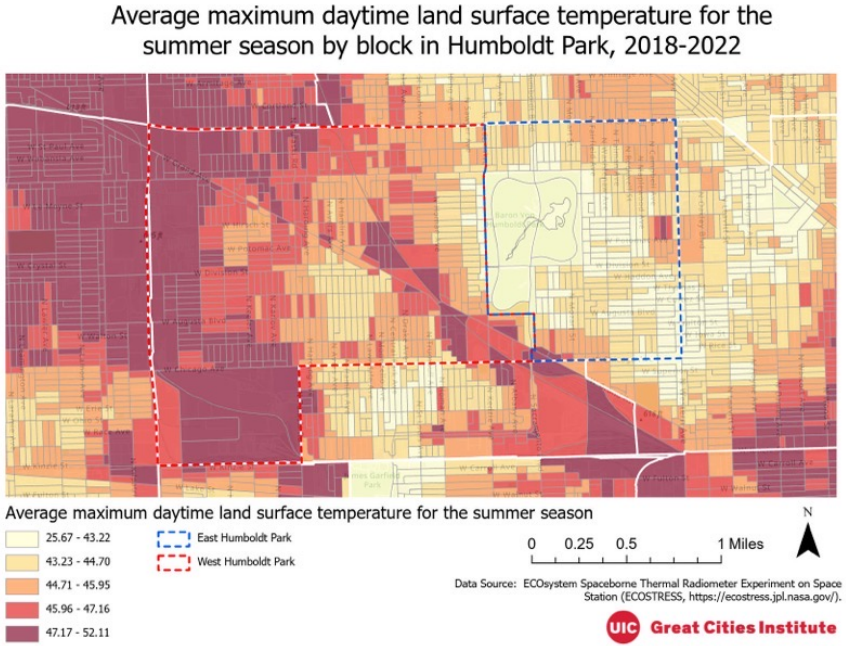
CHARACTERIZING THE UHI IN CHICAGO

Max Berkelhammer and Ralph Citron

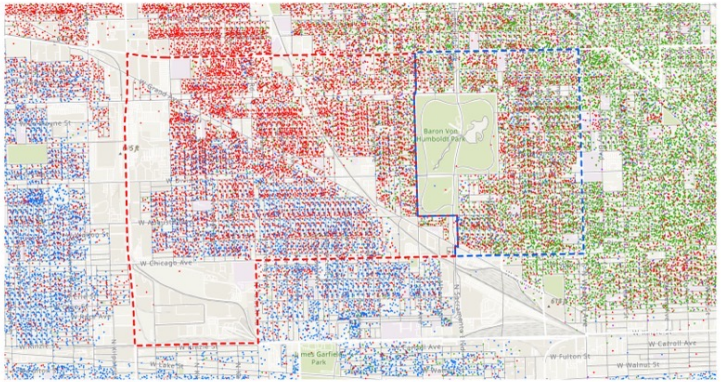




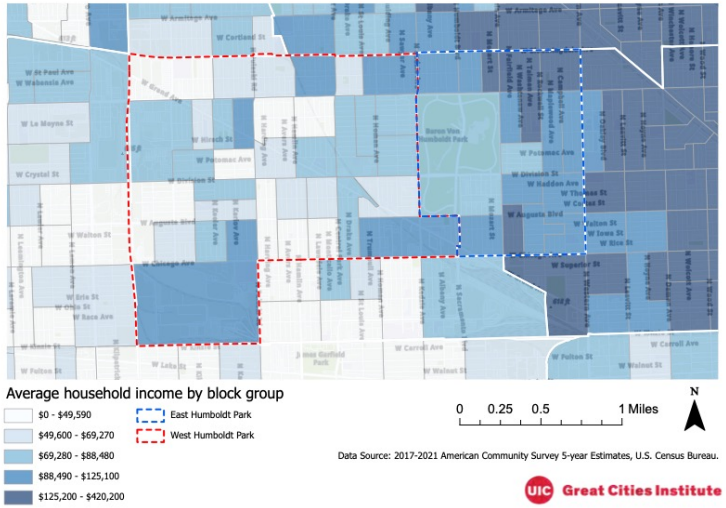
Data from NOAA's GOES-16 Satellite



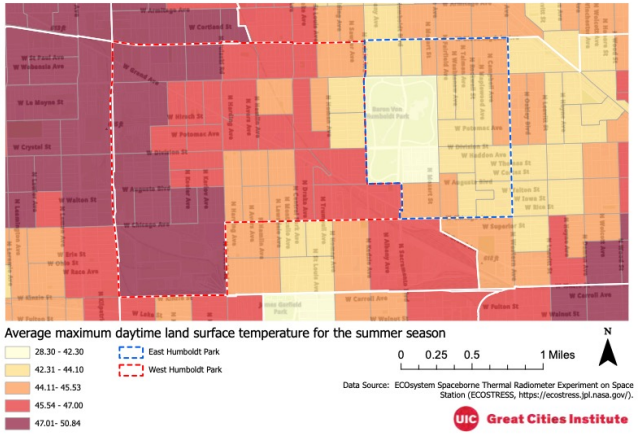
Population by race/ethnicity by block in Humboldt Park, 2020



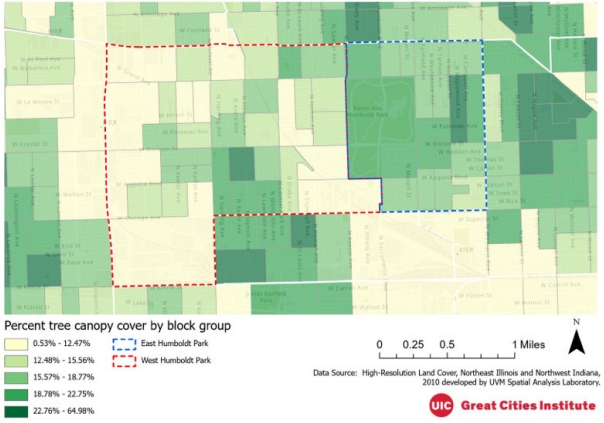
Average household income by block group in Humboldt Park, 2017-2011



Average maximum daytime land surface temperature for the summer season by block group in Humboldt Park, 2018-2022

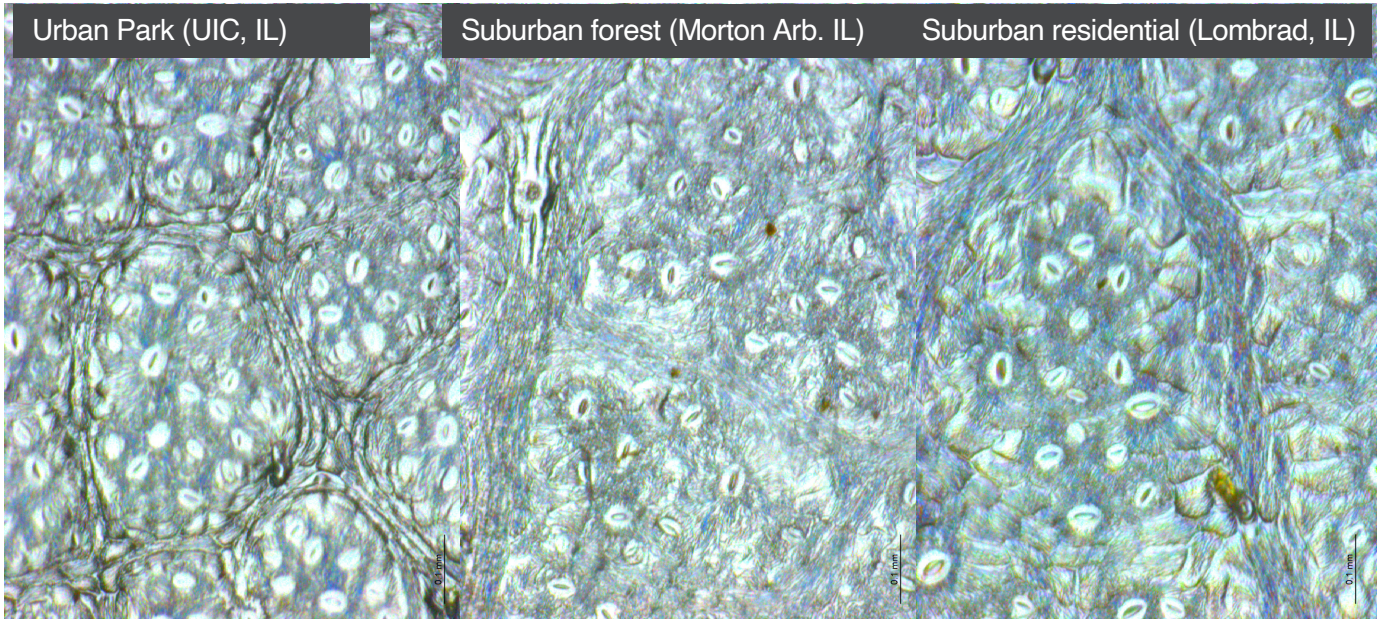


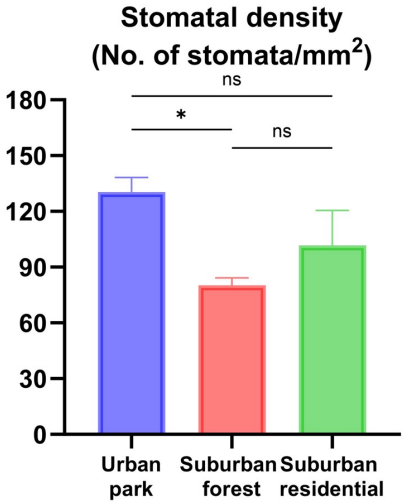
Percent tree canopy cover by block group in Humboldt Park, 2017



Miquel Gonzalez-Meler

• Stomatal Density (Little-leaf Linden)





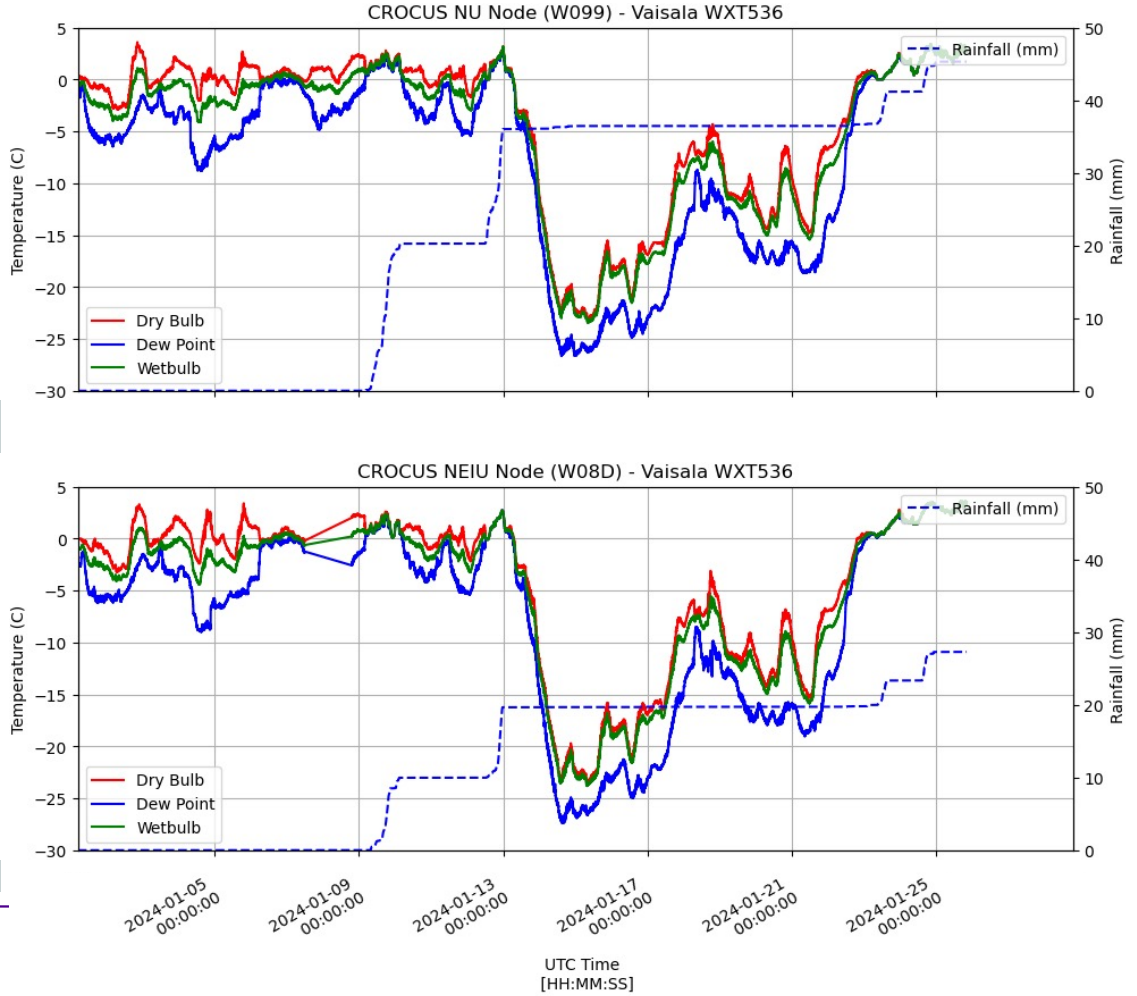
- Stomatal density of *Tilia cordata* (Little-leaf Linden) street trees sampled was 77, 48, and 60 stomata/mm^2 at the urban park, suburban forest, and suburban residential
- Little-leaf Linden trees in Urban Park had higher stomatal densities compared to suburban sites, suggesting a higher transpiration capacity and more potential for evaporative cooling than in suburban areas

THREE NODES ARE DEPLOYED

Five more before fall

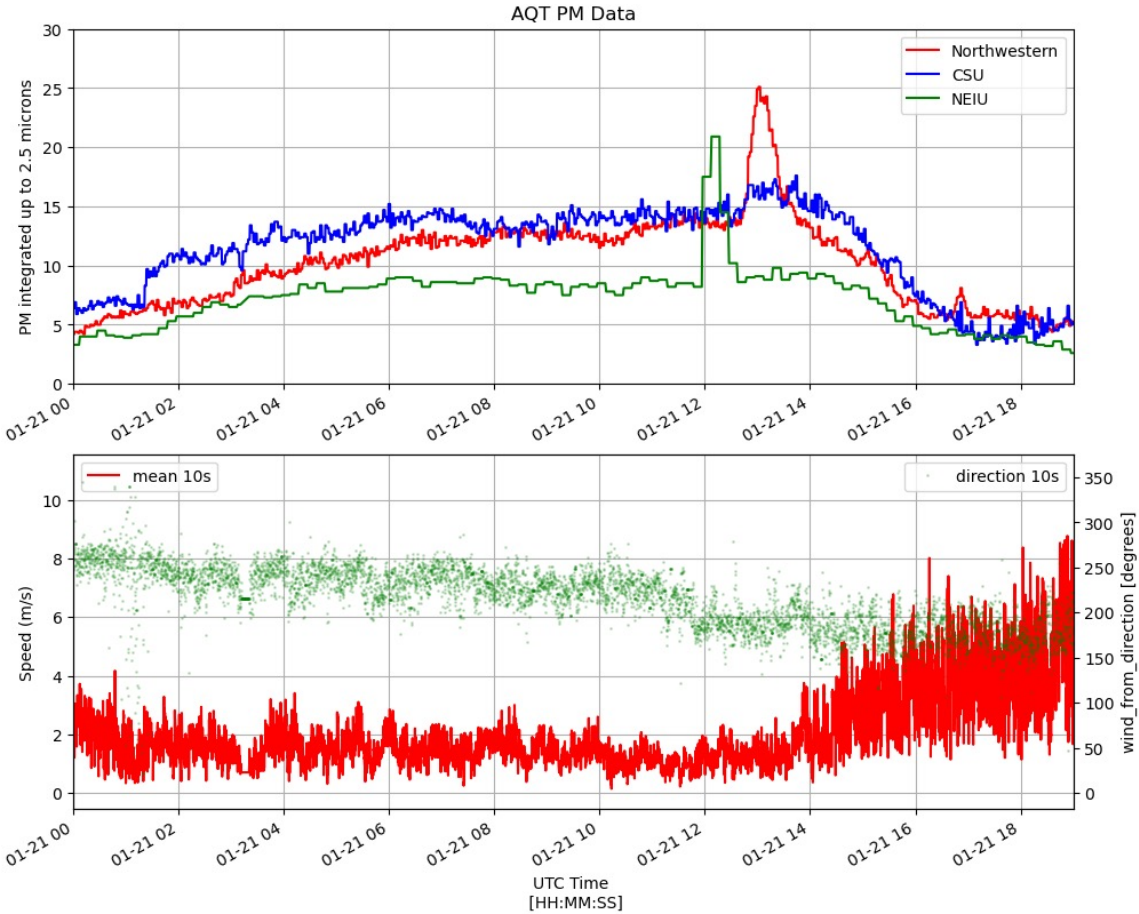
FRESH DATA

The cold crash…



FRESH DATA

Fast and slow mode PM



UPCOMING OPPORTUNITIES

CROCUS C**h**icago **U**rban **C**anyon Unveiling **K**nowledge of **L**and **E**ffect**s**, ChUCKLEs

ChUCKLEs is our first field campaign.

The science we will be tackling can be broadly described as “Understanding how an urban canyon couples to the atmosphere around Chicago. How does the lived experience in this canyon differ from our models?”

It will collect data to improve those models and represent urban canyons.

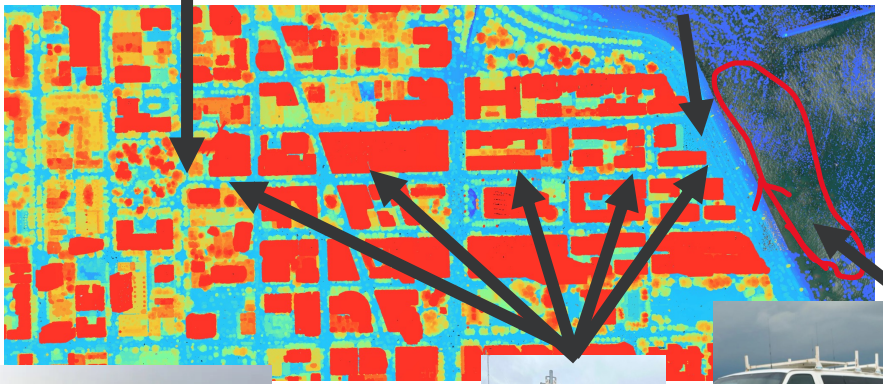
ETA, ~June/July 2024.

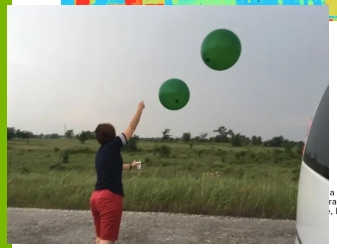
We will work with BSEC and other U-IFLs on our field campaign cadence. Once the micronet is fully realized we will have a large field campaign.

EXAMPLE DEPLOYMENT. DELAWARE AVE

SPARC

Radar Wind Profiler
LIDARS





Nodes

Balloons

Raven UAV

Argonne NATIONAL LABORATORY

CROCUS

Community Research on
Climate & Urban Science

https://crocus-urban.org/data/observations/

This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Biological and Environmental Research's Urban Integrated Field Laboratories research activity under contract number DE-AC02- 06CH11357