Metropolitan Mayors Caucus
November 14, 2023

AN OVERVIEW OF CROCUS AND COLLABORATION WITH MMC

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CROCUS
Community Research on Climate & Urban Science

INTRODUCTIONS

CROCUS: Community Research on Climate and Urban Science

- Cristina Negri – Argonne – CROCUS Director
- Suzanne Beaudry – Argonne – CROCUS Project Manager
- Jorja Porter – Argonne – Community Engagement Strategist

Why we are here:

To find ways to collaborate and work towards mutual benefits

AGENDA

- Introductions (5 minutes)
- A brief description of CROCUS (30 minutes)
  - Future scenarios
  - Connections with the Climate Action Plan
  - CROCUS expected outcomes
- Why we are here (5 minutes)
- Discussion: mutual benefits of collaboration (40 minutes)
- Recap of Action Items (10 minutes)

WHY, WHO AND WHAT IS CROCUS

U.S. DEPARTMENT OF ENERGY

CROCUS
Community Research on Climate & Urban Science

U.S. Department of Energy five-year vision for Urban Integrated Field Laboratories

SCIENCE GOALS

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

SOCIETAL BENEFITS

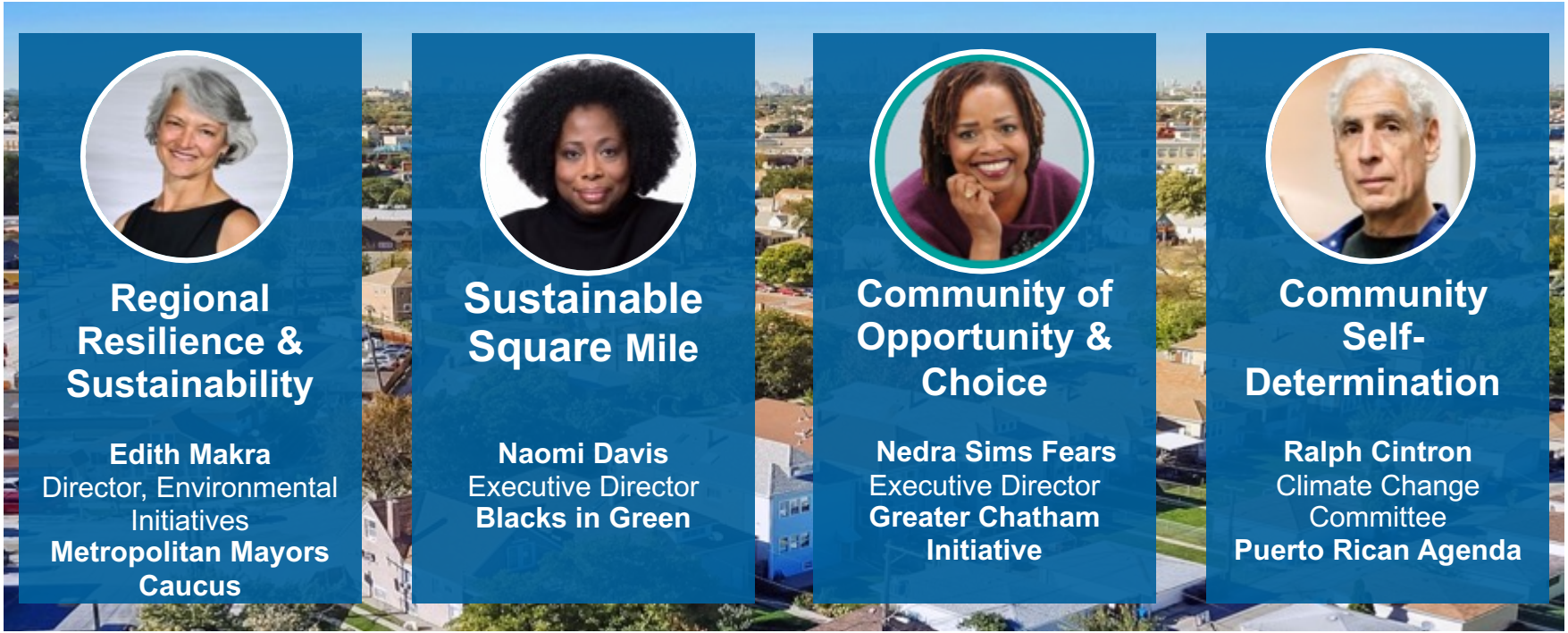
Sustainable, resilient, and equitable solutions, with special attention to underserved communities

FOUR LOCATIONS

Austin – U of Texas at Austin
Baltimore – Johns Hopkins U
Chicago – Argonne
SW Corridor – Arizona State U

COMMUNITY VISION

Climate Science Through the Lens of Community



Regional Resilience & Sustainability

Edith Makra
Director, Environmental Initiatives
Metropolitan Mayors Caucus

Sustainable Square Mile

Naomi Davis
Executive Director
Blacks in Green

Community of Opportunity & Choice

Nedra Sims Fears
Executive Director
Greater Chatham Initiative

Community Self-Determination

Ralph Cintron
Climate Change Committee
Puerto Rican Agenda

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 · University of Texas · Washington University in St. Louis · University of Wisconsin-Madison

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 will deliver a reliable representation of the complex urban environment and it's feedbacks with climate

Greater Chatham Initiative's Flood Fair

Systems-based approach for integrating physical, biological, and human dimensions of climate change

Framework to simulate, evaluate, and project impacts and feedbacks between climate and urban systems

Integrated approach to localizing observation and modeling

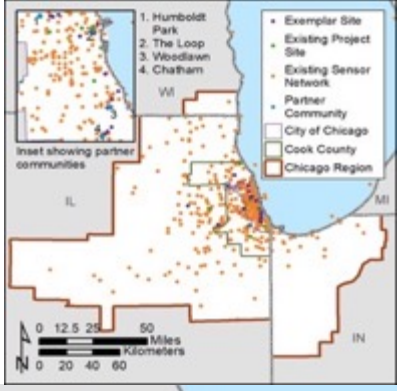
Advanced tools for making decisions and building stakeholder capacity

MOTIVATION AND CONTEXT

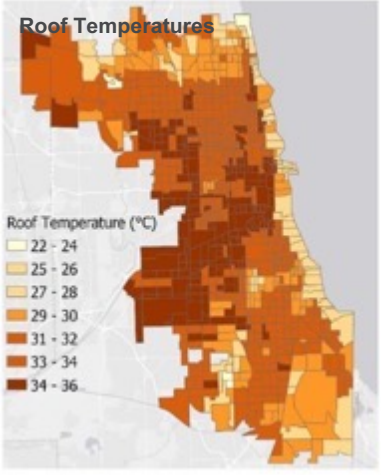
Urban climate science needs an integrated approach to evaluate physical and social drivers and community impacts of climate change

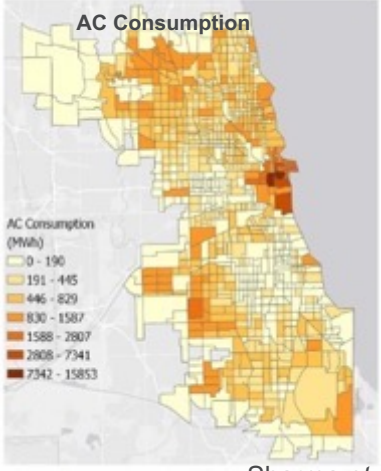
Chicago is 8th in income inequality among the Nation's largest cities.

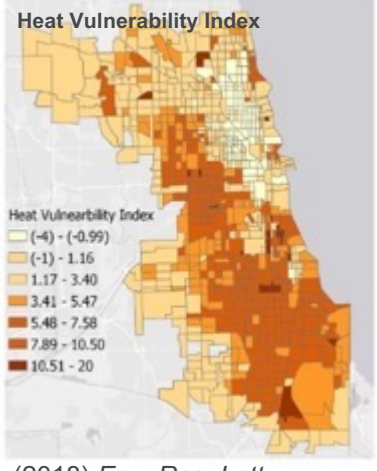
Today's inequalities in the region have old roots. These have pushed underrepresented communities into the most physically challenging areas with lower quality infrastructure.

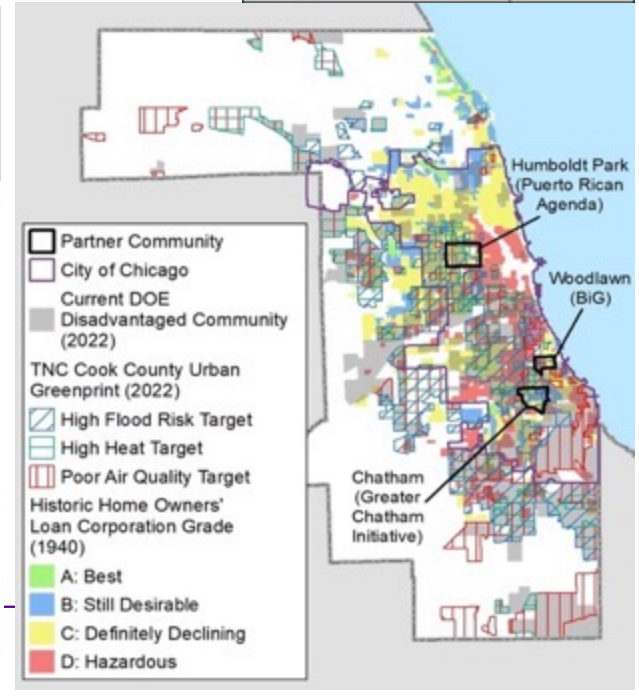


Flooding Heat Housing Marginalization Health Stress
Food security Extremes Tornadoes Gentrification Jobs
Green spaces Deterioration Variability







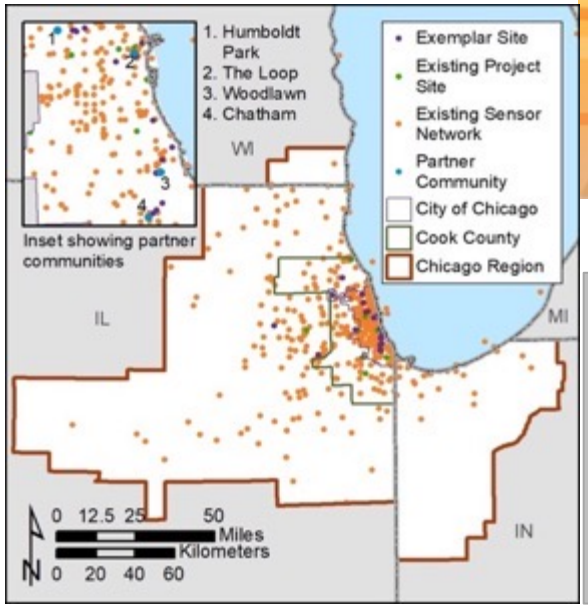


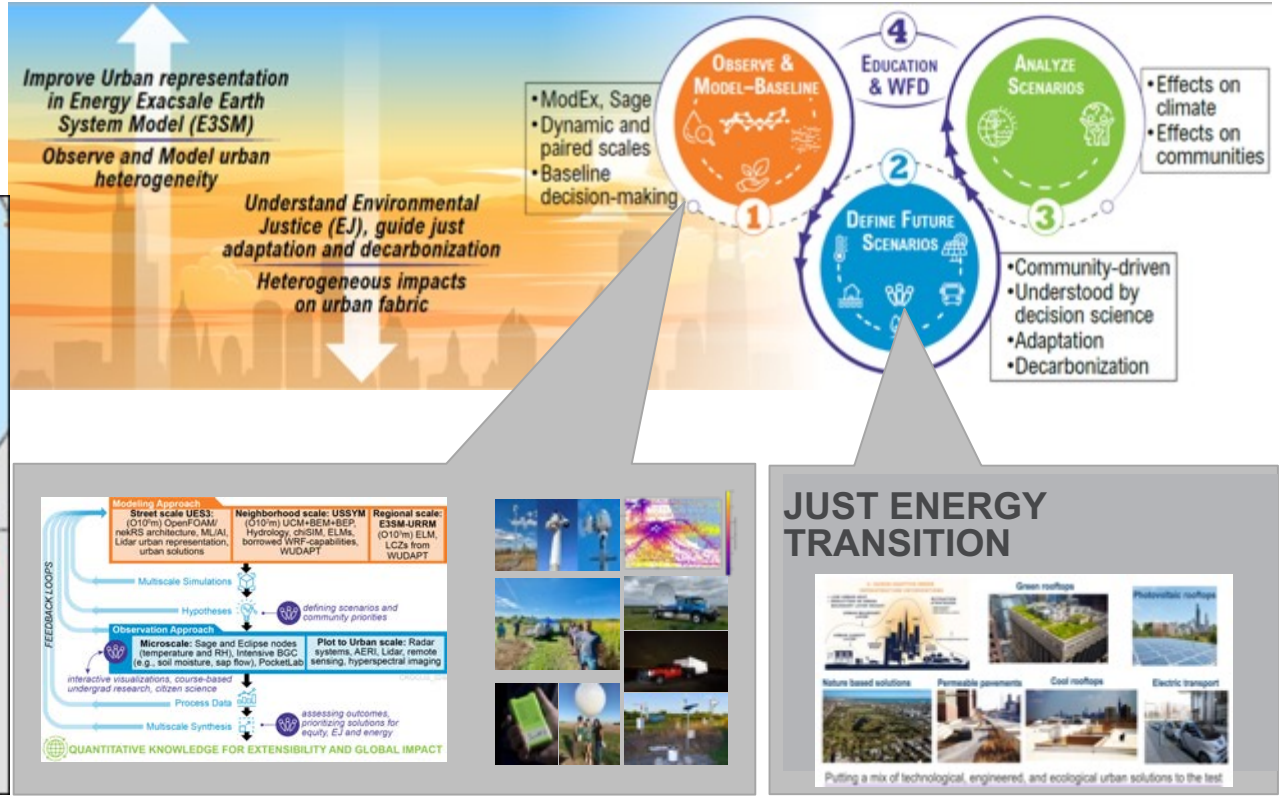
Sharma *et al.* (2018) *Env. Res. Lett.*

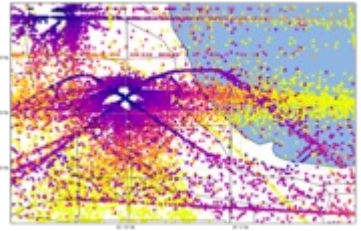
WHAT CONCERNS HAVE YOU MOST WORRIED ABOUT CLIMATE CHANGE?

SENSING AND MODELING INTEGRATED

The Chicago region provides an excellent test bed to understand urban to regional climate processes and how to implement solutions that are equitable to communities.







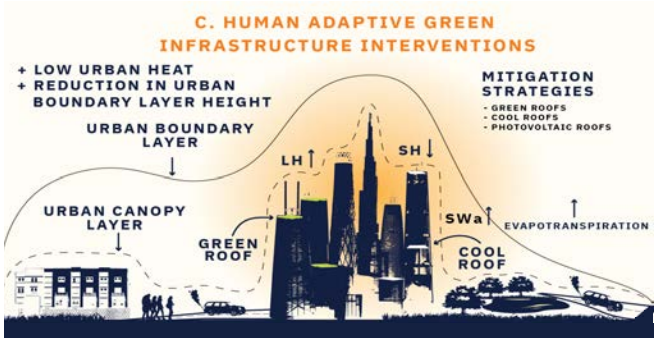


OBSERVATIONS WILL GENERATE THE RELEVANT DATA AT THE RIGHT SCALE

Four observational components:

- **CROCUS Micronet,**
- **Field campaigns,**
- **Public data**
- **Community science.**

COMMUNITY-DRIVEN SOLUTIONS
TO BENEFIT LOCAL AND LARGER URBAN ECOSYSTEMS



Green rooftops

Photovoltaic rooftops

Nature based solutions

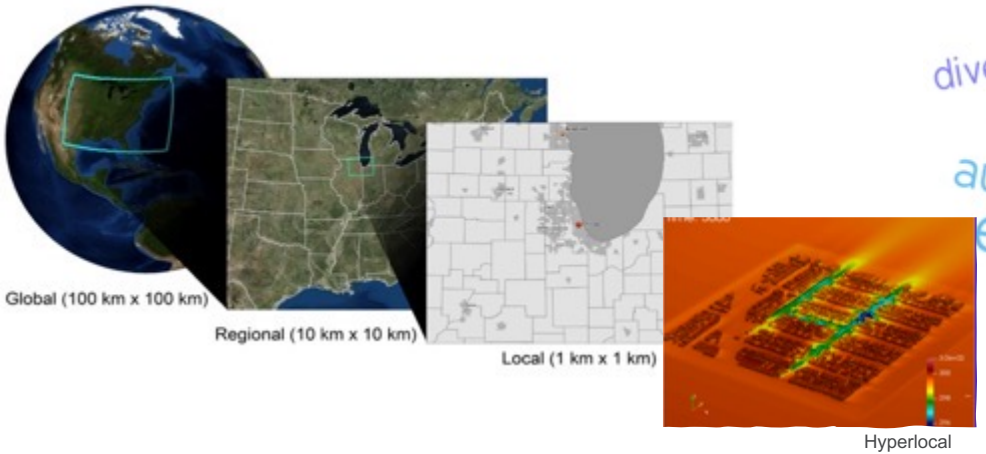
Permeable pavements

Cool rooftops

Electric transport

Putting a mix of technological, engineered, and ecological urban solutions to the test

THE BASIS FOR EQUITABLE AND INCLUSIVE SCIENCE



Fair, equitable and inclusive science begins with data that represent all ways of life in the studied environment, and models that account for inclusive baselines, and scenario settings, community vision and interests that are co-designed with all stakeholders

CO-DESIGNING AND QUANTIFYING BENEFITS OF EQUITABLE CLIMATE SOLUTIONS

What does this mean for CROCUS?

1. Gather with the community and understand what they prioritize as the biggest challenges they are facing in regards climate change and more generally building sustainable communities
2. Develop this knowledge into a series of science questions that we could address with the tools and capabilities we and our academic partners can bring to the table translated for a non-scientific stakeholder base
3. Convert these science questions into a rigorous process that includes the (1) the question posed as unambiguously as possible (b) testable hypothesis that could be an answer to the question (c) an experiment (model and observations) that can test the hypothesis, what to sense and where.

Expectations:

We expect our science not to be extractive but provide useful information to inform action

We expect our scientific discourse to be understandable to non-scientists and across scientific disciplines

We expect interactions to be ongoing, respectful and in good faith

We expect community participation in defining/performing the 'experiment' to test the hypothesis

We expect community participation in using the experimental data to test the hypothesis

COMMUNITY VOICE ADVANCING CLIMATE SCIENCE
(GRANGE, COLLIS)

Information Exchange

Attend community meetings and conferences to share the science, learn community's priorities, and invite residents to participate in research activity.

Engagement Planning

Established Community Engagement Team to ensure science objectives and community partners' contributions are integrated into research activity.

Community Science

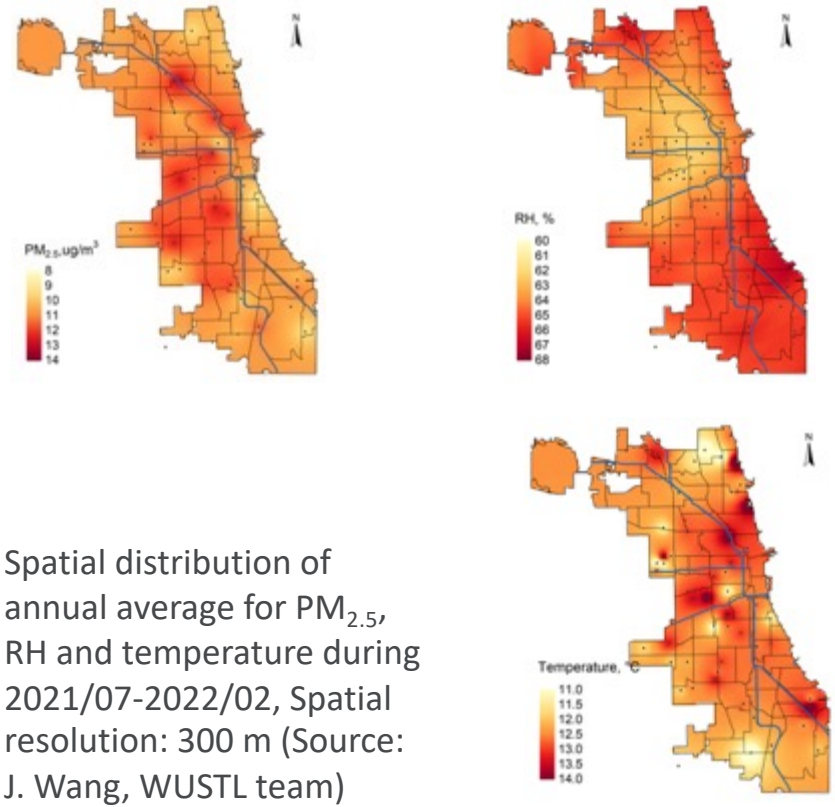
Led by community partners, researchers interact with communities to gain insights and identify sites for deployment of instrumentation, community science, and vision for the future.

DO YOU HAVE SUGGESTIONS THAT WOULD HELP CROCUS WORK FROM YOUR COMMUNITY ENGAGEMENT IN PREPARING THE CAC?

PROGRESS TO DATE:

- UNDERSTANDING THE HETEROGENEITY
- HYPERLOCAL MODELING AND OBSERVATIONS

LEVERAGING EXISTING DATA AND ADDING TO IT



Spatial distribution of annual average for $PM_{2.5}$, RH and temperature during 2021/07-2022/02, Spatial resolution: 300 m (Source: J. Wang, WUSTL team)

Digital elevation of Chicago from Light Detection and Ranging (LiDAR) data at 3m resolution. (Source: Li and Sharma, DPI and Argonne)

MAPPING TREE CANOPY AND ITS HEALTH

- Used Sentinel-2 data (10m) to calculate annual enhanced vegetation indices (EVI) across the city of Chicago during the peak growing season (June to August) between 2017 and 2023. EVI metrics were masked to the European Space Agency's WorldCover v200 tree cover class to include only pixels classified as tree cover in the analyses.
- Assessed spatial variation in EVI by summarizing current EVI and interannual summer EVI variance (2017-2023), a preliminary proxy for resilience, at the census-tract level
- Assessed preliminary income-based inequality with linear models using 2021 median household income data from the American Community Survey. We controlled for percent canopy cover in all analyses.
- All analyses were performed in Google Earth Engine and R

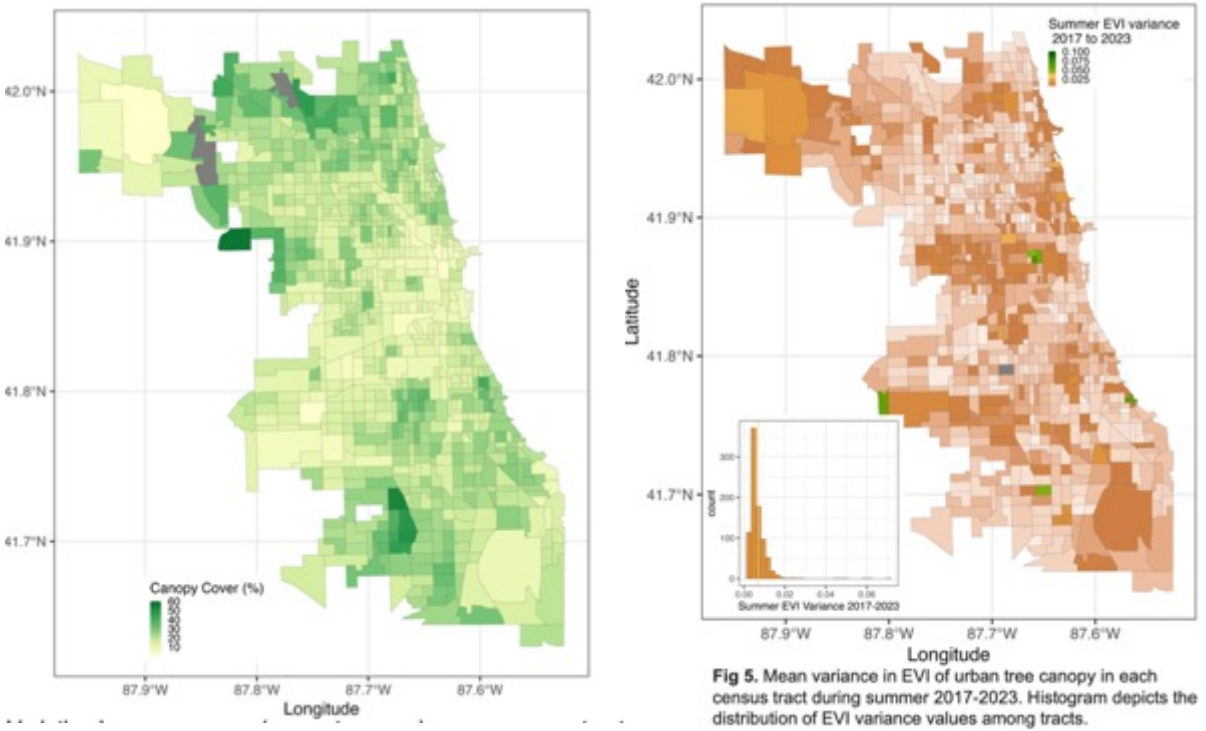
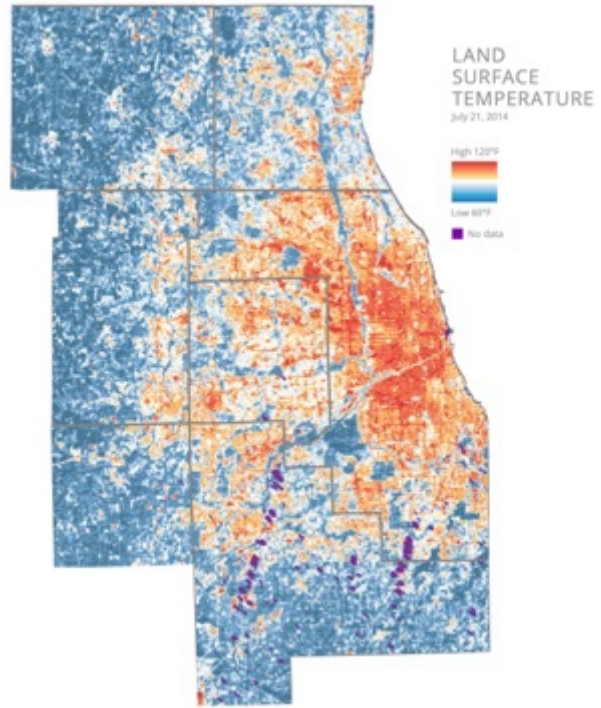
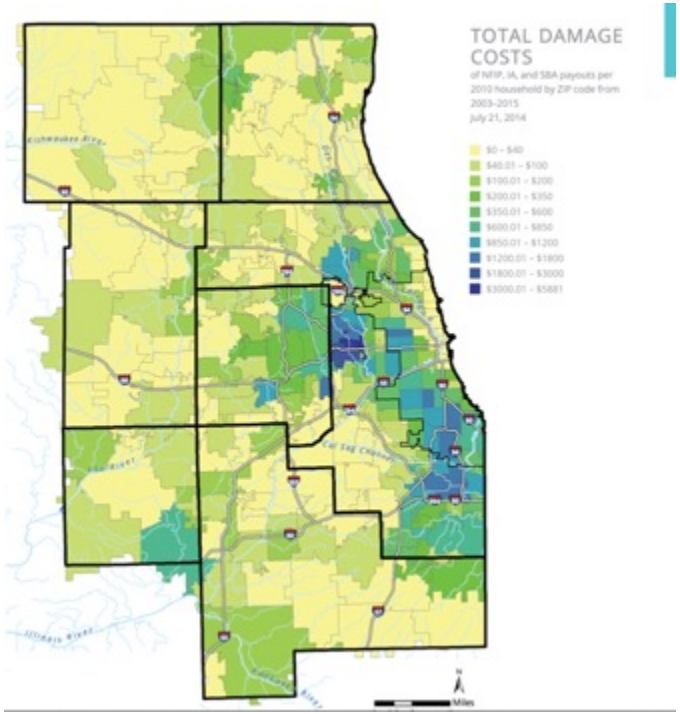


Fig 5. Mean variance in EVI of urban tree canopy in each census tract during summer 2017-2023. Histogram depicts the distribution of EVI variance values among tracts.

Source: Love, N., et al., (2023), UIC

TOUCHPOINTS WITH MMC'S CLIMATE ACTION PLAN





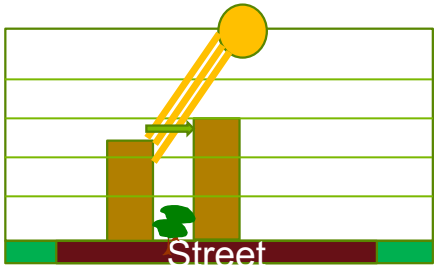
Identify relevant hot spot and hot moments

- Relevant to MMC
- Relevant to CROCUS science

Source: MMC, Climate Action plan for the Chicago Region, 2021

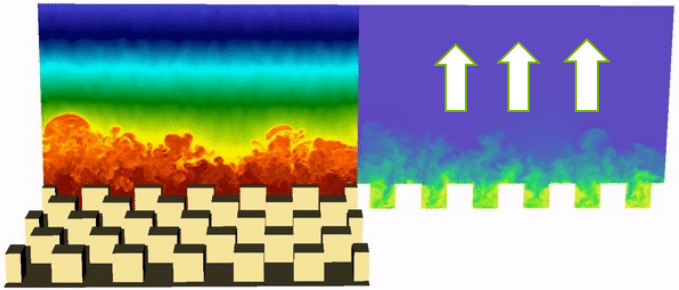
STREET-SCALE MODELING

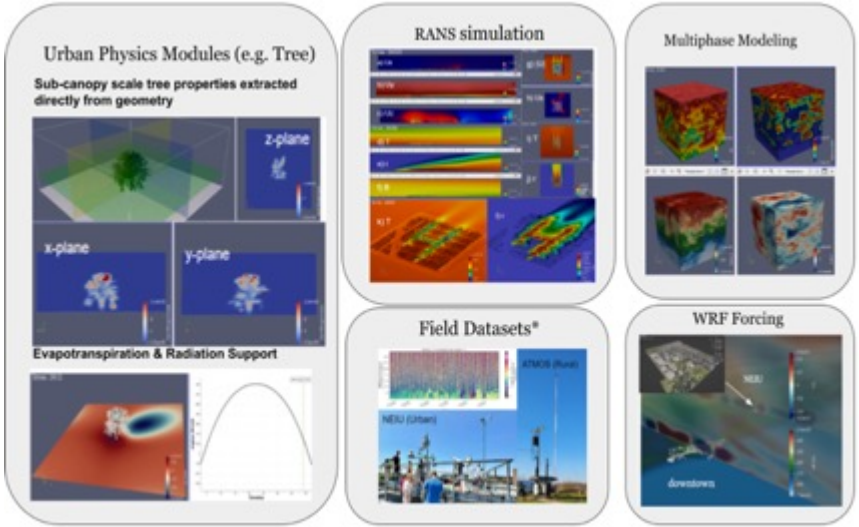
Micro-scale modeling to enhance the Building Effect Parameterization (BEP) schemes currently used in mesoscale models like WRF by incorporating these findings

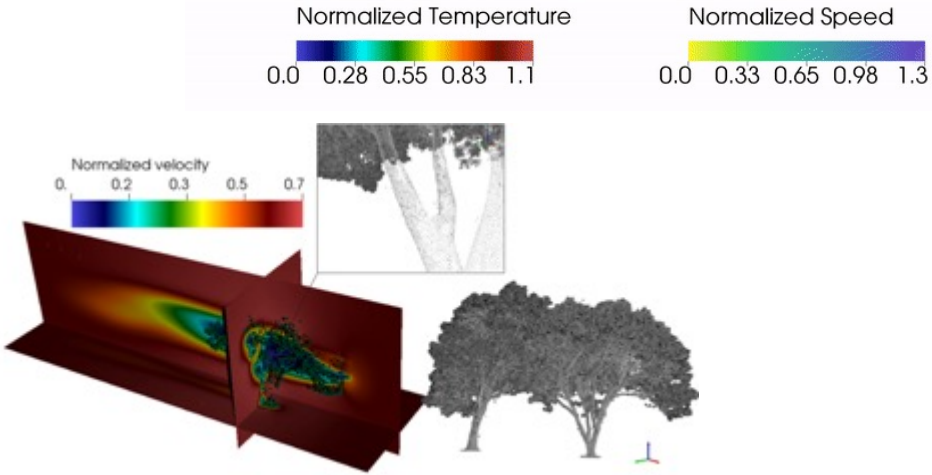


Source: Martilli, CIEMAT

Heat/moisture flux

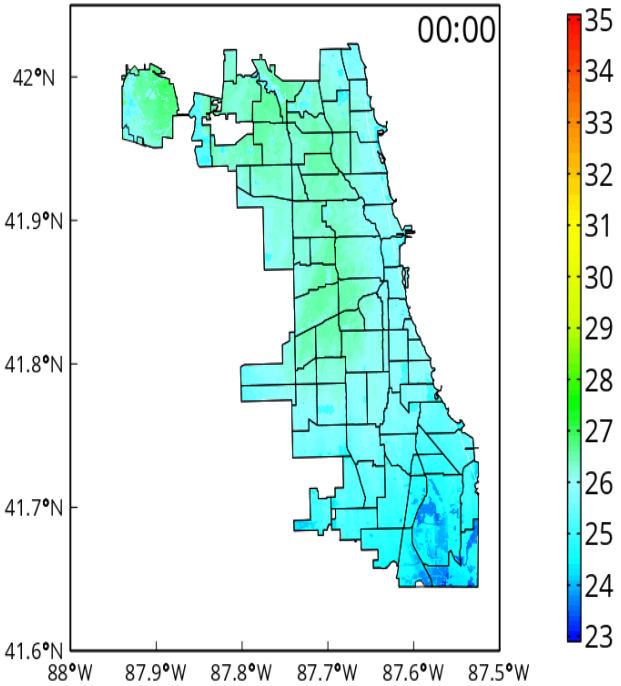


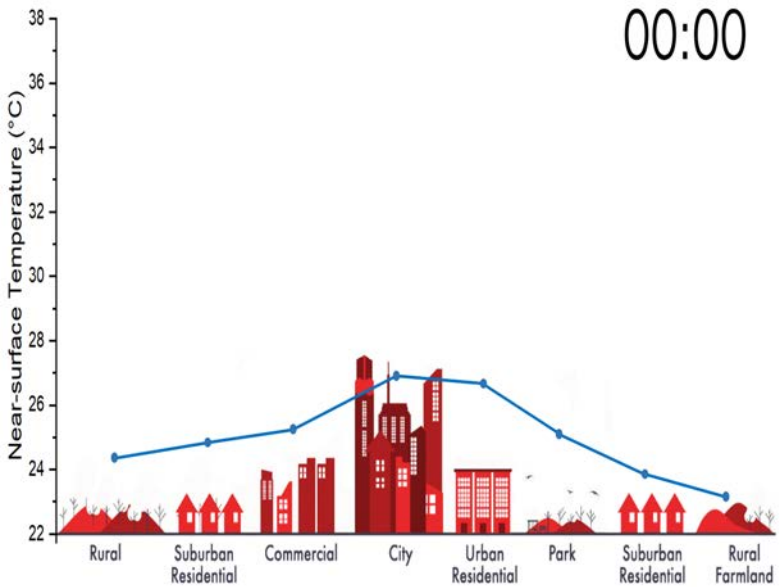




Source: D. Fytanidis, Argonne

CITY SCALE SIMULATION OF TEMPERATURES



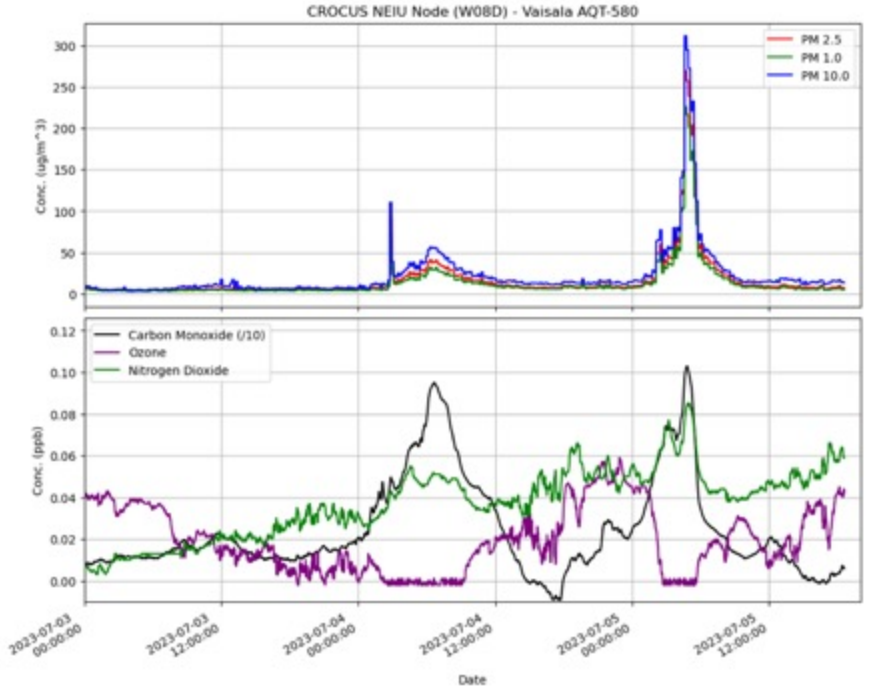


Source: Haochen Tan, Argonne National Laboratory

ATMOSPHERIC OBSERVATIONS

Two deployments provide initial data and test the approach, collaboration with NASA-NOAA campaigns supplement datasets

- Building the cyberinfrastructure
- Six additional deployments planned for FY24, guided by models and insights
- Testing low cost weather stations at ATMOS



Q1- ARE THERE SPECIFIC LOCATIONS THAT WOULD NEED A CLOSER LOOK?

EXAMINING POTENTIAL SOLUTIONS

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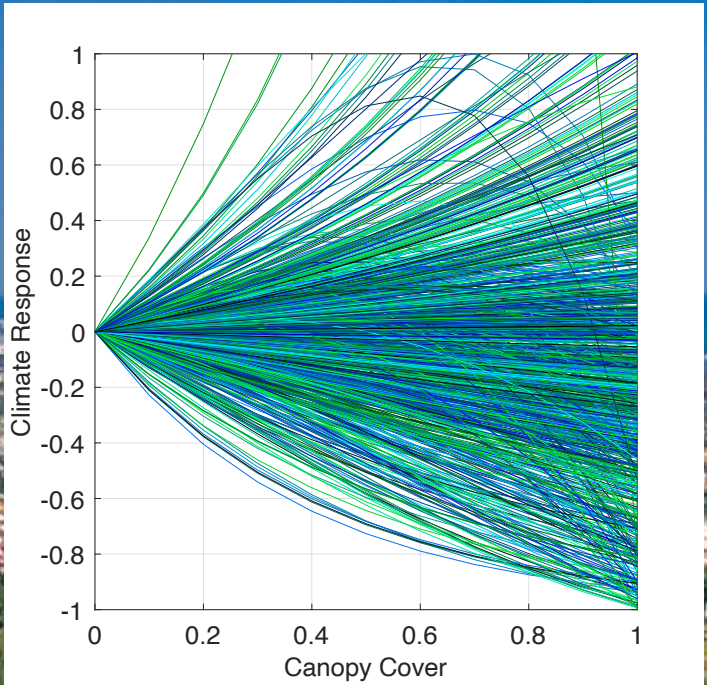
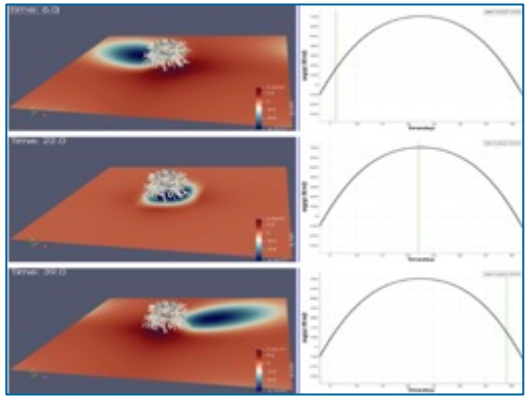
Climatic benefits of canopy cover

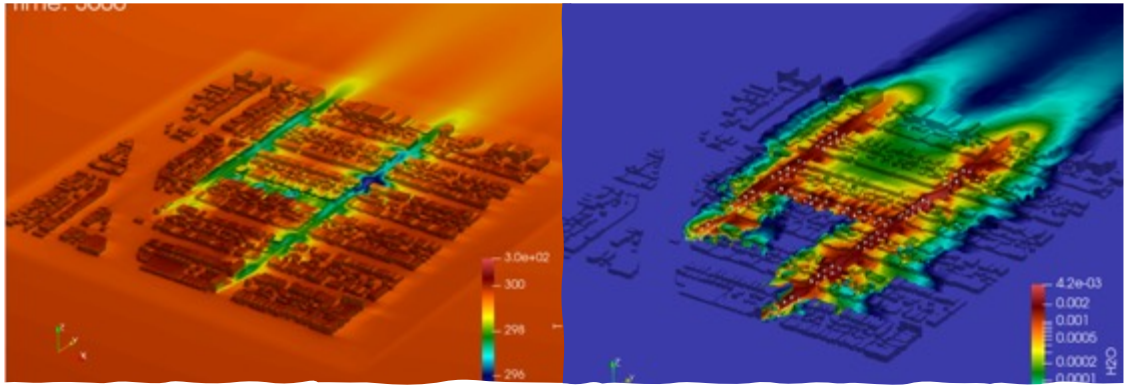


The benefits of tree canopy on **temperature**, **flooding**, **pollution or greenhouse gas reduction** are highly variable <u>across cities</u>, <u>within cities</u> and <u>over time</u>.

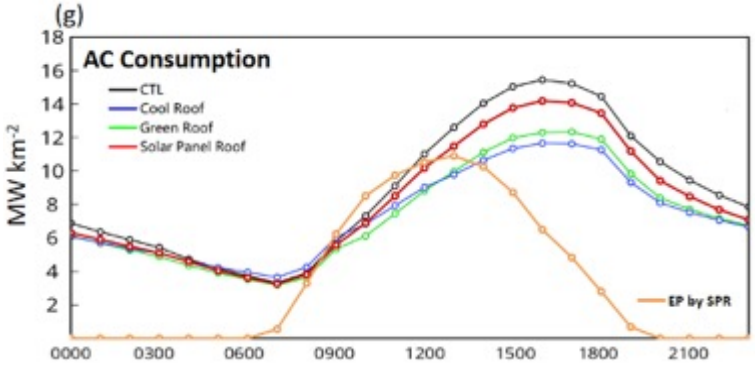
MODELING VEGETATION IN URBAN STREETS
(SEN AND FERNANDO)

A: estimation of surface radiative flux under solar radiation accounting for canopy shading. The right pane is the time evolution of the radiative flux averaged over the model domain including the tree, green line marks the time corresponding to the shading shown on the left. **B** and **C**: a simulation over the Humbolt park with southerly wind using a RANS model developed from OpenFOAM. Trees are included for test in the three streets (two N-S and one E-W). Simulation results after 1 hour simulation time, 3D view of the temperature (**B**) and water vapor (**C**) mixing ratio distribution at the surface (Wang and Fernando, manuscript in prep).

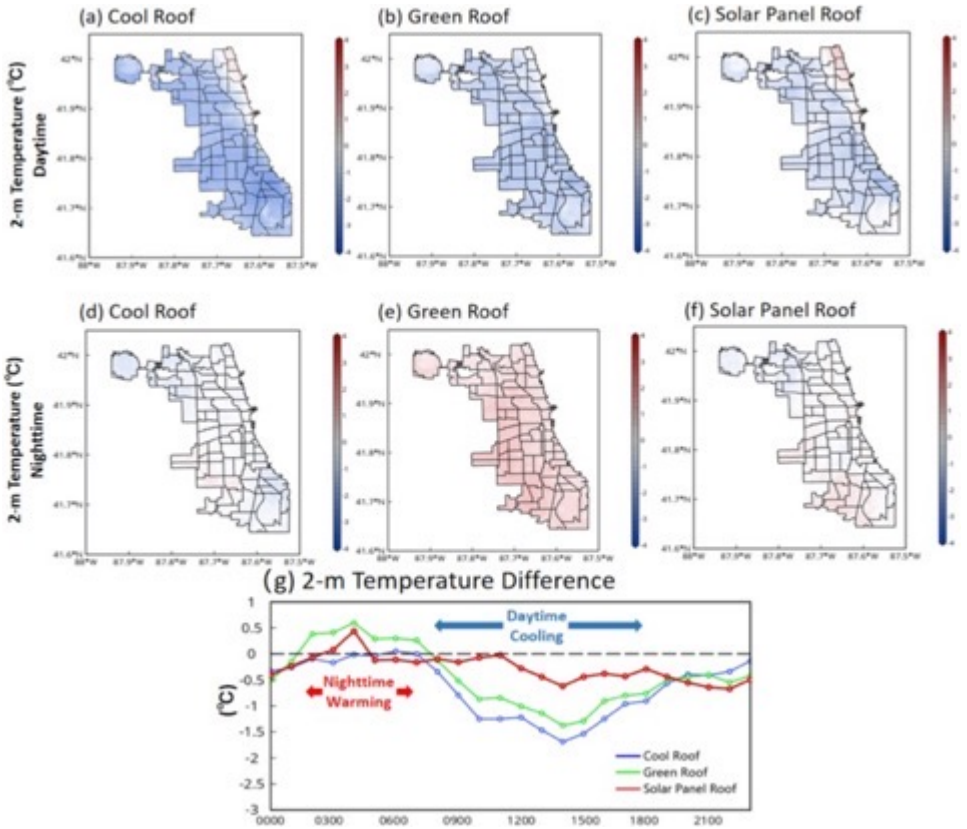




TEMPERATURE MITIGATION AND AC CONSUMPTION



Diurnal cycle of simulated air-conditioning electricity consumption for control simulation (black), Cool Roof (blue), Green Roof (green), and Solar Panel Roof (red) and the electricity production generated by Solar Panel Roof (orange).



TOUCHPOINTS WITH MMC'S CLIMATE ACTION PLAN - MITIGATION STRATEGIES

Examining potential solutions and projecting outcomes

- Implement clean energy policies – simulate outcomes related to energy burden, air quality, decarbonization
- Reduce vehicle miles traveled – simulate impacts to air quality, cost, other outcomes
- Sustain ecosystems to sequester carbon – quantify potential cooling and water retention, soil carbon dynamics, energy demands

- Quantify likelihood of extreme weather and potential impacts to infrastructure, community
- Simulating decisions and their outcomes and climate feedbacks

WHAT OTHER POTENTIAL SOLUTIONS IS MMC INTERESTED IN?

COMMUNITY AND DECISION MAKING

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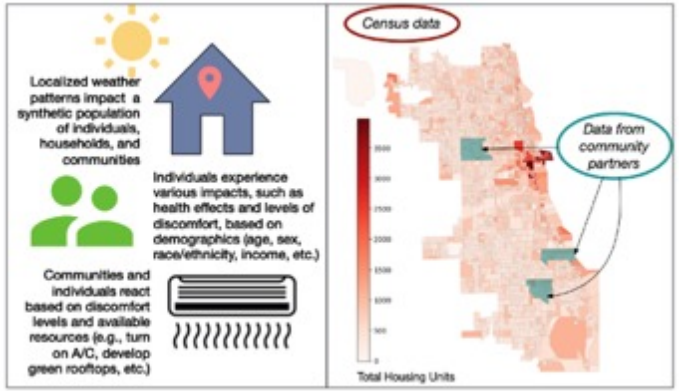
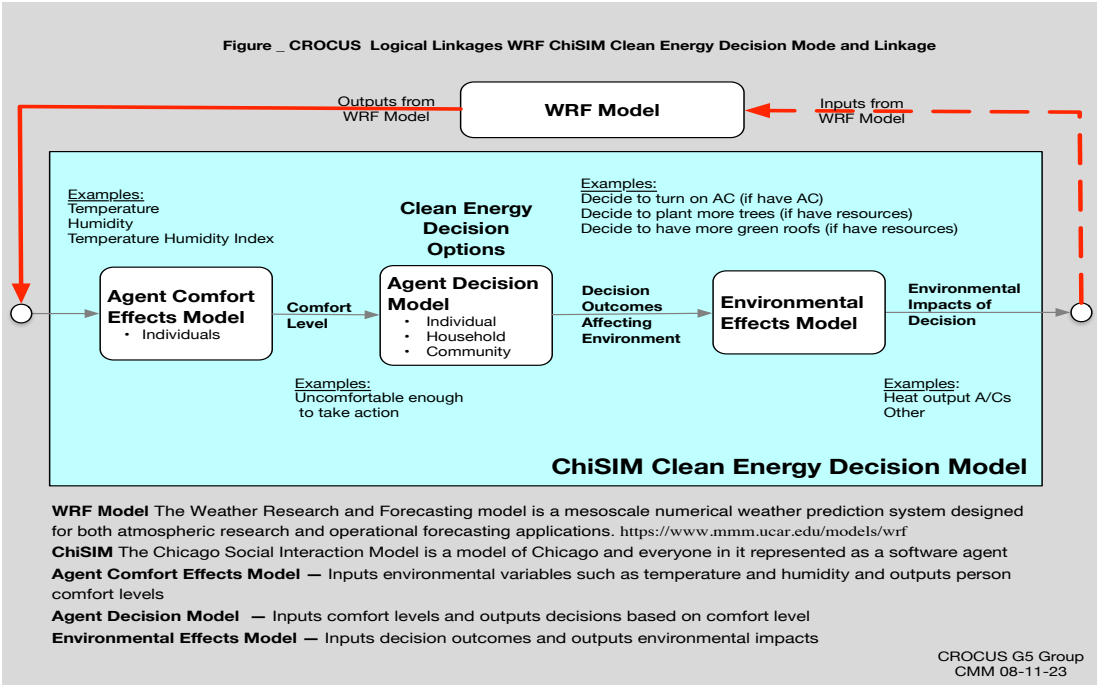
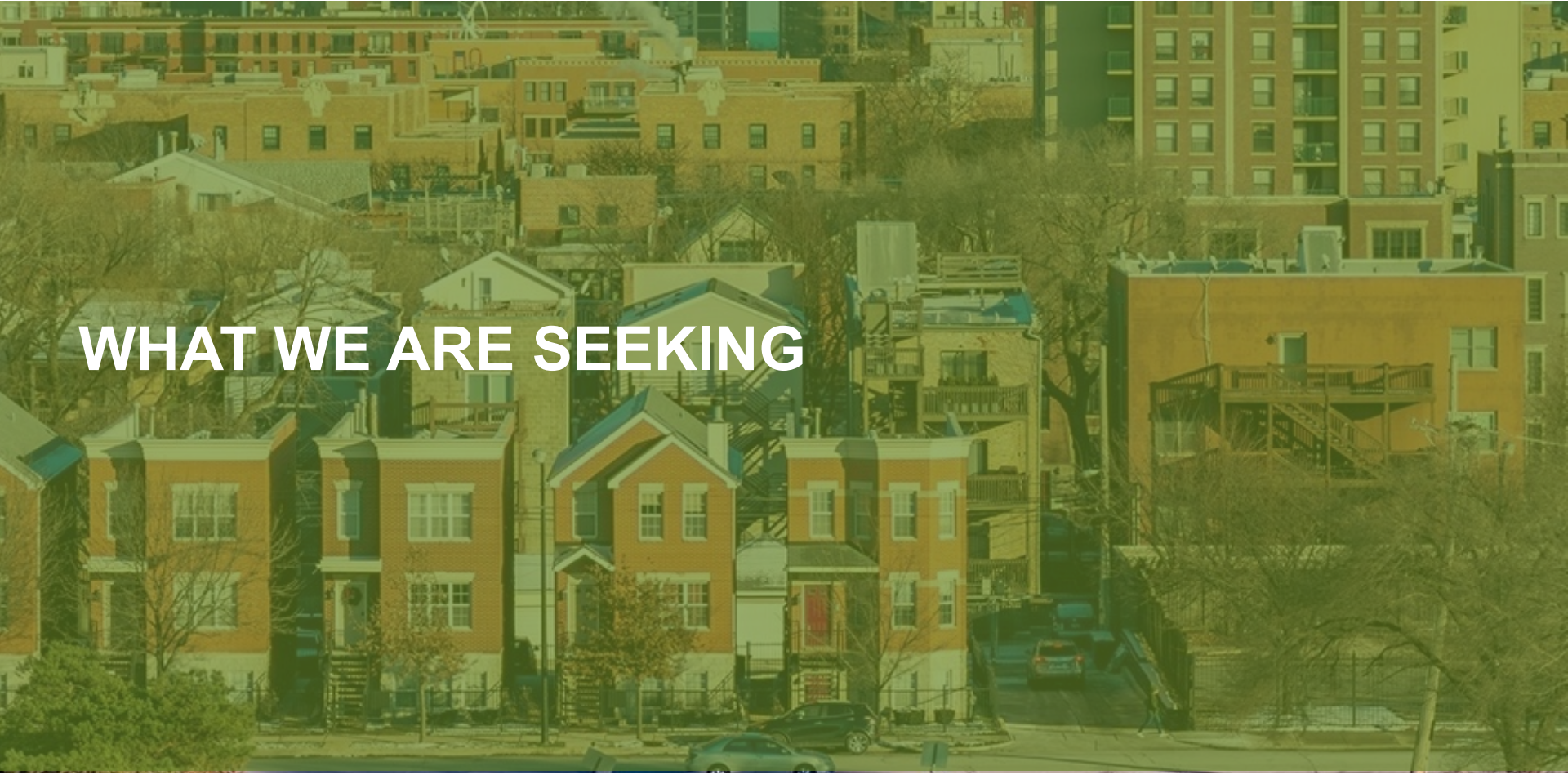
MODELING THE IMPACT OF DECISIONS

Linking physical models with Agent-based Decision Model (Macal and Ozik)



- Incorporate equity and inclusion
- Support decisions towards capital expenditures





WHAT WE ARE SEEKING

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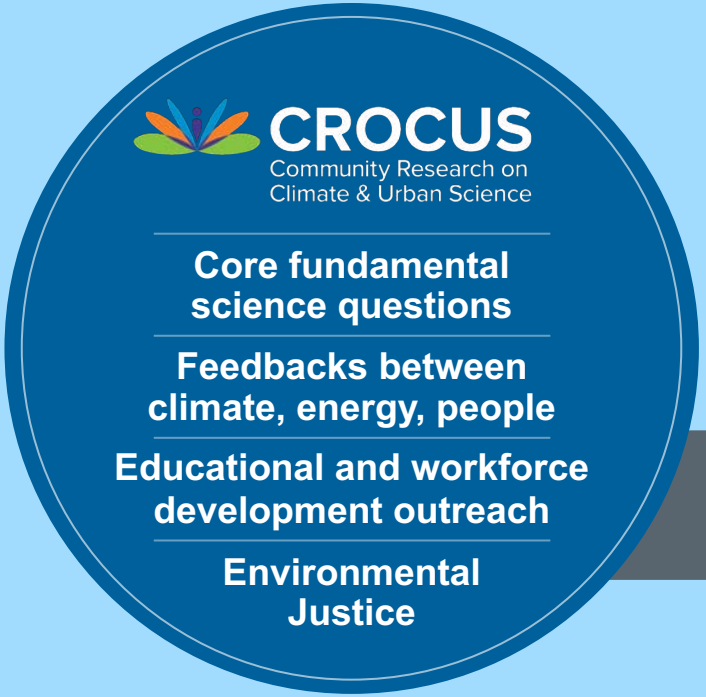
SEEKING COLLABORATIVE RESEARCH

- To identify common interests that advance the science and help the MMC
  - Any important locations for our instruments that help address specific local concerns?
  - Any scenarios for the future where our work help understand risks and ROIs?
  - Any concerns that have nor arisen yet?
  - Any questions that our science could help address?

A CATALYST FOR AN URBAN SCIENCE ECOSYSTEM

Chicago Integrated Field Laboratory



RESEARCH ECOSYSTEM

Broader industry and community participation

OTHER RESEARCH OPPORTUNITIES

Broader science and translational research

Health, access to transport, grid resilience, social sciences, and others

DATASETS AND MODELS APPLIED BEYOND CROCUS FUNDING →

DISCUSSION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