2016 Annual Conference

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56. Data Sources toward Urban-Scale Energy Modeling II

Urban Microclimate for Building Energy Models

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Learning Objectives

Objective 1. Identify what building information is needed to create energy models that provide useful results at an urban scale

Objective 2. Understand if and how urban scale energy modeling can augment building-level audits, meter data analysis, and benchmarking

Objective 3. Understand how geographic information and simplified building energy models can be integrated for urban scale building energy modeling, and how urban context would affect aggregated energy consumption

Objective 4. Explain the relationship between microclimate and building energy use

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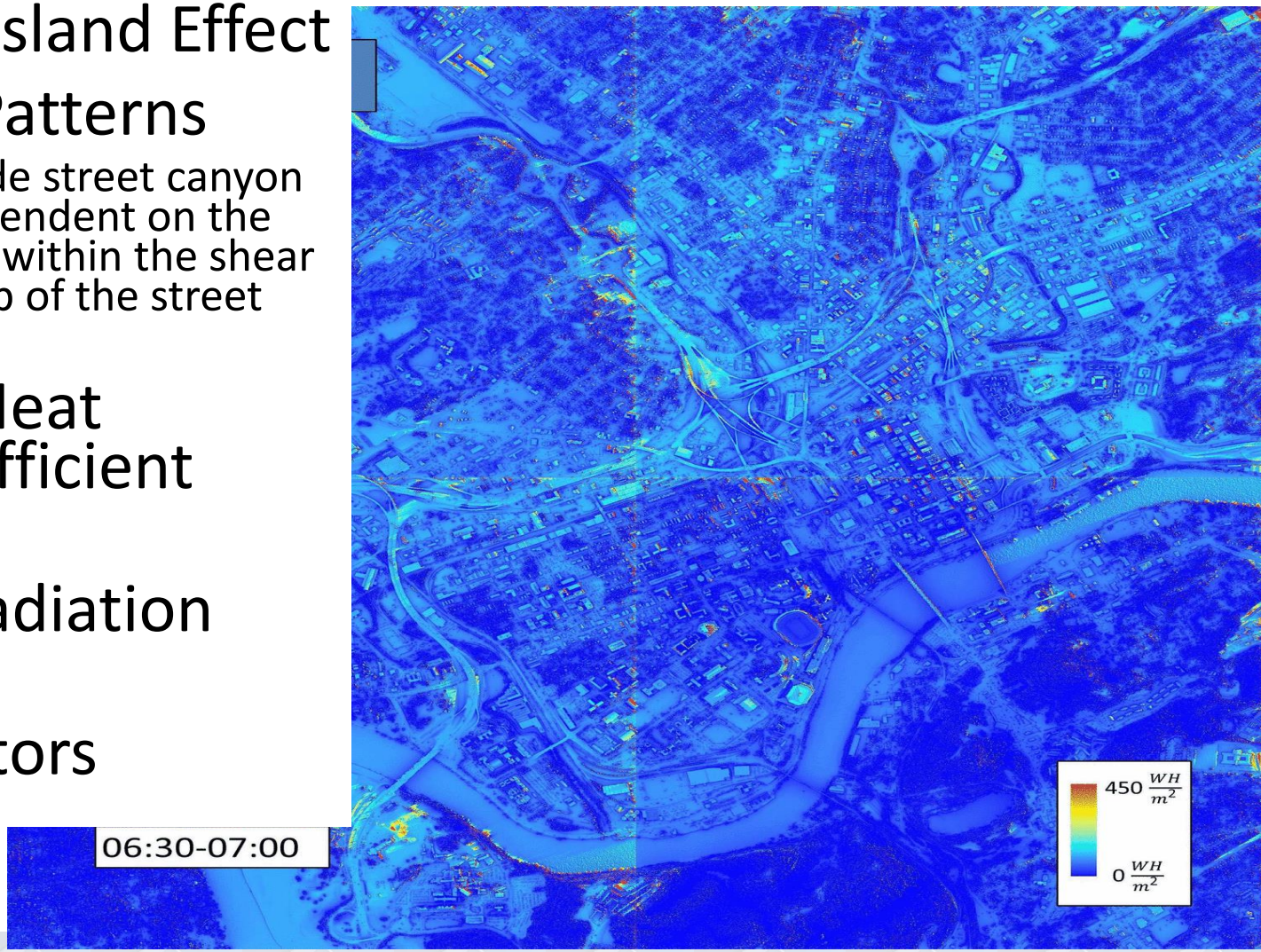
Outline/Agenda

- Modeling Urban Micrometeorological Processes
- Microclimate Projections for Future Energy Use
- Urbanization Projections for Future Energy Use
- Energy-efficient Urban Morphological Development
- Analysis and Visualization

Modeling Urban Micrometeorological Processes: Key Variables

- Urban Heat Island Effect
- Local Wind Patterns
  - Flow field inside street canyon is strongly dependent on the flow structure within the shear layer at the top of the street canyon.
- Convective Heat Transfer Coefficient (CHTC)
- Longwave Radiation Exchange
- SkyView Factors

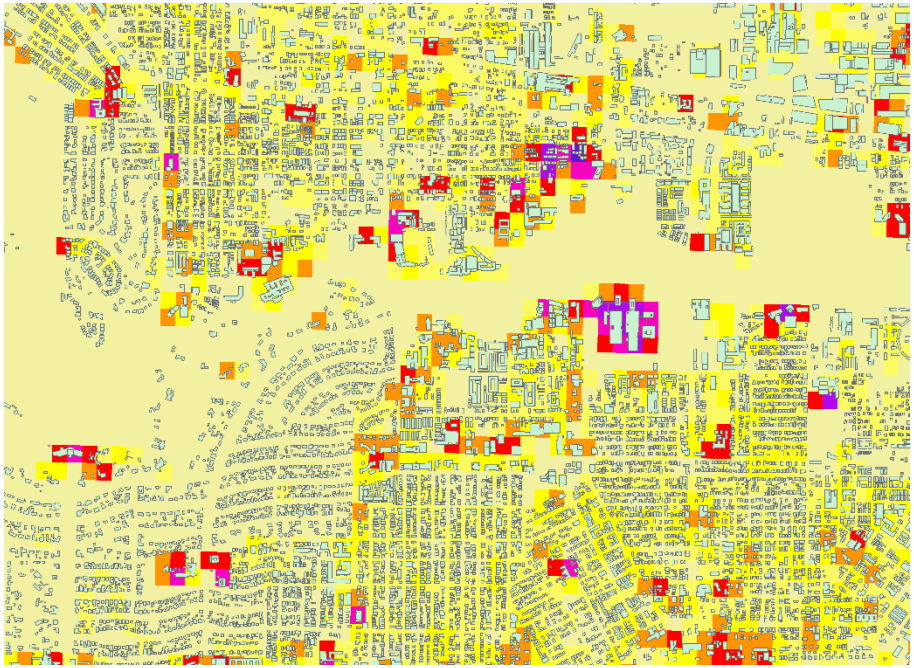


Modeling Urban Micrometeorological Processes: Popular Approaches

- CFD
  - Envi-MET
    - (GUI) separate from 3D modelling interfaces used by designers to model massing designs.
    - Limited utility for integrated architectural design with energy considerations
  - COMSOL
  - RANS, LES
- WRF
  - Meso to microscale
  - WRF-LES
  - WRF BEP/BEM

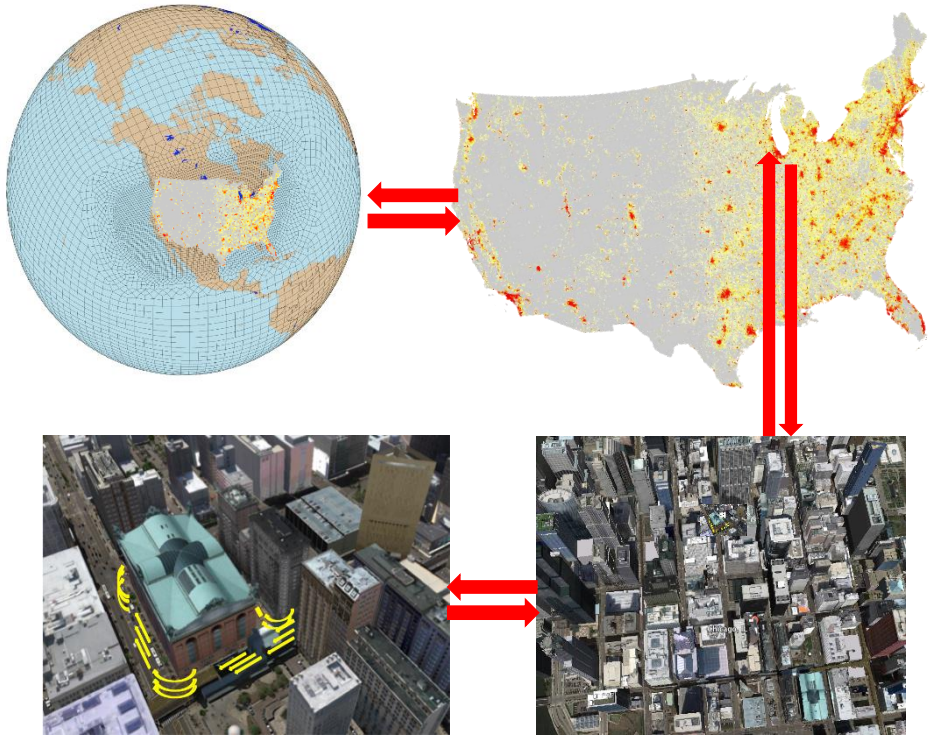
Energy-efficient Urban Morphological Development

- GIS Shapefiles/LiDAR
  - Provide city morphology to microclimate simulation platform
- Cold climates
  - Reduced winter energy demand in buildings due to urban heat island effects
- Warm climates
  - Building Geometry has a large impact on CHTC correlations



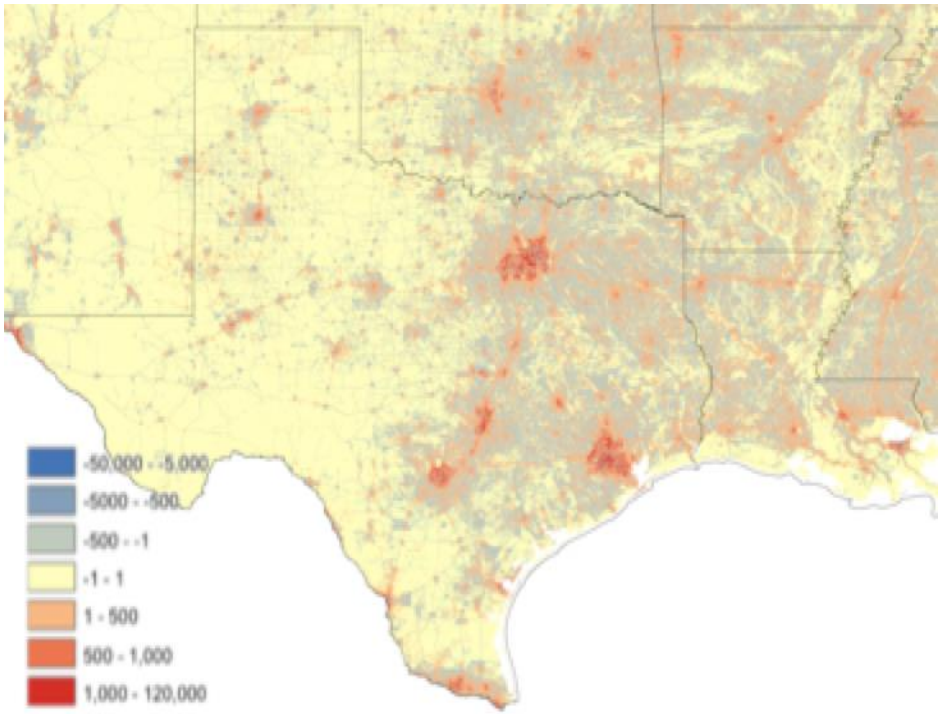
Microclimate Projections for Future Energy Use

- Global Climate Models as boundary conditions
  - CMIP5 Ensemble Members
- Regional model with embedded CFD
  - Downscale to meso and micro

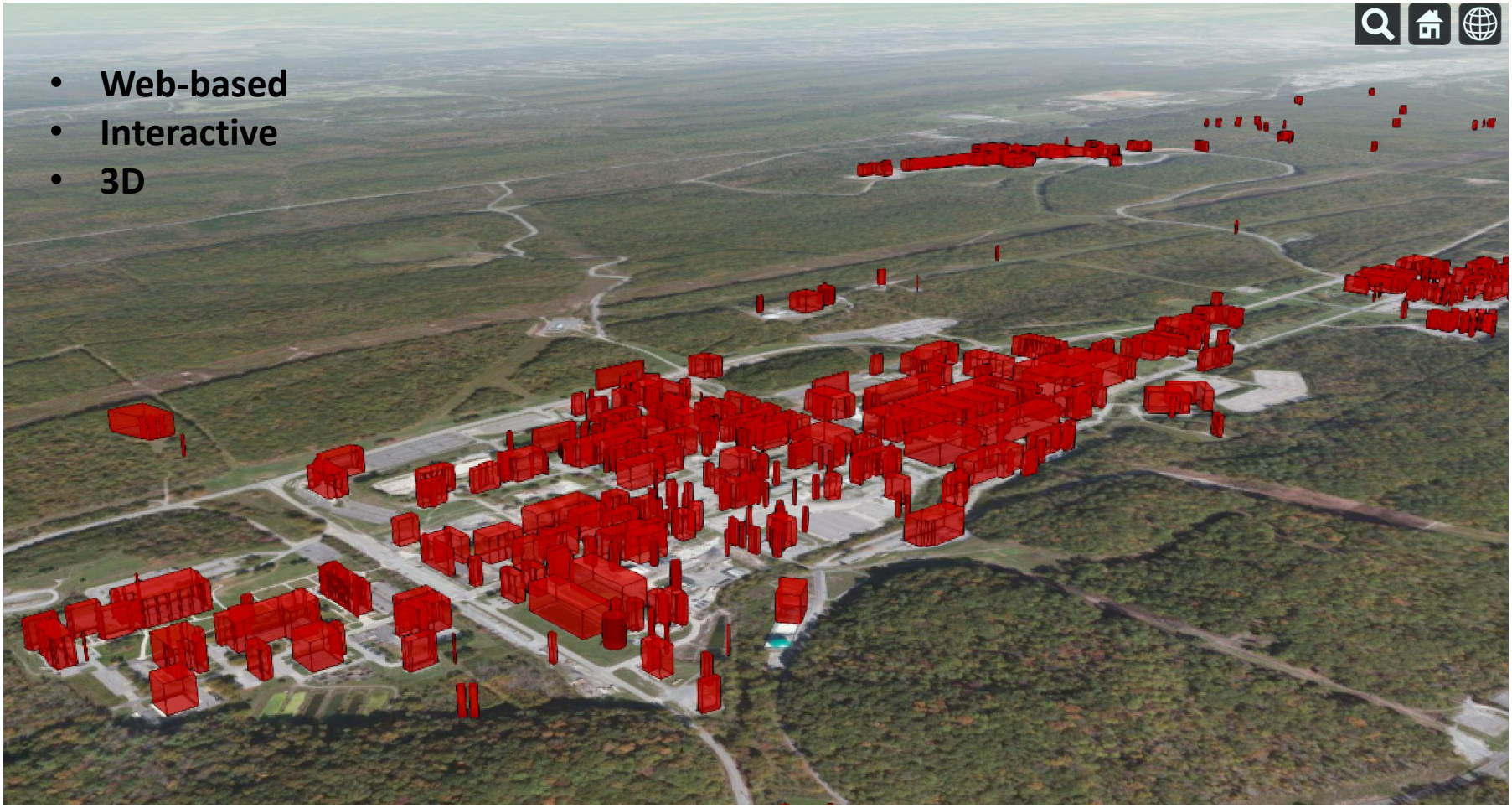


Urbanization Projections for Future Energy Use

- Population, demographics, etc.
  - Dense settlement can afford energy efficiencies by encouraging multi-dwelling living
  - In New York City the average carbon footprint is approximately 6.5 tons per capita in buildings holding the highest concentration of billionaires in the world and those of homeless individuals living less than a mile away
- LandCast
  - Locally adaptive, spatially explicit population predictions



Analysis and Visualization



Conclusions

- We can quantify, at neighborhood resolution, the effect of various microclimate effects and urban morphologies on energy usage for building heating and cooling for cities.
- Using historical data and and projected climate and urban morphology, we can calculate energy savings based on the interaction of these components.
- We can generate recommendations for optimal morphology and expected energy savings under various scenarios.

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Questions?

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Assessment

- Microclimate significantly affects energy consumption of the built environment under typical climate change scenarios.
  - **True** False
- What are common data sources for GIS modeling?
  - Architectural blueprints or floorplans.
  - **Geographical Information Systems (GIS) and image processi**ng.
  - Surveys of building occupants
- What is the most robust way of projecting future temperature and humidity at neighborhood scale?
  - Linear Extrapolation of meteorological observations
  - Probabilistic modeling based on historical data
  - **Dynamical downscaling of climate model output**
- Neighborhood building morphology affects energy use but not climate.
  - True **False**