

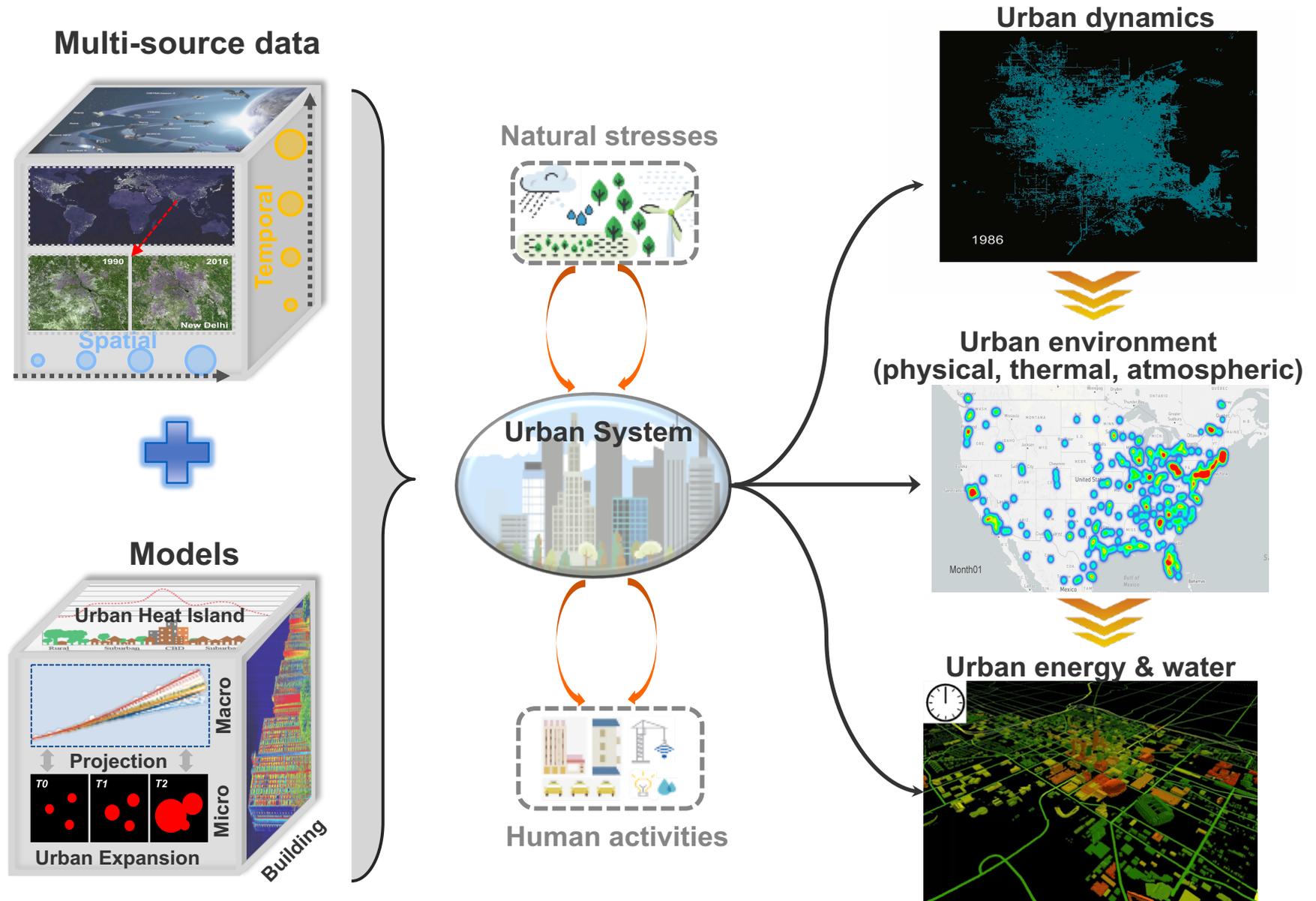
IOWA STATE UNIVERSITY

Dept. of Geological & Atmospheric Sciences

Satellite-supported monitoring and modeling of urban systems

Yuyu Zhou

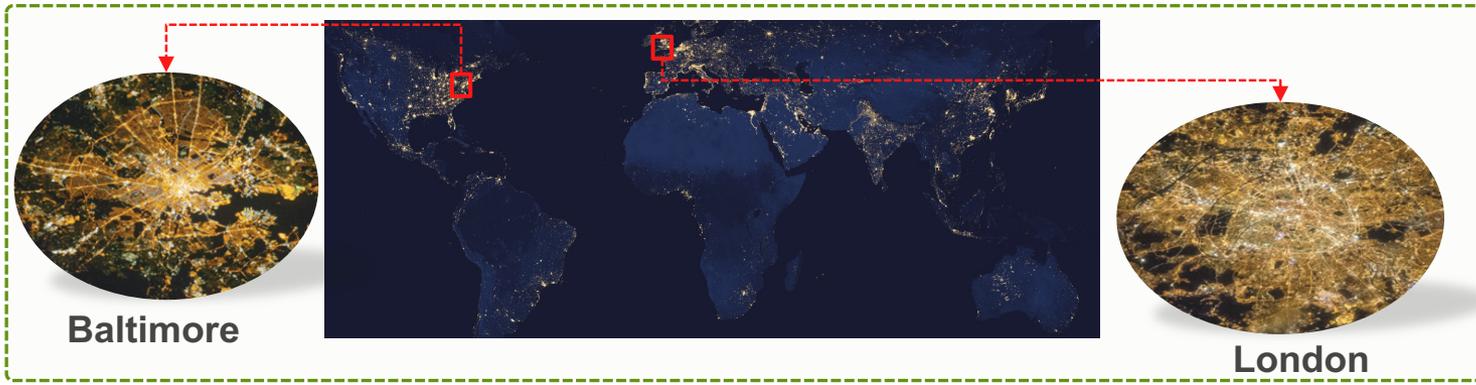
An overview of our research



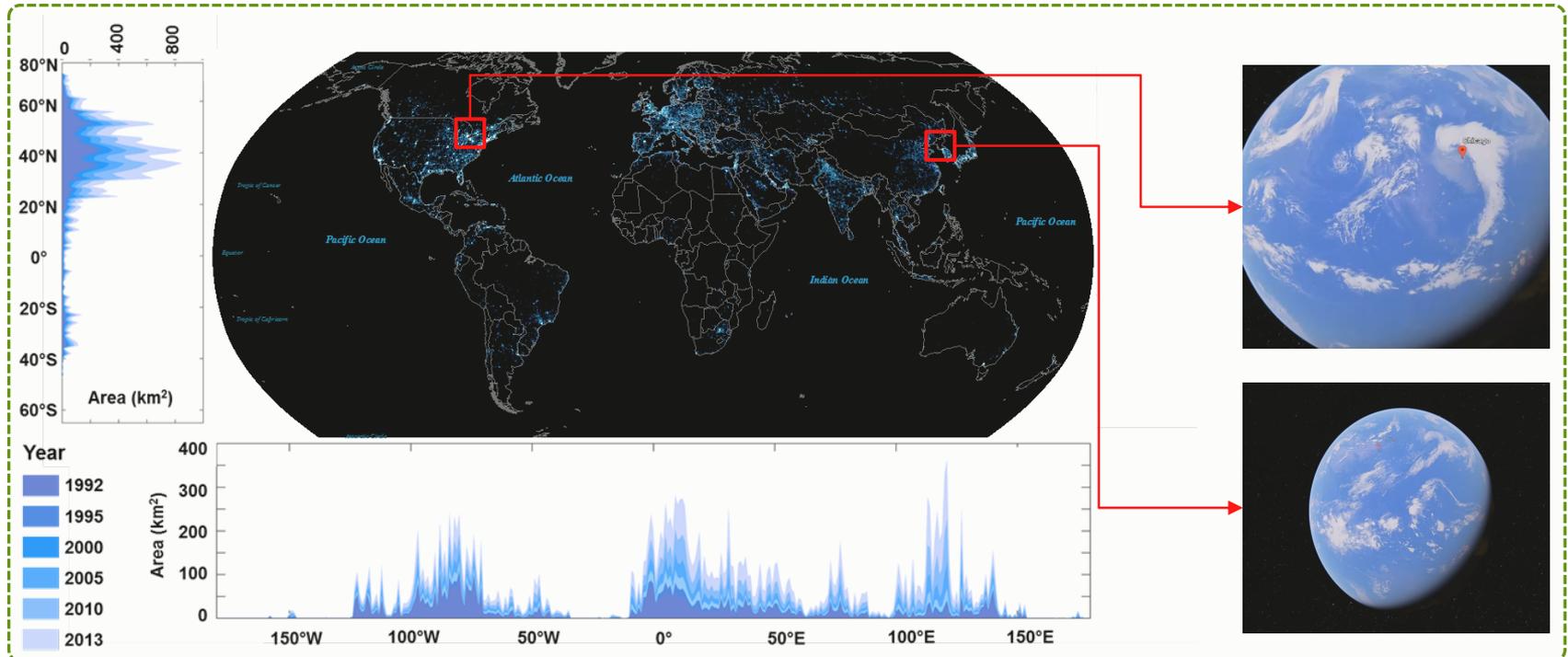
CURRENT PROGRESSES OF OUR URBAN STUDIES

Global urban dynamics from nightlights

Satellite Observed
Nightlights



Annual Urban Dynamics



High-res urban dynamics from Landsat

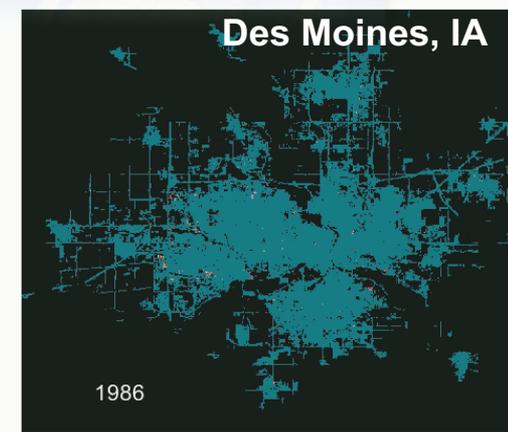
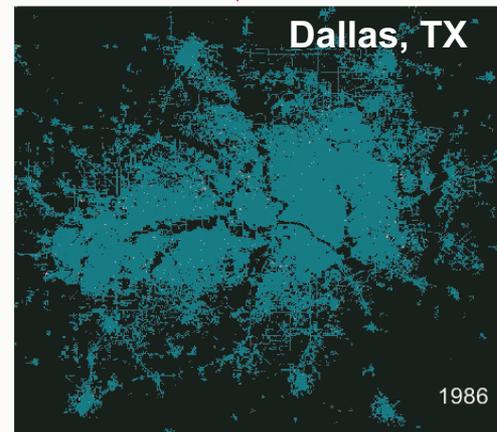
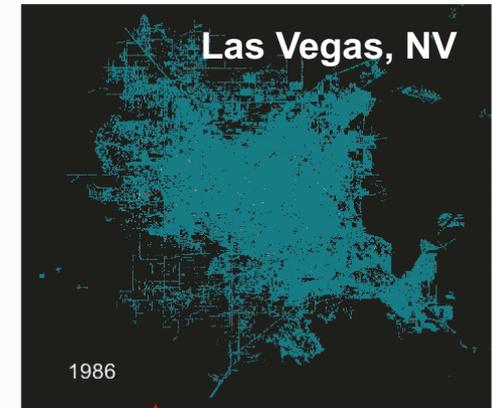
Landsat satellite

- 30-meter, global coverage
- 16-day, 1970s-now
- 1.5M scenes, >1PB



Google Earth Engine

- Cloud platform
- Planetary-scale analysis
- Parallel computation



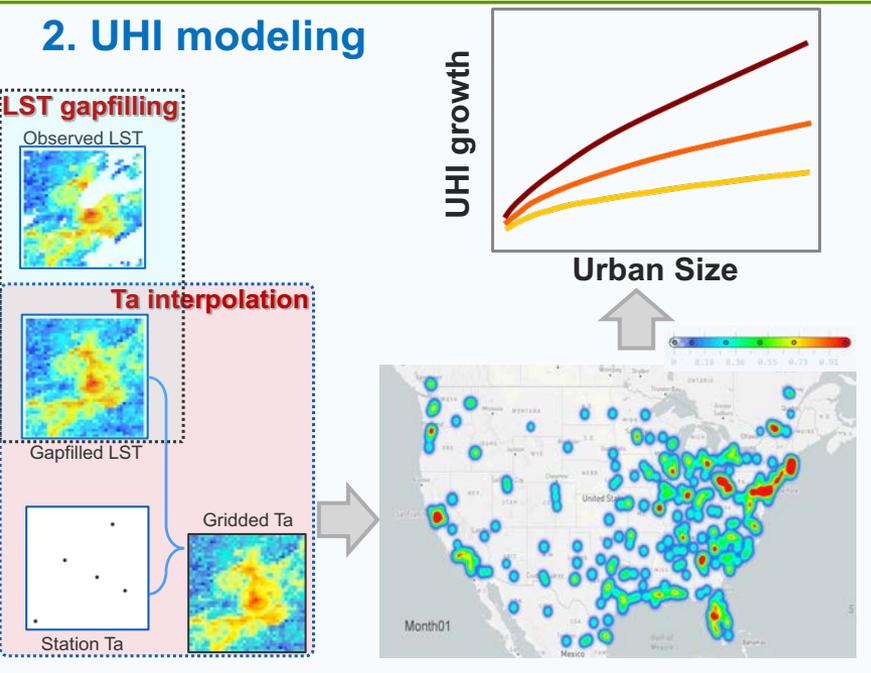
Urban heat island (UHI) impacts on building energy use using GCAM

1. Urban area demand modeling



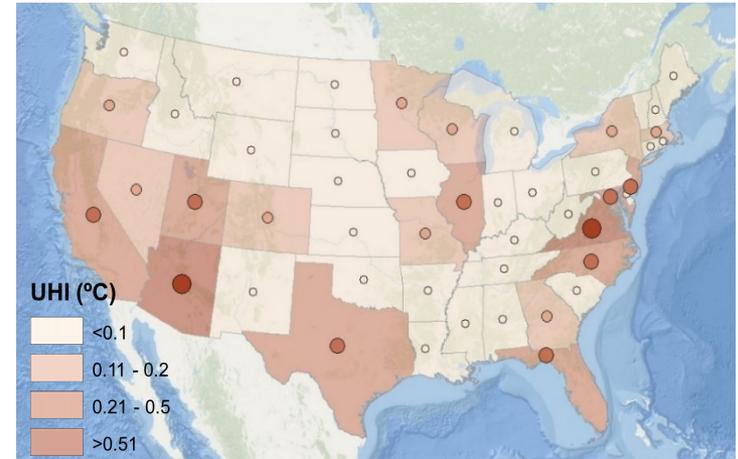
+

2. UHI modeling



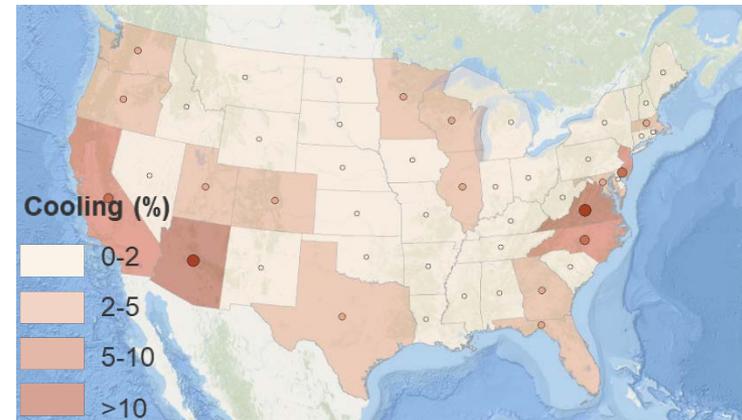
LST: land surface temperature
Ta: air temperature

Change of population weighted UHI in 2050

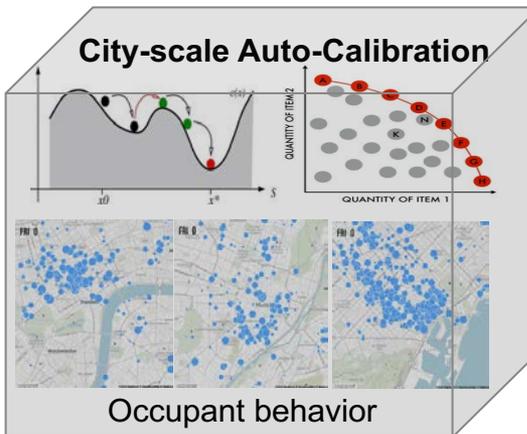
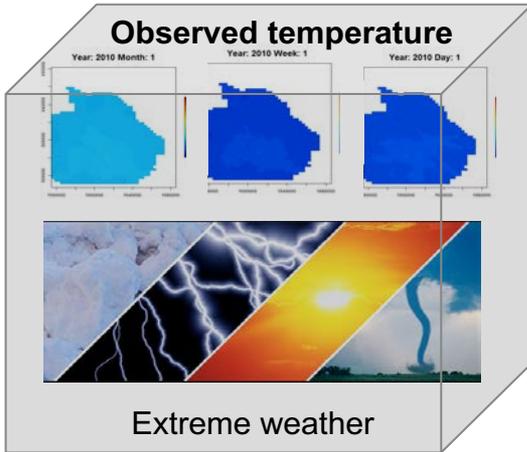


GCAM-USA

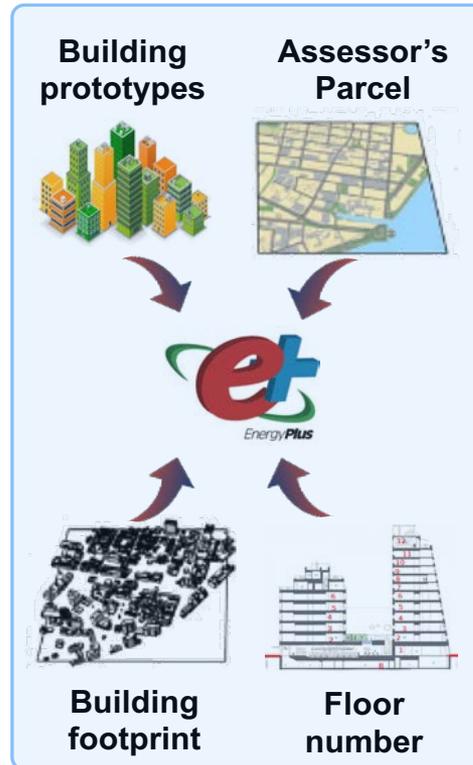
Change (%) in cooling energy use under UHI



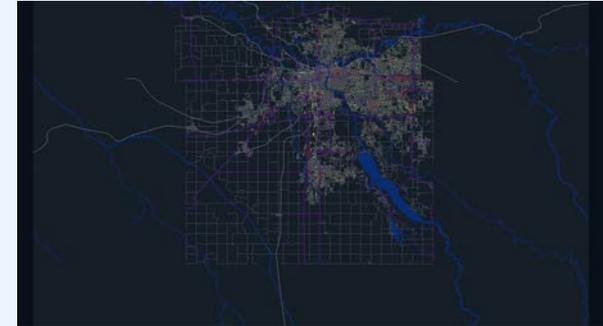
Fine scale modeling of urban system (building energy use)



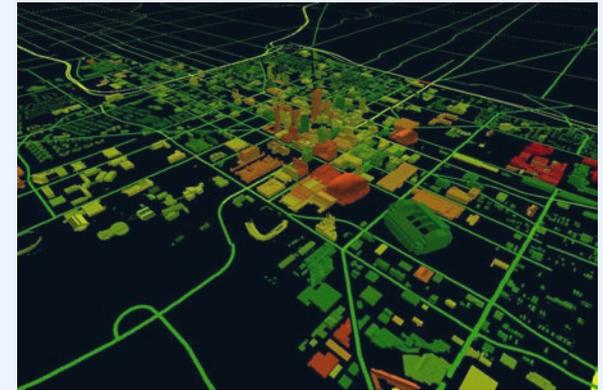
CityBEUM



Spatial pattern

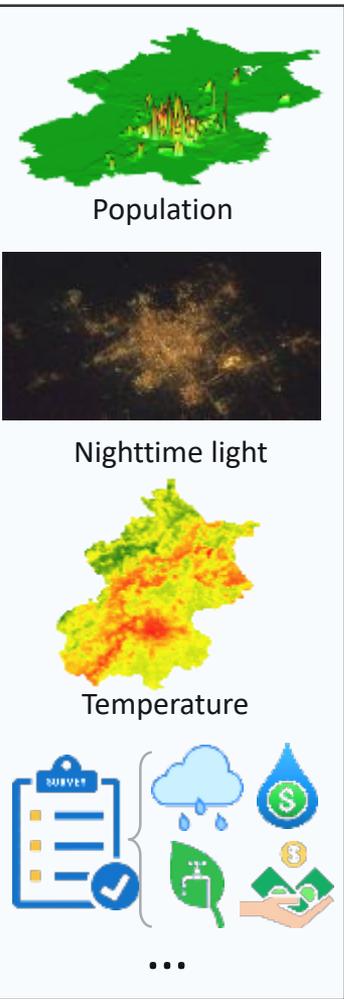


Temporal pattern

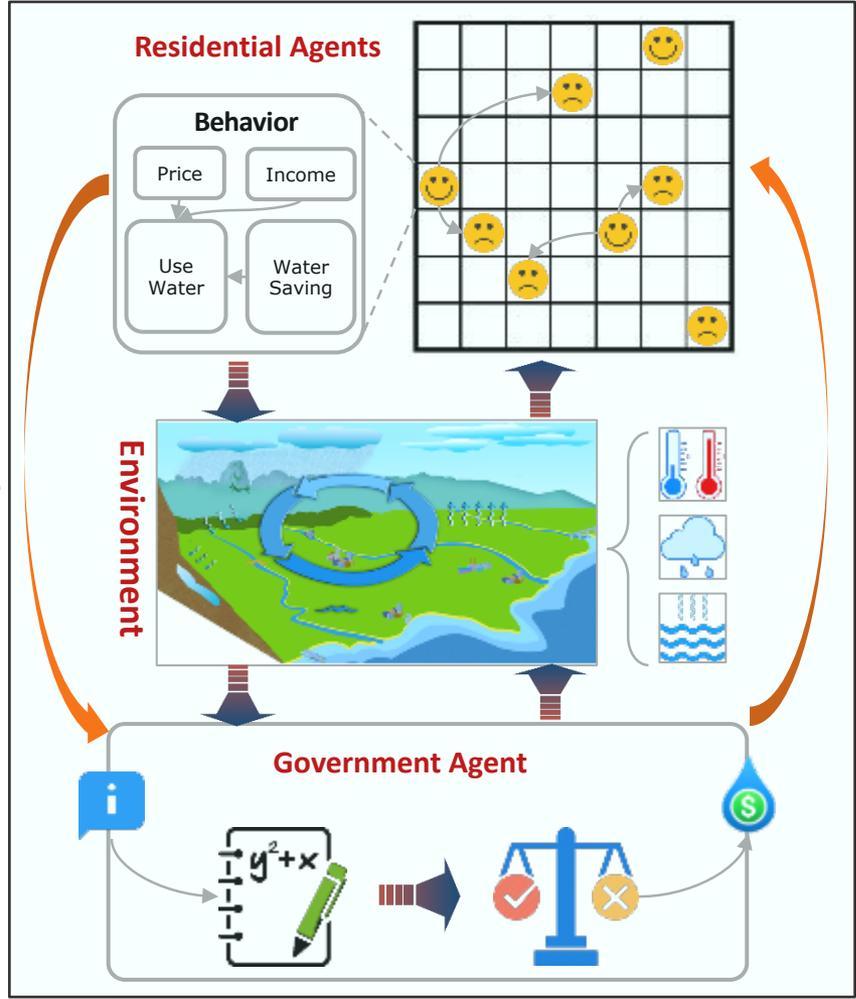


Fine scale modeling of urban system (domestic water use)

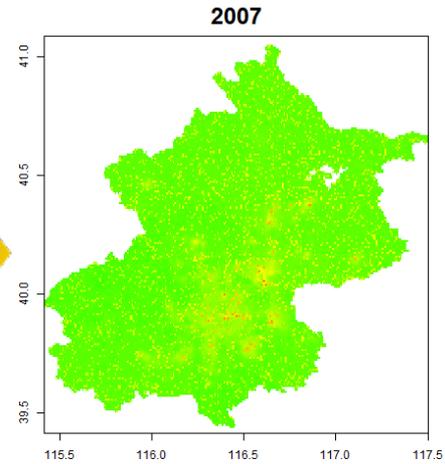
Data



Agent based model



Water use



NEEDED INNOVATIONS: DATA & MODELING

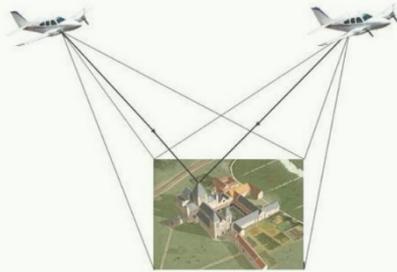
From 2D urban to 3D urban

Radar
(Global)

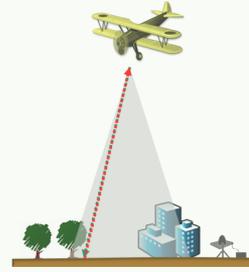


Stereo image

(Local)



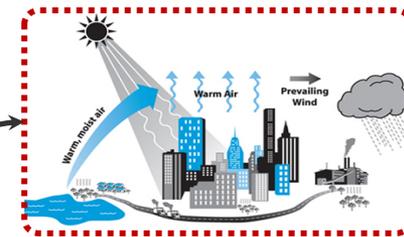
LiDAR



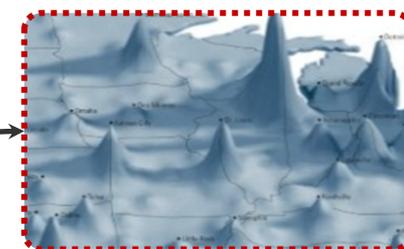
Earth System Modeling



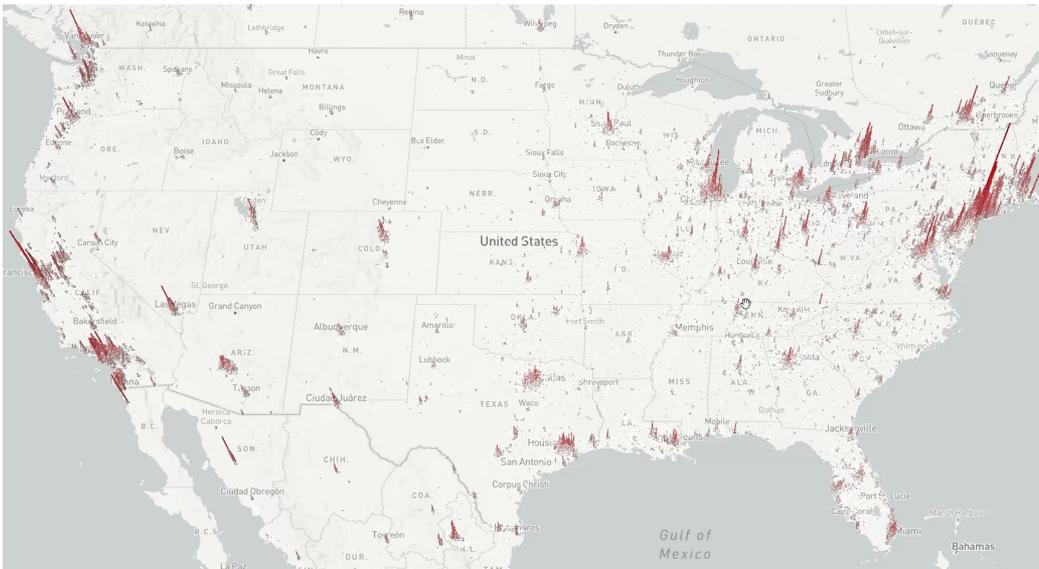
City Weather Modeling



Population Distribution



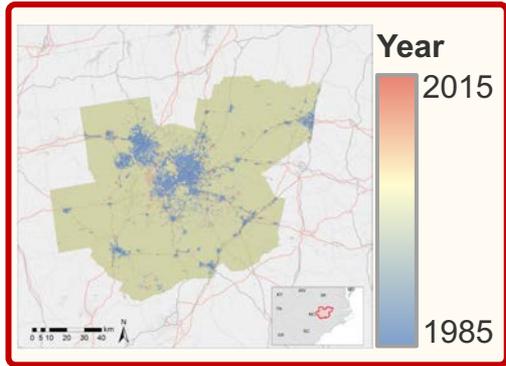
Building Energy Use



From historical -> future

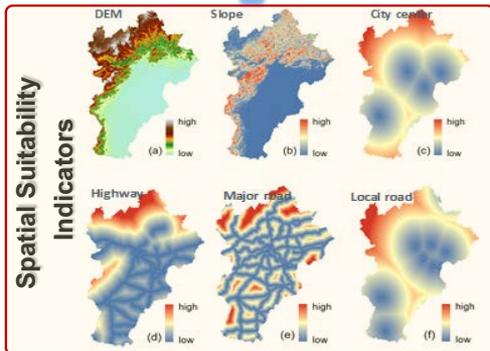
From urban extent -> landscape & more

Historical Urban Extents



Regional Socioeconomic drivers
(e.g., pop, GDP)

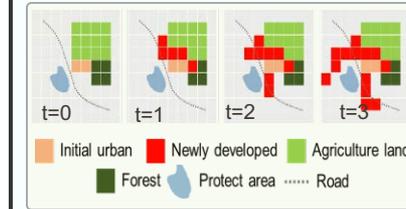
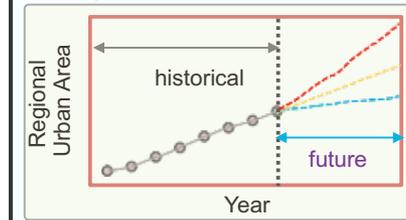
Policies & planning



Others: e.g., socialmedia, OSM, POI, height



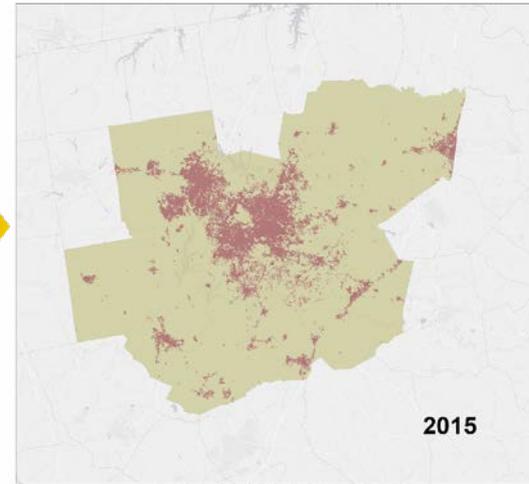
The top-down sub-model



The bottom-up sub-model

UrbanS2M

Future Urban Dynamics



Total Impervious Surface



Effective Impervious Surface



Urban Landscape



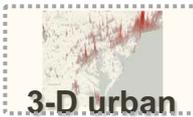
Urban Form



Urban Density

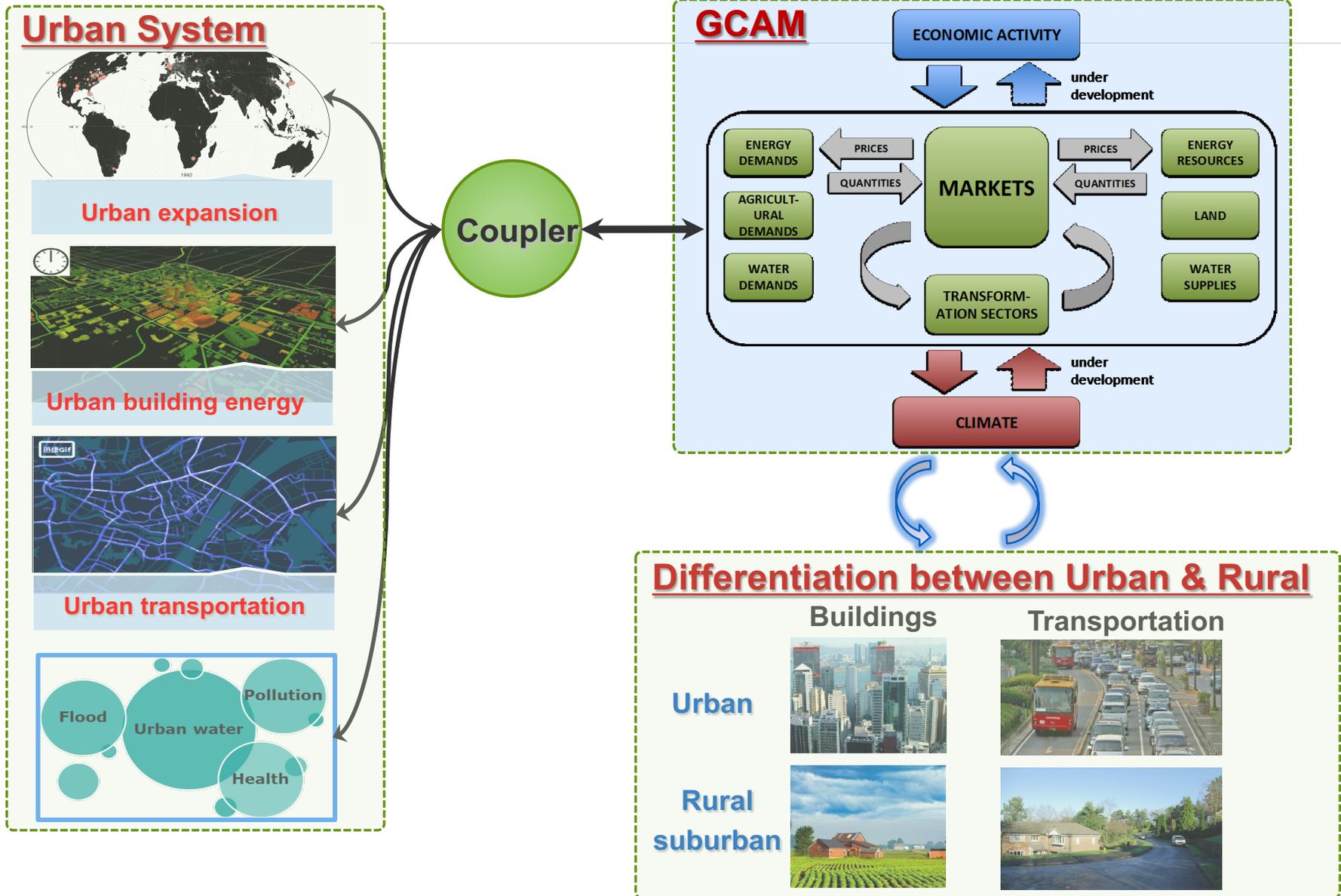


Function types



3-D urban

Coupling urban system modeling in Multi-Sector Dynamics Modeling (GCAM)



Thank You