Understanding Urban Building Anthropogenic Heat with Advanced Geospatial Modeling and Big Earth Observations Data
Important Role of Building Anthropogenic Heat

Background

Buildings have been included into a positive feedback loop with Urban heat island (UHI) effect. Increased cooling energy use & anthropogenic heat.
Important Role of Building Anthropogenic Heat

Until 2040

60% Total Building Floor Area
40% Building Energy Efficient

Urban Heat Island (UHI) Effect

© International Energy Agency
Implications of Understanding Building Anthropogenic Heat

Implementing building energy-saving strategies can effectively mitigate urban heat.
Challenges of Understanding Building Anthropogenic Heat

*Heating, ventilation, and air conditioning (HVAC)*
Building Energy Simulation

- Building prototypes with different functions
- Each building prototype provides a detailed description of construction materials, operational schedules, and the air conditioning system

Weather Prediction

- Weather Research and Forecasting (WRF)
Study Area and Data

**GIS**
- Boston government, Building footprint data
- Boston government, Accessor’s Parcel data

**Remote Sensing**
- Albedo, leaf area index, green fraction
- Land cover & land use

**Building Information**

**Building Prototypes**
- U.S. Department of Energy (DOE), Commercial Building Prototypes
- Pacific Northwest National Laboratory (PNNL), Residential Building Prototypes

**Building Energy Survey**
- U.S. Energy Information Administration (EIA), Residential Energy Consumption Survey (RECS) in 2009
- EIA, Commercial Building Energy Consumption Survey (CBECS) in 2012

**METHOD**

**GIS**
- Land Surface Properties
  - Albedo, leaf area index, green fraction
  - Land cover & land use
After calibration, modeled-actual Energy use intensity (EUI) for all building prototypes ranged from -8.2% to 9.8% for electricity and -10% to 7.7% for natural gas.
RESULTS

Monthly/hourly Building Anthropogenic Heat

- **Total Heat Emissions**
  - Envelope
  - Zone
  - HVAC System

**Hottest day:** July 17, 2012
**Coldest day:** Jan. 15, 2012

*Heating, ventilation, and air conditioning (HVAC)*
RESULTS

Annual Building Anthropogenic Heat Map

Energy-saving strategies

- Apply cool wall coating
- Apply insulation
- Add air sealing to seal leaks
- Natural ventilation schedule
- Plug load upgrade
- Cooling efficiency upgrade
- Smart thermostat schedule

*Heating, ventilation, and air conditioning (HVAC)
During heat wave days, the presence of the UHI effect could lead to up to 32% increase in cooling anthropogenic heat.
THANKS!

QUESTION?

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