Image source: Landsat-based Urban False Color

Urban Climate and Humans: Observing and modeling urban climate and its impacts on New York City during heat waves

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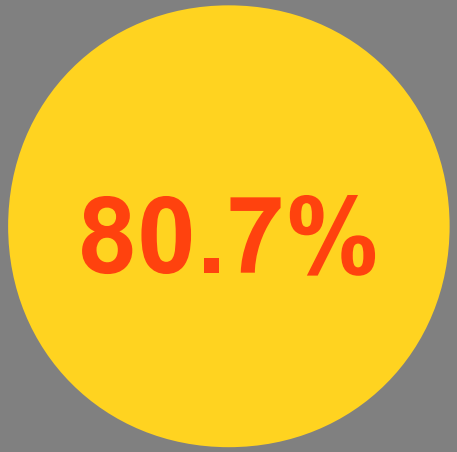
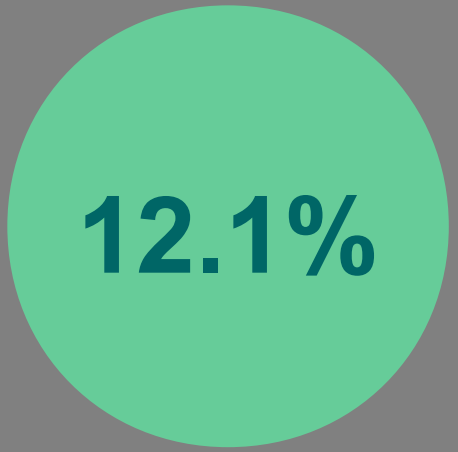
CUERG Coastal Urban Environmental Research Group

NOAA-CREST

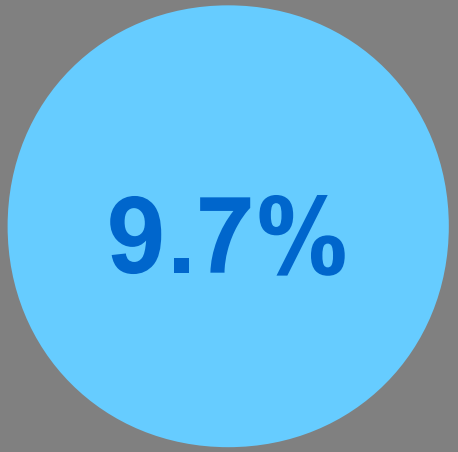
Why do we study urban climate?



U.S. Population in urban areas

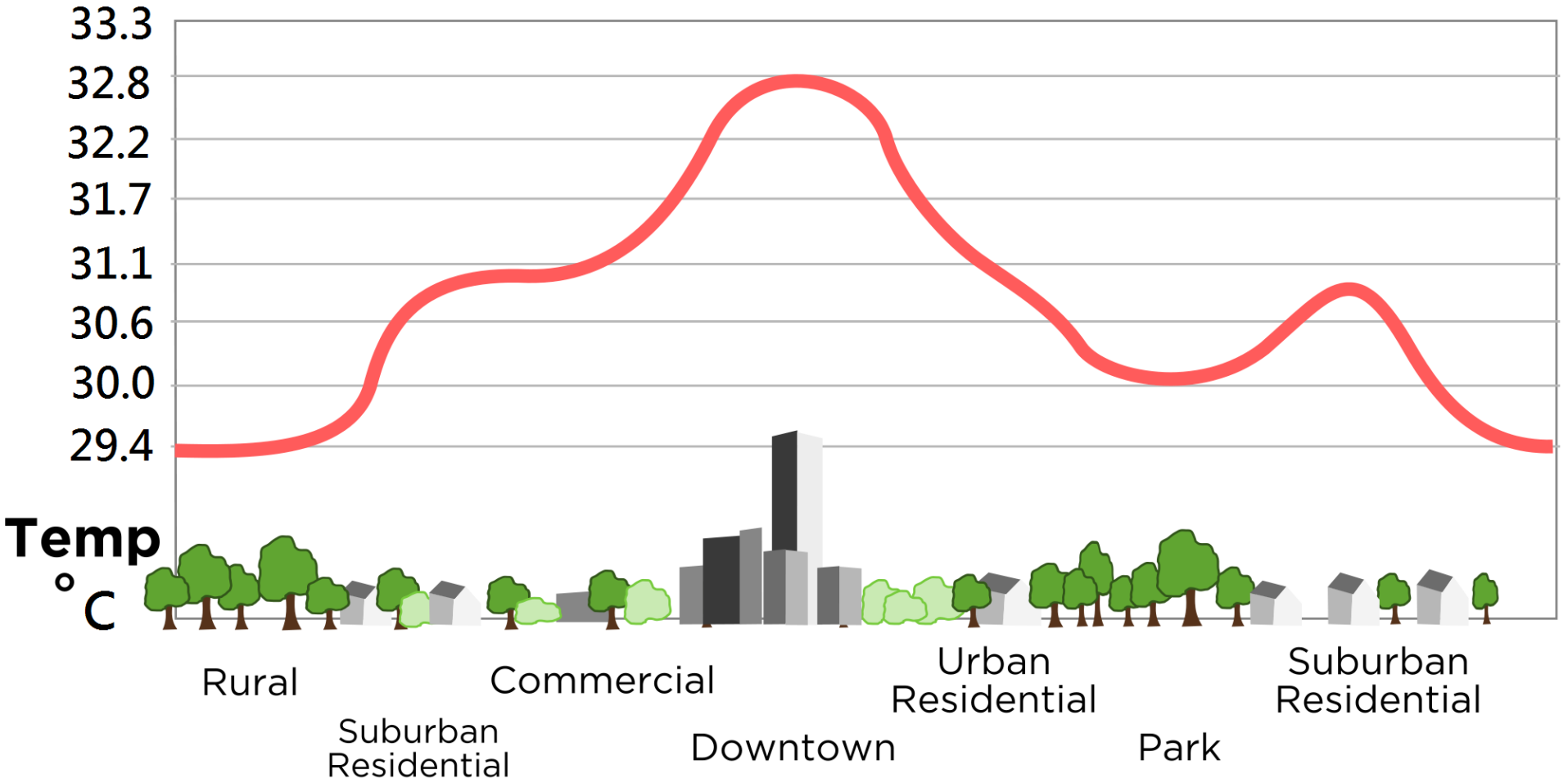


Urban population growth rate



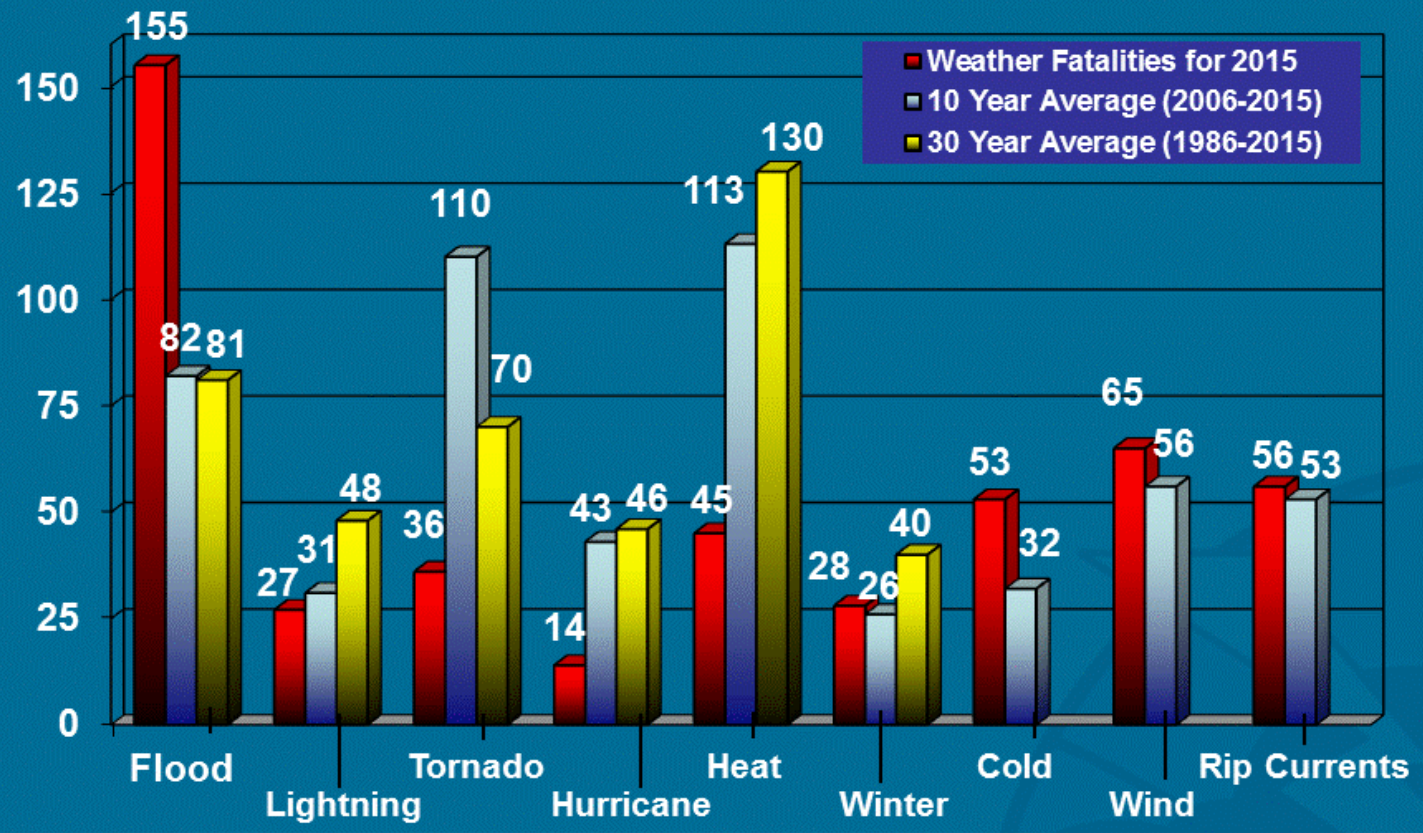
Rural population growth rate

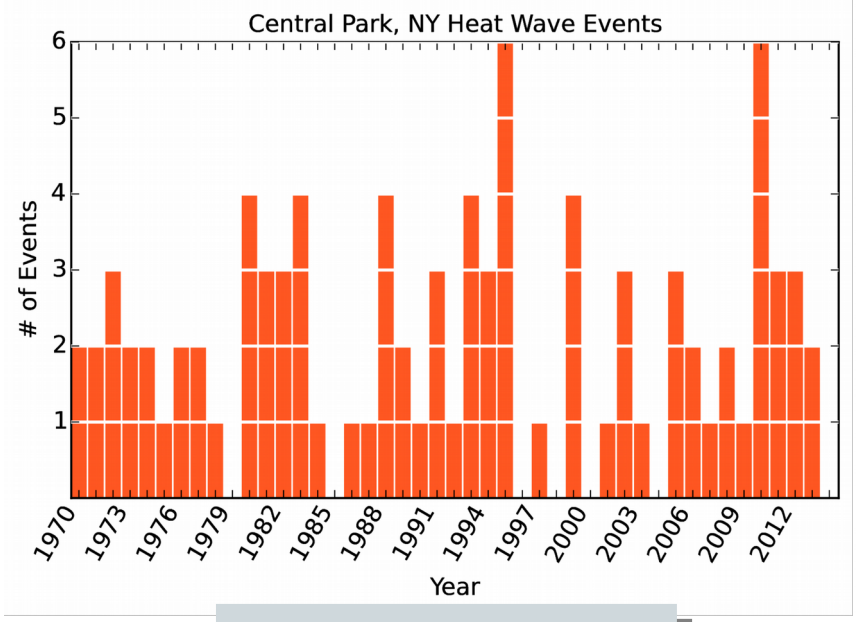
URBAN HEAT ISLAND PROFILE



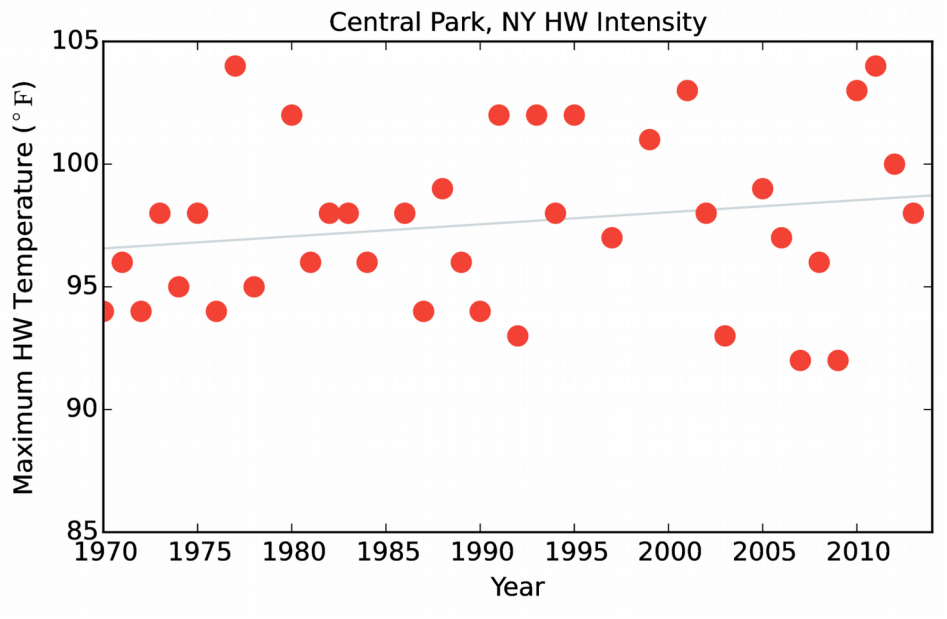
Source: Adapted from NOAA, public domain

Weather Fatalities





.1 events/decade*



.49 °F/decade

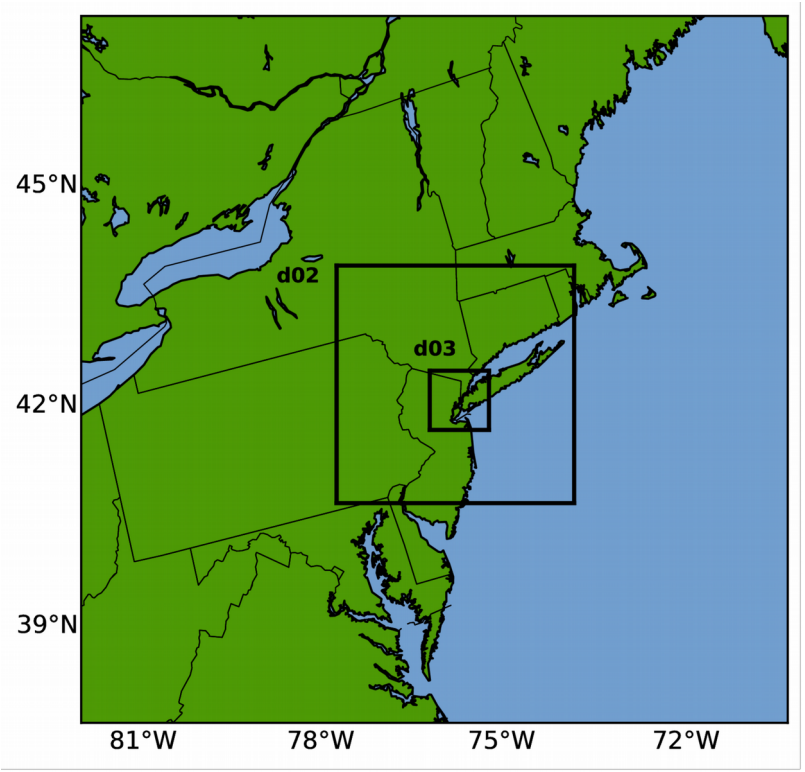
*Taken only from years with heat wave events.

Simulation Setup

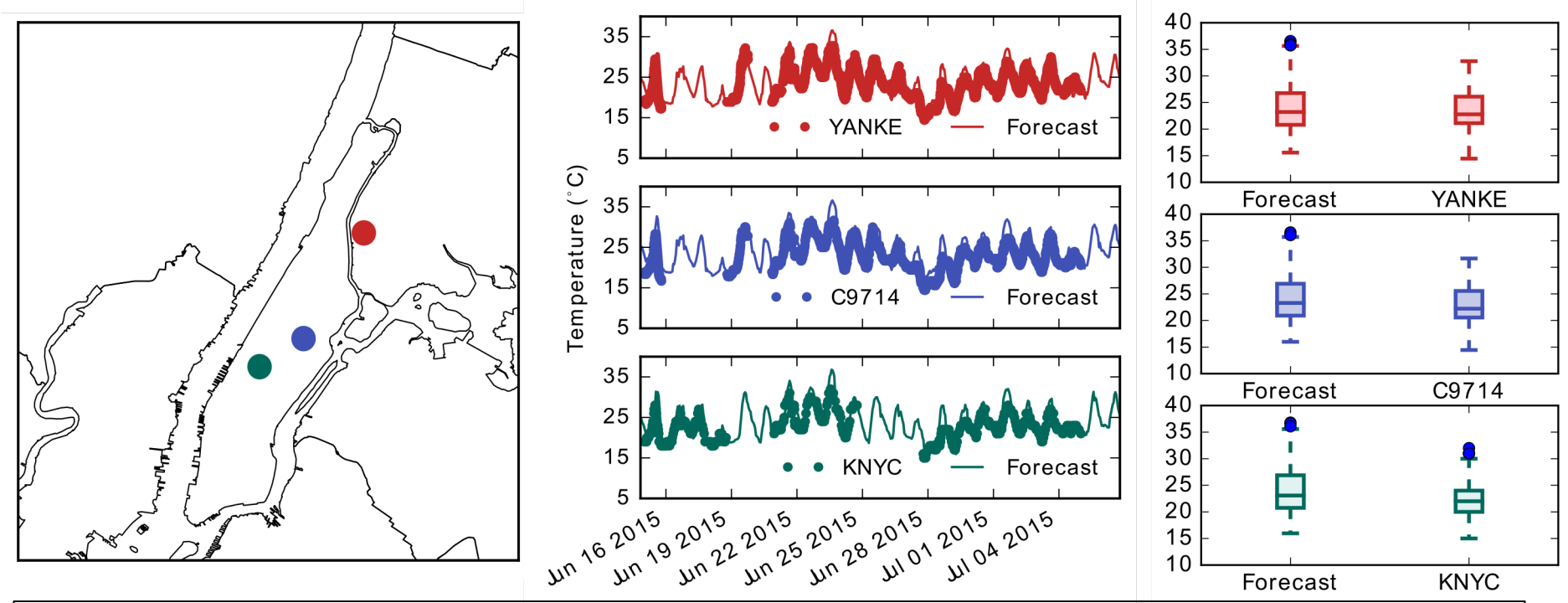
- ***Weather Research and Forecast Model (WRF) version 3.5.1***
- **Three domains (2 nests)**
  - D01: **Δx: 9 km** (1071 x 1071 km)
  - D02: **Δx: 3 km** (360 x 360 km)
  - D03: **Δx: 1 km** (90 x 90 km)

- **Model Physics Options**
  - Kain-Fritsch Cumulus (off in D03)
  - WSM6 Microphysics
  - BouLac PBL
  - RRTM Longwave
  - Dudhia Shortwave
  - Building Environment Parameterization and Building Energy Parameterization

- **Urban Morphology from PLUTO**



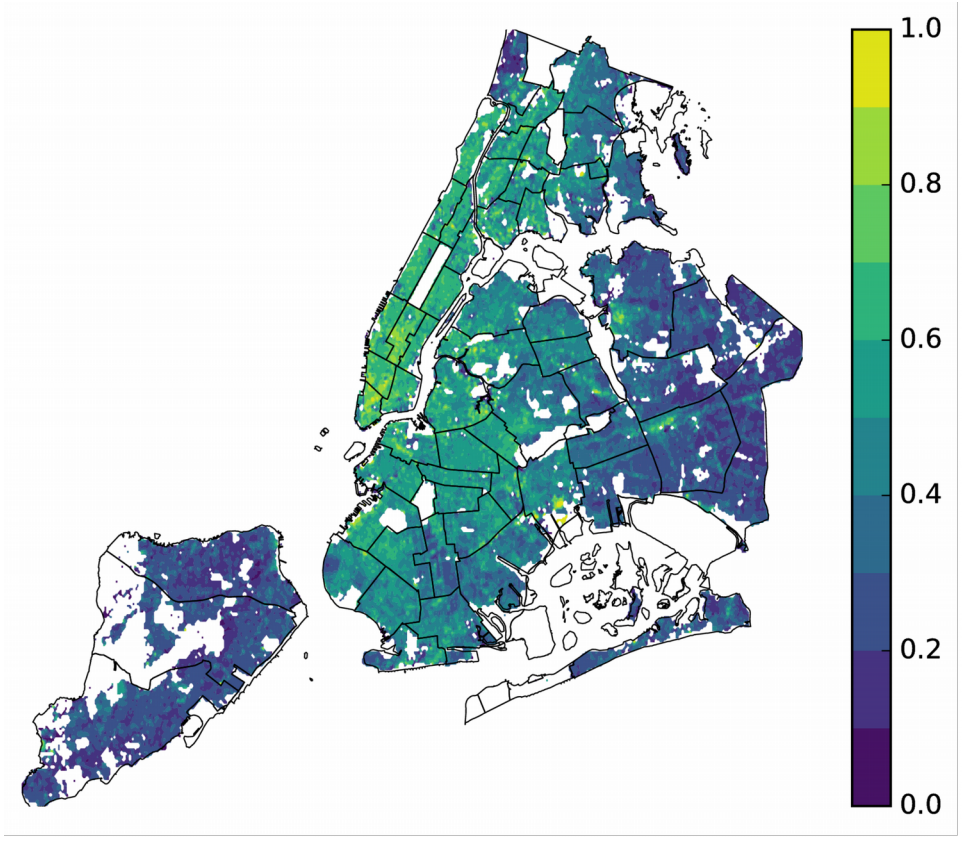
Validation: 2 m Air Temperatures



Distribution of model temperatures is close to the model interpolated values.
The model slightly overestimates the temperatures on some days.

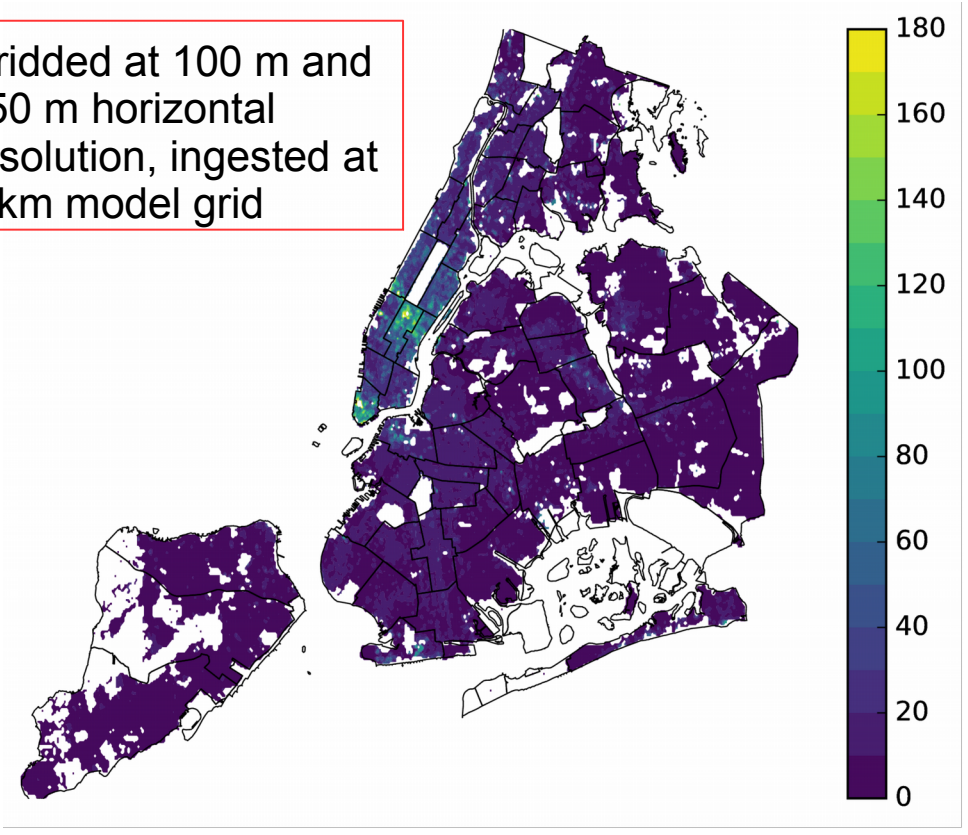
Incorporating Urban Morphology: NYC PLUTO

Building Grid Area Fraction

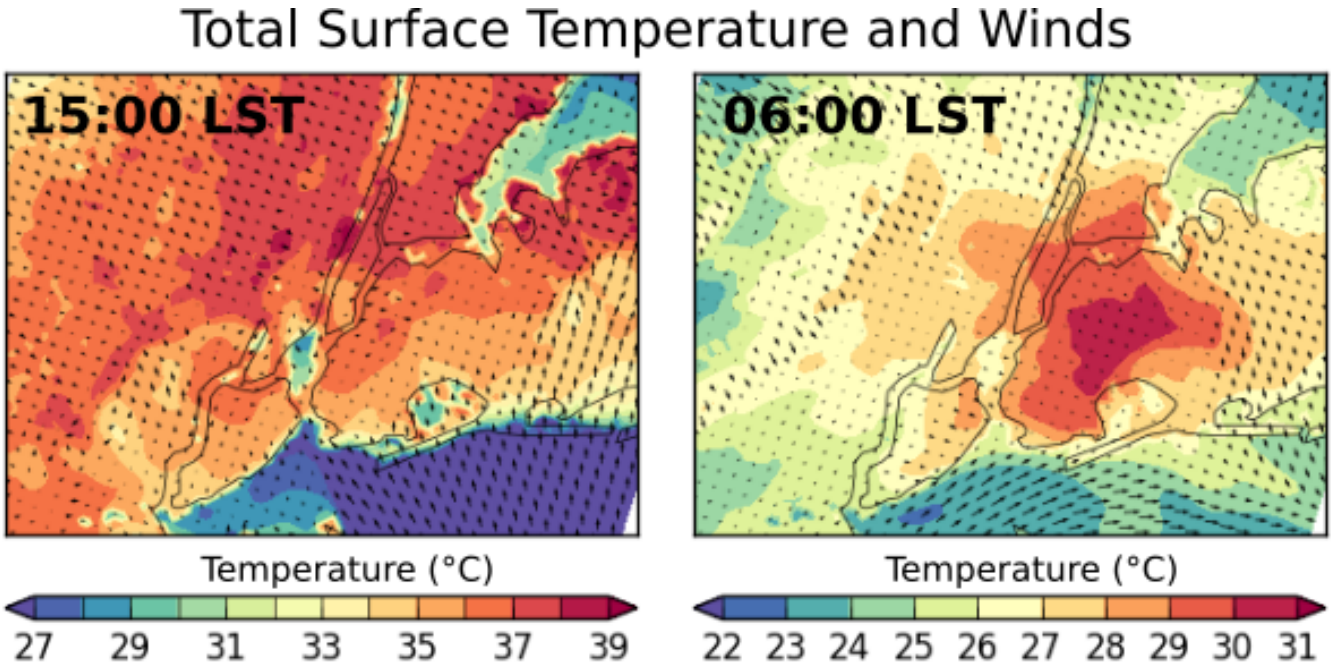


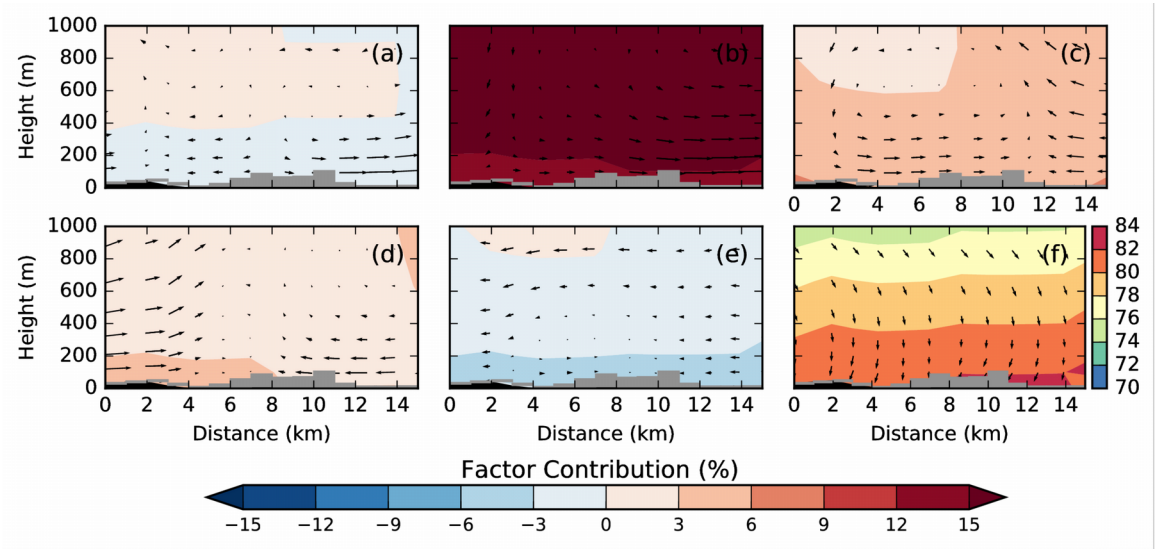
Building Grid Height (m)

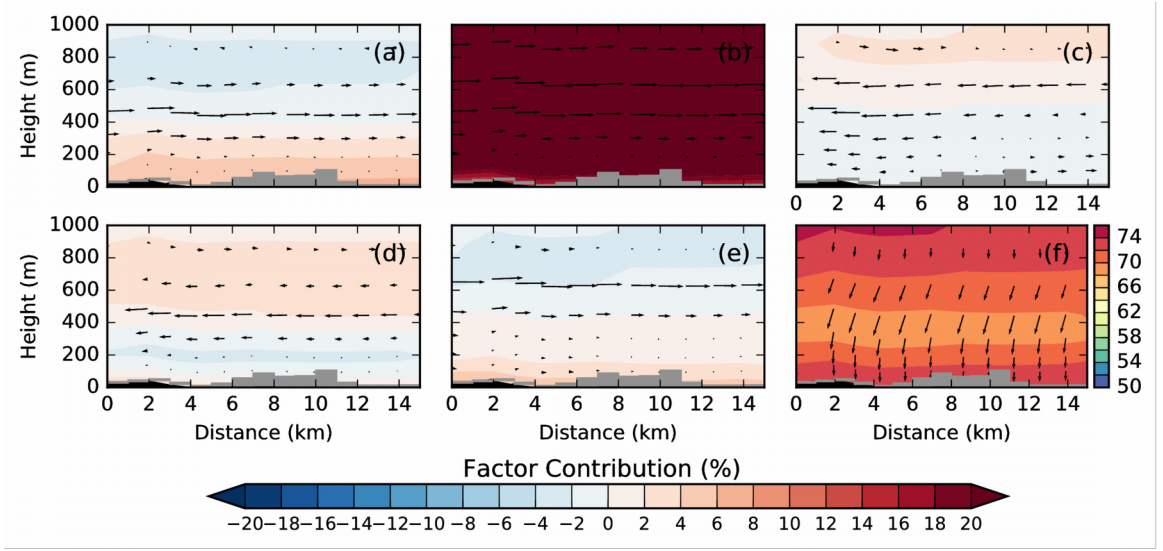
Gridded at 100 m and 250 m horizontal resolution, ingested at 1 km model grid



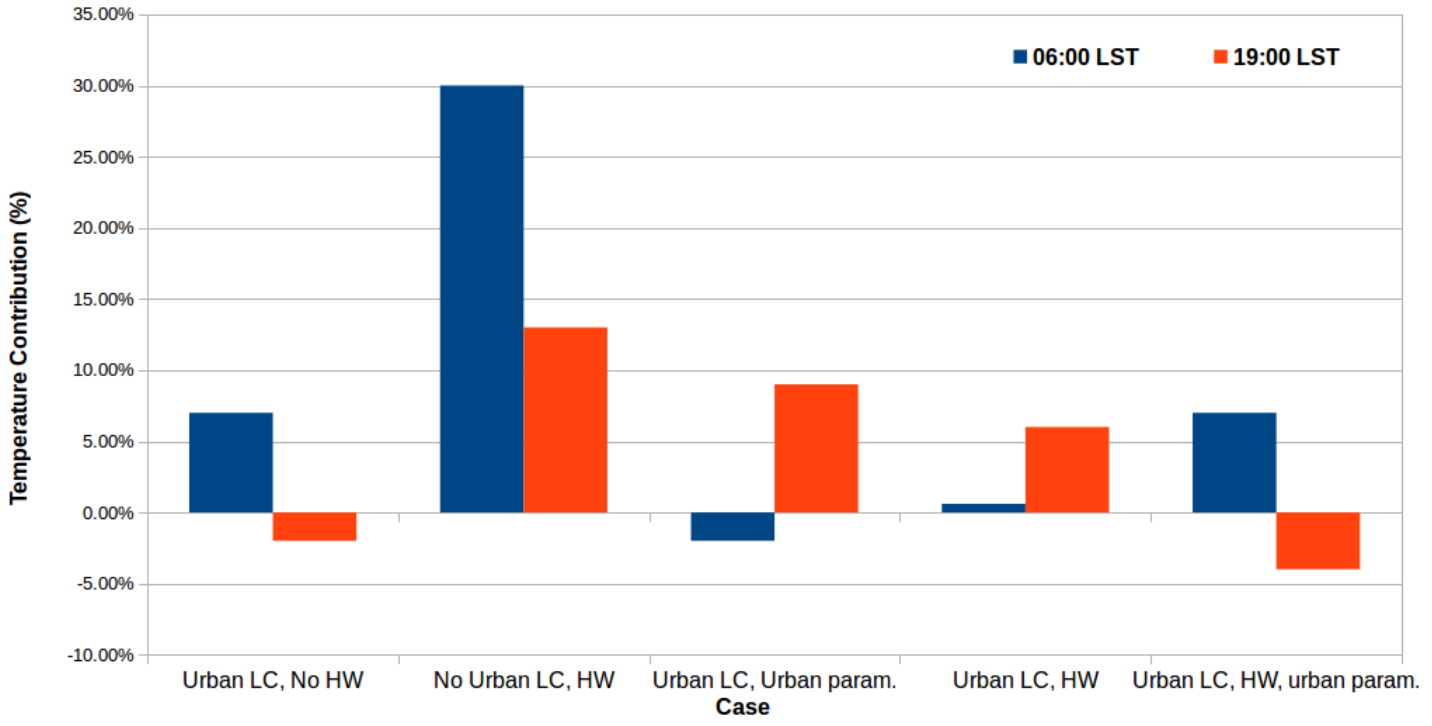
Urban-heat wave interactions: Factor Separation



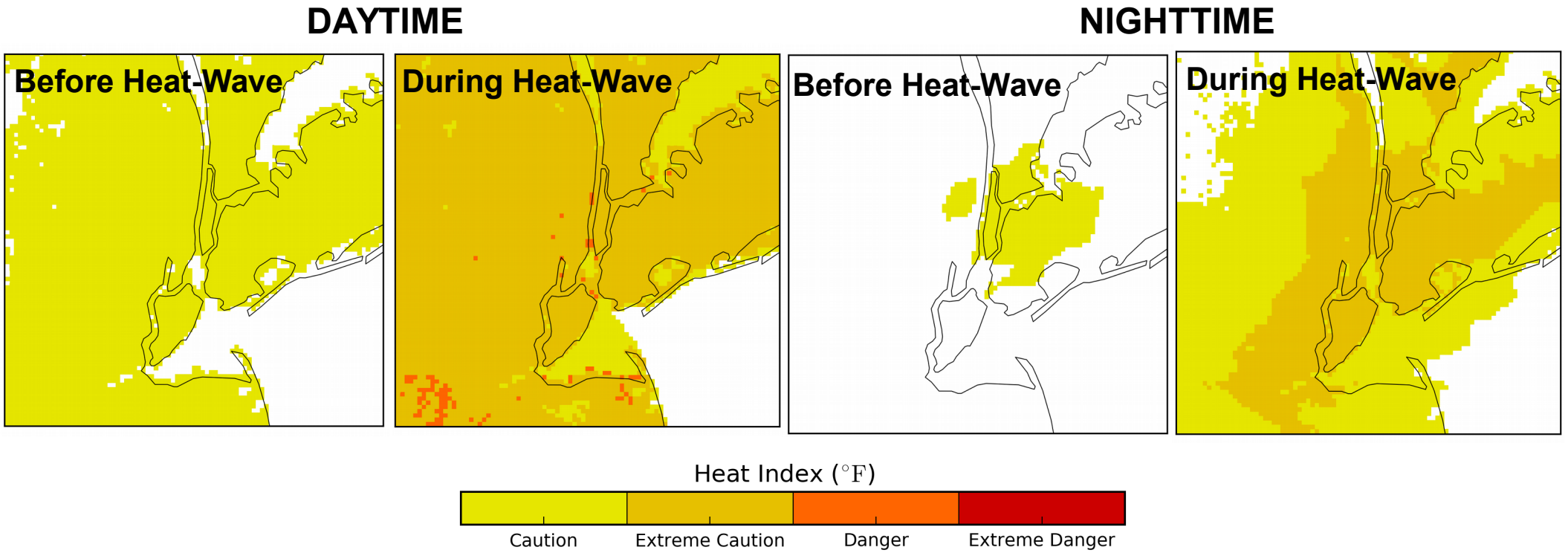

(a)
(b)
(c)
(d)
(e)
(f)
Height (m)
Distance (km)
Factor Contribution (%)
−15 −12 −9 −6 −3 0 3 6 9 12 15
84 82 80 78 76 74 72 70


(a)
(b)
(c)
(d)
(e)
(f)
Height (m)
Distance (km)
Factor Contribution (%)
−20 −18 −16 −14 −12 −10 −8 −6 −4 −2 0 2 4 6 8 10 12 14 16 18 20
74 70 66 62 58 54 50

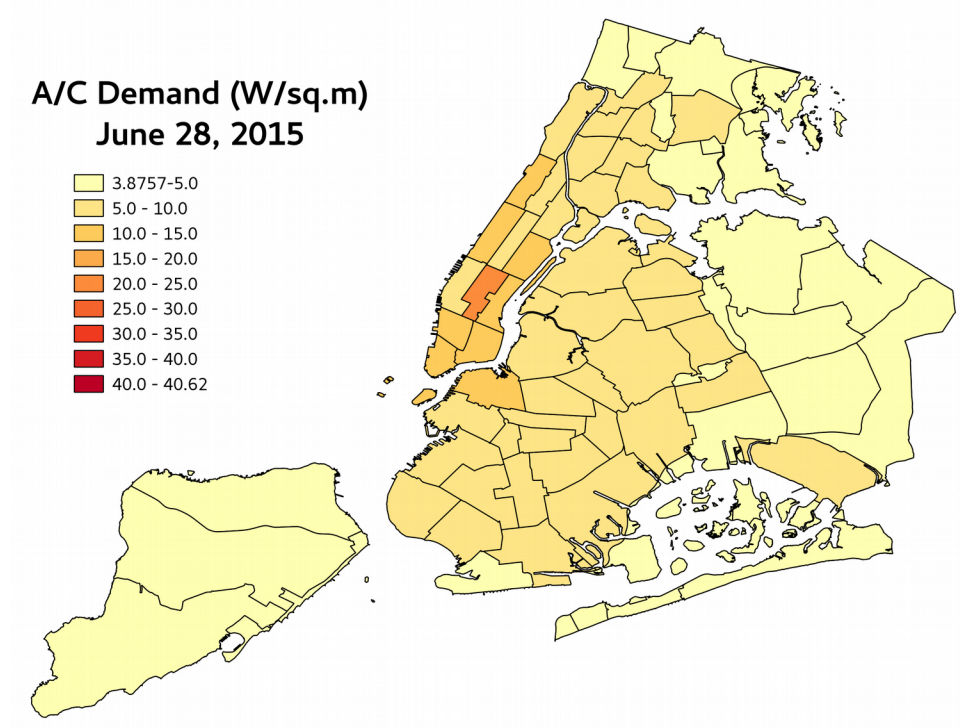
Contribution summary

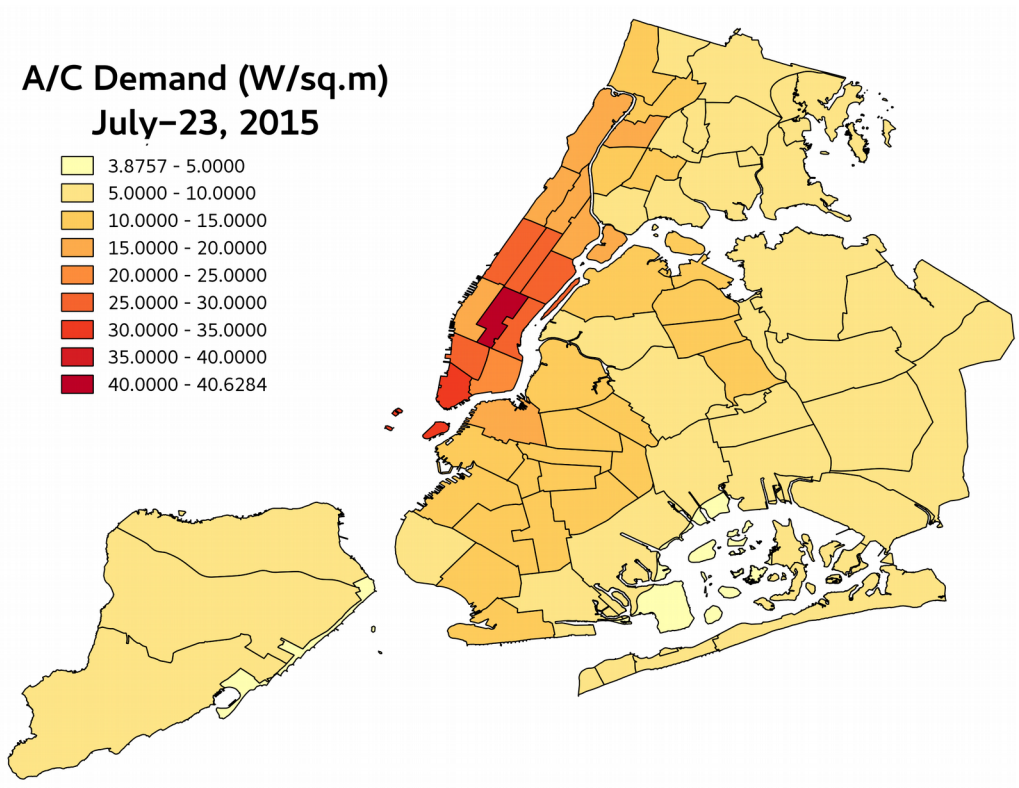


Impacts: Health



Neighborhood scale peak electric demand: Heat wave vs Non-heat wave day





Exploring Demand Mitigation

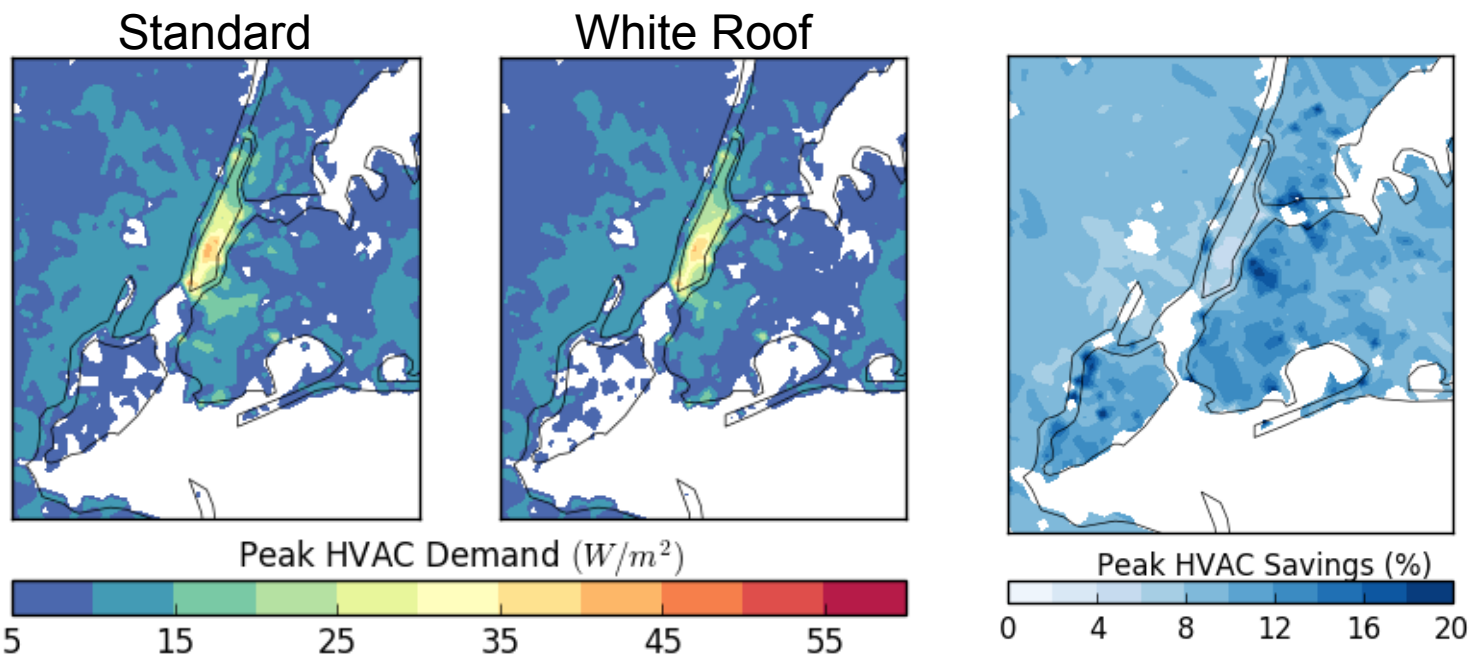
White roofs have been used as a mitigation strategy for peak demands by increasing reflective properties of building roofs.

June 22 – 25 2015 (highest peaks in the validation period) used to test white roofs in NYC

Roof reflectivity
Standard: 0.20
White Roof: 0.80

Higher energy savings observed outside of the highly urban Manhattan

With taller, more densely packed buildings, incoming roof radiation becomes a smaller component of the building envelope energy balance



Questions?