BOSTON UNIVERSITY

Seasonal Co-Variation in Land Surface Climate and Surface Properties in the Boston Metropolitan Area

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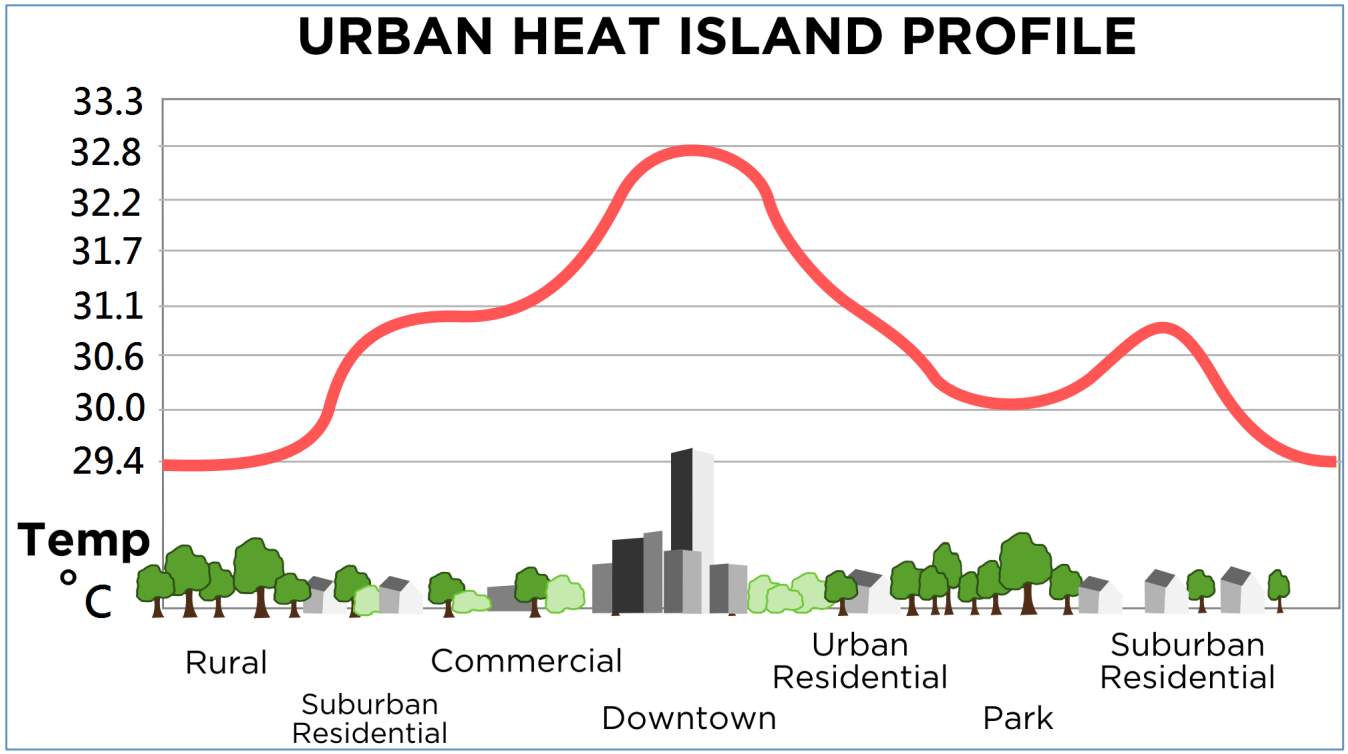
Landsat Science Team Meeting, July 2016, Brookings, SD

The Urban Heat Island (UHI)

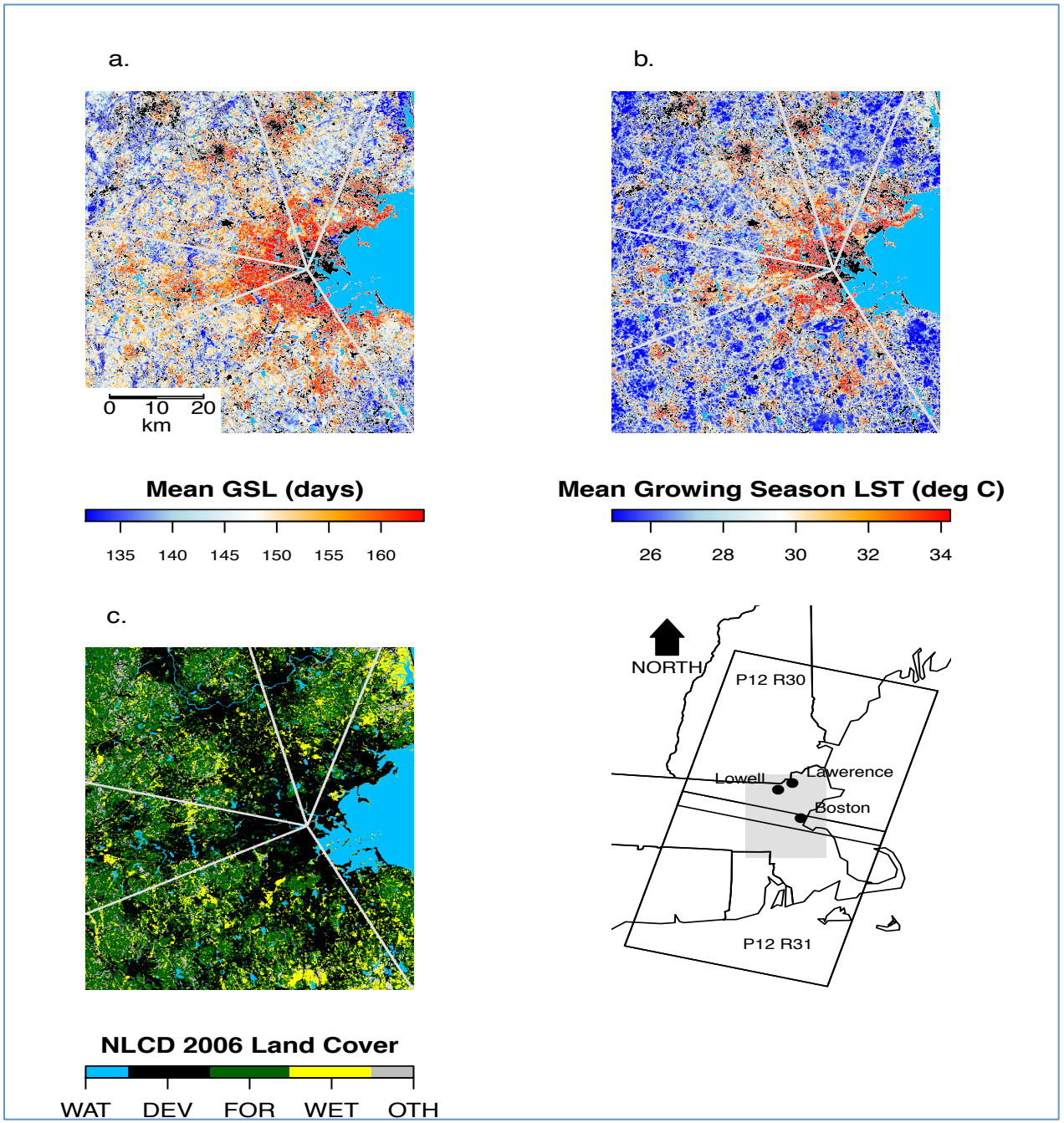


Three Studies

- ***Interactions Between Vegetation Phenology and Urban Heat Island: A Case Study in the Boston Metropolitan Region***
  - ***Melaas et al., ERL, 2016***

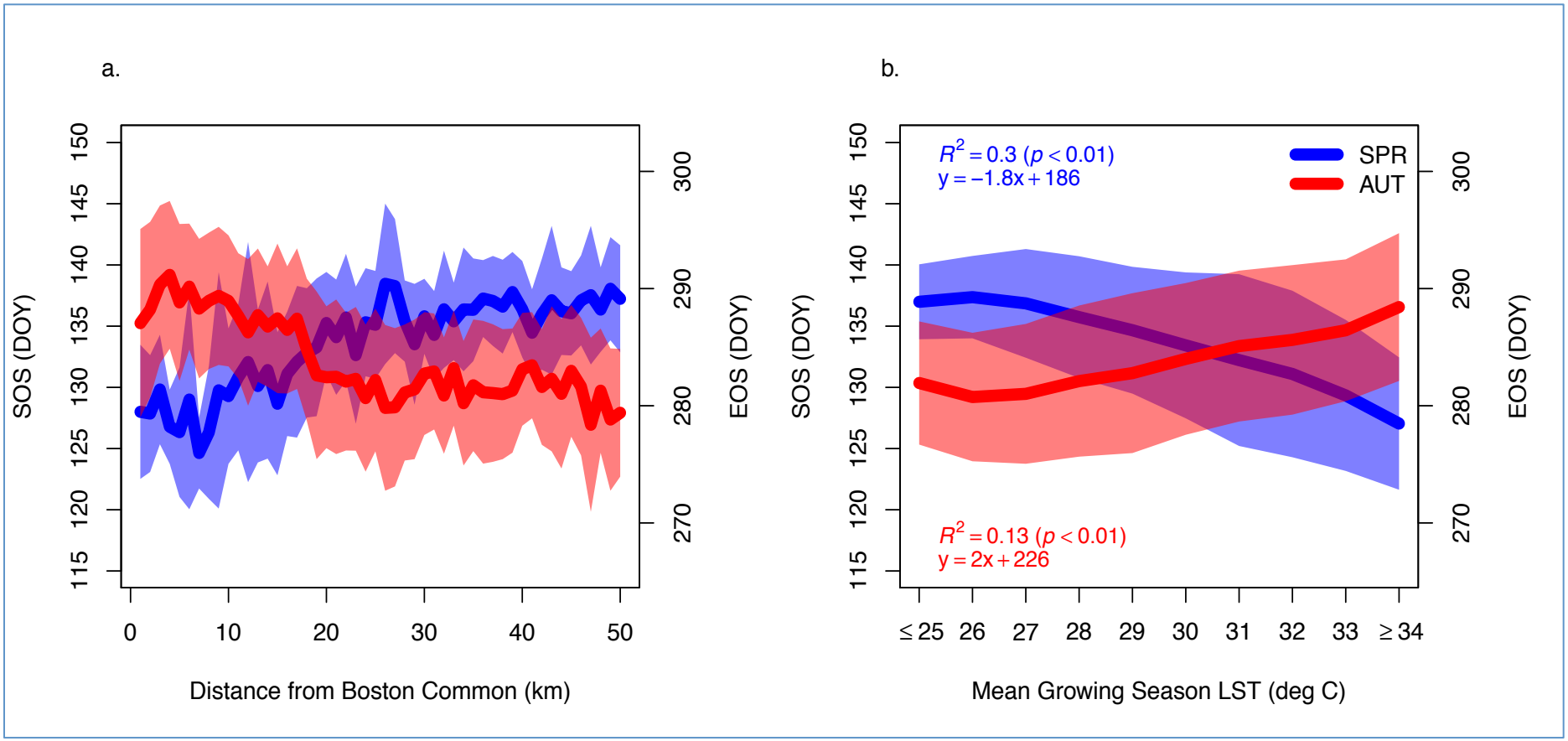
- ***Seasonal Co-Variation in Land Surface Properties and the Surface Urban Heat Island in Boston***
  - ***Cheek et al., in prep for RSE***

- ***Spatial and temporal variations in air temperature and humidity controlled by urban land use intensity in Boston, MA***
  - ***Wang et al., in prep, JCAM***

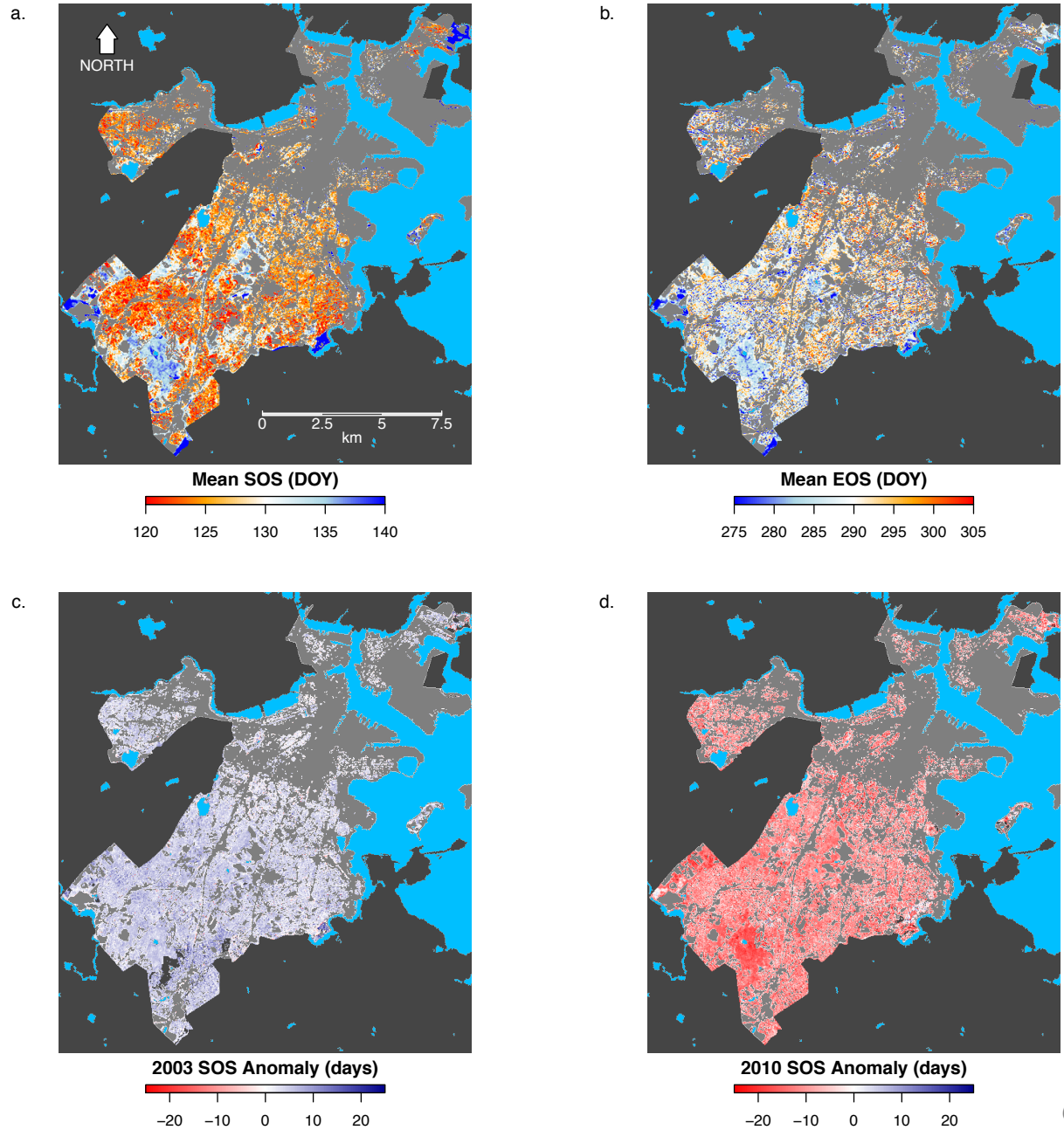


1. Interactions Between Vegetation Phenology and Urban Heat Island

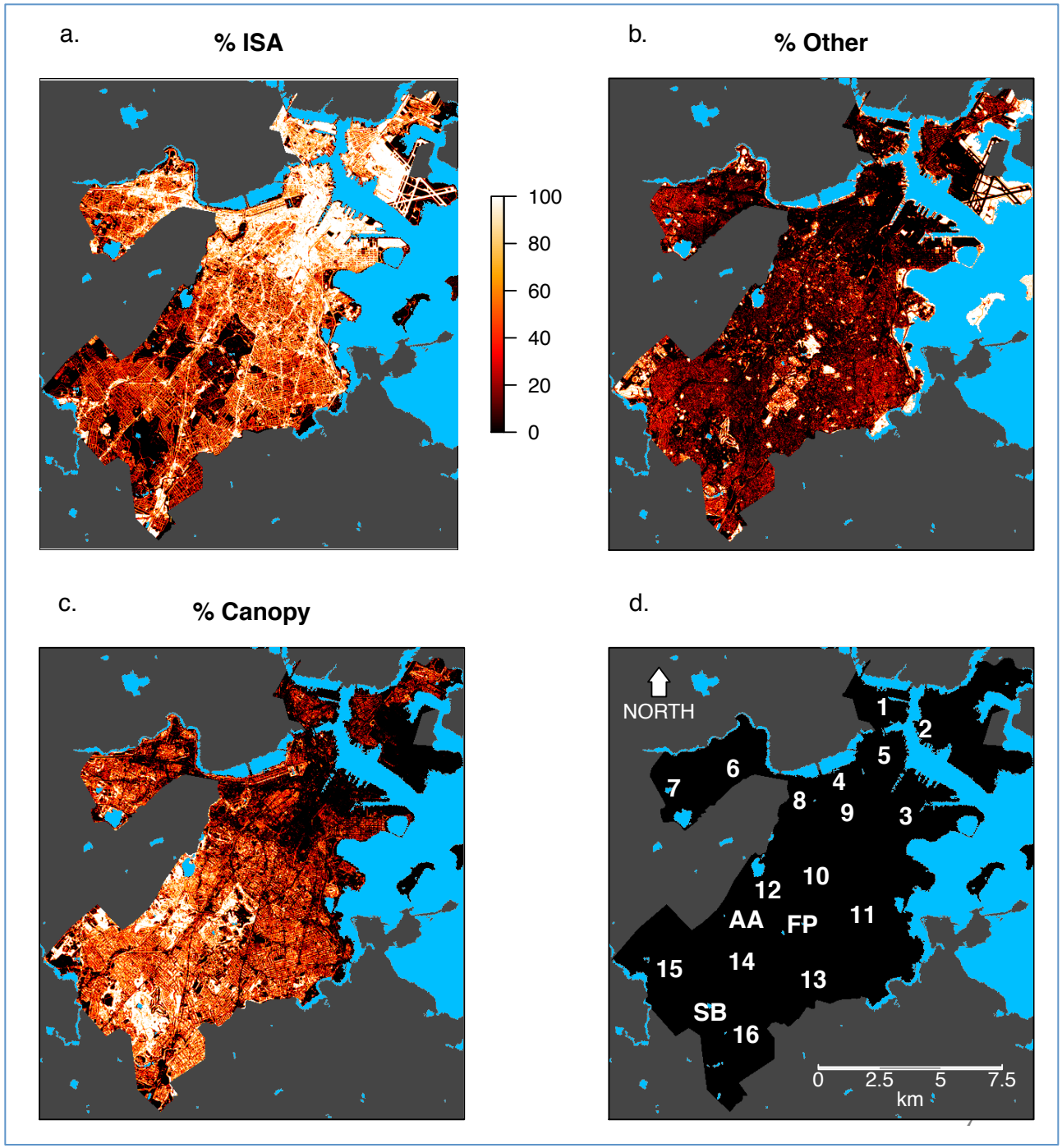
Start of Season, End of Season vs Urban-Rural Gradient



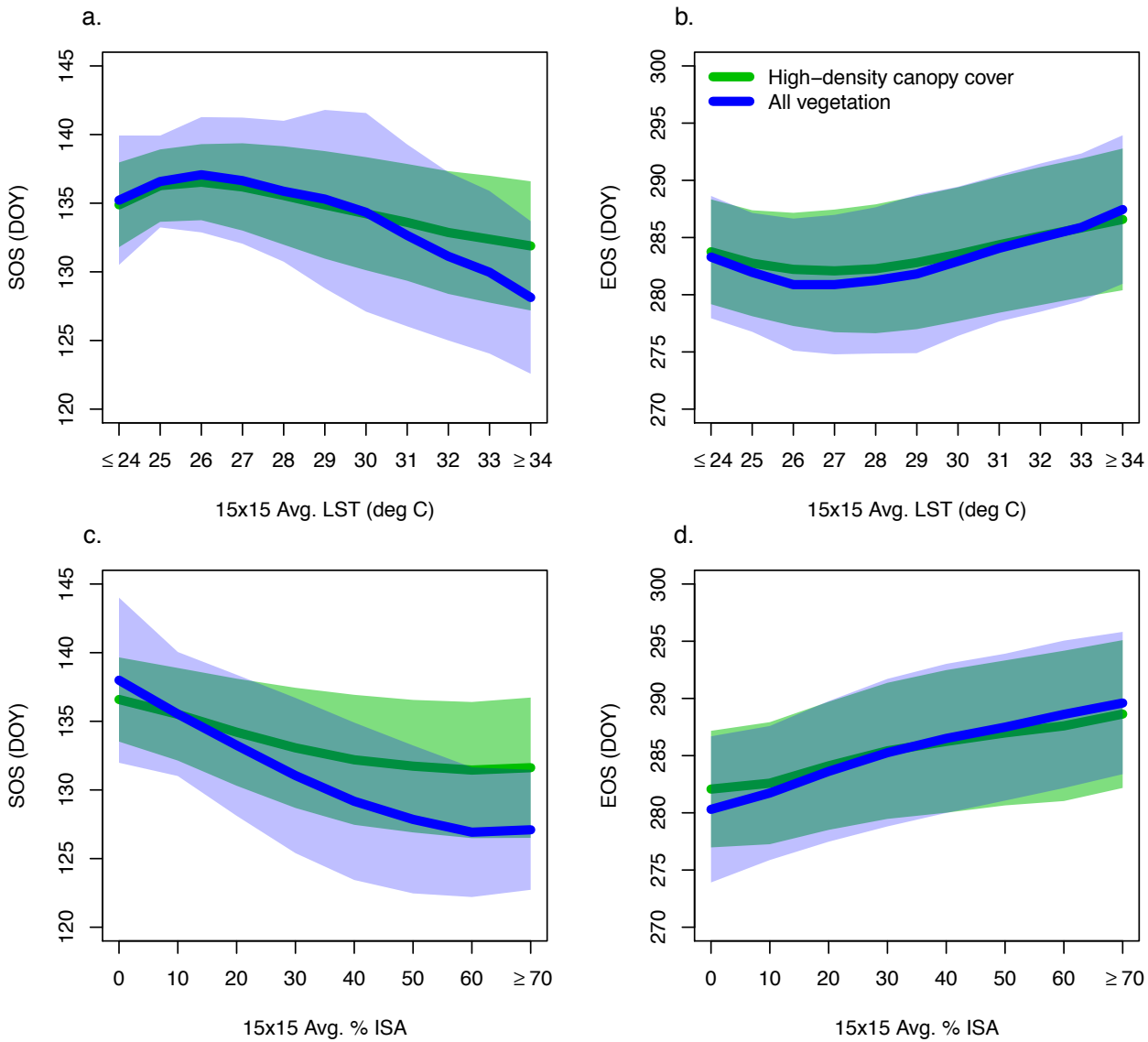
Zoom-In to Boston



Local temperature vs species composition?

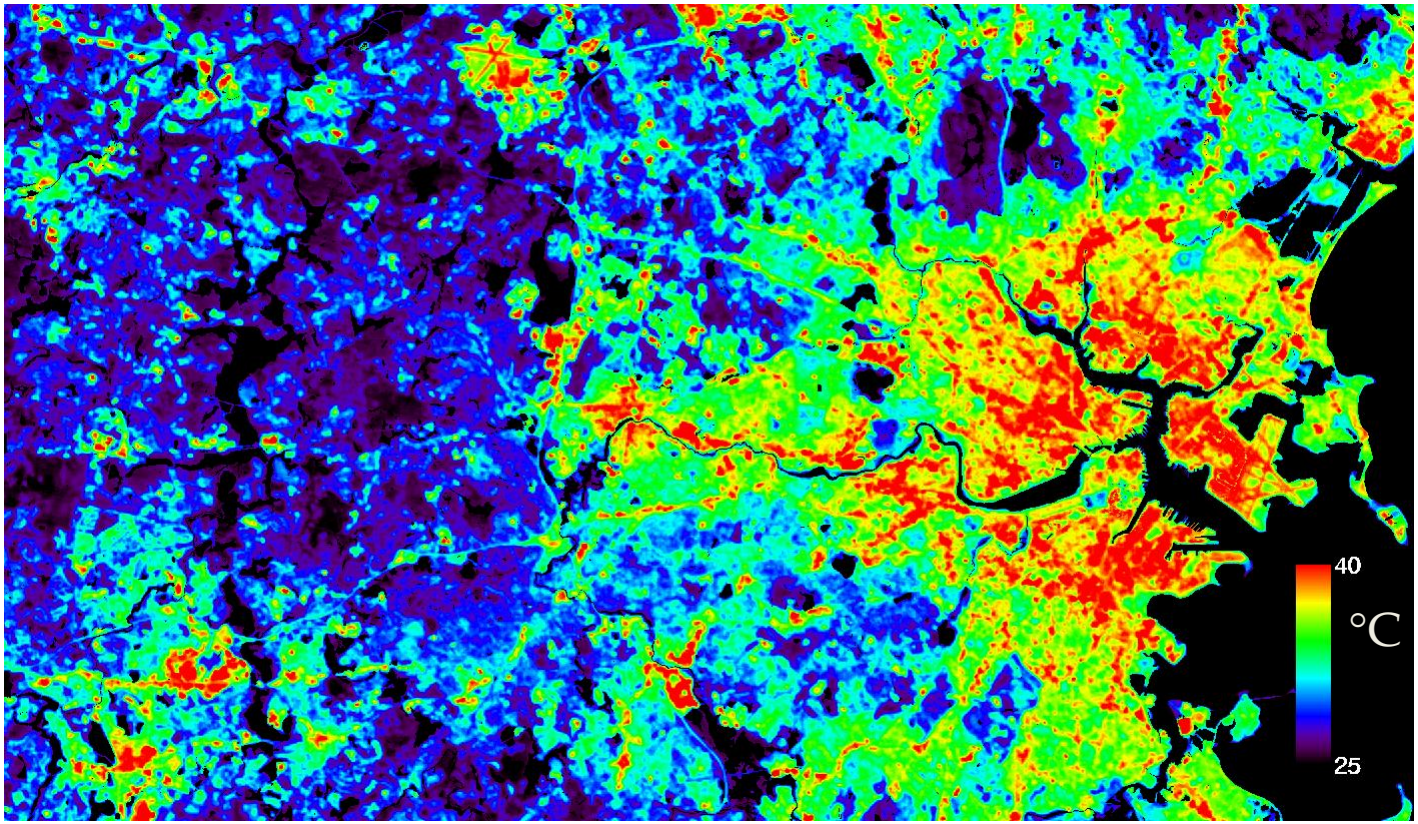


All Forests vs. High Tree Cover Pixels



2. *Surface Controls on the SUHI*

August, 2010



Current Challenges

Spatial Heterogeneity

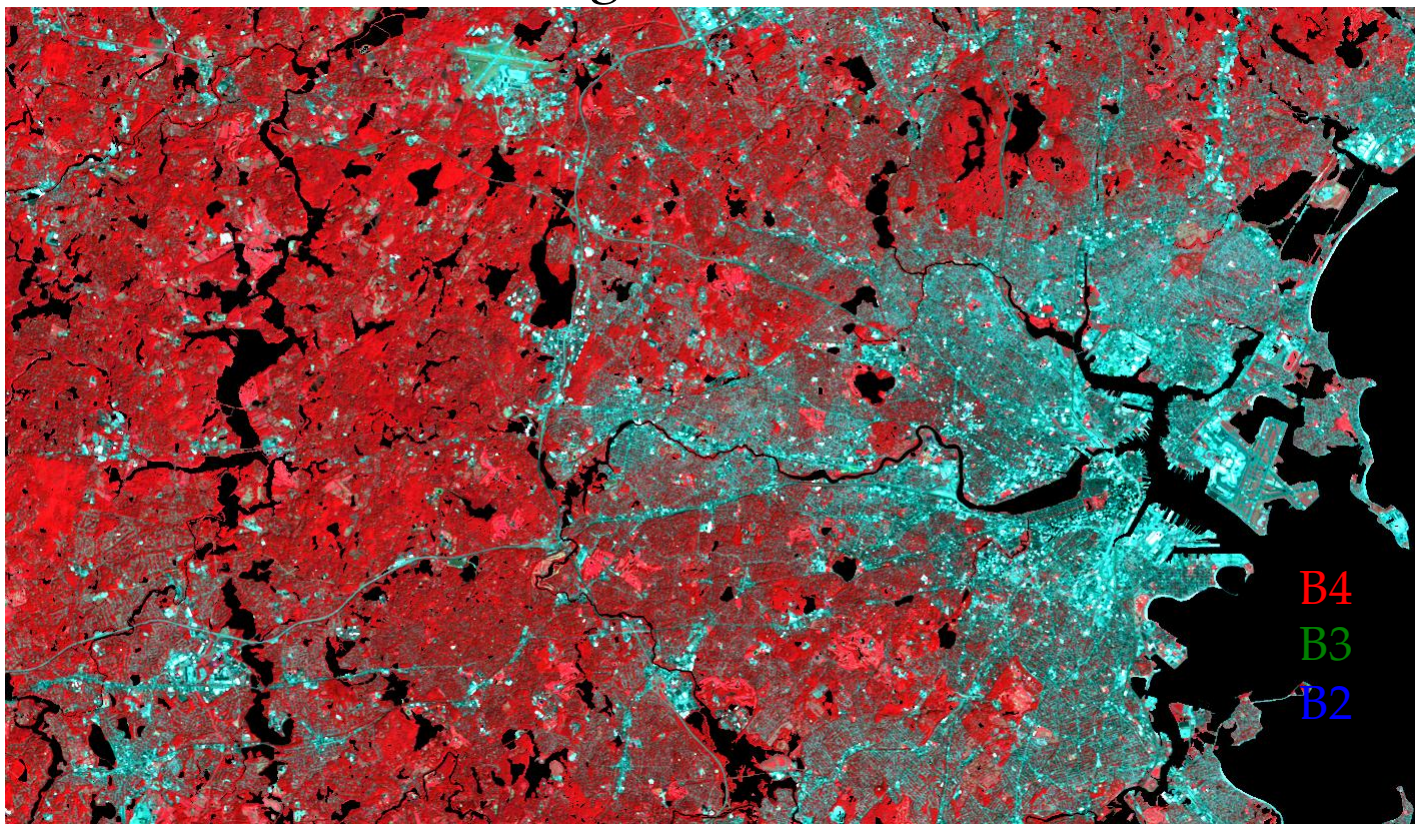
- *Variability below Landsat resolution*

Temporal Dynamics

- *Large seasonal change in veg. cover*

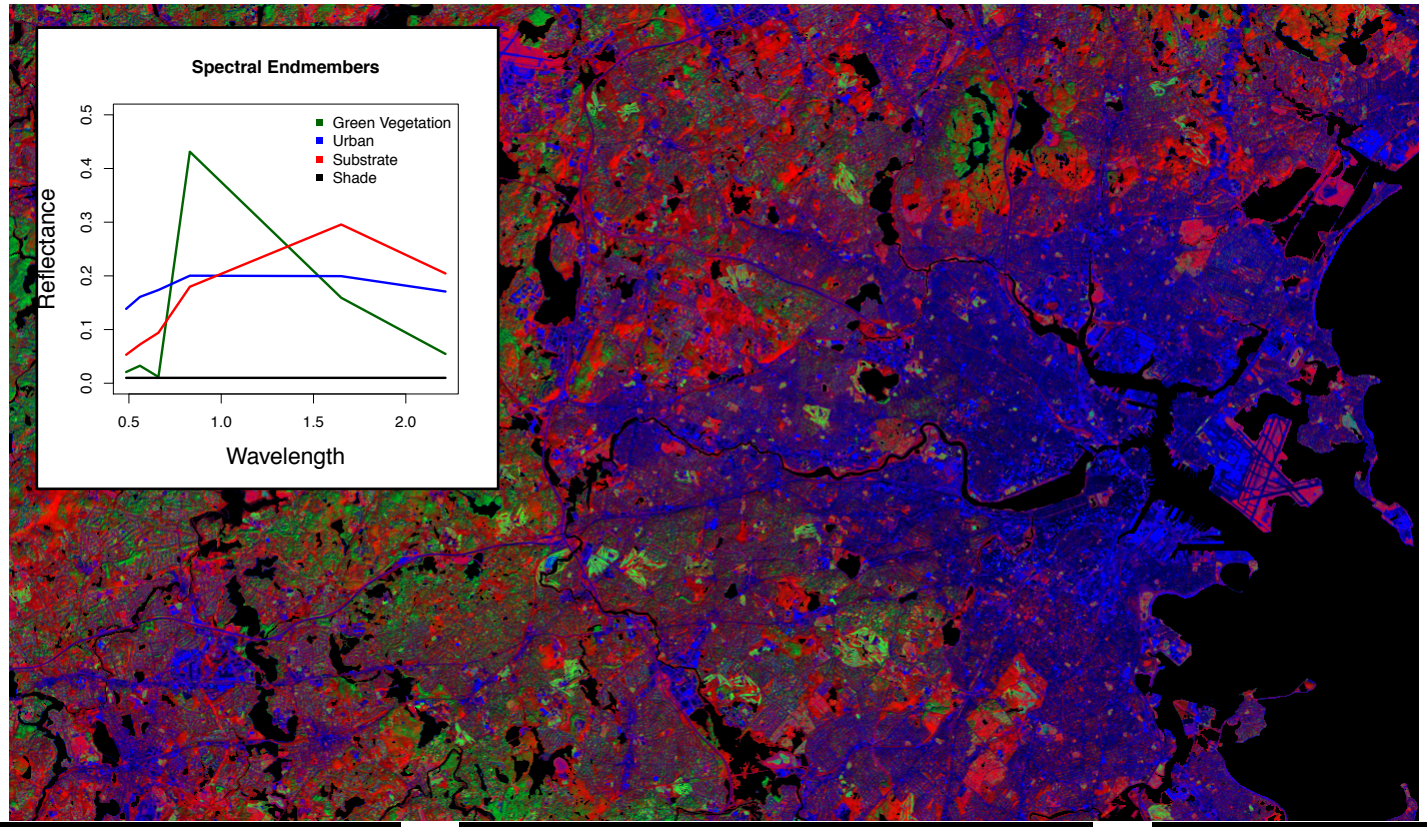
Characterizing Surface Properties

August, 2010



Spectral Mixture Analysis (SMA)

March, 2010



R: Substrate | G: Vegetation | B: Urban

e.g.: Weng et al., 2004; Wu & Murray, 2003; Rashed et al, 2005; Small, 2006; Yuan and Bauer, 2007; Roberts et al., 2012

Spectral Mixture Analysis (SMA)

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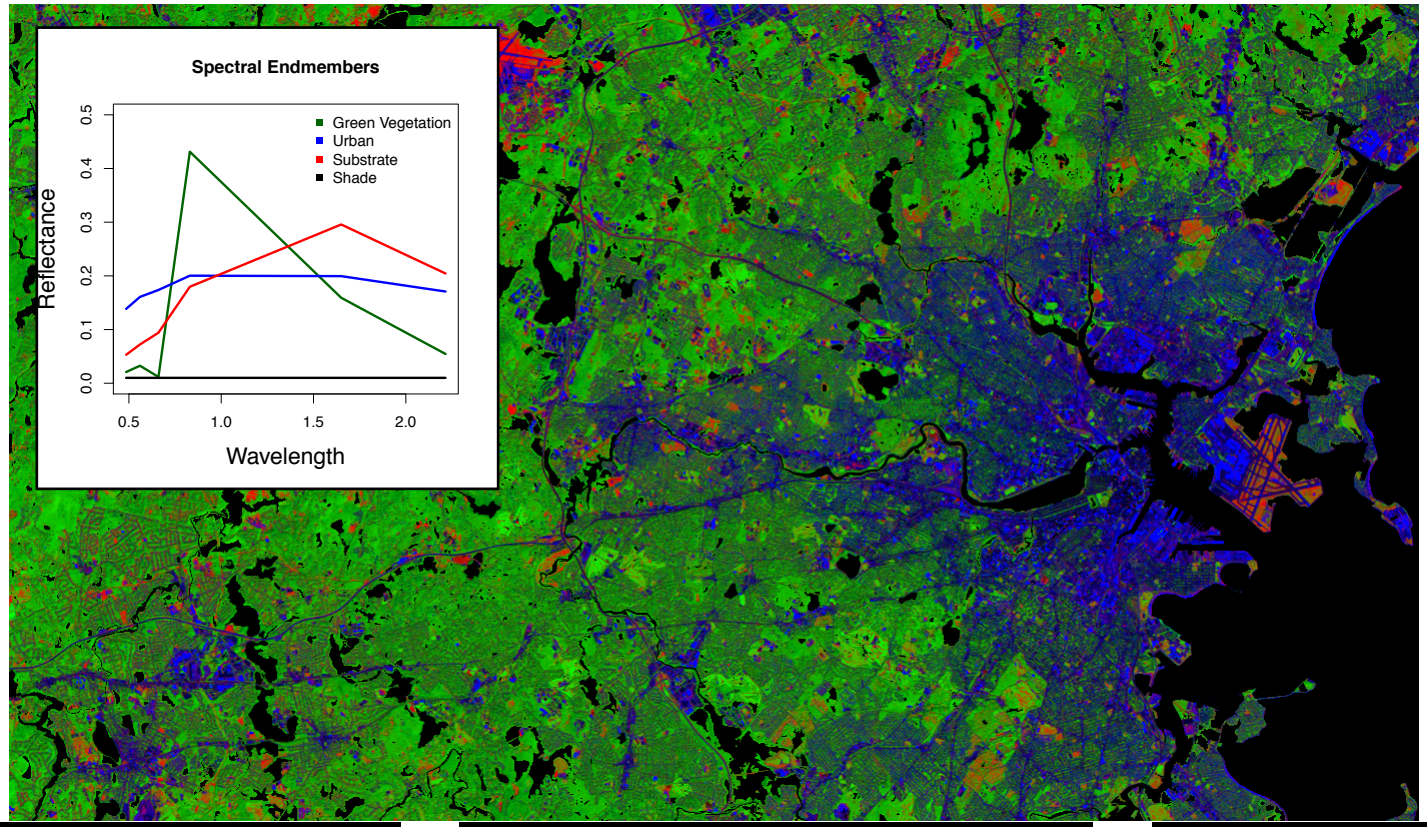

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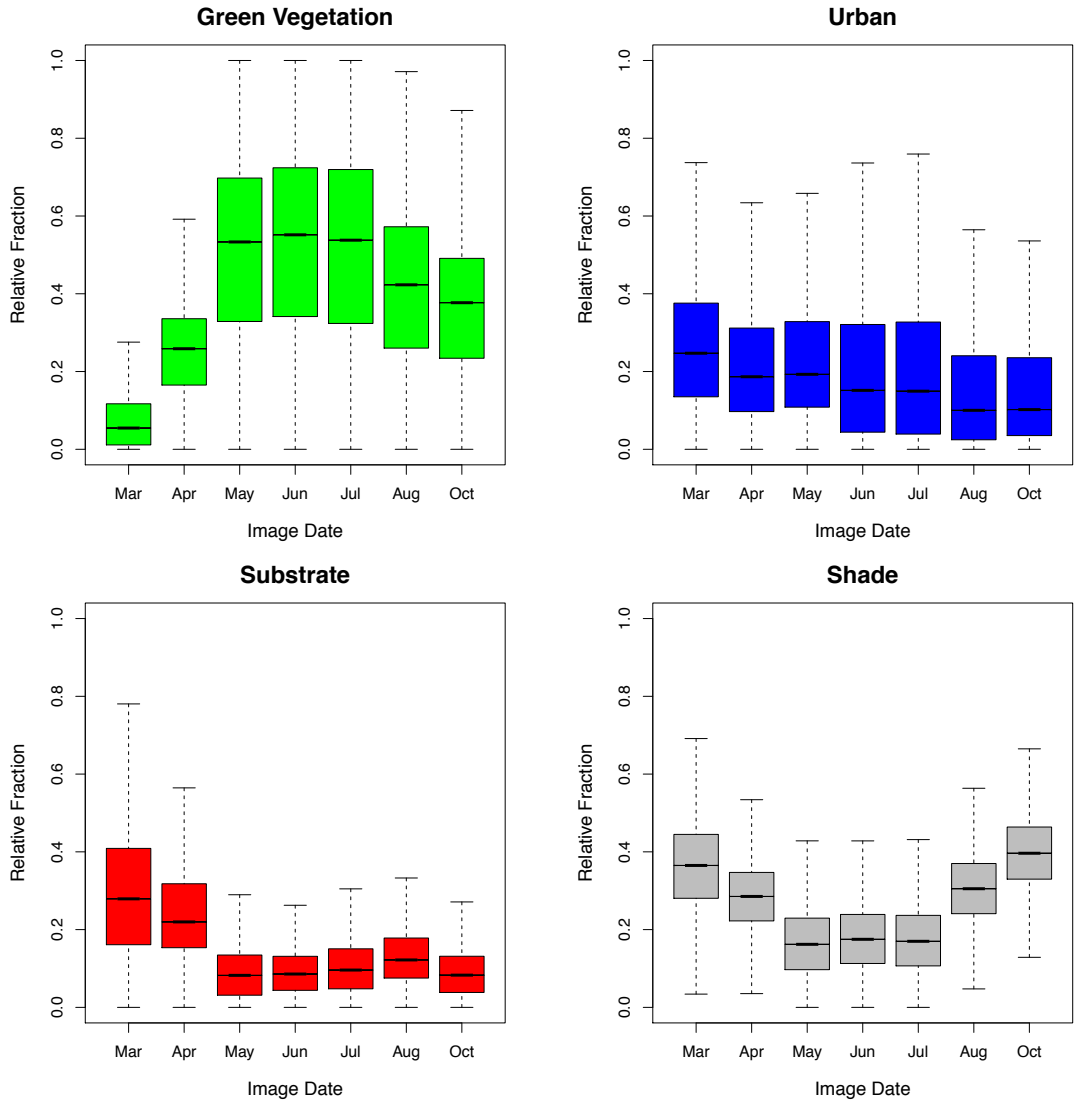
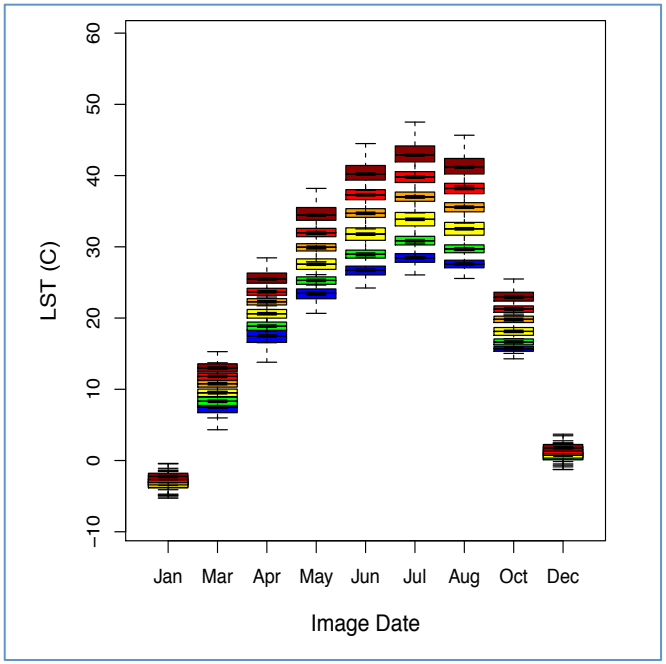
Seasonal Variation in End-Member Fractions

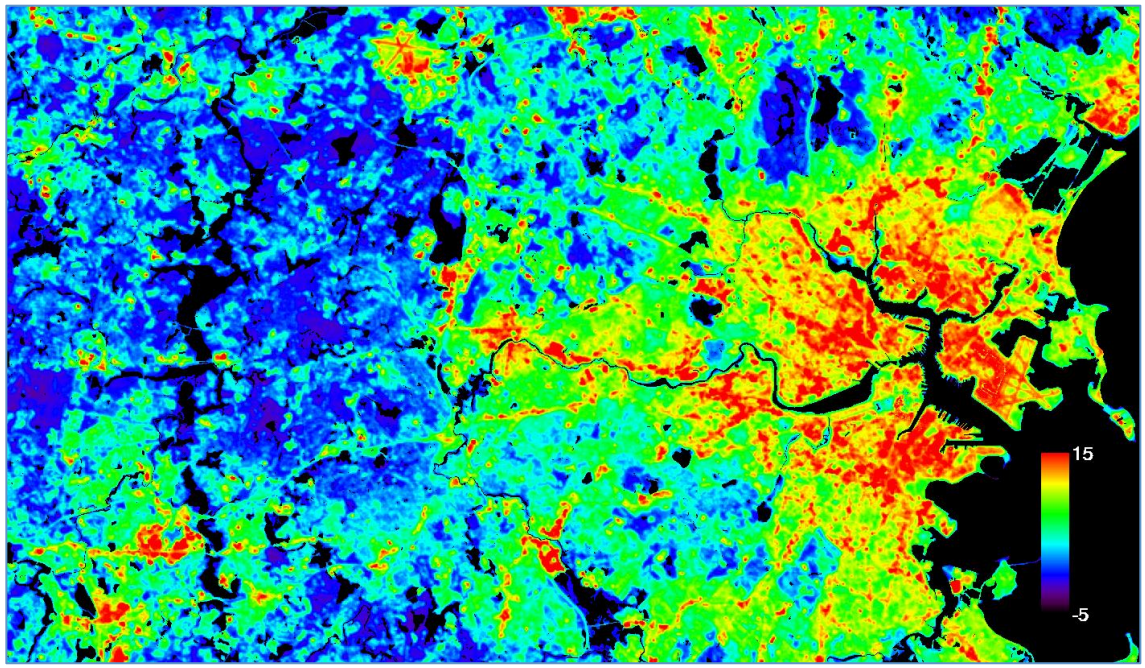


Defining the SUHI

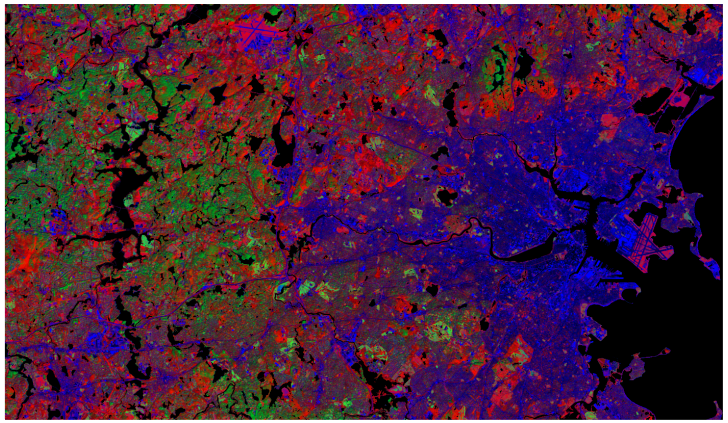
Land Surface Temperature Clusters



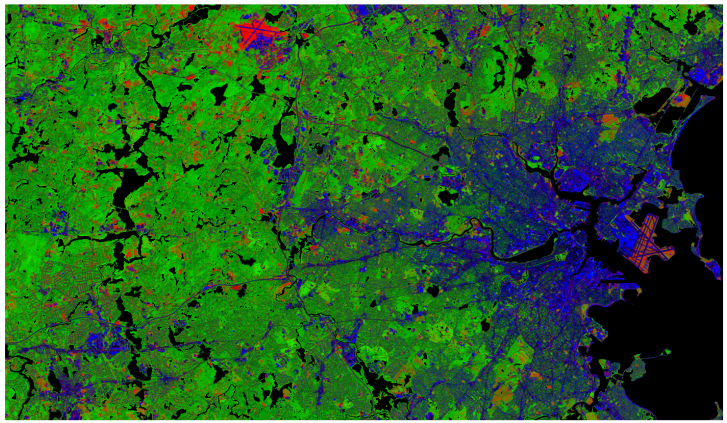
Urban Heat Island, August 2010



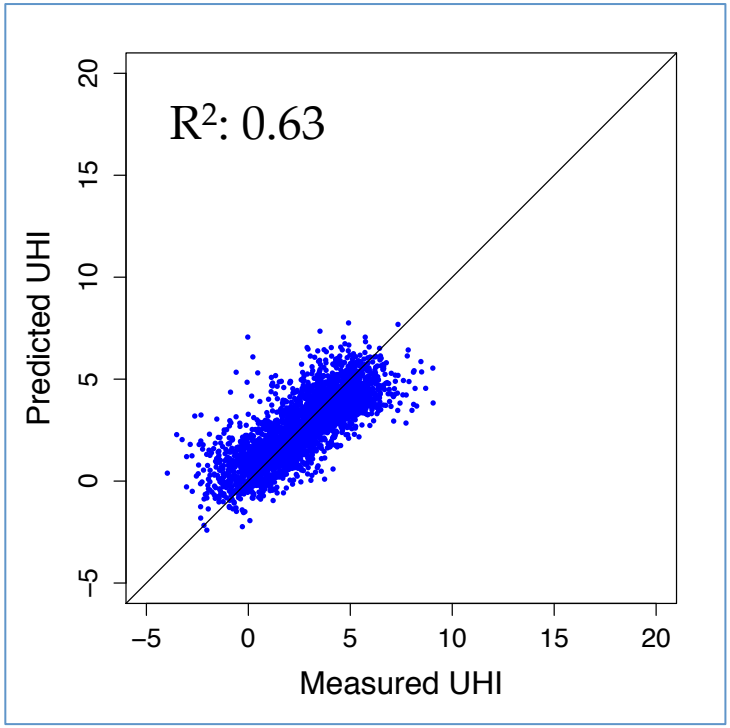
March

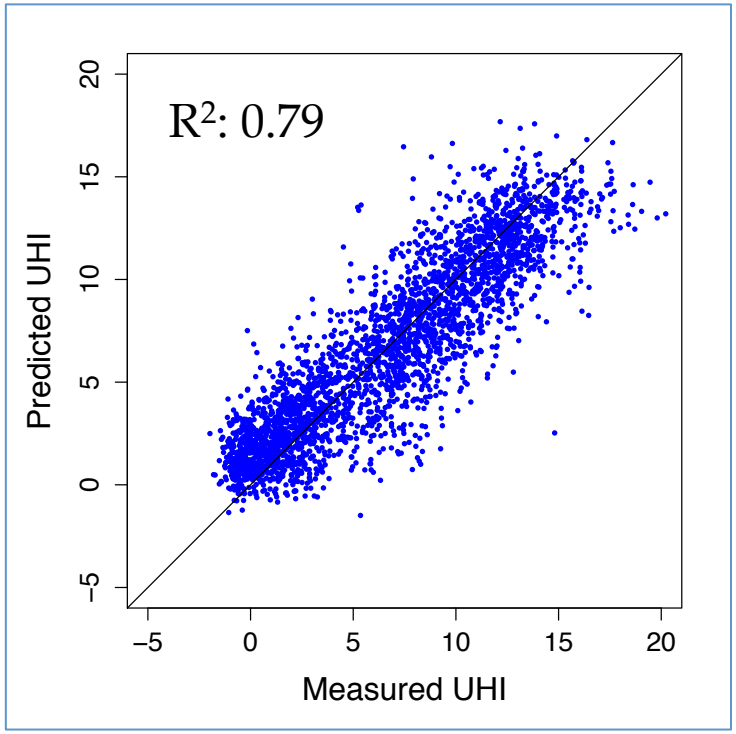


Aug

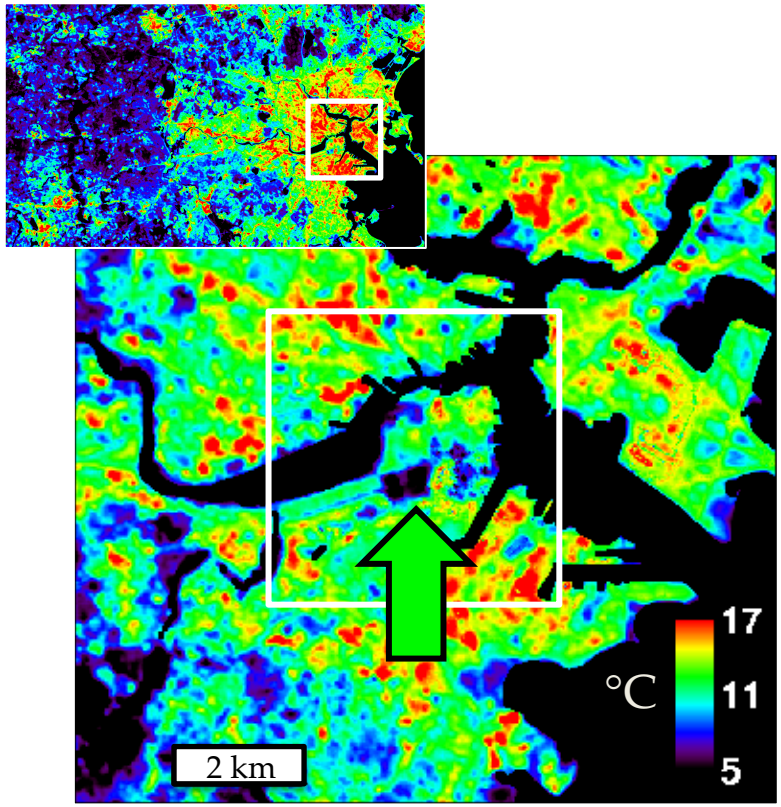


SUHI ~
Veg +
Urban +
Substrate +
Shade

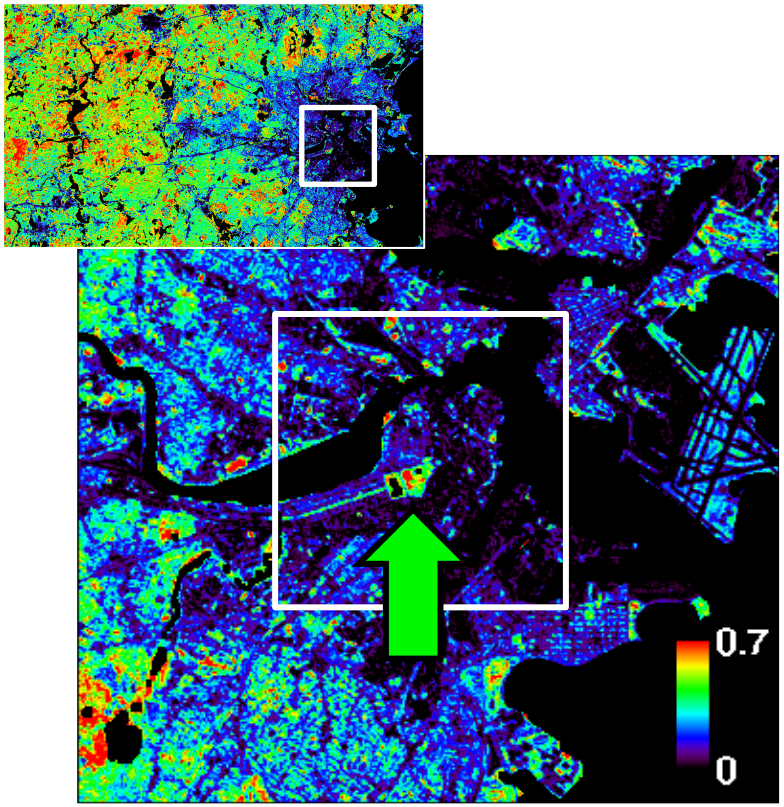




Urban Core SUHI Analysis



Urban Heat Island



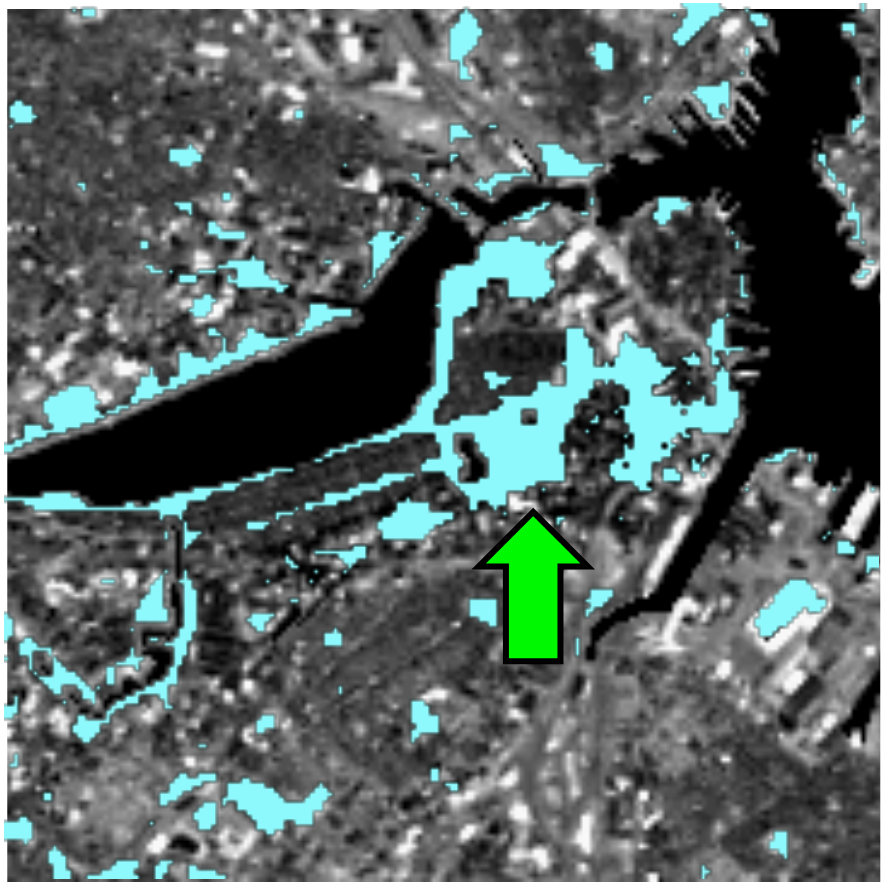
Fraction of vegetation

August, 2010

Urban Cool Islands

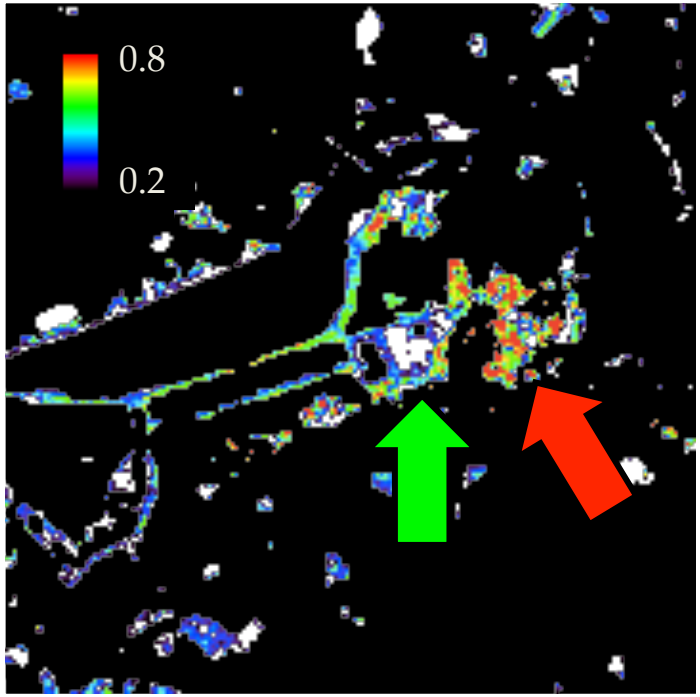
Blue:

SUHI below 10 °C



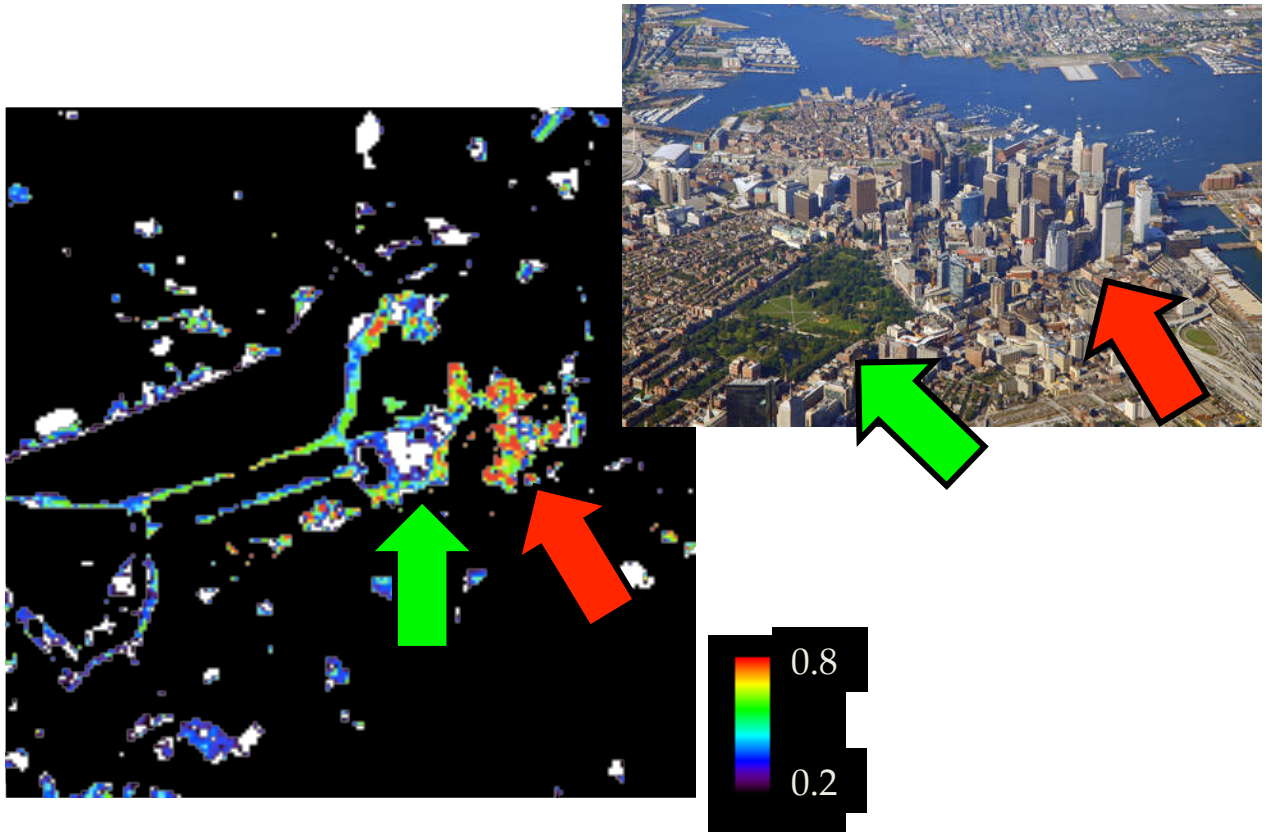
Urban Cool Islands + Shade

Colors:
low UHI that has abundant shade.



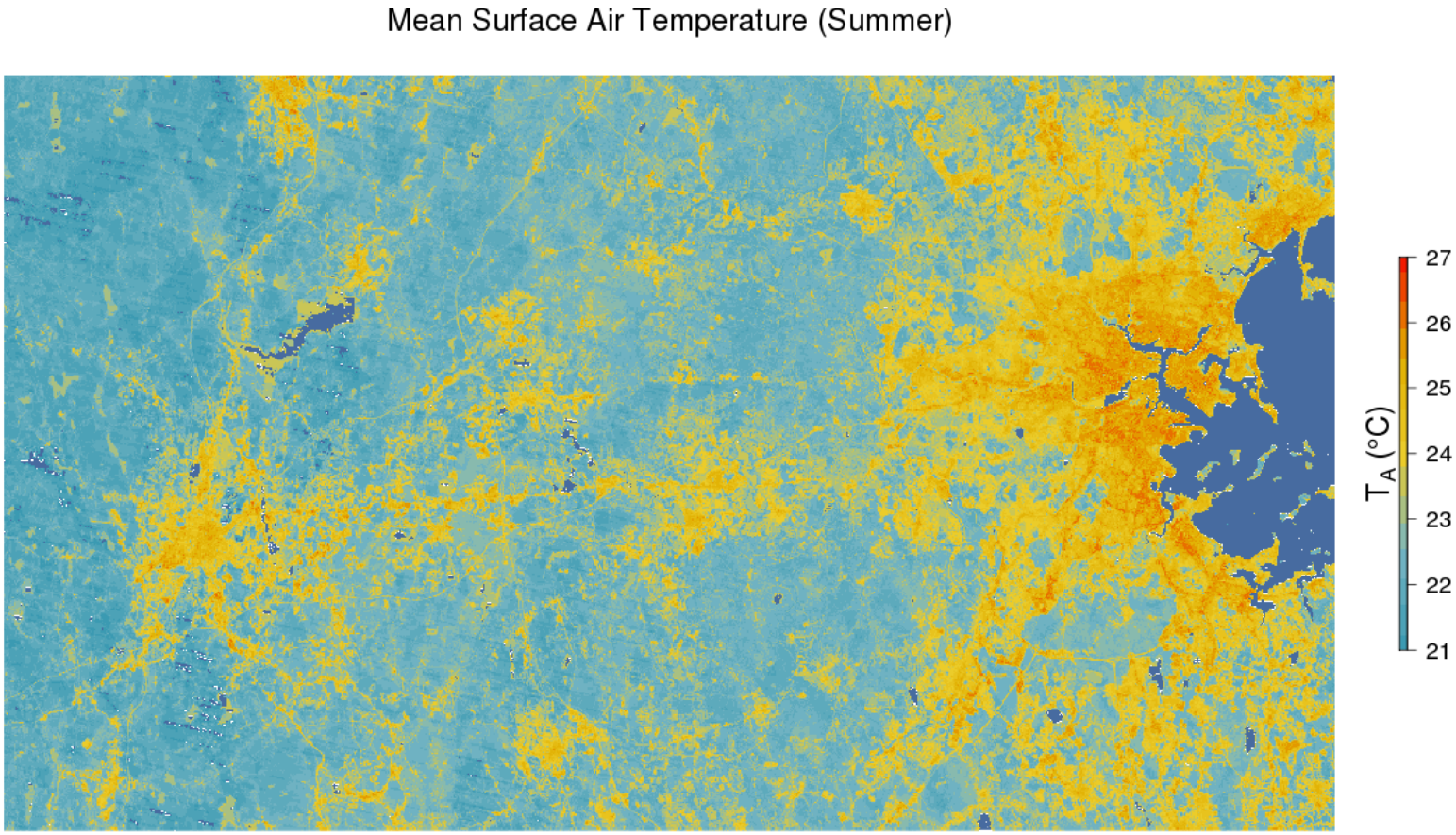
Shade fraction

Urban Cool Islands + Shade

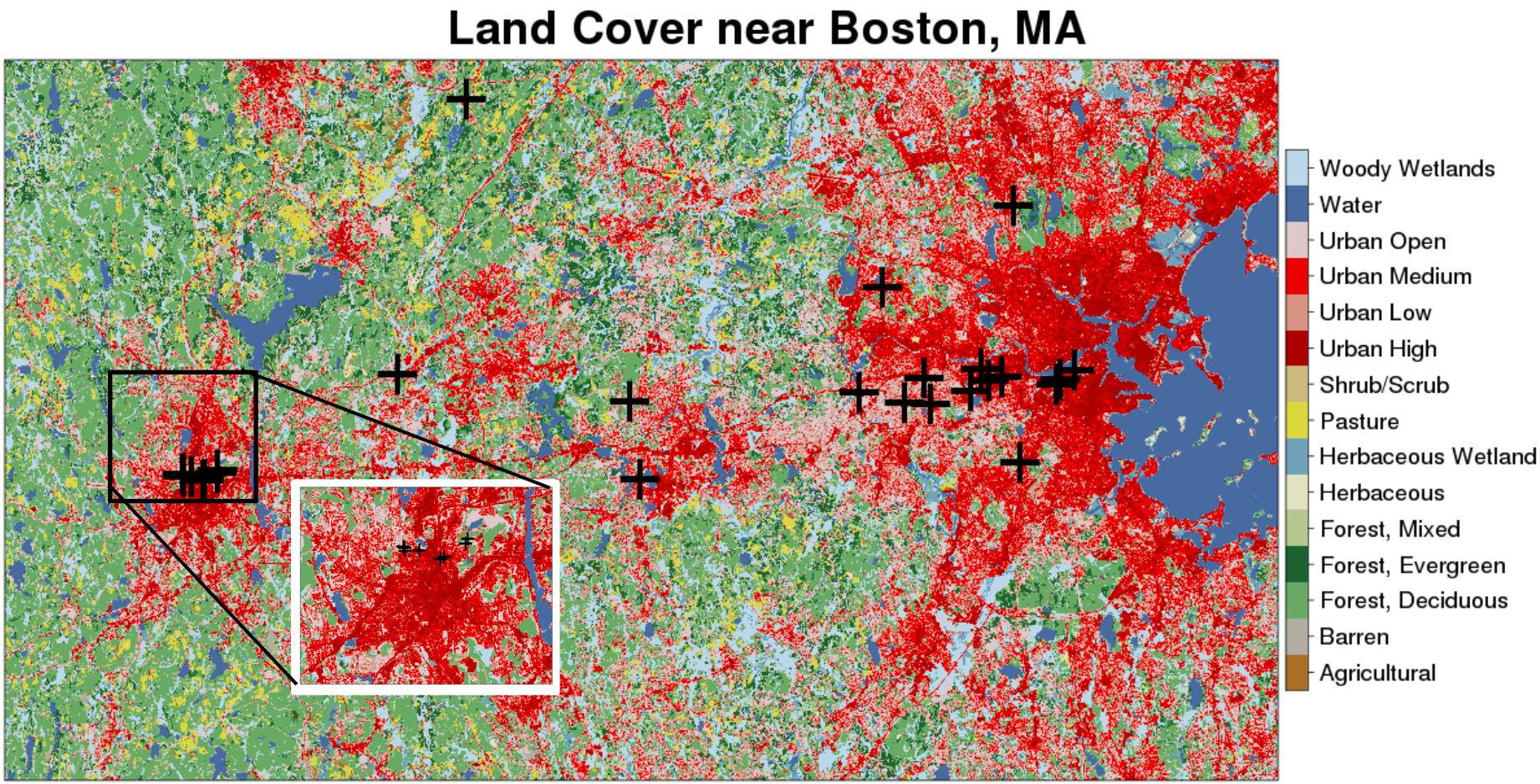


Shade fraction

3. Spatio-Temporal Variation in Air Temperature and Humidity Controlled by Urban Land Use Intensity

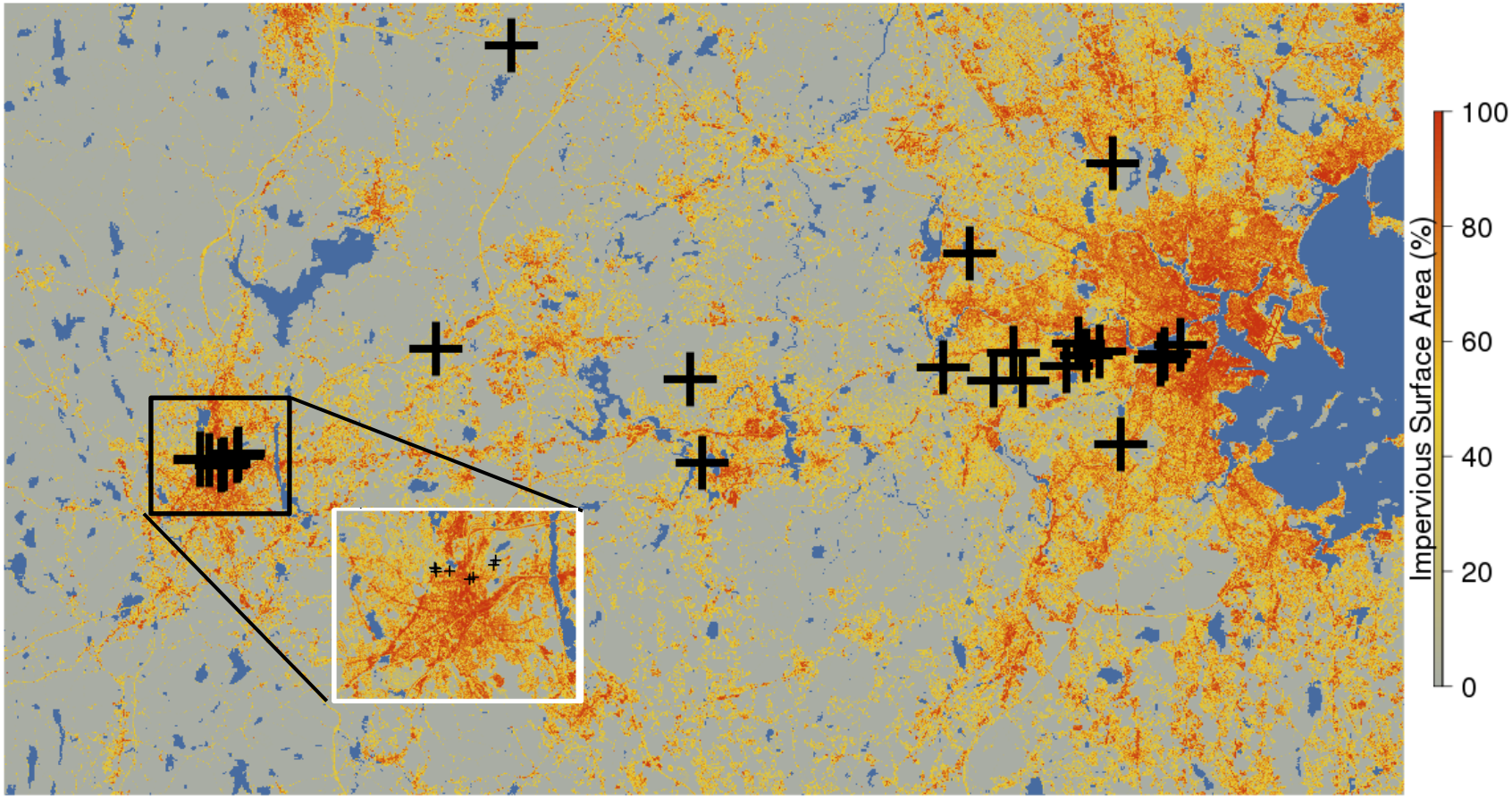


Sensor Network

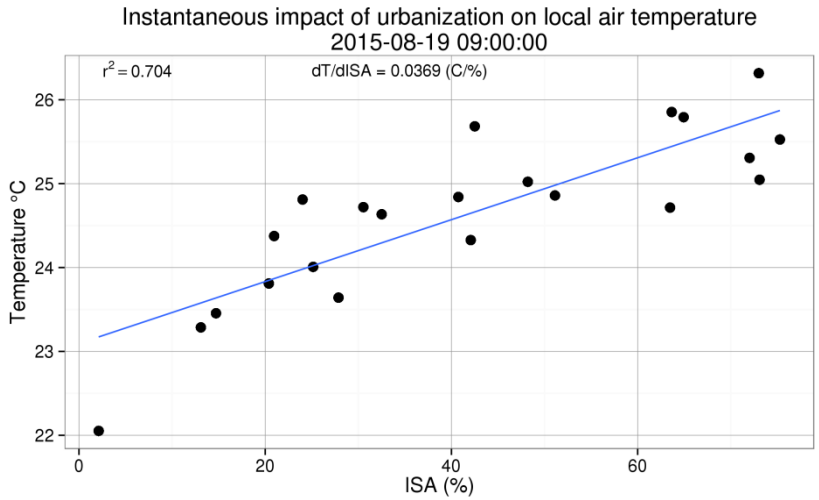


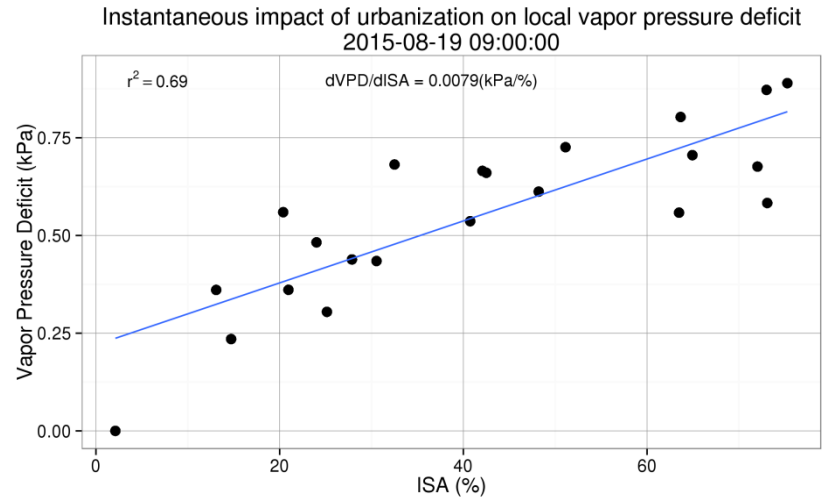
Sensor Network

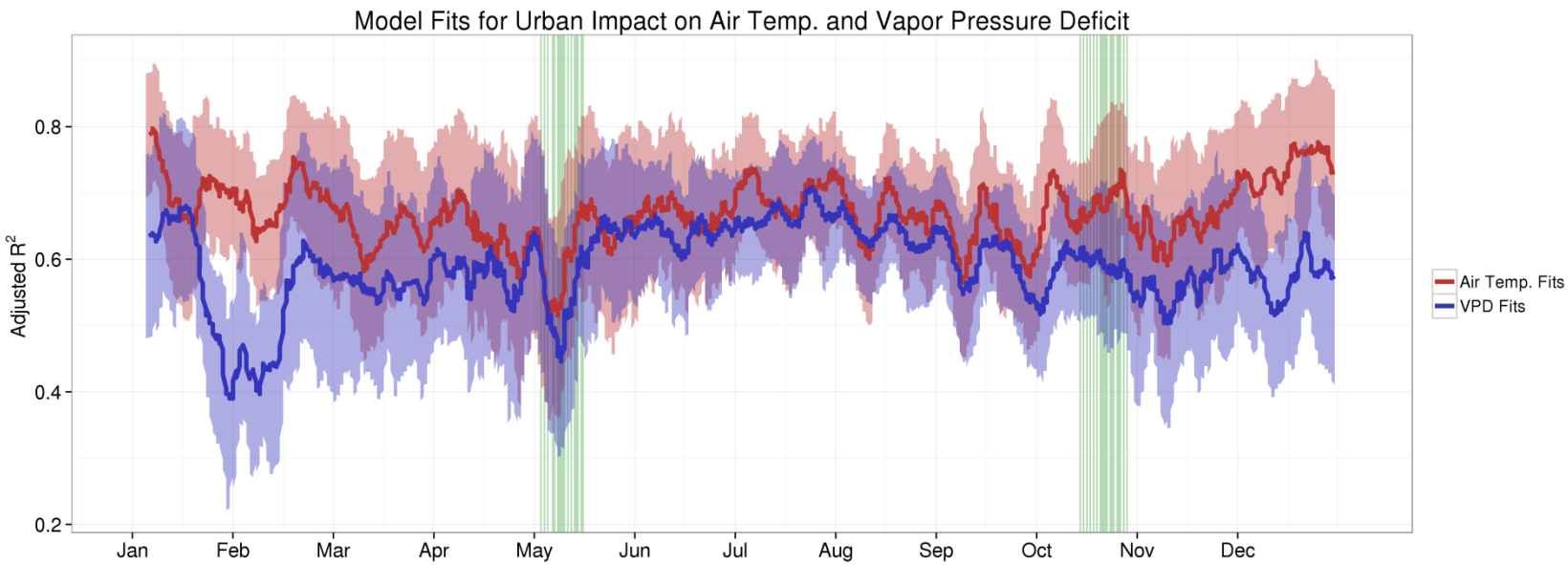
Impervious Surface Area near Boston, MA



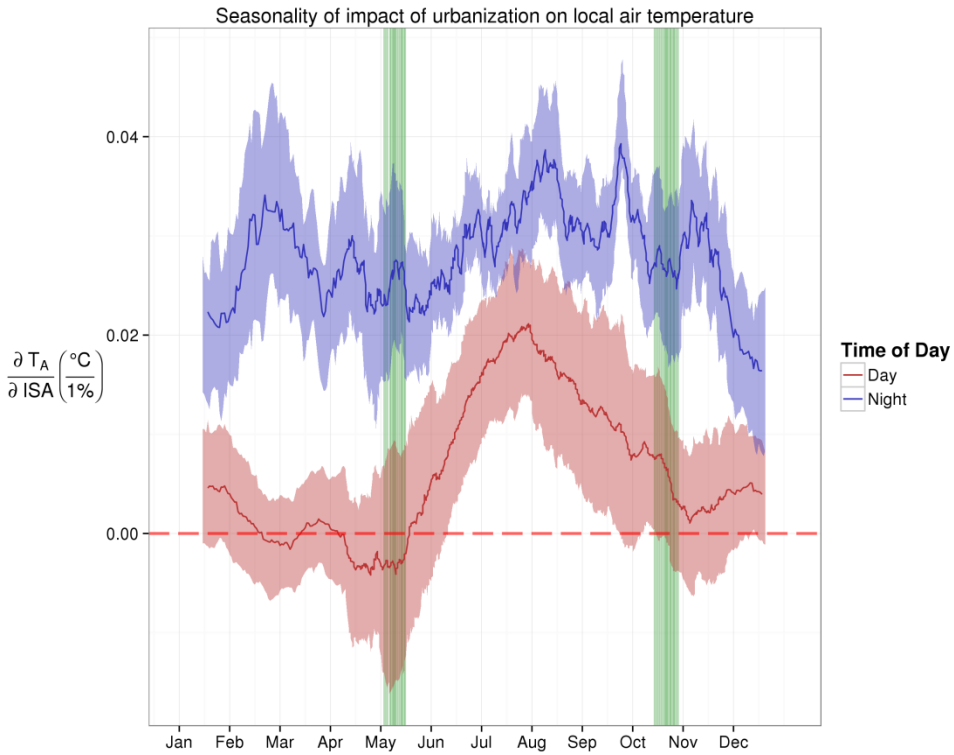
T_a , VPD vs. ISA

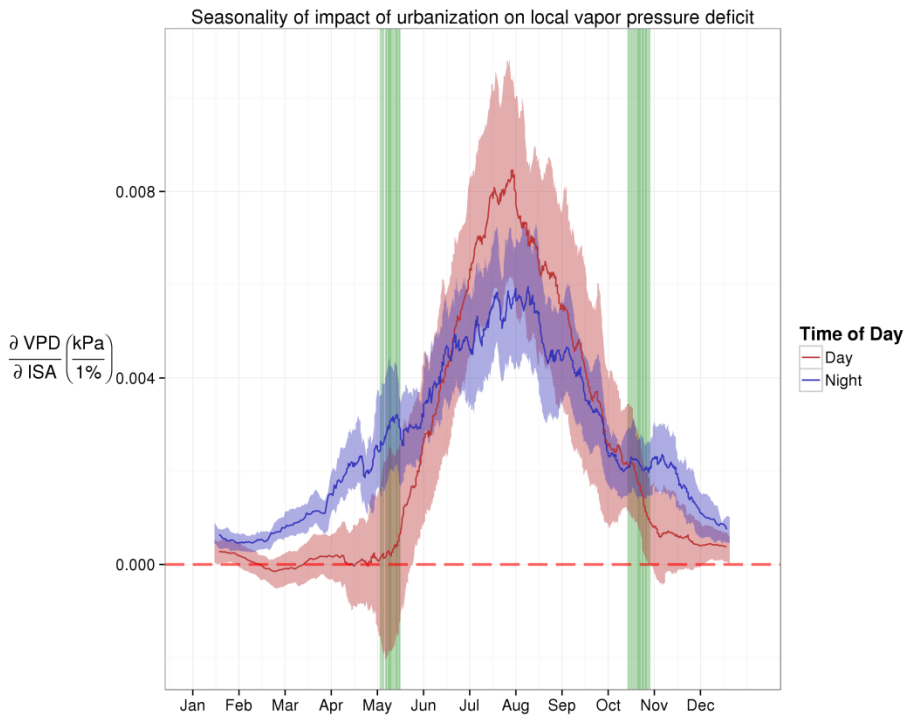

Instantaneous impact of urbanization on local air temperature
2015-08-19 09:00:00
r² = 0.704
dT/dISA = 0.0369 (C/%)
Temperature °C
ISA (%)


Instantaneous impact of urbanization on local vapor pressure deficit
2015-08-19 09:00:00
r² = 0.69
dVPD/dISA = 0.0079(kPa/%)
Vapor Pressure Deficit (kPa)
ISA (%)


Model Fits for Urban Impact on Air Temp. and Vapor Pressure Deficit
Adjusted R²
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Air Temp. Fits
VPD Fits

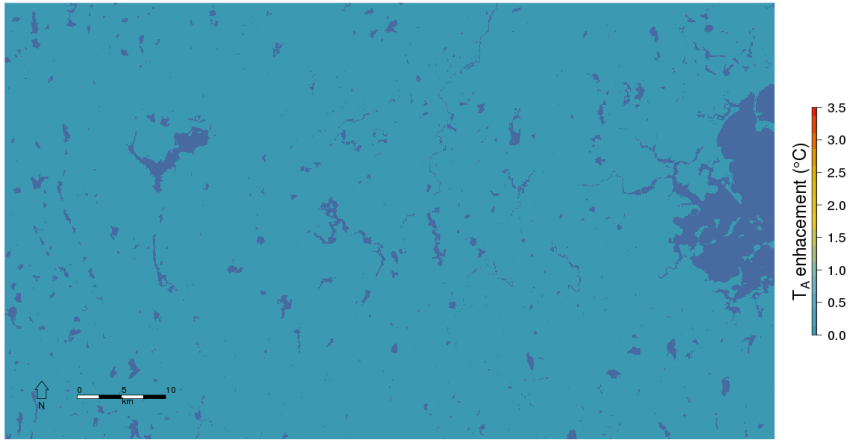
Seasonal Variation in Day, Night, Air Temperature, VPD Gradients



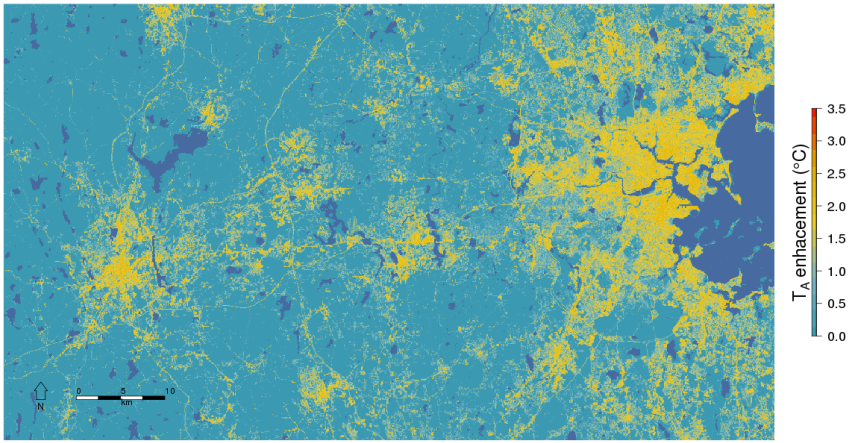


Spring, Summer, Day, Night Air Temperature Gradients

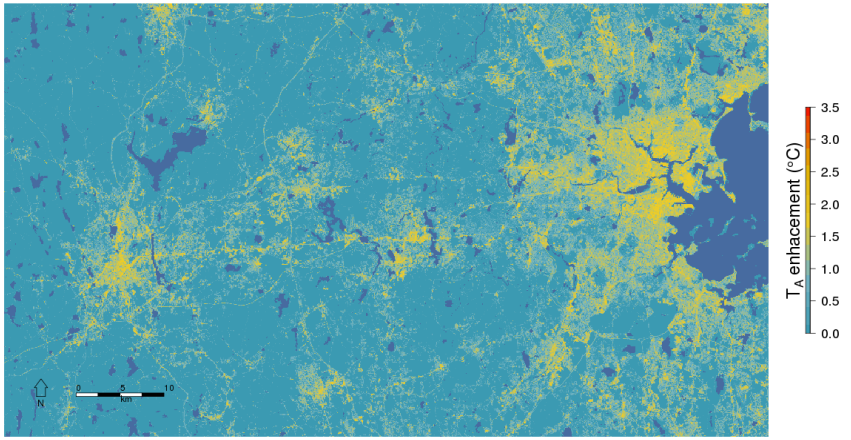
Average total T_A enhancement due to ISA (Spring, daytime)



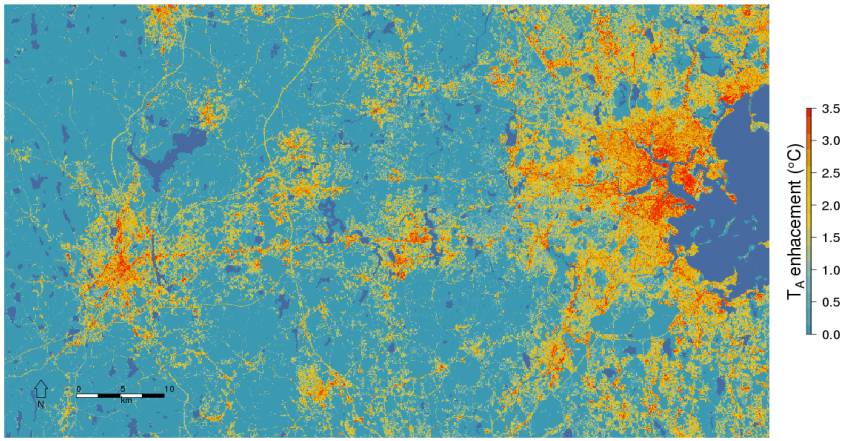
Average total T_A enhancement due to ISA (Spring, nighttime)



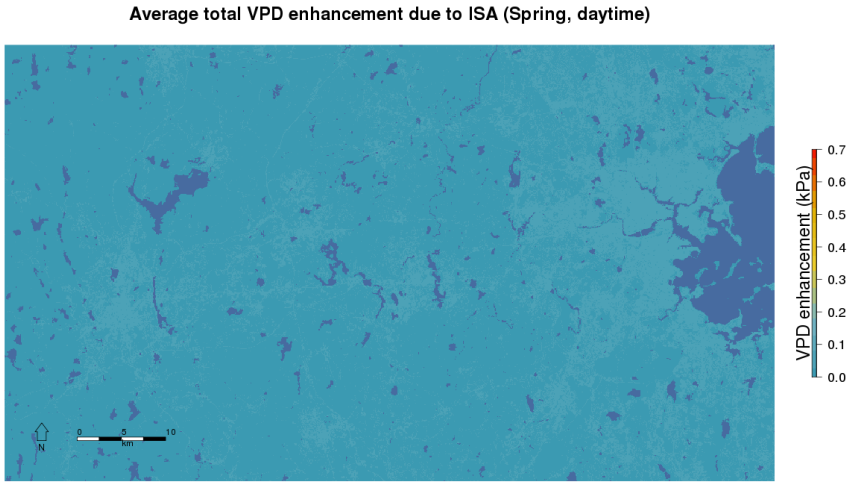
Average total T_A enhancement due to ISA (Summer, daytime)

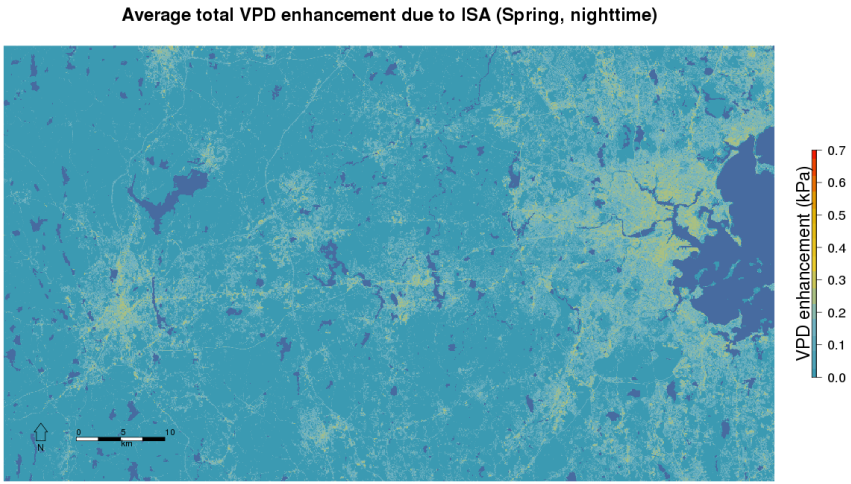


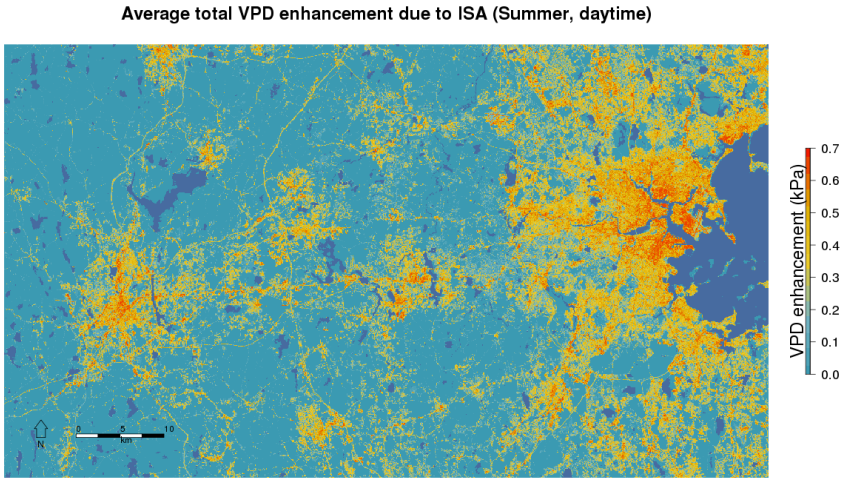
Average total T_A enhancement due to ISA (Summer, nighttime)

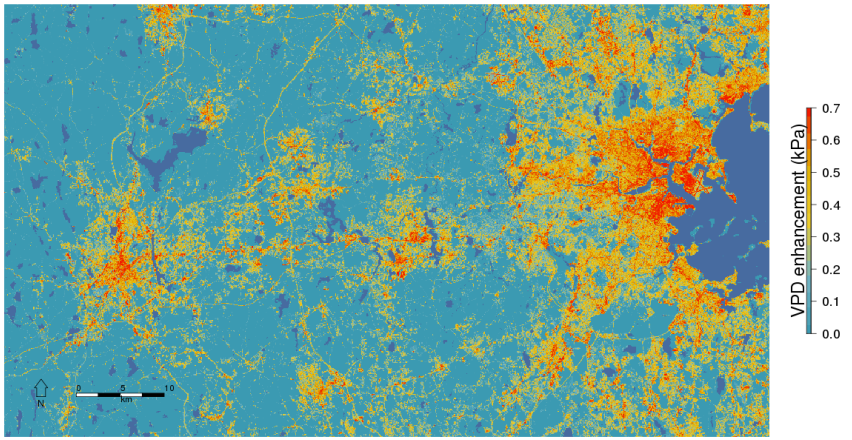


Spring, Summer, Day, Night VPD Gradients









Questions?