Skin of the Big Apple

Characterizing the Surface Heat Island of New York City & Integration with MM5 Climate Model

EPA Conference Call
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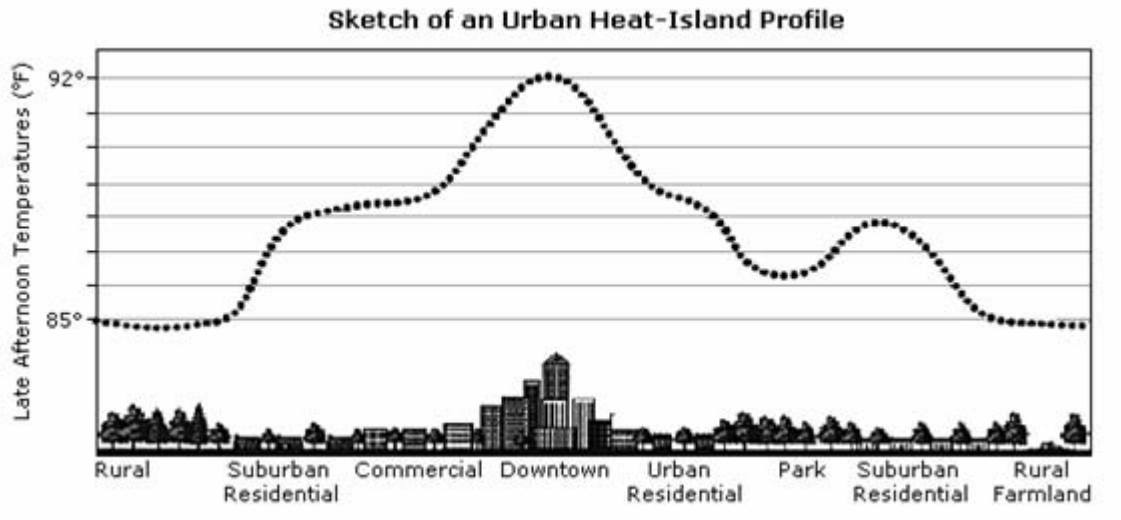
Presenter : **Jennifer R Cox**, Hunter College CUNY

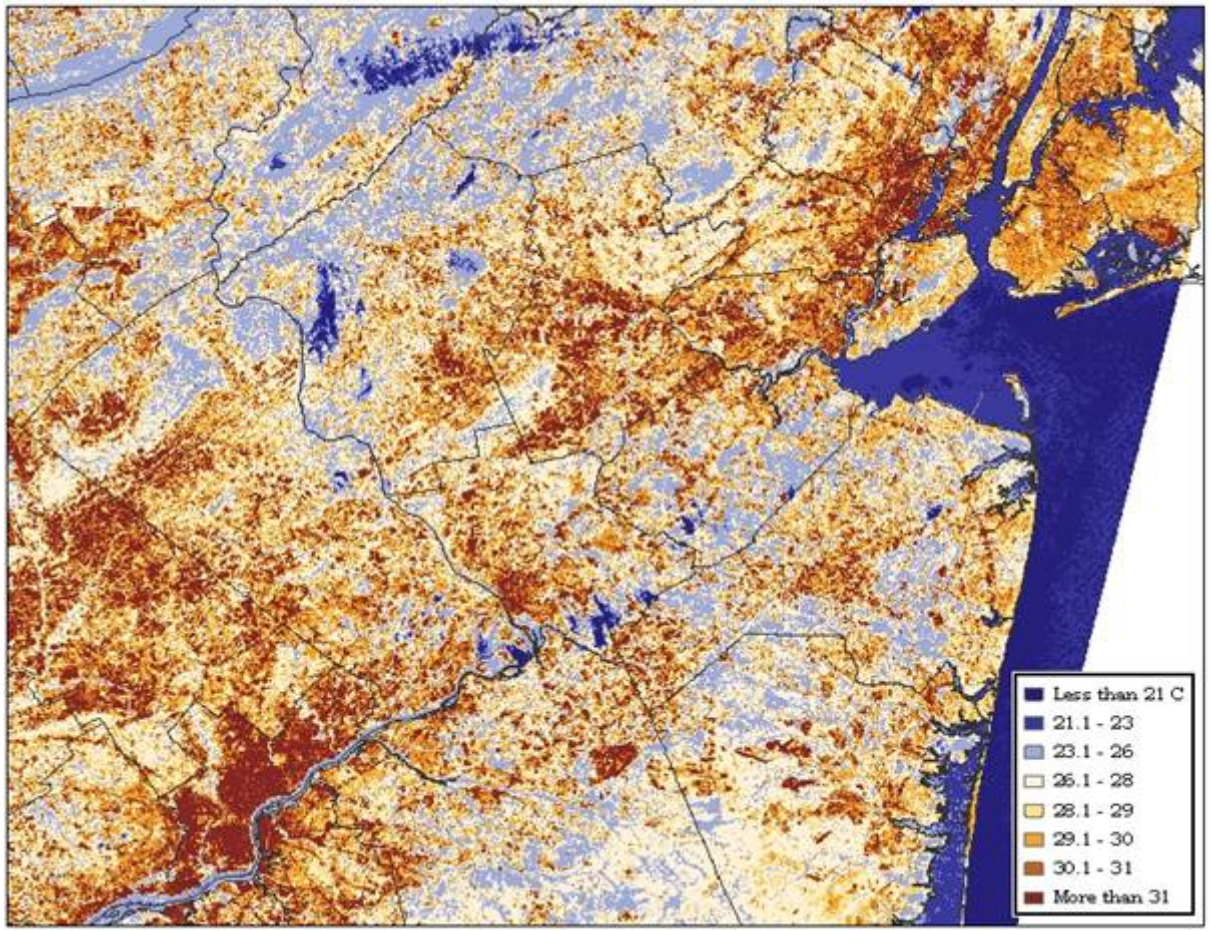
Sara Hodges, Hunter College, CUNY
Lilly Parshall, NASA GISS
Dr. Cynthia Rosenzweig, NASA GISS
Dr. William D Solecki, Hunter College, CUNY

1. Overview Surface Heat Island
2. Variables for UHI Analysis
3. Statistical Analysis
4. Integration with MM5
5. Scenario Development



HUNTER
The City University of New York

Our objective is to define the statistical relationship between surface temperature and a set of potential explanatory variables within New York City.



Three Landsat ETM Images

July 22 2002
Aug 14 2002
Sept 08 2002

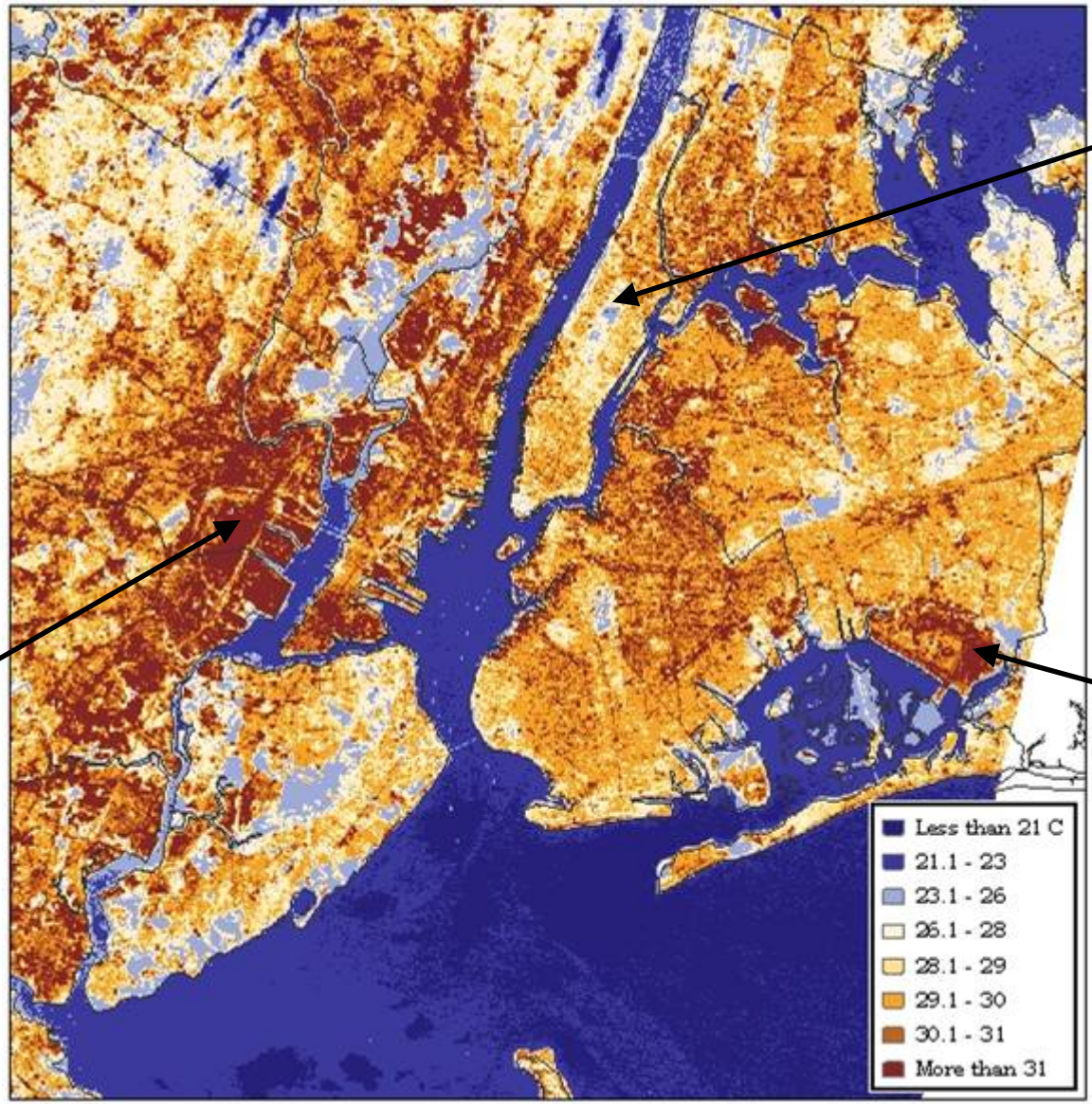
One ASTER Image

Sept 08 2002

One Day/Night MODIS Image

Sept 07 2002

New York City Surface Temperature



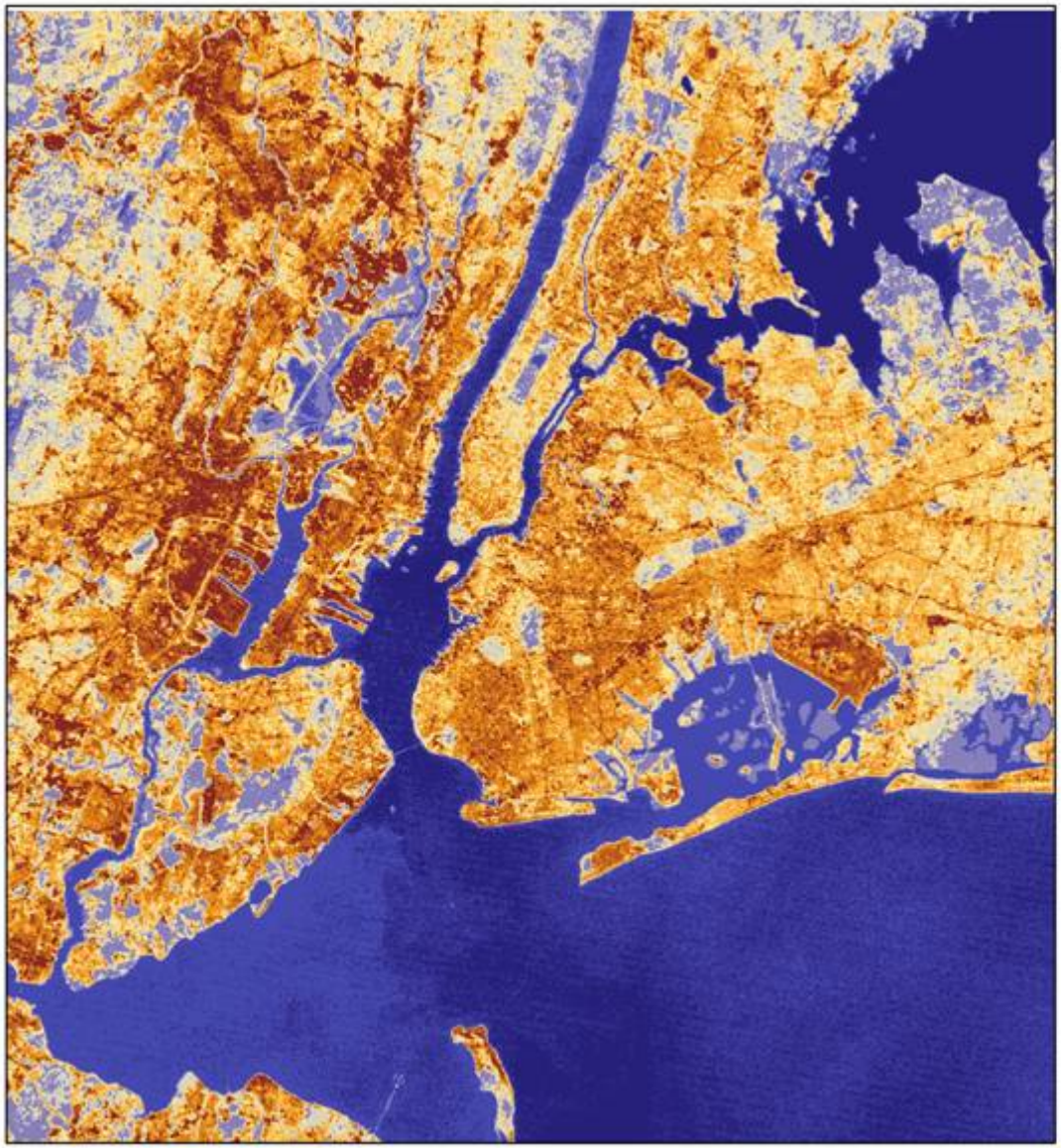
Central Park

Newark

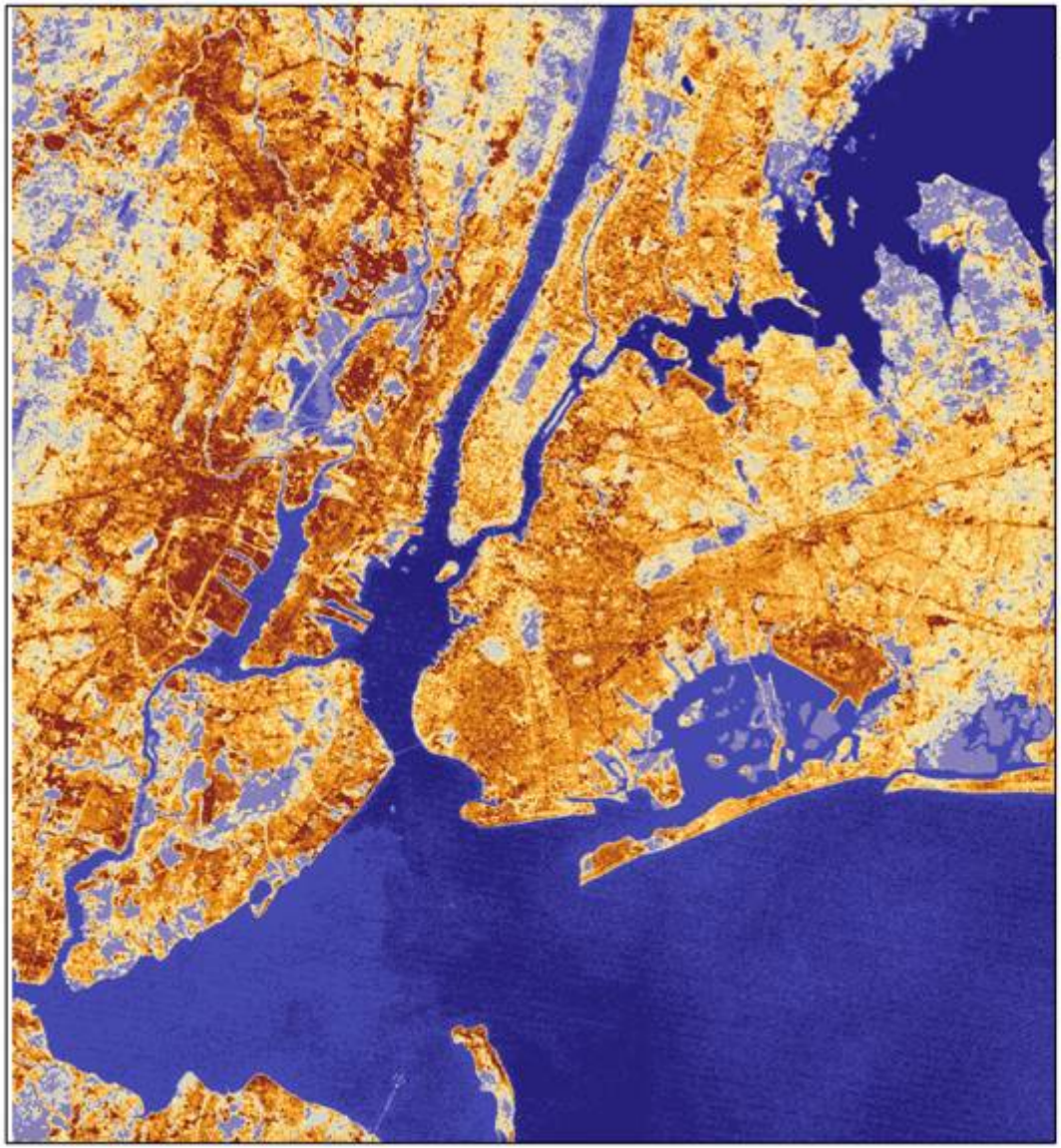
JFK

SURFACE TEMPERATURE
Landsat ETM 7
Aug 14 2002
10:30 AM

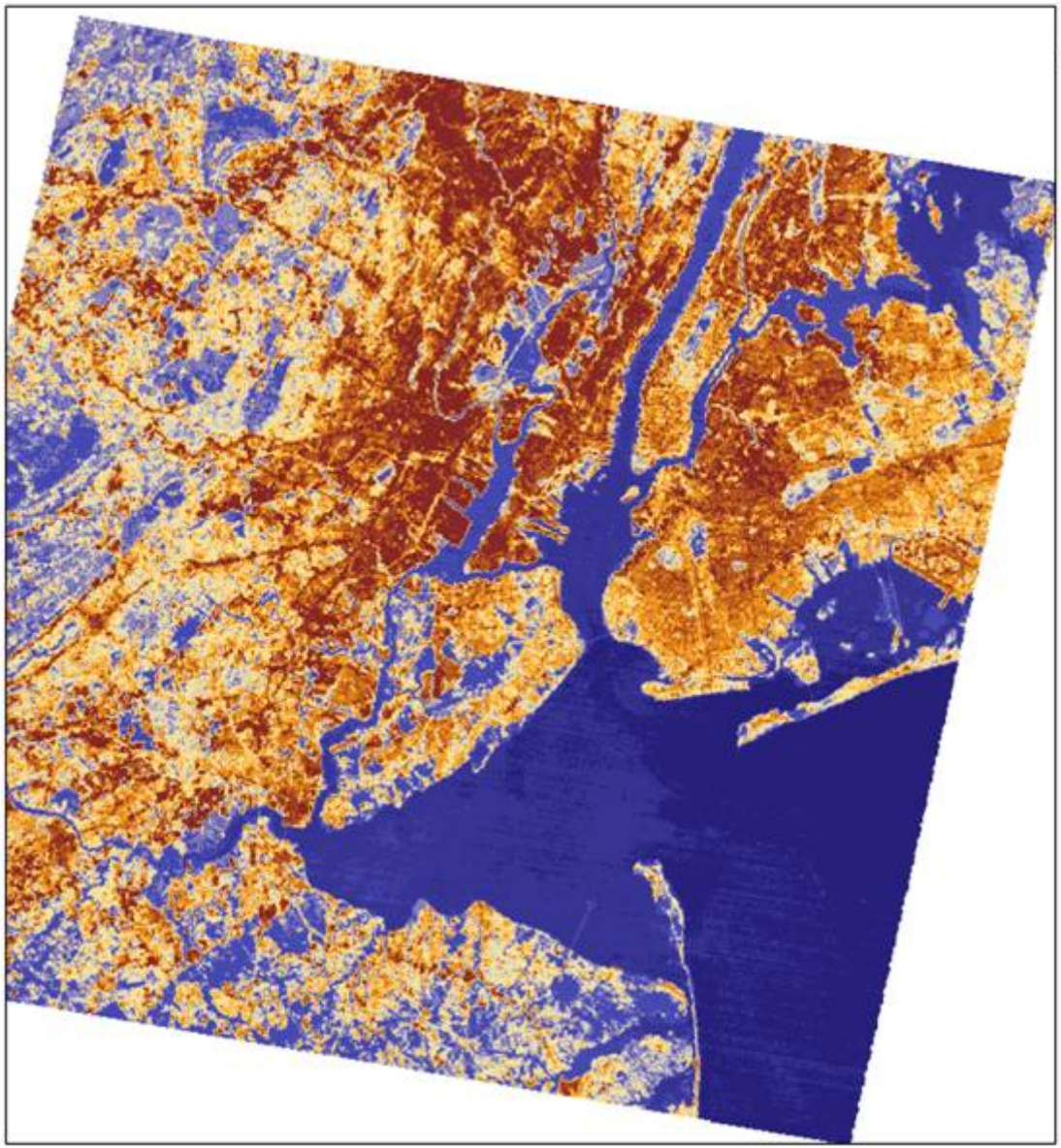
New York City Surface Temperature



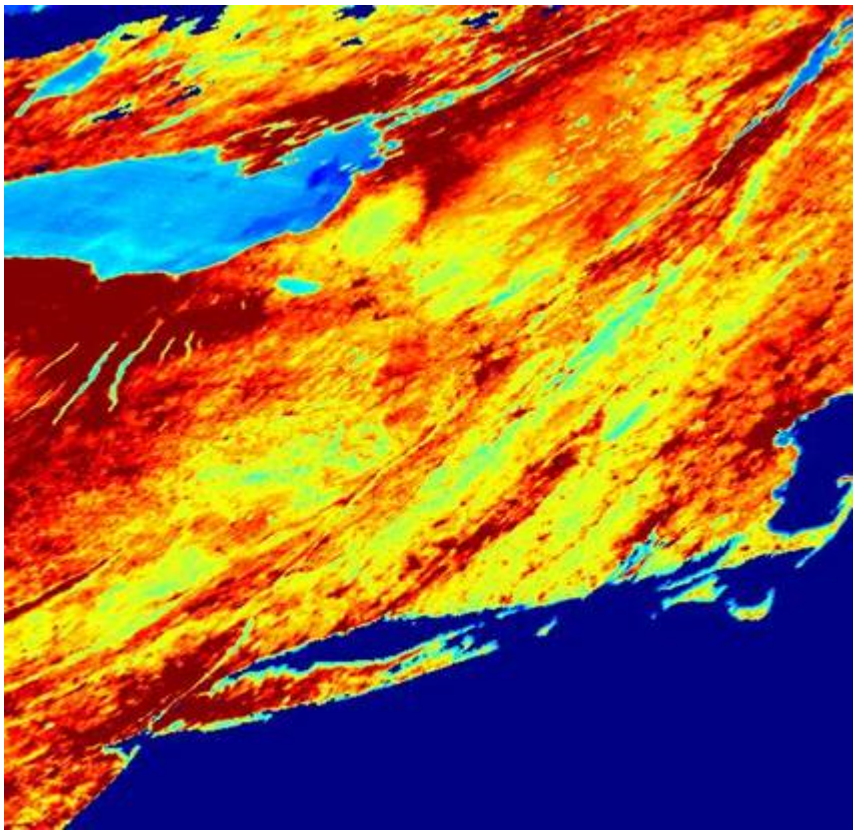
New York City Surface Temperature



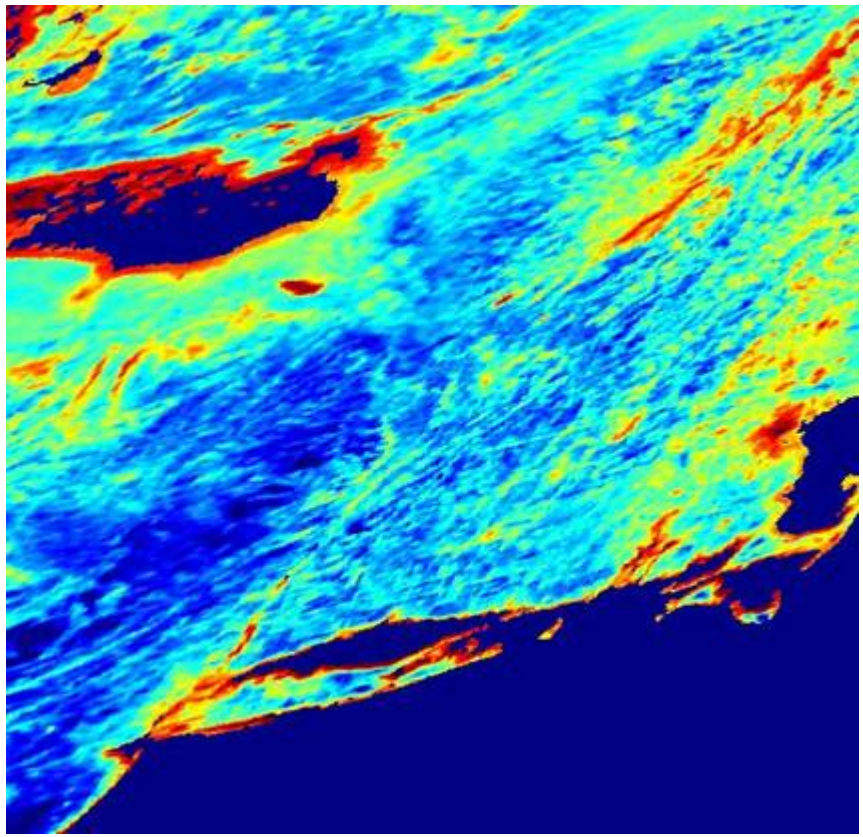
New York City Surface Temperature



MODIS Daily 1km Day and Nighttime Surface Temperature



Sept 08 2002 10:30 Am



Sept 08 2002 1030pm

More Info : http://edcdaac.usgs.gov/modis/mod11a1.asp

Creation of the GIS

Creation of a 250m by 250m GRID in GIS that compiles the following variables for New York City.

Surface Temperature (Independent Variable)

1. Landsat ETM+, Band 6, 60m resolution, Celsius
2. ASTER, Band 10, 90m resolution, Celsius
3. MODIS, Level 3 LST, 1km resolution, Kelvin

Land Surface Conditions

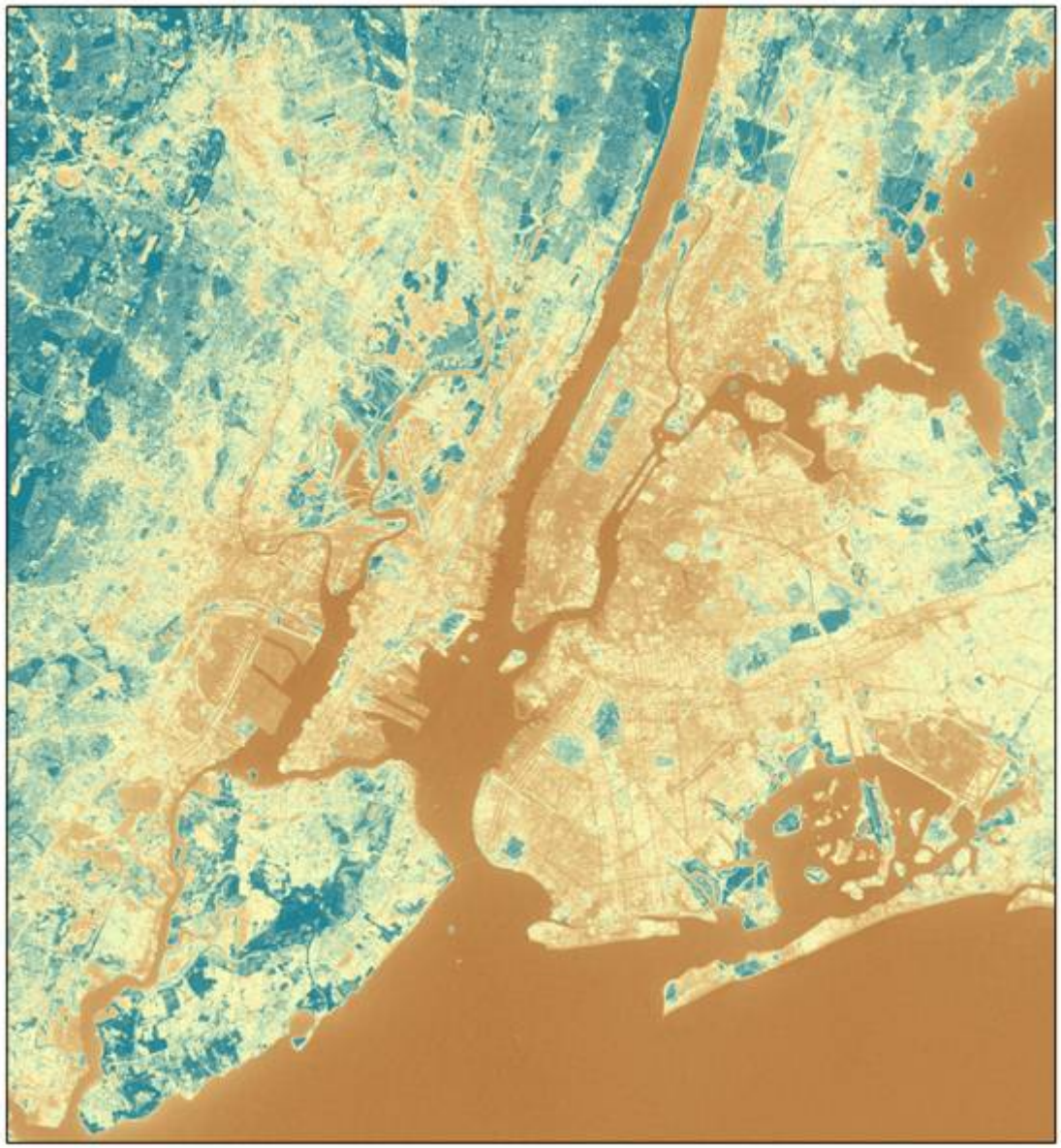
1. NDVI (each image)
2. Albedo Composite (Small, 2003)

Location and Geometry (Anthropogenic)

1. Building Square Footage
2. Year Structure Built
3. Building heights (number of stories)
4. Road Network Density / Intersection Density
5. Energy Constants for Buildings
6. Binary Variables - Distance to water body (meters) / Size of water body

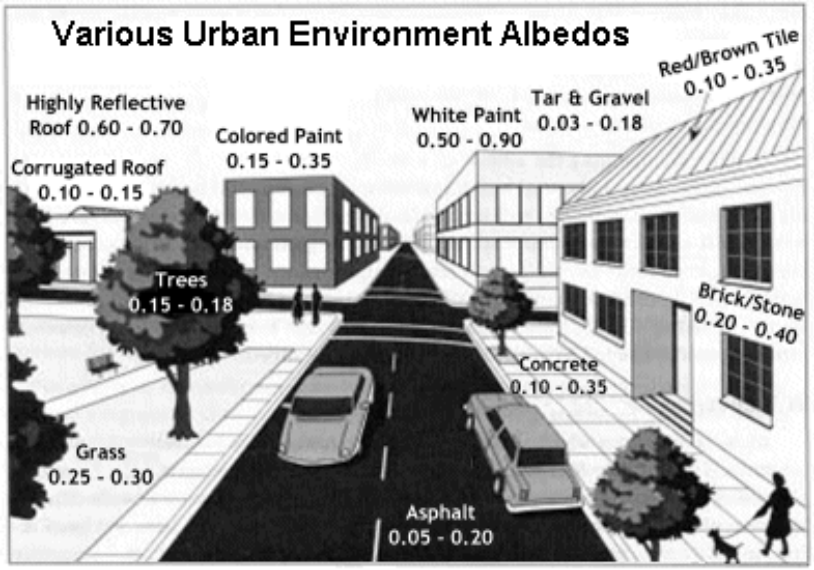
Social

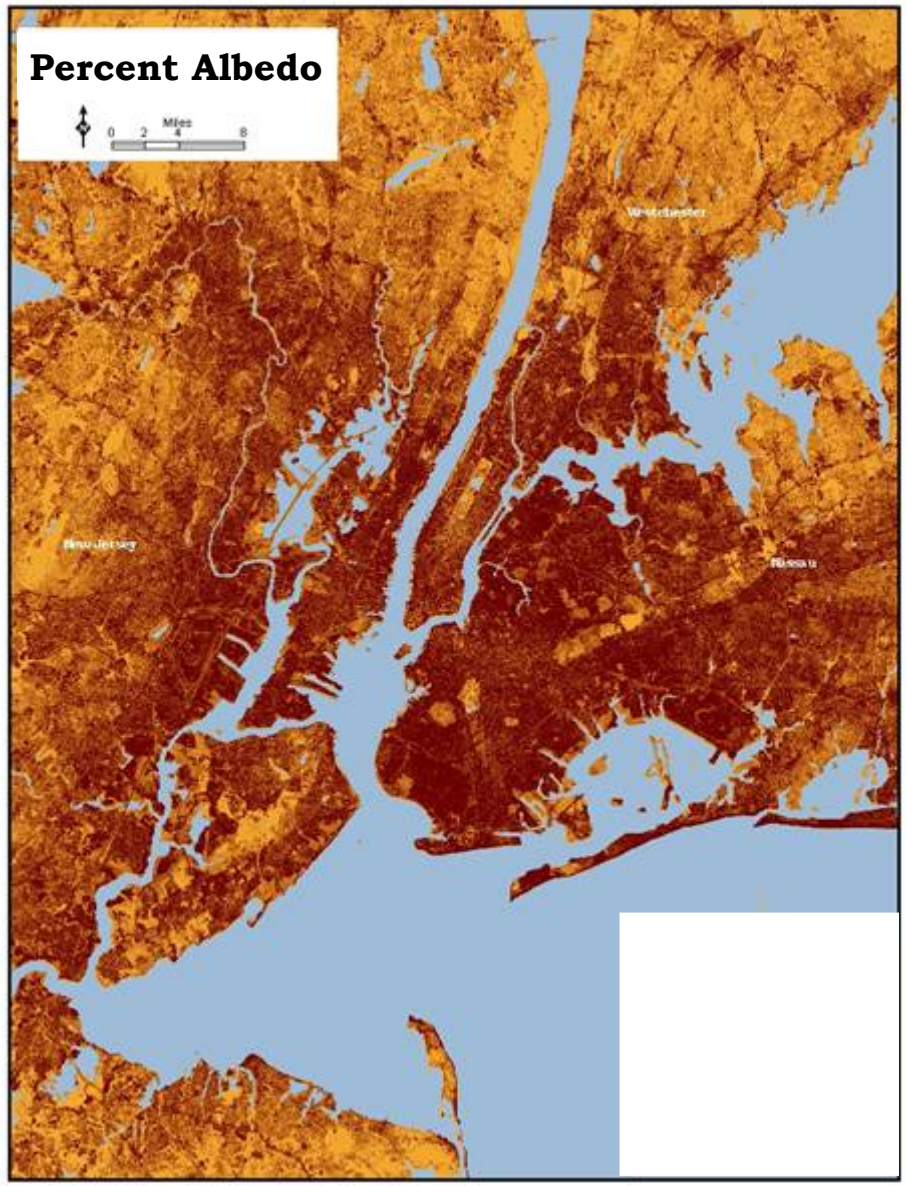
1. Population Density (per square mile)


NDVI
Landsat ETM
Sept 08 2002
10:30 AM
Legend
High : 0.458800
Low : -0.603600
N

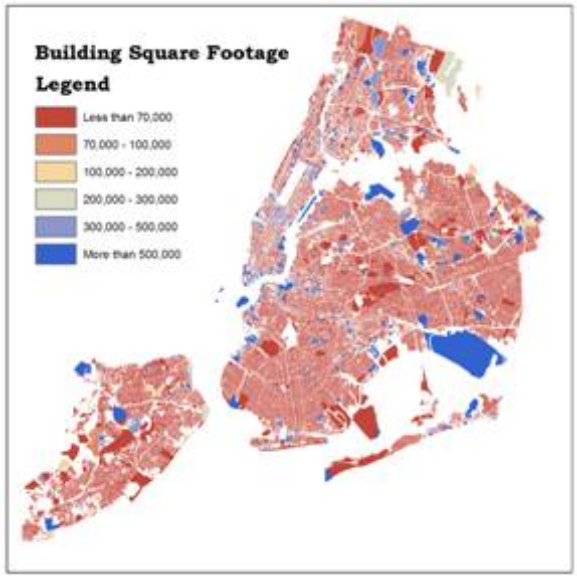
Albedo Composite with Vegetation

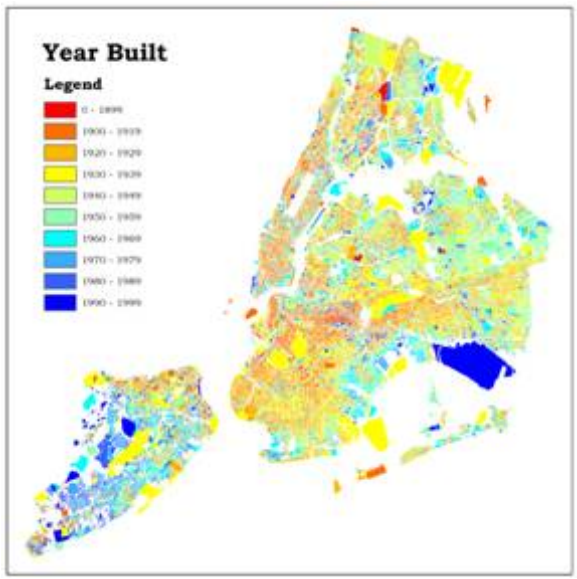
Landsat TM 7 Aug14, 2002 10:30 AM

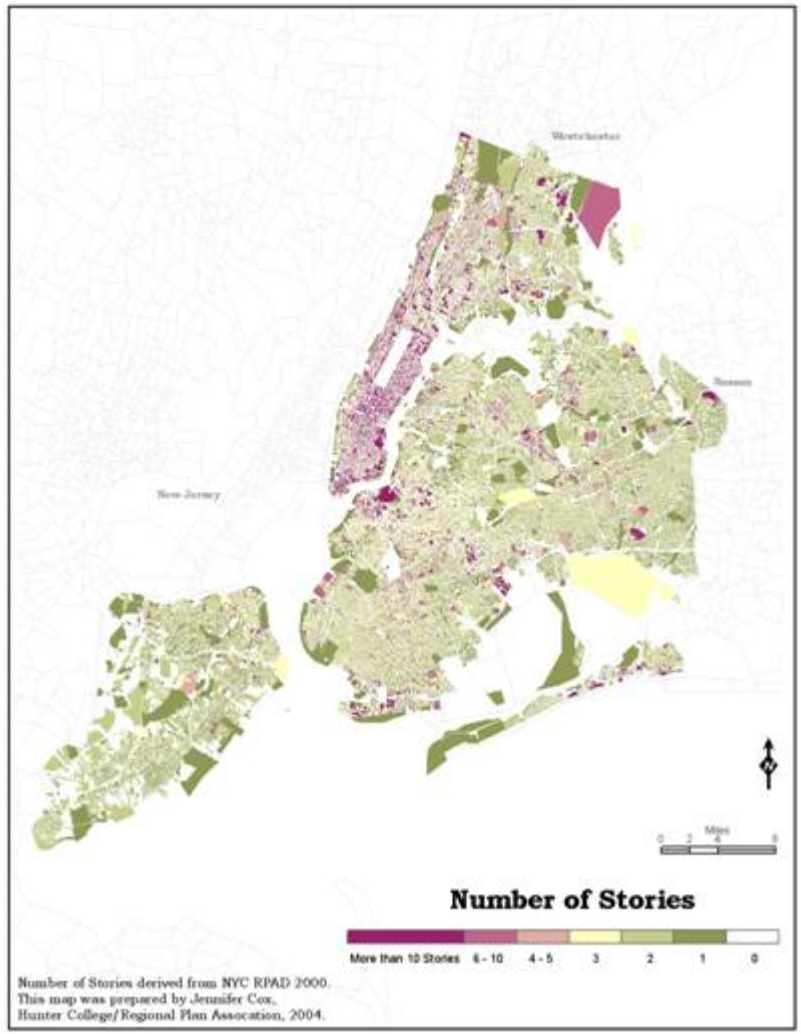




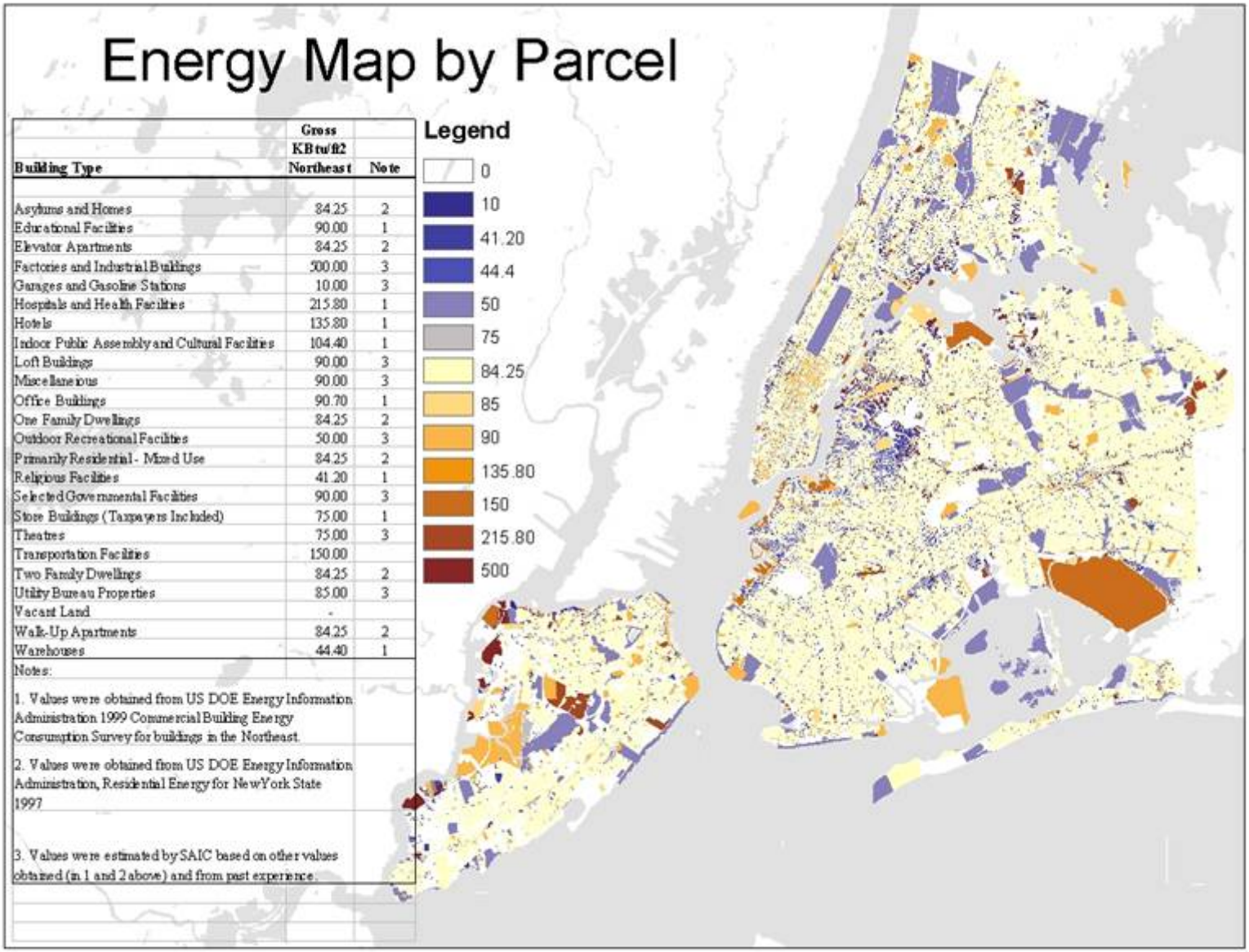
Location and Geometry (Anthropogenic)







Location and Geometry (Anthropogenic)



Building Type	Gross KBtu/ft2 Northeast	Note
Asylums and Homes	84.25	2
Educational Facilities	90.00	1
Elevator Apartments	84.25	2
Factories and Industrial Buildings	300.00	3
Garages and Gasoline Stations	10.00	3
Hospitals and Health Facilities	215.80	1
Hotels	135.80	1
Indoor Public Assembly and Cultural Facilities	104.40	1
Loft Buildings	90.00	3
Miscellaneious	90.00	3
Office Buildings	90.70	1
One Family Dwellings	84.25	2
Outdoor Recreational Facilities	50.00	3
Primarily Residential - Mixed Use	84.25	2
Religious Facilities	41.20	1
Selected Governmental Facilities	90.00	3
Store Buildings (Taxpayers Included)	75.00	1
Theatres	75.00	3
Transportation Facilities	150.00	
Two Family Dwellings	84.25	2
Utility Bureau Properties	85.00	3
Vacant Land	-	
Walk-Up Apartments	84.25	2
Warehouses	44.40	1

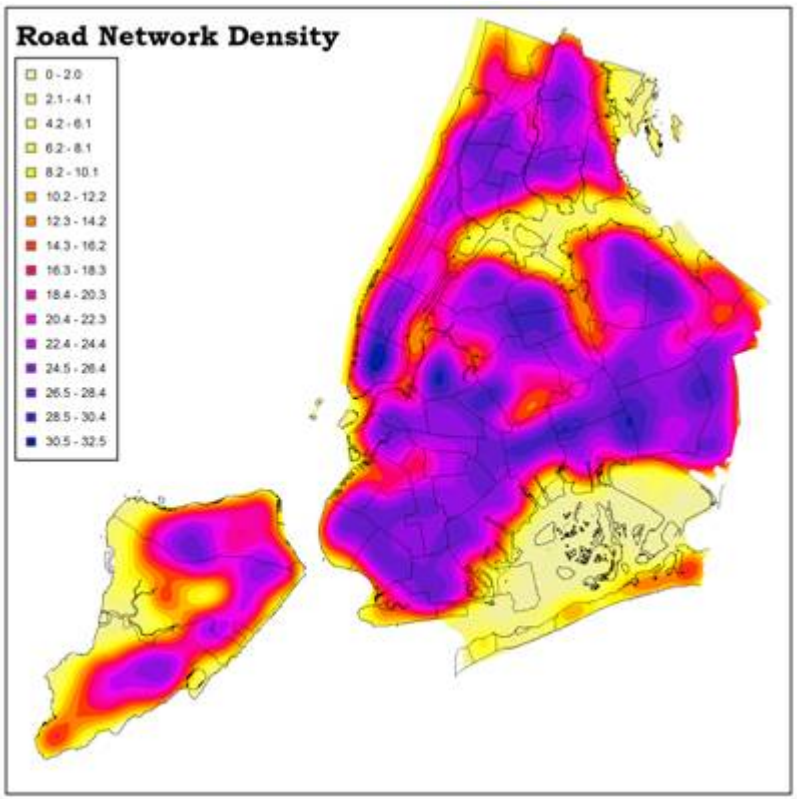
Notes:

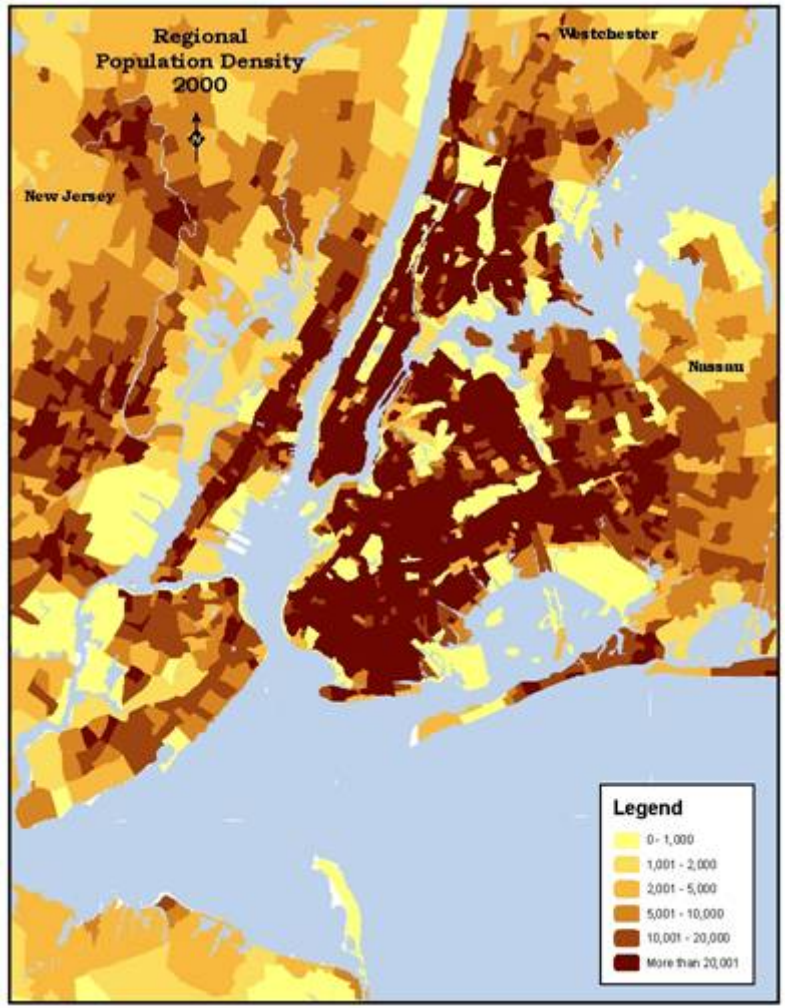
1. Values were obtained from US DOE Energy Information Administration 1999 Commercial Building Energy Consumption Survey for buildings in the Northeast.

2. Values were obtained from US DOE Energy Information Administration, Residential Energy for NewYork State 1997

3. Values were estimated by SAIC based on other values obtained (in 1 and 2 above) and from past experience.

Location and Geometry (Anthropogenic)



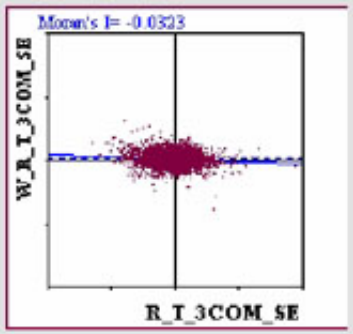


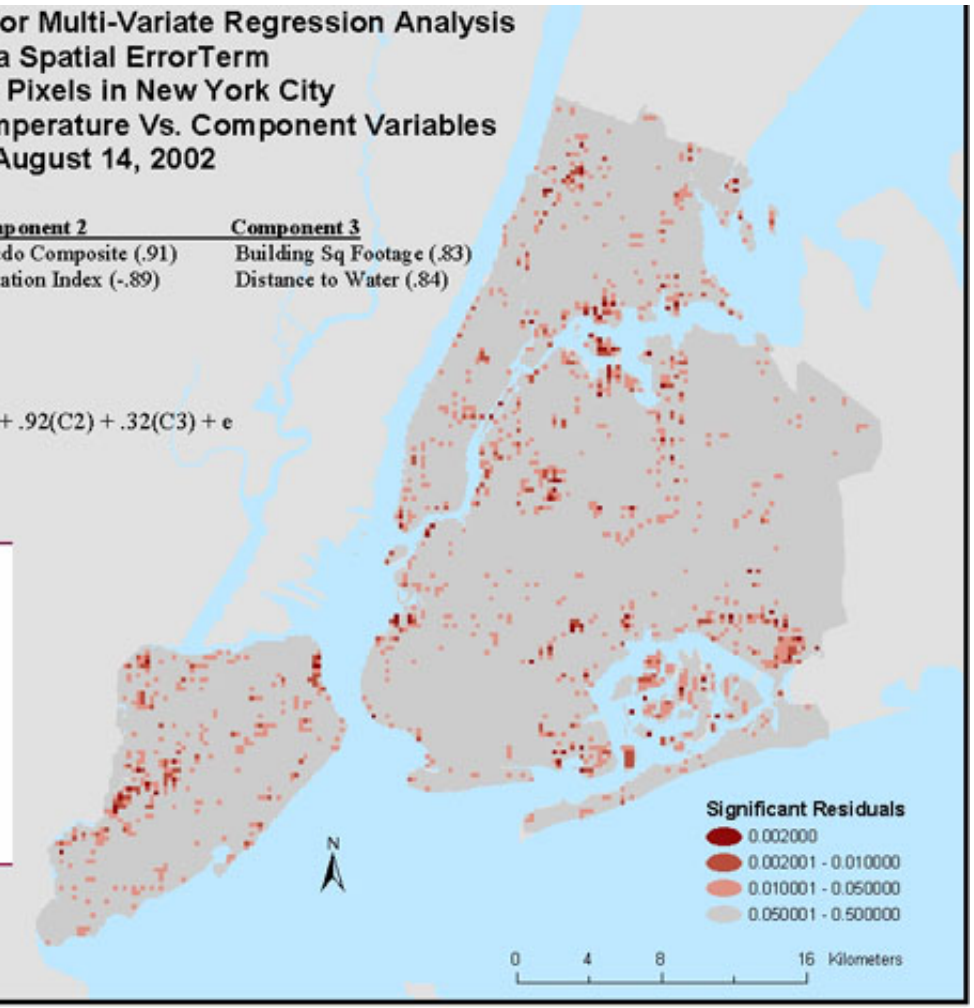
Significant Residuals for Multi-Variate Regression Analysis with a Spatial ErrorTerm 250 Meter Pixels in New York City Average Surface Temperature Vs. Component Variables August 14, 2002

Component 1	Component 2	Component 3
Intersection Density (.96)	Albedo Composite (.91)	Building Sq Footage (.83)
Road Density (.95)	Vegetation Index (-.89)	Distance to Water (.84)

$R^2 = .59$
S.E. = 1.41

$E(Y) = 28.79 + .67\lambda + + .87(C1) + .92(C2) + .32(C3) + e$



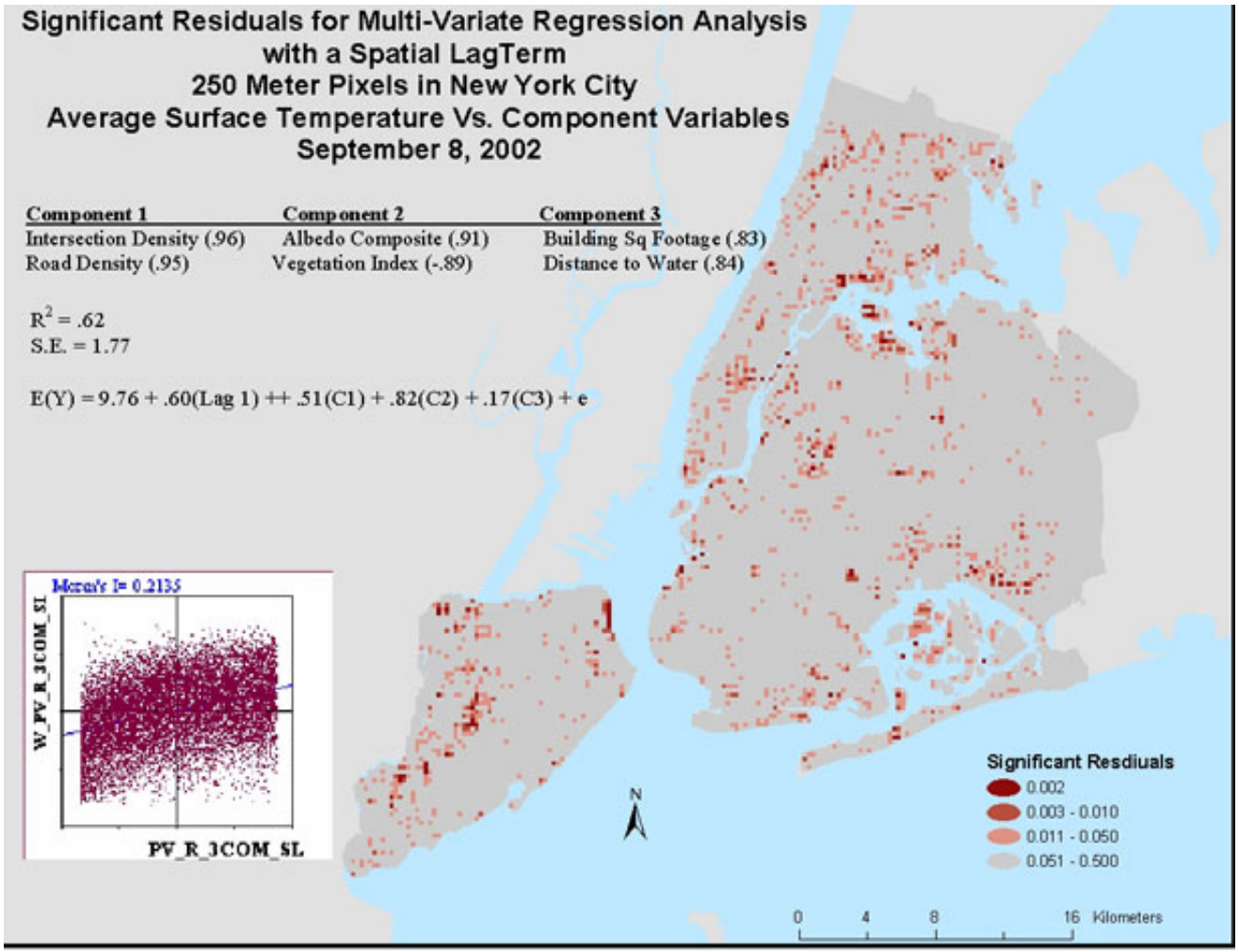


Significant Residuals for Multi-Variate Regression Analysis with a Spatial LagTerm 250 Meter Pixels in New York City Average Surface Temperature Vs. Component Variables September 8, 2002

Component 1	Component 2	Component 3
Intersection Density (.96)	Albedo Composite (.91)	Building Sq Footage (.83)
Road Density (.95)	Vegetation Index (-.89)	Distance to Water (.84)

$R^2 = .62$
S.E. = 1.77

E(Y) = 9.76 + .60(Lag 1) ++ .51(C1) + .82(C2) + .17(C3) + e



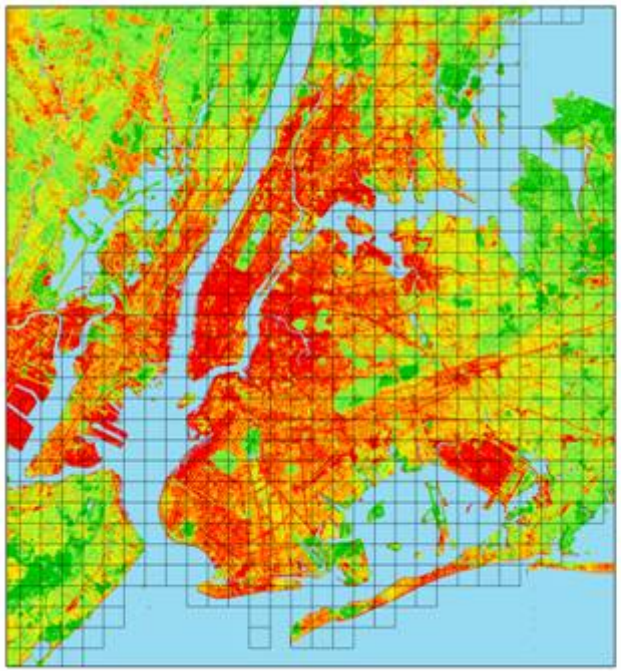
Downscaling the MM5 Model 4km to 1km

Analysis of Surface and Atmospheric
Urban Heat Island through Weather Station Data

Case Study Development for MM5 Modeling
and Surface UHI Characterization

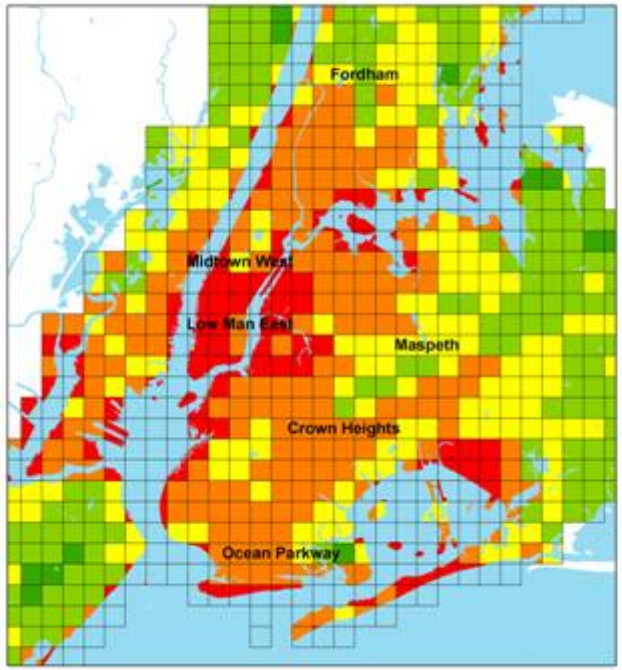
Development of 4 Mitigation Scenarios

Downscaling the MM5



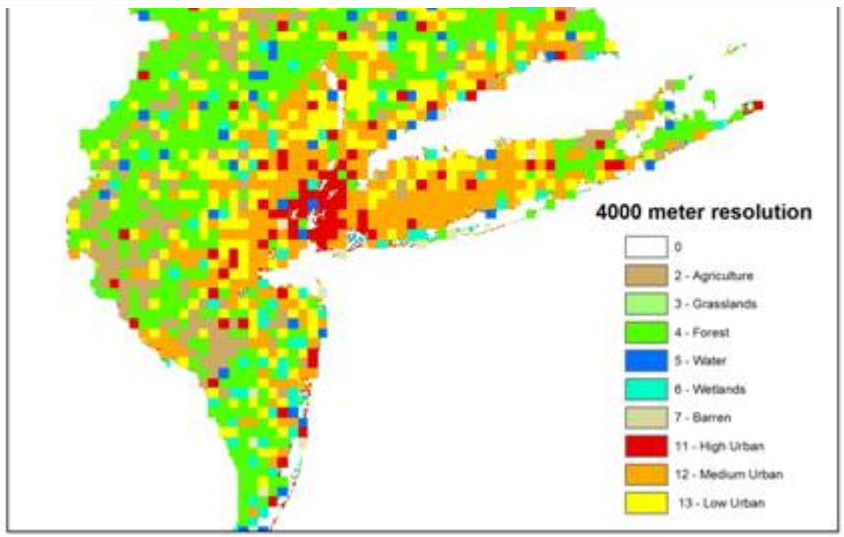
30 Meter Vegetation Fraction Data

0% - 10%
10.1% - 20%
20.1% - 30%
30.1% - 50%
50.1% - 100%

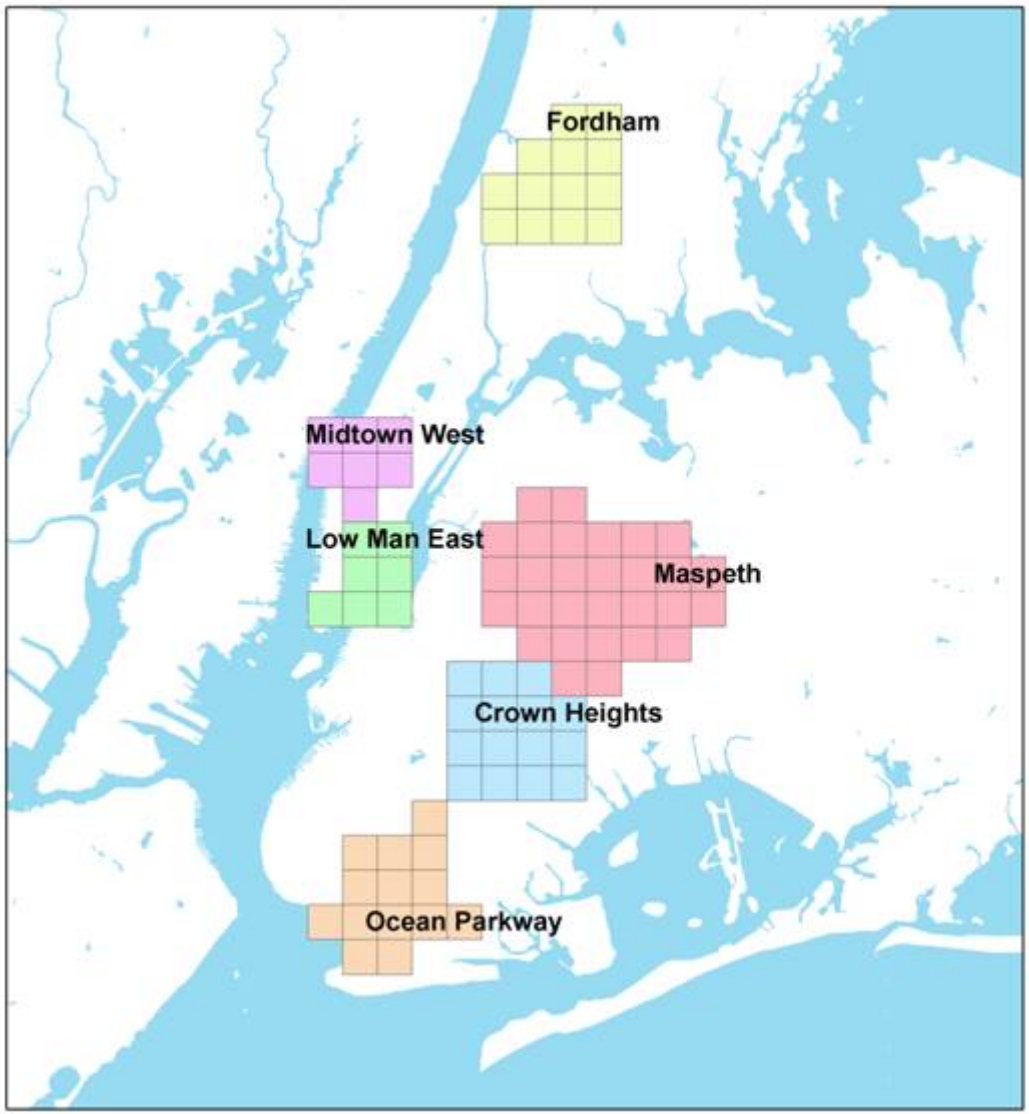


1 Km Vegetation Fraction Data

0.0% - 10%
10.1% - 20%
20.1% - 30%
30.1% - 50%
50.1% - 68.2%



Case Studies Development

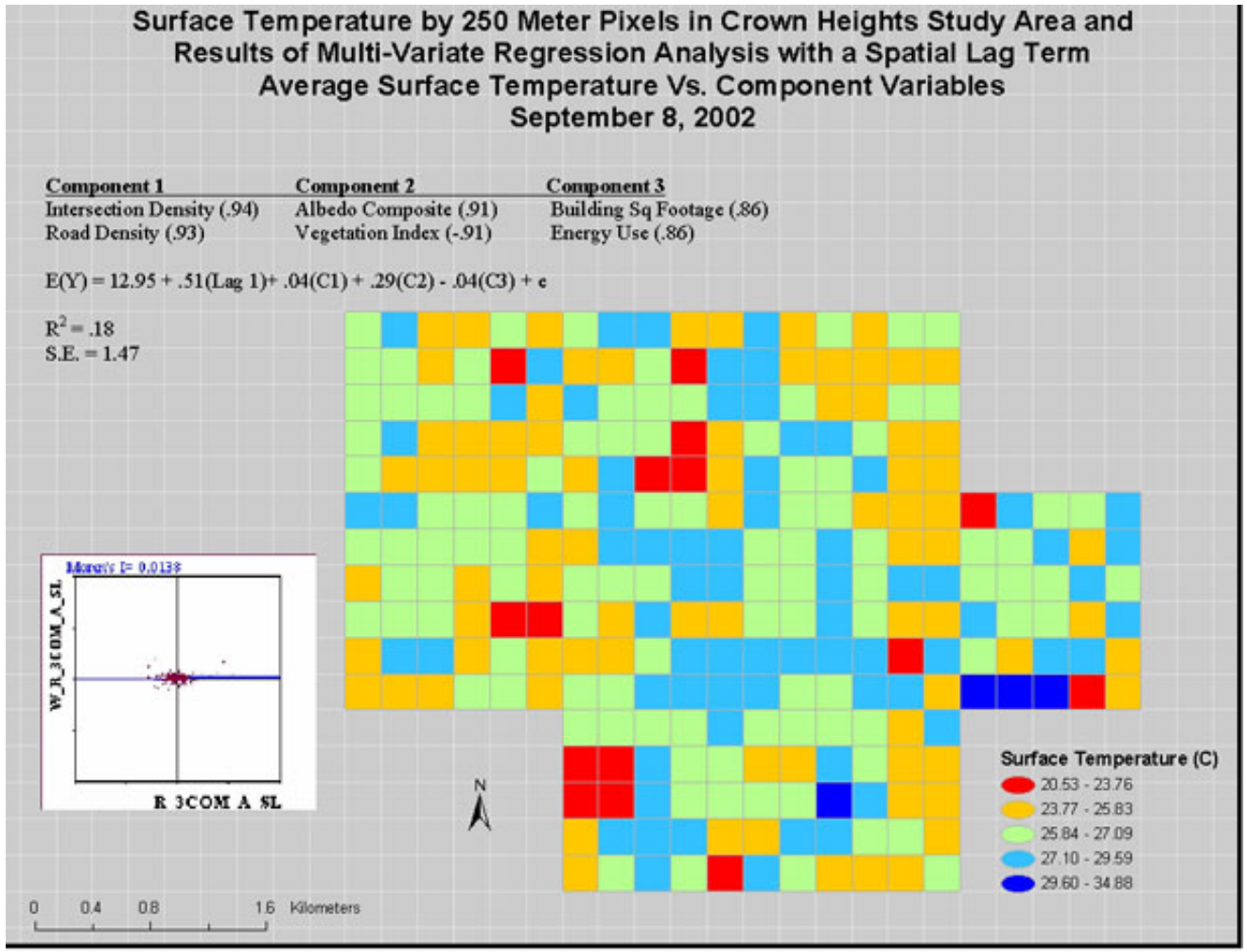


Case Studies

Local Surface Heat Island & MM5 Modeling

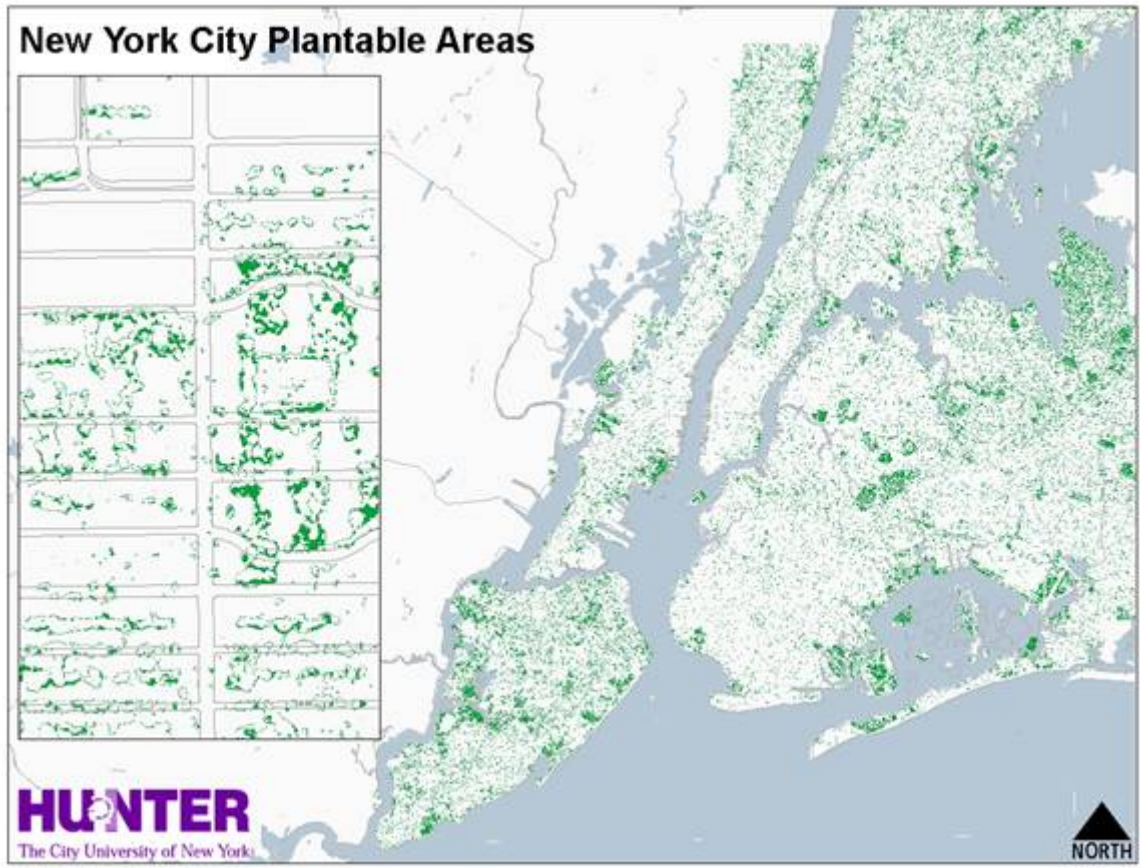
- Crown Heights
- Fordham
- Low Man East
- Maspeth
- Midtown West
- Ocean Parkway

Case Study Surface UHI Characterization



Development of 4 Mitigation Scenarios

1. Planting Trees
2. Green/Living Roofs
3. Surface Albedo Changes
4. Anthropogenic



. Surface Conditions such as Vegetation Index and Albedo that are derived directly from satellite imagery have been highly correlated at multiple scales of UHI Analysis. Regionally they are often the key variables, However at local scales, the analysis uncovered other variables such as Street Network Density and Building Square Footage play a larger role in the variation of the surface UHI effect across the landscape.

. Clearly define the Regression Equations for NYC as whole and our six case studies

. Continue the analysis of variables at differing Scales

.Incorporation of MODIS data to Review Night time UHI conditions

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For information on UHI Research of NYC Metropolitan Region

Contact:
Dr. William Solecki, Hunter College, CUNY wsolecki@hunter.cuny.edu
or
Jennifer R Cox, Hunter College CUNY/Regional Plan Association
jennifer@rpa.org

Or Visit:

www.geo.hunter.cuny.edu/~jcox