Mitigating New York City's Heat Island with Urban Forestry, Living Roofs, and Light Surfaces

New York City Regional Heat Island Initiative

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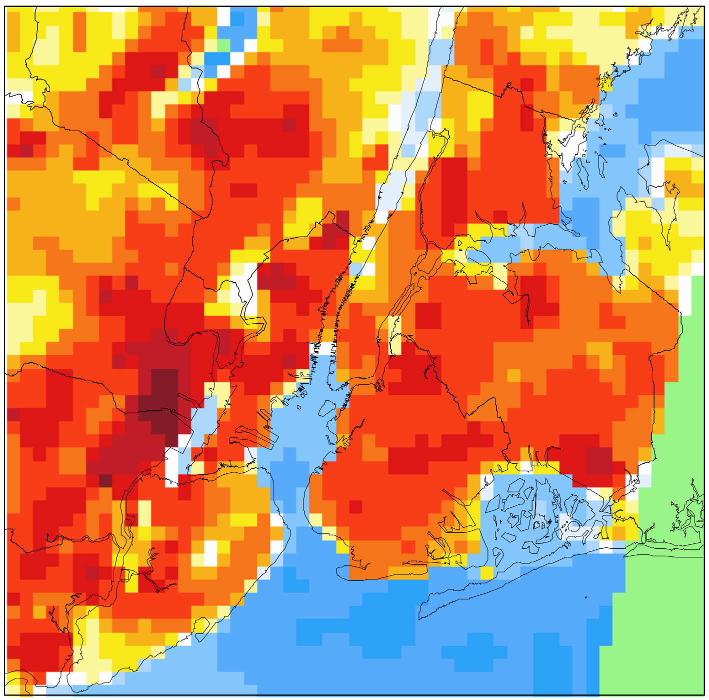
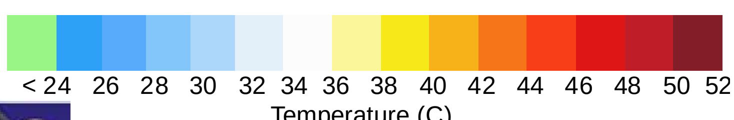
New York City's Heat Island Archipelago

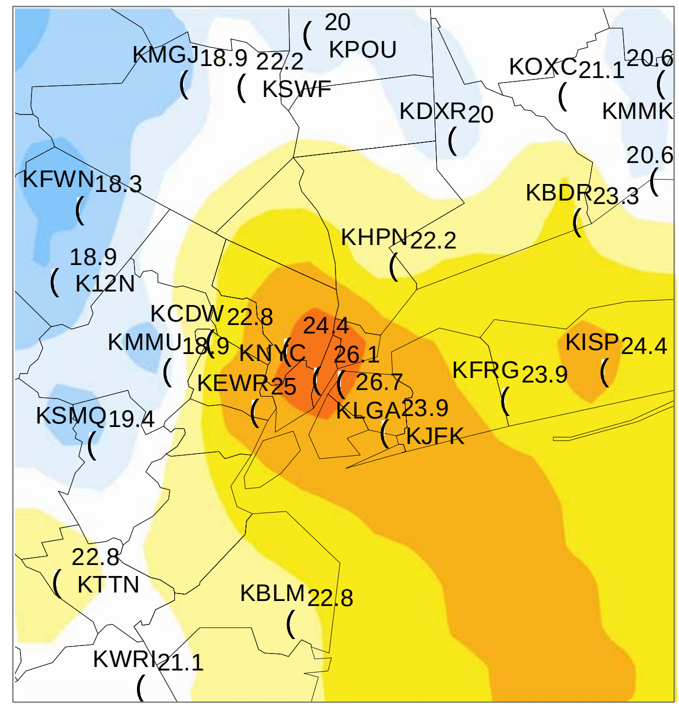
1 km Satellite Skin Temperature August 14, 2002, 10:30 AM



NASA/GISS Climate Impacts Group



NWS Observed Temperature August 14, 2002, 6:00 AM



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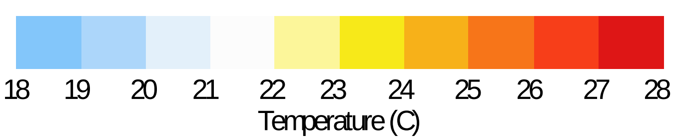


Heat Island Mitigation Strategies

Urban Forestry
- Tree-planting in open, grassy areas
- Tree-planting along streets to shade sidewalks and roads

Living Roofs
- Impervious roofs covered with vegetation

Light Surfaces
- Impervious roofs lightened
- All street-level and rooftop impervious surfaces lightened

Combinations: Ecological Infrastructure, Urban Forestry + Light Surfaces

Data Library

Observed Data

- Meteorological station data from NWS and WeatherBug
- Heatwave dates: July 2 – 4, July 28 – August 7, August 11 – 18

Satellite Data

- 3 Landsat images (7/22, 8/14, and 9/8; 10:30 AM, 60 meters)
- 1 ASTER image (9/8; 10:30 AM, 90 meters)
- 1 MODIS day-night pair (9/8; 10:30 AM, 1 kilometer)

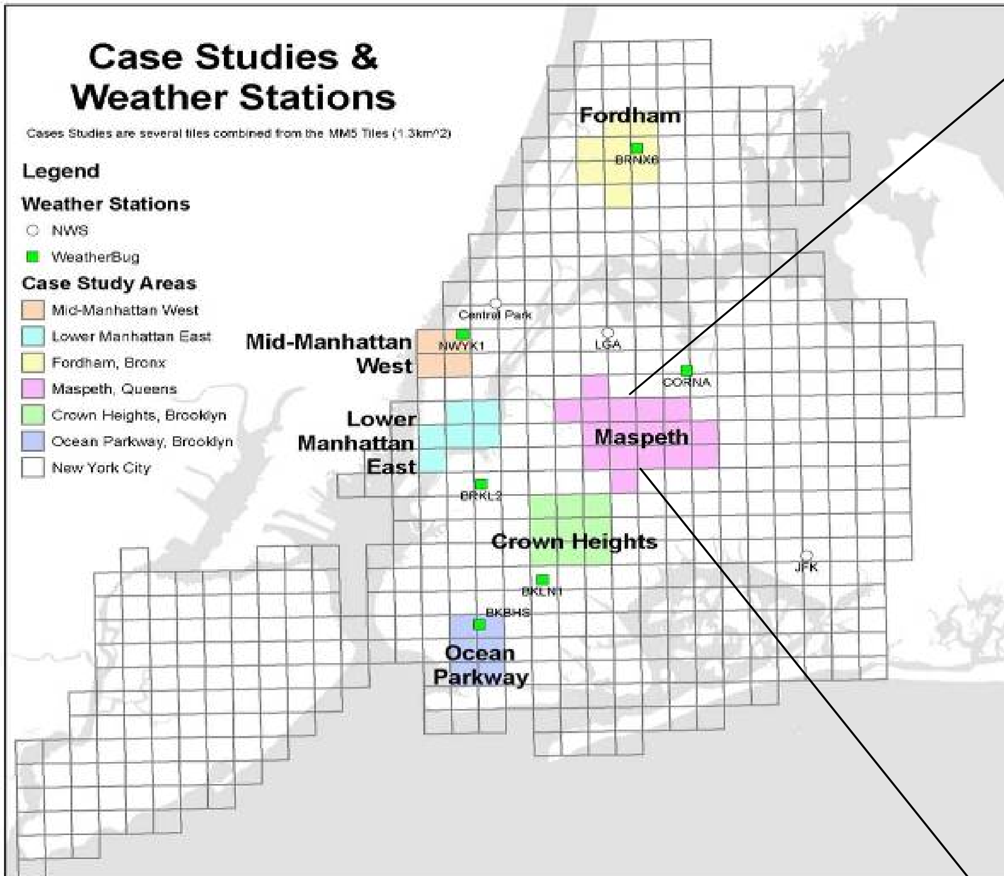
GIS Data Library

- Albedo composite *(Source: albedo proxy based on Small, 2003)*
- NDVI *(Source: calculated from each satellite image)*
- Road Density *(Source: Census TIGER 2003)*
- Population Density *(Source: Census 2000 Block Groups)*
- Building Square Footage *(Source: Tax Parcel Database of NYC)*
- Average Building Height *(Source: Tax Parcel Database of NYC)*
- Average Year Built *(Source: Tax Parcel Database of NYC)*
- Energy Use *(Source: Tax Parcel Database of NYC)*

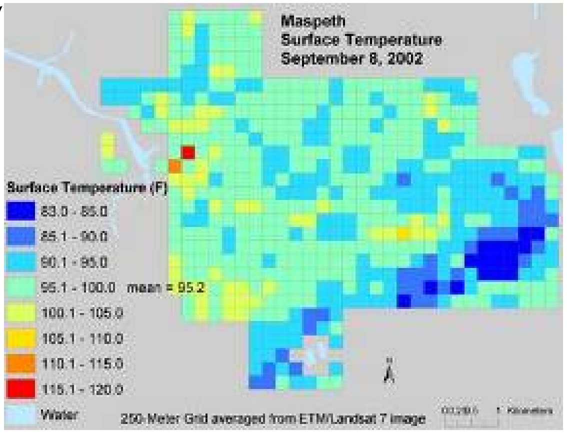
Land Surface Data

- Database of EMERGE aerial photography *(Source: Myeong et al., 2003)*

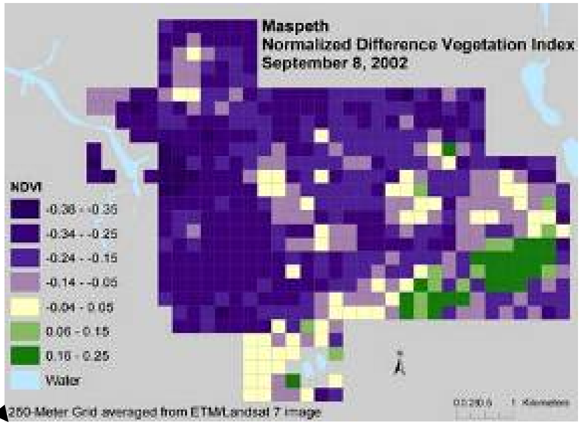
Case Study Areas



Case study areas and weather stations. Grid boxes correspond to the MM5 model 1.3 km grid. Selection criteria: [1] location within a load pocket, [2] hot spot, [3] available area for testing a range of heat island mitigation strategies.



Gridded surface temperature on September 8, 2002 with resolution of 250 meters.



Gridded NDVI with resolution of 250 meters.

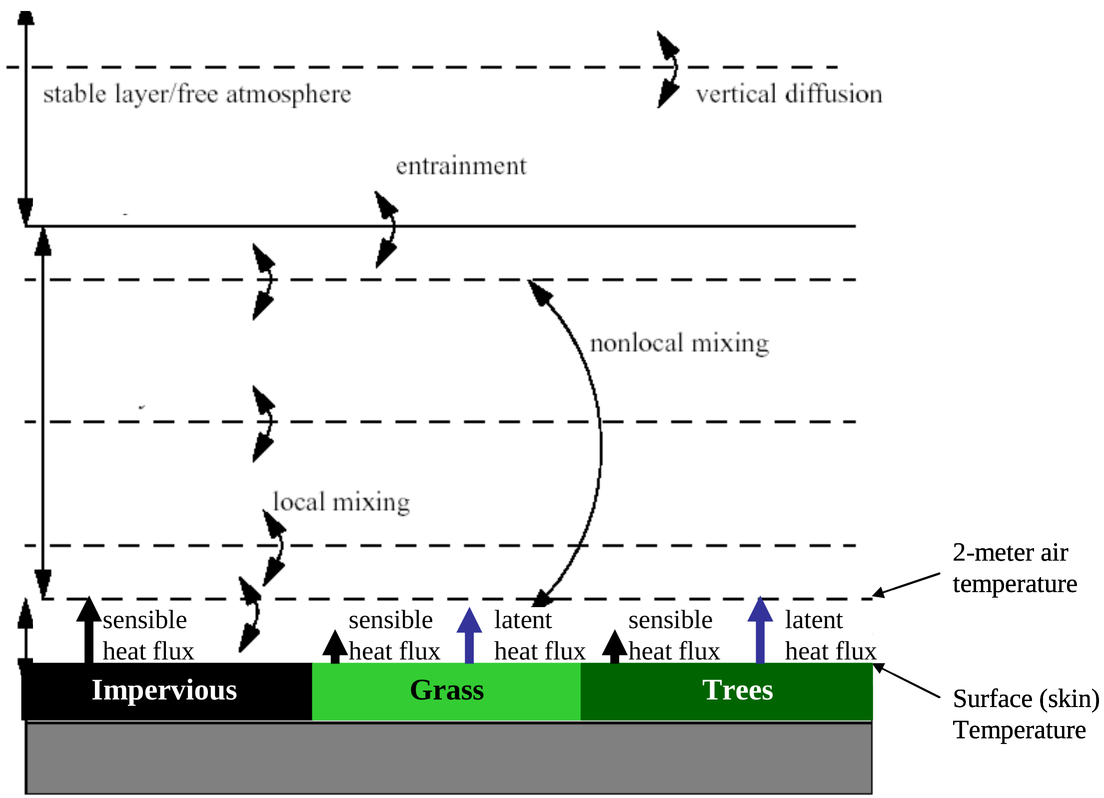
Note: Lower Manhattan case study links to EPA-funded project

Base Land Surface Cover Percentages

Case Study Area	Grass (%)	Trees (%)	Impervious (%)	Street Level Impervious (%)	Impervious Roofs (%)	Est. Avail. for Street Trees (%)
New York City	14.1	21.9	64.1	45.9	18.1	17.0
Mid-Manhattan West	2.6	3.1	94.3	49.3	45.0	26.1
Lower Manhattan East	8.3	8.1	83.6	48.2	35.4	29.4
Fordham Bronx	9.2	22.1	68.7	47.1	21.5	21.1
Maspeth Queens	17.5	22.3	60.2	38.2	22.0	17.9
Crown Heights	8.1	17.2	74.7	45.6	29.1	24.9
Ocean Parkway	5.5	14.8	79.6	50.8	28.9	23.2

MM5 Regional Climate Model

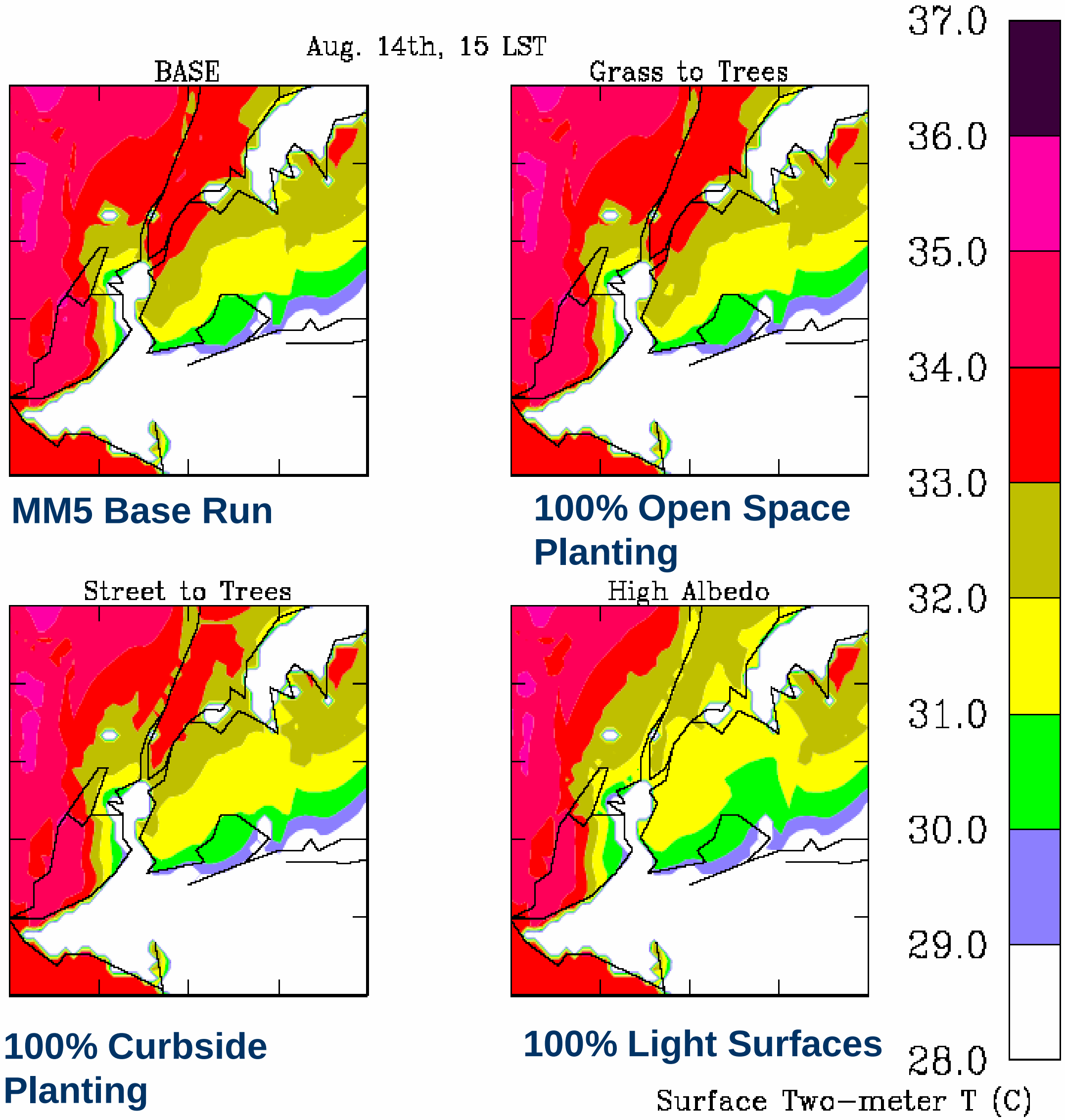
MM5 v3.7+SEBM



Mitigation Strategies Tested 4 Ways:

1) All else being equal, absolute temperature differences between surface cover types
2) Surface type x area, with base surface and 2-meter air temperature
3) Surface type x area, with weighted average near-surface air temperature
4) Interactive Mitigation scenarios

Interactive Mitigation Results



MM5 Base Run

100% Open Space Planting

100% Curbside Planting

100% Light Surfaces

Key Findings

- Vegetation cools surfaces more effectively than increases in albedo (light-colored surfaces).

- Of the mitigation strategies tested, street trees have the largest cooling potential per unit area.

- Light surfaces (roofs + streets + sidewalks) offer the greatest cooling potential city-wide air temperature cooling: 1.3°F (0.7°C) on average – because there is more available area in which to implement this strategy.

- Street trees have greater cooling potential than open space planting.

- Living roofs have greater cooling potential than light roofs.

Case Study Results

- Heat island mitigation potential is higher in Mid-Manhattan West and Lower Manhattan East because there is more available area in which to implement the mitigation strategies in these areas.

- Crown Heights and Ocean Parkway, both in Brooklyn, have hotter base surface and near-surface air temperatures. Therefore the marginal benefit of implementing the strategies in these areas may be higher.

- Fordham and Maspeth have moderate cooling potential.

Recommendations

1) Implement UHI mitigation strategies appropriate to conditions in individual neighborhoods and communities.
2) Plant street trees as an effective strategy for UHI mitigation in NYC.
3) Implement UHI strategies at large enough extents to be effective.
4) Monitor temperature of tree-planting programs and green roofs to observe actual mitigation levels over time. Use results to improve calibration and validation of energy balance and regional climate models.
5) Continue improving satellite data analyses, meteorological datasets, and simple energy and regional climate models to better represent urban areas.