Urban Vulnerability Assessment for the Health and Infrastructure Sectors

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NASA Headquarters, Washington D.C.

Mission and Activities

Explore regional vulnerabilities to climate variability and change in urban areas using an end-to-end approach that combines:

1) Downscaled Climate Projections (from CMIP phases 3 and 5 global climate models from GISS and the wider ensemble)

2) Urban Heat Island Analysis and Scenarios

3) Monitoring of Urban Climate, Green Infrastructure, and Heat Management

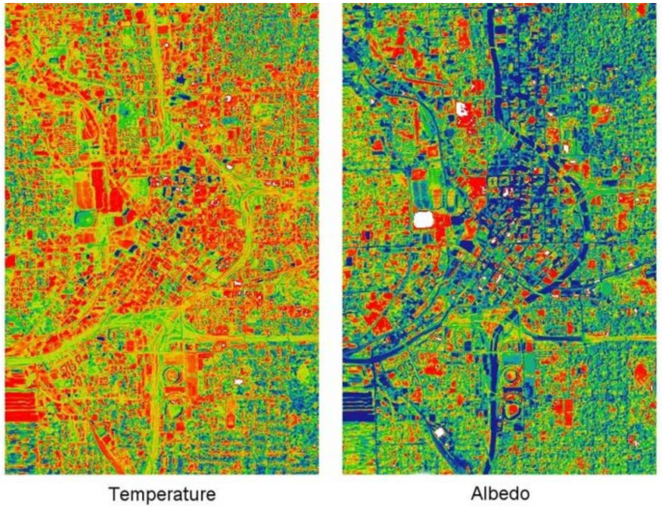
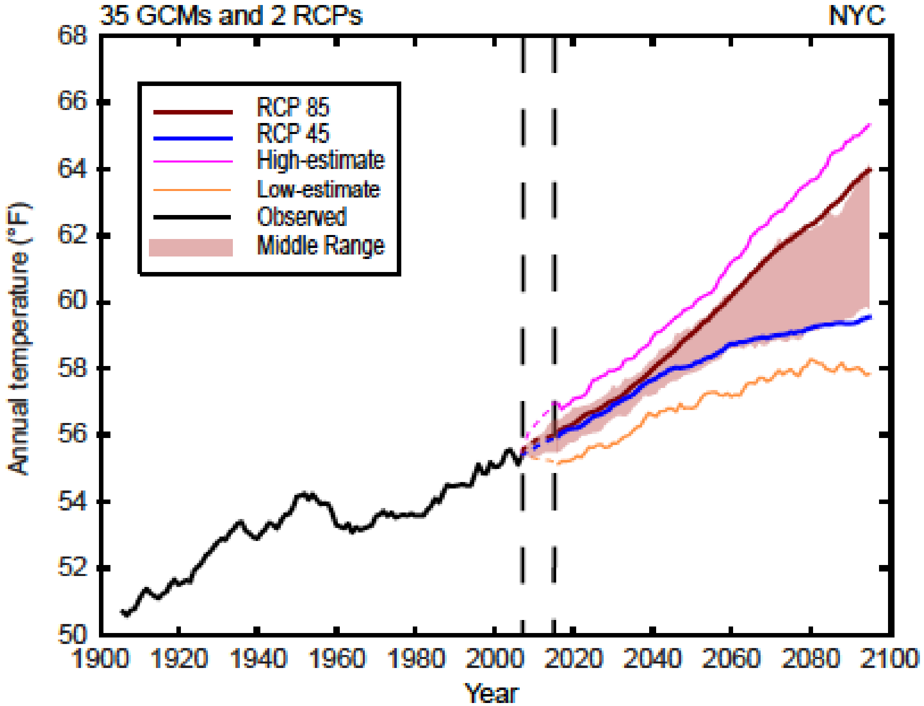


Figure 1. The image on the left illustrates daytime surface heating for urban surfaces across the Atlanta Georgia Central Business District (CBD) as derived from NASA aircraft data. White and red colors indicate very warm surfaces (~40-50°C). Green relates to surfaces of moderately warm temperatures (~25-30°C). Blue indicates cool surfaces (e.g., vegetation, shadows) (~15-20°C). Surface temperatures are reflected in the albedo image on the right where warm surfaces are dark (i.e., low reflectivity) and cooler surfaces are in red and green (i.e., higher reflectivity). The images show how urban surface characteristics influence temperature and albedo as UHI drivers (Quattrochi et al., 2000).

Downscaled CMIP5 Projections

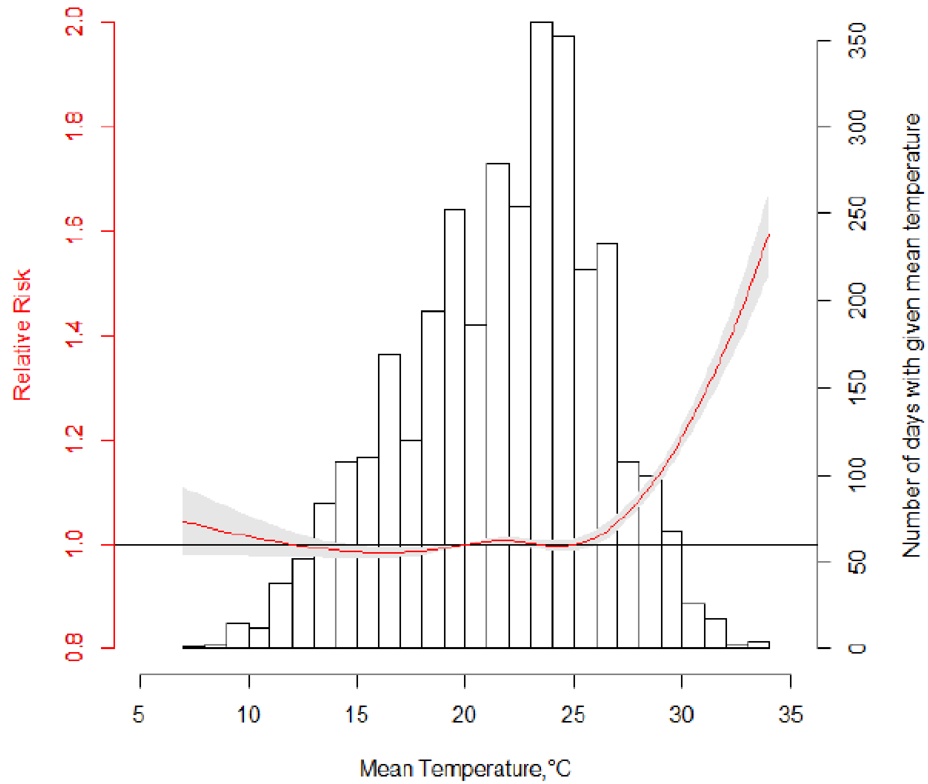


Number of days/year with maximum temperature at or above 95°F (1971-2000) 4 days/year	Low-estimate (10th percentile)	Middle range (25th to 75th percentile)	High-estimate (90th percentile)
2020s	6	8 to 10	11
2050s	10	13 to 22	28
2080s	14	17 to 41	59

New Initiatives

- Developed an empirical relationship between daily maximum temperature and daily deaths reported by Manhattan hospitals
- Projected daily maximum temperature for the 21st century based on
  - 35 CMIP5 Global Climate Models and two Representative Concentration Pathways
  - Hybrid downscaling technique based on monthly Bias Corrected Spatial Disaggregation (BCSD) and daily maximum temperature data from Central Park for the 1970-1999 period

New York City

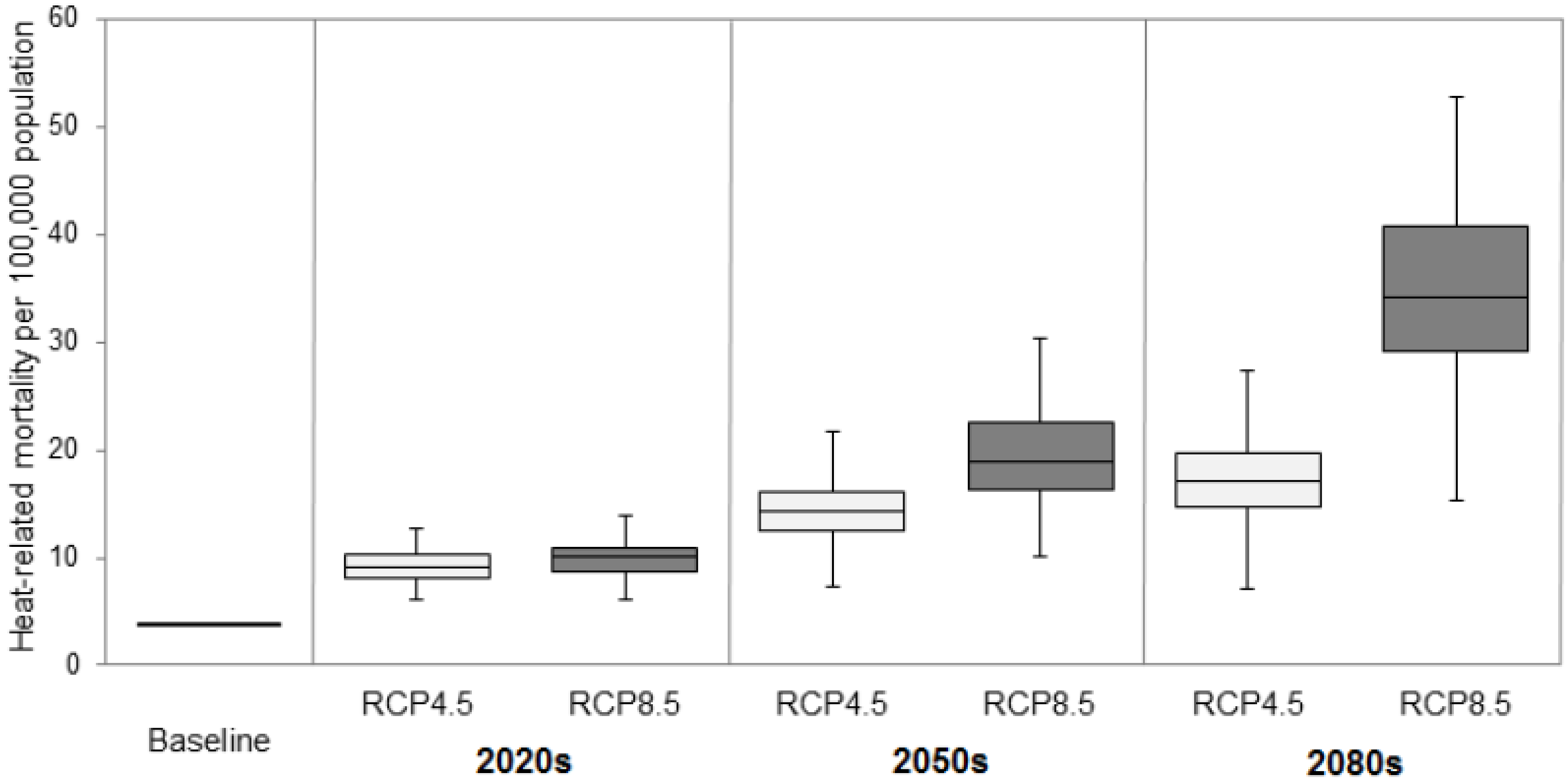


(**b**)

Figure 1. Temperature–mortality curves of overall cumulative relative risk over four days of lag and mean summer temperature histograms for (**a**) Boston (**b**) New York City and (**c**) Philadelphia based on data between 1985 and 2006. Relative risks calculated using a distributed lag non-linear model with natural cubic splines with four degrees of freedom for the temperature and the lag and 20 °C as a reference temperature.

Petkova et al. 2013

New York City



(**b**)

Figure 2. Projected annual heat-related mortality rates during the 2020s, 2050s and 2080s for (**a**) Boston (**b**) New York City and (**c**) Philadelphia, during the baseline period (1985–2006) and according to the 33 global climate models (GCMs) and two Representative Concentration Pathways (RCPs), RCP4.5 and RCP8.5. Box plots illustrate the minimum, lower quartile, median, upper quartile and maximum values across the GCMs, by period and RCP. Also displayed are the annual heat-related mortality rates computed for the baseline period between 1985 and 2006, based on observed temperatures.

Petkova et al. 2013

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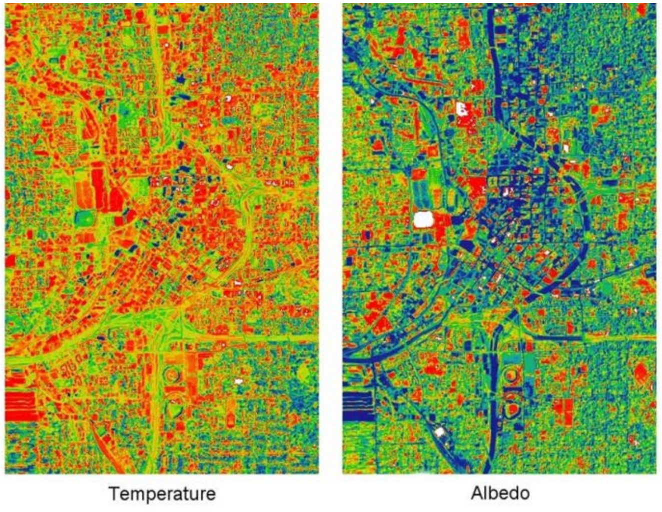

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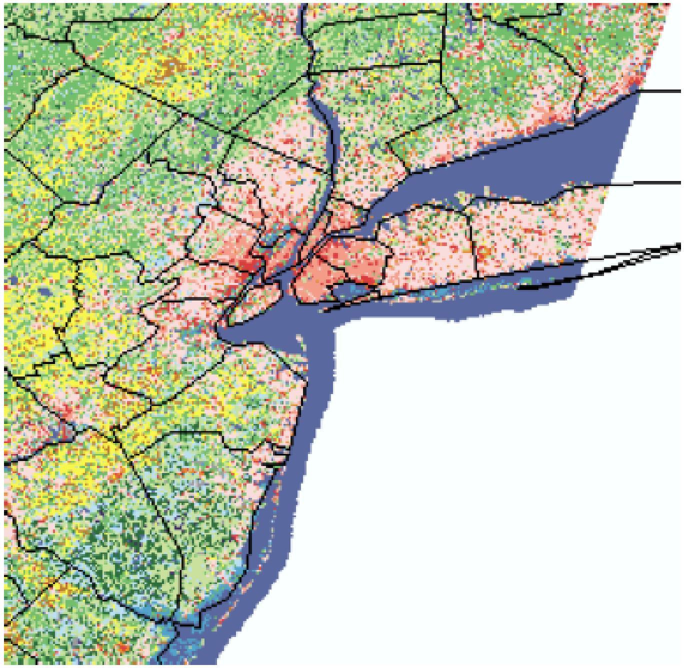
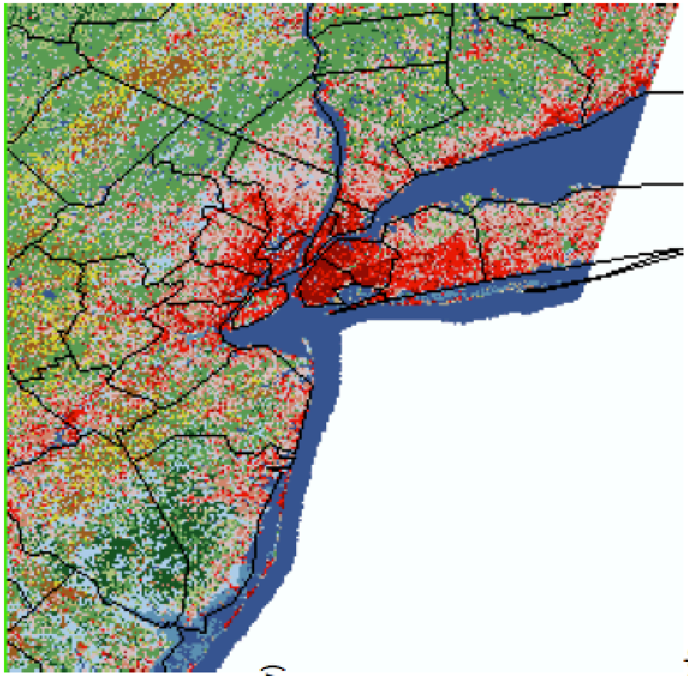
New York Landsat-derived Land Cover Land Use

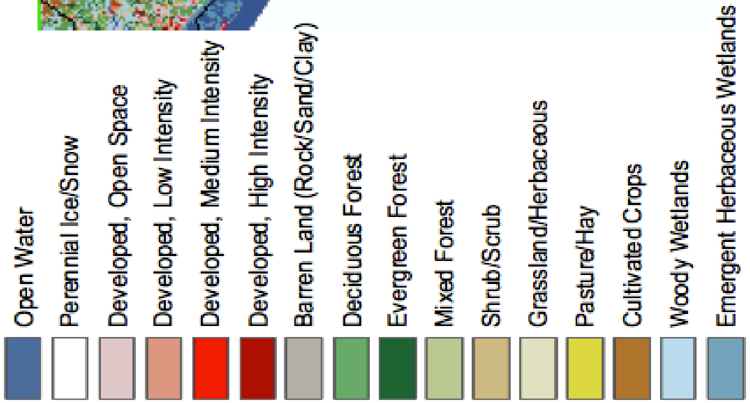
1992 NLCD



2006 NLCD



2006



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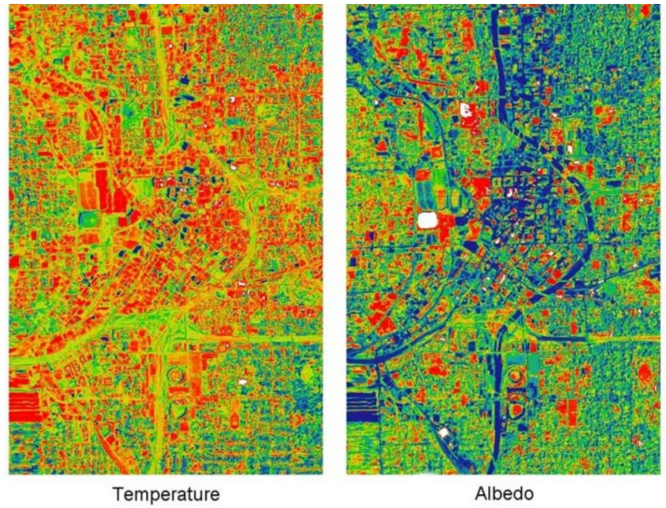

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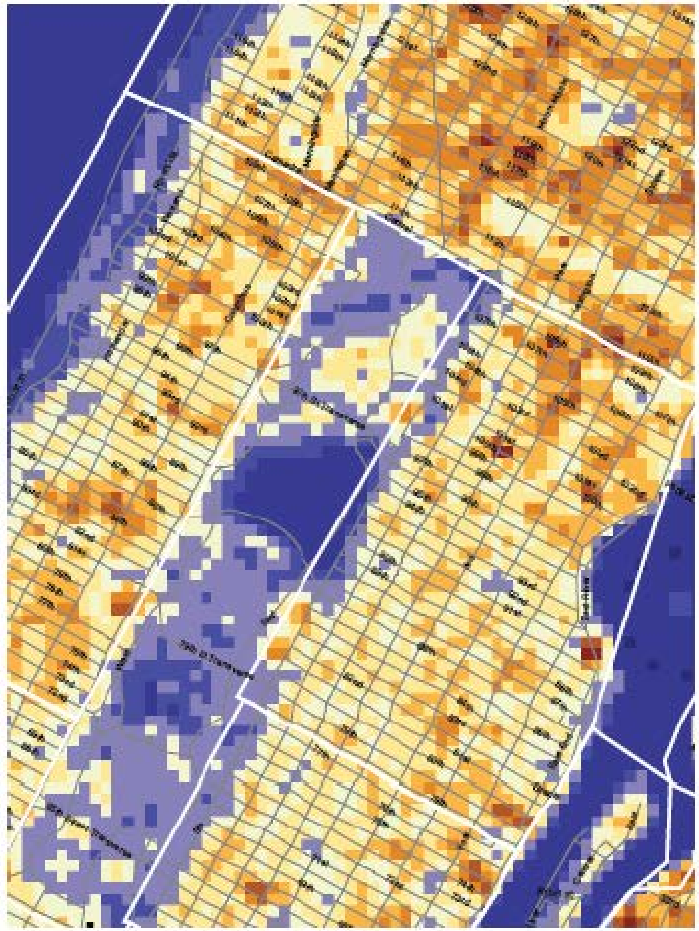
NASA Landsat 7 Surface Temperature Map

Aug 14, 2002 -10:30AM 60 meter resolution



Below Mean (27C) Surface Temperature (C)

6.8 - 21.0 | 21.1 - 24.1 | 24.2 - 25.6 | 25.7 - 27.1 | 27.2 - 28.1 | 28.2 - 29.0 | 29.1 - 30.0 | 30.1 - 31.0 | 31.1 - 31.9 | 32.0 - 45.8

A lot of fundamental science just with simple white roofs

- How much light is reflected and how does albedo decline over time ?
- Transmissivity of this light to TOA?
- **Carbon equivalence** of this negative radiative forcing ?
- Land area worldwide that is amenable to this form of geoenginnering ? (1-2 %)
- What does this mean regionally for climate mitigation?
- Consumer acceptance (neutral/low ?)
- Scattering of light in neighboring bldgs => UHI offset potential reduced ?
- Winter heat penalty
- Best protocols for measuring albedo, emissivity, temp properly
- Synergies between cool roofs and other roof infrastructure – PV, AC

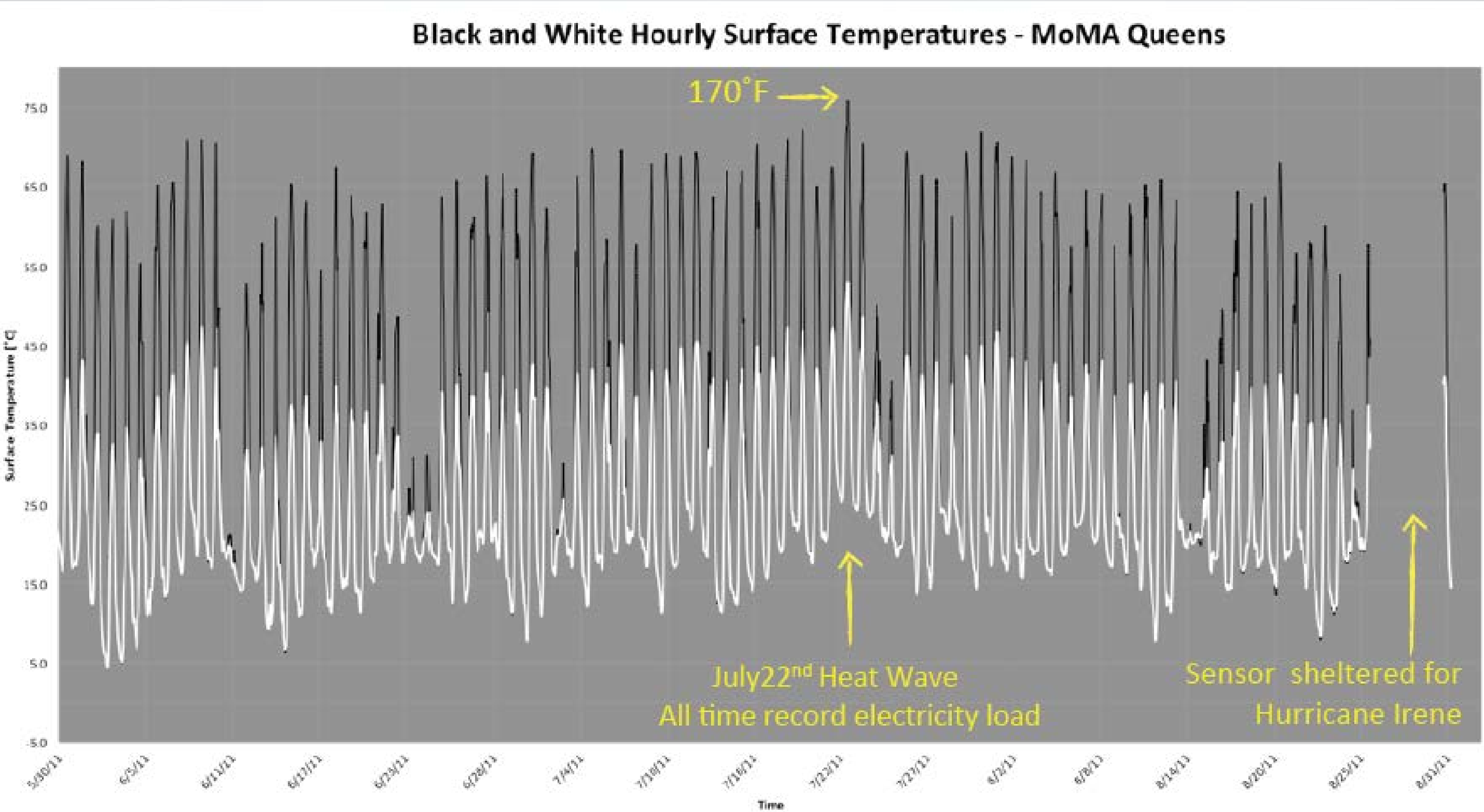
ELASTOMERIC ACRYLIC PAINT

APOC® 247 Sun-Shield White Reflective Roof Coating

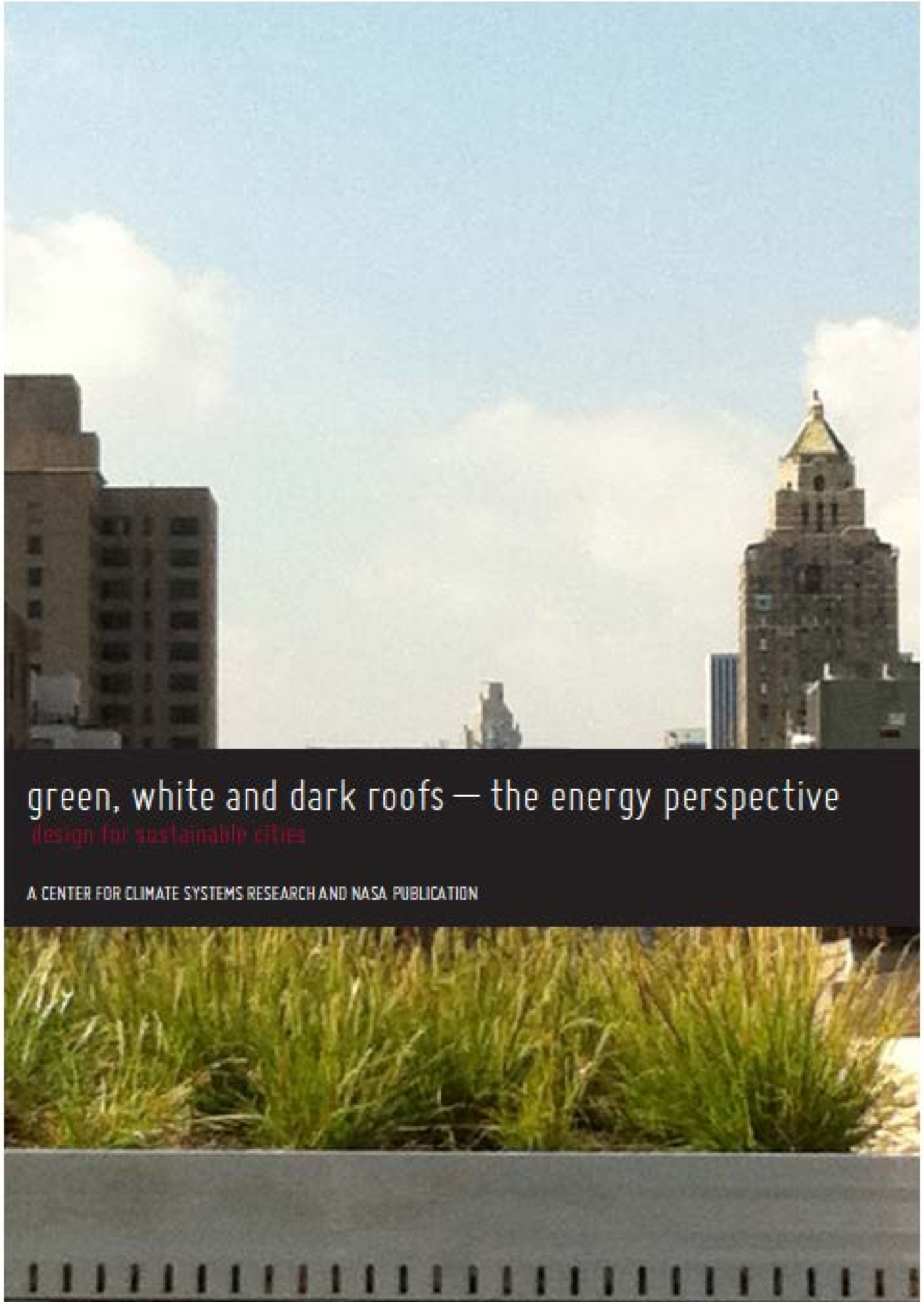
Experimental setup atop the MoMA Queens, Long Island City

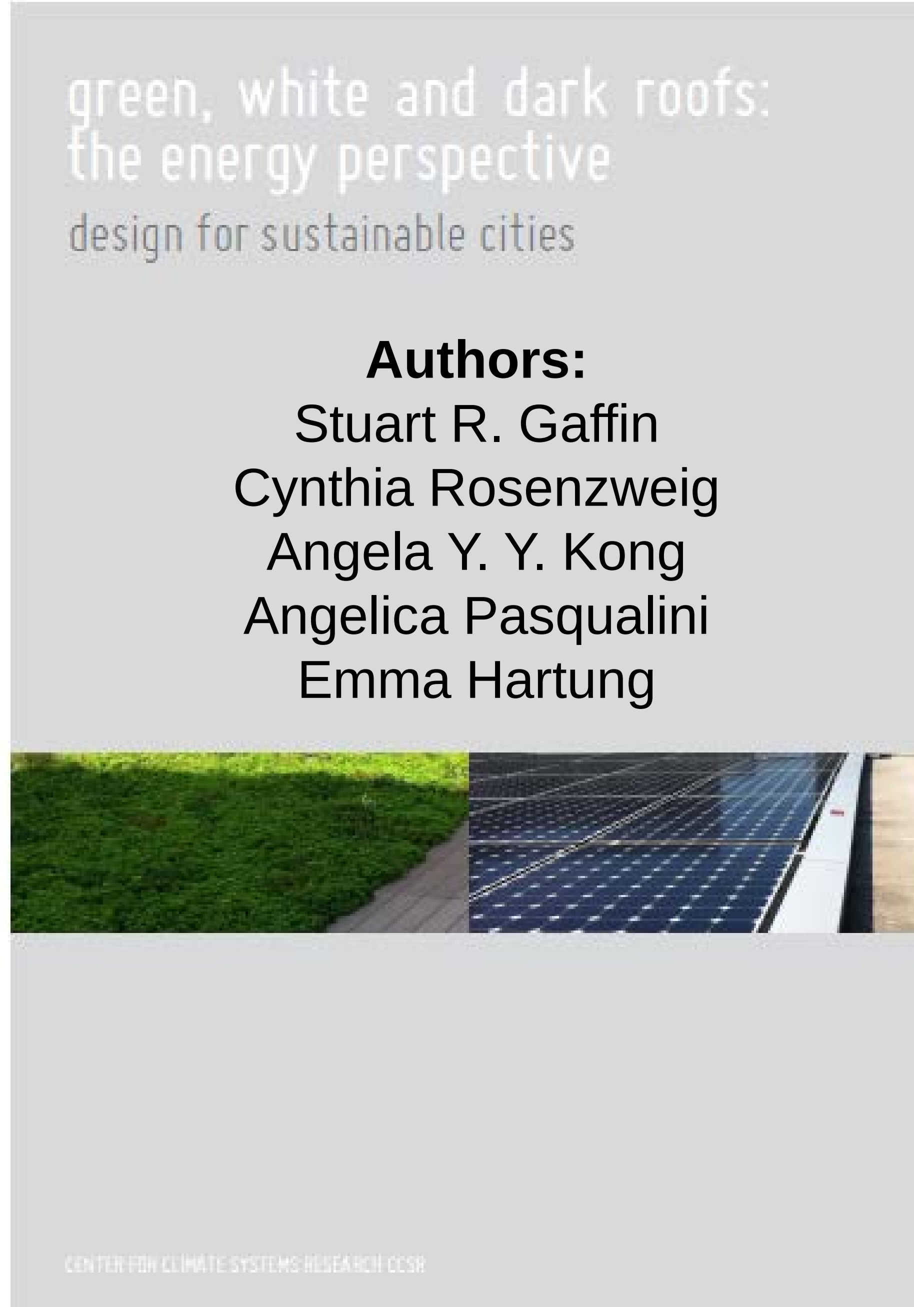
BLACK AND WHITE SURFACE TEMPERATURES

MoMA Queens, Summer 2011



Cool Roofs Guidebook





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Emma Hartung

New Initiatives

- Campaign to monitor 20 roofs coated by the NYC Cool roofs program over 4 years to study aging and albedo loss. Will use two new IR thermal imaging cameras.
- Deploying temp and RH sensors around NASA GSFC campus to study surface-air temp differences for prototypical urban-type surfaces there (e.g. parking lots, roofs, grass fields, tree shade).
- Collect data on urban street level new green infrastructure (e.g. bioswales, green streets) as an adaptation measure against climate change.
- **Better quantify** relationship between $T_{\mathbf{surface}}$ and $T_{\mathbf{air}}$