New York City Urban Heat Island "Reconnaissance":

Preliminary Findings On Street Trees, Parks and Various Urban Surfaces Using Mobile Sensors

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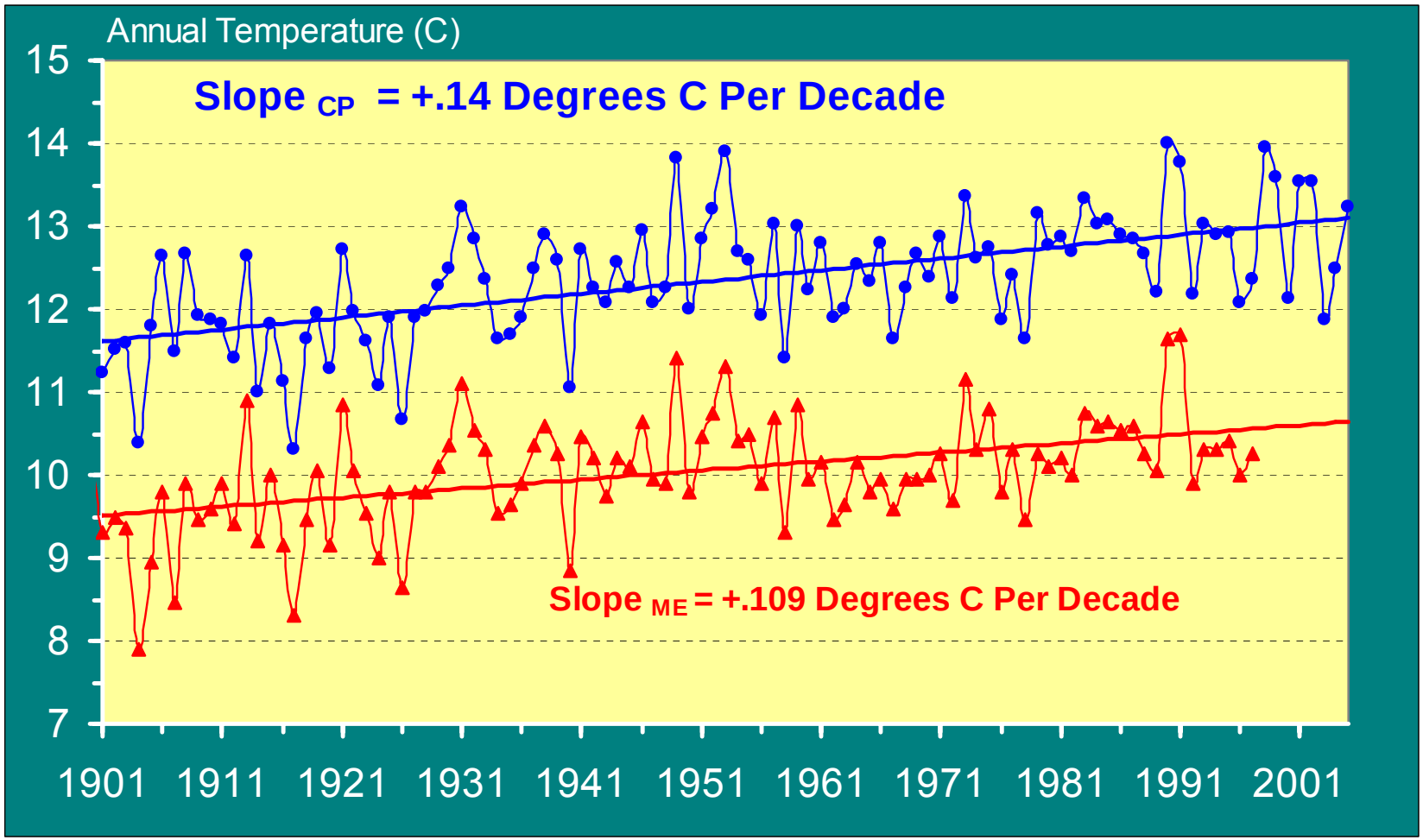
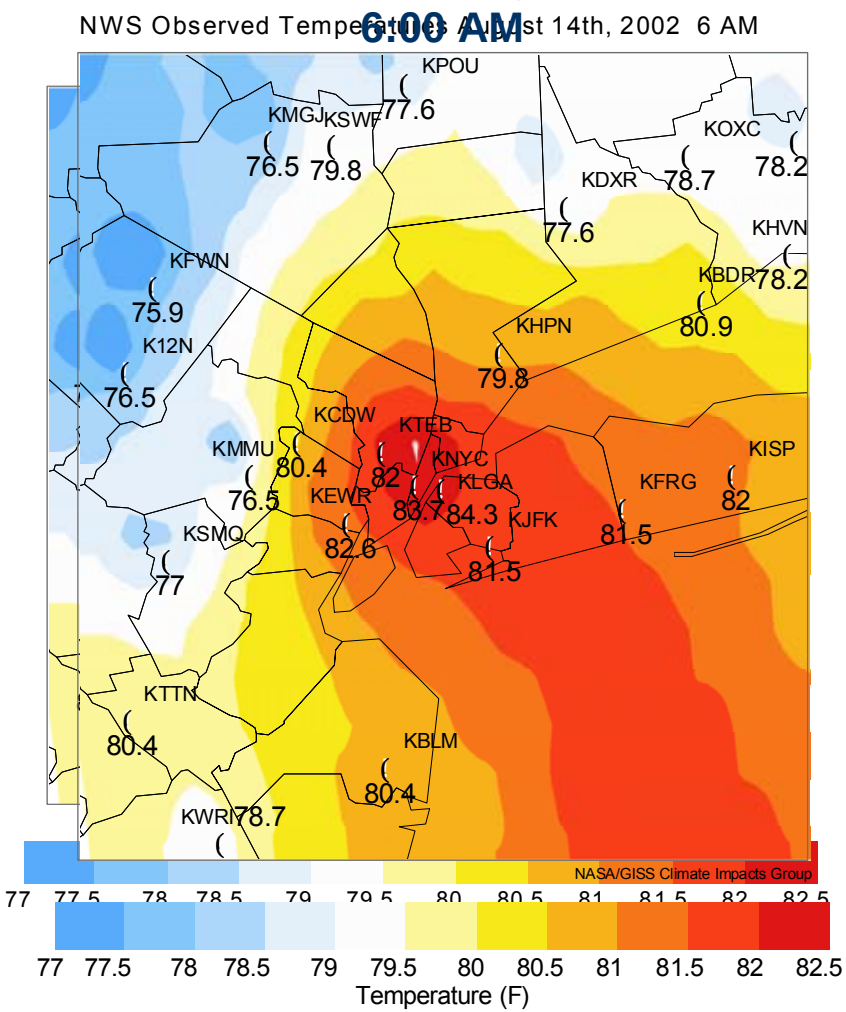
Central Park temperatures 1900-present (upper)
23 suburban and rural stations 1900-1997(lower)



New York City's Urban Heat Island – Two Different Views

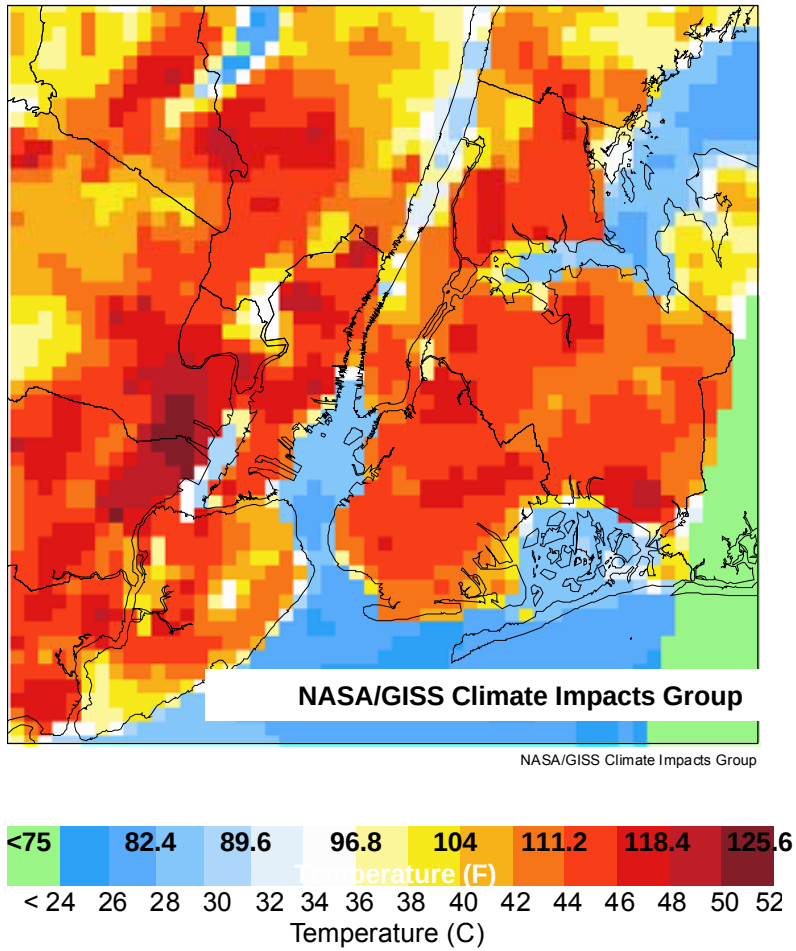
"Air Temperature Island "

Air Temperature August 14, 2002, 6:00 AM



" Surface Temperature Island"

Surface Temperature August 14, 2002, 10:30 AM



New York City's UHI Signal data from 1997-98

(Gedzleman et al, 2003)

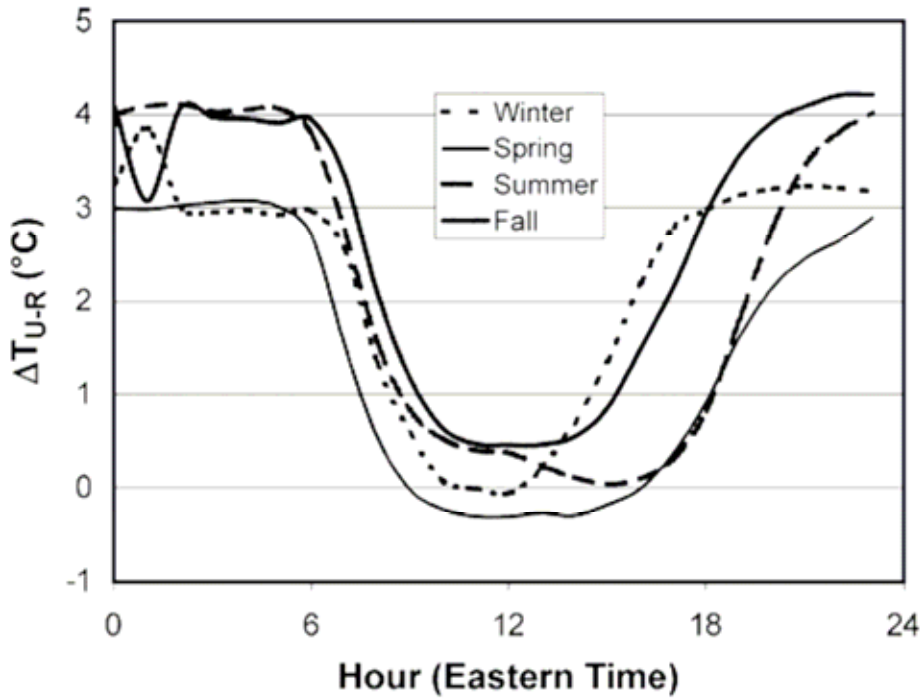
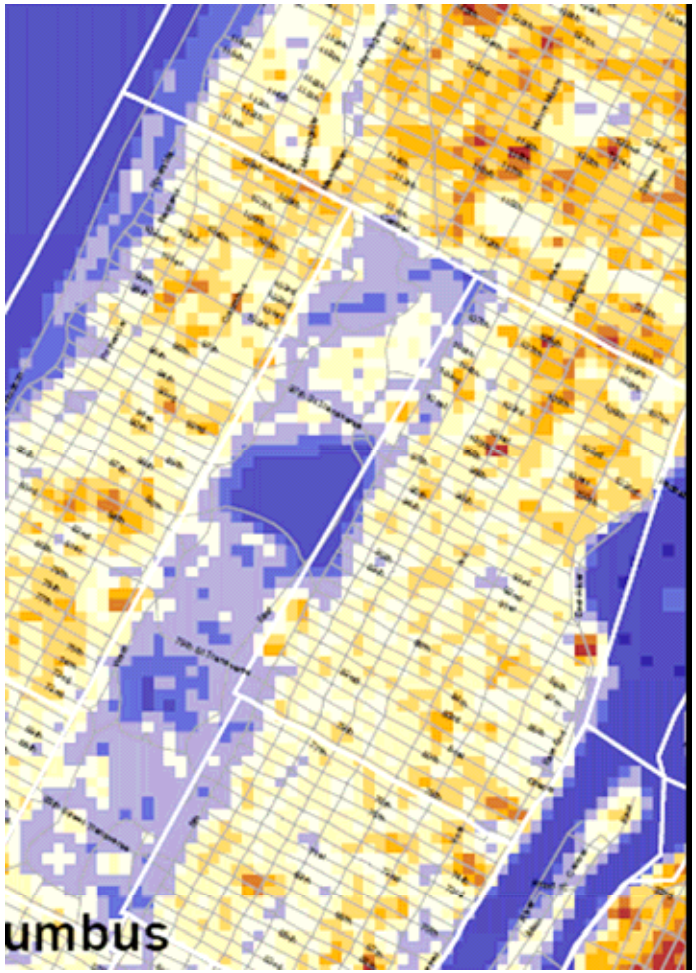
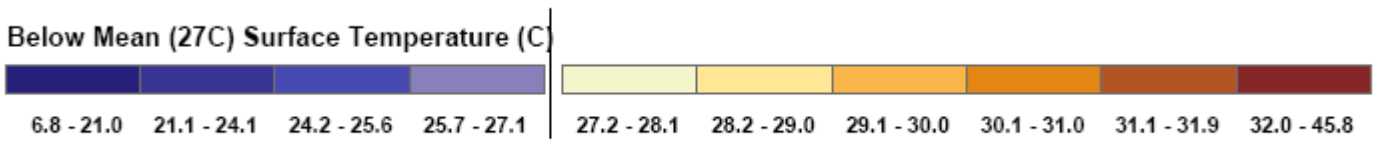


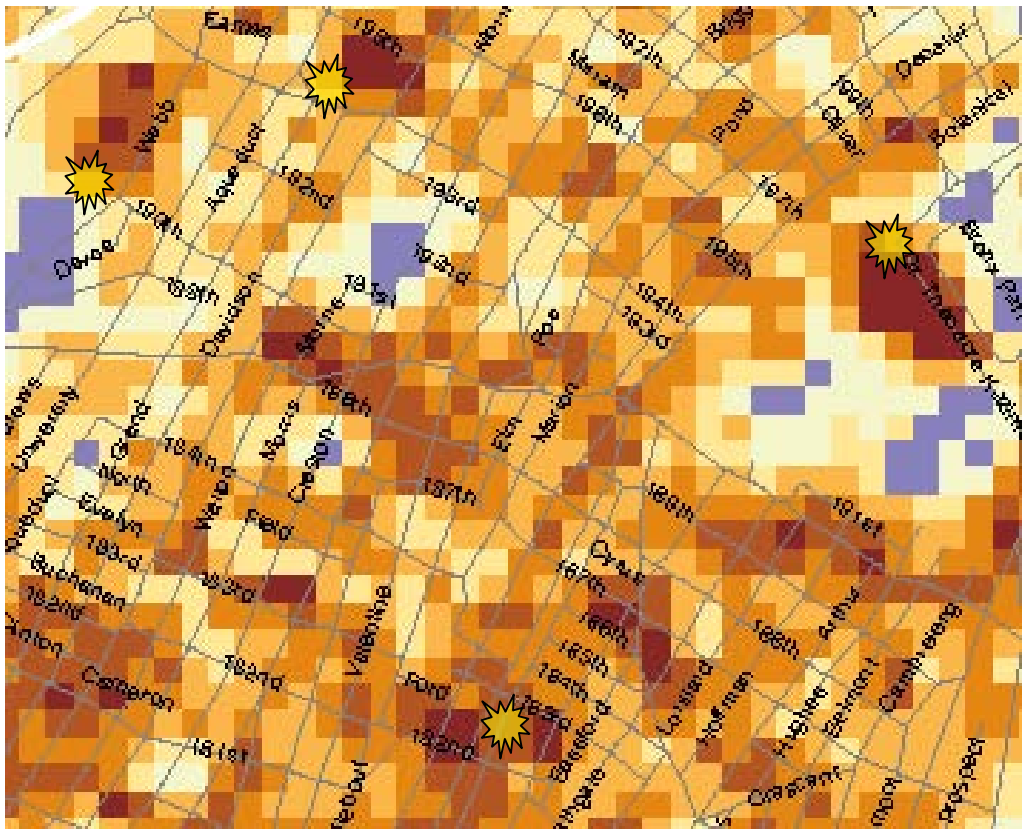
Fig. 3. Hourly values of urban – rural temperature difference, ΔT_{U-R}, for each of the four meteorological seasons (Winter = Dec–Feb)

Aug 14 10:30 AM Landsat Surface Temperature Map (30-60 meter resolution)





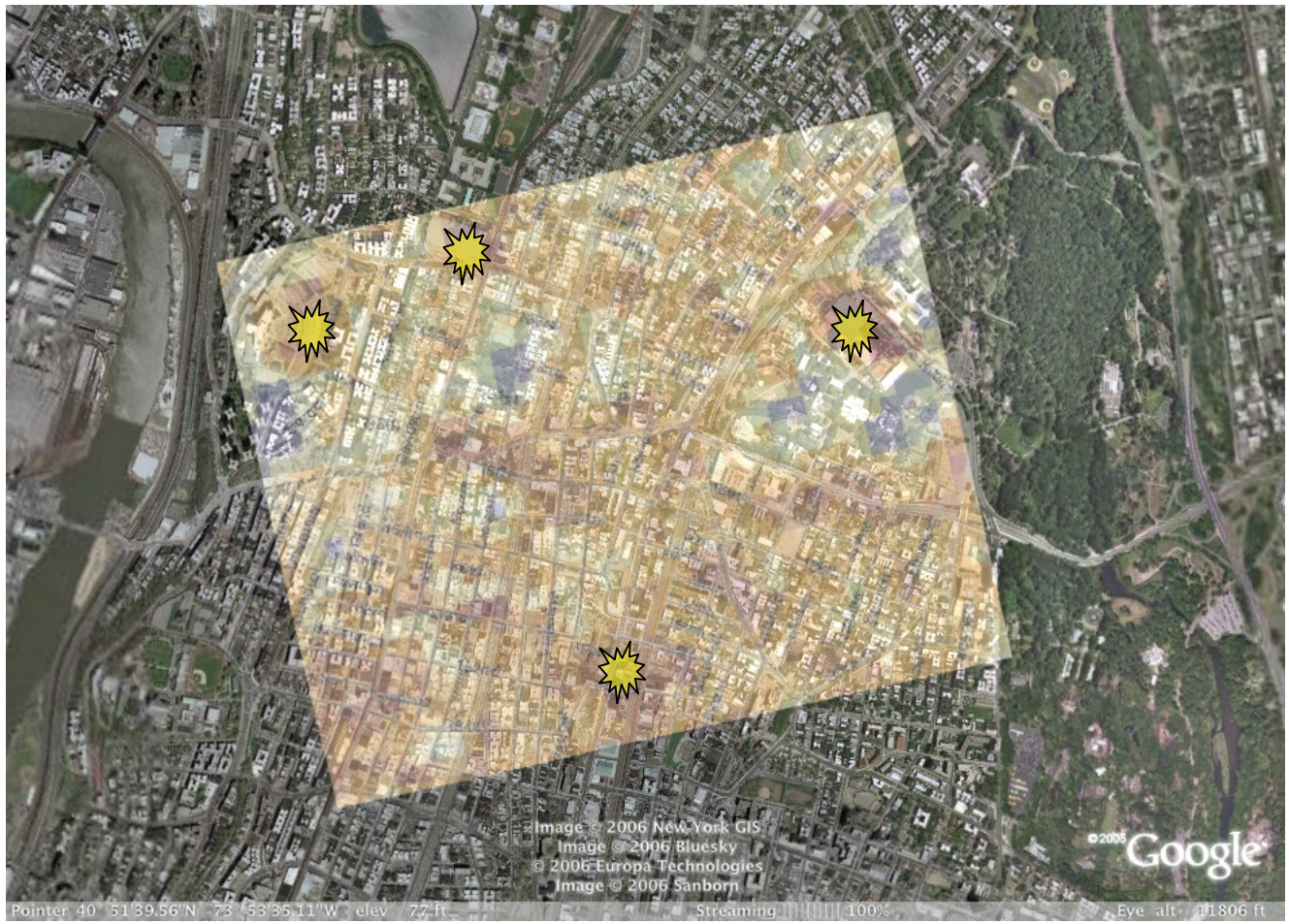
Can Identify Daytime Urban Hot Spots



(Image taken Aug. 14th, 2002 10:30AM)

Merge thermal data with satellite imagery

(courtesy of Google Earth™)



Visit Individual Sites for Further Recon

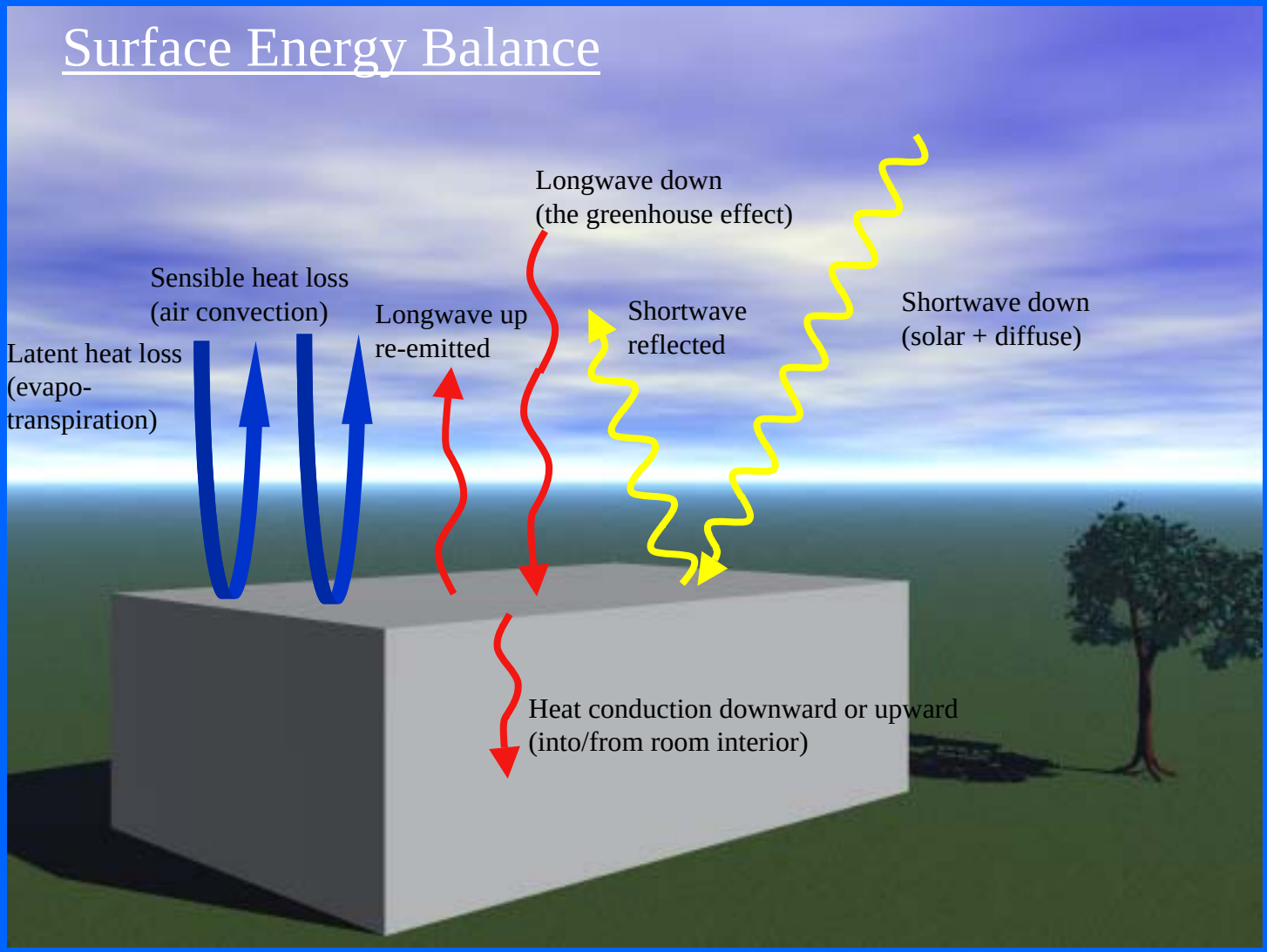
Summer 2006 Recon Goals

- Gather scientific data to advise a forthcoming NYSERDA Bronx Tree Planting Program.
- Determine whether we can detect cooling effects of trees on air temperatures.
- Detect cooling effects of trees *within* streets.
- Detect cooling effects of trees *between* streets.
- Detect cooling effects of different species and planting arrangements and clusterings.

Measurements We Planned For

- Surface temperatures
- Air temperatures (e.g. 2-meter)
- Longwave emissivity
- Albedo (shortwave “emissivity”)

Surface Energy Balance



Instruments Purchased from Thermoworks.com

has adjustable emissivity

$24.00

$99.00

Total for 2 sets is $250.00

$160.00 for
Solar radiometer

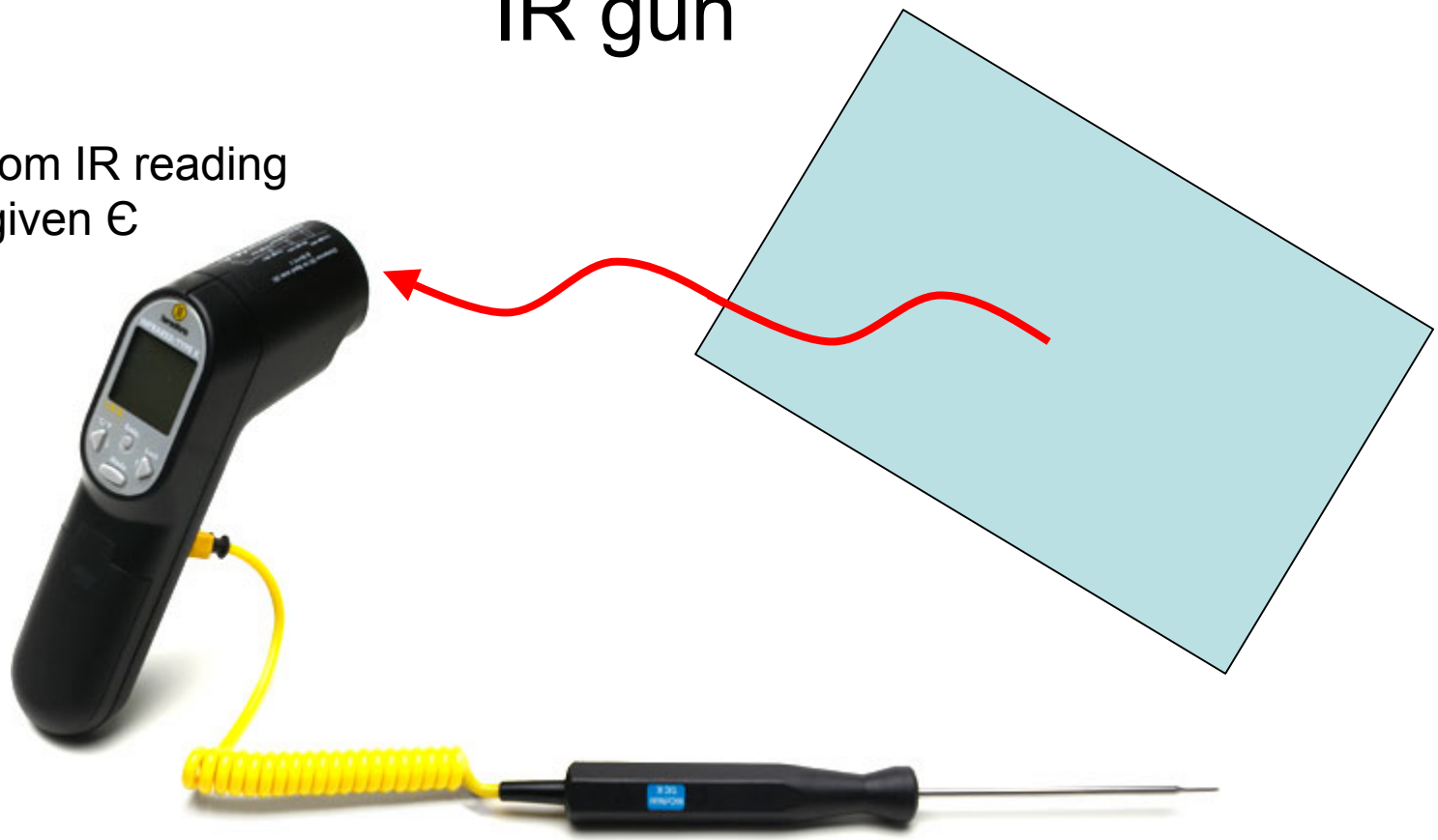
+ $160 for the transmittor

+ $295 for the console

$ 615.00 total

Principle for Determining Longwave Emissivity Є with an adjustable emissivity on IR gun

T_{surf} from IR reading for a given Є



Adjust Є on IR gun to match T_{surf} from contact probe

Having Surface IR Thermometer and Air Thermometer in one unit was very efficient for sampling

We were not able to get the adjustable emissivity to get a match between the surface contact thermometer and the IR thermometer

Portable Albedo Meter Can Be Cumbersome & Requires More Time to Do Extensive Sampling

sidewalk albedo only ~ 0.15

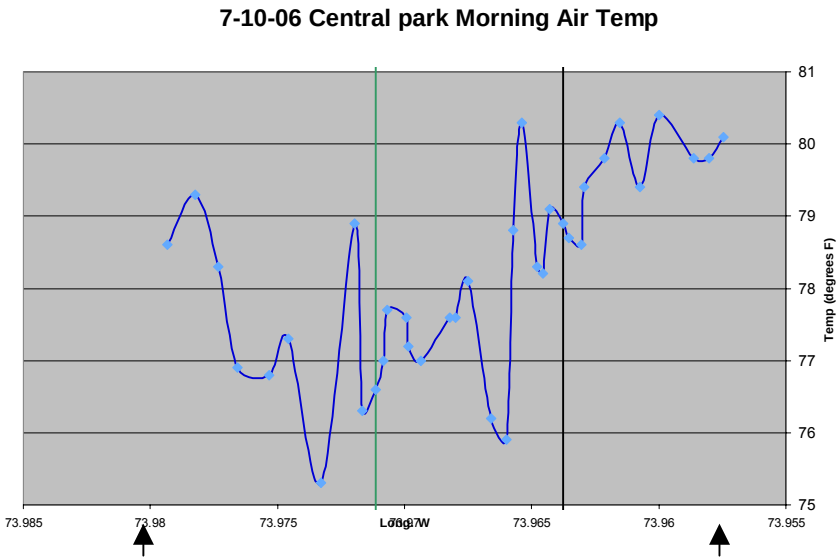
Sites Visited During Summer

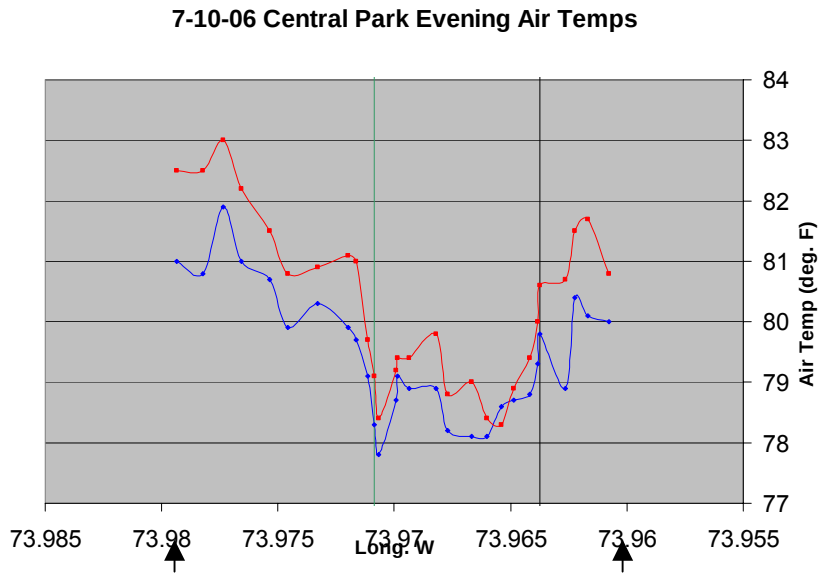
- Harlem, W122nd, July 7
- Central Park AM & PM July 10
- Bruner and Grace Ave, Bronx July 12, 13
- W111th & W113th, July 17 (heat wave 1)
- W111th & W112th, July 18 (heat wave 1)
- E222nd & E223 St, Bronx, July 19
- Radcliffe & Paulding, Bronx, July 24
- PS144 and PS180 Playgrounds, July 25, 26
- Morningside Park Albedo Measurements, Aug 1

Central Park Traverses July 10, 2006

10:30 AM Morning Traverse

9:00 PM Evening Traverse





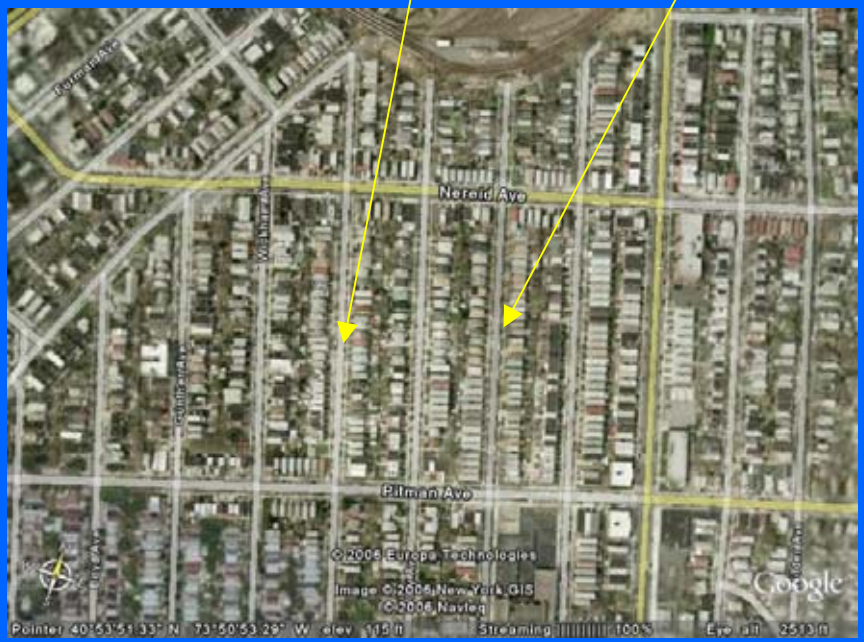
Began 10:30

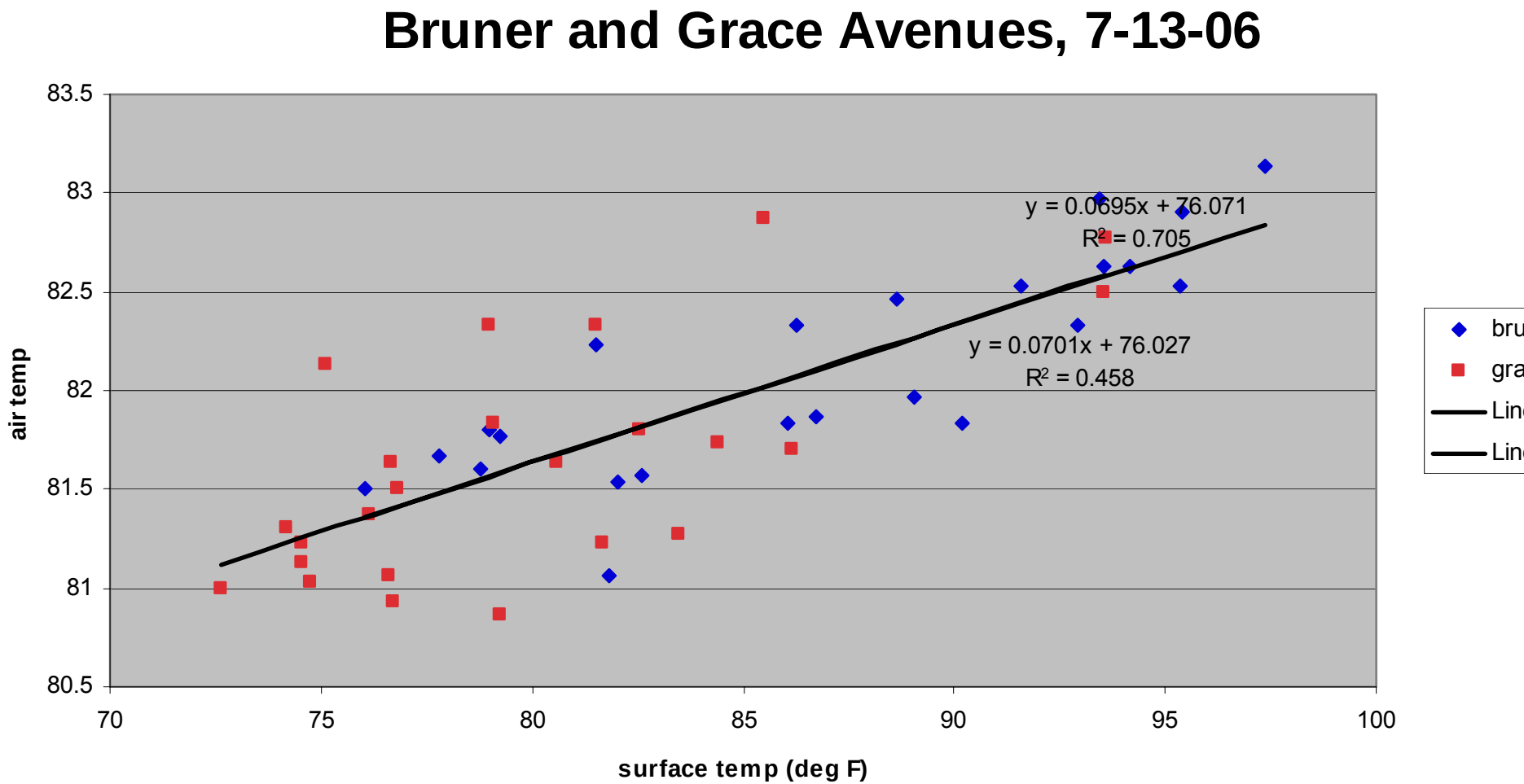
Ended ~noon

Began 9 pm

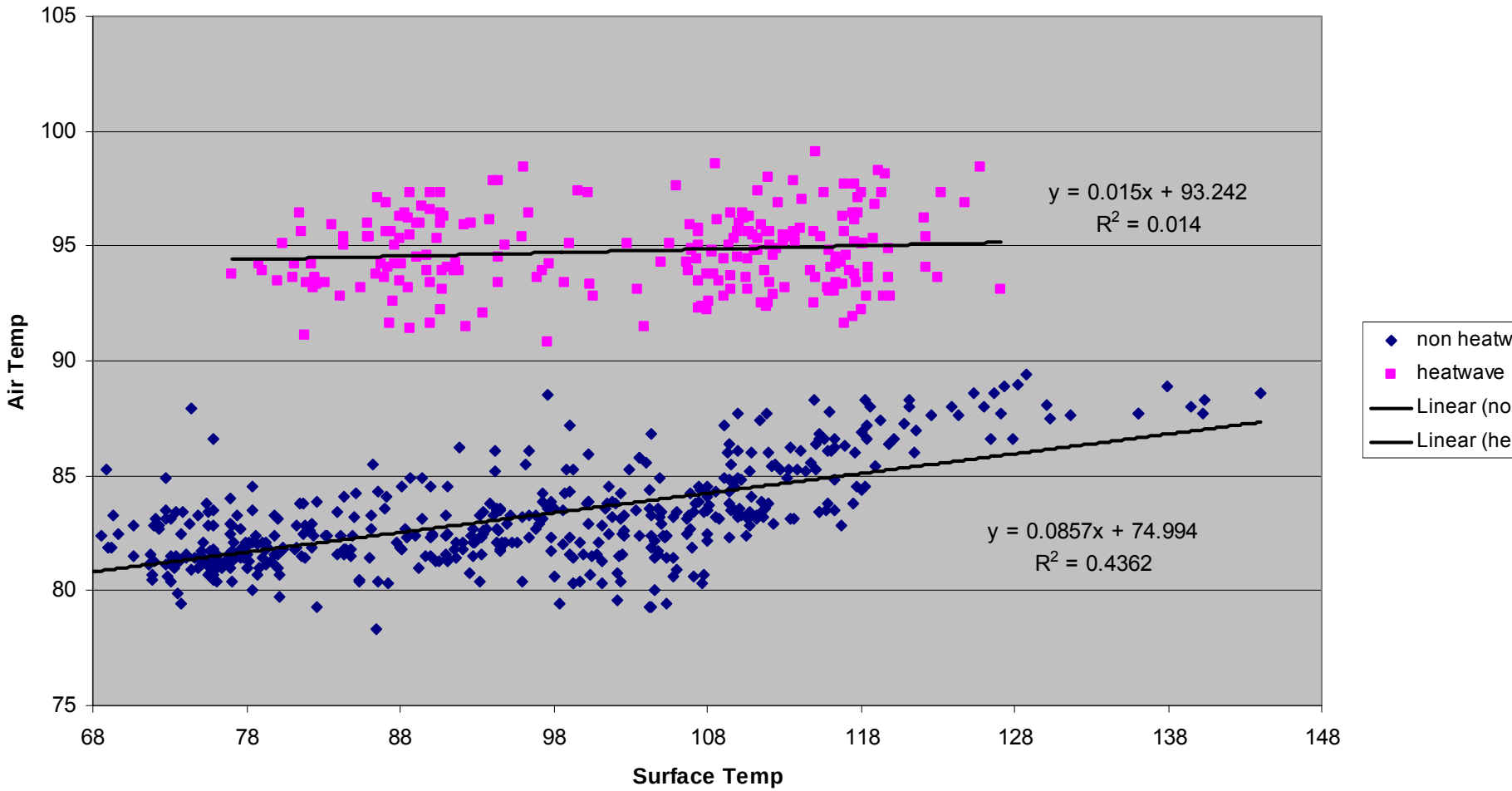
Ended ~10 pm

Bruner & Grace Ave's, Bronx
July 13, 2006 1:30 pm

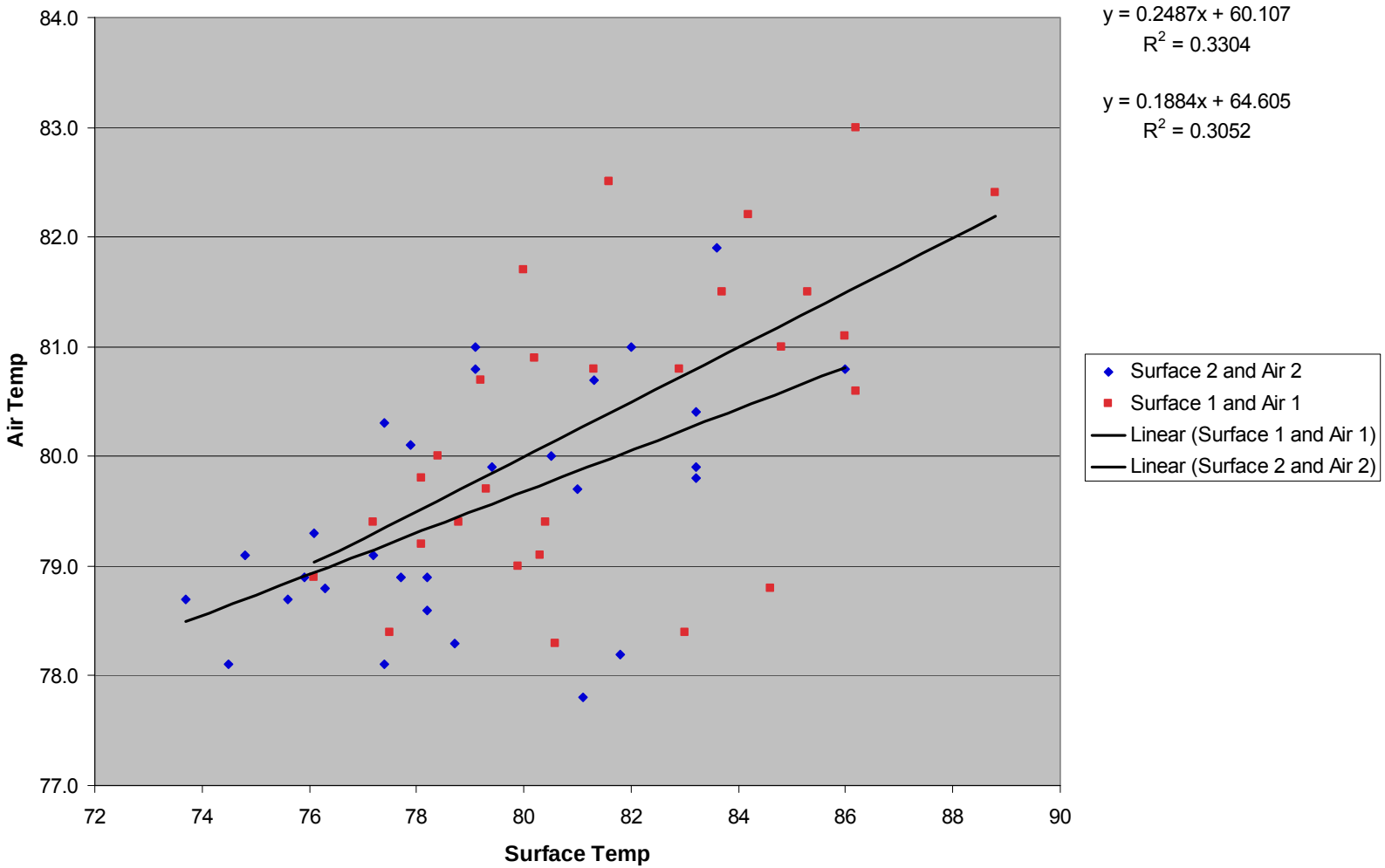



Bruner and Grace Avenues, 7-13-06
83.5
83
82.5
82
81.5
81
80.5
air temp
70
75
80
85
90
95
100
surface temp (deg F)
y = 0.0695x + 76.071
R² = 0.705
y = 0.0701x + 76.027
R² = 0.458
bru
gra
Lin
Lin

Air temperature vs. Surface temperature
All Daytime Data From All Sites



Central Park Nightime Correlation



Preliminary Findings on Surface and Air Temperature and Surface Albedo's at the PS180 Redesigned Playground and the PS144 "Old" Playground

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PS144 Playground

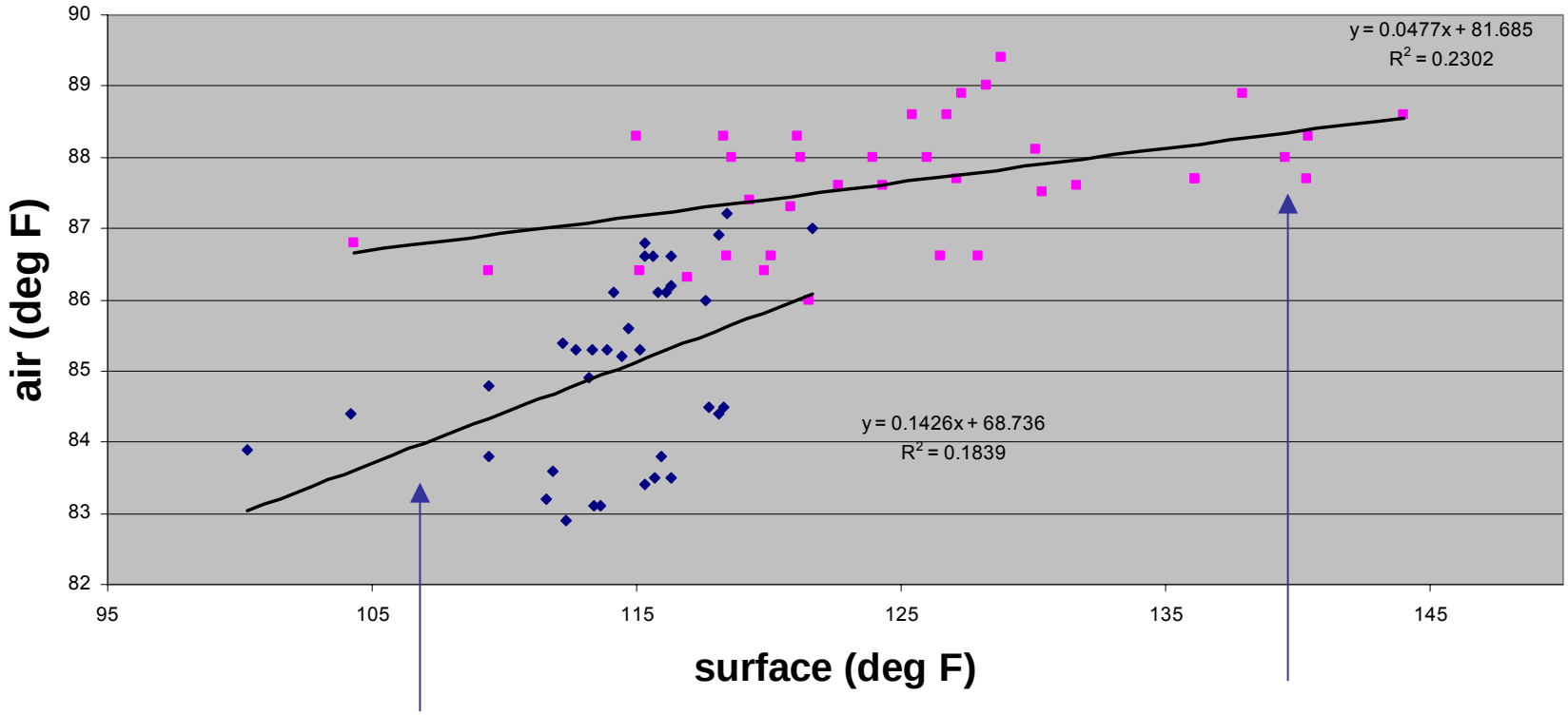
PS 180 Playground

PS180 Playground Prior to Redesign

Measurements

- Surface and (2-meter) Air Temperatures
- Taken every “5 paces” during 3-4 traverses along playground area
- Simultaneous Readings for about 30-40 minutes in the early afternoon (12:30 to 1:30 pm for example.)
- Albedo readings of different surfaces

July 26, 2006 Surface & Air Temperatures at the 2 Playgrounds
Excluding Rubber Mat



PS144 “Old Playground”

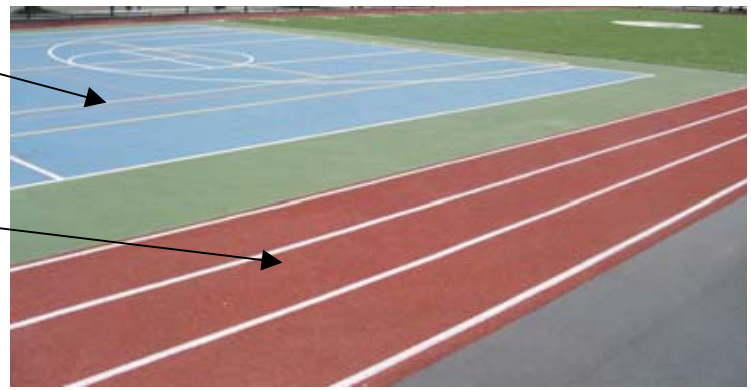
PS180 “New Playground”

Albedos

Asphalt (weathered)- .11

Asphalt (blue)- .15

Red Track- .25



Albedos

Asphalt (new)- .07

Astroturf - .07

Grass - .34

Summary of Albedos

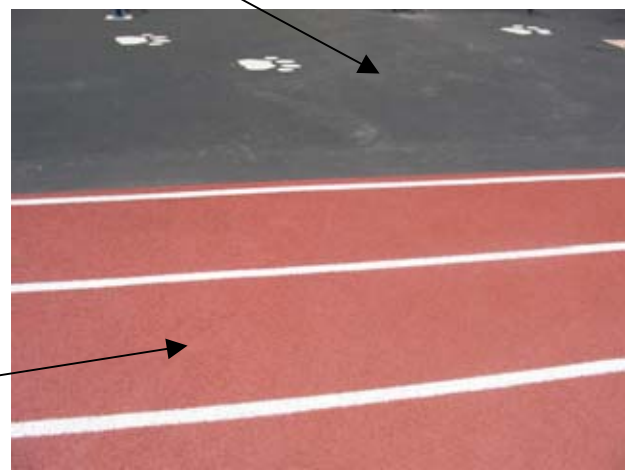
Asphalt (weathered)	.11
Asphalt (new)	.07
Asphalt (blue paint)	.15
Red Track	.25
Astroturf	.07
Grass	.34
Green Roof (St. Simon Stock School Bronx)	~.2

Albedo Readings of Various Surfaces

albedo = 7.3 %

albedo = 15.5 %

albedo = 7.2 %



albedo = 11.5 %

albedo = 25.6 %

Summary

- RS Thermal Maps: Landsat surface temperature map combined with visible surface imagery is a powerful tool for initial urban heat island reconnaissance. Simply visiting sites selected from the map gave many additional insights into UHI daytime causation (e.g. importance of land and roof slopes, building orientation, and facades).

- Instruments: Combined surface and air temperature probes were very efficient for doing extensive mobile sampling. The emissivity probe strategy did not work and needs follow-up with the manufacturers. The portable albedo meter is cumbersome and not easy for extensive sampling in parallel with temperature readings

- Field Methods: Having two separate teams with instruments was essential for testing hypotheses.

- Park Cool Island: We saw a clear Central Park cool island effect at night.

- Within- Street Tree Cooling: We are able to detect a clear *within street* cooling of air temperatures from tree shade.

- Between-Street Tree Cooling: It will be much more difficult to ascribe *between street* differences in temperature to specific causes including vegetation fraction. To detect optimal urban vegetation strategies will require careful control for between-street variations in building stock, pavement, traffic, anthropogenic heat, etc.

- Surface and Air Data Regression: We found a linear regression between surface air temperatures such that for every 10 degrees F that surface temperature drops due to tree shade and albedo, air temperatures statistically drop between 0.1 to 0.8 degrees F during the day. During the night the correlation appears to be stronger

- Artificial Sports Turf: Among the hottest surfaces we encountered. It may be worth opening discussions with manufactures to discuss alternative pigments (NIR) to lower temperatures.