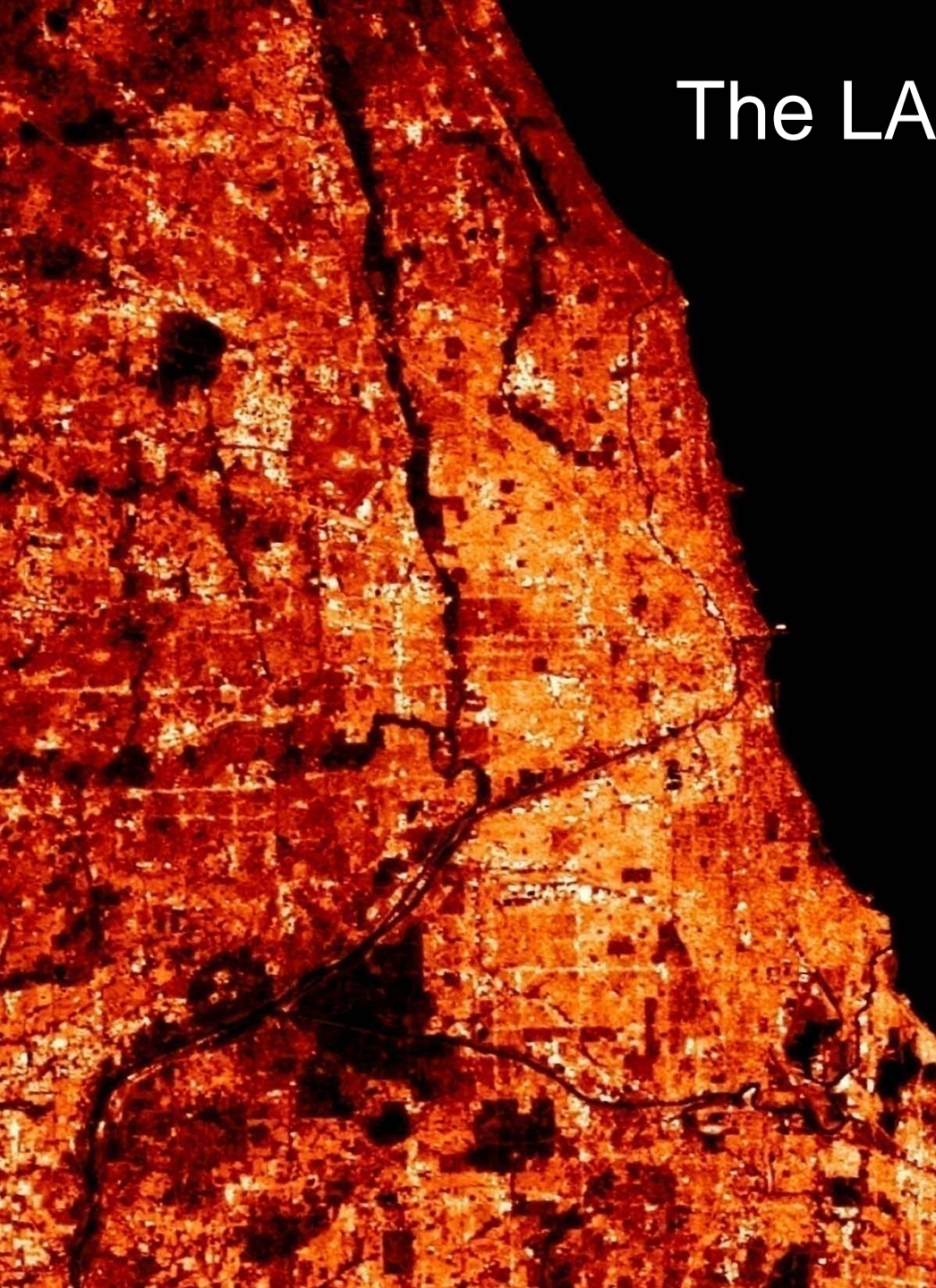
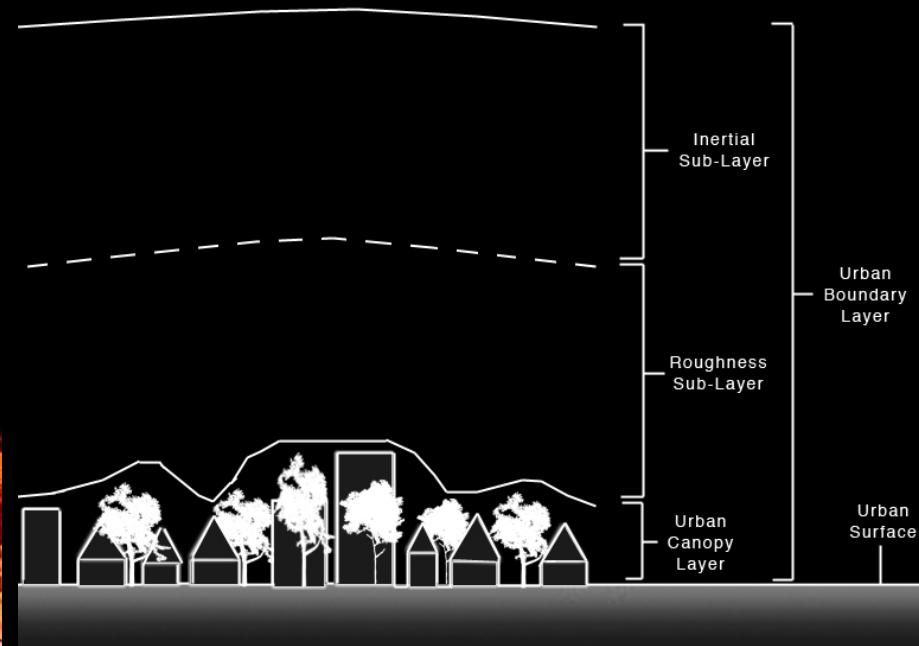


The LANDSAT Heat Island



The LANDSAT Heat Island

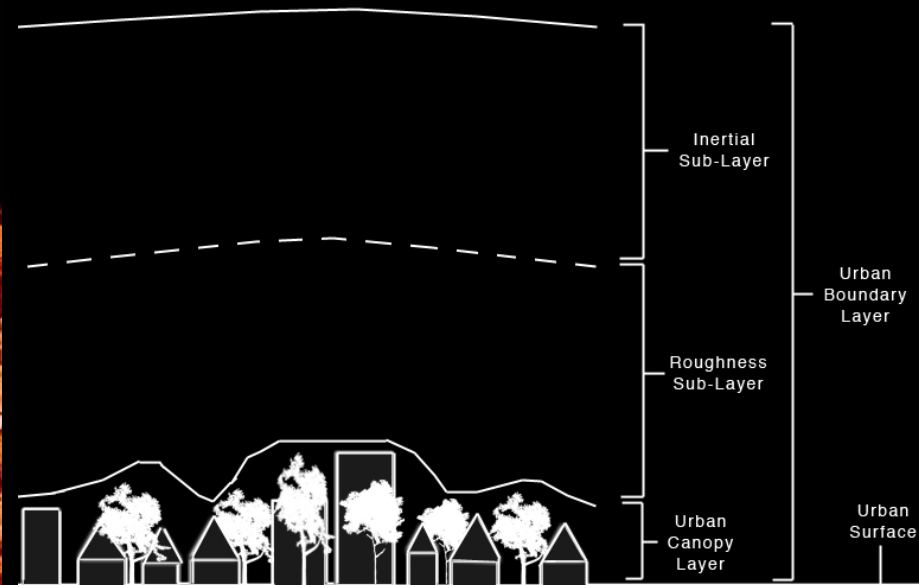
Heat island is usually defined by the difference in *air* temperature between an urban area and its surrounding rural area at the inertial sub-layer of the urban boundary layer.



The LANDSAT Heat Island

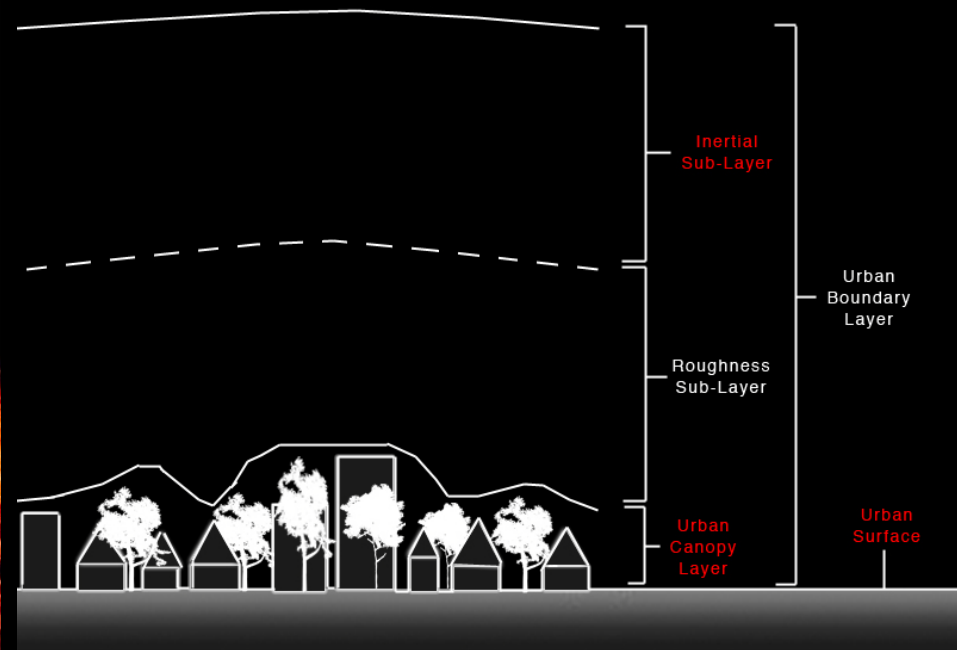
Other Accepted Forms of Heat Island:

- The air temperature difference of the urban canopy from the air temperature of the surrounding area.
- The difference in urban surface temperatures from surrounding surface temperature.



The LANDSAT Heat Island

LANDSAT measures none of the three accepted types of heat island.





The LANDSAT Heat Island

-LANDSAT temperature is roughly correlated to night-time air temperature* at the top of the urban canopy layer.

-Thus, it is probably most related to the urban canopy heat island at night out of the three accepted heat islands.

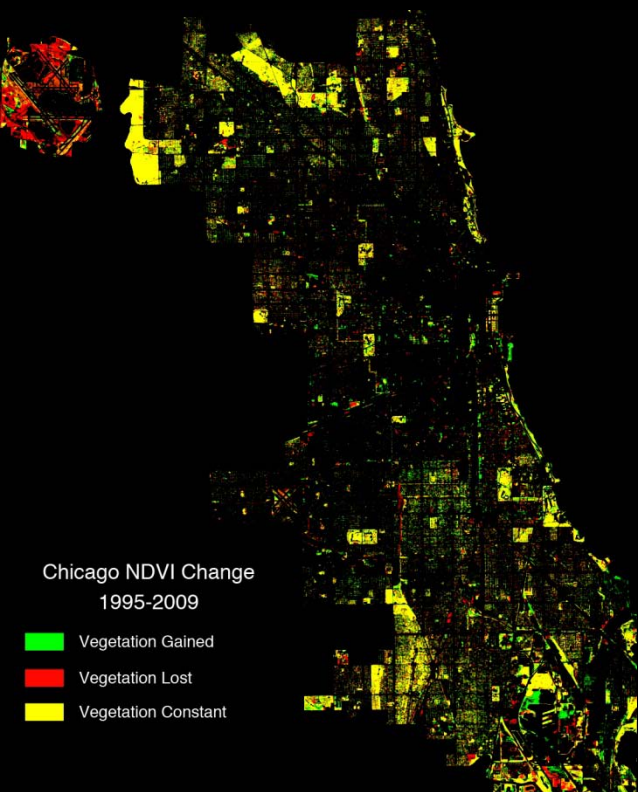
-However, the specific degree measurement of LANDSAT temperature cannot be trusted as a means of measuring any heat island.

-The best LANDSAT can offer is a hint at the sources of higher temperature in the night-time canopy by comparing LANDSAT temperatures to other criteria or to one another.

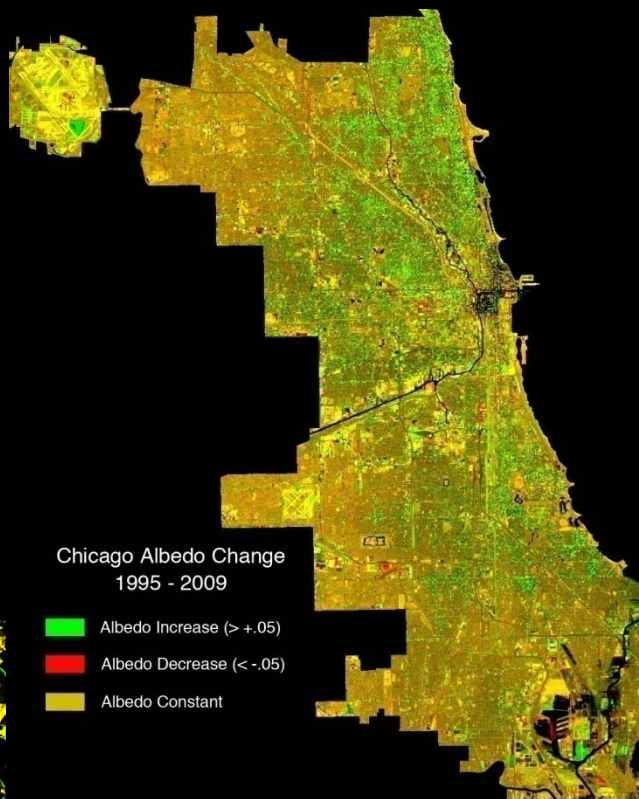
* Its is generally accepted that heat island is more intense at night and an inability to release heat at night intensifies the overall island.

Old Change Detection Images

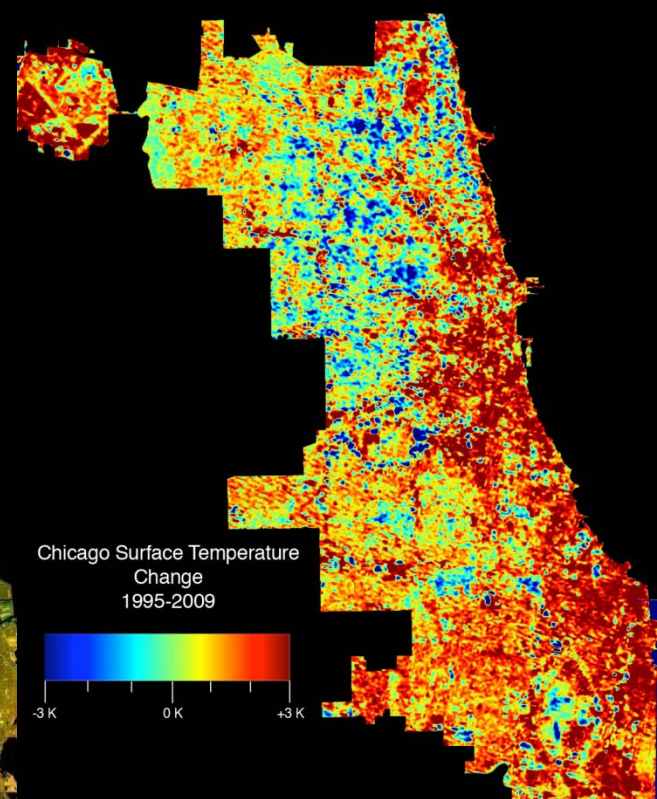
NDVI Change



Albedo Change

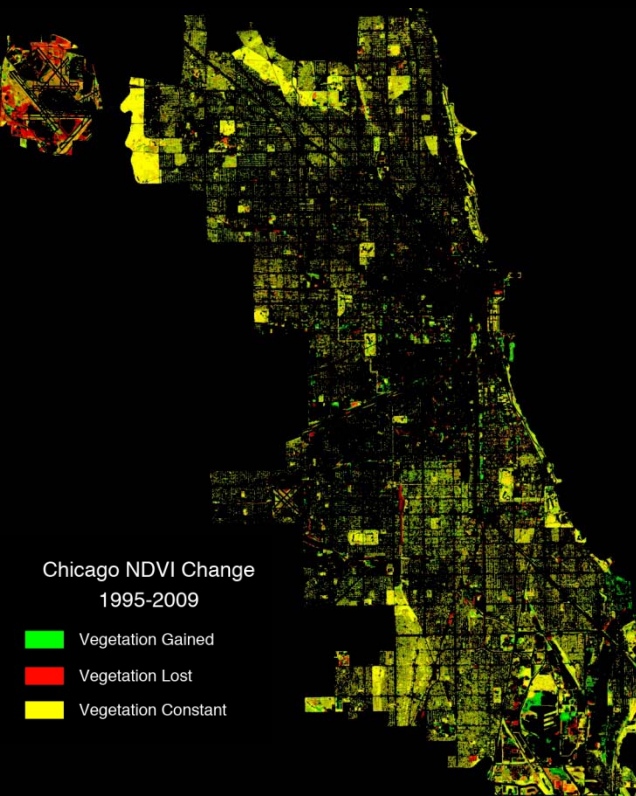


Temperature Change



New Change Detection Images

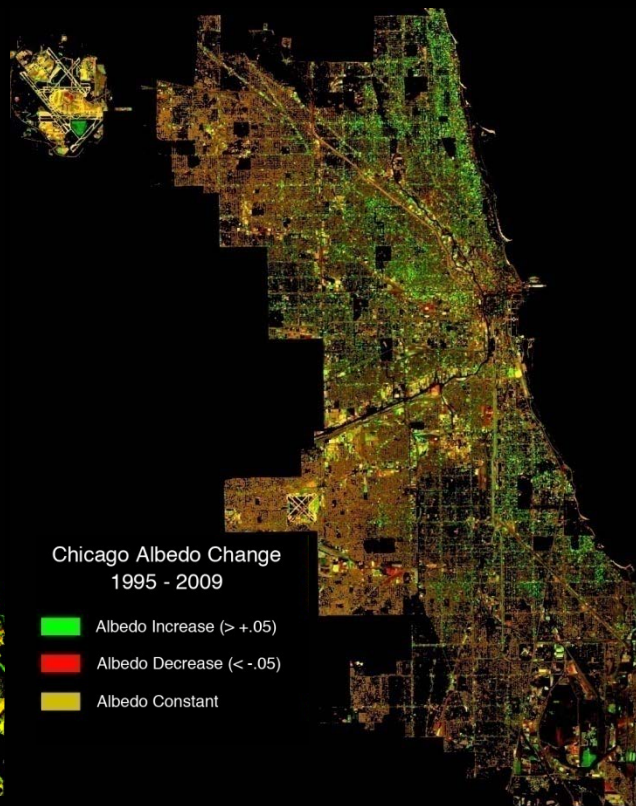
NDVI Change



Changes:

- Masked out non-vegetated pixels to NaN (enhanced image)
- Masked out water pixels (ie. algae)

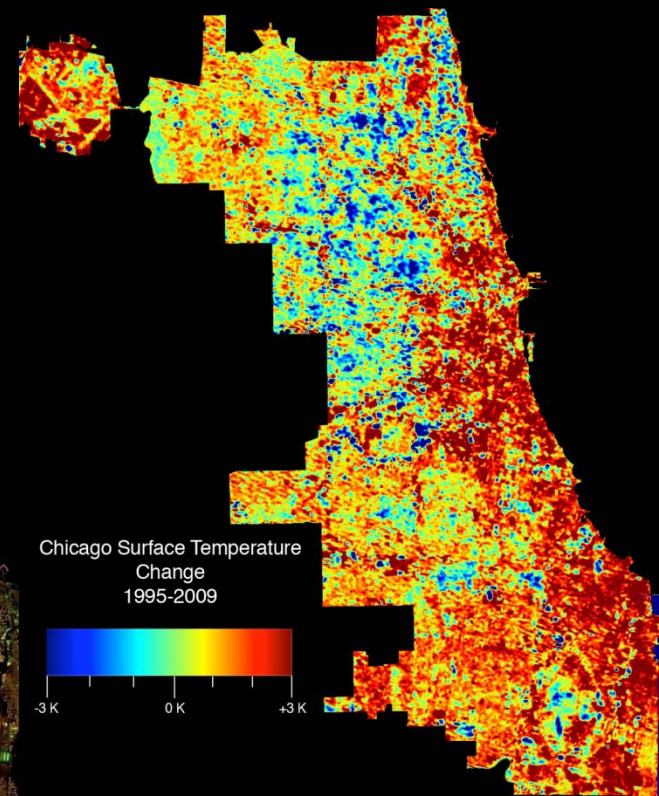
Albedo Change



Changes:

- Masked out vegetated pixels
- Masked out water pixels
- Masked out some shadow pixels

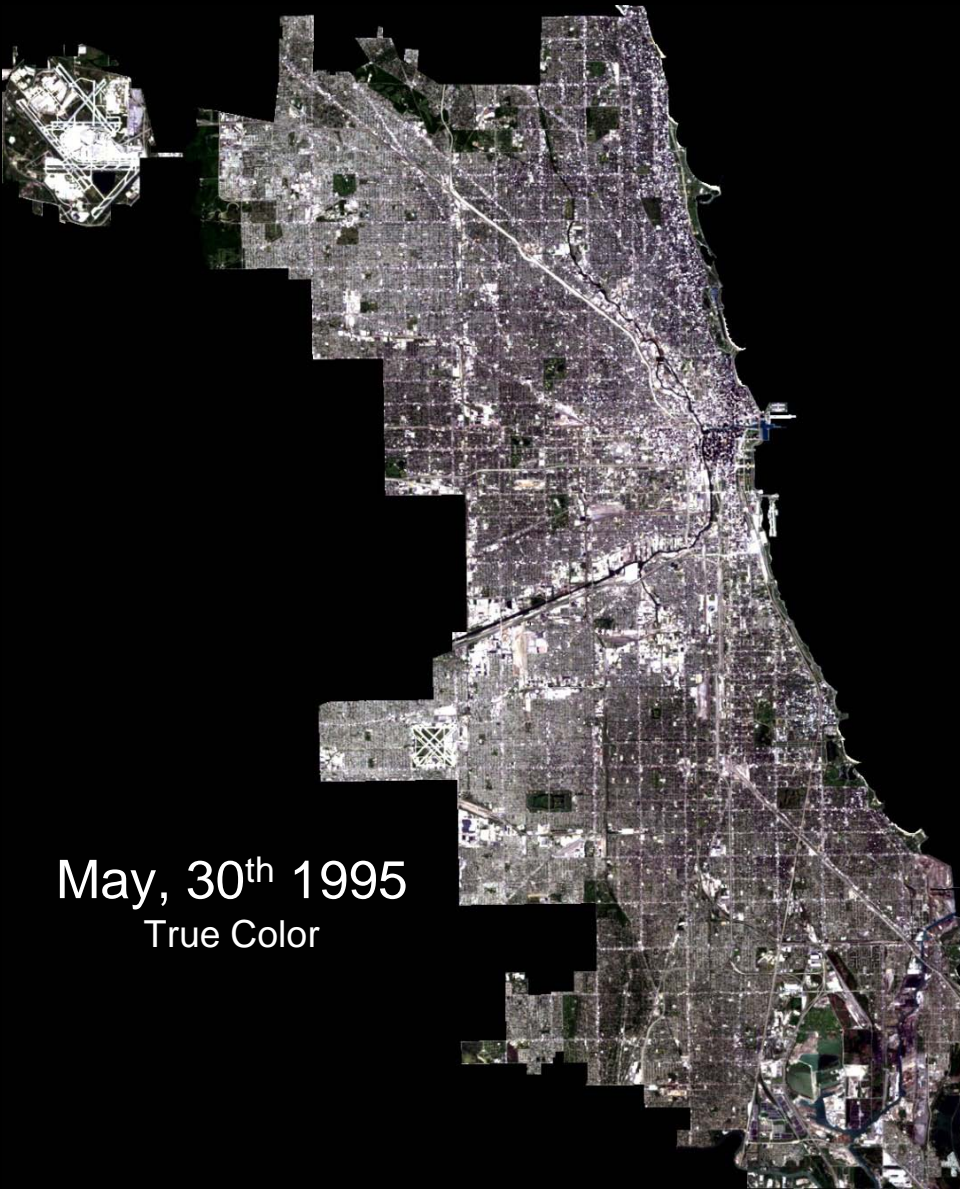
Temperature Change



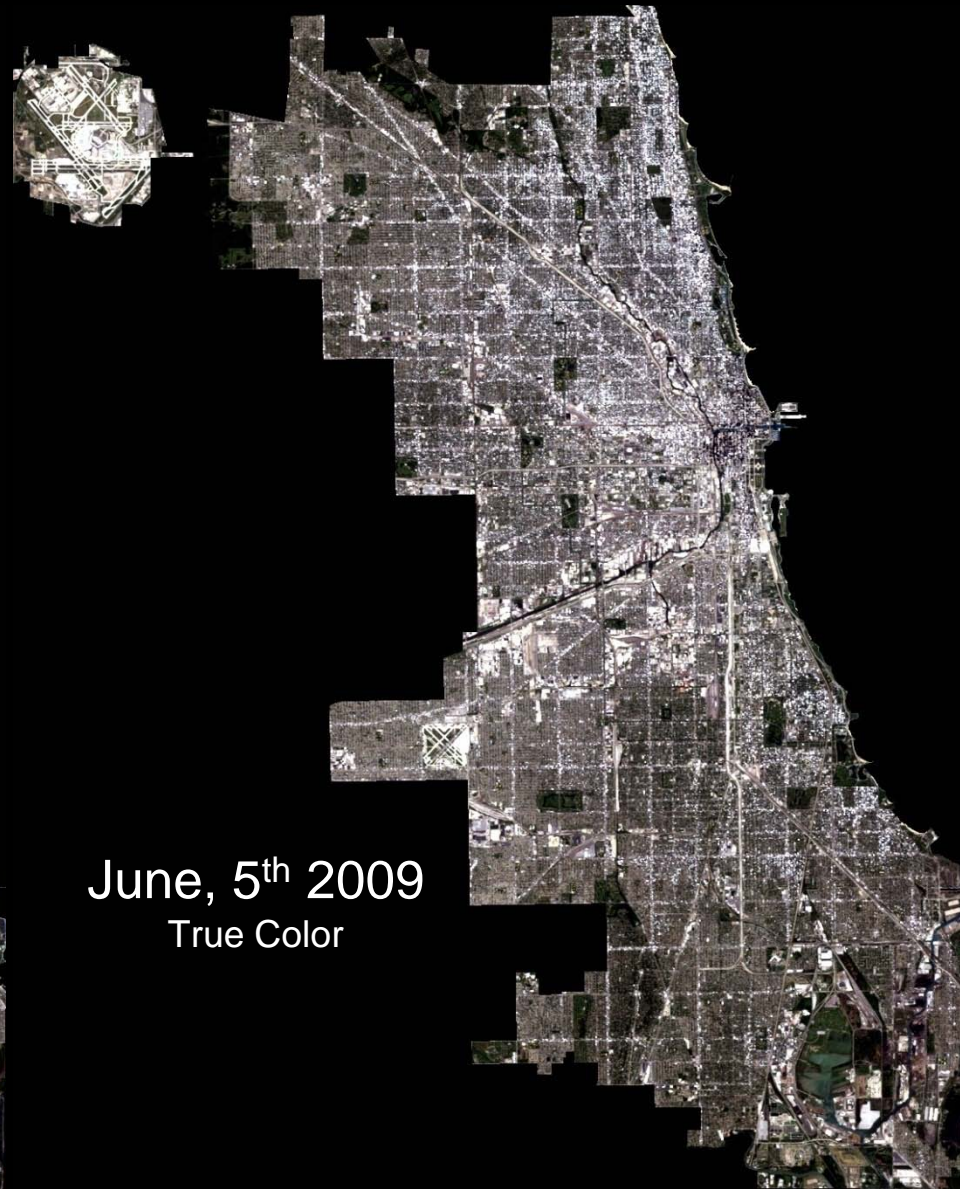
Changes:

No change since last time

Correlations in Single Images



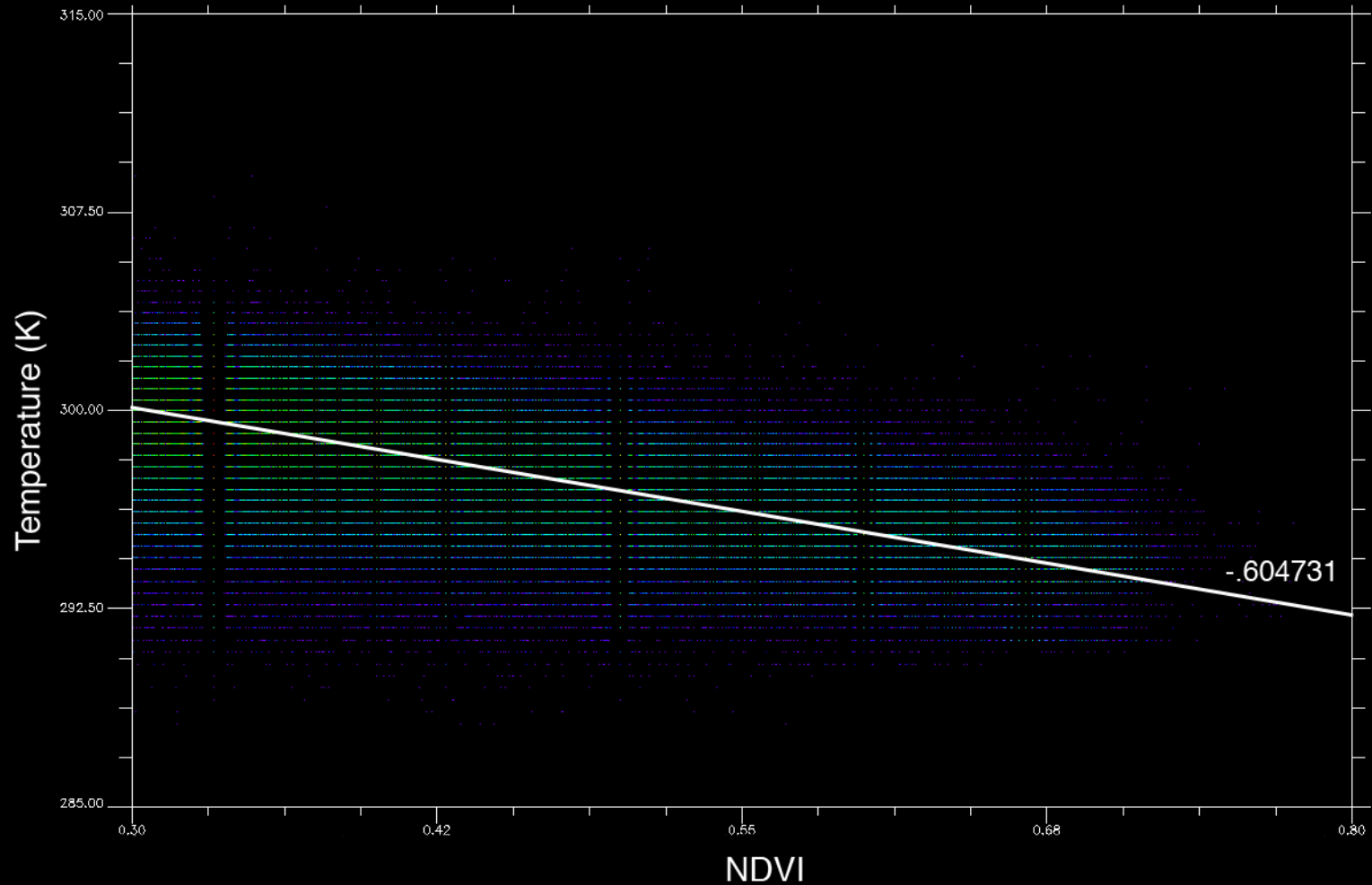
May, 30th 1995
True Color



June, 5th 2009
True Color

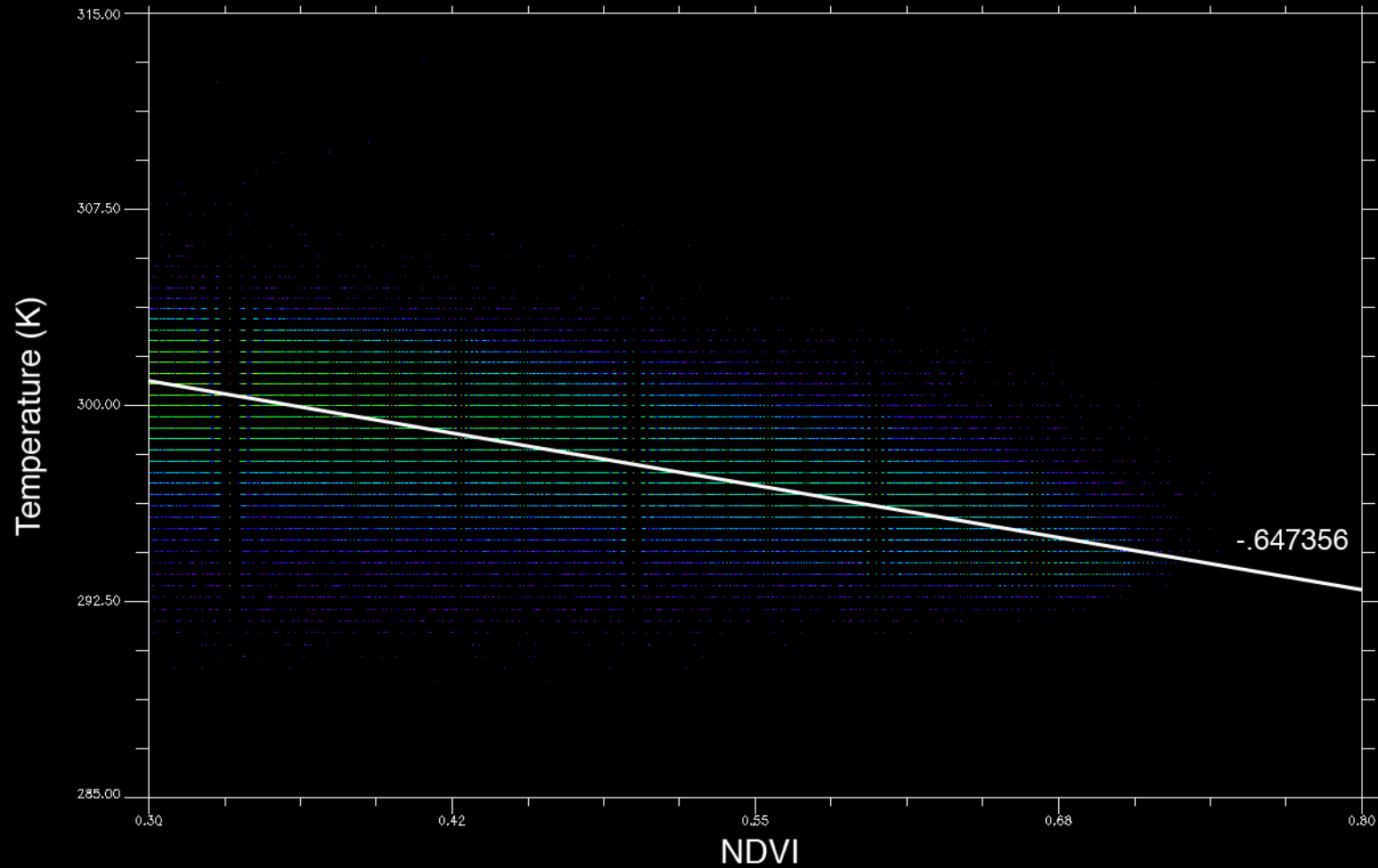
NDVI to Temperature Correlation

Vegetated Pixel NDVI to Surface Temperature 1995



NDVI to Temperature Correlation

Vegetated Pixel NDVI to Surface Temperature 2009



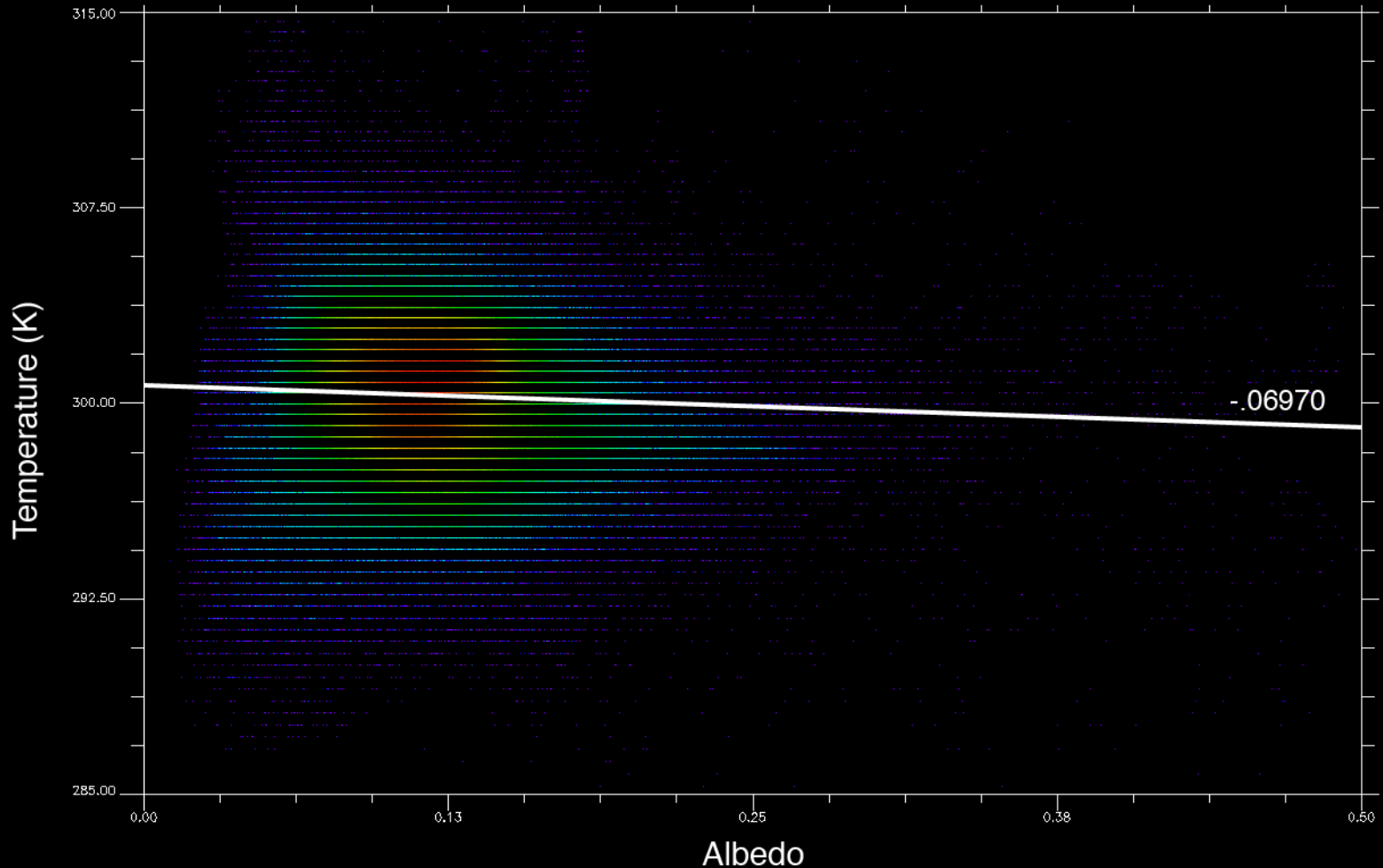
NDVI to Temperature

NDVI itself is very well correlated to lower temperatures

(this is the strongest correlation in the study)

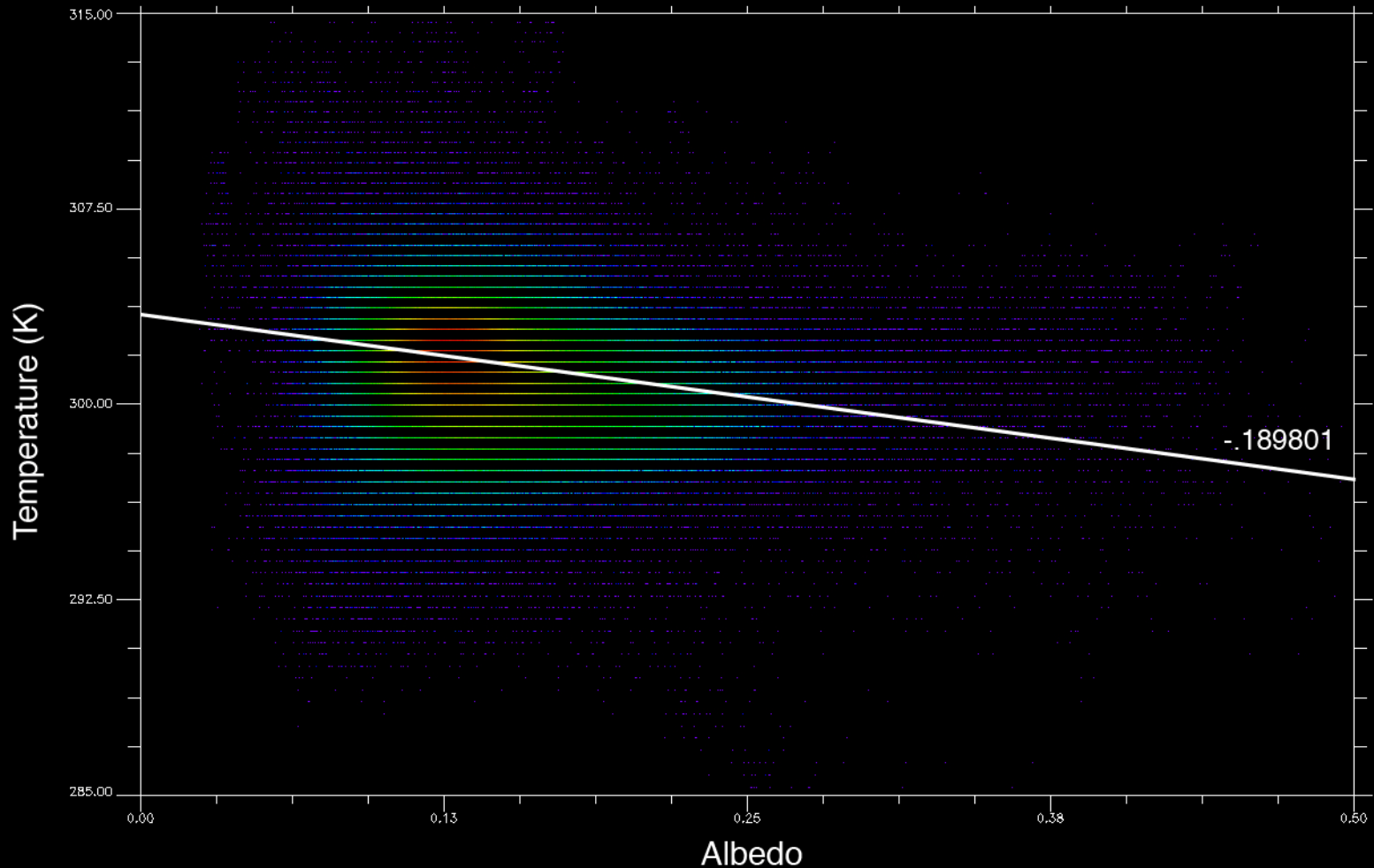
Albedo to Temperature Correlation

Non-Vegetated Non-Water Albedo to Surface Temperature 1995



Albedo to Temperature Correlation

Non-Vegetated Non-Water Albedo to Surface Temperature 2009



Albedo to Temperature

Albedo itself is not very well correlated to lower temperatures.

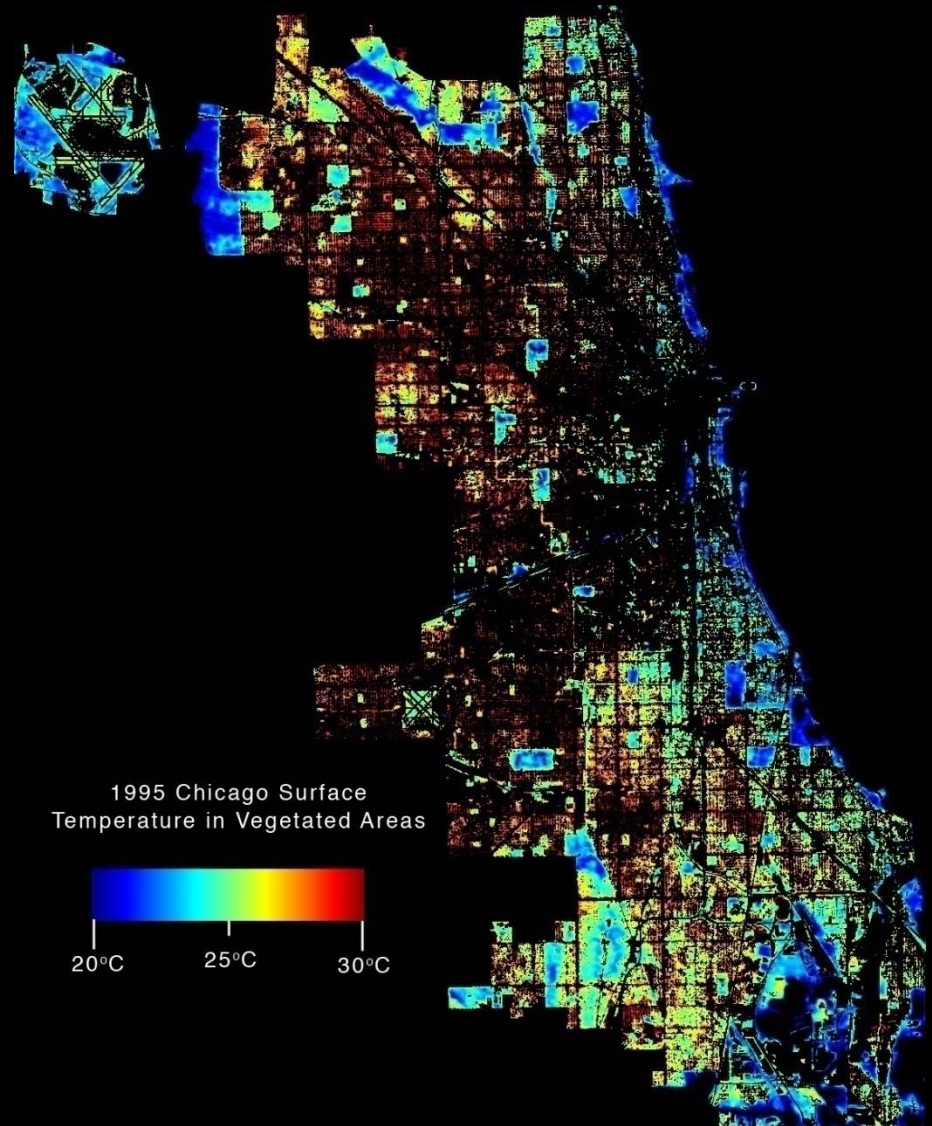
It's correlation cannot compare to that of vegetation and it sometimes appears to be non-existent.

However, the correlation of albedo to surface temperature increased almost threefold over the course of the study period.

Initial Conclusions

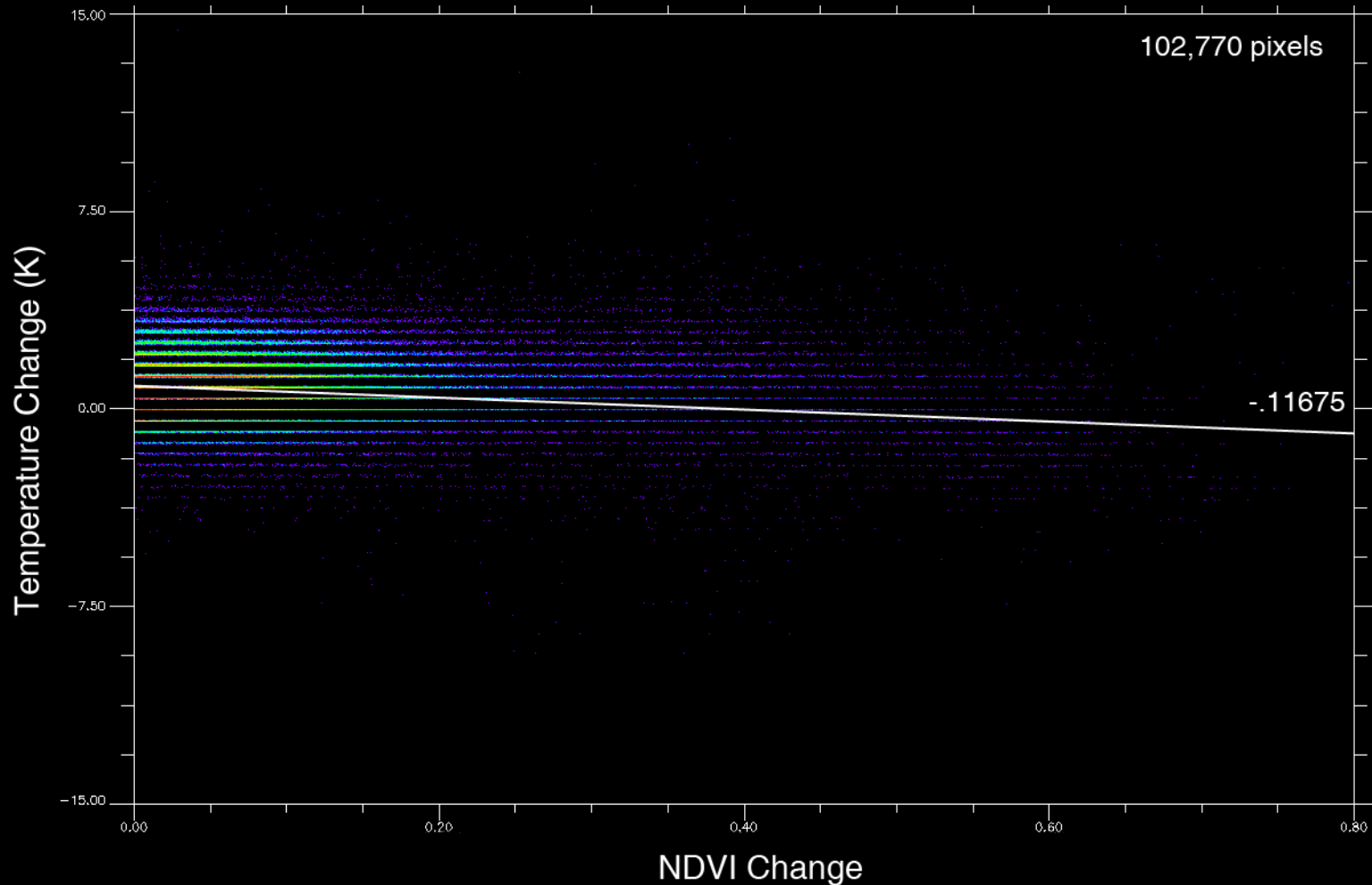
Conclusions:

- This method of LANDSAT analysis supports the scientific agreement that urban heat island is primarily caused by a removal of vegetation (and not albedo changes).
- It is consistent with observations that large parks and areas with abundant vegetation are often the coolest parts of a city in Summer.
- It suggests that the ideal method of dealing with urban heat island is to have abundant vegetation throughout the city.



Positive NDVI Change to Temperature Change (over the 13 study period)

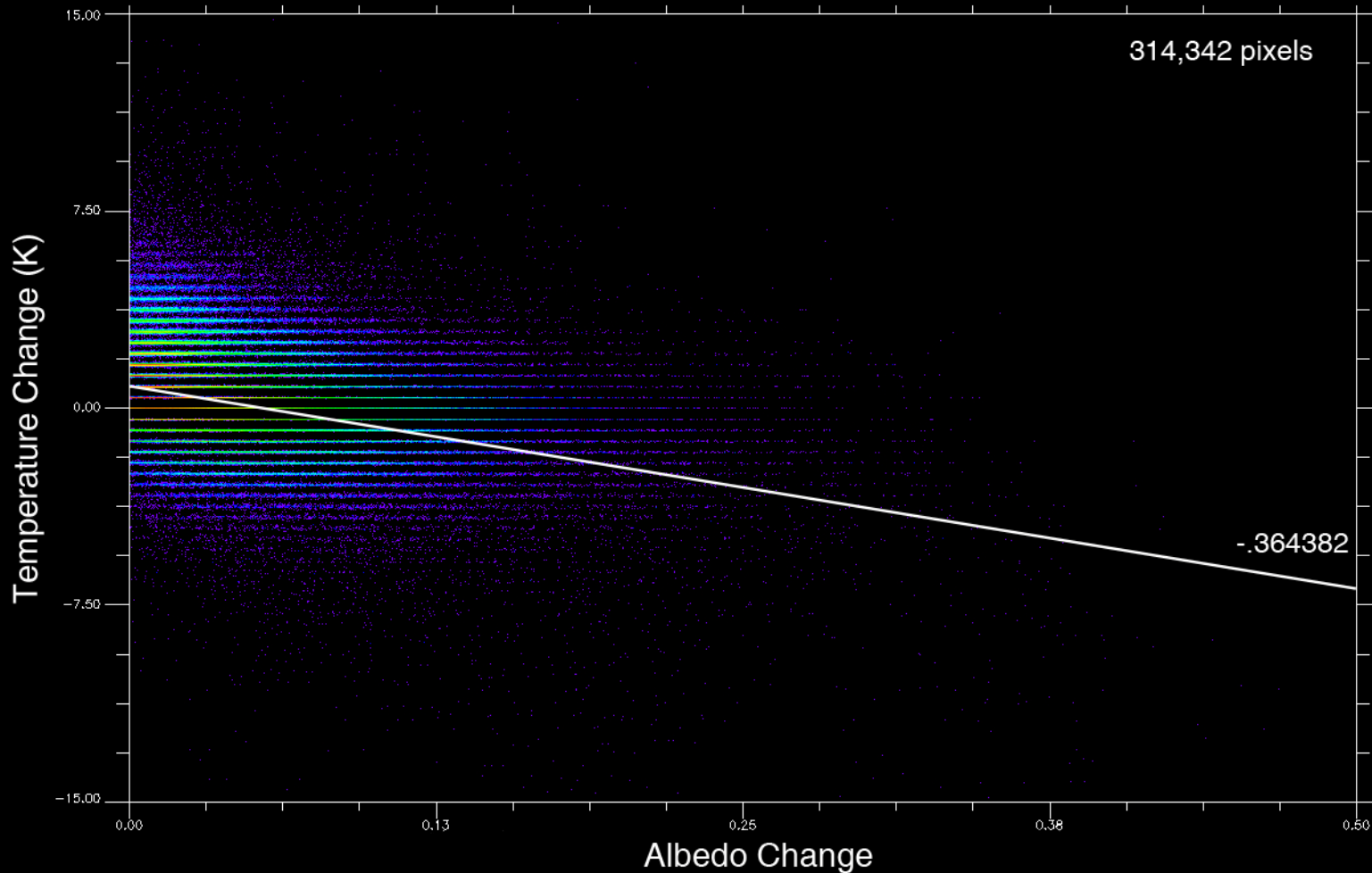
Positive NDVI Change to Surface Temperature Change (1995-2009)



Includes all pixels that increased past the .3 threshold or within the .3 threshold

Positive Albedo Change to Temperature Change (over the 13 study period)

Positive Albedo Change to Surface Temperature Change (1995-2009)



Includes all non-vegetated, non-water, non-shadow pixels that increased in albedo

Final Conclusions

The city's policies and citizen efforts to increase vegetation in the last 13 years do not seem to be restoring places to the cooling potential of abundantly-vegetated areas (as in the city's large parks).

The city's reflective policies are cooling urban surfaces more than might be typically expected by single date urban albedo studies.

Even though reflective roofs do not represent an ideal strategy for addressing urban heat island and probably should not represent a long-term or final goal, they can be much more effective over a 15-year period than vegetation strategies (at least in the case of Chicago).

This is probably because of cost.

Further Support

(Aerial Photography of Policy Examples)

Illinois Natural Resources Geospatial Data Clearinghouse



1998

Single visible band
1 meter resolution



2010

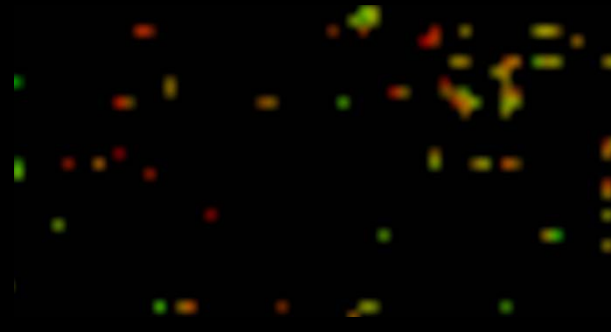
True color visible bands
1 meter resolution

Reflective Roof Neighborhood

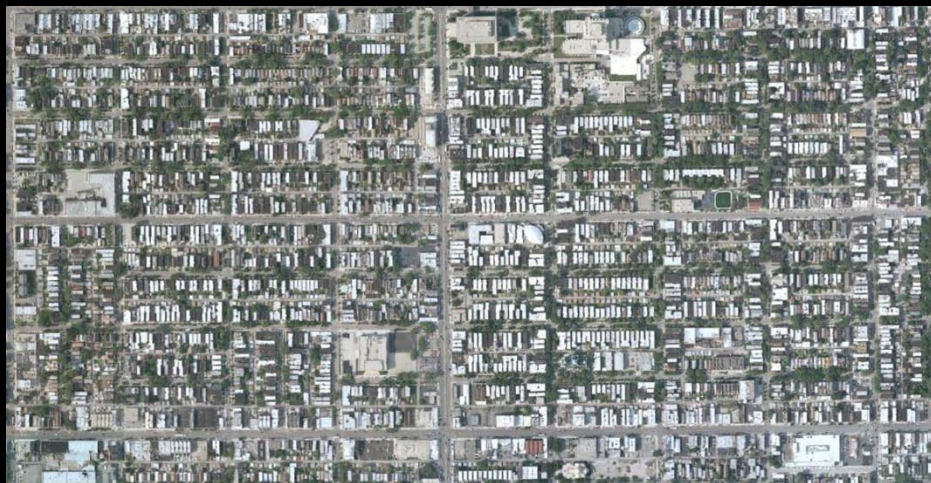
1998



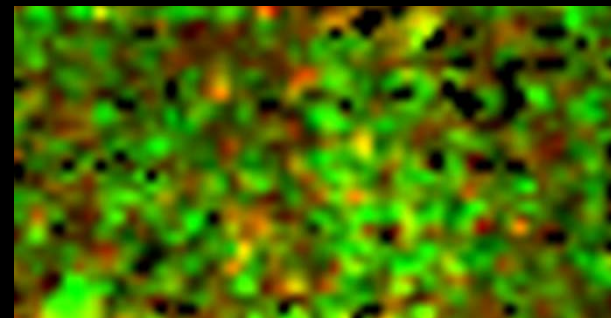
NDVI
Change



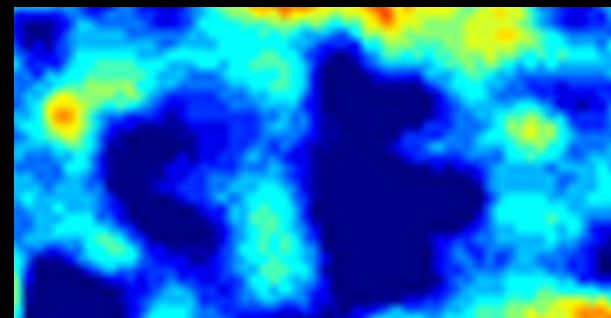
2010



Albedo
Change

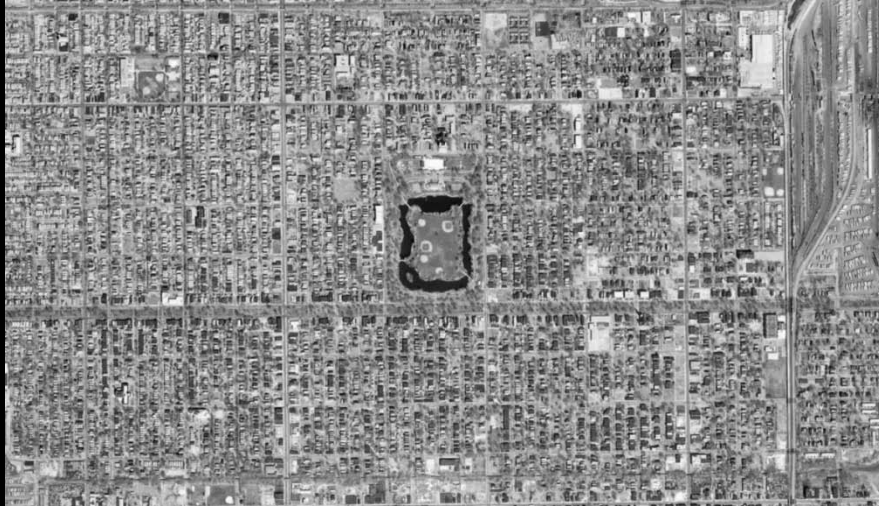


Temp.
Change

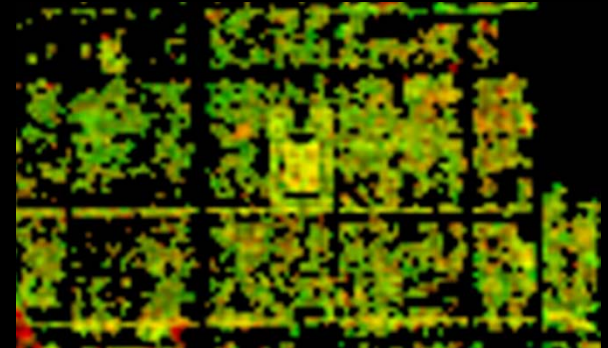


Street Tree Neighborhood

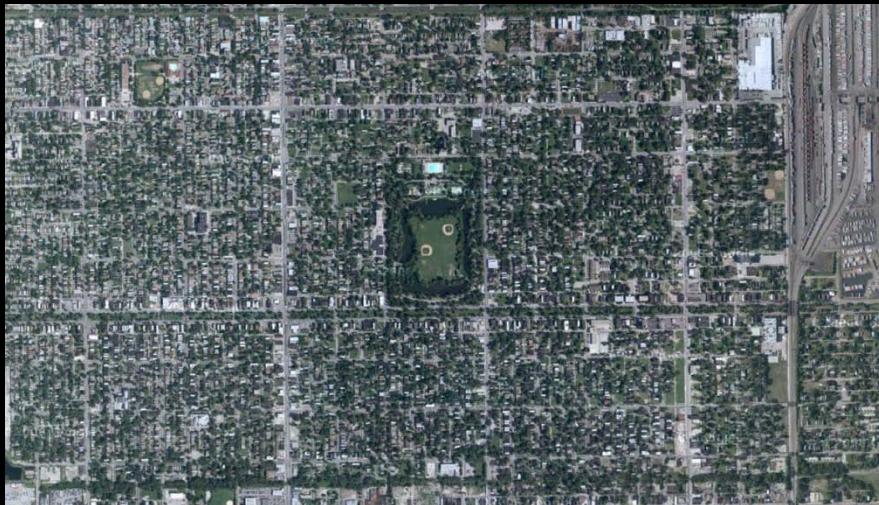
1998



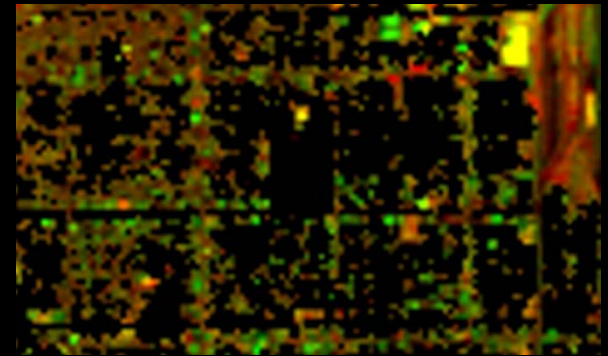
NDVI
Change



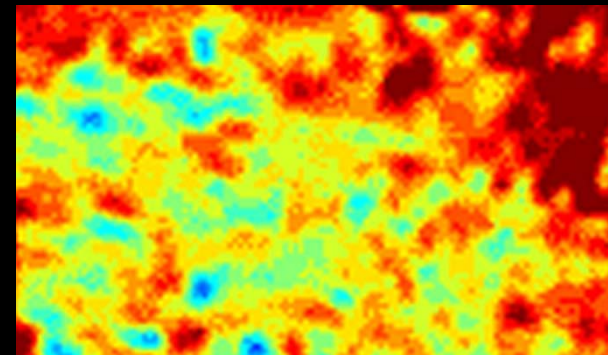
2010



Albedo
Change



Temp.
Change

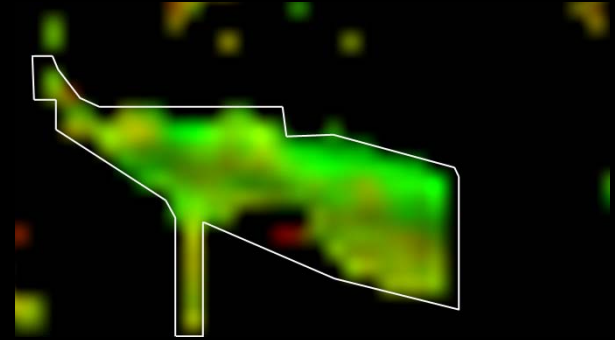


New Park 1 (from old rail yard)

1998



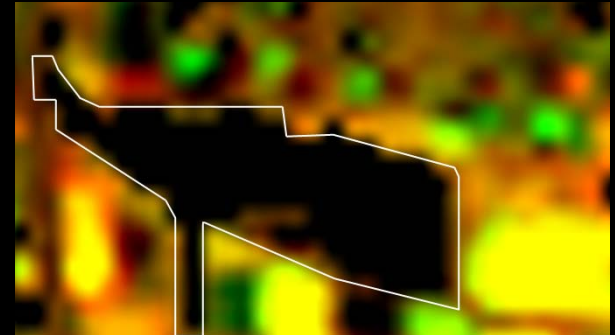
NDVI
Change



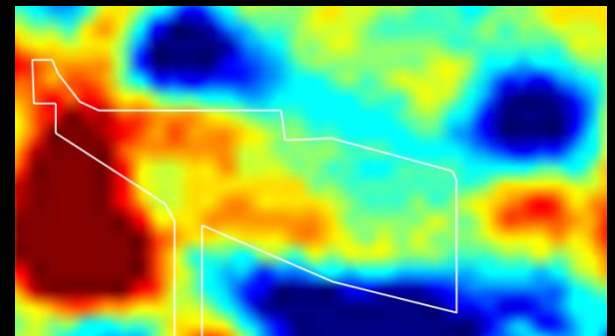
2010



Albedo
Change



Temp.
Change

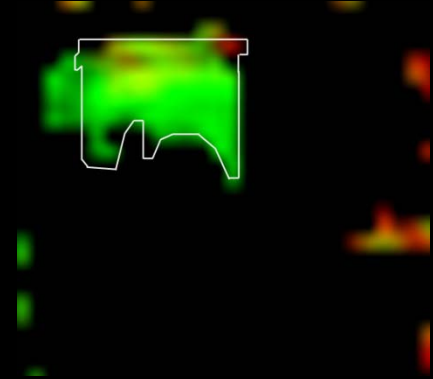


New Park 2 (from part of power plant)

1998



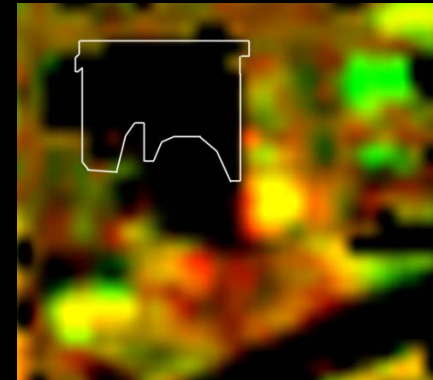
NDVI
Change



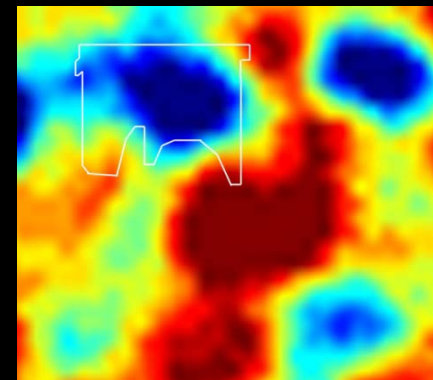
2010



Albedo
Change



Temp.
Change

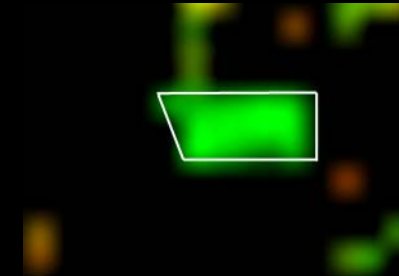


Grass Replacing Asphalt Schoolyard

1998



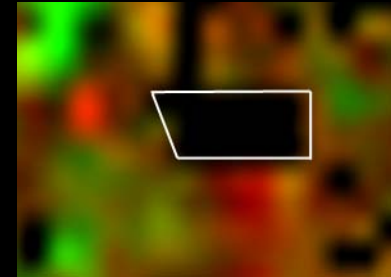
NDVI
Change



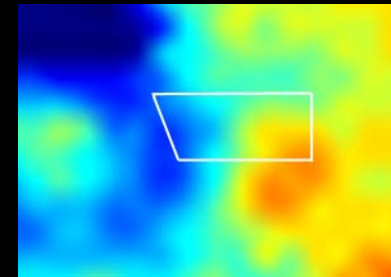
2010



Albedo
Change



Temp.
Change



New Greenroof

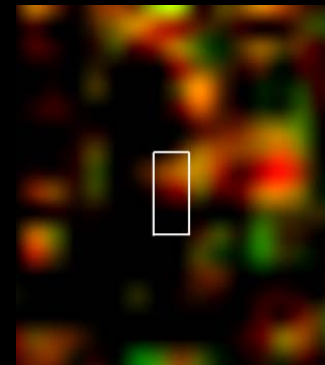
1998



NDVI
Change



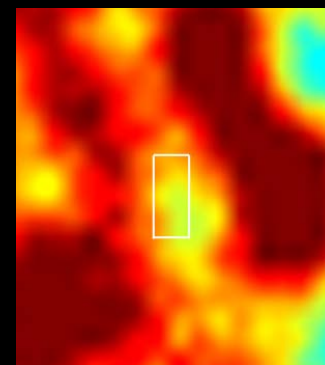
Albedo
Change



2010



Temp.
Change



Road Reflectivity Increase

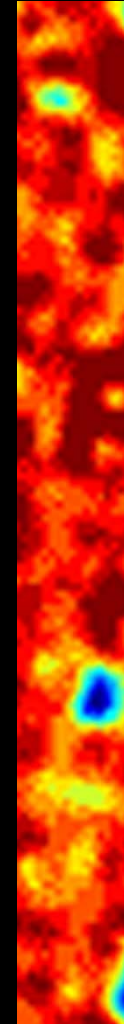
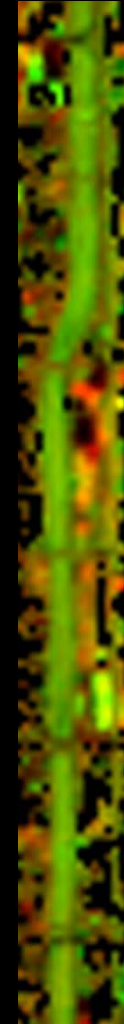
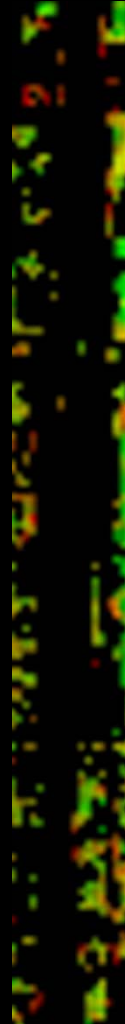
1998

2010

NDVI
Change

Albedo
Change

Temp.
Change

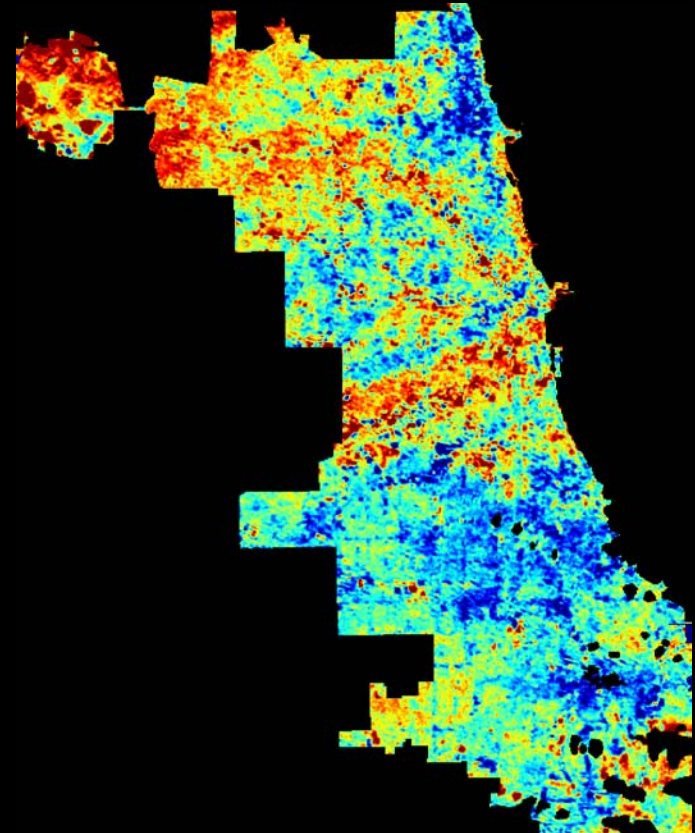
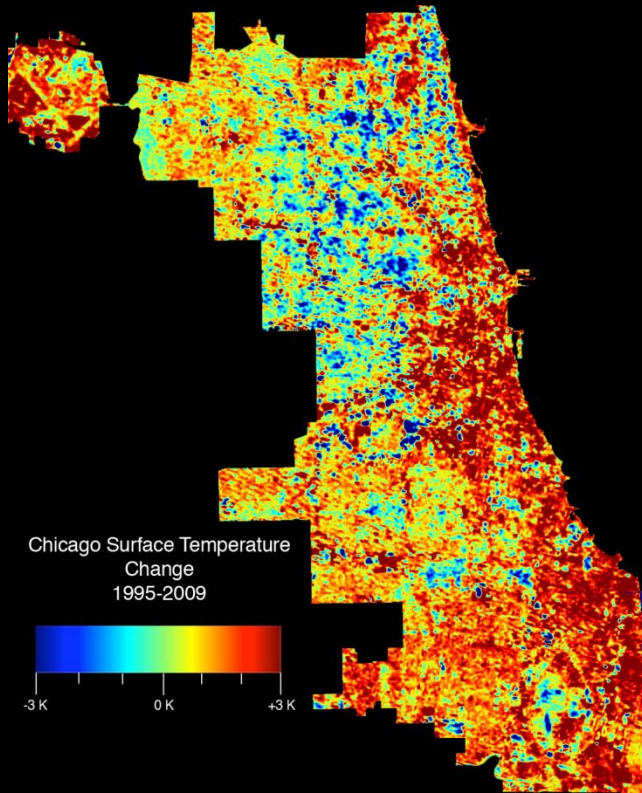


Further Support

(Replicated Experiment)

July 1st 1995
(O'Hare: Mean Temp of 65)

July 7th 2009
(O'Hare: Mean Temp of 68)



Further Support

(Replicated Experiment)

Correlations in Initial Image Pair:

1995 NDVI to Temp: $-.604731$

2009 NDVI to Temp: $-.647356$

1995 Albedo to Temp: $-.069700$

2009 Albedo to Temp: $-.189801$

Positive NDVI Change to Temp Change: $-.11675$

Albedo Change to Temp Change: $-.364382$

Number of Pixels with Increased NDVI: 102,770

Number of Pixels with Increased Albedo: 341,342

Correlations in Replicated Image Pair:

1995 NDVI to Temp: $-.701520$

2009 NDVI to Temp: $-.599737$

1995 Albedo to Temp: $-.165308$

2009 Albedo to Temp: $-.011913$

Positive NDVI Change to Temp Change: $-.201431$

Albedo Change to Temp Change: $-.249621$

Number of Pixels with Increased NDVI: 81,502

Number of Pixels with Increased Albedo: 245,254

Further Support

(Replicated Experiment)

Correlations in Initial Image Pair:

1995 NDVI to Temp: $-.604731$

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Correlations in Replicated Image Pair:

1995 NDVI to Temp: $-.701520$

2009 NDVI to Temp: $-.599737$

1995 Albedo to Temp: $-.165308$

2009 Albedo to Temp: $-.011913$

Positive NDVI Change to Temp Change: $-.201431$

Albedo Change to Temp Change: $-.249621$

Number of Pixels with Increased NDVI: 81,502

Number of Pixels with Increased Albedo: 245,254

Is this the result of broader leaves/hotter temperatures later in the summer or
is it some atmospheric anomaly?

Further Research

Examine the image pairs from early August:

July 30th 1994
(O'Hare: Mean Temp of 71)

August 3rd 2007
(O'Hare: Mean Temp of 80)