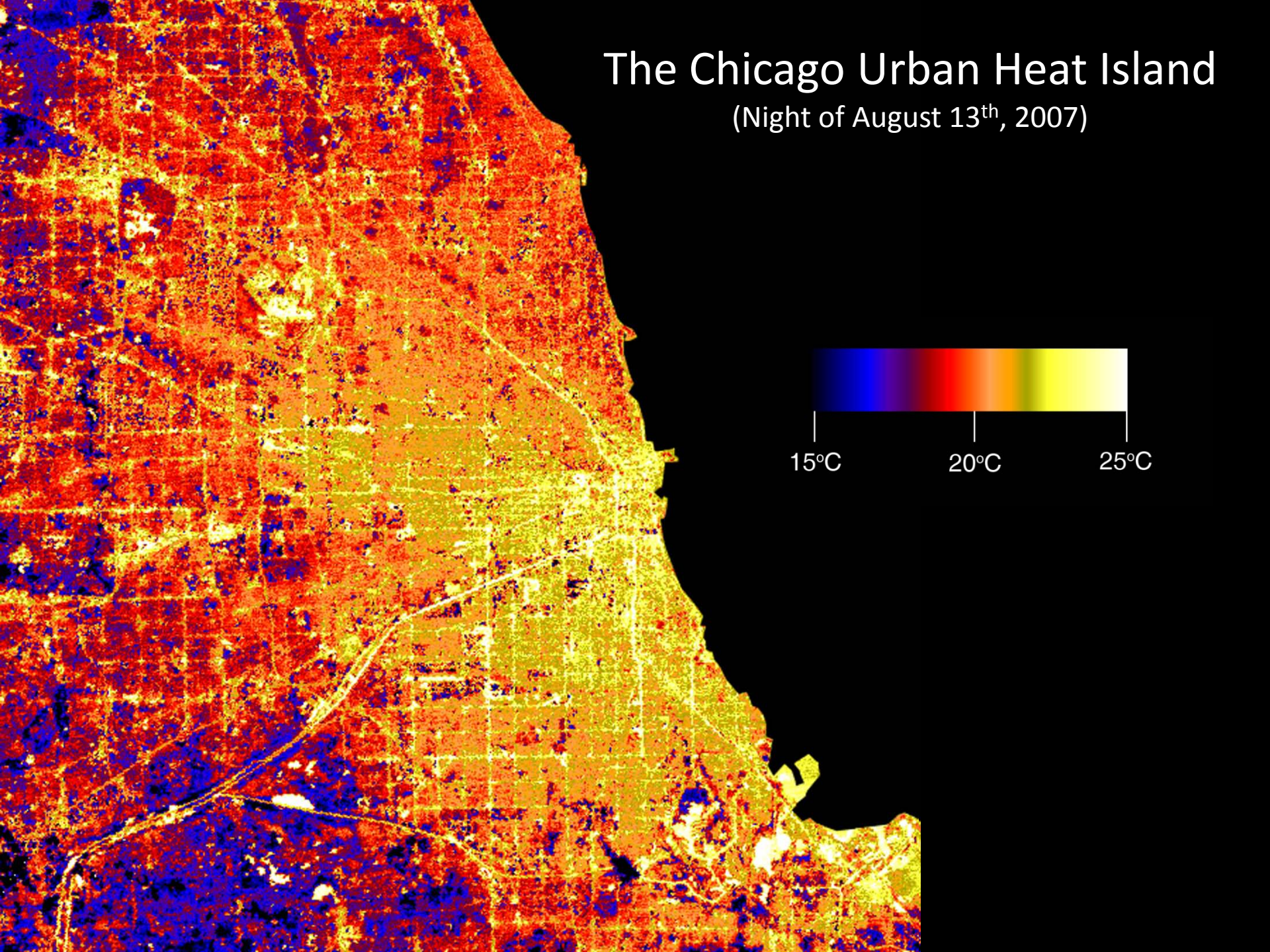
The Chicago Urban Heat Island

(Night of August 13th, 2007)



Last Time's Conclusions

Areas of high NDVI have a much better correlation to low temperatures than areas of high albedos within single images of the city.

However, the positive albedo changes that happened in the city from 1995 to 2009 are much better correlated to a temperature decrease than the positive changes in NDVI.

The reflective policies were significantly more effective than one might originally hypothesize based on single images and the vegetation policies were much less effective.

Conclusions are Supported by…

- Change detection scatter plots with two pairs of LANDSAT images (One from June 1995 + 2009 and one from July 1995 + 2007). These include numerical correlations and will include error bars to show that the results are significant.

- Qualitative comparisons of the change detection images in one of the LANDSAT pairs and the further relation of the images to aerial photographs.

- A potential explanation that areas increasing in NDVI did not have high temperatures to begin with while areas increasing in albedo did.

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NEW DEVELOPMENT

1) Replicated LANDSAT Change Detection

Correlations in Early June 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 Early July Image Pair:

1995 NDVI to Temp: -.701520
2007 NDVI to Temp: -.652529

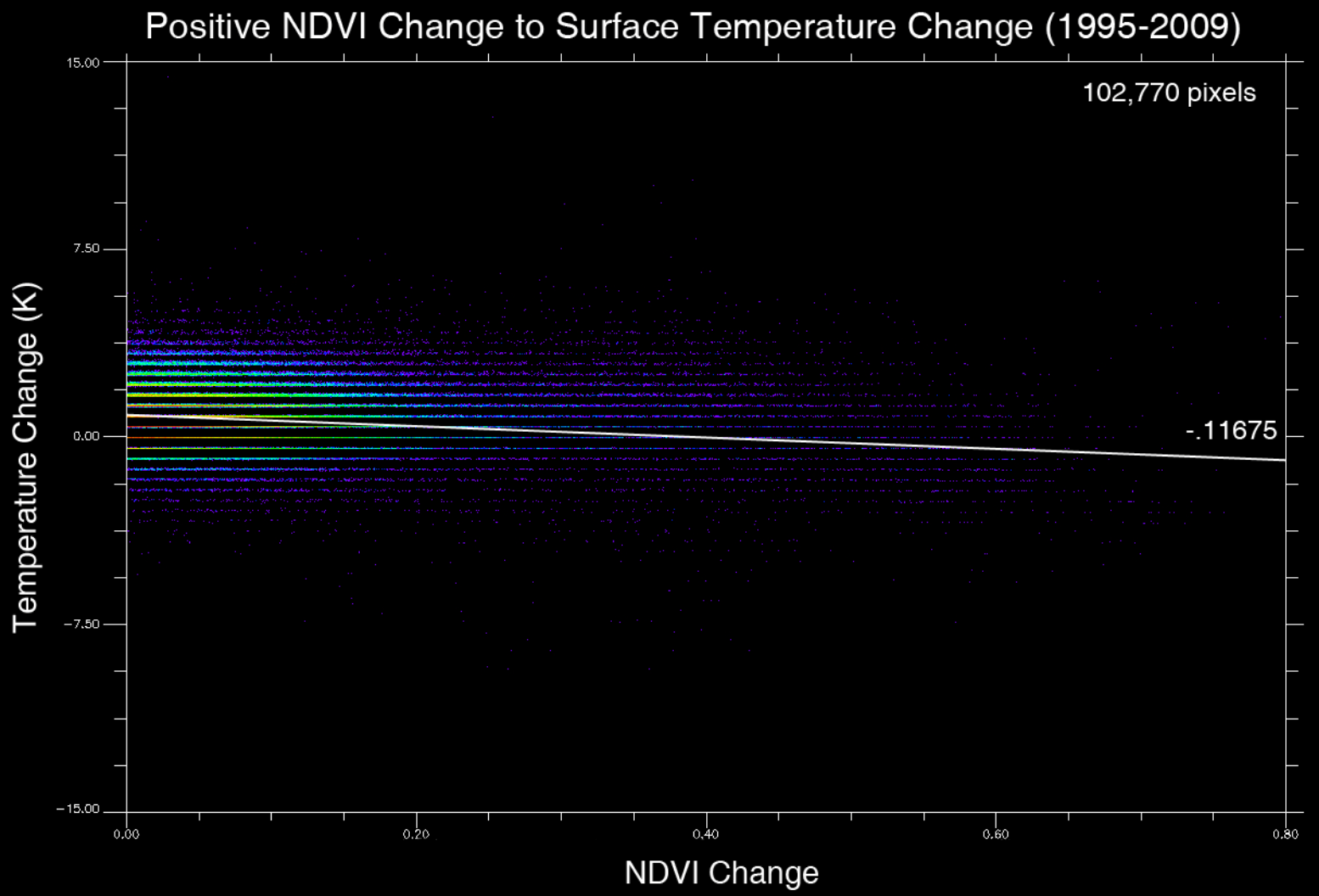
1995 Albedo to Temp: -.165308
2007 Albedo to Temp: -.109134

Positive NDVI Change to Temp Change: -.100943
Albedo Change to Temp Change: -.311276

Number of Pixels with Increased NDVI: 254,759
Number of Pixels with Increased Albedo: 204,909

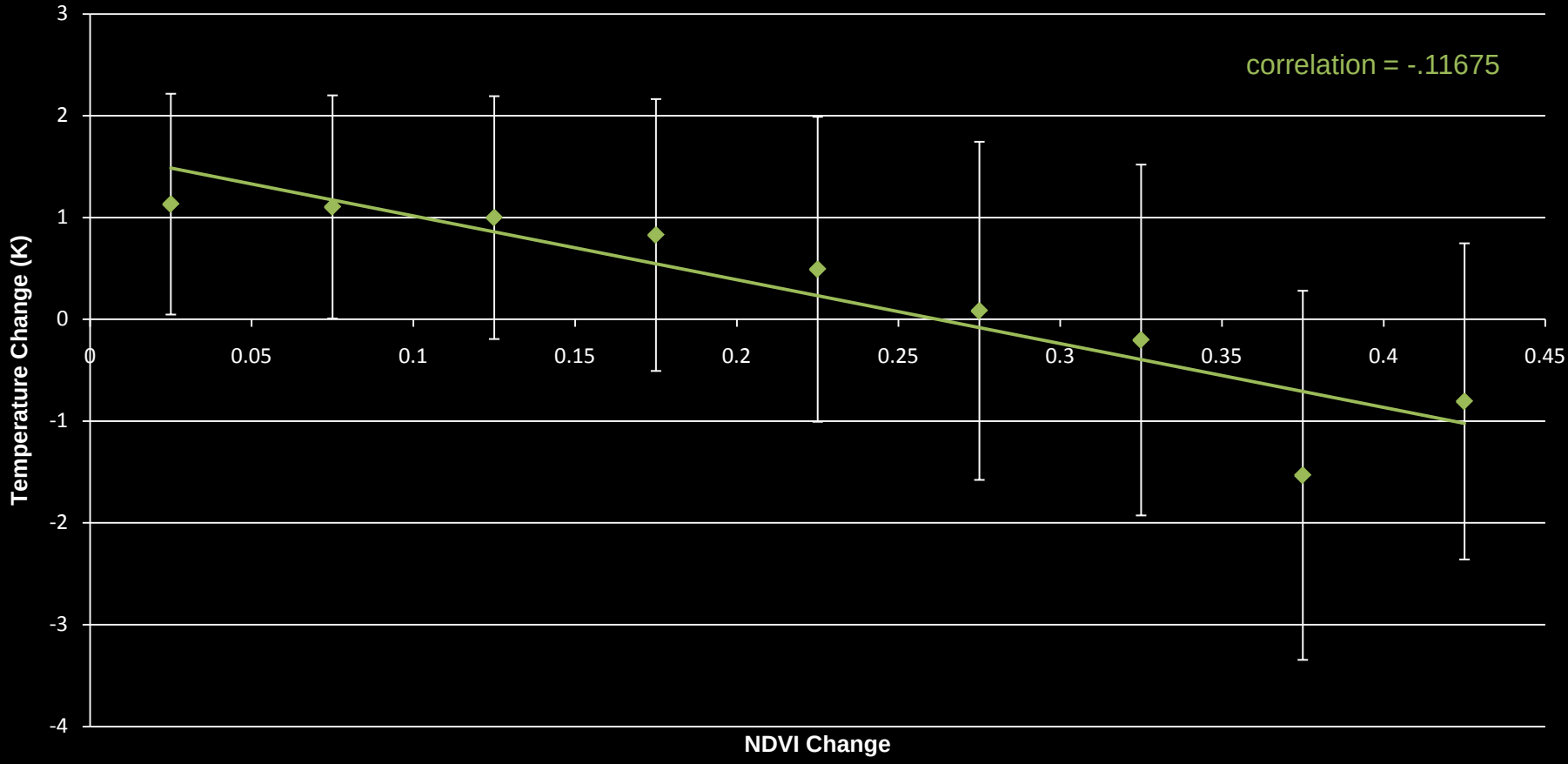
Positive NDVI Change to Temperature Change

(over the 13 study period)



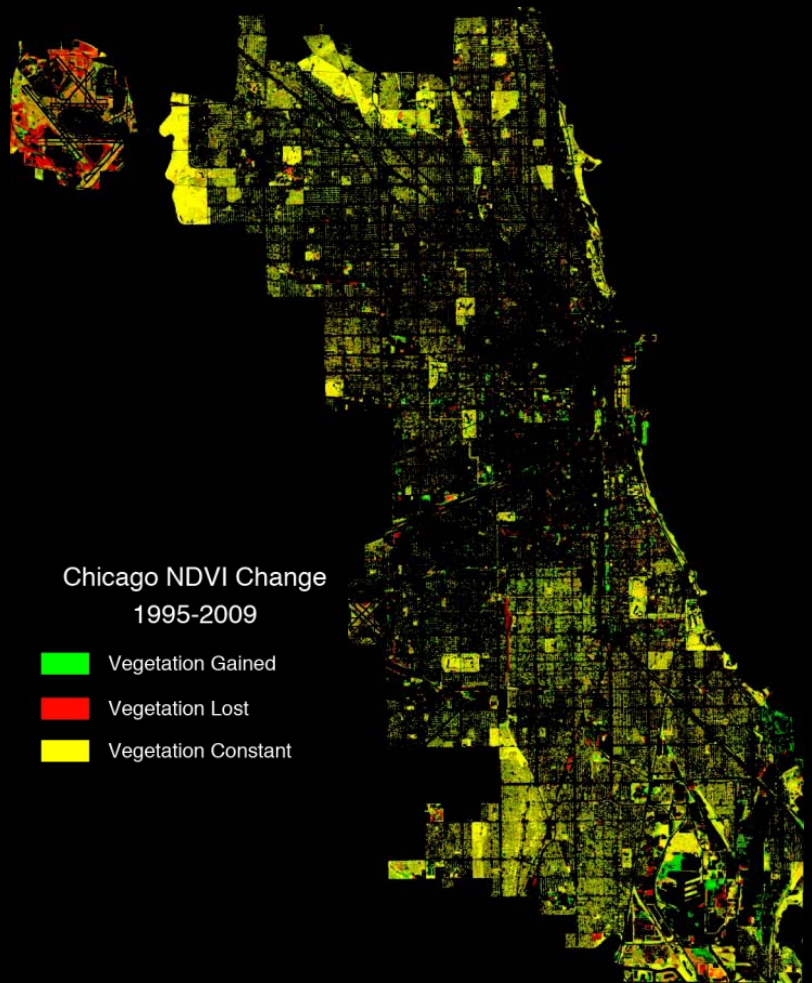
Includes all pixels that increased past the .3 threshold or within the .3 threshold

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

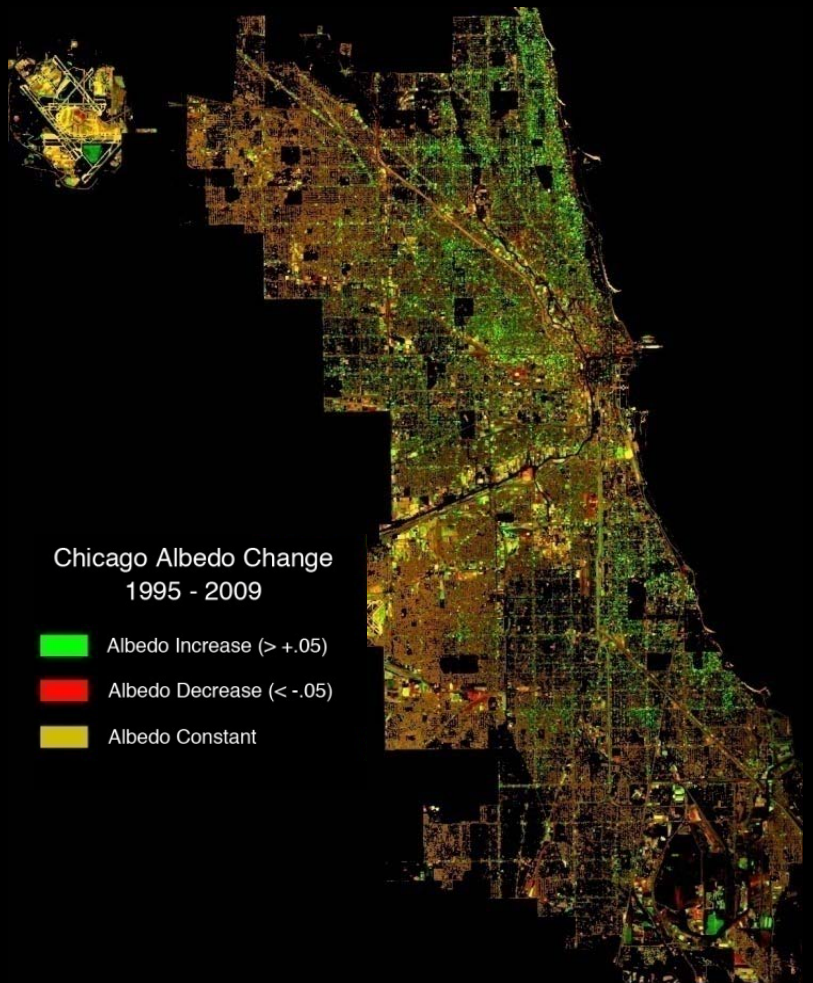


3) Possible Explanation for Results
(positive NDVI change happened in cooler pixels)

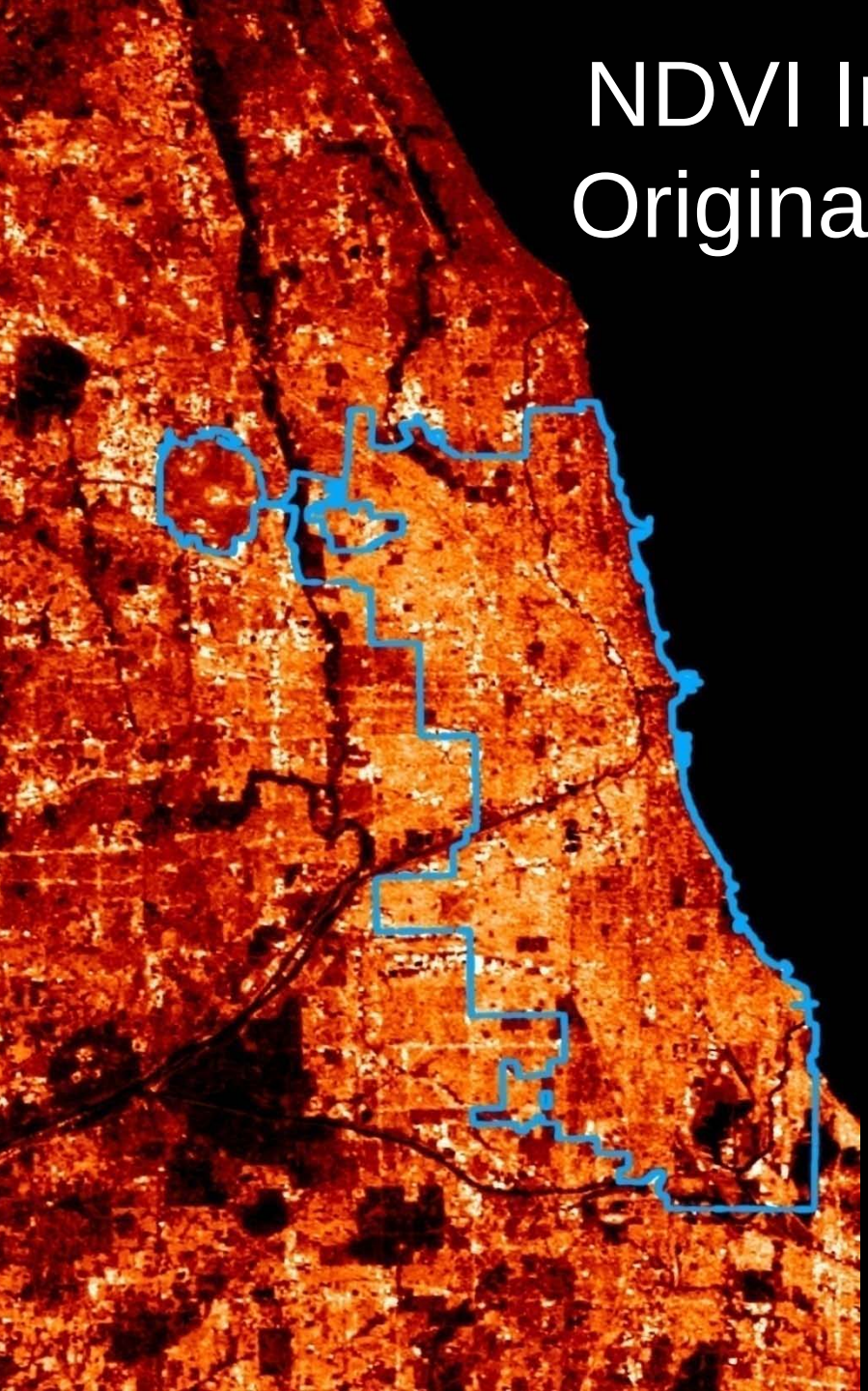
NDVI Change



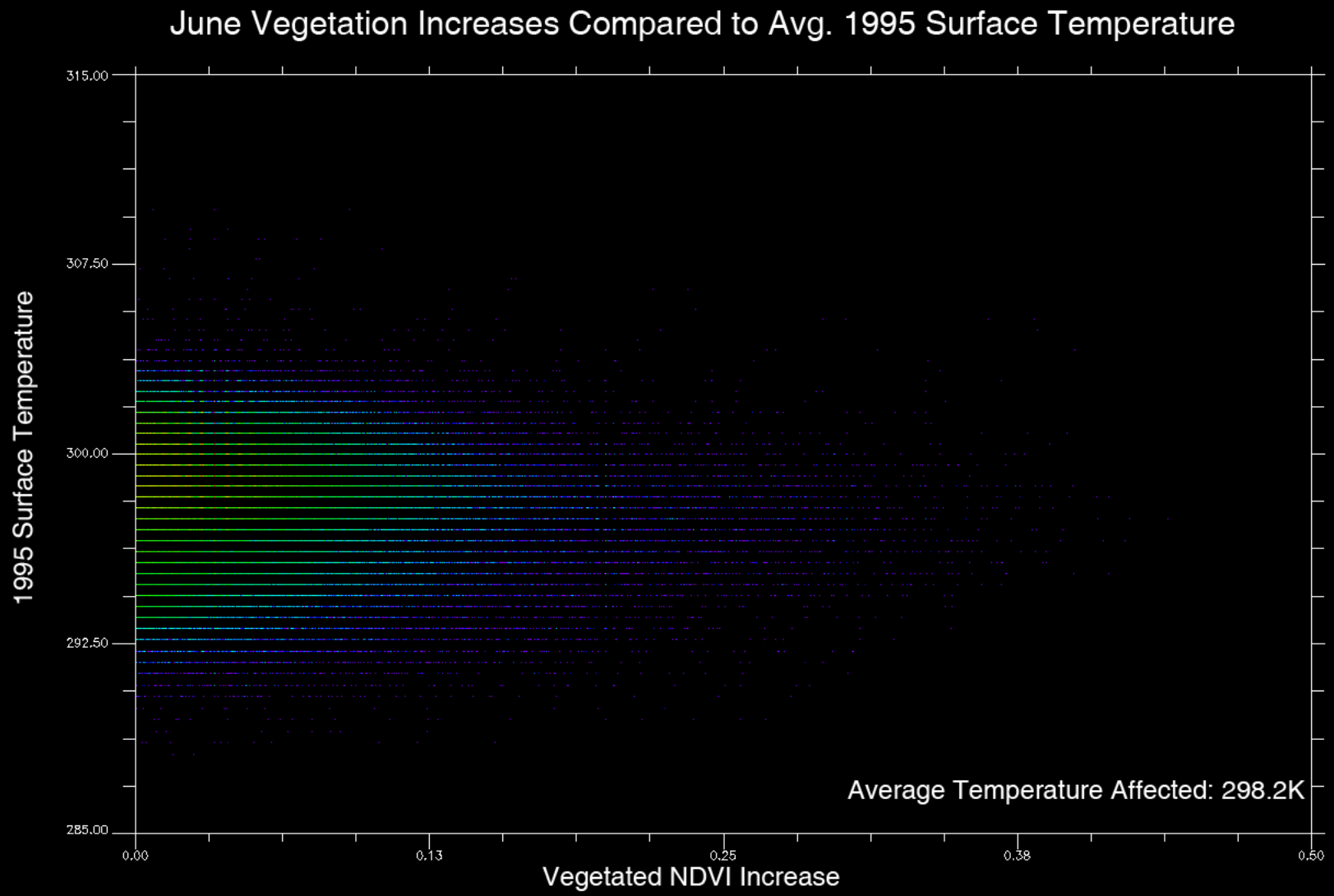
Albedo Change



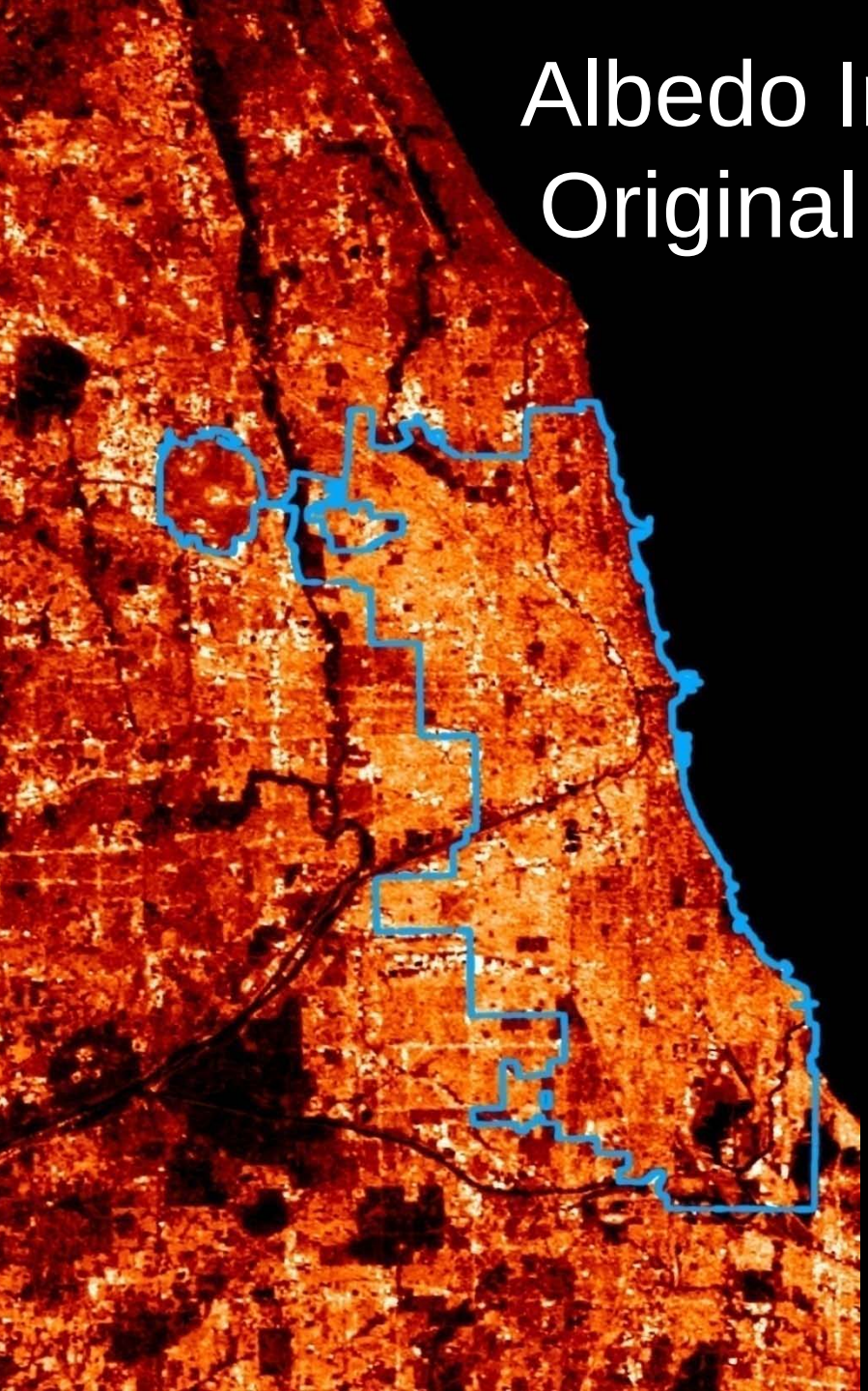
NDVI Increase Compared to Original Temperature in 1995



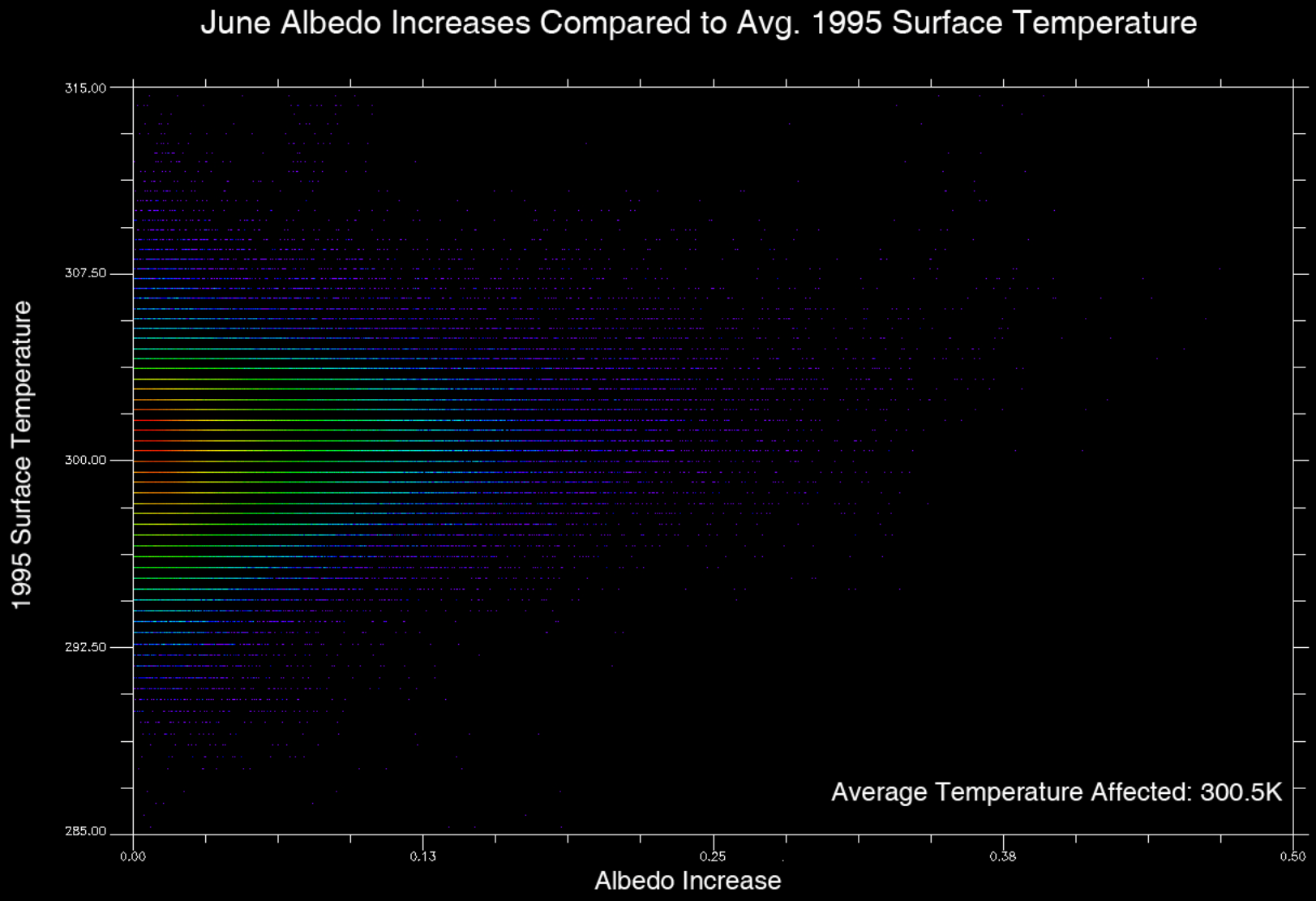
NDVI Increase to Original Temperature in 1995



Albedo Increase Compared to Original Temperature in 1995



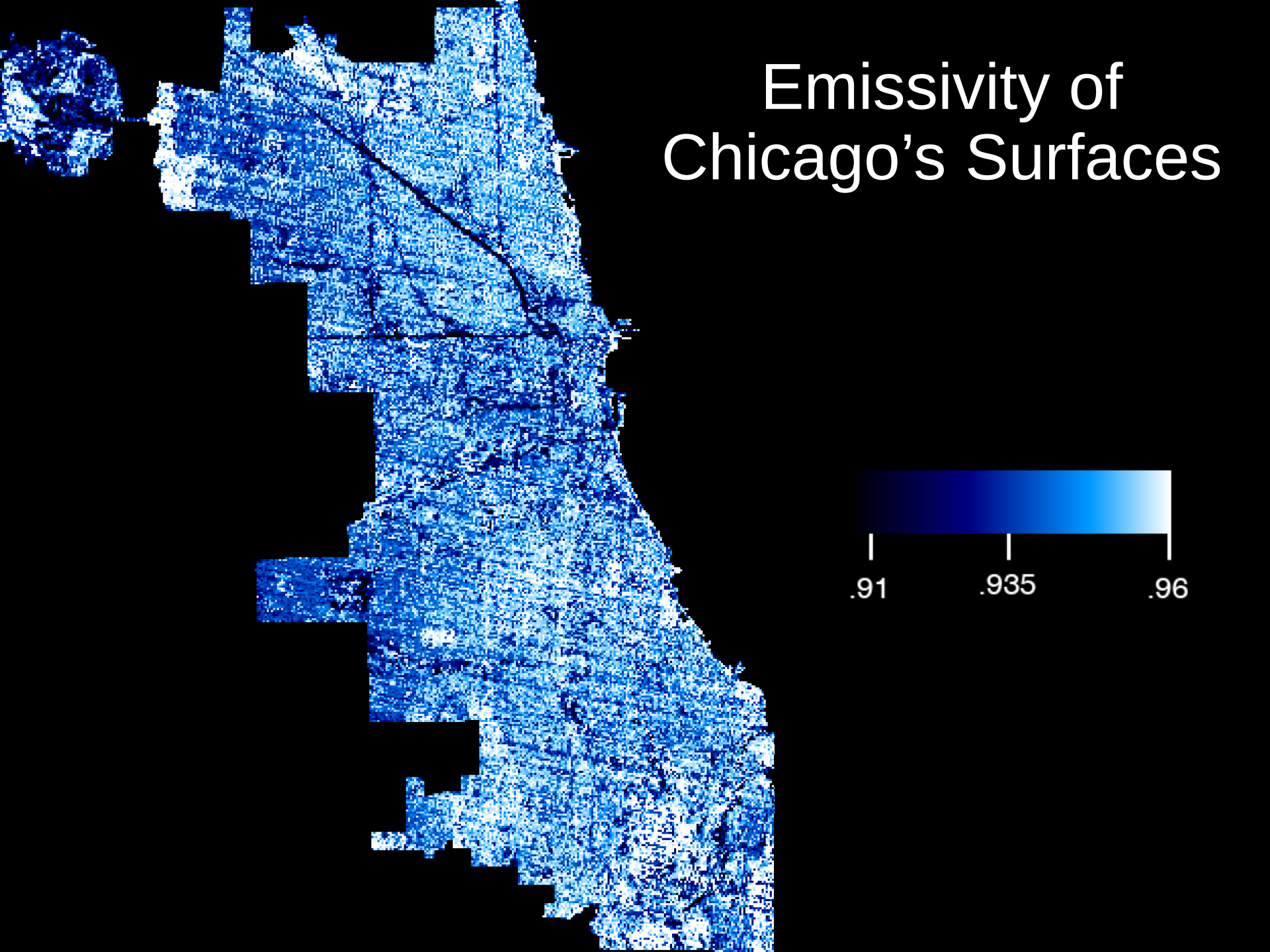
Albedo Increase to Original Temperature in 1995



Conclusions Weakened by…

- Observation of the average emissivities of Chicago's surfaces revealing that vegetation has a higher emissivity than impermeable surfaces.
- The question of whether Chicago would behave the same in a heat wave as in this study.
- The question of whether observing Chicago from a satellite is an effective way to measure heat island (as in, most of the reflective increases happened in the canopy above the level where citizens dwell while the vegetation increases mostly happened on the ground).

Emissivity of Chicago's Surfaces



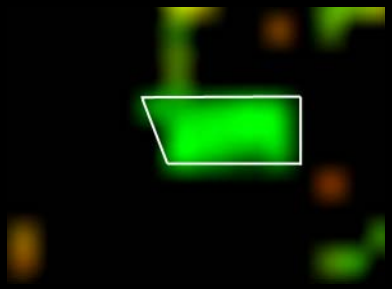
This suggests that the change of surfaces from asphalt to grass, for example, actually did cool surface temperatures slightly but it is not as detectable in the LANDSAT imagery.

Grass Replacing Asphalt Schoolyard

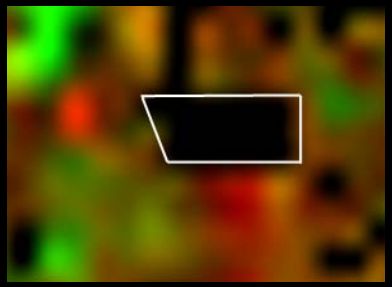
1998

2010

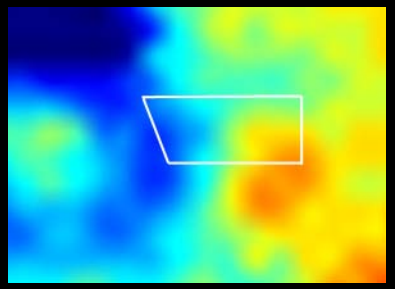
NDVI Change



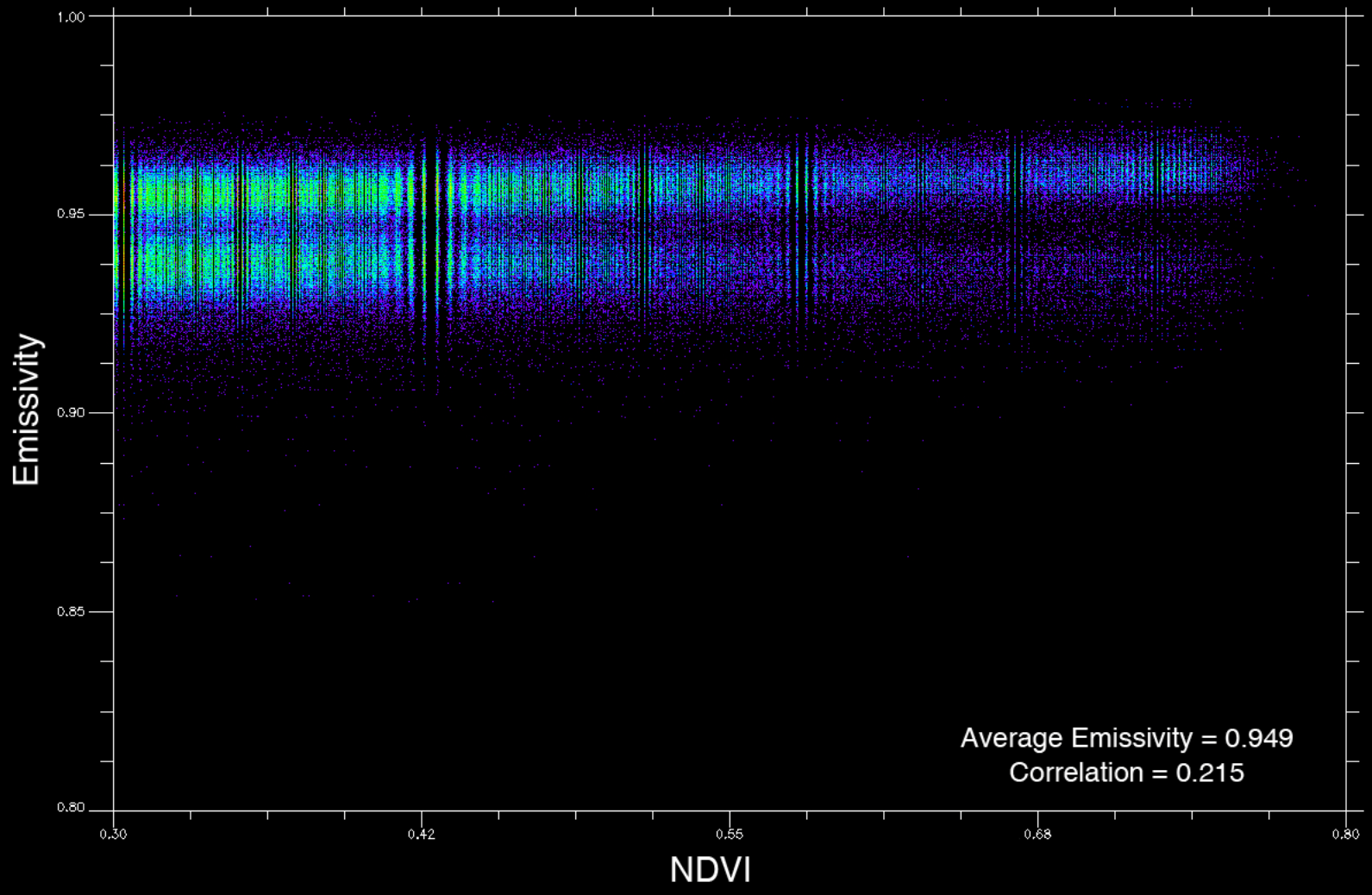
Albedo Change



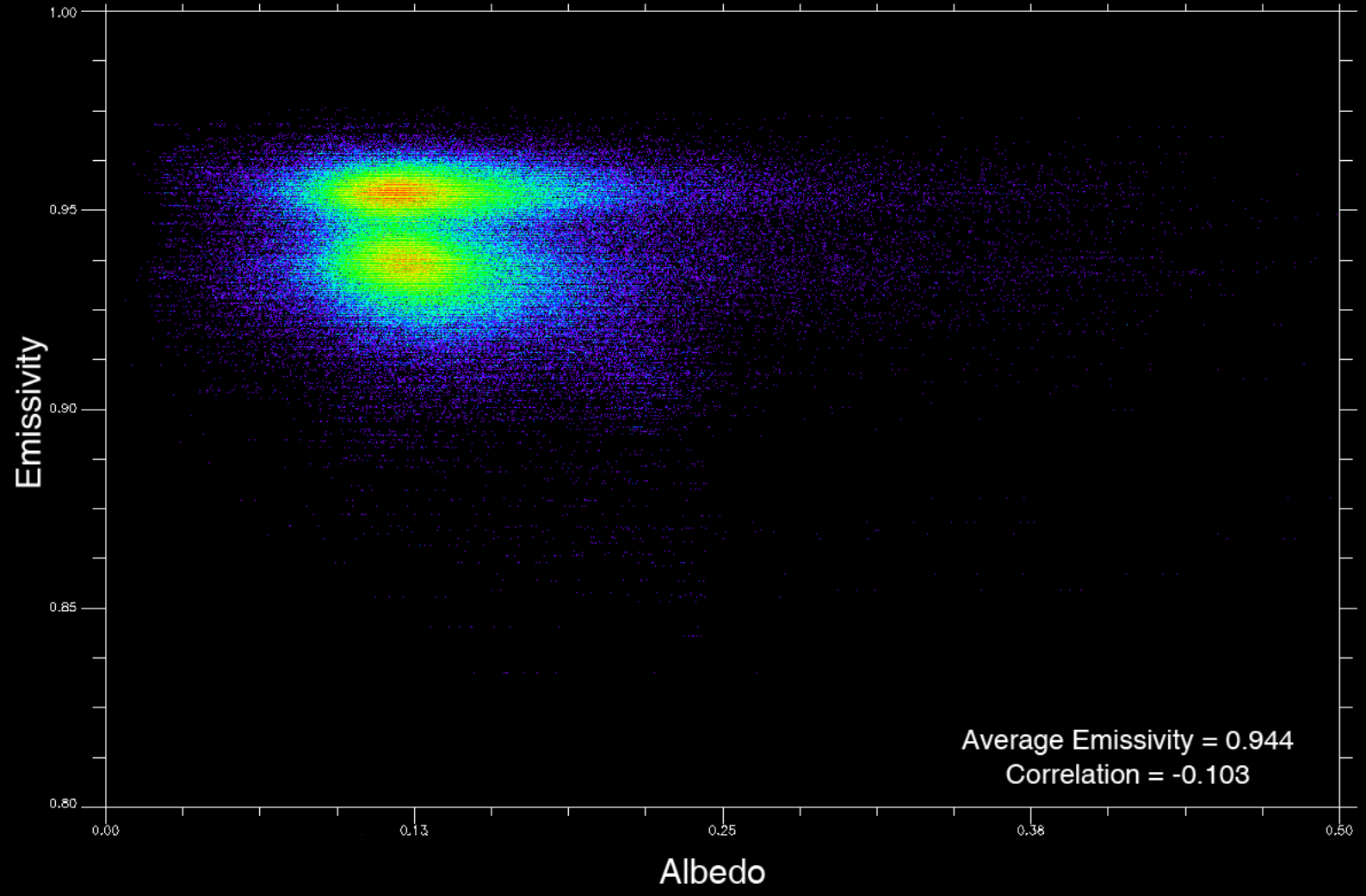
Temp. Change



Emissivity and NDVI



Emissivity and Albedo



Conclusion

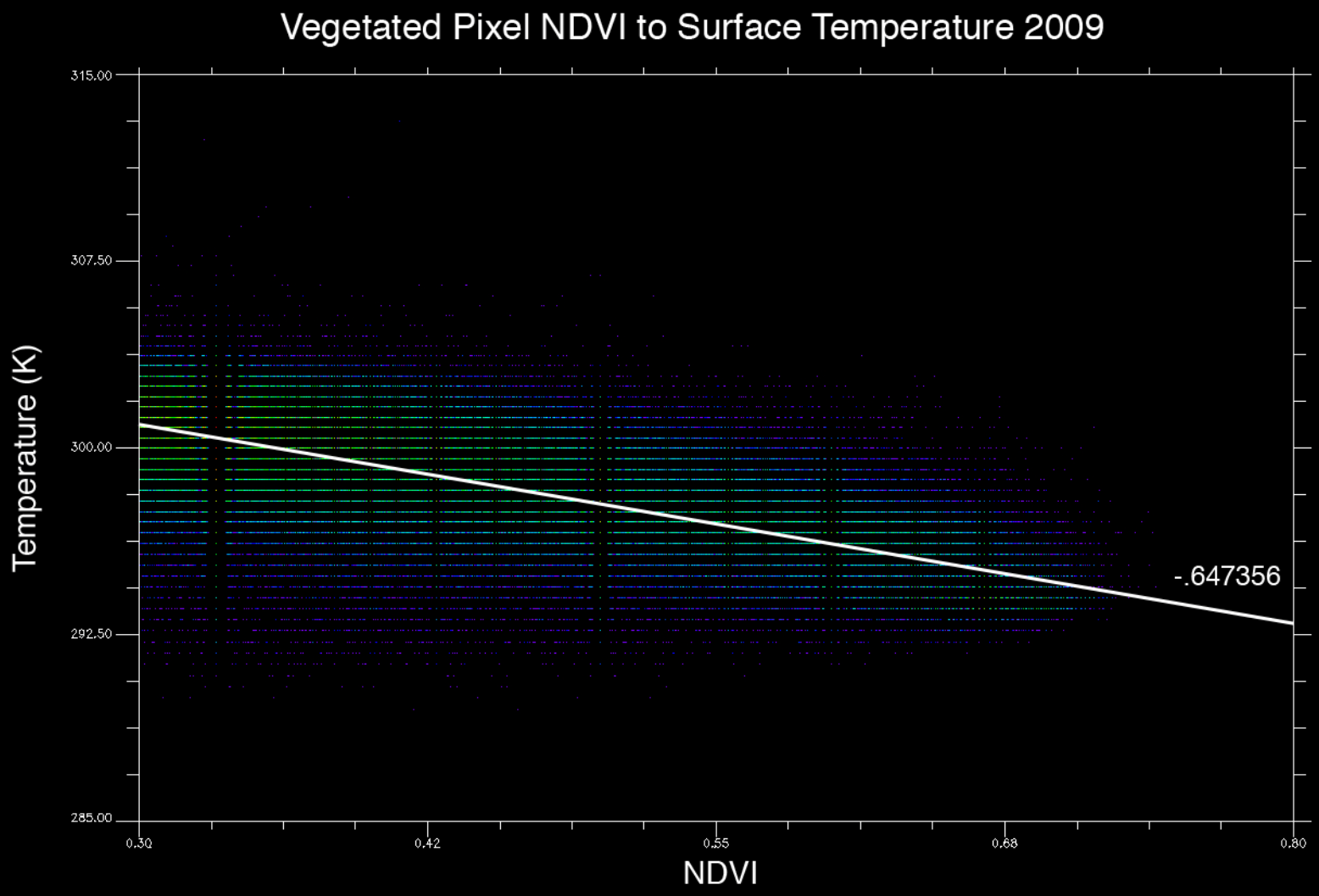
These emissivity observations are something that should be taken into account and they likely affected the results in small ways. However, they do not seem significant enough to completely undermine the aforementioned results.

Would the Results of this Study Still Hold True in a Heat Wave?

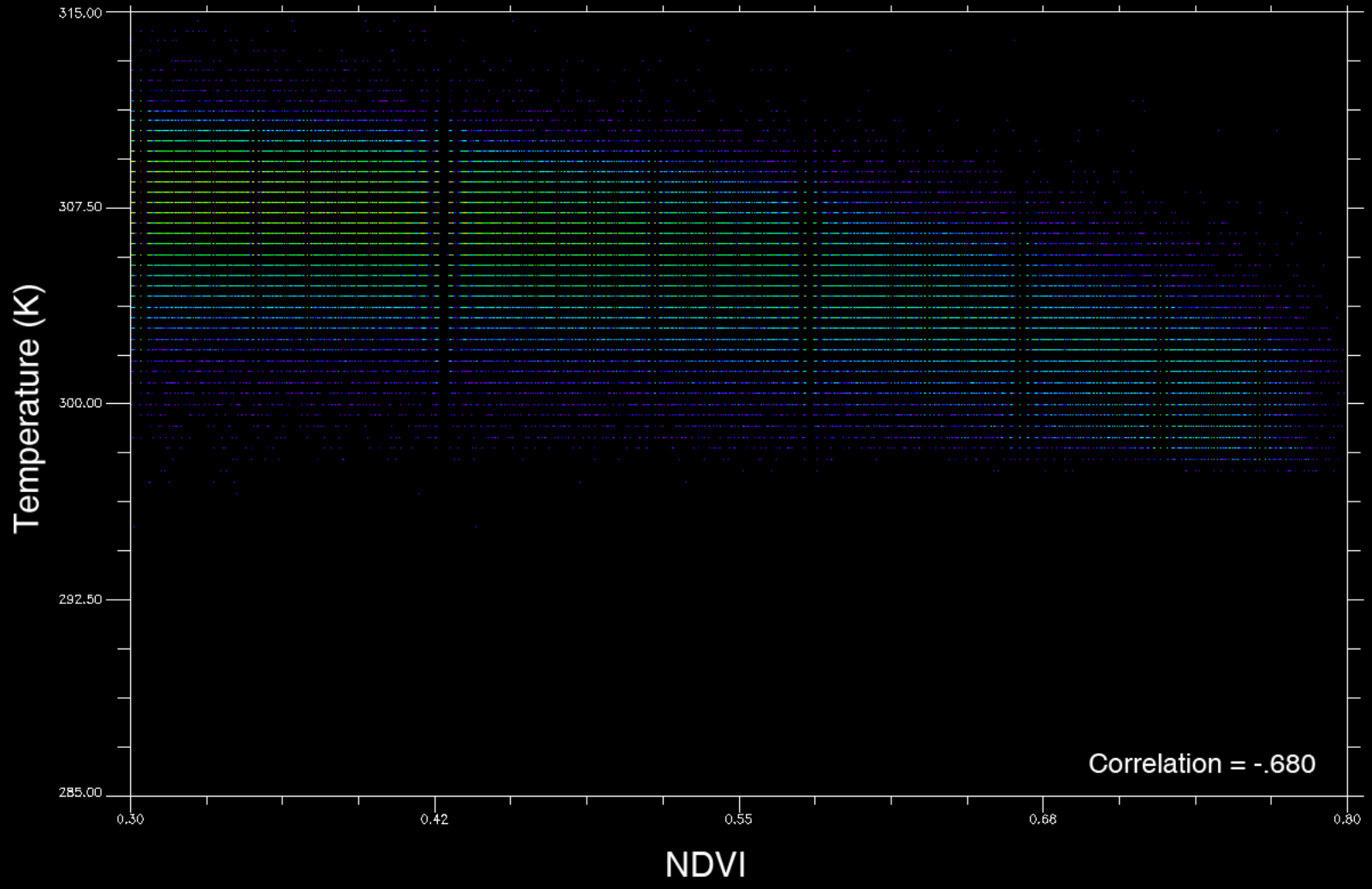
Would higher temperatures and broader leaves increase evapotranspiration above the influence of highly reflective surfaces?

Test image: August 3rd 2007 (Daily Air Temp of 80 degrees; Avg. Surface Temp of 307.0K)

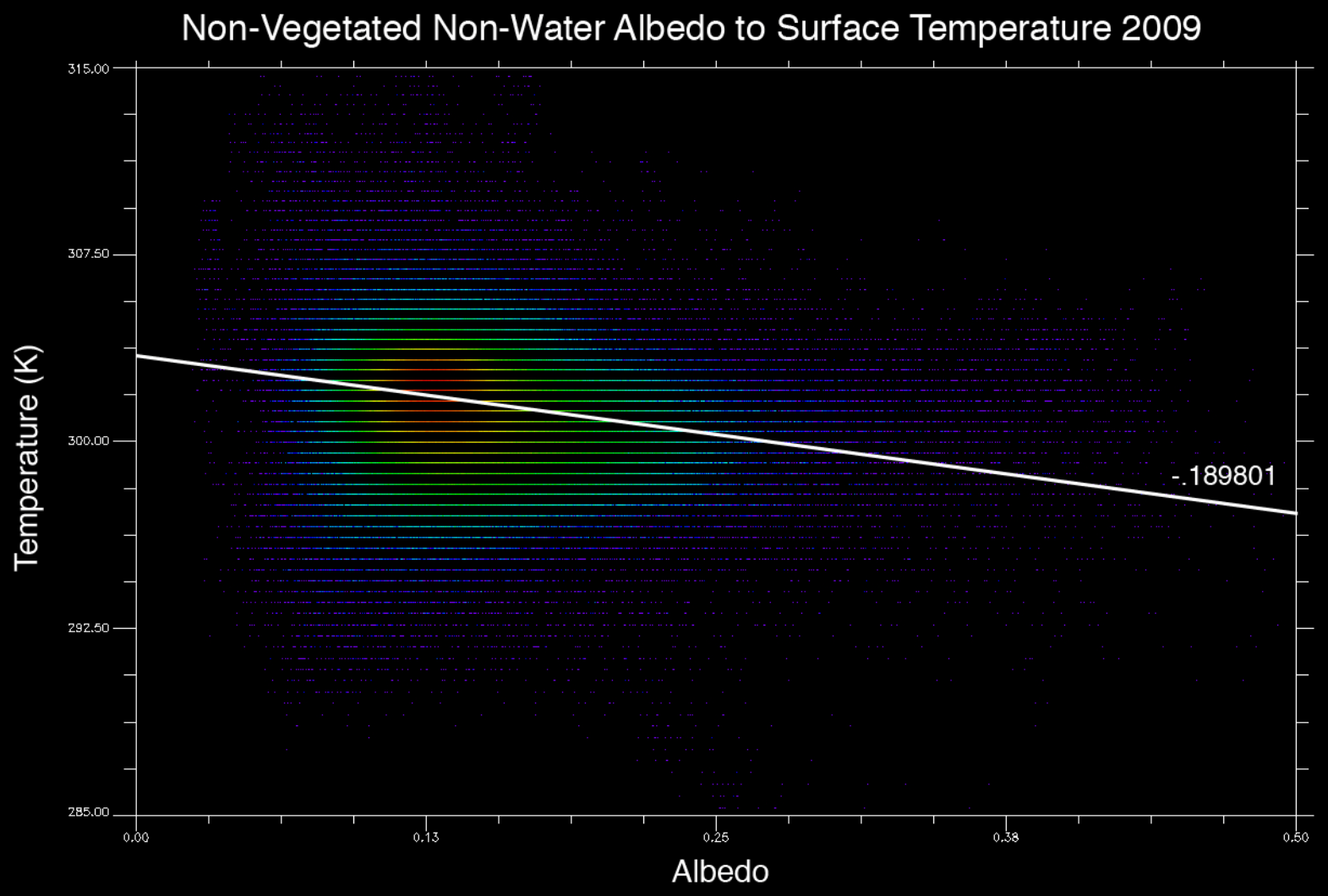
NDVI to Temperature Correlation



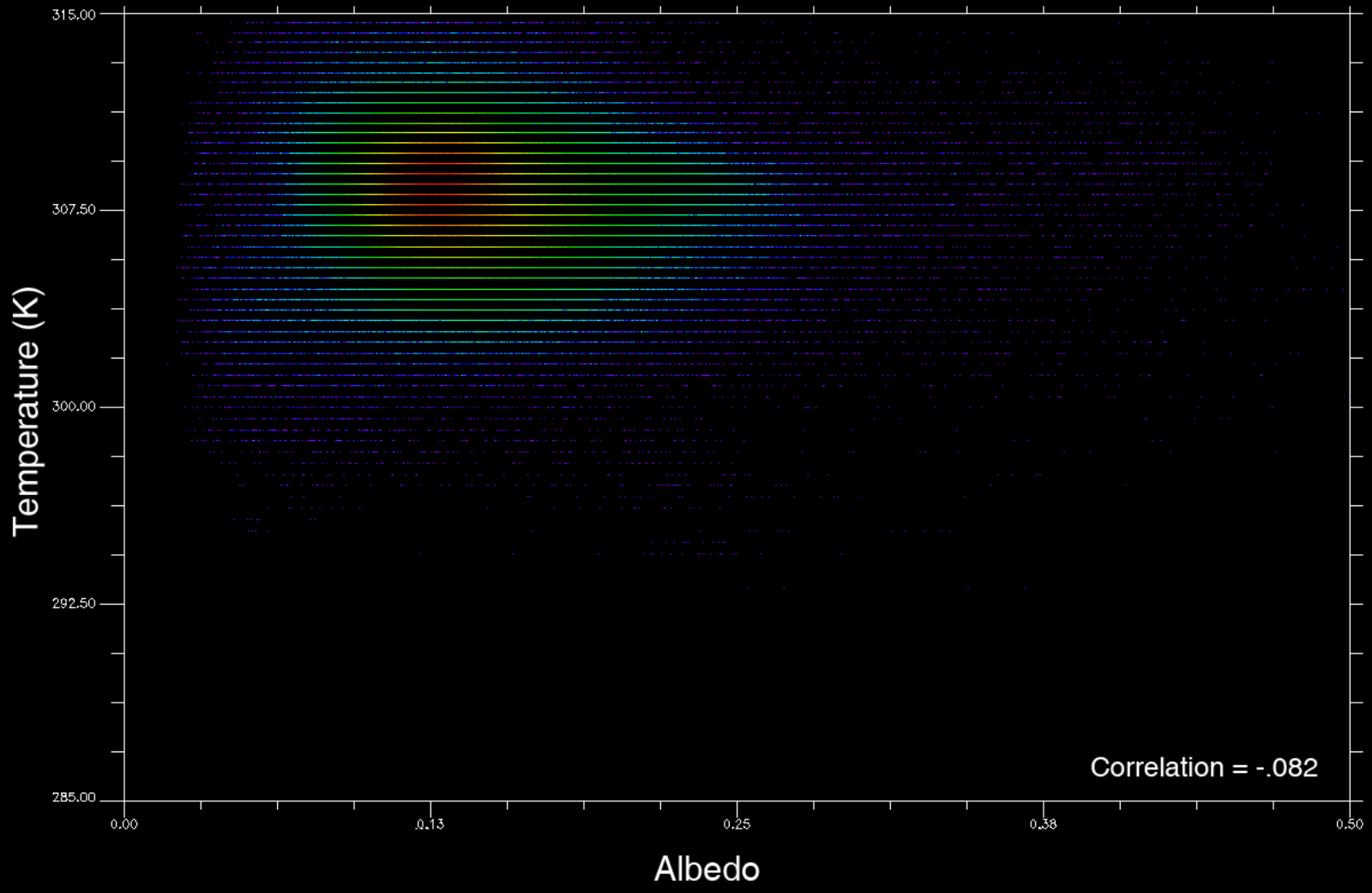
NDVI to Temperature in a Heat Wave



Albedo to Temperature Correlation



Albedo to Temperature in a Heat Wave



Conclusion

Considering the closeness of the correlations, it is probably safe to assume that we would see the same results in a heat wave as we do in the more moderate temperatures of the study.

The Nature of the LANDSAT Heat Island

We must accept the fact that satellite observation of heat islands tends to oversample surfaces that do not have as much of an impact on citizen thermal comfort (ie. roofs) and they undersample surfaces that have a large impact on citizen thermal comfort (ie. walls and the ground).

Thus, we should be careful in how we apply this data to specific ends.

Still, this does not change the results of the study itself. Nor does it change the fact that the reflective roofs performed better than can be expected in observation of single images.

Future Work

1) Spruce up the scatter plots into a more legible format.

2) Assemble the study into a written format.