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Thermal Observations of Urban Heat

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Overview

The purpose of the research is to observe and examine the variability of the thermal field around buildings. Previous research has shown that urban heating can increase building energy consumption for cooling and impact the general quality of life and public health in urban areas [1], leading to heat stress and an increase in mortality rates [2]. This study investigated the diurnal temperature changes of several buildings by measuring and comparing temperatures of different materials and building facings.

Methods

- A FLIR model A325 SC thermal camera was used.
- Spectral range of 7.5 μm to 13 μm. 18mm lens with a 25° viewing angle.
- FLIR ResearchIR program was used to gather and record the thermal images.
- A temperature sample is shown in Figure 1. The data were collected for all four sides of Cramer Research Hall.

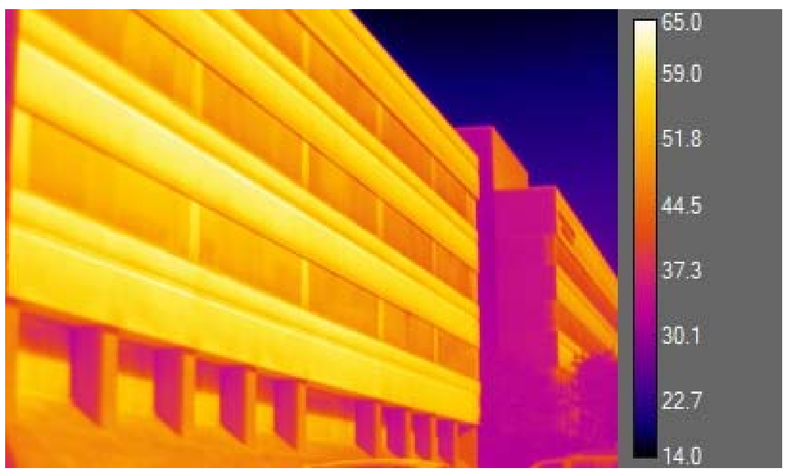

Image 1. IR image comparing the east facing side of Cramer Hall with a South facing wall.

- Brightness temperature changes were collected throughout the day at half hour intervals of four buildings in the same apartment complex composed of the same materials but facing different directions.

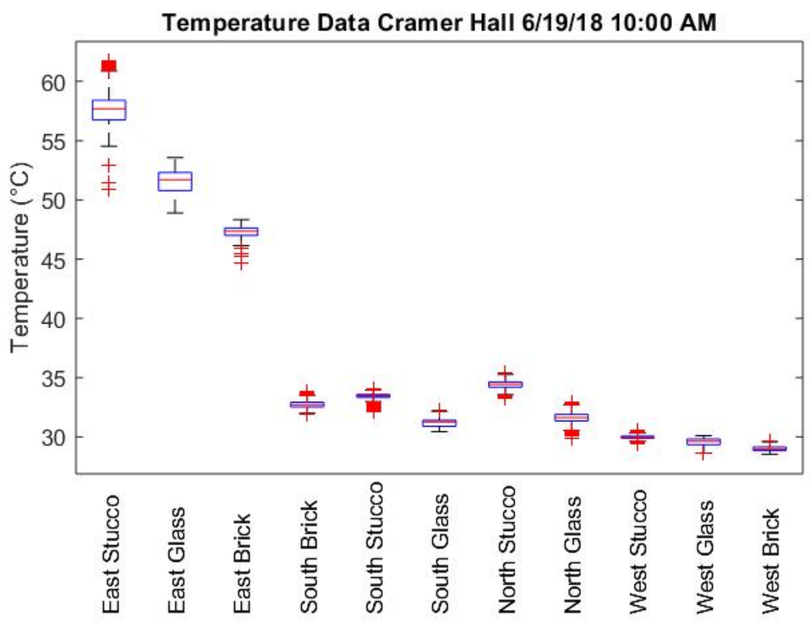

Figure 1. Temperature data for materials on all sides of Cramer Hall. The air temperature when the data was collected was approximately 29 °C

Results

- The stucco/plaster surfaces had the highest temperatures on all sides of the building (e.g. Figures 1).
- Stucco has a very high reflectance of 80%, likely leading to the very high temperature brightness especially compared to a reflectance of 20% for red brick.

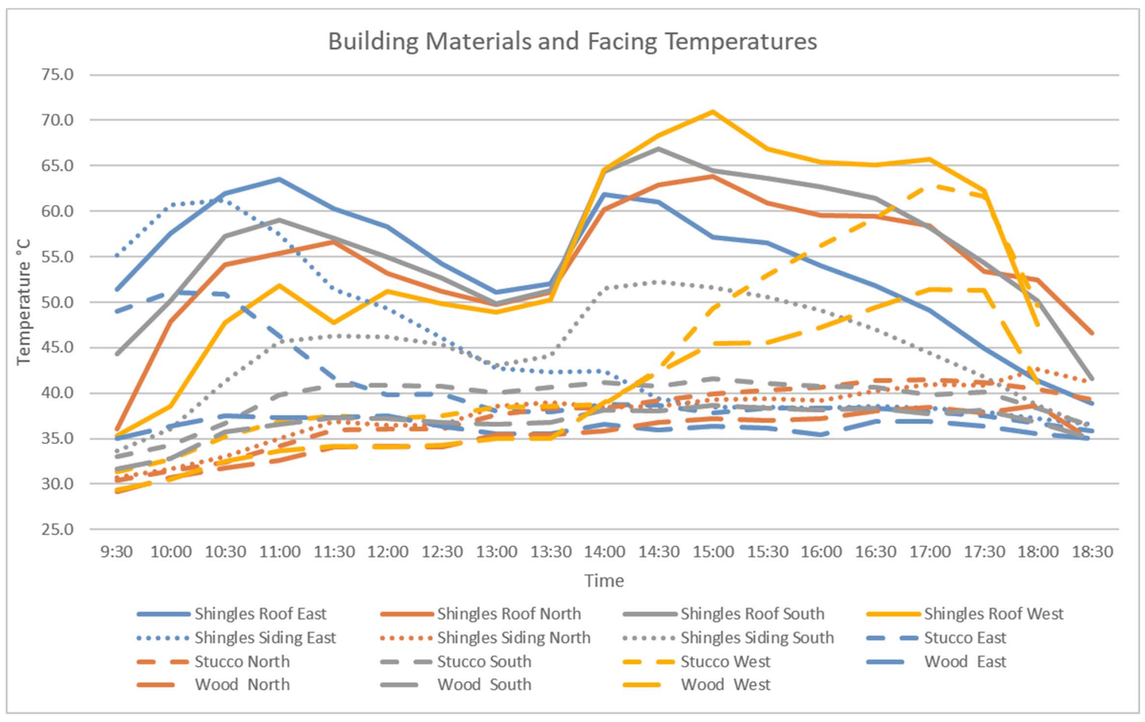

Figure 2. Diurnal Average Temperatures for Different Materials and Building Sides
(7/19/2018)

- The roof shingles of all four buildings exhibited the same trend in temperature change despite an average 10° C difference in minimum and maximum temperature.
- The dip in roof temperature on all buildings around midday coincided with a dip in air temperature and increased cloud cover.
- Wood surfaces had very little change with the exception of West facing wood surfaces.
- East facing stucco and shingles siding reached very high temperatures very early, but cooled off quickly and remained at low temperatures.
- West facing surfaces had the most rapid rate of cooling.

Conclusions

Based on their high temperatures throughout the day, shingles are most likely to have the highest impact on the local microclimate as well as indoor building heating. Shingles on the roof remained at high temperatures throughout the day regardless of facing. This is due to the roof's higher sky view factor. Stucco likely also has a large impact as it reached high temperatures. However, based on the heating and cooling trends, this impact is likely limited to the east side in the morning and the west in the evening due to the relatively fast heating and cooling.

References

1. Moonen et al. "Urban Physics: Effect of the micro-climate on comfort, health and energy demand." *Frontiers of Architectural* Research, 2012.
2. Jänicke et al. "Towards city-wide, building-resolving analysis of mean radiant temperature." *Urban Climate*, 2016 Vol 15. pp 83 – 98.

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