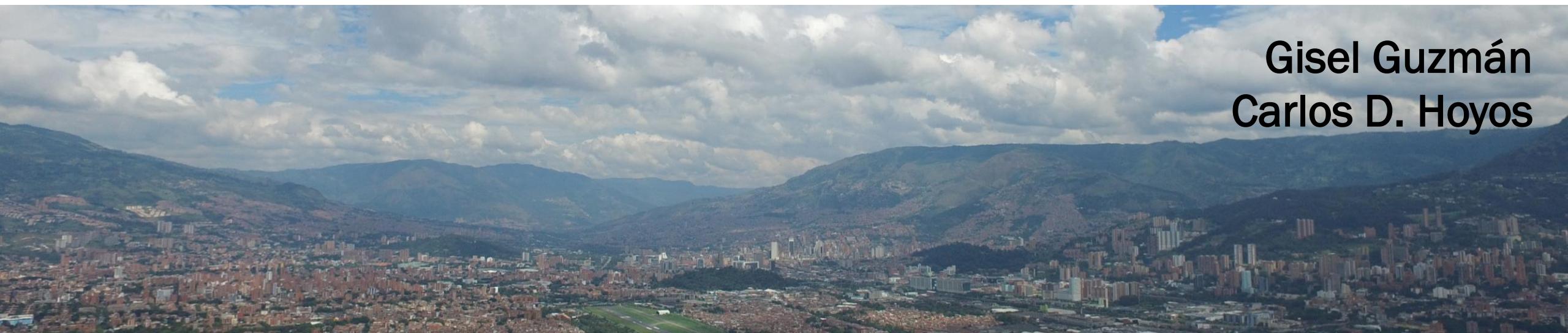


# Associating Land Surface Temperature Retrieved From Satellite and Unmanned Aerial Vehicle Data With Urban Cover and Topography in Aburrá Valley



Gisel Guzmán  
Carlos D. Hoyos



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DE COLOMBIA



Con el apoyo de:

epm® ISAGEN



Un proyecto de:

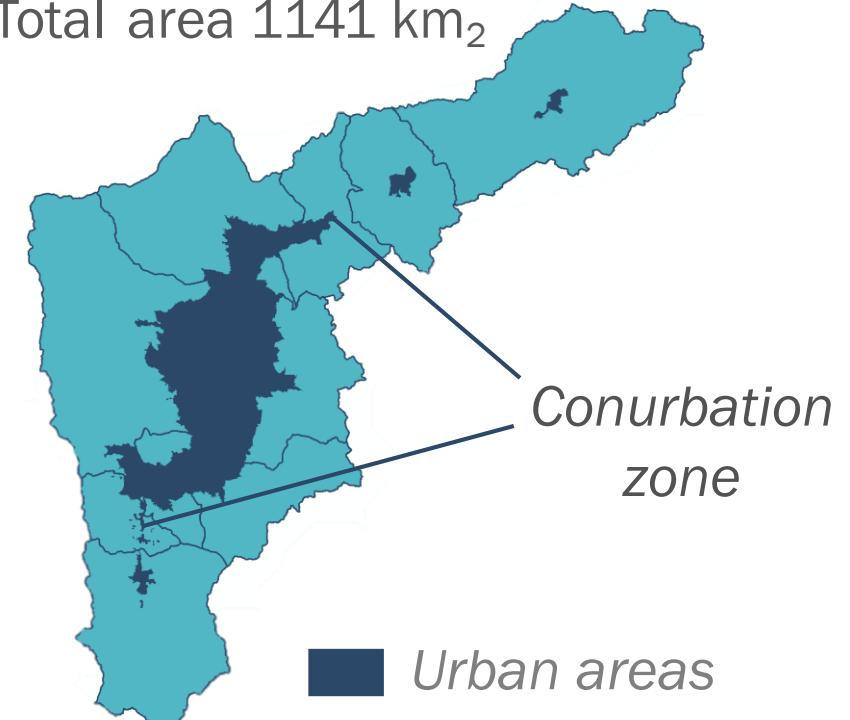


Alcaldía de Medellín

# Aburrá Valley - Colombia



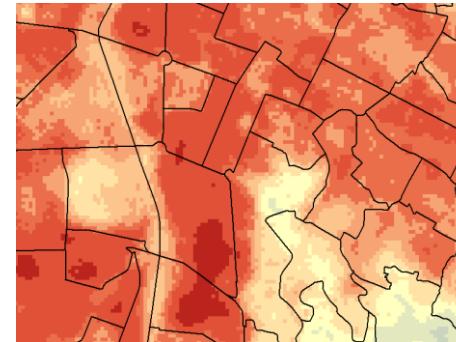
Total area 1141 km<sub>2</sub>



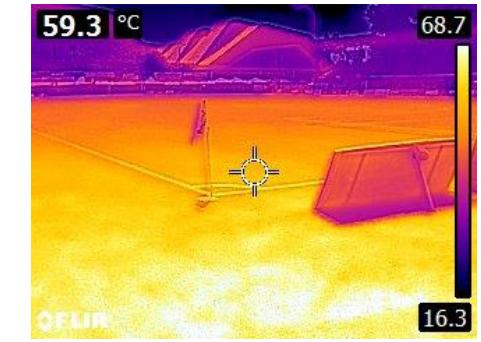
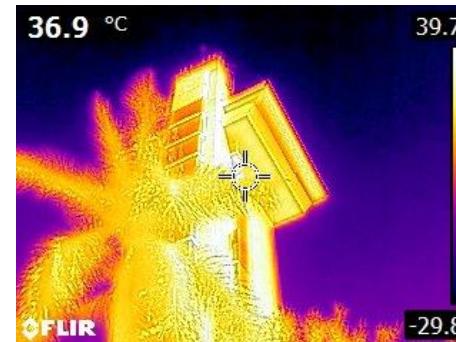
- Elevation ranges from 1300 to 2800 meters above sea level.
- Around 30 % of its area belong to urban zones.
- 3.8 million of people live there (95 % in urban areas)

## Motivation:

### *Impacts of urbanization on local meteorology – Urban Heat Island*



Local scale: Neighborhoods



Micro-scale: Individual materials



## *Data and methods*



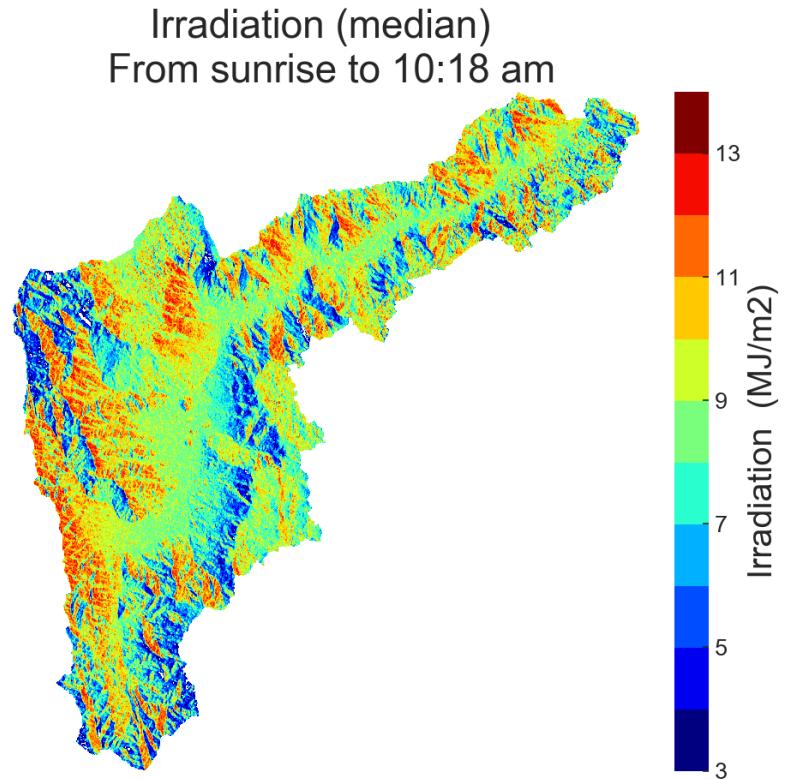
Land Surface Temperature (LST)



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## LST at local scale – Satellite data

- LST Composite with eight cloud-free **Landsat 8** images, obtained with a Single-channel Algorithm (Jimenez-Muñoz and Sobrino, 2004; Jimenez-Munoz et al. 2014).
- LST Composite with LST data of **MODIS** (Terra – day) data from 2013 – 2016.



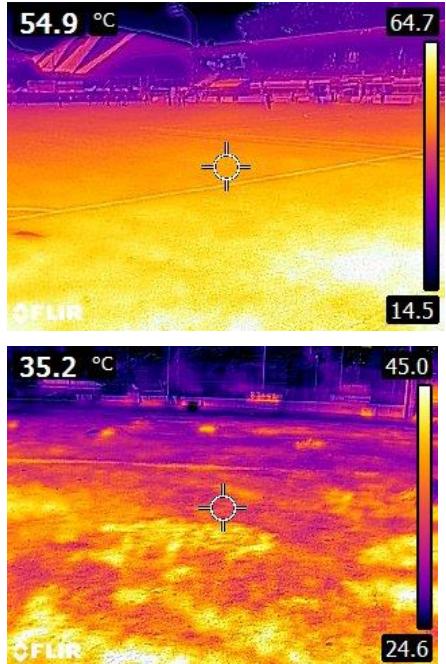
*Both satellites cross Aburrá Valley in the morning.*



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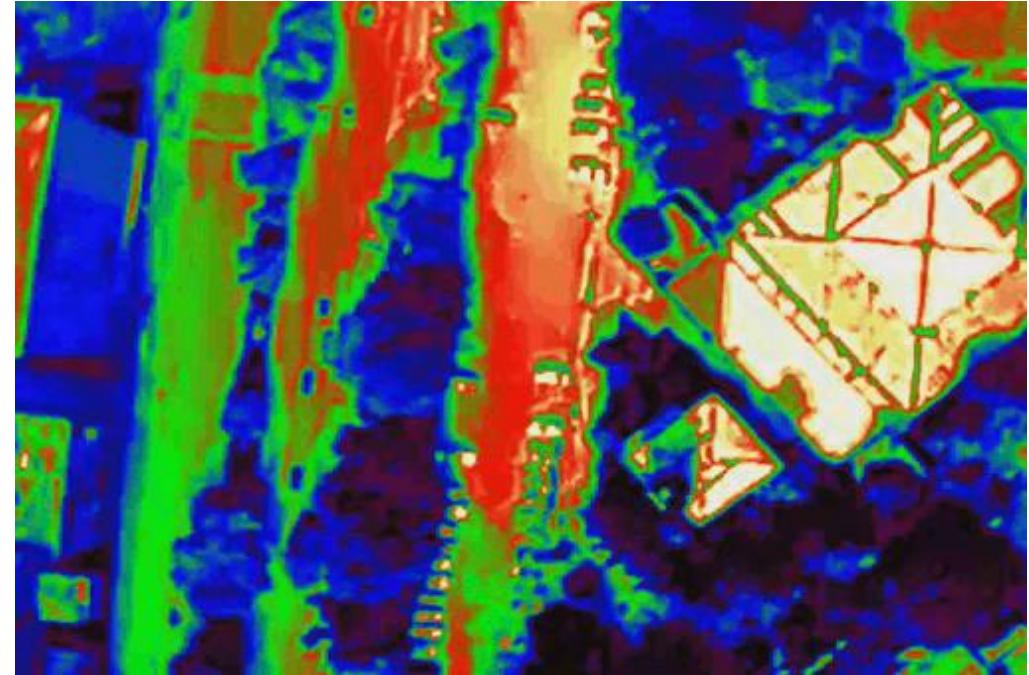
# LST at micro scale

## *Point measurements campaign:*



- FLIR E5 thermal camera
- Weather station with pyranometer

## *Flights campaign: (High resolution LST images)*



- FLIR Zenmuse XT-R
- Weather station with pyranometer





## *Results: Local scale*

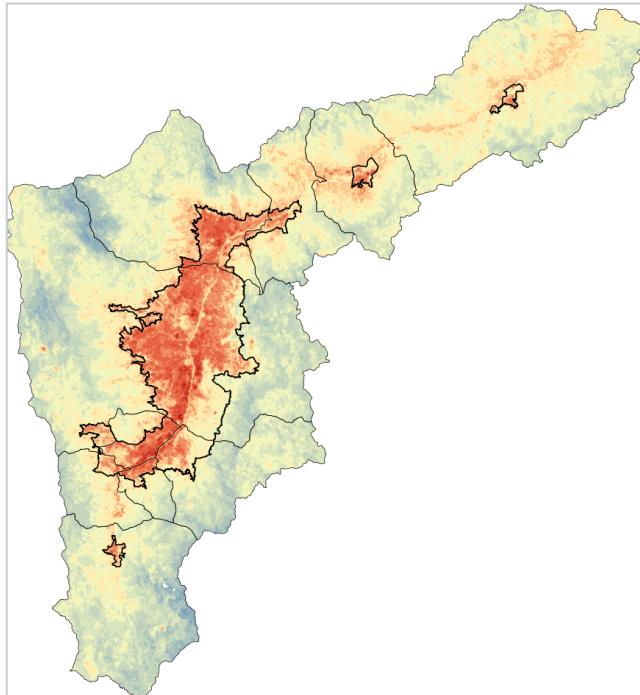
Analysis by neighborhoods



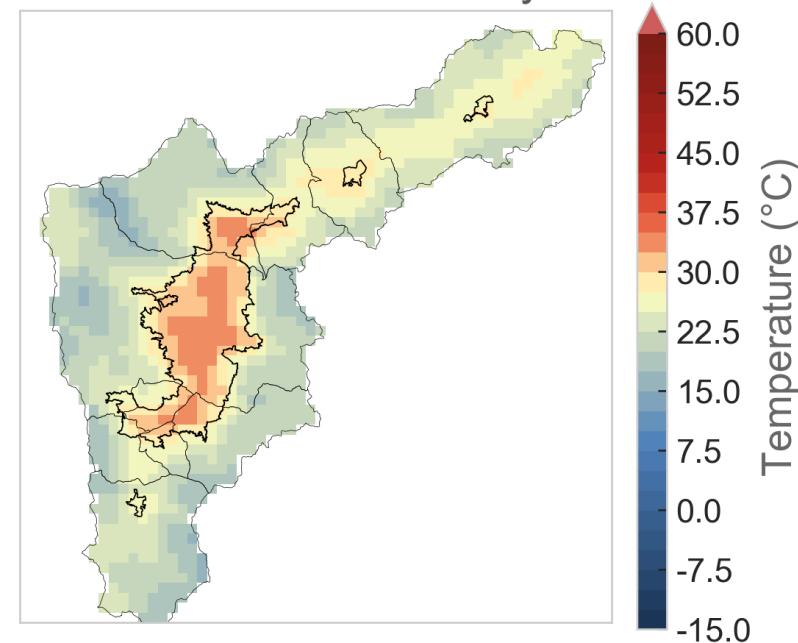
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# Local scale – Urban vs rural areas

Composite by median  
Landsat 8 (Aprox. 10:18 am)

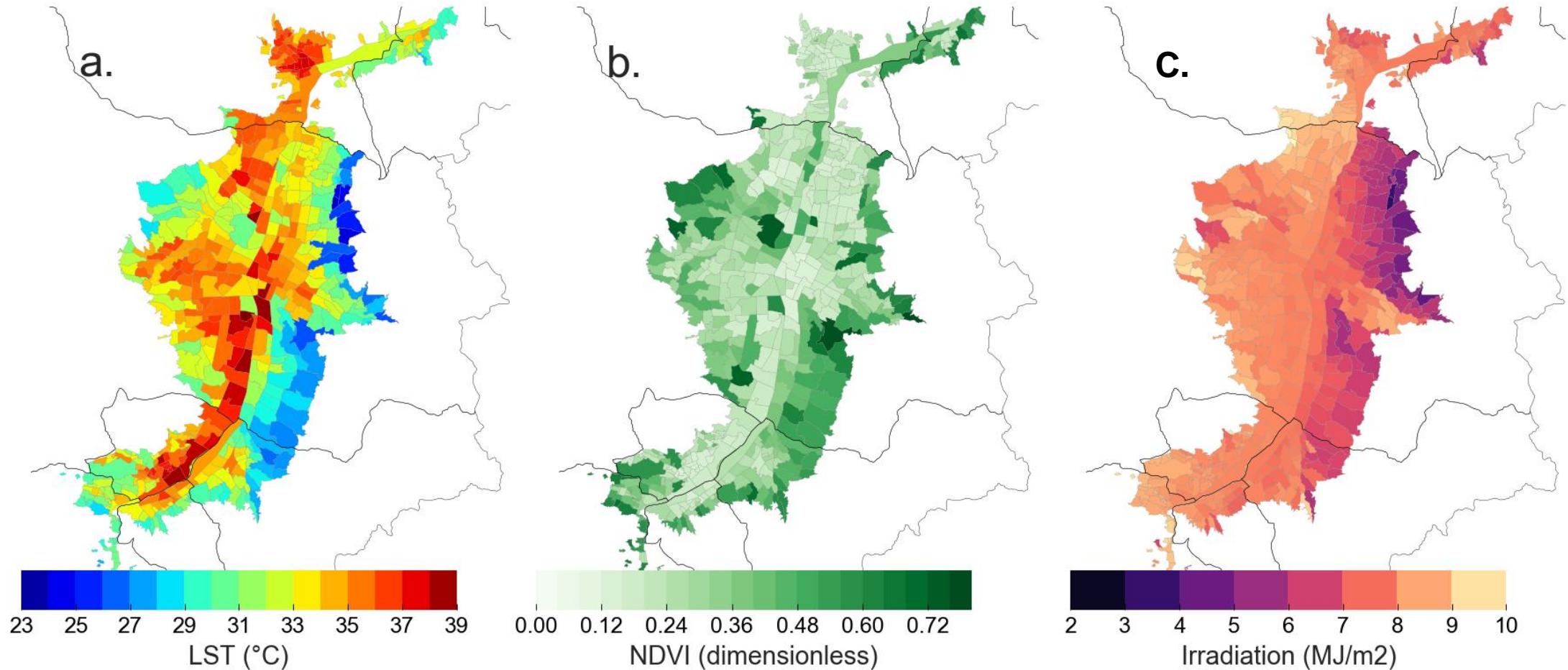


Composite by median since 2013  
MODIS-TERRA Day



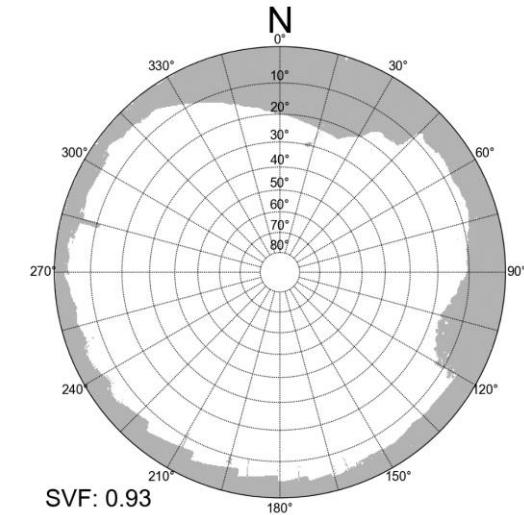
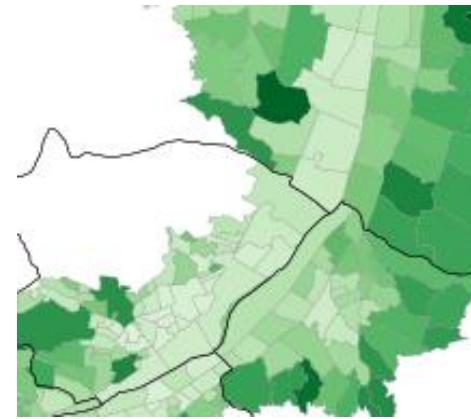
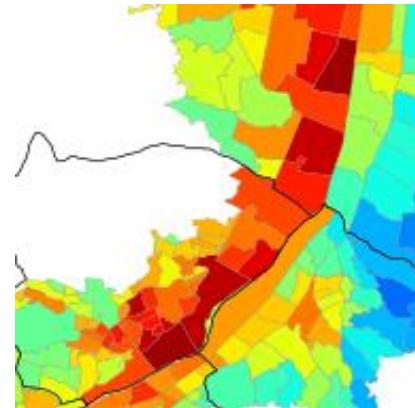
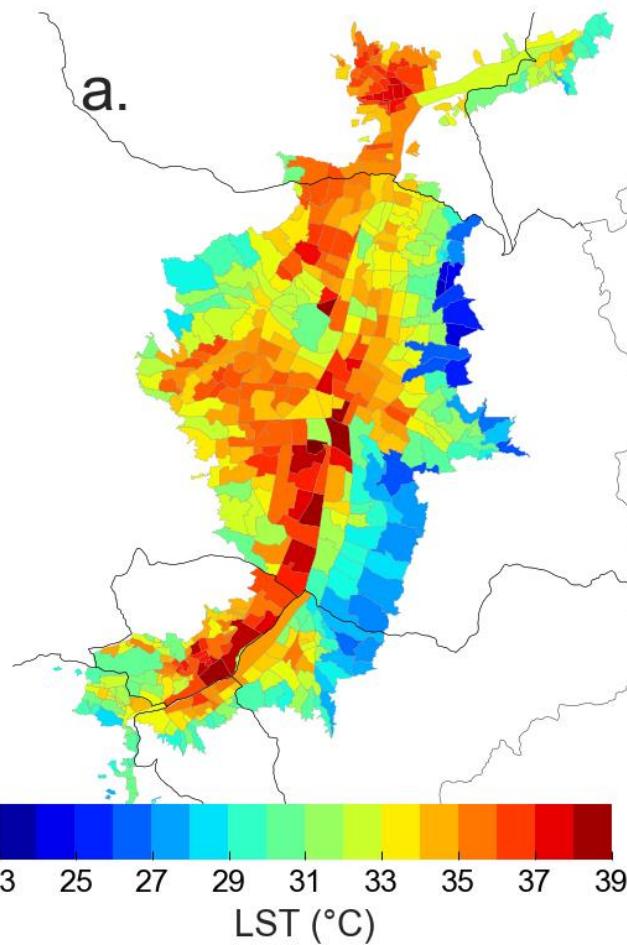
Increase in both datasets of greater than 30% of urban areas LST regarding rural ones.

## Local scale – Neighborhoods median



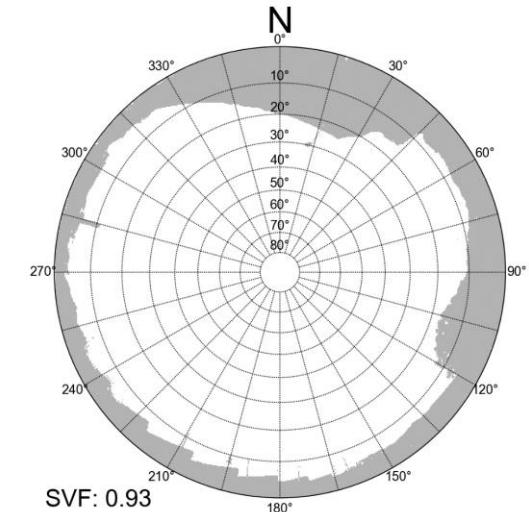
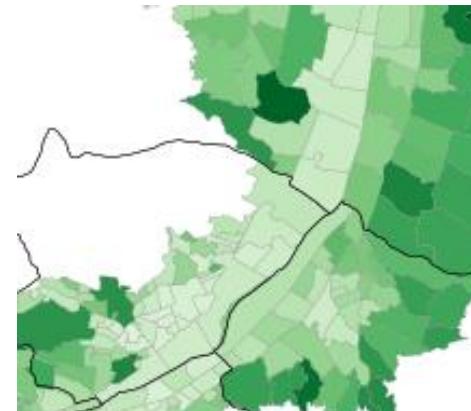
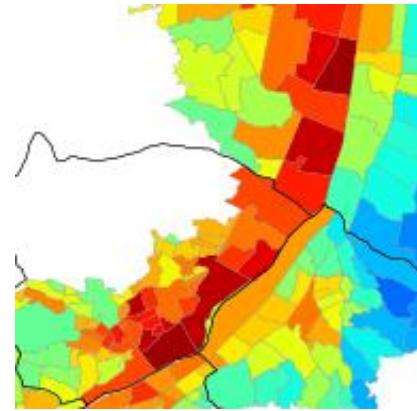
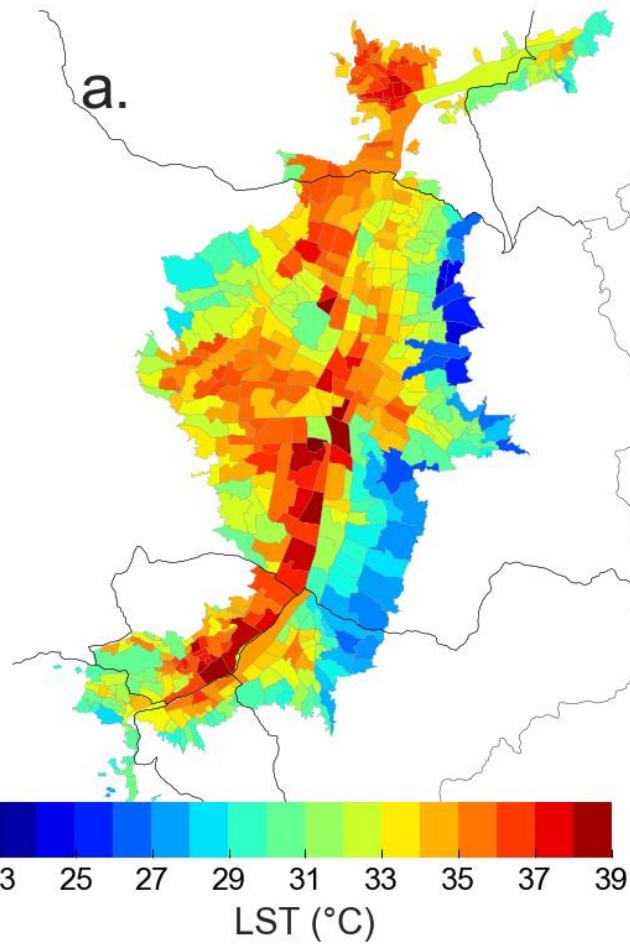
Neighborhoods are taken as basic area of analysis to intraurban variability

## Local scale – Case 1. Warmest Neighborhoods



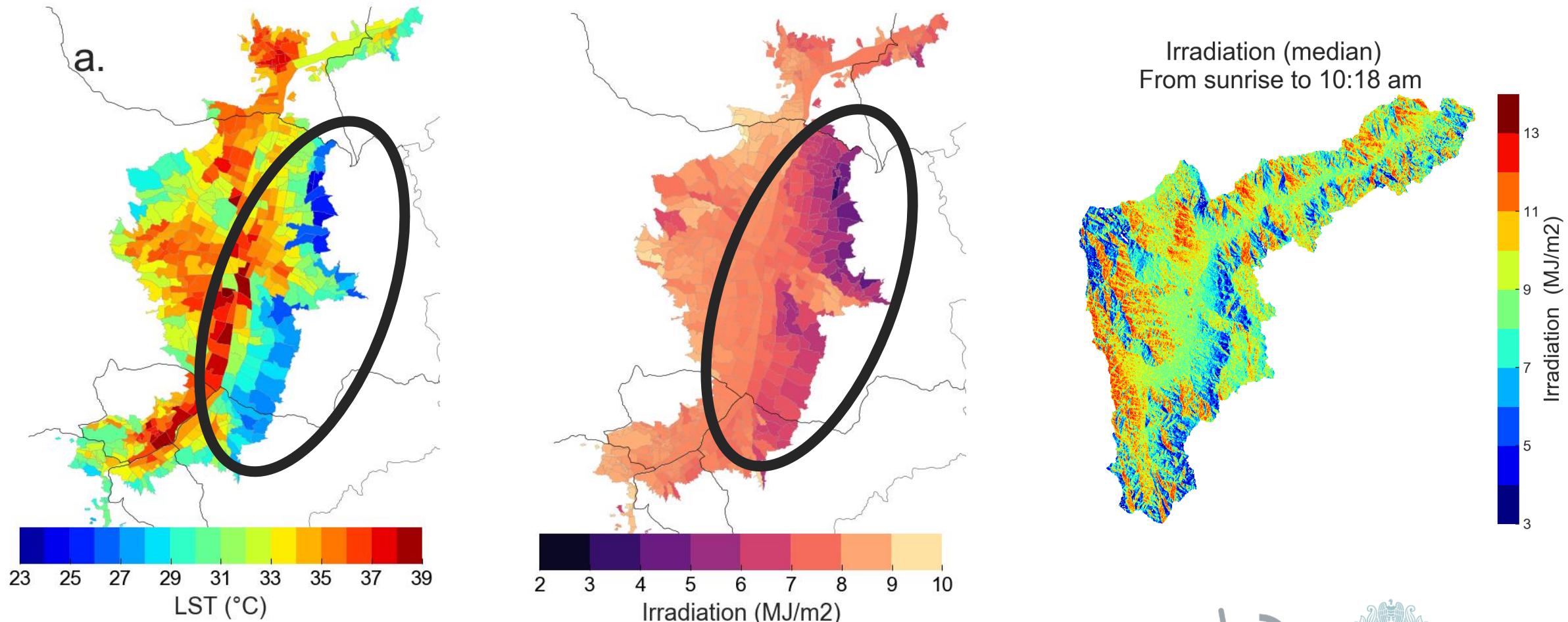
High sky view factor, low vegetation, large buildings, buildings with few stories

## Local scale – Case 1. Warmest Neighborhoods



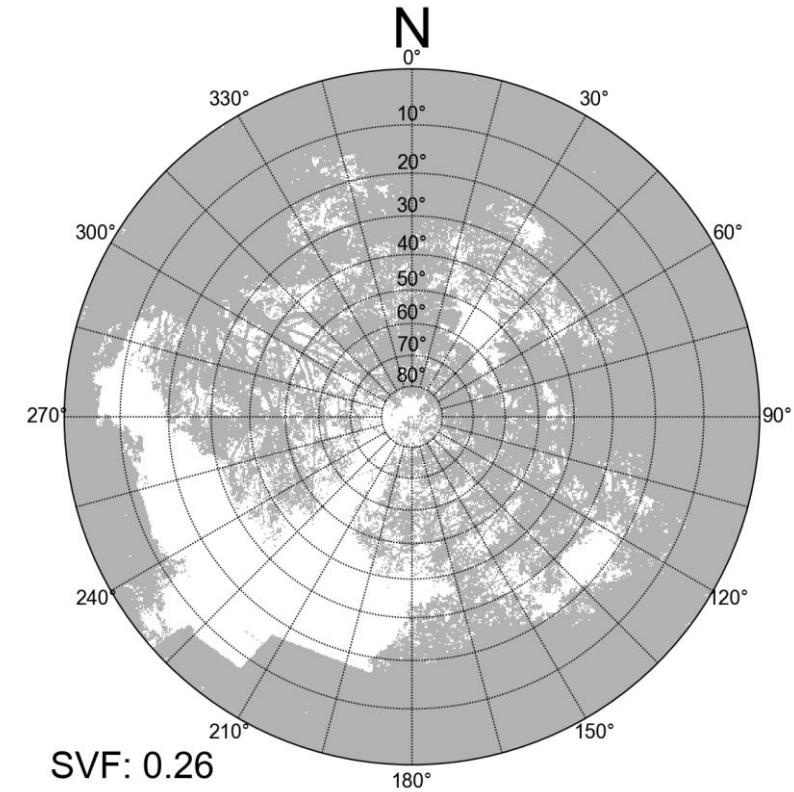
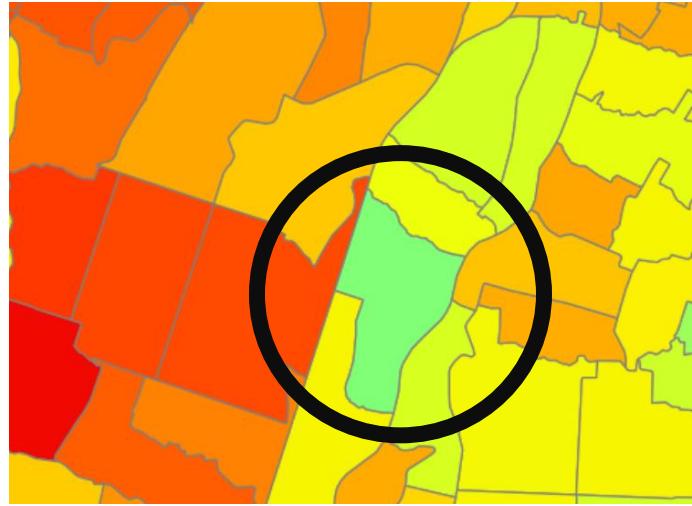
High sky view factor, low vegetation, large buildings, buildings with few stories

## Local scale – Case 2. Coldest Neighborhoods



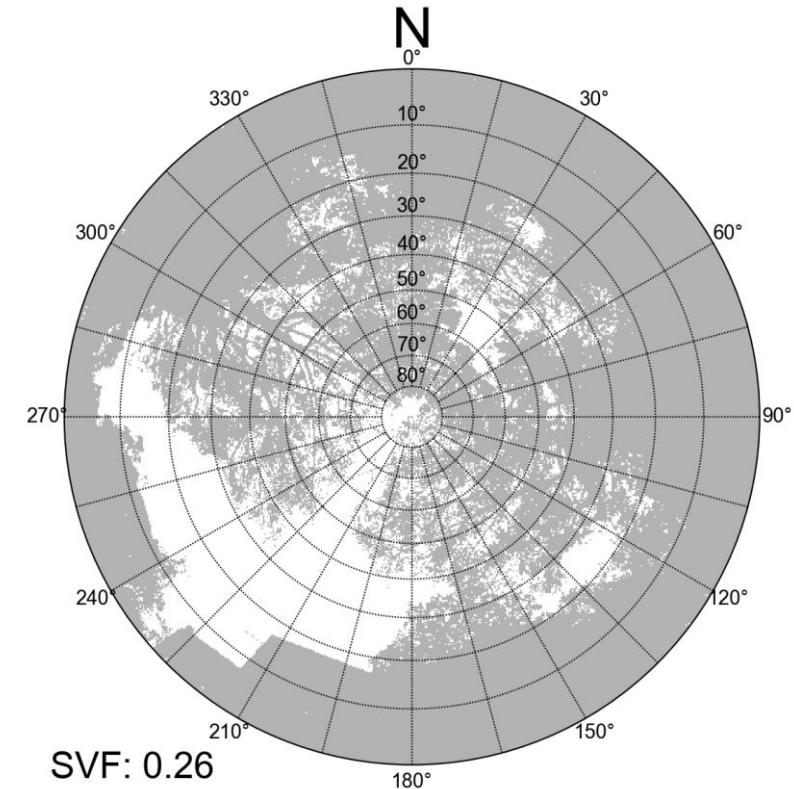
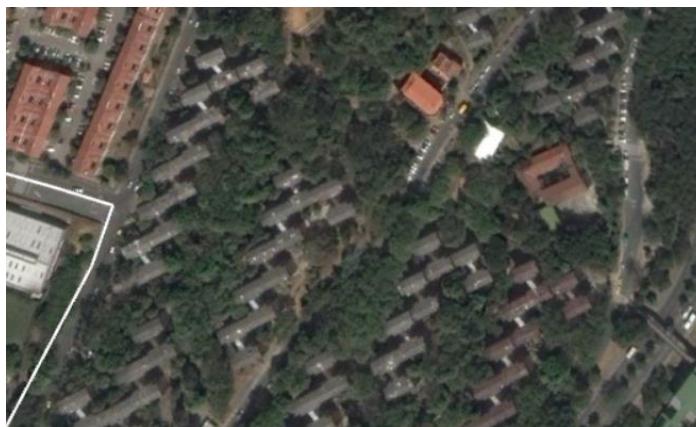
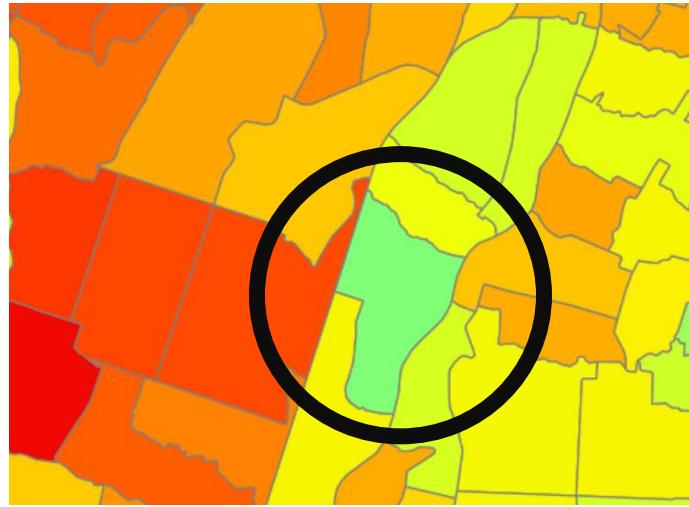
East hill-slopes received a less radiation.

## Local scale - Case 3. Neighborhoods with high vegetation



These neighborhoods are fresher than its surroundings

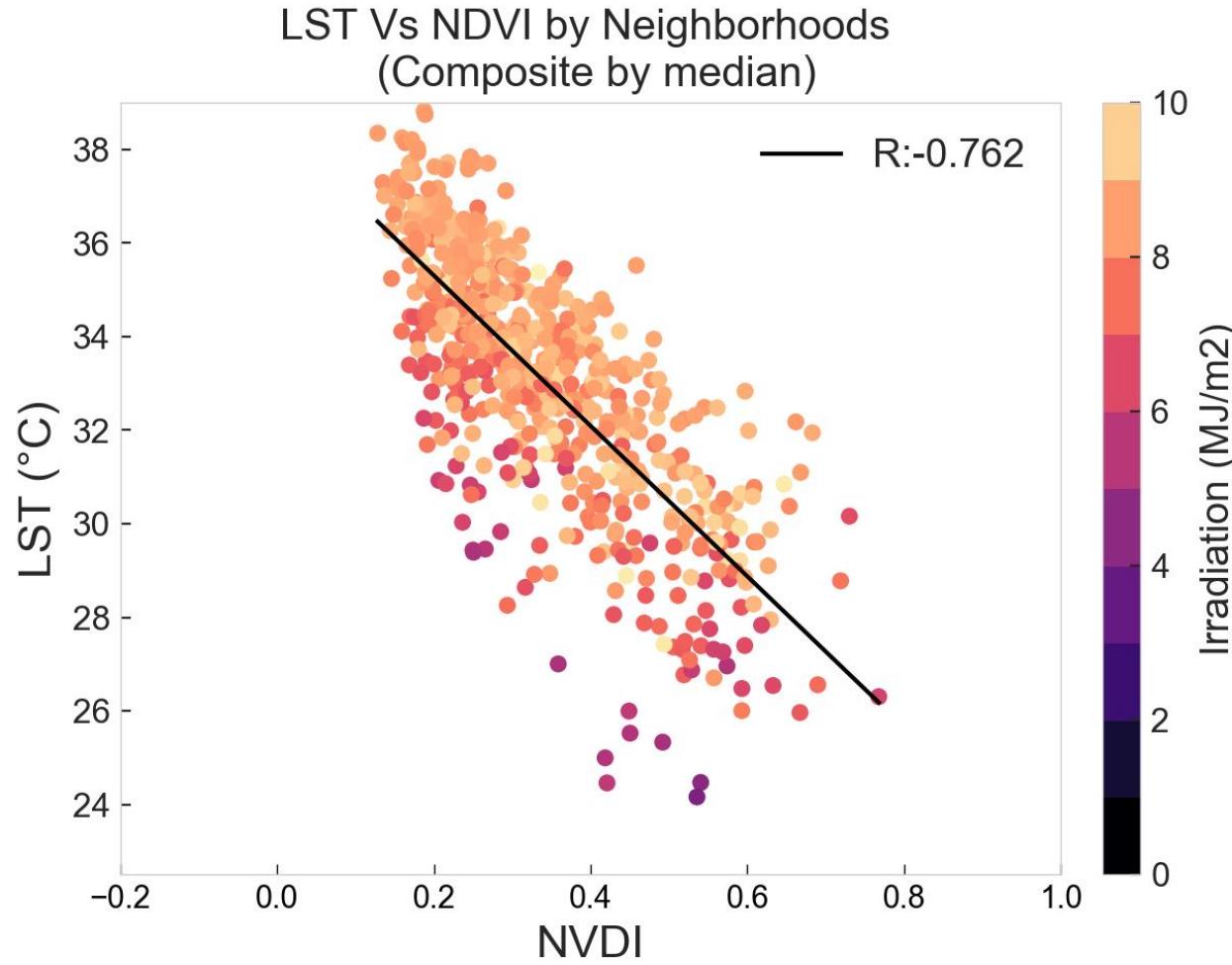
## Local scale - Case 3. Neighborhoods with high vegetation



These neighborhoods are fresher than its surroundings

## Local Scale – *NDVI, potential radiation and LST*

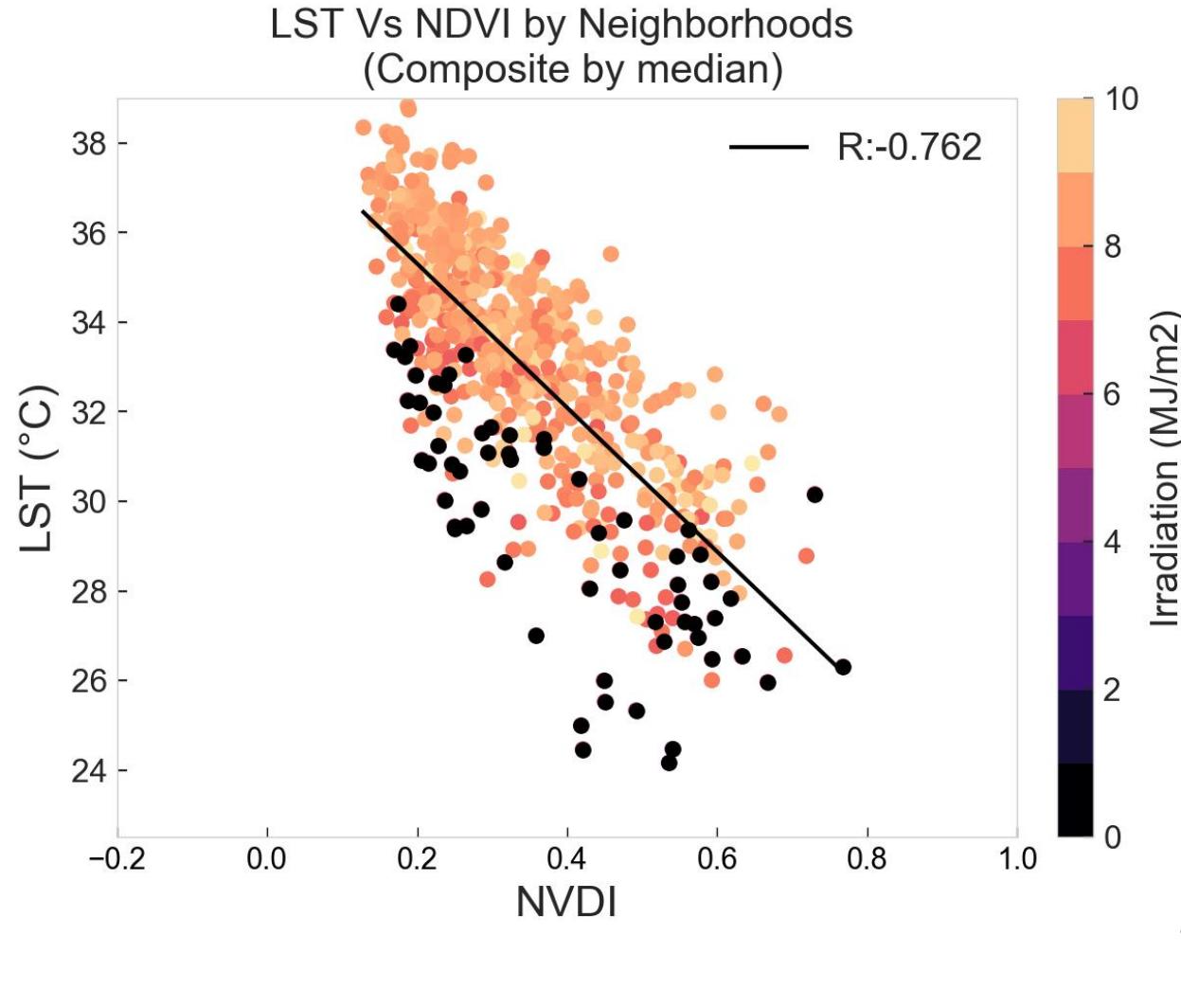
Vegetation  
diminish surface  
temperatures.



There is a high  
linear correlation  
between the  
amount of  
vegetation  
and LST in  
neighborhoods.

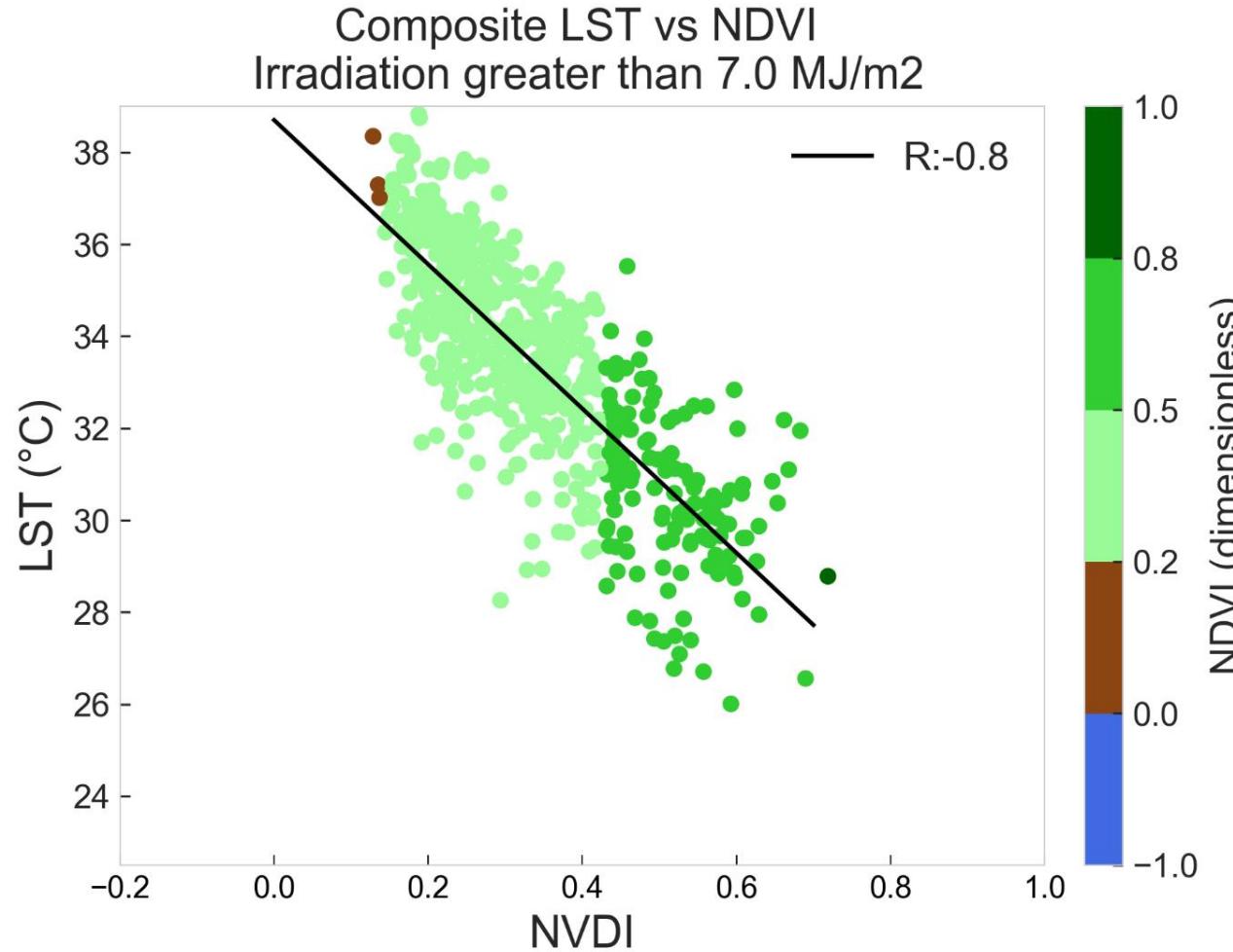
## Local Scale – *NDVI, potential radiation and LST*

Vegetation  
diminish surface  
temperatures.



## Local Scale – *NDVI, potential radiation and LST*

Vegetation  
diminish surface  
temperatures.



... and this  
relation is more  
evident when  
neighborhoods  
with  
corresponding  
low values of  
radiation are  
removed.



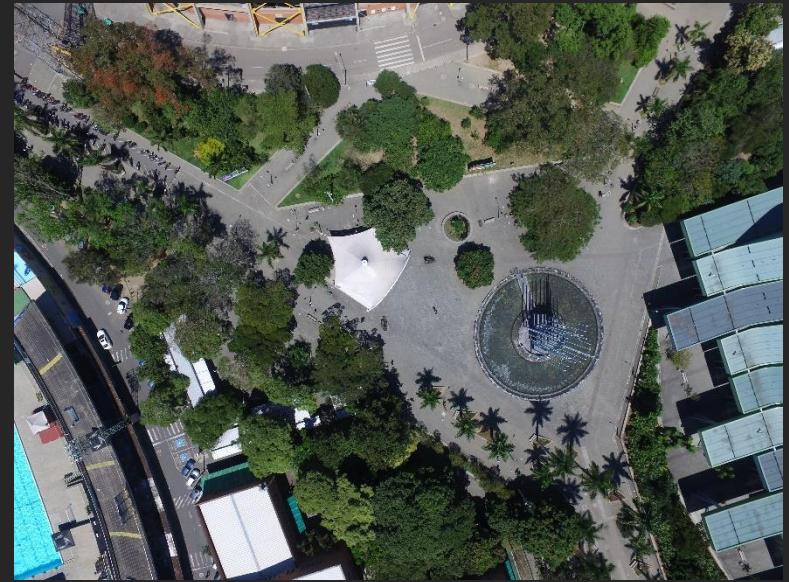
# Results: Micro-scale

## Case of study: Medellín Sport Complex

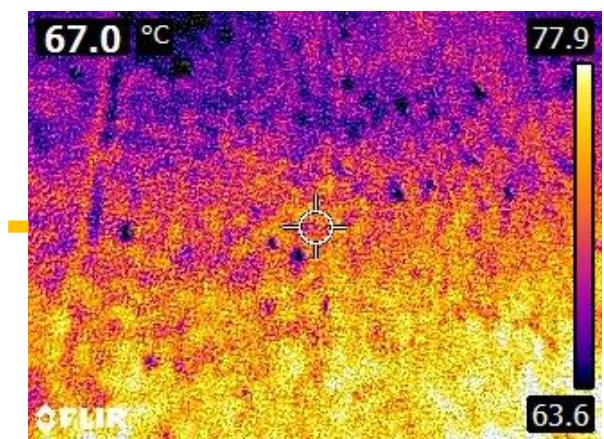
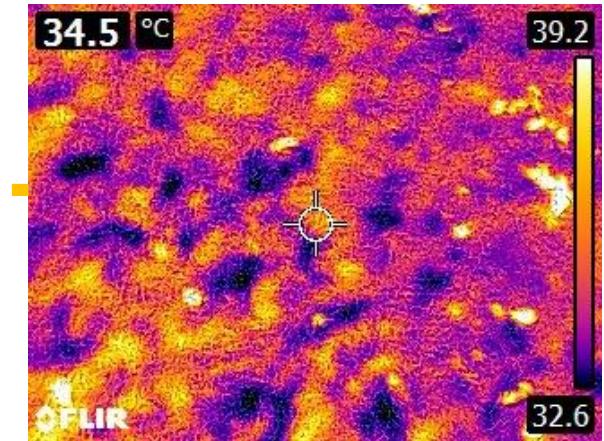


- Most used building materials in the region are together there.
- Also, there are vegetation and water elements.

*Case of study: Medellín Sport Complex*

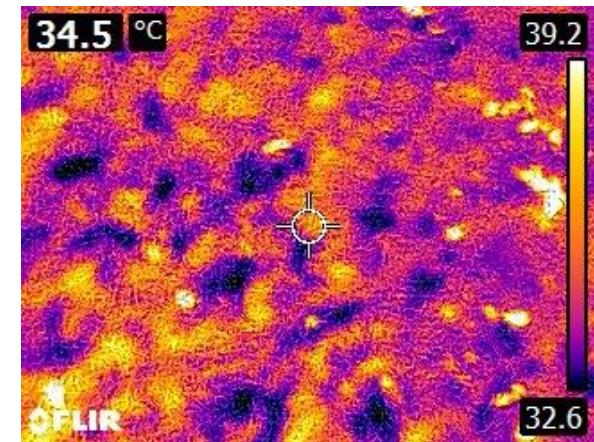
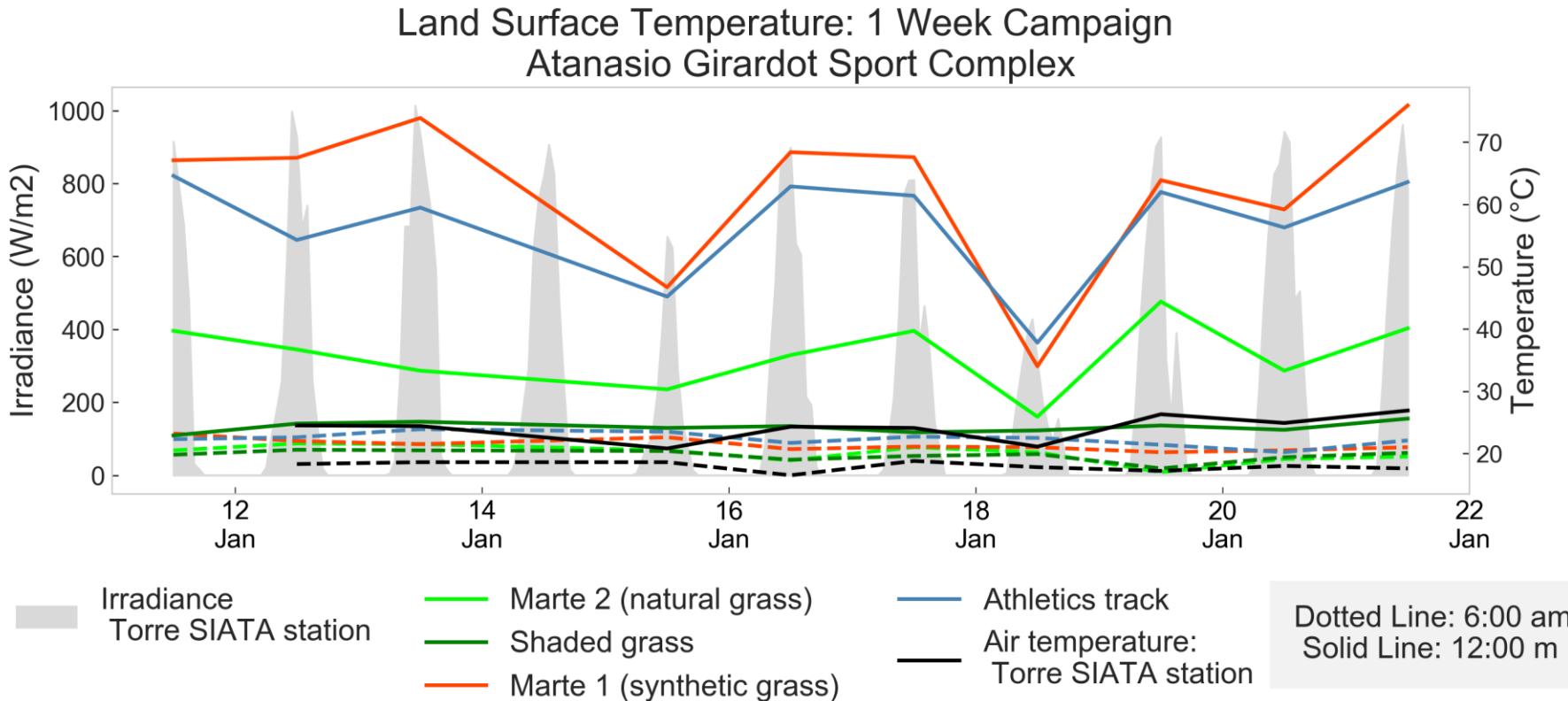


*Case of study: Medellín Sport Complex*

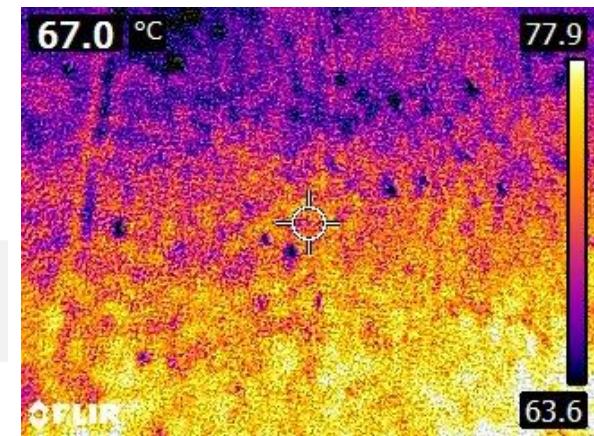


## Point measurement campaign

# In situ measurement campaign



Noon - Grass (direct sunlight)



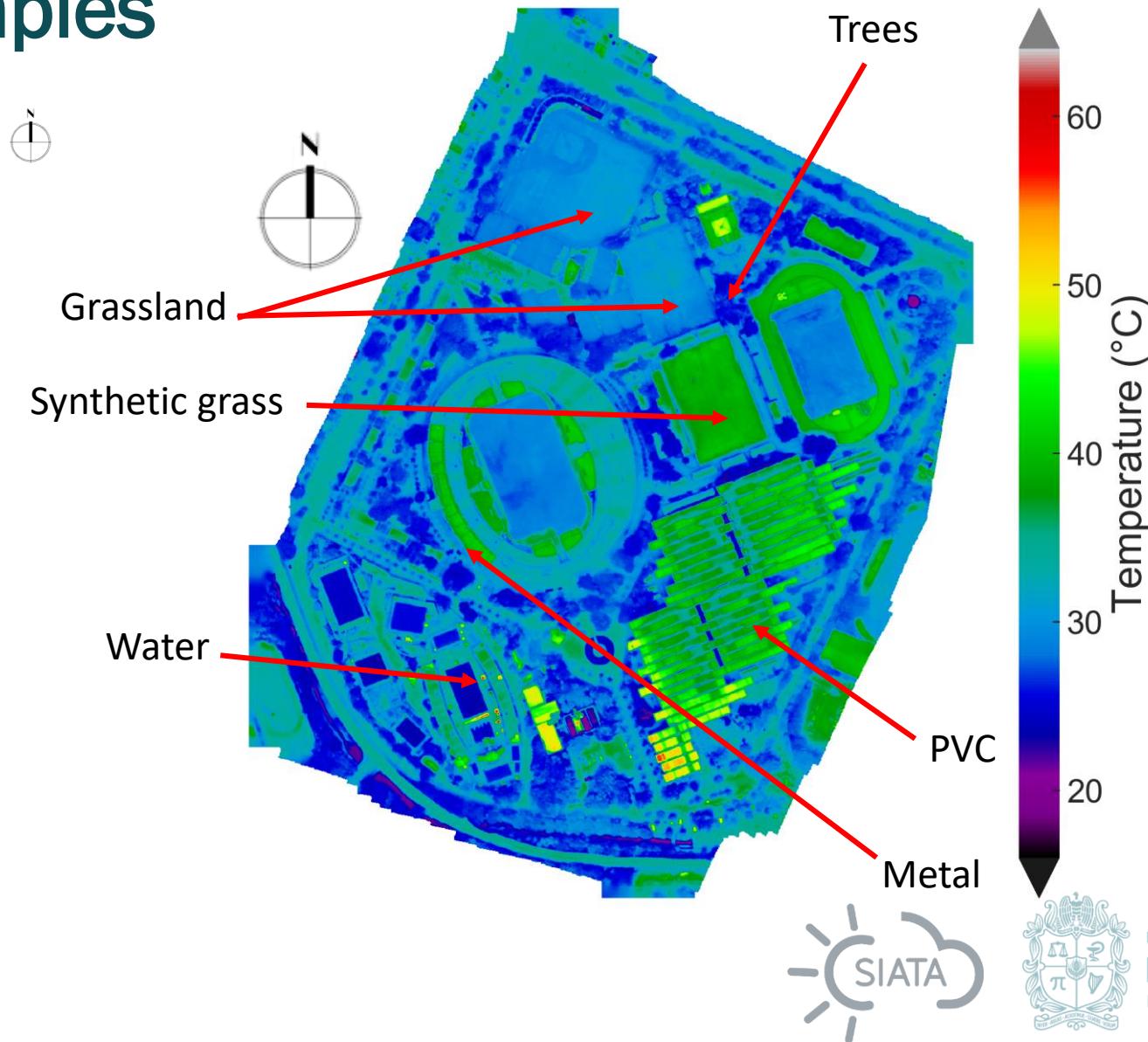
Noon - Polypropylene Grass

# UAV Flight - Examples



*Flight 014*

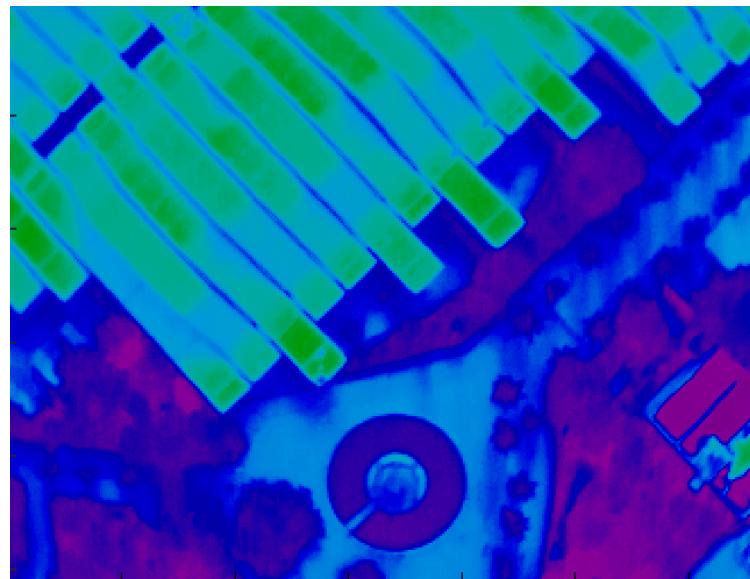
Conditions: noon – low radiation



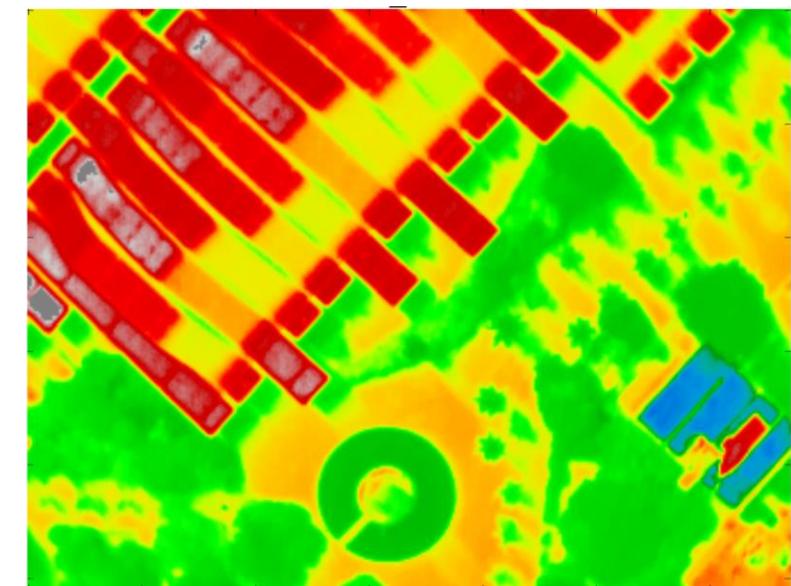
## UAV Flight - Examples



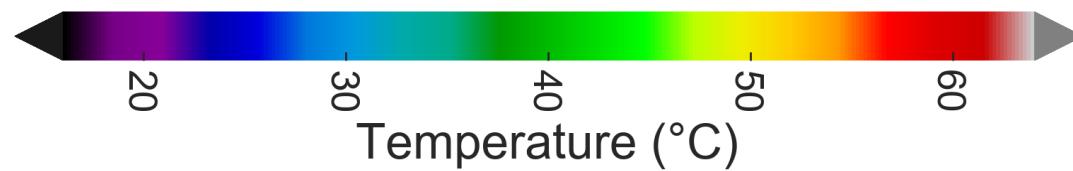
At sunrise



Low radiation (9:45 am)

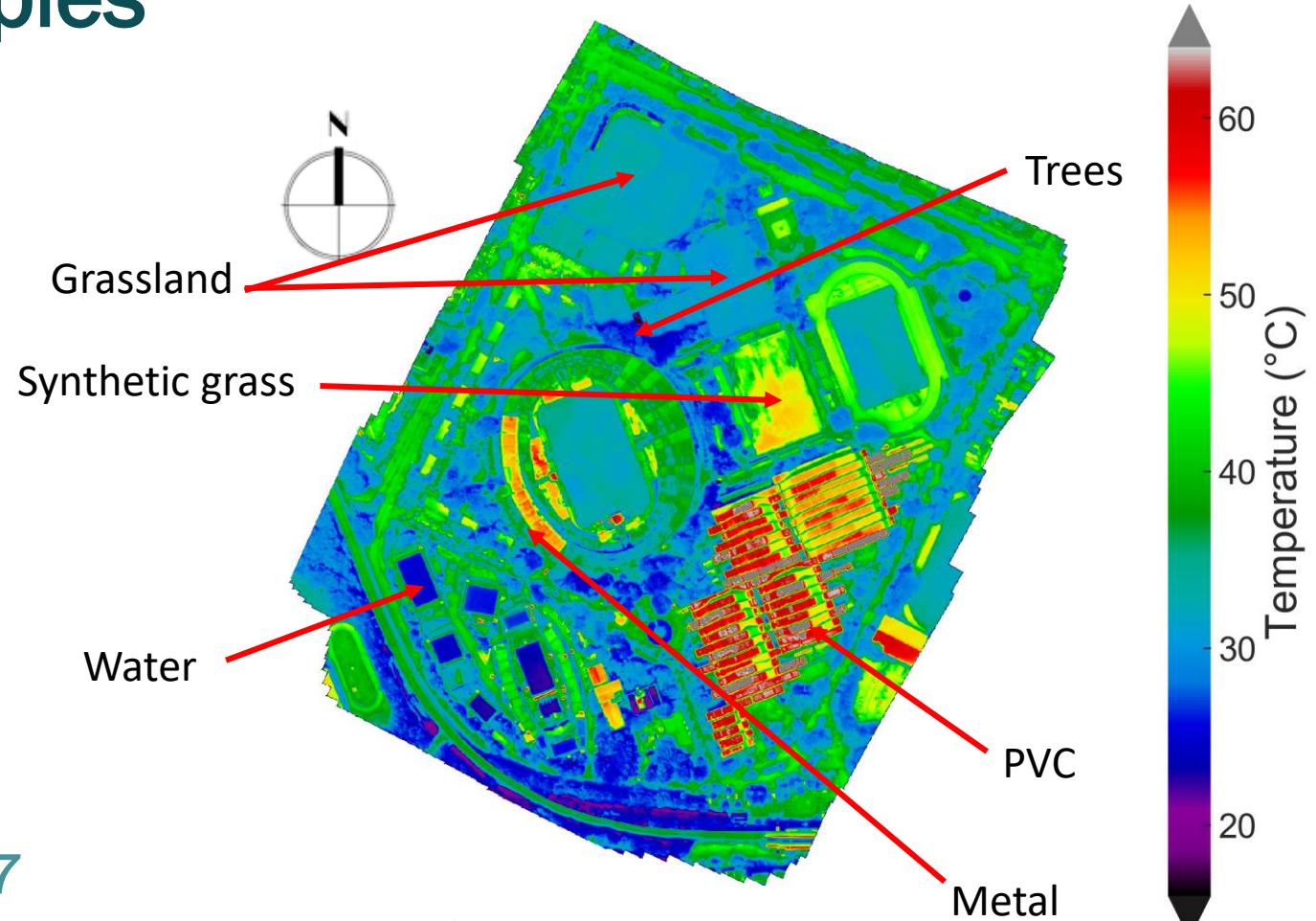


Medium radiation (10:45 am)



*Same materials but different radiation conditions*

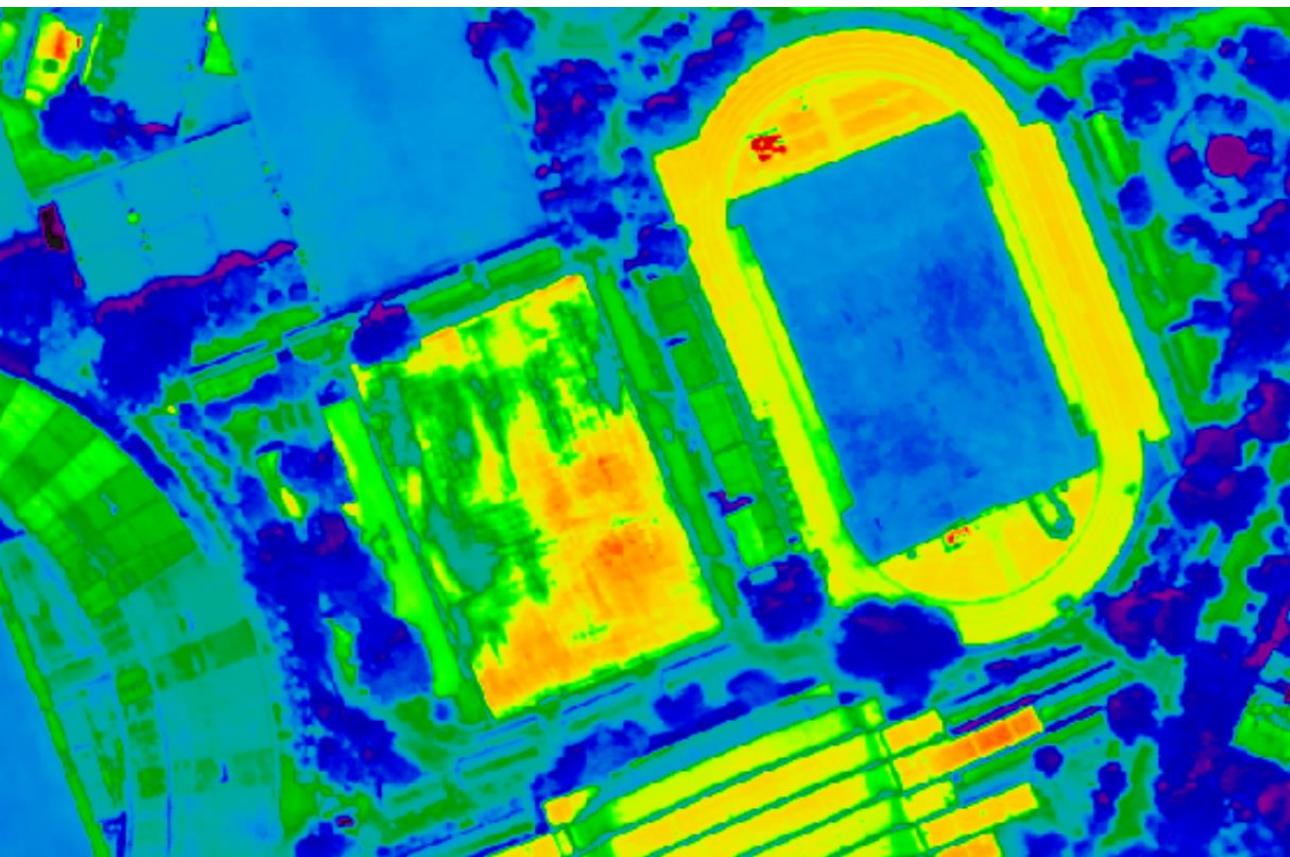
# UAV Flight - Examples



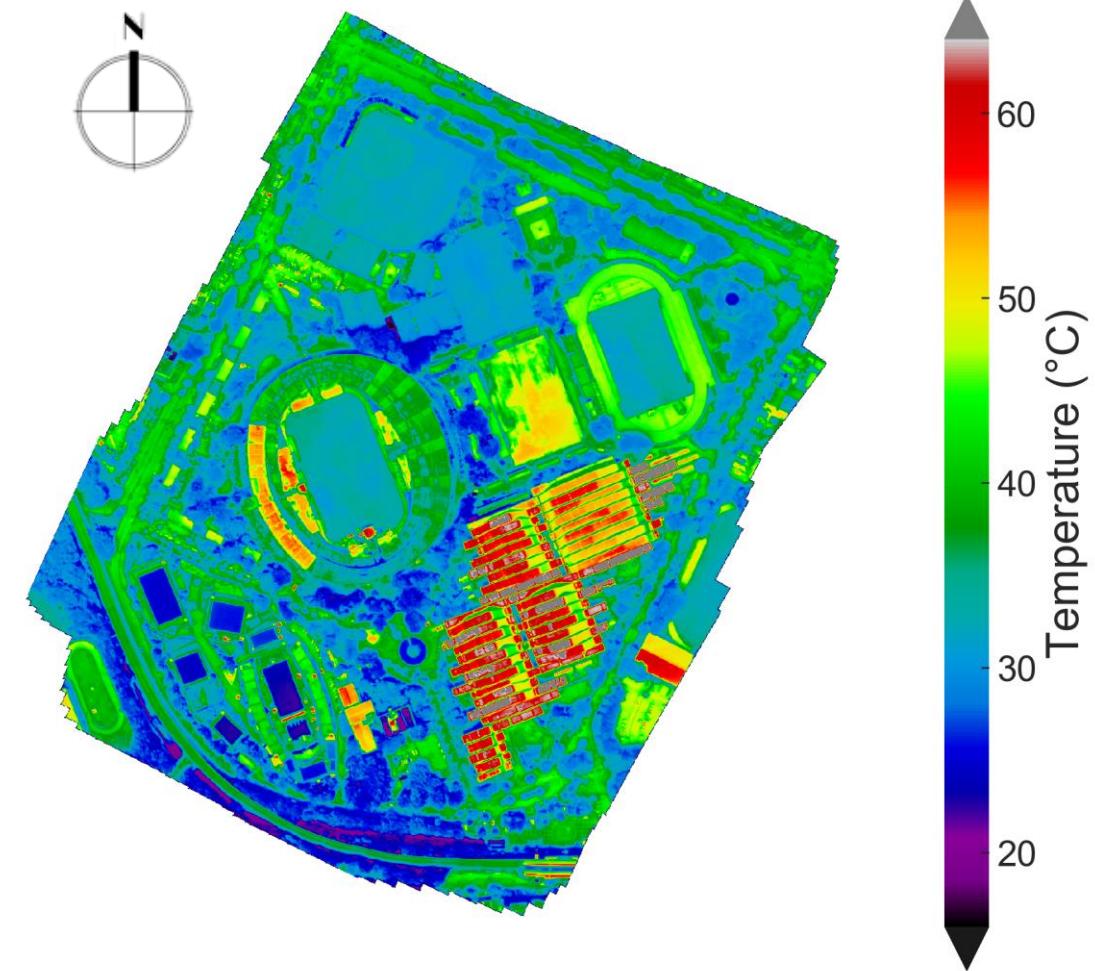
*Flight 017*

Conditions: noon – medium radiation – wet surfaces

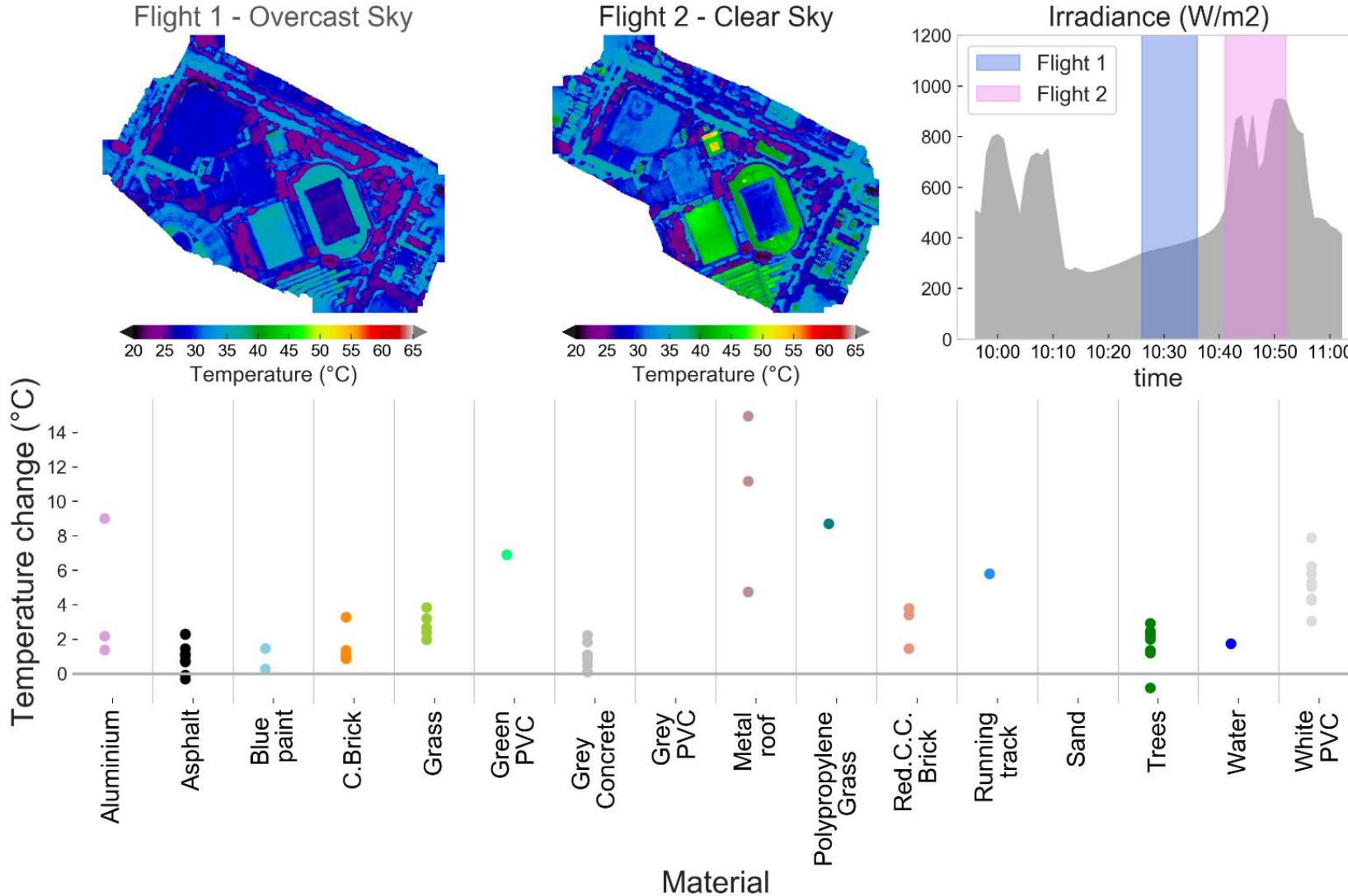
## UAV Flight - Examples



11:45 medium radiation



*Presence of wet surfaces at sunrise*



## Future work

- Heat capacity under real conditions of weathering
- Estimation of sensible and latent heat fluxes
- Urban heat island mitigation techniques

## Conclusions

Previous research and this study demonstrate the influence of urban cover on surface temperatures:

- It is marked the difference of temperature between urban and rural areas.
- In Aburrá Valley topography influence radiation and surface temperatures.
- It is notable the reduction of LST due to the amount of vegetation.
- At micro-scale, the use of thermal cameras and drones with radiometry cameras allow monitoring the behavior of individual materials.

## *Final words*

## *Applications*

This kind of information can be useful to create a framework to make studies of implementation of urban heat island mitigation techniques.

*In fact this information is currently having into account for local policies.*

And It can be a better tool with measures in the urban canopy layer.



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## Thank you!

For further information:

[www.siata.gov.co](http://www.siata.gov.co)

Gisel Guzmán: [gguzmane@unal.edu.co](mailto:gguzmane@unal.edu.co)



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