Jet Propulsion Laboratory
California Institute of Technology

High resolution thermal imaging of urban heat islands and heat waves

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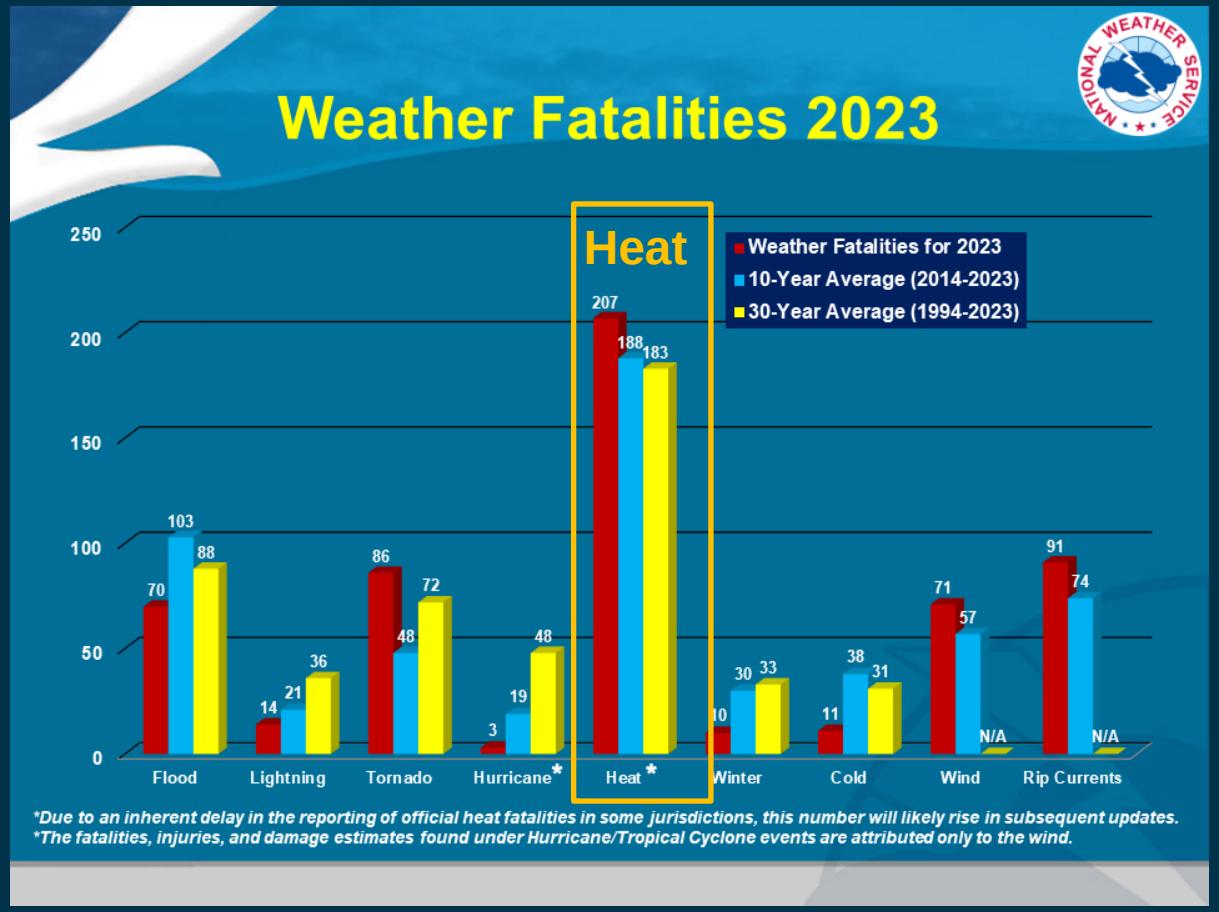
Joint SCERIN and MedRIN Workshop,
Chania, Greece, 16-19 July, 2024

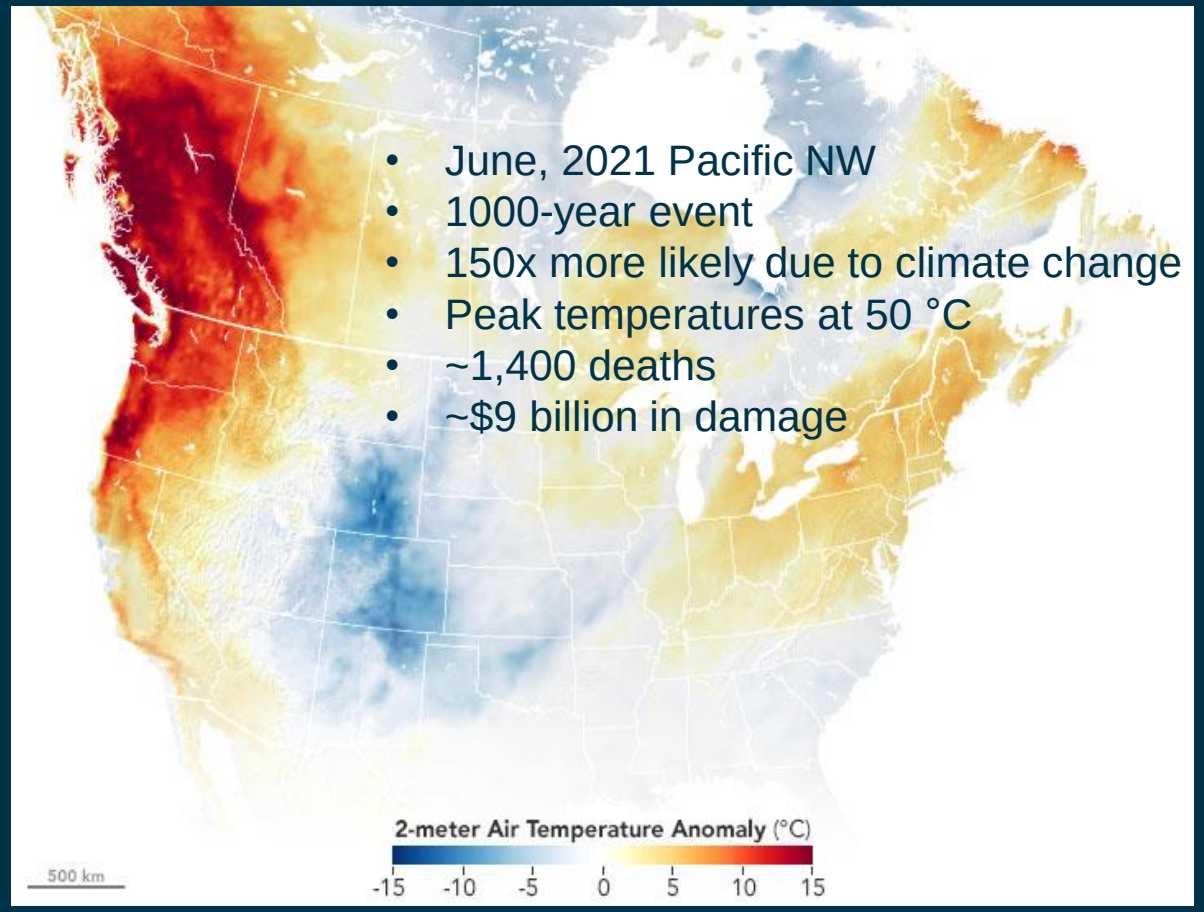
Heatwaves are the leading cause of death among natural disasters

Heat accounts for most deaths amongst natural disasters



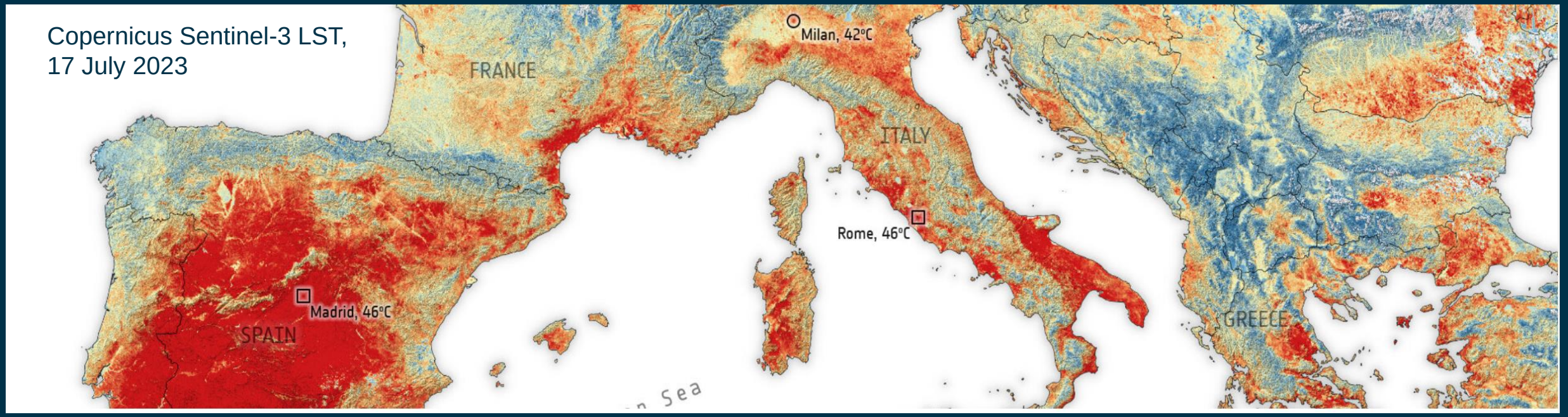
- Heat cramps, and heatstroke (hyperthermia) most common ER visits

Extreme heatwave events are becoming more likely



Temperature anomalies on June 27th, 2021 Credit: NASA Earth Observatory/Joshua Stevens

Extreme heat across Europe – July 2023

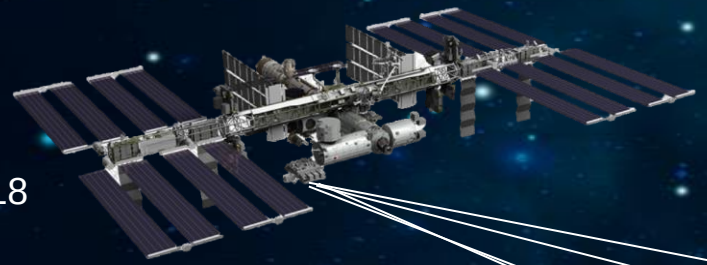


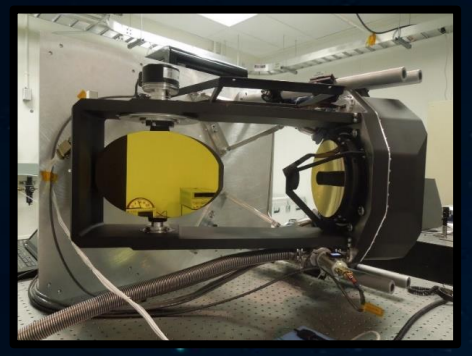
- The July 2023 ‘cerebus’ heatwave brought the hottest temperatures ever across Europe
- 70,000 people died from heat related illness in 2023 alone
- Highest mortality rates in Italy, Greece, Spain and Portugal
- Milk production in Italy reduced by 10%

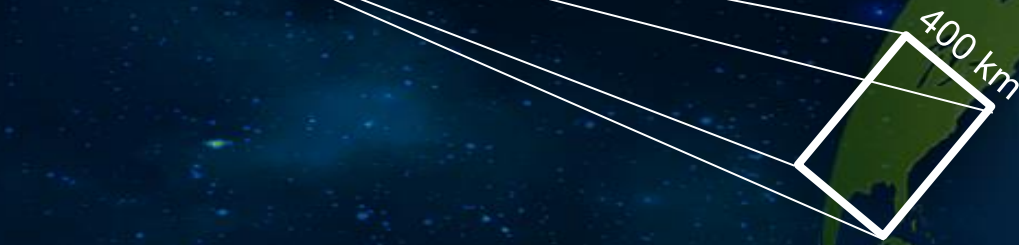
ECOSTRESS

ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station

ISS JEM-EF
launch, June 2018

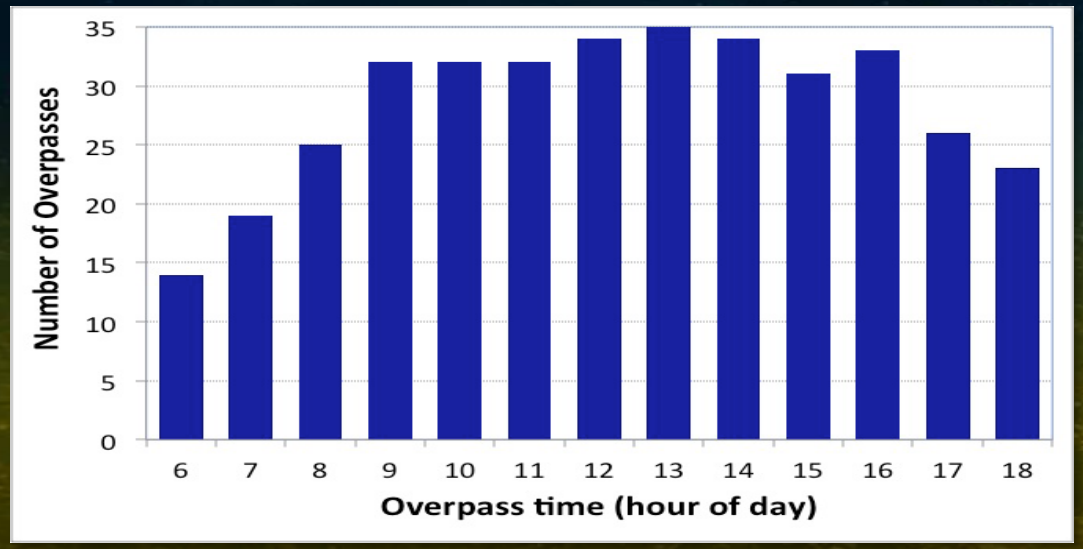




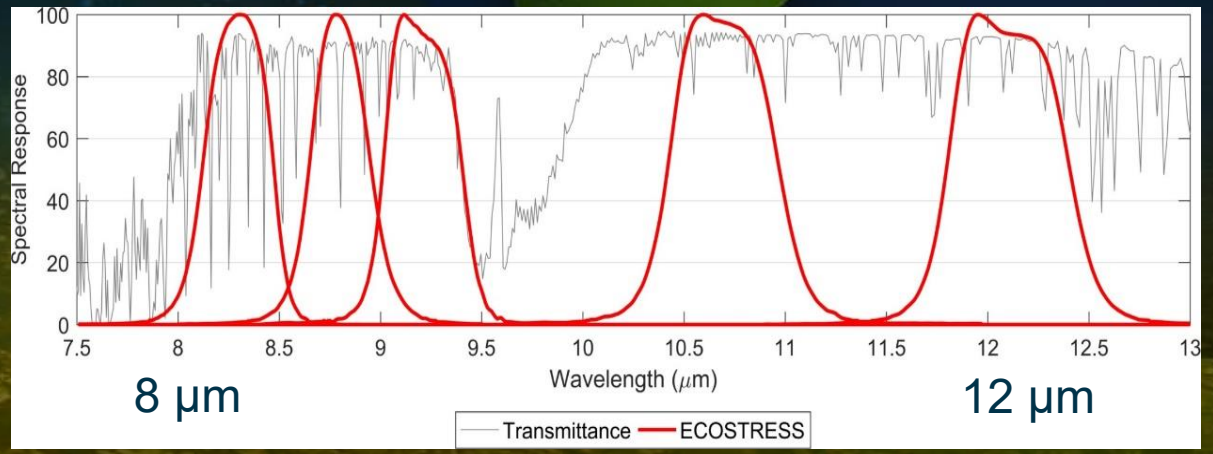


70 m resolution pixels

Observations over the diurnal cycle every 3-5 days

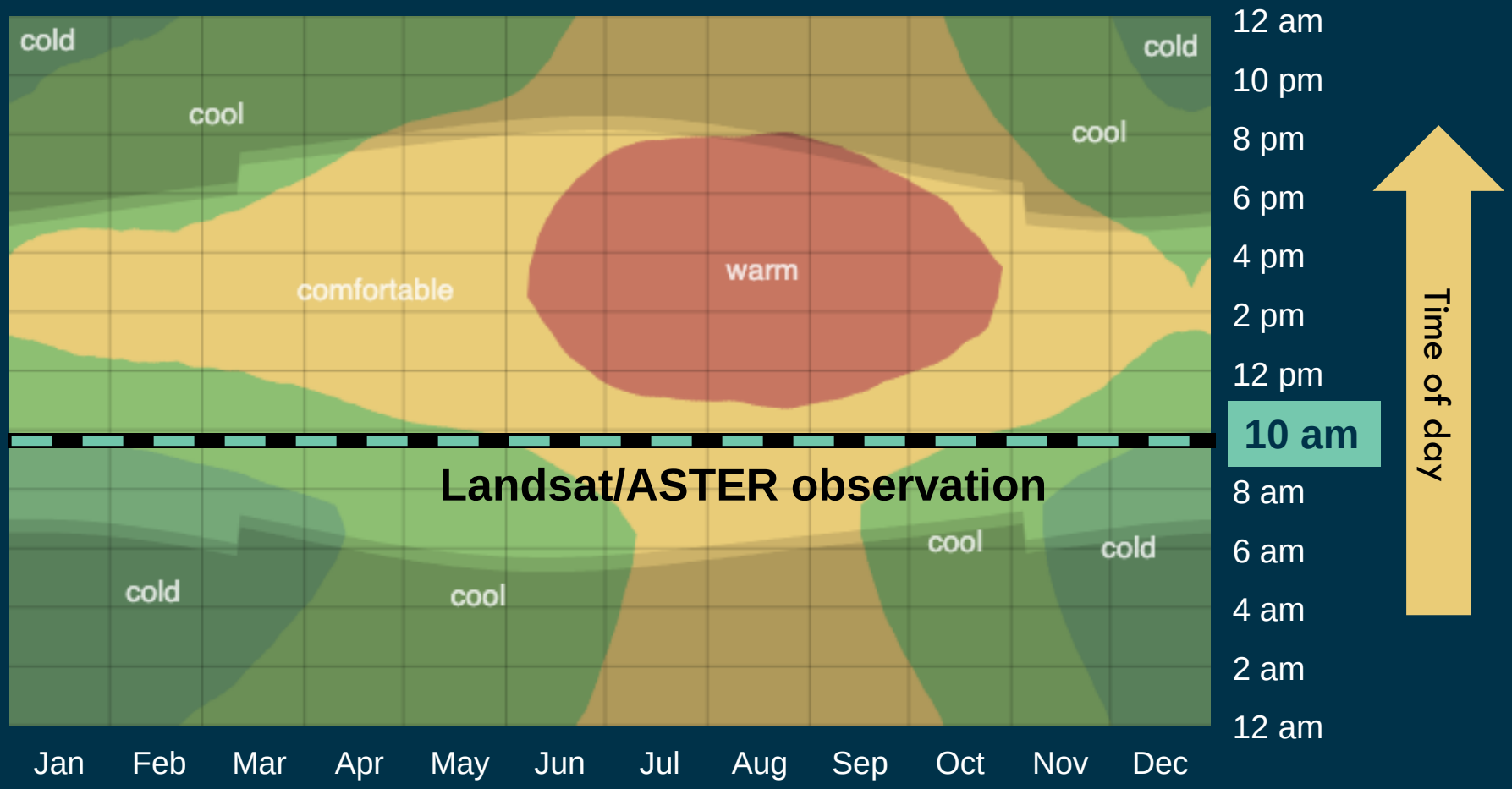


Five thermal infrared bands

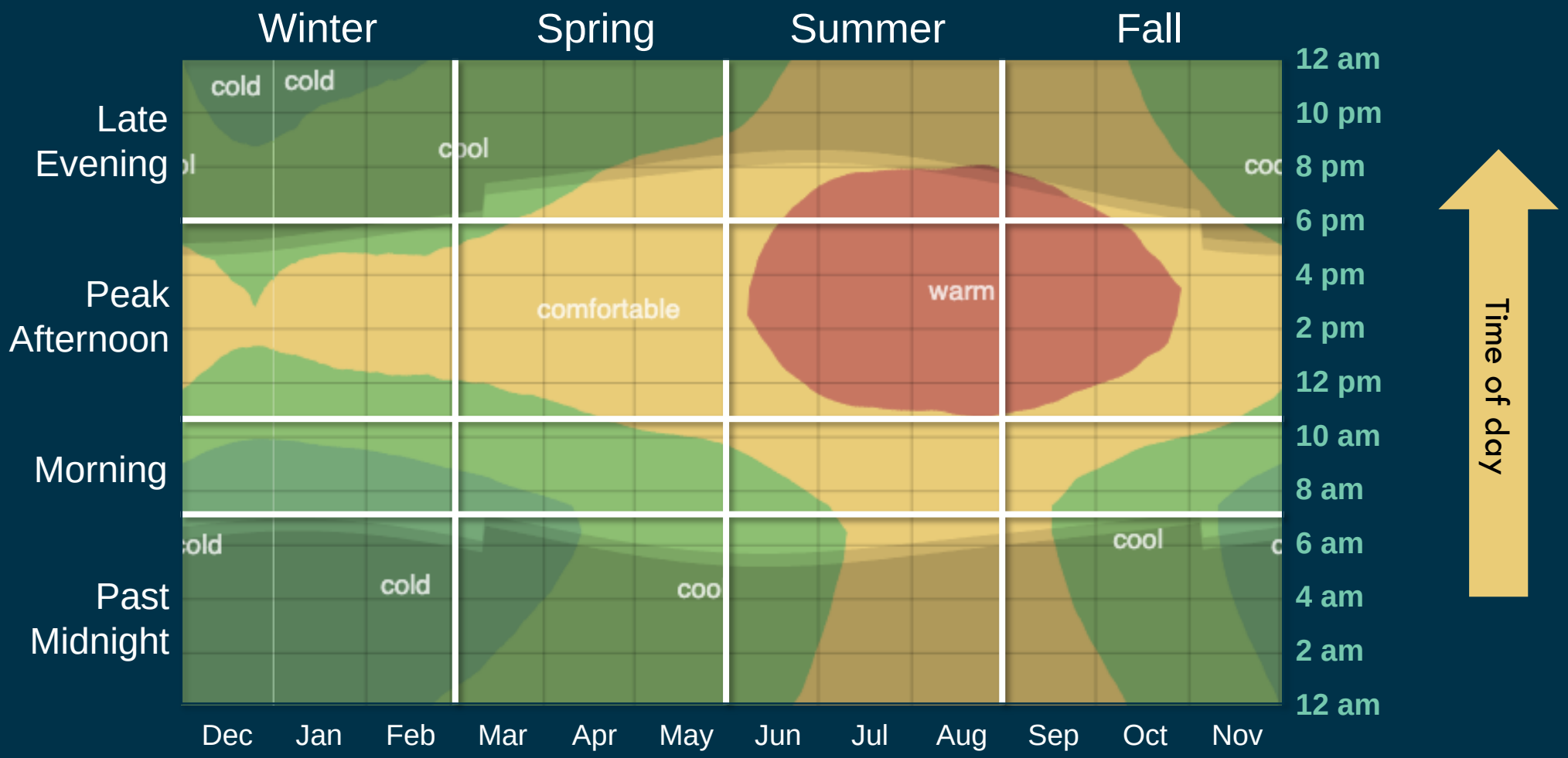


Peak diurnal and seasonal variations in temperature not captured by morning overpass TIR imagers

Los Angeles' diurnal and seasonal temperature profile

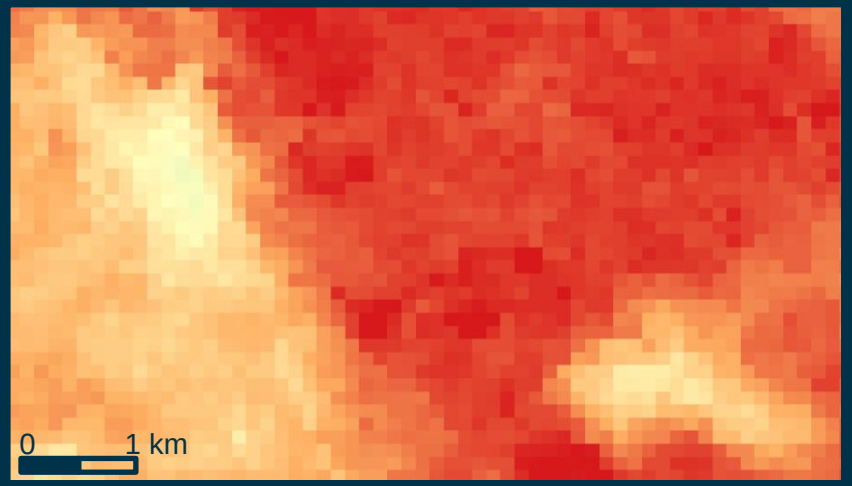


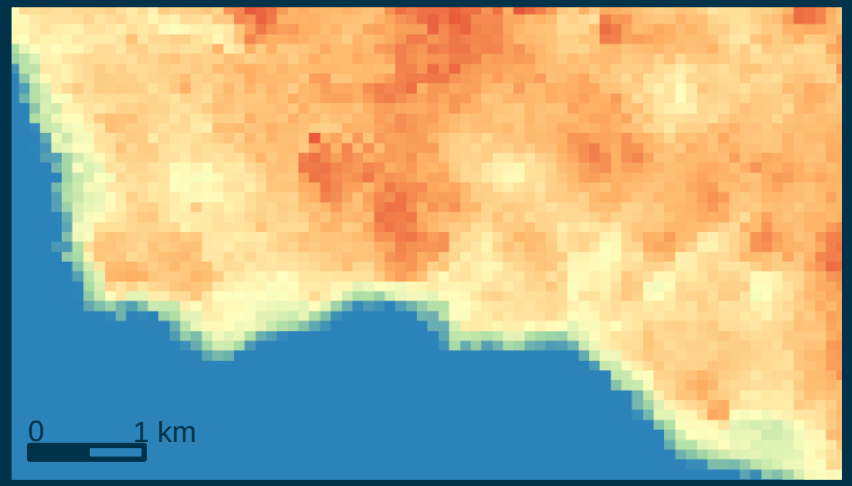
ECOSTRESS captures the diurnal and seasonal LST cycle



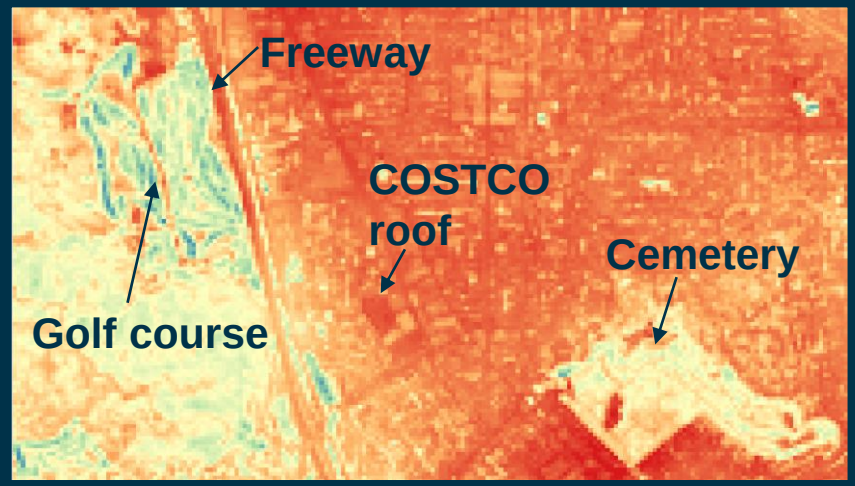
LST Downscaling or ‘thermal sharpening’ using Sentinel-2

ECOSTRESS LST **(70m)**

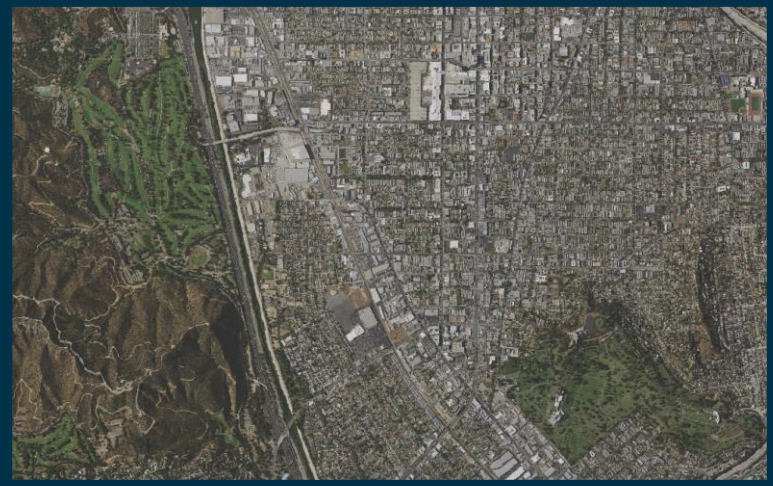


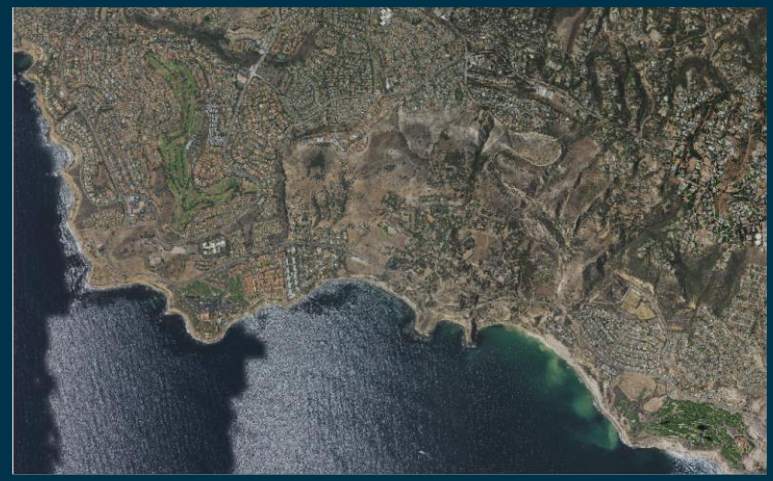


ECOSTRESS LST **(20m)**



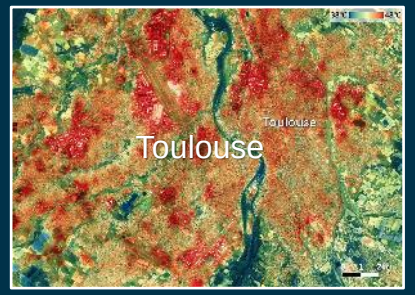
Visible imagery (0.6 m)

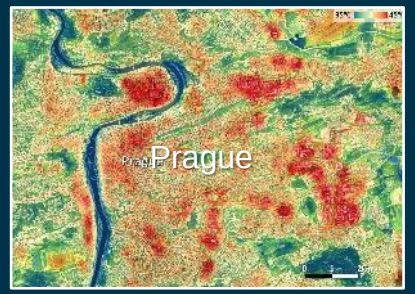


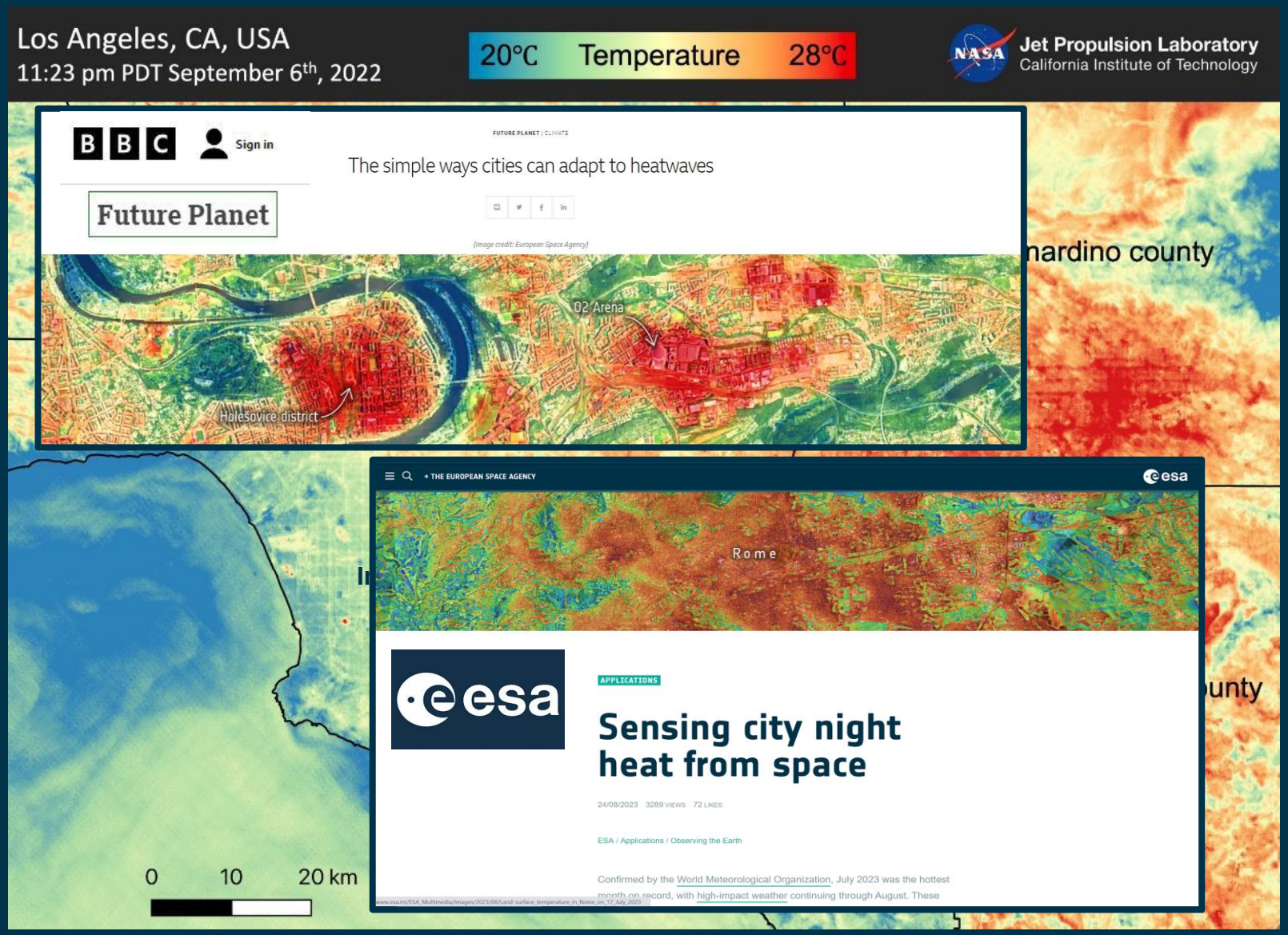


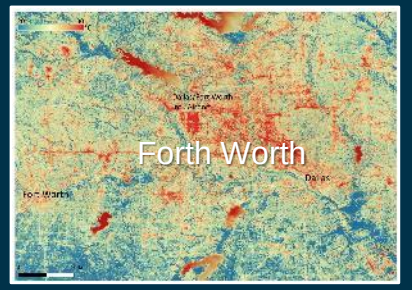
ECOSTRESS LST sharpening tutorial using Sentinel-2 surface reflectance data

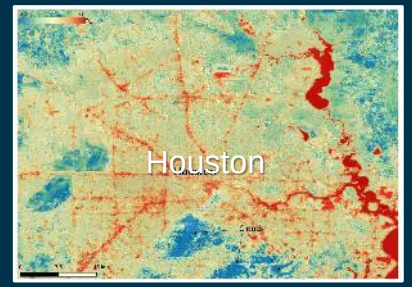
Mapping global extreme heat across the diurnal range





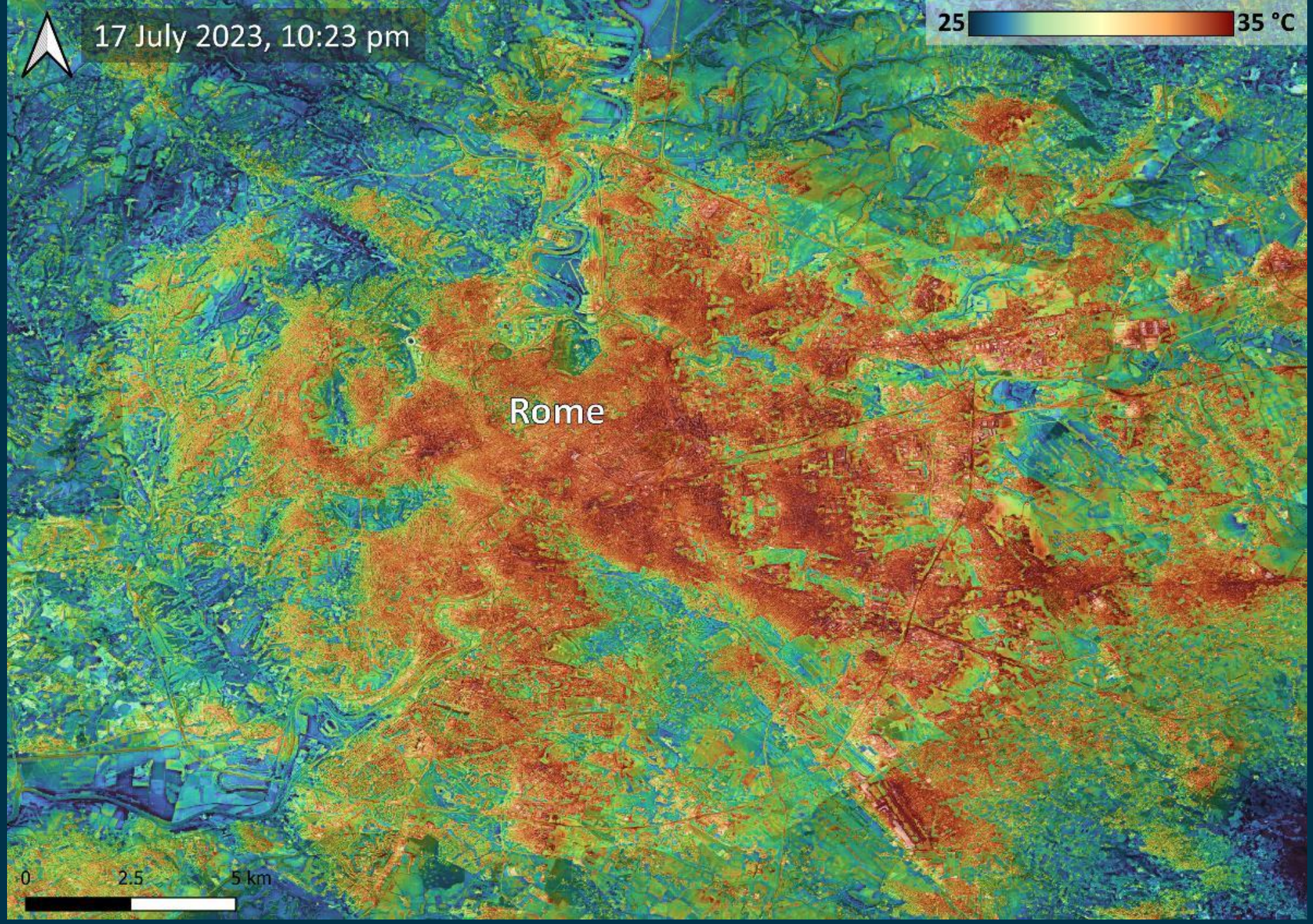






ECOSSTRESS LST, 17 July 2023

Rome's highest air temperature ever was recorded at **41.8 C on 18 July 2023**, breaking previous year's record of 40.7 C in June 2022

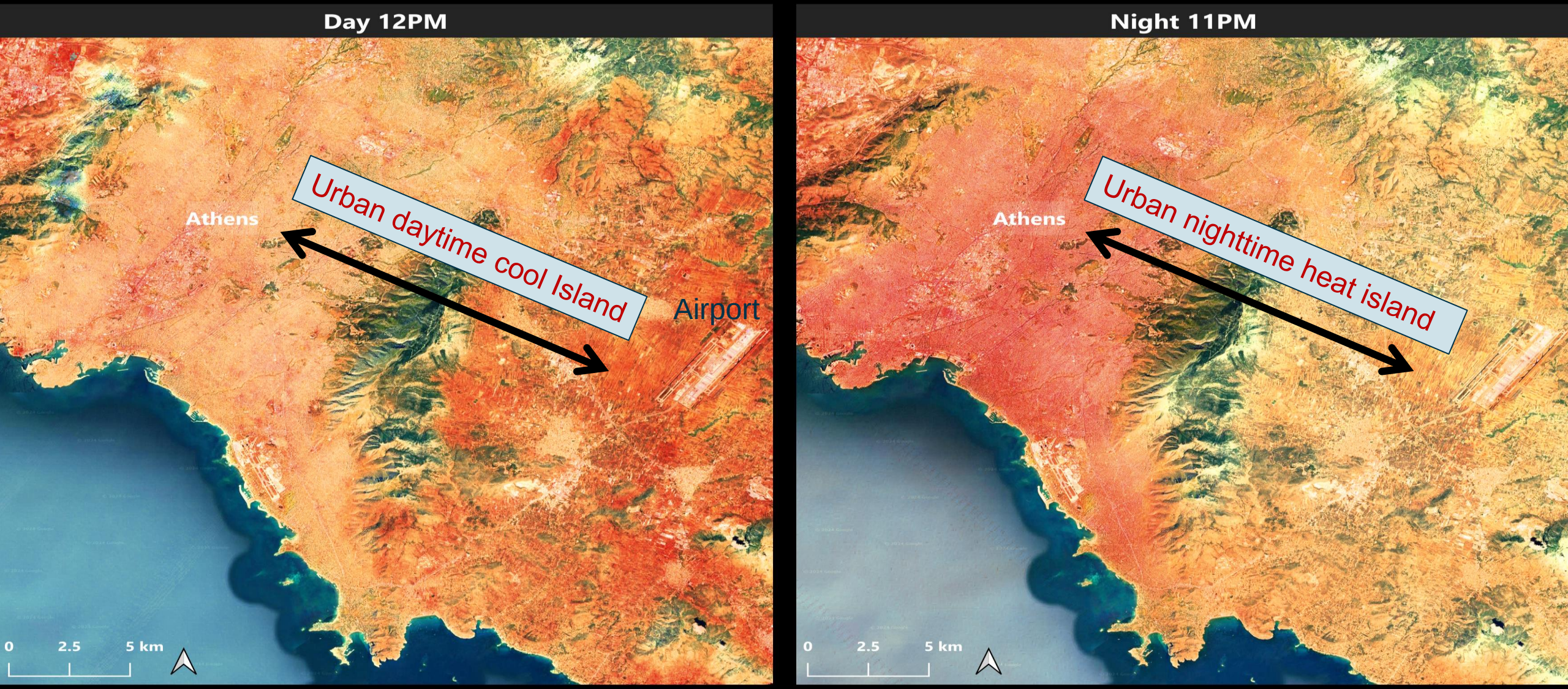


ECOSTRESS Land Surface Temperature

Eureopean ‘Cerberus’ Heatwave: July 2023

ECOSTRESS

Jet Propulsion Laboratory
California Institute of Technology



ECOSTRESS Land Surface Temperature
Second-degree Burn Risk Exposure Map – Phoenix, Arizona

ECOSTRESS

Jet Propulsion Laboratory
California Institute of Technology

Blazing hot surfaces are a danger for catastrophic burn injuries in the urban desert Southwest

Sizzling sidewalks and unshaded playgrounds are a danger for catastrophic burn injuries as air temperatures reach new summer highs in desert cities like Phoenix and Las Vegas

By ANITA SNOW Associated Press
July 2, 2024, 9:02 PM

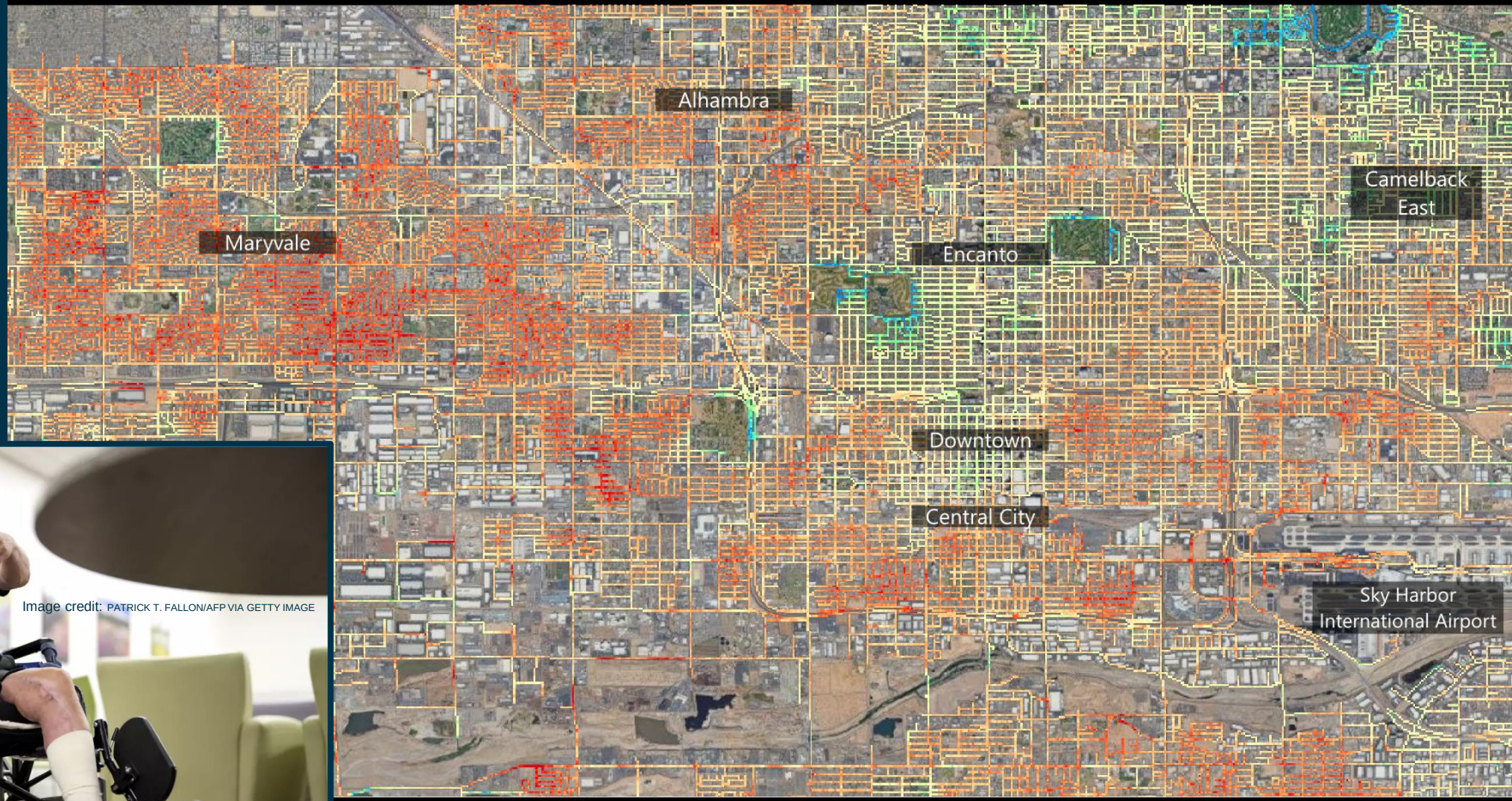
JULY 3, 2024 | 4 MIN READ

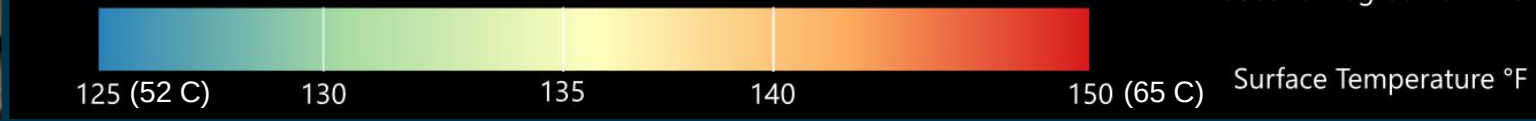
New Heat Map Shows Scorching Streets that Can Burn Skin in Seconds

Under the scorching summer sun, pavement can reach temperatures hot enough to cause second-degree burns

BY ANDREA THOMPSON

Image credit: PATRICK T. FALLON/AFP VIA GETTY IMAGE

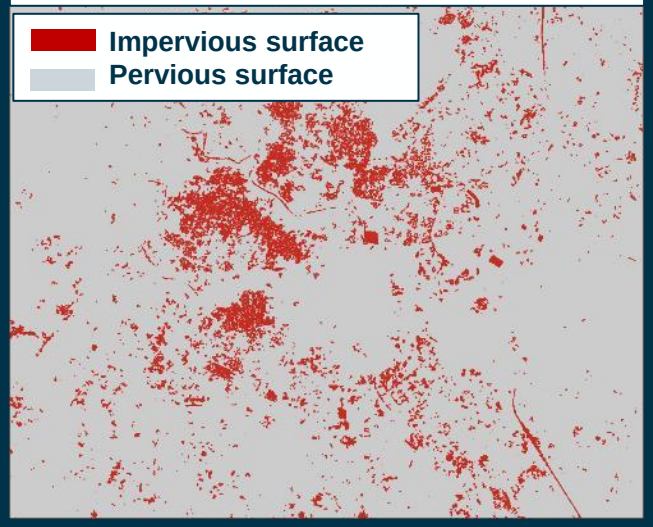




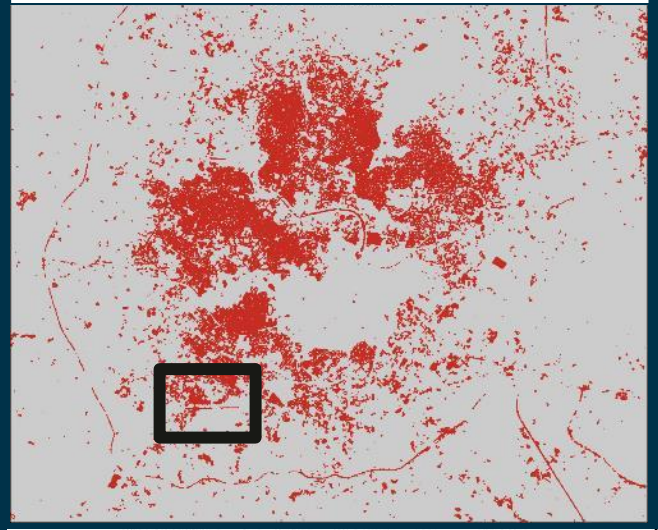
Quantifying connections between urban heat island and urban growth in India

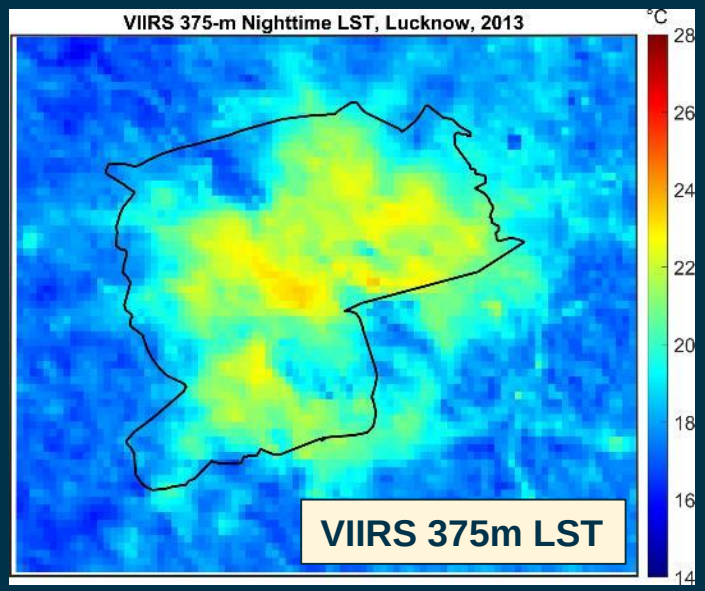
LCLUC, 2023, PI Hulley

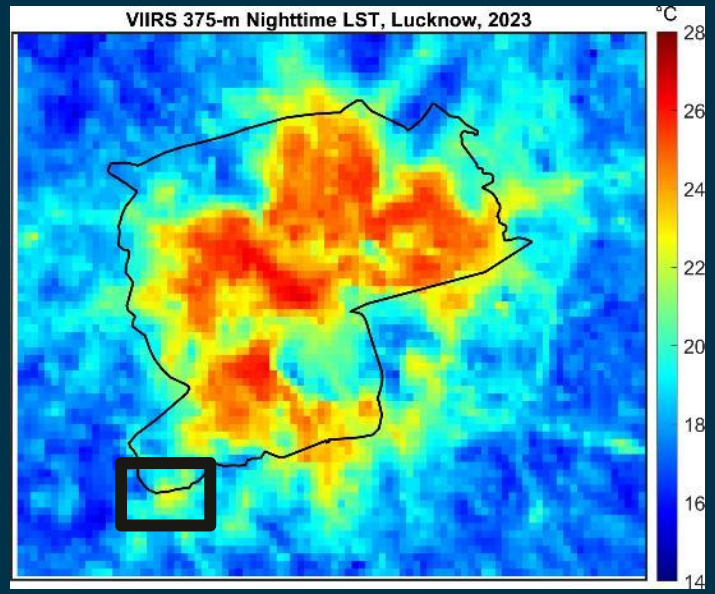
Lucknow , India, 2013



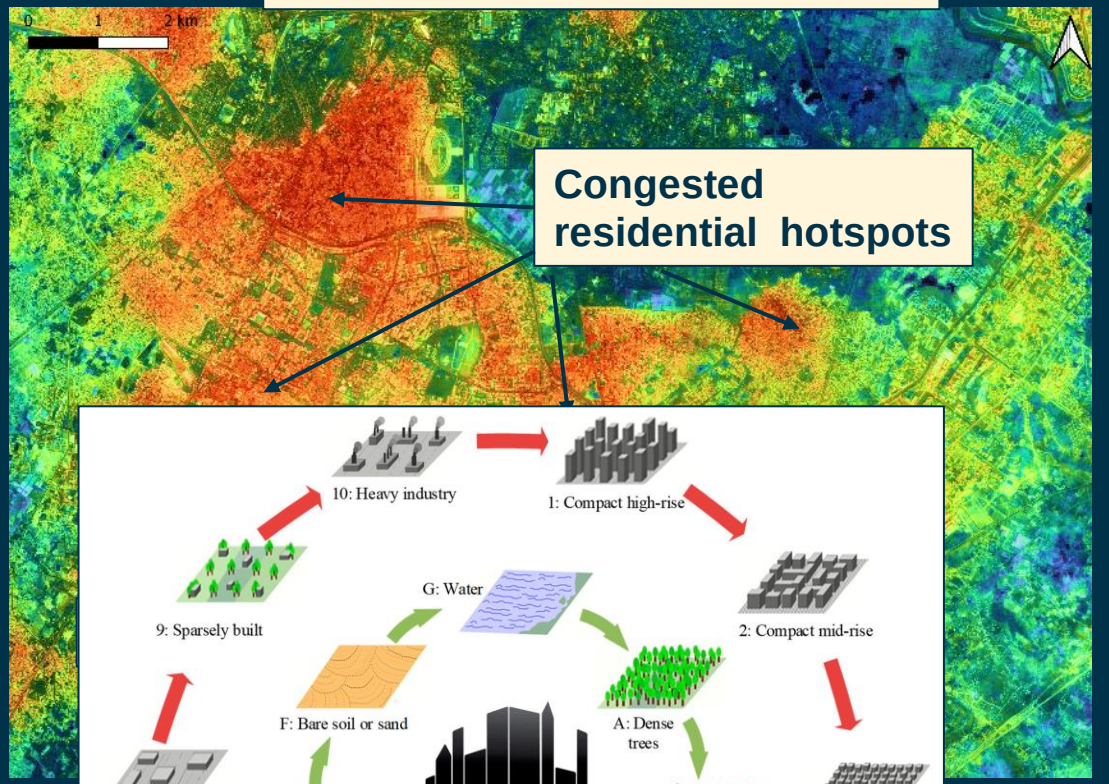
Lucknow , India, 2023

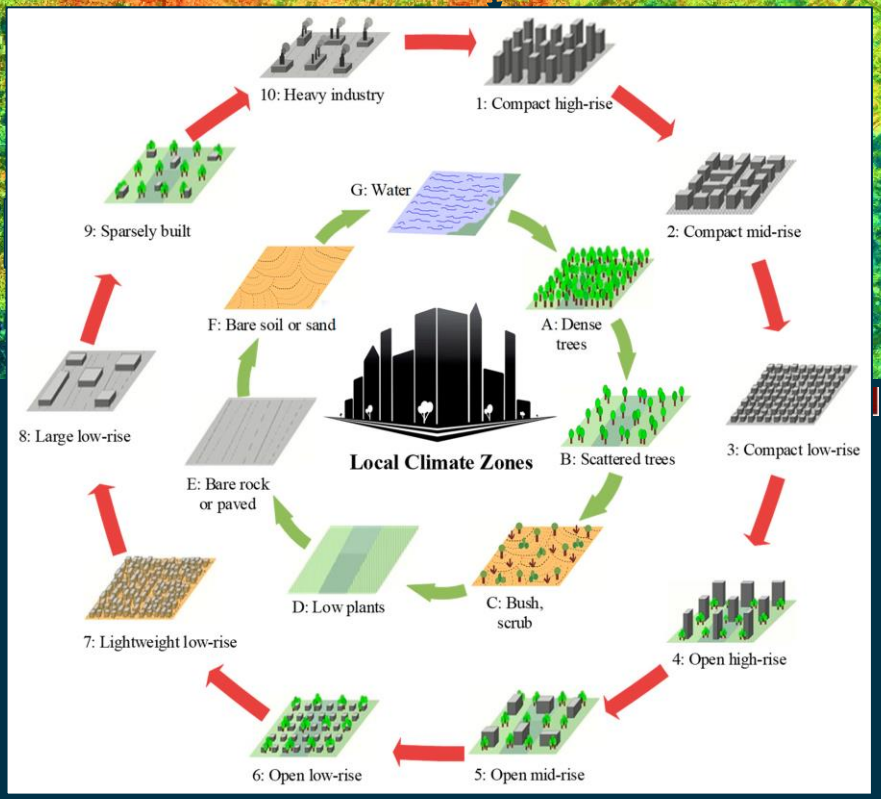




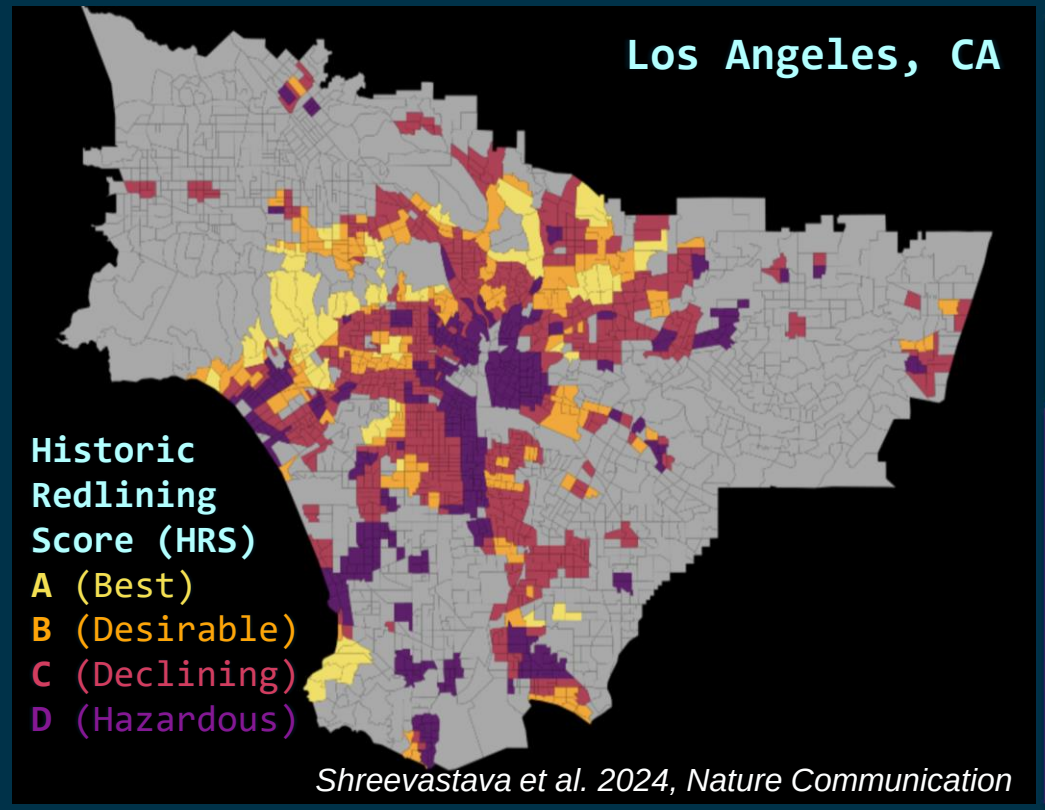


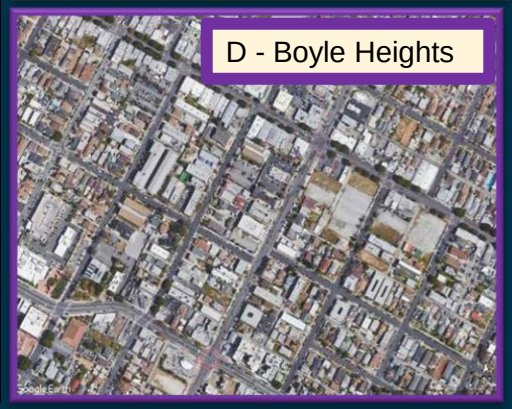
ECOSTRESS 30m nighttime LST

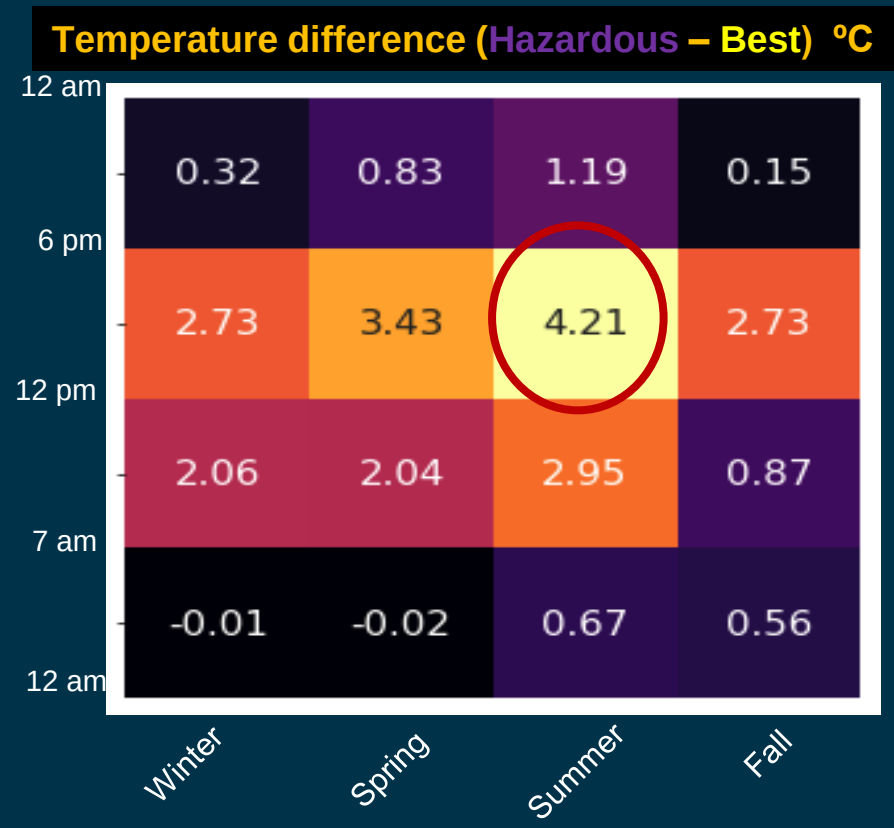


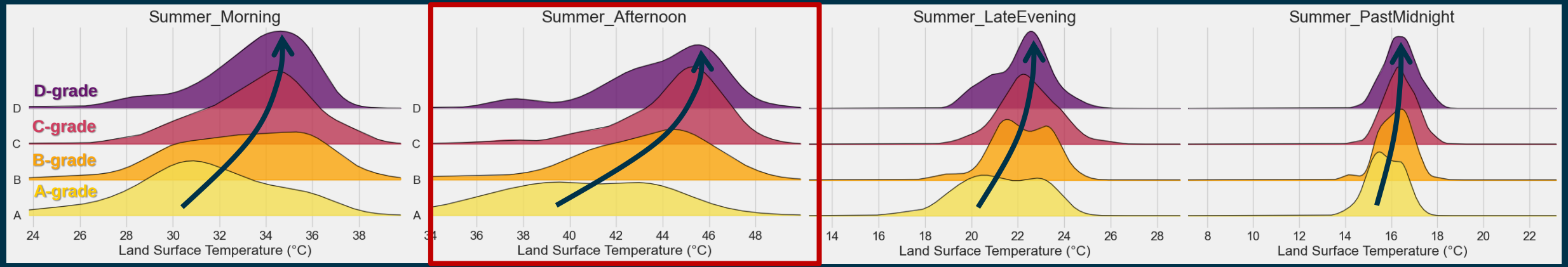


Urban heat inequalities throughout the diurnal cycle



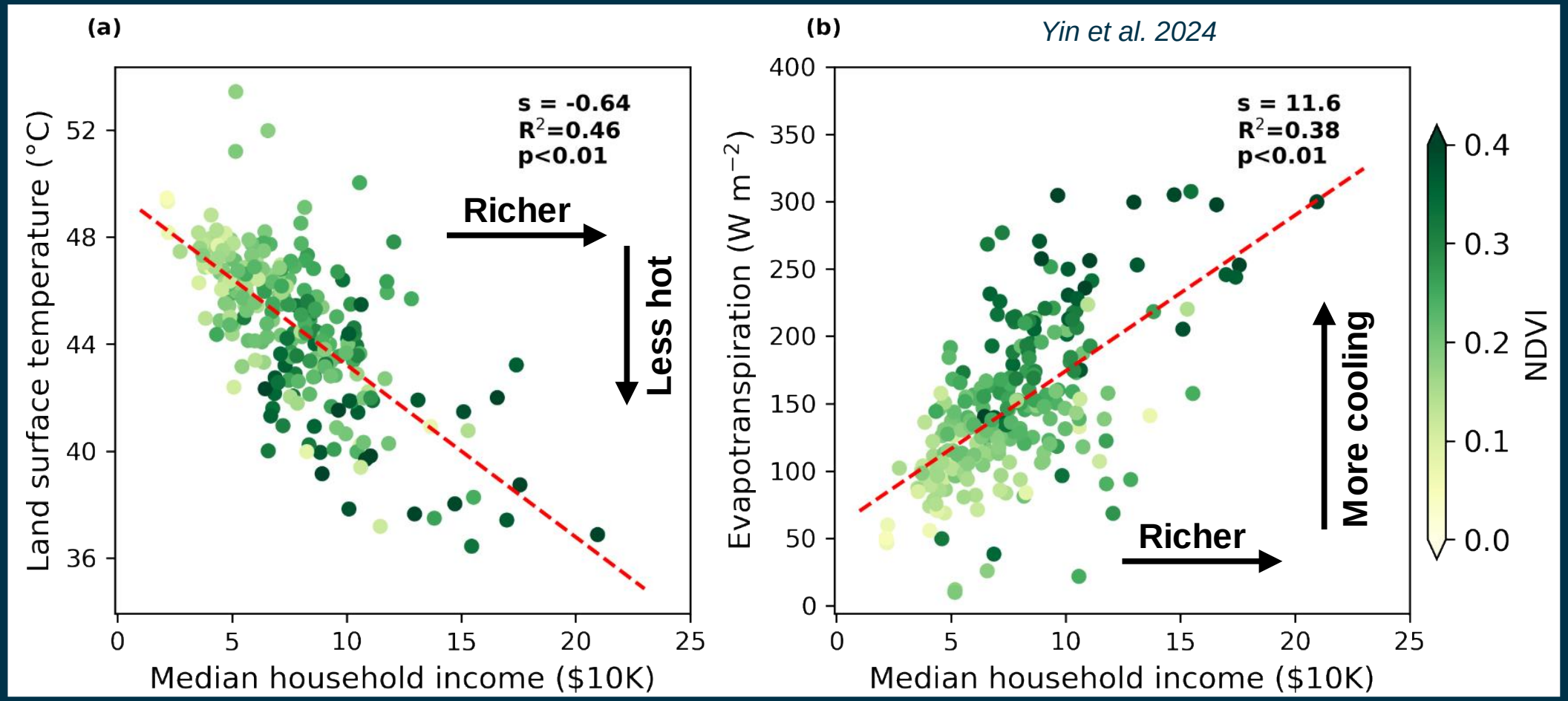






Quantifying urban heat inequalities

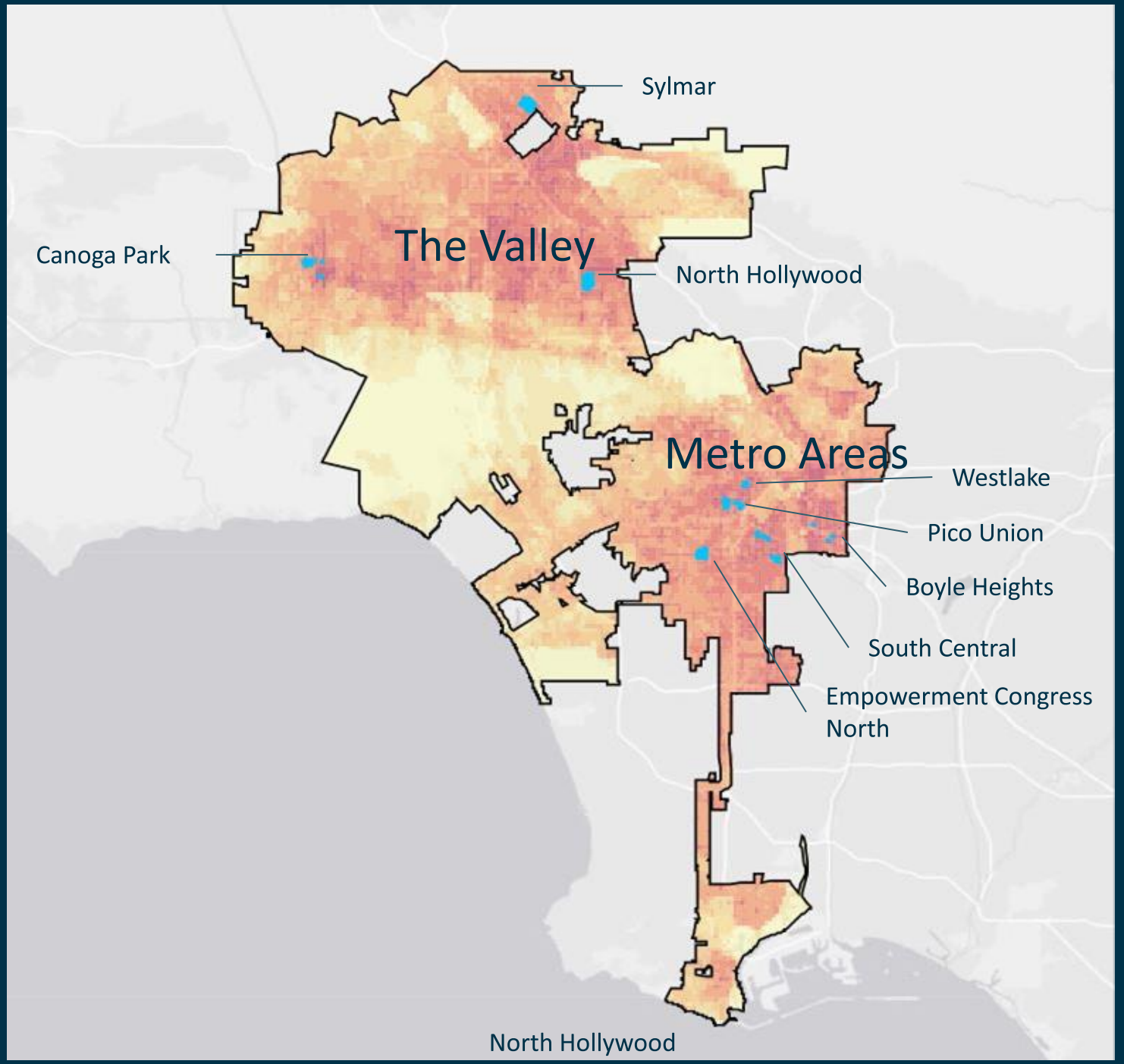
- Negative correlation between median household income and LST
- Positive correlation between income and ET (and NDVI)



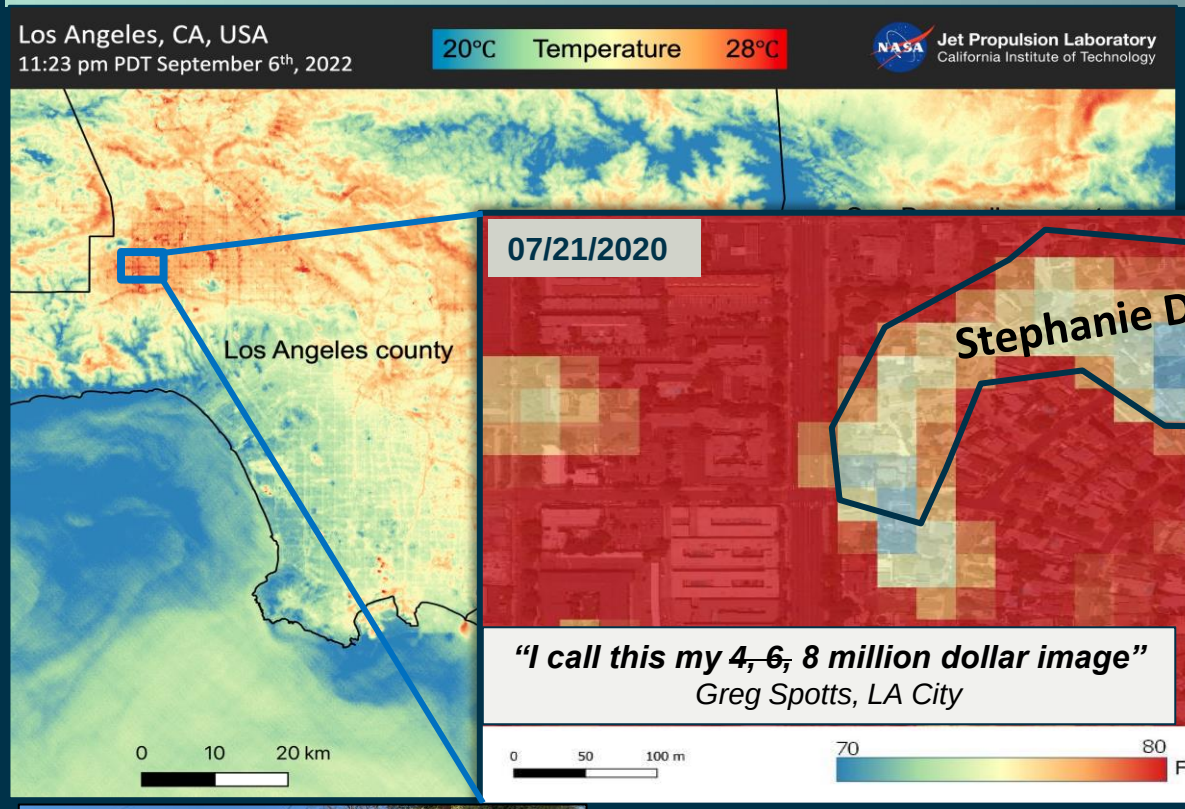
LA city heat intervention plan (FY 21-23):
- 300 city blocks of cool pavement coating
- Planting of 2,000 shade trees across 8 underserved neighborhoods

Machine-applied coating

Cutting of new tree wells



Urban heat mitigation and improving quality of life

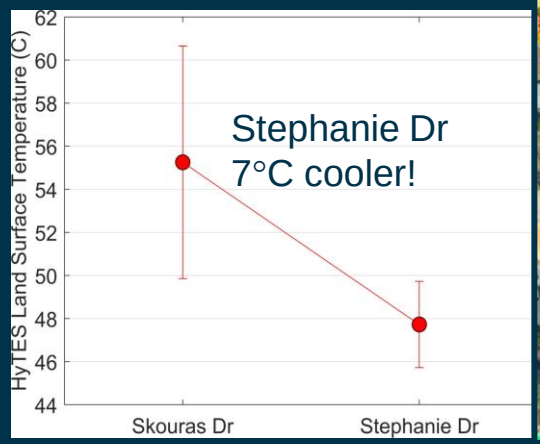


"I call this my ~~4, 6,~~ 8 million dollar image"
Greg Spotts, LA City

ECOSTRESS (30m)
~2°C cooling

HyTES (5m)
7°C cooling

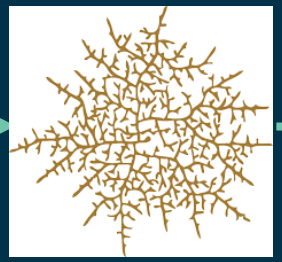
Stephanie Dr, 05/29/2018



Earth Action: Simulating Heat Intervention Solutions

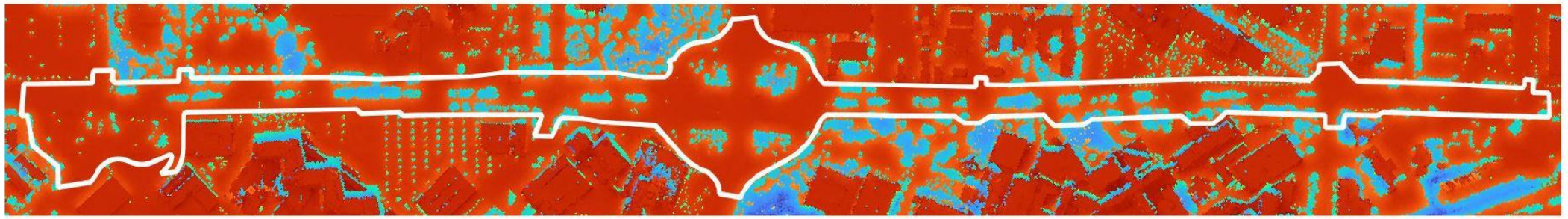
ECOSTRESS

Hyphae Design Lab



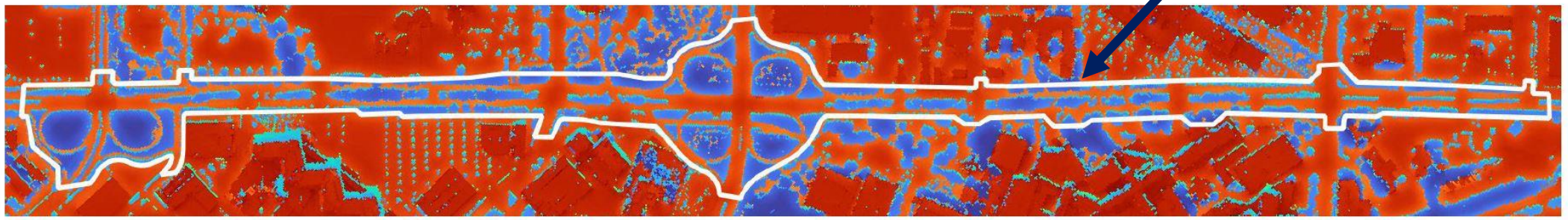
Mean Radiant Temperature

Thermal Comfort Index



Existing conditions: Mean Radiant Temperature = **64.7°C**

10°C cooling along pedestrian route after tree planting



Maximal Canopy: Mean Radiant Temperature = **55.6°C**

Image courtesy: Hyphae Design Lab

Questions?

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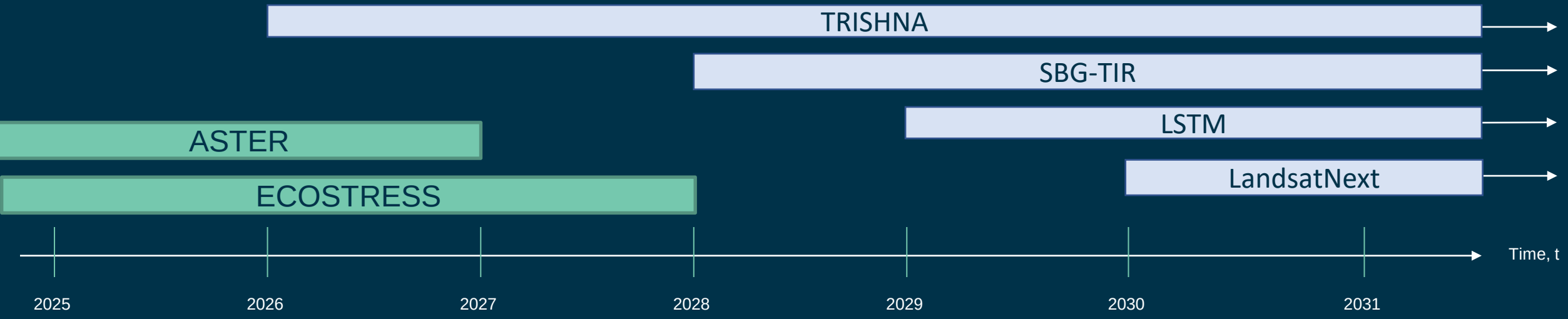
ECOSTRESS LST sharpening tutorial using Sentinel-2 surface reflectance data

High Resolution Multi-spectral TIR Data Continuity

TRISHNA, SBG-TIR and LSTM are staggered in order to produce a continuous record for climate studies and applications. TRISHNA launches in 2026, SBG-TIR in 2028 and LSTM in 2029. This allows for a **continuous record** and possibly some periods when all 3 satellites are available **which would allow daily coverage**. The current earliest launch for Landsat-N is the end of the decade, so SBG-TIR will be operating in a period when Landsat-N data is not yet available.



- Earliest possible launch dates shown, may launch later
- ** Shows data overlap not orbit alignment