Surface Urban Heat Island effect by Thermal Remote Sensing

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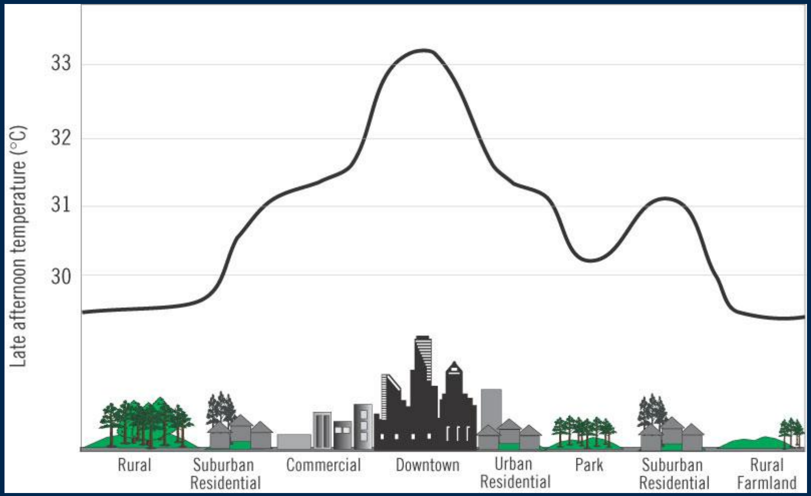
UHI and SUHI

The Urban Heat Island (UHI) effect refers to cities being warmer than their rural surroundings because of the built environment absorbing, retaining, and/or producing more heat than the natural landscape it replaces (Oke, 1982)

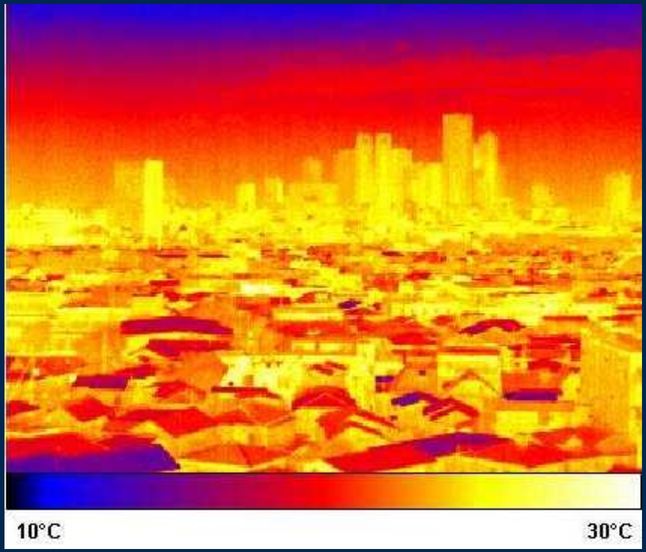
$$UHI = T_{AIR\ URBAN} - T_{AIR\ RURAL}$$



Remote sensors operated in thermal infrared wavelength region have been used to observe the Surface Urban Heat Island (SUHI).

$$SUHI = LST_{Urban} - LST_{Rural}$$

UHI-SUHI



- Day < 2 - 3^{o}C.
- Night> 6 – 10^{o}C

Big cities: Washington, Shanghai, Tokyo, etc,

From 30-80 years, Tmax summer increases 0.5 ºC each 10 years…

Cities are already suffering the impacts of global warming

More than 3 ºC

Today, 55% of the world's population (74% Europe) lives in urban areas (4.4 billions)

another 2.5 billion people to urban areas by 2050

Impacts

The impacts can be negative or positive depending on the climate and the time of year: *

Impact	**Cold weather region**	**Warm**
Human-health comfort	Positive (winter) Negative (summer)	Negative (four stations)
Energy consumption	Positive (winter) Negative (summer)	Negative
Air pollution	Negative	Negative

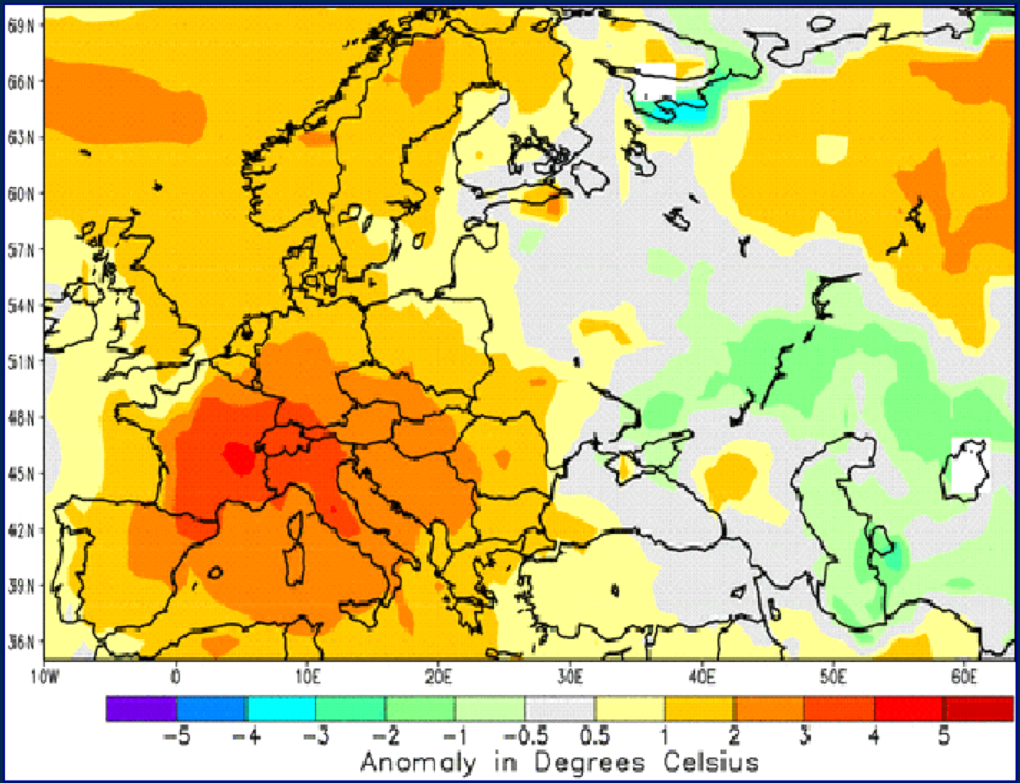
The risk of death is multiplied by 6 for each degree of TST increases during a heat wave**

*VOOGT, J. A., 2002, Urban Heat Island. In *Encyclopedia of Global Environmental Change, MUNN, T. (Ed.), pp. 660-666).*

JOHNSON, D. P., WILSON, J. S. & LUBER, G. C., 2009, Socioeconomic indicators of heat-related health risk supplemented with remotely sensed data. *International Journal of Health Geographics,* ***8.*

Summer 2003 Europe

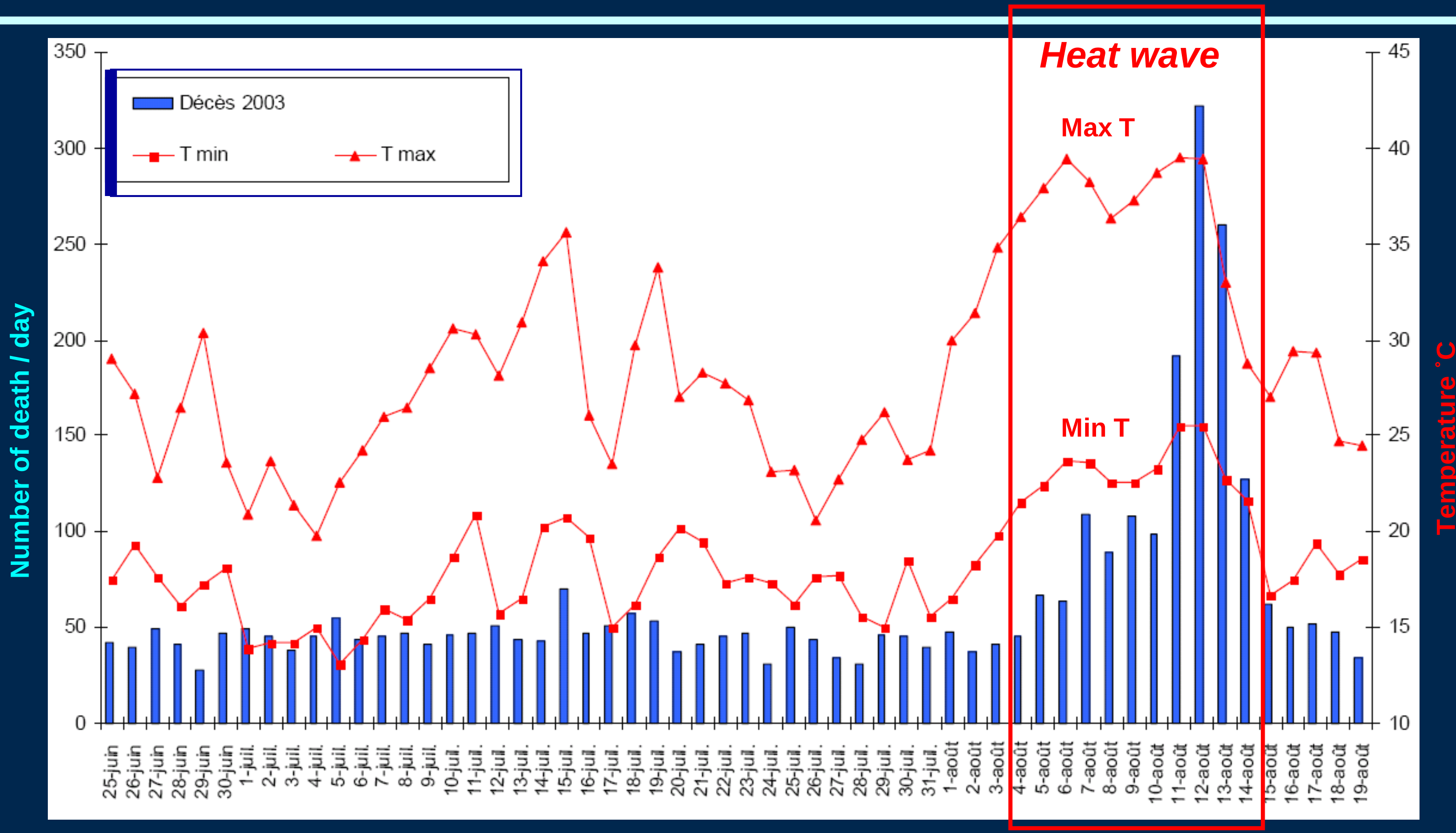
Average Temperature exceeded ~ 3° C the period 1961-90 *Shar et al., 2004, Nature, 427, 332-336.*



precipitation < average
Net radiation> average

June - August. 2003: LST anomalies.
In-situ and satellite 1988-2003 NOAA.

Summer 2003 Paris



Air Temperature from the Montsouris Park weather station and mortality from June 25 to August 19 2003, *(from InVS)*. Courtesy of Benedicte Dousset

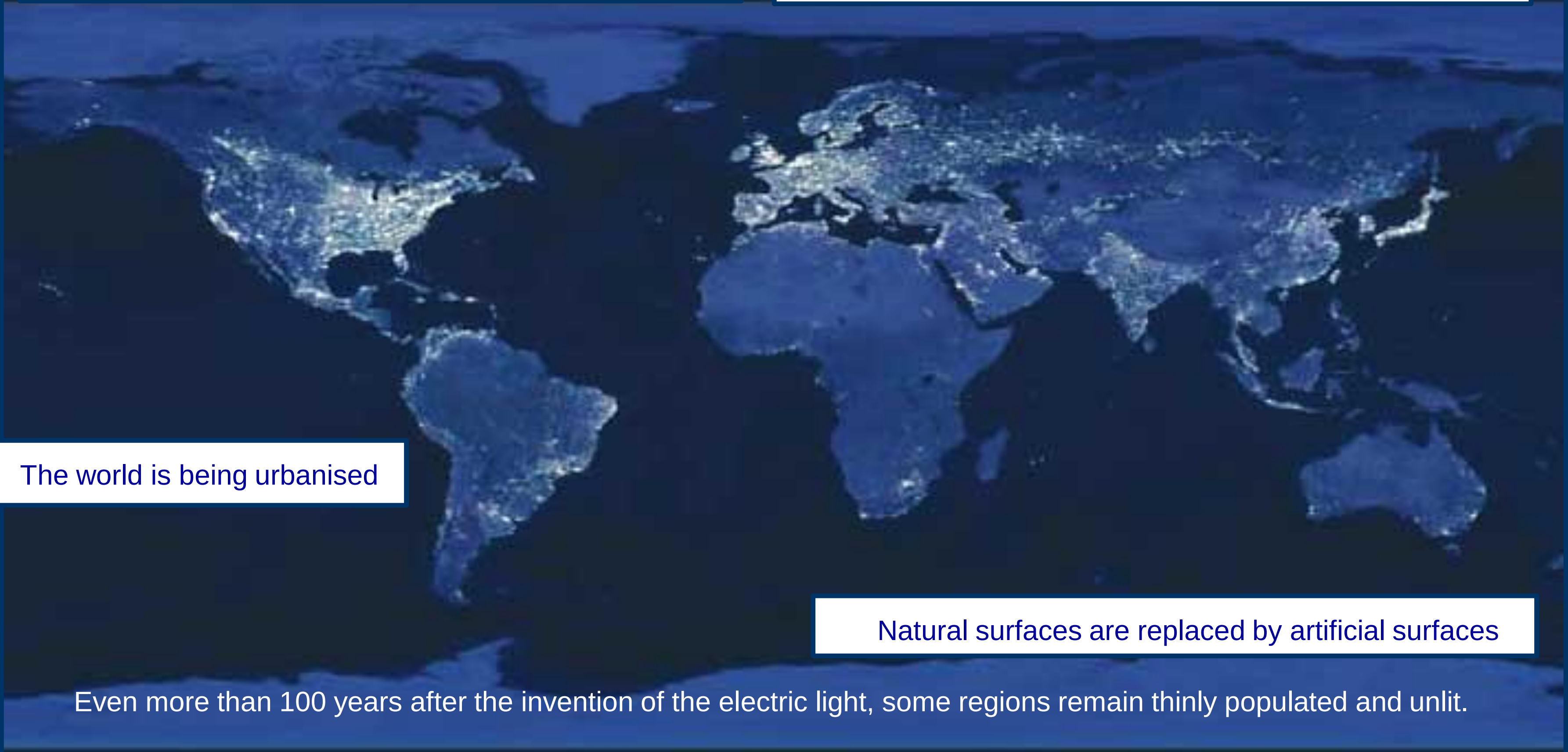
5,000 deaths due to heat stress Paris, 1-15 August 2003

-Chicago (July 1995): 600 deaths caused by heat wave
-Moscú (August 2010): mortality from 370 to 700

lights of the world

In 2018, 55% of the world population lived in cities*

In 2050, 68% of the world population will live in cities**



http://visibleearth.nasa.gov/images/1438/earth_lights.jpg

This image of Earth's city lights was created with data from the Defense Meteorological Satellite Program (DMSP) Operational Linescan System (OLS). Originally designed to view clouds by moonlight, the OLS is also used to map the locations of permanent lights on the Earth's surface.

*Population Reference Bureau, 2017. www.prb.org

*World urbanization prospects, 2011., United Nations, Department of Economic andSocial Affaris

Simulated Night Lights

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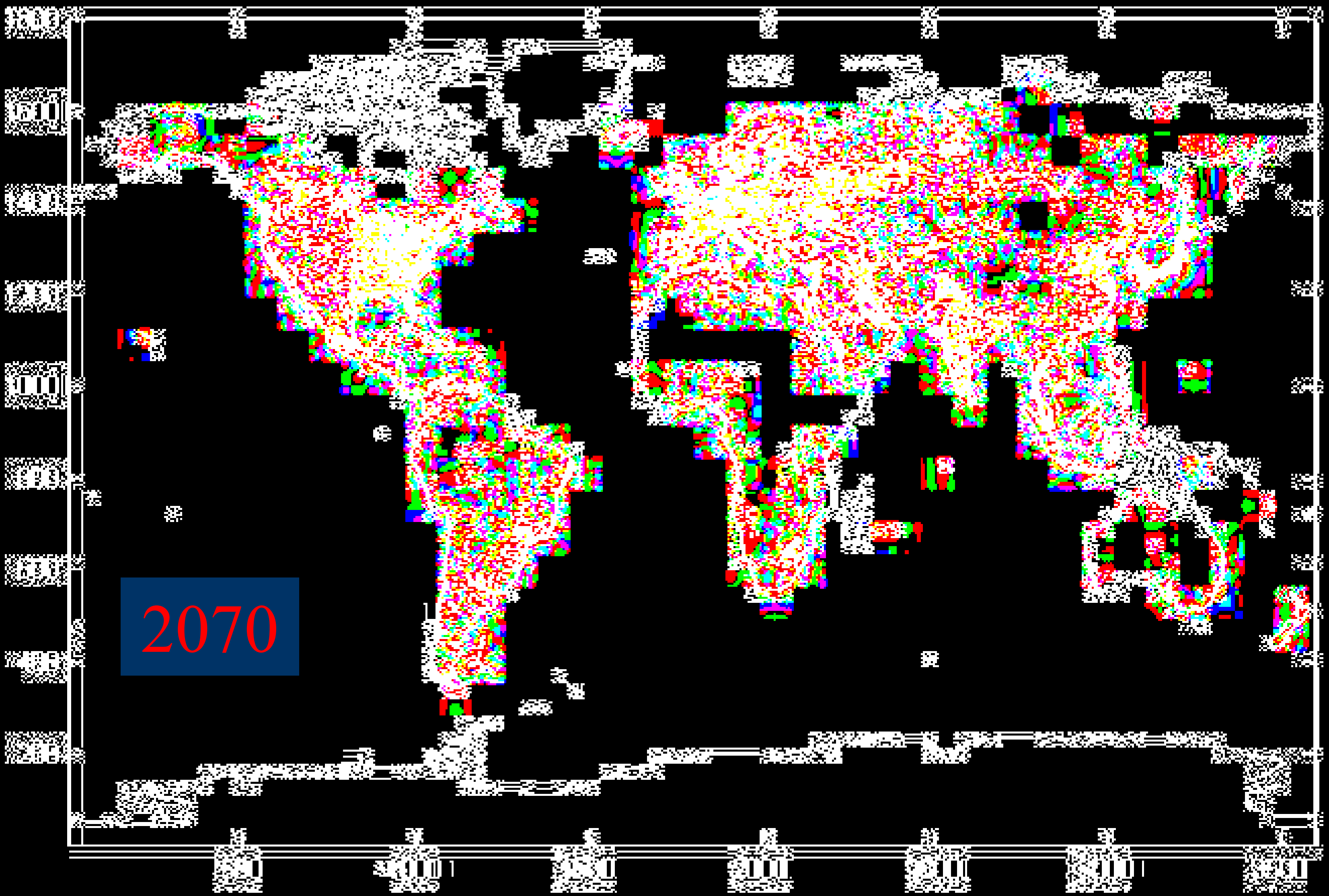
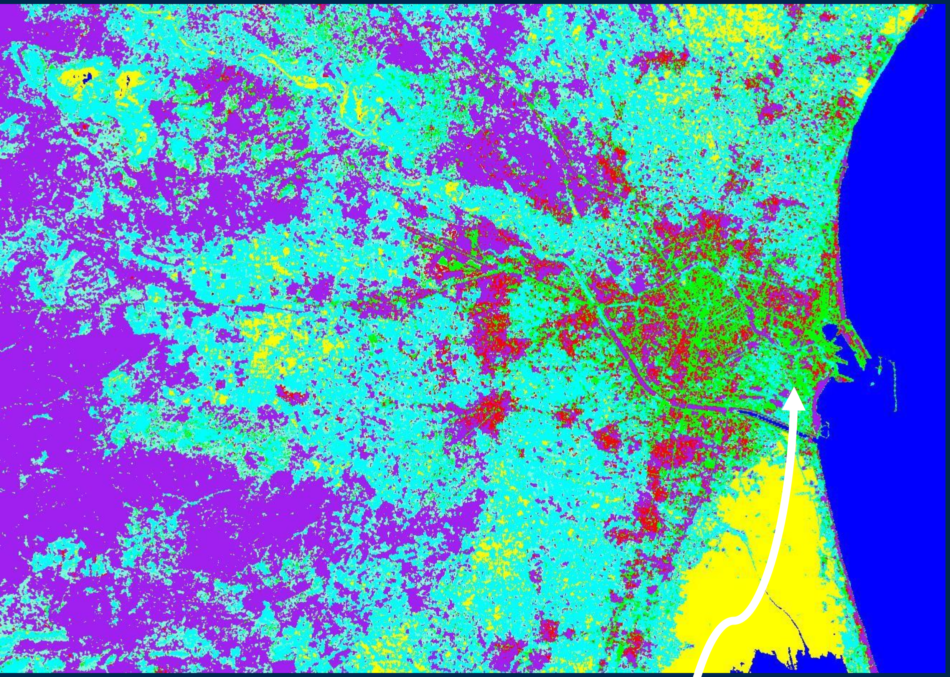
Image: H-J Schellnhuber

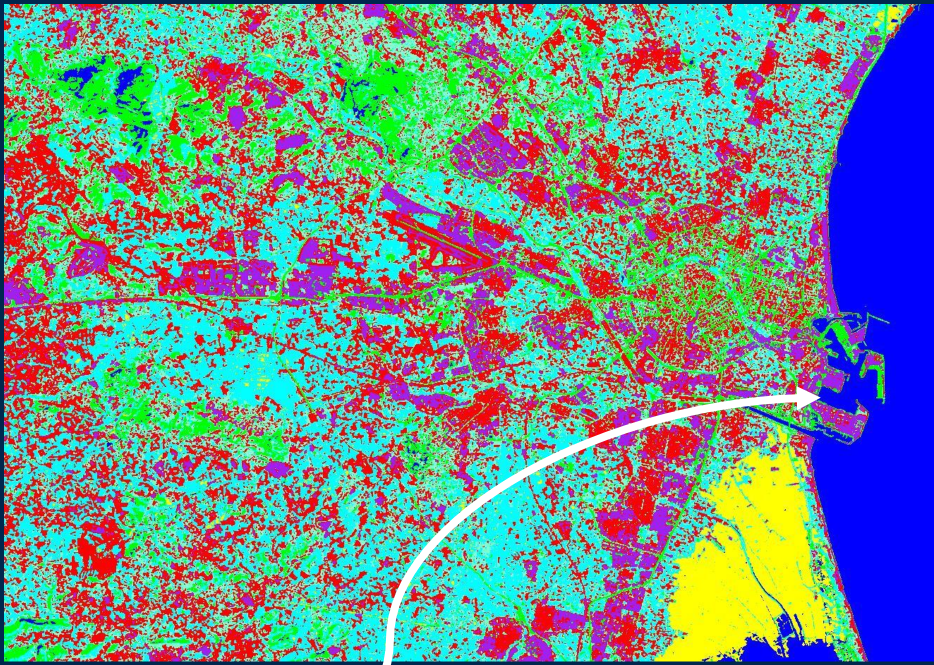


Founding Director, Potsdam Institute for Climate Impact Research;

red colour: urbanization



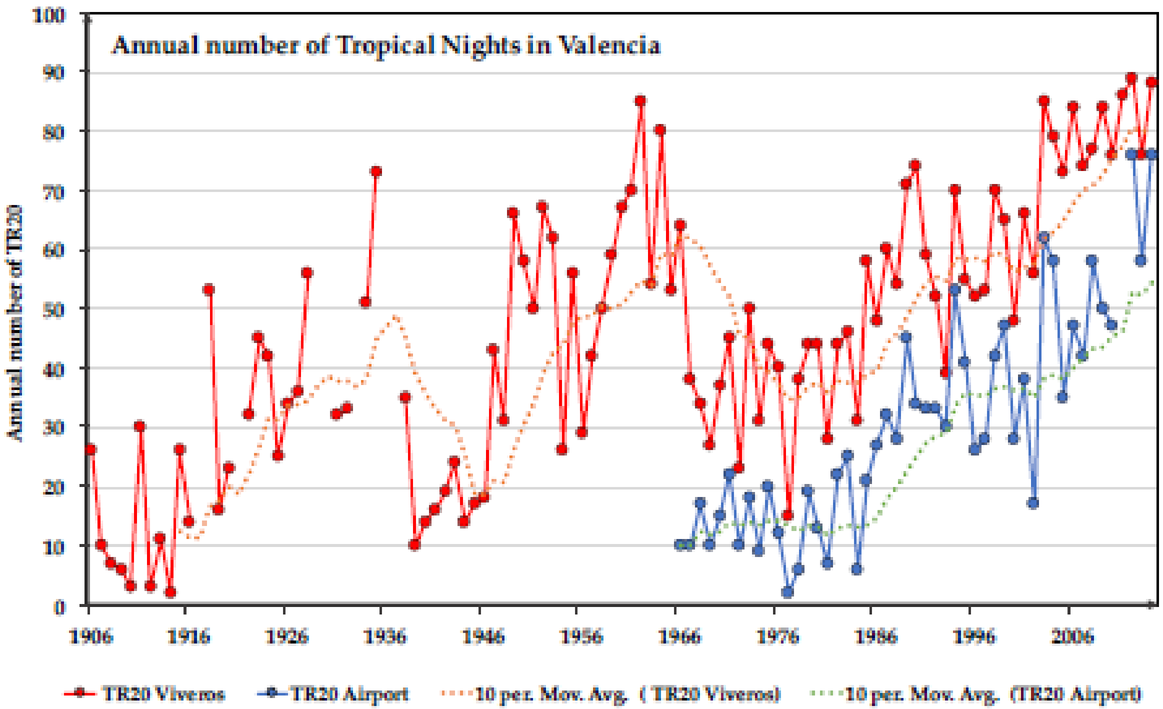
1987



2009

Valencia city

The urban heat island effect in the city of Valencia: a case study for hot summer days.
A. Lehoczky, J. A. Sobrino, D. Skoković and E. Aguilar. *Urban Sci.* **2017**, *1*(1), 9;
doi:10.3390/urbansci1010009



The annual number of ***tropical nights*** *(Tmin > 20.0 °C) at the airport and at the city centre (Viveros)*

- Significant increasing trend in mean temperature (0.23 °C per decade) between 1906 and 2014
- The number of warm days and warm nights increased, while the number of cool days and cool nights decreased
- The occurrence of cold spells drastically decreased in the second part of 20th century, while warm spells have become more common after 1997.

“Dual-use European Security IR Experiment 2008”

DESIREX 2008

Contract No. 21717/08/I-LG

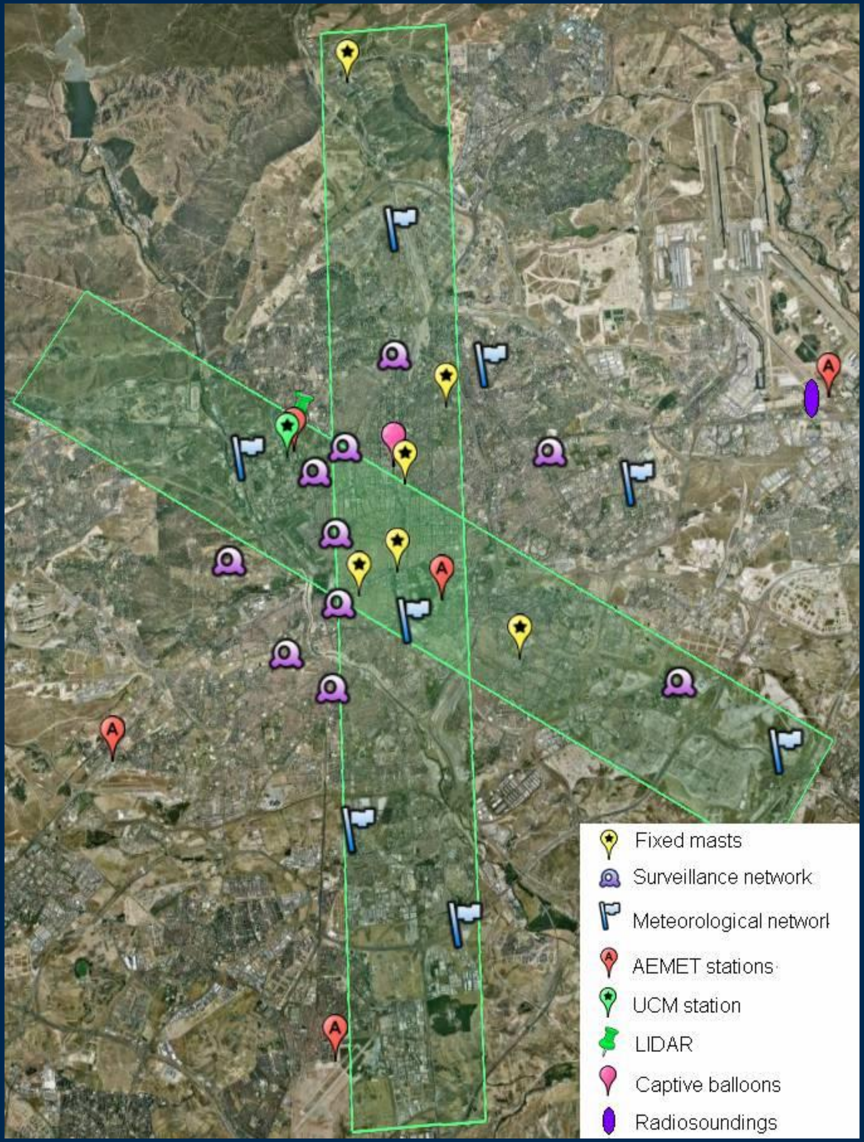
J. A. Sobrino (IP)

[1], G. Sòria[1], J. C. Jiménez-Muñoz[1], R. Oltra-Carrió[1], J. Cuenca[1], V. Hidalgo[1], B. Franch[1], C. Mattar[1], M. Romaguera[1], Y. Julien[1], R. Bianchi[2], M. Paganini[2], A. Fernández-Renau[3], J. A. Gómez[3], E. de Miguel[3], Ó. Gutiérrez[3], M. Jiménez[3], E. Prado[3], R. Rodríguez[3], I. Ruiz[3], F. Nerry[4], G. Najjar[4], P. Kastendeutch[4], M. Pujadas[5], F. Molero[5], J. F. Moreno[6], L. Alonso[6], F. Fernández[7], E. Galán[7], R. Cañada[7], E. Hernández[8], J. Hidalgo[9], J. Á. Acero[9], J. M. Romero[10], F. Moya[10], L. Gimeno[11]

[1]University of València – Global Change Unit (GCU) [2] European Space Agency (ESA), [3]Instituto Nacional de Técnica Aeroespacial (INTA), [4]Louis Pasteur University – LSIIT , [5]CIEMAT, [6]University of València – Laboratory of Earth Observation Unit (LEO), [7]Universidad Autónoma Madrid (UAM), [8]Universidad Complutense Madrid (UCM), [9]Labein-Tecnalia (LABEIN), [10] Madrid City Council, [11]University of Vigo.

Participantes:50

23 Junio al 6 julio 2008



DESIREX 2008 field campaign:

• Founded by the ESA

• Coordinated by the Global Change Unit (GCU) from the University of Valencia (UVEG)

• Data acquisition in collaboration with different European teams

Data acquired:

•Airborne data with the AHS sensor covering two different patterns

•Spaceborne images:
ASTER/TERRA, AATSR/ENVISAT, MODIS/TERRA and AQUA, TM/Landsat, AVHRR/NOAA and SEVIRI/MSG.

•Atmospheric and ground parameters:
air temperature, surface temperature, wind speed and direction, emissivity and reflectivity of urban and rural surfaces, radiation balance. (In situ measurements, fixed masts and car transects)

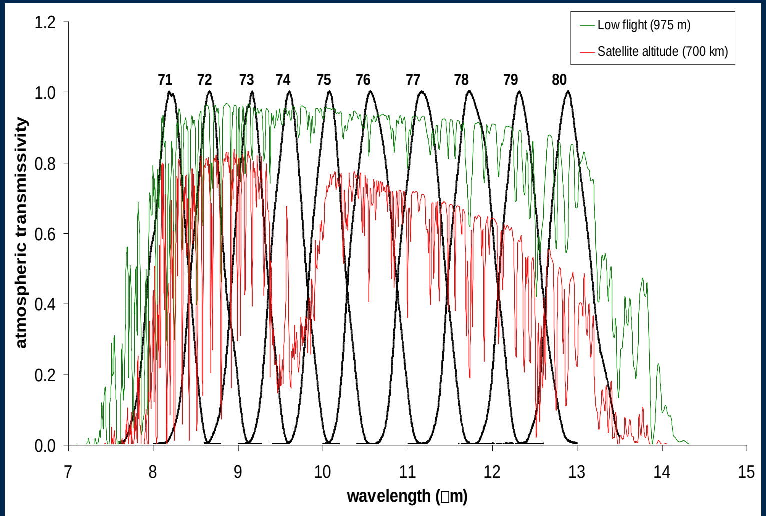
Oeste-Este (Pozuelo-Vallecas), Sur-Norte (Getafe-UAM). Cruzan Cibeles

AHS (INTA)

Airborne Hyperspectral System (AHS)
Operated by INTA

INTA C-212-200 EC-DUC aircraft

30 Flight Lines
- Time: 11h, 21h, 4h (UTC)
- Spatial resolution: 2, 4, 6 m.
- 1600, 2500, 3400 m altura
- 1000 Km longitud imagenes



80 bands
VNIR,SWIR, MIR,TIR

THERMOPOLIS 2009 field campaign:
• Founded by the ESA
• Coordinated by the Centre for Research and Technology Hellas (Greece)
• Ground measurements team: Global Change Unit (GCU) from the University of Valencia (UVEG)

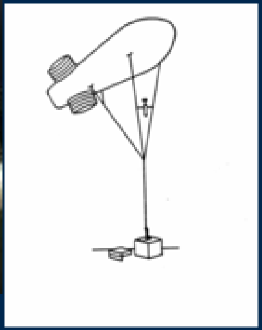
Data acquired:
•Airborne data with the AHS sensor covering 4 different patterns (see images) and the AEROPHOTO data acquisition system.

•Spaceborne images:
ASTER, ATSR and AATSR, MODIS, TM/Landsat, CERES, CALIPSO, AVHRR and SEVIRI.
•Atmospheric measurements.
Vertical profile soundings, aerosol measurements
•Reference Meteorological data
Air temperature, radiation balance
•Radiometric cal/val ground measurements (see image for the 3 cla/val points):
surface temperature, emissivity and reflectivity of urban and rural surfaces

DATOS ATMOSFERICOS

RADIOSONDEOS

2 diarios en Barajas, measuring: Pressure, Temperature, Relative Humidity, Wind direction, Wind Speed, …

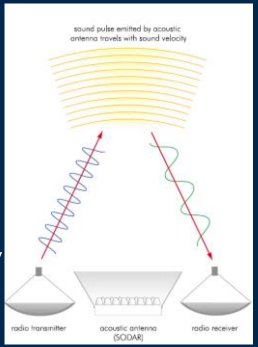


CAUTIVOS

Coincidently with AHS flights, launched at Nuevos Ministerios. Measuring Wet and Dry Temperature, Pressure, Relative Humidity, Wind Speed and Wind direction

SODAR-RASS

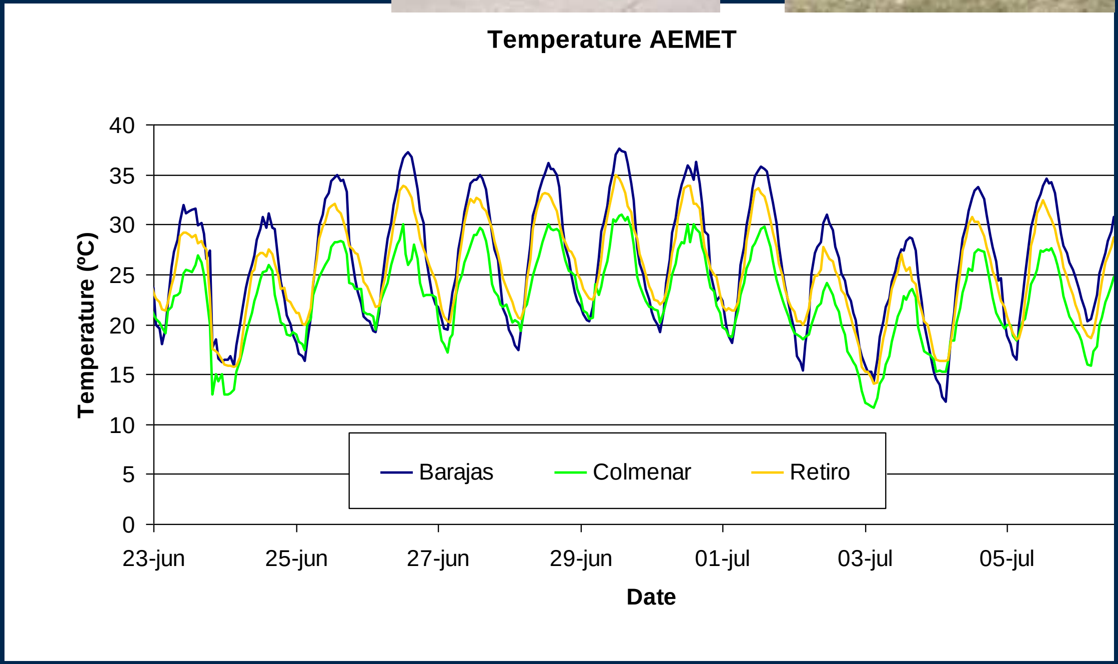
Every 20 min, **in the Almudena Cemetery**. Measuring wind speed, wind direction, mixed layer depth, temperature, atmospheric stability



Air Temperature

AEMET :

Station name
Madrid-Parque Retiro
Madrid Barajas
Madrid-Cuatro vientos
Madrid Getafe
Madrid-Ciudad Universitaria
Madrid -Torrejón de Ardoz
Arganda
Colmenar Viejo



Daily evolution during DESIREX

Cal/Val Activities DESIREX 2008

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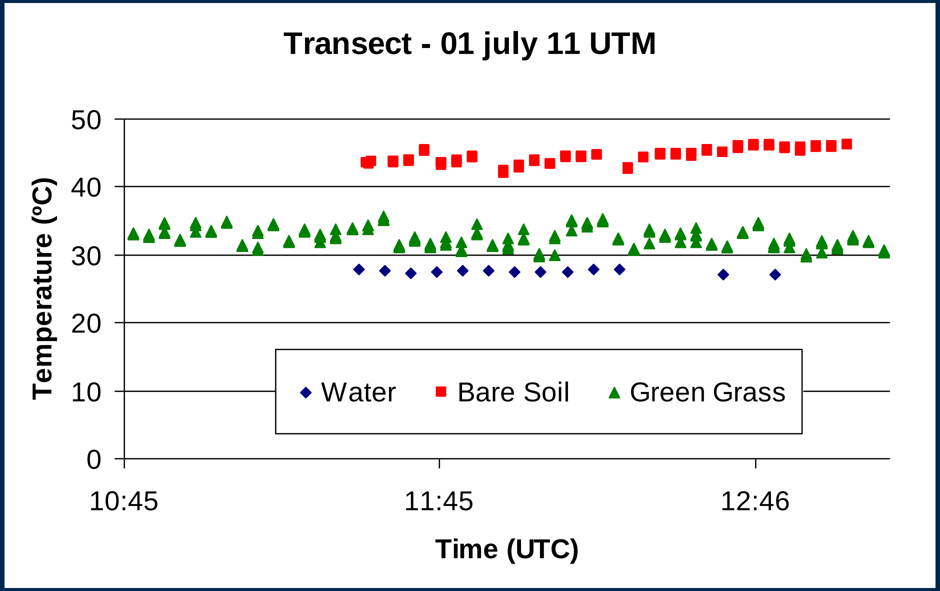
Green grass (Rugby field) at UAM

Bare soil (Soccer field) at UAM

Royal Palace (concrete)

Retiro Park (Water)

Reflectance and Surface Temperature measured simultaneously with the airborne/satellite overpass



Continuous measurements in masts. DESIREX 2008

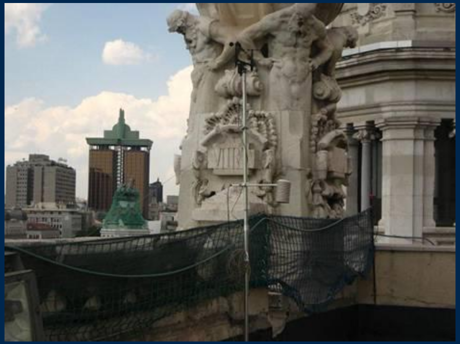
UAM

Continuous measurement of Air Temperature, Relative Humidity, Wind speed and direction, Radiometric temperature

Fireman Park

CSIC

SITE	
Rural /sub-Urban	UAM
Rural /sub-Urban	Fireman park
Urban Dense	CSIC
Urban Dense	New City Hall
Urban Dense	Printing
Urban Medium	Dpt. Cartography



Printing

New City Hall

Dpt. Cartography

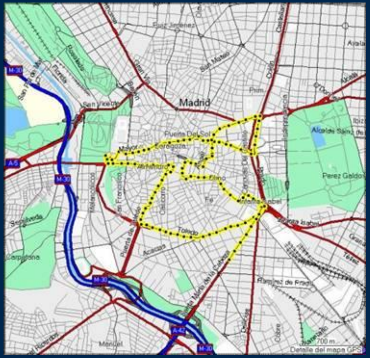
Mobile transects. DESIREX 2008

Daily car transects in four different routes, three times per day at 4h, 11h and 22h UTC

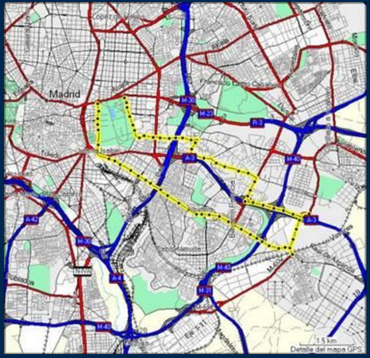
Measurements of Air Temperature, Air Humidity and Radiometric Temperature.

Transect 1: North South

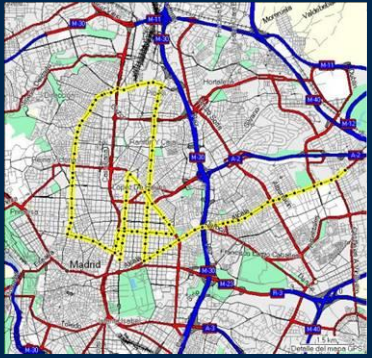
Transect 2: City Center

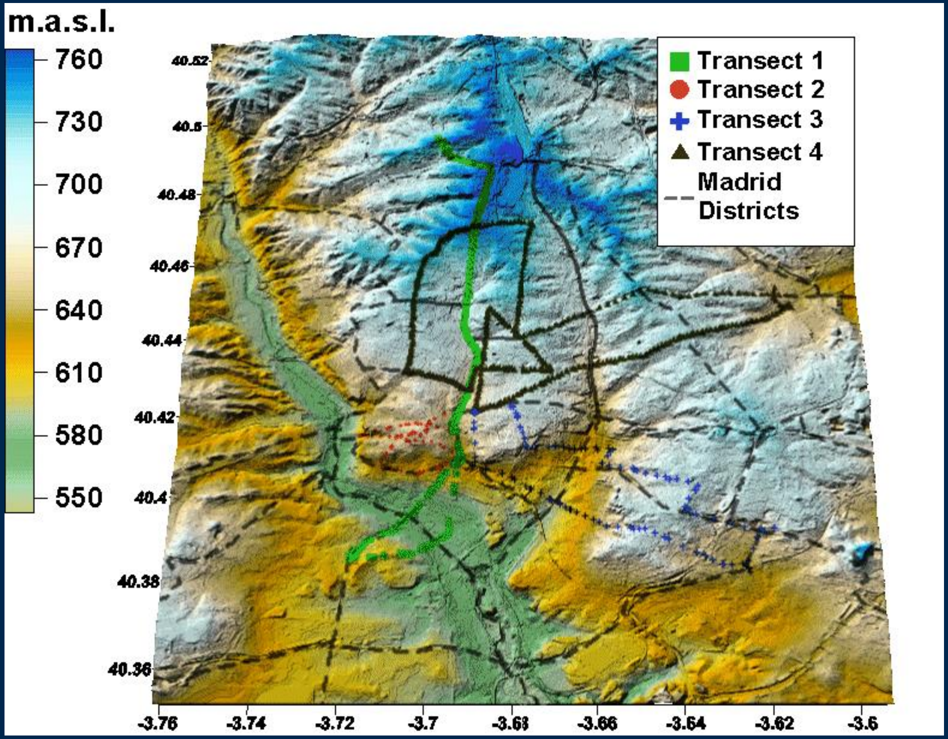


Transect 3: Vallecas



Transect 4: Salamanca





GROUND MEASUREMENTS

TRANSECTS WITH CARS

Tair and Hr sonde

Thermal Radiometer

GPS (f=10 sec)

Datalogger

Tair, Hr, Trad (f=5sec)

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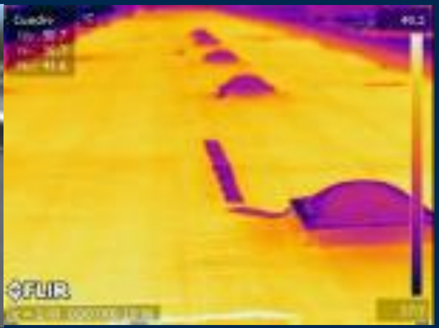
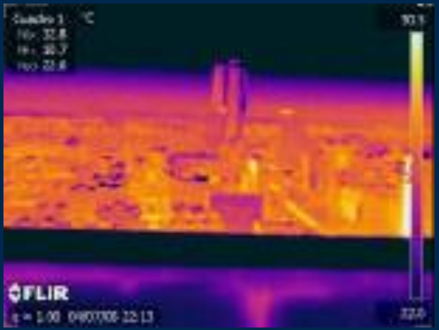
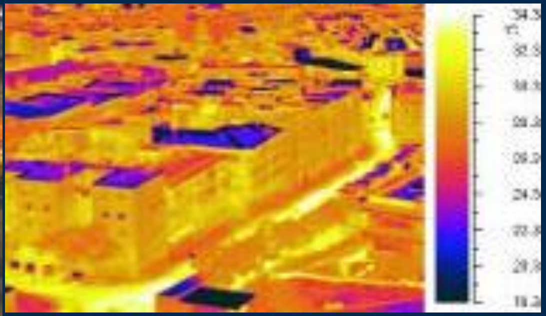
Urban Thermography images. DESIREX 2008

Urban thermography images from different urban structures obtained during the AHS overpass

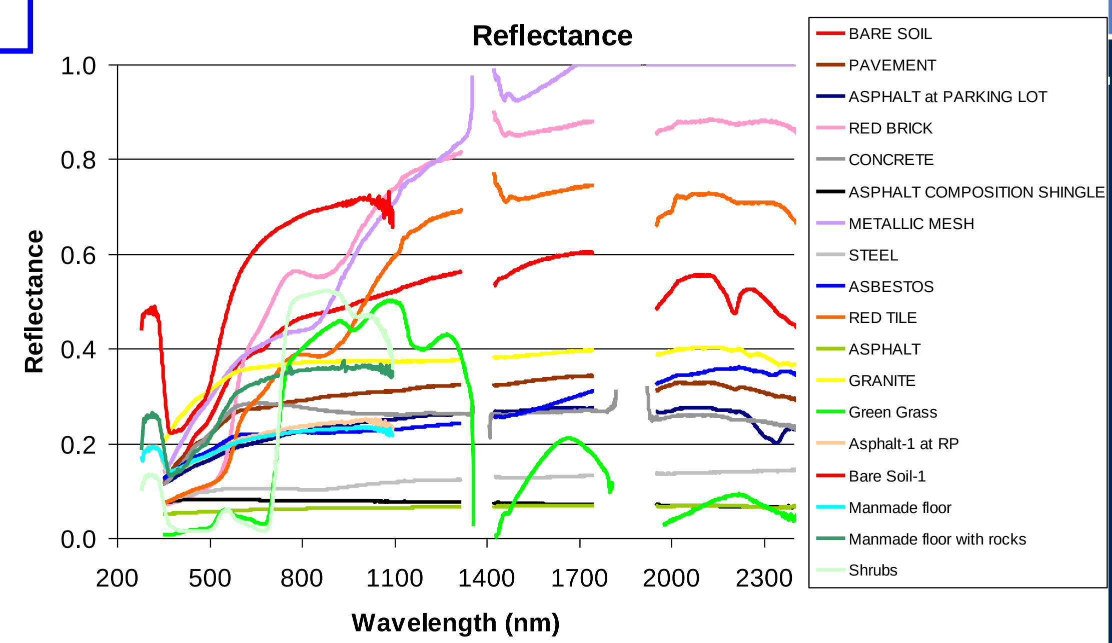


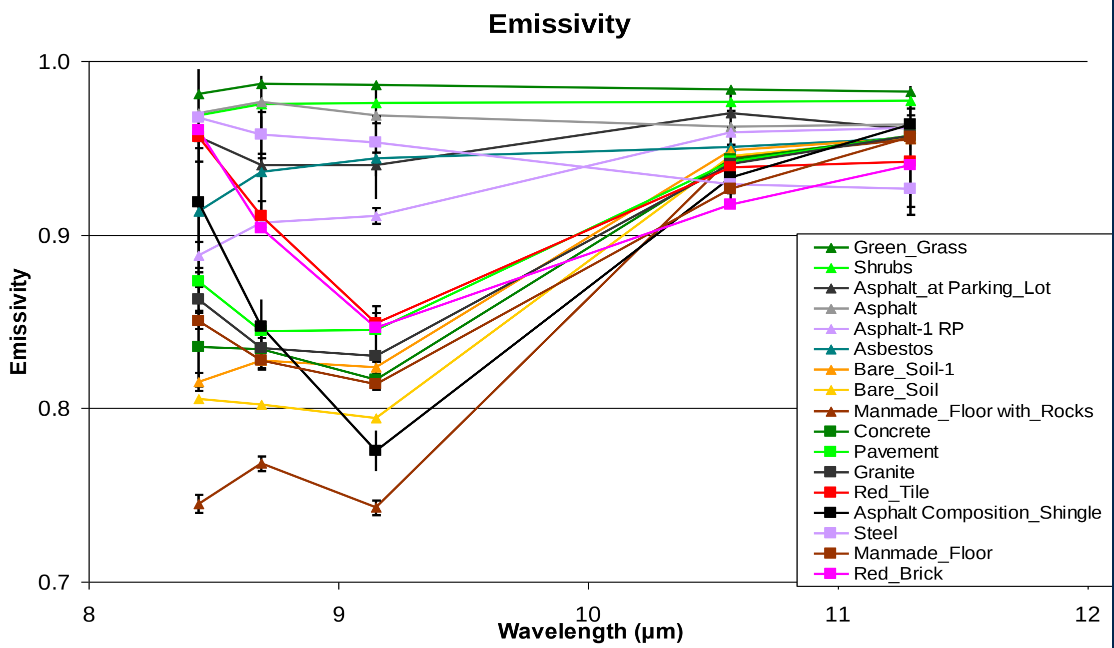


Spectral Library DESIREX 2008

Spectral Library of representative urban surfaces was obtained





Spectral Library THERMOPOLIS 2009

Green grass

Bare Soil

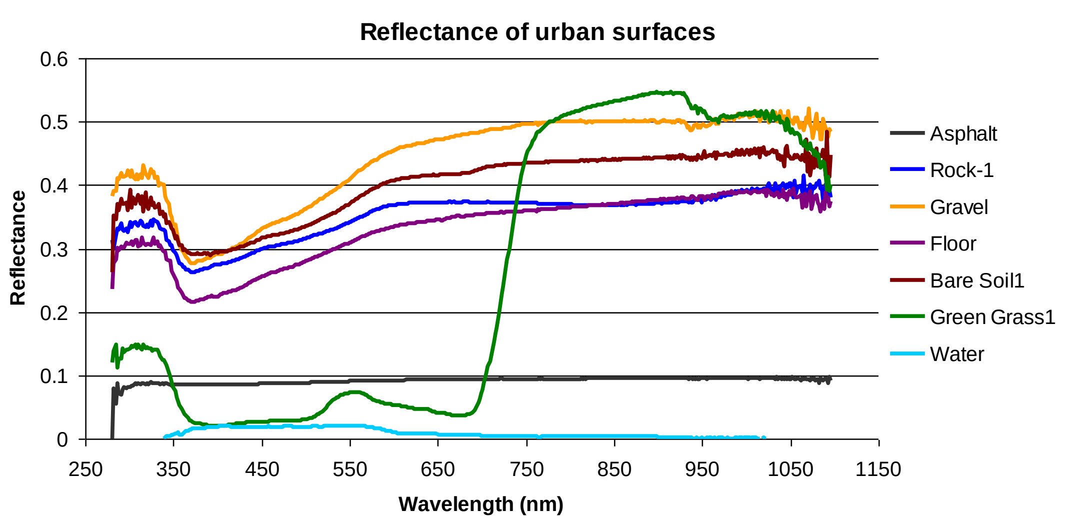
Gravel

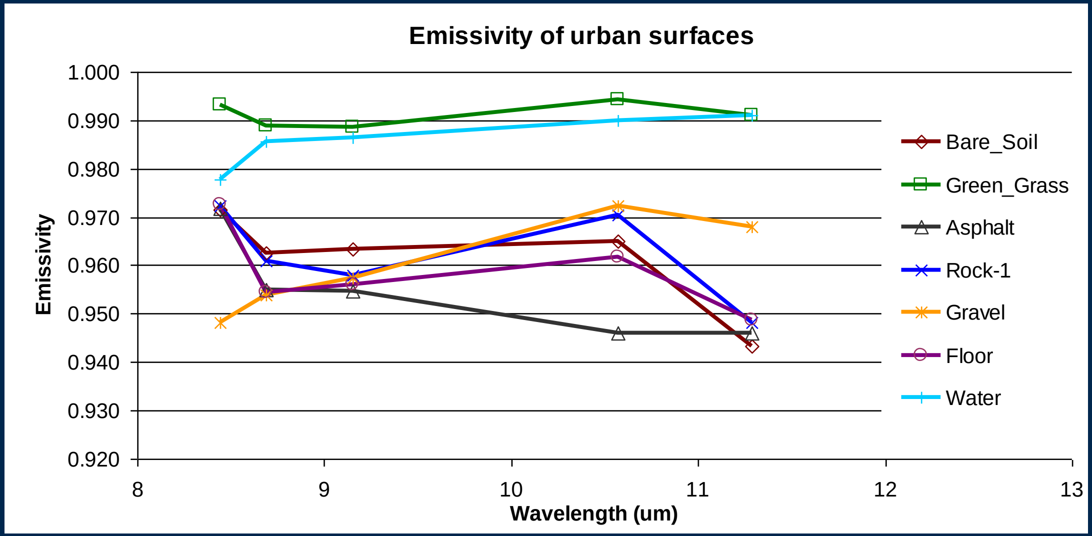
Floor

Asphalt

Rock

Water





Spectral Library of representative urban and rural surfaces was obtained

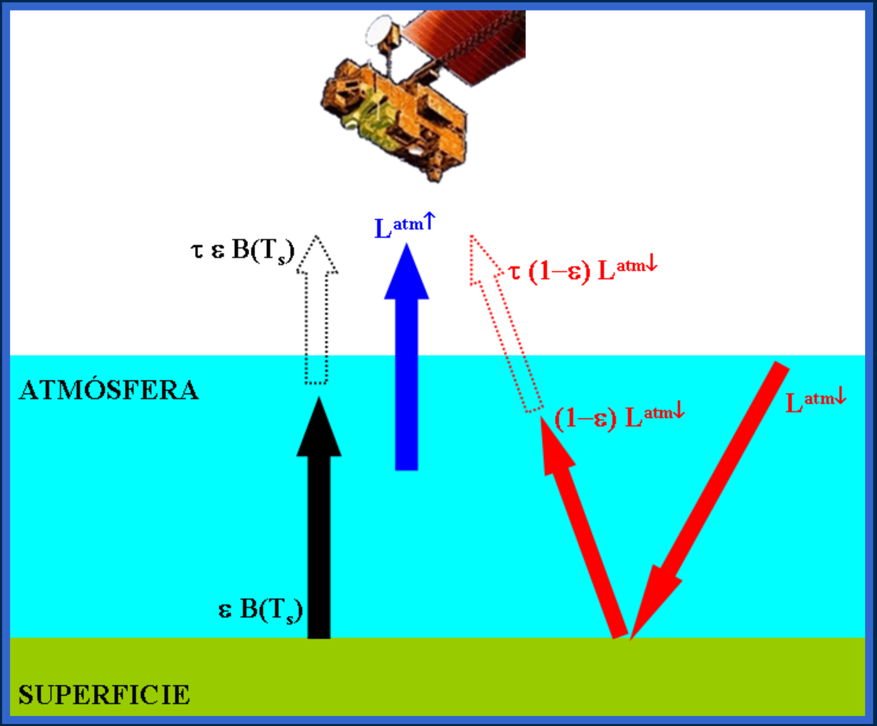
LAND SURFACE TEMPERATURE

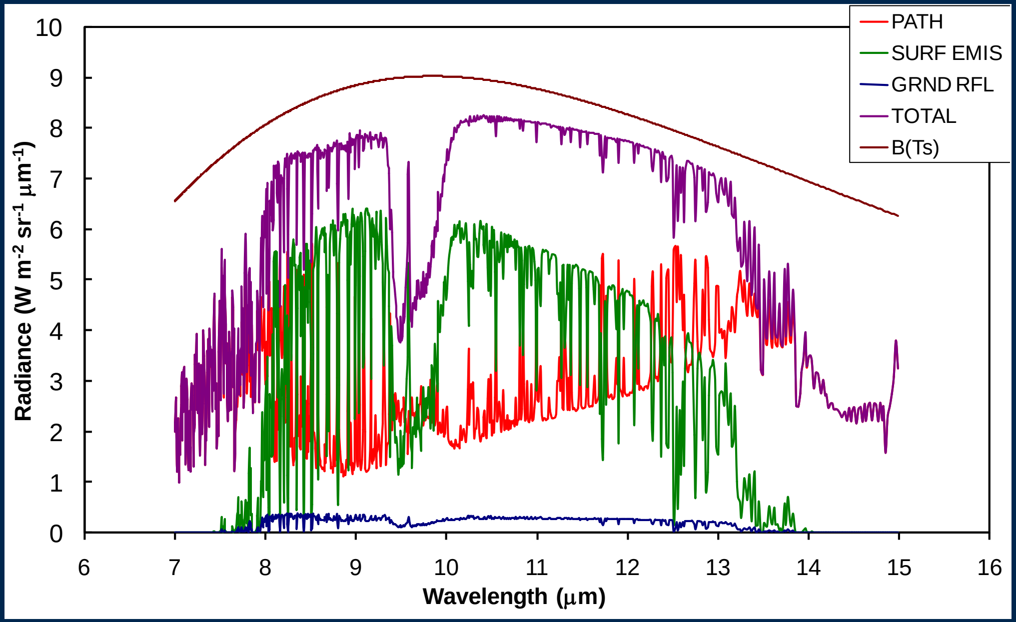
RADIATIVE TRANSFER EQUATION IN THE TIR RANGE (8-14 μm)

$$L_\lambda^{sen} = \left[\varepsilon_\lambda B_\lambda(T_s) + (1-\varepsilon_\lambda) L_\lambda^{atm\downarrow} \right] \tau_\lambda + L_\lambda^{atm\uparrow}$$

$(\lambda \rightarrow i)$

B: Planck's law
Brightness temperature: $L^{sen} \equiv B(T^{sen})$
LST: **Ts**





Methodology

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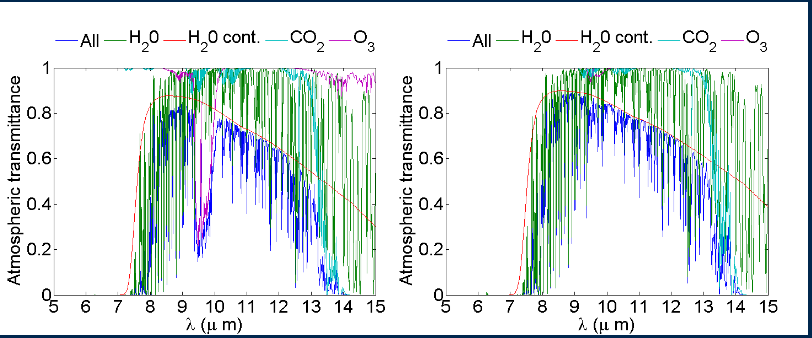

All the atmosphere Flight altitude (1860 m)

+ MODTRAN

$$L_i(T_i) = L_{g,i}\tau_i + L_i^{\uparrow}$$

$$L_{g,i} = \varepsilon_i B_i(T_s) + (1-\varepsilon_i)L_i^{\downarrow}$$

$$L_{g,i} = \frac{L_i(T_i) - L_i^{\uparrow}}{\tau_i}$$

LSE retrieval

NDVI^{TM*}

Input: ρ_{red} ; ρ_{NIR}

$$\varepsilon_i = \begin{cases} a_i + b_i\rho_{red} & \text{if NDVI} < 0.2 \\ \varepsilon_{v,i}P_v + \varepsilon_{bs,i}(1-P_v) + C_i & \text{if } 0.2 \le \text{NDVI} \le 0.5 \\ 0.99 & \text{if NDVI} > 0.5 \end{cases}$$

* Sobrino, J. A., et al. 2008. IEEE TGRS, 46.

TES**

Input: $L_{g,TIR}$

AHS TIR channels: 72, 73, 75, 76, 77, 78, 79

$\varepsilon_{min}=0.999-0.777MMD^{0.815}$

* * Gillespie, A. et al. 1998. IEEE TGRS, 36(4).

TISI***

Input: $L_{g,MWIR}$; $L_{g,TIR}$ night and day

$$\varepsilon_j = \left(\frac{\varepsilon_i}{TISIE_{ij}}\right)^{n_j/n_i}$$

i=channel in the MWIR region (AHS :66)
j=channel in the TIR region

*** Becker, F. Li, Z.-L., 1990. RSE, 32.

LST retrieval

Split Window

Input: w, LSE, T_{sensor}

$$T_s=T_i+0.723(T_i-T_j)+0.04275(T_i-T_j)^2-0.08463+(45.49-5.17w)(1-\varepsilon)+(-60.81+16.93w)\,\Delta\varepsilon$$

i=AHS band 75
j=AHS band 79

LST from AHS DESIREX

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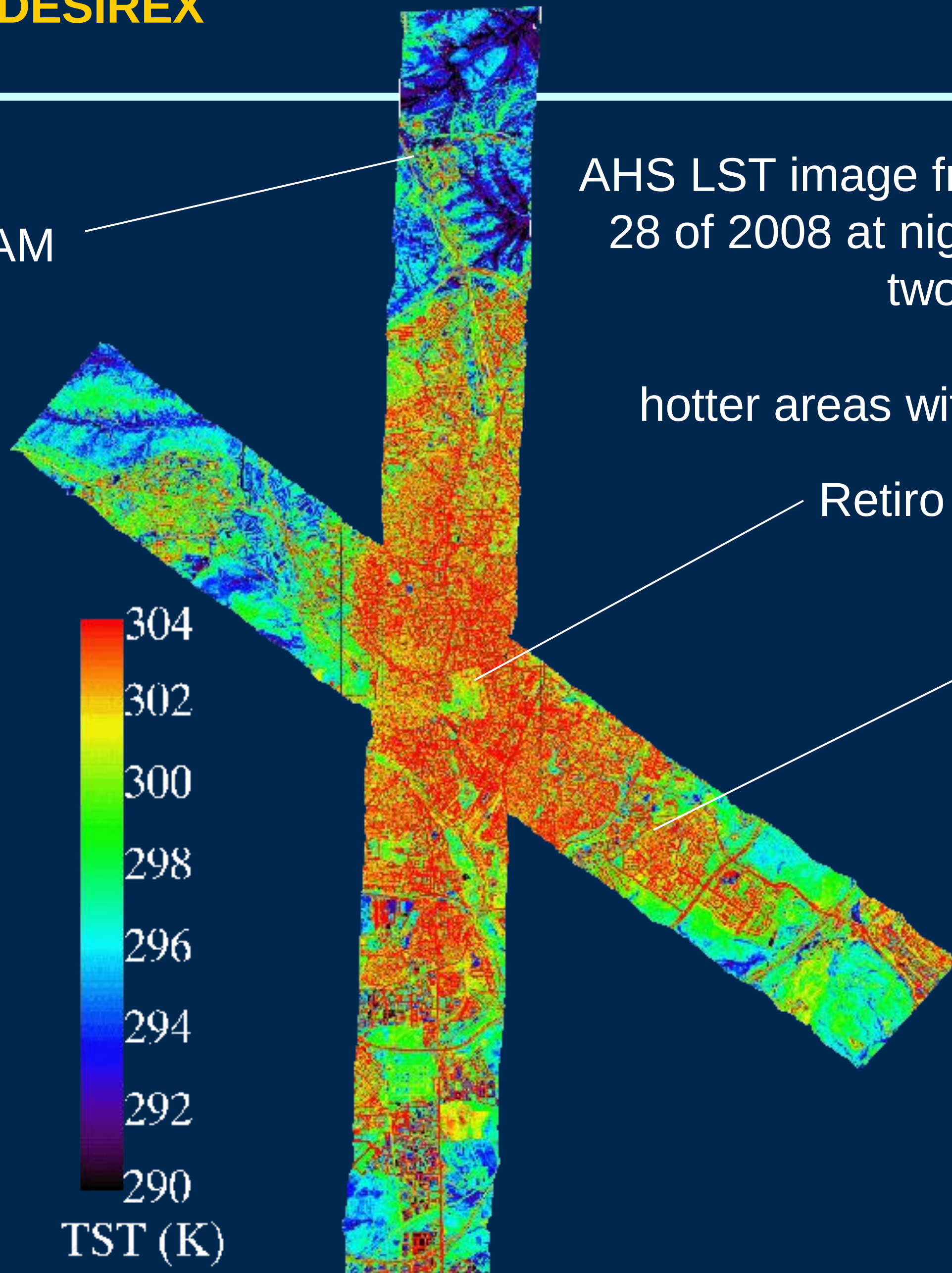
AHS LST image from TES algorithm. June 28 of 2008 at night time (composition of two patterns)

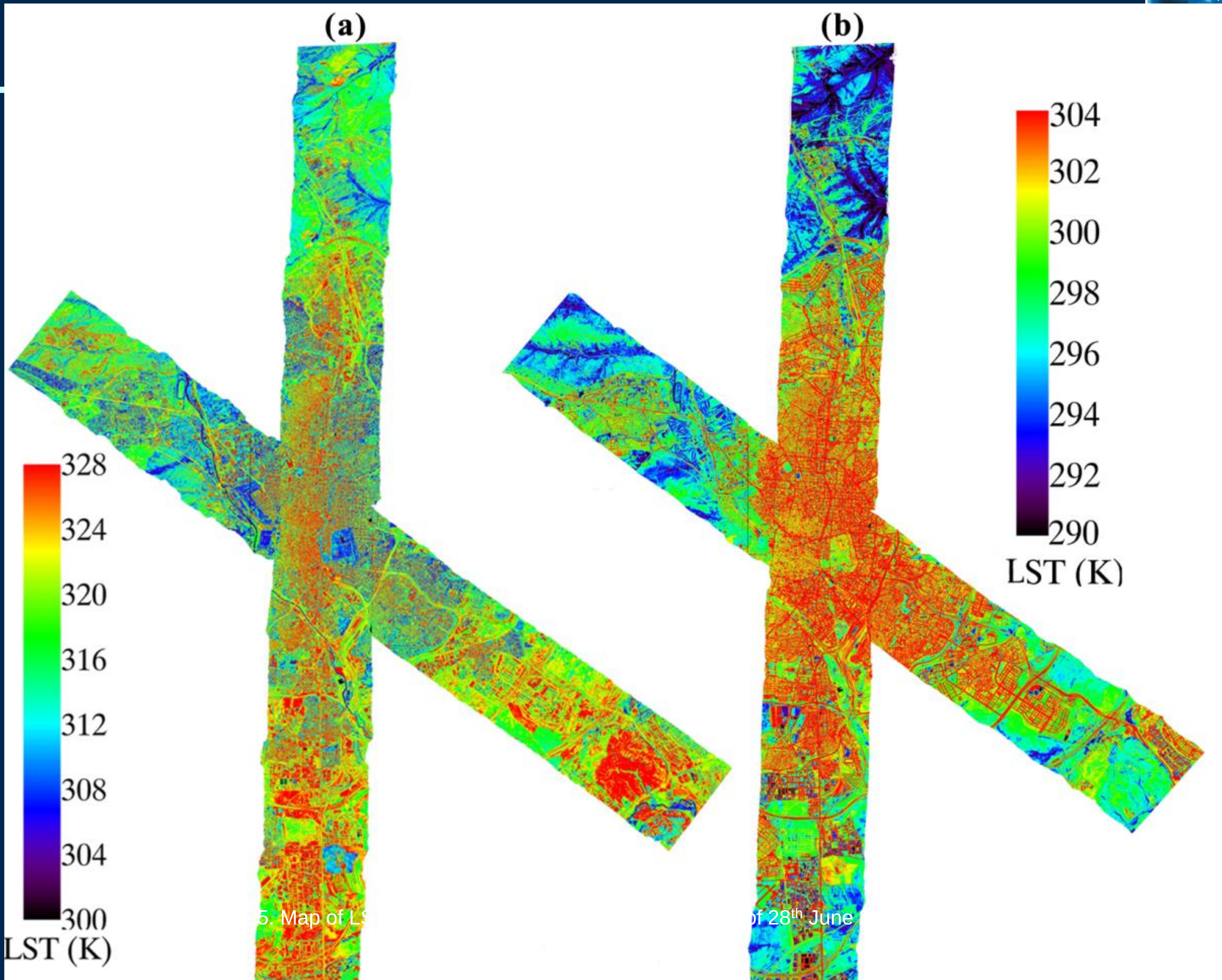
hotter areas within the city center



It corresponds to a night image and we can realize that the urban zone is warmer than its surroundings

•Land Surface Temperature (**LST**) and Land Surface Emissivity (**LSE**) have been retrieved from TIR bands by applying TES algorithm (Gillespie et al., 1998).

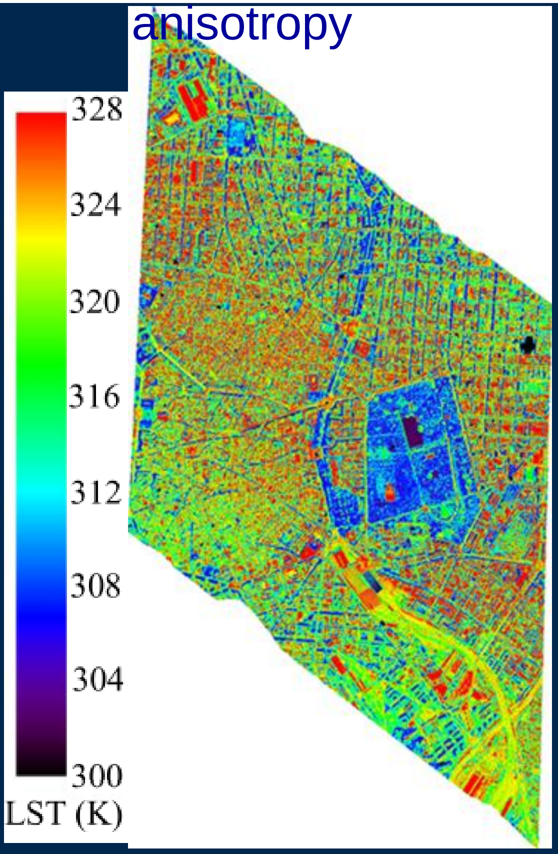
•Validation activities were developed successfully. For day measures the obtained validation RMSE is 3 K due to the presence of shadows. For **night flights** the RMSE improves obtaining a **validation RMSE of 1.4 K**



5. Map of LS … of 28th June

LST maps: Intersected area DAY

Urban surface anisotropy



P01I1 Overpass
(NW to SE
11:32 UTC)

<u>Seen surfaces:</u>
•Shadowed northern walls
•Shadowed areas south-north streets

P02I1 Overpass
(S to N
11:53 UTC)

<u>Seen surfaces:</u>
•Sunlit southern walls
•Shadowed areas south-north streets
•Eastern walls (left)
•Western walls (right)

LST maps: Intersected area NIGHT

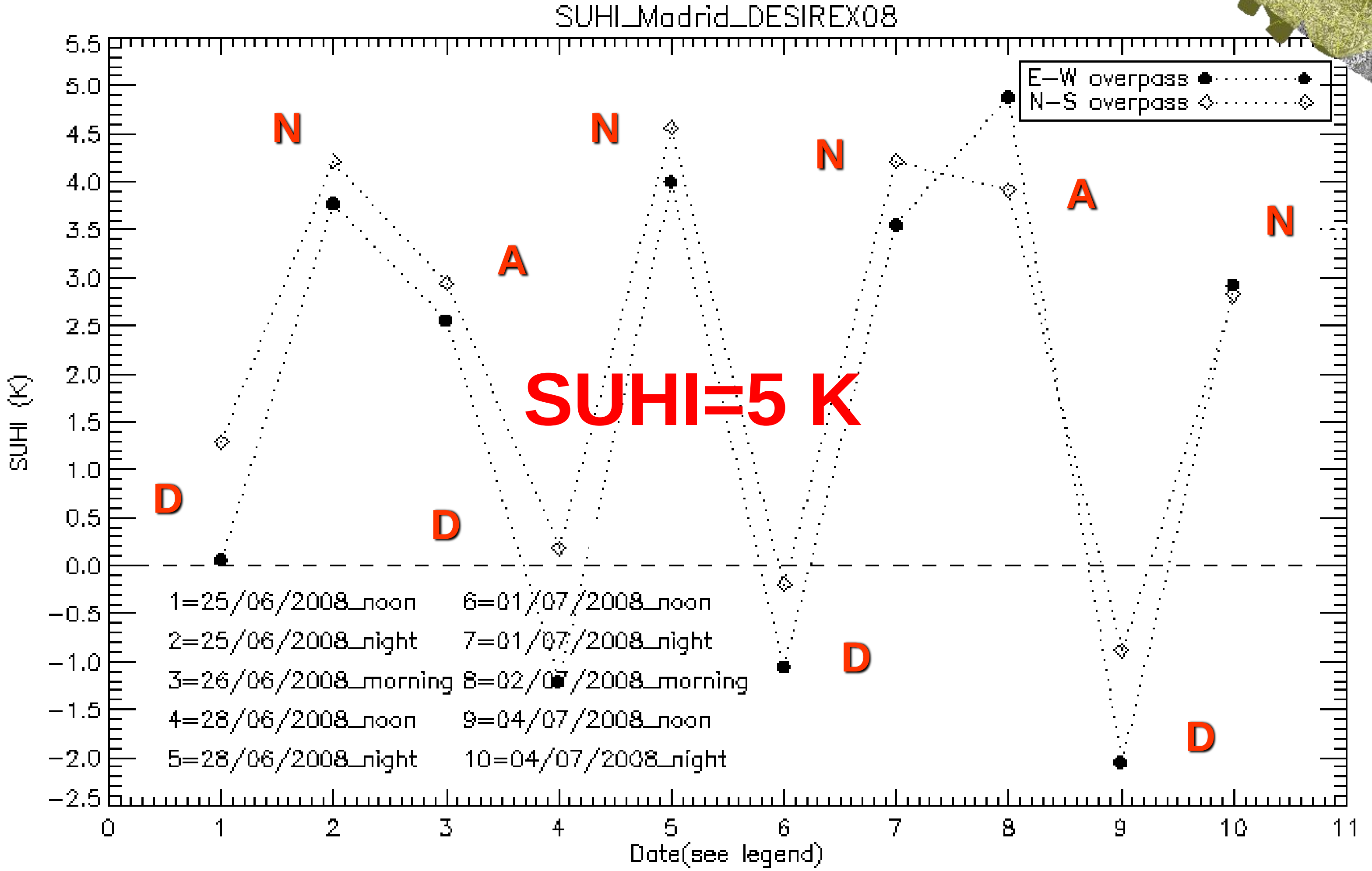
Urban surface anisotropy

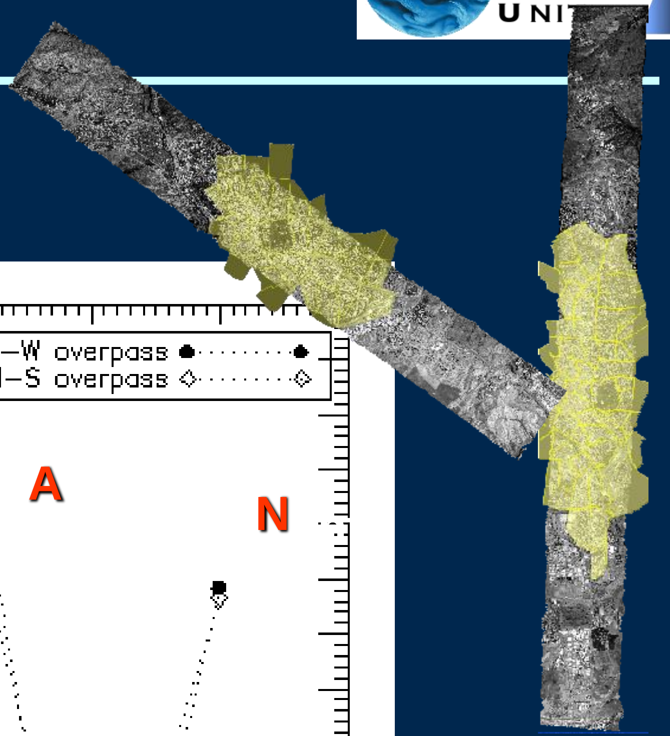
•No significant differences between both overpasses.

At night the LST retrieval is less affected by the time of acquisition and the geometry of observation

Evolution SUHI from AHS LST- DESIREX

$$SUHI = LST_{Urban} - LST_{Rural}$$





D 12 UTC

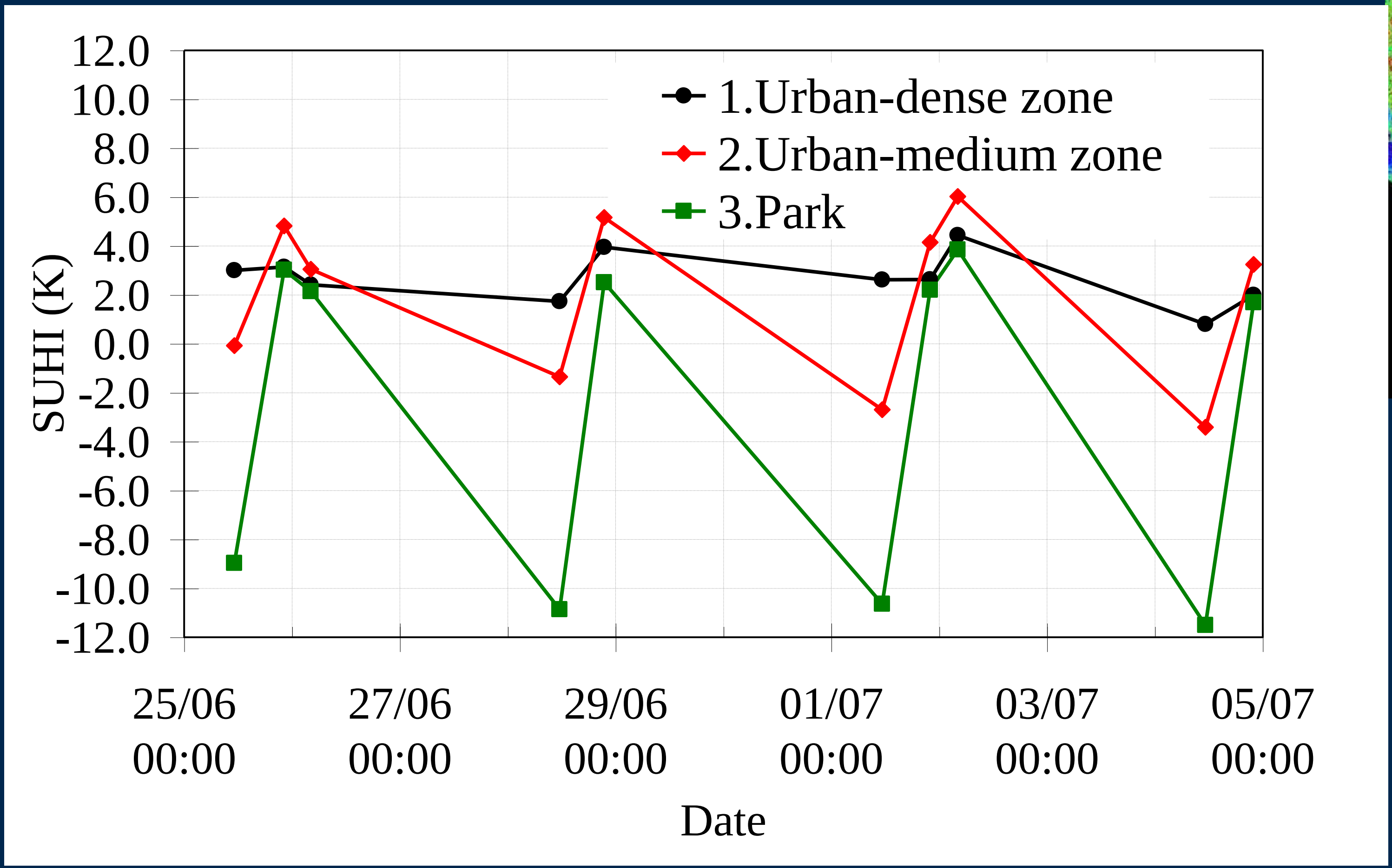
N 23 UTC

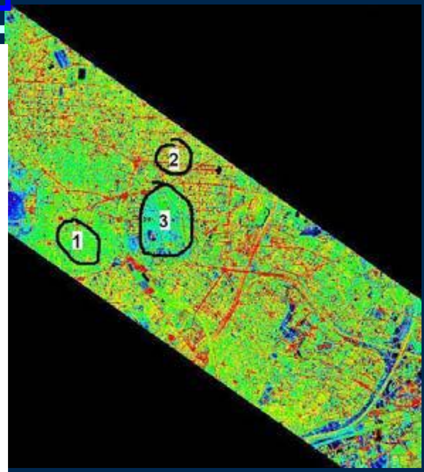
A 5 UTC

At noon SUHI D< 0

Night and Morning SUHI N-A> 0

Evolution of SUHI effect from AHS LST images. DESIREX 2008





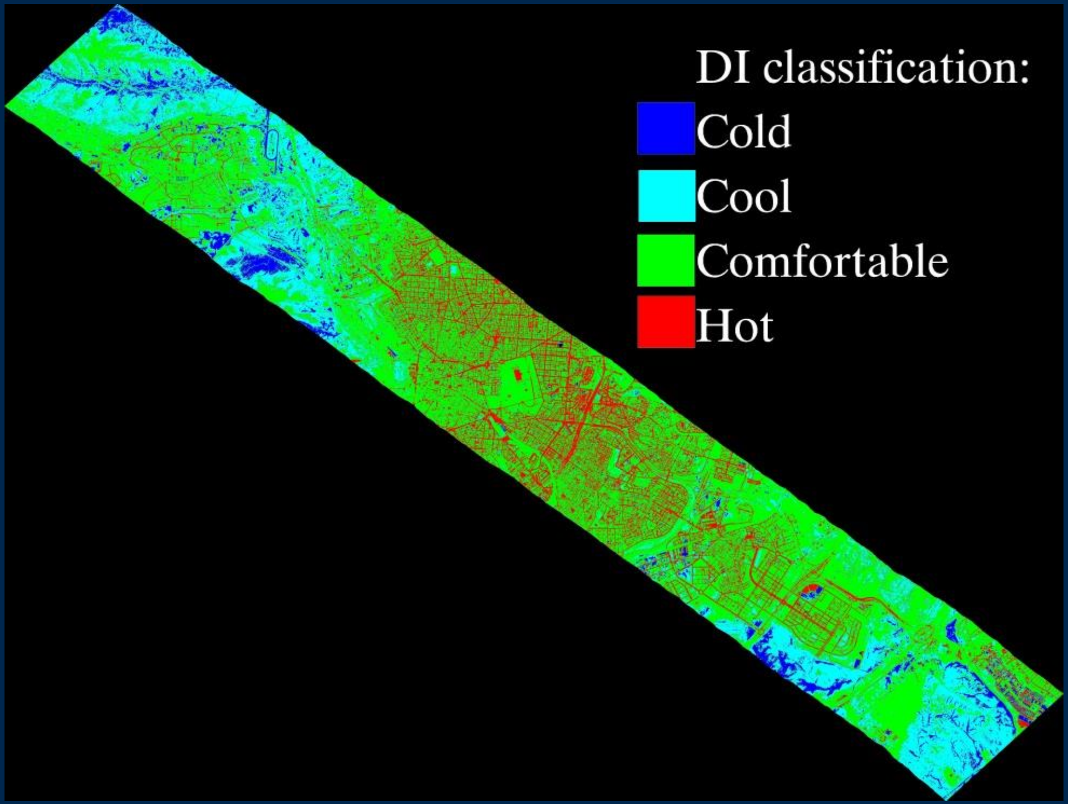
- Urban-dense zone: SUHI > 0 (always)
- At nigth $SUHI_{\text{urban-dense zone}}$ is around 1-2 K lower than $SUHI_{\text{Urban-medium dense}}$
- Park ⟶ Green areas mitigate the SUHI effect

Discomfort Index

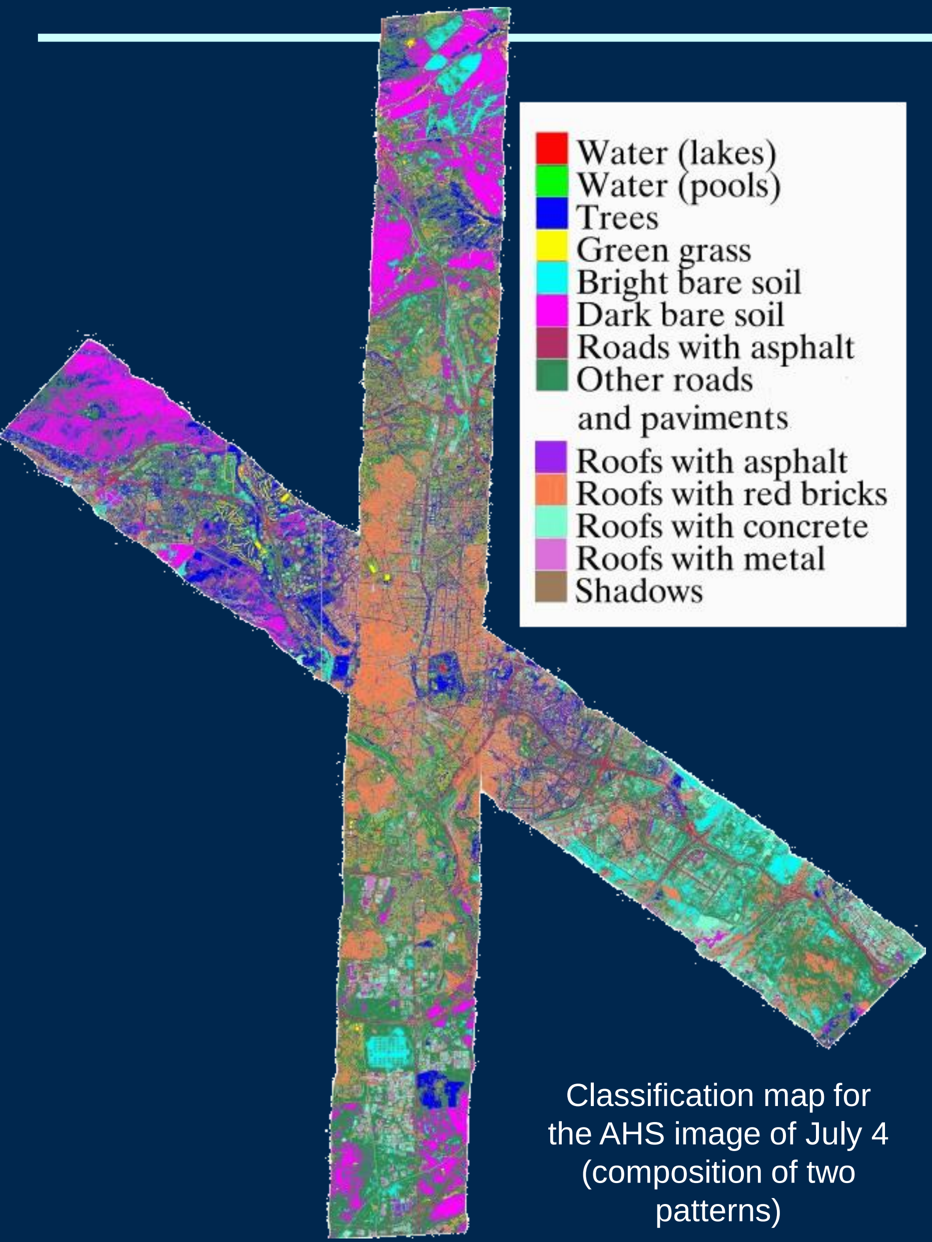
$$DI(^{o}C) = t - (0.55 - 0.0055f)(t - 14.5)$$

July 2nd, morning time
f = 32%

DI categories	DI temperature (ºC)
Hyperglacial	<-40
Glacial	-39.9 to -20
Extremely cold	-19.9 to -10
Very cold	-9.9 to -1.8
Cold	-1.7 to +12.9
Cool	+13 to +14.9
Comfortable	+15 to +19.9
Hot	+20 to +26.4
Very hot	+26.5 to +29.9
Torrid	>+30



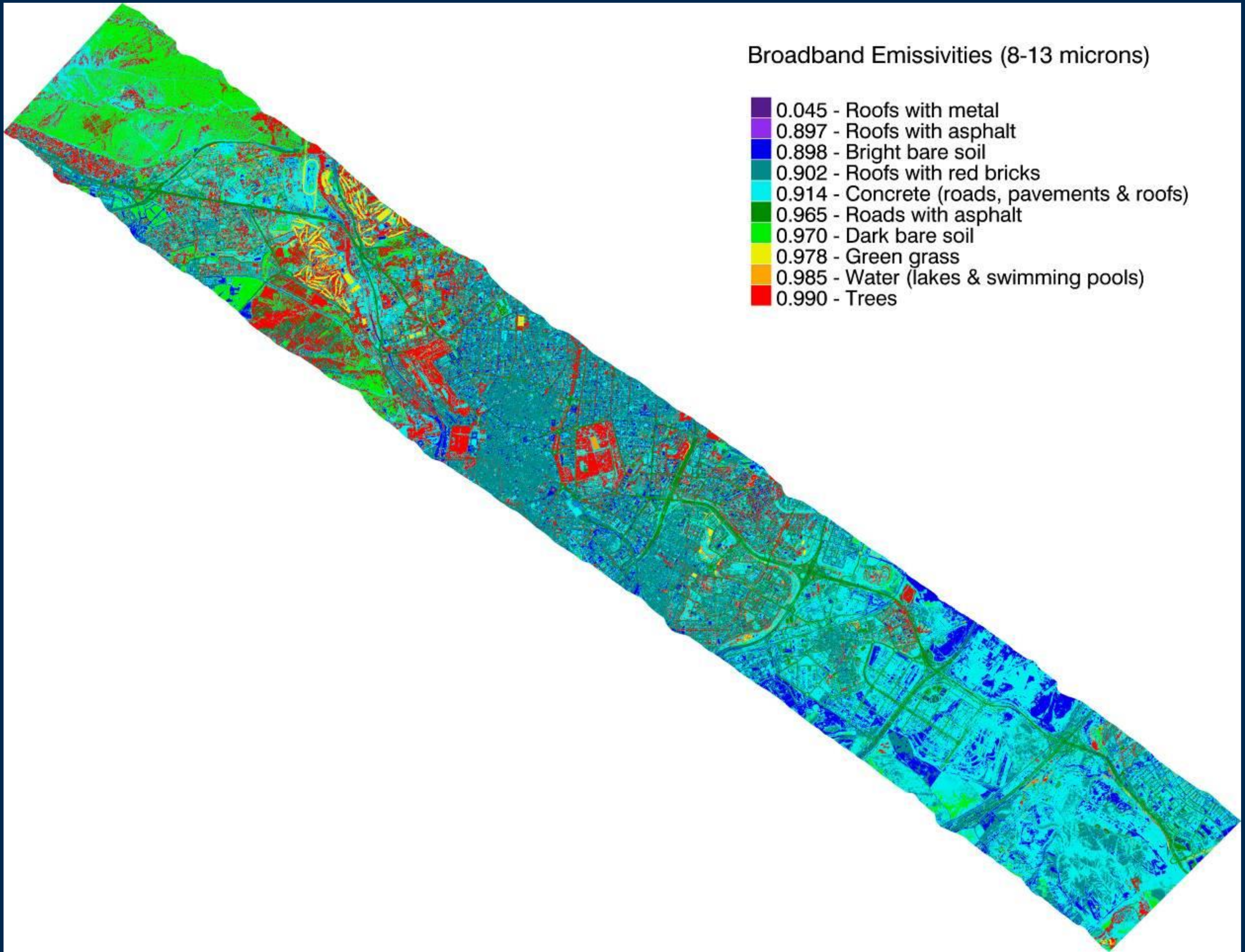
Classification

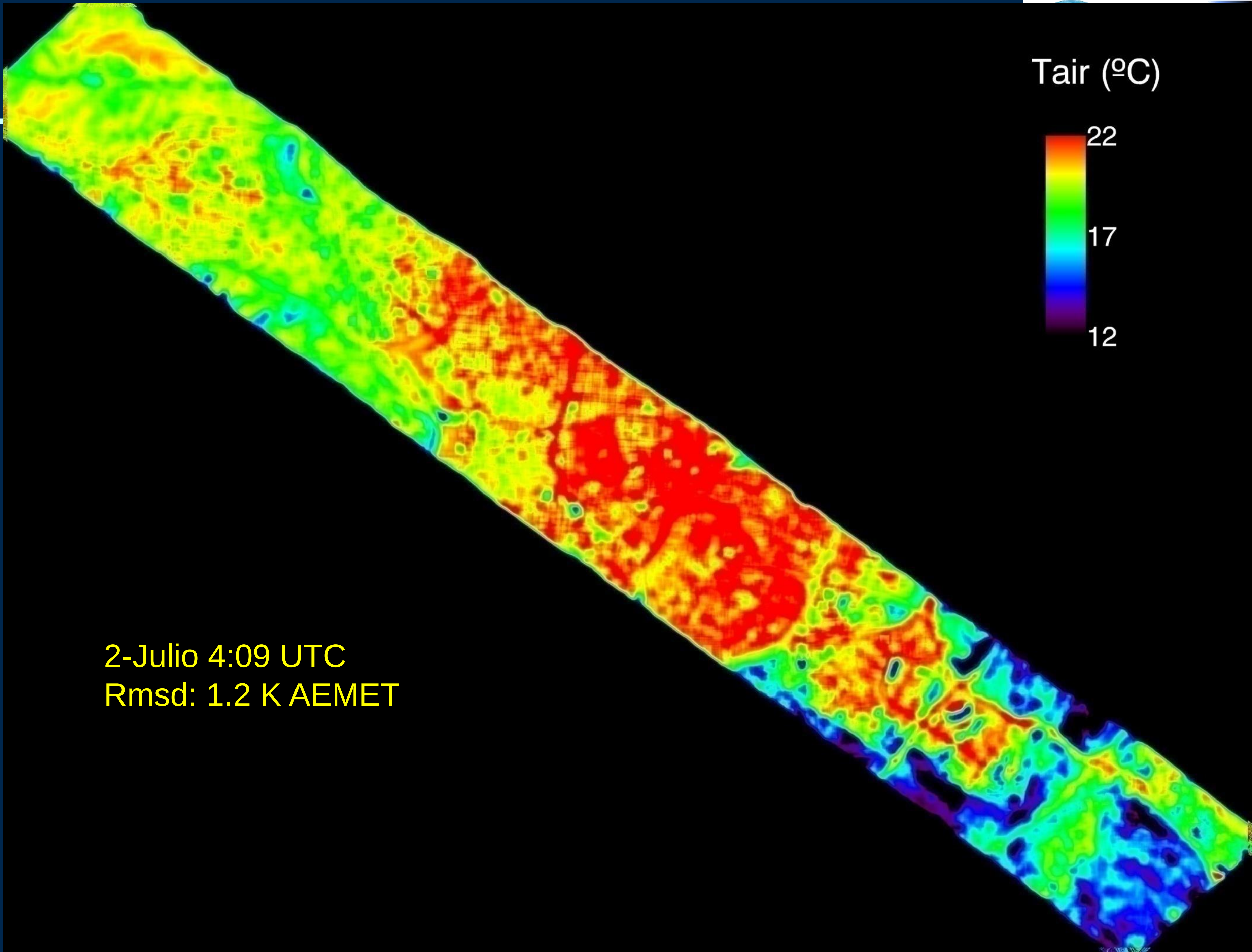


Classification map for the AHS image of July 4 (composition of two patterns)

- A **supervised classification** process using the ***Maximum Likelihood*** method as a decision rule has been considered.
- **Training classes** have been defined taking into account the in-situ measurements and also by visual inspection.
- The classification has been performed **using** at-sensor radiance values measured with the **80 spectral bands** of the AHS sensor.
- **12 classes** (plus shadows) have been differenciated.
- Validation: 200 independent regions results give a **κ** value of around **70 %.**

EMISSIVITY

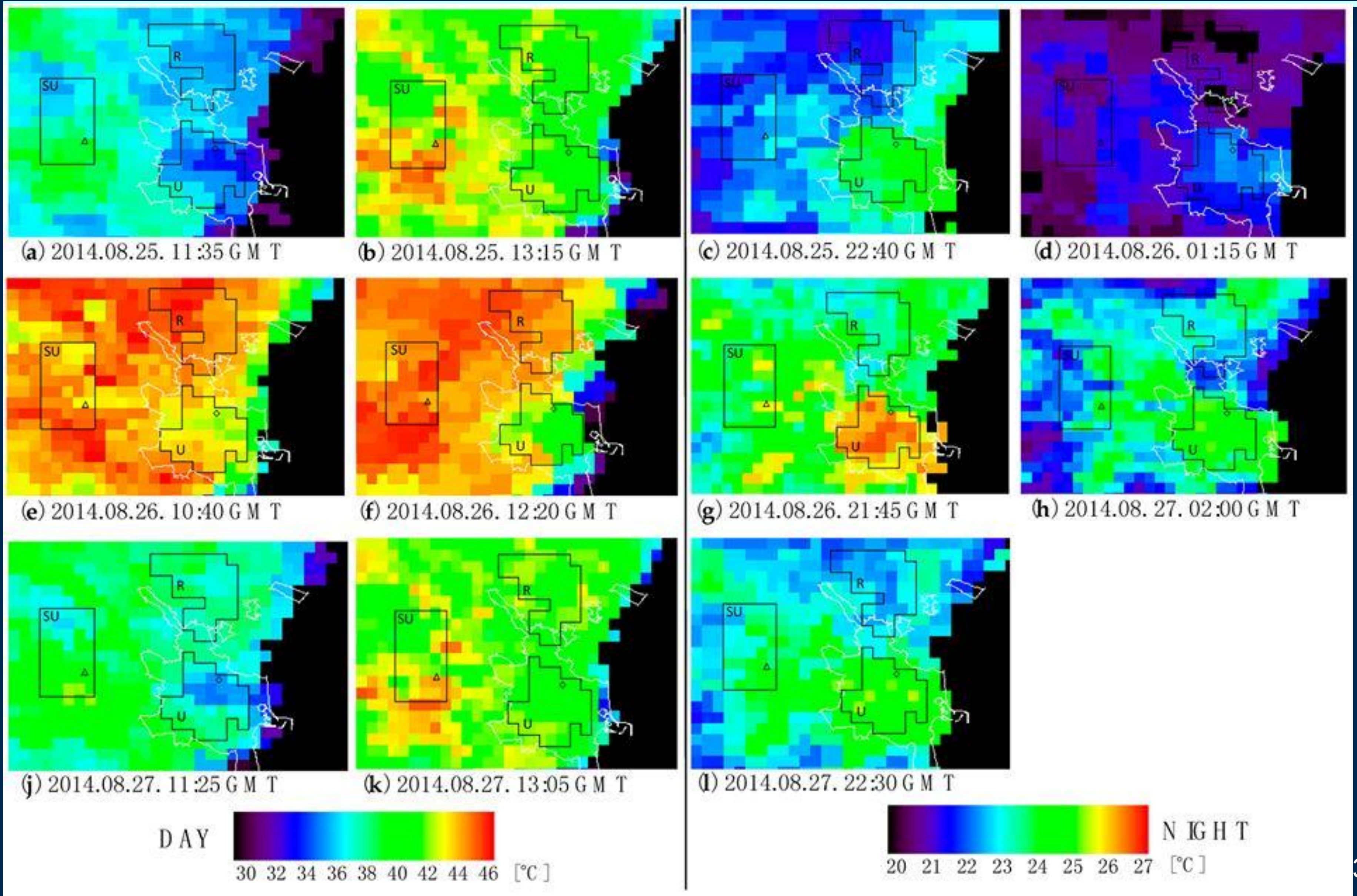

Broadband Emissivities (8-13 microns)
0.045 - Roofs with metal
0.897 - Roofs with asphalt
0.898 - Bright bare soil
0.902 - Roofs with red bricks
0.914 - Concrete (roads, pavements & roofs)
0.965 - Roads with asphalt
0.970 - Dark bare soil
0.978 - Green grass
0.985 - Water (lakes & swimming pools)
0.990 - Trees

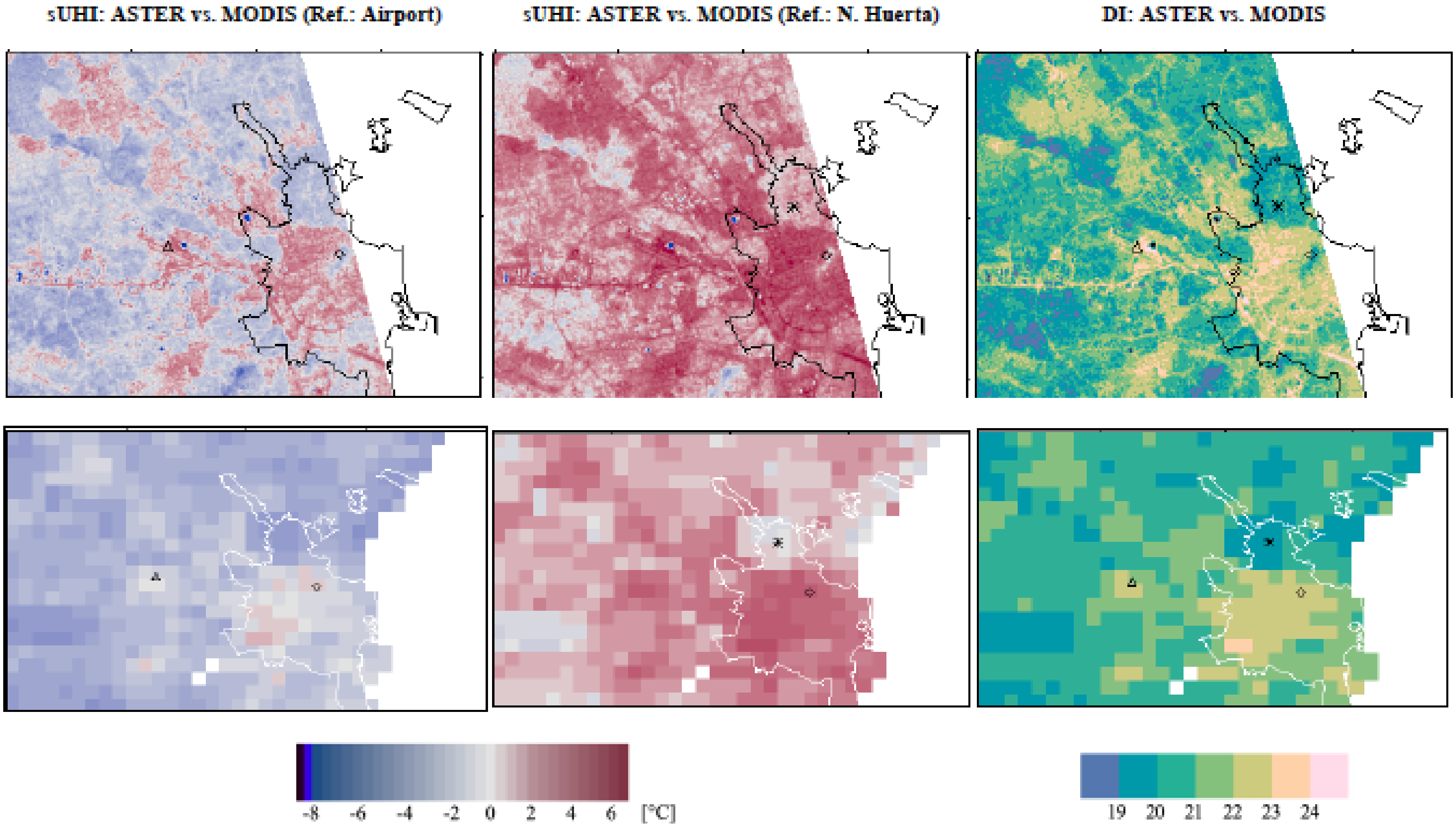

Tair (ºC)
22
17
12
2-Julio 4:09 UTC
Rmsd: 1.2 K AEMET

The urban heat island effect in the city of Valencia: a case study for hot summer days.
A. Lehoczky, J. A. Sobrino, D. Skoković and E. Aguilar. *Urban Sci.* **2017**, *1*(1), 9; doi:10.3390/urbansci1010009

GLOBAL CHANGE UNIT

SUHI-Valencia (MODIS 25-27 August 2014). 3K





High-resolution nighttime sUHI and DI during a summer night (28 June 2014).

→ less comfortable areas in the densely built up city centre, main traffic arteries and industrial zones

→ the urban and rural reference points need to be chosen prudently

→ high-resolution satellite images with more frequent data acquisition time are needed

COPERNICUS

http://land.copernicus.eu/
http://land.copernicus.eu/global/products/lst GLOBAL (LST- 5 km)

http://land.copernicus.eu/local/urban-atlas/view 2006, 2012

http://climate.copernicus.eu/
http://climate.copernicus.eu/sectoral-information-system
https://climate.copernicus.eu/urbansis-climate-information-european-cities
a method to downscale climate and impact indicators to the urban scale (~1x1km^2)

http://urbansis.climate.copernicus.eu/ Stockholm, Bologna, Rotterdam

http://atmosphere.copernicus.eu/catalogue/#/ aerosols (at. Correction Satellite images…)

Copernicus Global Land Service

Providing bio-geophysical products of global land surface

Copernicus Europe's eyes on Earth

GLOBAL CHANGE UNIT

Home Products News Product Access Viewing

Land Surface Temperature

The Land Surface Temperature (LST) is the radiative skin temperature of the land surface, as measured in the direction of the remote sensor. It is estimated from Top-of-Atmosphere brightness temperatures from the infrared spectral channels of a constellation of geostationary satellites (Meteosat Second Generation, GOES, MTSAT/Himawari). Its estimation further depends on the albedo, the vegetation cover and the soil moisture.

LST is a mixture of vegetation and bare soil temperatures. Because both respond rapidly to changes in incoming solar radiation due to cloud cover and aerosol load modifications and diurnal variation of illumination, the LST displays quick variations too. In turn, the LST influences the partition of energy between ground and vegetation, and determines the surface air temperature.

The Global Land Service provides the following LST-based products:

- LST: hourly LST from instantaneous observations
- LST10-DC: 10-day Land Surface Temperature with Daily Cycle
- LST10-TCI: Thermal Condidtion Index with a 10-day composite of Land Surface Temperature.

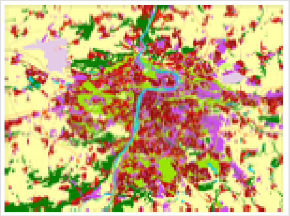
LST product types

Hourly LST | 10-day LST Daily Cycle | 10-day LST TCI

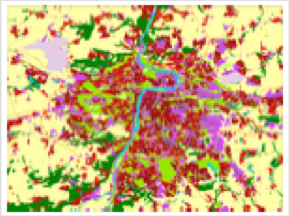
Access | Algorithm | Quality | Application | Technical | Documents | Gallery

Product version	Access	Status	Sensor	Temporal coverage	Spatial information	Timeliness
1	Product portal	Operational	Imagers on-board geostationary satellites	2009 - present, hourly	Global, 5km	Within 4 hours

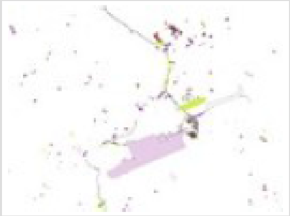
Urban Atlas



Urban Atlas 2006

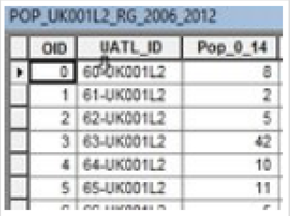


Urban Atlas 2012



Change 2006-2012

Street Tree Layer (STL)



POP_UK001L2_RG_2006_2012

OID	UATL_ID	Pop_0_14
0	60-UK001L2	8
1	61-UK001L2	2
2	62-UK001L2	5
3	63-UK001L2	42
4	64-UK001L2	10
5	65-UK001L2	11

Population estimates by Urban Atlas polygon

The Urban Atlas is providing pan-European comparable land use and land cover data for Functional Urban Areas (FUA). The Urban Atlas is a joint initiative of the European Commission Directorate-General for Regional and Urban Policy and the Directorate-General for Enterprise and Industry with the support of the European Space Agency and the European Environment Agency.

Urban Atlas 2006:

- FUAs with more than 100.000 inhabitants as defined by the Urban Audit. The GIS data can be downloaded together with a map for each urban area covered and a report with the metadata.

Urban Atlas 2012:

- 697 UA 2012 FUAs including 301 existing UA2006 FUAs and 394 new FUAs
- Most EU28 cities over 50,000 inhabitants
- 17 urban classes with MMU 0.25 ha; minor nomenclature changes
- 10 Rural Classes with MMU 1ha
- Street Tree Layer (STL) within Urban Areas for selected FUAs (depending on availability of suitable satellite imageries)

Read more (http://land.copernicus.eu/user-corner/technical-library/copy3_of_technical-library#local)

UrbanSIS - Climate Information for European Cities

home (/)

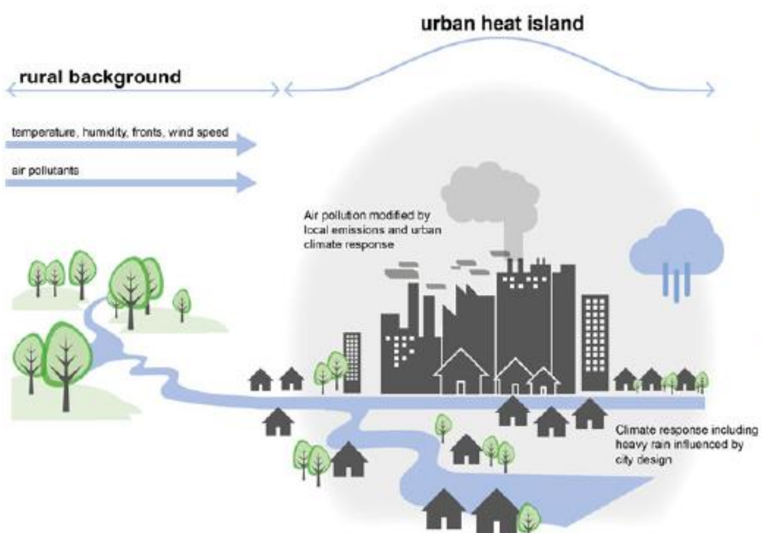
UrbanSIS website
(http://urbansis.climate.copernicus.eu/)

Urban SIS provides city specific climate data and impact indicators in support to the infrastructure and health sectors operating in cities.

The impact of climate change influenced hazards are considered to be of particular concern for urban infrastructure (buildings, transport systems, sewage and drainage systems) exposed to intense rainfall and river flooding as well as for heat waves and air pollution affecting citizen's health.

The objective of Urban SIS (Sectoral Information System) is to develop, demonstrate and put into production a method to downscale climate and impact indicators to the urban scale (~1x1km^2), delivering the information in such format that it is directly useful for consultants and urban engineers/scientists as input to specific/local models or dimensional calculations concerning in particular the following urban hazards:

- Intense rainfall
- Heat waves
- Extreme air pollution levels



Target:

- Major European cities

Pilot demonstrations:

- Bologna
- Stockholm
- Amsterdam-Rotterdam

Sectors:

- Infrastructure
- Health

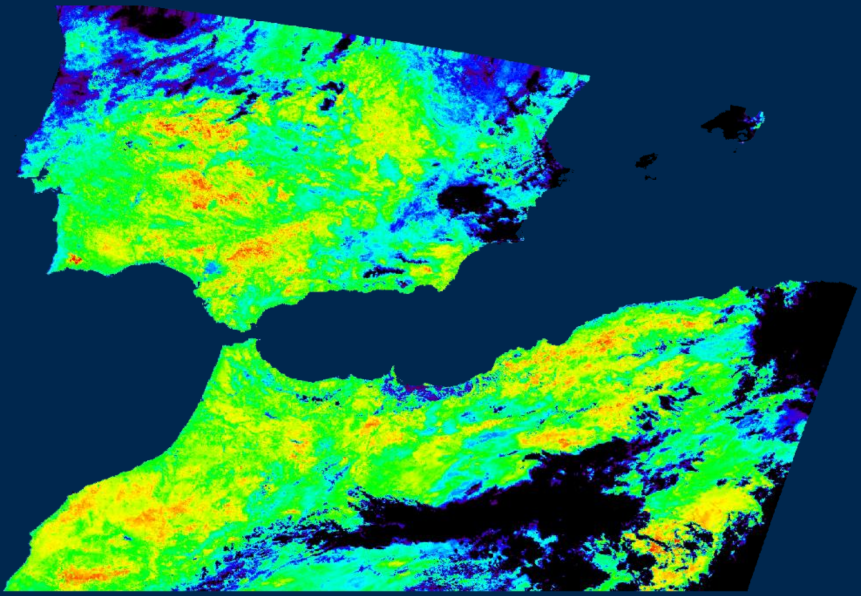
SENTINEL-3

https://sentinel.esa.int/web/sentinel/user-guides/sentinel-3-slstr/product-types/level-2-lst

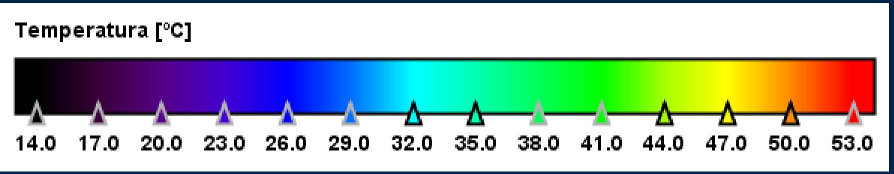
Product Level-2 LST: 1 km LST values and their estimated total uncertainties

Sentinel-3 Pre-Operations Data Hub

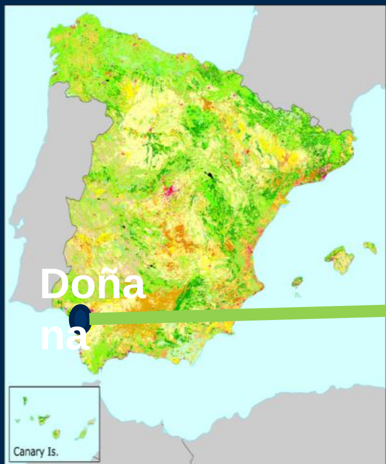
https://scihub.copernicus.eu/s3/#/home



SENTINEL 3 LST 17th August 8



GCU's Test sites:



DOÑANA

		Duque	o
	36.996 N, 6.513 W	36.998 N, 6.434 W	36.946 N, 6.389 W
Field cover	Pine forest	Marshland (water or vegetation)	Marshland (water or vegetation)
Field extension ($km \times km$)	2.5 × 3	> 10 × 10	2 × 5
Measure extension	5 m^2	5 m^2	2 m^2
LST annual Homogeneity (min – max – **mean**) High resolution sensors Low resolution sensors	High res 0.4 – 0.9 – **0.6** Low res 1.0 – 6.5 – **2.5** (Kelvin)	High res 0.2 – 1.1 – **0.6** Low res 0.6 – 3.5 – **0.9** (Kelvin)	High res 0.2 – 1.3 – **0.7** Low res 0.6 – 4.0 – **0.9** (Kelvin)

In the framework of the Working Group of Calibration and Validation (WGCV) , the GCU has managed the setting-up of experimental sites in Spain for the calibration of thermal infrared sensors and the validation of Land Surface Temperature (LST) products derived from stations data.

Efecto Isla de Calor Urbana (ICU) en Sevilla
17 Agosto 2018

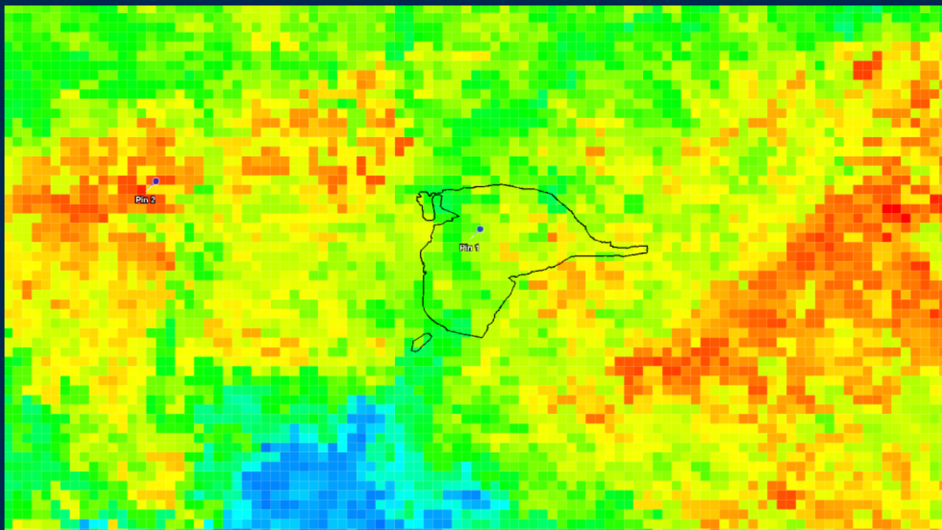
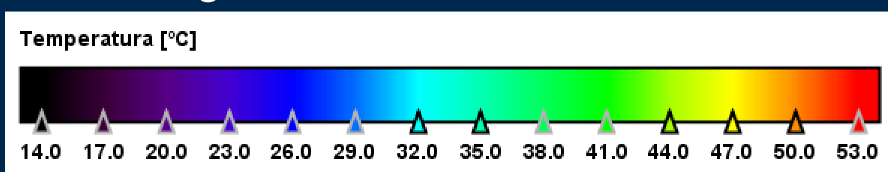


Imagen diurna. 10:27 UTC



Punto	Tipo	Coordenadas
1	Urban	37.40246 N, 5.97959 W
2	Rural	37.44347 N, 6.28261 W

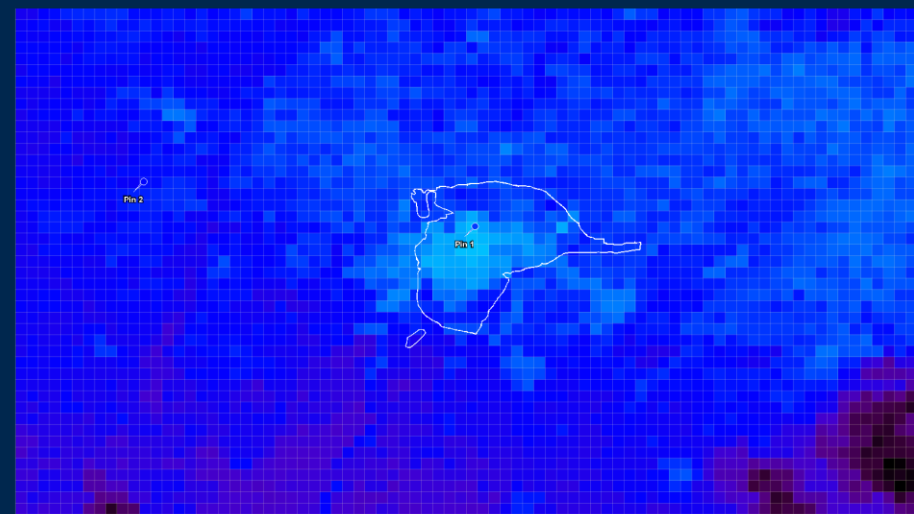


Imagen nocturna. 21:44 UTC

	Tdía (ºC)	T noche (ºC)	Dif (ºC)
Urban	43	31	12
Rural	52	27	25
SUHI	-9	+4	-13

Efecto Isla de Calor Urbana (ICU) en Sevilla
17 Agosto 2018

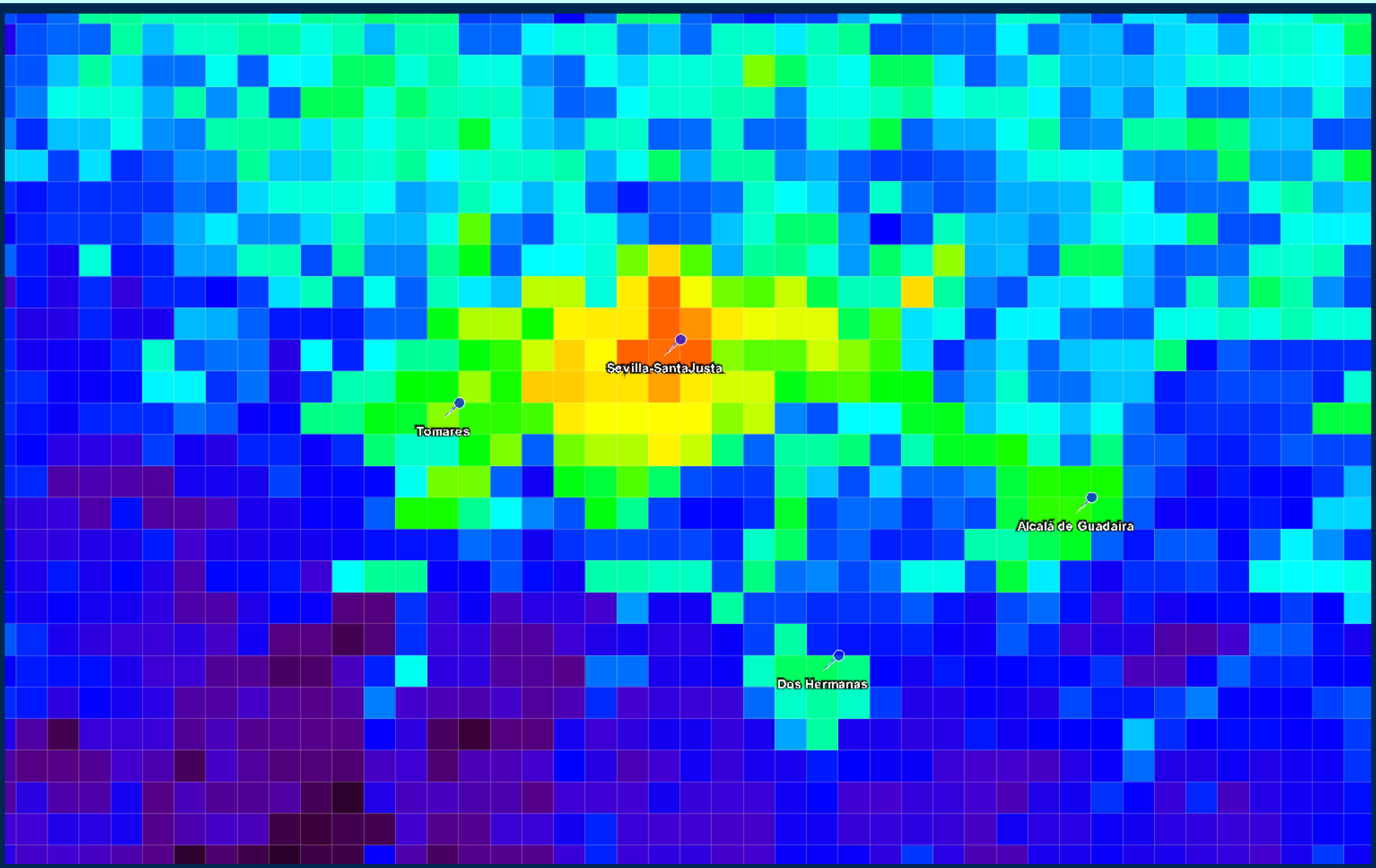
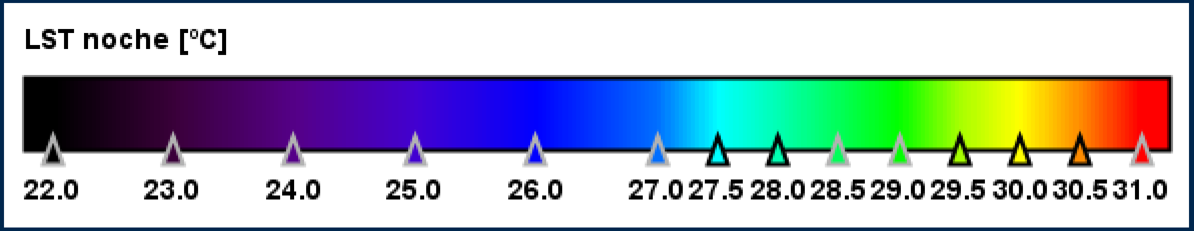


Imagen nocturna. 21:44 UTC



RECOMENDATIONS FOR A FUTURE TIR MISSION

1.-Band configuration

THERMAL INFRARED

Multiespectral : to estimate LSE

TIR (2 in 8-9 microns 2 in10-12 microns).

VNIR-SWIR-MIR

For atmospheric correction and clasificación

2.-Spatial resolution

UHI (1 km)

UHI –Urban planing: 50 m

3.-temporal Frequency

daily

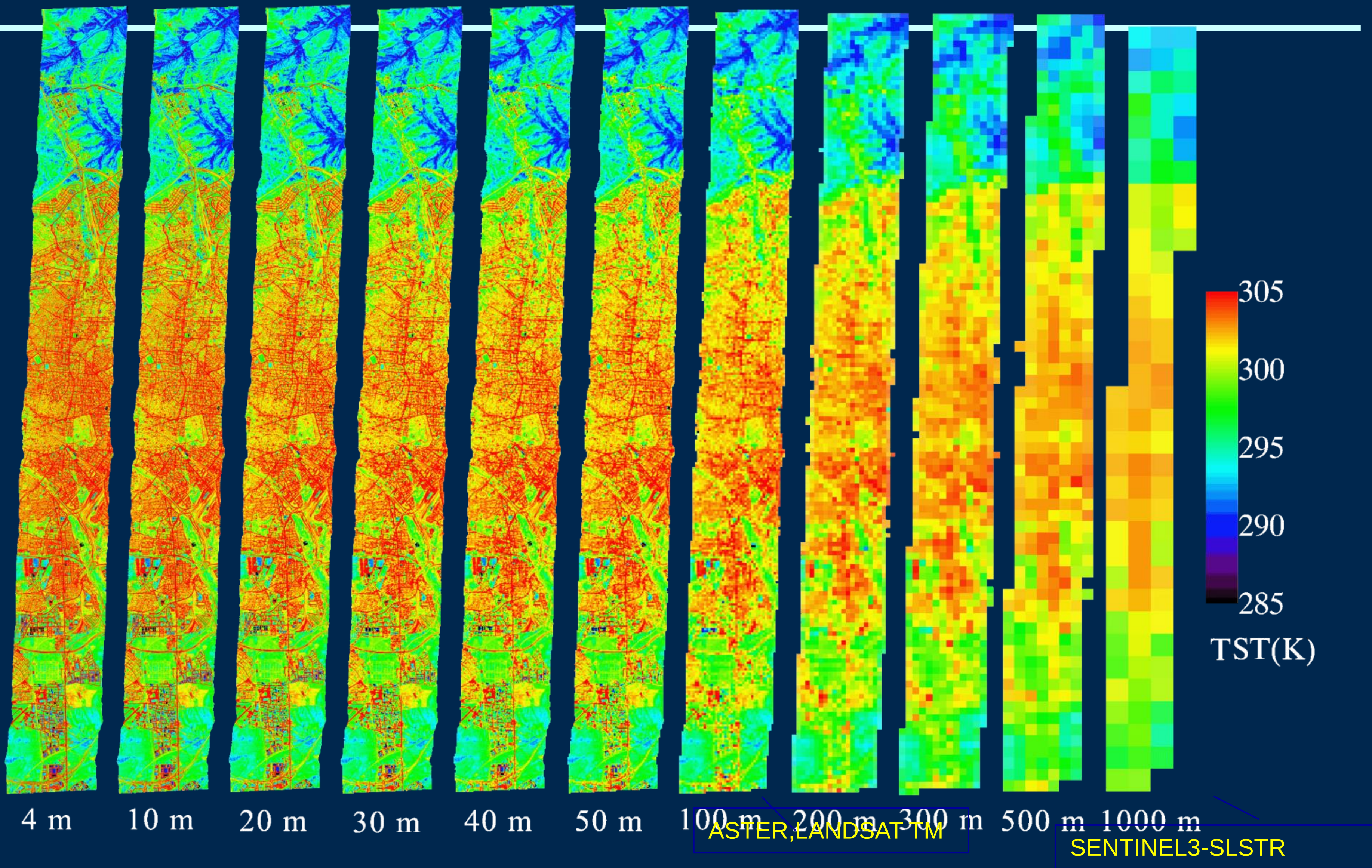
4.-Time

Tair near Ts

Between 0 and 6h UTC

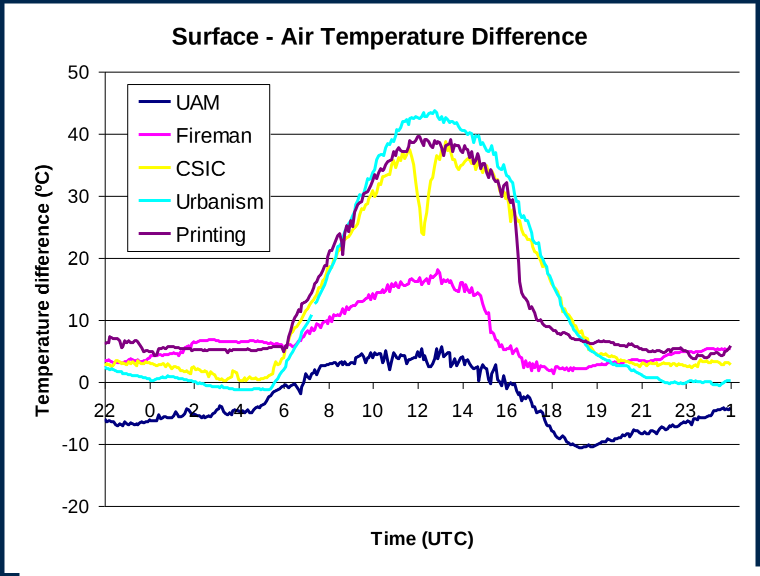
Spatial degradation of LST images. DESIREX 2008

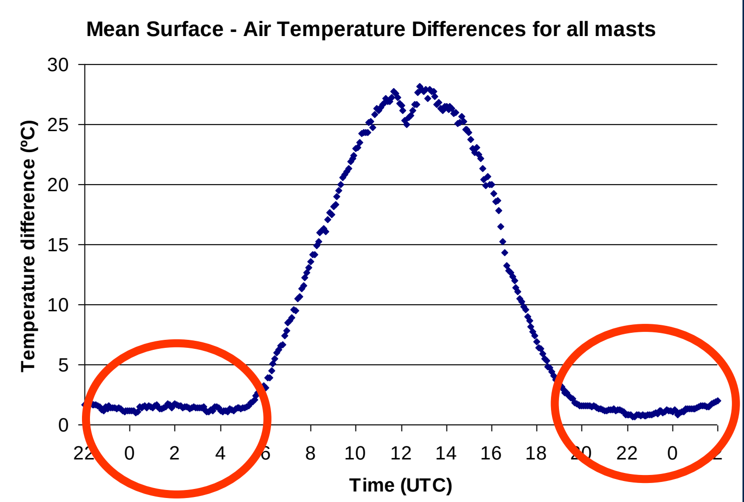
AHS images have been resized to a lower spatial resolution

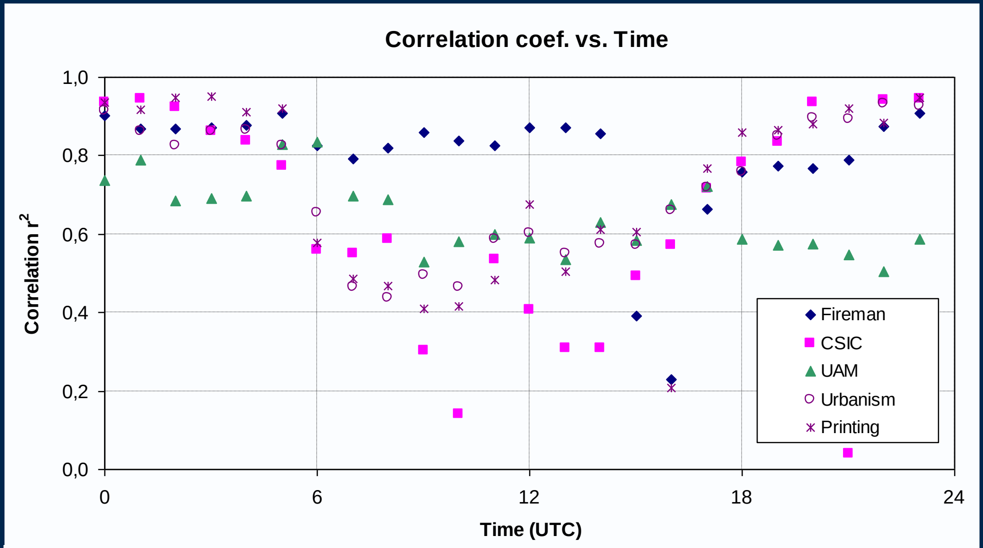


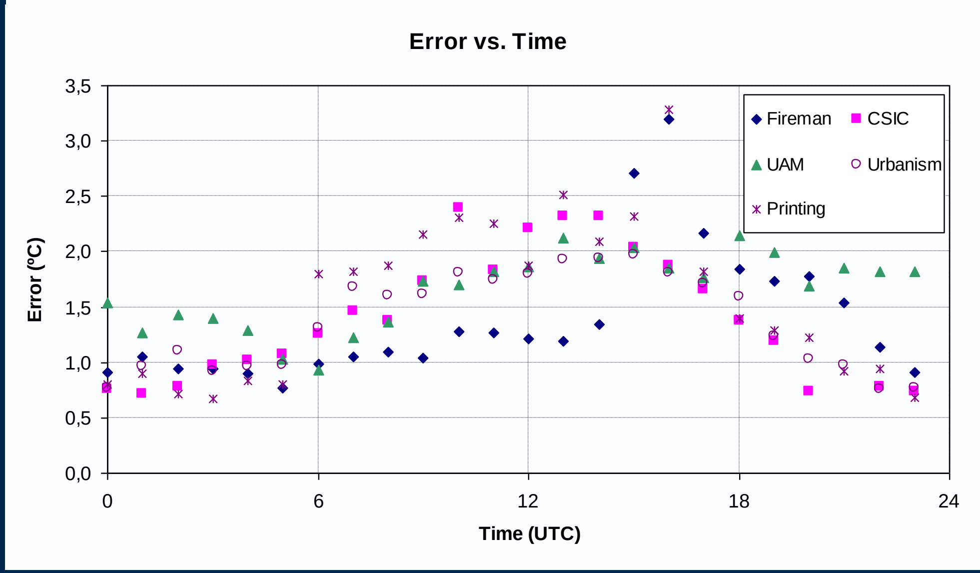
We can observe that there is a loss of information beyond 100 m resolution, which makes difficult to capture the urban temperature variations.

LST-Tair


Surface - Air Temperature Difference
Temperature difference (ºC)
Time (UTC)
UAM
Fireman
CSIC
Urbanism
Printing
50
40
30
20
10
0
-10
-20
22 0 2 4 6 8 10 12 14 16 18 19 21 23 1


Mean Surface - Air Temperature Differences for all masts
Temperature difference (ºC)
Time (UTC)
30
25
20
15
10
5
0
22 0 2 4 6 8 10 12 14 16 18 20 22 0 2


Correlation coef. vs. Time
Correlation r^2
Time (UTC)
Fireman
CSIC
UAM
Urbanism
Printing
1,0
0,8
0,6
0,4
0,2
0,0
0 6 12 18 24


Error vs. Time
Error (ºC)
Time (UTC)
Fireman
CSIC
UAM
Urbanism
Printing
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0,0
0 6 12 18 24

LSTM mission

Land Surface Temperature Monitoring (LSTM) mission, in the frame of the expansion of the Copernicus Program led by the European Space Agency (ESA) on behalf of the European Commission.

CONCLUSIONS

- DESIREX 2008 (AHS): UHI=4 K, SUHI=5K.
- SUHI (MODIS): 3 K
- SUHI from COPERNICUS (Sentinel 3)
- Future: ¿SENTINEL 8? 50 m x 50 m

How to mitigate the heat island effect?

- ❑ Increase green areas
- ❑ Increase albedo
- ❑ Reduce building density
- ❑ Integrating water
- ❑ Maintain / promote ventilation brokers

reduced energy consumption

THANKS FOR YOUR ATTENTION