From **Citizen Science**, **Machine Learning** and **Earth Observation** towards **Urban Climate Services**

Ana Oliveira, on behalf of the **AIR4health, CLIM4cities and the CLIM4health** Project Teams

ana.oliveira@colabatlantic.com

These projects is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

THE PROBLEM

WHY?

Photo Milivigerova from Pexels

WHY?

THE PROBLEM

Extended Summer Season

→ **25-50 days/year**

Heatwaves

→ **10-20 days/year**

Ageing Population, Ageing Buildings

→ **71% energy poverty rates**

Lack of Adaptation Capacity

→ **88% of houses without AC**

Coastal Setting

→ **60% of the cities**

Compound and Multi-Hazard Extremes

→ **80% of the population**

WHY?

THE PROBLEM

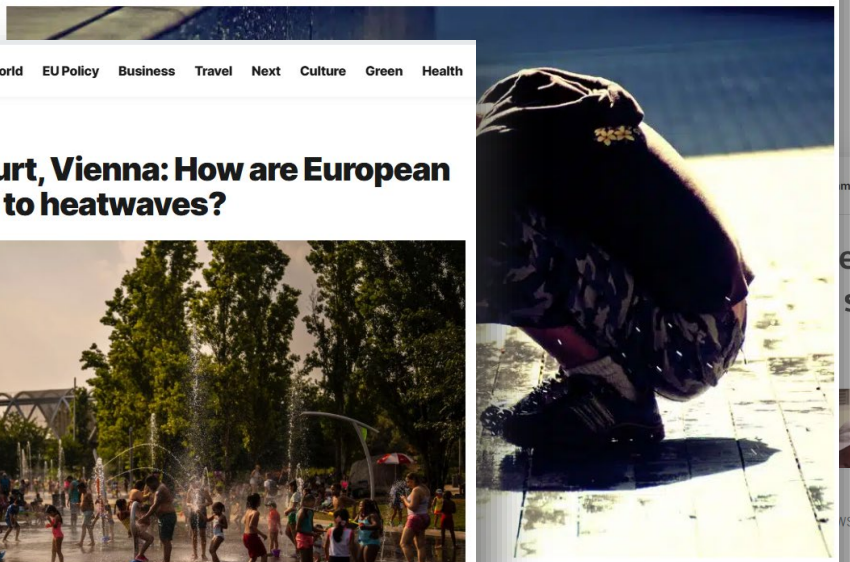
Europe's hottest city battles to keep its cool as tourists arrive for another scorching summer

CLIMATE CHANGE | CRISIS - VIABILITY OF LIFE ON EARTH

Extreme Heat Killed Nearly 48,000 People in Europe Last Year: Study

BY MARTINA IGINI | EUROPE | AUG 14TH 2024 | 3 MINS

EARTH.ORG IS POWERED BY OVER 150 CONTRIBUTING WRITERS



euronews. Latest Europe World EU Policy Business Travel Next Culture Green Health

Green > Eco-Innovation

Madrid, Frankfurt, Vienna: How are European cities adapting to heatwaves?

Copyright AP Photo/Manu Fernandez

By Lottie Limb

Published on 13/06/2024 - 15:00 GMT+2 • Updated 15:02

Share this article | Comments

As parts of Greece, Cyprus and Türkiye face searing heatwaves, here's how trees, water and green buildings can help.

Parts of southern Europe are facing scorching heatwaves as summer sets in - while others are suffering record rainfall.

These extreme weather events are becoming fiercer and more frequent as a result of climate change, and for western nations at least, it has been a frightening glimpse into the future.

Record-breaking days have exposed how ill-equipped our cities are to handle 40°C temperatures. Conversely, they've also made us more appreciative of the parts that provide relief: the tree-lined streets, leafy parks, lidos and air conditioned public venues.

varmest year on record.

Barcelona Institute for Global Health
been 80% higher if it weren't for

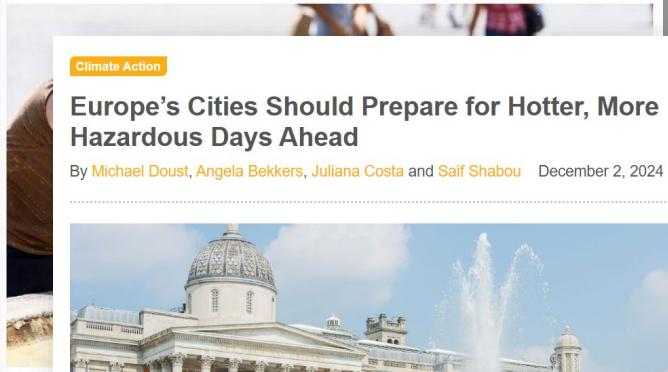
Aug 12 (Reuters) - More than 47,000 people died in E
countries in the region's south hit the hardest, accor
Health (ISGlobal) published on Monday.

was the world's hottest on record. As climate change
live in the world's fastest-warming continent, facing

euronews. Latest Europe World EU Policy Business Travel Next Culture Green Health

Green > Green News

Italy, Spain, Germany: The European countries where the most people died from heat last summer



Climate Action

Europe's Cities Should Prepare for Hotter, More Hazardous Days Ahead

By Michael Doust, Angela Bekkers, Juliana Costa and Saif Shabou December 2, 2024

Visitors to Trafalgar Square in London attempt to cool down near a fountain during the 2022 heat wave. London faced a record-breaking temperature of 40 degrees C (104 degrees F) in July 2022. Photo: Guy Bell/Alamy Stock Photo

Europe is the world's fastest warming continent, which is severely impacting cities and leading to tens of thousands of deaths, rising hospitalizations, school closures and people adjusting their lives to avoid inhospitable outdoor conditions.

London could
cities such as Birmingham and Manchester are forecast to challenge all-time July records.

By Zachary Rosenthal, AccuWeather staff writer

Published Jul 15, 2022 5:10 PM WEST | Updated Jul 17, 2022 11:16 PM WEST

For the first time ever, the United Kingdom Meteorological Office (UK Met Office) has issued a red extreme heat warning for parts of "central, northern, eastern and southeastern England" as unprecedented warmth is set to spread across the U.K. on Monday and Tuesday.

CNN World

Climate report shows 2022 Europe waves killed more than 61,000

Nearly 62,000 people died heat-related deaths last year during Europe's hottest summer found. CNN's Eleni Glokos speaks to a professor of global public health about the implica

05:50 - Source: CNN

WHY?

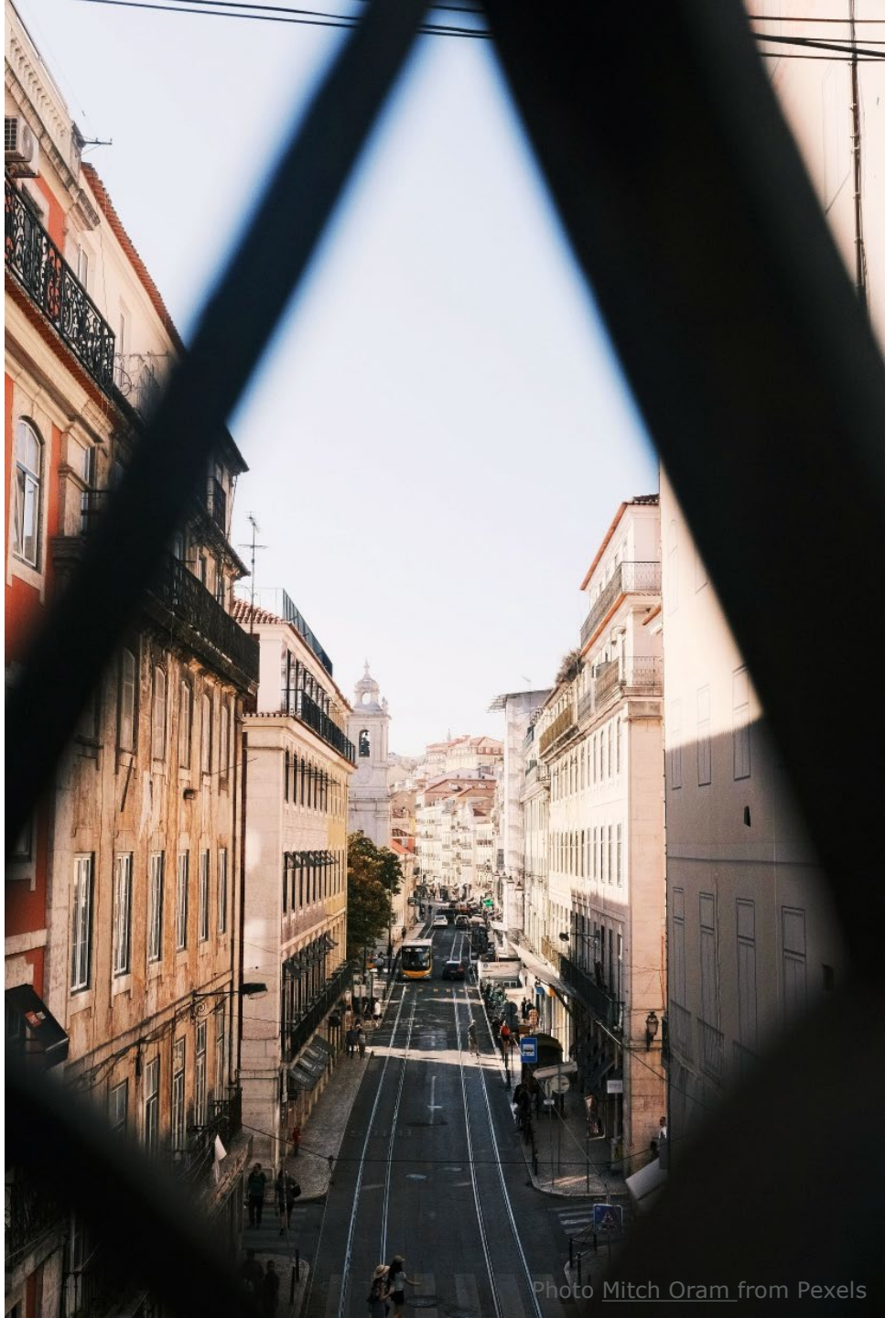
THE PROBLEM

Climate and Environmental Hazards are **LOCAL**

Forecasts and projections **ARE NOT**

✓**OK** regarding **WHEN**

! **NOK** regarding **WHY/WHERE**



THE USER

FOR WHOM?

Photo by Luis Quintero from Pexels

TO WHOM?

THE USER

PUBLIC HEALTH, CIVIL PROTECTION, URBAN PLANNING

GOALS: I'm an architect, and I'd like to identify which areas are likely to face greater hazard exposure in the future.

FRUSTRATIONS: Uncertainty around designing healthier cities and public spaces while factoring in climate change projections.

SOLUTION: Simulate the climate impacts of future urban scenarios and access reports on recommended adaptation measures.

MUNICIPAL EXECUTIVE BODY, POLICY-MAKER

GOALS: I'm a politician aiming to gain as much public support as possible, avoid controversy, and secure re-election.

FRUSTRATIONS: Constantly facing criticism from the opposition and being vulnerable to shifts in public opinion.

SOLUTION: To champion solutions that are popular and meaningful to the community, and easily presented to the public as innovative.

RESEARCHERS AND PROFESSORS, ACADEMIA

GOALS: I'm a researcher, and I'd like to access free data, select and subset a geospatial time series on demand, and download it.

FRUSTRATIONS: Options to subset or summarise large datasets prior to download are limited, and sharing geospatial outputs visually is challenging.

SOLUTION: To access the most reliable data via a fast platform that supports selection, querying, and merging.

COMMUNITY AND PUBLIC, NGOS AND MEDIA

GOALS: I'm a journalist, and I'd like to easily create engaging plots and infographics from climate and environmental data.

FRUSTRATIONS: Producing eye-catching infographics takes time, so we often struggle to have them ready when extreme events occur.

SOLUTION: To use an intuitive platform for downloading visually compelling infographics, videos, and maps.

Portuguese saying: « 3B's = Bom, Bonito, e Barato»

THE SOLUTION

HOW?

Photo Reinaldo Simões from Pexels

HOW?

THE SOLUTION

Local-relevant
FITNESS FOR PURPOSE

Empirical Approach to Hazard Mapping

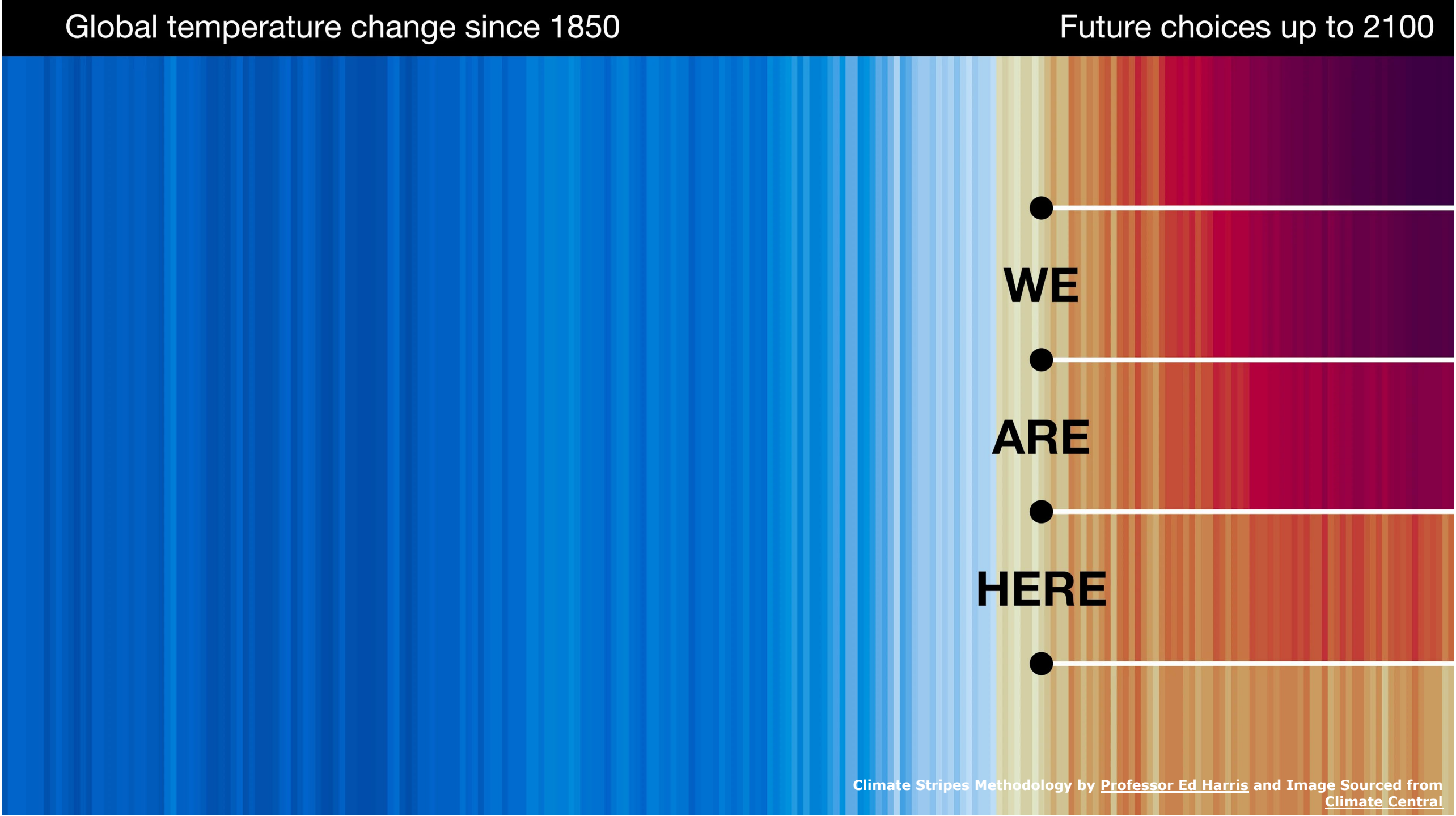
COST-EFFICIENT
for All Users

Open-Science Approach and Reproducibility

SCALABILITY
Across Urban Areas

Wide Coverage and Scalability

THE AIM is: To Optimise **Early Response Actions for Urban Health** and **Contribute Towards Local Climate Change Adaptation Strategies**


Global temperature change since 1850
Future choices up to 2100
WE
ARE
HERE
Climate Stripes Methodology by Professor Ed Harris and Image Sourced from Climate Central

WHAT?

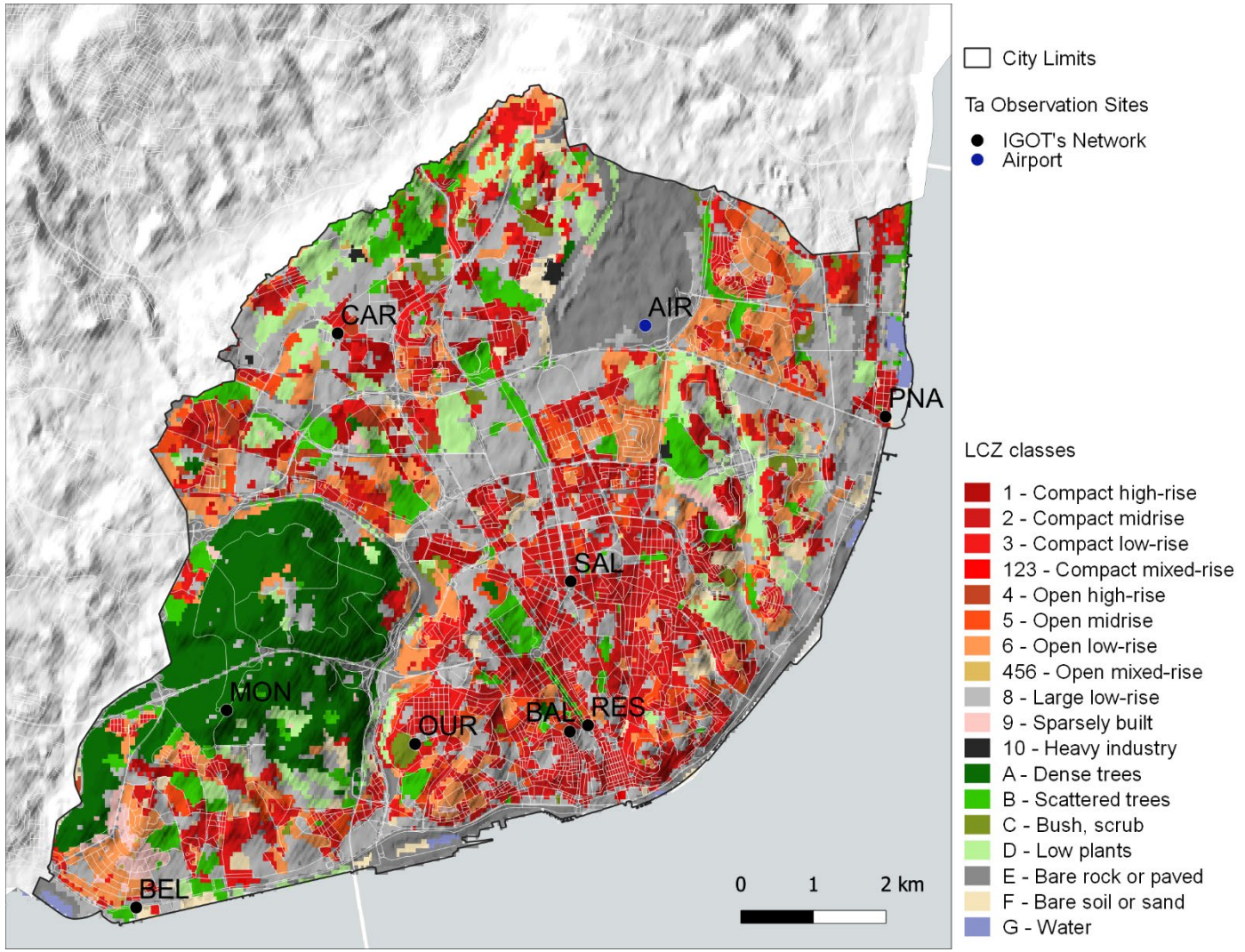
The Solution

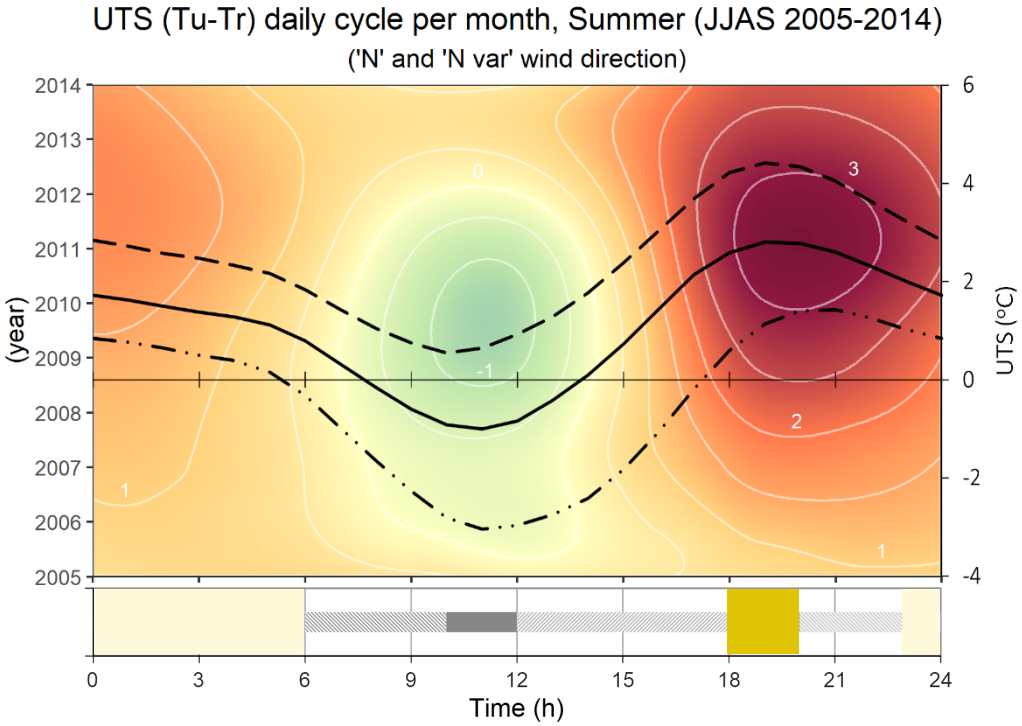
TODAY
[weather forecasts: predicting impacts]

YESTERDAY
[reanalysis: observing relationships, modelling effects]

TOMORROW
[climate projections: assess alternative scenarios]

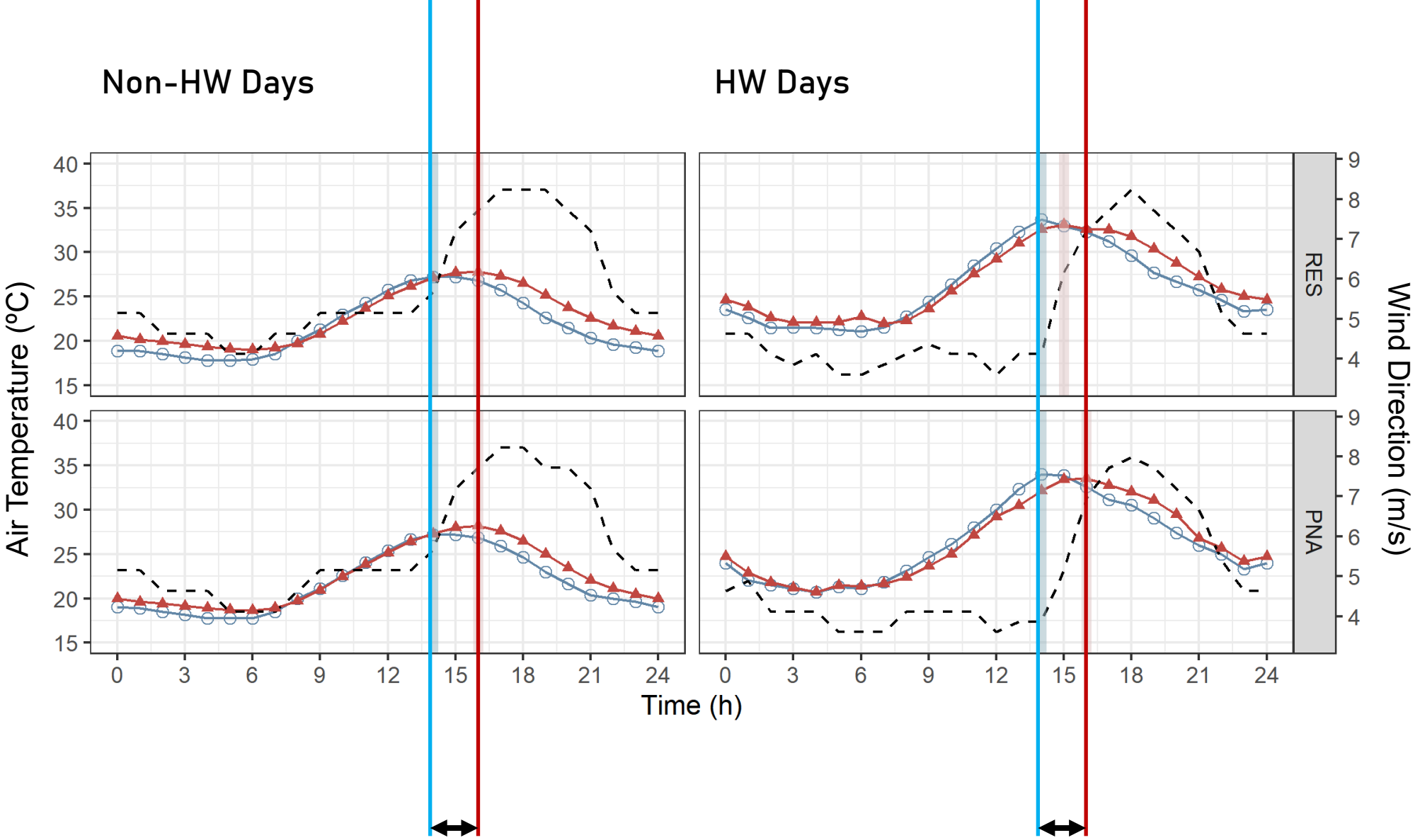
YESTERDAY
[reanalysis: observing relationships, modelling effects]



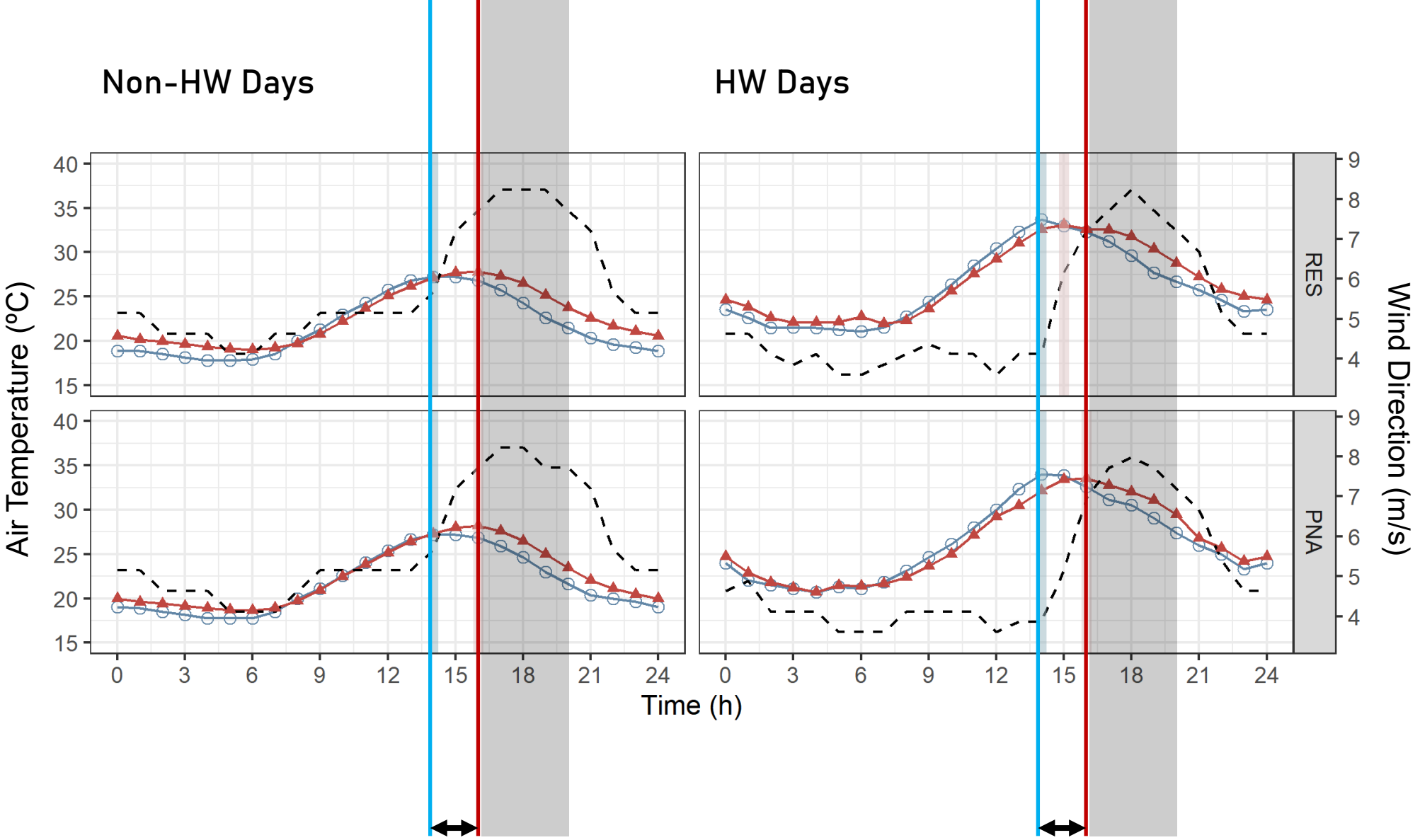


	UTS daily cycle stages	UTS signal
1	1. Nocturnal stable UHI	Positive
2	2. Morning transition to UCI	Positive to negative transition
3	3. Diurnal Peak UCI	Negative
4	4. Afternoon transition to UHI	Negative to positive transition
5	5. Late Afternoon peak UHI	Positive
6	6. Evening stabilizing UHI	Positive

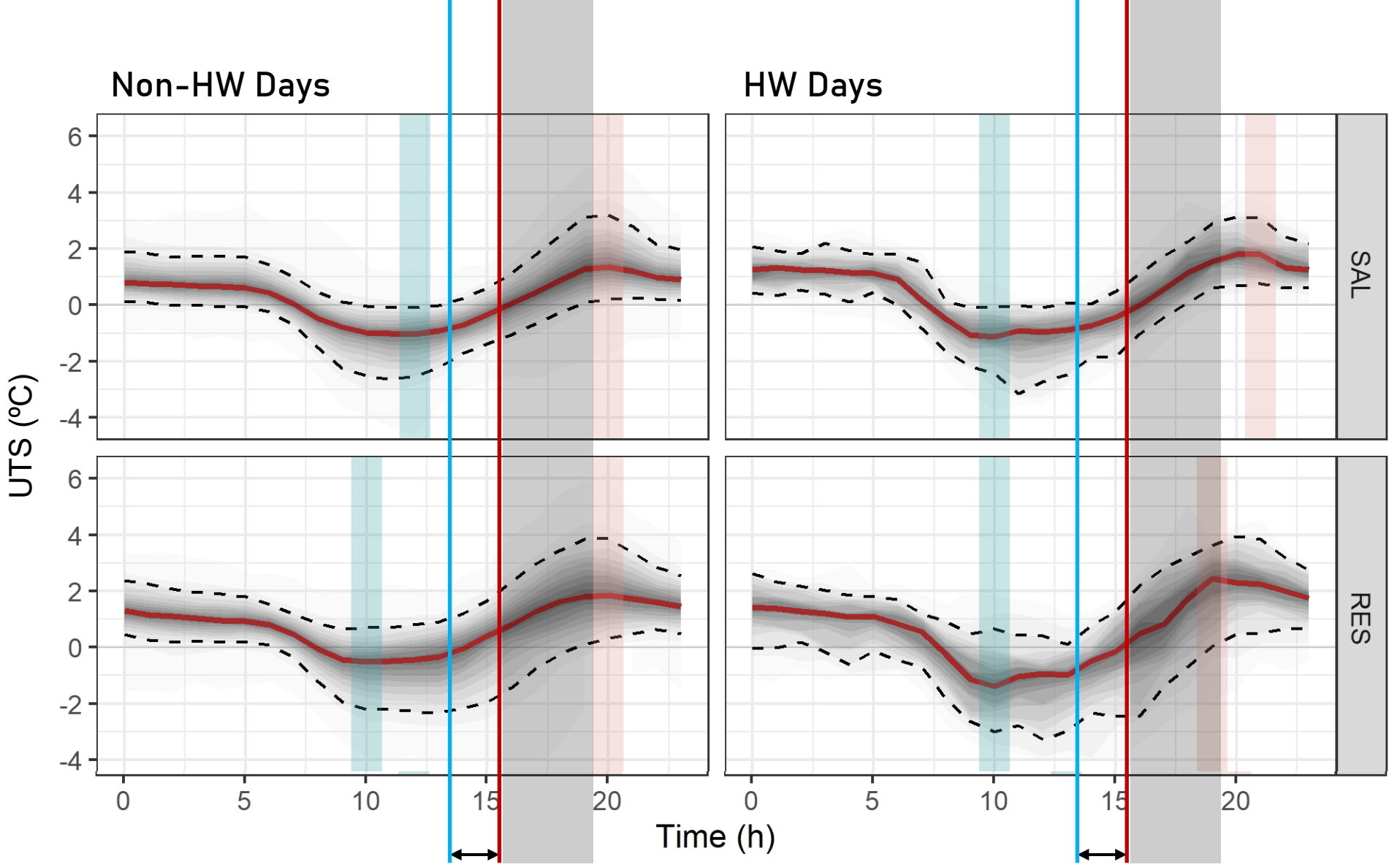
Sources:
https://www.epa.gov/heatislands/learn-about-heat-islands
Oliveira A, Lopes A, Correia E, Niza S, Soares A. Heatwaves and Summer Urban Heat Islands: A Daily Cycle Approach to Unveil the Urban Thermal Signal Changes in Lisbon, Portugal. Atmosphere. 2021; 12(3):292. https://doi.org/10.3390/atmos12030292



There is a **~2hour lag** between the **Rural** and **Urban Sites.**



There is a late afternoon **Wind Speed Peak.**



Both contribute to the **UTS** Late Afternoon **Peak?**

UTS upper bound intensity, 90th percentile (UTS90p)
UTS median intensity, 50th percentile (UTS50p)
UTS lower bound intensity, 10th percentile (UTS10p)

HOW?

THE SOLUTION

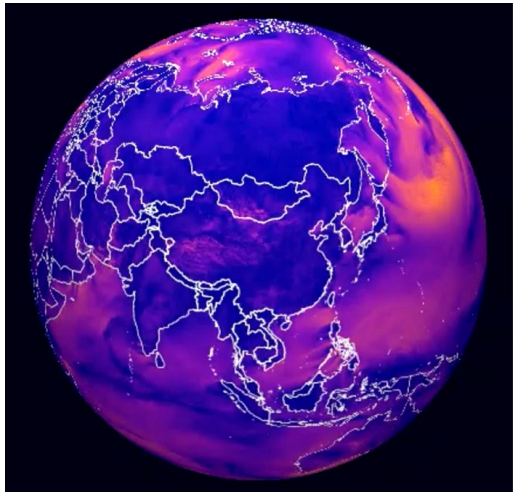
Observations

Sensors, IoT, Crowdsourcing

=

Synoptic (Background) Weather

Reanalysis, Forecast and Climate Projections



+

Local (Time-Fixed) Predictors

Landscape and Urban Features

Topography

Terrain, Topographic Wind Exposure

Green Features

Vegetation Density and Type, Phenology

+

Urban Features

Urban Density, Imperviousness, Sky View Factor

Blue Features

Proximity to the Coast or Large Water Bodies

+

Machine Learning

Domain-Informed Data-driven Downscaling

Informed decision-making

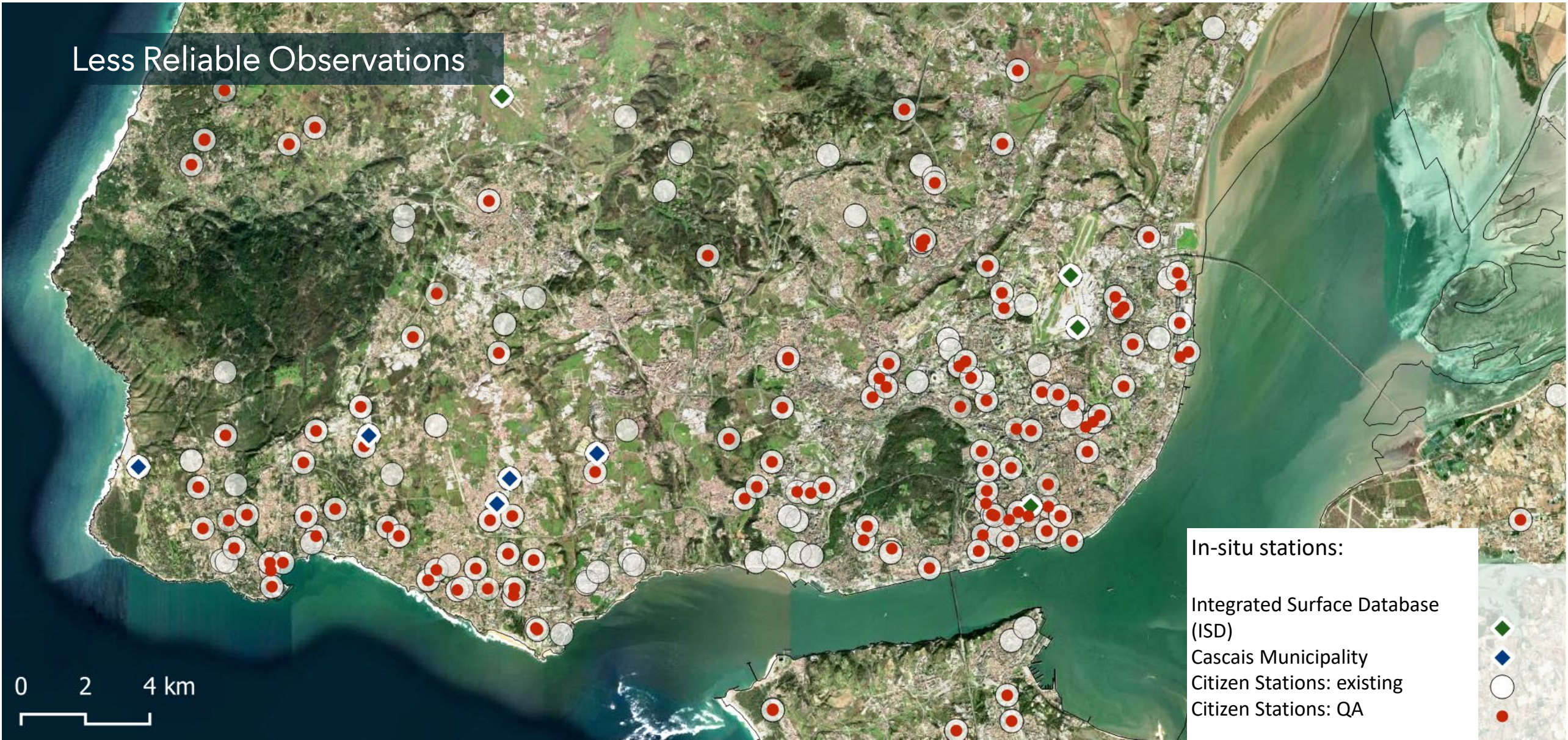
✓ What?
✓ When?
✓ **WHERE**?

HOW?

THE SOLUTION

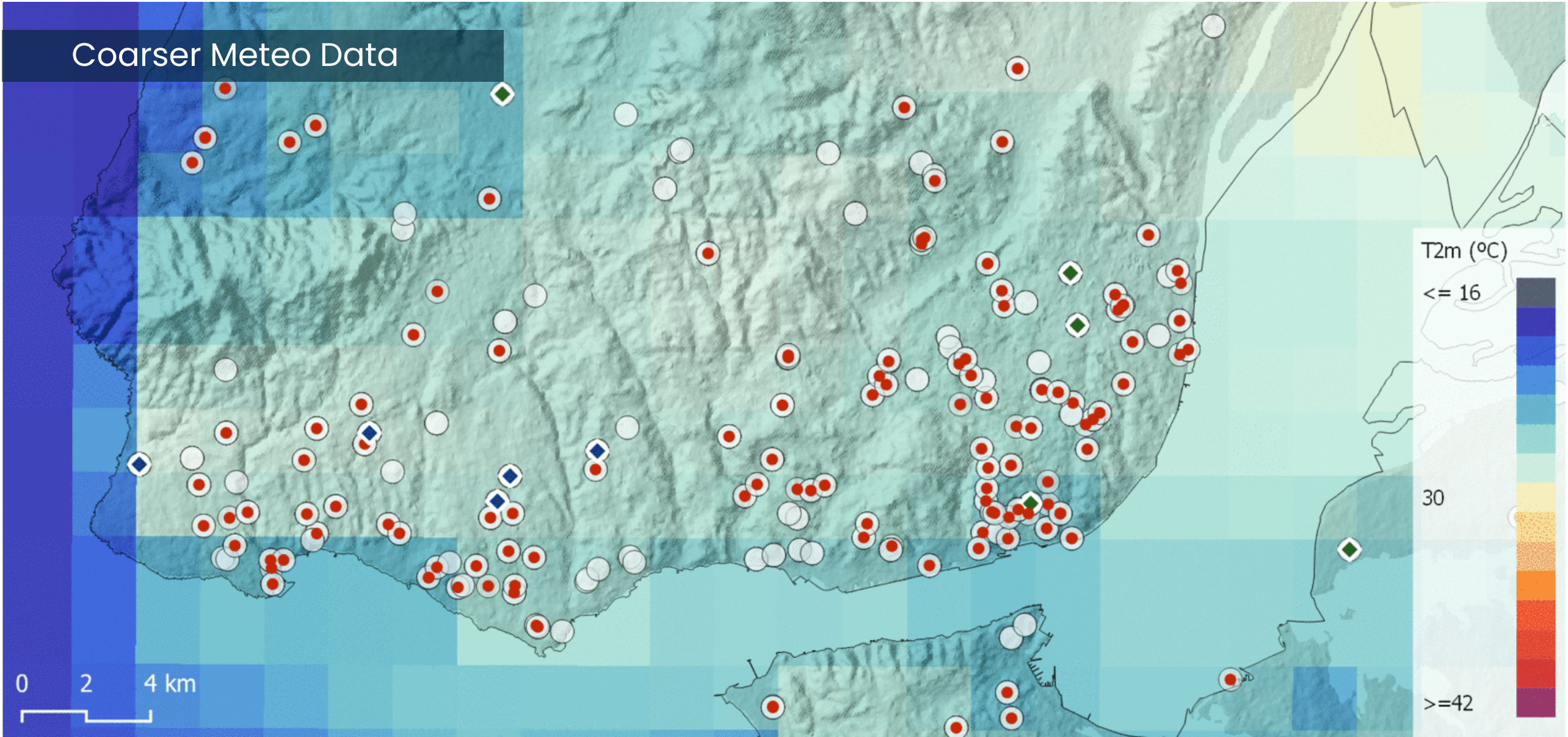
HOW?

THE SOLUTION



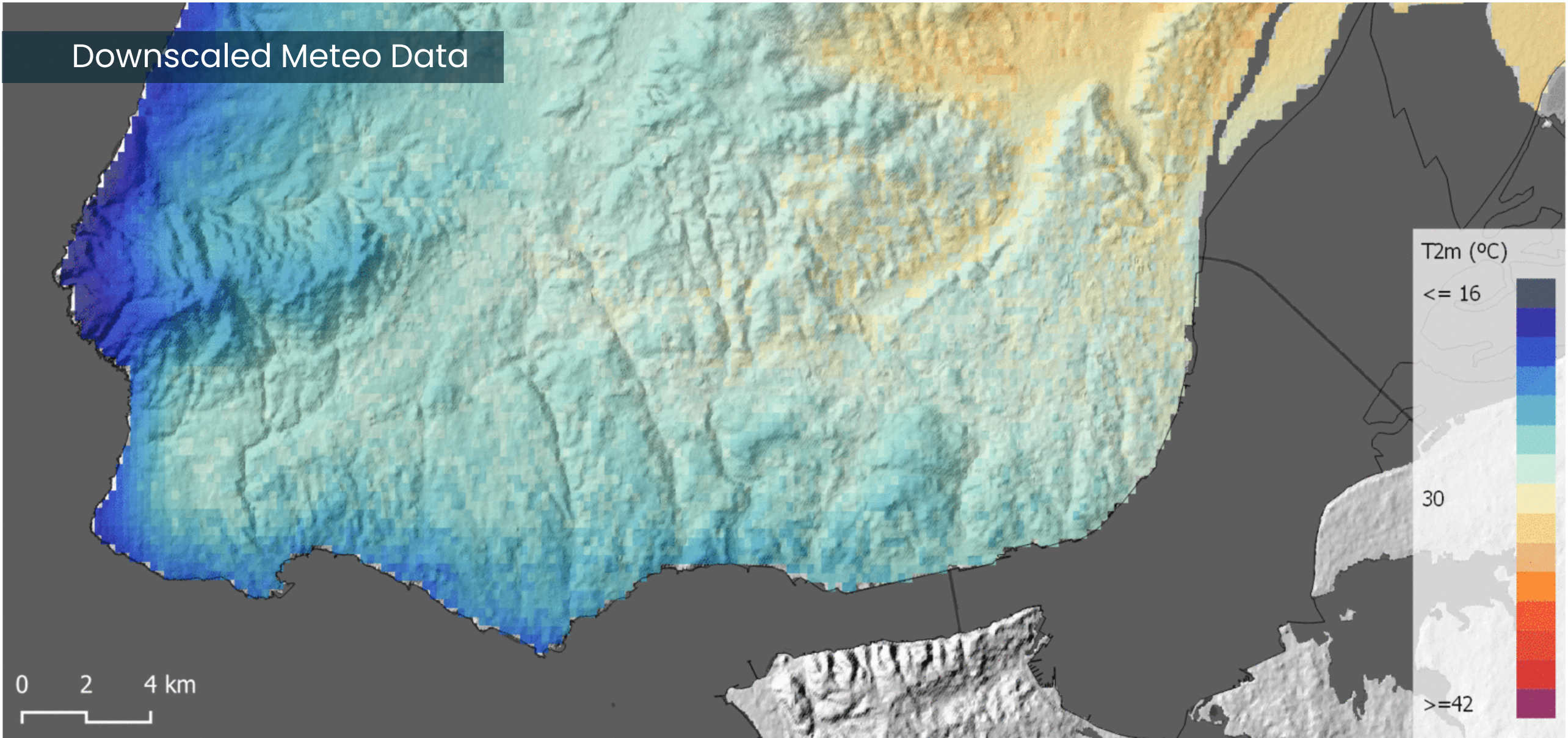
HOW?

THE SOLUTION

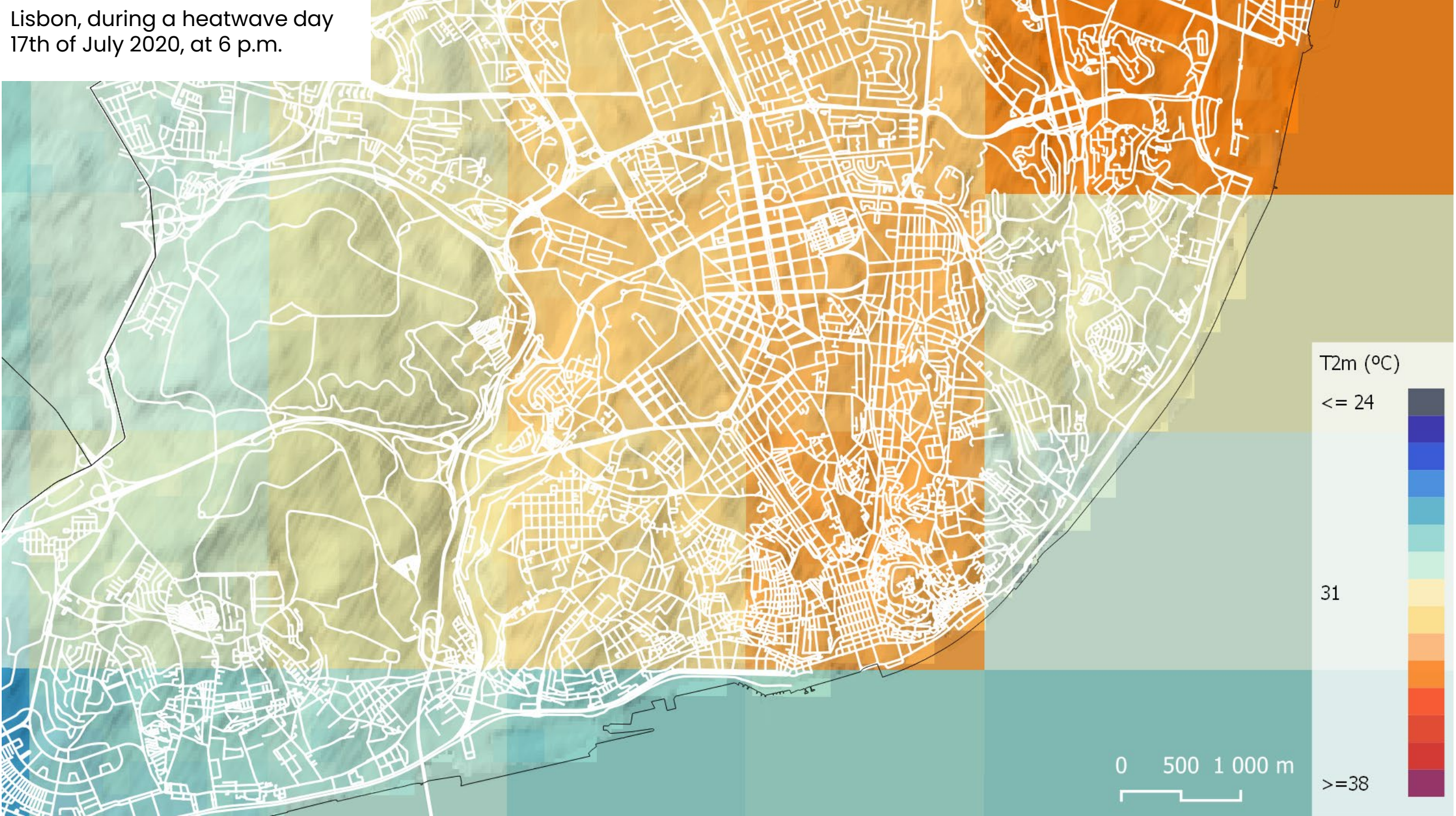


HOW?

THE SOLUTION

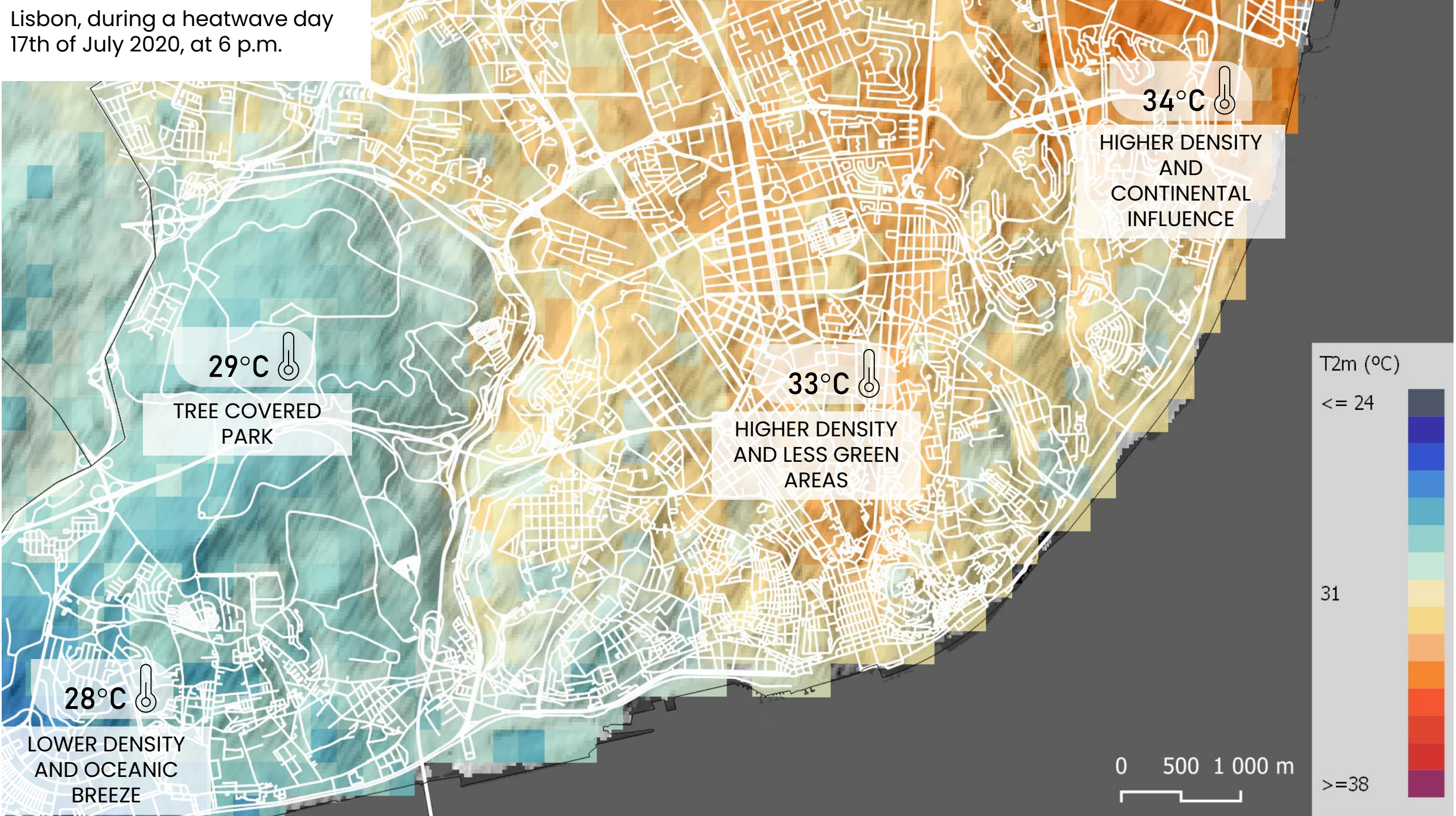


Lisbon, during a heatwave day
17th of July 2020, at 6 p.m.




Lisbon, during a heatwave day
17th of July 2020, at 6 p.m.
1
0

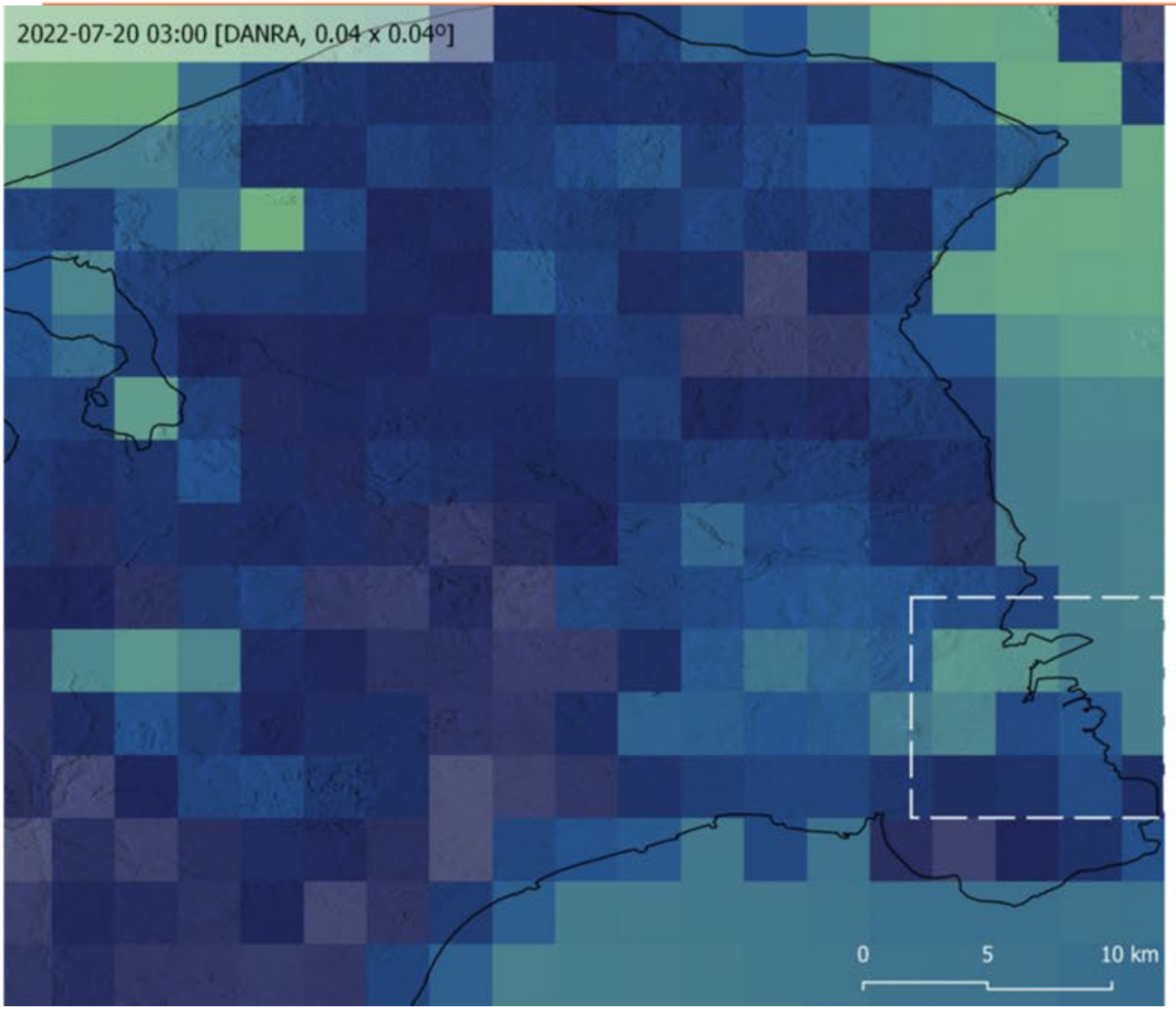

Lisbon, during a heatwave day
17th of July 2020, at 6 p.m.

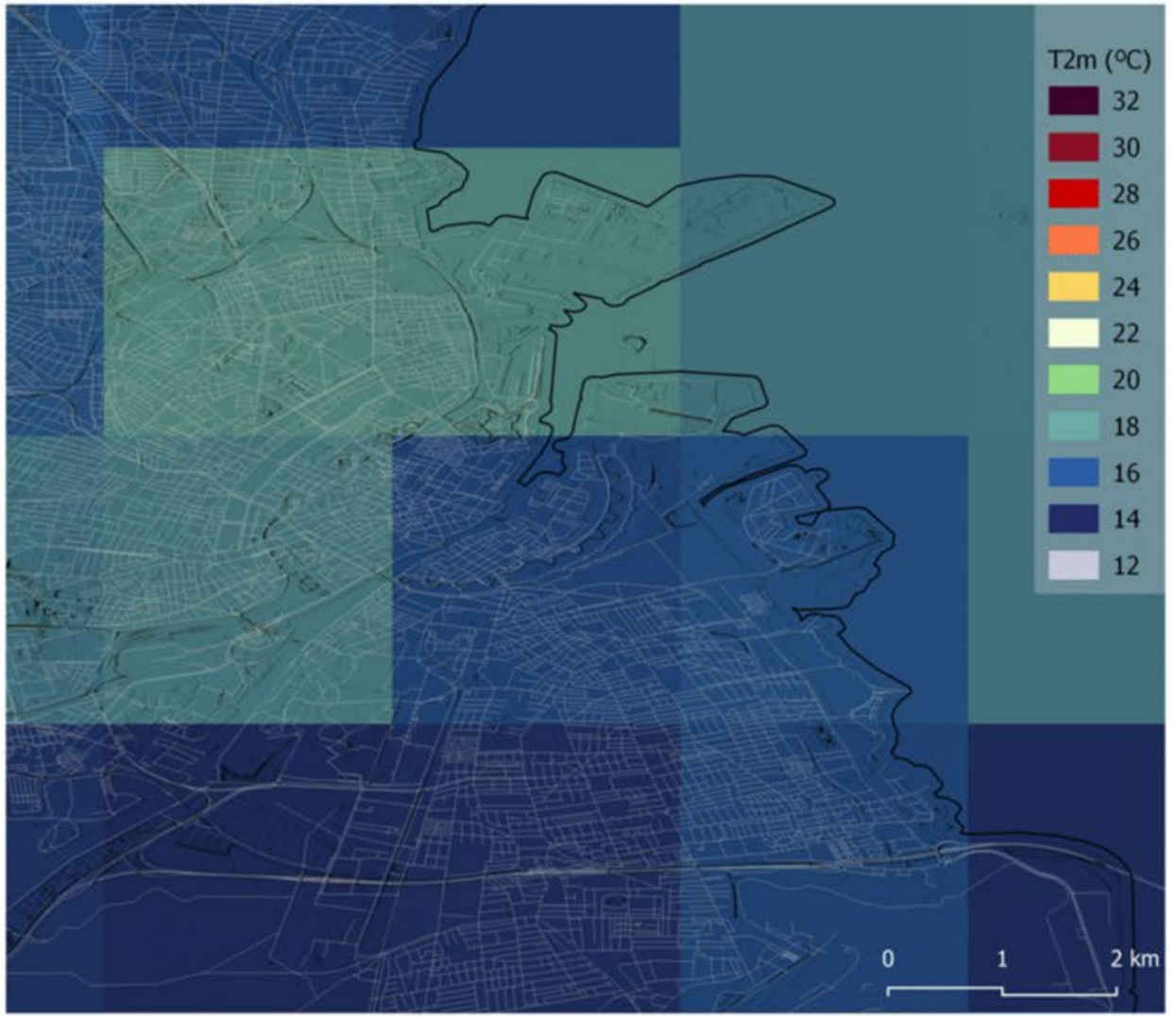

Lisbon, during a heatwave day
17th of July 2020, at 6 p.m.
34°C
HIGHER DENSITY AND CONTINENTAL INFLUENCE
29°C
TREE COVERED PARK
33°C
HIGHER DENSITY AND LESS GREEN AREAS
28°C
LOWER DENSITY AND OCEANIC BREEZE
T2m (°C)
<= 24
31
>=38
0 500 1 000 m

Results

CLIM4cities is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

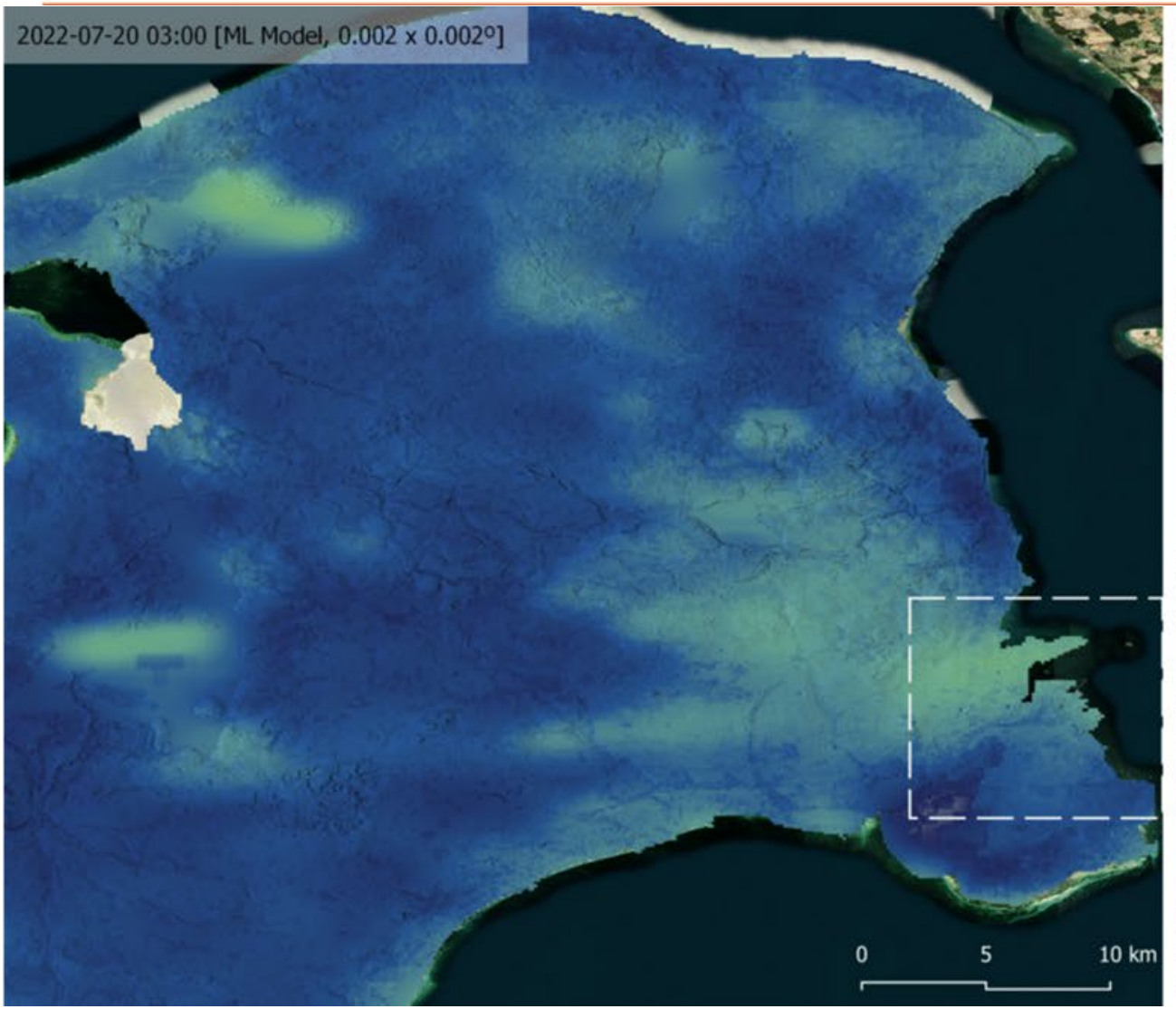
Results

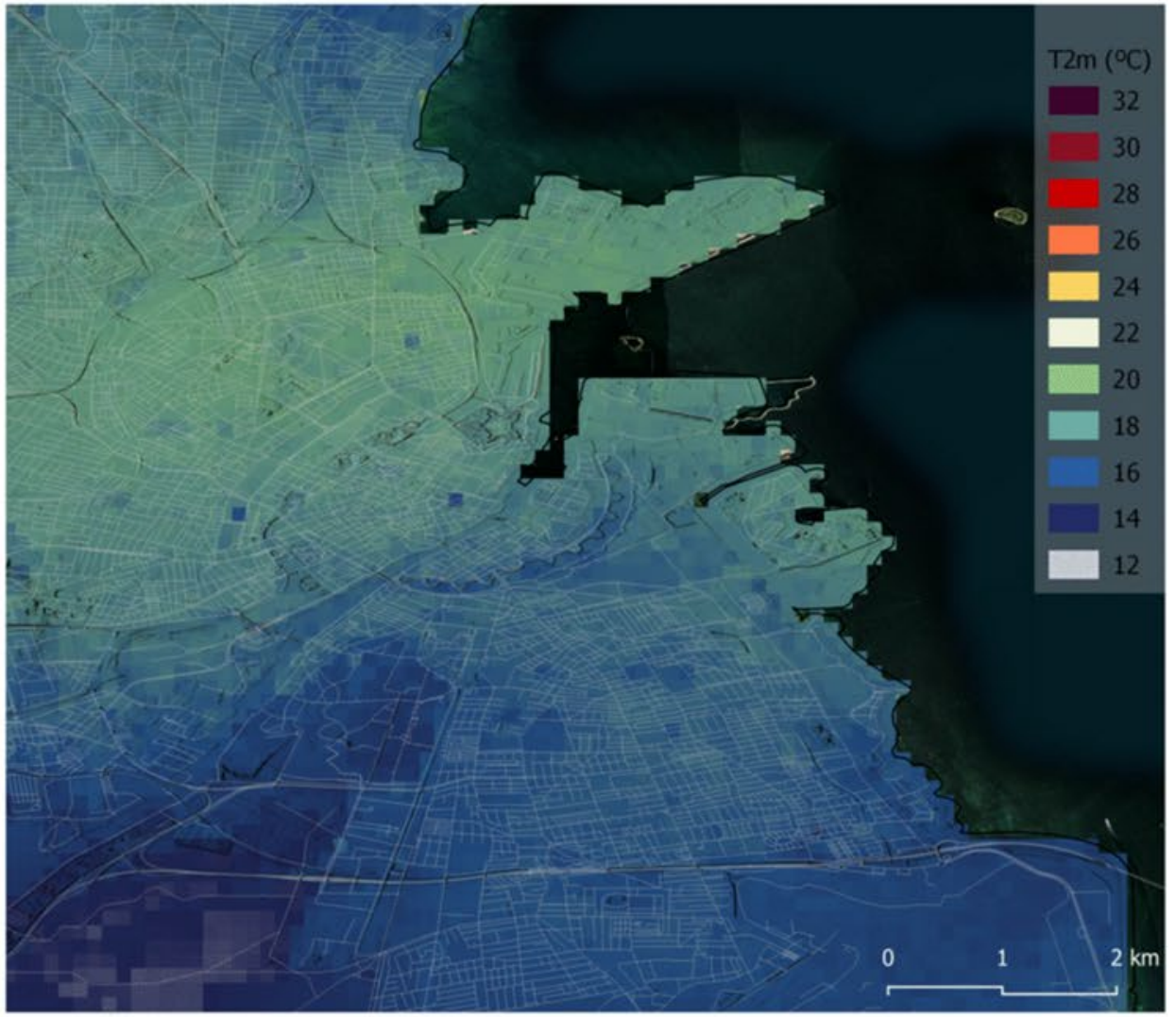




CLIM4cities is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

Results

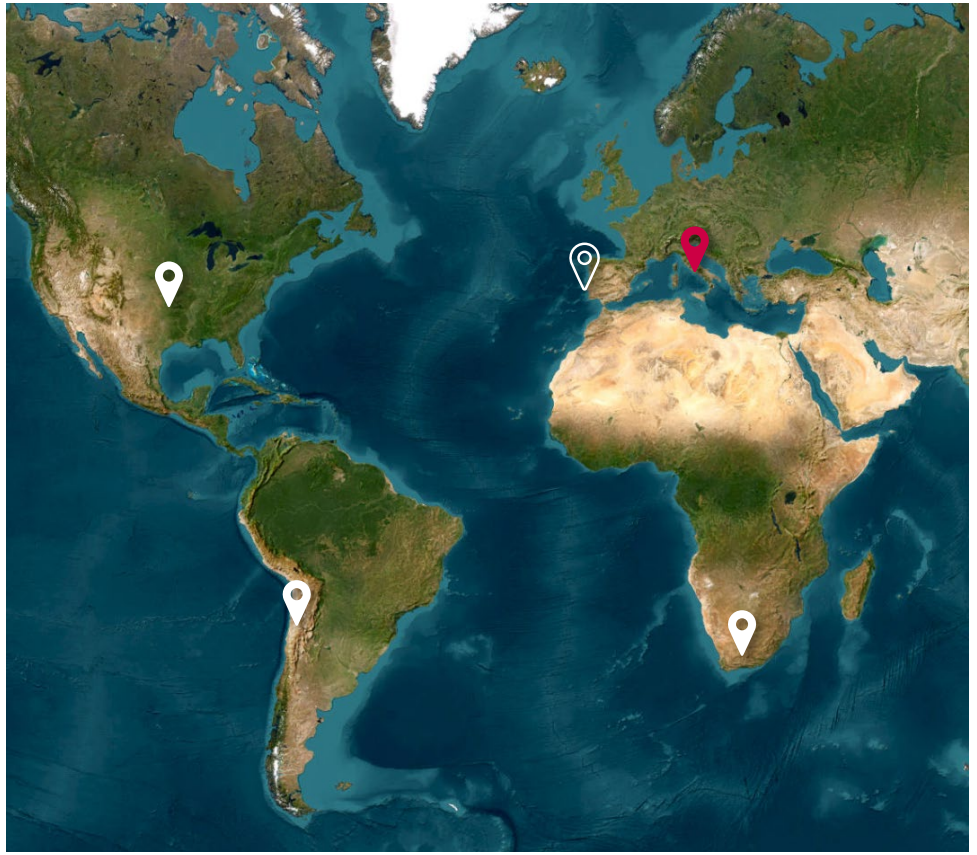


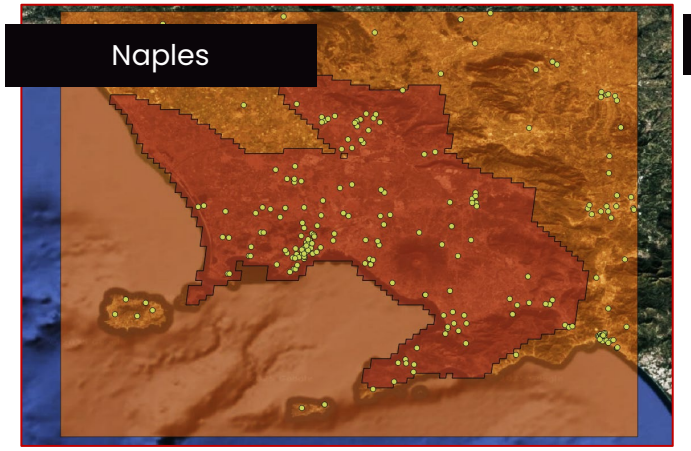


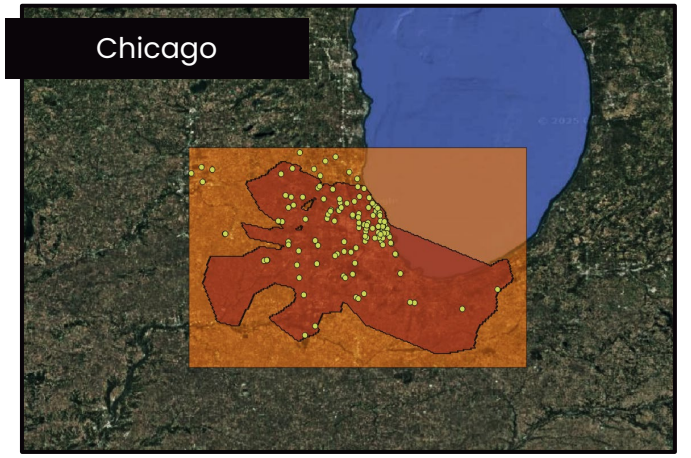
CLIM4cities is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

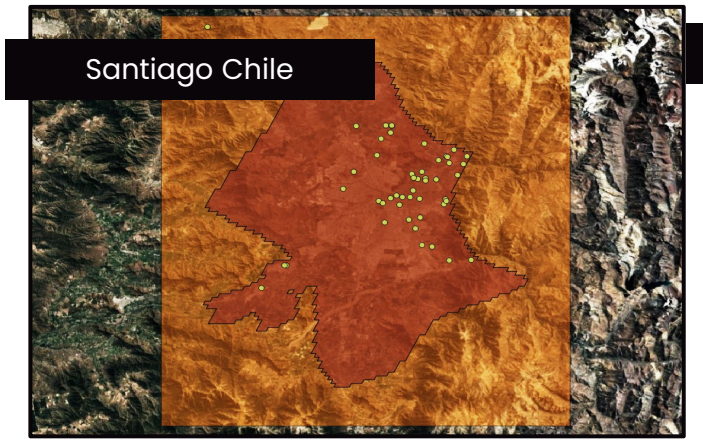
WHAT?

The Solution

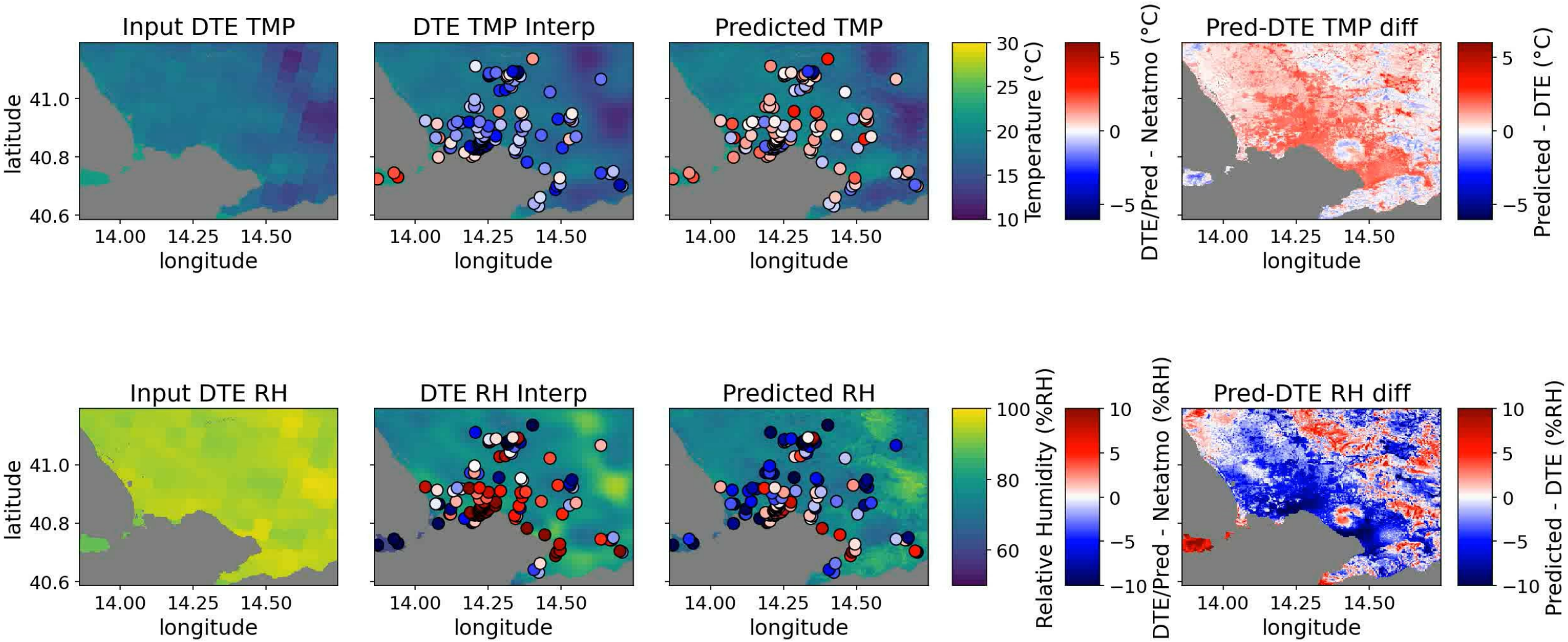








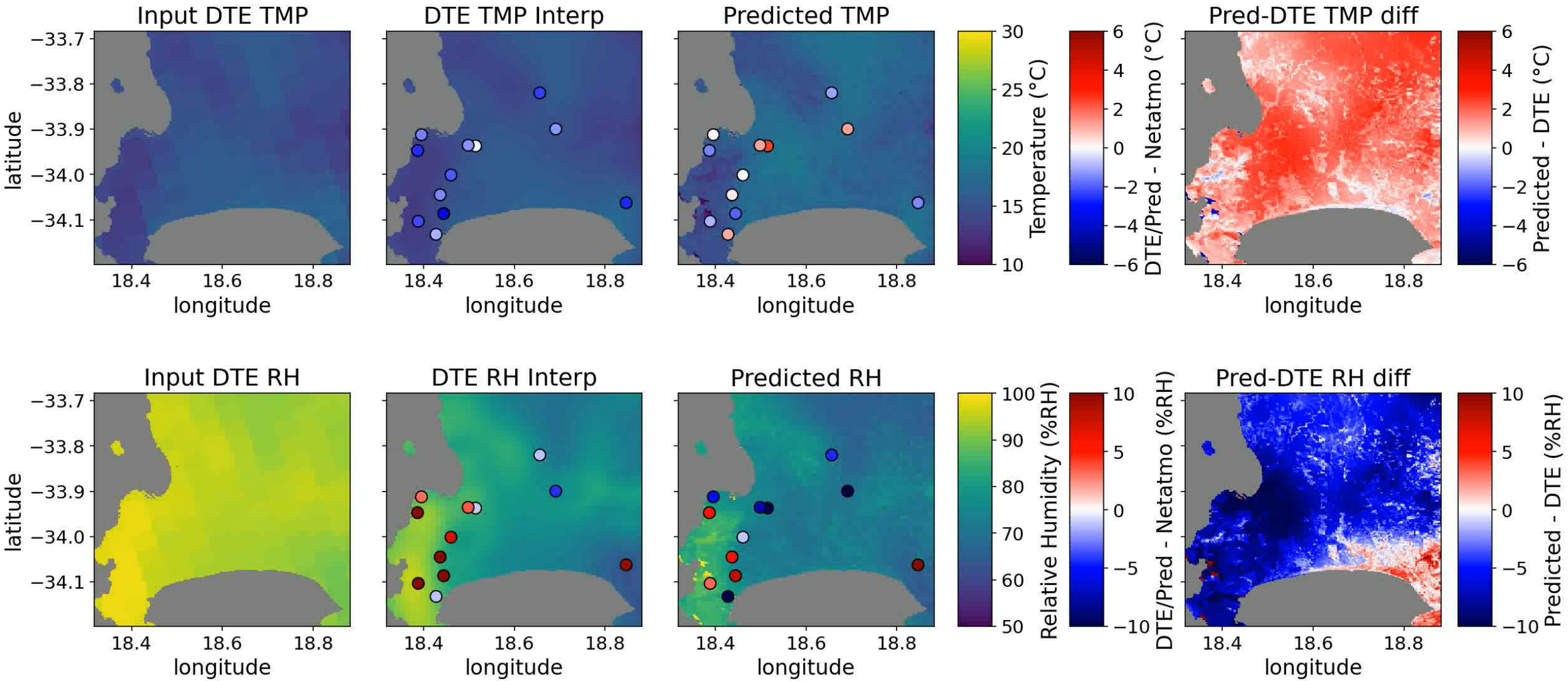
NAPLES - Prediction for 2025-10-01 00h



ECMWF CoLAB #ATLANTIC

Funded by the European Union Destination Earth implemented by ECMWF esa EUMETSAT

CAPETOWN - Prediction for 2025-10-01 00h

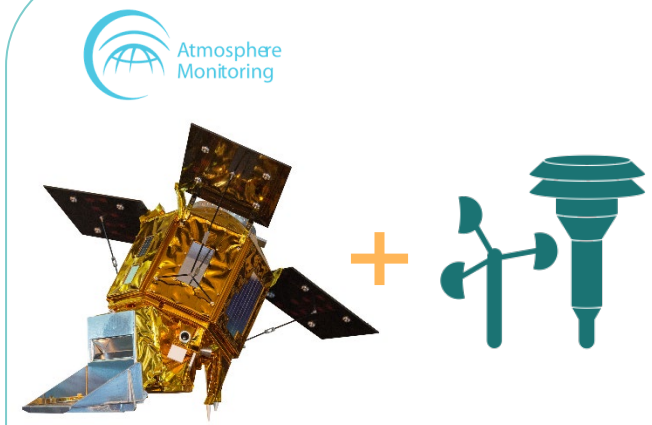


ECMWF
CoLAB #ATLANTIC
Funded by the European Union
Destination Earth
implemented by ECMWF esa EUMETSAT

AIR4health Approach

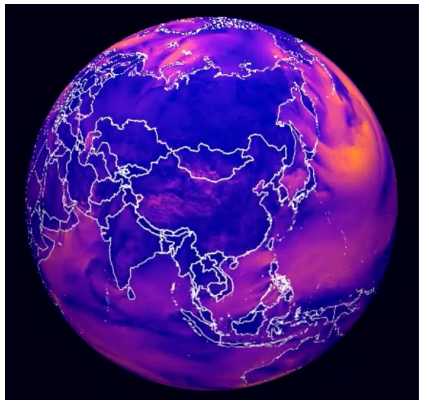
Observations

Sensors, Sentinel-5p, CAMS Reanalysis



Synoptic (Background) Conditions

CAMS Reanalysis (CAMS Forecasts)



Local (Time-Fixed) Predictors

Landscape and Urban Features

Topography

Terrain, Topographic Wind Exposure

Green/Blue Features

Vegetation Density and Type, Phenology

Urban Features

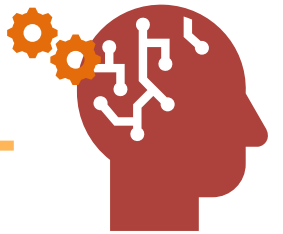
Urban Density, Imperviousness, Sky View Factor

Human Activity

Proximity to traffic lanes per typology

Machine Learning

Domain-Informed Data-driven Downscaling



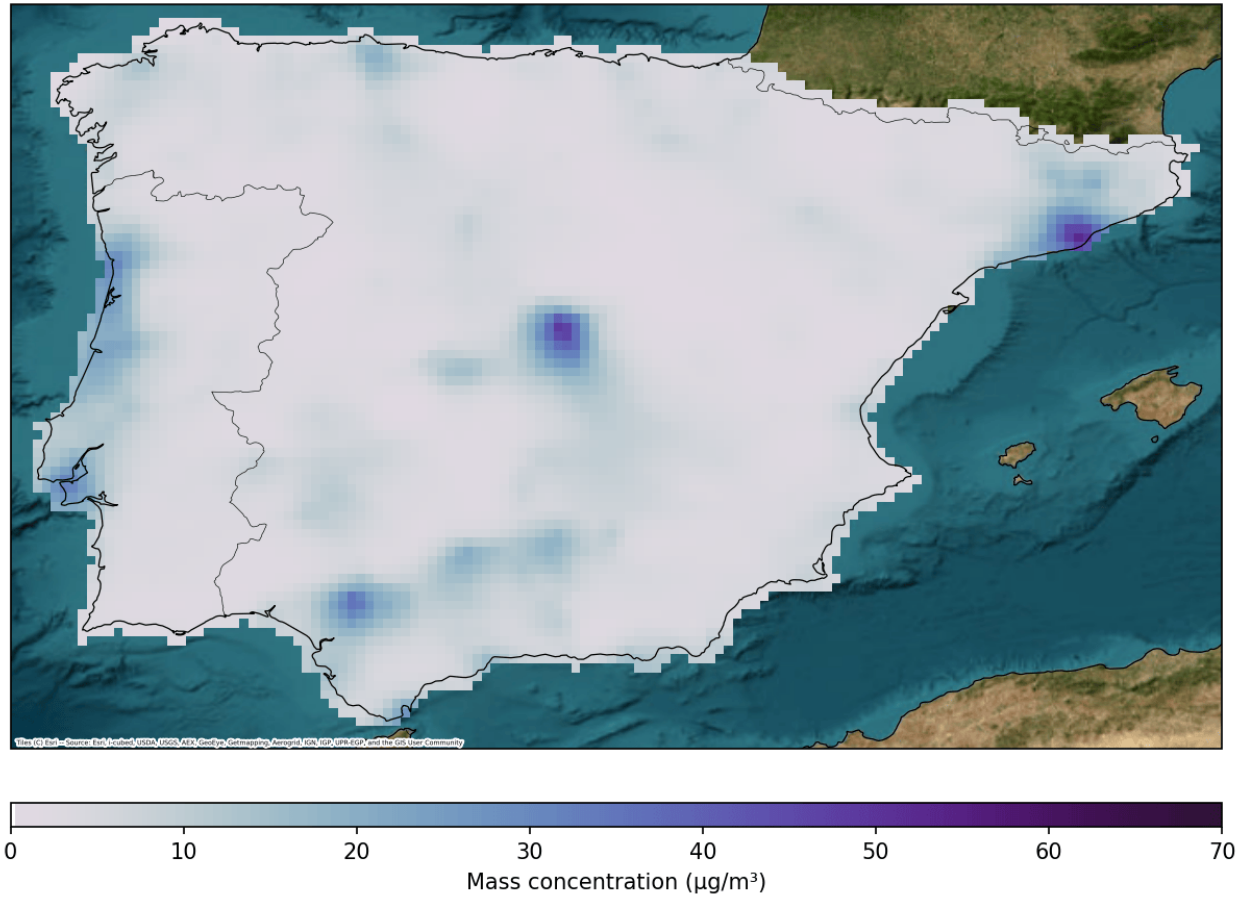
Informed decision-making

- ✓ What?
- ✓ When?
- ✓ **WHERE**?

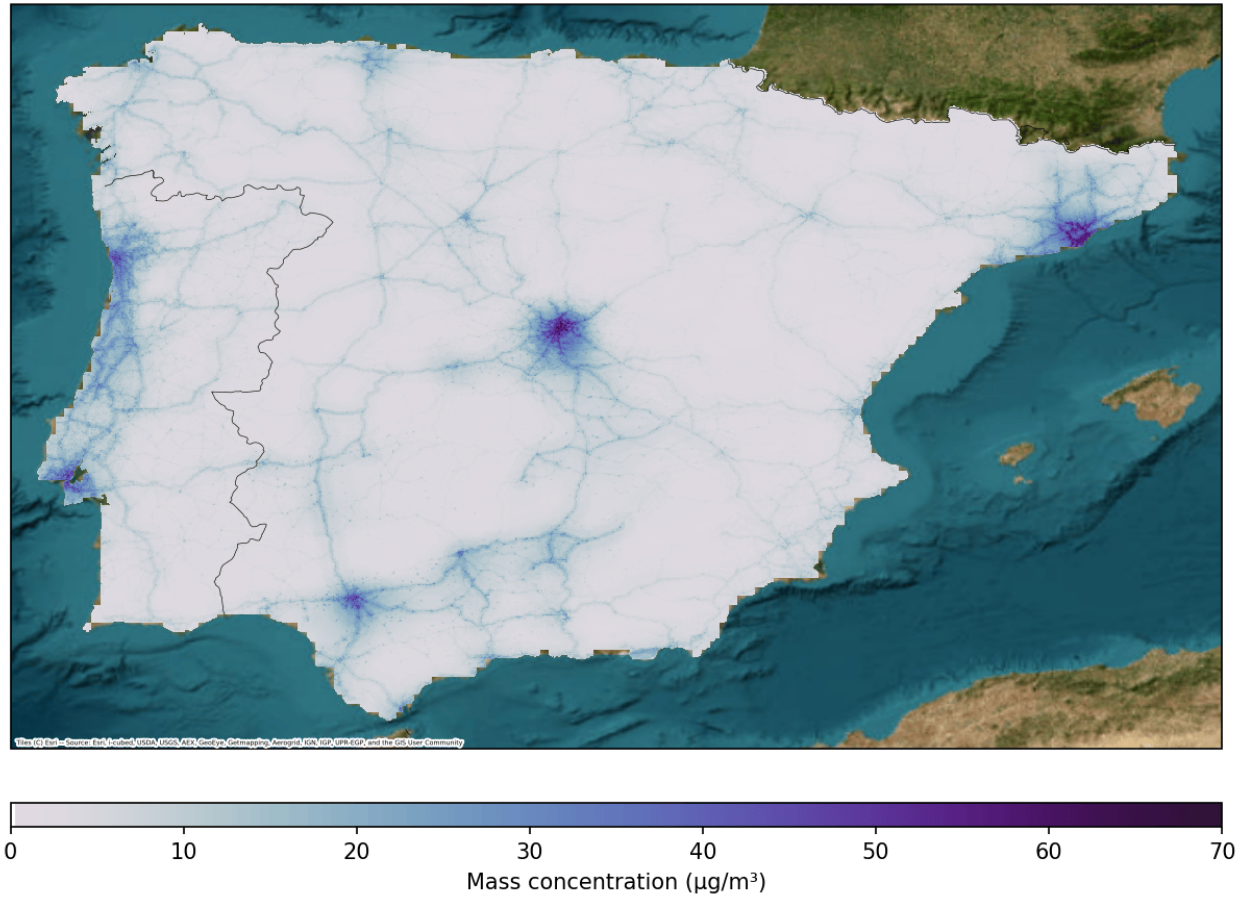
AIR4health is under a programme of, and funded by, the European Space Agency.
Views expressed do not reflect the official opinion of the European Space Agency.

AIR4health Results: Compound CW+NO_2 Events

CAMS NO_2 mass concentration 10km
2017-01-16



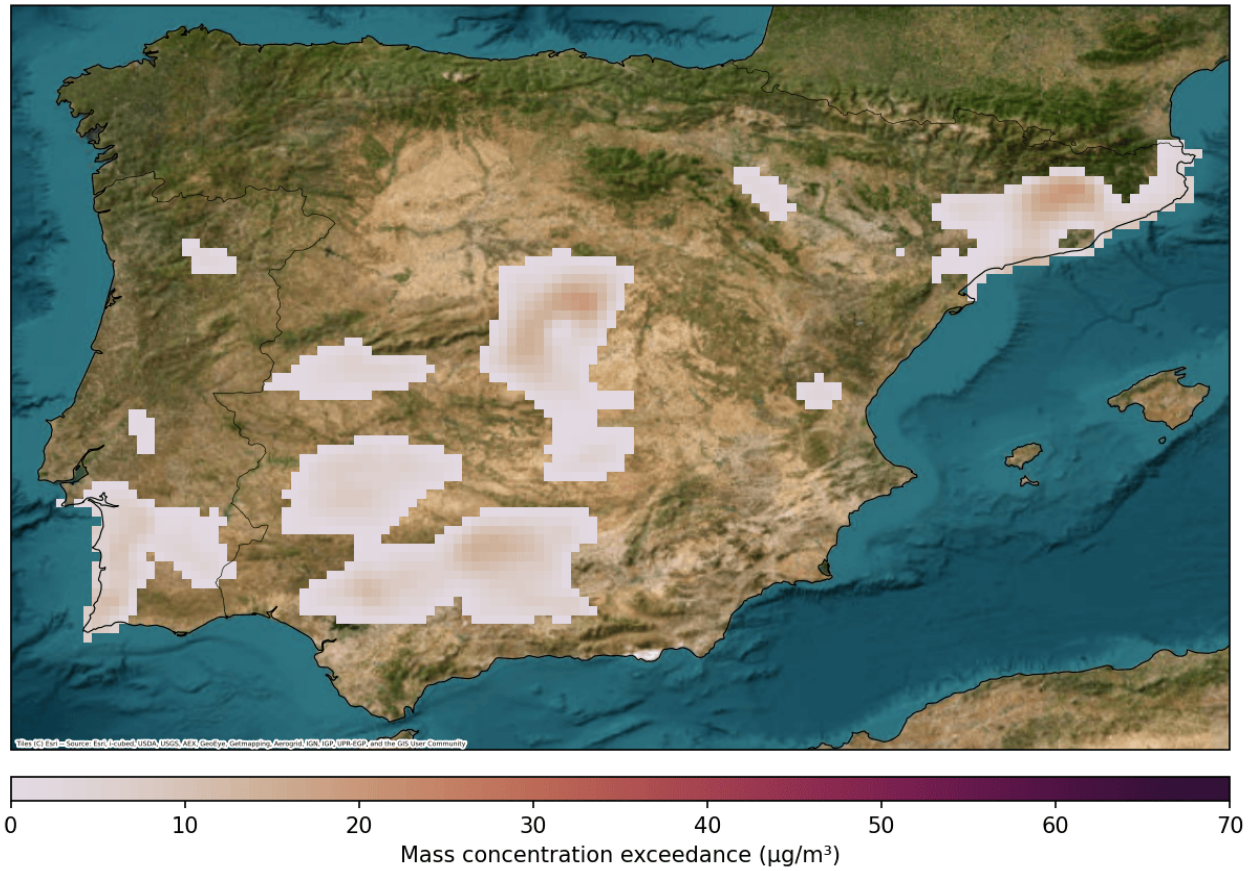
Downscaling NO_2 mass concentration
2017-01-16



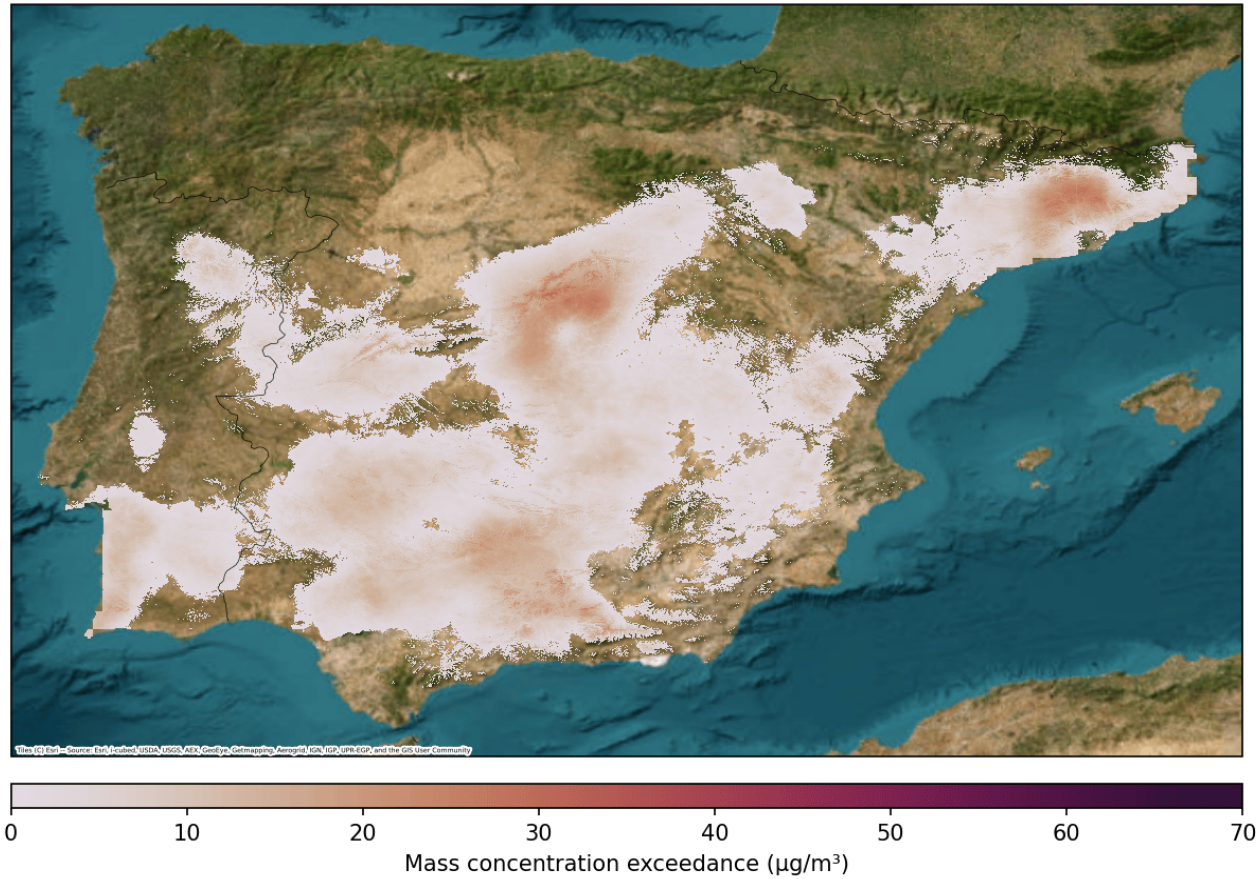
AIR4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

AIR4health Results: Compound HW+O_3 Events

CAMS O_3 mass concentration exceedance (10 km)
2013-07-01



Downscaled O_3 mass concentration exceedance
2013-07-01

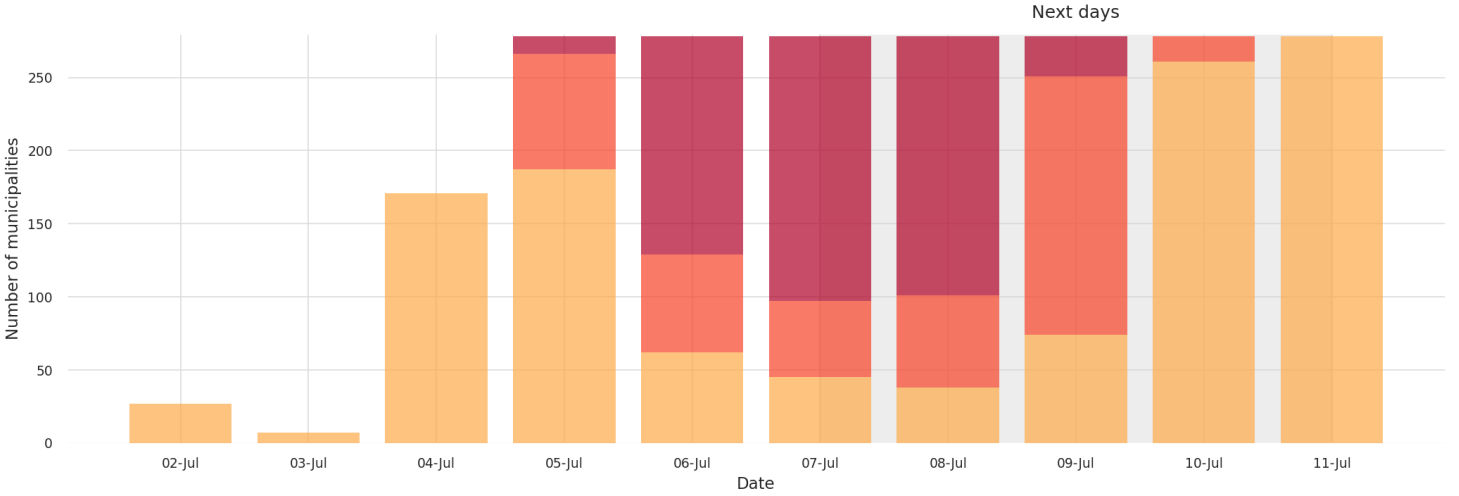


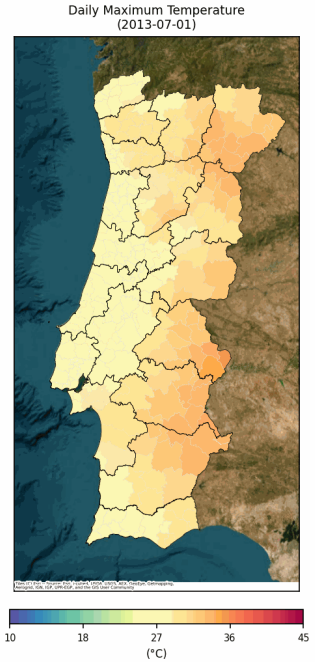
AIR4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

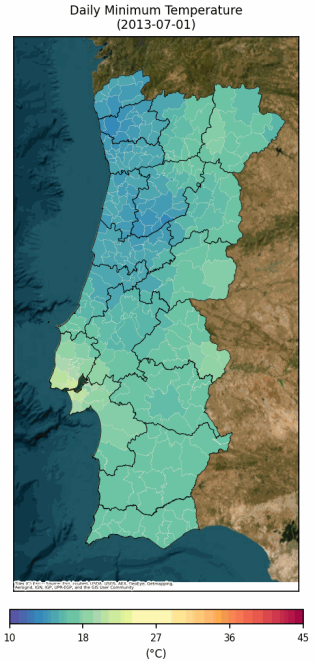
AIR4health Results: Compound HW+O_3 Events

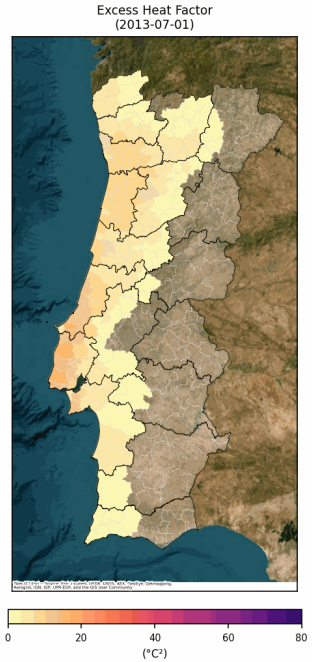
Case in Point: [July 2013 Compound HW+O_3 Event]

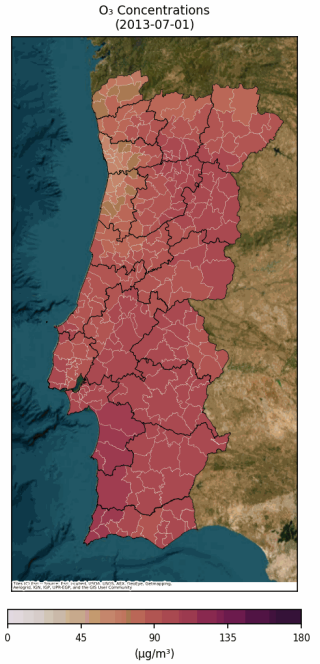
- **Start Date: 05-07-2013**
- **End Date: 10-07-2013**
- **Duration: 6 consecutive days**
- **Max. HW intensity: 49.0°C²**
- **Max. O3 Exceedance: 40.7μg/m³**

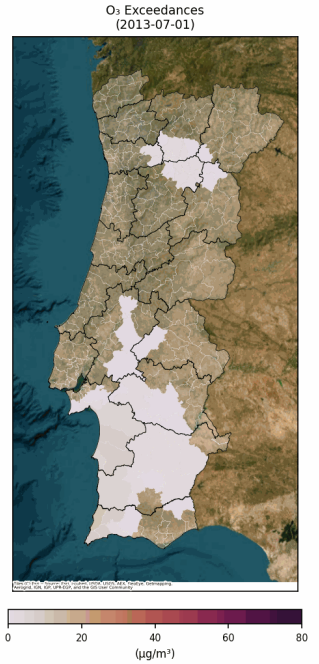


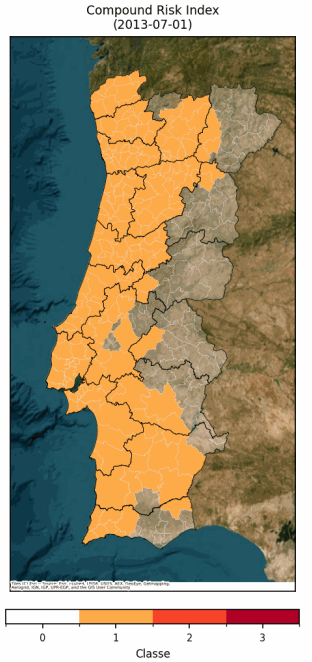










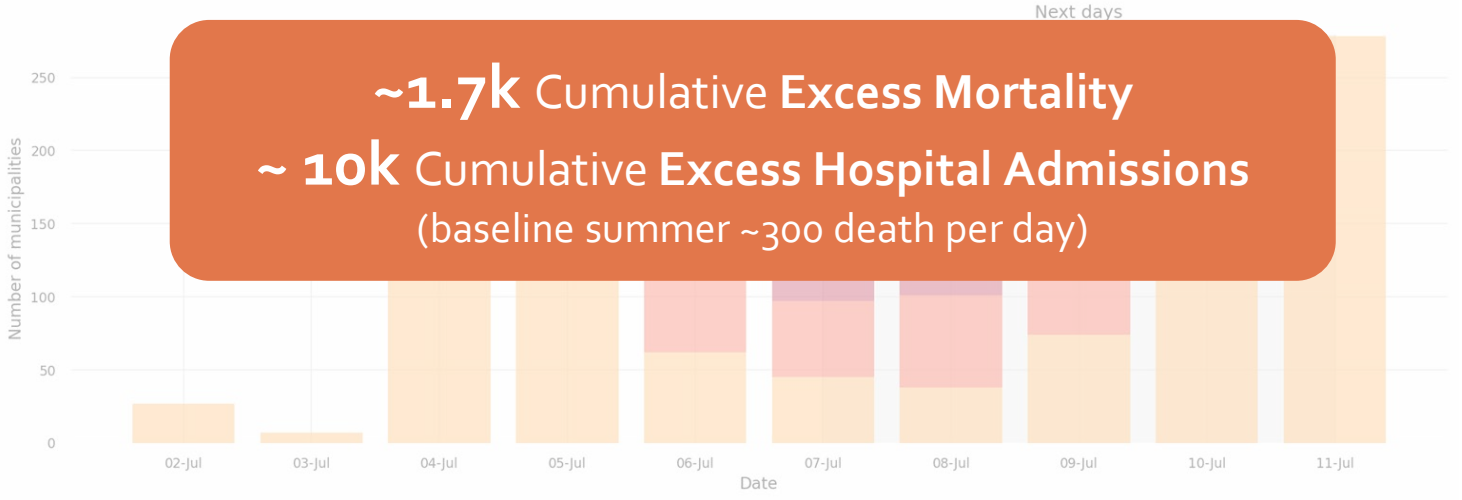


AIR4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

AIR4health Results: Compound HW+O_3 Events

Case in Point: [July 2013 Compound HW+O_3 Event]

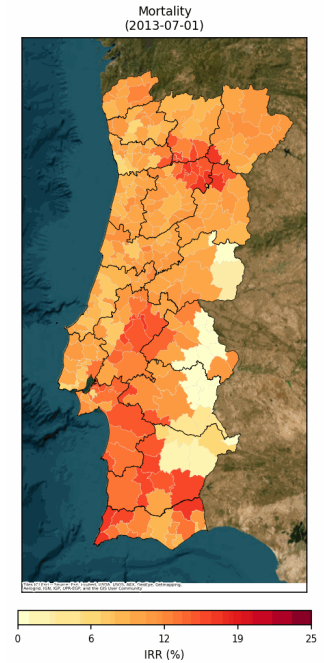
- **Start Date: 05-07-2013**
- **End Date: 10-07-2013**
- **Duration: 6 consecutive days**
- **Max. HW intensity: 49.0°C²**
- **Max. O3 Exceedance: 40.7μg/m³**

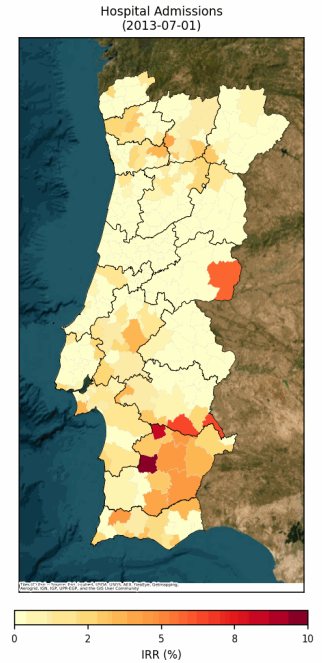


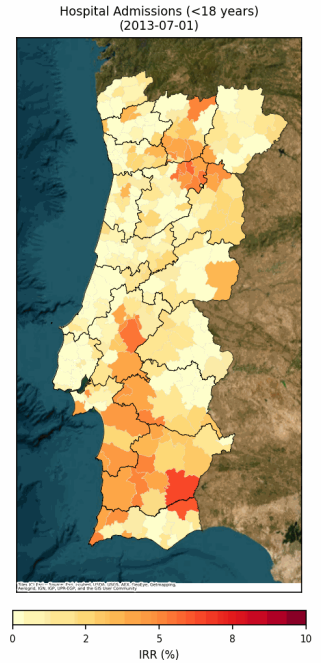
~1.7k Cumulative **Excess Mortality**

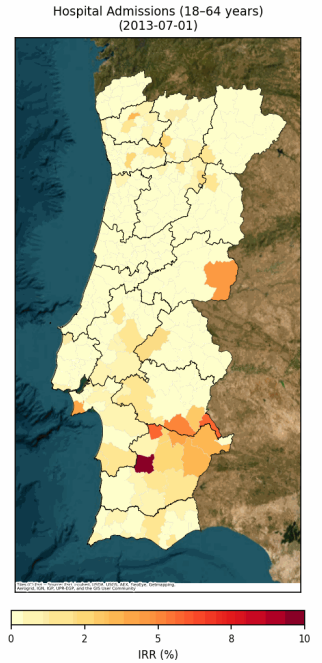
~ 10k Cumulative **Excess Hospital Admissions**

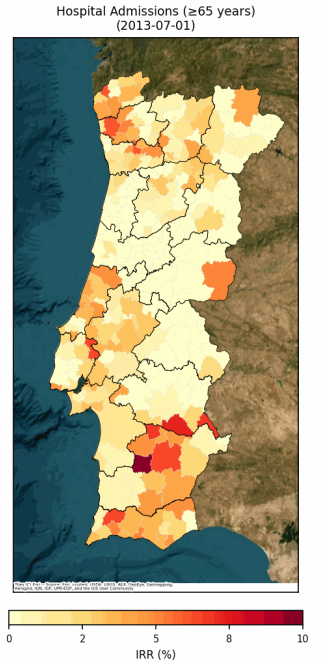
(baseline summer ~300 death per day)

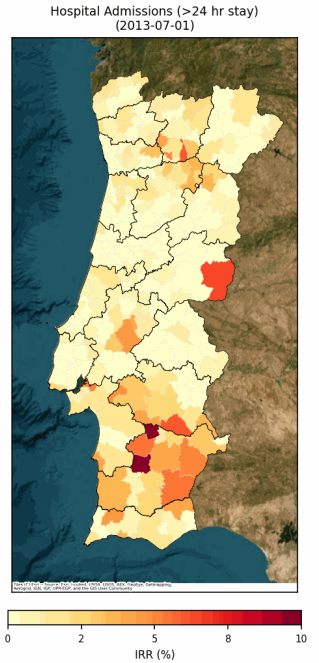










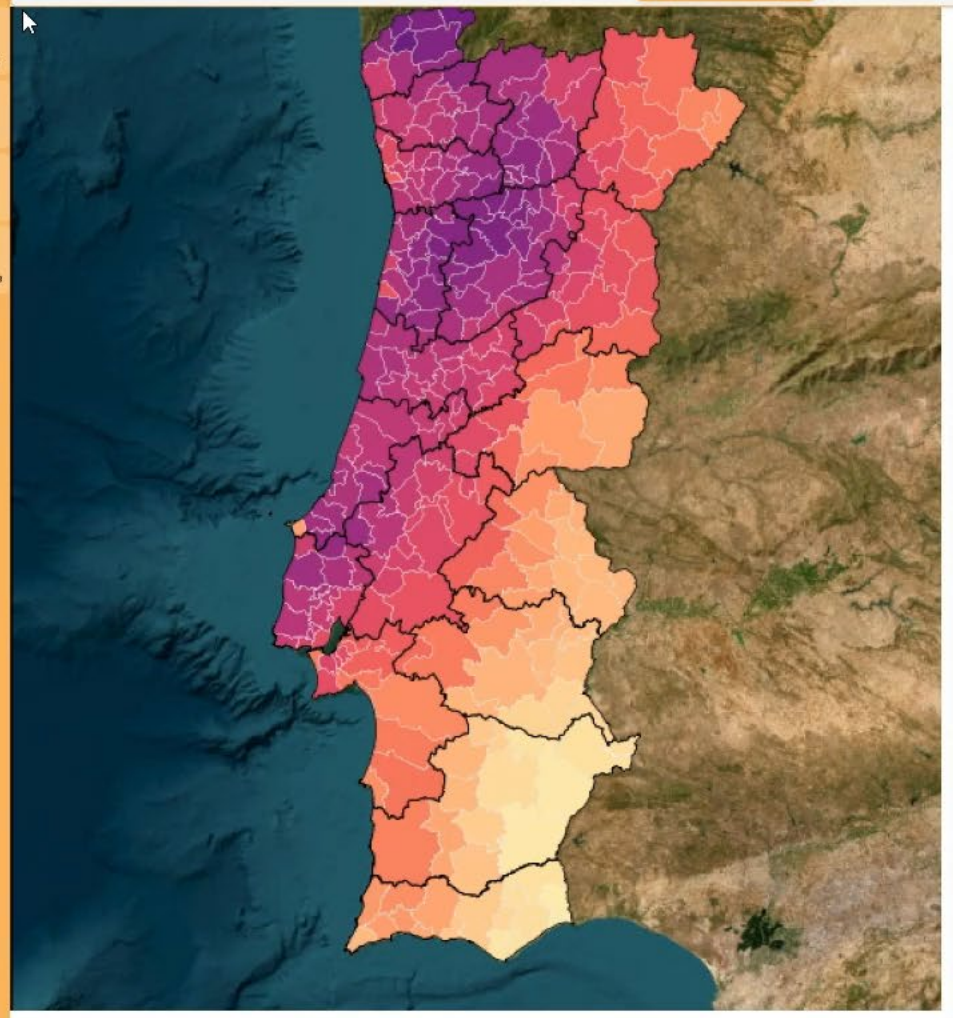


AIR4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

AIR4health: National System for Seasonal Surveillance and Alerting of the Effect of Extreme Temperatures and Air Quality on Health

Compound Risk Index | Excess Heat Factor | Daily Maximum Temperature | Daily Minimum Temperature | O3 Concentration | O3 Exceedances

Location | Search | About | Language



0 20 40 60 80 (°C²)

Today 07/07/2025 | Tomorrow 08/07/2025 | After 09/07/2025

Subscribe Notifications | Share | Download

Summer

Mainland

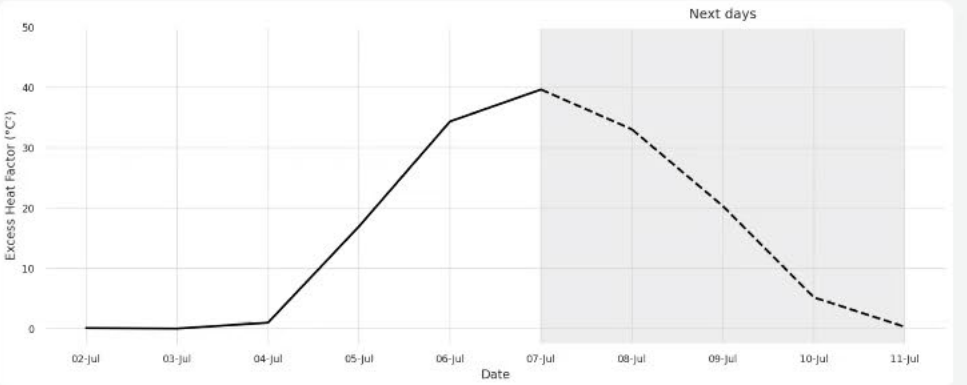
Portugal

Excess Heat Factor: 40°C²

O3 Exceedance: 20 µg/m³

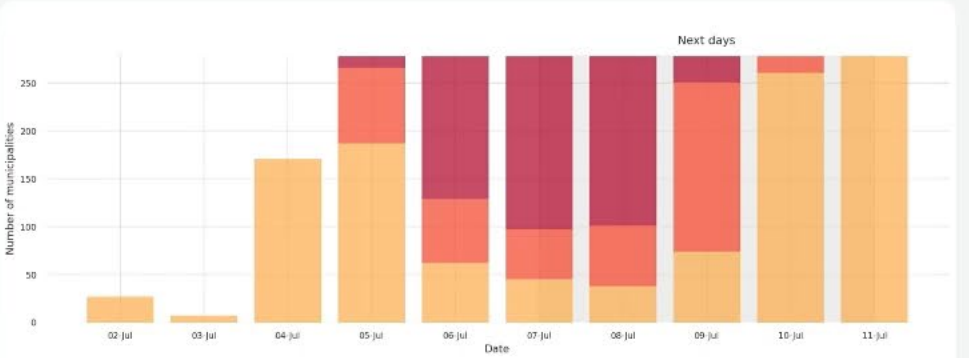
Compound Risk Index: SEVERE

Daily Forecast of Excess Heat Factor

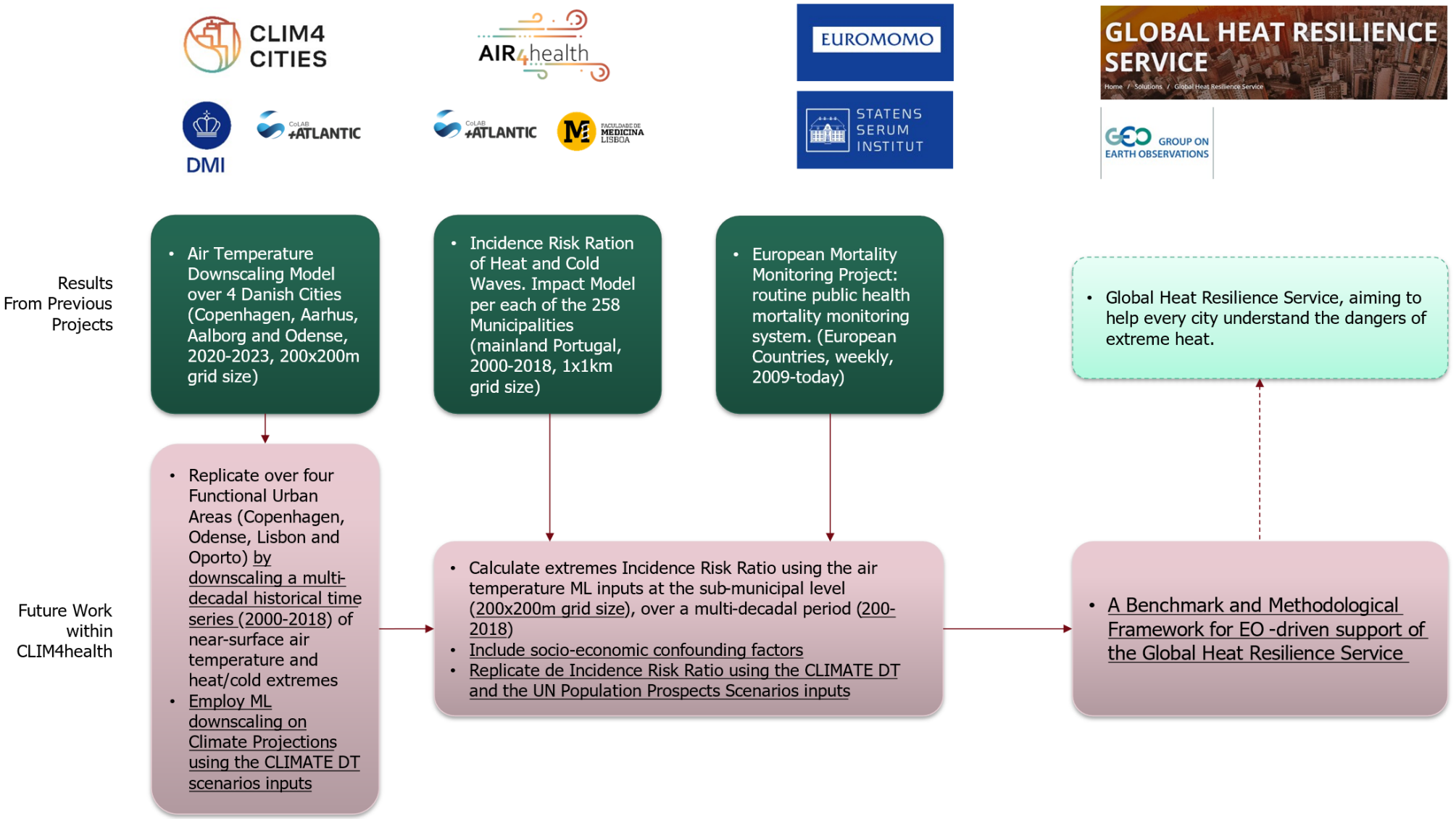


Daily Forecasts of Compound Risk Index

General Population | Age >= 65 Years | Age < 18 Years



No Risk | Low Risk | Moderate | Severe Risk

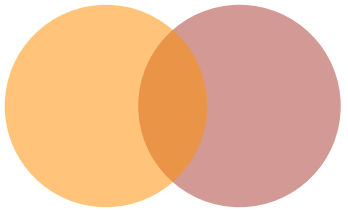


CLIM4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

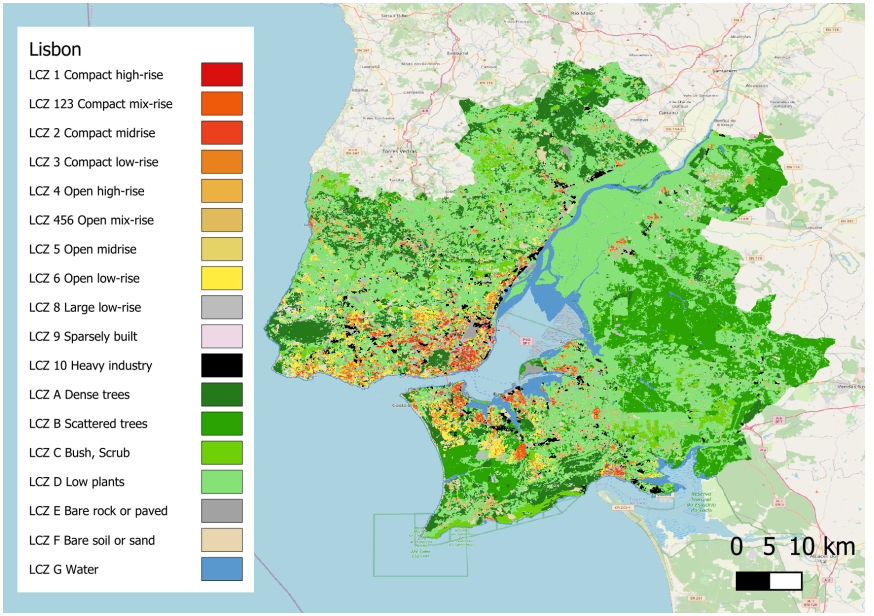
CLIM4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

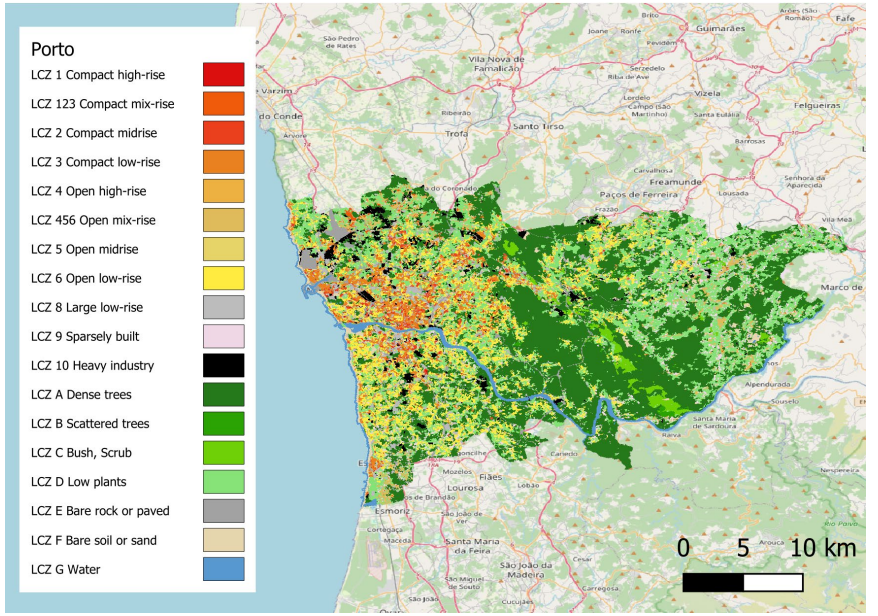
CLIM4health Overview

- The **CLIM4health** overarching goal is thus to develop symmetrical **Extreme Cold and Extreme Heat Climate-Health Risk Indices** (CLIM4health Risk Algorithms) for predicting excess **mortality** and **morbidity** by gender, age group and major diagnostic groups, at the sub-municipal level, over a **total of 4** (four) **metropolitan Functional Urban Areas** (FUAs) in **Portugal** and in **Denmark,** by considering **EO-based land surface indicators** such as vegetation indices, urban density and land cover classes.



Use Case Group 1, Portugal

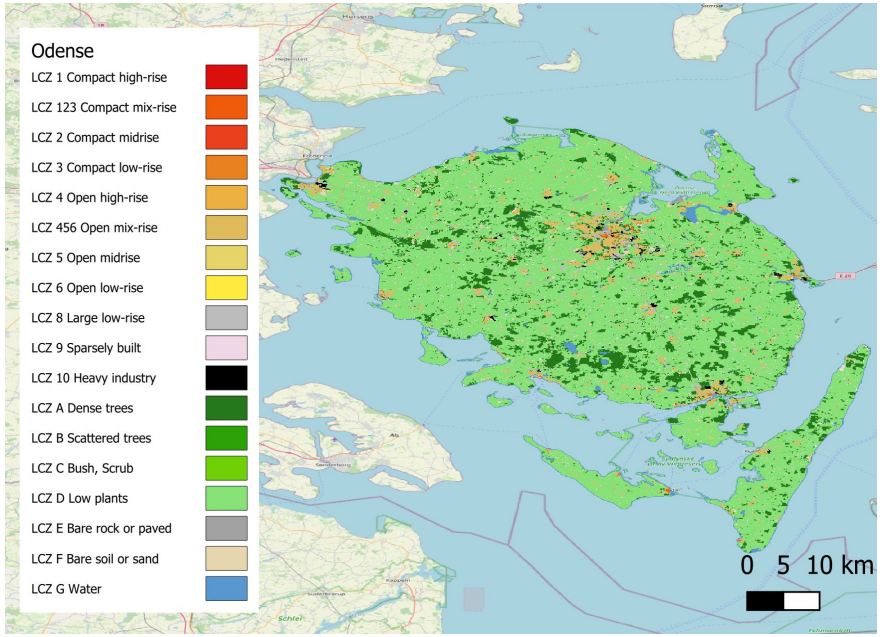


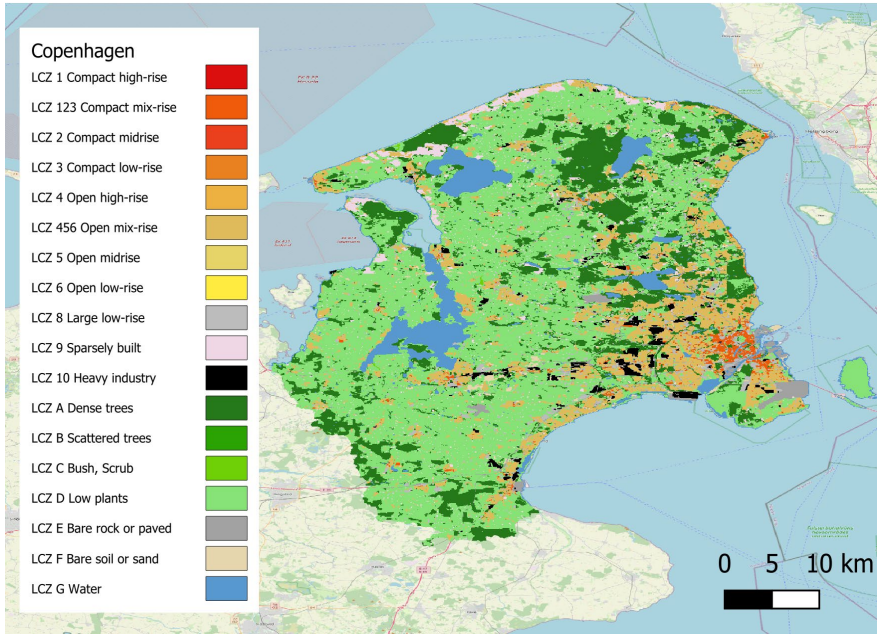


CLIM4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

CLIM4health Overview

- The **CLIM4health** overarching goal is thus to develop symmetrical **Extreme Cold and Extreme Heat Climate-Health Risk Indices** (CLIM4health Risk Algorithms) for predicting excess **mortality** and **morbidity** by gender, age group and major diagnostic groups, at the sub-municipal level, over a **total of 4** (four) **metropolitan Functional Urban Areas** (FUAs) in **Portugal** and in **Denmark,** by considering **EO-based land surface indicators** such as vegetation indices, urban density and land cover classes.

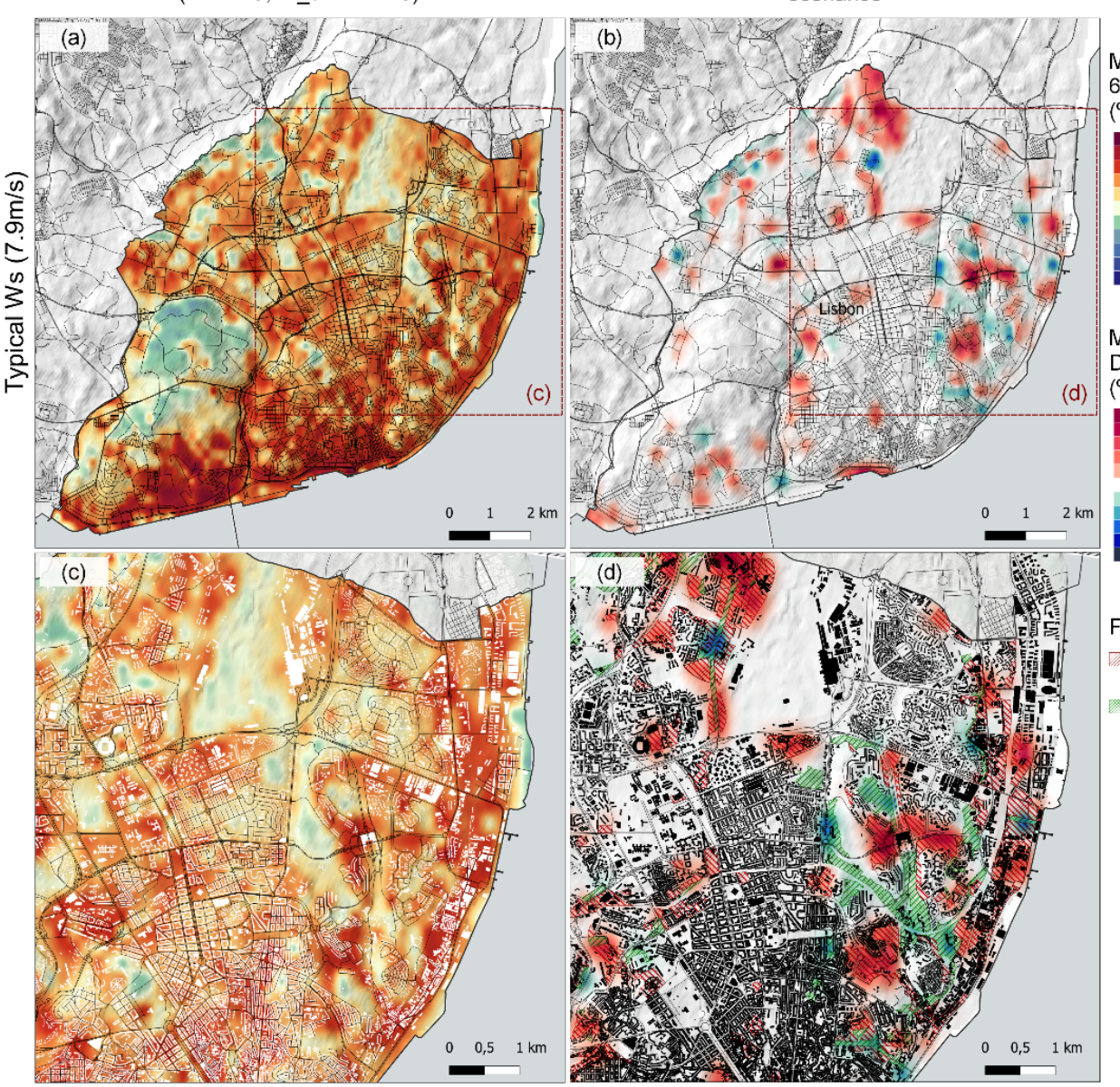




Use Case Group 2, Denmark

CLIM4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

CLIM4health Overview

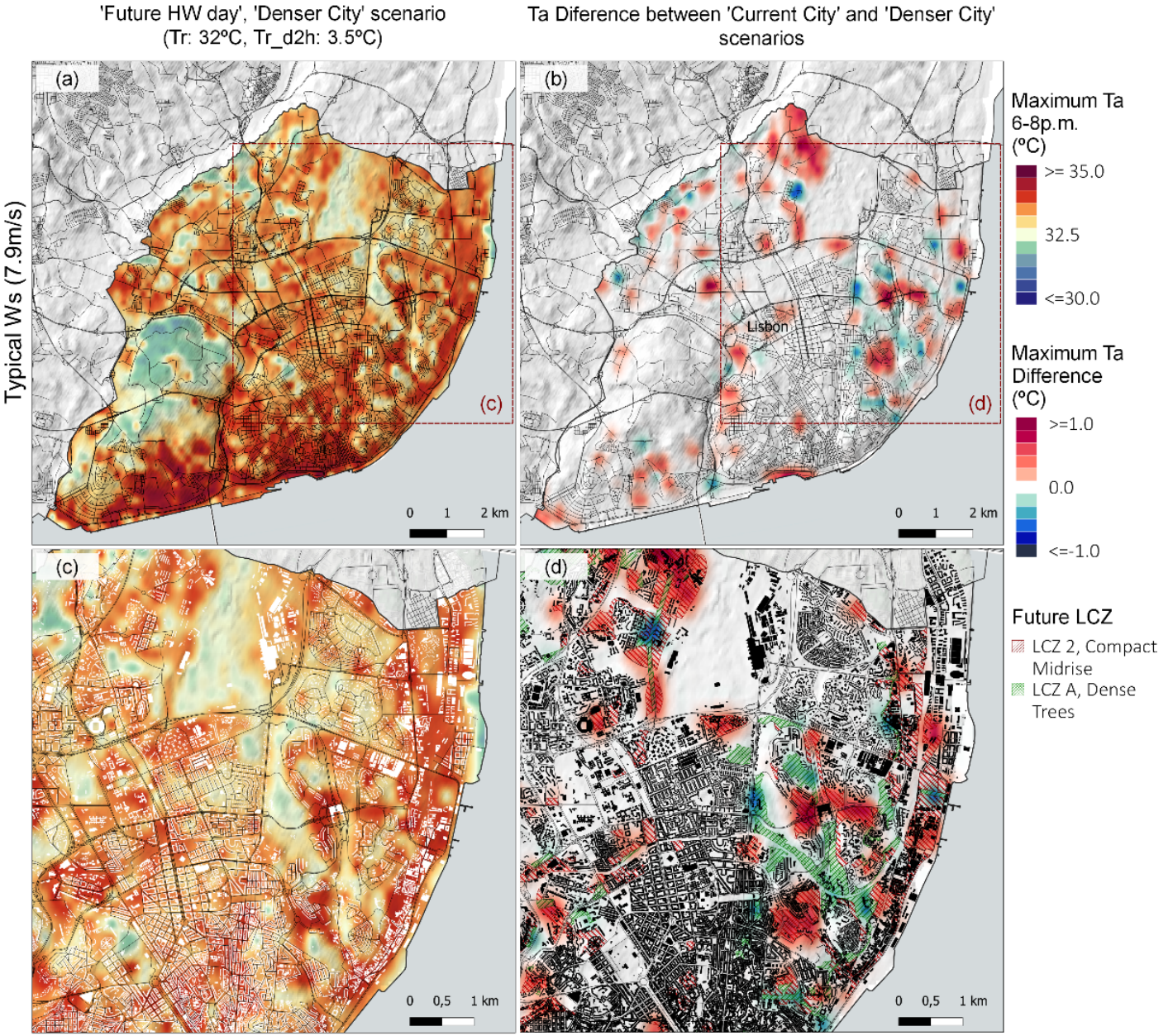


Intercomparison between 'Current City' and 'Denser City' Scenarios
Source: CoLAB +ATLANTIC

CLIM4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.

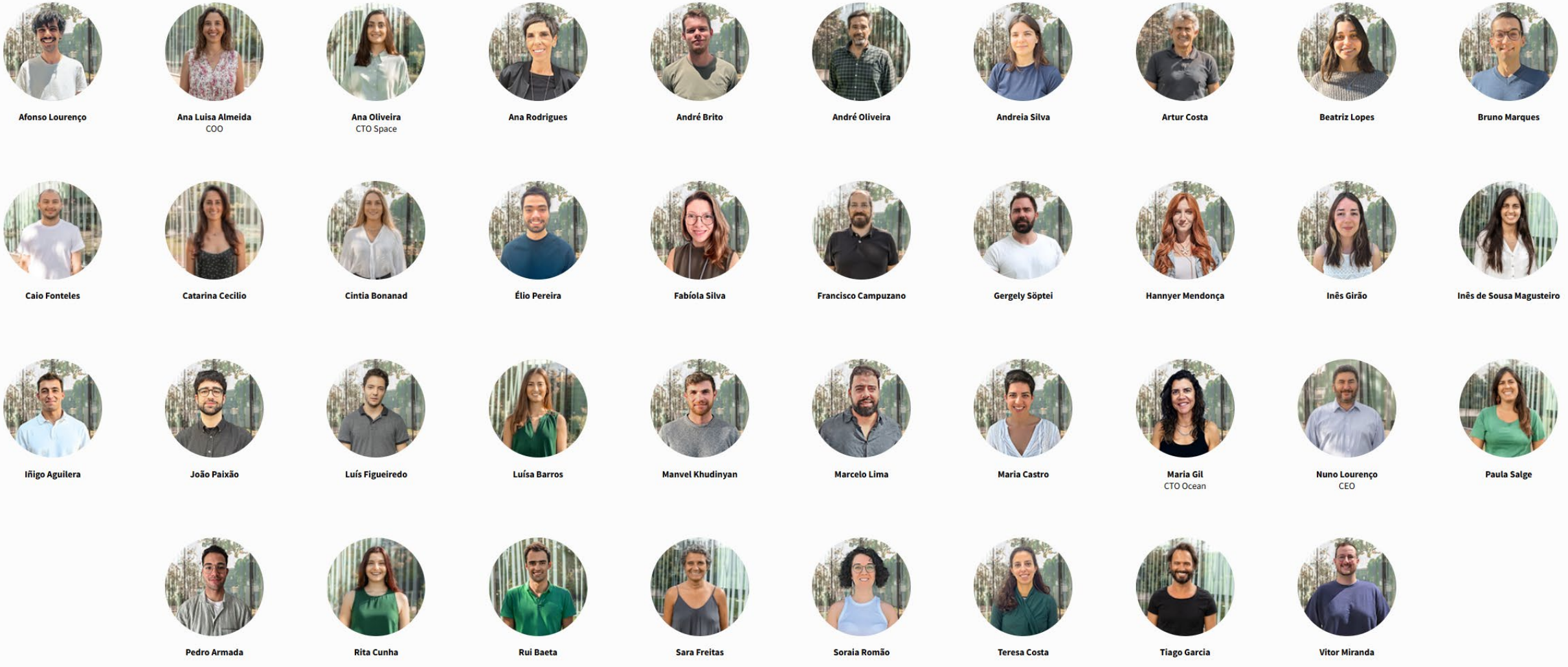
CLIM4health Overview

- How much cooler/warmer a neighbourhood is, compared to the long-term average climate?
- How extreme is the heat (cold) in a given neighbourhood, compared to the local temperature range?
- Which are the cooling (heating) acclimatization needs, in each neighbourhood?



Intercomparison between 'Current City' and 'Denser City' Scenarios
Source: CoLAB +ATLANTIC

CLIM4health is under a programme of, and funded by, the European Space Agency. Views expressed do not reflect the official opinion of the European Space Agency.



THANK YOU!

Ana Oliveira, on behalf of the **AIR4health, CLIM4cities and the CLIM4health** Project Teams

ana.oliveira@colabatlantic.com