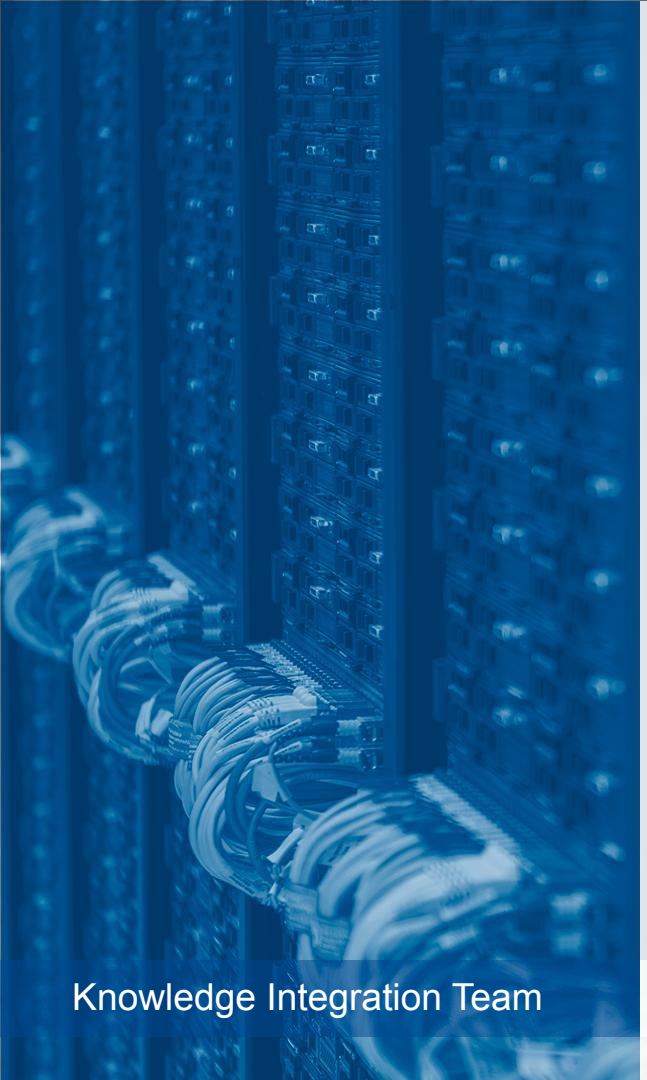
Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Generalitat de Catalunya
Departament de Recerca i Universitats

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional



Barcelona Supercomputing Center
Centro Nacional de Supercomputación

A twin of the Earth to tackle Climate Change

Un gemello della Terra per affrontare il cambiamento climatico

Knowledge Integration Team

Clàudia Huertas, Gerrit Versteeg

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

High Performance Computing (HPC)

Earth Sciences Department
Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Earth System Services

We co-design climate, air quality and health resilience services, while facilitating knowledge exchange and technology transfer of state-of-the-art research at local, national, and international levels.

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Knowledge Integration Team

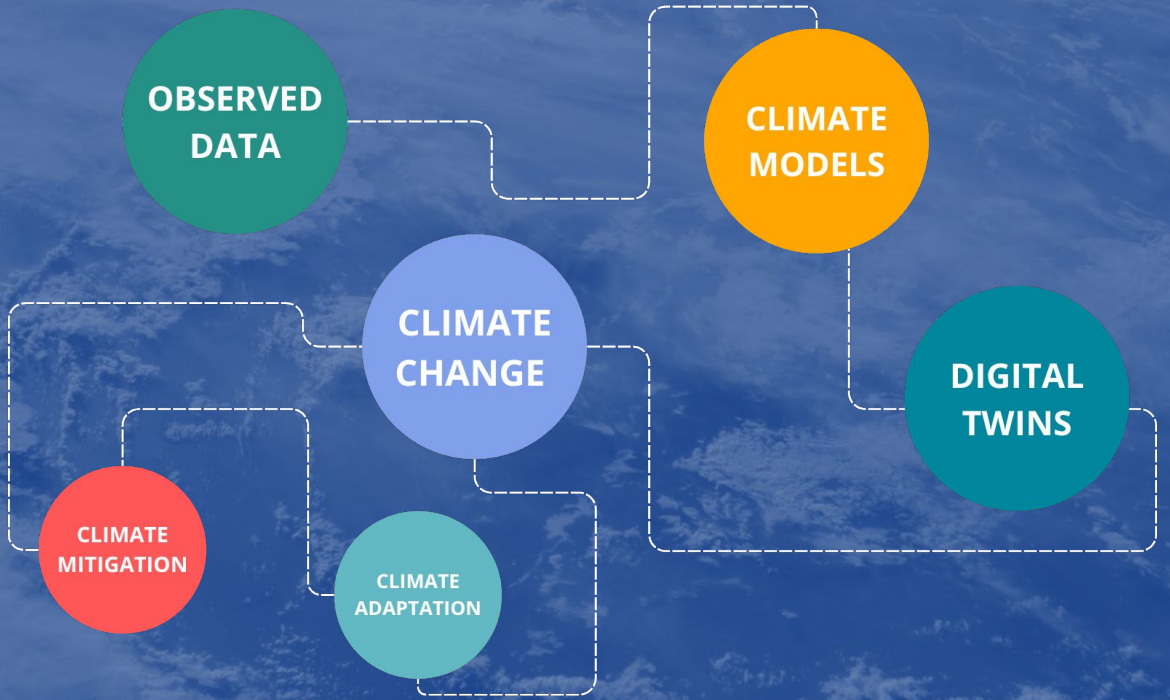
We co-create **climate and environmental tools** and services together with a wide range of actors — from scientists and policymakers to local communities.

By working together, we make scientific information more useful, understandable, and applicable in everyday life.

We involve users and stakeholders from the very beginning. We listen to their needs, share knowledge, and develop tailored solutions together.

This way, the services and products we create are **practical, inclusive, and ready to be used**, helping build a more resilient society in the face of climate change.

Our goal


OBSERVED DATA
CLIMATE MODELS
CLIMATE CHANGE
DIGITAL TWINS
CLIMATE MITIGATION
CLIMATE ADAPTATION

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

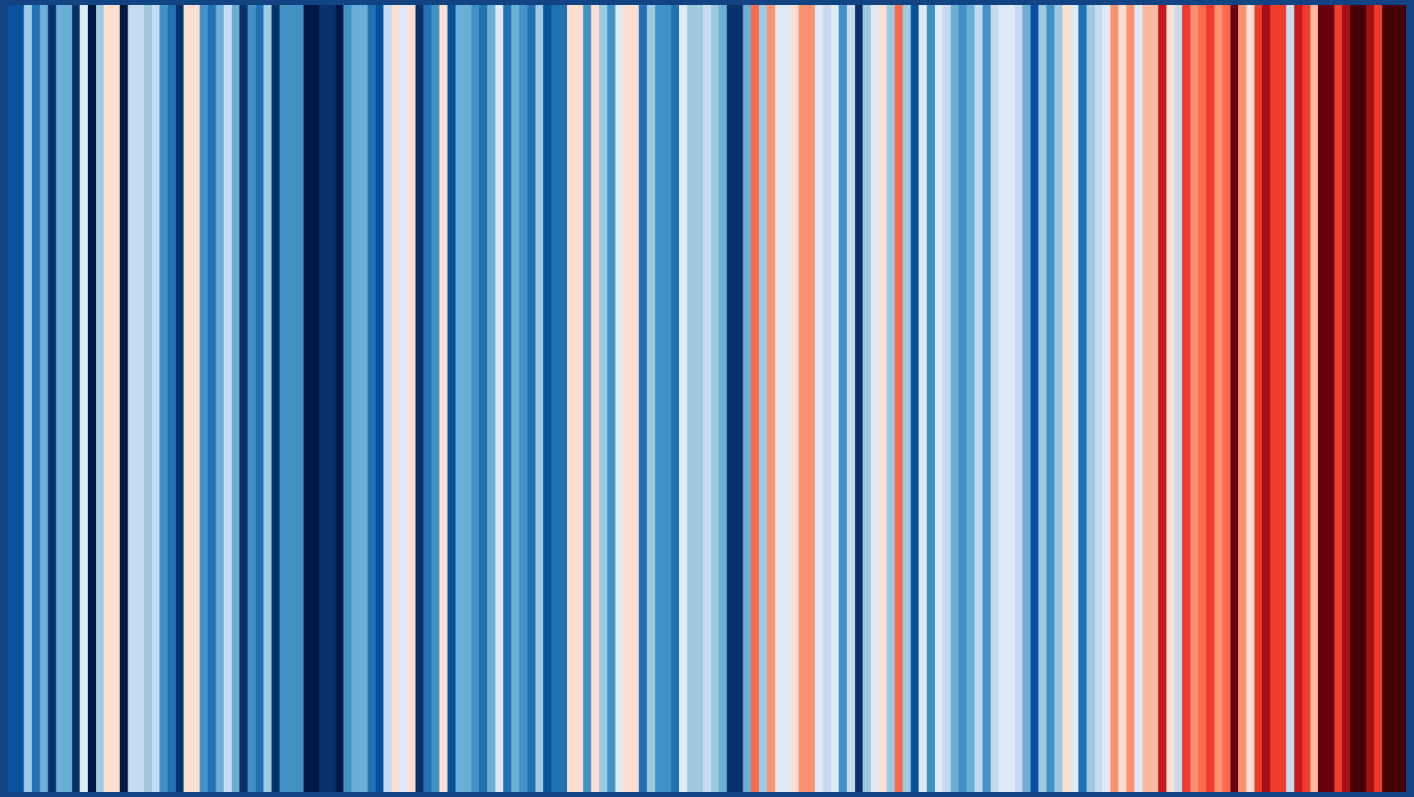
Let's get started!

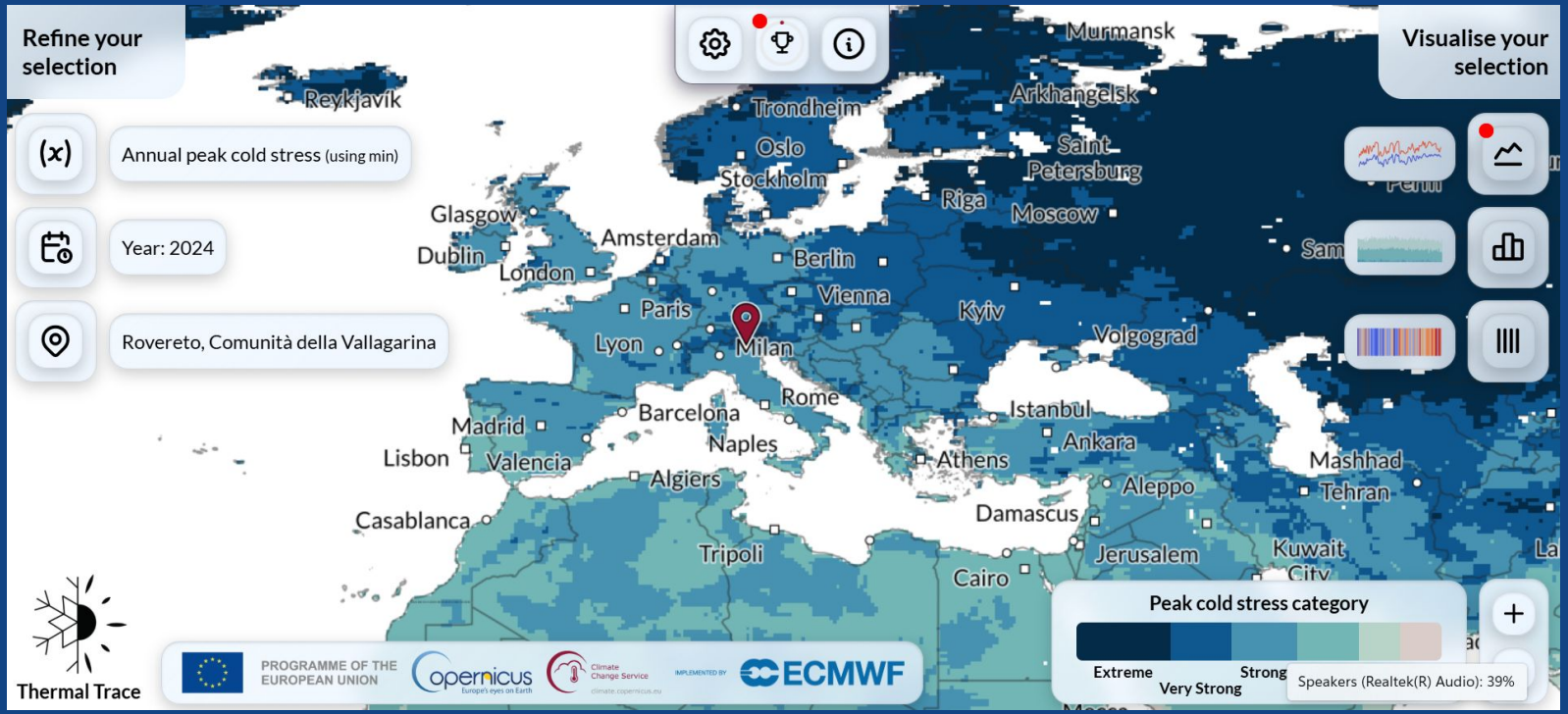
www.menti.com

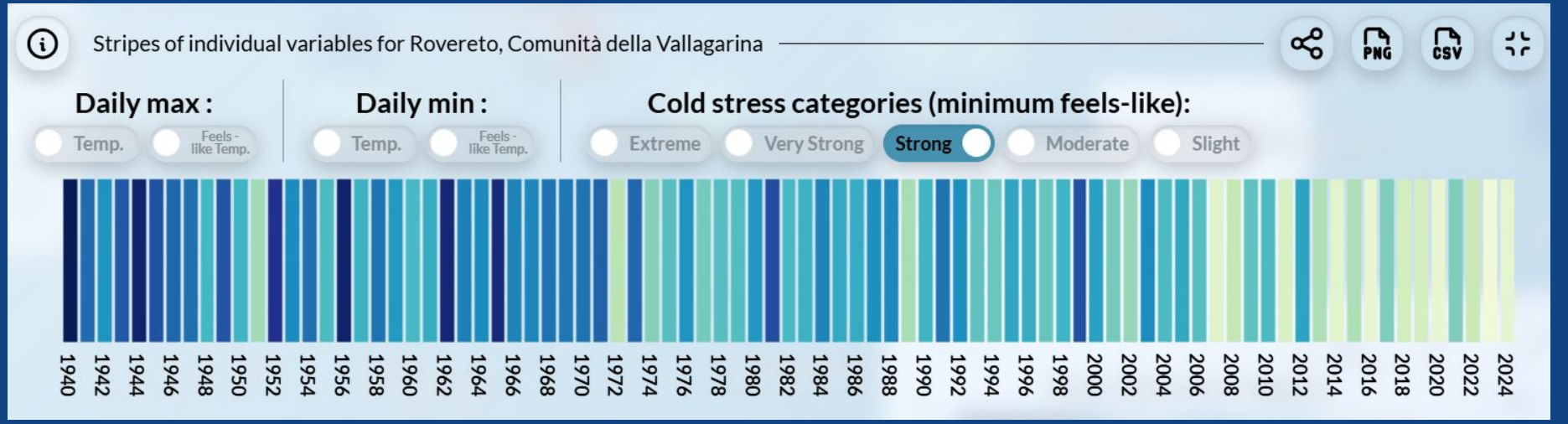
3455 6765

What have you seen?


GROUP
PROJECT




Refine your selection
Annual peak cold stress (using min)
Year: 2024
Rovereto, Comunità della Vallagarina
Visualise your selection
Reykjavik
Murmansk
Arkhangelsk
Trondheim
Oslo
Stockholm
Saint Petersburg
Riga
Moscow
Glasgow
Dublin
London
Amsterdam
Berlin
Vienna
Paris
Lyon
Milan
Kyiv
Volgograd
Rome
Barcelona
Madrid
Lisbon
Valencia
Naples
Istanbul
Ankara
Athens
Algiers
Casablanca
Tripoli
Damascus
Aleppo
Mashhad
Tehran
Jerusalem
Kuwait City
Cairo
Peak cold stress category
Extreme
Very Strong
Strong
Thermal Trace
PROGRAMME OF THE EUROPEAN UNION
opernicus
Climate Change Service
IMPLEMENTED BY
ECMWF
Speakers (Realtek(R) Audio): 39%


Stripes of individual variables for Rovereto, Comunità della Vallagarina
PNG
CSV
Daily max :
Temp.
Feels - like Temp.
Daily min :
Temp.
Feels - like Temp.
Cold stress categories (minimum feels-like):
Extreme
Very Strong
Strong
Moderate
Slight
1940
1942
1944
1946
1948
1950
1952
1954
1956
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024

Climate models & Digital Twins

CLIMATE PREDICTIONS

Near-term future timescales: from 1-4 weeks up to a decade.

They provide **the most robust climate information currently available**.

Presented as the **probability** of certain climate conditions occurring.

CLIMATE PROJECTIONS

Decades and up to the end of the century.

Assess the global evolution of the Earth's climate and to study phenomena such as climate change.

Require scenario hypotheses based on future projected **levels of greenhouse gases** and **socio-economic development.**

- A climate model is a mathematical representation of the Earth's climate system.
- It uses scientific equations to simulate how the atmosphere, oceans, land, and ice interact.
- Climate models help us understand past climates, study current trends, and project possible future changes, like temperature increases or rainfall patterns, under different scenarios.

The New York Times | CLIMATE

Originally published in 2018

How Much Hotter Is Your Hometown Than When You Were Born?

- A digital twin is a virtual copy of a real-world system — for example, a city, river basin, or energy network.
- It continuously receives real-time data from the real system and allows people to simulate, test, and optimize decisions before acting in the real world.
- Digital twins are interactive and can use models (including climate models) as part of their simulations.

Why are Digital Twins useful?

01
Understanding processes:

The digital twin produces simulations that allow researchers to understand the complex interactions of phenomena in the Earth-system that determine how our planet evolves.

02
Simulating scenarios:

The digital twin allows researchers, policy makers and practitioners to develop and test different climate and impact scenarios that help understand what might happen under various conditions.

03
Improving decision-making:

By providing clear and accurate insights on the past, present and future, the digital twin can support decision-makers, policy-makers and world leaders make better informed decisions to address climate-related risks effectively and sustainably

04
Enhancing interdisciplinary and transdisciplinarity:

Virtual models support collaboration among users from different disciplines, impact sectors, and geographical locations, ensuring a holistic approach to studying and solving real climate challenges.

DestinE Timeline

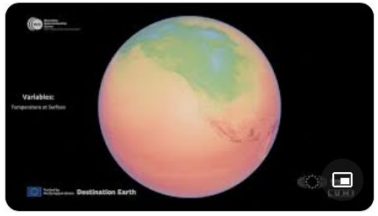
DestinE is being developed through the following key milestones:

Development
By 2023
Development of the main components begins.

Implementation
By 2024
All the components of the system (DestinE Platform, Data Lake, Digital Twin Engine) have been developed. The DestinE Platform and Data Lake have been transferred into operation. Demonstration of the first two digital twins on Weather-Induced Extremes and Climate Change Adaptation and the open core platform.

Enhancement
By 2026
Further enhancement of the DestinE system and integration of additional digital twins and related services.

Full Earth Replica
By 2030
A "full" digital replica of the Earth



A quick look at different atmospheric and oceanic variables. The data come from the...

A quick look at different atmospheric and oceanic variables.

The data come from the simulation of the SSP3-7.0 scenario using the IFS-NEMO model (with a resolution of 4.4 km for the atmosphere and land and 1/12th of a degree for the ocean and sea ice).
Speed: 1 day/second.

How to tackle climate change?

www.menti.com

1853 8364

Climate adaptation and mitigation

🌳 ADAPTATION

These actions aim to reduce vulnerability to the impacts of climate change

Create shaded areas in cities and plant more trees

Install green roofs on buildings to reduce heat and absorb water

Grow crop varieties resistant to drought or extreme heat

Manage water resources better to prevent shortages

Establish early warning systems for extreme weather events

🚴 MITIGATION

These actions aim to reduce or avoid greenhouse gas emissions

Plant trees and restore forests

Bike or walk instead of using a car

Improve energy efficiency in homes and buildings

Reduce consumption of meat and animal products

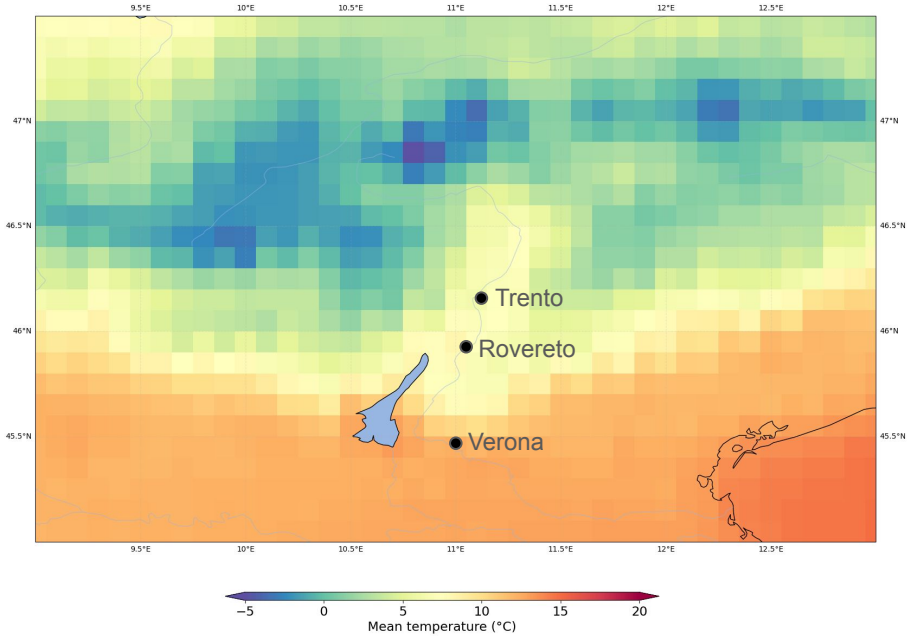
Reduce, reuse, and recycle waste

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

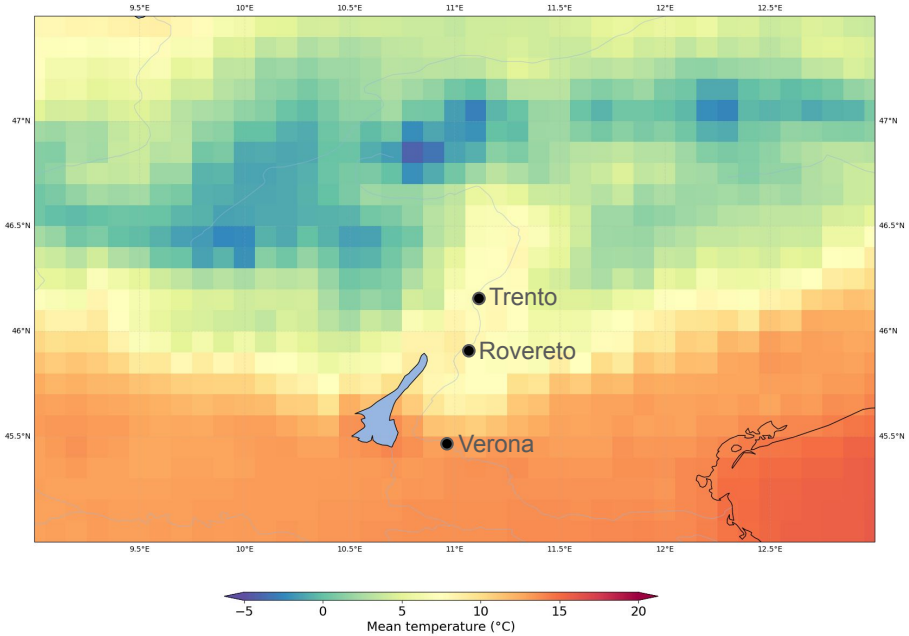
Destination Earth:
What about Rovereto?

WHAT ABOUT ROVERETO

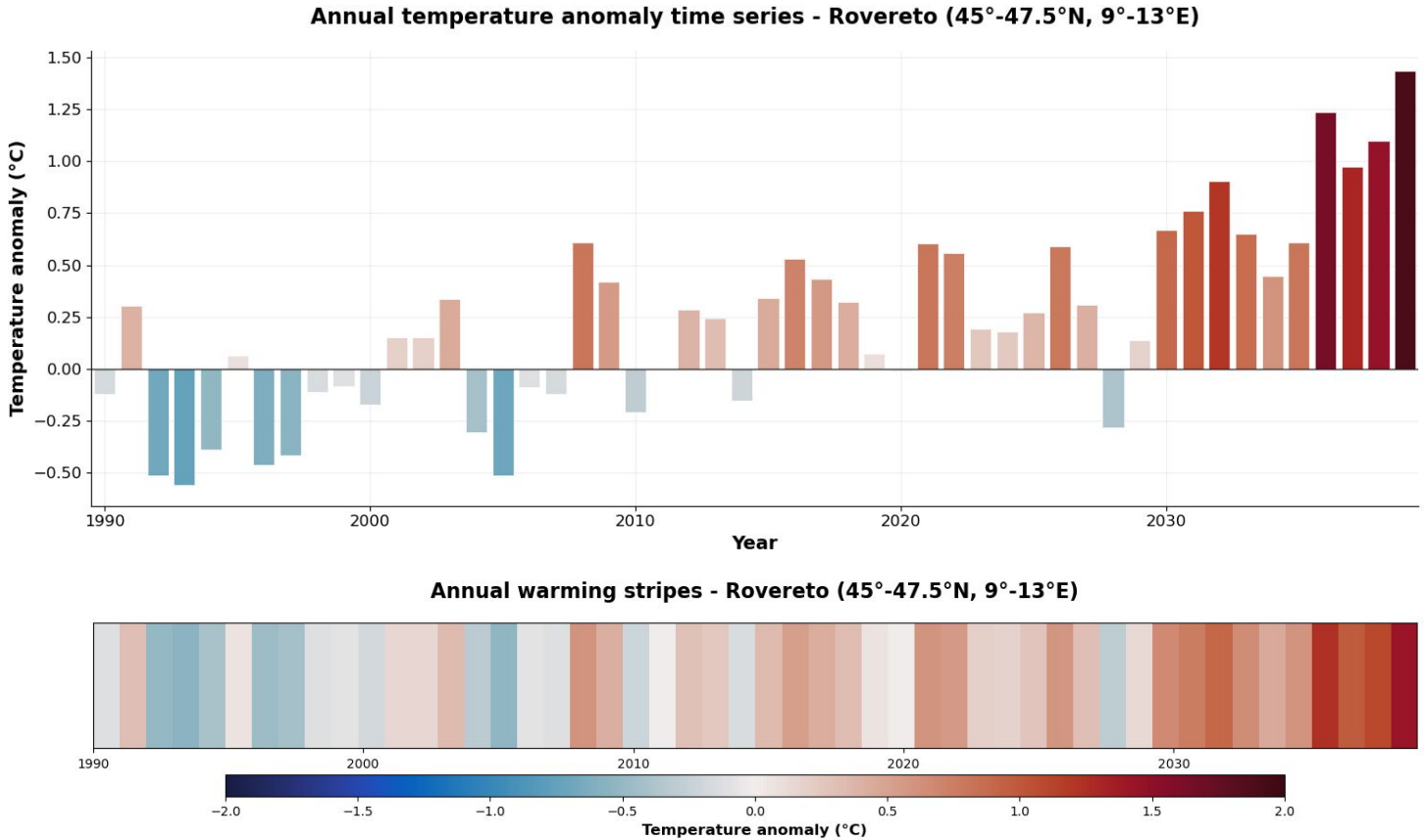
- Mean temperature in the historical period 1990-2019.



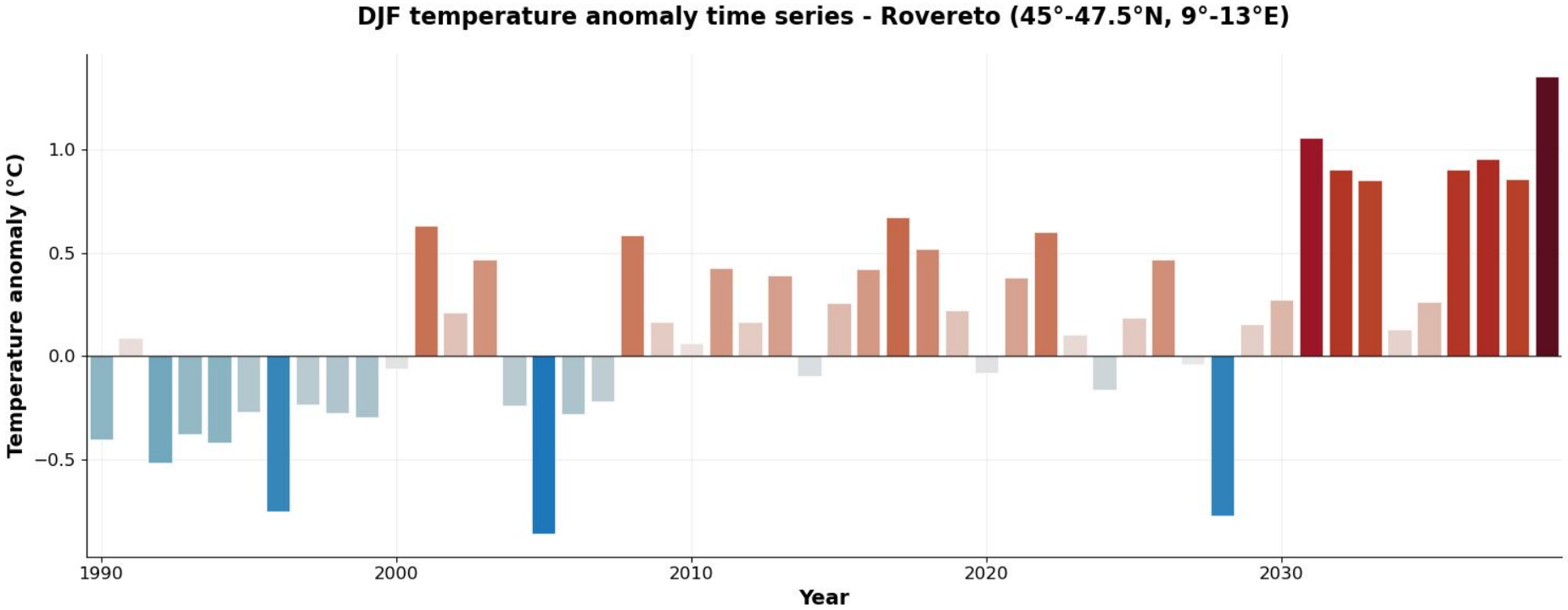
- Mean temperature in the projection period 2020-2039.



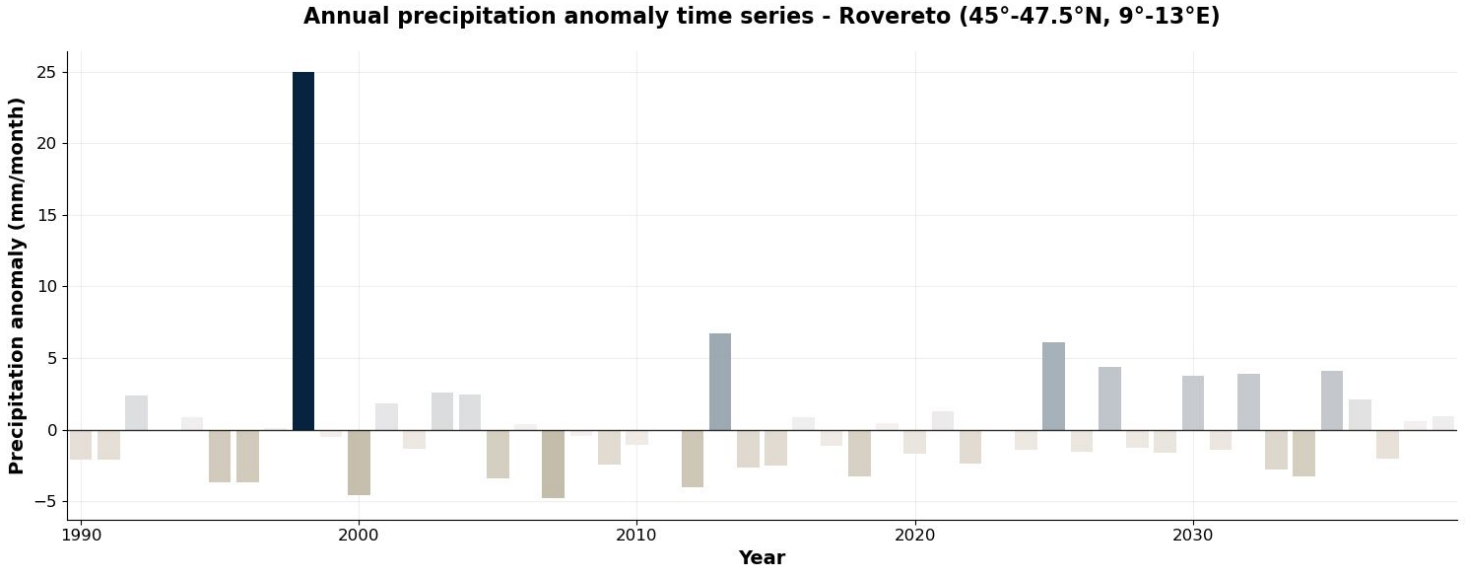
➢ Compared reference period 1990-2019

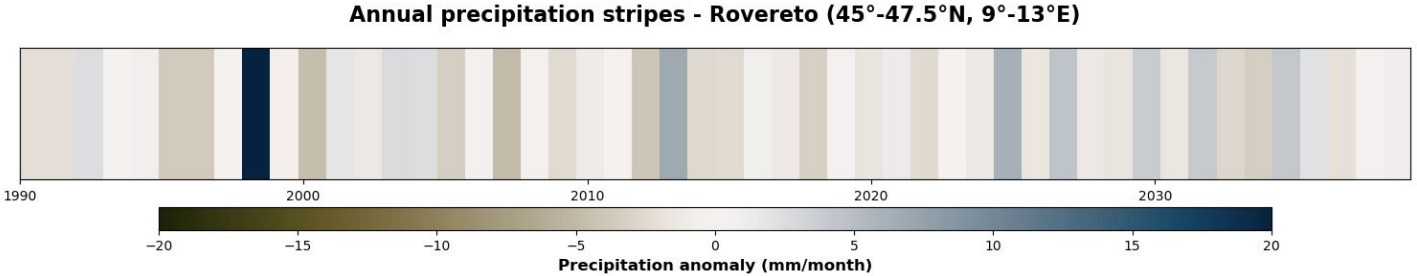


➢ **Winter season**: December - January - February (DJF) temperature anomaly time series (compared reference period 1990-2019).

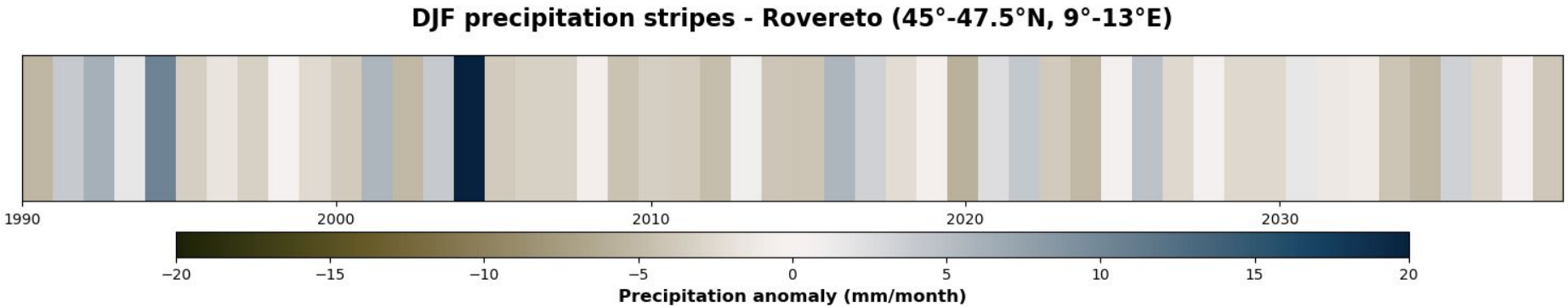


➢ Compared reference period 1990-2019





➢ **Winter season**: December - January - February (DJF) Compared reference period 1990-2019.



What about now?

www.menti.com
4680 8434

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Thanks for participating!

Vorremmo solo chiederti un'ultima cosa…

https://form.typeform.com/to/rQ4YZ26H

Knowledge Integration Team

Clàudia Huertas, Gerrit Versteeg

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Digital Twins:
A practical case

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

What if...

the heatwave that affected Europe in 2018 occurred in a +2ºC warmer world ?

https://climate-digital twin.bsc.es/