

Climate Adaptation Strategy

Second Climate Monitoring
Report of Roma Capitale

Summary



The city of Rome's **climate monitoring initiative** is the result of a technical and scientific collaboration between Roma Capitale and the CMCC Foundation.

This synergy led to the publication of the present report and the development of an interactive service available through Dataclime, the CMCC-managed platform, which can be accessed upon free registration.



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Content and graphics by the CMCC Foundation



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Rome Climate Hub: Monitoring Climate Change to Guide the City's Adaptation

Rome's Second climate monitoring report is part of an initiative launched in 2024 through the **technical and scientific collaboration between the City of Rome and the Euro-Mediterranean Center on Climate Change (CMCC)**, with the goal of developing increasingly effective tools to address the challenges of climate adaptation in urban settings.

The cornerstone of this initiative is **Rome's Climate Adaptation Strategy**, approved by the Capitoline Assembly on January 14, 2025, which identified the main priorities for the Roman territory and defined the adaptation objectives and measures necessary both in response to the impacts already underway and to the scenarios projected for 2050. In this context, climate monitoring is a fundamental tool for **guiding the implementation of the strategy and supporting the ongoing advancement of adaptation measures**. Among the main priorities identified are the growing risk of heavy rainfall and flooding that threaten neighborhoods and infrastructure, the security of water supplies in a scenario characterized by decreasing precipitation and longer periods of drought, the adaptation of neighborhoods to increasingly higher temperatures, with direct effects on people's health, and the impacts on the coastline linked to coastal erosion, the intensification of extreme events, and sea-level rise.

To support this effort, the *Roma Climate Hub* was developed, a portal created by CMCC and hosted on the **Dataclime platform**, which allows users to explore the **past, present and future climate of the city of Rome**. Through the platform, users can access historical data, catalogs of extreme events and climate projections, with the goal of better understanding the evolution of the urban climate and possible future scenarios. From the portal, you can download the first monitoring report for 2024, available in both a full version and a summary version.

The first report aimed to establish a framework for understanding Rome's climate through a system of indicators consistent with the **National Climate Change Adaptation Plan (PNACC)**, providing useful information to support planning and adaptation efforts. This second report continues the process initiated in 2024, enriching the platform with new data and new features.

Key Updates from the Second Year of Monitoring

Throughout 2025, the *Rome Climate Hub* was further developed to improve both the accessibility of the information and the tools available for climate monitoring. **The platform's structure and graphics were renewed** to make it easier and more intuitive to use. The new features and reorganization of content are designed to make it easier for citizens, technical experts, and administrators to explore the information.

The platform continues to integrate observational **data from weather stations and datasets based on climate reanalyses developed by CMCC** for Italy. The reanalyses combine various types of observations with physical models to coherently reconstruct climate evolution over time, enabling the analysis of climate conditions even where direct observations are limited. **The meteorological monitoring network has been updated with data from 2025** and strengthened by the **addition of six new stations** dedicated to measuring precipitation and air temperature.

The section dedicated to **satellite imagery**, already an integral part of the analysis launched in 2024, has also been **further expanded**. In the second year of monitoring, this information is also being used to **analyze changes in the marine environment** and to launch an in-depth study of the sea's role in Rome's climate system, with the goal of developing a future line of research dedicated to the dynamics of the Tyrrhenian Sea and their effects on the Roman coastline. To support these analyses, **ocean reanalyses** are used, specifically *ORAS5*¹, developed by the European Center for Medium-Range Weather Forecast (ECMWF), which are useful for monitoring the evolution of key marine variables and their interactions with the coastal system.

In this second year of monitoring, the platform also integrated **FAIR (Fast AI Reanalysis)**², a new service developed by the CMCC based on **CMCC's very high-resolution climate reanalysis (VHR_REA_IT)**³, already available on the platform.

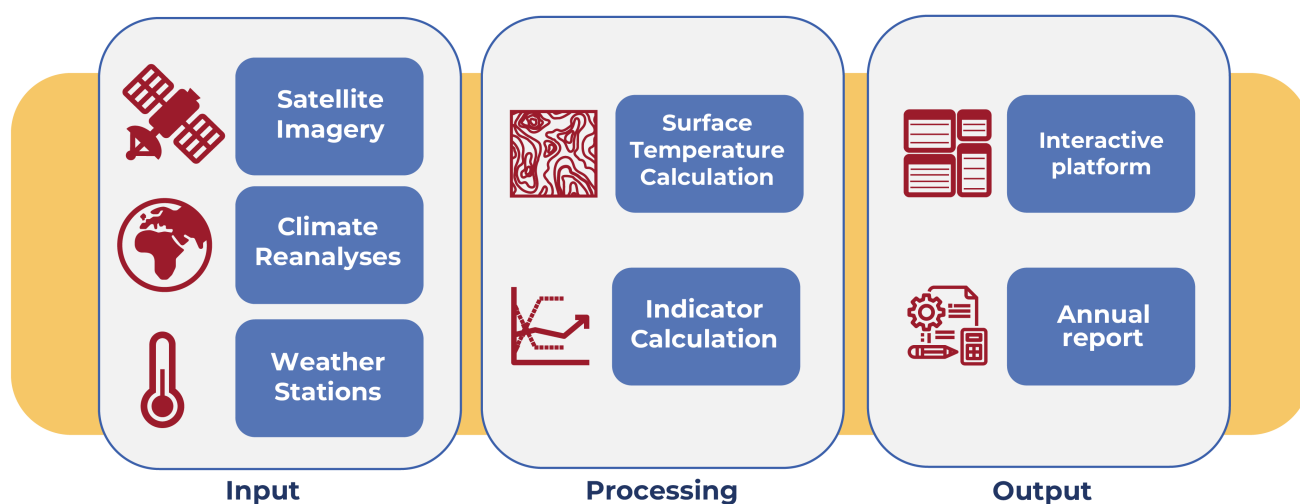
FAIR uses **artificial intelligence models** to provide updated climate data in near real time, with a delay of approximately six days. This allows for the timely tracking of recent changes in climate conditions across the territory, while maintaining high spatial resolution and consistency with the climate information framework already used in monitoring.

FAIR represents a significant advancement in the production of high-resolution climate data for Italy, as **it enables faster assessments of recent climate conditions and their potential impacts**. This information can **support decision-making processes in sectors particularly sensitive to climate variability and extreme events**, such as water resource management and the healthcare system, monitoring of abnormal heat and cold conditions, analysis of intense precipitation, and the study of the most significant meteorological and climatic events.

The integration of FAIR complements the other tools already available on the platform, enhancing its ability to provide an increasingly detailed, up-to-date, and reliable description of the climate dynamics of Rome's urban and coastal areas. A **new catalog of extreme events** has also been integrated, allowing for the analysis of episodes of abnormal heat and cold, intense precipitation, and strong winds across the entire municipal area. Finally, a **new section dedicated to climate projections for 2050** has been introduced, based on the very **high-resolution VHR-PRO-IT⁴** dataset, developed by CMCC, which allows for the exploration of possible future climate scenarios with a high level of detail.

The variety of integrated sources provides essential **support for the planning and monitoring of future climate adaptation actions by Roma Capitale** and other stakeholders involved in the process.

Climate Monitoring of Rome



The City of Rome in 2025

The first monitoring report highlighted that **2024 was the hottest year since 1991**, with an average daily temperature across the entire municipal area of 19.7 °C, 2.5 °C higher than the 1991–2020 average. The year 2024 was also marked by an **exceptionally high number of summer heat waves**. These results are not an isolated case, but are **part of a pattern of progressively rising temperatures observed in recent years**, with 2022 and 2023 having already shown significantly warmer climatic conditions compared to the 1991–2020 period.

This second report is dedicated to **analyzing Rome's climate in 2025** and examines in depth the evolution of key climate variables, assessing whether the trends observed in recent years are also confirmed in 2025. Annual monitoring makes it possible to track climate changes over time, assess the intensification of climate change indicators, and **provide useful information to guide adaptation strategies and risk management in the region**.

The following infographic summarizes the main findings from the monitoring.

Rome in 2025

Key Messages



2025 was the third warmest year of the period analyzed, surpassed only by 2024 and 2022



The **temperature of the Tyrrhenian Sea** that bathes the Roman coast **is rising**, in 2025 it was 0.85 °C above the 1991-2020 average



Frosty days, with temperatures dropping below 0°C, are increasingly rare: **zero in all of 2025**



2025 is also among the 5 warmest years since 1991 due to the **number of heat waves**



In 2025, 101 tropical nights were recorded, that is nights in which **the minimum temperature did not drop below 20°C**

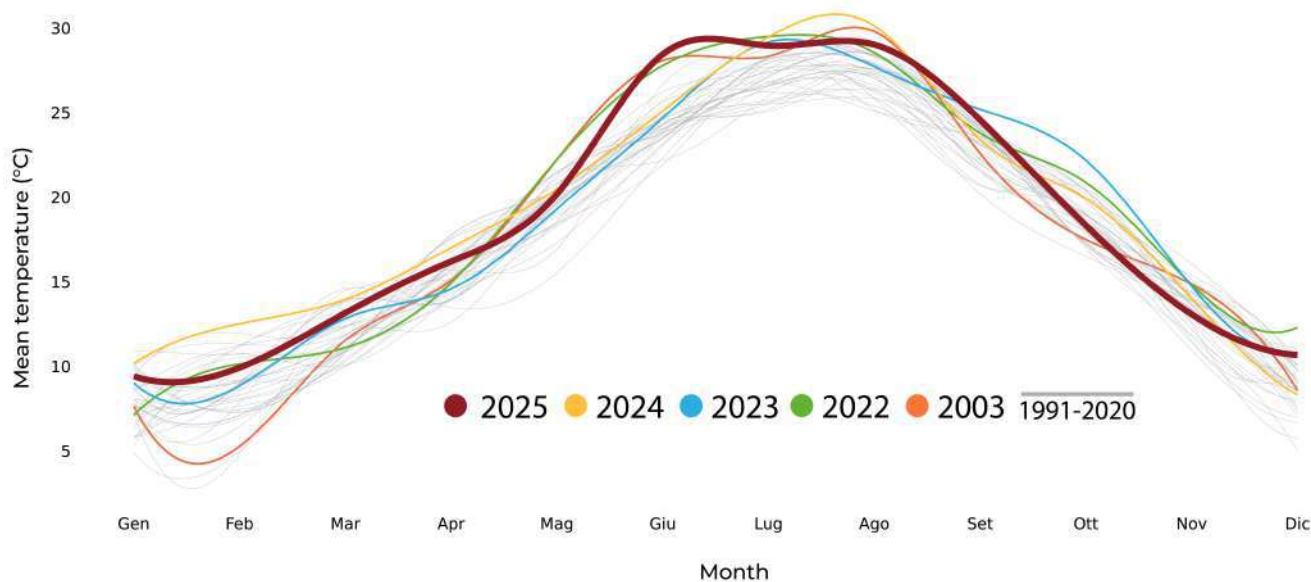


Polarization of climate-related potential energy needs: **in summer the demand for cooling is increasing sharply**, while in **winter the heating requirement is decreasing**

The Second Monitoring Report: 2025 among Rome's Five Hottest Years

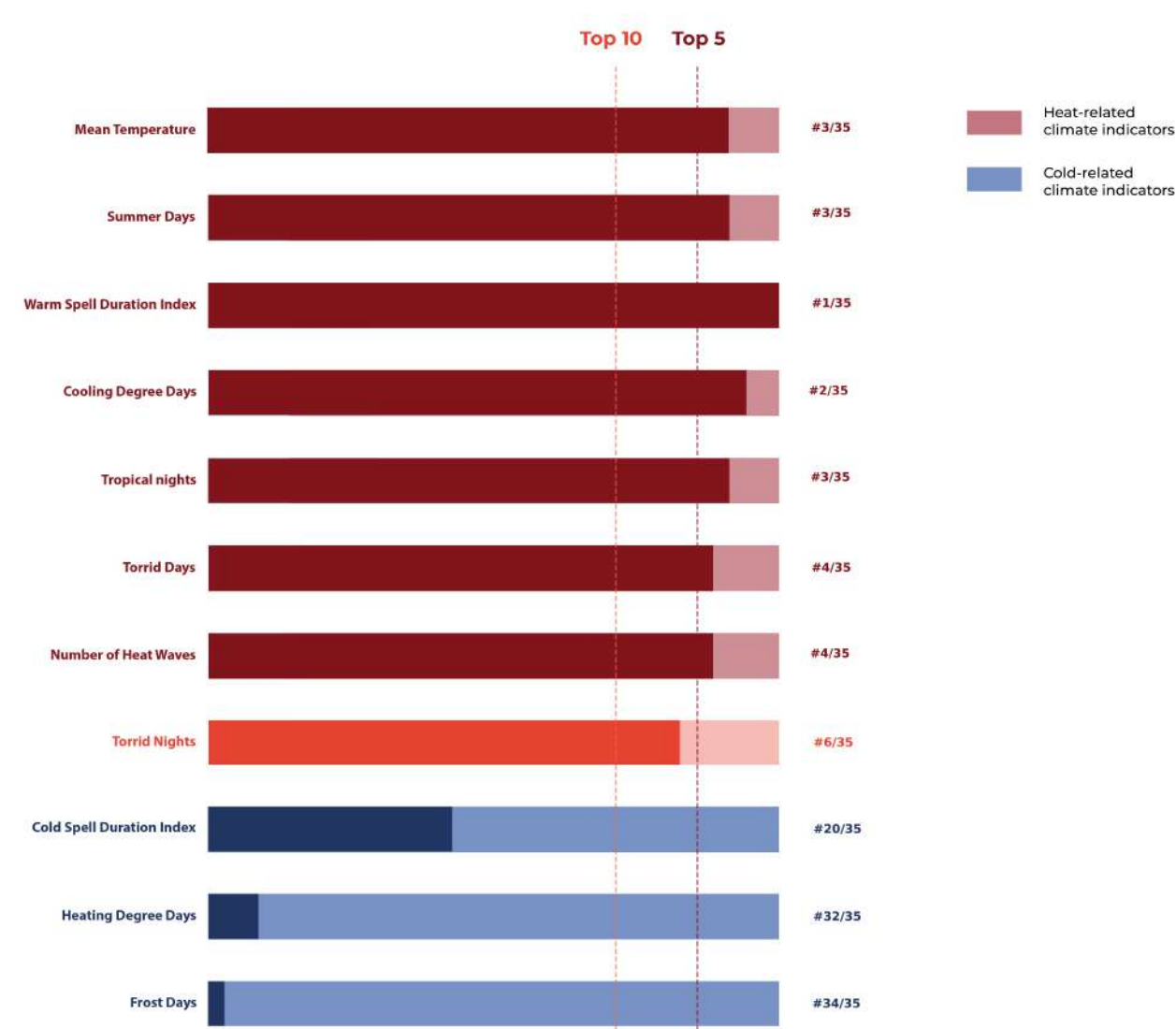
The second monitoring report provides a snapshot of Rome's climate in 2025, using various types of data, including data from weather stations, very high-resolution climate datasets produced by CMCC, and satellite data, which make it possible to reconstruct past climate conditions and compare them with current conditions. These results represent average values for the entire territory of the Municipality of Rome for the year 2025. The data show that **2025 was an extremely hot year**. The average daily temperature calculated for the entire municipal area confirms that **2025 was among the hottest years since 1991**. The graph shows that recent years have been, on average, warmer than the 1991–2020 thirty-year period, **confirming the gradual rise in temperatures observed over the past decades**.

In **2025 average monthly temperatures** remained above the reference average for the 30-year period 1991-2020, **confirming the warming trend** observed in the recent years



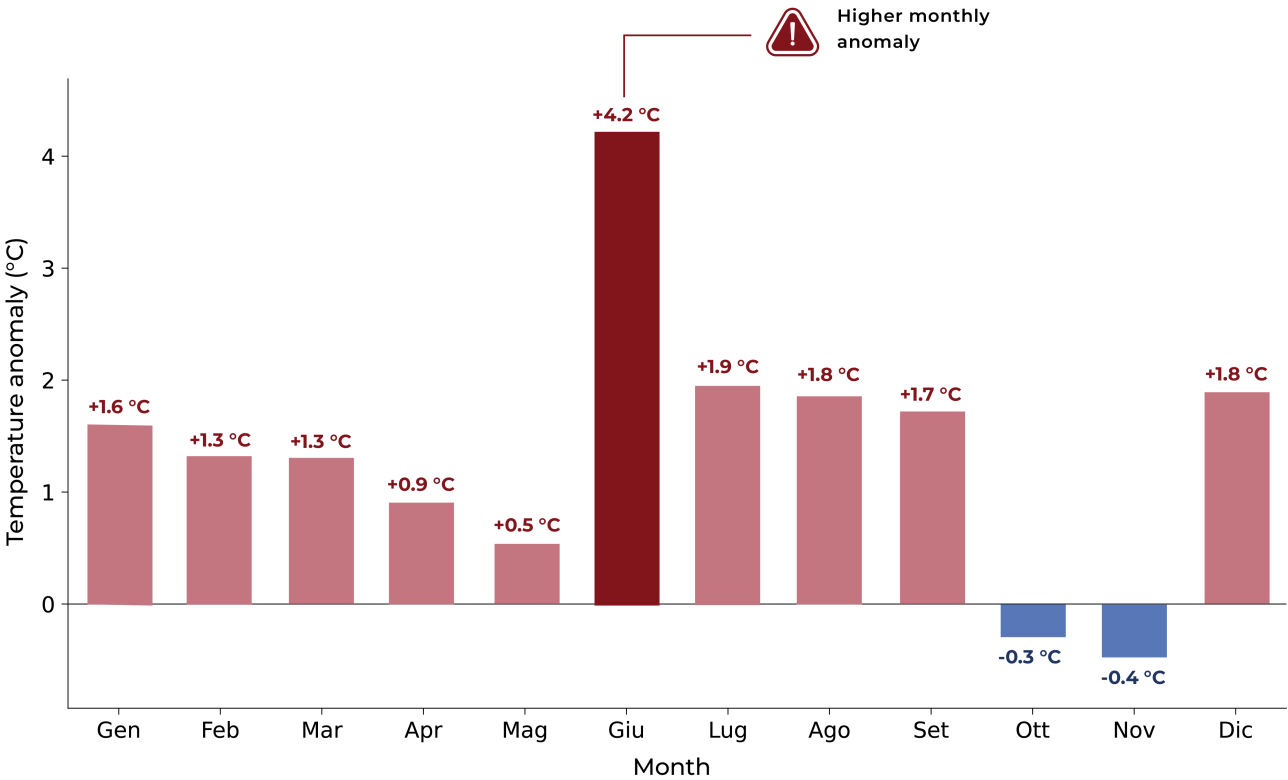
Considering the main thermal indicators, **2025 ranks as the third-hottest year in terms of annual average temperature** and is among the top five years, starting in 1991, for several indicators of extreme heat, including the Heat Duration Index, Cooling Degree Days, Tropical Nights, Scorching Days, and the Number of Heat Waves. At the same time, **2025 also stands out as one of the least cold years** in the entire observed period. For indicators such as Frost Days, that is, days with a minimum temperature below 0 °C, the **lowest values since 1991** were recorded, along with those for 2024.

Most **heat-related climate indicators** place **2025** in the **top 5** of the warmest years compared to the period 1991-2025



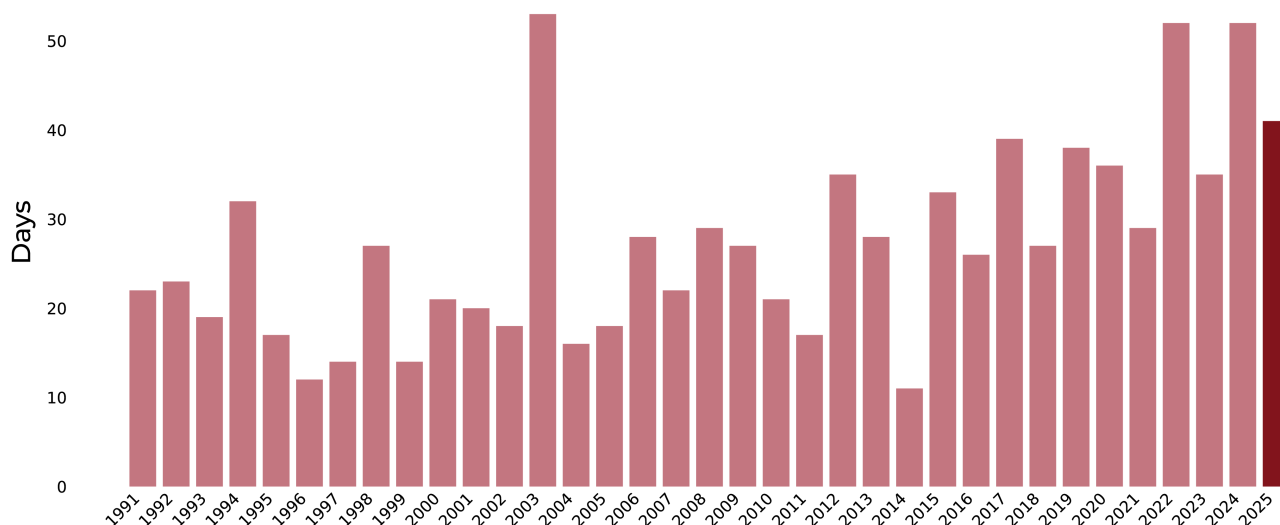
Every month in 2025 recorded temperatures above the 1991–2020 average. **The greatest deviation was observed in June**, which was marked by exceptionally hot conditions, with **average temperatures approximately 4 °C above the 1991–2020 30-year average**. The winter months also showed significant deviations: January, in particular, recorded average temperatures approximately 2 °C higher than the 1991–2020 average.

June 2025 recorded **the highest temperature anomalies**, becoming **the warmest June of the period 1991-2020**



The rise in temperatures is reflected in episodes of intense heat, concentrated primarily during the summer, as measured by the **Torrid Days** indicator, which counts the **number of days with a maximum temperature exceeding 35°C**. In 2025, more than 40 such days were recorded, **placing the year fourth in terms of the number of extremely hot days from 1991 to the present**. Only 2003, 2022, and 2024 recorded higher values.

The number of torrid days continues to remain high: **2025 ranks fourth** since 1991 for **days with maximum temperatures above 35 °C**



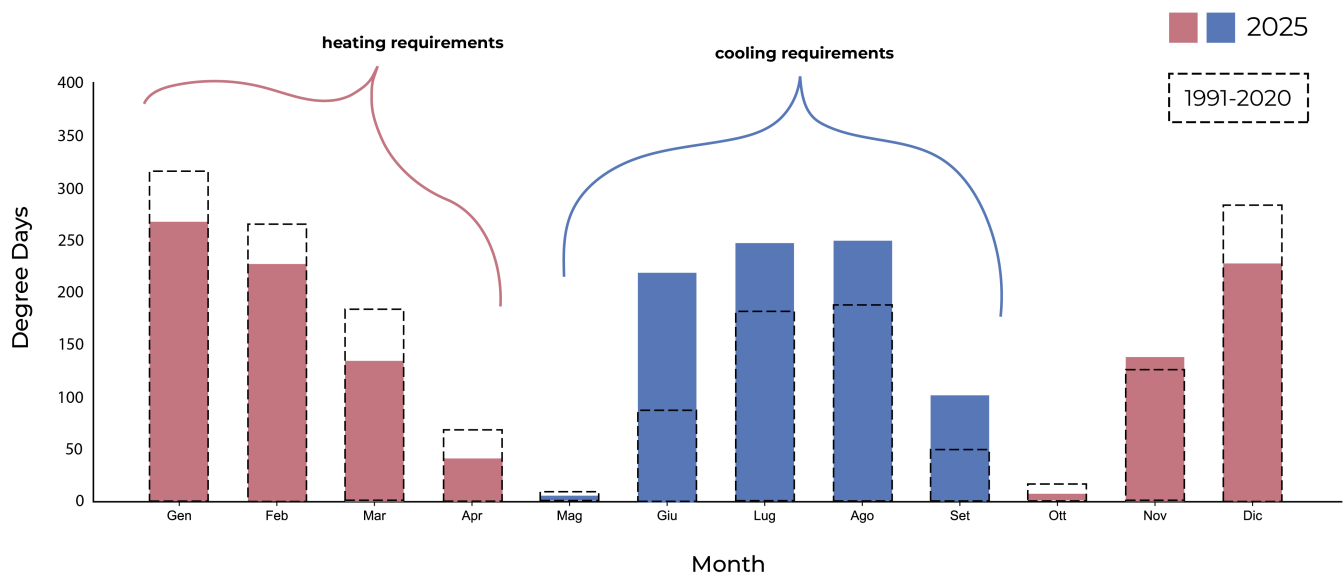
The year 2025 showed a marked difference from the climate norms for the 1991–2020 period in terms of both heating and cooling potential climatic demand. During the **winter months**, particularly between January and March, Heating Degree Days remained significantly below the 1991–2020 climate average, confirming a mild winter, with outdoor temperatures closer to the thermal comfort threshold and, therefore, a **lower need for indoor heating**.

In the summer season, however, **the opposite trend is observed**: Cooling Degree Days clearly exceed the 1991–2020 average values, indicating outdoor temperatures higher than the thermal comfort threshold and, consequently, a **greater need for cooling**.

Overall, these results indicate a **shift in potential climate-related energy demand**: the need for heating tends to decrease during the winter months, while the need for cooling increases during the summer months.

This trend primarily affects indoor environments, specifically residential, public, and commercial buildings, but may have broader implications for urban electricity demand, especially during the hottest periods. Actual energy demand, however, also depends on other factors, including building characteristics, system efficiency, the prevalence of air-conditioning systems, user behavior, and energy efficiency policies.

During summer 2025 **cooling degree days** significantly exceeded the 1991-2020 average, **doubling in June**, and indicating a **sharp increase in the climatic need for indoor cooling**



The table below shows **how certain indicators have varied in recent years compared to the average for the years 1991–2020**. Specifically, the following were taken into account: **Mean Temperature**, **Hot Days** (maximum temperature exceeds 30 degrees), **Torrid Days** (maximum temperature greater than 35 degrees), **Tropical Nights** (minimum temperature greater than 20 degrees), **Torrid Nights** (minimum temperature greater than 25 degrees), and **Frost Days** (minimum temperature less than 0°C).

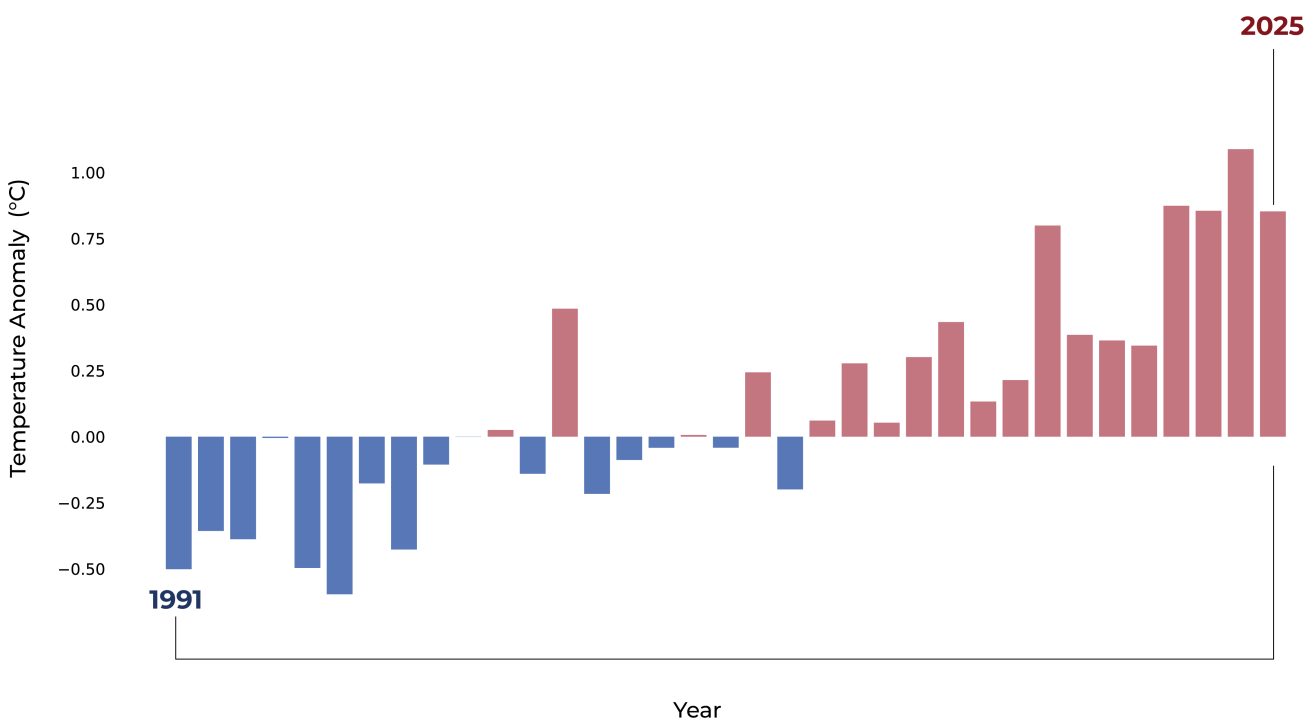
	Indicators	Average 1991-2020	2021	2022	2023	2024	2025
	Mean Temperature (°C)	17,2	17,5 (+0,3)	18,6 (+1,4)	18,3 (+1,1)	19,7 (+2,5)	18,5 (+1,3)
	Hot Days (> 30 °C)	81	93 (+12)	112 (+31)	97 (+16)	90 (+9)	103 (+22)
	Torrid Days (> 35 °C)	25	29 (+4)	52 (+27)	35 (+10)	52 (+27)	41 (+16)
	Tropical Nights (> 20 °C)	76	97 (+21)	107 (+31)	95 (+19)	92 (+16)	101 (+25)
	Torrid Nights (> 25 °C)	7	10 (+3)	23 (+16)	20 (+13)	36 (+29)	18 (+11)
	Frost Days (< 0 °C)	8	5 (+3)	3 (+5)	5 (-3)	0 (-8)	0 (-8)
	Extreme thermal discomfort (days)	25	31 (+6)	53 (+28)	36 (+11)	53 (+28)	36 (+11)

Rome from the Sea: A Sentinel of a Changing Climate

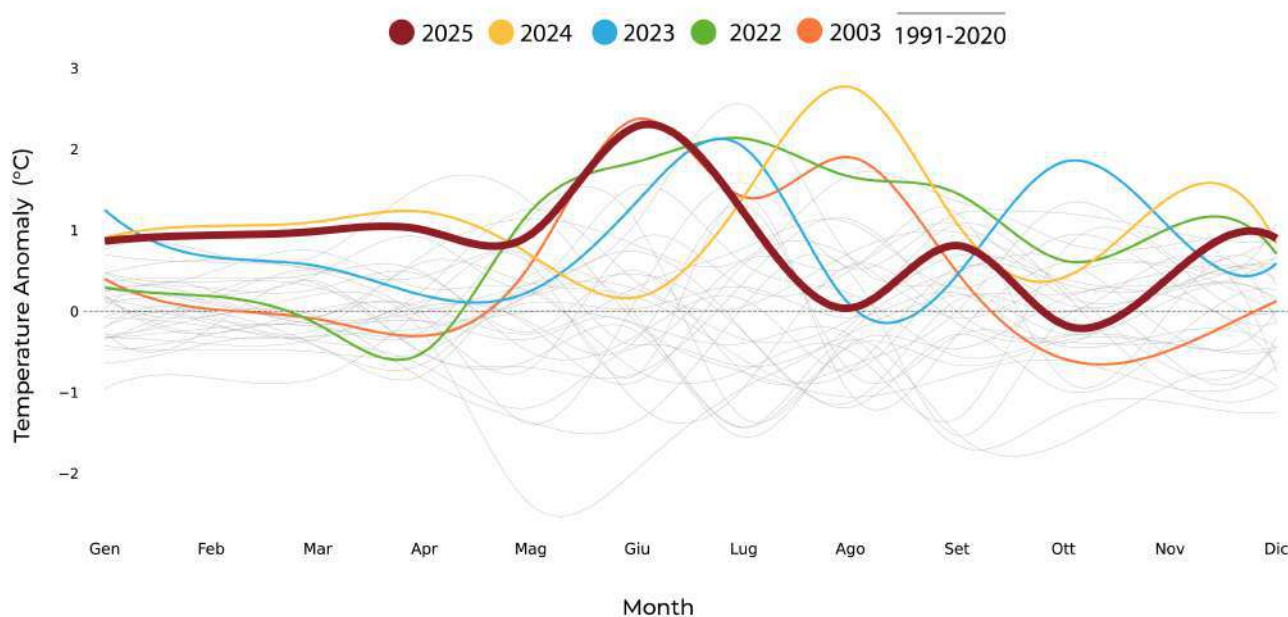
The rise in average temperatures does not affect only the urban area of Rome, but also extends to the sea along the Roman coastline. A preliminary analysis based on the ORAS5 marine reanalysis dataset shows that the **surface temperature of the Tyrrhenian Sea has been above the 1991–2020 30-year climate average since as early as 2011.**

Since 2022, the sea surface temperature has remained consistently about 0.7 °C above the climate average, reaching a **peak of about 1 °C above average in 2024.** An analysis of seasonal and annual variations over the period 1991–2025 highlights a **clear trend of surface warming in the Tyrrhenian Sea over the past decade.**

Sea surface temperature along the Roman coast shows a **clear warming trend from 1991 to 2025**, with an anomaly of **approximately 1 °C higher in 2024** than the average for the period 1991–2020



In **June 2025** the sea along the Roman coast reached exceptionally high temperatures, up to **2 °C above the 1991-2020 average**



This in-depth study expands upon satellite analyses of sea surface temperature, which provide a snapshot of observed conditions but do not, on their own, allow for the reconstruction of long-term historical time series. **The use of reanalysis data, on the other hand, enables the reconstruction of climate evolution over longer periods,** prioritizing temporal continuity over spatial detail.

The analysis also opens up new avenues for **exploring the relationship between the sea and the city**, with the aim of understanding how the gradual warming of the sea surface may influence the urban climate and contribute to the climatic dynamics of the Roman area.

Future Scenarios

To understand how Rome's climate might evolve in the coming decades, this second report incorporates the latest-generation climate scenarios adopted in the **IPCC's Sixth Assessment Report**⁵, based on the so-called *Shared Socioeconomic Pathways* (SSPs). The projections extend to the year 2050 and describe the expected average climate for the 30-year period 2036–2065.

The SSPs describe **possible future trajectories for the development of society, the economy, resource use, and greenhouse gas emissions**. These scenarios are used by the **latest-generation global climate models** (CMIP6)⁶ **to simulate how the climate might evolve depending on different levels of mitigation**. To represent climatic conditions at the Roman scale, techniques known as *downscaling*⁷ were used, which **provide climate information that is more representative of the local context**, in this case, Rome. Two possible pathways were considered: one characterized by a **gradual reduction in greenhouse gas emissions and sustainability-oriented development (SSP1-2.6)**, and one in which **emissions remain high (SSP3-7.0)**. These scenarios are not forecasts, but rather **possible climate trajectories useful for assessing future impacts and supporting the city's adaptation strategies**.

The estimates are calculated, in this case as well, relative to the climate average for the reference period 1991–2020. The analyses show that, in **both scenarios considered**, by 2050 **Rome could experience an increase in heat conditions, with higher temperatures and a greater frequency of very hot days**. In particular, in the low-emissions scenario (SSP1-2.6), the average daily temperature would increase by about 1.2 °C, while in the high-emissions scenario (SSP3-7.0), the increase would reach about 1.8 °C. Tropical nights, that is nights when the minimum temperature does not fall below 20°C, would grow by about 26 days in the SSP1-2.6 scenario and 36 days in the SSP3-7.0 scenario. Heat waves would also become much more frequent, with a 148% increase in the SSP1-2.6 scenario and a 203% increase in the SSP3-7.0 scenario. This means their number could increase by about two and a half times in the first case and by about three times in the second, compared to the average for the 1991–2020 reference period. There would also be an increase in the number of days when the combination of temperature and humidity results in extreme thermal discomfort, with a heat index exceeding 45 °C: these days would reach up to about 19 days in the low-emissions scenario and 28 days in the high-emissions scenario.

2050

CLIMATE SCENARIOS

SSP1-2.6
Environmental
sustainability and
low emissions

SSP3-7.0
High emissions
and limited
mitigation



**Mean
Temperature**
(°C)

+1,2

+1,8



**Number
of heat
waves** (%)

+148

+203



**Tropical
Nights**
(days)

+26

+36



**Days with
thermal
discomfort**
(days)

+19

+28

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