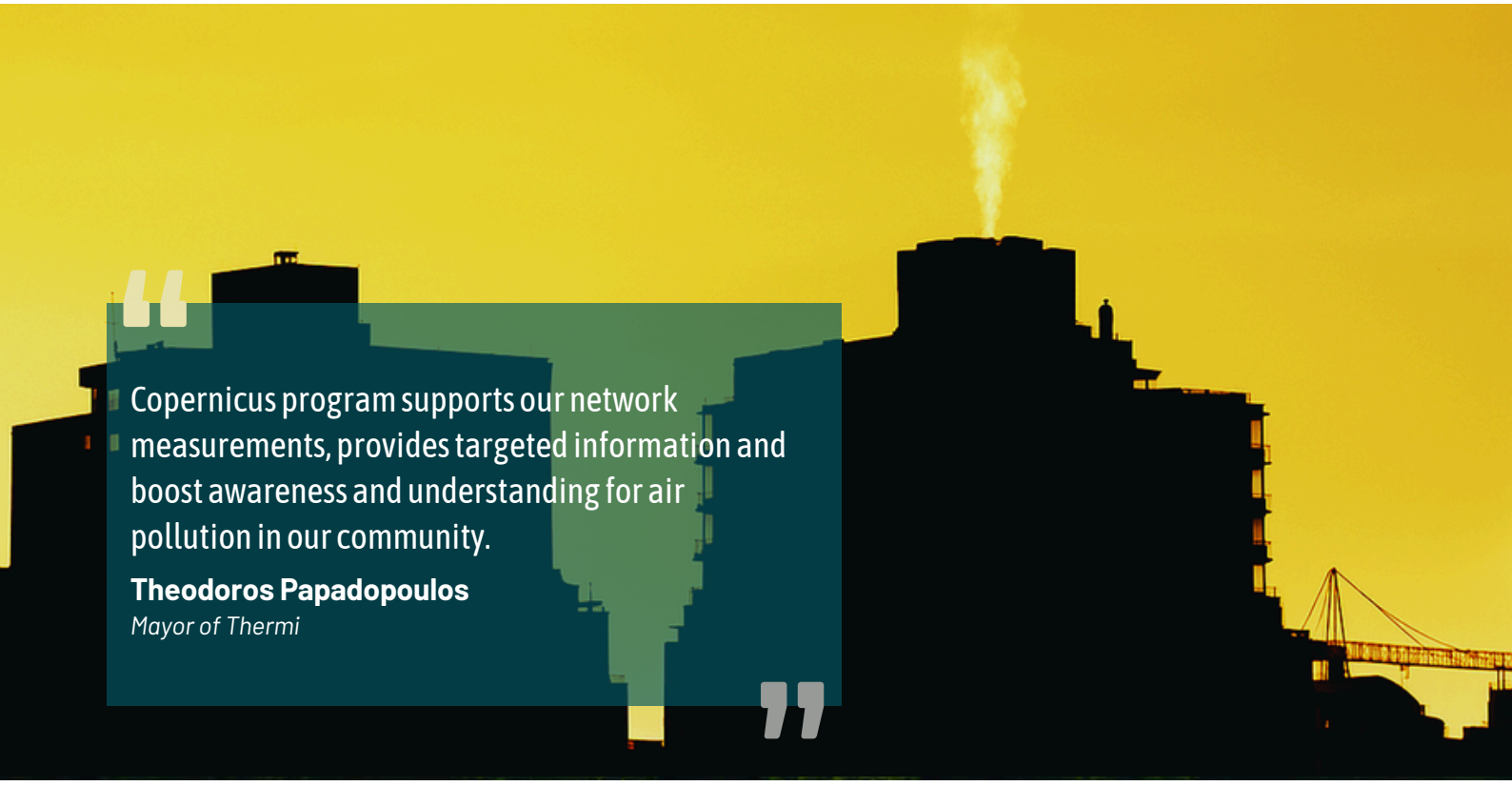
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COPERNICUS4REGIONS 2025

REAL TIME AIR QUALITY MONITORING AND FORECAST AT LOCAL SCALE

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University of Patras | Greece



> Copernicus program supports our network measurements, provides targeted information and boost awareness and understanding for air pollution in our community.
>
> **Theodoros Papadopoulos**
> *Mayor of Thermi*

PM2.5: An Urban Air Burden | Own work

The synergy of satellite data and real time particulate matter (PM) measurements facilitates the development of an effective tool to forecast the air pollution levels and implement better air quality mitigation strategies.

THE CHALLENGE

PM2.5 are correlated to several adverse health effects. Populated urban areas, suffer from increased PM2.5 levels that often exceed the WHO regulated guidelines for the daily PM2.5 concentrations.
The emergence of low-cost sensors enhanced PM monitoring capabilities across urban and rural areas during the last years. Thus, a monitoring system has been deployed across the Municipality of Thermi, Greece providing comprehensive insights on PM2.5 pollution emissions and hotspots in real time. In the scope of reducing citizens exposure to harmful PM2.5 levels, a forecast methodology has been implemented with the synergy of meteorological variables from the Copernicus Atmosphere Monitoring Service (CAMS).
Such air-quality forecasting enables local agencies to design and apply appropriate policies to tackle the problem of air pollution. The proposed system is currently being utilized semi-operationally by local authorities and is expected to be fully operational during the 2nd quarter of 2026.

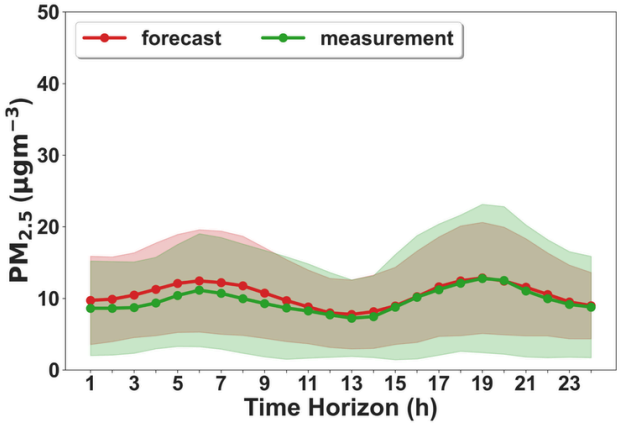
THE SPACE SOLUTIONS

An Internet of Things (IoTs) monitoring system equipped with 28 low-cost PM sensors was deployed in 2018 in the Municipality of Thermi, continuously monitoring and transferring information about PM concentrations.

The European Copernicus Atmosphere Monitoring Service (CAMS) provides hourly forecasts for Europe on a ~10 km spatial grid with a forecast horizon up to 96h. The meteorological parameters forecasts used in the proposed system were acquired from the Copernicus Atmosphere Data Store using the CAMS global atmospheric composition forecasts dataset. CAMS products serve as data inputs providing the necessary atmospheric and environmental parameters for accurate predictions.

The forecast methodology is based on a LSTM (Long Short-Term Memory) model. The main categories of input parameters used are: PM2.5 measurements (from the PM monitoring network) along with the meteorological variables (10-meter wind components (u and v), 2-meter temperature, boundary layer height, and total precipitation) from the CAMS global atmospheric composition forecasts, all related to air pollution. The major auxiliary predictor parameters (except PM2.5) in the applied methodology were the meteorological forecasts from CAMS.

The results of PM2.5 forecasting algorithm are continuously validated against in-situ measurements and satellite data.



Diurnal variability of PM2.5 forecasts and measurements (averages for 2023) | Screenshot

THEMATIC AREA

Public Health

REGION OF APPLICATION

Municipality of Thermi, Central Macedonia

SENTINEL MISSION USED

S5P

COPERNICUS SERVICE USED

CAMS

THE BENEFITS AND THE BENEFICIARIES

Thermi is a medium-sized city (approximately 55.000 inhabitants) affected by regional (long range and transboundary pollution) and domestic (biomass burning and traffic) emission sources.

The network's 6-year historical records have provided comprehensive insights, reporting increased PM2.5 concentrations during winter late afternoon and nighttime.

The implementation of PM2.5 forecasts facilitates policymakers and stakeholders towards a more effective air pollution management.

Moreover, it could serve as a valuable early warning system for the public and especially for vulnerable groups (elderly people, kids, people with asthma etc.).

The development of a user-friendly and open access platform also empowers citizens' participation in scientific research regarding air pollution characteristics and effects, acting as "citizen scientists". Related educational activities on PM2.5 measurements and forecasts emphasize raising children's awareness and curiosity about the quality of the air they breathe.

	TIER 1 SERVICE PROVIDER	TIER 2 PRIMARY USER	TIER 3 SECONDARY USER	TIER 4 END USER BENEFICIARIES
SERVICES AND BENEFITS	Sentinel-5P, Copernicus Atmospheric Monitoring Service	OA real time $PM_{2.5}$ concentration monitoring network of certified and regularly calibrated sensors and a forecasting system	Air quality index values; References for policy measures (e.g. actions for reducing the reduction of particulate matter concentrations)	Near real-time measurements and intra-day forecasts of air quality. Improved environmental education and awareness
BENEFICIARIES	Laboratory of Atmospheric Physis, Univeristy of Patras, Greece	Municipality of Thermi, Region of Central Macedonia, Greece	Municipality technical staff and policy makers, Scientists, Center of Education for the Environment and Sustainability	Citizens and Society

EU POLICY / DIRECTIVE

Ambient Air Quality Directive

TYPE OF SERVICE PROVIDER

Public Service

TYPE OF FUNDING SOURCE

National or regional non Space Programme

USAGE MATURITY LEVEL

4



A FUTURE WITH COPERNICUS

For the future, an updated version of the forecasting system will be used fully operationally during 2026, based on in-situ measurements of higher spatial resolution as well as Copernicus products.
The expected upgrades of CAMS services as well as the ongoing and future satellite missions are expected to improve the performance results of the forecasting system, facilitate the decision-making process by the local authorities and achieve more effective environmental and health awareness for the public.



DID YOU KNOW?

The Municipality of Thermi's network is one of the first to be developed in Greece and the first to be accompanied by an integrated online platform for informing the public in real time. It is focused on very small particles because of their adverse health effects and uses state of the art techniques and algorithms.

Acknowledgements

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