

JULY
SEPTEMBER
2026

11 Sen For Fire NEWSLETTER

SENFORFIRE. LOW-COST WIRELESS SENSOR NETWORK FOR THE PREVENTION AND EARLY DETECTION OF FOREST FIRES (S1/1.1/E0040)



Ángel López (UEx) updates the firmware of a SenForFire sensor node in the pilot areas of Cáceres.

In this issue:

FINAL PROTOTYPES FOR EARLY DETECTION

CSIC-INECO AGREEMENT TO PROTECT INFRASTRUCTURE

EXPANSION OF THE NETWORK IN PILOT AREAS

ADVANCES IN MICROSENSORS AND MULTISENSOR PLATFORMS

PRESENTATION AT INTERNATIONAL CONFERENCES

Final prototypes and network expansion in the pilot areas

The third quarter of 2026 has been a period of consolidation for SenForFire, which is now entering its final phase. In terms of coordination, a key development has been the preparation of the 5th follow-up meeting and the final event to disseminate the results, which will be held in Valladolid in November in conjunction with the Regional Government of Castile and León. At the same time, a formal agreement has been signed between the CSIC and INECO to protect transport infrastructure against forest fires, with an initial pilot area in Villarrubia de Santiago (Toledo).

On the technical front, the final prototypes for early fire detection are now ready, with more than sixty devices having been manufactured and installed in various pilot areas. Progress has also been made on humidity compensation in gas microsensors, on a new generation of multi-sensor platforms, and on the first field trials of nodes coated with $\text{TiO}_2\text{:Nb}$. Furthermore, the sensor network has been expanded with new deployments in Mirabel, Fundão, Andorra and Badajoz, and the analysis of soil and vegetation data has been intensified.

Dissemination efforts have also been significant, with a presence in the media and at international conferences, outreach activities, the launch of the SenForFire MOOC and a special issue of the journal Atmosphere.

**Interreg
Sudoe**



Co-funded by
the European Union

SenForFire

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JULIO-SEPTIEMBRE

Social media management. Outreach activity has continued on LinkedIn, Facebook and X, with multilingual posts (in Spanish, English, Portuguese and French) highlighting the quarter's key milestones. Notable posts include the recovery, following the summer's wildfires, of the SenForFire video filmed at Las Médulas and issue no. 6 of the SenForFire magazine Tecnología contra el fuego (Technology Against Fire), the announcement of the 4th call for proposals for Interreg Sudoe structural projects on forest fires, and the announcement of the project's participation in the 12th FUEGORED International Congress (Oviedo) and the 10th International Conference on Forest Fire Research (Coimbra).

Screening of the SenForFire video at Las Médulas (El Bierzo region, Castile and León). The video detailing the work carried out by SenForFire in the Las Médulas Cultural and Natural Area – a cultural landscape designated a UNESCO World Heritage Site and one of the project's pilot areas – has been screened. The film, commissioned by the Directorate-General for Cultural Heritage of the Regional Government of Castile and León, highlights the challenges faced by this site in the face of the growing risk of forest fires and how smart sensor networks and real-time environmental monitoring systems can help to protect it, combining the conservation of cultural heritage with that of the natural environment.

Available at:  <https://youtu.be/91VafJiieyw?si=2qMBEb0OWhbA6VFg>



Publication of issue no. 6 of the journal SenForFire: Fire Technology. This issue focuses on the risk forecasting work carried out throughout the year, featuring interviews with Marcelino Núñez (AEMET), Javier Madrigal (INIA-CSIC) and Elia Quirós (University of Extremadura) on the new IPIF hazard index, satellite monitoring and SenForFire's field sensors.

The interviewees also discuss the challenge of calibrating these systems using historical data in a changing climate, and the need for the technology to reach local authorities with fewer resources.

 <https://interreg-sudoe.eu/wp-content/uploads/2026/08/SenForFire-Revista-06-ES-v2.pdf?x82726>

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Release of Internal Bulletin No. 10. This new edition has been published and shared on social media; it highlights the main milestones achieved in recent months, as well as the latest developments, activities and next steps for the project, which are the result of the joint efforts of all the partners.

<https://interreg-sudoe.eu/wp-content/uploads/2026/07/SenForFire-BI-10-ES.pdf?x82726>

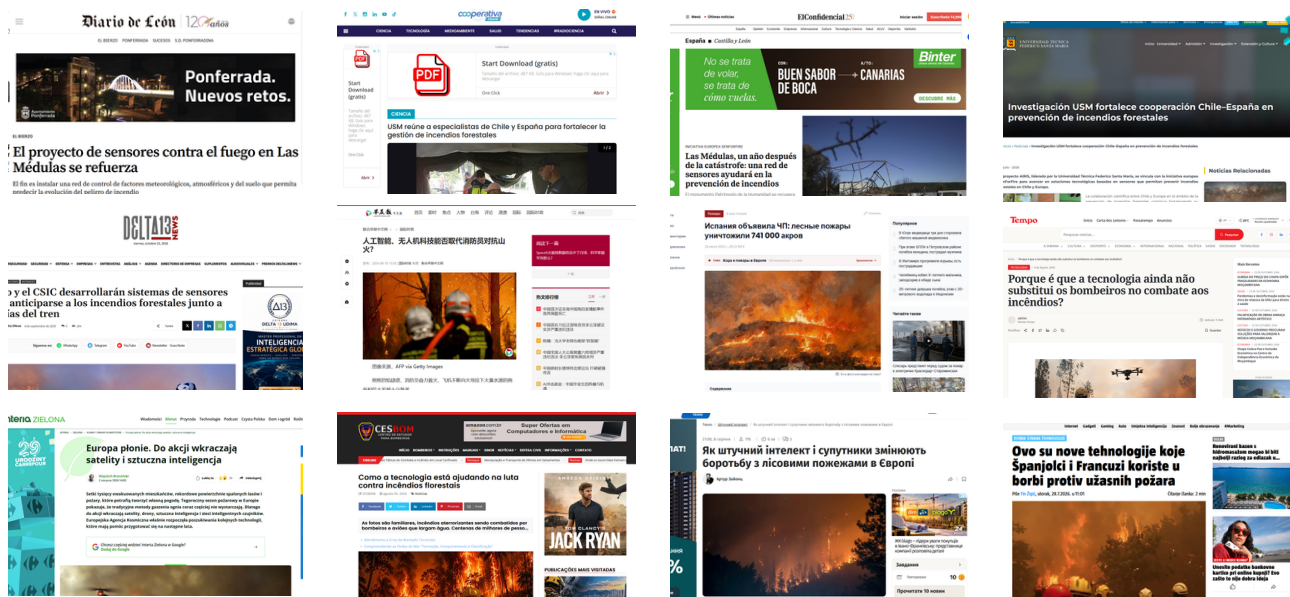
Special issue of the journal Atmosphere. Launch of a special issue of the journal Atmosphere entitled 'Low-cost atmospheric sensor networks for wildfire risk assessment and early detection'.

The members of the SenForFire team coordinating this special issue have drawn up a list of potential authors, whom they have invited to submit their contributions.

They have also begun work on a review article with the provisional title 'Atmospheric sensor networks for wildfire prevention and early detection: technologies, data integration, and operational applications', which will be published in the special issue.

PRESS CLIPPINGS Click on the image to view the news item

International media coverage of the project. Over the summer, SenForFire has received significant media coverage, with more than a dozen media outlets from nine countries reporting on the project. In Spain, Diario de León and El Confidencial reported on the sensor network deployed at Las Médulas, whilst Delta13news covered the agreement between the CSIC and INECO to protect railway infrastructure. In Chile, the Federico Santa María Technical University and Cooperativa Ciencia publicised the Chile–Spain conference on forest fires. Furthermore, in the wake of the major fires this summer, media outlets in Poland, Ukraine, Croatia, Brazil, Mozambique, Russia and China cited SenForFire amongst the innovative technologies for early fire detection.



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SEPTEMBER

Preparation for the 5th monitoring meeting and the project's final event. Organisation of the event, comprising (a) the 5th project monitoring meeting and (b) the final event to disseminate the project's results, in collaboration with the Directorate-General for Cultural Heritage of the Regional Government of Castile and León (JCyL). The event will take place in Valladolid on 16 (a) and 17–18 (b) November.

The event programme has been drawn up, and national and international experts have been selected and contacted to participate as guest speakers at (b). Click here to view the website and the registration form.

WG1 SPECIFICATIONS OF THE VALIDATION SCENARIOS AND TECHNICAL CHARACTERISTICS OF THE WSN

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A 1.1

JULY – SEPTEMBER

Collaboration agreement between the CSIC and INECO. Contacts between the Spanish public engineering and consultancy firm INECO, attached to the Ministry of Transport and Sustainable Mobility, and ITEFI-CSIC to explore possible collaborations with the aim of improving surveillance and early warning systems to protect railway infrastructure and users from forest fires, have resulted in an agreement signed on 21 July and published in the Official State Gazette (BOE) on 13 August ('Resolution of 5 August 2026, of the Undersecretariat, publishing the Agreement between the State Agency Higher Council for Scientific Research, M.P., and Engineering and Transport Economics, S.M.E., M.P., SA, to advance the analysis of forest fire management: identification of vulnerable areas and high-risk environments near transport infrastructure'), in which ITEFI-CSIC, INIA-CSIC and IMB-CSIC are participating.

Within this framework, a number of meetings have been held between the parties to the agreement to define the actions to be taken, and a pilot area has been established in Villarrubia de Santiago (Toledo), where ITEFI-CSIC installed a series of ground sensors on 29 July.

WG2 DEVELOP AND MANUFACTURE COMPONENTS AND SYSTEMS AND VERIFY THE PERFORMANCE OF WSN

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A 2.1

JULY – SEPTEMBER

Humidity compensation in gas microsensors. During July and August, datasets were collected using the IMB-CSIC microsensors whilst they were exposed to different humidity and temperature conditions.

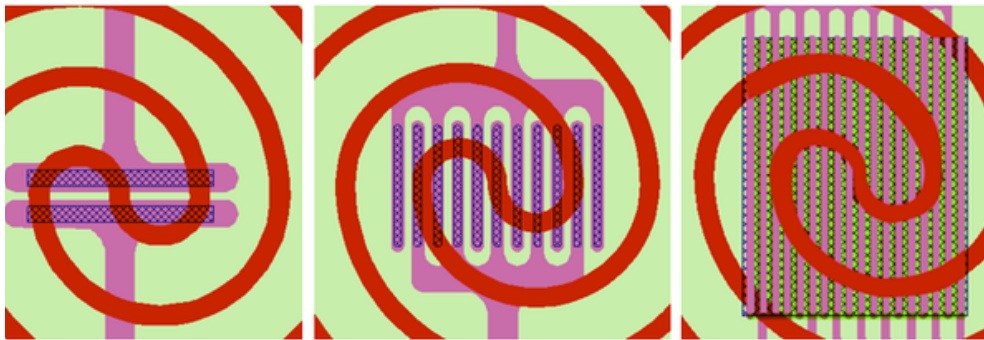
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This data was used to develop and validate humidity compensation models using causal baseline re-anchoring techniques. The ultimate aim is to minimise false alarms caused by variations in ambient humidity and to improve the robustness and reliability of gas microsenors deployed in the field under different humidity conditions. The results obtained enabled the preparation and submission of a scientific abstract for evaluation at the Conference on Electron Devices (CDE 2027).

A new generation of multi-sensor platforms with interdigitated electrodes for high-resistivity materials. Between July and September 2026, the CNRS-LAAS focused on developing a new generation of multi-sensor platforms that combine different interdigitated electrode geometries.

Given the difficulties involved in measuring sensitive, high-resistivity materials, both in the laboratory and using on-board electronics for field measurements, it was essential to modify the electrode design by increasing their number and reducing the spacing between them. The advantage of using multiple geometries lies in the ability to measure materials across a wide range of resistivities, which is suited to the variety of materials studied in this project: Ga-doped ZnO (low resistivity), Nb-doped TiO₂ (high resistivity) and magnesium or copper ferrites (medium-to-high resistivity). The production run was completed and a wafer was cut to supply samples to CNRS-CIRIMAT. At CNRS-CIRIMAT, sensitive layers based on TiO₂:Nb have been deposited with varying thicknesses, deposition conditions and annealing temperatures.

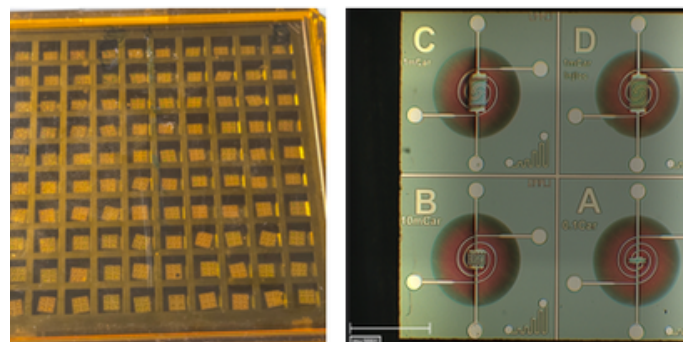
Work is currently underway at CNRS-LAAS to assemble the sensors into 12-pin TO-8 packages and to test them, with a view to integrating them into the housings supplied by our partner Ray-IE.



Different geometries of the sensor electrodes A ($F = 0.1$), B ($F = 0.01$) and C ($F = 0.001$); F is the geometric form factor relating to the measured sensitive layer.

Left: Individual multisensors cut from the 4-inch wafer.

Right: Photograph of the multisensor manufactured with the different sensor electrode geometries.



A 2.2

OCTOBER
6

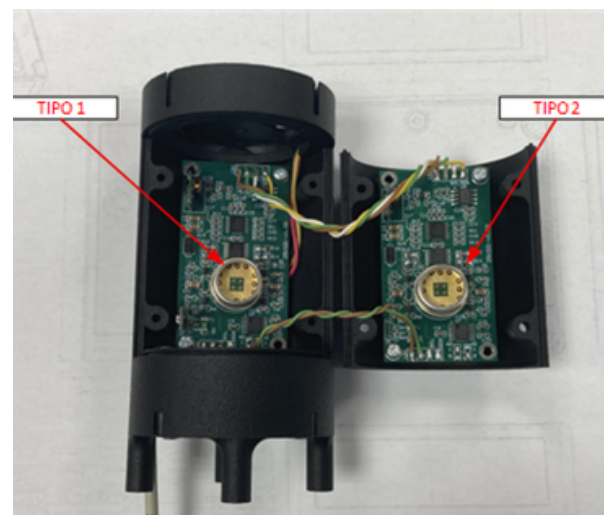
Final prototypes for early fire detection. The final prototypes developed as part of the SenForFire project are now ready. Three types of devices have been developed, each targeting a key indicator of combustion: gas sensors that detect changes in air composition (such as volatile organic compounds), electrochemical sensors capable of measuring carbon monoxide – one of the main gases generated during combustion processes – and optical sensors that identify airborne particles associated with smoke.

The three prototypes are the University of Extremadura's own design and incorporate energy-efficient components and autonomous solar-powered systems, enabling them to operate in remote forest environments. Furthermore, they feature long-range wireless communications (LoRaWAN), facilitating real-time data transmission without the need for complex infrastructure. More than sixty devices have been manufactured and installed for the summer campaign in various pilot areas.

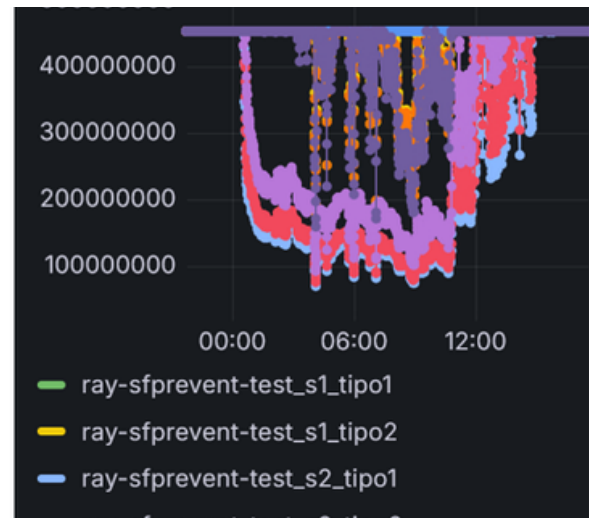


JULY – AUGUST

Initial field tests of the sensor node with $\text{TiO}_2\text{:Nb}$ coatings. The microsenors with $\text{TiO}_2\text{:Nb}$ sensitive layers developed by CNRS-LAAS and CNRS-CIRIMAT have been successfully integrated into the prototype designed by Ray-IE. The sensor node was installed outdoors for several weeks to assess its performance under real-world conditions. The resistance measurements obtained via Grafana confirmed the system's operational viability and, at the same time, highlighted a key next step: optimising the readout circuit to ensure that measurements remain within the optimal range.



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On the previous page: Circuit boards featuring the two types of $\text{TiO}_2\text{:Nb}$ microsensors (type 1 and type 2) integrated into the housing of the Ray-IE prototype.

Left: Sensor node installed outdoors to assess its performance under real-world conditions.

Right: Resistance measurements from the microsensors recorded in Grafana over the course of a day. The values that remain flat at the top of the scale indicate the need to optimise the readout circuit.

A 2.3

JULY
16-30

Coordination to integrate the intelligent models into the platform. Meetings between the University of Coimbra and the University of Évora to define the final approach for integrating the intelligent models into the platform.

A 2.5

Seminar on sensors and AI for forest fire management. The IMB-CSIC organised a two-part session on applied research into the detection and prevention of forest fires within the framework of SenForFire, led by researcher Stella Vallejos. Javier Madrigal (INIA-CSIC) presented the paper 'New challenges in nanosensors and AI for integrated fire management', and Fabián Guerrero (Federico Santa María Technical University, Chile) outlined the AIRIS project, an early warning system based on air quality monitoring. The recording was released on YouTube.

[Available here](#)

JULY
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Retos en tecnología de sensores para la monitorización de incendios forestales



Javier Madrigal
INIA-CSIC

Nuevos retos en nanosensores e IA para la gestión integrada de incendios



Fabián Guerrero
Univ. Téc. Federico Santa María (Chile)

AIRIS: Sistema de detección temprana de incendios forestales mediante la monitorización de la calidad del aire

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SEPTEMBER

Dissemination of the IMB-CSIC's microsensors at conferences and public outreach events. Activities were carried out to disseminate and publicise the results obtained using the microsensors developed by the IMB-CSIC. These included the 18th International Conference on Optical and Electronic Sensors (COE), where the paper 'Heterostructured Metal Oxide Microsensors for Environmental Gas Sensing' was presented, and Science Night at the CosmoCaixa Science Museum, where the project's objectives and activities were explained in the talk 'Microchips against fires: David versus Goliath'.



Left: Presentation of the paper 'Heterostructured Metal Oxide Microsensors for Environmental Gas Sensing' at the 18th International Conference on Optical and Electronic Sensors (COE 2026).
Right: Talk entitled 'Fire-fighting microchips: David versus Goliath' at La Nit de la Recerca, at the CosmoCaixa Science Museum (Barcelona).

SEPTEMBER
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Presentation of the SenForFire project at the DiCo-CHE 2026 workshop in Madrid. Participation in DiCo-CHE 2026 (International Workshop on Strategic Technologies for Diagnostics and Control in Cultural Heritage and Environmental Applications), held in Madrid (Spain) on 24 September 2026, with the presentation 'From sensors to decisions: data-driven intelligence for environmental monitoring and management', focusing on the SenForFire project.



Left: Presentation 'From sensors to decisions: data-driven intelligence for environmental monitoring and management' at the DiCo-CHE 2026 workshop (Madrid, 24 September).
Right: Group photo of participants at the DiCo-CHE 2026 workshop in Madrid.

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R 2.1

JULY
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Preparation of the appeal against the Erasmus Mundus MIDA-ESN decision. Meeting with partners to prepare and submit the application for a review (redress procedure) of the Erasmus Mundus MIDA-ESN decision.

SEPTEMBER

Approval of the SenForFire MOOC. The MOOC has been approved by the Vice-Rectorate for Digital University at the University of Extremadura and is scheduled for launch in mid-October 2026.

Jesús Lozano (University of Extremadura), coordinator of WG3, in one of the videos from the SenForFire MOOC.



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A 3.2

JULY – SEPTEMBER

New atmospheric nodes in pilot areas. Installation of new prototype atmospheric nodes (gases, VOCs and/or PM) in the pilot areas of Fundão, Mirabel (Cáceres) and Andorra.

Maintenance of the sensor network. Ongoing monitoring of the sensor network's operation and maintenance of atmospheric and ground-based nodes. Replacement of flat batteries and replacement of ground-based nodes with new prototypes offering improved performance (power supply and communication).

Firmware testing at the School of Industrial Engineering. Installation of six MOX sensor nodes at the School of Industrial Engineering to carry out firmware testing (next page, left-hand side).

Deployment of nodes in Las Vaguadas (Badajoz). Installation of several MOX, EC and PM sensor nodes, together with a LoRa router, in the vicinity of the Las Vaguadas neighbourhood in Badajoz (next page, on the right).

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MOX sensor nodes installed at the School of Industrial Engineering for firmware testing.



MOX, EC and PM sensor nodes and a LoRa router deployed near the Las Vaguadas neighbourhood (Badajoz).

JULY

Training on monitoring vegetation moisture in Fundão. INIA-CSIC provided training on vegetation sampling and data processing for monitoring the moisture content of relevant species to the organisations responsible for carrying out this monitoring in the municipality of Fundão, where three zones were selected: Zone 1: Carvalhal (without tree cover), Zone 2: Carvalhal (with tree cover) and Zone 3: Alcongosta. The species selected as relevant were, in Zone 1, herbaceous plants; in Zone 2, ferns and *Castanea sativa*; and in Zone 3, ferns, *Castanea sativa*, *Pinus pinaster* and *Quercus pyrenaica*.



Left: Sampling of ferns to monitor vegetation moisture in the Fundão pilot area.

Right: INIA-CSIC training session on vegetation sampling in Fundão.

JULY
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Deployment of the sensor network in Mirabel (Cáceres). Installation of a LoRa router and eleven wireless sensor network nodes for early fire warning in Mirabel (Cáceres). The deployment can be seen in the photographs on the following page.

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Left: Solar-powered LoRa router installed in Mirabel (Cáceres).

Right: Wireless sensor network node installed on a pine tree in Mirabel (Cáceres).



A 3.3

JULY – SEPTEMBER

Monitoring of fuel and soil moisture. Weekly monitoring of living fuel (HCV) and soil moisture continues at the INIA estate (Madrid), and monitoring of forest fuel moisture has continued at the Guadarrama experimental sites, as part of the collaboration with the Forest Fire Unit of the Madrid Regional Fire Service and the Cáceres Provincial Fire Service, with support from the Forest Fire Planning and Analysis Team (EPAIF) in Cáceres. Several online meetings have been held with the EPAIF in Cáceres and the ITEFI-CSIC to assess the trends in the data collected regarding vegetation and soil moisture.

Analysis of meteorological and soil data. Analysis and interpretation of meteorological and soil data (temperature, volumetric water content and water potential) acquired by the sensors over the past year. Comparison with data from the ERA5 and ERA5-Land reanalyses (Copernicus) and with satellite data (SMOS). Correlation with gravimetric measurements of vegetation moisture in pilot areas in Cáceres, Madrid and Andorra.

Firmware update for the UEx nodes. Monitoring of the sensor nodes developed by the University of Extremadura and updating of the firmware for the devices deployed in Coria, Cañaveral and Mirabel to prevent errors in data transmission. Photographs on the right and on the following page.



A sensor node from the University of Extremadura installed on a pine tree in one of the pilot areas in Cáceres.

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On-site firmware update of a sensor node to prevent data transmission errors.

A 3.4

JULY
6-8

Presentation at the NOSE 2026 conference. Dissemination of the project's results at the NOSE 2026 conference – 10th International Conference on Environmental Monitoring of Odours and VOCs, held in Bologna (Italy) from 6 to 8 July 2026. An oral presentation was given entitled 'Multisensor gas monitoring systems for early detection of forest fires'.

Chile-Spain International Conference on Forest Fires. Building on the international collaboration established with the Federico Santa María Technical University (Valparaíso, Chile) as part of the cooperation between the SenForFire and AIRIS (Intelligent Air Quality Alert due to Fires) projects, INIA-CSIC took part in the Chile-Spain International Conference on Forest Fires: Science, Innovation and Fire Management, held online, with a presentation entitled 'The SenForFire System and International Cooperation' given by Mercedes Guijarro. This conference was aimed at forest fire managers from Chile's National Forestry Corporation (CONAF). It also featured presentations by Javier Madrigal and Cristina Carrillo (INIA-CSIC).

AUGUST
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Presentation of the paper 'Multisensor gas monitoring systems for early detection of forest fires' at the NOSE 2026 conference, Bologna (Italy).



Poster for the Chile-Spain international conference on forest fires: 'Science, Innovation and Fire Management'.