



## WP4 - Atmosphere

Lucia Mona (CNR-IMAA)

on behalf of all WP4 UOs and participants







**IR000032 – ITINERIS, Italian Integrated Environmental Research Infrastructures System**  
(D.D. n. 130/2022 - CUP B53C22002150006) Funded by EU - Next Generation EU PNRR-  
Mission 4 “Education and Research” - Component 2: “From research to business” - Investment  
3.1: “Fund for the realisation of an integrated system of research and innovation infrastructures”



# WP4 Structure



-  **Objective 1** Integration and harmonization within the Italian Network of Environment RIs
-  **Objective 2** Pilot service on Aerosol types and sources
-  **Objective 3** Pilot service on Planetary Boundary Layer height and its impact on aerosol and trace gases concentration at ground
-  **Objective 4** Pilot service on impact of natural and anthropogenic fires on atmospheric composition

# OBJ1: Integration Harmonization – Main achievements



- ❑ Deploying trans-RI instruments at the different sites (made easier thanks to TNA)
- ❑ Reinforcing the observational capability at RI locations and beyond
- ❑ Building and empowering the digital resources collection & provision in atmospheric domain
- ❑ Building up a National community strengthening cooperation and collaboration
  - Mutual use of resources available in the National community for progressing on science
  - Mutual support based on specific expertise
  - Training activities (organized in WP3) saw the involvement of groups as lecturers and as attendees

# OBJ1: Integration Harmonization – An example



## □ Instruments for airborne measurements of aerosol

- **Aethalometer** for black carbon concentration, including biomass burning (BB) fraction
- **FMPS Fast Mobility particle Spectrometer** 5.6 to 5600 nm range with high time resolution (1 Hz) (customized for airborne use)
- **APS** - aerosol particle sizer 0.5 to 20  $\mu\text{m}$  (customized for airborne use)
- **Nephelometer** for scattering and backscattering coefficient at three wavelengths
- **Dust monitor** 0.15-40  $\mu\text{m}$  (customized for airborne use)
- **CPC CEN** (customized for airborne use)
- **Airborne Meteorological System** (airborne use)
- **Airborne isokinetic aerosol inlet** (airborne use)
- **Other possible inlets**



The perfect link between different gb sites

Piper Seneca III owned by OGS



**OGS**  
Istituto Nazionale  
di Oceanografia  
e di Geofisica  
Sperimentale

### Piper SENECA III specifications

Cruise speed	188 kts
Stall Speed	61 kts
Gross weight	2165 kg
Empty weight	1457 kg
Range	870 nmi
Service Ceiling	25000 ft
Seats	6

# OBJ1: Integration Harmonization – *Extra Domain*

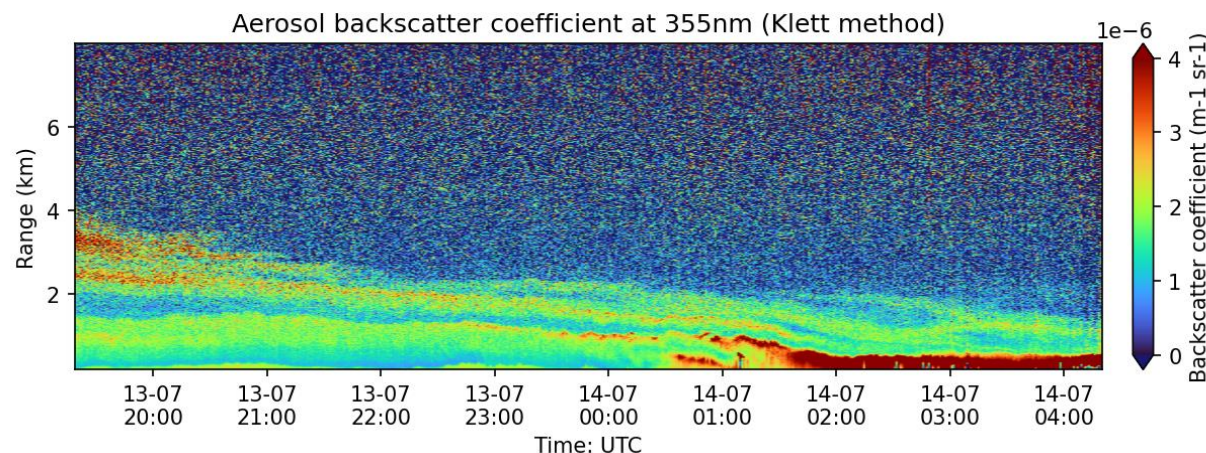


Development of Lidar observation capabilities at **AAOT** (WP4.6) and **Gaia Blu** (WP5.16) for regular monitoring of relevant atmospheric and marine variables and for innovative air-sea interaction studies

## Atmospheric Variables

### Vertical profiles of:

- Particle backscatter coefficient and depolarization ratio from aerosols and clouds
- Particle extinction coefficient from aerosols and clouds
- Aerosol fluorescence







First measurements  
during ITINERIS-EYES campaign

**Interconnections among marine  
ecosystems, aerosols, and clouds**

# OBJ1: Integration Harmonization – *National Level*

In ITINERIS 4 sites in Italy have been equipped with Picarro G2201-I for isotopic measurements of  $\delta^{13}\text{C}\text{-CH}_4$  and  $\delta^{13}\text{C}\text{-CO}_2$ :

-  Cimone
-  Potenza
-  Lamezia
-  Lampedusa

## Measurements extra RIs

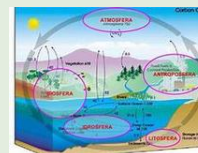
ITINERIS TNA useful for gathering **expertise** on the topic for researchers and PhD students

An unprecedented network over Europe for such measurements which are of interest for emission sources identification: **Italy** is in a **leading position** in this study field

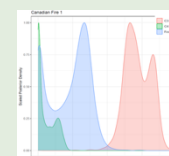
## The Role of Isotopic Analysis in Atmospheric Research



Identifying Emission Sources



Studying Carbon Exchange between Atmosphere, Biosphere and Oceans



Improving Climate Models for Source Apportionment and Greenhouse Gas Inventories

## OBJ1: Integration Harmonization – *National Level*

In ITINERIS, the capability of the chemical analysis for particulate collected on filters has been significantly enhanced for 3 sites in Italy:

 Venezia

 Potenza

 Lecce



*Xact*  
*ICP-OS*  
*ICP-MS*  
*Gas Chrom./Mass Spectr.*  
*Ion Chromatography*  
*OC/EC*  
*ED-XRF*  
*TC-TN.....*

These are not mandatory for ACTRIS





Different ACTRIS sites are going to **offer this as a service** for the whole community (even Italian sites under currently submitted proposals)

Italy with wide resource capability (instruments + ITINERIS res & tech) coupled with PIXE lab in INFN Florence has a **unique set up of resources** in this field

Potentially of interest for Air Quality management agencies.

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# Obj 2– Aerosol typing and sources

🌐 **2 aerosol typing algorithms (HETEAC-Flex, MAC)** have been translated into python and fine-tuned to accept ACTRIS-like lidar data

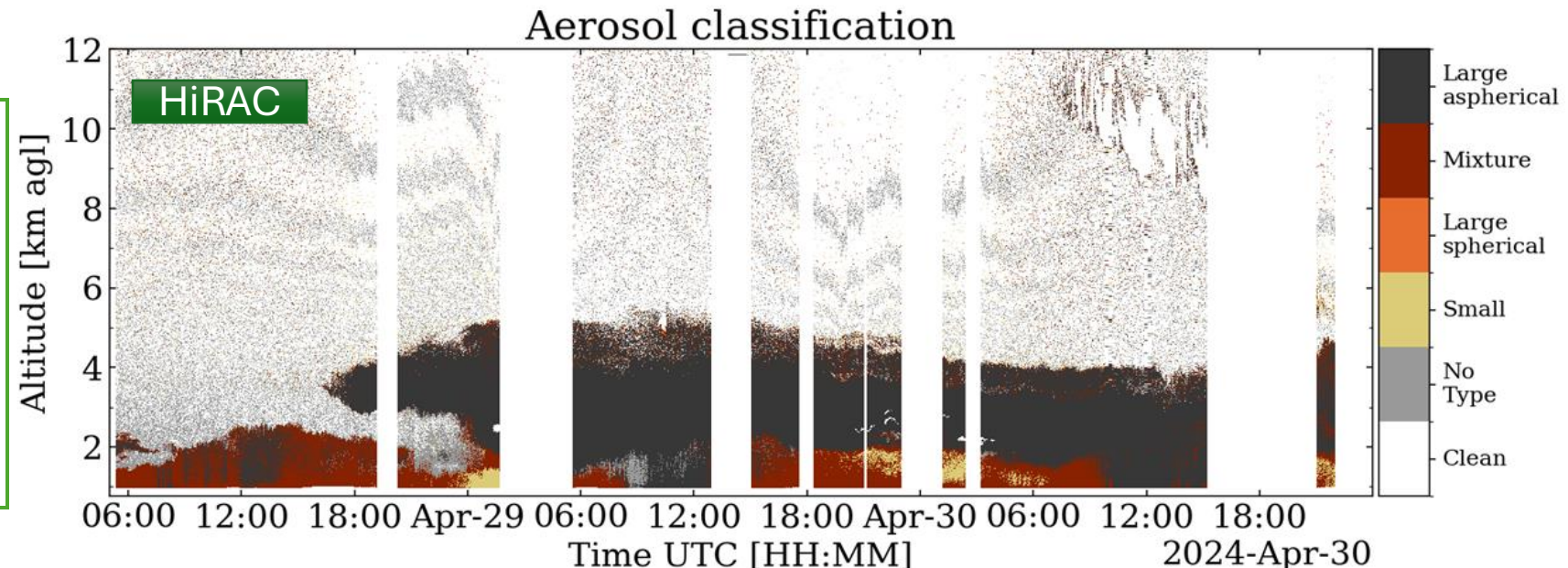
🌐 **1 high-temporal-resolution aerosol typing (HiRAC)** methodology has been developed for ACTRIS lidar data

🌐 A **dedicated server** hosts the abovementioned algorithms and their output with the goal to become the centrepiece of this task

🌐 An ITINERIS dataset of **pure dust vertical profiles** has been created using aerosol lidar measurements provided by the ACTRIS lidar stations in Italy

🌐 HiRAC is produced in near-real-time since June 2025

🌐 HiRAC and MAC outputs are available for the BELLA campaign @CNR-IMAA



# Obj 2– Aerosol typing and sources

## Impacts

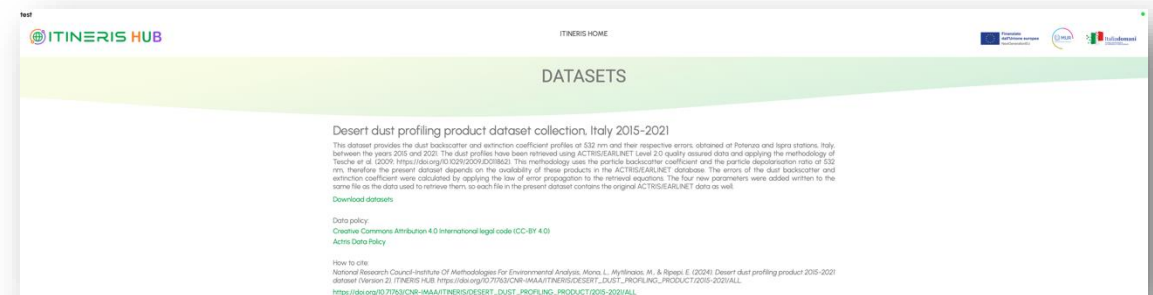
🌐 New data provided to CAMS through the link of specific provision contract @CNR-IMAA



🌐 Post processing server set up @CNR-IMAA unit thanks to ITINERIS allowing new products developments as experimental and potentially connected to ACTRIS DC

🌐 Dust profile and more in general the aerosol source identification has a direct impact for the new air quality regulation

🌐 Dust profiles dataset used into



# Obj 2– Aerosol sources - source apportionment (I)

Source apportionment of PM10, PM2.5, and oxidative potential multi-site (different typologies) by means of PMF5 receptor model.



Spatial and seasonal variability of the contribution of sources to PM<sub>2.5</sub>, PM<sub>10</sub> and their oxidative potential in different sites in a central Mediterranean area

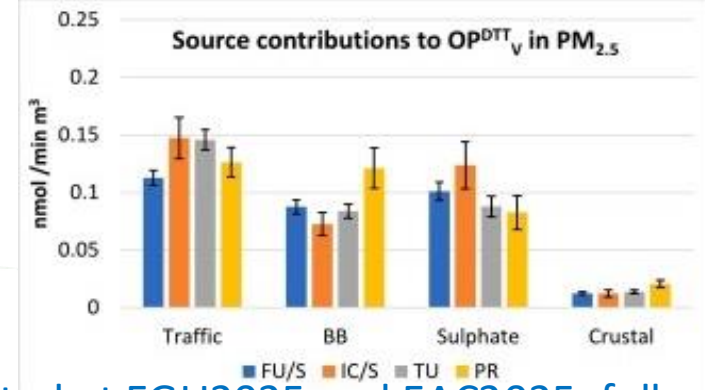
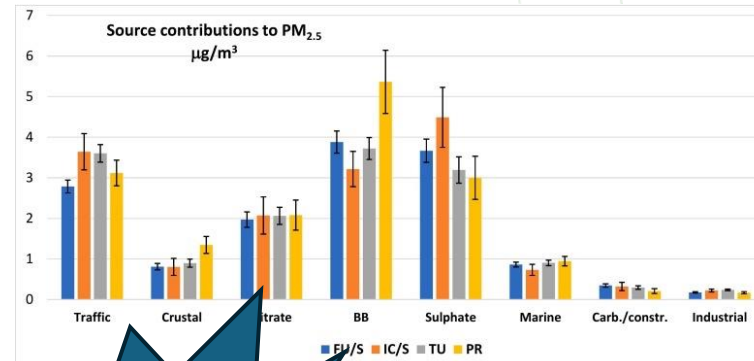
Serena Poti<sup>a,\*</sup>, Eva Merico<sup>a</sup>, Marianna Conte<sup>b</sup>, Florin Ungu<sup>a</sup>, Daniela Cesari<sup>a</sup>, Adelaide Dinol<sup>a</sup>, Anna Rita De Bartolomeo<sup>a</sup>, Antonio Pennetta<sup>a</sup>, Ermelinda Bloise<sup>a</sup>, Giuseppe Deluca<sup>a</sup>, Giuseppe Egilio De Benedetto<sup>a</sup>, Roberto Ferrera<sup>a</sup>, Enrico Bompadre<sup>a</sup>, Maria Rachele Guascito<sup>a,c</sup>, Daniele Contini<sup>a</sup>

Poti et al., 2025

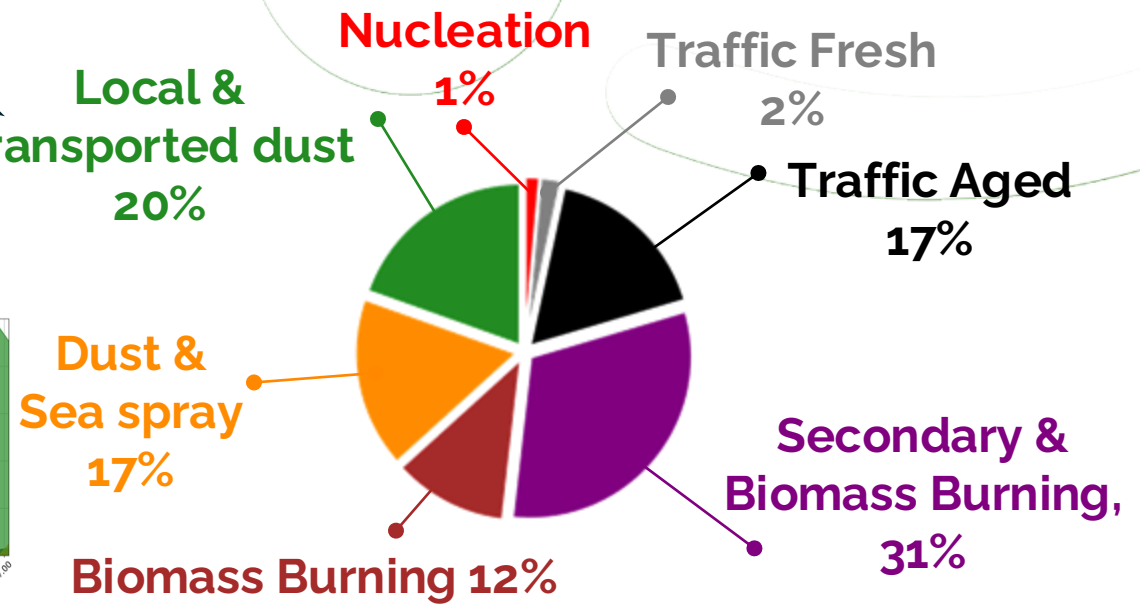
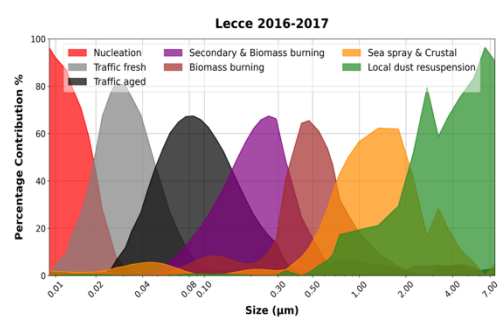
Source apportionment using particle number size distributions, eBC and NO-NO<sub>2</sub> measurements at hourly resolution

All datasets will be on ITINERIS Hub

## 2-year analysis - Lecce



Results presented at EGU2025 and EAC2025, full paper in preparation



# Obj 2– Aerosol sources - source apportionment (II)

Using online measurements for apportionment of carbonaceous aerosol.

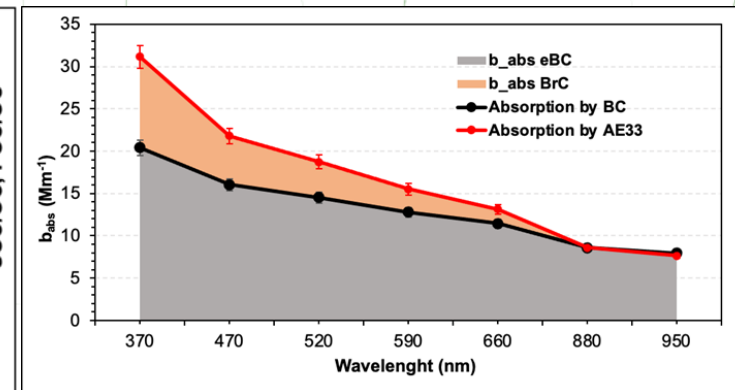
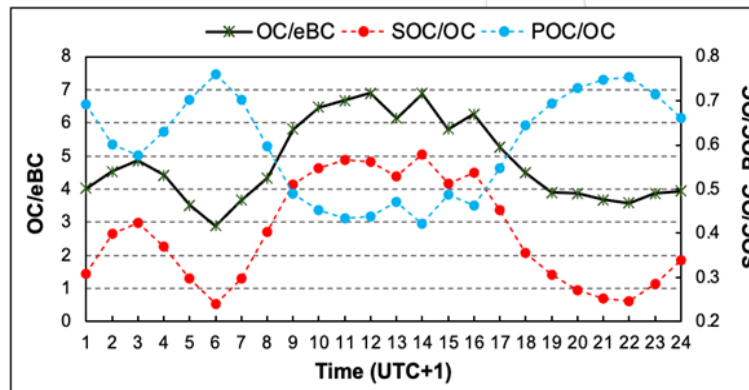
Cesari et al., *Atm.*, 2025



Article

## High-Time-Resolution Measurements of Equivalent Black Carbon in an Urban Background Site of Lecce, Italy

Daniela Cesari <sup>1,\*</sup>, Ermelinda Bloise <sup>1</sup>, Marianna Conte <sup>2</sup>, Adelaide Dinoi <sup>1</sup>, Giuseppe Deluca <sup>1</sup>, Antonio Pennetta <sup>1</sup>, Paola Semeraro <sup>1</sup>, Eva Merico <sup>1</sup> and Daniele Contini <sup>1</sup>



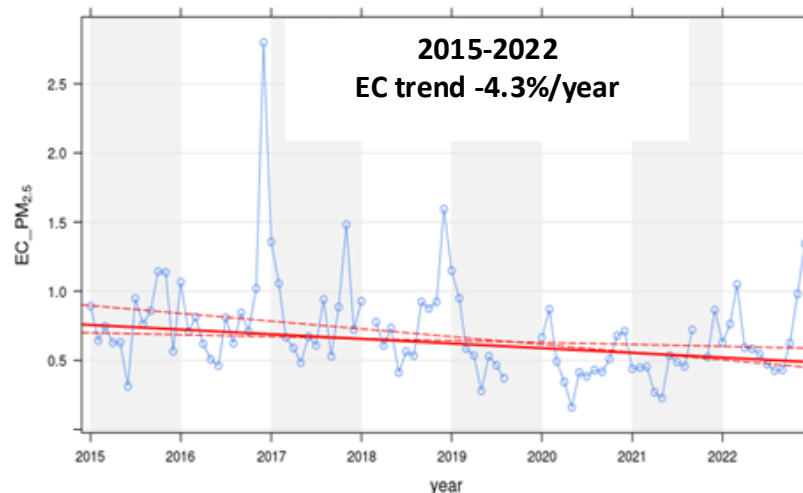
Long-term trend of elemental carbon at ECO Observatory



Long-term analysis of carbonaceous fractions of particulate at a Central Mediterranean site in Italy

Eva Merico <sup>\*,</sup>, Daniela Cesari <sup>,</sup>, Adelaide Dinoi <sup>,</sup>, Serena Poti <sup>\*,</sup>, Antonio Pennetta <sup>,</sup>, Ermelinda Bloise <sup>,</sup>, Daniele Contini <sup>,</sup>

Merico et al., *Atm. Poll.*, 2025



### Ongoing

Source apportionment based on online chemical composition with:

- TOF-ACSM
- ED-XRF (Xact)
- TCA (total carbon analyser)

# Obj 2– Aerosol typing and sources

## Bioaerosol

Systematic studies on the effects of atmospheric conditions on bacteria viability

*Vernocchi et al., (2023). Atmos. Meas. Tech., 16, 5479-5493*

### New experimental protocol

BACTERIA PREPARATION

Bacteria growth  
Inoculum characterization

BACTERIA EXPOSURE

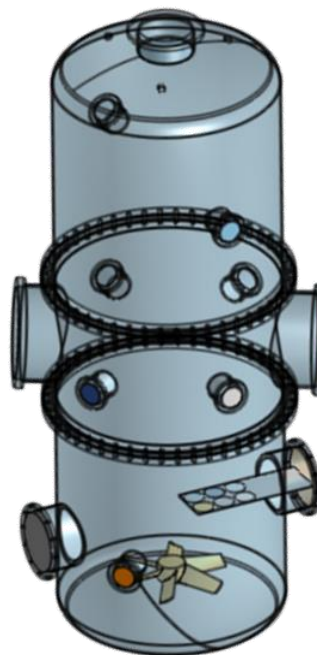
Bacteria injection in ChAMBRé  
Setting of atmospheric conditions in ChAMBRé  
Bacteria sampling

DATA ANALASYS

Determination of bacteria total concentration  
Determination of bacteria viable concentration

## ChAMBRé

Chamber for Aerosol Modelling  
and Bio-aerosol Research



## Optical properties

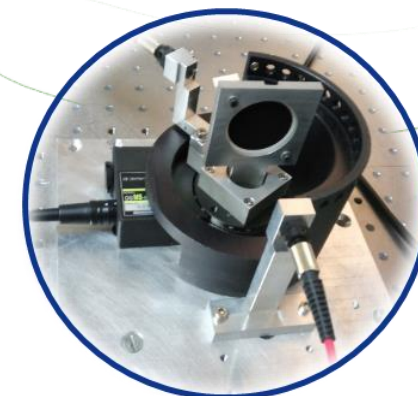
Online and offline determination of absorption/scattering/extinction coefficients

*Isolabella et al., (2023). NCC-C, 46, 1-4*

Production of “aerosol standards”

## BLAnCA

A new instrument for full-spectrum light absorption measurements of aerosols collected on filters










Optical apportionment of carbonaceous aerosol

*Isolabella et al., (2024). Atmos. Meas. Tech., 17, 1363-1373*

# Obj 2– Aerosol typing and sources





## ITINERIS campaigns and accesses to ChAMBRé

-  **MICRO**bial adaptations and **Antimicrobial Resistance** Genes in the **ocean-atmOsphere continuum** - MICROARGO
-  **Bioaerosols'** Evaluation And Machine-learning – BEAM
-  **Toxicological hazard assessment** of combustion emission under different aging processes by direct exposure of lung in vitro models at the air liquid interface - Tox-CEAPs
-  Characterization of Aerosols Emitted by the **Burning of Textile Waste** in Atacama and their Relevance to Air Quality - ATEXAQ
-  **Single scattering albedo and asymmetry PARameter** retrieval by photometric Analysis of atmospheric aerosol deposited on filters - SPARA
-  Degradation of **Benzothiazoles**: From **Urban** to **Polar** Atmosphere Conditions - UPAC-BTH
-  **Calibration** at varying relative humidity of the **ACSM** – CINEMA

Dataset will be published on the ITINERIS hub.

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## Obj 3– PBL and impact at the ground

**Extended campaign** for the assessment of MIPA (Morphological Image Processing Approach), an algorithm based on artificial intelligence, for the determination of the top of boundary layer. *Vivone et al., ACP 2021*



MIPA applies on timeseries of lidar profiles.

**BELLA** (Boundary layer Extensive campaign with multi instrumental Analysis) @**CIAO** (CNR-IMAA Atmospheric Observatory) – Spring 2024

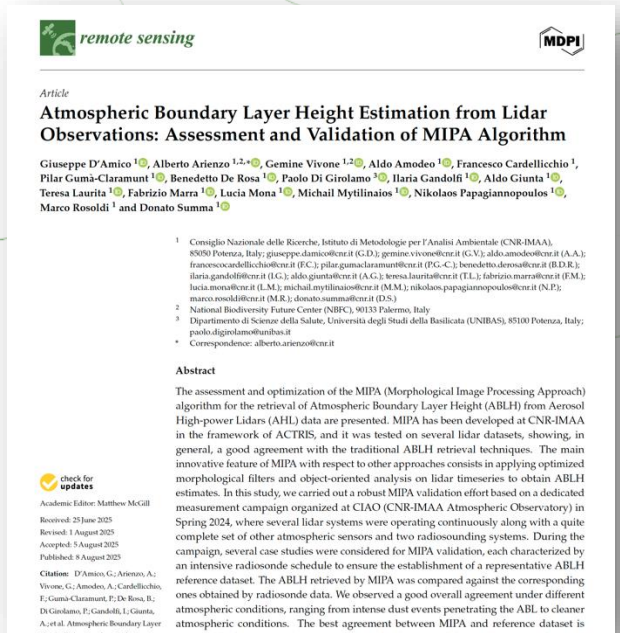
- MIPA applied on aerosol lidar profiles
- compared with 38 radiosounding as reference
- all ACTRIS cloud remote sensing instrument working h24/7d
- in situ online measurements up and running



GCOS Reference Upper-Air Network (GRUAN)

# Obj 3– PBL and impact at the ground

- Measurements **intensified** especially during **difficult** atmospheric conditions for the algorithm
- The **overall accuracy of MIPA ABLH retrievals** estimated as **below 100 m** (median bias)
- Good results especially under daytime conditions and when timeseries of ABS at 532 nm and 1064 nm wavelengths were used as input data.
- ABLH dataset** published



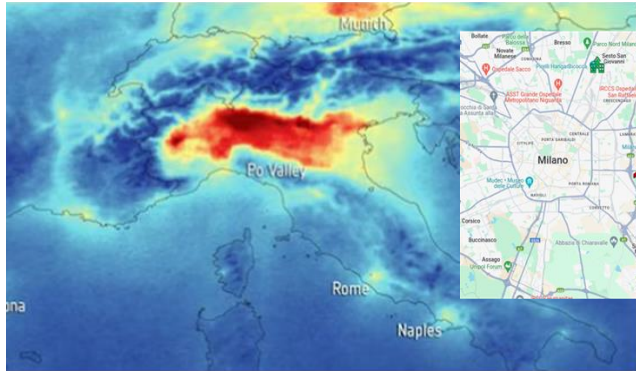
- Paper about extended analysis of MIPA application on ceilometer in preparation.
- Evaluation of ABLH retrieval using a multi-sensor approach.

*D'Amico et al., Rem. Sens. 2025*

# Obj 3– PBL and impact at the ground



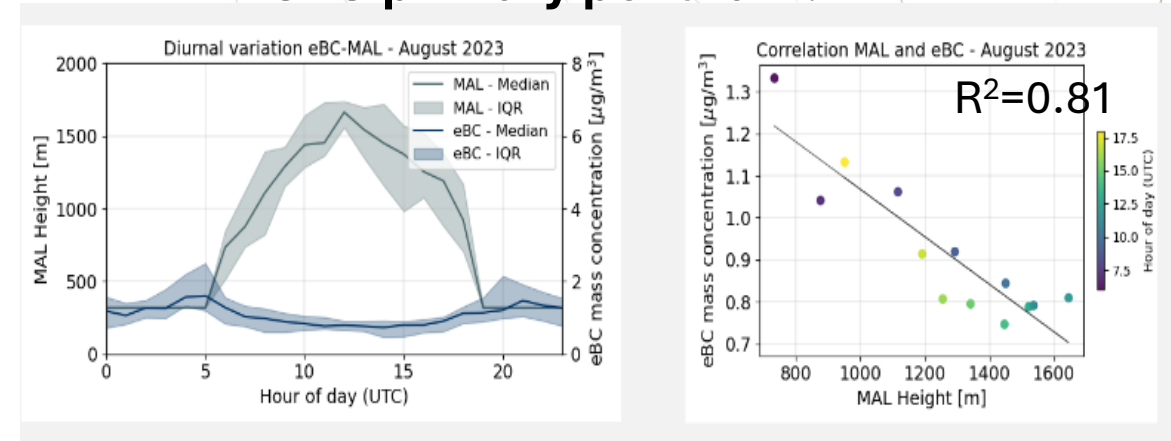
Several pilots performed in synergy with other projects (RI-URBANS, GAIA, ...) and in collaboration with PSI, University of Granada,...



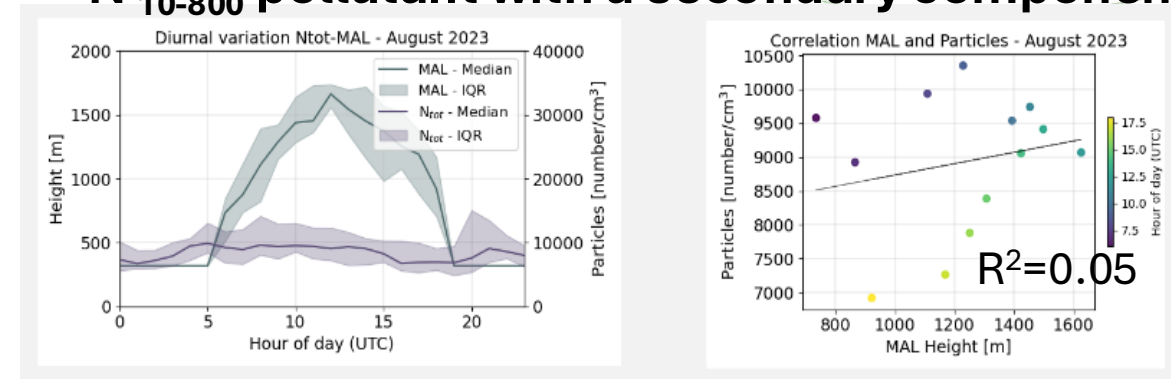
**Objective Milan 2023:**  
Study of in-situ pollutants variability at a hot spot site:  
- Role of PBL dilution  
- Impact of emissions



## eBC primary pollutant:



## N<sub>10-800</sub> pollutant with a secondary component

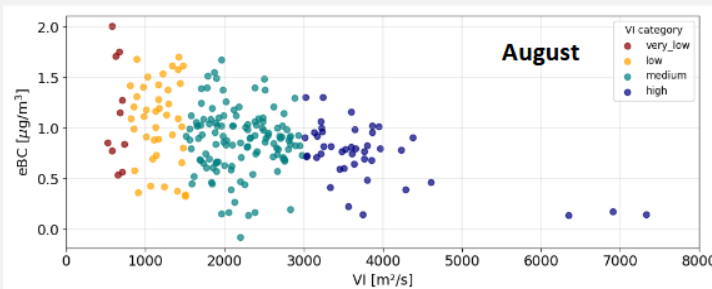
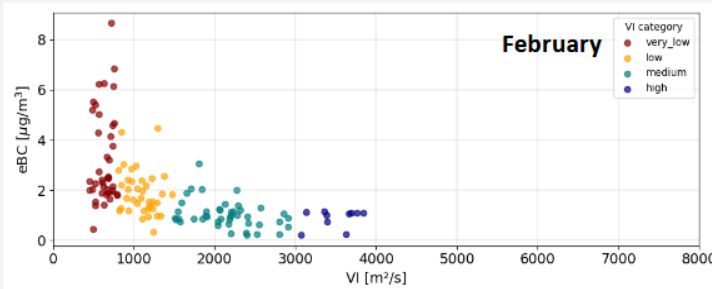


### Ventilation index (VI)

$$VI = MAL \times WS [m/s^2]$$

• Winter: VI correlates well with pollutants → when MAL is low, wind becomes the key driver of dilution

• Summer: despite high MAL, VI shows no clear relation with pollutants → dispersion is already efficient and concentrations mainly reflect emissions



(Work in progress..)

# Influence of PBL on mountain free troposphere, the Monte Cimone observatory long data series



**The “Ottavio Vittori Observatory”**  
 Italy (44°12' N, 10°42' E)  
 Peak of Monte Cimone (2165 m asl)

## Meteorology

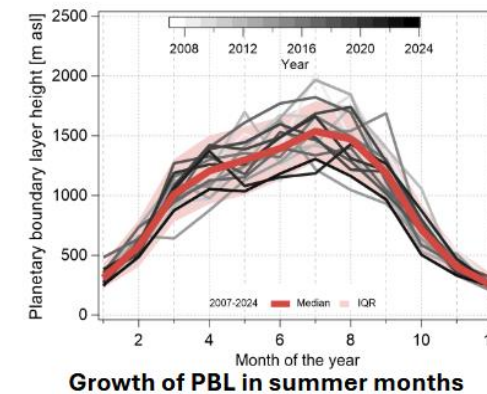
Seasonal evolution of boundary layer  
 Cold winter: free troposphere  
 Warm summer: boundary layer



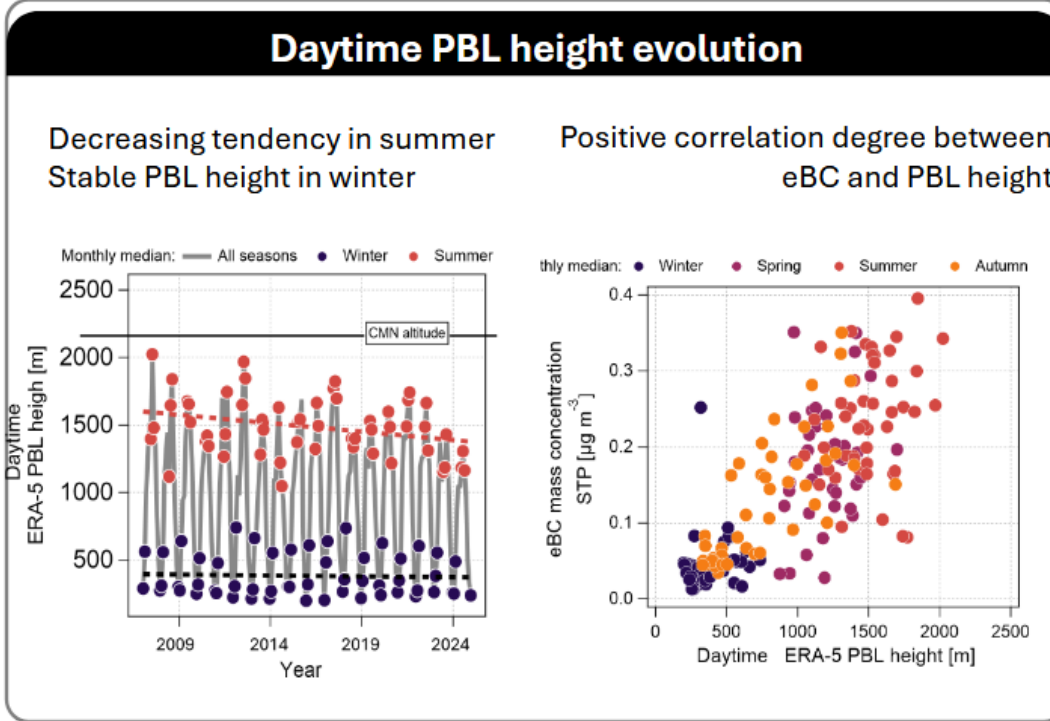
**Networks and RIs**  
 GAW global station  
 European RI : ACTRIS and ICOS

## Atmospheric dynamics

ERA5 hourly data on single levels  
 Height of the boundary layer over the Po-Valley

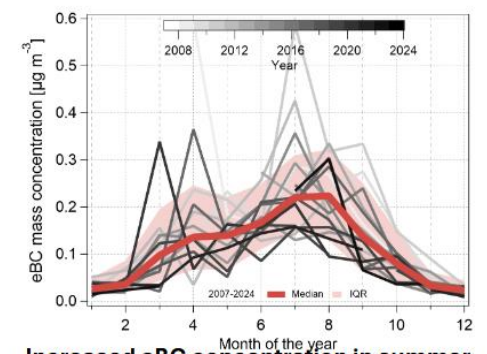


Growth of PBL in summer months



## Black carbon observations





The Mt. Cimone Observatory 2165 m asl  
 Equivalent BC (eBC) measured with MAAP  
 MAC = 10 m<sup>2</sup> g<sup>-1</sup>



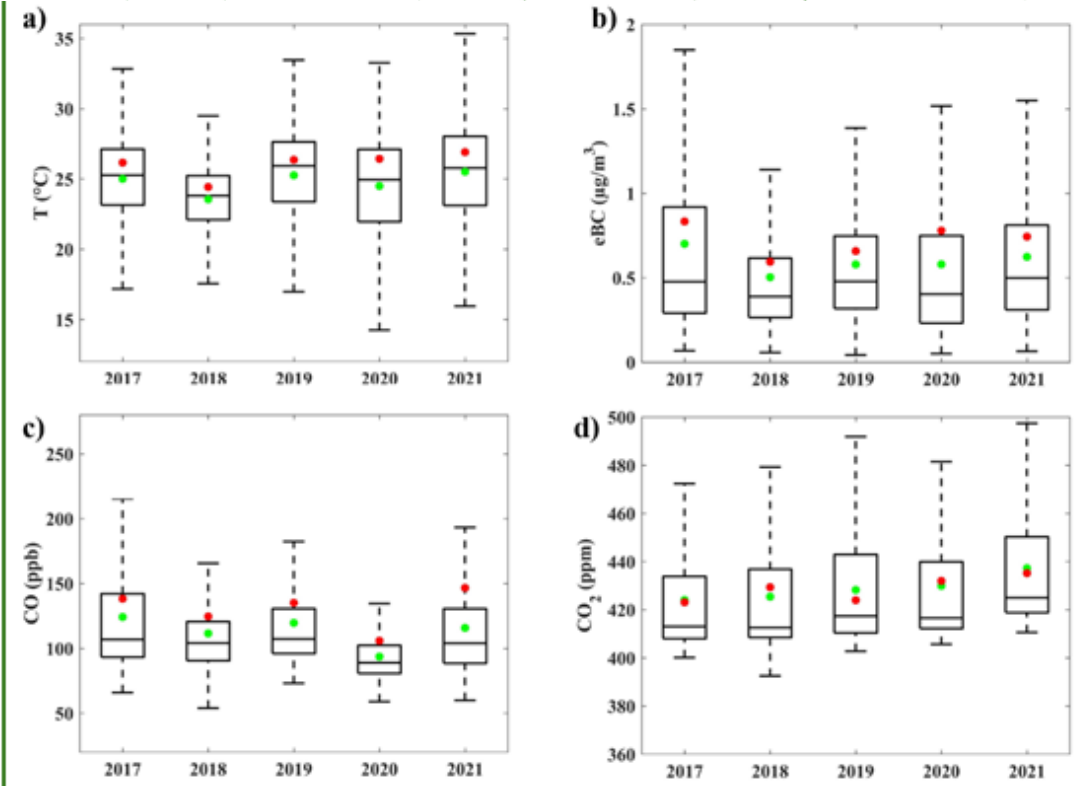
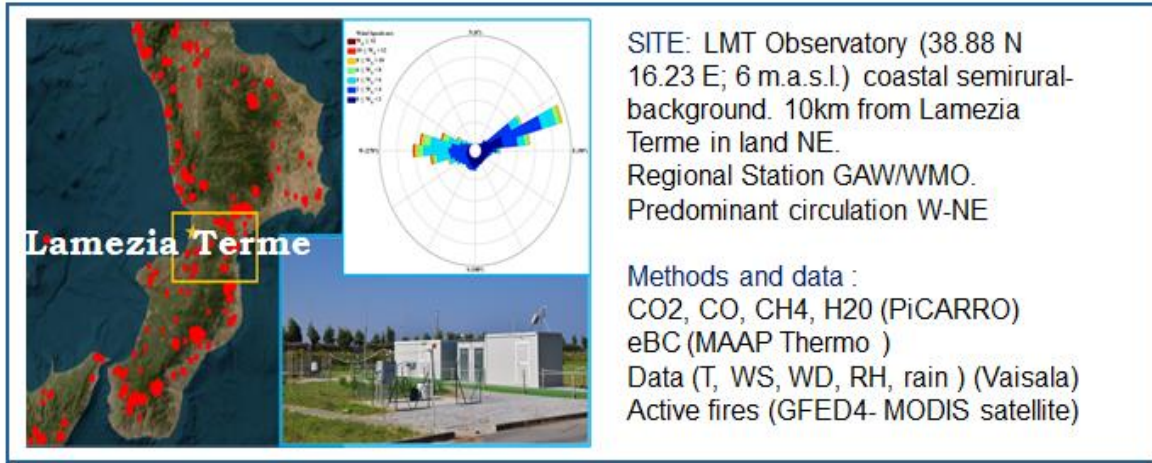
Increased eBC concentration in summer

# WP4 Structure



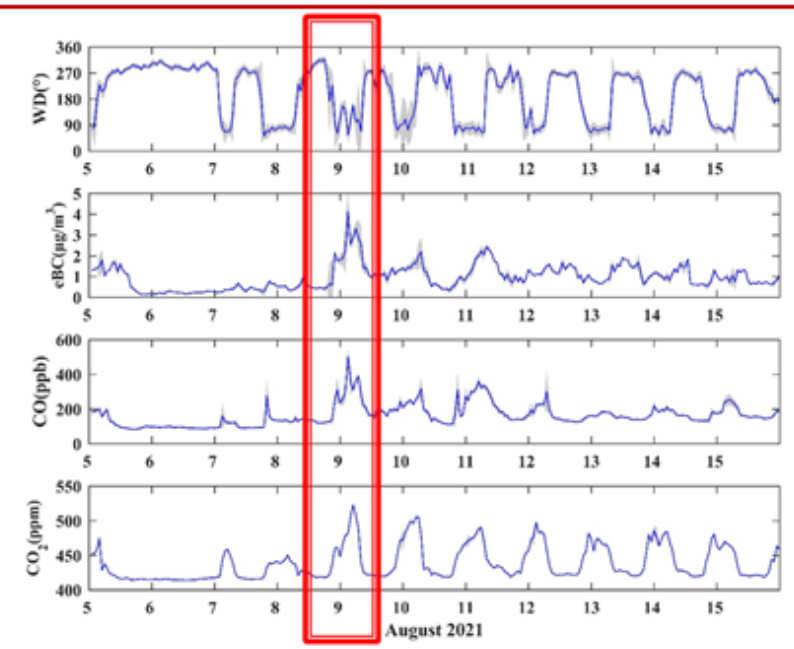
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# Obj 4– impact of fires on atmospheric composition



For each year 2017 – 2021 (years with biggest concentration of fires) for air-temperature (a), eBC (b), CO (c) and CO<sub>2</sub> (d).

- the average summer season values (green spots),
- the mean values for August months (red spots)
- the median (bold lines) and
- the 5<sup>th</sup>, 25<sup>th</sup>, 75<sup>th</sup> and 95<sup>th</sup> percentiles (box and whiskers)



## RESULTS

First case study of the 8<sup>th</sup>-12<sup>th</sup> August 2021 - the directionality of atmospheric circulation and wind fields, using also WRF output, with respect to the location of the experimental site were able to provide sufficient information to corroborate the hypotheses of comparison between the sources of fire events (yellow box in map above) and the concentrations of the detected combustion products in situ time series

## Obj 4– Impact of fires on atmospheric composition



### **Summer 2025 - Campaign in Calabria**

MAIN AIM:

Methodology for fires identification over the Italian region with highest number of fires


2 sites involved:

Lamezia Terme (coastal site) & Conflenti San Mazzeo (mountain site)

meteo-gases and aerosol monitoring

campaign is still ongoing

 Identification of background conditions and cases through time series threshold

 Investigating applicability to other locations and conditions

Dataset will be published on the ITINERIS HUB.

# Deliverables status at IO4.7 (Sep-Oct 2025) [B18]

## Deliverables released (PI4.4) - Status:

OBJ 1: **33** deliverables [33 due at the end of the project]

OBJ 2: **8** deliverables [9]

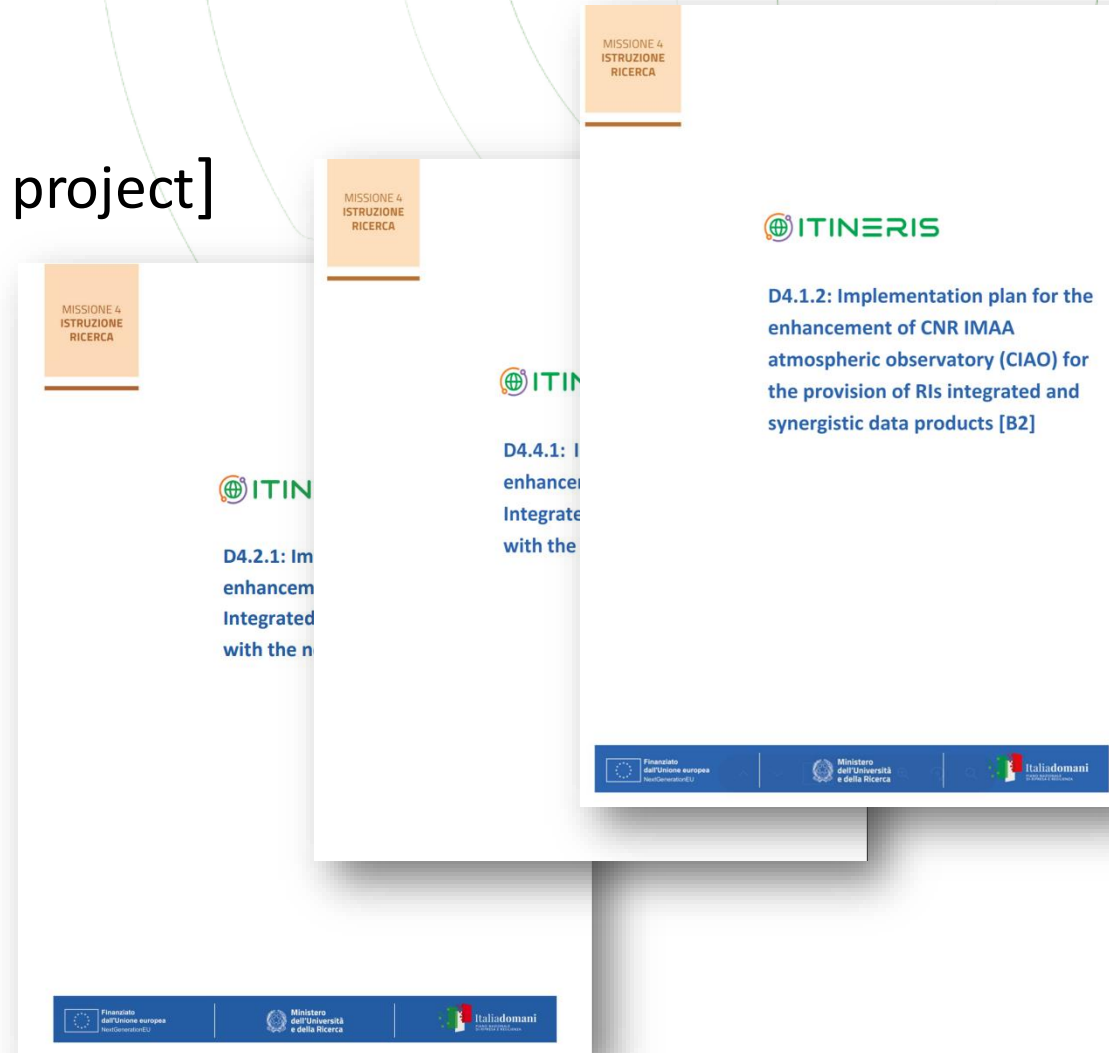
OBJ 3: **6** deliverables [6]

OBJ 4: **2** deliverables [3]

IO 4.7 was originally foreseen at B14 - moved to B17 now it has been postponed to B18



Everything released on schedule





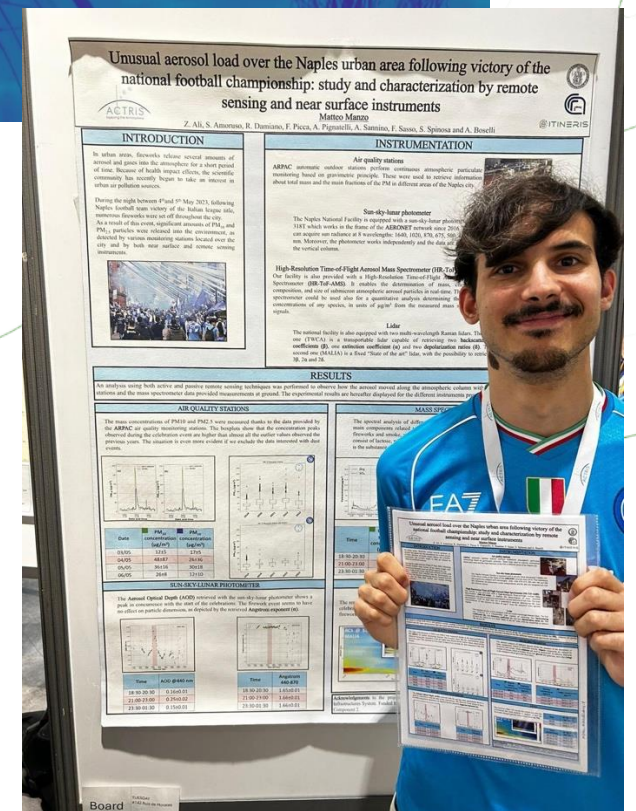
# WP4 scientific awards!



## Best Poster

**Matteo Manzo. UniNa, CNR-IMAA** 

*Unusual aerosol load over the Naples urban area following the victory of the national football championship: study and characterization by remote sensing and near-surface instruments*



WP4 scientific awards!



Grant for joint research with Research Institute for Applied  
Mechanics, Kyushu University, Fukuoka, Japan

**Bracci Alessandro. CNR-ISAC**

*Research Title: Long-term Statistics of Snowfall Microphysical Features for  
EarthCARE validation activities*



European Aerosol Conference  
31 August – 5 September 2025, Lecce, Italy

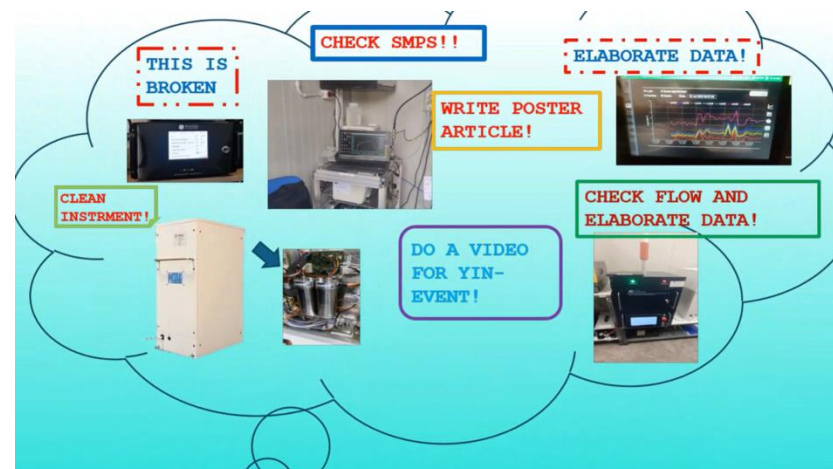
## YIN Meme Competition Award

mental health in research

Gesellschaft für Aerosolforschung (GAeF); Nordic Society for Aerosol Research (NOSA);  
Italian Aerosol Society (IAS); TSI GmbH

**Giuseppe Deluca**, CNR-ISAC, Lecce

*Video "MY HEAD IS EXPLODING"*



# Performance indicators at IO4.7 (September-October 2025)

## **Purchase procedures (PI 4.1; 4.3): Completed!**

Delays occurred in starting procedures:

- 100% of procedures started (expected status at B18: 98%)
- 90% of contract signed (expected status at B18: 91%)

IO 4.7 was originally foreseen at B14 - moved to B17 now it has been postponed to B18

## **Personnel selection (PI 4.2): Completed!**

12 Researchers, 4 Technicians and 12 Technologists



## **Datasets production (PI 4.5): 60 datasets at the project end**

- 33 DOI assigned to WP4 Atmosphere dataset (CNR-ISP, CNR-IMAA, CNR-ISAC-BO, CNR-ISAC-LT, UniVE) - approximately 27 pending release.

**Good!**



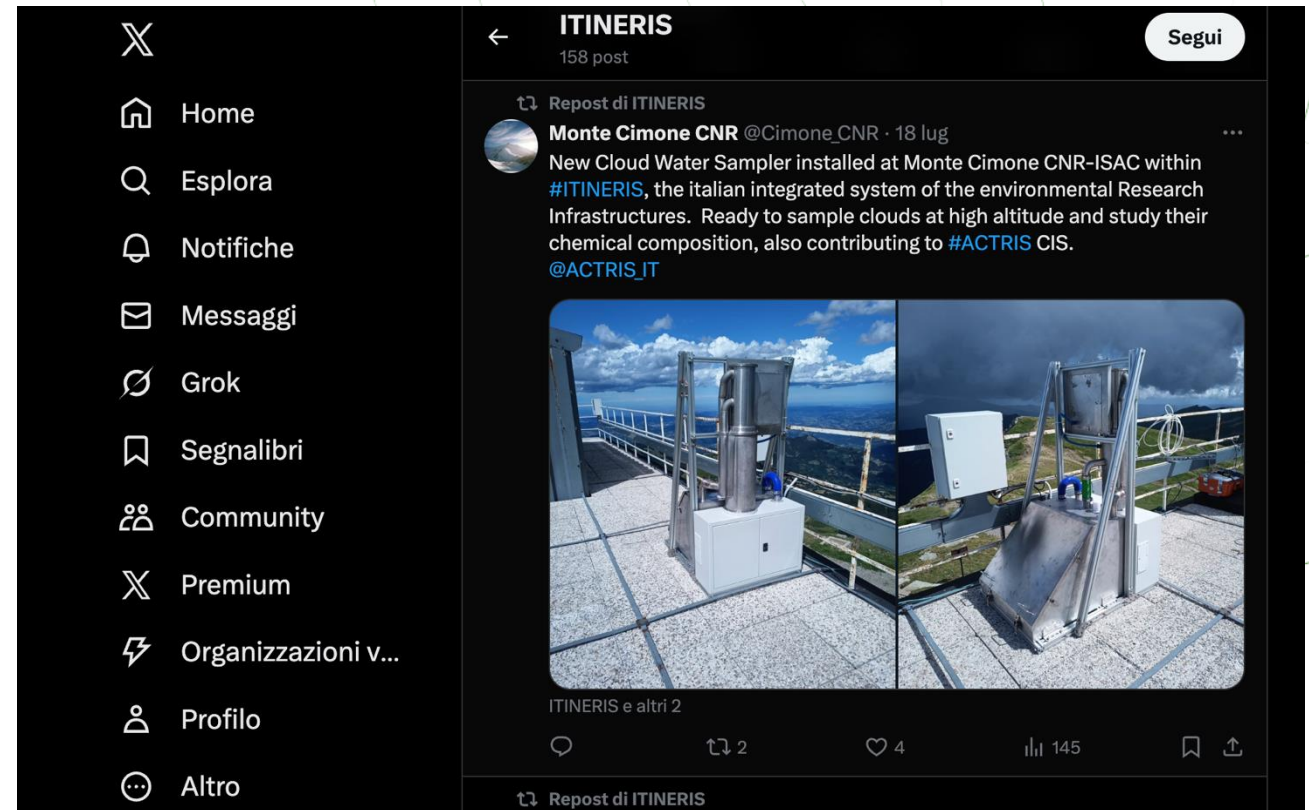
## Communication on social media

 50 posts on Social Media are expected

 Current status around 10

 Follow the ITINERIS news on the atmospheric RIs integration:

<https://itineris.cnr.it/the-italian-atmospheric-observational-capability-enhanced-through-itineris/>



# WP4 linkages with European and National projects



**SYLVA**  
Observing life in air

**ARCTIC PASSION**

**Copernicus**  
Europe's eyes on Earth

**INSIDE-HU**  
Integrated Systemic Detection of Pollutants in the Human Body

**Interreg Italia-Osterreich**  
Co-funded by the European Union

**Breathing**

**RIBURBANS**

**ATMO ACCESS**  
Access to Atmospheric Research Facilities

**IRISCC**

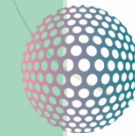
**Interreg Italia-Slovenija**  
ECOMAPS  
Collaborazione dall'Unione europea  
Sofinanziata dall'Unione europea  
Evropska unija

**INSINERGIA**

**ASI**  
Agenzia Spaziale Italiana  
**PRIMARY**



PRIN2022 - FEMTO



**NATIONAL BIODIVERSITY FUTURE CENTER**



PRIN2022 - PBHLsat

INFN - CSN5 2024 - HardLife

International Cooperative for Aerosol Prediction (ICAP)



## WP4 linkages with European and National projects

### **New calls and proposals submissions**

Also thanks to ITINERIS (through consolidated infrastructure but also consolidated national networking), participation of the WP4 UOs in several proposals and initiatives.

Some examples:

- EARLIcost (KoM in Brussel this week)
- Facilities mobile, fixed, laboratories and new fluorescence lidar in TNA proposals
- Consolidated role of aerosol and trace gases in situ + chambers in different proposals
- Participation for Atmospheric RI training programme

# Link to the ITINERIS HUB



As leader of 1 ACTRIS DC node, curated the ACTRIS metadata mapping to ITINERIS standard



Thanks to ACTRIS-ICOS DC personnel link, all ICOS metadata was mapped to ITINERIS standard



Handling SIOS Italian node, curated the SIOS metadata mapping to ITINERIS standard



Before ITINERIS the Italian RI CeTrA **had not at all a datacenter**

Thanks to ITINERIS, CeTrA is now equipped with:

- 1) data repository and data management organization compliant with the international standards and FAIR principles;
- 2) access portal, catalogue of services and scientific resources harmonized with the ITINERIS HUB

All the data are mapped in the ITINERIS HUB



Campaign based database, to be included in ITINERIS datasets

# Link to the ITINERIS HUB



# Stakeholders

- 🌐 High temporal resolution aerosol typing from Aerosol Lidar tested within ITINERIS project
- 🌐 Implemented through the post processing server set up in ITINERIS at ACTRIS ARES

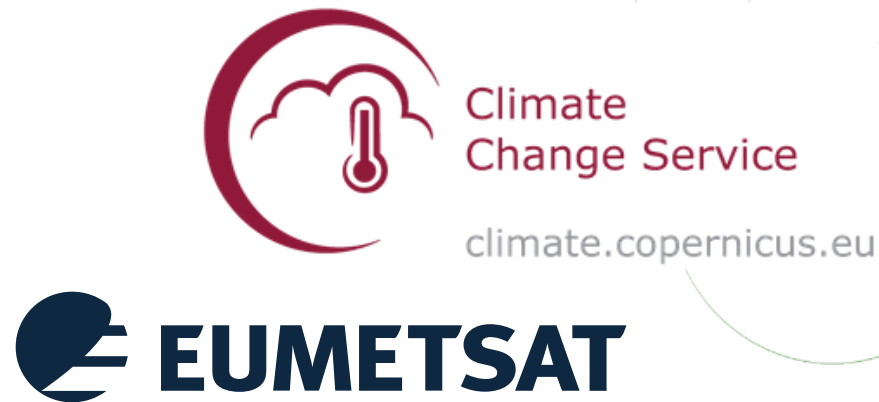


now ready for direct automatic and fast provision to CAMS



# Stakeholders

 Continuous link throughout the ITINERIS project with:



 through members of the Scientific Advisory Group + Coworking for Atmospheric Domain Trainings implementation

# Stakeholders



## Meeting with ISPRA, MASE and 14 ARPAs



Verso la nuova Direttiva Europea sulla qualità dell'aria:  
dialogo e sinergie tra infrastrutture di ricerca,  
enti locali e agenzie ambientali

7-8 Aprile 2025

Consiglio Nazionale delle Ricerche  
Piazzale Aldo Moro, 7 - ROMA  
Ingresso via dei Marrucini



# What next? What missing?

- 🌐 Datasets from instruments recently deployed
- 🌐 Datasets from recent campaigns
- 🌐 Upscale of algorithms and methods at other sites
- 🌐 Community Papers
- 🌐 Improved links to the other domains

# Main Results

- 🌐 Enhanced instrumental capabilities at national level
- 🌐 All Atm RI (meta)data into ITINERIS HUB
- 🌐 New data products developed
- 🌐 Improved linkages between all the Atmospheric Ris groups over Italy
- 🌐 Connection with other domains and stakeholders
- 🌐 Sum and integration of expertise and competences
- 🌐 Italy at the state of the art in the domain

# Just one Big Example

## Canadian Fires July-August 2025


- 🌐 The plume was transported and observed over Europe
- 🌐 Both ACTRIS and ICOS newsletters reported obs at Italian sites



ACTRIS


Home » News » ACTRIS Tracks Canadian Wildfire Smoke Reaching Europe

Published: 30 June, 2025



Since May 2025, wildfires occurring in Canada have emitted a humongous amount of atmospheric particles, some of which flew over the Atlantic Ocean and eventually reached the Old Continent in June.

Several newspapers and websites reported the observation of those plumes. Indeed, sky pictures showed foggy air and red-turned sunset, typical indicators of biomass burning (BB) particles. Through a dense network of continuous observations, ACTRIS data allow for characterising and quantifying such contribution. Biomass burning aerosols were observed in the atmospheric column from Western Europe to Central Europe and the Mediterranean sites since June 5. For instance, ACTRIS aerosol lidar measurements collected in Potenza – Italy (Fig.1) showed the arrival of the plume at very high altitudes (10-14 km) while lower altitudes were mostly affected by desert dust intrusion from Northern Africa.



ICOS


Home » News and events » News » Smoke plumes from North-American wildfires detected by ICOS stations in Europe

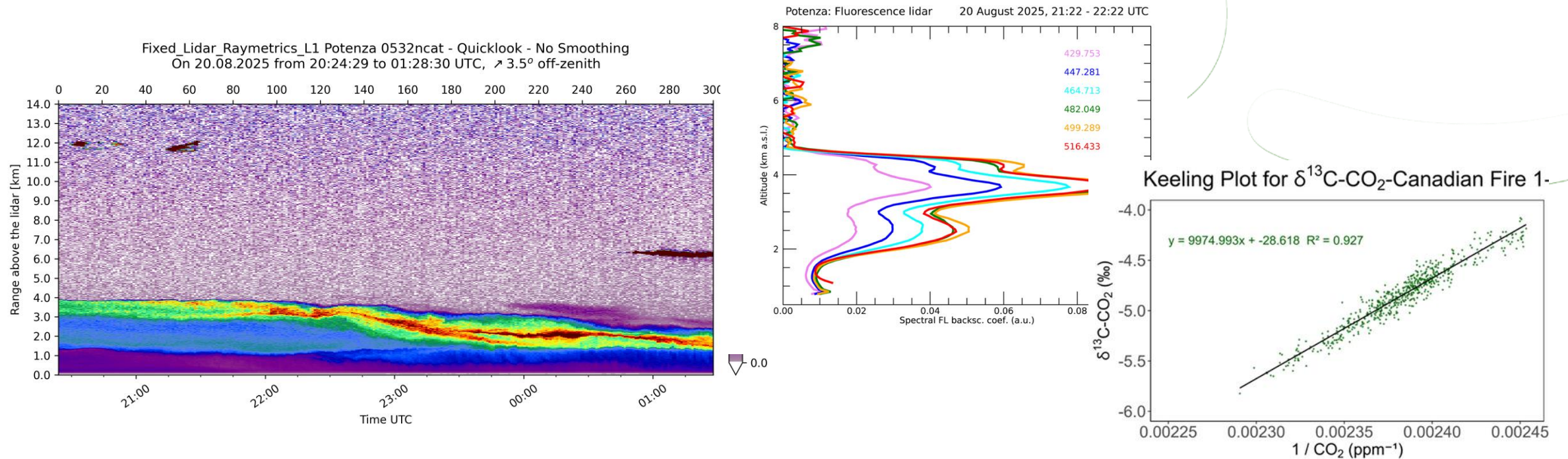
26 June 2025



The Monte Cimone Atmosphere station in Italy is located at an elevation of over 2000 meters.

## Canadian Fires July-August 2025

 New ITINERIS enhanced instrumental capabilities (fluorescence lidar and Carbon isotope measurements) provided insight and potential advancement in wildfire observations





# THANKS!

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Mission 4 "Education and Research" - Component 2: "From research to business" - Investment  
3.1: "Fund for the realisation of an integrated system of research and innovation infrastructures"

