MISSIONE 4
ISTRUZIONE RICERCA

ITINERIS

D4.1.4: Report on the enhancement of CNR IMAA atmospheric observatory for the provision of RIs integrated and synergistic data products

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1. INTRODUCTION

This deliverable is prepared in the context of the ITINERIS project, within the Work Package 4 that deals with the integration of Research Infrastructures (RIs) working in the atmospheric domain through synergistic approaches and cross boundaries developments.

Its main aim is to report the progress in the enhancement of the CNR-IMAA atmospheric observatory (CIAO) which was carried out by operating on multiple fronts: from a significant straightening of its observational capability of aerosol, clouds and trace gases with the aim of providing high quality data and integrated data products, to the enhancement of the CNR-IMAA connectivity for guarantying a stable, fast and protected connection of all the instruments to the respective European RI but also to the digital resources that are being developed in ITINERIS like the Virtual Research Environment (VRE) and the ITINERIS HUB.

All this has also been combined with an infrastructural enhancement of CIAO - with investment in civil infrastructures and related systems (platforms, internet and electricity supplying systems, and upgrade of electrical alimentation and distribution system) - and likewise of personnel with specific skills useful for carrying out the WP4 activities.

Through its participation in ITINERIS, CIAO had an additional opportunity to strengthen its role in ACTRIS and ICOS, improving the synergy capacity between the two RIs and significantly contributing to the building of the Italian Hub of Research Infrastructures in the environmental scientific domain for the observation and study of environmental processes in the specific domain of the atmosphere, providing access to data and services and supporting the Country to address current and expected environmental challenges.

The document is structured in three different sections, each addressing a specific issue related to the strengthening of CIAO. References are reported at the end of the document.

2. ENHANCEMENT OF CIAO WITHIN ITINERIS WP4 ACTIVITIES

As reported in "D4.1.2 - Implementation plan for the enhancement of CNR IMAA atmospheric observatory (CIAO) for the provision of RIs integrated and synergistic data products" of ITINERIS project, the CNR-IMAA has been involved in various actions related to:

- instrumental enhancement for data acquisition and production of integrated data products;
- digital enhancement for CIAO and for WP4 as a whole (ACTRIS remote sensing DC service for ARES component and provision to hub for atmospheric domain);
- infrastructural upgrading enhancement of the CIAO observatory.

Furthermore, the actions listed were also combined with a significant strengthening of the CIAO observatory staff, both in terms of fixed-term positions and doctoral students.

All this has contributed to increasing the competitiveness of the observatory on the national and international scene and to producing a significant increase in the level of competence and experience in the new generation of researchers, technologists and technicians,

contributing to the consolidation of Italian human resources capability in the atmospheric field.

All these points are discussed in detail in the following deliverable sections.

2.1 CNR-IMAA instrumental enhancement

A large variety of instruments aimed at producing specific and integrated data products on identified relevant topics specifically addressed in the three WP4 Pilots (i.e., aerosol typing and sources, atmospheric boundary layer height and its impacts at the ground, forest fires emissions) and at the RIs integration have been acquired at CNR-IMAA.

The datasets that will be provided represent a tangible result of WP4 available to researchers but also to different types of users such as air quality authorities, climate change stakeholders, meteorological agencies, solar plant managers and citizens.

The enhancement of each component (in situ, remote sensing) is discussed below.

2.1.1 Strengthening of the in situ observational component of CIAO

In order to mainly improve the in situ observation of the optical, physical and chemical properties of atmospheric aerosols at ground level, CNR-IMAA has enhanced the aerosol in-situ observational component already operational at the CIAO observatory (for a detailed description of the existing instrumentation and the variables observed, please see Laurita et al., 2024), by acquiring both on-line instrumentation and equipment for off-line chemical analyses of aerosols collected at ground level.

To complement this, a shelter equipped to be used as a chemical laboratory for the analysis of aerosol samples and a system for the measurement of atmospheric gas concentrations, were also purchased within ITINERIS project.

At the same time, the greenhouse gas current observation capability of CIAO as part of the ICOS research infrastructure (Lapenna et al., 2025) was also enhanced by adding a system for the determination of ^{13}C in CO_2 and CH_4 in air samples, along with an upgrade of the meteorological sensors mounted on its tall tower in order to meet the new ICOS requirements (ICOS RI, 2020).

Table 1 reports a summary of the progress of the purchasing procedures of the entire in-situ observational component of CIAO (both atmospheric aerosol and gases). The start date corresponds to the formal beginning of the procedure (i.e. the signing of the decision to contract), the final date corresponds to the signing of the contract with the identified economic operator. Finally, the costs shown are net of VAT.

Table 1 - Summary of the progress of the purchasing procedures for CIAO in situ observational component.

Component	*Instrument/ Complementary parts*	*Procedure*	*Start date*	*End date*	*Delivered*	Amount (euros)
Aerosol in situ (online)	Total Carbon Analyzer	European multi-lot tender	January 2024	July 2024	Yes	49.900,00

	14-stage cascade impactor	European multi-lot tender	January 2024	September 2024	Yes	102.400,00
	Aethalometer	European multi-lot tender	January 2024	July 2024	Yes	44.000,00
	Aerodynamic Particle Sizer	European multi-lot tender	January 2024	July 2024	Yes	83.172,13
	On-line system for multi-metals measurements in PM	European multi-lot tender	July 2024	November 2024	No	246.250,00
	Nephelometer	Request for Offer (direct assignment)	July 2024	September 2024	No	42.022,00
	System for detection and characterization of bioaerosol	European multi-lot tender	July 2024	November 2024	No	131.140,00
Aerosol in situ (offline)	Ion chromatography system	European multi-lot tender	July 2024	November 2024	No	119.337,37
	Triple Quadrupole GC-MS	European multi-lot tender	July 2024	December 2024	No	123.163,75
	Extraction and evaporation system	Request for Offer	July 2024	January 2025	No	147.281,80
	Shelter – chemical laboratory	Request for Offer (direct assignment)	November 2023	January 2024	Yes	98.360,00
	Chemical laboratory equipment	European multi-lot tender	January 2024	August 2024	Yes	43.885,00
Gas in situ	NO-NO_2-NO_x, SO_2, CO, O_3, CO_2, N_2O, NH_3, BTEX, CH_4 and NMVOCs measurement systems	European multi-lot tender	January 2024	October 2024	Yes	256.900,00
	detectors of stable gas, NO_x and aromatic pollutants	European multi-lot tender	January 2024	October 2024	Yes	81.500,00
	System for the determination of ^{13}C in	Request for Offer	July 2024	January 2025	Yes	196.780,84

	CO_2 and CH_4 by CRDS technique					
	ICOS tower measurement system for in altitude measures	Request for Offer	November 2024	January 2025	No	148.950,00

As Table 1 shows, all the planned procedures are finished and most of the instruments have been delivered, highlighting full compliance with the project deadlines. The strengthening of this observational component of CIAO required an economic investment equal to euros 1.766.092,89 (2.154.633,33 euros VAT included).

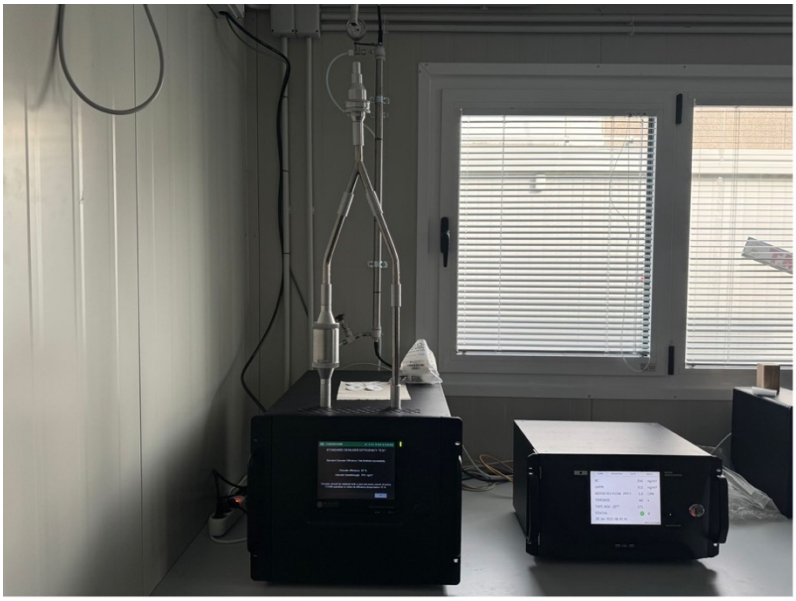
In particular, the following instruments for the online and real time measurements of aerosol properties were acquired within ITINERIS:

- a 14-stage cascade impactor for real-time particle size distribution and concentration measurements in the particle size range of 6 nm - 10 µm classified into 14 size fractions in a cascade impactor (Dekati, mod. ELPI+ - Figure 1a);
- a total carbon analyzer (TCA) for real-time measurements of the total carbon content of suspended aerosol particles (Aerosol Magee Scientific, mod. TCA08 - Figure 1b, on the left);
- an aethalometer at seven-wavelength from 370 to 950 nm for real-time measurement of black carbon (BC) concentration (Aerosol Magee Scientific, mod. A33 - Figure 1b, on the right);
- an Aerodynamic Particle Sizer (APS) for real-time measurements of the aerodynamic particle size from 0.5 to 20 µm (TSI, mod. 3321 - Figure 1c);
- an on-line system for multi-metals measurements in PM with high time resolution (COOPER Environmental, mod. Xact 625i - not delivered yet);
- a multi wavelength integrating nephelometer for measurements of aerosol total and back scattering coefficients at three wavelengths (450nm, 525nm and 635nm) (Acoem, mod. Aurora NE-300 - not delivered yet).

These instruments are complemented by an advanced system for the in-situ detection and characterization of bioaerosol (not delivered yet).

Figure 1. Instruments for online measurements of aerosol properties available at CIAO and purchased within ITINERIS: a) 14-stage cascade impactor; b) total carbon analyzer (on the left) and ethalometer (on the right); c) APS.

a)



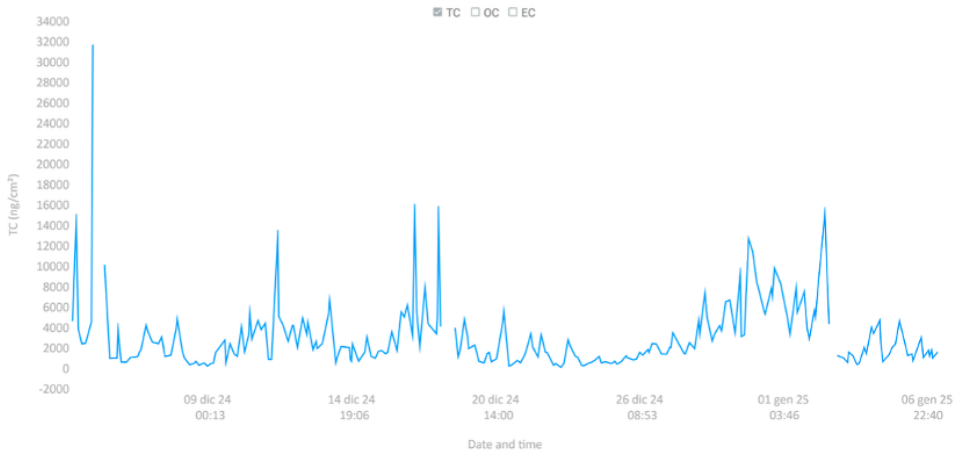
b)

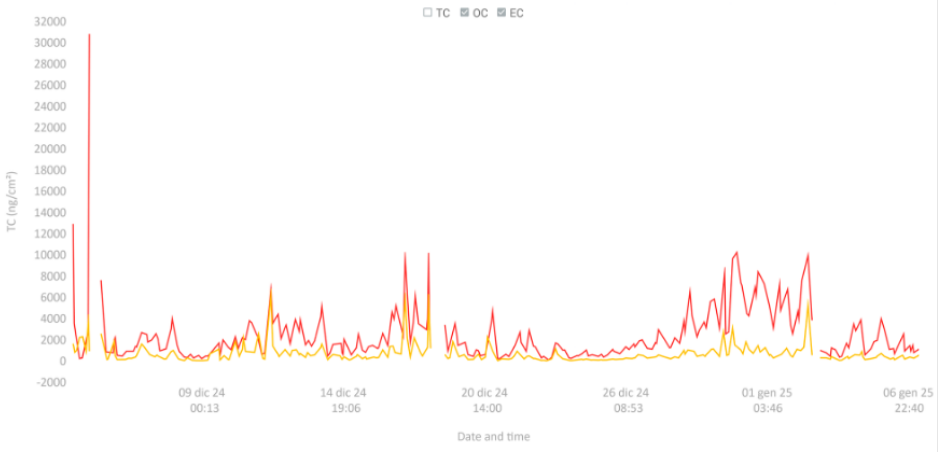
c)

Among the listed instruments, the TCA, the aethalometer and the APS are already operational and are providing continuous measurements, as can be seen below.

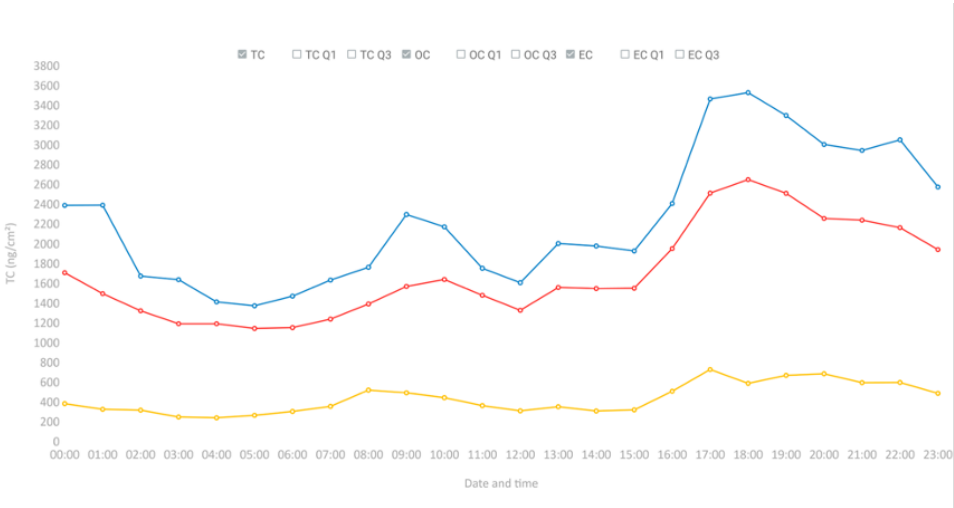
In particular, Figure 2a and Figure 2b show the temporal pattern of the concentration of total carbon (TC) and of its deconvolution into organic carbon (OC) and elemental carbon (EC) measured by the TCA08 starting from 4 December 2024 (date of its activation). In addition, the diurnal trend of the median concentration values of TC, OC and EC measured from 4 December 2024 to 7 January 2025 is also reported (Figure 2c).

Figure 2. Temporal pattern of the concentration of a) total carbon (TC) and b) organic carbon (OC) and elemental carbon (EC) and c) diurnal trend of the median concentration values of TC, OC and EC measured by the TCA08 at CIAO site from 4 December 2024





b)

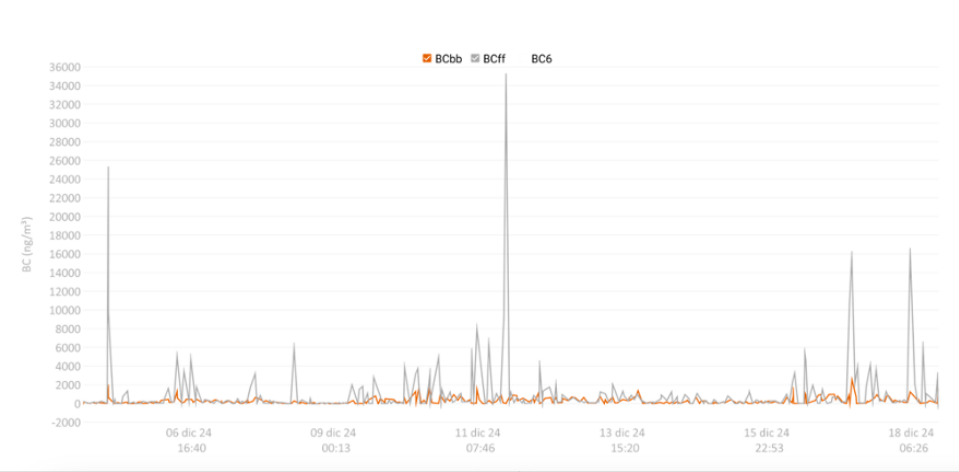


c)

Focusing on the AE33 aethalometer measurements performed at CIAO, Figure 3a reports the temporal pattern of black carbon (BC) concentrations while and Figure 3b shows the deconvolution of BC into the two fractions related to biomass burning (Bbb) and fossil fuel (Bff) contributions.

Figure 3. Temporal pattern of a) black carbon (BC) concentrations and b) of its deconvolution into the two fractions related to biomass burning (Bbb) and fossil fuel (Bff) contributions measured by the AE33 aethalometer at CIAO in December 2024

a)



b)

Moving to the offline aerosol chemical characterization, the Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) and the organic carbon (OC) and elemental carbon (EC) analyzer - already operational at CNR IMAA – have been complemented by

instrumentation for non-destructive multi-element analyses on atmospheric aerosol samples and for the determination of the ionic and organic components of aerosol.

In particular, the following instruments were acquired:

- an Ion chromatography system (Thermo Fisher Scientific, mod. ICS-6000 - not delivered yet);
- a Triple Quadrupole GC-MS (Agilent, mod. 8890/7010 - not delivered yet).

Furthermore, to allow the extraction of insoluble or poorly water-soluble organic compounds from PM samples for subsequent GC-MS analyses, an extraction and evaporation system was also acquired (Thermo Fisher Scientific, mod. EXTREVA ASE - not delivered yet).

All these instruments will be placed inside a shelter - also purchased within ITINERIS - equipped with all the necessary chemical laboratory equipment such as an ultrapure water production system, a chemical fume hood, a stove, a microbalance, etc.

Moreover, in order to fill the CIAO's gap relating to the lack of in situ measurements of gas species, CNR IMAA has also acquired gas in situ monitors for the measurements of the concentration at surface level of:

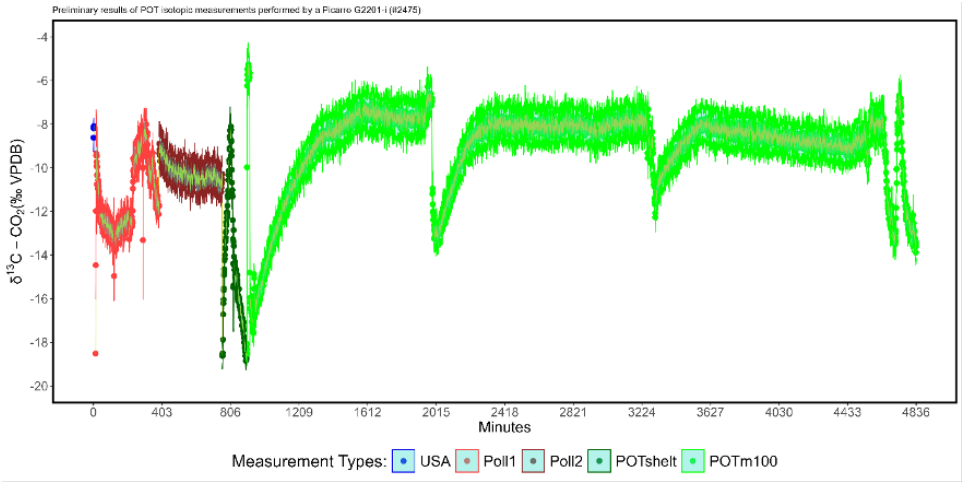
- nitrogen oxides (NO, NO_2 and NO_x, Thermo Scientific, mod. 42i);
- sulfur dioxide (SO_2, Thermo Scientific, mod. 43i);
- ozone (O_3, Thermo Scientific, mod. 49i);
- carbon monoxide (CO, Thermo Scientific, mod. 48i);
- carbon dioxide (CO_2, Thermo Scientific, mod. 410i);
- nitrous oxide (N_2O, Thermo Scientific, mod. 46i);
- ammonia (NH_3, Thermo Scientific, mod. 17i);
- benzene, toluene, ethylbenzene and xylene (BTEX, SYNSPEC, mod. GC955-601);
- methane (CH_4) and non-methane volatile organic compounds (NMVOCs) (SYNSPEC, mod. ALPHA 115);

and detectors of stable gas (Thermo Scientific, mod. 46i), NO_x (Thermo Scientific, mod. 42i), and aromatic pollutants (SYNSPEC, mod. GC955-601).

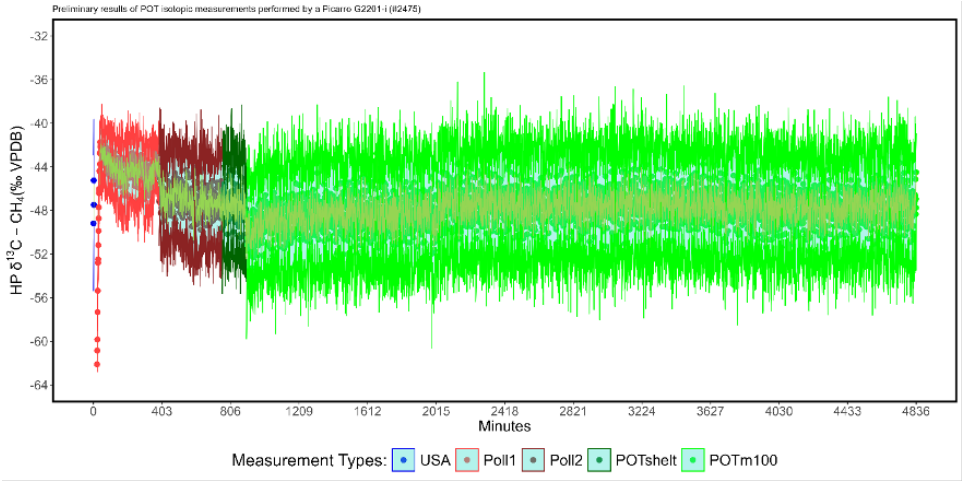
In addition, the Picarro G2201-i isotopic analyzer was also acquired and is already operational, collecting high-resolution data on the $\delta^{13}C$ isotopic signatures of CO_2 and CH_4, together with their molar fractions, in air samples collected at 100m on the ICOS tower.

Figure 4 shows preliminary isotopic data acquired by Picarro G2201-i.

Figure 4. Trend of a) δ13CO2 and b) δ13CH4 isotopic data acquired by Picarro G2201-i.



a)



b)

The measurement phases are categorized in different colors aimed at highlighting the difference between: USA (tests presumably done by Picarro in California, before shipment), Poll1 and Poll2 (tests presumably done by the dealer of the instrument before delivery), POTshelt and POTm100 (measurements at the tower with air from the shelter and from the maximum level of 100 meters)

Finally, two of the three meteorological stations present on the ICOS tower will soon be updated (at 50 m and 100 m) as well as their assembly will be adapted to the specifications required by this RI.

2.1.2 Strengthening of the remote sensing observational component of CIAO

Within WP4, CNR IMAA has been acquired a large variety of back-up instruments and main instrument components for guarantying the effective data provision of ACTRIS remote sensing stations on the Country and to extend the capabilities and opportunities for

measurements of the CNR-IMAA Atmospheric Observatory (CIAO). For the aerosol component, a very light and compact lidar system equipped with Raman and depolarization channels (elastic at 532, 355 nm, Raman at 387 and 407 nm, and depolarization at 532 and 355nm) for aerosol and water vapour measurements. This system can be easily and immediately loaded in a van and moved to the site of interest. A second multiwavelength Raman lidar system for aerosol measurements, also including ACTRIS compliance (elastic at 1064, 532, 355 nm, Raman at 387 and 607 nm, depolarization at 355nm), less compact than the previous one, but easily transportable to different sites, able to perform measurements in automatic way with the possibility to be left unattended in any weather conditions. Concerning the lidar equipment, a system for lidar characterization has also been acquired. This is a new kind of tool that allows to simulate lidar returns at different wavelengths and to check the performances of lidar systems in terms of linearity of the acquisition system, detector response at different wavelengths and light power, response of all optical and electronic elements of a lidar, presence of crosstalk between the detected channels, transmitter-receiver alignment, signal-to-noise ratio. As for the cloud remote sensing component, the following instruments are planned to be acquired: an easy transportable microwave radiometer providing real-time profiles of temperature, relative humidity and liquid water, along with integrated water vapor, integrated liquid water and cloud base height and temperature; a laser disdrometer providing real-time measurements of size distribution, falling speed, type, intensity and equivalent radar reflectivity of precipitation, which also allows to monitor the calibration stability of cloud radars operating at CIAO, using ACTRIS algorithms; three ceilometers operating at 910 nm for aerosols and clouds vertical layering; a spare laser optical module (LOM) to ensure measurement continuity of a ceilometer operating at 1064 nm. As for the trace gases remote sensing component, the acquisition of an automatic UV-VIS spectrometer MAXDOAS (Multi AXis Differential Optical Absorption Spectroscopy) is planned. This instrument provides real-time measurements of atmospheric total column ozone (O_3), nitrogen dioxide (NO_2) and formaldehyde (HCHO) and completes the implementation of the trace gases remote sensing component at CIAO, where a high-resolution FTIR (Fourier-Transform Infrared Spectrometers) spectrometer is already installed. The following table (Table 2) provides a list of the status of the purchasing procedures related to the remote sensing component. The total amount contractualized so far is 1.038.100,00 €. The costs show are net of VAT.

Table 2 - Purchasing procedure status for the remote sensing component.

Component	*Instrument/ Complementary parts*	*Procedure*	*Start date*	*End date*	*Delivered*	Amount (euros)
Aerosol Remote Sensing	*Transportable lidar system with Raman and depolarization channels*	*European multi-lot tender*	*May 2024*	*September 2024*	*No*	*225.200,00 €*
Aerosol Remote Sensing	*ACTRIS compliant MW Raman mobile lidar for observations in different sites*	*European multi-lot tender*	*May 2024*	*September 2024*	*No*	*327.500,00 €*
Aerosol Remote Sensing	*System for lidar characterization, lidar signal simulation and*	*European multi-lot tender*	*July 2024*	*October 2024*	*No*	35.000,00 €

	automatic remote control					
Cloud and aerosols	*n. 2 ceilometers equipped with depolarization channel*	*European multi-lot tender*	*May 2024*	*September 2024*	*Yes*	*98.100,00 €*
Cloud and aerosols	*Ceilometer for determining cloud layers and PBL height*	*European multi-lot tender*	*May 2024*	*September 2024*	*No*	*44.180,00 €*
Cloud and aerosols	*Microwave Radiometers*	*European multi-lot tender*	-	-	-	-
Cloud Remote Sensing	*Microwave Radiometer (MP-3000A)*	Request for Offer *(direct assignment)*	*January 2025*	-	-	-
Gas Remote Sensing	*PANDORA automatic trace gases*	*Request for Offer*	*November 2024*	*December 2024*	*No*	*167.450,00*
Cloud Remote Sensing	*Dysdrometer*	Request for Offer *(direct assignment)*	*October 2024*	*December 2024*	*No*	*12.500,00 €*
Aerosol Remote Sensing	*Photometer for aerosol measurements*	Request for Offer *(direct assignment)*	*May 2024*	*September 2024*	*Yes*	*70.830,00 €*
-	*Spare LOM for CHM 15K*	Request for Offer *(direct assignment)*	*May 2024*	*August 2024*	*Yes*	*57.340,00 €*

Among the instrument list linked to the Aerosol Remote Sensing component, the instruments that have been delivered are the following:

- 2 spare Laser Optical Module for the CHM15K Lufft Ceilometer. These spare units have been purchased as back up to the existing Laser Optical Module for the Lufft Ceilometer. The two modules have been delivered at CNR IMAA and tested by the CNR IMAA technicians between November 2024 and December 2025. The instrument is currently stored has a back-up in CNR IMAA laboratories.

Figure 5. The two spare Laser Optical Modules

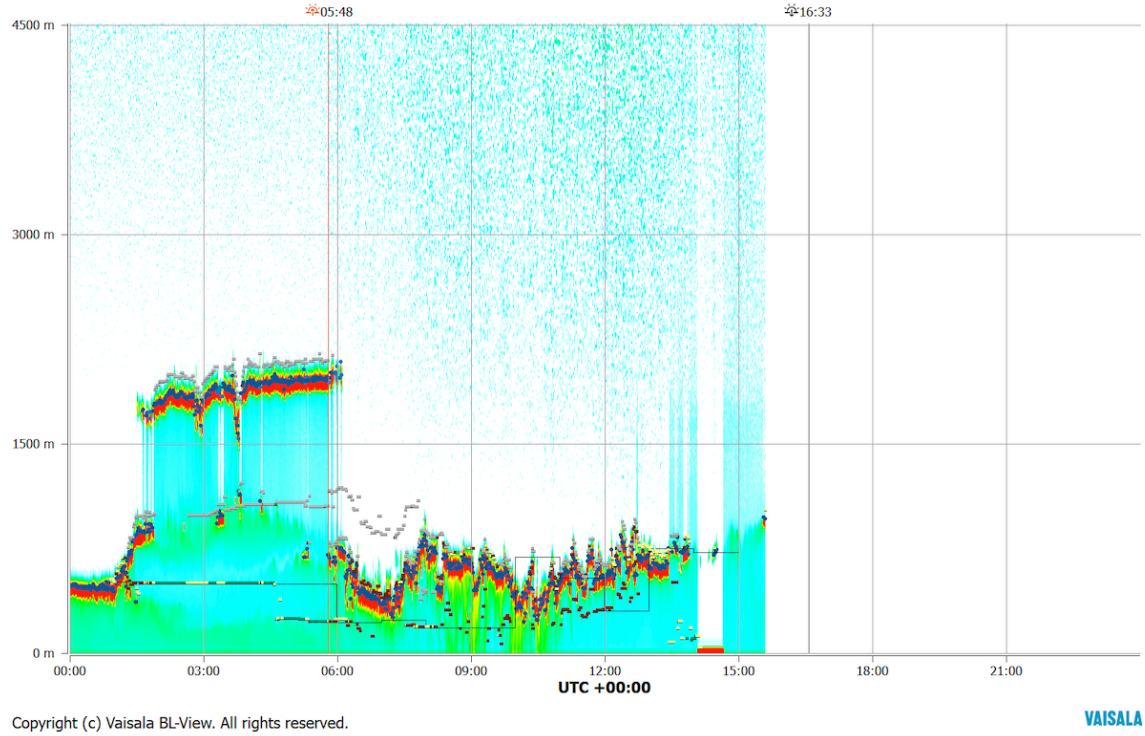
- A photometer Cimel XRV-CML-CE318-TP9, as a backup for the old photometer currently installed at the observatory. The instrument has been delivered at CNR IMAA in December 2025. The instrument has been certified by the CNR IMAA technicians in January 2025 and will be connected in the AERONET network in the upcoming months.

Figure 6. The photometer CIMEL XRV - CML - CE31 – TP9

- Two Ceilometers Vaisala CL61. The two instruments have been delivered and tested by CNR IMAA technicians among January and February 2025. One of the two instruments is currently being prepared for the data acquisition, while the second CL61 will be used as a backup unit.

Figure 7. The two ceilomenter Vaisala CL61 during the technical check. W4120858 on the left, W4120859 on the right

Figure 8. Early measurements from the CL61 (W4120858).



2.2 Digital enhancement for CIAO and for WP4

Among the technological equipment for enhancing distributed system for atmospheric data monitoring and provision, and for improving the level of data availability and data stream considered in WP4, CNR IMAA connectivity will be enhanced for guarantying a stable, fast and protected connection of all the instruments to the respective European Research infrastructure but also to the digital resources to be developed in ITINERIS like the VRE and the ITINERIS HUB. This required a large investment in digital devices and infrastructural adaptations, and it is crucial being CNR-IMAA a node of ACTRIS DC and acting in ITINERIS as central node for the provision of the atmospheric data products.

Table 3. Summary of the progress of the purchasing procedures for digital enhancement.

Instrument/ Complementary parts	*Procedure*	*Start date*	*End date*	*Delivered*	Amount (euros)
Server for virtualization environment with GPU	*CONSIP convention*	*March 2023*	*November 2023*	*Yes*	*€ 77.813,13*
Server for virtualization environment	*CONSIP convention*	*March 2023*	*June 2024*	*Yes*	*€ 278.392,37*

ICT Infrastructure: Storage, Networking, Firewall, DDI and backup	*European multi-lot tender*	*March 2023*	*September 2024*	*Yes*	*€ 4.335.430,01*
Data Center in container	*European tender*	*September 2023*	*April 2024*	*No*	*€ 2.455.000,00*
HPC Computing System	*Request for Offer*	*December 2024*	-	*No*	*€ 216.418,16*
Dark Fiber between CNR-IMAA Data Center and ICOS station	*Request for Offer*	*February 2024*	*January 2025*	*Yes*	*€ 138.000,00*

As Table 3 shows, the following equipment have been acquired:

- n. 2 rack server DELL PowerEdge R7525 for virtualization environment with AMD GPU;
- N. 22 rack server DELL PowerEdge R7525 for virtualization environments;
- ICT infrastructure composed by:
    - DELL PowerStore 3200T Fiber Channel full flash storage area network and DELL PowerScale A3000L/H700 Scale-Out Network Attached Storage. DELL Backup Appliance and DELL PowerProtect DD6400;
    - H.A. Firewall Paloalto Network PA-5410, Unified Wireless and Wireless Arista Networks 7050CX3-32S and 720XP-48ZC2. Open source SIEM for network monitoring.
    - IP Fabric EVPM/VxLAN Arista Networks based on 7050CX3-32S, 7050SX3, 7010TX, 7280SR3 and 720DP;
    - Infoblox DNS, DHCP and IPAM (DDI);
    - Veeam Backup and Replication.
- Vertiv Eco Data Center Infrastructure
- HPC computing system based on NVIDIA H100 GPU
- Dark optical fiber interconnection between CNR-IMAA DC and ICOS station, realized with 12 couples of single mode optical fiber with a minimum capacity of 10 Gbps full duplex.

2.3 Infrastructural upgrading enhancement of the CIAO observatory

The enhancement of the observational capabilities of CIAO, included the upgrade of civil infrastructures and related systems (e.g.: platforms, internet and electricity supplying systems, and upgrade of electrical alimentation and distribution system). However, due to some to delays occurred at the beginning of the project that inhibited the start of the procedures for almost 1 year, it was decided to reduce significantly the procedures related to civil infrastructures in the framework of ITINERIS and to carried out them with other resources, in order to guaranty the achievement of the overall enhancement of CIAO observational capability. Still some electrical upgrades and network connections will be performed using ITINERIS cost savings related to the equipment.

2.4 Strengthening of CIAO observatory staff

The strengthening of the CIAO atmospheric observatory also involved the hiring of new staff with specific skills useful for carrying out the WP4 activities. In particular, 8 personnel units were hired on a fixed-term basis: 5 researchers, 2 technologists, 3 technicians (details can be found in Table 4). Furthermore, starting from November 2023, a PhD position has been activated in collaboration with the University of Basilicata (Potenza).

Table 4 - Fixed-term personnel specifically hired at CNR IMAA for the implementation and support of WP4 activities.

n. of positions	*Professional profile*	*Main activities*	*Hiring date*
1	PhD student	Aerosol remote sensing [Salvatore Spinosa - UNINA]	1 January 2023
2	Researcher, level III	Aerosol remote sensing methods and investigations [Benedetto De Rosa – Michail Mytilinaios in WP8 for the first period]	2 May 2023
2	Technician, level VI	Technical support for the CIAO in situ observations and ICT infrastructural systems [Davide Amodio – Michele Volini in wp2 since 2024]	2 May 2023
1	Technologist, level III	Integration and harmonization of WP4 data and digital resource among participating RIs and towards the ITINERIS hub [Claudio Dema]	16 October 2023
1	PhD student	ICOS methods and observations [Isabella Zaccardo – UNIBAS]	1 December 2023
3	Researcher, level III	Aerosol and clouds remote sensing methods and	15 December 2023

		investigations; Aerosol in situ methods and investigations [Ilaria Gandolfi; Teresa Laurita e Rosa Sinisi]	
1	Technologist, level III	Drone observations and machine learning methods for atmospheric investigation [Felice Perciante]	30 October 2024

All the hirings foreseen by the project were carried out within the expected timescales. All the staff hired contributed to the achievement of the WP4 objectives, also disseminating the results obtained (reported in the following subsection).

2.4.1 Dissemination activities

The contribution through the ITINERIS project also saw the hired personnel in the WP4 contributing in the dissemination of ITINERIS main achievements and results through 5 posters in international conference and 1 journal article.
Here is a table reporting the main contribution of the CNR IMAA personnel to the ITINERIS dissemination.

Table 5 - CNR IMAA personnel contribution to the ITINEIRS results dissemination.

Type	*Title*	*Journal*	*Conference/ Event*
Poster	CIAO - CNR-IMAA Atmospheric Observatory: first intensive aerosol remote sensing and in-situ integration campaign		EGU2024
Poster	CIAO - CNR-IMAA Atmospheric Observatory: first in-situ measurements in conjunction with aerosol profiling		ACTRIS Science Conference 2024
Poster	ABLH retrievals using multi sensors approach		31st International Laser Radar Conference (ILRC), 23-28 June 2024, Landshut, Germany
Poster	Latent Heat Flux and TKE measurements from the combined use of Water Vapour		31st International Laser Radar Conference (ILRC), 23-28 June 2024, Landshut, Germany

	Raman with a Wind Doppler Lidars during WaLiNeas Campaign		
Poster	A new ICOS class 1 station at CNR-IMAA: starting the new infrastructure in the hearth of the Mediterranean basin		ICOS Science Conference. 10 - 12 settembre 2024
Journal Article	ICOS Potenza (Italy) Atmospheric Station: A New Spot for the Observation of Greenhouse Gases in the Mediterranean Basin	Atmosphere	
Journal Article	Giant Aerosol Observations with Cloud Radar: Methodology and Effects.	Remote Sensing	
Journal Article	Observations of Saharan Dust Intrusions over Potenza, Southern Italy, During 13 Years of Lidar Measurements: Seasonal Variability of Optical Properties and Radiative Impact.	Remote Sensing	
Journal Article	CIAO observatory main upgrade: building-up an ACTRIS compliant aerosol in-situ laboratory	Atmospheric Measurement Techniques (under review)	

3. CNR IMAA PERFORMANCE INDICATORS MONITORING (PI4.1, PI4.2 AND PI4.3)

3.1 WP4 Performance Indicators

Within the ITINERIS project a series of indicators have been designed for each work package to monitor the scientific activities and the infrastructural enhancements. Those indicators are reported in the Grant Agreement and the aim is to observe the WP performance across the ITINERIS project during the project's bimonthly periodical reporting. Here is a short list of the foreseen Performance Indicators:

- PI 4.1 – Percentage of started purchase procedures [5%, 10%, 30%, 50%,70%,90%, 100%, 100%] method for measurement: decision to contract signed
- PI 4.2 - No. personnel selection procedures initiated [20, 25, 25, 25, 25, 25, 25, 25] method for measurement: call for selection published
- PI 4.3 - Percentage of granted contracts [0%, 5%, 10%, 30%, 60%, 80%, 90%, 100%] method for measurement: contracts signed
- PI 4.4 - No. deliverables released [4, 6, 11, 20, 27, 36, 45, 51] method for measurement: deliverables available through project platform. Measuring progress against performance and result indicators will take place at the timing set by the milestones IOs, for implementation indicators for the ongoing monitoring (PI4.1 – PI4.4). Indicator measurement will pave the way to the overall performance assessment as well as to the introduction of corrective measures in case of significant deviations. Specific indicators are set up as impact indicators for assessing the effectiveness of the overall activities of WP4 in terms of potential impacts even in the long-term.
- PI 4.4b No. of new instruments up and running method for measurement: announcement of the start of the measurement for instrument or set of instruments on ITINERIS website and on social media [Target value at the end of the project 50 (estimated as 5 per each OU on average)]
- PI 4.5 No. of atmospheric datasets provided within ITINERIS method for measurement: number of atmospheric datasets available through ITINERIS resources [Target value at the end of the project 60 (estimated as 5 per each OU on average + 10 for the Pilot services activities ACT4.11-4.16)]
- PI 4.6 No. of scientific publications using atmospheric data and tools produced. Method for measurement: number of papers and conference abstracts with ITINERIS acknowledgements/references [Target value at the end of the project 30 (estimated as roughly 2 contributions as paper or abstract per each activity]. The measuring of impact indicators for the ex-post evaluation (PI 4.4 – PI 4.5) will take place annually. In order to monitor the performance indicators a series of Intermediate Objectives have been planned at WP level.

For the purposes of this deliverable, we will focus on the PI 4.1, 4.2 and 4.3 which are the PIs monitoring the instrumental and personnel integration of the CIAO in situ and remote sensing components.

3.2 Monitoring method

To monitor the status of the WP4 activities within ITINERIS the Performance Indicators were designed to be measured through a series Intermediate Objectives (IO). Each Performance Indicator is expected to achieve a specific value during the reporting period of the Intermediate Objective (e.g.: IO 4.1 is expected to be achieved in Bimester 2 (B2) and PI 4.1 is expected to be at 5%). The list of the Intermediate Objectives and their expected results during the ITINERIS project for the Performance Indicators 4.1, 4.2, and 4.3 can be consulted in Table 6. Differently for what initially drafted in the Intermediate Objective plan, starting from IO 4.6 (expected at B12) the delivery dates of the IO4.6, 4.7 and 4.8, have been modified accordingly to the ITINERIS six months extension. Here is a short summary of the IO shift:

- IO 4.6 shifted from B12 to B16
- IO 4.7 shifted from B14 to B17
- IO 4.8 shifted from B15 to B18

An internal monitoring system has been implemented by the WP4 coordinators to monitor all WP Operating Units Performance Indicators PI 4.1, 4.2 and 4.3. The monitoring system consisted of an Excel sheet where the operating units contact person inserted the status of the purchasing procedure of each instrument or personnel unit. Through this Excel sheet it has been possible to retrieve the procedures status for each operating unit, including those linked to the CIAO enhancement (see table 6). The table shows that CNR IMAA procedures status has been coherent with the planned intermediate objectives. All hiring and purchasing procedures have started and most of them have been contractualized. The current status (at February 2024) is the following: 100% of procedures have started, 92,5% of the procedures' contracts have been signed. This result is perfectly in line with the next intermediate objective (IO 4.6) which is expected by B16 (June 2024).

Table 6 - CNR-IMAA performance indicators and Intermediate Objectives at WP level.

IO number	*Period*	*PI number*	*PI name*	*Expected results*	*Achieved results*
IO4.1	B2 February 2023	PI4.1	Procedures officially started	5%	17%
		PI4.2	Personnel hired	20 initiated procedures at WP level [7 for CNR-IMAA]	7 initiated procedures
		PI4.3	Contracts Signed	0%	2%
IO4.2	B3 April 2023	PI4.1	Procedures officially started	10%	21%
		PI4.2	Personnel hired	25 initiated procedures at WP level [7 for CNR-IMAA]	7 initiated procedures

IO4.3	B7 December 2023	PI4.3	Contracts Signed	5%	2%
		PI4.1	Procedures officially started	30%	42%
		PI4.2	Personnel hired	25 initiated procedures at WP level [7 for CNR-IMAA]	7 initiated procedures
		PI4.3	Contracts Signed	10%	23%
IO4.4	B8 February 2024	PI4.1	Procedures officially started	50%	68%
		PI4.2	Personnel hired	25 initiated procedures at WP level [7 for CNR-IMAA]	7 initiated procedures
		PI4.3	Contracts Signed	30%	27%
IO4.5	B10 June 2024	PI4.1	Procedures officially started	70%	72%
		PI4.2	Personnel hired	25 initiated procedures at WP level [7 for CNR-IMAA]	7 initiated procedures
		PI4.3	Contracts Signed	60%	42%
IO4.6	B16 June 2025	PI4.1	Procedures officially started	90%	100% [at B14]
		PI4.2	Personnel hired	25 initiated procedures at WP level [7 for CNR-IMAA]	7 initiated procedures
		PI4.3	Contracts Signed	80%	92,5% [at B14]
IO4.7	B17 August 2025	PI4.1	Procedures officially started	100%	
		PI4.2	Personnel hired	25 initiated procedures at WP level [7 for CNR-IMAA]	
		PI4.3	Contracts Signed	90%	
IO4.8	B18 October 2025	PI4.1	Procedures officially started	100%	
		PI4.2	Personnel hired	25 initiated procedures	

				at WP level [7 for CNR-IMAA]	
		PI4.3	Contracts Signed	100%	

4. CONCLUSION

Through the upgrade realized during the ITINERIS project, the CNR-IMAA will significantly improve the observational capacity of both in situ and remote sensing components of the CIAO observatory. Part of the instrumental and technical upgrade is already installed and operative. All the new instrumentation will be delivered before the summer 2025 and will be installed before the end of the project. This infrastructural strengthening process will increase the CIAO capacity to attract new users embedding the ITINERIS goal of prioritizing access to the RIs facilities. Furthermore, these improvements will support an harmonized approach for RIs policies and metadata management, tackling the challenge of the different levels of RIs maturity regarding the FAIR compliance and Access management. Finally, the CIAO enhancement will allow CNR IMAA to contribute to the building of the Italian Hub of Research Infrastructures in the environmental scientific domain. The CNR IMAA contribution to the access to data, knowledge and services will support the assessment of current and upcoming environmental challenges at national level.

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