



**D4.1.3: Report on the
implementation at CNR IMAA of
systems for improving NRT data
provision, connectivity, and data
security. [B10]**



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List of acronyms

ACTRIS Aerosol, Cloud and Trace Gases Research Infrastructure

AERONET Aerosol Robotic Network

ARES ACTRIS Data Center for the aerosol profiling

CARS Center for Aerosol Remote Sensing

CIAO CNR-IMAA Atmospheric Observatory

DC Data Center

EARLINET European Aerosol Research Lidar Network

ECMWF European Centre for Medium-Range Weather Forecasts

ERIC European Research Infrastructure Consortium

ESA European Space Agency

GALION GAW Aerosol Lidar Observation Network

GAW Global Atmosphere Watch

GCOS Global Climate Observing System

GRUAN GCOS Reference Upper-Air Network

ICOS Integrated Carbon Observation System

JAXA Japan Aerospace Exploration Agency

NASA National Aeronautics and Space Administration

NDACC Network for the Detection of Atmospheric Composition Change

RI Research Infrastructure

SAMU Service and Access Management Unit

SDS-WAS Sand and Dust Storm Warning Advisory and Assessment System

1. INTRODUCTION

This deliverable is prepared in the context of the ITINERIS project, within the Work Package 4 (WP4) that deals with the integration of Research Infrastructures (RIs) working in the atmospheric domain through synergistic approaches and cross boundaries developments.

This deliverable reports the progress on the acquisition of equipment that will be integrated in the facilities of **CNR IMAA Atmospheric Observatory** (CIAO) and harmonized with the network, in the frame of the Task 4.1.

The aim of the Deliverable is to describe the enhancing of the distributed system for atmospheric data monitoring and provision, and for improving the level of data availability and data stream considered in WP4. This requires a large investment in digital devices and infrastructural adaptations, and it is crucial for CNR-IMAA being a node of ACTRIS Data Center (DC) and acting in ITINERIS as central node for the provision of the atmospheric data products.

One of the main scientific goals is to guarantee a high availability and high-quality level of the services provided by our DC to integrate and harmonize data and methods of different environmental research infrastructure.

The document is structured in four different chapters. Annexes and references are reported at the end of the document.

2. CNR IMAA ATMOSPHERIC OBSERVATORY AND ITS ROLE IN ATMOSPHERIC RIs

CIAO is in Tito Scalo, 6 km far from Potenza, Southern Italy, on the Apennine mountains (40.60N, 15.72E, 760 m a.s.l.) and less than 150 km from the West, South and East coasts (Figure 1).

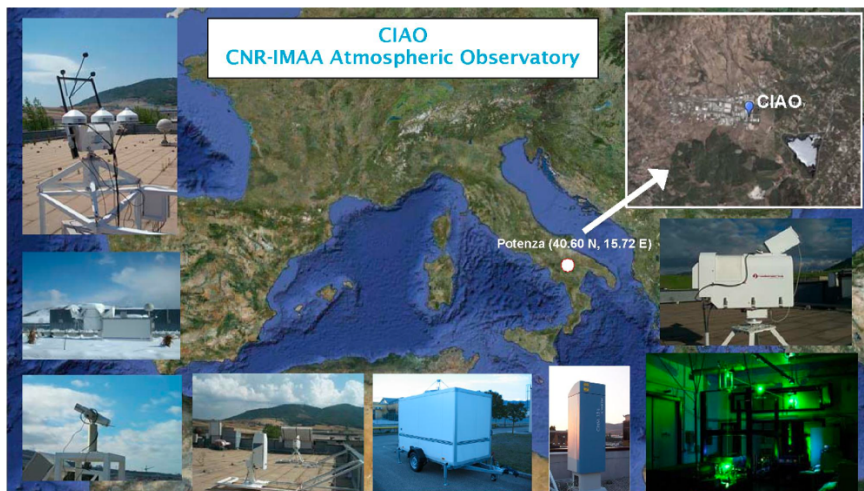


Figure 1: Location of CIAO. Pictures of several active and passive instruments operative at the observatory are also reported (Madonna et al., 2011)

The site is in a plain surrounded by low mountains (<1100 m a.s.l.). The observatory operates in a typical mountain weather strongly influenced by Mediterranean atmospheric circulation, resulting in generally dry, hot summers and cold winters. In this location, phenomena like orographically-induced effects on cloud formation can be studied.

The site is representative of the Mediterranean area and is affected by many Saharan dust intrusions each year (Mona et al., 2006; Biniotoglou et al., 2015; Soupiona et al., 2020). Moreover, the site was reached by volcanic aerosol at the level of free troposphere during the eruptions of Etna (Pappalardo et al., 2004) and Eyjafjallajökull (Mona et al., 2012) volcanos in 2002 and 2010, respectively, and within stratospheric layers (e.g., Sawamura et al., 2012). In recent years, the observatory has become actively involved in the study of smokes originated by wildfires occurring both at short-range, spreading with increased frequency in the surrounding forestry areas during the summer period (De Rosa et al., 2022), and long-range, such as the autumn 2020 California wildfires whose smokes transported in the stratosphere reached the site within 13 days (De Rosa et al., 2021).

CIAO represents one of the largest ground-based remote-sensing station in the Mediterranean Basin, and one of the first atmospheric observatories in Europe. The observatory consists of a combination of advanced systems able to provide high quality long-term observations of aerosol and cloud properties. In fact, since 2000, systematic observations of aerosol, water vapor and clouds have been collected and then the acquisition of active and passive microwave profilers strengthened the equipment required for performing accurate aerosol and cloud observations.

The main scientific objective is the long-term measurement for the climatology of aerosol and cloud properties. The observation strategy is mainly organized to provide quality assured measurements for satellite validation and model evaluation and to fully exploit the synergy and integration of the active and passive sensors for the improvement of the atmospheric profiling.

The main research lines currently active at CIAO include:

- design and implementation of lidar systems for aerosol, water vapor and cloud measurements
- development of algorithms for the integration of lidar and microwave radiometer measurements
- definition of measurement protocols, quality assurance programmes and data managing strategies
- definition of a suitable strategy for the satellite cal/val activities

- analysis of the physical and dynamical processes related to aerosol transport, their modification and classification.
- analysis and physical interpretation of observations provided by both active and passive sensors for the study of aerosol and cloud interactions and nucleation processes.
- organization and participation in measurement campaigns development of methods for the evaluation of aerosol transport and mesoscale weather prediction models networking.

CIAO provides access to data, services and to the research facility for carrying out measurement campaigns and instrument testing (<https://www.atmo-access.eu/observational-platforms/>).

At CIAO, research activity is conducted in cooperation with the main ground-based observation networks (EARLINET, ACTRIS, CloudNet, AERONET, NDACC, GRUAN, GALION), with the main goal of providing long-term observational data relevant for: climate and air quality research, supporting satellite missions (NASA, ESA, JAXA) in cooperation with the modelling community (ECMWF, AeroCom, SDS-WAS etc.). Data quality also matches the protocols developed in the frame of the international networks in which active and passive instruments are operational.

The CIAO infrastructure hosted international satellite validation experiments, it has been involved in several international experiments for the study of aerosols and clouds and their modelling, and it is among the fifteen backbone stations involved in the operations of GRUAN (GCOS Upper-Air Reference Network).

CIAO is an important node of ACTRIS. Within ACTRIS, the CNR IMAA hosts 3 ACTRIS Central Facilities units. IMAA hosts the SAMU (Service and Access Management Unit) in the Head Office of the ACTRIS ERIC, handling the access programme for the entire ACTRIS. IMAA also hosts the unit of the ACTRIS Data Center for the aerosol profiling (ARES) providing access to data to worldwide users, and it hosts a unit of the Center for Aerosol Remote Sensing (CARS) operational at European level.

As observational platform, CIAO already provides measurements and data for aerosol and clouds through remotes sensing observations. Furthermore, thanks to the recent upgrading of the observatory funded by the project PER-ACTRIS-IT - Potenziamento della componente italiana della Infrastruttura di Ricerca Aerosol, Clouds and Trace Gases Research Infrastructure”, COD. PIR01_00015, CUP B17E19000000007 - PON “Ricerca e Innovazione 2014-2020” Notice D.D. n. 424 del 28/02/2018, CIAO is now implementing instruments and methods for the measurement and characterization of aerosol at ground-level, and for trace gases remote sensing (Figure 2).

Finally, CIAO is candidate as ACTRIS Exploratory Platform for aerosol and/or clouds remote sensing measurements with the CIAO Mobile platform.



Figure 2: Picture of some of the measurement systems recently acquired and operational at CIAO

Since 2020, an ICOS atmosphere station of Level 1 is being equipped at CNR-IMAA and its labelling process according to the guidelines provided by the ICOS Atmosphere Thematic Centre (ATC) is officially started in 2023 (Figure 3). As continental ICOS atmospheric site, CIAO is equipped with a tall tower with air sampled at about 10, 50 and 100 m above the ground.



Figure 3: Picture of the Potenza ICOS atmosphere station during the construction phase.

3. UPGRADE OF CNR-IMAA ATMOSPHERIC OBSERVATORY DIGITAL INFRASTRUCTURE

The expected result of WP4 is the enhancement of the provision of atmospheric synergistic products, while also providing the resources to address open issues about atmospheric state, processes and knowledge about related risks and impacts related to it.

To contribute to the achievement of these results, the CNR IMAA will be involved in various strengthening actions to fill various gaps from digital and infrastructural point of view:

digital needs for CIAO and for WP4 as total (ACTRIS remote sensing DC service for ARES component and provision to hub for atmospheric domain).

infrastructural needs for CIAO observatory.

Consistently with what has been previously stated, the observational capability of CIAO observatory will be upgraded.

In fact, within WP4, CNR IMAA will acquire a large variety of instruments aimed at producing specific and integrated data products on identified relevant topics specifically addressed in the three WP4 Pilots (aerosol typing and sources, atmospheric boundary layer height and its impacts at the ground, and forest fires emissions) and at the integration of several RIs. The provided datasets will be a concrete outcome of the WP4 of interest of different communities of users, like air quality authorities, climate change stakeholders, meteorological agencies, solar plants managers, citizens at large and obviously national and international researchers.

Furthermore, since the ITINERIS objective is to be 100% digital, the WP4 digital implementation will benefit from investments that are directly linked with the Virtual Research Environment (VRE) realization in WP8. To this end, the Server for virtualized environmental with GPU and the VEEAM backup solution, have been moved as investments within the WP8 activities.

3.1 Equipment procedures

The purchasing procedures were split over two years (2023 and 2024), according to the project objectives to be achieved.

The purchasing procedure details are listed in the following table (Table 1.)

Table 1: Summary of the purchasing procedures for the acquirement of technological equipment for improving the accessibility to data products. CPV stands for Common Procurement Vocabulary

INSTRUMENT DESCRIPTION	CPV code	Price	PROCEDURE	Activity	Start of procedure	Intermediate state	End of procedure
Server for virtualized environmental	48820000-2	€ 278.392,37	Consip agreement	4.1	B3	Equipment delivered and tested in B10	/
Server for virtualized environmental with GPU	48820000-2	€ 77.813,13	Consip agreement	8.5	B3	/	B6
Storage Area Network (SAN) e Scale-OUT Network Attached Storage (NAS)	30230000-0	€ 1.415.000,00	European tender ICT_1 lot1	4.11	B6	Contract signed in B10	/
Firewall in Alta Affidabilità e sistema per	32420000-3	€ 1.353.00,00	European tender ICT_1 lot3	4.1	B6	Contract signed in B10	/

la gestione e analisi del traffico e degli incidenti di sicurezza							
Estensione dell'infrastruttura di rete EVPN/VXLAN e sistemi di automazione SDN	32420000-3	€ 1.404.000,00	European tender ICT_1 lot4	4.15	B6	Contract signed in B10	/
DNS, DHCP e IPAM (DDI)	48220000-6	€ 49.175,87	European tender ICT_1 lot5	4.15	B6	Contract signed in B9	/
Soluzione di backup VEEAM	48210000-3	€ 99.020,14	European tender ICT_1 lot6	8.5	B6	Contract signed in B9	/
Data Center in container	48820000-2	€ 2.455.000,00	European tender	4.1	B6	Contract signed in B9	/
ICOS optical fiber	32400000-7	€ 150.000,00	MePA RdO	4.1	B8	Offer evaluation in B10	/

4. CONCLUSION

Thanks to the upgrade made available through the ITINERIS project, the CNR-IMAA and CNR-IMAA Atmospheric Observatory (CIAO) will increase the IT efficiency and redundancy.

In particularly the new ECO Data Center will guarantee a very high availability level of all the services provided classified as E3/M4 TIER III (maximum downtime is of 1,6 hours per year), with a highly efficient cooling system that compared to a traditional freecooling systems, it will be able to guarantee an estimated saving of 44% (58 kWh/year), with an IT power of 120 kW. The ECO Data Center will be compliant with “Do No Significant Harm” (DNSH) principle, thanks to an estimated Power Usage Effectiveness (PUE) less than 1.2 as recommended by Climate Neutral Data Centre Pact, supported by the European Commission for Green Deal.

The upgrade of network, computational and storage infrastructure will ensure a high level of reliability and performance in the medium-long term, to be able to support CNR-IMAA research activities. All fiber optical uplink will have a minimum throughput of 200 Gbps with host access interfaces at 25/100 Gbps.

For example, thank to improvement of digital needs, the capability of ACTRIS ARES DC UNIT (hosted at CNR-IMAA) will be significantly upgraded to allow centralized data curation and data processing services for aerosol remote sensing data coming from lidar and photometer observations. Furthermore, the ability to provide dataset from CIAO observation will be a concrete outcome of the WP4.

Finally, the network interconnection, through high speed dark optical fiber, between CNR-IMAA headquarter and CNR-IMAA ICOS continental site will allow remote management of this site and near real time data acquisition.

ANNEX 1 – NEW DATA CENTER RENDERING

