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1. LIST OF ACRONYMS

AAOT: Acqua Alta Oceanographic Tower

ACTRIS: Aerosols, Clouds, and Trace gas Research InfraStructure

ACTRIS-IT: Italian component of the distributed research infrastructure ACTRIS

AERONET: Aerosol Robotic Network

AERONET OC: Aerosol Robotic Network Ocean Component

ARS: Aerosol Remote Sensing

CARS: Centre for Aerosol Remote Sensing

DMP: Data Management Plan

DO: Digital Object

EBV: Essential Biodiversity Variables

ECV: Essential Climate Variables

EOV: Essential Ocean Variables

ESFRI: European Strategy Forum on Research Infrastructures

FAIR: Findable, Accessible, Interoperable and Reusable

FOV: Field Of view

IADC: Italian Arctic Data Centre

IOOS: Italian Integrated Ocean Observing System

LIDAR: LIght Detection And Ranging

NADC: National Antarctic Data Centre

NF: National Facility

OU: Operative Unit

PMT: PhotoMulTipliers

RI: Research Infrastructure

VRE: Virtual Research Environment

WP: Work Package

2. 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 working in the atmospheric domain through synergistic approaches and cross boundaries developments. This deliverable reports the implementation plan of the Task 4.6 activity for the increasing of the integration and harmonization of the ACTRIS National Facilities. The main objective of this task is strengthening the observational capacity of the CNR-ISMAR-RM to characterize atmospheric aerosols through the achievement of two sub- objectives: i) Enhancing the ACTRIS Italian National Research Infrastructure through the development of an Aerosol Remote Sensing facility at the Aqua Alta Oceanographic Tower (AAOT, http://www.ismar.cnr.it/infrastrutture/piattaforma-acqua-alta); ii) Maintaining and improving the Lidar measurement capabilities of the Rome ACTRIS Aerosol Remote Sensing (ARS) National Facilities (NF) with the Italian Network of Environment RIs. In particular, this deliverable is related to the activity of the former sub-objective by defining the specific observational requirements to install an innovative lidar at the Acqua Alta Oceanographic Tower (AAOT) research facility.

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

3. ACQUA ALTA OCEANOGRAPHIC TOWER

The Acqua Alta Oceanographic Tower is one of the main research facilities operated by the National Research Council. This facility, installed in March 1970 about 8 miles off the coast of Venice, in a stretch of sea having a depth of about 16 m (GPS 45.3142467 N, 12.5082483 E), consists of a laboratory module and accommodations, as well as sophisticated distribution facilities, management and real-time data transfer from numerous measurement stations and sensors installed. AAOT is a reference point for research involving marine science and oceanography, water health monitoring, and meteorology. It is also an important fixed point for periodic acquisition of water column samples and analysis of biological and chemical parameters. The measurements acquired continuously by this infrastructure include some of the essential oceanic variables identified by the United Nations.

AAOT contributes to the European research infrastructures DANUBIUS-ESFRI, and JERICO-RI, LTER, EMBRC, as well as the NASA AERONET (Aerosol Robotic Network) monitoring network.

4. SCIENTIFIC OBJECTIVES

Marine aerosol feedback on biogeochemical cycles and the climate remains highly uncertain due to the complex interplay. Earth system models need to incorporate more realistic representations of bio-geochemical feedback processes in response to the changes in air quality and the climate due to human activities. For its location in the Venice Lagoon in the northern Adriatic Sea and the instrumentation installed, AAOT facility constitutes an ideal platform to study marine coastal aerosols (Piazzola et al., 2016), their interactions with anthropogenic pollutants and their effects on coastal urban air quality (Knipping and Dabdub, 2003). LiDAR remote sensing techniques offer a powerful and versatile tool for studying atmospheric aerosols, providing valuable insights into their properties, distribution, and impact on the environment and climate. Therefore, the installation of an off-shore lidar in the northern Adriatic Sea, a geographical region that is not currently covered by ACTRIS-IT stations, constitutes an absolute novelty within ACTRIS and is of great scientific interest in the study of marine aerosols and processes at the air-sea interface. This lidar system, together with the sunphotometer, part of the AERONET-OC network (Zibordi et al. 2009), will enhance the ACTRIS national research infrastructure through the establishment of a potential new ARS NF.

This Lidar system should provide the following measurement profiles:

- aerosol extinction and backscatter at 355 nm
- aerosol depolarization-ratio at 355 nm
- atmospheric water vapor
- marine diffuse attenuation coefficient (K_d) and particulate backscattering coefficient (b_{bp})

This will allow not only the production of ACTRIS compliant aerosol products but also the development of new atmospheric and marine synergetic lidar products for regular monitoring of relevant atmospheric and marine variables as well as for innovative air-sea interaction studies taking full advantage of the existing equipment in the AAOT.

5. IDENTIFIED GAPS AND NEEDS FOR INTEGRATION

The main needs of upgrade and harmonization the human capital of the facility of ISMAR in Rome are directly interconnected with the development of its technical research infrastructure (RI).

As far as the human capital is concerned, this is both integral and crucial for achieving resilience and long-term growth of the RIs. A lot of effort has been dedicated to the process of identifying and selecting qualified and motivated personnel for enhancing human capital formation by way of acquiring and improving the necessary skills to support the sustainability of an innovative harmonized system of research, with the ambition of an integration for a permanent position of such personnel. Indeed, the long-run viability of most pilot activities within ITINERIS is directly associated with much more than just the acquisition of innovative state-of-the-art instruments, but also with their installation, continuous maintenance, and calibration at either fixed or mobile facilities by qualified and experienced personnel.

Regarding the technical infrastructure, the system parameters shall be as much as possible compliant with the latest mandatory ACTRIS requirements for an ARS NF operation, albeit considering the specificity of such synergetic and innovative atmospheric-maritime LIDAR. In order to perform measurements of aerosol extinction, backscatter and depolarization-ratio profiles at 355 nm, the system must have the one-wavelength Raman with polarization discrimination capability by means of the Δ90 technique (+/- 45°) through the use of a motorized calibrator with a resolution equal to or lower than 0.01°. The data acquisition system must be designed so that the acquired profiles throughout the troposphere up to the lower stratosphere have a raw height resolution equal to or lower than 15 m and a time resolution equal to or lower than 60 s.

Moreover, in order to measure the same atmosphere, an automatic sun/sky/lunar photometer should be collocated within a maximum horizontal distance of 1 km. As mentioned, a Cimel sunphotometer is already installed at AAOT. In addition, the LIDAR must have the required features to perform the standard quality assurance procedures for NF operation defined by ACTRIS CARS. Thus, the LIDAR system must have the following features: laser beam alignment using camera images, polarisation calibration, telecover test, dark signal measurement and photodetector eye piece to address the detectors’ sensitivity inhomogeneity (Freudenthaler et al., 2018).

A detailed list of technical requirements for the hereby referred instrument is included in the ANNEX 1 of this document.

6. PROCEDURES FOR THE PERSONNEL

One position for personnel with the profile of Technologist (III level) has been published in the Italian “Gazzetta Ufficiale” and ad hoc CNR website. The call has been published on January 17th 2023 with a deadline on February 16th 2023. The number of applications received was 6. Evaluation committee has been nominated and the selective procedure established a ranking based on qualifications and interview following the CNR rules. The interview was carried out on May 10th 2023. The winner of the selection started on July 17th 2023.

The Technologist works in strict collaboration with the 2 researchers (III level) that are involved in the activity 4.6.

7. EQUIPMENT PROCEDURES

The Operative Unit of Roma organized the purchase procedures at ISMAR level. We planned 1 EU tender procedures. The following Table 1 reports the organization into EU procedures, classified by main CPV and timing details. The procedure will start according to the timeline foreseen in ITINERIS.

Instrument description	CPV code	ISMAR unit	Procedure	Internal Organization for EU-tenders	Activity	Start of procedure	End of procedure
LIDAR for the measurement of the optical properties of sea and atmosphere	38340000-0	ROMA	EU tender	EU n16 lotto1	4.6	B7	B13

Table 1: Procedures for acquisition of equipment. The start and end dates are given in terms of bimesters starting from the beginning of the project.

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ANNEX 1 – ISMAR-CNR ROMA LIDAR REQUIREMENTS

The LIDAR system for CNR-ISMAR-RM must have the following characteristics.

Emission
A Nd:YAG diode pumped solid-state pulsed laser with a linearly polarised emission at 355 nm, minimum pulse energy of 12 mJ, a repetition rate equal to or greater than 20 Hz, divergence of the laser beam emitted by the LIDAR system less than 0.1 mrad (full angle). The laser beam emitted by the LIDAR system must be classified as eye-safe, with a motorized alignment of the laser beam and a motorized control of the zenith angle of the LIDAR head.

Reception
A telescope diameter equal to 200 mm, with a variable and remotely adjustable field of view (FOV), a biaxial or coaxial configuration with a geometric overlap function O(z) equal to or higher than 0.9 below 60 meters and a characterization O(z) for the correction algorithms. The spatial resolution should be equal to or less than 3.75 meters, photomultipliers (PMTs) with a quantum efficiency optimized for the measured wavelengths and with a response time equal to or lower than 3 ns. Moreover, the system should be equipped with an eyepiece for imaging the aperture in front of each receiving channel and a system for calibrating the depolarization channel at 355 nm with the Δ90 technique (+/- 45°) using a motorized calibrator (Belegante et al., 2018).

Configuration of detection channels
The system should have a modular configuration to allow the addition of channels in the future. The initial channel set is as follows: one elastic channel and one cross-polarized elastic channel at 355 nm, one Raman channel at 387 nm and one Raman channel at 407.5 nm for water vapor measurement.

3D scanning range and operating environmental conditions
A manually operated azimuth from 0° to 360° and a zenith from -150° to vertical.
The main container of the instrument and any components external to the main container must be suitable for working in a marine environment, and it must be able to operate with external temperature from -15ºC up to +40ºC and a relative humidity from 0% to 100%.

The system must be designed considering that it will be installed on platforms subject to vibrations. Furthermore, since the system will be installed onto an off-shore platform and it will be powered with renewable energy generated by solar panels, it must be highly efficient with a power consumption lower than 1100 W when operating. An uninterruptible power supply (UPS) must also be installed in order to avoid damage or data loss to filter transients in the electrical current that could cause a sudden shutdown/restart/reset.

Measurement programming and data products
The system must have an integrated industrial computer for data storage, measurement programming and remote control of the instrument, an advanced scheduling software to allow multiple types of measurements (e.g. day/night measurements, weekly measurement, 24/7 measurements, etc.), automatic upload of measurement data and data processing software to perform pre-processing, depolarization calibration and retrieval of aerosols optical properties for regular monitoring of relevant atmospheric and marine variables.