Deliverable D42 (D5.8)

RI-URBANS services to ACTRIS and IAGOS portfolios

RI-URBANS

Research Infrastructures Services Reinforcing Air Quality Monitoring Capacities in European Urban & Industrial AreaS (GA n. 101036245)

By

FMI & UHEL

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Deliverable D42 (D5.8): RI-URBANS services to ACTRIS and IAGOS portfolios

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1. About this document

This Deliverable (D42, D5.8) "*RI-URBANS services to ACTRIS and IAGOS portfolios*" resulted from WP5 on "*Developing a Roadmap for Implementation*". This document reports on the status of service tools (STs) developed within the RI-URBANS project that have been added to the portfolios of the relevant European Research Infrastructures (RIs), ACTRIS (the Aerosol, Clouds and Trace Gases Research Infrastructure; https://actris.eu/) and IAGOS (In-service Aircraft for a Global Observing System; https://www.iagos.org).

This is a public document and will be distributed to all RI-URBANS partners for their use and submitted to the European Commission as an RI-URBANS Deliverable D42 (D5.8). This document can be downloaded at https://riurbans.eu/work-package-5/#deliverables-wp5.

2. Introduction

Both the ACTRIS and IAGOS provide access to a wide variety of high-quality services designed to support a broad range of users and needs, including scientific, technological, and innovation-oriented activities. As RIs, ACTRIS and IAGOS are committed to provision of data and services over the long-term (decadal timeframe and beyond). These services include data management, data curation, documentation, tools for visualisation, tools for quality control and quality assurance, as well as data provision, licensing and attribution. Several of their services are relevant for urban atmospheric observation and research and, within RI-URBANS, have been developed and extended accordingly.

In total 16 advanced service tools (STs) have been developed in the RI-URBANS project for assessing urban air quality (AQ). These STs were co-designed with stakeholders including air quality monitoring networks (AQMNs), the Network of EU AQ National Reference Laboratories (AQUILA), the co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe (unofficially termed 'European Monitoring and Evaluation Programme', EMEP) and Small and Medium-sized Enterprises (SMEs).

The transfer of specific aspects of these STs to the relevant RIs will ensure the continuity of the expertise and knowledge developed in the RI-URBANS project.

2.1 RI services for RI-URBANS

A full list of services provided by ACTRIS and IAGOS for urban sites is given in the RI-URBANS Deliverable D37 (D5.3) "*Service catalog on ACTRIS and IAGOS services for urban sites*".

The report describes which relevant service tools the European RIs ACTRIS and IAGOS have developed which are openly available to be used for urban sites. It includes provision of information about access to data, visualisation tools, and products resulted. A complete overview of the services available is available for ACTRIC (https://www.actris.eu/catalogue-of-services/services) and for IAGOS (https://iagos.aeris-data.fr/catalogue).

2.1.1 Data management

The RI-URBANS project collected data from multiple sources with different measurement characteristics and has been accessed from multiple data repositories, which may have different procedures for data management. The data management plan (DMP) for the RI-URBANS project was developed with guidance from the RI data management teams and is described in the RI-URBANS Deliverable D44 (D5.10) "*RI-URBANS Data management plan (Final)*".

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The DMP describes the management of all data both during the RI-URBANS project, and after the project ends. In particular, the DMP includes information about analysis of data sources relevant for RI-URBANS; the ARGOS platform; summary and links to full data management plan for associated repositories such as: UK-AIR, The Department for Environment, Food and Rural Affairs (DEFRA; http://uk-air.defra.gov.uk), University of Birmingham Research Archive (UBIRA; https://edata.bham.ac.uk), Epidemiological Studies; Cloudnet (https://cloudnet.fmi.fi), ACTRIS/EARLINET (https://data.earlinet.org), EBAS (http://ebas-data.nilu.no), IAGOS (https://www.atmo-access.eu/catalogue), Centre for Environmental Data Analysis (CEDA Archive; https://archive.ceda.ac.uk); and the full data management plan for each of the above mentioned repositories.

2.1.2 Data collection and curation

Through the participation in the Open Research Data Pilot (ORDP), many measurement datasets compiled within the scope of the RI-URBANS project have either been collected by, or been submitted to, and then curated by the ACTRIS and IAGOS Data Centres and been made publicly available. A full report is given in the RI-URBANS Deliverable D45 (D5.11) "*RI-URBANS Open Research Data (final)*".

The report also provides instructions on how to access RI-URBANS data. The curation entails full quality control and quality assurance, for which full documentation is available at the respective Data Centre portals. Adhering to FAIR (Findable, Accessible, Interoperable, and Reusable) principles, the Data Centres also ensure full meta data compliance, ensuring full traceability, publishes datasets with a DOI, and provides licensing and attribution information. Report provides aspects of data curation of the RI-URBANS in-situ data, aerosol remote profiling data and data products, and cloud profiling data, as well as conditions for use of RI-URBANS data, with future perspectives.

2.2 Service Tools

In RI-URBANS, a Service Tool (ST) is a tool that can be used to assess AQ in accordance with the AQ monitoring recommendations provided by RI-URBANS. The recommendations include protocols for measuring advanced AQ parameters, mapping protocols, emission inventories, modelling tools, and suggested epidemiological approaches to evaluate the health effects of new pollutants.

The full list of the RI-URBANS STs is given in Table 1 and documentation for each ST is available through links available on the RI-URBANS website at https://riurbans.eu/project/#service-tools.

A summary booklet describing the STs "*Summary of the Service Tools and Added Value*" is also available: https://riurbans.eu/wp-content/uploads/2025/08/Booklet_AXA_def.pdf (in English) as well as translated in Spanish.

To ensure long-term sustainable access to these STs beyond the project lifetime, relevant aspects of certain STs have been integrated within the service portfolios of the RIs ACTRIS and IAGOS and made openly available to users. Other aspects of certain STs have been integrated with other service providers such as the modelling services provided by the Copernicus Atmosphere Monitoring Service (CAMS).

The STs in Table 1 are grouped into protocols, methodologies and tools. A brief summary of each ST is given in order to identify the relevance for updating, or integrating into, the RI service portfolios.

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Table 1. RI-URBANS Service Tools for optimised urban air quality management

Number	Guidance document topic
Protocols for the measurement of novel AQ pollutants	
ST1	Ultrafine-Particle Number Size Distributions (UFP-PNSD)
ST2	Black Carbon (BC)
ST3	Offline and online particulate matter (PM) speciation
ST4	Oxidative potential of particulate matter (OP of PM)
ST5	Volatile Organic Compounds (VOCs)
ST6	Ammonia (NH_3)
Methodologies for vertical profiles of pollutants and meteorology	
ST7	Measurements of boundary level height
ST8	Measurements of vertical profiles of aerosols
ST9	Measurements of vertical IAGOS vertical profiles by commercial aircrafts
Methodologies for source apportionment receptor modelling	
ST10	Source apportionment techniques for particulate matter
ST11	Source apportionment of eBC, UFP, OP and VOCs
Methodologies for urban mapping of novel air quality pollutants	
ST12	Deterministic urban modelling of fine PM and PNC
ST13	Mapping ultrafine particles and citizen science
Methodologies for evaluating the health effects of novel AQ pollutants	
ST14	Evaluation of health effects of novel air quality parameters
Obtaining emission inventories for novel AQ pollutants	
ST15	First UFP-PNSD and non-exhaust vehicle PM EU emission
Modelling methodologies for novel AQ pollutants	
ST16	UFP-PNSD multiscale modelling

2.2.1 Protocols for the measurement of novel AQ pollutants

STs 1-6 detail the measurement protocols recommended for novel AQ pollutants or specific species:

ST1 highlighted the need for harmonisation of UFP measurements when upscaling the measurement techniques for AQ monitoring networks.

ST2 focuses on upscaling of measurement methods for black carbon (BC) within AQ monitoring networks.

ST3 presents both online and offline methods for Particulate Matter (PM) speciation, while noting that the number of sites making measurements is currently rather limited.

ST4 highlights the complexity of obtaining measurements of oxidative potential (OP) of PM from atmospheric filters (offline method) and states that EU-scale harmonisation is crucial.

ST5 summarises the analytical techniques that are recommended and notes that several instruments are required to cover all 45 Volatile Organic Compounds (VOCs) detailed in the air quality directive.

ST6 notes that there had been no harmonised protocol in Europe for ammonia (NH_3) measurements and that there are a wide variety of instruments (both online and offline methods) employed.

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2.2.2 Methodologies for vertical profiles of pollutants and meteorology

ST7 presents recommendations on how to monitor boundary layer dynamics and the boundary layer depth with remote sensing.

ST8 provides recommendations on how to extend measurements into the vertical using remote sensing in urban environments.

ST9 describes the measurements in the vertical dimension provided by IAGOS with a recommendation to use additional services in tandem also provided by IAGOS, including a visualisation tool developed in the ATMO-ACCESS project: https://www.atmo-access.eu/virtual-access/#/footprint-services and timeseries analyses at different altitudes: https://www.atmo-access.eu/virtual-access/#/.

2.2.3 Methodologies for source apportionment receptor modelling

ST10 and **ST11** describe the procedures for source apportionment using receptor models, using Positive Matrix Factorization (PMF) in particular. It Is recommended that the RIs are the sources of data used as inputs for **ST10** and **ST11** to ensure that the inputs are of sufficient quality and have passed the quality checks.

2.2.4 Methodologies for urban mapping of novel air quality pollutants

ST12 provides guidance for deterministic modelling of atmospheric particle mass and number concentrations at urban scale.

ST13 provides methods for stakeholders for developing fine spatial resolution maps of urban air pollution derived from monitoring methods complimentary to routine monitoring with standard reference equipment at sparse locations and complimentary to deterministic dispersion models.

ST14 presents the guidance for conducting an epidemiological analysis linking novel air quality metrics with health effects.

2.2.5 Obtaining emission inventories for novel AQ pollutants

ST15 provides guidance for the preparation of emission inventories at horizontal resolution of 6 km European-wide and a tool to downscale to 1 km resolution in urban areas (CAMS-REG-UrbEm).

2.2.6 Modelling methodologies for novel AQ pollutants

ST16 concerns multi-scale modelling of ultrafine particles (UFP, equivalent to nanoparticles or particles <100 nm) and their particle number size distribution (PNSD), together termed UFP-PNSD. One of the inputs that ST16 requires is the primary UFP-PNSD emission inventories provided by **ST15**.

2.3 Potential for integration with RI services

The 16 Service Tools (STs) created in RI-URBANS differ in their level of complexity, maturity, intended user community, and dependency on established Research Infrastructures (RIs). Their potential for integration with ACTRIS and IAGOS services can therefore be grouped as follows:

STs 1–6: Measurement protocols

These STs define harmonised measurement procedures for emerging air-quality (AQ) pollutants (e.g. Ultrafine particles, black carbon, VOCs, ammonia, oxidative potential (OP)) and advanced off-line and on-line particulate-matter speciatio. Overall, they are directly aligned with the long-term observation mandates of ACTRIS and IAGOS. However, only a subset of them is currently incorporated within ACTRIS or IAGOS observations.

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Opportunities: UFP, BC, VOC and on-line chemical measurements are already implemented in ACTRIS aerosol- and trace gas in-situ observation sites. The data management and near-real-time data delivery is being piloted and experimented with all of these AQ parameters.

Barriers: Ammonia, OP and off-line chemical composition are not part of current ACTRIS variables. EMEP can provide facilities for ammonia and off-line chemical composition measurements. Discussions within the ACTRIS community is on-going related to expanding the ACTRIS observations to include e.g. OP is on-going. However, the timeline towards implementation can be long due to extended time needed for financial and technical planning related to required calibration facilities and financial considerations. Pathways to include novel variables is currently being planned in forthcoming infrastructure development projects. We also need to keep in mind that in ACTRIS, the final decisions on the measurements and associated calibration structures is agreed on the General Assembly level, where the ACTRIS Member States make the strategic decisions related to infrastructure upgrades and major changes.

General barrier: Limited number of urban observation sites within the ACTRIS supersites. Co-location of ACTRIS observation sites with air quality supersites (urban background or rural background sites) can expand the measurement representation.

STs 7–9: Vertical-profile methodologies

These STs provide methods and processing software for boundary-layer and vertical profile observations using remote sensing and aircraft-based measurements.

Opportunities: The processing and quality-control software is open-source and interoperable with ACTRIS's and IAGOS's existing systems. ACTRIS has begun incorporating these tools in its catalogue for urban applications, while IAGOS complements them with its regular aircraft profiling. This guarantees that urban vertical-profile data streams can continue to be generated and visualised within the RI structures.

Barriers: Limited number of urban observation sites within the ACTRIS supersites, however, STs 7 and 8 can be applied to individual instruments independent of ACTRIS as long as ACTRIS procedures are applied. Co-location of ACTRIS observation sites with air quality supersites (urban background or rural background sites) can also expand the measurement representation. Limited number of cities where vertical profiling is done with IAGOS fleet.

STs 10–11: Source apportionment (SA)

These STs are designed to implemented by the stakeholders themselves and tailored to their specific needs. It has been successfully demonstrated that the source apportionment (SA) STs can be run in near-real-time (NRT) in the pilot phase as described in the RI-URBANS Deliverable D5 (D1.5) "*NRT Source Apportionment Service Tools for submicron carbonaceous matter (final)*". This report summarizes the work performed regarding the development, establishment and implementation of the advanced NRT SA service tools for fine carbonaceous aerosols based on best procedures and methodologies to apportion novel health-related AQ metrics.

The Deliverable D24 (D4.3) "*Summary: source apportionment pilots, sustainability and associated benefits*" describes the pilot phase, summary of main findings, and recommendations, and next steps and future upscaling potential of NRT-SA tools. The pilot on NRT-SA of carbonaceous aerosols employs the SA tool for the aerosol chemical speciation monitor (ACSM; organics, sulphate, nitrate, ammonium and chloride) and multi-wavelength aethalometer (AE, Black Carbon) data. Expected outputs include contributions of primary sources such as traffic, wood burning, and cooking (depending on measurement site), quantification of the secondary organic aerosols (SOA) fraction, automatic transfer of data (organic aerosols matrices and aethalometer BC concentrations) to ACTRIS Data Centres. It was concluded in that further development would be necessary for these SA's STs to be

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included in the RI service portfolios. Therefore, these tools have not yet been transferred to the RI service portfolios. However, their inputs are typically datasets provided by the ACTRIS and IAGOS RIs.

STs 12–16: Urban mapping, emission inventories and multi-scale modelling

STs 12-16 are designed to be implemented by the stakeholders by themselves and tailored to their specific needs. As such, these tools have not been transferred to the RI service portfolios. However, their inputs may be derived from datasets provided by the ACTRIS and IAGOS RIs.

Opportunities: Urban mapping around AQ supersites allow novel insights into the representativeness of the measurements. ACTRIS can contribute to harmonization of the UFP and BC measurements with mobile platforms, which are exploratory platforms in ACTRIS terminology.

Barriers: The expertise for modelling is in the modelling research groups, not within RIs.

3. Updates to RI services from RI-URBANS

In this section we summarise the updates – general ones, for protocols, and for methodologies - made to the RI service portfolios for the relevant STs:

3.1 General updates

The following updates are applicable for all RI-URBANS STs:

- Data management: the relevant portions of the RI-URBANS DMP has been incorporated within the DMPs of the ACTRIS and IAGOS;
- Access to data;
- Access to guidelines, training and documentation for each ST;
- Updates to RI vocabulary to capture new measurement parameters, new instrument types, and new measurement protocols associated with each ST.

3.2 Specific updates for protocols (STs 1-6)

- Documenting common standard operating procedures and data reporting procedures;
- Providing new or updated data submission tools and templates, and ensuring the inclusion of all relevant metadata with data submission;
- Extending the RI data quality control and quality assurance processes to encompass the new measured species and measurement procedures, and ensuring that these adhere to the protocols.

3.3 Specific updates for methodologies (STs 7-8)

The processing software and quality control procedures applied within ACTRIS for the remote sensing methodologies developed in STs 7-8 are open source and documented and can be applied to datasets acquired from similar instruments in urban locations that are not ACTRIS stations. Applications to ACTRIS to host these independent datasets can be made via the ACTRIS Homeless Data Portal.

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4. Sustainability

The work on service tools in RI-URBANS is closely connected to the European Research Infrastructures (RIs) ACTRIS and IAGOS that will establish a durable mechanism for retaining the knowledge, experience, and tools gained in RI-URBANS well beyond the project's lifetime. This integration ensures that the scientific and technical advances achieved—covering measurement protocols, vertical-profile methodologies, data-management practices and quality-control procedures—will continue to support European and global air-quality monitoring and research.

A key element of this long-term impact is harmonisation of measurement standards. By working closely with European Air Quality Monitoring Networks (AQMNs), ACTRIS and IAGOS need to maintain and expand harmonised operating procedures and metadata standards. This will enhance the usability, comparability and robustness of air-quality observations across Europe, facilitating coherent urban air-quality assessments and policy actions.

Open and sustained access is equally critical. ACTRIS has committed to hosting the RI-URBANS Service Tools (STs), together with all associated documentation, guidelines and training materials, on its official website as part of its service catalogue. This guarantees that urban air-quality stakeholders, from local monitoring networks to international research communities, will retain free and open access to the tools, including updates and user support resources.

In addition, long-term data stewardship will be assured. As formal European RIs, ACTRIS and IAGOS provide persistent data curation and archiving of all relevant datasets and metadata in line with the FAIR (Findable, Accessible, Interoperable and Reusable) principles. This includes comprehensive traceability of data provenance, full attribution of contributions, and assignment of persistent identifiers such as DOIs.

By combining these elements—permanent online availability of the STs and training materials, harmonised operational standards, and FAIR-compliant data curation—ACTRIS and IAGOS will secure the continuity and future growth of the RI-URBANS legacy. This ensures that the project's innovations remain embedded in the European air-quality infrastructure and continue to deliver scientific, technological and societal benefits well into the next decades.

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