

Deliverable D45 (D5.11)

RI-URBANS Open Research Data (final)



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

By

NILU, FMI & CNR-IMAA



26 March 2025

Deliverable D45 (D5.11): Open Research Data (final)

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Table of Contents

TABLE OF CONTENTS	1
1. ABOUT THIS DOCUMENT	1
2. INTRODUCTION	1
3. DATA CURATION OF RI-URBANS IN-SITU DATA	3
3.1 ACCESSING IN-SITU RI-URBANS DATA FROM EBAS.....	3
3.2 OVERVIEW OF IN-SITU DATA SUBMITTED TO RI-URBANS	7
3.3 OVERVIEW OF THE USE OF IN-SITU DATA FROM RI-URBANS.....	8
4. DATA CURATION OF AEROSOL REMOTE PROFILING DATA AND DATA PRODUCTS FROM ARES	9
4.1 ADVANCEMENT IN ARES DATA PRODUCTS OF INTEREST FOR RI-URBANS	9
4.2 DATA CURATION FOR AEROSOL REMOTE PROFILING DATA	10
4.3 ACCESSING RI-URBANS AEROSOL PROFILING DATA FROM ARES.....	11
5. DATA CURATION FOR RI-URBANS CLOUD PROFILING DATA	13
5.1 DATA SUBMISSION.....	13
5.2 ACCESSING RI-URBANS CLOUD PROFILING DATA FROM CLU.....	13
5.3 OVERVIEW OF RI-URBANS CLOUD PROFILING DATA.....	14
6. THE CONDITIONS OF USE OF RI-URBANS DATA	16
7. SUMMARY AND FUTURE PERSPECTIVES	16

1. About this document

RI-URBANS participates in the Open Research Data Pilot (ORDP), and this report presents the status of measurement datasets submitted and made available to users, in accordance with the expectations outlined in the project plan. It documents the various datasets compiled during the first 42 months of RI-URBANS, along with details on their accessibility. This is the final report on data curation within RI-URBANS, following the preliminary report submitted in month 24: *D36 (D5.2) Open Research Data (Preliminary)*.

In total, approximately 5,000 datasets have been ingested into the databases, covering ca 150 different variables from 125 sites across 13 countries. All these datasets are available to users, as detailed in this report.

This document provides: 1) An overview of general data management within RI-URBANS. 2) Instructions on how to access RI-URBANS data. 3) The status of data submissions.

RI-URBANS data have been submitted to three data units within the ACTRIS Data Centre (DC):

- In Situ: Aerosol and trace gas in situ data, submitted to the data repository EBAS (<https://ebas.nilu.no>), hosted at NILU in Norway.
- ARES: Aerosol profiling data, submitted to the data repository EARLINET (<https://data.earlinet.org>), hosted at CNR in Italy.
- CLU: Cloud remote sensing data, submitted to the data repository Cloudnet (<https://cloudnet.fmi.fi>), hosted at FMI in Finland.

This document also describes how to access data stored in these repositories, including access through the ACTRIS Data Discovery, Virtual Access, and Services (DVAS) platform (<https://data.actris.eu/>).

Additionally, it provides information on datasets used in large-scale surveys and publications, which have been made available through Zenodo:

- BC: <https://zenodo.org/records/7982201>
- ACSM: <https://zenodo.org/records/6672710>
- As well as the RI-URBANS website (<https://riurbans.eu/results/#open-data>)

It is important to note that, although this is the final report on the status of RI-URBANS data availability, data submissions to open databases will continue until the project's completion and beyond.

This is a public document intended for distribution to all RI-URBANS partners and will be submitted to the European Commission as deliverable D45 (D5.11). The document is available for download at: <https://riurbans.eu/work-package-5/#deliverables-wp5>.

2. Introduction

The RI-URBANS project collects data from several sources, covering observational data on various compounds, such as nanoparticles and atmospheric particulate matter, their sizes, constituents, and gaseous precursors at ground level and in height profiles. The overall goal of data production within RI-URBANS is to ensure the harmonized

management of urban air quality data across Europe by leveraging established service tools from atmospheric Research Infrastructures (RIs). RI-URBANS aims to create a lasting connection between RIs and urban air quality networks, as well as to build capacity for [FAIR](#) data management in urban air quality (AQ) networks. This is crucial for ensuring traceable, comparable, and harmonized data across urban and regional scales.

At the beginning of the project, a Data Management Plan (DMP) was developed to describe the planned data flow, repositories, and data management routines for the data produced and collected in this project (*Deliverable D35 (D5.1: Data Management Plan (Preliminary))*). The DMP was updated midway through the project (*Deliverable D43 (D5.9): RI-URBANS Data Management Plan (Update)*), and the final version is published alongside this deliverable as *Deliverable D45 (D5.11): RI-URBANS Data Management Plan (Final)*.

The DMP provides data curation recommendations for all data generated within the project. Depending on the type of data, RI-URBANS data management involves all units of the ACTRIS DC, as well as data centres dealing with aircraft measurements, epidemiological studies, and national UK data. Throughout the project, data from all these resources have been used, but the datasets specifically collected and produced for RI-URBANS have been submitted to the ACTRIS DC and are the ones described in this report.

RI-URBANS has implemented five pilot studies in nine selected European cities to test and demonstrate different services. These cities include Athens, Barcelona, Birmingham, Bucharest, Helsinki, Milan-Bologna, Paris, Rotterdam-Amsterdam, and Zurich. Both near real-time (NRT) and regular annual data were expected from these pilot cities, though the type of data varies between them. These pilot studies were conducted as part of WP4 (*Pilot Implementations for Testing and Demonstrating Services*).

Additionally, within WP1 (*Novel Air Quality Metrics and Advanced Source Apportionment Service Tools for Particulate Matter and Nanoparticles*), data from a large number of existing urban air quality supersites were collected from National Air Quality Management Systems (AQMS). The work in WP4 (pilots) and the service tools developed in WP1 have both provided important input for scaling up data deliveries by offering strategic guidance and tools for expanding data services beyond RI-URBANS (WP5), as illustrated in Figure 1.

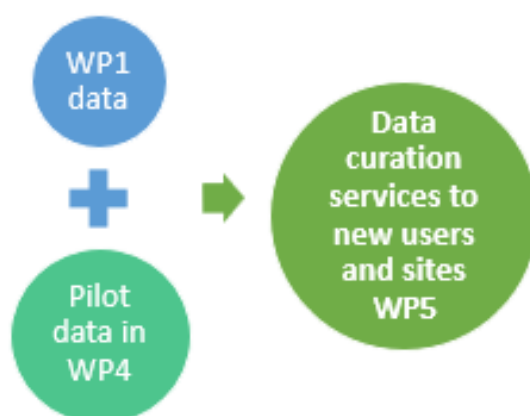


Figure 1. Measurement data production within RI-URBANS.

In late 2022, RI-URBANS WP5 held a [workshop](#) dedicated to implementing the project’s DMP by building capacity among data providers and training them in data reporting routines. While a data manager determines which information needs to be archived as metadata, the data provider holds the actual content to be archived. Thus,

capacity building for data providers is a key component of any data management strategy, ensuring that data are FAIR with the necessary traceability and documentation.

The workshop featured several presentations and tools to assist data providers with data submission. [An introduction video](#) on how to submit data was also developed.

The ATMO-ACCESS H2020 project has provided a highly valuable opportunity to simplify campaign data submissions. This has been particularly beneficial for data providers who are unfamiliar with data submission procedures. The [homeless data portal](#) was established to manage airborne observations as well as ground-based remote and in-situ data. A significant amount of relevant RI-URBANS data has been submitted using this service.

3. Data curation of RI-URBANS in-situ data

Submission of in-situ aerosol and trace gas measurements to EBAS follows standardized procedures outlined in the [Submission Manual](#) to ensure high-quality data with rich metadata. The manual provides guidance on the submission process, including file format specifications, metadata templates, and quality control flags used during data reporting. Additionally, tools are available to assist with submission and final quality control.

RI-URBANS has contributed a significant number of new sites to EBAS. In collaboration with data providers, the DC has defined these sites and their required metadata. Furthermore, new instrument types, instrument models, and analytical instrumentation have been incorporated into the database to ensure accurate documentation of submitted observations.

3.1 Accessing in-situ RI-URBANS data from EBAS

There are several access points for data that are curated in EBAS:

- EBAS Web Portal (<https://ebas-data.nilu.no>): This portal allows users to search, visualize data in online plots, and download datasets. RI-URBANS measurement data are categorized into two frameworks:
 - RI-URBANS – Quality-assured data submitted under standardized reporting guidelines.
 - RI-URBANS_NRT – Near real-time data following an automatic but limited quality control protocol.

Data meeting ACTRIS requirements are also associated with that framework. Some datasets are further linked to EMEP due to collaboration between EMEP, ACTRIS, and RI-URBANS during intensive VOC measurement campaigns in 2022 and September 2024. Data submitted via the ATMO-ACCESS Homeless Data Portal are also associated with that framework.

As shown in Figure 2, a substantial number of data series from RI-URBANS project are available in EBAS, in March 2025 there were in total 5000 datasets. This is data series from 13 countries, 123 stations, 22 different types of instruments, 142 different components.

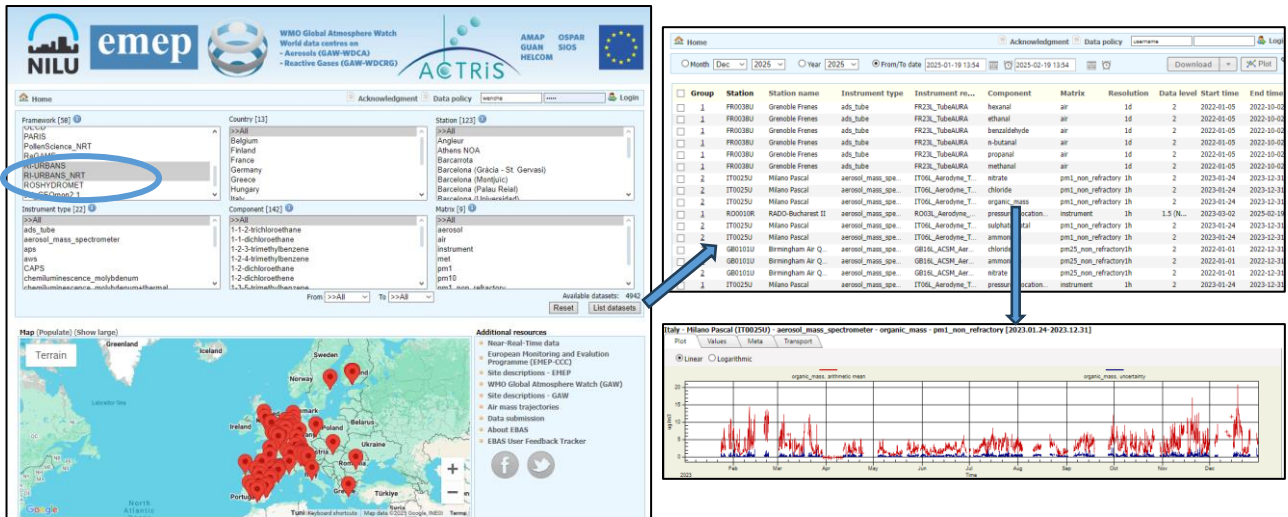


Figure 2. Snapshot from EBAS web portal (<https://ebas-data.nilu.no>) illustrating data associated with the frameworks RI-URBANS and RI-URBANS_NRT, accessed 19 February 2025.

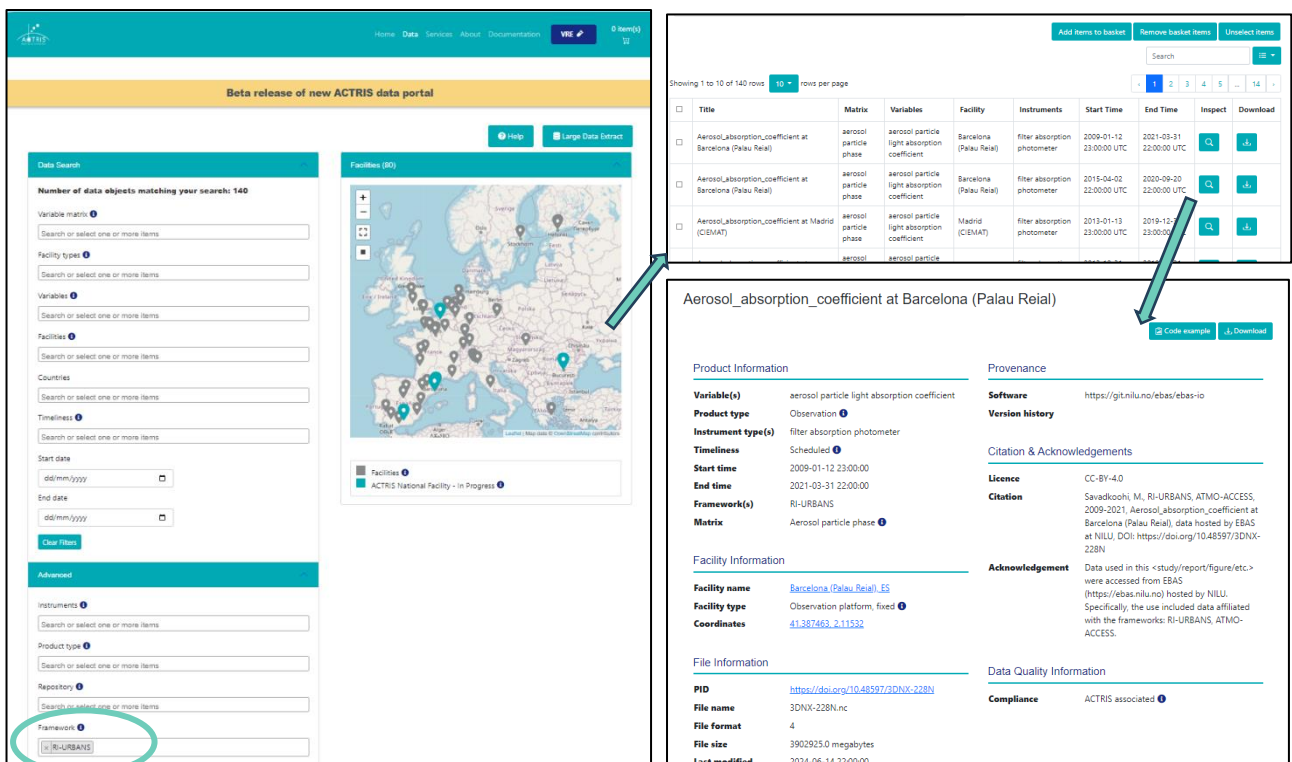


Figure 3. Snapshot from ACTRIS DC web portal (<https://data.actris.eu/search>) illustrating data associated with the framework RI-URBANS, accessed 19 February 2025.

- ACTRIS data centre web portal (<https://actris.nilu.no>): Provides access to both in-situ and remote sensing data. Figure 3. To access, analyse and work with the data, one may use the ACTRIS Virtual Research Environment (VRE). Details in how to use this tool can be found here: <https://data.actris.eu/vre>.

- **EBAS Near real time data service** (<https://ebas-nrt.nilu.no>): An interactive interface displaying data from the last month. Useful for monitoring ongoing episodes and verifying instrument performance. If a data stream ceases for over a month, it is removed from the showcase but remains available via the main EBAS web portal. An example of timeseries from one site is shown in Figure 4.
- **THREDDS Data Server** (<https://thredds.nilu.no/thredds/catalog.html>). Offers catalog, metadata, and data access services for scientific datasets from EBAS including Near Real-Time Data. Supports protocols such as OPeNDAP (file streaming) and HTTPServer (direct download), making it ideal for routine access to large datasets. The recommended search method is via the ACTRIS Metadata REST API (<https://prod-actris-md2.nilu.no/index.html>).
- **DOI landing page.** Each dataset in EBAS is assigned a DOI with a corresponding landing page, allowing users to download data in netCDF format. An example page is shown in Figure 5.
- **The RI-URBANS web page** (<https://riurbans.eu/results/#open-data>): Provides an overview of reported RI-URBANS data and links for access. The page is regularly updated (Figure 6).
- **ZENODO:**
 - BC: <https://zenodo.org/records/7982201>
 - ACSM: <https://zenodo.org/records/6672710>

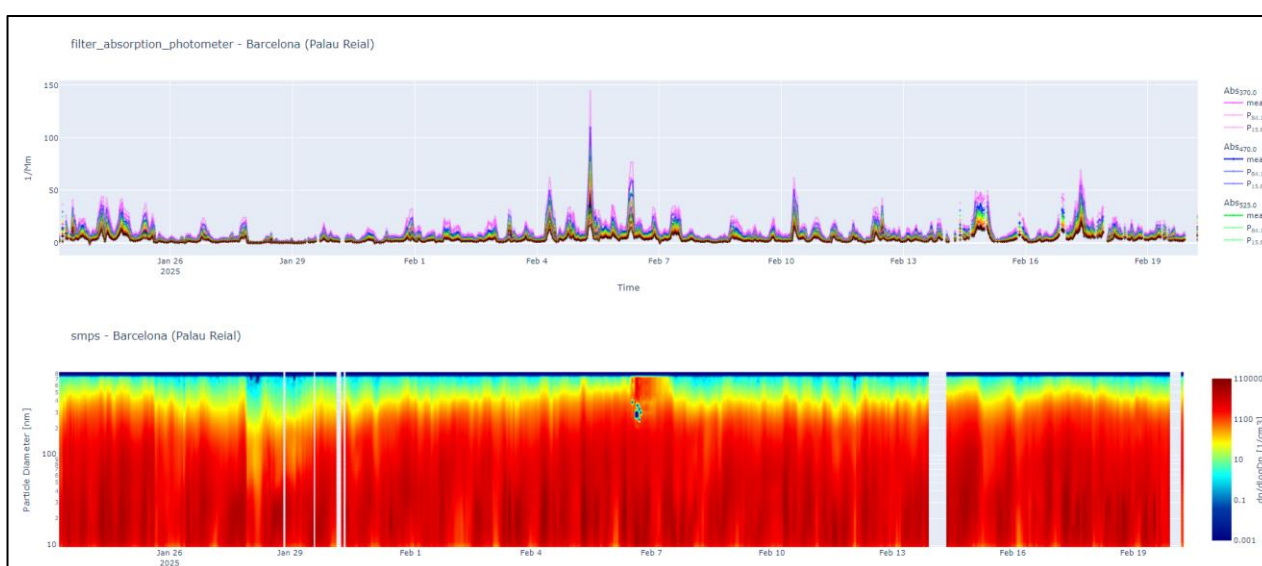


Figure 4. Snapshot from EBAS Near Real time data web portal (<https://ebas-nrt.nilu.no>) with a showcase of NRT data of absorption measurement at Barcelona (Palau Reial) data associated with the frameworks RI-URBANS_NRT, from 20 February 2025

Aerosol_absorption_coefficient at Barcelona (Palau Reial) Download

13 January 2009 - 1 April 2021

Summary | Data coverage

Product information

Variable(s) aerosol_absorption_coefficient

Product type [Observation](#)

Instrument type(s) Filter Absorption Photometer

Timeliness [Scheduled](#)

Start time 13 January 2009

Stop time 1 April 2021

Framework RI-URBANS, ATMO-ACCESS

Instrument model(s) Thermo/5012

Facility information

Facility name Barcelona (Palau Reial) (E50019U)

Facility type [Observation platform, fixed](#)

Coordinates [41.387463°N, 2.11532°E](#)

Altitude 80.0 m

File information

PID <https://doi.org/10.48597/3DNX-228N>

Filename 3DNX-228N.nc

Format(s) HDF5 (NetCDF4)

Filesize 3.9 MB

Version v1

Last modified 28 June 2023 09:05:49

Data Access [OPENDAP](#)
[DAP4](#)
[HTTPServer](#)

Metadata access [NCML](#)
[UDDC](#)
[etc.](#)

Citation & acknowledgements

Licence [CC BY 4.0](#)

Citation string Savadkoobi, M. RI-URBANS, ATMO-ACCESS, 2009-2021, Aerosol_absorption_coefficient at Barcelona (Palau Reial), data hosted by EBAS at NILU, DOI: <https://doi.org/10.48597/3DNX-228N>

Please include the following information in your publication. You may edit the text to suit publication standards.

Acknowledgements Data used in this <study/report/figure/etc.> were accessed from EBAS (<https://ebas.nilu.no>) hosted by NILU. Specifically, the use included data affiliated with the framework: RI-URBANS, ATMO-ACCESS

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Figure 5. Example of a landing page for DOI showing aerosol absorption data from Barcelona (Palau Reial) including downloading and siting information.

[PROJECT](#) [RESULTS](#) [NEWS & EVENTS](#) [PARTNERS](#) [OUTREACH](#) [CONTACT US](#) [INTRANET](#) [in](#) [Q](#)

Table 1 – quality-controlled data sets

The total number of sites given in parentheses includes those relevant sites that have been reported to other frameworks and those sites expected to be in EBAS soon. It does not include NRT data.

Note that the number of sites and datasets is continuously changing, current information is representative for end of May 2024.

IMPORTANT
The first time you follow the link to the EBAS page, a general disclaimer will appear. Please accept it and follow the link again to visit the pollutant info.

Variable	Instruments	#NRT sites	#sites	# data sets (level 2)	Link to dataset (level 2)
Aerosol absorption coefficient (also used for estimating eBC)	Filter absorption photometers (MAAP, AE33, AE31)	8.0	45.0	223.0	EBAS
particle number size distribution (PNSD)	DMPS, SMPS, CPC, APS	6.0	17.0	2082.0	EBAS
VOC data (111 number of different gas components)	Adsorption, tube, PTR-MS, online-GC, steel canister	-	23.0	1074.0	EBAS
NH ₃	Online absorption, CRDS, online IC, chemiluminescence, passive sampler	-	58.0	62.0	EBAS
Aerosol chemical composition (NH ₄ , SO ₄ , NO ₃ , organic mass)	Aerosol mass spectrometer (ACSM)	2.0	2.0	21.0	EBAS
NO, NO ₂	CAPS, chemiluminescence	-	1.0	8.0	EBAS
SO ₂	UV- fluorescence	-	1.0	4.0	EBAS
Elemental and organic carbon (EC/OC)	High volume sampler	-	1.0	18.0	EBAS
eBC	-	53.0	53.0	-	ZENODO
Non-refractory PM	ACSM	22.0	22.0	-	ZENODO

Figure 6. Snapshot from RI-URBANS open data web portal (<https://riurbans.eu/results/#open-data>) illustrating data, accessed 19 March 2025.

3.2 Overview of in-situ data submitted to RI-URBANS

This section provides an overview of RI-URBANS ground-based in-situ data submitted to the ACTRIS data centre (EBAS repository) by mid-February 2025. Additionally, it includes links to publicly accessible compiled datasets. The section describes the compiled data and lists the cities/sites and periods for each pollutant: ultrafine particles (UFP)–particle number size distribution (PNSD), equivalent black carbon (eBC) derived from absorption coefficients, ammonia (NH₃), volatile organic compounds (VOCs), and aerosol chemistry.

Data submission in RI-URBANS follows three different pathways:

- **WP1 Data Compilation:** A major dataset compilation from existing AQ supersites was conducted ([Deliverable.1.1](#)). These datasets were made available on the RI-URBANS intranet, and some were compiled in secondary repositories (e.g., Zenodo). Most of these data were centrally submitted to EBAS rather than by data owners, unless previously submitted to programs such as EMEP, ACTRIS, or GUAN. Aerosol data (PNSD, aerosol absorption coefficients (eBC)) was compiled and reported by IDEA-E-CSIC, while VOCs and NH₃ data were handled by IMT-Nord. ATMO-ACCESS homeless portal was used for part of this submission.
- **Annual Submissions:** RI-URBANS partners submitted data through established ACTRIS guidelines or via the ATMO-ACCESS homeless portal.
- **NRT Data Submission (WP4 Pilot Studies):** Five pilot studies were conducted in nine cities (Athens, Barcelona, Birmingham, Bucharest, Helsinki, Milan-Bologna (Po Valley), Paris, Rotterdam-Amsterdam, and Zurich), focusing on various processes.

Figure 7 and Table 1 provides an overview of the ground-based in-situ datasets submitted under RI-URBANS. Note that relevant urban data have also been submitted to other frameworks such as ACTRIS, EMEP, and GUAN and they do not appear in the tables and figures below if not also tagged with RI-URBANS.

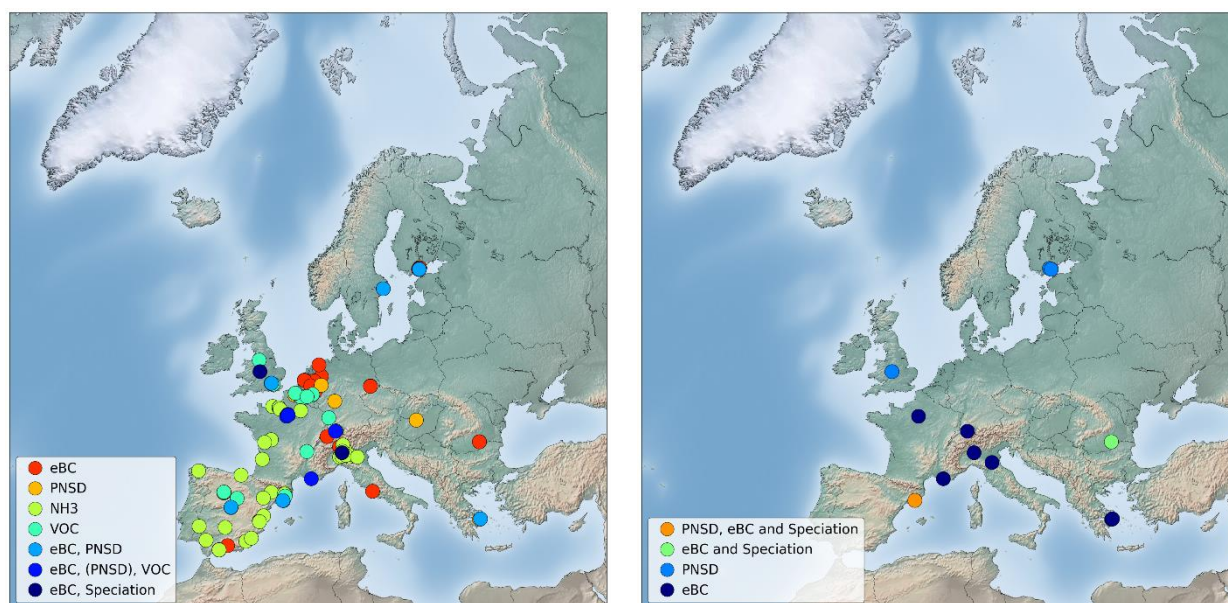


Figure 7. Geographical distribution of sites which have reported level 2 (left) and NRT data (right).

Table 1. Summary of RI-URBANS data available in EBAS (mid-February 2025), including links to quality-controlled datasets (excluding NRT data).

Variable	Instruments	#sites NRT	#sites level 2	# data sets level 2	Link to dataset level 2
Aerosol absorption coefficient (eBC)	Filter absorption photometers (MAAP, AE33, AE31)	9	45	223	EBAS
particle number size distribution (PNSD) and ultrafine particle concentration (UFP)	SMPS, DMPS, APS, CPC	7	16	1923	EBAS
VOC data (112 number of different gas components)	Adsorption, tube, PTR-MS, online-GC, steel canister	-	23	1078	EBAS
NH ₃	Online absorption, CRDS, online IC, chemiluminescence, passive sampler	-	60	65	EBAS
Aerosol chemical composition (NH ₄ , SO ₄ , NO ₃ , organic mass)	Aerosol mass spectrometer (ACSM)	2	2	21	EBAS
NO, NO ₂	CAPS, chemiluminescence-Mo	-	1	8	EBAS
Elemental and organic carbon (EC/OC)	High volume sampler	-	1	18	EBAS
SO ₂	UV- fluorescence	-	1	4	EBAS

Since the NRT data repository is changing from day to day separate links to the different sites are not provided, but a general link to the NRT data is found here: [RI-URBANS NRT-EBAS](#).

Detailed metadata information, including methods and sampling durations, is available in the associated data files. Generally, the measurements of aerosols using various types of monitors and for the level 2 data that are available in the web interface these data are aggregated to hourly resolution, while VOCs and NH₃ data depend on the methodology (e.g., manual VOC grab sampling twice per week or weekly passive NH₃ samplers).

A large fraction of the data compiled in WP1 is also openly available in secondary repositories:

- **Absorption Measurements & eBC Data:** Hourly concentrations from 50 sites: *Savadkoohi, Marjan, & Pandolfi, Marco. (2023). The variability of mass concentrations and source apportionment analysis of equivalent black carbon across urban Europe [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.7982201>*
- **Online PM Chemical Composition Data:** Hourly concentrations of sulfate, nitrate, chloride, ammonium, and organic aerosol from a larger number of sites are compiled in a secondary repository: *Chen, Gang. (2022). European Aerosol Phenomenology - 8: Harmonised Source Apportionment of Organic Aerosol using 22 Year-long ACSM/AMS Datasets [Data set]. In Environment International (Version 2nd, Vol. 166, p. 107325). Zenodo. <https://doi.org/10.5281/zenodo.6672710>*

3.3 Overview of the use of in-situ data from RI-URBANS

The RI-URBANS in-situ data are extensively used. Figure 8 illustrates the access requests for RI-URBANS data, with approximately 35 000 variable years accessed. A variable year is defined as one year's worth of data for one variable. The statistics represent the sum of variable years downloaded, displayed, or plotted over the last two years (2023-January 2025) While data are downloaded across Europe, there is also significant interest from

countries on other continents. While data are downloaded across Europe, there is also significant interest from countries on other continents.

VOCs account for most downloaded datasets. This is because VOCs include multiple components, resulting in a larger number of datasets per instrument. When analysing downloads by unique IP addresses, the most accessed data types are particle number size distribution (PNSD) followed by absorption data (eBC). It is important to note that the number of unique IP addresses does not directly correspond to the number of individual users. Many institutes, universities, and organizations use a single public IP address for all outbound traffic. As a result, multiple users within the same institution may appear as a single unique IP address.

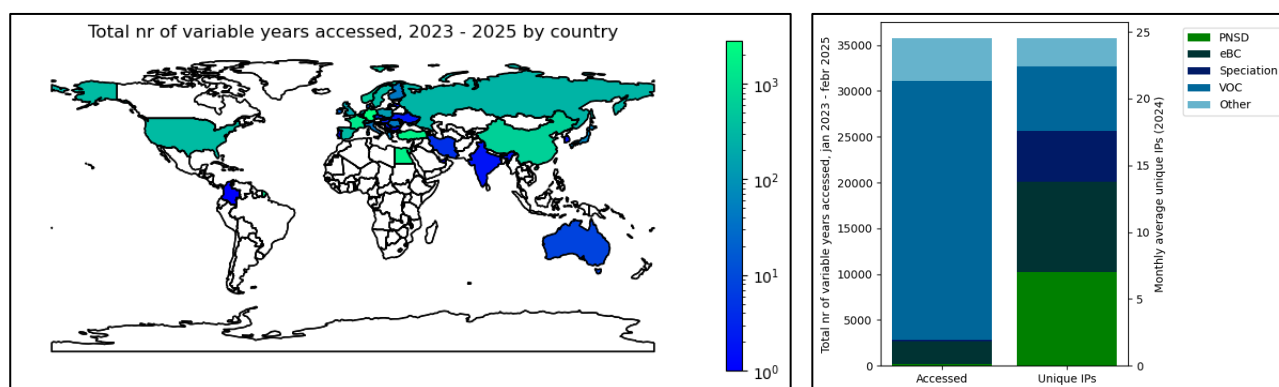


Figure 8. Access statistics for RI-URBANS data from EBAS, showing the number variable years accessed from 1 January 2023 to January 2025, along with the number of unique IP addresses per month in 2024.

4. Data curation of aerosol remote profiling data and data products from ARES

As stated in the RI-URBANS DMP, aerosol profiling data is handled by the ACTRIS DC aerosol remote sensing unit ARES, which operates the ACTRIS/EARLINET portal (<https://data.earlinet.org>), hosted by CNR in ITALY.

ARES contributes to RI-URBANS in two main ways: 1) Advancing ARES data products relevant for RI-URBANS scientific aims. 2) Data curation of aerosol remote profiling data provided by users external to ARES.

4.1 Advancement in ARES data products of interest for RI-URBANS

The climatological products related to aerosol remote sensing profiles have been improved within RI-URBANS as of interest for understanding the typical conditions as well as the possible trends in aerosol optical properties profile over Europe as observed at ACTRIS/EARLINET stations, which are typically located in suburban and rural locations. In the frame of RI-URBANS, ARES climatological products have been improved including more years in the baseline (up to 2019) and new stations.

The climatological datasets (namely Level 3 products) are obtained as aggregated products from the fully quality controlled (QC) aerosol optical products (i.e., Level 2 products). The Level 3 products are centrally and automatically produced by the ACTRIS Data Centre node for the Aerosol Remote Sensing (ARES) at CNR, guaranteeing harmonized procedures on the datasets. This is compliant with the general structure of the EARLINET database, allowing for versioning, traceability, and harmonisation of the processes. An example of Level 3 climatological aggregated data product is reported in Figure 9.

More details about the Level 3 climatological products are reported in the Level 3 documentation available at EARLINET website (<https://earlinet.org/index.php?id=322>) and data are published with DOI as a collection and single station datasets (ACTRIS/EARLINET Level 3 2000-2019 climatological dataset, 2024, https://doi.org/10.57837/cnr-imaa/ares/actris-earlinet/level3/climatological/2000_2019/all).

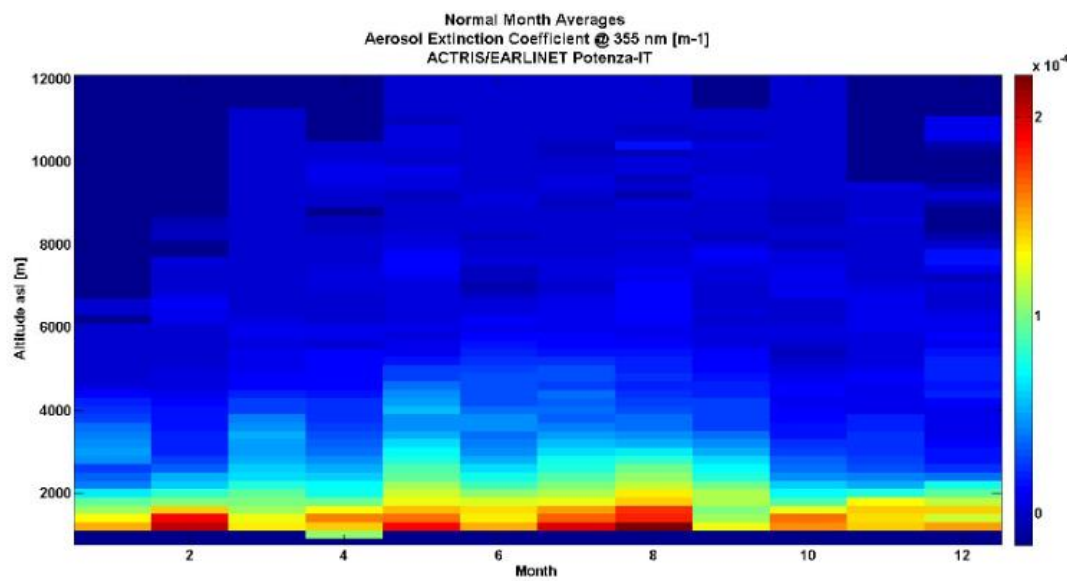


Figure 9. Normal month averages (calculated on 2000-2019 period) of aerosol extinction coefficient profiles at 355 nm for Potenza-IT.

4.2 Data curation for aerosol remote profiling data

The recommended service for submitting RI-URBANS aerosol remote sensing profiling data is via the [homeless data portal](#) from the ATMO-ACCESS project. These are the main categories of curation considered for ARES:

- Addition of aerosol remote sensing data to the ACTRIS/EARLINET database (following format and content requirements).
- Inclusion of a new system/station to the ARES processing and of resulting data in ACTRIS/EARLINET database.
- Provision of DOI and access to advanced and high scientific content datasets.

Up to now, only the last service has been requested in the framework of RI-URBANS, therefore in the following this kind of service and its outcome are described.

After the request for the service, the ARES team evaluated the feasibility of service #3 provision in terms of: i) dataset relevance for ARES topic; ii) scientific relevance of the data, iii) quality of the data and methods; iv) quality of metadata. Each one of the first 3 listed points should be satisfied to start the work aimed to the release of a DOI to the proposed dataset.

ARES team provides support and specification to the users for optimizing metadata quality. For the real provision of the DOI, a template for DOI release accordingly to DataCite schema is sent by ARES to the users given the needed support. Access to the data is additionally provided through the ACTRIS/EARLINET webpage. An aerosol remote sensing dataset is provided by ARES in the framework of RI-URBANS about aerosol typing: [the NATALI Earlinet Typing 2015-2023](#).

This dataset provides the aerosol type vertical profile (i.e. a vertical sequence of aerosol classes which are predominant in each aerosol layer in the troposphere). NATALI code (Neural Network Aerosol Typing Algorithm based on Lidar data) has been applied on fully quality controlled lidar datasets collected between 2015 and 2023 by 26 ACTRIS/EARLINET stations. Figure 10 shows the distribution of the stations over Europe and the number of layers typed with high confidence and reported in the dataset.

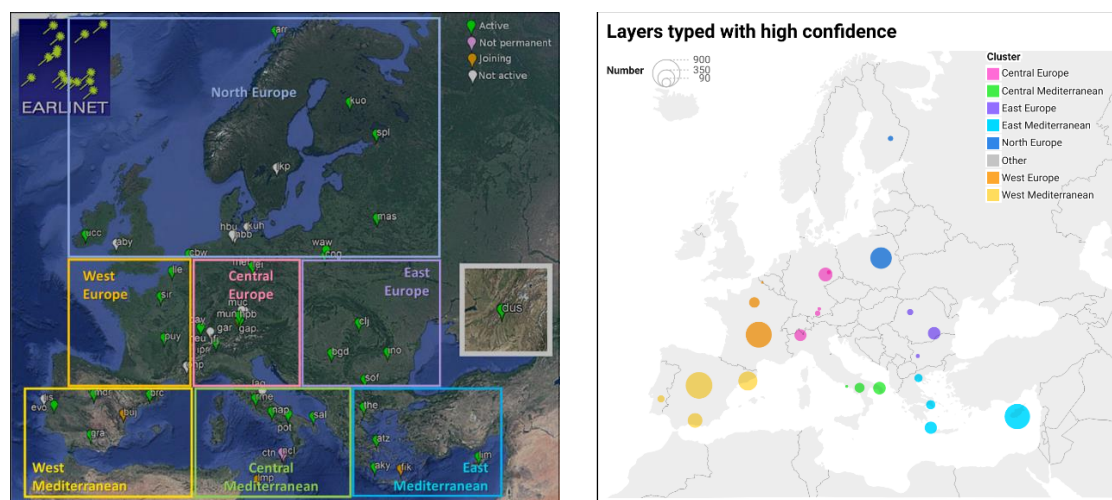


Figure 10. Distribution of stations across cluster regions: EARLINET map (left panel); number of layers typed with high confidence, for each participating station (right panel).

4.3 Accessing RI-URBANS aerosol profiling data from ARES

The above-described RI-URBANS ARES products are reachable through respective landing pages and related pages on [CommonDataCite](https://www.commonscite.org/) where all details related to the datasets are available including funding project(s) (see

Figure 11).

Additionally, these products are discoverable through human interaction with the well-established and widely known [EARLINET website](https://www.earlinet.eu/). Climatological aerosol profile products and the NATALI typing dataset are described in EARLINET web page in the Database menu under “Level 3 data” and “Special dataset” submenus, respectively. Climatological data products are freely and openly available. NATALI aerosol typing dataset is instead under embargo and available upon request.

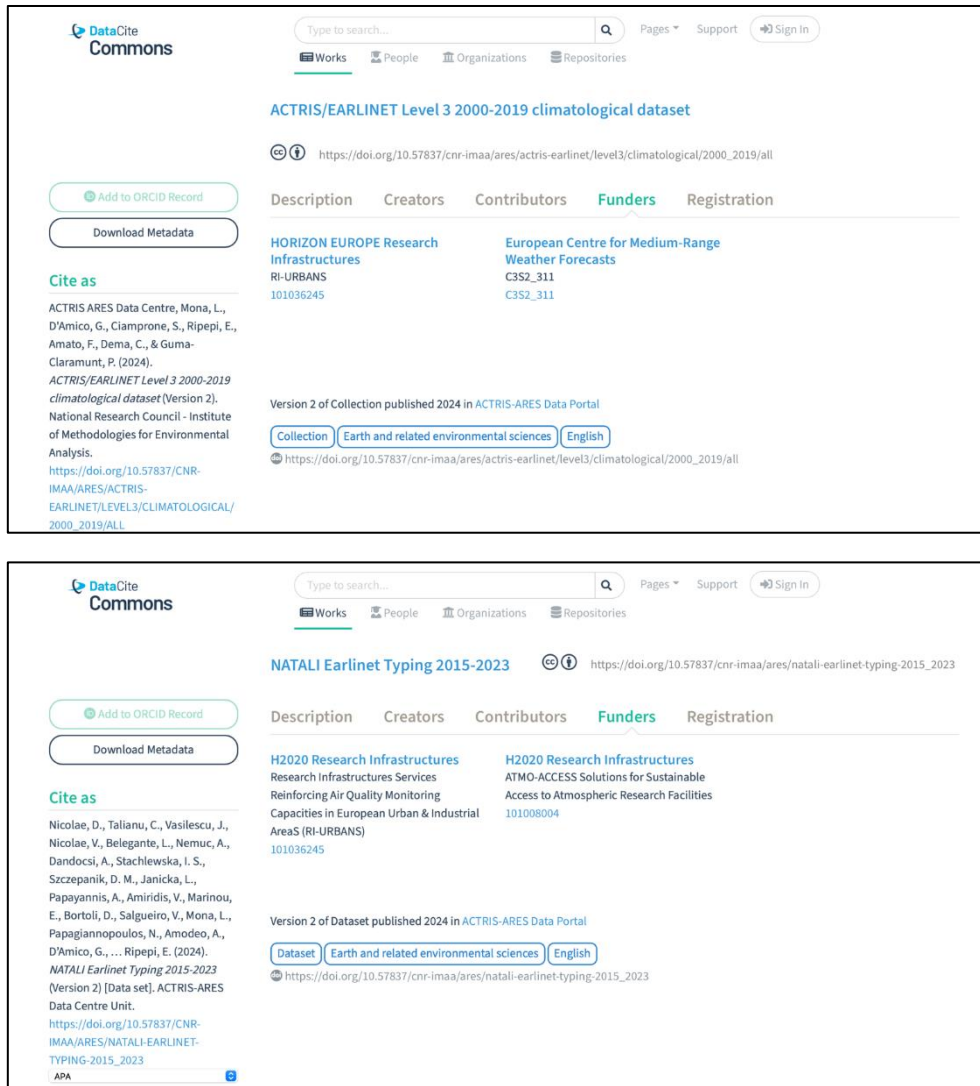


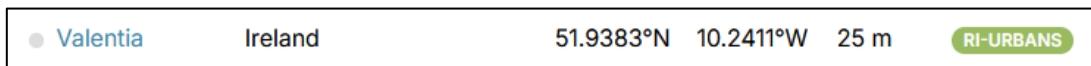
Figure 11. Example of visualization of information for the ARES RI-URBANS datasets: RI-URBANS reported in funding for the climatological (upper panel) and aerosol typing (lower panel) datasets.

5. Data curation for RI-URBANS cloud profiling data

As stated in the RI-URBANS DMP, cloud profiling data (including Doppler wind lidar) is handled by the ACTRIS DC cloud profiling unit CLU, which operates the Cloudnet portal (<https://cloudnet.fmi.fi>) hosted by FMI in Finland.

5.1 Data submission

The recommended service for initial queries on submitting RI-URBANS cloud profiling data via the [homeless data portal](#) from the ATMO-ACCESS project. The processing chain for almost all cloud-profiling data requires ancillary data including output from a numerical weather prediction model. For new stations, this requires CLU to add a new site to the station database and to include the new site coordinates in the model data extraction process which obtains the vertical column of model variables above each station from the ECMWF MARS archive.



Instrument type and model, together with calibration procedures and data formats are checked by CLU and then the appropriate metadata entered into the CLU instrument database. CLU already handles almost all known cloud profiling instrumentation and checks the instrument setup and operation are suitable for processing by CLU. Most cloud profiling instrumentation also provides the data in formats accepted by CLU (instrument binary format or netCDF). Citation and Acknowledgment information are also requested by CLU at this stage.

All data submission is then made direct to CLU is via a web API and is usually automated using a tool ([cloudnet-submit](#)) provided by CLU. This submission tool enables automatic real-time submission and can also be used for batch submission (submit months/years of data at once) for historical data. Processing and quick look generation for real-time data is performed in real time (within minutes) whereas batch submits may be queued.

5.2 Accessing RI-URBANS cloud profiling data from CLU

There are three main access points for data curated by CLU, whereof two is implemented at the time of writing this report:

- CLU web portal (<https://cloudnet.fmi.fi>). The portal provides a searchable interface, with browsable quicklooks and data file download functions. Framework tags (as seen in Figure 12) show which framework the data is associated with, noting that data can be associated with more than one framework. Note that the **Show all sites** radio button under **Location** must be selected from the main search interfaces in order to display all sites (default is to only show full ACTRIS cloud profiling stations).
- CLU web API. Programmatic access to all CLU metadata is provided through HTTP REST API. Metadata can be queried with multiple routes and the API responds with JSON. Metadata for processed data, products generated from the processed data, and the original raw data are all available, with file downloading scriptable by parsing the JSON response.
- Access through the ACTRIS DC web portal (<https://actris.nilu.no>) will be implemented soon.

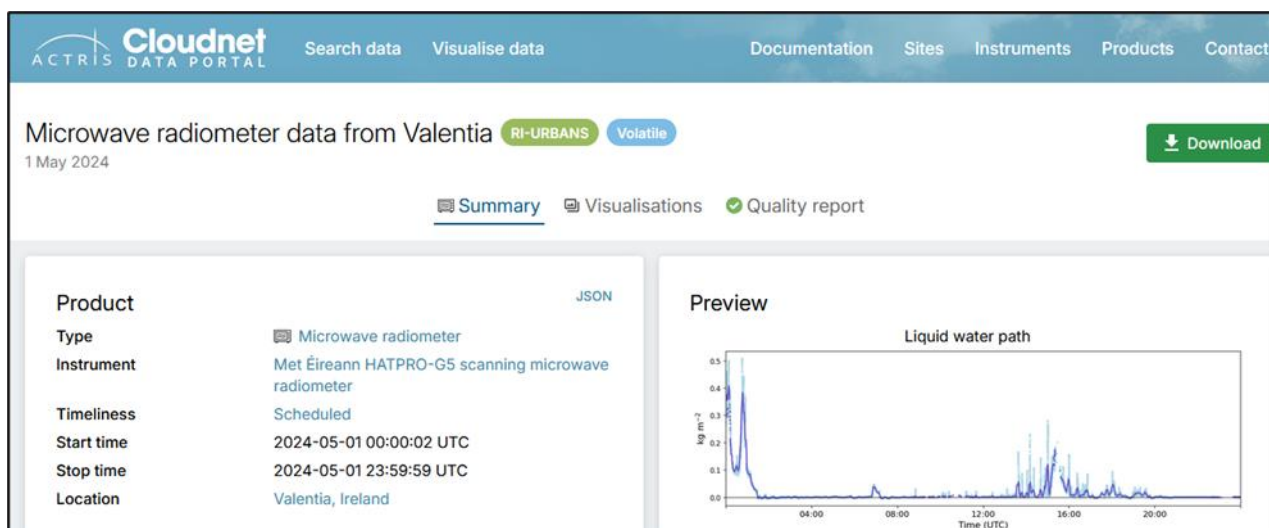


Figure 12. Example landing page for a dataset belonging to the RI-URBANS framework. The RI-URBANS framework tag is visible next to the title of the dataset.

5.3 Overview of RI-URBANS cloud profiling data

CLU hosts RI-URBANS cloud profiling data from one station: Valentia, Ireland. The station does not operate the full complement of instruments required to be an ACTRIS cloud profiling station so is not termed an ACTRIS cloud profiling station or a Cloudnet station. The station provides data from one component (a microwave radiometer), however, the data submitted from this instrument is suitable for deriving one of the products provided by an ACTRIS cloud profiling station: Liquid water path. Figure 13 shows the current quantity of data currently submitted from Valentia. The station is also preparing to send data from an additional instrument: a Doppler lidar which will provide wind and turbulent products.

Products are provided in daily files, with each file (data object) having a PID and an associated landing page. One portion of an example landing page is given in Figure 12. Figure 14 shows additional components of the landing page for each file/data object, which contains the PID, provenance, citation/acknowledgements and data license.

DOI's are created by CLU when a file or file collection is downloaded. Arbitrary file collections are permitted for users (for example for referral in a publication), and DOIs for datasets with yearly granularity are created by CLU for the submitting station if requested.

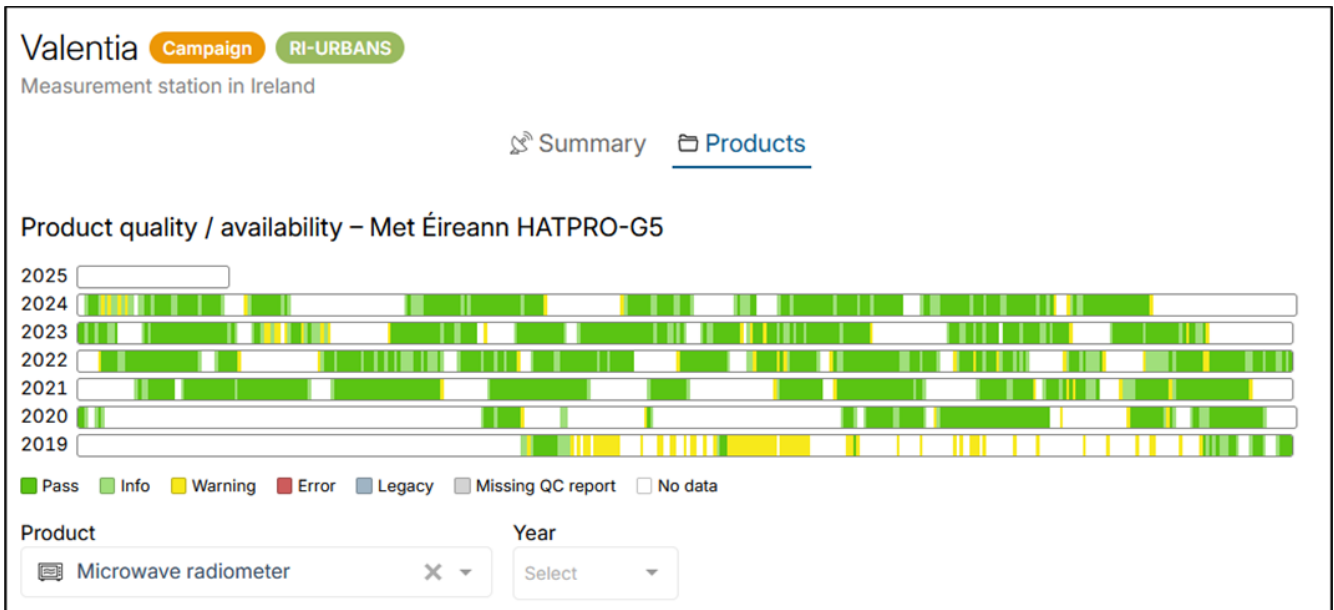


Figure 13. Product availability for data submitted for the Microwave radiometer operating at Valentia, Ireland.

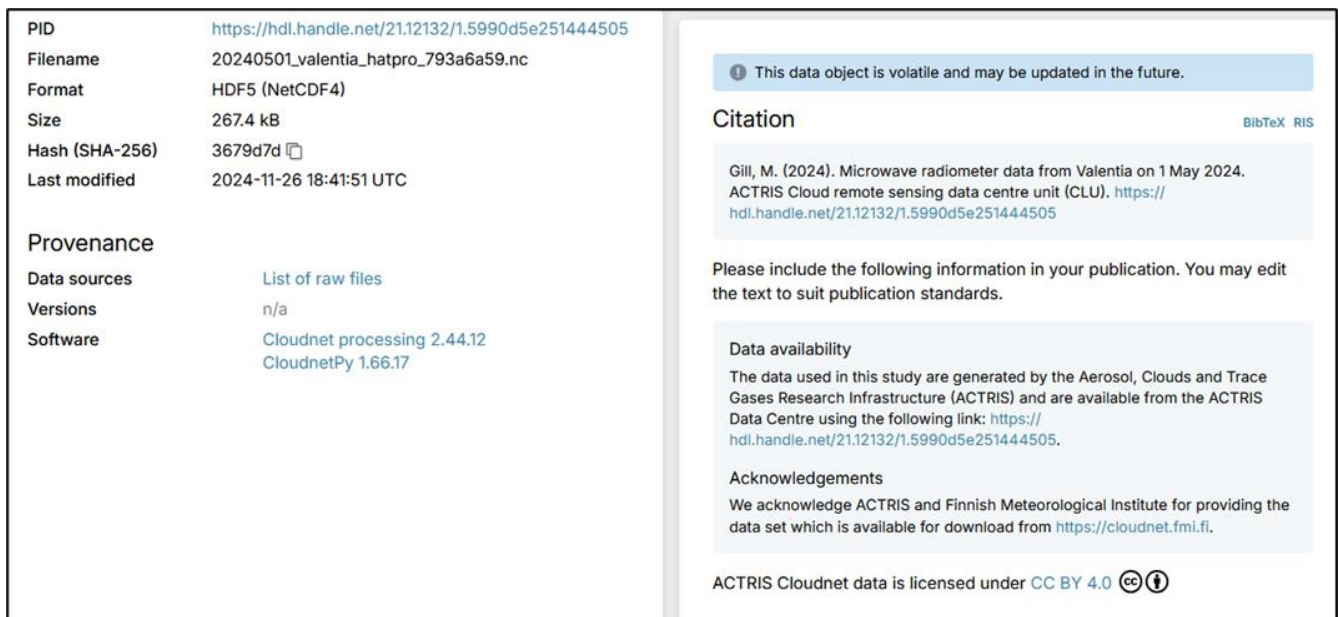


Figure 14. Additional components of an example landing page for a data file belonging to the RI-URBANS framework.

6. The conditions of use of RI-URBANS data

One important requirement for data to be open and FAIR is information on condition of use, and a licence statement. RI-URBANS data are offered to users with the CC-BY-4.0 license, and this information is included in the meta data items. Briefly, with this license the data user can i) Share — copy and redistribute the material in any medium or format and ii) Adapt — remix, transform, and build upon the material for any purpose, even commercially.

Attribution to RI-URBANS is required from users to give appropriate credit. Information on this is included in the files. All scientific articles and reports using data need to acknowledge the project; *“This study is using data that has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 101036245”*

7. Summary and future perspectives

RI-URBANS has successfully compiled extensive datasets on advanced air quality (AQ) parameters, including particle number size distribution (PNSD, ultrafine particles (UFP)), aerosol absorption coefficient (equivalent black carbon (eBC)), chemical speciation, ammonia (NH₃), and volatile organic compounds (VOCs). These emerging pollutants monitored in RI-URBANS are particularly relevant given their inclusion in the EU’s recently adopted revised Ambient Air Quality Directive (AAQD).

Through aligning to ACTRIS-recommended reporting guidelines, RI-URBANS ensures traceability, quality assurance, and accessibility of its datasets. This harmonized approach strengthens collaboration between atmospheric research infrastructures and urban air quality networks, fostering a more integrated and standardized AQ monitoring system across Europe. The development of near real-time (NRT) data services has proven highly successful, with these data now integrated into several platforms, including an extension of the Copernicus Atmosphere Monitoring Service (CAMS) to urban areas.

Beyond in-situ measurements, RI-URBANS has also contributed with climatological products and aerosol profiling datasets. Similarly, the cloud profiling data curated within RI-URBANS has demonstrated the feasibility of integrating Doppler wind lidar and microwave radiometer data.

Looking forward, it is expected that the data services and infrastructures developed within RI-URBANS will continue at multiple sites, especially considering the EU’s efforts to upscale measurement programs and co-design databases and service tools. The long-term sustainability of these initiatives will depend on continued collaboration between research infrastructures, national monitoring networks, and European policymakers.