Deliverable D8 (D1.8)

Integration for strategical guidance for upscaling and stakeholders' engagement

RI-URBANS

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

By

CSIC & PSI

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Deliverable D8 (D1.8): Integration for strategical guidance for upscaling and stakeholders' engagement

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Comments	This document summarises the work performed in Task 1.4 of RI-URBANS on "Integration for strategical guidance for upscaling and stakeholders' engagement". It reports on the interaction of WP1 with other RI-URBANS WPs to develop, demonstrate, extend and transfer WP1 compiled data and service tools (STs).

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1 About this document

RI-URBANS build upon 4 strategic pillars:

- SP1 compiles available RIs and AQMNs advanced observations and tools; evaluates the datasets and operational conditions, new monitoring and modelling tools; and develops STs in work packages (WPs) 1-3 to be demonstrated in SP2 and upscaled in SP3.
- SP2 (WP4) demonstrates the sustainable and interoperable implementation of STs developed in SP1. 5 pilot concepts are implemented with the participation of the RIs and AQMNs from 11 cities (Athens, Barcelona, Birmingham, Bucharest, Milan-Bologna, Paris, Rotterdam-Amsterdam, Helsinki and Zurich), representing a wide variety of environments.
- SP3 proposes the roadmap for upscaling the implementation (by RIs-AQMNs in Europe) of the STs and data management (WP5) provided by SP1 and demonstrated by SP2, as well as the transfer of these to stakeholders (WP6).

SP1 is built by WPs 1-3. WP1 specific objectives are: (i) Selection of novel AQ metrics and other key source tracers, based on aerosol and health effect sciences and the experience of the RIs and AQMNs involved; (ii) Development of new and improving existing service tools (STs) for identification and apportionment of sources of PM and nanoparticles; (iii) Development of STs for observations with high vertical and horizontal resolution in and around urban environments; (iv) Assessing the added value of the novel AQ metrics and sources contributions at urban supersites in Europe; (v) Developing synergies of the STs with downstream WPs 2-3, demonstration in pilots (WP4) and SP3 (WPs 5-6).

This deliverable summarizes the work performed in Task 1.4 of RI-URBANS on "Integration for strategical guidance for upscaling and stakeholders' engagement". The aim of T1.4 is to optimize the interaction of WP1 with WPs 2-4 and to integrate WP1 results to support the roadmap for upscaling STs (WP5-6) on the novel AQ metrics and SA and spatially resolved information. This document summarizes the interaction of WP1 with other RI-URBANS WPs to develop, demonstrate, extend and transfer WP1 service tools (STs).

T1.4 has organised and participated in a number of meetings with WPs 2-3 and WPs 4-6, to discuss the selection of sites, variables and periods for this kind of studies.

The data collected in WP1 have been made available to WP2 for epidemiological studies and to WP3 for modelling. In a first phase, the processed and original databases were archived on the RI-URBANS intranet, and subsequently were uploaded to the EBAS database according to the data management plan designed in conjunction with WP5. Data has also made available for other EU-Projects such FOCI (H2020- HORIZON-CL5-2021-D1-01). And data has been received from the STARGATE H2020 project for implementing STs on source apportionment.

WP1 provided guideline documents for a number of STs (STs 1-3 and STs 5-11) to be used in pilots in WP4. Interaction with pilots has contributed to improving tailored STs to yield the final guidance documents. WP1 also interact with WPs 5-6. WP1 results will support the roadmap for upscaling STs (WP5) on the novel AQ metrics and SA and spatially resolved information. Detailed guidance for measuring novel metrics and for SA were provided to WP6 to be included in the Guidance Documents for the Implementation of 16 STs. Although WP1 is finished in month 40, interaction with WP5 and WP6 will

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continue until the end of the project, as we considered this collaboration relevant for upscaling and for implementation of the new EU Directive on Air Quality (2024/2881/EC).

This is a public document that will be distributed to all RI-URBANS partners for their use and submitted to the European Commission as a RI-URBANS deliverable D26 (D4.5). This document can be downloaded at https://riurbans.eu/work-package-1/#deliverables-wp1.

2 Interaction with WPs 2-3 in SP1

Interaction between WP1 and WPs 2-3 mainly consisted in the provision of the data gathered by WP1. Data gathered in WP1 of both non-regulated and regulated were provided to WPs 2-3 for health assessment and modelling evaluation and improvement, respectively.

Selection of novel AQ metrics, e.g., number concentration of nanoparticles (PNC=UFP) and their particle number size distribution (PNSD), PM components (including BC) and gaseous precursors, and other key source tracers, was performed in WP1, in collaboration with WPs 2-3 and Air Quality Monitoring Networks (AQMN), based on aerosol and health effect sciences and the experience of the RIs and AQMNs involved. The selected variables were adopted by the new European Ambient Air Quality Directive (EU) 2024/2881 (NAQD) to be measured at urban supersites and hotspots.

T1.4 has organised and participated in a number of meetings with WPs 2-3, to discuss the selection of sites, variables and periods for this kind of studies.

2.1 Interaction with WP2

2.1.1 Interaction with T2.1

Data gathered in WP1 on the selected non-regulated variables, such as PM components, BC, UFP (T1.1), and individual source contributions of PM and UFP (T1.2), were provided to WP2 (T2.1), to complement data on regulated pollutants (PM2.5, PM10, NO_2) for epidemiological studies and impact assessment to demonstrate the added value of new metrics beyond routinely measured pollutants. T2.1 linked the time series of new AQ metrics to those of daily mortality and hospital admissions and meteorological parameters and produced deliverable **D9 (D2.1)** on the best practices for evaluating the association between short-term exposure to air pollution and health outcomes (mortality and morbidity). The report includes recommendations on the type of data needed, sources for the health data, common challenges of health data collection, and a summary of two types of analyses, time series analysis and health impact assessment.

Cities used for the epidemiological studies are showed in Figure 1. Metrics considered for this study were: PNC, UFP, PNSD modes, PM2.5, BC, sources of UFP and sources of BC. In total, complete data for 12 cities were available for implementing studies on the short-term effects of UFP, fractions of PNSD and source contributions to PNC, and BC. The cross-sectional studies for short-term health outcomes were carried out by ISGlobal or in the UK and Germany using the same algorithms due to health data restrictions out of the country (D10 (D2.2) to be submitted soon). All analyses have been completed and all results are available. These include analyses linking mortality (from natural, cardiovascular or respiratory causes) and hospital admissions (from cardiovascular or respiratory causes) with different AQ metrics, including total PNC, UFP, Nucleation, Aitken and Accumulation mode independently, as well as daily source contributions), lung deposition surface area metrics, PM metrics, gases, black carbon and black carbon sources (all these received from WP1).

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2.1.2 Interaction with T2.2

T2.2 deals with the evaluation of oxidative potential (OP) as an additional metric to assess potential toxicological effects of PM10 and PM2.5, in relation to PM components and their source contributions using online and off-line techniques. T2.2 delivered report **D11 (D2.3)** on the harmonization of the oxidative potential of PM monitoring for application in pilots. This deliverable revises the last advances and practices for evaluating the association between air pollution and oxidative potential. It includes an overview of OP measurement methods and the integration of OP in different epidemiological studies. The report includes recommendations for future studies of health impacts through the application of OP assays. PM10 and PM2.5 source apportionment data from WP1 (T1.2) is being used to identify the predominant sources contributing to OP with inputs from available data and pilot studies providing both OP and source contribution data (T4.4). This evaluation is done for Athens, Paris, Zurich and Barcelona.

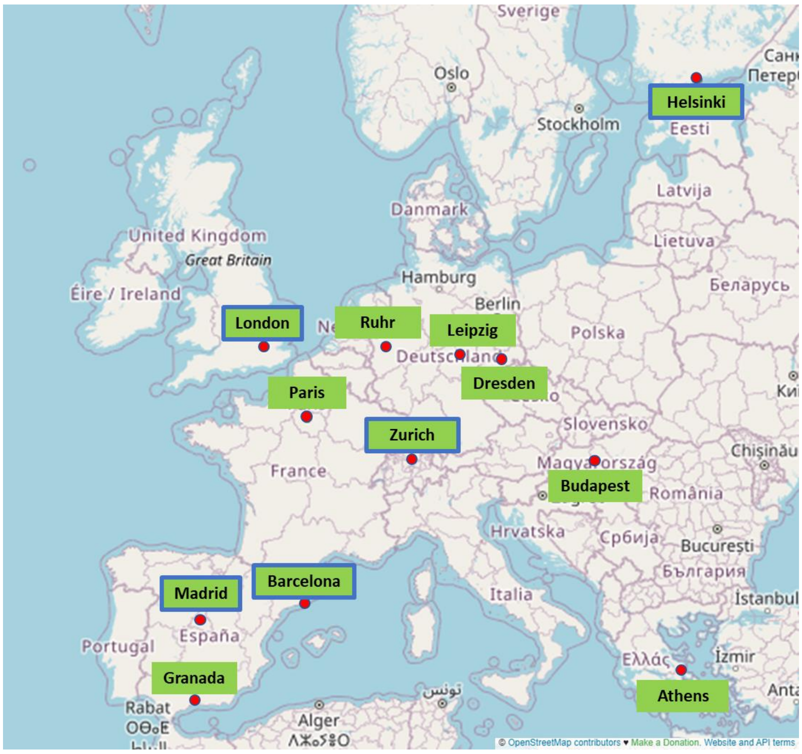

Figure 1. *Location of the different cities and regions included in the mortality (all marked cities) and hospitalisation (marked with blue borders) time-series analysis (source: Openstreet* maps), from **D10 (D2.2)**

2.2 Interaction with WP3

WP1 provided gathered datasets of both non-regulated and regulated variables for modelling validation and evaluation. Interaction with modellers in WP3 has mainly focused in three WP3 tasks: T3.1, T3.3 and T3.4.

Interaction between WP1 and WP3 was key for the comparison of measured and modelled variables for evaluation of models. The link between WP1 and WP3 helped to have harmonized data for assessments (and quality control) and improves the uptake of novel metrics observations.

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2.2.1 Interaction with T3.1

This task focuses on the characterization of urban dispersion using advanced observations-based methodologies and modelling. This task led to the development of a methodology to improve urban aerosol particle emissions combining in-situ measurements and novel modelling tools.

The atmospheric chemistry model MONARCH and three different emission inventories (two versions of the European-scale emission inventory CAMS-REG_v4 and the HERMESv3 detailed national inventory for Spain) were used to assess the uncertainties in carbonaceous aerosols (CA) simulation and source allocation (from traffic, residential wood combustion - RWC, shipping, fires and others) in in Northeast Spain. For this, WP1 provided measurements and source apportionment of black carbon (BC) and organic aerosol (OA) performed by CSIC at three supersites representing different environments (urban, regional and remote).

Performance of the developed new version of the street–scale CALIOPE dispersion model was evaluated by comparing with BC datasets recorded by CSIC at an urban background supersite, also provided by WP1.

The accuracy of traffic emission factors was estimated from modelled concentrations simulated in the streets of Paris using the street-network model MUNICH. The representation of traffic emissions in the model was assessed by the comparisons of the model outputs with the observational concentrations of NO2, PM2.5, EC and PNC measured at urban background and at traffic sites in Paris, that were collected in T1.1. Since the model simulates CE, observed BC concentrations were normalized using a harmonization factor (Savadkoohi et al., 2023), following WP1 recommendations, prior to comparison with experimental measurements.

A system now used in CAMS84 for the comparison between model and CAMS21b and IAGOS vertical observations over regional areas has been extended to urban environments on the new data streams (from T1.3). A toolbox for model evaluations over urban areas has been proposed (**D16 (D3.1)**). The routine validation activity in CAMS is currently based on surface observations of the prime regulatory components (NO_2, O_3, PM10, PM2.5 and SO_2), on TROPOMI satellite data of NO_2 (later also HCHO and CHOCHO), on O_3 profiles from sondes and IAGOS, and on CO profile from IAGOS. The proposed toolbox aims to study the added value of above-surface observations which are currently not exploited in an operational way, to provide a link between in-situ surface and satellite column observations by using profile observations, and to exploit campaign data to better understand the three-dimensional distribution of pollutants. To evaluate models over urban areas the toolbox makes use of the profiling observations compiled in T1.3, such as IAGOS NO and NO_2 aircraft observations; PANDORA and MAXDOAS surface remote sensing data, with a focus on NO2; Lidar profiles from EARLINET (ACTRIS) and Ceilometers to study the vertical profiles of aerosol over urban areas, to link surface PM, surface AOD (Aeronet) and satellite aerosol observations; Datasets from campaigns with a focus on urban areas (Ruisdael Rotterdam campaign, CINDI-3), using a suite of ground based in-situ monitors on fixed and mobile platforms.

2.2.2 Interaction with T3.3

This task, which aims to extend air quality modelling to health and policy-relevant indicators down to the urban scale, has delivered **D19 (D3.4)** on high-resolution mapping in European areas. This deliverable was produced by a consortium of 8 European air quality modelling teams in very close collaboration with observation providers (WP1). The task was designed originally to enhance selected chemistry-transport models (CTMs) to quantify source contributions to conventional and novel AQ health metrics (such as BC, OA and UFP). Besides modelling developments, an important focus was given to combine the CTMs with urban observational data of in situ atmospheric concentrations, in connection with WP1.

2.2.2.1 BC evaluation.

Modelled elemental carbon (EC) by the CAMS ensemble of models (8 models in this case) is compared with equivalent black carbon (eBC) measurement by using aethalometer. To this end, T3.3. developed a robust

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methodology builds upon information provided by the RI-URBANS measurement community to account for observation uncertainties in the model evaluation (ST2). The link between WP1 and WP3 helps to have harmonized data for eBC assessments (and quality control) and improves the uptake of WP1 eBC observations. Modelling of eBC the source apportionment of solid fuel and liquid fuels has been also evaluated.

For this validation exercise, eBC was collected from 18 urban background sites; 8 of them also providing EC data (see Table 1). Moreover, the average attribution of BC to fossil fuel was modelled and compared with results obtained in WP1 and reported in Savadkoohi et al., 2023, by applying the aethalometer model (Sandradewi et al., 2008) by using different Absorption Angstrom Exponents (AAE), following WP1 recommendations (ST11).

T3.3 also developed a programme for the evaluation in near-real time (NRT) of hourly BC concentrations and source distribution of CAMS models based on aethalometer measurements. NRT eBC measurements and source apportionment were performed at the pilots by using the service tools provided by WP1. Harmonization of measurements were performed according to WP1 guidance. A demonstrator of NRT evaluation is proposed as a first stage towards a future ST to be further refined in WP5.

Table 1. *Comparison between surface concentrations of EC and eBC measured and simulated by the model Ensemble from CAMS in 2018. Comparison between mean source attribution of eBC to fossil fuel modelled an estimated from observations. Modified from* ***D19 (D3.4).***

	Mean concentration (µg/m^3)				Mean source attribution to fossil fuel (%)	
	EC observations	EC modelled	eBC observations	eBC modelled	Observations	Modelled
Mean stations	0.73	0.58 (σ = 0.27)	0.74	0.60 (σ = 0.28)	77.2	62.5
Paris Sirta	0.50	0.79 (σ = 0.30)	0.37	0.78 (σ = 0.29)	72.7	56.5
Athens NOA	1.16	0.66 (σ = 0.30)	1.02	0.65 (σ = 0.29)	67.1	77.8
Athens Demokritos	0.36	0.48 (σ = 0.29)	0.49	0.50 (σ = 0.30)	75.1	77.2
Bern Bollwerk	0.86	0.54 (σ = 0.23)	0.50	0.54 (σ = 0.23)	70.0	59.1
Marseille Longch.	0.96	0.34 (σ = 0.11)	0.92	0.48 (σ = 0.17)	83.2	61.2
Zurich Kaserne	0.54	0.68 (σ = 0.36)	0.47	0.66 (σ = 0.33)	76.2	58.4
Lille Villeneuve d'Ascq			0.41	1.25 (σ = 0.52)	72.4	50.9
Stockholm Torkel			0.17	0.29 (σ = 0.12)	74.9	53.8
Barcelona Palau Reial			0.92	0.73 (σ = 0.31)	81.1	56.1
Helsinki Itä-Hakkila			0.54	0.30 (σ = 0.14)	65.1	63.7
Milan Pascal			1.10	1.29 (σ = 0.82)	85.0	74.9
Stockholm Hornsgatan			0.55	0.29 (σ = 0.12)	85.8	53.9
Bucharest INO			1.10	0.88 (σ = 0.42)	61.8	42.2
Paris Blvd Haussman			1.36	0.88 (σ = 0.36)	87.8	65.7
SMEAR II Hyytiälä			0.18	0.11 (σ = 0.05)	89.0	54.1
Granada UGR			1.21	0.17 (σ = 0.08)	72.9	89.1
Madrid CIEMAT			1.19	0.11 (σ = 0.04)	81.2	65.0
Paris PA13			0.83	0.87 (σ = 0.35)	88.1	65.0

2.2.2.2 Organic Aerosol (OA) evaluation.

The Aerosol Chemical Speciation Monitor (ACSM) provides information on concentration of fine PM non-refectory compounds, including sulphate, nitrate, chloride, ammonium and organic aerosols (OA). Moreover, PMF analysis permit to estimate the sources contributing to OA concentrations, such as hydrogenated, biomass burning and oxygenated organic aerosols (HOA, BBOA and OOA, respectively).

T3.3. performed an intercomparison between ACSM OA PMF results and OA simulation results from several CTMs for years 2017 to 2019. The data provided by WP1 for this study are predominantly from the sites studied in Chen et al. (2022), with extended PMF analyses covering a longer time period for Athens-Demokritos, Barcelona,

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Bucharest, Carnsore Point, Dublin, Hyytiala, Marseille, ATOLL, and SIRTA (see Table 2). An additional site in London (Marylebone Road) and a site in Cyprus (Nicosia) were also included, as well as 10 French sites. In total, WP1 provided data for 31 European sites, most of which are urban.

The ACSM OA PMF datasets were processed using the same method, employing the harmonized protocol recommended by WP1 (ST10) to resolve the sources of organic aerosols (OA) through rolling PMF analysis. This approach offers the advantage of capturing temporal variability in source profiles across multi-year datasets. Primary and secondary organic aerosol factors were resolved for these datasets. The well-known primary factors include HOA (Hydrocarbon-like OA) and BBOA (Biomass Burning OA), identified at all sites except the rural site Hyytiala. Other primary factors were resolved at such sites, including COA (Cooking OA), CCOA (Coal Combustion OA), SFOA (Solid Fuel OA), etc. The secondary factors were distinguished between less and more oxidized oxygenated OA (LO-OOA and MO-OOA). For model evaluation, the POA and SOA sources identified from ACSM OA PMF, were simplified to HOA, BBOA and OOA, that were the OA sources modelled. Interaction between WP1 and WP3 was fundamental for the harmonization of measured and modelled sources, and therefore for the model evaluation.

A NRT comparison between Regional CTMs (such as those used in Operational production in CAMS) models and ACSM PMF for OA was performed at pilot sites. Further work will be required in the model to apply such evaluation techniques using NRT ACSM data consolidated in the pilot supersites.

Table 2. Stations providing ACMS OA PMF data for model evaluation. Period: 2017-2019. From ***D19 (D3.4).***

Station Name	Station ID	Country	Latitude	Longitude	Station Type
Athens-Demokritos	DEM	Greece	37.995	23.816	Urban Background
Athens-Thissio	NOA	Greece	37.98	23.7	Urban Background
Barcelona	BCN-PR	Spain	41.3875	2.118	Urban Background
Birkenes	BIR	Norway	58.383	8.25	Regional Background
Magurele-Bucharest	INO	Romania	44.348	26.029	Suburban
Carnsore Point	CRP	Ireland	52.19	-6.34	Regional Background
Dublin	DUB	Ireland	53.3083611	-6.2235555	Urban Background
Helsinki	HEL	Finland	60.1964389	24.9519805	Traffic
Hohenpeißenberg	HPB	Germany	47.8013889	11.009722	Regional Background
Hyytiala	SMR	Finland	61.85	24.28333	Rural
Kosetice	KOS	Czech Republic	49.6	15.12	Regional Background
Krakow	KRK	Poland	50.0666667	19.91666	Suburban
ATOLL-Lille	ATOLL	France	50.611	3.1403	Suburban
London-Marylebone	LON-MR	United Kingdom	51.52	-0.15	Traffic
London-North Kensington	LON-NK	United Kingdom	51.5	-0.2	Urban Background
Marseille Longchamps	MAR-LCP	France	43.3052333	5.39469	Urban Background
Melpitz	MEL	Germany	51.9	13.55	Rural
Nicosia	CAO-NIC	Cyprus	35.1407755	33.3805388	Urban Background
SIRTA-Paris	SIRTA	France	48.71	2.15	Suburban
Tartu	TAR	Estonia	58.3705556	26.7347222	Urban Background
Zurich	ZUR	Switzerland	47.3775556	8.5305	Urban Background
Gennevilliers	GEN	France	48.9298083	2.2946194	Urban Background
Paris Les Halles	HALL	France	48.8627083	2.3446972	Urban Background
Paris BPEst	BPEst	France	48.8385167	2.4126242	Trafic
Rennes	REN	France	48.08965	-1.65911	Urban Background
Metz	MET	France	49.1102806	6.2233361	Urban Background
Strasbourg	STR	France	48.5062222	7.7511806	Urban Background
Creil	CRL	France	49.2597222	2.4744444	Urban Background
Lyon	LYN	France	45.75779	4.85422	Urban Background
Poitiers	POI	France	46.5839885	0.3455967	Urban Background
Talence	TAL	France	44.800442	-0.5893941	Urban Background

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2.2.2.3 Modelling of UFP at European Scale

The three-dimensional chemical transport model PMCAMx-UF simulates both chemically resolved mass concentrations and size-dependent particle number down to the nanometre size range. During RI-URBANS, PMCAMx-UF was upgraded, treating fresh primary organic particles as semi-volatile, and a new inventory for UFP emission was implemented. The model was compared to observations and used to assess the main sector contributing to UFP at European scale. This activity also largely relies on data collected in WP1, including particle number size distribution (PNSD) measurements and source apportionment. The PNSD over three cities (Athens, Barcelona, and Paris) has been simulated for the summer and winter of 2019 by using PMCAMx-UF. Moreover, LOTOS-EUROS was used for modelling of UFP in the city of Rotterdam. Modelled PNC was evaluated by comparison with observations provided by WP1.

2.2.3 Interaction with T3.4

T3.4 implement novel AQ indicators in tools supporting policy decision making to improve citizen health This task tests a pilot system that can be used to assess efficiency of policy measures at different scales (city, national, EU), building on the new emission inventories (T3.2) and the improved modelling (T3.3) using the novel (ROS, SA information, nanoparticles) and AQ indicators. The models cover a range of scales starting from regional and reaching out to urban areas. Several strategies are used to quantify the local vs non-local contribution to city AQ. The models simulate the changes in novel AQ indicators and SA resulting from specific local (WP4), national and EU policies and are assessed by comparing the model results to the SA data (from WP1), historic SA data and other observational data available.

3 Interaction with WP4 in SP2

WP4 aims to test and to demonstrate solutions for advanced urban AQ monitoring systems and evaluation of exposures at representative areas and hot spots in Europe. It implements 5 testing and demonstration pilots in 9 cities (Athens, Barcelona, Birmingham, Bucharest, Helsinki, Milano-Bologna, Paris, Rotterdam-Amsterdam and Zurich, with at least 3 cities in each pilot), covering the full range of European urban environments, for testing and demonstrating services produced in WPs 1-3. It creates synergies with SP3 to devise the roadmap for upscaling STs. These pilots aim to demonstrate at a real scale the ability to integrate complementary AQ measurement systems in existing AQMNs, addressing modalities where the RIs are engaged with the national/local authorities, proposing innovative solutions such as mobile instrumentation and building on citizens' observatory initiatives, applying tools developed, and improving their operational integration in AQMNs.

The guidance documents and preliminary STs produced in RI-URBANS WPs1-3 were tested at the pilot cities. The final version of STs will be RI-URBANS' deliverable **D46 (D6.1)**, containing guidance for all service tools provided in the project). Table 3 shows the cities participating at each pilot, indicating which are the official (X) and the follower (F) cities. STs tested at each pilot are also summarized, with a main focus on these produced in WP1, which are listed below:

- ST1: Ultrafine (nano)-Particle Number Size Distributions (UFP-PNSD)
- ST2: Black Carbon (BC)
- ST3: Offline and Online particulate matter (PM) speciation
- ST5: Volatile Organic Compounds (VOCs)
- ST6: Ammonia (NH3)
- ST7: Measurements of boundary level height
- ST8: Measurements of vertical profiles of aerosols
- ST9: Measurements of IAGOS vertical profiles by commercial aircrafts

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- ST10: Source apportionment of PM based on offline and online PM speciation
- ST11: Source apportionment of UFP, BC, OP and VOCs using receptor modelling

Table 3. *WP4 Pilots. Official cities participating (X) and followers (F). ST: service tool; NRT: Near real time; SA: source apportionment; PNSD: Particle number size distribution; ATH: Athens; BCN: Barcelona; BIR: Birmingham; BUC: Bucharest; HEL: Helsinki; MIL: Milano/Bologna; PAR: Paris; ROT: Rotterdam/Amsterdam; ZUR: Zurich.*

Pilot	STs tested (WP)	ATH	BCN	BIR	BUC	HEL	MIL	PAR	ROT	ZUR
1. NRT source apportionment of carbonaceous aerosols	WP1: NRT-SA ST (D1.4/D1.5) WP1: ST10/ST11	**X**	**F**		**F**	**X**	**X**	**X**		**X**
2. NRT data provision of nanoparticle and PNSD	WP1: NRT-PNSD ST (M3(M1.3)) WP1: ST1		**X**	**X**		**X+F**				**F**
3. Urban fine mapping	WP1: ST1, ST2, ST3, ST5, ST6, ST7, ST8, ST9; WP2 STs & WP3 STs	**X**		**X**	**X**	**F**		**X**	**X**	
4. Novel health indicators	WP1: ST1, ST2, ST3, ST5, ST6, **ST7**, ST8, ST9, ST10, ST11; WP2: ST4, ST14	**X**	**X**					**F**		**X**
5. Hot spots	WP2: ST14				**X**	**F**	**X**		**X**	

3.1 Pilot 4.1. NRT aerosol source apportionment of carbonaceous aerosols (NRT SA CA)

The pilot on NRT-SA of carbonaceous aerosols employs the source apportionment tool (NRT-SA ST, from WP1-T1.2) for the PM compositional data obtained by using the Aerosol Chemical Speciation Monitor (ACSM, Organic Matter, sulphate, nitrate, ammonium and chloride) and the multi-wavelength aethalometer (Black Carbon, BC).

Online PM speciation was made according to WP1 recommendations on (i) instrumentation and (ii) analysis to be implemented for organic and inorganic PM components, compiled in ST3, to allow advanced source apportionment, Task 4.1 and ST2. Continuous eBC measurements were also carried out according to WP1 recommendations on instrumentation and measurements, compiled in ST2.

The preliminary version of the **NRT-SA** functionalities, with operational requirements of the software and data transfer/formatting STs was delivered in **D4 (D1.4). This first version of the** NRT-SA STs has been tested online in **T4.1** (**WP4**) pilot during 2023 and updated based on the interaction with pilot cities. The performance of NRT-SA of PM was evaluated **(D23 (D4.1)** by comparing the NRT source apportionment and the “regular” manual PMF in the pilot cities, performed according RI-URBANS guidance (ST10 and ST11).

The final version **D5 (D1.5)** NRT-SA ST for submicron carbonaceous matter was released in month 36 and is being evaluated for upscaling (WP5).

3.2 Pilot 4.2. NRT data provision of nanoparticle and their size distributions (NRT-PNSD)

This pilot provides PNSD (including the nanoparticle range) data from different cities’ environments in Europe. A NRT data transmission software tool for nanoparticle PNSD (NRT-PNSD ST) was updated and adapted for RI-URBANS by WP1, based on the software developed in CAMS21a, and was provided (**M3 (M1.3)** for demonstrations (T4.2) and to define the roadmap of interoperable services (SP3).

Contact with the three pilot cities (Barcelona, Birmingham and Helsinki) was made by the ACTRIS Central Facility CAIS-ECAC to ensure that the measurement guidelines (ST1) at the stations are followed and to collect individual information of the station’s hard- and software with respect to the new NRT data transmission tool. This is done to confirm compatibility of the observational data between ACTRIS and AQMN aerosol size distribution measurements. The instrument setups are checked with regards to, for example, their sampling protocols, sample drying, instrument maintenance, size classification and standard operating procedures. The NRT data transmission

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software was changed accordingly and implemented at the sites and continuous testing was carried out at the pilot cities. Test datasets were generated and checked by WCCAP-CAIS-ECAC.

3.3 Pilot 4.3. Urban fine scale mapping; innovative modelling, monitoring, and crowdsourcing

This pilot focuses on mapping urban outdoor concentrations of nanoparticles and other pollutants by using mobile measurements, urban scale modelling and citizen's science (smart sensors) to obtain the high spatial resolution variability of urban exposure. This pilot benefit from the different advanced STs developed in WP1 (STs 1-3 and STs 5-6), WP2 and WP3 to describe the urban variability of outdoor exposure to nanoparticles and other pollutants using modelling tools, mobile measurements with nanoparticles, BC and mid cost sensors for measuring atmospheric PM, novel dispersion measurements, and the participation of networks of citizens and new innovative instruments by SMEs.

The potential of vertical profiling to improve AQ mapping and monitoring was estimated by testing STs 7-9, produced in WP1, for measuring vertical and horizontal variability (3D measurements) of specific pollutants and key meteorological parameters (such as the atmospheric planetary boundary), using surface remote sensing instrumentation.

3.4 Pilot 4.4. Novel health indicators

Pilot 4 on novel health indicators aims at evaluating the health effects of the novel AQ metrics and source contributions by means of epidemiological and oxidative potential approaches. This pilot initially includes Athens, Barcelona and Zurich, cities with long time series data of novel AQ variables obtained in combination with AQMNs and RIs. Pilot actions were also performed at a pris urban background site. New datasets of novel metrics, including eBC, PNSD, PM composition and OP were obtained following the recommendations of **D1 (D1.1)** generated within the framework of RI-URBANS WP1 and complied in ST1-ST6. These STs provide guidelines to measure the selected non-regulated pollutants and to perform quality analysis. Source apportionment tools were applied to the collected data to obtain the source contributions to nanoparticles, PM and BC, following WP1 recommendations (STs 10-11). These data are used to evaluate premature mortality and morbidity by cause, gender and age, and compared with the health outcomes of conventionally measured AQ pollutants. In terms of epidemiology, the evaluation of the associated health effects of the novel metrics and sources is performed according to WP2 ST14. This ST has been assessed and proposed for sustainable operation.

Furthermore, time series of PM2.5 and PM10 speciation and source apportionment have been used to assess the oxidative potential (OP) and the sources and components with the highest OP, by following recommendation from STs10-11 (WP1), and ST4 (WP2).

3.5 Pilot 4.5. Hotspots

Pilot 5 focuses on quantifying emission sources and concentrations in and near urban areas with intense traffic and/or industrial activities, and to identify the contribution of these hot spots to air pollutant exposure. To accomplish that, the pilot cities of Rotterdam-Amsterdam (The Netherlands), Bucharest (Romania) and Milano-Bologna (Italy) were selected as representative European areas for intensive measurement campaigns. The selected pollution hot spots include roadsides, harbours, airports, and industrial plants. Additional pilot actions were performed in Helsinki related to a traffic hotspot.

Exposure estimates in the hotspots were obtained in the urban areas closest to the emission sources by using targeted fixed-site measurements, mobile measurements, and modelling. The measurement and mapping recommended by ST14 (WP2) were used. Gathered WP1 data from both regional and urban background sites, combined with regional and high regional modelling and novel observations within and near hotspot areas were used to estimate the contributions of hotspot emission to AQ and exposure. The pollutants addressed were number

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concentrations of ultrafine particles, mass concentrations of PM2.5, PM10, BC, and NO_2, according to WP1 recommendations (STs 1-3 and 5-6, and ST4 from WP2). Furthermore, source contributions to pollutants obtained with receptor and direct modelling tools from WP1 (STs 10-11) and from WP3 were used. Measuring vertical and horizontal variability (3D measurements) of specific pollutants and key meteorological parameters (such as the atmospheric planetary boundary), using surface remote sensing instrumentation, according to STs 7-9, to better support the spatial origin of the contributions to urban pollutants.

4 Interaction with WPs 5-7 in SP3

SP3 proposes the roadmap for upscaling the implementation (by RIs-AQMNs in Europe) of the STs and data management (WP5) provided by SP1 and demonstrated by SP2, as well as the transfer of these to stakeholders (WP6).

RI-URBANS demonstrated by the analysis of numerous existing datasets on the novel AQ parameters (UFP-PNSD, PM speciation, BC, NH3, VOCs, OP), their evaluation for source contributions and associated health effects (WPs 1-3). These evaluations have a pan-European focus to show common and specific patterns and evidence, the added value of implementing the enhanced observation proposed. WP4 demonstrates the sustainable and interoperable implementation of these observations, and WPs 5-6 provide the roadmap the demonstration of their European added value, including the values for AQ policy assessment, integration of RIs and AQMNs, cost-benefits, potential growth of SMEs at local/regional scales.

4.1 WP5 Strategic guidance for upscaling RI-URBANS STs

WP5 is built to develop strategies and solutions for the consolidation of a sustainable access to the RI-URBANS services that will enhance synergies with AQMNs. WP5 develops guidance for upscaling and implementation of the STs developed in SP1 (WPs 1-3) and further tested in SP2 (WP4).

4.1.1 T5.1 Implementing data management framework

WP5 designs the conditions for an optimal data and data quality management framework in the project and beyond and contains the necessary knowledge transfer component to ensure all users, incl. AQMNs have all the necessary skills to operate the RI-URBANS' STs.

WP1 collaborated with WP5 for the preliminary Data Management Plan (**D35 (D5.1)** and the updated one **(D43 (5.9)**). In a first step, the data collected in WP1 for both unregulated and regulated metrics were made available for internal use on the RI-URBANS intranet. In a second step, most of the data gathered on the selected novel metrics have been uploaded to EBAS (https://ebas.nilu.no/) by WP1 partners and data providers. To this end, a webinar was arranged (**M29 (M5.1)**) by WP5 in collaboration to WP1 to support EBAS data submission.

As a result, a large set of data is publicly available following the guidelines outlined in the RI-URBANS data management plan (**D43 (D5.9)**; WP5). Data curation follows ACTRIS guidelines in compliance with FAIR principles using the EBAS infrastructure (https://ebas.nilu.no/). Currently (January 2025) more than 3540 datasets, covering 139 different variables, from 118 stations in 13 countries have been reported and made available through EBAS. An overview of the available data can be found on the RI-URBANS website (https://riurbans.eu/results/#open-data).

The NRT system needed at the pilot sites in WP4 was set up and installed (**M18 (M4.2)**). NRT data, using STs produced in WP1, is continuously submitted to EBAS. So far, more than 1390 NRT datasets are publicly available in EBAS.

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Interaction with AQMN data providers during data compilation and submission, revealed limitations /difficulties for data providers that need to be addressed for upscaling. The process has to be simplified and interaction with official databases is needed.

4.1.2 T5.2 Establishment of the measurement quality framework

This task establishes the measurement quality framework, by addressing quality assurance/quality control (QA/QC), traceability and standards of conducted measurements and ensuring knowledge transfer to relevant stakeholders (AQMNs in particular).

Technical framework for QA/QC related to new, highly valuable AQ variables and tools developed in WP1-3, not yet included as RI-variables (in ACTRIS nor IAGOS), such as OP, or Atmospheric Boundary Layer (ABL) height are addressed. T5.2 compiles technical guidelines for AQ monitoring and assessment tools, such as source apportionment, produced by WP1 and summarized in the STs documents.

4.1.3 T5.3. Establishing the modelling framework

WP5 assess the maturity of the modelling developments initiated within WP3 in close collaboration with observation providers in WPs 1-2 (in particular to make use of the data collected in pilot cities as part of WP4). This task will transfer the developments of STs in WP3 to CAMS.

4.1.4 T5.4. Demonstration of replicability and uptake pathways of services: example of Poland

WP5 provided measurement guidelines and advise for instrumentation based on WP1 outputs.

4.1.5 T5.5. Strategic guidance for upscaling

WP1 together with WP5 worked on supporting WP6 on formulating a joint response of ACTRIS and RI-URBANS to the first draft of the NAQD. The comments were prepared by a joint ACTRIS/RI-URBANS team with the purpose to formulate a series of suggestions and technical recommendations based on the expertise of both to support the discussion process in defining measurements of advanced AQ parameters in supersites, proposed by the NAQD. The technical recommendations arisen from WPs 1-2, related to the current level of preparedness of relevant ACTRIS and RI-URBANS tools to be incorporated in the NAQD.

During the discussion of the NAQD, many Member States argued that the added value of measuring the new parameters was not proven. WP1 generated and provided documents on guidance for measurements and Pan-European overview of concentrations of the non-regulated pollutants. WP1 already published articles on the PM components causing OP, on the phenomenology of UFP-PNSD in urban Europe, on the trends of NH_3 in urban Europe, and several others on BC, PM, VOCs. Furthermore, WP1 already produced a Pan-European report for the added value of measuring these novel metrics now included in the NAQD and of applying the source apportionment studies (**D2 (D1.2)**). All these results were summarised in the guidance chapters of advanced AQ parameters provided to WP6 (STs 1-3 and 5-11 from WP1 and ST4 from WP2). This information is being used in WP5 to support upscaling of these STs.

4.2 WP6 Stakeholder engagement strategies

WP6 aims at maximising engagement of stakeholders to ensure the transfer and implementation of RI-URBANS STs and the demonstration of the project's societal and environmental benefits, by implementing suitable strategies to engage each different group of stakeholders, with a focus on enhancing the AQMNs-RIs links.

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4.2.1 T6.1. Stakeholders' engagement for maximising impact of RI-URBANS

This task aims at transferring the results and STs to local, regional and national AQMN stakeholders by elaborating information packages that will be presented by in-situ visits and in a specific workshop to be organised. WP1 provided preliminary STs to WP6 and discuss with WP6 on the adequacy of these STs for transferring to stakeholders.

Service tools produced based in WP1 data collection, guidance and pan-European overview are STs1-3; 5-11:

- ST1: Ultrafine (nano)-Particle Number Size Distributions (UFP-PNSD)
- ST2: Black Carbon (BC)
- ST3: Offline and Online particulate matter (PM) speciation
- ST5: Volatile Organic Compounds (VOCs)
- ST6: Ammonia (NH3)
- ST7: Measurements of boundary level height
- ST8: Measurements of vertical profiles of aerosols
- ST9: Measurements of IAGOS vertical profiles by commercial aircrafts
- ST10: Source apportionment of PM based on offline and online PM speciation
- ST11: Source apportionment of UFP, BC, OP and VOCs using receptor modelling

Final versions of the guidance documents are available at https://riurbans.eu/project/#service-tools.

Furthermore, there will be soon available in the same section of the webs a summary document on the 'Guidance for measurements and added value of the novel air quality pollutants.

4.2.2 T6.3. Interaction with EC bodies and agencies on AQ and AQ-health

WP6 (T6.3) interacts with EC bodies and agencies on AQ and AQ-health. Key EC bodies, such as DG-ENV, DG-SANTE, DGREGIO, DG-DEFIS the Mission Board of Neutral-Climate Cities, and European and international agencies (such as EEA, UNECE-EMEP, WHO, WMO, the Copernicus Program) have been approached to show the European added value of RI-URBANS STs. Actions aim at obtaining input and feedback that would be paving the way for the amplest possible transfer and implementation of STs. WP1 participated in meetings and workshops organised by WP6. Feedback was considered for the final version of STs.

WP1 participated in stakeholder training webinars organised by RI-URBANS in collaboration with ACTRIS and ATMOACCESS to provide guidance on reference and monitoring methods for the new metrics and to showcase the added value of measuring "new" pollutants. These webinars are related to the implementation of the new EU Air Quality Directive.

4.2.3 T6.4. Interaction with SMEs related with AQ instrumentation and management

Connection of WP1 with RIs and AQMN for data compilation permitted to identify SMEs providing instrumentation for the advanced AQ observations of the selected novel metrics and other AQ pollutants to be approached by WP6. WP1 and WP6 interacted with SMEs to address potential limitations for updating advanced measurements for AQ monitoring according NAQD requirements.

Many of the RI-URBANS supersites will be included in the network official network of supersites of the NAQD.

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4.3 WP7 dissemination

WP1 collaborated with WP7 in the design of new sections in the website, following the reviewers' comments from RP1. WP1 supplied the open data and contributed to the elaboration and dissemination of the ST guidance documents and participated in numerous meetings organised by WP6 and WP7.

Furthermore, a large number of open access scientific articles have been published:

P1.1. Trechera et al., 2023, Phenomenology of ultrafine particle concentrations and size distribution across urban Europe. Environ. Int., 172, 107744, ISSN 0160-4120. https://doi.org/10.1016/j.envint.2023.107744
P1.2. Liu et al. 2023. Ambient air particulate total lung deposited surface area (LDSA) levels in urban Europe. Sci. Total Environ. 898, 165466 https://doi.org/10.1016/j.scitotenv.2023.165466.
P1.3. Garcia-Marlès et al., 2024a. Inter-annual trends of ultrafine particles in urban Europe. Environ. Int., 185, 108510. https://doi.org/10.1016/j.envint.2024.108510
P1.4. Garcia-Marlès et al., 2024b. Source apportionment of UFP-PNSD in urban Europe. Environ. Int., 194, 109149, https://doi.org/10.1016/j.envint.2024.109149
P1.5. Savadkoohi et al., 2023. The variability of mass concentrations and source apportionment analysis of equivalent black carbon across urban Europe. Environ. Int., 178, 10808. https://doi.org/10.1016/j.envint.2023.108081
P1.6. Rovira J. et al., 2022. Non-linear models for black carbon exposure modelling using air pollution datasets. Atmos. Res. 212, B, 113269. https://doi.org/10.1016/j.envres.2022.113269
P1.7. Savadkoohi et al., 2024. Recommendations for reporting equivalent black carbon (eBC) mass concentrations based on long-term pan-European in-situ observation. Environ. Int. 185, 108553. https://doi.org/10.1016/j.envint.2024.108553
P1.8. Liu, X. et al., 2024a. PM10-bound trace elements in pan-European urban atmosphere. Environ. Res., 119630, https://doi.org/10.1016/j.envres.2024.119630
P1.9. Chen et al., 2022a, European aerosol phenomenology − 8: Harmonised source apportionment of organic aerosol using 22 Year-long ACSM/AMS datasets, Environ. Int., 166, 2022, 107325. https://doi.org/10.1016/j.envint.2022.107325
P1.10. Liu et al., 2024b. Variability of ambient volatile organic compounds in European cities. Under review.
P1.11. Liu et al., 2025. Exploring the variations in ambient BTEX in urban Europe and its environmental health implications. Atmos. Phys. Chem., 625–638, https://doi.org/10.5194/acp-25-625-2025
P1.12. Reche et al., 2022. 2011–2020 trends of urban and regional ammonia in and around Barcelona, NE Spain. Chemosphere, 304, 135347. https://doi.org/10.1016/J.CHEMOSPHERE.2022.135347
P1.13. Liu, et al., 2024a Variability of ambient air ammonia in urban Europe (Finland, France, Italy, Spain, and the UK). Environ. Int., 185, 2024, 108519, ISSN 0160-4120, https://doi.org/10.1016/j.envint.2024.108519.
P1.14. Harni et al. S.D., 2023. Effects of emission sources on the particle number size distribution of ambient air in the residential area. Atmos. Environ. 293, 119419. https://doi.org/10.1016/j.atmosenv.2022.119419
P1.15. Amato F., et al. 2024. Aerosol source apportionment uncertainty linked to the choice of input chemical components. Environ. Int., 184, art. no. 108441. https://doi.org/10.1016/j.envint.2024.108441
P1.16. Chen et al., 2022b, Real-Time Source Apportionment of Organic Aerosols in Three European Cities. Environ. Sci. Technol. 2022, 56, 22, 15290–15297. https://doi.org/10.1021/acs.est.2c02509
P1.17. Vía M. et al., 2023. Towards a better understanding of fine PM sources: online and offline datasets combination in a single PMF. Environ. Int., 177, 108006, https://doi.org/10.1016/j.envint.2023.108006
P1.18. in'tVeld et al., 2024. Identification of volatile organic compounds and their sources driving ozone and secondary organic aerosol formation in NE Spain. Sci of the Total Environ 906:167159. https://doi.org/10.1016/j.scitotenv.2023.167159

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P1.19. Kotthaus, S. et al., 2023. Atmospheric boundary layer height from ground-based remote sensing: a review of capabilities and limitations, Atmos. Meas. Tech., 16, 433–479, https://doi.org/10.5194/amt-16-433-2023
P1.20. Bellini, A., et al., 2024. Alicenet – An Italian network of Automated Lidar-Ceilometers for 4D aerosol monitoring: infrastructure, data processing, and applications. Atmos. Meas. Tech., 17, 6119–6144, https://doi.org/10.5194/amt-17-6119-2024
P1.21. Harni, S. D., et al., 2024. Source apportionment of particle number size distribution at the street canyon and urban background sites, Atmos. Chem. Phys., 24, 12143–12160, https://acp.copernicus.org/articles/24/12143/2024/
P1.22. Fung, P.L, et al., 2024. Constructing transferable and interpretable machine learning models for black carbon concentrations, 184, 108449, https://doi.org/10.1016/j.envint.2024.108449.
P1.23. Vasilakopoulou, C.N., et al., 2023. Development and evaluation of an improved offline aerosol mass spectrometry technique, Atmos. Meas. Tech., 16, 2837–2850, https://doi.org/10.5194/amt-16-2837-2023
P1.24. Atabakhsh S., et al., 2023. A 1-year aerosol chemical speciation monitor (ACSM) source analysis of organic aerosol particle contributions from anthropogenic sources after long-range transport at the TROPOS research station Melpitz. Atmos. Chem. Phys., 6963–6988. https://doi.org/10.5194/acp-23-6963-2023
P1.25. Canals A., et al., 2024. Evaluation of air quality changes in a Chinese megacity over a 15-year period (2006–2021) using PM2.5 receptor modelling. Environ. Poll., 340, 1, 22803, https://doi.org/10.1016/j.envpol.2023.122803
P1.26. Davuliene L., et al., 2024. Synergic use of in-situ and remote sensing techniques for comprehensive characterization of aerosol optical and microphysical properties. Sci. Total Environ., 906, 167585, https://doi.org/10.1016/j.scitotenv.2023.167585
P1.27. Di Antonio, L., 2023. Aerosol optical depth climatology from the high-resolution MAIAC product over Europe: differences between major European cities and their surrounding environments. Atmos. Chem. Phys. 23, 12455–12475, https://doi.org/10.5194/acp-23-12455-2023
P1.28. Foreback, B., et al., 2022. Measurement report: A multi-year study on the impacts of Chinese New Year celebrations on air quality in Beijing, China. Atmos. Chem. Phys, 22, 11089–11104, https://doi.org/10.5194/acp-22-11089-2022
P1.29. in 't Veld M., 2023. Characterizing the sources of ambient PM10 organic aerosol in urban and rural Catalonia, Spain. Sci. The Total Environ., 902, 166440, https://doi.org/10.1016/j.scitotenv.2023.166440
P1.30. Kulmala, M., et al., 2024. A paradigm shift in investigating the general characteristics of atmospheric new particle formation using field observations, Aerosol Res., 2, 49–58, https://doi.org/10.5194/ar-2-49-2024
P1.31. Mahura, A., et al., 2024. Towards seamless environmental prediction – development of Pan-Eurasian EXperiment (PEEX) modelling platform. Big Earth Data, 8, 2, https://doi.org/10.1080/20964471.2024.2325019
P1.32. Okuljar, M., et al., 2023. Influence of anthropogenic emissions on the composition of highly oxygenated organic molecules in Helsinki: a street canyon and urban background station comparison, Atmos. Chem. Phys., 23, 12965–12983, https://doi.org/10.5194/acp-23-12965-2023
P1.33. Panahifar, H., et al., 2023. Simultaneous Use of Ground-Based and Satellite Observation to Evaluate Atmospheric Air Pollution over Amman, Jordan. Atmosphere,14, 2, 274, https://doi.org/10.3390/atmos14020274
P1.34. Petzold, A., et al., 2024. New directions in atmospheric research offered by research infrastructures combined with open and data-intensive science, Atmos. Chem. Phys., 24, 5369–5388, https://doi.org/10.5194/acp-24-5369-2024
P1.35. Stolzenburg, D., et al., 2023. Improved counting statistics of an ultrafine differential mobility particle size spectrometer system, Atmos. Meas. Tech., 16, 2471–2483, https://doi.org/10.5194/amt-16-2471-2023
P1.36. Zhang X., et al., 2024. New particle formation event detection with convolutional neural networks. Atmos. Environ., 327, 120487, https://doi.org/10.1016/j.atmosenv.2024.120487
P1.37. Kadantsev, E., et al., 2024. On dissipation timescales of the basic second-order moments: the effect on the energy and flux budget (EFB) turbulence closure for stably stratified turbulence. Non-Linear* Processes in Geophys. 31, 395–40, https://doi.org/10.5194/npg-31-395-2024

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P1.38. Rowell, A., et al., 2024. Insights into the sources of ultrafine particle numbers at six European urban sites obtained by investigating COVID-19 lockdowns, Atmos. Chem. Phys., 24, 9515–9531, https://doi.org/10.5194/acp-24-9515-2024

5 Summary

RI-URBAN is based on three highly interrelated strategic pillars (SPs). In SP1, **WPs 1-3** compiled advanced observations and tools available from RI and AQMN; evaluated data sets and operating conditions, new monitoring and modelling tools; and developed service tools (STs) to measure novel metrics and apportion sources contributing to ultrafine particles (UFP) and PM. These STs have been tested and upgraded in selected pilots in SP2 **WP4**, aiming to demonstrate solutions for advanced urban AQ monitoring systems and evaluation of exposures at representative areas and hot spots in Europe. In SP3, **WP5** proposes the roadmap for upscaling the implementation (by RIs-AQMNs in Europe) of the STs and data management provided by SP1 and demonstrated by SP2, whereas **WP6** aims at maximising engagement of stakeholders to ensure the transfer and implementation of RI-URBANS STs and the demonstration of the project's societal and environmental benefits. This document summarizes the interaction of WP1 with other WPs to develop, demonstrate, extend and transfer **WP1 STs** for upscaling.

Selection of novel AQ metrics was performed in **WP1**, in collaboration with **WPs 2-3**, based on aerosol and health effect sciences and the experience of the RIs and AQMNs involved. The selected variables were adopted by the new European Ambient **Air Quality Directive (EU) 2024/2881 (NAQD**) to be measured at urban supersites and hotspots. Data gathered in **WP1** on the selected novel AQ and on source contributions of PM and UFP, were provided to **WP2** for epidemiological studies and impact assessment, to demonstrate the added value of new metrics beyond regulated pollutants. **WP1** data (UFP, BC and OA) was provided to **WP3** for model validation. The link between **WP1** and **WPs2-3** helped to have harmonized data for assessments and improves the uptake of novel observations.

WP4 implemented 5 pilots in 9 cities, covering the full range of European urban environments, for testing and demonstrating STs produced in WPs 1-3. All the **STs** produced in **WP1,** including the NRT tools for source apportionment of carbonaceous aerosols and for measuring PNSD, were tested in **WP4.** Interaction with pilots contributed to improving tailored STs to yield the final guidance documents. **WP4** pilots demonstrated at a real scale the ability to integrate advanced AQ measurement systems in existing AQMNs, proposing innovative solutions, applying tools developed, and improving their operational integration in AQMNs.

WP5 develops guidance for upscaling and implementation of the STs developed in SP1 and further tested in SP2. **WP1** has collaborated with **WP5** for the Data Management Plan. **WP1'**s interaction with AQMN data providers during data compilation and reporting, highlighting the need to streamline the process and to interact with official databases for upscaling. During RI-URBANS, **WP1-WP5** cooperation resulted in the public availability of the data collected by **WP1** at EBAS database (https://ebas.nilu.no/). **WP1** supported **WP6** on formulating a joint response of ACTRIS and RI-URBANS **for assessment of the first draft of the NAQD**, showing the added value of measuring the new variables proposed by the NAQD. **WP1** generated and provided documents on guidance for measurements, published scientific articles and produced a Pan-European report for the added value of measuring these novel metrics now included in the NAQD. Detailed guidance for measuring novel metrics and for SA were provided to **WP6** to be included in the Guidance Documents for the Implementation of 16 STs (STs 1-3 and 5-11 from **WP1**).

Although **WP1** is finished in month 40, interaction with WP5 and WP6 will continue until the end of the project, as we considered this collaboration relevant for upscaling and for implementation of the new EU Directive on Air Quality (2024/2881/EC).

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6 References

Garcia-Marlès, M., Lara, R., Reche, C., Pérez, N., Tobías, A., Savadkoohi, M., Beddows, D., Salma, I., Vörösmarty, M., Weidinger, T., Hueglin, C., Mihalopoulos, N., Grivas, G., Kalkavouras, P., Ondráček, J., Zíková, N., Niemi, J. V., Manninen, H. E., Green, D. C., Tremper, A. H., Norman, M., Vratolis, S., Eleftheriadis, K., Gómez-Moreno, F. J., Alonso-Blanco, E., Wiedensohler, A., Weinhold, K., Merkel, M., Bastian, S., Hoffmann, B., Altug, H., Petit, J.-E., Favez, O., Dos Santos, S. M., Putaud, J.-P., Dinoi, A., Contini, D., Timonen, H., Lampilahti, J., Petäjä, T., Pandolfi, M., Hopke, P. K., Harrison, R. M., Alastuey, A., and Querol, X.: Inter-annual trends of ultrafine particles in urban Europe, Environment International, 185, 108510, https://doi.org/10.1016/j.envint.2024.108510, 2024a.

Garcia-Marlès, M., Lara, R., Reche, C., Pérez, N., Tobías, A., Savadkoohi, M., and Querol, X.: Source apportionment of ultrafine particles in urban Europe, Environ. Int. (Submitted), 2024b.

Savadkoohi, M., Pandolfi, M., Reche, C., Niemi, J. V., Mooibroek, D., Titos, G., Green, D. C., Tremper, A. H., Hueglin, C., Liakakou, E., Mihalopoulos, N., Stavroulas, I., Artiñano, B., Coz, E., Alados-Arboledas, L., Beddows, D., Riffault, V., De Brito, J. F., Bastian, S., Baudic, A., Colombi, C., Costabile, F., Chazeau, B., Marchand, N., Gómez-Amo, J. L., Estellés, V., Matos, V., van der Gaag, E., Gille, G., Luoma, K., Manninen, H. E., Norman, M., Silvergren, S., Petit, J.-E., Putaud, J.-P., Rattigan, O. V., Timonen, H., Tuch, T., Merkel, M., Weinhold, K., Vratolis, S., Vasilescu, J., Favez, O., Harrison, R. M., Laj, P., Wiedensohler, A., Hopke, P. K., Petäjä, T., Alastuey, A., and Querol, X.: The variability of mass concentrations and source apportionment analysis of equivalent black carbon across urban Europe, Environment International, 178, 108081, https://doi.org/10.1016/j.envint.2023.108081, 2023.

Trechera, P., Garcia-Marlès, M., Liu, X., Reche, C., Pérez, N., Savadkoohi, M., Beddows, D., Salma, I., Vörösmarty, M., Casans, A., Casquero-Vera, J. A., Hueglin, C., Marchand, N., Chazeau, B., Gille, G., Kalkavouras, P., Mihalopoulos, N., Ondracek, J., Zikova, N., Niemi, J. V., Manninen, H. E., Green, D. C., Tremper, A. H., Norman, M., Vratolis, S., Eleftheriadis, K., Gómez-Moreno, F. J., Alonso-Blanco, E., Gerwig, H., Wiedensohler, A., Weinhold, K., Merkel, M., Bastian, S., Petit, J.-E., Favez, O., Crumeyrolle, S., Ferlay, N., Martins Dos Santos, S., Putaud, J.-P., Timonen, H., Lampilahti, J., Asbach, C., Wolf, C., Kaminski, H., Altug, H., Hoffmann, B., Rich, D. Q., Pandolfi, M., Harrison, R. M., Hopke, P. K., Petäjä, T., Alastuey, A., and Querol, X.: Phenomenology of ultrafine particle concentrations and size distribution across urban Europe, Environment International, 172, 107744, https://doi.org/10.1016/j.envint.2023.107744, 2023.

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