European Commission

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Deliverable D22 (D4.1)

Monthly reports of concentration levels and PMF for each city during the pilot operation

RI URBANS

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

By

FMI & CNRS

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

cnrs

30th May 2023

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Deliverable D22 (D4.1): Monthly reports of concentration levels and PMF for each city during the pilot operation

Authors: Hilkka Timonen (FMI) & Jean-Eudes Petit (CNRS)

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Version	Final
Reviewed by	WP4 leaders
Accepted by	RI-URBANS Project Coordination Team
Comments	This document describes the monthly reporting system of ACSM and BC measurement and near-real time source apportionment (NRT-SA) results in 13 RI-URBANs pilot sites. This is being implemented in the pilot one of WP4.

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1. About this document

WP4 aims at testing and to demonstrating solutions for advanced urban AQ monitoring systems and evaluation of exposures (WP 1-3) at representative areas and hot spots in Europe. Specifically, implementing 5 testing and demonstration pilots in (originally) 9 cities (Athens, Barcelona, Birmingham, Bucharest, Helsinki, Milano, Paris, Rotterdam-Amsterdam and Zurich, with at least 3 cities in each pilot) and create synergies with WP5 to devise the roadmap for upscaling service tools (STs). These pilots encompass diverse European urban environments and will demonstrate at a real scale the ability to integrate complementary air quality (AQ) measurement systems in existing AQ monitoring networks (AQMNs), addressing modalities where the research infrastructures (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 pilots include the demonstration of the following STs
- Near-real time aerosol source apportionment (NRT-SA) of carbonaceous aerosols (T4.1).
- NRT nanoparticle-particle number size distribution (NRT-PNSD) data (T4.2)
- The urban fine scale mapping including innovative modelling, monitoring, and crowdsourcing (T4.3)
- Novel health indicators of nanoparticles and PM components and source contributions (T4.4).
- Quantifying emission sources in/near urban areas and identifying contribution of hotspots to air pollutant exposure (T4.5).

The pilot on NRT-SA of carbonaceous aerosols employs the source apportionment tool (from T1.2) for the ACSM (organics, sulphate, nitrate, ammonium and chloride) and multi-wavelength aethalometer (BC) data. Expected outputs: tracers and contributions of primary sources such as traffic, wood burning, and cooking (depending on measurement site); quantification of the secondary organic aerosols (SOA) fraction; automatic transfer of data (organic aerosols matrices and aethalometer BC concentrations) to ACTRIS DC. These will be reported on a monthly basis by the pilot cities (D22 (D4.1)) to allow uniform view on the sources of aerosol particles across European urban environments.

D22 (D4.1) describes the i) monthly reporting and ii) visualization system of ACSM and BC measurement and results in 13 RI-URBANs pilot sites from 8 cities. The reporting system is important in order to follow the progress of pilots, ensure comparability of the results and to validate the NRT-SA results in different pilot environments. Visualization is utmost important to have a quick access to data and enables quick comparison between sites.

This is a public document that will be distributed to all RI-URBANS partners for their use and submitted to European Commission as a RI-URBANS deliverable D22 (D4.1). This document can be downloaded at https://riurbans.eu/work-package-4/#deliverables-wp4

2. Instrumentation, pilot sites and data processing

2.1 Instrumentation

The measurements of carbonaceous particles in all cities are conducted with Aerosol Chemical Speciation Monitor (ACSM, Aerodyne Research Inc, US) and Aethalometer A33 (Magee Scientific, Slovenia). ACSM measures the mass concentration of organic compounds, sulphate, nitrate, ammonium and chloride and Aethalometer measures mass concentration of black carbon derived from absorption measurements. See Milestone M17 (M4.1): Source apportionment started, for the detailed description of the instrumentation.

2.2. Pilot sites

Measurements during the pilot phase (year 2023) will be conducted at 13 stations (pilot sites) situated in different environments (2 traffic, 9 urban, 1 suburban and 1 regional) from 8 cities. Figure 1 shows the locations of these pilot sites. The exact locations of the sites and station codes are given Table 1.

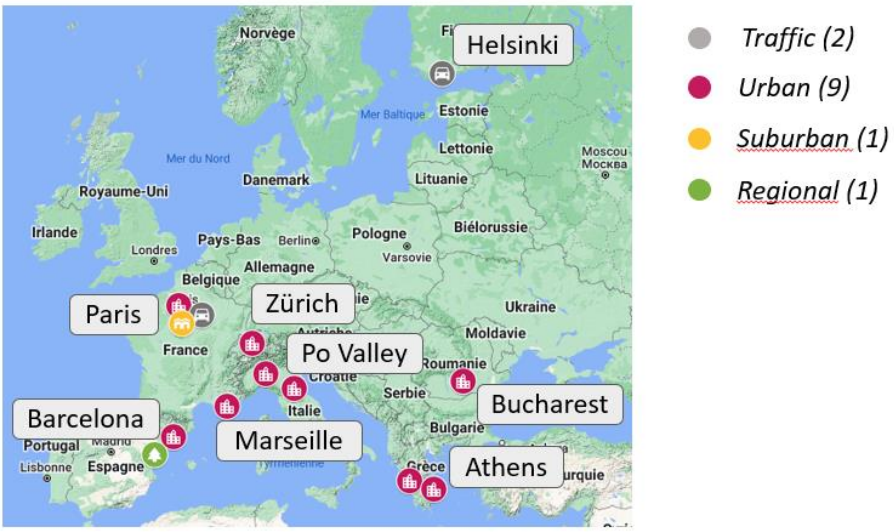


Figure 1*. Geographical locations of the near-real-time source apportionment (NRT-SA) pilot sites.*

Table 1. *The information of pilot stations (Name, EBAS ID, coordinates, EBAS platform and lab IDs, framework and EBAS station name).*

Pilot city	Station Name	EBAS Station ID	Lat (°) N	Lon (°) E	EBAS Platform ID	EBAS Lab ID	framework	EBAS Station Name
Paris	SIRTA	FR0020R	48.719	2.149	FR0020S	FR01L	ACTRIS / RI-URBANS	SIRTA Atmospheric Research Observatory
Paris	Chatelet	FR0041U	48.86214	2.34462	FR0041S	FR21L	RI-URBANS	Paris Chatelet
Paris	BPEst	FR0042U	48.83857	2.412713	FR0042S	FR21L	RI-URBANS	Paris BPEst
Athens	AthensNOA	GR0004U	37.97312	23.71805	GR0004S	GR07L	ACTRIS / RI-URBANS	Athens NOA
Athens	AthensDEM	GR0100B	37.99532	23.81672	GR0100S	GR05L	ACTRIS / RI-URBANS	DEM_Athens
Bucharest	RADO-Bucharest	RO0007R	44.344°N	26.012°E	RO0007S	RO03L	ACTRIS / RI-URBANS	Bucharest
Helsinki	Supersite	FI0039U	60.19635	24.95222	FI0039S	FI03L	RI-URBANS	Mäkelänkatu
Po Valley	Milano	IT0025U	45.47833	9.23144	IT0025S	IT006L	ACTRIS / RI-URBANS	Milano Pascal
Po Valley	Bologna	IT0022C	44.52366	11.33833	IT0022S	IT006L	ACTRIS / RI-URBANS	ISAC Bologna II
Zürich	Kaserne	CH0010U	47.37759	8.530419	CH0010S	CH02L	RI-URBANS	Zürich-Kaserne
Marseille	Longchamp	FR0035U	43.30529	5.394716	FR0035S	FR17L	RI-URBANS	Marseille Longchamp
Barcelona	PalauReial	ES0019U	41.38744	2.115306	ES0019S	ES05L	ACTRIS / RI-URBANS	Barcelona
Barcelona	Montseny	ES1778R	41.77934	2.358033	ES1778S	ES05L	ACTRIS / RI-URBANS	Montseny

2.3 Data processing, reporting and visualization

Milestone M18 (M4.2) describes the dataflows from the pilot sites to server and to subsequent visualization in detail. Figure 2 represents the simplified version of the data flow from stations to server.

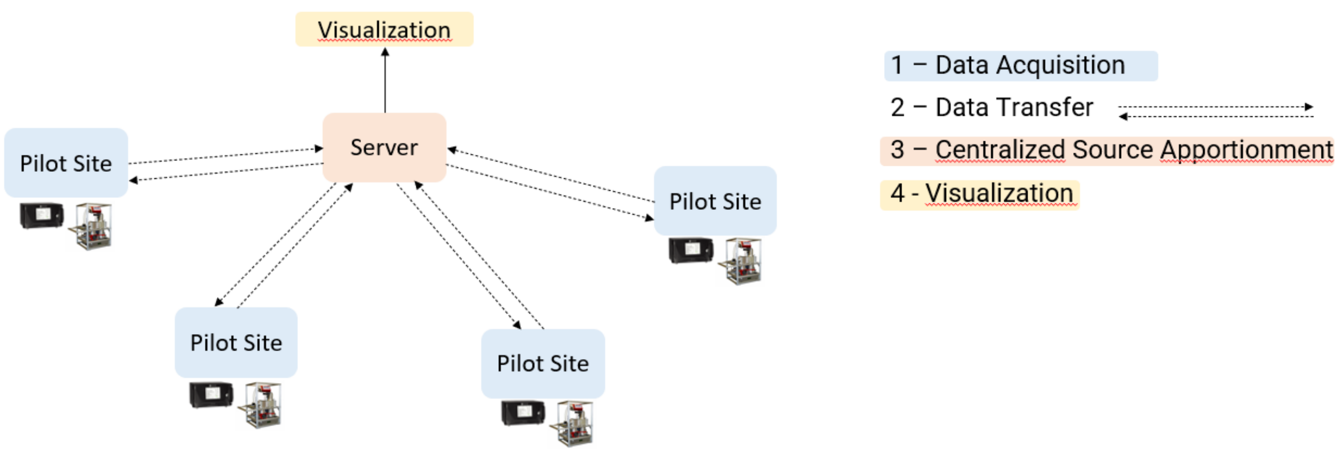


Figure 2. *The schematics of the dataflow system from pilot sites to server and visualization.*

A reporting template was compiled to assist pilot cities in the monthly reporting of results. The template (Annex 1) includes information about the instruments, main results of manual source apportionment, and information about anything unusual (breakdowns, events, observations, etc.) during the month. Annex 1 shows an example report from Helsinki at March 2023. The reports are collected by task leaders for subsequent use. To harmonise communication and reporting, following colours for different source apportionment results were recommended (see Table 2).

Table 2. *Proposed colours, abbreviations, and factor names for source apportionment results.*

Color	Abbreviation	Name
	BClf	Liquid fuel Black Carbon
	BCsf	Solid Fuel Black Carbon
	HOA	Hydrocarbon-like Organic Aerosol
	BBOA	Biomass Burning Organic Aerosol
	COA	Cooking Organic Aerosol
	SFOA	Solid Fuel Organic Aerosol
	CCOA	Coal Combustion Organic Aerosol
	58-OA	Organic aerosol with m/z 58
	Coffee OA	Coffee roastery Organic aerosol
	Ship Industry OA	Shipping Organic aerosol
	Sea Salt	Sea salt organic aerosol
	CSOA	Cigarette Smoking Organic Aerosol
	MOOOA	More Oxidized Organic Aerosol
	LOOOA	Less Oxidized Organic Aerosol

To ensure progress, monthly meetings are organized continuously during 2023 with pilot sites to go through the ACSM and AE33 as well as NRT-SA results and status of measurements in each month. Any issues will be reported by cities.

3. PM concentration, composition, and source apportionment results

The hourly/ daily/ monthly average ACSM, AE33 and NRT-SA results can be found and visualized in real time from the internet page that is being compiled for this purpose. The aim is that air quality monitoring networks can see their source apportionment results from there as needed. Figure 3 shows the left control panel of visualization page. The panel contains the information about the selected site and allows user to select the time period, plotted components as well as the style of graphical presentation. All plots are given for the selected style and for the selected time period. This enables a quick plotting of the data in different locations.

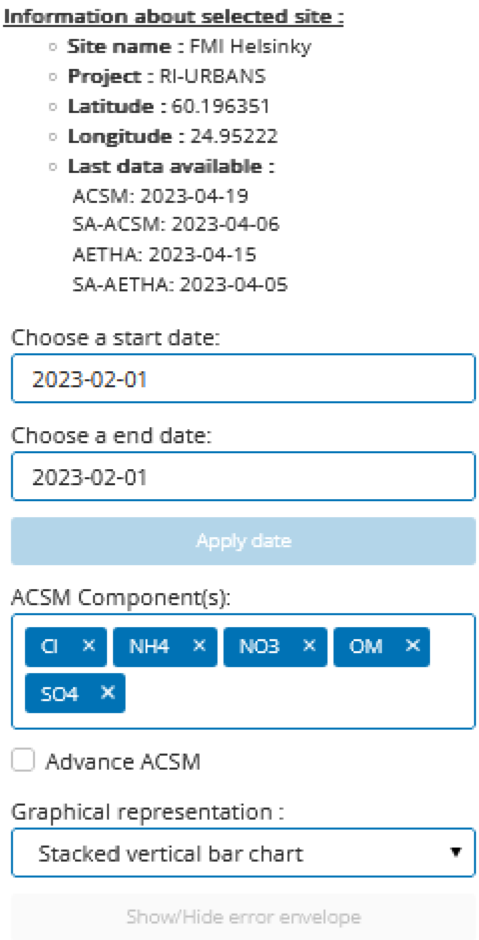


Figure 3*. Panel overview allowing the user to select different time period, chemical component and graphical presentation format. Panel also shows the basic information about the selected site.*

To enable usability and easy availability of the data, at the top of the page there is a map of geographical locations with measurements (Figure 4). By selecting a particular location, the available data from the corresponding location can be visualised/ plotted for a selected period.

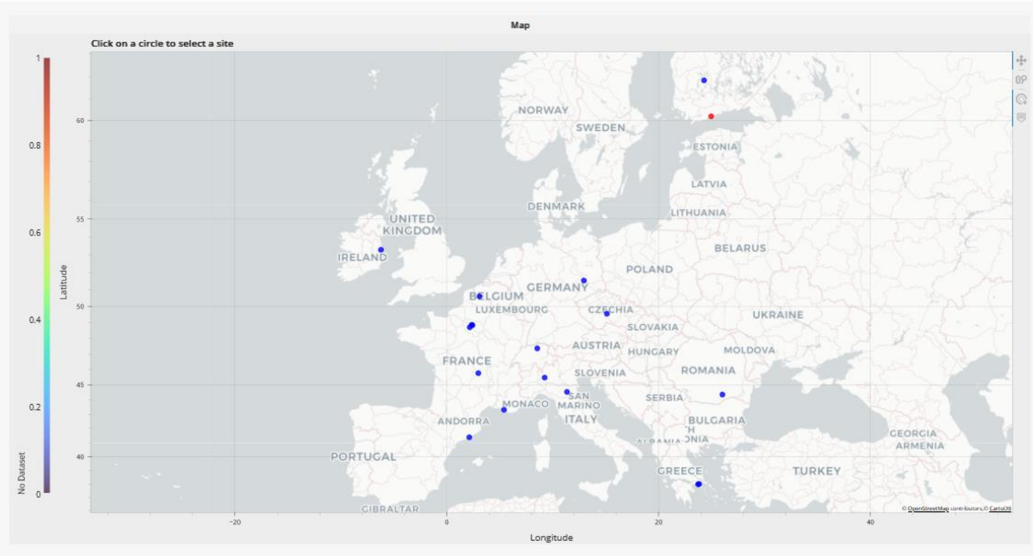
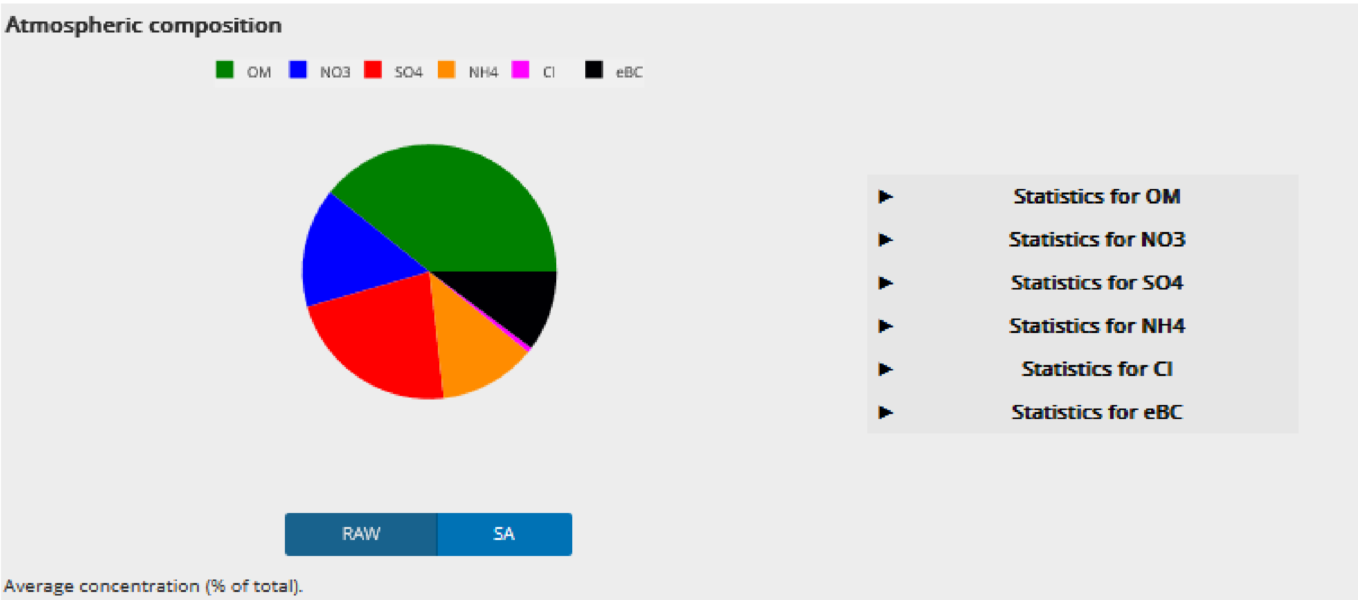
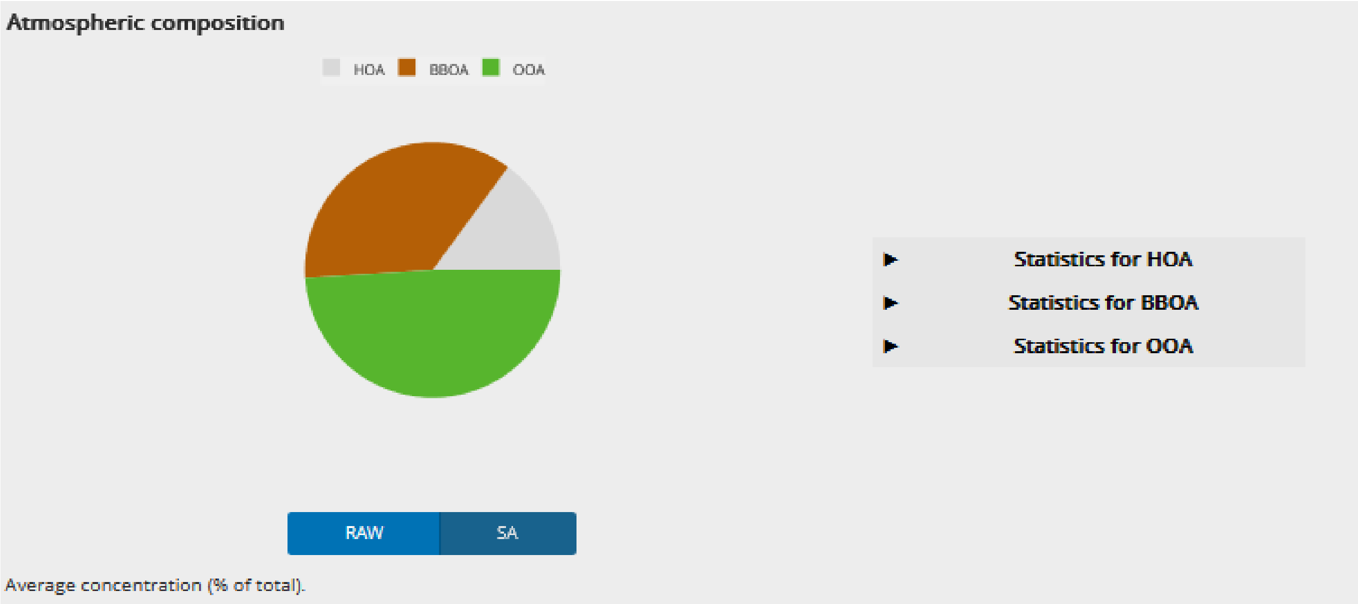


***Figure 4**. The map visualizing the geographical locations of the measurement sites. By clicking on the city name, data from the corresponding city can be plotted.*

Next to the map (shown in Figure 4) the average contribution of chemical species (organics, sulphate, ammonium, nitrate, chloride) or factors with statistics (maximum, minimum, mean and standard deviation) is shown for all chemical components and factors (Figure 5) for a selected time period. This enables a quick view on data for a given time period.



(a)

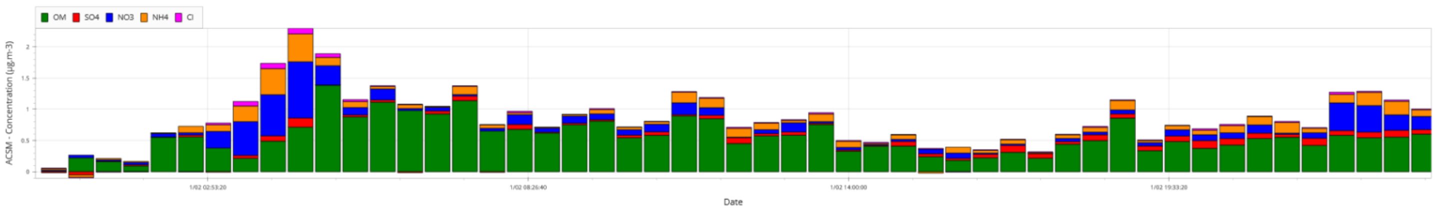


(b)

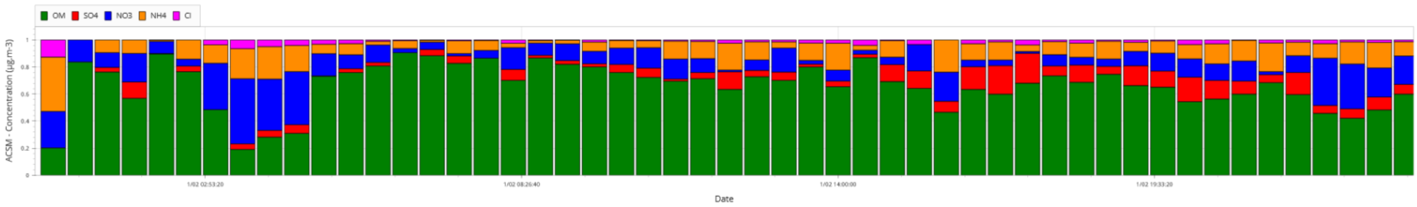
Figure 5. *Visualization (pie-chart) of the a) composition and b) average concentration for the factors identified by the NRT-SA. OM=organic matter, NO3=nitrate, SO4=sulphate, NH4=ammonium, Cl=chloride, eBC=equivalent BC, HOA=Hydrocarbon-like organic aerosol, BBOA=Biomass Burning Organic Aerosol, OOA=Oxidated organic aerosol. Example data is from SIRTA station at May 2023.*

3.1. ACSM

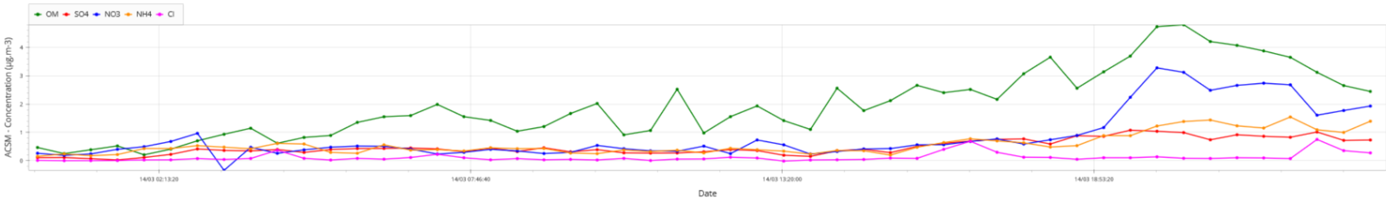
For ACSM visualization of hourly average composition and contribution of different species (organic matter, sulphate, nitrate, ammonium, chloride) are given for selected time periods as shown below in Figure 6. Also, the three panels (a-b-c) represent the different visualization options; stacked bars, stacked contributions and scatter plot for all data.



(a)



(b)

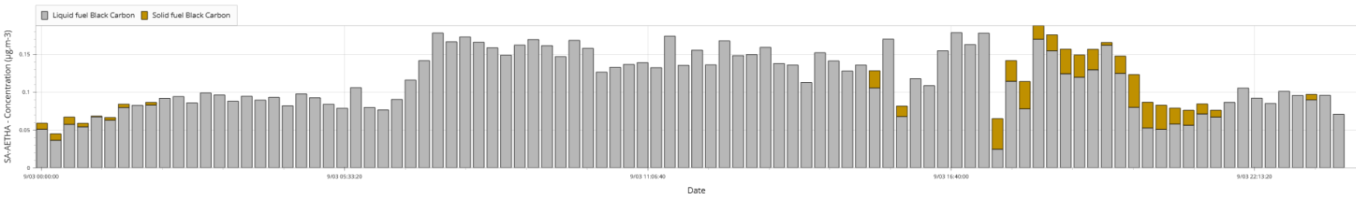


(c)

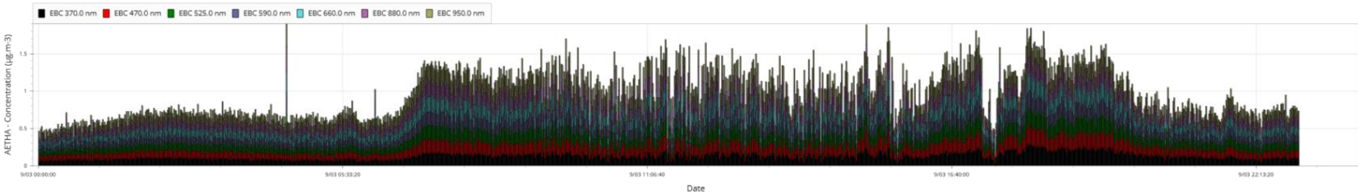
***Figure 6**. Examples of visualization of ACSM results during 1.2.2023 at Helsinki (Finland) pilot site with three different visualization options: (a) timeseries of concentrations of individual compounds stacked, (b) contributions of individual compounds and (c) the timeseries of individual compounds.*

3.2. AE33

For the aethalometer, the visualization shows both hourly average contribution of BCsf and BClf as well as average absorption at different wavelengths between 370 nm and 950 nm (Figure 7).



(a)

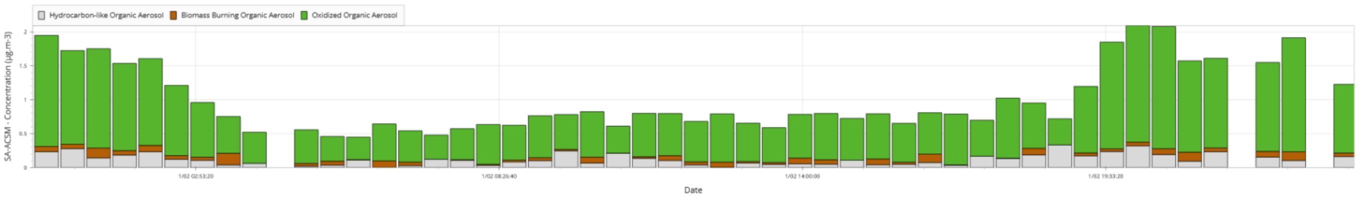


(b)

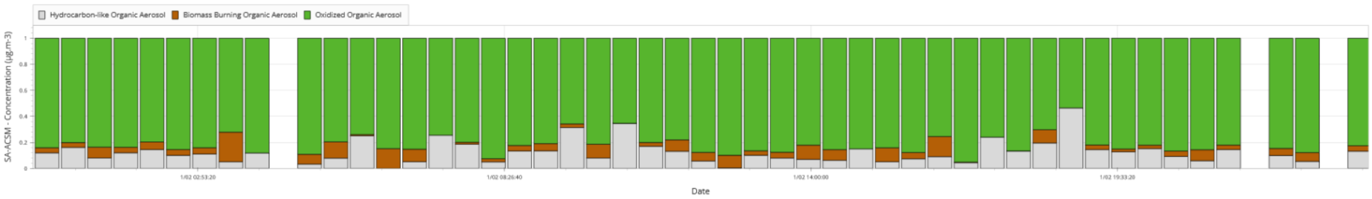
***Figure 7.** Examples of visualization of AE33 results during 9.3.2023 at Sirta, France: (a) timeseries of source apportionment results (solid fuel and liquid fuel black carbon concentrations) and (b) timeseries of concentrations of BC at the seven different wavelengths from 370nm to 950nm.*

3.3. NRT-SA

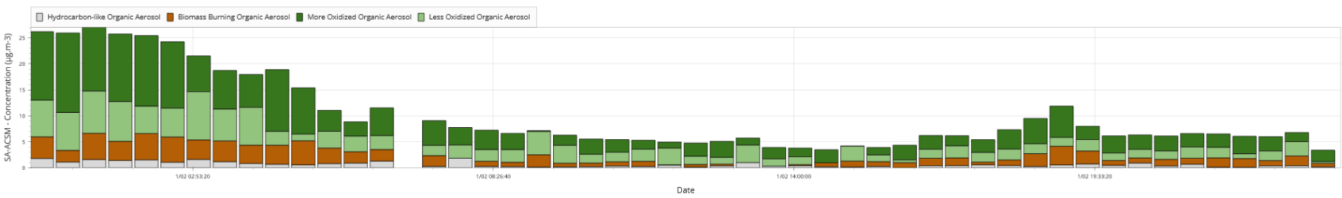
For the NRT-SA, the visualization tool shows hourly average source apportionment results either as average concentration or contribution (Figure 8) of factor. Typically 3-6 factors are identified, depending on the site and season.



(a)



(b)



(c)

***Figure 8**. The NRT-SA results for SIRTA, France (a,b) and Bucharest, Romania (c) stations at 1.2.2023.: (a) the concentrations (a) and contributions (b) of factors in SIRTA France and (c) concentrations of factors at Bucharest , Romania.*

4. Conclusions

The near-real-time source apportionment (NRT-SA) on the ACSM and AE33 data is successfully running. The developed visualization tool enables easy plotting of results and results are available for the air quality monitoring network (AQMN) in easy and understandable format. Hourly, daily or monthly average concentrations as well as NRT-SA results for both ACSM and AE33 can be extracted from the visualization tool for any of the pilot sites and for any month.

Furthermore, the RI-URBANS pilot sites will compile monthly report (example in Annex 1) containing information about the chemical composition and manual offline source apportionment results. Monthly meetings are kept with pilot sites to go through the NRT-SA and manually conducted PMF results with the sites. This enables validation of the NRT-SA results in different measurement locations.

The follow-up deliverable D4.2 will conduct an in-depth comparison between the NRT-SA and manually conducted PMF results in order to validate the NRT-SA results.

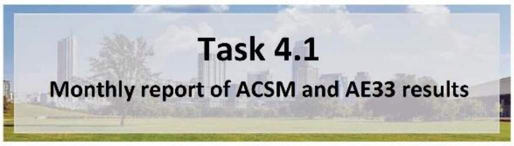
5. References

Chen, G., Canonaco, F., Tobler, A., Aas, W., Alastuey, A., Atabakhsh, S., Aurela, M., Baltensperger, U., Bougiatioti, A., Brito, D., Ceburnis, D., Chazeau, B., Chebaicheb, H., Ehn, M., Haddad, I. E., Eleftheriadis, K., Favez, O., Flentje, H., Font, A., Fossum, K., Freney, E., Gini, M., Heikkinen, L., Herrmann, H., Kalogridis, A.-C., Lhotka, R., Lin, C., Lunder, C., Maasikmets, M., Manousakas, I., Marchand, N., Marin, C., Marmureanu, L., Močnik, G., Nęcki, J., O'Dowd, C., Ovadnevaite, J., Peter, T., Petit, J.-E., Pikridas, M., Platt, S. M., Pokorná, P., Poulain, L., Priestman, M., Riffault, V., Rinaldi, M., Różański, K., Schwarz, J., Sciare, J., Simon, L., Skiba, A., Slowik, J. G., Stavroulas, I., Styszko, K., Teinemaa, E., Timonen, H., Vasilescu, J., Via, M., Vodička, P., Wiedensohler, A., Minguillón, M. C., and Prévôt, A. S. H.: European Aerosol Phenomenology - 8: Harmonised Source Apportionment of Organic Aerosol using 22 Year-long ACSM/AMS Datasets, Environ. Int. 166, 107325.

6. ANNEX 1. Example of monthly reporting template from Helsinki site for March 2023

European Commission

ANNEX 1. Example monthly reporting template from Helsinki site at March 2023



RI-URBANS

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

By

Finnish Meteorological Institute

European Commission

Work package (WP)	WP4, Task 4.1
Name of the station	Helsinki, Finland
Month	03, 2023
Instruments	Q-ACSM AE33
Analysis made by	M. Aurela, FMI
Comments	Annex 1. contains proposed colors for the source apportionment results

1. Timeseries of main compounds during the month

Data analysis has been conducted with IGOR 8.04. Collection efficiency (CE) default value of 0.45 was used. Table 1. contains information about the measured concentrations.

Table 1. the average concentration and contribution of different compounds in ACSM during the month.

Compound	*Concentration (µg m-3)*	*Contribution (%)*
Organics	***1.49***	***55.4***
Sulphate	***0.40***	***14.9***
Nitrate	***0.49***	***18.1***
Chloride	***0.03***	***1.1***
Ammonium	***0.28***	***10.5***

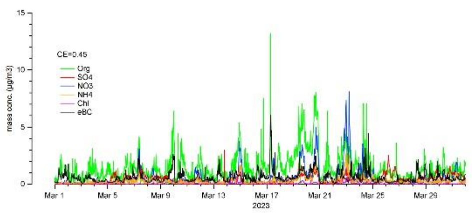


Figure 1. The timeseries of organics, sulfate, nitrate, ammonium and chloride measured with ACSM and eBC measured with AE33.

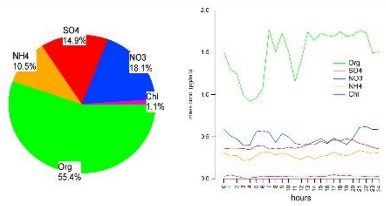


Figure 2. Monthly average contribution and diurnal variation of different compounds (organics, sulfate, nitrate, ammonium and chloride) during the month.

PMF results

Table 2 shows the list of identified factors and source and identification information. The factors HOA and BBOA were constrained. In PMF following details were used (100 runs, random a-value, bootstraps enable, evaluation criteria)

Table 2. Factor name and source/identification information

Factor name	*Constrains (value, ref)*	*source, idenfitication*
HOA	***0.262 (3-F) a-value range: 0.1-0.4***	***traffic, diurnal correlates with BC_{lf}***
BBOA	***0.305 (3-F) a-value range: 0.1-0.5***	***Biomass combustion, ts corr with BC_{sf} explained var m/z 60***
OOA		***Oxygenated organic aerosol, all selected***
..		

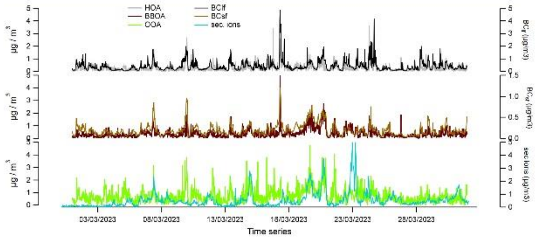


Figure 3. Timeseries of different factors with external timeseries.

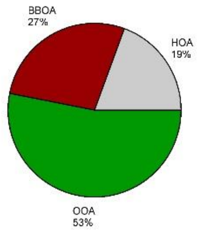


Figure 4. Monthly average contributions of PMF factors. The left pie with Coffee Roaster factor and right one without it.

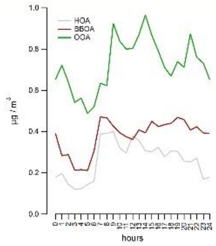


Figure 5. Diurnal variation of factors. The left plot with Coffee Roaster factor and right one without it.

2. AE33 source apportionment

Aethalometer AE33 was used to measure the BC concentration and aethalometer model to analyse the BCsf and BClf contributions. Table 4. includes the used values for $\alpha_{sf\ and}\ \alpha_{sf}$

Table 4. The parameters for AE33 and any notes comments related to AE33 operation during that month.

Parameter	value
Average BC concentration (µg m-3)	**0.59**
α_{sf}	**1**
αl_f	**1.6**
Any notes/comments	α_{sf} and αl_f have been estimated from filter samples (e.g. levoglucosan)

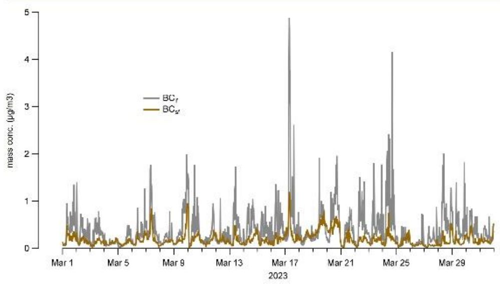


Figure 6. Timeseries of BCsf, BClf during the month. Averaged to the ACSM-time range.

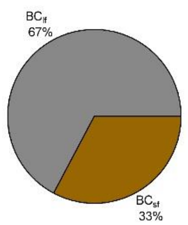


Figure 7. Average contributions of BCsf, BClf during the month

3. Description of observations during the month

Table 3. includes description of observations as well as information about any abnormal events during the month, such as technical issues, changes in filter tape or parts (filament, detector), calibrations, events affecting air quality (forest fires, LRT, etc)

Table 3. observations and information about disruptions during the month.

Time	Description of observation, disruption (breakdown, change of filament) or event (LRT, forest fire, road dust etc..)
March 2023	Peaks from Coffee Roastery not seen

4. Any additional comments

Please, send report preferably prior to the task 4.1 meeting (15. day of each month) to Hilkka Timonen Hilkka.timonen@fmi.fi and Jean-Eudes Petit jean-eudes.petit@lsce.ipsl.fr . Any questions and comments are also welcome!

Annex 1. Proposed colours for the source apportionment results

	BClf	Liquid fuel Black Carbon
	BCsf	Solid Fuel Black Carbon
	HOA	Hydrocarbon-like Organic Aerosol
	BBOA	Biomass Burning Organic Aerosol
	COA	Cooking Organic Aerosol
	SFOA	Solid Fuel Organic Aerosol
	CCOA	Coal Combustion Organic Aerosol
	58-OA	

	Coffee OA	
	Ship Industry OA	
	Sea Salt	
	CSOA	Cigarette Smoking Organic Aerosol
	MOOOA	More Oxidized Organic Aerosol
	LOOOA	Less Oxidized Organic Aerosol

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