ST2: Equivalent black carbon
ST11: Source apportionment of eBC

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ST2: Equivalent black carbon

- AQ Directive: Black carbon' or 'BC' means carbonaceous aerosols measured by light absorption → BC to be monitored in super sites.
- Optical absorption is proportional to BC by a constant factor called the 'mass absorption cross-section' (MAC).
- There is no standard method for measuring "BC" mass concentration, and therefore no limit value → Indirect determination → several sources of uncertainties!
- Different measurement principles: Optical measurements (light absorption coefficient) and thermal-optical analysis (elemental carbon mass concentration).
- A suitable MAC for the conversion of light absorption into mass concentration, when reporting eBC mass concentration
- A harmonized way to apply corrections to filter-based absorption photometers (i.e. filter-loading, multiple scattering effect) is needed.

→ Reference measurements are required to measure the absorption coefficient and correct for filter photometer artifacts!

Added Value of RI-URBANS Service Tool 2 (Black Carbon Guideline)

Definition of Black Carbon (BC)	Provides a clear and standardized framework for distinguishing eBC, supporting consistent use in research and policy.
Methods for Determining eBC	Offers validated protocols (FAPs) ensuring reproducibility and comparability across sites.
Harmonization of Absorption and eBC Determinations	Aligns methodologies across monitoring networks, reducing discrepancies and enabling interoperability.
Data Management	Establishes common formats and processing guidelines, supporting near-real-time source apportionment and FAIR data principles.
Recommendations and Main Findings	Demonstrated added value in pilot cities: improves variability representation, reduces artefacts, supports EU AQ Directive inclusion of BC.

Pan-European overview of eBC mass concentrations in urban Europe

- Need for more long-term in-situ monitoring of BC and EC mass concentration across diverse urban, remote environments.
- Lack of harmonized methods, ensuring data comparability within European AQ monitoring networks.
- Integration of harmonized Absorption and BC data into climate-related and modeling studies.
- Harmonized source apportionment practices directly linked to health impacts.
- Real-time eBC source apportionment is needed for efficient abatement measures.

Steps to go further what FAPs are providing as raw data (eBC)

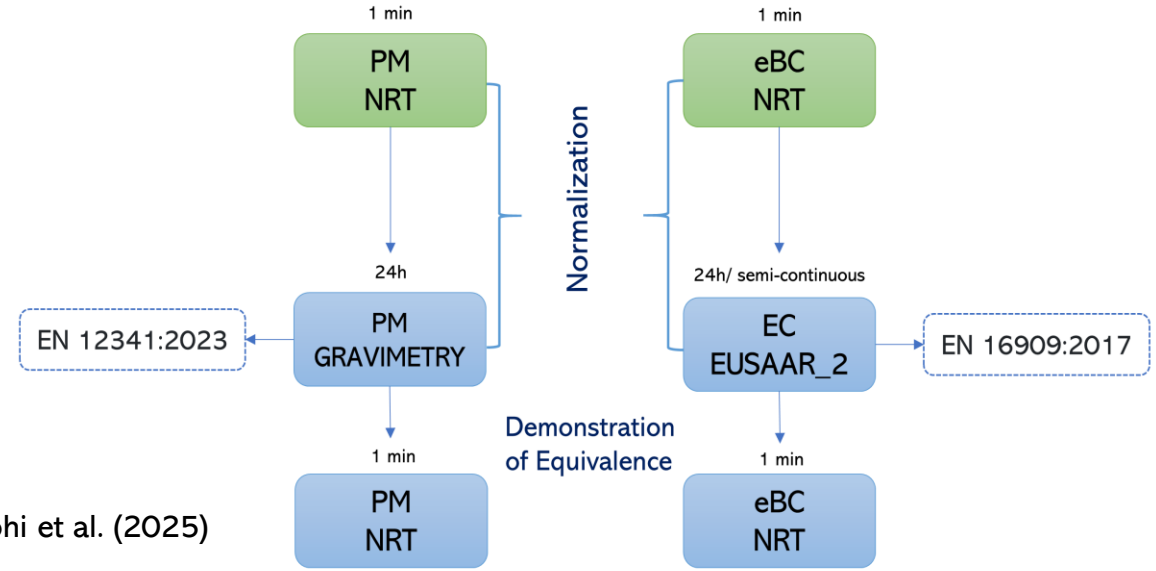
- For demonstrating the equivalence of a candidate method (e.g. the Beta-gauge technique) with the reference (gravimetric) method, it is allowed to establish first a site and time dependent calibration factor.
- Using site and time dependent MAC values would very probably make it possible to demonstrate the equivalence between FAP techniques and the CEN standard method (EN16909) for determining EC.

The EN 16909 standard method for determining EC → EC

GRAVIMETRY Protocol for Europe (Reference technique) → PM

BC ← FAPs (filter absorption photometers; MAAP, AE33, AE36)

PM ← NRT techniques for PM mass concentration (GRIMM;…)



Savadkoohi et al. (2025)

ST11: Source apportionment of BC

AE approach (Sandradewi et al., 2008) → Only two sources of pollution (limitation) ≠

Aircraft

Industrial

Shipping

On-road, Off-road cars

Agricultural burning

Wildfires

Heating

Cooking

primary & secondary emission sources

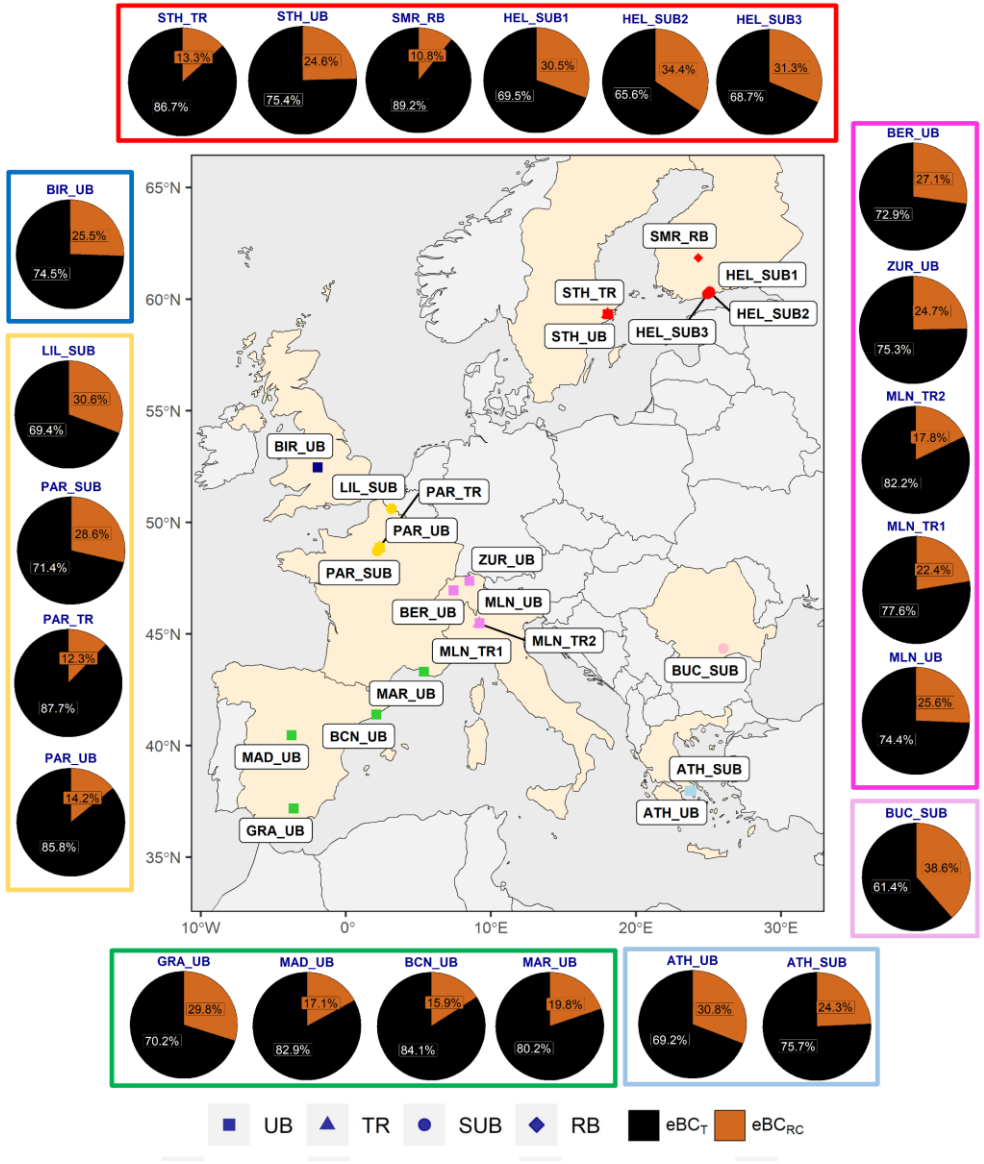
❗ Highly sensitive to the choice of:

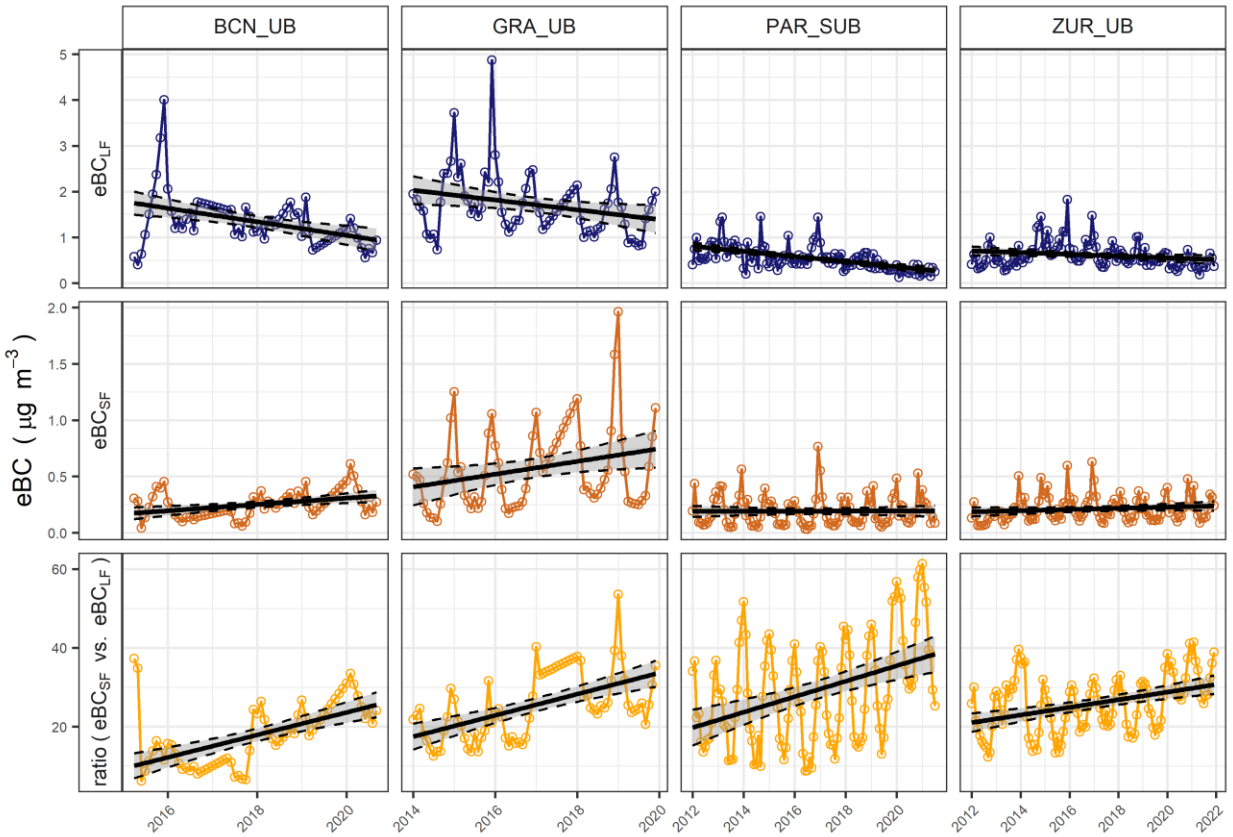
Absorption Angstrom exponents (AAE) pairs

- **AAE_{LF}** (liquid fuels): ~0.8–1.2
- **AAE_{SF}** (solid fuels): variable, >1

- **Fixed AAE values** → ignores variability from sources, fuels, combustion conditions.
- AAE is **site-dependent** (affected by source mix, atmospheric aging, morphology, transport).

r analyzing temporal
› AQ policies!



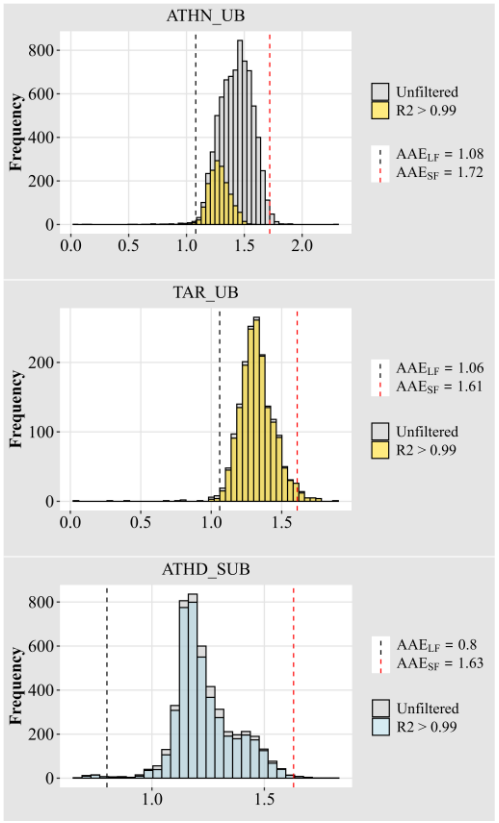


Source: Savadkoohi et al. (2023)

Methodological Approaches in ST11

- Refine the **AE SA approach**.
- Evaluate model performance with site-dependent AAE_{LF} & AAE_{SF}.
- Assess applicability of site-dependent approach for near real-time eBC dataset.

→ AAE probability density function and percentile threshold to identify AAE_{LF} and AAE_{SF}



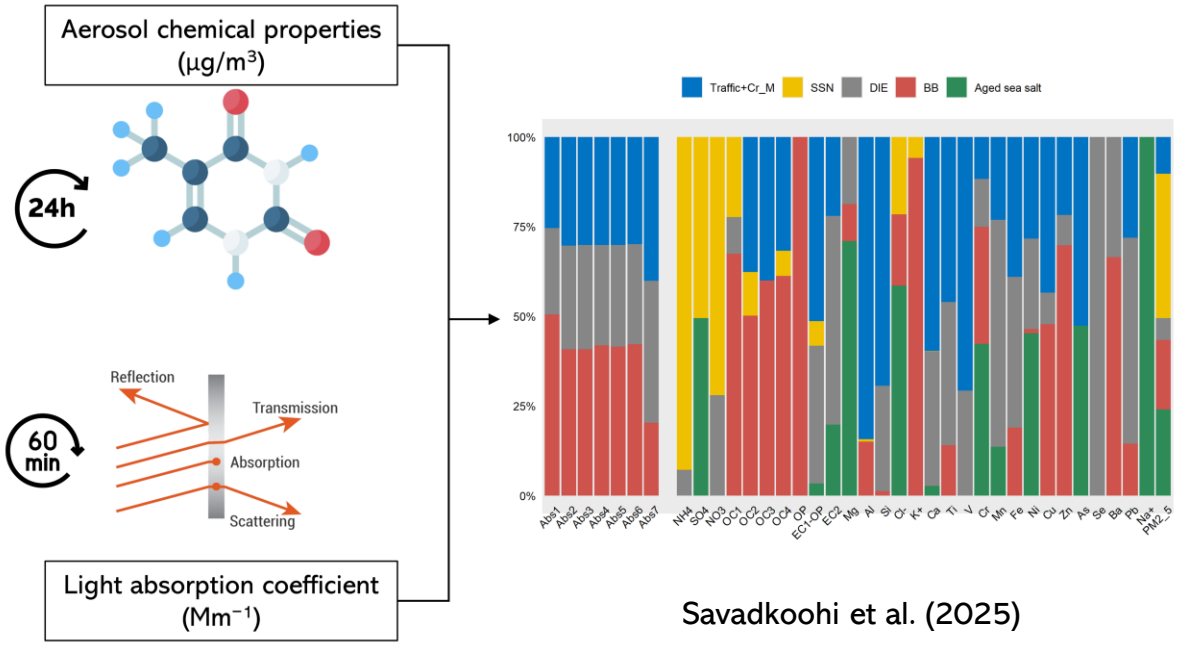
Savadkoohi et al. (2025)

Assessed the performance of PC approach: signal at mass-to-charge 60 (m/z 60; from ACSM) measurements, as an independent indicators of BB emissions.

❖ Variability in AAE also affected by **solid fuel sources rather than BB** → **Aged organic aerosol** with diverse chemical/physical properties, and **brown carbon** contributions → **misclassification**, especially with overlapping sources (e.g., shipping, coal, biomass, wildfires, traffic)

Other source apportionment methods

- High-resolution chemical + optical data enable **multi-time resolution factor analysis (MT-FA)** using receptor models.



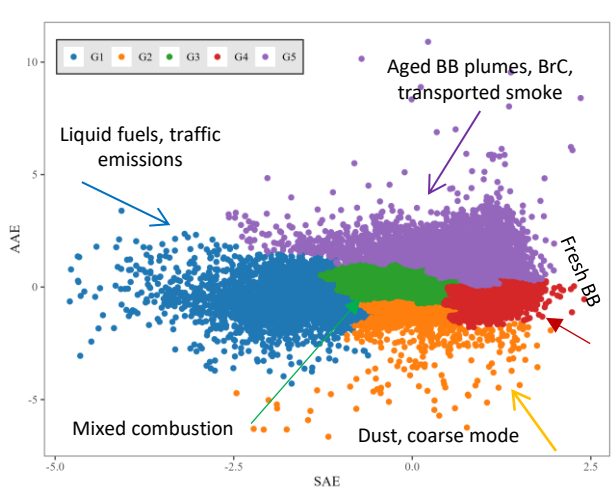
Savadkoohi et al. (2025)

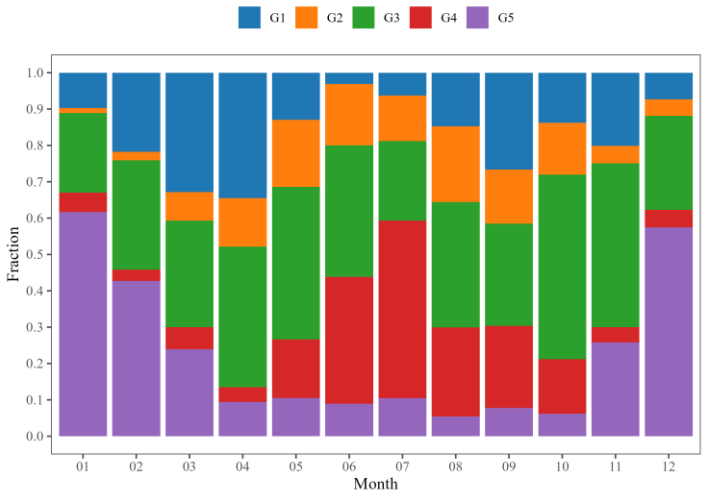
Site & source-specific AAE variability

Other source apportionment methods

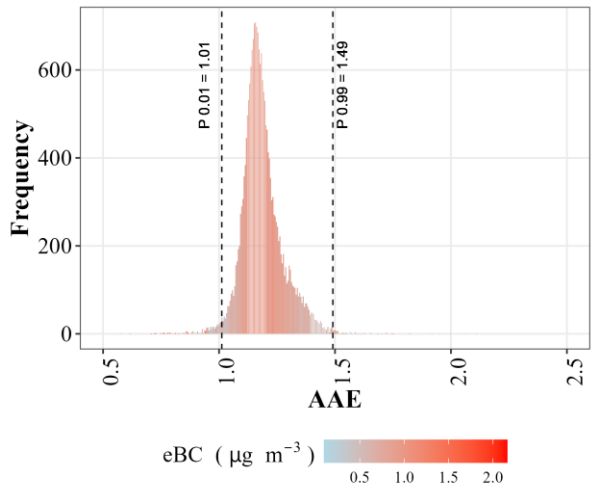
- Aerosol light scattering and absorption using Clustering analysis

BCN-UB

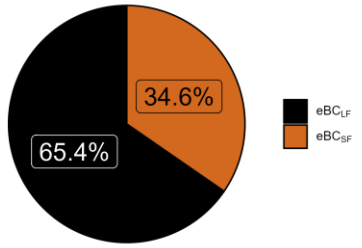




Percentile approach



Aethalometer approach



Savadkoohi et al. (2025), in preparation