Metrology for light absorption by atmospheric aerosols: the EMPIR Black Carbon Project

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Motivation

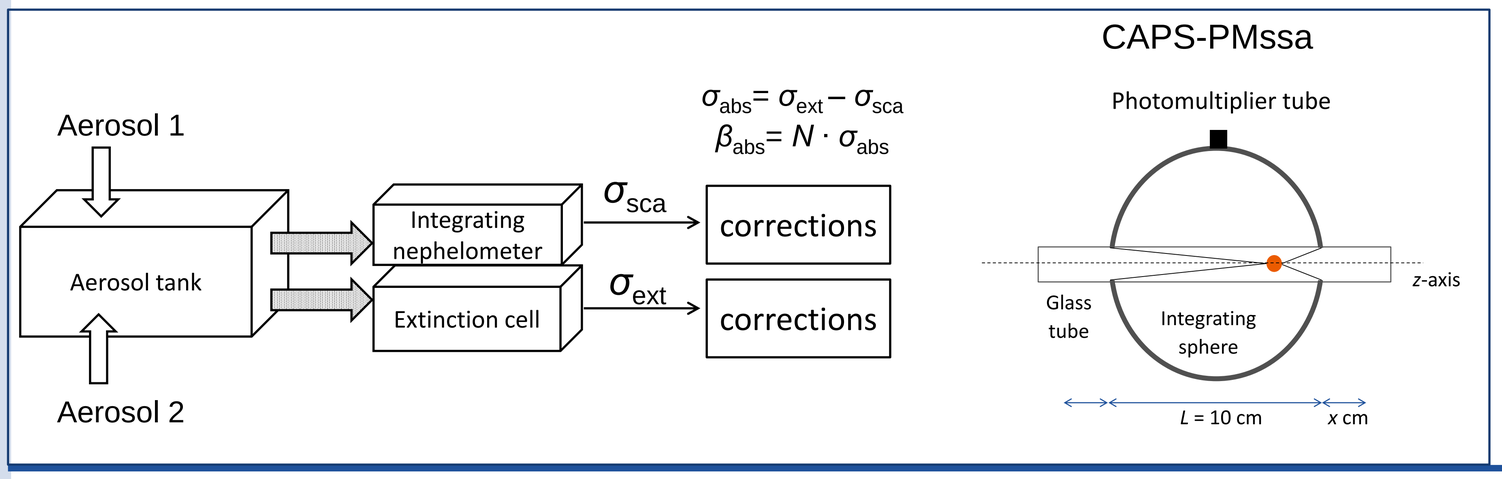
Black carbon (BC) is widely recognized as the foremost particulate absorber of solar radiation in the atmosphere and has been associated with the detrimental health effects of air pollution. To monitor BC concentrations, the atmospheric-science community has developed an array of technologies based on light absorption measurements[1,2]. These absorption measurements are typically reported as mass concentrations of Equivalent Black Carbon (EBC) by using a standard mass absorption cross-section at a given wavelength. However, there is currently a lack of SI traceability for such absorption measurements. In addition, the most common field instruments measure EBC after depositing aerosol particles onto a filter, which introduces complex uncertainties and a need for standardized calibration methods[3].

The EMPIR Black Carbon project, *Metrology for light absorption by atmospheric aerosols (2017 – 2020)*[4], aims to establish SI traceability for atmospheric aerosol light absorption measurements, based on filter-free methods such as extinction-minus-scattering, photoacoustic spectroscopy, or photothermal interferometry, as well as standardised calibration procedures for filter-based instruments.

Scientific Objectives

WP1

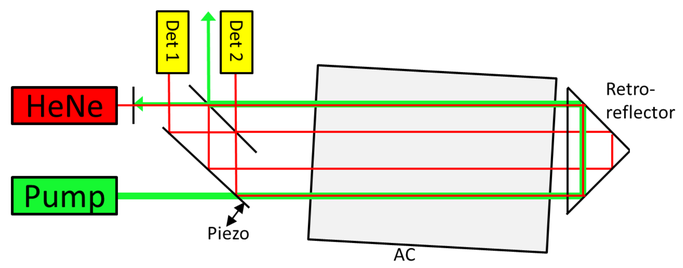
Absorption = Extinction - Scattering



Photoacoustic spectroscopy (not shown)

CAPS-PMssa

Photothermal interferometry

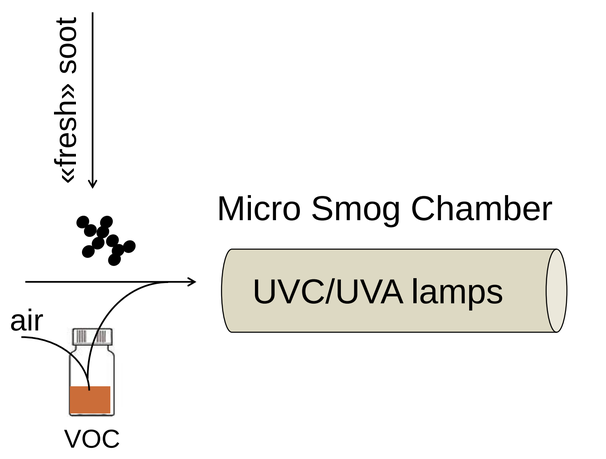


WP1 will seek to establish SI traceability for primary in-situ methods to measure the light absorption coefficient of airborne particles. The provision of traceability for the underlying physical measurement will underpin the other technical work packages.

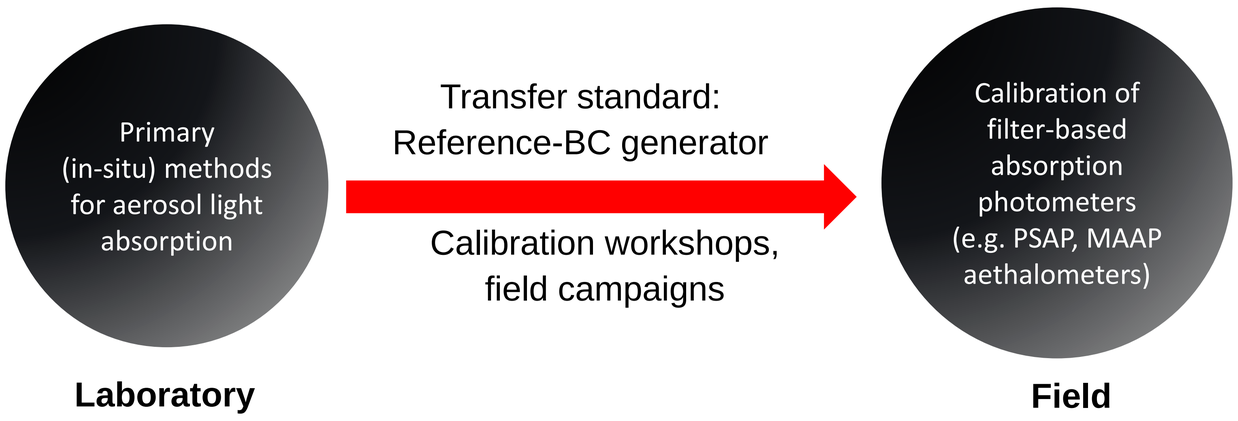
WP2

Candidate BC aerosol sources → 1. rough parameters of BC source → Physical characterisation of aerosols (e.g. SMPS, EC/OC, Aethalometer, nephelometer microRaman, TEM) → 2. select optimal operation points → **Model Aerosol 1 (fresh soot)** mobility diameter 50 nm - 100 nm, EC/TC>0.8, AAE ~1, SSA ~0.4 → Accurate characterisation with primary methods (WP1)

WP2 will investigate and select candidate methods in order to simulate "fresh" and "aged" light-absorbing atmospheric aerosols in the lab. Several BC aerosol sources/materials[5] will be tested, including diffusion flame generators, graphite spark generators, fullerene soot, colloidal graphite and black polystyrene latex spheres. To produce "aged" aerosols a micro smog chamber will be used. The model aerosols will be characterized using the facilities developed in WP1.



WP3



WP3 will build on WPs 1 and 2 to **provide a practical and robust calibration procedure for Black Carbon monitoring methods** commonly used in Europe[6]. The validation will include checks under controlled laboratory conditions, targeted field campaigns and round robin exercises.

Literature

[1] T. C. Bond and R. W. Bergstrom, "Light absorption by carbonaceous particles: An investigative review", Aerosol Science and technology, **40**, 27-67, 2006

[2] H. Moosmüller et al., "Aerosol light absorption and its measurement: A review," J. Quant. Spect. Rad. Trans., 110(11), 844-878, 2009.

[3] A. Petzold et al., "Recommendations for reporting black carbon measurements", Atmos. Chem. Phys., **13**, 8365-8379

[4] www.empirblackcarbon.com

[5] Soot reference materials for instrument calibration and intercomparisons: a workshop summary with recommendations, D. Baumgardner et al., Atmos. Meas. Tech. **5**, 1869-1887, 2012.

[6] https://www.actris.eu/DataServices/ObservationalFacilities/AccesstoObservationalFacilities.aspx

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