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MONITORING OF THE AIR POLLUTANTS BLACK CARBON & ULTRAFINE PARTICLES: IMPORTANCE, GUIDELINES, QUALITY ASSURANCE & CAPACITY BUILDING

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Advanced Aerosol Variables for Air Quality Measurements

- To obtain a **better understanding** of the health risk of aerosol particles, following variables became of interest to measure:
 - **particle number concentration (PNC)**
 - **mass concentration of equivalent black carbon (eBC)**
- The focus is on variables related to **ultrafine particles (UFP)**
- UFP are defined as **particles <100 nm** in diameter
- The main **sources of UFP** in the city are automotive & industrial **emissions by combustion**.



WHO Global Air Quality Guidelines (Sept. 2021)

- There are also **now clearer insights** about sources of emissions and the **contribution of air pollutants** to the **global burden of disease**.
- Certain types of PM, such as **black carbon**, elemental carbon, and **ultrafine particles**.

DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

Proposal of the EU directive from 2022

- Fixed measurements of particulate matter (PM10 and PM2.5), nitrogen dioxide (NO₂), ozone (O₃), **black carbon** (BC), ammonia (NH₃) and **ultrafine particles** (UFP).



ACTRIS ERIC

- ACTRIS is a distributed **European Research Infrastructure Consortium (ERIC)**
- ACTRIS has more than **100 National Facilities** for aerosol, cloud, & trace gas measurement across Europe.
- **Aerosol in-situ measurements** are performed at about **80 observatories and exploratory platforms** (chambers & mobile facilities)
- ACTRIS has **Central Facilities (CF)** for all components to assure the quality of the measurements and data
- The **Center for Aerosol In-Situ Measurements (CAIS-ECAC)** is the responsible CF for the **QA/QC of the aerosol in-situ measurements** at the National Facilities.



ACTRIS Standard Procedures

- CAIS-ECAC developed **standard procedures for 12 advanced aerosol in-situ measurements** variables incl. PNC and eBC (via light absorption).
- CAIS-ECAC standard procedures are **based on ISO & CEN standards**, scientific publications, and the **WMO-GAW** guidelines.
- CAIS-ECAC provides **performance test for instruments** of different manufacturers to confirm the ACTRIS compliance for high quality measurements.
- CAIS-ECAC provides **traceable instrument calibrations** against reference instruments & certified standards.
- All ACTRIS aerosol **in-situ instruments** are calibrated at the central facilities **bi-annually**.



Quality assurance - PNC

- PNC measurement must follow coming up **EU standard** (current version prEN 16976).
- The lower detection efficiency **diameter is 10 nm**.
- The determination of the PNC is taken often as **proxy for UFP measurements**.
- There are Condensation Particle Counters (CPC) following the EU standard. The employment of the **CEN CPCs is obligatory** for the PNC measurement.
- **Biannual calibrations** for the detection efficiency and linearity for high concentrations are obligatory.



Quality assurance – eBC (Light Absorption)

- The determination of the **eBC mass concentrations** is based on **filter-based particle light absorption** measurements.
- In ACTRIS, the **particle light absorption** is derived from **light attenuation** through a filter and a harmonization factor to a reference method.
- In ACTRIS, **the eBC mass concentration** is determined from the particle light absorption coefficient using a mean **mass absorption cross section** of “the European aerosol”.
- **Biannual calibrations of absorption photometers** against a reference are obligatory for the comparability in ACTRIS.



Capacity Building & Mitigation

The WMO-GAW - WCCAP provides worldwide:

- **Audits** of observatories and air quality stations
- **Short courses** for advances aerosol in-situ measurements
 - In connection with audits of GAW stations
 - GAWTEC courses in Germany via the WMO
- **Advice for implementation** of aerosol measurements
- Instrument **calibrations at the WCCAP** in Germany



Summary – Quality Assurance at a Higher Level

ACTRIS QA/QC standard procedures for UFP & BC

- Lead to **enhanced innovation** in particle technology across manufactures.
- **Harmonize measurements** for PNC and eBC measurements.
- Provide **comparable high-quality data** for UFP-related aerosol variables.
- Are the **base for advanced aerosol measurements** in air quality networks
- These **standard procedures** can be also mitigated to **Asia**

