

BLACK CARBON METROLOGY AND REPORTING

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BC Metrology and Nomenclature Issues

- ◆ BC, a clear climate-forcing agent

→ **RF = +1.10 W m⁻² ± 90%**

- ◆ BC operates as a universal carrier of a wide variety of combustion-derived toxic chemical constituents, and a good indicator of health exposure

- ◆ But a ill-defined variable to measure

→ **Agglomeration** of nanometric spherules

→ **Refractory** behavior

→ **Insoluble** in water

→ Strong **light absorber** in IR VIS spectrum

Recommendations for reporting "black carbon" measurements

A. Petzold¹, J. A. Ogren², M. Fiebig³, P. Laj⁴, S.-M. Li⁵, U. Baltensperger⁶,
T. Holzer-Popp⁷, S. Kinne⁸, G. Pappalardo⁹, N. Sugimoto¹⁰, C. Wehrli¹¹, A. Wiedensohler¹²,
and X.-Y. Zhang¹³

→ 469 citations since 2013

- Equivalent Black Carbon (EBC) should be used for measurements derived from filter-based methods.
- Equivalent refractory Carbon (rBC) should be used for measurement derived from incandescence methods
- Elemental Carbon (EC) should be used for measurements derived from thermo-optical methods

Relationship between EC and EBC

Instrument

**Filter based
photometers**

**Thermal-optical
analysis**

Stress

Light

Light & temperature

**Measured
property**

Light absorption
 $\sigma_{ap}(\lambda)$

Combustion
products

Conversion

**Mass Absorption
Coefficient (MAC)**

Internal Standards

Nomenclature

**Equivalent black
carbon (eBC)**

**Elemental carbon
(EC)**

Reporting

**Online 1-h
resolution**

**Offline 24-h
resolution**

Information on EC and EBC variability and trends

→ For the regional background

→ Quality controlled from ACTRIS in Europe

→ ACTRIS/EMEP available on EBAS

→ For the urban areas

→ Additional Data exist but not easily findable

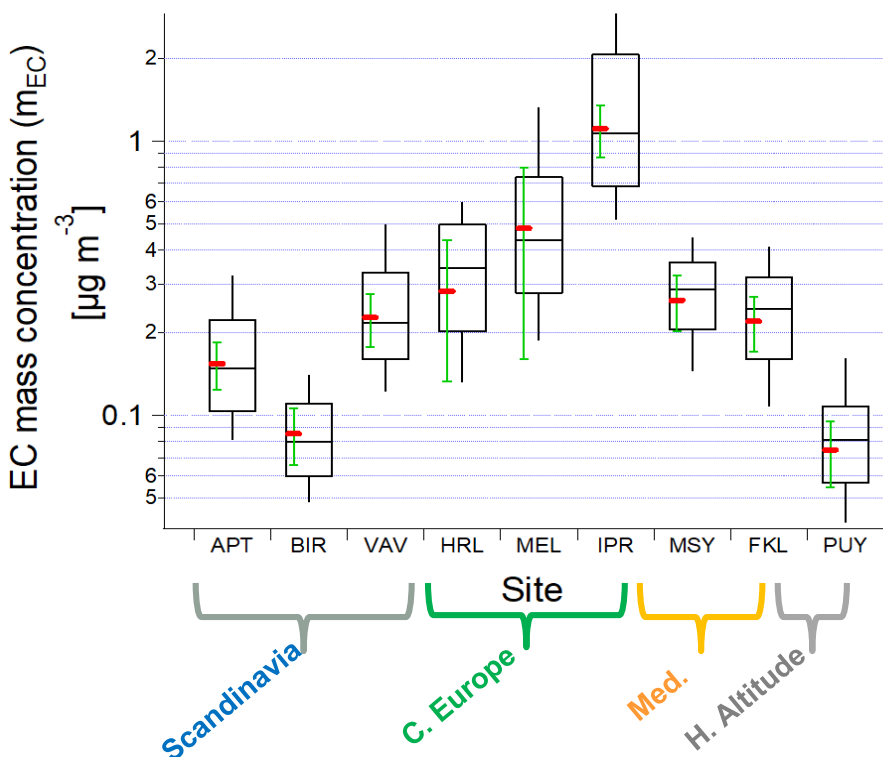
→ Check Kutzner et al. 2018 for Germany

Current Provision of EC in Europe (Regional background sites)



- Less than 25 sites offering continuous monitoring reported in EBAS (ACTRIS/EMEP/GAW)
- Approx. 15 with full ACTRIS QA/QC procedures (Cavalli et al., 2016)

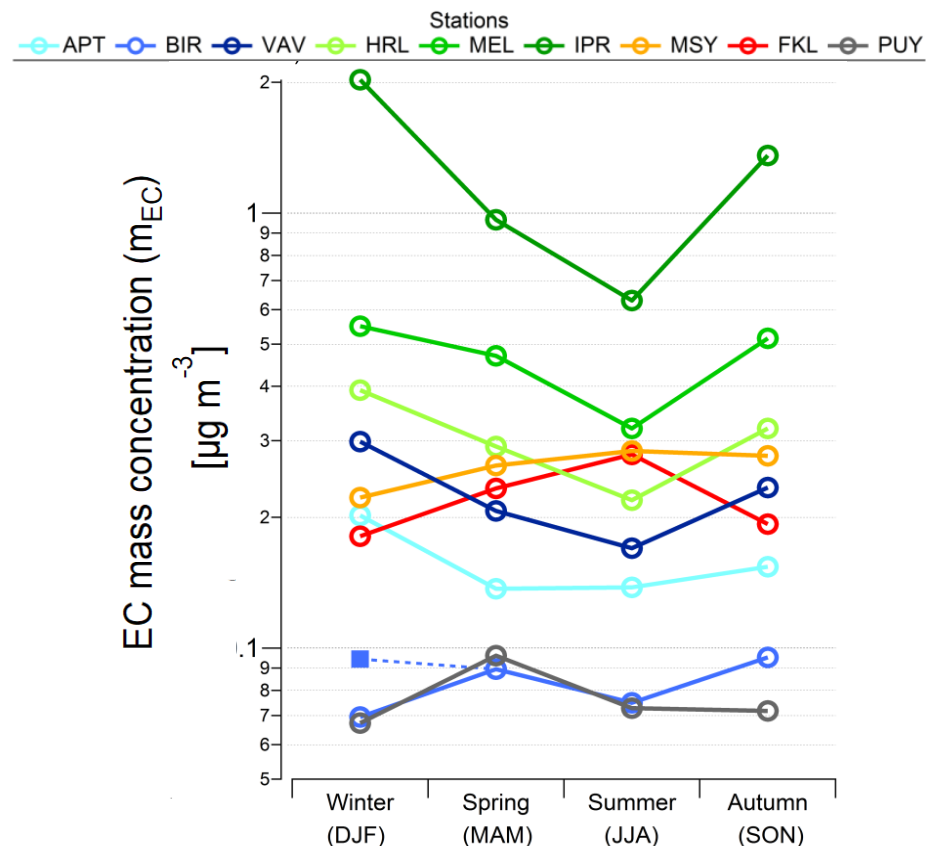
EC SPATIAL AND SEASONAL VARIABILITY (CAVALLI ET AL., 2016)



Max: Ispra: $1.1 \mu\text{g m}^{-3}$

Min: Puy de Dôme: $0.075 \mu\text{g m}^{-3}$

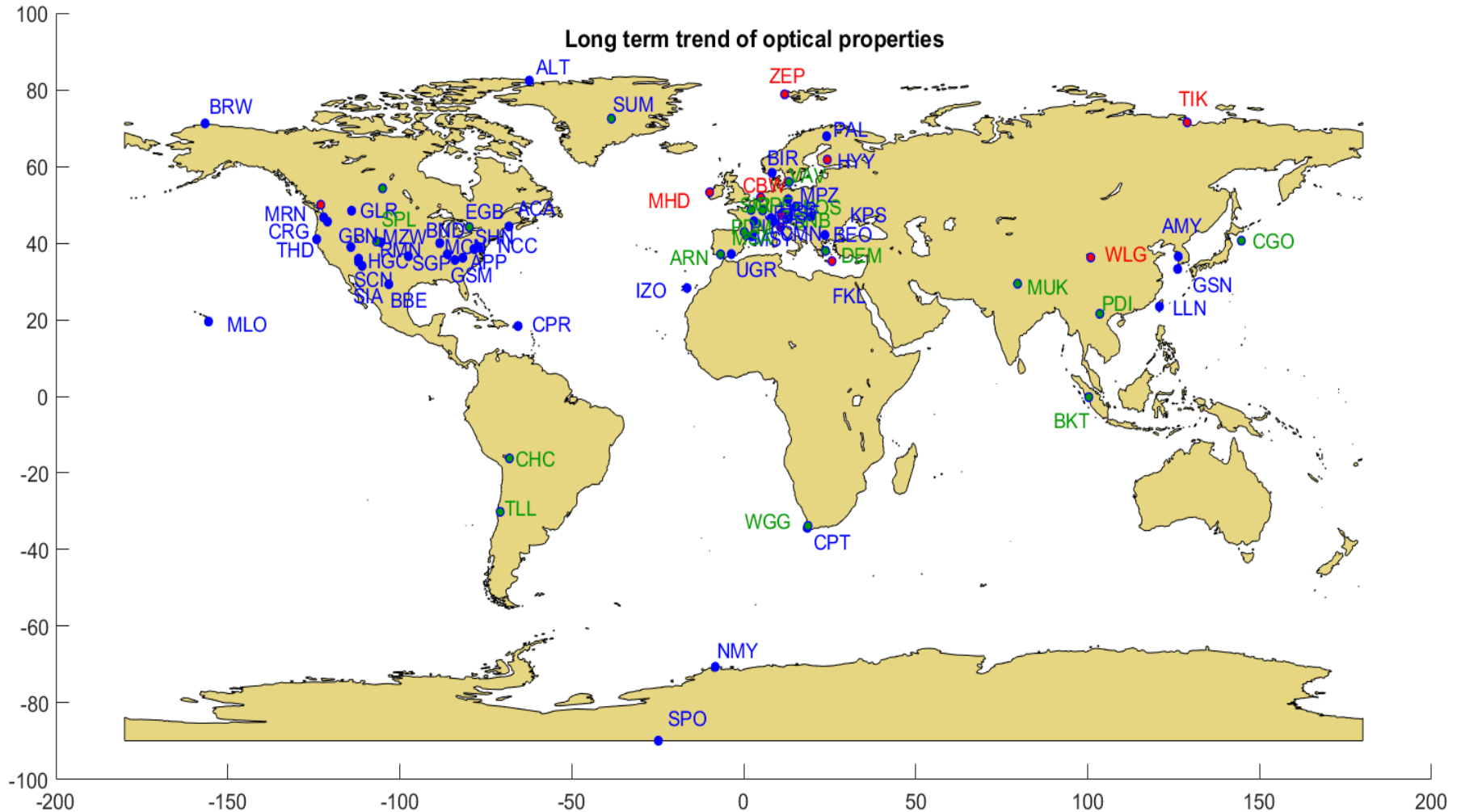
Strong spatial and temporal dependency of EC concentration



Statistically significant seasonal variability

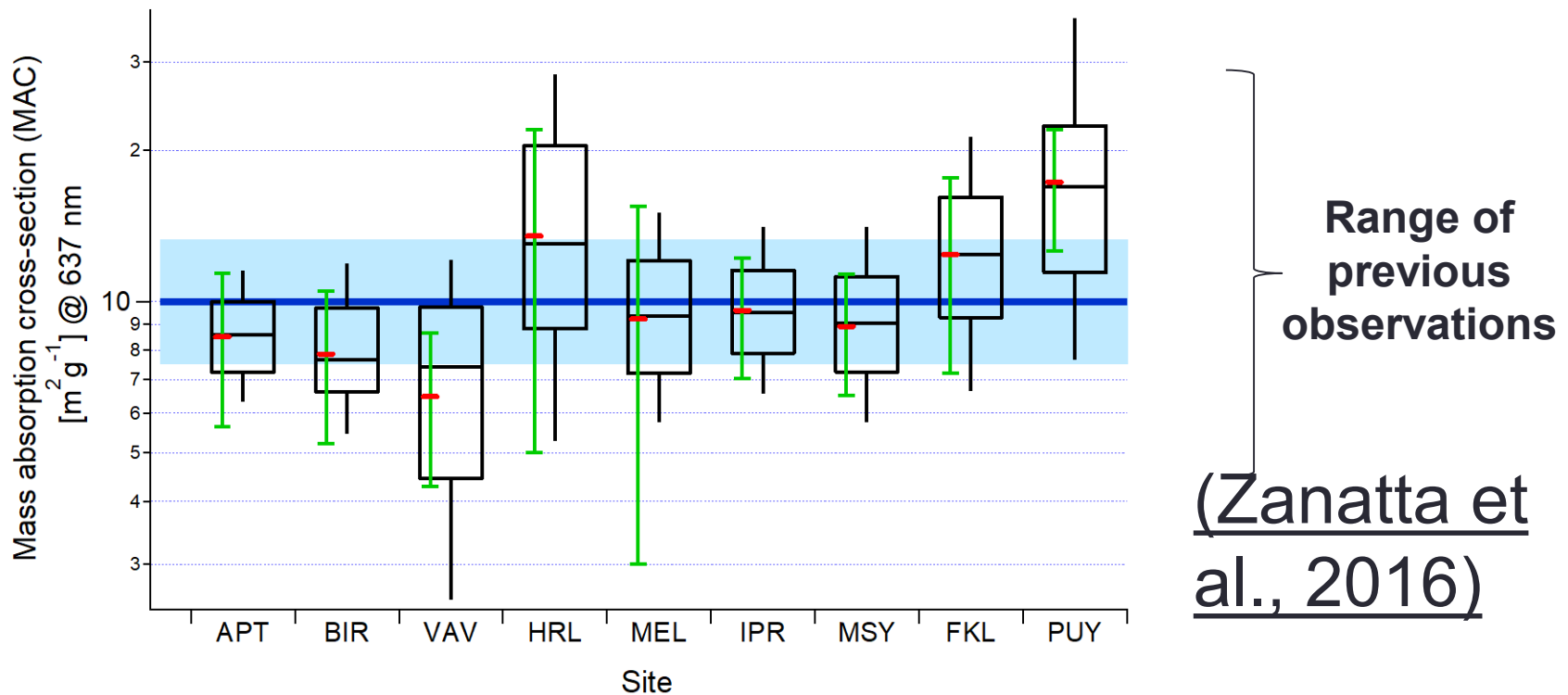
Current Provision of Absorption Coeff.

50 stations $\geq 10y$, 30 $< 10y$ (NOAA/IMPROVE, ACTRIS/EMEP-40 -)



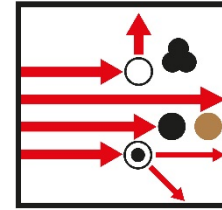
From Absorption Coeff to EBC

➤ Need a Mass Absorption Coefficient



➤ Standard Operation Procedures needed to ensure traceability and comparability of measurements (ACTRIS)

Towards reference methods for BC measurements (EURAMET)



EMPIR
BLACK
CARBON

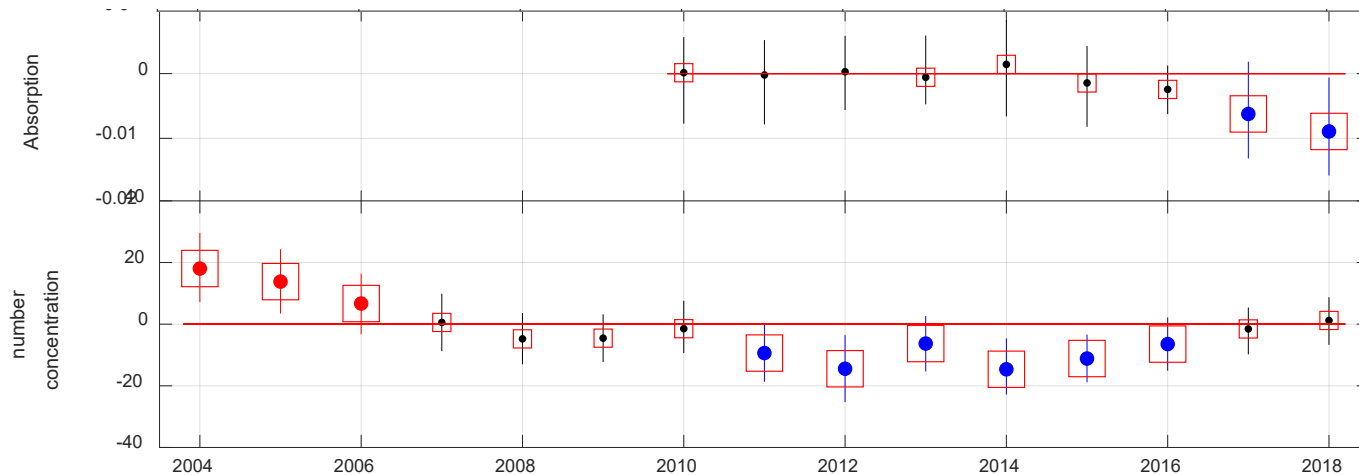
National Metrology Institutes + ACTRIS (NPL lead)

- High accuracy SI-traceable filter-free methods (Extinction-Scattering)
- Aerosol sources characterised by SI-traceable methods
- Traceable calibration methods for filter-based field instruments

Expected outcome in 2020

BC trends and variability

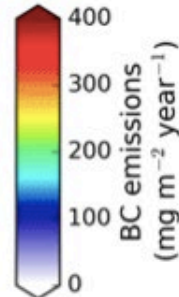
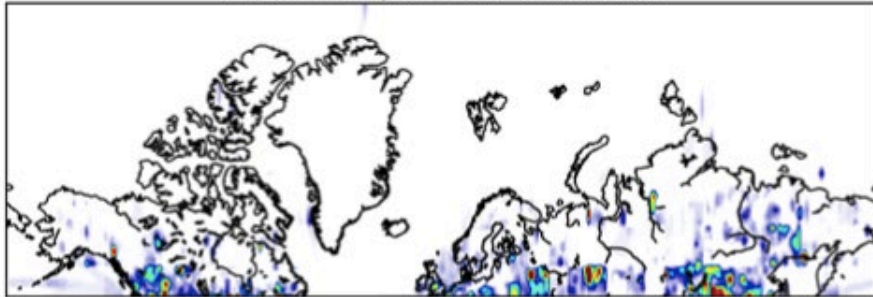
- Ongoing Integrated aerosol assessment
- Decreasing trends (concentrations) of EBC over the European continent (to be confirmed)
- Example JFJ 1996-2018 (Collaud Coen, in progress)



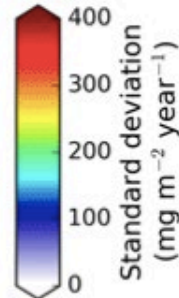
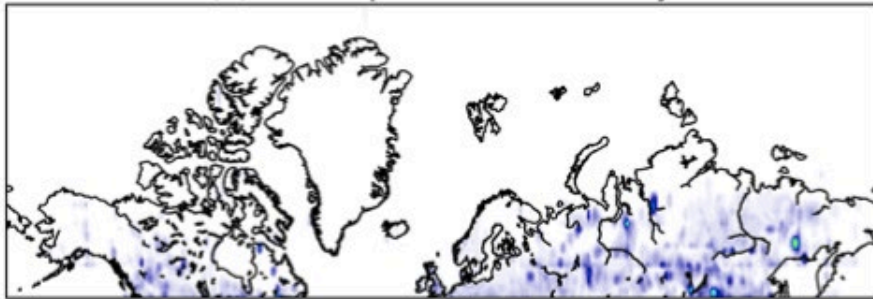
- Evaluating model performances for BC (AEROCOM)

Constraining BC emissions (Evangeliou et al. 2016)

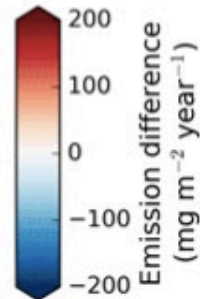
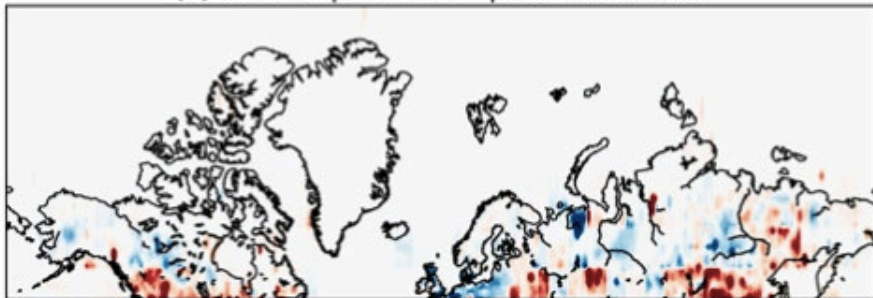
(a) Annual posterior emissions



(b) Annual posterior uncertainty



(c) Annual posterior - prior emissions



- BC inversions at high northern latitudes (> 50° N) for the 2013–2015 period.
- The annual a posteriori emissions of BC significantly smaller a priori emissions
- To be performed now on larger data sets

Conclusions

- BC-related Data Reporting and quality greatly improved in the last decade
 - Better constrains on trends, variability and sources (general decrease observed in Europe)
 - Improved model performances
 - Many (urban-scale) observations still out of radar
- Common terminology is accepted and used but work on metrology still needed towards a reference method
- Engaged in Real-Time provision of BC-related data for Copernicus Atmospheric Monitoring Services (ACTRIS)
- Sustainability of BC data chain (provision→QA/QC→Reporting) is being implemented in ACTRIS but not yet achieved