Recommendations for the interpretation of "black carbon" measurements

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Although black carbon (BC) is one of the key atmospheric particulate components driving climate change and air quality, there is no agreement on the terminology that considers all aspects of specific properties, definitions, measurement methods, and related uncertainties. Following Bond et al. (2013), who deserve credit for synthesizing BC definitions for the first time, BC is characterized by the following distinct properties: (1) it strongly absorbs visible light; (2) it is refractory with a volatilization temperature near 4000K; (3) it is insoluble in water and in the other components of the atmospheric aerosol; and (4) it consists of aggregates of small carbon spherules of < 10 to approx. 50 nm in diameter. In order to include distinct microstructure features, the authors add a fifth property saying that (5) it contains a high fraction of graphite-like sp2–bonded C atoms; see Table 1 for details.

There is much ambiguity in the scientific literature of measurements and numerical models that refer to BC with different names and based on different properties of the particles, with no clear definition of the terms. In consideration of the inadequate definitions available in the literature, and in order to overcome this unsatisfying situation, the authors propose a consistent terminology which is built along material properties.

The term “black carbon” (BC) is considered a useful qualitative description when referring to light-absorbing carbonaceous substances in atmospheric aerosol. In the absence of a method for uniquely determining the mass of BC, the term "BC" should be used as a qualitative and descriptive term when referring generally to material that shares some of the characteristics of BC in particular its carbonaceous composition combined with its light-absorbing properties. For quantitative applications the term requires clarification of the underlying determination:

- Equivalent black carbon (EBC) should be used instead of BC for data derived from optical absorption methods. It is recommended to report the optical measurements primarily as light absorption coefficient, and secondarily as EBC, together with a suitable mass absorption coefficient (MAC) for the conversion of light absorption coefficient into mass concentration.
- Refractory black carbon (rBC) should be used instead of BC for measurements derived from laser incandescence methods.
- Elemental carbon (EC) should be used instead of BC for data derived from methods that are specific to the carbon content of carbonaceous matter (evolved carbon, aerosol mass spectrometry, Raman spectroscopy).
- Soot is a useful qualitative description when referring to particles formed from incomplete combustion. This term is appropriate to and widely used in the research field on the formation of carbonaceous particles in combustion processes and on the emission of particulate matter from combustion sources.

Table 1. Properties defining Black Carbon

Property	Characteristics
Microstructure	graphitic-like structure containing a high fraction of sp^2-bonded carbon atoms
Morphology	aggregates consisting of small carbon spherules of < 10 to approx. 50 nm in diameter
Thermal stability	refractory material with a volatilization temperature near 4000K, gasification is possible only by oxidation which starts at temperatures above 340°C
Solubility	insoluble in organic solvents, in water, and in the other components of the atmospheric aerosol
Light absorption	uniformly absorbing in the spectral range of visible light with MAC(550 nm) > 5 m^2g^{-1} for freshly produced particles; characterized by a significant, non-zero and wavelength-independent imaginary part of the refractive index over the visible and near-visible spectral regions

The coherent terminology proposed here reflects the widespread origin of BC data and permits a consistent reporting of data in the scientific literature that were generated by similar methods. In order to support this effort authors of research papers are requested to clearly state means of calibration and conversion as metadata with any published values.

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SAG website: http://gaw.tropos.de/index.html

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