

Interactive comment on “Are black carbon and soot the same?” by P. R. Buseck et al.

Anonymous Referee #1

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Are black carbon and soot the same? Buseck et al. 2012 ACPD.

“Flags ambiguous usage, but doesn’t provide an acceptable solution”

The manuscript points out ambiguous usage in the literature describing measurements and modeling of combustion generated aerosol products. The authors suggest new nomenclature in an attempt to reduce such usage, and to clarify data products of specific measurement techniques.

The main justification for publication is the value associated with the push towards increased precision in writing/thinking made by the authors. However, the manuscript is not original or complete in its presentation of the ambiguities, which have been addressed in papers cited in the manuscript; it does not provide a complete analysis of nomenclature beyond revealing some of the inconsistencies; it does not present a complete analysis of the issues, as exemplified by K. Prather’s comment; and does not

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present a convincing solution to the problem.

Given these characteristics, I weakly recommend publication based on the need to continue to foster awareness of the possible pitfalls associated with specific choices of word usage in the field.

I note that there are at least two kinds of ambiguity that need to be addressed in the field: first is the use of different words to describe the same unique material – this is largely the case for EC/BC/soot, and this appears to be the main topic of the manuscript, although the authors explicitly state that ns-soot is not EC or BC. The second is giving the same name to different materials and mixtures of materials, as is the case, for example, if “EC” were used to refer to all the aerosol products of a burning candle. This second issue is entangled with the fact that full understanding of the spectrum of carbonaceous composition and properties does not exist.

For the first, often the experimentalists and modelers who use these different words believe that they are referring to the same unique substance. The question of how well the various instrumental approaches quantify the mass of this substance in a sample is an experimental one that is not addressed here, but that is actually the limiting factor in assessing their practical equivalence (as in Kondo et al., 2011, which experimentally equated TOT-EC, SP2-BC, and ~PSAP-effective BC in the absence of non-refractory material in Tokyo). The introduction of a new descriptor, ns-soot, will not solve this issue, and it appears that the main value of “ns-soot” is merely that it is a new term that hasn’t had the opportunity to be mis-used. I will continue this review using “BC” to refer to this material, as is semi-commonly done in the modeling community when either referring to TOT/TOA measured EC or SP2 measured BC.

For the second, the authors undermine a growing consensus about nomenclature describing combustion-generated aerosol: they cite Bond and Bergstrom, 2006, to point out that in that work BC was identified as a single component of the composite material therein referred to as “soot” as an example of one possible usage. However, this usage

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is increasingly used in the literature, and is in line with the popular usage of “soot” as is found in the dictionary, namely as the non-gaseous material products of combustion. For example, in the abstract of the 2012 Baumgardner et al. work cited by the authors, uses “soot” and “elemental carbon” in a manner consistent with this framework:

“Soot, which is produced from biomass burning and the incomplete combustion of fossil and biomass fuels. those who use thermal optical analysis (TOA) to analyze the organic and elemental carbon components of soot.” (Baumgardner et al 2012).

Hence, “soot” as used above is a descriptive term of wide applicability and little specificity. EC is a specific term that serves essentially the same function as “BC” or “rBC” as the authors state that the SP2 community uses it (irrespective of the instrument’s commercial name), and would likely be identified by the various experimentalists involved with SP2s and TOA/TOT analysis as the functional/practical equivalent of ns-soot as identified by the authors with TEM -within experimental limitations. In deed, the authors maintain this basic framework of a single unique material of $BC = EC = ns\text{-soot}$ in their section on coatings, in which they identify ns-soot as the “backbone” of a particle containing other materials. In the SP2 community, BC is often referred to as the “core” of “BC-containing” particles, and in the TOA community EC is often “internally mixed” with OC. In the “ns-soot versus BC” chapter, if the author merely named ns-soot BC, this would remain consistent with (some) existing specific literature. Hence I recommend that the authors, instead of concentrating on supporting a new definition of BC, attempt to apply their insights within the existing framework of a general term, “soot”, made up specifically of $BC=EC(=ns\text{-soot})$ and other materials.

In this vein, the authors are correct that “BC particle” is not an acceptably specific term unless referring only to an externally mixed (i.e. bare BC “backbone”). The authors state that externally mixed “ns-soot” exists in nature, so I imagine they would have no problem with this usage if “BC” is used (first ambiguity) as an equivalent to ns-soot. Then it makes sense that internally mixed particles would “contain BC” or “have non-zero BC mass fraction.”

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Although the authors present a good case for the utility of TEM in identifying “ns-soot” by relying on determination of particle morphology and direct measurement of amorphous structure in the BC component of individual particles, its broad application to determinations by other techniques is unlikely as TEM is limited: TEM is not a measurement that can generally be applied to ambient measurements. It is time consuming, off line, expensive, complicated, and, without full 3-D analysis, ambiguous as to total BC volume in individual particles. Nevertheless, in support of more clearly defining the existing soot dichotomy ($soot = (BC=EC) + others$), the manuscript can provide a worthwhile review of the issue.

I point out that absorption measurements are not the same as BC mass measurements, an issue that goes beyond the questions of the material/optical properties of BC externally mixed, as even absolutely correct absorption measurements may contribute from non-BC materials.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 24821, 2012.

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