



Comparison of quantification methods to measure fire-derived (black/elemental) carbon using reference materials from soil, water, sediment and the atmosphere

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Black carbon (BC), the product of incomplete combustion of fossil fuels and biomass (called elemental carbon in atmospheric sciences (EC)), was studied in terms of its chemical and physical properties that dictate its resistance to decomposition in the environment. BC was quantified in 12 different materials by 17 laboratories from different disciplines, using seven different methods. The materials were divided in three classes: (1) potentially interfering materials, (2) laboratory-produced BC-rich materials, and (3) BC-containing environmental matrices (from soil, water, sediment and the atmosphere). This is a first comprehensive intercomparative study (multi-method, multi-lab, multi-sample), focusing mainly on methods used for soil and sediment BC studies. Results from the different methods were variable. BC as proportion of organic carbon (OC) for the BC-rich materials showed insightful differences: for soot it varied from 26-96%, for the wood char 0-100% and for the rice char 2-83%. Two harsh chemical/thermal oxidation methods were able to distinguish between highly condensed soot BC and less condensed char BC. Most methods measured BC in varying amounts in materials that per definition does not contain fire-derived organic carbon. We found that atmospheric BC quantification methods cannot be used for soil and sediment studies since the definition of BC as light-absorbing material irrespective of its origin is incorporated in its methodology. This is a source of biases when applied to terrestrial and sedimentary materials. This study has made clear that any attempt to merge data generated via different methods must consider the different, operationally defined analytical windows of the BC continuum detected by each technique, as well as the limitations and potential biases of each technique. A major goal of this ring trial was to provide assistance in making this choice for BC quantification in soil and sediment studies. In this manuscript we summarize what we see as the advantages and disadvantages of each method, based mainly on the results of the ring trial. In future studies, we strongly recommend the calibration of all methods analyzing for BC in soils and sediments against the set of BC reference materials analyzed here.