Geophysical Research Abstracts
Vol. 18, EGU2016-16757, 2016
EGU General Assembly 2016


# Online single particle measurements of black carbon coatings, structure and optical properties

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The impacts of black carbon on meteorology and climate remain a major source of uncertainty, owing in part to the complex relationship between the bulk composition of the particulates and their optical properties. A particular complication stems from how light interacts with particles in response to the microphysical configuration and any 'coatings', i.e. non-black carbon material that is either co-emitted or subsequently obtained through atmospheric processing. This may cause the particle to more efficiently absorb or scatter light and may even change the sign of its radiative forcing potential.

While much insight has been gained through measurements of bulk aerosol properties, either while suspended or after collection on a filter or impactor substrate, this does not provide a complete picture and thus may not adequately constrain the system. Here we present an overview of recent work to better constrain the properties of black carbon using online, in situ measurements of single particles, primarily using a Single Particle Soot Photometer (SP2). We have developed novel methods of inverting the data produced and combining the different metrics derived so as to give the most effective insights into black carbon sources, processes and properties. We have also used this measurement in conjunction with other instruments (sometimes in series) and used the data to challenge many commonly used models of optical properties such as core-shell Mie, Rayleigh-Debeye-Gans and effective medium. This work has been carried out in a variety of atmospheric environments and with laboratory-produced soots, e.g. from a diesel engine rig.

Highlights include the finding that with real-world atmospheric aerosols, bulk optical measurements may be insufficient to derive brown carbon parameters without detailed morphological data. We also show that the enhancement of absorption for both ambient and laboratory generated particles only occurs after the coating mass fraction reaches a certain threshold, something that may explain some apparently contradictory results from field measurements. These findings should help to inform atmospheric black carbon models and reduce uncertainties when evaluating its impacts.