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The "dual-spot" Aethalometer: an improved measurement of aerosol black carbon with real-time loading compensation

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Abstract. Aerosol black carbon is a unique primary tracer for combustion emissions. It affects the optical properties of the atmosphere and is recognized as the second most important anthropogenic forcing agent for climate change. It is the primary tracer for adverse health effects caused by air pollution. For the accurate determination of mass equivalent black carbon concentrations in the air and for source apportionment of the concentrations, optical measurements by filter-based absorption photometers must take into account the "filter loading effect". We present a new real-time loading effect compensation algorithm based on a two parallel spot measurement of optical absorption. This algorithm has been incorporated into the new Aethalometer model AE33. Intercomparison studies show excellent reproducibility of the AE33 measurements and very good agreement with post-processed data obtained using earlier Aethalometer models and other filter-based absorption photometers. The real-time loading effect compensation algorithm provides the high-quality data necessary for real-time source apportionment and for determination of the temporal variation of the compensation parameter k.

1 Introduction

The combustion of carbonaceous fuels inevitably results in the emission of gas and particulate air pollutants. One of the fractions of the emitted particles are light-absorbing carbonaceous aerosol compounds, in particular black carbon (BC), an aerosol species exhibiting very large optical absorption across the visible part of the optical spectrum. Black carbon is a unique primary tracer for combustion emissions as it has no non-combustion sources. It is inert and can be transported over great distances (Hansen et al., 1989; Bodhaine, 1995; Sciare et al., 2009). Black carbon affects the optical properties of the atmosphere when suspended and is recognized as the second most important anthropogenic forcing agent for climate change after CO_2 (Ramanathan and Carmichael, 2008; Bond et al., 2013). Black carbon is also the leading indicator of the adverse health effects caused by particulate air pollution (Janssen et al., 2011, 2012; Grahame et al., 2014). Reducing air pollution is a major societal need, which must be addressed at a local, national, regional and global scale. Source apportionment of air pollutants and determination of the time evolution of the source contributions to their ambient concentrations are essential for these efforts. Black car-