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Constraining biases in filter-based absorption photometry using photoacoustic and cavity ring-down spectroscopy.

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One of the major contributors to the uncertainty in estimates of direct radiative forcing is due to the poorly constrained aerosol single scattering albedo. Aerosol absorption is widely measured using filter-based absorption photometry, which can be subject to large biases. Using the EXSCALABAR instrument (EXtinction, SCattering of Absorption of Light for AirBorne Aerosol Research) – consisting of a suite of photoacoustic and cavity ring-down spectrometers – on an airborne platform (Facility for Airborne Atmospheric Measurements), this study assesses the magnitude of these biases for a Particle Soot Absorption Photometer (PSAP, Radiance Research) and a Tricolor Absorption Photometer (TAP, BMI). Biases are evaluated for three aerosol types: pollution emissions over London, fresh biomass burning aerosol over West Africa and aged biomass burning over the Southeast Atlantic Ocean. To correct for biases in the filter-based absorption photometer measurements, three independent correction schemes are applied, namely the Bond et al. (1999), Virkkula (2010) and Müller et al. (2014) corrections, using scattering coefficients determined from photoacoustic and cavity ring-down spectroscopy, and asymmetry parameters derived using nephelometry. The accuracy of the photoacoustic and cavity ring-down spectrometers is assessed initially by comparing the measured and modelled optical properties of aerosolised nigrosin dye. Biases in the filter-based absorption photometer measurements are then assessed for each correction schemes and for a range of aerosol compositions, organic aerosol concentrations and altitudes.