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Corrigendum to

"Chemical apportionment of southern African aerosol mass and optical depth" published in Atmos. Chem. Phys., 9, 7643–7655, 2009

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Abstract. A correction to results by Magi (2009) is presented here. By combining the in situ measurements of speciated aerosol mass concentrations with concurrent measurements of total aerosol optical properties at a wavelength of 550 nm, it is shown that ∼66 % of scattering is due to carbonaceous aerosol, where derived mass scattering cross sections (MSC) for OC and BC are $3.8 \pm 0.5\,\mathrm{m^2\,g^{-1}}$ and $2.9 \pm 0.8\,\mathrm{m^2\,g^{-1}}$, respectively. Derived values of mass absorption cross sections (MAC) for OC and BC are $0.7 \pm 0.2\,\mathrm{m^2\,g^{-1}}$ and $12.1 \pm 0.8\,\mathrm{m^2\,g^{-1}}$, respectively. The values of MAC imply that ∼21 % of the mid-visible aerosol absorption in southern Africa is due to OC, with the remainder due to BC. SSA for BC and OC are about the same as Magi (2009). The results here are determined using an approach that accounts for the fact that OC and BC are partially scattering and absorbing.

1 Discussion

Magi (2009) used in situ measurements of speciated aerosol mass concentrations with concurrent measurements of total aerosol optical properties at a wavelength of 550 nm to determine speciated mass scattering cross section (MSC), mass absorption cross section (MAC), single scattering albedo (SSA) and apportionment of total aerosol scattering (SCA) and absorption (ABS). The measurements of species mass concentrations, total aerosol optical properties (SCA and ABS), and apportionment of $PM_{2.5}$ remain the are correctly described by Magi (2009). The methods used to determine values of MSC, MAC, SSA, and the apportionment of SCA and ABS, however, neglected cross-terms in scattering and absorption. The multiple linear regression (MLR) technique described by Magi (2009) is replaced with a methodology to account for non-linearities, as described below.

The modified technique uses the following equations to describe the apportionment of SCA and ABS using measured species mass concentrations (M):

$$\mathrm{SCA} = \sum_{i=1}^{4} M_i \cdot \mathrm{SSA}_i \cdot \mathrm{MSC}_i \tag{1}$$

$$\mathrm{ABS} = \sum_{i=1}^{4} M_i \cdot (1 - \mathrm{SSA}_i) \cdot \mathrm{MAC}_i \tag{2}$$

Thus, the apportionment is dependent on the scattering and absorbing component of the mass of particular species (i). Magi (2009) double-accounted for species mass contribution to SCA and ABS by neglecting the SSA term. Eq. (1) can be re-written as

$$\mathrm{SCA} = \sum_{i=1}^{4} M_i \cdot \sigma_i \tag{3}$$

$$\mathrm{ABS} = \sum_{i=1}^{4} M_i \cdot \alpha_i \tag{4}$$

where σ and α are defined as

$$\sigma_i = \frac{\mathrm{MSC}_i^2}{\mathrm{MSC}_i + \mathrm{MAC}_i} \tag{5}$$

$$\alpha_i = \frac{\mathrm{MAC}_i^2}{\mathrm{MSC}_i + \mathrm{MAC}_i} \tag{6}$$

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Table 1. Optical properties and contributions to SCA and ABS, all at a wavelength of 550 nm. Values from Magi (2009) are listed in brackets for comparison.

species	MSC ($m^2\,g^{-1}$)	MAC ($m^2\,g^{-1}$)	SSA	contribution to SCA	contribution to ABS
SO_4	6.1 ± 2.1	0	1	0.28 ± 0.11	0
	[0.6 ± 0.8]	[0]	[1]	[0.04–0.14]	[0]
NO_3	5.5 ± 2.1	0	1	0.05 ± 0.03	0
	[0.6 ± 0.8]	[0]	[1]	[0.04–0.16]	[0]
OC	3.8 ± 0.5	0.7 ± 0.2	0.85 ± 0.05	0.65 ± 0.10	0.21 ± 0.07
	[3.9 ± 0.6]	[0.7 ± 0.6]	[0.85]	[0.41–0.54]	[0.24–0.36]
BC	2.9 ± 0.8	12.1 ± 0.8	0.19 ± 0.05	0.010 ± 0.007	0.79 ± 0.07
	[1.6 ± 0.2]	[8.2 ± 1.1]	[0.17]	[0.29–0.38]	[0.64–0.76]

Instead of the MLR technique, a non-linear optimization is used to estimate the coefficients σ and α, noting that SSA for SO_4 and NO_3 are both assumed to be 1 and ABS is entirely due to BC and OC, per the discussion by Magi (2009). The values of MSC and MAC are then determined by

$$\frac{\mathrm{MSC}_i}{\mathrm{MAC}_i} = \sqrt{\frac{\sigma_i}{\alpha_i}} \quad (7)$$

and

$$\mathrm{EXT} = \mathrm{SCA} + \mathrm{ABS} \quad (8)$$

where EXT is extinction at 550 nm, and EXT, SCA, and ABS are the measured quantities.

The apportionment of ABS and SCA is determined using the estimates of σ, α, and Eq. (2) for each species. This differs from Magi (2009) in that the apportionment of ABS and SCA was determined there using MSC and MAC for each species. The results by Magi (2009) and the results taking into account the methods described above are listed in Table 1. Magi (2009) significantly overestimated the contribution of BC to SCA and underestimated species contributions that are predominantly scattering (SO_4, NO_3, OC). Similarly, the contribution of BC to ABS was underestimated, while the contribution of OC was overestimated.

These results provide valuable constraints to fundamental properties of aerosol species simulated by models. Like Magi (2009), these results show that OC is a significant absorber of mid-visible radiation over southern Africa.