Research brief

Summary of research paper published in Atmospheric Chemistry and Physics titled: Spatial, temporal and source contribution assessments of black carbon over the northern interior of South Africa

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According to the latest assessment report of the Intergovernmental Panel on Climate (IPCC), aerosol black carbon (BC) is considered the second most important contributor to global warming after carbon dioxide (CO2). Since BC is part of the atmospheric particulate fraction that have a relatively short atmospheric lifetime, the climatic influence of BC is particularly relevant on a regional scale. This paper presents equivalent black carbon (eBC) (derived from an optical absorption method) data collected from three sites in the interior of South Africa, where continuous measurements were conducted, i.e. Elandsfontein, Welgegund and Marikana, as well elemental carbon (EC) (determined by evolved carbon method) at five sites where samples were collected once a month on a filter and analysed off-line, i.e. Louis Trichardt, Skukuza, Vaal Triangle, Amersfoort and Botsalano.

Analyses of eBC and EC spatial concentration patterns across the eight sites indicate that the mass concentrations in the South African interior are in general higher than what has been reported for the developed world and that different sources are likely to influence different sites. The mean eBC or EC mass concentrations for the background sites (Welgegund, Louis Trichardt, Skukuza, Botsalano) and sites influenced by industrial activities and/or nearby settlements (Elandsfontein, Marikana, Vaal Triangle and Amersfoort) ranged between 0.7 and 1.1, and 1.3 and 1.4 µg/m3, respectively.

Similar seasonal patterns were observed at all three sites where continuous measurement data were collected (Elandsfontein, Marikana and Welgegund), with the highest eBC mass concentrations measured during June to October, indicating contributions from household combustion in the cold winter months (June-August), as well as savannah and grassland fires during the dry season (May to mid-October). Diurnal patterns of eBC at Elandsfontein, Marikana and Welgegund indicated maximum concentrations in the early mornings and late evenings, and minima during daytime. From the patterns it could be deduced that for Marikana and Welgegund, household combustion, and savannah and grassland fires were the most significant sources, respectively.

Possible contributing sources were explored in greater detail for Elandsfontein. Five main sources, i.e. coal-fired power stations, pyrometallurgical smelters, traffic, household combustion, as well as savannah and grassland fires, were identified and the source strengths quantified. A comparison of these source strengths indicated that household combustion, and savannah and grassland fires were the most significant sources of eBC, particularly during winter and spring months, while coal-fired power stations, pyro-metallurgical smelters and traffic contribute to eBC concentrations year round. Concentration ratios, which can be used as emission factors for the afore-mentioned sources were also presented.