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Time evolution and emission factors of aerosol particles from day and night time savannah fires

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The largest uncertainties in the current global climate models originate from aerosol particle effects (IPCC, 2007) and at the same time aerosol particles also pose a threat to human health (Pope and Dockery, 2006). In southern Africa wild fires and prescribed burning are one of the most important sources of aerosol particles, especially during the dry season from June to September (e.g. Swap et al., 2003; Vakkari et al., 2012). The aerosol particle emissions from savannah fires in southern Africa have been studied in several intensive campaigns such as SAFARI 1992 and 2000 (Swap et al., 2003). However, all previous measurements have been carried out during the daytime, whereas most of the prescribed fires in southern Africa are lit up only after sunset. Furthermore, the previous campaigns followed the plume evolution for up to one hour after emission only.

In this study, combining remote sensing fire observations to ground-based long-term measurements of aerosol particle and trace gas properties at the Welgegund measurement station (www.welgegund.org), we have been able to follow the time evolution of savannah fire plumes up to several hours in the atmosphere. For the first time the aerosol particle size distribution measurements in savannah fire plumes cover both day and night time plumes and also the ultrafine size range below 100 nm.

During the period from May 20^{th} 2010 to April 15^{th} 2012 altogether 61 savannah fire plumes were observed at Welgegund. The evolution of the aerosol size distribution remained rapid for at least five hours after the fire: during this period the growth rate of the aerosol particle count mean diameter (size range 12 to 840 nm) was 24 nm h^{-1} for daytime plumes and 8 nm h^{-1} for night time plumes. The difference in the day and night time growth rate shows that photochemical reactions significantly increase the condensable vapour concentration in the plume. Furthermore, the condensable vapour concentration was found to affect both the number and size of particles larger than 100 nm; if this is not accounted for the current emission factors may underestimate the CCN-sized particle yield from savannah fires by a factor of two to three.

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