SEASONAL BEHAVIOUR OF NEW PARTICLE FORMATION IN A SEMI-CLEAN SAVANNAH ENVIRONMENT

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INTRODUCTION

Combined long-term measurements of trace gas concentrations, aerosol particle mass concentrations and number size distributions (especially in ultrafine size range), air ion number size distributions and meteorological variables are extremely few in Southern Africa (Piketh et al., 2005; Laakso et al., 2008).

In this abstract we show results preliminary results on seasonal behaviour of new particle formation observed with a transportable measurement trailer (Petäjä et al., 2007) in a relatively clean savannah environment in Botsalano game reserve during the period 20 July 2006 – 30 January 2008.

MEASUREMENTS AND METHODS

The measurement station and the site are described in detail by Laakso et al. (2008) and Vakkari (2009) so we only summarize here the measurement relevant for the current study.

The aerosol particle size distribution from 10 to 840 nm was measured using a DMPS system and air ion and charged particle distribution from 0.4 to 40 nm using an Air Ion Spectrometer (AIS, Airel Ltd, Estonia, Mirme et al.2007).

New particle formation events were classified and formation and growth rates calculated according to DalMas et al. (2005) for the DMPS measurements and according to Yli-Juuti et al. (2009) for the AIS measurements. From the ion spectra the growth rates for 1.5-3nm, 3-7nm and 7-20nm ions were calculated using the method described in Hirsikko et al. (2005). The 2-3nm ion formation rate $J_2$ was calculated as in Kulmala et al. (2007). For the calculation of ion J we assumed the number of neutral 2-3nm particles to be 100 times the sum of the total 2-3nm ion concentration as recent observations from Boreal forest suggest (Manninen et al., 2009).

RESULTS

Clear new particle formation and growth was observed on 69\% of the days during the measurement period, Figure 1 classes I and II. In addition to this, on 14\% of the days non-growing ion formation was observed (see e.g. Yli-Juuti et al., 2009). The new particle formation frequency, Figure 1, does not have a discernible seasonal behaviour.

The average particle growth rate for particle size range 10-30 nm was 9.7 nm h\textsuperscript{-1} and average formation rate of 10nm particles, $J_{10}$, 3.8 cm\textsuperscript{-3}s\textsuperscript{-1}. The average ion (or charged particle) growth rates for size ranges 1.5-3 nm, 3-7 nm and 7-20 nm were 7.5 nm h\textsuperscript{-1}, 9.9 nm h\textsuperscript{-1}, and 8.9 nm h\textsuperscript{-1}, respectively. The average formation rate of 2-nm ions (sum of both polarities), $J_2$, was 0.5 cm\textsuperscript{-3}s\textsuperscript{-1}. Both the aerosol particle growth
rate from the DMPS (Figure 2) and the air ion growth rates from the AIS (Figure 3) show a weak minimum during the Southern hemisphere winter (May-August) and maximum at spring (September-October) and summer (October-March). Also the $J_{10}$ has a clear seasonal trend with peaks during the spring and late summer, Figure 2. These trends of growth and formation rate concur with previous observations from other sites (Kulmala et al., 2004). The levels of growth rates and formation rates are among the highest observed in continental areas (Kulmala et al., 2004; Hamed et al., 2007).

Figure 1 New particle formation classification for the complete measurement period. Classes I and II show clear new particle formation and subsequent growth. For class I new particle formation events it was possible to calculate formation and growth rates. Ion bursts include bursts of non-growing intermediate ions (see e.g. Yli-Juuti et al., 2009).
Figure 2 Monthly averaged 10-30 nm growth rate and 10 nm formation rate from the DMPS measurements over 1.5 years.

Figure 3 Monthly averaged growth and formation rates for ions on different size ranges. Data from March-April 2007 is missing as the device was under maintenance in Estonia.

CONCLUSIONS

The observed formation and growth rates, as well as the new particle formation frequency, are among the highest reported in the literature, and thus the particle formation may significantly affect the clouds and their properties. The new particle formation frequency does not present seasonal dependency but stays high throughout the year. The peaks in the growth and 10 nm formation rate in spring and summer and minima in winter suggest biological activity to contribute significantly to the growth of the particles.

REFERENCES


