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Seasonality of the chemistry in atmospheric new particle formation in southern Africa

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Atmospheric new particle formation has been observed in various different environments ranging from remote background regions to polluted megacities. In many environments it has also been shown to increase the concentration of particles in sizes that can act as cloud condensation nuclei and therefore affect the climate. New particle formation is essentially a two-step process, where the first step is nucleation in the nanometer size range, which is followed by a growth phase to climatically relevant sizes. While recent advances in experimental methods have enabled direct observations of atmospheric nucleation, aerosol particle chemistry during the growth phase following nucleation has been characterised in relatively few studies and never covered a full seasonal cycle.

In this study we utilized one year of continuous online chemical composition measurements of submicron aerosol particles with an Aerosol Chemical Speciation Monitor (ACSM) together with concurrent size distribution measurements from 12 to 840 nm with a Differential Mobility Particle Sizer (DMPS). The measurements were carried out at Welgegund measurement station in South Africa, which is approximately 100 km west of Johannesburg from September 2010 to August 2011. During this period the frequency of new particle formation events was 78 % with 90 % data coverage. The high frequency of new particle formation events enabled us to study the chemistry of aerosol particle growth in 89 new particle formation events during the one year period.

Organic aerosol and sulphate were the dominant constituents in the growth of newly formed particles at Welgegund. On average, organic aerosol constituted 49 % of the growth and sulphate 36 %. However, the ratio of organic aerosol and sulphate varied widely depending on whether the air masses originated in the clean sector or in the anthropogenic sector. Ammonium correlated with sulphate (correlation coefficient 0.83) and constituted on average 11 % of the growth, while nitrate was a minor constituent with a 4 % average fraction. We observed a clear seasonal pattern in the organic aerosol source rate with the highest values occurring during the local spring and summer.