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Modelling the progression in the mix of particles within the Arctic stratospheric aerosol layer, including the seasonal source of meteoric smoke particles from the Arctic winter polar vortex

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Meteoric smoke particles (MSPs) provide a steady source of condensation nuclei to the Arctic lower stratosphere, with heterogeneous nucleation to sulphuric acid aerosol particles. Internally mixed meteoric-sulphuric particles likely also play a significant role in the formation of polar stratospheric clouds and thereby influence stratospheric ozone depletion chemistry, particularly in the quiescent stratosphere.

In several Arctic winter field campaigns (EUPLEX 2002/3, RECONCILE 2009/10, ESSenCe 2010/11), in-situ stratospheric aerosol particle concentrations measurements were made from the high-altitude Geophysica aircraft, the COPAS instrument measuring total and refractory (non-volatile) particle concentrations at 20 km altitude (see Curtius et al., 2003; Weigel et al., 2014).

These measurements are consistent with there being a substantial seasonal source of meteoric-sulphuric particles to the lower Arctic stratosphere, from each year's influx of MSPs within the winter-time Arctic polar vortex. In this study we investigate the effect of MSPs on the quiescent Junge layer particle concentration as the polar vortex builds up and after it dissipates.

We use the nudged configuration of the UM-UKCA stratosphere-troposphere composition-climate model to reproduce the vertical profile of stratospheric particles measured in-situ during the COPAS 2003 campaign. Our model simulates two types of stratospheric aerosol particles - pure sulphuric acid particles and sulphuric acid particles with a MSP-core. We show that the model is able to reproduce the vertical profile of aerosol particles observed during the COPAS measurements in winter 2003.

Our findings illustrate the influx of MSP and SO2 from higher altitudes through the polar vortex, the winter-time build-up of SO2 triggering homogeneous nucleation of pure sulphuric particles, also with the seasonal source of MSP-core sulphuric particles nucleated heterogeneously. We assess the effects of MSPs on the quiescent period particle concentration in the Arctic during winter through to spring.