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The prevalence of meteoric-sulphuric particles within the stratospheric aerosol layer

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The widespread presence of meteoric smoke particles (MSPs) within a distinct class of stratospheric aerosol particles has become clear from in-situ measurements in the Arctic, Antarctic and at mid-latitudes.

We apply an adapted version of the interactive stratosphere aerosol configuration of the composition-climate model UM-UKCA, to predict the global distribution of meteoric-sulphuric particles nucleated heterogeneously on MSP cores. We compare the UM-UKCA results to new MSP-sulphuric simulations with the European stratosphere-troposphere chemistry-aerosol modelling system IFS-CB05-BASCOE-GLOMAP.

The simulations show a strong seasonal cycle in meteoric-sulphuric particle abundance results from the winter-time source of MSPs transported down into the stratosphere in the polar vortex. Coagulation during downward transport sees high latitude MSP concentrations reduce from ~500 per cm3 at 40km to ~20 per cm3 at 25km, the uppermost extent of the stratospheric aerosol particle layer (the Junge layer).

Once within the Junge layer's supersaturated environment, meteoric-sulphuric particles form readily on the MSP cores, growing to 50-70nm dry-diameter (Dp) at 20-25km. Further inter-particle coagulation between these non-volatile particles reduces their number to 1-5 per cc at 15-20km, particle sizes there larger, at Dp ~100nm.

The model predicts meteoric-sulphurics in high-latitude winter comprise >90% of Dp>10nm particles above 25km, reducing to ~40% at 20km, and ~10% at 15km.

These non-volatile particle fractions are slightly less than measured from high-altitude aircraft in the lowermost Arctic stratosphere (Curtius et al., 2005; Weigel et al., 2014), and consistent with mid-latitude aircraft measurements of lower stratospheric aerosol composition (Murphy et al., 1998), total particle concentrations also matching in-situ balloon measurements from Wyoming (Campbell and Deshler, 2014).

The MSP-sulphuric interactions also improve agreement with SAGE-II observed stratospheric aerosol extinction in the quiescent 1998-2002 period.

Simulations with a factor-8-elevated MSP input form more Dp>10nm meteoric-sulphurics, but the increased number sees fewer growing to Dp ~100nm, the increased MSPs reducing the stratospheric aerosol layer's light extinction.