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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "Enhancements of the refractory submicron aerosol fraction in the Arctic polar vortex: feature or exception?" *by* R. Weigel et al.

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The paper sumarises well an important and interesting piece of work. Some gramatical corrections have been given by independent reviewers and I would support those changes. Understanding the refractory material in the stratosphere is of great importance to issues including the nucleation of solid aerosol in the polar stratospheric vortex as well as the issue of the meteor input function (MIF - the amount of material entering the atmosphere commonly referred to in tons per day or per year).

Methods / instrumentation:

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Interactive Discussion

Discussion Paper

As mentioned by one reviewer, it is important to consider modelling studies of meteoric smoke when interpreting the data.

The heated COPAS inlet has a lower particle size cutoff at 10 nm. However, Bardeen (2008, J. Geophys. Res.) predicted that a significant amount of the meteoric mass will be in smaller (~3 nm) particles at these altitudes. This is mentioned in sections 4.1 and 5.1, however the impact of dissolution of such particles is not discussed. MSP will dissolve when entrained in acidic liquid aerosol (Saunders, 2012, Atmos. Chem. Phys.). Measurements of midlatitude stratospheric aerosol have shown that Junge layer sulfuric acid droplets contain 0.5 wt% iron (Cziczo, 2001, Science). I estimate that 0.5 wt% of iron condensing from a solution droplet of 500 nm radius to an iron sulfate crystal could not have an equivalent spherical radius of more than 2 nm. However, the 'half of particles contain 1 wt% iron' number is from midlatitudes and could be higher (due to mesospheric influx) or lower (due to growth of Junge layer aerosol at colder temperatures). The 6 nm unheated channel might be expected to pick up some of this material, but not if MSP were rapidly coated with acids at higher altitudes. This leads to the possibility that a significant portion of meteoric smoke will not be detected by the COPAS instrument, and should be discussed in the paper.

The density assumption for meteoric material seems reasonable, however there is also significant terrestrial material in the stratosphere. Additionally, if the refractory aerosol detected is coming out of solution when a liquid aerosol evaporates, the salt density would be higher. (iron sulphate hydrates have densities from 1.8-3 g cm-3).

MIF (section 5.4):

The discussion of MSP dynamics given in one of the independent reviews, combined with the possibilities of higher density residuals and a larger contribution from smaller MSP, could lead to an even greater discrepancy with the MIF.

On the other hand, aerosol (such as Junge layer droplets containing eg. terrestrial dust or soot) may penetrate the vortex more easily than gasses (such as N2O). ie.

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There may be a significant contribution of 'non-mesospheric' non-volatile aerosol being counted as meteoric influx. This could have a large impact on the estimate produced for the MIF. A further study is mentioned which will describe the chemical nature of the refractory material. Hopefully this will shed some light on the origin of the aerosol. Without accounting for other sources of refractory aerosol this study can only be considered as an upper limit to the MIF.

References:

Bardeen, C. G., et al. "Numerical simulations of the three dimensional distribution of meteoric dust in the mesosphere and upper stratosphere." Journal of Geophysical Research: Atmospheres (1984–2012) 113.D17 (2008).

Saunders, R. W., et al. "Interactions of meteoric smoke particles with sulfuric acid in the Earth's stratosphere." Atmospheric Chemistry and Physics 12.10 (2012): 4387-4398.

Cziczo, D. J., D. S. Thomson, and D. M. Murphy. "Ablation, flux, and atmospheric implications of meteors inferred from stratospheric aerosol." Science 291.5509 (2001): 1772-1775.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 9849, 2014.

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