Geophysical Research Abstracts
Vol. 18, EGU2016-18191, 2016
EGU General Assembly 2016

Revisiting methods to predict the rate of equilibration of viscous aerosol particles

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Recent attention on aerosol particle phase state has motivated questions about methods to model diffusion through them. At the single particle level, some methods have already been used to: prescribe general equilibration timescales; infer relative importance of processes in SOA formation; derive diffusion coefficients in mixtures and even assess effects on cloud dynamics. Modelling diffusion is a well-established discipline. It is important to assess models that attempt to predict or infer the effects of diffusion limitations in order to report findings with confidence. In this study, we compare equilibration timescales estimated by three different models. Particles were subject to varying saturation ratio changes of a semi-volatile component in the gas phase, with the diffusion coefficient both dependent and independent of composition. We show that introducing a composition dependant diffusion coefficient significantly alters the perceived importance of kinetic mass transfer limitations in viscous aerosol, relative to a constant diffusion coefficient. In a fickian framework, simplified approximations to the partial differential form of Ficks second law can be used for all studied scenarios, although computational expense of previously available models may be an important factor to consider. We demonstrate the ability to capture the behaviour of simulations with compositional dependant diffusion coefficients in a box model framework, enabling potential effects on the microphysics of aerosol populations to be assessed.