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Investigating the sensitivity of ice cloud formation to water diffusion

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Recent studies have investigated inhibition of bulk water transport through ultra-viscous Secondary Organic Aerosols (SOA). To quantify this effect, water diffusion coefficients through SOA particles have been measured directly and a huge variability in these measurements has been found around the glass transition temperature. Our study will use published water diffusion coefficients for atmospherically relevant SOA to investigate the effect of ultra-viscous particles on cloud microphysics, particularly focussing on ice nucleation in the Tropical Troposphere Layer (TTL).

Slow water diffusion found in various SOA mixtures could be influential to how aerosols interact within cloud systems. Diffusion coefficients are inversely proportional to timescales of diffusion and affect the radial concentration gradient of water within the aerosol particles, in turn influencing their surface properties and interactions on a microphysical scale with humid air. Although water diffusion effects in subsaturated environments have been found to be insignificant, diffusion processes could still have implications for cloud formation processes under conditions found in the TTL.

We explore the effect of recently published water diffusion coefficients through amorphous SOA have upon ice nucleation. Our results are found using a cloud parcel model with bin microphysics that is coupled with an aerosol diffusion framework. We notice a suppression in homogeneous ice nucleation while using published water diffusion coefficients through atmospherically relevant SOA in comparison to using a constant diffusion coefficient. The results of further investigation into the non-ideal effects of diffusion and the implications this could have for cloud formation will be presented and discussed at the meeting.