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Multiphase chemical kinetics and cloud formation by organic aerosol

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Organic aerosol (OA) is ubiquitous in the atmosphere. It is well-known that OA particles can undergo amorphous phase transition; displaying a continuous change from liquid to solid phase state in response to temperature and humidity changes. OA particles can react with atmospheric oxidants, take up water, and act as ice-nucleating particles (INPs). We determined the reactive uptake coefficients of OH radicals by amorphous OA surrogate film substrates for temperatures as low as 213 K using a custom-built chemical ionization mass spectrometer coupled to a low-temperature flow-reactor. The phase state and viscosity of applied substrates were estimated using a poke-flow experiment. The OH reactivity of the organic substrate is interpreted using the resistor model accounting for viscosity changes in the condensed phase. Application of a temperature-controlled flow reactor, we observed that the phase state of OA modulates the resulting particle hygroscopicity after oxidation by OH. Oxidation of solid OA yielded greater hygroscopicity compared to when OA is in a liquid phase state. Lastly, we discuss the potential of laboratory and field-collected OA particles to act as INPs by combining ice nucleation experiments with single-particle micro-spectroscopic analytical techniques such as X-ray microscopy and scanning electron microscopy.