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Evaluation of the atmospheric significance of multiphase reactions in atmospheric secondary organic aerosol formation

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Abstract. In a simple conceptual cloud-aerosol model the mass of secondary organic aerosol (SOA) that may be formed in multiphase reaction in an idealized scenario involving two cloud cycles separated with a cloud-free period is evaluated. The conditions are set to those typical of continental clouds, and each parameter used in the model calculations is selected as a mean of available observational data of individual species for which the multiphase SOA formation route has been established. In the idealized setting gas and aqueous-phase reactions are both considered, but only the latter is expected to yield products of sufficiently low volatility to be retained by aerosol particles after the cloud dissipates. The key variable of the model is the Henry-constant which primarily determines how important multiphase reactions are relative to gas-phase photooxidation processes. The precursor considered in the model is assumed to already have some affinity to water, i.e. it is a compound having oxygen-containing functional group(s). As a principal model output an aerosol yield parameter is calculated for the multiphase SOA formation route as a function of the Henry-constant, and has been found to be significant already above $H \sim 10^3$ M atm^{-1}. Among the potential precursors that may be eligible for this mechanism based on their Henry constants, there are a suite of oxygenated compounds such as primary oxidation products of biogenic and anthropogenic hydrocarbons, including, for example, pinonaldehyde. Finally, the analogy of multiphase SOA formation to in-cloud sulfate production is exploited.

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