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Molecular Characterization of Aerosol Precursor Volatility

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Despite its global importance, the formation of secondary organic aerosol (SOA) is still poorly understood. Recently, a new group of oxidation products of many volatile organic compounds, called highly oxygenated molecules (HOM), was discovered. HOM can potentially explain a major part of the discrepancies in our understanding of SOA formation. HOM, owing to their high oxygen contents, are thought to be of very low volatility: they may even take part in the very first steps of new particle formation. However, due to their exotic structures, the precise estimation of their volatilities remains challenging, with estimates varying up to over ten orders of magnitude. Improved knowledge of their volatilities would be essential for assessing the effect of HOM on formation and characteristics of atmospheric aerosol.

In this study, we conducted a series of continuous flow chamber experiments to assess the volatilities of HOM formed in the ozonolysis of alpha-pinene, the most abundant monoterpene emitted globally. We used injections of inorganic seed aerosol to alter the condensational lifetime of vapours in the chamber and monitored the responses of individual HOM peaks to these changes. Based on these responses, we were able to infer their volatilities. Our results are consistent with HOM having volatilities in the lower range of prior estimates, falling mainly into the low or extremely low volatility ranges. We were also able to parametrize the observed volatilities of the HOM, based on their carbon, hydrogen, oxygen and nitrogen content. This parametrization is likely accurate only to HOM formed in systems similar to the one probed here, but the experimental method is applicable to many other systems as well.