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Observing molecule specific particle evolution of atmospherically relevant timescales using electrodynamic balance mass spectrometry of single levitated particles

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The evolution of aerosol particle composition impacts particle properties and mass concentration, which affects the understanding of particle effects on climate and human health. This evolution of particles can take place over the entire particle lifetime, which often extends over multiple days. Previous laboratory studies over these long timescales have used single particles suspended in levitation devices, e.g., electrodynamic balances (EDBs), optical levitators, or acoustic traps, using optical detection techniques. These techniques have provided valuable information but have been limited in the degree of molecular specific information.

We present results using an EDB coupled with a custom-built ionization source and commercial time-of-flight mass spectrometer as a new platform for laboratory atmospheric chemistry research. Mass spectra of single charged particles (radius $\sim$10 μm) are analyzed revealing the chemical evolution of these particles over hours or days, appropriate timescales for understanding transformations of atmospheric particles.

We present studies of the evaporation of particles consisting of polyethylene glycol (PEG) molecules of mixed chain lengths. The new experimental approach can quantify the compositional evolution of single particles and determination of the vapor pressures of the individual components within the complex mixture. We present new results of detailed chemical changes of particle composition in a controlled laboratory environment being monitored on timescales comparable to those of particles in the atmosphere.