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Towards an understanding of semi-volatile organic aerosol mixtures: gas-particle partitioning and mixing of primary and secondary organic aerosols

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Atmospheric organic matter constitutes a significant fraction of the total fine aerosol mass. Some particulates, secondary organic aerosol (SOA), can be formed via atmospheric reactions with organic gaseous species. However, the chemical composition and the mechanisms from which SOA form are not well understood. In this a study, SOA formed in the Carnegie Mellon University environmental smog chamber was mixed with different types of primary organic aerosol (diesel exhaust and motor oil). The SOA was generated from α-pinene in a dark ozonlysis reaction. Primary organic aerosol was injected into the chamber after SOA nucleation had occurred and the mixture was allowed to age for roughly four hours. A suite of instruments characterized changes in size, volatility, and chemical composition of the aerosol mixtures. A High Resolution Time of Flight Aerodyne aerosol mass spectrometer (AMS) measured the change in mass spectra throughout the experiment and a thermodenuder was used to characterize changes in mixed aerosol volatility. The AMS particle time-of-flight data was used to quantify the extent of mixing. Our results indicate that the mixture of biogenic SOA with motor-oil produces a weakly mixed particles, with two coexisting phases. In contrast, the SOA readily mixes with diesel exhaust particles. The semi-volatile diesel exhaust matter rapidly evaporates and re-condenses in the system to form a one phase aerosol mixture. Understanding the mixing behavior of two distinct semi-volatile organic aerosol species will help resolve the discrepancies between top-down and bottom-up SOA estimates.