Semi-volatile organic compounds diffuse between atmospheric particles

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Researchers led by Carnegie Mellon University's Neil M. Donahue have shown that semi-volatile organic compounds can readily diffuse into the billions of tiny atmospheric particles that inhabit the air, easily moving

among them. The findings, published in the early online edition of the *Proceedings of the National Academy of Sciences* (*PNAS*), provide greater understanding into how organic particles behave in the atmosphere.

The air is full of microscopic airborne particles called aerosols. Aerosols can come from natural sources, like fires or sea spray, or they can come from man-made sources, like emissions from cars and power plants. As the aerosol particles travel through the atmosphere, they encounter other particle populations and chemically evolve, resulting in a dense soup of oxidized organic matter. While many atmospheric particles start off too small to influence climate, as they grow their potential to impact climate increases. Understanding how these particles change is crucial to understanding how they affect the environment and human health.

As the particles grow and travel through the atmosphere, they pick up material called secondary organic aerosol (SOA). Much of the SOA consists of semi-volatile organic compounds (SVOCs) that can diffuse into particles—moving from one particle, entering the gas phase, and moving to another particle.

Recently, there has been controversy as to whether or not SVOCs are able to diffuse into "glassy" atmospheric particles. If SVOCs can't diffuse into these particles, they will not condense onto them, which will slow down particle growth rates.

"Our work shows that some particles are kind of crunchy when they are dry—they are glassy—but they turn gooey when they get wet; under most conditions, the semi-volatile compounds will diffuse into particles quite easily," said Donahue, the Lord Professor of Chemistry in the Mellon College of Science, and Professor of Chemical Engineering and Engineering and Public Policy in the College of Engineering. Donahue is also a member of Carnegie Mellon University's Center for Atmospheric

Particle Studies (CAPS), which is a leader in studying the chemistry of atmospheric particles and has completed groundbreaking studies that are revealing how these atmospheric particles change over time.

In the current study, chemistry doctoral student Qing Ye used single-particle mass spectrometry to see if SVOCs diffused from one group of particles into another, adding to the particles' complexity. Ye looked at two different types of secondary organic aerosols formed by the oxidation of organic gases: alpha-pinene, a molecule given off by pine trees, and toluene, an aromatic hydrocarbon in gasoline that is also often used as a solvent or in the production of industrial materials. She combined two populations of the particles, one of which was isotopically labeled, and measured the populations over time. In the alpha-pinene particles, the isotopes from the labeled particles easily evaporated into the unlabeled particles. The toluene particles also diffused easily, but only if the relative humidity was above 30 percent.

The findings show that SVOCs can travel between atmospheric particles, but the conditions under which they can travel are dependent on the particle's original source.

More information: Secondary organic aerosols do mix: Semivolatile mixing versus relative humidity, *PNAS*, www.pnas.org/cgi/doi/10.1073/pnas.1604536113

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