A day and night difference: Molecular composition of aerosols differs from day to night

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Tiny aerosols particles in the atmosphere have a significant effect on the climate. They affect the climate directly by interacting with solar

radiation. Depending on the type of particle, they can block sunlight, cooling the atmosphere, or absorb sunlight, warming the atmosphere. They also affect climate indirectly by acting as seeds for warm and cold cloud formation. But scientists lack information on these aerosols' molecular composition. This is especially true of aerosols during the day and night above agricultural fields.

In a study published in *ACS Earth and Space Chemistry*, scientists probed what are called secondary organic aerosols (SOAs). These aerosols form through an atmospheric oxidation of freshly emitted aerosols. They studied these SOAs over agricultural fields in the Southern Great Plains in Oklahoma. The team determined that organosulfates (compounds of oxygen, sulfates, and organic residues) were more prevalent in the aerosols during the daytime than during the nighttime over the Southern Great Plains agricultural fields. They also found that nighttime aerosols were more liquid-like than those identified during the daytime, and that some aerosols could be traced back to sources in urban areas.

SOAs are one of the most abundant types of atmospheric aerosols. Understanding how they are distributed, their makeup, and how they vary will help scientists track the progression of climate change. This will also help scientists understand a variety of atmospheric processes. Changes in atmospheric aerosols can affect weather patterns and the temperature of the Earth's surface. These changes have significant effects on crop health, water access, snowmelt, and other important requirements for life on Earth. This research provides important data for incorporation into models of atmospheric processes, as well as for more completely understanding climate processes.

A multi-institutional team of scientists from Pacific Northwest National Laboratory, Sandia National Laboratories, and Brookhaven National Laboratory collected samples at the Southern Great Plains atmospheric observatory in Oklahoma. The field measurement site was established by

the Atmospheric Radiation Measurement (ARM) research facility, a Department of Energy (DOE) Office of Science user facility.

Researchers collected samples twice each day—once in the daytime and once at night—over the span of one month during the springtime. In addition to chemical make-up, the team obtained supplemental information on wind direction, relative humidity, and complex particle size distribution. Working with the collected samples, scientists from the Environmental Molecular Sciences Laboratory (EMSL), also a DOE Office of Science user facility, used nanospray desorption electrospray ionization with high-resolution mass spectrometry (nano-DESI-HRMS) to characterize the molecular composition of aerosols within the samples. The team identified molecular formulas that featured carbon, hydrogen, and oxygen (CHO), nitrogen (CHNO), and/or sulfur (CHOS, CHNOS).

Their findings revealed higher organosulfate proportions during the daytime at 41% compared to at night at 30%. Nighttime aerosols featured increases in CHO, CHNO, and extremely low-volatility organic carbon species. However, due to high relative humidity, the nighttime aerosols phase state was found to be more liquid-like than in the daytime. Additionally, the results indicated that aerosols had traveled far from urban environments. This study provides key insights into organosulfates above agricultural fields by demonstrating a dependence on day-to-night cycles, as well as episodic emissions stemming from anthropogenic sources.

More information: Gregory W. Vandergrift et al, Molecular Characterization of Organosulfate-Dominated Aerosols over Agricultural Fields from the Southern Great Plains by High-Resolution Mass Spectrometry, *ACS Earth and Space Chemistry* (2022). DOI: 10.1021/acsearthspacechem.2c00043

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