Gases work with particles to promote cloud formation, study finds

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Researchers at Columbia Engineering and Georgia Institute of Technology have published a study in the online Early Edition of *Proceedings of the National Academy of Sciences* (*PNAS*) showing—for the first time—that certain volatile organic gases can promote cloud formation in a way never considered before by atmospheric scientists. The study will be published the week of February 4, 2013.

"This is the first time gases have been shown to affect cloud formation in this way," says V. Faye McNeill, Associate Professor in Chemical Engineering at Columbia University's Fu Foundation School for Engineering and Applied Science, and co-leader of the research team. "This is a very exciting finding that will improve our ability to model cloud formation, an important component of climate."

The research team, co-led by Athanasios Nenes, Professor & Georgia Power Faculty Scholar at the Georgia Institute of Technology, has been focused on understanding the impacts of aerosols, or airborne particulate matter, on clouds, because clouds have such an significant influence over our climate.

"Low-level clouds cool the planet by reflecting incoming sunlight back to space, so anything that perturbs them can have a major impact on our climate," explains Nenes, adding that pollution produced by humans releases many airborne particles to the atmosphere which can act as a seed for forming a cloud droplet, so clouds formed in polluted airmasses have a good chance of being more reflective than their cleaner counterparts.

"Our study," Nenes says, "shows that certain gas phase compounds tend to stick on particles, making them 'soapier' and promoting their ability to form cloud droplets. This mechanism has not been considered in climate models before."

Clouds form when water vapor condenses on atmospheric particulates called cloud condensation nuclei (CCN). Variations in CCN concentrations, say the researchers, can profoundly impact cloud properties with important effects on both regional and global climate. Organic matter, which makes up a significant percentage of aerosol mass in the troposphere, (the lowest layer of the Earth's atmosphere and the one in which we live) can profoundly influence the activity and concentration of CCN and cloud droplets.

In this *PNAS* study, the researchers present evidence that two ubiquitous atmospheric trace gases, methylglyoxal and acetaldehyde, can enhance aerosol CCN activity even if they do not contribute any detectable organic mass when taken up by aerosol particles. They generated aerosol particles in the McNeill Lab and exposed them to the surfactant gases methylglyoxal and/or acetaldehyde in the lab's aerosol reaction chamber for up to five hours. The exposed particles were then tested for their ability to form cloud droplets using a cloud chamber that was co-invented by the Nenes group. Their results showed the gas-phase surfactants may enhance the activity of atmospheric CCN, so that, as they conclude in the study, "volatile organics in the atmosphere may act as a reservoir of surfactants that can be taken up by aerosol particles and augment their CCN activity."

McNeill and Nenes plan to do more experimental work with other organic gases under a variety of conditions that will, they say, "help us understand how general this newly discovered phenomenon is, and, most importantly, will enable us to incorporate it into models of cloud formation so we can improve the predictive power of climate models."

"The effects of aerosols on clouds is one of the greatest sources of uncertainty in our understanding of climate," adds McNeill, "so it's fun to work on a problem that is both important and

intellectually fascinating."

Provided by Columbia University

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