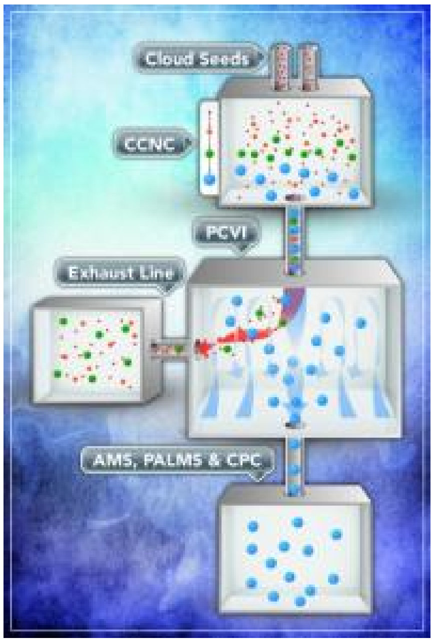
Cloud droplets, ready for prime time

December 28 2011



Cloud "seeds" are sent into the cloud condensation nucleation chamber (CCNC). Under supersaturation, some particles make cloud droplets and are separated from the particles that don't make droplets in the pumped counterflow virtual impactor (PCVI). The particle remains are then chemically analyzed with two different mass spectrometry techniques (AMS and PALMS). The number density of particles is counted using a condensation particle counter (CPC). These droplets are formed, separated, and characterized by size and composition using commercially available instruments, within typical operation parameters.

(PhysOrg.com) -- Some make the cut, some don't. Like auditions for the school play, scientists from Pacific Northwest National Laboratory and Goethe-University Frankfurt were looking for promising atmospheric particles that turn into cloud droplets, and then plotting their origins. Separating the formed droplets from the inactive particles, they uncovered the chemical structure of those that formed droplets. In doing so, they devised a method that can be used in real-life scenes to characterize these promising particles. Their research was published in Atmospheric Measurement Techniques.

Clouds have a starring role in the Earth's climate system. They create a cooling effect by reflecting and scattering sunlight away from the Earth. And, they carry and release—or don't release—rain and snow over the Earth. While clouds' effects are seen and felt, how clouds are formed, especially under the influence of tiny particles called aerosols suspended in the air, is still largely a mystery. This study looked at the particles that attract water at above 100 percent humidity, conditions typically found in a cloud, and the particles that don't. Revealing the true identity of these tiny particles will help solve some of the cloud mystery and their effects on floods and droughts.

Particles act as seeds for cloud droplets, which lead to clouds. But not all particles form droplets. Linking the effectiveness of three instruments, a research team led by Dr. Naruki Hiranuma at PNNL was able to produce, separate, and analyze cloud droplets. The team's process provides a path for future on-site characterization of those particles that form clouds.

"In the laboratory, we can't possibly reproduce all the chemical and physical cloud processes that happen in the atmosphere. So it's important to develop instruments we can take to the field, or in an aircraft, to get the true chemical identity of cloud-nucleating particles," said Hiranuma. "With this combination of off-the-shelf instruments, we can do just that."

The team used a commercially available cloud condensation nuclei chamber, or CCNC, to supersaturate particles to form cloud droplets. They immediately pushed all particles from the CCNC through a counterflow virtual impactor (CVI) using inertia to separate the droplets from inactivated particles. After separation, the droplets were chemically analyzed. The team used an aerosol mass spectrometer and a particle analysis by laser mass spectrometer to chemically characterize the residual material. Their procedure was validated to show that only droplets of a certain size made it through the CVI for analysis.

Under supersaturation conditions, some particles take up lots of water, some don't. Because of the dilution factor and flow restrictions of the instruments, the team had to start with a lot of particles to achieve enough droplets to characterize.

This research is the first to connect a commercial CCN, with a CVI and mass spectrometers to study the chemistry of aerosol particles that activate to cloud droplets.

In this study, the team characterized the composition of the activated or cloud-forming particles. They have planned a series of improvements to their methods to improve outflow and quantitatively characterize the aerosol particles.

More information: Hiranuma N, M Kohn, MS Pekour, DA Nelson, JE Shilling and DJ Cziczo. 2011. "Droplet Activation, Separation, and Compositional Analysis: Laboratory Studies and Atmospheric Measurements," *Atmospheric Measurement Techniques*, 4, 2333-2343. DOI:10.5194/amt-4-2333-2011

Provided by Pacific Northwest National Laboratory