

Atmospheric lead causes clouds to form more easily, could change pattern of rain and snow

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Cirrus clouds (also known as ice clouds) form high in the atmosphere. Their formation may be affected by lead generated from human activities. Courtesy of the National Weather Service

(PhysOrg.com) -- By sampling clouds -- and making their own -- researchers have shown for the first time a direct relation between lead in the sky and the formation of ice crystals that foster clouds. The results suggest that lead generated by human activities causes clouds to form at warmer temperatures and with less water. This could alter the pattern of both rain and snow in a warmer world.

The lead-laden [clouds](#) come with a silver lining, however. Under some conditions, these clouds let more of the earth's heat waft back into space, cooling the world slightly. Atmospheric lead primarily comes from

human sources such as coal.

The international team of researchers reported their results in the May issue of *Nature Geoscience*. The collaboration included researchers from institutions in the United States, Switzerland and Germany.

"We know that the vast majority of lead in the atmosphere comes from man-made sources," said atmospheric chemist Dan Cziczo of the Department of Energy's Pacific Northwest National Laboratory and study author. "And now we show that the lead is changing the properties of clouds and therefore the balance of the sun's energy that affects our atmosphere."

Globe Trotting for Lead

Scientists first attempted to goad rain from the sky with silver and lead iodide in the 1940s. Since then, researchers have known that lead can pump up the ice crystals in clouds. But daily human activities also add lead to the atmosphere. The top sources include coal burning, small airplanes flying at the altitude where clouds form, and construction or wind freeing lead from the ground. Cziczo and colleagues wanted to know how lead from these sources affects clouds.

To find out, the researchers collected air from high atop a mountain peak on the Colorado-Wyoming border. In their high altitude lab, they created artificial clouds from the air in a cloud chamber about the size of a small refrigerator. Half of the ice crystals they plucked from the synthetic clouds, they found, contained lead.

The team then collected a dollop of real cloud atop a mountain in Switzerland. About half of those ice crystals also contained lead. But finding lead in an incriminating position doesn't mean it causes ice crystals.

To determine whether lead causes [ice crystals](#) and clouds to form, the team turned to a lab in Germany that houses a cloud chamber three stories tall, as well as a smaller chamber in Switzerland. They created dust particles that were either lead-free or contained one percent lead by weight, which is about what scientists find in the atmosphere. They put these dust particles into the chambers and measured the temperature and humidity at which point ice nucleated around the dust.

They found that lead changed the conditions under which clouds appeared. The air didn't have to be as cold or as heavy with water vapor if lead was present.

"Most of what nucleates clouds are dust particles," said Cziczo. "Half of the ones we looked at had lead supercharging them."

Leaden Clouds, Cooler Climes

To investigate what this might mean for the earth's climate, the researchers simulated the global climate with either lead-free dust particles floating around, or with either 10 percent or all of them containing lead.

The computer simulation showed that the clouds they looked at -- typically high, thin clouds -- formed at lower altitudes and different locations in the northern hemisphere when lead was present in [dust particles](#). This will probably affect precipitation, said Cziczo.

"In our atmosphere, lead affects the distribution and density of the kinds of clouds we looked at," said Cziczo, "which might then affect where and when rain and snow fall."

Clouds at lower altitudes let more of the earth's heat, or so-called longwave radiation, escape out to space. So lead-triggered clouds could

partly offset global warming due to greenhouse gases.

But that doesn't mean lead in the atmosphere will simply cool the planet, said Cziczo, since they looked at only one type of cloud. Cloudy skies are far more complicated than their wispy image lets on.

"This work highlights how complex these interactions between lead and water vapor and temperature are," said Cziczo. "They're not as simple as greenhouse gases."

Future work will look at the type of lead and how much is needed to affect clouds and precipitation, as well as the atmospheric distribution of the metal dust.

More information: D. J. Cziczo, O. Stetzer, A. Worringen, M. Ebert, S. Weinbruch, M. Kamphus, S. J. Gallavardin, J. Curtius, S. Borrmann, K. D. Froyd, S. Mertes, O. Möhler and U. Lohmann, Inadvertent Climate Modification Due to Anthropogenic [Lead](#), [Nature Geoscience](#), May 2009, DOI 10.1038/NGEO499 (www.nature.com/ngeo/index.html).

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