Dust involved in sulfate production in clouds

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Measurement Station Schmücke. HCCT 2010 (Hill Cap Cloud Thuringia 2010) - A ground-based integrated study of chemical-aerosol-cloud interactions at the Schmücke Mountain in the Thuringian Forest in September/October 2010.

(Phys.org) —A new study from Germany has studied the tiny dust particles within clouds and their influence on the climate. The influence of dust particles on cloud formation and on the chemical reactions within clouds has been poorly understood until now.

The research team, led by Eliza Harris of the Max Planck Institute for Chemistry in Germany, determined that sulfates are formed within clouds by oxidation of sulfur dioxide on the surface of coarse mineral dust particles. The oxidation is catalyzed by metal ions within the dust particles.

Mineral dust particles are released into the atmosphere by human activities such as intensive agricultural practices and deforestation, while metallic particles are released through industrial combustion processes, including the burning of fuels containing lead.

It was previously thought that sulfates were primarily formed in clouds through the action of peroxide formed during photochemical reactions, but the new study shows that this is a less dominant process. The researchers were able to show this because the two oxidation routes favor different isotopes of sulfur, and by examining the ratio of isotopes in sulfur dioxide entering clouds and sulfates in the clouds, they were able to demonstrate that the mineral dust/metal ion route was the dominant one.

The findings are important because sulfates in clouds are thought to increase cloud formation and light scattering by clouds, both of which have a cooling effect. Peroxides and mineral dusts have different distributions across the globe, and so assuming that peroxide was the dominant route led to incorrect assumptions about the production of sulfates in different regions. The findings that relatively large particles are involved also means the sulfates do not stay in the clouds as long as previously thought since they are formed on relatively large particles that easily drop out. This means the influence of sulfates and the cooling associated with them has been overestimated.

A second study, led by atmospheric scientist Dan Cziczo of the Massachusetts Institute of Technology (MIT), studied ice formation in cirrus clouds, which typically form several kilometers above the ground, and found that ice nucleation had occurred around specks of mineral dust or metallic particles in the clouds.

Dr. Harris, who is now also at MIT, said it was interesting that the two studies had been published at the same time, and both should help to refine the climate models, which currently do not adequately take into account the importance of mineral dust and its effects on the climate.

More information: Harris, E. et al. Enhanced role of transition metal ion catalysis during in-cloud oxidation of SO_2, *Science* Vol. 340, 727-730, doi: 10.1126/science.1230911 , Published May 10th, 2013.

ABSTRACT
Global sulfate production plays a key role in aerosol radiative forcing; more than half of this production occurs in clouds. We found that sulfur dioxide oxidation catalyzed by natural transition metal ions is the dominant in-cloud oxidation pathway. The pathway was observed to occur primarily on coarse mineral dust, so the sulfate produced will have a short lifetime and little direct or indirect climatic effect. Taking this into account will lead to large changes in estimates of the magnitude and spatial distribution of aerosol forcing. Therefore, this oxidation pathway—which is currently included in only one of the 12 major global climate models—will have a significant impact on assessments of current and future climate.

Press release