Sulfate lens enhances climate warming properties of atmospheric soot

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Particulate pollution thought to be holding climate change in check by reflecting sunlight instead enhances warming when combined with airborne soot, a new study has found.

Like a black car on a bright summer day, soot absorbs solar energy. Recent atmospheric models have ranked soot, also called black carbon, second only to carbon dioxide in potential for atmospheric warming. But particles, or aerosols, such as soot mix with other chemicals in the atmosphere, complicating estimates of their role in changing climate.

"Until now, scientists have had to assume how soot is mixed with other chemical species in individual particles and estimate how that ultimately impacts their warming potential," said Kimberly Prather, professor in the Department of Chemistry and Biochemistry and the Scripps Institution of Oceanography at the University of California, San Diego. "Our measurements show that soot is most commonly mixed with other chemicals such as sulfate and this mixing happens very quickly in the atmosphere. These are the first direct measurements of the optical properties of atmospheric soot and allow us to better understand the role of soot in climate change."

Prather and Ryan Moffet, a former graduate student at UC San Diego who is now at the Lawrence Berkeley National Laboratory, measured atmospheric aerosols over Riverside, California and Mexico City. Using an instrument that measures the size, chemical composition and optical properties of aerosols in real time, they showed that jagged bits of fresh

soot quickly become coated with a spherical shell of other chemicals, particularly sulfate, nitrate, and organic carbon, through light-driven chemical reactions.

Within several hours of sunrise, most of the atmospheric carbon they measured had been altered in this way, they report in the Proceedings of the National Academy of Sciences online the week of June 29.

Particles of sulfate or nitrate alone reflect light, and some have proposed pumping sulfate aerosols into the atmosphere to slow climate change. But these chemicals play a different role when they mix with soot.

"The coating acts like a lens and focuses the light into the center of the particle, enhancing warming," Prather said. "Many people think sulfate aerosols are a good thing because they are highly reflective and cool our planet. However we are seeing that sulfate is commonly mixed with soot in the same particles, which means in some regions sulfate could lead to more warming as opposed to more cooling as one would expect for a pure sulfate aerosol."

Their measurements showed that in the atmosphere the lens-like shell of sufate and nitrate enhances absorption of light by coated soot particles 1.6 times over pure soot particles.

Soot comes from fires, including those used to cook food and clear agricultural fields, as well as burning of diesel fuel in trucks and ships. Simple measures such as providing better cook stoves with more complete combustion to those in developing countries would help reduce atmospheric soot levels.

Efforts to reduce soot would pay off soon. Unlike carbon dioxide, which lingers in the atmosphere for centuries, soot falls from the sky in a matter of days to weeks, making the reduction of soot a quicker option

for slowing down climate change.

"While reducing CO2 concentrations is extremely important, changes we make today will not be felt for quite a while, whereas changes we make today on soot and sulfate could affect our planet on timescales of months," Prather said. "This could buy us time while we grapple with the problems of reducing carbon dioxide and other greenhouse gases."

Source: University of California - San Diego (news : web)