Invisible gases form most organic haze in urban, rural areas

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Organic haze at sunset over the San Bernadino Valley, Calif. Credit: Mike Cubison, CU-Boulder

A new study involving the University of Colorado at Boulder shows that invisible, reactive gases hovering over Earth's surface, not direct emissions of particulates, form the bulk of organic haze in both urban and rural areas around the world.

Many science and health professionals have believed sources that spew soot and other tiny particles directly into the air were the primary culprit in the formation of organic haze. But a new study by researchers at CU-Boulder's Cooperative Institute for Research in Environmental Sciences show aerosols formed chemically in the air account for about two-thirds of the total organic haze in urban areas and more than 90 percent of organic haze in rural areas.

The study was led by Qi Zhang, a former CIRES scientist now at the Atmospheric Sciences Research Center at State University of New York, Albany and CIRES researcher Jose-Luis Jimenez. The study was published in the July 7 online issue of *Geophysical Research Letters*.

The scientists compared concentrations of directly emitted, or primary, aerosols with chemically formed, or secondary aerosols. They surveyed urban areas, areas downwind of urban areas and rural areas from 37 sites in 11 countries.

"What we're seeing is that concentrations of secondary organic aerosols decrease little downwind from urban areas," said Jimenez, also an assistant professor in CU-Boulder's chemistry and biochemistry department. "That tells us there has to be an extended source or continuous formation for the pollution."

The scientists believe the extended source of particle pollution is reactive, colorless gases called Volatile Organic Compounds, or VOCs, the same gases that form smog. Jimenez said he believes VOCs emitted in urban and regional areas immediately begin undergoing a chemical transformation that causes them to stick to particles and increase such pollution.

"We think the gases react over a few days as the air travels downwind into more rural regions, producing more organic haze," he said.

Reactive gases are a diverse group of chemical compounds that include VOCs, surface ozone, nitrogen compounds and sulfur dioxide. All play a major role in the chemistry of the atmosphere and as such are heavily involved in interrelations between atmospheric chemistry and climate.

VOCs are released by cars and trucks, gasoline evaporation that occurs during gas station fill-ups, and some industrial processes, said Zhang.

VOCs also are produced naturally by vegetation.

The U.S. Environmental Protection Agency does not currently regulate VOCs except for on-road vehicles and industrial settings, said Jimenez.

Jimenez and Zhang are working to better understand the relative importance of natural and human sources of VOCs in the production of secondary organic aerosol pollution, including which human sources significantly contribute to the problem.

"One question is whether we could improve air quality if we directly targeted VOC emissions and not just particle emissions," said Zhang. "Until we understand the breakdown between human-caused and natural VOC emissions, and between different human sources, we won't have an answer to that question."

Source: University of Colorado at Boulder