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NEWS RELEASE

10/21/02

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EDITORS: The paper, "Control of fossil-fuel particulate black carbon and organic matter, possibly the most effective method of slowing global warming" (22 pages), appears in the *Journal of Geophysical Research Atmospheres* this month. Journalists may obtain a copy by pdf or fax on request to Emily Crum, ecrum@agu.org. Please provide your name, name of publication, address, phone, fax and email address. It is not embargoed.

Citation: Jacobson, M. Z., Control of fossil-fuel particulate black carbon and organic matter, possibly the most effective method of slowing global warming, *J. Geophys. Res.*,107(D19), 4410, DOI:10.1029/2001JD001376, 2002.

A photo of Jacobson is available on the web at http://newsphotos.stanford.edu/.

Despite lower carbon dioxide emissions, diesel cars may promote more global warming than gasoline cars

Laws that favor the use of diesel, rather than gasoline, engines in cars may actually encourage global warming, according to a new study. Although diesel cars obtain 25 to 35 percent better mileage and emit less carbon dioxide than similar gasoline cars, they can emit 25 to 400 times more mass of particulate black carbon and associated organic matter ("soot") per kilometer [mile]. The warming due to soot may more than offset the cooling due to reduced carbon dioxide emissions over several decades, according to Mark Z. Jacobson, associate professor of civil and environmental engineering at Stanford University.

Writing in the *Journal of Geophysical Research Atmospheres*, Jacobson describes computer simulations leading to the conclusion that control of fossil-fuel black carbon and organic matter may be the most effective method of slowing global warming, in terms of the speed and magnitude of its effect on climate. Not only does soot warm the air to a much greater extent than does carbon dioxide per unit mass, but the lifetime of soot in the air (weeks to months) is much less than is that of carbon dioxide (50 to 200 years). As such, removing soot emissions may have a faster effect on slowing global warming than removing carbon dioxide emissions.

The model Jacobson used tested 12 identifiable effects of airborne particles, known as aerosols, on climate, eight of which had not previously been described in scientific literature. Jacobson notes that it is not currently possible to quantify each of these effects individually, only the net effect of all of them operating simultaneously.

"Since 1896, when Svante Arrhenius first postulated the theory of global warming due to carbon dioxide, control of carbon dioxide has been considered the most effective method of slowing warming," Jacobson says in an interview. "Whereas carbon dioxide clearly causes most global warming, control of shorter-lived warming constituents, such as black carbon, should have a faster effect on slowing warming, which is the conclusion I have drawn from this study. The Kyoto Protocol of 1997 does not even consider black carbon as a pollutant to control with respect to global warming."

The reason the issue of diesel versus gasoline is important, says Jacobson, is that, in Europe, one of the major strategies for satisfying the Kyoto Protocol is to promote further the use of diesel vehicles and specifically to provide a greater tax advantage for diesel. Tax laws in all European Union countries, except the United Kingdom, currently favor diesel, thereby inadvertently promoting global warming, Jacobson says. Further, some countries, including Sweden, Finland, Norway and the Netherlands, also tax fuels based on their carbon content. These taxes also favor diesel, he notes, since diesel releases less carbon per kilometer [mile] than does gasoline. Nevertheless, the small amount of black carbon and organic matter emitted by diesel may warm the atmosphere more over 100 years than the additional carbon dioxide emitted by gasoline.

In Europe and the United States, particulate emissions from vehicles are expected to decline over the next decade. For example, by 2005, the European Union will introduce more stringent standards for particulate emissions from light duty vehicles of 0.025 grams per kilometer [0.04 grams per mile]. Even under these standards, diesel-powered cars may still warm the climate more over the next 100 years than may gasoline-powered cars, according to the study.

The state of California is implementing an even more restrictive standard in 2004, allowing only 0.006 grams per kilometer [0.01 grams per mile] of particulate emissions. Even if the California standard were introduced worldwide, says Jacobson, diesel cars may still warm the climate more than gasoline cars over 13 to 54 years.

In an interview, Jacobson says that new particle traps being introduced by some European automobile manufacturers in their diesel cars appear to reduce black carbon emissions to 0.003 grams per kilometer [0.005 grams per mile], even below the California standard. "I think this is great, and it is an indication that tough environmental laws encourage industry to change." But, he says, "diesel vehicles emitting at this level may still warm the climate more than gasoline over a 10 to 50 year period, not only because of black carbon emissions, but also because the traps themselves require addition fuel use. Gasoline/battery hybrid vehicles now available not only get better mileage than the newest diesels but also emit less black carbon."

In practice, less than 0.1 percent of light vehicles in the United States run on diesel fuel, whereas more than 25 percent do in Europe. (Almost a third of new European cars in 2000 were diesel powered.) In both the United States and Europe, virtually all heavy trucks and buses are diesel powered, and American diesel consumption rates for all modes of ground transportation combined are about 75 to 80 percent of those in Europe.

Control of fossil-fuel black carbon and organic matter will not by itself eliminate long-term global warming, says Jacobson. This would require reductions in emissions of carbon dioxide and other greenhouse gases, in addition to reduction of particles. Other strategies to be considered for reducing black carbon and organic matter from the atmosphere could include the phasing out of indoor biomass and coal burning and improved particle collection from jet fuel and coal burning, he says. This reduction would provide the additional benefit of reducing the 2.7 million people who die annually from air pollution, as estimated by the World Health Organization. The health costs of particulate pollution range, in industrial countries, from $200,000 to $2.75 million per ton, Jacobson notes.

The research was supported by NASA, the Environmental Protection Agency, the National Science Foundation, the David and Lucile Packard Foundation and the Hewlett-Packard Co.

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