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Good morning. My name is Mark Jacobson. I am a Professor of Civil and Environmental Engineering and Director of the Atmosphere/Energy Program at Stanford University. I would like to testify briefly about two issues (1) the climate effects of black carbon, the main component of soot and (2) the air pollution health impacts of locally- and globally-emitted carbon dioxide.

First black carbon is a global-warming agent whose immediate control will slow the demise of Arctic sea ice faster than will control of any other global-warming agent. In 2000, I demonstrated that black carbon was the second-leading cause of global warming after carbon dioxide in terms of radiative forcing and, in 2002, that its control was the most effective method of slowing warming. Both results have held up to scrutiny in the peer-reviewed literature. Despite knowledge by the international scientific community of black carbon's importance as a warming agent, BC has been neglected in climate warming treaties and legislation until recently. On October 18, 2007, I and four colleagues testified in the House Committee on Oversight and Government Reform Hearing on Black Carbon and Global Warming.

http://www.stanford.edu/group/efmh/jacobson/101807_testimony.htm

Subsequently, four U.S. laws related to black carbon emission controls and studies were proposed (H.R. 1760, H.R. 7250, S.R. 110-489, and S. 849.IS). Thus, the tide is turning with respect to regulating BC for its climate effects. Here, I am asking the EPA to join with the scientific and legislative community and include black carbon along with greenhouse gases under the endangerment finding.

Although black carbon from motor vehicles is already regulated under vehicle PM emission rules due to known PM health effects, such regulations still permit substantial BC emissions, and the climate effects of such emissions are significant. Specifically, regardless of the time period, each gram of black carbon in the air warms the air over 300,000 times more than does each gram of CO_2. Because eliminating BC emissions almost immediately removes atmospheric BC whereas eliminating CO_2 emissions removes atmospheric CO_2 over only many decades, eliminating BC can immediately slow down the loss of Arctic ice, whereas eliminating GHG emissions can slow loss only over a longer period. However, both BC and GHG controls are needed.

To date, fossil-fuel plus biofuel soot has caused about 12.5-15% of gross global warming (warming before non-soot cooling particles have been subtracted) or 28-40% of net observed warming (net warming less cooling by non-soot particles)*. Thus, reducing soot in isolation could eliminate one-third of net warming to date. Whereas, the U.S. emits ~21% of the world's anthropogenic CO_2, it emits ~6.1% of its soot. However, the warming due to U.S. soot exceeds that due to U.S. methane or nitrous oxide (www.stanford.edu/group/efmh/jacobson/0710LetHouseBC%201.pdf, Table 4), both of which are included in the endangerment portfolio. Clearly, soot should be included in this portfolio, since its control is the most effective method of reducing Arctic ice loss. Immediate GHG control is still absolutely necessary to stem short and long-term climate damage. Further, controlling soot will significantly reduce particulate air pollution deaths. Controlling GHGs will also reduce such deaths, as discussed next.

I have performed two recent studies on CO_2's effect on air pollution mortality.

http://www.stanford.edu/group/efmh/jacobson/Ve.html
http://www.stanford.edu/group/efmh/jacobson/urbanCO2domes.html

The first study found that globally-emitted CO_2 increases U.S. air pollution deaths by about +1000 (+350 to +1800) each year per 1.8 degrees Fahrenheit (1 K), with about 40% due to ozone. These additional deaths are occurring today, as historic temperatures are about 0.75-0.85 K higher than in preindustrial times. A simple extrapolation from U.S. to world population gives 21,600 (7400-39,000) deaths/yr worldwide per 1 K due to carbon dioxide's effects on air pollution. The reasons for the higher ozone are that higher temperatures and water vapor due to higher CO_2 increase ozone-forming reaction rates when the ozone is already high. Higher PM occurs because CO_2 increases the relative humidity, causing particles to swell and absorb more soluble gases. Also, higher temperatures from CO_2 increase biogenic gas emissions, increasing secondary organic PM. Finally, enhanced stability from CO_2 reduces particle dispersion.

The second study found that local CO_2 emissions produce CO_2 domes over cities, which increase local ozone and PM, increasing local mortality. Data indicate that a city's downtown can have up to 500 ppmv CO_2, higher than the global background of 385 ppmv. The increase in local CO_2 increases water vapor, ozone, and PM. The study found that CO_2 domes increase air pollution deaths by 50-100 per year in California, with most occurring in Los Angeles. As such, reducing locally-emitted CO_2 reduces local air pollution deaths even if CO_2 in adjacent regions is not controlled. This result contradicts the basis for all air pollution regulation worldwide, none of which considers controlling local CO_2 based on its local health impact. Thank you for considering my testimony.

*Fossil-fuel plus biofuel soot warming is ~0.24-0.3 K. Gross GHG+urban heat island warming is ~1.9-2 K. Aerosol cooling is ~1.05-1.25 K, and net global warming is ~0.75-0.85 K. Thus, soot warming is ~12.5-15% of gross warming and ~28-40% of net warming. The 20-year global warming potential (GWP) due to black carbon in soot is about 4500, and the 100-year GWP is about 1500-2200. The GWPs of soot itself are about 2500 for 20 years and 800-1300 for 100 years.