Domestic Mitigation of Black Carbon From Diesel Emissions

by Hannah Chang

Hannah Chang wrote this Article while a Fellow at Columbia Law School's Center for Climate Change Law.

Editors' Summary

Black carbon, a component of soot and particulate matter, competes closely with methane as the largest anthropogenic contributor to global warming after carbon dioxide. Regulation of black carbon has been identified as an affordable, politically feasible, fast-action means to mitigate the warming temperatures caused by climate change. With an emphasis on domestic mitigation, this Article examines how emissions are controlled under the CAA and what EPA, states, and municipalities can do to mitigate black carbon emissions further.

Black carbon (BC), a component of soot and particulate matter (PM), competes closely with methane as the largest anthropogenic contributor to global warming after carbon dioxide (CO_2).[1] Both domestically and internationally, BC can be mitigated by affordable technologies that already exist. Moreover, such mitigation has nearly immediate effects, as BC remains in the atmosphere for mere days or weeks, in contrast to CO_2, which remains in the atmosphere for a century or more.[2] BC is linked to cardiovascular symptoms and decreased lung function, so mitigation also produces tremendous public health benefits. As a result, BC's profile as the "lowest hanging of the low-hanging fruit"—an affordable, politically feasible, fast-action means to mitigate the warming temperatures caused by climate change[3]—has risen in recent years, especially in the arena of international mitigation.[4]

BC emissions from different sources have different warming effects, however. Whereas fossil fuel soot is clearly warming, biomass soot has a lesser warming effect on the climate and may even have a net cooling effect. Consequently, one of the key conclusions drawn at an April 2010 Yale Climate and Energy Institute workshop on BC was that diesel emissions, a prime source of fossil fuel soot, should be the target of mitigation efforts, rather than emissions from biofuel-burning cookstoves, which have been the center of attention to date.[5]

Although the United States is a relatively small contributor to worldwide BC emissions, it has per capita emissions comparable to those in developing regions where the vast majority of BC is emitted.[6] Moreover, diesel emissions—the sort of emissions that have an undeniable warming

1. Jessica Seddon Wallack & Veerabhadran Ramanathan, *The Other Climate Changers: Why Black Carbon and Ozone Also Matter*, 88 Foreign Aff. 105, 106 (2009).
2. *Id.* at 107.
3. Andrew Childers, *Environmental Groups Discuss Ways to Reduce Impact of Black Carbon*, BNA Daily Env't Rep. A-1 (Mar. 6, 2009).
4. The United Nation Environment Programme's Integrated Assessment on Black Carbon and Ozone, a report that aims to define the climate, air pollution, health, and agriculture impacts of BC and ozone and examines the temperature impacts of feasible mitigation measures, is expected to be released in February 2011.
5. Bidisha Banerjee, *Black Carbon's Grey Areas: Key Messages From a Yale Workshop, Parts I and II* (July 2010), *available at* http://www.yaleclimatemediaforum.org/2010/07/black-carbons-grey-areas/, *and* http://www.yaleclimatemediaforum.org/2010/07/black-carbons-grey-areas-pt2/. *See, e.g.*, Flavia Krause-Jackson & Peter S. Green, *Shell, UN to Back $100 Million Plan for Clean Energy Cookstoves*, Bloomberg, Sept. 20, 2010, http://www.bloomberg.com/news/2010-09-20/shell-un-to-back-100-million-plan-for-clean-energy-cookstoves.html.
6. *Black Carbon: Hearing Before the H. Select Comm. on Energy Independence and Global Warming*, 111th Cong. 5 (2010) (statement of V. Ramanathan, Scripps Institution of Oceanography); John-Michael Cross, *Opportunities to Reduce Black Carbon Emissions* (Climate Inst. 2009), *available at* http://www.climate.org/publications/Climate%20Alerts/Autumn2009/BCreductions.html.

effect—are the main source of BC in the United States.[7] This Article, therefore, brings a narrow focus to domestic mitigation of BC, primarily through mitigation of diesel emissions under the Clean Air Act (CAA).[8] Although the U.S. Environmental Protection Agency (EPA) has achieved substantial reductions in soot emissions in the past decades, more can be done. The political palatability of regulating BC, evidenced by a bipartisan bill introduced in April 2009[9] by senators as ideologically opposed in matters of climate change as Sens. Jim Inhofe (R-Okla.) and Barbara Boxer (D-Cal.),[10] suggests that more *can* be done.

I. About BC

BC is a product of incomplete and inefficient combustion of biomass and fossil fuels, such as wood, dung, crop residue, diesel, and coal.[11] BC warms the earth directly by absorbing solar energy in the atmosphere and melting any snow or ice it lands on after washing out of the atmosphere.[12] It also causes warming through indirect means, including thickening Arctic clouds, which traps more heat in the atmosphere, and reducing the albedo, or reflectivity, of the earth by leading to faster ice melt that exposes dark soil.[13] Through these processes, one pound of BC can cause up to 700 times as much warming as one pound of CO_2.[14]

A. Sources

BC emissions primarily result from four sources: burning of residential solid fuels, such as wood and coal; open burning of land; diesel engines; and industrial processes, such as small boilers. About 65% of BC emissions result from the burning of biomass, through forest fires, agricultural clearing, and use of biomass in cookstoves, residential heating, and small-scale industries.[15] The remaining 35% of worldwide BC emissions result from the combustion of fossil fuels, particularly diesel.[16]

The United States contributes about 6% of the global total of BC emissions, most of which arises from diesel engines.[17] Developing countries, where open burning of wood, coal, and biomass are more common, are by far the greater source of BC emissions.[18] Africa and the Middle East account for about 25% of global BC emissions, while South and East Asia account for 30% of global BC emissions.[19] In South Asia, the burning of biomass in cookstoves contributes to nearly two-thirds of BC emissions in the region.[20] In East Asia, the primary source of BC is coal combustion for residential heating and industrial uses.[21] Diesel emissions are also increasingly a problem in developing countries, where the anticipated growth of diesel vehicles that are not equipped with emissions controls and do not use ultra-low sulfur diesel fuel is expected to cause global BC emissions from transportation to increase from 7% in 2001 to 77% in 2020.[22]

B. Environmental and Public Health Impacts

BC has distinct local and regional impacts. Locally, exposure to the fine particles in soot produced from cookstoves, coal combustion, and diesel engines is associated with premature mortality from heart and lung disease, including heart attacks, decreased lung function, asthma attacks, and bronchitis.[23] Studies also link diesel exhaust to increased

7. *Black Carbon: Hearing Before the H. Select Comm. on Energy Independence and Global Warming*, 111th Cong. 6 (2010) (statement of Tami C. Bond, Associate Professor, Univ. of Illinois at Urbana-Champaign).
8. 42 U.S.C. §§7401-7671q, ELR Stat. CAA §§101-618.
9. S. 849, 111th Cong. (2009). *See also* Andrew C. Revkin, *Senate Foes Agree on Dangerous Pollutant* (NY Times Dot Earth blog, Apr. 22, 2009), http://dotearth.blogs.nytimes.com/2009/04/22/senate-foes-agree-on-dangerous-pollutant/.
10. The Bill directed EPA to study the environmental impacts of BC and identify cost-effective means to reduce BC emissions. The U.S. Congress incorporated substantially similar provisions in a fiscal year 2010 appropriations bill, directing EPA to submit a report to Congress within 18 months on domestic and international BC emissions. Pub. L. No. 111-88, 123 Stat. 2904, 2939 (Oct. 30, 2009). EPA's report is due in early 2011.
11. Veerabhadran Ramanathan & Gregory R. Carmichael, *Global and Regional Climate Changes Due to Black Carbon*, 1 Nature Geoscience 221 (2008).
12. Cheryl Hogue, *Black Carbon: A Key Cause of Warming Not Well Recognized*, SEJournal 10-11 (Spring 2009).
13. *Id.* at 11. *See also* Remy Garderet & Daniel W. Emmett, *Integrating Black Carbon Into Climate Change Agreements* (Innovo Energy Solutions Group, LLC, Sept. 2009).
14. Bond testimony, *supra* note 7, at 4. Estimates for BC's radiative-forcing capacity vary, ranging from the Intergovernmental Panel on Climate Change's estimate of +0.20 ± 0.15 W m^{-2} to an estimate of +0.9 W m^{-2} (with a range of +0.4 to +1.2 W m^{-2}), where a higher radiative-forcing capacity signifies a greater warming effect. *See* Intergovernmental Panel on Climate Change, *Chapter 2 Changes in Atmospheric Constituents and in Radiative Forcing* 165, *in* Climate Change 2007: The Physical Science Basis—Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007); Ramanathan & Carmichael, *supra* note 11, at 222; *see also* Mark Z. Jacobson, *Strong Radiative Heating Due to the Mixing State of Black Carbon*, Nature 409, 695-97 (2001), *available at* http://www.nature.com/nature/journal/v409/n6821/abs/409695a0.html; Serena H. Chung & John H. Seinfeld, *Global Distribution and Climate Forcing of Carbonaceous Eerosols*, 107 J. Geophys. Res. 4407 (2002). These variations in the estimated warming potential of BC are due to the complexities in BC properties and effects, including the mixing of BC with other aerosols and the variable concentrations of BC at different elevations. *See* Ramanathan & Carmichael, *supra* note 11, at 222.
15. *Id.*
16. Wallack & Ramanathan, *supra* note 1, at 107.
17. Bond testimony, *supra* note 7, at 6.
18. Andrew Childers, *Study Links Black Carbon, Decline in Sulfate Emissions to Arctic Warming*, BNA, Inc. A-6 (Apr. 3, 2009).
19. *See Climate Change, Black Carbon & Clean Diesel* 2 (Diesel Technology Forum Oct. 2009), *available at* http://www.dieselforum.org/news-center/pdfs/Black%20Carbon_FINAL.pdf.
20. Jeff Tollefson, *Climate's Smoky Spectre*, 460 Nature 29, 32 (July 2009).
21. Ramanathan & Carmichael, *supra* note 11, at 226.
22. *See Climate Change, Black Carbon & Clean Diesel*, *supra* note 19, at 3.
23. *See* U.S. EPA, Fine Particle Designations Basic Information, http://www.epa.gov/pmdesignations/basicinfo.htm.

incidence of lung cancer.[24] The World Health Organization estimates that indoor air pollution from cooking and residential heating causes 1.6 million premature deaths each year.[25] Diesel particulate emissions are estimated to have caused over 21,000 premature deaths in the United States in 2010.[26]

In terms of regional effects, BC interacts with other aerosols to form hotspots of atmospheric solar heating, which have been identified in South Asia, eastern China, most of Southeast Asia, regions of Africa, Central America and Mexico, and parts of South America.[27] Additionally, BC is swept only a relatively short distance from its source before falling out of the atmosphere, where its absorption of sunlight contributes to rapid melting of any ice or snow on which it lands.[28] Arctic sea ice is melting as much as a result of regional BC emissions as a result of warming caused by greenhouse gases (GHGs),[29] and BC is thought to have caused about one-third of the glacial retreat in the Himalayas.[30]

Scientific uncertainty remains, however, concerning the complex interactions between BC and other aerosols caused by anthropogenic pollution, like sulfates and the light-colored particles in soot, which actually reflect sunlight and therefore have a cooling effect.[31] Because BC is emitted with and interacts with these other aerosols, its net climate effects vary depending on the source, location, and timing of emissions and the composition of aerosols in the atmosphere.[32] As far as sources go, the current state of scientific knowledge suggests that diesel engine emissions have the greatest composition of warming BC, followed by emissions from residential cooking and heating.[33] Open burning of biomass contains the smallest fraction of BC and the largest fraction of cooling pollutants.[34] According to some studies, fossil fuel soot, dominated as it is by BC, has three times the warming effect of biomass soot.[35]

C. *Policy Appeal and a Word on International Mitigation*

Mitigation of BC is an appealing policy goal for a number of reasons. First, BC's existence as the byproduct of inefficient combustion is notable: unlike CO_2 and other GHGs, BC is not an essential byproduct of our current sources of energy.[36] Therefore, unlike CO_2, mitigation of which requires cutting back on energy consumption in part, BC can be reduced without necessarily limiting the underlying emissions-producing activity. Furthermore, the fact that mitigating BC has near-term local and regional benefits eliminates a difficulty that has plagued GHG mitigation policy, which would not result in palpable improvement in the near term or for any particular area. These characteristics of mitigation policy are particularly relevant internationally insofar as developing countries are reluctant to adopt measures to address emissions that historically have come largely from developed countries, that would restrict economic development, and whose benefits would be globally diffuse. BC mitigation in developing countries, on the other hand, would not prohibit the underlying emission-causing activity and would reap immediate benefits for local public health and address regional warming and glacier melt.

Given that the majority of BC emissions arises from non-U.S. sources, the greatest opportunities for mitigation lie in the international arena, and momentum has been gathering on this front. The Arctic Council, comprised of representatives from Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, the United States, and local indigenous populations, formed a task force in April 2009 to examine BC and other non-CO_2 climate forcers in the Arctic region; the task force is expected to make mitigation recommendations in April 2011.[37] The fifteenth Conference of Parties to the United Nations Framework Convention on Climate Change held in Copenhagen in December 2009 established the Safe Access to Firewood and Alternative Energy in Humanitarian Settings project, which aims to scale up distribution of fuel-efficient stoves in developing countries.[38] Additionally, an Ad Hoc Expert Group on Black Carbon has been formed under the United Nations Convention on Long-Range Transboundary Air Pollution. Commentators also have discussed the possibility of developing BC mitigation as an offset project or having BC

24. Control of Air Pollution From New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, 66 Fed. Reg. 5002 (Jan. 18, 2001).
25. *See* World Health Organization, *Indoor Air Pollution and Health*, *at* http://www.who.int/mediacentre/factsheets/fs292/en/index.html.
26. *Diesel and Health in America: The Lingering Threat* 1 (Clean Air Task Force, Feb. 2005), *available at* http://www.catf.us/resources/publications/files/Diesel_Health_in_America.pdf.
27. Ramanathan & Carmichael, *supra* note 11, at 221.
28. *Id.*
29. Wallack & Ramanathan, *supra* note 1, at 106; *Black Carbon: Hearing Before the H. Select Comm. on Energy Independence and Global Warming*, 111th Cong. (2010) (statement of Dr. Drew T. Shindell, Senior Scientist, NASA Goddard Inst. for Space Studies). *See also* Surabi Menon et al., *Black Carbon Aerosols and the Third Polar Ice Cap*, Atmos. Chem. Phys. Discuss. 9, 26593-625 (2009), http://www.atmos-chem-phys-discuss.net/9/26593/2009/acpd-9-26593-2009.html; James Hansen et al., *Black Soot and the Survival of Tibetan Glaciers*, Proc. Nat. Acad. Sci. (Dec. 8, 2009), http://www.pnas.org/content/early/2009/12/07/0910444106.full.pdf+html.
30. Tollefson, *supra* note 20, at 32.
31. *Id.*; Johannes Quaas, *Smoke and Climate Change*, 325 Sci. 153 (July 10, 2009).
32. *See* Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496, 66520 (Dec. 15, 2009) [hereinafter GHG Endangerment Finding].
33. *Id.* at 66520; Garderet & Emmett, *supra* note 13, at 9 (explaining that reducing fossil fuel BC emissions has a greater cooling effect on the climate than reducing the same amount of BC emissions from biomass burning).
34. *A Policy-Relevant Summary of Black Carbon Climate Science and Appropriate Emission Control Technologies* 8 (Int'l Council on Clean Transportation, June 2009), *available at* http://www.theicct.org/documents/0000/1022/BC_policy-relevant_summary_Final.pdf [hereinafter A Policy-Relevant Summary of BC]; Bond testimony, *supra* note 7.
35. Garderet & Emmett, *supra* note 13, at 10.
36. Wallack & Ramanathan, *supra* note 1, at 106.
37. Marcus Hoy, *Arctic Task Force Will Tackle Emissions of Black Carbon, Methane in Polar Region*, BNA A-5 (May 1, 2009).
38. *See* United Nations World Food Programme, *WFP Launches Safe Stoves Initiative to Protect Women and Save Fuel*, Dec. 16, 2009, http://www.wfp.org/news/news-release/wfp-launches-safe-stoves-initiative-protect-women-and-save-fuel.

mitigation policies implemented as "nationally appropriate mitigation actions" by developing countries.[39]

The U.S. role in international BC mitigation lies in financing and facilitating international efforts.[40] For instance, to replace the 500 million existing biomass-fueled cookstoves with cleaner burning, efficient stoves,[41] the United States could help fund and disseminate cleaner stoves, including through program coordination, distribution, and proper disposal of old stoves.[42] The Waxman-Markey Bill that passed the U.S. House of Representatives in June 2009 considered precisely this, requiring EPA to issue recommendations "to bring clean, efficient, safe, and affordable stoves, fuels, or both stoves and fuels to residents of developing countries," including a "large-scale implementation strategy with a goal of collectively reaching 20,000,000 homes" and increasing "stove efficiency by over 50 percent."[43]

Given that fossil fuel soot from burning diesel has a stronger warming effect than biofuel soot, however, and that EPA is empowered to mitigate diesel emissions, the balance of this Article discusses actions to further domestic mitigation of diesel emissions.

II. Mitigating BC Through the National Ambient Air Quality Standards

One of the primary means of domestic mitigation under the CAA is through the establishment of national ambient air quality standards (NAAQS), which are generally implemented by the states through state implementation plans (SIPs).[44] BC is a component of PM, which is already regulated as one of the six criteria pollutants with designated NAAQS.[45] Air quality standards for $PM_{10,}$ or coarse PM with a diameter of 10 micrometers or less, were first established in 1971. BC, specifically, is a component of $PM_{2.5}$, fine PM with a diameter of 2.5 micrometers or less, for which standards were first established in 1997 and made more stringent in 2006.[46]

A policy difficulty with respect to BC and climate change lies in the scientific uncertainty regarding the precise interactions of PM in the atmosphere.[47] PM is a complex mixture of chemically and physically diverse solids and liquid droplets, of which BC is only one component. Some of the components, like BC, are directly emitted by a source. Other components of PM are formed only upon interactions in the atmosphere. Sulfates and nitrates, for instance, are formed in the atmosphere from emissions of sulfur dioxide (SO_2) and nitrogen oxide (NO_x), both of which are among the six criteria pollutants regulated under the CAA. Moreover, while some of the components of the PM mixture, like sulfates and nitrates, have a cooling effect, others, like BC, have a warming effect.

The CAA's designation of this entire complex mixture as a single pollutant—PM—makes it difficult to assess the specific climate impacts of PM and to regulate accordingly. Thus far, mitigation of PM has been effected through control of direct PM emissions (through installation of scrubbers, filters, and more efficient technologies),[48] efforts to reduce interstate transport of NO_x (as through the NO_x SIP Call[49]), and efforts to reduce NO_x and SO_2 emissions from power plants (as through the Clean Air Interstate Rule[50] and its proposed replacement, the Transport Rule[51]). Although such reduction of NO_x and SO_2 contributes to mitigation of PM as a whole, these policies do not necessarily contribute to the mitigation of the BC component of PM. In fact, air quality policies enacted since the 1970s that have successfully reduced NO_x and SO_2 actually may have led to accelerated warming, as the decrease in the cooling effects of sulfate and nitrate aerosols in the atmosphere "unmasks" the heating caused by GHGs.[52]

EPA is directed by the CAA to review NAAQS every five years, and is currently conducting a PM NAAQS review in which it is also addressing the U.S. Court of Appeals for the District of Columbia (D.C.) Circuit's remand[53] of portions of the 2006 PM NAAQS.[54] The independent Clean Air Scientific Advisory Committee (CASAC) that issues recommendations in the NAAQS review process has pressed EPA to pay greater attention to the climate implications of PM. In an April 2009 draft review, the Committee urged EPA to consider "[t]he implications of PM size and composition for climate effects," and recommended that

39. *See* Garderet & Emmett, *supra* note 13; Wallack & Ramanathan, *supra* note 1; *Black Carbon: Hearing Before the H. Select Comm. on Energy Independence and Global Warming*, 111th Cong. (2010) (statement of Conrad Schneider, Advocacy Director, Clean Air Task Force).
40. David B. Hunter, *International Climate Negotiations: Opportunities and Challenges for the Obama Administration*, 19 Duke Envtl. L. & Pol'y F. 247, 273 (2009).
41. Schneider testimony, *supra* note 39, at 15.
42. *Id.* at 16.
43. H.R. 2454, §851.
44. CAA §108.
45. *See* GHG Endangerment Finding, *supra* note 32, at 66519-20.
46. In 2009, the U.S. Court of Appeals for the District of Columbia (D.C.) Circuit remanded, but did not vacate, portions of the 2006 revision of the PM NAAQS for further justification. American Farm Bureau Federation v. EPA, 559 F.3d 512 (D.C. Cir. 2009). EPA is responding to the court's remand as part of the current review of the PM NAAQS. In the meantime, EPA has proceeded to enforce the 2006 24-hour $PM_{2.5}$ NAAQS, which was not challenged in the suit, and recently notified 29 states and territories of their failure to meet the CAA's deadlines for submitting SIPs to meet the standard. *See* Finding of Failure to Submit Section 110 State Implementation Plans for Interstate Transport for the 2006 National Ambient Air Quality Standards for Fine Particulate Matter, 75 Fed. Reg. 32673 (June 9, 2010) (to be codified at 40 C.F.R. pt. 52).
47. EPA Science Advisors Urge Greater Focus on Climate Effects in PM Review (InsideEPA.com, May 19, 2009) (noting that "PM-climate synergies are complicated and not entirely understood").
48. *See* U.S. EPA, List of Potential Control Measures for $PM_{2.5}$ and Precursors, *available at* http://www.epa.gov/pm/measures/pm_control_measures_tables_ver1.pdf.
49. Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone, 63 Fed. Reg. 57356 (Oct. 27, 1998) (codified at 40 C.F.R. pts. 51, 72, 75, 96).
50. Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone (Clean Air Interstate Rule), 70 Fed. Reg. 25162 (May 12, 2005).
51. Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone, 75 Fed. Reg. 45210 (Aug. 2, 2010).
52. *See* Shindell testimony, *supra* note 29.
53. *See* note 46.
54. EPA Science Advisors Urge Greater Focus on Climate Effects in PM Review, *supra* note 47.

EPA detail the "differential effects of different PM components, the relative contributions of PM components originating in the U.S. to global aerosol and radiation budgets, and discussion of potential health effects of PM-induced climate changes."[55]

A subsequent CASAC review of revised EPA documents, issued in May 2010, agreed with "preliminary [EPA] conclusions on the climate impact of [atmospheric PM]"—that there is "insufficient evidence on which to base a national standard."[56] However, the CASAC went on to emphasize that a "causal relationship" between PM and climate change "is established" and "the risk of aerosol impact on climate is high," and consequently urged: "[F]urther research on a regional basis is urgently required. This need should be strongly voiced . . . and research should be undertaken sooner rather than later. If possible, research should be designed and begun now to be included in future assessments of the NAAQS."[57]

If it follows the Committee's recommendations, EPA can begin to parse the climate impacts of various PM components, including BC, and thereby start the process of harmonizing conventional air quality considerations with climate change considerations. Rather than the traditional singular focus on air quality, for instance, mitigation policy could be targeted at sources whose emissions contain the lowest ratio of cooling aerosols in relation to BC to ensure that mitigation also results in decreased warming. "By targeting emissions rich in black carbon, carbon monoxide and volatile organic compounds (warming aerosols) relative to sulfur dioxide and nitrogen oxides (cooling aerosols), many options are available that will simultaneously benefit climate change."[58]

III. Mitigating BC From Mobile Sources

In 2009, mobile sources in the United States, comprised of about 13 million on-highway vehicles, 7 million nonroad engines, and 47,000 locomotive and marine engines, produced about 300,000 tons of directly emitted $PM_{2.5}$.[59] EPA can target fossil fuel soot with the greatest composition of warming BC by targeting these emissions under its Title II authority to regulate mobile sources.

Section 202 of the CAA authorizes EPA to regulate emissions of "any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines" that "cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare."[60] The Act directs EPA to set standards for new heavy-duty vehicles or engines,[61] and also authorizes EPA to "prescribe requirements to control rebuilding practices, including standards applicable to emissions from any rebuilt heavy-duty engines (whether or not the engine is past its statutory useful life)."[62]

Section 213 establishes a regulatory program to reduce emissions from new *nonroad* engines and vehicles, a category that includes construction and mining equipment, marine engines, and locomotives.[63] Under this section, EPA is required to promulgate regulations to address emissions of carbon monoxide (CO), NO_x, and volatile organic compounds (VOCs) from new nonroad engines and vehicles that "are significant contributors" to ozone or CO NAAQS nonattainment in more than one area.[64] EPA is also authorized to regulate additional pollutants from new nonroad engines or vehicles (other than CO, NO_x, and VOCs) if it determines that the emissions "significantly contribute to air pollution which may reasonably be anticipated to endanger public health or welfare."[65]

EPA is further authorized under §231 to regulate "any air pollutant" from new or existing aircraft engines that "causes, or contributes to, air pollution which may reasonably be anticipated to endanger public health or welfare."[66]

As the following section shows, EPA already has taken significant steps to reduce diesel emissions from new mobile sources with a focus on minimizing PM and NO_x. EPA launched the National Clean Diesel Campaign in 2000, for instance, which incorporated both regulatory approaches that set standards for new engines and voluntary programs that encouraged mitigation of emissions from existing engines. However, at least three avenues under Title II have not been, and should be, utilized to further control BC emissions.[67] First, EPA should use its

55. CASAC PM Review Panel, *Deliberative Draft Letter for Discussion Re: CASAC Comments on First External Review Draft of Integrated Science Assessment for Particulate Matter* 2, 12 (Apr. 30, 2009), *available at* http://yosemite.epa.gov/sab/sabproduct.nsf/264cb1227d55e02c85257402007446a4/DBB7F85266AB19F28525759F007138BE/$File/CASAC+Draft+ISA+Letter+for+5-7-09+CASAC+PM+Rev+Panel+Mtg.pdf. *See also* Andrew Childers, *EPA Advisers Want Science Assessment of Particulates to Include Climate Change*, BNA A-2 (May 8, 2009).
56. CASAC PM Review Panel, *CASAC Review of Policy Assessment for the Review of the PM NAAQS—First External Review Draft (March 2010)* 21 (May 17, 2010), *available at* http://yosemite.epa.gov/sab/sabproduct.nsf/264cb1227d55e02c85257402007446a4/E504EE3276D87A9E8525772700647AFB/$File/EPA-CASAC-10-011-unsigned.pdf. The review refers to "atmospheric particulate matter" as "aerosols."
57. *Id.*
58. Shindell testimony, *supra* note 29.
59. U.S. EPA, *Report to Congress: Highlights of the Diesel Emissions Reduction Program* 9 (2008), *available at* http://epa.gov/cleandiesel/documents/420r09006.pdf [hereinafter *Report to Congress*]
60. CAA §202, 42 U.S.C. §7521. EPA issued an endangerment finding for GHGs under this section, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496 (Dec. 15, 2009) (to be codified at 40 C.F.R. ch. I), and has since worked with the National Highway Traffic Safety Administration to promulgate standards for light-duty vehicles, effective July 6, 2010, that will reduce GHG emissions and improve fuel economy. Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, 75 Fed. Reg. 25324 (May 7, 2010).
61. CAA §202(a)(3)(A)(i).
62. *Id.* §202(a)(3)(D).
63. *Id.* §213(a)(3)-(4).
64. *Id.* §213(a)(2)-(3).
65. *Id.* §213(a)(4).
66. *Id.* §231(a)(2)(A).
67. A complaint was filed in June 2010 by the Center for Biological Diversity and other environmental groups in D.C. district court challenging EPA's failure to respond to petitions requesting that EPA make an endangerment finding for GHG and BC emissions from marine vessels, aircraft engines, and other nonroad vehicles and engines. Center for Biological Diversity et al. v. EPA (D.D.C. June 11, 2010), *available at* http://www.earthjustice.org/library/legal_docs/mobile-source-ghg-petitions-complaint-10-06-11-final.pdf. In September 2010, a rulemaking petition to EPA was filed requesting

§202 authority to promulgate regulations requiring clean diesel retrofits when heavy-duty engines are rebuilt. Second, EPA should exercise its authority under §213 to regulate rebuilding practices of nonroad engines. Finally, EPA should exercise its §231 authority to regulate BC emissions from aircraft engines. Given EPA's limited reach over in-use diesel engines and the limited funds available for voluntary programs, a national strategy to mitigate BC emissions also should include state and municipal mandates regarding low-sulfur fuels, retrofits, and accelerated fleet turnover.

A. *Setting Standards for New Diesel Vehicles and Engines*

Minimizing BC emissions from diesel engines requires both advanced technologies to control emissions and lower sulfur content in diesel fuel. Lower sulfur content, which results in a cleaner burning fuel, is necessary because sulfur damages the advanced emissions control systems that minimize PM. Over the past decades, EPA has used its Title II authority to enact major initiatives that have required both use of ultra-low sulfur diesel (ULSD) fuel—fuel with a maximum sulfur content of 15 parts per million (ppm)—and set PM emission standards for new on-road and nonroad diesel vehicles and engines.

The 2007 Clean Diesel Trucks and Buses Rule finalized in 2001, for instance, set emission standards for new heavy-duty highway vehicles beginning with the 2007 model year and required a 97% reduction in the sulfur content of highway diesel fuel.[68] Pursuant to the rule's sulfur content requirement, refiners began producing ULSD fuel for use in highway vehicles in June 2006. The rule gave engine manufacturers flexibility to meet the new standards through a phase-in approach from 2007 to 2010. EPA estimates that the program will "reduce particulate matter and oxides of nitrogen emissions from heavy duty engines by 90 percent and 95 percent below [2001] standard levels, respectively,"[69] which reduces soot by 110,000 tons per year and prevents 8,300 premature deaths.[70]

EPA finalized a similar program in 2004 to address emissions from new nonroad diesel engines, which produce 47% of mobile source diesel PM emissions nationwide.[71] The 2004 Clean Air Nonroad Diesel Rule established a program requiring emissions controls on diesel engines used in most construction, agricultural, industrial, and mining equipment, beginning with the 2008 model year and phased in through 2015.[72] EPA estimates that the standards will reduce PM emissions by 95% (as well as reduce NO_x by 90% and virtually eliminate sulfur oxide emissions) from nonroad diesel engines. The rule also included fuel controls, which took effect in mid-2007 and are still being phased in, that regulate nonroad diesel fuel used in nonroad diesel engines, locomotives, and marine vessels. Sulfur levels in such diesel fuel will ultimately be capped at 15 ppm, a greater than 99% reduction in sulfur content. When the fleet of older nonroad engines has turned over by 2030, it is estimated that the Clean Air Nonroad Diesel Rule will reduce $PM_{2.5}$ by 129,000 tons annually and prevent 12,000 premature deaths in the United States each year.[73]

B. *Addressing the Existing Fleet of Diesel Vehicles and Engines*

As the foregoing section shows, EPA has been active in using its Title II authority to require diesel emission reductions from *newly manufactured* diesel engines and vehicles. These EPA rulemakings under the CAA have contributed substantially to mitigation of direct PM emissions, and hence BC mitigation. But diesel engines operate for one million or more miles before replacement and stay in use for decades.[74] Therefore, setting standards for new technologies and fuels, although important, fails to address substantial BC emissions from the existing fleet of diesel engines.

Diesel engines are rebuilt, rather than replaced, at the end of their useful lifetimes, and existing heavy-duty vehicle engines are often rebuilt multiple times before being scrapped.[75] Currently, other than regulations mandated by the CAA for urban buses, there is no requirement to rebuild diesel engines to meet more stringent standards. Instead, many diesel engines are rebuilt to meet the standards in effect at the time of their original manufacture.[76] In testimony before the U.S. Congress, the Clean Air Task Force emphasized that "the best opportunity to reduce diesel black carbon" in the United States lies in "retrofitting existing diesel engines . . . and adopting policies to accelerate fleet turnover to new engines already fitted with filter technology."[77]

---

that it promulgate regulations to reduce GHG and BC emissions from locomotives pursuant to the CAA. Petition for Rulemaking Under the Clean Air Act to Reduce Greenhouse Gas and Black Carbon Emissions From Locomotives (Sept. 21, 2010), http://www.biologicaldiversity.org/programs/climate_law_institute/transportation_and_global_warming/pdfs/Locomotives_Petition_09_21_2010.pdf.

68. Control of Air Pollution From New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, 66 Fed. Reg. 5002 (Jan. 18, 2001).
69. *Id.* at 5002.
70. *See* U.S. EPA, Heavy-Duty Highway Diesel Program, *at* www.epa.gov/otaq/highway-diesel/index.htm.
71. Case Studies of Construction Equipment Diesel Retrofit Projects 2 (Manufacturers of Emission Controls Assoc. July 2009), *available at* http://www.meca.org/galleries/default-file/Construction%20retrofit%20case%20studies%20July%202009.pdf.
72. Control of Emissions of Air Pollution From Nonroad Diesel Engines and Fuel, 69 Fed. Reg. 38958 (June 29, 2004).
73. *Id.* at 38958.
74. Notice of Agency Completion of Study Regarding Heavy-Duty Engine Rebuilding Practices and Availability of Documents, 60 Fed. Reg. 42881 (Aug. 17, 1995).
75. Schneider testimony, *supra* note 39, at 5.
76. Retrofitting Emission Controls for Diesel-Powered Vehicles 9 (Manufacturers of Emission Controls Assoc. Oct. 2009), *available at* http://www.meca.org/galleries/default-file/MECA%20diesel%20retrofit%20white%20paper%201009.pdf.
77. Schneider testimony, *supra* note 39, at 10.

1. Regulating Engine Rebuilding Practices

EPA has authority under §202(a)(3)(D) of the CAA to regulate rebuilding of heavy-duty vehicle engines. Although the CAA does not otherwise require specific rulemaking for particular types of vehicles, the statute singles out urban buses in §219, in which it requires EPA to use its §202 rebuilding authority to promulgate regulations to retrofit urban buses.[78] Specifically, the statute mandates that EPA use its §202 authority to require that buses operating in areas with a 1980 population of 750,000 or more and having engines replaced or rebuilt after 1995, implement "the best retrofit technology and maintenance practices reasonably achievable."[79] EPA subsequently promulgated the 1994 Urban Bus Rule, which established provisions for the urban bus retrofit/rebuild program that affected all 1993 and earlier model year urban buses whose engines are rebuilt or replaced after January 1, 1995.[80]

In the Urban Bus Rule, EPA noted that "[t]he time of rebuild is a logical time for the addition of emission controls because the engine is already disassembled . . . ."[81] Despite recognizing the need to address dirty in-use diesel engines and its own power to regulate at a "logical" juncture, however, EPA has thus far failed to exercise its §202 authority for any type of heavy-duty engine other than urban buses. EPA could use this authority to require installation of diesel particulate filters (which can trap up to 90% of BC emissions) when heavy-duty vehicle engines are rebuilt.[82] The exercise of such authority could reach one million of the approximately 11 million existing diesel engines in use today.[83]

2. EPA Efforts to Incentivize Voluntary Diesel Emission Reductions

EPA's approach toward the existing diesel fleet has focused instead on encouraging voluntary control strategies across five separate programs in its National Clean Diesel Campaign: Clean Agriculture, Clean Construction, Clean Ports, Clean School Bus, and Smartway Transport.[84] These nonregulatory initiatives provide technical and financial assistance to encourage implementation of various strategies to reduce emissions from the existing fleet. The strategies, all loosely termed "retrofit strategies," include: reducing idling, using cleaner fuels, properly maintaining engines, replacing older equipment or vehicles, replacing older engines (otherwise known as repowering), and installing retrofit devices on existing engines. As part of the Campaign, EPA has established, in conjunction with the California Air Resources Board, a list of verified emission control technologies that projects applying for federal funds are required to use.[85] EPA also has organized seven regional collaboratives involving states, municipalities, local nonprofit organizations, and industry to encourage regional reductions and public-private collaboration. EPA reports that the Campaign's nonregulatory initiatives have resulted in the retrofit of over 400,000 existing diesel engines and reduction of over 30,000 tons of PM.[86]

The problem with the voluntary approach, however, is insufficient funding. The Diesel Emissions Reduction Act (DERA), enacted as a part of the Energy Policy Act of 2005,[87] authorized appropriations of up to $200 million for each of fiscal years 2007 through 2011, to encourage clean diesel activity.[88] The DERA directs 70% of its funds to EPA for a national grant and loan program consisting of three separate competitions: the National Clean Diesel Funding Assistance Program (to assist communities in reducing diesel emissions); the National Clean Diesel Emerging Technologies Program (to encourage deployment of new technologies and encourage private-sector investment in innovation); and the SmartWay Clean Diesel Finance Program (to leverage innovative financing methods for clean diesel technologies).[89] The remaining 30% of DERA funds are used for the State Clean Diesel Grant and Loan Program, which allocates funds under certain conditions to "support grant and loan programs administered by States that are designed to achieve significant reductions in diesel emissions."[90]

Congress' first appropriation under the DERA came in 2008, in the amount of $49.2 million, less than one-quarter of the authorized amount.[91] In this first year, all 50 states elected to participate in the state allocation program, and 32 states were able to match federal funding and thereby receive additional incentive funding.[92] In 2009, the DERA received $60 million in appropriations, and the American

78. CAA §219(d).
79. *Id.*
80. 40 C.F.R. ch. I, subch. C, pt. 85, subpt. O.
81. Retrofit/Rebuild Requirements for 1993 and Earlier Model Year Urban Buses; Fuel Quality Regulations for Certification Diesel Test Fuel, 58 Fed. Reg. 21359, 21360 (Apr. 21, 1993).
82. Although particulate filters could slightly increase CO_2 emissions due to decreased engine efficiency, proper vehicle operation and maintenance can largely offset this increase. The overall conclusion remains that particulate filters "represent a win-win for air quality and climate." *See* Shindell testimony, *supra* note 29.
83. Schneider testimony, *supra* note 39, at 5.
84. *See* U.S. EPA, National Clean Diesel Campaign, http://www.epa.gov/cleandiesel/index.htm,
85. *See* U.S. EPA, Diesel Retrofit Technology Verification, *at* http://www.epa.gov/otaq/retrofit/index.htm. EPA also recognizes the list of verified technologies approved by the California Air Resources Board.
86. *See* U.S. EPA, Clean Diesel Program Facts and Figures, http://www.epa.gov/cleandiesel/documents/420f04040.htm.
87. Energy Policy Act, Title VII, Subtitle G, 42 U.S.C. §§16131-37, Pub. L. No. 105-98 (2005).
88. *Id.* at §§16132-16133, 16137. The U.S. Department of Transportation's Federal Highway Administration and Federal Transit Administration also jointly administer the Congestion Mitigation and Air Quality (CMAQ) program, which was authorized between 2005 and 2009 to provide funds to state transportation departments, metropolitan planning organizations, and transit agencies to invest in projects to reduce criteria air pollutants from transportation-related sources. States were required to prioritize diesel retrofits in distributing CMAQ funds. The program has not been reauthorized since 2009.
89. *See* 42 U.S.C. §16132.
90. 42 U.S.C. §16133. EPA issued a notice announcing the funding opportunity. *See* Energy Policy Act of 2005 Diesel Emissions Reduction Program; State Clean Diesel Grant Program Funding Fiscal Year 2008, 73 Fed. Reg. 12728 (Mar. 10, 2008).
91. *Id.* at 19.
92. *Report to Congress*, *supra* note 59, at 6, 27.

Recovery and Reinvestment Act of 2009 directed an additional $300 million to the DERA.[93] In response to this $300 million appropriation, EPA received more than 600 applications requesting over $2 billion in funding and offering more than $2 billion in matching funds.[94] EPA is consequently "sitting on $1.7 billion worth of requests for diesel retrofits that could be carried out immediately."[95] Despite apparent demand, then, the lack of funding and mandates means that diesel retrofit technology has "barely penetrated the existing fleet."[96]

3. The Role of States and Municipalities

The inadequacy of funding for voluntary programs and the limited reach of EPA's authority over in-use engines under the CAA means that states and municipalities play an important role in BC mitigation.

EPA has issued guidance on incorporating voluntary mobile source emission reduction programs in SIPs (VMEP guidance).[97] The VMEP guidance sets a limit of 3% on the extent to which reductions can count in a state's SIP. In other words, such reductions can count for no more than 3% of the total projected future year emissions reductions required for attainment of the appropriate NAAQS.[98] EPA issued related guidance in 2006 to help states quantify and use emission reductions from diesel retrofits to achieve SIP conformity.[99] In this guidance, EPA clarified that the 3% limit on voluntary reductions does not apply to state or local regulations or ordinances that are written into SIPs:

> For example, retrofit projects would not be subject to the VMEP guidance if a state or local regulation or ordinance that required retrofit projects was included in the SIP. Another example of a project that would not be subject to the VMEP guidance would be a state program that is described in the SIP that requires state transportation construction contracts to be implemented with retrofitted construction equipment.[100]

At the same time, DERA funds for the national loan and grant program cannot be used "to fund the costs of emissions reductions that are mandated under Federal, State or local law."[101] But, "voluntary or elective emissions reduction measures . . . *regardless of whether the reductions are included in the State implementation plan of a State*," are not considered "mandated."[102] In other words, state or local programs encouraging voluntary reductions can count for only 3% of a state's SIP obligations, but regardless of whether such a voluntary program is included in a state's SIP, it is eligible to receive federal funds. State or local laws that *mandate* emission reductions, on the other hand, can be written without limit into the state's SIP, but such programs would not be eligible to receive federal funds.

This legal framework may have the perverse incentive of discouraging states and municipalities from enacting mandates on diesel retrofits, because creating a legal obligation would prevent eligible entities from receiving DERA funds for the reduction. On the other hand, several factors point to the limited appeal and scope of voluntary programs and the corresponding value of mandatory emission reductions. First, the 3% limit on the use of voluntary reductions in SIPs disincentivizes voluntary programs, insofar as states can only attribute a limited portion of emission reductions toward attainment of federal obligations. Second, DERA funds have been scarce and competition for the funds fierce. In the first year of the program, the National Clean Diesel Funding Assistance Program, one of the three national competitions administered by EPA, received 236 applications requesting five times the amount available.[103] Moreover, entities eligible for DERA funding include only "regional, State, local, or tribal agenc[ies]" and certain nonprofit organizations or institutions.[104] This limitation means that private fleet owners must partner with eligible entities to apply for and receive federal funds—a significant barrier to participation in voluntary programs.[105]

Given the limitation of voluntary programs, mandatory requirements at the state and local levels can have a significant impact. These requirements could be fashioned to address the private entities that federal funding fails to incentivize, and the resulting diesel emission reductions could be incorporated without limit into an SIP. The California Air Resources Board's Diesel Risk Reduction Plan is a model in this arena.[106] Adopted in 2000 as a comprehensive plan to reduce diesel PM from on-road, off-road, and stationary diesel engines, the plan includes a mandatory retrofit program for most in-use diesel-powered vehicles in the state. A 2007 regulation required all existing nonroad diesel vehicles in the state—whether privately or publicly owned—to reduce diesel emissions.[107] A 2008 regulation similarly required existing heavy-duty diesel vehicles operating in the state to install retrofits and meet certain performance requirements between 2011 and 2013, and to

93. American Recovery and Reinvestment Act, Pub. L. No. 111-5, 170 (Feb. 17, 2009).
94. *Report to Congress*, *supra* note 59, at 7.
95. Schneider testimony, *supra* note 39, at 12; Stacy Feldman, *Black Carbon Crackdown Offers Fast-Action Solution to Slow Warming* (SolveClimate blog, Mar. 17, 2010), *available at* http://solveclimate.com/blog/20100317/black-carbon-crackdown-offers-fast-action-solution-slow-warming.
96. Schneider testimony, *supra* note 39, at 10.
97. U.S. EPA, Guidance on Incorporating Voluntary Mobile Source Emission Reduction Programs in State Implementation Plans (SIPs) (1997), *available at* http://www.epa.gov/otaq/stateresources/policy/general/vmep-gud.pdf.
98. *Id.* at 5.
99. *See* U.S. EPA, Diesel Retrofits: Quantifying and Using Their Benefits in SIPs and Conformity—Guidance for State and Local Air and Transportation Agencies (2006), *available at* http://www.epa.gov/oms/stateresources/transconf/policy/420b06005.pdf.
100. *Id.* at 12-13.
101. 42 U.S.C. §16132(d)(2)(A).
102. *Id.* §16132(d)(2)(B) (emphasis added).
103. *Report to Congress*, *supra* note 59, at 9.
104. 42 U.S.C. §16131(3).
105. *Report to Congress*, *supra* note 59, at 39.
106. *See* California Environmental Protection Agency Air Resources Board, Risk Reduction Plan to Reduce Particulate Matter Emissions From Diesel-Fueled Engines and Vehicles (2000), *available at* http://www.arb.ca.gov/diesel/documents/rrpfinal.pdf.
107. Cal. Code Regs. tit. 13, §2449. The California Air Resources Board delayed the regulation's NO_x and PM requirements, but reporting, labeling, idling, and disclosure requirements are still in effect.

accelerate vehicle replacement.[108] These pioneering regulations were recently amended, however, to delay compliance and allow for greater leniency,[109] but even so, remain "the toughest in the nation."[110]

Although the breadth of California's plan—its reach over both private and public fleets and on-road and nonroad diesel—is ideal, other cities and states have taken more limited, but still beneficial, measures to address diesel emissions from public fleets and/or public projects. In New York City, for instance, a successful diesel emissions reduction demonstration was carried out for the 7 World Trade Center development, in which the developer entered an agreement to use ULSD fuel and retrofit technology on construction equipment.[111] The success of the experiment spurred passage of a local law in 2003 that required low-sulfur fuel and retrofit technologies on city-owned or leased construction equipment at all city-run construction sites, and further required that public works contracts "include specifications that all contractors . . . use ULSD fuel and the best available technology for reducing the emission of pollutants for diesel-powered nonroad vehicles."[112] The city moved to address existing on-road emissions in a 2005 local law that mandated ULSD fuel and phase-in of retrofits for existing diesel motor vehicles owned or operated by city agencies.[113]

New York State followed the city's lead. Regulations implementing the state's 2006 Diesel Emissions Reduction Act were approved in June 2009, and require use of ULSD fuel in state-owned or contracted heavy-duty, on-road and nonroad vehicles, and further require all heavy-duty diesel vehicles owned by New York State agencies, authorities, and contractors working on behalf of the state be retrofitted or replaced to decrease diesel emissions.[114] Other cities and states have enacted similar mandates.[115] New Jersey, for instance, enacted a Diesel Retrofit Law in 2005, requiring certain diesel on-road and nonroad vehicles, publicly owned or under public contract, to install retrofits.[116] In 2009, Cook County, Illinois, enacted an ordinance requiring county contractors working on public construction contracts to use ULSD fuel for nonroad equipment, and further requiring contractors to install diesel retrofits on nonroad equipment used in publicly funded projects beginning in May 2011.[117]

These city and state mandates have far-reaching effects on minimizing BC emissions in a system where EPA has no statutory authority to mandate retrofits on in-use vehicles or to require early retirement, and has failed to use its §202 authority to regulate rebuilding of heavy-duty engines, and where funds to incentivize retrofits are limited and cannot be easily accessed by private entities. In other words, EPA's statutory constraints and unwillingness to exercise full CAA authority, together with the limited nature of DERA funding and eligibility, leave a gap into which cities and states can step.

C. Addressing Emissions From Nonroad Diesel Engines Under §213

EPA already has taken steps to minimize PM (and NO_x) emissions from new, and even existing, marine engines under its §213 authority and should similarly exercise this authority to regulate existing nonroad diesels other than marine engines.

Marine diesel engines are the source of about 42,000 tons of PM per year, which represents 4.4% of the directly emitted PM from mobile sources.[118] In 1999, EPA promulgated the Commercial Marine Diesel Rule, which set emission standards for new commercial marine diesel engines rated at 37 or more kilowatts (kW) to minimize NO_x, hydrocarbons, CO, and PM.[119] The standards exceeded requirements specified by the International Maritime Organization and began to take effect between 2004 and 2007. In 2002, EPA enacted similar standards for new diesel engines used in recreational marine vessels.[120] Most recently, EPA promulgated standards to address emissions from the largest marine diesel engines primarily used in ocean-going vessels (referred to as Category 3 engines). The Category 3 Marine Diesel Engines Rule,[121] which went into effect in June 2010, and will begin applying to newly built engines in 2011,[122] likely will have only minimal effect on BC emissions, because these standards focus on

108. Cal. Code Regs. tit. 13, §2025.
109. *See* Press Release, California Air Resources Board, Changes to Diesel Rules Protect Health, Provide Relief and Flexibility to California Businesses (Dec. 17, 2010), http://www.arb.ca.gov/newsrel/newsrelease.php?id=171.
110. Margot Roosevelt, *California Eases Diesel Soot Crackdown*, L.A. Times, Dec. 18, 2010, http://articles.latimes.com/2010/dec/18/local/la-me-diesel-pollution-20101218.
111. *See generally* http://www.cleanaircommunities.org/projects/wtc.html.
112. N.Y.C. Local Law No. 77, §1 (2003).
113. N.Y.C. Local Law No. 39 (2005).
114. Use of Ultra Low Sulfur Diesel Fuel and Best Available Retrofit Technology for Heavy Duty Vehicles, 6 NYCRR pt. 248.
115. *See* Case Studies of Construction Equipment Diesel Retrofit Projects, *supra* note 71, at 2.
116. N.J. Admin. Code tit. 7, ch. 27, subch. 32, *available at* http://www.nj.gov/dep/aqm/sub32%20090807.pdf.
117. Cook County Code, ch. 30, art. IX, §§30-950 to 30-955, *available at* http://www.dcl-inc.com/images/stories/PDF/cook%20county%20ordinance.pdf.
118. *See* Notice of Proposed Rulemaking: Control of Emissions of Air Pollution From New CI Marine Engines at or Above 37 kW, 63 Fed. Reg. 68508, 68511 (Dec. 11, 1999).
119. Control of Emissions of Air Pollution From New Marine Compression-Ignition Engines at or Above 37 kW, 40 C.F.R. pts. 89, 92, and 94 (1999).
120. Control of Emissions From Nonroad Large Spark-Ignition Engines, and Recreational Engines (Marine and Land-Based), 40 C.F.R. pts. 89, 90, 91, 94, 1048, 1051, 1065, and 1068 (2002). This rule also established standards for land-based recreational engines, like snowmobiles and all-terrain vehicles.
121. Control of Emissions From New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder, 75 Fed. Reg. 22896 (Apr. 30, 2010).
122. These CAA standards are one part of a three-pronged EPA strategy to reduce emissions from ocean vessels, including designating U.S. coasts as Emission Control Areas through an amendment to Annex VI of MARPOL and promulgating regulations under the Maritime Pollution Prevention Act of 2008 (Pub. L. No. 110-280, July 21, 2008) to implement the provisions of MARPOL Annex VI on U.S. and foreign ships operating in U.S. waters. *See generally* U.S. EPA, Ocean-Going Vessels, *at* http://www.epa.gov/otaq/oceanvessels.htm#regs.

NO_x reduction and do not include requirements for direct PM emissions.[123]

EPA has even chosen to regulate remanufacture of in-use marine engines under its §213 authority. In the 2008 Marine Diesel Engines Rule, EPA issued the first ever national emission standards for existing marine diesel engines, applying emissions standards to marine diesel engines over 600 kW when they are remanufactured.[124] In that rule, EPA noted that a "commercial marine vessel can be in operation in excess of 40 years" and its engine remanufactured to as-new conditions three or more times before the vessel is scrapped.[125] "Because these remanufactured engines are returning to as-new condition, section 213(a)(3) and (4) give EPA the authority to set emission standards for those engines."[126] This rationale applies to all nonroad engines under §213, which means EPA should exercise its authority to set emission standards for non-marine nonroad diesel engines.

D. Addressing Emissions From Aircraft Engines Under §231

Section 231 of the CAA directs the EPA Adminstrator to "issue proposed emission standards applicable to the emission of any air pollutant from any class or classes of aircraft engines which in his judgment causes, or contributes to, air pollution which may reasonably be anticipated to endanger public health or welfare."[127] EPA has adopted rules under §231 to establish new emission standards for NO_x,[128] and more recently has proposed regulations to address lead emissions from aircraft,[129] but so far has failed to exercise this authority to address BC or other global warming pollutants from aircraft emissions. The Federal Aviation Administration (FAA), a key player in regulating aircraft emissions, is reportedly funding research on BC through the Partnership for Air Transportation Noise and Emissions Reduction.[130]

Preliminary studies show that 4-8% of surface warming since 1850 can be attributed to aircraft, and that a twentyfold reduction of BC from aircraft emissions could stop warming from airplane vapor trails and actually induce slight cooling from these vapor trails.[131] Use of §231 authority in conjunction with FAA action, therefore, presents a potentially significant avenue for mitigating BC (and GHG) emissions.[132]

IV. Conclusion

Although the greatest opportunities may lie in facilitating mitigation in developing countries, this Article has sought to point to the ways in which BC is, and can further be, mitigated at home under the CAA. Other statutes, such as the Clean Water Act,[133] also may present avenues for EPA action,[134] and of course the ultimate long-term policy goal is to move away from fossil fuel use altogether. This Article suggests that in the meantime, however, certain EPA, state, and municipal actions can have an immediate impact on lowering BC emissions in the United States.

It is critical to emphasize, though, that BC mitigation can "only help delay and not prevent" climate change and therefore is a supplement to, rather than a substitute for, a climate change policy addressing GHGs.[135] As one expert analogized, reducing BC and other short-term climate forcers "is like applying an emergency brake in a car out of control": "It will slow the vehicle quickly and give you a little time to think. But the problem will continue if you don't take your foot off the gas pedal—that is, if CO_2 emissions are maintained."[136] Together with municipal and state mandates hastening BC mitigation from in-use diesel vehicles and engines, EPA—by considering climate change impacts of PM in updating NAAQS, and by fully utilizing its existing authority to reduce BC emissions from rebuilt heavy-duty engines under §202, rebuilt nonroad engines under §213, and aircraft under §231—has the power to begin applying the emergency brake now.

123. The rule is expected to reduce PM emissions primarily due to the requirement that diesel fuel with 1,000 ppm sulfur content be produced for use by Category 3 marine vessels (which currently use fuel with sulfur content of 30,000 ppm or more). Control of Emissions From New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder, *supra* note 121, at 22897.
124. Control of Emissions of Air Pollution From Locomotive Engines and Marine Compression-Ignition Engines Less Than 30 Liters per Cylinder, 73 Fed. Reg. 25098 (May 6, 2008).
125. *Id.* at 25104.
126. *Id.*
127. CAA §231(a)(2)(A).
128. Control of Air Pollution From Aircraft and Aircraft Engines; Emission Standards and Test Procedures, 70 Fed. Reg. 69664 (Nov. 17, 2005).
129. Advance Notice of Proposed Rulemaking on Lead Emissions From Piston-Engine Aircraft Using Leaded Aviation Gasoline, 75 Fed. Reg. 22440 (Apr. 28, 2010).
130. *See generally* http://web.mit.edu/aeroastro/partner/about/index.html.
131. *See* Rex Dalton, *How Aircraft Emissions Contribute to Warming,* Nature.com (Dec. 21, 2009), http://www.nature.com/news/2009/091221/full/news.2009.1157.html (referencing results from a soon-to-be-published study presented by Stanford scientist Mark Jacobson at the American Geophysical Union's annual meeting).
132. The complaint mentioned in footnote 68 challenges EPA's failure to determine whether GHGs endanger public health or welfare pursuant to §231.
133. 33 U.S.C. §§1251-1387, ELR Stat. FWPCA §§101-607.
134. *See* Petition to EPA for Water Quality Criteria for Black Carbon on Sea Ice and Glaciers Under Section 304 of the Clean Water Act, 33 U.S.C. §1314, Center for Biological Diversity (Feb. 22, 2010), *available at* http://www.biologicaldiversity.org/programs/climate_law_institute/global_warming_what_how_why/black_carbon/pdfs/EPA_CWA_Black_Carbon_Petition_2-22-10.pdf.
135. Ramanathan & Carmichael, *supra* note 11, at 226.
136. Bond testimony, *supra* note 7, at 3. A recently published study suggests that BC mitigation is actually an essential part of the mitigation necessary to limit global warming to two degrees Celsius. If BC emissions continue on their current trajectory, the study found, more aggressive reductions in CO_2 than previously anticipated would be required to meet the two-degree goal. *See* Robert E. Kopp & Denise L. Mauzerall, *Assessing the Climatic Benefits of Black Carbon Mitigation,* Proc. Nat'l Acad. Sci. (June 21, 2010), *available at* http://www.pnas.org/content/early/2010/06/15/0909605107.full.pdf.