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CENTER for
BIOLOGICAL
DIVERSITY

November 26, 2008

VIA ELECTRONIC MAIL

Administrator Stephen L. Johnson
c/o Air and Radiation Docket and Information Center
Environmental Protection Agency
Mailcode: 2822T
1200 Pennsylvania Ave., NW
Washington, DC 20460

**RE: Regulating Greenhouse Gas Emissions Under the Clean Air Act –
Docket Id No. EPA-HQ-AOR-2008-0318**

Dear Administrator Johnson:

Earthjustice, on behalf of the Center for Biological Diversity, is pleased to submit the following comments on the Advanced Notice of Proposed Rulemaking “Regulating Greenhouse Gas Emissions Under the Clean Air Act,” 73 Fed. Reg. 44354-44520 (July 30, 2008).

Among other critical issues, the Environmental Protection Agency (EPA) seeks comment on “how to address black carbon (and co-emitted organic carbon) regarding the definition of ‘air pollution’ in the endangerment context.” *Id.* at 44425. Our comments are limited to this issue.

1. Summary

The United States must take immediate action to sharply reduce emissions of all global warming pollutants, including black carbon, to slow global and Arctic warming and avoid catastrophic tipping points such as the rapid and uncontrolled release of methane and carbon as permafrost melts, and rising sea levels resulting from the melting of the Greenland ice sheet.

Because black carbon is a short-lived climate forcing agent with an atmospheric residence time of only days or weeks, reducing these emissions is among the most effective strategies for mitigating warming in the near term.¹ The substantial body of recent scientific

¹ Quinn, P. K., et al., Short-lived pollutants in the Arctic: Their climate impact and possible mitigation strategies, *Atmospheric Chemistry and Physics*, 8, 1723-1735 (2008); *see also* Jacobson, M., Testimony for the Hearing on Black Carbon and Arctic, House Committee on Oversight and Government Reform United States House of Representatives, Oct. 18, 2007 (concluding that control of black carbon “appears to be the fastest method of slowing

studies on black carbon indicates that the net warming effect of black carbon emissions from major fossil fuel source categories, taking into account any cooling effect of co-emitted organic carbon, is significant. EPA actions to reduce these emissions would thus be an effective rapid action strategy to slow warming in the near term, in effect buying critical time for the implementation of measures to reduce long-lived greenhouse gases (GHGs).²

We strongly urge EPA to include black carbon within its definition of “air pollution” for the purpose of an endangerment finding. The science is clear: the significant net climate warming effect of black carbon and co-emitted organic carbon from many major sources endangers public welfare. Existing PM_{2.5} regulations were developed absent consideration of the climate forcing effect of black carbon and are therefore inadequate to protect the public welfare. It is critical that EPA take additional action to control black carbon emissions.

The state of the science regarding black carbon’s radiative forcing effect, the precautionary nature of the Clean Air Act, and EPA’s authority under the Act to regulate many of the major mobile and stationary sources of black carbon emissions, all urgently call for a specific endangerment finding with respect to black carbon.

2. There is a substantial body of new science on black carbon’s climate forcing effect

EPA notes that “[s]ome recent research, published after the IPCC Fourth Assessment Report, has suggested that black carbon may play a larger role in warming than previously thought.” (citation omitted). In fact there is a substantial body of published research since the Fourth Assessment Report that identifies black carbon as a critical climate forcing agent, and suggests that reducing these emissions may be among the most effective near-term strategies for slowing Arctic warming and the melting of sea ice, the Greenland ice sheet, and glaciers and snow pack around the world.³ It has been estimated that the “soot effect on snow albedo may be

global warming for a specific period”); Ramanathan, V. & Carmichael, G., Global and Regional Climate Changes Due to Black Carbon, *Nature Geoscience* at 226 (2008); and Hansen, J & L. Nazarenko, Soot Climate Forcing Via Snow and Ice Albedos, 101 Proc. of the Nat’l Acad. Of Sci. 423 (13 January 2004).

² Bond, T.C., Testimony for the Hearing on Black Carbon and Climate Change, Oversight and Government Reform Committee, U.S. House of Representatives, October 18, 2007 (2007).

³ Ramanathan and Carmichael 2008 *supra* note 2. Estimates of the direct and indirect climate forcing effects of black carbon range from + 0.3 watts per square meter ($W m^{-2}$) (IPCC Fourth Assessment Report), to a recent estimate of 1.0-1.2 $W m^{-2}$, which is “as much as 55% of CO₂ forcing and is larger than that due to CH₄, CFCs, N₂O, or tropospheric ozone.” *See also*:

- a) Ramanathan, V., et al., Atmospheric Brown Clouds: Regional Assessment Report with Focus on Asia, Published by the United Nations Environment Programme, Nairobi, Kenya (2008);
- b) Shindell, D. T., et al., A multi-model assessment of pollution transport to the Arctic, *Atmos. Chem. Phys.*, 8, 5353–5372 (2008);
- c) Shindell, D., J.-F. Lamarque, N. Unger, D. Koch, G. Faluveg, S. Bauer, and H. Teich., Climate forcing and air quality change due to regional emissions reductions by economic sector, *Atmos. Chem. Phys. Discuss.*, 8, 11609–11642 (2008);
- d) Schwarz, J. P., et al., Coatings and their enhancement of black carbon light absorption in the tropical atmosphere, *J. Geophys. Res.*, 113, D03203, doi:10.1029/2007JD009042 (2008);
- e) Quinn, P. K., et al., 2008 *supra* note 2;
- f) Kirkevåg, A., T. Iversen, J. E. Kristjansson, O. Seland, J.B. Debernard, On the additivity of climate response to anthropogenic aerosols and CO₂, and the enhancement of future global warming by carbonaceous aerosols, *Tellus*, 60A, 513-527 (2008);

responsible for a quarter of observed global warming.”⁴ EPA’s discussion of the climate forcing effects of black carbon would benefit from additional analysis based on this significant new body of literature.

EPA observes that “black carbon has different climate properties compared to long-lived GHGs.” 73 Fed. Register at 44425. Principal among these differences is that black carbon is a short-lived climate forcing agent, with an atmospheric residence time of only days to weeks.⁵ Hence agency action to reduce black carbon emissions has the potential to be an effective rapid action strategy to slow warming in the near term, in effect buying critical time for the implementation of measures to reduce long-lived GHGs. Implementation of regulatory strategies to further reduce emissions of black carbon and other short-term climate forcing agents, *e.g.*, tropospheric ozone and methane, are thus critical.

3. Evaluating Black Carbon and Co-Emitted Organic Carbon

EPA seeks comment on how to treat black carbon and co-emitted organic carbon with respect to defining “air pollution” for purposes of an endangerment finding. *Id.* at 44425. EPA correctly observes that since black carbon is co-emitted with other aerosols such as organic carbon that tend to have a cooling effect, control measures should target sources where black carbon emissions predominate.⁶ Nevertheless, the relative warming and cooling effect of these two aerosols is not equivalent. EPA fails to note that the climate forcing effects of black carbon (absorption of incoming solar energy and radiated heat) are significantly stronger than the reflective, or scattering, effect of organic carbon.⁷

EPA must consider the relative strength of black and organic carbon as climate forcing agents when evaluating what is meant by the “net effect” of emissions of these two aerosols. This difference is not mentioned in the ANPRM.

3.1 Direct and indirect climate forcing effects of black carbon

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- g) Lack, D., B. Lerner, C. Granier, T. Baynard, E. Lovejoy, P. Massoli, A.R. Ravishankara and E. Williams, Light absorbing carbon emissions from commercial shipping, *Geophysical Research Letters*, 35, L13815 (2008).
 - h) Flanner, M. G., C. S. Zender, J. T. Randerson, and P. J. Rasch, Present-day climate forcing and response from black carbon in snow, *J. Geophys. Res.*, 112, D11,202, doi:10.1029/2006JD008,003 (2007);
 - i) Koch, D., T.C. Bond, D. Streets, N. Unger, and G.R. van der Werf, Global impacts of aerosols from particular source regions and sectors, *Journal of Geophysical Research*, 112, D02205, doi:10.1029/2005JD007024 (2007);
 - j) McConnell, J. R., et al., 20th-century industrial black carbon emissions altered arctic climate forcing, *Science*, 317(5843), 1381–1384, doi:10.1126/science.1144,856 (2007);
 - k) Streets, D. G., Dissecting future aerosol emissions: warming tendencies and mitigation opportunities, *Climatic Change*, 81:313–330 DOI 10.1007/s10584-006-9112-8 (2007);
 - l) Reddy, M. S. and O. Boucher, Climate impact of black carbon emitted from energy consumption in the world’s regions, *Geophysical Research Letters*, 34, L11802, doi:10.1029/2006GL028904 (2007);

⁴ Hansen & Nazarenko 2004 *supra* note 1.

⁵ Ramanathan and Carmichael 2008 *supra* note 1.

⁶ Bond, T.C., and H. Sun, Can reducing black carbon emissions counteract global warming?, *Environmental Science and Technology*, 39, 5921-5926 (2005).

⁷ Bond, T.C., C. Venkataraman, O. Masera, “Global atmospheric impacts of residential fuels,” *Energy for Sustainable Development*, VIII (3), July 2004.

Black carbon exerts both direct and indirect climate forcing effects. Black carbon is a potent climate warming agent in the atmosphere and when deposited on snow and ice, exerting a forcing effect through direct absorption of heat in the top of the atmosphere, changing cloud dynamics, and reducing albedo, or reflectivity.⁸

The direct absorption of sunlight by black carbon heats the atmosphere; it is here that ratio of black to organic carbon, and the net climate forcing effect, is critical to consider.⁹ But black carbon also nucleates clouds, increasing cloud droplet concentrations and thickening low-level clouds that trap more of the Earth's radiated heat.¹⁰ (Black carbon is a significant component of Arctic haze.)¹¹ Moreover, the radiative forcing of suspended black carbon particles is thought to be amplified at the poles, where there is more light reflected from the Earth's surface, and thus more light available for the black carbon particles to absorb.¹²

Black carbon also warms when it is deposited on snow and ice.¹³ Surface deposition of black carbon darkens snow and ice, reducing the albedo, or reflectivity, of these bright surfaces. "Soot deposition increases surface melt on ice masses, and the melt water spurs multiple radiative and dynamic feedback processes that accelerate ice disintegration."¹⁴ Melting reveals darker water or ground below; these darker surfaces in turn absorb more incoming sunlight, which causes additional warming.¹⁵ Co-emitted organic carbon has very little if any cooling effect on snow and ice because they do not contrast with these high albedo surfaces. Thus a direct comparison of the radiative forcing effects of black carbon and organic carbon is not appropriate.¹⁶

3.2 Black carbon is a potent climate forcing agent in the Arctic

Recent science published since the Fourth Assessment Report indicates that black carbon appears to warm the Arctic more than any other climate forcing agent except CO₂ because of its multiple direct and indirect climate forcing effects.¹⁷ The Arctic is warming about twice as fast as the rest of the earth, and the Greenland ice sheet is melting twice as fast as the global mean.¹⁸

⁸ Ramanathan and Carmichael 2008 *supra* note 1.

⁹ Bond, T. C., D. G. Streets, K. F. Yarber, S. M. Nelson, J.-H. Woo, and Z. Klimont, A technology-based global inventory of black and organic carbon emissions from combustion, *J. Geophys. Res.*, 109(D14203), doi:10.1029/2003JD003,697 (2004).

¹⁰ Ramanathan and Carmichael 2008 *supra* note 1.

¹¹ Zender, C., Arctic Climate Effects of Black Carbon. Written testimony to the Oversight and Government Reform Committee, U.S. House of Representatives, October 18, 2007 (2007).

¹² IPCC, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS, CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, Forster, P., et al. *Changes in Atmospheric Constituents and in Radiative Forcing* (2007) at 163.

¹³ Quinn et al. 2008 *supra* note 1.

¹⁴ Hansen, J & L. Nazarenko 2004 *supra* note 1.

¹⁵ *Id.*

¹⁶ Flanner et al. 2007 *supra* note 3.

¹⁷ Zender, C., 2007, *supra* note 11.

¹⁸ Hassol, S.J., Arctic Climate Impact Assessment. Cambridge University Press (2005).

Chylek & Lohman, Ratio of Greenland to global temperature change: Comparison of observations and climate modeling results. 32 *Geophysical Research Letters* L14705 (2005).

During the course of the Arctic spring, black carbon-contaminated snow absorbs enough extra sunlight to melt earlier, sometimes weeks earlier, than clean snow.¹⁹

Ice at the North Pole melted at an unprecedented rate in August 2008, with leading scientists warning that the Arctic could be ice-free in summer by 2013; sea ice thickness and winter temperatures are also at record lows.²⁰ The accelerated pace of Arctic warming risks a series of potentially catastrophic tipping points, including permafrost melt and resulting methane release, melting of the Greenland ice sheet and sea level rise. Mitigating the climate forcing effect of black carbon is also a key factor in slowing further retreat of glaciers and melting of snow pack, which provide drinking water for large U.S. populations.²¹

4 The climate warming effects of black carbon urgently require additional control measures

Fossil fuel PM_{2.5} emissions are composed of significantly more black carbon than organic carbon, making emissions reductions from these sources powerful mitigation strategies.²² For these source categories, the warming effect of black carbon predominates, indicating that there are numerous effective regulatory options to mitigate the climate forcing effect of these emissions.

EPA states that “major U.S. sources of black carbon are already being aggressively reduced through regulatory actions due to health concerns.” 73 Fed. Register at 44425. While it is true that the suite of diesel rules, including the Highway Diesel Rule and Nonroad Diesel Rule, represent a significant first step, they are inadequate to reduce the climate forcing effects of black carbon and protect the public welfare. Many of the standards in these rules do not phase in fully for new engines until 2015, with benefits accruing incrementally over a long period after that due to the slow turnover of older engines. Moreover, with the exception of rebuilt heavy duty engines, the rules do not require any additional black carbon emissions reductions in the existing, or “legacy,” fleet of diesel vehicles, which have long life spans. Given that rapid reductions in black carbon are essential to slow dangerous climate change and avert potentially catastrophic Arctic tipping points, other actions are urgently required.²³

¹⁹ Quinn et al. 2008 *supra* note 1; Zender, C. 2007 *supra* note 11.

²⁰ McKie, R. Meltdown in the Arctic is speeding up Scientists warn that the North Pole could be free of ice in just five years' time instead of 60, *The Observer*, <http://www.guardian.co.uk/environment/2008/aug/10/climatechange.arctic>, August 10, 2008 (2008); *see also*: Correll, B. UN meeting of Arctic Parliamentarians, June 2008 (2008).

²¹ Ramanathan and Carmichael 2008 *supra* note 1; *see also*: Cayan, D., Luers, A., Hanemann, M., Franco, G and Croes, B. Climate Change Scenarios for California: an Overview. California Energy Commission PIER working paper (2006).

²² Batty, W. and K. Boyer Methods for Improving Global Inventories of Black Carbon and Organic Carbon Particulates, Report produced for Thompson G. Pace, U.S. EPA, Research Triangle Park, NC (2002).

²³ Although the health impacts of black carbon/fine particle emissions are not the focus of these comments, it is clear that they are not sufficiently addressed by the current rules. EPA states on its website that “[e]ven with the new diesel rules, millions of diesel engines already in use will continue to emit large amounts of nitrogen oxides, particulate matter and air toxics, which contribute to serious public health problems. These emissions are linked to thousands of premature deaths, hundreds of thousands of asthma attacks, millions of lost workdays, and numerous other health impacts every year.” National Clean Diesel Campaign, www.epa.gov/cleandiesel/, September 2008.

Current measures designed to reduce PM_{2.5}, and thus black carbon, emissions under the Clean Air Act were aimed at addressing the public health effects of direct exposure, not the climate forcing effect of PM_{2.5}/black carbon emissions.²⁴ Because the net climate forcing effect of black carbon and organic carbon from mobile and stationary diesel sources, as well as from some industrial sources, is warming and thus adverse to public welfare, EPA should include black carbon as an “air pollutant” for the purposes of an endangerment finding analysis.

To better target and quantify the climate benefits of black carbon reduction, we also recommend that EPA undertake an assessment to:

- Identify and inventory major sources of black carbon emissions, particularly those sources of regional emissions affecting the Arctic and regional glaciers and snow pack;
- Estimate current and future emissions;
- Identify feasible and cost-effective emissions reduction measures and control technologies when considering the climate change benefits as well as the health benefits of these reductions, including a lifecycle climate impact analysis of control technologies;
- Assess and describe the most recent scientific information on the climate forcing effects of black carbon, especially with respect to the major identified sources;
- Develop a black carbon reduction strategy and rules-based program;
- Develop metrics, including possible CO₂-equivalency factors, to facilitate comparisons between the impacts and efficiencies of short-lived black carbon emissions reductions and other measures to reduce long-lived GHGs.

We also urge the agency to quickly make recommendations for additional actions that the federal government could take to reduce black carbon emission, including, among others:

- Significantly increasing funding for EPA’s current voluntary diesel engine retrofit program;
- Promulgating new regulatory authority to require installation of diesel particulate filters (i.e., particle traps) on the existing, or “legacy,” fleet of on- and off-road diesel vehicles, and the identification and retirement of super-emitters, i.e. older or poorly maintained high-emitting devices.²⁵
- Inventory local sources of black carbon emissions in the American [Alaskan] Arctic, which are thought to have a disproportionate effect on the Arctic climate,²⁶ and develop targeted programs to retrofit and retire these sources.

4.1 Undertake rulemakings for rebuilt heavy-duty engines and marine engines

²⁴ This is similar to the current situation of tropospheric ozone, the other short-lived climate forcer that is regulated under the Act.

²⁵ For example, the California Global Warming Solutions Act (AB 32) includes several early action measures to reduce black carbon emissions, which can serve as a useful model for advocacy in other states, especially those that are located “north of 40 degrees” latitude, where black carbon emissions are carried north to the Arctic by long range environmental transport more than from other places in the U.S. states whose emissions have a disproportionate impact on Arctic warming. These include: use of shore power for ships at berth; goods movement efficiency measures (i.e., ocean-going vessel speed reduction, retrofits and turnover of pre-1994 trucks); heavy-duty vehicle emission reductions; low carbon fuel standards and proposed regulation for In-Use On-Road Diesel Vehicles. *See generally* California Environmental Protection Agency Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking. Proposed Regulation for In-Use On-Road Diesel Vehicles*. Mobile Source Control Division, Heavy-Duty Diesel In-Use Strategies Branch, October 2008 (2008).

²⁶ *See, for example:* Quinn et al. 2008 *supra* note 1; Lack et al. 2008 *supra* note 3; and Zender 2007 *supra* note 11.

We urge that EPA to urgently undertake a rulemaking without delay to reduce black carbon emissions from those diesel sources that are currently unregulated, including establishing stringent emissions standards for rebuilt heavy-duty engines and marine engines.

4.1.1 Rebuilt heavy-duty engines

Heavy-duty diesel engines, such as those found in buses and long-haul trucks, are a significant source of fine particle emissions, of which EPA estimates that approximately 75% is black carbon.²⁷ These engines have very long life spans, and are usually rebuilt once or twice before they are taken out of service.

EPA has authority to establish emissions standards for rebuilt heavy-duty engines under section 202(a)(3)(D) of the Act, which states: “The Administrator may prescribe standards to control rebuilding practices, including standards applicable to emissions from any rebuilt heavy-duty engines..., which in [EPA’s] judgment cause, or contribute to, air pollution which may be reasonably anticipated to endanger public health or welfare taking costs into account.” 42 U.S.C. § 7521(a)(3)(D). Section 202(a)(3)(D) also provides that such standards are to be based on a study of rebuilding practices and emissions and other relevant information. EPA performed such a study in 1995, but did not establish emission standards at that time.²⁸

To reduce black carbon emissions from the existing fleet of heavy-duty diesel engines they should be required, when they are rebuilt, to meet PM_{2.5} emissions standards that are at least equivalent to the 2007 Heavy-Duty Engine and Vehicle Standards diesel rule.²⁹ Such standards can be met using technology that is widely available, such as diesel particulate filters that can reduce particulate emissions, including black carbon, by 90% or more.

4.1.2 Ocean-going vessels

Marine diesel engines in ocean-going vessels represent another source of black carbon emissions for which immediate rule-making is necessary to reduce emissions of black carbon as well as other climate forcing global warming pollutants.³⁰ By promulgating regulations in response to the three petitions that the Agency has before it to limit greenhouse gas and black carbon emissions from ships, and by mandating cleaner fuels for marine diesel engines, EPA can achieve significant reductions in the emissions of black carbon and other climate change pollutants from ships.

²⁷ See: http://www.epa.gov/ttn/chief/emch/speciation/pm25_prof_titles_revised.xls.

²⁸ EPA, “Notice of Agency Completion of Study Regarding Heavy-Duty Engine Rebuilding Practices and Availability of Documents,” 60 Fed. Reg. 42881 (August 17, 1995) EPA, “Heavy-Duty Engine Rebuilding Practices, Final Report,” EPA Manufacturers Operations Division, EPA Doc. No. A-95-27; II-A-13 (March 21, 1995).

²⁹ EPA, “Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements; Final Rule,” 66 Fed. Reg. 5002 (Jan.18, 2001).

³⁰ EPA requests comment on all elements of the three petitions the Agency has received seeking regulations to reduce greenhouse gas emissions from ocean-going vessels. 73 Fed. Reg. 44458-44460. The instant comments are restricted to a discussion of regulating black carbon emissions from this source.

The Clean Air Act provides EPA with clear authority to take these actions. EPA has authority under section 213(a)(4) of the Act to regulate specific classes or categories of new non-road engines and vehicles, such as marine engines and vessels, if the Agency determines that new non-road engines and vehicles, as a whole, contribute significantly to an air pollution problem. Accordingly, and as confirmed by the Supreme Court in *Massachusetts v. EPA*, 127 S. Ct. 1438 (2007), EPA is authorized to study and regulate emissions, including emissions of global warming pollutants, from nonroad vehicles and engines. Section 211 of the Clean Air Act grants broad discretion to EPA to regulate the content of fuels manufactured or sold for use in nonroad vehicles and engines, allowing the Administrator to promulgate such regulations as he “may deem appropriate.” 42 U.S.C. § 7545(c)(1). The Act also allows EPA to control or ban the manufacture or sale of fuels whose emission products cause or contribute to air pollution which may reasonably be anticipated to endanger the public health or welfare. 42 U.S.C. § 7545(c)(1). Black carbon emissions from ships satisfy this statutory test.

Estimates of the percentage of black carbon in PM_{2.5} from marine transport emissions range from 43% (best estimate) to 59% (high estimate).³¹ Based on EPA’s 1999 National Emissions Inventory, U.S.-flagged ships in U.S. waters emit between 16 and 21 tons of black carbon to the atmosphere per year (best and high estimates, respectively).³² As the retreat of Arctic sea ice opens up new shipping routes, it becomes ever more urgent to regulate local sources of black carbon emissions, including going vessels, which are known to exert a disproportionate impact on Arctic warming.³³ EPA has the authority under section 213(a)(4) of the CAA to regulate emissions of black carbon and carbon dioxide from ships. The Agency should use this authority to set emissions limits stringent enough to carry out the statutory goal of limiting air pollution reasonably anticipated to endanger public health and welfare. Emissions limits can be accomplished via reductions in fuel consumption and use of cleaner fuels. Black carbon can be further reduced by after-treatment emission control devices.³⁴

Opportunities to reduce fuel consumption from the world’s shipping fleet include:

- Vessel speed reduction: Fuel consumption increases with a power function of speed (approximating a cubic function in large cargo ships), so a 10% reduction in speed of a vessel may result in an approximately 23% reduction in GHG emissions, while a 34% speed reduction can reduce emissions by approximately 57%.
- Modifications to vessel and propeller design to reduce fuel consumption, including: hull optimization (e.g., use of a stern flap which lengthens the bottom surface of a hull or replacement of flat bottom hull surface with an air cavity system), propeller system improvements, propeller coatings, and a bulbous bow.

³¹ Battye and Boyer 2002 *supra* note 22 at 9.

³² *Id.*

³³ *See, for example:* Quinn et al. 2008 *supra* note 1 ; Lack et al. 2008 *supra* note 3; and Zender *supra* note 11. International shipping emits between 71,000 and 160,000 metric tons of black carbon annually. *See generally:* Lack, D., et. al. 2008 *supra* note 3; *see also:* Corbett, et.al. Review of Marpol Annex VI and the NOx Technical Code: Allocation and Forecasting of Global Ship Emissions; International Maritime Organization: London, UK, (2007).

³⁴ *See, Green, Winebrake and Corbett, Reduction of Air Pollution from Ships, Opportunities for Reducing Greenhouse Gas Emissions from Ships; International Maritime Organization; MEPC 58/INF.21: London, UK, August 2008.*

- Maximum use of alternative power technologies: one of the most promising is wind – sails and kites can assist in ship propulsion, reducing fuel consumption and thus black carbon and other pollutants.
- Measures to improve ship routing and logistics: Such measures include: planning to better utilize existing fleets; weather routing to exploit favorable weather and currents; just-in-time routing; reduced time at port through optimal cargo handling, berthing, mooring and anchoring; and improved terminal operations to reduce delays.

In addition to reducing fuel consumption, adopting stringent restrictions on the sulfur content of marine fuels would enable the reduction of black carbon emissions through the use of pollution control devices that work more effectively with the use of lower-sulfur fuel.³⁵ Ships commonly use “residual fuels” which are high in sulfur content. Switching to low-sulfur fuels would reduce emissions of fine particles, including black carbon, as well as carbon dioxide, nitrogen oxides, and nitrous oxides, and enable the use of other emissions control equipment that the sulfur levels in residual fuel would otherwise impede. Moreover, the most promising are after-treatment devices that control particulate emissions in exhaust gases, which require low-sulfur fuel. For example, diesel particulate filter systems are particularly effective at controlling black carbon, reducing emissions by 95 to 99.9% by mass (with 70-95% reductions in total PM).³⁶ Similarly, use of selective catalytic reduction systems has also been shown to decrease particulate emissions by 60 percent when marine distillate is used.³⁷

Marine diesel oil and marine gas oil (collectively, marine distillate) have shown significant decreases in particulate matter compared to heavy fuel oil.³⁸ A switch from heavy fuel oil to marine diesel oil would result in a 63 percent reduction in particulate matter (of which black carbon is a component) emitted per ton of fuel consumed.³⁹ The California Air Resources Board expects that moving from residual fuel (with sulfur content of approximately 25,000 ppm) to 1,000 ppm marine gas oil will reduce PM, SO_x, and NO_x by 83 percent, 96 percent, and 6 percent, respectively.⁴⁰

4 Conclusion

The urgent need to take swift action to significantly reduce emissions of all global warming pollutants is overwhelmingly clear. The IPCC Fourth Assessment Report (FAR) concluded that “delayed emission reductions significantly constrain the opportunities to achieve

³⁵ Friends of the Earth International, “Reducing Shipping Emissions of Air Pollution—Feasible and Cost-effective Option,” submitted to IMO’s Marine Environment Protection Committee, April 7, 2005, MEPC 53/4/1, at 9 (“FOEI Cost-effective options”), available at <http://www.bluewaternet.org/reports/cv/imoairpollution.pdf>.

³⁶ Majewski, W. A. Diesel Particulate Filers. http://www.dieselnet.com/tech/dpf_top.html (July 30, 2001). Note that diesel oxidation catalysts reduce some particulate matter constituents, but do not reduce black carbon.

³⁷ Entec UK Limited, Final Report for European Commission Directorate-General-Environment, “Service Contract of Ship Emissions: Assignment, Abatement and Market-based Instruments,” at iv-vi, (August 2005) available at <http://europa.eu.int/comm/environment/air/transport.htm>.

³⁸ James Winebrake and James Corbett, *Technical Memorandum: Total Fuel Cycle Analysis for Container Ships: A Comparison of Residual Oil, Marine Gas Oil and Marine Diesel Oil*, (2007) at 4.

³⁹ *Id.* at 6.

⁴⁰ *Id.* at 3-4.

lower stabilization levels and increase the risk of more severe climate change impacts.”⁴¹ There is no time to waste.

The significant body of scientific studies published since the IPCC FAR indicates that the net warming effects of black carbon emissions from major source categories, taking into account the cooling effect of co-emitted organic carbon, are significant, and that sharply reducing these emissions is a critical short term strategy to slow global warming and the melting of Arctic sea ice, the Greenland ice sheet and glaciers and snow pack across the United States.

EPA has the authority and a duty to act now to regulate both mobile and stationary source emissions of all global warming pollutants, including black carbon and GHGs, using the time-tested tools provided in the Clean Air Act. The science is clear – the significant net climate warming effect of black carbon and co-emitted organic carbon from many major sources contributes to the endangerment of public health and welfare. We urge the Agency, without delay, to issue proposed rules to reduce black carbon emissions from rebuilt heavy-duty engines and marine vessels, and to issue an endangerment finding with respect to black carbon.

Respectfully submitted,

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⁴¹ Intergovernmental Panel on Climate Change, *Climate Change 2007 Fourth Assessment Synthesis Report* (Nov. 2007), at 19.