Pulling the Second Lever: Regulating Black Carbon to Combat Global Warming

by Emily Baer

Emily Baer is a managing editor on the *Journal of Energy and Environmental Law* at the George Washington University Law School, where she expects to graduate in May 2017 and focuses on international and environmental law.

> We are now slowly realizing that we have delayed [carbon dioxide] reduction by so long we have simply lost the luxury of pulling one lever to reduce warming. Fortunately [short-lived climate pollutants] provide us with a second lever. We have two hands. We should be able to pull both levers down.
>
> —*Veerabhadran Ramanathan of the Scripps Institute of Oceanography*[1]

Black carbon, a component of soot and the result of incomplete combustion,[2] is one of the most climate-forcing substances in existence.[3] Additionally, black carbon is extremely harmful, with more people dying from indoor air pollution each year than from malaria and HIV/AIDS combined.[4] Due to black carbon's extremely short life in the atmosphere, curbing its emissions would have a near-immediate effect on climate change.[5] While black carbon is currently unregulated internationally, the technology to substantially reduce emissions exists and is readily available to curb some of the worst sources and those most dangerous to human health.[6] Black carbon's short life in the atmosphere makes it a low-hanging fruit in the world of climate change reduction, and regulations to curtail it should be introduced immediately.[7]

To effectively control black carbon emissions, comprehensive international regulation is needed. This regulation should be contained in a multilateral environmental agreement (MEA) and must include a process for monitoring and ongoing research, strict standards on emissions, funding mechanisms including emissions trading, and a dispute resolution procedure in order to achieve successful implementation. This Comment will propose an MEA for the regulation of black carbon.

In advancing this MEA for regulating black carbon emissions, the Comment will first examine the scientific background of black carbon emissions, including its formation and effects and the existing technology to reduce emissions. It will then explore the legal framework, detailing key components of MEAs and the existing legal framework for international environmental regulations. The third part will begin to analyze the Montreal and Kyoto Protocols in order to understand how to create a successful MEA. Finally, the Comment will present a proposed MEA regulating black carbon emissions, including model language and several key components of the agreement.

1. *See* Climate & Clean Air Coalition Secretariat, *COP21: Lima Paris Action Agenda, Short-Lived Climate Pollutants Focus Event*, Climate & Clean Air Coalition, Dec. 6, 2015, http://www.ccacoalition.org/en/news/cop21-lima-paris-action-agenda-short-lived-climate-pollutants-focus-event.
2. U.S. Environmental Protection Agency (EPA), *Basic Information: What Is Black Carbon*, http://www3.epa.gov/blackcarbon/basic.html (last visited Oct. 12, 2016).
3. *See* Anjali D. Nanda, *India's Environmental Trump Card: How Reducing Black Carbon Through Common but Differentiated Responsibilities Can Curb Climate Change*, 39 Denv. J. Int'l L. & Pol'y 523, 528 (2011).
4. Damian Carrington, *More People Die From Air Pollution Than Malaria and HIV/Aids, New Study Shows*, The Guardian, Sept. 16, 2015, http://www.theguardian.com/environment/2015/sep/16/more-people-die-from-air-pollution-than-malaria-and-hivaids-new-study-shows. *See* Environmental and Energy Study Institute, *Black Carbon and Its Implications for Climate Change and Public Health*, http://www.eesi.org/briefings/view/black-carbon-and-its-implications-for-climate-change-and-public-health (last visited Oct. 12, 2016). In addition to the devastating health effects of black carbon emissions, the lack of clean energy in many developing countries contributes to emissions and also has human rights implications, keeping mostly girls out of school and negatively affecting the quality of life of women and children especially. For more on this discussion, see Karen Bice et al., Black Carbon: A Review and Policy Recommendations §1.1.3 (2009), *available at* http://www.princeton.edu/~mauzeral/WWS591e/Princeton.WWS591E.Black.Carbon.report.2009.pdf; Albert C. Achudume, *Environmental Health, Development, and Economic Empowerment of Rural Women in Nigeria*, 11 Env't, Dev. & Sustainability 459, 460 (2009), *available at* http://link.springer.com/article/10.1007/s10668-007-9124-1.
5. *See* Clean Air Task Force, *Short-Lived Climate Pollutants*, http://www.catf.us/climate/pollutants/ (last visited Oct. 12, 2016).
6. *See* Elisabeth Rosenthal, *Third-World Stove Soot Is Target in Climate Fight*, N.Y. Times, Apr. 15, 2009, *available at* http://www.nytimes.com/2009/04/16/science/earth/16degrees.html?_r=0.
7. *See Short-Lived Climate Pollutants*, *supra* note 5.

I. Black Carbon: A Scientific Overview

To appreciate the importance of having an efficient regulatory framework for black carbon, it is important to understand what black carbon is and how it affects the environment. This part will describe black carbon as a substance and then explain its health and environmental effects.

A. The Formation of Black Carbon

Black carbon is "a solid form of mostly pure carbon that absorbs solar radiation (light) at all wavelengths. [Black carbon] is the most effective form of [particulate matter], by mass, at absorbing solar energy, and is produced by incomplete combustion."[8] The incomplete combustion of fossil fuels, biomass, and biofuels forms the light-absorbing small particulate known as black carbon or, more commonly, soot.[9] Organic materials including diesel, coal, wood, and crop residue burn inefficiently, leaving behind soot, of which black carbon is the main component.[10]

Industry and transportation make up roughly 40% of the black carbon emissions, open biomass burning (namely wildfires and crop burning) about 35%, and residential use approximately 25%.[11] These various sources of black carbon emissions have different effects, making regulating it a challenge.[12] While slated to slowly decrease, black carbon emissions can have a major effect on climate change if dealt with immediately.[13]

B. The Effects of Black Carbon Emissions

Black carbon negatively impacts the environment through climate change, and specifically global warming.[14] Black carbon absorbs more light than any other component of particulate matter, absorbing one million times more energy than carbon dioxide per unit of mass in the atmosphere.[15] Black carbon warms the earth both directly, through the absorption of solar energy in the atmosphere, and indirectly, by thickening Arctic clouds, thereby trapping more heat in the atmosphere and reducing the reflectivity of the earth.[16]

Black carbon has specific regional effects. This is due, in large part, to the relatively short distance black carbon travels in the atmosphere between its source and where it falls.[17] Black carbon interacts with other aerosols in the atmosphere, and together they form hot spots of atmospheric solar heating.[18] These hot spots contribute to droughts and to desertification, with parts of South Asia, eastern China, the majority of Southeast Asia, Central America and Mexico, regions of South America, and Africa being particularly vulnerable due to existing environmental conditions.[19]

When black carbon falls on snow or ice, its absorption of sunlight increases the melting of snow and ice where it lands.[20] This causes problems and concerns in Scandinavia, Canada, Russia, the United States, Finland, and other countries with significant amounts of snow or ice.[21] Due to black carbon's warming effects, together with its resultant drought and desertification, the Arctic, Alpine, and drought prone regions are particularly susceptible to the emissions.[22] In some of these regions, air pollution from black carbon is already critical and in others, it is becoming serious.[23]

In addition to its regional effects, black carbon negatively affects the environment globally though climate change and warming.[24] Black carbon, behind only carbon dioxide as a climate-forcing substance, generates 18% of the global warming effect, compared to carbon dioxide's 40%.[25] Although research suggests black carbon's effect may be up to twice as much as is currently thought, even the 18% figure would be three to four times higher than was originally estimated in 2007.[26] Through direct and

8. *See* U.S. EPA, Report to Congress on Black Carbon §2.3 (2012) (EPA-450/S-12-001).
9. *See Basic Information: What Is Black Carbon*, *supra* note 2.
10. *See* Hannah Chang, *Domestic Mitigation of Black Carbon From Diesel Emissions*, 41 ELR 10126, 10127 (Feb. 2011).
11. Black carbon emissions are naturally decreasing in some developed countries due to clean air regulations and switching to clean sources of energy, but continues to rise in many other countries. *See Basic Information: What Is Black Carbon*, *supra* note 2.
12. Ralph Sims et al., Black Carbon Mitigation and the Role of the Global Environment Facility: A STAP Advisory Document, Global Environment Facility 31 (2015), *available at* https://www.thegef.org/sites/default/files/council-meeting-documents/EN_GEF.STAP_.C.49.Inf_.02_Black_Carbon_Mitigation_and_the_Role_of_the_GEF_5.pdf. This Comment will propose a system to convert these differing values into a common unit that can be regulated and traded. See discussion *infra* Part IV.B.1., Standard Setting and Emissions Trading.
13. *Short-Lived Climate Pollutants*, *supra* note 5.
14. *See* Report to Congress on Black Carbon, *supra* note 8, at §6.1.
15. *See Basic Information: What Is Black Carbon*, *supra* note 2.
16. *See* Chang, *supra* note 10, at 10127.
17. *See id.* at 10128.
18. *See* Veerabhadran Ramanathan & Gregory R. Carmichael, *Global and Regional Climate Changes Due to Black Carbon*, 1 Nature Geoscience 221, 221 (2008).
19. *See* Chang, *supra* note 10, at 10128.
20. *See generally* Patricia K. Quinn et al., The Impact of Black Carbon on Arctic Climate, Arctic Monitoring and Assessment Programme 3 (2011), *available at* https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjuo-vKqpPLAhVMRiYKHcd9Aj8QFggdMAA&url=http%3A%2F%2Fwww.amap.no%2Fdocuments%2Fdownload%2F977&usg=AFQjCNFd4ZIh5W8Cyy4lePJRXBX7iXgMlw&sig2=YV4i2ZlHxnHr77AhpfNb5Q&bvm=bv.115277099,d.eWE&cad=rja.
21. *See generally* Quinn et al., *supra* note 20.
22. *See* Report to Congress on Black Carbon, *supra* note 8, at §2.1.
23. *See* William Roper, *Article and Comment: Wood Stoves: Can We Solve the Emissions Problem Before It Goes Up in Smoke?*, 11 B.C. Envtl. Aff. L. Rev. 273, 279 (1984).
24. *See* Report to Congress on Black Carbon, *supra* note 8, at §6.4.
25. *See* Rosenthal, *supra* note 6.
26. Press Association, *Black Carbon Causes Twice as Much Global Warming Than Previously Thought*, The Guardian, Jan. 15, 2013, http://www.theguardian.com/environment/2013/jan/15/black-carbon-twice-global-warming; Rosenthal, *supra* note 6; Nanda, *supra* note 3, at 528.

indirect warming, one pound of black carbon can have up to 700 times the warming effect of one pound of carbon dioxide.[27] Additionally, as black carbon has a much shorter life in the atmosphere than other forms of emissions, curbing black carbon emissions may be the fastest way to slow global warming.[28]

Further, black carbon ranks ninth in the most important health risk factors and is responsible for nearly 3% of disease worldwide.[29] Black carbon causes serious health concerns, such as respiratory infections including pneumonia, tuberculosis, low birth weight, cataracts, cardiovascular events, and all-cause mortality.[30] Moreover, with regard to the economic effect of disease caused by black carbon emissions, it is estimated that the negative health effect of small particulate matter air pollution in India and China is up to 3.6% and 2.2% of their gross domestic products, respectively.[31] These negative health and economic effects of black carbon emissions add urgency to regulating black carbon.

C. Existing Technology to Reduce Black Carbon Emissions

Burning biofuels, as measured on the "energy ladder," which measures the polluting effect, efficiency, and cost of domestic fuels, is near the bottom.[32] Electricity is at the top of the ladder; next is kerosene, coal, and gas, all non-biomass fuels, then charcoal as the most efficient biomass fuel, followed by crop residues, wood, dried animal dung, and twigs and grass.[33] Thus, nearly any alternative form of energy provided will be more efficient and less of a pollutant than the current use of biofuels in developing countries, and several options exist to make energy production more efficient in developed countries.

There are many existing measures to reduce black carbon emissions. They include the creation of domestic standards for the reduction of pollutants from both on- and off-road vehicles,[34] and the elimination of high-emitting vehicles both on- and off-road.[35] Residential emissions can be reduced by replacing lump coal with coal briquettes, replacing traditional fuel wood combustion technologies with wood pellet stoves using dry fuel, and substituting biomass cook-stoves with those using lean-burning fuels or solar-powered cook-stoves.[36] Industrial black carbon emissions, meanwhile, can be reduced by replacing traditional brick kilns and coke ovens with more efficient designs and by moving away from using coal as an energy source.[37] Banning the open burning of agricultural and forest wastes can reduce agricultural black carbon emissions.[38] The most effective MEA will include all types of reduction methods.

II. The Legal Framework

In addition to understanding what black carbon is and what effects it has, it is important to understand existing legal options for curbing emissions. The main legal strategies for affecting environmental change internationally are regulation and litigation, which can be international, regional, or domestic.[39] International measures have the potential to effect the greatest change because of the number of countries they can reach, but regional and domestic measures are able to be more specific and are often more forceful.[40]

International environmental law traditionally operates through MEAs, treaties, and other forms of cooperative agreements.[41] While some of the more notable agreements, such as the Montreal Convention,[42] create legally binding obligations, others, like the Kyoto Protocol,[43] rely on civil society and diplomatic pressure to keep Parties accountable.[44] However, whether binding or non-binding, these agreements are usually enforced by soft law measures.[45] There are currently no major international agree-

27. *See* Chang, *supra* note 10, at 10127.
28. *See* Lauren Morello, *Cutting Black Carbon and Methane Promises Immediate Climate Change Impacts*, Sci. Am., Feb. 22, 2011, http://www.scientificamerican.com/article/cutting-black-carbon-methane-immediate-climate-change/; Veerabhadran Ramanathan & Daniel Press, *Op-Ed: To Help Stop Global Warming, Curb Short-Lived Pollutants*, L.A. Times, Dec. 28, 2015, *available at* http://www.latimes.com/opinion/op-ed/la-oe-1225-ramanathan-press-slcps-climate-change-20151225-story.html; Nanda, *supra* note 3, at 523 (discussing black carbon's life-span).
29. *See* World Health Organization (WHO), Global Health Risks: Mortality and Burden of Disease Attributable to Selected Major Risks 12 (2009), *available at* http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf.
30. *See id.*; Nanda, *supra* note 3, at 526; Duncan G. Fullerton et al., *Indoor Air Pollution From Biomass Fuel Smoke Is a Major Health Concern in the Developing World*, 102(9) Transactions Royal Soc'y Tropical Med. & Hygiene 843, 845 (2008).
31. *See* Nanda, *supra* note 3, at 526-27.
32. *See* Fullerton et al., *supra* note 30, at 846.
33. *See id.*
34. *See* Sims et al., *supra* note 12, at 31.
35. *See id.* at 30.
36. *See id.* at 31; Solar Cookers International, *About*, http://solarcookers.org/about/ (last visited Oct. 12, 2016).
37. *See* Sims et al., *supra* note 12, at 31.
38. *See id. See also* Nanda, *supra* note 3, at 529-30 (referencing *Black Carbon in Arctic Russia*, Think Progress, Dec. 12, 2009, https://thinkprogress.org/black-carbon-in-arctic-russia-caed2c99d189#.ciwlxpx5h). This article discusses agricultural burning and suggests increased regulation in areas bordering regions more sensitive to black carbon regions, specifically increased regulation in Russia due to its proximity to the Arctic and its propensity to engage in agricultural burning.
39. *See, e.g.*, Trail Smelter Case (U.S. v. Can.) 3 R.I.A.A. 1905, 1938-66 (Perm. Ct. Arb. 1941); Indian Council for Enviro-Legal Action v. Union of India, A.I.R. 1996 S.C. 1446, (1996) 3 S.C.C. 212.
40. Carl Bruch, *Is International Environmental Law Really "Law"?: An Analysis of Application in Domestic Courts*, 23 Pace Envtl. L. Rev. 423, 424-25 (2006).
41. Multilateral agreements are those between at least three countries. *See* The Law Dictionary, *What Is Multilateral Agreement?*, http://thelawdictionary.org/multilateral-agreement/ (last visited Oct. 12, 2016).
42. Robin Eckersley, *The Big Chill: The WTO and Multilateral Environmental Agreements*, 4 Global Envtl. Pol. 24, 27 (2006).
43. *See* Kyoto Protocol to the United Nations Framework Convention on Climate Change, Dec. 10, 1997, art. 3, 37 I.L.M. 22, http://unfccc.int/essential_background/kyoto_protocol/items/1678.php [hereinafter Kyoto Protocol].
44. *See* Joel B. Eisen, *From Stockholm to Kyoto and Back to the United States: International Environmental Law's Effect on Domestic Law*, 32 U. Rich. L. Rev. 1435, 1482-83 (1999); Samantha Page, *No, The Paris Climate Agreement Isn't Binding. Here's Why That Doesn't Matter*, Think Progress, Dec. 14, 2015, http://thinkprogress.org/climate/2015/12/14/3731715/paris-agreement-is-an-actual-agreement/.
45. For a discussion on soft law, see Joseph DiMento, *International Environmental Law: A Global Assessment*, 33 ELR 10387, 10425 (June 2003).

ments that regulate or could easily be adapted to regulate black carbon.[46]

A. *Key Features of MEAs*

This section will provide a brief background of components to MEAs that are included in the proposed MEA on black carbon. These components are standard setting and emissions trading, compliance mechanisms, and ongoing monitoring and research.

1. Standard Setting and Emissions Trading

Standard setting is the first component of many MEAs.[47] The Parties to the MEA establish what substances need to be regulated and decide on the desired result(s).[48] The Parties then set a standard that will achieve this goal, often by decreasing the allowable emissions incrementally over a set time period.[49] Scientists are often heavily involved in both this stage and in establishing emissions trading schemes.[50]

To reduce emissions, MEAs often use mechanisms such as emissions trading schemes or cap-and-trade programs.[51] These mechanisms are essentially a contract to trade units of emissions between countries or companies.[52] Such programs can facilitate investment and innovation, in addition to easing the regulatory burdens of companies by allowing them to find the most cost-effective way to reduce emissions.[53] Some trading programs grant reduction credits for reductions abroad from clean development mechanism (CDM) projects.[54]

2. Compliance Mechanisms

International environmental agreements provide for compliance mechanisms.[55] As failure to comply with an obligation, or to meet a goal, is generally the result of an inability to do so, environmental agreements usually provide for a commission that will assist failing States Parties in meeting their goals.[56] Such an approach is preferable because traditional measures of enforcement, such as retaliation or sanctions, are counterproductive, coming too late to have an effect or making it even more difficult for the failing Party to comply.[57] Instead, measures such as international pressure or assistance, either technical/scientific or financial, from the Conference of the Parties or other commissions set up in the agreement are used to deal with violations of the treaty.[58] States can also self-report in order to receive assistance when they are struggling to meet a goal.[59] This makes such agreements more palpable to States who are giving up some sovereignty by joining the agreement.[60]

3. Ongoing Monitoring and Research

Ongoing monitoring and research are both required to ensure that the goals of the MEA are met.[61] Monitoring establishes the effects of the Parties' actions, and research helps the Parties to improve their strategies and technology in order to more efficiently and cost-effectively meet the reduction standards.[62] Ongoing research and monitoring are important parts of any environmental regulation.[63] As science and technology evolve, more efficient and more cost-effective ways can be found to reduce black carbon emissions, but this can only happen if research into the area is ongoing. If reducing black carbon emissions becomes a priority, it may force innovation as companies compete to find better and more effective ways to reduce their own emis-

46. Thomas L. Brewer, *Arctic Black Carbon: The Challenge for International Governance*, 9 Biores (2015), http://www.ictsd.org/bridges-news/biores/news/arctic-black-carbon-the-challenge-for-international-governance.
47. *See, e.g.*, International Carbon Action Partnership, *Cap Setting*, https://icapcarbonaction.com/en/about-emissions-trading/cap-setting (last visited Oct. 12, 2016).
48. *See generally* Bhaskar Nath, Environmental Regulations and Standard Setting (Encyclopedia of Life Support Systems 2000), http://www.eolss.net/sample-chapters/c09/E4-22.pdf; ISEAL Alliance, *Standard-Setting Code*, http://www.isealalliance.org/our-work/defining-credibility/codes-of-good-practice/standard-setting-code (last visited Oct. 12, 2016).
49. *See, e.g.*, International Carbon Action Partnership, *supra* note 47.
50. Lawrence E. Susskind & Saleem H. Ali, Environmental Diplomacy: Negotiating More Effective Global Agreements 70 (2d ed. 2015).
51. *See e.g.*, Center on Budget and Policy Priorities, *Policy Basics: Policies to Reduce Greenhouse Gas Emissions*, CBPP (Dec. 21, 2015), http://www.cbpp.org/research/policy-basics-policies-to-reduce-greenhouse-gas-emissions.
52. Environmental Defense Fund, *How Cap and Trade Works*, https://www.edf.org/climate/how-cap-and-trade-works (last visited Nov. 2); European Commission, *The EU Emissions Trading System (EU ETS)* (Oct. 27, 2016), https://ec.europa.eu/clima/policies/ets/index_en.htm [hereinafter European Commission].
53. *See How Cap and Trade Works*, *supra* note 52.
54. CDM projects generally involve emitters in developed countries reducing emissions in developing countries through some sort of development project that reduces the use of or the emission of the substances being reduced. UNFCCC, *International Emissions Trading*, http://unfccc.int/kyoto_protocol/mechanisms/emissions_trading/items/2731.php (last visited Oct. 12, 2016) [hereinafter *International Emissions Trading*].
55. *See generally* United Nations Environment Programme, Compliance Mechanisms Under Selected Multilateral Environmental Agreements (2006).
56. *See* John H. Knox, *A New Approach to Compliance With International Environmental Law: The Submissions Procedure of the NAFTA Environmental Commission*, 28 Ecology L.Q. 1, 9 (2001).
57. *See* Joseph F. Dimento & Pamela M. Doughman, *Soft Teeth in the Back of the Mouth: The NAFTA Environmental Side Agreement Implemented*, 10 Geo. Int'l Envtl. L. Rev. 651, 736 (1998).
58. Conference of the Parties (COP) refers to the meeting of the Parties to a treaty where progress is assessed, decisions are made, amendments or new protocols are signed, and the treaty is generally examined and updated. Relevant new research and monitoring reports can also be discussed at the COP. *See, e.g.*, UNFCCC, *Conference of the Parties (COP)*, http://unfccc.int/bodies/body/6383.php (last visited Oct. 12, 2016).
59. *See* United Nations Environment Programme, Auditing the Implementation of Multilateral Environmental Agreements (MEAs): A Primer for Auditors 22 (2006).
60. *See* Anne C. Dowling, *"Un-Locke-ing" a "Just Right" Environmental Regime: Uncovering the Three Bears of International Environmentalism—Sovereignty, Locke, and Compensation*, 26 Wm. & Mary Envtl. L. & Pol'y Rev. 891, 951-52 (2002).
61. *See* Susskind & Ali, *supra* note 50, at 81-83.
62. *See id.*
63. For examples, *see, e.g.*, Montreal Protocol on Substances That Deplete the Ozone Layer, Sept. 16, 1987, S. Treaty Doc. No. 100-10, 1522 U.N.T.S. 3 [hereinafter Montreal Protocol]; *see generally* European Commission, *supra* note 52.

sions, as in the case of the Montreal Protocol on Substances That Deplete the Ozone Layer (Montreal Protocol).[64] Measures are needed to ensure that new technology is shared with developing countries, but also that countries still have an incentive to develop such technology.[65]

B. Existing International Environmental Agreements

While no international instruments regulate black carbon emissions, several may nonetheless offer useful lessons.[66] This section will introduce two of the most relevant existing treaties, the United Nations Framework Convention on Climate Change (UNFCCC) and its subsequent protocols, including the Kyoto Protocol; and the Vienna Convention for the Protection of the Ozone Layer, revised in the Montreal Protocol.

The UNFCCC, entered into force in 1994, is an instrument of cooperation on climate change that acknowledged the common concern of climate change and the shared responsibility of developed and developing countries.[67] The UNFCCC's goal is to stabilize greenhouse gas (GHG) concentrations in the atmosphere at a level that prevents "dangerous human interference with the climate system."[68] The UNFCCC separated countries into annexes based on levels of development and set up basic reduction frameworks for each class.[69] It lacked any timetables or emissions targets, which were provided in the Kyoto Protocol in 1997.[70]

The Kyoto Protocol, linked to the UNFCCC, set legally binding emissions reduction targets for Parties.[71] The Kyoto Protocol established a baseline for emissions and removals of GHGs and set the timetables and emissions targets that the UNFCCC lacked.[72] Under the Protocol, developing nations are not obligated to reduce emissions, but the CDM gives developed countries that are party to the Protocol the option to meet their reductions requirements through investment in emissions reductions, or through projects to reduce emissions in developing countries.[73] In this scheme, the developed countries are given reduction credits that count toward their own reduction requirements for such projects as are completed in developing countries.[74]

The Kyoto Protocol caps emissions for Annex 1 countries at 5% below either the 1990 or 1995 baseline levels, to be reached between 2008 and 2012.[75] The Annex 1 countries are assigned a national emissions cap and by the end of the period, each emitter must have acquired, from purchase or trade of additional allocation credits or through allocation from their governments, enough credits to cover their emissions.[76] The cap-and-trade program assigns the following units: the assigned amount units (AAUs) that are reduced by removal units (RMUs) from reforestation and other land use practices projects that remove carbon dioxide.[77] These units are converted into emission reduction units (ERUs) to enable international trade.[78] CDMs and joint implementation (JI) projects provide additional ways for GHG emitters to obtain credits.[79] Through CDMs, companies can earn certified emissions reductions (CERs) for each ton of emissions reduced.[80]

Like the UNFCCC, the Vienna Convention is considered a framework convention.[81] Adopted in 1985, the Convention entered into force in September 1988, and was universally ratified in 2009.[82] The goals of the Vienna Convention are to promote cooperation, research, and information exchange on human activities' effects on the ozone layer, and to adopt measures against acts that harm or are likely to harm the ozone layer.[83] The Vienna Convention did not require any concrete actions; these were established in the Montreal Protocol.[84]

One of the world's foremost documents on climate change, the Montreal Protocol was established with the goal of repairing the hole in the ozone layer.[85] The Montreal Protocol has been an astonishing success, reducing emissions by 135 billion tons.[86] Since its relatively inauspicious beginnings, the Protocol has been nearly universally ratified and Parties regularly amended the Protocol to

64. *See* Cass R. Sunstein, *Of Montreal and Kyoto: A Tale of Two Protocols*, 31 Harv. Envtl. L. Rev. 1, 4 (2007).
65. *See, e.g.*, Mark A. Drumbl, *Poverty, Wealth, and Obligation in International Environmental Law*, 76 Tul. L. Rev. 843, 850-53, n.15 (2002); Gaetan Verhoosel, *Beyond the Unsustainable Rhetoric of Sustainable Development: Transferring Environmentally Sound Technologies*, 11 Geo. Int'l Envtl. L. Rev. 49, 53-54 (1998).
66. *See* Brewer, *supra* note 46.
67. *See* United Nations Framework Convention on Climate Change (UNFCCC), May 9, 1992, 1771 U.N.T.S. 107 [hereinafter UNFCCC].
68. *See* American Society of International Law, *Treaties and Agreements United Nations Conference on Environment and Development: Framework Convention on Climate Change*, 31 I.L.M. 849, art. 2 (1992); United Nations, *UN and Climate Change*, http://www.un.org/climatechange/towards-a-climate-agreement/? (last visited Oct. 12, 2016).
69. UNFCCC, *Parties & Observers*, http://unfccc.int/parties_and_observers/items/2704.php (last visited Oct. 12, 2016).
70. Kyoto Protocol, *supra* note 43; World Meteorological Organization, *WMO at the UNFCCC*, http://public.wmo.int/en/our-mandate/climate/wmo-unfccc-cop (last visited Oct. 12, 2016).
71. *Id.*
72. *See generally* Kyoto Protocol, *supra* note 43, at arts. 2-7.
73. *See* Nanda, *supra* note 3, at 536.
74. *See id.*
75. *See, e.g.*, Kyoto Protocol, *supra* note 43.
76. Steven Ferrey, *The Failure of International Global Warming Regulation to Promote Needed Renewable Energy*, 37 Legal Stud. Res. Paper Series 67, 80 (2010).
77. *See Report of the Conference of the Parties Serving as the Meeting of the Parties to the Kyoto Protocol on Its First Session, Held at Montreal From 28 November to 10 December 2005*, UNFCCC, Addendum, U.N. Doc. FCCC/KP/CMP/2005/8/Add.1 (2006).
78. Steven Ferrey, Unlocking the Global Warming Toolbox: Key Choices for Carbon Restriction and Sequestration 52 (2010).
79. *Id.* at 54-57.
80. *See, e.g.*, UNFCCC, Clean Development Mechanisms (CDM), http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php (last visited Oct. 12, 2016); Ved P. Nanda, *The European Union's Multinational Carbon Trading Program*, 85 Denv. U. L. Rev. 995, 998-99 (2008).
81. Vienna Convention for the Protection of the Ozone Layer, Mar. 22, 1985, T.I.A.S. No. 11097, 1513 U.N.T.S. 293 [hereinafter Vienna Convention].
82. *Id.*
83. *Id.*
84. *Id.*
85. *Id.*
86. United Nations Environment Programme Ozone Secretariat, *Montreal Protocol—Achievements to Date and Challenges Ahead*, http://ozone.unep.org/en/focus/montreal-protocol-achievements-date-and-challenges-ahead (last visited Oct. 12, 2016); Sunstein, *supra* note 64, at 3-4.

reflect new research, adapt new funding mechanisms, and generally better reduce ozone-depleting substances.[87]

The Montreal Protocol is structured around groups of chlorofluorocarbons, assigning each a value dependent on its ozone-depleting effect.[88] Parties use these assigned values to trade emissions.[89] Parties to the Protocol agreed to only trade ozone-depleting substances with other Members to the treaty, incentivizing non-Parties to join.[90] The Montreal Protocol builds on the principle of common but differentiated responsibilities by giving a five-year grace period to developing countries.[91] This grace period allows developing countries to implement the phaseout schedule after developed countries.[92] Further, the performance of developing world countries is predicated on the transfer of technology, financial assistance, and the creation of the necessary infrastructure.[93] The Multilateral Fund for the Implementation of the Protocol supplies developing countries with the funds to cover costs incurred meeting the reduction standards.[94] Perhaps most importantly, the Montreal Protocol departs from the typical unanimity requirement for decisionmaking, allowing a two-thirds majority vote of the States Parties to pass rules, allowing the Parties to quickly respond to new information.[95]

III. Lessons From Montreal and Kyoto

This Comment advocates for an international approach to regulating black carbon emissions. Domestic and regional regulations, while important, are not adequate to address the growing problem. Although the immediately felt effects are largely localized, giving States a stronger interest in prevention than with other forms of global pollution,[96] developing and developed countries are largely unequipped to reduce their black carbon emissions at home and, more importantly, the global climate change effects of black carbon emissions do not respect national borders.[97] Litigation also has too many drawbacks to be a viable solution here.[98]

A. *International Systems*

International systems arguably provide the best chance of reducing black carbon emissions for several reasons. Addressing black carbon emissions globally allows countries to make the most cost-effective reductions to emissions, largely in developing countries first, quickly reducing global black carbon emissions.[99] This allows time to develop technology to cost-effectively reduce other types of emissions, largely in developed countries. By addressing the problem globally instead of domestically, cost-effective progress can be made continuously and immediately.[100] This is what happened with the Montreal Protocol, which proved to be one of the most effective environmental treaties.[101]

The main problem with international systems is the political will needed to get a large number of countries to agree on an issue.[102] Because of the difficulty getting countries to agree, terms are often vague and obligations are non-binding or loosely enforced.[103] However, even non-binding treaties often effect positive change as countries feel honor-bound to uphold their agreements and diplomatic pressure encourages compliance.[104]

Despite the issues with international regulatory systems, this Comment advocates for an MEA regulating black carbon for several reasons. First, while the worst effects of black carbon are largely domestic, the warming caused by

87. *Montreal Protocol—Achievements to Date and Challenges Ahead*, *supra* note 86.
88. *See generally* Montreal Protocol, *supra* note 63, at art. 2, annexes, 204.
89. *See generally id*.
90. Montreal Protocol, *supra* note 63, at art. 4; Mark W. Roberts & Peter M. Grabiel, *A Window of Opportunity: Combating Climate Change by Amending the Montreal Protocol to Regulate the Production and Consumption of HFCs and ODS Banks*, 22 Geo. Int'l Envtl. L. Rev. 99, 102 (2009).
91. Montreal Protocol, *supra* note 63, at art. 5; *see* Donald Kaniaru et al., *Strengthening the Montreal Protocol: Insurance Against Abrupt Climate Change*, *in* The Montreal Protocol: Celebrating 20 Years of Environmental Progress 165-66 (Donald Kaniaru ed., 2007).
92. *See* Montreal Protocol, *supra* note 63, at art. 5.
93. *See id*. at arts. 5(5), 10-10A.
94. *Id*. at art. 10; Roberts & Grabiel, *supra* note 90, at 103.
95. *See* Montreal Protocol, *supra* note 63; *see also* Eva M. Kornicker Uhlmann, *State Community Interests,* Jus Cogens *and Protection of the Global Environment: Developing Criteria for Peremptory Norms*, 11 Geo. Int'l Envtl. L. Rev. 101, 124 (1998).
96. Chang, *supra* note 10, at 10128; Ramanathan & Carmichael, *supra* note 18, at 221.
97. Holli Riebeek, *Global Warming*, Earth Observatory, June 3, 2010, http://earthobservatory.nasa.gov/Features/GlobalWarming/.
98. *See* Alan Boyle, *Human Rights and the Environment: Where Next?*, 23 Eur. J. Int'l L. 613, 631-32 (2012); Christopher H. Schroeder, *Lost in Translation: What Environmental Regulation Does That Tort Cannot Duplicate*, 41 Washburn L.J. 583, 585 (2002). For a discussion on domestic private action cases concerning violations of the right to a clean environment, mainly in the form of the Clean Water and Clean Air Acts, see Institute for Global Labour and Human Rights, *Private Right of Action* (Feb. 15, 2008), http://www.globallabourrights.org/alerts/private-right-of-action. For a discussion of the public trust doctrine in environmental law, see generally Center for Climate and Energy Solutions, *Public Trust Doctrine Cases*, http://www.c2es.org/federal/courts/public-trust-doctrine-cases (last visited Oct. 12, 2016) (discussing two public trust cases in the United States); Holly Doremus, *Groundwater and the Public Trust Doctrine, California Style*, LegalPlanet, July 21, 2014, http://legal-planet.org/2014/07/21/groundwater-and-the-public-trust-doctrine-california-style/; Richard Frank, *The Public Trust Doctrine Revisited*, LegalPlanet, Apr. 18, 2012, http://legal-planet.org/2012/04/18/the-public-trust-doctrine-revisited/. Among other things, litigation action requires a harm to have already occurred, whereas regulation can prevent the harm. *See* Schroeder, *supra* note 98, at 583-84.
99. *See generally* Bryan Green, *Comment: Lessons From the Montreal Protocol: Guidance for the Next International Climate Change Agreement*, 39 Envtl L. 253 (2009) (explaining how in regards to ozone-depleting substances, the resources to reduce emissions were largely in the developed world and also describing mechanisms for allowing countries to reduce emissions as cost-effectively as possible).
100. *See id*. at 267.
101. *See, e.g.*, Armin Rosencranz et al., The Principles, Structure, and Implementation of International Environmental Law (1999), http://www.ucar.edu/communications/gcip/m3elaw/m3html.html; Nathan Thanki, *An Effective Environmental Treaty? Montreal Protocol*, Earth in Brackets, Sept. 27, 2012, http://www.earthinbrackets.org/2012/09/27/an-effective-environmental-treaty-montreal-protocol/.
102. *See* Asumpta Lattus, *Lack of "Political Will" Hampering Environmental Laws*, Deutsche Welle, June 23, 2014, http://www.dw.com/en/lack-of-political-will-hampering-environmental-laws/a-17730845.
103. *See* Legal Response Initiative, Training Manual 11 (2013), *available at* http://legalresponseinitiative.org/wp-content/uploads/2013/04/LRI-Training-Manual.pdf; Eric A. Posner, *International Agreements: A Rational Choice Approach*, 44 Va. J. Int'l L. 113 (2003).
104. *See generally* Andrew T. Guzman, *A Compliance-Based Theory of International Law*, 90 Cal. L. Rev. 1823 (2002), *available at* http://scholarship.law.berkeley.edu/californialawreview/vol90/iss6/2.

black carbon is a global issue.[105] Further, while domestic and regional systems lend themselves to more binding and specific regulatory schemes, countries often set binding and specific regulation domestically in order to meet the standards set in international systems.[106] Additionally, due to the amount of black carbon emissions, the legislation of one country or regional system in isolation would not have a large impact on global warming.[107] Finally, such an MEA would be able to most effectively fund the reduction of black carbon agreements because of black carbon's compatibility with a cap-and-trade regulatory approach.

B. The Montreal Protocol

The Montreal Protocol was a diplomatic feat, the first treaty to recognize the precautionary principle in international environmental law, with the negotiators successfully arguing the duty to take action even before scientific research was fully developed due to the potentially dire consequences that waiting could have.[108] Black carbon is, in many ways, similar; the problem of climate change is largely established but discoveries of black carbon's effects are relatively new.[109] Consequently, a similar precautionary approach can potentially be used to argue for the need of international action on black carbon emission reductions, especially in light of the impact black carbon emissions have on human health.[110]

To bolster the Montreal Protocol's chance of success, given scientific progress, the negotiators created a flexible instrument that could be adapted as new research developed.[111] The flexibility of the Protocol was especially important, as early estimates of ozone depletion significantly underestimated the extent of the damage.[112] This would also be of importance in regulating black carbon, as much of the science is relatively new, and the magnitude of black carbon's effects seems still to be discovered.[113] Additionally, the flexibility and super-majority voting of the Montreal Protocol should be emulated, since allowing for adjustments to the Protocol reflecting scientific and technological progress also requires constant reevaluation and revision, which keeps the Protocol relevant and in the forefront of environmental protection.[114]

Trade provisions also contributed to the success of the Montreal Protocol; signatories limited themselves to trading controlled substances only with other signatories.[115] Thus, once the significant producers of the controlled substances signed the Protocol, anyone who wanted to use the substances followed their lead.[116] This facet had a major functional benefit but is difficult to adapt to an MEA on black carbon, as common sources of black carbon are not widely traded.[117] However, certain types of transportation, especially ocean freight shipping and diesel engines, could be adapted to a similar prohibition. As ocean freight shipping is a significant emitter of black carbon and also by nature travels internationally, and diesel engines are also often sold internationally, adapting the Montreal Protocol's prohibition on trade into these areas may be useful.[118] For example, Parties could limit themselves to buying and selling only diesel engines that meet certain efficiency requirements or regulating shipping to require the use of ships meeting proscribed emission standards.[119]

C. The Kyoto Protocol

Unlike the Montreal Protocol, the Kyoto Protocol has been largely ineffective.[120] Like the Montreal Protocol, the Kyoto Protocol provided measurable goals for Parties to meet.[121] However, many States Parties have ignored these standards; due to the principle of differentiated responsibility, developed countries that are often large emitters of GHGs have no obligations, and the United States, one of the largest emitters of GHGs, did not join, leading to limited overall effects.[122]

Potential black carbon instruments would likely face a similar issue, as many developing countries are high emitters of black carbon.[123] To effectively deal with black

105. Chang, *supra* note 10, at 10128; Ramanathan & Carmichael, *supra* note 18, at 221.
106. Bruch, *supra* note 40, at 424-25.
107. *See* Morello, *supra* note 28.
108. Ian Rae, *Saving the Ozone Layer: Why the Montreal Protocol Worked*, The Conversation, Sept. 9, 2012, http://theconversation.com/saving-the-ozone-layer-why-the-montreal-protocol-worked-9249.
109. Press Association, *supra* note 26.
110. WHO, *supra* note 29; Fullerton et al., *supra* note 30, at 845.
111. Rae, *supra* note 108.
112. *Id.*
113. *Compare* Ed Hayward, *Impact of Black Carbon Aerosol on Atmospheric Warming Questioned in First Field Study*, Boston College, Aug. 2012, https://www.bc.edu/offices/pubaf/news/2012-jun-aug/carbon.html, *with* Michael D. Lemonick, *Black Carbon Second Only to CO_2 in Heating the Planet*, Climate Central, Jan. 15, 2013, http://www.climatecentral.org/news/black-carbon-second-only-to-co2-in-heating-the-planet-new-study-15465.
114. Elias Mossos, *The Montreal Protocol and the Difficulty With International Change*, 10 Alb. L. Envtl. Outlook 1, 4, 24 (2005); Montreal Protocol, *supra* note 63, at art. 10.
115. Montreal Protocol, *supra* note 63, at art. 4.
116. Rae, *supra* note 108.
117. This is because many sources of black carbon emissions, such as biomass burning and the burning of crop residue for residential use, are not traded.
118. *See* Adelman's, *International Engines*, http://www.adelmans.com/international-engines (last visited Oct. 12, 2016), for an example of a diesel engine retailer engaged in business internationally; *see also* U.S. EPA, *Black Carbon Diesel Initiative in the Russian Arctic*, http://www.epa.gov/international-cooperation/black-carbon-diesel-initiative-russian-arctic (last visited Oct. 12, 2016).
119. For a discussion on the black carbon effects of diesel engines, particularly those used in international shipping, see *id.*
120. *See* Institut Economique Molinari, Economic Note, The Economic Costs and Ineffectiveness of the Kyoto Protocol 1 (2006), *available at* http://www.institutmolinari.org/IMG/pdf/note20066.pdf.
121. *See* Kyoto Protocol, *supra* note 43, at art. 3; Montreal Protocol, *supra* note 63, at art. 2.
122. Sunstein, *supra* note 64, at 4-5. India and China, in particular, have emitted exponentially greater amounts of GHGs and have no obligations under the Kyoto Protocol. *See id.*
123. Prior to the formation of the Vienna Convention and UNFCCC, the developed world had produced much of the existing pollution but was cutting their emissions drastically, while the pollution in developing countries was growing. Here, the situation is similar but not exact, as the developing world has already outpaced the developed world in terms of black carbon emissions. However, the similarities in the price of reducing emissions, inexpensive in developing countries but potentially cost prohibitive in developed countries, make the emissions trading agreements particularly applicable. *International Emissions Trading*, *supra* note 54.

carbon, developed countries must reduce their emissions alongside developing countries.[124] Historically, developing countries tend to refuse to agree to environmental treaties that impose binding reduction goals on them.[125] To counter this, the proposed MEA should have mechanisms for funding and for the transfer of technology, like the Montreal Protocol.[126]

The Kyoto Protocol's cap-and-trade scheme was based on the principle of differentiated responsibility, effectively setting requirements for developed countries but only suggestions for developing countries.[127] However, many of the countries with no obligations are now the largest producers of GHGs or have rapidly growing emissions.[128] Additionally, the Kyoto Protocol's cap-and-trade program fails to give credits for mitigating measures, such as forest preservation, in its emission reduction scheme.[129] Forests absorb GHGs and their preservation could significantly reduce the amount of carbon dioxide in the atmosphere.[130] Moreover, the CDMs encourage "cream-skimming" carbon-reduction investments, in which carbon emissions, such as methane, are flared, reducing the methane but also not utilizing it as an alternative power source, which would further reduce GHGs and decrease dependence on traditional power sources.[131] This allows developed countries to obtain emissions reduction credits without providing any significant benefit, making the cap-and-trade program merely a cheap way for such countries to buy credits without contributing to any sustainable solutions to the reduction of GHGs.[132]

Further, the Kyoto Protocol does not shift the energy base toward renewable energy.[133] This has caused major problems as the developing world increases its reliance on coal to expand the power grid, resulting in rapidly increasing GHG emissions.[134] This is arguably partly because the cap-and-trade mechanism established by the Kyoto Protocol merely requires a reduction in GHG emissions, but does not regulate renewable power generation technologies, likely due to the increased costs.[135] Not only is the use of renewable energy not required, it is not recognized as an offset because "the emission reduction doesn't occur at the site of the renewable generator [but] in backing out other carbon intensive generation."[136]

D. Applying Lessons From Montreal and Kyoto to a New MEA for Black Carbon

Learning from these lessons, the proposed MEA for black carbon should (1) allow all measures that mitigate the effects of black carbon, (2) ensure that reduction credits from CDMs help shift the energy dependency away from black carbon-emitting sources toward cleaner sources, and (3) give credit for preservation efforts that affect black carbon.

In addition to the regulatory issues, the Kyoto Protocol did not have the support of industry, unlike the Montreal Protocol.[137] It also cost more for countries as a whole than the Montreal Protocol.[138] Further, the public perception of the treaties was noticeably different, arguably affecting industry reception.[139] Media coverage and consumer interest, caused possibly by the visible and dramatic effect of ozone-depleting substances and the hole in the ozone layer together with the fear of skin cancer, spurred industry action with regard to ozone-depleting substances.[140] Additionally, the measures to reduce the use of ozone-depleting substances did not significantly affect customers, especially in terms of consumer costs.[141]

Similarly, a global black carbon instrument arguably has the potential to gain widespread recognition due to its health and climate effects.[142] Specifically, the very concrete and devastating effects of climate change, exemplified for example by the plight of small island nations, may spur action. Small island nations, especially the Maldives, have already been vocal about the effects non-regulation has on their states and livelihoods, with the minister of environment and energy of the Maldives, Thoriq Ibrahim, stating that "[a]s a Small Island Developing State, we face an existential threat from sea level rise. Any effort to rapidly reduce gases that have high Global Warming Power

124. For a more detailed discussion on the sources and amounts of black carbon emissions, see Fullerton et al., *supra* note 30, at 529; Nanda, *supra* note 3, at 526.
125. *See, e.g.*, Emma A. Barry-Pheby, *The Growth of Environmental Justice and Environmental Protection in International Law: In the Context of Regulation of the Arctic's Offshore Oil Industry*, 13 Sustainable Dev. L. & Pol'y (2012), *available at* http://digitalcommons.wcl.american.edu/cgi/viewcontent.cgi?article=1529&context=sdlp.
126. Montreal Protocol, *supra* note 63, at art. 10.
127. Sunstein, *supra* note 64, at 3-4.
128. Duncan Clark, *Which Nations Are Most Responsible for Climate Change?*, The Guardian, Apr. 21, 2011, http://www.theguardian.com/environment/2011/apr/21/countries-responsible-climate-change; UNFCCC, Fact Sheet: The Kyoto Protocol (Feb. 2011), *available at* https://unfccc.int/files/press/backgrounders/application/pdf/fact_sheet_the_kyoto_protocol.pdf.
129. Ferrey, *supra* note 76, at 67.
130. *Id.* at 86-97.
131. Jean-Charles Hourcade & Michael Grubb, *Economic Dimensions of the Kyoto Protocol*, *in* Climate Change and European Leadership: A Sustainable Role for Europe?, 173, 197 (Joyeeta Gupta & Michael Grubb eds., 2000); *see generally Rethinking Offsets*, Carbon Control News, Oct. 9, 2008.
132. Jeffrey Ball, *Kyoto's Caps on Emissions Hit Snag in Marketplace*, Wall St. J., Dec. 3, 2007, at A-1.
133. Ferrey, *supra* note 76, at 69.
134. U.S. Department of Energy, Energy Information Administration, International Energy Outlook 7-8 & fig. 11 (2009) (DOE/EIA-0484 (2009)), *available at* http://arsiv.setav.org/ups/dosya/25025.pdf; Steven Ferrey, *The Missing International Link for Carbon Control*, 22 Electricity J. 17, 19 (2009); Susan Sim, *Overtaking the West: Asia's Teaming Urbanites*, Straites Times (Singapore), Dec. 9, 1996, at A41; Deborah E. Cooper, *The Kyoto Protocol and China: Global Warming's Sleeping Giant*, 11 Geo. Int'l Envtl. L. Rev. 401, 405 (1999).
135. Using renewable technologies is estimated to raise costs of carbon reduction by 400%. *See* Neal Cabral, *The Role of Renewable Portfolio Standards in the Context of a National Carbon Cap-and-Trade Program*, Sustainable Dev. L. & Pol'y 13, 14-15 (2007).
136. Lambert Schneider, Is the CSM Fulfilling Its Environmental and Sustainable Development Objectives? An Evaluation of the CDM and Options for Improvement, Öko-Institut 19, 44-45 (2007).
137. Sunstein, *supra* note 64, at 35-36.
138. *See id.* at 6-7.
139. *See id.* at 11.
140. *See id.*
141. *See id.*
142. *See, e.g.*, discussion *supra* Part I.B., The Effects of Black Carbon Emissions.

is vital for our survival."[143] While the survival of small island nations may not spark action among developed countries per se, the potential number of climate refugees from these nations may have that effect. Media campaigns could highlight both the current health effects and the potential climate change refuges to generate public interest and concern.

IV. Framework Convention on the Regulation of Black Carbon Emissions

In order to save their credibility after decades of inaction regarding climate change, the political community should begin by focusing on short-lived climate pollutants. As noted in the *Lancet*, "[t]he impact of these pollutants on health and global warming is evident, the technology to reduce them already available, and the effect of doing so would be rapidly rewarding."[144] This part will first propose model language for a multilateral black carbon treaty before discussing the main components of the MEA, including standard-setting and cap-and-trade measures, monitoring and research mechanisms, and compliance.

A. Preamble Model Language

Establishing model preamble language is important as it sets out the rationale for the agreement in general, in addition to often establishing its object and purpose.[145] These are often used to help interpret any disputed provisions, and to evaluate the obligations of Parties who have signed but not ratified the agreement.[146]

This language is modeled from several MEAs and sets the intent of the MEA. The language in the preamble should inspire action and a broad agreement from the Parties. Here, the language includes several important components: (1) common concern, (2) differentiated responsibility, and (3) respect for State sovereignty. The components are commonly found, and assuage some of the concerns States typically have in joining treaties.[147]

The Parties to this Protocol,

Acknowledging that change in the earth's climate and the adverse effects are a common concern[148];

Sharing a common concern for the environment and humanity and the adverse impacts of black carbon emissions on these things and *accepting* the principles of differentiated responsibility[149];

Mindful of a duty to act to preserve the environment and to protect human health[150];

Acknowledging the role of human activities in creating conditions leading to global warming and adversely affecting the environment;

Noting that black carbon is one of the most climate-forcing emissions, the lack of existing regulations, and the likelihood of global emissions continuing to grow[151];

Aware that the speed with which black carbon leaves the atmosphere makes reducing black carbon emission one of the fastest ways to slow warming and climate change[152];

Noting the need to utilize fast-acting solutions due to past failures to curb emissions of climate-forcing substances and the increasing emissions globally[153];

Reaffirming the principle of State sovereignty in international cooperation addressing climate change;

Have agreed as follows:

The MEA will then continue by listing the key components agreed to by those signing.

B. Proposals for Key Components of the MEA

This section will discuss the key components of an effective agreement in more detail. They include standard setting and emissions trading, ongoing research and monitoring, and compliance and funding mechanisms.

143. *COP21: Lima Paris Action Agenda, Short-Lived Climate Pollutants Focus Event*, *supra* note 1.
144. *Short-Lived Climate Pollutants: A Focus for Hot Air*, 386 The Lancet 1707, 1707 (2015), *available at* http://www.ccacoalition.org/en/news/short-lived-climate-pollutants-focus-hot-air.
145. *See, e.g.*, Isabelle Buffard & Karl Zemanek, *The "Object and Purpose" of a Treaty: An Enigma?*, 3 Austrian Rev. Int'l & Eur. L. 311 (1998).
146. Vienna Convention, *supra* note 81.
147. *See, e.g.*, UNFCCC, *supra* note 67; Vienna Convention, *supra* note 54; Kyoto Protocol, *supra* note 43; Montreal Protocol, *supra* note 63.
148. UNFCCC, *supra* note 67; *Black Carbon and Its Implications for Climate Change and Public Health*, *supra* note 4.
149. "Common concern" has become a multi-purpose term in international environmental agreements, serving to both unify States and protect sovereignty. *Black Carbon and Its Implications for Climate Change and Public Health*, *supra* note 4; Carrington, *supra* note 4; Nanda, *supra* note 3, at 528.
150. Protocol to the African Charter on Human and Peoples' Rights on the Rights of Women in Africa, art. 18, http://www.achpr.org/instruments/women-protocol/#13; Michael Redclift, Sustainable Development: Exploring the Contradictions (2002), *available at* https://books.google.com/books?hl=en&lr=&id=_vCIAgAAQBAJ&oi=fnd&pg=PP1&dq=right+to+sustainable+development&ots=iH0XO988X7&sig=W1XYABXdGelHAaLr4ISNipUVsmg#v=onepage&q=right%20to%20sustainable%20development&f=false.
151. University of Georgia Skidaway Institute of Oceanography, *Climate Change Likely to Increase Black Carbon Input to the Arctic Ocean*, ScienceDaily, Nov. 30, 2015, http://www.sciencedaily.com/releases/2015/11/151130182247.htm.
152. According to a professor of climate science at the Scripps Institute of Oceanography, Dr. Veerabhadran Ramanathan, reducing black carbon emissions by 50% could result in the delaying of the carbon dioxide's warming effects on the earth by one to two decades. Nanda, *supra* note 3, at 528-29; Press Release, Scripps Institution of Oceanography, Cutting Non-CO_2 Pollutants Can Delay Abrupt Climate Change, Solve "Fast Half" of Climate Problem: Scripps Researchers Among Team Calling for Expansion of Montreal Protocol (Oct. 12, 2009), http://scrippsnews.ucsd.edu/Releases/?releaseID=1028. Language of the purpose is drawn from the UNFCCC; *see generally* UNFCCC, *supra* note 67.
153. UNFCCC, *supra* note 67.

1. Standard Setting and Emissions Trading

Setting a uniform standard for the reduction of black carbon is difficult because black carbon has varying effects depending on its source, location, and the extent of co-pollutants.[154] Therefore, in the proposed MEA, black carbon emissions should be classified based on their source, for example, as resulting from transport, residential use, industry, and agriculture, and possibly by the region where the black carbon is emitted, based on vulnerability.[155] In other words, a value should be assigned for each ton of black carbon emitted in each category, correlating to the warming effect of the emission and the vulnerability of the region where the black carbon was emitted.

For example, as diesel emissions have a greater warming effect than other forms of emissions, one ton of black carbon emissions from diesel engines may be an "8" in a vulnerable region and a "7" in a non-vulnerable area, whereas residential source emissions for the respective areas may be a "7" and a "6."[156] Assigning numbers to the emission units will allow both a fair standard to be set and for a cap-and-trade system to run smoothly once emissions are categorized. The standardization is required so that reduction quotas are uniform and units can be evenly traded.

In addition to assigning values to emissions, values need to be assigned to removal units for actions that remove black carbon from the air,[157] ERUs for reductions obtained through JI projects,[158] and CERs for reductions from CDM projects.[159] Learning from the Kyoto and Montreal Protocols, credit for replacing black carbon-emitting energy sources with more efficient, but still black carbon-emitting energy sources, will be significantly lower than credits for projects that shift energy sources to clean energy.[160]

A cap-and-trade regime is especially important in reducing black carbon emissions because some reduction methods are significantly cheaper than others (such as composting crops instead of burning them, compared to bringing off-road vehicle emissions up to the standards of on-road vehicles), and allowing for emissions trading will arguably make the MEA fiscally viable. It also allows countries and their black carbon emitters to meet their obligations immediately though existing technological solutions, while also developing the technology to meet them in the future, thus allowing constant cost-effective reductions to be made.[161]

Similar to other international environmental agreements, countries would be split into developed and developing countries.[162] The countries in or bordering the most vulnerable regions, such as the Arctic or Alpine regions or areas already suffering from the effects of black carbon, should also form a separate category where emissions have a higher value.[163] As there are vulnerable regions in both developed and developing countries, there would be two subsections to each of the broader categories. Therefore, in effect, these groups would be:

Group A1: Vulnerable Developed Countries
Group A2: Non-vulnerable Developed Countries
Group B1: Vulnerable Developing Countries
Group B2: Non-vulnerable Developing Countries

2. Measuring, Monitoring, and Research

In order to make the MEA effective, it is of vital importance to adopt dynamic and cutting-edge measuring, monitoring, and research approaches and strategies. Selecting between the different approaches requires understanding the options, how they operate, and their benefits and drawbacks.

With regard to measuring methods, one option for measuring black carbon emissions is to consider using an "inhalable" standard that would measure the amount of black carbon particulates able to be inhaled.[164] Because black carbon particulates are so small, this has the potential to have a profound impact and to accurately measure the amount of particulates in the air.[165]

Black carbon can also be measured using an optical test.[166] The optical test has a variety of advantages over the traditional methods; namely, optical tests done using an integrating sphere allow for the measurement of a large number of samples because the measure of spectral absorbance can be measured in a short amount of time.[167]

154. Sims et al., *supra* note 12, at 14.
155. This is because some places, due to feedback, are more vulnerable to black carbon emissions. *See id*. at 31.
156. *See id*. at 43.
157. *International Emissions Trading*, *supra* note 54.
158. *Id*. This can be seen in the Applied Energy Services (AES) forestry project in Guatemala. Here, carbon was sequestered in trees to reduce emissions that resulted from deforestation and to offset the carbon dioxide emissions from an AES coal-fired electric power plant to be built in the United States. The project, if successful, will, at a cost of less than two dollars per ton, reduce atmospheric carbon dioxide by 15.5 million tons. *See* David Hodas, *The Climate Change Convention and Evolving Legal Models of Sustainable Development*, 13 Pace Envtl. L. Rev. 75, 93-94 (1995).
159. *International Emissions Trading*, *supra* note 54.
160. *Id*.
161. For current existing solutions, see discussion *supra* Part I.C., Existing Technology to Reduce Black Carbon Emissions. Future solutions may include increased solar or wind power sources, ways to make diesel engines more efficient, widespread use of electric cars, and others.
162. This facilitates trade and allows for a differentiation of responsibility. *See, e.g.*, European Commission, *supra* note 52; Center for Climate and Energy Solutions, Market Mechanisms: Understanding the Options (April 2015), *available at* http://www.c2es.org/publications/market-mechanisms-understanding-options.
163. United Nations Convention to Combat Desertification, UNCCD Thematic Fact Sheet Series No. 1: Climate Change and Desertification (June 2007), *available at* http://www.unccd.int/Lists/SiteDocumentLibrary/Publications/Desertificationandclimatechange.pdf; *Black Carbon in Arctic Russia*, *supra* note 38. A separate classification system is especially needed for Arctic regions due to the feedback effect of black carbon and warming regarding snow.
164. Nicole A.H. Janssen et al., Health Effects of Black Carbon, WHO Regional Office for Europe 1 (2012), *available at* http://www.euro.who.int/__data/assets/pdf_file/0004/162535/e96541.pdf.
165. Roper, *supra* note 23, at 274.
166. Masahiro Yamaguchi et al., *Optical Method for Measuring Deposition Amount of Black Carbon Particles on Foliar Surface*, 6-4 Asian J. Atmospheric Env't 268, 268 (2012), *available at* http://asianjae.org/download_jnr.php?no=112&PHPSESSID=9b39752b32995b41e0077ae6c9b17057.
167. *Id*. at 269.

Although more research is needed, the optical method, which measures black carbon particles that are deposited on the foliar surface of the forest in order to track black carbon emissions, is a promising simple, fast, and cost-effective technique for field measurements of black carbon.[168]

Lastly, it is also possible to measure the amount of black carbon in precipitation, although this may be difficult in particularly dry areas.[169] While measuring black carbon at the emission source is the most effective means of measuring emissions, it is also technically challenging and can be relatively expensive.[170]

Considering the benefits and drawbacks of all of the measuring technologies discussed above, adopting the optical test as the measuring standard for the MEA would offer the best balance between affordability, availability, technological competence, and accuracy. The main drawback to the inhalable method is its expense, if the optical test proves to be difficult in non-forested areas. This assessment may be changed based on the availability of more recent scientific data and methods, but using the optical method as the starting point for the negotiations would remove some uncertainty as to the technical specifications of the treaty.

Additionally, just as different sources of black carbon emissions have different effects, they also have different best ways to monitor them.[171] In the transportation sector and in industry, for example, emissions can be estimated by monitoring tailpipe emissions while operating a vehicle in standard driving conditions in a laboratory, and multiplying these results by typical vehicle usage in the country.[172] The optical test discussed above or other field tests, meanwhile, are best used for measuring residential- and agricultural-sourced emissions of black carbon.[173]

In order to set standards for reduction, monitor reduction, and trade units of black carbon emissions, Parties need to agree to a measurement system. Generally, black carbon can be measured as Emissions = A × EF - eff, where *A* is the level of activity of a particular source, *EF* is the emission factor (g of black carbon per activity), and *eff* is the removal efficiency of any control equipment used.[174] Open biomass burning is slightly different and can be measured as Emissions = BA × FL × CC × EF.[175] In this equation, *BA* is the burned area (square kilometer (km^2)), *FL* is the available fuel load in kilograms per km^2, *CC* is the combustion completeness faction, and *EF* is the emission factor or the grams of compound emitted per kilogram of dry matter.[176]

Monitoring should also account for mitigating or reduction actions by subtracting the emissions level for a particular activity—cooking in one household on a traditional stove using crop residue, for example—from the emissions level produced by the mitigation or reduction—zero for solar ovens, for example, or a reduced number for a more efficient wood-burning cook-stove.

All of these factors need to be monitored to establish the black carbon emissions of each State Party to the MEA and to determine its reductions of black carbon emissions. As black carbon does not linger in the atmosphere, monitoring should take place throughout the year, or as negotiated by the Parties, and averaged to determine the amount of black carbon emissions.[177]

Ongoing research should include more effective and efficient means of monitoring black carbon emissions. Such research should also focus on creating new ways to reduce black carbon emissions or making existing ways more effective. Taking the Vienna Convention as a guide, the Parties should commit to the following:

> The Parties undertake, as appropriate, to initiate and cooperate in, directly or through competent international bodies, the conduct of research and scientific assessments on[178]:
>
> a. The research on the physical and chemical processes of black carbon emissions;
>
> b. The human health implications of and climatic effects deriving from black carbon emissions;
>
> c. Mechanisms to measure the emissions of black carbon accurately and cost effectively and to monitor their effect on the climate in general and global warming in particular;
>
> d. Substances and methods of combustion that produce black carbon and their unique effects;
>
> e. Alternative substances and technologies; related socioeconomic matters.[179]

These commitments will enable the successful regulation and reduction of black carbon through an MEA.

3. Compliance Mechanisms and Management

The Vienna Convention's prescribed Conference of the Party and secretariat framework should be adopted in this MEA.[180] In addition, the proposed MEA should include the right for private individuals to bring evidence or allegations of failure to meet reduction targets to the governing body.[181] Such measures help to hold governments accountable, provide additional information for the governing body, which would otherwise rely heavily on the State for compliance information, and increase citizen involvement.[182] Additionally, the Multilateral Fund used in

168. *Id.* at 273.
169. *Id.* at 270.
170. Sims et al., *supra* note 12, at 59-60.
171. *Id.* at 60-63.
172. *Id.* at 60.
173. *Id.* at 60-61.
174. *Id.* at 60.
175. *Id.* at 62.
176. *Id.*
177. *See* discussion *supra* Part I., Black Carbon: A Scientific Overview.
178. Vienna Convention, *supra* note 81.
179. *Id.*
180. As the Vienna Convention is a well-performing treaty with enviable results, adopting its governing structure is a better option than attempting to reinvent a governing structure. *See id.* at arts. 6-7.
181. Eisen, *supra* note 44, at 1457-58.
182. *See id.*

the Montreal Protocol should be adapted to this MEA.[183] These measures will help to ensure the effective implementation and management of the MEA.

V. Conclusion

This Comment proposes a framework MEA regulating black carbon based on cap-and-trade, requiring ongoing monitoring and research, and applying the governing body structure of the Montreal Protocol. Regulating black carbon emissions is imperative. The climate-forcing effects of black carbon, combined with its potential to quickly impact global warming, both make it one of the most dangerous and consequential substances to affect the climate and make tackling it one of the most effective ways of combating climate change before it is too late. Taking into account the major health effects on humans, acting on it is also a moral necessity. The technology to greatly reduce black carbon emissions exists and needs only to be implemented globally.

A cap-and-trade-based MEA would prove the most sustainable and effective solution, allowing Parties to choose the most cost-effective way to reduce emissions, leading to quicker results that are both efficient and cost-effective. In the absence of international regulation, countries are unable to effectively work together to reduce their black carbon emissions. As one of the fastest ways to reduce global warming and climate change, black carbon emissions should be regulated using this framework as soon as possible.

183. Montreal Protocol, *supra* note 63, at art. 10; Roberts & Grabiel, *supra* note 90, at 103.