Health & Clean Air newsletter

Spring 2008

Deciding On Human Plunder

> ***As we peer into society's future, we—you and I, and our government—must avoid the impulse to live only for today, plundering, for our own ease and convenience, the precious resources of tomorrow.***
>
> Dwight David Eisenhower
> January 17, 1961[a]

The term "decider" has been tossed about quite a lot lately, principally because of the spirited declaration on April 18, 2006 by President George Bush in protection of his then-embattled Secretary of Defense Donald Rumsfeld. At a press conference in the White House Rose Garden, Bush told reporters, "I hear the voices and I read the front page and I hear the speculation," adding "But I'm the decider, and I decide what's best. And what's best is for Don Rumsfeld to remain as the Secretary of Defense."[1]

It became the stuff of almost instant controversy and ridicule,[2] yet implicit in the statement is a fundamental but too-often unrecognized truth. There are two ways of making decisions: purposefully, or by being a "decider," in Bush's terms; or, by avoiding purposeful outcomes, thus allowing others, or circumstances, to dictate the future. As it is with individual humans, so, too, it is with human soci-

[a] Farewell address by President Dwight D. Eisenhower, January 17, 1961; Final TV Talk 1/17/61 (1), Box 38, Speech Series, Papers of Dwight D. Eisenhower as President, 1953–61, Eisenhower Library; National Archives and Records Administration.

NATIONAL PUBLIC HEALTH WEEK, April 7–13, 2008 is devoted to global warming. The American Public Health Association, the oldest and largest organization of public health professionals in the world, is declaring that "There is a direct connection between climate change and the health of our nation today. Yet few Americans are aware of the very real consequences of climate change on the health of our communities, our families and our children." APHA, "Climate Change: Our Health in the Balance," http://www.nphw.org/nphw08/NPHW_bro.pdf

CLIMATE FORCINGS[1]

Total	**3.05 W/m^2**
"Well mixed" GHGs	2.75
Ozone	0.24
CH4-derived stratospheric H_2O	0.06
Black Carbon	0.43

Earth is now absorbing 0.85 ± 0.15 W/m^2 more solar energy than it radiates to space as heat. Of this, ozone, methane and black carbon currently account for about 0.73 W/m^2.

[1] Source: Hansen, J. et. al. Earth's Energy Imbalance: Confirmation and Implications. Science 3 June 2005: Vol. 308. no. 5727, pp. 1431–1435

ety. Confronted now with arguably the gravest threat to its survival in recorded history, humanity is, on the one hand, allowing sheer inertia to dictate the outcome, while on the other deciding affirmatively, but wrongly. Rather than acting in concert to reduce emissions of pollutants that could deliver cooling benefits within a few days to a few years, while at the same time avoiding hundreds of thousands of deaths and millions of illnesses, nations and their citizens are instead focusing on pollutants whose concentrations will not fall for hundreds to thousands of years.

The Earth is, in the words of one prominent climatologist, "perilously close to dramatic climate change that could run out of our control."[3]

HEALTH & CLEAN AIR newsletter

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Carbon dioxide: Carbon dioxide (CO_2), created when carbon rich fuels like coal, oil, gasoline and diesel are burned, is considered the most dangerous of the greenhouse gases, mostly because there is an immense amount of it, and billions of sources. But other greenhouse pollutants are also important—indeed cutting them is crucial if humanity is to survive long enough to slow CO_2 emissions and keep climate within or near the range of the past million years.[4]

Methane: Many consider the most important of the non-CO_2 greenhouse gas pollutants to be methane (CH_4), or natural gas. Emitted from coal mines, oil and gas wells and refineries and agricultural operations,[5] methane poses a double threat: it is not only a greenhouse gas in its own right, but also forms two other global warming pollutants, tropospheric ozone, or smog—the third most powerful warming agent—and water vapor.

Black carbon: Largely overlooked until recently, more and more studies suggest that black carbon, or soot, may be a much more powerful—and, fortunately, easily eliminated—cause of global warming than previously believed. Very recently, researchers V. Ramanathan, an atmospheric scientist at the Scripps Institution of Oceanography, and Greg Carmichael, a chemical engineer at the University of Iowa, concluded that fine particles of carbon—produced by cooking fires, burning vegetation, industrial processes and diesel engines—could be up to 55 percent as potent as CO_2 in warming the planet.[6] If correct, that would place the warming effect of soot at two to four times more powerful than estimated by the recent report of the Intergovernmental Panel on Climate Change and ahead of other major greenhouse gases, including methane, chlorofluorocarbons, nitrous oxide and tropospheric ozone. Their conclusions were based on examination of recent data collected by satellites, aircraft and measurements at the Earth's surface.

Black carbon, like smog, has a disproportionate impact on snow and ice, especially in the Arctic. Two other pollutants of major importance are carbon monoxide (CO) and oxides of nitrogen (NO_X), for reasons explained later. The official estimates of methane's contribution to global warming place it as about 15 percent, but some scientists conclude that it is roughly twice that amount, up to a third of all climate warming between the 1750s and today.[7]

Outside California, there is little recognition that global warming and the deadly pollutants ozone and black carbon are coupled—and avoidable—threats. Even within the state, little action has been taken to implement the sweeping changes that could result from the "California Suite" of laws enacted in 2006. For that reason, this Newsletter is devoted to a closer examination of black carbon and ozone.

THE LIGHT-ABSORBING CARBONS

For centuries, when breathers complained of air pollution what they almost universally had in mind was soot, the black material in smoke from wood and coal fires. It was nasty enough in 13th century England for the King to ban the burning of so-called sea coal, the dirtiest sort of that fuel, and enforce the prohibition through capital punishment.[8]

Formed when coal, oil, wood and other fuels are burned incompletely[9], the darkest component of soot, black carbon (BC), has a relatively short lifetime in the atmosphere—by some estimates from six to ten days[10]—because it is washed out by rain or other precipitation into or onto soil, oceans, snow and ice. Black carbon is extremely resistant to breakdown by heat, chemicals or organisms,[11] so it can reside for hundreds to thousands of years, acting as an enormous sink for carbon.[12] It is found virtually everywhere, even at remote and seemingly pristine islands.[13] Between 35 to 80 percent of total carbon in the air is in the submicron, or exceedingly fine, fraction, which is the most dangerous from a health perspective.

For one specific type of black carbon, diesel soot, 99.5 percent of the particles are either ultrafine (less than one-tenth of a micron (millionth of a meter) or fine (0.1-2.0 microns).[15]

Fine particles of carbon—produced by cooking fires, burning vegetation, industrial processes and diesel engines—could be up to 55% as potent as CO_2 in warming the planet.

V. Ramanathan and Greg Carmichael

Most pollutants cause global warming by trapping heat from the Earth's surface, preventing it from being radiated into space. Black carbon causes warming by darkening things—droplets of cloud water, for example—and thus causing them to absorb incoming sunlight.[16, 17] The effect is particularly pronounced in snowy and icy environments, including the polar regions of the south,[18] as well as the north, where deposition in the early 20th century was so great that the warming effect was roughly 3 watts per square meter, or eight times the typical pre-industrial level.[19] Some climatologists calculate that black soot may be responsible for 25 percent of observed global warming over the past century.[20]

Some pollutants, especially sulfates, formed when sulfur-rich fuels like coal and oil are burned, have a cooling effect. In some regions they overwhelm the warming caused by greenhouse pollutants to cause cooling, which alters regional or local scale environments. The largest total elemental (EC) and organic carbon (OC) emissions occur over China, but the largest OC emission per unit surface area occur over India.[21] Increased summer flooding in south China, drought in north China, and moderate cooling in China and India are attributed by scientists to the mix of warming and cooling pollutants.

Delving into the literature can be a confusing and frustrating exercise because there is a wide variety of carbons—black, brown, elemental, apparent, and evident, to name but five[b]—and they can have different properties in air, water, soil, snow and ice.[23] Then, there are the pollutants that contain carbon—diesel exhaust, aircraft and power plant plumes, and smouldering fires, to again name but a few.[24]

That black and other carbons cause global warming is generally accepted: Chapter 2 of the Fourth Assessment Report (FAR) of the Intergovernmental Panel on Climate Change (IPCC)[25] says fossil-fuel black carbon causes "forcing," or warming, of +0.2 ± 0.1 watts per square meter (W/m^2) The estimate expressly excludes semi-direct effects and the effect on snow or sea ice. The IPCC also estimates that black carbon from biomass burning causes another +0.2 W/m^2 for total of +0.4.[26]

[b] The term "elemental" carbon is sometimes used interchangeably with BC, though they are in reality different. Elemental carbon is pure carbon, but black carbons are impure forms of the element produced by incomplete combustion of fossil fuels or biomass. They are highly variable in makeup and are widely distributed over the globe. Black carbons are usually coated with organic matter, and the ratio of the two depends on the temperature of combustion: high temperature favors creation of BC, while lower temperature yields higher levels of organic matter. J. Goldberg, *Black Carbon in the Environment: Properties and Distribution*, (New York, 1985), Wiley & Sons. See also Mark Z. Jacobson, *Atmospheric Pollution: history, science and regulation*, Cambridge University Press, Cambridge, England (2002), p. 124.

If sources of (methane) and (ozone) precursors were reduced in the future, the change in climate forcing by (non-carbon dioxide [CO_2] Greenhouse Gases) in the next 50 years could be zero. Combined with a reduction of black carbon emissions and plausible success in slowing CO_2, this reduction . . . could lead to a decline in the rate of global warming, reducing the danger of dramatic climate change.

James Hansen
NASA Goddard Institute for Space Studies

Some scientists believe the IPCC range is a substantial under-estimate. Several studies have calculated that the forcing from all forms of soot ranges from 0.5 to 1 W/m^2,[27] and there is a strong and growing consensus that these pollutants may contribute even more substantially to global warming.[28] Indeed, some are convinced that black carbon is second only to carbon dioxide as a cause of global warming,[29] and globally, BC is estimated to have a warming impact at least comparable to methane, or natural gas, second only to the effect of carbon dioxide, the most powerful warming agent.[30]

Recently scientists determined that there is another light-absorbing carbon that is not black, but brown (C_{brown}).[31] Brown carbon is mainly organic material that is strongly light-absorbing or soot coated with such material. These, together with soil dust and absorbing gases form massive, continent-sized "brown clouds," a witches brews of pollution. They start in heavily populated regions with millions of sources—cars, trucks and powerplants in cities like Los Angeles, or cook stoves and fires in places like Beijing or Mumbai. The clouds travel thousands of miles, crossing the Atlantic and Pacific Oceans, moving over mountain ranges and into distant and seemingly pristine regions.[32]

One recent study in which three unmanned aerial drones overflew the Indian Ocean in a total of 18 missions to measure pollutant concentrations and temperature variations provided real world confirmation of the warming effects. The aerial vehicles were vertically stacked between 0.5 and 3 kilometers (0.3 to 1.9 miles) and with horizontal separation measured in tens of meters—meaning the time separation was about ten seconds. At the end of the measurement campaign, researchers concluded that the pollutant cloud boosted heating in the lower atmosphere by about 50 percent, an amount, they said that might "be sufficient to account for the observed retreat of the Himalayan glaciers."[33]

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In addition to causing warming throughout the globe, black carbon also has disproportionate impacts in snow and ice covered regions.[34] Unpolluted snow and ice reflect sunlight, but soot absorbs solar radiation, increasing warming and melting, which, in turn, exposes dark soils and ocean waters that further increase warming. Using "supercomputers" to run a highly sophisticated model, researchers at the National Atmospheric and Space Administration (NASA) calculated that roughly 25 percent of global warming from 1880 was carbon-caused. The largest warming effects occurred when there was heavy snow cover and sufficient sunlight.[35]

Another team also examined the impact of black carbon on Arctic snow and ice, concluding that it was contributing roughly 0.5 watts per square meter, and was at its maximum just as snow melt is starting. They concluded that the black carbon had a forcing effect at least triple that of carbon dioxide.[36]

Emissions inventories,[37] climate models,[38] meteorological back-trajectories,[39] and in situ samples[40] confirm that most Arctic BC originates as fuel combustion by-products, primarily from the northern hemisphere mid-latitudes, followed by Asia in importance. Roughly one-fourth of global emissions are believed to originate in China, with about 83 percent of that principally from residential combustion of coal and biofuels.[41]

Serious Illness and Death

Studies of fine particles have been entering the literature for almost two decades, inventorying the wide range of illnesses and, ultimately, deaths they cause.[42] Recently, studies have begun discriminating between particles based on their composition, and some are now attempting to assess the impacts of black carbon, often used as a proxy for traffic density or proximity because much of it is emitted by vehicles, especially diesels.[43] Although it is clear that black carbon has effects similar to other fine particles, it does not appear at present to be the primary driver. However, the associations between fine particles and both death and illness hold up with black carbon as well.

Given the chemicals found in engine exhaust, it should come as no surprise that breathing it can cause serious injury. In one analysis, researchers determined that diesel exhaust contained tin (Sn), manganese (Mn), iron (Fe), zinc (Zn), chromium (Cr), magnesium (Mg), phosphorus (P), calcium (Ca), chromium (Cr), molybdnum (Mo), barium (Ba), sodium (Na), sulfur (S) and silicon (Si). When black carbon or coal dust are instilled in the lungs of rats, measures of inflammation climb.[44] One analyst found that carbon "nanoparticles" pass directly through the lung and into the blood.[45]

Children are particularly at risk from black carbon

- A 10-year study of 1,759 children, found a strong association between reduced annual growth in the amount of air the children could forcibly exhale in one second, (FEV1) and exposures to elemental carbon.[46]
- When 202 Boston children were enrolled at birth between 1986 and 2001, then tested at an average age of 9.6 years, higher levels of black carbon predicted decreased cognitive function in vocabulary, intelligence and other assessments of verbal and nonverbal intelligence and memory constructs.[47]
- A 2004 study involving 1,109 third through fifth graders in Oakland, California, a relatively low-polluted area, found "modest but significant" increases in bronchitis symptoms and physician-diagnosed asthma tied to black carbon levels.[48]

A sobering study in the United Kingdom leaves little room for doubt about the toxic nature of black carbon.

Researchers at the University of Leicester assessed the carbon content of macrophages, or white blood cells, found in the airways of 64 children. They found that as the PM_{10} content of the air rose by 1.0 micrograms per cubic meter (ug/m3) , the carbon content of airway macrophages increased 0.10 ug/m3; and, that an increase in macrophage carbon content of 1.0 ug/m3 was associated with a 17 percent reduction in FEV1 (the volume of air that can be forcibly exhaled in one second). Forced vital capacity, the amount of air that can be exhaled forcibly from a full lung, dropped 34.7 percent. The researchers' concluded that "there is a dose-dependent inverse association between the carbon content of airway macrophages and lung function in children."[c]

In an editorial accompanying the article, Dr. James Gauderman of the University of Southern California School of Medicine, who has done much of the seminal work in the field of air pollution's impact on children, explained the significance of the study's findings:

> *Why should we care about lung function in children? The lungs develop steadily throughout childhood, with peak function occurring between 20 and 25 years of age. Lung function then remains stable for as long as 10 years before beginning to decline with increasing age. Superimposed on these lifetime patterns may be acute, disease-related episodes of reversible airflow obstruction. For a given degree of obstruction, the severity of symptoms may depend on the baseline function that is carried throughout life. Reduced lung function later in life has been described as second only to the exposure to tobacco smoke as a risk factor for death.*[d]

Some of the children's exposure is in school buses. In southern California, investigators examined children riding in diesel-engined buses. They found that the exposures of school bus riders "were many times greater" than for the population at large.[49]

[c] Kulkarni, N., Pierse, N., Rushton, L. & Grigg, J. Carbon in Airway Macrophages and Lung Function in Children, p. 21, *N Engl J Med* 355:1 July 6, 2006.

[d] Gauderman, WJ, Air Pollution and Children-An Unhealthy Mix, p. 78, *N Engl J Med* 355:1 July 6, 2006.

Adults placed at cardiac risk by black carbon

Adults are by no means unaffected by black carbon. On the contrary, studies show heart disease and death are linked to BC.

- In Boston, 203 patients with implanted heart defibrillators were followed between 1995 and 2002 for an average of 3.1 years. The implanted devices were checked for evidence of ventricular arrhythmias, which were then compared with air pollution records. They found that after an arrhythmia, the risk of another increased significantly with levels of pollution, including black carbon.[50] A 2000 study of defibrillator discharge interventions among 100 adult patients reached similar conclusions.[51]
- In still another Boston study, this of 269 elderly residents equipped with Holter monitors, an elevated BC level was associated with ST-segment depression, a measure of the probability and severity of coronary artery disease.[52] In elderly subjects in Boston, BC increases were associated with a decrease in flow-mediated vascular reactivity,[53] which can signal atherosclerosis.[54] Black carbon levels are also linked to an increase in exhaled nitric oxide, a sign of lung inflammation.[55]
- A Dutch study estimated pollution exposure at the home addresses of 5,000 participants and found that living near a major road, a measure of BC exposure, was associated with cardiopulmonary mortality.[56]
- A number of studies have also found a linkage between exposure to traffic-related or other fine particles and heart attack.[57] Peters and coworkers interviewed heart attack victims in the Intensive Care Unit to discover what they were doing immediately preceding the onset of symptoms, and what they were doing at the same time of day on the previous few days. They found that subjects were 2.9 times more likely to be in traffic the hour preceding their heart attack than the same hour of the day before.[58]

The horrific toll of indoor black carbon in developing nations

The dominant source of black carbon in urban areas is and developed nations is combustion in engines, especially diesels. Elsewhere, however, the burning of biomass is the culprit. This may be of crop resides in agricultural regions or fireplaces and woodstoves in rural areas. In less developed nations, however, the principal cause of black smoke is cooking and heating, which take a horrific toll on human health.

Throughout much of the developing world, cooking is done on primitive stoves in small rooms that frequently lack adequate ventilation. In one survey, 60 percent of households used a three-stone hearth or a U-shaped mud-plastered hearth known as a chulha. Only 28 percent of kitchens had chimneys, and only 32 percent had windows for ventilation. Under these circumstances, exposure to indoor air pollutants is unavoidable.[59]

The pollution burden falls most heavily on women, who do most of the cooking, and on infants and children, who spend a great deal of time near their mothers and are highly susceptible to its damages. Acute respiratory infections (ARI) are the single most important cause of mortality in children under age 5,[60] and as indoor burning of biomass increases, so do ARIs. This has been documented generally,[61] as well as in the specific nations of South Africa,[62] Zimbabwe,[63] Nigeria,[64] Tanzania,[65] Gambia,[66, 67] Brazil,[68] Argentina,[69] and Nepal,[70] to name but a few. Indoor wood smoke is also associated with low birth weight[71] as well as infant mortality.[72]

By one estimate, the number of deaths because of indoor air pollution in India alone is as much as 400,000 per year.[73] Globally, it is estimated to account for two million deaths in developing countries and 4 percent of the world's disease burden.[74] Evidence also exists of associations with increased infant and perinatal mortality, pulmonary tuberculosis, nasopharyngeal and laryngeal cancer, cataract, and, specifically in respect of the use of coal, with lung cancer.[75]

Diesel Engines

The adverse health effects of one specific source of black carbon, diesel engines, are well established. The hazards range from light-headedness, cough and nausea to lung cancer.[76] In a recent study 20 men with a history of heart attack were exposed while exercising to either filtered air or diluted diesel exhaust at a level comparable to one that would be routinely encountered in traffic. Breathing diesel exhaust triggered myocardial ischemia, or reduced blood supply to the heart, as well as declines in endogenous fibrinolytic capacity,[77] a symptom of chronic, low-grade inflamation thought to be an important contributor to heart attacks.[78] One investigator concluded that the study showed that the relationship between diesel fumes and heart troubles "is indeed a causal relationship."[79]

GLOBAL OZONE

To most, ozone[e] is smog, the pollutant that chokes virtually all of the world's cities and, when inhaled, causes sharp pain. But ozone is more—much more: a pollutant that causes asthma,[80] reduces crop yields,[81] kills forests[82] and, both directly and indirectly, unnaturally warms the planet. It also is associated with death in humans.[83]

Formation and health damages of ozone

Tropospheric ozone is not directly emitted, but is instead formed chemically from methane, other hydrocarbons, carbon monoxide and nitrogen oxides. All of these pollutants influence the climate, most by causing warming either directly or indirectly. In addition, the transport of ozone into the Arctic during spring, winter and fall, greatly increases warming and melting there. By one calculation, the impact of these non-CO_2 warming gases in the Arctic is between 2.5 and 5 times that of carbon dioxide.[84]

Ozone is three oxygen atoms linked together so weakly that the molecule easily disintegrates into a two-atom oxygen molecule and a single oxygen atom that instantly reacts with organic matter, whether it's a bacterium in water or the cell wall of a lung. It has been known for two decades that at levels routinely encountered in most American cities, ozone burns through cell walls in lungs and airways. Tissues redden and swell.[85] Cellular fluid seeps into the lungs[86, 87, 88, 89, 90] and over time their elasticity drops.[91, 92, 93, 94, 95, 96]

Concentrations of free, or background, ozone have been increasing for roughly at least a century. Some studies conclude that levels have approximately doubled, while others have found a five-fold increase.

Neutrophils, specialized white blood cells that are the body's first line of defense against bacteria, viruses, molds and other threats, rush to the lung's aid, but they too are stunned by the ozone.[97, 98] Susceptibility to bacterial infections increases, possibly because ciliated cells that normally expel foreign particles and organisms have been killed and replaced by thicker, stiffer, non-ciliated cells.[99, 100] Scars and lesions form in the airways.[101]

Children who exercise—that is, play three or more sports—in areas with high ozone levels develop asthma.[102] Finally, breathing ozone can be fatal,[103] a finding based on dozens of studies in places ranging from Rotterdam, Holland[104] to St. Johns, Canada,[105] as well as 95 U.S. Cities,[106] and 23 European cities.[107]

Injury to plants

Because ozone is so reactive, it has much the same effect on plant tissue as in humans. It enters the stomata, the tiny pores through which plants take up carbon dioxide, then once inside the leaf destroys cells.[108] The aggregate impact of these injuries is to substantially reduce the growth of a wide range of plants, including crops as well as trees. One group has concluded that increasing levels of tropospheric ozone under a business-as-usual scenario could cut global crop yields by nearly 40 percent worldwide by 2100.[109] Another group examined the indirect contribution that widespread ozone injury might have by reducing the ability of plants to take up and fix carbon dioxide. Carbon dioxide, an essential nutrient for plants, is removed by them and sequestered in their tissues. Ozone, however, by causing "significant suppression" of plant growth would lessen the ability of plants to sequester CO_2, indirectly causing global warming. Indeed, the indirect contribution to warming would greater than the direct impact.[110]

Ozone-caused warming

Ozone is created in the lower air by complex reactions between a variety of others pollutants, especially methane, oxides of nitrogen and carbon monoxide.[111] All of these pollutants have extremely short lifetimes in the air, sometimes only minutes,

[e] Ozone is the pollutant measured for regulatory purposes, but there are many oxidants. See Finlayson-Pitts, B.J. & Pitts, J.N. *Chemistry of the Upper and Lower Atmosphere* (Elsevier, 1999).

so their concentrations vary markedly from place to place,[112] but in the aggregate they account for a substantial fraction of current warming. Ozone traps heat being radiated from the Earth's surface that otherwise would escape into space, increasing global temperature by 0.25 to 0.65 watts per square meter, according to the IPCC.[113]

In addition to its global impact, ozone also causes warming in the Arctic, principally in the non-summer seasons. During summer, sunlight and heat accelerate atmospheric reactions that destroy ozone, preventing it from persisting long enough to be transported from mid-latitudes to the Arctic. But in the cooler temperatures of the fall, winter, and spring, ozone pollution survives long enough to be blown into the frigid regions of Alaska and elsewhere in the Arctic, where it causes 0.4° C to 0.5° C degrees warming there.[114] One team of investigators concluded that traffic in Europe alone could account for 12 percent of the ozone in the Arctic and remote maritime regions during July; and, in January, 15 percent in the Arctic and 8 percent elsewhere.[115]

Other studies conclude that if traffic-related pollution in all regions of the world were to reach the same per capita levels as in Europe and in the United States, ozone levels in south Asia would essentially double, rising by 30 to 50 parts per billion. Warming due to ozone from vehicles would jump to 0.27 watts per square meter (W/m^2).[116] That compares to the IPCC 2007 estimate of ozone's contribution to global warming of 0.25 to 0.65 watts per square meter.[117] Some believe the IPCC's estimate is conservative and estimate that ozone accounts for about 15 percent of total global warming.[118]

Concentrations of free, or background, ozone have been increasing for roughly at least a century. Some studies conclude that levels have approximately doubled,[120] while others have found a five-fold increase.[121] Increases have also been found in Bavaria, Germany,[122] Ahmedabad, India,[123] and the tropical Pacific region of South America[124] to name but a few. Levels are currently increasing faster than in the past and are projected to continue rising unless action is taken to reduce precursors.[125]

Importance of methane

One ozone precursor, methane, is of special importance. According to the IPCC, methane is the second largest human-made contributor to global warming. Emitted from coal mines, rice paddies, oil and gas operations and landfills to name but a few, methane is also the principal cause of ozone found outside industrialized areas. Methane plus the smog that it forms account for perhaps one-third or more of current global warming.

The Hydroxyl radical

Although methane is directly emitted by a wide range of sources, its concentration in the air is greatly influenced by another constituent of the atmosphere, the hydroxyl radical. It is, in turn, influenced by carbon monoxide.

The hydroxyl radical (OH), often called the atmosphere's "cleansing agent," because it reacts with and destroys other pollutants, ranging from hydrogen sulfide (that's the rotten egg smell near some refineries) to methane.[126] The hydroxyl is one of three principal oxidants in the lower atmosphere. The others are ozone and a by-product of ozone's destruction by sunlight, hydrogen peroxide (H_2O_2). A number of critical atmospheric chemical reactions depend on the earth's "oxidizing capacity," which is essentially the global burden of these oxidants, including the destruction of methane and other organic compounds.[127]

A "healthy" level of the hydroxyl radical keeps in check atmospheric concentrations of many potent greenhouse gases such as methane and the hydrochlorofluorocarbons (HCFCs). Other pollutants also react with and destroy the OH radical, including carbon monoxide. With fewer radicals available, the oxidation process slows, effectively increasing the warming of greenhouse gases such as methane and HCFCs—and this is exactly what has happened.

If we could somehow stop emitting black carbon today, it would be gone from the atmosphere in a week or two.

Globally, hydroxyl radical levels in the atmosphere have dropped dramatically because of carbon monoxide destruction. This, in turn, has raised the mean lifetimes of methane and methyl chloroform by 1.3 years and 7 months, respectively, to 8.9 and 4.8 years.[128] In effect, this increases the warming due to methane by roughly 14 percent and methyl chloroform by 17 percent.

POLLUTION SOURCES

Black and other carbons

In cities, the dominant sources of black carbon are diesel engines. When investigators measured emissions in the Caldecott Tunnel in the San Francisco Bay Area during the summer of 1996, diesel soot dwarfed the contribution from cars and light trucks.[129] In Europe, investigators used a unique 40-year record of 150 urban and rural stations in the "Black Smoke and SO_2 Network" of Great Britain to calculate current black carbon emissions. They concluded that BC levels in the UK were roughly the same as those in western and central Europe and that inventories being used by governments understated emissions by about a factor of two, with diesels being the principal source.[130] "The results imply," they reported "that there is the potential for improved technology to achieve large reduction of global ambient BC."[131]

Arctic warming and melting has already opened the famed Northwest Passage for the first time in recorded history.[132] As the Arctic becomes increasingly ice free, shipping traffic is projected to increase and, with it, levels of air pollution. Ozone may rise to levels of industrialized regions.[133] Black carbon emissions will also increase dramatically because cargo ships burn bunker fuel, which is extraordinarily high in carbon, in two-or four-stroke diesel engines.

Humanity's extraordinary opportunity

The short lifetimes of black carbon, as well as methane, ozone and ozone precursors, provide a window of opportunity for humanity. In the words of one scientist, "if we could somehow stop emitting black carbon today, it would be gone from the atmosphere in a week or two."[134] In the words of another, "Control of methane emissions turns out to be a more powerful lever to control global warming than would be anticipated,"[135] a view supported by others.[136]

Ozone

There can be no doubt that reducing emissions of its precursors will also decrease concentrations of ozone.[137] Similarly, reducing carbon monoxide emissions will free hydroxyl radicals that would otherwise be scavenged to destroy methane.[138] One analysis has concluded that full application of today's emissions control technologies would reduce ozone below the levels experienced in the 1990s and switch their effect from net warming to net cooling.[139]

Black carbon

The combined emissions from wood, diesel, and coal represent more than 75 percent of the total global black carbon emissions.[140] Reducing emissions of black and other carbons is relatively straightforward. Diesel cars, trucks and buses can be fitted with trap oxidizers, which are devices that capture particles and burn them.[141] The same can be done with very large diesels, such as those found on ships.[142] Emissions from jet aircraft would drop sharply from replacing older aircraft with newer ones.[143]

Similarly, in China, which accounts for roughly one-quarter of the world's black carbon emissions, the dominant sources are neither vehicles nor electricity generating plants but instead indoor cooking and heating with coal or biomass. These uses account for roughly 83 percent of China's BC emissions, and they could virtually be eliminated by simply substituting coal briquettes or natural gas for raw coal, as well as some other measures.[144]

In the United States burning wood in fireplaces and stoves is also a major source of black carbon. Emissions could be cut 49 to 69 percent by replacing old stoves with newer ones and switching others to natural gas.[145] This would not only provide almost immediate cooling benefits, but reduce annual air-pollution-related deaths in the United States by 2,000.[146]

CONCLUSIONS

It is no overstatement that humanity could save the climate future and hundreds of thousands of lives by reducing black carbon as well as methane and other ozone precursors. California has launched a program to do exactly that, but whether the laws will be implemented as written is, at present, highly uncertain. Elsewhere, advocates and officials seem utterly unaware of the threat posed by global warming to human survival and the urgent need to slow global warming by reducing short-lived pollutants that cause global warming.

The need to reduce emissions presents the world with a unique opportunity. On one hand, developed nations are the largest sources of carbon dioxide, with the United States accounting for roughly 25 percent of the global total, for example. On the other hand developing nations are the largest sources of emissions of black carbon, with China accounting for roughly 25 percent of the global total.

While the reluctance of China, India and other developing nations to embrace substantial near-term cuts in emissions of carbon dioxide is understandable, reducing emissions of black and other carbons, as well as ozone precursors, would save the lives of their own citizens. Similarly, reductions of carbon dioxide by developed nations would provide the impetus for the development and commercialization of pollution-free technologies based on sunlight and wind power, which can then be marketed globally. It could be a win-win proposition for developed and developing nations alike. Otherwise, it can also be—indeed, will without doubt be—a lose-lose proposition.

Citations available at www.healthandcleanair.org

by David V. Bates, CM, MD, FRCP, FRCPC, FACP, FRSC, (Deceased)

From the late David Bates' 1997 book, Five Minutes Into the "Eroica"

On Research

I believe that when the full history of the era through which I have lived, comes to be written, it will be the advances in medical science—which have benefitted both affluent and third world countries—that will be considered to be one of the main positive achievements; beside them, the record of the politicians seems to me to be meager and uneven.

However, for most practicing physicians, research is an arcane pursuit and far from their interests. Certainly research requires different qualities from those that characterize the successful practitioner. In practice, emphasis on knowledge or the appeal to experience easily becomes autocratic; research generates a scientific scepticism that values opinion for what it is, but sets limits on its authority.

Research consists in making new paths—the painstaking labor that requires stone removal in one place, and the addition of earth in another—where before there was none. Once a path is made we can stroll along it without giving much thought to the labor that went into it.

It is the role of science in medicine not only to study the basic mechanisms of disease and of normal human physiology, but also to look for associations between lifestyle and disease occurrence. Some, fearful that their assumptions may be shown to be foolish, are frightened by research, and favor a static world in which everything that is going to be known, has already been discovered. Applied research, such as that in epidemiology, is very likely to upset firmly held opinions—and hence is often seen as politically undesirable. It may reveal that there are twice as many surgical procedures (tonsillectomy or hysterectomy) in one population as in another, both in the same country. It may reveal that air pollution is responsible for human morbidity when the politicians, and polluters, have been claiming that no risk to health exists.

Nothing replaces the excitement of the first realization that something important has been achieved in the laboratory. I have enjoyed this a number of times—most recently in analyzing the results of data on hospital emergency visits in Vancouver—but before this in looking at the first data on radioactive xenon distribution over the lung, and on diffusing capacity in a variety of clinical conditions. I feel that I have been very privileged to have experienced these moments.

It is difficult to predict the direction from which important new knowledge may come. My teachers would have been astonished to be told that genetics would come to play an important role in medicine, or that artificial hips would be implanted. It is one of the problems faced by health services that they must be able to be flexible, adopting new advances and being able to fund them when these offer major improvements in what can be done for the patient.

Ronald Christie once remarked that in moving from Edinburgh to The Rockefeller Institute in New York in the 1920's, he moved from an environment in which what was valued was knowledge, into one where what was valued was creativity. It is a difficult transition. Ronald's research on Galen and Erasistratus indicated that the dichotomy—and even hostility—between the two outlooks goes back as far as the roots of medicine can be traced.

What is often forgotten, is that everything a doctor uses, has been developed by virtue of someone's exploration. Some physicians often speak as if their diagnostic tools or medications are somehow a 'given'; as if their introduction into medicine had never been opposed by their conservative colleagues. Laennec was ridiculed for the introduction of the stethoscope; x-rays were only slowly adopted in Britain; and I can recall one of the pediatricians at Bart's saying that no patient of his would ever have a cardiac catheterization.

The identification of an important question requires a background knowledge of the subject that must go back many years—this is what the research director supplies. Getting ideas as to how a problem might be tackled is something that comes when the mind is allowed to worry at a problem; it is as likely, or more likely, to come to a mind free of assumptions—which is why the important insight may come to the graduate student rather than to the research director. It is also why freedom to pursue ideas is an essential ingredient of researchlikely, or more likely, to come to a mind free of assumptions—which is why the important insight may come to the graduate student rather than to the research director. It is also why freedom to pursue ideas is an essential ingredient of research.

Worth Noting

The poet George Santayana's cautioned that "Those who cannot remember the past are condemned to repeat it."[a] His words are worth remembering, for today the world may stand at the brink of repeating the events of 80 years ago—events that arguably led to the greatest public health catastrophe of the 20th century, one that could and should have been prevented. In both instances, what lies at the heart of the matter is a gasoline additive.

In 1928, DuPont researcher Thomas Midgely[1] developed an additive for gasoline to eliminate "knock" in gasoline engines—the loud pinging and rapping that occurs when the fuel explodes prematurely in a part of the cylinder distant from the spark plug. Within a few years, the additive, tetraethyl lead (TEL), marketed as "Ethyl" by the corporation of the same name, was in such widespread use that it would ultimately contaminate the planet's entire surface and every living thing on it.[2, 3]

Lead is potentially toxic wherever it is found, and it is found everywhere.[4] Ethyl has now been banned by virtually all of the world's nations.[5] This is in part because it destroys the intelligence of children and renders them social misfits, but also because it poisons irreparably the pollution control devices on cars, rendering them useless.[6]

Today, as the TEL market approaches the vanishing point, the same company that developed and marketed it is now attempting–so far with considerable success—to shift the world's gasoline, and those who breathe its fumes, into reliance on another additive, methylcyclopentadienyl manganese tricarbonyl (MMT). The parallels between then and now, and between the two additives, are remarkable:

- The chemicals were developed by the same company: Ethyl, for the same purpose: to boost octane in gasoline.
- Each is based on a heavy metal: Ethyl on lead, MMT on manganese.
- Each metal is a powerful neurotoxin: acute lead poisoning's symptoms include declines in manual dexterity, as well as anemia, neurological disturbances including headache, irritability, lethargy, convulsions, muscle weakness, tremors and paralysis; "manganese madness" is characterized by hallucinations, irritability and aggressiveness, tremors, shuffling gait and weakness.
- Each metal causes diseases of the nervous system that can be, and often are, fatal: occupational exposure to lead is associated with development of Parkinson's disease as well as amyotrophic lateral sclerosis (ALS), or Lou Gehrig's disease; workplace exposure to manganese is associated with development of Parkinson's disease.
- When Ethyl was first marketed, the dangers of low level exposures were discounted: streets would be "so free from lead that it will be impossible to detect it." Today the makers of MMT contend that tea contains more manganese than petrol with MMT[7] and that levels in the air would be so vanishingly small that no injury would occur.[8]
- The corporation that developed the lead additive and marketed it throughout the world was Ethyl, then owned by DuPont and Standard Oil. The company that developed and is marketing MMT throughout the world today is Ethyl (though its name has changed to Acton).
- It is known today with absolute certainty that long-term exposure to low levels of lead destroys intelligence in children and is associated with youth violence, teenage pregnancy, delinquency, depression, disruptive classroom behavior and homicide. What long-term exposure to low levels of MMT might cause is not known, and quite possibly not knowable, without exposing millions people over decades—that is, repeating the same global experiment.
- From the 1920s onward the Ethyl Corporation's executives ignored the warnings of health scientists against widespread marketing of the lead additives, aggressively marketing it throughout the world. Today, the same company and many of the same corporate executives that disregarded those warnings are today turning a deaf ear to the cautions of today's scientists and promoting equally aggressively sales of MMT causing the number of countries in which MMT is used to increase from 4 to 30 by 1995.[9]

When Ethyl was entering the market, the U.S. Surgeon General, in a letter dated December 20, 1922, asked for more information.[10] Midgely, in response, assured him that "the average congested street will probably be so free from lead that it will be impossible to detect it." In response to another letter, Midgely wrote "poisoning is almost impossible…the exhaust does not contain enough lead to worry about, but no one knows what legislation might come into existence fostered by competition and fanatical health cranks."[11]

But when Ernest Oelgert ran shrieking from three imaginary figures, the world knew something was wrong. He first displayed this sign of lead-induced dementia on October 21, 1924.[12] He was followed

[a] George Santayana, *The Life of Reason*, Volume 1, 1905.

Citations available at www.healthandcleanair.org

	Ethyl Lead Additive	MMT Manganese Additive
Company that developed it?	Ethyl	Ethyl
Purpose?	Boost octane	Boost octane
Based on a heavy metal?	Yes - lead	Yes - manganese
Is metal a neurotoxin?	Yes	Yes
Symptoms of acute poisoning?	Declines in manual dexterity, as well as anaemia, neurological disturbances including headache, irritability, lethargy, convulsions, muscle weakness, tremors and paralysis.	Hallucinations, irritability and aggressiveness, tremors, shuffling gait and weakness.
Does it cause recognized disease?	Yes. Parkinson's disease as well as amyotrophic lateral sclerosis (ALS), or "Lou Gehrig's disease."	Yes. Parkinson's disease.
Chief defense of toxicity?	Streets would be "so free from lead that it will be impossible to detect it."	Tea contains more manganese than gasoline with MMT.
Do low-level, long term exposures cause injury?	Yes. Destroys intelligence in children and is associated with youth violence, teenage pregnancy, delinquency, depression, disruptive classroom behavior and homicide	Unknown, possibly unknowable without long-term exposure to millions.
Were there warnings about dangers of widespread disease?	Yes. Lead "may lead eventually to recognizable lead poisoning or to chronic degenerative diseases."	Yes

four days later by William McSweeney who was hauled from his home in a straitjacket. Then William Kresge threw himself out of a second story window. Walter Dymock was locked in a nearby home for the violently insane and died.[13, 14] All worked at a Bayway, New Jersey refinery and were victims of the octane-boosting gasoline additive.

Lead and manganese are two of several heavy metals—others include arsenic, cadmium, lithium, mercury and thallium—whose principal target is the nervous system.[15] The exact mechanisms by which these neuorotoxics work is incompletely understood, but the symptoms of both lead and manganese poisoning are consistent with damage to the same region of the brain[16] or some other common pathway.[17] Manganese, once in the body, readily enters the brain. Several months of exposure to high doses produces "manganese madness," characterized by hallucinations, irritability and aggressiveness, tremors, shuffling gait and weakness.[18, 19] Similarly, symptoms of lead poisoning include fatigue, irritability, poorer hand-eye coordination, short attention span and, of course, reduced intelligence and attention deficit.[20]

MMT is itself a potent killer of cells —"acutely cytotoxic," in the words of one investigator.[21] But what of the chemicals formed when it is burned in a car's engine?

The exact content of the exhaust from combustion of gasoline containing MMT depends on the fuel composition, but generally the manganese emitted will be phosphate, sulfate or oxides.[22] Emitted particles are quite small—5 microns or less[23]—and therefore able to reach the deepest recesses of the lung. Some are nano particles as small as 0.2 microns, or two-tenths of one millionth of a meter.[24] Manganese phosphate[25] and sulfate dissolve into water,[26] allowing them to be quickly relocated from the lung to other tissues,[27] including the olfactory bulb, which sits atop—and thus provides a path into—the rest of the brain.[28] In addition, the ultrafine particles can be translocated though olfactory nerves, which provide the sense of smell, directly into the brain.[29] Whatever the exact mechanism, inhaled manganese is very efficiently transported from the lung to the brain,[30] and concentrated in a mass of nervous tissue buried deep within the cerebral hemispheres, the basal ganglia, which are responsible for motor control, cognition, emotions and learning.[31]

The brain site where most manganese is deposited plays, in the words of one investigator, "a unique and critical role"[32] and damage to it can cause a Parkinson's-like disease[33] or perhaps Parkinson's itself.[34] Because these target sites control the body's movements, e.g., something as simple as head-turning,[35] disease or injury "produce profound motor dysfunction in humans and experimental animals," in the words of one.[36]

Workplace exposure to lead sulfate is associated with development of Parkinson's disease.[37] Occupational exposures to lead are also linked to ALS.[38] In ALS, the same regions of the brain damaged by manganese poisoning[39]—the striatum, globus pallidus and substantia nigra—undergo degenerative change.[40]

Researchers attempting to develop a sort of early warning system for manganese poisoning, administered a body of tests to exposed workers, who were found to have a variety of nervous system dysfunctions, ranging from decreased ability to smell to diminished motor function.[41] Another team, attempted to assess the effects of shorter-term and lower-level exposures examined welders who worked for about 1.5 years constructing a new span of the San Francisco-Oakland Bay Bridge. Neurological, neuropsychological, neurophysiological and pulmonary tests revealed that the welders had increased hand tremor, decreased ability to smell, reduced sexual function, fatigue, depression and headache.[42]

Laboratory animals exposed to manganese undergo significant impairment of neurobehavioral function as well.[43] The disease continues to worsen even after exposure has ceased.[44]

Workplace exposures to manganese are linked to irritability, losses of equilibrium and memory and increased tremor.[45] Studies suggest that there is a progression in manganese toxicity with increasing cumulative dose.[46] If so, a lifetime of low level exposure might be toxicologically equivalent to a few years of high doses.

Manganese phosphate and sulfate dissolve into water, allowing them to be quickly relocated from the lung to other tissues, including the olfactory bulb, which sits atop—and thus provides a path into—the rest of the brain. In addition, the ultrafine particles can be translocated though olfactory nerves, which provide the sense of smell, directly into the brain.

In areas of Michigan where there is industrial use of heavy metals (iron, zinc, copper, mercury, magnesium, and manganese), the death rates from Parkinson's disease is higher.[47] In agricultural workers exposed to the manganese-based fungicide maneb, investigators found significantly higher rates of headache, fatigue, nervousness, memory complaints, and sleepiness compared to workers not exposed.[48]

Yet all of these effects are at high levels of exposure. What happens at the quite dilute level of the ambient air?

For lead, the answer to that question is quite clear, because of the half-century experiment by the DuPont, Ethyl and General Motors Corporations with the health and well being of the world's residents. The earliest reports of lead poisoning all focused on only one plant, Dupont's facility dubbed by workers the "House of Butterflies" because so many workers saw insects during the Ethyl-induced hallucinations. But as reporters began digging, they uncovered deaths elsewhere. At least two had died at the General Motors research division in Dayton, Ohio and four others at the DuPont plant in Deepwater, New Jersey where *The New York Times* uncovered 300 cases of lead poisoning. The *Times* reported that roughly 80 percent of those who worked at, or who went in to make repairs at the "the House of Butterflies" were killed or severely poisoned.[49]

After the poisonings at the Elizabeth, New Jersey "House of Butterflies," TEL was pulled from the market, a committee was appointed by the U.S. Surgeon General to review potential effects and return with recommendations. With only seven months to complete its review and lacking data on low levels of exposure, the panel concluded that there were "no good grounds for prohibiting the use of ethyl gasoline…as a motor fuel, provided that its distribution and use are controlled by proper regulations." Then it added—

> *It remains possible that, if the use of leaded gasolines becomes widespread, conditions may arise very different from those studied by us which would render its use more of a hazard than would appear to be the case from this investigation. Longer experience may show that even such slight storage of lead as was observed [among human*

guinea pigs] in these [1925] studies may lead eventually to recognizable lead poisoning or to chronic degenerative diseases of a less obvious character. In view of such possibilities the committee feels that the investigation begun under their direction must not be allowed to lapse.[50]

The Ethyl additive immediately was returned to market. Government research on its effects on human health were conducted by the U.S. Bureau of Mines, but the release of studies and their design were under the control of General Motors and DuPont and kept secret.[51] By 1976, the level of lead in the blood of American children rose to an average of approximately 16 micrograms per deciliter.[52] This compares to the current "action level" of 10, which some scientists say should be reduced to 2 because of "sufficient and compelling evidence" that the current standard is not protective.[53]

Ironically, when the government began to remove lead from gasoline, it was principally to prevent the poisoning of catalytic converts and the consequent economic loss to car makers.[54] As the amount of lead used in gasoline began to fall, the concentrations in blood dropped in lockstep.[55]

The contamination of the global environment and all of humanity with a substance that is toxic in every known form and of utterly no nutritional value is arguably the greatest avoidable public health catastrophe in human history, and certainly the 20th century. The intelligence of billions of humans, the essence of their humanity, has been destroyed fractionally, with unknowable consequences. U.S. EPA calculated that the benefits of lead removal, based on avoided losses of IQ in the U.S. alone, translated into one trillion dollars.[56]

Lead's damage is not limited to intelligence destruction. The metal clearly is toxic to areas of the brain that control socialization, resulting in increases in a wide range of anti-social behaviors. These range from youth violence and teenage pregnancy[57] to delinquency and depression,[58] as well as disruptive classroom behavior.59 This shows even in children between 12 and 36 months of age.[60] Specific types of outcomes linked to lead include homicide.[61]

Inhaled manganese is very efficiently transported from the lung to the brain, and concentrated in a mass of nervous tissue buried deep within the cerebral hemispheres, the basal ganglia, which are responsible for motor control, cognition, emotions and learning.

But what of the low-dosage effects of MMT?

Because the adverse effects of exposure would be subtle, as they are with lead, to answer that question to a certainty would require an extraordinarily powerful study involving hundreds of thousands, perhaps even millions of subjects over many years, perhaps decades. However, limited studies to date suggest that chronic, low-level exposures produce effects very similar to those of lead, including a possible link to death during the first year of life.[62]

For a variety of reasons, children and infants are more susceptible to manganese exposure than adults. Neither their livers nor blood-brain barriers, two primary protective mechanisms, are fully formed. Thus, manganese can pass into the body, especially the brain, through either by being inhaled or eaten or drunk. For example, infants retain 41 percent of the manganese in breast milk and 20 percent in formula.[63] Similarly, in animal studies, when manganese chloride was instilled in the trachea of rats once a week for four weeks to simulate inhalation, levels rose 68 percent in blood, 205 percent in the striatum, 48 percent in the cortex and 27 percent in the cerebellum.[64] These increases can occur very quickly: in one study the metal was found in the olfactory bulb within 30 minutes.[65]

It is not only clear that manganese can enter and remain in the tissues of children and infants, but also that it causes nervous system damage. In Bangladesh in children whose drinking water was contaminated with manganese, investigators found significant decrements in intellectual function as daily consumption of manganese rose.[66] Similarly, in children that investigators began to follow while they were still unborn, as levels of manganese in the umbilical cord rose, later scores of tests of attention, nonverbal memory and hand skills fell.[67]

Deciduous, or "baby" teeth and tooth enamel can also provide a record of heavy metal exposure in utero. When investigators compared levels of manganese with activity after birth, they found higher concentrations linked to measures of behavioral disinhibition (e.g. play with a forbidden toy at 36 months), impulsive errors (at 54 months), parents' and teachers' ratings of externalizing and attention problems in the 1st and 3rd grades, and teacher ratings on the disruptive behavior in the 3rd grade.[68] Other studies have found the same relationship between manganese in hair and learning disability later in life.[69] In Chinese children, higher levels of managese in hair was also associated with poorer performance in school.[70]

Such studies do not constitute proof beyond a reasonable doubt that MMT would have the same toxic impact on the world's inhabitants as did lead, but they certainly suggest that great caution should be exercised, and that the additive should be placed in commerce only after extensive and sophisticated testing.

However, Afton-Ethyl, has conducted no such studies. Instead, like DuPont, General Motors and Ethyl before it, it has relied on lawyers and litigation to compel governments to approve MMT. It has filed a succession of lawsuits[71] against the U.S. Environmental Protection Agency to force MMT onto the market, successfully arguing that protection of public health is not a legal basis for prohibiting its use.[72]

In Canada, Ethyl-Afton not only sued to force MMT onto the market, but filed a claim under the North American Free Trade Agreement for monetary damages when the government banned the importation and inter-provincial trade of MMT.[73] Ethyl asserted that the ban violated NAFTA, was an "expropriation" of its "property" (its anticipated profits) and that parliamentary debate caused "damage" to its "good reputation."[74]

Ethyl took its suit to NAFTA because under the trade agreement its complaint would be heard by a secret tribunal whose records are not disclosed and whose decisions cannot be appealed. The Canadian government, concluding that its chances of winning were slim, capitulated. It paid Ethyl US$13 million and allowed the corporation to resume its sales of MMT in Canada. The Canadian government also agreed, in the words of one observer, to "lie to its citizens," and announce that "MMT poses no health risk."[75, b]

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MMT has not been approved for use in more nations because a small number of current and former air pollution regulators—including the head of Germany's air pollution control program and a former Secretary of the California Environmental Protection Agency—have persisted in bringing to the attention of public health advocates the dangers of the additive and the tragic history of its predecessor, Ethyl.

When the tetraethyl lead additive was being introduced, the responses of Ethyl to the expressions of concern by public health scientists, was to attack their credibility and qualifications. Recently, this has begun with MMT as the lawyer who represented Ethyl in its lawsuits against the U.S. Environmental Protection Agency and Canada, Kevin L. Fast,[76] has mounted an attack against one of MMT's critics, Michael P. Walsh.

Walsh once ran the vehicle emissions program in the United States and has served as a consultant to dozens of governments throughout the world. He was awarded the Dr. Arie Haagen Smit Clean Air Award by the California Air Resources Board for his "global efforts towards mobile source emission reductions."[77] He also was the first recipient of the U.S. Environmental Protection Agency lifetime achievement award for air pollution control for "outstanding achievement, demonstrated leadership, and a lasting commitment to promoting clean air."[78] In 2005, he was selected to receive a five-year, $500,000 MacArthur Fellowship, some times referred to as the "genius grant."[79]

Yet Last's view of Walsh's work is that it is "incomplete and skewed" and "falls far short," while it is "without a thorough and complete assessment of the science."[80] The attacks are remarkably similar in tone and content to those made 80 years ago against scientists who cautioned against leaded gasoline.[81]

The MMT additive can now be sold in China, Australia, Russia, France, Argentina and South Africa, in addition to Canada.[82] Those charged with deciding whether the additive should be allowed in gasoline, thus once again potentially exposing the world's population to grave and irrevocable injury, should bear the experience of eighty years ago in mind. That was a massive and unprecedented experiment whose complete results will likely never be known, because it is impossible to find creatures uncontaminated by the Ethyl additive to test for its effects. As Santayana urged, they should remember the past, so as not to repeat it.

[b] Although MMT is a legal product in the United States (except California) and Canada, most North American. refiners have responded to pressure from the public and environmental groups and voluntarily agreed not to use MMT in their gasoline products. Sanford Gaines, "Environmental Policy Implications of Investor-State Arbitration Under NAFTA Chapter 11," Commission of Environmental Cooperation, Third North American Symposium on Assessing the Environmental Effects of Trade, Nov. 30-Dec.1, 2005, Montreral, Canada.

Norsk institutt for luftforskning
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Et institutt i CIENS og Miljøalliansen

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FOR IMMEDIATE RELEASE

Short-lived pollutants contribute to Arctic warming

An immediate reduction of methane, tropospheric ozone and black carbon may delay the melting of the Arctic, is the unanimous recommendation from a group of leading climate scientists after an international conference in Oslo.

The 2nd Short-lived Pollutants and Arctic Climate Workshop, gathering 40 leading climate scientists from Europe, Asia and the U.S., was hosted by the Norwegian Institute for Air Research (NILU) in Oslo, Norway, 5-7 November.

Reductions in the atmospheric burden of CO2 are the backbone of any meaningful effort to mitigate climate forcing. But, even if swift and deep reductions were made, given the long lifetime of CO2, the reductions may not be achieved in time to delay a rapid melting of the Arctic. Hence, the goal of constraining the length of the melt season and, in particular, delaying the onset of spring melt, may best be achieved by targeting shorter-lived climate forcing agents which also impact Arctic climate. Addressing these species has the advantage that emission reductions will trigger climate response almost immediately. These agents include methane, tropospheric ozone, and black carbon all of which are strongly influenced by human activity.

The workshop concluded, after three days of work and discussions, on the following statement for immediate:

- Reduce methane emissions globally.
- Implement a northern hemisphere tropospheric ozone reduction strategy targeting NMVOCs, CO and methane with an emphasis on reductions at higher latitudes.
- Due to their impact on climate, emissions of short-lived pollutants within the Arctic should be minimized.
- Implement a black carbon (BC) reduction strategy in the northern hemisphere with an emphasis on BC sources that result in deposition within the Arctic - particularly during winter and spring.

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Dear Friends:

For the moment at least, this will be the last *Health & Clean Air Newsletter*. Yet to come, however, is a searchable compilation of all the Newsletters, with the information presented in a way that, hopefully, will allow readers to access it.

We will provide online and, for subscribers to the printed version, compact discs, with all of the Newsletters, citations and other information. The intent is to provide a comprehensive document that will, for example, allow parents to search for “children” or “school” or “manganese” or “polyaromatic hydrocarbons” and find not only explanations, but abstracts of the articles.

Quite a number of readers have urged that the *Newsletter* continue. There is some merit in this suggestion. This issue, for example, includes a thorough review of the potential hazards of a gasoline additive, MMT, something unlikely to be found in any other publication even though its maker is seeking to establish a global market without having conducted the requisite testing to assure protection of human health. Thus, it is possible that this unique undertaking will be continued.

Thank you all for your interest and support.

Curtis A. Moore
Editor and Publisher

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