MONTEREY BAY
Unified Air Pollution Control District
serving Monterey, San Benito, and Santa Cruz counties

AIR POLLUTION CONTROL OFFICER
Douglas Quetin

24580 Silver Cloud Court • Monterey, California 93940 • 831/647-9411 • FAX 831/647-8501

May 21, 2008

Ms. Jacqueline Onciano
Planning Services Manager
Monterey County Planning Department
168 West Alisal Street, 2nd Floor
Salinas, CA 93901

Sent electronically to:
CEQAcomments@co.monterey.ca.us
Original Sent by First Class Mail.

SUBJECT: DEIR FOR RANCHO CANADA SUBDIVISION

Dear Ms. Onciano:

The following comments represent the Air District's comments on the first Draft EIR and substantive issues discussed with the County and its EIR Consultant, Jones & Stokes, in the last two months:

Complete Description of Project Activities

Until the EIR describes all project activities with potential air quality impacts, the environmental analysis would not reflect project-specific or cumulative impacts. Accordingly, the Air District suggests that the Project Description include the following:

Grading, Excavation, and Related Work

- Source of the fill material and haul route to be used (offsite and onsite hauling).
- Haul schedule (estimated beginning and end dates of haul schedule, total number of haul days, days per week, daily start and end times).
- Grading / earthmoving onsite (estimated beginning and end dates, including before, during and after hauling of fill material).

Construction

- Include estimated start and end dates, which were also discussed with the Air District.
- Specify construction equipment to be used (per equipment list developed as result of discussions with the District and the County's consultants).

- Describe paving and building to be done.
- Please refer to Title 13 CCR § 2485, below, concerning idling of diesel-powered commercial vehicles:

California Code of Regulations
§ 2485. Airborne Toxic Control Measure to Limit Diesel-Fueled Commercial Motor Vehicle Idling (a) Purpose. The purpose of this airborne toxic control measure is to reduce public exposure to diesel particulate matter and other air contaminants by limiting the idling of diesel-fueled commercial motor vehicles. (b) Applicability. This section applies to diesel-fueled commercial motor vehicles that operate in the State of California with gross vehicular weight ratings of greater than 10,000 pounds that are or must be licensed for operation on highways. This specifically includes: (1) California-based vehicles; and (2) Non-California-based vehicles. (c) Requirements. On or after February 1, 2005, the driver of any vehicle subject to this section: (1) shall not idle the vehicle's primary diesel engine for greater than 5.0 minutes at any location, except as noted in Subsection (d); and (2) shall not operate a diesel-fueled auxiliary power system (APS) to power a heater, air conditioner, or any ancillary equipment on that vehicle during sleeping or resting in a sleeper berth for greater than 5.0 minutes at any location when within 100 feet of a restricted area, except as noted in Subsection (d).

Estimation of Air Quality Impacts
URBEMIS 2007 should be used to estimate project impacts, and it should be input with available project-specific information rather than defaults. All project elements (grading/excavation, building, including architectural coatings; paving; and ongoing operations) should be estimated.

Traffic Report / Hot Spots Analysis
A "Hot Spots" analysis should be performed at the two intersections that report LOS E or F (understanding that signalization could mitigate the impacts). A carbon monoxide analysis along the truck corridor, fill source and deposition site should also be done.

Health Risk Assessment
This should reflect the impacts associated with the diesel equipment to be used in the various stages of the project, and should include a discussion of how emissions were determined (including horsepower and load factors).
The special health risk posed to Carmel Middle School students has been raised by its Principal, Edmund Gross. In addition to the health risks posed by diesel exhaust and emissions of acrolein, Mr. Gross has alerted the Air District to the potential health impacts of silica-laden soil that would be disturbed during grading activities, as well as Aspergillus, an allergen that is common to the area. The Air District suggests that the County confer with its County Health Officer concerning the potential health impacts of silica and Aspergillus.

Attached to this letter is a copy of an article in the Spring 2008 edition of the *Health & Clean Air Newsletter* regarding the special risk to children from black carbon, the cardiac risk posed by black carbon to adults, and the impacts of diesel engines to human health.

Current Air Quality Management Plan (AQMP)
The current AQMP was adopted by the Air Board in 2004.

Feasibility of Project Schedule and Mitigation Measures
The feasibility of proposed mitigation measures should be addressed in the Draft EIR and secondary or "fall-back" mitigations should be presented. For example, biodiesel is being proposed as mitigation for many development projects in the North Central Coast Air Basin, while demand exceeds supply. This mitigation may not be feasible, so a "menu" of options to reduce diesel particulate matter and other constituents of exhaust should be presented. The same applies to various diesel particulate filters.
The possibility of scheduling the grading/excavation/haul truck work during the summer when students might not be present at Carmel Middle School requires greater scrutiny. When Air District staff suggested such a scheduling option, it was told that the School District leases the school property for a variety of public events throughout the summer. Accordingly, the Air District suggests that the County fully investigates what realistic options such scheduling might offer to reduce air quality impacts to the students and other occupants of Carmel Middle School.

Thank you for the opportunity to review and comment on the proposed project.

Sincerely,

Jean Getchell
Supervising Planner
Planning and Air Monitoring Division

cc: Edmund Gross, Carmel Middle School
Hugh F. Stallworth, M.D., M.P.H., Monterey County Health Officer

Attachment

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/m²**
"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/m² more solar energy than it radiates to space as heat. Of this, ozone, methane and black carbon currently account for about 0.73 W/m².

[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

The *Health and Clean Air Newsletter* is edited by Curtis Moore. Reviewers include Drs. John Balmes, Bart Croes, Shankar Prasad and George Thurston. Correspondence may be addressed to HCAN, 1100 Eleventh Street, Suite 311, Sacramento, California 95814. Issues, abstracts and citations may be found at www.healthandcleanair.org

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

> *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*

are either ultrafine (less than one-tenth of a micron (millionth of a meter) or fine (0.1-2.0 microns).[15]

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 $+0.2 \pm 0.1$ 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]

> 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

[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.

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

The pollutant cloud boosted heating in the lower atmosphere by about 50%, an amount, they said, that might "be sufficient to account for the observed retreat of the Himalayan glaciers."

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]

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).