

1. The two-week Earth Summit, formally known as the United Nations Conference on Environment and Development, attracted 30,000 people including officials from 172 nations—108 of them heads of state or government—and was covered by 10,000 on-site journalists. (<http://www.un.org/geninfo/bp/enviro.html>)

It focused on so-called “sustainable” development—that is, in the words of an earlier U.N. effort “development which meets the needs of the present without compromising the ability of future generations to meet their own needs.” (the Brundtland Report, http://www.ace.mmu.ac.uk/eae/Sustainability/Older/Brundtland_Report.html) The Summit developed and adopted five major international agreements:

- The Convention on Biological Diversity;
- The Framework Convention on Climate change;
- Principles of Forest Management;
- The Rio Declaration on Environment and Development; and,
- Agenda 21, called a “blueprint” for sustainable development.

Under the auspices of the second of these, the United Nations Framework of Climate Change (UNFCCC) annual meetings, or Conference of the Parties (COP) began efforts to reach an international agreement to cope with global warming.

The first COP was held in Berlin, followed by Vienna, then Kyoto, where the now famous Kyoto Protocol was developed calling for global reductions in emissions of six greenhouse gases, air pollutants that cause global warming, by about 5 percent below 1990 levels. For an excellent explanation of the Kyoto Protocol and related matters, see Wikipedia, http://en.wikipedia.org/wiki/Kyoto_Protocol.

2. The Kyoto Protocol (<http://unfccc.int/resource/docs/convkp/kpeng.html>) is actually an amendment to the UNFCCC that was adopted in Rio de Janeiro in 1992. It assigns mandatory targets for reducing emissions of “greenhouse gases” emissions to signatory nations. Although literally hundreds of pollutants cause global warming, the Protocol singled out only six: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆).

The rationale for limited the Protocol’s focus to these six pollutants was that they are “well mixed,” meaning that the variation of concentrations through the planet is relatively less than with other greenhouse pollutants; and, that the science underpinning their identification and consequences of reductions was of greater certainty.

(<http://www.esrl.noaa.gov/research/themes/forcing/>) (See also National Academy of Sciences, *Radiative Forcing of Climate Change: Expanding the Concept and Addressing Uncertainties* (2005), <http://darwin.nap.edu/books/0309095069/html/11.html>).

3. “Nations in standoff over issues at global warming conference,” Reuters, Nov. 21, 2000 (<http://archives.cnn.com/2000/NATURE/11/21/hague.conference.reut/index.html>).

4. Scientists at the Goddard Institute for Space Studies at the U.S. government's National Aeronautics and Space Administration have concluded that the world's temperature is reaching "a level that has not been seen in thousands of years." Used temperature measurements taken around the world during the last century, they concluded that the Earth has been warming at the "remarkably rapid" rate of approximately 0.36° Fahrenheit (0.2° Celsius) per decade for the past 30 years. ("NASA Study Finds World Warmth Edging Ancient Levels," Sep. 25, 2006, <http://www.giss.nasa.gov/research/news/20060925/>)
5. Global mean sea level has been rising at an average rate of 1 to 2 mm/year over the past 100 years, which is significantly larger than the rate averaged over the last several thousand years. (National Oceanic and Atmospheric Administration, <http://lwf.ncdc.noaa.gov/oa/climate/globalwarming.html#Q9>). See also "Sea Level Rise Reports" at <http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsSeaLevelRiseIndex.html>
6. For example, glaciers in the Blackfoot-Jackson Glacier Basin of Glacier National Park, Montana, decreased in area from 21.6 square kilometers in 1850 to 7.4 km² in 1979, or roughly 66 percent. Myrnah Hall and Daniel Fagre, "Modeled Climate-Induced Glacier Change in Glacier National Park, 1850–2100," <http://www.bioone.org/perlserv/?request=get-abstract&issn=0006-3568&volume=053&issue=02&page=0131>.
7. In March, 2002, for example, in one of the most dramatic events ever recorded, the Larsen Ice Shelf shattered and separated from the Antarctic continent. The amount of ice lost would dwarf Rhode Island. See "Larsen B Ice Shelf Collapses in Antarctica," <http://www.nsidc.colorado.edu/iceshelves/larsenb2002/>. Satellite imagery of Larsen's collapse can be viewed at <http://www.nsidc.org/iceshelves/larsenb2002/animation.html>.
8. In 1996, the United States emitted roughly 24 percent of the worldwide energy-related carbon pollution. <http://www.infoplease.com/ipa/A0004686.html> The current inventory of U.S. greenhouse gas emissions and sinks can be downloaded at "US Emissions Inventory 2006," <http://yosemite.epa.gov/oar/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2006.html>
9. In 2002, U.S. President George W. Bush called for a decade of further research before taking any measures to curb global warming except those that are voluntary. Eric Pianin, "Group Meets on Global Warming," *The Washington Post*, Dec. 2, 2002. For its part, the U.S. Senate adopted by a vote of 96–0 the so-called Byrd-Hagel Resolution, which directed U.S. climate negotiators to reject any agreement to "limit or reduce greenhouse gas emissions" in industrialized nations unless limits were also imposed on developing nations. <http://www.nationalcenter.org/KyotoSenate.html>

10. The first automotive emissions control technology in the nation, Positive Crankcase Ventilation (PCV), was mandated in 1961 by the California Motor Vehicle State Bureau of Air Sanitation to control hydrocarbon crankcase emissions. PCV withdraws blowby gases from the crankcase and returns them with the fresh air and fuel mixture in the cylinders.<http://www.arb.ca.gov/html/brochure/history.htm>
11. From 1941 to 1977, Hoffman Electronics Corporation, based in Los Angeles, was a major developer and manufacturer of solar photovoltaic cells (PVs), which convert sunlight into electricity. Although it sold its PV business in 1977, Hoffman was the leading manufacturer of silicon solar cells in the 1950s and 1960s. California used solar thermal systems even earlier: about 1,600 "Climax" solar hot water systems were installed throughout Southern California by 1900, including roughly one-third of the households in Pasadena. <http://www.hoffmanvideo.com/aboutus.asp> and <http://www.californiasolarcenter.org/index.html>
12. Over 600 Enertech 44/15 wind turbines were operating in California Windfarms by 1983. <http://www.telosnet.com/wind/govprog.html> Wind farms in California made up the majority of wind turbine installations until the early 1990s. Over 17,000 machines, ranging in output from 20 to 350 kilowatts, were installed in wind farms between 1981 and 1990. At the height of development, these turbines had a collected rating of over 1,700 megawatts and produced over 3 million megawatt hours of electricity, enough (at peak output) to power a city of 300,000. <http://www.telosnet.com/wind/recent.html>
13. The first plant to generate electricity from a water-dominated geothermal resource was placed in operation at the East Mesa field in the Imperial Valley in California. The plant is named for B.C. McCabe, the geothermal pioneer who, with his Magma Power Company, did field development work at several sites, including The Geysers in California. http://www.energyquest.ca.gov/time_machine/1970ce-1980ce.html
14. Integrated generation-combined cycle (IGCC) systems (1) convert coal to gas, which (2) is then burned in a gas turbine to generate electricity. Then (3) exhaust heat is recovered from the gas turbine and (4) used to generate steam that (5) powers a second turbine to generate electricity. The systems are much more efficient than conventional pulverized coal plants, with reductions in air pollution of up to 98 percent. <http://www.netl.doe.gov/technologies/coalpower/gasification/system/CurrentFutureIGCC2Revisionfinal.pdf>The basic IGCC concept was first successfully demonstrated at commercial scale at the pioneer Cool Water Project in Southern California from 1984 to 1989. <http://www.netl.doe.gov/technologies/coalpower/gasification/pubs/pdf/18.pdf>
15. See, e.g, DEM WELCOMES NRC RECOMMENDATION THAT STATES BE ALLOWED TO SET CALIFORNIA AIR POLLUTION STANDARDS FOR VEHICLE, <http://www.dem.ri.gov/news/2006/pr/0317061.htm>
16. The most important greenhouse gases in Earth's atmosphere include carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), water vapor (H₂O), ozone (O₃), and the

chlorofluorocarbons (CFCs including CFC-12 (CCl₂F₂) and CFC-11 (CCl₃F)). In addition to reflecting sunlight, clouds are also a major greenhouse substance. Ozone is created in the atmosphere by reactions initiated by sunlight. The CFCs are synthetic industrial compounds developed and released into the atmosphere by humankind. In addition, sulfur hexafluoride (SF₆) and perfluorocarbon gases such as carbon tetrafluoride (CF₄) are very potent. According to the National Academy of Sciences, “Literally thousands of gases have been identified as being present in the atmosphere at some place and at some time, and all but a few have the ability to absorb terrestrial infrared radiation.” National Academy of Sciences, *Climate Change Science: An Analysis of Some Key Questions* (2001), pp. 9–14, National Academy Press, Washington, D.C. 2001.

17. Juliet Eilperin, “Debate on Climate Shifts to Issue of Irreparable Change Some Experts on Global Warming Foresee ‘Tipping Point’ When It Is Too Late to Act,” *Washington Post*, p. A1, Jan. 29, 2006. The most notable scientist to express this view is probably James Lovelock, the scientist who first came up with the Gaia hypothesis to define how the earth’s environment was built of a planetary-wide control system. He reports that he believes the catastrophic consequences of global warming can no longer be avoided because components of the earth’s systems work together in a giant feedback loop system and their actions have been keeping the world cooler than it normally would be. He now believes the system has been switched into a state where the feedback loop will create an environment where humans will be hardpressed to survive. Rather than calling for further ways of countering climate change, Lovelock is calling on governments to begin large-scale preparations for surviving what he calls “a hell of a climate.”
<http://www.pacificviews.org/weblog/archives/001750.html>
18. See, e.g, Felicity Barringer, “California, Taking Big Gamble, Tries to Curb Greenhouse Gases,” *New York Times*, p. A1, Sep. 15, 2006: “The Democratic-controlled legislature and the Republican governor also agreed at that time on legislation to reduce industrial carbon dioxide emissions by 25 percent by 2020, a measure that affects not only power plants but also other large producers of carbon dioxide, including oil refineries and cement plants.”
19. The conventional view is that carbon dioxide has a lifetime of one or two centuries (see <http://www.epa.gov/nonco2/econ-inv/table.html>). However, “The idea that anthropogenic CO₂ may affect the climate of the earth for hundreds of thousands of years has not reached general public awareness.” Archer, D. Fate of fossil fuel CO₂ in geologic time. *J. of Geophysical Research* 110, C09S05, Sep. 21, 2005.
http://geosci.uchicago.edu/~archer/reprints/archer.2005.fate_co2.pdf
20. The term black carbon (BC) is a general one applied to various carbonaceous products of incomplete combustion and includes chars, charcoals and soots. BC is ubiquitous in the environment, including in aerosols, sediments and soils. In 1999, members of the Geochemical Society established an International Steering Committee for Black Carbon to collect information on and establish a “suite of widely available and representative BC benchmark materials.” This information can be seen at

<http://www.du.edu/~dwismith/bcsteer.html>.

21. Intergovernmental Panel on Climate Change, *Climate Change 2001: The Scientific Basis. Summary for Policymakers* (Cambridge, UK: Cambridge University Press, 2001), p. 44.
22. Ostro, B. et. al. Fine Particulate Air Pollution and Mortality in Nine California Counties: Results from CALFINE. *114 Environ. Health Perspect.* 114:29–33. (Jan. 2006).<http://www.ehponline.org/members/2005/8335/8335.pdf>
23. [266]
POPE, C.A.III., BURNETT, R.T., THUN, M.J., CALLE, E.E., KREWSKI, D., ITO, K., & THURSTON, G.D.
Lung Cancer, Cardiopulmonary mortality, and long-term exposure to fine particulate air pollution
JAMA 2002; 287; 1132–1141
American Cancer Society cohort recruited in 1982. Analysis of over 500,000 people in an average of 51 metropolitan districts. Interesting data showing reductions in PM_{2.5} from 1979–1983 and from 1999 to 2000, values ranging from 10 to 30 in the first period, and from 5 to 20 in the second. Nonparametric smoothed response functions shown for the three categories of diagnosis; conclude that for a 10 microgram/m³ change in PM₁₀, all cause mortality increased by 4 percent; cardiopulmonary mortality increased by 6 percent, and lung cancer mortality increased by 8 percent. 95 percent confidence levels of all indices of RR were above 1.0. Coarse particle fraction and TSP not consistently associated with mortality. Other pollutants considered were sulfate, sulfur dioxide, nitrogen dioxide, carbon monoxide, and ozone. Numbers of metropolitan areas that could be considered varied with the different pollutants. Cox proportional hazards model with inclusion of a metropolitan-based random effects component in a two stage analysis. The continuous smoking variables included nine different indices (such as “current smokers years of smoking squared” and eight others). Controls also devised for educational level and occupational exposures. A 2 dimensional term was inserted to account for spatial trends. Higher regressions were noted in men than in women, and lower educational status was associated with higher risks. Risks in never smokers were also generally higher than in former or current smokers.

Authors conclude: “The findings of this study provide the strongest evidence to date that long-term exposure to fine particulate air pollution common to many metropolitan areas is an important risk factor for cardiopulmonary mortality.”

The US EPA Draft Criteria Document (June 2002) makes these points about the new analysis: “(a) doubles the follow-up time from eight years to sixteen years, and triples the number of deaths: (b) expands the ambient air pollution data substantially, including two recent years of fine particle data, and adds data on gaseous co-pollutants: (c) improves statistical adjustment for occupational exposure; (d) incorporates data on dietary covariates believed to be important factors in mortality, including total fat consumption, and consumption of vegetables, citrus fruit, and high-fiber grains: and (e) uses recent

developments in non-parametric spatial smoothing and random effects statistical models as input to the Cox Proportional hazards model.”

24. Cohen, A.J. et. al. The global burden of disease due to outdoor air pollution. *Journal of Toxicology and Environmental Health, Part A*, 68:1–7, 2005.
Ambient air pollution, in terms of fine particulate air pollution (PM_{2.5}), causes about 3 percent of mortality from cardiopulmonary disease, about 5 percent of mortality from cancer of the trachea, bronchus, and lung, and about 1 percent of mortality from acute respiratory infections in children under 5 yr, worldwide. This amounts to about 0.8 million (1.2 percent) premature deaths and 6.4 million (0.5 percent) years of life lost (YLL).
25. Those who share this fear include not just scientists, but the U.S. military as well. David Stipp, "The Pentagon's Weather Nightmare," *Fortune*, Jan. 26, 2004.
<http://www.climate-talks.net/2005-ENVRE130/PDF/20040126-Fortune-Pentagon-and-Climate.pdf>
26. James Lovelock, the scientist who developed the Gaia principle, which holds that Earth is a self-regulating, interconnected system), claimed that by the year 2100 the only place where humans will be able to survive will be the Arctic. James Lovelock, *The Revenge of Gaia: Why the Earth Is Fighting Back - and How We Can Still Save Humanity* (Penguin, 2006)
27. Myron Ebell, Director of Energy & Global Warming Policy, of the Competitive Enterprise Institute, which is funded by ExxonMobil and other polluters, claims that responding to global warming would require an “energy starvation diet.”
<http://www.cei.org/gencon/003,05396.cfm>
28. Catalytic converters, or “catalysts,” were first installed on cars in the mid-1970s. First generation catalytic converters, called “two-way converters,” only controlled carbon monoxide (CO) and hydrocarbon (HC) emissions. In the early 1980s, catalysts were introduced that could control nitrogen oxides (NO_x), in addition to controlling CO and HC. All cars sold in the U.S. today are equipped with this type of catalytic converter, called a three-way converter. Catalytic converters have also been developed for use on trucks, buses, and motorcycles, as well as on construction equipment, lawn and garden equipment, marine engines, and other non-road engines. manufacturers of Emissions Controls Association, “Clean Air Facts,”
<http://72.14.209.104/search?q=cache:0kQRDOyCSEQJ:www.meca.org/galleries/default-file/catconfact%25200106.pdf+first+catalytic+converter&hl=en&gl=us&ct=clnk&cd=12>
29. According to the market research firm, the McIlvaine Company, “China will spend \$5 billion/yr for scrubbers over the next 5 years. By 2010 China will then have more installed scrubber capacity than the U.S. and Germany combined (the next two largest users).”
<http://www.environmental-expert.com/resultteachpressrelease.asp?cid=5122&codi=7253>

&idproducttype=10&level=1

30. The heat of combustion causes the oxygen and nitrogen in the air to combine to form oxides of nitrogen, often referred to as “thermal NO_x,” a process also described as the Zel’dovich Mechanism. See Ya A Smorodinskii, D A Frank-Kamenetskii, “YAKOV BORISOVICH ZEL’DOVICH (On the Occasion of his Fiftieth Birthday)”, SOV PHYS USPEKHI, 1964, 7 (2), 332–338,
http://www.turpion.org/php/paper.phtml?journal_id=pu&paper_id=3668. Black carbon is the product of incomplete combustion of carbon bearing fuels. See International Steering Committee for Black Carbon Reference Material,
<http://www.geo.unizh.ch/phys/bc/>
31. U.S. Environmental Protection Agency, “An Introduction to Indoor Air Quality,”
<http://www.epa.gov/iaq/co.html>.
32. L.A. Currie, J.D. Kessler, et. al.”Isotopic Black Carbon in the Environment: New Metrology for ¹⁴C and its International Impact,”
<http://www.cstl.nist.gov/div837/Division/techac/1999/IsotopicBlackCarbon.htm>
33. Some model calculations suggest that the climate forcing of black carbon may rival that of methane, and that the present day global warming due to black carbon may be as much as 0.3–0.4 Watts per cubic meter. Jacobson, M. Z.: Climate response of fossil fuel and biofuel soot, accounting for soot’s feedback to snow and sea ice albedo and emissivity, J. Geophys. Res., 109, D21201,doi:10.1029/2004JD004945, 2004. As with all things scientific, the term “black carbon” is something of an oversimplification and even somewhat inaccurate. A more accurate name for all forms of light absorbing carbonaceous aerosols would be “light absorbing carbon” not “black carbon.” Andreae, M. O. and Gelencser, A. Black carbon or brown carbon? The nature of light-absorbing carbonaceous aerosols. Atmos. Chem. Phys. Discuss., 6, 3419–3463, 2006.
34. Jacobson, M. Z. Strong Radiative Heating Due To The Mixing State Of Black Carbon In Atmospheric Aerosols.Nature 409, 695-697, 2001. Also Stanford University News Service, “Scientists discover a major cause of global warming—ordinary soot,”
<http://www.stanford.edu/dept/news/pr/01/soot214.html>
35. [387]
VIIDANOJA, J., SILLANPAA, M., LAAKIA, J., KERMINEN, V-M.M HILLAMO, R., AARNIO, P., & KOSKENTALO, T.
Organic and black carbon in PM_{2.5} and PM₁₀: 1 year of data from an urban site in Helsinki, Finland
Atmospheric Environment 36 (2002): 3183–3193
Daily average PM_{2.5} varied between 1.0 and 8.5 micrograms/m³ for organic carbon, and between 0.3 and 5.7 micrograms/m³ for black carbon. On an annual basis, particulate organic matter accounted for 50 percent of the total PM_{2.5} and 36 percent of the PM₁₀, and the comparable figures for black carbon were 14 percent and 7 percent. However,

typically more than 90 percent of the black carbon was in the PM_{2.5} fraction. Wide variation in coarse particle contribution. Further calculations of the contribution of secondary organic aerosol were made. The ratio organic carbon/black carbon is thought to represent the primary traffic-emitted aerosol.

36. Using 1996 fuel use data, one team of researchers calculated that contributions of fossil fuel, biofuel, and open burning to total black carbon loading were 38 percent, 20 percent, and 42 percent, respectively. Bond, T. C, Streets, D.G., et. al. A technology-based global inventory of black and organic carbon emissions from combustion. *J. GEOPHYSICAL RESEARCH*, VOL. 109, D14203. July, 24, 2004.
37. [111]
PETERS, A., LIU, E., VERRIER, R.L., SCHWARTZ, J., GOLD, D.R., MITTELMAN, M., BALIFF, J., OH, J.A., ALLEN, G., MONAHAN, K., & DOCKERY, D.W.
Air Pollution and incidence of cardiac arrhythmia
Epidemiology 2000: 11: 11–17
Patients with implanted cardioverter defibrillators. 100 cases in Eastern Massachusetts. Pollution indices of particulate matter, black carbon, and gaseous air pollutants measured daily 1995-1997. A 26 ppb increase in NO₂ was associated with increased defibrillator interventions 2 days later (OR = 1.8: CI 1.1-2.9).
Patients with ten or more interventions experienced increased arrhythmias in association with NO₂, CO, Black carbon, and fine particle mass. Levels of pollutants are given. The 95% percentile values were: PM₁₀ = 37; PM_{2.5} = 26.6; Black carbon = 2.84; CO = 0.97 ppm; O₃ = 0.036 ppm; SO₂ = 0.019 ppm; NO₂ = 0.037 ppm. Maximal values were about twice these, and the mean values were about half. Strongest associations were for NO₂. Two pollutant models with CO and black carbon suggested that NO₂ was dominant. Odds ratios appeared to be linearly related to pollutant level.
38. [1161]
KIM, J.J., SMORODINSKY, S., LIPSETT, M., SINGER, B.C., HODGSON, A.T., & OSTRO, B.
Traffic-related air pollution near busy roads
Am J Respir Crit Care Med 170; 520–526; 2004
School-based cross sectional study conducted in Alameda County, in California which includes Oakland and about 20 kilometers south of it. Children in grades 3–5 enrolled, and 1,109 questionnaires were completed. 30 percent of households had incomes below the poverty line. Respiratory symptoms were associated with proximity to heavily traveled roads, and among those at their current residences for at least a year, the adjusted odds ratio for asthma in relationship to the interquartile difference in NO₂, was 1.07. The association with black carbon was also significant. Bronchitis prevalence rates were also associated with higher levels of both pollutants. Of the schools, lowest NO₂ was 19 ppb, and highest was 31 ppb.
39. Observation of submicron aerosol, black carbon and visibility degradation in remote area at temperature range from -24 to 20 degree C. Raunemaa, T; Kikas, U; Bernotas, T;

Atmospheric Environment [ATMOS. ENVIRON.]. Vol. 28, no. 5, pp. 865–871. 1994.

0.010-10 μm sized aerosol and black carbon were measured in a remote Rautavaara site in periods in August, October and December by using electric aerosol spectrometer EAS and Aethalometers. During the study the lowest temperature was -24 degree C. The formation of new 0.010-0.030 μm sized aerosols was observed during decreasing temperatures below -10 degree C. Black carbon was seen to be strongly correlated with aerosols in the size range of 0.100-0.180 μm . The amount of black carbon was high at below 0 degree C. Visibility impairment could be coupled to rapid condensation of near micron-sized aerosols during the increasing temperature gradient. Solar flux changes and chemical composition of aerosols, especially black carbon, were shown to be strongly linked.

40. Hansen, J., Sato, M. et. al. Global temperature change. Global surface temperature has increased {approx} 0.2°C per decade in the past 30 years, similar to the warming rate predicted in the 1980s in initial global climate model simulations with transient greenhouse gas changes. Warming is larger in the Western Equatorial Pacific than in the Eastern Equatorial Pacific over the past century, and we suggest that the increased West–East temperature gradient may have increased the likelihood of strong El Niños, such as those of 1983 and 1998. Comparison of measured sea surface temperatures in the Western Pacific with paleoclimate data suggests that this critical ocean region, and probably the planet as a whole, is approximately as warm now as at the Holocene maximum and within {approx} 1°C of the maximum temperature of the past million years. BAU scenarios continue to grow at {approx} 2% per year in the first half of this century, and non- CO_2 positive forcings such as CH_4 , N_2O , O_3 , and black carbon (BC) aerosols also continue to grow. BAU, with nominal climate sensitivity ($3 \pm 1^{\circ}\text{C}$ for doubled CO_2), yields global warming (above year 2000 level) of at least $2\text{--}3^{\circ}\text{C}$ by 2100. The authors conclude that “global warming of more than {approx} 1°C , relative to 2000, will constitute 'dangerous' climate change as judged from likely effects on sea level and extermination of species.
41. National Academy of Sciences, *Rethinking the Ozone Problem in Urban and Regional Air Pollution*, pp. 109–62, National Academy Press, Washington, D.C. 1991.
42. United Nations Environment Programme and World Health Organization, *Urban Air Pollution in Magacities of the World*, Blackwell, Oxford, England, 1992.
43. Summer lightning over the United States causes a significant increase in regional ozone and other gases that affects air chemistry three to eight miles above the Earth’s surface. The amounts of ozone and nitrogen oxide that lightning creates surpass even those from human activities. Renyi Zhang, R., Xuexi Tie, X. & Bond, D.W. Impacts of anthropogenic and natural NO_x sources over the U.S. on tropospheric chemistry. Proc. Natl. Academy of Sci., vol. 100 | no. 4 | 1505–1509, Feb. 18, 2003. See also National Aeronautics and Space Administration, “Surprise! Lightning has Big Effect on Atmospheric Chemistry,” March 19, 2003, Proceedings of the National Academy of

Sciences.

44. Greenhut, G.K, Jochum, A.M. & Neininger, B. Boundary-layer turbulent transport and production/destruction of ozone during summertime smog episodes over the Swiss Plateau. *Earth and Environmental Science*, Volume 73, Number 4 / March, 1995.
45. The so-called “ozone layer” in the stratosphere keeps 95–99 percent of the sun's ultraviolet radiation from striking the earth. NASA Advanced Supercomputing Division, “Stratospheric Ozone Depletion” <http://www.nas.nasa.gov/About/Education/Ozone>
46. National Academy of Sciences, *Rethinking the Ozone Problem in Urban and Regional Air Pollution*, pp. 109–62, National Academy Press, Washington, D.C. 1991.
47. Volz, A. and Kley, D. Evaluation of the Montsouris series of ozone measurements made in the nineteenth century. *Nature* 332, 240–242 (17 March 1988).
Growing evidence that ozone levels in the lower troposphere over the continents of the Northern Hemisphere had been increasing during the previous decades led to a search for data from the early days of ozone monitoring, during the second half of the 19th century. Unfortunately, most measurements were then made using Schönbein test paper, giving only semi-quantitative information due to poor standardization and the influence of humidity and wind speed on its sensitivity 3–5. Volz and Kley reinvestigated a set of ozone measurements gathered at the Observatoire de Montsouris, located on the outskirts of Paris, where a quantitative method was established in 1876 and used continuously for 34 years. The evaluation of the technique, together with the analysis of nearly 3,000 of the original daily measurements that previously remained unnoticed in a statistical bulletin of the City of Paris, provided, according to the authors, “conclusive evidence” that ozone levels in central Europe 100 years ago averaged 10 p.p.b. and exhibited a seasonal variation, with a maximum during the spring months. “Comparisons with modern data show that ozone levels in rural areas have more than doubled over the past century and that the tropospheric ozone budget is now strongly influenced by photochemical production due to increased levels of NO_x.”
Other researchers reached similar conclusions. Anfossi D.; Sandroni S. Ozone levels in Paris one century ago. *Atmospheric Environment*, V. 31, No. 20, October 1997, pp. 3481-3482(2).
48. U.S. Environmental Protection Agency, “Air Pollution Monitoring,” <http://www.epa.gov/air/oaqps/montring.html#aqtrends>
49. According to the United Nations, -134a which replaced CFCs in mobile air conditions, has a global warming potential, expressed in 20 years, that is 3,400 times that of carbon dioxide, and an atmospheric lifetime of 14.6 years. United nations Framework Convention on Climate Change, “Global Warming Potentials,” <http://ghg.unfccc.int/gwp.html>.
- 50.

Chemical Name	Life-time in years	ODP1 (WMO 2002 ¹)	ODP2 (Montreal Protocol)	ODP3 (40 CFR)	GWP1 (WMO 2002)	GWP2 (SAR)	GWP3 (TAR)	GWP4 (40 CFR)	CAS No.
CFC-11 (CCl ₃ F) Trichlorofluoromethane	45	1.0	1.0	1.0	4680	3800	4600	4000	75-69-4
CFC-12 (CCl ₂ F ₂) Dichlorodifluoromethane	100	1.0	1.0	1.0	10720	8100	10600	8500	75-71-8
CFC-113 (C ₂ F ₃ Cl ₃) 1,1,2-Trichlorotrifluoroethane	85	1.0	0.8	1.0	6030	4800	6000	5000	76-13-1

¹The Scientific Assessment of Ozone Depletion, 2002 updated a limited number of GWPs and ODPs (semiempirical values for all updated ODPs except CFC-114 and CFC-115, which are model-derived). All GWPs and ODPs that were not updated in 2002 are 1998 values that have not changed.

Source: U.S. Environmental Protection Agency, "Class I Ozone-Depleting Substances," <http://www.epa.gov/ozone/ods.html>

51. Wilfred Bach and Atul K Jain, *From climate crisis to climate protection : how effective are the measures to reduce the man-made greenhouse warming?* Center for Applied Climatology and Environmental Studies. University of Munster (1991).
52. Although Assembly Bill 32 originated in the lower chamber, the Assembly, it was amended extensively by the Senate and passed on August 30 by a vote of 23 to 14. The next day, it was passed by the Assembly 46–31.
53. Doug Burns and Gary Lovett, "An Assessment of Recovery and Key Processes Affecting the Response of Surface Waters to Reduced Levels of Acid Precipitation in the Adirondack and Catskill Mountains ," New York State Energy Research and Development Authority, 2006.
54. Moore, Curtis; "Marketing Failure: The Experience with Air Pollution Trading in the United States," 34 ELR 10, 281 (March 2004); Johnson, Stephen; "Economics vs. Equity: Do Market-based Environmental Reforms Exacerbate Environmental Justice?" 56 Wash. & Lee L. Rev. 111 (1999).
55. <http://www.bloomberg.com/>, July 16, 2006.
56. Robert Gale, et. Al., *Green Budget Reform*, pp. 163–72, Earthscan Publications Limited (London, 1995).
57. Suvendrini Kakuchi, "Pollution victims seek cleaner growth," Asia Times, 3 July 1999.
58. The bill also requires the Energy Commission to develop tracking, accounting, verification and enforcement mechanisms for renewable energy credits that could be purchased by retail sellers of electricity who cannot meet the RPS. Each municipal utility must report annually on renewable resources in its generating portfolio and on progress toward meeting its RPS.

59. The final rulemaking package was filed with the Secretary of the State on September 15, 2005, to become effective on October 15, 2005.
<http://www.arb.ca.gov/regact/grnhsgas/grnhsgas.htm>
60. They are Edison International's Southern California Edison; PG&E Corp.'s Pacific Gas & Electric Co., and Sempra Energy's San Diego Gas & Electric Co.
61. Felicity Barringer, "California Air Is Cleaner, but Troubles Remain," The New York Times, August 3, 2005.
62. Also, Meyer, Mohaddes Associates, Inc., "Port of Los Angeles Baseline Transportation Study," http://www.portoflosangeles.org/DOC/REPORT_Draft_Traffic_Baseline.pdf
63. The Los Angeles/Long Beach Port complex has become the world's third largest. Andrea M. Hricko, "Road to an Unhealthy Future for Southern California's Children," University of Southern California Urban Initiative, Keck School of Medicine, University of Southern California, <http://www.scpcs.ucla.edu/news/CHSPolicyBrief.pdf>. See also William J. Kelly, "Ports of Cough," LA Weekly, September 22, 2005.
64. Southern California Association of Government, "Southern California Regional Strategy for Goods Movement: A Plan for Action, February, 2005," <http://www.scag.ca.gov/goodsmove/pdf/GoodsmovePaper0305.pdf>
65. Cancer risk estimates at the Ports of Los Angeles and Long Beach are about 1 per every 700 people exposed. This rate is far above the 1-in-a-million risk level considered acceptable by the U.S. EPA. Children and the elderly are most at risk. According to a report by the California Air Resources Board, air pollution from the ports caused 2,400 premature deaths, 62,000 asthma and lower respiratory symptoms, 360,000 lost work days, and 1,100,000 school absence days—in 2005 alone. Port air pollution's ill effects cost California's economy a staggering \$19 billion per year.
66. Macrophages in the lung's small air airways are the first line of host defense against inhaled organisms and soluble and particulate molecules. Fels AO & Cohn ZA. The alveolar macrophage. J Appl Physiol. 1986 Feb;60(2):353-69.
67. [12189]
KULKARNI, N., PIERSE, N., RUSHTON, L., & GRIGG, J.
Carbon in airway macrophages and lung function in children
N Engl J Med 2006; 355; 21-30 (6b)
Airway macrophages in 64 of 114 healthy children. General PM₁₀ exposure at home site evaluated by study of residence location and data from local monitors. Ambient exposure to PM₁₀ evaluated and an increase in primary PM₁₀ of 1.0 micrograms/ m³ was associated with an increase of 0.10 microns per square meter in the carbon content of airway macrophages. Also, each increase of 1.0 micron/square meter in carbon content was associated with a reduction of 17 percent in FEV₁, 12.9 percent in FVC, and 34.7 percent

in FEF_{25-75} . A few children with asthma also studied, and the carbon content of their macrophages was lower than in the normal children. All children were cotinine negative to exclude passive exposure to tobacco smoke, and none had any respiratory symptoms. All PFTs were within normal limits. Sputum induction methodology described. Lung function measured 20 minutes before sputum induction. Visual evaluation of area in macrophages occupied by black material using 100 randomly selected cells per child. Convincing association (with an r^2 of 0.13) between FEV_1 and median carbon area of the macrophages. Authors discuss the significance of the findings and believe that their data provide a link between environmental exposure and long term consequences in the children.

The abstract prepared by the research team described the study as follows:

Epidemiologic studies indirectly suggest that the inhalation of carbonaceous particulate matter impairs lung function in children. Using the carbon content of airway macrophages as a marker of individual exposure to particulate matter derived from fossil fuel, we sought direct evidence of this association.

METHODS: Airway macrophages were obtained from healthy children through sputum induction, and the area of airway macrophages occupied by carbon was measured. Lung function was measured with the use of spirometry. We modeled the exposure to primary particulate matter (PM) that is less than 10 μm in aerodynamic diameter (PM_{10}) at or near each child's home address. Linear regression was used to evaluate associations between carbon content of alveolar macrophages and variables that may affect individual exposure. To determine whether lung function that is reduced for other reasons is associated with an increase in the carbon content of airway macrophages, we also studied children with severe asthma. **RESULTS:** We were able to assess the carbon content of airway macrophages in 64 of 114 healthy children (56 percent). Each increase in primary PM_{10} of 1.0 microg per cubic meter was associated with an increase of 0.10 microm² (95 percent confidence interval, 0.01 to 0.18) in the carbon content of airway macrophages, and each increase of 1.0 microm² in carbon content was associated with a reduction of 17 percent (95 percent confidence interval, 5.6 to 28.4 percent) in forced expiratory volume in one second, of 12.9 percent (95 percent confidence interval, 0.9 to 24.8 percent) in forced vital capacity, and of 34.7 percent (95 percent confidence interval, 11.3 to 58.1 percent) in the forced expiratory flow between 25 and 75 percent of the forced vital capacity. The carbon content of airway macrophages was lower in children with asthma than in healthy children.

CONCLUSIONS: There is a dose-dependent inverse association between the carbon content of airway macrophages and lung function in children. We found no evidence that reduced lung function itself causes an increase in carbon content. Copyright 2006

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http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=16822993&dopt=Abstract

68. For each increase in primary PM_{10} of 1.0 micrograms per cubic meter was associated with an increase of 0.10 square micrometers in the carbon content of airway macrophages, and each increase of 1.0 microm² in carbon content was associated with a reduction of—

- 17 percent in forced expiratory volume in one second;
- 12.9 percent in forced vital capacity; and,
- 34 percent in forced expiratory flow between 25 and 75 percent of the forced vital capacity.

69. Hole DJ, Watt GC, Davey-Smith G, Hart CL, Gillis CR, Hawthorne VM. Impaired lung function and mortality risk in men and women: findings from the Renfrew and Paisley prospective population study. *BMJ* 1996;313:711–715.
- To assess the relation between forced expiratory volume in one second (FEV1) and subsequent mortality, 7058 men and 8353 women aged 45-64 years at baseline screening in 1972–76 were followed to determine mortality from all causes, ischaemic heart disease, cancer, lung and other cancers, stroke, respiratory disease, and other causes of death after 15 years of follow up. During the follow up period 2545 men and 1894 women died. Significant trends of increasing risk with diminishing FEV1 apparent for both sexes for all the causes of death examined after adjustment for age, cigarette smoking, diastolic blood pressure, cholesterol concentration, body mass index, and social class. The relative hazard ratios for all cause mortality for subjects in the lowest fifth of the FEV1 distribution were 1.92 (95% confidence interval 1.68 to 2.20) for men and 1.89 (1.63 to 2.20) for women. Corresponding relative hazard ratios were 1.56 (1.26 to 1.92) and 1.88 (1.44 to 2.47) for ischaemic heart disease, 2.53 (1.69 to 3.79) and 4.37 (1.84 to 10.42) for lung cancer, and 1.66 (1.07 to 2.59) and 1.65 (1.09 to 2.49) for stroke. Reduced FEV1 was also associated with an increased risk for each cause of death examined except cancer for lifelong nonsmokers.
- Impaired lung function is a major clinical indicator of mortality risk in men and women for a wide range of diseases. The use of FEV1 as part of any health assessment of middle aged patients should be considered. Smokers with reduced FEV1 should form a priority group for targeted advice to stop smoking.
70. [12190]
GAUDERMAN, W.J.
Editorial: Air Pollution and children – an unhealthy mix
New Engl J Med 2006; 355; 78–79
^(6b)
- 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.
- Comments on mounting evidence that exposure to urban air pollution induces long term effects in children. Assesses significance of previous paper [12189] and considers that it provides the first evidence of the mechanism whereby long term pollution exposure may induce chronic effects in the lung during childhood.
71. Bates D. V., Hogg J. C., Bruce N. G., Dherani M. K., Smith K. R., Gohil J. R., Grigg J. Inhaled Carbon and Lung Function in Children.
N Engl J Med 2006; 355:1496–1497, Oct 5, 2006.
Kulkarni and colleagues (July 6 issue)1 found that the level of carbon in airway

macrophages in children was strongly associated with expiratory flow rates, although in the 64 healthy children with sufficient numbers of airway macrophages for analysis, all these values were within generally acceptable normal limits. Why should this be? We suggest that this finding indicates that an accumulation of particles was a strong indicator of exposure to urban particulate air pollution and that exposure, in turn, is associated with chronic respiratory subclinical bronchiolitis. If so, we suggest that current exposures to urban pollution have to be taken very seriously.”

72. Gauderman W. J. Air Pollution and Children—An Unhealthy Mix. *N Engl J Med* 2006; 355:78–79, Jul 6, 2006.