Air Resources Board

State of California

Governor Arnold Schwarzenegger

October 2005 Revisions* to
Chapters 1-2
Appendix B
Reference Lists: (Chapters 1-11, Appendix B, and Appendix G)

of the March 11, 2005 Staff Report

Review of the California Ambient Air Quality Standard for Ozone

October 27, 2005

California Environmental Protection Agency

Air Resources Board

***Revisions noted in underline (new text) and strikeout (deleted text).**

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our Website: http://www.arb.ca.gov.

California Environmental Protection Agency

Alan C. Lloyd, Ph.D., Secretary

Printed on Recycled Paper

Chapter 1

Executive Summary

Chapter 2

Overview and Staff Recommendations

1 Executive Summary

The California Health and Safety Code in section 39606, requires the Air Resources Board to adopt ambient air quality standards at levels that adequately protect the health of the public, including infants and children, with an adequate margin of safety. Ambient air quality standards are the legal definition of clean air. In December 2000, as a requirement of the Children's Environmental Health Protection Act (Senate Bill 25, Escutia, Stats. 1999, Health and Safety Code 39606 (d)(1)), the Air Resources Board (ARB or Board), approved a report, "Adequacy of California Ambient Air Quality Standards" (ARB and OEHHA, 2000) that contained a brief review of all of the existing health-based California ambient air quality standards.

Following this review, the standard for ozone, currently set at 0.09 parts per million (ppm) for one hour, was prioritized to undergo full review after review of the standards for particulate matter and sulfates. Staff from ARB and the Office of Environmental Health Hazard Assessment (OEHHA) have reviewed the scientific literature on public exposure, atmospheric chemistry, health effects of exposure to ozone, and welfare effects. This Staff Report or Initial Statement of Reasons (Staff Report) presents the findings of the review and the staff recommendations to revise the ozone standard in order to adequately protect public health. The proposed amendments to the ambient air quality standard for ozone are based on the health effects review contained in Volume III of this Report and the recommendation of OEHHA, as required by Health and Safety Code section 39606(a)(2).

1.1 Summary of the Staff Report/Initial Statement of Reasons

1.1.1 Health Effects of Ozone

Controlled human exposure studies demonstrate that ~~Scientific studies show that exposure to~~ ozone exposure can result in reduced lung function, increased respiratory symptoms, increased airway hyperreactivity, and increased airway inflammation. Epidemiologic studies indicate that exposure to ozone is also associated with premature death, hospitalization for cardiopulmonary causes, emergency room visits for asthma, and restrictions in activity.

In controlled human exposure studies (see Chapter 9), exercising individuals exposed for 1 hour (hr) to an ozone concentration as low as 0.12 parts per million (ppm) or for 6.6 hours to a concentration as low as 0.08 ppm experienced lung function decrements and symptoms of respiratory irritation such as cough, wheeze, and pain upon deep inhalation. The lowest ozone concentrations at which airway hyperreactivity (an increase in the tendency of the airways to constrict in reaction to exposure to irritants) has been reported are 0.18 ppm ozone following 2-hour exposure in exercising subjects, 0.40 ppm following 2-hour exposure in resting subjects, and 0.08 ppm ozone in subjects exercising for 6.6 hr. Airway inflammation has been reported following 2-hour exposures to 0.20 ppm ozone and following 6.6-hour exposure to 0.08 ppm ozone.

Additional support for the exposure/response relationship for ozone health effects is derived from animal toxicological studies, which have shown that chronic ozone exposure can induce morphological (tissue) changes throughout the respiratory tract, particularly at the junction of the conducting airways and the gas exchange zone in the deep lung. In addition, the magnitude of ozone-induced effects is related to the inhaled dose (ozone concentration times breathing rate times exposure duration). Of these three factors ozone concentration is the most significant in predicting the magnitude of observed effects, followed by ventilation rate. Exposure duration has the least influence of the three factors.

Epidemiological studies (see Chapter 10) have shown positive associations between ozone levels and several health effects, including decreased lung function, respiratory symptoms, hospitalizations for cardiopulmonary causes, emergency room visits for asthma, and premature death. Children may be more affected by ozone than the general population due to effects on the developing lung and to relatively higher exposure than adults. There is little information available on the effects of ozone exposure on infants. Also, asthmatics may represent a sensitive sub-population for ozone. Since most California residents are exposed to levels at or above the current State ozone standard during some parts of the year, the statewide potential for significant health impacts associated with ozone exposure is large and wide-ranging.

1.1.2 Summary of Non-health Issues

The Staff Report contains reviews and discussions of non-health topics to provide a context for the health review and the staff recommendations for the State ozone standard. Almost all of the ozone in California's atmosphere results from reactions between substances emitted from sources including motor vehicles and other mobile sources, power plants, industrial plants, and consumer products. These reactions involve volatile organic compounds (VOC) and oxides of nitrogen (NO_X) in the presence of sunlight (Chapter 3). Ozone is a regional pollutant, as the reactions forming it take place over time, and downwind from the sources of the emissions. As a photochemical pollutant, ozone is formed only during daylight hours under appropriate conditions, but is destroyed throughout the day and night. Thus, ozone concentrations vary depending upon both the time of day and the location. Even in pristine areas there is some ambient ozone that forms from natural emissions that are not controllable (Chapter 4). This is termed "background" ozone. The average "background" ozone concentrations near sea level are in the range of 0.015 to 0.035 ppm, with a maximum of about 0.04 ppm.

The Staff Report includes an overview of statewide ozone precursor emissions that are involved in the formation of ozone (Chapter 5). The Staff Report also includes a discussion of the current ultraviolet photometry monitoring method, and a listing of approved samplers (Chapter 6). Although there are two measurement methods for ozone approved for use in the U.S. by the U.S. Environmental Protection Agency (USEPA), the method based on ultraviolet photometry is almost universally used in practice and is approved for use in California for state air quality standards.

The Staff Report includes a summary of current air quality in California, as well as long-term trends in statewide ozone concentrations (Chapter 7). Ozone is monitored continuously at approximately 175 sites in California. The highest number of exceedance days for both the State and federal 1-hour standards occurred in the San Joaquin Valley Air Basin and the South Coast Air Basin. Both areas had more than 115 State standard exceedance days and 31 or more federal standard exceedance days during each of the three years from 2001 through 2003. The Sacramento Metro Area, Mojave Desert Air Basin, and Salton Sea Air Basin all averaged more than 50 State standard exceedance days and averaged 6 or more federal standard exceedance days during 2001 through 2003. The remaining five areas (Mountain Counties Air Basin, San Diego Air Basin, San Francisco Bay Area Air Basin, South Central Coast Air Basin, and the Upper Sacramento Valley) averaged from 12 to 45 State standard exceedance days. The Upper Sacramento Valley area had no exceedances of the federal standard while the Mountain Counties Air Basin, San Diego Air Basin, San Francisco Bay Area Air Basin, and South Central Coast Air Basin each averaged 1 to 2 federal standard exceedance days for the three-year period.

The range of the measured maximum 1-hour concentrations tends to follow a similar pattern. The South Coast Air Basin showed the highest values, with measured concentrations of 0.169 ppm or higher during 2001 through 2003. The next highest 1-hour ozone concentrations occurred in the Salton Sea Air Basin and San Joaquin Valley Air Basin, which had concentrations of 0.149 ppm or higher during all three years. During 2001 through 2003, neither the State nor federal 1-hour standard was exceeded in the Lake County Air Basin, North Coast Air Basin, or Northeast Plateau Air Basin. Data for four additional areas, Great Basin Valleys Air Basin, Lake Tahoe Air Basin, North Central Coast Air Basin, and the Upper Sacramento Valley show exceedances of the State standard, but not the federal 1-hour standard (as described earlier, representative data for the Northeast Plateau Air Basin and Great Basin Valleys Air Basin are available for 2002 and 2003 only). Both the State and federal 1-hour standards were exceeded during at least two of the three years in all other areas.

Californians' indoor and personal exposures to ozone are largely determined by the outdoor ozone concentrations in their community. Nonetheless, some Californians experience a substantial exposure to ozone indoors, due to the increasing use of certain types of appliances and equipment that emit ozone. Children and those who are employed in outdoor occupations or exercise heavily outdoors, experience substantially greater exposures to ozone than the rest of the population, because they spend time outdoors during peak ozone periods.

A review of welfare effects, including effects of ozone on forest trees, agricultural crops, and materials is also discussed in this report (Chapter 8). Elevated concentrations of ozone can cause adverse effects on agricultural crops, forest trees and materials at current ambient levels, and the proposed health-based ozone standards should also provide protection to crops, forests and materials. In broad terms, impacts to crops are generally more severe than for forest trees owing to their inherently more vigorous rates of growth. Discussed in the subsection on crops and the methods used to expose plants to ozone. This is followed by an examination of the physiological basis of ozone damage to plants, with special emphasis on carbon metabolism and the resulting impacts on crop growth and yield. Data collected since the 1950s on mixed conifer forests in the San Bernardino Mountains and the Sierra Nevada indicate that increasing numbers of ponderosa and Jeffrey pines exhibit ozone-specific needle damage due to the pollutant's cumulative effects. Also discussed are the impacts of ozone on materials, including building materials, rubber, paint, and fabrics. Although the proposed ozone standards are based on human health effects, progress toward attaining the proposed standards will provide welfare benefits.

1.2 Staff Recommendations for the Ozone Standard

California ambient air quality standards are defined in the Health and Safety Code section 39014, and 17 Cal. Code Regs. section 70101, and comprise four elements: (1) a definition of the air pollutant, (2) an averaging time, (3) a pollutant concentration, and (4) a monitoring method to determine attainment of the standard. The current California ambient air quality standard for ozone is 0.09 ppm averaged over one hour and was set by the Board in 1988. The data indicate that the current standard alone is not sufficiently protective of human health. Based on the review of the scientific literature and recommendations by OEHHA, the staff recommends that the following revisions be made to the California ambient air quality standard for ozone:

1. Ozone will continue to be the pollutant addressed by the standard.
2. Ozone 1-hour-average Standard – retain the current 1-hour-average standard for ozone at **0.09 ppm, not to be exceeded**.
3. Ozone 8-hour-average Standard – establish a new 8-hour-average standard for ozone at **0.070 ppm**, **not to be exceeded.**
4. Ozone Monitoring Method: retain the current monitoring method for ozone which uses the ultraviolet (UV) photometry method for determining compliance with the State ambient air quality standard for ozone. Incorporate by reference (17 Cal. Code Regs. section 70101) all federally approved UV methods (i.e., samplers) for ozone as "California Approved Samplers". This will result in no change in air monitoring equipment practices, but will align state monitoring requirements with federal requirements.

These recommendations are based on the following findings:

a. Reduced lung function and increased respiratory or ventilatory symptoms following 1-hour exposure to 0.12 ppm ozone with moderate to heavy exercise.

b. Increased airway hyperreactivity following 2-hour exposure to 0.18 ppm in exercising subjects.

c. Airway inflammation following 2-hour exposure to 0.20 ppm ozone in exercising subjects

d. Reduced lung function, increased respiratory and ventilatory symptoms, increased airway hyperreactivity, and increased airway inflammation following 6.6 to 8-hour exposure to 0.08 ppm ozone.

e. Evidence from epidemiological studies of several health endpoints at current ambient concentrations of ozone including premature death, hospitalization, respiratory symptoms, and restrictions in activity and lung function.

f. Evidence from epidemiological studies of emergency room visits for asthma suggesting a possible threshold concentration between 0.075 and 0.11 ppm from analyses based on a 1-hour averaging time, and a possible threshold concentration between 0.070 and 0.10 ppm from analyses based on an 8-hour averaging time.

g. There is no evidence that children and infants respond to lower ozone concentrations than adults. Their risk is primarily related to their greater ventilation rate and greater exposure duration.

h. The dose-rate of ozone inhalation influences the magnitude of observed effects.

The staff recommendations for revision of the California ambient air quality standard for ozone are primarily based on controlled human exposure studies. Epidemiologic data contributed to development of the margin of safety.

1.3 Other Recommendations

In light of the adverse health effects observed at current ambient concentrations and the lack of a demonstrated effect threshold for the population as a whole, staff makes the following comments:

1. Fund additional research investigating the responses of human subjects to multi-hour exposures to ozone concentrations between 0.04 and 0.08 ppm.
2. The standards should be revisited within five years, in order to re-evaluate the evidence regarding the health effects associated with ozone exposure.
3. In any air basin in California that currently attains the ambient air quality standards for ozone, air quality should not be degraded from present levels.

1.4 Estimated Health ~~Benefits~~ Impacts of Ozone Exposure

~~Staff estimates that attainment of the proposed ozone standards throughout California would avoid a significant number of adverse health effects each year, specifically:~~

Exposure to ozone at current ambient levels has substantial health impacts, including, but not limited to, death, hospitalization, emergency room visits, and symptoms of respiratory irritation. Staff estimates that the annual health impact of exposure to ozone at current levels, compared to attainment of the proposed State 8-hour and 1-hour ozone standards throughout California includes:

- 630 (310 – 950 probable range) ~~580 (290 – 870, probable range)~~ premature deaths for all ages.
- 4,200 (2,400 - 5,800, 95% confidence interval (CI)) ~~3,800 (2,200 – 5,400, 95% confidence interval (CI))~~ hospitalizations due to respiratory diseases for all ages.
- 660 (400 – 920, 95% CI) ~~600 (360 – 850, 95% CI)~~ emergency room visits for asthma for children under 18 years of age.
- 4.7 million (1,200,000 – 8,600,000, 95% CI) ~~3.3 million (430,000 – 6,100,000, 95% CI)~~ school absences for children 5 to 17 years of age.
- 3.1 million (1.3 million – 5.0 million, 95% CI) ~~2.8 million (1.2 million – 4.6 million, 95% CI)~~ minor restricted activity days for adults above 18 years of age.

These health impact estimates are based on the results of epidemiologic studies on the health effects of ozone exposure and an exposure reduction methodology modified from analyses conducted by the U.S. EPA and other investigators (see Appendix B). The health impacts estimates were made for only a small number of the known health effects of ozone exposure and, consequently, underestimate the total public health impact. The health impacts assessment was not used to select the appropriate levels of the proposed ozone standards.

For comparison purposes, we also estimated the health impacts o current ozone levels compared to attainment of the federal 8-hour ozone standard of 0.08 ppm, and the health impacts of current ozone levels compared to attainment of the State 1-hour ozone standard alone. Specifically, we estimate that 360 (180 – 550, probable range) premature deaths annually are related to current ozone levels, compared to statewide attainment of the federal 8-hour standard, and about 540 (270 – 810, probable range) premature deaths annually are related to current ozone levels, compared to statewide attainment of the State 1-hour standard. Results for other health endpoints are in Appendix B.

The differences between the results are the “incremental” impacts of not attaining the State 1-hour and 8-hour standards, compared to the federal 8-hour ozone standard. However, it is more reasonable to consider attainment of the two State standards together, compared to current ozone levels, since it is unlikely that control strategies will be geared to fist attain one standard and then the other. Nonetheless, the current impact of not attaining the federal 8-hour standard is about 360 premature deaths annually, with an additional 270 deaths associated with not attaining the proposed State 8-hour standard, making the total estimated impact of not attaining both standards 630 deaths. Similarly, the current impact of not attaining the State 1-hour standard is about 540 premature deaths annually, with an additional 90 deaths associated with not attaining the proposed 8-hour standard, making the total estimated impact of not attaining both the State 1-hour and 8-hour ozone standards 630 premature deaths. More detailed discussion of this analysis is available in Appendix B.

As discussed in Appendix B, there are a several important assumptions and uncertainties in this analysis. Some have to do with study design, statistical methods, and choice of epidemiological studies used to develop the concentration-response (CR) functions used in the analysis. Few studies have investigated the shape of the CR function, or whether there is a population response threshold for health endpoints other than emergency room visits for asthma. Further uncertainty is added by assumptions in the statewide exposure assessment. It should also be noted that since several health effects related to acute exposure, and effects of chronic ozone exposure, are not included in the estimates, the health benefits associated with lowering ozone exposure are likely underestimated.

1.5 Public and Peer Review of the Staff Recommendations

The draft version of this Staff Report was released to the public on June 21, 2004 and presented for review and comment at public workshops during 2004 on July 14 in Sacramento, July 15 in El Monte, July 16 in Fresno, and August 25 in Sacramento.

The draft Staff Report was peer reviewed by the Air Quality Advisory Committee (AQAC). AQAC is a scientific peer review committee, appointed by the University of California, to independently evaluate the scientific basis of staff findings and recommendations in the draft Staff Report for revising the California ambient air quality standard for ozone. The AQAC held a public meeting to discuss its review of the draft Staff Report, comments submitted by the public, and staff responses to those comments. AQAC concluded that the report was well written and researched, and that the proposed revision to the State ozone standard was adequately supported. AQAC findings, public comments, and staff responses can be found in Appendices C-E. Following the meeting of the Air Quality Advisory Committee (AQAC), staff revised the draft Staff Report based on comments received from AQAC and the public.

1.6 Environmental and Economic Impacts

The proposed ambient air quality standards will in and of themselves have no environmental or economic impacts. Standards simply define clean air. Once adopted, local air pollution control or air quality management districts are responsible for the adoption of rules and regulations to control emissions from stationary sources to assure their achievement and maintenance. The ARB is responsible for adoption of emission standards for mobile sources and consumer products. A number of different implementation measures are possible, and each could have its own environmental or economic impact. These impacts must be evaluated when the control measure is proposed. Any environmental or economic impacts associated with the imposition of future measures will be considered if and when specific measures are proposed.

1.7 Environmental Justice Considerations

State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. The available literature suggests there appears to be no special vulnerability related to race, ethnicity or income level, although there may be higher exposure. Ambient air quality standards define clean air; therefore, all of California's communities will benefit from the proposed health-based standards.

1.8 Comment Period and Board Hearing

Release of this Staff Report opens the official 45-day public comment period required by the Administrative Procedure Act prior to the public meeting of the Air Resources Board to consider the staff's recommendations. Please direct all comments to either the following postal or electronic mail address:

Clerk of the Board
Air Resources Board
1001 "I" Street, 23rd Floor
Sacramento, California 95814
ozone05@listserve.arb.ca.gov

To be considered by the Board, written submissions not physically submitted at the hearing must be received at the ARB no later than 12:00 noon, April 27, 2005. Public workshops will be scheduled for April 2005 to present the final staff recommendations and receive public input on the Staff Report. Information on these workshops, as well as summaries of the presentations from past workshops and meetings are available by calling 1-916-445-0753 or at the following ARB website:
http://www.arb.ca.gov/research/aaqs/ozone-rs/ozone-rs.htm.

An oral report summarizing the staff recommendations for revising the ozone standard will be presented to the Board at a public hearing scheduled for April 28, 2005.

The staff recommends that the Board adopt the proposed amendments to the ambient air quality standards for ozone as stated above. The proposed amendments and their basis are described in detail in this Staff Report, which contains the findings of ARB and OEHHA staff's full review of the public health, scientific literature, and exposure pattern data for ozone in California. Due to the extensive nature of the literature review and the hundreds of studies reviewed, the Staff Report is divided into four volumes. Volume I contains the Executive Summary, Overview and Staff Recommendations, and Appendix A, the proposed amendments to the California Code of Regulations (amended regulatory text). Volumes II through IV present more detailed discussions of the material that is summarized in Volume I. Volume II includes background material on non-health topics, including chemistry of ozone formation and deposition, ozone precursor sources and emissions, ozone exposure and background levels, measurement methods, and welfare effects of ozone exposure. Volume III contains a summary of ozone health effects and an in-depth discussion of the basis for the staff recommendation. Volume IV includes several appendices, including an analysis of the estimated health benefits associated with attainment of the proposed standards, summaries of Air Quality Advisory Committee and public comments and staff responses, and supplemental animal toxicologic data.

1.9 References

Air Resources Board and Office of Environmental Health Hazard Assessment (2000). Adequacy of California Ambient Air Quality Standards: Children's Environmental Health Protection Act. Staff Report. Sacramento, CA. Available at http://www.arb.ca.gov/ch/programs/sb25/airstandards.htm.

2 Overview and Staff Recommendations

Ozone (O_3) can damage human cells upon contact, and has been implicated in a variety of adverse health effects. Scientific studies show that exposure to ozone can result in reduced lung function, increased respiratory symptoms, increased airway hyperreactivity, and airway inflammation. Exposure to ozone is also associated with premature death, hospitalization for cardiopulmonary causes, emergency room visits for asthma, and restrictions in activity. Ozone forms in the atmosphere as the result of reactions involving sunlight and two classes of directly emitted precursors. One class of precursors includes nitric oxide (NO) and nitrogen dioxide (NO_2), collectively referred to as nitrogen oxides or NO_X. The other class of precursors includes volatile organic compounds (VOCs, also called reactive organic gases or ROG), such as hydrocarbons. Ozone forms in greater quantities on hot, sunny, calm days. In metropolitan areas of California and areas downwind, ozone concentrations frequently exceed existing health-protective standards in the summertime. The current California ambient air quality standard for ozone is 0.09 ppm for one hour.

The sources of ozone precursor emissions within California have been grouped into three major categories: point sources, which are distinct facilities such as power plants and factories; mobile sources, which includes cars, trucks, and off-road mobile equipment; and area-wide sources, which include agricultural and construction activities, and consumer products. VOCs are emitted from vehicles, factories, fossil fuels combustion, evaporation of paints, and many other sources. NO_X is emitted from high-temperature combustion processes, such as at power plants or in motor vehicle exhaust .

The concentrations of ozone measured in the air vary both regionally and seasonally throughout California. For example, the Los Angeles area and the San Joaquin Valley experience highest ozone levels in the state. Ozone concentrations are typically higher during the summer months than the winter months.

To help understand which sources contribute to high ozone levels, the ARB has developed and maintains detailed facility and source specific estimates of the overall estimated ozone precursor emissions. Only the precursor gases are estimated. As a complement to emission inventory and routinely collected air quality monitoring data, the ARB conducts atmospheric modeling, using these precursor emission inventories and other appropriate information, to estimate ozone levels

2.1 Setting California Ambient Air Quality Standards

Ambient air quality standards (AAQS) represent the legal definition of clean air. They specify concentrations and durations of exposure to air pollutants that reflect the relationships between the intensities and composition of air pollution and undesirable effects (Health and Safety Code section 39014). The objective of an AAQS is to provide a basis for preventing or abating adverse health or welfare effects of air pollution (17 Cal. Code Regs. section 70101).

Health and Safety Code section 39606(a)(2) authorizes the Air Resources Board (Board) to adopt standards for ambient air quality "in consideration of public health, safety, and welfare, including, but not limited to, health, illness, irritation to the senses, aesthetic value, interference with visibility, and effects on the economy." Standards represent the highest pollutant concentration for a given averaging time that is estimated to be without adverse effects for most people. Standards are set to ensure that sensitive population sub-groups are protected from exposure to levels of pollutants that may cause adverse health effects. A margin of safety is added to account for possible deficiencies in the data and measuring methodology. Health-based standards are based on the recommendation of the Office of Environmental Health Hazard Health Assessment (OEHHA).

Recent legislation requires that infants and children be given special consideration when ambient air quality standards are adopted. As part of its recommendation to the ARB, the statute requires OEHHA to use current principles, practices, and methods used by public health professionals to assess the following considerations for infants and children:

1. Exposure patterns among infants and children that are likely to result in disproportionately high exposure to ambient air pollutants in comparison to the general population.
2. Special susceptibility of infants and children to ambient air pollutants in comparison to the general population.
3. The effects on infants and children of exposure to ambient air pollutants and other substances that have a common mechanism of toxicity.
4. The interaction of multiple air pollutants on infants and children, including the interaction between criteria air pollutants and toxic air contaminants.

The law also requires that the scientific basis or the scientific portion of the method used to assess these considerations be peer reviewed (Health and Safety Code section 39606(c)). The draft Staff recommendations and their bases, including OEHHA's assessment and recommendation, is peer reviewed by the Air Quality Advisory Committee (AQAC). AQAC is an external peer review committee established in accordance with section 57004 of the Health and Safety Code and appointed by the President of the University of California a University of California. The AQAC meets to independently evaluate the scientific basis of draft recommendations for revising the California ambient air quality standards.

Ambient air quality standards should not be interpreted as permitting, encouraging, or condoning degradation of present air quality that is superior to that stipulated in the standards. Rather, they represent the minimum acceptable air quality. An AAQS adopted by the Board is implemented, achieved, and maintained by numerous rules and regulations that limit pollution from specific sources of ozone precursors. These rules and regulations are primarily, though not exclusively, emission limitations established by the regional and local air pollution control and air quality management districts for stationary sources, and by the Board for vehicular sources and consumer products (see generally, Health and Safety Code sections 39002, 40000, and 40001).

2.2 Current California Ambient Air Quality Standard for Ozone

The current California ambient air quality standard for ozone, established in 1988, is 0.09 ppm (180 µg/m^3) for a one-hour average. This value is not to be exceeded. This standard was established based on the following most relevant effects, which are listed in the table of standards (17 Cal. Code Regs. section 70200):

a. Short-term exposures:

(1) Pulmonary function decrements and localized lung edema in humans and animals.

(2) Risk to public health implied by alterations in pulmonary morphology and host defence in animals.

b. Long-term exposures: Risk to public health implied by altered pulmonary morphology in animals after long-term exposures and pulmonary function decrements in chronically exposed humans.

c. Welfare effects:

(1) Yield loss in important crops and predicted economic loss to growers and consumers.

(2) Injury and damage to native plants and potential changes in species diversity and number.

(3) Damage to rubber and elastomers and to paints, fabric, dyes, pigments, and plastics.

The US EPA has set national ambient air quality standards, as noted in the table below. The federal one-hour standard will be phased out beginning in June 2005. The Federal Clean Air Act gives California authority to set its own ambient air quality standards in consideration of statewide concerns. California has the largest number of exceedances of the Federal 8-hour ozone standard in the United States, supporting California’s need to address a significant statewide public health issue.

Current Ambient Air Quality Standards for Ozone

Averaging Time	California Standard	Federal Standard
1 Hour	0.09 ppm (180 µg/m^3)	0.12 ppm (235 µg/m^3)
8 Hour	—	0.08 ppm (157 µg/m^3)

2.3 History of Ozone/Oxidant Standards

The first state oxidant standard was set in December 1959 by the state Department of Public Health (DPH), which had the responsibility for setting air pollution standards before the creation of the ARB. This standard was set at 0.15 ppm, averaged for one hour. The standard was for oxidant, rather than ozone, because the monitoring method available at that time, the potassium iodide (KI) method, measured all ambient oxidant gases, including ozone and other oxidants such as peroxyacetyl nitrate (PAN) nitrogen dioxide, photochemical aerosols, and other unknown oxidants.

In 1969, the newly-created ARB reviewed the oxidant standard set by DPH and revised the standard to a concentration of 0.10 ppm, averaged over one hour, not to be equaled or exceeded. The information considered by the Board in 1969 included adverse effects upon: (1) the health of humans and animals; (2) vegetation; (3) materials; and (4) visibility. Eye irritation was listed as the most relevant effect of oxidant.

In 1974, the Board introduced ultraviolet photometry as the monitoring method for the standard. However, since ultraviolet photometry measures only ozone, the Board changed the designation of the standard from “oxidant” to “oxidant (as ozone).” Because only ozone was to be measured, the Board changed the most relevant effect from: “eye irritation” (which is caused primarily by peroxyacyl nitrates or PANs) to “aggravation of respiratory disease” (which is caused primarily by ozone).

In 1988, the Board changed the designation of the standard from “oxidant (as ozone)” to "ozone", and revised the standard to a concentration of 0.09 ppm, averaged over one hour, to reflect that the listed relevant effects were related to ozone exposure, rather than to oxidants in general.

For comparison, in 2000, the World Health Organization established a guideline value for ozone in ambient air of 120 $\mu g/m^3$ (0.061 ppm) for a maximum period of 8 hours per day (WHO 2000).

2.4 Review of the California Ambient Air Quality Standards

The Children's Environmental Health Protection Act (Senate Bill 25, Escutia, Stats. 1999, ch. 731) required the ARB, in consultation with the OEHHA, to evaluate all health-based standards by December 31, 2000, to determine whether the standards were adequately protective of the health of the public, including infants and children (Health and Safety Code section 39606 (d)). At its December 7, 2000 meeting, the Board approved a report, “Adequacy of California Ambient Air Quality Standards: Children's Environmental Health Protection Act” (ARB, et al., 2000), prepared by ARB and OEHHA staffs. The Adequacy Report concluded that health effects may occur in infants and children and other potentially susceptible subgroups exposed to ozone at or near levels corresponding to the current standard. The report identified the standard for ozone as having the second highest priority for further detailed review and possible revision. The standard for PM10 (including sulfates) had the highest priority and was reviewed and revised in 2002, including establishment of a new standard for PM2.5.

2.5 Findings of the Standard Review

2.5.1 Chemistry and Physics

Most of the ozone in California’s air results from reactions between substances emitted from sources including motor vehicles, power plants, industrial plants, consumer products, and vegetation. These reactions involve volatile organic compounds (VOCs, which the ARB also refers to as reactive organic gases or ROG) and oxides of nitrogen (NO_X) in the presence of sunlight. Ozone is a regional pollutant, as the reactions forming it take place over time, and downwind from the precursor sources. As a photochemical pollutant, ozone is formed only during daylight hours under appropriate conditions, but is destroyed throughout the day and night. Thus, ozone concentrations vary depending upon both the time of day and the location. Ozone concentrations are higher on hot, sunny, calm days. In metropolitan and downwind areas of California, ozone concentrations frequently exceed regulatory standards during the summer.

2.5.2 Ozone Background

Even in pristine areas there is some ambient ozone that forms from natural emissions that are not controllable. This is termed “background” ozone. Overall, it appears that “background” ozone in California is dominated by natural tropospheric and stratospheric processes. The effects of occasional very large biomass fires and anthropogenic emissions are secondary factors. The foregoing discussion indicates that average “natural background” ozone near sea level is in the range of 0.015 to 0.035 ppm, with a maximum of about 0.04 ppm. Exogenous enhancements to “natural” levels generally are small (about 0.005 ppm), and are unlikely to alter peak concentrations.

At altitudes above 2 km stratospheric intrusions can push peak ambient concentrations to 0.045 to 0.050 ppm. The timing, spatial extent, and chemical characteristics of stratospheric air mass intrusions makes these events recognizable in air quality records, providing that the affected region has a fairly extensive monitoring network and that multiple air quality parameters (CO, VOC, PM, RH) are being measured as well.

Intermittent episodes of “natural” ozone from very large biomass fires in boreal forests (Alaska, Canada, Siberia) can produce short-lived pulses of ozone up to 0.020 ppm that may arrive during the North American ozone season. Present understanding suggests that these are infrequent events at latitudes below about 50N. There are no data documenting such an event in California. Long range transport of anthropogenic ozone may grow as Asian energy consumption increases the continent’s NO_X emissions. Model studies indicate that the Asian ozone increment in North America could double over the next few decades. Assuming the temporal pattern of transport remains unchanged, such an impact could increase mean ozone concentrations by 0.002 to 0.006 ppm. The potential effect on peak transport events is unknown at this time.

2.5.3 Ozone Precursor Emissions

Ozone is an oxidant gas that forms photochemically in the atmosphere when nitrogen oxides (NO_X) and reactive organic gases (ROG) are present under appropriate atmospheric conditions (see Chapter 5). Carbon monoxide (CO) is also an ozone precursor. Both ROG and NO_X are emitted from mobile sources, point sources, and area-wide sources. ROG emissions from anthropogenic sources result primarily from incomplete fuel combustion, and from the evaporation of solvents and fuels, while NO_X and CO emissions result almost entirely from combustion processes.

2.5.4 Monitoring Method

Two measurement methods for ozone are approved for use in the U.S. by the USEPA: one is based on the chemiluminescence that occurs when ozone and ethylene react, and the other on the attenuation of ultraviolet (UV) radiation by ozone. The method based on UV spectrometry is almost universally used in practice. Specifications and criteria for both methods exist in federal regulation. The UV photometry-based method is approved for use in California for state air quality standards. Both state and federal requirements are applied directly by the ARB and the air districts in the ozone monitoring network in California.

2.5.5 Exposure

During 2001 through 2003, neither the State nor federal 1-hour standard was exceeded in the Lake County Air Basin, North Coast Air Basin, or Northeast Plateau Air Basin. Data for four additional areas, Great Basin Valleys Air Basin, Lake Tahoe Air Basin, North Central Coast Air Basin, and the Upper Sacramento Valley show exceedances of the State standard, but not the federal 1-hour standard (as described earlier, representative data for the Northeast Plateau Air Basin and Great Basin Valleys Air Basin are available for 2002 and 2003 only). Both the State and federal 1-hour standards were exceeded during at least two of the three years in all other areas.

The highest 8-hour average values were found in the South Coast Air Basin and San Joaquin Valley Air Basin. Maximum 8-hour concentrations in the South Coast Air Basin ranged from 0.144 ppm to 0.153 ppm during 2001 through 2003, while maximum 8-hour concentrations in the San Joaquin Valley ranged from 0.120 ppm to 0.132 ppm during the same three-year period. Three other areas, the Mojave Desert Air Basin, the Sacramento Metro Area, and the Salton Sea Air Basin also had a maximum 8-hour concentration above 0.120 ppm during at least one of the three years.

With respect to the federal 8-hour ozone standard, Lake County Air Basin and North Coast Air Basin showed no exceedance days during 2001 through 2003. One area, the Lake Tahoe Air Basin, averaged only one exceedance day for the three-year period, while the North Central Coast Air Basin averaged three 8-hour exceedance days. In contrast, the San Joaquin Valley Air Basin showed the highest average number of exceedance days (123), followed by the South Coast Air Basin (99). The Sacramento Metro Area, Mojave Desert Air Basin, Mountain Counties Air Basin, and Salton Sea Air Basin each averaged between 42 and 68 exceedance days during 2001 through 2003. The remaining four areas averaged between 7 and 25 federal 8-hour exceedance days during the three-year period.

Californians’ indoor and personal exposures to ozone are largely determined by the outdoor ozone concentrations in their community. Nonetheless, some Californians experience a substantial exposure to ozone indoors, due to the increasing use of certain types of appliances and equipment that emit ozone. Others, such as many children and those who are employed in outdoor occupations, may experience substantially greater exposures to ozone than the rest of the population, because they spend time outdoors during peak ozone periods.

2.5.6 Welfare Effects

A review of welfare effects, including effects of ozone on forest trees, agricultural crops, and materials is also discussed in this report (Chapter 8). Elevated concentrations of ozone can cause adverse effects on agricultural crops, forest trees and materials at current ambient levels, and the proposed health-based ozone standards should also provide protection to crops, forests and materials. In broad terms, impacts to crops are generally more severe than for forest trees owing to their inherently more vigorous rates of growth. Discussed in the subsection on crops and the methods used to expose plants to ozone. This is followed by an examination of the physiological basis of ozone damage to plants, with special emphasis on carbon metabolism and the resulting impacts on crop growth and yield. Data collected since the 1950s on mixed conifer forests in the San Bernardino Mountains and the Sierra Nevada indicate that increasing numbers of ponderosa and Jeffrey pines exhibit ozone-specific needle damage due to the pollutant's cumulative effects. Also discussed are the impacts of ozone on materials, including building materials, rubber, paint, and fabrics. Although the proposed ozone standards are based on human health effects, progress toward attaining the proposed standards will provide welfare benefits.

2.5.7 Health Effects

Review of the controlled human exposure, animal toxicology and epidemiologic literature led to the following conclusions as to the health effects of ozone exposure:

1. The lowest ozone concentration at which reduced lung function and increased respiratory and ventilatory symptoms have been observed following 1-hour exposure is 0.12 ppm with moderate to heavy exercise.
2. The lowest ozone concentration at which increased airway hyperreactivity following 2-hour exposure has been reported is 0.18 ppm in exercising subjects.
3. The lowest ozone concentration at which airway inflammation following 2-hour exposure has been reported is 0.20 ppm ozone in exercising subjects
4. Reduced lung function, increased respiratory and ventilatory symptoms, increased airway hyperreactivity, and increased airway inflammation have been reported following 6.6- to 8-hour exposure to 0.08 ppm ozone.
5. Evidence from epidemiological studies of several health endpoints including premature death, hospitalization, respiratory symptoms, and restrictions in activity and lung function.
6. Evidence from epidemiological studies of emergency room visits for asthma suggests a possible threshold concentration between 0.075 and 0.11 ppm from analyses based on a 1-hour averaging time, and a possible threshold concentration between 0.070 and 0.10 ppm from analyses based on an 8-hour averaging time.
7. There is no evidence that children and infants respond to lower ozone concentrations than adults. Their risk is primarily related to their greater ventilation rate and greater exposure duration.
8. The dose-rate of ozone inhalation influences the magnitude of observed effects.

2.6 Summary of Recommendations

Following a detailed review of the scientific literature on the health and welfare effects of ozone, staff is proposing to revise the ambient air quality standard for ozone. The recommended ozone standards are based on scientific information about the health impacts associated with ozone exposure, recognizing the uncertainties in these data. The definition of California ambient air quality standards assumes a threshold below which effects do not occur. However, the extremely wide range of individual responsiveness to ozone makes identification of a threshold on a population level somewhat problematic. In addition, the Children's Environmental Health Protection Act [Senate Bill 25, Escutia; Stats. 1999, Ch. 731, H&SC section 39606(d)(2)] requires a standard that "adequately protects the health of the public, including infants and children, with an adequate margin of safety." Recognizing the uncertainties in the database, staff makes the following recommendations.

1. Ozone will continue to be the pollutant addressed by the standard.
2. One-hour ambient air quality standard: staff recommends retaining the current 1-hour ozone standard at a concentration of **0.09 ppm**, not to be exceeded, based on several factors. First, at 0.12 ppm, in several studies 10 - 25% of the subjects experienced a decline of 10% of more in FEV1. In one study, these lung function changes were accompanied by increases in cough. At 0.24 ppm, increases were also observed in shortness of breath and pain on deep breath. These lung function and symptom outcomes have been demonstrated and replicated in several carefully controlled human exposure studies. The population at risk for these effects includes children and adults engaged in active outdoor exercise and workers engaged in physical labor outdoors. Thus, a margin of safety is necessary to account for variability in human responses. In addition, the chamber studies, by design, do not include potentially vulnerable populations (e.g., people with moderate to severe asthma, Chronic Obstructive Pulmonary Disease or COPD, and heart disease) who may be incorporated in the epidemiologic studies.

   Second, chamber studies indicate that bronchial responsiveness and pulmonary inflammation occur with 1-hour exposure to 0.18 to 0.20 ppm. Bronchial responsiveness can aggravate pre-existing chronic respiratory disease. The ultimate impact of the inflammatory response is unclear but repeated exposures to high ozone levels may result in restructuring of the airways, fibrosis, and possibly permanent respiratory injury. These latter outcomes are supported by animal toxicology studies, which also suggest the possibility of decreases in lung defense mechanisms.

   Third, epidemiological studies completed over the last 10 years indicate the potential for severe adverse health outcomes including premature death, hospitalizations, and emergency room visits. These studies include concentrations to which the public is currently being exposed. It is possible that some of these associations are due to relatively short-term exposures, for example less than two hours, since people at risk of experiencing these endpoints are unlikely to be engaged in multi-hour periods of moderate or heavy work or exercise outdoors. However, since there is high temporal correlation between 1-, 8-, and 24-hour average ozone concentrations, the averaging time of concern cannot be discerned from these studies.

   Viewing all of the evidence, staff recommends retention of the 1-hour standard of 0.09 ppm, not to be exceeded, as being protective of public health with an adequate margin of safety.
3. Eight-hour ambient air quality standard: We recommend establishing a new 8-hour average standard of **0.070 ppm**, not to be exceeded. Our recommendation for the 8-hour standard is based primarily on the chamber studies that have been conducted

over the last 15 years, supported by the important health outcomes reported in many of the epidemiologic studies. With exposure for 6.6 to 8-hours to an ozone concentration of 0.08 ppm, several studies have reported statistically significant group effects on lung function changes, ventilatory and respiratory symptoms, airway hyperresponsiveness, and airway inflammation in healthy, exercising individuals. A substantial fraction of subjects in these studies exhibited particularly marked responses in lung function and symptoms. Consequently, a concentration of 0.08 ppm ozone for an 8-hour averaging time can not be considered adequately protective of public health, and does not include any margin of safety, based on the definitions put forth in State law. The one published multi-hour study investigating a concentration below 0.08 ppm showed no statistically significant group mean decrement in lung function or symptoms at 0.04 ppm compared to a baseline of clear air. In addition, all individual subjects had changes in FEV1 of less than 10%. One unpublished multi-hour study at 0.06 ppm (Adams 1998) reported no statistically significant group mean changes, relative to clean air, in either lung function or symptoms including pain on deep inhalation and total symptom score. Therefore, staff has recommended an 8-hour concentration of 0.070 ppm. Many of the studies, and issues and concerns associated with the epidemiological studies listed above concerning the 1-hour standard are also relevant to the 8-hour standard. As discussed above, it may be that the health effects, often correlated with 1-hour exposures in the epidemiologic studies, are actually associated with 8-hour (or other) average exposures. Therefore, these epidemiologic findings were factored into the margin of safety for the 8-hour average.

It should be noted that the recommended 8-hour average concentration has three rather than two decimal places. Staff initially considered selection of 0.07 ppm. However, rounding conventions applied to air quality data (see Section 7.1.4) are such that any measured value up to and including 0.074 ppm would round down to 0.07 ppm. The available data suggested that selection of 0.07 ppm would not include an adequate margin of safety, as required by State law. The one available study at 0.06 ppm did not find a group mean effect. Staff is recommending that the 8 hour average standard have three decimal places, 0.070 ppm, to ensure an adequate margin of safety. Section 6.3 discusses issues related to precision and accuracy of the monitored data.

4. Monitoring method for ozone: Staff recommends retention of the current monitoring method for ozone which uses the ultraviolet (UV) absorption method for determining compliance with the state Ambient Air Quality Standard for ozone. Incorporate by reference all federally approved UV methods for ozone as California Approved Samplers for ozone. This will not change current air monitoring practices, but will align state monitoring requirements with federal requirements.

2.6.1 Consideration of Infants and Children

The Children's Environmental Health Protection Act [Health and Safety Code section 39606 (b)] requires that air pollution effects on children and infants be specifically considered in selection of ambient air quality standards. Children have a higher ventilation rate relative to body weight at rest and during activity than adults. Children also tend to spend more time outside and be more active than adults. Consequently, virtue of their higher ventilation rates and outdoor behavior patterns, they are likely to inhale larger total doses of ozone than the general population. However, the chamber studies of exercising children suggest that they have responses generally similar to adults, pointing to a similar degree of responsiveness. Epidemiologic studies that have examined both children and adults do not show clear evidence for greater sensitivity in children. Studies in animals at high exposure concentrations (0.5 ppm and higher, 8 hrs/day for several consecutive days) indicate that developing lungs of infant animals are adversely affected by ozone. The recommended standards are well below that level of exposure. Two studies have shown evidence of lower lung function in young adults raised in high ozone areas (Kunzli et al. 1997; Galizia and Kinney 1999). The study by Kunzli et al. (1997) suggested that exposure to ozone prior to age 6 was associated with lower attained lung function. Examination of data for the Los Angeles basin from the early 1980s, show summer averages of the 1-hour maximum to be above 0.10 ppm. This is considerably above present levels and above the recommended 1-hour standard. There is also evidence that children who play three or more sports are at higher risk of developing asthma if they also live in high ozone communities in Southern California. This study needs to be repeated before the effect can be attributed to ozone exposure with greater certainty, but the finding is of concern. The warm season daily 8-hour maximum concentrations of ozone measured in these high ozone areas, over the four years of study, was 0.084 ppm. The proposed 8-hour standard of 0.070 ppm, therefore, should protect most children from asthma induction that may be associated with ozone exposure. Collectively, this body of evidence suggests that although children appear to be similarly responsive to a given dose of ozone as adults, they are at greater risk than adults of experiencing adverse responses to ozone by virtue of their higher level of outdoor activity, and consequently greater total exposure.

2.7 Estimated Health Impacts ~~Benefits~~

Exposure to ozone at current ambient levels has substantial health impacts, including, but not limited to, death, hospitalization, emergency room visits, and symptoms of respiratory irritation. Staff estimates that the annual health impact of exposure to ozone at current levels, compared to attainment of the proposed State 8-hour and 1-hour ozone standards throughout California includes :

~~It is estimated that attainment of the proposed ozone standards throughout California would avoid a significant number of adverse health effects each year, specifically:~~

- 630 (310 – 950, probable range) ~~580 (290 – 870, probable range)~~ premature deaths for all ages.
- 4,200 (2,400 – 5,400, 95% CI) ~~3,800 (2,200 – 5,400, 95% confidence interval (CI))~~ hospitalizations due to respiratory diseases for all ages.
- 660 (400 – 920, ~~600 (360 – 850,~~ 95% CI) emergency room visits for asthma for children under 18 years of age.
- 4.7 million (1,200,000 – 8,600,000,~~3.3 million (430,000 – 6,100,000,~~ 95% CI) school absences for children 5 to 17 years of age.
- 3.1 million (1.3 million – 5.0 million, ~~2.8 million (1.2 million – 4.6 million,~~ 95% CI) minor restricted activity days for adults above 18 years of age.

These health impact estimates are based on the results of epidemiologic studies on the health effects of ozone exposure and an exposure reduction methodology modified from analyses conducted by the U.S. EPA and other investigators (see Appendix B). The health impacts estimates were made for only a small number of the known health effects of ozone exposure and, consequently, underestimate the total public health impact. The health impacts assessment was not used to select the appropriate levels of the proposed ozone standards.

For comparison purposes, we also estimated the health impacts o current ozone levels compared to attainment of the federal 8-hour ozone standard of 0.08 ppm, and the health impacts of current ozone levels compared to attainment of the State 1-hour ozone standard alone. Specifically, we estimate that 360 (180 – 550, probable range) premature deaths annually are related to current ozone levels, compared to statewide attainment of the federal 8-hour standard, and about 540 (270 – 810, probable range) premature deaths annually are related to current ozone levels, compared to statewide attainment of the State 1-hour standard. Results for other health endpoints are in Appendix B.

The differences between the results are the “incremental” impacts of not attaining the State 1-hour and 8-hour standards, compared to the federal 8-hour ozone standard. However, it is more reasonable to consider attainment of the two State standards together, compared to current ozone levels, since it is unlikely that control strategies will be geared to fist attain one standard and then the other. Nonetheless, the current impact of not attaining the federal 8-hour standard is about 360 premature deaths annually, with an additional 270 deaths associated with not attaining the proposed State 8-hour standard, making the total estimated impact of not attaining both standards 630 deaths. Similarly, the current impact of not attaining the State 1-hour standard is about 540 premature deaths annually, with an additional 90 deaths associated with not attaining the proposed 8-hour standard, making the total estimated impact of not attaining both the State 1-hour and 8-hour ozone standards 630 premature deaths. More detailed discussion of this analysis is available in Appendix B.

As discussed in Appendix B, there are a several important assumptions and uncertainties in this analysis. Some concern the study design, statistical methods, and choice of epidemiological studies used to develop the concentration-response (CR) functions used in the analysis. Few studies have investigated the shape of the CR function, or whether there is a population response threshold for health endpoints other than emergency room visits for asthma. Further uncertainty is added by assumptions in the statewide exposure assessment. It should also be noted that since several health effects related to acute exposure, and effects of chronic ozone exposure, are not included in the estimates noted above, the health benefits associated with lowering ozone exposure are likely underestimated.

2.8 Public Outreach and Review

A draft Staff Report containing staff’s preliminary findings was released to the public on June 21, 2004 titled, “Review of California Ambient Air Quality Standard for Ozone”. Public outreach for the standard review involved dissemination of information through various outlets to include the public in the regulatory process. In an ongoing effort to include the public in the review of the ozone standard, the ARB and OEHHA integrated outreach into public meetings, workshop presentations, electronic “list serve” notification systems, and various web pages. Notification of release of the Staff Report, the schedule for public meetings and workshops, and invitations to submit comments on the Staff Report were made through the “list serve” notification system. Public workshops on the proposed ozone standard were held on July 14 – 16, 2004 in Sacramento, El Monte, and Fresno. An additional public workshop was held on August 24, 2004 in Sacramento.

Individuals or parties interested in signing up for an electronic e-mail “list serve” notification on the ~~PM~~ozone standards, as well as any air quality-related issue, may self-enroll at the following location: www.arb.ca.gov/listserv/aaqs/aaqs.htm. Additional information on the standards review process is also available at the ozone standards review schedule website at: www.arb.ca.gov/research/aaqs/ozone-rs/ozone-rs.htm.

2.9 Air Quality Advisory Committee Review

The Air Quality Advisory Committee, an external scientific peer review committee that was appointed by the President of the University of California, met January 11 and 12, 2005, in Berkeley, California to review the initial Staff Report and public comments, and to ensure that the scientific basis of the recommendations for the ozone standard are based upon sound scientific knowledge, methods, and practices. The AQAC held a public meeting, which provided time for oral public comments, and discussed their review of the draft Staff Report and the draft recommendations, and provided comments for improving the draft Staff Report. Final findings were received on February 24, 2005.

The AQAC determined that the staff recommendations were well founded on the scientific literature, and voted to endorse them. The Committee made suggestions for minor changes to the draft Staff Report to increase clarity, requested more detailed discussion of several topics, and inclusion of several additional scientific papers. The AQAC findings ~~is~~are included in this Initial Statement of Reasons as Appendix C, in Volume IV.

2.10 Environmental and Economic Impacts

The proposed ambient air quality standards are scientific in nature, and will in and of themselves have no environmental or economic impacts. Standards simply define clean air. Once adopted, local air pollution control or air quality management districts are responsible for the adoption of rules and regulations to control emissions from stationary sources to assure their achievement and maintenance. The Board is responsible for adoption of emission standards for mobile sources. A number of different implementation measures are possible, and each could have its own environmental and/or economic impact. These impacts must be evaluated when the control measure is proposed. Any environmental or economic impacts associated with the imposition of future measures will be considered if and when specific measures are proposed.

2.11 Environmental Justice

State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies (Senate Bill 115, Solis; Stats 1999, Ch. 690; Government Code §65040.12(c)). The Board established a framework for incorporating environmental justice into the ARB's programs consistent with the directives of State law (ARB, 2001). The policies developed apply to all communities in California, but recognize that environmental justice issues have been raised more in the context of low-income and minority communities, which sometimes experience higher exposures to some pollutants as a result of the cumulative impacts of air pollution from multiple mobile, commercial, industrial, areawide, and other sources.

Because ambient air quality standards simply define clean air, all of California's communities will benefit from the proposed health-based standards, as progress is made to attain the standards. Over the past twenty years, the ARB, local air districts, and federal air pollution control programs have made substantial progress towards improving the air quality in California. However, some communities continue to experience higher exposures than others as a result of the cumulative impacts of air pollution from multiple mobile and stationary sources and thus may suffer a disproportionate level of adverse health effects. Since the same ambient air quality standards apply to all regions of the State, these communities will benefit by a wider margin and receive a greater degree of health improvement from the revised standards than less affected communities, as progress is made to attain the standards. Moreover, just as all communities would benefit from new, stricter standards, alternatives to the proposed recommendations, such as not proposing an eight-hour ozone standard, would adversely affect many communities.

While it is possible that residents in environmental justice communities may be particularly sensitive to ozone, only one study investigated whether socioeconomic status (SES) alters responses to ozone exposure, and those results were difficult to explain. Hence, the study did not allow inferences as to whether socioeconomic status impacts on sensitivity to ozone. Moreover, other controlled studies investigating whether gender, ethnicity or environmental factors contribute to the responses to ozone exposure could not convincingly demonstrate a link with responsiveness. Therefore, the database is insufficient to conclude whether differences in ozone susceptibility exist in environmental justice communities. These studies are discussed in more detail in Section 9.6.8.

Once ambient air quality standards are adopted, the ARB and the local air districts will propose emission standards and other control measures designed to result in a reduction of ambient ozone levels. The environmental justice aspects of each proposed control measure will be evaluated in a public forum at this time.

As additional relevant scientific evidence becomes available, the ozone standards will be reviewed again to make certain that the health of the public is protected with an adequate margin of safety.

2.12 References

Adams WC. 1998. Dose-response effects of varied equivalent minute ventilation rates on pulmonary function responses during exposure to ozone. Final Report to the American Petroleum Institute. Washington D.C.

Air Resources Board. Ambient Air Quality Standard for Ozone: Health and Welfare Effects. Staff Report. September 1987. Sacramento, CA.

Air Resources Board and Office of Environmental Health Hazard Assessment. Adequacy of California Ambient Air Quality Standards: Children's Environmental Health Protection Act. Staff Report. 2000.

Air Resources Board (2001). Policies and Actions for Environmental Justice, December 13, 2001.

Galizia A, Kinney PL. 1999. Long-term residence in areas of high ozone: associations with respiratory health n a nationwide sample of nonsmoking young adults. Environ Health Perspect 107:675-679.

Kunzli N, Lurmann F, Segal M, Ngo L, Balmes J, Tager IB. 1997. Association between lifetime ambient ozone exposure and pulmonary function in college freshmen – results of a pilot study. Environ Res 72:8-23.

McConnell R, Berhane K, Gilliland F, London SJ, Islam T, Gauderman WJ, Avol E, Margolis HG, Peters JM. 2002. Asthma in exercising children exposed to ozone: a cohort study. Lancet 359:386-391.

World Health Organization (2000). Air Quality Guidelines for Europe, Second Edition. (WHO regional publications, European series, No. 91.)

Appendix B

Quantifying the Health ~~Benefits of Reducing~~Impacts of Ozone Exposure

Appendix B

Quantifying the Health ~~Benefits of Reducing~~Impacts of Ozone Exposure

Quantifying the Health ~~Benefits~~Impacts of ~~Reducing~~ Ozone Exposure

~~The objectives of this appendix are to quantify the adverse health effects of current ozone levels in California by estimating the health benefits that would accrue from a hypothetical control strategy that achieves the proposed ambient air quality standards for ozone. This health effects assessment is not being used to set the health standards or in any formal cost-benefit analysis. As such, the results from this appendix are provided for public information about the expected benefits of attaining the proposed standards and do not include monetary values.~~

~~There have been several recent published efforts to estimate the health benefits associated with reducing population exposures to ozone (U.S. Environmental Protection Agency 1999; Levy et al. 2000).~~ Numerous epidemiologic studies conducted in the United States and other countries point to~~the~~ adverse health effects from exposure to ozone. The effects from short-term exposure include, but are not limited to: hospital admissions for respiratory causes, emergency-room visits for asthma, minor restricted activity days, acute respiratory symptoms, exacerbation of asthma, and premature mortality (National Research Council, 2002; U.S. Environmental Protection Agency, 2004). In addition, there is more limited evidence that long-term exposure to ozone may result in new cases of asthma and premature mortality.

~~Below we describe the methods, data, results and uncertainties involved with estimating the healthbenefits of the proposed~~The objective of this appendix is to quantify a subset of adverse health effects attributable to current ozone levels in California to illustrate some of the health impacts of continued ozone exposures. This health impacts assessment was not used to select the appropriate levels of health-based ambient air quality or to perform a cost-benefit analysis. Rather, the results from this assessment provide information to the public on some of the health impacts of current ozone levels. While this section presents the results of our analysis as the impacts of exposure to current levels of ozone, the results can also be viewed as the public health benefits expected to accrue with attainment of the proposed standards.

Specifically, we present results of an analysis of the impacts of the current ozone levels compared to attaining both the proposed State 8-hour standard and the federal 8-hour standard. In addition, we compare the benefits from attaining the proposed State 8-hour standard to the state 1-hour standard.

There have been several recent published efforts to estimate the impacts of ozone on public health, and the health benefits likely to be associated with reducing population exposures to ozone (U.S. Environmental Protection Agency 1999; Levy et al. 2000, Hubbell et al. 2005). This appendix presents a specific analysis of the health impacts of ozone exposure. It describes the methods, data, results and uncertainties involved with estimating the health impacts associated with exposures to current ambient concentrations of ozone.

The reader should note that health impacts estimates were made for only a small number of known effects of ozone exposure, and consequently this analysis is an underestimate of the total public health impact of current ozone levels.

Health Effects Estimation Approach

Section 812 of the federal Clean Air Act ~~required~~requires the U.S. EPA to periodically conduct an analysis of the health benefits of current federal air pollution regulations, which resulted in a report to the U.S. Congress (U.S. EPA, 1999). These efforts have undergone years of public review and comment as well as full peer review by the U.S. EPA's independent Science Advisory Board and by the National Research Council (2002). We have, therefore, drawn considerably from these prior efforts at the federal level, particularly in the development of concentration-response functions. We have also added new studies~~published~~ from around the world that have appeared since publication of the most recent U.S. EPA report. ~~The selection~~Selection of the studies and functions ~~to include~~included in our analysis has undergone review by several independent experts on the subject of air pollution and health.

Estimating the health ~~benefits~~impacts associated with ~~reductions in~~current levels of ambient ozone involves four elements:

1. Estimates of the changes in ozone concentrations due to a hypothetical ~~control strategy.~~ ozone reduction control strategy that achieves attainment of a standard.
2. Estimates of the number of people exposed to ozone.
3. Baseline incidence of the adverse health outcomes associated with ozone.
4. Concentration-response (CR) functions that link changes in ozone concentrations with changes in the incidence of adverse health effects. These functions ~~produce~~come from epidemiological studies and are expressed in terms of a beta coefficient, indicating the percent reduction in a given health outcome due to a unit change in ozone.

Health effects results from epidemiological studies are based on various ozone averaging times: 24-hour, 8-hour and 1-hour. As a result, we converted the 8-hour and 24-hour epidemiological results into equivalent values on a 1-hour scale to allow direct comparison of the different studies.

Ultimately, the product of ~~these~~the above four elements generates estimates ~~of the expected number of avoided adverse health outcomes associated with a hypothetical control strategy to reduce current levels of ozone to the proposed standard.~~that represent the current impact of ozone on public health, compared to attainment of the proposed 8-hour standard, since that is the more stringent of the two standards proposed. Each of these elements is discussed below. Our methods make use of U.S. EPA's~~development of the~~ Environmental Benefits Mapping and Analysis Program

(BenMAP), with modifications where appropriate to reflect~~the~~ application to California. In addition, we incorporated several recent studies that were not available when the most recent version of BenMAP was ~~California's setting and more recent studies.~~ released (Bell et al., 2004; Gryparis et al., 2004). All methods and results presented herein are consistent with those methods used by U.S. EPA in their health benefits assessment (Hubbell et al., 2005). In addition, we have derived substantial material from other previous health impact studies including the U.S. EPA estimates of health benefits of the Clean Air Act (U.S. EPA, 1999), the World Health Organization (WHO) meta-analysis of ozone health effects (Anderson et al. 2004), and the Levy et al. (2001) analysis of the public health ~~benefits of reducing ozone.~~ impacts of current ozone concentrations.

Exposure Estimation and Assumptions

The estimation of ozone exposure involves two key elements: assessing changes in ozone concentrations, and estimating the population exposed to these changes in ozone levels.

To assess the changes in the current ozone concentrations necessary to achieve the proposed standards, we first determined the design value, the benchmark used for attainment status. The design value is the Expected Peak Day Concentration, ~~the~~a value that reflects the highest concentration expected to ~~occur on any given year~~occur, once per year on average, based on the past three years of air quality monitoring data. The use of three years of data reduces the effect of an anomalous year. Details on how the design values are calculated are presented in Chapter 7. Because the designations of the air quality standards are ~~done mostly~~generally made at the air basin level, the design value for the basin was used for all counties within the basin.

Monitoring data for 2001 to 2003 were used from all monitors in the State meeting quality assurance criteria for valid data, and were extracted from the ARB ADAM database (ARB, 2004). Chapter 7 provides detailed analyses of exposure to ozone in California.

To calculate changes in exposure to ozone that reflect a hypothetical attainment of the proposed ambient air quality standards, a proportional linear rollback procedure was used. Under real-world conditions, control strategies will likely have some impact on days with low and moderate levels of ozone, as well as on days with high levels. Our rollback procedure reflects this observation. Details on the changes in the distribution of ozone concentrations over time are provided in the Supplement to this appendix.

Design Value Rollback Method

Rollback factors from the 1-hour and 8-hour ozone design values to the applicable standard were calculated for each air ~~To~~basin to assess the daily reductions in current ozone concentrations estimated to result at all monitoring sites when the standards are achieved. ~~achieved, rollbackfactors from the 1-hour and 8-hour ozone design values to the applicable standard were calculated for each air basin. The ozone design value selected~~ Rollback factors were based on design values for 2003. The design values reflect measured air quality for three years, 2001 through 2003. The design value was determined for each monitoring site according to the relevant regulatory specifications. For example, the Federal 8-hour design value is the three-year average of the annual 4th highest 8-hour ozone measurements. The design values for the state 1-hour and 8-hour standards are Expected Peak Day Concentrations (the statistically derived value expected to be exceeded once per year, on average – details are in Section 7.1.2 of ~~was the highest for the three-year period (2001 to 2003).~~Chapter 7). Design values for basins are simply the highest design value at any site within the basin. The basin design values typically determine attainment of each ozone standard. An uncontrollable ozone concentration of 0.04 ppm (see Chapter 4) was factored into the calculation of the rollback factor (see below). This represents the average daily one-hour maximum background ozone concentration. The rollback factor was assumed to apply to each site in the air basin for every day in a given year.

~~This~~Our methodology assumed that under the hypothetical attainment ~~setting,~~condition all ozone observations within an air basin were subjected to the same percentage rollback factor based on the basin's three-year high value. To investigate the plausibility of this assumption, we examined the trends in the annual distributions of the 1-hour and 8-hour concentrations of ozone in the South Coast Air Basin (SoCAB). Due to its population and current ozone levels, a significant proportion of current statewide health ~~benefits are projected to accrue~~impacts occur in the SoCAB. For this region, the estimated downward trend was consistent for both 1-hour and 8-hour concentration reductions from the 1980s to the current ~~levels.~~period. The maximum, the 90th, 80th, 70th, 60th, 50th and 40th percentiles from the annual distribution of the basin's daily high concentrations, as well as the individual site's daily highs, show a consistent downward trend ~~from~~since the 1980s. More importantly, when we examined the rate of change in the concentrations above background ~~from~~since the 1980s, it was similar among the percentiles. This analysis ~~justifies~~supports our application of a constant percentage rollback to all sites within ~~an~~each air basin. Results for several representative sites used in this analysis of ozone trends can be found in the Supplement to this appendix.

Roll-Back Procedure

For each ~~monitoring site~~air basin in the State, the rollback factor necessary to move~~from~~ the basin-high design value to the proposed standard was calculated for both the 1- and

8-hour averages. We assumed that only the portion of each ozone value above a background of 40 ppb will decrease as progress toward attainment takes place. For example, in the table of hypothetical values below (Table B-1), suppose the basin-high design value would need to be reduced by 50% for the portion above 40 ppb to achieve the standard. Thus, an ozone measurement of 100 ppb today would face a reduction of (100 – 40) x 50% = 30 ppb. Hence the projected value at attainment would be 30 ppb + 40 ppb = 70 ppb. The effective rollback rate of moving from 100 ppb to 70 ppb is 30%. Similarly, a value close to 40 ppb like 50 ppb would face a reduction of (50 – 40) x 50% = 5 ppb. With the projected value at attainment of 5 ppb + 40 ppb = 45 ppb, the effective rollback rate is 10%, calculated from 50 ppb today. In summary, while both measurements in this hypothetical example (100 ppb and 50 ppb) are subject to the same rollback rate of 50%, the effective rollback rate differs due to the rollback procedure taking into account the background of 40 ppb

.

Table B-1: Example of Proportional Roll-Back Procedure

Current ozone		Rollback Rate for Portion Above 40 ppb	Future ozone		Effective Rollback Rate
Measured (ppb)	Above 40 ppb		Above 40 ppb	Projected	
100	60	50%	30	70	30%
50	10	50%	5	45	10%

For the 1-hour standard, rollback factors based on 1-hour design values were used to project 1-hour observations assuming a scenario where the 1-hour standard of 0.09 ppm was attained. Specifically, the rollback factor for an air basin was: (0.094 ppm – 0.04 ppm) / (1-hour Design Value – 0.04 ppm). The concentration of 0.094 was used since this is the highest value considered in attainment (after being rounded to 0.09), based on rounding conventions. This procedure produced basin-specific rollback factors, which were applied to daily maximum 1-hour ozone values at all sites in the applicable basin, considering the background of 0.04 ppm. Basin-specific ratios were used for this purpose since the ratios can be significantly different from one basin to another. For example, in the South Coast Air Basin, the 1-hour design value was 0.178 ppm, so the rollback factor was (0.094 – 0.04) / (0.178 – 0.04) = 39%.

For the 8-hour standard, we used basin-specific 1-hour and 8-hour design values to convert the 1-hour data into a form useable for rollback calculations for the 8-hour standard. One-hour ozone concentrations are highly correlated with 8-hour concentrations. Therefore, we calculated the 1-hour value when the 8-hour standard is attained in each air basin and defined this as the “equivalent design value” for the 8-hour standard in that basin. The target for the 8-hour standard (0.070 ppm) was converted to a basin-specific 1-hour equivalent so that the CR functions that were all converted to 1-hour averaging times could be utilized. The conversion was based on the assumption that the future ratio between 1-hour and 8-hour design values will be similar to its current value. For example, in the South Coast, the 1-hour and 8-hour design values are 0.178 and 0.146 ppm, respectively. To attain the 8-hour standard of 0.070 ppm, the equivalent 1-hour target was projected to be 0.070 * (0.178/0.146) = 0.086 ppm. Therefore, 0.086 is the equivalent 1-hour target for attainment of the proposed State 8-hour standard in the South Coast.

Rollback factors for attainment of the 8-hour standard are calculated as: (Equivalent Target – 0.040 ppm) / (1-hour Design Value – 0.04 ppm). So, for the South Coast Air Basin, the rollback factor was (0.086 – 0.04) / (0.178 – 0.040) = 33%.

~~These~~The roll-back procedure toward a 0.040 ppm background reflects currently observed rates of change in all parts of the ozone concentration distribution. The rollback factors were~~then~~ applied on a site–by-site basis to the ozone ~~readings for every~~monitoring data for each day. The difference between the observed value and the rolled-back value was calculated for each day of the year in terms of 1-hour maximum ozone (for both standards), thus avoiding the uncertainty associated with converting CR functions into an 8-hour maximum ozone scale.

Similar calculations were made for the federal 8-hour standard. The concentration of 0.084 ppm was used in the rollback since this is the highest value considered in attainment (after being rounded to 0.08), based on rounding conventions.

Health ~~effects~~impacts were then estimated for each day in a given year, summed across sites over the year, and then averaged over the three years of data. We also ensured that no ~~benefits~~impacts would be calculated for any day with an average concentration at or below the assumed background ozone level of 0.04 ppm. For the technical reader, the mathematical formulae for our rollback procedure and evidence ~~for~~supporting the rollback assumptions are provided in the Supplement to this appendix.

Estimation of Exposed Population

To estimate the number of people exposed to the ozone changes observed at each monitoring site, the county population was divided by the number of monitoring sites in a given county. This assumes that the population is equally distributed around each monitoring site within a county. We used county population data from the year 2000 census. For further details, see the Supplement to this appendix. We also examined the sensitivity of this assumption by considering two alternative methods for estimating exposure to ozone: census tract interpolation and county averaging of monitored concentrations. Details of these sensitivity analyses are provided below.

Estimates of the Baseline Incidence of Adverse Health Outcomes

The health effect baseline incidences are the number of health events per year per unit population. In this analysis, all baseline incidence rates except those for school absenteeism were taken from U.S. EPA’s BenMAP software program.

~~For mortality, the~~Mortality incidence rates were obtained from the U.S. Centers for Disease Control (CDC), as derived from~~the~~ U.S. death records and the U.S. Census Bureau. Regional hospitalization counts were obtained from the National Center for Health Statistics (NCHS) National Hospital Discharge Survey (NHDS). Per capita hospitalizations were calculated by dividing these counts by the estimated county population estimates derived from the U.S. Census Bureau and the population projections used by NHDS. Hospitalization rates for “all respiratory causes” included ICD-9 codes 460-519. Similarly, regional asthma emergency room visit counts were obtained from the National Ambulatory Medical Care Survey (NHAMCS), combined with population estimates from the 2000 U.S. Census to obtain rates. Illness-related school loss baseline incidence rates were based on Hall et al. (2003). Ostro and Rothschild (1989) provided the estimated rate for minor restricted activity days.

The assumed incidence rates are summarized in Table ~~B-17~~B-19 in the Supplement to this appendix. All counties and sites within each county were assumed to have the same incidence rate for a given population age group.

Concentration-Response Functions

Concentration-response (CR) functions are equations developed from epidemiologic studies that relate the change in the number of adverse health effect incidences in a population to a change in pollutant concentration experienced by that population. As reviewed in Chapter 9 (Controlled Exposure ~~10,~~Studies) and Chapter 10 (Epidemiologic Studies), a wide range of adverse health effects has been associated with exposure to current ambient concentrations of ozone. However, we only used CR functions derived from epidemiologic studies in this analysis. Developing concentration-response functions from this vast and not fully consistent literature is a difficult task and ultimately involves subjective evaluations. In this section, we aim to provide a fair and accurate reflection of the current scientific literature. We also aim to provide enough detail so that others may fully evaluate our assumptions and methodology. Below, we provide CR functions for effects of short-term ozone exposure on premature mortality, hospital admissions for respiratory disease, emergency room visits for asthma, school absenteeism, and minor restrictions in activity. Although epidemiologic studies also ~~other effects have been related to~~report other adverse effects associated with ozone exposure – such as asthma exacerbations, respiratory symptoms, hospital admissions for cardiovascular disease with short-term ozone exposures, and mortality and asthma onset associated with long-term exposure (i.e., several years) – we determined that the existing evidence was either insufficient or too uncertain to serve as a basis for making quantitative ~~CR function~~impacts estimates. A good example is asthma exacerbations for which several studies have reported associations with ozone. However, different subgroups of asthmatics and different outcome measures were used, making it difficult to develop consensus estimates.

In this appendix, the primary studies used in the health ~~benefit~~impacts assessment are~~generally~~ epidemiological. There are a number of reasons for using epidemiological studies. While human chamber studies have the merit of being able to carefully control for dose and response, they usually involve small sample sizes that ~~do~~may not include the most sensitive subpopulations, and cannot capture severe outcomes like hospitalization or premature death. Lagged or cumulative effects are similarly omitted, and only a limited range of exposures is examined. In short, human chamber studies are helpful to support causality and to determine effects of short-term exposure on measures like lung function ~~in generally healthy individuals,~~and airways inflammation, but they do not necessarily provide ~~the~~information on general population responses to exposure to ozone. For the latter purpose, epidemiological studies which incorporate varying subgroups, exposure scenarios, behaviors, and health outcomes will best serve to ~~determine~~estimate the overall potential human ~~response to a particular pollutant~~health impact of air pollutants and be the source of CR functions used for quantitative~~estimates for~~ health impact assessment.

Besides the primary studies, some CR functions were developed from previous estimates of the health impacts of ozone exposures. Sources for these studies include the U.S. EPA estimates of the health effects associated with the Clean Air Act under Section 812 (U.S. EPA, 1999), the World Health Organization~~(WHO)~~ meta-analyses on ozone (Anderson et al., 2004), and the Levy et al. (2001) analysis of the public health benefits of reducing ozone.

This section discusses some factors that impact health effect estimates and outlines the epidemiological studies that were used for the basis of the CR functions.

Conversions for Ozone Measurements of Various Averaging Times

Most health studies considered in our analysis were conducted with ozone levels measured as 1-hour maximum or 8-hour maximum. However, there were some studies that measured ozone averaged over other time increments. Since these studies were conducted throughout the United States and other parts of the world,~~a~~ national average~~of~~ adjustment factors were used to convert all measurements to 1-hour and 8-hour averages (Schwartz 1997). The 1-hour maximum was assumed to be 2.5 times the 24-hour average, and 1.33 times the 8-hour average concentration. These conversion factors have been used in previous meta-analyses ~~of~~in the ozone epidemiological literature (Levy et al., 2001; Thurston and Ito 2001). Our examination of California monitoring data for 2001-2003 in the San Francisco Bay Area and South Coast indicates that the ratios in California are similar. To reduce the uncertainty associated with converting the results into both the 1-hour and 8-hour time scales, we converted the epidemiological results into a common 1-hour scale only. Because the majority of studies report findings in term of ppb, CR functions were calculated per ppb, and air quality measurements were converted from ppm to ppb accordingly in the calculation of health effects.

Thresholds

Assumptions regarding the appropriateness of applying thresholds, and at what level, can have a major effect on health ~~effects~~impacts estimates. One important issue in estimating ~~ozone health effects~~ozone-related health impacts is whether it is valid to apply the CR functions throughout the range of predicted changes in ambient concentrations, even changes occurring at levels approaching the natural background concentration (without any human activity).

As reviewed in Chapter 10, most of the epidemiologic studies include very low ozone concentrations in their analysis and no clear threshold for effects has been reported, although the issue has not been fully investigated except with reference to ER visits for asthma. These latter studies, reviewed in Section 10.2.3 suggest a population threshold in the range of 0.075 to 0.110 ppm for 1-hour exposures, and 0.056 to 0.084 ppm (using a ratio of 1.33) for 8-hour exposures (see pg. 8-14; figure 8-1). In our approach of applying a constant percent change rollback to all of the basin-wide monitors, many of the reductions in ozone concentrations will occur below the proposed standard. Thus, for some days, our estimate of ~~benefits~~impacts of ozone exposure will be based on ozone concentrations that are within the range of the original epidemiologic studies, but below the proposed standards. In our ~~base case~~base-case model, we assumed that there was no effect threshold ~~was in evidence and~~concentration, and therefore we used the background level of 0.04 ppm as the no effects level. ~~As an alternative for a~~For the sensitivity analysis, we assumed ~~a~~several no effects ~~level at 0.075 ppm~~levels but adjusted the remaining slope to account for application of a threshold to the concentration-response function. This is described in greater detail below.

Developing the Concentration-Response Function

Most of the epidemiologic studies used in our estimates have used a log-linear model to ~~represent~~describe the relationship between ozone exposure and the health endpoint. In this case, the relationship between ozone levels and the natural logarithm of the health effect is estimated by a linear regression. This regression model generates a beta coefficient that relates the percent change in the health outcome to a unit ~~increase~~change in ozone. Existing studies have reported either a beta coefficient for a unit change in exposure or a relative risk (RR) for a specified change in ozone concentrations, such as 10 ppb ~~1-hour~~in 1-hour maximum. The RR is defined as the ratio of the health effect predicted from the higher exposure relative to some baseline exposure. Health effect estimates presented in a given study as RR for a specified change in ozone, Δ-O_3, were converted into an estimated beta using the equation:

$\beta = \ln(RR) / \Delta O_3$

-The daily change in ozone at each monitoring site i.e., the difference between current ozone and the standard (= ΔO_3) was used to calculate RR:

$RR = \exp(\beta \Delta O_3)$

Then, the RR estimates were used to determine the population attributable risk (PAR), which represents the proportion of the health effects in the whole population that may be prevented if the cause (ozone pollution in our case) is reduced by a given amount. Specifically,

$PAR = (RR - 1) / RR$

Ultimately, the estimated impact on the health outcome is calculated as follows:

$\Delta y = PAR \times y_0 \times pop$

where:

Δy = changes in the incidence of a health endpoint corresponding to a particular change in ozone,
y_0 = baseline incidence rate/person within a defined at-risk subgroup, and
pop = population size of the group exposed.

The parameters in the functions differ depending on the study. For example, some studies considered only members of a particular subgroup of the population, such as individuals 65 and older or children, while other studies considered the entire population in the study location. When using a CR function from an epidemiological study to estimate changes in the incidence of a health endpoint corresponding to a particular change in ozone in a location, it is important to use the appropriate parameters for the CR function. That is, the ozone averaging time, the subgroup studied, and the health endpoint should be the same as, or as close as possible to, those used in the study that estimated the CR function.

In some cases, results from several studies of the same health endpoint were combined to estimate the health effect. An inverse-variance weighting scheme was used to pool results from these studies, allowing studies with greater statistical power to receive more weight in the pooled assessment. This approach implicitly assumes that all studies are equally valid and representative of the population in question, and is the standard approach applied in many impact analysis settings.

Mortality from Short-Term Exposure

Chapter 10 concludes that there is sufficient evidence for an effect of daily exposure to ozone (possibly with a lag response of a day or two) on premature mortality. These effects are based on daily time-series studies of counts of daily all-cause mortality within a given city reviewed over several years. The studies control for most other factors that may impact daily mortality such as weather, time trends, seasonality, day of week, and other pollutants. In addition, the studies have been undertaken over a wide range of weather conditions, seasonal patterns, covarying pollutants, baseline population characteristics. Chapter 10 reviews the uncertainties inherent in these studies. The U.S. EPA ~~is currently funding~~has funded several meta-analyses ~~of the ozone-mortality~~investigating the association ~~but this information is currently not~~between ozone and mortality, but the results of these analyses are not yet available. Therefore, below we present the effect estimates from the available literature and develop our rationale for a central estimate and probable bounds that reflect the observed range of effect estimates. Figure 1 summarizes the most relevant meta-analytic studies to date. Additional information about these studies is provided in Chapter 10.

The World Health Organization ~~(WHO)~~(Anderson et al., 2004) conducted a meta-analysis of the 15 cities in Europe (Anderson et al. 2004). Their meta-estimates indicate a relative risk of 1.003 (95% CI = 1.001 – 1.004) for a 10 μg/m^3 change in 8-hour ozone. For standard pressure (1 atmosphere) and temperature (25º C), 1 ppb ozone equals 1.96 μg/m^3. We have assumed the ratio between 1-hour and 8-hour ozone of 1.33 and between 1-hour and 24-hour of 2.5 (Schwartz 1997). Making the conversions, the WHO estimate implies a 1.13% change (95% CI = 0.38 - 1.51) in daily mortality per 10 ppb change in~~24- hour~~24-hour average ozone. The WHO also provided an estimate correcting for possible publication bias using a trim and fill technique. Under an assumption that bias was present, the adjusted estimate is 0.75 % (95% CI = 0.19 – 1.32) per 10-ppb change in 24-hour average ozone.

This estimate is very similar to that produced by Levy et al. (2001). In their meta-analysis they began with 50 time-series analyses from 39 published articles. A set of very strict inclusion criteria was applied, which eliminated all but four studies. Reasons for exclusion included: studies outside the US, use of linear temperature terms (versus non-linear and better modeled temperature), lack of quantitative estimates, and failure to include particulate matter (PM) in the regression models. Ultimately, their analysis generated an estimate of 0.98% (95% CI = 0.59 – 1.38) per 10 ppb change in 24-hour average ozone. If the criteria are loosened to include eleven more studies, the pooled estimate decreases to 0.80 (0.60 – 1.00). Stieb et al. (2002) also reported a similar effect estimate based on 109 previous studies (including those with single- and multi-pollutant models) of 1.12 (0.32 – 1.92). Thurston and Ito (2001) reviewed studies published prior to the year 2000. When the authors focused on seven studies that more carefully specified the effect of a possible confounder, daily temperature, by using non-linear functional forms, the resulting meta-estimate was 1.37% (95% CI = 0.78 – 1.96). Relaxing this constraint to include all 19 available studies, the resulting risk estimate was 0.89% (95% CI = 0.56 – 1.22) per 10-ppb change in 24-hour ozone.

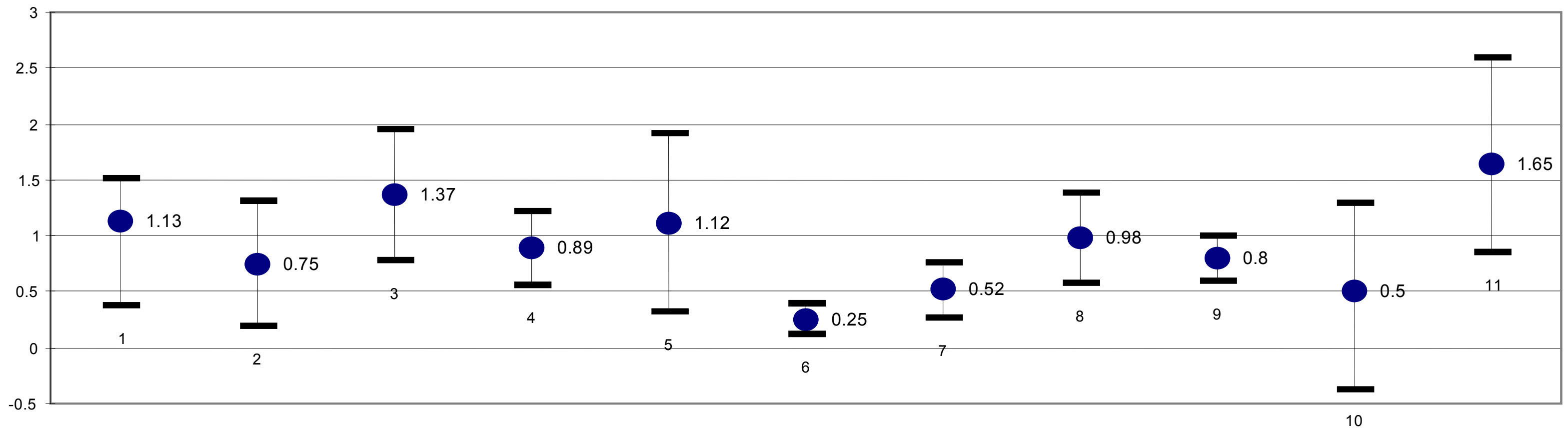
Two more recent meta-analyses have been published that provide lower effect estimates. Gryparis et al. (2004) is an analysis of 23 European cities from the ~~APEHA2~~APEAH2 study. The study controlled for potential confounders by including average daily temperature and humidity, respiratory epidemics, day of week in the regression model. The overall full-year estimate was 0.5% (95% CI = -0.38 – 1.30) per 10-ppb change in 24-hour average ozone. A meta-analysis was also conducted using summer-only data. Presumably this estimate will be less confounded by seasonality and also represent a time when the population would be spending more time outdoors. The summer-only estimate was 1.65% (95% CI = 0.85 – 2.60) per 10-ppb change in 24-hour average ozone. This summer-specific estimate might be particularly relevant for California due to its~~milder~~ climate. A meta-analysis of the 95 largest U.S. cities from the National Morbidity, Mortality, and Air Pollution Study (NMMAPS) data base provided estimates using a similar natural spline model for every city (Bell et al., 2004). Ultimately, the model suggested an effect estimate of 0.25% (95% CI = 0.12 – 0.39) per 10-ppb change in 24-hour average ozone. The NMMAPS study may generate an underestimate of the impact of mortality due to the modeling methodology used to control weather factors. Specifically, this effort included four different controls for temperature and dewpoint, where most other times-series analyses used only two or modeled extreme weather events more carefully and used city-specific models to ensure the best fits. In comparing the results for particulate matter (PM) for a given city with studies of individual cities by other researchers, the NMMAPS results are usually lower (Samet al ~~et.,~~et al, 2000). This estimate was based on a lag consisting of today's and yesterday's ozone concentrations. When a longer period 7-day lag was used the estimate increased to 0.52% (95% CI = 0.27 – 0.77) per 10-ppb change in 24-hour ozone.

Our estimates for the effects of ozone on mortality~~attempt to~~ reflect the range provided in the ~~above cited~~above-cited studies. Table B-2 summarizes the effect estimates reported in these studies. Figure B-1 provides a graphical summary of the range of effect estimates and our suggested central, low and high estimates. A low estimate of 0.5% per 10 ppb, 24-hour average ozone, corresponds to~~the best~~ estimates from the NMMAPS study (using a one-week cumulative lag) and the ~~APEHA2~~APEAH2 European study, but is below most of the other central estimates. ~~A central estimates~~The central estimate of 1% per 10 ppb is very similar to the central estimate generated by WHO (Anderson et al., 2004), Levy et al. (2001), and Stieb (2003). Finally, as a high estimate, we use 1.5% per 10 ppb, which reflects the central estimates of Thurston and Ito (using non-linear functions for temperature) and the summer-only estimates of Gryparis et al. (2004). ~~Bates (personal communication, 2005) suggested that these concentration-response relationships may be underestimated.~~ Our range of estimates is applied to all age groups.

On the 1-hour scale, a 1% change per 10 ppb of 24-hour ozone is about 0.4% per 10 ppb change in 1-hour daily maximum ozone based on an assumed the ratio between 1-hour and 8-hour ozone of 1.33 and between 1-hour and 24-hour of 2.5 (Schwartz 1997). Specifically,

$$\frac{1\%}{10\,ppb24hr} = \frac{1\%}{10\,ppb24hr}\,x\,\frac{1\,ppb24hr}{2.5\,ppb1hr} = \frac{0.40\%}{10\,ppb1hr}$$

Figure B-1: Percent Change in Mortality Associated with Ozone (per 10 ppb 24-hour average)



Study #	**Author**	**# of studies**	**Comment**
1	Anderson (2004)	15	European
2	Anderson (2004)	20	Euro, corrected for possible publication bias
3	Thurston+Ito (2001)	7	Studies using non-linear temperature
4	Thurston+Ito (2001)	19	All studies
5	Stieb et al. (2003)	109	All studies
6	Bell et. al. (2004)	95	NMMAPS, lag(01)
7	Bell et. al. (2004)	95	NMMAPS, lag(06)
8	Levy et al. (2001)	4	Strict criteria
9	Levy et al. (2001)	15	Less strict criteria
10	Gryparis et al. (2004)	23	All year Europe
11	Gryparis et al. (2004)	23	Summer Europe

Hospital Admissions for Respiratory Diseases

Studies of a possible ozone-hospitalization relationship have been conducted for a number of locations in the United States, including California. These studies use a daily time-series design and focus on hospitalizations with a first-listed discharge diagnosis attributed to diseases of the circulatory system (ICD9-CM codes 390-459) or diseases associated with the respiratory system (ICD9-CM codes 460-519). Various age groups are also considered, which vary across studies. For ~~this~~our estimate, we ~~rely~~relied on the meta-analysis by Thurston and Ito (1999). These authors used a random effects model ~~using~~based on three studies from North America. The studies were Burnett et al. (1994), Thurston et al. (1994), and Burnett et al. (1997). The category of all respiratory admissions for all ages yielded an estimate of relative risk of 1.18 (95% CI= 1.10 – 1.26) per 100 ppb change in daily 1-hour maximum ozone. This category includes hospital admissions for asthma and bronchitis, so separate estimates of these outcomes are not necessary. The estimate converts to a 1.65% change in hospital admissions (95% CI = 0.95 – 2.31%) per 10 ppb change in 1-hour daily maximum ozone. This estimate was applied to all age groups. Additional studies of respiratory admissions for specific diseases or subpopulations provide additional support for the above relationship, but are not quantified to avoid double counting. For example, Anderson et al. (1997) reported a relative risk of 1.04 (95% CI= 1.02-1.07) for hospital admissions for COPD for all ages for a 50 ~~µ/m~~µg/m^3 change in 24-hour ozone. This converts to ~~2.05%~~0.63% per 10 ppb change in 1-hour maximum ozone. Burnett et al. (2001) investigated respiratory hospitalizations in children under age 2, and reported a~~relative risk of 1.348 (95% CI= 1.193 – 1.523), which converts to a 6.6%~~7.8% increase in hospital admissions per 10 ppb change in five-day moving average of 1-hour daily maximum ~~ozone.~~ ozone concentrations.

Emergency Room Visits for Asthma

Some studies have examined the relationship between air pollution and emergency room (ER) visits for pediatric asthma. Because most ER visits do not result in an admission to the hospital, we ~~treated~~evaluated hospital admissions and ER visits separately, taking into account~~of~~ the fraction of ER patients that were admitted to the hospital. Our estimate is based on five studies which provide CR functions across the full range of ozone concentrations: Tolbert et al. (2000), Friedman et al. (2001), Jaffe et al. (2003), Romieu et al. (1995), and Stieb et al. (1996). Tolbert et al. (2000) report an association between pediatric emergency room visits (age < 16) for asthma and ozone in Atlanta during the summers of 1993-1995. The authors report a relative risk of 1.04 (95% CI = 1.008 – 1.074) per 20 ppb change in 8-hour ozone. Friedman et al. (2001) reported an association between daily counts for asthma in two pediatric emergency departments (age 1 to 16) and ozone in Atlanta during the summer of 1996. They report a RR of 1.2 (95% CI = 0.99 – 1.56) per 50 ppb change in 1-hour maximum ozone. This model included PM10 as a co-pollutant. Jaffe et al. (2003) reported an association between ozone and emergency room visits for asthma (ages 5 to 34) among Medicaid recipients in three cities in Ohio for the summer months from 1991- 1996. Estimates for the combined three cities indicate a RR of 1.03 (1.00 – 1.06) for a 10 ppb change in the

8-hour average of ozone. Romieu et al. (1995) reported results for emergency visits for asthma (age < 16) in Mexico City from January to June, 1990. A RR of 1.43 (95% CI= 1.24 – 1.66) was obtained for a 50 ppb change in 1-hour maximum ozone. Finally, Stieb et al. (1996) reported a beta of 0.0035 (95% CI = 0.00 –0.0070) for a 1 ppb change in 1 hour maximum ozone for ER visits for asthma in Saint John, New Brunswick, Canada.

Using an inverse variance weight for these five studies, we obtained a meta-analytic result of 2.4% per 10 ppb in daily 1-hour maximum ozone with a 95% CI = 1.46 to 3.34%. This estimate was applied over the entire range of ozone concentrations to children under 18. Several studies on ER visits for asthma report a non-linear response consistent with an effect threshold (see Section 8.3.3.2 and Figure 8-1, and Section 10.2.5). The threshold level appears to be somewhere between 0.075 and 0.110 ppm for a 1-hour average (or, using a ratio of 1.33, an 8-hour average of 0.056 to 0.084~~).~~ ppm). This threshold may be due to lower power in detecting effects at low concentrations. In addition, the studies indicate some increased risks observed at below threshold concentrations. Regardless, if a zero slope (implying a threshold) is applied to the lower portion of the data, the concentration-response function for the remaining portion of the data must be larger than the slope for the entire data set. Below we ~~use some of the available information on~~describe how to adjust the slope ~~in order~~of the CR function to investigate the implications of imposing a threshold on the CR function.

School Absences

In addition to hospital admissions and ER visits, there is considerable scientific research that has reported significant relationships between elevated ozone levels and other morbidity effects. Controlled human studies have established relationships between ozone and symptoms such as cough, pain on deep inhalation, shortness of breath, and wheeze. In addition, epidemiological research has found relationships between ozone exposure and acute infectious diseases (e.g., bronchitis, and sinusitis) and a variety of "symptom-day" categories. Some "symptom-day" studies examine excess incidences of days with identified symptoms such as wheeze, cough, or other specific upper or lower respiratory symptoms. Other studies estimate relationships with a more general description of days with adverse health impacts, such as "respiratory restricted activity days" or work loss days. We selected a few endpoints that reflect some minor morbidity effects and carefully adjusted estimates to avoid double counting (e.g., adjusted minor restricted activity days by number of asthma-related emergency room visits).

One of these studies demonstrated that absence from school was associated with ozone concentrations in a study of 1,933 fourth grade students from 12 southern California communities participating in the Children's Health Study (Gilliland et al. 2001). For illness-related absences, verified through telephone contact, further questions assessed whether the illness was respiratory or gastrointestinal, with respiratory including runny nose/sneeze, sore throat, cough, earache, wheezing, or asthma attack. Associations were observed between 8-hour average ozone and school absenteeism due to several different respiratory-related illnesses. Specifically, the authors report a 62.9% (95% CI = 18.4 -124.1%) change in new episodes of absences from all illnesses

associated with a 20 ppb change in 8-hour average ozone. This provides the basis for our quantitative estimate, which was applied to all schoolchildren aged 5-17.
On the 1-hour scale, 62.9% change per 20 ppb change of 8-hour ozone is about 21.2% per 10 ppb change in 1-hour daily maximum ozone using the assumed ratio between 1-hour and 8-hour ozone of 1.33 and between 1-hour and 24-hour of 2.5 (Schwartz 1997). Thus, we estimated:

$$\frac{62.9\%}{20 ppb8hr} x \frac{1 ppb8hr}{1.33 ppb1hr} = \frac{21.2\%}{10 ppb8hr}$$

In calculating the change ~~in school loss days,~~ in episodes of school loss, we assumed children did not attend school during weekends and holidays, that about 20% of students attended year-round schools, and adjusted the attendance rate for each month of the year. The baseline absence rate reported by Hall et al. (2003), based on a telephone survey of school districts, was applied.
To convert episodes of school loss into days, we estimated 1.265 days as the average duration of an illness-related school absence, the result of dividing the average daily school loss rate from BenMAP by the episodic absence rate from Gilliland et al. (2001).

Minor Restricted Activity Days

Ostro and Rothschild (1989) estimated the impact of PM2.5 on the incidence of minor restricted activity days (MRADs) and respiratory-related restricted activity days (RRADs) in a national sample of the adult working population, ages 18 to 65, living in metropolitan areas. The annual national survey results used in this analysis were conducted in 1976-1981. Controlling for PM2.5, two-week average ozone concentration has a highly variable but statistically significant association with MRADs but not with RRADs. MRADs are days where people reduced their activity, but did not miss work, and can therefore be viewed as relatively minor and transient symptom days.

For our MRAD estimate, we initially reanalyzed on an individual year basis each of the six years of data from Ostro and Rothschild (1989) using their multi-pollutant model that included PM2.5. We then used an inverse variance-weighted meta-analysis to combine the six individual year results. This resulted in an estimate of a 0.112% change (95%CI 0.046 – 0.178%) per µg/m^3 of 1-hour maximum ozone. Conversion to ppb yielded an effect estimate of 2.24% change (95%CI = 0.92 – 3.56%) per 10 ppb change in 1-hour maximum ozone concentration. This estimate was applied to all adults above age 18.

Sensitivity ~~Analysis~~Analyses

~~Several~~We also performed several additional analyses ~~were run to indicate~~to evaluate the sensitivity of the results to our assumptions. In our first analysis, we considered two alternative ways to characterize ozone exposure and population. First, we ~~re-estimated the assignment of exposure for each of the county residents~~estimated ozone concentration at the census-tract level. Specifically, we used population data from the year 2000 census and determined the population centroid for every census tract in the state. The assigned ozone concentration at each centroid was determined using the inverse square distance weighted interpolation of the ozone concentrations observed at the monitors within a 50-kilometer radius of the centroid. This value was then assigned to each resident in~~of~~ the census tract. Second, we averaged the observed concentrations at the monitors within each county and assigned the county average concentration to the entire county population.

As a second sensitivity analysis, we imposed a threshold on all of the CR functions and accompanied this assumption with a re-estimated, higher CR function for the remaining data. Most of existing studies assume a non-threshold model, either linear or logistic, over the entire range of ozone concentrations. If one were to impose a threshold or no-effects level over the lower range of the data, the remaining slope estimate would have to increase to fit the remaining observations. Unfortunately, there is only limited data to suggest the magnitude of the increase in the slope. Specifically, several of the studies of emergency room visits for asthma estimated a slope for both the full range and for an upper portion of the data. Therefore, as a sensitivity analysis, we attempted to draw inference about how the slope would increase, drawing on both the direct and indirect ~~evidence.~~ evidence, described below.

Stieb et al. (1996) examined the effects of ozone on emergency department (ED) visits for asthma in Saint John, Canada. In the basic analysis, they report a beta coefficient for the full population of 0.0035 for a change of 1 ppb in 1-hr maximum~~average of~~ ozone, using a lag of 0 and 1 day. When a dichotomous model was developed to examine the effect of concentrations above versus below 75 ppb, the beta increased to 0.45. Based on graphical and descriptive data presented in the paper, the mean concentrations above and below 75 ppb were assumed to be 95 and 35 ppb, a difference of 60. This results in a beta of 0.0076 and a ratio of the slope using the highest quartile, where effects are observed, versus the slope for the full range of data of approximately 2.16.

Tolbert et al. (2000) examined the effects of ozone on pediatric ED visits in Atlanta. In the basic analysis, a relative risk (RR) of 1.042 was reported for a 20 ppb change in the 8-hour maximum daily ozone. This relates to a beta of 0.00206 ~~(= ln(1.042)/20)~~(β= ln(1.042)/20)) or converting to a 1-hr maximum using a ratio of 1.33, a beta of 0.0015. The authors also report an RR of 1.23 for concentrations above 100 ppb range versus low concentrations (< 50 ppb) of ozone. Assuming the mean for concentrations above 100 ppb was 105 ppb and the mean concentrations for values below 50 ppb was 40 ppb, the resulting beta coefficient is 0.00318 ~~(=~~(β= ln(1.23/(105-40)) for an 8-hour change in ozone or 0.0024 for a 1-hour change which is 1.6 times the slope using all of the ozone data.

Finally, Romieu et al. (1995) studied ozone and pediatric ED visits in Mexico City. The authors report an RR of 1.43 for a 50 ppb change in 1-hour maximum ozone, using a one-day lag. This relates to a beta of 0.00715 for a 1-hour change in ozone. However, when they examined multiple days with high peaks greater than 110 ppb, the RR increased to 1.68 for a cumulative lag of 0 and 1 and to a RR of 2.33 for a cumulative lag of 1 and 2 days. Based on personal communication with the authors, the mean concentration for days below 110 ppb was 67 ppb versus a mean for days above 110 ppb of 127 ppb. Thus, the resultant betas become 0.0086 ~~(=ln(1.68)/60) and 0.0141 (=ln(2.33)/60),~~(β =ln(1.68)/60)) and 0.0141 (β =ln(2.33)/60)), respectively. This suggests a ratio of the slope based on data above a threshold relative to the slope for the full data of between 1.21 and 1.97.

Overall, the empirical evidence confirms the logical expectation that the slope for only the upper end of the distribution of concentrations will be much larger than that for the entire distribution. The existing evidence, however, involves different cutpoints for the higher end and different averaging times, which clearly will affect the ultimate slope. However, given these results, it appears that for a sensitivity analysis, an increase of 40% in the slope above a threshold of 60 ppb (8-hour average) is a reasonable approximation. We also examined a presumed threshold of 50 ppb (8-hour average) using a slope increase of 100%. As additional sensitivity analysis, we determined, assuming a 40% increase in the slope in the upper segment of the data, what the threshold concentration would have to be to generate effects similar to those from a non-threshold model. Finally, we determined what the increase in the slope would have to be in the upper segment, given a threshold of 70 ppb 8-hour average, to generate effects similar to a non-threshold model.

Note, however, that these presumed threshold values are well within the range of concentrations observed in most, if not all, of the original epidemiologic studies. In fact, these values are often in the upper end of the range of values, rendering this assumption somewhat unlikely. Nevertheless, it is of interest to examine the effects of such an assumption.

Health Effects Results

Table ~~B-2~~B-3 presents the estimated statewide annual health ~~benefits from reducing the~~impacts of current (2001-2003) levels of ~~ozone to achieve the 1-hour standard of 0.09~~ozone, compared to attainment of the Federal 8-hour standard of 0.08 ppm. For most of the endpoints, the 95% confidence intervals around each central estimate reflects the uncertainty associated ~~reflect the uncertainty associated with the beta coefficient derived from the epidemiological studies used in the calculation. As discussed above, for mortality, the uncertainty was based on the range of estimates generated from severalmeta analyses.~~with the beta coefficient derived from the epidemiological studies used in the calculation. For mortality, the uncertainty was based on the range of estimates generated from several meta-analyses. For example, the results indicate that the impact of not attaining the federal 8-hour standard of 0.08 ~~full attainment of the proposed 1-hour standard would result in 580 fewer~~ppm statewide is 360 cases of premature mortality (probable range = ~~290 – 870), 3,800 fewer~~180 – 550), 2,400 hospital admissions (95% CI = ~~2,200 – 5,400) and 3,300,000 fewer days of~~1,400 – 3,500), 380 emergency room visits for asthma (95% CI = 230-530), 2.5 million days of illness-related school loss (95% CI = 690,000 – 4,200,000), and 1.8 million (95% CI

~~430,000 – 6,100,000)~~= 730,000 – 2,800,000) minor restricted activity days per year. Since the results for premature mortality due to short-term exposures were derived from~~examining the~~ evidence from several papers, rather than combining the results into a confidence interval, we use the terminology of~~a~~ "probable range," rather than 95% confidence interval.

Table B-4 presents the estimated annual statewide health impacts of current (2001-2003) levels of ozone, compared to attainment of the State 1-hour standard of 0.09 ppm. Again, for most of the endpoints, the 95% confidence intervals around each central estimate reflect the uncertainty associated with the beta coefficient derived from the epidemiological studies used in the calculation. As discussed above, for mortality, the uncertainty was based on the range of estimates generated from several meta-analyses. The results indicate that the current impact of ozone compared to attainment of the proposed 1-hour standard of 0.09 ppm statewide is 540 cases of premature mortality (probable range = 270 – 810), 3,600 hospital admissions (95% CI = 2,000 – 5,000), 560 emergency room visits for asthma (95% CI = 340-790), 3.8 million days of illness-related school loss (95% CI = 1,040,000 – 6,900,000), and 2.6 million (95% CI = 1,100,000 – 4,200,000) minor restricted activity days per year.

Similar to Table ~~B-2, Table B-3 presents statewide results from achieving~~B-4, Table B-5 presents the impact of current ozone levels compared to attainment of the proposed State 8-hour standard of 0.070 ppm. Generally speaking, the health ~~benefits from~~impacts of not attaining the ~~1-hour~~8-hour standard are greater than those associated with not attaining the~~8-hour standard. Since~~ 1-hour ~~and 8-hour~~ standard. For example, the results indicate that the impact of current ozone levels, compared to full attainment of the proposed 8-hour standard statewide is 630 cases of premature mortality (probable range = 310 – 950), 4,200 hospital admissions (95% CI = 2,400 – 5,800), 660 emergency room visits for asthma (95% CI = 400-920), 4.7 million days of illness-related school loss (95% CI = 1,200,000 – 8,600,000), and 3.1 million (95% CI = 1,300,000 – 5,000,000) minor restricted activity days per year.

~~concentrations are highly correlated, it is not appropriate to add the estimated benefits from Tables B-2 and B-3 together. Tables B-4 and B-5~~Tables B-6, B-7 and B-8 present estimates of the annual health ~~benefits of~~impacts of not attaining the federal 8-hour, and the proposed State 1-hour and 8-hour standards, respectively, by air basin.

~~Table B-6 presents estimates of the annual health benefits of attaining either of the standards, whichever provides the greatest amount of control.~~

Incremental Impacts Discussion

The differences between the results in Tables B-3 (federal 8-hour standard), B-4 (State 1-hour standard) and B-5 (State 8-hour standard) are the "incremental" impacts of not attaining the State 1-hour and 8-hour standards, compared to the federal 8-hour ozone standard, respectively. However, it is more reasonable to consider attainment of the two state standards together, compared to current ozone levels, since it is unlikely that control strategies will be geared to first attain one standard and then the other. Therefore, the impacts are not separable and should not be treated as such. Nonetheless, the following discussion can be helpful in understanding the incremental impacts.

Comparing Tables B-3 and B-5, the current impact of not attaining the federal 8-hour standard is about 360 premature deaths, with an additional 270 deaths associated with not attaining the proposed State 8-hour standard, making the total estimated impact of not attaining both standards 630 premature deaths. Similarly, statewide about 2,400 hospital admissions annually are associated with nonattainment of the federal 8-hour standard, and an additional 1,800 hospitalizations are due to nonattainment of the proposed State 8-hour standard, making the total estimated impact of not attaining both the federal 8-hour and State 8-hour standards 4,200 hospital admissions. For ER visits, we estimate that 380 cases are associated with nonattainment of the federal 8-hour standard, and an additional 280 cases with nonattainment of the proposed State 8-hour standard, for a total of 660 cases associated annually with nonattainment of the proposed 8-hour standard. For school loss, 2.5 million days are estimated to be associated with the nonattainment of the federal 8-hour standard, and an additional 2.2 million days, a total of 4.7 million days, associated with nonattainment of the proposed State 8-hour standard. Lastly, we estimated that the impact of current ozone levels is about 1.8 million minor restricted activity days due to nonattainment of the federal 8-hour standard, and an additional 1.3 million, for a total of 3.1 million days, associated with nonattainment of the proposed State 8-hour standard.

A similar examination of Tables B-4 and B-5 reveals the incremental impacts of not attaining the proposed State 8-hour standard compared to the State 1-hour standard. The current impact of not attaining the State 1-hour standard is about 540 premature deaths, with an additional 90 deaths associated with not attaining the proposed 8-hour standard, making the total estimated impact of not attaining both the State 1-hour and 8-hour standards 630 premature deaths. Similarly, statewide about 3,600 hospital admissions annually are associated with nonattainment of the State 1-hour standard, and an additional 600 hospitalizations are due to nonattainment of the proposed 8-hour standard, making the total impact of not attaining both the State 1-hour and 8-hour standards 4,200 hospital admissions. For ER visits, we estimate that 560 cases are associated with nonattainment of the 1-hour standard, and an additional 100 cases with nonattainment of the proposed 8-hour standard, for a total of 660 cases associated annually with nonattainment of the proposed 8-hour standard. For school loss, 3.8 million days are estimated to be associated with the nonattainment of the State 1-hour standard, and an additional 900,000 days, a total of 4.7 million days, associated with nonattainment of the proposed 8-hour standard. Lastly, we estimated that the impact of current ozone levels is about 2.6 million minor restricted activity days due to nonattainment of the 1-hour standard, and an additional 500,000, for a total of 3.1 million days, associated with nonattainment of the proposed 8-hour standard.

Figure B-2: Incremental Impacts of Ozone Exposures Compared to Attainment of Ozone Standards for Premature Deaths and School Absences (Annual statewide cases avoided with attainment of ozone standards. Details are given in the text.)

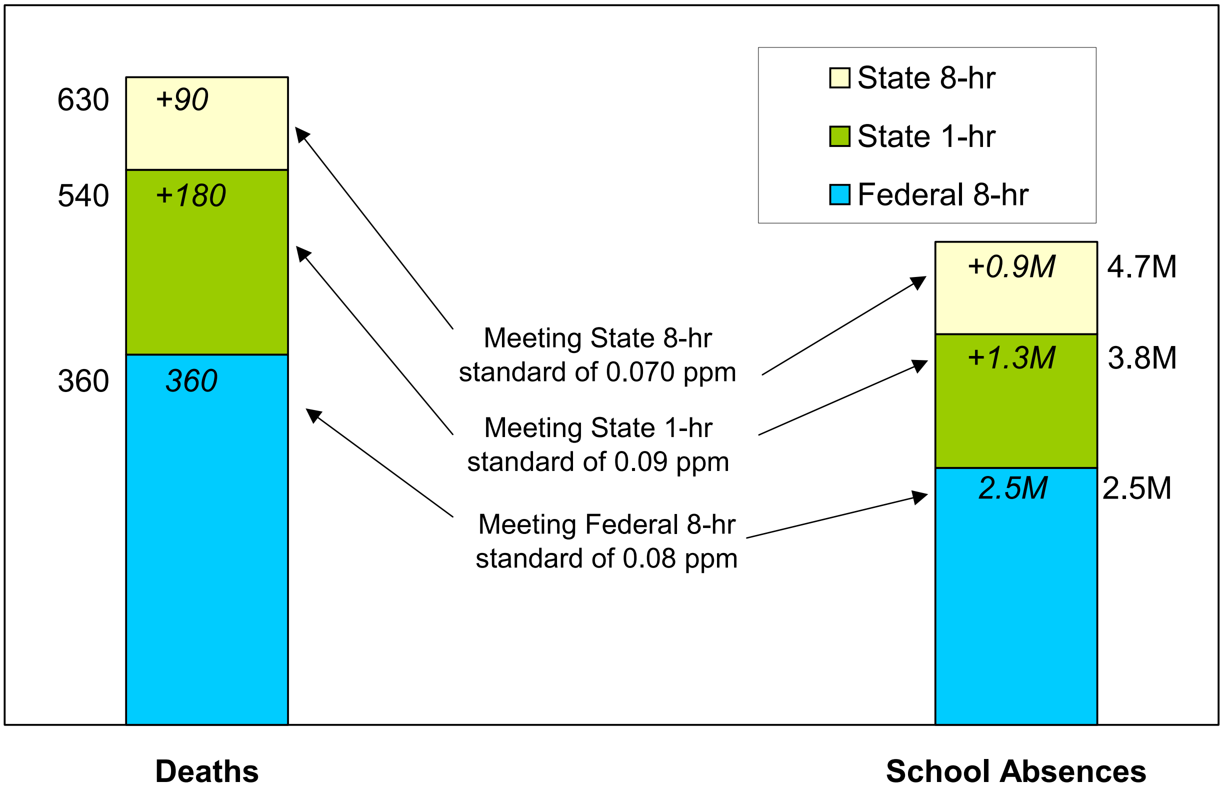


Figure B-2 summarizes the results of the above incremental impacts discussion for two endpoints: premature death and school absences. The numbers within each stacked bar represent the incremental impacts analysis. For premature death, attainment of the federal 8-hour standard would avoid 360 deaths annually in California. An additional 180 deaths, as indicated inside the stacked bar, would be avoided with attainment of the State 1-hour standard, and another 90 deaths would be avoided with attainment of the proposed State 8-hour standard, for a total of 630 deaths avoided annually at full attainment, as indicated on the side next to the bar. For illness-related school absences, the incremental analysis estimates annual avoidance of about 2.5 million school absences with attainment of the federal 8-hour standard, an additional 1.3 million avoided school absences with attainment of the current State 1-hour standard, and another 900,000 (indicated by +0.9M inside the stacked bar) with attainment of the proposed 8-hour standard, for a total of 4.7 million fewer school absences.

Sensitivity Analysis Results

We performed several sensitivity analyses to investigate two key assumptions in our analysis. Here, we discuss results on both the State 8-hour standard and the 1-hour standard. Our first sensitivity analysis examined the implications of~~an~~ alternative exposure assessments. ~~Specifically~~In the first reassessment, we interpolated concentrations for each census tract using nearby monitoring data. The exposure of the population within each census tract was determined using the inverse square distance weighted interpolation of the ozone concentrations observed at the monitors within a 50-kilometer radius of the centroid. The results for mortality are similar to those obtained using the base-case approach.~~Attaining the 1-hour ozone standard statewide~~Not attaining the proposed California 8-hour ozone standard using census-tract interpolations led to ~~570~~an estimated current impact of 610 deaths compared to ~~580 deaths avoided~~630 deaths using our base-case approach. Not attaining the State 1-hour ozone standard using census-tract interpolations lead to an estimated current impact of 530 deaths compared to 540 deaths using our base-case approach. In the second ~~assessment using~~reassessment of exposure, we assigned residents to their county-wide average ozone ~~concentrations, similar results, about 630 deaths, are obtained.~~concentrations. Similar impacts of about 680 deaths was obtained for the proposed 8-hour standard and 580 deaths was obtained for the State 1-hour standard.

In our second sensitivity analysis, we examined the implications of assuming alternative threshold models. If we assumed a threshold of 60 ppb and a 40% increase of the slope of the remaining higher concentrations, it resulted in about~~a~~ 10% to 14% decrease in estimated health ~~outcomes.~~impacts. For example, the estimated mortality impact would decrease from ~~580 to 520.~~630 to 540 comparing current ozone levels with attainment of the proposed 8-hour standard, and from 540 to 490 comparing current ozone levels with attainment of the 1-hour standard. The breakeven point associated with a 40% increase in the slope would be about 55 ppb for both the 1-hour and 8-hour standards. In other words, if the slope at the higher end of exposure was 40% greater than the slope for the full range of exposures, we would obtain the same ~~number of cases~~impact estimate as in the base case, if the higher slope estimate was applied to concentrations greater than 55 ppb. For an assumed threshold of 70 ppb, the slope would have to increase by about ~~140% to get the same number of cases as in~~150% for the 8-hour standard or about 130% for the 1-hour standard to obtain about the same impact as in the base case, non-threshold model. If we assumed a threshold at 50 ppb with a 100% increase in the remaining slope, the ~~estimate number of case~~estimated impact would increase by about 70% for the 8-hour standard and about 75% for the 1-hour standard.

Uncertainties and Limitations

There are a number of uncertainties involved in quantitatively estimating the impacts on health~~benefits~~ associated with~~reductions in~~ outdoor ozone air pollution. Over time, some of these will be reduced as new research is conducted. However, some uncertainty will remain in any estimate. Below, we briefly discuss some of the major uncertainties and limitations of these estimated health ~~benefits.~~impacts. These issues are discussed in more detail in Chapter 10 (also see Levy et al., 2001; Thurston and Ito, 1999).

Developing concentration-response functions

A primary uncertainty is the choice of the specific studies and concentration-response functions used in ~~this~~the quantification. Several challenges and unresolved issues present themselves with respect to designing and interpreting time-series studies of ~~ozone-related~~ozone-related health effects. The principal challenge facing the analyst ~~in the daily time series context~~ is to remove bias due to confounding by short-term temporal factors operating over time scales from days to seasons. The correlation of ozone with these confounding terms tends to be higher than that for PM or other gaseous pollutants. Thus, model specifications that may be appropriate for PM, the primary focus of much of the available literature, may not necessarily be adequate for ozone. Few studies to date have thoroughly investigated these potential effects with reference to ozone, introducing an element of uncertainty into the~~health benefits~~ analysis.

Of particular importance is the strong seasonal cycle for ozone, high in summer and low in winter,~~which is~~ opposite to the usual cycle in daily mortality and morbidity, which is typically high in winter and low in summer. Inadequate control for seasonal patterns in time series analyses leads to biased effect estimates. In the case of ozone, inadequate seasonal pattern control generally yields statistically significant inverse associations between ozone and health outcomes. In contrast, for winter-peaking pollutants such as CO and NO_2, the bias is toward overly positive effect estimates. Also, temporal cycles in daily hospital admissions or emergency room visits are often considerably more episodic and variable than is usually the case for daily mortality. As a result, smoothing functions that have been developed and tuned for analyses of daily mortality data may not work as well at removing cyclic patterns from morbidity analyses.

Potential confounding by daily variations in co-pollutants and weather is another analytical issue to be considered. With respect to co-pollutants, daily variations in ozone tends not to correlate highly with most other criteria pollutants (e.g., CO, NO_2, SO_2, PM10), but may be more correlated with secondary fine particulate matter (e.g., PM2.5) measured during the summer months. Assessing the independent health effects of two pollutants that are somewhat correlated over time is problematic. However, much can be learned from the classic approach of first estimating the effects of each pollutant individually, and then estimating their effects in a two-pollutant model. For this reason, we have emphasized use of studies that have also controlled for PM.

The choice of the studies and concentration-response functions used for health impact assessment can affect the ~~benefits~~impact estimates. Because of differences, likely related to study location, subject population, study size and duration, and analytical methods, effect estimates differ somewhat between studies. We have addressed this issue by emphasizing meta-analyses and multi-city studies, and also by presenting estimates derived from several studies.

To a substantial degree, the growing literature on acute ozone effects is an artifact of interest in studying acute PM effects. For example, of the 84 time-series mortality studies published between 1995 and mid-2004, 35 studies examined PM but not ozone; 47 studies examined both PM and ozone; and only 2 studies examined ozone but not PM. In many of the multi-pollutant studies, ozone is treated primarily as a potential confounder of the PM effects under study. As a result, many of these studies lack specific hypotheses regarding mortality effects of ozone, and fail to provide the range and depth of analyses, including sensitivity analyses, that would be most useful in judging whether ozone is an independent risk factor for acute mortality. This is in contrast to morbidity studies where hypotheses regarding ozone effects on respiratory symptoms, lung function, hospitalization and ER visits, etc. have been studied with ozone treated as a key pollutant. Fortunately, studies of short-term exposure and mortality have been replicated in many cities throughout the world, under a wide range of exposure conditions, climates and covarying pollutants. As a result, the evidence of an effect of ozone on premature mortality is compelling. Nevertheless, uncertainty remains about the actual magnitude of the effect and the appropriate confidence interval.

Thresholds

A second major uncertainty relates to the general shape of the concentration-response function and the existence of a threshold. This is discussed in detail earlier, with the conclusion that there is little evidence for a threshold. An important consideration in determining if a safe level of ozone can be identified is whether the CR relationship is linear across the full concentration range or instead shows evidence of a threshold. Among the ozone epidemiology literature, only a few studies of hospital admissions and emergency room visits have examined the shape of the CR function. These studies also provide the only epidemiologic investigations into whether or not there is an ozone effect threshold. Since only a few studies have investigated whether there is an effect threshold, and the few studies available do not cover all endpoints, the epidemiologic literature does not provide a basis for concluding whether or not there is a population level effect threshold. However, many of the available studies were conducted at fairly low concentrations of ambient ozone, so we are never extrapolating beyond the range of the studies. Therefore, for this analysis, we have assumed that there is no threshold for ozone effects and we estimated ~~benefits~~impacts down to an assumed background concentration of 0.04 ppm. To the extent that there may not be health effects below the proposed ozone standard, the analysis may overestimate the impacts of ~~reducing~~ambient ozone. However, we also conducted a sensitivity analysis ~~with an assumption of~~assuming several different possible thresholds. In doing so, we also adjusted the slope of the upper segment of the ozone concentrations to conform with the implications of a threshold model. If we had assumed zero ~~benefits~~impacts accrue below the proposed standards and provided no adjustment to the concentration-response functions, our estimates would be reduced by about 80%.

A related issue is that limited data suggest that ozone effects may be seasonal. While analysis of year round data suggests positive associations between a number of endpoints and ozone exposure, some data sets that have been analyzed seasonally report positive RR estimates for summer and negative RR estimates for winter. The cause of this phenomenon has not been adequately investigated, but may be related to thresholds, differences in personal exposure between seasons, or to co-pollutant exposures. In light of this uncertainty, this analysis used year-round effect ~~estimates.~~

~~In~~estimates, ~~addition,~~although the relatively long, warm season in California may make the summer estimates more relevant than those of the winter season.

Assumptions about rollback

A further uncertainty concerns the process used to design and implement strategies for controlling ozone-producing compounds. Such control strategies have been designed with the objective of reducing ozone episodes during worst-case meteorological conditions. In addition, basin-wide strategies have focused on the ozone concentrations at the highest (design) site in each basin. How these strategies would affect other sites during dissimilar episodes cannot be answered with certainty. Site-by-site analyses almost always have found that trends for multiple sites within a basin are very similar to each other. Similarly, monthly trends within a basin have usually proved to be similar, while the prevalence of different episode types may be markedly different for different months during the overall ozone season. (See trend analysis in the Supplement).

Unquantified adverse effects

An additional limitation in this analysis is the inability to quantify all possible ~~health benefits that could be~~impacts that are associated with current ozone concentrations, ~~achieving the proposed ozone standards,~~ since estimates are provided for only a subset of possible adverse outcomes. For example, estimates of the effects of ozone on asthma exacerbation, asthma ~~exacerbation~~induction, respiratory symptoms, airway inflammation, and acute and long-term changes in lung function are not presented. Although there is some evidence for such effects, the available data were either too inconsistent or sparse to justify quantification of possible ~~benefits of achieving the proposed ozone standards.~~impacts of not achieving the proposed ozone standards, or the evidence comes from controlled exposure studies that can not be used to make population level effects estimates. To the extent that certain important health outcomes were excluded, we may have underestimated the health ~~benefits~~impacts of the proposed standards.

Baseline rates of mortality and morbidity

There is also uncertainty in the baseline rates for the investigated health outcomes in the studied population. Often, one must assume a baseline incidence level for the city or country of interest. In addition, incidence can change over time as health habits, income and other factors change.

Exposure assessment

There are likely uncertainties in the statewide exposure assessment, and in whether the existing monitoring network provides representative estimates of exposure for the general population. We have attempted to reproduce the same relationship between monitor readings and exposure as in the original epidemiological studies. Most of these studies use population-oriented, background, fixed site monitors, often aggregated to the county level. The available epidemiological studies have used multiple pollutant averaging times, and we have proposed conversion ratios for 1-hour to 8-hour and 24-hour ozone concentrations based on national estimates. A preliminary examination of the California monitoring data indicates that the ratios are similar to those found in the highly populated areas of the State. However, uncertainty is added to the estimated ~~benefits of attainment of~~impacts of not attaining the proposed standards to the extent the converted concentration bases differ from monitored concentrations.

Summary

The purpose of this appendix is to provide quantitative estimates of some of the health ~~benefits that may accrue from~~impacts of current levels of ozone, compared to those that would occur under a hypothetical control strategy that brings the State into attainment with the proposed ozone standards. This assessment should not be regarded as exhaustive, since we have provided estimates only for a ~~selection of the most plausible effects for which there were high quality studies from which to derive CR functions.~~subset of health effects endpoints. However, the results presented support the conclusion that significant public health ~~benefits would result from statewide~~impacts are associated with current ozone concentrations in California that would not occur with attainment of the proposed ~~ambient air quality standards for ozone.~~ ozone standards. It is estimated that attainment of the proposed ozone standards throughout California would ~~avoid a significant~~significantly reduce the number of ozone-related adverse health effects each year. ~~The higher central estimate between the values calculated for 1-hour and 8-hour averaging times is given below.~~

Specifically, we estimate that the current impact of exposures above the proposed standard is:

- ~~580 (290 – 870,~~630 (310 – 950, probable range) premature deaths for all ages.
- ~~3,800 (2,200 – 5,400,~~4,200 (2,400 – 5,800, 95% confidence interval (CI)) hospitalizations due to respiratory diseases for all ages.
- ~~600 (360 – 850,~~660 (400 – 920, 95% CI) emergency room visits for asthma for children under 18 years of age.
- ~~3.3 million (430,000 – 6,100,000, 95% CI)~~4.7 million (1,200,000 – 8,600,000, 95% CI) illness-related school absences for children 5 to 17 years of age.
- ~~2.8~~3.1 million ~~(1.2~~(1.3 million – ~~4.6~~5.0 million, 95% CI) minor restricted activity days for adults above 18 years of age.

These estimates are based on attainment of the proposed State 8-hour standard, as it is the more stringent of the two (1-hour and 8-hour) proposed standards. The reader is cautioned that since 1-hour and 8-hour concentrations are highly correlated, it is not appropriate to add the estimated ~~benefits from Tables B-2 and B-3 together.~~ impacts from Tables B-3, B-4 and B-5 together. Instead, the estimates above represent the total impacts estimated to accrue from attaining both the proposed 8-hour and 1-hour standards. For a discussion of the incremental impacts of current ozone levels compared to attainment of the proposed 8-hour standard over the State 1-hour standard and the federal 8-hour standard, see page B-19.

As noted above, there are several important assumptions and uncertainties in this analysis. Some concern the study design, the statistical modeling methodologies used, and the selection of studies from which the CR functions are derived. Few studies have investigated the shape of the CR function, or whether there is a population response threshold for health endpoints other than emergency room visits for asthma. Further, but likely small, uncertainty is added by assumptions in the statewide exposure assessment. Nonetheless, when new evidence on mortality from short-term exposures to ozone is published from the recent meta-analyses sponsored by the US EPA, we will update our estimates and use the census-tract interpolation to characterize ambient ozone exposure. It should also be noted that since several health effects related to acute~~exposure,~~ and~~effects of~~ chronic ozone ~~exposure,~~exposures are not included in the estimates, the health ~~benefits~~impacts associated with lowering ozone exposure are likely underestimated.

Table ~~B-1:~~B-2: Summary of Meta-Analyses Linking Daily Ozone to Mortality (for 10 ppb change in 24-hour average ozone)

Study Number	Author	# of studies	% Change in Mortality (95% CI)	comment
1	Anderson (2004)	15	1.13 (0.38 - 1.51)	European studies only
2	Anderson (2004)	20	0.75 (0.19 – 1.32)	European studies corrected for possible publication bias
3	Thurston+Ito (2001)	7	1.37 (0.78 – 1.96)	Earlier studies using non-linear specification for temperature
4	Thurston+Ito (2001)	19	0.89 (0.56 – 1.22)	All earlier studies
5	Stieb et al. (2003)	109	1.12 (0.32 – 1.92)	Meta-analysis including single and mult-pollutant models
6	Bell et. al. (2004)	95	0.25 (0.12 – 0.39)	NMMAPS, using lag(01)
7	Bell et. al. (2004)	95	0.52 (0.27 – 0.77)	NMMAPS,lag(06)
8	Levy et al. (2001)	4	0.98 (0.59 – 1.38)	Using relatively stringent inclusion criteria
9	Levy et al. (2001)	15	0.80 (0.60 – 1.00)	Using less stringent inclusion criteria
10	Gryparis et al. (2004)	23	0.5 (-0.38 – 1.30)	~~APEHA2~~APEAH2 studies in Europe, all year
11	Gryparis et al. (2004)	23	1.65 (0.85 – 2.60)	~~APEHA2~~APEAH2 studies in Europe, summer only

Table ~~B-2:~~B-3: California Annual Health ~~Benefits from Attaining a 1-hour~~Impacts of Current Ozone Concentrations Compared to the Federal 8-hour Ozone Standard of ~~0.09~~0.08 ppm*

Health Endpoint	**Population**	~~**Estimated Beta (% per 10 ppb) (95% Confidence Interval)**~~ **Estimated Beta** (% per 10 ppb 1-hour ozone) (95% Confidence Interval)**	~~**Avoided Incidence (cases/year) Mean 95% Confidence Interval**~~ **Incidence (cases/year) (95% Confidence Interval)**
Premature Mortality due to Short-term Exposures	All ages	0.0040 (0.0020 - 0.0060) **	~~580 (290 – 870) **~~ 360 (180 – 550) ***
Hospital Admissions for Respiratory Diseases	All ages	0.0164 (0.0095 - 0.0228)	~~3,800 (2,200 – 5,400)~~ 2,400 (1,400 – 3,500)
Emergency Room Visits for Asthma	Age < 18	0.0237 (0.01446 – 0.0329)	~~600 (360 – 850)~~ 380 (230 – 530)
School Loss Days	Age 5-17	~~0.2123 (0.0334 – 0.3295)~~ 0.2123 (0.06672 – 0.3295)	~~3,300,000 (430,000 – 6,100,000)~~ 2,500,000 (690,000 – 4,200,000)
Minor Restricted Activity Days	Age > 18	0.0222 (0.0092 - 0.0350)	~~2,800,000 (1,200,000 – 4,600,000)~~ 1,800,000 (730,000 – 2,800,000)

*Base period 2001-2003. Since 1-hour and 8-hour concentrations are highly correlated, it is not appropriate to add the estimated impacts from Tables B-3, B-4 and B-5 together. Due to rounding conventions in the process of determining attainment of the federal 8-hour standard, the concentration of 0.084 ppm was used since this is the highest value considered in attainment.

**As discussed in detail in the text, the evaluation of impacts of not attaining the 8-hour standard was based on the equivalent 1-hour concentration. Therefore, the beta coefficients here are in 1-hour scale.

~~benefits from Tables B-2 and B-3 together. **Results~~***Results for premature mortality represent a probable range of likely values rather than a 95% confidence interval since the coefficients were derived from examining the evidence from several studies separately rather than combining their results in a formal meta-analysis.

Table ~~B-3:~~B-4: California Annual Health ~~Benefits from Attaining an 8-hour~~Impacts of Current Ozone Concentrations Compared to the State 1-hour Ozone Standard of ~~0.070~~0.09 ppm*

Health Endpoint	Population	~~Estimated Beta (% per 10 ppb) (95% Confidence Interval)~~ Estimated Beta (% per 10 ppb 1-hour ozone) (95% Confidence Interval)	~~Avoided Incidence (cases/year) Mean (95% Confidence Interval)~~ Incidence (cases/year) (95% Confidence Interval)
Premature Mortality due to Short-term Exposures	All ages	~~0.0053 (0.0027 – 0.0079)**~~ 0.0040 (0.0020 - 0.0060	540 (270 – 810) **
Hospital Admissions for Respiratory Diseases	All ages	~~0.0218 (0.0126 - 0.0302)~~ 0.0164 (0.0095 - 0.0228)	3,600 (2,000 – 5,000)
Emergency Room Visits for Asthma	Age < 18	~~0.0314 (0.0192 - 0.0434)~~ 0.0237 (0.01446 – 0.0329)	~~570 (340 – 800)~~ 560 (340 – 790)
School Loss Days	Age 5-17	~~0.2440 (0.0844 – 0.4034)~~ 0.2123 (0.06672 – 0.3295)	~~2,600,000 (760,000 – 5,200,000)~~ 3,800,000 (1,040,000 – 6,900,000)
Minor Restricted Activity Days	Age > 18	~~0.0294 (0.0121 - 0.0462)~~ 0.0222 (0.0092 - 0.0350)	2,600,000 (1,100,000 – 4,200,000)

*Base period 2001-2003. Since 1-hour and 8-hour concentrations are highly correlated, it is not appropriate to add the estimated impacts from Tables B-3, B-4 and B-5 together. Due to rounding conventions in the process of determining attainment of the 1-hour standard, the concentration of 0.094 ~~benefits from Tables B-2 and B-3 together.~~ ppm was used since this is the highest value considered in attainment.

**Results for premature mortality represent a probable range of likely values rather than a 95% confidence interval since the coefficients were derived from examining the evidence from several studies separately rather than combining their ~~results.~~results in a formal meta-analysis.

Table B-5: California Annual Health Impacts of Current Ozone Concentrations Compared to the State 8-hour Ozone Standard of 0.070 ppm*

Health Endpoint	**Population**	**Estimated Beta** (% per 10 ppb 1-hour ozone) (95% Confidence Interval)**	**Incidence (cases/year) (95% Confidence Interval)**
Premature Mortality due to Short-term Exposures	All ages	0.0040 (0.0020 - 0.0060)	630 (310 – 950) ***
Hospital Admissions for Respiratory Diseases	All ages	0.0164 (0.0095 - 0.0228)	4,200 (2,400 –5,800)
Emergency Room Visits for Asthma	Age < 18	0.0237 (0.01446 – 0.0329)	660 (400 – 920)
School Loss Days	Age 5-17	0.2123 (0.06672 – 0.3295)	4,700,000 (1,200,000 – 8,600,000)
Minor Restricted Activity Days	Age > 18	0.0222 (0.0092 - 0.0350)	3,100,000 (1,300,000 – 5,000,000)

*Base period 2001-2003. Since 1-hour and 8-hour concentrations are highly correlated, it is not appropriate to add the estimated impacts from Tables B-3, B-4 and B-5 together.

**As discussed in detail in the text, the evaluation of impacts of not attaining the 8-hour standard was based on the equivalent 1-hour concentration. Therefore, the beta coefficients here are in 1-hour scale.

***Results for premature mortality represent a probable range of likely values rather than a 95% confidence interval since the coefficients were derived from examining the evidence from several studies separately rather than combining their results in a formal meta analysis.

~~Table B-4: Annual Health Benefits from Attaining 1-hour Ozone Standard of Air Basin of 0.09 ppm~~ Table B-6: Annual Health Impacts of Current Ozone Concentrations Compared to the Federal 8-hour Ozone Standard of 0.08 ppm by Air Basin (cases/year).

Air Basin	Mortality	Hospital Admissions	Emergency Room Visits	School Absences	Minor Restricted Activity Days
Great Basin Valley	<1	<1	<1	~~340~~ 280	~~370~~ 250
Lake County	0	0	0	0	0
Lake Tahoe	<1	~~3~~ <1	<1	~~2,500~~ 450	~~2,400~~ 360
Mountain Counties	~~10~~ 7	~~52~~ 36	~~7~~ 5	~~40,000~~ 33,000	~~41,000~~ 29,000
Mojave Desert	~~43~~ 26	~~300~~ 180	~~50~~ 29	~~280,000~~ 190,000	~~220,000~~ 130,000
North Coast	~~<1~~ 0	~~<1~~ 0	~~<1~~ 0	~~370~~ 0	~~330~~ 0
North Central Coast	~~1~~ 0	~~10~~ 0	~~2~~ 0	~~9,000~~ 0	~~7,700~~ 0
Northeast Plateau	0	0	0	0	0
South Coast	~~300~~ 220	~~2,100~~ 1,500	~~330~~ 230	~~1,700,000~~ 1,400,000	~~1,600,000~~ 1,100,000
South Central Coast	~~16~~ 7	~~110~~ 48	~~16~~ 7	~~97,000~~ 50,000	~~83,000~~ 36,000
San Diego	~~24~~ 11	~~160~~ 71	~~22~~ 10	~~120,000~~ 67,000	~~120,000~~ 55,000
San Francisco Bay	~~23~~ 1	~~150~~ 5	~~21~~ 1	~~100,000~~ 3,700	~~120,000~~ 3,900
San Joaquin Valley	~~95~~ 62	~~610~~ 400	~~110~~ 70	~~650,000~~ 480,000	~~440,000~~ 280,000
Salton Sea	~~20~~ 15	~~120~~ 86	~~20~~ 14	~~120,000~~ 105,000	~~88,000~~ 62,000
Sacramento Valley	~~39~~ 19	~~220~~ 103	~~32~~ 15	~~170,000~~ 94,000	~~170,000~~ 78,000
Statewide	~~580~~ 360	~~3,800~~ 2,400	~~600~~ 380	~~3,300,000~~ 2,500,000	~~2,800,000~~ 1,800,000

Note: Some columns may not add up to the statewide totals due to rounding. Since 1-hour and 8-hour concentrations are highly correlated, it is not appropriate to add the estimated ~~benefits~~impacts from

Tables ~~B-4 and B-5~~B-6, B-7 and B-8 together. Table ~~B-6~~B-8 should be used to estimate the maximum health ~~benefit~~impact per air basin. The uncertainty behind the mortality estimates is on the order of +/-50% and varies for other endpoints.

Table ~~B-5:~~B-7: Annual Health ~~Benefits from Attaining 8-hour~~Impacts of Current Ozone Concentrations Compared to the State 1-hour Ozone Standard of ~~0.070~~0.09 ppm by Air Basin (cases/year).

Air Basin	**Mortality**	**Hospital Admissions**	**Emergency Room Visits**	**School Absences**	**Minor Restricted Activity Days**
Great Basin Valley	<1	~~1~~ <1	<1	~~650~~ 300	~~820~~ 260
Lake County	~~<1~~ 0	~~<1~~ 0	~~<1~~ 0	~~35~~ 0	~~53~~ 0
Lake Tahoe	~~1~~ <1	~~9~~ 2	~~1~~ <1	~~6,100~~ 1,900	~~6,600~~ 1,400
Mountain Counties	~~12~~ 9	~~62~~ 48	~~8~~ 6	~~41,000~~ 45,000	~~50,000~~ 38,000
Mojave Desert	~~51~~ 40	~~350~~ 270	~~59~~ 45	~~280,000~~ 310,000	~~260,000~~ 200,000
North Coast	<1	~~1~~ <1	<1	~~720~~ 0	~~750~~ 0
North Central Coast	~~2~~ 1	~~12~~ 7	~~2~~ 1	~~9,100~~ 7,600	~~8,800~~ 5,300
Northeast Plateau	~~<1~~ 0	~~<1~~ 0	~~<1~~ 0	~~88~~ 0	~~140~~ 0
South Coast	~~260~~ 290	~~1,700~~ 2,000	~~270~~ 310	~~1,100,000~~ 2,000,000	~~1,300,000~~ 1,500,000
South Central Coast	~~17~~ 14	~~120~~ 97	~~18~~ 14	~~92,000~~ 106,000	~~91,000~~ 73,000
San Diego	~~25~~ 21	~~170~~ 140	~~23~~ 19	~~110,000~~ 130,000	~~130,000~~ 100,000
San Francisco Bay	~~14~~ 20	1~~92~~ 40	~~13~~ 18	~~51,000~~ 110,000	~~72,000~~ 110,000
San Joaquin Valley	~~100~~ 89	~~670~~ 570	~~120~~ 100	~~600,000~~ 740,000	~~470,000~~ 410,000
Salton Sea	~~21~~ 19	~~130~~ 110	~~21~~ 19	~~110,000~~ 140,000	~~91,000~~ 81,000
Sacramento Valley	39	~~220~~ 200	~~32~~ 29	~~140,000~~ 200,000	~~160,000~~ 150,000
Statewide	540	3,600	~~570~~ 560	~~2,600,000~~ 3,800,000	2,600,000

Note: Some columns may not add up to the statewide totals due to rounding. Since 1-hour and 8-hour concentrations are highly correlated, it is not appropriate to add the estimated ~~benefits~~impacts from

Tables ~~B-4 and B-5~~B-6, B-7 and B-8 together. Table ~~B-6~~B-8 should be used to estimate the maximum health ~~benefit~~impacts per air basin. The uncertainty behind the mortality estimates is on the order of +/-50% and varies for other endpoints.

~~Table B-6: Annual Health Benefits from Attaining Both 1-hour and 8-hour Ozone Standards by Air Basin~~

Table B-8: Annual Health Impacts of Current Ozone Concentrations Compared to the State 8-hour Ozone Standard of 0.070 ppm by Air Basin (cases/year).

Air Basin	Mortality	Hospital Admissions	Emergency Room Visits	School Absences	Minor Restricted Activity Days
Great Basin Valley	<1	~~1~~ <1	<1	~~650~~ 1,100	~~820~~ 870
Lake County	~~<1~~ 0	~~<1~~ 0	~~<1~~ 0	~~35~~ 49	~~53~~ 48
Lake Tahoe	~~1~~ <1	~~9~~ 8	~~1~~ <1	~~6,100~~ 8,600	~~6,600~~ 6,400
Mountain Counties	~~12~~ 10	~~62~~ 61	8	~~41,000~~ 61,000	~~50,000~~ 49,000
Mojave Desert	~~51~~ 50	~~350~~ 340	~~59~~ 58	~~280,000~~ 420,000	~~260,000~~ 250,000
North Coast	<1	1	<1	~~720~~ 1,400	~~750~~ 990
North Central Coast	2	~~12~~ 17	~~2~~ 3	~~9,100~~ 19,000	~~8,800~~ 12,700
Northeast Plateau	~~<1~~ 0	~~<1~~ 0	~~<1~~ 0	~~88~~ 270	~~140~~ 270
South Coast	~~300~~ 320	~~2,100~~ 2,200	~~330~~ 350	~~1,700,000~~ 2,300,000	1,600,000
South Central Coast	~~17~~ 19	~~120~~ 130	~~18~~ 19	~~97,000~~ 150,000	~~91,000~~ 97,000
San Diego	~~25~~ 33	~~170~~ 220	~~23~~ 30	~~120,000~~ 220,000	~~130,000~~ 170,000
San Francisco Bay	~~23~~ 21	~~150~~ 140	~~21~~ 19	~~100,000~~ 120,000	~~120,000~~ 110,000
San Joaquin Valley	100	~~670~~650	~~120~~110	~~650,000~~ 880,000	~~470,000~~ 460,000
Salton Sea	~~21~~ 24	~~130~~ 150	~~21~~ 24	~~120,000~~ 200,000	~~91,000~~ 110,000
Sacramento Valley	~~39~~ 45	~~220~~ 250	~~32~~ 37	~~170,000~~ 250,000	~~170,000~~ 190,000
Statewide	630	4,200	660	4,700,000	3,100,000

Note: ~~The higher central estimate for the benefit values (either 1-hour or 8-hour averaging times) is given above for each endpoint by~~Some columns may not add up to the statewide totals due to rounding. Since

1-hour and 8-hour concentrations are highly correlated, it is not appropriate to add the estimated impacts from Tables B-6, B-7 and B-8 together. Table B-8 should be used to estimate the maximum health impacts per air basin. The uncertainty behind the mortality estimates is on the order of +/- 50% and varies for other endpoints.

References

ARB (2004) Aerometric Data Analysis and Management System (ADAM) http://www.arb.ca.gov/adam/welcome.html

Anderson HR, Atkinson RW, Peacock JL, Marston L, Konstantinou K. 2004. Meta-analysis of time-series studies and panel studies of particulate matter (PM) and ozone. Report of a WHO task group. World Health Organization. (http://www.euro.who.int/document/e82792.pdf)

Anderson HR, Spix C, Medina S, Schouten JP, Castellsague J, Rossi G, Zmirou D, Touloumi G, Wojtyniak B, Ponka A, Bacharova L, Schwartz J, Katsouyanni K. 1997. Air pollution and daily admissions for chronic obstructive pulmonary disease in 6 European cities: results from the APHEA project. Eur Respir J 10:1064-71.

~~Bates, DV. 2005. Personal statement made at Air Quality Advisory Committee Meeting, January 12, 2005.~~

Bell M, McDermott A, Zeger S, Samet J, Dominici F. 2004. Ozone and short-term mortality in 95 US urban communities, 1987-2000. JAMA 292, 19:2372-2378.

Burnett RT, Brook JR, Yung WT, Dales RE, Krewski D. 1997. Association between ozone and hospitalization for respiratory diseases in 16 Canadian cities. Environ Res 72:24-31.

Burnett RT, Dales RE, Raizenne ME, Krewski D, Summers PW, Roberts GR, Raad-Young M, Dann T, Brook J. 1994. Effects of low ambient levels of ozone and sulfates on the frequency of respiratory admissions to Ontario hospitals. Environ Res 65:172-94.

Burnett RT, Smith-Doiron M, Stieb D, Raizenne ME, Brook JR, Dales RE, Leech JA, Cakmak S, Krewski D. 2001. Association between ozone and hospitalization for acute respiratory diseases in children less than 2 years of age. Am J Epidemiol 153:444-52.

Friedman MS, Powell KE, Hutwagner L, Graham LM, Teague WG. 2001. Impact of changes in transportation and commuting behaviors during the 1996 Summer Olympic Games in Atlanta on air quality and childhood asthma. JAMA 285:897-905.

Gilliland FD, Berhane K, Rappaport EB, Thomas DC, Avol E, Gauderman WJ, London SJ, Margolis HG, McConnell R, Islam KT, Peters JM. 2001. The effects of ambient air pollution on school absenteeism due to respiratory illnesses. Epidemiology 12:43-54.

Gryparis A, Forsberg, B, Katsouyanni K, Analitis A, Touloumi G, Schwartz J, Somoli, E, Medina S, Anderson R, Niciu, E, Wichmann H, Kriz B, Kosnik M, Skordovsky J, Vonk J, Dorbudak Z. 2004. Acute effects of ozone on mortality from the “Air Pollution and Health: A European Approach” project. Am J Respir Crit Care Med 170: 1080-1087.

Hall JV, Brajer V, Lurmann FW. 2003. Economic valuation of ozone-related school absences in the south coast air basin of California. Contemporary Economic Policy 21:407-417.

Hubbell, BJ, Halberg A, McCubbin, DR, Post, E. 2005. Health-related benefits of attaining the 8-hr ozone standard. Environ Health Perspect 113:73-82.

Jaffe DH, Singer ME, Rimm AA. 2003. Air pollution and emergency department visits for asthma among Ohio Medicaid recipients, 1991-1996. Environ Res 91:21-8.

Levy JI, Carrothers TJ, Tuomisto JT, Hammitt JK, Evans JS. 2001. Assessing the public health benefits of reduced ozone concentrations. Environ Health Perspect 109:1215-26.

National Research Council. 2002. Estimating the public health benefits of proposed air pollution regulations. Washington, D.C.: National Academy Press.

Ostro BD, Rothschild S. 1989. Air pollution and acute respiratory morbidity: an observational study of multiple pollutants. Environ Res 50 :238-47.

Romieu I, Meneses F, Sienra-Monge JJ, Huerta J, Ruiz Velasco S, White MC, Etzel RA, Hernandez-Avila M. 1995. Effects of urban air pollutants on emergency visits for childhood asthma in Mexico City. Am J Epidemiol 141:546-53.

Samet JM, Zeger SL, Dominici F, Curriero F, Coursac I, Dockery DW *et al*. (2000). The National Morbidity, Mortality, and Air Pollution Study. Part II: Morbidity and mortality from air pollution in the United States. Health Effects Institute (94 Pt 2).

Schwartz J. 1997 Health effects of air pollution from traffic: ozone and particulate matter. Health at the crossroads: transport policy and urban health. New York: John Wiley.

Stieb DM, Burnett RT, Beveridge RC, Brook JR. 1996. Association between ozone and asthma emergency department visits in Saint John, New Brunswick, Canada. Environ Health Perspect 104:1354-60.

Stieb DM, Judek S, Burnett RT. 2003. Meta-analysis of time-series studies of air pollution and mortality: update in relation to the use of generalized additive models. J Air Waste Manag Assoc 53:258-261.

Thurston, G.T. and Ito, K. 1999. Epidemiologic studies of ozone exposure effects. In: Air Pollution and Health (Holgate ST, Samet JM, Koren Hs, Maynard RL, eds.) London:Academic Press.

Thurston GD, Ito K. 2001. Epidemiological studies of acute ozone exposures and mortality. J Expo Anal Environ Epidemiol 11: 286-94.

Thurston GD, Ito K, Hayes CG, Bates DV, Lippmann M. 1994. Respiratory hospital admissions and summertime haze air pollution in Toronto, Ontario: consideration of the role of acid aerosols. Environ Res 65: 271-90.

Tolbert PE, Mulholland JA, MacIntosh DL, Xu F, Daniels D, Devine OJ, Carlin BP, Klein M, Dorley J, Butler AJ, Nordenberg DF, Frumkin H, Ryan PB, White MC. 2000. Air quality and pediatric emergency room visits for asthma in Atlanta, Georgia, USA. Am J Epidemiol 151:798-810.

U.S. Environmental Protection Agency. 1999. The benefits and costs of the clean air act 1990 to 2010: EPA report to Congress. Washington, D.C.: Office of Air and Radiation and Office of Policy. Report No.: EPA-410-R-99-001, November. (http://www.epa.gov/air/sect812/copy99.html).

U.S. Environmental Protection Agency. 2004. Advisory on plans for health effects analysis in the analytical plan for EPA's second prospective analysis benefits and costs of the clean air act, 1990-2020; advisory by the health effects subcommittee of the advisory council on clean air compliance analysis. Washington, D.C. Report No.: EPA-SAB-COUNCIL-ADV-04-002 Environmental. (http://www.epa.gov/sab/pdf/council_adv_04002.pdf)

Supplement to Appendix B

Rollback Formulae

For the technical reader, the mathematical formulae for our rollback procedure follow. Denote:

OzCurrent = current daily ozone observed value,
BasinMax = design value based on three years of measured data,
BG = background ozone of 0.04 ppm,
Std = ~~proposed standard (0.09 ppm for 1-hour and 0.070 ppm for 8-hour),~~0.094 ppm for 1-hour, or basin-specific equivalent 1-hour design value for 8-hour standard of 0.070 ppm, or basin-specific equivalent 1-hour design value for federal 8-hour standard of 0.084 ppm, and
OzAttain = rolled-back ozone value in the “attainment” scenario.

First, the reduction percentage (or reduction factor RF) was calculated for each basin as follows:

If BasinMax > Std, then RF = (BasinMax - Std) / (BasinMax – BG).
If BasinMax <= Std, then RF = 0.

The rollback factor, 1-RF, is applied as follows. For all sites within the basin, the portion of the site’s current ozone levels above background was adjusted:

If OzCurrent > BG, then OzAttain = BG + (1 - RF) × (OzCurrent – BG).
If OzCurrent <= BG, then OzAttain = OzCurrent.

The change in ozone concentrations is OzCurrent – OzAttain, calculated at the daily level for each site, which is the difference between the observed value and the rolled-back value for each site on each day of the year.

Note that we used the actual levels of the standards, 0.09 and 0.070 ppm, in the rollback rather than the maximal values that round to the standards as is done with air quality modeling. Such modeling usually assumes worst-case meteorology, unlike our methodology of using the three-year high value.

Rollback Method Development

The assumption of a constant rollback factor applied to an entire air basin was justified through an empirical analysis of the trends in the percentiles at South Coast Air Basin monitoring sites. This air basin was selected for the analysis since the air quality trends were clear, there is a range of coastal and inland environments, and a majority of benefits are projected to occur in that air basin. Figures ~~B-2 through B-11 and Tables B-7 through B-16~~B-3 through B-12 and Tables B-9 through B-18 provide examples of the results from that analysis, and the materials are representative of the results used for development of the rollback factor applied in the benefits analysis. In the graphs, the dotted line indicates the ozone standard, and the dashed line represents the assumed background level. Due to space limitations, the legend for every percentile line was not provided. However, the reader is advised to examine the solid lines in each graph, from top to bottom, to represent the maximum, 90th percentile, 80th percentile, 70th percentile, 60th percentile, 50th percentile, and 40th percentile of the annual distribution of ozone measurements.

Briefly, the analysis showed that since 1980, the trend in the monitored values associated with the distribution of percentiles was consistently downward, and that the relationships were relatively parallel and linear. Consequently, we assumed a constant rollback factor based on a basin's three-year high value, and applied it to all daily high values at all sites within the basin. In other words, when a control strategy is geared towards reducing the highest ozone levels in an air basin, its impact on days with low and moderate ozone levels is comparable to those days with high ozone levels.

Estimation of Exposed Population

To estimate the number of people exposed to the ozone changes observed at each monitoring site, the county population was divided by the number of monitoring sites in a given county. For example, suppose a county has N monitoring stations and population POP according to year 2000 census. Then we would estimate that (POP/N) persons were exposed to ozone levels at each of the N monitors within this county. The health incidences were then calculated based on the concentration-response functions relating changes in ozone concentrations and exposed population for each day at each monitor. The sensitivity of this methodology is discussed in detail on page ~~B-15.~~B-16.

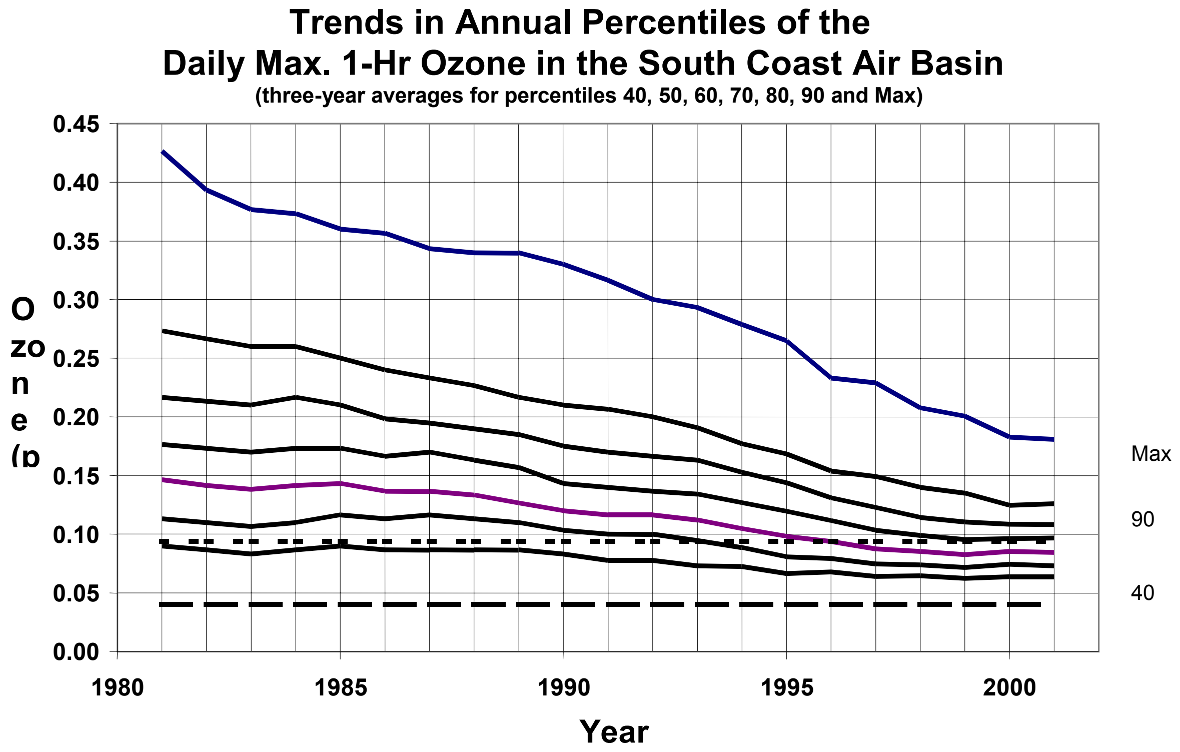


Figure ~~B-2:~~B-3: Trends in Annual Percentiles of Daily Max 1-hour Ozone in the South Coast Air Basin

Table ~~B-7:~~B-9: Summary of Trends in Annual Percentiles of the Daily Max. 1-Hr Ozone in the South Coast Air Basin

	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.427**	**0.317**	**0.183**
Δ% above background		**28%**	**63%**
90th Percentile	**0.273**	**0.207**	**0.125**
Δ% above background		**29%**	**64%**
80th Percentile	**0.217**	**0.170**	**0.109**
Δ% above background		**26%**	**61%**
70th Percentile	**0.177**	**0.140**	**0.096**
Δ% above background		**27%**	**59%**
60th Percentile	**0.147**	**0.117**	**0.086**
Δ% above background		**28%**	**57%**
50th Percentile	**0.113**	**0.100**	**0.075**
Δ% above background		**18%**	**53%**
40th Percentile	**0.090**	**0.078**	**0.064**
Δ% above background		**24%**	**52%**

note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background”, where background is defined as 0.04 ppm.

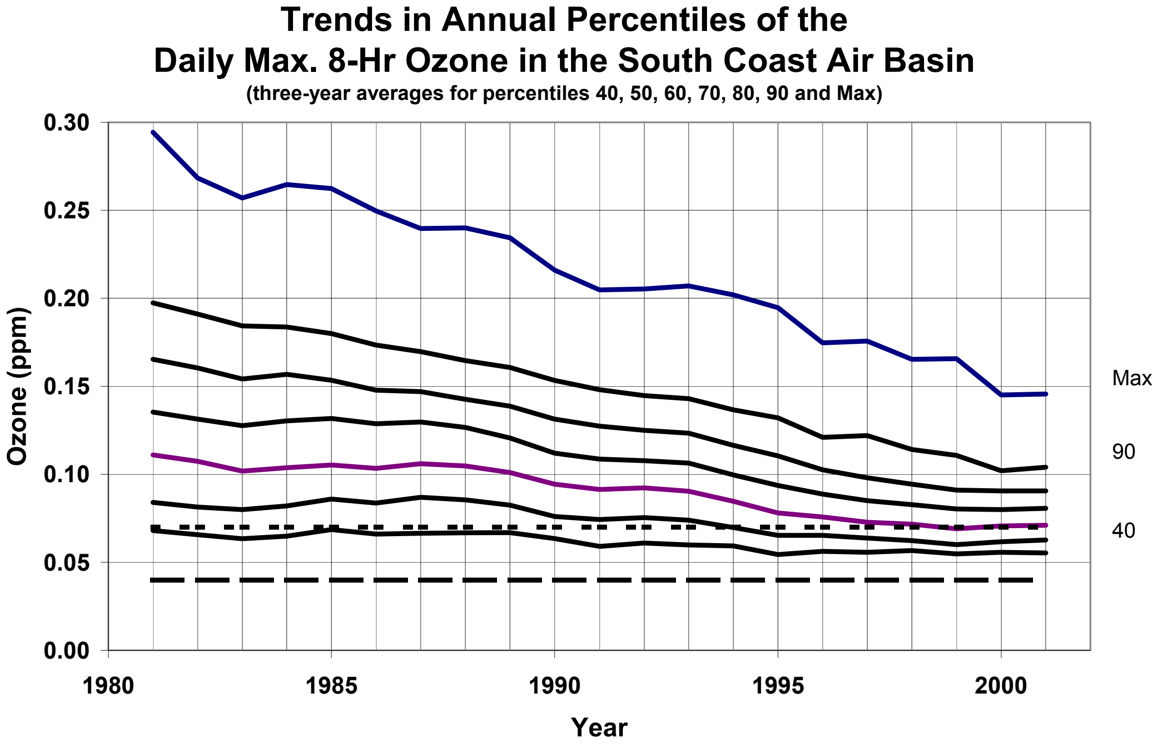
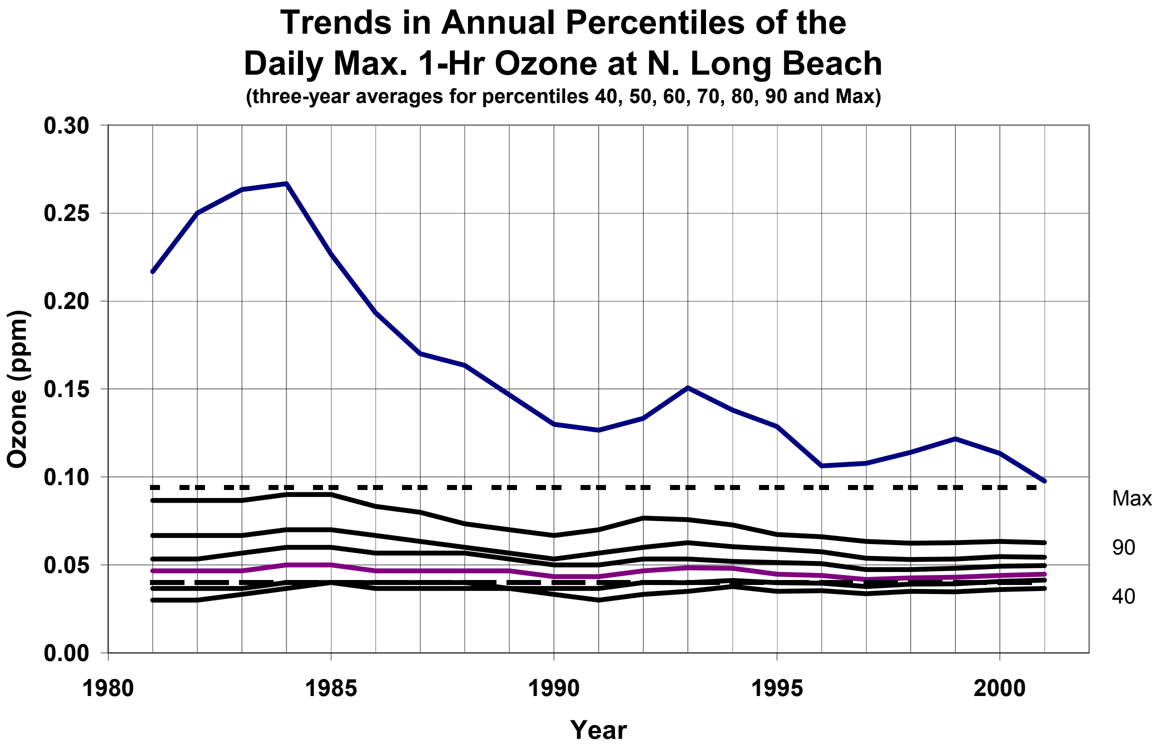


Figure ~~B-3:~~B-4: Trends in Annual Percentiles of Daily Max 8-hour Ozone in the
South Coast Air Basin

Table ~~B-8:~~B-10: Summary of Trends in Annual Percentiles of the Daily Max. 8-hr Ozone in the South Coast Air Basin

	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.294**	**0.205**	**0.145**
Δ% above background		35%	59%
90th Percentile	**0.197**	**0.148**	**0.102**
Δ% above background		31%	61%
80th Percentile	**0.165**	**0.127**	**0.091**
Δ% above background		30%	60%
70th Percentile	**0.135**	**0.109**	**0.080**
Δ% above background		28%	58%
60th Percentile	**0.111**	**0.091**	**0.071**
Δ% above background		28%	57%
50th Percentile	**0.084**	**0.074**	**0.062**
Δ% above background		22%	51%
40th Percentile	**0.068**	**0.059**	**0.056**
Δ% above background		32%	44%

note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background”, where background is defined as 0.04 ppm.



~~Figure B-4:~~Figure B-5: **Trends in Annual Percentiles of Daily Max 1-hour Ozone at N. Long Beach**

Table ~~B-9:~~B-11: Summary of Trends in Annual Percentiles of the Daily Max 1-hour Ozone at N. Long Beach

	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.217**	**0.127**	**0.113**
Δ% above background		**51%**	**58%**
90th Percentile	**0.087**	**0.070**	**0.063**
Δ% above background		**36%**	**50%**
80th Percentile	**0.067**	**0.057**	**0.055**
Δ% above background		**38%**	**45%**
70th Percentile	**0.053**	**0.050**	**0.049**
Δ% above background		**25%**	**30%**
60th Percentile	**0.047**	**0.043**	**0.044**
Δ% above background		**50%**	**40%**
50th Percentile	**0.037**	**0.037**	**0.041**
Δ% above background		**Percentiles are below background.**	
40th Percentile	**0.030**	**0.030**	**0.036**
Δ% above background		**Percentiles are below background.**	
note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background", where background is defined as 0.04 ppm.			

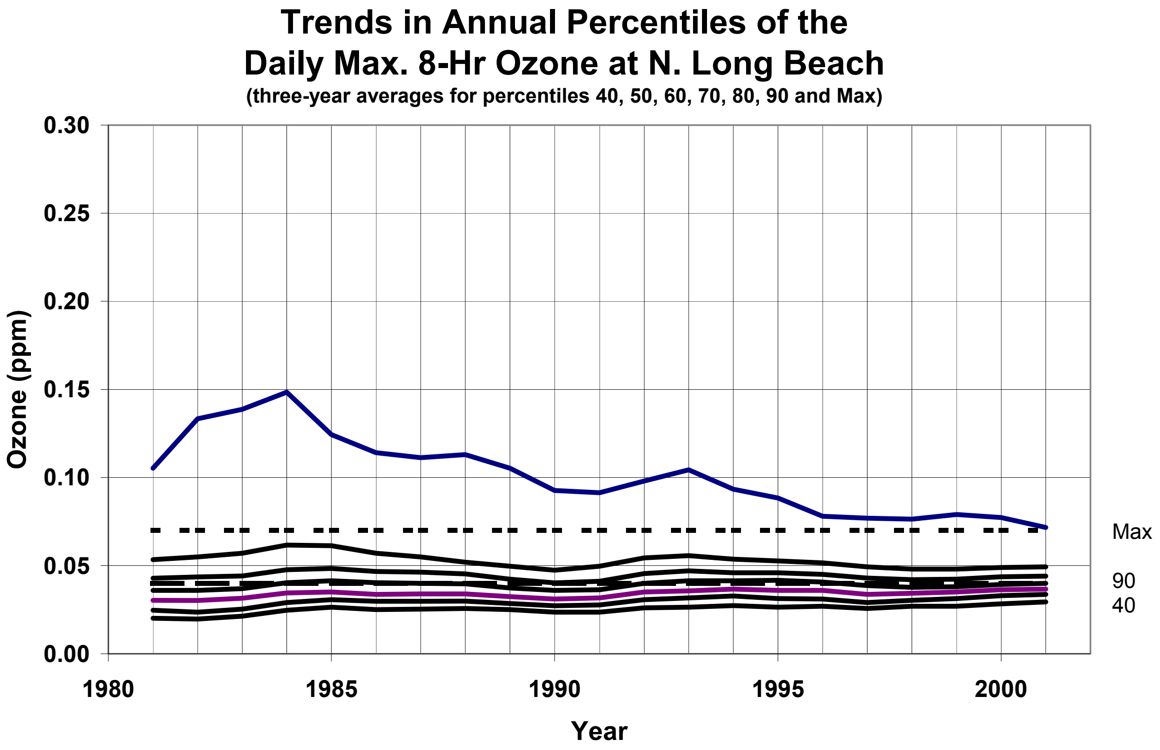


Figure ~~B-5:~~B-6: Trends in annual percentiles of daily max 8-hour ozone at N. Long Beach

Table ~~B-10:~~B-12: Summary of Trends in Annual Percentiles of the Daily Max 8-hour Ozone at N. Long Beach

	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.105**	**0.091**	**0.077**
Δ% above background		21%	43%
90th Percentile	**0.053**	**0.050**	**0.049**
Δ% above background		28%	33%
80th Percentile	**0.043**	**0.041**	**0.044**
Δ% above background		59%	-29%
70th Percentile	**0.036**	**0.036**	**0.039**
Δ% above background		Percentiles are below background.	
60th Percentile	**0.030**	**0.032**	**0.036**
Δ% above background		Percentiles are below background.	
50th Percentile	**0.025**	**0.028**	**0.033**
Δ% above background		Percentiles are below background.	
40th Percentile	**0.020**	**0.024**	**0.028**
Δ% above background		Percentiles are below background.	

note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background", where background is defined as 0.04 ppm.

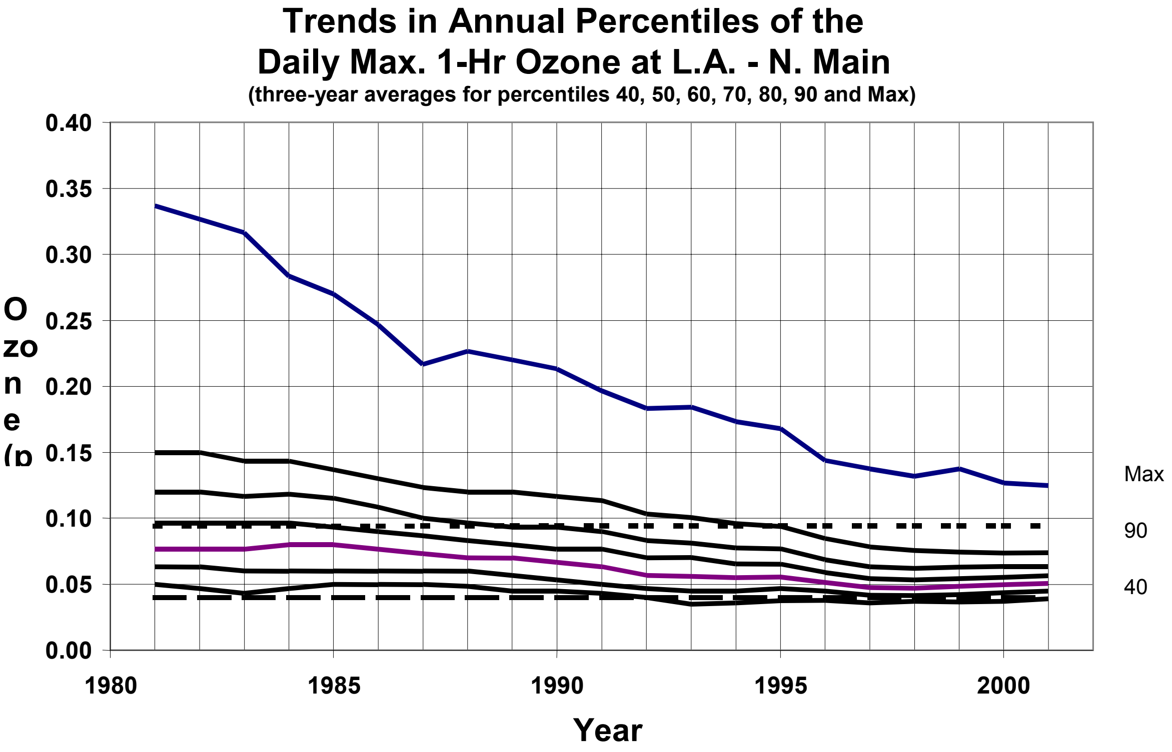


Figure ~~B-6:~~B-7: Trends in annual percentiles of daily max 1-hour ozone L.A. – N. Main

Table ~~B-11:~~B-13: Summary of Trends in Annual Percentiles of the Daily Max 1-hour Ozone at L.A. - N. Main

	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.337**	**0.197**	**0.127**
Δ% above background		47%	71%
90th Percentile	**0.150**	**0.113**	**0.074**
Δ% above background		33%	69%
80th Percentile	**0.120**	**0.090**	**0.064**
Δ% above background		38%	70%
70th Percentile	**0.097**	**0.077**	**0.055**
Δ% above background		35%	73%
60th Percentile	**0.077**	**0.063**	**0.050**
Δ% above background		36%	74%
50th Percentile	**0.063**	**0.050**	**0.044**
Δ% above background		57%	84%
40th Percentile	**0.050**	**0.043**	**0.037**
Δ% above background		67%	100%

note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background", where background is defined as 0.04 ppm.

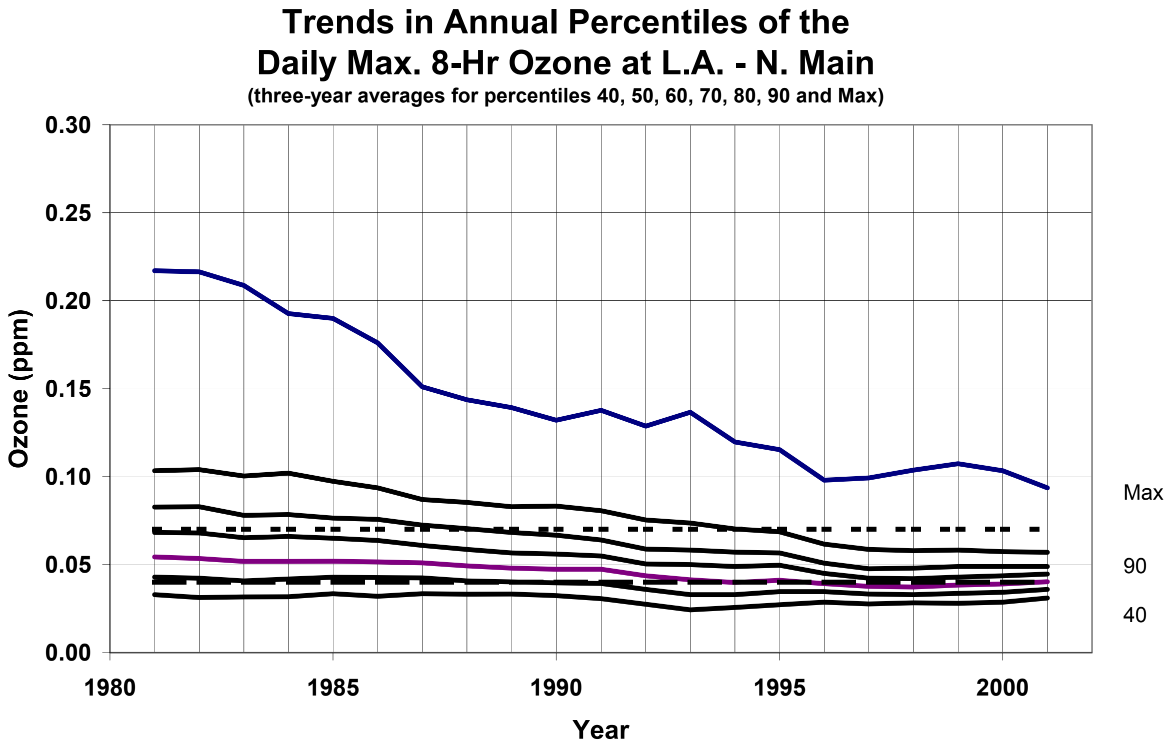


Figure ~~B-7:~~B-8: Trends in annual percentiles of daily max 8-hour ozone at L.A.-N. Main

Table ~~B-12:~~B-14: Summary of Trends in Annual Percentiles of the Daily Max 8-hour Ozone at L.A. - N. Main

	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.217**	**0.138**	**0.103**
Δ% above background		45%	64%
90th Percentile	**0.103**	**0.081**	**0.057**
Δ% above background		36%	73%
80th Percentile	**0.083**	**0.064**	**0.049**
Δ% above background		44%	79%
70th Percentile	**0.068**	**0.055**	**0.044**
Δ% above background		47%	87%
60th Percentile	**0.054**	**0.047**	**0.039**
Δ% above background		49%	100%
50th Percentile	**0.043**	**0.039**	**0.034**
Δ% above background		100%	100%
40th Percentile	**0.033**	**0.031**	**0.029**
Δ% above background		Percentiles are below background.	

note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background", where background is defined as 0.04 ppm.

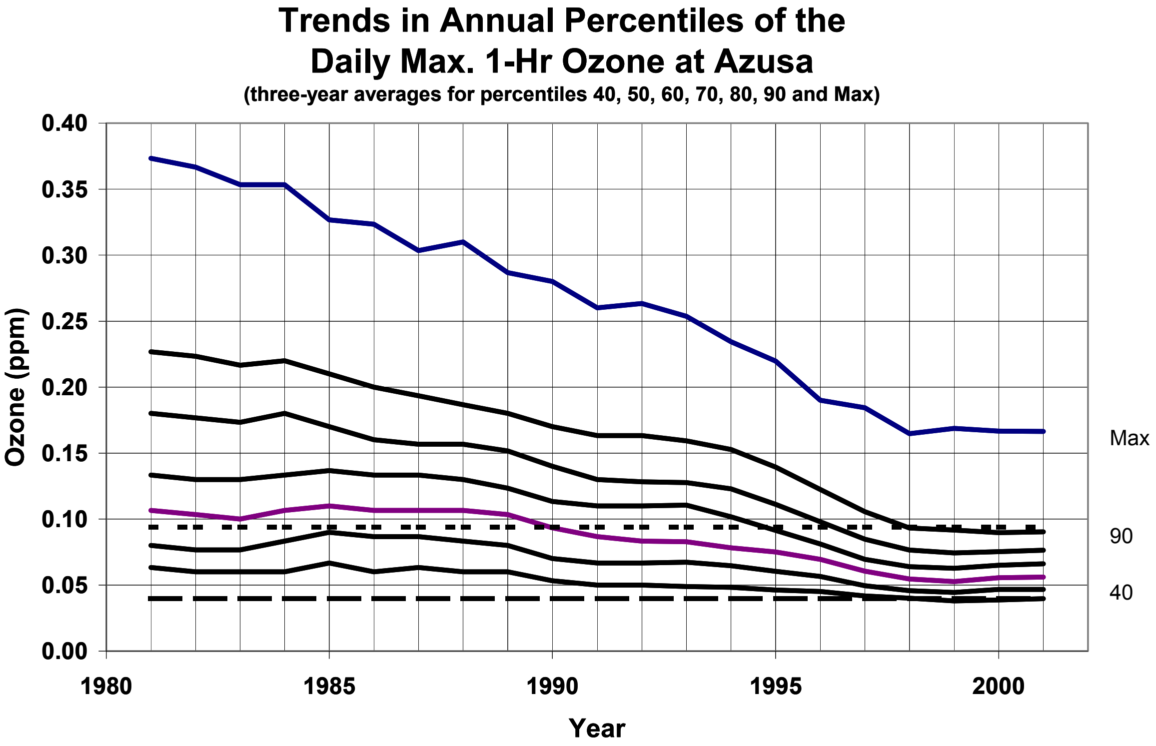


Figure ~~B-8:~~B-9: Trends in annual percentiles of daily max 1-hour ozone at Azusa

Table ~~B-13:~~B-15: Summary of Trends in Annual Percentiles of the Daily Max 1-hour Ozone at Azusa

Summary of Trends in Annual Percentiles of the Daily Max. 1-Hr Ozone at Azusa			
	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.373**	**0.260**	**0.167**
Δ% above background		34%	62%
90th Percentile	**0.227**	**0.163**	**0.090**
Δ% above background		34%	73%
80th Percentile	**0.180**	**0.130**	**0.075**
Δ% above background		36%	75%
70th Percentile	**0.133**	**0.110**	**0.065**
Δ% above background		25%	73%
60th Percentile	**0.107**	**0.087**	**0.056**
Δ% above background		30%	77%
50th Percentile	**0.080**	**0.067**	**0.047**
Δ% above background		33%	83%
40th Percentile	**0.063**	**0.050**	**0.039**
Δ% above background		57%	100%

note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background”, where background is defined as 0.04 ppm.

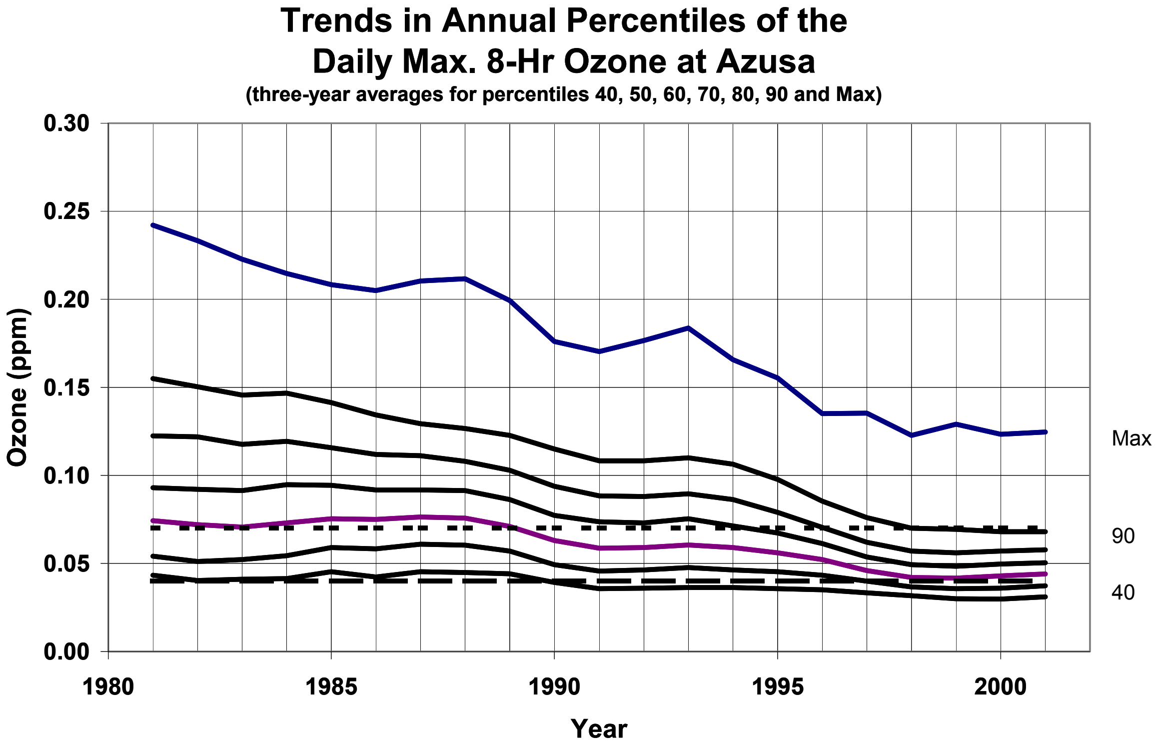


Figure ~~B-9:~~B-10: Trends in annual percentiles of daily max 8-hour ozone at Azusa

Table ~~B-14:~~B-16: Summary of Trends in Annual Percentiles of the Daily Max 8-hour Ozone at Azusa

	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.242**	**0.170**	**0.123**
Δ% above background		**35%**	**59%**
90th Percentile	**0.155**	**0.108**	**0.068**
Δ% above background		**41%**	**76%**
80th Percentile	**0.123**	**0.088**	**0.057**
Δ% above background		**41%**	**79%**
70th Percentile	**0.093**	**0.074**	**0.050**
Δ% above background		**36%**	**82%**
60th Percentile	**0.074**	**0.059**	**0.043**
Δ% above background		**46%**	**100%**
50th Percentile	**0.054**	**0.046**	**0.036**
Δ% above background		**60%**	**100%**
40th Percentile	**0.043**	**0.036**	**0.030**
Δ% above background		**100%**	**100%**

note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background", where background is defined as 0.04 ppm.

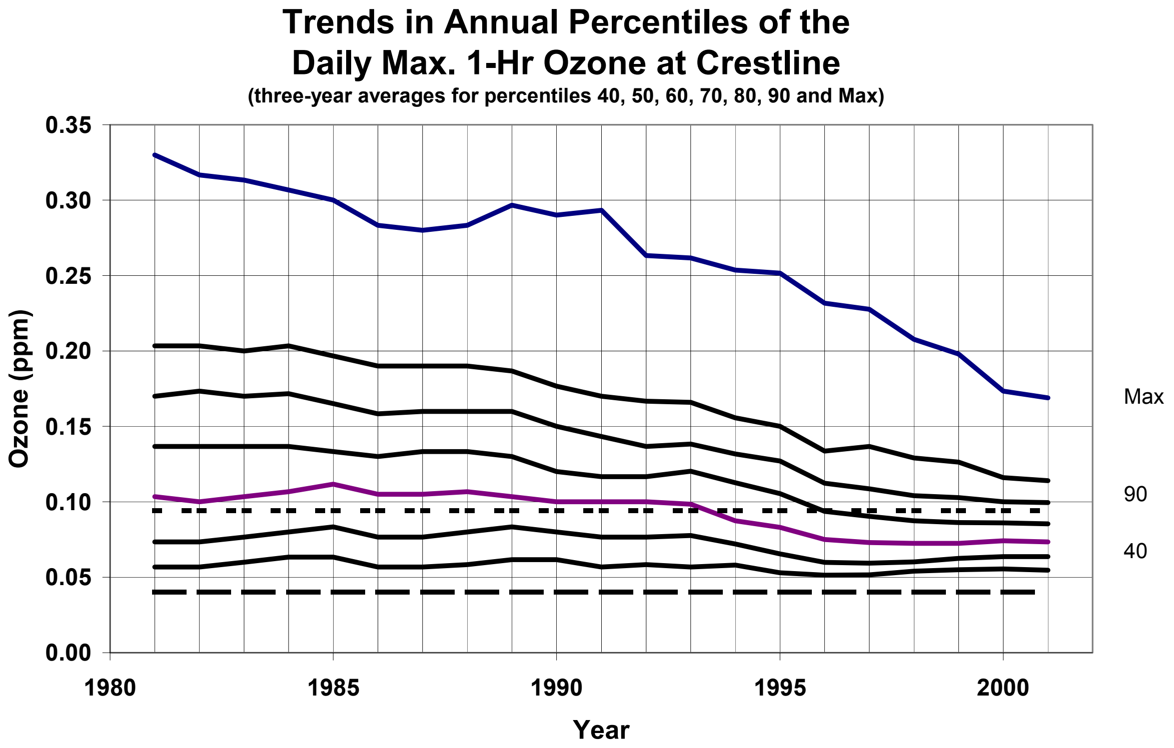


Figure ~~B-10:~~B-11: Trends in annual percentiles of daily max 1-hour ozone at Crestline

Table ~~B-15:~~B-17: Summary of Trends in Annual Percentiles of the Daily Max 1-hour Ozone at Crestline

	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.330**	**0.293**	**0.173**
Δ% above background		**13%**	**54%**
90th Percentile	**0.203**	**0.170**	**0.116**
Δ% above background		**20%**	**53%**
80th Percentile	**0.170**	**0.143**	**0.100**
Δ% above background		**21%**	**54%**
70th Percentile	**0.137**	**0.117**	**0.086**
Δ% above background		**21%**	**52%**
60th Percentile	**0.103**	**0.100**	**0.074**
Δ% above background		**5%**	**46%**
50th Percentile	**0.073**	**0.077**	**0.064**
Δ% above background		**-10%**	**29%**
40th Percentile	**0.057**	**0.057**	**0.056**
Δ% above background		**0%**	**7%**

note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background”, where background is defined as 0.04 ppm.

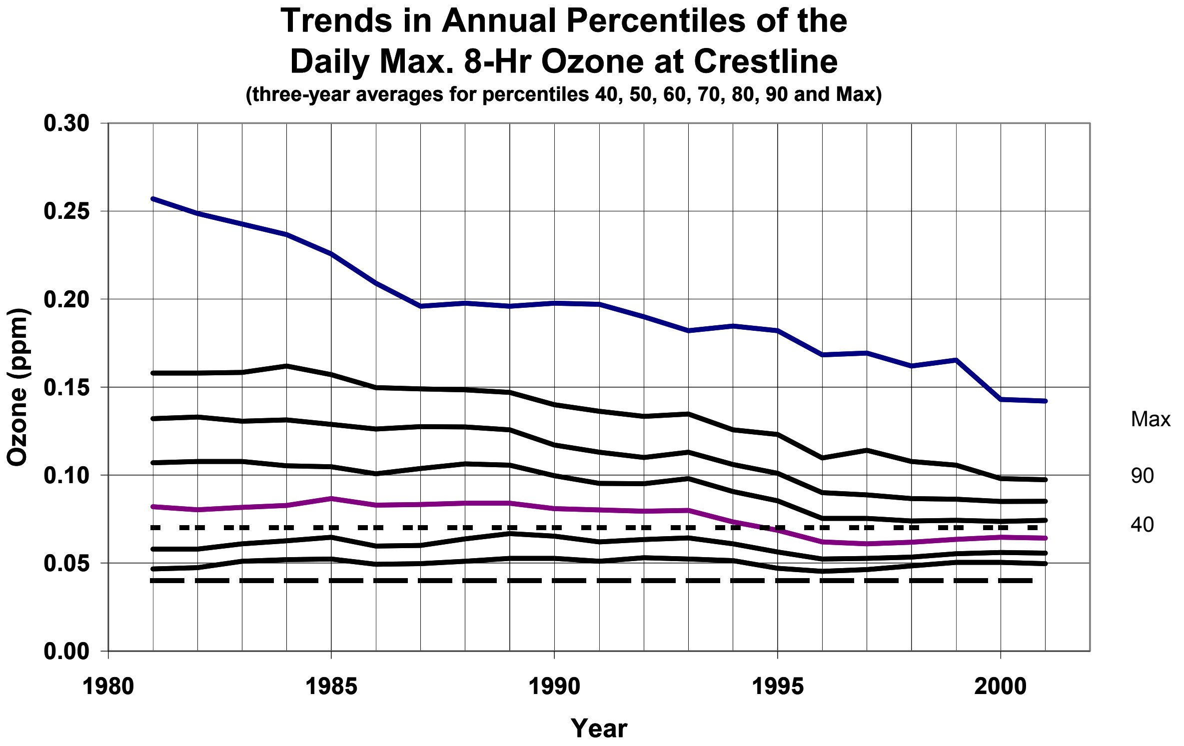


Figure B-1~~1:~~2: Trends in annual percentiles of daily max 8-hour ozone at Crestline

Table ~~B-16:~~B-18: Summary of Trends in Annual Percentiles of the Daily Max 8-hour Ozone at Crestline

	Average Value During Period		
Indicator	**1980-1982**	**1990-1992**	**2000-2002**
Maximum	**0.257**	**0.197**	**0.143**
Δ% above background		**28%**	**53%**
90th Percentile	**0.158**	**0.136**	**0.098**
Δ% above background		**18%**	**51%**
80th Percentile	**0.132**	**0.113**	**0.085**
Δ% above background		**21%**	**51%**
70th Percentile	**0.107**	**0.095**	**0.074**
Δ% above background		**17%**	**50%**
60th Percentile	**0.082**	**0.080**	**0.065**
Δ% above background		**4%**	**41%**
50th Percentile	**0.058**	**0.062**	**0.056**
Δ% above background		**-22%**	**11%**
40th Percentile	**0.047**	**0.051**	**0.050**
Δ% above background		**-65%**	**-55%**

note: Delta % above background is the change in the portion of measured ozone since 1980-82 above "background", where background is defined as 0.04 ppm.

Table ~~B-17:~~B-19: Baseline Incidence Rates (Incidence/1000 Persons/Year)

County Name	Mortality (Short-Term Exposures) Non-Accidental, All Ages	Hospital Admissions, All Respiratory, All Ages	ER Visits for Asthma, Age Under 18	School Loss Days, All Illness, Age 5-17	MRAD Age>18
Alameda County	6.60	10.13	3.81	5990.10	7805.39
Alpine County	7.40	10.13	3.81	5990.10	7805.39
Amador County	9.99	10.13	3.81	5990.10	7805.39
Butte County	10.40	10.13	3.81	5990.10	7805.39
Calaveras County	8.90	10.13	3.81	5990.10	7805.39
Colusa County	7.10	10.13	3.81	5990.10	7805.39
Contra Costa County	6.78	10.13	3.81	5990.10	7805.39
Del Norte County	8.41	10.13	3.81	5990.10	7805.39
El Dorado County	6.29	10.13	3.81	5990.10	7805.39
Fresno County	6.41	10.13	3.81	5990.10	7805.39
Glenn County	7.71	10.13	3.81	5990.10	7805.39
Humboldt County	8.51	10.13	3.81	5990.10	7805.39
Imperial County	5.44	10.13	3.81	5990.10	7805.39
Inyo County	11.81	10.13	3.81	5990.10	7805.39
Kern County	6.60	10.13	3.81	5990.10	7805.39
Kings County	5.66	10.13	3.81	5990.10	7805.39
Lake County	13.13	10.13	3.81	5990.10	7805.39
Lassen County	5.75	10.13	3.81	5990.10	7805.39
Los Angeles County	6.08	10.13	3.81	5990.10	7805.39
Madera County	6.35	10.13	3.81	5990.10	7805.39
Marin County	7.47	10.13	3.81	5990.10	7805.39
Mariposa County	9.48	10.13	3.81	5990.10	7805.39
Mendocino County	8.89	10.13	3.81	5990.10	7805.39
Merced County	6.29	10.13	3.81	5990.10	7805.39
Modoc County	11.62	10.13	3.81	5990.10	7805.39
Mono County	3.87	10.13	3.81	5990.10	7805.39
Monterey County	5.88	10.13	3.81	5990.10	7805.39
Napa County	10.45	10.13	3.81	5990.10	7805.39
Nevada County	8.56	10.13	3.81	5990.10	7805.39
Orange County	5.68	10.13	3.81	5990.10	7805.39

Placer County	7.00	10.13	3.81	5990.10	7805.39
Plumas County	10.08	10.13	3.81	5990.10	7805.39
Riverside County	7.37	10.13	3.81	5990.10	7805.39
Sacramento County	7.14	10.13	3.81	5990.10	7805.39
San Benito County	5.06	10.13	3.81	5990.10	7805.39
San Bernardino County	6.10	10.13	3.81	5990.10	7805.39
San Diego County	6.41	10.13	3.81	5990.10	7805.39
San Francisco County	8.78	10.13	3.81	5990.10	7805.39
San Joaquin County	6.98	10.13	3.81	5990.10	7805.39
San Luis Obispo County	7.87	10.13	3.81	5990.10	7805.39
San Mateo County	6.77	10.13	3.81	5990.10	7805.39
Santa Barbara County	6.80	10.13	3.81	5990.10	7805.39
Santa Clara County	5.19	10.13	3.81	5990.10	7805.39
Santa Cruz County	6.56	10.13	3.81	5990.10	7805.39
Shasta County	9.50	10.13	3.81	5990.10	7805.39
Sierra County	9.26	10.13	3.81	5990.10	7805.39
Siskiyou County	10.42	10.13	3.81	5990.10	7805.39
Solano County	5.90	10.13	3.81	5990.10	7805.39
Sonoma County	8.17	10.13	3.81	5990.10	7805.39
Stanislaus County	7.22	10.13	3.81	5990.10	7805.39
Sutter County	7.43	10.13	3.81	5990.10	7805.39
Tehama County	9.90	10.13	3.81	5990.10	7805.39
Trinity County	10.73	10.13	3.81	5990.10	7805.39
Tulare County	6.71	10.13	3.81	5990.10	7805.39
Tuolumne County	9.50	10.13	3.81	5990.10	7805.39
Ventura County	5.76	10.13	3.81	5990.10	7805.39
Yolo County	6.37	10.13	3.81	5990.10	7805.39
Yuba County	7.26	10.13	3.81	5990.10	7805.39

Reference Lists

Chapters 1-11, Appendix B and Appendix G

Chapter 1

1. Air Resources Board and Office of Environmental Health Hazard Assessment (2000). Adequacy of California Ambient Air Quality Standards: Children's Environmental Health Protection Act. Staff Report. Sacramento, CA. Available at

   http://www.arb.ca.gov/ch/programs/sb25/airstandards.htm.

Chapter 2

2. Adams WC. 1998. Dose-response effects of varied equivalent minute ventilation rates on pulmonary function responses during exposure to ozone. Final Report to the American Petroleum Institute. Washington D.C.
3. Air Resources Board. Ambient Air Quality Standard for Ozone: Health and Welfare Effects. Staff Report. September 1987. Sacramento, CA.
4. Air Resources Board and Office of Environmental Health Hazard Assessment. Adequacy of California Ambient Air Quality Standards: Children's Environmental Health Protection Act. Staff Report. 2000.
5. Air Resources Board (2001). Policies and Actions for Environmental Justice, December 13, 2001.
6. Galizia A, Kinney PL. 1999. Long-term residence in areas of high ozone: associations with respiratory health in a nationwide sample of nonsmoking young adults. Environ Health Perspect 107:675-679.
7. Kunzli N, Lurmann F, Segal M, Ngo L, Balmes J, Tager IB. 1997. Association between lifetime ambient ozone exposure and pulmonary function in college freshmen – results of a pilot study. Environ Res 72:8-23.
8. McConnell R, Berhane K, Gilliland F, London SJ, Islam T, Gauderman WJ, Avol E, Margolis HG, Peters JM. 2002. Asthma in exercising children exposed to ozone: a cohort study. Lancet 359:386-391.
9. World Health Organization (2000). Air Quality Guidelines for Europe, Second Edition. (WHO regional publications, European series, No. 91.)

Chapter 3

10. Air Resources Board/Planning and Technical Support Division. 2002. California Ambient Air Quality Data – 1980 – 2001. Sacramento, CA.: December. Data CD Number: PTSD-02-017-CD

11. Chameides WL, Fehsenfeld F, Rodgers MO, Cardelino C, Martinez J, Parrish D, Lonneman W, Lawson DR, Rasmussen RA, Zimmerman P, Greenberg J, Middleton P, Wang T. 1992. Ozone Precursor Relationships in the Ambient Atmosphere. Journal of Geophysical Research 97:6037-55.
12. Croes BE, Dolislager LJ, Larsen LC, Pitts JN. 2003. The O_3 "Weekend Effect" and NO_X Control Strategies -- Scientific and Public Health Findings and Their Regulatory Implications. Environ Manager July:27-35.
13. Finlayson-Pitts BJ, Pitts JN. 2000. Chemistry of the Upper and Lower Atmosphere - Theory, Experiments, and Applications. Academic Press, San Diego, CA.
14. National Research Council. 1991. Rethinking the Ozone Problem in Urban and Regional Air Pollution, National Academy Press, Washington, DC.
15. Smith TB, Lehrman DE, Knuth WR, Johnson D. 1997. Monitoring in Ozone Transport Corridors. Final report prepared for ARB/RD (contract # 94-316).
16. Whitten GZ, 1993. The Chemistry of Smog Formation: A Review of Current Knowledge. Environment Intenational. 9:447-463.

Chapter 4

17. Berntsen, T., Karlsdottir, S., Jaffe, D. 1999. Influence of Asian emissions on the composition of air reaching the North Western United States, Geophys. Res. Lett. 26(14): 2,171-2,174.
18. Bertschi, I. T., D. A. Jaffe, L. Jaegle, H. U. Price, J. B. Dennison. 2004. PHOBEA/ITCT 2002 airborne observations of transpacific transport of ozone, CO, volatile organic compounds, and aerosols to the northeast Pacific: Impacts of Asian anthropogenic and Siberian boreal fire emissions, J. Geophys. Res. 109: D23S12, doi:10.1029/2003JD004328.
19. Bojkov, R. 1986. Surface ozone during the second half of the nineteenth century. Mon. Weather Rev. 25: 353-352.
20. Browell, E. et al. 2003. Ozone, aerosol, potential vorticity, and trace gas trends observed at high latitudes over North America from February to May 2000. J. Geophys. Res. 108(D4).

21. California Department of Forestry and Fire Protection (CDFFP). 2004a. 2003 Fire Summary http://WWW.FIRE.CA.GOV/php/2003fireseasonstats_v2.asp.

22. California Department of Forestry and Fire Protection (CDFFP). 2004b. 2003 Large Fires. http://WWW.FIRE.CA.GOV/php/fire_er_content/downloads/2003LargeFires.pdf

23. Crutzen, P. 1995. My life with O_3, NO_X and other YZO_Xs, Nobel Lecture, December 8, 1995.

24. Derognat, C., M. Beekmann, M. Baeumle, D. Martin, H. Schmidt. 2003. Effect of biogenic volatile organic compound emissions on tropospheric chemistry during the Atmospheric Pollution Over the Paris Area (ESQUIF) campaign in the Ile-de-France region. J. Geophys. Res. 108(D17).

25. Dreyfus, G. B., Schade, G. W., Goldstein, A.H. 2002. Observational constraints on the contribution of isoprene oxidation to ozone production on the western slope of the Sierra Nevada, CA. J. Geophys. Res. 107(D19).

26. Fiore, A. et al. 2002. Background ozone over the United States in summer: Origin, trend, and contribution to pollution episodes. J. Geophys. Res. 107(D15).

27. Galani, E., et al*.* 2003. Observations of stratosphere-to-troposphere transport events over the eastern Mediterranean using a ground-based lidar system. J. Geophys. Res. 108(D12).

28. Galanter, M., Levy, H., Carmichael, G. 2000. Impacts of biomass burning on tropospheric CO, NO_X, and O_3. J. Geophys. Res. 105(D5): 6,633-6,653.

29. Hauglustaine, D., Brasseur, G. 2001. Evolution of tropospheric ozone under anthropogenic activities and associated radiative forcing of climate. J. Geophys. Res. 106(D23).

30. Jaegle, L., Jaffe, D., Price, H., Weiss-Penzias, P., Palmer, P., Evans, M., Jacob, D., Bey, I. 2003. Sources and budgets for CO and O_3 in the northeastern Pacific during the spring of 2001: Results from the PHOBEA-II Experiment. J. Geophys. Res. 108(D20).

31. Jacob, D., Logan, J., Murti, P. 1999. Effect of rising Asian emissions on surface ozone in the United States. Geophys. Res. Let*t.* 26(14): 2,175-2,178.

32. Jaffe, D., I. Bertschi, L. Jaegle, P. Novelli, J. S. Reid, H. Tanimoto, R. Vingarzan, D. L. Westphal. 2004. Long-range transport of Siberian biomass burning emissions and impact on surface ozone in western North America. Geophys. Res. Lett., 31, L16106, doi:10.1029/2004GL020093.

33. Jaffe, D., et al*.* 1999. Transport of Asian Air Pollution to North America, Geophys Res. Lett. 26(6): 711-714.

34. Jaffe, D., Weiss-Penzias, P., Dennison, J., Bertschi, I., Westphal, D. 2003a. Siberian Biomass Burning Plumes Across the Pacific: Impact on Surface Air Quality in the Pacific Northwest, Eos Trans. AGU, 84(46), Fall Meet. Suppl., Abstract A11I-02.
35. Jaffe, D., Price, H., Parrish, D., Goldstein, A., Harris, J. 2003b. Increasing background ozone during spring on the west coast of North America, Geophys. Res. Lett. 30(12).
36. Jaffe, D., McKendry, I., Anderson, T., Price, H. 2003. Six 'new' episodes of trans-Pacific transport of air pollutants. Atmos. Env. 37m 391-404.
37. Jenkins, G., Ryu, J-H. 2003. Linking horizontal and vertical transport of biomass fire emissions to the Tropical Atlantic Ozone Paradox during the Northern Hemisphere winter season: climatology. Atmos. Chem. Phys. Discuss. 3: 5,061-5,098.
38. Lawrence, M., vonKuhlmann, R., Salzmann, M., Rasch, P. 2003. The balance of effects of deep convective mixing on tropospheric ozone, Geophys. Res. Lett. 30(18).
39. Lelieveld, J., Dentener, F. 2000. What controls tropospheric ozone?, J. Geophys. Res.105(D3).
40. Lefohn, A., Oltmans, S., Dann, T., Singh, H 2001. Present-day variability of background ozone in the lower troposphere. J. Geophys. Res. 106(D9).
41. Levine, J. 1985. The Structure of the Atmosphere. In: Levine, J., ed. *The Photochemistry of Atmospheres.*, Academic Press, Orlando, FL. pp. 7-9.
42. Lin, C-Y, Jacob, D., Munger, J., Fiore, A. 2000. Increasing background ozone in surface air over the United States. Geophys. Res. Lett. 27(21): 3,465-3,468.
43. Lisac, I., Grubilisic, V. 1991. An analysis of surface ozone data measured at the end of the 19th century in Zagreb, Yugoslavia. Atmos. Env. 25A(2): 481-486.
44. Newchurch, M. J., et al. 2003. Vertical distribution of ozone at four sites in the United States. J. Geophys. Res. 108(D1).
45. Pochanart, P., Akimoto, H., Kajii, Y., Potemkin, V., Khodzher, T. 2003. Regional background ozone and carbon monoxide variations in remote Siberia/East Asia. J. Geophys. Res. 108(D1).
46. Seo, K.-H., K. P. Bowman. 2002. Lagrangian estimate of global stratosphere-troposphere mass exchange. J. Geophys. Res. 107(D21).

47. STACCATO. 2003. Influence of Stratosphere-Troposphere Exchange in a Changing Climate on Atmospheric Transport and Oxidation Capacity (STACCATO). Lehrstuhl für Bioklimatologie und Immissionsforschung, Technische Universität München, Germany, Web Report, http://www.forst.tu-muenchen.de/EXT/LST/METEO/staccato/

48. St. John, J., Chameides, W., Saylor, R. 1998. The Role of anthropogenic NO_X and VOC as ozone precursors: A case study from the SOS Nashville/Middle Tennessee Ozone Study. J. Geophys. Res. 103(D17): 22,415–22,423.

49. Thouret, V., et al. 2001. Tropospheric ozone layers observed during PEM-Tropics B. J. Geophys. Res. 106(D23): 32,527–32,538.

50. Trickl, T., Cooper, O., Eisele, H., James, P., Mucke, R., Stohl, A. 2003. Intercontinental transport and its influence on the ozone concentrations over central Europe: Three case studies. J. Geophys. Res. 108(D12).

51. Turco, R. 1985. The Photochemistry of the Stratosphere. In: Levine, J., ed. *The Photochemistry of Atmospheres.* Academic Press, Orlando, FL. pp. 77-128.

52. VanCuren, R., Cahill, T. 2002. Asian aerosols in North America: Frequency and concentration of fine dust. 107(D24).

53. Weiss-Penzias, P., Jaffe, D-., McClintick, A., Jaegle, L., Liang, Q. 2003. The influence of long-range transport of pollution on the annual cycles of carbon monoxide and ozone. Eos Trans. AGU, 84(46), Fall Meet. Suppl., Abstract A31D-0077.

54. Wernli H., Bourqui, M. A. 2002. Lagrangian "1-year climatology" of (deep) cross tropopause exchange in the extra-tropical Northern Hemisphere. J. Geo. Res. 107: 4021.

Chapter 5

55. Planning and Technical Support Division, Air Resources Board. The 2003 California Almanac of Emissions and Air Quality.

56. Emission Inventory Branch, Air Resources Board. May 1996.Emission Inventory Procedure Manual, Volume I, Inventory Development Process.

Chapter 6

57. Air Resources Board. September, 1987. Effects of ozone on health, technical support document, pages 5-13.

58. Code of Federal Regulations. Title 40, Part 50, Appendix D, Measurement principles and calibration procedure for the measurement of ozone in the atmosphere.
59. Code of Federal Regulation. Title 40, Part 53, Revised requirements for designation of reference and equivalent methods for PM2.5 and ambient air quality surveillance for particulate matter. Pgs 1-28.
60. McElroy F, Dennis M, Monica N. 1997. Determination of ozone by ultraviolet analysis. A new method for Volume II, Ambient air specific methods, quality assurance handbook for air pollution measurement systems.
61. USEPA. 1996. Air Quality Criteria for ozone and related photochemical oxidants, EPA/600/P-93/004q-cF, pages 3-90 to 3-102. http://cfpub.epa.gov/ncea/cfm/ozone.cfm
62. Title 17, Barclay California Code of Regulation, section 70200.
63. USEPA/ORD (2002). List of designated reference and equivalent methods. http://www.epa.gov/ttn/amtic/criteria.html
64. Appendix A (1995). Dasibi model 1003 AH ozone analyzer. Volume II: standard operating procedures for air monitoring, air monitoring quality assurance, California Air Resources Board. http://www.arb.ca.gov/aaqm/qmosqual/qamanual/qamanual.htm
65. USEPA, 1984. Special Report, Issues Concerning the Use of Precision and Accuracy Data, EPA-450/4-84-006, pages 2 – 23. http://www.epa.gov/ttn/amtic/cpreldoc.html
66. USEPA, 1983. Guideline on the Meaning and Use of Precision and Accuracy Data Required By 40 CFR Part 58, Appendices A and B, EPA-600/4-83-023, pages 6-33. http://www.epa.gov/ttn/amtic/cpreldoc.html

Chapter 7

67. Air Resources Board. December 2002. Area Designations and Maps 2002.
68. Air Resources Board. December 2002. California Ambient Air Quality Data 1980-2001 Data CD.
69. Air Resources Board. January 20, 2005. ARB warns, danger from popular “air purifying” machines. Available from: http://www.arb.ca.gov/newsrel/nr012005.htm
70. Air Resources Board. January 2004. California Ambient Air Quality Data 1980-2002.
71. Air Resources Board. September 1993. Guidance for Using Air Quality-Related Indicators in Reporting Progress in Attaining the State Ambient Air Quality Standards.

72. Air Resources Board. December 2003. Proposed Amendments to the Area Designation Criteria and Area Designations for State Ambient Air Quality Standards and Maps of Area Designations for State and National Ambient Air Quality Standards.

73. Allen RJ, Wadden RA, Ross ED. 1978. Characterization of potential indoor sources of ozone. Am Ind Hyg Assoc J 39:466-471.

74. Atkinson R, and Arey J, 2003. Gas-phase tropospheric chemistry of biogenic volatile organic compounds: a review. Atmospheric Environment 37 Supp. 2: S197-S1219.

75. Avol EL, Navidi WC, Colome SD. 1998. Modeling ozone levels in and around Southern California homes. Environ Sci Technol 32:463-8.

76. Boeniger MF. 1995. Use of ozone generating devices to improve indoor air quality. Am Ind Hyg Assoc J 56: 590-8.

77. Brauer M, Brook JR. 1995. Personal and fixed-site ozone measurements with a passive sampler. J Air Waste Manag Assoc 45:529-37.

78. Brown SK, 1999. Assessment of Pollutant Emissions from Dry-Process Photocopiers, Indoor Air, Denmark, 9:259-267.

79. California Department of Health Services (DHS). 1997. News release (April 1997) available at http://www.applications.dhs.ca.gov/pressreleases/store/PressReleases/27-97.html

80. Chen, W and Zhang, JS. 2004. Effectiveness of Portable Room Air Cleaners for Control of Volatile Organic Compounds in Indoor Air, presented at CIB World Building Congress, Toronto.

81. Consumers Union. 1992. Household air cleaners. Consum Rep Oct.:657-62.

82. Delfino RJ, Coate BD, Zeiger RS, Seltzer JM, Street DH, Koutrakis P. 1996. Daily asthma severity in relation to personal ozone exposure and outdoor fungal spores. Am J Respir Crit Care Med 154:633-41.

83. Geyh AS, Xue J, Ozkaynak H, Spengler JD. 2000. The Harvard Southern California Chronic Ozone Exposure Study: assessing ozone exposure of grade-school-age children in two southern California communities. Environ Health Perspect 108:265-70.

84. Gold DR, Allen G, Damokosh A, Serrano P, Hayes C, Castillejos M. 1996. Comparison of outdoor and classroom ozone exposures for school children in Mexico City. J Air Waste Manag Assoc 46:335-42.

85. Hansen RB, Andersen B. 1986. Ozone and other air pollutants from photocopying machines. Am Ind Hyg Assoc J 47:659-65.

86. Hayes SR. 1989. Estimating the effect of being indoors on total personal exposure to outdoor air pollution. JAPCA 39:1453-61.

87. Hayes SR. 1991. Use of an indoor air quality model (IAQM) to estimate indoor ozone levels. Journal of Air and Waste Management Association 41:161-70.
88. Health Cananda, 1999. News release (April 13, 1999) available at http://www.hc-sc.gc.ca/english/protection/warnings/1999/99_62e.htm
89. Jakobi G, Fabian P. 1997. Indoor/outdoor concentrations of ozone and peroxyacetyl nitrate (PAN). Int J Biometerol. May 40:162-5.
90. Jenkins PL, Phillips TJ, Mulberg EJ, Hui SP. 1992. Activity patterns of Californians: use of and proximity to incoor pollutant sources. Atmos Environ 26:2141-2148.
91. Kissel JC. 1993. Potential impact of deliberately introduced ozone on indoor air quality. J Expo Anal Environ Epidemiol 3:155-64.
92. Kleno JG, Clausen PA, Weschler CJ, Wolkoff P. 2001. Determination of ozone removal rates by selected building products using the FLEC emission cell. Environ Sci Technol; 35:2548-2553.
93. Lee K, Vallarino J, Dumyahn T, Ozkaynak H, Spengler JD. 1999 . Ozone decay rates in residences. J Air Waste Manag Assoc 49(:1238-44.
94. Lee K, Xue J, Geyh AS, Ozkaynak H, Leaderer BP, Weschler CJ, Spengler JD. 2002. Nitrous acid, nitrogen dioxide, and ozone concentrations in residential environments. Environ Health Perspect 110:145-50.
95. Leovic KW, Sheldon LS, Whitaker DA, Hates RG, Calcagni JA, Baskir JN. 1996. Measurement of indoor air emissions from dry-process photocopy machines. J Air Waste Manag Assoc 46:821-29.
96. Lioy PJ. 1989. Exposure assessment of oxidant gases and acidic aerosols. Annu Rev Public Health 10:9-84.
97. Liu LJ, Delfino R, Koutrakis P. 1997. Ozone exposure assessment in a southern California community. Environ Health Perspect105:58-65.
98. Liu LJ, Koutrakis P, Leech J, Broder I. 1995 . Assessment of ozone exposures in the greater metropolitan Toronto area. J Air Waste Manag Assoc 45:223-34.
99. Liu LJ, Koutrakis P, Suh HH, Mulik JD, Burton RM. 1993. Use of personal measurements for ozone exposure assessment: a pilot study. Environ Health Perspec 101:318-24.
100. Mason MA, Sparks LE, Moore SA, Dolgov I, and Perry RB, 2000. Characterization of ozone emissions from air cleaners equipped with ozone generators and sensor and feedback control circuitry. Proceedings of the Engineering Solutions to Indoor Air Quality Problems Symposium, VIP-98, A&WMA, pp. 254-269.

101. Moriske HJ, Ebert G, Konieczny L, Menk G, Schondube M. 1998. Concentrations and decay rates of ozone in indoor air in dependence on building and surface materials. Toxicol Lett 96-97:319-323.

102. PhillipsTJ, Jenkins PL, Mulberg EJ. 1991. Children in California: activity patterns and presence of pollutant souces. Proceedings of the 84th Annual Meeting and Exhibition, Air & Waste Management Association 17:Paper no. 91-172.5, June 1991.

103. Phillips TJ, Bloudoff DP, Jenkins PL, Stroud KR. 1999. Ozone emissions from a personal air purifier. J Expo Anal Environ Epidemiol 9:594-601.

104. Reiss R, Ryan PB, Koutrakis P, Tibbetts SJ. 1995a. Ozone reactive chemistry on interior latex paint. Environ Sci Technol; 29:1906-12.

105. Reiss R, Ryan PB, Tibbetts SJ, Koutrakis P. 1995b. Measurement of organic acids, aldehydes, and ketones in residential environments and their relation to ozone. J Air Waste Manag Assoc 45:811-22.

106. Reiss R, Ryan PB, Koutrakis P. 1994. Modeling ozone deposition onto indoor residential surfaces. Environ Sci Technol 28:504-13.

107. Selway MD, Allen RJ, Wadden RA. 1980. Ozone production from photocopying machines. Am Ind Hyg Assoc J 41:455-9.

108. Shaughnessy RJ, Mcdaniels TJ, Weschler CJ. 2001. Indoor chemistry: ozone and volatile organic compounds found in tobacco smoke. Environ Sci Technol. 35:2758-64.

109. The Freedonia Group, 2004. Consumer Water Purification and Air Cleaning Systems to 2008–Market Size, Market Share, Market Leaders, Demand Forecast and Sales. Cleveland. http://www/freedoniagroup.com

110. Tuomi T, Engstrom B, Niemela R, Svinhufvud J, Reijula K. 2000. Emission of ozone and organic volatiles from a selection of laser printers and photocopiers. Appl Occup Environ Hyg 15:629-34.

111. U.S. Environmental Protection Agency. 1995. Office equipment: design, indoor air emissions, and pollution prevention opportunities. Washington, DC: Office of Research and Development. Report no. EPA/600/R-95/045.

112. United States Environmental Protection Agency. 1998. Guideline on Data Handling Conventions for the 8-Hour Ozone NAAQS: Appendix I to 40 CFR, Part 50, Interpretation of the 8-Hour Primary and Secondary National Ambient Air Quality Standards for Ozone. December 1998.our PRIMARY AND SECONDARY National Ambient Air Quality Standards for Ozone.

113. United States Environmental Protection Agency. 1986. Guideline on the Identification and Use of Air Quality Data Affected by Exceptional Events. July 1986. Publication No. EPA-450/4-86-007.

114. Wainman T, Zhang J, Weschler CJ, Lioy PJ. 2000. Ozone and limonene in indoor air: a source of submicron particle exposure. Environ Health Perspect 108:1139-45.

115. Weschler CJ, Shields HC, Naik DV. 1989. Indoor ozone exposures. JAPCA 39: 562-8.

116. Weschler CJ, Shields HC. 1999. Indoor ozone/terpene reactions as a source of indoor particles. Atmos Environ 33:2301-2312.

117. Weschler CJ, Shields HC. 2000. The influence of ventilation on reactions among indoor pollutants: modeling and experimental observations. Indoor Air 10:92-100.

118. Weschler CJ. 2000. Ozone in indoor environments: concentration and chemistry. Indoor Air 10:269-88.

119. Weschler, CJ, Hodgson, AT, Wooley, JD. 1992. Indoor chemistry: ozone, volatile organic compounds and carpets. Environ Sci Technol 26:2371-2377.

120. Weschler, CJ, Shields HC, Naik DV. 1994. Indoor chemistry involving O_3, NO, and NO_2 as evidenced by 14 months of measurements at a site in Southern California. Environ Sci Technol 28:2120-2132.

121. Wiley JA, Robinson JP, Cheng YT, Piazza T, Stork L, Pladsen K. 1991a. Activity patterns of California residents. Final report, ARB contract A733-149.

122. Wiley JA, Robinson JP, Piazza T, Garrett K, Cirksena K, Martin G. 1991b. Activity patterns of California residents. Final report, ARB contract A6-177-33.

123. Wilkins CK, Clausen PA, Wolkoff P, Larsen ST, Hammer M, Larsen K, Hansen V, and Nielsen GD, 2001. Formation of strong airway irritants in mixtures of isoprene/ozone and isoprene/ozone/nitrogen dioxide. Environ Health Perspect 109:937-941.

124. Wolkoff P, Johnsen C, Franck C, Wilhardt P, Albrechtsen O. 1992. A study of human reactions to office machines in a climatic chamber. J Expo Anal Environ Epidemiol (Suppl.1):71-96.

125. Zhang J, Lioy PJ. 1994a. Ozone in residential air: concentrations, I/O ratios, indoor chemistry, and exposures. Indoor Air 2:95-105.

126. Zhang J, Wilson WE, Lioy PJ. 1994b. Sources of organic acids in indoor air: a field study. J Expo Anal Environ Epidemiol 4:25-47.

Chapter 8

127. Aber JD, Nadelhoffer KJ, Steudler P, Melillo JM. 1989. Nitrogen saturation in northern forest ecosystems. Bioscience 39:378-386.

128. Adams MB, Edwards NT, Taylor GE Jr, Skaggs BL. 1990. Whole-plant ^{14}C-photosynthate allocation in *Pinus taeda:* Seasonal patterns at ambient and elevated ozone levels. Can J For Res 152-158.

129. Adams MB, Kelly JM, Edwards NT. 1988. Growth of *Pinus taeda* L. seedlings varies with family and ozone exposure level. Water Air Soil Pollut 38:137-150.

130. Adams RM, Glyer JD, Mccarl BA. 1988. The NCLAN economic assessment: approach, findings and implications. In: Heck WW, Taylor OC, Tingey DT, Eds. Assessment Of Crop Loss From Air Pollutants: Proceedings Of An International Conference; October 1987; Raleigh, NC. New York, NY: Elsevier Applied Science 473-504.

131. Adams, R.M., Hamilton, S.A., McCarl, B.A. 1986. The benefits of pollution control: the case of ozone and U.S. agriculture. American Journal of Agricultural Economics 68:886-893.

132. Air Resources Board, 1987. Effect of Ozone On Vegetation And Possible Alternative Ambient Air Quality Standards: Technical Support Document March 1987.

133. Air Resources Board (ARB). 2005. The California Almanac of Emissions and Air Quality. Sacramento, CA.

134. Ajax, R.L.; C.J. Conlee; J.B. Upham. 1967. The Effects of Air Pollution on the Fading of Dyed Fabrics, JAPCA, 17(4): 220-224.

135. Alscher RG, Amundson RG, Cumming JR, Fellows S, Fincher J, Rubin G, van Leuken P, Weinstein LH. 1989. Seasonal changes in pigments, carbohydrates, and growth of red spruce as affected by ozone. New Phytol. 113: 211-223.

136. Alscher, R. G.; Wellburn, A. R., Eds. 1994. Plant Responses To The Gaseous Environment. Molecular, Metabolic And Physiological Aspects. London, UK: Chapman and Hall.

137. Alscher, R., Donahue, J.L., Cramer, C.L., 1997. Reactive Oxygen Species And Antioxidants: Relationships In Green Cells. Physiologia Plantarum 100, 224-233.

138. Amthor JS, Cumming JR. 1988. Low Levels Of Ozone Increase Bean Leaf Maintenance Respiration. Can J Bot; 66: 724-726.

139. Amundson RG, Alscher RG, Fellows S, Rubin G, Fincher J, Van Leuken P, Weinstein LH. 1991. Seasonal Changes In The Pigments, Carbohydrates And Growth Of Red Spruce As Affected By Exposure To Ozone For Two Growing Seasons. New Phytol 118: 127-137.

140. Andersen CP. 2003. Source-sink balance and carbon allocation below ground in plants exposed to ozone. New Phytol. 157: 213-228.

141. Andersen, CP, Hogsett, WE, Wessling, R, Plocher, M, 1991. Ozone Decreases Spring Root-Growth And Root Carbohydrate Content In Ponderosa Pine The Year Following Exposure. Canadian Journal of Forest Research 21: 1288-1291.

142. Arbaugh MJ, Miller PR, Carroll JJ, Takemoto B, Procter T. 1998. Relationships of ozone exposure to pine injury in the Sierra Nevada and San Bernardino Mountains of California, USA. Environ Pollut. 101: 291-301.

143. Arbaugh MJ, Peterson DL, Miller PR. 1999. Air pollution effects on growth on ponderosa pine, Jeffrey pine, and Bigcone Douglas-fir. In: Miller PR, McBride JR, editors. Oxidant air pollution impacts in the montane forests of southern California: a case study of the San Bernardino mountains. New York: Springer. Ecological Studies, Vol 134, p. 179-207.

144. Arndt, U. 1995. Air Pollutants and Pheromones - A Problem? Chemosphere 30: 1023-1031.

145. Ashmore, M. R.; Bell, J. N. B.; Mimmack, A. 1988. Crop Growth Along A Gradient Of Ambient Air Pollution. Environ. Pollut. 53: 99-121.

146. Badiani, M.; Fuhrer, J.; Paolacci, A. R.; Sermanni, G. G.; Sermanni 1996. Deriving Critical Levels for Ozone Effects On Peach Trees (Prunus Persica (L.) Batsch) Grown In Open-Top Chambers In Central Italy. Fresenius Envir. Bull 5: 592-597.

147. Bahl, A.; Loitsch, S.M.; Kahl, G. 1995. Transcriptional Activation Of Plant Defence Genes By Short Term Air Pollutant Stress. Environ. Pollut. 89: 221-227

148. Balaguer, L., Barnes, J.D., Panicucci, A., Borland, A.M., 1995. Production And Utilization Of Assimilates In Wheat (Triticum Aestivum L.) Leaves Exposed To Elevated CO2 and/or O_3. New Phytol. 129, 557-568.

149. Baldocchi, D.D., Hicks, B.B., Camara, P. 1987. A Canopy Stomatal Resistance Model for Gaseous Deposition To Vegetated Surfaces. Atmos Environ. 21, 91-101.

150. Barnard JE, Lucier AA, Brooks RT, Johnson AH, Dunn PH, and Karnosky DF. 1991. Changes in forest health and productivity in the United States and Canada. NAPAP Report 16. IN: Irving PM , ed. Acidic Deposition: State of Science and Technology. Vol. III. Terrestrial, Materials, Health and Visibility Effects. Washington, DC.: NAPAP.

151. Barnes JD, Davison AW. 1988. The influence of ozone on the winter hardiness of Norway spruce [*Picea abies* (L.) Karst.] New Phytol. 108: 159-166.

152. Barnes JD, Eamus D, Brown KA. 1990. The influence of ozone, acid mist, and soil nutrient status on Norway spruce [*Picea abies* (L.) Karst.] II. Photosynthesis, dark respiration, and soluble carbohydrates of trees during late autumn. New Phytol. 115: 149-156.

153. Barnes RL. 1972. Effects of chronic exposure to ozone on photosynthesis and respiration of pines. Environ Pollut. 3: 133-138.

154. Barnes, J.D., Davison, A.W., Booth, T.A., 1998. Ozone Accelerates Structural Degradation Of Epicuticular Wax On Norway Spruce Needles. New Phytologist, 110, 309-3l8.

155. Barnes, J.D., Ollerenshaw, J.H., Whitfield. C.P., 1995. Effects Of Elevated CO2 and/or O_3 On Growth, Development And Physiology Of Wheat (Triticum Aestivum L.). Global Change Biology 1, 129-142.

156. Bastrup-Birk A, Brandt J, Zlatev Z. 1997. Studying cumulative ozone exposures in Europe during a 7-year period. J Geophys Res. 102(D20): 23,917-23,935.

157. Bauer MR, Hultman NE, Panek JA, Goldstein AH. 2000. Ozone deposition to a ponderosa pine plantation in the Sierra Nevada Mountains (CA): a comparison of two different climatic years. J Geophys Res. 105(D17): 22,123-22,136.

158. Beare, J. A.; Archer, S. A.; Bell, J. N. B. 1999. Marssonina Leafspot Disease of Poplar Under Elevated Ozone: Pre-Fumigated Host And In Vitro Studies. Environ. Pollut. 105: 409-417.

159. Bell, J. N. B., Marshall, F.M. 2000. Field Studies on Impacts of Air Pollution on Agricultural Crops. In: Agrawal, S.B. and Agrawal, M., eds. Environmental Pollution and Plant Responses. Lewis Publishers, London. Pp. 99-110.

160. Bell, J. N. B.; Treshow, M., Eds. 2002. Air Pollution and Plant Life. 2nd Ed. Chichester, UK: John Wiley & Sons.

161. Beloin, N.J. 1972. A Field Study: Fading of Dyed Fabrics by Air Pollution, Textile Chem. Colorist, 4:77-78.

162. Beloin, N.J. 1973. Fading of Dyed Fabrics Exposed to Air Pollutants, Textile Chem. Colorist, 5:128-133.

163. Bender, J.; Herstein, U.; Black, C. R. 1999. Growth and Yield Responses Of Spring Wheat To Increasing Carbon Dioxide, Ozone And Physiological Stresses: A Statistical Analysis Of 'ESPACE-Wheat' Results. Eur. J. Agron. 10: 185-195.

164. Bender, J.; Weigel, H.-J.; Jäger, H.J. 1990. Regression Analysis to Describe Yield and Metabolic Responses of Beans (*Phaseolus Vulgaris*) to Chronic Ozone Stress. Angew Bot 64: 329-343.

165. Benner P, Wild A. 1987. Measurement of photosynthesis in spruce trees with various degrees of damage. J Plant Physiol.129: 59-72.

166. Bennett, J.P., Oshima, R.J., Lippert, L.F. 1979. Effects of Ozone on Injury and Dry Matter Partitioning in Pepper Plants. Environmental and Experimental Botany 19: 33-39.

167. Benton, J.; Fuhrer, J.; Gimeno, B. S.; Skarby, L.; Palmer-Brown, D.; Balls, G.; Roadknight, C.; Mills, G. 2000. An International Cooperative Programme Indicates the Widespread Occurrenc of Ozone Injury on Crops. Agric. Ecosys. Environ. 78: 19-30.

168. Bergweiler, C.J.; Manning, W.J. 1999. Inhibition Of Flowering and Reproductive Success in Spreading Dogbane (Apocynum Androsaemifolium) by Exposure to Ambient Ozone. Environ. Pollut. 105:333-339.

169. Beyers JL, Riechers GH, Temple PJ. 1992. Effects of Long-Term Ozone Exposure and Drought on the Photosynthetic Capacity of Ponderosa Pine (Pinus Ponderosa Laws.). New Phytol. 122: 81-90.

170. Bielenberg, D. G.; Lynch, J. P.; Pell, E. J. 2001. A Decline in Nitrogen Availability Affects Plant Responses to Ozone. New Phytol. 151: 413-425.

171. Black, V. J.; Black, C. R.; Roberts, J. A.; Stewart, C. A. 2000. Impact of Ozone on the Reproductive Development of Plants. New Phytol. 147: 421-447.

172. Blum, U., Mrozek Jr., E., Johnson. E., 1983. Investigation Of Ozone (O_3) Effects on ^{14}C Distribution in Ladino Clover. Environmental and Experimental Botany. 23: 369-378.

173. Böhm M, McCune B, Vandetta T. 1991. Diurnal curves of tropospheric ozone in the western United States. Atmos Environ. 25A(8): 1,577-1,590.

174. Booker, F.L., 2000. Influence of Carbon Dioxide Enrichment, Ozone and Nitrogen Fertilization on Cotton (Gossypium Hirsutum L.) Leaf and Root Composition. Plant Cell and Environment. 23: 573-583.

175. Broadmeadow, M.S.J., Jackson, S.B. 2000. Growth Responses of Quercus Petraea, Fraxinus Excelsior and Pinus Sylvestris to Elevated Carbon Dioxide, Ozone and Water Supply. New Phytol. 146: 437-451.

176. Browning, V.D., Taylor, H.M., Huck, M.G., Klepper, B. 1975. Water Relations of Cotton: A Rhizotron Study. Auburn University, Agricultural Experiment Station Bulletin No. 467.

177. Butler, L.K., Tibbits, T.W. 1979. Stomatal Mechanisms Determining Genetic Resistance to Ozone in Phaseolus Vulgaris L. Journal of The American Society Of Horticultural Science. 104: 213-216.

178. Bytnerowicz A, Miller PR, Olszyk DM, Dawson PJ, Fox CA. 1987. Gaseous and particulate air pollution in the San Gabriel mountains of southern California. Atmos Environ. 21(8): 1,805-1,814.

179. Bytnerowicz A, Olszyk DM, Dawson PJ, Morrison L. 1989a. Effects of air filtration on concentration and deposition of gaseous and particulate air pollutants in open-top field chambers. J Environ Qual. 18(3); 268-273.

180. Bytnerowicz A, Olszyk DM, Huttunen S, Takemoto B. 1989b. Effects of photochemical smog on growth, injury, and gas exchange of pine seedlings. Can J Bot. 67: 2,175-2,181.

181. Bytnerowicz A, Takemoto BK. 1989. Effects of photochemical smog on the growth and physiology of ponderosa pine seedlings grown under nitrogen and magnesium deficiencies. In: Olson RK, Lefohn AS, editors. Effects of air pollution on western forests. APCA Trans Ser. 16: 455-467.

182. Cahill TA, Annegarn H, Ewell D, Pedersen B. 1989. Monitoring of Atmospheric Particles and Ozone in Sequoia National Park: 1985-1987. Sacramento, CA. ARB Final Report No. A5-180-32. NTIS No. PB90157512.

183. California Department of Forestry and Fire Protection (CDF). 1988. California's Forests and Rangelands: Growing Conflict over Changing Uses. Sacramento, CA. Forest and Rangeland Resources Assessment Program.

184. Cardoso-Vilhena, J.; Barnes, J. 2001. Does Nitrogen Supply Affect the Response Of Wheat (Triticum Aestivum Cv. Hanno) To The Combination Of Elevated CO_2 and O_3? J. Exp. Bot. 52: 1901-1911.

185. Carroll JJ, Dixon AJ. 1993. Sierra Cooperative Ozone Impact Assessment Study: Year 3. Sacramento, CA. ARB Final Report No. A132-188. NTIS No. PB94208865.

186. Carroll JJ, Dixon AJ. 1995. Sierra Cooperative Ozone Impact Assessment Study: Year 4. Volume 1. Sacramento, CA. ARB Final Report No. 92-346. NTIS No. PB96195912.

187. Carroll JJ. 1992. Sierra Cooperative Ozone Impact Assessment Study: Year 2. Sacramento, CA. ARB Final Report, No. A032-129. NTIS No. PB93210292.

188. Carroll JJ. 1991. Sierra Ozone Impact Assessment Study. Sacramento, CA. ARB Final Report, No. A933-097. NTIS No. PB92104660.

189. Castillo F J ; Heath R L. 1990a. Active and Passive Calcium Transport Are Affected by Ozone Exposure in Leaf Plant Membranes. Physiologia Plantarum. 79: A124.

190. Castillo F J; Heath R L. 1990b. Calcium Ion Transport in Membrane Vesicles from Pinto Bean Leaves and Its Alteration after Ozone Exposure. Plant Physiology (Rockville). 94(2). 788-795.

191. Chapin FS III, Bloom AJ, Field CB, Waring RH. 1987. Plant responses to multiple environmental factors. Bioscience. 37: 49-57.

192. Chappelka, A. H.; Freer-Smith, P. H. 1995. Predisposition of Trees by Air Pollutants to Low Temperatures and Moisture Stress. Environ. Pollut. 87: 105-117.

193. Chappelka, A. H.; Samuelson, L. J. 1998. Ambient Ozone Effects on Forest Trees of The Eastern United States: A Review. New Phytol. 139: 91-108.

194. Chappelka, A.H., Chevone, B.I. 1988. Growth and Physiological Responses of Yellow-Poplar Seedlings Exposed to Ozone and Simulated Acidic Rain. Environmental Pollution. 49: 1-18.

195. Chappelka, A.H., Chevone, B.I., Burk, T.E. 1988. Growth Response of Green and White Ash Seedlings to Ozone, Sulphur Dioxide and Simulated Acid Rain. Forest Science. 34: 1016-1029.

196. Colbeck I, Harrison RM. 1985. Dry deposition of ozone: Some measurements of deposition velocity and of vertical profiles to 100 metres. Atmos Environ. 19: 1,807-1,818.

197. Coleman, M.D., Dickson, R.E., Isebrands, J.G., Karnosky, D.F. 1995. Carbon Allocation and Partitioning in Aspen Clones Varying in Sensitivity to Tropospheric Ozone. Tree Physiology. 15: 593-604.

198. Colls, J. J.; Baker, C. K. 1988. The methodology of open-field fumigation. In: Mathy, P., ed. Air Pollution and Ecosystems, Proceedings of an International Symposium, Grenoble, France, 18-22 May, 1987. Reidel Publishing, Dordrecht. pp. 361-371.

199. Constantinidou HA, Kozlowski TT. 1979. Effects of Sulfur Dioxide and Ozone on Ulmus Americana Seedlings: II. Carbohydrates, Proteins and Lipids. Can J Bot. 57(2): 176-184.

200. Cooley DR, Manning WJ. 1987. The Impact of Ozone on Assimilate Partitioning in Plants: A Review. Environmental Pollution. 47(2). 95-113.

201. Cooley, DR. Manning, W. J. 1988. Ozone Effects on Growth and Assimilate Partitioning in Alfalfa, Medicago Sativa L. Environ. Pollut. 49: 19-36.

202. Coyne PI, Bingham GE. 1981. Comparative ozone dose response of gas exchange in a ponderosa pine stand exposed to long-term fumigations. J Air Pollut Contr Assoc. 31(1): 38-41.

203. Coyne PI, Bingham GE. 1982. Variation in photosynthesis and stomatal conductance in an ozone-stressed ponderosa pine stand: Light response. For Sci. 28(2): 257-273.

204. Craigon, J., Fangmeier, A., Jones, M, Donnelly, A., Bindi, M., De Temmerman, L., Persson, K., Ojanpera, K. 2002. Growth and marketable-yield responses of potato to increased CO_2 and O_3. European Journal of Agronomy. 17: 273-289.

205. Craker LE, Starbuck JS. 1972. Metabolic Changes Associated With Ozone Injury Of Bean Leaves. Can J Plant Sci 52: 589-597.

206. Crisosto, C. H.; Retzlaff, W. A.; Williams, L. E.; Dejong, T. M.; Zoffoli, J. P. 1993. Postharvest Performance Evaluation of Plum (Prunus Salicina Lindel., 'Casselman') Fruit Grown Under Three Ozone Concentrations. J. Amer. Soc. Hort. Sci. 118 (4): 497-502.

207. Dale JW, technical coordinator. 1996. California Forest Health in 1994 and 1995. San Francisco, CA~~.~~: USDA, Forest Service, Pacific Southwest Region. Report R-5-FPM-PR-002.

208. Danielsson, H.; Karlsson, G. P.; Karisson, P. E.; Pleijel, J. 2003. Ozone Uptake Modelling and Flux-Response Relationships--An Assessment of Ozone-Induced Yield Loss in Spring Wheat. Atmos. Environ. 37: 475-485.

209. Dann, M.S., Pell, E.J. 1989. Decline of Activity and Quantity of Ribulose Bisphosphate Carboxylase Oxygenase and Net Photosynthesis in Ozone-Treated Potato Foliage. Plant Physiology. 91: 427-432.

210. Darrall, N.M., 1989. The Effect of Air Pollutants on Physiological Processes in Plants. Plant, Cell And Environment. 12: 1-30.

211. Davison, A.W., Barnes, J.D., 1998. Effects of Ozone on Wild Plants. New Phytol. 139:135-151.

212. De Santis, F. 1999. New Directions: Will A New European Vegetation Ozone Standard Be Fair To All European Countries? Atmos. Environ. 33: 3873-3874.

213. De Santis, F. 2000. New Directions: Use and Abuse of the AOT4O Concept. Atmos Environ. 34:1158-1159.

214. De Temmerman, L.; Vandermeiren, K.; Guns, M. 1992. Effects of Air Filtration Onspring Wheat Grown in Open-Top Field Chambers at a Rural Site. I. Effect on Growth, Yield and Dry Matter Partitioning. Environ. Pollut. 77: 1-5

215. Dickson RE, Isebrands JG. 1993. Carbon Allocation Terminology: Should It Be More Rational? Bull Ecol Soc Am. 74:175-177.

216. Dickson, R.E., Coleman, M.D., Riemenschneider, D.E., Isebrands, J.G., Hogan, G.D., Einig, W., Lauxmann, U., Hauch, B., Hampp, R., Landolt, W., Maurer, S., Matyssek, R., 1997. Ozone-Induced Accumulation of Carbohydrates Changes Enzyme Activities of Carbohydrate Metabolism in Birch Leaves. New Phytol. 137:673-680.

217. Docherty, M.; Salt, D. T.; Holopainen, J. K. 1997. The Impacts of Climate Change and Pollution on Forest Pests. In: Watt, A. D.; Stork, N. E.; Hunter, M. D., Eds. Forests and Insects. New York, NY: Chapman and Hall; Pp. 229-247.

218. Dodd, I.C., Stikic, R., Davies, W.J., 1996. Chemical Regulation of Gas Exchange and Growth of Plants in Drying Soil in the Field. Journal of Experimental Botany. 47:1475-1490.

219. Dominy, P. J.; Heath, R. L. 1985. Inhibition of the K^+-Stimulated Atpase of the Plasmalemma of Pinto Bean (*Phaseolus vulgaris*) Leaves by Ozone. Plant Physiol. 77: 43-45.

220. Drisko, K.; G.R. Cass, J.R. Druzik. 1984. Fading of Artists' Pigments Due to Atmospheric Ozone. Presented at 77th Annual meeting of the APCA, San Francisco, CA, June 24-29, 1984

221. Drogoudi, P. D; Ashmore, M. R. 2000. Does Elevated Ozone Have Differing Effects in Flowering and Deblossomed Strawberry? New Phytol. 147:561-569.

222. Eason, G., Reinert, R. A. 1991. Responses Of Closely Related Bush Blue Lake Snap Bean Cultivars to Increasing Concentrations of Ozone. J. Am. Soc. Hortic. Sci. 116: 520-524.

223. Einig, W., Lauxmann, U., Hauch, B., Hampp, R., Landolt, W., Maurer, S., Matyssek, R., 1997. Ozone-Induced Accumulation of Carbohydrates Changes Enzyme Activities of Carbohydrate Metabolism in Birch Leaves. New Phytol. 137: 673-680.

224. Eissenstat, D. M.; Syvertsen, J. P.; Dean, T. J.; Yelenosky, G.; Johnson, J. D. 1991a. Sensitivity of frost resistance and growth in citrus and avocado to chronic ozone exposure. New Phytol. 118:139-146.

225. Elagoz, V., Manning, W.J. 2002. Ozone and bean plants: morphology matters. Environmental Pollution 120: 521-524.

226. Elkiey, T., Ormrod, D.P. 1979. Ozone and/or Sulfur Dioxide Effects On Tissue Permeability Of Petunia Leaves. Atmos Environ. 13(8). 1165-1168.

227. Emberson, L.; Ashmore, M. R.; Cambridge, H. M.; Simpson, D Tuovinen, J.-P. 2000. Modelling Stomatal Ozone Flux Across Europe. Environ. Pollut. 109: 403-413.

228. Evans LS, Ting IP. 1973. Ozone-Induced Membrane Permeability Changes. Amer J Bot. 60(2): 155-162.

229. Evans, P. A.; Ashmore, M. R. 1992. The Effects of Ambient Air on a Semi-Natural Grassland Community. Agric. Ecosyst. Environ. 38: 91-97.

230. Fangmeier, A., Brockerhoff, U., Gruters, U., Jager, H.J., 1994b. Growth And Yield Responses Of Spring Wheat (Triticum Aestivum L. Cv. Turbo) Grown In Open-Top Chambers to Ozone and Water-Stress. Environmental Pollution. 83: 317-325.

231. Fangmeier, A.; Brunschon, S.; Jager, H.-J. 1994a. Time Course of Oxidant Stress Biomarkers in Flag Leaves of Wheat Exposed to Ozone and Drought Stress. New Phytol. 126: 63-69.

232. Farage, P.K., Long, S.P. 1995. An In Vivo Analysis of Photosynthesis during Short-Term O_3 Exposure in Three Contrasting Species. Photosynthesis Research. 43: 11-18.

233. Farage, P.K., Long, S.P., Lechner, E.G., Baker, N.R., 1991. The Sequence of Change within the Photosynthetic Apparatus of Wheat Following Short-Term Exposure to Ozone. Plant Physiology, 95: 529-535.

234. Fenn ME, Poth MA, Johnson DW. 1996. Evidence for Nitrogen Saturation in the San Bernardino Mountains in Southern California. For Ecol Manage; 82: 211-230.

235. Fernandez-Bayon, J.M., Barnes, J.D., Ollerenshaw, J.H., Davison, A.W., 1993. Physiological Effects of Ozone on Cultivars of Watermelon (Citrullus Lanatus) And Muskmelon (Cucumis Melo) Widely Grown in Spain. Environmental Pollution, 81: 199-206.

236. Fialho, R.C., Bucker, J. 1996. Changes in Levels of Foliar Carbohydrates and Myoinositol before Premature Leaf Senescence of Populus Nigra Induced by a Mixture of O_3 and SO_2. Canadian Journal Botany 74: 965-970.

237. Finnan, J. M.; Jones, M. B.; Burke, J. I. 1996a. A Time-Concentration Study on the Effects of Ozone on Spring Wheat (Triticum Aestivum L.) .1. Effects on Yield. Agriculture Ecosystems & Environment 57: 159-167.

238. Flagler, R.B., 1998. Recognition of Air Pollution Injury to Vegetation: A Pictorial Atlas. 2nd Edition. Air and Waste Management Assoc., Pittsburgh.

239. Fluckiger, W.; Braun, S.; Hiltbrunner, E. 2002. Effects of Air Pollutants on Biotic Stress. In: Bell, J. N. B.; Treshow, M., Eds. Air Pollution and Plant Life. 2nd Ed. Chichester, UK: John Wiley and Sons. Pp. 379-406.

240. Foot, J. P.; Caporn, S. J. M.; Lee, J. A.; Ashenden, T. W. 1997. Evidence that Ozone Exposure Increases the Susceptibility of Plants to Natural Frosting Episodes. New Phytol. 135: 369-374.

241. Foot, J.P., Caporn, S.J.M., Lee, J.A., Ashenden, T.W., 1996. The Effect of Long-Term Ozone Fumigation on the Growth, Physiology and Frost Sensitivity of Calluna Vulgaris. New Phytologist. 133: 503-511.

242. Forberg, E., Aarnes, H., Nilsen, S., 1987. Effects of Ozone on Net Photosynthesis in Oat (Avena Sativa) and Duckweed (Lemna Gibba). Environmental Pollution. 47: 285-291.

243. Fredericksen, T. S.; Kolb, T. E.; Skelly, J. M.; Steiner, K. C.; Joyce, B. J.; Savage, J. E. 1996a. Light Environment Alters Ozone Uptake per Net Photosynthetic Rate in Black Cherry Trees. Tree Physiol. 16: 485-490.

244. Fredericksen, T. S.; Skelly, J. M.; Snyder, K. R.; Steiner, K. C. 1996b. Predicting Ozone Uptake from Meteorological and Environmental Variables. J. Air Waste Manage. Assoc. 46: 464-469.

245. Friend, A.L., Tomlinson, P.T., 1992. Mild Ozone Exposure Alters ^{14}C Dynamics in Foliage of Pinus Taeda L. Tree Physiology. 11: 215-227.

246. Fuhrer J., Skärby L., Ashmore M.R. 1997. Critical Levels for Ozone Effects on Vegetation in Europe. Environ Pollut. 97: 91-106.

247. Fuhrer, J. 1994. Effects of ozone on managed pasture: I. Effects of open-top chambers on microclimate, ozone flux, and plant growth. Environmental Pollution. 86: 297-305.

248. Fuhrer, J.; Egger, A.; Lehnherr, B.; Grandjean, A.; Tschannen, W. 1989. Effects of Ozone on The Yield of Spring Wheat (*Triticum Aestivum* L., Cv. Albis) Grown in Open-Top Field Chambers. Environ. Pollut. 60: 273-289.

249. Fuhrer, J.; Grimm, A. G.; Tschannen, W.; Shariat-Madari, H. 1992. The Response of Spring Wheat (Triticum Aestivum L.) to Ozone at Higher Elevations. New Phytol. 121: 211-219.

250. Fumagalli, I.; Ambrogi, R.; Mignanego, L. 2001a. Yield Responses of Plants Exposed to Ambient Ozone in the River Po Valley (Italy). Agronomie. 21: 227-233.

251. Fumagalli, I.; Gimeno, B. S.; Velissariou, D.; De Temmerman, L.; Mills, G. 2001b. Evidence of Ozone-Induced Adverse Effects on Crops in the Mediterranean Region. Atmospheric Environment. 35: 2583-2587.

252. Gate, I. M.; McNeill, S.; Ashmore, M. R. 1995. Effects of Air Pollution on the Searching Behaviour of an Insect Parasitoid. Water Air Soil Pollut. 85: 1425-1430.

253. Gelang, J.; Pleijel, H.; Sild, E.; Danielsson, H.; Younis, S.; Sellden, G. 2000. Rate and Duration of Grain Filling in Relation to Flag Leaf Senescence and Grain Yield in Spring Wheat (Triticum Aestivum) Exposed to Different Concentrations of Ozone. Physiologia Plantarum. 110: 366-375.

254. Gimeno, B. S.; Bermejo, V.; Reinert, R. A.; Zheng, Y. B.; Barnes, J. D. 1999. Adverse Effects of Ambient Ozone on Watermelon Yield and Physiology at a Rural Site in Eastern Spain. New Phytologist. 144: 245-260.

255. Goldschmidt, E.E., Huber, S.C., 1992. Regulation of Photosynthesis by End-Product Accumulation in Leaves of Plants Storing Starch, Sucrose, and Hexose Sugars. Plant Physiology. 99: 1443-1448.

256. Goldstein AH, Panek J~~. YEAR~~ 2002. Modeling ozone flux to forests across an ozone concentration gradient in the Sierra Nevada Mountains, California. Final Report Summary for EPA Agreement No. R826601.

257. Gorissen, A., Van Veen, J.A. 1988. Temporary Disturbances of Translocation of Assimilates in Douglas Firs Caused by Low Levels of Ozone and Sulphur Dioxide. Plant Physiology. 88: 559-563.

258. Grandjean, A.; Fuhrer, J. 1989. Growth and Leaf Senescence in Spring Wheat (*Triticum Aestivum*) Grown at Different Ozone Concentrations in Open-Top Field Chambers. Physiol. Plant. 77: 389-394.

259. Grantz D.A., Farrar J.F. 2000. Ozone Inhibits Phloem Loading from a Transport Pool: Compartmental Efflux Analysis in Pima Cotton. Australian Journal of Plant Physiology. 27(8-9): 859-868.

260. Grantz, D. A., J. H. B. Garner, and D. W. Johnson. 2002. Ecological effects of particulate matter. Environment International. 29: 213-239.

261. Grantz, D.A. 1990. Response of Plants to Humidity. Plant Cell and Environment. 13:667-679.

262. Grantz, D.A., Farrar, H., 1999. Acute Exposure to Ozone Inhibits Rapid Carbon Translocation from Source Leaves of Pima Cotton. Journal of Experimental Botany. 50: 1253-1262.

263. Grantz, D.A., Macpherson, J.I., Massman, W.J. Pederson, J., 1994. ~~Aircraft~~ Study Demonstrates ~~Measurements Demonstrate~~ Ozone Uptake by San Joaquin Valley Crops. California Agriculture. 48:9-12.

264. Grantz, D.A., Mccool, P.H., 1992. Effect of Ozone on Pima and Acala Cottons in the San Joaquin Valley. In: Herber, D.J., Richter, D.A., (Eds.), Proceedings 1992 Beltwide Cotton Conferences, Vol 3. National Cotton Council of America, Memphis, TN. Pp. 1082-1084.

265. Grantz, D.A., Yang, S., 2000. Ozone Impacts on Allometry and Root Hydraulic Conductance Are Not Mediated by Source Limitation Nor Developmental Age. Journal of Experimental Botany. 51: 919-927.

266. Grantz, D.A., Yang, S., 1996. Effects of O_3 on Hydraulic Architecture in Pima Cotton. Biomass Allocation and Water Transport Capacity of Roots and Shoots. Plant Physiology. 112: 1649-1657.

267. Grantz, D.A., Zhang, X., Carlson, T.N., 1999. Observations and Model Simulations Link Stomatal Inhibition to Impaired Hydraulic Conductance Following Ozone Exposure in Cotton. Plant Cell and Environment. 22: 1201-1210.

268. Grantz, D.A., Zhang, X.J., Massman, W.J., Delany, A., Pederson, J.R., 1997. Ozone Deposition to a Cotton (Gossypium Hirsutum L.) Field: Stomatal and Surface Wetness Effects during the California Ozone Deposition Experiment. Agricultural and Forest Meteorology. 85: 19-31.

269. Grantz, D.A., Zhang, X.J., Massman, W.J., Den Hartog, G., Neumann, H.H., Pederson, J.R., 1995. Effects of Stomatal Conductance and Surface Wetness on Ozone Deposition in Field-Grown Grape. Atmospheric Environment. 29: 3189-3198.

270. Greitner, C.S., Pell, E.J., Winner, W.E. 1994. Analysis of aspen foliage exposed to multiple stresses: ozone, nitrogen deficiency and drought. New Phytologist. 127:579-589.

271. Grulke N.E., Andersen C.P., Hogsett W.E. 2001. Seasonal Changes in Above- and Below-ground Carbohydrate Concentrations of Ponderosa Pine Along a Pollution Gradient. Tree Physiology. 21(2-3):173-181.

272. Grulke NE, Andersen CP, Fenn ME, Miller PR. 1998. Ozone and nitrogen deposition reduces root biomass of ponderosa pine in the San Bernardino Mountains, California. Environ Pollut. 103: 63-73.

273. Grulke NE. 1999. Physiological Responses of Ponderosa Pine to Gradients of Environmental Stressors. In: Miller PR, Mcbride JR, Editors. Oxidant Air Pollution Impacts in the Montane Forests of Southern California: A Case Study of the San Bernardino Mountains. New York: Springer; Ecological Studies, Vol 134, Pgs. 126-163.

274. Grulke, N.E., Balduman, L., 1999. Deciduous Conifers: High N Deposition and O_3 Exposure Effects on Growth and Biomass Allocation in Ponderosa Pine. Water, Air and Soil Pollution. 116: 235-248.

275. Grunhage, L., Jager, H.-J., Haenel, H.-D., Hanewald, K., Krupa, S.V., 1997. PLATIN (Plant-Atmosphere Interaction): II. Co-occurrence of High Ambient O_3 Concentrations and Factors Limiting Plant Absorbed Dose. Environmental Pollution. 98: 51-60.

276. Grunhage, L.; Jager, H.-J. 1994. Influence of the Atmospheric Conductivity on the Ozone Exposure of Plants under Ambient Conditions: Considerations for establishing ozone standards to protect vegetation. Environmental Pollution. 85: 125-129.

277. Grunhage, L.; Jager, H.-J.; Haenel, H.-D.; Lopmeier, F.-J.; Hanewald, K. 1999. The European Critical Levels for Ozone: Improving Their Usage. Environ. Pollut. 105: 163-173.

278. Grunhage, L.; Krause, G. H. M.; Kollner, B.; Bender, J.; Weigel, H. J.; Jager, H. J.; Guderian, R. 2001. A New Flux-Orientated Concept to Derive Critical Levels for Ozone to Protect Vegetation. Environmental Pollution. 111: 355-362.

279. Guidi, L., Nali, C., Ciompi, S., Lorenzini, G., Soldatini, G.F. 1997. The Use Of Chlorophyll Fluorescence And Leaf Gas Exchange As Methods For Studying The Different Responses To Ozone Of Two Bean Cultivars. Journal Of Experimental Botany, 48, 173-179.

280. Guidi, L.; Tonini, M.; Soldatini, G. F. 2000. Effects of High Light and Ozone Fumigation on Photosynthesis in Phaseolus Vuigaris. Plant Physiol. Biochem. 38: 717-725.

281. Gunn, S., Bailey, S.J., Farrar, J.F. 1999. Partitioning of Dry Weight and Leaf Area Within Plants of Three Native Species Grown at Elevated CO_2. Functional Ecology. 13: 3-11.

282. Hanson, G.P., Stewart, W.S. 1970. Photochemical Oxidants: Effect on Starch Hydrolysis in Leaves. Science. 168: 1223-1224.

283. Harris, M.J., Heath, R.L. 1981. Ozone Sensitivity in Sweet Corn (Zea Mays L.) Plants: A Possible Relationship to Water Balance. Plant Physiology. 68: 885-890.

284. Hausladen A, Madamanchi NR, Alscher RG, Amundson RG, Fellows S. 1990. Seasonal changes in antioxidants in red spruce as affected by ozone. New Phytol. 115: 447-458.

285. Haynie, F.H.; J.W. Spence; J.B. Upham. 1976. Effects of Gaseous Pollutants on Materials – A Chamber Study. EPA-600/3-76-015, U.S. EPA, RTP, NC.

286. Haynie, F.H.; Spence, J.W. 1984. Air Pollution to Exterior Household Paints. JAPCA 34: 941-44.

287. Heagle, A. S. 1989. Ozone and Crop Yield. Annu. Rev. Phytopathol. 27: 397-423.

288. Heagle, A. S.; Brandenburg, R. L.; Burns, J. C.; Miller, J. E. 1994. Ozone and Carbon Dioxide Effects on Spider Mites in White Clover and Peanut. J. Environ. Qual. 23: 1168-1176.

289. Heagle, A. S.; Miller, J. E.; Booker, F. L.: Pursley, W. A. 1999. Ozone Stress, Carbon Dioxide Enrichment, And Nitrogen Fertility Interactions In Cotton. Crop Sci. 39: 731-741.

290. Heagle, A. S.; Miller, J. E.; Chevone, B. I.; Dreschel, T. W.; Manning, W. J.; Mccool, P. M.; Morrison, C. L.; Neely, G. E.; Rebbeck, J. 1995. Response of a White Clover Indicator System to Tropospheric Ozone at Eight Locations in the United States. Water Air And Soil Pollution 85: 1373-1378.

291. Heagle, A. S.; Miller, J. E.; Pursley, W. A. 2000. Growth And Yield Responses Of Winter Wheat To Mixtures Of Ozone And Carbon Dioxide. Crop Sci.40: 1656-1664.

292. Heagle, A. S.; Philbeck, R. B.; Ferrell, R. E.; Heck, W. W. 1989a. Design And Performance Of A Large, Field Exposure Chamber To Measure Effects Of Air Quality On Plants. J. Environ. Qual. 18: 361-368.

293. Heagle, A. S; Heck, W. W.; Lesser, V. M.; Rawlings, J. O.; Mowry, F.L. 1986. Injury and yield response of cotton to chronic doses of ozone and sulfur-dioxide. Journal of Environ. Qual. 15: 375-379.

294. Heagle, A. S.; Philbeck, R. B.; Heck-, W. W. 1973. An Open-Top Chamber to Assess the Impact of Air Pollution on Plants. Journal of Environmental Quality 2: 365-368.

295. Heagle, A. S.; Philbeck, R. B.; Rogers, H. H.; Letchworth, M. B. 1979b. Dispensing and Monitoring Ozone in Open-Top Field Chambers for Plant-Effects Studies. Phytopathology. 69: 15-20.

296. Heagle, A. S.; Rebbeck, J.; Shafer, S. R.; Blum, U.; Heck, W. W. 1989b. Effects of long-term ozone exposure and soil moisture deficit on growth of a ladino clover-tall fescue pasture. Phytopathology. 79: 128-136.

297. Heagle, A. S.; Kress, L. W.; Temple, P. J.; Kohut, R. J.; Miller, J. E.; Heggestad, H. E. 1988a. Factors Influencing Ozone Dose-Yield Response Relationships in Open-Top Field Chamber Studies. In: Heck, W. W.; Taylor, 0. C.; Tingey, D. T., Eds. Assessment of Crop Loss from Air Pollutants: Proceedings of an International Conference; October, 1987; Raleigh, NC. New York, NY: Elsevier Applied Science. London: Elsevier Press. Pp. 141-179.

298. Heagle, A.S., Cure, W.W., Rawlings, J.O. 1985. Response of turnips to chronic doses of ozone in open-top chambers. Environmental Pollution. 38:305-319.

299. Heagle, A.S., Miller, J.E., Heck, W.W., Patterson, R.P. 1988b. Injury and yield response of cotton to chronic doses of ozone and soil moisture deficit. Journal of Environmental Quality. 17: 627-635.

300. Heagle, A.S., Reinert, R.A., Miller, J.E. 1996. Response of white clover to ozone in different environments. Journal of Environmental Quality. 25:273-278.

301. Heath, R.L., 1980. Initial Events in Injury to Plants by Air Pollutants. Annual Review of Plant Physiology. 31: 395-431.

302. Heath, R.L., 1988. Biomechanical Mechanisms of Pollutant Stress. In: Heck, W.W., Tingey, D.T., Taylor, O.C., Eds. Assessment of Crop Loss from Air Pollutants. Elsevier, London. Pp. 259-286.

303. Heck W.W.; Taylor O C; Adams R; Bingham G; Miller J; Preston E; Weinstein L. 1982. Assessment of Crop Loss from Ozone. Journal of the Air Pollution Control Association. 32(4): 353-361.

304. Heck WW, Furiness C.S. 2001. The Effects of Ozone on Ecological Systems: Time for a Full Assessment. Env. Mgr. October: 15-24.

305. Heck, W. W.; Dunning, J. A.; Reinert, R. A.; Prior, S. A.; Rangappa, M.; Benepal, P. S. 1988. Differential Responses of Four Bean Cultivars to Chronic Doses of Ozone. J. Am. Soc. Hortic. Sci. 113: 46-51.

306. Heck, W. W.; Furiness, C. S.; Cowling, E. B.; Sims, C. K. 1998. Effects of Ozone on Crop, Forest, and Natural Ecosystems: Assessment Of Research Needs. Env. Mgr. October: 11-22.

307. Heck, W.W., 1989. Assessment of Crop Loss from Air Pollutants in the United States. In: Mackenzie, J.J. And El-Ashry, M.T. Air Pollution's Toll On Forest And Crops. Yale University Press, New Haven, Chapter 6, Pgs. 235-315.

308. Heck, W.W., Cure, W., Rawlings, J., Zaragoza, L., Heagle, A. et al., 1984. Assessing impacts of ozone on agricultural crops. II. Crop yield functions and alternative exposure statistics. J. Air Pollut. Control Assoc. 34:810-817.

309. Heck, W.W., Taylor, O.C., Tingey, D.T. 1988a. Assessment of Crop Loss rom Air Pollutants: Proceedings of an International Conference, Raleigh, North Carolina, USA, October 25-29, 1987. Elsevier Applied Science, New York.

310. Heggestad, H.E., Anderson, E.L., Gish, T.J., Lee, E.H. 1988. Effects of Ozone and Soil Water Deficit on Roots and Shoots of Field-Grown Soybeans. Environmental Pollution. 50: 259-278.

311. Heggestad, H.E., Gish, T.J., Lee, E.H., Bennett, J.H., Douglass, L.W., 1985. Interaction of Soil Moisture Stress and Ambient Ozone on Growth and Yield of Soybeans. Phytopathology. 75: 472-477.

312. Heggestad, H.E., Lee, E.H., 1990. Soybean Root Distribution, Top Growth and Yield Response to Ambient Ozone and Soil Moisture Stress When Grown in Soil Columns in Greenhouses. Environmental Pollution. 65: 195-207.

313. Hendrix, D.L., Grange, R.I., 1991. Carbon Partitioning and Export from Mature Cotton Leaves. Plant Physiology. 95: 228-233.

314. Hendrix, D.L., Peelen, K.K. 1987. Artifacts in the Analysis of Plant-Tissues for Soluble Carbohydrates. Crop Science. 27: 710-715.

315. Hicks, B.B., Baldocchi, D.D., Meyers, T.P., Hosker, R.P., Jr., Man, D.R., 1987. A Preliminary Multiple Resistance Routine for Deriving Dry Deposition Velocities from Measured Quantities. Water Air and Soil Pollution. 36: 311-330.

316. Hill, A.C., Littlefield, N., 1969. Ozone: Effect on Apparent Photosynthesis, Rate of Transpiration and Stomatal Closure in Plants. Environmental Science and Technology. 3:52-56.

317. Ho, L.C., 1976. The Relationship between the Rates of Carbon Transport and of Photosynthesis in Tomato Leaves. Journal of Experimental Botany. 27: 87-97.

318. Hogsett, W.; Tingey, D. T.; Lee, E. H. 1988. Ozone Exposure Indices: Concepts for Development and Evaluation of Their Use. In: Heck, W. W.; Taylor, O. C.; Tingey, D. T., Eds. Assessment of Crop Loss from Air Pollutants: Proceedings of an International Conference; October 1987; Raleigh, NC. New York, NY: Elsevier Applied Science. Pp. 107-138.

319. Holopainen, J.K. 2002. Aphid response to elevated ozone and CO_2. Entomologia Experimentalis et Applicata. 104:137-142.

320. Holt, D.A. 1988. Crop Assessment: International Needs and Opportunities, In: Heck, W. W.; Taylor, O. C.; Tingey, D. T., Eds. Assessment of Crop Loss from Air Pollutants: Proceedings of an International Conference; October 1987; Raleigh, NC. New York, NY: Elsevier Applied Science. P~~p~~gs. ~~107-138~~9-26.

321. Hormaza, J.I., Pinney, K., Polito, V.S. 1996. Correlation in the tolerance to ozone between sporophytes and male gametophytes of several fruit and tree nut species (Rosaceae). Sexual Plant Reproduction. 9:44-48.

322. Hummel, R.L., Brandenburg, R.L., Heagle, A.S., Arellano, C. 1998. Effect of ozone on reproduction of two spotted spider mite (Acari:Tetrannychidae) on white clover. Environmental Entomology. 27:388-394.

323. Hunt, R. 1990. Basic Growth Analysis. Unwin Hyman, London.

324. Isebrands, J. G.; Mcdonald, E. P.; Kruger, E.; Hendrey, G.; Percy, K.; Pregitzer, K.; Sober, J.; Karnosky, D. F. 2001. Growth Responses of Populus Tremuloides Clones to Interacting Carbon Dioxide and Tropospheric Ozone. Environ. Pollut. 115: 359-371.

325. Jarvis, P.G., McNaughton, K.G. 1986. Stomatal Control of Transpiration-Scaling Up from Leaf to Region. Advances in Ecological Research. 15: 1-49.

326. Johnson, B. G.; Hale, B. A.; Ormrod, D. P. 1996a. Carbon Dioxide and Ozone Effects on Growth of a Legume-Grass Mixture. J. Environ. Qual. 25: 908-916.

327. Jones, H.C., Lacasse, N.L., Liggett, W.S., Weatherford, F. 1977. Experimental air exclusion system for field studies of SO_2 effects on crop productivity. Muscle Shoals, AL, Tennessee Valley Authority, No. E-EP-77-5.

328. Kangasjarvi, J., Talvinen, J., Utriainen, M., Kargalainen, R., 1994. Plant Defense Systems Induced by ozone. Plant Cell and Environment. 17: 783-794.

329. Karenlampi, L.; Skarby, L. 1996. Critical Levels for Ozone in Europe: Testing and Finalizing the Concepts. UN-ECE Workshop Report. Kupio, Finland: University Of Kuopio, Department of Ecology and Environmental Science.

330. Karlsson, P.E., Medin, E.L., Wallin, G., Selldén, G., Skärby, L. 1997. Effects of Ozone and Drought Stress on the Growth of Two Clones of Norway Spruce (Picea Abies). New Phytologist. 136: 265-275.

331. Karnosky, D. F.; Mankovska. B.; Percy, K.; Dickson, R. E.; Podila, G. K.; Sober, J.; Noormets, A.; Hendrey, G.; Coleman, M. D.; Kubiske, M.; Pregitzer K. S.; Isebrands, J. G. 1999. Effects of Tropospheric O_3 on Trembling Aspen and Interaction with CO_2: Results from an O_3 Gradient and a FACE Experiment. Water Air Soil Pollut. 116: 311-322.

332. Karnosky, D.F. et al. 1996. Changes in Growth, Leaf Abscission, and Biomass Associated with Seasonal Tropospheric Ozone Exposures of Populus tremuloides Clones and Seedlings. Canadian Journal of Forest Research 16:23-27

333. Kasana, M.S., Mansfield, T.A., 1986. Effects of Air Pollutants on the Growth and Functioning of Roots. Proceedings of Indian Academy of Sciences (Plant Sciences). 96: 429-441.

334. Kats, G.; Dawson, P. J.; Bytnerowicz, A.; Wolf, J. W.; Thompson, C. R.; Olszyk, D. M. 1985. Effects of Ozone or Sulfur Dioxide on Growth and Yield of Rice. Agric. Ecosyst. Environ. 14: 103-117.

335. Kelly JM, Taylor GE Jr, Edwards NT, Adams MB, Edwards GS, Friend AL. 1993. Growth, Physiology, and Nutrition of Loblolly Pine Seedlings Stressed by Ozone and Acidic Precipitation: A Summary of the ROPIS-South Project. Water Air Soil Pollut. 69: 363-391.

336. Kerstiens G ; Lendzian K J. 1989a. Interactions between Ozone and Plant Cuticles I. Ozone Deposition and Permeability. New Phytologist. 112:13-20.

337. Kerstiens G ; Lendzian K J. 1989b. Interactions between Ozone and Plant Cuticles II. Water Permeability. New Phytologist. 112: 21-28.

338. Khan, M. R.; Khan, M. W. 1998. Interactive Effects of Ozone and Root-Knot Nematode on Tomato. Agric. Ecosyst. Environ. 70: 97-107.

339. Khan, M. R.; Khan, M. W. 1999. Effects of Intermittent Ozone Exposures on Powdery Mildew of Cucumber. Environ. Exp. Bot. 42:163-171.

340. Kickert, R. N.; Krupa, S. V. 1991. Modeling Plant Response to Tropospheric Ozone: A Critical Review. Environ. Pollut. 70: 271-383.

341. Kickert, R. N.; Tonella, G.; Simonov, A.; Krupa, S. V. 1999. Predictive Modeling of Effects under Global Change. Environ. Pollut. 100: 87-132.

342. Kim, H. J.; Helfand, G. E.; Howitt, R. E. 1998. An Economic Analysis of Ozone Control in California's San Joaquin Valley. J. Agric. Resource Econ. 23: 55-70.

343. Kleier, C.; Farnsworth, B.; Winner, W. 2001. Photosynthesis and Biomass Allocation of Radish Cv. "Cherry Belle" in Response to Root Temperature and Ozone. Environ. Pollut. 111:127-133.

344. Kobayashi, K.; Okada, M.; Nouchi, I. 1994. A Chamber System for Exposing Rice (Oryza Sativa L.) to Ozone in a Paddy Field. New Phytologist. 126: 317-325.

345. Kobayashi, K.; Okada, M.; Nouchi, I. 1995a. Effects of Ozone on Dry-Matter Partitioning and Yield of Japanese Cultivars of Rice (Oryza-Sativa L.). Agriculture Ecosystems & Environment. 53:109-122.

346. Kohut, R. J.; Amundson, R. G.; Laurence, J. A.; Colavito, L.; Van Leuken, P.; King, P. 1987. Effects of Ozone and Sulfur Dioxide on Yield of Winter Wheat. Phytopathology. 77: 71-74.

347. Kopp, R.J., Vaughn, W.J., Hazilla, M., Carson, R. 1985. Implications of environmental policy for U.S. agriculture: the case of ambient ozone standards. Journal of Environmental Management. 20:321-331.

348. Kostka-Rick, R., Manning, W.J., 1992. Partitioning of Biomass and Carbohydrates in Field-Grown Radish under Ambient Concentrations of Ozone, and Treated with the Anti-Ozonant Ethylene-Diurea (EDU). New Phytologist. 121: 187-200.

349. Kostka-Rick, R., Manning, W.J., Buonaccorsi, J.P. 1993. Dynamics of Biomass Partitioning in Field-Grown Radish Varieties Treated with Ethylenediurea. Environmental Pollution. 80:133-145.

350. Koziol, M.J., Whatley, F., 1984. Gaseous Air Pollutants and Plant Metabolism. Butterworths, London.

351. Kozlowski TT, Kramer PJ, Pallardy SG. The physiological ecology of woody plants. San Diego: Academic Press, Inc.; 1981. 657 pp.

352. Krapp, A., Hoffmann, B., Schafer, C., Stitt, M., 1993. Regulation of the Expression of Rbcs and Other Photosynthetic Genes by Carbohydrates – A Mechanism for the Sink Regulation Of Photosynthesis. Plant Journal. 3: 817-828.

353. Krapp, A., Quick, W.P., Stitt, M., 1991. Ribulose-1,5-Bisphosphate Carboxylase-Oxygenase, Other Calvin-Cycle Enzymes, and Chlorophyll Decrease When Glucose Is Supplied to Mature Spinach Leaves Via the Transpiration Stream. Planta. 186: 58-69.

354. Kress LW, Allen HL, Mudano JE, Stow TK. Impact of ozone on loblolly pine seedling foliage production and retention. Environ Toxicol Chem. 1992: 11: 1,115-1,128.

355. Krupa, S.; Kickert, R. 1997. Considerations for Establishing Relationships between Ambient Ozone (O_3) and Adverse Crop Response. Environmental Reviews. 5: 55-77.

356. Krupa, S.V., Nosal, M., Legge, A.H. 1994. Ambient ozone and crop loss: Establishing a cause-effect relationship. Environmental Pollution. 83:269-276.

357. Kurpius MR, McKay M, Goldstein AH. 2002. Annual ozone deposition to a Sierra Nevada ponderosa pine plantation. Atmos Environ. 36: 4,503-4,515.

358. Laisk A; Kull O; Moldau H. 1989. Ozone Concentration In Leaf Intercellular Air Spaces Is Close to Zero. Plant Physiology (Rockville). 90:1163-1167.

359. Landolt, W, Gunthardt-Goerg, M, Pfenninger, I., Scheidegger, C. 1994. Ozone Induced Microscopic Changes and Quantitative Carbohydrate Contents of Hybrid Poplar (Populus X Euramericana). Trees-Structure and Function. 8:183-190.

360. Landolt, W., Bühlmann, U., Bleuler, P., Bucher, J.B. 2000. Ozone Exposure-Response Relationships for Biomass and Root/Shoot Ratio of Beech (Fagus Sylvatica), Ash (Fraxinus Excelsior), Norway Spruce (Picea Abies) and Scots Pine (Pinus Sylvestris). Environmental Pollution. 109: 473-478.

361. Larcher W. 1975. Physiological Plant Ecology. Berlin: Springer-Verlag.

362. Laurence JA, Kohut RJ, Amundson RG. 1989. Response of red spruce seedlings exposed to ozone and simulated acidic precipitation in the field. Arch Environ Contam Toxicol. 18: 285-290.

~~363.~~Laurence, J.A., Amundson, R.G., Friend, A.L., Pell, E.J., Temple, P.J., 1994. Allocation of Carbon in Plants under Stress--An Analysis of the ROPIS Experiments. Journal of Environmental Quality. 23:412-417.

363.

364. Lawson, T.; Craigon, J.; Black, C. R.; Colls, J. J.; Tulloch, A.-M.; Landon, G. 2001a. Effects of Elevated Carbon Dioxide and Ozone on the Growth and Yield of Potatoes (Solanum Tuberosum) Grown in Open-Top Chambers. Environ. Pollut. 111:479-491.

365. Lechowicz MJ. 1987. Resource Allocation by Plants under Air Pollution Stress: Implications for Plant-Pest-Pathogen Interactions. Bot Rev. 53: 281-300.

366. Lee EH, Bennett JH. 1982. Superoxide Dismutase: A Possible Protective Enzyme against Ozone Injury in Snap Beans (Phaseolus Vulgaris L.). Plant Physiol. 69: 1,444-1,449.

367. Lee T.T. 1965. Sugar Content and Stomatal Width as Related to Ozone Injury in Tobacco Leaves. Can J Bot. 43: 677-685.

368. Lee, E. H.; Hogsett, W. E. 1999. Role of Concentrations and Time of Day In Developing Ozone Exposure Indices for a Secondary Standard. J. Air Waste Manage. Assoc. 49: 669-681.

369. Lee, E. H.; Tingey, D. T.; Hogsett, W. E. 1988. Evaluation of Ozone Exposure Indices in Exposure-Response Modeling. Environ. Pollut. 53:43-62.

370. Lee, E.H., Hogsett, W.E., Tingey, D.T. 1994. Attainment and effects issues regarding alternative secondary ozone air-quality standards. Jour. Environ. Qual. 23:1129-1140.

371. Lee, W.S., Chevone, B.I., Seiler, J.R., 1990. Growth Response and Drought Susceptibility of Red Spruce Seedlings Exposed to Simulated Acidic Rain and Ozone. Forest Science. 36: 265-275.

372. Lefohn AS, Krupa SV, Winstanley D. 1990. Surface Ozone Exposures Measured at Clean Locations Around the World. Environ Pollut. 63:189-224.

373. Lefohn, A. S.; Laurence, J.A.; Kohut R.J. 1988. A comparison of indices that describe the relationship between exposure to ozone and reduction in the yie~~i~~ld of agricultural crops. Atmos. Environ. 49: 669-681.

374. Legge, A. H.; Grunhage, L.; Nosal, M.; Jager, H.-J.; Krupa, S. V. 1995. Ambient Ozone and Adverse Crop Response: An Evaluation of North

American and European Data As They Relate to Exposure Indices and Critical Levels. Angew. Bot. 69: 192-205.

375. Lesser, V. M.; Rawlings, J. O.; Spruill, S. E.; Somerville, M. C. 1990. Ozone Effects on Agricultural Crops: Statistical Methodologies and Estimated Dose-Response Relationships. Crop Sci. 30: 148-155.

376. Leuning, R., Neumann, H.H., Thurtell, G.W., 1979a. Ozone Uptake by Corn (Zea Mays L.): A General Approach. Agricultural Meteorology 20, 115-135.

377. Leuning, R., Unsworth, M.H., Neumann, H.H., King, K.M., 1979b. Ozone Fluxes to Tobacco and Soil under Field Conditions. Atmospheric Environment. 13:1155-1163.

378. Lorenzini, G.; Medeghini Bonatti, P.; Nali, C.; Baroni Fornasiero, R. 1994. The Protective Effect of Rust Infection against Ozone, Sulphur Dioxide and Paraquat Toxicity Symptoms in Broad Bean. Physiol. Mol. Plant Pathol. 45: 263-279.

379. Lyons, T.M., Barnes, J.D., Davison, A.W., 1997. Relationships between Ozone Resistance and Climate in European Populations of Plantago Major. New Phytologist. 136: 503-510.

380. Lyons, T.M.; Barnes, J.D. 1998. Influence of Plant Age on Ozone Resistance in Plantago Major. New Phytologist. 138:83-89.

381. Mandl, R. H.; Weinstein, L. H.; Mccune, D. C.; Keveny, M. 1973. A Cylindrical, Open-Top Chamber for the Exposure of Plants to Air Pollutants in ~~The~~the Field. J. Environ. Qual. 2: 371-376.

382. Manning, W. J.; Krupa, S. V. 1992. Experimental Methodology ~~For~~for Studying ~~The~~the Effects ~~Of~~of Ozone ~~On~~on Crops ~~And~~and Trees. In: Lefohn, A. S., Ed. Surface Level Ozone Exposures ~~A~~and Their Effects ~~O~~on Vegetation. Chelsea, MI: Lewis Publishers, Inc.~~;~~ Pp. 93-156.

383. Martin, M.J., Frage, P.K., Humphrie, S.W., Long, S.P., 2000. Can Stomatal Changes Caused ~~B~~by Acute Ozone Exposure ~~B~~be Predicted ~~B~~by Changes Occurring In ~~T~~the Mosophyll? A Simplification ~~For~~for Models ~~Of~~of Vegetation Response ~~To~~to ~~The~~the Global Increase ~~In~~in Tropospheric Elevated Ozone Episodes. Australian Journal ~~Of~~of Plant Physiology~~,~~. 27~~,~~: 211-219.

384. Massman WJ, Musselman RC, Lefohn AS. 2000. A Conceptual Ozone Dose-Response Model ~~To~~to Develop ~~A~~a Standard ~~To~~to Protect Vegetation. Atmos Environ. 34~~(5)~~: 745-759.

385. Massman, W.J., Grantz, D.A., 1995. Estimating Canopy Con~~-D~~ductance ~~T~~to Ozone Uptake ~~F~~from Observations ~~O~~of Evapotranspiration ~~A~~at ~~T~~the Canopy Scale ~~A~~and ~~A~~at ~~T~~the Leaf Scale. Global Change Biology. 1~~,~~: 183-198.

386. Massman, W.J., Pederson, J., Delany, A., Grantz, D., Den Hartog, G., Neumann, H.H., Oncley, S.P, Pearson, R., Jr., Shaw, R.H., 1994. An

Evaluation ~~Of~~of ~~The~~the Regional Acid Deposition Model Surface Module ~~For~~for Ozone Uptake ~~At~~at Three Sites ~~In~~in ~~The~~the San Joaquin Valley ~~Of~~of California. J. Geophysical Research. 99(D4~~)~~:~~, ~~8281-8294).

387. Materna, J., 1984. Impact ~~Of~~of Atmospheric Pollution ~~On~~on Natural Ecosystems. In: Treshow, M. (Ed.), Air Pollution ~~And~~and Plant Life. John Wiley & Sons, Chichester, UK~~,~~. Pp 397-416.

388. Mauzerall, D.L., Wang, X. 2001. Protecting agricultural crops from the effects of troposopheric ozone exposure: Reconciling science and standard setting in the United States, Europe, and Asia. Annu. Rev. Energy Environ. 26: 237-68.

389. McCool, P. M.; Musselman, R. C. 1990. Impact ~~Of~~of Ozone ~~On~~on Growth ~~Of~~of Peach, Apricot ~~And~~and Almond. Hortscience. 25~~(11)~~:-1384-1385.

390. McCool, P. M.; Musselman, R. C.; Teso, R. R. 1987. Air Pollutant Yield-Loss Assessment ~~For~~for Four Vegetable Crops. Agric. Ecosys. ~~A~~and Environ.~~,~~ 20: 11-21.

391. McCool, P.M., Menge, J.A. 1983. Influence ~~Of~~of Ozone ~~On~~on Carbon Partitioning In Tomato: Potential Role ~~Of~~of Carbon Flow ~~In~~in Regulation ~~Of~~of ~~The~~the Mycorrhizal Symbiosis ~~Under~~under Conditions ~~Of~~of Stress. New Phvtologist. 94~~,~~: 241-247.

392. McCrady, J.K., Anderson, C.P., 2000. The Effect ~~Of~~of Ozone ~~On~~on Below-Ground Carbon Allocation ~~In~~in Wheat. Environmental Pollution~~,~~. 107~~,~~: 465-472.

393. McLaughlin SB, Layton PA, Adams MB, Edwards NT, Hanson PJ, O'Neill EG, Roy WK. 1994. Growth responses of 53 open-pollinated loblolly pine families to ozone and acid rain. J Environ Qual.~~ 1994;~~ 23: 247-257.

394. McLaughlin SB, McConathy RK. 1983. Effects ~~Of~~of SO_2 ~~And~~and ~~ozone~~ O_3 ~~O~~on Allocation ~~O~~of ^{14}C-Labeled Photosynthate ~~I~~in Phaseolus Vulgaris. Plant Physiol~~;~~. 73: 630-635.

395. McLaughlin SB, Shriner DS. 1980. Allocation ~~Of~~of Resources ~~To~~to Defense ~~And~~and Repair. In: Horsfall JB, Cowling EB, Editors. Plant Disease, Vol. 5. New York: Academic Press; P. 407-431.

~~396.McLaughlin SB, Shriner DS. Allocation of resources to defense and repair. In: Horsfall JB, Cowling EB, editors. Plant Disease, Vol. 5. New York: Academic Press; 1980, p. 407-431.~~

~~397.~~396. McLaughlin, S.B., McConathy, R.K., Durick, D., Mann, L.K. 1982. Effects ~~Of~~of Chronic Air Pollution Stress ~~On~~on Photosynthesis, Carbon Allocation ~~And~~and Growth ~~Of~~of White Pine Trees. Forestry Science. 28~~,~~: 60-70.

~~398.~~397. McLeod, A. R.; Baker, C. K. 1988. The Use ~~Of~~of Open Field Systems ~~To~~to Assess Yield Response ~~To~~to Gaseous Pollutants. In: Heck, W. W.; Taylor, O. C.; Tingey, D. T., Eds. Assessment ~~Of~~of Crop Loss

~~From~~from Air Pollutants. London, United Kingdom: Elsevier Applied Science~~;~~. Pp. 181-210.

~~399.~~398. McLeod, A. R.; Shaw, P. J. A.; Holland, M. R. 1992. The Liphook Forest Fumigation Project: Studies ~~Of~~of Sulphur Dioxide ~~And~~and Ozone Effects ~~On~~on Coniferous Trees. For. Ecol. Manage. 51: 121-127.

~~400.~~399. Mehlhorn H, Seufert G, Schmit A, Kunert KJ. 1986. Effect ~~Of~~of S~~o~~O$_2$ ~~And~~and ~~ozone~~ O$_3$ ~~On~~on Production ~~Of~~of Antioxidants ~~In~~in Conifers. Plant Physiol. 82: 336-338.

~~401.~~400. Meier S, Grand LF, Schoeneberger MM, Reinert RA, Bruck RI. 1990. Growth, Ectomycorrhizae ~~A~~and Nonstructural Carbohydrates ~~O~~of Loblolly Pine Seedlings Exposed ~~T~~to Ozone ~~A~~and Soil Water Deficit. Environ Pollut. 64: 11-27.

~~402.~~401. Meinzer, F.C., Grantz, D.A.~~,~~ 1989. Stomatal Control ~~Of~~of Transpiration ~~From~~from ~~A~~a Developing Sugarcane Canopy. Plant Cell ~~And~~and Environment. 12~~,~~: 635-642.

~~403.~~402. Meinzer, F.C., Grantz, D.A.~~,~~ 1990. Stomatal ~~And~~and Hydraulic Conductance ~~In~~in Growing Sugarcane: Stomatal Adjustment ~~To~~to Water Transport Capacity. Plant Cell ~~And~~and Environment. 13~~,~~: 383-388.

~~404.~~403. Meyer, U., Kollner, B., Willenbrink, J., Krause, G.H.M.~~,~~ 1997. Physiological Changes ~~On~~on Agricultural Crops Induced ~~B~~by Different Ambient Ozone Exposure Regimes. 1. Effects ~~O~~on Photosynthesis ~~A~~and Assimilate Allocation ~~I~~in Spring Wheat. New Phytologist. 136~~,~~: 645-652.

~~405.~~404. Miller JE, Vozzo SF, Patterson RP, Pursley WA, Heagle AS. 1995. Effects ~~Of~~of Ozone ~~And~~and Water Deficit ~~On~~on Field-Grown Soybean: II. Leaflet Nonstructural Carbohydrates. J Environ Qual. 24: 670-677.

~~406.~~405. Miller PR, Chow J, Watson JG, editors. 1996a. Assessment of Acidic Deposition and Ozone Effects on Conifer Forests in the San Bernardino Mountains. Sacramento, CA.~~:~~ ARB~~;~~ ~~1996a.~~ Final Report~~,~~ No. A032-180. NTIS No. PB97115612.

~~407.~~406. Miller PR, Chow JC, Watson JG, editors. 1996b. Ecosystem Level Alterations in Soil Nutrient Cycling: An Integrated Measure of Cumulative Effects of Acidic Deposition on a Mixed Conifer Forest in Southern California. Sacramento, CA.~~:~~ ARB~~;~~ ~~1996b.~~ Final Report~~,~~ No. 92-335. NTIS No. PB97106223.

~~408.~~407. Miller PR, Evans LS. Histopathology of oxidant injury and winter fleck injury on needles of western pines. Phytopath 1974; 64: 801-806.

~~409.Miller PR, McBride JR, editors. Oxidant air pollution impacts in the montane forests of southern California: a case study of the San Bernardino mountains. New York: Springer; 1999, Ecological Studies, Vol 134.~~

~~410.~~408. Miller PR, Millecan AA. 1971. Extent of oxidant air pollution damage to some pines and other conifers in California. Plant Disease R. ~~1971;~~ 55~~(6)~~: 555-559.

~~411.~~409. Miller PR, Parmeter JR Jr, Flick BH, Martinez CW. 1969. Ozone dosage response of ponderosa pine seedlings. J Air Pollut Contr Assoc ~~1969;~~. 19~~(6)~~: 435-438.

~~412.~~410. Miller PR, Taylor OC, Poe MP. 1986. Spatial variation of summer ozone concentrations in the San Bernardino ~~mountains~~Mountains. Minneapolis, MN.~~:~~ APCA 79th Ann Mtg.~~; 1986,~~ Paper No. 86-39.2.

~~413.~~411. Miller PR. 1969. Air pollution and the forests of California. Calif Air Environ. ~~1969;~~ 1: 1-2.

~~414.~~412. Miller, J.E., 1988. Effects ~~O~~on Photosynthesis, Carbon Allocation, ~~A~~and Plant Growth Associated ~~W~~with Air Pollutant Stress. In: Heck, W.W., Tingey, D.T., Taylor, C.C. (Eds.), Assessment ~~Of~~of Crop Loss ~~From~~from Air Pollutants. Elsevier, London~~,~~. Pp. 287-314.

~~415.~~413. Miller, J.E., Patterson, R.P., Heagle, A.S., Pursley, W.A., Heck, W.W. 1988. Growth of cotton under chronic ozone stress at two levels of soil moisture. Journal of Environmental Quality. 17: 635-643.

~~416.~~414. Miller, J.E., Patterson, R.P., Pursley, W.A., Heagle, A.S., Heck, W.A., 1989. Response ~~Of~~of Soluble Sugars ~~And~~and Starch ~~In~~in Field-Grown Cotton ~~To~~to Ozone, Water Stress, ~~And~~and Their Combination. Environmental ~~And~~and Experimental Botany. 29~~,~~: 477-486.

~~417.~~415. Miller, P., Mcbride J.R., 1999. Oxidant Air Pollution Impacts ~~I~~in ~~T~~the Montane Forests ~~O~~of Southern California: A Case Study ~~O~~of ~~T~~the San Bernardino Mountains. Ecological Studies vol. 134~~;~~. Springer~~; 424 Pages.~~: New York.

~~418.~~416. Mills, G.; Ball, G.; Hayes, F.; Fuhrer, J.; Skarby, L.; Gimeno, B.S.; de Temmerman, L.; Heagle, A. 2000. Development ~~O~~of ~~A~~a Multi-Factor Model ~~F~~for Predicting ~~T~~the Critical Level ~~O~~of Ozone for White Clover. Environ. Pollut. 109: 533-542.

~~419.~~417. Minnocci, A, Panicucci, A., Sebastiana, L., Lorenzini, G., Vitagliano, C., 1999. Physiological ~~And~~and Morphological Responses ~~Of~~of Olive Plants ~~To~~to Ozone Exposure ~~During~~during ~~A~~a Growing Season. Tree Physiology~~,~~. 19~~,~~: 391-397.

~~420.~~418. Moldau, H.; Bichele, I. 2002. Plasmalemma Protection ~~By~~by ~~The~~the Apoplast As Assessed From Above-Zero Ozone Concentrations ~~In~~in Leaf Intercellular Air Spaces. Planta. 214: 484-487.

~~421.~~419. Mortensen, L. M. 1990. Effects ~~Of~~of Ozone ~~On~~on Growth ~~Of~~of Triticum Aestivum L. At Different Light, Air Humidity, ~~And~~and CO_2 Levels. Norw. J. Agric. Sci. 4: 343-348.

~~422.~~420. Mortensen, L., Engvild, K.C., 1995. Effects ~~Of~~of Ozone ~~On~~on ^{14}C Translocation Velocity ~~And~~and Growth ~~Of~~of Spring Wheat (Triticum Aestivum L.) Exposed ~~I~~in Open-Top Chambers. Environmental Pollution. 87~~,~~: 135-140.

~~423.~~421. Mudd J B. 1996. Biochemical Basis ~~For~~for ~~The~~the Toxicity ~~Of~~of Ozone. In: Yunus, M.; Iqbal, M.: Eds. Plant Response ~~To~~to Air Pollution. ~~,~~ 267-283.

~~424.~~422. Mulchi, C.; Rudorff, B.; Lee, E.; Rowland, R.; Pausch, R. 1995. Morphological Responses ~~Among Crop Species To 53 Full-Season Exposures To Enhanced Concentrations Of~~among Crop Species to 53 Full-Season Exposures to Enhanced Concentrations of Atmospheric CO_2 ~~And~~and ~~ozone.~~ O_3. Water Air Soil Pollut. 85: 1379-1386.

~~425.~~423. Murphy, J.J.; Deluki, M.A.; Mccubbin D.R.; Kim H.J. 1999. The Cost ~~Of~~of Crop Damage Caused By Ozone Air Pollution ~~From~~from Motor Vehicles. Journal ~~Of~~of Environmental Management 55: 273-289.

~~426.~~424. Musselman RC, Minnick TJ. 2000. Nocturnal stomatal conductance and ambient air quality standards for ozone. Atmos Environ.~~ 2000;~~ 34~~(5)~~: 719-733.

~~427.~~425. Musselman, R.C.; Massman, W. J. 1999. Ozone Flux ~~To~~to Vegetation ~~And~~and Its Relationship ~~To~~to Plant Response ~~And~~and Ambient Air Quality Standards. Atmos Environ. 33: 65-73.

~~428.~~426. Mutters, R.~~–~~, Soret, S. 1998. Statewide Potential Crop Losses ~~From~~from Ozone Exposure. Final Report ~~To~~to California Air Resources Board ~~On~~on Contract 94-345.

~~429.~~427. Mutters, R., Guzy M. Thompson, C.R. 1993. Crop Losses ~~From~~from Air Pollutants—A Computer ~~And~~and Field-Based Assessment Program ~~And~~and Crop ~~And~~and Forest Losses ~~From~~from Air Pollutants—~~An~~an Assessment Program. Final Report ~~To~~to California Air Resources Board ~~On~~on Contracts A033-174 ~~And~~and A933-190.

~~430.~~428. Mutters, R., Soret, S. 1995. Crop Losses ~~From~~from Air Pollutants--A GIS Regional Analysis ~~And~~and Statewide Crop Losses From Air Pollutants. Final Report ~~To~~to California Air Resources Board ~~On~~on Contracts A133-185 ~~And~~and A92-350.

~~431.~~429. NARSTO (North American Research Strategy ~~For~~for Tropospheric ozone). 2000. The NARSTO ~~ozone~~O_3 Assessment—Critical Reviews. Atmospheric Environment. 34~~,~~: 1853-2332.

~~432.~~430. Nouchi, I., Ito, O., Harazono Y., Kobayashi, K. 1991. Effects of chronic ozone exposure on growth, root respiration and nutrient uptake of rice plants. Environmental Pollution. 74: 149-164.

~~433.~~431. Noormets, A.; Sôber, A,; Pell, E. J.,; Dickson, R. E.; Podila, G. K.; Sôber, J. Isebrands, J. G.; Karnosky, D. F.; 2001a. Stomatal and non-stomatal limitation to photosynthesis in two trembling aspen (Populus tremuloides Michx.) clones exposed to elevated CO_2 and/or O_3. Plant, Cell ~~&~~and Environment. ~~Volume~~ 24: 327-336.

~~434.~~432. Nussbaum, S., Geissmann, M., Fuhrer, J. 1995. Ozone exposure-response relationships for mixtures of perennial ryegrass and white clover depend on ozone exposure patterns. Atmospheric Environment 29: 989-995.

~~435.~~433. Ojanpera K.; Patsikka, E.; Ylaranta, T. 1998. Effects ~~Of~~of Low Ozone Exposure ~~Of~~of Spring Wheat ~~On~~on Net CO_2 Uptake, Rubisco, Leaf Senescence ~~And~~and Grain Filling. New Phytol. 138: 451-460.

~~436.~~434. Okano, K., Ito, O., Takeba, G., Shimizu, A., Totsuka, T., 1984. Alteration ~~-~~o~~O~~f ^{13}C-Assimilate Partitioning ~~I~~in Plants ~~O~~of Phaseolus Vulgaris Exposed ~~T~~to Ozone. New Phytologist. 97~~,~~: 155-163.

~~437.~~435. Ollerenshaw, J. H.; Lyons, T. 1999. Impacts ~~Of~~of Ozone ~~On~~on ~~The~~the Growth ~~And~~and Yield ~~Of~~of Field-Grown Winter Wheat. Environ. Poll. 106:67-72.

~~438.~~436. Ollerenshaw, J.H., Lyons, T., Barnes, J.D., 1999. Impacts ~~Of~~of Ozone ~~On~~on ~~The~~the Growth ~~And~~and Yield ~~Of~~of Field-Grown Winter Oilseed Rape. Environmental Pollution~~,~~. 104~~,~~: 53-59.

~~439.~~437. Olson RK, Binkley D, Böhm M, ed~~itor~~s. The Response of Western Forests to Air Pollution.~~ New York:~~ Springer-Verlag, New York~~;~~. 1992.

~~440.~~438. Olszyk, D. M.; Bytnerowicz, A.; Kats, G.; Dawson, P. J.; Wolf, J.; Thompson, C. R. 1986a. Effects ~~Of~~of Sulfur Dioxide ~~And~~and Ambient Ozone ~~On~~on Winter Wheat ~~And~~and Lettuce. J. Environ. Qual. 15: 363-369.

~~441.~~439. Olszyk, D. M.; Bytnerowicz, A.; Kats, G.; Dawson, P. J.; Wolf, J.; Thompson, C. R. 1986b. Crop Effects from air pollutants in air exclusion systems vs. field chambers. J. Environ. Qual. 15: 417-422.

~~442.~~440. Olszyk, D. M.; Kats, G. L.; Morrison, C. L.; Dawson, P. J.; Gocka, I.; Wolf, J.; Thompson, C.R. 1990b. ‘Valencia' Orange Fruit Yield With Ambient Oxidant ~~Or~~or Sulfur Dioxide Exposures. J. Amer. Soc. Hort. Sci. 115(6): 878-883.

~~443.~~441. Olszyk, D. M.; Tibbitts, T. W.; Hertzberg, W. M. 1980. Environment In Open-Top Field Chambers Utilized ~~F~~for Air Pollution Studies. J. Environ. Qual. 9: 610-615.

~~444.~~442. Olszyk, D., Bytnerowicz, A., Kats, G., Reagan, C., Hake, S., Kerby, T., Millhouse, D., Roberts, B., Anderson, C., Lee, H.~~,~~ 1993. Cotton Yield Losses ~~And~~and Ambient Ozone Concentrations ~~In~~in California's San Joaquin Valley. Journal ~~Of~~of Environmental Quality. 22~~,~~: 602-611.

~~445.~~443. Olszyk, D.M., Takemoto, B.K., Kats, G., Dawson, P.J., Morrison, C.L., Preston, J.W., Thompson, C.R. 1992. Effects of open top chambers on “Valencia” orange trees. Journal of Environmental Quality. 21:128-134.

~~446.~~444. Olszyk, D.M., Takemoto, B.K., Poe, M. 1991. Leaf Photosynthetic ~~And~~and Water Relations Responses ~~For~~for "Valencia" Orange Trees Exposed ~~T~~to Oxidant Air Pollution. Environmental ~~And~~and Experimental Botany. 31~~,~~: 427-436.

~~447.~~445. Olszyk, D.M., Wise, C., 1997. Interactive Effects ~~Of~~of Elevated CO_2 ~~And~~and ~~ozone~~ O_3 ~~On~~on Rice ~~And~~and Flacca Tomato. Agriculture, Ecosystems ~~And~~and Environment~~,~~. 66~~,~~: 1-10.

~~448.~~Ommen, O. E.; Donnelly, A.; Vanhoutvin, S.; Van Oijen, M.; Manderscheid, R. 1999. Chlorophyll Content ~~O~~of Spring Wheat Flag Leaves Grown Under Elevated CO_2 Concentrations ~~A~~and Other Environmental Stresses Within ~~T~~the 'ESPACE-Wheat' Project. Eur. J. Agron. 10: 197-203.

446.

~~449.Oren, R., Werk, K.S., Meyer, J, Schulze, E.-D. 1989.. Potentials And Limitations Of Field Studies On Forest Decline Associated With Anthropogenic Pollution. Chapt. 3 in Schulze, E-D., Lange, O.L., Oren, R. (eds.) Ecological Studies Vol. 77 “Forest Decline And Air Pollution: A Study Of Spruce (*Picaea Abies*) On Acid Soils” Springer Verlag, Berlin.~~

447. Oren, R., Werk, K.S., Meyer, J, Schulze, E.-D. 1989. Potentials and Limitations of Field Studies on Forest Decline Associated with Anthropogenic Pollution. In: Schulze, E-D., Lange, O.L., Oren, R., eds. Ecological Studies Vol. 77. Chapt. 3 “Forest Decline and Air Pollution: A Study Of Spruce (*Picaea Abies*) on Acid Soils.” Springer Verlag, Berlin.

~~450.~~448. Ormrod, D.P., Marie, B.A. ~~And~~ Allen, O.B. 1988.~~,~~ Research Approaches ~~T~~to Pollutant Crop Loss Functions, In: Heck, W. W.; Taylor, 0. C.; Tingey, D. T., Eds. Assessment ~~O~~of Crop Loss ~~F~~from Air Pollutants: Proceedings ~~O~~of ~~A~~an International Conference; October, (1987); Raleigh, NC. New York, NY: Elsevier Applied Science.~~;~~ ~~Pp. 27-44.~~ London: Elsevier Press. Pgs. 27-44.

~~451.~~449. Oshima, R. J.; Braegelmann, P. K.; Baldwin, D. W.; Van Way, V.; Taylor, O. C. 1977a. Responses ~~Of~~of Five Cultivars ~~Of~~of Fresh Market Tomato ~~To~~to Ozone: A Contrast ~~Of~~of Cultivar Screening With Foliar Injury ~~And~~and Yield. J. Am. Soc. Hortic. Sci. 102: 286-289.

~~452.~~450. Oshima, R. J.; Poe, M. P.; Braegelmann, P. K.; Baldwin, D. W.; Van Way, V. 1976. Ozone Dosage-Crop Loss Function ~~For~~for Alfalfa: A Standardized Method ~~For~~for Assessing Crop Losses ~~From~~from Air Pollutants. J. Air Pollut. Control Assoc. 326: 861-865.

~~453.~~451. Oshima, R.J., Bennett, J.P., Braegelmann, P.K.~~,~~ 1978. Effect ~~O~~of Ozone ~~O~~on Growth ~~A~~and Assimilate Partitioning ~~I~~in Parsley. Journal ~~Of~~of ~~The~~the American Society ~~Of~~of Horticultural Science~~,~~. 103~~,~~: 348-350.

~~454.~~452. Oshima, R.J., Braegelmann, P.K., Baldwin, D.W., Van Way, V., Taylor, O.C.~~,~~ 1977b. Reduction ~~In~~in Tomato Fruit Size ~~And~~and Yield ~~By~~by

Ozone. Journal ~~Of~~of ~~The~~the American Society ~~Of~~of Horticultural Science~~,~~. 102~~,~~: 289-293.

~~455.~~453. Oshima, R.J., Braegelmann, P.K., Flagler, R.B., Teso, R.R., 1979. The Effects ~~Of~~of Ozone ~~On~~on ~~The~~the Growth, Yield ~~And~~and Partitioning Of Dry Matter ~~In~~in Cotton. Journal ~~Of~~of Environmental Quality. 8~~,~~: 474-479.

~~456.~~454. Paakkonen, E.; Holopainen, T.~~;~~ 1995. Influence of nitrogen supply on the response of clones of birch (Betula pendula Roth) to ozone. New Phytologist 129: 595-603.

~~457.~~455. Palou, L.; Crisosto, C.H.; Smilanick, J.L.; Adaskaveg, J.E.; Zoffoli, J.P. 2002. Effects of continuous 0.3 ppm ozone exposure on decay development and physiological responses of peaches and table grapes in cold storage. Postharvest Biology and Technology. 24: 39-48.

~~458.~~456. Parker GG. 1990. Evaluation of dry deposition, pollutant damage, and forest health with throughfall studies. In: Lucier AA, Haines GG, editors. Mechanisms of forest response to acidic deposition. New York: Springer-Verlag~~; 1990,~~. Pgs.~~ p.~~ 10-61.

~~459.~~457. Patterson MT, Rundel PW. 1989. Seasonal physiological responses of ozone stressed Jeffrey pine in Sequoia National Park, California. In: Olson RK, Lefohn AS, edi~~tor~~s. Effects of air pollution on western forests. APCA Trans Ser.~~ 1989;~~ 16~~:~~. Pgs. 419-427.

~~460.~~458. Peace, A., Lea, P.J., Darrall, N.M., 1995 The Effect ~~O~~of Open Fumigation With SO_2 And ~~ozone~~ O_3 ~~O~~on .Carbohydrate Metabolism ~~I~~in Scots Pine (Pinus ~~S~~iylvestris) ~~A~~and Norway Spruce (Picea Abies). Plant Cell ~~And~~and Environment. 18~~,~~: 277-283.

~~461.~~459. Pearson, M. 1995. Effects of Ozone on Growth and Gas-Exchange of Eucalyptus-Globulus Seedlings. Tree Physiol. 15: 207-210.

~~462.~~460. Pell, E. J.; Sinn, J. P.; Eckardt, N.; Johansen, C. V.; Winner, W. E.; Mooney, H.A. 1993. Response ~~Of~~of Radish ~~To~~to Multiple Stresses II. Influence ~~Of~~of Season ~~And~~and Genotype ~~On~~on Plant Response ~~To~~to Ozone ~~And~~and Soil Moisture Deficit. New Phytol. 123: 153-163.

~~463.~~461. Pell, E. J.; Sinn, J. P.; Johansen C. V. 1995. Nitrogen Supply ~~As~~as ~~A~~a Limiting Factor Determining ~~The~~the Sensitivity ~~Of~~of Populus Tremuloides Michx. ~~T~~to Ozone Stress. New Phytol. 130: 437-446.

~~464.~~462. Pell, E.J., Eckardt, N., Enyedi, A.J., 1992. Timing ~~Of~~of Ozone Stress ~~And~~and Resulting Status ~~Of~~of Ribulose Bisphosphate Carboxylase~~-~~/Oxygenase ~~A~~and Associated Net Photosynthesis. New Phytologist~~,~~. 120~~,~~: 397-405.

~~465.~~463. Pell, E.J., Pearson, N.S., 1983. Ozone Induced Reduction ~~I~~in Quantity ~~O~~of Ribulose-1,5-Bisphosphate Carboxylase ~~I~~in Alfalfa Foliage. Plant Physiology. 73~~,~~: 185-187.

~~466.~~464. Pell, E.J., Schlagnhaufer, C.D., Arteca, R.N.~~,~~ 1997. ~~ozone~~O_3-Induced Oxidative Stress: Mechanisms ~~Of~~of Action ~~And~~and Reaction. Physiologia Plantarum. 100~~,~~: 264-273.

~~467.~~465. Pell, E.J., Temple, P.J., Friend, A.L., Mooney, H.A., Winner, W.E.~~,~~ 1994. Compensation ~~As~~as ~~A~~a Plant Response ~~To~~to Ozone ~~And~~and Associated Stresses: An Analysis ~~Of~~of ROPIS Experiments. Journal ~~Of~~of Environmental Quality. 23~~,~~: 429-436.

~~468.~~466. Peterson DL, Arbaugh MJ, Robinson LJ. 1991. Regional growth changes in ozone-stressed ponderosa pine (*Pinus ponderosa*) in the Sierra Nevada, California, USA. Holocene. ~~1991;~~ 1: 50-61.

~~469.~~467. Peterson DL, Arbaugh MJ, Wakefield VA, Miller PR. 1987. Evidence of growth reduction in ozone-injured Jeffrey pine (*Pinus jeffreyi* Grev. and Balf.) in Sequoia and Kings Canyon National Parks. J Air Pollut Contr Assoc.~~ 1987;~~ 37: 906-912.

~~470.~~468. Peterson DL, Arbaugh MJ. 1988. An evaluation of the effects of ozone injury on radial growth of ponderosa pine *(Pinus ponderosa)* in the southern Sierra Nevada. J Air Pollut Contr Assoc.~~ 1988;~~ 38: 921-927.

~~471.~~469. Peterson DL, Silsbee DG, Poth M, Arbaugh MJ, Biles FE. 1995. Growth response of big-cone Douglas fir *(Pseudotsuga macrocarpa)* to long-term ozone exposure in southern California. J Air Waste Manage ~~1995;~~. 45: 36-45.

~~472.~~470. Pleiejl, H.; Karlsson, G.P.; Danielsson, H.; Sellden, G. 1995. Surface Wetness Enhances Ozone Deposition to a Pasture Canopy. Atmospheric Environ. 29: 3391-3393.

~~473.~~471. Pleijel, H.; Skarby, L. 1991. Yield And Grain Quality Of Spring Wheat (Triticum Aestivum L., Cv. Drabant) Exposed ~~T~~to Different Concentrations ~~O~~of Ozone ~~I~~in Open-Top Chambers. Environmental Pollution. 69: 151-168.

~~474.~~472. Pleijel, H.; Skärby, L.; Ojanperä, K.; Selldén, G. 1992. Yield ~~A~~and Quality ~~O~~of Spring Barley, Hordeum Vulgare L., Exposed ~~T~~to Different Concentrations ~~O~~of Ozone ~~I~~in Open-Top Chambers. Agriculture, Ecosystems ~~A~~and Environment. 38: 21-29.

~~475.~~473. Pleijel, H.; Wallin, G.; Karlsson, P. E.; Skarby, L.; Sellden, G. 1994b. Ozone Deposition ~~To~~to ~~An~~an Oat Crop (Avena Sativa L.) Grown ~~I~~in Open-Top Chambers ~~A~~and ~~I~~in ~~T~~the Ambient Air~~,~~. Atmos. Environ. 28: 1971-1979.

~~476.~~474. Poorter, H., Perez-Soba, M. 2001. The growth response of plants to elevated CO_2 under non-optimal environmental conditions. Oecologia. 129: 1-20.

~~477.~~475. Pye JM. 1988. Impact of ozone on the growth and yield of trees: A review. J Environ Qual.~~ 1988;~~ 17~~(3)~~: 347-360.

~~478.~~476. Rebbeck J, Jensen KF, Greenwood MS. 1993. Ozone effects on grafted mature and juvenile red spruce: photosynthesis, stomatal conductance, and chlorophyll concentration. Can J For Res.~~ 1993;~~ 23: 450-456.

~~479.~~477. Reich PB, Amundson RG. 1985. Ambient levels of ozone reduce net photosynthesis in tree and crop species. Science.~~ 1985;~~ 230: 566-570.

~~480.~~478. Reich PB, Schoettle AW, Stroo HF, Troiano J, Amundson RG. 1987. Effects of ozone and acid rain on white pine *(Pinus strobus)* seedlings grown in five soils. I. Net photosynthesis and growth. Can J Bot ~~1987;~~ 65: 977-987.

~~481.~~479. Reich PB. 1987. Quantifying Plant Response ~~To~~to Ozone: A Unifying Theory. Tree Physiol. 3: 63-91.

~~482.~~480. Reich, P.H., 1983. Effects ~~Of~~of Low Concentrations ~~O~~of O_3 ~~ozone~~ ~~O~~on Net Photosynthesis, Dark Respiration, ~~A~~and Chlorophyll Contents ~~I~~in Aging Hybrid Poplar Leaves. Plant Physiology. 73~~,~~: 291-296.

~~483.~~481. Reich, P.H., Amundson, R.G., 1984. Low Level ~~ozone~~ O_3 ~~And/Or~~and/or SO_2 Exposure Causes ~~A~~a Linear Decline ~~I~~in Soybean Yield. Environmental Pollution. 34~~,~~: 345-355.

~~484.~~482. Reiling, K., Davison, A.W.~~,~~ 1992a. The Response ~~Of~~of Native, Herbaceous Species ~~To~~to Ozone: Growth ~~And~~and Fluorescence Screening. New Phytologist. ~~,~~120~~,~~: 29-37.

~~485.~~483. Reiling, K., Davison, A.W.~~,~~ 1992b. Spatial Variation ~~In~~in Ozone Resistance ~~Of~~of British Populations ~~Of~~of Plantago Major L. New Phytologist~~,~~. 122~~,~~: 699-708.

~~486.~~484. Reiling, K., Davison, A.W.~~,~~ 1994. Effects ~~Of~~of Exposure ~~To~~to Ozone ~~To~~to Different Stages ~~In~~in ~~The~~the Development ~~Of~~of Plantago Major L. ~~O~~on Chlorophyll Fluorescence ~~A~~and Gas Exchange. New Phytologist~~,~~. 128~~,~~: 509-514.

~~487.~~485. Reinert, R.A., Ho, M.C.~~,~~ 1995. Vegetative Growth ~~Of~~of Soybean ~~A~~as Affected ~~B~~by Elevated Carbon Dioxide ~~A~~and Ozone. Environmental Pollution~~,~~. 89~~,~~: 89-96.

~~488.~~486. Reinert, R.A., Schafer, S.R., Eason, G., Schoeneberger, M.M., Horton, S.J., 1996. Response ~~Of~~of Loblolly Pine ~~To~~to Ozone ~~And~~and Simulated Acidic Rain. Canadian Journal ~~Of~~of Forest Research~~,~~. 26~~,~~: 1715-1723.

~~489.~~487. Renaud J. P.; Allard, G.; Mauffette, Y. 1997. Effects ~~Of~~of Ozone ~~On~~on Yield, Growth, ~~And~~and Root Starch Concentrations ~~Of~~of Two Alfalfa (Mediago Sativa L.) Cultivars. Environmental Pollution. 95: 273-281.

~~490.~~488. Retzlaff, W. A.; Arthur, M. A.; Grulke, N. E.; Weinstein, D. A.; Gollands, B. 2000. Use ~~O~~of ~~A~~a Single-Tree Simulation Model ~~T~~to Predict

Effects ~~O~~of Ozone ~~A~~and Drought ~~O~~on Growth ~~O~~of ~~A~~a White Fir Tree. Tree Physiol. 20: 195-202.

~~491.~~489. Retzlaff, W. A.; Williams, L. E~~.~~; Dejong, T. M. 1997. Growth ~~And~~and Yield Response ~~Of~~of Commercial Bearing-Age 'Casselman' Plum Trees ~~To~~to Various Ozone Partial Pressures. Journal ~~Of~~of Environmental Quality. 26~~ (3)~~: 858-865.

~~492.~~490. Retzlaff, W. A.; Williams, L. E.; Dejong, T. M. 1992. Photosynthesis, Growth, ~~And~~and Yield Response ~~Of~~of 'Casselman' Plum ~~To~~to Various Ozone Partial Pressures ~~During~~during Orchard Establishment. J. Am. Soc. Hortic. Sci. 117: 703-710.

~~493.~~491. Retzlaff, W.A., Williams, L.E., DeJong, T.M. 1991. The effect of different atmospheric ozone partial pressures on photosynthesis and growth of nine fruit and nut tree species. Tree Physiology. 8:93-105.

~~494.~~492. Richards BL Sr, Taylor OC, Edmunds GF Jr. 1968. Ozone needle mottle of pine in southern California. J Air Pollut Contr Assoc.~~ 1968;~~ 18~~(2)~~: 73-77.

~~495.~~493. Richardson CJ, Sasek TW, Fendick EA, Kress LW. 1992. Ozone exposure-response relationships for photosynthesis in genetic strains of loblolly pine seedlings. For Ecol Manage.~~ 1992;~~ 51: 163-178.

~~496.~~494. Roberts, B.R., Cannon, W.N., Jr., 1992. Growth ~~A~~and Water Relationships ~~O~~of Red Spruce Seedlings Exposed ~~T~~to Atmospheric Deposition ~~A~~and Drought. Canadian Journal ~~Of~~of Forest Research. 22~~,~~: 193-197.

~~497.~~495. Rocchio JE, Ewell DM, Procter CT, Takemoto BK. 1993. Project FOREST: The Forest Ozone Response Study. In: Brown WE, Veirs SD Jr, edi~~tor~~s. Partners in stewardship. Hancock, MI.~~:~~ Geo Wright Soc~~; 1993,~~. Pgs ~~p~~. 112-119.

~~498.~~496. Roper, T.R., Williams, L.E., 1989. Effect ~~Of~~of Ambient ~~And~~and Acute Partial Pressures ~~Of~~of Ozone ~~On~~on Leaf Net CO_2 Assimilation ~~Of~~of Field-Grown Vitis Vinifera L. Plant Physiology. 91~~,~~:~~-~~1501-1506.

~~499.~~497. Rosen, P.M., Runeckles, V.C. 1976. Interaction of ozone and greenhouse whitefly in plant injury. Environmental Conservation. 3:70-71.

~~500.~~498. Rosenbaum BJ, Strickland TC, McDowell MK. 1994. Mapping critical levels of ozone, sulfur dioxide and nitrogen dioxide for crops, forests and natural vegetation in the United States. Water Air Soil Pollut. ~~1994; ~~74: 307-319.

~~501.~~499. Rowe, R.D.; ~~C.G~~L. ~~Lauraine~~Chestnut; D.C. Peterson; C. Miller; R.M Adamas; W.R. Oliver; ~~and ~~H. Hogo~~,~~. The Benefits of Air Pollution Control in California, Report for the ARB, 1986

~~502.~~500. Rudorff B. F. T.; Mulchi, C. L.; Lee, E. H.; Rowland, R.; Pausch, R. 1996a. Effects ~~Of~~of Enhanced ~~ozone~~ O$_3$ ~~And~~and CO$_2$ Enrichment ~~On~~on Plant Characteristics ~~In~~in Wheat ~~And~~and Corn. Environ. Pollut. 94: 53-60.

~~503.~~501. Rudorff, B. F. T.; Mulchi, C. L.; Fenny, P.; Lee, E. H.; Rowland, R. 1996c. Wheat Grain Quality ~~Under~~under Enhanced Tropospheric CO$_2$ ~~And~~and ~~ozone~~O$_3$ Concentrations. Journal ~~Of~~of Environmental Quality. 25: 1384-1388.

~~504.~~502. Runeckles, V. C.; Wright, E. F.; White, D. 1990. A Chamberless Field Exposure System ~~For~~for Determining ~~The~~the Effects ~~Of~~of Gaseous Air Pollutants ~~On~~on Crop Growth ~~And~~and Yield. Environ. Pollut. 63: 61-77.

~~505.~~503. Rusch, H.; Laurence, J. A. 1993. Interactive Effects ~~Of~~of Ozone ~~And~~and Powdery Mildew ~~On~~on Pea Seedlings. Phytopathology. 83: 1258-1263.

~~506.~~504. Sah, D. N.; Von Tiedemann, A.; Fehrmann, H. 1993. Effects ~~Of~~of Ozone Exposure ~~On~~on Resistance ~~Of~~of Wheat Genotypes ~~To~~to Phrenophora Tritici-Repentis. J. Phytopathol. 138: 249-256.

~~507.~~505. Sakaki, T., Saito, K., Kawaguchi, A., Kondo, N., Yamada, M. 1990. Conversion ~~Of~~of Monogalactosyldiacylglycerols ~~To~~to Triacylglycerols ~~In~~in Ozone-Fumigated Spinach Leaves. Plant Physiology (Rockville). 94~~(2).~~: 766-772.

~~508.~~506. Sandermann, H., Jr. 1996. Ozone ~~And~~and Plant Health. Annu. Rev. Phytopathol. 34: 347-366.

~~509.~~507. Sanders, G. E.; Clark, A. G.; Colls, J. J. 1991. The influence of open-top chambers on the growth and development of field bean. New Phytologist. 117: 439-447.

~~510.~~508. Sanders, G. E.; Colls, J. J.; Clark, A. G.; Galaup, S.; Bonte, J.; Cantuel, J. 1992b. *Phaseolus vulgaris* and ozone: results from open-top chamber experiments in France and England. Agriculture, Ecosystems and Environment. 38: 31-40.

~~511.~~509. Sanders, G. E.; Robinson, A. D.; Geissler, P. A.; Colls, J. J. 1992a. Yield stimulation of a commonly grown cultivar of Phaseolus vulgaris L. at near-ambient ozone concentrations. New Phytologist. 122: 63-70.

~~512.~~510. Schenone, G.; Botteschi, G.; Fumagalli, I.; Montinaro, F. 1992. Effects ~~Of~~of Ambient Air Pollution ~~In~~in Open-Top Chambers ~~On~~on Bean (Phaseolus Vulgaris L.) I. Effects ~~On~~on Growth ~~And~~and Yield. New Phytol. 122: 689-697.

~~513.~~511. Schenone, G.; Fumagalli, I.; Mignanego, F.; Montinaro, F.; Soldatini, G.F. 1994. Effects of Ambient Air Pollution in Open-Top Chambers on Bean (Phaseolus vulgaris L.). II. Effects on Photosynthesis and Stomatal Conductance. New Phytol. 126: 309-315.

~~514.~~512. Schulze E-D. 1989. Air pollution and forest decline in a spruce (*Picea abies*) forest. Science.~~ 1989;~~ 244: 776-783.

~~515.~~513. Schulze, E-D., Lange, O.L., Oren, R. (Eds.)~~,~~. 1989. Forest Decline ~~And~~and Air Pollution: A Study ~~Of~~of Spruce (Picea Abies) ~~O~~on Acid Soils. Springer-Verlag. New York.

~~516.~~514. Shafer SR, Heagle AS, Camberato DM. 1987. Effects of chronic doses of ozone on field-grown loblolly pine: seedling responses in the first year. J Air Pollut Contr Assoc.~~ 1987;~~ 37: 1,179-1,184.

~~517.~~515. Shafer SR, Heagle AS. 1989. Growth responses of field-grown loblolly pine to chronic doses of ozone during multiple growing seasons. Can J For Res.~~ 1989;~~ 19: 821-831.

~~518.~~516. S~~haver, C.L.~~igal L.L.; T.H. Nash III, 1983. Lichen Communities on Conifers in Southern California Mountains: An Ecological Survey Relative to Oxidant Air Pollution~~;~~. Ecology. 64~~(6)~~: 1342-1354~~, 1983~~.

~~519.~~517. Shaver, C.L.; Cass, G.R.; Druzik, J.R.~~.~~ 1983. Ozone and the Deterioration of Works of Art. Environ. Sci. Technol.~~,~~ 17: 749-752.~~, (1983)~~

~~520.~~518. Shaw, P.J. 1986. The Liphook forest fumigation experiment: description and project plan. TPRD/L/2985/R86: 1-15. Central Electricity Generating Board, technology planning and research division. Kelvin Ave. Leatherhead, Surrey KT22 7SE.

~~521.~~519. Showman, R.E. 1991. A comparison of ozone injury to vegetation during moist and drought years. Journal of the Air and Waste Management Association. 41: 63-64.

~~522.~~520. Shriner DS, Heck WW, McLaughlin SB, Johnson DW, Irving PM, Joslin JD, Peterson CE. 1991. Response of vegetation to atmospheric deposition and air pollution. ~~NAPAP Report 18.~~ In: Irving PM, ed~~itor~~. Acidic Deposition: State of Science and Technology. NAPAP Report 18. Vol. III. Terrestrial, Materials, Health and Visibility Effects. Washington, DC.~~:~~ NAPAP~~; 1991~~.

~~523.~~521. Skärby L, Troeng E, Boström C-Å. 1987. Ozone Uptake ~~And~~and Effects ~~On~~on Transpiration, Net Photosynthesis, ~~And~~and Dark Respiration ~~In~~in Scots Pine. For Sci. 33~~(3)~~: 801-808.

~~524.~~522. Skelly, J.M., Yang, Y-S., Chevonne, B.I., Long, S.J., Nellessen, J.E., Winner, W.E.~~,~~ 1983. Ozone Concentrations ~~And~~and Their Influence ~~On~~on Forest Species ~~In~~in ~~The~~the Blue Ridge Mountains ~~Of~~of Virginia. In: David, D.D., Miller, A.A., Dochinger, L., ~~(~~Eds.~~),~~ Air Pollution ~~A~~and ~~T~~the Productivity ~~O~~of ~~T~~the Forest. Isaac~~.~~ Walton League ~~O~~of America~~,~~. Arlington, VA~~,~~. P~~p~~gs. 143-160.

~~525.~~523. Smeulders, S.M., Gorissen, A., Joosten, N.N., Vanveen, J.A.~~,~~ 1995. Effects ~~Of~~of Short-Term Ozone Exposure ~~On~~on ~~The~~the Carbon Economy ~~Of~~of Mature ~~And~~and Juvenile Douglas Firs [Pseudotsuga Menziesii (Mirb) Franco]. New Phytologist. 129:~~,~~ 45-53.

~~526.~~524. Snyder, R. G.; Simon, J. E.; Reinert, R. A.; Simini, M.; Heck, W. W. 1988. Effects ~~Of~~of Air Quality ~~On~~on Foliar Injury, Growth, Yield, ~~A~~and Quality ~~O~~of Muskmelon. Environ. Pollut. 53: 187-196.

~~527.~~525. Snyder, R. G.; Simon, J. E.; Reinert, R. A.; Simini, M.; Wilcox, G. E. 1991. Effects ~~Of~~of Air Quality ~~On~~on Growth, Yield, ~~And~~and Quality ~~Of~~of Watermelon. ~~Hortscience~~ Hortscienc. 26: 1045-1047.

~~528.~~526. Soja, G.; Barnes, J. D.; Posch, M.; Vandemieiren, K.; Pleijel, H.; Mills. G. 2000. Phenological Weighting ~~Of~~of Ozone Exposures ~~In~~in ~~The~~the Calculation ~~Of~~of Critical Levels ~~For~~for Wheat, Bean ~~And~~and Plantain. Environmental Pollution. 109: 517-524.

~~529.~~527. Spash, C. L. 1997. Assessing ~~The~~the Economic Benefits ~~To~~to Agriculture ~~From~~from Air Pollution Control. J. Econ. Surv. 11: 47-70.

~~530.~~528. Spence, R.D., Rykiel, E.J., Sharpe, P.J.H.~~,~~ 1990. Ozone Alters Carbon Allocation ~~In~~in Loblolly Pine: Assessment ~~With~~with Carbon-11 Labeling. Environmental Pollution. 64, 93-106.

~~531.~~529. Stewart, C. A.; Black, V. J.; Black, C. R.; Roberts, J. A. 1996. Direct Effects ~~O~~of Ozone ~~O~~on– ~~T~~the Reproductive Development ~~O~~of Brassica Species. J. Plant Physiol. 148: 172-178.

~~532.~~530. Summers, C. G.; Retzlaff, W. A., Stephenson, S. 1994. The effect of ozone on the mean relative growth rate of Diuraphis Noxia (Mordvilko) (Homoptera:Aphididae). Journal of Agricultural Entomology. 11: 181-187.

~~533.~~531. Takemoto BK, Bytnerowicz A, Dawson PJ, Morrison CL, ~~and~~ Temple PJ. 1997. Effects of ozone on *Pinus ponderosa* seedlings: comparison of responses in the first and second growing seasons of exposure. Can J For Res. ~~1997;~~ 27: 23-30.

~~534.~~532. Takemoto BK, Bytnerowicz A, Fenn ME. 2001. Current ~~And Future Effects Of Ozone And Atmospheric Nitrogen Deposition On~~and Future Effects of Ozone and Atmospheric Nitrogen Deposition on California's Mixed Conifer Forests. For Ecol Manage~~;~~. 144: 159-173.

~~535.~~533. Takemoto, B. K.; Olszyk, D. M.; Johnson, A. G.; Parada, C. R. 1988b. Yield Responses ~~Of~~of Field-Grown Crops ~~To~~to Acidic Fog ~~And~~and Ambient Ozone. J. Environ. Qual. 17:192-197.

~~536.~~534. Taylor GE Jr, Hanson PJ. 1992. Forest trees and tropospheric ozone: role of canopy deposition and leaf uptake in developing exposure-response relationships. Agric Ecosys Environ. ~~1992;~~ 42: 255-273.

~~537.~~535. Taylor GE Jr, Norby RJ, McLaughlin SB, Johnson AH, Turner RS. 1986. Carbon dioxide assimilation and growth of red spruce (*Picea rubens* Sarg.) seedlings in response to ozone, precipitation chemistry, and soil type. Oecologi.~~a 1986;~~ 70: 163-171.

~~538.~~536. Taylor GE Jr. 1994. Role of genotype in the response of loblolly pine to tropospheric ozone: effects at the whole-tree, stand, and regional level. J Environ Qual.~~ 1994;~~ 23: 63-82.

~~539.~~537. Taylor, G. E. Jr.; Tingey, D. T.; Ratsch, H. C. 1982a. Ozone Flux ~~In~~in Glycine Max (L.) Merr.: Sites ~~O~~of Regulation ~~A~~and Relationship ~~T~~to Lea~~ve~~f Injury. Oecologia. 53: 179-186.

~~540.~~538. Taylor, G., Davies, W.J.~~,~~ 1990. Root Growth ~~Of~~of Fagus Sylvatica: Impact ~~Of~~of Air Quality ~~And~~and Drought ~~At~~at ~~A~~a Site ~~In~~in Southern Britain. New Phytologist~~,~~. 116~~,~~: 457-464.

~~541.~~539. Taylor, G., Ferris, R.~~,~~ 1996. Influence ~~Of~~of Air Pollution ~~On~~on Root Physiology ~~And~~and Growth. In: Yunus, M., Iqbal, M., ~~E~~eds. Plant Response ~~To~~to Air Pollution. London, J.Wiley ~~And~~and Sons~~,~~. P~~p~~gs. 375-394.

~~542.~~540. Taylor, G.E., Johnson, D.J., Andersen, C.P. 1994. Air Pollution ~~And~~and Forest Ecosystems: A Regional ~~To~~to Global Perspective. Ecological Applications. 4~~,~~: 662-689.

~~543.~~541. Temple PJ, Bytnerowicz A. 1993. Growth, Physiological, and Biochemical Responses of Ponderosa Pine *(Pinus ponderosa)* to Ozone. Sacramento, CA.~~:~~ ARB~~; 1993.~~ Final Report~~,~~ on contracts~~ Nos.~~ A733-137, A833-083, and A033-056. NTIS No. PB94131372.

~~544.~~542. Temple PJ, Miller PR. 1994. Foliar ozone injury and radial growth of ponderosa pine. Can J For Res.~~ 1994;~~ 24: 1,877-1,882.

~~545.~~543. Temple PJ, Riechers GH, Miller PR, Lennox RW. Growth responses of ponderosa pine to long-term exposure to ozone, wet and dry acidic deposition, and drought. Can J For Res 1993; 23: 59-66.

~~546.~~544. Temple PJ, Riechers GH, Miller PR. 1992. Foliar injury responses of ponderosa pine seedlings to ozone, wet and dry acidic deposition, and drought. Environ Exp Bot.~~ 1992;~~ 32~~(2)~~: 101-113.

~~547.~~545. Temple, P. J. 1991. Variations ~~In~~in Responses ~~Of~~of Dry Bean (*Phaseolus Vulgaris*) Cultivars ~~To~~to Ozone. Agric. Ecosyst. Environ. 36: 1-11.

~~548.~~546. Temple, P. J., Lennox, R. W.; Bytnerowicz, A.; Taylor, O. C. 1987. Interactive Effects ~~Of~~of Simulated Acidic Fog ~~The~~and Ozone ~~On~~on Field-Grown Alfalfa. Environ. And Exper. Bot. 27~~(4)~~: 409-417.

~~549.~~547. Temple, P. J.; Jones, T. E., Lennox, R. W. 1990. Yield Loss Assessments ~~F~~for Cultivars ~~O~~of Broccoli, Lettuce, ~~A~~and Onion Exposed ~~T~~to Ozone. Environmental Pollution. 66: 289-299.

~~550.~~548. Temple, P.J. 1990b. Growth ~~And~~and Yield Responses ~~Of~~of Processing Tomato (Lycopersicon Esculentum Mill.) Cultivars ~~To~~to Ozone. Environ. And Exper. Bot. 30~~(3)~~: 283-291.

~~551.~~549. Temple, P.J.~~,~~ 1986. Stomatal Conductance ~~And~~and Transpirational Responses ~~Of~~of Field-Grown Cotton ~~To~~to Ozone. Plant Cell ~~And~~and Environment. 9~~,~~: 315-321.

~~552.~~550. Temple, P.J.~~,~~ 1990a. Water Relations ~~O~~of Differentially Irrigated Cotton Exposed ~~T~~to Ozone. Agronomy Journal. 82~~,~~: 800-805.

~~553.~~551. Temple, P.J.~~,~~ 1990c. Growth Form ~~And~~and Yield Responses ~~Of~~of Four Cotton Cultivars ~~To~~to Ozone. Agronomy Journal. 82~~,~~: 1045-1050.

~~554.~~552. Temple, P.J., Benoit, L.F., Lennox, R.W., Reagan, C.A., Taylor, O.C. 1988b. Combined Effects ~~O~~of Ozone ~~A~~and Water Stress ~~O~~on Alfalfa Growth ~~A~~and Yield. Journal ~~Of~~of Environmental Quality 17, 108-113.

~~555.~~553. Temple, P.J., Kupper, R.S., Lennox, R.W., Rohr, K., 1988a. Injury ~~A~~and Yield Responses ~~O~~of Differentially Irrigated Cotton ~~T~~to Ozone. Agronomy Journal. 80~~,~~: 751-755.

~~556.Temple, P.J., Riechers, G.H., Miller, P.R., Lennox, R.W. 1993. Growth Responses Of Ponderosa Pine To Long-Term Exposure To Ozone, Wet And Dry Acidic Deposition, And Drought. Canadian Journal Of Forestry Research 23, 559-566.~~

~~557.~~554. Tetlow, I.J., Farrar, J.F. 1993. Apoplastic Sugar Concentration ~~A~~and ~~P~~p~~h~~H ~~I~~in Barley Leaves Infected ~~W~~with Brown Rust. Journal ~~Of~~of Experimental Botany. 44~~,~~: 929-936.

~~558.~~555. Thompson, C. R. 1985. Effects ~~Of~~of Sulfur Dioxide ~~And~~and Ambient Ozone ~~On~~on Winter Grown Crop ~~In~~in California. California Air Resoures Board. Final Report ~~Agreement No.~~ Contract A3-057-33~~;~~. Pp. 51 ~~And~~and Appendix.

~~559.~~556. Thompson, C.R. Olszyk, D.M. 1986. Crop Loss ~~From~~from Air Pollutants Assessment Program. Interim Report ~~To~~to California Air Resources Board ~~On~~on Contracts A5-031-33 ~~And~~and A4-088-33.

~~560.~~557. Thomson, W.W., Dugger, W.M., Palmer, R.L.~~,~~ 1966. Effect ~~Of~~of Ozone ~~On~~on ~~The~~the Fine Structure ~~Of~~of ~~The~~the Palisade Parenchyma Cells ~~Of~~of Bean Leaves. Canadian Journal ~~Of~~of Botany~~,~~. 44~~,~~: 1677-1682.

~~561.~~558. Ting IP, Mukerji SK. 1971. Leaf Ontogeny ~~As~~as ~~A~~a Factor ~~In~~in Susceptibility ~~To~~to Ozone: Amino Acid ~~And~~and Carbohydrate Changes ~~During~~during Expansion. Amer J Bot. 58~~(6)~~: 497-504.

~~562.~~559. Tingey, D. T.; Rodecap, K. D.; Lee, E. H.; Hogsett, W. E.; Gregg, J. W. 2002. Pod Development Increases ~~T~~the Ozone Sensitivity ~~O~~of Phaseolus Vulgaris. Water Air Soil Pollut. 139: 325-341.

~~563.~~560. Tingey, D.T., Fites, R.C., Wickliff, C.~~,~~ 1973. Foliar Sensitivity ~~Of~~of Soybeans ~~To~~to Ozone ~~As~~as Related ~~T~~to Several Leaf Parameters. Environmental Pollution. 4~~,~~: 183-192.

~~564.~~561. Tingey, D.T., Heck, W.W., Reinert, R.A.~~,~~ 1971. Effect ~~Of~~of Low Concentrations ~~Of~~of Ozone ~~And~~and Sulfur Dioxide ~~On~~on Foliage Growth

~~And~~and Yield ~~Of~~of Radish. Journal ~~Of~~of ~~The~~the American Society ~~Of~~of Horticultural Science. 96~~,~~: 369-371.

~~565.~~562. Tjoelker M.G.~~,~~; Volin J.C.; Oleksyn J; Reich P.B. 1995b. Interaction ~~Of~~of Ozone Pollution ~~And~~and Light Effects ~~On~~on Photosynthesis ~~In~~in ~~A~~a Forest Canopy Experiment. Plant, Cell ~~&~~and Environment. 18~~(8).~~: 895-905.

~~566.~~563. Tjoelker M.G., Volin, J.C., Oleksyn, J., Reich, P.B. 1995a. Light environment alters response to ozone stress in seedlings of *Acer saccharum* Marsh and hybrid *Populus* L. I~~.~~. *In situ* net photosynthesis, dark respiration and growth. New Phytologist. 124: 627-636.

~~567.~~564. Tonneijck, A. E. G. 1994. Effects ~~Of~~of Various Ozone Exposures ~~On~~on ~~The~~the Susceptibility ~~Of~~of Bean Leaves (Phaseolus Vulgaris L.) ~~T~~to Botrytis Cinerea. Environ. Pollut. 85: 59-65.

~~568.~~565. Tonneijck, A. E. G.; Leone, G. 1993. Changes ~~In~~in Susceptibility ~~Of~~of Bean Leaves (Phaseolus Vulgaris) To Sclerotinia Sclerotiorum ~~And~~and Botrytis Cinerea ~~By~~by Pre-Inoculative Ozone Exposures. Neth. J. Plant Pathol. 99: 313-322.

~~569.~~566. Tonneijck, A. E. G.; Van Dijk, C. J. 1998. Responses ~~Of~~of Bean (Phaseolus Vulgaris L. Cv. Pros) ~~T~~to Chronic Ozone Exposure ~~A~~at Two Levels ~~O~~of Atmospheric Ammonia. Environ. Pollut. 99: 45-51.

~~570.~~567. Topa, M.A., Vanderklein, D.W., Corbin, A. 2001. Effects of elevated ozone and low light on diurnal and seasonal carbon gain in sugar maple. Plant Cell and Environment. 24:663-677.

~~571.~~568. Torsethaugen G., Pell, E.J., Assmann, S.M.~~,~~ 1999. Ozone Inhibits Guard Cell K+ Channels Implicated ~~I~~in Stomatal Opening. Proceedings National Academy ~~Of~~of Sciences~~,~~. 96~~,~~: 13577-13582.

~~572.~~569. Troughton, A., 1955. The Application ~~Of~~of ~~The~~the Allometric Formula ~~To~~to ~~The~~the Study ~~Of~~of ~~The~~the Relationship ~~Between~~between Roots ~~And~~and Shoots. Agricultural Progress~~,~~. 30~~,~~: 59-65.

~~573.~~570. Turner, N.C., Rich, S., Waggoner, P.E.~~,~~ 1973. Removal ~~Of~~of Ozone ~~By~~by Soil. Journal ~~Of~~of Environmental Quality~~,~~. 2~~,~~: 259-264.

~~574.~~571. Tyree, M.T., Sperry, J.S. 1988. Do Woody Plants Operate Near ~~T~~the Point ~~O~~of Catastrophic Xylem Dysfunction Caused ~~B~~by Dynamic Water Stress? Plant Physiology. 88~~,~~: 574-580.

~~575.~~572. United States Environmental Protection Agency. 1978. Air Quality Criteria ~~F~~for Ozone And Other Photochemical Oxidants. Research Triangle Park, NC: Office ~~Of~~of Health ~~And~~and Environmental Assessment, Environmental Criteria ~~And~~and Assessment Office; Report No. EPA-600/8-78-004. Available From NTIS, Springfield, VA; PB80-124753.

~~576.~~573. United States Environmental Protection Agency. 1986. Air Quality Criteria ~~For~~for Ozone ~~And~~and Other Photochemical Oxidants. Research Triangle Park, NC: Office ~~Of~~of Health ~~And~~and Environmental Assessment, Environmental Criteria ~~And~~and Assessment Office; Report No. EPA-600/8-84-020af-Ef. 5 Volumes. Available From NTIS, Springfield, VA; PB87-142949.

~~577.~~574. United States Environmental Protection Agency. 1992. Summary Of Selected New Information ~~O~~on Effects ~~O~~of Ozone~~-~~ ~~O~~on Health ~~A~~and Vegetation: Supplement ~~T~~to 1986 Air Quality Criteria ~~F~~for Ozone ~~A~~and Other Photochemical Oxidants. Research Triangle Park, NC: Office ~~Of~~of Health ~~And~~and Environmental Assessment, Environmental Criteria ~~And~~and Assessment Office; Report No. EPA-600/8-88/105F. Available From NTIS, Springfield, VA; PB92-235670.

~~578.~~575. United States Environmental Protection Agency. 1996a. Air Quality Criteria ~~For~~for Ozone ~~And~~and Other Photochemical Oxidants. Research Triangle Park, NC: Office ~~Of~~of Research ~~And~~and Development; Reports No. EPA-600/AP-93/004af-Cf. 3 Volumes. Available From NTIS, Springfield, VA; PB96-185582, PB96-185590, PB96-185608, And Online At: Www.Epa.Gov/Ncea/Ozone.Htm.

~~579.~~576. United States Environmental Protection Agency. 1996b. A Review ~~O~~of National Ambient Air Quality Standards ~~F~~for Ozone: Assessment ~~O~~of Scientific ~~A~~and Technical Information. OAQPS ~~s~~Staff Paper. Research Triangle Park, NC: Office ~~Of~~of Air Quality Planning ~~And~~and Standards; Reports No. EPA-452/R-96/007. Available From NTIS, Springfield, VA; PB96-203435/XAB, And Online At Http://Epa.Gov/Ttn/Oarpg/T1sp.Html.

~~580.~~577. Unsworth, M.H., Heagle, A.S., Heck, W.W. 1984a. Gas exchange in open-top field chambers. I. Measurement and analysis of atmospheric resistances to gas exchange. Atmospheric Environment. 18:373-380.

~~581.~~578. Unsworth, M.H., Heagle, A.S., Heck, W.W. 1984b. Gas exchange in open-top field chambers. II. Resistances to ozone uptake by soybeans. Atmospheric Environment. 18:381-385.

~~582.~~579. Van Oijen, M., Ewert, F. 1999. The effects of climatic variation in Europe on the yield response of spring wheat cv. Minaret to elevated CO_2 and ~~ ozone~~O_3: an analysis of open-top chamber experiments by means of two crop growth simulation models. European Journal of Agronomy. 10:249-264.

~~583.~~580. Van Ooy DJ, Carroll JJ. 1995. The spatial variation of ozone climatology on the western slope of the Sierra Nevada. Atmos Environ. ~~1995;~~ 29~~(11)~~: 1,319-1,330.

~~584.~~581. Volin, J. C.; Reich, P. B.; Givnish, T. J. 1998. Elevated Carbon Dioxide Ameliorates ~~T~~the Effects ~~O~~of Ozone ~~O~~on Photosynthesis ~~A~~and Growth: Species Respond Similarly Regardless ~~O~~of Photosynthetic Pathway or Plant Functional Group. New Phytol. 138: 315-325.

~~585.~~582. Vorne, V.; Ojanpera, K.; De Temmerman, L.; Bindi, M.; Hogy, P.; Jones, M. B.; Lawson, T.; Persson, K. 2002. Effects ~~Of~~of Elevated Carbon Dioxide ~~And~~and Ozone ~~On~~on Potato Tuber Quality ~~In~~in ~~The~~the European

Multiple-Site Experiment 'CHIP-Project'. European Journal ~~Of~~of Agronomy. 17: 369-381.

~~586.~~583. Vozzo, S. F.; Miller, J. E.; Pursley, W. A.; Heagle, A. S. 1995. Effects ~~Of~~of Ozone ~~And~~and Water Deficit ~~On~~on Field-Grown Soybean: I. Leaf Gas Exchange. J. Environ. Qual. 24: 663-670.

~~587.~~584. Wallace RA, King JL, Sanders GP. 1981. Biology: The science of life. ~~Santa Monica:~~ Goodyear Publishing Co., Inc. Santa Monica, CA~~; 1981. 1,140 pp~~.

~~588.~~585. Warwick, K.R., Taylor, G., 1995. Contrasting Effects ~~O~~of Tropospheric Ozone ~~O~~on Five Native Herbs ~~W~~which Coexist ~~I~~in Calcareous Grassland. Global Change Biology~~,~~. 1~~,~~: 143-151.

~~589.~~586. Weber JA, Clark CS, Hogsett WE. 1993. Analysis of the relationships among ozone uptake, conductance, and photosynthesis in needles of *Pinus ponderosa*. Tree Physiol.~~ 1993;~~ 13: 157-172.

~~590.~~587. Weinstock, L.; Kender, W. J.; Musselman, R. C. 1982. Microclimate ~~Within~~within Open-Top Air Pollution Chambers ~~And~~and Its Relation ~~To~~to Grapevine Physiology. J. Am. Soc. Hortic. Sci. 107: 923-929.

~~591.~~588. Welfare, K.; Flowers, T. J.; Taylor, G.; Yeo, A. R. 1996. Additive and antagonistic effects of ozone and salinity on the growth, ion contents, and gas exchange of five varieties of rice (*Oryza sativa* L.). Environmental Pollution. 92: 257-266.

~~592.~~589. Wesely, M.L., Eastman, J.A., Cook, D.R., Hicks, B.B.~~,~~ 1978. Daytime Variations ~~Of~~of Ozone Eddy Fluxes ~~To~~to Maize. Boundary-Layer Meteorology. 15:~~,~~ 361-373.

~~593.~~590. Whitfield, C.P., Davison, A.W., Ashenden, T.W. 1998. The effects of nutrient limitation on the response of Plantago major to ozone. New Phytologist. 140: 219-230.

~~594.~~591. Whittaker, J. B. ~~(~~1994~~)~~. Interactions ~~Between~~between Insects ~~And~~and Air Pollutants. In: Alscher, R. G.; Wellburn, A. R., Eds. Plant Responses ~~To~~to ~~The~~the Gaseous Environment. Molecular, Metabolic ~~And~~and Physiological Aspects.~~ London, United Kingdom:~~ Chapman ~~And~~and Hall~~;~~. London, United Kingdom. P~~p~~gs. 365-384.

~~595.~~592. Wiese, C.B., Pell, E.J., 1997. Influence ~~O~~of Ozone ~~O~~on Transgenic Tobacco Plants Expressing Reduced Quantities ~~O~~of Rubisco. Plant, Cell ~~And~~and Environment~~,~~. 20~~,~~: 1283-1291.

~~596.~~593. Wilbourn, S., Davison, A.W., Ollerenshaw, J.H. 1995. The Use ~~Of An Unenclosed Field Fumigation System To Determine The~~of an Unenclosed Field Fumigation System to Determine the Effects Of ozone On ~~A~~a Grass-Clover Mixture. New Phytologist. 129, 23-32.

~~597.~~594. Wilkinson TG, Barnes RL. 1973. Effects of ozone on $^{14}CO_2$ fixation patterns in pine. Can J Bot.~~ 1973;~~ 51~~(9)~~: 1,573-1,578.

~~598.~~595. Williams WT, Williams JA. 1986. Effects of oxidant air pollution on needle health and annual-ring width in a ponderosa pine forest. Environ Conserv. ~~1986;~~ 13~~(3)~~: 229-234.

~~599.~~596. Wiltshire, J. J. J.; Wright, C. J.; Unsworth, M. H. 1992. A New Method ~~For~~for Exposing Mature Trees ~~To~~to Ozone Episodes. For. Ecol. Manage. 51: 115-120.

~~600.~~597. Wolfenden J, Wellburn AR. 1991. Effects of summer ozone on membrane lipid composition during subsequent frost hardening in Norway spruce [*Picea abies* (L.) Karst]. New Phytol ~~1991;~~. 118: 323-329.

~~601.~~598. Younglove, T.; Mccool, P. M.; Musselman, R. C.; Kahl, M. E. 1994. Growth-Stage Dependent Crop Yield Response ~~To~~to Ozone Exposure. Environmental Pollution. 86: 287-295.

~~602.~~599. Zelitch I. 1982. The close relationship between net photosynthesis and crop yield. Bioscience. ~~1982;~~ 32: 796-802.

~~603.~~600. Zhang, J., Davies, WJ. Changes in the concentration of ABA in xylem sap as a function of changing soil water status can account for change in ~~L~~leaf ~~C~~conductance ~~And~~and ~~G~~growth. Plant Cell ~~And~~and Environment. 13~~,~~:277-285.

~~604.~~601. Zheng, Y., Shimizu, H., Barnes, J.D., 2002. Limitations ~~To~~to CO_2 Assimilation ~~In~~in Ozone-Exposed Leaves ~~Of~~of Plantago Major. New Phytologist. 155~~,~~: 67-78.

~~605.~~602. Zheng, Y.; Lyons, T.; Barnes, J. 2000. Effects ~~Of~~of Ozone ~~On~~on ~~The~~the Production ~~And~~and Utilization ~~Of~~of Assimilates ~~I~~in Plantago Major. Environmental ~~And~~and Experimental Botany. 43: 171-180.

~~606.~~603. Zimmerman R, Oren R, Schulze E-D, Werk KS. 1988. Performance of two *Picea abies* (L.) Karst. stands at different stages of decline. II. Photosynthesis and leaf conductance. Oecologia. ~~1988;~~ 76: 513-518.

Chapter 9

~~607.~~604. Adams WC, Brookes KA, Schelegle ES. 1987. Effects of NO_2 alone and in combination with ~~ozone~~ O_3 on young men and women. J Appl Physiol 62:1698-704.

~~608.~~605. Adams WC, Savin WM, Christo AE. 1981. Detection of ozone toxicity during continuous exercise via the effective dose concept. J Appl Physiol 51:415-22.

~~609.~~606. Adams WC, Schelegle ES, Shaffrath JD. 1989. Oral and oronasal breathing during continuous exercise produce similar responses to ozone inhalation. Arch Environ Health 44:311-6.

~~610.~~607. Adams WC, Schelegle ES. 1983. Ozone and high ventilation effects on pulmonary function and endurance performance. J Appl Physiol 55:805-12.

~~611.~~608. Adams WC. 1986. Physiological responses of healthy human subjects consequent to inhalation of NO_2, ~~ozone~~ O_3 and NO_2 plus ozone during heavy, sustained exercise. Sacramento, CA: California Air Resources Board. Sacramento, CA: California Air Resources Board.

~~612.~~609. Adams WC. 2000a. Feasibility study of prolonged ozone inhalation exposure via face mask. Inhal Toxicol 12:299-313

~~613.~~610. Adams WC. 2000b. Ozone dose-response effects of varied equivalent minute ventilation rates. J Expo Anal Environ Epidemiol 10: 217-26.

~~614.~~611. Adams WC. 2002. Comparison of chamber and face-mask 6.6-hour exposures to ozone on pulmonary function and symptoms responses. Inhal Toxicol 14:745-64.

~~615.~~612. Adams WC. 2003a. Comparison of chamber and face mask 6.6-hour exposure to 0.08 ppm ozone via square-wave and triangular profiles on pulmonary responses. Inhal Toxicol 15:265-81.

~~616.~~613. Adams WC. 2003b. Relation of pulmonary responses induced by 6.6-hour exposures to 0.08 ppm ozone and 2-hour exposures to 0.30 ppm ozone via chamber and face-mask inhalation. Inhal Toxicol 15:745-59.

~~617.~~614. Adamson IY, Vincent R, Bjarnason SG. 1999. Cell injury and interstitial inflammation in rat lung after inhalation of ozone and urban particulates. Am J Respir Cell Mol Biol 20:1067-72.

~~618.~~615. American Thoracic Society. 1995. Standards for the diagnosis and care of patients with chronic obstructive pulmonary disease: definitions, epidemiology, pathophysiology, diagnosis, and staging. 152 :S78-S83.

~~619.~~616. Aris R, Christian D, Sheppard D, Balmes JR. 1991. The effects of sequential exposure to acidic fog and ozone on pulmonary function in exercising subjects. Am Rev Respir Dis 143:85-91.

~~620.~~617. Aris R, Christian D, Tager I, Ngo L, Finkbeiner WE, Balmes JR. 1993a. Effects of nitric acid gas alone or in combination with ozone on healthy volunteers. Am Rev Respir Dis 148:965-73.

~~621.~~618. Aris RM, Christian D, Hearne PQ, Kerr K, Finkbeiner WE, Balmes JR. 1993b. Ozone-induced airway inflammation in human subjects as determined by airway lavage and biopsy. Am Rev Respir Dis 148:1363-72.

~~622.~~619. Aris RM, Tager I, Christian D, Kelly T, Balmes JR. 1995.

Methacholine responsiveness is not associated with ~~ozone~~ O_3-induced decreases in FEV1. Chest 107:621-8.

~~623.~~620. Arito H, Uchiyama I, Arakawa H, Yokoyama E. 1990. Ozone-induced bradycardia and arrhythmia and their relation to sleep-wakefulness in rats. Toxicol Lett 52:169-78.

~~624.~~621. Arsalane K, Broeckaert F, Knoops B, Clippe A, Buchet JP, Bernard A. 1999. Increased serum and urinary concentrations of lung ~~c~~Clara cell protein in rats acutely exposed to ozone. Toxicol Appl Pharmacol 159:169-74.

~~625.~~622. Asplund PT, Ben-Jebria A, Rigas ML, Ultman JS. 1996. Longitudinal distribution of ozone absorption in the lung: effect of continuous inhalation exposure. Arch Environ Health 51:431-8.

~~626.~~623. Avissar NE, Reed CK, Cox C, Frampton MW, Finkelstein JN. 2000. Ozone, but not nitrogen dioxide, exposure decreases glutathione peroxidases in epithelial lining fluid of human lung. Am J Respir Crit Care Med 162:1342-7.

~~627.~~624. Avol EL, Linn WS, Shamoo DA, Spier CE, Valencia LM, Venet TG, Trim SC, Hackney JD. 1987. Short-term respiratory effects of photochemical oxidant exposure in exercising children. JAPCA 37:158-62.

~~628.~~625. Avol EL, Linn WS, Shamoo DA, Valencia LM, Anzar UT, Venet TG, Hackney JD. 1985. Respiratory effects of photochemical oxidant air pollution in exercising adolescents. Am Rev Respir Dis 132:619-22.

~~629.~~626. Avol EL, Linn WS, Venet TG, Shamoo DA, Hackney JD. 1984. Comparative respiratory effects of ozone and ambient oxidant pollution exposure during heavy exercise. J Air Pollut Control Assoc 34:804-9.

~~630.~~627. Avol EL, Navidi WC, Rappaport EB, Peters JM. 1998. Acute effects of ambient ozone on asthmatic, wheezy, and healthy children. Res Rep Health Eff Inst ~~:iii,~~Report #82. 1-18; discussion 19-30.

~~631.~~628. Ball BA, Folinsbee LJ, Peden DB, Kehrl H.~~OU~~R. 1996. Allergen bronchoprovocation of patients with mild allergic asthma after ozone exposure. J Allergy Clin Immunol 98:563-72.

~~632.~~629. Balmes JR, Aris RM, Chen LL, Scannell C, Tager IB, Finkbeiner W, Christian D, Kelly T, Hearne PQ, Ferrando R, Welch B. 1997. Effects of ozone on normal and potentially sensitive human subjects. Part I: Airway inflammation and responsiveness to ozone in normal and asthmatic subjects. Res Rep Health Eff Inst.~~:~~ 1-37; discussion 81-99.

~~633.~~630. Balmes JR, Chen LL, Scannell C, Tager I, Christian D, Hearne PQ, Kelly T, Aris RM. 1996. Ozone-induced decrements in FEV1 and FVC do not correlate with measures of inflammation. Am J Respir Crit Care Med 153:904-9.

~~634.~~631. Barr BC, Hyde DM, Plopper CG, Dungworth DL. 1988. Distal airway remodeling in rats chronically exposed to ozone. Am Rev Respir Dis 137:924-38.

~~635.~~632. Barr BC, Hyde DM, Plopper CG, Dungworth DL. 1990. A comparison of terminal airway remodeling in chronic daily versus episodic ozone exposure. Toxicol Appl Pharmacol 106:384-407.

~~636.~~633. Barry BE, Crapo JD. 1985. Application of morphometric methods to study diffuse and focal injury in the lung caused by toxic agents. Crit Rev Toxicol 14:1-32.

~~637.~~634. Barry BE, Mercer RR, Miller FJ, Crapo JD. 1988. Effects of inhalation of 0.25 ppm ozone on the terminal bronchioles of juvenile and adult rats. Exp Lung Res 14:225-45.

~~638.~~635. Barry BE, Miller FJ, Crapo JD. 1985. Effects of inhalation of 0.12 and 0.25 parts per million ozone on the proximal alveolar region of juvenile and adult rats. Lab Invest 53:692-704.

~~639.~~636. Bartlett D Jr, Faulkner CS 2nd, Cook K. 1974. Effect of chronic ozone exposure on lung elasticity in young rats. J Appl Physiol 37:92-6.

~~640.~~637. Bascom R, Naclerio RM, Fitzgerald TK, Kagey-Sobotka A, Proud D. 1990. Effect of ozone inhalation on the response to nasal challenge with antigen of allergic subjects. Am Rev Respir Dis 142:594-601.

~~641.~~638. Basha MA, Gross KB, Gwizdala CJ, Haidar AH, Popovich J Jr. 1994. Bronchoalveolar lavage neutrophilia in asthmatic and healthy volunteers after controlled exposure to ozone and filtered purified air. Chest 106:1757-65.

~~642.~~639. Bassett D, Elbon-Copp C, Otterbein S, Barraclough-Mitchell H, Delorme M, Yang H. 2001. Inflammatory cell availability affects ozone-induced lung damage. J Toxicol Environ Health A 64:547-65.

~~643.~~640. Bassett DJ, Elbon-Copp C, Ishii Y, Barraclough-Mitchell H, Yang H. 2000. Lung tissue neutrophil content as a determinant of ozone-induced injury. J Toxicol Environ Health A 60:513-30.

~~644.~~641. Bates DV, Bell GM, Burnham CD, Hazucha M, Mantha J, Pengelly LD, Silverman F. 1972. Short-term effects of ozone on the lung. J Appl Physiol 32:176-81.

~~645.~~642. Bayram H, Rusznak C, Khair OA, Sapsford RJ, Abdelaziz MM. 2002. Effect of ozone and nitrogen dioxide on the permeability of bronchial epithelial cell cultures of non-asthmatic and asthmatic subjects. Clin Exp Allergy 32:1285-92.

~~646.~~643. Beckett WS, McDonnell WF, Horstman DH, House DE. 1985. Role of the parasympathetic nervous system in acute lung response to ozone. J Appl Physiol 59:1879-85.

~~647.~~644. Bedi JF, Drechsler-Parks DM, Horvath SM. 1985. Duration of increased pulmonary function sensitivity to an initial ozone exposure. Am Ind Hyg Assoc J 46:731-4.

~~648.~~645. Bedi JF, Folinsbee LJ, Horvath SM, Ebenstein RS. 1979. Human exposure to sulfur dioxide and ozone: absence of a synergistic effect . Arch Environ Health 34:233-9.

~~649.~~646. Bedi JF, Horvath SM, Drechsler-Parks DM. 1988. Reproducibility of the pulmonary function response of older men and women to a 2-hour ozone exposure. JAPCA 38:1016-9.

~~650.~~647. Bedi JF, Horvath SM, Drechsler-Parks DM. 1989. Adaptation by older individuals repeatedly exposed to 0.45 parts per million ozone for two hours. JAPCA 39:194-9.

~~651.~~648. Bedi JF, Horvath SM, Folinsbee LJ. 1982. Human exposure to sulfur dioxide and ozone in a high temperature-humidity environment. Am Ind Hyg Assoc J 43:26-30.

~~652.~~649. Bell KA, Linn WS, Hazucha M, Hackney JD, Bates DV. 1977. Respiratory effects of exposure to ozone plus sulfur dioxide in Southern Californians and Eastern Canadians. Am Ind Hyg Assoc J 38:696-706.

~~653.~~650. Bergamaschi E, De Palma G, Mozzoni P, Vanni S, Vettori MV, Broeckaert F, et al. 2001. Polymorphism of quinone-metabolizing enzymes and susceptibility to ozone-induced acute effects. Am J Respir Crit Care Med 163(6):1426-31.

~~654.~~651. Berger WE. 2003. Overview of allergic rhinitis. Ann Allergy Asthma Immunol 90:7-12.

~~655.~~652. Bhalla DK, Gupta SK. 2000. Lung injury, inflammation, and inflammatory stimuli in rats exposed to ozone. J Toxicol Environ Health A 59:211-28.

~~656.~~653. Bhalla DK. 1999. Ozone-induced lung inflammation and mucosal barrier disruption: toxicology, mechanisms, and implications. J Toxicol Environ Health B Crit Rev 2:31-86.

~~657.~~654. Biagini RE, Moorman WJ, Lewis TR, Bernstein IL. 1986. Ozone enhancement of platinum asthma in a primate model. Am Rev Respir Dis 134:719-25.

~~658.~~655. Bignami G. 1996. Economical test methods for developmental neurobehavioral toxicity. Environ Health Perspect 104 Suppl 2:285-98.

~~659.~~656. Bignami G, Musi B, Dell'Omo G, Laviola G, Alleva E. 1994. Limited effects of ozone exposure during pregnancy on physical and neurobehavioral development of CD-1 mice. Toxicol Appl Pharmacol 129:264-71.

~~660.~~657. Blomberg A, Mudway IS, Nordenhall C, Hedenstrom H, Kelly FJ, Frew AJ, Holgate ST, Sandstrom T. 1999. Ozone-induced lung function decrements do not correlate with early airway inflammatory or antioxidant responses. Eur Respir J 13:1418-28.

~~661.~~658. Boatman ES, Frank R. 1974. Morphologic and ultrastructural changes in the lungs of animals during acute exposure to ozone. Chest 65:Suppl:9S-11S.

~~662.~~659. Boorman GA, Hailey R, Grumbein S, Chou BJ, Herbert RA, Goehl T, Mellick PW, Roycroft JH, Haseman JK, Sills R. 1994. Toxicology and carcinogenesis studies of ozone and ozone 4-(N- nitrosomethylamino)-1-(3-pyridyl)-1-butanone in Fischer-344/N rats. Toxicol Pathol 22:545-54.

~~663.~~660. Boorman GA, Schwartz LW, Dungworth DL. 1980. Pulmonary effects of prolonged ozone insult in rats. Morphometric evaluation of the central acinus. Lab Invest 43:108-15.

~~664.~~661. Bosson J, Stenfors N, Bucht A, Helleday R, Pourazar J, Holgate ST, Kelly FJ, Sandstrom T, Wilson S, Frew AJ, Blomberg A. 2003. Ozone-induced bronchial epithelial cytokine expression differs between healthy and asthmatic subjects. Clin Exp Allergy 33:777-82.

~~665.~~662. Bouthillier L, Vincent R, Goegan P, Adamson IY, Bjarnason S, Stewart M, Guenette J, Potvin M, Kumarathasan P. 1998. Acute effects of inhaled urban particles and ozone: lung morphology, macrophage activity, and plasma endothelin-1. Am J Pathol 153:1873-84.

~~666.~~663. Brook RD, Brook JR, Urch B, Vincent R, Rajagopalan S, Silverman F. 2002. Inhalation of fine particulate air pollution and ozone causes acute arterial vasoconstriction in healthy adults. Circulation 105:1534-6.

~~667.~~664. Brookes KA, Adams WC, Schelegle ES. 1989. O.35 ppm O_3~~ozone~~ exposure induces hyperresponsiveness on 24-h reexposure to 0.20 ppm ~~ozone~~ O_3. J Appl Physiol 66:2756-62.

~~668.~~665. Brummer MEG, Schwartz LW, McQuillen NK. 1977. A quantitative study of lung damage by scanning electron microscopy. Inflammatory cell response to high-ambient levels of ozone. Chicago, IL: IIT Research Institute. Chicago, IL: IIT Research Institute:513-8.

~~669.~~666. Bush ML, Asplund PT, Miles KA, Ben-Jebria A, Ultman JS. 1996. Longitudinal distribution of O_3 absorption in the lung: gender differences and intersubject variability. J Appl Physiol 81:1651-1657.

~~670.~~667. Calderon-Garciduenas L, Devlin RB, Miller FJ. 2000a. Respiratory tract pathology and cytokine imbalance in clinically healthy children chronically and sequentially exposed to air pollutants. Med Hypotheses 55:373-8.

~~671.~~668. Calderon-Garciduenas L, Mora-Tiscareno A, Chung CJ, Valencia G, Fordham LA, Garcia R, Osnaya N, Romero L, Acuna H, Villarreal-Calderon A, Devlin RB, Koren HS. 2000b. Exposure to air pollution is associated with lung hyperinflation in healthy children and adolescents in Southwest Mexico City: a pilot study. Inhal Toxicol 12:537-61.

~~672.~~669. California Air Resources Board. 1994. Review of the one-hour ambient air quality standard for sulfur dioxide. Staff Report. August.

~~673.~~670. California Department of Health Services. 1987. Recommendation for an Ambient Air Quality Standard for Ozone.

~~674.~~671. Castleman WL, Dungworth DL, Schwartz LW, Tyler WS. 1980. Acute respiratory bronchiolitis: an ultrastructural and autoradiographic study of epithelial cell injury and renewal in rhesus monkeys exposed to ozone. Am J Pathol 98:811-40.

~~675.~~672. Castleman WL, Tyler WS, Dungworth DL. 1977. Lesions in respiratory bronchioles and conducting airways of monkeys exposed to ambient levels of ozone. Exp Mol Pathol 26:384-400.

~~676.~~673. Catalano PJ, Chang LY, Harkema JR, Kaden DA, Last JA, Mellick PW, Parks WC, Pinkerton KE, Radhakrishnamurthy B, Ryan LM, et al. 1995a. Consequences of prolonged inhalation of ozone on F344/N rats: collaborative studies. Part XI: Integrative Summary. Res Rep Health Eff Inst: 1-54; discussion 55-85.

~~677.~~674. Catalano PJ, Rogus J, Ryan LM. 1995b. Consequences of prolonged inhalation of ozone on F344/N rats: collaborative studies. Part X: Robust composite scores based on median polish analysis. Res Rep Health Eff Inst: 1-57; discussion 59-64.

~~678.~~675. Centanni S, Di Marco F, Castagna F, Santus P, Guarnieri R, Allegra L. 2001. Atopy prevalence and spirometric performance in asymptomatic schoolchildren exposed to air pollution. Monaldi Arch Chest Dis 56:304-8.

~~679.~~676. Centers for Disease Control and Prevention National Center for Environmental Health. 2004. Asthma: Asthma's Impact on Children and Adolescents.

~~680.~~677. Chang LY, Huang Y, Stockstill BL, Graham JA, Grose EC, Menache MG, Miller FJ, Costa DL, Crapo JD. 1992. Epithelial injury and interstitial fibrosis in the proximal alveolar regions of rats chronically exposed to a simulated pattern of urban ambient ozone. Toxicol Appl Pharmacol 115:241-52.

~~681.~~678. Chang LY, Stockstill BL, Menache MG, Mercer RR, Crapo JD. 1995. Consequences of prolonged inhalation of ozone on F344/N rats: collaborative studies. Part VIII: Morphometric analysis of structural alterations in alveolar regions. Res Rep Health Eff Inst: 3-39; discussion 99-110.

~~682.~~679. Charpin D, Pascal L, Birnbaum J, Armengaud A, Sambuc R, Lanteaume A, Vervloet D. 1999. Gaseous air pollution and atopy. Clin Exp Allergy 29:1474-80.

~~683.~~680. Cheek JM, Buckpitt AR, Li C, Tarkington BK, Plopper CG. 1994. Ozone injury to alveolar epithelium in vitro does not reflect loss of antioxidant defenses. Toxicol Appl Pharmacol 125:59-69.

~~684.~~681. Cheek JM, McDonald RJ, Rapalyea L, Tarkington BK, Hyde DM. 1995. Neutrophils enhance removal of ozone-injured alveolar epithelial cells in vitro. Am J Physiol 269:L527-35.

~~685.~~682. Chen LC, Miller PD, Lam HF, Guty J, Amdur MO. 1991. Sulfuric acid-layered ultrafine particles potentiate ozone-induced airway injury. J Toxicol Environ Health 34:337-52.

~~686.~~683. Chen LL, Tager IB, Peden DB, Christian DL, Ferrando RE, Welch BS, et al. 2004. Effect of ozone exposure on airway responses to inhaled allergen in asthmatic subjects. Chest 125:2328-35.

~~687.~~684. Cheng PW, Boat TF, Shaikh S, Wang OL, Hu PC, Costa DL. 1995. Differential effects of ozone on lung epithelial lining fluid volume and protein content. Exp Lung Res 21:351-65.

~~688.~~685. Chow CK, Plopper CG, Chiu M, Dungworth DL. 1981. Dietary vitamin E and pulmonary biochemical and morphological alterations of rats exposed to 0.1 ppm ozone. 24. 24:315-24.

~~689.~~686. Christian DL, Chen LL, Scannell CH, Ferrando RE, Welch BS, Balmes JR. 1998. Ozone-induced inflammation is attenuated with multiday exposure. Am J Respir Crit Care Med 158:532-7.

~~690.~~687. Coffey MJ, Wheeler CS, Gross KB, Eschenbacher WL, Sporn PH, Peters-Golden M. 1996. Increased 5-lipoxygenase metabolism in the lungs of human subjects exposed to ozone. Toxicology 114:187-97.

~~691.~~688. Cohen MD, Sisco M, Baker K, Li Y, Lawrence D, van Loveren H, Zelikoff JT, Schlesinger RB. 2002. Effects of inhaled ozone on pulmonary immune cells critical to antibacterial responses in situ. Inhal Toxicol 14:599-619.

~~692.~~689. Cohen MD, Sisco M, Li Y, Zelikoff JT, Schlesinger RB. 2001. Ozone-induced modulation of cell-mediated immune responses in the lungs. Toxicol Appl Pharmacol 171:71-84.

~~693.~~690. Cohen MD, Zelikoff JT, Chen L-C, Schlesinger RB. 1997. Pulmonary retention and distribution of inhaled chromium: effects of particle solubility and coexposure to ozone. 9. 9:843-65.

~~694.~~691. Coleridge HM, Coleridge JC, Baker DG, Ginzel KH, Morrison MA. 1978. Comparison of the effects of histamine and prostaglandin on afferent C-fiber endings and irritant receptors in the intrapulmonary airways. Adv Exp Med Biol 99:291-305.

~~695.~~692. Coleridge HM, Coleridge JC, Ginzel KH, Baker DG, Banzett RB, Morrison MA. 1976. Stimulation of 'irritant' receptors and afferent C-fibers in the lungs by prostaglandins. Nature 264:451-3.

~~696.~~693. Coleridge JC, Coleridge HM, Schelegle ES, Green JF. 1993. Acute inhalation of ozone stimulates bronchial C-fibers and rapidly adapting receptors in dogs. J Appl Physiol 74:2345-52.

~~697.~~694. Corradi M, Alinovi R, Goldoni M, Vettori M, Folesani G, Mozzoni P, et al. (2002 Aug). Biomarkers of oxidative stress after controlled human exposure to ozone. Toxicol Lett 134(1-3):219-25.

~~698.~~695. Costa DL, Hatch GE, Highfill J, Stevens MA, Tepper JS. 1988. Pulmonary function studies in the rat addressing concentration versus time relationships of ozone (~~ozone)~~O_3). US Environmental Protection Agency, Health Effects Research Laboratory. US Environmental Protection Agency, Health Effects Research Laboratory (Research Triangle Park, NC).

~~699.~~696. Costa DL, Hatch GE, Highfill J, Stevens MA, Tepper JS. 1989. Pulmonary function studies in the rat addressing concentration versus time relationships of ozone. ~~Pittsburgh, PA: Air & Waste Management Association. Pittsburgh, PA: Air & Waste Management Association:120-6.~~In: Schneider, T, Lee SD, Wolters GJR, Grant LD, eds. Atmospheric ozone research and its policy implications. Proceedings of the Third US – Dutch International Symposium. Nijmegen, The Netherlands, May 9-13, 1988. Elsevier. Amsterdam.

~~700.~~697. Costa DL, Tepper JS. 1988. Repeated exposure to ozone (~~ozone~~O_3) and chronic lung disease: recent animal data. Presented at the 81st Annual Meeting of the Air Pollution Control Association, June 1988. Dallas, Texas. Paper no. 88-122.3.

~~701.~~698. Costello RW, Jacoby DB, Gleich GJ, Fryer AD. 2000. Eosinophils and airway nerves in asthma. Histol Histopathol 15:861-8.

~~702.~~699. Criqui GI, Solomon C, Welch BS, Ferrando RE, Boushey HA, Balmes JR. 2000. Effects of azithromycin on ozone-induced airway neutrophilia and cytokine release. Eur Respir J 15:856-62.

~~703.~~700. Currie WD, van Schaik SM, Vargas I, Enhorning G. 1998. Ozone affects breathing and pulmonary surfactant function in mice. Toxicology 125 :21-30.

~~704.~~701. D'Amato G, Liccardi G, D'Amato M, Cazzola M. 2002. Respiratory allergic diseases induced by outdoor air pollution in urban areas. Monaldi Arch Chest Dis 57:161-3.

~~705.~~702. D'Amato G, Liccardi G. 1998. Outdoor environmental injury of the airways and development of allergic respiratory diseases. Pulm Pharmacol Ther 11:369-74.

~~706.~~703. Damji KS, Sherwin RP. 1989. The effect of ozone and simulated high altitude on murine lung elastin: quantitation by image analysis. Toxicol Ind Health 5:995-1003.

~~707.~~704. David GL, Romieu I, Sienra-Monge JJ, Collins WJ, Ramirez-Aguilar M, del Rio-Navarro BE, et al. (2003 Nov). Nicotinamide adenine dinucleotide (phosphate) reduced:quinone oxidoreductase and glutathione S-transferase M1 polymorphisms and childhood asthma. Am J Respir Crit Care Med 168(10):1199-204.

~~708.~~705. Dell'Omo G, Fiore M, Petruzzi S, Alleva E, Bignami G. 1995a. Neurobehavioral development of CD-1 mice after combined gestational and postnatal exposure to ozone. Arch Toxicol 69:608-16.

~~709.~~706. Dell'Omo G, Wolfer D, Alleva E, Lipp HP. 1995b. Developmental exposure to ozone induces subtle changes in swimming navigation of adult mice. Toxicol Lett 81:91-9.

~~710.~~707. DeMore WB, Romanovsky JC, Feldstein M, Hamming WJ, Mueller PK. 1976 Interagency comparison of iodometric methods for ozone determination. Calibration in Air Monitoring. Vol. ASTM STP 598. American Society for Testing and Materials, p. 131-143.

~~711.~~708. Depuydt PO, Lambrecht BN, Joos GF, Pauwels RA. 2002. Effect of ozone exposure on allergic sensitization and airway inflammation induced by dendritic cells. Clin Exp Allergy 32:391-6.

~~712.~~709. Devlin RB, Folinsbee LJ, Biscardi F, Hatch G, Becker S, Madden MC, Robbins M, Koren HS. 1997. Inflammation and cell damage induced by repeated exposure of humans to ozone~~-~~. ~~9~~ ~~.~~Inhal Tox 9:211-35.

~~713.~~710. Devlin RB, Koren HS. 1990. The use of quantitative two-dimensional gel electrophoresis to analyze changes in alveolar macrophage proteins in humans exposed to ozone. Am J Respir Cell Mol Biol 2:281-8.

~~714.~~711. Devlin RB, McDonnell WF, Becker S, Madden MC, McGee MP, Perez R, Hatch G, House DE, Koren HS. 1996. Time-dependent changes of inflammatory mediators in the lungs of humans exposed to 0.4 ppm ozone for 2 hour: a comparison of mediators found in bronchoalveolar lavage fluid 1 and 18-hour after exposure. Toxicol Appl Pharmacol 138:176-85.

~~715.~~712. Devlin RB, McDonnell WF, Mann R, Becker S, House DE, Schreinemachers D, Koren HS. 1991. Exposure of humans to ambient levels of ozone for 6.6 hours causes cellular and biochemical changes in the lung. Am J Respir Cell Mol Biol 4:72-81.

~~716.~~713. Devlin RB, McKinnon KP, Noah T, Becker S, Koren HS. 1994. Ozone-induced release of cytokines and fibronectin by alveolar macrophages and airway epithelial cells. Am J Physiol 266:L612-9 .

~~717.~~714. Dimeo MJ, Glenn MG, Holtzman MJ, Sheller JR, Nadel JA, Boushey HA. 1981. Threshold concentration of ozone causing an increase in bronchial reactivity in humans and adaptation with repeated exposures. Am Rev Respir Dis 124:245-8.

~~718.~~715. Dormans JA, Rombout PJ, van Loveren H. 1990. Surface morphology and morphometry of rat alveolar macrophages after ozone exposure. J Toxicol Environ Health 31:53-70.

~~719.~~716. Dormans JA, van Bree L, Boere AJ, Marra M, Rombout PJ. 1989. Study of the effects of ozone in emphysematous rats. J Toxicol Environ Health 26:1-18.

~~720.~~717. Dormans JA, van Bree L, Boere AJ, Marra M, Rombout PJ. 1999. Interspecies differences in time course of pulmonary toxicity following repeated exposure to ozone. Inhal Toxicol 11:309-29.

~~721.~~718. Dormans JAMA, Boere AJF, van Loveren H, Rombout PJA, Marra M, van Bree L 1996. Age-related toxicity in rat lungs following acute and repeated ozone exposure. Inhal Toxicol 8:903-25.

~~722.~~719. Drechsler-Parks DM, Bedi JF, Horvath SM. 1984. Interaction of peroxyacetyl nitrate and ozone on pulmonary functions. Am Rev Respir Dis 130:1033-7.

~~723.~~720. Drechsler-Parks DM, Bedi JF, Horvath SM. 1987a. Pulmonary function responses of older men and women to ozone exposure. Exp Gerontol 22:91-101.

~~724.~~721. Drechsler-Parks DM, Bedi JF, Horvath SM. 1987b. Pulmonary function desensitization on repeated exposures to the combination of peroxyacetyl nitrate and ozone. JAPCA 37:1199-201.

~~725.~~722. Drechsler-Parks DM, Bedi JF, Horvath SM. 1989. Pulmonary function responses of young and older adults to mixtures of ~~ozone~~ O_3, NO_2 and PAN~~-~~. Toxicol Ind Health 5:505-17.

~~726.~~723. Drechsler-Parks DM, Horvath SM, Bedi JF. 1990. The "effective dose" concept in older adults exposed to ozone. Exp Gerontol 25:107-15.

~~727.~~724. Drechsler-Parks DM. 1987. Effect of nitrogen dioxide, ozone, and peroxyacetyl nitrate on metabolic and pulmonary function. Res Rep Health Eff Inst :1-37.

~~728.~~725. Driscoll KE, Vollmuth TA, Schlesinger RB. 1987. Acute and subchronic ozone inhalation in the rabbit: response of alveolar macrophages~~-~~. J Toxicol Environ Health 21:27-43.

~~729.~~726. Dungworth DL, Castleman WL, Chow CK, Mellick PW, Mustafa MG, Tarkington B, Tyler WS. 1975. Effect of ambient levels of ozone on monkeys. Fed Proc 34:1670-4.

~~730.~~727. Dye JA, Madden MC, Richards JH, Lehmann JR, Devlin RB, Costa DL. 1999. Ozone effects on airway responsiveness, lung injury, and inflammation. Comparative rat strain and in vivo/in vitro investigations. Inhal Toxicol 11:1015-40.

~~731.~~728. Dziedzic D, White HJ. 1986. Thymus and pulmonary lymph node response to acute and subchronic ozone inhalation in the mouse. Environ Res 41~~-~~:598-609.

~~732.~~729. Elsayed NM, Mustafa MG, Postlethwait EM. 1982. Age-dependent pulmonary response of rats to ozone exposure. J Tox Environ Health 9:835-848.

~~733.~~730. Emmons K, Foster WM. 1991. Smoking cessation and acute airway response to ozone. Arch Environ Health 46:288-95.

~~734.~~731. Eschenbacher WL, Ying RL, Kreit JW, Gross KB. 1989. Ozone-induced lung function changes in normal and asthmatic subjects and the effect of indomethacin. In: Schneider T, Lee SD, Wolters GJR, Grant, LD, eds. Atmospheric ozone research and its policy implications: proceedings of the 3rd US-Dutch international symposium, May 1988, Nijmegen, The Netherlands. Amsterdam, The Netherlands: Elsevier Science Publishers: 493-9.

~~735.~~732. Eustis SL, Schwartz LW, Kosch PC, Dungworth DL . 1981. Chronic bronchiolitis in nonhuman primates after prolonged ozone exposure. Am J Pathol 105:121-37.

~~736.~~733. Evans MJ, Fanucchi MV, Baker GL, Van Winkle LS, Pantle LM, Nishio SJ, Schelegle ES, Gershwin LJ, Miller LA, Hyde DM, Sannes PL, Plopper CG. 2003. Atypical development of the tracheal basement membrane zone of infant rhesus monkeys exposed to ozone and allergen. Am J Physiol Lung Cell Mol Physiol 285:L931-9.

~~737.~~734. Evans MJ, Johnson LV, Stephens RJ, Freeman G. 1976. Renewal of the terminal bronchiolar epithelium in the rat following exposure to NO_2 or ~~ozone~~ O_3. Lab Invest 35:246-57.

~~738.~~735. Fahy JV, Wong HH, Liu JT, Boushey HA. 1995. Analysis of induced sputum after air and ozone exposures in healthy subjects. Environ Res 70 :77-83.

~~739.~~736. Fakhrzadeh L, Laskin JD, Laskin DL. 2002. Deficiency in inducible nitric oxide synthase protects mice from ozone-induced lung inflammation and tissue injury. Am J Respir Cell Mol Biol 26:413-9.

~~740.~~737. Farrell BP, Kerr HD, Kulle TJ, Sauder LR, Young JL. 1979. Adaptation in human subjects to the effects of inhaled ozone after repeated exposure. Am Rev Respir Dis 119:725-30.

~~741.~~738. Fernandes AL, Molfino NA, McClean PA, Silverman F, Tarlo S, Raizenne M, Slutsky AS, Zamel N. 1994. The effect of pre-exposure to 0.12 ppm of ozone on exercise-induced asthma. Chest 106:1077-82.

~~742.~~739. Folinsbee LJ, Bedi JF, Horvath SM. 1980. Respiratory responses in humans repeatedly exposed to low concentrations of ozone. Am Rev Respir Dis 121:431-9.

~~743.~~740. Folinsbee LJ, Bedi JF, Horvath SM. 1981. Combined effects of ozone and nitrogen dioxide on respiratory function in man. Am Ind Hyg Assoc J 42:534-41.

~~744.~~741. Folinsbee LJ, Bedi JF, Horvath SM. 1984. Pulmonary function changes after 1 h continuous heavy exercise in 0.21 ppm ozone. J Appl Physiol 57:984-8.

~~745.~~742. Folinsbee LJ, Bedi JF, Horvath SM. 1985. Pulmonary response to threshold levels of sulfur dioxide (1.0 ppm) and ozone (0.3 ppm). J Appl Physiol 58:1783-7.

~~746.~~743. Folinsbee LJ, Drinkwater BL, Bedi JF, Horvath SM. 1978a. The influence of exercise on the pulmonary function changes due to exposure to low concentrations of ozone. New York, NY: Academic Press. New York, NY: Academic Press: 125-45.

~~747.~~744. Folinsbee LJ, Hazucha MJ. 2000. Time course of response to ozone exposure in healthy adult females. Inhal Toxicol 12:151-67.

~~748.~~745. Folinsbee LJ, Horstman DH, Kehrl HOUR, Harder S, Abdul-Salaam S, Ives PJ. 1994. Respiratory responses to repeated prolonged exposure to 0.12 ppm ozone. Am J Respir Crit Care Med 149:98-105.

~~749.~~746. Folinsbee LJ, Horstman DH, Kehrl HOUR, McDonnell WF, Gerrity TR, Seal. E. , Larson R, Hazucha MJ, Abdul-Salaam S, Faucette B, Ives PJ. 1991. Effects of single and repeated prolonged low-level ozone exposure in man. Presented at the annual meeting of the Society for Occupational and Environmental Health, March, Washington, DC.

~~750.~~747. Folinsbee LJ, Horstman DH, Vorona RD, Prince JM, Berry M. 1986. Determinants of endurance performance during ozone inhalation. 30th International Union of Physiological Sciences Congress, Vancouver, BC, Canada. 16. 16:176.

~~751.~~748. Folinsbee LJ, Horvath SM, Bedi JF, Delehunt JC . 1978b. Effect of 0.62 ppm NO_2 on cardiopulmonary function in young male nonsmokers. Environ Res 15:199-205.

~~752.~~749. Folinsbee LJ, Horvath SM, Raven PB, Bedi JF, Morton AR, Drinkwater BL, Bolduan NW, Gliner JA. 1977. Influence of exercise and heat stress on pulmonary function during ozone exposure. J Appl Physiol 43:409-13.

~~753.~~750. Folinsbee LJ, Horvath SM. 1986. Persistence of the acute effects of ozone exposure. Aviat Space Environ Med 57:1136-43.

~~754.~~751. Folinsbee LJ, McDonnell WF, Horstman DH. 1988. Pulmonary function and symptom responses after 6.6-hour exposure to 0.12 ppm ozone with moderate exercise. JAPCA 38:28-35.

~~755.~~752. Folinsbee LJ, Silverman F, Shephard RJ. 1975. Exercise responses following ozone exposure. J Appl Physiol 38:996-1001.

~~756.~~753. Folinsbee LJ. 1989. Human health effects of exposure to airborne acid. Environ Health Perspect 79:195-9.

~~757.~~754. Folinsbee LJ. 1993. Human health effects of air pollution. Environ Health Perspect 100:45-56.

~~758.~~755. Forster J, Kuehr J. 2000. The role of ozone. Pediatr Allergy Immunol 11 Suppl 13:23-5.

~~759.~~756. Foster WM, Brown RH, Macri K, Mitchell CS. 2000. Bronchial reactivity of healthy subjects: 18-20 h postexposure to ozone. J Appl Physiol 89:1804-10.

~~760.~~757. Foster WM, Stetkiewicz PT. 1996. Regional clearance of solute from the respiratory epithelia: 18-20 h postexposure to ozone. J Appl Physiol 81:1143-9.

~~761.~~758. Fouke JM, DeLemos RA, Dunn MJ, McFadden ER Jr. 1990. Effects of ozone on cyclooxygenase metabolites in the baboon tracheobronchial tree. J Appl Physiol 69:245-50.

~~762.~~759. Fouke JM, Delemos RA, McFadden ER Jr. 1988. Airway response to ultra short-term exposure to ozone. Am Rev Respir Dis 137:326-30.

~~763.~~760. Fouke JM, Wolin AD, McFadden ER Jr. 1991. Effects of ozone on lung mechanics and cyclooxygenase metabolites in dogs. Prostaglandins 42:343-53.

~~764.~~761. Fox SD, Adams WC, Brookes KA, Lasley BL. 1993. Enhanced response to ozone exposure during the follicular phase of the menstrual cycle. Environ Health Perspect 101:242-4.

~~765.~~762. Foxcroft WJ, Adams WC. 1986. Effects of ozone exposure on four consecutive days on work performance and V_{O2max}. J Appl Physiol 61:960-6.

~~766.~~763. Frampton MW, Balmes JR, Cox C, Krein PM, Speers DM, Tsai Y, Utell MJ. 1997a. Effects of ozone on normal and potentially sensitive human subjects. Part III: Mediators of inflammation in bronchoalveolar lavage fluid from nonsmokers, smokers, and asthmatic subjects exposed to ozone: a collaborative study. Res Rep Health Eff Inst :73-9; discussion 81-99.

~~767.~~764. Frampton MW, Morrow PE, Cox C, Levy PC, Condemi JJ, Speers D, Gibb FR, Utell MJ. 1995. Sulfuric acid aerosol followed by ozone exposure in healthy and asthmatic subjects. Environ Res 69:1-14.

~~768.~~765. Frampton MW, Morrow PE, Torres A, Voter KZ, Whitin JC, Cox C, Speers DM, Tsai Y, Utell MJ. 1997b. Effects of ozone on normal and potentially sensitive human subjects. Part II: Airway inflammation and responsiveness to ozone in nonsmokers and smokers. Res Rep Health Eff Inst :39-72; discussion 81-99.

~~769.~~766. Frampton MW, Pryor WA, Cueto R, Cox C, Morrow PE, Utell MJ. 1999. Ozone exposure increases aldehydes in epithelial lining fluid in human lung. Am J Respir Crit Care Med 159:1134-7.

~~770.~~767. Frank R, Liu MC, Spannhake EW, Mlynarek S, Macri K, Weinmann GG. 2001. Repetitive ozone exposure of young adults: evidence of persistent small airway dysfunction. Am J Respir Crit Care Med 164:1253-60.

~~771.~~768. Freed AN, Cueto R, Pryor WA. 1999. Antioxidant transport modulates peripheral airway reactivity and inflammation during ozone exposure . J Appl Physiol 87:1595-603.

~~772.~~769. Freeman G, Juhos LT, Furiosi NJ, Mussenden R, Stephens RJ, Evans MJ. 1974. Pathology of pulmonary disease from exposure to interdependent ambient gases (nitrogen dioxide and ozone). Arch Environ Health 29:203-10.

~~773.~~770. Freeman G, Stephens RJ, Coffin DL, Stara JF. 1973. Changes in dogs' lung after long-term exposure to ozone: light and electron microscopy. Arch Environ Health 26:209-16.

~~774.~~771. Frischer T, Studnicka M, Gartner C, Tauber E, Horak F, Veiter A, Spengler J, Kuhr J, Urbanek R. 1999. Lung function growth and ambient ozone: a three-year population study in school children. Am J Respir Crit Care Med 160:390-6.

~~775.~~772. Fu J, Chen P, Xiang X. 2002. [Eotaxin in induced sputum in patients with asthma and chronic bronchitis: relationship with airway inflammation]. Zhonghua Jie He He Hu Xi Za Zhi 25:29-32.

~~776.~~773. Fujinaka LE, Hyde DM, Plopper CG, Tyler WS, Dungworth DL, Lollini LO. 1985. Respiratory bronchiolitis following long-term ozone exposure in bonnet monkeys: a morphometric study. Exp Lung Res 8:167-90.

~~777.~~774. Galbo H. 1983. Hormonal and metabolic adaptation to exercise. New York, NY: Thieme and Straton.

~~778.~~775. Galizia A, Kinney PL. 1999. Long-term residence in areas of high ozone: associations with respiratory health in a nationwide sample of nonsmoking young adults. Environ Health Perspect 107:675-9.

~~779.~~776. Gauderman WJ, Gilliland GF, Vora H, Avol E, Stram D, McConnell R, Thomas D, Lurmann F, Margolis HG, Rappaport EB, Berhane K, Peters JM. 2002. Association between air pollution and lung function growth in southern California children: results from a second cohort. Am J Respir Crit Care Med 166:76-84.

~~780.~~777. Gauvreau GM, Watson RM, O'Byrne PM. 1999. Kinetics of allergen-induced airway eosinophilic cytokine production and airway inflammation. Am J Respir Crit Care Med 160:640-7.

~~781.~~778. Gent JF, Triche EW, Holford TR, Belanger K, Bracken MB, Beckett WS, Leaderer BP. 2003. Association of low-level ozone and fine particles with respiratory symptoms in children with asthma. JAMA 290:1859-67.

~~782.~~779. Gerrity TR, McDonnell WF, House DE. 1994. The relationship between delivered ozone dose and functional responses in humans. Toxicol Appl Pharmacol 124:275-83.

~~783.~~780. Gerrity TR, Weaver RA, Berntsen J, House DE, O'Neil JJ. 1988. Extrathoracic and intrathoracic removal of ~~ozone~~ O_3 in tidal-breathing humans. J Appl Physiol 65:393-400.

~~784.~~781. Gerrity TR. 1995. Regional deposition of gases and particles in the lung: implications for mixtures. Toxicology 105:327-34.

~~785.~~782. Gershwin LJ, Osebold JW, Zee YC. 1981. Immunoglobulin E-containing cells in mouse lung following allergen inhalation and ozone exposure. Int Arch Allergy Appl Immunol 65:266-77.

~~786.~~Gertner A, Bromberger-Barnea B, Traystman R, Berzon D, Menkes H. 1983a. Responses of the lung periphery to ozone and histamine. J Appl Physiol 54:640-6.

783.

784. Gertner A, Bromberger-Barnea B, Traystman R, Menkes H. 1983b. Effects of ozone on peripheral lung reactivity. J Appl Physiol 55:777-84.

~~788.~~785. Gibbons SI, Adams WC. 1984. Combined effects of ozone exposure and ambient heat on exercising females. J Appl Physiol 57:450-6.

~~789.~~786. Gilmour MI, Hmieleski RR, Stafford EA, Jakab GJ. 1991. Suppression and recovery of the alveolar macrophage phagocytic system during continuous exposure to 0.5 ppm ozone. Exp Lung Res 17:547-58.

~~790.~~787. Gilmour MI, Park P, Doerfler D, Selgrade MK. 1993. Factors that influence the suppression of pulmonary antibacterial defenses in mice exposed to ozone. Exp Lung Res 19:299-314.

~~791.~~788. Gilmour MI, Selgrade MK. 1993. A comparison of the pulmonary defenses against streptococcal infection in rats and mice following ~~ozone~~ O_3 exposure: differences in disease susceptibility and neutrophil recruitment. Toxicol Appl Pharmacol 123:211-8.

~~792.~~789. Gilmour MI. 1995. Interaction of air pollutants and pulmonary allergic responses in experimental animals. Toxicology 105:335-42.

~~793.~~790. Gliner JA, Horvath SM, Folinsbee LJ. 1983. Preexposure to low ozone concentrations does not diminish the pulmonary function response on exposure to higher ozone concentrations. Am Rev Respir Dis 127:51-5.

~~794.~~791. Golden JA, Nadel JA, Boushey HA. 1978. Bronchial hyperirritability in healthy subjects after exposure to ozone. Am Rev Respir Dis 118:287-94.

~~795.~~792. Gong H Jr, Bedi JF, Horvath SM. 1988. Inhaled albuterol does not protect against ozone toxicity in nonasthmatic athletes. Arch Environ Health 43:46-53.

~~796.~~793. Gong H Jr, Bradley PW, Simmons MS, Tashkin DP. 1986. Impaired exercise performance and pulmonary function in elite cyclists during low-level ozone exposure in a hot environment. Am Rev Respir Dis 134:726-33.

~~797.~~794. Gong H Jr, McManus MS, Linn WS. 1997a. Attenuated response to repeated daily ozone exposures in asthmatic subjects. Arch Environ Health 52:34-41.

~~798.~~795. Gong H Jr, Shamoo DA, Anderson KR, Linn WS. 1997b. Responses of older men with and without chronic obstructive pulmonary disease to prolonged ozone exposure. Arch Environ Health 52:18-25~~-~~.

~~799.~~796. Gong H Jr, Wong R, Sarma RJ, Linn WS, Sullivan ED, Shamoo DA, Anderson KR, Prasad SB. 1998 . Cardiovascular effects of ozone exposure in human volunteers. Am J Respir Crit Care Med 158:538-46.

~~800.~~797. Goodman JW, Peter-Fizaine FE, Shinpock SG, Hall EA, Fahmie DJ. 1989. Immunologic and hematologic consequences in mice of exposure to ozone. J Environ Pathol Toxicol Oncol 9:243-52.

~~801.~~798. Gordon RE, Park E, Laskin D, Schuller-Levis GB~~-~~. 1998. Taurine protects rat bronchioles from acute ozone exposure: a freeze fracture and electron microscopic study. Exp Lung Res 24:659-74~~-~~.

~~802.~~799. Gould HJ, Sutton BJ, Beavil AJ, Beavil RL, McCloskey N, Coker HA, Fear D, Smurthwaite L. 2003. The biology of IGE and the basis of allergic disease. Annu Rev Immunol 21:579-628.

~~803.~~800. Graham D, Henderson F, House D. 1988. Neutrophil influx measured in nasal lavages of humans exposed to ozone. Arch Environ Health 43:228-33.

~~804.~~801. Graham DE, Koren HS. 1990. Biomarkers of inflammation in ozone-exposed humans. Comparison of the nasal and bronchoalveolar lavage. Am Rev Respir Dis 142:152-6.

~~805.~~802. Graham JA, Gardner DE, Blommer EJ, House DE, Menache MG, Miller FJ. 1987. Influence of exposure patterns of nitrogen dioxide and modifications by ozone on susceptibility to bacterial infectious disease in mice. J Toxicol Environ Health 21:113-25.

~~806.~~803. Green RH, Brightling CE, McKenna S, Hargadon B, Parker D, Bradding P, Wardlaw AJ, Pavord ID. 2002. Asthma exacerbations and sputum eosinophil counts: a randomised controlled trial. Lancet 360:1715-21.

~~807.~~804. Grievink L, van't Veer JSM, Brunekreef B. 1998. Acute effects of ozone on pulmoary function of cyclists receiving antioxidant supplements. Occup Environ Med 55:13-17.

~~808.~~805. Grose EC, Stevens MA, Hatch GE, Jaskot RH, Selgrade MJK, Stead AG, et al. 1989 The impact of a 12-month exposure to a diurnal pattern of ozone on pulmonary function, antioxidant biochemistry and immunology. In: Schneider T, Lee SD, Wolters GJR, Grant, LD, eds. Atmospheric ozone research and its policy implications: proceedings of the 3rd US-Dutch international symposium May 1988, Nijmegen. Amsterdam, The Netherlands: Elsevier Science Publishers, p. 535-543.

~~809.~~806. Gross KB, Sargent NE. 1992. Increases in bronchial hyperresponsiveness induced by ozone and the effects of selected non-steroidal anti-inflammatory agents. 145. 145:A97.

~~810.~~807. Gross KB, White HJ. 1986. Pulmonary functional and morphological changes induced by a 4-week exposure to 0.7 ppm ozone followed by a 9-week recovery period. J Toxicol Environ Health 17:143-57.

~~811.~~808. Gross KB, White HJ. 1987. Functional and pathologic consequences of a 52-week exposure to 0.5 PPM ozone followed by a clean air recovery period. Lung 165:283-95.

~~812.~~809. Gunnison AF, Weideman PA, Sobo M, Koenig KL, Chen LC (1992 Apr). Age-dependence of responses to acute ozone exposure in rats. Fundam Appl Toxicol 18(3):360-9.

~~813.~~810. Guyton AC, Hall JE 1996. Textbook of Medical Physiology. Philadelphia, PA : WB Saunders Company.

~~814.~~811. Hacker AD, Mustafa MG, Ospital JJ, Elsayed NM, Lee SD. 1986. Relationship of age to rat lung collagen synthesis in response to ozone exposure. Age 9:1-5.

~~815.~~812. Hackney JD, Linn WS, Avol EL. 1989. Acid fog: effects on respiratory function and symptoms in healthy and asthmatic volunteers. Environ Health Perspect 79:159-62.

~~816.~~813. Hackney JD, Linn WS, Buckley RD, Hislop HJ. 1976. Studies in adaptation to ambient oxidant air pollution: effects of ozone exposure in Los Angeles residents vs. new arrivals. Environ Health Perspect 18:141-6.

~~817.~~814. Hackney JD, Linn WS, Law DC, Karuza SK, Greenberg H, Buckley RD, Pedersen EE. 1975a. Experimental studies on human health effects of air pollutants. III. Two-hour exposure to ozone alone and in combination with other pollutant gases. Arch Environ Health 30:385-90.

~~818.~~815. Hackney JD, Linn WS, Mohler JG, Collier CR. 1977. Adaptation to short-term respiratory effects of ozone in men exposed repeatedly. J Appl Physiol 43:82-5.

~~819.~~816. Hackney JD, Linn WS, Mohler JG, Pedersen EE, Breisacher P, Russo A. 1975b. Experimental studies on human health effects of air pollutants. II. Four-hour exposure to ozone alone and in combination with other pollutant gases. Arch Environ Health 30:379-84.

~~820.~~817. Hanania NA, Tarlo SM, Silverman F, Urch B, Senathirajah N, Zamel N, Corey P. 1998. Effect of exposure to low levels of ozone on the response to inhaled allergen in allergic asthmatic patients. Chest 114:752-6.

~~821.~~818. Harkema JR, Mauderly JL. 1994. Consequences of prolonged inhalation of ozone on F344/N rats: collaborative studies. Part V: Effects on pulmonary function. Res Rep Health Eff Inst :3-17; discussion 19-26.

~~822.~~819. Harkema JR, Plopper CG, Hyde DM, St George JA, Dungworth DL. 1987a. Effects of an ambient level of ozone on primate nasal epithelial mucosubstances. Quantitative histochemistry. Am J Pathol 127:90-6.

~~823.~~820. Harkema JR, Plopper CG, Hyde DM, St George JA, Wilson DW, Dungworth DL. 1987b. Response of the macaque nasal epithelium to ambient levels of ozone. A morphologic and morphometric study of the transitional and respiratory epithelium. Am J Pathol 128:29-44.

~~824.~~821. Harkema JR, Plopper CG, Hyde DM, St George JA, Wilson DW, Dungworth DL. 1993. Response of macaque bronchiolar epithelium to ambient concentrations of ozone. Am J Pathol 143:857-66.

~~825.~~822. Haro R, Paz C. 1993. Effects of ozone exposure during pregnancy on ontogeny of sleep in rats. Neurosci Lett 164:67-70.

~~826.~~823. Hassett C, Mustafa MG, Coulson WF, Elashoff RM . 1985. Murine lung carcinogenesis following exposure to ambient ozone concentrations. J Natl Cancer Inst 75:771-7.

~~827.~~824. Hatch GE, Slade R, Harris LP, McDonnell WF, Devlin RB, Koren HS, Costa DL, McKee J. 1994. Ozone dose and effect in humans and rats. A comparison using oxygen-18 labeling and bronchoalveolar lavage. Am J Respir Crit Care Med 150:676-83.

~~828.~~825. Hazbun ME, Hamilton R, Holian A, Eschenbacher WL. 1993. Ozone-induced increases in substance P and 8-epi-prostaglandin F2 alpha in the airways of human subjects. Am J Respir Cell Mol Biol 9:568-72.

~~829.~~826. Hazucha M, Bates DV. 1975. Combined effect of ozone and sulphur dioxide on human pulmonary function. Nature 257:50-1.

~~830.~~827. Hazucha M, Silverman F, Parent C, Field S, Bates DV. 1973. Pulmonary function in man after short-term exposure to ozone. Arch Environ Health 27:183-8.

~~831.~~828. Hazucha MJ, Bates DV, Bromberg PA. 1989. Mechanism of action of ozone on the human lung. J Appl Physiol 67:1535-41.

~~832.~~829. Hazucha MJ, Folinsbee LJ, Seal E Jr. 1992. Effects of steady-state and variable ozone concentration profiles on pulmonary function. Am Rev Respir Dis 146:1487-93.

~~833.~~830. Hazucha MJ, Folinsbee LJ, Seal E, Bromberg PA. 1994. Lung function response of healthy women after sequential exposures to NO_2 and ~~ozone~~ O_3. Am J Respir Crit Care Med 150:642-7.

~~834.~~831. Hazucha MJ, Madden M, Pape G, Becker S, Devlin R, Koren HS, Kehrl H, Bromberg PA. 1996. Effects of cyclo-oxygenase inhibition on ozone-induced respiratory inflammation and lung function changes. Eur J Appl Physiol Occup Physiol 73:17-27.

~~835.~~832. Hazucha MJ. 1987. Relationship between ozone exposure and pulmonary function changes. J Appl Physiol 62:1671-80.

~~836.~~833. Henderson FW, Dubovi EJ, Harder S, Seal E Jr, Graham D. 1988. Experimental rhinovirus infection in human volunteers exposed to ozone. Am Rev Respir Dis 137:1124-8.

~~837.~~834. Herbert RA, Hailey JR, Grumbein S, Chou BJ, Sills RC, Haseman JK, Goehl T, Miller RA, Roycroft JH, Boorman GA. 1996. Two-year and lifetime toxicity and carcinogenicity studies of ozone in B6C3F1 mice. Toxicol Pathol 24:539-48.

~~838.~~835. Hiltermann JT, Lapperre TS, van Bree L, Steerenberg PA, Brahim JJ, Sont JK, Sterk PJ, Hiemstra PS, Stolk J. 1999. Ozone-induced inflammation assessed in sputum and bronchial lavage fluid from asthmatics: a new noninvasive tool in epidemiologic studies on air pollution and asthma. Free Radic Biol Med 27:1448-54.

~~839.~~836. Hiltermann TJ, Peters EA, Alberts B, Kwikkers K, Borggreven PA, Hiemstra PS, Dijkman JH, van Bree LA, Stolk J. 1998. Ozone-induced airway hyperresponsiveness in patients with asthma: role of neutrophil-derived serine proteinases. Free Radic Biol Med 24:952-8.

~~840.~~837. Hiltermann TJ, Stolk J, Hiemstra PS, Fokkens PH, Rombout PJ, Sont JK, Sterk PJ, Dijkman JH. 1995. Effect of ozone exposure on maximal airway narrowing in non-asthmatic and asthmatic subjects. Clin Sci (Lond) 89:619-24.

~~841.~~838. Holtzman MJ, Cunningham JH, Sheller JR, Irsigler GB, Nadel JA, Boushey HA. 1979. Effect of ozone on bronchial reactivity in atopic and nonatopic subjects. Am Rev Respir Dis 120:1059-67.

~~842.~~839. Holz O, Jorres RA, Timm P, Mucke M, Richter K, Koschyk S, Magnussen H. 1999. Ozone-induced airway inflammatory changes differ between individuals and are reproducible. Am J Respir Crit Care Med 159:776-84.

~~843.~~840. Holz O, Mucke M, Paasch K, Bohme S, Timm P, Richter K, Magnussen H, Jorres RA. 2002. Repeated ozone exposures enhance bronchial allergen responses in subjects with rhinitis or asthma. Clin Exp Allergy 32:681-9.

~~844.~~841. Hornof WJ, Schelegle E, Kammerman M, Gunther RA, Fisher PE, Cross CE (1989 Sep). Ozone-induced accelerated lung clearance of 99mTc-DTPA aerosol in conscious sheep. Respir Physiol 77(3):277-90.

~~845.~~842. Horstman DH, Ball BA, Brown J, Gerrity T, Folinsbee LJ. 1995. Comparison of pulmonary responses of asthmatic and nonasthmatic subjects performing light exercise while exposed to a low level of ozone. Toxicol Ind Health 11:369-85.

~~846.~~843. Horstman DH, Folinsbee LJ, Ives PJ, Abdul-Salaam S, McDonnell WF. 1990. Ozone concentration and pulmonary response relationships for 6.6-hour exposures with five hours of moderate exercise to 0.08, 0.10, and 0.12 ppm. Am Rev Respir Dis 142:1158-63.

~~847.~~844. Horvath SM, Bedi JF, Drechsler-Parks DM. 1986. Effects of peroxyacetyl nitrate alone and in combination with ozone in healthy young women. J Air Pollut Control Assoc 36:265-70.

~~848.~~845. Horvath SM, Bedi JL, Drechsler-Parks DM, Williams RE. 1991. Alterations in pulmonary function parameters during exposure to 80 ppb ozone for 6.6 hours in healthy middle aged individuals. Pittsburgh, PA: Air and Waste Management Association. Pittsburgh, PA: Air and Waste Management Association:59-70.

~~849.~~846. Horvath SM, Folinsbee LJ, Bedi JF. 1987. Combined effect of ozone and sulfuric acid on pulmonary function in man. Am Ind Hyg Assoc J 48:94-8.

~~850.~~847. Horvath SM, Gliner JA, Folinsbee LJ. 1981. Adaptation to ozone: duration of effect. Am Rev Respir Dis 123:496-9.

~~851.~~848. Horvath SM, Gliner JA, Matsen-Twisdale JA. 1979. Pulmonary function and maximum exercise responses following acute ozone exposure. Aviat Space Environ Med 50:901-5.

~~852.~~849. Hotchkiss JA, Harkema JR, Henderson RF. 1991. Effect of cumulative ozone exposure on ozone-induced nasal epithelial hyperplasia and secretory metaplasia in rats. Exp Lung Res 17:589-600.

~~853.~~850. Hotchkiss JA, Harkema JR, Kirkpatrick DT, Henderson RF. 1989a. Response of rat alveolar macrophages to ozone: quantitative assessment of population size, morphology, and proliferation following acute exposure. Exp Lung Res 15:1-16.

~~854.~~851. Hotchkiss JA, Harkema JR, Sun JD, Henderson RF . 1989b. Comparison of acute ozone-induced nasal and pulmonary inflammatory responses in rats. Toxicol Appl Pharmacol 98:289-302.

~~855.~~852. Housley DG, Eccles R, Richards RJ. 1996. Gender difference in the concentration of the antioxidant uric acid in human nasal lavage. Acta Otolaryngol 11:751-754.

~~856.~~853. Hu SC, Ben-Jebria A, Ultman JS. 1992a. Simulation of ozone uptake distribution in the human airways by orthogonal collocation on finite elements. Comput Biomed Res 25:264-78.

~~857.~~854. Hu SC, Ben-Jebria A, Ultman JS. 1992b. Longitudinal distribution of ozone absorption in the lung: quiet respiration in healthy subjects. J Appl Physiol 73:1655-61.

~~858.~~855. Huffman LJ, Judy DJ, Brumbaugh K, Frazer DG, Reynolds JS, McKinney WG, Goldsmith WT. 2001. Hyperthyroidism increases the risk of ozone-induced lung toxicity in rats. Toxicol Appl Pharmacol 173:18-26.

~~859.~~856. Hyde DM, Miller LA, McDonald RJ, Stovall MY, Wong V, Pinkerton KE, Wegner CD, Rothlein R, Plopper CG. 1999. Neutrophils enhance clearance of necrotic epithelial cells in ozone-induced lung injury in rhesus monkeys. Am J Physiol 277:L1190-8.

~~860.~~857. Hynes B, Silverman F, Cole P, Corey P. 1988. Effects of ozone exposure: a comparison between oral and nasal breathing. Arch Environ Health 43:357-60.

~~861.~~858. Ichinose T, Sagai M. 1992. Combined exposure to NO_2, ~~ozone~~ O_3 and H_2SO_4-aerosol and lung tumor formation in rats. Toxicology 74:173-84.

~~862.~~859. Iijima MK, Kobayashi T, Kamada H, Shimojo N. 2001. Exposure to ozone aggravates nasal allergy-like symptoms in guinea pigs. Toxicol Lett 123:77-85.

~~863.~~860. Islam MS, ~~Grosskurth D,~~ Ulmer WT. 1979. Long-term exposure against a gas mixture of SO_2, NO_2 and O_3 in three-times MIC on lung function and reagibility of the bronchial system on healthy persons. ~~Effect of ozone (0.1-0.15 ppm) on ventilatory function in human volunteers. 2.~~Wissenschaft und Umwelt. 4:186-190.~~ 2:67-73.~~

~~864.~~861. Iwasaki T, Takahashi M, Saito H, Arito H. 1998. Adaptation of extrapulmonary responses to ozone exposure in conscious rats. Ind Health 36:57-60.

~~865.~~862. Jabbour AJ, Altman LC, Wight TN, Luchtel DL. 1998. Ozone alters the distribution of beta1 integrins in cultured primate bronchial epithelial cells. Am J Respir Cell Mol Biol 19:357-65.

~~866.~~863. Jakab GJ, Bassett DJ. 1990. Influenza virus infection, ozone exposure, and fibrogenesis. Am Rev Respir Dis 141:1307-15.

~~867.~~864. Janssen LJ, O'Byrne PM, Daniel EE. 1991. Mechanism underlying ozone-induced in vitro hyperresponsiveness in canine bronchi. Am J Physiol 261:L55-62.

~~868.~~865. Jenkins HS, Devalia JL, Mister RL, Bevan AM, Rusznak C, Davies RJ. 1999. The effect of exposure to ozone and nitrogen dioxide on the airway response of atopic asthmatics to inhaled allergen: dose- and time-dependent effects. Am J Respir Crit Care Med 160:33-9.

~~869.~~866. Joad JP, Bric JM, Weir AJ, Putney L, Hyde DM, Postlethwait EM, Plopper CG. 2000. Effect of respiratory pattern on ozone injury to the airways of isolated rat lungs. Toxicol Appl Pharmacol 169:26-32.

~~870.~~867. Johansen H, Dutta M, Mao Y, Chagani K, Sladecek I. 1992. An investigation of the increase in preschool-age asthma in Manitoba, Canada.

Health Rep 4:379-402.

~~871.~~868. Johnson HG, Stout BK, Ruppel PL. 1988. Inhibition of the 5-lipoxygenase pathway with piriprost (U-60,257) protects normal primates from ozone-induced methacholine hyperresponsive small airways. Prostaglandins 35:459-66.

~~872.~~869. Johnston CJ, Oberdorster G, Gelein R, Finkelstein JN. 2000. Newborn mice differ from adult mice in chemokine and cytokine expression to ozone, but not to endotoxin. Inhal Tox 12:205-224.

~~873.~~870. Johnson NF, Hotchkiss JA, Harkema JR, Henderson RF. 1990. Proliferative responses of rat nasal epithelia to ozone. Toxicol Appl Pharmacol 103 :143-55.

~~874.~~871. Jonsson LM, Edlund T, Marklund SL, Sandstrom T . 2002. Increased ozone-induced airway neutrophilic inflammation in extracellular-superoxide dismutase null mice. Respir Med 96:209-14.

~~875.~~872. Jorres R, Nowak D, Magnussen H. 1996. The effect of ozone exposure on allergen responsiveness in subjects with asthma or rhinitis. Am J Respir Crit Care Med 153:56-64.

~~876.~~873. Jorres RA, Holz O, Zachgo W, Timm P, Koschyk S, Muller B, Grimminger F, Seeger W, Kelly FJ, Dunster C, Frischer T, Lubec G, Waschewski M, Niendorf A, Magnussen H. 2000. The effect of repeated ozone exposures on inflammatory markers in bronchoalveolar lavage fluid and mucosal biopsies. Am J Respir Crit Care Med 161:1855-61.

~~877.~~874. Kabel JR, Ben-Jebria A, Ultman JS. 1994. Longitudinal distribution of ozone absorption in the lung: comparison of nasal and oral quiet breathing. J Appl Physiol 77:2584-92.

~~878.~~875. Kagawa J, Tsuru K. 1979. [Effects of ozone and smoking alone and in combination on bronchial reactivity to inhaled acetylcholine aerosol in normal subjects (author's transl)]. Nihon Kyobu Shikkan Gakkai Zasshi 17:703-9.

~~879.~~876. Kagawa J. 1983. Respiratory effects of two-hour exposure with intermittent exercise to ozone, sulfur dioxide and nitrogen dioxide alone and in combination in normal subjects. Am Ind Hyg Assoc J 44:14-20.

~~880.~~877. Kagawa J. 1986. Experimental studies on human health effects of aerosol and gaseous pollutants. Chelsea, MI: Lewis Publishers, Inc. Chelsea, MI: Lewis Publishers, Inc.: 683-97.

~~881.~~878. Kavlock R, Daston G, Grabowski CT. 1979. Studies on the developmental toxicity of ozone. I. Prenatal effects. Toxicol Appl Pharmacol

48:19-28.

~~882.~~879. Kavlock RJ, Meyer E, Grabowski CT. 1980. Studies on the developmental toxicity of ozone: postnatal effects. Toxicol Lett 5:3-9.

~~883.~~880. Keefe MJ, Bennett WD, DeWitt P, Seal E, Strong AA, Gerrity TR. 1991. The effect of ozone exposure on the dispersion of inhaled aerosol boluses in healthy human subjects. Am Rev Respir Dis 144:23-30.

~~884.~~881. Kehrl H~~OU~~R, Hazucha MJ, Solic JJ, Bromberg PA. 1985. Responses of subjects with chronic obstructive pulmonary disease after exposures to 0.3 ppm ozone. Am Rev Respir Dis 131:719-24.

~~885.~~882. Kehrl H~~OU~~R, Peden DB, Ball B, Folinsbee LJ, Horstman D. 1999. Increased specific airway reactivity of persons with mild allergic asthma after 7.6 hours of exposure to 0.16 ppm ozone. J Allergy Clin Immunol 104:1198-204.

~~886.~~883. Kerr HD, Kulle TJ, McIlhany ML, Swidersky P. 1975. Effects of ozone on pulmonary function in normal subjects. An environmental-chamber study. Am Rev Respir Dis 111:763-73.

~~887.~~884. Kimmel TA, Chen LC, Bosland MC, Nadziejko C. 1997. Influence of acid aerosol droplet size on structural changes in the rat lung caused by acute exposure to sulfuric acid and ozone. Toxicol Appl Pharmacol 144:348-55.

~~888.~~885. Kinney PL, Nilsen DM, Lippmann M, Brescia M, Gordon T, McGovern T, El-Fawal H, Devlin RB, Rom WN. 1996. Biomarkers of lung inflammation in recreational joggers exposed to ozone. Am J Respir Crit Care Med 154:1430-5.

~~889.~~886. Kirichenko A, Li L, Morandi MT, Holian A. 1996. 4-hydroxy-2-nonenal-protein adducts and apoptosis in murine lung cells after acute ozone exposure. Toxicol Appl Pharmacol 141:416-24.

~~890.~~887. Kleeberger SR, Ohtsuka Y, Zhang LY, Longphre M . 2001. Airway responses to chronic ozone exposure are partially mediated through mast cells. J Appl Physiol 90:713-23.

~~891.~~888. Kleinman MT. 1991. Effects of ozone on pulmonary function: the relationship of response to dose. J Expos Anal Environ Epidemiol 1:309-325.

~~892.~~889. Kleinman MT, Bailey RM, Chang YT, Clark KW, Jones MP, Linn WS, Hackney JD. 1981. Exposures of human volunteers to a controlled atmospheric mixture of ozone, sulfur dioxide and sulfuric acid. Am Ind Hyg Assoc J 42:61-9.

~~893.~~890. Kodavanti UP, Costa DL, Richards J, Crissman KM, Slade R, Hatch GE. 1996. Antioxidants in bronchoalveolar lavage fluid cells isolated from ozone--exposed normal and ascorbate-deficient guinea pigs. Exp Lung Res 22:435-48.

~~894.~~891. Kodavanti UP, Hatch GE, Starcher B, Giri SN, Winsett D, Costa DL. 1995. Ozone-induced pulmonary functional, pathological, and biochemical changes in normal and vitamin C-deficient guinea pigs. Fundam Appl Toxicol 24:154-64.

~~895.~~892. Koenig JQ, Covert DS, Hanley QS, van Belle G, Pierson WE. 1990. Prior exposure to ozone potentiates subsequent response to sulfur dioxide in adolescent asthmatic subjects. Am Rev Respir Dis 141:377-80.

~~896.~~893. Koenig JQ, Covert DS, Marshall SG, Van Belle G, Pierson WE. 1987. The effects of ozone and nitrogen dioxide on pulmonary function in healthy and in asthmatic adolescents. Am Rev Respir Dis 136:1152-7.

~~897.~~894. Koenig JQ, Covert DS, Morgan MS, Horike M, Horike N, Marshall SG, Pierson WE. 1985. Acute effects of 0.12 ppm ozone or 0.12 ppm nitrogen dioxide on pulmonary function in healthy and asthmatic adolescents. Am Rev Respir Dis 132:648-51.

~~898.~~895. Koenig JQ, Covert DS, Pierson WE, Hanley QS, Rebolledo V, Dumler K, McKinney SE. 1994. Oxidant and acid aerosol exposure in healthy subjects and subjects with asthma. Part I: Effects of oxidants, combined with sulfuric or nitric acid, on the pulmonary function of adolescents with asthma. Res Rep Health Eff Inst :1-36.

~~899.~~896. Koenig JQ, Covert DS, Smith MS, van Belle G, Pierson WE. 1988a. The pulmonary effects of ozone and nitrogen dioxide alone and combined in healthy and asthmatic adolescent subjects. Toxicol Ind Health 4:521-32.

~~900.~~897. Koenig JQ, Pierson WE, Covert DS, Marshall SG, Morgan MS, van Belle G. 1988b. The effects of ozone and nitrogen dioxide on lung function in healthy and asthmatic adolescents. Res Rep Health Eff Inst :5-24.

~~901.~~898. Koren HS, Devlin RB, Becker S, Perez R, McDonnell WF. 1991. Time-dependent changes of markers associated with inflammation in the lungs of humans exposed to ambient levels of ozone. Toxicol Pathol 19:406-11.

~~902.~~899. Koren HS, Devlin RB, Graham DE, Mann R, McDonnell WF. 1989a The inflammatory response in human lung exposed to ambient levels of ozone. Amsterdam, The Netherlands~~-~~: Elsevier Science Publishers B.V., p. 745-753.

~~903.~~900. Koren HS, Devlin RB, Graham DE, Mann R, McGee MP, Horstman

DH, Kozumbo WJ, Becker S, House DE, McDonnell WF, et al. 1989b. Ozone-induced inflammation in the lower airways of human subjects. Am Rev Respir Dis 139:407-15.

~~904.~~901. Koren HS, Hatch GE, Graham DE. 1990. Nasal lavage as a tool in assessing acute inflammation in response to inhaled pollutants. Toxicology 60:15-25.

~~905.~~902. Koren HS. 1995. Associations between criteria air pollutants and asthma. Environ Health Perspect 103 Suppl 6:235-42.

~~906.~~903. Kotlikoff MI, Jackson AC, Watson JW. 1984. Oscillatory mechanics of the respiratory system in ozone-exposed rats. J Appl Physiol 56:182-6.

~~907.~~904. Kreit JW, Gross KB, Moore TB, Lorenzen TJ, D'Arcy J, Eschenbacher WL. 1989. Ozone-induced changes in pulmonary function and bronchial responsiveness in asthmatics. J Appl Physiol 66:217-22.

~~908.~~905. Krishna MT, Springall D, Meng QH, Withers N, Macleod D, Biscione G, Frew A, Polak J, Holgate S. 1997. Effects of ozone on epithelium and sensory nerves in the bronchial mucosa of healthy humans. Am J Respir Crit Care Med 156:943-50.

~~909.~~906. Kulle TJ, Kerr HD, Farrell BP, Sauder LR, Bermel MS. 1982. Pulmonary function and bronchial reactivity in human subjects with exposure to ozone and respirable sulfuric acid aerosol. Am Rev Respir Dis 126:996-1000.

~~910.~~907. Kulle TJ, Milman JH, Sauder LR, Kerr HD, Farrell BP, Miller WR. 1984. Pulmonary function adaptation to ozone in subjects with chronic bronchitis. Environ Res _ 34:55-63.

~~911.~~908. Kulle TJ, Sauder LR, Hebel JR, Chatham MD. 1985. Ozone response relationships in healthy nonsmokers. Am Rev Respir Dis 132:36-41.

~~912.~~909. Kulle TJ, Sauder LR, Kerr HD, Farrell BP, Bermel MS, Smith DM. 1982. Duration of pulmonary function adaptation to ozone in humans. Am Ind Hyg Assoc J 43:832-7.

~~913.~~910. Kunzli N, Lurmann F, Segal M, Ngo L, Balmes J, Tager IB. 1997. Association between lifetime ambient ozone exposure and pulmonary function in college freshmen--results of a pilot study. Environ Res 72:8-23.

~~914.~~911. Larsen RI, McDonnell WF, Horstman DH, Folinsbee LJ. 1991. An air quality data analysis system for interrelating effects, standards, and needed source reductions: Part 11. A lognormal model relating human lung function decrease to ozone exposure. J Air Waste Manage Assoc 41:455-9.

~~915.~~912. Larson SD, Schelegle ES, Walby WF, Gershwin LJ, Fanucchi MV, Evans MJ, Joad JP, Tarkington BK, Hyde DM, Plopper CG. 2004. Postnatal remodeling of the neural components of the epithelial-mesenchymal trophic unit in the proximal airways of infant rhesus monkeys exposed to ozone and allergen. Toxicol Appl Pharmacol 194:211-20.

~~916.~~913. Laskin DL, Heck DE, Laskin JD. 1998. Role of inflammatory cytokines and nitric oxide in hepatic and pulmonary toxicity. Toxicol Lett 102-103:289-93.

~~917.~~914. Laskin DL, Pendino KJ, Punjabi CJ, Rodriguez del Valle M, Laskin JD. 1994. Pulmonary and hepatic effects of inhaled ozone in rats. Environ Health Perspect 102 Suppl 10:61-4.

~~918.~~915. Last JA, Gelzleichter T, Harkema J, Parks WC, Mellick P. 1993. Effects of 20 months of ozone exposure on lung collagen in Fischer 344 rats. Toxicology 84:83-102.

~~919.~~916. Last JA, Greenberg DB, Castleman WL. 1979. Ozone-induced alterations in collagen metabolism of rat lungs. Toxicol Appl Pharmacol 51:247-58.

~~920.~~917. Last JA, Pinkerton KE. 1997. Chronic exposure of rats to ozone and sulfuric acid aerosol: biochemical and structural responses. Toxicology 116 :133-46.

~~921.~~918. Last JA, Reiser KM, Tyler WS, Rucker RB. 1984. Long-term consequences of exposure to ozone. I. Lung collagen content. Toxicol Appl Pharmacol 72:111-8.

~~922.~~919. Last JA, Reiser KM. 1984. Collagen biosynthesis. Environ Health Perspect 55:169-77.

~~923.~~920. Last JA, Warren DL, Pecquet-Goad E, Witschi H. 1987. Modification by ozone of lung tumor development in mice. J Natl Cancer Inst 78:149-54.

~~924.~~921. Lategola MT, Melton CE, Higgins EA. 1980. Pulmonary and symptom threshold effects of ozone in airline passenger and cockpit crew surrogates. Aviat Space Environ Med 51:878-84.

~~925.~~922. Lauritzen SK, Adams WC. 1985. Ozone inhalation effects consequent to continuous exercise in females: comparison to males. J Appl Physiol 59:1601-6.

~~926.~~923. Lee LY, Dumont C, Djokic TD, Menzel TE, Nadel JA. 1979. Mechanism of rapid, shallow breathing after ozone exposure in conscious dogs. J Appl Physiol 46:1108-14.

~~927.~~924. Leikauf GD, Zhao Q, Zhou S, Santrock J. 1993. Ozonolysis products of membrane fatty acids activate eicosanoid metabolism in human airway epithelial cells. Am J Respir Cell Mol Biol 9:594-602.

~~928.~~925. Leikauf GD, Zhao Q, Zhou S, Santrock J. 1995. Activation of eicosanoid metabolism in human airway epithelial cells by ozonolysis products of membrane fatty acids. Res Rep Health Eff Inst :1-15; discussion 19-26.

~~929.~~926. Li AF, Richters A. 1991. Ambient level ozone effects on subpopulations of thymocytes and spleen T lymphocytes. Arch Environ Health 46:57-63.

~~930.~~927. Li L, Hamilton RF Jr, Holian A. 2000. Protection against ozone-induced pulmonary inflammation and cell death by endotoxin pretreatment in mice: role of HO-1. Inhal Toxicol 12:1225-38.

~~931.~~928. Li Z, Daniel EE, Lane CG, Arnaout MA, O'Byrne PM. 1992. Effect of an anti-Mo1 MAb on ozone-induced airway inflammation and airway hyperresponsiveness in dogs. Am J Physiol 263:L723-6.

~~932.~~929. Linder J, Herren D, Monn C, Wanner HU. 1988. [Effect of ozone on physical performance]. Schweiz Z Sportmed 36:5-10.

~~933.~~930. Linn WS, Anderson KR, Shamoo DA, Edwards SA, Webb TL, Hackney JD, Gong H Jr. 1995. Controlled exposures of young asthmatics to mixed oxidant gases and acid aerosol. Am J Respir Crit Care Med 152:885-91.

~~934.~~931. Linn WS, Avol EL, Shamoo DA, Peng RC, Valencia LM, Little DE, Hackney JD. 1988. Repeated laboratory ozone exposures of volunteer Los Angeles residents: an apparent seasonal variation in response. Toxicol Ind Health 4 :505-20.

~~935.~~932. Linn WS, Avol EL, Shamoo DA, Spier CE, Valencia LM, Venet TG, Fischer DA, Hackney JD. 1986 . A dose-response study of healthy, heavily exercising men exposed to ozone at concentrations near the ambient air quality standard. Toxicol Ind Health 2:99-112.

~~936.~~933. Linn WS, Buckley RD, Spier CE, Blessey RL, Jones MP, Fischer DA, Hackney JD. 1978. Health effects of ozone exposure in asthmatics. Am Rev Respir Dis 117:835-43.

~~937.~~934. Linn WS, Fischer DA, Medway DA, Anzar UT, Spier CE, Valencia LM, Venet TG, Hackney JD. 1982. Short-term respiratory effects of 0.12 ppm ozone exposure in volunteers with chronic obstructive pulmonary disease. Am Rev Respir Dis 125:658-63.

~~938.~~935. Linn WS, Gong H Jr, Shamoo DA, Anderson KR, Avol EL. 1997. Chamber exposures of children to mixed ozone, sulfur dioxide, and sulfuric acid. Arch Environ Health 52:179-87.

~~939.~~936. Linn WS, Jones MP, Bachmayer EA, Clark KW, Karuza SK, Hackney JD. 1979. Effect of low-level exposure to ozone on arterial oxygenation in humans. Am Rev Respir Dis 119:731-40.

~~940.~~937. Linn WS, Jones MP, Bachmayer EA, Spier CE, Mazur SF, Avol EL, Hackney JD. 1980. Short-term respiratory effects of polluted ambient air: a laboratory study of volunteers in a high-oxidant community. Am Rev Respir Dis 121:243-52.

~~941.~~938. Linn WS, Medway DA, Anzar UT, Valencia LM, Spier CE, Tsao FS, Fischer DA, Hackney JD. 1982~~–~~. Persistence of adaptation to ozone in volunteers exposed repeatedly for six weeks. Am Rev Respir Dis 125:491-5.

~~942.~~939. Linn WS, Shamoo DA, Anderson KR, Peng RC, Avol EL, Hackney JD. 1994. Effects of prolonged, repeated exposure to ozone, sulfuric acid, and their combination in healthy and asthmatic volunteers. Am J Respir Crit Care Med 150:431-40.

~~943.~~940. Linn WS, Shamoo DA, Venet TG, Spier CE, Valencia LM, Anzar UT, Hackney JD. 1983. Response to ozone in volunteers with chronic obstructive pulmonary disease. Arch Environ Health 38:278-83.

~~944.~~941. Long NC, Suh J, Morrow JD, Schiestl RH, Murthy GG, Brain JD, Frei B. 2001. Ozone causes lipid peroxidation but little antioxidant depletion in exercising and nonexercising hamsters. J Appl Physiol 91:1694-700.

~~945.~~942. Longphre M, Zhang L, Harkema JR, Kleeberger SR~~–~~. 1999. Ozone-induced pulmonary inflammation and epithelial proliferation are partially mediated by PAF. J Appl Physiol 86:341-9.

~~946.~~943. Mannino DM, Homa DM, Akinbami LJ, Moorman JE, Gwynn C, Redd SC. 2002. Surveillance for asthma--United States, 1980-1999. MMWR Surveill Summ 51:1-13.

~~947.~~944. Mariassy AT, Abraham WM, Phipps RJ, Sielczak MW, Wanner A. 1990. Effect of ozone on the postnatal development of lamb mucociliary apparatus. J Appl Physiol 68:2504-10.

~~948.~~945. Mariassy AT, Sielczak MW, McCray MN, Abraham WM, Wanner A. 1989. Effects of ozone on lamb tracheal mucosa. Quantitative glycoconjugate histochemistry. Am J Pathol 135:871-9.

~~949.~~946. Martin CJ, Boatman ES, Ward G. 1983. Mechanical properties of alveolar wall after pneumonectomy and ozone exposure. J Appl Physiol 54:785-8.

~~950.~~947. Matricardi PM. 2001. Prevalence of atopy and asthma in eastern versus ~~w~~Western Europe: why the difference? Ann Allergy Asthma Immunol 87 (6 Suppl 3): 24-27.

~~951.~~948. Matsumura Y. 1970a. The effects of ozone, nitrogen dioxide, and sulfur dioxide on the experimentally induced allergic respiratory disorder in guinea pigs. I. The effect on sensitization with albumin through the airway. Am Rev Respir Dis 102:430-7.

~~952.~~949. Matsumura Y. 1970b. The effects of ozone, nitrogen dioxide, and sulfur dioxide on the experimentally induced allergic respiratory disorder in guinea pigs. II. The effects of ozone on the absorption and the retention of antigen in the lung. Am Rev Respir Dis 102:438-43.

~~953.~~950. Mautz WJ, Bufalino C. 1989. Breathing pattern and metabolic rate responses of rats exposed to ozone. Respir Physiol 76:69-77.

~~954.~~951. Mautz WJ, Kleinman MT, Phalen RF, Crocker TT. 1988. Effects of exercise exposure on toxic interactions between inhaled oxidant and aldehyde air pollutants. J Toxicol Environ Health 25:165-77.

~~955.~~952. Mautz WJ, McClure TR, Reischl P, Phalen RF, Crocker TT. 1985. Enhancement of ozone-induced lung injury by exercise. J Toxicol Environ Health 16:841-54.

~~956.~~953. Mautz WJ. 2003. Exercising animal models in inhalation toxicology: interactions with ozone and formaldehyde. Environ Res 92: 14-26.

~~957.~~954. McBride DE, Koenig JQ, Luchtel DL, Williams PV, Henderson WR Jr. 1994. Inflammatory effects of ozone in the upper airways of subjects with asthma. Am J Respir Crit Care Med 149:1192-7.

~~958.~~955. McDonnell WF 3rd, Chapman RS, Leigh MW, Strope GL, Collier AM. 1985a. Respiratory responses of vigorously exercising children to 0.12 ppm ozone exposure. Am Rev Respir Dis 132:875-9.

~~959.~~956. McDonnell WF 3rd, Horstman DH, Abdul-Salaam S, House DE. 1985b. Reproducibility of individual responses to ozone exposure. Am Rev Respir Dis 131:36-40.

~~960.~~957. McDonnell WF, Horstman DH, Abdul-Salaam S, Raggio LJ, Green JA. 1987. The respiratory responses of subjects with allergic rhinitis to ozone exposure and their relationship to nonspecific airway reactivity. Toxicol Ind Health 3:507-17.

~~961.~~958. McDonnell WF, Horstman DH, Hazucha MJ, Seal E Jr, Haak ED, Salaam SA, House DE. 1983. Pulmonary effects of ozone exposure during exercise: dose-response characteristics. J Appl Physiol 54:1345-52.

~~962.~~959. McDonnell WF, Kehrl H~~OU~~R, Abdul-Salaam S, Ives PJ, Folinsbee LJ, Devlin RB, O'Neil JJ, Horstman DH. 1991. Respiratory response of humans exposed to low levels of ozone for 6.6 hours. Arch Environ Health 46: 145-50.

~~963.~~960. McDonnell WF, Muller KE, Bromberg PA, Shy CM. 1993. Predictors of individual differences in acute response to ozone exposure. Am Rev Respir Dis 147:818-25.

~~964.~~961. McDonnell WF, Smith MV. 1994. Description of acute ozone response as a function of exposure rate and total inhaled dose. J Appl Physiol 76:2776-84.

~~965.~~962. McDonnell WF, Stewart PW, Andreoni S, Seal E Jr, Kehrl H~~OU~~R, Horstman DH, Folinsbee LJ, Smith MV. 1997. Prediction of ozone-induced FEV1 changes. Effects of concentration, duration, and ventilation. Am J Respir Crit Care Med 156:715-22.

~~966.~~McDonnell WF, Stewart PW, Andreoni S, Smith MV–. 1995. Proportion of moderately exercising individuals responding to low-level, multi-hour ozone exposure. Am J Respir Crit Care Med 152:589-96.

963.

964. McDonnell WF, Stewart PW, Smith MV, Pan WK, Pan J. 1999. Ozone-induced respiratory symptoms: exposure-response models and association with lung function. Eur Respir J 14:845-53.

~~968.~~965. McGee MP, Devlin R, Saluta G, Koren H. 1990. Tissue factor and factor VII messenger RNAs in human alveolar macrophages: effects of breathing ozone. Blood 75:122-7.

~~969.~~966. McKittrick T, Adams WC. 1995. Pulmonary function response to equivalent doses of ozone consequent to intermittent and continuous exercise. Arch Environ Health _ 50:153-8.

~~970.~~967. Mellick PW, Dungworth DL, Schwartz LW, Tyler WS. 1977. Short term morphologic effects of high ambient levels of ozone on lungs of rhesus monkeys. Lab Invest 36:82-90.

~~971.~~968. Messineo TD, Adams WC. 1990. Ozone inhalation effects in females varying widely in lung size: comparison with males. J Appl Physiol 69:96-103.

~~972.~~969. Miller FJ, Overton JH Jr, Jaskot RH, Menzel DB~~-~~. 1985. A model of the regional uptake of gaseous pollutants in the lung. I. The sensitivity of the uptake of ozone in the human lung to lower respiratory tract secretions and exercise. Toxicol Appl Pharmacol 79:11-27.

~~973.~~970. Miller LA, Hyde DM, Gershwin LJ, Schelegle ES, Fanucchi MV, Evans MJ, Gerriets JE, Putney LF, Stovall MY, Tyler NK, Usachenko JL, Plopper CG. 2003. The effect of house dust mite aeroallergen and air pollutant exposures during infancy. Chest 123:434S.

~~974.~~971. Miller PD, Ainsworth D, Lam HF, Amdur MO. 1987. Effect of ozone exposure on lung functions and plasma prostaglandin and thromboxane concentrations in guinea pigs. Toxicol Appl Pharmacol 88:132-40.

~~975.~~972. Miller PD, Ainsworth D, Lam HF, Amdur MO. 1988. Indomethacin and cromolyn sodium alter ozone-induced changes in lung function and plasma eicosanoid concentrations in guinea pigs. Toxicol Appl Pharmacol 93:175-86.

~~976.~~973. Mills PC, Roberts CA, Smith NC. 1996. Effects of ozone and airway inflammation on glutathione status and iron homeostasis in the lungs of horses. Am J Vet Res 57:1359-63.

~~977.~~974. Moffatt RK, Hyde DM, Plopper CG, Tyler WS, Putney LF. 1987. Ozone-induced adaptive and reactive cellular changes in respiratory bronchioles of bonnet monkeys. Exp Lung Res _ 12:57-74.

~~978.~~975. Molfino NA, Wright SC, Katz I, Tarlo S, Silverman F, McClean PA, Szalai JP, Raizenne M, Slutsky AS, Zamel N. 1991. Effect of low concentrations of ozone on inhaled allergen responses in asthmatic subjects. Lancet 338:199-203.

~~979.~~976. Moore PF, Schwartz LW. 1981. Morphological effects of prolonged exposure to ozone and sulfuric acid aerosol on the rat lung. Exp Mol Pathol 35:108-23.

~~980.~~977. Morgan MS, Meyer P, Holub R, Frank R. 1986. Overall and regional lung function in dogs exposed acutely to ozone. Environ Res 41:546-57.

~~981.~~978. Murlas CG, Lang Z, Williams GJ, Chodimella V. 1992. Aerosolized neutral endopeptidase reverses ozone-induced airway hyperreactivity to substance P. J Appl Physiol 72:1133-41.

~~982.~~979. Murlas CG, Murphy TP, Chodimella V. 1990. ~~ozone~~ O_3-induced mucosa-linked airway muscle hyperresponsiveness in the guinea pig. J Appl Physiol 69:7-13.

~~983.~~980. Musi B, Dell'Omo G, Ricceri L, Santucci D, Laviola G, Bignami G, Alleva E. 1994. Effects of acute and continuous ozone (~~ozone~~O_3) exposure on activity/exploration and social behavior of CD-1 mice. Neurotoxicology 15:827-35.

~~984.~~981. Nayak AS. 2003. The asthma and allergic rhinitis link. Allergy Asthma Proc 24:395-402.

~~985.~~982. Neuhaus-Steinmetz U, Uffhausen F, Herz U, Renz H. 2000. Priming of allergic immune responses by repeated ozone exposure in mice. Am J Respir Cell Mol Biol 23:228-33.

~~986.~~983. Nicolai T. 2002. Pollution, environmental factors and childhood respiratory allergic disease. Toxicology 181-182:317-21.

~~987.~~984. Nightingale JA, Rogers DF, Barnes PJ. 1999. Effect of inhaled ozone on exhaled nitric oxide, pulmonary function, and induced sputum in normal and asthmatic subjects. Thorax 54:1061-9.

~~988.~~985. Nightingale JA, Rogers DF, Fan Chung K, Barnes PJ. 2000. No effect of inhaled budesonide on the response to inhaled ozone in normal subjects. Am J Respir Crit Care Med 161:479-86.

~~989.~~986. Nikula KJ, Wilson DW, Giri SN, Plopper CG, Dungworth DL. 1988. The response of the rat tracheal epithelium to ozone exposure. Injury, adaptation, and repair. Am J Pathol 131:373-84.

~~990.~~987. Nishikawa M, Suzuki S, Ikeda H, Fukuda T, Suzuki J, Okubo T. 1990. Dose-response relationship of ozone-induced airway hyperresponsiveness in unanesthetized guinea pigs. J Toxicol Environ Health 30:123-34.

~~991.~~988. O'Byrne P. 1998. Asthma pathogenesis and allergen-induced late responses. J Allergy Clin Immunol 102:S85-9~~-~~.

~~992.~~989. Oosting RS, van Golde LM, Verhoef J, Van Bree L. 1991. Species differences in impairment and recovery of alveolar macrophage functions following single and repeated ozone exposures. Toxicol Appl Pharmacol 110:170-8.

~~993.~~990. Osebold JW, Gershwin LJ, Zee YC. 1980. Studies on the enhancement of allergic lung sensitization by inhalation of ozone and sulfuric acid aerosol. J Environ Pathol Toxicol 3:221-34.

~~994.~~991. Osebold JW, Zee YC, Gershwin LJ. 1988. Enhancement of allergic lung sensitization in mice by ozone inhalation. Proc Soc Exp Biol Med 188:259-64.

~~995.~~992. Oshima Y, Ishizaki T, Miyamoto T,– Kabe J, Makino S. 1964. A study of Tokyo-Yokohama asthma among Japanese. _Am Rev Respir Dis 90:632-4.

~~996.~~993. Ostro BD, Lipsett MJ, Jewell NP. 1989. Predicting respiratory disease from pulmonary function tests: a reanalysis of ozone chamber studies. JAPCA 39:1313-8.

~~997.~~994. Otto-Knapp R, Jurgovsky K, Schierhorn K, Kunkel G (2003 Feb). Antioxidative enzymes in human nasal mucosa after exposure to ozone. Possible role of GSTM1 deficiency. Inflamm Res 52(2):51-5.

~~998.~~995. Overton JH, Graham RC, Miller FJ. 1987. A model of the regional uptake of gaseous pollutants in the lung. II. The sensitivity of ozone uptake in laboratory animal lungs to anatomical and ventilatory parameters. Toxicol Appl Pharmacol 88:418-32.

~~999.~~996. Ozawa M, Fujimaki H, Imai T, Honda Y, Watanabe N. 1985. Suppression of IgE antibody production after exposure to ozone in mice. Int Arch Allergy Appl Immunol_ 76:16-9.

~~1000.~~997. Paige RC, Plopper CG. 1999. Acute and chronic effects of ozone in animal models. 531-57.

~~1001.~~998. Paige RC, Royce FH, Plopper CG, Buckpitt AR. 2000. Long-term exposure to ozone increases acute pulmonary centriacinar injury by 1--nitronaphthalene: I. Region-specific enzyme activity. J Pharmacol Exp Ther 295:934-41.

~~1002.~~999. P'an AY, Jeiger Z. 1972. Trypsin protein esterase in relation to ozone-induced vascular damage. Arch Environ Health 24:233-6.

~~1003.~~1000. Paquette NC, Zhang LY, Ellis WA, Scott AL, Kleeberger SR. 1996. Vitamin A deficiency enhances ozone-induced lung injury. Am J Physiol 270:L475-82.

~~1004.~~1001. Passannante AN, Hazucha MJ, Bromberg PA, Seal E, Folinsbee L, Koch G. 1998. Nociceptive mechanisms modulate ozone-induced human lung function decrements. J Appl Physiol 85:1863-70.

~~1005.~~1002. Paz C. 1997. Some consequences of ozone exposure on health. Arch Med Res 28:163-70.

~~1006.~~1003. Peden DB, Boehlecke B, Horstman D, Devlin R. 1997. Prolonged acute exposure to 0.16 ppm ozone induces eosinophilic airway inflammation in asthmatic subjects with allergies. J Allergy Clin Immunol 100:802-8.

~~1007.~~1004. Peden DB, Setzer RW Jr, Devlin RB. 1995. Ozone exposure has both a priming effect on allergen-induced responses and an intrinsic inflammatory action in the nasal airways of perennially allergic asthmatics. Am J Respir Crit Care Med 151:1336-45.

~~1008.~~1005. Peters EA, Hiltermann JT, Stolk J. 2001. Effect of apocynin on ozone-induced airway hyperresponsiveness to methacholine in asthmatics. Free Radic Biol Med 31:1442-7.

~~1009.~~1006. Peters JM, Avol E, Gauderman WJ, Linn WS, Navidi W, London SJ, Margolis H, Rappaport E, Vora H, Gong H Jr, Thomas DC. 1999. A study of twelve Southern California communities with differing levels and types of air pollution. II. Effects on pulmonary function. Am J Respir Crit Care Med 159:768-75.

~~1010.~~1007. Petruzzi S, De Acetis L, Chiarotti F, Sorace A, Alleva E. 1999. Limited changes in handedness and morphine reactivity in CD-1 mice after pre- and postnatal ozone exposure. Acta Neurobiol Exp (Wars) 59:115-22.

~~1011.~~1008. Petruzzi S, Fiore M, Dell'Omo G, Bignami G, Alleva E. 1995. Medium and long-term behavioral effects in mice of extended gestational exposure to ozone. Neurotoxicol Teratol 17:463-70.

~~1012.~~1009. Phalen RF, Crocker TT, McClure TR, Tyler NK (1986). Effect of ozone on mean linear intercept in the lung of young beagles. J Toxicol Environ Health 17(2-3):285-96.

~~1013.~~1010. Pickrell JA, Hahn FF, Rebar AH, Horoda RA, Henderson RF. 1987. Changes in collagen metabolism and proteinolysis after repeated inhalation exposure to ozone. Exp Mol Pathol 46:159-67.

~~1014.~~1011. Pinkerton KE, Brody AR, Miller FJ, Crapo JD. 1989. Exposure to low levels of ozone results in enhanced pulmonary retention of inhaled asbestos fibers. Am Rev Respir Dis 140:1075-81.

~~1015.~~1012. Pinkerton KE, Joad JP. 2000. The mammalian respiratory system and critical windows of exposure for children's health. Environ Health Perspect 108 Suppl 3:457-62.

~~1016.~~1013. Pinkerton KE, Menache MG, Plopper CG. 1995. Consequences of prolonged inhalation of ozone on F344/N rats: collaborative studies. Part IX: Changes in the tracheobronchial epithelium, pulmonary acinus, and lung antioxidant enzyme activity. Res Rep Health Eff Inst~~:~~. 41-98; discussion 99-110.

~~1017.~~1014. Pinkerton KE, Mercer RR, Plopper CG, Crapo JD. 1992. Distribution of injury and microdosimetry of ozone in the ventilatory unit of the rat. J Appl Physiol 73:817-24.

~~1018.~~1015. Pinkerton KE, Weller BL, Menache MG, Plopper CG. 1998. Consequences of prolonged inhalation of ozone on F344/N rats: collaborative studies. Part XIII. A comparison of changes in the tracheobronchial epithelium and pulmonary acinus in male rats at 3 and 20 months. Res Rep Health Eff Inst.-:1-32; discussion 33-7.

~~1019.~~1016. Pino MV, McDonald RJ, Berry JD, Joad JP, Tarkington BK, Hyde DM. 1992. Functional and morphologic changes caused by acute ozone exposure in the isolated and perfused rat lung. _Am Rev Respir Dis 145:882-9.

~~1020.~~1017. Plopper CG, Chang AM, Pang A, Buckpitt AR. 1991. Use of microdissected airways to define metabolism and cytotoxicity in murine bronchiolar epithelium. Exp Lung Res 17:197-212.

~~1021.~~1018. Plopper CG, Chow CK, Dungworth DL, Brummer M, Nemeth TJ. 1978. Effect of low level of ozone on rat lungs. II. Morphological responses during recovery and re-exposure. Exp Mol Pathol 29:400-11.

~~1022.~~1019. Plopper CG, Chow CK, Dungworth DL, Tyler WS. 1979. Pulmonary alterations in rats exposed to 0.2 and 0.1 ppm ozone: a correlated morphological and biochemical study. Arch Environ Health 34:390-5.

~~1023.~~1020. Plopper CG, Chu FP, Haselton CJ, Peake J, Wu J, Pinkerton KE. 1994a. Dose-dependent tolerance to ozone. I. Tracheobronchial epithelial reorganization in rats after 20 months' exposure. Am J Pathol 144:404-20.

~~1024.~~1021. Plopper CG, Duan X, Buckpitt AR, Pinkerton KE. 1994b. Dose-dependent tolerance to ozone. IV. Site-specific elevation in antioxidant enzymes in the lungs of rats exposed for 90 days or 20 months. Toxicol Appl Pharmacol 127:124-31.

~~1025.~~1022. Plopper CG, Hatch GE, Wong V, Duan X, Weir AJ, Tarkington BK, Devlin RB, Becker S, Buckpitt AR. 1998. Relationship of inhaled ozone concentration to acute tracheobronchial epithelial injury, site-specific ozone dose, and glutathione depletion in rhesus monkeys. Am J Respir Cell Mol Biol 19:387-99.

~~1026.~~1023. Postlethwait EM, Joad JP, Hyde DM, Schelegle ES, Bric JM, Weir AJ, Putney LF, Wong VJ, Velsor LW, Plopper CG. 2000. Three-dimensional mapping of ozone-induced acute cytotoxicity in tracheobronchial airways of isolated perfused rat lung. Am J Respir Cell Mol Biol 22:191-9.

~~1027.~~1024. Pryor WA, Squadrito GL, Friedman M. 1995. The cascade mechanism to explain ozone toxicity: the role of lipid ozonation products. Free Radic Biol Med 19:935-41.

~~1028.~~1025. Pryor WA. 1992. How far does ozone penetrate into the pulmonary air/tissue boundary before it reacts? Free Radic Biol Med 12:83-8.

~~1029.~~1026. Rahman I, Massaro GD, Massaro D. 1992. Exposure of rats to ozone: evidence of damage to heart and brain. Free Radic Biol Med 12:323-6.

~~1030.~~1027. Raub JA, Miller FJ, Graham JA (1983). Effects of low-level ozone exposure on pulmonary function in adult and neonatal rats. Advances in Modern Environmental Toxicology 5:363-7.

~~1031.~~1028. Redd SC, Mokdad AH. 2002. Invited commentary: obesity and asthma--new perspectives, research needs, and implications for control programs. Am J Epidemiol 155:198-202.

~~1032.~~1029. Reinhart PG, Gupta SK, Bhalla DK. 1999. Attenuation of ozone-induced lung injury by interleukin-10. Toxicol Lett 110:35-42.

~~1033.~~1030. Reisenauer CS, Koenig JQ, McManus MS, Smith MS, Kusic G, Pierson WE. 1988. Pulmonary response to ozone exposures in healthy individuals aged 55 years or greater. JAPCA 38:51-5.

~~1034.~~1031. Reiser KM, Tyler WS, Hennessy SM, Dominguez JJ, Last JA. 1987. Long-term consequences of exposure to ozone. II. Structural alterations in lung collagen of monkeys. Toxicol Appl Pharmacol 89:314-22.

~~1035.~~1032. Riedel F, Kramer M, Scheibenbogen C, Rieger CH~~-~~. 1988. Effects of SO_2 exposure on allergic sensitization in the guinea pig. J Allergy Clin Immunol 82:527-34.

~~1036.~~1033. Rigas ML, Ben-Jebria A, Ultman JS. 1997. Longitudinal distribution of ozone absorption in the lung: effects of nitrogen dioxide, sulfur dioxide, and ozone exposures. Arch Environ Health 52:173-8.

~~1037.~~1034. Rivas-Arancibia S, Vazquez-Sandoval R, Gonzalez-Kladiano D, Schneider-Rivas S, Lechuga-Guerrero A. 1998. Effects of ozone exposure in rats on memory and levels of brain and pulmonary superoxide dismutase. Environ Res 76 :33-9.

~~1038.~~1035. Rivas-Manzano P, Paz C. 1999. Cerebellar morphological alterations in rats induced by prenatal ozone exposure. Neurosci Lett 276:37-40.

~~1039.~~1036. Rombout PJA, Lioy PJ, Goldstein BD. 1986. Rationale for and eight-hour ozone standard. 36. 36(8):913-7.

~~1040.~~1037. Rombout PJA, van Bree L, Heisterkamp SH, Marra M. 1989. The need for an eight hour ozone standard. Atmospheric ozone research and its policy implications: proceedings of the 3rd US-Dutch international symposium May 1988; Nijmegen, The Netherlands. Amsterdam, The Netherlands: Elsevier Science Publishers B. V., p. 701-710.

~~1041.~~1038. Romero-Velazquez RM, Alfaro-Rodriguez A, Gonzalez-Pina R, Gonzalez-Maciel A (2002). Effect of ozone prenatal exposure on postnatal development of cerebellum. Proc West Pharmacol Soc 45:65-7.

~~1042.~~1039. Romieu I, Meneses F, Ramirez M, Ruiz S, Perez Padilla R, Sienra JJ, Gerber M, Grievink L, Dekker R, Walda I, Brunekreef B. 1998. Antioxidant supplementation and respiratory functions among workers exposed to high levels of ozone. Am J Respir Crit Care Med 158:226-232.

~~1043.~~1040. Romieu I, Sienra-Monge JJ, Ramirez-Aguilar M, Moreno-Macias H, Reyes-Ruiz NI, Estela del Rio-Navarro B, et al. 2004. Genetic polymorphism of GSTM1 and antioxidant supplementation influence lung function in relation to ozone exposure in asthmatic children in Mexico City. Thorax 59:8-10.

~~1044.~~1041. Romieu I, Sienra-Monge JJ, Ramirez-Aguilar M, Tellez-Rojo MM, Moreno-Macias H, Reyes-Ruiz NI, del Rio-Navarro BE, Ruiz-Navarro MX, Hatch G, Slade R, Hernandez-Avila M. 2002. Antioxidant supplementation and lung functions among children with asthma exposed to high levels of air pollutants. Am J Respir Crit Care Med 166:703-709.

~~1045.~~1042. Rossiter CE, Weill H. 1974. Ethnic differences in lung function: evidence for proportional differences. Int J Epidemiol 3:55-61.

~~1046.~~1043. Roux E, Hyvelin JM, Savineau JP, Marthan R. 1999. Human isolated airway contraction: interaction between air pollutants and passive sensitization. Am J Respir Crit Care Med 160:439-45.

~~1047.~~1044. Salvi S. 2001. Pollution and allergic airways disease. Curr Opin Allergy Clin Immunol 1:35-41.

~~1048.~~1045. Samet JM, Hatch GE, Horstman D, Steck-Scott S, Arab L, Bromberg PA, Levine M, McDonnell WF, Devlin RB. 2001. Effect of antioxidant supplementation on ozone-induced lung injury in human subjects. Am J Respir Crit Care Med 164:819-25.

~~1049.~~1046. Sarangapani R, Gentry PR, Covington TR, Teeguarden JG, Clewell HJ 3rd. 2003. Evaluation of the potential impact of age- and gender-specific lung morphology and ventilation rate on the dosimetry of vapors. Inhal Toxicol 15:987-1016.

~~1050.~~1047. Sasaki K, Nadel JA, Hahn HL. 1987. Effect of ozone on breathing in dogs: vagal and nonvagal mechanisms. J Appl Physiol 62:15-26.

~~1051.~~1048. Savin WM, Adams WC. 1979. Effects of ozone inhalation on work performance and VO_{2max}. J Appl Physiol 46:309-14.

~~1052.~~1049. Scannell C, Chen L, Aris RM, Tager I, Christian D, Ferrando R, Welch B, Kelly T, Balmes JR. 1996. Greater ozone-induced inflammatory responses in subjects with asthma. Am J Respir Crit Care Med 154: 24-9.

~~1053.~~1050. Schelegle ES, Adams WC, Giri SN, Siefkin AD. 1989. Acute ozone exposure increases plasma prostaglandin F2 alpha in ozone-sensitive human subjects. Am Rev Respir Dis 140:211-6.

~~1054.~~1051. Schelegle ES, Adams WC, Siefkin AD. 1987. Indomethacin pretreatment reduces ozone-induced pulmonary function decrements in human subjects. Am Rev Respir Dis 136:1350-4.

~~1055.~~1052. Schelegle ES, Adams WC. 1986. Reduced exercise time in competitive simulations consequent to low level ozone exposure. Med Sci Sports Exerc 18:408-14.

~~1056.~~1053. Schelegle ES, Carl ML, Coleridge HM, Coleridge JC, Green JF. 1993. Contribution of vagal afferents to respiratory reflexes evoked by acute inhalation of ozone in dogs. J Appl Physiol 74:2338-44.

~~1057.~~1054. Schelegle ES, Eldridge MW, Cross CE, Walby WF, Adams WC. 2001. Differential effects of airway anesthesia on ozone-induced pulmonary responses in human subjects. Am J Respir Crit Care Med 163:1121-7.

~~1058.~~1055. Schelegle ES, Miller LA, Gershwin LJ, Fanucchi MV, Van Winkle LS, Gerriets JE, Walby WF, Mitchell V, Tarkington BK, Wong VJ, Baker GL, Pantle LM, Joad JP, Pinkerton KE, Wu R, Evans MJ, Hyde DM, Plopper CG. 2003a. Repeated episodes of ozone inhalation amplifies the effects of allergen sensitization and inhalation on airway immune and structural development in Rhesus monkeys . Toxicol Appl Pharmacol 191:74-85.

~~1059.~~1056. Schelegle ES, Siefkin AD, McDonald RJ. 1991. Time course of ozone-induced neutrophilia in normal humans. Am Rev Respir Dis 143:1353-8.

~~1060.~~1057. Schelegle ES, Walby WF, Alfaro MF, Wong VJ, Putney L, Stovall MY, Sterner-Kock A, Hyde DM, Plopper CG. 2003b. Repeated episodes of ozone inhalation attenuates airway injury/repair and release of substance P, but not adaptation. Toxicol Appl Pharmacol 186:127-42.

~~1061.~~1058. Schierhorn K, Hanf G, Fischer A, Umland B, Olze H, Kunkel G. 2002. Ozone-induced release of neuropeptides from human nasal mucosa cells. Int Arch Allergy Immunol 129:145-51.

~~1062.~~1059. Schlesinger RB, Cohen M, Gordon T, Nadziejko C, Zelikoff JT, Sisco M, Regal JF, Menache MG. 2002. Ozone-induced modulation of airway hyperresponsiveness in guinea pigs. Res Rep Health Eff Inst :1-40; discussion 41-51.

~~1063.~~1060. Schlesinger RB, Gorczynski JE, Dennison J, Richards L, Kinney PL, Bosland MC. 1992a. Long-term intermittent exposure to sulfuric acid aerosol, ozone, and their combination: alterations in tracheobronchial mucociliary clearance and epithelial secretory cells. Exp Lung Res 18:505-34.

~~1064.~~1061. Schlesinger RB, Zelikoff JT, Chen LC, Kinney PL. 1992b. Assessment of toxicologic interactions resulting from acute inhalation exposure to sulfuric acid and ozone mixtures. Toxicol Appl Pharmacol 115:183-90.

~~1065.~~1062. Schonfeld BR, Adams WC, Schelegle ES. 1989. Duration of enhanced responsiveness upon re-exposure to ozone. Arch Environ Health 44:229-36.

~~1066.~~1063. Schuller-Levis GB, Gordon RE, Park E, Pendino KJ, Laskin DL. 1995. Taurine protects rat bronchioles from acute ozone-induced lung inflammation and hyperplasia. Exp Lung Res 21:877-88.

~~1067.~~1064. Schwartz LW, Dungworth DL, Mustafa MG, Tarkington BK, Tyler WS. 1976. Pulmonary responses of rats to ambient levels of ozone: effects of 7-day intermittent or continuous exposure. Lab Invest 34:565-78.

~~1068.~~1065. Seal E Jr, McDonnell WF, House DE, Salaam SA, Dewitt PJ, Butler SO, Green J, Raggio L. 1993. The pulmonary response of white and black adults to six concentrations of ozone. Am Rev Respir Dis 147:804-10.

~~1069.~~1066. Seal E Jr, McDonnell WF, House DE. 1996. Effects of age, socioeconomic status, and menstrual cycle on pulmonary response to ozone . Arch Environ Health 51:132-7.

~~1070.~~1067. Selgrade MK, Cooper KD, Devlin RB, van Loveren H, Biagini RE, Luster MI. 1995. Immunotoxicity--bridging the gap between animal research and human health effects. Fundam Appl Toxicol 24:13-21.

~~1071.~~1068. Selgrade MK, Hatch GE, Grose EC, Stead AG, Miller FJ, Graham JA, Stevens MA, Hardisty JF. 1990. Pulmonary effects due to subchronic exposure to oil fog. Toxicol Ind Health 6:123-43.

~~1072.~~1069. Selgrade MK, Illing JW, Starnes DM, Stead AG, Menache MG, Stevens MA. 1988. Evaluation of effects of ozone exposure on influenza infection in mice using several indicators of susceptibility. Fundam Appl Toxicol 11:169-80.

~~1073.~~1070. Seltzer J, Bigby BG, Stulbarg M, Holtzman MJ, Nadel JA, Ueki IF, Leikauf GD, Goetzl EJ, Boushey HA. 1986. ~~ozone~~ O_3-induced change in bronchial reactivity to methacholine and airway inflammation in humans. J Appl Physiol 60:1321-6.

~~1074.~~1071. Sherwin RP, Richters V. 1985. Effect of 0.3 ppm ozone exposure on type II cells and alveolar walls of newborn mice: an image-analysis quantitation. J Toxicol Environ Health 16:535-46.

~~1075.~~1072. Shore SA, Abraham JH, Schwartzman IN, Murthy GG, Laporte JD. 2000. Ventilatory responses to ozone are reduced in immature rats. J Appl Physiol 88:2023-30.

~~1076.~~1073. Shore SA, Johnston RA, Schwartzman IN, Chism D, Krishna Murthy GG. 2002. Ozone-induced airway hyperresponsiveness is reduced in immature mice. J Appl Physiol 92:1019-28.

~~1077.~~1074. Sienra-Monge JJ, Ramirez-Aguilar M, Moreno-Macias H, Reyes-Ruiz NI, del Rio-Navarro BE, Ruiz-Navarro MX, Hatch G, Crissman K, Slade R, Devlin RB, Romieu I. 2004. Antioxidant supplementation and nasal inflammatory responses among young asthmatics exposed to high levels of ozone. Clin Exp Immunol 138:317-322.

~~1078.~~1075. Silbaugh SA, Mauderly JL. 1986. Effects of ozone and sulfuric acid aerosol on gas trapping in the guinea pig lung. J Toxicol Environ Health 18 :133-41.

~~1079.~~1076. Sills RC, Hong HL, Greenwell A, Herbert RA, Boorman GA, Devereux TR. 1995. Increased frequency of K-ras mutations in lung neoplasms from female B6C3F1 mice exposed to ozone for 24 or 30 months. Carcinogenesis 16:1623-8.

~~1080.~~1077. Silverman F, Folinsbee LJ, Barnard J, Shephard RJ. 1976. Pulmonary function changes in ozone-interaction of concentration and ventilation. J Appl Physiol 41:859-64.

~~1081.~~1078. Silverman F. 1979. Asthma and respiratory irritants (ozone). Environ Health Perspect 29:131-6.

~~1082.~~1079. Smiler KL, Anver MR, Brady AN. 1988. Histopathological effects of chronic exposure of Fischer-344 rats to low-levels of ozone. ~~r~~Research publication no. GMR-6355. ~~research publication no. GMR-6355.~~

~~1083.~~1080. Smith BW, Kolb EJ, Phelps HW, Weiss HA, Hollinden AB. 1964. Tokyo-Yokohama asthma, an area specific air pollution disease. Arch Environ Health 81:805-17.

~~1084.~~1081. Solic JJ, Hazucha MJ, Bromberg PA. 1982. The acute effects of 0.2 ppm ozone in patients with chronic obstructive pulmonary disease. Am Rev

Respir Dis 125:664-9.

~~1085.~~1082. Sorace A, de Acetis L, Alleva E, Santucci D. 2001. Prolonged exposure to low doses of ozone: short- and long-term changes in behavioral performance in mice. Environ Res 85:122-34.

~~1086.~~1083. Spannhake EW. 1996. Down-regulation of canine airway mast cell ~~f~~function following exposure to ozone in vivo. Exp Lung Res 22:163-78.

~~1087.~~1084. Stacy RW, Seal E Jr, House DE, Green J, Roger LJ, Raggio L. 1983. A survey of effects of gaseous and aerosol pollutants on pulmonary function of normal males. Arch Environ Health 38:104-15.

~~1088.~~1085. Stenfors N, Pourazar J, Blomberg A, Krishna MT, Mudway I, Helleday R, Kelly FJ, Frew AJ, Sandstrom T. 2002. Effect of ozone on bronchial mucosal inflammation in asthmatic and healthy subjects. Respir Med 96:352-8.

~~1089.~~1086. Stephens RJ, Buntman DJ, Negi DS, Parkhurst RM, Thomas DW. 1983. Tissue levels of vitamin E in the lung and the cellular response to injury resulting from oxidant gas exposure. ~~83 (suppl.).~~ Chest 83 (suppl.):37S-9S.

~~1090.~~1087. Stephens RJ, Evans MJ, Sloan MF, Freeman G. 1974. A comprehensive ultrastructural study of pulmonary injury and repair in the rat resulting from exposures to less than one PPM ozone. Chest 65:Suppl:11S-13S.

~~1091.~~1088. Stephens RJ, Freeman G, Stara JF, Coffin DL. 1973. Cytologic changes in dogs lungs induced by chronic exposure to ozone. Am J Pathol 73:711-26.

~~1092.~~1089. Stephens RJ, Sloan MF, Evans MJ, Freeman G. 1974a. Early response of lung to low levels of ozone. Am J Pathol 74:31-58.

~~1093.~~1090. Stephens RJ, Sloan MF, Evans MJ, Freeman G. 1974b. Alveolar type 1 cell response to exposure to 0.5 PPM ~~ozone~~ O_3 for short periods. Exp Mol Pathol 20:11-23.

~~1094.~~1091. Stephens RJ, Sloan MF, Groth DG, Negi DS, Lunan KD. 1978. Cytologic responses of postnatal rat lungs to ~~ozone~~ O_3 or NO_2 exposure. Am J Pathol 93:183-200.

~~1095.~~1092. Stephens RJ, Sloan MF, Groth DG. 1976. Effects of long-term, low-level exposure of NO_2 or ~~ozone~~ O_3 on rat lungs. ~~16.~~Environ Health Perspect 16:178-9.

~~1096.~~1093. Sterling TD, Phair JJ, Pollack SV, Schumsky DA, DeGroot I. 1966.

Urban ~~disease~~ morbidity and air pollution. A first report. Arch Environ Health 13:158-70 contd.

~~1097.~~1094. Sterner-Kock A, Kock M, Braun R, Hyde DM. 2000. Ozone-induced epithelial injury in the ferret is similar to nonhuman primates. Am J Respir Crit Care Med 162:1152-6.

~~1098.~~1095. Sterner-Kock A, Vesely KR, Stovall MY, Schelegle ES, Green JF, Hyde DM. 1996. Neonatal capsaicin treatment increases the severity of ozone-induced lung injury. Am J Respir Crit Care Med 153:436-43.

~~1099.~~1096. Stiles J, Tyler WS. 1988. Age-related morphometric differences in responses of rat lungs to ozone. Toxicol Appl Pharmacol 92:274-85.

~~1100.~~1097. Sulakvelidze I, Inman MD, Rerecich T, O'Byrne PM. 1998. Increases in airway eosinophils and interleukin-5 with minimal bronchoconstriction during repeated low-dose allergen challenge in atopic asthmatics. Eur Respir J 11:821-7.

~~1101.~~1098. Sumitomo M, Nishikawa M, Fukuda T, Kaneko T, Ikeda H, Suzuki S, Okubo T. 1990. Effects of ozone exposure on experimental asthma in guinea pigs sensitized with ovalbumin through the airway. Int Arch Allergy Appl Immunol 93:139-47.

~~1102.~~1099. Suzuki E, Takahashi Y, Aida S, Kimula Y, Ito Y, Miura T. 1992. Alteration in surface structure of Clara cells and pulmonary cytochrome P-450b level in rats exposed to ozone. Toxicology 71:223-32.

~~1103.~~1100. Takebayashi T, Abraham J, Murthy GG, Lilly C, Rodger I, Shore SA. 1998. Role of tachykinins in airway responses to ozone in rats. J Appl Physiol 85:442-50.

~~1104.~~1101. Tepper JS, Costa DL, Lehmann JR, Weber MF, Hatch GE. 1989. Unattenuated structural and biochemical alterations in the rat lung during functional adaptation to ozone. Am Rev Respir Dis 140:493-501.

~~1105.~~1102. Tepper JS, Wiester MJ, Weber MF, Fitzgerald S, Costa DL. 1991. Chronic exposure to a simulated urban profile of ozone alters ventilatory responses to carbon dioxide challenge in rats. Fundam Appl Toxicol 17:52-60.

~~1106.~~1103. Tepper JS, Wiester MJ, Weber MF, Menache MG. 1990. Measurements of cardiopulmonary response in awake rats during acute exposure to near-ambient concentrations of ozone. J Appl Toxicol 10:7-15.

~~1107.~~1104. Torres A, Utell MJ, Morow PE, Voter KZ, Whitin JC, Cox C, Looney RJ, Speers DM, Tsai Y, Frampton MW. 1997. Airway inflammation in smokers and nonsmokers with varying responsiveness to ozone. Am J

Respir Crit Care Med 156:728-36.

~~1108.~~1105. Trenga CA, Koenig JQ, Williams PV. 2001. Dietary antioxidants and ozone-induced bronchial hyperresponsiveness in adults with asthma. Arch Environ Health _ 56:242-9.

~~1109.~~1106. Tyler WS, Tyler NK, Last JA, Barstow TJ, Magliano DJ, Hinds DM. 1987. Effects of ozone on lung and somatic growth. Pair fed rats after ozone exposure and recovery periods. Toxicology 46:1-20.

~~1110.~~1107. Tyler WS, Tyler NK, Last JA, Gillespie MJ, Barstow TJ. 1988. Comparison of daily and seasonal exposures of young monkeys to ozone. Toxicology 50:131-44.

~~1111.~~1108. Tyler WS, Tyler NK, Magliano DJ, Hinds DM, Tarkington B , Julian MD, et al. 1991 Effects of ozone inhalation on lungs of juvenile monkeys. Morphometry after a 12-month exposure and following and following a 6 month post-exposure period. In: Berglund RL, Lawson DR, McKee DJ, eds. Tropospheric ozone and the environment: Papers from an international conference, March 1990, Los Angeles, CA. Pittsburgh, PA: Air and Waste Management Assoc., p. 151-160.

~~1112.~~1109. Tyson CA, Lunan KD, Stephens RJ. 1982. Age-related differences in GSH-shuttle enzymes in NO2- or ~~ozone~~ O_3-~~-~~exposed rat lungs. Arch Environ Health 37:167-76.

~~1113.~~1110. Uchida DA, Ballowe CA, Irvin CG, Larsen GL. 1992. Assessment of airway responsiveness to inhaled methacholine and the effects of short-term ozone exposure in aged Fischer-344 rats. 1. 1:20-3.

~~1114.~~1111. Umezu T, Shimojo N, Tsubone H, Suzuki AK, Kubota K, Shimizu A. 1987. Effect of ozone toxicity in the drinking behavior of rats. Arch Environ Health 42:58-62.

~~1115.~~1112. US EPA. 1996. Air Quality Criteria for Ozone and Related Photochemical Oxidants. Vol. 3.

~~1116.~~1113. Utell MJ, Frampton MW, Morrow PE, Cox C, Levy PC, Speers DM, Gibb FR. 1994. Oxidant and acid aerosol exposure in healthy subjects and subjects with asthma. Part II: Effects of sequential sulfuric acid and ozone exposures on the pulmonary function of healthy subjects and subjects with asthma. Res Rep Health Eff Inst.- -:37-93, discussion 95-112.

~~1117.~~1114. Vagaggini B, Taccola M, Cianchetti S, Carnevali S, Bartoli ML, Bacci E, Dente FL, Di Franco A, Giannini D, Paggiaro PL. 2002. Ozone exposure increases eosinophilic airway response induced by previous allergen challenge. Am J Respir Crit Care Med 166:1073-7.

~~1118.~~1115. Vagaggini B, Taccola M, Conti I, Carnevali S, Cianchetti S, Bartoli ML, Bacci E, Dente FL, Di Franco A, Giannini D, Paggiaro PL. 2001. Budesonide reduces neutrophilic but not functional airway response to ozone in mild asthmatics. Am J Respir Crit Care Med 164:2172-6.

~~1119.~~1116. Van Bree L, Dormans JA, Boere AJ, Rombout PJ. 2001. Time study on development and repair of lung injury following ozone exposure in rats. Inhal Toxicol 13:703-18.

~~1120.~~1117. Van Bree L, Marra M, van Scheindelen HJ, Fischer PH, de Loos S, Buringh E, Rombout PJ. 1995. Dose-effect models for ozone exposure: tool for quantitative risk estimation. Toxicol Lett 82-83:317-21.

~~1121.~~1118. Van Bree L, Rombout PJA, Rietjens IMCM, Dormans JAMA, Marra M. 1989. Pathochemical effects in rat lung related to episodic ozone exposure. Nijmegen, The Netherlands. Nijmegen, The Netherlands (Elsevier Science Publishers, Amsterdam, The Netherlands):723-32.

~~1122.~~1119. Van Loveren H, Krajnc EI, Rombout PJ, Blommaert FA, Vos JG. 1990. Effects of ozone, hexachlorobenzene, and bis(tri-n-butyltin)oxide on natural killer activity in the rat lung. Toxicol Appl Pharmacol 102:21-33.

~~1123.~~1120. Van Loveren H, Rombout PJ, Wagenaar SS, Walvoort HC, Vos JG. 1988. Effects of ozone on the defense to a respiratory Listeria monocytogenes infection in the rat. Suppression of macrophage function and cellular immunity and aggravation of histopathology in lung and liver during infection. Toxicol Appl Pharmacol 94:374-93.

~~1124.~~1121. Vargas MH, Romero L, Sommer B, Zamudio P, Gustin P, Montano LM. 1998. Chronic exposure to ozone causes tolerance to airway hyperresponsiveness in guinea pigs: lack of SOD role. J Appl Physiol 84:1749-55.

~~1125.~~1122. Vargas MH, Segura P, Campos MG, Hong E, Montano LM. 1994. Effect of ozone exposure on antigen-induced airway hyperresponsiveness in guinea pigs. J Toxicol Environ Health 42:435-42.

~~1126.~~1123. Vesely KR, Hyde DM, Stovall MY, Harkema JR, Green JF, Schelegle ES. 1999a. Capsaicin-sensitive C-fiber-mediated protective responses in ozone inhalation in rats. J Appl Physiol 86:951-62.

~~1127.~~1124. Vesely KR, Schelegle ES, Stovall MY, Harkema JR, Green JF, Hyde DM. 1999b. Breathing pattern response and epithelial labeling in ozone-induced airway injury in neutrophil-depleted rats. Am J Respir Cell Mol Biol 20:699-709.

~~1128.~~1125. Victorin K. 1996. Genotoxicity and carcinogenicity of ozone. Scand J Work Environ Health 22 Suppl 3:42-51.

~~1129.~~1126. Vincent R, Adamson IY. 1995. Cellular kinetics in the lungs of aging Fischer 344 rats after acute exposure to ozone. Am J Pathol 146:1008-16.

~~1130.~~1127. Vincent R, Bjarnason SG, Adamson IY, Hedgecock C, Kumarathasan P, Guenette J, Potvin M, Goegan P, Bouthillier L. 1997. Acute pulmonary toxicity of urban particulate matter and ozone. Am J Pathol 151:1563-70.

~~1131.~~1128. Wagner JG, Hotchkiss JA, Harkema JR. 2002. Enhancement of nasal inflammatory and epithelial responses after ozone and allergen coexposure in Brown Norway rats. Toxicol Sci 67:284-94.

~~1132.~~1129. Warren JB, Dalton N. 1983. A comparison of the bronchodilator and vasopressor effects of exercise levels of adrenaline in man. Clin Sci (Lond) 64:475-9.

~~1133.~~1130. Watkinson WP, Campen MJ, Nolan JP, Costa DL. 2001. Cardiovascular and systemic responses to inhaled pollutants in rodents: effects of ozone and particulate matter. Environ Health Perspect 109 Suppl 4:539-46.

~~1134.~~1131. Watkinson WP, Gordon CJ. 1993. Caveats regarding the use of the laboratory rat as a model for acute toxicological studies: modulation of the toxic response via physiological and behavioral mechanisms. Toxicology 81:15-31.

~~1135.~~1132. Watt KC, Plopper CG, Weir AJ, Tarkington B, Buckpitt AR. 1998. Cytochrome P450 2E1 in rat tracheobronchial airways: response to ozone exposure. Toxicol Appl Pharmacol 149:195-202.

~~1136.~~1133. Wayne WS, Wehrle PF, Carroll RE. 1967. Oxidant air pollution and athletic performance. JAMA 199:901-4.

~~1137.~~1134. Weinman GG, Liu MC, Proud D, Weidenbach-Gerbase M, Hubbard W, Frank R. 1995a. Ozone exposure in humans: inflammatory, small and peripheral airway responses. Am J Respir Crit Care Med 152: 1175-1182.

~~1138.~~1135. Weinmann GG, Weidenbach-Gerbase M, Foster WM, Zacur H, Frank R. 1995b. Evidence for ozone-induced small-airway dysfunction: lack of menstrual-cycle and gender effects. Am J Respir Crit Care Med 152:988-96.

~~1139.~~1136. Weymer AR, Gong H Jr, Lyness A, Linn WS. 1994. Pre-exposure to ozone does not enhance or produce exercise-induced asthma. Am J Respir Crit Care Med 149:1413-9.

~~1140.~~1137. Whittemore AS, Korn EL. 1980. Asthma and air pollution in the Los Angeles Area. Am J Public Health 70:687-96.

~~1141.~~1138. Wiester MJ, Tepper JS, Doerfler DL, Costa DL. 1995. Ozone adaptation in rats after chronic exposure to a simulated urban profile of ozone. Fundam Appl Toxicol _ 24:42-51.

~~1142.~~1139. Wiester MJ, Tepper JS, Winsett DW, Crissman KM, Richards JH, Costa DL. 1996a. Adaptation to ozone in rats and its association with ascorbic acid in the lung. Fundam Appl Toxicol 31:56-64 .

~~1143.~~1140. Wiester MJ, Watkinson WP, Costa DL, Crissman KM, Richards JH, Winsett DW, Highfill JW. 1996b. Ozone toxicity in the rat. III. Effect of changes in ambient temperature on pulmonary parameters. J Appl Physiol 81:1691-700.

~~1144.~~1141. Wiester MJ, Winsett DW, Richards JH, Jackson MC, Crissman KM, Costa DL. 2000. Ozone adaptation in mice and its association with ascorbic acid in the lung. Inhal Toxicol 12:577-90.

~~1145.~~1142. Wilson DW, Plopper CG, Dungworth DL. 1984. The response of the macaque tracheobronchial epithelium to acute ozone injury. A quantitative ultrastructural and autoradiographic study. Am J Pathol 116:193-206.

~~1146.~~1143. Witschi H, Breider MA, Schuller HM. 1993a. Failure of ozone and nitrogen dioxide to enhance lung tumor development in hamsters. Res Rep Health Eff Inst.~~-~~ ~~:~~1-25; discussion 27-38.

~~1147.~~1144. Witschi H, Espiritu I, Pinkerton KE, Murphy K, Maronpot RR. 1999. Ozone carcinogenesis revisited. Toxicol Sci 52:162-7.

~~1148.~~1145. Witschi H, Wilson DW, Plopper CG. 1993b. Modulation of N-nitrosodiethylamine-induced hamster lung tumors by ozone. Toxicology 77:193-202.

~~1149.~~1146. Wright E, Gross K, Smiler K. 1989. Continuous chronic exposure to ozone: biochemical, functional and histopathologic effects in rat lung. ~~Presented at:~~Proceedings of the 82nd annual meeting of the Air and Waste Management Association, June 25-30, 1989, Anaheim, CA Paper no.~~. 89.~~ 89:12.2.

~~1150.~~1147. Wright ES, White DM, Smiler KL. 1990. Effects of chronic exposure to ozone on pulmonary lipids in rats. Toxicology 64:313-24.

~~1151.~~1148. Yang IA, Holz O, Jorres RA, Magnussen H, Barton SJ, Rodriguez S, et al. 2005. Association of tumor necrosis factor-alpha polymorphisms and ozone-induced change in lung function. Am J Respir Crit Care Med 171:171-6.

~~1152.~~1149. Ying RL, Gross KB, Terzo TS, Eschenbacher WL. 1990. Indomethacin does not inhibit the ozone-induced increase in bronchial responsiveness in human subjects. Am Rev Respir Dis 142:817-21.

~~1153.~~1150. Yokoyama E, Goto H, Kawai K, Kyono H. 1989. Mechanical properties of rabbit lung with edema caused by exposure to ozone. J Environ Pathol Toxicol Oncol 9:95-108.

~~1154.~~1151. Yokoyama E, Ichikawa I, Nambu Z, Kawai K, Kyono Y. 1984. Respiratory effects of intermittent exposure to ozone of rats. Environ Res 33:271-83.

~~1155.~~1152. Yokoyama E, Nambu Z, Ichikawa I, Uchiyama I, Arakawa H. 1987. Pulmonary response to exposure to ozone of emphysematous rats. Environ Res 42:114-20.

~~1156.~~1153. Yokoyama E. 1984. A simple method for measuring the respiratory uptake of carbon monoxide in unanesthetized rats: an application to rats acutely exposed to ozone. Arch Environ Health 39:375-8.

~~1157.~~1154. Yoshida. R. , Motomiya K, Saito H, Funabashi S 1974. Clinical Implications of Air Pollution Research. Acton, MA: Publishing Sciences Group, Inc.

~~1158.~~1155. Young WA, Shaw DB, Bates DV. 1964. Effect of low concentrations of ozone on pulmonary function in man. J Appl Physiol 19:765-8.

~~1159.~~1156. Yu M, Pinkerton KE, Witschi H. 2002. Short-term exposure to aged and diluted sidestream cigarette smoke enhances ozone-induced lung injury in B6C3F1 mice. Toxicol Sci 65:99-106.

~~1160.~~1157. Zeidberg LD, Prindle RA, Landau UE. 1961. The Nashville air pollution study. I. Sulfur dioxide and bronchial asthma. A preliminary report. Am Rev Respir Dis 84:489-503.

~~1161.~~1158. Zitnik LA, Schwartz LW, McQuillen NK, Zee YC, Osebold JW. 1978. Pulmonary changes induced by low-level ozone: morphological observations. J Environ Pathol Toxicol 1:365-76.

Chapter 10

~~1162.~~1159. Abbey DE, Nishino N, McDonnell WF, Burchette RJ, Knutsen SF, Lawrence Beeson W, Yang JX. 1999. Long-term inhalable particles and other air pollutants related to ~~death~~ mortality in nonsmokers. Am J Respir Crit Care Med 159:373-82.

~~1163.~~1160. Abbey DE, Petersen FF, Mills PK, Kittle L. 1993. Chronic respiratory disease associated with long-term ambient concentrations of sulfates and other air pollutants. J Expo Anal Environ Epidemiol 3 Suppl 1: 99-115.

~~1164.~~1161. Anderson H~~OU~~R, Atkinson RW, Peacock JL, Marston L, Konstantinou K. 2004. Meta-analysis of time-series studies and panel studies of particulate matter (PM) and ozone (ozone). Report of a WHO task group. World Health Organization.

~~1165.~~1162. Anderson H~~OU~~R, Ponce de Leon A, Bland JM, Bower JS, Emberlin J, Strachan DP. 1998. Air pollution, pollens, and daily admissions for asthma in London 1987-92. Thorax 53:842-8.

~~1166.~~1163. Anderson H~~OU~~R, Ponce de Leon A, Bland JM, Bower JS, Strachan DP. 1996. Air pollution and daily ~~death~~ mortality in London: 1987-92. BMJ 312:665-9.

~~1167.~~1164. Anderson H~~OU~~R, Spix C, Medina S, Schouten JP, Castellsague J, Rossi G, Zmirou D, Touloumi G, Wojtyniak B, Ponka A, Bacharova L, Schwartz J, Katsouyanni K. 1997. Air pollution and daily admissions for chronic obstructive pulmonary disease in 6 European cities: results from the APHEA project. Eur Respir J 10:1064-71.

~~1168.~~1165. Ballester F, Tenias JM, Perez-Hoyos S. 2001. Air pollution and emergency hospital admissions for cardiovascular diseases in Valencia, Spain. J Epidemiol Community Health 55:57-65~~-~~.

~~1169.~~1166. Bates DV, Baker-Anderson M, Sizto R. 1990. Asthma attack periodicity: a study of hospital emergency visits in Vancouver. Environ Res 51 :51-70.~~Bell ML.~~

~~1170.~~1167. Bell ML, McDermott A. Zeger SL. Samet JM. Dominici F. 2004. Ozone and short-term ~~death~~ mortality in 95 US urban communities, 1987-2000. JAMA. 292(19):2372-8.

~~1171.~~1168. Borja-Aburto VH, Castillejos M, Gold DR, Bierzwinski S, Loomis D. 1998. ~~Death~~ Mortality and ambient fine particles in southwest Mexico City, 1993-1995. Environ Health Perspect 106:849-55.

~~1172.~~1169. Borja-Aburto VH, Loomis DP, Bangdiwala SI, Shy CM, Rascon-Pacheco RA. 1997a. ozone, suspended particulates, and daily ~~death~~ mortality in Mexico City. 145. 145:258-68.

~~1173.Borja-Aburto VH, Loomis DP, Bangdiwala SI, Shy CM, Rascon-Pacheco RA. 1997b. Ozone, suspended particulates, and daily death in Mexico City. Am J Epidemiol 145:258-68.~~

~~1174.~~1170. Brauer M, Blair J, Vedal S. 1996. Effect of ambient ozone exposure on lung function in farm workers. Am J Respir Crit Care Med 154:981-7.

~~1175.~~1171. Bremner SA, Anderson H~~OU~~R, Atkinson RW, McMichael AJ, Strachan DP, Bland JM, Bower JS. 1999. Short-term associations between outdoor air pollution and ~~death~~ mortality in London 1992-4. Occup Environ Med 56:237-44.

~~1176.~~1172. Buchdahl R, Parker A, Stebbings T, Babiker A. 1996. Association between air pollution and acute childhood wheezy episodes: prospective observational study. BMJ 312:661-5.

~~1177.~~1173. Buchdahl R, Willens C, Vander M, Babiker A. 2000. Associations between ambient ozone, hydrocarbons, and childhood wheezy episodes: a prospective observational study in southeast London. 57. 57:86-93.

~~1178.~~1174. Burnett RT, Brook J, Dann T, Delocla C, Philips O, Cakmak S, Vincent R, Goldberg MS, Krewski D. 2000. Association between particulate- and gas-phase components of urban air pollution and daily ~~death~~ mortality in eight Canadian cities. Inhal Toxicol 12 Suppl 4:15-39.

~~1179.~~1175. Burnett RT, Brook JR, Yung WT, Dales RE, Krewski D. 1997a. Association between ozone and hospitalization for respiratory diseases in 16 Canadian cities. Environ Res 72:24-31.

~~1180.~~1176. Burnett RT, Cakmak S, Brook JR, Krewski D. 1997b. The role of particulate size and chemistry in the association between summertime ambient air pollution and hospitalization for cardiorespiratory diseases. Environ Health Perspect 105:614-20.

~~1181.~~1177. Burnett RT, Dales R, Krewski D, Vincent R, Dann T, Brook JR. 1995. Associations between ambient particulate sulfate and admissions to Ontario hospitals for cardiac and respiratory diseases. Am J Epidemiol 142:15-22.

~~1182.~~1178. Burnett RT, Smith-Doiron M, Stieb D, Cakmak S, Brook JR. 1999. Effects of particulate and gaseous air pollution on cardiorespiratory hospitalizations. Arch Environ Health 54:130-9.

~~1183.~~1179. Burnett RT, Smith-Doiron M, Stieb D, Raizenne ME, Brook JR, Dales RE, Leech JA, Cakmak S, Krewski D. 2001. Association between ozone and hospitalization for acute respiratory diseases in children less than 2 years of age. Am J Epidemiol 153:444-52.

~~1184.~~1180. Calderon-Garciduenas L, Osnaya N, Rodriguez-Alcaraz A, Villarreal-Calderon A. 1997. DNA damage in nasal respiratory epithelium from children exposed to urban pollution. Environ Mol Mutagen 30:11-20.

~~1185.~~1181. Calderon-Garciduenas L, Osorno-Velazquez A, Bravo-Alvarez H, Delgado-Chavez R, Barrios-Marquez R. 1992. Histopathologic changes of the nasal mucosa in southwest Metropolitan Mexico City inhabitants. Am J Pathol 140:225-32.

~~1186.~~1182. Calderon-Garciduenas L, Rodriguez-Alcaraz A, Garcia R, Ramirez L, Barragan G. 1995. Nasal inflammatory responses in children exposed to a polluted urban atmosphere. J Toxicol Environ Health 45:427-37.

~~1187.~~1183. Calderon-Garciduenas L, Wen-Wang L, Zhang YJ, Rodriguez-Alcaraz A, Osnaya N, Villarreal-Calderon A, Santella RM. 1999. 8-hydroxy-2'-deoxyguanosine, a major mutagenic oxidative DNA lesion, and DNA strand breaks in nasal respiratory epithelium of children exposed to urban pollution. Environ Health Perspect 107:469-74.

~~1188.~~1184. Cassino C, Ito K, Bader I, Ciotoli C, Thurston G, Reibman J. 1999. Cigarette smoking and ozone-associated emergency department use for asthma by adults in New York City. Am J Respir Crit Care Med 159:1773-9.

~~1189.~~1185. Castellsague J, Sunyer J, Saez M, Anto JM. 1995. Short-term association between air pollution and emergency room visits for asthma in Barcelona. Thorax 50:1051-6.

~~1190.~~1186. Charpin D, Pascal L, Birnbaum J, Armengaud A, Sambuc R, Lanteaume A, Vervloet D. 1999. Gaseous air pollution and atopy. Clin Exp Allergy 29:1474-80.

~~1191.~~1187. Chen L, Yang W, Jennison BL, Goodrich A, Omaye ST. 2002. Air pollution and birth weight in northern Nevada, 1991-1999. Inhal Toxicol 14:141-57.

~~1192.~~1188. Chen PC, Lai YM, Chan CC, Hwang JS, Yang CY, Wang JD. 1999. Short-term effect of ozone on the pulmonary function of children in primary school. Environ Health Perspect 107:921-5.

~~1193.~~1189. Chew FT, Goh DY, Ooi BC, Saharom R, Hui JK, Lee BW. 1999. Association of ambient air-pollution levels with acute asthma exacerbation among children in Singapore. Allergy 54:320-9.

~~1194.~~1190. Chock DP, Winkler SL, Chen C. 2000. A study of the association between daily ~~death~~ mortality and ambient air pollutant concentrations in Pittsburgh, Pennsylvania. J Air Waste Manag Assoc 50:1481-500.

~~1195.~~1191. Dab W, Medina S, Quenel P, Le Moullec Y, Le Tertre A, Thelot B, Monteil C, Lameloise P, Pirard P, Momas I, Ferry R, Festy B. 1996. Short term respiratory health effects of ambient air pollution: results of the APHEA project in Paris. J Epidemiol Community Health 50 Suppl 1:s42-6.

~~1196.~~1192. De Leon SF, Thurston GD, Ito K. 2003. Contribution of respiratory disease to nonrespiratory ~~death~~ mortality associations with air pollution. Am J Respir Crit Care Med 167:1117-23.

~~1197.~~1193. Delfino RJ, Coate BD, Zeiger RS, Seltzer JM, Street DH, Koutrakis P. 1996. Daily asthma severity in relation to personal ozone exposure and outdoor fungal spores. Am J Respir Crit Care Med 154:633-41.

~~1198.~~1194. Delfino RJ, Zeiger RS, Seltzer JM, Street DH. 1998a. Symptoms in pediatric asthmatics and air pollution: Differences in effects by symptom severity, anti-inflammatory medication use, and particulate averaging time. Environ Health Perspect 106: 751-61.

~~1199.~~1195. Delfino RJ, Murphy-Moulton AM, Becklake MR. 1998b. Emergency room visits for respiratory illnesses among the elderly in Montreal: association with low level ozone exposure. Environ Res 76:67-77.

~~1200.~~1196. Delfino RJ, Murphy-Moulton AM, Burnett RT, Brook JR, Becklake MR. 1997a. Effects of air pollution on emergency room visits for respiratory illnesses in Montreal, Quebec. Am J Respir Crit Care Med 155:568-76.

~~1201.~~1197. Delfino RJ, Zeiger RS, Seltzer JM, Street DH, Matteucci RM, Anderson PR, Koutrakis P. 1997b. The effect of outdoor fungal spore concentrations on daily asthma severity. Environ Health Perspect 105:622-35.

~~1202.~~1198. Delfino RJ, Gong H Jr, Linn WS, Hu Y, Pellizzari ED. 2003. Asthma symptoms in Hispanic children and daily ambient exposures to toxic and criteria air pollutants. Environ Health Perspect 111:647-656.

~~1203.~~1199. Delfino RJ, Quintana PJE, Floro J, Gastañaga VM, Samimi BS, Kleinman MT, Liu L-JS, Bufalino C, Wu C-F, McLaren CE. 2004. Association of FEV1 in asthmatic children with personal and microenvironmental exposure to airborne particulate matter. Environ Health Perspect 112:932-41.

~~1204.~~1200. Desqueyroux H, Pujet JC, Prosper M, Le Moullec Y, Momas I. 2002. Effects of air pollution on adults with chronic obstructive pulmonary disease. Arch Environ Health 57:554-60.

~~1205.~~1201. Detels R, Tashkin DP, Sayre JW, Rokaw SN, Coulson AH, Massey FJ Jr, Wegman DH. 1987. The UCLA population studies of chronic obstructive respiratory disease. 9. Lung function changes associated with chronic exposure to photochemical oxidants; a cohort study among never-smokers. Chest 92:594-603.

~~1206.~~1202. Detels R, Tashkin DP, Sayre JW, Rokaw SN, Massey FJ Jr, Coulson AH, Wegman DH. 1991. The UCLA population studies of CORD: X. A cohort study of changes in respiratory function associated with chronic exposure to SOx, NOx, and hydrocarbons. Am J Public Health 81:350-9.

~~1207.~~1203. Devlin RB, McDonnell WF, Mann R, Becker S, House DE, Schreinemachers D, Koren HS. 1991. Exposure of humans to ambient levels of ozone for 6.6 hours causes cellular and biochemical changes in the lung. Am J Respir Cell Mol Biol 4:72-81.

~~1208.~~1204. Diaz J, Garcia R, Ribera P, Alberdi JC, Hernandez E, Pajares MS, Otero A. 1999. Modeling of air pollution and its relationship with ~~death~~ mortality and ~~disease~~ morbidity in Madrid, Spain. Int Arch Occup Environ Health 72:366-76.

~~1209.~~1205. Dockery DW, Schwartz J, Spengler JD. 1992. Air pollution and daily ~~death~~ mortality: associations with particulates and acid aerosols. Environ Res 59:362-73.

~~1210.~~1206. Dominici F, Daniels M, McDermott A, Zeger SL, Samet JM. 2003. Shape of the Exposure-Response Relation and ~~Death~~ Mortality Displacement in the NMMAPS Database. Health Effects Institute Special Report. Health Effects Institute Special Report:91-6.

~~1211.~~1207. Dominici F, McDermott A, Zeger SL, Samet JM. 2002. On the use of generalized additive models in time-series studies of air pollution and health. Am J Epidemiol 156:193-203.

~~1212.~~1208. Euler GL, Abbey DE, Hodgkin JE, Magie AR. 1988. Chronic obstructive pulmonary disease symptom effects of long-term cumulative exposure to ambient levels of total oxidants and nitrogen dioxide in California Seventh-Day Adventist residents. Arch Environ Health 43:279-85.

~~1213.~~1209. Fairley D. 1999. Daily ~~death~~ mortality and air pollution in Santa Clara County, California: 1989-1996. Environ Health Perspect 107: 637-41.

~~1214.~~1210. Fairley D. 2003. ~~Death~~ Mortality and Air Pollution for Santa Clara County, California, 1989-1996. Health Effects Institute Special Report. Health Effects Institute Special Report. ~~:~~ 97-106.

~~1215.~~1211. Friedman, M.S., Powell, K.E., Lori Hutwagner, LeRoy M. Graham, W. Gerald Teague. 2001. Impact of Changes in Transportation and Commuting Behaviors During the 1996 Summer Olympic Games in Atlanta on Air Quality and Childhood Asthma. JAMA 285:897-905.

~~1216.~~1212. Frischer T, Studnicka M, Gartner C, Tauber E, Horak F, Veiter A, Spengler J, Kuhr J, Urbanek R. 1999. Lung function growth and ambient ozone: a three-year population study in school children. Am J Respir Crit Care Med 160:390-6.

~~1217.~~1213. Galizia A, Kinney PL. 1999. Long-term residence in areas of high ozone: associations with respiratory health in a nationwide sample of nonsmoking young adults. Environ Health Perspect 107:675-9.

~~1218.~~1214. Gamble JF. 1998. PM2.5 and ~~death~~ mortality in long-term prospective cohort studies: cause-effect or statistical associations? Environ Health Perspect 106:535-49.

~~1219.~~1215. Garcia-Aymerich J, Tobias A, Anto JM, Sunyer J . 2000. Air pollution and ~~death~~ mortality in a cohort of patients with chronic obstructive pulmonary disease: a time series analysis. J Epidemiol Community Health 54:73-4.

~~1220.~~1216. Garty BZ, Kosman E, Ganor E, Berger V, Garty L, Wietzen T, Waisman Y, Mimouni M, Waisel Y. 1998. Emergency room visits of asthmatic children, relation to air pollution, weather, and airborne allergens. Ann Allergy Asthma Immunol 81:563-70.

~~1221.~~1217. Gauderman WJ, McConnell R, Gilliland F, London S, Thomas D, Avol E, Vora H, Berhane K, Rappaport EB, Lurmann F, Margolis HG, Peters J. 2000. Association between air pollution and lung function growth in southern California children. Am J Respir Crit Care Med 162:1383-90.

~~1222.~~1218. Gauderman WJ, Avol E, Gilliland F, Vora H, Thomas D, Berhane K, McConnell R, Kuenzli N, Lurmann F, Rappaport E, Margolis H, Bates D, Peters J. 2004. The effect of air pollution on lung development from 10 to 18 years of age. N Engl J Med 351(11):1057-67

~~1223.~~1219. Gent JF, Triche EW, Holford TR, Belanger K, Bracken MB, Beckett WS, Leaderer BP. 2003. Association of low-level ozone and fine particles with respiratory symptoms in children with asthma. JAMA 290:1859-67.

~~1224.~~1220. Gielen MH, van der Zee SC, van Wijnen JH, van Steen CJ, Brunekreef B. 1997. Acute effects of summer air pollution on respiratory health of asthmatic children. Am J Respir Crit Care Med 155:2105-8.

~~1225.~~1221. Gilliland FD, Berhane K, Rappaport EB, Thomas DC, Avol E, Gauderman WJ, London SJ, Margolis HG, McConnell R, Islam KT, Peters JM. 2001. The effects of ambient air pollution on school absenteeism due to respiratory illnesses. Epidemiology 12:43-54.

~~1226.~~1222. Gold DR, Damokosh AI, Pope CA 3rd, Dockery DW, McDonnell WF, Serrano P, Retama A, Castillejos M. 1999. Particulate and ozone pollutant effects on the respiratory function of children in southwest Mexico City. Epidemiology 10:8-16.

~~1227.~~1223. Goldberg MS, Burnett RT. 2003. Revised analysis of the Montreal time-series study. Health Effects Institute Special Report. Health Effects Institute Special Report:113-32.

~~1228.~~1224. Goldberg MS, Burnett RT, Stieb D. 2003. A review of time-series studies used to evaluate the short-term effects of air pollution on human health. Rev Environ Health 18:269-303.

~~1229.~~1225. Gong H Jr, Simmons MS, Linn WS, McDonnell WF, Westerdahl D. 1998. Relationship between acute ozone responsiveness and chronic loss of lung function in residents of a high-ozone community. Arch Environ Health 53:313-9.

~~1230.~~1226. Gouveia N, Fletcher T. 2000a. Respiratory diseases in children and outdoor air pollution in Sao Paulo, Brazil: a time series analysis. Occup Environ Med 57:477-83.

~~1231.~~1227. Gouveia N, Fletcher T. 2000b. Time series analysis of air pollution and ~~death~~ mortality: effects by cause, age and socioeconomic status. J Epidemiol Community Health 54:750-5.

~~1232.~~1228. Gryparis A, Forsberg B, Katsouyanni K, Analitis A, Touloumi G, Schwartz J, Samoli E, Medina S, Anderson H~~OU~~R, Niciu EM, Wichmann HE, Kriz B, Kosnik M, Skorkovsky J, Vonk JM, Dortbudak Z. 2004. Acute effects of ozone on ~~death~~ mortality from the "air pollution and health: a European approach" project. Am J Respir Crit Care Med. 170:1080-7.

~~1233.~~1229. Gwynn RC, Burnett RT, Thurston GD. 2000. A time-series analysis of acidic particulate matter and daily ~~death~~ mortality and ~~disease~~morbidity in the Buffalo, New York, region. Environ Health Perspect 108:125-33.

~~1234.~~1230. Hagen JA, Nafstad P, Skrondal A, Bjorkly S, Magnus P. 2000. Associations between outdoor air pollutants and hospitalization for respiratory diseases. Epidemiology 11:136-40.

~~1235.~~1231. Hajat S, Anderson H~~OU~~R, Atkinson RW, Haines A. 2002. Effects of air pollution on general practitioner consultations for upper respiratory diseases in London. Occup Environ Med 59:294-9.

~~1236.~~1232. Hernandez-Garduno E, Perez-Neria J, Paccagnella AM, Pina-Garcia M, Munguia-Castro M, Catalan-Vazquez M, Rojas-Ramos M. 1997. Air pollution and respiratory health in Mexico City. J Occup Environ Med 39:299-307.

~~1237.~~1233. Hiltermann TJ, Stolk J, van der Zee SC, Brunekreef B, de Bruijne CR, Fischer PH, Ameling CB, Sterk PJ, Hiemstra PS, van Bree L~~-~~. 1998. Asthma severity and susceptibility to air pollution. Eur Respir J 11:686-93.

~~1238.~~1234. Hodgkin JE, Abbey DE, Euler GL, Magie AR. 1984. COPD prevalence in nonsmokers in high and low photochemical air pollution areas. Chest 86:830-8.

~~1239.~~1235. Hoek G. 2003. Daily ~~Death~~ Mortality and Air Pollution in The Netherlands. Special Report, Health Effects Institute. Special Report, Health Effects Institute.~~:~~ 133-42.

~~1240.~~1236. Hoek G, Brunekreef B, Verhoeff A, van Wijnen J, Fischer P. 2000. Daily ~~death~~ mortality and air pollution in The Netherlands. J Air Waste Manag Assoc 50:1380-9.

~~1241.~~1237. Hoek G, Fischer P, Van Den Brandt P, Goldbohm S, Brunekreef B. 2001. Estimation of long-term average exposure to outdoor air pollution for a cohort study on ~~death~~ mortality. J Expo Anal Environ Epidemiol 11:459-69.

~~1242.~~1238. Hoek G, Schwartz JD, Groot B, Eilers P. 1997. Effects of ambient particulate matter and ozone on daily ~~death~~ mortality in Rotterdam, The Netherlands. Arch Environ Health 52:455-63.

~~1243.~~1239. Holmen A, Blomqvist J, Frindberg H, Johnelius Y, Eriksson NE, Henricson KA, Herrstrom P, Hogstedt B. 1997. Frequency of patients with acute asthma in relation to ozone, nitrogen dioxide, other pollutants of ambient air and meteorological observations. Int Arch Occup Environ Health 69:317-22.

~~1244.~~1240. Ito K. 2003. Associations of Particulate Matter Components with Daily ~~Death~~ mortality and ~~Disease~~ Morbidity in Detroit, Michigan. Health Effects Institute Special Report. Health Effects Institute Special Report. ~~:~~143-56.

~~1245.~~1241. Ito K, Thurston GD. 1996. Daily PM10/~~death~~ mortality associations: an investigation~~ns~~ of at-risk subpopulations. J Expo Anal Environ Epidemiol 6:79-95.

~~1246.~~1242. Jaffe DH, Singer ME, Rimm AA. 2003. Air pollution and emergency department visits for asthma among Ohio Medicaid recipients, 1991-1996. Environ Res 91:21-8.

~~1247.~~1243. Jones GN, Sletten C, Mandry C, Brantley PJ. 1995. Ozone level effect on respiratory illness: an investigation of emergency department visits. South Med J 88:1049-56.

~~1248.~~1244. Kinney PL, Aggarwal M, Nikiforov SV, Nadas A. 1998. Long-term exposure to ozone: development of methods to estimate past exposures and health outcomes.~~Methods development for epidemiologic investigations of the health effects of prolonged ozone exposure. Part III. An approach to retrospective estimation of lifetime ozone exposure using a questionnaire and ambient monitoring data (U.S. sites).~~ Res Rep Health Eff Inst. ~~:~~79-108; discussion 109-21.

~~1249.~~1245. Kinney PL, Ito K, Thurston GD. 1995. A sensitivity analysis of ~~death~~ mortality/PM10 associations in Los Angeles. In: Phalen, RF, Bates DV, eds. Proceedings of the colloquium on particulate air pollution and human ~~death and disease~~mortality and morbidity~~,~~. January 1994, Irvine, CA. 7.

7:59-69.

~~1250.~~1246. Kinney PL, Lippmann M. 2000. Respiratory effects of seasonal exposures to ozone and particles. Arch Environ Health 55:210-6.

~~1251.~~1247. Kinney PL, Nilsen DM, Lippmann M, Brescia M, Gordon T, McGovern T, El-Fawal H, Devlin RB, Rom WN. 1996. Biomarkers of lung inflammation in recreational joggers exposed to ozone. Am J Respir Crit Care Med 154:1430-5.

~~1252.~~1248. Kinney PL, Ozkaynak H. 1991. Associations of daily ~~death~~ mortality and air pollution in Los Angeles County. Environ Res 54:99-120.

~~1253.~~1249. Klemm RJ, Mason RM Jr. 2000. Aerosol Research and Inhalation Epidemiological Study (ARIES): air quality and daily ~~death~~ mortality statistical modeling--interim results. J Air Waste Manag Assoc 50:1433-9.

~~1254.~~1250. Kopp MV, Ulmer C, Ihorst G, Seydewitz HH, Frischer T, Forster J, Kuehr J. 1999. Upper airway inflammation in children exposed to ambient ozone and potential signs of adaptation. Eur Respir J 14:854-61.

~~1255.~~1251. Kunzli N, Lurmann F, Segal M, Ngo L, Balmes J, Tager IB. 1997. Association between lifetime ambient ozone exposure and pulmonary function in college freshmen--results of a pilot study. Environ Res 72:8-23.

~~1256.~~1252. Kuo HW, Lai JS, Lee MC, Tai RC, Lee MC. 2002. Respiratory effects of air pollutants among asthmatics in central Taiwan. Arch Environ Health 57:194-200.

~~1257.~~1253. Lee JT, Schwartz J. 1999. Reanalysis of the effects of air pollution on daily ~~death~~ mortality in Seoul, Korea: A case-crossover design. Environ Health Perspect 107:633-6.

~~1258.~~1254. Lee JT, Shin D, Chung Y. 1999. Air pollution and daily ~~death~~ mortality in Seoul and Ulsan, Korea. Environ Health Perspect 107:149-54.

~~1259.~~1255. Lierl MB, Hornung RW. 2003. Relationship of outdoor air quality to pediatric asthma exacerbations. Ann Allergy Asthma Immunol 90:28-33.

~~1260.~~1256. Lin CA, Martins MA, Farhat SC, Pope CA 3rd, Conceicao GM, Anastacio VM, Hatanaka M, Andrade WC, Hamaue WR, Bohm GM, Saldiva PH . 1999. Air pollution and respiratory illness of children in Sao Paulo, Brazil. Paediatr Perinat Epidemiol 13:475-88.

~~1261.~~1257. Lin M, Chen Y, Burnett RT, Villeneuve PJ, Krewski D. 2003. Effect of short-term exposure to gaseous pollution on asthma hospitalisation in children: a bi-directional case-crossover analysis. J Epidemiol Community Health 57:50-5.

~~1262.~~1258. Linn WS, Shamoo DA, Anderson KR, Peng RC, Avol EL, Hackney JD, Gong H Jr. 1996. Short-term air pollution exposures and responses in Los Angeles area schoolchildren. J Expo Anal Environ Epidemiol 6:449-72.

~~1263.~~1259. Linn WS, Szlachcic Y, Gong H Jr, Kinney PL, Berhane KT. 2000. Air pollution and daily hospital admissions in metropolitan Los Angeles. Environ Health Perspect 108:427-34.

~~1264.~~1260. Lipfert FW, Morris SC, Wyzga RE. 2000. Daily ~~death~~ mortality in the Philadelphia metropolitan area and size-classified particulate matter. J Air Waste Manag Assoc 50:1501-13.

~~1265.~~1261. Lippmann M, Ito K, Nadas A, Burnett RT. 2000. Association of particulate matter components with daily ~~death~~ mortality and ~~disease~~ morbidity in urban populations. Res Rep Health Eff Inst :5-72, discussion 73-82.

~~1266.~~1262. Lipsett M, Hurley S, Ostro B. 1997. Air pollution and emergency room visits for asthma in Santa Clara County, California. Environ Health Perspect 105:216-22.

~~1267.~~1263. Mann JK, Tager IB, Lurmann F, Segal M, Quesenberry CP Jr, Lugg MM, Shan J, Van Den Eeden SK. 2002. Air pollution and hospital admissions for ischemic heart disease in persons with congestive heart failure or arrhythmia. Environ Health Perspect 110:1247-52~~-~~.

~~1268.~~1264. Martins LC, Latorre Mdo R, Saldiva PH, Braga AL. 2002. Air pollution and emergency room visits due to chronic lower respiratory diseases in the elderly: an ecological time-series study in Sao Paulo, Brazil. J Occup Environ Med 44:622-7.

~~1269.~~1265. McConnell R, Berhane K, Gilliland F, London SJ, Islam T, Gauderman WJ, Avol E, Margolis HG, Peters JM. 2002. Asthma in exercising children exposed to ozone: a cohort study. Lancet 359:386-91.

~~1270.~~1266. McDonnell WF, Abbey DE, Nishino N, Lebowitz MD~~-~~. 1999. Long-term ambient ozone concentration and the incidence of asthma in nonsmoking adults: the AHSMOG Study. Environ Res 80:110-21.

~~1271.~~1267. Moolgavkar SH, Luebeck EG, Anderson EL. 1997. Air pollution and hospital admissions for respiratory causes in Minneapolis-St. Paul and Birmingham. Epidemiology 8:364-70.

~~1272.~~1268. Moolgavkar SH, Luebeck EG, Hall TA, Anderson EL. 1995. Air pollution and daily ~~death~~ mortality in Philadelphia. Epidemiology 6: 476-84.

~~1273.~~1269. Moolgavkar, S. H. and Lubeck, E. G. 1996. A critical review of the evidence on particulate air pollution and ~~death~~ mortality. Epidemiology 7, 420-428.

~~1274.~~1270. Morgan G, Corbett S, Wlodarczyk J, Lewis P. 1998. Air pollution and daily ~~death~~ mortality in Sydney, Australia, 1989 through 1993. Am J Public Health 88:759-64.

~~1275.~~1271. Mortimer KM, Tager IB, Dockery DW, Neas LM, Redline S. 2000. The Effect of Ozone on Inner-City Children with Asthma. Identification of Susceptible Subgroups. Am J Respir Crit Care Med 162:1838-1845.

~~1276.~~1272. Mullahy J, Portney PR. 1990. Air pollution, cigarette smoking, and the production of respiratory health. J Health Econ 9:193-205.

~~1277.~~1273. Nauenberg E, Basu K. 1999. Effect of insurance coverage on the relationship between asthma hospitalizations and exposure to air pollution. Public Health Rep 114:135-48.

~~1278.~~1274. Neas LM, Dockery DW, Koutrakis P, Speizer FE. 1999a. Fine particles and peak flow in children: acidity versus mass. Epidemiology 10:550-3.

~~1279.~~1275. Neas LM, Schwartz J, Dockery D. 1999b. A case-crossover analysis of air pollution and ~~death~~ mortality in Philadelphia. Environ Health Perspect 107~~-~~:629-31.

~~1280.~~1276. Nutman A, Solomon Y, Mendel S, Nutman J, Hines E, Topilsky M, Kivity S. 1998. The use of a neural network for studying the relationship between air pollution and asthma-related emergency room visits. Respir Med 92:1199-202.

~~1281.~~1277. Ostro B. 1995. Fine particulate air pollution and ~~death~~ mortality in two Southern California counties. Environ Res 70:98-104.

~~1282.~~1278. Ostro B, Lipsett M, Mann J, Braxton-Owens H, White M. 2001. Air pollution and exacerbation of asthma in African-American children in Los Angeles. Epidemiology 12:200-8.

~~1283.~~1279. Ostro B, Sanchez JM, Aranda C, Eskeland GS. 1996. Air pollution and ~~death~~ mortality: results from a study of Santiago, Chile. J Expo Anal Environ Epidemiol 6:97-114.

~~1284.~~1280. Pereira LA, Loomis D, Conceicao GM, Braga AL, Arcas RM, Kishi HS, Singer JM, Bohm GM, Saldiva PH. 1998. Association between air pollution and intrauterine ~~death~~ mortality in Sao Paulo, Brazil. Environ Health Perspect 106:325-9.

~~1285.~~1281. Peters A, Skorkovsky J, Kotesovec F, Brynda J, Spix C, Wichmann HE, Heinrich J. 2000. Associations between ~~death~~ mortality and air pollution in central Europe. Environ Health Perspect 108:283-7.

~~1286.~~1282. Peters JM, Avol E, Gauderman WJ, Linn WS, Navidi W, London SJ, Margolis H, Rappaport E, Vora H, Gong H Jr, Thomas DC. 1999a. A study of twelve Southern California communities with differing levels and types of air pollution. II. Effects on pulmonary function. Am J Respir Crit Care Med 159:768-75.

~~1287.~~1283. Peters JM, Avol E, Navidi W, London SJ, Gauderman WJ, Lurmann F, Linn WS, Margolis H, Rappaport E, Gong H, Thomas DC. 1999b. A study of twelve Southern California communities with differing levels and types of air pollution. I. Prevalence of respiratory disease. Am J Respir Crit Care Med 159:760-7.

~~1288.~~1284. Petroeschevsky A, Simpson RW, Thalib L, Rutherford S. 2001. Associations between outdoor air pollution and hospital admissions in Brisbane, Australia. Arch Environ Health 56:37-52~~-~~.

~~1289.~~1285. Ponce de Leon A, Anderson H~~OU~~R, Bland JM, Strachan DP, Bower J. 1996. Effects of air pollution on daily hospital admissions for respiratory disease in London between 1987-88 and 1991-92. J Epidemiol Community Health 50 Suppl 1:s63-70.

~~1290.~~1286. Ponka A, Savela M, Virtanen M. 1998. ~~Death~~ Mortality and air pollution in Helsinki. Arch Environ Health 53:281-6.

~~1291.~~Ponka A, Virtanen M. 1996. Asthma and ambient air pollution in Helsinki. J Epidemiol Community Health 50 Suppl 1:s59-62.

1287.

~~1292.~~1288. Pope CA 3rd, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, Thurston GD. 2002. Lung cancer, cardiopulmonary ~~death~~ mortality, and long-term exposure to fine particulate air pollution. JAMA 287:1132-41.

~~1293.~~1289. Prescott GJ, Cohen GR, Elton RA, Fowkes FG, Agius RM. 1998. Urban air pollution and cardiopulmonary ill health: a 14.5 year time series study. Occup Environ Med 55:697-704.

~~1294.~~1290. Ramadour M, Burel C, Lanteaume A, Vervloet D, Charpin D, Brisse F, Dutau H, Charpin D. 2000. Prevalence of asthma and rhinitis in relation to long-term exposure to gaseous air pollutants. Allergy 55:1163-9.

~~1295.~~1291. Ritz B, Yu F, Chapa G, Fruin S. 2000. Effect of air pollution on preterm birth among children born in Southern California between 1989 and 1993. Epidemiology 11:502-11.

~~1296.~~1292. Roemer WH, van Wijnen JH. 2001. Daily ~~death~~ mortality and air pollution along busy streets in Amsterdam, 1987-1998. Epidemiology 12:649-53.

~~1297.~~1293. Romieu I, Meneses F, Ruiz S, Huerta J, Sienra JJ, White M, Etzel R, Hernandez M. 1997. Effects of intermittent ozone exposure on peak expiratory flow and respiratory symptoms among asthmatic children in Mexico City-. Arch Environ Health 52:368-76.

~~1298.~~1294. Romieu I, Meneses F, Ruiz S, Sienra JJ, Huerta J, White MC, Etzel RA. 1996. Effects of air pollution on the respiratory health of asthmatic children living in Mexico City. Am J Respir Crit Care Med 154:300-7.

~~1299.~~1295. Romieu I, Meneses F, Sienra-Monge JJ, Huerta J, Ruiz Velasco S, White MC, Etzel RA, Hernandez-Avila M. 1995. Effects of urban air pollutants on emergency visits for childhood asthma in Mexico City. Am J Epidemiol 141:546-53.

~~1300.~~1296. Ross MA, Persky VW, Scheff PA, Chung J, Curtis L, Ramakrishnan V, Wadden RA, Hryhorczuk DO. 2002. Effect of ozone and aeroallergens on the respiratory health of asthmatics. Arch Environ Health 57:568-78.

~~1301.~~1297. Saez M, Tobias A, Munoz P, Campbell MJ. 1999. A GEE moving average analysis of the relationship between air pollution and ~~death~~ mortality for asthma in Barcelona, Spain. Stat Med 18:2077-86.

~~1302.~~1298. Saldiva PH, Lichtenfels AJ, Paiva PS, Barone IA, Martins MA, Massad E, Pereira JC, Xavier VP, Singer JM, Bohm GM. 1994. Association between air pollution and ~~death~~ mortality due to respiratory diseases in children in Sao Paulo, Brazil: a preliminary report. Environ Res 65:218-25.

~~1303.~~1299. Saldiva PH, Pope CA 3rd, Schwartz J, Dockery DW, Lichtenfels AJ, Salge JM, Barone I, Bohm GM. 1995. Air pollution and ~~death~~ mortality in elderly people: a time-series study in Sao Paulo, Brazil. Arch Environ Health 50:159-63.

~~1304.~~1300. Samet JM, Dominici F, Curriero FC, Coursac I, Zeger SL. 2000. Fine particulate air pollution and ~~death~~ mortality in 20 U.S. cities, 1987-1994. N Engl J Med 343:1742-9.

~~1305.~~1301. Sartor F, Snacken R, Demuth C, Walckiers D. 1995. Temperature, ambient ozone levels, and ~~death~~ mortality during summer 1994, in Belgium. Environ Res 70:105-13.

~~1306.~~1302. Schmitzberger R, Rhomberg K, Buchele H, Puchegger R, Schmitzberger-Natzmer D, Kemmler G, Panosch B. 1993. Effects of air pollution on the respiratory tract of children. Pediatr Pulmonol 15:68-74.

~~1307.~~1303. Schouten JP, Vonk JM, de Graaf A. 1996. Short term effects of air pollution on emergency hospital admissions for respiratory disease: results of the APHEA project in two major cities in The Netherlands, 1977-89. J Epidemiol Community Health 50 Suppl 1:s22-9.

~~1308.~~1304. Schwartz J. 1989. Lung function and chronic exposure to air pollution: a cross-sectional analysis of NHANES II. Environ Res 50:309-21.

~~1309.~~1305. Schwartz J. 1991. Particulate air pollution and daily ~~death~~ mortality in Detroit. Environ Res 56:204-13.

~~1310.~~1306. Schwartz J. 1996. Air pollution and hospital admissions for respiratory disease. Epidemiology 7:20-8.

~~1311.~~1307. Schwartz J, Slater D, Larson TV, Pierson WE, Koenig JQ. 1993. Particulate air pollution and hospital emergency room visits for asthma in Seattle. Am Rev Respir Dis 147:826-831.

~~1312.~~1308. Schwartz J, Spix C, Touloumi G, Bacharova L, Barumamdzadeh T, le Tertre A, Piekarksi T, Ponce de Leon A, Ponka A, Rossi G, Saez M, Schouten JP. 1996. Methodological issues in studies of air pollution and daily counts of deaths or hospital admissions. J Epidemiol Community Health 50 Suppl 1:S3-11.

~~1313.~~1309. Sheppard L, Levy D, Norris G, Larson TV, Koenig JQ. 1999. Effects of ambient air pollution on nonelderly asthma hospital admissions in Seattle, Washington, 1987-1994. Epidemiology 10:23-30.

~~1314.~~1310. Simpson RW, Williams G, Petroeschevsky A, Morgan G, Rutherford S. 1997. Associations between outdoor air pollution and daily ~~death~~ mortality in Brisbane, Australia. Arch Environ Health 52:442-54.

~~1315.~~1311. Stern B, Jones L, Raizenne M, Burnett R, Meranger JC, Franklin CA. 1989. Respiratory health effects associated with ambient sulfates and ozone in two rural Canadian communities. Environ Res 49:20-39.

~~1316.~~1312. Stern BR, Raizenne ME, Burnett RT, Jones L, Kearney J, Franklin CA. 1994. Air pollution and childhood respiratory health: exposure to sulfate and ozone in 10 Canadian rural communities. Environ Res 66: 125-42.

~~1317.~~1313. Stieb DM, Burnett RT, Beveridge RC, Brook JR. 1996. Association between ozone and asthma emergency department visits in Saint John, New Brunswick, Canada. Environ Health Perspect 104:1354-60.

~~1318.~~1314. Sunyer J, Basagana X. 2001. Particles, and not gases, are associated with the risk of death in patients with chronic obstructive pulmonary disease. Int J Epidemiol 30:1138-40.

~~1319.~~1315. Sunyer J, Castellsague J, Saez M, Tobias A, Anto JM. 1996. Air pollution and ~~death~~ mortality in Barcelona. J Epidemiol Community Health 50 Suppl 1:s76-80.

~~1320.~~1316. Tager IB, Kunzli N, Ngo L, Balmes J. 1998. Methods development for epidemiologic investigations of the health effects of prolonged ozone exposure. Part I: Variability of pulmonary function measures. Res Rep Health Eff Inst :1-25; discussion 109-21.

~~1321.~~1317. Tellez-Rojo MM, Romieu I, Ruiz-Velasco S, Lezana MA, Hernandez-Avila MM. 2000. Daily respiratory ~~death~~ mortality and PM10 pollution in Mexico City: importance of considering place of death. Eur Respir J 16: 391-6.

~~1322.~~1318. Tenias JM, Ballester F, Perez-Hoyos S, Rivera ML. 2002. Air pollution and hospital emergency room admissions for chronic obstructive pulmonary disease in Valencia, Spain. Arch Environ Health 57:41-7.

~~1323.~~1319. Tenias JM, Ballester F, Rivera ML. 1998. Association between hospital emergency visits for asthma and air pollution in Valencia, Spain. Occup Environ Med 55:541-7.

~~1324.~~1320. Thompson AJ, Shields MD, Patterson CC. 2001. Acute asthma exacerbations and air pollutants in children living in Belfast, Northern Ireland. Arch Environ Health 56:234-41.

~~1325.~~1321. Tobias A, Campbell MJ, Saez M. 1999. Modelling asthma epidemics on the relationship between air pollution and asthma emergency visits in Barcelona, Spain. Eur J Epidemiol 15:799-803.

~~1326.~~1322. Tolbert PE, Mulholland JA, MacIntosh DL, Xu F, Daniels D, Devine OJ, Carlin BP, Klein M, Dorley J, Butler AJ, Nordenberg DF, Frumkin H, Ryan PB, White MC. 2000. Air quality and pediatric emergency room visits for asthma in Atlanta, Georgia, USA. Am J Epidemiol 151:798-810.

~~1327.~~1323. Touloumi G, Katsouyanni K, Zmirou D, Schwartz J, Spix C, de Leon AP, Tobias A, Quennel P, Rabczenko D, Bacharova L, Bisanti L, Vonk JM, Ponka A. 1997. Short-term effects of ambient oxidant exposure on ~~death~~ mortality: a combined analysis within the APHEA project. Air Pollution and Health: a European Approach. Am J Epidemiol 146:177-85.

~~1328.~~1324. US EPA. 1996. Air Quality Criteria for Ozone and Related Photochemical Oxidants. Vol. 3.

~~1329.~~1325. Vedal S, Brauer M, White R, Petkau J. 2003. Air pollution and daily ~~death~~ mortality in a city with low levels of pollution. Environ Health Perspect 111:45-52.

~~1330.~~1326. Verhoeff AP, Hoek G, Schwartz J, van Wijnen JH–. 1996. Air pollution and daily ~~death~~ mortality in Amsterdam. Epidemiology 7:225-30.

~~1331.~~1327. Weisel CP, Cody RP, Georgopoulos PG, Purushothaman V, Weiss SH, Bielory L, Gregory P, Stern AH. 2002. Concepts in developing health-based indicators for ozone. Int Arch Occup Environ Health 75:415-22.

~~1332.~~1328. Weisel CP, Cody RP, Lioy PJ. 1995. Relationship between summertime ambient ozone levels and emergency department visits for asthma in central New Jersey. Environ Health Perspect 103 Suppl 2:97-102.

~~1333.~~1329. White MC, Etzel RA, Wilcox WD, Lloyd C. 1994. Exacerbations of childhood asthma and ozone pollution in Atlanta. Environ Res 65:56-68.

~~1334.~~1330. Wong TW, Lau TS, Yu TS, Neller A, Wong SL, Tam W, Pang SW. 1999. Air pollution and hospital admissions for respiratory and cardiovascular diseases in Hong Kong. Occup Environ Med 56:679-83.

~~1335.~~1331. Zmirou D, Barumandzadeh T, Balducci F, Ritter P, Laham G, Ghilardi JP. 1996. Short term effects of air pollution on ~~death~~ mortality in the city of Lyon, France, 1985-90. J Epidemiol Community Health 50 Suppl 1:S30-5.

~~1336.~~1332. Zmirou D, Schwartz J, Saez M, Zanobetti A, Wojtyniak B, Touloumi G, Spix C, Ponce de Leon A, Le Moullec Y, Bacharova L, Schouten J, Ponka A, Katsouyanni K. 1998. Time-series analysis of air pollution and cause-specific ~~death~~ mortality. Epidemiology 9:495-503.

~~1337.~~1333. Zwick H, Popp W, Wagner C, Reiser K, Schmoger J, Bock A, Herkner K, Radunsky K. 1991. Effects of ozone on the respiratory health, allergic sensitization, and cellular immune system in children. Am Rev Respir Dis 144:1075-9.

Chapter 11

~~1338.~~1334. Abbey DE, Nishino N, McDonnell WF, Burchette RJ, Knutsen SF, Lawrence Beeson W, Yang JX. 1999. Long-term inhalable particles and other air pollutants related to ~~death~~ mortality in nonsmokers. Am J Respir Crit Care Med 159:373-82.

~~1339.~~1335. Adams WC. 1998. Dose-response effects of varied equivalent minute ventilation rates on pulmonary function responses during exposure to ozone. Final Report to the American Petroleum Institute. Washington, D. C.

~~1340.~~1336. Adams WC. 2002. Comparison of chamber and face-mask 6.6-hour exposures to ozone on pulmonary function and symptoms responses. Inhal Toxicol 14:745-64.

~~1341.~~1337. Adams WC. 2003. Comparison of chamber and face mask 6.6-hour exposure to 0.08 ppm ozone via square-wave and triangular profiles on pulmonary responses. Inhal Toxicol 15:265-81.

~~1342.~~1338. American Thoracic Society. 1985. Guidelines as to what constitutes an adverse respiratory health effect, with special reference to epidemiologic studies of air pollution. 131. 131:666-8.

~~1343.~~1339. American Thoracic Society. 2000. What constitutes an adverse health effect of air pollution? 161. 161:665-73.

~~1344.~~1340. Anderson H~~OU~~R, Spix C, Medina S, Schouten JP, Castellsague J, Rossi G, Zmirou D, Touloumi G, Wojtyniak B, Ponka A, Bacharova L, Schwartz J, Katsouyanni K. 1997. Air pollution and daily admissions for chronic obstructive pulmonary disease in 6 European cities: results from the APHEA project. Eur Respir J 10:1064-71.

~~1345.~~1341. Bates DV (1992) Health indices of the adverse effects of air pollution: the question of coherence. Environ Res 43:217-31.

~~1346.~~1342. Bell M, McDermott A, Zeger S, Samet J, Dominici F. 2004. Ozone and short-term ~~death~~ mortality in 95 US urban communities, 1987-2000. JAMA 292, 19:2372-2378.

~~1347.~~1343. Brauer M, Blair J, Vedal S. 1996. Effect of ambient ozone exposure on lung function in farm workers. Am J Respir Crit Care Med 154:981-7.

~~1348.~~1344. Burnett RT, Cakmak S, Brook JR, Krewski D. 1997. The role of particulate size and chemistry in the association between summertime ambient air pollution and hospitalization for cardiorespiratory diseases. Environ Health Perspect 105:614-20.

~~1349.~~1345. California Department of Health Services. 1987. Recommendation for an Ambient Air Quality Standard for Ozone.

~~1350.~~1346. Catalano PJ, Rogus J, Ryan LM. 1995. Consequences of prolonged inhalation of ozone on F344/N rats: collaborative studies. Part X: Robust composite scores based on median polish analysis. Res Rep Health Eff Inst :1-57; discussion 59-64.

~~1351.~~1347. Dominici F. 2003. Shape of the Exposure-Response Relation and ~~Death~~ Mortality Displacement in the NMMAPS Database. Health Effects Institute Special Report. Health Effects Institute Special Report.~~:~~ 91-6.

~~1352.~~1348. Drechsler-Parks DM, Bedi JF, Horvath SM. 1987. Pulmonary function responses of older men and women to ozone exposure. Exp Gerontol 22:91-101.

~~1353.~~1349. Drechsler-Parks DM, Bedi JF, Horvath SM. 1989. Pulmonary function responses of young and older adults to mixtures of O3, NO2 and PAN-. Toxicol Ind Health 5:505-17.

~~1354.~~1350. Emmons K, Foster WM. 1991. Smoking cessation and acute airway response to ozone. Arch Environ Health 46:288-95.

~~1355.~~1351. Evans MJ, Fanucchi MV, Baker GL, Van Winkle LS, Pantle LM, Nishio SJ, Schelegle ES, Gershwin LJ, Miller LA, Hyde DM, Sannes PL, Plopper CG. 2003. Atypical development of the tracheal basement membrane zone of infant rhesus monkeys exposed to ozone and allergen. Am J Physiol Lung Cell Mol Physiol 285:L931-9.

~~1356.~~1352. Folinsbee LJ, Horstman DH, Kehrl HOUR, McDonnell WF, Gerrity TR, Seal. E. , Larson R, Hazucha MJ, Abdul-Salaam S, Faucette B, Ives PJ. 1991. Effects of single and repeated prolonged low-level ozone exposure in man. Presented at the annual meeting of the Society for Occupational and Environmental Health, March, Washington, DC.

~~1357.~~1353. Galizia A, Kinney PL. 1999. Long-term residence in areas of high ozone: associations with respiratory health in a nationwide sample of nonsmoking young adults. Environ Health Perspect 107:675-9.

~~1358.~~1354. Gauderman WJ, McConnell R, Gilliland F, London S, Thomas D, Avol E, Vora H, Berhane K, Rappaport EB, Lurmann F, Margolis HG, Peters J. 2000. Association between air pollution and lung function growth in southern California children. Am J Respir Crit Care Med 162:1383-90.

~~1359.~~1355. Gauderman WJ, Gilliland GF, Vora H, Avol E, Stram D, McConnell R, Thomas D, Lurmann F, Margolis HG, Rappaport EB, Berhane K, Peters JM. 2002. Association between air pollution and lung function growth in southern California children: results from a second cohort. Am J Respir Crit Care Med 166:76-84.

~~1360.~~1356. Gent JF, Triche EW, Holford TR, Belanger K, Bracken MB, Beckett WS, Leaderer BP. 2003. Association of low-level ozone and fine particles with respiratory symptoms in children with asthma. JAMA 290:1859-67.

~~1361.~~1357. Gilliland FD, Berhane K, Rappaport EB, Thomas DC, Avol E, Gauderman WJ, London SJ, Margolis HG, McConnell R, Islam KT, Peters JM. 2001. The effects of ambient air pollution on school absenteeism due to respiratory illnesses. Epidemiology 12:43-54.

~~1362.~~1358. Goldberg MS, Burnett RT, Valois MF, Flegel K, Bailar JC 3rd, Brook J, Vincent R, Radon K. 2003. Associations between ambient air pollution and daily ~~death~~ mortality among persons with congestive heart failure. Environ Res 91 :8-20.

~~1363.~~1359. Goldberg MS, Burnett RT. 2003. Revised analysis of the Montreal time-series study. Health Effects Institute Special Report. Health Effects Institute Special Report 113-32.

~~1364.~~1360. Gong H Jr, Bradley PW, Simmons MS, Tashkin DP. 1986. Impaired exercise performance and pulmonary function in elite cyclists during low-level ozone exposure in a hot environment. Am Rev Respir Dis 134:726-33.

~~1365.~~1361. Gong H Jr, Wong R, Sarma RJ, Linn WS, Sullivan ED, Shamoo DA, Anderson KR, Prasad SB. 1998 . Cardiovascular effects of ozone exposure in human volunteers. Am J Respir Crit Care Med 158:538-46.

~~1366.~~1362. Gryparis A, Forsberg B, Katsouyanni K, Analitis A, Touloumi G, Schwartz J, Samoli E, Medina S, Anderson HOUR, Niciu EM, Wichmann HE, Kriz B, Kosnik M, Skorkovsky J, Vonk JM, Dortbudak Z. 2004. Acute effects of ozone on ~~death~~ mortality from the "air pollution and health: a European approach" project. Am J Respir Crit Care Med. 170:1080-7.

~~1367.~~1363. Harkema JR, Plopper CG, Hyde DM, St George JA, Wilson DW, Dungworth DL. 1993. Response of macaque bronchiolar epithelium to ambient concentrations of ozone. Am J Pathol 143:857-66.

~~1368.~~1364. Hazucha MJ, Folinsbee LJ, Seal E Jr. 1992. Effects of steady-state and variable ozone concentration profiles on pulmonary function. Am Rev Respir Dis 146:1487-93.

~~1369.~~1365. Hoek G, Brunekreef B, Verhoeff A, van Wijnen J, Fischer P. 2000. Daily ~~death~~ mortality and air pollution in The Netherlands. J Air Waste Manag Assoc 50:1380-9.

~~1370.~~1366. Horstman DH, Folinsbee LJ, Ives PJ, Abdul-Salaam S, McDonnell WF. 1990. Ozone concentration and pulmonary response relationships for 6.6-hour exposures with five hours of moderate exercise to 0.08, 0.10, and 0.12 ppm. Am Rev Respir Dis 142:1158-63.

~~1371.~~1367. Kinney PL, Lippmann M. 2000. Respiratory effects of seasonal exposures to ozone and particles. Arch Environ Health 55:210-6.

~~1372.~~1368. Kinney PL, Nilsen DM, Lippmann M, Brescia M, Gordon T, McGovern T, El-Fawal H, Devlin RB, Rom WN. 1996. Biomarkers of lung inflammation in recreational joggers exposed to ozone. Am J Respir Crit Care Med 154:1430-5.

~~1373.~~1369. Kunzli N, Lurmann F, Segal M, Ngo L, Balmes J, Tager IB. 1997.

Association between lifetime ambient ozone exposure and pulmonary function in college freshmen--results of a pilot study. Environ Res 72:8-23.

~~1374.~~1370. Larson SD, Schelegle ES, Walby WF, Gershwin LJ, Fanuccihi MV, Evans MJ, Joad JP, Tarkington BK, Hyde DM, Plopper CG. 2004. Postnatal remodeling of the neural components of the epithelial-mesenchymal trophic unit in the proximal airways of infant rhesus monkeys exposed to ozone and allergen. Toxicol Appl Pharmacol 194:211-20.

~~1375.~~1371. Last JA, Gelzleichter TR, Harkema J, Hawk S. 1994. Consequences of prolonged inhalation of ozone on Fischer-344/N rats: collaborative studies. Part I: Content and cross-linking of lung collagen. Res Rep Health Eff Inst. ~~:~~1-29; discussion 31-40.

~~1376.~~1372. Levy JI, Carrothers TJ, Tuomisto JT, Hammitt JK, Evans JS. 2001. Assessing the public health benefits of reduced ozone concentrations. Environ Health Perspect 109:1215-26.

~~1377.~~1373. Linn WS, Shamoo DA, Anderson KR, Peng R-C, Avol EL, Hackney JD, Gong H Jr. 1996. Short-term air pollution exposure and responses in Los Angeles area schoolchildren. J Exp Anal Environ Epidemiol 6:449-471.

~~1378.~~1374. McConnell R, Berhane K, Gilliland F, London SJ, Islam T, Gauderman WJ, Avol E, Margolis HG, Peters JM. 2002. Asthma in exercising children exposed to ozone: a cohort study. Lancet 359:386-91.

~~1379.~~1375. McDonnell WF, Horstman DH, Hazucha MJ, Seal E Jr, Haak ED, Salaam SA, House DE. 1983. Pulmonary effects of ozone exposure during exercise: dose-response characteristics. J Appl Physiol 54:1345-52.

~~1380.~~1376. McDonnell WF, Kehrl H~~OU~~R, Abdul-Salaam S, Ives PJ, Folinsbee LJ, Devlin RB, O'Neil JJ, Horstman DH. 1991. Respiratory response of humans exposed to low levels of ozone for 6.6 hours. Arch Environ Health 46: 145-50.

~~1381.~~1377. McDonnell WF 3rd, Chapman RS, Leigh MW, Strope GL, Collier AM. 1985a. Respiratory responses of vigorously exercising children to 0.12 ppm ozone exposure. Am Rev Respir Dis 132:875-9.

~~1382.~~1378. McDonnell WF 3rd, Horstman DH, Abdul-Salaam S, House DE. 1985b. Reproducibility of individual responses to ozone exposure. Am Rev Respir Dis 131:36-40.

~~1383.~~1379. Moolgavkar SH, Luebeck EG, Anderson EL. 1997. Air pollution and hospital admissions for respiratory causes in Minneapolis-St. Paul and Birmingham. Epidemiology 8:364-70.

~~1384.~~1380. National Asthma Education and Prevention Program . 2002.

National Asthma Education and Prevention Program Expert Panel Report: guidelines for the diagnosis and management of asthma update on selected topics. 110. 110((5 pt 2)): S141-219.

~~1385.~~1381. Peters JM, Avol E, Gauderman WJ, Linn WS, Navidi W, London SJ, Margolis H, Rappaport E, Vora H, Gong H Jr, Thomas DC. 1999. A study of twelve Southern California communities with differing levels and types of air pollution. II. Effects on pulmonary function. Am J Respir Crit Care Med 159:768-75.

~~1386.~~1382. Pinkerton KE, Menache MG, Plopper CG. 1995. Consequences of prolonged inhalation of ozone on F344/N rats: collaborative studies. Part IX: Changes in the tracheobronchial epithelium, pulmonary acinus, and lung antioxidant enzyme activity. Res Rep Health Eff Inst :41-98; discussion 99-110.

~~1387.~~1383. Pinkerton KE, Weller BL, Menache MG, Plopper CG. 1998. Consequences of prolonged inhalation of ozone on F344/N rats: collaborative studies. Part XIII. A comparison of changes in the tracheobronchial epithelium and pulmonary acinus in male rats at 3 and 20 months. Res Rep Health Eff Inst :1-32; discussion 33-7.

~~1388.~~1384. Pope CA 3rd, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, Thurston GD. 2002a. Lung cancer, cardiopulmonary ~~death~~ mortality, and long-term exposure to fine particulate air pollution. JAMA 287:1132-41.

~~1389.~~1385. Reiser KM, Tyler WS, Hennessy SM, Dominguez JJ, Last JA. 1987. Long-term consequences of exposure to ozone. II. Structural alterations in lung collagen of monkeys. Toxicol Appl Pharmacol 89:314-22.

~~1390.~~1386. Sarnat JA, Schwartz J, Catalano PJ, Suh HH. 2001. Gaseous pollutants in particulate matter epidemiology: confounders or surrogates? Environ Health Perspect 109:1053-61.

~~1391.~~1387. Schelegle ES, Miller LA, Gershwin LJ, Fanucchi MV, Van Winkle LS, Gerriets JE, Walby WF, Mitchell V, Tarkington BK, Wong VJ, Baker GL, Pantle LM, Joad JP, Pinkerton KE, Wu R, Evans MJ, Hyde DM, Plopper CG. 2003a. Repeated episodes of ozone inhalation amplifies the effects of allergen sensitization and inhalation on airway immune and structural development in Rhesus monkeys. Toxicol Appl Pharmacol 191:74-85.

~~1392.~~1388. Seal E Jr, McDonnell WF, House DE, Salaam SA, Dewitt PJ, Butler SO, Green J, Raggio L. 1993. The pulmonary response of white and black adults to six concentrations of ozone. Am Rev Respir Dis 147:804-10.

~~1393.~~1389. Sherwin R. 1983. What is an adverse health effect? Environ Health Perspect 52:177-182.

~~1394.~~1390. Simpson RW, Williams G, Petroeschevsky A, Morgan G, Rutherford S. 1997. Associations between outdoor air pollution and daily ~~death~~ mortality in Brisbane, Australia. Arch Environ Health 52:442-54.

~~1395.~~1391. Szarek JL, Stewart NL, Zhang JZ, Webb JA, Valentovic MA, Catalano P. 1995. Contractile responses and structure of small bronchi isolated from rats after 20 months' exposure to ozone. Fundam Appl Toxicol 28:199-208.

~~1396.~~1392. Tager IB, Kunzli N, Lurmann F, Ngo L, Segal M, Balmes J. 1998. Methods development for epidemiologic investigations of the health effects of prolonged ozone exposure. Part II. An approach to retrospective estimation of lifetime ozone exposure using a questionnaire and ambient monitoring data (California sites). Res Rep Health Eff Inst :27-78; discussion 109-21.

~~1397.~~1393. Thurston GD, Ito K. 2001. Epidemiological studies of acute ozone exposures and ~~death~~ mortality. J Expo Anal Environ Epidemiol 11: 286-94.

~~1398.~~1394. Tolbert PE, Mulholland JA, MacIntosh DL, Xu F, Daniels D, Devine OJ, Carlin BP, Klein M, Dorley J, Butler AJ, Nordenberg DF, Frumkin H, Ryan PB, White MC. 2000. Air quality and pediatric emergency room visits for asthma in Atlanta, Georgia, USA. Am J Epidemiol 151:798-810.

~~1399.~~1395. Tyler WS, Tyler NK, Last JA, Gillespie MJ, Barstow TJ. 1988. Comparison of daily and seasonal exposures of young monkeys to ozone. Toxicology 50:131-44.

~~1400.~~1396. Vedal S, Brauer M, White R, Petkau J. 2003. Air pollution and daily ~~death~~ mortality in a city with low levels of pollution. Environ Health Perspect 111:45-52.

~~1401.~~1397. Weisel CP, Cody RP, Lioy PJ. 1995. Relationship between summertime ambient ozone levels and emergency department visits for asthma in central New Jersey. Environ Health Perspect 103 Suppl 2:97-102.

Appendix B

~~1402.~~1398. ARB (2004) Aerometric Data Analysis and Management System (ADAM) http://www.arb.ca.gov/adam/welcome.html

~~1403.~~1399. Anderson HR, Atkinson RW, Peacock JL, Marston L, Konstantinou K. 2004. Meta-analysis of time-series studies and panel studies of particulate matter (PM) and ozone (~~ozone~~O$_3$). Report of a WHO task group. World Health Organization. (http://www.euro.who.int/document/e82792.pdf)

~~1404.~~1400. Anderson HR, Spix C, Medina S, Schouten JP, Castellsague J, Rossi G, Zmirou D, Touloumi G, Wojtyniak B, Ponka A, Bacharova L, Schwartz J, Katsouyanni K. 1997. Air pollution and daily admissions for chronic obstructive pulmonary disease in 6 European cities: results from the APHEA project. Eur Respir J 10:1064-71.

~~1405.Bates, DV. 2005. Personal statement made at Air Quality Advisory Committee Meeting, January 12, 2005.~~

~~1406.~~1401. Bell M, McDermott A, Zeger S, Samet J, Dominici F. 2004. Ozone and short-term mortality in 95 US urban communities, 1987-2000. JAMA 292, 19:2372-2378.

~~1407.~~1402. Burnett RT, Brook JR, Yung WT, Dales RE, Krewski D. 1997. Association between ozone and hospitalization for respiratory diseases in 16 Canadian cities. Environ Res 72:24-31.

~~1408.~~1403. Burnett RT, Dales RE, Raizenne ME, Krewski D, Summers PW, Roberts GR, Raad-Young M, Dann T, Brook J. 1994. Effects of low ambient levels of ozone and sulfates on the frequency of respiratory admissions to Ontario hospitals. Environ Res 65:172-94.

~~1409.~~1404. Burnett RT, Smith-Doiron M, Stieb D, Raizenne ME, Brook JR, Dales RE, Leech JA, Cakmak S, Krewski D. 2001. Association between ozone and hospitalization for acute respiratory diseases in children less than 2 years of age. Am J Epidemiol 153:444-52.

~~1410.~~1405. Friedman MS, Powell KE, Hutwagner L, Graham LM, Teague WG. 2001. Impact of changes in transportation and commuting behaviors during the 1996 Summer Olympic Games in Atlanta on air quality and childhood asthma. JAMA 285:897-905.

~~1411.~~1406. Gilliland FD, Berhane K, Rappaport EB, Thomas DC, Avol E, Gauderman WJ, London SJ, Margolis HG, McConnell R, Islam KT, Peters JM. 2001. The effects of ambient air pollution on school absenteeism due to respiratory illnesses. Epidemiology 12:43-54.

~~1412.~~1407. Gryparis A, Forsberg, B, Katsouyanni K, Analitis A, Touloumi G, Schwartz J, Somoli, E, Medina S, Anderson R, Niciu, E, Wichmann H, Kriz B, Kosnik M, Skordovsky J, Vonk J, Dorbudak Z. 2004. Acute effects of ozone on mortality from the "Air Pollution and Health: A European Approach" project. Am J Respir Crit Care Med 170: 1080-1087.

~~1413.~~1408. Hall JV, Brajer V, Lurmann FW. 2003. Economic valuation of ozone-related school absences in the south coast air basin of California.

Contemporary Economic Policy 21:407-417.

~~1414.~~1409. Hubbell, BJ, Halberg A, McCubbin, DR, Post, E. 2005. Health-related benefits of attaining the 8-hr ozone standard. Environ Health Perspect 113:73-82.

~~1415.~~1410. Jaffe DH, Singer ME, Rimm AA. 2003. Air pollution and emergency department visits for asthma among Ohio Medicaid recipients, 1991-1996. Environ Res 91:21-8.

~~1416.~~1411. Levy JI, Carrothers TJ, Tuomisto JT, Hammitt JK, Evans JS. 2001. Assessing the public health benefits of reduced ozone concentrations. Environ Health Perspect 109:1215-26.

~~1417.~~1412. National Research Council. 2002. Estimating the public health benefits of proposed air pollution regulations. Washington, D.C.: National Academy Press.

~~1418.~~1413. Ostro BD, Rothschild S. 1989. Air pollution and acute respiratory morbidity: an observational study of multiple pollutants. Environ Res 50~~ :~~: 238-47.

~~1419.~~1414. Romieu I, Meneses F, Sienra-Monge JJ, Huerta J, Ruiz Velasco S, White MC, Etzel RA, Hernandez-Avila M. 1995. Effects of urban air pollutants on emergency visits for childhood asthma in Mexico City. Am J Epidemiol 141:546-53.

~~1420.~~1415. Samet JM, Zeger SL, Dominici F, Curriero F, Coursac I, Dockery DW *et al*. (2000). The National Morbidity, Mortality, and Air Pollution Study. Part II: Morbidity and mortality from air pollution in the United States. Health Effects- Institute (94 Pt 2).

~~1421.~~1416. Schwartz J. 1997 Health effects of air pollution from traffic: ozone and particulate matter. In: Fletcher T and McMichaels AJ, eds. Health at the crossroads: transport policy and urban health. New York: John Wiley. Chapter 6.

~~1422.~~1417. Stieb DM, Burnett RT, Beveridge RC, Brook JR. 1996. Association between ozone and asthma emergency department visits in Saint John, New Brunswick, Canada. Environ Health Perspect 104:1354-60.

~~1423.~~1418. Stieb DM, Judek S, Burnett RT. 2003. Meta-analysis of time-series studies of air pollution and mortality: update in relation to the use of generalized additive models. J Air Waste Manag Assoc 53:258-261.

~~1424.~~1419. Thurston, G.T. and Ito, K. 1999. Epidemiologic studies of ozone exposure effects. In: Holgate ST, Samet JM, Koren HS, Maynard RL, eds. Air Pollution and Health. ~~(Holgate ST, Samet JM, Koren Hs, Maynard RL,~~

~~eds.)~~ London~~:~~. Academic Press.

~~1425.~~1420. Thurston GD, Ito K. 2001. Epidemiological studies of acute ozone exposures and mortality. J Expo Anal Environ Epidemiol 11: 286-94.

~~1426.~~1421. Thurston GD, Ito K, Hayes CG, Bates DV, Lippmann M. 1994. Respiratory hospital admissions and summertime haze air pollution in Toronto, Ontario: consideration of the role of acid aerosols. Environ Res 65: 271-90.

~~1427.~~1422. Tolbert PE, Mulholland JA, MacIntosh DL, Xu F, Daniels D, Devine OJ, Carlin BP, Klein M, Dorley J, Butler AJ, Nordenberg DF, Frumkin H, Ryan PB, White MC. 2000. Air quality and pediatric emergency room visits for asthma in Atlanta, Georgia, USA. Am J Epidemiol 151:798-810.

~~1428.~~U.S. Environmental Protection Agency. 1999. The benefits and costs of the clean air act 1990 to 2010: EPA report to Congress. Washington, D.C.: Office of
~~1429.~~1423. Air and Radiation and Office of Policy. Report No.: EPA-410-R-99-001, November. (http://www.epa.gov/air/sect812/copy99.html).

~~1430.~~U.S. Environmental Protection Agency. 2004. Advisory on plans for health effects analysis in the analytical plan for EPA's second prospective analysis benefits and costs of the clean air act, 1990-2020; advisory by the health effects subcommittee of the advisory council on clean air compliance analysis. Washington, D.C. Report No.: EPA-SAB-COUNCIL-ADV-04-002 Environmental.
~~1431.~~1424. (http://www.epa.gov/sab/pdf/council_adv_04002.pdf)

Appendix G

~~1432.~~1425. Abraham WM, Januszkiewicz AJ, Mingle M, Welker M, Wanner A, Sackner MA (1980 May). Sensitivity of bronchoprovocation and tracheal mucous velocity in detecting airway responses to O_3. J Appl Physiol 48(5):789-93.

~~1433.~~1426. Abraham WM, Sielczak MW, Delehunt JC, Marchette B, Wanner A (1986 Feb). Impairment of tracheal mucociliary clearance but not ciliary beat frequency by a combination of low level ozone and sulfur dioxide in sheep. Eur J Respir Dis 68(2):114-20.

~~1434.~~1427. Adamson IY, Vincent R, Bjarnason SG (1999 May). Cell injury and interstitial inflammation in rat lung after inhalation of ozone and urban particulates. Am J Respir Cell Mol Biol 20(5):1067-72.

~~1435.~~1428. Allegra L, Abraham WMCGA, Wanner A (1983). Targets of allergic airway challenge and tracheobronchial irritation with ozone in an animal model (sheep). European Journal of Respiratory Diseases 64 (suppl

126):45-52.

~~1436.~~1429. Aranyi C, Vana SC, Thomas PT, Bradof JN, Fenters JD, Graham JA, et al. (1983 Jul). Effects of subchronic exposure to a mixture of O_3, SO_2, and $(NH_4)_2SO_4$ on host defenses of mice. J Toxicol Environ Health 12(1):55-71.

~~1437.~~1430. ARB (1987). Effects of Ozone on Health. Technical Support Document. Prepared by the California Air Resources Board. September.

~~1438.~~1431. Arito H, Uchiyama I, Arakawa H, Yokoyama E (1990 Jul). Ozone-induced bradycardia and arrhythmia and their relation to sleep- wakefulness in rats. Toxicol Lett 52(2):169-78.

~~1439.~~1432. Arito H, Uchiyama I, Yokoyama E (1992). Acute effects of ozone on EEG activity, sleep-wakefulness and heart rate in rats. Ind Health 30(1):23-34.

~~1440.~~1433. Armstrong LC, Watkins K, Pinkerton KE, Last JA (1994 Jul). Collagen mRNA content and distribution in the lungs of rats exposed to ozone. Am J Respir Cell Mol Biol 11(1):25-34.

~~1441.~~1434. Barry BE, Mercer RR, Miller FJ, Crapo JD (1988). Effects of inhalation of 0.25 ppm ozone on the terminal bronchioles of juvenile and adult rats. Exp Lung Res 14(2):225-45.

~~1442.~~1435. Barry BE, Miller FJ, Crapo JD (1985 Dec). Effects of inhalation of 0.12 and 0.25 parts per million ozone on the proximal alveolar region of juvenile and adult rats. Lab Invest 53(6):692-704.

~~1443.~~1436. Bassett DJ, Bowen-Kelly E, Elbon CL, Reichenbaugh SS (1988). Rat lung recovery from 3 days of continuous exposure to 0.75 ppm ozone. J Toxicol Environ Health 25(3):329-47.

~~1444.~~1437. Becker S, Quay J, Koren HS (1991 Nov). Effect of ozone on immunoglobulin production by human B cells in vitro. J Toxicol Environ Health 34(3):353-66.

~~1445.~~1438. Ben-Jebria A, Hu SC, Kitzmiller EL, Ultman JS (1991 Dec). Ozone absorption into excised porcine and sheep tracheae by a bolus- response method. Environ Res 56(2):144-57.

~~1446.~~1439. Bermudez E, Ferng SF, Castro CE, Mustafa MG (1999 Jul). DNA strand breaks caused by exposure to ozone and nitrogen dioxide. Environ Res 81(1):72-80.

~~1447.~~1440. Bhalla DK (1996 Dec). Alteration of alveolar macrophage chemotaxis, cell adhesion, and cell adhesion molecules following ozone exposure of rats. J Cell Physiol 169(3):429-38.

~~1448.~~1441. Bhalla DK (1999 Jan-1999 Mar). Ozone-induced lung inflammation and mucosal barrier disruption: toxicology, mechanisms, and implications. J Toxicol Environ Health B Crit Rev 2(1):31-86.

~~1449.~~1442. Bhalla DK, Crocker TT (1986 Sep). Tracheal permeability in rats exposed to ozone. An electron microscopic and autoradiographic analysis of the transport pathway. Am Rev Respir Dis 134(3):572-9.

~~1450.~~1443. Bhalla DK, Crocker TT (1987). Pulmonary epithelial permeability in rats exposed to O_3. J Toxicol Environ Health 21(1-2):73-87.

~~1451.~~1444. Bhalla DK, Hoffman L (1997). Time course of airway epithelial and inflammatory changes in rats exposed to moderate levels of ozone. Inhalation Toxicology 9:829-42.

~~1452.~~1445. Bhalla DK, Mannix RC, Kleinman MT, Crocker TT (1986). Relative permeability of nasal, tracheal, and bronchoalveolar mucosa to macromolecules in rats exposed to ozone. J Toxicol Environ Health 17(2-3):269-83.

~~1453.~~1446. Bhalla DK, Mannix RC, Lavan SM, Phalen RF, Kleinman MT, Crocker TT (1987). Tracheal and bronchoalveolar permeability changes in rats inhaling oxidant atmospheres during rest or exercise. J Toxicol Environ Health 22(4):417-37.

~~1454.~~1447. Bhalla DK, Rasmussen RE, Daniels DS (1993 Dec). Adhesion and motility of polymorphonuclear leukocytes isolated from the blood of rats exposed to ozone: potential biomarkers of toxicity. Toxicol Appl Pharmacol 123(2):177-86.

~~1455.~~1448. Bignami G (1996 Apr). Economical test methods for developmental neurobehavioral toxicity. Environ Health Perspect 104 Suppl 2:285-98.

~~1456.~~1449. Bignami G (1996 Apr). Economical test methods for developmental neurobehavioral toxicity. Environ Health Perspect 104 Suppl 2:285-98.

~~1457.~~1450. Bignami G, Musi B, Dell'Omo G, Laviola G, Alleva E (1994 Dec). Limited effects of ozone exposure during pregnancy on physical and neurobehavioral development of CD-1 mice. Toxicol Appl Pharmacol 129(2):264-71.

~~1458.~~1451. Bleavins MR, Dziedzic D (1990 Aug). An immunofluorescence study of T and B lymphocytes in ozone-induced pulmonary lesions in the mouse. Toxicol Appl Pharmacol 105(1):93-102.

~~1459.~~1452. Boehme DS, Hotchkiss JA, Henderson RF (1992 Feb). Glutathione and GSH-dependent enzymes in bronchoalveolar lavage fluid cells in response to ozone. Exp Mol Pathol 56(1):37-48.

~~1460.~~1453. Bolarin DM, Bhalla DK, Kleinman MT (1997). Effects of repeated exposures of geriatric rats to ozone and particle-containing atmospheres: an analysis of bronchoalveolar lavage and plasma proteins. Inhalation Toxicology 9:423-34.

~~1461.~~1454. Boorman GA, Hailey R, Grumbein S, Chou BJ, Herbert RA, Goehl T, et al. (1994 Sep-1994 Oct). Toxicology and carcinogenesis studies of ozone and ozone 4-(N- nitrosomethylamino)-1-(3-pyridyl)-1-butanone in

Fischer-344/N rats. Toxicol Pathol 22(5):545-54.

~~1462.~~1455. Boorman GA, Sills RC, Grumbein S, Hailey R, Miller RA, Herbert RA (1995 Dec). Long-term toxicity studies of ozone in F344/N rats and B6C3F1 mice. Toxicol Lett 82-83:301-6.

~~1463.~~1456. Borek C, Ong A, Zaider M (1989 Aug). Ozone activates transforming genes in vitro and acts as a synergistic co-carcinogen with gamma-rays only if delivered after radiation. Carcinogenesis 10(8):1549-51.

~~1464.~~1457. Borek C, Zaider M, Ong A, Mason H, Witz G (1986 Sep). Ozone acts alone and synergistically with ionizing radiation to induce in vitro neoplastic transformation. Carcinogenesis 7(9):1611-3.

~~1465.~~1458. Bornholdt J, Dybdahl M, Vogel U, Hansen M, Loft S, Wallin H (2002 Sep). Inhalation of ozone induces DNA strand breaks and inflammation in mice. Mutat Res 520(1-2):63-71.

~~1466.~~1459. Bouthillier L, Vincent R, Goegan P, Adamson IY, Bjarnason S, Stewart M, et al. (1998 Dec). Acute effects of inhaled urban particles and ozone: lung morphology, macrophage activity, and plasma endothelin-1. Am J Pathol 153(6):1873-84.

~~1467.~~1460. Burleson GR, Keyes LL, Stutzman JD (1989). Immunosuppression of pulmonary natural killer activity by exposure to ozone. Immunopharmacol Immunotoxicol 11(4):715-35.

~~1468.~~1461. Calderon-Garciduenas L, Gambling TM, Acuna H, Garcia R, Osnaya N, Monroy S, et al. (2001b Jun). Canines as sentinel species for assessing chronic exposures to air pollutants: part 2. Cardiac pathology. Toxicol Sci 61(2):356-67.

~~1469.~~1462. Calderon-Garciduenas L, Mora-Tiscareno A, Fordham LA, Chung CJ, Garcia R, Osnaya N, et al. (2001a Jun). Canines as sentinel species for assessing chronic exposures to air pollutants: part 1. Respiratory pathology. Toxicol Sci 61(2):342-55.

~~1470.~~1463. Campen MJ, Norwood J, McKee JL, Mebane R, Hatch GE, Watkinson WP (2000). Ozone-induced hypothermia and bradycardia in rats and guinea pigs in nose-only or whole-body inhalation systems. Journal of Thermal Biology 25:81-9.

~~1471.~~1464. Canning BJ, Hmieleski RR, Spannhake EW, Jakab GJ (1991 Oct). Ozone reduces murine alveolar and peritoneal macrophage phagocytosis: the role of prostanoids. Am J Physiol 261(4 Pt 1):L277-82.

~~1472.~~1465. Cassee FR, Boere AJ, Bos J, Fokkens PH, Dormans JA, van Loveren H (2002 Jul). Effects of diesel exhaust enriched concentrated PM2.5 in ozone preexposed or monocrotaline-treated rats. Inhal Toxicol 14(7):721-43.

~~1473.~~1466. Chang LY, Huang Y, Stockstill BL, Graham JA, Grose EC, Menache MG, et al. (1992 Aug). Epithelial injury and interstitial fibrosis in the proximal alveolar regions of rats chronically exposed to a simulated pattern of urban ambient ozone. Toxicol Appl Pharmacol 115(2):241-52.

~~1474.~~1467. Chang MM, Wu R, Plopper CG, Hyde DM (1998 Sep). IL-8 is one of the major chemokines produced by monkey airway epithelium after ozone-induced injury. Am J Physiol 275(3 Pt 1):L524-32.

~~1475.~~1468. Cheek JM, Buckpitt AR, Li C, Tarkington BK, Plopper CG (1994 Mar). Ozone injury to alveolar epithelium in vitro does not reflect loss of antioxidant defenses. Toxicol Appl Pharmacol 125(1):59-69.

~~1476.~~1469. Chen LC, Miller PD, Lam HF, Guty J, Amdur MO (1991 Nov). Sulfuric acid-layered ultrafine particles potentiate ozone-induced airway injury. J Toxicol Environ Health 34(3):337-52.

~~1477.~~1470. Chen LC, Qu Q, Amdur MO, Schlesinger RB (1995 Jan-1995 Feb). Alteration of pulmonary macrophage intracellular pH following inhalation exposure to sulfuric acid/ozone mixtures. Exp Lung Res 21(1):113-28.

~~1478.~~1471. Cheng PW, Boat TF, Shaikh S, Wang OL, Hu PC, Costa DL (1995 May-1995 Jun). Differential effects of ozone on lung epithelial lining fluid volume and protein content. Exp Lung Res 21(3):351-65.

~~1479.~~1472. Chow CK, Kaneko JJ (1979 Jun). Influence of dietary vitamin E on the red cells of ozone-exposed rats. Environ Res 19(1):49-55.

~~1480.~~1473. Christman CA, Schwartz LW (1982 Aug). Enhanced phagocytosis by alveolar macrophages induced by short-term ozone insult. Environ Res 28(2):241-50.

~~1481.~~1474. Churg A, Brauer M, Keeling B (1996 Apr). Ozone enhances the uptake of mineral particles by tracheobronchial epithelial cells in organ culture. Am J Respir Crit Care Med 153(4 Pt 1):1230-3.

~~1482.~~1475. Cohen Hubal EA, Kimbell JS, Fedkiw PS (1996). Incorporation of nasal-lining mass-transfer resistance into a CFD model for prediction of ozone dosimetry in the upper respiratory tract. Inhalation Toxicology 8:831-57.

~~1483.~~1476. Cohen MD, Sisco M, Baker K, Bowser D, Chen LC, Schlesinger RB (2003 Jan). Impact of coexposure to ozone on the carcinogenic potential of inhaled chromium. 1. effects on retention and on extra- and intracellular distribution. J Toxicol Environ Health A 66(1):39-55.

~~1484.~~1477. Cohen MD, Sisco M, Baker K, Li Y, Lawrence D, van Loveren H, et al. (2002 Jun). Effects of inhaled ozone on pulmonary immune cells critical to antibacterial responses in situ. Inhal Toxicol 14(6):599-619.

~~1485.~~1478. Cohen MD, Sisco M, Li Y, Zelikoff JT, Schlesinger RB (2001 Mar). Ozone-induced modulation of cell-mediated immune responses in the lungs. Toxicol Appl Pharmacol 171(2):71-84.

~~1486.~~1479. Cohen MD, Zelikoff JT, Chen L-C, Schlesinger RB (1997). Pulmonary retention and distribution of inhaled chromium: effects of particle solubility and coexposure to ozone. Inhalation Toxicology 9:843-65.

~~1487.~~1480. Cohen MD, Zelikoff JT, Chen LC, Schlesinger RB (1998 Sep). Immunotoxicologic effects of inhaled chromium: role of particle solubility and co-exposure to ozone. Toxicol Appl Pharmacol 152(1):30-40.

~~1488.~~1481. Creutzenberg O, Bellmann B, Klingebiel R, Heinrich U, Muhle H (1995 May). Phagocytosis and chemotaxis of rat alveolar macrophages after a combined or separate exposure to ozone and ARBon black. Exp Toxicol Pathol 47(2-3):202-6.

~~1489.~~1482. Dell'Omo G, Fiore M, Petruzzi S, Alleva E, Bignami G (1995a). Neurobehavioral development of CD-1 mice after combined gestational and postnatal exposure to ozone. Arch Toxicol 69(9):608-16.

~~1490.~~1483. Dell'Omo G, Wolfer D, Alleva E, Lipp HP (1995b Nov). Developmental exposure to ozone induces subtle changes in swimming navigation of adult mice. Toxicol Lett 81(2-3):91-9.

~~1491.~~1484. DeLucia AJ, Adams WC (1977 Jul). Effects of O_3 inhalation during exercise on pulmonary function and blood biochemistry. J Appl Physiol 43(1):75-81.

~~1492.~~1485. Devlin RB, Folinsbee LJ, Biscardi F, Hatch G, Becker S, Madden MC, et al. (1997). Inflammation and cell damage induced by repeated exposure of humans to ozone. Inhalation Toxicology 9:211-35.

~~1493.~~1486. Devlin RB, McDonnell WF, Mann R, Becker S, House DE, Schreinemachers D, et al. (1991 Jan). Exposure of humans to ambient levels of ozone for 6.6 hours causes cellular and biochemical changes in the lung. Am J Respir Cell Mol Biol 4(1):72-81.

~~1494.~~1487. Dillon D, Combes R, McConville M, Zeiger E (1992). Ozone is mutagenic in Salmonella. Environ Mol Mutagen 19(4):331-7.

~~1495.~~1488. Donaldson K, Brown GM, Brown DM, Slight J, Maclaren W, Davis JMG (1993). Characteristics of bronchoalveolar leucocytes from the lungs of rats inhaling 0.2-0.8 ppm of ozone. Inhalation Toxicology 5:149-64.

~~1496.~~1489. Donaldson K, Brown GM, Brown DM, Slight J, Maclaren WM, Davis JM (1991 Oct). Leukocyte-mediated epithelial injury in ozone-exposed rat lung. Res Rep Health Eff Inst (44):1-27.

~~1497.~~1490. Dormans JA, Rombout PJ, van Loveren H (1990 Sep). Surface morphology and morphometry of rat alveolar macrophages after ozone exposure. J Toxicol Environ Health 31(1):53-70.

~~1498.~~1491. Dormans JA, van Bree L, Boere AJ, Marra M, Rombout PJ (1999 Apr). Interspecies differences in time course of pulmonary toxicity following repeated exposure to ozone. Inhal Toxicol 11(4):309-29.

~~1499.~~1492. Dormans JAMA, Boere AJF, van Loveren H, Rombout PJA, Marra M, van Bree L (1996). Age-related toxicity in rat lungs following acute and repeated ozone exposure. Inhalation Toxicology 8:903-25.

~~1500.~~1493. Driscoll KE, Vollmuth TA, Schlesinger RB (1987). Acute and subchronic ozone inhalation in the rabbit: response of alveolar macrophages. J Toxicol Environ Health 21(1-2):27-43.

~~1501.~~1494. Duan X, Buckpitt AR, Pinkerton KE, Ji C, Plopper CG (1996 Jan). Ozone-induced alterations in glutathione in lung subcompartments of rats and monkeys. Am J Respir Cell Mol Biol 14(1):70-5.

~~1502.~~1495. Dubick MA, Keen CL (1983 Jul). Tissue trace elements and lung superoxide dismutase activity in mice exposed to ozone. Toxicol Lett 17(3-4):355-60.

~~1503.~~1496. Dziedzic D, White HJ (1986a Dec). T-cell activation in pulmonary lymph nodes of mice exposed to ozone. Environ Res 41(2):610-22.

~~1504.~~1497. Dziedzic D, White HJ (1986b Dec). Thymus and pulmonary lymph node response to acute and subchronic ozone inhalation in the mouse. Environ Res 41(2):598-609.

~~1505.~~1498. Dziedzic D, Wright ES, Sargent NE (1990 Apr). Pulmonary response to ozone: reaction of bronchus-associated lymphoid tissue and lymph node lymphocytes in the rat. Environ Res 51(2):194-208.

~~1506.~~1499. el-Fawal HA, McGovern T, Schlesinger RB (1995 Jan-1995 Feb). Nonspecific bronchial responsiveness assessed in vitro following acute inhalation exposure to ozone and ozone/sulfuric acid mixtures. Exp Lung Res 21(1):129-39.

~~1507.~~1500. el-Fawal HA, Schlesinger RB (1994 Mar). Nonspecific airway hyperresponsiveness induced by inhalation exposure to sulfuric acid aerosol: an in vitro assessment. Toxicol Appl Pharmacol 125(1):70-6.

~~1508.~~1501. Elsayed NM, Kass R, Mustafa MG, Hacker AD, Ospital JJ, Chow CK, et al. (1988). Effect of dietary vitamin E level on the biochemical response of rat lung to ozone inhalation. Drug Nutr Interact 5(4):373-86.

~~1509.~~1502. Eskew ML, Scheuchenzuber WJ, Scholz RW, Reddy CC, Zarkower A (1986 Aug). The effects of ozone inhalation on the immunological response of selenium- and vitamin E-deprived rats. Environ Res 40(2):274-84.

~~1510.~~1503. Evans MJ, Fanucchi MV, Baker GL, Van Winkle LS, Pantle LM, Nishio SJ, et al. (2003 Oct). Atypical development of the tracheal basement membrane zone of infant rhesus monkeys exposed to ozone and allergen. Am J Physiol Lung Cell Mol Physiol 285(4):L931-9.

~~1511.~~1504. Farman CA, Watkins K, van Hoozen B, Last JA, Witschi H, Pinkerton KE (1999 Feb). Centriacinar remodeling and sustained procollagen gene expression after exposure to ozone and nitrogen dioxide. Am J Respir Cell Mol Biol 20(2):303-11.

~~1512.~~1505. Ferng SF, Castro CE, Afifi AA, Bermudez E, Mustafa MG (1997 Jul). Ozone-induced DNA strand breaks In guinea pig tracheobronchial epithelial cells. J Toxicol Environ Health 51(4):353-67.

~~1513.~~1506. Foster WM, Freed AN (1999 Feb). Regional clearance of solute from peripheral airway epithelia: recovery after sublobar exposure to ozone. J Appl Physiol 86(2):641-6.

~~1514.~~1507. Freed AN, Cueto R, Pryor WA (1999 Nov). Antioxidant transport modulates peripheral airway reactivity and inflammation during ozone exposure. J Appl Physiol 87(5):1595-603.

~~1515.~~1508. Fujimaki H (1989 Apr). Impairment of humoral immune responses in mice exposed to nitrogen dioxide and ozone mixtures. Environ Res 48(2):211-7.

~~1516.~~1509. Fujimaki H, Ozawa M, Imai T, Shimizu F (1984 Dec). Effect of short-term exposure to O_3 on antibody response in mice. Environ Res 35(2):490-6.

~~1517.~~1510. Fujimaki H, Shiraishi F, Ashikawa T, Murakami M (1987 Jun). Changes in delayed hypersensitivity reaction in mice exposed to O_3. Environ Res 43(1):186-90.

~~1518.~~1511. Gelzleichter TR, Witschi H, Last JA (1992a Jan). Concentration-response relationships of rat lungs to exposure to oxidant air pollutants: a critical test of Haber's Law for ozone and nitrogen dioxide. Toxicol Appl Pharmacol 112(1):73-80.

~~1519.~~1512. Gelzleichter TR, Witschi H, Last JA (1992b Sep). Synergistic interaction of nitrogen dioxide and ozone on rat lungs: acute responses. Toxicol Appl Pharmacol 116(1):1-9.

~~1520.~~1513. Gilmour MI, Hmieleski RR, Stafford EA, Jakab GJ (1991 May-1991 Jun). Suppression and recovery of the alveolar macrophage phagocytic system during continuous exposure to 0.5 ppm ozone. Exp Lung Res 17(3):547-58.

~~1521.~~1514. Gilmour MI, Jakab GJ (1991). Modulation of immune function in mice exposed to 0.8 ppm ozone. Inhalation Toxicology 3:293-308.

~~1522.~~1515. Gilmour MI, Park P, Doerfler D, Selgrade MK (1993b May-1993b Jun). Factors that influence the suppression of pulmonary antibacterial defenses in mice exposed to ozone. Exp Lung Res 19(3):299-314.

~~1523.~~1516. Gilmour MI, Park P, Selgrade MK (1993a Mar). Ozone-enhanced pulmonary infection with Streptococcus zooepidemicus in mice. The role of alveolar macrophage function and capsular virulence factors. Am Rev Respir Dis 147(3):753-60.

~~1524.~~1517. Gilmour MI, Selgrade MK (1993 Dec). A comparison of the pulmonary defenses against streptococcal infection in rats and mice following O_3 exposure: differences in disease susceptibility and neutrophil recruitment. Toxicol Appl Pharmacol 123(2):211-8.

~~1525.~~1518. Goldsmith CA, Ning Y, Qin G, Imrich A, Lawrence J, Murthy GG, et al. (2002 Apr). Combined air pollution particle and ozone exposure increases airway responsiveness in mice. Inhal Toxicol 14(4):325-47.

~~1526.~~1519. Goodman JW, Peter-Fizaine FE, Shinpock SG, Hall EA, Fahmie DJ (1989 May-1989 Jun). Immunologic and hematologic consequences in mice of exposure to ozone. J Environ Pathol Toxicol Oncol 9(3):243-52.

~~1527.~~1520. Graham JA, Gardner DE, Blommer EJ, House DE, Menache MG, Miller FJ (1987). Influence of exposure patterns of nitrogen dioxide and modifications by ozone on susceptibility to bacterial infectious disease in mice. J Toxicol Environ Health 21(1-2):113-25.

~~1528.~~1521. Grose EC, Stevens MA, Hatch GE, Jaskot RH, Selgrade MJK, Stead AG, et al. (1989). The impact of a 12-month exposure to a diurnal pattern of ozone on pulmonary function, antioxidant biochemistry and immunology. In: Schneider, T. //Lee, S. D. //Wolters, G. J. R. //Grant, L. D. eds. Atmospheric ozone research and its policy implications: proceedings of the 3rd US-Dutch international symposium; May 1988; Nijmegen, The Netherlands, Elsevier Science Publishers B. V., Amsterdam, The Netherlands. pp. 535-543 (Studies in environmental science 35).

~~1529.~~1522. Gross KB, White HJ (1987). Functional and pathologic consequences of a 52-week exposure to 0.5 PPM ozone followed by a clean air recovery period. Lung 165(5):283-95.

~~1530.~~1523. Grotberg JB, Sheth BV, Mockros LF (1990 May). An analysis of pollutant gas transport and absorption in pulmonary airways. J Biomech Eng 112(2):168-76.

~~1531.~~1524. Gunnison AF, Weideman PA, Sobo M, Koenig KL, Chen LC (1992 Apr). Age-dependence of responses to acute ozone exposure in rats. Fundam Appl Toxicol 18(3):360-9.

~~1532.~~1525. Guth DJ, Warren DL, Last JA (1986 Aug). Comparative sensitivity of measurements of lung damage made by bronchoalveolar lavage after short-term exposure of rats to ozone. Toxicology 40(2):131-43.

~~1533.~~1526. Hackney JD, Linn WS, Buckley RD, Pedersen EE, Karuza SK, Law DC, et al. (1975 Aug). Experimental studies on human health effects of air pollutants: I. Design considerations. Arch Environ Health 30(8):373-8.

~~1534.~~1527. Haney JT Jr, Connor TH, Li L (1999 Apr). Detection of ozone-induced DNA single strand breaks in murine bronchoalveolar lavage cells acutely exposed in vivo. Inhal Toxicol 11(4):331-41.

~~1535.~~1528. Hanna LM, Frank R, Scherer PW (1989). Absorption of soluble gases and vapors in the respiratory system. In: Chang, H. K.; Paiva, M., eds. Respiratory physiology: an analytical approach. New York: Marcel Dekker, Inc.; pp. 277-316.

~~1536.~~1529. Haro R, Paz C (1993 Dec). Effects of ozone exposure during pregnancy on ontogeny of sleep in rats. Neurosci Lett 164(1-2):67-70.

~~1537.~~1530. Hassett C, Mustafa MG, Coulson WF, Elashoff RM (1985a Aug). Splenomegaly in mice following exposure to ambient levels of ozone. Toxicol Lett 26(2-3):139-44.

~~1538.~~1531. Hassett C, Mustafa MG, Coulson WF, Elashoff RM (1985b Oct). Murine lung carcinogenesis following exposure to ambient ozone concentrations. J Natl Cancer Inst 75(4):771-7.

~~1539.~~1532. Hatch GE, Slade R, Harris LP, McDonnell WF, Devlin RB, Koren HS, et al. (1994 Sep). Ozone dose and effect in humans and rats. A comparison using oxygen-18 labeling and bronchoalveolar lavage. Am J Respir Crit Care Med 150(3):676-83.

~~1540.~~1533. Hatch GE, Slade R, Stead AG, Graham JA (1986). Species comparison of acute inhalation toxicity of ozone and phosgene. J Toxicol Environ Health 19(1):43-53.

~~1541.~~1534. Hatch GE, Wiester MJ, Overton JHJr, Aissa M (1989). Respiratory tract dosimetry of [18]O-labeled ozone in rats: Implications for a rat-human extrapolation of ozone dose. In: Schneider, T. //Lee, S. D. //Wolters, G. J. R. //Grant, L. D. eds. Atmospheric ozone research and its policy implications: proceedings of the 3rd US-Dutch international symposium; May 1989; Nijmegen, The Netherlands, Elsevier Science Publishers B. V., Amsterdam, The Netherlands. pp. 553-560 (Studies in environmental science 35).

~~1542.~~1535. Herbert RA, Hailey JR, Grumbein S, Chou BJ, Sills RC, Haseman JK, et al. (1996 Sep-1996 Oct). Two-year and lifetime toxicity and carcinogenicity studies of ozone in B6C3F1 mice. Toxicol Pathol 24(5):539-48.

~~1543.~~1536. Hicks JJ, Medina-Navarro R, Guzman-Grenfell A, Wacher N, Lifshitz A (1996 Summer). Possible effect of air pollutants (Mexico City) on superoxide dismutase activity and serum lipoperoxides in the human adult. Arch Med Res 27(2):145-9.

~~1544.~~1537. Highfill JW, Hatch GE, Slade R, Crissman KM, Norwood J, Devlin RB, et al. (1992). Concentration-time models for the effects of ozone on bronchoalveolar lavage fluid protein from rats and guinea pigs. Inhalation Toxicolgy 4:1-16.

~~1545.~~1538. Hoffer E, Baum Y, Tabak A, Frevert C (1999 Sep). Adhesion molecules of blood polymorphonuclear leukocytes and alveolar macrophages in rats: modulation by exposure to ozone. Hum Exp Toxicol 18(9):547-51.

~~1546.~~1539. Hornof WJ, Schelegle E, Kammerman M, Gunther RA, Fisher PE, Cross CE (1989 Sep). Ozone-induced accelerated lung clearance of 99mTc-DTPA aerosol in conscious sheep. Respir Physiol 77(3):277-90.

~~1547.~~1540. Horstman DH, Folinsbee LJ, Ives PJ, Abdul-Salaam S, McDonnell WF (1990 Nov). Ozone concentration and pulmonary response relationships for 6.6-hour exposures with five hours of moderate exercise to 0.08, 0.10, and 0.12 ppm. Am Rev Respir Dis 142(5):1158-63.

~~1548.~~1541. Hotchkiss JA, Harkema JR, Kirkpatrick DT, Henderson RF (1989a). Response of rat alveolar macrophages to ozone: quantitative assessment of population size, morphology, and proliferation following acute exposure. Exp Lung Res 15(1):1-16.

~~1549.~~1542. Hotchkiss JA, Harkema JR, Sun JD, Henderson RF (1989b Apr). Comparison of acute ozone-induced nasal and pulmonary inflammatory responses in rats. Toxicol Appl Pharmacol 98(2):289-302.

~~1550.~~1543. Hu SC, Ben-Jebria A, Ultman JS (1992 Oct). Longitudinal distribution of ozone absorption in the lung: quiet respiration in healthy subjects. J Appl Physiol 73(4):1655-61.

~~1551.~~1544. Hyde DM, Hubbard WC, Wong V, Wu R, Pinkerton K, Plopper CG (1992 May). Ozone-induced acute tracheobronchial epithelial injury: relationship to granulocyte emigration in the lung. Am J Respir Cell Mol Biol 6(5):481-97.

~~1552.~~Ichinose T, Sagai M (1989 Dec). Biochemical effects of combined gases of nitrogen dioxide and ozone. III. Synergistic effects on lipid peroxidation and antioxidative protective systems in the lungs of rats and guinea pigs. Toxicology 59(3):259-70.

1545.

~~1553.~~1546. Ichinose T, Sagai M (1992 Sep). Combined exposure to NO_2, O_3 and H_2SO_4-aerosol and lung tumor formation in rats. Toxicology 74(2-3):173-84.

~~1554.~~1547. Ishii Y, Hirano K, Morishima Y, Masuyama K, Goto Y, Nomura A, et al. (2000~~ Sep~~). Early molecular and cellular events of oxidant-induced pulmonary fibrosis in rats. Toxicol Appl Pharmacol 167(3):173-81.

~~1555.~~1548. Iwasaki T, Takahashi M, Saito H, Arito H (1998 Jan). Adaptation of extrapulmonary responses to ozone exposure in conscious rats. Ind Health 36(1):57-60.

~~1556.~~1549. Jackson RM, Frank L (1984 Mar). Ozone-induced tolerance to hyperoxia in rats. Am Rev Respir Dis 129(3):425-9.

~~1557.~~1550. Jakab GJ, Bassett DJ (1990 May). Influenza virus infection, ozone exposure, and fibrogenesis. Am Rev Respir Dis 141(5 Pt 1):1307-15.

~~1558.~~1551. Jakab GJ, Hmieleski RR (1988). Reduction of influenza virus pathogenesis by exposure to 0.5 ppm ozone. J Toxicol Environ Health 23(4):455-72.

~~1559.~~1552. Joad JP, Bric JM, Pino MV, Hyde DM, McDonald RJ (1993 Jun). Effects of ozone and neutrophils on function and morphology of the isolated rat lung. Am Rev Respir Dis 147(6 Pt 1):1578-84.

~~1560.~~1553. Kavlock R, Daston G, Grabowski CT (1979 Mar). Studies on the developmental toxicity of ozone. I. Prenatal effects. Toxicol Appl Pharmacol 48(1 Pt 1):19-28.

~~1561.~~1554. Kavlock RJ, Meyer E, Grabowski CT (1980 Jan). Studies on the developmental toxicity of ozone: postnatal effects. Toxicol Lett 5(1):3-9.

~~1562.~~1555. Kimmel TA, Chen LC, Bosland MC, Nadziejko C (1997 Jun). Influence of acid aerosol droplet size on structural changes in the rat lung caused by acute exposure to sulfuric acid and ozone. Toxicol Appl Pharmacol 144(2):348-55.

~~1563.~~1556. Kirschvink N, Fievez L, Bureau F, Degand G, Maghuin-Rogister G, Smith N, et al. (2002 Jan). Adaptation to multiday ozone exposure is associated with a sustained increase of bronchoalveolar uric acid. Free Radic Res 36(1):23-32.

~~1564.~~1557. Kleeberger SR, Levitt RC, Zhang LY (1993 Jan). Susceptibility to ozone-induced inflammation. I. Genetic control of the response to subacute exposure. Am J Physiol 264(1 Pt 1):L15-20.

~~1565.~~1558. Kleeberger SR, Levitt RC, Zhang LY, Longphre M, Harkema J, Jedlicka A, et al. (1997 Dec). Linkage analysis of susceptibility to ozone-induced lung inflammation in inbred mice. Nat Genet 17(4):475-8.

~~1566.~~1559. Kleeberger SR, Longphre M, Tankersley CG (1999 Apr). Mechanisms of response to ozone exposure: the role of mast cells in mice. Res Rep Health Eff Inst (85):1-30; discussion 31-6.

~~1567.~~1560. Kleinman MT, Bhalla DK, Ziegler B, Bucher-Evans S, McClure T (1993). Effects of inhaled fine particles and ozone on pulmonary macrophages and epithelia. Inhalation Toxicology 5:371-88.

~~1568.~~1561. Kleinman MT, Bufalino C, Rasmussen R, Hyde D, Bhalla DK, Mautz WJ (2000 Sep-2000 Oct). Toxicity of chemical components of ambient fine particulate matter (PM 2.5) inhaled by aged rats. J Appl Toxicol 20(5):357-64.

~~1569.~~1562. Kleinman MT, Mautz WJ, Bjarnason S (1999 Mar). Adaptive and non-adaptive responses in rats exposed to ozone, alone and in mixtures, with acidic aerosols. Inhal Toxicol 11(3):249-64.

~~1570.~~1563. Kleinman MT, Phalen RF, Mautz WJ, Mannix RC, McClure TR, Crocker TT (1989 Feb). Health effects of acid aerosols formed by atmospheric mixtures. Environ Health Perspect 79:137-45.

~~1571.~~1564. Kobayashi T, Todoroki T, Sato H (1987). Enhancement of pulmonary metastasis of murine fibrosarcoma NR-FS by ozone exposure. J Toxicol Environ Health 20(1-2):135-45.

~~1572.~~1565. Kodavanti UP, Costa DL, Dreher KL, Crissman K, Hatch GE (1995b Jul). Ozone-induced tissue injury and changes in antioxidant homeostasis in normal and ascorbate-deficient guinea pigs. Biochem Pharmacol

50(2):243-51.

~~1573.~~1566. Kodavanti UP, Costa DL, Richards J, Crissman KM, Slade R, Hatch GE (1996 Jul-1996 Aug). Antioxidants in bronchoalveolar lavage fluid cells isolated from ozone-- exposed normal and ascorbate-deficient guinea pigs. Exp Lung Res 22(4):435-48.

~~1574.~~1567. Kodavanti UP, Hatch GE, Starcher B, Giri SN, Winsett D, Costa DL (1995a Feb). Ozone-induced pulmonary functional, pathological, and biochemical changes in normal and vitamin C-deficient guinea pigs. Fundam Appl Toxicol 24(2):154-64.

~~1575.~~1568. Koike E, Kobayashi T, Nelson DJ, McWilliam AS, Holt PG (1998 Feb). Effect of ozone exposure on alveolar macrophage-mediated immunosuppressive activity in rats. Toxicol Sci 41(2):217-23.

~~1576.~~1569. Koren HS, Devlin RB, Becker S, Perez R, McDonnell WF (1991). Time-dependent changes of markers associated with inflammation in the lungs of humans exposed to ambient levels of ozone. Toxicol Pathol 19(4 Pt 1):406-11.

~~1577.~~1570. Koren HS, Devlin RB, Graham DE, Mann R, McDonnell WF (1989a). The inflammatory response in human lung exposed to ambient levels of ozone. In: Schneider, T. //Lee, S. D. //Wolters, G. J. R. //Grant, L. D. eds. Atmospheric ozone research and its policy implications: proceedings of the 3rd US-Dutch international symposium; May 1988; Nijmegen, The Netherlands, Elsevier Science Publishers B. V., Amsterdam, The Netherlands. pp. 745-753 (Studies in environmental science 35).

~~1578.~~1571. Koren HS, Devlin RB, Graham DE, Mann R, McGee MP, Horstman DH, et al. (1989b Feb). Ozone-induced inflammation in the lower airways of human subjects. Am Rev Respir Dis 139(2):407-15.

~~1579.~~1572. Larson SD, Schelegle ES, Walby WF, Gershwin LJ, Fanuccihi MV, Evans MJ, et al. (2004 Feb). Postnatal remodeling of the neural components of the epithelial-mesenchymal trophic unit in the proximal airways of infant rhesus monkeys exposed to ozone and allergen. Toxicol Appl Pharmacol 194(3):211-20.

~~1580.~~1573. Laskin DL, Heck DE, Laskin JD (1998 Dec). Role of inflammatory cytokines and nitric oxide in hepatic and pulmonary toxicity. Toxicol Lett 102-103:289-93.

~~1581.~~1574. Laskin DL, Pendino KJ, Punjabi CJ, Rodriguez del Valle M, Laskin JD (1994 Dec). Pulmonary and hepatic effects of inhaled ozone in rats. Environ Health Perspect 102 Suppl 10:61-4.

~~1582.~~1575. Last JA, Gelzleichter T, Harkema J, Parks WC, Mellick P (1993b Nov). Effects of 20 months of ozone exposure on lung collagen in Fischer 344 rats. Toxicology 84(1-3):83-102.

~~1583.~~1576. Last JA, Gelzleichter TR, Pinkerton KE, Walker RM, Witschi H (1993a Aug). A new model of progressive pulmonary fibrosis in rats. Am

Rev Respir Dis 148(2):487-94.

~~1584.~~1577. Last JA, Pinkerton KE (1997 Jan). Chronic exposure of rats to ozone and sulfuric acid aerosol: biochemical and structural responses. Toxicology 116(1-3):133-46.

~~1585.~~1578. Last JA, Warren DL, Pecquet-Goad E, Witschi H (1987 Jan). Modification by ozone of lung tumor development in mice. J Natl Cancer Inst 78(1):149-54.

~~1586.~~1579. Lee JS, Mustafa MG, Afifi AA (1990). Effects of short-term, single and combined exposure to low-level NO_2 and O_3 on lung tissue enzyme activities in rats. J Toxicol Environ Health 29(3):293-305.

~~1587.~~1580. Lee S-L, Afifi AA, Mustafa MG (1989). Effects of short-term, single and combined exposure of rats to NO_2 and O_3 on lung tissue enzyme activities. Inhalation Toxicology 1:21-35.

~~1588.~~1581. Li AF, Richters A (1991a Jan-1991a Feb). Ambient level ozone effects on subpopulations of thymocytes and spleen T lymphocytes. Arch Environ Health 46(1):57-63.

~~1589.~~1582. Li AFY, Richters A (1991b). Effects of 0.7 ppm ozone exposure on thymocytes: in vivo and in vitro studies. Inhalation Toxicology 3:61-71.

~~1590.~~1583. Long NC, Suh J, Morrow JD, Schiestl RH, Murthy GG, Brain JD, et al. (2001 Oct). Ozone causes lipid peroxidation but little antioxidant depletion in exercising and nonexercising hamsters. J Appl Physiol 91(4):1694-700.

~~1591.~~1584. Madden MC, Richards JH, Dailey LA, Hatch GE, Ghio AJ (2000 Oct). Effect of ozone on diesel exhaust particle toxicity in rat lung. Toxicol Appl Pharmacol 168(2):140-8.

~~1592.~~1585. Mariassy AT, Abraham WM, Phipps RJ, Sielczak MW, Wanner A (1990 Jun). Effect of ozone on the postnatal development of lamb mucociliary apparatus. J Appl Physiol 68(6):2504-10.

~~1593.~~1586. Mariassy AT, Sielczak MW, McCray MN, Abraham WM, Wanner A (1989 Nov). Effects of ozone on lamb tracheal mucosa. Quantitative glycoconjugate histochemistry. Am J Pathol 135(5):871-9.

~~1594.~~1587. Mautz WB, Nadziejko C (2000). California Air Resources Board. Effects of ozone on proteases and protease inhibitors of the human and rat lung. Sacramento, CA: Research Division; 2000. Contract No. A033-175.

~~1595.~~1588. Mautz WJ, Bufalino C (1989 Apr). Breathing pattern and metabolic rate responses of rats exposed to ozone. Respir Physiol 76(1):69-77.

~~1596.~~1589. Mautz WJ, Finlayson-Pitts BJ, Messer K, Kleinman MT, Norgren MB, Quirion J (1991). Effects of ozone combined with components of acid fogs on breathing pattern, metabolic rate, pulmonary surfactant composition, and lung injury in rats. Inhalation Toxicology 3:1-25.

~~1597.~~1590. Mautz WJ, Kleinman MT, Bhalla DK, Phalen RF (2001 Jun). Respiratory tract responses to repeated inhalation of an oxidant and acid gas-particle air pollutant mixture. Toxicol Sci 61(2):331-41.

~~1598.~~1591. Mautz WJ, Kleinman MT, Phalen RF, Crocker TT (1988). Effects of exercise exposure on toxic interactions between inhaled oxidant and aldehyde air pollutants. J Toxicol Environ Health 25(2):165-77.

~~1599.~~1592. McBride RK, Oberdoerster G, Marin MG (1991 Jun). Effects of ozone on the cholinergic secretory responsiveness of ferret tracheal glands. Environ Res 55(1):79-90.

~~1600.~~1593. Mercer RR, Anjilvel S, Miller FJ, Crapo JD (1991 May). Inhomogeneity of ventilatory unit volume and its effects on reactive gas uptake. J Appl Physiol 70(5):2193-205.

~~1601.~~1594. Miller FJ, Conolly RB (1995). Uncertainties in health risk assessments: commentary on selected issues and research needs. In: Lee, S. D. //Schneider, T. eds. Comparative risk analysis and priority setting for air pollution issue: proceedings of the 4th US-Dutch international symposium; June 1993; Keystone, CO, Air and Waste Management Association, Pittsburg, PA. pp. 76-91.

~~1602.~~1595. Miller FJ, Illing JW, Gardner DE (1978a). Effect of urban ozone levels on laboratory-induced respiratory infections. Toxicology Letters 2:163-9.

~~1603.~~1596. Miller FJ, Menzel DB, Coffin DL (1978b Aug). Similarity between man and laboratory animals in regional pulmonary deposition of ozone. Environ Res 17(1):84-101.

~~1604.~~1597. Miller FJ, Overton JH Jr, Jaskot RH, Menzel DB (1985 Jun). A model of the regional uptake of gaseous pollutants in the lung. I. The sensitivity of the uptake of ozone in the human lung to lower respiratory tract secretions and exercise. Toxicol Appl Pharmacol 79(1):11-27.

~~1605.~~1598. Miller FJ, Overton JH, Gerrity TR, Graham RC (1988). Interspecies dosimetry of reactive gases. In: Mohr U, Dungworth D, Kimmerle G, Lewkowski J, McClellan R, Stober W, editors. Inhalation toxicology: the design and interpretation of inhalation studies and their use in risk assessment. New York: Springer-Verlag; pp. 139-155.

~~1606.~~1599. Miller PD, Gordon T, Warnick M, Amdur MO (1986). Effect of ozone and histamine on airway permeability to horseradish peroxidase in guinea pigs. J Toxicol Environ Health 18(1):121-32.

~~1607.~~1600. Mills PC, Roberts CA, Smith NC (1996 Sep). Effects of ozone and airway inflammation on glutathione status and iron homeostasis in the lungs of horses. Am J Vet Res 57(9):1359-63.

~~1608.~~1601. Mochitate K, Ishida K, Ohsumi T, Miura T (1992 Apr). Long-term effects of ozone and nitrogen dioxide on the metabolism and population of alveolar macrophages. J Toxicol Environ Health 35(4):247-60.

~~1609.~~1602. Mole ML Jr, Stead AG, Gardner DE, Miller FJ, Graham JA (1985 Sep). Effect of ozone on serum lipids and lipoproteins in the rat. Toxicol Appl Pharmacol 80(3):367-76.

~~1610.~~1603. Musi B, Dell'Omo G, Ricceri L, Santucci D, Laviola G, Bignami G, et al. (1994 Winter). Effects of acute and continuous ozone (O_3) exposure on activity/exploration and social behavior of CD-1 mice. Neurotoxicology 15(4):827-35.

~~1611.~~1604. Mustafa MG, Hassett CM, Newell GW, Schrauzer GN (1988). Pulmonary carcinogenic effects of ozone. Ann N Y Acad Sci 534:714-23.

~~1612.~~1605. Nikula KJ, Wilson DW, Giri SN, Plopper CG, Dungworth DL (1988 May). The response of the rat tracheal epithelium to ozone exposure. Injury, adaptation, and repair. Am J Pathol 131(2):373-84.

~~1613.~~1606. Oosting RS, van Golde LM, Verhoef J, Van Bree L (1991 Aug). Species differences in impairment and recovery of alveolar macrophage functions following single and repeated ozone exposures. Toxicol Appl Pharmacol 110(1):170-8.

~~1614.~~1607. Overton JH, Barnett AE, Graham RC (1989a). Significances of the variability of tracheobronchial airway paths and their air flow rates to dosimetry model predictions of the absorption of gases. In: Crapo JD; Smolko ED; Miller FJ; Graham JA; Hayes AW; eds. Extrapolation of dosimetric relationships for inhaled particles and gases. San Diego: Academic Press, Inc.; pp. 273-291.

~~1615.~~1608. Overton JH, Graham RC (1989b). Predictions of ozone absorption in human lungs from newborn to adult. Health Phys 57 Suppl 1:29-36.

~~1616.~~1609. Overton JH, Graham RC, Miller FJ (1987 May). A model of the regional uptake of gaseous pollutants in the lung. II. The sensitivity of ozone uptake in laboratory animal lungs to anatomical and ventilatory parameters. Toxicol Appl Pharmacol 88(3):418-32.

~~1617.~~1610. Paz C (1997 Summer). Some consequences of ozone exposure on health. Arch Med Res 28(2):163-70.

~~1618.~~1611. Paz C, Bazan-Perkins B (1992 Jun). Sleep-wake disorganization in cats exposed to ozone. Neurosci Lett 140(2):270-2.

~~1619.~~1612. Paz C, Huitron-Resendiz S (1996 Feb). The effects of ozone exposure on the sleep-wake cycle and serotonin contents in the pons of the rat. Neurosci Lett 204(1-2):49-52.

~~1620.~~1613. Pearson AC, Bhalla DK (1997 Feb). Effects of ozone on macrophage adhesion in vitro and epithelial and inflammatory responses in vivo: the role of cytokines. J Toxicol Environ Health 50(2):143-57.

~~1621.~~1614. Petruzzi S, De Acetis L, Chiarotti F, Sorace A, Alleva E (1999). Limited changes in handedness and morphine reactivity in CD-1 mice after pre- and postnatal ozone exposure. Acta Neurobiol Exp (Warsz) 59(2):115-

22.

~~1622.~~1615. Petruzzi S, Fiore M, Dell'Omo G, Alleva E (1995a). Exposure to ozone inhibits isolation-induced aggressive behavior of adult CD-1 male mice. Aggressive Behavior 21:387-96.

~~1623.~~1616. Petruzzi S, Fiore M, Dell'Omo G, Bignami G, Alleva E (1995 Jul-1995 Aug). Medium and long-term behavioral effects in mice of extended gestational exposure to ozone. Neurotoxicol Teratol 17(4):463-70.

~~1624.~~1617. Phalen RF, Crocker TT, McClure TR, Tyler NK (1986). Effect of ozone on mean linear intercept in the lung of young beagles. J Toxicol Environ Health 17(2-3):285-96.

~~1625.~~1618. Phipps RJ, Denas SM, Sielczak MW, Wanner A (1986 Mar). Effects of 0.5 ppm ozone on glycoprotein secretion, ion and water fluxes in sheep trachea. J Appl Physiol 60(3):918-27.

~~1626.~~1619. Pickrell JA, Gregory RE, Cole DJ, Hahn FF, Henderson RF (1987b Apr). Effect of acute ozone exposure on the proteinase-antiproteinase balance in the rat lung. Exp Mol Pathol 46(2):168-79.

~~1627.~~1620. Pickrell JA, Hahn FF, Rebar AH, Horoda RA, Henderson RF (1987a Apr). Changes in collagen metabolism and proteinolysis after repeated inhalation exposure to ozone. Exp Mol Pathol 46(2):159-67.

~~1628.~~1621. Pinkerton KE, Brody AR, Miller FJ, Crapo JD (1989 Oct). Exposure to low levels of ozone results in enhanced pulmonary retention of inhaled asbestos fibers. Am Rev Respir Dis 140(4):1075-81.

~~1629.~~1622. Pinkerton KE, Joad JP (2000 Jun). The mammalian respiratory system and critical windows of exposure for children's health. Environ Health Perspect 108 Suppl 3:457-62.

~~1630.~~1623. Pino MV, Levin JR, Stovall MY, Hyde DM (1992a Jan). Pulmonary inflammation and epithelial injury in response to acute ozone exposure in the rat. Toxicol Appl Pharmacol 112(1):64-72.

~~1631.~~1624. Pino MV, Stovall MY, Levin JR, Devlin RB, Koren HS, Hyde DM (1992b Jun). Acute ozone-induced lung injury in neutrophil-depleted rats. Toxicol Appl Pharmacol 114(2):268-76.

~~1632.~~1625. Plopper CG, Duan X, Buckpitt AR, Pinkerton KE (1994 Jul). Dose-dependent tolerance to ozone. IV. Site-specific elevation in antioxidant enzymes in the lungs of rats exposed for 90 days or 20 months. Toxicol Appl Pharmacol 127(1):124-31.

~~1633.~~1626. Plopper CG, Hatch GE, Wong V, Duan X, Weir AJ, Tarkington BK, et al. (1998 Sep). Relationship of inhaled ozone concentration to acute tracheobronchial epithelial injury, site-specific ozone dose, and glutathione depletion in rhesus monkeys. Am J Respir Cell Mol Biol 19(3):387-99.

~~1634.~~1627. Postlethwait EM, Langford SD, Bidani A (1994 Mar). Determinants of inhaled ozone absorption in isolated rat lungs. Toxicol Appl Pharmacol

125(1):77-89.

~~1635.~~1628. Prasad SB, Rao VS, Mannix RC, Phalen RF (1988). Effects of pollutant atmospheres on surface receptors of pulmonary macrophages. J Toxicol Environ Health 24(3):385-402.

~~1636.~~1629. Pryor WA (1992). How far does ozone penetrate into the pulmonary air/tissue boundary before it reacts? Free Radic Biol Med 12(1):83-8.

~~1637.~~1630. Pryor WA, Das B, Church DF (1991 May-1991 Jun). The ozonation of unsaturated fatty acids: aldehydes and hydrogen peroxide as products and possible mediators of ozone toxicity. Chem Res Toxicol 4(3):341-8.

~~1638.~~1631. Rahman I, Clerch LB, Massaro D (1991 Jun). Rat lung antioxidant enzyme induction by ozone. Am J Physiol 260(6 Pt 1):L412-8.

~~1639.~~1632. Rahman I, Massaro GD, Massaro D (1992). Exposure of rats to ozone: evidence of damage to heart and brain. Free Radic Biol Med 12(4):323-6.

~~1640.~~1633. Rajini P, Gelzleichter TR, Last JA, Witschi H (1993 Aug). Alveolar and airway cell kinetics in the lungs of rats exposed to nitrogen dioxide, ozone, and a combination of the two gases. Toxicol Appl Pharmacol 121(2):186-92.

~~1641.~~1634. Raub JA, Miller FJ, Graham JA (1983). Effects of low-level ozone exposure on pulmonary function in adult and neonatal rats. Advances in Modern Environmental Toxicology 5:363-7.

~~1642.~~1635. Reinhart PG, Bassett DJ, Bhalla DK (1998 May). The influence of polymorphonuclear leukocytes on altered pulmonary epithelial permeability during ozone exposure. Toxicology 127(1-3):17-28.

~~1643.~~1636. Reiser KM, Tyler WS, Hennessy SM, Dominguez JJ, Last JA (1987 Jul). Long-term consequences of exposure to ozone. II. Structural alterations in lung collagen of monkeys. Toxicol Appl Pharmacol 89(3):314-22.

~~1644.~~1637. Richters A (1988). Effects of nitrogen dioxide and ozone on blood-borne cancer cell colonization of the lungs. J Toxicol Environ Health 25(3):383-90.

~~1645.~~1638. Rietjens IM, Van Bree L, Marra M, Poelen MC, Rombout PJ, Alink GM (1985 Dec). Glutathione pathway enzyme activities and the ozone sensitivity of lung cell populations derived from ozone exposed rats. Toxicology 37(3-4):205-14.

~~1646.~~1639. Rivas-Arancibia S, Vazquez-Sandoval R, Gonzalez-Kladiano D, Schneider-Rivas S, Lechuga-Guerrero A (1998 Jan). Effects of ozone exposure in rats on memory and levels of brain and pulmonary superoxide dismutase. Environ Res 76(1):33-9.

~~1647.~~1640. Rivas-Manzano P, Paz C (1999 Nov). Cerebellar morphological alterations in rats induced by prenatal ozone exposure. Neurosci Lett

276(1):37-40.

~~1648.~~1641. Rombout PJA, van Bree L, Heisterkamp SH, Marra M (1989). The need for an eight hour ozone standard. In: Schneider, T.; Lee, S. D.; Wolters, G. J. R.; Grant, L. D. eds. Atmospheric ozone research and its policy implications: proceedings of the 3rd US-Dutch international symposium; May 1988; Nijmegen, The Netherlands, Elsevier Science Publishers B. V., Amsterdam, The Netherlands. pp. 701-710 (Studies in Environmental Science 35).

~~1649.~~1642. Romero-Velazquez RM, Alfaro-Rodriguez A, Gonzalez-Pina R, Gonzalez-Maciel A (2002). Effect of ozone prenatal exposure on postnatal development of cerebellum. Proc West Pharmacol Soc 45:65-7.

~~1650.~~1643. Ross BK, Hlastala MP, Frank R (1979 May-1979 Jun). Lack of ozone effects on oxygen hemoglobin affinity. Arch Environ Health 34(3):161-3.

~~1651.~~1644. Ryer-Powder JE, Amoruso MA, Czerniecki B, Witz G, Goldstein BD (1988 Nov). Inhalation of ozone produces a decrease in superoxide anion radical production in mouse alveolar macrophages. Am Rev Respir Dis 138(5):1129-33.

~~1652.~~1645. Sagai M, Ichinose T (1991 Feb). Biochemical effects of combined gases of nitrogen dioxide and ozone. IV. Changes of lipid peroxidation and antioxidative protective systems in rat lungs upon life span exposure. Toxicology 66(2):121-32.

~~1653.~~1646. Saldiva PH, King M, Delmonte VL, Macchione M, Parada MA, Daliberto ML, et al. (1992 Feb). Respiratory alterations due to urban air pollution: an experimental study in rats. Environ Res 57(1):19-33.

~~1654.~~1647. Sarangapani R, Gentry PR, Covington TR, Teeguarden JG, Clewell HJ 3rd (2003 Sep). Evaluation of the potential impact of age- and gender-specific lung morphology and ventilation rate on the dosimetry of vapors. Inhal Toxicol 15(10):987-1016.

~~1655.~~1648. Schelegle ES, Miller LA, Gershwin LJ, Fanucchi MV, Van Winkle LS, Gerriets JE, et al. (2003a Aug). Repeated episodes of ozone inhalation amplifies the effects of allergen sensitization and inhalation on airway immune and structural development in Rhesus monkeys. Toxicol Appl Pharmacol 191(1):74-85.

~~1656.~~1649. Schelegle ES, Walby WF, Alfaro MF, Wong VJ, Putney L, Stovall MY, et al. (2003b Feb). Repeated episodes of ozone inhalation attenuates airway injury/repair and release of substance P, but not adaptation. Toxicol Appl Pharmacol 186(3):127-42.

~~1657.~~1650. Schlesinger RB, Gorczynski JE, Dennison J, Richards L, Kinney PL, Bosland MC (1992a Jul-1992a Aug). Long-term intermittent exposure to sulfuric acid aerosol, ozone, and their combination: alterations in tracheobronchial mucociliary clearance and epithelial secretory cells. Exp

Lung Res 18(4):505-34.

~~1658.~~1651. Schlesinger RB, Zelikoff JT, Chen LC, Kinney PL (1992b Aug). Assessment of toxicologic interactions resulting from acute inhalation exposure to sulfuric acid and ozone mixtures. Toxicol Appl Pharmacol 115(2):183-90.

~~1659.~~1652. Selgrade MK, Cooper KD, Devlin RB, van Loveren H, Biagini RE, Luster MI (1995 Jan). Immunotoxicity--bridging the gap between animal research and human health effects. Fundam Appl Toxicol 24(1):13-21.

~~1660.~~1653. Selgrade MK, Daniels MJ, Grose EC (1990). Acute, subchronic, and chronic exposure to a simulated urban profile of ozone: effects on extrapulmonary natural killer cell activity and lymphocyte mitogenic responses. Inhalation Toxicology 2:375-89.

~~1661.~~1654. Selgrade MK, Illing JW, Starnes DM, Stead AG, Menache MG, Stevens MA (1988 Jul). Evaluation of effects of ozone exposure on influenza infection in mice using several indicators of susceptibility. Fundam Appl Toxicol 11(1):169-80.

~~1662.~~1655. Shepson PB, Kleindienst TE, Edney EO, Namie GR, Pittman JH, Cupitt LT, et al. (1985). The mutagenic activity of irradiated toluene/NO~~$_x$~~$_X$/H_2O/air mixtures. Environ Sci Technol 19:249-55.

~~1663.~~1656. Sherwin RP, Richters V (1985). Effect of 0.3 ppm ozone exposure on type II cells and alveolar walls of newborn mice: an image-analysis quantitation. J Toxicol Environ Health 16(3-4):535-46.

~~1664.~~1657. Sherwood RL, Lippert WE, Goldstein E (1986 Dec). Effect of 0.64 ppm ozone on alveolar macrophage lysozyme levels in rats with chronic pulmonary bacterial infection. Environ Res 41(2):378-87.

~~1665.~~1658. Shore SA, Johnston RA, Schwartzman IN, Chism D, Krishna Murthy GG (2002 Mar). Ozone-induced airway hyperresponsiveness is reduced in immature mice. J Appl Physiol 92(3):1019-28.

~~1666.~~1659. Sielczak MW, Denas SM, Abraham WM (1983 Apr-1983 Jun). Airway cell changes in tracheal lavage of sheep after ozone exposure. J Toxicol Environ Health 11(4-6):545-53.

~~1667.~~1660. Sills RC, Hong HL, Greenwell A, Herbert RA, Boorman GA, Devereux TR (1995 Jul). Increased frequency of K-ras mutations in lung neoplasms from female B6C3F1 mice exposed to ozone for 24 or 30 months. Carcinogenesis 16(7):1623-8.

~~1668.~~1661. Slade R, Crissman K, Norwood J, Hatch G (1993 Jul-1993 Aug). Comparison of antioxidant substances in bronchoalveolar lavage cells and fluid from humans, guinea pigs, and rats. Exp Lung Res 19(4):469-84.

~~1669.~~1662. Slade R, Highfill JW, Hatch GE (1989). Effects of depletion of ascorbic acid or nonprotein sulfhydryls on the acute inhalation toxicity of nitrogen dioxide, ozone, and phosgene. Inhalation Toxicology 1:261-71.

~~1670.~~1663. Slade R, Watkinson WP, Hatch GE (1997 Jan). Mouse strain differences in ozone dosimetry and body temperature changes. Am J Physiol 272(1 Pt 1):L73-7.

~~1671.~~1664. Sorace A, de Acetis L, Alleva E, Santucci D (2001 Feb). Prolonged exposure to low doses of ozone: short- and long-term changes in behavioral performance in mice. Environ Res 85(2):122-34.

~~1672.~~1665. Sterner-Kock A, Kock M, Braun R, Hyde DM (2000 Sep). Ozone-induced epithelial injury in the ferret is similar to nonhuman primates. Am J Respir Crit Care Med 162(3 Pt 1):1152-6.

~~1673.~~1666. Tepper JS, Costa DL, Lehmann JR, Weber MF, Hatch GE (1989 Aug). Unattenuated structural and biochemical alterations in the rat lung during functional adaptation to ozone. Am Rev Respir Dis 140(2):493-501.

~~1674.~~1667. Tepper JS, Wiester MJ, Weber MF, Menache MG (1990 Feb). Measurements of cardiopulmonary response in awake rats during acute exposure to near-ambient concentrations of ozone. J Appl Toxicol 10(1):7-15.

~~1675.~~1668. Thomassen DG, Harkema JR, Stephens ND, Griffith WC (1991 Jun). Preneoplastic transformation of rat tracheal epithelial cells by ozone. Toxicol Appl Pharmacol 109(1):137-48.

~~1676.~~1669. Tyler WS, Tyler NK, Last JA, Gillespie MJ, Barstow TJ (1988 Jul). Comparison of daily and seasonal exposures of young monkeys to ozone. Toxicology 50(2):131-44.

~~1677.~~1670. Tyler WS, Tyler NK, Magliano DJ, Hinds DM, Tarkington B, Julian MD, et al. (1991). Effects of ozone inhalation on lungs of juvenile monkeys. Morphometry after a 12 month exposure and following a 6 month post-exposure period. In: Berglund RL, Lawson DR, McKee DJ, eds. Tropospheric Ozone and the Environment: Papers from an International Conference, March 1990, Los Angeles, CA, Pittsburgh, PA: Air and Waste Management Association, p. 151-160.

~~1678.~~1671. Tyson CA, Lunan KD, Stephens RJ (1982 May-1982 Jun). Age-related differences in GSH-shuttle enzymes in NO_2- or O_3-exposed rat lungs. Arch Environ Health 37(3):167-76.

1672. U.S. Environmental Protection Agency (1996). Air Quality Criteria for Ozone and Related Photochemical Oxidants. Volume III. Chapter 8. Extrapolation of Animal Toxicological Data to Humans.
EPA/600/P-93/004a-cF p. 8-1 to 8-101. Can be obtained online at: http://cfpub.epa.gov/ncea/cfm/ozone.cfm?ActType=default .

~~1680.~~1673. Uchiyama I, Simomura Y, Yokoyama E (1986 Dec). Effects of acute exposure to ozone on heart rate and blood pressure of the conscious rat. Environ Res 41(2):529-37.

~~1681.~~1674. Uchiyama I, Yokoyama E (1989 Feb). Effects of short- and long-term exposure to ozone on heart rate and blood pressure of emphysematous rats. Environ Res 48(1):76-86.

~~1682.~~1675. Ulrich MM, Alink GM, Kumarathasan P, Vincent R, Boere AJ, Cassee FR (2002 Oct). Health effects and time course of particulate matter on the cardiopulmonary system in rats with lung inflammation. J Toxicol Environ Health A 65(20):1571-95.

~~1683.~~1676. Umezu T, Shimojo N, Tsubone H, Suzuki AK, Kubota K, Shimizu A (1987 Jan-1987 Feb). Effect of ozone toxicity in the drinking behavior of rats. Arch Environ Health 42(1):58-62.

~~1684.~~1677. van Bree L, Dormans JA, Boere AJ, Rombout PJ (2001 Aug). Time study on development and repair of lung injury following ozone exposure in rats. Inhal Toxicol 13(8):703-18.

~~1685.~~1678. van Bree L, Dormans JA, Koren HS, Devlin RB, Rombout PJ (2002 Aug). Attenuation and recovery of pulmonary injury in rats following short-term, repeated daily exposure to ozone. Inhal Toxicol 14(8):883-900.

~~1686.~~1679. Van Loveren H, Krajnc EI, Rombout PJ, Blommaert FA, Vos JG (1990 Jan). Effects of ozone, hexachlorobenzene, and bis(tri-n-butyltin)oxide on natural killer activity in the rat lung. Toxicol Appl Pharmacol 102(1):21-33.

~~1687.~~1680. Van Loveren H, Rombout PJ, Wagenaar SS, Walvoort HC, Vos JG (1988 Jul). Effects of ozone on the defense to a respiratory Listeria monocytogenes infection in the rat. Suppression of macrophage function and cellular immunity and aggravation of histopathology in lung and liver during infection. Toxicol Appl Pharmacol 94(3):374-93.

~~1688.~~1681. Vaughan WJ, Adamson GL, Lindgren FT, Schooley JC (1984 Jul). Serum lipid and lipoprotein concentrations following exposure to ozone. J Environ Pathol Toxicol Oncol 5(4-5):165-73.

~~1689.~~1682. Victorin K (1996). Genotoxicity and carcinogenicity of ozone. Scand J Work Environ Health 22 Suppl 3:42-51.

~~1690.~~1683. Victorin K, Stahlberg M (1988). A method for studying the mutagenicity of some gaseous compounds in Salmonella typhimurium. Environ Mol Mutagen 11(1):65-77.

~~1691.~~1684. Vincent R, Bjarnason SG, Adamson IY, Hedgecock C, Kumarathasan P, Guenette J, et al. (1997 Dec). Acute pulmonary toxicity of urban particulate matter and ozone. Am J Pathol 151(6):1563-70.

~~1692.~~1685. Warren DL, Guth DJ, Last JA (1986 Jul). Synergistic interaction of ozone and respirable aerosols on rat lungs. II. Synergy between ammonium sulfate aerosol and various concentrations of ozone. Toxicol Appl Pharmacol 84(3):470-9.

~~1693.~~1686. Warren DL, Last JA (1987 Apr). Synergistic interaction of ozone and respirable aerosols on rat lungs. III. Ozone and sulfuric acid aerosol. Toxicol Appl Pharmacol 88(2):203-16.

~~1694.~~1687. Watkinson WP, Aileru AA, Dowd SM, Doerfler DL, Tepper JS, Costa DL (1993). Acute effects of ozone on heart rate and body temperature in the unanesthetized, unrestrained rat maintained at different ambient temperatures. Inhalation Toxicology 5:129-47.

~~1695.~~1688. Watkinson WP, Campen MJ, Nolan JP, Costa DL (2001 Aug). Cardiovascular and systemic responses to inhaled pollutants in rodents: effects of ozone and particulate matter. Environ Health Perspect 109 Suppl 4:539-46.

~~1696.~~1689. Watkinson WP, Wiester MJ, Highfill JW (1995 Mar). Ozone toxicity in the rat. I. Effect of changes in ambient temperature on extrapulmonary physiological parameters. J Appl Physiol 78(3):1108-20.

~~1697.~~1690. Weller BL, Crapo JD, Slot J, Posthuma G, Plopper CG, Pinkerton KE (1997 Nov). Site- and cell-specific alteration of lung copper/zinc and manganese superoxide dismutases by chronic ozone exposure. Am J Respir Cell Mol Biol 17(5):552-60.

~~1698.~~1691. Wiester MJ, Tepper JS, King ME, Menache MG, Costa DL (1988 Oct). Comparative study of ozone (O_3) uptake in three strains of rats and in the guinea pig. Toxicol Appl Pharmacol 96(1):140-6.

~~1699.~~1692. Wiester MJ, Tepper JS, Winsett DW, Crissman KM, Richards JH, Costa DL (1996a May). Adaptation to ozone in rats and its association with ascorbic acid in the lung. Fundam Appl Toxicol 31(1):56-64.

~~1700.~~1693. Wiester MJ, Watkinson WP, Costa DL, Crissman KM, Richards JH, Winsett DW, et al. (1996b Oct). Ozone toxicity in the rat. III. Effect of changes in ambient temperature on pulmonary parameters. J Appl Physiol 81(4):1691-700.

~~1701.~~1694. Wiester MJ, Williams TB, King ME, Menache MG, Miller FJ (1987 Jul). Ozone uptake in awake Sprague-Dawley rats. Toxicol Appl Pharmacol 89(3):429-37.

~~1702.~~1695. Wiester MJ, Winsett DW, Richards JH, Jackson MC, Crissman KM, Costa DL (2000 Jul). Ozone adaptation in mice and its association with ascorbic acid in the lung. Inhal Toxicol 12(7):577-90.

~~1703.~~1696. Witschi H (1988 Jan). Ozone, nitrogen dioxide and lung cancer: a review of some recent issues and problems. Toxicology 48(1):1-20.

~~1704.~~1697. Witschi H (1991 Mar-1991 Apr). Effects of oxygen and ozone on mouse lung tumorigenesis. Exp Lung Res 17(2):473-83.

~~1705.~~1698. Witschi H, Espiritu I, Pinkerton KE, Murphy K, Maronpot RR (1999 Dec). Ozone carcinogenesis revisited. Toxicol Sci 52(2):162-7.

~~1706.~~1699. Witschi H, Wilson DW, Plopper CG (1993 Jan). Modulation of N-nitrosodiethylamine-induced hamster lung tumors by ozone. Toxicology 77(1-2):193-202.

~~1707.~~1700. Wong CG, Bonakdar M, Mautz WJ, Kleinman MT (1996 Feb).

Chronic inhalation exposure to ozone and nitric acid elevates stress-inducible heat shock protein 70 in the rat lung. Toxicology 107(2):111-9.

~~1708.~~1701. Wright ES, Kehrer JP, White DM, Smiler KL (1988 Mar). Effects of chronic exposure to ozone on collagen in rat lung. Toxicol Appl Pharmacol 92(3):445-52.

~~1709.~~1702. Yokoyama E, Frank R (1972 Aug). Respiratory uptake of ozone in dogs. Arch Environ Health 25(2):132-8.

~~1710.~~1703. Young C, Bhalla DK (1992 Feb). Time course of permeability changes and PMN flux in rat trachea following O_3 exposure. Fundam Appl Toxicol 18(2):175-80.

~~1711.~~1704. Yu M, Pinkerton KE, Witschi H (2002 Jan). Short-term exposure to aged and diluted sidestream cigarette smoke enhances ozone-induced lung injury in B6C3F1 mice. Toxicol Sci 65(1):99-106.

~~1712.~~1705. Zelikoff JT, Kraemer GL, Vogel MC, Schlesinger RB (1991 Dec). Immunomodulating effects of ozone on macrophage functions important for tumor surveillance and host defense. J Toxicol Environ Health 34(4):449-67.