United States Environmental Protection Agency

Review of the National Ambient Air Quality Standards for Ozone:

Policy Assessment of Scientific and Technical Information

Appendices to OAQPS Staff Paper – Second Draft

EPA-452/D-05-002
July 2006

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U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina

DISCLAIMER

APPENDIX 2A. PLOTS OF DIURNAL POLICY RELEVANT BACKGROUND OZONE PATTERNS FOR 12 URBAN AREAS BASED ON RUNS OF THE GEOS-CHEM MODEL FOR APRIL-OCTOBER 2001

Figure 2A-1. Atlanta CSA: Diurnal Policy Relevant Background Ozone Patterns.

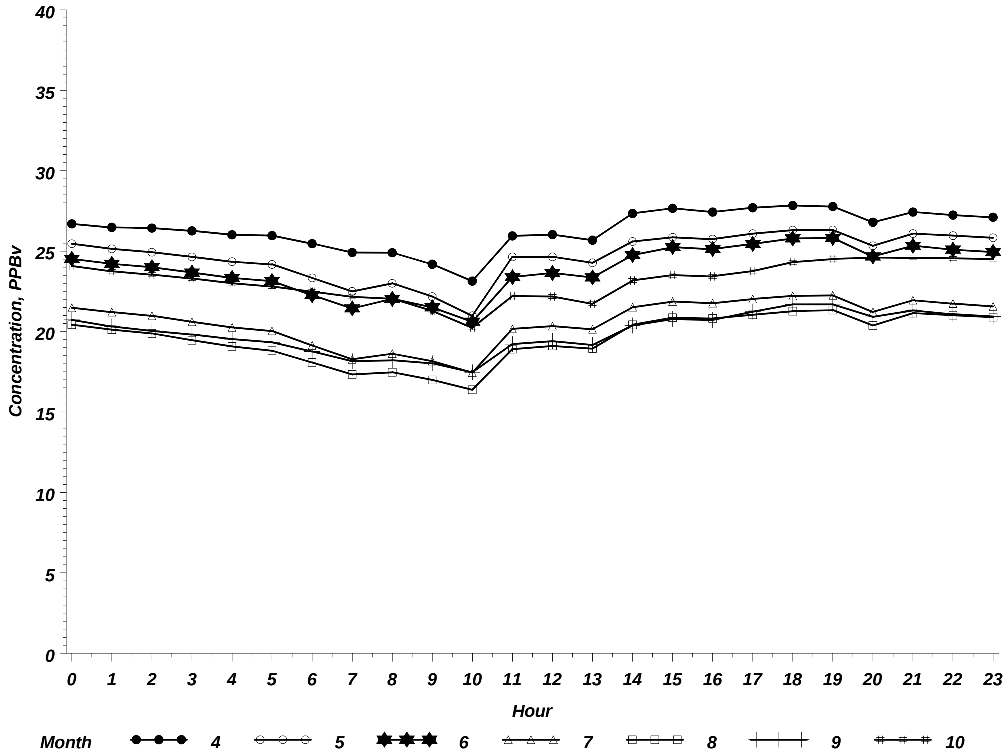


Figure 2A-2. Boston CSA: Diurnal Policy Relevant Background Ozone Patterns.

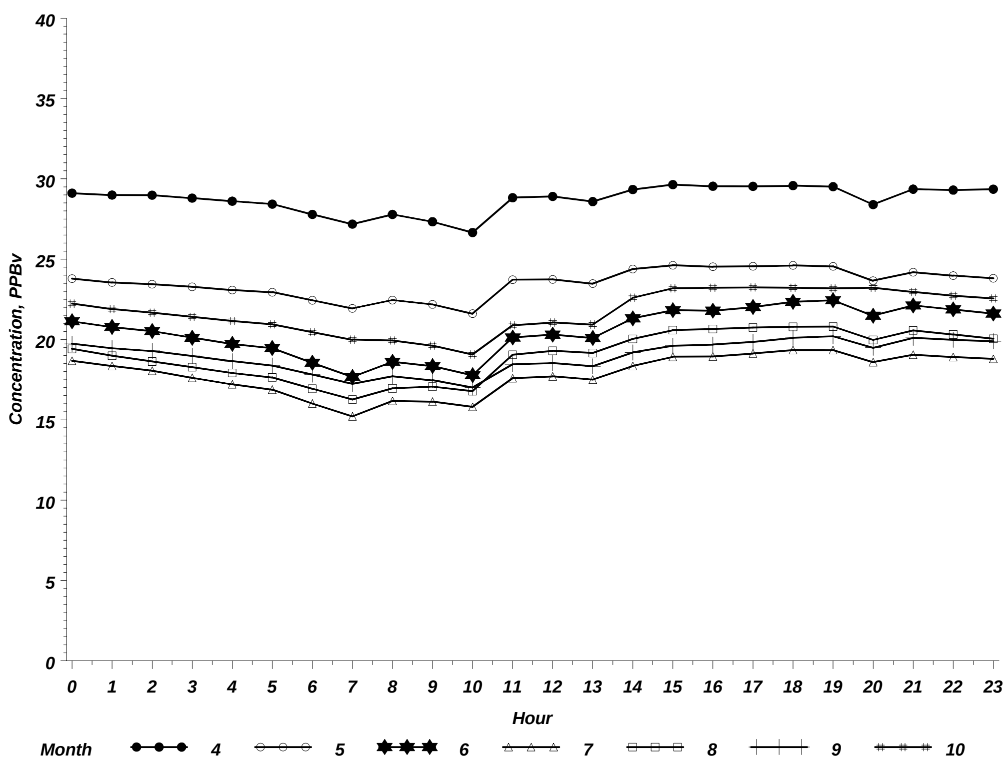


Figure 2A-3. Chicago CSA: Diurnal Policy Relevant Background Ozone Patterns.

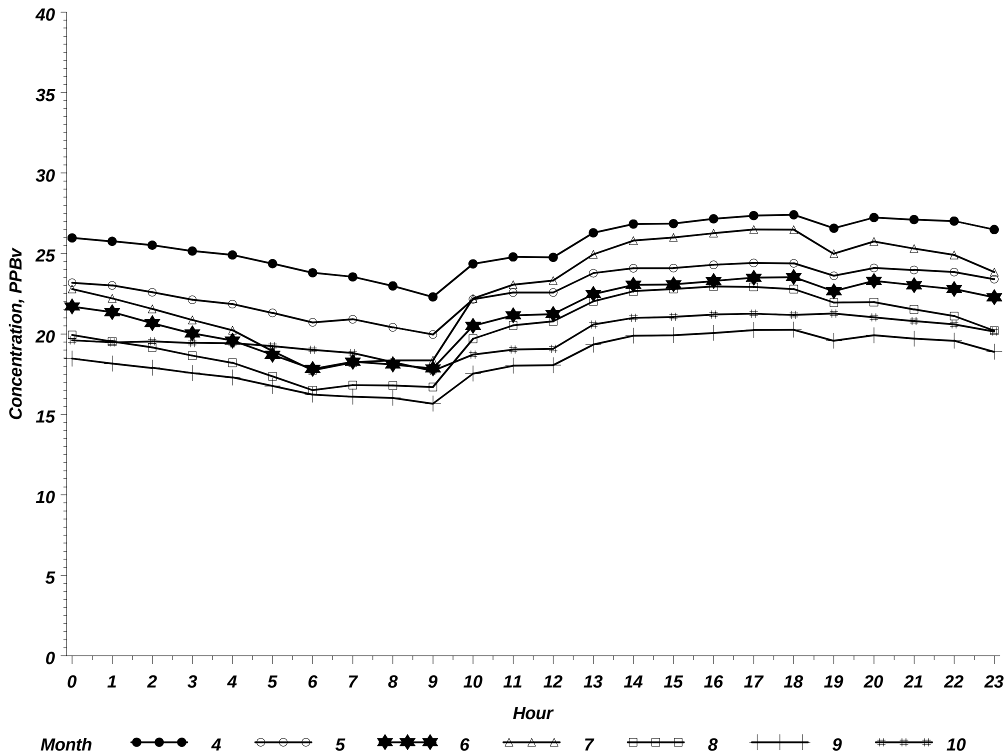


Figure 2A-4. Cleveland CSA: Diurnal Policy Relevant Background Ozone Patterns.

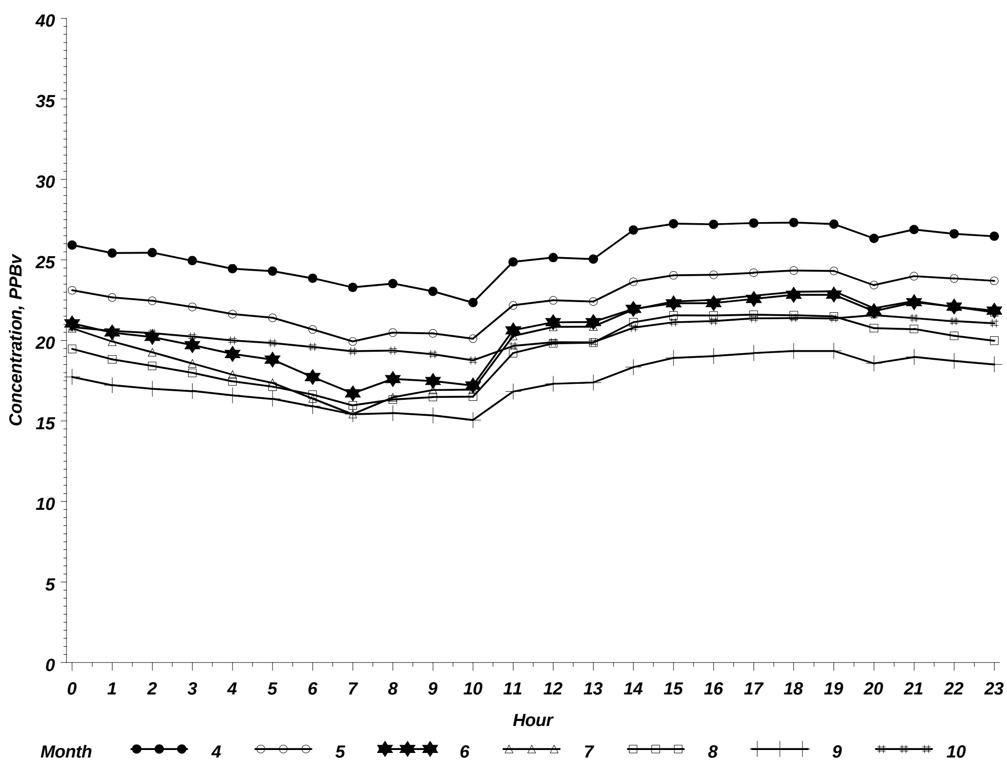


Figure 2A-5. Detroit CSA: Diurnal Policy Relevant Background Ozone Patterns.

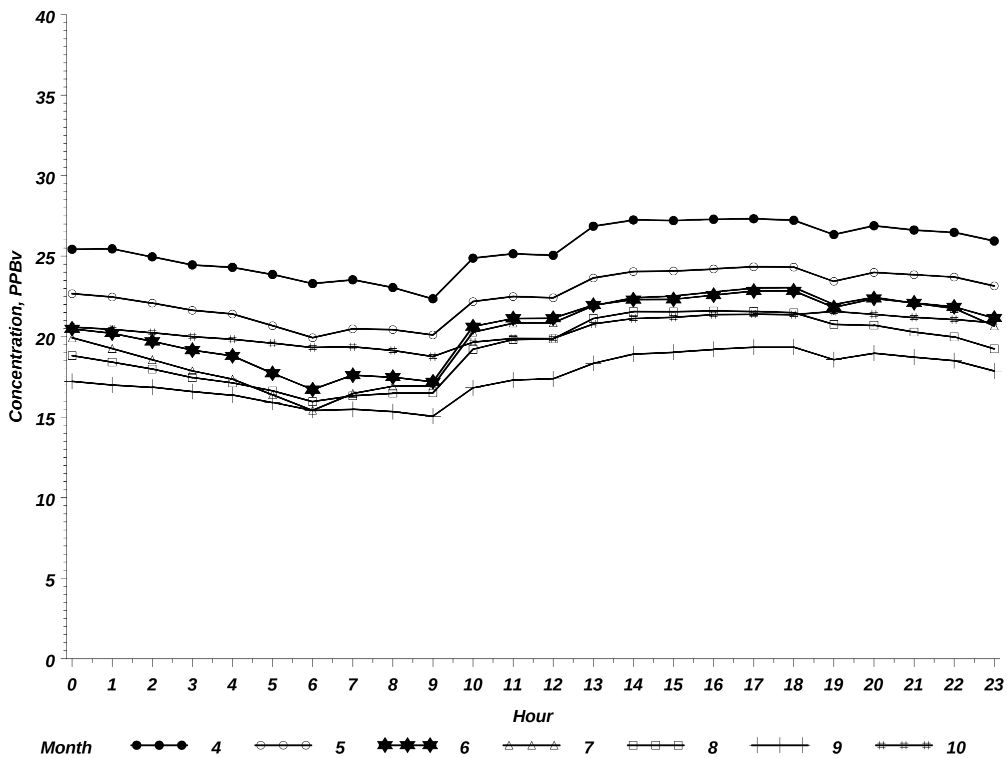


Figure 2A-6. Houston CSA: Diurnal Policy Relevant Background Ozone Patterns.

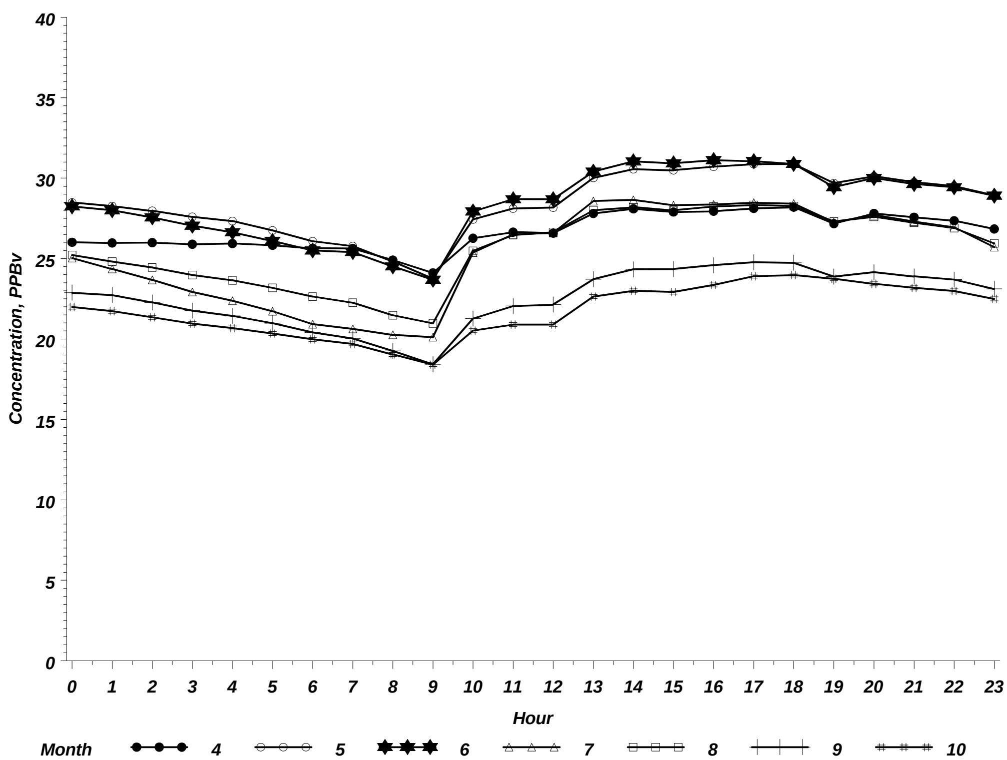


Figure 2A-7. Los Angeles CSA: Diurnal Policy Relevant Background Ozone Patterns.

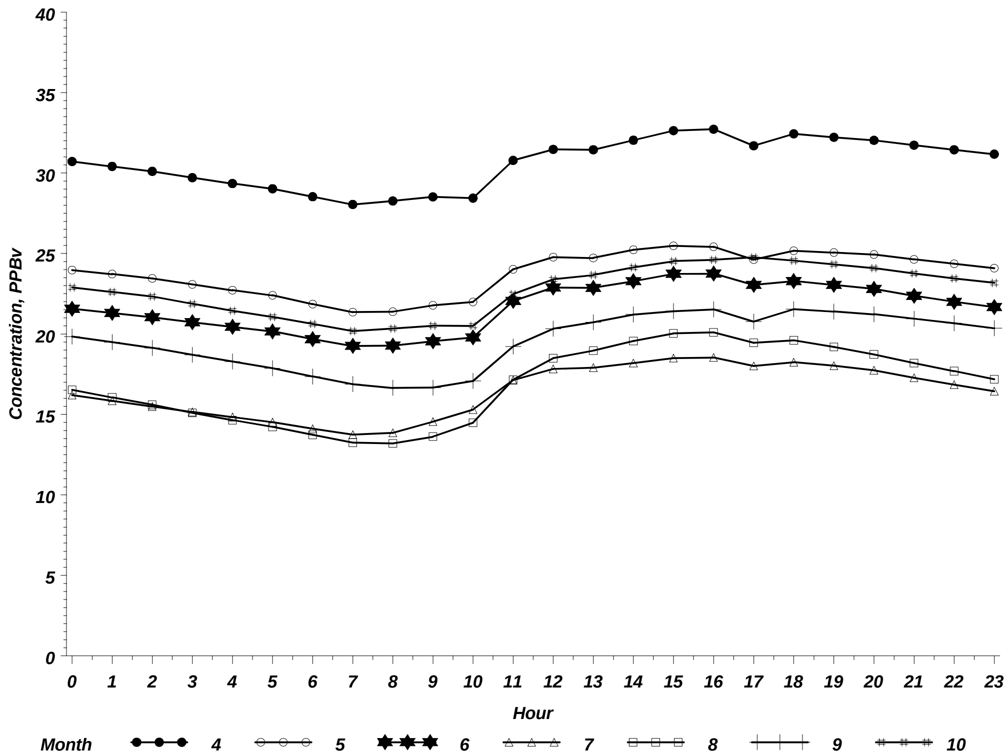


Figure 2A-8. New York CSA: Diurnal Policy Relevant Background Ozone Patterns.

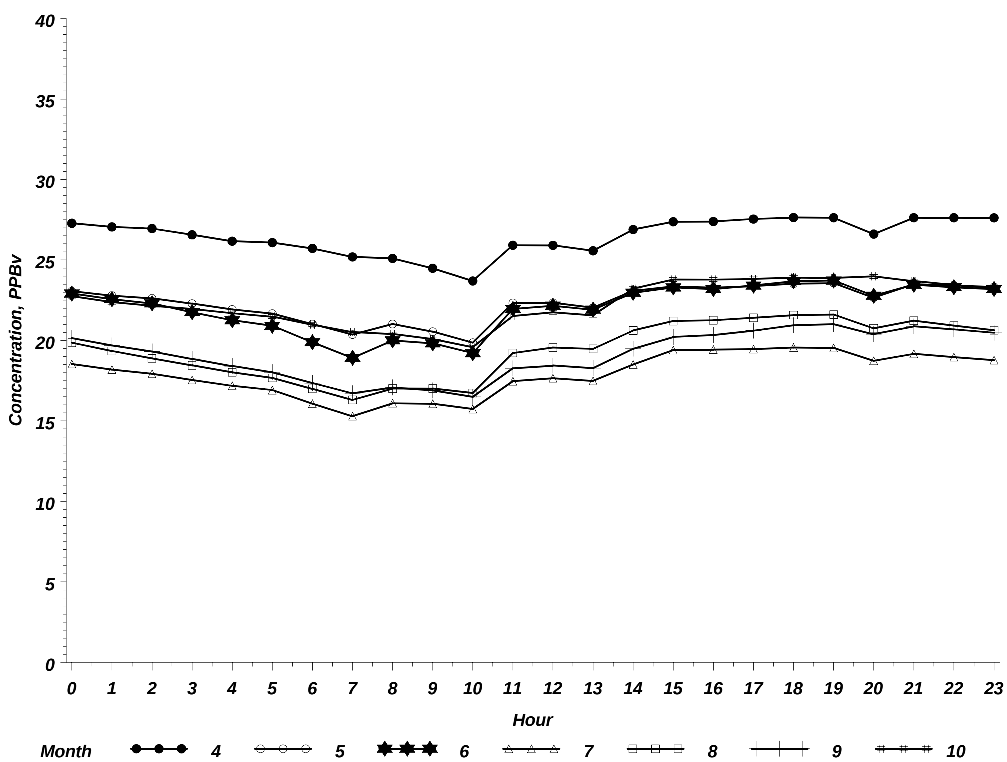


Figure 2A-9. Philadelphia CSA: Diurnal Policy Relevant Background Ozone Patterns.

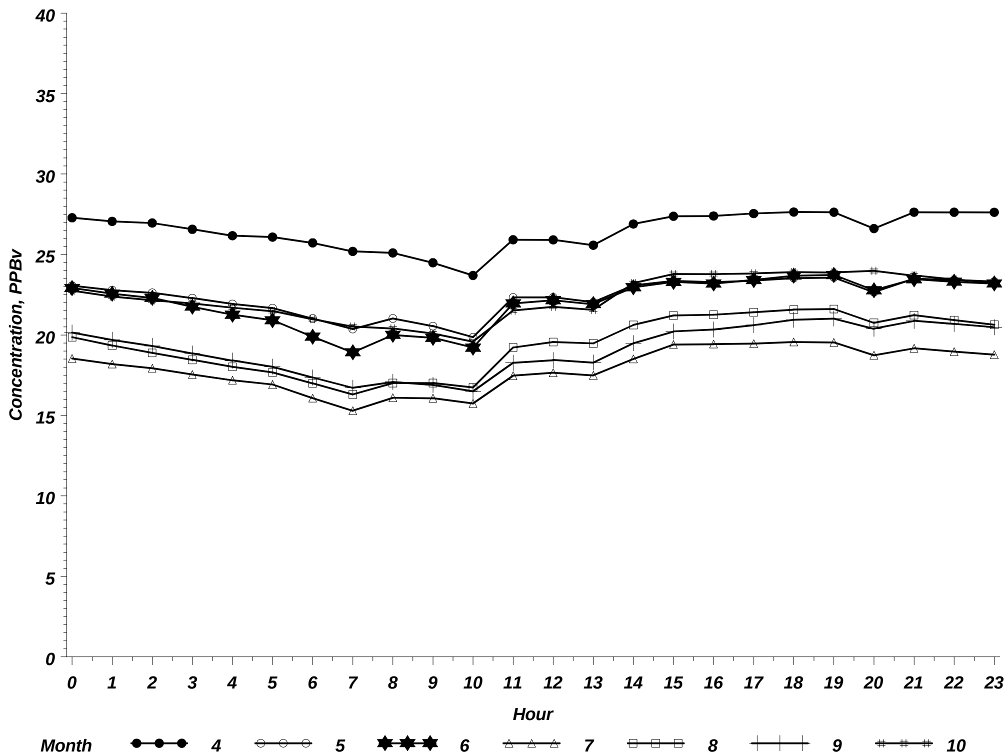


Figure 2A-10. Sacramento CSA: Diurnal Policy Relevant Background Ozone Patterns.

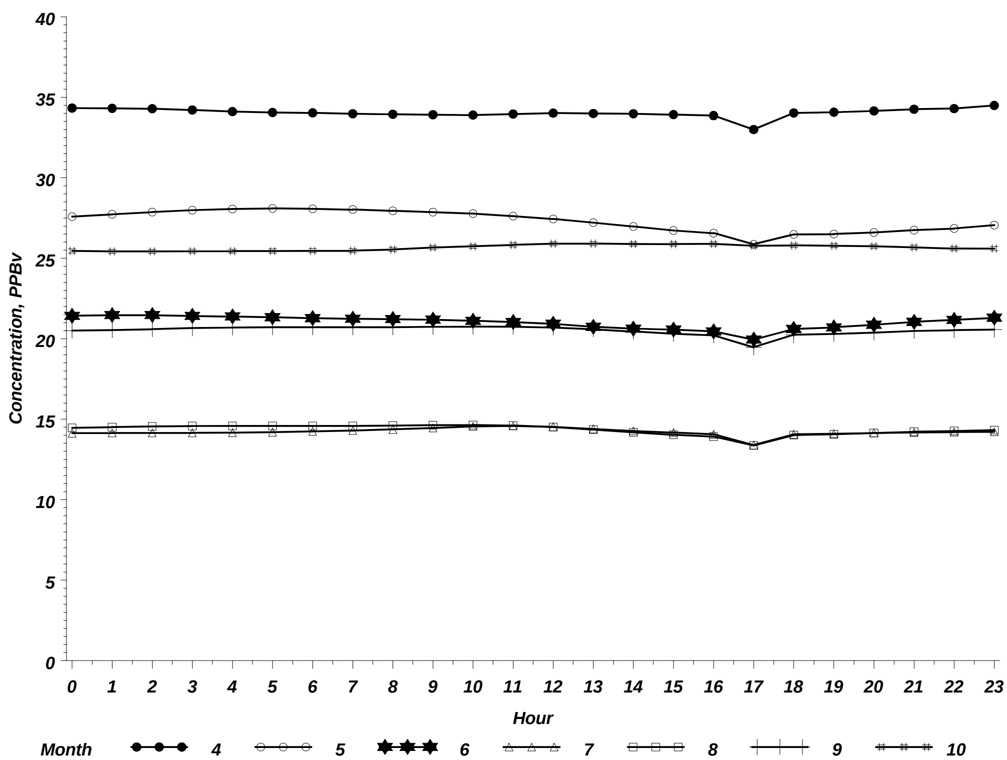


Figure 2A-11. St. Louis CSA: Diurnal Policy Relevant Background Ozone Patterns.

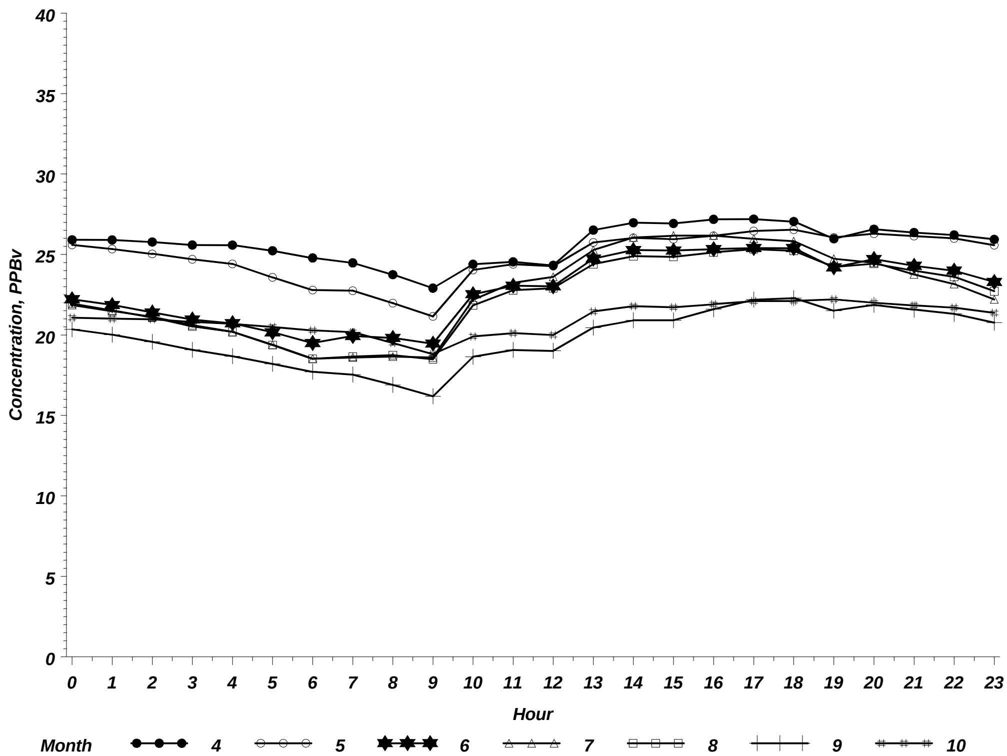
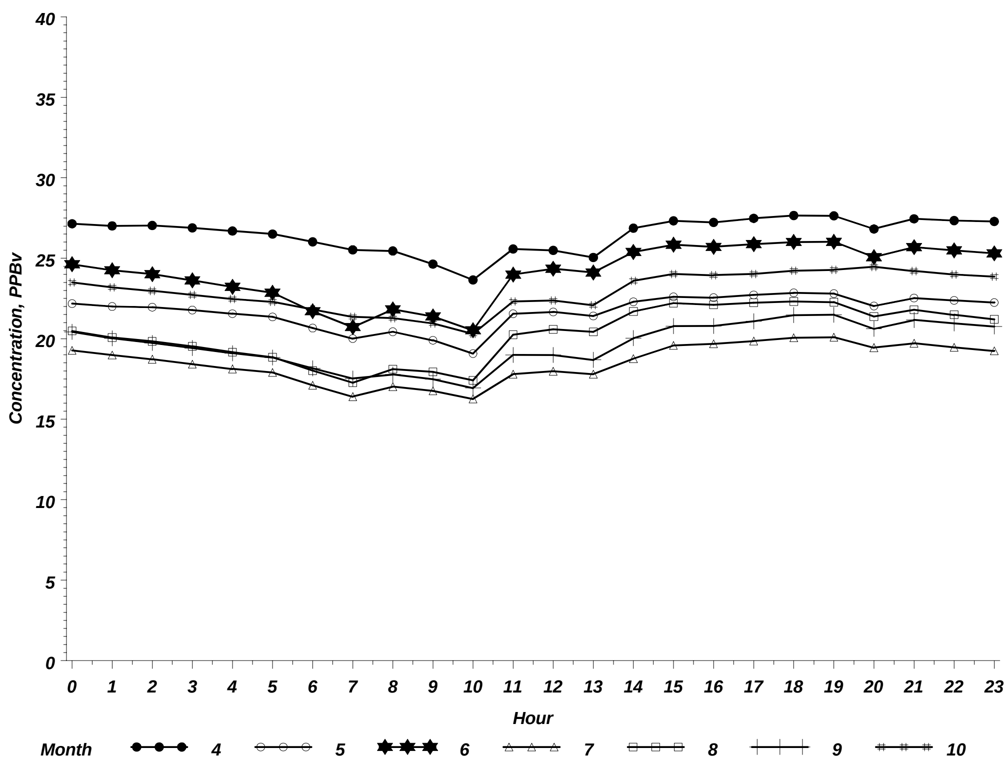


Figure 2A-12. Washington CSA: Diurnal Policy Relevant Background Ozone Patterns.



APPENDIX 3A: MECHANISMS OF TOXICITY

This Appendix provides an overview of evidence covered in Chapters 5 and 6 of the CD on possible mechanisms by which exposure to O_3 may result in acute and chronic health effects.

Pulmonary Function Responses

The direct pulmonary effects of O_3 include changes in breathing pattern, symptoms of breathing discomfort, lung function changes, and airway hyperreactivity. Subjects who engage in physical activity for several hours while exposed to O_3 may experience respiratory tract symptoms and acute physiological changes. Airway irritation is consistently the most typical symptomatic response reported in studies and can be accompanied by several physiological changes. These physiological changes include alteration in breathing pattern, airway hyperresponsiveness, airway inflammation, immune system activation, and epithelial injury. Severity of symptoms and magnitude of response depend on dose of inhaled O_3, individual sensitivity to O_3, and the extent of tolerance resulting from previous O_3 exposures. Development of effects is time-dependent with a substantial degree of overlap of increasing and receding effects. Time sequences, magnitudes, and types of responses of this series of events, in terms of development and recovery, indicate that several mechanisms, activated at different times, must contribute to the overall lung function response. (CD, pp. 6-11) For the full discussion of the mechanisms of pulmonary function responses, see section 6.2.5 of the CD.

Breathing Pattern Changes

Human controlled-exposure studies have consistently found that inhalation of O_3 alters the breathing pattern without significantly affecting minute ventilation (CD, pp. 6-12). A progressive decrease in tidal volume and an increase in frequency of breathing to maintain steady ventilation during exposure of human subjects indicates a direct impact on ventilation. These changes are similar to responses in many animal species exposed to O_3 and other respiratory irritants. Bronchial C-fibers and rapidly adapting receptors appear to be the primary modulators of O_3-induced changes in ventilatory rate and O_3 penetration in both humans and animals (CD, section 6.2.5.1).

Symptoms and Lung Function Changes

In addition to changes in ventilatory control, O_3 inhalation by humans induces a variety of symptoms (e.g., cough, pain on deep inspiration), reduces inspiratory capacity (IC) and vital capacity (VC) and related functional measures, and increases airway resistance (CD, pp. 6-13).

The reduction in VC caused by exposure to O_3 is a reflex action and not a voluntary early termination of inspiration resulting from discomfort. An inhaled topical anesthetic substantially reduces O_3-induced symptom responses (mediated in part by bronchial C-fibers) while having only minor and irregular effect on pulmonary function decrements and rapid, shallow breathing. Since respiratory symptom responses were largely abolished by anesthetic, these findings support reflex inhibition of VC due to stimulation by both bronchial and pulmonary C-fibers. Intersubject variability in FEV_1 responses is not explained by differences in O_3 doses between similarly exposed individuals (CD, section 6.2.5.1).

Airway Hyperresponsiveness

Bronchial or airway hyperresponsiveness (AHR) refers to a condition in which the propensity for the airways to bronchoconstrict, due to a variety of specific (e.g., allergens and antigens) or nonspecific (e.g., histamine and cold air) stimuli, becomes increased (CD, p. 6-30). Despite a common mechanism (CD, pp. 6-13 and 6-14), post- O_3 exposure pulmonary function changes and AHR (either early or late phase) are poorly correlated either in time or magnitude. Neither does post- O_3 exposure AHR seem to be related to baseline airway responsiveness. These findings imply that the mechanisms are either not related or are activated independently in time. Animal studies (with limited support from human studies) have suggested that stimulation of C-fibers can lead to increased responsiveness of bronchial smooth muscle independently of systemic and inflammatory changes which may be absent. A characteristic of O_3-induced inflammatory airway neutrophilia, which at one time was considered a leading AHR mechanism, has been found to be only coincidentally associated with AHR, i.e., there was no cause and effect relationship. This observation does not rule out involvement of other cells in AHR modulation. However, there is some evidence that release of inflammatory mediators can sustain AHR and bronchoconstriction. Late AHR observed in some studies is plausibly due to sustained damage of the airway epithelium and continual release of inflammatory mediators. In conclusion, O_3-induced AHR appears to be a product of many mechanisms acting at different time periods and levels of the bronchial smooth muscle signa ling pathways (CD, section 6.2.5.1).

Extrapulmonary Effects

Ozone reacts rapidly on contact with lipids and antioxidants in the epithelial lining fluid (ELF) and the epithelial cell layer and is not absorbed or transported to extrapulmonary sites to any significant degree (CD, p. 6-42). Laboratory animal studies suggest that reaction products formed by the interaction of O_3 with respiratory system fluids or tissues may produce effects measured outside the respiratory tract. Studies of the effects on hematological parameters and blood chemistry in rats have shown that erythrocytes are a target of O_3. Exposures to 1.0 ppm O_3

for 3 hr have been found to decrease heart rate (HR), mean arterial pressure (MAP), and core temperature (T_{CO}) and to induce arrhythmias with some exposures in rats. These effects are more pronounced in adult and awake rats than in younger or sleeping animals. Exposures of 0.2 ppm for 48 hr have been shown to cause bradycardia, while exposures of 0.1 ppm O_3 for 3 days have been shown to cause bradyarrhythmia in these animals (CD, Section 5.3.3).

More recent studies of rats have consistently demonstrated effects on heart rate, T_{CO} and activity levels. One study exposed rats to FA for 6 hr, followed 2 days later by a 5 hr exposure to 0.1 ppm O_3, 5 days later by a 5 hr exposure to 0.3 ppm O_3, and 10 days later by a 5 hr exposure to 0.5 ppm O_3 (Arito et al., 1997). Each of the O_3 exposures was preceded by a 1 hr exposure to FA. Transient rapid, shallow breathing with slightly increased HR appeared 1 to 2 min after the start of O_3 exposures and was attributed to an olfactory response. Persistent rapid, shallow breathing with a progressive decrease in HR occurred with a latent period of 12 hr. During the last 90-min of exposure, averaged values for relative $V0_E$ tended to decrease with the increase in O_3 concentration for young (4 to 6 months) but not old (20 to 22 months) rats.

Studies by Watkinson et al. (1995, 2001) and Highfill and Watkinson (1996) demonstrated that when HR was reduced during a 5-day, 0.5 ppm O_3 exposure, T_{CO} and activity levels also decreased. The decreases in T_{CO} and BP reported in these studies and by Arito et al. (1997) suggest that the changes in ventilation and HR are mediated through physiological and behavioral defense mechanisms in an attempt to minimize the irritant effects of O_3 inhalation.

Similar cardiovascular and thermoregulatory responses in rats to O_3 were reported by Iwasaki et al. (1998). Repeated exposure to 0.1, 0.3, and 0.5 ppm O_3 8 hr/day for 4 consecutive days caused disruption of circadian rhythms of HR and T_{CO} on the first and second exposure days that was concentration-dependent. The decreased HR and T_{CO} recovered to control values on the third and fourth days of O_3 exposure.

The thermoregulatory response to O_3 was further characterized by Watkinson et al. (2003). Rats were either exposed to 0.0 ppm for 24 hr/day (air), 0.5 ppm for 6 hr/day (intermittent), or to 0.5 ppm for 23 hr/day (continuous) at 3 temperatures, 10 °C (cold), 22 °C (room), or 34 °C (warm). Another protocol examined the effects of O_3 exposure (0.5 ppm) and exercise (described as rest, moderate, or heavy) or CO_2-stimulated ventilation. Both intermittent and continuous O_3 exposure caused decreases in HR and T_{CO} and increases in BALF inflammatory markers. Exercise in FA caused increases in HR and T_{CO} while exercise in O_3 caused decreases in those parameters. Several factors were suggested that may modulate the hypothermic response, including dose, animal mass, and environmental stress.

One of the major postulated molecular mechanisms of action of O_3 is peroxidation of mono- and polyunsaturated fatty acids and unsaturated neutral lipids in the lung, resulting in lipid ozonation products (see Figure 5-1 in the CD). Ozone can penetrate only a short distance into the ELF; and, therefore, it reacts with epithelial cell membranes only in regions of distal lung where ELF is very thin or absent. The inflammatory cascade initiated by O_3 generates a mix of secondary reactants which then are likely to oxidize lipids and proteins in cell membranes. (CD Section 5.1.2.4).

Recent in vitro studies of O_3 reactions with cholesterol in lung surfactant found consequent generation of highly reactive products such as oxysterols and β-epoxide in BALF isolated from rats exposed to 2.0 ppm O_3 for 4 hr (Pulfer and Murphy, 2004). Additionally, both 5β,6β- epoxycholesterol and its most abundant metabolite, cholestan-6-oxo-3β,5α-diol, were shown to be cytotoxic to human lung epithelial (16-HBE) cells and to inhibit cholesterol synthesis. Studies (Pulfer et al., 2005) of mice exposed to 0.5, 1.0, 2.0, or 3.0 ppm O_3 for 3 hr also demonstrated that these oxysterols were produced in vivo. These results suggest that this may be an additional mechanism of O_3 toxicity, including a pathway by which O_3 may play a possible role in the development of atherosclerosis and other cardiovascular effects.

The presence of oxysterols in human atherosclerotic lesions implicates the oxidation of cholesterol in the pathogenesis of atherosclerosis, a well-known contributor to development of cardiovascular disease. Oxysterols may arise from different cholesterol oxidation mechanisms, (including free radical-mediated oxidations), and their unabated accumulation in macrophages and smooth muscle cells of arterial walls lead to formation of fatty streaks in advanced lesions. The presence of one of the O_3-induced oxysterols, secosterol, in endogenously formed arterial plaques (Wentworth et al., 2003) suggests that the oxysterols produced in the lung either due to direct O_3 interaction with surfactant cholesterol or with oxidant radicals at the O_3-induced inflammation site may have potential involvement in the development of cardiovascular and myocardial diseases. In addition, the recent in vitro observation (Sathishkumar et al. 2005) of increased apoptosis (programmed cell death) induced by secosterol in H9c2 cardiomyocytes (heart cells) supports possible involvement of such biologically active oxysterols in O_3-induced cardiovascular effects observed in the epidemiologic studies. Also, the detection of oxysterols in the BALF of rats exposed to O_3 suggests their potential to be used as biomarkers of O_3 exposure. Demonstration of relationships between oxysterols of the type generated in lung surfactant with O_3 exposure and cardiovascular disease outcomes in clinical settings or epidemiologic studies would add considerable value to the experimental observations thus for reported in the animal toxicology studies.

Other potential mechanisms by which O_3 exposure may be associated with cardiovascular disease outcomes have been described. Laboratory animals exposed to relatively high O_3 concentrations (≥ 0.5 ppm) demonstrate tissue edema in the heart and lungs. This may be due to increased circulating levels of atrial natriuretic factor (ANF), which is known to mediate capillary permeability, vasodilation, and BP (Daly et al., 2002). Ozone-induced changes in heart rate, edema of heart tissue, and increased tissue and serum levels of ANF found with 8-hr 0.5 ppm O_3 exposure in animal toxicology studies (Vesely et al., 1994a,b,c) raise the possibility of potential cardiovascular effects of acute O_3 exposures.

Earlier work demonstrated O_3-induced release of functionally active platelet activating factor (PAF) from rodent epithelial cells and the presence of PAF receptors on AMs. New work examining lipid metabolism (CD, Section 5.2.1.4) and mediators of inflammatory response and injury (CD, Section 5.2.3.4) confirm earlier findings indicating that PAF (Kafoury et al., 1999) and PAF receptors (Longphre et al., 1999) are involved in responses to O_3. In addition to the role of PAF in pulmonary inflammation and hyperpermeability, this potent inflammatory mediator may have clotting and thrombolytic effects, though this has not been demonstrated experimentally. This cardiovascular effect may help explain, in part, some limited epidemiologic findings suggestive of possible association of heart attack and stroke with ambient O_3 exposure described in section 3.3.1.4, below. As indicated by the studies described above, an emerging body of animal toxicology evidence is beginning to suggest mechanisms by which O_3 can affect the cardiovascular system.

In a controlled human exposure study described in the CD in Chapter 6, Gong et al. (1998) exposed 10 hypertensive and 6 healthy adult males, 41 to 78 years of age, to 0.3 ppm O_3 for 3 hr while at intermittent exercise, at 30 L/min. For all subjects combined (no significant group differences), there was an O_3-induced decrement of 7% in FEV_1 and a statistically significant increase (70%) in the alveolar-arterial oxygen tension gradient. The overall results did not indicate any major acute cardiovascular effects of O_3 in either the hypertensive or normal subjects. Foster et al. (1993) demonstrated that even in relatively young healthy adults (26.7 ± 7 yrs old), O_3 exposure can cause ventilation to shift away from the well perfused basal lung. This effect of O_3 on ventilation distribution (and, by association, the small airways) may persist beyond 24-hr postexposure (Foster et al., 1997). Gong et al. (1998) suggested that by impairing alveolar-arterial oxygen transfer, the O_3 exposure could potentially lead to adverse cardiac events by decreasing oxygen supply to the myocardium. However, the subjects in their study apparently had sufficient functional reserve so as to not experience significant ECG changes or myocardial ischemia and/or injury. Information about the impact of O_3 exposure on the cardiovascular system from epidemiologic studies is discussed in section 3.3.1.4.

Appendix 3B. Ozone Epidemiological Study Results: Summary of effect estimates and air quality data reported in studies, distribution statistics for 8-hr daily maximum ozone concentrations for the study period and location, and information about monitoring data used in study.

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Respiratory Symptoms:							
Mortimer et al., 2002 8 U.S. cities morning symptoms	1.35 (1.06, 1.71)	8h	48	64.3	66	28.8-66	6/1/93 - 8/31/93 AQS, all monitors in corresponding county, averaged for 10am to 6pm
Gent et al., 2003 New England cities chest tightness	1.19 (1.05, 1.34)	8h 1d	51.3	95.2	91.8	27.1-99.6	4/1/01 - 9/30/01 10 sites in CT and 4 in Springfield MA
Gent et al., 2003 New England cities shortness of breath	1.17 (1.03, 1.33)	8h 1d	51.3	95.2	91.8	27.1-99.6	4/1/01 - 9/30/01 10 sites in CT and 4 in Springfield MA
Ostro et al., 2001 2 S Cal counties Asthma med use	1.15 (1.12, 1.19)	1h	59.5/ 95.8 (57.2)	121	122	14-122	Aug-Nov 1993 2 sites - downtown LA and Pasadena, individuals matched to closest site
Ostro et al., 2001 2 S Cal counties shortness of breath	1.01 (0.92, 1.10)	1h 3d	59.5/ 95.8 (57.2)	121	122	14-122	Aug-Nov 1993 2 sites - downtown LA and Pasadena, individuals matched to closest site
Ostro et al., 2001 2 S Cal counties Wheeze	0.94 (0.88, 1.00)	1h 3d	59.5/ 95.8 (57.2)	121	122	14-122	Aug-Nov 1993 2 sites - downtown LA and Pasadena, individuals matched to closest site
Ostro et al., 2001 2 S Cal counties Cough	0.93 (0.87, 0.99)	1h 3d	59.5/ 95.8 (57.2)	121	122	14-122	Aug-Nov 1993 2 sites - downtown LA and Pasadena, individuals matched to closest site

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Neas et al., 1995 Uniontown PA pm cough	1.36 (0.86, 2.14)	12h 0d	37.2 (56.1)	85.3	98	15-98	6/10/90 - 8/23/90 1 site near Laurel Highlands HS
Delfino et al., 2003 San Diego, CA Symptom score>1	0.75 (0.24, 2.33)	8h 0d	17.1	34.8	35.2	5.8-35.2	Nov 99 - Jan 00 Huntington Park central site
Delfino et al., 2003 San Diego, CA Symptom score>1	1.55 (0.52, 4.63)	8h 1d	17.1	34.8	35.2	5.8-35.2	Nov 99 - Jan 00 Huntington Park central site
Delfino et al., 2003 San Diego, CA Symptom score>2	6.67 (1.09, 40.88)	8h 0d	17.1	34.8	35.2	5.8-35.2	Nov 99 - Jan 00 Huntington Park central site
Delfino et al., 2003 San Diego, CA Symptom score>2	1.15 (0.41, 3.17)	8h 1d	17.1	34.8	35.2	5.8-35.2	Nov 99 - Jan 00 Huntington Park central site
Delfino et al., 1998 San Diego, CA Asthma symptoms	1.26 (1.00, 1.58)	8h 0d	73	107	109	43-109	8/1/95 - 10/30/95 SDAPCD site
Schwartz et al., 1994 6 US cities Cough	1.15 (0.99, 1.33)	24h 1d	36.9				Harvard 6 cities sites; school year period for each, from 1985/6 to 1987/8
Schwartz et al., 1994 6 U.S. cities lower respiratory symptoms	1.22 (1.00, 1.50)	24h 1d	36.9				Harvard 6 cities sites; school year period for each, from 1985/6 to 1987/8

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Ross et al., 2002 East Moline, IL morning symptoms	1.12 (1.05, 1.20)	8h 3d ave	41.5	68.8	75	8.9-78.3	Apr-Oct 1994 AQS data - East Moline sites
Ross et al., 2002 East Moline, IL Evening symptoms	1.12 (1.06, 1.19)	8h 3d ave	41.5	68.8	75	8.9-78.3	Apr-Oct 1994 AQS data - East Moline sites
Ross et al., 2002 East Moline, IL Asthma med use	1.08 (0.99, 1.17)	8h 3d ave	41.5	68.8	75	8.9-78.3	Apr-Oct 1994 AQS data - East Moline sites
Thurston et al., 1997 Connecticut chest symptoms	1.21 (1.12, 1.31)	1h 0d	83.6	NA	NA	NA	last wk of June 1991-93 on-site monitor
Thurston 1997 Connecticut Asthma med use	1.19 (1.08, 1.32)	1h 0d	83.6	NA	NA	NA	last wk of June 1991-93 on-site monitor
Lung Function Changes:							
Mortimer et al., 2002 8 U.S. cities am PEF (%)	-0.59% (-1.05, -0.13)	8h	48	64.3	66	28.8-66	6/1/93 - 8/31/93 AQS, all monitors in corresponding county, averaged for 10am to 6pm
Linn et al., 1996 Los Angeles FEV1 (ml)	-0.26 (SE 0.25) (am) -0.18 (SE 0.20) (pm)	24h 0d	23	150	164	2.5-192.5	Jan 91-Dec 92 SCAQMD sites in 3 communities: Upland, Rubidoux, Torrance

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98^{th} %	99^{th} %	Range	
Newhouse et al., 2004 Tulsa, OK am PEF (L/min)	-0.274 (p<0.05) (mean O_3) -0.289 (p<0.05) (max O_3)	24h 1d	30	92.7	104.7	17.3-104.7	9/1/00 - 10/31/00 OK DEQ site about 1 km from U Tulsa
Ross et al., 2002 East Moline, IL PEF (L/min)	-2.29 (-4.26, -0.33) (am) -2.58 (-4.26, -0.89) (pm)	8h 0-1d 1d	41.5	68.8	75	8.9-78.3	Apr-Oct 1994 AQS data - East Moline sites
Neas et al., 1995 Uniontown PA PEF (L/min)	-2.79 (-6.7, -1.1) (pm)	12h 0d	37.2 (56.1)	85.3	98	15-98	6/10/90 - 8/23/90 1 site near Laurel Highlands HS
Neas et al., 1999 Philadelphia PA PEF (L/min)	-1.38 (-2.81, 0.04) (am) -2.58 (-4.91, -0.35) (pm)	12h 0d 1-5d ave	56	96.9	104.5	17.7-104.5	7/8/93 - 9/3/93 2 sites: Airport and Presbyterian Nursing Home (58th and Greenway)
Korrick et al., 1998 Mt. Washington NH FEV1 (%)	-2.6 (-4.1, -0.4)	1h 0d	40	87	89	24 – 91	summers 1991, 92 2 sites: Mt. Washington Observatory and mountain base at Auto Rd
Thurston et al., 1997 Connecticut summer camp PEF (L/min)	-0.096 (p<0.05)	1h 0d	83.6	NA	NA	NA	last wk of June, 1991-1993 on-site monitor
Naeher et al., 1999 SW Virginia PEF (L/min)	-7.65 (-13.0, -2.25) (pm)	24h 1-5d ave	34.87	74	79	13-87	summers 1995-1996 1 site in Vinton VA

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Brauer et al., 1996 Fraser Valley, BC FEV1 (mL)	-3.8 (SE 0.4) (end shift) -4.5 (SE 0.6) (next day)	1h 0d	40.3	55	55	3-55	June-August 1993 BC Ministry of Environment sites
Emergency Department Visits: Respiratory Diseases							
Peel et al., 2005 Atlanta	2.89 (1.03, 4.77)	8h 3d ave	55.6	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Delfino et al., 1997 Montreal (>64yo)	28.93 (11.98, 45.88)	8h 1d	34.7	57.5	64.9	7-64.9	May-Aug 1988 and 1989 AQS data, 5 sites
Delfino et al., 1997 Montreal (>64yo)	31.61 (12.91, 50.31)	1h 1d	34.7 (28.9)	57.5	64.9	7-64.9	May-Aug 1988 and 1989 AQS data, 5 sites
Jones et al., 1995 Baton Rouge, LA (1-17 yo)	-13.00 (-32.82, 12.66)	24h 0d	28.2 (56.4)	111.8	118	21-119	6/1/90 - 8/31/90 DEQ 3 sites
Jones et al., 1995 Baton Rouge, LA (18-60 yo)	20.00 (2.29, 40.78)	24h 0d	28.2 (56.4)	111.8	118	21-119	6/1/90 - 8/31/90 DEQ 3 sites
Jones et al., 1995 Baton Rouge, LA (>60 yo)	27.00 (-3.48, 67.10)	24h 0d	28.2 (56.4)	111.8	118	21-119	6/1/90 - 8/31/90 DEQ 3 sites
Wilson et al., 2005 Portland NH,	-3.00 (-8.49, 2.82)	8h 0d	43.1	108	121	15-142	Apr-Oct 1998-2000 AQS data, single monitor in each city
Wilson et al., 2005 Manchester NH	-3.00 (-8.53, 2.87)	8h 0d		85	93	5-121	Apr-Oct 1998-2000 AQS data, single monitor in each city

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Stieb et al., 1996 St. John, Canada	9.33 (-0.07, 18.74)	1h 2d	41.6 (36.1)	83	91	5-140.5	May-Sept 1984-1992 EC data averaged across sites
Emergency Department Visits: Asthma							
Peel et al., 2005 Atlanta, GA	2.65 (-0.50, 5.89)	8h 3d ave	55.6	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Wilson et al., 2005 Manchester NH	-3.00 (-8.91, 3.29)	8h 0d	NA	108	121	15-142	Apr-Oct 1998-2000 AQS data, single monitor in each city
Wilson et al., 2005 Portland NH	9.40 (10.26, 8.55)	8h 0d	NA	85	93	5-121	Apr-Oct 1998-2000 AQS data, single monitor in each city
Friedman et al., 2001 Atlanta GA (1-16 yo)	30.89 (5.34, 62.64)	1h 0-1d	77.2 (60.7)	85.8	85.8	20-85.8	7/19/96 - 8/4/96 3 sites in Atlanta
Tolbert et al., 2000 Atlanta, GA	6.37 (2.53, 10.34)	8h 1d	59.3 (60.7)	92.4	112.6	16.2-135.8	AQS, GA and Fulton Co., SOS, USGS; 7 sites in Atlanta MSA
Zhu et al., 2003 Atlanta, GA (0-16 yo)	2.41 (-2.39, 7.44)	8h 0d					
Jaffe et al., 2003 3 Ohio cities	9.27 (0.13, 19.25)	8h 2-3d	(66.1)	104	108	24-124	7/1/91 to 6/30/96 all data from active monitors
Jaffe et al., 2003 Cincinnati	15.76 (-1.01, 35.38)	8h 2d	60	106	116	24-124	7/1/91 to 6/30/96 all data from active monitors
Jaffe et al., 2003 Cleveland	3.03 (-8.52, 16.04)	8h 2d	50	104	107	27-111	7/1/91 to 6/30/96 all data from active monitors
Jaffe et al., 2003 Columbus	15.76 (-2.49, 37.44)	8h 3d	57	98	106	25-117	7/1/91 to 6/30/96 all data from active monitors

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Cassino et al., 1999 NYC (in heavy smokers)	-5.42 (-8.38, -2.36)	24h 0d	17.5 (32.6)	83.3	88.8	3-114.6	1/1/89 - 12/31/93 data from sites throughout NYC
Cassino et al., 1999 NYC (in heavy smokers)	2.74 (-3.00, 8.83)	24h 1d	17.5 (32.6)	83.3	88.8	3-114.6	1/1/89 - 12/31/93 data from sites throughout NYC
Cassino et al., 1999 NYC (in heavy smokers)	9.69 (3.93, 15.76)	24h 2d	17.5 (32.6)	83.3	88.8	3-114.6	1/1/89 - 12/31/93 data from sites throughout NYCl
Cassino et al., 1999 NYC (in heavy smokers)	-1.62 (-7.01, 4.08)	24h 3d	17.5 (32.6)	83.3	88.8	3-114.6	1/1/89 - 12/31/93 data from sites throughout NYC
Emergency Department Visits: Other respiratory diseases:							
Peel et al., 2005 Atlanta, GA Pneumonia	1.80 (-2.27, 6.04)	8h 3d ave	55.6	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Peel et al., 2005 Atlanta, GA COPD	3.49 (-2.77,10.15)	8h 3d ave	55.6	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Peel et al., 2005 Atlanta, GA upper respiratory infection	3.25 (1.10, 5.44)	8h 3d ave	55.6	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Cardiovascular outcomes, biomarkers, and physiological changes:							

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Liao et al., 2004 3 US cities HRV (high frequency power)	-0.010 (SE 0.016)	8h 1d	41				1996-1998 AQS data
Liao et al., 2004 3 US cities SD of normal RR intervals	-0.336 (SE 0.290)	8h 1d	41				1996-1998 AQS data
Peters et al., 2000 Boston Defibrillator discharge	OR 0.96 (0.47, 1.98) (patients with 1+ event) OR 1.23 (0.53, 2.87) (patients with 10+ events)	24h 0d	18.6	75.2	78.1	15.7-102.7	Jan 95 - Dec 97 1 site
Peters et al., 2001 Boston Myocardial infarction	OR 1.31 (0.85, 2.03) (2h O_3) OR 0.94 (0.60, 1.49) (24h O_3)	24h and 2h 1d and 1h	19.9	75.8	81.5	17.7-102.7	Jan 95 - May 96 1 site (case-crossover)
Park et al., 2004 Boston HRV (low frequency power)	-11.5% (-21.3, -0.4)	4h	23	81.8	92	10-122.6	Nov 2000- Oct 2003 Mass Dept. Environ. Protection sites
Gold et al., 2000 Boston HRV (r-MSSD) (ms)	-3.0 (SE 1.9) (first rest period) -5.8 (SE 2.4) (slow breathing period)	1h	34	77.3	92.5	21.8-100	June-Sept 1997 1 site, MA Dept. Environ. Protection

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Dockery et al., 2005 Boston Ventricular arrhythmia	OR 1.09 (0.93, 1.29) (all events)	48h	22.9	75	82.1	2–102.7	7/11/95 - 7/11/02 6 sites, Mass Dept. Envir. Protection
Rich et al., 2005 Boston Ventricular arrhythmia	OR 1.21 (1.00, 1.45) (all events)	24h	22.6	74	81.5	2-102.7	Aug 1995 - June 2002 6 sites, Mass Dept. Envir. Protection
Emergency Department Visits: Cardiovascular Diseases							
Metzger et al., 2004 Atlanta, GA all CV	0.96 (-1.59, 3.58)	8h 3dave	53.9	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Metzger et al., 2004 Atlanta, GA Dysrrhythmia	0.96 (-3.96, 6.13)	8h 3dave	53.9	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Metzger et al., 2004 Atlanta, GA CHF	-4.19 (-9.74, 1.71)	8h 3dave	53.9	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Metzger et al., 2004 Atlanta, GA IHD	2.28 (-2.30, 7.09)	8h 3dave	53.9	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Metzger et al., 2004 Atlanta, GA peripheral vascular	1.68 (-1.57, 5.05)	8h 3dave	53.9	127	140	3-152	1/1/93 to 12/21/02 AQS Confederate Ave monitor
Hospital Admissions: Cardiovascular Diseases							

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Linn et al., 2000 Los Angeles CA (summer)	2.02 (-16.14, 24.11)	24h 0d	32.9 (98.7)	175	180	188	Los Angeles basin - averaged from monitors across basin
Fung et al., 2003 Windsor CV <65 yo	-0.14 (-11.79, 13.06)	1h 0d	39.3 (31.6)	78	85	0-106	4/1/95 - 12/31/00 4 sites in Winsdor
Fung et al., 2003 Windsor CV <65 yo	5.84 (-10.50, 25.16)	1h 0-2d ave	39.3 (31.6)	78	85	0-106	4/1/95 - 12/31/00 4 sites in Winsdor
Fung et al., 2003 Windsor CV 65+ yo	-3.57 (-10.35, 3.72)	1h 0d	39.3 (31.6)	78	85	0-106	4/1/95 - 12/31/00 4 sites in Winsdor
Fung et al., 2003 Windsor CV 65+ yo	1.94 (-8.01, 12.95)	1h 0-2d ave	39.3 (31.6)	78	85	0 -106	4/1/95 - 12/31/00 4 sites in Winsdor
Burnett et al., 1997 Toronto CV	20.47 (9.32, 32.76)	1h 2-4d ave	41.2 (31.6)	62	64	0-79	summers 1992, 93, 94 7-9 sites in metro Toronto
Gwynn et al., 2000 Buffalo circulatory	0.23 (-1.27, 1.74)	24h 1d	26.2 (38.7)	92.5	104	4.5-123	1988-1990 AQS data from multiple sites in Buffalo/Rochester area
Hospital Admissions: Specific Cardiovascular Diseases							
Koken et al., 2003 Denver CO myocardial infarction	-32.91 (-47.16, -14.82)	24h 0d	25 (44.2)	64.5	65.5	11-76	July-August 1993-1997 AQS sites in Denver County (2 sites)

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Koken et al., 2003 Denver Coronary Atheroschlerosis	27.02 (8.30, 48.98)	24h 2d	25 (44.2)	64.5	65.5	11-76	July-August 1993-1997 AQS sites in Denver County (2 sites)
Koken et al., 2003 Denver Pulm Heart Disease	49.16 (8.35, 105.22)	24h 1d	25 (44.2)	64.5	65.5	11-76	July-August 1993-1997 AQS sites in Denver County (2 sites
Ito, 2003 Detroit MI ischemic heart disease	0.52 (-2.27, 3.39)	24h 3d	25 (38.7)	80	85	4.3-101.3	1992-1994 AQS data, 4 ozone sites
Ito, 2003 Detroit MI dysrrhythmia	-1.04 (-5.87, 4.04)	24h 3d	25 (38.7)	80	85	4.3-101.3	1992-1994 AQS data, 4 ozone sites
Ito, 2003 Detroit MI heart failure	0.76 (-2.47, 4.09)	24h 3d	25 (38.7)	80	85	4.3-101.3	1992-1994 AQS data 4 ozone sites
Ito, 2003 Detroit MI stroke	0.50 (-3.03, 4.15)	24h 3d	25 (38.7)	80	85	4.3-101.3	1992-1994 AQS data 4 ozone sites
Hospital Admissions: Respiratory Diseases							
Luginaah et al., 2003 Windsor (males)	5.56 (-10.57, 24.59)	1h 0d	39.3 (31.6)	78	85	0-106	4/1/95 - 12/31/00 4 sites in Winsdor
Luginaah et al., 2003 Windsor (females)	-6.83 (-23.92, 14.09)	1h 0d	39.3 (31.6)	78	85	0-106	4/1/95 - 12/31/00 4 sites in Winsdor

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Thurston et al., 1992 Buffalo NY	4.94 (-0.23, 10.12)	1h 2d	60 (58.9)	125.5	133	24-133	June-Aug 1988-1989 NYDEC monitors
Delfino et al., 1994 Montreal	4.05 (1.00, 7.11)	8h 4d	32.1	69	73.8	8.6-82.3	Jul-Aug 1984-1988 7 sites in Montreal; 2 sites near heavy traffic areas not used
Burnett et al., 1994 Toronto	3.95 (2.50, 5.43)	1h 1d	(41.7)	79	81.5	15-104.3	1983-1988 Ont Min Environ 22 sites May-August
Burnett et al., 1997 16 Canadian city	6.72 (3.52, 10.02)	1h 1d	32.9 (25.3)	47.1	51.3	6.2-68.4	4/1/81 - 12/31/91 used Apr-Dec data, all stations in each city
Burnett et al., 1997 Toronto	17.57 (10.44, 25.15)	1h 1-3d ave	41.2 (31.6)	62	64	0-79	summers 1992, 93, 94 7-9 sites in metro Toronto
Yang et al., 2003 Vancouver (<3 yo)	50.43 (32.64, 70.61)	24h 4d	13.41 (21.3)	42.7	47.3	1.1-71.9	1/1/86 - 12/31/98 25 sites, Great Vancouver Regional District
Yang et al., 2003 Vancouver (65+yo)	28.53 (18.47, 39.43)	24h 4d	13.41 (21.3)	42.7	47.3	1.1-71.9	1/1/86 - 12/31/98 25 sites, Great Vancouver Regional District
Schwartz et al., 1996 Cleveland	3.51 (0.88, 6.20)	1h 1-2d ave	56 (55.1)	91	99	5-120.3	1988-1990 Cuyahoga county warm season only
Moolgavkar et al., 1997 Minneapolis/St. Paul	8.08 (4.47, 11.81)	24h 1d	26.2 (45.1)	83.2	87.7	4.6-101.8	1/1/86 - 12/31/91 AQS data from all monitoring stations
Gwynn et al., 2001 NYC (white)	1.08 (-0.44, 2.63)	24h 1d	22.1 (34.2)	90.6	106	6-125	1988-1990 AQS data

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Gwynn et al., 2001 NYC (nonwhite)	4.01 (2.47, 5.57)	24h 1d	22.1 (34.2)	90.6	106	6-125	1988-1990 AQS data
Gwynn et al., 2001 NYC (uninsured)	4.51 (2.80, 6.25)	24h 1d	22.1 (34.2)	90.6	106	6-125	1988-1990 AQS data
Thurston et al., 1992 NYC	0.42 (0.10, 0.74)	1h 3d	29.1				June-Aug 1988-1989 NYDEC monitors
Gwynn et al., 2000 Buffalo	3.94 (1.78, 6.15)	24h 1d	26.2 (38.7)	92.5	104	4.5-123	1988-1990 AQS data from multiple sites in Buffalo/Rochester area
Schwartz et al., 1996 Spokane	19.08 (0.17, 41.57)	1h 2d	79	NA	NA	NA	1988-1990 1 residential site
Thurston et al., 1994 Toronto	15.30 (4.11, 26.50)	1hr 0d	57.47 (45.8)	92	94	8-125	July-Aug, 1986-1988 Breadalbane site
Hospital Admissions: Asthma							
Sheppard et al., 2003 Seattle, WA	3.44 (0.58, 6.39)	8h 2d	30.4	65	73	2-100	1987-1994 1 site at Lake Sammamish
Nauenberg et al., 1999 Los Angeles (all insurance)	1.00 (-6.28, 8.84)	24h 0d	19.88 (19.1)	46.5	50.5	2-67	(11/15-3/1)1991-1994 2 SCAQMD sites in zip codes 90025 and 90012
Burnett et al., 2001 Toronto (<2 yo)	30.25 (16.87, 45.15)	1h 5d ave	45.2 (38.6)	77.7	83.7	9-110.8	1/1/80 - 12/31/94 4 sites
Thurston et al., 1992 Buffalo NY	6.59 (1.29, 11.89)	1h 3d	60 (58.9)	125.5	133	24-133	June-Aug 1988-1989 NYDEC monitors

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Burnett et al., 1999 Toronto	6.47 (3.68, 9.33)	24h 1-3d ave	19.5 (26.7)	68.4	74.8	0.1-110.8	summers 1992, 93, 94 7-9 sites in metro Toronto
Lin et al., 2003 Toronto, 6-12 yo	-7.84 (-22.02, 8.92) (female) -26.04 (-44.53, -1.39) (male)	1h 0d	28.2	68.4	74.8	0.14-110.8	1981-1993 4 sites, Ontario Ministry of Environment and Energy (case-crossover)
Thurston et al., 1992 New York City	0.95 (0.20, 1.69)	1h 1d	29.1				June-Aug 1988-1989 NYDEC monitors
Schwartz et al., 1994 Detroit	10.81 (5.13, 16.80)	24h 1d	21 (37.6)	82.8	88.5	10-122.7	1986-1989 AQS data 9 sites in 86 and 89, 8 sites in 87 and 88
Hospital Admissions: Other respiratory diseases							
Moolgavkar et al., 1997 Minneapolis/St. Paul pneumonia	8.90 (4.62, 13.34)	24h 1d	26.2 (45.1)	83.2	87.7	4.6-101.8	1/1/86 - 12/31/91 AQS data from all monitoring stations
Ito, 2003 Detroit MI pneumonia	3.10 (-1.84, 8.28)	24h 3d	25 (38.7)	80	85	4.3-101.3	1992-1994 AQS data, 4 ozone sites
Ito, 2003 Detroit MI COPD	1.25 (-3.55, 6.28)	24h 3d	25 (38.7)	80	85	4.3-101.3	1992-1994 AQS data 4 ozone sites
Burnett et al., 1999 Toronto COPD	7.49 (4.00, 11.10)	24h 2-4d ave	19.5 (26.7)	68.4	74.8	0.1-110.8	summers 1992, 93, 94 7-9 sites in metro Toronto

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Schwartz et al., 1994 Detroit COPD	11.68 (2.92, 21.19)	24h 1d	21 (37.6)	82.8	88.5	10-122.7	1986-1989 AQS data 9 sites in 86 and 89, 8 sites in 87 and 88
Moolgavkar et al., 1997 Minneapolis/St. Paul COPD	6.04 (1.22, 11.10)	24h 1d	26.2 (45.1)	83.2	87.7	4.6-101.8	1/1/86 - 12/31/91 AQS data from all monitoring stations
Burnett et al., 1999 Toronto Respiratory Infection	4.52 (2.43, 6.64)	24h 1-2d ave	19.5	68.4	74.8	0.1-110.8	summers 1992, 93, 94 7-9 sites in metro Toronto
Mortality: Total nonaccidental							
Bell et al., 2004 95 U.S. cities (warm)	0.44 (0.14, 0.74)	24h 0d	26.84				1987-2000 AQS data, 10% trimmed mean to average across monitors after correction for each monitor
Bell et al., 2004 95 U.S. cities (warm)	0.78 (0.26, 1.30)	24h 0-6d dl	26.84				1987-2000 AQS data, 10% trimmed mean to average across monitors after correction for each monitor
Schwartz et al., 2004 14 U.S. cities (warm)	1.04 (0.30, 1.79)	1h 0d	45.9				1986-1993 AQS data, May-September (case-crossover)
Ostro et al., 2003 Coachella Valley CA	-1 (-4.42, 2.55)	1h	62				1/1/89 – 12/20/98 sites in Palm Springs and Indio

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Ostro et al., 1995 2 Southern CA counties	0.80 (-0.18, 1.78)	1h 0d	140				1980-1986 4 sites in San Bernardino and Riverside counties: Upland, Rubidoux, Redlands, Perris
Moolgavkar et al., 1995 Philadelphia (summer)	2.82 (1.33, 4.33)	24h 1d	35.5				1973-1988 AQS data
Ito, 2003 Detroit MI	0.86 (-0.36, 2.09)	24h 0d	20.9 (34.3)	81.5	88.7	2-123.5	1985-1990 AQS data, 4 ozone sites
Ito, 2003 Detroit MI	1.88 (-1.69, 5.58)	24h 0d	25 (38.7)	80	85	4.3-101.3	1992-1994 AQS data, 4 ozone sites
Fairley, 2003 San Jose CA	2.81 (-0.27, 5.99)	8-h 0d	29	67	74	2-105	1989-1996 San Jose 4th St. site
Chock et al., 2000 Pittsburg PA (<75 yo)	-1.48 (-5.63, 2.85)	1h 0d	(35.4)	80	88.9	2.3-92.5	1989-1991 1 site with daily obs, used only data between 1200 and 2000 hours
Chock et al., 2000 Pittsburg PA (75+)	-1.82 (-6.03, 2.59)	1h 0d	(35.4)	80	88.9	2.3-92.5	1989-1991 1 site with daily obs, used only data between 1200 and 2000 hours
Kinney et al., 1995 Los Angeles	0.00 (-4.90, 5.15)	1h 1d	70 (53.4)	115.3	130	5.4-156.1	1985-1990 8 ozone sites
Gamble et al., 1998 Dallas TX	3.69 (0.85, 6.62)	24h 1-2d	22 (37.9)	81	86.3	2-98.7	1990-1994 TNRCC data, 2-3 sites in Dallas Co.
Dockery et al., 1992 St. Louis	0.60 (-2.46, 3.750	24h 1d	22.5				Sept 1985-August 1986 Harvard site on S side of city

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Dockery et al., 1992 E Tennesse	-1.30 (-7.91, 5.78)	24h 1d	23				Sept 1985-August 1986 Harvard site, ~50 km SW of Knoxville
Ito et al., 1996 Cook County	3.89 (2.21, 5.59)	1h 0-1d	38.1 (31.8)	76	85.6	2.7-124	1985-1990 AQS sites with at least 4 y data, 5 O3 sites
Klemm et al., 2004 Atlanta quartknot **	2.40 (-3.39, 8.54)	8h 0-1d	47.03			6.63-124.41	ARIES database, as described in Klemm 2000
Klemm et al., 2004 Atlanta monthknot **	4.16 (-2.42, 11.19)	8h 0-1d	47.03			6.63-124.41	ARIES database, as described in Klemm 2000
Goldberg et al., 2003 Montreal (CHFunderlying)	4.26 (-5.30, 14.78)	24h 0-2d	29				1984-1993 Environment Canada data, 9 sites
Vedal et al., 2003 Vancouver	16.63 (5.54, 28.88)	1h 0d	27.4 (21.4)	53.3	47.3	1.1-58.7	Jan 94 - Dec 96 19 sites in Greater Vancouver Regional District and EC
Villeneuve et al., 2003 Vancouver	1.31 (-0.78, 3.45)	24h 0d	13.4 (21.3)	69.3	47.3	3.1-71.9	1/1/86 - 12/31/98 13 census subdivisions
Mortality: Cardiovascular or Cardiorespiratory diseases							
Bell et al., 2004 95 U.S. cities	1.28 (0.61, 1.96)	24h 0-6d dl	26.84				1987-2000 AQS data, 10% trimmed mean to average across monitors after correction for each monitor

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Huang et al., 2004 19 U.S. cities	1.47 (0.54, 2.40)	24h 0d	18-56				June 1- Sept 30, 1987-1994 AQS data
Lipfert, et al., 2000 Philadelphia	30.19 (p<0.055)	1h 0-1dave	44.76 (39.7)	88.8	93.6	2.3-116.6	May 92 - Sept 95 1 Camden and 1 Phila site
Lipfert, et al., 2000 Philadelphia	-2.00 (p<0.055)	1h 0-1dave	44.76 (39.7)	88.8	93.6	2.3-116.6	May 92 - Sept 95 1 Camden and 1 Phila site
Ostro et al., 2003 Coachella Valley	-4 (-8.88, 1.14)	1h	62				1/1/89 – 12/20/98 sites in Palm Springs and Indio
Ito, 2003 Detroit MI	1.45 (-0.29, 3.21)	24h 0d	20.9 (34.3)	81.5	88.7	2-123.5	1985-1990 AQS data, 4 ozone sites
Ito, 2003 Detroit MI	1.79 (-3.38, 7.24)	24h 0d	25 (38.7)	80	85	4.3-101.3	1992-1994 AQS data, 4 ozone sites
Fairley, 2003 San Jose CA	2.36 (-2.12, 7.04)	8h 0d	29	67	74	2-105	1989-1996, San Jose 4th St. site
Gamble et al., 1998 Dallas TX	3.28 (-1.48, 8.27)	24h 1-2d	22 (37.9)	81	86.3	2-98.7	1990-1994 TNRCC data, 2-3 sites in Dallas Co.
Ito et al., 1996 Cook County	4.64 (2.07, 7.27)	1h 0-1d	38.1 (31.8)	76	85.6	2.7-124	1985-1990, AQS sites with at least 4 y data, 5 O3 sites
Moolgavkar et al., 2003 Cook County	0.30 (0.16, 0.44)	24h 0d	18				1987-1995 AQS data
Villeneuve et al., 2003 Vancouver	0.66 (-2.57, 3.99)	24h 0d	13.4 (21.3)	69.3	47.3	3.1-71.9	1/1/86 - 12/31/98 13 census subdivisions

Study; Location	Effect Estimate (lower CL, upper CL)	Air Quality Data from Study *		Statistics for 8-hr daily max air quality data **			Study period; Monitoring information
		Ave time; Lag	Mean	98th %	99th %	Range	
Goldberg et al., 2001 Montreal	2.81 (1.35, 4.30)	24h 0-2d	29				1984-1993 Environment Canada data, 9 sites
Vedal et al., 2003 Vancouver	16.19 (-0.67, 35.91)	1h 0d	27.4 (21.4)	53.3	47.3	1.1-58.7	Jan 94 - Dec 96 19 sites in Greater Vancouver Regional District and EC
Mortality: Respiratory Diseases							
Ostro et al., 2003 Coachella Valley	3 (-8.77, 16.29)	1h	62				1/1/89 – 12/20/98 sites in Palm Springs and Indio
Ito, 2003 Detroit MI	0.07 (-4.34, 4.68)	24h 0d	20.9 (34.3)	81.5	88.7	2-123.5	1985-1990 AQS data, 4 ozone sites
Ito, 2003 Detroit MI	7.44 (-5.37, 21.99)	24h 0d	25 (38.7)	80	85	4.3-101.3	1992-1994 AQS data, 4 ozone sites
Vedal et al., 2003 Vancouver	6.01 (-22.53, 45.06)	1h 0d	27.4 (21.4)	53.3	47.3	1.1-58.7	Jan 94 - Dec 96 19 sites in Greater Vancouver Regional District and EC
Villeneuve et al., 2003 Vancouver	1.50 (-4.24, 7.58)	24h 0d	13.4 (21.3)	69.3	47.3	3.1-71.9	1/1/86 - 12/31/98 13 census subdivisions
Moolgavkar et al., 2003 Cook County (COPD)	0.30 (-0.10, 0.71)	24h 0d	18				1987-1995 AQS data

* Includes ozone averaging period and lag period for effect estimate calculation; for example, 1h represents 1-hour maximum concentration and 0d represents a 0-day lag period. Mean values taken from study publications, for the ozone averaging period used in the study (e.g., 1h, 8h, 24h). Where 8-hour daily max ozone concentrations were used, the mean 8-hour daily max concentration is presented in parentheses.

** Using ozone data obtained for the study period in the location of the study, 8-hour daily maximum concentrations were derived and statistics calculated. The 98th and 99th percentile values for the full study period distribution are presented here, along with the range (minimum-maximum) of concentrations. Since the time periods of the studies vary in length, from several weeks to over 10 years, the 98th and 99th percentile values were selected for presentation here as a high study period concentration that roughly approximates a 4th maximum concentration, depending on the study period length. NA= data not available

APPENDICES FOR CHAPTER 5

5A.1. Ozone Air Quality Information for 12 Urban Areas

Table 5A-1. Monitor-Specific O_3 Air Quality Information: Atlanta, GA

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
1305700011	0.089			
1306700031	0.100	0.084	0.073	0.085
1307700021	0.099	0.077	0.083	0.086
1308500012	0.088	0.077	0.068	0.077
1308900021	0.095	0.080	0.084	0.086
1308930011	0.090	0.091	0.088	0.089
1309700041	0.098	0.085	0.080	0.087
1311300011	0.088	0.077	0.084	0.083
1312100551	0.100	0.091	0.089	0.093
1313500021	0.089	0.088	0.092	0.089
1315100021	0.099	0.082	0.085	0.088
1322300031	0.099	0.083	0.073	0.085
1324700011	0.099	0.078	0.087	0.088
Average:	0.095	0.083	0.082	
			Design Value*:	0.093

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-2. Monitor-Specific O_3 Air Quality Information: Boston, MA

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
2500900051	0.088			
2500920061	0.100	0.079	0.081	0.086
2500940041	0.094	0.080	0.077	0.083
2501711021	0.096	0.073	0.070	0.079
2502130031	0.107	0.088	0.078	0.091
2502500411	0.102	0.078	0.079	0.086
2502500421	0.074	0.074	0.064	0.07
2502700151	0.091	0.080	0.074	0.081
Average:	0.094	0.079	0.075	
			Design Value*:	0.091

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-3. Monitor-Specific O_3 Air Quality Information: Chicago, IL

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
1703100011	0.094	0.077	0.065	0.078
1703100321	0.096	0.080	0.067	0.081
1703100422	0.103			
1703100501	0.084	0.069		
1703100641	0.085	0.067	0.054	0.068
1703100721	0.085	0.075	0.060	0.073
1703100761			0.068	
1703110032	0.092	0.071	0.067	0.076
1703116011	0.081	0.075	0.067	0.074
1703140021	0.084	0.070	0.059	0.071
1703140071	0.093	0.073	0.064	0.076
1703142011	0.087	0.080	0.067	0.078
1703142012	0.067		0.051	
1703170021	0.091	0.082	0.071	0.081
1703180031	0.074			
1704360011	0.084	0.066	0.065	0.071
1708900051	0.082	0.076	0.069	0.075
1709710021	0.090	0.074	0.068	0.077
1709710071	0.100	0.078	0.071	0.083
1709730011	0.087			
1711100011	0.090	0.079	0.068	0.079
1719710081	0.086	0.077	0.063	0.075
1719710111	0.087	0.073	0.068	0.076
1808900221	0.094	0.076	0.064	0.078
1808900241	0.086	0.081		
1808900301			0.064	
1808920081	0.101	0.081	0.067	0.083
1809100051	0.107	0.082	0.070	0.086
1809100101	0.100	0.084		
1812700202	0.097	0.079		
1812700241	0.101	0.077	0.069	0.082
1812700261	0.100	0.082	0.072	0.084
5505900021	0.110	0.085		
5505900191	0.116	0.088	0.078	0.094
5505900221	0.096	0.088		
Average:	0.092	0.077	0.066	
			Design Value*:	0.094

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-4. Monitor-Specific O_3 Air Quality Information: Cleveland, OH

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
3900710011	0.103	0.099	0.081	0.094
3903500341	0.090	0.076	0.057	0.074
3903500641	0.090	0.079	0.063	0.077
3903550021	0.098	0.089	0.077	0.088
3905500041	0.115	0.097	0.075	0.095
3908500031	0.104	0.092	0.079	0.091
3908530021	0.088	0.080	0.076	0.081
3909300171	0.099	0.085	0.074	0.086
3910300031	0.091	0.086	0.077	0.084
3913310011	0.097	0.091	0.081	0.089
3915300201	0.103	0.089	0.077	0.089
Average:	0.098	0.088	0.074	
			Design Value*:	0.095

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-5. Monitor-Specific O_3 Air Quality Information: Detroit, MI

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
2604900211	0.088	0.087	0.075	0.083
2604920011	0.089	0.091	0.077	0.085
2609900091	0.095	0.102	0.081	0.092
2609910031	0.092	0.101	0.071	0.088
2612500012	0.093	0.090	0.075	0.086
2614700051	0.100	0.086	0.074	0.086
2616100081	0.091	0.091	0.071	0.084
2616300012	0.088	0.085	0.065	0.079
2616300161	0.092	0.084	0.066	0.08
2616300192	0.083	0.098	0.066	0.082
Average:	0.091	0.092	0.072	
			Design Value*:	0.092

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-6. Monitor-Specific O_3 Air Quality Information: Houston, TX

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
4803910032	0.095			
4803910041	0.092	0.097	0.103	0.097
4803910161			0.081	
4816700141	0.093	0.092	0.088	0.091
4816710022	0.083	0.082		
4820100242	0.096	0.095	0.096	0.095
4820100263	0.088	0.098	0.085	0.09
4820100292	0.098	0.096	0.090	0.094
4820100461	0.078	0.093	0.084	0.085
4820100472	0.072	0.082	0.083	0.079
4820100512	0.101	0.103	0.095	0.099
4820100551	0.094	0.107	0.104	0.101
4820100621	0.095	0.094	0.097	0.095
4820100661	0.084	0.081	0.097	0.087
4820100701	0.088	0.100	0.078	0.088
4820100751	0.078	0.096	0.093	0.089
4820110151		0.108	0.093	
4820110342	0.093	0.102	0.091	0.095
4820110353	0.092	0.105	0.092	0.096
4820110391	0.095	0.113	0.097	0.101
4820110411	0.090			
4820110501	0.094	0.092	0.097	0.094
4833900781	0.082	0.094	0.080	0.085
Average:	0.090	0.097	0.091	
			Design Value*:	0.101

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-7. Monitor-Specific O_3 Air Quality Information: Los Angeles, CA

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
0603700021	0.097	0.104	0.092	0.097
0603700161	0.111	0.123	0.095	0.109
0603701131	0.073	0.083	0.076	0.077
0603710021	0.091	0.096	0.089	0.092
0603711031	0.077	0.082	0.078	0.079
0603712011	0.111	0.119	0.101	0.11
0603713011	0.049	0.057	0.065	0.057
0603716011	0.074	0.082	0.079	0.078
0603717011	0.099	0.109	0.095	0.101
0603720051	0.095	0.101	0.093	0.096
0603740021	0.059	0.063	0.070	0.064
0603750011	0.064	0.070		
0603750051			0.085	
0603760121	0.131	0.137	0.107	0.125
0603790331	0.102	0.103	0.095	0.1
0605900071	0.069	0.080	0.088	0.079
0605910031	0.066	0.079	0.076	0.073
0605920221	0.081	0.095	0.085	0.087
0605950011	0.071	0.080	0.075	0.075
0606500121	0.113	0.127	0.112	0.117
0606520021	0.097	0.100	0.094	0.097
0606550011	0.109	0.105	0.099	0.104
0606560011	0.107	0.116	0.095	0.106
0606580011	0.109	0.120	0.111	0.113
0606590011	0.104	0.112	0.100	0.105
0606590031			0.060	
0607100011	0.092	0.088	0.082	0.087
0607100051	0.131	0.130	0.122	0.127
0607100121	0.115	0.103	0.097	0.105
0607100171	0.087	0.084	0.087	0.086
0607103061	0.106	0.104	0.085	0.098
0607110042	0.105	0.114	0.102	0.107
0607112341	0.089	0.087	0.082	0.086
0607120021	0.114	0.132	0.111	0.119
0607140011	0.113	0.110	0.099	0.107
0607140031	0.117	0.137	0.119	0.124
0607190021	0.101	0.111	0.102	0.104
0607190041	0.105	0.123	0.112	0.113
0611100051	0.076			
0611100071	0.080	0.087	0.086	0.084
0611100091	0.087	0.093	0.086	0.088
0611110041	0.097	0.093	0.092	0.094
0611120021	0.092	0.093	0.092	0.092
0611120031	0.064	0.074	0.069	0.069
0611130011	0.064	0.069	0.065	0.066
Average:	0.093	0.099	0.091	
			Design Value*:	0.127

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-8. Monitor-Specific O_3 Air Quality Information: New York, NY

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
3600500831	0.096	0.079	0.074	0.083
3600501101	0.089	0.082	0.069	0.08
3602700071	0.111	0.081	0.076	0.089
3607150011	0.082	0.087	0.078	0.082
3607900051	0.102	0.082	0.082	0.088
3608100981	0.082	0.072	0.064	0.072
3608101241	0.089	0.086	0.075	0.083
3608500671	0.099	0.086	0.083	0.089
3610300021	0.108	0.094	0.081	0.094
3610300041	0.090	0.082		
3610300092	0.103	0.102	0.079	0.094
3611110051	0.084	0.082	0.076	0.08
3611920041	0.102	0.091	0.078	0.09
Average:	0.095	0.085	0.076	
			Design Value*:	0.094

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-9. Monitor-Specific O_3 Air Quality Information: Philadelphia, PA

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
4201700121	0.111	0.087	0.082	0.093
4202900501	0.104	0.085		
4202901001	0.112	0.085	0.085	0.094
4204500021	0.106	0.080	0.081	0.089
4209100131	0.101	0.085	0.083	0.089
4210100041	0.082	0.069	0.054	0.068
4210100141	0.098	0.083	0.077	0.086
4210100241	0.110	0.082	0.091	0.094
4210101361	0.094	0.070	0.073	0.079
Average:	0.102	0.081	0.078	
			Design Value*:	0.094

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-10. Monitor-Specific O_3 Air Quality Information: Sacramento, CA

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
0601700101	0.098	0.096	0.089	0.094
0601700111	0.067	0.065		
0601700121	0.077	0.075	0.073	0.075
0601700201	0.111	0.106	0.089	0.102
0605700051	0.099	0.098	0.093	0.096
0605700071	0.093	0.090	0.085	0.089
0605710011	0.065			
0606100021	0.101	0.094	0.092	0.095
0606100041	0.101	0.089	0.087	0.092
0606100061	0.095	0.085	0.082	0.087
0606100071		0.068		
0606130011	0.097			
0606700021	0.095	0.086	0.076	0.085
0606700061	0.105	0.097	0.083	0.095
0606700101	0.083	0.076	0.067	0.075
0606700111	0.069	0.087	0.077	0.077
0606700121	0.104	0.098	0.087	0.096
0606700131	0.079	0.075	0.067	0.073
0606750031	0.097	0.097	0.089	0.094
0611300041	0.076	0.077	0.071	0.074
0611310031	0.088	0.082	0.069	0.079
Average:	0.090	0.086	0.081	
			Design Value*:	0.102

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-11. Monitor-Specific O_3 Air Quality Information: St. Louis, MO

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
1708310011	0.100	0.083	0.073	0.085
1711700021	0.085	0.077	0.068	0.076
1711900081	0.094	0.089	0.074	0.085
1711910091	0.090	0.088	0.078	0.085
1711920072	0.090	0.082	0.068	0.08
1711930071	0.084	0.083	0.073	0.08
1716300102	0.093	0.079	0.073	0.081
2909900121	0.093	0.082	0.070	0.081
2918310021	0.099	0.091	0.077	0.089
2918310041	0.098	0.090	0.076	0.088
2918900041	0.098	0.088	0.070	0.085
2918900061	0.094	0.086	0.067	0.082
2918930011	0.094	0.082	0.067	0.081
2918950011	0.095	0.088	0.068	0.083
2918970031	0.093	0.088	0.069	0.083
2951000071	0.090	0.084		
2951000721	0.081	0.071	0.058	0.07
2951000861	0.098	0.090	0.072	0.086
Average:	0.093	0.085	0.071	
			Design Value*:	0.089

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-12. Monitor-Specific O_3 Air Quality Information: Washington, D.C.

AIRS Monitor ID	Fourth Daily Maximum 8-Hour Average (ppm)			Average of the 3 Year-Specific Values (ppm)
	2002	2003	2004	
1100100251	0.097	0.079	0.080	0.085
1100100411	0.102	0.082	0.070	0.084
1100100431	0.106	0.081	0.081	0.089
Average:	0.102	0.081	0.077	
			Design Value*:	0.089

*The design value is the maximum of the monitor-specific averages of the annual fourth daily maximum 8-hour average over the 3 year period.

Table 5A-13. Composite Monitor Statistics: 2004

Urban Area	24-Hour Average (ppm)			1-Hour Maximum (ppm)			8-Hour Maximum (ppm)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Atlanta	0.0091	0.0279	0.0504	0.0170	0.0578	0.1267	0.0146	0.0499	0.1103
Boston 1*	0.0060	0.0276	0.0571	0.0185	0.0433	0.1060	0.0128	0.0379	0.0904
Boston 2*	0.0114	0.0310	0.0603	0.0218	0.0450	0.0956	0.0194	0.0411	0.0842
Chicago	0.0110	0.0270	0.0453	0.0152	0.0432	0.0758	0.0119	0.0389	0.0679
Cleveland	0.0080	0.0257	0.0445	0.0123	0.0404	0.0743	0.0090	0.0360	0.0676
Detroit	0.0074	0.0239	0.0459	0.0140	0.0430	0.0793	0.0094	0.0375	0.0730
Houston	0.0075	0.0262	0.0572	0.0155	0.0510	0.1243	0.0137	0.0443	0.1082
Los Angeles 1**	0.0204	0.0338	0.0491	0.0351	0.0634	0.1005	0.0319	0.0555	0.0867
Los Angeles 2**	0.0249	0.0398	0.0568	0.0410	0.0656	0.0992	0.0387	0.0597	0.0888
New York 1***	0.0055	0.0242	0.0494	0.0128	0.0449	0.0920	0.0085	0.0378	0.0811
New York 2***	0.0052	0.0241	0.0491	0.0115	0.0447	0.0883	0.0076	0.0378	0.0806
Philadelphia	0.0037	0.0272	0.0486	0.0090	0.0492	0.0915	0.0057	0.0426	0.0775
Sacramento	0.0164	0.0323	0.0462	0.0307	0.0593	0.0953	0.0241	0.0520	0.0806
St. Louis	0.0078	0.0248	0.0425	0.0175	0.0468	0.0890	0.0114	0.0409	0.0688
Washington, D.C.	0.0055	0.0283	0.0526	0.0140	0.0521	0.1020	0.0103	0.0450	0.0916

*"Boston 1" denotes Suffolk County; "Boston 2" denotes Essex, Middlesex, Norfolk, Suffolk, and Worcester Counties.

**"Los Angeles 1" denotes Los Angeles County; "Los Angeles 2" denotes Los Angeles, Riverside, San Bernardino, and Orange Counties.

***"New York 1" denotes the 5 boroughs of New York City -- Brooklyn, Queens, Manhattan, Bronx, and Staten Island. "New York 2" denotes the 5 boroughs plus Westchester County.

Table 5A-14. Composite Monitor Statistics: 2002

Urban Area	24-Hour Average (ppm)			1-Hour Maximum (ppm)			8-Hour Maximum (ppm)		
	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum
Atlanta	0.0102	0.0308	0.0559	0.0193	0.0623	0.1307	0.0157	0.0540	0.1166
Boston 1*	0.0133	0.0314	0.0783	0.0210	0.0503	0.1185	0.0178	0.0434	0.1128
Boston 2*	0.0132	0.0359	0.0852	0.0213	0.0526	0.1213	0.0169	0.0479	0.1162
Chicago	0.0101	0.0295	0.0545	0.0206	0.0488	0.0986	0.0137	0.0437	0.0899
Cleveland	0.0103	0.0338	0.0685	0.0177	0.0548	0.1070	0.0138	0.0488	0.1044
Detroit	0.0085	0.0277	0.0572	0.0170	0.0516	0.0987	0.0151	0.0450	0.0923
Houston	0.0089	0.0258	0.0568	0.0163	0.0492	0.1167	0.0131	0.0427	0.1017
Los Angeles 1**	0.0158	0.0313	0.0492	0.0283	0.0613	0.1009	0.0252	0.0525	0.0842
Los Angeles 2**	0.0192	0.0385	0.0586	0.0292	0.0652	0.0967	0.0247	0.0587	0.0881
New York 1***	0.0062	0.0280	0.0565	0.0130	0.0529	0.1294	0.0088	0.0448	0.0999
New York 2***	0.0075	0.0286	0.0576	0.0133	0.0537	0.1333	0.0088	0.0458	0.1032
Philadelphia	0.0069	0.0322	0.0619	0.0133	0.0573	0.1235	0.0091	0.0501	0.0999
Sacramento	0.0182	0.0353	0.0604	0.0242	0.0647	0.1090	0.0212	0.0564	0.0954
St. Louis	0.0058	0.0289	0.0585	0.0157	0.0556	0.1127	0.0087	0.0484	0.1000
Washington, D.C.	0.0095	0.0357	0.0708	0.0193	0.0627	0.1430	0.0164	0.0548	0.1210

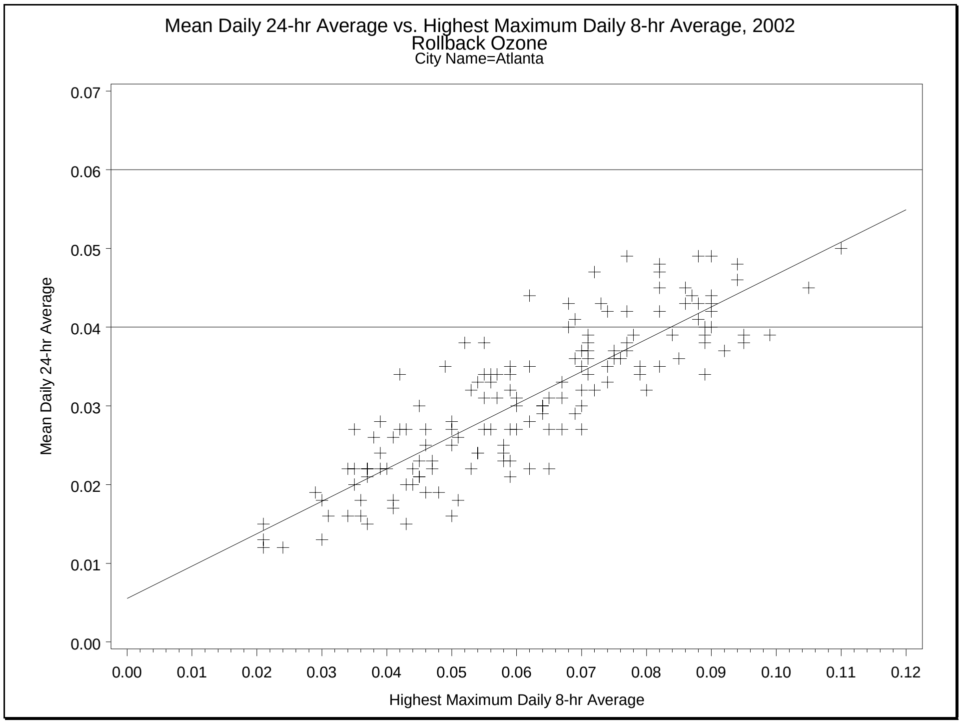
*"Boston 1" denotes Suffolk County; "Boston 2" denotes Essex, Middlesex, Norfolk, Suffolk, and Worcester Counties.

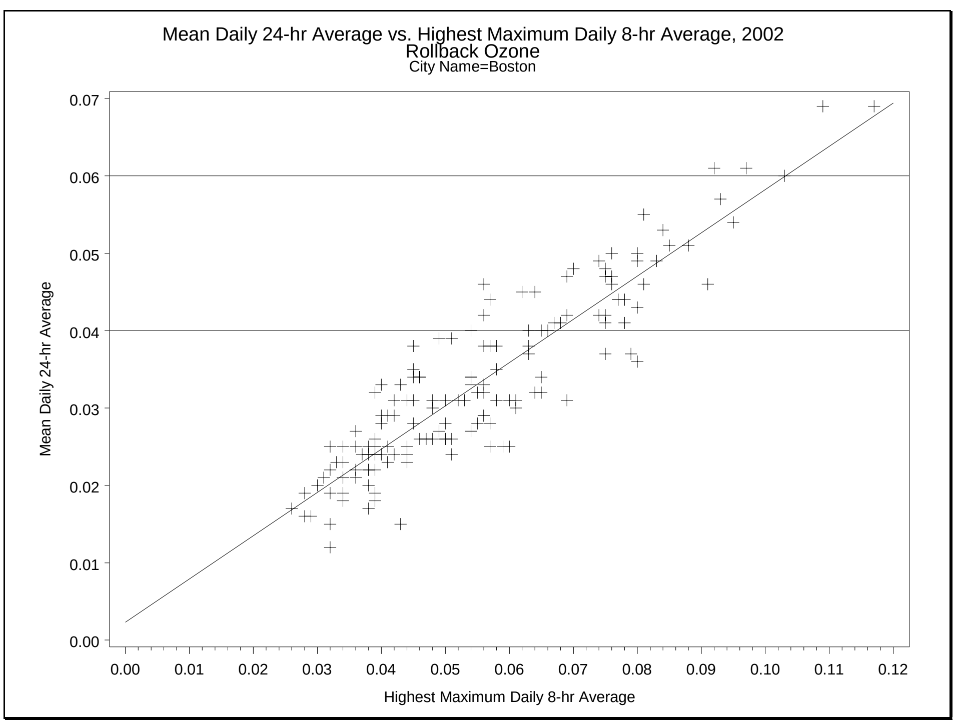
**"Los Angeles 1" denotes Los Angeles County; "Los Angeles 2" denotes Los Angeles, Riverside, San Bernardino, and Orange Counties.

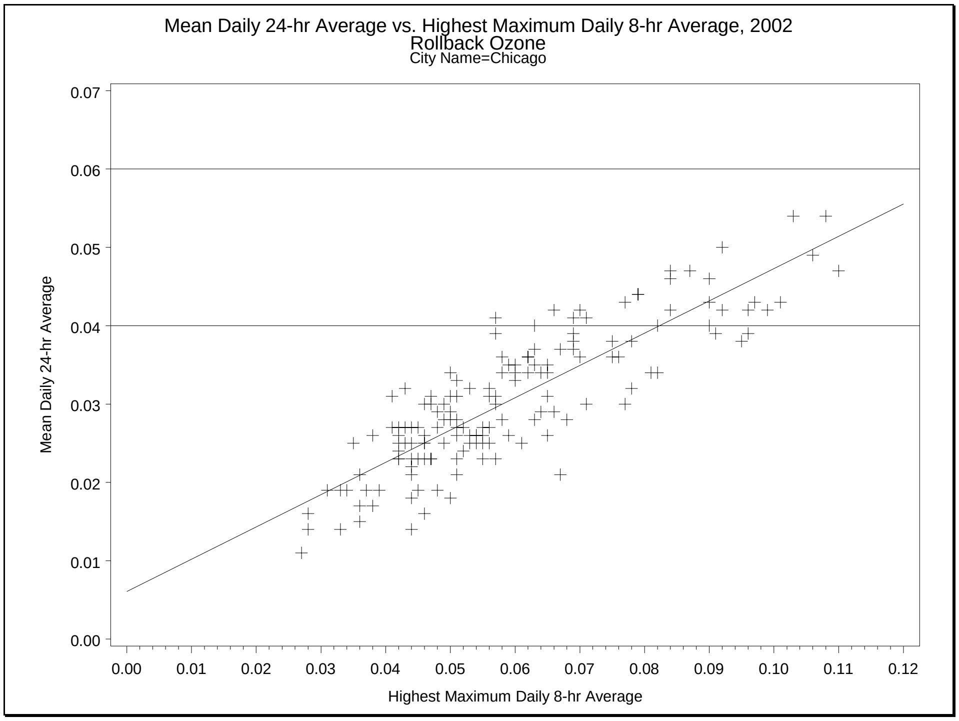
***"New York 1" denotes the 5 boroughs of New York City -- Brooklyn, Queens, Manhattan, Bronx, and Staten Island. "New York 2" denotes the 5 boroughs plus Westchester County.

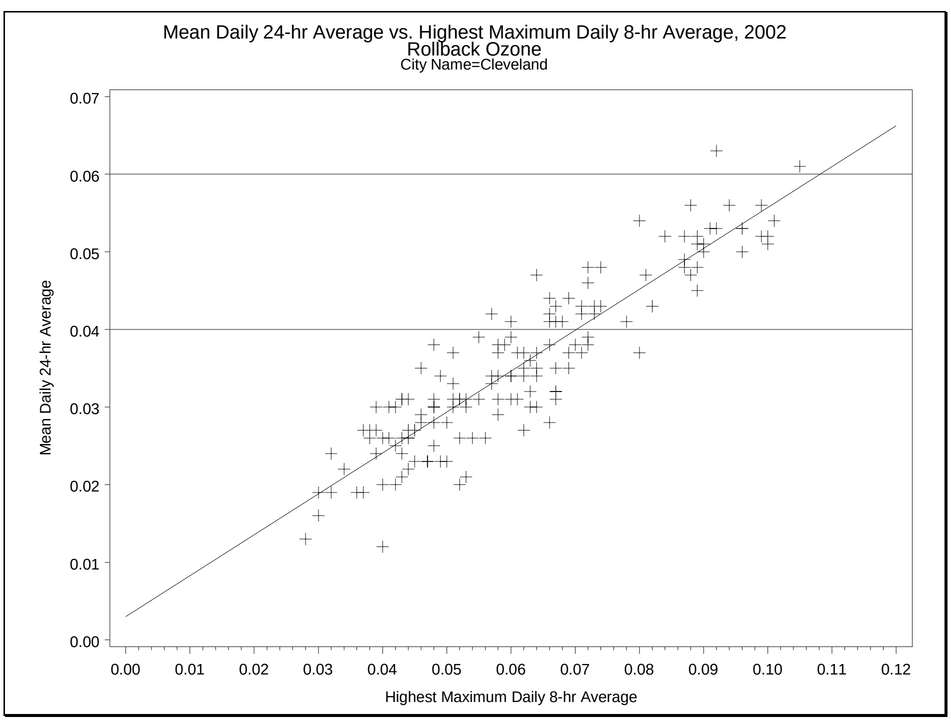
5A.2 Scatter Plots

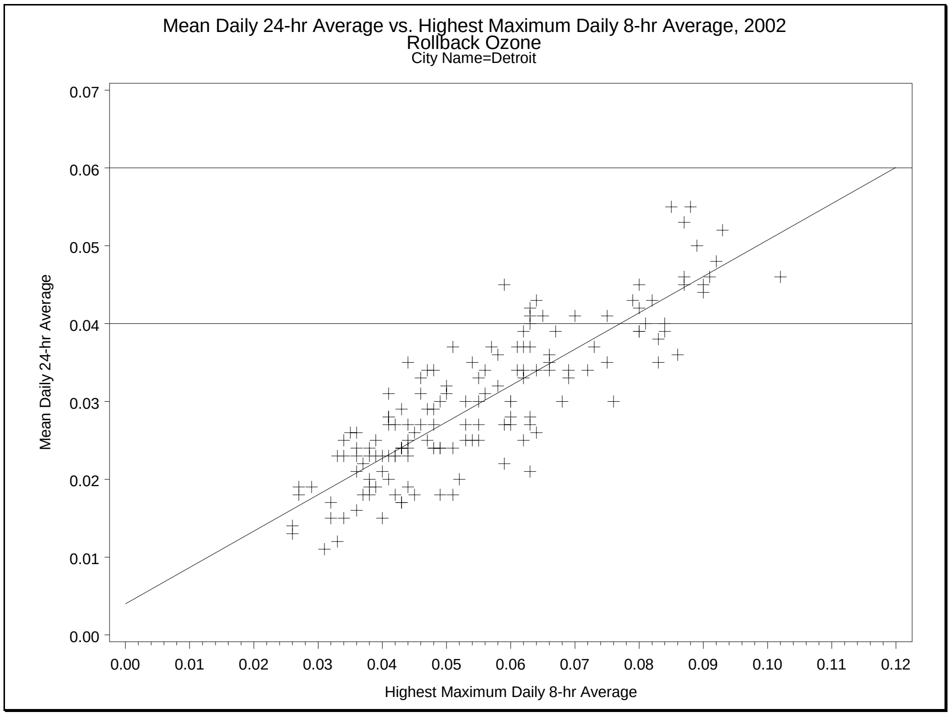
This Appendix provides scatter plots comparing 8-hr daily maximum concentrations at the highest monitor with the average of the 24-hr average over all monitors within each of the 12 urban areas included in the risk assessment.


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Atlanta
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
0.12


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Boston
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
0.12


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Chicago
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
0.12


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Cleveland
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
0.12


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Detroit
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
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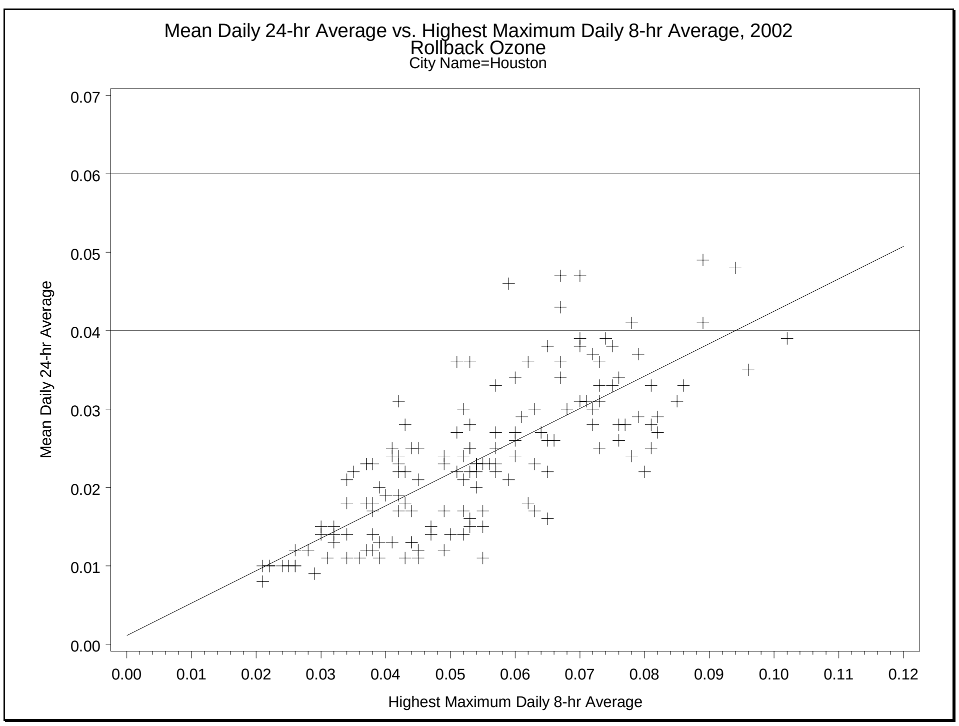
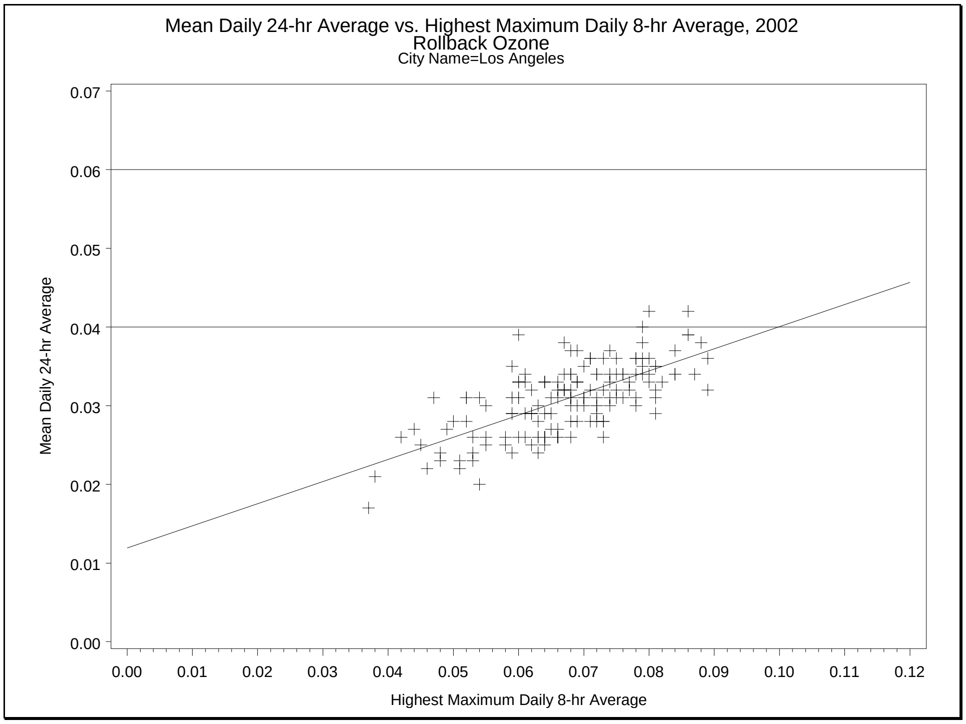
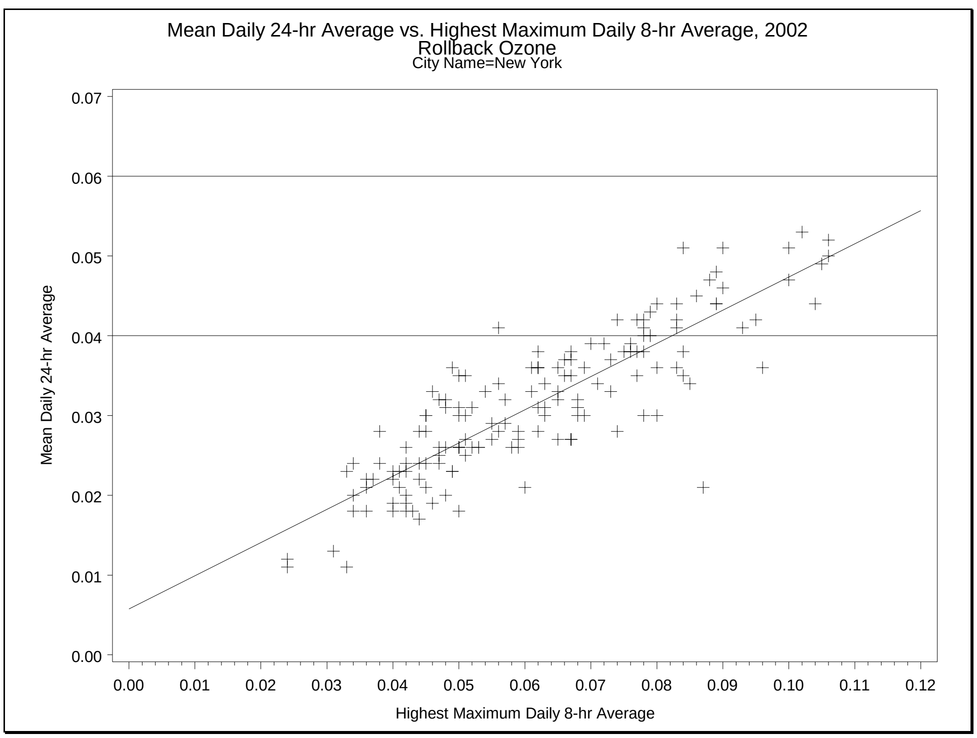
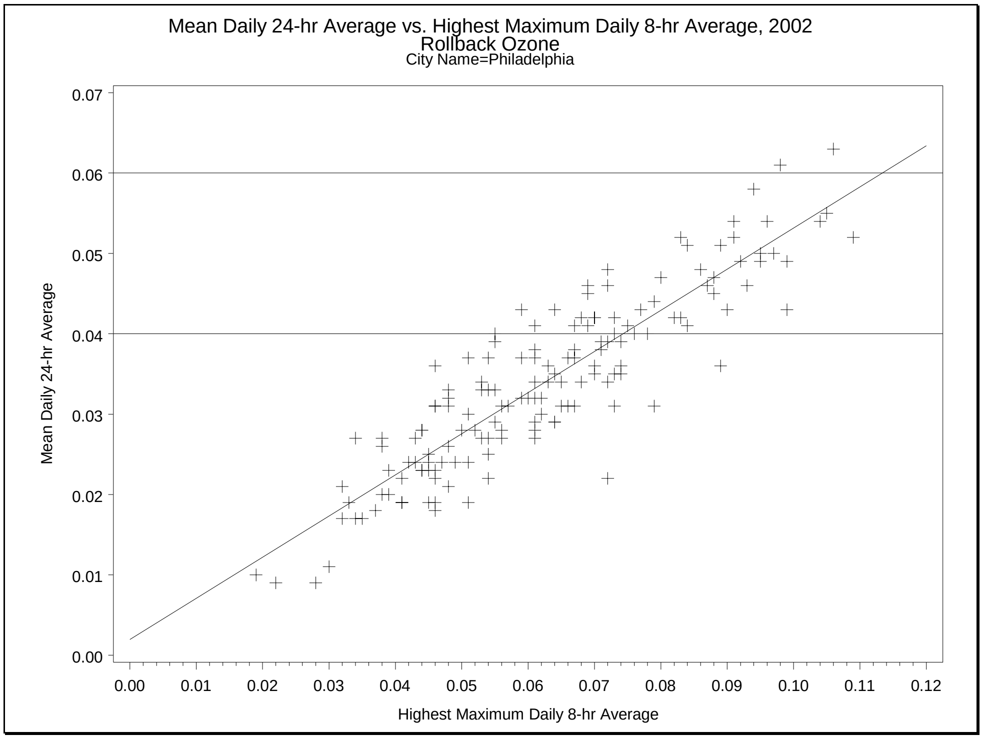
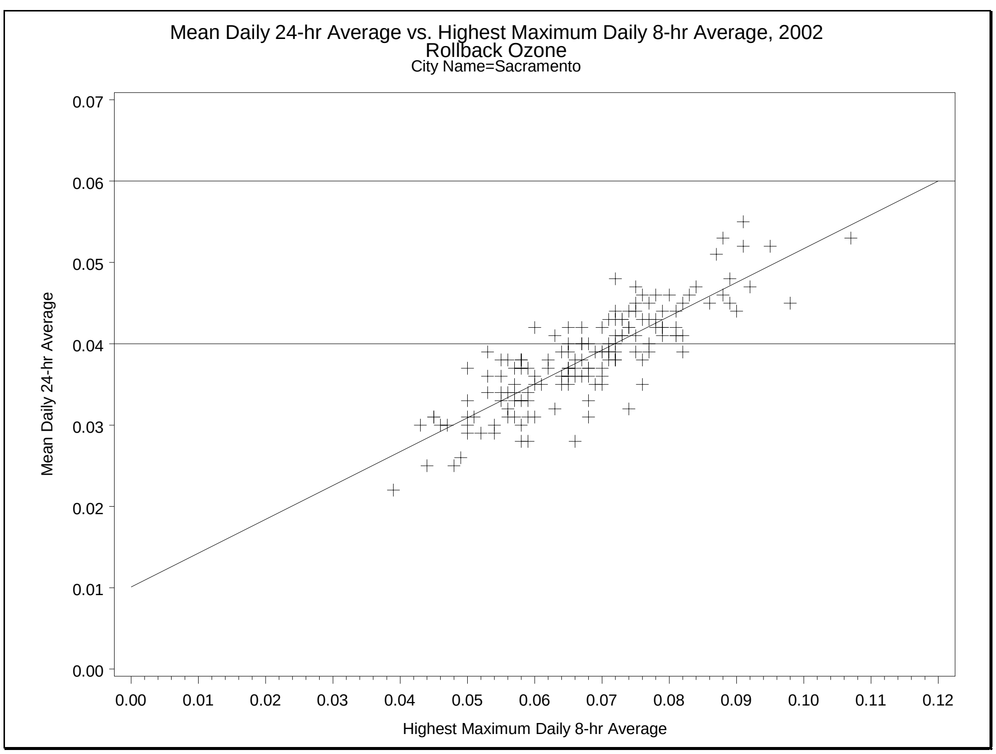
Highest Maximum Daily 8-hr Average

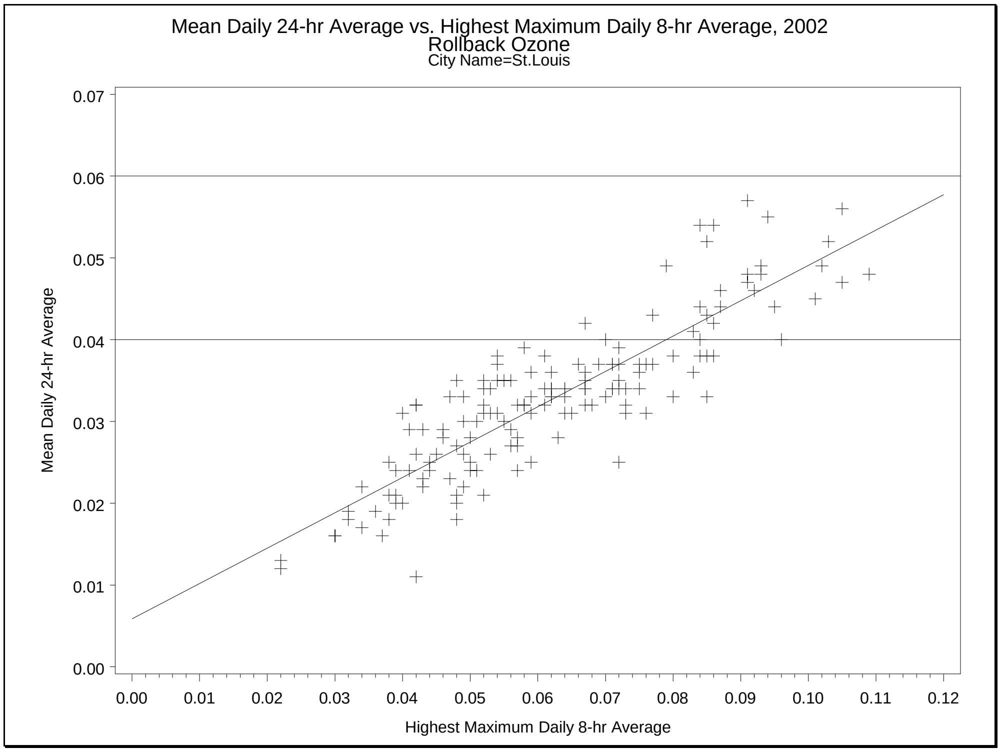

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Houston
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11 0.12
Highest Maximum Daily 8-hr Average

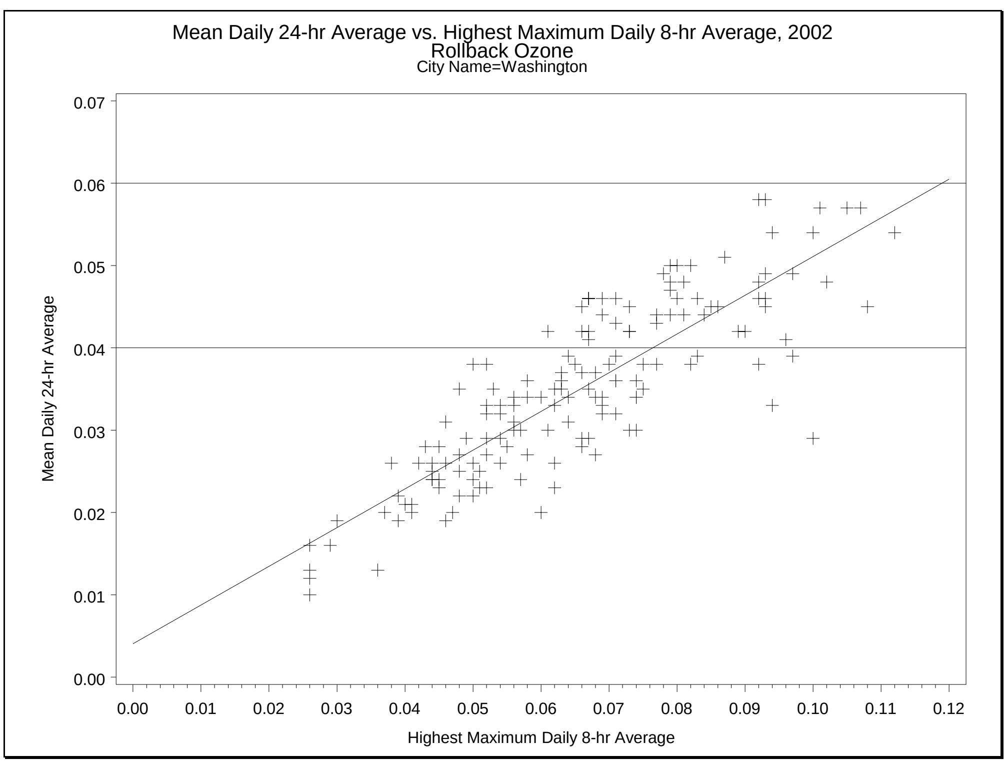

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Los Angeles
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
0.12

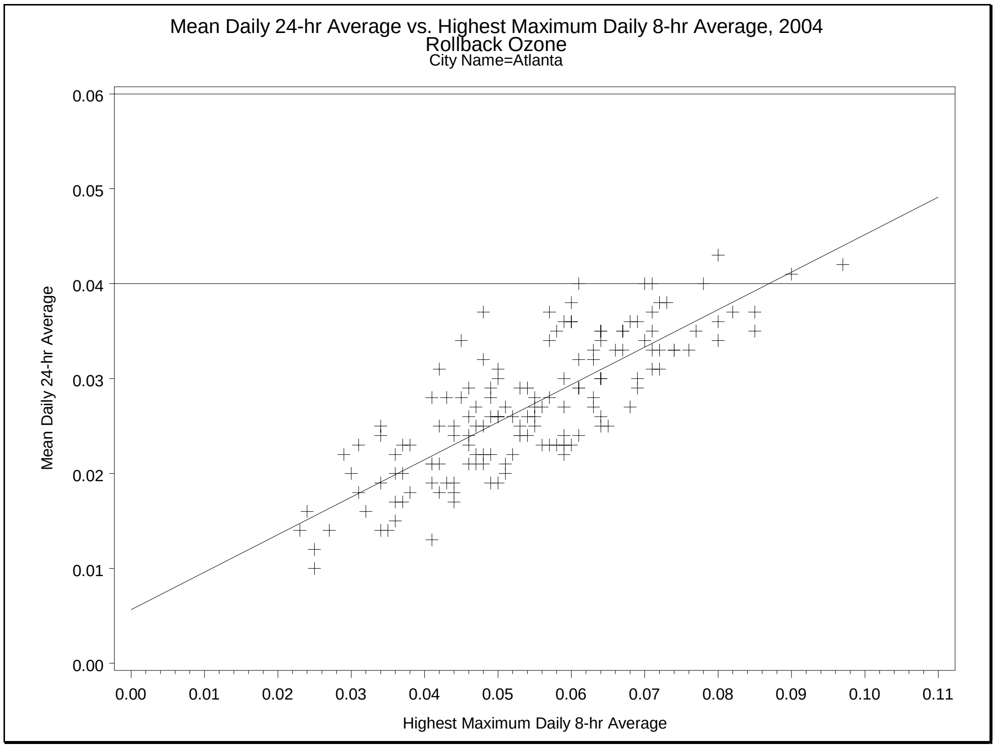

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=New York
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11
0.12

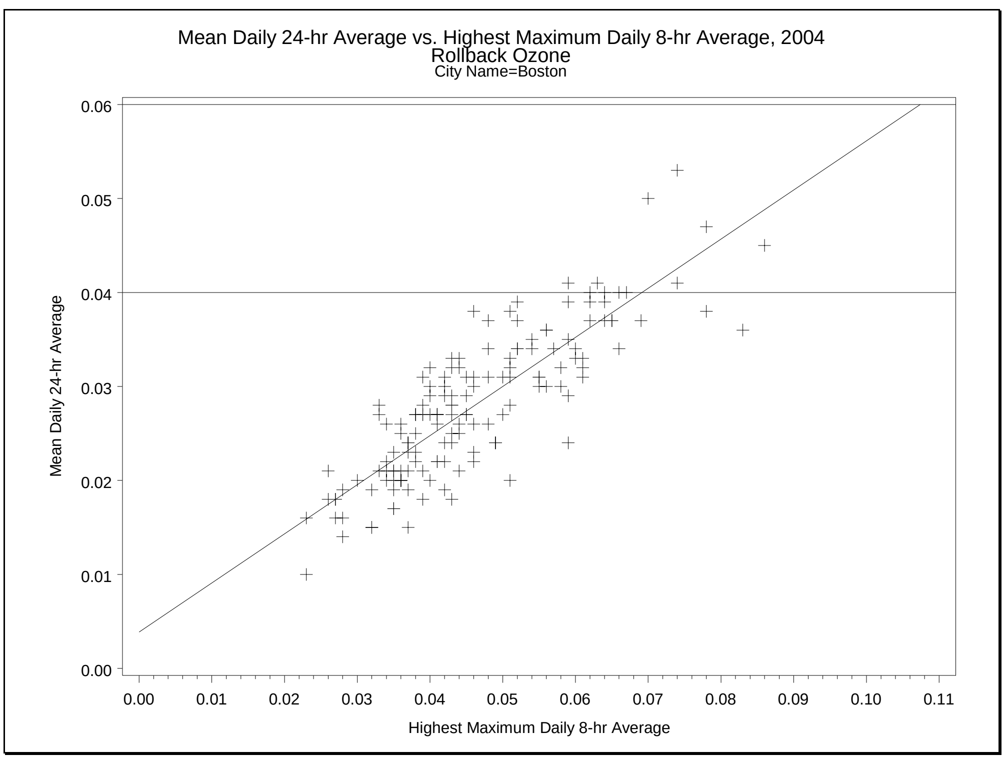

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Philadelphia
Mean Daily 24-hr Average
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11 0.12
Highest Maximum Daily 8-hr Average

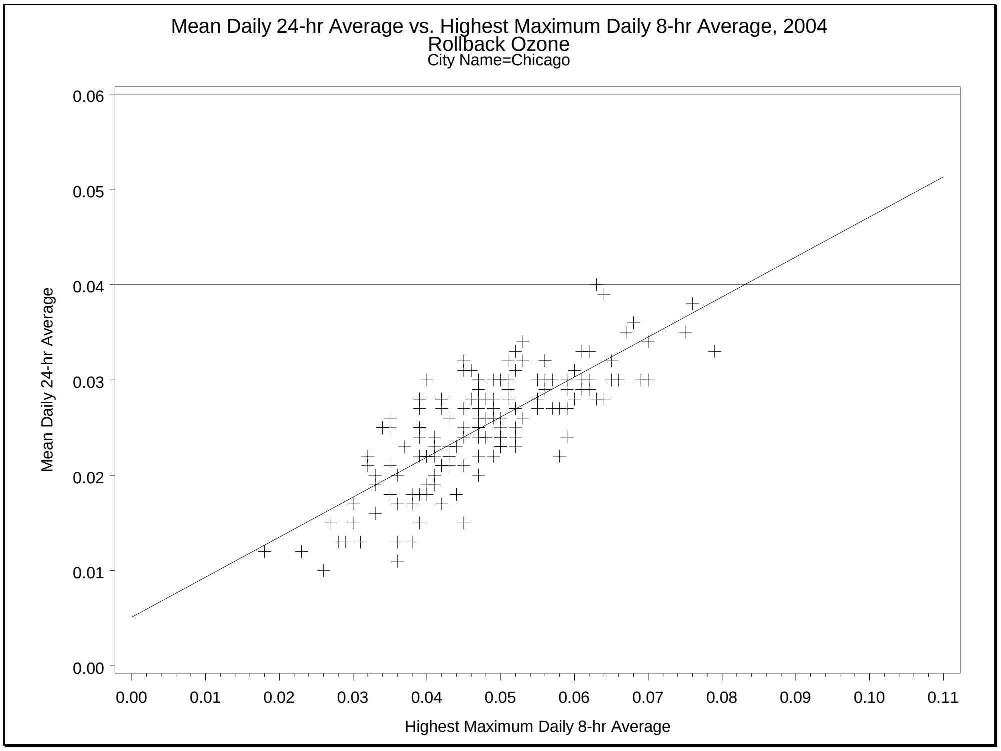

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Sacramento
Mean Daily 24-hr Average
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11 0.12
Highest Maximum Daily 8-hr Average

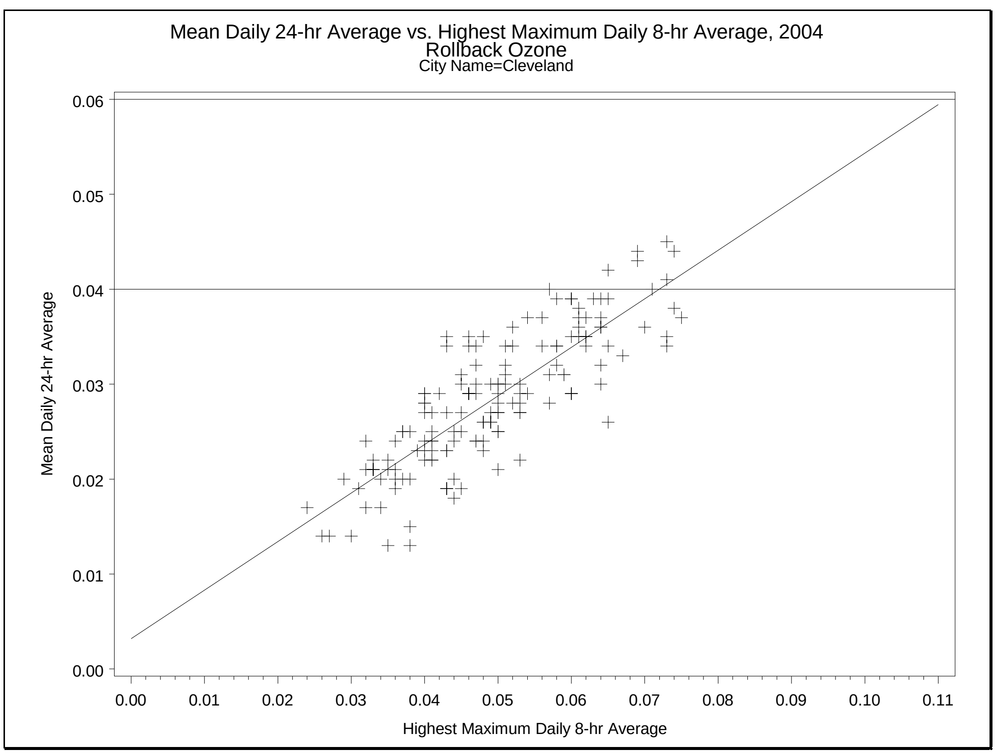

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=St.Louis
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11 0.12
Highest Maximum Daily 8-hr Average

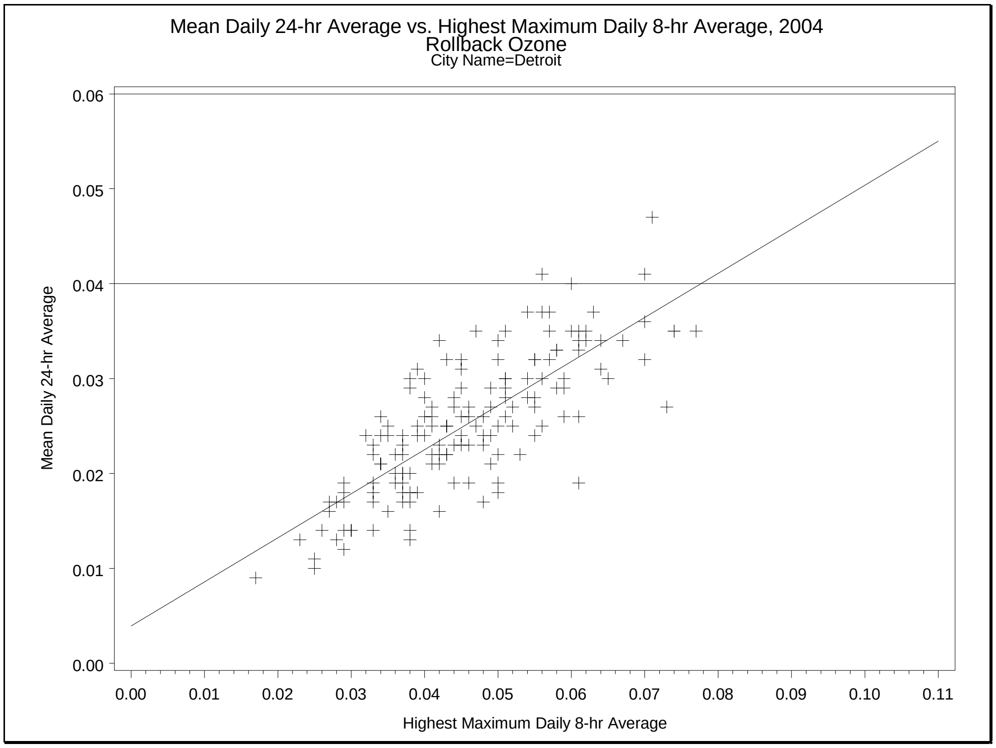

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Washington
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11 0.12
Highest Maximum Daily 8-hr Average

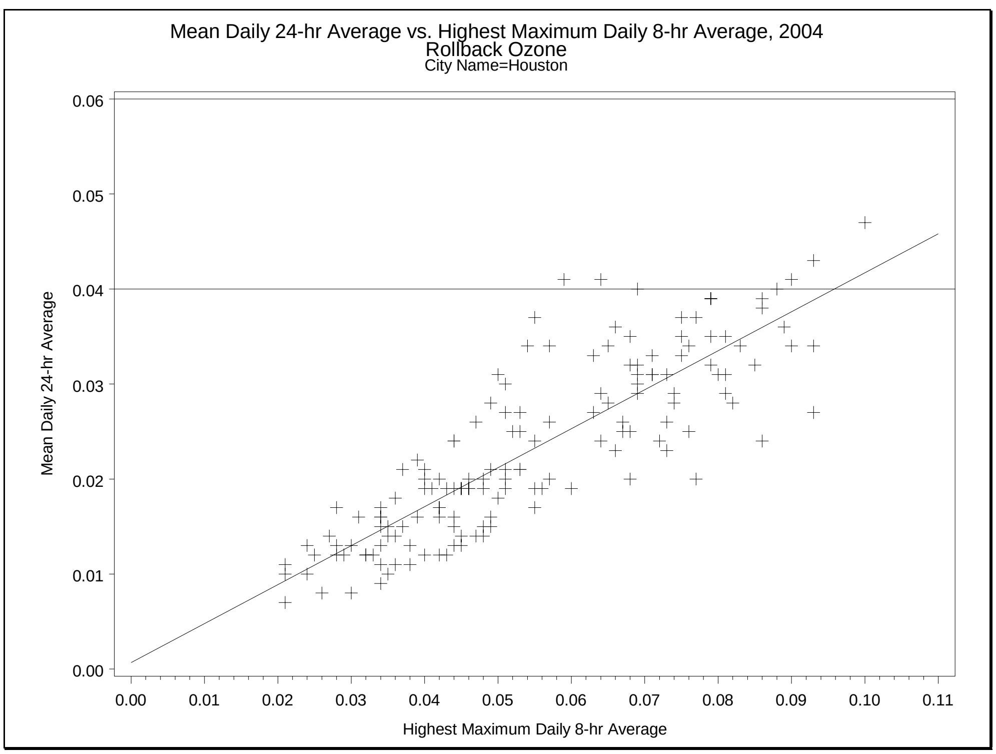

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Atlanta
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11

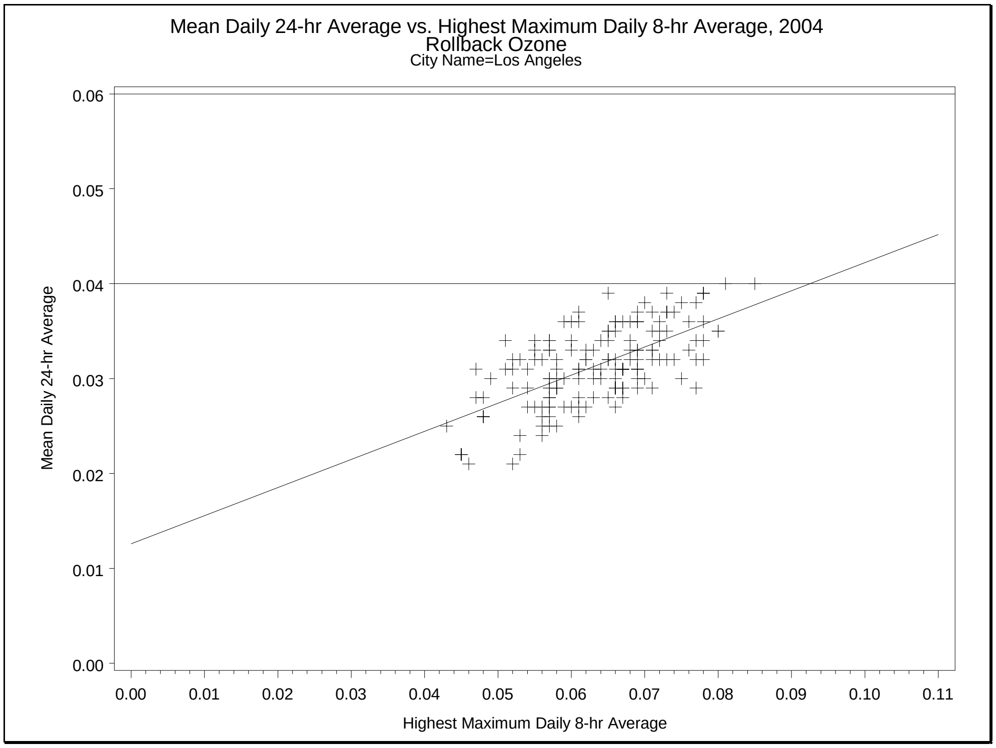

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Boston
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.11

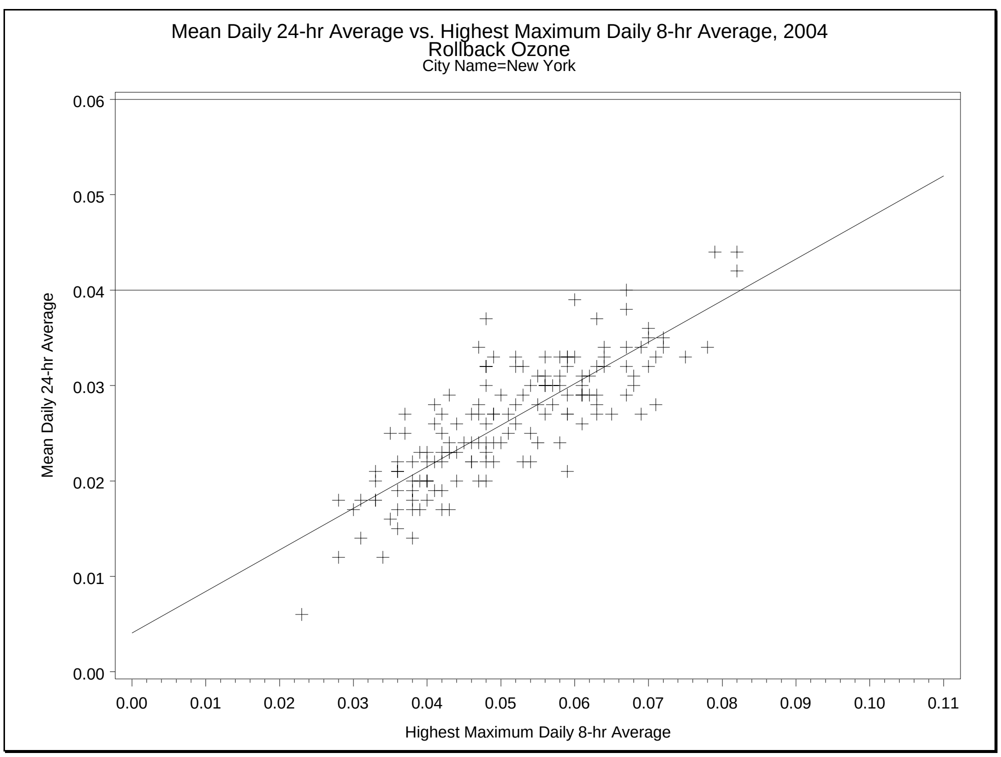

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Chicago
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00 0.01 0.02 0.03 0.04 0.05 0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11

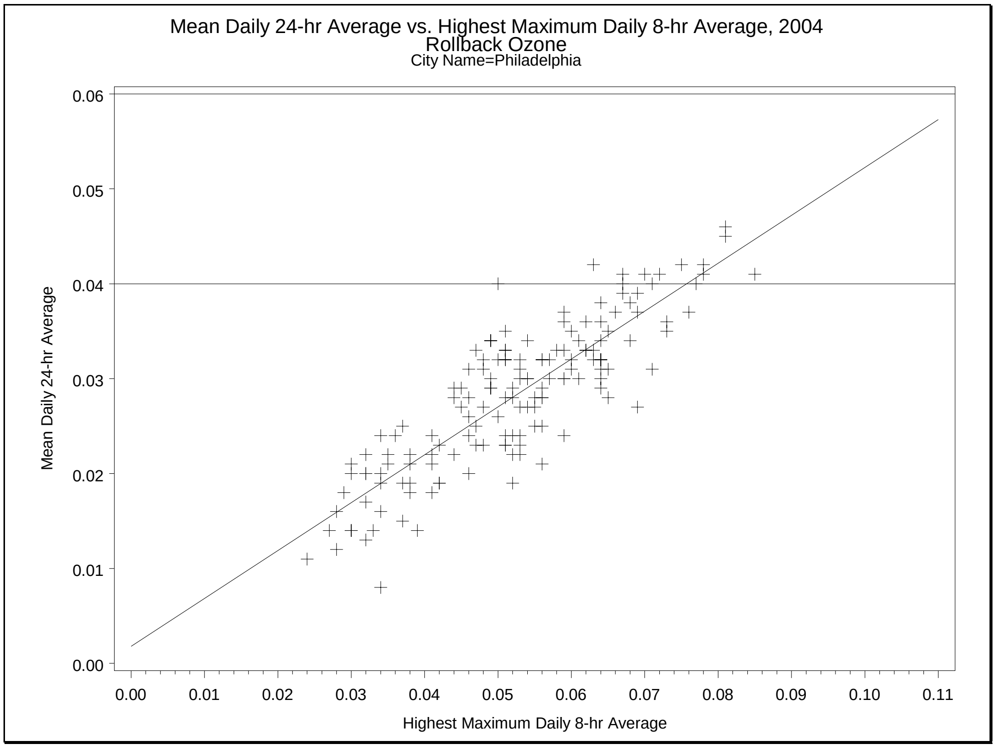

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Cleveland
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00 0.01 0.02 0.03 0.04 0.05 0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11

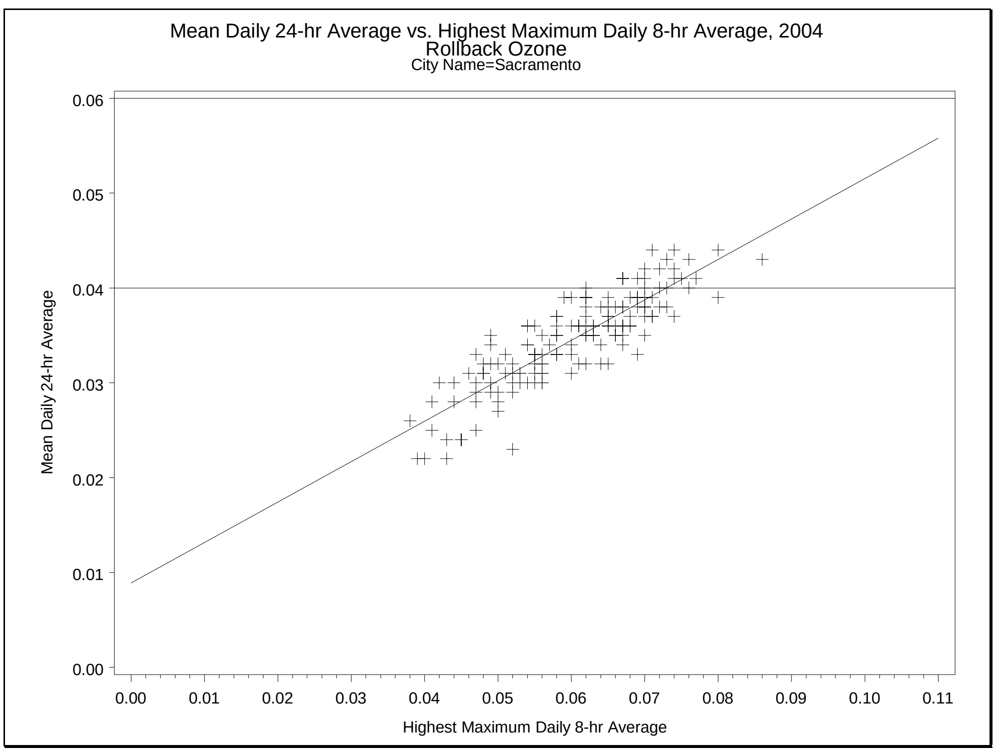

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Detroit
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11
Highest Maximum Daily 8-hr Average

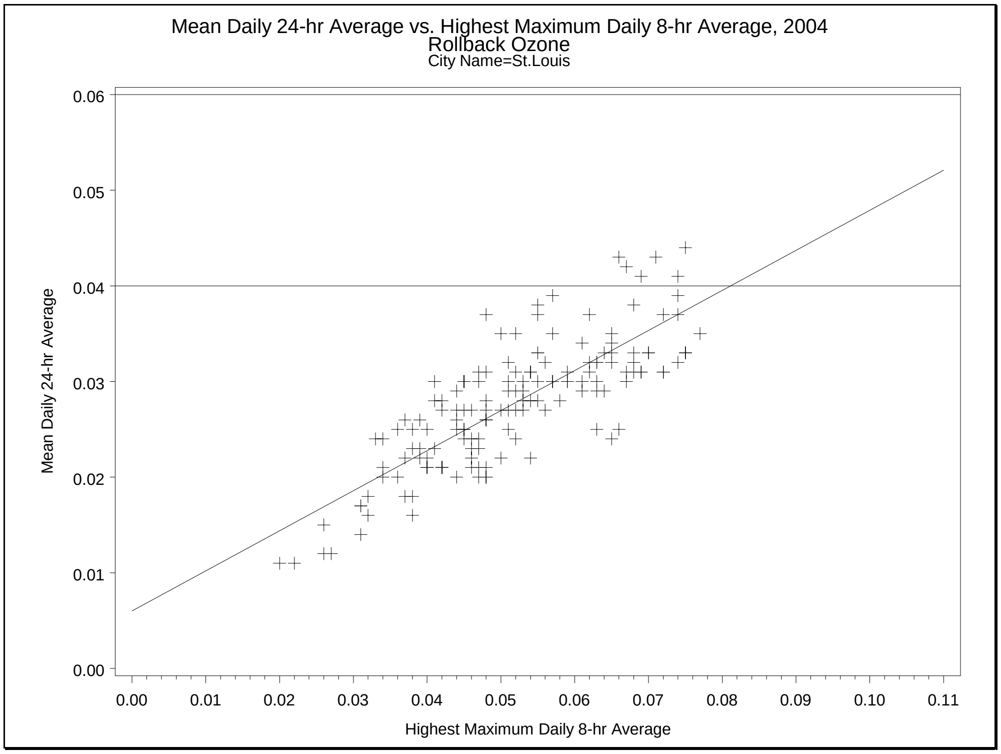

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Houston
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11
Highest Maximum Daily 8-hr Average


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Los Angeles
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11
Highest Maximum Daily 8-hr Average


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=New York
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11
Highest Maximum Daily 8-hr Average


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Philadelphia
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11
Highest Maximum Daily 8-hr Average


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Sacramento
Mean Daily 24-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11
Highest Maximum Daily 8-hr Average



Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=St.Louis
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
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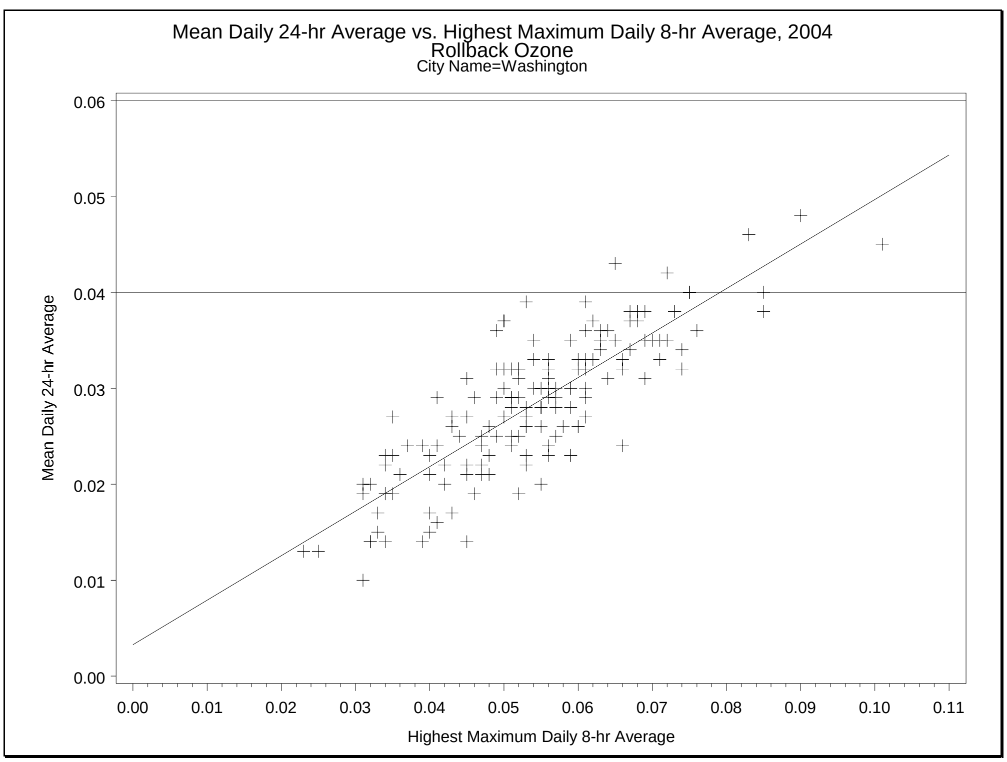


Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Washington
Mean Daily 24-hr Average
Highest Maximum Daily 8-hr Average
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10 0.11

5B.1 Tables of Study-Specific Information

Table 5B-1. Study-Specific Information for O_3 Studies in Atlanta, GA

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb)		O_3 Coefficient	Lower Bound	Upper Bound
								min.	max.			
Bell et al. (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	0	71	0.00020	-0.00084	0.00123
Bell et al. -- 95 US Cities (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065
Huang et al. (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	0	71	0.00120	-0.00039	0.00279
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00124	0.00047	0.00201
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	PM10	NA	NA	0.00074	-0.00033	0.00171
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	NO2	NA	NA	0.00060	0.00011	0.00109
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	SO2	NA	NA	0.00051	0.00001	0.00102
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	CO	NA	NA	0.00069	0.00020	0.00117

*Health effects are associated with short-term exposures to O_3.
**Rounded to the nearest ppb.
NA denotes "not available."

Table 5B-2. Study-Specific Information for O_3 Studies in Boston, MA

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb)		O_3 Coefficient	Lower Bound	Upper Bound
								min.	max.			
Bell et al. -- 95 US Cities (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065
Gent et al. (2003)	Respiratory symptoms -- chest tightness	---	0 - 12	1-day lag	1 hr max.	logistic	none	27	126	0.00462	0.00000	0.00784
Gent et al. (2003)	Respiratory symptoms -- chest tightness	---	0 - 12	0-day lag	1 hr max.	logistic	PM2.5	27	126	0.00771	0.00331	0.01220
Gent et al. (2003)	Respiratory symptoms -- chest tightness	---	0 - 12	1-day lag	1 hr max.	logistic	PM2.5	27	126	0.00701	0.00262	0.01153
Gent et al. (2003)	Respiratory symptoms -- chest tightness	---	0 - 12	1-day lag	8 hr max.	logistic	none	21	100	0.00570	0.00172	0.00965
Gent et al. (2003)	Respiratory symptoms -- shortness of breath	---	0 - 12	1-day lag	1 hr max.	logistic	none	27	126	0.00398	0.00040	0.00743
Gent et al. (2003)	Respiratory symptoms -- shortness of breath	---	0 - 12	1-day lag	8 hr max.	logistic	none	21	100	0.00525	0.00098	0.00952
Gent et al. (2003)	Respiratory symptoms -- wheeze	---	0 - 12	0-day lag	1 hr max.	logistic	PM2.5	21	100	0.00600	0.00209	0.01002

*Health effects are associated with short-term exposures to O_3.
**Rounded to the nearest ppb.

Table 5B-3. Study-Specific Information for O_3 Studies in Chicago, IL

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb) min.	Observed Concentrations** (ppb) max.	O_3 Coefficient	Lower Bound	Upper Bound
Bell et al. -- 95 US Cities (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065
Schwartz (2004)	Mortality, non-accidental	< 800	all	0-day lag	1 hr max.	logistic	none	NA	NA	0.00099	0.00031	0.00166
Schwartz -- 14 US Cities (2004)	Mortality, non-accidental	< 800	all	0-day lag	1 hr max.	logistic	none	NA	NA	0.00037	0.00012	0.00062
Huang et al. (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	0	65	0.00075	-0.00067	0.00218
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00124	0.00047	0.00201
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	PM10	NA	NA	0.00074	-0.00033	0.00171
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	NO2	NA	NA	0.00060	0.00011	0.00109
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	SO2	NA	NA	0.00051	0.00001	0.00102
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	CO	NA	NA	0.00069	0.00020	0.00117

*Health effects are associated with short-term exposures to O_3.
**Rounded to the nearest ppb.
NA denotes "not available."

Table 5B-4. Study-Specific Information for O_3 Studies in Cleveland, OH

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb) min.	Observed Concentrations** (ppb) max.	O_3 Coefficient	Lower Bound	Upper Bound
Bell et al. (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	2	75	0.00061	-0.00038	0.00161
Bell et al. -- 95 US Cities (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065
Huang et al. (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	2	75	0.00148	-0.00004	0.00299
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00124	0.00047	0.00201
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	PM10	NA	NA	0.00074	-0.00033	0.00171
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	NO2	NA	NA	0.00060	0.00011	0.00109
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	SO2	NA	NA	0.00051	0.00001	0.00102
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	CO	NA	NA	0.00069	0.00020	0.00117
Schwartz et al. (1996)	Hospital admissions, respiratory illness	460-519	65+	avg of 1-day and 2-day lags	1 hr max.	log-linear	none	NA	NA	0.00169	0.00039	0.00291

*Health effects are associated with short-term exposures to O_3.
**Rounded to the nearest ppb.
NA denotes "not available."

Table 5B-5. Study-Specific Information for O_3 Studies in Detroit, MI

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb)		O_3 Coefficient	Lower Bound	Upper Bound
								min.	max.			
Bell et al. (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	2	75	0.00076	-0.00024	0.00177
Bell et al. -- 95 US Cities	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065
Schwartz (2004)	Mortality, non-accidental	< 800	all	0-day lag	1 hr max.	logistic	none	NA	NA	0.00068	-0.00011	0.00148
Schwartz -- 14 US Cities (2004)	Mortality, non-accidental	< 800	all	0-day lag	1 hr max.	logistic	none	NA	NA	0.00037	0.00012	0.00062
Ito (2003)	Mortality, non-accidental	< 800	all	0-day lag	24 hr avg.	log-linear (GAM str.	none	NA	55	0.00093	-0.00085	0.00271
Ito (2003)	Mortality, respiratory	460-519	all	0-day lag	24 hr avg.	log-linear	none	NA	55	0.00359	-0.00276	0.00993
Huang et al. (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	2	75	0.00135	-0.00015	0.00286
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00124	0.00047	0.00201
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	PM10	NA	NA	0.00074	-0.00033	0.00171
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	NO2	NA	NA	0.00060	0.00011	0.00109
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	SO2	NA	NA	0.00051	0.00001	0.00102
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	CO	NA	NA	0.00069	0.00020	0.00117
Ito (2003)	Hospital admissions (unscheduled), pneumonia	480-486	65+	0-day lag	24 hr avg.	log-linear (GAM str. estimation)**	none	NA	55	-0.00218	-0.00621	0.00186
Ito (2003)	Hospital admissions (unscheduled), pneumonia	480-486	65+	1-day lag	24 hr avg.	log-linear (GAM str. estimation)	none	NA	55	-0.00054	-0.00459	0.00352
Ito (2003)	Hospital admissions (unscheduled), pneumonia	480-486	65+	2-day lag	24 hr avg.	log-linear (GAM str. estimation)	none	NA	55	0.00066	-0.00342	0.00473
Ito (2003)	Hospital admissions (unscheduled), pneumonia	480-486	65+	3-day lag	24 hr avg.	log-linear (GAM str. estimation)	none	NA	55	0.00190	-0.00216	0.00595
Ito (2003)	Hospital admissions (unscheduled), COPD	490-496	65+	0-day lag	24 hr avg.	log-linear (GAM str. estimation)	none	NA	55	-0.00191	-0.00667	0.00286
Ito (2003)	Hospital admissions (unscheduled), COPD	490-496	65+	1-day lag	24 hr avg.	log-linear (GAM str. estimation)	none	NA	55	0.00187	-0.00293	0.00667
Ito (2003)	Hospital admissions (unscheduled), COPD	490-496	65+	2-day lag	24 hr avg.	log-linear (GAM str. estimation)	none	NA	55	-0.00027	-0.00513	0.00459
Ito (2003)	Hospital admissions (unscheduled), COPD	490-496	65+	3-day lag	24 hr avg.	log-linear (GAM str. estimation)	none	NA	55	0.00011	-0.00475	0.00497

*Health effects are associated with short-term exposures to O_3.

**Rounded to the nearest ppb.

***"GAM str. estimation" denotes that estimation of the log-linear C-R function used a generalized additive model with a stringent convergence criterion. This study also estimated log-linear C-R functions using generalized linear models (GLM).

NA denotes "not available."

Table 5B-6. Study-Specific Information for O_3 Studies in Houston, TX

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb)		O_3 Coefficient	Lower Bound	Upper Bound
								min.	max.			
Bell et al. (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	1	76	0.00079	0.00005	0.00154
Bell et al. -- 95 US Cities	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065
Schwartz (2004)	Mortality, non-accidental	< 800	all	0-day lag	1 hr max.	logistic	none	NA	NA	0.00044	0.00004	0.00084
Schwartz -- 14 US Cities (2004)	Mortality, non-accidental	< 800	all	0-day lag	1 hr max.	logistic	none	NA	NA	0.00037	0.00012	0.00062
Huang et al. (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	1	76	0.00122	-0.00016	0.00261
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00124	0.00047	0.00201
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	PM10	NA	NA	0.00074	-0.00033	0.00171
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	NO2	NA	NA	0.00060	0.00011	0.00109
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	SO2	NA	NA	0.00051	0.00001	0.00102
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	CO	NA	NA	0.00069	0.00020	0.00117

*Health effects are associated with short-term exposures to O_3.
**Rounded to the nearest ppb.
NA denotes "not available."

Table 5B-7. Study-Specific Information for O_3 Studies in Los Angeles, CA

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb)		O_3 Coefficient	Lower Bound	Upper Bound
								min.	max.			
Bell et al. (2004)***	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	0	68	0.00018	-0.00043	0.00079
Bell et al. -- 95 US Cities (2004)***	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065
Huang et al. (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	0	68	0.00107	0.00001	0.00213
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00124	0.00047	0.00201
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	PM10	NA	NA	0.00074	-0.00033	0.00171
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	NO2	NA	NA	0.00060	0.00011	0.00109
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	SO2	NA	NA	0.00051	0.00001	0.00102
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	CO	NA	NA	0.00069	0.00020	0.00117
Linn et al. (2000)****	Hospital admissions (unscheduled), pulmonary illness --	75-101*****	30+	0-day lag	24 hr avg.	log-linear	none	1	70	0.00110	-0.00047	0.00267
Linn et al. (2000)****	Hospital admissions (unscheduled), pulmonary illness --	75-101*****	30+	0-day lag	24 hr avg.	log-linear	none	1	70	0.00060	-0.00077	0.00197

*Health effects are associated with short-term exposures to O_3.

**Rounded to the nearest ppb.

***Los Angeles is defined in this study as Los Angeles County.

****Los Angeles is defined in this study as Los Angeles, Riverside, San Bernardino, and Orange Counties.

*****Linn et al. (2000) used DRG codes instead of ICD codes.

Table 5B-8. Study-Specific Information for O_3 Studies in New York, NY

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb) min.	Observed Concentrations** (ppb) max.	O_3 Coefficient	Lower Bound	Upper Bound
Bell et al. -- 95 US Cities (2004)***	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065
Huang et al. (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	-2	81	0.00170	0.00054	0.00286
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00124	0.00047	0.00201
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	PM10	NA	NA	0.00074	-0.00033	0.00171
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	NO2	NA	NA	0.00060	0.00011	0.00109
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	SO2	NA	NA	0.00051	0.00001	0.00102
Huang et al. -- 19 US Cities (2004)***	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	CO	NA	NA	0.00069	0.00020	0.00117
Thurston et al. (1992)****	Hospital admissions (unscheduled),	466, 480-486, 490, 491, 492, 493	all	3-day lag	1 hr max.	linear	none	NA	206	1.370E-08	3.312E-09	2.409E-08
Thurston et al. (1992)****	Hospital admissions (unscheduled), asthma	493	all	1-day lag	1 hr max.	linear	none	NA	206	1.170E-08	2.488E-09	2.091E-08

*Health effects are associated with short-term exposures to O_3.

**Rounded to the nearest ppb.

***New York in this study is defined as the five boroughs of New York City plus Westchester County.

****New York in this study is defined as the five boroughs of New York City.

NA denotes "not available."

Table 5B-9. Study-Specific Information for O_3 Studies in Philadelphia, PA

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb) min.	Observed Concentrations** (ppb) max.	O_3 Coefficient	Lower Bound	Upper Bound
Bell et al. -- 95 US Cities (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065
Moolgavkar et al. (1995)	Mortality, non-accidental	< 800	all	1-day lag	24 hr avg.	log-linear	none	1	159	0.00140	0.00086	0.00191
Moolgavkar et al. (1995)	Mortality, non-accidental	< 800	all	1-day lag	24 hr avg.	log-linear	TSP, SO2	1	159	0.00139	0.00066	0.00212
Huang et al. (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	-3	84	0.00151	0.00007	0.00296
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00124	0.00047	0.00201
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	PM10	NA	NA	0.00074	-0.00033	0.00171
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	NO2	NA	NA	0.00060	0.00011	0.00109
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	SO2	NA	NA	0.00051	0.00001	0.00102
Huang et al. -- 19 US Cities (2004)	Mortality, cardiorespiratory	390-448; 490-496; 487; 480-486; 507.	all	0-day lag	24 hr avg.	log-linear	CO	NA	NA	0.00069	0.00020	0.00117

*Health effects are associated with short-term exposures to O_3.

**Rounded to the nearest ppb.

NA denotes "not available."

Table 5B-10. Study-Specific Information for O_3 Studies in Sacramento, CA

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb)		O_3 Coefficient	Lower Bound	Upper Bound
								min.	max.			
Bell et al. (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	0	71	0.00026	-0.00079	0.00131
Bell et al. -- 95 US Cities (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065

*Health effects are associated with short-term exposures to O_3.
**Rounded to the nearest ppb.
NA denotes "not available."

Table 5B-11. Study-Specific Information for O_3 Studies in St. Louis, MO

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb)		O_3 Coefficient	Lower Bound	Upper Bound
								min.	max.			
Bell et al. (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	0	118	0.00044	-0.00072	0.00159
Bell et al. -- 95 US Cities (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065

*Health effects are associated with short-term exposures to O_3.
**Rounded to the nearest ppb.
NA denotes "not available."

Table 5B-12. Study-Specific Information for O_3 Studies in Washington, D.C.

Study	Health Effects*	ICD-9 Codes	Ages	Lag	Exposure Metric	Model	Other Pollutants in Model	Observed Concentrations** (ppb)		O_3 Coefficient	Lower Bound	Upper Bound
								min.	max.			
Bell et al. -- 95 US Cities (2004)	Mortality, non-accidental	< 800	all	distributed lag	24 hr avg.	log-linear	none	NA	NA	0.00039	0.00013	0.00065

*Health effects are associated with short-term exposures to O_3.
**Rounded to the nearest ppb.
NA denotes "not available."

5B.2 Concentration-Response Functions and Health Impact Functions

Notation:

$y_0 = Incidence\ under\ baseline\ conditions$
$y_c = Incidence\ under\ control\ conditions$
$\Delta y = y_0 - y_c$
$x_0 = O_3\ levels\ under\ baseline\ conditions$
$x_c = O_3\ levels\ under\ control\ conditions$
$\Delta x = x_0 - x_c$

5B.2.1 Log-linear

The log-linear concentration-response function is: $y = Be^{\beta x}$

The derivation of the corresponding health impact function is as follows:

$$y = Be^{\beta x}$$

$$y_0 = Be^{\beta x_0}$$

$$y_c = Be^{\beta x_c}$$

$$\Delta y = Be^{\beta x_0} - Be^{\beta x_c}$$

$$\Delta y = Be^{\beta x_0} \cdot \left(1 - \frac{Be^{\beta x_c}}{Be^{\beta x_0}}\right)$$

$$\Delta y = Be^{\beta x_0} \cdot \left(1 - e^{\beta \cdot \left(x_c - x_0\right)}\right)$$

$$\Delta y = Be^{\beta x_0} \cdot \left(1 - e^{-\beta \Delta x}\right)$$
$$\Delta y = y_0 \cdot \left(1 - e^{-\beta \Delta x}\right)$$

5B.2.2 Linear

The linear concentration-response function is: $y = \alpha + \beta x$

The derivation of the corresponding health impact function is as follows:

$$y = \alpha + \beta x$$
$$y_0 = \alpha + \beta x_0$$
$$y_c = \alpha + \beta x_c$$
$$\Delta y = y_0 - y_c = \beta x_0 - \beta x_c$$
$$\Delta y = \beta (x_0 - x_c) = \beta \Delta x$$

5B.2.3 Logistic

The logistic concentration-response function is: $y = \left(\frac{e^{\beta x}}{1 + e^{\beta x}} \right) = \frac{1}{1 + e^{-\beta x}}$

The derivation of the corresponding health impact function is as follows:

$$y = \frac{1}{1 + e^{-\beta x}}$$
$$odds = \frac{y}{1 - y} = \frac{\left(\frac{1}{1 + e^{-\beta x}} \right)}{1 - \left(\frac{1}{1 + e^{-\beta x}} \right)}$$
$$odds = \frac{\left(\frac{1}{1 + e^{-\beta x}} \right)}{\left(\frac{e^{-\beta x}}{1 + e^{-\beta x}} \right)} = \frac{1}{e^{-\beta x}} = e^{\beta x}$$
$$odds\ ratio = \frac{e^{\beta x_0}}{e^{\beta x_c}} = e^{\beta \Delta x}$$
$$\frac{\left(\frac{y_c}{1 - y_c} \right)}{\left(\frac{y_0}{1 - y_0} \right)} = e^{-\beta \Delta x}$$
$$\frac{y_c}{1 - y_c} = \left(\frac{y_0}{1 - y_0} \right) \cdot e^{-\beta \Delta x}$$
$$y_c = (1 - y_c) \cdot \left(\frac{y_0}{1 - y_0} \right) \cdot e^{-\beta \Delta x}$$

$$y_c + y_c \cdot \left(\frac{y_0}{1-y_0}\right) \cdot e^{-\beta\Delta x} = \left(\frac{y_0}{1-y_0}\right) \cdot e^{-\beta\Delta x}$$

$$y_c \cdot \left[1 + \left(\frac{y_0}{1-y_0}\right) \cdot e^{-\beta\Delta x}\right] = \left(\frac{y_0}{1-y_0}\right) \cdot e^{-\beta\Delta x}$$

$$y_c = \frac{\left(\frac{y_0}{1-y_0}\right) \cdot e^{-\beta\Delta x}}{1 + \left(\frac{y_0}{1-y_0}\right) \cdot e^{-\beta\Delta x}}$$

$$y_c = \frac{y_0 \cdot e^{-\beta\Delta x}}{1 - y_0 + y_0 \cdot e^{-\beta\Delta x}}$$

$$y_c = \frac{y_0}{(1-y_0) \cdot e^{\beta\Delta x} + y_0}$$

$$y_0 - y_c = y_0 - \frac{y_0}{(1-y_0) \cdot e^{\beta\Delta x} + y_0}$$

$$\Delta y = y_0 \cdot \left(1 - \frac{1}{(1-y_0) \cdot e^{\beta\Delta x} + y_0}\right)$$

5B.3 The Calculation of "Shrinkage" Estimates from the Location-Specific Estimates Reported in Huang et al. (2004)

"Shrinkage" estimates were calculated from the location-specific estimates reported in Table 1 of Huang et al. (2004), using the method described in DuMouchel (1994). Both Huang et al. (2004) and DuMouchel (1994) consider a Bayesian hierarchical model. Although they use different notation, the models are the same. The notation comparison is given in Table B-13 below.

Given a posterior distribution for τ, π(τ | y), a shrinkage estimate for the ith location is calculated as:

$$\theta_i^* \equiv E[\theta_i \,|\, y] = \int \theta_i^*(\tau)\pi(\tau \,|\, y)d\tau$$

where $\theta_i^*(\tau) \equiv E[\theta_i \,|\, y, \tau] = \mu^*(\tau) + [y_i - \mu^*(\tau)]\tau^2 / (\tau^2 + s_i^2)$,

where $\mu^*(\tau) \equiv E[\mu \,|\, y, \tau] = \sum_i w_i(\tau) y_i$,

where $w_i(\tau) = (\tau^2 + s_i^2)^{-1} / \sum_j (\tau^2 + s_j^2)^{-1}$.

A shrinkage estimate for the ith location is thus defined to be the expected value of the ith location-specific parameter, given all the location-specific estimates (see Table 1 for notation explanations). The posterior variance of the true ith location-specific parameter, given all the location-specific estimates, is given by:

$$\theta_i^{**} \equiv V[\theta_i \,|\, y] = \int \{V[\theta_i \,|\, y, \tau] + [\theta_i^*(\tau) - \theta_i^*]^2\} \pi(\tau \,|\, y)\, d\tau ,$$

where $V[\theta_i \,|\, y, \tau] = [s_i^2 / (\tau^2 + s_i^2)]^2 / \sum_j (\tau^2 + s_j^2)^{-1} + \tau^2 s_i^2 / (\tau^2 + s_i^2)$.

A 95 percent credible interval around the ith shrinkage estimate was calculated as $\theta_i^* \pm 1.96 * (\sqrt{\theta_i^{**}})$.

Table 5B-13. Notation

	Huang et al. (2004)	DuMouchel (1994)
Location indicator	c	i
parameter being estimated for location c (or i)	θ^c	θ_i
Estimate of parameter for location c (or i)*	$\hat{\theta}^c$	y_i
variance in the overall distribution of true θs.	τ^2	τ^2
variance of the estimate of θ^c or (θ_i)**	v^c	s_i^2
The mean of the overall distribution of true θs	μ	μ
The model:	$\hat{\theta}^c \sim N(\theta^c, v^c)$ (1) $\theta^c \sim N(\mu, \tau^2)$ (2) $(1) \& (2) \Rightarrow \hat{\theta}^c \sim N(\mu, v^c + \tau^2)$	$y_i = \mu + \delta_i + \varepsilon_i$ (1) $\theta_i = \mu + \delta_i$ (2) $\delta_i \sim N(0, \tau^2)$ (3) $\varepsilon_i \sim N(0, s_i^2)$ (4) $(2)\ and\ (3) \Rightarrow \theta_i \sim N(\mu, \tau^2)$ $(1),(2),(3) \& (4) \Rightarrow y_i \sim N(\mu, \tau^2 + s_i^2)$

*Given in Table 1 of Huang et al. (2004)

**Estimated by taking the square of the location-specific standard error, reported in Huang et al. (2004) for each location.

APPENDIX 5C. ADDITIONAL HEALTH RISK ASSESSMENT ESTIMATES

Table 5C-1. Number of Active Children (Ages 5-18) Engaged in Moderate Exercise Estimated to Experience At Least One Lung Function Response Associated with Exposure to O_3 Concentrations That Just Meet the Current and Alternative Daily Maximum 8-Hour Standards: Based on 2004 O_3 Concentrations*

Location	Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	Response = Decrease in FEV_1 Greater Than or Equal to 10%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	32 (9 - 57)	32 (9 - 56)	28 (7 - 51)	24 (5 - 45)	23 (5 - 43)	22 (5 - 42)	19 (4 - 37)	15 (2 - 31)
Boston-Worcester-Manchester__MA-NH	24 (5 - 46)	21 (4 - 42)	21 (4 - 41)	20 (4 - 39)	17 (3 - 34)	15 (2 - 32)	14 (2 - 30)	11 (1 - 24)
Chicago-Naperville-Michigan_City__IL-IN-WI	33 (5 - 65)	30 (5 - 61)	28 (4 - 58)	25 (3 - 53)	23 (3 - 48)	21 (2 - 46)	19 (2 - 42)	14 (1 - 32)
Cleveland-Akron-Elyria__OH	11 (2 - 22)	10 (2 - 20)	10 (2 - 20)	8 (1 - 17)	8 (1 - 16)	7 (1 - 15)	7 (1 - 15)	5 (1 - 12)
Detroit-Warren-Flint__MI	24 (5 - 46)	22 (4 - 43)	21 (4 - 41)	20 (4 - 40)	17 (3 - 34)	15 (2 - 32)	14 (2 - 30)	11 (1 - 24)
Houston-Baytown-Huntsville__TX	34 (10 - 58)	31 (8 - 54)	29 (8 - 52)	25 (6 - 45)	24 (5 - 43)	22 (5 - 40)	20 (4 - 38)	15 (2 - 30)
Los_Angeles-Long_Beach-Riverside__CA	62 (15 - 110)	58 (14 - 104)	51 (11 - 93)	38 (7 - 71)	37 (7 - 69)	34 (6 - 65)	29 (5 - 55)	14 (2 - 28)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	82 (16 - 160)	76 (14 - 151)	71 (12 - 142)	55 (7 - 116)	56 (8 - 119)	53 (7 - 113)	49 (6 - 105)	37 (3 - 84)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	32 (8 - 58)	29 (6 - 54)	28 (6 - 52)	23 (4 - 45)	22 (4 - 44)	20 (3 - 41)	19 (3 - 38)	15 (2 - 32)
Sacramento-Arden-Arcade-Truckee__CA-NV	6 (2 - 10)	6 (1 - 10)	5 (1 - 9)	4 (1 - 7)	4 (1 - 7)	4 (1 - 7)	3 (1 - 6)	2 (0 - 4)
St._Louis-St._Charles-Farmington__MO-IL	15 (3 - 28)	14 (3 - 26)	13 (3 - 25)	11 (2 - 22)	10 (2 - 21)	10 (1 - 19)	9 (1 - 18)	7 (1 - 15)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	44 (12 - 79)	39 (9 - 72)	39 (9 - 71)	33 (7 - 62)	31 (6 - 59)	28 (5 - 55)	26 (5 - 53)	20 (3 - 42)
	Response = Decrease in FEV_1 Greater Than or Equal to 15%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	9 (1 - 35)	9 (1 - 35)	7 (0 - 31)	5 (0 - 27)	5 (0 - 26)	4 (0 - 25)	3 (0 - 22)	2 (0 - 18)
Boston-Worcester-Manchester__MA-NH	5	4	4	4	2	2	2	1

Location	Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4* **	**0.084/3**	**0.080/4*******	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4*******	**0.064/4**
	(0 - 28)	(0 - 25)	(0 - 25)	(0 - 24)	(0 - 20)	(0 - 19)	(0 - 18)	(0 - 14)
Chicago-Naperville-Michigan_City__IL-IN-WI	5 (0 - 39)	4 (0 - 36)	4 (0 - 34)	3 (0 - 31)	2 (0 - 28)	2 (0 - 27)	2 (0 - 24)	1 (0 - 19)
Cleveland-Akron-Elyria__OH	2 (0 - 13)	2 (0 - 12)	2 (0 - 12)	1 (0 - 10)	1 (0 - 10)	1 (0 - 9)	1 (0 - 9)	0 (0 - 7)
Detroit-Warren-Flint__MI	5 (0 - 28)	4 (0 - 25)	4 (0 - 25)	3 (0 - 24)	2 (0 - 20)	2 (0 - 19)	2 (0 - 18)	1 (0 - 14)
Houston-Baytown-Huntsville__TX	10 (1 - 37)	8 (1 - 33)	8 (1 - 32)	5 (0 - 27)	5 (0 - 26)	4 (0 - 24)	4 (0 - 23)	2 (0 - 18)
Los_Angeles-Long_Beach-Riverside__CA	14 (0 - 67)	13 (0 - 63)	10 (0 - 56)	6 (0 - 42)	6 (0 - 41)	6 (0 - 39)	4 (0 - 32)	2 (0 - 17)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	15 (0 - 96)	13 (0 - 90)	11 (0 - 85)	6 (0 - 68)	7 (0 - 70)	6 (0 - 67)	5 (0 - 62)	3 (0 - 49)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	7 (0 - 35)	6 (0 - 33)	6 (0 - 32)	4 (0 - 27)	4 (0 - 26)	3 (0 - 24)	3 (0 - 23)	2 (0 - 19)
Sacramento-Arden-Arcade-Truckee__CA-NV	1 (0 - 6)	1 (0 - 6)	1 (0 - 5)	1 (0 - 4)	1 (0 - 4)	1 (0 - 4)	0 (0 - 3)	0 (0 - 2)
St._Louis-St._Charles-Farmington__MO-IL	3 (0 - 17)	3 (0 - 16)	2 (0 - 15)	2 (0 - 13)	2 (0 - 12)	1 (0 - 11)	1 (0 - 11)	1 (0 - 9)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	11 (1 - 49)	9 (1 - 44)	9 (1 - 43)	6 (0 - 38)	6 (0 - 35)	5 (0 - 33)	4 (0 - 31)	2 (0 - 25)
	Response = Decrease in FEV_1 Greater Than or Equal to 20%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	2 (0 - 23)	2 (0 - 22)	1 (0 - 20)	1 (0 - 18)	0 (0 - 16)	0 (0 - 16)	0 (0 - 14)	0 (0 - 12)
Boston-Worcester-Manchester__MA-NH	1 (0 - 17)	0 (0 - 16)	0 (0 - 15)	0 (0 - 15)	0 (0 - 13)	0 (0 - 12)	0 (0 - 11)	0 (0 - 9)
Chicago-Naperville-Michigan_City__IL-IN-WI	0 (0 - 24)	0 (0 - 23)	0 (0 - 22)	0 (0 - 19)	0 (0 - 18)	0 (0 - 17)	0 (0 - 15)	0 (0 - 11)
Cleveland-Akron-Elyria__OH	0 (0 - 8)	0 (0 - 8)	0 (0 - 7)	0 (0 - 6)	0 (0 - 6)	0 (0 - 6)	0 (0 - 5)	0 (0 - 4)
Detroit-Warren-Flint__MI	1 (0 - 18)	0 (0 - 16)	0 (0 - 16)	0 (0 - 15)	0 (0 - 13)	0 (0 - 12)	0 (0 - 11)	0 (0 - 9)
Houston-Baytown-Huntsville__TX	2	1	1	1	1	0	0	0

Location	Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	(0 - 24)	(0 - 22)	(0 - 21)	(0 - 18)	(0 - 17)	(0 - 16)	(0 - 15)	(0 - 11)
Los_Angeles-Long_Beach-Riverside__CA	1 (0 - 44)	1 (0 - 42)	1 (0 - 37)	0 (0 - 28)	0 (0 - 27)	0 (0 - 26)	0 (0 - 21)	0 (0 - 11)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	1 (0 - 60)	1 (0 - 57)	1 (0 - 53)	0 (0 - 42)	0 (0 - 43)	0 (0 - 41)	0 (0 - 38)	0 (0 - 29)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	1 (0 - 23)	1 (0 - 21)	1 (0 - 20)	0 (0 - 17)	0 (0 - 16)	0 (0 - 15)	0 (0 - 14)	0 (0 - 11)
Sacramento-Arden-Arcade-Truckee__CA-NV	0 (0 - 4)	0 (0 - 4)	0 (0 - 4)	0 (0 - 3)	0 (0 - 3)	0 (0 - 3)	0 (0 - 2)	0 (0 - 2)
St._Louis-St._Charles-Farmington__MO-IL	0 (0 - 11)	0 (0 - 10)	0 (0 - 10)	0 (0 - 8)	0 (0 - 8)	0 (0 - 7)	0 (0 - 7)	0 (0 - 5)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	2 (0 - 31)	1 (0 - 28)	1 (0 - 28)	1 (0 - 24)	1 (0 - 22)	0 (0 - 21)	0 (0 - 20)	0 (0 - 15)

*Numbers are median (0.5 fractile) numbers of children. Numbers in parentheses below the median are 95% confidence intervals based on statistical uncertainty surrounding the O3 coefficient.

**Incidence was quantified down to estimated policy relevant background levels. Incidences are rounded to the nearest 1000.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Table 5C-2. Percent of Active Children (Ages 5-18) Engaged in Moderate Exercise Estimated to Experience At Least One Lung Function Response Associated with Exposure to O_3 Concentrations That Just Meet the Current and Alternative Daily Maximum 8-Hour Standards: Based on 2004 O_3 Concentrations*

Location	Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	Response = Decrease in FEV_1 Greater Than or Equal to 10%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	7.2% (2% - 12.7%)	7.1% (1.9% - 12.5%)	6.3% (1.6% - 11.3%)	5.4% (1.2% - 10.1%)	5% (1.1% - 9.5%)	5% (1% - 9.4%)	4.3% (0.8% - 8.3%)	3.4% (0.5% - 6.9%)
Boston-Worcester-Manchester__MA-NH	5% (1.1% - 9.5%)	4.5% (0.9% - 8.7%)	4.4% (0.9% - 8.6%)	4.2% (0.8% - 8.2%)	3.5% (0.6% - 7.1%)	3.2% (0.5% - 6.6%)	3% (0.4% - 6.3%)	2.3% (0.2% - 5.1%)
Chicago-Naperville-Michigan_City__IL-IN-WI	3.7% (0.6% - 7.4%)	3.4% (0.5% - 7%)	3.2% (0.5% - 6.6%)	2.8% (0.4% - 6%)	2.6% (0.3% - 5.5%)	2.4% (0.3% - 5.2%)	2.1% (0.2% - 4.7%)	1.6% (0.1% - 3.7%)
Cleveland-Akron-Elyria__OH	4.5% (0.9% - 8.7%)	4.1% (0.7% - 8%)	3.9% (0.7% - 7.8%)	3.2% (0.5% - 6.7%)	3.1% (0.4% - 6.4%)	2.8% (0.4% - 6%)	2.7% (0.3% - 5.7%)	2.1% (0.2% - 4.6%)
Detroit-Warren-Flint__MI	4.9% (1% - 9.3%)	4.4% (0.8% - 8.5%)	4.2% (0.8% - 8.3%)	4% (0.7% - 8%)	3.3% (0.5% - 6.8%)	3% (0.4% - 6.3%)	2.9% (0.4% - 6.1%)	2.2% (0.2% - 4.8%)
Houston-Baytown-Huntsville__TX	6.9% (2% - 11.9%)	6.3% (1.7% - 11%)	6% (1.6% - 10.6%)	5% (1.2% - 9.2%)	4.8% (1.1% - 8.9%)	4.4% (0.9% - 8.3%)	4.1% (0.8% - 7.7%)	3.1% (0.5% - 6.1%)
Los_Angeles-Long_Beach-Riverside__CA	3.8% (0.9% - 6.8%)	3.6% (0.8% - 6.4%)	3.2% (0.7% - 5.7%)	2.4% (0.4% - 4.4%)	2.3% (0.4% - 4.3%)	2.1% (0.4% - 4%)	1.8% (0.3% - 3.4%)	0.9% (0.1% - 1.7%)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	4.5% (0.9% - 8.7%)	4.2% (0.8% - 8.2%)	3.9% (0.7% - 7.8%)	3% (0.4% - 6.3%)	3.1% (0.4% - 6.5%)	2.9% (0.4% - 6.2%)	2.6% (0.3% - 5.7%)	2% (0.2% - 4.6%)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	5.9% (1.4% - 10.9%)	5.4% (1.2% - 10.1%)	5.2% (1.1% - 9.8%)	4.3% (0.8% - 8.4%)	4.2% (0.7% - 8.2%)	3.8% (0.6% - 7.7%)	3.5% (0.5% - 7.1%)	2.8% (0.3% - 5.9%)
Sacramento-Arden-Arcade-Truckee__CA-NV	4% (1% - 6.9%)	3.7% (0.9% - 6.5%)	3.4% (0.8% - 6%)	2.7% (0.6% - 4.9%)	2.5% (0.5% - 4.6%)	2.3% (0.5% - 4.3%)	2% (0.4% - 3.7%)	1.4% (0.2% - 2.7%)
St._Louis-St._Charles-Farmington__MO-IL	5.4% (1.2% - 10%)	4.9% (1% - 9.4%)	4.7% (0.9% - 9%)	3.9% (0.7% - 7.7%)	3.7% (0.6% - 7.4%)	3.4% (0.5% - 6.9%)	3.1% (0.4% - 6.5%)	2.5% (0.3% - 5.3%)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	6.4% (1.7% - 11.5%)	5.7% (1.4% - 10.5%)	5.6% (1.3% - 10.4%)	4.8% (1% - 9.1%)	4.5% (0.9% - 8.7%)	4% (0.7% - 8%)	3.9% (0.7% - 7.7%)	2.9% (0.4% - 6.2%)
	Response = Decrease in FEV_1 Greater Than or Equal to 15%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	2% (0.2% - 7.9%)	1.9% (0.2% - 7.7%)	1.5% (0.1% - 7%)	1.2% (0.1% - 6.1%)	1% (0% - 5.7%)	1% (0% - 5.7%)	0.7% (0% - 5%)	0.4% (0% - 4.1%)

Location	Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
Boston-Worcester-Manchester__MA-NH	1.1% (0.1% - 5.8%)	0.8% (0% - 5.2%)	0.8% (0% - 5.1%)	0.7% (0% - 4.9%)	0.5% (0% - 4.2%)	0.4% (0% - 3.9%)	0.4% (0% - 3.7%)	0.2% (0% - 3%)
Chicago-Naperville-Michigan_City__IL-IN-WI	0.6% (0% - 4.4%)	0.5% (0% - 4.1%)	0.4% (0% - 3.9%)	0.3% (0% - 3.5%)	0.3% (0% - 3.2%)	0.2% (0% - 3.1%)	0.2% (0% - 2.8%)	0.1% (0% - 2.1%)
Cleveland-Akron-Elyria__OH	0.8% (0% - 5.2%)	0.7% (0% - 4.8%)	0.6% (0% - 4.6%)	0.4% (0% - 3.9%)	0.4% (0% - 3.8%)	0.3% (0% - 3.6%)	0.3% (0% - 3.4%)	0.2% (0% - 2.7%)
Detroit-Warren-Flint__MI	1% (0% - 5.6%)	0.8% (0% - 5.1%)	0.7% (0% - 4.9%)	0.7% (0% - 4.8%)	0.4% (0% - 4%)	0.4% (0% - 3.7%)	0.3% (0% - 3.6%)	0.2% (0% - 2.8%)
Houston-Baytown-Huntsville__TX	2% (0.2% - 7.5%)	1.7% (0.2% - 6.8%)	1.6% (0.1% - 6.6%)	1.1% (0.1% - 5.6%)	1% (0.1% - 5.4%)	0.9% (0% - 5%)	0.7% (0% - 4.6%)	0.4% (0% - 3.6%)
Los_Angeles-Long_Beach-Riverside__CA	0.9% (0% - 4.1%)	0.8% (0% - 3.9%)	0.6% (0% - 3.5%)	0.4% (0% - 2.6%)	0.4% (0% - 2.5%)	0.3% (0% - 2.4%)	0.3% (0% - 2%)	0.1% (0% - 1%)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	0.8% (0% - 5.2%)	0.7% (0% - 4.9%)	0.6% (0% - 4.6%)	0.3% (0% - 3.7%)	0.4% (0% - 3.8%)	0.3% (0% - 3.6%)	0.3% (0% - 3.4%)	0.1% (0% - 2.7%)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	1.4% (0.1% - 6.6%)	1.2% (0% - 6.1%)	1.1% (0% - 5.9%)	0.7% (0% - 5%)	0.7% (0% - 4.9%)	0.6% (0% - 4.5%)	0.5% (0% - 4.2%)	0.3% (0% - 3.5%)
Sacramento-Arden-Arcade-Truckee__CA-NV	1% (0% - 4.2%)	0.9% (0% - 3.9%)	0.8% (0% - 3.6%)	0.5% (0% - 2.9%)	0.5% (0% - 2.8%)	0.4% (0% - 2.6%)	0.3% (0% - 2.2%)	0.2% (0% - 1.6%)
St._Louis-St._Charles-Farmington__MO-IL	1.1% (0% - 6.1%)	1% (0% - 5.6%)	0.9% (0% - 5.4%)	0.6% (0% - 4.6%)	0.5% (0% - 4.4%)	0.5% (0% - 4.1%)	0.4% (0% - 3.8%)	0.2% (0% - 3.1%)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	1.7% (0.1% - 7.1%)	1.3% (0.1% - 6.4%)	1.3% (0.1% - 6.3%)	0.9% (0% - 5.5%)	0.8% (0% - 5.2%)	0.7% (0% - 4.8%)	0.6% (0% - 4.6%)	0.3% (0% - 3.6%)
	Response = Decrease in FEV_1 Greater Than or Equal to 20%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	0.4% (0% - 5.1%)	0.3% (0% - 5%)	0.2% (0% - 4.5%)	0.1% (0% - 3.9%)	0.1% (0% - 3.7%)	0.1% (0% - 3.6%)	0.1% (0% - 3.2%)	0% (0% - 2.6%)
Boston-Worcester-Manchester__MA-NH	0.1% (0% - 3.6%)	0.1% (0% - 3.3%)	0.1% (0% - 3.2%)	0.1% (0% - 3.1%)	0% (0% - 2.6%)	0% (0% - 2.4%)	0% (0% - 2.3%)	0% (0% - 1.8%)
Chicago-Naperville-Michigan_City__IL-IN-WI	0% (0% - 2.8%)	0% (0% - 2.6%)	0% (0% - 2.4%)	0% (0% - 2.2%)	0% (0% - 2%)	0% (0% - 1.9%)	0% (0% - 1.7%)	0% (0% - 1.3%)
Cleveland-Akron-Elyria__OH	0.1% (0% - 3.3%)	0.1% (0% - 3%)	0% (0% - 2.9%)	0% (0% - 2.4%)	0% (0% - 2.4%)	0% (0% - 2.2%)	0% (0% - 2.1%)	0% (0% - 1.6%)
Detroit-Warren-Flint__MI	0.1% (0% - 3.5%)	0.1% (0% - 3.2%)	0.1% (0% - 3.1%)	0.1% (0% - 3%)	0% (0% - 2.5%)	0% (0% - 2.3%)	0% (0% - 2.2%)	0% (0% - 1.7%)

Location	Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4* **	**0.084/3**	**0.080/4******	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4******	**0.064/4**
Houston-Baytown-Huntsville__TX	0.4% (0% - 4.8%)	0.3% (0% - 4.4%)	0.3% (0% - 4.3%)	0.1% (0% - 3.6%)	0.1% (0% - 3.5%)	0.1% (0% - 3.2%)	0.1% (0% - 3%)	0% (0% - 2.3%)
Los_Angeles-Long_Beach-Riverside__CA	0.1% (0% - 2.7%)	0.1% (0% - 2.6%)	0.1% (0% - 2.3%)	0% (0% - 1.7%)	0% (0% - 1.7%)	0% (0% - 1.6%)	0% (0% - 1.3%)	0% (0% - 0.7%)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	0.1% (0% - 3.3%)	0.1% (0% - 3.1%)	0% (0% - 2.9%)	0% (0% - 2.3%)	0% (0% - 2.4%)	0% (0% - 2.2%)	0% (0% - 2.1%)	0% (0% - 1.6%)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	0.2% (0% - 4.2%)	0.1% (0% - 3.9%)	0.1% (0% - 3.7%)	0.1% (0% - 3.2%)	0% (0% - 3.1%)	0% (0% - 2.9%)	0% (0% - 2.6%)	0% (0% - 2.1%)
Sacramento-Arden-Arcade-Truckee__CA-NV	0.1% (0% - 2.8%)	0.1% (0% - 2.6%)	0.1% (0% - 2.4%)	0% (0% - 1.9%)	0% (0% - 1.8%)	0% (0% - 1.7%)	0% (0% - 1.5%)	0% (0% - 1%)
St._Louis-St._Charles-Farmington__MO-IL	0.1% (0% - 3.9%)	0.1% (0% - 3.6%)	0.1% (0% - 3.4%)	0% (0% - 2.9%)	0% (0% - 2.8%)	0% (0% - 2.6%)	0% (0% - 2.4%)	0% (0% - 1.9%)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	0.3% (0% - 4.5%)	0.2% (0% - 4.1%)	0.2% (0% - 4%)	0.1% (0% - 3.5%)	0.1% (0% - 3.3%)	0.1% (0% - 3%)	0% (0% - 2.9%)	0% (0% - 2.3%)

*Numbers are median (0.5 fractile) percents of children. Numbers in parentheses below the median are 95% confidence intervals based on statistical uncertainty surrounding the O3 coefficient.

**Incidence was quantified down to estimated policy relevant background levels. Percents are rounded to the nearest tenth.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Table 5C-3. Number of Active Children (Ages 5-18) Engaged in Moderate Exercise Estimated to Experience At Least One Lung Function Response Associated with Exposure to O_3 Concentrations That Just Meet the Current and Alternative Daily Maximum 8-Hour Standards: April - September, Based on 2002 O_3 Concentrations*

Location	Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	Response = Decrease in FEV_1 Greater Than or Equal to 10%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	45 (16 - 74)	45 (15 - 73)	40 (13 - 67)	35 (10 - 60)	33 (9 - 57)	32 (9 - 57)	28 (7 - 50)	22 (5 - 42)
Boston-Worcester-Manchester__MA-NH	53 (20 - 84)	47 (17 - 76)	46 (16 - 76)	43 (15 - 72)	36 (11 - 63)	33 (9 - 58)	31 (9 - 56)	24 (5 - 46)
Chicago-Naperville-Michigan_City__IL-IN-WI	89 (32 - 145)	83 (28 - 137)	77 (25 - 129)	69 (21 - 118)	63 (18 - 109)	58 (16 - 104)	53 (13 - 97)	41 (8 - 78)
Cleveland-Akron-Elyria__OH	30 (12 - 48)	27 (10 - 44)	26 (9 - 43)	22 (7 - 38)	21 (7 - 36)	19 (5 - 33)	18 (5 - 32)	14 (3 - 27)
Detroit-Warren-Flint__MI	55 (21 - 89)	50 (17 - 81)	48 (17 - 80)	47 (16 - 78)	39 (11 - 67)	35 (10 - 62)	33 (9 - 59)	26 (6 - 48)
Houston-Baytown-Huntsville__TX	34 (10 - 57)	30 (8 - 53)	29 (8 - 51)	24 (6 - 44)	23 (5 - 42)	22 (5 - 40)	20 (4 - 37)	14 (2 - 28)
Los_Angeles-Long_Beach-Riverside__CA	63 (16 - 110)	61 (15 - 107)	53 (12 - 95)	38 (7 - 70)	37 (7 - 69)	36 (7 - 67)	29 (5 - 55)	15 (2 - 29)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	178 (60 - 296)	167 (54 - 280)	156 (48 - 267)	123 (32 - 221)	127 (34 - 227)	120 (31 - 216)	110 (26 - 202)	85 (17 - 165)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	70 (28 - 108)	63 (24 - 101)	61 (23 - 98)	51 (17 - 85)	49 (16 - 82)	45 (14 - 77)	43 (12 - 74)	33 (8 - 61)
Sacramento-Arden-Arcade-Truckee__CA-NV	11 (4 - 17)	10 (3 - 16)	9 (3 - 15)	8 (2 - 13)	7 (2 - 12)	7 (2 - 12)	6 (2 - 11)	4 (1 - 8)
St._Louis-St._Charles-Farmington__MO-IL	36 (15 - 55)	33 (13 - 52)	31 (12 - 50)	27 (9 - 44)	25 (8 - 42)	23 (7 - 39)	21 (6 - 37)	17 (4 - 30)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	82 (31 - 130)	72 (25 - 118)	72 (25 - 117)	63 (20 - 106)	58 (18 - 100)	52 (15 - 91)	50 (14 - 88)	40 (9 - 73)
	Response = Decrease in FEV_1 Greater Than or Equal to 15%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	16	16	13	10	9	9	7	4

Location	Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
	(3 - 49)	(3 - 48)	(2 - 43)	(1 - 38)	(1 - 35)	(1 - 35)	(0 - 31)	(0 - 25)
Boston-Worcester-Manchester__MA-NH	21 (5 - 57)	17 (4 - 51)	17 (3 - 50)	15 (3 - 47)	11 (2 - 40)	9 (1 - 37)	9 (1 - 35)	5 (0 - 28)
Chicago-Naperville-Michigan_City__IL-IN-WI	33 (6 - 95)	29 (5 - 89)	25 (3 - 83)	21 (2 - 75)	17 (2 - 68)	15 (1 - 64)	13 (1 - 59)	8 (0 - 47)
Cleveland-Akron-Elyria__OH	12 (3 - 32)	10 (2 - 29)	10 (2 - 28)	7 (1 - 24)	7 (1 - 23)	5 (0 - 21)	5 (0 - 20)	3 (0 - 16)
Detroit-Warren-Flint__MI	21 (4 - 59)	18 (3 - 53)	17 (3 - 52)	16 (2 - 50)	11 (1 - 42)	9 (1 - 38)	9 (1 - 36)	5 (0 - 29)
Houston-Baytown-Huntsville__TX	10 (1 - 36)	8 (1 - 33)	8 (1 - 32)	6 (0 - 27)	5 (0 - 26)	5 (0 - 24)	4 (0 - 22)	2 (0 - 17)
Los_Angeles-Long_Beach-Riverside__CA	15 (1 - 67)	15 (1 - 65)	12 (0 - 57)	7 (0 - 42)	7 (0 - 41)	6 (0 - 40)	5 (0 - 32)	2 (0 - 17)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	62 (10 - 192)	55 (8 - 180)	49 (6 - 169)	32 (2 - 136)	34 (3 - 141)	30 (2 - 133)	25 (1 - 123)	15 (0 - 99)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	29 (7 - 74)	25 (5 - 68)	23 (4 - 65)	17 (2 - 55)	16 (2 - 53)	14 (2 - 49)	12 (1 - 46)	8 (0 - 37)
Sacramento-Arden-Arcade-Truckee__CA-NV	4 (0 - 11)	3 (0 - 10)	3 (0 - 10)	2 (0 - 8)	2 (0 - 8)	2 (0 - 7)	1 (0 - 6)	1 (0 - 5)
St._Louis-St._Charles-Farmington__MO-IL	15 (4 - 38)	13 (3 - 35)	12 (2 - 33)	9 (1 - 29)	8 (1 - 27)	7 (1 - 25)	6 (1 - 23)	4 (0 - 18)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	33 (7 - 88)	26 (5 - 77)	26 (4 - 77)	21 (3 - 68)	18 (2 - 63)	15 (1 - 57)	14 (1 - 55)	9 (0 - 44)
	Response = Decrease in FEV_1 Greater Than or Equal to 20%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	4 (0 - 31)	4 (0 - 31)	3 (0 - 27)	2 (0 - 24)	2 (0 - 23)	2 (0 - 23)	1 (0 - 20)	0 (0 - 16)
Boston-Worcester-Manchester__MA-NH	7 (1 - 36)	5 (1 - 32)	5 (1 - 32)	4 (0 - 30)	3 (0 - 25)	2 (0 - 23)	2 (0 - 22)	1 (0 - 17)
Chicago-Naperville-Michigan_City__IL-IN-WI	9 (1 - 61)	8 (0 - 57)	6 (0 - 53)	4 (0 - 48)	3 (0 - 44)	3 (0 - 41)	2 (0 - 38)	1 (0 - 30)
Cleveland-Akron-Elyria__OH	4	3	3	2	2	1	1	0

Location	Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4* **	**0.084/3**	**0.080/4*******	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4*******	**0.064/4**
	(0 - 21)	(0 - 18)	(0 - 18)	(0 - 15)	(0 - 15)	(0 - 13)	(0 - 12)	(0 - 10)
Detroit-Warren-Flint__MI	6 (0 - 38)	5 (0 - 34)	4 (0 - 33)	4 (0 - 32)	2 (0 - 27)	2 (0 - 24)	1 (0 - 23)	1 (0 - 18)
Houston-Baytown-Huntsville__TX	2 (0 - 23)	2 (0 - 21)	1 (0 - 20)	1 (0 - 17)	1 (0 - 17)	1 (0 - 16)	0 (0 - 14)	0 (0 - 11)
Los_Angeles-Long_Beach-Riverside__CA	2 (0 - 45)	2 (0 - 43)	1 (0 - 38)	0 (0 - 28)	0 (0 - 27)	0 (0 - 26)	0 (0 - 21)	0 (0 - 11)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	16 (1 - 122)	13 (1 - 115)	11 (0 - 108)	5 (0 - 87)	6 (0 - 89)	5 (0 - 85)	4 (0 - 78)	1 (0 - 62)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	10 (1 - 47)	8 (1 - 43)	7 (1 - 42)	4 (0 - 35)	4 (0 - 34)	3 (0 - 31)	2 (0 - 30)	1 (0 - 24)
Sacramento-Arden-Arcade-Truckee__CA-NV	1 (0 - 7)	1 (0 - 7)	1 (0 - 6)	0 (0 - 5)	0 (0 - 5)	0 (0 - 5)	0 (0 - 4)	0 (0 - 3)
St._Louis-St._Charles-Farmington__MO-IL	5 (1 - 24)	4 (0 - 22)	4 (0 - 21)	2 (0 - 18)	2 (0 - 17)	2 (0 - 16)	1 (0 - 15)	1 (0 - 12)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	10 (1 - 56)	7 (0 - 49)	7 (0 - 49)	5 (0 - 43)	4 (0 - 40)	3 (0 - 36)	2 (0 - 35)	1 (0 - 28)

*Numbers are median (0.5 fractile) numbers of children. Numbers in parentheses below the median are 95% confidence intervals based on statistical uncertainty surrounding the O3 coefficient.

**Incidence was quantified down to estimated policy relevant background levels. Incidences are rounded to the nearest 1000.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Table 5C-4. Percent of Active Children (Ages 5-18) Engaged in Moderate Exercise Estimated to Experience At Least One Lung Function Response Associated with Exposure to O_3 Concentrations That Just Meet the Current and Alternative Daily Maximum 8-Hour Standards: Based on 2002 O_3 Concentrations*

Location	Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	Response = Decrease in FEV_1 Greater Than or Equal to 10%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	10.2% (3.5% - 16.6%)	10% (3.4% - 16.4%)	8.9% (2.8% - 14.9%)	7.8% (2.3% - 13.5%)	7.3% (2% - 12.8%)	7.3% (2% - 12.7%)	6.2% (1.5% - 11.3%)	5% (1% - 9.4%)
Boston-Worcester-Manchester__MA-NH	11.1% (4.3% - 17.7%)	9.8% (3.5% - 16.1%)	9.7% (3.4% - 16%)	9.1% (3.1% - 15.2%)	7.7% (2.3% - 13.3%)	7% (2% - 12.3%)	6.6% (1.8% - 11.8%)	5.1% (1.1% - 9.6%)
Chicago-Naperville-Michigan_City__IL-IN-WI	10.5% (3.7% - 17%)	9.7% (3.3% - 16.1%)	9.1% (2.9% - 15.2%)	8.1% (2.4% - 13.9%)	7.4% (2.1% - 12.9%)	6.9% (1.8% - 12.2%)	6.3% (1.6% - 11.4%)	4.8% (1% - 9.2%)
Cleveland-Akron-Elyria__OH	12.4% (4.8% - 19.6%)	11.1% (4% - 17.9%)	10.7% (3.8% - 17.5%)	9.2% (3% - 15.5%)	8.8% (2.8% - 14.9%)	7.8% (2.2% - 13.6%)	7.4% (2% - 13%)	5.9% (1.4% - 10.9%)
Detroit-Warren-Flint__MI	11.6% (4.3% - 18.5%)	10.4% (3.6% - 17%)	10.1% (3.5% - 16.6%)	9.8% (3.3% - 16.2%)	8% (2.4% - 13.9%)	7.3% (2% - 12.8%)	6.9% (1.8% - 12.4%)	5.3% (1.2% - 10.1%)
Houston-Baytown-Huntsville__TX	7.1% (2.1% - 12%)	6.4% (1.8% - 11%)	6.1% (1.6% - 10.7%)	5.1% (1.2% - 9.2%)	4.9% (1.1% - 8.9%)	4.5% (1% - 8.4%)	4.1% (0.9% - 7.8%)	3% (0.5% - 6%)
Los_Angeles-Long_Beach-Riverside__CA	3.9% (1% - 6.8%)	3.8% (0.9% - 6.6%)	3.3% (0.8% - 5.8%)	2.3% (0.5% - 4.3%)	2.3% (0.5% - 4.2%)	2.2% (0.4% - 4.1%)	1.8% (0.3% - 3.3%)	0.9% (0.2% - 1.8%)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	9.9% (3.3% - 16.3%)	9.2% (3% - 15.5%)	8.6% (2.7% - 14.7%)	6.8% (1.8% - 12.2%)	7% (1.9% - 12.5%)	6.6% (1.7% - 12%)	6.1% (1.5% - 11.2%)	4.7% (0.9% - 9.1%)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	13.1% (5.2% - 20.4%)	11.9% (4.5% - 18.9%)	11.5% (4.2% - 18.4%)	9.6% (3.2% - 16%)	9.2% (3% - 15.5%)	8.5% (2.6% - 14.5%)	8% (2.3% - 13.9%)	6.3% (1.5% - 11.4%)
Sacramento-Arden-Arcade-Truckee__CA-NV	7.2% (2.4% - 11.5%)	6.6% (2.1% - 10.7%)	6.1% (1.9% - 10.1%)	5% (1.4% - 8.5%)	4.8% (1.3% - 8.2%)	4.5% (1.2% - 7.7%)	4% (1% - 7%)	2.9% (0.6% - 5.3%)
St._Louis-St._Charles-Farmington__MO-IL	13.4% (5.4% - 20.7%)	12.3% (4.8% - 19.4%)	11.6% (4.4% - 18.5%)	10% (3.4% - 16.4%)	9.4% (3.1% - 15.6%)	8.6% (2.7% - 14.6%)	8% (2.4% - 13.7%)	6.2% (1.5% - 11.2%)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	12.1% (4.6% - 19.1%)	10.6% (3.7% - 17.3%)	10.5% (3.7% - 17.2%)	9.2% (3% - 15.5%)	8.6% (2.6% - 14.6%)	7.7% (2.2% - 13.4%)	7.4% (2% - 13%)	5.8% (1.3% - 10.7%)
	Response = Decrease in FEV_1 Greater Than or Equal to 15%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	3.6% (0.6% - 10.9%)	3.5% (0.6% - 10.7%)	2.8% (0.4% - 9.5%)	2.3% (0.2% - 8.5%)	2% (0.2% - 7.9%)	2% (0.2% - 7.9%)	1.5% (0.1% - 6.9%)	1% (0% - 5.6%)

Location	Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4* **	**0.084/3**	**0.080/4*******	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4*******	**0.064/4**
Boston-Worcester-Manchester__MA-NH	4.5% (1.1% - 12%)	3.6% (0.8% - 10.6%)	3.6% (0.7% - 10.5%)	3.2% (0.6% - 9.9%)	2.4% (0.3% - 8.4%)	2% (0.2% - 7.7%)	1.8% (0.2% - 7.4%)	1.1% (0.1% - 5.8%)
Chicago-Naperville-Michigan_City__IL-IN-WI	3.9% (0.7% - 11.2%)	3.4% (0.5% - 10.4%)	3% (0.4% - 9.8%)	2.4% (0.3% - 8.8%)	2.1% (0.2% - 8%)	1.8% (0.1% - 7.5%)	1.5% (0.1% - 7%)	0.9% (0% - 5.5%)
Cleveland-Akron-Elyria__OH	5.1% (1.1% - 13.3%)	4.2% (0.7% - 11.8%)	3.9% (0.7% - 11.5%)	3% (0.4% - 9.9%)	2.8% (0.3% - 9.5%)	2.2% (0.2% - 8.5%)	2% (0.2% - 8.1%)	1.3% (0.1% - 6.6%)
Detroit-Warren-Flint__MI	4.5% (0.8% - 12.3%)	3.7% (0.6% - 11.1%)	3.5% (0.5% - 10.8%)	3.4% (0.5% - 10.5%)	2.4% (0.2% - 8.7%)	2% (0.1% - 8%)	1.8% (0.1% - 7.6%)	1.1% (0% - 6.1%)
Houston-Baytown-Huntsville__TX	2.1% (0.3% - 7.6%)	1.8% (0.2% - 6.9%)	1.6% (0.1% - 6.6%)	1.2% (0.1% - 5.6%)	1.1% (0.1% - 5.4%)	0.9% (0% - 5.1%)	0.8% (0% - 4.7%)	0.4% (0% - 3.5%)
Los_Angeles-Long_Beach-Riverside__CA	0.9% (0% - 4.1%)	0.9% (0% - 4%)	0.7% (0% - 3.5%)	0.4% (0% - 2.6%)	0.4% (0% - 2.5%)	0.4% (0% - 2.4%)	0.3% (0% - 2%)	0.1% (0% - 1.1%)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	3.4% (0.6% - 10.6%)	3% (0.4% - 10%)	2.7% (0.3% - 9.4%)	1.8% (0.1% - 7.5%)	1.9% (0.2% - 7.8%)	1.7% (0.1% - 7.4%)	1.4% (0.1% - 6.8%)	0.9% (0% - 5.5%)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	5.5% (1.3% - 13.9%)	4.7% (0.9% - 12.7%)	4.4% (0.8% - 12.2%)	3.3% (0.5% - 10.3%)	3% (0.4% - 9.9%)	2.6% (0.3% - 9.2%)	2.3% (0.2% - 8.7%)	1.5% (0.1% - 7%)
Sacramento-Arden-Arcade-Truckee__CA-NV	2.5% (0.3% - 7.4%)	2.1% (0.2% - 6.8%)	1.9% (0.2% - 6.4%)	1.4% (0.1% - 5.3%)	1.3% (0.1% - 5%)	1.2% (0.1% - 4.7%)	1% (0% - 4.3%)	0.6% (0% - 3.2%)
St._Louis-St._Charles-Farmington__MO-IL	5.8% (1.4% - 14.2%)	5% (1.1% - 13.1%)	4.6% (0.9% - 12.4%)	3.5% (0.5% - 10.7%)	3.1% (0.4% - 10%)	2.7% (0.3% - 9.3%)	2.4% (0.2% - 8.6%)	1.5% (0.1% - 6.8%)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	4.8% (1% - 12.8%)	3.8% (0.7% - 11.3%)	3.8% (0.6% - 11.3%)	3% (0.4% - 10%)	2.6% (0.3% - 9.3%)	2.2% (0.2% - 8.4%)	2% (0.2% - 8.1%)	1.3% (0.1% - 6.5%)
	Response = Decrease in FEV_1 Greater Than or Equal to 20%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	1% (0.1% - 7%)	0.9% (0.1% - 6.8%)	0.7% (0% - 6.1%)	0.5% (0% - 5.4%)	0.4% (0% - 5.1%)	0.4% (0% - 5.1%)	0.2% (0% - 4.4%)	0.1% (0% - 3.6%)
Boston-Worcester-Manchester__MA-NH	1.5% (0.2% - 7.6%)	1.1% (0.1% - 6.8%)	1.1% (0.1% - 6.7%)	0.9% (0.1% - 6.3%)	0.6% (0% - 5.3%)	0.4% (0% - 4.9%)	0.4% (0% - 4.6%)	0.1% (0% - 3.6%)
Chicago-Naperville-Michigan_City__IL-IN-WI	1.1% (0.1% - 7.2%)	0.9% (0% - 6.7%)	0.7% (0% - 6.2%)	0.5% (0% - 5.6%)	0.4% (0% - 5.1%)	0.3% (0% - 4.8%)	0.2% (0% - 4.4%)	0.1% (0% - 3.5%)
Cleveland-Akron-Elyria__OH	1.6% (0.1% - 8.4%)	1.2% (0.1% - 7.5%)	1.1% (0.1% - 7.3%)	0.7% (0% - 6.3%)	0.6% (0% - 6%)	0.4% (0% - 5.4%)	0.4% (0% - 5.1%)	0.2% (0% - 4.2%)
Detroit-Warren-Flint__MI	1.3% (0.1% - 7.8%)	1% (0% - 7.1%)	0.9% (0% - 6.9%)	0.8% (0% - 6.7%)	0.5% (0% - 5.6%)	0.3% (0% - 5.1%)	0.3% (0% - 4.8%)	0.1% (0% - 3.8%)

Location	Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Houston-Baytown-Huntsville__TX	0.5% (0% - 4.9%)	0.3% (0% - 4.5%)	0.3% (0% - 4.3%)	0.2% (0% - 3.6%)	0.1% (0% - 3.5%)	0.1% (0% - 3.3%)	0.1% (0% - 3%)	0% (0% - 2.3%)
Los_Angeles-Long_Beach-Riverside__CA	0.1% (0% - 2.7%)	0.1% (0% - 2.7%)	0.1% (0% - 2.3%)	0% (0% - 1.7%)	0% (0% - 1.7%)	0% (0% - 1.6%)	0% (0% - 1.3%)	0% (0% - 0.7%)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	0.9% (0.1% - 6.8%)	0.7% (0% - 6.3%)	0.6% (0% - 6%)	0.3% (0% - 4.8%)	0.3% (0% - 4.9%)	0.3% (0% - 4.7%)	0.2% (0% - 4.3%)	0.1% (0% - 3.5%)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	1.8% (0.2% - 8.9%)	1.4% (0.1% - 8.1%)	1.3% (0.1% - 7.8%)	0.8% (0% - 6.6%)	0.7% (0% - 6.3%)	0.6% (0% - 5.8%)	0.5% (0% - 5.6%)	0.2% (0% - 4.5%)
Sacramento-Arden-Arcade-Truckee__CA-NV	0.5% (0% - 4.8%)	0.4% (0% - 4.4%)	0.4% (0% - 4.2%)	0.2% (0% - 3.5%)	0.2% (0% - 3.3%)	0.1% (0% - 3.1%)	0.1% (0% - 2.8%)	0% (0% - 2.1%)
St._Louis-St._Charles-Farmington__MO-IL	1.9% (0.2% - 9.1%)	1.6% (0.1% - 8.4%)	1.4% (0.1% - 7.9%)	0.9% (0% - 6.8%)	0.8% (0% - 6.4%)	0.6% (0% - 5.9%)	0.5% (0% - 5.5%)	0.2% (0% - 4.4%)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	1.5% (0.1% - 8.2%)	1.1% (0.1% - 7.2%)	1% (0.1% - 7.2%)	0.7% (0% - 6.3%)	0.6% (0% - 5.9%)	0.4% (0% - 5.3%)	0.4% (0% - 5.1%)	0.2% (0% - 4.1%)

*Numbers are median (0.5 fractile) percents of children. Numbers in parentheses below the median are 95% confidence intervals based on statistical uncertainty surrounding the O_3 coefficient.

**Incidence was quantified down to estimated policy relevant background levels. Percents are rounded to the nearest tenth.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Table 5C-5. Estimated Number of Occurrences of Lung Function Response Associated with Exposure to O_3 Concentrations That Just Meet the Current and Alternative Daily Maximum 8-Hour Standards Among Active Children (Ages 5-18) Engaged in Moderate Exercise: April - September, Based on 2004 O_3 Concentrations*

Location	Number of Occurrences (in 1000s) of Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	Response = Decrease in FEV_1 Greater Than or Equal to 10%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	333 (31 - 1143)	327 (29 - 1129)	298 (24 - 1058)	264 (18 - 974)	248 (16 - 932)	245 (16 - 925)	219 (12 - 852)	179 (8 - 737)
Boston-Worcester-Manchester__MA-NH	205 (15 - 767)	186 (12 - 716)	184 (11 - 711)	176 (10 - 691)	154 (8 - 629)	142 (6 - 594)	135 (6 - 576)	110 (3 - 497)
Chicago-Naperville-Michigan_City__IL-IN-WI	319 (16 - 1181)	297 (14 - 1120)	281 (12 - 1072)	252 (10 - 988)	229 (8 - 916)	214 (7 - 869)	195 (6 - 808)	151 (3 - 654)
Cleveland-Akron-Elyria__OH	115 (7 - 420)	106 (6 - 396)	103 (6 - 386)	88 (4 - 346)	85 (4 - 336)	79 (3 - 319)	74 (3 - 304)	60 (2 - 256)
Detroit-Warren-Flint__MI	219 (14 - 805)	201 (12 - 756)	195 (11 - 742)	189 (10 - 724)	162 (7 - 650)	150 (6 - 613)	142 (5 - 589)	113 (3 - 497)
Houston-Baytown-Huntsville__TX	266 (31 - 602)	242 (26 - 542)	233 (24 - 519)	194 (18 - 413)	187 (17 - 395)	170 (14 - 346)	155 (12 - 297)	99 (7 - 85)
Los_Angeles-Long_Beach-Riverside__CA	1106 (73 - 3598)	1058 (67 - 3472)	966 (56 - 3213)	729 (35 - 2455)	700 (33 - 2357)	646 (29 - 2168)	521 (21 - 1712)	279 (9 - 731)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	795 (48 - 2939)	754 (42 - 2833)	710 (36 - 2717)	582 (22 - 2363)	596 (24 - 2405)	570 (21 - 2326)	526 (18 - 2195)	412 (10 - 1813)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	331 (27 - 1085)	307 (23 - 1028)	296 (21 - 1002)	254 (15 - 899)	248 (14 - 881)	232 (12 - 841)	218 (10 - 802)	178 (6 - 687)
Sacramento-Arden-Arcade-Truckee__CA-NV	94 (7 - 315)	88 (6 - 300)	82 (5 - 283)	69 (4 - 248)	66 (3 - 238)	62 (3 - 228)	56 (2 - 208)	41 (1 - 160)
St._Louis-St._Charles-Farmington__MO-IL	150 (12 - 507)	139 (10 - 478)	132 (9 - 461)	113 (6 - 409)	108 (6 - 395)	100 (5 - 373)	92 (4 - 351)	72 (3 - 288)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	394 (34 - 1374)	356 (27 - 1281)	353 (27 - 1274)	313 (20 - 1173)	295 (18 - 1124)	269 (15 - 1054)	260 (13 - 1028)	210 (8 - 881)
	Response = Decrease in FEV_1 Greater Than or Equal to 15%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	27	26	20	15	13	13	9	6

Location	Number of Occurrences (in 1000s) of Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	(1 - 592)	(1 - 584)	(1 - 544)	(0 - 497)	(0 - 473)	(0 - 469)	(0 - 430)	(0 - 368)
Boston-Worcester-Manchester__MA-NH	12 (0 - 391)	10 (0 - 363)	9 (0 - 360)	8 (0 - 349)	6 (0 - 315)	5 (0 - 297)	4 (0 - 286)	2 (0 - 244)
Chicago-Naperville-Michigan_City__IL-IN-WI	13 (0 - 615)	11 (0 - 581)	9 (0 - 555)	7 (0 - 510)	5 (0 - 471)	5 (0 - 446)	4 (0 - 413)	2 (0 - 333)
Cleveland-Akron-Elyria__OH	6 (0 - 218)	5 (0 - 205)	4 (0 - 200)	3 (0 - 178)	3 (0 - 172)	2 (0 - 163)	2 (0 - 155)	1 (0 - 130)
Detroit-Warren-Flint__MI	12 (0 - 416)	10 (0 - 389)	9 (0 - 381)	8 (0 - 371)	5 (0 - 330)	4 (0 - 310)	4 (0 - 297)	2 (0 - 249)
Houston-Baytown-Huntsville__TX	27 (1 - 374)	22 (1 - 341)	21 (1 - 328)	15 (0 - 271)	14 (0 - 260)	11 (0 - 235)	10 (0 - 210)	5 (0 - 106)
Los_Angeles-Long_Beach-Riverside__CA	58 (1 - 1948)	53 (1 - 1878)	43 (0 - 1738)	26 (0 - 1340)	24 (0 - 1290)	21 (0 - 1192)	15 (0 - 962)	5 (0 - 479)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	38 (1 - 1521)	33 (0 - 1461)	28 (0 - 1397)	16 (0 - 1202)	17 (0 - 1225)	15 (0 - 1183)	12 (0 - 1112)	6 (0 - 910)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	23 (1 - 581)	19 (0 - 548)	17 (0 - 533)	12 (0 - 475)	11 (0 - 465)	9 (0 - 443)	8 (0 - 422)	4 (0 - 359)
Sacramento-Arden-Arcade-Truckee__CA-NV	5 (0 - 166)	5 (0 - 158)	4 (0 - 149)	3 (0 - 130)	3 (0 - 124)	2 (0 - 119)	2 (0 - 108)	1 (0 - 83)
St._Louis-St._Charles-Farmington__MO-IL	10 (0 - 267)	8 (0 - 251)	7 (0 - 241)	5 (0 - 212)	4 (0 - 205)	4 (0 - 193)	3 (0 - 181)	2 (0 - 148)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	29 (1 - 711)	23 (1 - 659)	23 (1 - 654)	17 (0 - 598)	14 (0 - 571)	11 (0 - 533)	10 (0 - 519)	6 (0 - 440)
	Response = Decrease in FEV_1 Greater Than or Equal to 20%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	2 (0 - 244)	2 (0 - 240)	2 (0 - 218)	1 (0 - 194)	1 (0 - 182)	1 (0 - 180)	0 (0 - 160)	0 (0 - 131)
Boston-Worcester-Manchester__MA-NH	1 (0 - 149)	1 (0 - 135)	1 (0 - 134)	0 (0 - 128)	0 (0 - 111)	0 (0 - 103)	0 (0 - 98)	0 (0 - 79)
Chicago-Naperville-Michigan_City__IL-IN-WI	0 (0 - 235)	0 (0 - 219)	0 (0 - 206)	0 (0 - 185)	0 (0 - 167)	0 (0 - 156)	0 (0 - 142)	0 (0 - 109)
Cleveland-Akron-Elyria__OH	0 (0 - 84)	0 (0 - 78)	0 (0 - 75)	0 (0 - 65)	0 (0 - 62)	0 (0 - 58)	0 (0 - 54)	0 (0 - 43)

Location	Number of Occurrences (in 1000s) of Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
Detroit-Warren-Flint__MI	1 (0 - 160)	0 (0 - 147)	0 (0 - 143)	0 (0 - 138)	0 (0 - 118)	0 (0 - 109)	0 (0 - 103)	0 (0 - 81)
Houston-Baytown-Huntsville__TX	3 (0 - 202)	2 (0 - 185)	2 (0 - 178)	1 (0 - 150)	1 (0 - 145)	1 (0 - 133)	0 (0 - 122)	0 (0 - 80)
Los_Angeles-Long_Beach-Riverside__CA	2 (0 - 826)	2 (0 - 791)	1 (0 - 723)	0 (0 - 545)	0 (0 - 524)	0 (0 - 483)	0 (0 - 390)	0 (0 - 213)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	2 (0 - 583)	1 (0 - 553)	1 (0 - 520)	0 (0 - 424)	0 (0 - 435)	0 (0 - 415)	0 (0 - 382)	0 (0 - 296)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	2 (0 - 244)	1 (0 - 227)	1 (0 - 219)	0 (0 - 188)	0 (0 - 183)	0 (0 - 172)	0 (0 - 161)	0 (0 - 130)
Sacramento-Arden-Arcade-Truckee__CA-NV	0 (0 - 70)	0 (0 - 66)	0 (0 - 61)	0 (0 - 51)	0 (0 - 49)	0 (0 - 46)	0 (0 - 41)	0 (0 - 30)
St._Louis-St._Charles-Farmington__MO-IL	1 (0 - 111)	0 (0 - 103)	0 (0 - 98)	0 (0 - 83)	0 (0 - 80)	0 (0 - 74)	0 (0 - 68)	0 (0 - 53)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	3 (0 - 288)	2 (0 - 261)	2 (0 - 258)	1 (0 - 229)	1 (0 - 215)	0 (0 - 196)	0 (0 - 190)	0 (0 - 152)

*Numbers are median (0.5 fractile) numbers of occurrences. Numbers in parentheses below the median are 95% confidence intervals based on statistical uncertainty surrounding the O_3 coefficient.

**Incidence was quantified down to estimated policy relevant background levels. Incidences are rounded to the nearest 1000.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Table 5C-6. Estimated Number of Occurrences of Lung Function Response Associated with Exposure to O_3 Concentrations That Just Meet the Current and Alternative Daily Maximum 8-Hour Standards Among Active Children (Ages 5-18) Engaged in Moderate Exercise: April - September, Based on 2002 O_3 Concentrations*

Location	Number of Occurrences (in 1000s) of Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	Response = Decrease in FEV_1 Greater Than or Equal to 10%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	404 (55 - 1203)	399 (53 - 1192)	362 (44 - 1116)	327 (35 - 1037)	306 (31 - 992)	305 (31 - 989)	271 (24 - 909)	224 (16 - 792)
Boston-Worcester-Manchester__MA-NH	378 (57 - 1146)	344 (47 - 1079)	340 (46 - 1072)	326 (42 - 1044)	289 (32 - 966)	268 (27 - 921)	258 (24 - 899)	215 (16 - 798)
Chicago-Naperville-Michigan_City__IL-IN-WI	662 (97 - 1881)	623 (85 - 1802)	592 (77 - 1742)	542 (64 - 1638)	498 (53 - 1545)	474 (48 - 1493)	441 (41 - 1418)	361 (26 - 1234)
Cleveland-Akron-Elyria__OH	254 (42 - 712)	233 (35 - 673)	228 (33 - 664)	200 (25 - 609)	193 (24 - 595)	178 (20 - 565)	171 (18 - 550)	142 (12 - 486)
Detroit-Warren-Flint__MI	433 (69 - 1227)	396 (57 - 1155)	387 (55 - 1140)	378 (52 - 1121)	325 (38 - 1014)	298 (31 - 959)	287 (29 - 934)	235 (18 - 819)
Houston-Baytown-Huntsville__TX	227 (28 - 475)	207 (23 - 423)	199 (22 - 402)	165 (16 - 310)	158 (15 - 291)	145 (13 - 252)	130 (11 - 201)	79 (6 - 3)
Los_Angeles-Long_Beach-Riverside__CA	997 (70 - 3105)	966 (67 - 3020)	856 (54 - 2685)	609 (32 - 1862)	601 (31 - 1830)	571 (29 - 1721)	436 (20 - 1207)	218 (9 - 281)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	1587 (212 - 4682)	1506 (189 - 4524)	1435 (170 - 4384)	1197 (114 - 3888)	1228 (120 - 3957)	1173 (108 - 3839)	1099 (93 - 3677)	894 (59 - 3183)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	641 (108 - 1710)	596 (93 - 1627)	580 (87 - 1598)	511 (67 - 1469)	494 (62 - 1437)	463 (54 - 1376)	443 (49 - 1334)	371 (32 - 1184)
Sacramento-Arden-Arcade-Truckee__CA-NV	140 (15 - 436)	132 (13 - 418)	125 (12 - 401)	108 (9 - 361)	104 (8 - 351)	99 (8 - 338)	91 (6 - 318)	73 (4 - 268)
St._Louis-St._Charles-Farmington__MO-IL	282 (50 - 744)	263 (44 - 709)	252 (40 - 688)	222 (31 - 630)	210 (28 - 607)	198 (25 - 581)	185 (22 - 555)	151 (14 - 480)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	712 (110 - 2044)	646 (90 - 1917)	641 (89 - 1909)	578 (72 - 1781)	546 (63 - 1715)	501 (53 - 1621)	487 (49 - 1592)	406 (33 - 1409)
	Response = Decrease in FEV_1 Greater Than or Equal to 15%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	51 (4 - 647)	49 (4 - 641)	40 (2 - 596)	32 (1 - 550)	27 (1 - 524)	27 (1 - 522)	20 (0 - 477)	13 (0 - 411)

Location	Number of Occurrences (in 1000s) of Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
Boston-Worcester-Manchester__MA-NH	55 (7 - 614)	44 (5 - 572)	43 (5 - 569)	39 (4 - 551)	29 (2 - 505)	24 (1 - 478)	21 (1 - 465)	13 (0 - 407)
Chicago-Naperville-Michigan_City__IL-IN-WI	92 (8 - 1033)	80 (6 - 985)	71 (5 - 949)	58 (3 - 887)	48 (2 - 832)	42 (2 - 801)	35 (1 - 758)	21 (0 - 652)
Cleveland-Akron-Elyria__OH	40 (5 - 391)	33 (3 - 366)	32 (3 - 360)	23 (2 - 327)	22 (1 - 318)	18 (1 - 300)	16 (1 - 291)	10 (0 - 254)
Detroit-Warren-Flint__MI	66 (6 - 670)	54 (4 - 626)	52 (4 - 616)	49 (3 - 605)	34 (2 - 540)	28 (1 - 508)	25 (1 - 493)	15 (0 - 427)
Houston-Baytown-Huntsville__TX	25 (1 - 307)	21 (1 - 278)	19 (1 - 267)	14 (0 - 217)	13 (0 - 207)	11 (0 - 187)	9 (0 - 161)	5 (0 - 65)
Los_Angeles-Long_Beach-Riverside__CA	57 (1 - 1718)	54 (1 - 1671)	43 (1 - 1494)	24 (0 - 1068)	24 (0 - 1052)	22 (0 - 997)	15 (0 - 741)	6 (0 - 292)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	197 (15 - 2539)	174 (11 - 2442)	155 (9 - 2357)	99 (3 - 2063)	106 (4 - 2103)	94 (3 - 2034)	79 (2 - 1940)	47 (1 - 1661)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	104 (12 - 957)	88 (8 - 905)	83 (7 - 887)	61 (4 - 807)	57 (3 - 787)	49 (2 - 750)	44 (2 - 725)	28 (1 - 636)
Sacramento-Arden-Arcade-Truckee__CA-NV	14 (1 - 232)	12 (0 - 221)	10 (0 - 212)	8 (0 - 189)	7 (0 - 184)	6 (0 - 176)	5 (0 - 166)	3 (0 - 138)
St._Louis-St._Charles-Farmington__MO-IL	49 (6 - 416)	42 (5 - 394)	39 (4 - 380)	29 (2 - 345)	26 (2 - 331)	23 (1 - 316)	20 (1 - 300)	12 (0 - 256)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	105 (11 - 1109)	84 (7 - 1030)	83 (7 - 1025)	66 (4 - 949)	57 (3 - 909)	47 (2 - 854)	43 (2 - 836)	28 (1 - 731)
	Response = Decrease in FEV_1 Greater Than or Equal to 20%							
Atlanta-Sandy_Springs-Gainesville__GA-AL	8 (0 - 293)	7 (0 - 290)	5 (0 - 264)	3 (0 - 239)	3 (0 - 225)	3 (0 - 224)	1 (0 - 199)	1 (0 - 165)
Boston-Worcester-Manchester__MA-NH	11 (1 - 272)	8 (1 - 248)	8 (1 - 246)	7 (0 - 236)	4 (0 - 210)	3 (0 - 195)	2 (0 - 188)	1 (0 - 157)
Chicago-Naperville-Michigan_City__IL-IN-WI	15 (1 - 480)	12 (0 - 452)	10 (0 - 431)	7 (0 - 396)	5 (0 - 365)	4 (0 - 348)	3 (0 - 324)	1 (0 - 266)
Cleveland-Akron-Elyria__OH	8 (0 - 183)	6 (0 - 168)	5 (0 - 165)	3 (0 - 145)	3 (0 - 140)	2 (0 - 130)	2 (0 - 125)	1 (0 - 104)
Detroit-Warren-Flint__MI	12 (0 - 312)	9 (0 - 286)	8 (0 - 280)	7 (0 - 273)	4 (0 - 236)	3 (0 - 218)	2 (0 - 210)	1 (0 - 173)

Location	Number of Occurrences (in 1000s) of Lung Function Response Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
	0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Houston-Baytown-Huntsville__TX	3 (0 - 172)	2 (0 - 158)	2 (0 - 152)	1 (0 - 128)	1 (0 - 123)	1 (0 - 114)	0 (0 - 102)	0 (0 - 65)
Los_Angeles-Long_Beach-Riverside__CA	3 (0 - 745)	3 (0 - 722)	2 (0 - 641)	1 (0 - 458)	1 (0 - 452)	1 (0 - 430)	0 (0 - 331)	0 (0 - 172)
New_York-Newark-Bridgeport__NY-NJ-CT-PA	29 (1 - 1154)	24 (1 - 1097)	19 (0 - 1047)	9 (0 - 878)	10 (0 - 900)	8 (0 - 861)	6 (0 - 808)	2 (0 - 659)
Philadelphia-Camden-Vineland__PA-NJ-DE-MD	20 (1 - 463)	15 (1 - 432)	14 (1 - 421)	8 (0 - 373)	7 (0 - 361)	6 (0 - 340)	5 (0 - 325)	2 (0 - 274)
Sacramento-Arden-Arcade-Truckee__CA-NV	1 (0 - 103)	1 (0 - 97)	1 (0 - 92)	1 (0 - 80)	0 (0 - 77)	0 (0 - 73)	0 (0 - 68)	0 (0 - 54)
St._Louis-St._Charles-Farmington__MO-IL	10 (1 - 203)	8 (0 - 190)	7 (0 - 182)	4 (0 - 161)	4 (0 - 153)	3 (0 - 145)	2 (0 - 136)	1 (0 - 111)
Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV	19 (1 - 515)	13 (1 - 468)	13 (1 - 465)	9 (0 - 421)	7 (0 - 398)	5 (0 - 367)	4 (0 - 357)	2 (0 - 299)

*Numbers are median (0.5 fractile) numbers of occurrences. Numbers in parentheses below the median are 95% confidence intervals based on statistical uncertainty surrounding the O3 coefficient.

**Incidence was quantified down to estimated policy relevant background levels. Incidences are rounded to the nearest 1000.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Table 5C-7. Estimated Incidence of Health Risks Associated with O_3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: Boston, MA, April - September, Based on 2004 O_3 Concentrations

Respiratory Symptoms*	Study	Ages	Lag	Exposure Metric	Other Pollutants in Model	Incidence of Respiratory Symptom-Days (in 100s) Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
						0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	none	45 (7 - 79)	42 (7 - 75)	42 (7 - 74)	41 (7 - 73)	38 (6 - 67)	36 (6 - 64)	35 (6 - 62)	31 (5 - 55)
Chest tightness	Gent et al. (2003)	0 - 12	0-day lag	1 hr max.	PM2.5	72 (32 - 107)	68 (30 - 102)	67 (30 - 101)	66 (29 - 99)	61 (27 - 92)	58 (26 - 88)	56 (25 - 85)	50 (22 - 75)
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	PM2.5	66 (25 - 102)	62 (24 - 97)	62 (24 - 96)	61 (23 - 94)	56 (21 - 87)	53 (20 - 83)	52 (20 - 81)	45 (17 - 71)
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	8 hr max.	none	46 (15 - 75)	44 (14 - 71)	43 (14 - 70)	42 (13 - 69)	39 (12 - 63)	37 (12 - 61)	36 (11 - 59)	31 (10 - 52)
Shortness of breath	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	none	48 (6 - 87)	46 (6 - 83)	45 (5 - 82)	44 (5 - 80)	41 (5 - 74)	39 (5 - 71)	38 (5 - 69)	33 (4 - 60)
Shortness of breath	Gent et al. (2003)	0 - 12	1-day lag	8 hr max.	none	53 (10 - 92)	50 (10 - 87)	50 (10 - 87)	49 (9 - 85)	45 (9 - 78)	43 (8 - 75)	41 (8 - 72)	36 (7 - 64)
Wheeze	Gent et al. (2003)	0 - 12	0-day lag	1 hr max.	PM2.5	132 (47 - 208)	124 (44 - 197)	123 (44 - 196)	121 (43 - 192)	111 (39 - 177)	106 (37 - 169)	103 (36 - 164)	90 (32 - 145)

*Respiratory symptoms among asthmatic medication-users associated with short-term exposures to O_3.

**Incidence was quantified down to estimated policy relevant background levels. Incidences of respiratory symptom-days are rounded to the nearest 100.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O3 coefficient.

Table 5C-8. Estimated Percent of Total Incidence of Health Risks Associated with O_3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: Boston, MA, April - September, Based on 2004 O_3 Concentrations

Respiratory Symptoms*		Ages	Lag	Exposure Metric	Other Pollutants in Model	Percent of Total Incidence of Respiratory Symptom-Days Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
						0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	none	8% (1.3% - 14.2%)	7.6% (1.2% - 13.4%)	7.5% (1.2% - 13.3%)	7.4% (1.2% - 13.1%)	6.8% (1.1% - 12%)	6.5% (1% - 11.5%)	6.3% (1% - 11.2%)	5.5% (0.9% - 9.8%)
Chest tightness	Gent et al. (2003)	0 - 12	0-day lag	1 hr max.	PM2.5	12.9% (5.8% - 19.3%)	12.2% (5.5% - 18.3%)	12.1% (5.4% - 18.2%)	11.9% (5.3% - 17.8%)	11% (4.9% - 16.5%)	10.5% (4.6% - 15.8%)	10.1% (4.5% - 15.3%)	8.9% (3.9% - 13.5%)
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	PM2.5	11.9% (4.6% - 18.4%)	11.2% (4.3% - 17.4%)	11.1% (4.3% - 17.3%)	10.9% (4.2% - 17%)	10% (3.8% - 15.7%)	9.6% (3.7% - 15%)	9.3% (3.5% - 14.6%)	8.2% (3.1% - 12.8%)
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	8 hr max.	none	8.3% (2.6% - 13.4%)	7.8% (2.5% - 12.7%)	7.8% (2.5% - 12.6%)	7.6% (2.4% - 12.4%)	7% (2.2% - 11.4%)	6.7% (2.1% - 10.9%)	6.5% (2% - 10.6%)	5.7% (1.8% - 9.3%)
Shortness of breath	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	none	7% (0.8% - 12.6%)	6.6% (0.8% - 11.9%)	6.5% (0.8% - 11.8%)	6.4% (0.8% - 11.6%)	5.9% (0.7% - 10.6%)	5.6% (0.7% - 10.2%)	5.4% (0.6% - 9.9%)	4.7% (0.6% - 8.7%)
Shortness of breath	Gent et al. (2003)	0 - 12	1-day lag	8 hr max.	none	7.6% (1.5% - 13.2%)	7.2% (1.4% - 12.5%)	7.2% (1.4% - 12.4%)	7% (1.4% - 12.2%)	6.4% (1.2% - 11.2%)	6.1% (1.2% - 10.7%)	5.9% (1.1% - 10.4%)	5.2% (1% - 9.1%)
Wheeze	Gent et al. (2003)	0 - 12	0-day lag	1 hr max.	PM2.5	10.1% (3.6% - 16%)	9.6% (3.4% - 15.2%)	9.5% (3.4% - 15.1%)	9.3% (3.3% - 14.8%)	8.6% (3% - 13.7%)	8.2% (2.9% - 13%)	7.9% (2.8% - 12.7%)	6.9% (2.4% - 11.2%)

*Respiratory symptoms among asthmatic medication-users associated with short-term exposures to O_3.

**Incidence was quantified down to estimated policy relevant background levels. Percents are rounded to the nearest tenth.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O3 coefficient.

Table 5C-9. Estimated Incidence of Health Risks Associated with O_3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: Boston, MA, April - September, Based on 2002 O_3 Concentrations

Respiratory Symptoms*	Study	Ages	Lag	Exposure Metric	Other Pollutants in Model	Incidence of Respiratory Symptom-Days (in 100s) Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
						0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	none	61 (10 - 105)	58 (9 - 101)	58 (9 - 1)	57 (9 - 99)	53 (9 - 93)	52 (8 - 90)	50 (8 - 88)	46 (7 - 80)
Chest tightness	Gent et al. (2003)	0 - 12	0-day lag	1 hr max.	PM2.5	96 (44 - 141)	93 (42 - 136)	92 (42 - 135)	90 (41 - 133)	85 (38 - 126)	82 (37 - 122)	80 (36 - 119)	73 (33 - 109)
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	PM2.5	89 (35 - 135)	85 (33 - 130)	85 (33 - 129)	83 (32 - 127)	78 (30 - 120)	76 (29 - 116)	74 (29 - 114)	67 (26 - 104)
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	8 hr max.	none	64 (21 - 101)	61 (20 - 97)	60 (20 - 97)	59 (19 - 95)	56 (18 - 90)	54 (17 - 87)	53 (17 - 85)	48 (15 - 77)
Shortness of breath	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	none	66 (8 - 117)	63 (8 - 113)	63 (8 - 112)	61 (8 - 110)	58 (7 - 103)	56 (7 - 1)	54 (7 - 98)	49 (6 - 89)
Shortness of breath	Gent et al. (2003)	0 - 12	1-day lag	8 hr max.	none	73 (15 - 125)	70 (14 - 120)	70 (14 - 119)	68 (13 - 117)	64 (13 - 110)	62 (12 - 107)	61 (12 - 104)	55 (11 - 95)
Wheeze	Gent et al. (2003)	0 - 12	0-day lag	1 hr max.	PM2.5	178 (65 - 277)	171 (62 - 266)	169 (61 - 264)	166 (60 - 259)	156 (56 - 245)	151 (54 - 238)	147 (53 - 232)	134 (48 - 212)

*Respiratory symptoms among asthmatic medication-users associated with short-term exposures to O3.

**Incidence was quantified down to estimated policy relevant background levels. Incidences of respiratory symptom-days are rounded to the nearest 100.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O3 coefficient.

Table 5C-10. Estimated Percent of Total Incidence of Health Risks Associated with O_3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: Boston, MA, April - September, Based on 2002 O_3 Concentrations

Respiratory Symptoms*		Ages	Lag	Exposure Metric	Other Pollutants in Model	Percent of Total Incidence of Respiratory Symptom-Days Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
						0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	none	11% (1.8% - 18.9%)	10.5% (1.7% - 18.2%)	10.4% (1.7% - 18.1%)	10.2% (1.6% - 17.7%)	9.6% (1.5% - 16.7%)	9.3% (1.5% - 16.2%)	9% (1.4% - 15.8%)	8.2% (1.3% - 14.4%)
Chest tightness	Gent et al. (2003)	0 - 12	0-day lag	1 hr max.	PM2.5	17.3% (7.9% - 25.4%)	16.6% (7.6% - 24.5%)	16.5% (7.5% - 24.3%)	16.2% (7.3% - 23.9%)	15.3% (6.9% - 22.6%)	14.8% (6.7% - 21.9%)	14.4% (6.5% - 21.4%)	13.1% (5.9% - 19.6%)
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	PM2.5	16% (6.3% - 24.3%)	15.3% (6% - 23.3%)	15.2% (6% - 23.2%)	14.9% (5.8% - 22.7%)	14% (5.5% - 21.5%)	13.6% (5.3% - 20.9%)	13.3% (5.1% - 20.4%)	12% (4.6% - 18.7%)
Chest tightness	Gent et al. (2003)	0 - 12	1-day lag	8 hr max.	none	11.4% (3.7% - 18.2%)	10.9% (3.5% - 17.5%)	10.9% (3.5% - 17.4%)	10.6% (3.4% - 17%)	10% (3.2% - 16.1%)	9.7% (3.1% - 15.6%)	9.5% (3% - 15.2%)	8.6% (2.7% - 13.9%)
Shortness of breath	Gent et al. (2003)	0 - 12	1-day lag	1 hr max.	none	9.5% (1.2% - 16.9%)	9.1% (1.1% - 16.2%)	9% (1.1% - 16.1%)	8.8% (1.1% - 15.8%)	8.3% (1% - 14.9%)	8% (1% - 14.4%)	7.8% (0.9% - 14%)	7.1% (0.9% - 12.8%)
Shortness of breath	Gent et al. (2003)	0 - 12	1-day lag	8 hr max.	none	10.6% (2.1% - 17.9%)	10.1% (2% - 17.2%)	10% (2% - 17.1%)	9.8% (1.9% - 16.8%)	9.2% (1.8% - 15.8%)	8.9% (1.8% - 15.4%)	8.7% (1.7% - 15%)	7.9% (1.5% - 13.7%)
Wheeze	Gent et al. (2003)	0 - 12	0-day lag	1 hr max.	PM2.5	13.7% (5% - 21.3%)	13.1% (4.8% - 20.5%)	13% (4.7% - 20.4%)	12.8% (4.6% - 20%)	12% (4.3% - 18.9%)	11.6% (4.2% - 18.3%)	11.3% (4.1% - 17.9%)	10.3% (3.7% - 16.3%)

*Respiratory symptoms among asthmatic medication-users associated with short-term exposures to O3.

**Incidence was quantified down to estimated policy relevant background levels. Percents are rounded to the nearest tenth.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O3 coefficient.

Table 5C-11. Estimated Percent of Total Incidence of Hospital Admissions Associated with O_3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: New York, NY, April - September, Based on 2004 O_3 Concentrations

Hospital Admissions	Lag	Incidence of Health Effects Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
		0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
Respiratory illness (unscheduled)	3-day lag	366 (89 - 644)	334 (81 - 588)	341 (82 - 599)	314 (76 - 551)	304 (73 - 534)	279 (67 - 490)	278 (67 - 489)	241 (58 - 424)
Asthma (unscheduled)	1-day lag	313 (66 - 559)	286 (61 - 510)	291 (62 - 520)	268 (57 - 479)	259 (55 - 464)	238 (51 - 425)	238 (51 - 425)	206 (44 - 368)
Hospital Admissions	**Lag**	**Incidence of Health Effects per 100,000 Relevant Population Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
		0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
Respiratory illness (unscheduled)	3-day lag	4.6 (1.1 - 8)	4.2 (1 - 7.3)	4.3 (1 - 7.5)	3.9 (0.9 - 6.9)	3.8 (0.9 - 6.7)	3.5 (0.8 - 6.1)	3.5 (0.8 - 6.1)	3 (0.7 - 5.3)
Asthma (unscheduled)	1-day lag	3.9 (0.8 - 7)	3.6 (0.8 - 6.4)	3.6 (0.8 - 6.5)	3.3 (0.7 - 6)	3.2 (0.7 - 5.8)	3 (0.6 - 5.3)	3 (0.6 - 5.3)	2.6 (0.5 - 4.6)
Hospital Admissions	**Lag**	**Percent of Total Incidence of Health Effects Associated with O3 Concentrations that Just Meet the Current and Alternative O3 Standards**							
		0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
Respiratory illness (unscheduled)	3-day lag	1% (0.3% - 1.8%)	0.9% (0.2% - 1.7%)	1% (0.2% - 1.7%)	0.9% (0.2% - 1.6%)	0.9% (0.2% - 1.5%)	0.8% (0.2% - 1.4%)	0.8% (0.2% - 1.4%)	0.7% (0.2% - 1.2%)
Asthma (unscheduled)	1-day lag	2.4% (0.5% - 4.3%)	2.2% (0.5% - 3.9%)	2.2% (0.5% - 4%)	2% (0.4% - 3.6%)	2% (0.4% - 3.5%)	1.8% (0.4% - 3.2%)	1.8% (0.4% - 3.2%)	1.6% (0.3% - 2.8%)

*Based on single-pollutant models from Thurston et al. (1992) relating daily hospital admissions among all ages to daily 1-hr maximum O_3 exposures. New York in this study is defined as the five boroughs of New York City.

**Incidence was quantified down to estimated policy relevant background levels. Incidences are rounded to the nearest whole number; incidences per 100,000 relevant population and percent of total incidence are rounded to the nearest tenth.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O_3 coefficient.

Table 5C-12. Estimated Percent of Total Incidence of Hospital Admissions Associated with O_3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: New York, NY, April - September, Based on 2002 O_3 Concentrations

Hospital Admissions	Lag	Incidence of Health Effects Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
		0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
Respiratory illness (unscheduled)	3-day lag	513 (124 - 902)	472 (114 - 830)	483 (117 - 850)	452 (109 - 795)	439 (106 - 772)	404 (98 - 710)	410 (99 - 721)	365 (88 - 642)
Asthma (unscheduled)	1-day lag	438 (93 - 783)	403 (86 - 720)	413 (88 - 738)	386 (82 - 690)	375 (80 - 670)	345 (73 - 617)	350 (75 - 626)	312 (66 - 558)
Hospital Admissions	**Lag**	**Incidence of Health Effects per 100,000 Relevant Population Associated with O3 Concentrations that Just Meet the Current and Alternative O3 Standards**							
		0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
Respiratory illness (unscheduled)	3-day lag	6.4 (1.5 - 11.3)	5.9 (1.4 - 10.4)	6 (1.5 - 10.6)	5.6 (1.4 - 9.9)	5.5 (1.3 - 9.6)	5 (1.2 - 8.9)	5.1 (1.2 - 9)	4.6 (1.1 - 8)
Asthma (unscheduled)	1-day lag	5.5 (1.2 - 9.8)	5 (1.1 - 9)	5.2 (1.1 - 9.2)	4.8 (1 - 8.6)	4.7 (1 - 8.4)	4.3 (0.9 - 7.7)	4.4 (0.9 - 7.8)	3.9 (0.8 - 7)
Hospital Admissions	**Lag**	**Percent of Total Incidence of Health Effects Associated with O3 Concentrations that Just Meet the Current and Alternative O3 Standards**							
		0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
Respiratory illness (unscheduled)	3-day lag	1.5% (0.4% - 2.6%)	1.3% (0.3% - 2.3%)	1.4% (0.3% - 2.4%)	1.3% (0.3% - 2.2%)	1.2% (0.3% - 2.2%)	1.1% (0.3% - 2%)	1.2% (0.3% - 2%)	1% (0.2% - 1.8%)
Asthma (unscheduled)	1-day lag	3.3% (0.7% - 6%)	3.1% (0.7% - 5.5%)	3.1% (0.7% - 5.6%)	2.9% (0.6% - 5.3%)	2.9% (0.6% - 5.1%)	2.6% (0.6% - 4.7%)	2.7% (0.6% - 4.8%)	2.4% (0.5% - 4.2%)

*Based on single-pollutant models from Thurston et al. (1992) relating daily hospital admissions among all ages to daily 1-hr maximum O_3 exposures. New York in this study is defined as the five boroughs of New York City.

**Incidence was quantified down to estimated policy relevant background levels. Incidences are rounded to the nearest whole number; incidences per 100,000 relevant population and percent of total incidence are rounded to the nearest tenth.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppm and an nth daily maximum. So, for example, the current standard is 0.084/4 -- 0.084 ppm, 4th daily maximum 8-hr average using the current rounding convention.

****This alternative 8-hr standard assumes an alternative rounding convention where the standard is specified to the third decimal place.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O_3 coefficient.

Table 5C-13. Estimated Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: April - September, Based on 2004 O_3 Concentrations*

Location	Study	Lag	Exposure Metric	Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Atlanta	Bell et al. (2004)	distributed lag	24 hr avg.	5 (-20 - 29)	5 (-20 - 29)	4 (-18 - 26)	4 (-16 - 23)	4 (-15 - 22)	4 (-15 - 22)	3 (-13 - 19)	3 (-11 - 16)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	9 (3 - 15)	9 (3 - 15)	8 (3 - 14)	7 (2 - 12)	7 (2 - 12)	7 (2 - 12)	6 (2 - 10)	5 (2 - 8)
Boston	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	6 (2 - 9)	5 (2 - 9)	5 (2 - 9)	5 (2 - 8)	4 (1 - 7)	4 (1 - 7)	4 (1 - 7)	3 (1 - 6)
Chicago	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	33 (11 - 55)	31 (10 - 52)	29 (10 - 48)	26 (9 - 43)	23 (8 - 39)	22 (7 - 36)	19 (6 - 32)	14 (5 - 24)
	Schwartz (2004)	0-day lag	1 hr max.	314 (99 - 525)	300 (95 - 501)	288 (91 - 482)	268 (85 - 448)	249 (79 - 417)	238 (75 - 399)	222 (70 - 372)	183 (58 - 307)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	118 (37 - 199)	113 (35 - 190)	108 (34 - 182)	101 (31 - 170)	93 (29 - 157)	89 (28 - 151)	83 (26 - 140)	69 (21 - 116)
Cleveland	Bell et al. (2004)	distributed lag	24 hr avg.	19 (-12 - 49)	18 (-11 - 46)	17 (-11 - 44)	15 (-9 - 39)	14 (-9 - 37)	14 (-9 - 36)	13 (-8 - 33)	10 (-6 - 26)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	12 (4 - 20)	11 (4 - 19)	11 (4 - 18)	9 (3 - 16)	9 (3 - 15)	9 (3 - 14)	8 (3 - 13)	6 (2 - 11)
Detroit	Bell et al. (2004)	distributed lag	24 hr avg.	24 (-8 - 56)	22 (-7 - 51)	21 (-7 - 49)	21 (-7 - 48)	17 (-6 - 40)	16 (-5 - 38)	15 (-5 - 35)	11 (-4 - 27)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	12 (4 - 20)	11 (4 - 19)	11 (4 - 18)	11 (4 - 18)	9 (3 - 15)	8 (3 - 14)	8 (3 - 13)	6 (2 - 10)
	Schwartz (2004)	0-day lag	1 hr max.	107 (-17 - 229)	102 (-17 - 218)	99 (-16 - 212)	97 (-16 - 209)	87 (-14 - 186)	83 (-13 - 178)	78 (-13 - 168)	66 (-11 - 142)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	58 (18 - 98)	55 (17 - 93)	54 (17 - 91)	53 (17 - 89)	47 (15 - 79)	45 (14 - 76)	42 (13 - 72)	36 (11 - 61)

Location	Study	Lag	Exposure Metric	Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	Ito (2003)	0-day lag	24 hr avg.	29 (-27 - 85)	27 (-25 - 78)	26 (-24 - 75)	25 (-23 - 73)	21 (-20 - 62)	20 (-18 - 57)	18 (-17 - 53)	14 (-13 - 41)
Houston	Bell et al. (2004)	distributed lag	24 hr avg.	22 (1 - 42)	20 (1 - 39)	19 (1 - 37)	17 (1 - 32)	16 (1 - 30)	15 (1 - 28)	13 (1 - 25)	8 (0 - 15)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	11 (4 - 18)	10 (3 - 16)	10 (3 - 16)	8 (3 - 13)	8 (3 - 13)	7 (2 - 12)	6 (2 - 11)	4 (1 - 6)
	Schwartz (2004)	0-day lag	1 hr max.	70 (6 - 132)	66 (6 - 126)	65 (6 - 123)	59 (5 - 112)	57 (5 - 109)	55 (5 - 104)	52 (5 - 99)	42 (4 - 80)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	58 (18 - 98)	55 (17 - 93)	54 (17 - 91)	49 (15 - 83)	48 (15 - 81)	46 (14 - 77)	43 (14 - 73)	35 (11 - 59)
Los Angeles	Bell et al. (2004)	distributed lag	24 hr avg.	31 (-74 - 135)	30 (-72 - 131)	27 (-66 - 120)	22 (-52 - 95)	20 (-49 - 90)	19 (-46 - 83)	16 (-38 - 69)	9 (-22 - 41)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	67 (22 - 111)	64 (22 - 107)	59 (20 - 98)	47 (16 - 78)	44 (15 - 74)	41 (14 - 68)	34 (11 - 56)	20 (7 - 33)
New York	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	43 (15 - 72)	38 (13 - 63)	39 (13 - 65)	35 (12 - 58)	33 (11 - 55)	29 (10 - 48)	29 (10 - 49)	24 (8 - 39)
Philadelphia	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	17 (6 - 28)	15 (5 - 25)	15 (5 - 25)	13 (4 - 22)	13 (4 - 21)	12 (4 - 20)	11 (4 - 19)	9 (3 - 15)
	Moolgavkar et al. (1995)	1-day lag	24 hr avg.	59 (37 - 81)	54 (34 - 75)	54 (34 - 74)	47 (30 - 65)	46 (29 - 63)	42 (27 - 58)	41 (26 - 56)	33 (21 - 46)
Sacramento	Bell et al. (2004)	distributed lag	24 hr avg.	8 (-25 - 42)	8 (-25 - 41)	8 (-23 - 39)	7 (-21 - 35)	7 (-21 - 34)	7 (-20 - 34)	6 (-19 - 31)	5 (-16 - 26)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	12 (4 - 21)	12 (4 - 20)	11 (4 - 19)	10 (4 - 17)	10 (3 - 17)	10 (3 - 17)	9 (3 - 15)	8 (3 - 13)
St Louis	Bell et al. (2004)	distributed lag	24 hr avg.	3 (-4 - 9)	2 (-4 - 8)	2 (-4 - 8)	2 (-3 - 6)	2 (-3 - 6)	1 (-2 - 5)	1 (-2 - 5)	1 (-1 - 3)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	2 (1 - 4)	2 (1 - 3)	2 (1 - 3)	2 (1 - 3)	1 (0 - 2)	1 (0 - 2)	1 (0 - 2)	1 (0 - 1)

Location	Study	Lag	Exposure Metric	Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4* **	**0.084/3**	**0.080/4******	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4******	**0.064/4**
Washington	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	7 (2 - 12)	6 (2 - 10)	6 (2 - 11)	6 (2 - 9)	6 (2 - 9)	5 (2 - 8)	5 (2 - 8)	4 (1 - 7)

*All results are for mortality (among all ages) associated with short-term exposures to O3. All results are based on single-pollutant models.

**Incidence was quantified down to estimated policy relevant background levels. Incidences are rounded to the nearest whole number.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppb and an nth daily maximum. So, for example, the current standard is 84/4 -- 84 ppb, 4th daily maximum 8-hr average.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O_3 coefficient.

Table 5C-14. Estimated Percent of Total Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: April - September, Based on 2004 O_3 Concentrations*

Location	Study	Lag	Exposure Metric	Percent of Total Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Atlanta	Bell et al. (2004)	distributed lag	24 hr avg.	0.1% (-0.4% -0.6%)	0.1% (-0.4% -0.6%)	0.1% (-0.4% -0.6%)	0.1% (-0.3% -0.5%)	0.1% (-0.3% -0.5%)	0.1% (-0.3% -0.5%)	0.1% (-0.3% -0.4%)	0.1% (-0.2% -0.3%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)
Boston	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.2% (0.1% -0.4%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.1% (0% -0.2%)
Chicago	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.2% (0.1% -0.3%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.1%)
	Schwartz (2004)	0-day lag	1 hr max.	1.5% (0.5% -2.5%)	1.4% (0.5% -2.4%)	1.4% (0.4% -2.3%)	1.3% (0.4% -2.1%)	1.2% (0.4% -2%)	1.1% (0.4% -1.9%)	1.1% (0.3% -1.8%)	0.9% (0.3% -1.5%)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	0.6% (0.2% -0.9%)	0.5% (0.2% -0.9%)	0.5% (0.2% -0.9%)	0.5% (0.1% -0.8%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.7%)	0.3% (0.1% -0.6%)
Cleveland	Bell et al. (2004)	distributed lag	24 hr avg.	0.3% (-0.2% -0.7%)	0.2% (-0.1% -0.6%)	0.2% (-0.1% -0.6%)	0.2% (-0.1% -0.5%)	0.2% (-0.1% -0.5%)	0.2% (-0.1% -0.5%)	0.2% (-0.1% -0.4%)	0.1% (-0.1% -0.4%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.1%)
Detroit	Bell et al. (2004)	distributed lag	24 hr avg.	0.3% (-0.1% -0.6%)	0.2% (-0.1% -0.5%)	0.2% (-0.1% -0.5%)	0.2% (-0.1% -0.5%)	0.2% (-0.1% -0.4%)	0.2% (-0.1% -0.4%)	0.2% (-0.1% -0.4%)	0.1% (0% -0.3%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)
	Schwartz (2004)	0-day lag	1 hr max.	1.1% (-0.2% -2.4%)	1.1% (-0.2% -2.3%)	1.1% (-0.2% -2.3%)	1% (-0.2% -2.2%)	0.9% (-0.1% -2%)	0.9% (-0.1% -1.9%)	0.8% (-0.1% -1.8%)	0.7% (-0.1% -1.5%)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	0.6% (0.2% -1%)	0.6% (0.2% -1%)	0.6% (0.2% -1%)	0.6% (0.2% -0.9%)	0.5% (0.2% -0.8%)	0.5% (0.1% -0.8%)	0.5% (0.1% -0.8%)	0.4% (0.1% -0.6%)
	Ito (2003)	0-day lag	24 hr avg.	0.3%	0.3%	0.3%	0.3%	0.2%	0.2%	0.2%	0.1%

Location	Study	Lag	Exposure Metric	Percent of Total Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
				(-0.3% -0.9%)	(-0.3% -0.8%)	(-0.3% -0.8%)	(-0.2% -0.8%)	(-0.2% -0.7%)	(-0.2% -0.6%)	(-0.2% -0.6%)	(-0.1% -0.4%)
Houston	Bell et al. (2004)	distributed lag	24 hr avg.	0.2% (0% -0.5%)	0.2% (0% -0.4%)	0.2% (0% -0.4%)	0.2% (0% -0.4%)	0.2% (0% -0.3%)	0.2% (0% -0.3%)	0.1% (0% -0.3%)	0.1% (0% -0.2%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0% (0% -0.1%)
	Schwartz (2004)	0-day lag	1 hr max.	0.8% (0.1% -1.5%)	0.7% (0.1% -1.4%)	0.7% (0.1% -1.4%)	0.6% (0.1% -1.2%)	0.6% (0.1% -1.2%)	0.6% (0.1% -1.1%)	0.6% (0.1% -1.1%)	0.5% (0% -0.9%)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	0.6% (0.2% -1.1%)	0.6% (0.2% -1%)	0.6% (0.2% -1%)	0.5% (0.2% -0.9%)	0.5% (0.2% -0.9%)	0.5% (0.2% -0.8%)	0.5% (0.1% -0.8%)	0.4% (0.1% -0.7%)
Los Angeles	Bell et al. (2004)	distributed lag	24 hr avg.	0.1% (-0.3% -0.5%)	0.1% (-0.3% -0.5%)	0.1% (-0.2% -0.4%)	0.1% (-0.2% -0.3%)	0.1% (-0.2% -0.3%)	0.1% (-0.2% -0.3%)	0.1% (-0.1% -0.3%)	0% (-0.1% -0.2%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.1% (0% -0.2%)	0.1% (0% -0.1%)
New York	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.1%)
Philadelphia	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)
	Moolgavkar et al. (1995)	1-day lag	24 hr avg.	0.7% (0.5% -1%)	0.7% (0.4% -0.9%)	0.7% (0.4% -0.9%)	0.6% (0.4% -0.8%)	0.6% (0.4% -0.8%)	0.5% (0.3% -0.7%)	0.5% (0.3% -0.7%)	0.4% (0.3% -0.6%)
Sacramento	Bell et al. (2004)	distributed lag	24 hr avg.	0.2% (-0.6% -1%)	0.2% (-0.6% -1%)	0.2% (-0.6% -0.9%)	0.2% (-0.5% -0.8%)	0.2% (-0.5% -0.8%)	0.2% (-0.5% -0.8%)	0.1% (-0.5% -0.7%)	0.1% (-0.4% -0.6%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.3%)
St Louis	Bell et al. (2004)	distributed lag	24 hr avg.	0.1% (-0.2% -0.5%)	0.1% (-0.2% -0.4%)	0.1% (-0.2% -0.4%)	0.1% (-0.1% -0.3%)	0.1% (-0.1% -0.3%)	0.1% (-0.1% -0.3%)	0.1% (-0.1% -0.2%)	0% (-0.1% -0.1%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0% (0% -0.1%)
Washington	Bell et al. -- 95 US	distributed	24 hr avg.	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%

Location	Study	Lag	Exposure Metric	Percent of Total Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4* **	**0.084/3**	**0.080/4********	**0.074/5**	**0.074/4**	**0.074/3**	**0.070/4********	**0.064/4**
	Cities (2004)	lag		(0.1% -0.4%)	(0.1% -0.4%)	(0.1% -0.4%)	(0.1% -0.3%)	(0.1% -0.3%)	(0.1% -0.3%)	(0.1% -0.3%)	(0.1% -0.3%)

*All results are for mortality (among all ages) associated with short-term exposures to O3. All results are based on single-pollutant models.

**Incidence was quantified down to estimated policy relevant background levels. Percents are rounded to the nearest tenth.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppb and an nth daily maximum. So, for example, the current standard is 84/4 -- 84 ppb, 4th daily maximum 8-hr average.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O_3 coefficient.

Table 5C-15. Estimated Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: April - September, Based on 2002 O_3 Concentrations*

Location	Study	Lag	Exposure Metric	Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Atlanta	Bell et al. (2004)	distributed lag	24 hr avg.	7 (-30 - 43)	7 (-30 - 43)	6 (-28 - 40)	6 (-26 - 38)	6 (-24 - 35)	6 (-24 - 35)	5 (-22 - 32)	4 (-19 - 27)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	14 (5 - 23)	14 (5 - 23)	13 (4 - 21)	12 (4 - 20)	11 (4 - 19)	11 (4 - 19)	10 (3 - 17)	9 (3 - 14)
Boston	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	9 (3 - 15)	8 (3 - 14)	8 (3 - 14)	8 (3 - 13)	7 (3 - 12)	7 (2 - 12)	7 (2 - 12)	6 (2 - 10)
Chicago	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	55 (18 - 91)	52 (18 - 87)	50 (17 - 84)	47 (16 - 79)	44 (15 - 74)	43 (14 - 71)	40 (13 - 67)	34 (11 - 57)
	Schwartz (2004)	0-day lag	1 hr max.	427 (136 - 712)	412 (131 - 687)	401 (127 - 669)	381 (121 - 636)	361 (115 - 603)	350 (111 - 585)	335 (106 - 559)	294 (93 - 493)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	161 (51 - 271)	156 (49 - 261)	151 (47 - 254)	144 (45 - 242)	136 (43 - 229)	132 (41 - 222)	126 (39 - 212)	111 (35 - 187)
Cleveland	Bell et al. (2004)	distributed lag	24 hr avg.	49 (-31 - 128)	47 (-30 - 123)	46 (-29 - 120)	43 (-27 - 112)	42 (-26 - 109)	40 (-25 - 105)	39 (-25 - 102)	35 (-22 - 91)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	31 (10 - 52)	30 (10 - 50)	29 (10 - 49)	27 (9 - 45)	27 (9 - 44)	26 (9 - 43)	25 (8 - 41)	22 (7 - 37)
Detroit	Bell et al. (2004)	distributed lag	24 hr avg.	46 (-15 - 106)	43 (-14 - 100)	43 (-14 - 98)	42 (-14 - 97)	38 (-12 - 87)	35 (-11 - 81)	34 (-11 - 79)	29 (-9 - 67)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	24 (8 - 39)	22 (7 - 37)	22 (7 - 36)	22 (7 - 36)	19 (6 - 32)	18 (6 - 30)	18 (6 - 29)	15 (5 - 25)
	Schwartz (2004)	0-day lag	1 hr max.	158 (-26 - 336)	150 (-24 - 320)	148 (-24 - 316)	147 (-24 - 313)	134 (-22 - 287)	128 (-21 - 274)	125 (-20 - 268)	111 (-18 - 239)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	86 (27 - 144)	82 (26 - 137)	81 (25 - 136)	80 (25 - 134)	73 (23 - 123)	70 (22 - 117)	68 (21 - 115)	61 (19 - 102)
	Ito (2003)	0-day lag	24 hr avg.	56	53	52	51	46	43	42	36

Location	Study	Lag	Exposure Metric	Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
				(-52 - 162)	(-49 - 151)	(-48 - 150)	(-48 - 147)	(-42 - 132)	(-40 - 124)	(-39 - 120)	(-33 - 103)
Houston	Bell et al. (2004)	distributed lag	24 hr avg.	18 (1 - 34)	16 (1 - 32)	16 (1 - 31)	13 (1 - 26)	13 (1 - 25)	12 (1 - 23)	11 (1 - 21)	7 (0 - 13)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	9 (3 - 15)	8 (3 - 13)	8 (3 - 13)	7 (2 - 11)	6 (2 - 10)	6 (2 - 10)	5 (2 - 9)	3 (1 - 5)
	Schwartz (2004)	0-day lag	1 hr max.	63 (6 - 119)	59 (5 - 113)	58 (5 - 110)	53 (5 - 100)	51 (5 - 97)	48 (4 - 92)	46 (4 - 87)	36 (3 - 69)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	53 (16 - 88)	50 (16 - 84)	49 (15 - 82)	44 (14 - 74)	43 (13 - 72)	40 (13 - 68)	38 (12 - 64)	30 (9 - 51)
Los Angeles	Bell et al. (2004)	distributed lag	24 hr avg.	24 (-58 - 105)	23 (-55 - 100)	21 (-50 - 91)	15 (-36 - 66)	15 (-35 - 64)	13 (-32 - 59)	11 (-26 - 48)	7 (-16 - 29)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	52 (17 - 86)	49 (17 - 82)	45 (15 - 74)	33 (11 - 54)	32 (11 - 53)	29 (10 - 48)	24 (8 - 39)	14 (5 - 23)
New York	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	84 (28 - 139)	76 (25 - 126)	78 (26 - 130)	73 (24 - 121)	70 (23 - 116)	64 (21 - 106)	65 (22 - 108)	57 (19 - 95)
Philadelphia	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	30 (10 - 50)	28 (10 - 47)	28 (9 - 47)	26 (9 - 43)	26 (9 - 42)	24 (8 - 40)	24 (8 - 40)	21 (7 - 35)
	Moolgavkar et al. (1995)	1-day lag	24 hr avg.	107 (67 - 146)	101 (63 - 138)	101 (63 - 137)	93 (58 - 127)	91 (57 - 124)	86 (54 - 117)	85 (53 - 116)	75 (47 - 103)
Sacramento	Bell et al. (2004)	distributed lag	24 hr avg.	12 (-37 - 60)	12 (-36 - 58)	11 (-35 - 57)	11 (-32 - 53)	10 (-32 - 52)	10 (-31 - 50)	10 (-30 - 49)	9 (-27 - 44)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	18 (6 - 30)	17 (6 - 29)	17 (6 - 28)	16 (5 - 26)	15 (5 - 26)	15 (5 - 25)	14 (5 - 24)	13 (4 - 22)
St Louis	Bell et al. (2004)	distributed lag	24 hr avg.	5 (-9 - 20)	5 (-9 - 19)	5 (-8 - 18)	4 (-8 - 16)	4 (-7 - 15)	4 (-7 - 15)	4 (-6 - 14)	3 (-5 - 12)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	5 (2 - 8)	5 (2 - 8)	4 (1 - 7)	4 (1 - 7)	4 (1 - 6)	4 (1 - 6)	3 (1 - 6)	3 (1 - 5)
Washington	Bell et al. -- 95	distributed lag	24 hr avg.	14	12	13	12	12	10	11	10

Location	Study	Lag	Exposure Metric	Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
	US Cities (2004)			(5 - 23)	(4 - 20)	(4 - 21)	(4 - 19)	(4 - 19)	(3 - 17)	(4 - 18)	(3 - 16)

*All results are for mortality (among all ages) associated with short-term exposures to O3. All results are based on single-pollutant models.

**Incidence was quantified down to estimated policy relevant background levels. Incidences are rounded to the nearest whole number.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppb and an nth daily maximum. So, for example, the current standard is 84/4 -- 84 ppb, 4th daily maximum 8-hr average.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O_3 coefficient.

Table 5C-16. Estimated Percent of Total Incidence of Non-Accidental Mortality Associated with O3 Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: April - September, Based on 2002 O3 Concentrations*

Location	Study	Lag	Exposure Metric	Percent of Total Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
Atlanta	Bell et al. (2004)	distributed lag	24 hr avg.	0.2% (-0.7% -0.9%)	0.1% (-0.6% -0.9%)	0.1% (-0.6% -0.9%)	0.1% (-0.6% -0.8%)	0.1% (-0.5% -0.8%)	0.1% (-0.5% -0.8%)	0.1% (-0.5% -0.7%)	0.1% (-0.4% -0.6%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.3%)
Boston	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.3% (0.1% -0.6%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.2% (0.1% -0.4%)
Chicago	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.3% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)
	Schwartz (2004)	0-day lag	1 hr max.	2% (0.6% -3.4%)	2% (0.6% -3.3%)	1.9% (0.6% -3.2%)	1.8% (0.6% -3%)	1.7% (0.5% -2.9%)	1.7% (0.5% -2.8%)	1.6% (0.5% -2.7%)	1.4% (0.4% -2.3%)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	0.8% (0.2% -1.3%)	0.7% (0.2% -1.2%)	0.7% (0.2% -1.2%)	0.7% (0.2% -1.1%)	0.6% (0.2% -1.1%)	0.6% (0.2% -1.1%)	0.6% (0.2% -1%)	0.5% (0.2% -0.9%)
Cleveland	Bell et al. (2004)	distributed lag	24 hr avg.	0.7% (-0.4% -1.7%)	0.6% (-0.4% -1.7%)	0.6% (-0.4% -1.6%)	0.6% (-0.4% -1.5%)	0.6% (-0.4% -1.5%)	0.5% (-0.3% -1.4%)	0.5% (-0.3% -1.4%)	0.5% (-0.3% -1.2%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.4% (0.1% -0.7%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.6%)	0.4% (0.1% -0.6%)	0.3% (0.1% -0.6%)	0.3% (0.1% -0.6%)	0.3% (0.1% -0.5%)
Detroit	Bell et al. (2004)	distributed lag	24 hr avg.	0.5% (-0.2% -1.1%)	0.5% (-0.1% -1.1%)	0.5% (-0.1% -1%)	0.4% (-0.1% -1%)	0.4% (-0.1% -0.9%)	0.4% (-0.1% -0.9%)	0.4% (-0.1% -0.8%)	0.3% (-0.1% -0.7%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.3% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)
	Schwartz (2004)	0-day lag	1 hr max.	1.7% (-0.3% -3.6%)	1.6% (-0.3% -3.4%)	1.6% (-0.3% -3.4%)	1.6% (-0.3% -3.3%)	1.4% (-0.2% -3%)	1.4% (-0.2% -2.9%)	1.3% (-0.2% -2.8%)	1.2% (-0.2% -2.5%)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	0.9% (0.3% -1.5%)	0.9% (0.3% -1.5%)	0.9% (0.3% -1.4%)	0.8% (0.3% -1.4%)	0.8% (0.2% -1.3%)	0.7% (0.2% -1.2%)	0.7% (0.2% -1.2%)	0.6% (0.2% -1.1%)
	Ito (2003)	0-day lag	24 hr avg.	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.4%	0.4%

Location	Study	Lag	Exposure Metric	Percent of Total Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4
				(-0.6% -1.7%)	(-0.5% -1.6%)	(-0.5% -1.6%)	(-0.5% -1.6%)	(-0.5% -1.4%)	(-0.4% -1.3%)	(-0.4% -1.3%)	(-0.3% -1.1%)
Houston	Bell et al. (2004)	distributed lag	24 hr avg.	0.2% (0% -0.4%)	0.2% (0% -0.3%)	0.2% (0% -0.3%)	0.1% (0% -0.3%)	0.1% (0% -0.3%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.1%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.1% (0% -0.2%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)	0% (0% -0.1%)
	Schwartz (2004)	0-day lag	1 hr max.	0.7% (0.1% -1.3%)	0.7% (0.1% -1.2%)	0.6% (0.1% -1.2%)	0.6% (0.1% -1.1%)	0.6% (0.1% -1.1%)	0.5% (0% -1%)	0.5% (0% -1%)	0.4% (0% -0.8%)
	Schwartz -- 14 US Cities (2004)	0-day lag	1 hr max.	0.6% (0.2% -1%)	0.5% (0.2% -0.9%)	0.5% (0.2% -0.9%)	0.5% (0.2% -0.8%)	0.5% (0.1% -0.8%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.7%)	0.3% (0.1% -0.6%)
Los Angeles	Bell et al. (2004)	distributed lag	24 hr avg.	0.1% (-0.2% -0.4%)	0.1% (-0.2% -0.4%)	0.1% (-0.2% -0.3%)	0.1% (-0.1% -0.2%)	0.1% (-0.1% -0.2%)	0% (-0.1% -0.2%)	0% (-0.1% -0.2%)	0% (-0.1% -0.1%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.2%)	0.1% (0% -0.1%)	0.1% (0% -0.1%)
New York	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.3% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)
Philadelphia	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.4% (0.1% -0.6%)	0.4% (0.1% -0.6%)	0.4% (0.1% -0.6%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.5%)	0.3% (0.1% -0.4%)
	Moolgavkar et al. (1995)	1-day lag	24 hr avg.	1.3% (0.8% -1.8%)	1.3% (0.8% -1.7%)	1.3% (0.8% -1.7%)	1.2% (0.7% -1.6%)	1.1% (0.7% -1.5%)	1.1% (0.7% -1.5%)	1.1% (0.7% -1.4%)	0.9% (0.6% -1.3%)
Sacramento	Bell et al. (2004)	distributed lag	24 hr avg.	0.3% (-0.9% -1.4%)	0.3% (-0.8% -1.4%)	0.3% (-0.8% -1.3%)	0.3% (-0.8% -1.3%)	0.2% (-0.8% -1.2%)	0.2% (-0.7% -1.2%)	0.2% (-0.7% -1.2%)	0.2% (-0.6% -1%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.4% (0.1% -0.7%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.6%)	0.4% (0.1% -0.6%)	0.4% (0.1% -0.6%)	0.3% (0.1% -0.6%)	0.3% (0.1% -0.5%)
St Louis	Bell et al. (2004)	distributed lag	24 hr avg.	0.3% (-0.5% -1%)	0.3% (-0.4% -0.9%)	0.2% (-0.4% -0.9%)	0.2% (-0.4% -0.8%)	0.2% (-0.4% -0.8%)	0.2% (-0.3% -0.7%)	0.2% (-0.3% -0.7%)	0.2% (-0.3% -0.6%)
	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.4%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.2% (0.1% -0.3%)	0.1% (0% -0.2%)
Washington	Bell et al. -- 95 US Cities (2004)	distributed lag	24 hr avg.	0.5% (0.2% -0.8%)	0.4% (0.1% -0.7%)	0.5% (0.2% -0.8%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.6%)	0.4% (0.1% -0.7%)	0.4% (0.1% -0.6%)

Location	Study	Lag	Exposure Metric	Percent of Total Incidence of Non-Accidental Mortality Associated with O_3 Concentrations that Just Meet the Current and Alternative O_3 Standards**							
				0.084/4***	0.084/3	0.080/4****	0.074/5	0.074/4	0.074/3	0.070/4****	0.064/4

*All results are for mortality (among all ages) associated with short-term exposures to O3. All results are based on single-pollutant models.

**Incidence was quantified down to estimated policy relevant background levels. Percents are rounded to the nearest tenth.

***An 8-hr average standard, denoted m/n is characterized by a concentration of m ppb and an nth daily maximum. So, for example, the current standard is 84/4 -- 84 ppb, 4th daily maximum 8-hr average.

Note: Numbers in parentheses are 95% confidence or credible intervals based on statistical uncertainty surrounding the O_3 coefficient.

Figure 5C-1. Percent of Active Children (Ages 5-18) Engaged in Moderate Exertion Estimated to Experience At Least One Lung Function Response (Decrement in $FEV_1 \geq 15$ %) Associated with Exposure to O_3 Concentrations That Just Meet the Current and Alternative Average 4th Daily Maximum 8-Hour Standards, for Location-Specific O_3 Seasons: Based on Adjusting 2002 O_3 Concentrations

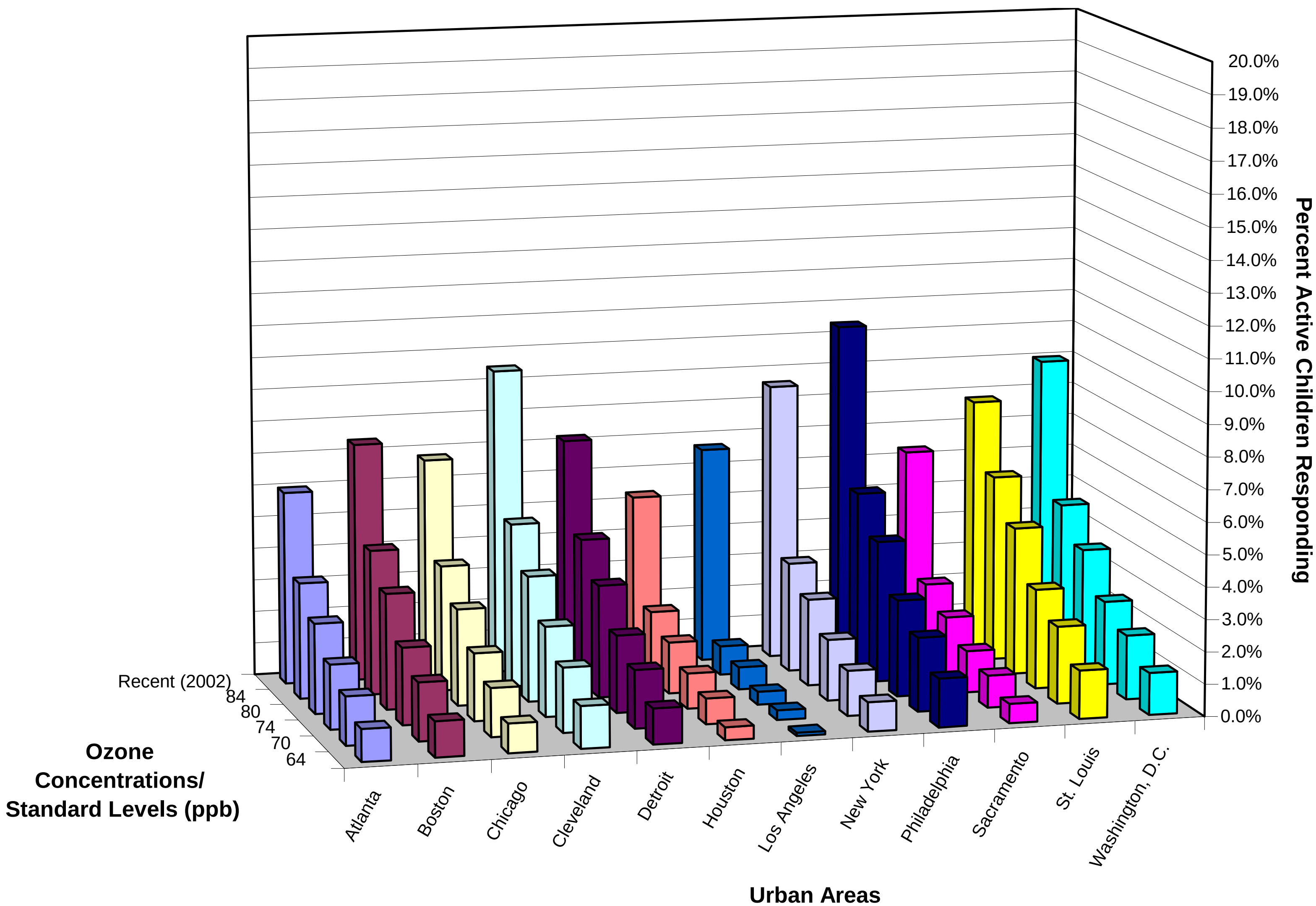


Figure 5C-2a. Percent of Active Children (Ages 5-18) Engaged in Moderate Exertion Estimated to Experience At Least One Lung Function Response (Decrement in FEV1 ≥ 15 %) Associated with Exposure to Recent (2002) O_3 Levels and Levels That Just Meet Alternative Average 4th Daily Maximum 8-Hour Standards, for Location-Specific O_3 Seasons: Based on Adjusting 2002 O_3 Concentrations

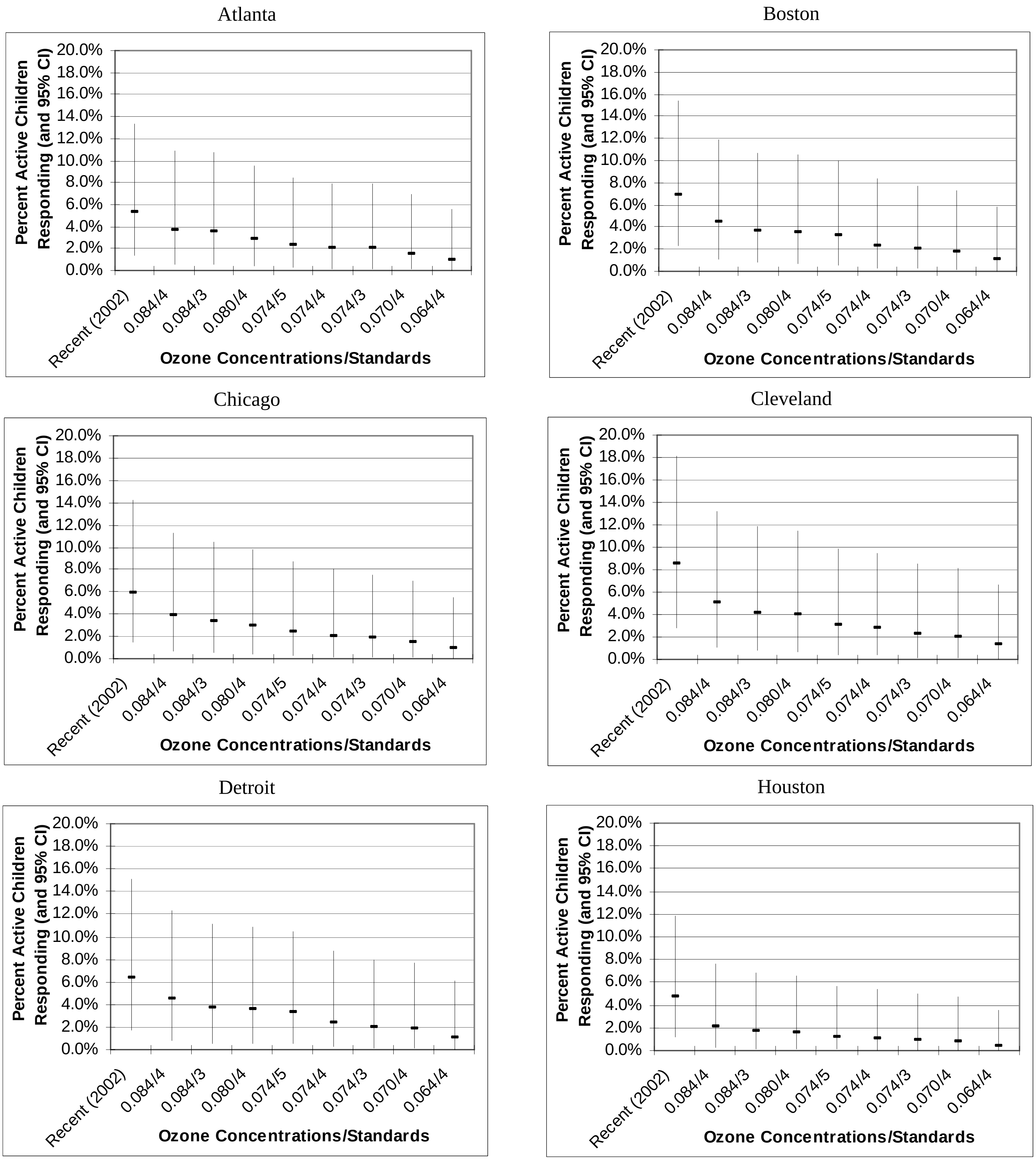
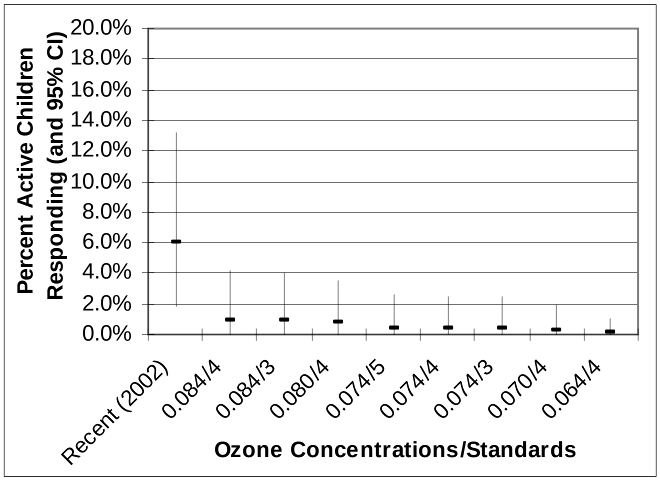
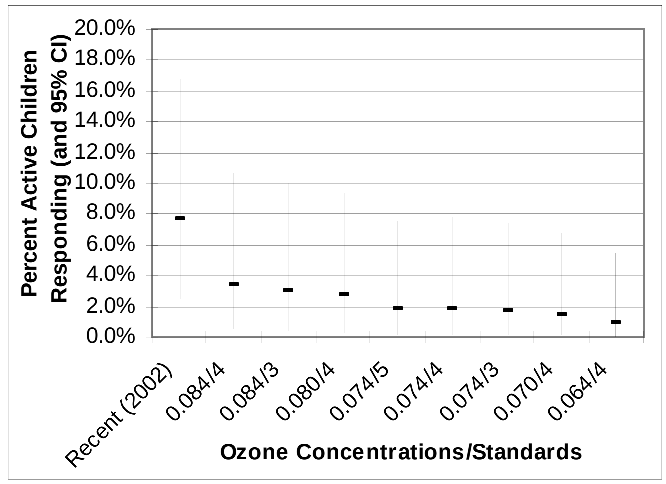


Figure 5C-2b. Percent of Active Children (Ages 5-18) Engaged in Moderate Exertion Estimated to Experience At Least One Lung Function Response (Decrement in FEV1 ≥ 15 %) Associated with Exposure to Recent (2002) O_3 Levels and Levels That Just Meet Alternative Average 4th Daily Maximum 8-Hour Standards, for Location-Specific O_3 Seasons: Based on Adjusting 2002 O_3 Concentrations (cont'd)

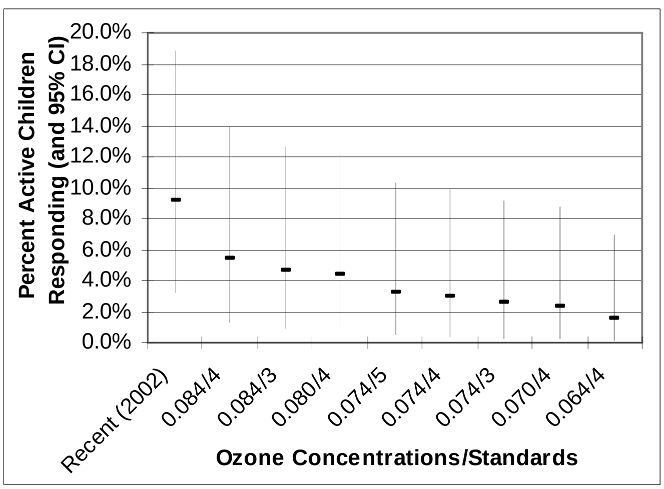
Los Angeles



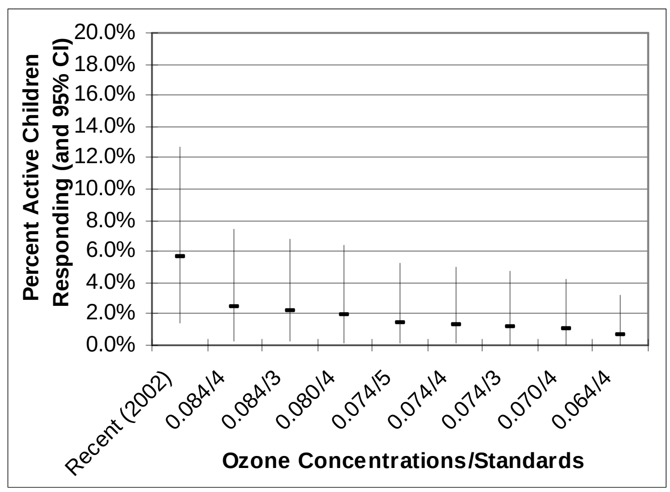
New York



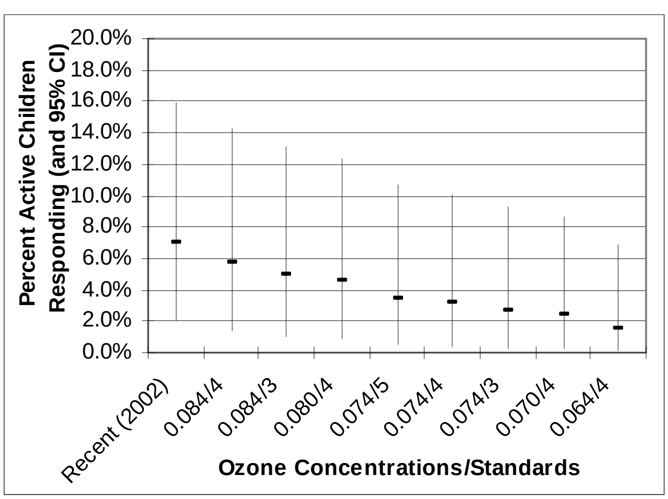
Philadelphia



Sacramento



St. Louis



Washington, D.C.

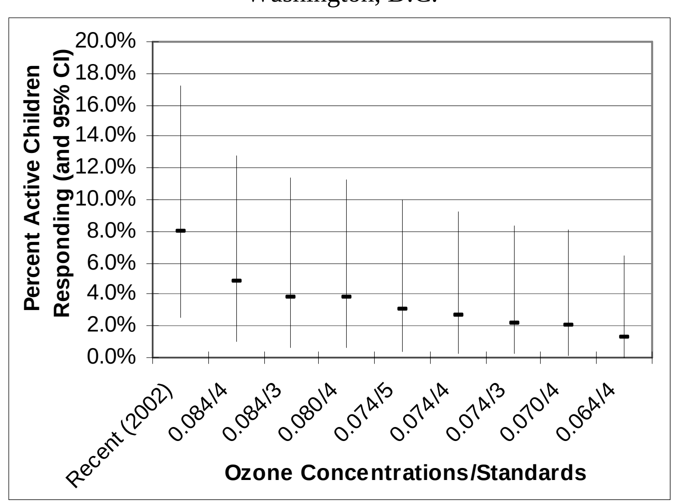


Figure 5C-3. Estimated Symptom-Days for Chest Tightness Among Moderate/Severe Asthmatic Children (Ages 0 – 12) in Boston Associated with O_3 Concentrations that Just Meet the Current and Alternative Average 4th Daily Maximum 8-Hour Standards (Based on Gent et al., 2003): April – September, 2002

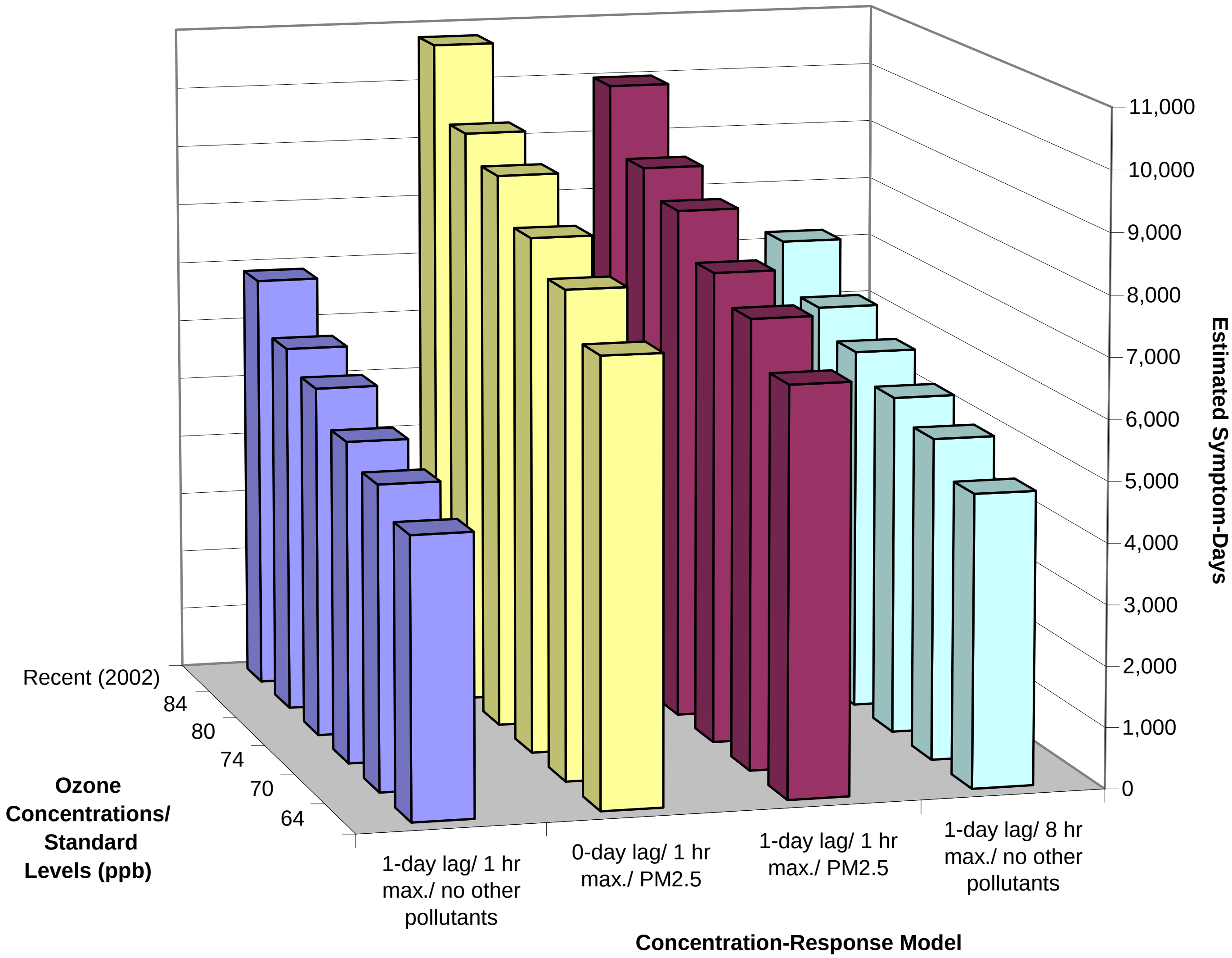


Figure 5C-4. Estimated Incidence of (Unscheduled) Respiratory Hospital Admissions per 100,000 Relevant Population in New York Associated with Recent O_3 Concentrations and with O_3 Concentrations that Just Meet the Current and Alternative Average 4th Daily Maximum 8-Hour Standards (Based on Thurston et al., 1992): April – September, 2002

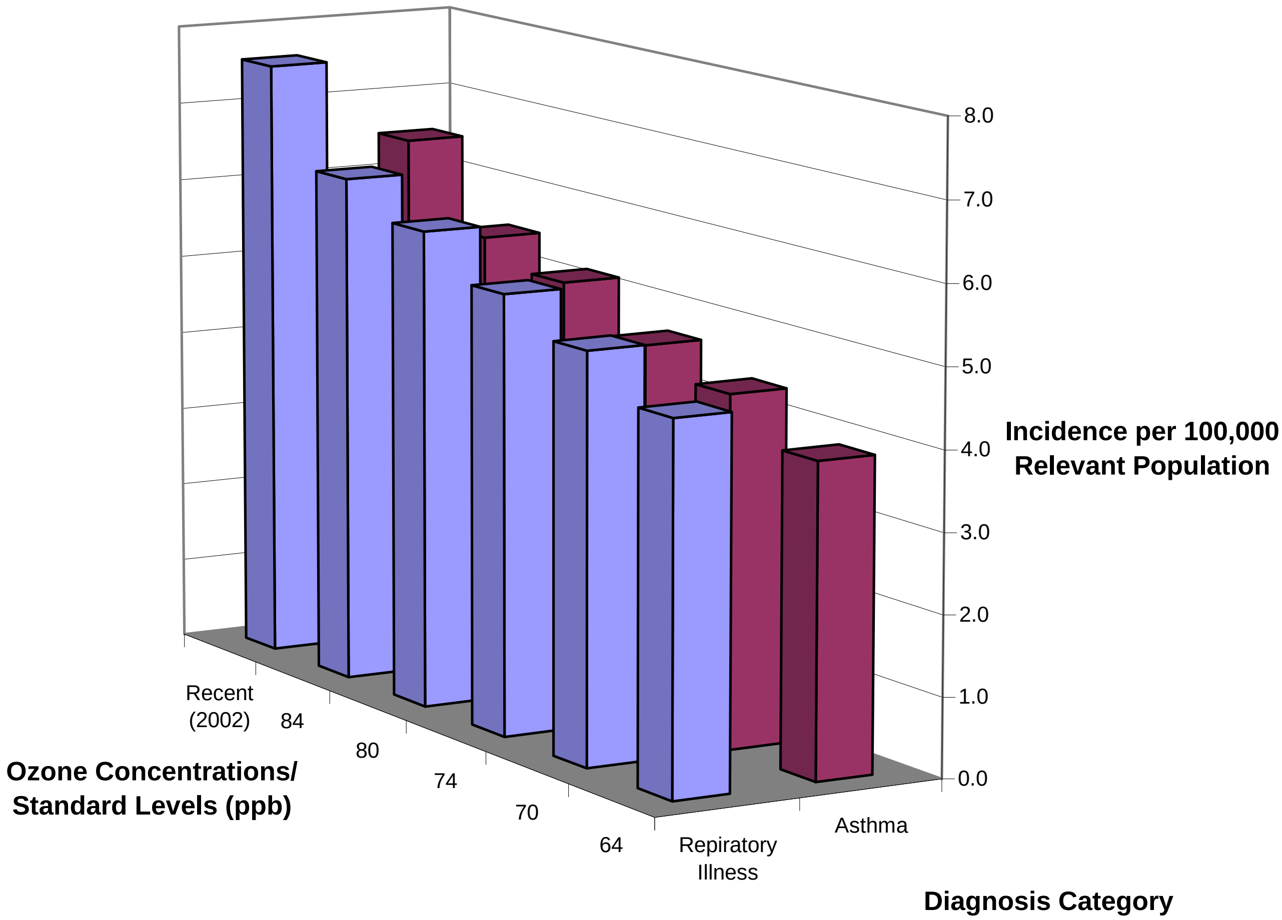


Figure 5C-5. Estimated Incidence of Non-Accidental Mortality per 100,000 Relevant Population Associated with Recent O3 Concentrations and with O3 Concentrations that Just Meet the Current and Alternative Average 4th Daily Maximum 8-Hour Standards: April – September, 2002

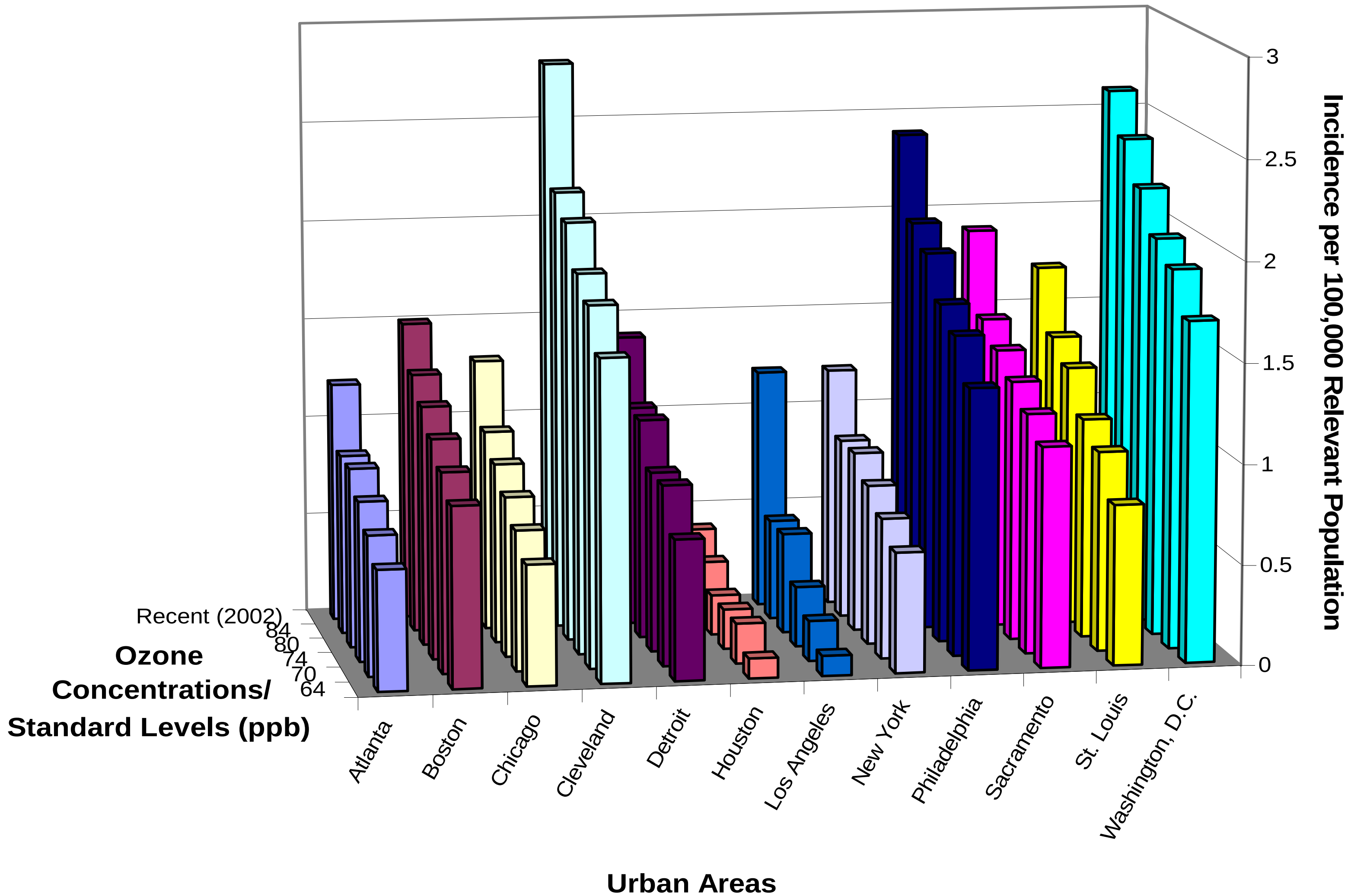
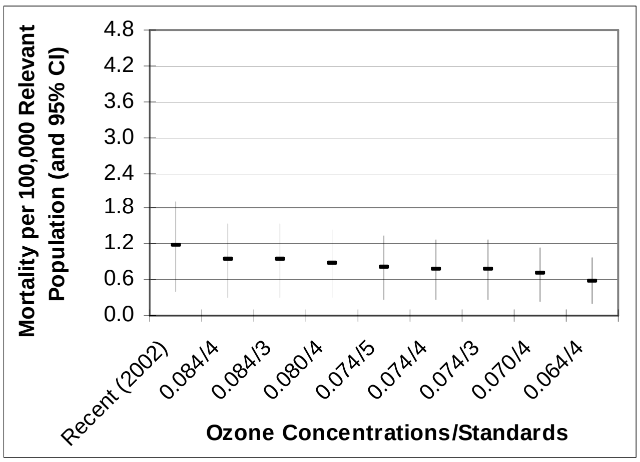
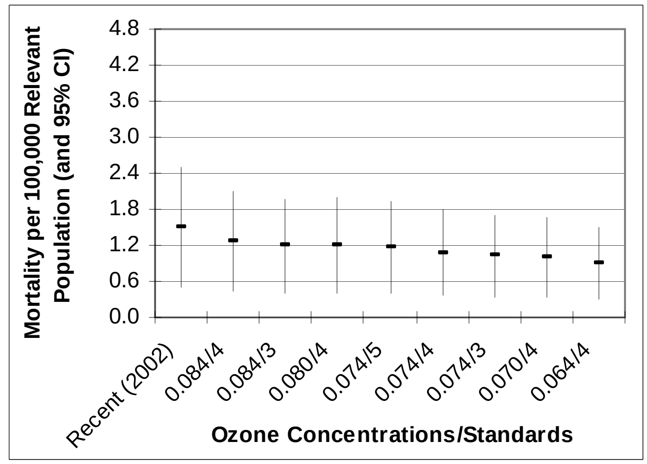


Figure5C-6a. Annual Warm Season (April to September) Estimated Cases of Ozone-Related Non-Accidental Mortality per Hundred Thousand Relevant Population Associated with Recent Air Quality (2002) and with Just Meeting Alternative 8-hr Ozone Standards (Using Bell et al., 2004 – 95 U.S. Cities), Based on 2002 Ozone Concentrations

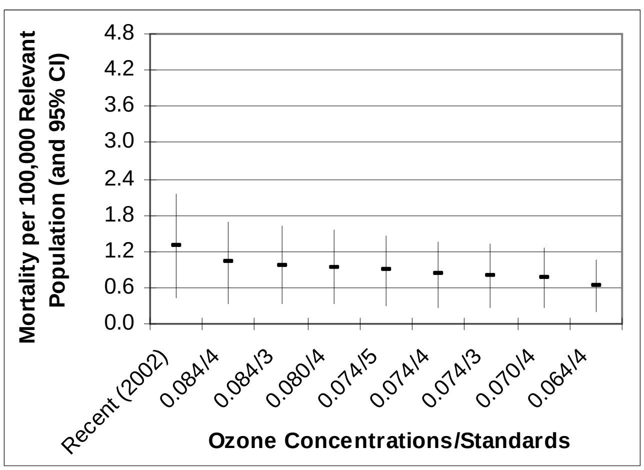
Atlanta



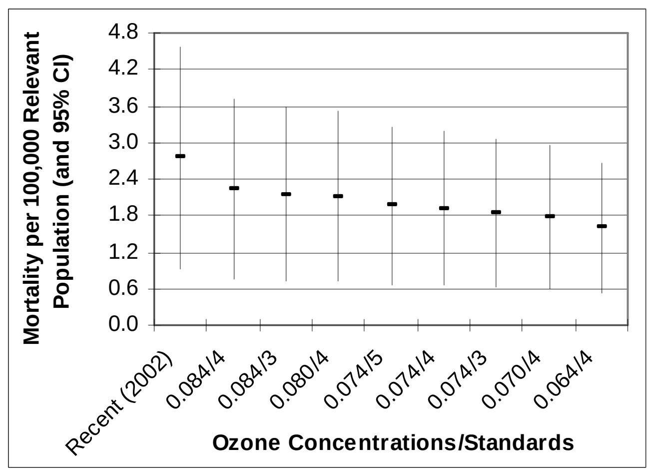
Boston



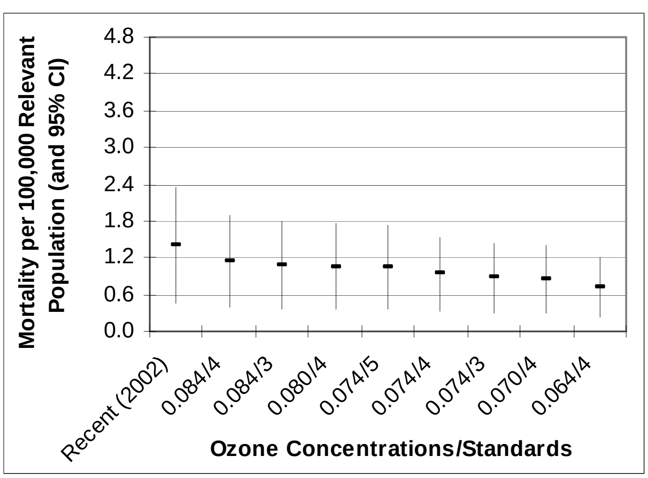
Chicago



Cleveland



Detroit



Houston

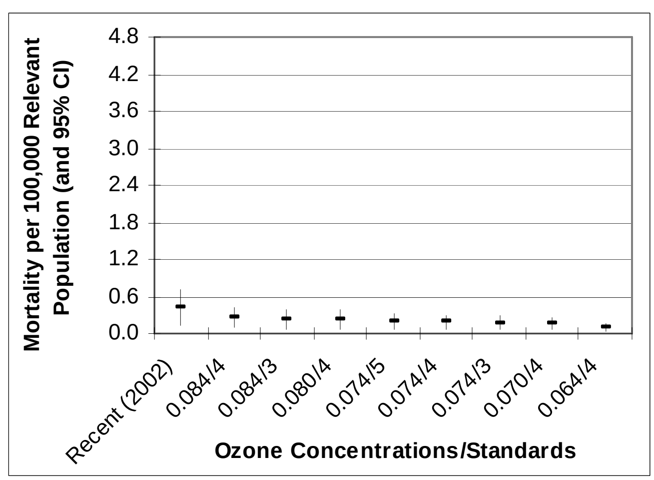
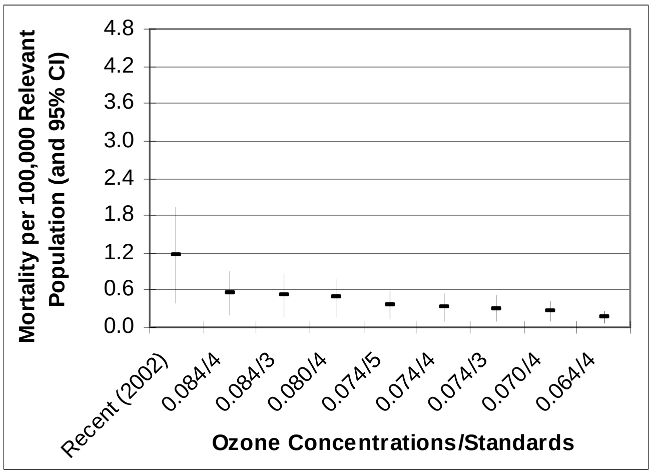
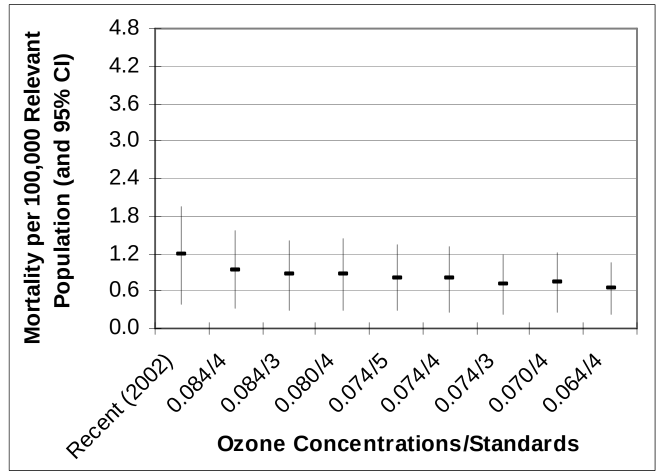


Figure 5C-6b. Annual Warm Season (April to September) Estimated Cases of Ozone-Related Non-Accidental Mortality per Hundred Thousand Relevant Population Associated with Recent Air Quality (2002) and with Just Meeting Alternative 8-hr Ozone Standards (Using Bell et al., 2004 – 95 U.S. Cities), Based on 2002 Ozone Concentrations (cont'd)

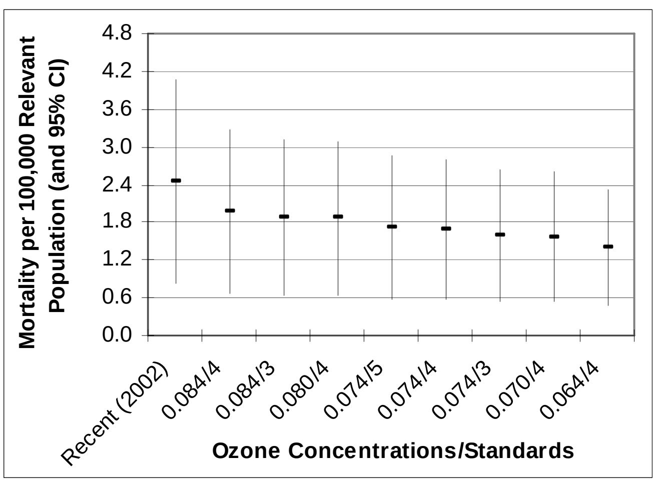
Los Angeles



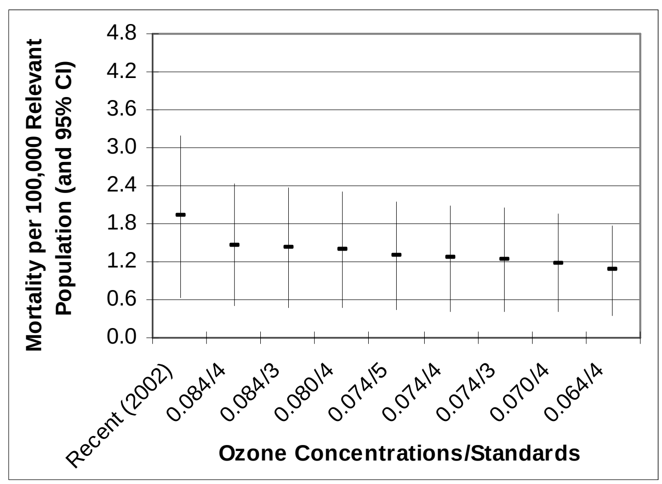
New York



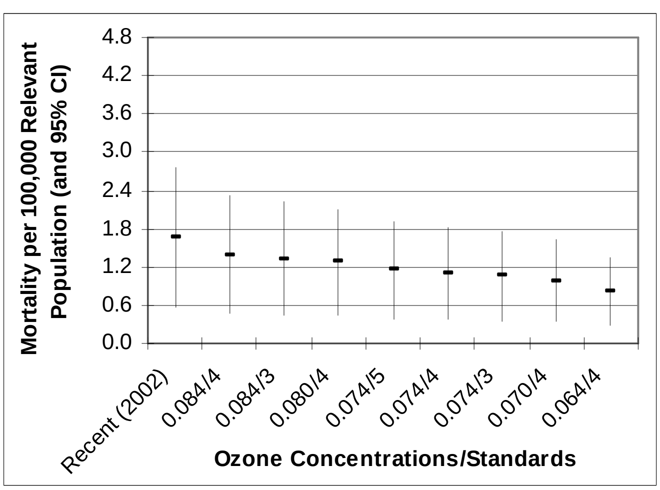
Philadelphia



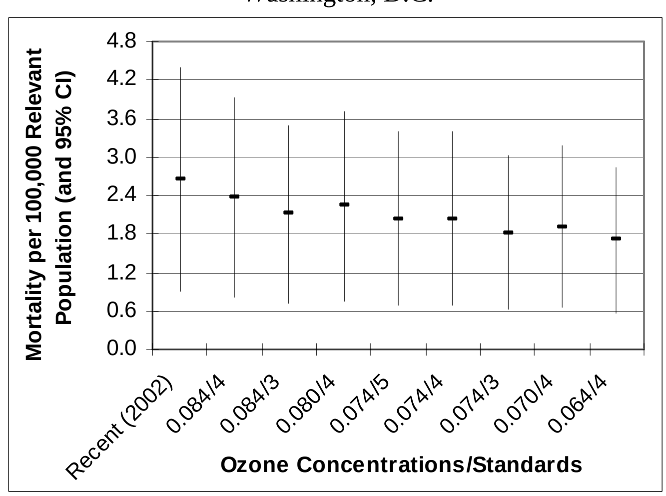
Sacramento



St. Louis



Washington, D.C.



APPENDIX 7A: BIOLOGICALLY RELEVANT FORMS OF AIR QUALITY INDICES APPROPRIATE FOR CHARACTERIZING VEGETATION EXPOSURES AND ASSOCIATED LEVELS

APPENDIX 7A.

This appendix provides a general overview of several biologically relevant forms considered appropriate for characterizing exposures relevant to vegetation and currently in use or considered for use in a management context.

CUMULATIVE, CONCENTRATION WEIGHTED FORMS: SUM06, W126, AOT40

In an analysis done by Lee, et al., 1989, a group of cumulative, concentration-weighted forms performed equally well in predicting crop yield loss using data from the NCLAN studies. All three indices were evaluated in the 1996 Staff Paper. In some cases such O_3 exposure indices have been shown to explain O_3 effects as well or better than calculated internal O_3 dose (Grulke, et al. 2002; Hanson et al., 1994). Additional research needs to be done to better evaluate the performance of these indices under a wide range of exposure scenarios.

In the interim between the 1996 proposal notice and the 1997 final rule, the results of a consensus-building workshop on the need for a long-term cumulative secondary O_3 standard were published. At this workshop, expert scientists expressed their judgments on what standard form(s) and level(s) would provide vegetation with adequate protection from O_3-related adverse effects. After agreeing that some form of a cumulative standard would be most appropriate for a secondary standard, consensus was achieved that the SUM06 and W126 forms would give very similar protection against O_3 effects on vegetation. It was agreed that SUM06 was an acceptable form of a secondary standard with the caveat that the acceptance of the SUM06 should not be interpreted as an acceptance of a threshold (Heck and Cowling, 1997).

Consensus was also reached with respect to selecting appropriate levels in terms of a 3-month, 12-hr SUM06 standard. Below are the 3-month, 12-hr SUM06 ranges participants agreed should be considered for a number of endpoints. For foliar injury to natural ecosystems – a SUM06 range of 8 to 12 ppm-hr; for growth effects to tree seedlings in natural forest stands – a range of 10 to 15 ppm-hr; for growth effects to tree seedlings and saplings in plantations – a range of 12 to 16 ppm-hr; and for yield reductions in agricultural crops – a range of 15 to 20 ppm-hr (Heck and Cowling, 1997). Staff note that the AOT40 is another cumulative, concentration weighted form that is currently in use in Europe. This form cumulates the area over the 40 ppb threshold by subtracting 40 ppb from the value of the measured O_3 level. See the Critical Level discussion below for levels of the AOT40 identified with protection for various vegetation effects endpoints.

FLUX-BASED INDICES

As discussed in Chapter 7 above, a measure or prediction of plant O_3 uptake is intuitively a better predictor of plant response to O_3 exposure in the field than a measure of ambient exposure because it accounts for the plant's integration of environmental factors that influence stomatal conductance. In practice, however, there are a number of complicating factors that are not easily accounted for in predictive uptake models. These include:

(1) The potential disconnect between the timing of two diunal patterns: 1) of maximum stomatal conductance and 2) the timing of peak exposure events. In the absence of synchronicity between these patterns, maximal stomatal conductance of O_3 will not occur and the predicted O_3 effect for that species/individual on the basis of flux will be an overestimation. This concern is especially apparent when assessing the impact of O_3 across all the varied climatic regions and species occurring within the United States.

(2) Not all O_3 stomatal uptake results in a reduction in yield. This nonlinear relationship between O_3 uptake and plant injury (not growth alteration) response depends to some degree on the amount of internal detoxification occurring with each particular species; species having high amounts of detoxification potential may show less of a relationship between O_3 stomatal uptake and plant response. Because detoxification potential is genetically determined, it cannot be generalized across species. Scientific understanding of the detoxification mechanisms is not yet complete, so that much more needs to be learned about the detoxification processes available to plants and to what extent they modify the potentially phytotoxic dose in the leaf interior before this factor can be meaningfully considered in a biologically-relevant index.

(3) The varying significance of nocturnal stomatal conductance. Musselman and Minnick (2000) performed an extensive review of the literature and reported that a large number of species had varying degrees of nocturnal stomatal conductance (Musselman and Minnick, 2000). Although stomatal conductance was lower at night than during the day for most plants, nocturnal conductance could result in some measurable O_3 flux into the plants. In addition, it was suggested that plants might be more susceptible to O_3 exposure at night than during the daytime, because of possibly lower plant defenses at night (Musselman and Minnick, 2000). Nocturnal O_3 flux also depends on the level of

turbulence that intermittently occurs at night. Thus, it would appear that the importance of nocturnal conductance and its contribution to total diurnal flux is species and site specific. For additional information on nocturnal conductance see Chapter 9 and AX9 of CD (EPA, 2006).

As is evident from the above discussion, multiple meteorological, species- and site-specific factors influence O_3 uptake. In order to integrate those factors that drive the patterns of stomatal conductance and exposure, the use of O_3 flux models is required. Though significant new research into flux model development has occurred since the last review, at this point in time these models remain species and site specific which limits their usefulness in national or regional scale risk assessments. However, in some countries, efforts are under way to incorporate flux into the policy context (see Critical Level discussion below).

The Critical Level Approach

Both the concentration-based and flux-based exposure index forms can be used to establish a "critical level" for plant exposure to O_3. One definition of a critical level is "the concentration of pollutant in the atmosphere above which direct adverse effects on receptors, such as plants, ecosystems, or materials may occur according to present knowledge" (UNECE, 1988). As used by the United Nations Economic Commission for Europe International Cooperative Programme (UNECE ICP), the critical levels are not air quality regulatory standards in the U.S. sense, but rather planning targets for reductions in pollutant emissions to protect ecological resources. Critical levels for O_3 are intended to prevent long-term deleterious effects on the most sensitive plant species under the most sensitive environmental conditions, but not to quantify O_3 effects. The nature of the "adverse effects" was not specified in the original definition, which provided for different levels for different types of harmful effect (e.g., visible injury or loss of crop yield). There are also different levels for crops, forests, and seminatural vegetation. The caveat, "according to present knowledge," is important because critical levels are not rigid; they are revised periodically as new scientific information becomes available. To date, critical levels (Level I) have been set for agricultural crops, for foliar injury symptoms in the field and for forest trees in terms of the AOT40 index (see section 7.2.5 and EPA, 2005b). Specifically, critical levels of a 3 month, 3 ppm-hr and a 6 month, 10 ppm-hr AOT40 have been established for crops and tree seedlings, respectively. An additional provisional level of 7 ppm-hr over 6 months for herbaceous perennials has been recommended. Level I critical levels are currently used to map and identify areas in

Europe in which the levels are exceeded, and that information is then used to plan optimized and effects-based abatement strategies.

In the 1990s, however, many exposure studies demonstrated that the simple, exposure-based approach led to the overestimation of effects in some regions and underestimation in others (Fuhrer et al., 1997; Kärenlampi and Skärby, 1996) because it did not differentiate between plant species, and it did not include modifying site and micrometeorological factors of O_3 uptake such vapor pressure deficit (VPD), water stress, temperature, and light and variation in canopy height. At that time, a decision was made by the UNECE ICP to work towards a flux-based approach for the critical levels ("Level II"), with the goal of modeling O_3 flux-effect relationships for three vegetation types: crops, forests, and seminatural vegetation (Grünhage and Jäger, 2003). Progress has been made in modeling flux (Ashmore et al., 2004a,b) and the Mapping Manual is being revised (Ashmore et al., 2004a,b; Grennfelt, 2004; Karlsson et al., 2003). The revisions may include a flux-based approach for three crops: wheat, potatoes, and cotton. However, because of a lack of flux-response data, a cumulative, cutoff concentration-based (e.g., AOT40) exposure index will remain in use for the near future for most crops and for forests and seminatural herbaceous vegetation (Ashmore et al., 2004a).

Summary

Flux-based models are currently limited by the species-specific information required and by the observed nonlinearity between total flux and plant response. Better understanding of the detoxification and compensation processes would be required to account for this nonlinearity in future models. Other relevant information that should be evaluated include the extent to which: (1) nighttime exposures represent a significant percentage of total diurnal exposures, and whether their impact on growth or foliar injury effects are proportional; (2) the degree to which elevation and nocturnal turbulence alter actual nocturnal uptake; and (3) differences in plant defense mechanisms and other processes at night.

Until such research can be done, the current CD (EPA, 2006) concludes that, at this time, based on the current state of knowledge, exposure indices that differentially weight the higher hourly average O_3 concentrations but include the mid-level values still represent the best approach for relating vegetation effects to O_3 exposure in the U.S.. This is due in part to the existence of a large database that has been used for establishing exposure-response relationships. Such a database does not yet exist for relating O_3 flux to growth response.

Staff anticipate that, as the overlapping mathematical relationships of conductance, concentration, and defense mechanisms are better defined, O_3-flux-based models may be able to predict vegetation injury and/or damage at least for some categories of canopy-types with more accuracy than the currently available exposure-response models. The results of these studies and reviews indicate the need to continue to develop indices that are more physiologically and meteorologically connected to the actual dose of O_3 the plant receives. The flux approach should provide an opportunity to improve upon the concentration-based exposure index in the future, recognizing that a concerted research effort is needed to develop the necessary experimental data and modeling tools that will provide the scientific basis for such critical levels for O_3 (Dämmgen et al., 1994; Fuhrer et al., 1997; Grünhage et al., 2004).

APPENDIX 7B: CMAQ EXPOSURE MODEL

APPENDIX 7B.

Staff investigated the appropriateness of using the spatial scaling from the EPA/NOAA Community Multi-scale Air Quality (CMAQ) model system (http://www.epa.gov/asmdnerl/CMAQ, Byun and Ching, 1999; Arnold et al. 2003, Eder and Yu, 2005) O_3 outputs to improve spatial interpolations based on a regionally limited and unevenly distributed O_3 monitoring network in the western U.S. (see section 7.5.3). The CMAQ model is a multi-pollutant, multiscale air quality model that contains state-of-science techniques for simulating all atmospheric and land processes that affect the transport, transformation, and deposition of atmospheric pollutants and/or their precursors on both regional and urban scales. It is designed as a science-based modeling tool for handling many major pollutants (including photochemical oxidants/O_3, particulate matter, and nutrient deposition) holistically. The CMAQ model can generate estimates of hourly O_3 concentrations for the contiguous U.S., making it possible to express model outputs in terms of a variety of exposure indices (e.g., SUM06, 8-hr average). Due to the significant resources required to run CMAQ, however, model outputs are only available for a limited number of years. For this review, 2001 outputs from CMAQ version 4.5 were the most recent data available. This version of CMAQ utilizes the more refined 12 km x 12 km grid for the eastern U.S., while using the 36 km x 36 km grid for the western U.S. The 12 km x 12 km domain covers an area from roughly central Texas, north to North Dakota, east to Maine, and south to central Florida.

The CMAQ modeling system has undergone two external peer reviews through the Community Modeling and Analysis System (CMAS) based at the University of North Carolina at Chapel Hill (UNC) Carolina Environmental Program (Amar et al. 2005, 2004). In addition, EPA/NOAA recently conducted an initial evaluation of the eastern U.S. domain of CMAQ version 4.5 (Appel et al., 2005; http://www.cmascenter.org/docs/CMAQ/v4.5/CMAQv4.5_EvaluationDocument-Final2005.pdf). Based on this evaluation, hourly O_3 patterns are predicted well during the daytime. The prediction of daily maximum 8-hr average O_3 was relatively good, showing a slight positive normalized mean bias of 1.62% and a normalized mean error of 17.4%. Overall, CMAQ predictions of daily maximum 8-hr O_3 averages were improved in the 12 km x 12 km grid size when compared to the 36 km x 36 km grid size. However, the CMAQ consistently over-predicted hourly O_3 at night. Since many of the assessments outlined below rely daytime O_3 accumulated in the 12-hr SUM06 (8 am-8 pm), the night-time over-prediction is less of an issue.

The results of the CMAQ version 4.5 evaluation should be used with caution for several reasons. First, this evaluation ignores the mismatch of spatial resolution and treats CMAQ output as a point-value, a concern raised by Fuentes and Rafterty 2005. The problem is well known, but is often ignored since there are not standard operational methods that can be applied to the CMAQ model output to deal with this problem. Secondly, the size of the grid being used is unable to capture the rapidly changing O_3 gradients that often occur in complex terrain, across urban/rural gradients and along coastal areas. In these cases significant differences in O_3 concentration could occur with a 12x12km cell and the uncertainties associated with these areas are unknown. Many such features occur in rural areas of importance in this assessment and it is recognized that any estimates of O_3 exposure in complex terrain are very uncertain. Unfortunately, complex terrain is of greater significance in the west, where the CMAQ grid is even larger and the monitoring network is for the most part, sparse. These limitations proved to be determinant in selecting an interpolation technique for the west.

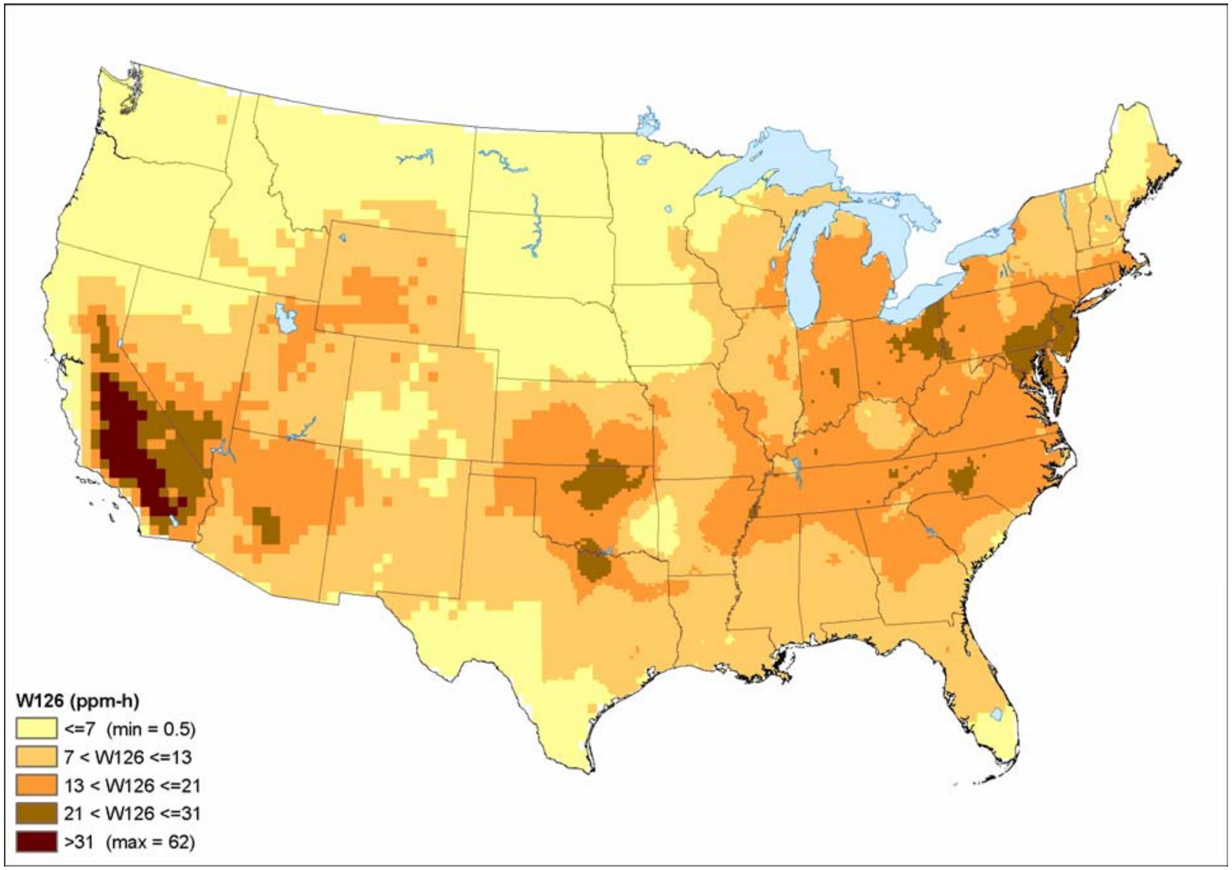
The CMAQ model incorporates output fields from emissions and meteorological modeling systems and several other data sources through special interface processors into the CMAQ Chemical Transport Model (CCTM). Currently, the Sparse Matrix Operator Kernel Emissions (SMOKE) System produces the emissions factors and the Fifth Generation Penn State University/ National Center for Atmospheric Research Mesoscale Model (MM5) provides the meteorological fields. CCTM then performs chemical transport modeling for multiple pollutants on multiple scales. Emission inventories of SO_2, CO, NOx, and VOCs are based on EPA's 2001 National Emission Inventory (NEI) and are consistent with inventories used for the analysis of the Clean Air Interstate Rule (CAIR) rule (EPA, 2005b). Biogenic emissions, from natural sources, were processed using the Biogenic Emissions Inventory System (BEIS) version 3.13. The staff recognizes that O_3 exposures vary between years depending on meteorology and other factors.

Recently EPA/NOAA conducted an initial evaluation of the eastern U.S. domain of CMAQ version 4.5 (Appel et al., 2005; http://www.cmascenter.org/docs/CMAQ/v4.5/CMAQv4.5_EvaluationDocument-Final2005.pdf). This evaluation used the same metrics published by Eder and Yu (2005) for the CMAQ version 4.4 model release. For the modeled summer months of June, July and August of 2001, CMAQ version 4.5 predictions were compared to AQS monitor sites. The prediction of daily maximum 8-hr average O_3 was relatively good, showing a slight positive normalized mean bias of 1.62% and a normalized mean error of 17.4%. Hourly ozone patterns are predicted well during the daytime. However, the CMAQ consistently over-predicted hourly O_3 at night. Nighttime over-predictions in O_3 have been improved over CMAQ version 4.4 by modifications to the minimum K_z approximation in CMAQ version 4.5, but additional investigations are needed. Again, since many of the assessments outlined below rely daytime O_3 accumulated in the 12-hr SUM06 (8 am to 8 pm), the night-time over-prediction is less of an issue. Overall, CMAQ predictions of daily 8hr O_3 averages were improved in the 12km x 12km grid size when compared to the 36km x 36km grid size. Since CMAQ output is averaged over large square blocks and monitor observations are effectively averages over much smaller regions, CMAQ output and monitor observations have a mismatch in spatial resolution. (Fuentes and Rafterty 2005). The problem is well known, but is often ignored since there are not standard operational methods that can be applied to the CMAQ model output to deal with this problem. The CMAQ version 4.5 evaluation described above ignores the mismatch of spatial resolution and treats CMAQ output as a point-value. The staff believes this simplification is reasonable in flat rural areas where many important crops and vegetation grow, because O_3 is a secondary pollutant and its concentration generally varies fairly smoothly across those areas. However, O_3 is notably more variable in complex terrain, across urban/rural gradients and along coastal areas. In these cases significant differences in O_3 concentration could occur with a 12x12km cell and the uncertainties associated with these areas are unknown. The current assessment is most concerned with rural areas and it is recognized that any estimates of O_3 exposure in complex terrain are very uncertain. Unfortunately, complex terrain is of greater significance in the west, where the CMAQ grid is larger and the monitoring network is for the most part, sparse. These limitations proved to be determinant in selecting an interpolation technique for the west.

APPENDIX 7C. INTERPOLATED 3MONTH, 12-HR W126 EXPOSURES

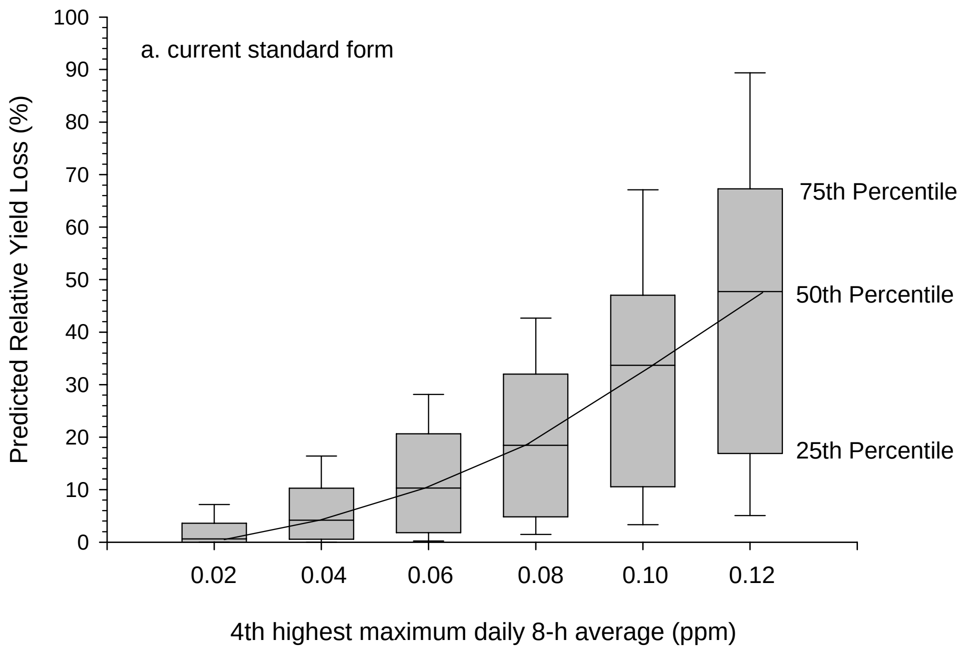
Figure 7C-1. Estimated 12-Hr W126 Ozone Exposure – Max 3-months for 2001

"As Is" scenario



APPENDIX 7D. NCLAN RE-ANALYSIS USING THE 8-HR AVERAGE METRIC

Figure 7D-1. Median crop yield loss from NCLAN crops characterized the annual 4th highest maximum 8-hr average (the current standard form).



Distribution of biomass loss predictions from Weibull exposure-response models that relate yield to O_3 exposure characterized with the 4th highest max. 8-hr average statistic using data from 31 crop studies from National Crop Loss Assessment Network (NCLAN). Separate regressions were calculated for studies with multiple harvests or cultivars, resulting in a total of 54 individual equations from the 31 NCLAN studies. Each equation was used to calculate the predicted relative yield or biomass loss at 0.02, 0.04, 0.06, 0.10 and 0.12 ppm, and the distributions of the resulting loss were plotted. The solid line represents the Weibull fit at the 50th percentile.

APPENDIX 7E. C-R FUNCTIONS USED IN CROP AND TREE SEEDLING ANALYSES

Table 7E-1. Ozone Exposure-Response Functions for Selected NCLAN Crops

Ozone Index	Quantity	Crop	Function
W126	Max	Cotton	1-exp(-(index/74.6)^1.068)
W126	Min	Cotton	1-exp(-(index/113.3)^1.397)
W126	Median	Cotton	1-exp(-(index/96.1)^1.482)
W126	Max	Field Corn	1-exp(-(index/92.7)^2.585)
W126	Min	Field Corn	1-exp(-(index/94.2)^4.167)
W126	Median	Field Corn	1-exp(-(index/97.9)^2.966)
W126	Median	Grain Sorghum*	1-exp(-(index/205.9)^1.963)
W126	Median	Peanut*	1-exp(-(index/96.8)^1.890)
W126	Max	Soybean	1-exp(-(index/130.1)^1)
W126	Min	Soybean	1-exp(-(index/476.7)^1.113)
W126	Median	Soybean	1-exp(-(index/110.2)^1.359)
W126	Max	Winter Wheat	1-exp(-(index/24.7)^1.0)
W126	Min	Winter Wheat	1-exp(-(index/76.8)^2.031)
W126	Median	Winter Wheat	1-exp(-(index/53.4)^2.367)
W126	Median	Lettuce*	1-exp(-(index/54.6)^4.917)
W126	Median	Kidney Bean*	1-exp(-(index/43.1)^2.219)
W126	Min	Potato	1-exp(-(index/113.8)^1.299)
W126	Max	Potato	1-exp(-(index/96.3)^1)
W126	Median	Potato	1-exp(-(index/99.5)^1.242)

Source: Lee and Hogsett (1996) table 10. *Peanuts, Grain Soghum, Lettuce and Kidney Bean only have one C-R function and therefore do not have a max and min.

Table 7E-2. Ozone Exposure-Response Functions for Selected Fruits and Vegetable Crops

Ozone Index	Quantity	Fruit/Vegetable	Function
12-hr	Median	Onion*	1-(5034-(10941*12hr))/(5034-(10941*base12))
7-hr	Median	Rice*	1-(exp(-((7hr/0.2016)^2.474)))/(exp(-((base7/0.2016)^2.474)))
12-hr	Median	Valencia Oranges*	1-(53.7-(261.1*12hr))/(53.7-(261.1*base12))
7-hr	Median	Cantaloupes*	1-(35.8-(280.8*7hr))/(35.8-(280.8*base7))
12-hr	Min	Grapes	1-(1.121-(6.63*12hr))/(1.121-(6.63*base12))
12-hr	Max	Grapes	1-(9315-(64700*12hr))/(9315-(64700*base12))
12-hr	Median	Grapes	1-(357.254-(2300*12hr))/(357.254-(2300*base12))
12-hr	Max	Tomatoes-Processing	1-(8590-(41277*12hr))/(8590-(41277*base12))
12-hr	Min	Tomatoes-Processing	1-(6315-(21070*12hr))/(6315-(21070*base12))
12-hr	Median	Tomatoes-Processing	1-(9055-(32367*12hr))/(9055-(32367*base12))

Source: Abt (1995) Exhibit 11. *Onions, Rice, Oranges, and Cantaloupes only have one C-R function and therefore do not have a max and min. base7 = 0.027 and base12 = 0.025 which are equal to the concentrations in the charcoal-filtered treatments.

Table 7E-3. Median Composite Ozone Exposure-Response Functions* for Tree Seedlings

Ozone Index	Quantity	Crop	Function
W126	Median	Ponderosa Pine	1-exp(-(index/159.63)^1.190)
W126	Median	Red Alder	1-exp(-(index/179.06)^1.2377)
W126	Median	Black Cherry	1-exp(-(index/38.92)^0.9921)
W126	Median	Tulip Poplar	1-exp(-(index/51.38)^2..0889)
W126	Median	Sugar Maple	1-exp(-(index/36.35)^5.7785)
W126	Median	E. White Pine	1-exp(-(index/63.23)^1.6582)
W126	Median	Red Maple	1-exp(-(index/318.12)^1.3756)
W126	Median	Douglas Fir	1-exp(-(index/106.83)^5.9631)
W126	Median	Aspen	1-exp(-(index/109.81)^1.2198)
W126	Median	Virginia Pine	1-exp(-(index/1714.64)^1)

Source: Lee and Hogsett (1996) table 14. *Individual exposure-response curves are reported using the 12-hr-SUM06 index adjusted to a 92-day exposure duration.

Table 7E-4. Median Percent Relative Yield Loss* for Crops

	Air Quality Scenarios				
Crops	**As Is (2001)**	**8-hr, 84 ppb**	**SUM06 25**	**8-hr, 70 ppb**	**SUM06 15**
Kidney Bean	3.8%	1.8%	0.3%	0.3%	0.1%
Grapes	23.5%	20.5%	16.6%	16.7%	15.0%
Lettuce	0.0%	0.0%	0.0%	0.0%	0.0%
Potato	12.6%	8.6%	3.2%	3.3%	2.0%
Rice	18.1	15.7%	11.2%	11.4%	9.8%
Grain Sorghum	1.0%	0.5%	0.1%	0.1%	0.1%
Cantaloupe	23.5%	19.1%	14.9%	14.8%	12.8%
Corn	0.2%	0.1%	0.0%	0.0%	0.0%
Cotton	7.7%	4.8%	1.3%	1.3%	0.7%
Onion	8.1%	7.0%	5.7%	5.8%	5.2%
Peanut	5.4%	3.1%	0.8%	0.7%	0.3%
Soybean	3.4%	1.7%	1.7%	0.8%	0.8%
Valencia Orange	17.0%	15.1%	12.0%	12.1%	10.8%
Tomato Processing	13.8%	11.9%	9.8%	9.8%	8.8%
Winter Wheat	1.4%	0.6%	0.1%	0.1%	0.0%

* Modified from Figures for Yield Loss (5-5) and Yield Gain (5.6 to 5-9) in the draft Environmental Assessment TSD (Abt, 2006)

Table 7E-5. Median Percent Relative Biomass Loss* for Tree Seedlings

	Air Quality Scenarios				
Tree Species	**As Is (2001)**	**8-hr, 84 ppb**	**SUM06 25**	**8-hr, 70 ppb**	**SUM06 15**
Aspen	12.0%	5.6%	6.3%	2.3%	3.3%
Black Cherry	40.9%	24.1%	25.5%	12.3%	15.9%
Douglas Fir	0.0%	0.0%	0.0%	0.0%	0.0%
Ponderosa Pine	19.9%	10.6%	3.1%	4.2%	2.2%
Red Alder	0.6%	0.6%	0.6%	0.6%	0.6%
Red Maple	2.3%	1.0%	1.1%	0.4%	0.5%
Sugar Maple	3.0%	0.2%	0.2%	0.0%	0.0%
Tulip Poplar	13.5%	3.6%	5.1%	0.8%	1.4%
Virginia Pine	1.2%	0.6%	0.7%	0.3%	0.4%
Eastern White Pine	13.6%	5.8%	5.6%	1.9%	2.4%

* Modified from Figures for Tree Seedling Biomass Loss (5-10) and Biomass Gain (5-11 to 5-14) in the draft Environmental Assessment TSD (Abt, 2006)

APPENDIX 7F. PREDICTED YIELD LOSS FOR SELECTED MAJOR COMMODITY CROPS BASED ON PLANTING AREAS AND PREDICTIONS OF 2001 O_3 EXPOSURE USING THE 12-HR W126 INDEX.

Figure 7F-1. Estimated corn yield loss based on interpolated 2001 3-month 12-hr W126

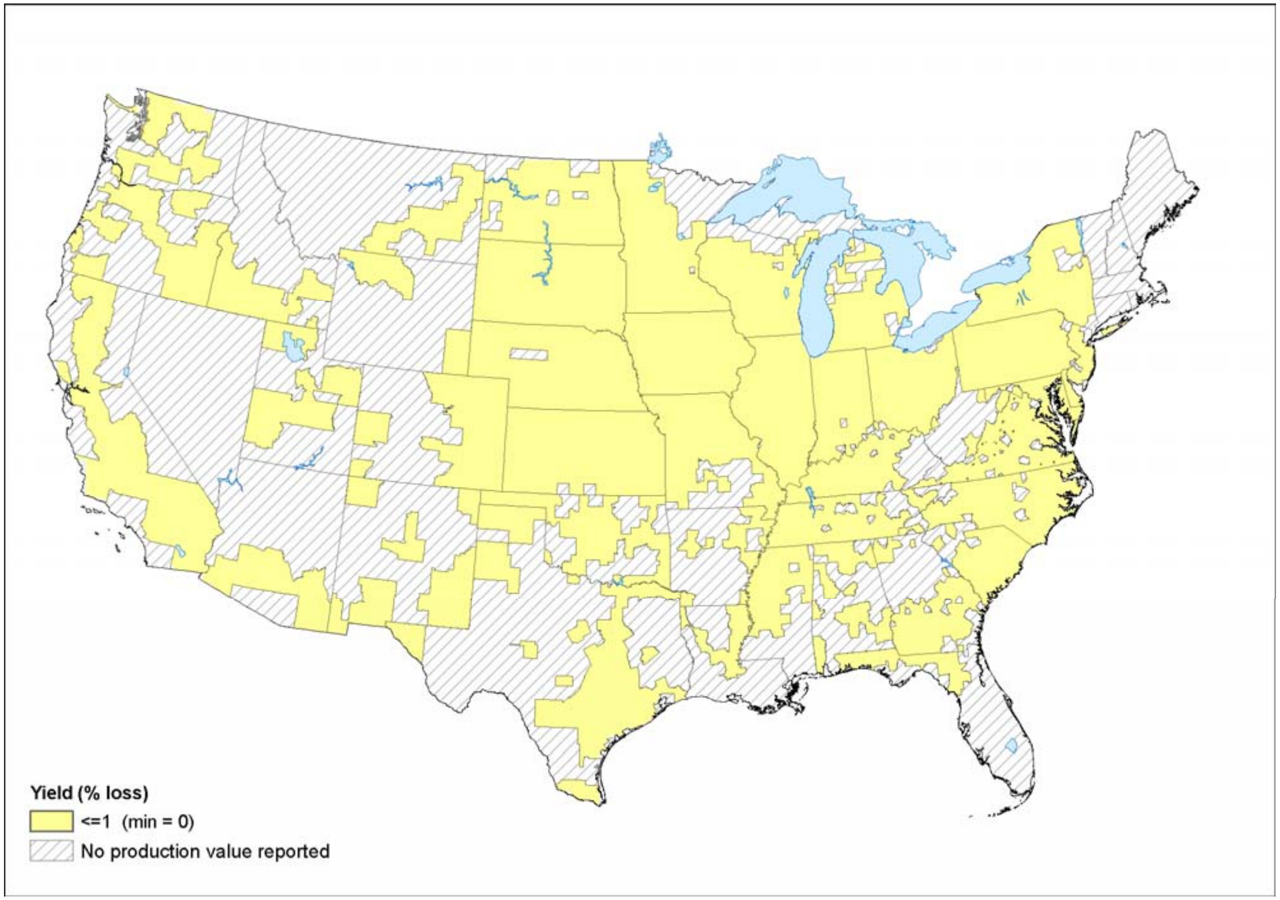


Figure 7F-2. Estimated cotton yield loss based on interpolated 2001 3-month 12-hr W126

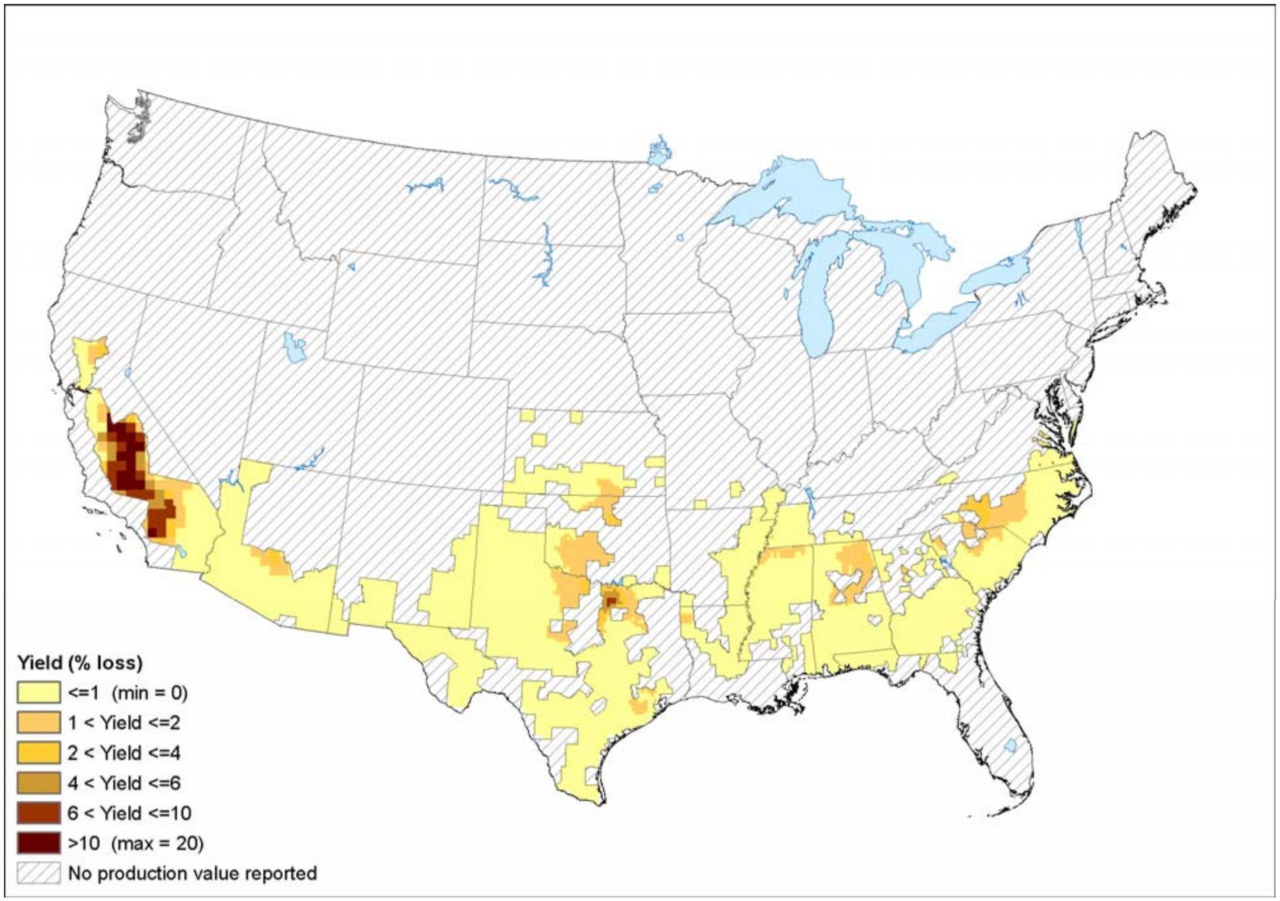
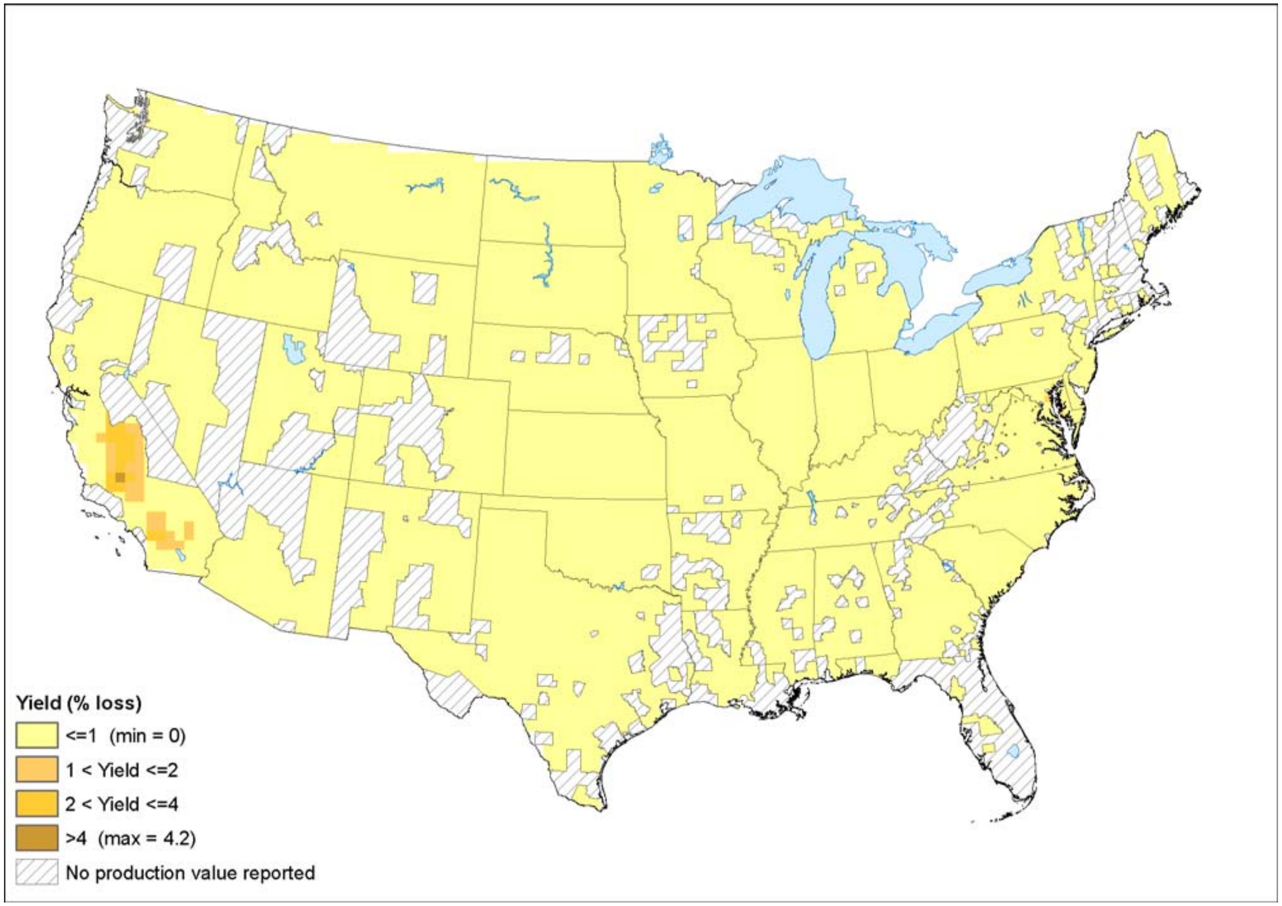
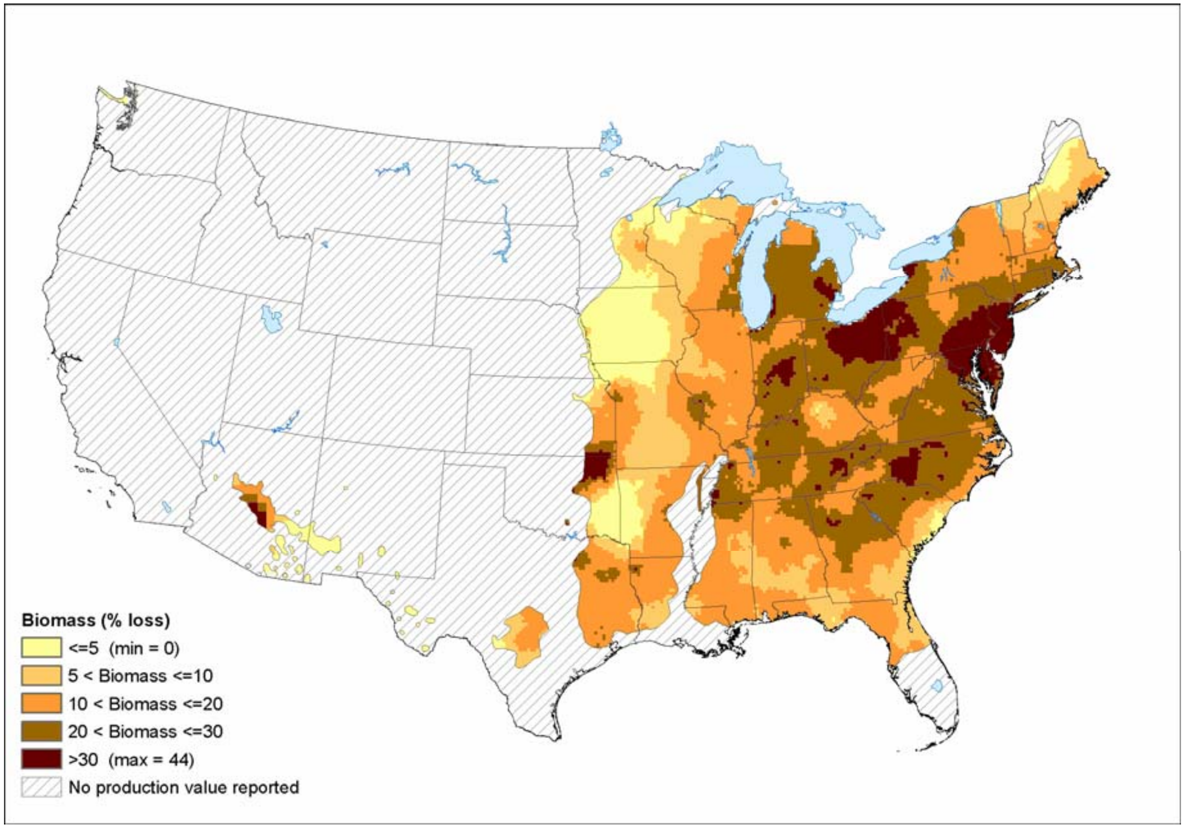


Figure 7F-3. Estimated winter wheat yield loss based on interpolated 2001 3-month 12-hr W126



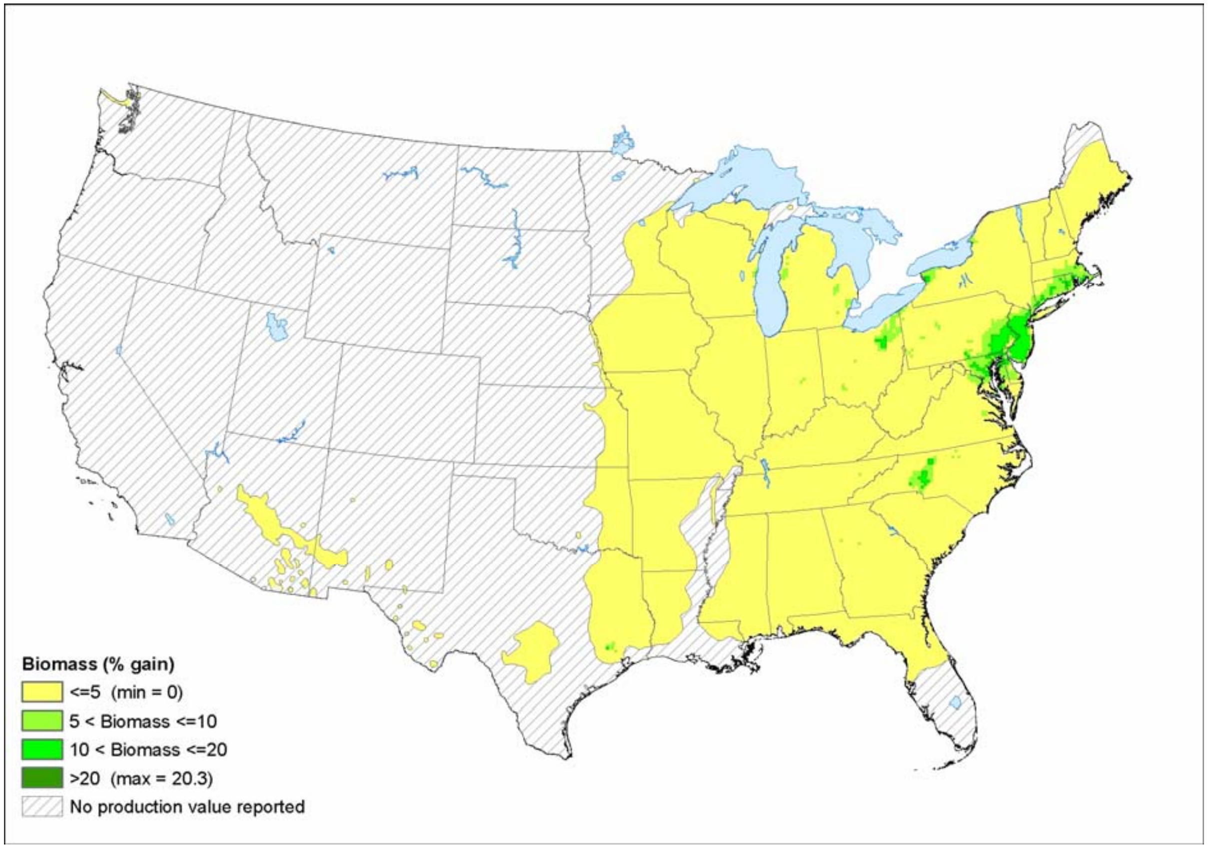
APPENDIX 7G. TREE SEEDLING BIOMASS LOSS AND GAIN MAPS UNDER VARYING AIR QUALITY SCENARIOS

Figure 7G-1. Estimated black cherry seedling* annual biomass **loss** based on interpolated 2001 air quality. Values expressed in terms of the 3-month 12-hr W126.



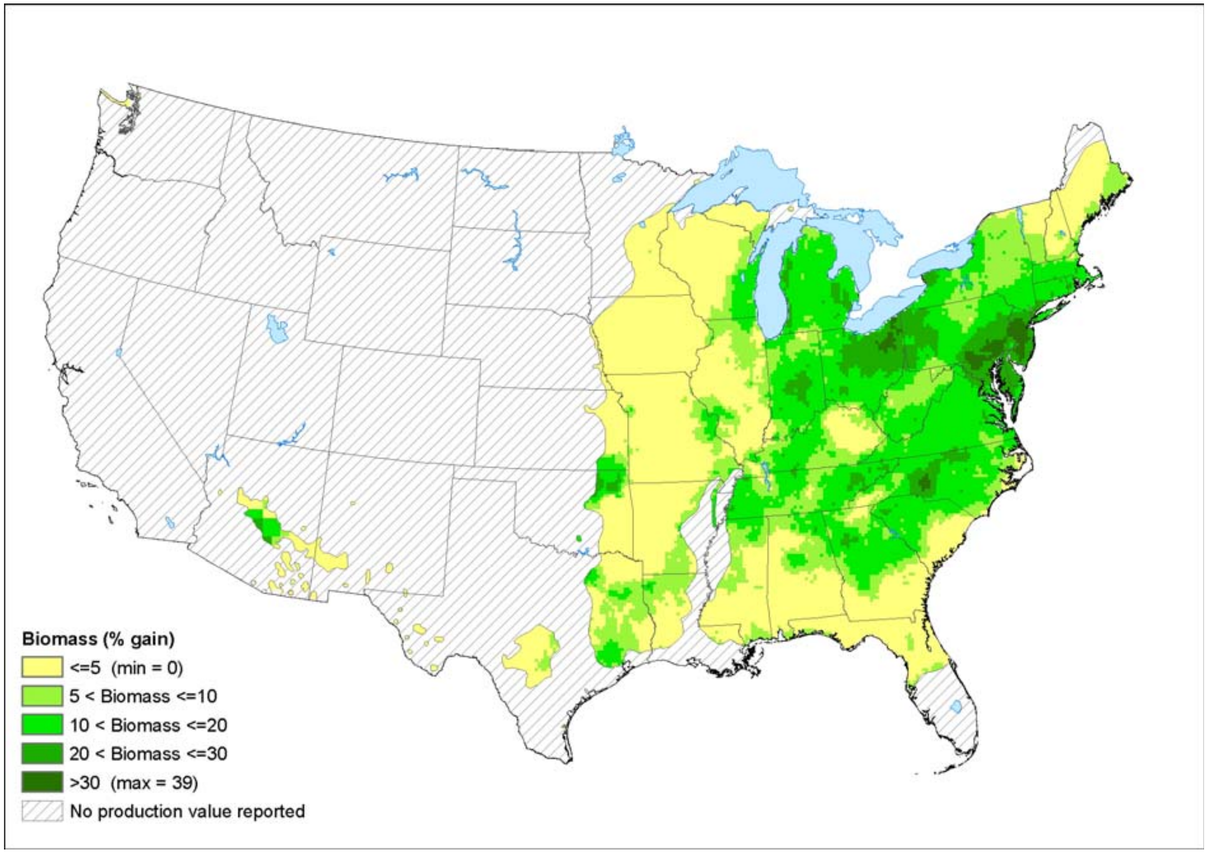
* This map indicates the geographic range for black cherry, but it does not necessarily indicate that black cherry will be found at every point within its range.

Figure 7G-2. Estimated black cherry seedling* annual biomass **gain** for air quality rolled-back to the 4th highest maximum 8-hr average of 0.08 ppm. Values expressed in terms of W126 form.



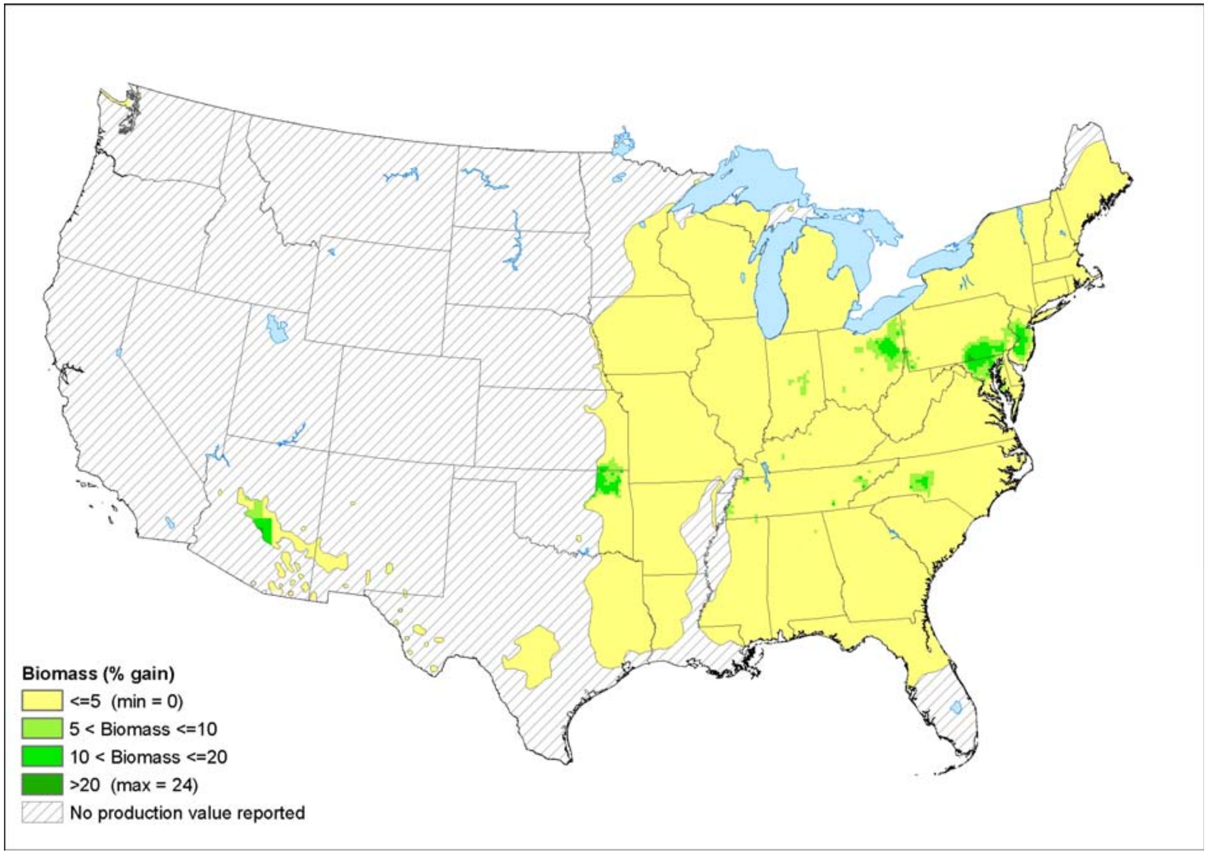
*.This map indicates the geographic range for black cherry, but it does not necessarily indicate that black cherry will be found at every point within its range.

Figure 7G-3. Estimated black cherry seedling* annual biomass **gain** for 2001interpolated air quality rolled-back to the 4th highest maximum 8-hr average of 0.070 ppm. Values expressed in terms of the 12-hr W126



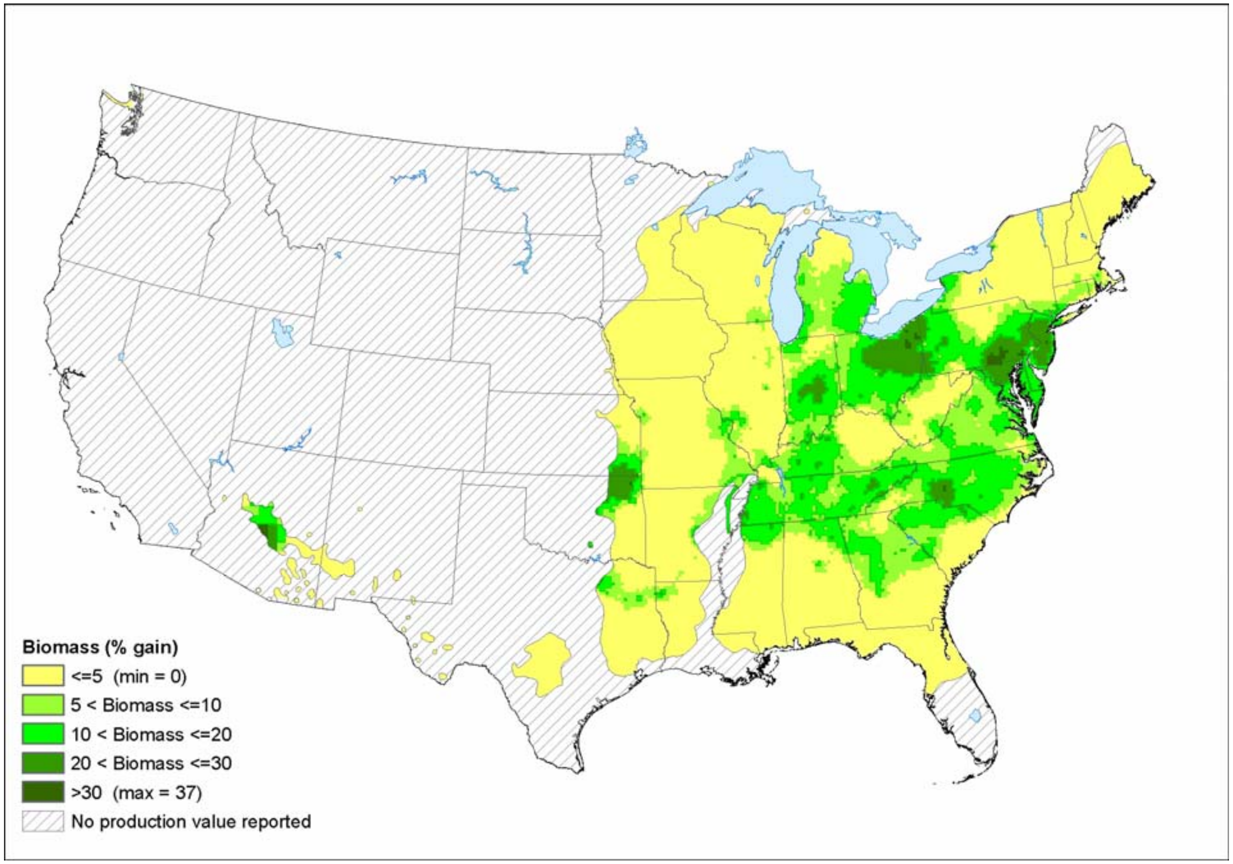
*.This map indicates the geographic range for black cherry, but it does not necessarily indicate that black cherry will be found at every point within its range.

Figure 7G-4. Estimated black cherry *seedling annual biomass **gain** for air quality rolled-back to the 12-hr SUM06 level of 25ppm-hr. Values expressed in terms of W126.



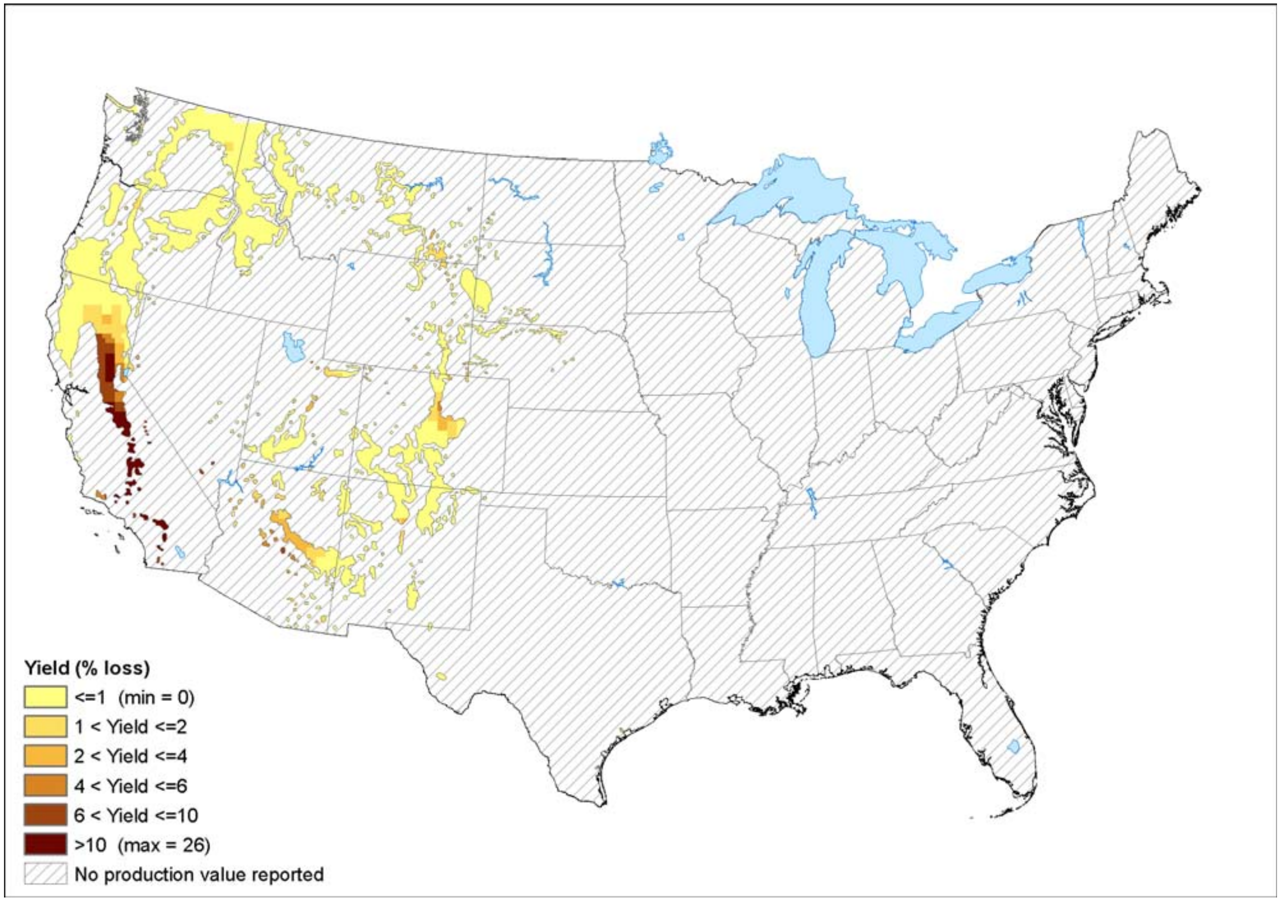
*.This map indicates the geographic range for black cherry, but it does not necessarily indicate that black cherry will be found at every point within its range.

Figure 7G-5. Estimated black cherry* seedling annual biomass **gain** for air quality rolled-back to a 12-hr SUM06 of 15 ppm-hr. Values expressed in terms of the 12-hr W126.



* This map indicates the geographic range for black cherry, but it does not necessarily indicate that black cherry will be found at every point within its range.

Figure 7G-6. Estimated ponderosa pine* seedling annual biomass **loss** based on interpolated 2001 air quality. Values expressed in terms of 12-hr W126.



*This map indicates the geographic range for ponderosa pine, but it does not necessarily indicate that ponderosa pine will be found at every point within its range.

APPENDIX 7H. COUNTY-LEVEL INCIDENCE OF FOLIAR INJURY

Figure 7H-1. 2002 County-level incidence of visible foliar injury in the eastern and western U.S. as measured by the US Forest Service FIA program