Review of the National Ambient Air Quality Standards for Ozone:

Policy Assessment of Scientific and Technical Information

Appendices to OAQPS Staff Paper – Second Draft
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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 O₃ may result in acute and chronic health effects.

Pulmonary Function Responses
The direct pulmonary effects of O₃ 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 O₃ 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 O₃, individual sensitivity to O₃, and the extent of tolerance resulting from previous O₃ 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 O₃ 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 O₃ and other respiratory irritants. Bronchial C-fibers and rapidly adapting receptors appear to be the primary modulators of O₃-induced changes in ventilatory rate and O₃ penetration in both humans and animals (CD, section 6.2.5.1).

Symptoms and Lung Function Changes
In addition to changes in ventilatory control, O₃ 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 O₃ is a reflex action and not a voluntary early termination of inspiration resulting from discomfort. An inhaled topical anesthetic substantially reduces O₃-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 FEV₁ responses is not explained by differences in O₃ 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- O₃ exposure pulmonary function changes and AHR (either early or late phase) are poorly correlated either in time or magnitude. Neither does post- O₃ 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 O₃-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, O₃-induced AHR appears to be a product of many mechanisms acting at different time periods and levels of the bronchial smooth muscle signaling 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 O₃ 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 O₃. Exposures to 1.0 ppm O₃...
for 3 hr have been found to decrease heart rate (HR), mean arterial pressure (MAP), and core
temperature (Tco) 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 O₃ 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, Tco 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 O₃, 5 days later by a 5 hr exposure to 0.3 ppm O₃, and 10 days later by a 5 hr
exposure to 0.5 ppm O₃ (Arito et al., 1997). Each of the O₃ 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 O₃ 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 VO₂ tended to decrease with the
increase in O₃ concentration for young (4 to 6 months) but not old (20 to 22 months) rats.

demonstrated that when HR was reduced during a 5-day, 0.5 ppm O₃ exposure, Tco and activity
levels also decreased. The decreases in Tco 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 O₃ inhalation.

Similar cardiovascular and thermoregulatory responses in rats to O₃ were reported by
Iwasaki et al. (1998). Repeated exposure to 0.1, 0.3, and 0.5 ppm O₃ 8 hr/day for 4 consecutive
days caused disruption of circadian rhythms of HR and Tco on the first and second exposure days
that was concentration-dependent. The decreased HR and Tco recovered to control values on the
third and fourth days of O₃ exposure.

The thermoregulatory response to O₃ 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 O₂ exposure (0.5 ppm) and
exercise (described as rest, moderate, or heavy) or CO₂-stimulated ventilation. Both intermittent
and continuous O₃ exposure caused decreases in HR and Tco and increases in BALF
inflammatory markers. Exercise in FA caused increases in HR and Tco while exercise in O₃
causde 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 O₃ 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 far 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 O₃ exposure in animal toxicology studies (Vesely et al., 1994a,b,c) raise the possibility of potential cardiovascular effects of acute O₃ exposures.

Earlier work demonstrated O₃-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 O₃. 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 O₃ 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 O₃ 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 O₃ for 3 hr while at intermittent exercise, at 30 L/min. For all subjects combined (no significant group differences), there was an O₃-induced decrement of 7% in FEV₁ 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 O₃ in either the hypertensive or normal subjects. Foster et al. (1993) demonstrated that even in relatively young healthy adults (26.7 ± 7 yrs old), O₃ exposure can cause ventilation to shift away from the well perfused basal lung. This effect of O₃ 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 O₃ 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 O₃ 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.

<table>
<thead>
<tr>
<th>Study; Location</th>
<th>Effect Estimate (lower CL, upper CL)</th>
<th>Air Quality Data from Study *</th>
<th>Statistics for 8-hr daily max air quality data **</th>
<th>Study period; Monitoring information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ave time; Lag</td>
<td>Mean</td>
<td>98th %</td>
</tr>
<tr>
<td>Respiratory Symptoms:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortimer et al., 2002</td>
<td>1.35 (1.06, 1.71)</td>
<td>8h</td>
<td>48</td>
<td>64.3</td>
</tr>
<tr>
<td>8 U.S. cities</td>
<td>morning symptoms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gent et al., 2003</td>
<td>1.19 (1.05, 1.34)</td>
<td>8h</td>
<td>51.3</td>
<td>95.2</td>
</tr>
<tr>
<td>New England cities</td>
<td>chest tightness</td>
<td>1d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gent et al., 2003</td>
<td>1.17 (1.03, 1.33)</td>
<td>8h</td>
<td>51.3</td>
<td>95.2</td>
</tr>
<tr>
<td>New England cities</td>
<td>shortness of breath</td>
<td>1d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ostro et al., 2001</td>
<td>1.15 (1.12, 1.19)</td>
<td>1h</td>
<td>59.5/</td>
<td>121</td>
</tr>
<tr>
<td>2 S Cal counties</td>
<td>Asthma med use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ostro et al., 2001</td>
<td>1.01 (0.92, 1.10)</td>
<td>1h</td>
<td>59.5/</td>
<td>121</td>
</tr>
<tr>
<td>2 S Cal counties</td>
<td>shortness of breath</td>
<td>3d</td>
<td>95.8</td>
<td></td>
</tr>
<tr>
<td>Ostro et al., 2001</td>
<td>0.94 (0.88, 1.00)</td>
<td>1h</td>
<td>59.5/</td>
<td>121</td>
</tr>
<tr>
<td>2 S Cal counties</td>
<td>Wheeze</td>
<td>3d</td>
<td>95.8</td>
<td></td>
</tr>
<tr>
<td>Ostro et al., 2001</td>
<td>0.93 (0.87, 0.99)</td>
<td>1h</td>
<td>59.5/</td>
<td>121</td>
</tr>
<tr>
<td>2 S Cal counties</td>
<td>Cough</td>
<td>3d</td>
<td>95.8</td>
<td></td>
</tr>
<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study *</td>
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<td>Study period; Monitoring information</td>
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<tr>
<td>----------------</td>
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</tr>
<tr>
<td>Neas et al., 1995 Uniontown PA pm cough</td>
<td>1.36 (0.86, 2.14)</td>
<td>12h 0d 37.2 (56.1)</td>
<td>98th %</td>
<td>99th %</td>
</tr>
<tr>
<td>Delfino et al., 2003 San Diego, CA Symptom score&gt;1</td>
<td>0.75 (0.24, 2.33)</td>
<td>8h 0d 17.1</td>
<td>98th %</td>
<td>99th %</td>
</tr>
<tr>
<td>Delfino et al., 2003 San Diego, CA Symptom score&gt;1</td>
<td>1.55 (0.52, 4.63)</td>
<td>8h 1d 17.1</td>
<td>98th %</td>
<td>99th %</td>
</tr>
<tr>
<td>Delfino et al., 2003 San Diego, CA Symptom score&gt;2</td>
<td>6.67 (1.09, 40.88)</td>
<td>8h 0d 17.1</td>
<td>98th %</td>
<td>99th %</td>
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<tr>
<td>Delfino et al., 2003 San Diego, CA Symptom score&gt;2</td>
<td>1.15 (0.41, 3.17)</td>
<td>8h 1d 17.1</td>
<td>98th %</td>
<td>99th %</td>
</tr>
<tr>
<td>Delfino et al., 1998 San Diego, CA Asthma symptoms</td>
<td>1.26 (1.00, 1.58)</td>
<td>8h 0d 73</td>
<td>98th %</td>
<td>99th %</td>
</tr>
<tr>
<td>Schwartz et al., 1994 6 US cities Cough</td>
<td>1.15 (0.99, 1.33)</td>
<td>24h 1d 36.9</td>
<td>98th %</td>
<td>99th %</td>
</tr>
<tr>
<td>Schwartz et al., 1994 6 U.S. cities lower respiratory symptoms</td>
<td>1.22 (1.00, 1.50)</td>
<td>24h 1d 36.9</td>
<td>98th %</td>
<td>99th %</td>
</tr>
<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study</td>
<td>Statistics for 8-hr daily max air quality data</td>
<td>Study period; Monitoring information</td>
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</tr>
<tr>
<td>Ross et al., 2002 East Moline, IL morning symptoms</td>
<td>1.12 (1.05, 1.20)</td>
<td>8h 3d ave 41.5</td>
<td>68.8 75 8.9-78.3</td>
<td>Apr-Oct 1994 AQS data - East Moline sites</td>
</tr>
<tr>
<td>Ross et al., 2002 East Moline, IL Evening symptoms</td>
<td>1.12 (1.06, 1.19)</td>
<td>8h 3d ave 41.5</td>
<td>68.8 75 8.9-78.3</td>
<td>Apr-Oct 1994 AQS data - East Moline sites</td>
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<tr>
<td>Ross et al., 2002 East Moline, IL Asthma med use</td>
<td>1.08 (0.99, 1.17)</td>
<td>8h 3d ave 41.5</td>
<td>68.8 75 8.9-78.3</td>
<td>Apr-Oct 1994 AQS data - East Moline sites</td>
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<tr>
<td>Thurston et al., 1997 Connecticut chest symptoms</td>
<td>1.21 (1.12, 1.31)</td>
<td>1h 0d 83.6</td>
<td>NA NA NA</td>
<td>last wk of June 1991-93 on-site monitor</td>
</tr>
<tr>
<td>Thurston 1997 Connecticut Asthma med use</td>
<td>1.19 (1.08, 1.32)</td>
<td>1h 0d 83.6</td>
<td>NA NA NA</td>
<td>last wk of June 1991-93 on-site monitor</td>
</tr>
</tbody>
</table>

**Lung Function Changes:**

<table>
<thead>
<tr>
<th>Study; Location</th>
<th>Effect Estimate (lower CL, upper CL)</th>
<th>Air Quality Data from Study</th>
<th>Statistics for 8-hr daily max air quality data</th>
<th>Study period; Monitoring information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortimer et al., 2002 8 U.S. cities am PEF (%)</td>
<td>-0.59% (-1.05, -0.13)</td>
<td>8h 48</td>
<td>64.3 66 28.8-66</td>
<td>6/1/93 - 8/31/93 AQS, all monitors in corresponding county, averaged for 10am to 6pm</td>
</tr>
<tr>
<td>Linn et al., 1996 Los Angeles FEV1 (ml)</td>
<td>-0.26 (SE 0.25) (am) -0.18 (SE 0.20) (pm)</td>
<td>24h 0d 23</td>
<td>150 164 2.5-192.5</td>
<td>Jan 91-Dec 92 SCAQMD sites in 3 communities: Upland, Rubidoux, Torrance</td>
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<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study *</td>
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<td>Study period; Monitoring information</td>
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<td>-----------------------------------</td>
</tr>
<tr>
<td></td>
<td>Ave time; Lag</td>
<td>Mean</td>
<td>98&lt;sup&gt;th&lt;/sup&gt; %</td>
<td>99&lt;sup&gt;th&lt;/sup&gt; %</td>
</tr>
<tr>
<td>Newhouse et al., 2004 Tulsa, OK am PEF (L/min)</td>
<td>-0.274 (p&lt;0.05) (mean O&lt;sub&gt;3&lt;/sub&gt;) -0.289 (p&lt;0.05) (max O&lt;sub&gt;3&lt;/sub&gt;)</td>
<td>24h 1d 30</td>
<td>92.7</td>
<td>104.7</td>
</tr>
<tr>
<td>Ross et al., 2002 East Moline, IL PEF (L/min)</td>
<td>-2.29 (-4.26, -0.33) (am) -2.58 (-4.26, -0.89) (pm)</td>
<td>8h 0-1d 1d 41.5</td>
<td>68.8</td>
<td>75</td>
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<td>Neas et al., 1995 Uniontown PA PEF (L/min)</td>
<td>-2.79 (-6.7, -1.1) (pm)</td>
<td>12h 0d 37.2 (56.1)</td>
<td>85.3</td>
<td>98</td>
</tr>
<tr>
<td>Neas et al., 1999 Philadelphia PA PEF (L/min)</td>
<td>-1.38 (-2.81, 0.04) (am) -2.58 (-4.91, -0.35) (pm)</td>
<td>12h 0d 1-5d ave 56</td>
<td>96.9</td>
<td>104.5</td>
</tr>
<tr>
<td>Korrick et al., 1998 Mt. Washington NH FEV1 (%)</td>
<td>-2.6 (-4.1, -0.4)</td>
<td>1h 0d 40</td>
<td>87</td>
<td>89</td>
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<td>Thurston et al., 1997 Connecticut summer camp PEF (L/min)</td>
<td>-0.096 (p&lt;0.05)</td>
<td>1h 0d 83.6</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Naheer et al., 1999 SW Virginia PEF (L/min)</td>
<td>-7.65 (-13.0, -2.25) (pm)</td>
<td>24h 1-5d ave 34.87</td>
<td>74</td>
<td>79</td>
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<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study **</td>
<td>Statistics for 8-hr daily max air quality data **</td>
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<tr>
<td>Brauer et al., 1996 Fraser Valley, BC</td>
<td>-3.8 (SE 0.4) (end shift)</td>
<td>1h 0d 40.3</td>
<td>98th % 99th % Range</td>
<td>June-August 1993 BC Ministry of Environment sites</td>
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<tr>
<td></td>
<td>-4.5 (SE 0.6) (next day)</td>
<td></td>
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<td></td>
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<tr>
<td>Peel et al., 2005 Atlanta</td>
<td>2.89 (1.03, 4.77)</td>
<td>8h 3d ave 55.6</td>
<td>127 140 3-152</td>
<td>1/1/93 to 12/21/02 AQS Confederate Ave monitor</td>
</tr>
<tr>
<td>Delfino et al., 1997 Montreal (&gt;64yo)</td>
<td>28.93 (11.98, 45.88)</td>
<td>8h 1d 34.7</td>
<td>57.5 64.9 7-64.9</td>
<td>May-Aug 1988 and 1989 AQS data, 5 sites</td>
</tr>
<tr>
<td>Delfino et al., 1997 Montreal (&gt;64yo)</td>
<td>31.61 (12.91, 50.31)</td>
<td>1h 1d 34.7 (28.9)</td>
<td>57.5 64.9 7-64.9</td>
<td>May-Aug 1988 and 1989 AQS data, 5 sites</td>
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<tr>
<td>Jones et al., 1995 Baton Rouge, LA (1-17 yo)</td>
<td>-13.00 (-32.82, 12.66)</td>
<td>24h 0d 28.2 (56.4)</td>
<td>111.8 118 21-119</td>
<td>6/1/90 - 8/31/90 DEQ 3 sites</td>
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<tr>
<td>Jones et al., 1995 Baton Rouge, LA (18-60 yo)</td>
<td>20.00 (2.29, 40.78)</td>
<td>24h 0d 28.2 (56.4)</td>
<td>111.8 118 21-119</td>
<td>6/1/90 - 8/31/90 DEQ 3 sites</td>
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<tr>
<td>Jones et al., 1995 Baton Rouge, LA (&gt;60 yo)</td>
<td>27.00 (-3.48, 67.10)</td>
<td>24h 0d 28.2 (56.4)</td>
<td>111.8 118 21-119</td>
<td>6/1/90 - 8/31/90 DEQ 3 sites</td>
</tr>
<tr>
<td>Wilson et al., 2005 Portland NH,</td>
<td>-3.00 (-8.49, 2.82)</td>
<td>8h 0d 43.1</td>
<td>108 121 15-142</td>
<td>Apr-Oct 1998-2000 AQS data, single monitor in each city</td>
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<tr>
<td>Wilson et al., 2005 Manchester NH</td>
<td>-3.00 (-8.53, 2.87)</td>
<td>8h 0d 85 93 5-121</td>
<td>Apr-Oct 1998-2000 AQS data, single monitor in each city</td>
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<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study *</td>
<td>Statistics for 8-hr daily max air quality data **</td>
<td>Study period; Monitoring information</td>
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<td>Ave time; Lag</td>
<td>Mean</td>
<td>98th %</td>
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<tr>
<td>Stieb et al., 1996 St. John, Canada</td>
<td>9.33 (-0.07, 18.74)</td>
<td>1h 2d</td>
<td>41.6 (36.1)</td>
<td>83</td>
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<tr>
<td>Peel et al., 2005 Atlanta, GA</td>
<td>2.65 (-0.50, 5.89)</td>
<td>8h 3d ave</td>
<td>55.6</td>
<td>127</td>
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<tr>
<td>Wilson et al., 2005 Manchester NH</td>
<td>-3.00 (-8.91, 3.29)</td>
<td>8h 0d</td>
<td>NA</td>
<td>108</td>
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<tr>
<td>Wilson et al., 2005 Portland NH</td>
<td>9.40 (10.26, 8.55)</td>
<td>8h 0d</td>
<td>NA</td>
<td>85</td>
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<tr>
<td>Friedman et al., 2001 Atlanta GA (1-16 yo)</td>
<td>30.89 (5.34, 62.64)</td>
<td>1h 0-1d</td>
<td>77.2 (60.7)</td>
<td>85.8</td>
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<td>Tolbert et al., 2000 Atlanta, GA</td>
<td>6.37 (2.53, 10.34)</td>
<td>8h 1d</td>
<td>59.3 (60.7)</td>
<td>92.4</td>
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<td>Zhu et al., 2003 Atlanta, GA (0-16 yo)</td>
<td>2.41 (-2.39, 7.44)</td>
<td>8h 0d</td>
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<tr>
<td>Jaffe et al., 2003 3 Ohio cities</td>
<td>9.27 (0.13, 19.25)</td>
<td>8h 2-3d</td>
<td>(66.1)</td>
<td>104</td>
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<tr>
<td>Jaffe et al., 2003 Cincinnati</td>
<td>15.76 (-1.01, 35.38)</td>
<td>8h 2d</td>
<td>60</td>
<td>106</td>
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<tr>
<td>Jaffe et al., 2003 Cleveland</td>
<td>3.03 (-8.52, 16.04)</td>
<td>8h 2d</td>
<td>50</td>
<td>104</td>
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<tr>
<td>Jaffe et al., 2003 Columbus</td>
<td>15.76 (-2.49, 37.44)</td>
<td>8h 3d</td>
<td>57</td>
<td>98</td>
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**Emergency Department Visits: Asthma**

1/1/93 to 12/21/02
AQS Confederate Ave monitor
Apr-Oct 1998-2000
AQS data, single monitor in each city
Apr-Oct 1998-2000
AQS data, single monitor in each city
7/19/96 - 8/4/96
3 sites in Atlanta
AQS, GA and Fulton Co., SOS, USGS; 7 sites in Atlanta MSA
7/1/91 to 6/30/96
all data from active monitors
7/1/91 to 6/30/96
all data from active monitors
7/1/91 to 6/30/96
all data from active monitors
7/1/91 to 6/30/96
all data from active monitors
<table>
<thead>
<tr>
<th>Study; Location</th>
<th>Effect Estimate (lower CL, upper CL)</th>
<th>Air Quality Data from Study *</th>
<th>Statistics for 8-hr daily max air quality data **</th>
<th>Study period; Monitoring information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cassino et al., 1999 NYC</td>
<td>-5.42 (-8.38, -2.36)</td>
<td>24h Mean: 17.5 (32.6)</td>
<td>98&lt;sup&gt;th&lt;/sup&gt; %: 83.3</td>
<td>99&lt;sup&gt;th&lt;/sup&gt; %: 88.8</td>
</tr>
<tr>
<td>(in heavy smokers)</td>
<td></td>
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</tr>
<tr>
<td>Cassino et al., 1999 NYC</td>
<td>2.74 (-3.00, 8.83)</td>
<td>24h Mean: 17.5 (32.6)</td>
<td>98&lt;sup&gt;th&lt;/sup&gt; %: 83.3</td>
<td>99&lt;sup&gt;th&lt;/sup&gt; %: 88.8</td>
</tr>
<tr>
<td>(in heavy smokers)</td>
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<tr>
<td>Cassino et al., 1999 NYC</td>
<td>9.69 (3.93, 15.76)</td>
<td>24h Mean: 17.5 (32.6)</td>
<td>98&lt;sup&gt;th&lt;/sup&gt; %: 83.3</td>
<td>99&lt;sup&gt;th&lt;/sup&gt; %: 88.8</td>
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<tr>
<td>(in heavy smokers)</td>
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<tr>
<td>Cassino et al., 1999 NYC</td>
<td>-1.62 (-7.01, 4.08)</td>
<td>24h Mean: 17.5 (32.6)</td>
<td>98&lt;sup&gt;th&lt;/sup&gt; %: 83.3</td>
<td>99&lt;sup&gt;th&lt;/sup&gt; %: 88.8</td>
</tr>
<tr>
<td>(in heavy smokers)</td>
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<td></td>
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<tr>
<td>Peel et al., 2005 Atlanta, GA</td>
<td>1.80 (-2.27, 6.04)</td>
<td>8h 3d ave Mean: 55.6</td>
<td>98&lt;sup&gt;th&lt;/sup&gt; %: 127</td>
<td>99&lt;sup&gt;th&lt;/sup&gt; %: 140</td>
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<tr>
<td>Pneumonia</td>
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<tr>
<td>Peel et al., 2005 Atlanta, GA</td>
<td>3.49 (-2.77, 10.15)</td>
<td>8h 3d ave Mean: 55.6</td>
<td>98&lt;sup&gt;th&lt;/sup&gt; %: 127</td>
<td>99&lt;sup&gt;th&lt;/sup&gt; %: 140</td>
</tr>
<tr>
<td>COPD</td>
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<tr>
<td>Peel et al., 2005 Atlanta, GA</td>
<td>3.25 (1.10, 5.44)</td>
<td>8h 3d ave Mean: 55.6</td>
<td>98&lt;sup&gt;th&lt;/sup&gt; %: 127</td>
<td>99&lt;sup&gt;th&lt;/sup&gt; %: 140</td>
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<tr>
<td>upper respiratory infection</td>
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**Emergency Department Visits: Other respiratory diseases:**

**Cardiovascular outcomes, biomarkers, and physiological changes:**
<table>
<thead>
<tr>
<th>Study; Location</th>
<th>Effect Estimate (lower CL, upper CL)</th>
<th>Air Quality Data from Study *</th>
<th>Statistics for 8-hr daily max air quality data **</th>
<th>Study period; Monitoring information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liao et al., 2004 3 US cities HRV (high frequency power)</td>
<td>-0.010 (SE 0.016)</td>
<td>8h 1d 41</td>
<td></td>
<td>1996-1998 AQS data</td>
</tr>
<tr>
<td>Liao et al., 2004 3 US cities SD of normal RR intervals</td>
<td>-0.336 (SE 0.290)</td>
<td>8h 1d 41</td>
<td></td>
<td>1996-1998 AQS data</td>
</tr>
<tr>
<td>Peters et al., 2000 Boston Defibrillator discharge</td>
<td>OR 0.96 (0.47, 1.98) (patients with 1+ event) OR 1.23 (0.53, 2.87) (patients with 10+ events)</td>
<td>24h 0d 18.6</td>
<td>75.2 78.1 15.7-102.7</td>
<td>Jan 95 - May 96 1 site (case-crossover)</td>
</tr>
<tr>
<td>Peters et al., 2001 Boston Myocardial infarction</td>
<td>OR 1.31 (0.85, 2.03) (2h O3) OR 0.94 (0.60, 1.49) (24h O3)</td>
<td>24h 2h 19.9</td>
<td>75.8 81.5 17.7-102.7</td>
<td>Jan 95 - May 96 1 site (case-crossover)</td>
</tr>
<tr>
<td>Park et al., 2004 Boston HRV (low frequency power)</td>
<td>-11.5% (-21.3, -0.4)</td>
<td>4h 23</td>
<td>81.8 92.0 10-122.6</td>
<td>Nov 2000- Oct 2003 Mass Dept. Environ. Protection sites</td>
</tr>
<tr>
<td>Gold et al., 2000 Boston HRV (r-MSSD) (ms)</td>
<td>-3.0 (SE 1.9) (first rest period) -5.8 (SE 2.4) (slow breathing period)</td>
<td>1h 34</td>
<td>77.3 92.5 21.8-100</td>
<td>June-Sept 1997 1 site, MA Dept. Environ. Protection</td>
</tr>
<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study</td>
<td>Statistics for 8-hr daily max air quality data</td>
<td>Study period; Monitoring information</td>
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<tr>
<td>Dockery et al., 2005 Boston Ventricular arrhythmia</td>
<td>OR 1.09 (0.93, 1.29) (all events)</td>
<td>48h 22.9</td>
<td>75 82.1 2–102.7</td>
<td>7/11/95 - 7/11/02 6 sites, Mass Dept. Envir. Protection</td>
</tr>
<tr>
<td>Rich et al., 2005 Boston Ventricular arrhythmia</td>
<td>OR 1.21 (1.00, 1.45) (all events)</td>
<td>24h 22.6</td>
<td>74 81.5 2-102.7</td>
<td>Aug 1995 - June 2002 6 sites, Mass Dept. Envir. Protection</td>
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<tr>
<td>Metzger et al., 2004 Atlanta, GA all CV</td>
<td>0.96 (-1.59, 3.58)</td>
<td>8h 3dave 53.9</td>
<td>127 140 3-152</td>
<td>1/1/93 to 12/21/02 AQS Confederate Ave monitor</td>
</tr>
<tr>
<td>Metzger et al., 2004 Atlanta, GA Dysrrhythmia</td>
<td>0.96 (-3.96, 6.13)</td>
<td>8h 3dave 53.9</td>
<td>127 140 3-152</td>
<td>1/1/93 to 12/21/02 AQS Confederate Ave monitor</td>
</tr>
<tr>
<td>Metzger et al., 2004 Atlanta, GA CHF</td>
<td>-4.19 (-9.74, 1.71)</td>
<td>8h 3dave 53.9</td>
<td>127 140 3-152</td>
<td>1/1/93 to 12/21/02 AQS Confederate Ave monitor</td>
</tr>
<tr>
<td>Metzger et al., 2004 Atlanta, GA IHD</td>
<td>2.28 (-2.30, 7.09)</td>
<td>8h 3dave 53.9</td>
<td>127 140 3-152</td>
<td>1/1/93 to 12/21/02 AQS Confederate Ave monitor</td>
</tr>
<tr>
<td>Metzger et al., 2004 Atlanta, GA peripheral vascular</td>
<td>1.68 (-1.57, 5.05)</td>
<td>8h 3dave 53.9</td>
<td>127 140 3-152</td>
<td>1/1/93 to 12/21/02 AQS Confederate Ave monitor</td>
</tr>
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</table>

**Emergency Department Visits: Cardiovascular Diseases**

**Hospital Admissions: Cardiovascular Diseases**
<table>
<thead>
<tr>
<th>Study; Location</th>
<th>Effect Estimate (lower CL, upper CL)</th>
<th>Air Quality Data from Study *</th>
<th>Statistics for 8-hr daily max air quality data **</th>
<th>Study period; Monitoring information</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Ave time; Lag</td>
<td>Mean</td>
<td>98th %</td>
</tr>
<tr>
<td>Linn et al., 2000 Los Angeles CA (summer)</td>
<td>2.02 (-16.14, 24.11)</td>
<td>24h 0d</td>
<td>32.9 (98.7)</td>
<td>175</td>
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<tr>
<td>Fung et al., 2003 Windsor CV &lt;65 yo</td>
<td>-0.14 (-11.79, 13.06)</td>
<td>1h 0d</td>
<td>39.3 (31.6)</td>
<td>78</td>
</tr>
<tr>
<td>Fung et al., 2003 Windsor CV &lt;65 yo</td>
<td>5.84 (-10.50, 25.16)</td>
<td>1h 0-2d ave</td>
<td>39.3 (31.6)</td>
<td>78</td>
</tr>
<tr>
<td>Fung et al., 2003 Windsor CV 65+ yo</td>
<td>-3.57 (-10.35, 3.72)</td>
<td>1h 0d</td>
<td>39.3 (31.6)</td>
<td>78</td>
</tr>
<tr>
<td>Fung et al., 2003 Windsor CV 65+ yo</td>
<td>1.94 (-8.01, 12.95)</td>
<td>1h 0-2d ave</td>
<td>39.3 (31.6)</td>
<td>78</td>
</tr>
<tr>
<td>Burnett et al., 1997 Toronto CV</td>
<td>20.47 (9.32, 32.76)</td>
<td>1h 2-4d ave</td>
<td>41.2 (31.6)</td>
<td>62</td>
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<tr>
<td>Gwynn et al., 2000 Buffalo circulatory</td>
<td>0.23 (-1.27, 1.74)</td>
<td>24h 1d</td>
<td>26.2 (38.7)</td>
<td>92.5</td>
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<tr>
<td>Hospital Admissions: Specific Cardiovascular Diseases</td>
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<tr>
<td>Koken et al., 2003 Denver CO myocardial infarction</td>
<td>-32.91 (-47.16, -14.82)</td>
<td>24h 0d</td>
<td>25 (44.2)</td>
<td>64.5</td>
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<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study *</td>
<td>Statistics for 8-hr daily max air quality data **</td>
<td>Study period; Monitoring information</td>
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<td>Ave time; Lag</td>
<td>Mean</td>
<td>98th %</td>
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<td>Koken et al., 2003</td>
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<td>24h</td>
<td>25 (44.2)</td>
<td>64.5</td>
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<tr>
<td>Denver Coronary Atherosclerosis</td>
<td>27.02 (8.30, 48.98)</td>
<td>2d</td>
<td>25</td>
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<td></td>
<td></td>
<td>24h</td>
<td>25 (44.2)</td>
<td>64.5</td>
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<tr>
<td>Koken et al., 2003</td>
<td>49.16 (8.35, 105.22)</td>
<td>1d</td>
<td>25</td>
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<tr>
<td>Denver Pulm Heart Disease</td>
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<td>24h</td>
<td>25 (44.2)</td>
<td>64.5</td>
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<td></td>
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<td>1d</td>
<td>25 (44.2)</td>
<td>64.5</td>
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<tr>
<td>Ito, 2003 Detroit MI ischemic heart disease</td>
<td>0.52 (-2.27, 3.39)</td>
<td>24h</td>
<td>25 (38.7)</td>
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<td></td>
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<td>3d</td>
<td>25 (38.7)</td>
<td>80</td>
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<tr>
<td>Ito, 2003 Detroit MI dysrrhythmia</td>
<td>-1.04 (-5.87, 4.04)</td>
<td>3d</td>
<td>25 (38.7)</td>
<td>80</td>
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<td>24h</td>
<td>25 (38.7)</td>
<td>80</td>
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<tr>
<td>Ito, 2003 Detroit MI heart failure</td>
<td>0.76 (-2.47, 4.09)</td>
<td>3d</td>
<td>25 (38.7)</td>
<td>80</td>
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<td>24h</td>
<td>25 (38.7)</td>
<td>80</td>
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<tr>
<td>Ito, 2003 Detroit MI stroke</td>
<td>0.50 (-3.03, 4.15)</td>
<td>3d</td>
<td>25 (38.7)</td>
<td>80</td>
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<td></td>
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<td>24h</td>
<td>25 (38.7)</td>
<td>80</td>
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<td>Hospital Admissions: Respiratory Diseases</td>
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<tr>
<td>Luginaah et al., 2003 Windsor (males)</td>
<td>5.56 (-10.57, 24.59)</td>
<td>1h</td>
<td>39.3 (31.6)</td>
<td>78</td>
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<td>0d</td>
<td>39.3 (31.6)</td>
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<tr>
<td>Luginaah et al., 2003 Windsor (females)</td>
<td>-6.83 (-23.92, 14.09)</td>
<td>1h</td>
<td>39.3 (31.6)</td>
<td>78</td>
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<tr>
<td></td>
<td></td>
<td>0d</td>
<td>39.3 (31.6)</td>
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July-August 1993-1997 AQS sites in Denver County (2 sites)

1993-1997 AQS sites in Denver County (2 sites)

1992-1994 AQS data, 4 ozone sites

1992-1994 AQS data, 4 ozone sites

1992-1994 AQS data 4 ozone sites

1992-1994 AQS data 4 ozone sites

4/1/95 - 12/31/00 4 sites in Windsor

4/1/95 - 12/31/00 4 sites in Windsor
<table>
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<tr>
<th>Study; Location</th>
<th>Effect Estimate (lower CL, upper CL)</th>
<th>Air Quality Data from Study *</th>
<th>Statistics for 8-hr daily max air quality data **</th>
<th>Study period; Monitoring information</th>
</tr>
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<tbody>
<tr>
<td>Thurston et al., 1992 Buffalo NY</td>
<td>4.94 (-0.23, 10.12)</td>
<td>1h 2d</td>
<td>60 (58.9)</td>
<td>125.5 133 24-133</td>
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<tr>
<td>Delfino et al., 1994 Montreal</td>
<td>4.05 (1.00, 7.11)</td>
<td>8h 4d</td>
<td>32.1</td>
<td>69 73.8 8.6-82.3</td>
</tr>
<tr>
<td>Burnett et al., 1994 Toronto</td>
<td>3.95 (2.50, 5.43)</td>
<td>1h 1d</td>
<td>(41.7)</td>
<td>79 81.5 15-104.3</td>
</tr>
<tr>
<td>Burnett et al., 1997 16 Canadian city</td>
<td>6.72 (3.52, 10.02)</td>
<td>1h 1d</td>
<td>32.9 (25.3)</td>
<td>47.1 51.3 6.2-68.4</td>
</tr>
<tr>
<td>Burnett et al., 1997 Toronto</td>
<td>17.57 (10.44, 25.15)</td>
<td>1h 1-3d ave</td>
<td>41.2 (31.6)</td>
<td>62 64 0-79</td>
</tr>
<tr>
<td>Yang et al., 2003 Vancouver (&lt;3 yo)</td>
<td>50.43 (32.64, 70.61)</td>
<td>24h 4d</td>
<td>13.41 (21.3)</td>
<td>42.7 47.3 1.1-71.9</td>
</tr>
<tr>
<td>Yang et al., 2003 Vancouver (65+yo)</td>
<td>28.53 (18.47, 39.43)</td>
<td>24h 4d</td>
<td>13.41 (21.3)</td>
<td>42.7 47.3 1.1-71.9</td>
</tr>
<tr>
<td>Schwartz et al., 1996 Cleveland</td>
<td>3.51 (0.88, 6.20)</td>
<td>1h 1-2d ave</td>
<td>56 (55.1)</td>
<td>91 99 5-120.3</td>
</tr>
<tr>
<td>Moolgavkar et al., 1997 Minneapolis/St. Paul</td>
<td>8.08 (4.47, 11.81)</td>
<td>24h 1d</td>
<td>26.2 (45.1)</td>
<td>83.2 87.7 4.6-101.8</td>
</tr>
<tr>
<td>Gwynn et al., 2001 NYC (white)</td>
<td>1.08 (-0.44, 2.63)</td>
<td>24h 1d</td>
<td>22.1 (34.2)</td>
<td>90.6 106 6-125</td>
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<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study</td>
<td>Statistics for 8-hr daily max air quality data **</td>
<td>Study period; Monitoring information</td>
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<tr>
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<tr>
<td></td>
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<td>Ave time; Lag</td>
<td>Mean</td>
<td>98th %</td>
</tr>
<tr>
<td>Gwynn et al., 2001 NYC (nonwhite)</td>
<td>4.01 (2.47, 5.57)</td>
<td>24h 1d</td>
<td>22.1 (34.2)</td>
<td>90.6</td>
</tr>
<tr>
<td>Gwynn et al., 2001 NYC (uninsured)</td>
<td>4.51 (2.80, 6.25)</td>
<td>24h 1d</td>
<td>22.1 (34.2)</td>
<td>90.6</td>
</tr>
<tr>
<td>Thurston et al., 1992 NYC</td>
<td>0.42 (0.10, 0.74)</td>
<td>1h 3d</td>
<td>29.1</td>
<td></td>
</tr>
<tr>
<td>Gwynn et al., 2000 Buffalo</td>
<td>3.94 (1.78, 6.15)</td>
<td>24h 1d</td>
<td>26.2 (38.7)</td>
<td>92.5</td>
</tr>
<tr>
<td>Schwartz et al., 1996 Spokane</td>
<td>19.08 (0.17, 41.57)</td>
<td>1h 2d</td>
<td>79</td>
<td>NA</td>
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<tr>
<td>Thurston et al., 1994 Toronto</td>
<td>15.30 (4.11, 26.50)</td>
<td>1hr 0d</td>
<td>57.47 (45.8)</td>
<td>92</td>
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</table>

**Hospital Admissions: Asthma**

<table>
<thead>
<tr>
<th>Study; Location</th>
<th>Effect Estimate (lower CL, upper CL)</th>
<th>Air Quality Data from Study</th>
<th>Statistics for 8-hr daily max air quality data **</th>
<th>Study period; Monitoring information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheppard et al., 2003 Seattle, WA</td>
<td>3.44 (0.58, 6.39)</td>
<td>8h 2d</td>
<td>30.4</td>
<td>65</td>
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<tr>
<td>Nauenberg et al., 1999 Los Angeles (all insurance)</td>
<td>1.00 (-6.28, 8.84)</td>
<td>24h 0d</td>
<td>19.88 (19.1)</td>
<td>46.5</td>
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<tr>
<td>Burnett et al., 2001 Toronto (&lt;2 yo)</td>
<td>30.25 (16.87, 45.15)</td>
<td>1h 5d ave</td>
<td>45.2 (38.6)</td>
<td>77.7</td>
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<tr>
<td>Thurston et al., 1992 Buffalo NY</td>
<td>6.59 (1.29, 11.89)</td>
<td>1h 3d</td>
<td>60 (58.9)</td>
<td>125.5</td>
</tr>
<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study *</td>
<td>Statistics for 8-hr daily max air quality data **</td>
<td>Study period; Monitoring information</td>
</tr>
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<td>----------------</td>
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<tr>
<td>Burnett et al., 1999 Toronto</td>
<td>6.47 (3.68, 9.33)</td>
<td>24h 1-3d ave</td>
<td>19.5 (26.7)</td>
<td>68.4 74.8 0.1-110.8</td>
</tr>
<tr>
<td>Lin et al., 2003 Toronto, 6-12 yo</td>
<td>-7.84 (-22.02, 8.92) (female) -26.04 (-44.53, -1.39) (male)</td>
<td>1h 0d</td>
<td>28.2</td>
<td>68.4 74.8 0.14-110.8</td>
</tr>
<tr>
<td>Thurston et al., 1992 New York City</td>
<td>0.95 (0.20, 1.69)</td>
<td>1h 1d</td>
<td>29.1</td>
<td></td>
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<tr>
<td>Schwartz et al., 1994 Detroit</td>
<td>10.81 (5.13, 16.80)</td>
<td>24h 1d</td>
<td>21 (37.6)</td>
<td>82.8 88.5 10-122.7</td>
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<tr>
<td>Hospital Admissions: Other respiratory diseases</td>
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<tr>
<td>Moolgavkar et al., 1997 Minneapolis/St. Paul pneumonia</td>
<td>8.90 (4.62, 13.34)</td>
<td>24h 1d</td>
<td>26.2 (45.1)</td>
<td>83.2 87.7 4.6-101.8</td>
</tr>
<tr>
<td>Ito, 2003 Detroit MI pneumonia</td>
<td>3.10 (-1.84, 8.28)</td>
<td>24h 3d</td>
<td>25 (38.7)</td>
<td>80 85 4.3-101.3</td>
</tr>
<tr>
<td>Ito, 2003 Detroit MI COPD</td>
<td>1.25 (-3.55, 6.28)</td>
<td>24h 3d</td>
<td>25 (38.7)</td>
<td>80 85 4.3-101.3</td>
</tr>
<tr>
<td>Burnett et al., 1999 Toronto COPD</td>
<td>7.49 (4.00, 11.10)</td>
<td>24h 2-4d ave</td>
<td>19.5 (26.7)</td>
<td>68.4 74.8 0.1-110.8</td>
</tr>
<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study *</td>
<td>Statistics for 8-hr daily max air quality data **</td>
<td>Study period; Monitoring information</td>
</tr>
<tr>
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<td>-------------------------------</td>
<td>-----------------------------------------------</td>
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</tr>
<tr>
<td>Schwartz et al., 1994 Detroit COPD</td>
<td>11.68 (2.92, 21.19)</td>
<td>24h 1d Mean 21 (37.6)</td>
<td>98&lt;sup&gt;th&lt;/sup&gt; % 99&lt;sup&gt;th&lt;/sup&gt; % Range 82.8 88.5 10-122.7</td>
<td>1986-1989 AQS data 9 sites in 86 and 89, 8 sites in 87 and 88</td>
</tr>
<tr>
<td>Moolgavkar et al., 1997 Minneapolis/St. Paul COPD</td>
<td>6.04 (1.22, 11.10)</td>
<td>24h 1d Mean 26.2 (45.1)</td>
<td>83.2 87.7 4.6-101.8</td>
<td>1/1/86 - 12/31/91 AQS data from all monitoring stations</td>
</tr>
<tr>
<td>Burnett et al., 1999 Toronto Respiratory Infection</td>
<td>4.52 (2.43, 6.64)</td>
<td>24h 1-2d ave Mean 19.5</td>
<td>68.4 74.8 0.1-110.8</td>
<td>summers 1992, 93, 94 7-9 sites in metro Toronto</td>
</tr>
</tbody>
</table>

**Mortality: Total nonaccidental**

<table>
<thead>
<tr>
<th>Study; Location</th>
<th>Effect Estimate (lower CL, upper CL)</th>
<th>Air Quality Data from Study *</th>
<th>Statistics for 8-hr daily max air quality data **</th>
<th>Study period; Monitoring information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al., 2004 95 U.S. cities (warm)</td>
<td>0.44 (0.14, 0.74)</td>
<td>24h 0d Mean 26.84</td>
<td>1987-2000 AQS data, 10% trimmed mean to average across monitors after correction for each monitor</td>
<td></td>
</tr>
<tr>
<td>Bell et al., 2004 95 U.S. cities (warm)</td>
<td>0.78 (0.26, 1.30)</td>
<td>24h 0-6d dl Mean 26.84</td>
<td>1987-2000 AQS data, 10% trimmed mean to average across monitors after correction for each monitor</td>
<td></td>
</tr>
<tr>
<td>Schwartz et al., 2004 14 U.S. cities (warm)</td>
<td>1.04 (0.30, 1.79)</td>
<td>1h 0d Mean 45.9</td>
<td>1986-1993 AQS data, May-September (case-crossover)</td>
<td></td>
</tr>
<tr>
<td>Ostro et al., 2003 Coachella Valley CA</td>
<td>-1 (-4.42, 2.55)</td>
<td>1h Mean 62</td>
<td>1/1/89 – 12/20/98 sites in Palm Springs and Indio</td>
<td></td>
</tr>
<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study *</td>
<td>Statistics for 8-hr daily max air quality data **</td>
<td>Study period; Monitoring information</td>
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<td>-----------------------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td></td>
<td>Ave time; Lag</td>
<td>Mean</td>
<td>98th %</td>
<td>99th %</td>
</tr>
<tr>
<td>Ostro et al., 1995 2 Southern CA counties</td>
<td>0.80 (-0.18, 1.78)</td>
<td>1h</td>
<td>140</td>
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<tr>
<td>Moolgavkar et al., 1995 Philadelphia (summer)</td>
<td>2.82 (1.33, 4.33)</td>
<td>24h</td>
<td>35.5</td>
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</tr>
<tr>
<td>Ito, 2003 Detroit MI</td>
<td>0.86 (-0.36, 2.09)</td>
<td>24h</td>
<td>20.9</td>
<td>81.5</td>
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<tr>
<td>Ito, 2003 Detroit MI</td>
<td>1.88 (-1.69, 5.58)</td>
<td>24h</td>
<td>25</td>
<td>80</td>
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<tr>
<td>Fairley, 2003 San Jose CA</td>
<td>2.81 (-0.27, 5.99)</td>
<td>8-h</td>
<td>29</td>
<td>67</td>
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<tr>
<td>Chock et al., 2000 Pittsburg PA (&lt;75 yo)</td>
<td>-1.48 (-5.63, 2.85)</td>
<td>1h</td>
<td>(35.4)</td>
<td>80</td>
</tr>
<tr>
<td>Chock et al., 2000 Pittsburg PA (75+)</td>
<td>-1.82 (-6.03, 2.59)</td>
<td>1h</td>
<td>(35.4)</td>
<td>80</td>
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<tr>
<td>Kinney et al., 1995 Los Angeles</td>
<td>0.00 (-4.90, 5.15)</td>
<td>1h</td>
<td>70</td>
<td>115.3</td>
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<tr>
<td>Gamble et al., 1998 Dallas TX</td>
<td>3.69 (0.85, 6.62)</td>
<td>24h</td>
<td>22</td>
<td>81</td>
</tr>
<tr>
<td>Dockery et al., 1992 St. Louis</td>
<td>0.60 (-2.46, 3.750)</td>
<td>24h</td>
<td>22.5</td>
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</tr>
<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study *</td>
<td>Statistics for 8-hr daily max air quality data **</td>
<td>Study period; Monitoring information</td>
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<td>------------------------------</td>
<td>-----------------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ave time; Lag</td>
<td>Mean</td>
<td>98th %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24h</td>
<td>1d</td>
<td>23</td>
</tr>
<tr>
<td>Dockery et al., 1992 E Tennessee</td>
<td>-1.30 (-7.91, 5.78)</td>
<td>1d</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Ito et al., 1996 Cook County</td>
<td>3.89 (2.21, 5.59)</td>
<td>1h</td>
<td>38.1</td>
<td>76</td>
</tr>
<tr>
<td>Klemm et al., 2004 Atlanta quartknot **</td>
<td>2.40 (-3.39, 8.54)</td>
<td>8h</td>
<td>47.03</td>
<td>6.63-</td>
</tr>
<tr>
<td>Klemm et al., 2004 Atlanta monthknot **</td>
<td>4.16 (-2.42, 11.19)</td>
<td>8h</td>
<td>47.03</td>
<td>6.63-</td>
</tr>
<tr>
<td>Goldberg et al., 2003 Montreal (CHFunderlying)</td>
<td>4.26 (-5.30, 14.78)</td>
<td>24h</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Vedal et al., 2003 Vancouver</td>
<td>16.63 (5.54, 28.88)</td>
<td>1h</td>
<td>27.4</td>
<td>53.3</td>
</tr>
<tr>
<td>Villeneuve et al., 2003 Vancouver</td>
<td>1.31 (-0.78, 3.45)</td>
<td>24h</td>
<td>13.4</td>
<td>69.3</td>
</tr>
<tr>
<td>Mortality: Cardiovascular or Cardiorespiratory diseases</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bell et al., 2004 95 U.S. cities</td>
<td>1.28 (0.61, 1.96)</td>
<td>24h</td>
<td>26.84</td>
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<tr>
<td>Study; Location</td>
<td>Effect Estimate (lower CL, upper CL)</td>
<td>Air Quality Data from Study</td>
<td>Statistics for 8-hr daily max air quality data</td>
<td>Study period; Monitoring information</td>
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<td>Huang et al., 2004 19 U.S. cities</td>
<td>1.47 (0.54, 2.40)</td>
<td>24h 0d</td>
<td>Ave time; Lag</td>
<td>Mean</td>
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<td>Lipfert, et al., 2000 Philadelphia</td>
<td>30.19 (p&lt;0.055)</td>
<td>44.76 (39.7)</td>
<td>1h 0-1dave</td>
<td>44.76 (39.7)</td>
</tr>
<tr>
<td>Lipfert, et al., 2000 Philadelphia</td>
<td>-2.00 (p&lt;0.055)</td>
<td>44.76 (39.7)</td>
<td>1h 0-1dave</td>
<td>44.76 (39.7)</td>
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<tr>
<td>Ostro et al., 2003 Coachella Valley</td>
<td>-4 (-8.88, 1.14)</td>
<td>62</td>
<td>1h</td>
<td>62</td>
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<tr>
<td>Ito, 2003 Detroit MI</td>
<td>1.45 (-0.29, 3.21)</td>
<td>20.9 (34.3)</td>
<td>24h 0d</td>
<td>20.9 (34.3)</td>
</tr>
<tr>
<td>Ito, 2003 Detroit MI</td>
<td>1.79 (-3.38, 7.24)</td>
<td>25</td>
<td>24h 0d</td>
<td>25</td>
</tr>
<tr>
<td>Fairley, 2003 San Jose CA</td>
<td>2.36 (-2.12, 7.04)</td>
<td>29</td>
<td>8h 0d</td>
<td>29</td>
</tr>
<tr>
<td>Gamble et al., 1998 Dallas TX</td>
<td>3.28 (-1.48, 8.27)</td>
<td>22</td>
<td>24h 1-2d</td>
<td>22 (37.9)</td>
</tr>
<tr>
<td>Ito et al., 1996 Cook County</td>
<td>4.64 (2.07, 7.27)</td>
<td>38.1 (31.8)</td>
<td>1h 0-1d</td>
<td>38.1 (31.8)</td>
</tr>
<tr>
<td>Moolgavkar et al., 2003 Cook County</td>
<td>0.30 (0.16, 0.44)</td>
<td>18</td>
<td>24h 0d</td>
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<tr>
<td>Villeneuve et al., 2003 Vancouver</td>
<td>0.66 (-2.57, 3.99)</td>
<td>13.4 (21.3)</td>
<td>24h 0d</td>
<td>13.4 (21.3)</td>
</tr>
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</table>

June 1- Sept 30, 1987-1994 AQS data
May 92 - Sept 95 1 Camden and 1 Phila site
May 92 - Sept 95 1 Camden and 1 Phila site
1/1/89 – 12/20/98 sites in Palm Springs and Indio
1985-1990 AQS data, 4 ozone sites
1992-1994 AQS data, 4 ozone sites
1989-1996, San Jose 4th St. site
1990-1994 TNRCC data, 2-3 sites in Dallas Co.
1985-1990, AQS sites with at least 4 y data, 5 O3 sites
1987-1995 AQS data
1/1/86 - 12/31/98 13 census subdivisions
<table>
<thead>
<tr>
<th>Study; Location</th>
<th>Effect Estimate (lower CL, upper CL)</th>
<th>Air Quality Data from Study *</th>
<th>Statistics for 8-hr daily max air quality data **</th>
<th>Study period; Monitoring information</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Ave time; Lag</td>
<td>Mean</td>
<td>98th %</td>
<td>99th %</td>
</tr>
<tr>
<td>Goldberg et al., 2001 Montreal</td>
<td>2.81 (1.35, 4.30)</td>
<td>24h 0-2d</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Vedal et al., 2003 Vancouver</td>
<td>16.19 (-0.67, 35.91)</td>
<td>1h 0d</td>
<td>27.4 (21.4)</td>
<td>53.3</td>
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<tr>
<td>Mortality: Respiratory Diseases</td>
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<tr>
<td>Ostro et al., 2003 Coachella Valley</td>
<td>3 (-8.77, 16.29)</td>
<td>1h 0d</td>
<td>62</td>
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<td>Ito, 2003 Detroit MI</td>
<td>0.07 (-4.34, 4.68)</td>
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<td>20.9 (34.3)</td>
<td>81.5</td>
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<tr>
<td>Ito, 2003 Detroit MI</td>
<td>7.44 (-5.37, 21.99)</td>
<td>24h 0d</td>
<td>25 (38.7)</td>
<td>80</td>
</tr>
<tr>
<td>Vedal et al., 2003 Vancouver</td>
<td>6.01 (-22.53, 45.06)</td>
<td>1h 0d</td>
<td>27.4 (21.4)</td>
<td>53.3</td>
</tr>
<tr>
<td>Villeneuve et al., 2003 Vancouver</td>
<td>1.50 (-4.24, 7.58)</td>
<td>24h 0d</td>
<td>13.4 (21.3)</td>
<td>69.3</td>
</tr>
<tr>
<td>Moolgavkar et al., 2003 Cook County (COPD)</td>
<td>0.30 (-0.10, 0.71)</td>
<td>24h 0d</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

* 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 98\textsuperscript{th} and 99\textsuperscript{th} percentile values were selected for presentation here as a high study period concentration that roughly approximates a 4\textsuperscript{th} maximum concentration, depending on the study period length. NA= data not available
5A.1. Ozone Air Quality Information for 12 Urban Areas

Table 5A-1. Monitor-Specific O$_3$ Air Quality Information: Atlanta, GA

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>1305700011</td>
<td>0.089</td>
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</tr>
<tr>
<td>1306700031</td>
<td>0.100</td>
<td>0.084</td>
</tr>
<tr>
<td>1307700021</td>
<td>0.099</td>
<td>0.077</td>
</tr>
<tr>
<td>1308500012</td>
<td>0.088</td>
<td>0.077</td>
</tr>
<tr>
<td>1308900021</td>
<td>0.095</td>
<td>0.080</td>
</tr>
<tr>
<td>1308930011</td>
<td>0.090</td>
<td>0.091</td>
</tr>
<tr>
<td>1309700041</td>
<td>0.098</td>
<td>0.085</td>
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<tr>
<td>1311300011</td>
<td>0.088</td>
<td>0.077</td>
</tr>
<tr>
<td>1312100551</td>
<td>0.100</td>
<td>0.091</td>
</tr>
<tr>
<td>1313500021</td>
<td>0.089</td>
<td>0.088</td>
</tr>
<tr>
<td>1315100021</td>
<td>0.099</td>
<td>0.082</td>
</tr>
<tr>
<td>1322300031</td>
<td>0.099</td>
<td>0.083</td>
</tr>
<tr>
<td>1324700011</td>
<td>0.099</td>
<td>0.078</td>
</tr>
<tr>
<td>Average:</td>
<td>0.095</td>
<td>0.083</td>
</tr>
<tr>
<td>Design Value*:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>2500900051</td>
<td>0.088</td>
<td></td>
</tr>
<tr>
<td>2500920061</td>
<td>0.100</td>
<td>0.079</td>
</tr>
<tr>
<td>2500940041</td>
<td>0.094</td>
<td>0.080</td>
</tr>
<tr>
<td>2501711021</td>
<td>0.096</td>
<td>0.073</td>
</tr>
<tr>
<td>2502130031</td>
<td>0.107</td>
<td>0.088</td>
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<tr>
<td>2502500411</td>
<td>0.102</td>
<td>0.078</td>
</tr>
<tr>
<td>2502500421</td>
<td>0.074</td>
<td>0.074</td>
</tr>
<tr>
<td>2502700151</td>
<td>0.091</td>
<td>0.080</td>
</tr>
<tr>
<td>Average:</td>
<td>0.094</td>
<td>0.079</td>
</tr>
<tr>
<td>Design Value*:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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 O₃ Air Quality Information: Chicago, IL

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>1703100011</td>
<td>0.094</td>
<td>0.077</td>
</tr>
<tr>
<td>1703100321</td>
<td>0.096</td>
<td>0.080</td>
</tr>
<tr>
<td>1703100422</td>
<td>0.103</td>
<td></td>
</tr>
<tr>
<td>1703100501</td>
<td>0.084</td>
<td>0.069</td>
</tr>
<tr>
<td>1703100641</td>
<td>0.085</td>
<td>0.067</td>
</tr>
<tr>
<td>1703100721</td>
<td>0.085</td>
<td>0.075</td>
</tr>
<tr>
<td>1703100761</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1703110032</td>
<td>0.092</td>
<td>0.071</td>
</tr>
<tr>
<td>1703116011</td>
<td>0.081</td>
<td>0.075</td>
</tr>
<tr>
<td>1703140021</td>
<td>0.084</td>
<td>0.070</td>
</tr>
<tr>
<td>1703140071</td>
<td>0.093</td>
<td>0.073</td>
</tr>
<tr>
<td>1703142011</td>
<td>0.087</td>
<td>0.080</td>
</tr>
<tr>
<td>1703142012</td>
<td>0.067</td>
<td></td>
</tr>
<tr>
<td>1703170021</td>
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<td>0.082</td>
</tr>
<tr>
<td>1703180031</td>
<td>0.074</td>
<td></td>
</tr>
<tr>
<td>1704360011</td>
<td>0.084</td>
<td>0.066</td>
</tr>
<tr>
<td>1708900051</td>
<td>0.082</td>
<td>0.076</td>
</tr>
<tr>
<td>1709710021</td>
<td>0.090</td>
<td>0.074</td>
</tr>
<tr>
<td>1709710071</td>
<td>0.100</td>
<td>0.078</td>
</tr>
<tr>
<td>1709730011</td>
<td>0.087</td>
<td></td>
</tr>
<tr>
<td>1711100011</td>
<td>0.090</td>
<td>0.079</td>
</tr>
<tr>
<td>1719710081</td>
<td>0.086</td>
<td>0.077</td>
</tr>
<tr>
<td>1719710111</td>
<td>0.087</td>
<td>0.073</td>
</tr>
<tr>
<td>1808900221</td>
<td>0.094</td>
<td>0.076</td>
</tr>
<tr>
<td>1808900241</td>
<td>0.086</td>
<td>0.081</td>
</tr>
<tr>
<td>1808900301</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1808920081</td>
<td>0.101</td>
<td>0.081</td>
</tr>
<tr>
<td>1809100051</td>
<td>0.107</td>
<td>0.082</td>
</tr>
<tr>
<td>1809100101</td>
<td>0.100</td>
<td>0.084</td>
</tr>
<tr>
<td>1812700202</td>
<td>0.097</td>
<td>0.079</td>
</tr>
<tr>
<td>1812700241</td>
<td>0.101</td>
<td>0.077</td>
</tr>
<tr>
<td>1812700261</td>
<td>0.100</td>
<td>0.082</td>
</tr>
<tr>
<td>5505900021</td>
<td>0.110</td>
<td>0.085</td>
</tr>
<tr>
<td>5505900191</td>
<td>0.116</td>
<td>0.088</td>
</tr>
<tr>
<td>5505900221</td>
<td>0.096</td>
<td>0.088</td>
</tr>
<tr>
<td><strong>Average:</strong></td>
<td>0.092</td>
<td>0.077</td>
</tr>
</tbody>
</table>

*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 \( \text{O}_3 \) Air Quality Information: Cleveland, OH

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>3900710011</td>
<td>0.103</td>
<td>0.099</td>
</tr>
<tr>
<td>3903500341</td>
<td>0.090</td>
<td>0.076</td>
</tr>
<tr>
<td>3903500641</td>
<td>0.090</td>
<td>0.079</td>
</tr>
<tr>
<td>3903550021</td>
<td>0.098</td>
<td>0.089</td>
</tr>
<tr>
<td>3905500041</td>
<td>0.115</td>
<td>0.097</td>
</tr>
<tr>
<td>3908500031</td>
<td>0.104</td>
<td>0.092</td>
</tr>
<tr>
<td>3908530021</td>
<td>0.088</td>
<td>0.080</td>
</tr>
<tr>
<td>3909300171</td>
<td>0.099</td>
<td>0.085</td>
</tr>
<tr>
<td>3910300031</td>
<td>0.091</td>
<td>0.086</td>
</tr>
<tr>
<td>3913310011</td>
<td>0.097</td>
<td>0.091</td>
</tr>
<tr>
<td>3915300201</td>
<td>0.103</td>
<td>0.089</td>
</tr>
<tr>
<td>Average:</td>
<td>0.098</td>
<td>0.088</td>
</tr>
</tbody>
</table>

*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 \( \text{O}_3 \) Air Quality Information: Detroit, MI

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>2604900211</td>
<td>0.088</td>
<td>0.087</td>
</tr>
<tr>
<td>2604920011</td>
<td>0.089</td>
<td>0.091</td>
</tr>
<tr>
<td>2609900091</td>
<td>0.095</td>
<td>0.102</td>
</tr>
<tr>
<td>2609910031</td>
<td>0.092</td>
<td>0.101</td>
</tr>
<tr>
<td>2612500012</td>
<td>0.093</td>
<td>0.090</td>
</tr>
<tr>
<td>2614700051</td>
<td>0.100</td>
<td>0.086</td>
</tr>
<tr>
<td>2616100081</td>
<td>0.091</td>
<td>0.091</td>
</tr>
<tr>
<td>2616300012</td>
<td>0.088</td>
<td>0.085</td>
</tr>
<tr>
<td>2616300161</td>
<td>0.092</td>
<td>0.084</td>
</tr>
<tr>
<td>2616300192</td>
<td>0.083</td>
<td>0.098</td>
</tr>
<tr>
<td>Average:</td>
<td>0.091</td>
<td>0.092</td>
</tr>
</tbody>
</table>

*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 O₃ Air Quality Information: Houston, TX

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>4803910032</td>
<td>0.095</td>
<td></td>
</tr>
<tr>
<td>4803910041</td>
<td>0.092</td>
<td>0.097</td>
</tr>
<tr>
<td>4803910161</td>
<td></td>
<td>0.081</td>
</tr>
<tr>
<td>4816700141</td>
<td>0.093</td>
<td>0.092</td>
</tr>
<tr>
<td>4816710022</td>
<td>0.083</td>
<td>0.082</td>
</tr>
<tr>
<td>4820100242</td>
<td>0.096</td>
<td>0.095</td>
</tr>
<tr>
<td>4820100263</td>
<td>0.088</td>
<td>0.098</td>
</tr>
<tr>
<td>4820100292</td>
<td>0.098</td>
<td>0.096</td>
</tr>
<tr>
<td>4820100461</td>
<td>0.078</td>
<td>0.093</td>
</tr>
<tr>
<td>4820100472</td>
<td>0.072</td>
<td>0.082</td>
</tr>
<tr>
<td>4820100512</td>
<td>0.101</td>
<td>0.103</td>
</tr>
<tr>
<td>4820100551</td>
<td>0.094</td>
<td>0.107</td>
</tr>
<tr>
<td>4820100621</td>
<td>0.095</td>
<td>0.094</td>
</tr>
<tr>
<td>4820100661</td>
<td>0.084</td>
<td>0.081</td>
</tr>
<tr>
<td>4820100701</td>
<td>0.088</td>
<td>0.100</td>
</tr>
<tr>
<td>4820100751</td>
<td>0.078</td>
<td>0.096</td>
</tr>
<tr>
<td>4820110151</td>
<td></td>
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</tr>
<tr>
<td>4820110342</td>
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<td>4820110353</td>
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</tr>
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<td>4820110391</td>
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<td>0.113</td>
</tr>
<tr>
<td>4820110411</td>
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</tr>
<tr>
<td>4820110501</td>
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<td>0.092</td>
</tr>
<tr>
<td>4833900781</td>
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<td>0.094</td>
</tr>
<tr>
<td>Average:</td>
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<td>0.097</td>
</tr>
<tr>
<td>Design Value*:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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 O3 Air Quality Information: Los Angeles, CA

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>0603700021</td>
<td>0.097</td>
<td>0.104</td>
</tr>
<tr>
<td>0603700161</td>
<td>0.111</td>
<td>0.123</td>
</tr>
<tr>
<td>0603701131</td>
<td>0.073</td>
<td>0.083</td>
</tr>
<tr>
<td>0603710021</td>
<td>0.091</td>
<td>0.096</td>
</tr>
<tr>
<td>0603711031</td>
<td>0.077</td>
<td>0.082</td>
</tr>
<tr>
<td>0603712011</td>
<td>0.111</td>
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</tr>
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<td>0603713011</td>
<td>0.049</td>
<td>0.057</td>
</tr>
<tr>
<td>0603716011</td>
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<td>0.082</td>
</tr>
<tr>
<td>0603717011</td>
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<td>0.109</td>
</tr>
<tr>
<td>0603720051</td>
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<td>0.101</td>
</tr>
<tr>
<td>0603740021</td>
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<td>0.063</td>
</tr>
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<td>0.070</td>
</tr>
<tr>
<td>0603750051</td>
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</tr>
<tr>
<td>0603761121</td>
<td>0.131</td>
<td>0.137</td>
</tr>
<tr>
<td>0603790031</td>
<td>0.102</td>
<td>0.103</td>
</tr>
<tr>
<td>0605900071</td>
<td>0.069</td>
<td>0.080</td>
</tr>
<tr>
<td>0605910031</td>
<td>0.066</td>
<td>0.079</td>
</tr>
<tr>
<td>0605920221</td>
<td>0.081</td>
<td>0.095</td>
</tr>
<tr>
<td>0605950011</td>
<td>0.071</td>
<td>0.080</td>
</tr>
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<td>0.097</td>
<td>0.100</td>
</tr>
<tr>
<td>0606550011</td>
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<td>0.105</td>
</tr>
<tr>
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<tr>
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<td>0.088</td>
</tr>
<tr>
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</tr>
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<td>0.103</td>
</tr>
<tr>
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<td>0.084</td>
</tr>
<tr>
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</tr>
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<td>0607110042</td>
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<td>0.087</td>
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<td>0.132</td>
</tr>
<tr>
<td>0607140011</td>
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</tr>
<tr>
<td>0607140031</td>
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<td>0.137</td>
</tr>
<tr>
<td>0607190021</td>
<td>0.101</td>
<td>0.111</td>
</tr>
<tr>
<td>0607190041</td>
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<td>0.123</td>
</tr>
<tr>
<td>0611110051</td>
<td>0.076</td>
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</tr>
<tr>
<td>0611110071</td>
<td>0.080</td>
<td>0.087</td>
</tr>
<tr>
<td>0611110091</td>
<td>0.087</td>
<td>0.093</td>
</tr>
<tr>
<td>0611110041</td>
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<td>0.093</td>
</tr>
<tr>
<td>0611120021</td>
<td>0.092</td>
<td>0.093</td>
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<tr>
<td>0611120031</td>
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<td>0.074</td>
</tr>
<tr>
<td>0611130011</td>
<td>0.064</td>
<td>0.069</td>
</tr>
</tbody>
</table>

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 O₃ Air Quality Information: New York, NY

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>3600500831</td>
<td>0.096</td>
<td>0.079</td>
</tr>
<tr>
<td>3600501101</td>
<td>0.089</td>
<td>0.082</td>
</tr>
<tr>
<td>3602700071</td>
<td>0.111</td>
<td>0.081</td>
</tr>
<tr>
<td>3607150011</td>
<td>0.082</td>
<td>0.087</td>
</tr>
<tr>
<td>3607900051</td>
<td>0.102</td>
<td>0.082</td>
</tr>
<tr>
<td>3608100981</td>
<td>0.082</td>
<td>0.072</td>
</tr>
<tr>
<td>3608101241</td>
<td>0.089</td>
<td>0.086</td>
</tr>
<tr>
<td>3608500671</td>
<td>0.099</td>
<td>0.086</td>
</tr>
<tr>
<td>3610300021</td>
<td>0.108</td>
<td>0.094</td>
</tr>
<tr>
<td>3610300041</td>
<td>0.090</td>
<td>0.082</td>
</tr>
<tr>
<td>3610300092</td>
<td>0.103</td>
<td>0.102</td>
</tr>
<tr>
<td>3611100051</td>
<td>0.084</td>
<td>0.082</td>
</tr>
<tr>
<td>3611920041</td>
<td>0.102</td>
<td>0.091</td>
</tr>
<tr>
<td><strong>Average:</strong></td>
<td>0.095</td>
<td>0.085</td>
</tr>
<tr>
<td><strong>Design Value:</strong></td>
<td>0.094</td>
<td></td>
</tr>
</tbody>
</table>

*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 O₃ Air Quality Information: Philadelphia, PA

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>4201700121</td>
<td>0.111</td>
<td>0.087</td>
</tr>
<tr>
<td>4202900501</td>
<td>0.104</td>
<td>0.085</td>
</tr>
<tr>
<td>4202901001</td>
<td>0.112</td>
<td>0.085</td>
</tr>
<tr>
<td>4204500021</td>
<td>0.106</td>
<td>0.080</td>
</tr>
<tr>
<td>4209100131</td>
<td>0.101</td>
<td>0.085</td>
</tr>
<tr>
<td>4210100041</td>
<td>0.082</td>
<td>0.069</td>
</tr>
<tr>
<td>4210100141</td>
<td>0.098</td>
<td>0.083</td>
</tr>
<tr>
<td>4210100241</td>
<td>0.110</td>
<td>0.082</td>
</tr>
<tr>
<td>4210101361</td>
<td>0.094</td>
<td>0.070</td>
</tr>
<tr>
<td><strong>Average:</strong></td>
<td>0.102</td>
<td>0.081</td>
</tr>
<tr>
<td><strong>Design Value:</strong></td>
<td>0.094</td>
<td></td>
</tr>
</tbody>
</table>

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

*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 $\text{O}_3$ Air Quality Information: St. Louis, MO

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>1708310011</td>
<td>0.100</td>
<td>0.083</td>
</tr>
<tr>
<td>1711700021</td>
<td>0.085</td>
<td>0.077</td>
</tr>
<tr>
<td>1711900081</td>
<td>0.094</td>
<td>0.089</td>
</tr>
<tr>
<td>1711910091</td>
<td>0.090</td>
<td>0.088</td>
</tr>
<tr>
<td>1711920072</td>
<td>0.090</td>
<td>0.082</td>
</tr>
<tr>
<td>1711930071</td>
<td>0.084</td>
<td>0.083</td>
</tr>
<tr>
<td>1716300102</td>
<td>0.093</td>
<td>0.079</td>
</tr>
<tr>
<td>2909900121</td>
<td>0.093</td>
<td>0.082</td>
</tr>
<tr>
<td>2918310021</td>
<td>0.099</td>
<td>0.091</td>
</tr>
<tr>
<td>2918310041</td>
<td>0.098</td>
<td>0.090</td>
</tr>
<tr>
<td>2918900041</td>
<td>0.098</td>
<td>0.088</td>
</tr>
<tr>
<td>2918900061</td>
<td>0.094</td>
<td>0.086</td>
</tr>
<tr>
<td>2918930011</td>
<td>0.094</td>
<td>0.082</td>
</tr>
<tr>
<td>2918950011</td>
<td>0.095</td>
<td>0.088</td>
</tr>
<tr>
<td>2918970031</td>
<td>0.093</td>
<td>0.088</td>
</tr>
<tr>
<td>2951000071</td>
<td>0.090</td>
<td>0.084</td>
</tr>
<tr>
<td>2951000721</td>
<td>0.081</td>
<td>0.071</td>
</tr>
<tr>
<td>2951000861</td>
<td>0.098</td>
<td>0.090</td>
</tr>
</tbody>
</table>

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 $\text{O}_3$ Air Quality Information: Washington, D.C.

<table>
<thead>
<tr>
<th>AIRS Monitor ID</th>
<th>Fourth Daily Maximum 8-Hour Average (ppm)</th>
<th>Average of the 3 Year-Specific Values (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2002</td>
<td>2003</td>
</tr>
<tr>
<td>1100100251</td>
<td>0.097</td>
<td>0.079</td>
</tr>
<tr>
<td>1100100411</td>
<td>0.102</td>
<td>0.082</td>
</tr>
<tr>
<td>1100100431</td>
<td>0.106</td>
<td>0.081</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Urban Area</th>
<th>24-Hour Average (ppm)</th>
<th>1-Hour Maximum (ppm)</th>
<th>8-Hour Maximum (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Mean</td>
<td>Maximum</td>
</tr>
<tr>
<td>Atlanta</td>
<td>0.0091</td>
<td>0.0279</td>
<td>0.0504</td>
</tr>
<tr>
<td>Boston 1*</td>
<td>0.0060</td>
<td>0.0276</td>
<td>0.0571</td>
</tr>
<tr>
<td>Boston 2*</td>
<td>0.0114</td>
<td>0.0310</td>
<td>0.0603</td>
</tr>
<tr>
<td>Chicago</td>
<td>0.0110</td>
<td>0.0270</td>
<td>0.0453</td>
</tr>
<tr>
<td>Cleveland</td>
<td>0.0080</td>
<td>0.0257</td>
<td>0.0445</td>
</tr>
<tr>
<td>Detroit</td>
<td>0.0074</td>
<td>0.0239</td>
<td>0.0459</td>
</tr>
<tr>
<td>Houston</td>
<td>0.0075</td>
<td>0.0262</td>
<td>0.0572</td>
</tr>
<tr>
<td>Los Angeles 1**</td>
<td>0.0204</td>
<td>0.0338</td>
<td>0.0491</td>
</tr>
<tr>
<td>Los Angeles 2**</td>
<td>0.0249</td>
<td>0.0398</td>
<td>0.0568</td>
</tr>
<tr>
<td>New York 1***</td>
<td>0.0055</td>
<td>0.0242</td>
<td>0.0494</td>
</tr>
<tr>
<td>New York 2***</td>
<td>0.0052</td>
<td>0.0241</td>
<td>0.0491</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>0.0037</td>
<td>0.0272</td>
<td>0.0486</td>
</tr>
<tr>
<td>Sacramento</td>
<td>0.0164</td>
<td>0.0323</td>
<td>0.0462</td>
</tr>
<tr>
<td>St. Louis</td>
<td>0.0078</td>
<td>0.0248</td>
<td>0.0425</td>
</tr>
<tr>
<td>Washington, D.C.</td>
<td>0.0055</td>
<td>0.0283</td>
<td>0.0526</td>
</tr>
</tbody>
</table>

**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**

<table>
<thead>
<tr>
<th>Urban Area</th>
<th>24-Hour Average (ppm)</th>
<th>1-Hour Maximum (ppm)</th>
<th>8-Hour Maximum (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Mean</td>
<td>Maximum</td>
</tr>
<tr>
<td>Atlanta</td>
<td>0.0102</td>
<td>0.0308</td>
<td>0.0559</td>
</tr>
<tr>
<td>Boston 1*</td>
<td>0.0133</td>
<td>0.0314</td>
<td>0.0783</td>
</tr>
<tr>
<td>Boston 2*</td>
<td>0.0132</td>
<td>0.0359</td>
<td>0.0852</td>
</tr>
<tr>
<td>Chicago</td>
<td>0.0101</td>
<td>0.0295</td>
<td>0.0545</td>
</tr>
<tr>
<td>Cleveland</td>
<td>0.0103</td>
<td>0.0338</td>
<td>0.0685</td>
</tr>
<tr>
<td>Detroit</td>
<td>0.0085</td>
<td>0.0277</td>
<td>0.0572</td>
</tr>
<tr>
<td>Houston</td>
<td>0.0089</td>
<td>0.0258</td>
<td>0.0568</td>
</tr>
<tr>
<td>Los Angeles 1**</td>
<td>0.0158</td>
<td>0.0313</td>
<td>0.0492</td>
</tr>
<tr>
<td>Los Angeles 2**</td>
<td>0.0192</td>
<td>0.0385</td>
<td>0.0586</td>
</tr>
<tr>
<td>New York 1***</td>
<td>0.0062</td>
<td>0.0280</td>
<td>0.0565</td>
</tr>
<tr>
<td>New York 2***</td>
<td>0.0075</td>
<td>0.0286</td>
<td>0.0576</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>0.0069</td>
<td>0.0322</td>
<td>0.0619</td>
</tr>
<tr>
<td>Sacramento</td>
<td>0.0182</td>
<td>0.0353</td>
<td>0.0604</td>
</tr>
<tr>
<td>St. Louis</td>
<td>0.0056</td>
<td>0.0289</td>
<td>0.0585</td>
</tr>
<tr>
<td>Washington, D.C.</td>
<td>0.0095</td>
<td>0.0357</td>
<td>0.0708</td>
</tr>
</tbody>
</table>

**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.

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*July 2006*
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=Philadelphia

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2002
Rollback Ozone
City Name=Sacramento
Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Atlanta

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Boston
Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Chicago

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Cleveland
Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Detroit

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Houston
Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Philadelphia

Mean Daily 24-hr Average vs. Highest Maximum Daily 8-hr Average, 2004
Rollback Ozone
City Name=Sacramento
### 5B.1 Tables of Study-Specific Information

#### Table 5B-1. Study-Specific Information for O₃ Studies in Atlanta, GA

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>0</td>
<td>71</td>
<td>0.00020</td>
<td>-0.00084</td>
</tr>
<tr>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
</tr>
<tr>
<td>Huang et al. (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>0</td>
<td>71</td>
<td>0.00120</td>
<td>-0.00039</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>0</td>
<td>71</td>
<td>0.00112</td>
<td>0.00047</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>PM10</td>
<td>NA</td>
<td>NA</td>
<td>0.00074</td>
<td>-0.00033</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>NO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00060</td>
<td>0.00011</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>SO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00051</td>
<td>0.00001</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>CO</td>
<td>NA</td>
<td>NA</td>
<td>0.00069</td>
<td>0.00020</td>
</tr>
</tbody>
</table>

*Health effects are associated with short-term exposures to O₃.

**Rounded to the nearest ppb.

NA denotes "not available."

#### Table 5B-2. Study-Specific Information for O₃ Studies in Boston, MA

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
</tr>
<tr>
<td>Gent et al. (2003)</td>
<td>Respiratory symptoms -- chest tightness</td>
<td>---</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>none</td>
<td>27</td>
<td>126</td>
<td>0.00462</td>
<td>0.00000</td>
</tr>
<tr>
<td>Gent et al. (2003)</td>
<td>Respiratory symptoms -- chest tightness</td>
<td>---</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>PM2.5</td>
<td>27</td>
<td>126</td>
<td>0.00771</td>
<td>0.00331</td>
</tr>
<tr>
<td>Gent et al. (2003)</td>
<td>Respiratory symptoms -- chest tightness</td>
<td>---</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>PM2.5</td>
<td>27</td>
<td>126</td>
<td>0.00701</td>
<td>0.00262</td>
</tr>
<tr>
<td>Gent et al. (2003)</td>
<td>Respiratory symptoms -- chest tightness</td>
<td>---</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>6 hr max.</td>
<td>logistic</td>
<td>none</td>
<td>21</td>
<td>100</td>
<td>0.00570</td>
<td>0.00172</td>
</tr>
<tr>
<td>Gent et al. (2003)</td>
<td>Respiratory symptoms -- chest tightness</td>
<td>---</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>none</td>
<td>27</td>
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<tr>
<td>Gent et al. (2003)</td>
<td>Respiratory symptoms -- chest tightness</td>
<td>---</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>8 hr max.</td>
<td>logistic</td>
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<td>Gent et al. (2003)</td>
<td>Respiratory symptoms -- chest tightness</td>
<td>---</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>PM2.5</td>
<td>21</td>
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</tr>
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</table>

*Health effects are associated with short-term exposures to O₃.

**Rounded to the nearest ppb.
### Table 5B-3. Study-Specific Information for O₃ Studies in Chicago, IL

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. -- 95 US Cities</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
<td>0.00065</td>
</tr>
<tr>
<td>(2004)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>0.00099</td>
<td>0.00031</td>
<td>0.00166</td>
</tr>
<tr>
<td>Schwartz (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>none</td>
<td>NA</td>
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<td>0.00012</td>
<td>0.00062</td>
</tr>
<tr>
<td>Schwartz -- 14 US Cities</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>none</td>
<td>NA</td>
<td>0.00099</td>
<td>0.00031</td>
<td>0.00166</td>
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<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
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<td>0.00075</td>
<td>-0.00067</td>
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</tr>
<tr>
<td>Huang et al. -- 19 US Cities</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>NA</td>
<td>NA</td>
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<td>0.00171</td>
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<td>Huang et al. -- 19 US Cities</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
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<td>NA</td>
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<td>0.00047</td>
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<td>Huang et al. -- 19 US Cities</td>
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<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
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<td>0.00109</td>
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<td>0.00102</td>
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<tr>
<td>Huang et al. -- 19 US Cities</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>SO2</td>
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<td>0.00117</td>
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<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
<td>0.00065</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>CO</td>
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<td>0.00117</td>
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<td>(2004)</td>
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<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
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</tr>
</tbody>
</table>

*Health effects are associated with short-term exposures to O₃.**Rounded to the nearest ppb. NA denotes “not available.”

### Table 5B-4. Study-Specific Information for O₃ Studies in Cleveland, OH

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>2 75</td>
<td>0.00061</td>
<td>-0.00038</td>
<td>0.00161</td>
</tr>
<tr>
<td>Bell et al. -- 95 US Cities</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
<td>0.00065</td>
</tr>
<tr>
<td>(2004)</td>
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<td>Huang et al. (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>2 75</td>
<td>0.00124</td>
<td>0.00047</td>
<td>0.00201</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>0.00074</td>
<td>-0.00033</td>
<td>0.00171</td>
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<td>NA</td>
<td>NA</td>
<td>0.00060</td>
<td>0.00011</td>
<td>0.00109</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>PM10</td>
<td>NA</td>
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<td>NA</td>
<td>0.00007</td>
<td>0.00011</td>
<td>0.00109</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>NO2</td>
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<td>NA</td>
<td>0.00069</td>
<td>0.00020</td>
<td>0.00117</td>
</tr>
<tr>
<td>Schwartz et al. (1996)</td>
<td>Hospital admissions, respiratory illness</td>
<td>460-519</td>
<td>65+ avg of 1-day and 2-day lags</td>
<td>1 hr max.</td>
<td>avg of 1-day and 2-day lags</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>0.00169</td>
<td>0.00039</td>
<td>0.00291</td>
</tr>
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</table>

*Health effects are associated with short-term exposures to O₃.**Rounded to the nearest ppb. NA denotes “not available.”
Table 5B-5. Study-Specific Information for O₃ Studies in Detroit, MI

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>2</td>
<td>75</td>
<td>0.000076</td>
<td>-0.000024</td>
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<tr>
<td>Bell et al. -- 95 US Cities</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
</tr>
<tr>
<td>Schwartz (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
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<td>Mortality, non-accidental</td>
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<td>all</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00037</td>
<td>0.00012</td>
</tr>
<tr>
<td>Ito (2003)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
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<td>Mortality, respiratory</td>
<td>460-519</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
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<tr>
<td>Huang et al. (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>2</td>
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<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>PM10</td>
<td>NA</td>
<td>NA</td>
<td>0.00074</td>
<td>-0.00033</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>NO2</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>SO2</td>
<td>NA</td>
<td>NA</td>
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<td>0.00001</td>
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<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>CO</td>
<td>NA</td>
<td>NA</td>
<td>0.00069</td>
<td>0.00020</td>
</tr>
<tr>
<td>Ito (2003)</td>
<td>Hospital admissions (unscheduled), pneumonia</td>
<td>480-486</td>
<td>65+</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear (GAM str. estimation)**</td>
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<td>Hospital admissions (unscheduled), pneumonia</td>
<td>480-486</td>
<td>65+</td>
<td>1-day lag</td>
<td>24 hr avg.</td>
<td>log-linear (GAM str. estimation)</td>
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<td>Hospital admissions (unscheduled), pneumonia</td>
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<td>2-day lag</td>
<td>24 hr avg.</td>
<td>log-linear (GAM str. estimation)</td>
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<td>3-day lag</td>
<td>24 hr avg.</td>
<td>log-linear (GAM str. estimation)</td>
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<td>24 hr avg.</td>
<td>log-linear (GAM str. estimation)</td>
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<td>NA</td>
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<td>-0.00667</td>
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<td>Ito (2003)</td>
<td>Hospital admissions (unscheduled), COPD</td>
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<td>65+</td>
<td>1-day lag</td>
<td>24 hr avg.</td>
<td>log-linear (GAM str. estimation)</td>
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<td>NA</td>
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<tr>
<td>Ito (2003)</td>
<td>Hospital admissions (unscheduled), COPD</td>
<td>490-496</td>
<td>65+</td>
<td>2-day lag</td>
<td>24 hr avg.</td>
<td>log-linear (GAM str. estimation)</td>
<td>none</td>
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<td>-0.00513</td>
</tr>
<tr>
<td>Ito (2003)</td>
<td>Hospital admissions (unscheduled), COPD</td>
<td>490-496</td>
<td>65+</td>
<td>3-day lag</td>
<td>24 hr avg.</td>
<td>log-linear (GAM str. estimation)</td>
<td>none</td>
<td>NA</td>
<td>55</td>
<td>0.00011</td>
<td>-0.00475</td>
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*Health effects are associated with short-term exposures to O₃.  
**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 O₃ Studies in Houston, TX

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>1</td>
<td>76</td>
<td>0.00079</td>
<td>0.00005</td>
</tr>
<tr>
<td>Bell et al. -- 95 US Cities</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
</tr>
<tr>
<td>Schwartz (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00044</td>
<td>0.00004</td>
</tr>
<tr>
<td>Schwartz -- 14 US Cities (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>logistic</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00037</td>
<td>0.00012</td>
</tr>
<tr>
<td>Huang et al. (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>1</td>
<td>76</td>
<td>0.00122</td>
<td>-0.00016</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00124</td>
<td>0.00047</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>PM10</td>
<td>NA</td>
<td>NA</td>
<td>0.00074</td>
<td>-0.00033</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>NO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00060</td>
<td>0.00011</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>SO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00051</td>
<td>0.00001</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>CO</td>
<td>NA</td>
<td>NA</td>
<td>0.00069</td>
<td>0.00020</td>
</tr>
</tbody>
</table>

*Health effects are associated with short-term exposures to O₃.
**Rounded to the nearest ppb.
NA denotes "not available."
Table 5B-7. Study-Specific Information for O₃ Studies in Los Angeles, CA

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. (2004)***</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear none</td>
<td>0</td>
<td>68</td>
<td>0.00018</td>
<td>-0.00043</td>
<td>0.00079</td>
</tr>
<tr>
<td>Bell et al. -- 95 US Cities (2004)**</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
<td>0.00065</td>
</tr>
<tr>
<td>Huang et al. (2004)***</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear none</td>
<td>0</td>
<td>68</td>
<td>0.00107</td>
<td>0.00001</td>
<td>0.00213</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear none</td>
<td>NA</td>
<td>NA</td>
<td>0.00124</td>
<td>0.00047</td>
<td>0.00201</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>PM10</td>
<td>NA</td>
<td>NA</td>
<td>0.00074</td>
<td>-0.00033</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>NO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00060</td>
<td>0.00011</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>SO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00051</td>
<td>0.00001</td>
</tr>
<tr>
<td>Linn et al. (2000)****</td>
<td>Hospital admissions (unscheduled), pulmonary illness --</td>
<td>75-101*****</td>
<td>30+</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear none</td>
<td>1</td>
<td>70</td>
<td>0.00110</td>
<td>-0.00047</td>
<td>0.00267</td>
</tr>
<tr>
<td>Linn et al. (2000)****</td>
<td>Hospital admissions (unscheduled), pulmonary illness --</td>
<td>75-101*****</td>
<td>30+</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear none</td>
<td>1</td>
<td>70</td>
<td>0.00060</td>
<td>-0.00077</td>
<td>0.00197</td>
</tr>
</tbody>
</table>

*Health effects are associated with short-term exposures to O₃.
**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 O₃ Studies in New York, NY

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. -- 95 US Cities (2004)**</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
</tr>
<tr>
<td>Huang et al. (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>-2</td>
<td>81</td>
<td>0.00170</td>
<td>0.00054</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00124</td>
<td>0.00047</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>PM10</td>
<td>NA</td>
<td>NA</td>
<td>0.00074</td>
<td>-0.00033</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>NO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00060</td>
<td>0.00011</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>SO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00051</td>
<td>0.00001</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)**</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>CO</td>
<td>NA</td>
<td>NA</td>
<td>0.00069</td>
<td>0.00020</td>
</tr>
<tr>
<td>Thurston et al. (1992)****</td>
<td>Hospital admissions (unscheduled), asthma</td>
<td>466, 480-486, 490, 491, 492, 493</td>
<td>all</td>
<td>3-day lag</td>
<td>1 hr max.</td>
<td>linear</td>
<td>none</td>
<td>NA</td>
<td>206</td>
<td>3.312E-09</td>
<td>2.409E-08</td>
</tr>
<tr>
<td>Thurston et al. (1992)****</td>
<td>Hospital admissions (unscheduled), asthma</td>
<td>493</td>
<td>all</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>linear</td>
<td>none</td>
<td>NA</td>
<td>206</td>
<td>2.488E-09</td>
<td>2.091E-08</td>
</tr>
</tbody>
</table>

*Health effects are associated with short-term exposures to O₃.
**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 O₃ Studies in Philadelphia, PA

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
</tr>
<tr>
<td>Moolgavkar et al. (1995)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>1-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>1</td>
<td>159</td>
<td>0.00140</td>
<td>0.00086</td>
</tr>
<tr>
<td>Moolgavkar et al. (1995)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>1-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>TSP, SO2</td>
<td>1</td>
<td>159</td>
<td>0.00139</td>
<td>0.00066</td>
</tr>
<tr>
<td>Huang et al. (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>-3</td>
<td>84</td>
<td>0.00151</td>
<td>0.00007</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00124</td>
<td>0.00047</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>PM10</td>
<td>NA</td>
<td>NA</td>
<td>0.00074</td>
<td>-0.00033</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>NO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00060</td>
<td>0.00011</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>SO2</td>
<td>NA</td>
<td>NA</td>
<td>0.00051</td>
<td>0.00001</td>
</tr>
<tr>
<td>Huang et al. -- 19 US Cities (2004)</td>
<td>Mortality, cardiorespiratory</td>
<td>390-448; 490-496; 487; 480-486; 507.</td>
<td>all</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>CO</td>
<td>NA</td>
<td>NA</td>
<td>0.00069</td>
<td>0.00020</td>
</tr>
</tbody>
</table>

*Health effects are associated with short-term exposures to O₃.
**Rounded to the nearest ppb.
NA denotes "not available."
Table 5B-10. Study-Specific Information for O₃ Studies in Sacramento, CA

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>0</td>
<td>71</td>
<td>0.00026</td>
<td>-0.00079</td>
</tr>
<tr>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
</tr>
</tbody>
</table>

*Health effects are associated with short-term exposures to O₃.
**Rounded to the nearest ppb.
NA denotes "not available."

Table 5B-11. Study-Specific Information for O₃ Studies in St. Louis, MO

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>0</td>
<td>118</td>
<td>0.00044</td>
<td>-0.00072</td>
</tr>
<tr>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
</tr>
</tbody>
</table>

*Health effects are associated with short-term exposures to O₃.
**Rounded to the nearest ppb.
NA denotes "not available."

Table 5B-12. Study-Specific Information for O₃ Studies in Washington, D.C.

<table>
<thead>
<tr>
<th>Study</th>
<th>Health Effects*</th>
<th>ICD-9 Codes</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Model</th>
<th>Other Pollutants in Model</th>
<th>Observed Concentrations** (ppb)</th>
<th>O₃ Coefficient</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>Mortality, non-accidental</td>
<td>&lt; 800</td>
<td>all</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>log-linear</td>
<td>none</td>
<td>NA</td>
<td>NA</td>
<td>0.00039</td>
<td>0.00013</td>
</tr>
</tbody>
</table>

*Health effects are associated with short-term exposures to O₃.
**Rounded to the nearest ppb.
NA denotes "not available."
5B.2 Concentration-Response Functions and Health Impact Functions

Notation:

\( y_0 = \text{Incidence under baseline conditions} \)
\( y_c = \text{Incidence under control conditions} \)
\( \Delta y = y_0 - y_c \)
\( x_0 = O_3 \text{ levels under baseline conditions} \)
\( x_c = O_3 \text{ levels under control conditions} \)
\( \Delta x = x_0 - x_c \)

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:

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

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:

\[
y = \frac{e^{\beta x}}{1 + e^{\beta x}} = \frac{1}{1 + e^{-\beta x}}
\]

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

\[
y = \frac{1}{1 + e^{-\beta x}}
\]

\[
\text{odds} = \frac{y}{1-y} = \frac{\left(\frac{1}{1+e^{-\beta x}}\right)}{1-\left(\frac{1}{1+e^{-\beta x}}\right)}
\]

\[
\text{odds} = \frac{\left(\frac{1}{1+e^{-\beta x}}\right)}{\left(e^{-\beta x}\right)} = \frac{1}{e^{-\beta x}} = e^{\beta x}
\]

\[
\text{odds ratio} = \frac{e^{\beta x_0}}{e^{\beta x_c}} = e^{\beta(x_0 - x_c)}
\]

\[
\frac{y_c}{1-y_c} = e^{-\beta a x}
\]

\[
\frac{y_0}{1-y_0} \cdot \left(\frac{y_0}{1-y_0}\right) = e^{-\beta a x}
\]

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

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

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

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

\[ y_c = \frac{y_0 \cdot e^{-\beta x}}{1 - y_0 + y_0 \cdot e^{-\beta x}} \]

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

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

\[ \Delta y = y_0 \cdot \left( 1 - \frac{1}{(1-y_0) \cdot e^{\beta x} + y_0} \right) \]
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 $\tau$, $\pi(\tau | y)$, a shrinkage estimate for the $i$th location is calculated as:

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

where

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

where

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

where

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

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

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

where

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

A 95 percent credible interval around the $i$th shrinkage estimate was calculated as $\theta_i^* \pm 1.96 \times \sqrt{\theta_i^{**}}$. 

### Table 5B-13. Notation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter being estimated for location c (or i)</td>
<td>$\theta^c$</td>
<td>$\theta_i$</td>
</tr>
<tr>
<td>Estimate of parameter for location c (or i)*</td>
<td>$\hat{\theta}^c$</td>
<td>$y_i$</td>
</tr>
<tr>
<td>Variance in the overall distribution of true $\theta$s.</td>
<td>$\tau^2$</td>
<td>$\tau^2$</td>
</tr>
<tr>
<td>Variance of the estimate of $\theta^c$ or ($\theta_i$)**</td>
<td>$\nu^c$</td>
<td>$s_i^2$</td>
</tr>
<tr>
<td>The mean of the overall distribution of true $\theta$s</td>
<td>$\mu$</td>
<td>$\mu$</td>
</tr>
<tr>
<td>The model:</td>
<td>$\hat{\theta}^c \sim N(\theta^c, \nu^c)$ (1)</td>
<td>$y_i = \mu + \delta_i + \epsilon_i$ (1)</td>
</tr>
<tr>
<td></td>
<td>$\theta^c \sim N(\mu, \tau^2)$ (2)</td>
<td>$\theta_i = \mu + \delta_i$ (2)</td>
</tr>
<tr>
<td></td>
<td>(1) &amp; (2) $\Rightarrow \hat{\theta}^c \sim N(\mu, \nu^c + \tau^2)$</td>
<td>$\delta_i \sim N(0, \tau^2)$ (3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\epsilon_i \sim N(0, s_i^2)$ (4)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) and (3) $\Rightarrow \theta_i \sim N(\mu, \tau^2)$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1), (2), (3) &amp; (4) $\Rightarrow y_i \sim N(\mu, \tau^2 + s_i^2)$</td>
</tr>
</tbody>
</table>

*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.
<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td></td>
<td>Response = Decrease in FEV₁ Greater Than or Equal to 10%</td>
</tr>
<tr>
<td></td>
<td>0.084/3</td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>(9 - 57)</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>(5 - 46)</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>(5 - 65)</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>(2 - 22)</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>(5 - 46)</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>(10 - 58)</td>
</tr>
<tr>
<td>Los_Angles-Long_Beach-Riverside__CA</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td>(15 - 110)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>(16 - 160)</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>(8 - 58)</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(2 - 10)</td>
</tr>
<tr>
<td>St_Louis-St_Charles-Farmington__MO-IL</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>(3 - 28)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Response = Decrease in FEV₁ Greater Than or Equal to 15%</td>
</tr>
</tbody>
</table>

Atlanta-Sandy_Springs-Gainesville__GA-AL     | 9          | 7         | 5         | 4         | 3         | 2          |
<p>|                                              | (1 - 35)   | (0 - 31)  | (0 - 27)  | (0 - 26)  | (0 - 25)  | (0 - 22)  | (0 - 18)     |
| Boston-Worcester-Manchester__MA-NH           | 5          | 4         | 4         | 2         | 2         | 1          |</p>
<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>(0 - 28)</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>(0 - 13)</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>(0 - 28)</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>(1 - 37)</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside_CA</td>
<td>(0 - 67)</td>
</tr>
<tr>
<td></td>
<td>14</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>(0 - 96)</td>
</tr>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>(0 - 35)</td>
</tr>
<tr>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>(0 - 6)</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>St._Louis-St._Charles-Farmington__MO-IL</td>
<td>(0 - 17)</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>(1 - 49)</td>
</tr>
<tr>
<td></td>
<td>11</td>
</tr>
</tbody>
</table>

Response = Decrease in FEV₁ Greater Than or Equal to 20%
<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>(0 - 44)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>(0 - 60)</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>(0 - 23)</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>(0 - 4)</td>
</tr>
<tr>
<td>St_Louis-St_Charles-Farmington__MO-IL</td>
<td>(0 - 11)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>(0 - 31)</td>
</tr>
</tbody>
</table>

*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 O₃ Concentrations That Just Meet the Current and Alternative Daily Maximum 8-Hour Standards: Based on 2004 O₃ Concentrations*

<table>
<thead>
<tr>
<th>Location</th>
<th>Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td><strong>Response = Decrease in FEV₁ Greater Than or Equal to 10%</strong></td>
<td></td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>7.2%</td>
</tr>
<tr>
<td></td>
<td>(2% - 12.7%)</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>(1.1% - 9.5%)</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>3.7%</td>
</tr>
<tr>
<td></td>
<td>(0.6% - 7.4%)</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>4.5%</td>
</tr>
<tr>
<td></td>
<td>(0.9% - 8.7%)</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>4.9%</td>
</tr>
<tr>
<td></td>
<td>(1% - 9.3%)</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>6.9%</td>
</tr>
<tr>
<td></td>
<td>(2% - 11.9%)</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>3.8%</td>
</tr>
<tr>
<td></td>
<td>(0.9% - 6.8%)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>4.5%</td>
</tr>
<tr>
<td></td>
<td>(0.9% - 8.7%)</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>5.9%</td>
</tr>
<tr>
<td></td>
<td>(1.4% - 10.9%)</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>(1% - 6.9%)</td>
</tr>
<tr>
<td>St_Louis-St_Charles-Farmington__MO-IL</td>
<td>5.4%</td>
</tr>
<tr>
<td></td>
<td>(1.2% - 10%)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>6.4%</td>
</tr>
<tr>
<td></td>
<td>(1.7% - 11.5%)</td>
</tr>
<tr>
<td><strong>Response = Decrease in FEV₁ Greater Than or Equal to 15%</strong></td>
<td></td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>(0.2% - 7.9%)</td>
</tr>
<tr>
<td>Location</td>
<td>Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>----------</td>
<td>----------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td><strong>Percent of Active Children</strong></td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td><strong>0.084/4</strong>*</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>1.1%</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City_IL-IN-WI</td>
<td>0.6%</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>0.8%</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>1%</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>2%</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>0.9%</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>0.8%</td>
</tr>
<tr>
<td>Philadelphia-Camdenport_PA-NJ-DE-MD</td>
<td>1.4%</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>1%</td>
</tr>
<tr>
<td>St._Louis-St._Charles-Farmington__MO-IL</td>
<td>1.1%</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>1.7%</td>
</tr>
</tbody>
</table>

Response = Decrease in FEV₁ Greater Than or Equal to 20%
<table>
<thead>
<tr>
<th>Location</th>
<th>Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>0.4%  (0% - 4.8%)</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>0.1% (0% - 2.7%)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>0.1% (0% - 3.3%)</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>0.2% (0% - 4.2%)</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>0.1% (0% - 2.8%)</td>
</tr>
<tr>
<td>St_Louis-St_Charles-Farmington__MO-IL</td>
<td>0.1% (0% - 3.9%)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>0.3% (0% - 4.5%)</td>
</tr>
</tbody>
</table>

*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 O₃ Concentrations That Just Meet the Current and Alternative Daily Maximum 8-Hour Standards: April - September, Based on 2002 O₃ Concentrations*

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td><strong>Response = Decrease in FEV₁ Greater Than or Equal to 10%</strong></td>
<td></td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>45</td>
</tr>
<tr>
<td>(16 - 74)</td>
<td>(15 - 73)</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>53</td>
</tr>
<tr>
<td>(20 - 84)</td>
<td>(17 - 76)</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>89</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>30</td>
</tr>
<tr>
<td>(12 - 48)</td>
<td>(10 - 44)</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>55</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>34</td>
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<tr>
<td>(10 - 57)</td>
<td>(8 - 53)</td>
</tr>
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<tr>
<td>(16 - 110)</td>
<td>(15 - 107)</td>
</tr>
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<tr>
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<td>(54 - 280)</td>
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<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
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<td>11</td>
</tr>
<tr>
<td>(4 - 17)</td>
<td>(3 - 16)</td>
</tr>
<tr>
<td>St._Louis-St._Charles-Farmington__MO-IL</td>
<td>36</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>82</td>
</tr>
<tr>
<td>(31 - 130)</td>
<td>(25 - 118)</td>
</tr>
</tbody>
</table>

**Response = Decrease in FEV₁ Greater Than or Equal to 15%**

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>16</td>
</tr>
<tr>
<td>Location</td>
<td>Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>0.084/4/***</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>(3 - 49)</td>
</tr>
<tr>
<td></td>
<td>(5 - 57)</td>
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<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>(6 - 95)</td>
</tr>
<tr>
<td></td>
<td>(3 - 49)</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>(3 - 32)</td>
</tr>
<tr>
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<td>(1 - 36)</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>(4 - 59)</td>
</tr>
<tr>
<td></td>
<td>(0 - 31)</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>(1 - 36)</td>
</tr>
<tr>
<td></td>
<td>(1 - 36)</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>(1 - 36)</td>
</tr>
<tr>
<td></td>
<td>(1 - 36)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>(10 - 192)</td>
</tr>
<tr>
<td></td>
<td>(1 - 36)</td>
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<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
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</tr>
<tr>
<td></td>
<td>(7 - 74)</td>
</tr>
<tr>
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<td>(0 - 11)</td>
</tr>
<tr>
<td></td>
<td>(0 - 11)</td>
</tr>
<tr>
<td>St._Louis-St._Charles-Farmington__MO-IL</td>
<td>(4 - 38)</td>
</tr>
<tr>
<td></td>
<td>(4 - 38)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>(7 - 88)</td>
</tr>
<tr>
<td></td>
<td>(7 - 88)</td>
</tr>
</tbody>
</table>

**Response = Decrease in FEV₁ Greater Than or Equal to 20%**
<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Active Children (in 1000s) Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>(0 - 21)</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(0 - 38)</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>(0 - 23)</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(0 - 23)</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>(0 - 45)</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(0 - 45)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>(1 - 122)</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>(1 - 115)</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>(1 - 47)</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>(1 - 43)</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>(0 - 7)</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(0 - 7)</td>
</tr>
<tr>
<td>St._Louis-St._Charles-Farmington__MO-IL</td>
<td>(1 - 24)</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(1 - 24)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>(1 - 56)</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>(0 - 49)</td>
</tr>
</tbody>
</table>

*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 O₃ Concentrations That Just Meet the Current and Alternative Daily Maximum 8-Hour Standards: Based on 2002 O₃ Concentrations*

<table>
<thead>
<tr>
<th>Location</th>
<th>Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>10.2%</td>
</tr>
<tr>
<td></td>
<td>(3.5% - 16.6%)</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester_MA-NH</td>
<td>11.1%</td>
</tr>
<tr>
<td></td>
<td>(4.3% - 17.7%)</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>10.5%</td>
</tr>
<tr>
<td></td>
<td>(3.7% - 17%)</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>12.4%</td>
</tr>
<tr>
<td></td>
<td>(4.8% - 19.6%)</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>11.6%</td>
</tr>
<tr>
<td></td>
<td>(4.3% - 18.5%)</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>7.1%</td>
</tr>
<tr>
<td></td>
<td>(2.1% - 12%)</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>3.9%</td>
</tr>
<tr>
<td></td>
<td>(1% - 6.8%)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>9.9%</td>
</tr>
<tr>
<td></td>
<td>(3.3% - 16.3%)</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland_PA-NJ-DE-MD</td>
<td>13.1%</td>
</tr>
<tr>
<td></td>
<td>(5.2% - 20.4%)</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade- Truckee__CA-NV</td>
<td>7.2%</td>
</tr>
<tr>
<td>St_Louis-St_Charles-Farmington__MO-IL</td>
<td>13.4%</td>
</tr>
<tr>
<td></td>
<td>(5.4% - 20.7%)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>12.1%</td>
</tr>
<tr>
<td></td>
<td>(4.6% - 19.1%)</td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>3.6%</td>
</tr>
<tr>
<td></td>
<td>(0.6% - 10.9%)</td>
</tr>
</tbody>
</table>

Response = Decrease in FEV₁ Greater Than or Equal to 10%
<table>
<thead>
<tr>
<th>Location</th>
<th>0.084/4***</th>
<th>0.084/3</th>
<th>0.080/4****</th>
<th>0.074/5</th>
<th>0.074/4</th>
<th>0.074/3</th>
<th>0.070/4****</th>
<th>0.064/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>4.5%</td>
<td>3.6%</td>
<td>3.6%</td>
<td>3.2%</td>
<td>2.4%</td>
<td>2%</td>
<td>1.8%</td>
<td>1.1%</td>
</tr>
<tr>
<td></td>
<td>(1.1% - 12%)</td>
<td>(0.8% - 10.6%)</td>
<td>(0.7% - 10.5%)</td>
<td>(0.6% - 9.9%)</td>
<td>(0.3% - 8.4%)</td>
<td>(0.2% - 7.7%)</td>
<td>(0.2% - 7.4%)</td>
<td>(0.1% - 5.8%)</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>3.9%</td>
<td>3.4%</td>
<td>3%</td>
<td>2.4%</td>
<td>2.1%</td>
<td>1.8%</td>
<td>1.5%</td>
<td>0.9%</td>
</tr>
<tr>
<td></td>
<td>(0.7% - 11.2%)</td>
<td>(0.5% - 10.4%)</td>
<td>(0.4% - 9.8%)</td>
<td>(0.3% - 8.8%)</td>
<td>(0.2% - 8%)</td>
<td>(0.1% - 7.5%)</td>
<td>(0.1% - 7%)</td>
<td>(0% - 5.5%)</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>5.1%</td>
<td>4.2%</td>
<td>3.9%</td>
<td>3%</td>
<td>2.8%</td>
<td>2.2%</td>
<td>2%</td>
<td>1.3%</td>
</tr>
<tr>
<td></td>
<td>(1.1% - 13.3%)</td>
<td>(0.7% - 11.8%)</td>
<td>(0.7% - 11.5%)</td>
<td>(0.4% - 9.9%)</td>
<td>(0.3% - 9.5%)</td>
<td>(0.2% - 8.5%)</td>
<td>(0.2% - 8.1%)</td>
<td>(0.1% - 6.6%)</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>4.5%</td>
<td>3.7%</td>
<td>3.5%</td>
<td>3.4%</td>
<td>2.4%</td>
<td>2%</td>
<td>1.8%</td>
<td>1.1%</td>
</tr>
<tr>
<td></td>
<td>(0.8% - 12.3%)</td>
<td>(0.6% - 11.1%)</td>
<td>(0.5% - 10.8%)</td>
<td>(0.5% - 10.5%)</td>
<td>(0.2% - 8.7%)</td>
<td>(0.1% - 8%)</td>
<td>(0.1% - 7.6%)</td>
<td>(0% - 6.1%)</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>2.1%</td>
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<td>1.6%</td>
<td>1.2%</td>
<td>1.1%</td>
<td>0.9%</td>
<td>0.8%</td>
<td>0.4%</td>
</tr>
<tr>
<td></td>
<td>(0.3% - 7.6%)</td>
<td>(0.2% - 6.9%)</td>
<td>(0.1% - 6.6%)</td>
<td>(0.1% - 5.6%)</td>
<td>(0.1% - 5.4%)</td>
<td>(0% - 5.1%)</td>
<td>(0% - 4.7%)</td>
<td>(0% - 3.5%)</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>0.9%</td>
<td>0.9%</td>
<td>0.7%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.3%</td>
<td>0.1%</td>
</tr>
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<td>(0% - 2.6%)</td>
<td>(0% - 2.5%)</td>
<td>(0% - 2.4%)</td>
<td>(0% - 2%)</td>
<td>(0% - 1.1%)</td>
</tr>
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<td>3%</td>
<td>2.7%</td>
<td>1.8%</td>
<td>1.9%</td>
<td>1.7%</td>
<td>1.4%</td>
<td>0.9%</td>
</tr>
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<td>(0.3% - 9.4%)</td>
<td>(0.1% - 7.5%)</td>
<td>(0.2% - 7.8%)</td>
<td>(0.1% - 7.4%)</td>
<td>(0.1% - 6.8%)</td>
<td>(0% - 5.5%)</td>
</tr>
<tr>
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<td>4.4%</td>
<td>3.3%</td>
<td>3%</td>
<td>2.6%</td>
<td>2.3%</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
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<td>(0.9% - 12.7%)</td>
<td>(0.8% - 12.2%)</td>
<td>(0.5% - 10.3%)</td>
<td>(0.4% - 9.9%)</td>
<td>(0.3% - 9.2%)</td>
<td>(0.2% - 8.7%)</td>
<td>(0% - 1.7%)</td>
</tr>
<tr>
<td>St._Louis-St_Charles-Farmington__MO-IL</td>
<td>2.5%</td>
<td>2.1%</td>
<td>1.9%</td>
<td>1.4%</td>
<td>1.3%</td>
<td>1.2%</td>
<td>1%</td>
<td>0.6%</td>
</tr>
<tr>
<td></td>
<td>(0.3% - 7.4%)</td>
<td>(0.2% - 6.8%)</td>
<td>(0.2% - 6.4%)</td>
<td>(0.1% - 5.3%)</td>
<td>(0.1% - 5%)</td>
<td>(0.1% - 4.7%)</td>
<td>(0% - 4.3%)</td>
<td>(0% - 3.2%)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VW</td>
<td>4.8%</td>
<td>3.8%</td>
<td>3.8%</td>
<td>3%</td>
<td>2.6%</td>
<td>2.2%</td>
<td>2%</td>
<td>1.3%</td>
</tr>
<tr>
<td></td>
<td>(1% - 12.8%)</td>
<td>(0.7% - 11.3%)</td>
<td>(0.6% - 11.3%)</td>
<td>(0.4% - 9.3%)</td>
<td>(0.2% - 8.4%)</td>
<td>(0% - 8.1%)</td>
<td>(0% - 6.5%)</td>
<td>(0% - 3.6%)</td>
</tr>
<tr>
<td><strong>Response = Decrease in FEV1 Greater Than Or Equal To 20%</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Percent of Active Children Estimated to Experience at Least One Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>0.084/4***</td>
<td>0.084/3</td>
<td>0.080/4****</td>
<td>0.074/5</td>
<td>0.074/4</td>
<td>0.074/3</td>
<td>0.070/4****</td>
<td>0.064/4</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>0.5%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>(0% - 4.9%)</td>
<td>(0% - 4.5%)</td>
<td>(0% - 4.3%)</td>
<td>(0% - 3.6%)</td>
<td>(0% - 3.5%)</td>
<td>(0% - 3.3%)</td>
<td>(0% - 3%)</td>
<td>(0% - 2.3%)</td>
</tr>
<tr>
<td>Los_Angles-Long_Beach-Riverside__CA</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>(0% - 2.7%)</td>
<td>(0% - 2.7%)</td>
<td>(0% - 2.3%)</td>
<td>(0% - 1.7%)</td>
<td>(0% - 1.7%)</td>
<td>(0% - 1.6%)</td>
<td>(0% - 1.3%)</td>
<td>(0% - 0.7%)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>0.9%</td>
<td>0.7%</td>
<td>0.6%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.3%</td>
<td>0.2%</td>
<td>0.1%</td>
</tr>
<tr>
<td></td>
<td>(0.1% - 6.8%)</td>
<td>(0% - 6.3%)</td>
<td>(0% - 6%)</td>
<td>(0% - 4.8%)</td>
<td>(0% - 4.9%)</td>
<td>(0% - 4.7%)</td>
<td>(0% - 4.3%)</td>
<td>(0% - 3.5%)</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>1.8%</td>
<td>1.4%</td>
<td>1.3%</td>
<td>0.8%</td>
<td>0.7%</td>
<td>0.6%</td>
<td>0.5%</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td>(0.2% - 8.9%)</td>
<td>(0.1% - 8.1%)</td>
<td>(0.1% - 7.8%)</td>
<td>(0% - 6.6%)</td>
<td>(0% - 6.3%)</td>
<td>(0% - 5.8%)</td>
<td>(0% - 5.6%)</td>
<td>(0% - 4.5%)</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>0.5%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.2%</td>
<td>0.2%</td>
<td>0.1%</td>
<td>0.1%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>(0% - 4.8%)</td>
<td>(0% - 4.4%)</td>
<td>(0% - 4.2%)</td>
<td>(0% - 3.5%)</td>
<td>(0% - 3.3%)</td>
<td>(0% - 3.1%)</td>
<td>(0% - 2.8%)</td>
<td>(0% - 2.1%)</td>
</tr>
<tr>
<td>St._Louis-St._Charles-Farmington__MO-IL</td>
<td>1.9%</td>
<td>1.6%</td>
<td>1.4%</td>
<td>0.9%</td>
<td>0.8%</td>
<td>0.6%</td>
<td>0.5%</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td>(0.2% - 9.1%)</td>
<td>(0.1% - 8.4%)</td>
<td>(0.1% - 7.9%)</td>
<td>(0% - 6.8%)</td>
<td>(0% - 6.4%)</td>
<td>(0% - 5.9%)</td>
<td>(0% - 5.5%)</td>
<td>(0% - 4.4%)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>1.5%</td>
<td>1.1%</td>
<td>1%</td>
<td>0.7%</td>
<td>0.6%</td>
<td>0.4%</td>
<td>0.4%</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td>(0.1% - 8.2%)</td>
<td>(0.1% - 7.2%)</td>
<td>(0.1% - 7.2%)</td>
<td>(0% - 6.3%)</td>
<td>(0% - 5.9%)</td>
<td>(0% - 5.3%)</td>
<td>(0% - 5.1%)</td>
<td>(0% - 4.1%)</td>
</tr>
</tbody>
</table>

*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-5. Estimated Number of Occurrences of Lung Function Response Associated with Exposure to O₃ 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 O₃ Concentrations*

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Occurrences (in 1000s) of Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td><strong>Response = Decrease in FEV₁ Greater Than or Equal to 10%</strong></td>
<td></td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>333</td>
</tr>
<tr>
<td></td>
<td>(31 - 1143)</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>205</td>
</tr>
<tr>
<td></td>
<td>(15 - 767)</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>319</td>
</tr>
<tr>
<td></td>
<td>(16 - 1181)</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>115</td>
</tr>
<tr>
<td></td>
<td>(7 - 420)</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>219</td>
</tr>
<tr>
<td></td>
<td>(14 - 805)</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>266</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>1106</td>
</tr>
<tr>
<td></td>
<td>(73 - 3598)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>795</td>
</tr>
<tr>
<td></td>
<td>(48 - 2939)</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>331</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>(7 - 315)</td>
</tr>
<tr>
<td>St._Louis-St._Charles-Farmington__MO-IL</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>(12 - 507)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>394</td>
</tr>
</tbody>
</table>

**Response = Decrease in FEV₁ Greater Than or Equal to 15%**
<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Occurrences (in 1000s) of Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>(1 - 592)</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>(1 - 615)</td>
</tr>
<tr>
<td></td>
<td>13</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>(1 - 218)</td>
</tr>
<tr>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>(0 - 416)</td>
</tr>
<tr>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>(1 - 374)</td>
</tr>
<tr>
<td></td>
<td>27</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>(1 - 1948)</td>
</tr>
<tr>
<td></td>
<td>58</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>(1 - 1521)</td>
</tr>
<tr>
<td></td>
<td>38</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>(1 - 581)</td>
</tr>
<tr>
<td></td>
<td>23</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>(0 - 166)</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>St._Louis-St._Charles-Farmington__MO-IL</td>
<td>(0 - 267)</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>(1 - 711)</td>
</tr>
<tr>
<td></td>
<td>29</td>
</tr>
<tr>
<td>Response = Decrease in FEV1 Greater Than or Equal to 20%</td>
<td></td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>(0 - 244)</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>(0 - 149)</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>(0 - 235)</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>(0 - 84)</td>
</tr>
<tr>
<td>Location</td>
<td>Number of Occurrences (in 1000s) of Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(0 - 160)</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(0 - 202)</td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(0 - 826)</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(0 - 583)</td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(0 - 244)</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
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</tr>
<tr>
<td></td>
<td>(0 - 70)</td>
</tr>
<tr>
<td>St_Louis-St_Charles-Farmington__MO-IL</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(0 - 111)</td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(0 - 288)</td>
</tr>
</tbody>
</table>

*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-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*

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Occurrences (in 1000s) of Lung Function Response Associated with ( O_3 ) Concentrations that Just Meet the Current and Alternative ( O_3 ) Standards**</th>
<th>0.084/4***</th>
<th>0.084/3</th>
<th>0.080/4****</th>
<th>0.074/5</th>
<th>0.074/4</th>
<th>0.074/3</th>
<th>0.070/4****</th>
<th>0.064/4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Response = Decrease in FEV(_1) Greater Than or Equal to 10%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>404 (55 - 1203) 399 (53 - 1192) 362 (44 - 1116) 327 (35 - 1037) 306 (31 - 992) 305 (31 - 989) 271 (24 - 909) 224 (16 - 792)</td>
<td>404</td>
<td>399</td>
<td>362</td>
<td>327</td>
<td>306</td>
<td>305</td>
<td>271</td>
<td>224</td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>662 (97 - 1881) 623 (85 - 1802) 592 (77 - 1742) 542 (64 - 1638) 498 (53 - 1545) 474 (48 - 1493) 441 (41 - 1418) 361 (26 - 1234)</td>
<td>254</td>
<td>233</td>
<td>228</td>
<td>200</td>
<td>193</td>
<td>178</td>
<td>171</td>
<td>142</td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>433 (69 - 1227) 396 (57 - 1155) 387 (55 - 1140) 378 (52 - 1121) 325 (38 - 1014) 298 (31 - 959) 287 (29 - 934) 235 (18 - 819)</td>
<td>254</td>
<td>233</td>
<td>228</td>
<td>200</td>
<td>193</td>
<td>178</td>
<td>171</td>
<td>142</td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>433 (69 - 1227) 396 (57 - 1155) 387 (55 - 1140) 378 (52 - 1121) 325 (38 - 1014) 298 (31 - 959) 287 (29 - 934) 235 (18 - 819)</td>
<td>254</td>
<td>233</td>
<td>228</td>
<td>200</td>
<td>193</td>
<td>178</td>
<td>171</td>
<td>142</td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>227 (28 - 475) 207 (23 - 423) 199 (22 - 402) 165 (16 - 310) 158 (15 - 291) 145 (13 - 252) 130 (11 - 201) 79 (6 - 3) 218 (28 - 475) 207 (23 - 423) 199 (22 - 402) 165 (16 - 310) 158 (13 - 252) 145 (11 - 201) 79 (6 - 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>997 (70 - 3105) 966 (67 - 3020) 856 (54 - 2685) 609 (32 - 1862) 601 (31 - 1830) 571 (29 - 1721) 436 (20 - 1207) 218 (9 - 281)</td>
<td>997</td>
<td>966</td>
<td>856</td>
<td>609</td>
<td>601</td>
<td>571</td>
<td>436</td>
<td>218</td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>1587 (212 - 4682) 1506 (189 - 4524) 1435 (170 - 4384) 1197 (114 - 3888) 1228 (120 - 3957) 1173 (108 - 3839) 1099 (93 - 3677) 894 (59 - 3183)</td>
<td>1587</td>
<td>1506</td>
<td>1435</td>
<td>1197</td>
<td>1228</td>
<td>1173</td>
<td>1099</td>
<td>894</td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>140 (15 - 436) 132 (13 - 418) 125 (12 - 401) 108 (9 - 361) 104 (8 - 351) 99 (8 - 338) 91 (6 - 318) 73 (4 - 268)</td>
<td>140</td>
<td>132</td>
<td>125</td>
<td>108</td>
<td>104</td>
<td>99</td>
<td>91</td>
<td>73</td>
</tr>
<tr>
<td>St_Louis-St_Charles-Farmington__MO-IL</td>
<td>282 (50 - 744) 263 (44 - 709) 252 (40 - 688) 222 (31 - 630) 210 (28 - 607) 198 (25 - 581) 185 (22 - 555) 151 (14 - 480)</td>
<td>282</td>
<td>263</td>
<td>252</td>
<td>222</td>
<td>210</td>
<td>198</td>
<td>185</td>
<td>151</td>
</tr>
<tr>
<td><strong>Response = Decrease in FEV(_1) Greater Than or Equal to 15%</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>51 (4 - 647) 49 (4 - 641) 40 (2 - 596) 32 (1 - 550) 27 (1 - 524) 27 (1 - 522) 20 (0 - 477) 13 (0 - 411)</td>
<td>51</td>
<td>49</td>
<td>40</td>
<td>32</td>
<td>27</td>
<td>27</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>Location</td>
<td>Number of Occurrences (in 1000s) of Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-----------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td><strong>Location Number of Occurrences (in 1000s) of Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards</strong></td>
<td>0.084/4*** 0.084/3 0.080/4**** 0.074/5 0.074/4 0.074/3 0.070/4**** 0.064/4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>55 (7 - 614) 44 (5 - 572) 43 (5 - 569) 39 (4 - 551) 29 (2 - 505) 24 (1 - 478) 21 (1 - 465) 13 (0 - 407)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>92 (8 - 1033) 80 (6 - 985) 71 (5 - 949) 58 (3 - 887) 48 (2 - 832) 42 (2 - 801) 35 (1 - 758) 21 (0 - 652)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>40 (5 - 391) 33 (3 - 366) 32 (3 - 360) 23 (2 - 327) 22 (1 - 318) 18 (1 - 300) 16 (1 - 291) 10 (0 - 254)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>66 (6 - 670) 54 (4 - 626) 52 (4 - 616) 49 (3 - 605) 34 (2 - 540) 28 (1 - 508) 25 (1 - 493) 15 (0 - 427)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>25 (1 - 307) 21 (1 - 278) 19 (1 - 267) 14 (0 - 217) 13 (0 - 207) 11 (0 - 187) 9 (0 - 161) 5 (0 - 65)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Los_Angeles-Long_Beach-Riverside__CA</td>
<td>57 (1 - 1718) 54 (1 - 1671) 43 (1 - 1494) 24 (0 - 1068) 24 (0 - 1052) 22 (0 - 997) 15 (0 - 741) 6 (0 - 292)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>197 (15 - 2539) 174 (11 - 2442) 155 (9 - 2357) 99 (3 - 2063) 94 (3 - 2034) 94 (2 - 1940) 79 (1 - 1661) 47 (1 - 636)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>104 (12 - 957) 88 (9 - 905) 83 (7 - 887) 61 (4 - 807) 57 (3 - 787) 49 (2 - 750) 44 (2 - 725) 28 (1 - 636)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>14 (1 - 232) 12 (0 - 221) 10 (0 - 212) 8 (0 - 189) 7 (0 - 184) 6 (0 - 176) 5 (0 - 166) 3 (0 - 138)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>St._Louis-St._Charles-Farmington__MO-IL</td>
<td>49 (6 - 416) 42 (5 - 394) 39 (4 - 380) 29 (2 - 345) 26 (2 - 331) 23 (1 - 316) 20 (1 - 300) 12 (0 - 256)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>105 (11 - 1109) 84 (7 - 1030) 83 (7 - 1025) 66 (4 - 949) 57 (3 - 909) 47 (2 - 854) 43 (2 - 836) 28 (1 - 731)</td>
<td></td>
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</tr>
<tr>
<td><strong>Response = Decrease in FEV₁ Greater Than or Equal to 20%</strong></td>
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</tr>
<tr>
<td>Atlanta-Sandy_Springs-Gainesville__GA-AL</td>
<td>8 (0 - 293) 7 (0 - 290) 5 (0 - 264) 3 (0 - 239) 3 (0 - 225) 3 (0 - 224) 1 (0 - 199) 1 (0 - 165)</td>
<td></td>
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</tr>
<tr>
<td>Boston-Worcester-Manchester__MA-NH</td>
<td>11 (1 - 272) 8 (1 - 248) 8 (1 - 246) 7 (0 - 236) 4 (0 - 210) 4 (0 - 195) 3 (0 - 188) 1 (0 - 157)</td>
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</tr>
<tr>
<td>Chicago-Naperville-Michigan_City__IL-IN-WI</td>
<td>15 (1 - 480) 12 (0 - 452) 10 (0 - 431) 7 (0 - 396) 5 (0 - 365) 4 (0 - 348) 3 (0 - 324) 1 (0 - 266)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleveland-Akron-Elyria__OH</td>
<td>8 (0 - 183) 6 (0 - 168) 5 (0 - 165) 3 (0 - 145) 3 (0 - 140) 2 (0 - 130) 2 (0 - 125) 1 (0 - 104)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Detroit-Warren-Flint__MI</td>
<td>12 (0 - 312) 9 (0 - 286) 8 (0 - 280) 7 (0 - 273) 4 (0 - 236) 3 (0 - 218) 2 (0 - 210) 1 (0 - 173)</td>
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<td></td>
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</tr>
<tr>
<td>Location</td>
<td>Number of Occurrences (in 1000s) of Lung Function Response Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>----------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>0.084/4***</td>
<td>0.084/3</td>
<td>0.080/4/****</td>
<td>0.074/5</td>
<td>0.074/4</td>
<td>0.074/3</td>
<td>0.070/4/****</td>
<td>0.064/4</td>
<td></td>
</tr>
<tr>
<td>Houston-Baytown-Huntsville__TX</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0 - 172)</td>
<td>(0 - 158)</td>
<td>(0 - 152)</td>
<td>(0 - 128)</td>
<td>(0 - 123)</td>
<td>(0 - 114)</td>
<td>(0 - 102)</td>
<td>(0 - 65)</td>
<td></td>
</tr>
<tr>
<td>Los_Angles-Long_Beach-Riverside__CA</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0 - 745)</td>
<td>(0 - 722)</td>
<td>(0 - 641)</td>
<td>(0 - 458)</td>
<td>(0 - 452)</td>
<td>(0 - 430)</td>
<td>(0 - 331)</td>
<td>(0 - 172)</td>
<td></td>
</tr>
<tr>
<td>New_York-Newark-Bridgeport__NY-NJ-CT-PA</td>
<td>29</td>
<td>24</td>
<td>19</td>
<td>9</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1 - 1154)</td>
<td>(1 - 1097)</td>
<td>(0 - 1047)</td>
<td>(0 - 878)</td>
<td>(0 - 900)</td>
<td>(0 - 861)</td>
<td>(0 - 808)</td>
<td>(0 - 659)</td>
<td></td>
</tr>
<tr>
<td>Philadelphia-Camden-Vineland__PA-NJ-DE-MD</td>
<td>20</td>
<td>15</td>
<td>14</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1 - 463)</td>
<td>(1 - 432)</td>
<td>(1 - 421)</td>
<td>(0 - 373)</td>
<td>(0 - 361)</td>
<td>(0 - 340)</td>
<td>(0 - 325)</td>
<td>(0 - 274)</td>
<td></td>
</tr>
<tr>
<td>Sacramento-Arden-Arcade-Truckee__CA-NV</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0 - 103)</td>
<td>(0 - 97)</td>
<td>(0 - 92)</td>
<td>(0 - 80)</td>
<td>(0 - 77)</td>
<td>(0 - 73)</td>
<td>(0 - 68)</td>
<td>(0 - 54)</td>
<td></td>
</tr>
<tr>
<td>St_Louis-St_Charles-Farmington__MO-IL</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1 - 203)</td>
<td>(0 - 190)</td>
<td>(0 - 182)</td>
<td>(0 - 161)</td>
<td>(0 - 153)</td>
<td>(0 - 145)</td>
<td>(0 - 136)</td>
<td>(0 - 111)</td>
<td></td>
</tr>
<tr>
<td>Washington-Baltimore-Northern_Virginia__DC-MD-VA-WV</td>
<td>19</td>
<td>13</td>
<td>13</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1 - 515)</td>
<td>(1 - 468)</td>
<td>(1 - 465)</td>
<td>(0 - 421)</td>
<td>(0 - 398)</td>
<td>(0 - 387)</td>
<td>(0 - 357)</td>
<td>(0 - 299)</td>
<td></td>
</tr>
</tbody>
</table>

*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 O₃ Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: Boston, MA, April - September, Based on 2004 O₃ Concentrations

<table>
<thead>
<tr>
<th>Respiratory Symptoms*</th>
<th>Study</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Other Pollutants in Model</th>
<th>Incidence of Respiratory Symptom-Days (in 100s) Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><em>0.084/4</em>**</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>none</td>
<td>45 (7 - 79)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
<td>72 (32 - 107)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
<td>66 (25 - 102)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>8 hr max.</td>
<td>none</td>
<td>46 (15 - 75)</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>none</td>
<td>48 (6 - 87)</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>8 hr max.</td>
<td>none</td>
<td>53 (10 - 92)</td>
</tr>
<tr>
<td>Wheeze</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
<td>132 (47 - 208)</td>
</tr>
</tbody>
</table>

*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-8. Estimated Percent of Total Incidence of Health Risks Associated with O₃ Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: Boston, MA, April - September, Based on 2004 O₃ Concentrations

<table>
<thead>
<tr>
<th>Respiratory Symptoms*</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Other Pollutants in Model</th>
<th>Percent of Total Incidence of Respiratory Symptom-Days Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1.3% - 14.2%)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(5.8% - 19.3%)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(4.6% - 18.4%)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>8 hr max.</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(2.6% - 13.4%)</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.8% - 12.6%)</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>8 hr max.</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1.5% - 13.2%)</td>
</tr>
<tr>
<td>Wheeze</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(3.6% - 16%)</td>
</tr>
</tbody>
</table>

*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-9. Estimated Incidence of Health Risks Associated with O₃ Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: Boston, MA, April - September, Based on 2002 O₃ Concentrations

<table>
<thead>
<tr>
<th>Respiratory Symptoms*</th>
<th>Study</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Other Pollutants in Model</th>
<th>Incidence of Respiratory Symptom-Days (in 100s) Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>none</td>
<td>61</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(10 - 105)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
<td>96</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
<td>89</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>8 hr max.</td>
<td>none</td>
<td>64</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>none</td>
<td>66</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>(8 - 117)</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>8 hr max.</td>
<td>none</td>
<td>73</td>
</tr>
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<td></td>
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<td>(15 - 125)</td>
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<tr>
<td>Wheeze</td>
<td>Gent et al. (2003)</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
<td>178</td>
</tr>
</tbody>
</table>

*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 O₃ Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: Boston, MA, April - September, Based on 2002 O₃ Concentrations

<table>
<thead>
<tr>
<th>Respiratory Symptoms*</th>
<th>Ages</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Other Pollutants in Model</th>
<th>Percent of Total Incidence of Respiratory Symptom-Days Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.084/4**** 0.084/3 0.080/4**** 0.074/5 0.074/4 0.074/3 0.070/4**** 0.064/4</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>none</td>
<td>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%)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
<td>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%)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
<td>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%)</td>
</tr>
<tr>
<td>Chest tightness</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>8 hr max.</td>
<td>none</td>
<td>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%)</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>1 hr max.</td>
<td>none</td>
<td>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%)</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>0 - 12</td>
<td>1-day lag</td>
<td>8 hr max.</td>
<td>none</td>
<td>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%)</td>
</tr>
<tr>
<td>Wheeze</td>
<td>0 - 12</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>PM2.5</td>
<td>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%)</td>
</tr>
</tbody>
</table>

*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 O₃ Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: New York, NY, April - September, Based on 2004 O₃ Concentrations

<table>
<thead>
<tr>
<th>Hospital Admissions</th>
<th>Lag</th>
<th>Incidence of Health Effects Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Respiratory illness (unscheduled)</td>
<td>3-day lag</td>
<td>366 (89 - 644)</td>
</tr>
<tr>
<td>Asthma (unscheduled)</td>
<td>1-day lag</td>
<td>313 (66 - 559)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospital Admissions</th>
<th>Lag</th>
<th>Incidence of Health Effects per 100,000 Relevant Population Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Respiratory illness (unscheduled)</td>
<td>3-day lag</td>
<td>4.6 (1.1 - 8)</td>
</tr>
<tr>
<td>Asthma (unscheduled)</td>
<td>1-day lag</td>
<td>3.9 (0.8 - 7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospital Admissions</th>
<th>Lag</th>
<th>Percent of Total Incidence of Health Effects Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Respiratory illness (unscheduled)</td>
<td>3-day lag</td>
<td>1% (0.3% - 1.8%)</td>
</tr>
<tr>
<td>Asthma (unscheduled)</td>
<td>1-day lag</td>
<td>2.4% (0.5% - 4.3%)</td>
</tr>
</tbody>
</table>

*Based on single-pollutant models from Thurston et al. (1992) relating daily hospital admissions among all ages to daily 1-hr maximum O₃ 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 O₃ coefficient.
Table 5C-12. Estimated Percent of Total Incidence of Hospital Admissions Associated with O₃ Concentrations that Just Meet the Current and Alternative 8-Hour Daily Maximum Standards: New York, NY, April - September, Based on 2002 O₃ Concentrations

<table>
<thead>
<tr>
<th>Hospital Admissions</th>
<th>Lag</th>
<th>Incidence of Health Effects Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.084/4*** 0.084/3 0.080/4**** 0.074/5 0.074/4 0.074/3 0.070/4**** 0.064/4</td>
</tr>
<tr>
<td>Respiratory illness (unscheduled)</td>
<td>3-day lag</td>
<td>513 (124 - 902) 472 (114 - 830) 483 (117 - 850) 452 (109 - 795) 439 (106 - 772) 404 (98 - 710) 410 (99 - 721) 365 (88 - 642)</td>
</tr>
<tr>
<td>Asthma (unscheduled)</td>
<td>1-day lag</td>
<td>438 (93 - 783) 403 (86 - 720) 413 (88 - 738) 386 (82 - 690) 375 (80 - 670) 345 (73 - 617) 350 (75 - 626) 312 (66 - 558)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospital Admissions</th>
<th>Lag</th>
<th>Incidence of Health Effects per 100,000 Relevant Population Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.084/4*** 0.084/3 0.080/4**** 0.074/5 0.074/4 0.074/3 0.070/4**** 0.064/4</td>
</tr>
<tr>
<td>Respiratory illness (unscheduled)</td>
<td>3-day lag</td>
<td>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)</td>
</tr>
<tr>
<td>Asthma (unscheduled)</td>
<td>1-day lag</td>
<td>5.5 (1.2 - 9.8) 5 (1.1 - 9) 5.2 (1.1 - 9.2) 4.8 (1 - 8.6) 4.7 (0.9 - 7.7) 4.3 (0.9 - 7.8) 4.4 (0.8 - 7) 3.9 (0.07 - 0.9)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hospital Admissions</th>
<th>Lag</th>
<th>Percent of Total Incidence of Health Effects Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.084/4*** 0.084/3 0.080/4**** 0.074/5 0.074/4 0.074/3 0.070/4**** 0.064/4</td>
</tr>
<tr>
<td>Respiratory illness (unscheduled)</td>
<td>3-day lag</td>
<td>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%)</td>
</tr>
<tr>
<td>Asthma (unscheduled)</td>
<td>1-day lag</td>
<td>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%)</td>
</tr>
</tbody>
</table>

*Based on single-pollutant models from Thurston et al. (1992) relating daily hospital admissions among all ages to daily 1-hr maximum O₃ 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 O₃ coefficient.
<table>
<thead>
<tr>
<th>Location</th>
<th>Study</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Atlanta</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(20 - 29)</td>
<td></td>
<td></td>
<td>(-20 - 29)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(3 - 15)</td>
<td></td>
<td></td>
<td>(3 - 15)</td>
</tr>
<tr>
<td>Boston</td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(2 - 9)</td>
<td></td>
<td></td>
<td>(2 - 9)</td>
</tr>
<tr>
<td>Chicago</td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>314</td>
</tr>
<tr>
<td></td>
<td>Schwartz -- 14 US Cities (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>118</td>
</tr>
<tr>
<td>Cleveland</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>(12 - 49)</td>
<td></td>
<td></td>
<td>(11 - 46)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(4 - 20)</td>
<td></td>
<td></td>
<td>(4 - 19)</td>
</tr>
<tr>
<td>Detroit</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>(8 - 56)</td>
<td></td>
<td></td>
<td>(7 - 51)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>(4 - 20)</td>
<td></td>
<td></td>
<td>(4 - 19)</td>
</tr>
<tr>
<td></td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Schwartz -- 14 US Cities (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>58</td>
</tr>
<tr>
<td>Location</td>
<td>Study</td>
<td>Lag</td>
<td>Exposure Metric</td>
<td>Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------------</td>
<td>--------------------</td>
<td>-----------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Incidence</td>
<td>Current O₃ Standard 0.084/4***</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Metric</td>
<td>24 hr avg.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0-day lag</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Houston</td>
<td>Ito (2003)</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Schwartz -- 14 US Cities (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td></td>
</tr>
<tr>
<td>Los Angeles</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Moolgavkar et al. (1995)</td>
<td>1-day lag</td>
<td>24 hr avg.</td>
<td></td>
</tr>
<tr>
<td>Sacramento</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td></td>
</tr>
<tr>
<td>St Louis</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Study</td>
<td>Lag</td>
<td>Exposure Metric</td>
<td>Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------</td>
<td>-----------</td>
<td>-----------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Washington</td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.084/4*** 0.084/3 0.080/4**** 0.074/5 0.074/4 0.074/3 0.070/4**** 0.064/4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2 - 12)</td>
<td>(2 - 10)</td>
</tr>
</tbody>
</table>

*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 O₃ coefficient.
Table 5C-14. 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 2004 O3 Concentrations*

<table>
<thead>
<tr>
<th>Location</th>
<th>Study</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Percent of Total Incidence of Non-Accidental Mortality Associated with O3 Concentrations that Just Meet the Current and Alternative O3 Standards**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.084/4***</td>
</tr>
<tr>
<td>Atlanta</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(-0.4% -0.6%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.1% -0.3%)</td>
</tr>
<tr>
<td>Boston</td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.1% -0.4%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.1% -0.3%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.1% -0.4%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.1% -0.4%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.1% -0.4%)</td>
</tr>
<tr>
<td></td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>1.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.5% -2.5%)</td>
</tr>
<tr>
<td></td>
<td>Schwartz -- 14 US Cities (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>0.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.2% -0.9%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(-0.2% -0.7%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.1% -0.3%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(-0.1% -0.6%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0% -0.2%)</td>
</tr>
<tr>
<td></td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>1.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(-0.2% -2.4%)</td>
</tr>
<tr>
<td></td>
<td>Schwartz -- 14 US Cities (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>0.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.2% -1%)</td>
</tr>
<tr>
<td>Ito (2003)</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td></td>
<td>0.3%</td>
</tr>
<tr>
<td>Location</td>
<td>Study</td>
<td>Lag</td>
<td>Exposure Metric</td>
<td>Percent of Total Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------------</td>
<td>----------------------</td>
<td>-----------------</td>
<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.084/4***</td>
<td>-0.3% -0.9%</td>
<td>(-0.3% -0.8%) (-0.2% -0.8%) (-0.2% -0.7%) (-0.2% -0.6%) (-0.2% -0.6%) (-0.1% -0.4%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.084/3</td>
<td>(0% -0.5%)</td>
<td>(0% -0.4%) (0% -0.4%) (0% -0.3%) (0% -0.3%) (0% -0.3%) (0% -0.2%)</td>
</tr>
<tr>
<td>Houston</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2% 0.2% 0.2% 0.2% 0.2% 0.1% 0.1% 0.1%</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.1% 0.1% 0.1% 0.1% 0.1% 0.1% 0.1% 0%</td>
</tr>
<tr>
<td></td>
<td>Cities (2004)</td>
<td></td>
<td></td>
<td>(0% -0.2%) (0% -0.2%) (0% -0.2%) (0% -0.1%) (0% -0.1%) (0% -0.1%) (0% -0.1%) (0% -0.1%)</td>
</tr>
<tr>
<td></td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>0.8% 0.7% 0.7% 0.6% 0.6% 0.6% 0.6% 0.5%</td>
</tr>
<tr>
<td></td>
<td>Schwartz -- 14 US</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>0.6% 0.6% 0.6% 0.5% 0.5% 0.5% 0.5% 0.5%</td>
</tr>
<tr>
<td></td>
<td>Cities (2004)</td>
<td></td>
<td></td>
<td>(0.2% -1.1%) (0.2% -1%) (0.2% -1%) (0.2% -0.9%) (0.2% -0.9%) (0.2% -0.8%) (0.2% -0.8%) (0.1% -0.8%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.1% 0.1% 0.1% 0.1% 0.1% 0.1% 0.1% 0.1%</td>
</tr>
<tr>
<td></td>
<td>Cities (2004)</td>
<td></td>
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<td>(0% -0.2%) (0% -0.2%) (0% -0.2%) (0% -0.2%) (0% -0.2%) (0% -0.2%) (0% -0.2%) (0% -0.2%)</td>
</tr>
<tr>
<td></td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>0.6% 0.6% 0.6% 0.5% 0.5% 0.5% 0.5% 0.4%</td>
</tr>
<tr>
<td></td>
<td>Schwartz -- 14 US</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>0.6% 0.6% 0.6% 0.5% 0.5% 0.5% 0.5% 0.4%</td>
</tr>
<tr>
<td></td>
<td>Cities (2004)</td>
<td></td>
<td></td>
<td>(0.2% -1.1%) (0.2% -1%) (0.2% -1%) (0.2% -0.9%) (0.2% -0.9%) (0.2% -0.8%) (0.2% -0.8%) (0.1% -0.8%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2%</td>
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<td></td>
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<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2%</td>
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<tr>
<td></td>
<td>Bell et al. -- 95 US</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2%</td>
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<td>Cities (2004)</td>
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<td></td>
<td>(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%)</td>
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<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
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<td>0.6% 0.6% 0.6% 0.5% 0.5% 0.5% 0.5% 0.4%</td>
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<tr>
<td></td>
<td>Cities (2004)</td>
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<td></td>
<td>(0.2% -1.1%) (0.2% -1%) (0.2% -1%) (0.2% -0.9%) (0.2% -0.9%) (0.2% -0.8%) (0.2% -0.8%) (0.1% -0.8%)</td>
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<tr>
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<td>1-day lag</td>
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<td>0.7% 0.7% 0.7% 0.6% 0.6% 0.6% 0.5% 0.5%</td>
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<tr>
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<td>(0.5% -1%) (0.4% -0.9%) (0.4% -0.9%) (0.4% -0.8%) (0.4% -0.8%) (0.3% -0.7%) (0.3% -0.7%) (0.3% -0.6%)</td>
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<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2%</td>
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<td></td>
<td>Bell et al. -- 95 US</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2%</td>
</tr>
<tr>
<td></td>
<td>Cities (2004)</td>
<td></td>
<td></td>
<td>(0.1% -0.3%) (0.1% -0.3%) (0.1% -0.3%) (0.1% -0.3%) (0.1% -0.3%) (0.1% -0.3%) (0.1% -0.3%) (0.1% -0.3%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.3% 0.3% 0.3% 0.3% 0.3% 0.3% 0.3% 0.3%</td>
</tr>
<tr>
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<td>Cities (2004)</td>
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<td></td>
<td>(0.1% -0.5%) (0.1% -0.5%) (0.1% -0.5%) (0.1% -0.5%) (0.1% -0.5%) (0.1% -0.5%) (0.1% -0.5%) (0.1% -0.5%)</td>
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<td></td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.1% 0.1% 0.1% 0.1% 0.1% 0.1% 0.1% 0.1%</td>
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<td>24 hr avg.</td>
<td>0.1% 0.1% 0.1% 0.1% 0.1% 0.1% 0.1% 0.1%</td>
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<td>(0% -0.2%) (0% -0.2%) (0% -0.2%) (0% -0.1%) (0% -0.1%) (0% -0.1%) (0% -0.1%) (0% -0.1%)</td>
</tr>
<tr>
<td></td>
<td>Washington</td>
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<td>24 hr avg.</td>
<td>0.3% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2%</td>
</tr>
<tr>
<td></td>
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<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.3% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2% 0.2%</td>
</tr>
<tr>
<td>Location</td>
<td>Study</td>
<td>Lag</td>
<td>Exposure Metric</td>
<td>Percent of Total Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------</td>
<td>-----</td>
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<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cities (2004)</td>
<td>lag</td>
<td></td>
<td>0.084/4***</td>
<td>0.084/3 0.080/4**** 0.074/5 0.074/4 0.074/3 0.070/4**** 0.064/4 (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%)</td>
</tr>
</tbody>
</table>

*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 O₃ coefficient.
Table 5C-15. Estimated 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*

<table>
<thead>
<tr>
<th>Location</th>
<th>Study</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
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<tbody>
<tr>
<td></td>
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<td></td>
<td>0.084/4***</td>
<td>0.084/3</td>
</tr>
<tr>
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<td>24 hr avg.</td>
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<td>24 hr avg.</td>
<td>14</td>
</tr>
<tr>
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<td>24 hr avg.</td>
<td>9</td>
</tr>
<tr>
<td>Chicago</td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>427</td>
</tr>
<tr>
<td></td>
<td>Schwartz -- 14 US Cities (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>161</td>
</tr>
<tr>
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<td>24 hr avg.</td>
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<td>1 hr max.</td>
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<tr>
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<td>86</td>
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<td>Ito (2003)</td>
<td>0-day lag</td>
<td>24 hr avg.</td>
<td>56</td>
</tr>
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<td>Location</td>
<td>Study</td>
<td>Lag</td>
<td>Exposure Metric</td>
<td>Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------</td>
<td>-----------</td>
<td>----------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.084/4***</td>
<td>0.084/3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(-52 - 162)</td>
<td>(-49 - 151)</td>
</tr>
<tr>
<td>Houston</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>18 (1 - 34)</td>
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<tr>
<td></td>
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<td>distributed lag</td>
<td>24 hr avg.</td>
<td>9 (3 - 15)</td>
</tr>
<tr>
<td></td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>63 (6 - 119)</td>
</tr>
<tr>
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<td>Schwartz – 14 US Cities (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>53 (16 - 88)</td>
</tr>
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<td>24 hr avg.</td>
<td>24 (-58 - 105)</td>
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<td>distributed lag</td>
<td>24 hr avg.</td>
<td>52 (17 - 86)</td>
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<td>distributed lag</td>
<td>24 hr avg.</td>
<td>84 (28 - 139)</td>
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<td>24 hr avg.</td>
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</tr>
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<td>24 hr avg.</td>
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<td>distributed lag</td>
<td>24 hr avg.</td>
<td>14</td>
</tr>
<tr>
<td>Location</td>
<td>Study</td>
<td>Lag</td>
<td>Exposure Metric</td>
<td>Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
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<td>-----------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
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<tr>
<td>US Cities (2004)</td>
<td></td>
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<td>0.084/4***</td>
<td>0.084/3 0.080/4**** 0.074/5 0.074/4 0.074/3 0.070/4**** 0.064/4</td>
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<td>(5 - 23)</td>
<td>(4 - 20) (4 - 21) (4 - 19) (4 - 19) (3 - 17) (4 - 18) (3 - 16)</td>
</tr>
</tbody>
</table>

*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 O₃ coefficient.
<table>
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<tr>
<th>Location</th>
<th>Study</th>
<th>Lag</th>
<th>Exposure Metric</th>
<th>Percent of Total Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
</tr>
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<td>0.084/4***</td>
<td>0.084/3</td>
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<td>( -0.7% -0.9%)</td>
<td>( -0.6% -0.9%)</td>
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<td>(0.1% -0.4%)</td>
<td>(0.1% -0.4%)</td>
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<td>(0.4% -1.7%)</td>
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<td>(0.1% -0.7%)</td>
<td>(0.1% -0.7%)</td>
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<td>(0.3% -1.5%)</td>
<td>(0.3% -1.5%)</td>
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<tr>
<td>Ito (2003)</td>
<td>0-day lag</td>
<td></td>
<td>24 hr avg.</td>
<td>0.6%</td>
</tr>
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<td>Location</td>
<td>Study</td>
<td>Lag</td>
<td>Exposure Metric</td>
<td>Percent of Total Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</td>
</tr>
<tr>
<td>---------------</td>
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<td>------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.084/4***</td>
<td>0.084/3</td>
</tr>
<tr>
<td>Houston</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>(-0.6% -1.7%)</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(-0.0% -0.4%)</td>
<td>(-0.0% -0.3%)</td>
</tr>
<tr>
<td></td>
<td>Schwartz (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>0.7%</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>(-0.1% -1.3%)</td>
<td>(-0.1% -1.2%)</td>
</tr>
<tr>
<td></td>
<td>Schwartz -- 14 US Cities (2004)</td>
<td>0-day lag</td>
<td>1 hr max.</td>
<td>0.6%</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(0.2% -1%)</td>
<td>(0.2% -0.9%)</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.1%</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(-0.1% -0.3%)</td>
<td>(-0.1% -0.3%)</td>
</tr>
<tr>
<td>New York</td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.3%</td>
</tr>
<tr>
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<td></td>
<td>(0.1% -0.4%)</td>
<td>(0.1% -0.4%)</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
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</tr>
<tr>
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<td>(0.1% -0.6%)</td>
<td>(0.1% -0.6%)</td>
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<tr>
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<td>Moolgavkar et al. (1995)</td>
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<td>24 hr avg.</td>
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<td>(0.8% -1.8%)</td>
<td>(0.8% -1.7%)</td>
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<tr>
<td>Sacramento</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
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</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.4%</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>(0.1% -0.7%)</td>
<td>(0.1% -0.7%)</td>
</tr>
<tr>
<td>St Louis</td>
<td>Bell et al. (2004)</td>
<td>distributed lag</td>
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<td>0.3%</td>
</tr>
<tr>
<td></td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.1% -0.4%)</td>
<td>(0.1% -0.4%)</td>
</tr>
<tr>
<td>Washington</td>
<td>Bell et al. -- 95 US Cities (2004)</td>
<td>distributed lag</td>
<td>24 hr avg.</td>
<td>0.5%</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(0.2% -0.8%)</td>
<td>(0.1% -0.7%)</td>
</tr>
</tbody>
</table>

**Percent of total incidence associated with O₃ concentrations that just meet the current and alternative O₃ standards.**
<table>
<thead>
<tr>
<th>Location</th>
<th>Study</th>
<th>Lag Metric</th>
<th>Percent of Total Incidence of Non-Accidental Mortality Associated with O₃ Concentrations that Just Meet the Current and Alternative O₃ Standards**</th>
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<td></td>
<td>0.084/4*** 0.084/3 0.080/4**** 0.074/5 0.074/4 0.074/3 0.070/4**** 0.064/4</td>
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</tbody>
</table>

*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 O₃ 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 FEV₁ ≥ 15 %) Associated with Exposure to O₃ Concentrations That Just Meet the Current and Alternative Average 4th Daily Maximum 8-Hour Standards, for Location-Specific O₃ Seasons: Based on Adjusting 2002 O₃ 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) O₃ Levels and Levels That Just Meet Alternative Average 4th Daily Maximum 8-Hour Standards, for Location-Specific O₃ Seasons: Based on Adjusting 2002 O₃ 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) O3 Levels and Levels That Just Meet Alternative Average 4th Daily Maximum 8-Hour Standards, for Location-Specific O3 Seasons: Based on Adjusting 2002 O3 Concentrations (cont’d)
Figure 5C-3. Estimated Symptom-Days for Chest Tightness Among Moderate/Severe Asthmatic Children (Ages 0 – 12) in Boston Associated with O3 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 4$^{th}$ 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
Figure 5C-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
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)
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 O3 exposure indices have been shown to explain O3 effects as well or better than calculated internal O3 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 O3 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 O3-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 O3 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 O3 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 O₃ uptake is intuitively a better predictor of plant response to O₃ 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 diurnal 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 O₃ will not occur and the predicted O₃ effect for that species/individual on the basis of flux will be an overestimation. This concern is especially apparent when assessing the impact of O₃ across all the varied climatic regions and species occurring within the United States.

(2) Not all O₃ stomatal uptake results in a reduction in yield. This nonlinear relationship between O₃ 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 O₃ 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 O₃ flux into the plants. In addition, it was suggested that plants might be more susceptible to O₃ exposure at night than during the daytime, because of possibly lower plant defenses at night (Musselman and Minnick, 2000). Nocturnal O₃ 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 O₃ uptake. In order to integrate those factors that drive the patterns of stomatal conductance and exposure, the use of O₃ 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 O₃. 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 O₃ are intended to prevent long-term deleterious effects on the most sensitive plant species under the most sensitive environmental conditions, but not to quantify O₃ 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 O₃ 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 O₃ 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 O₃ concentrations but include the mid-level values still represent the best approach for relating vegetation effects to O₃ 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) O₃ outputs to improve spatial interpolations based on a regionally limited and unevenly distributed O₃ 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/O₃, particulate matter, and nutrient deposition) holistically. The CMAQ model can generate estimates of hourly O₃ 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 O₃ patterns are predicted well during the daytime. The prediction of daily maximum 8-hr average O₃ 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 O₃ 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 O₃ at night. Since many of the assessments outlined below rely daytime O₃ 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 O₃ gradients that often occur in complex terrain, across urban/rural gradients and along coastal areas. In these cases significant differences in O₃ concentration could occur with a 12x12 km 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 O₃ 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 SO₂, 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 O₃ 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 O₃ 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 O₃ at night. Nighttime over-predictions in O₃ have been improved over CMAQ version 4.4 by modifications to the minimum Kₑcrit approximation in CMAQ version 4.5, but additional investigations are needed. Again, since many of the assessments outlined below rely daytime O₃ 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 O₃ 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 Raftery 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 O₃ is a secondary pollutant and its concentration generally varies fairly smoothly across those areas. However, O₃ is notably more variable in complex terrain, across urban/rural gradients and along coastal areas. In these cases significant differences in O₃ 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 O₃ 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 O₃ 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

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

Source: Lee and Hogsett (1996) table 10. *Peanuts, Grain Sorghum, 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

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

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

<table>
<thead>
<tr>
<th>Ozone Index</th>
<th>Quantity</th>
<th>Crop</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>W126</td>
<td>Median</td>
<td>Ponderosa Pine</td>
<td>1-exp(-(index/159.63)^1.190)</td>
</tr>
<tr>
<td>W126</td>
<td>Median</td>
<td>Red Alder</td>
<td>1-exp(-(index/179.06)^1.2377)</td>
</tr>
<tr>
<td>W126</td>
<td>Median</td>
<td>Black Cherry</td>
<td>1-exp(-(index/38.92)^0.9921)</td>
</tr>
<tr>
<td>W126</td>
<td>Median</td>
<td>Tulip Poplar</td>
<td>1-exp(-(index/51.38)^2.0889)</td>
</tr>
<tr>
<td>W126</td>
<td>Median</td>
<td>Sugar Maple</td>
<td>1-exp(-(index/36.35)^5.7785)</td>
</tr>
<tr>
<td>W126</td>
<td>Median</td>
<td>E. White Pine</td>
<td>1-exp(-(index/63.23)^1.6582)</td>
</tr>
<tr>
<td>W126</td>
<td>Median</td>
<td>Red Maple</td>
<td>1-exp(-(index/318.12)^1.3756)</td>
</tr>
<tr>
<td>W126</td>
<td>Median</td>
<td>Douglas Fir</td>
<td>1-exp(-(index/106.83)^5.9631)</td>
</tr>
<tr>
<td>W126</td>
<td>Median</td>
<td>Aspen</td>
<td>1-exp(-(index/109.81)^1.2198)</td>
</tr>
<tr>
<td>W126</td>
<td>Median</td>
<td>Virginia Pine</td>
<td>1-exp(-(index/1714.64)^1)</td>
</tr>
</tbody>
</table>

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

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

* 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

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

* 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 O₃ 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 4\(^{th}\) 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 2001 interpolated 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.