Air Quality Data Analysis Technical Support Document for the Proposed Interstate Air Quality Rule

Prepared For
Office of Air and Radiation

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I. Introduction and Background Regarding Ambient Air Quality Monitoring Data

There are several components associated with analyzing data measured by ambient air monitoring networks (air quality data analysis). The first component in air quality data analysis is the monitoring network. The Nation's air quality is measured using monitoring networks consisting of more than one thousand monitors located across the county. The monitors are sited according to the spatial and temporal nature of the pollutant they measure, and to best represent the actual air quality in the United States. The second component in air quality data analysis is the database that accepts the data from the monitoring networks, stores it, and allows the analysts to retrieve the data. The final component is the job of the analyst, to use statistics and graphics to process the data in order to compare the results to meaningful air quality indicators.

This section summarizes key aspects of these components, provides references for further details, and then presents the results of air quality analyses for PM2.5 and ozone.

A. Ambient Air Monitoring Networks in the United States

In 1970, the Clean Air Act (CAA) was signed into law. The CAA and its amendments provide the framework for the Nation's overall protection of the Nation's air quality. EPA's principal responsibilities under the CAA, as amended in 1990 include:

- setting National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to the public health and environment,
- ensuring, in cooperation with the states, that the air quality standards are met or attained through national standards and strategies to control emissions from sources, and
- ensuring that the sources of toxic air pollutants are well controlled.

To assess air quality and to ensure compliance with air quality standards, EPA developed an ambient air quality monitoring program. Air quality samples are generally collected for one or more of the following purposes:

- to judge compliance with and/or progress made towards meeting ambient air quality standards,
- to activate emergency control procedures that prevent or alleviate air pollution episodes,
- to observe pollution trends throughout the region, including non-urban areas,
- to provide a database for research , for planning (urban, land-use, and transportation), for development and evaluation of abatement strategies, and /or development and validation of diffusion models, and
- to provide daily air quality reporting via the Air Quality Index (AQI).

With the end use of the air quality samples as a prime consideration, the network should be designed to meet one of these four basic monitoring objectives:

- to determine the highest concentrations expected to occur in the area covered by the network,
- to determine representative concentrations in areas of high population density,
- to determine the impact on ambient pollution levels of significant sources or source categories,
- to determine general background concentration levels,
- to determine the extent of Regional pollutant transport among populated areas; and in support of secondary standards, and
- to determine the welfare-related impact in more rural and remote areas (such as visibility impairment and effects on vegetation.

These six objectives illustrate the nature of the samples that a monitoring network collects, which is representative of the spatial area being studied. With respect to PM2.5 and ground-level ozone, the monitoring networks are primarily designed to measure in major metropolitan areas. Both of these networks include some monitors to measure the highest concentrations expected to occur in the area covered by the network and to determine general background concentration levels, although these sites are relatively few in number, and are not considered in the analysis of air quality data reported in this section.

In the United States, monitoring networks are operated largely by State and local agencies and tribal nations. The networks include development, review, and oversight by EPA through consultation with State, local, and tribal steering committees and working groups. Principal factors that have expanded and challenged the capability of the nation's networks include the following: new and revised NAAQS and other regulatory needs, shifts in the nation's air quality issues (e.g., general trend toward reduced concentrations of criteria pollutants), and an influx of scientific findings and technological advancements. A significant recent addition to the networks is the more than 1,000 monitors for measuring PM2.5.

To measure the levels of NAAQS-related pollutants, also called criteria pollutants, (including SO2, NO2, CO, O3, Pb, PM2.5, and PM10), the State and Local Air Monitoring Stations (SLAMS) network, and a subset of SLAMS - the National Air Monitoring Stations (NAMS), were started in the 1970s. NAMS are designated as national trend sites. SLAMS and NAMS are comprised of more than 5,000 monitors at approximately 3,000 sites. These monitoring sites use Federal Reference or Equivalent methods (FRM/FEM), when making measurements so that direct comparisons to the NAAQS can be made. Design and measurement requirements for these networks are set forth in the Code of Federal Regulations (CFR) parts 58 (design and quality assurance), 53 (equivalent methods) and 50 (reference methods). The SLAMS and NAMS networks experienced accelerated growth throughout the 1970s, and grew again with a major addition of PM2.5 monitors starting in 1999 with the promulgation of the 1977 PM NAAQS. Most recently, the number of monitors has declined, with the exception of monitors for ozone and PM2.5.

The SLAMS network consists of approximately 4,000 monitoring sites whose distribution is largely determined by the needs of State and local air pollution control agencies to meet their respective State Implementation Plan (SIP) requirements. The NAMS (1,080 sites) are a subset of the SLAMS network with emphasis being given to urban and multi-source areas. In effect, they are key sites under SLAMS, with emphasis on areas of maximum concentrations and high population density.

The SLAMS and NAMS networks are subject to significant quality assurance procedures. All ambient monitoring methods or analyzers used in SLAMS are tested periodically to quantitatively assess the quality of the SLAMS data being produced. Measurement accuracy and precision are estimated for both automated and manual methods. The individual results of these tests for each method or analyzer are reported to EPA, and EPA calculates quarterly integrated estimates of precision and accuracy applicable to the SLAMS data. Data assessment results are reported to EPA only for methods and analyzers approved for use in SLAMS monitoring under Appendix C of CFR Part 50. For further information, see http://www.epa.gov/airprogm/oar/oaqps/qa/index.html.

In summary, State and local agencies and tribes implement a quality-based network to measure air quality across the United States. EPA provides guidance to ensure a thorough understanding of the quality of the data produced by these networks. For many years, the monitoring data have been used to characterize the status of the nation's air quality and the trends across the United States (see http://www.epa.gov/airtrends/).

B. Air Quality System Database

The Air Quality System (AQS) contains ambient air pollution data collected by EPA, State, local, and tribal air pollution control agencies from thousands of monitoring stations. AQS also contains meteorological data, descriptive information about each monitoring station (including its geographic location and its operator), and data quality assurance/quality control information. State and local agencies are required to submit their air quality monitoring data into AQS by the end of the quarter following the quarter in which the data were collected. This ensures timely submission of these data for use by State, local, and tribal agencies, EPA, and the public.

EPA’s Office of Air Quality Planning and Standards (OAQPS) and other AQS users rely upon the data in AQS to assess air quality, assist in attainment/nonattainment designations, evaluate State Implementation Plans (SIPs), perform modeling for permit review analysis, and other air quality management functions. AQS information is also used to prepare reports for Congress as mandated by the Clean Air Act.

AQS was recently re-engineered from a mainframe application (referred to as “AIRS” by many) to a UNIX based Oracle database accessed by a PC-based application. The PC-based application went into production status in January 2002. Today, State, local, and tribal agencies submit their data directly to AQS via this client/server application. Registered users may also retrieve data through the AQS application and through the use of third party software such as the Discoverer tool from Oracle Corporation. The mainframe version of AQS is still available for retrievals of data; however, no updates have been made to the mainframe AQS database since December 2001.

Data from the mainframe AQS database was imported into the new AQS Oracle database, including all site and monitor data and raw data for the years 1992-2001. All summary calculations for this data have been completed. All raw precision and accuracy data values have been loaded, and partial summaries have been calculated. For more detailed information about the AQS database, see http://www.epa.gov/ttn/airs/airsaqs/index.htm.

C. Indicators

In analyzing the levels of PM2.5 and ozone across the United States, the raw data must be processed into a form pertinent for useful interpretations. For this study, the data have been processed consistent with the formats associated with the NAAQS for these air pollutants (with an exception discussed below for the PM2.5 data during the 1999-2001 period). The resulting estimates are used to indicate the level of air quality relative to the NAAQS. In addition to air quality data, we also present information about areas that have been officially designated as nonattainment in the appendices (these areas may or may not be currently experiencing air quality violations as there are additional requirements that must be met in order to be redesingated as attaining the standard).

For PM2.5 air quality indicators, we developed estimates for making comparisons with the annual standard for PM2.5. Compliance with this standard is judged on the basis of the most recent three years of ambient air quality monitoring data. For PM2.5, the annual standard is met when the 3-year average of the annual mean concentration is 15.0 :g/m3 or less. The 3-year average annual mean concentration is computed at each site by averaging the daily Federal Reference Method (FRM) samples taken each quarter, averaging these quarterly averages to obtain an annual average, and then averaging the three annual averages. The 3-year average annual mean concentration is also called the annual standard design value. For details see 40 CFR Part 50, Appendix K and N. The PM2.5 design values are based on 1999 through 2001 and 2000 through 2002 data.

As previously mentioned, the PM2.5 monitoring network has recently been installed. In general, EPA regulations require at least 75% data capture in each quarter of a consecutive 3-year period in order for a design value to be valid. If the design value is over the standard, less data are required. For the annual standard, 11 samples a quarter are sufficient. In addition, EPA regulations and guidance permit data substitution under certain circumstances in order to bolster completeness, (see 40 CFR Part 50, Appendix N and also the Guideline on Data Handling for the PM NAAQS EPA number or web location). The information developed for this analysis is based on data after applying the substitution guidance.

The only exception to routine data handling procedures occurred for PM2.5 data for the 1999-2001. In general, the data completeness criteria for monitors exceeding the PM2.5 annual standard is 11 samples per quarter for all 12 quarters for the three year period (1999-2001).

Given the newness of this network (where many monitors had not been installed in January 1999), and the importance of having as broad a preliminary understanding of PM2.5 levels across the United States as possible, we have relaxed this criteria somewhat in our analysis of the 1999-2001 data. Thus, in an attempt to understand as fully as possible the areas where PM2.5 levels exceed the level of the annual standard, we estimated air quality levels for monitors that had at least one sample in each of 10 of the 12 quarters for the three year periods (1999-2001). This added 20 counties to the 129 counties where monitors exceeding the annual PM2.5 standard based on 1999-2001 data.

Two qualifiers are worth noting here. First, it is possible that those areas with the somewhat incomplete data could show overall air quality to be better than the standards once 3 years of complete data are available. However, for the areas well above the standard, this is unlikely. Second, for counties that do not have monitors, we do not have air quality estimates and, for some of these counties, it is likely that the PM2.5 levels exceed the level of the annual standard. Thus, this analysis may understate the number of people that experience air quality that exceeds the annual standard for PM2.5.

The analysis for 2000-2002 PM2.5 data followed the data completeness criteria specified in Appendix N using certified data.

For ozone air quality indicators, we developed estimates for the 1-hour O3 standard and the 8-hour O3 standard. The EPA set the 1-hour O3 standard at 0.12 parts per million (ppm) daily maximum 1-hour average concentration not to be exceeded more than once per year on average. Compliance with the 1-hour ozone standard is judged on the basis of the most recent three years of ambient air quality monitoring data. The 1-hour ozone standard is not met at a monitoring site if the average number of estimated exceedances of the ozone standard is greater than 1.0 (1.05 rounds up). The level of the 8-hour O3 NAAQS is 0.08 ppm. The 8-hour O3 standard is not met if the 3-year average of the annual 4th highest daily maximum 8-hour O3 concentration is greater than 0.08 ppm (0.085 rounds up). There is a separate process for determining attainment status (see Federal Register 68 FR 32802, Proposed Rule to Implement the 8-hour Ozone National Ambient Air Quality Standard, Proposed Rule, June 2, 2003) Accordingly, further analysis will occur before these design values are used in implementing the national ambient air quality standards for ozone.

II. Ambient Air Quality Monitoring Data 1999-2001

A. 1999-2001 Data Analysis

The purpose of this section is to provide summary information concerning analyses of 1999-2001 air quality using measured ambient air quality data. The analyses will be used as input data for general characterizations of air quality in the United States and for use in Regulatory Impact Analysis (RIA) accompanying various rulemakings. As described further below, we are using a measured air quality to estimate the number of people living in areas with the potential for unhealthful concentrations of air pollution, as indicated by the NAAQS for

PM10, PM2.5, and ozone. We estimated air quality within a range of annual average concentrations of fine particulate matter (expressed as PM2.5), and 8-hour peak daily average concentrations of ozone. These analyses will be used to provide relevant information concerning the need for additional reductions in emissions to attain and maintain the PM2.5 and ozone NAAQS, to reduce exposures to harmful levels of particulate matter and ozone, and to provide input to estimate the effects of improvements in air quality on public health and welfare. For both PM2.5 and ozone, air quality data from AQS as of July 8, 2002 were used to calculate design value for the 1999-2001 period.

B. 1999-2001 Data Summaries

Table II-1 provides a summary of the populations living in counties at various levels of air quality, based on 1999 -2001 data (as represented by a design value). Additional results are presented in the Appendix A for PM2.5 and Appendix B for ozone. Figures II-1, II-2, and II-3 display PM2.5 and ozone levels, represented by design values, across the United States.

Table II-1. Population Living in Counties with Measured 1999-2001 PM2.5 and Ozone at Various Concentrations.

Air Pollutant	AQ Levels Based on 1999-2001 Data	Population 2000	Co #	Population Categories	Result
PM2.5					
	Total Population > NAAQS (>15µg/m^3)	74,237,509	149	Total Monitored population	191,040,346
	13 µg/m^3 #Population < 15 µg/m^3)	31,113,929	101	meeting modified completeness criteria	
	Total population > 25 µg/m^3	12,774,159	3	Percent of monitored population > 25 µg/m^3	7%
	Total population > 20 µg/m^3	21,985,250	13	Percent of monitored population > 20 µg/m^3	12%
	Total population > 15 µg/m^3	74,237,509	149	Percent of monitored population > 15 µg/m^3	39%
	Total population > 10 µg/m^3	170,009,669	433	Percent of monitored population > 10 µg/m^3	89%
	Total population > 5 µg/m^3	189,796,377	544	Percent of monitored population > 5 µg/m^3	99%
Ozone 8hr					
	Total Population > NAAQS ($85 ppb)	110,747,890	291	Total Monitored population	201,084,504
				meeting completeness criteria	
	Total population $ 105 ppb	20,116,399	12	Percent of monitored population $105 ppb	10%
	Total population $ 95 ppb	40,022,574	68	Percent of monitored population $ 95 ppb	20%
	Total population $ 85 ppb	110,747,890	291	Percent of monitored population $ 85 ppb	55%
	Total population $ 75 ppb	160,599,281	487	Percent of monitored population $ 75 ppb	80%
	Total population $ 65 ppb	177,011,021	550	Percent of monitored population $ 65 ppb	88%
Ozone 1hr					
	Total Population > NAAQS ($125 ppb)	55,049,038	81	Total Monitored population	201,084,504
	Total population $ 175 ppb	3,400,578	1	Percent of monitored population $175 ppb	2%
	Total population $ 150 ppb	16,198,983	8	Percent of monitored population $150 ppb	8%
	Total population $ 125 ppb	55,049,038	81	Percent of monitored population $125 ppb	27%
	Total population $ 100 ppb	152,616,961	412	Percent of monitored population $100 ppb	76%
	Total population $ 75 ppb	183,001,544	573	Percent of monitored population $ 75 ppb	91%
	113 ppb #Total population < 125 ppb	41,412,633	132		21%
Ozone 8hr					
	Total Population > NAAQS ($85 ppb) but not exceeding 1-hr NAAQS	57,426,028	206	Total Monitored population for counties not exceeding 1-hr NAAQS	128,132,021
	Total Population $105 ppb but not exceeding 1-hr NAAQS	0	0	Percent of monitored population $105 ppb but not exceeding 1-hr NAAQS	0%
	Total Population $ 95 ppb but not exceeding 1-hr NAAQS	4,149,608	18	Percent of monitored population $95 ppb but not exceeding 1-hr NAAQS	3%
	Total Population $ 85 ppb but not exceeding 1-hr NAAQS	57,426,028	206	Percent of monitored population $85 ppb but not exceeding 1-hr NAAQS	45%

1. Population data are from the 2000 U.S. census.

2. Total population in the U.S. in 2000 was 281.4 million

Figure II-1. PM2.5 Levels - Annual Design Values

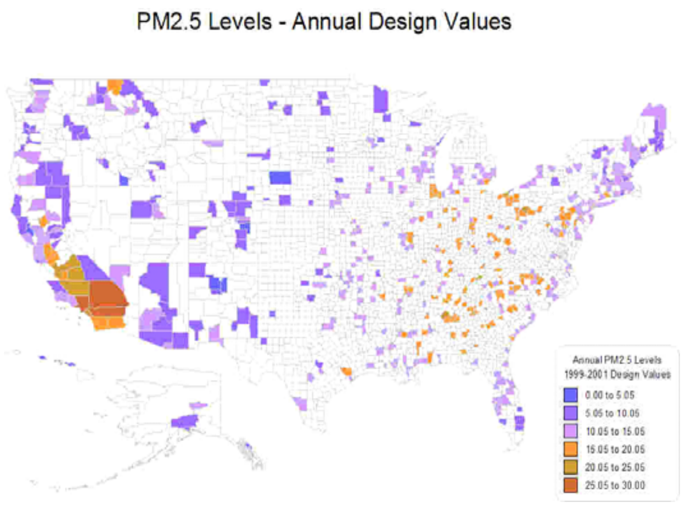


Figure II-2. Ozone Levels 1-Hour Design Values

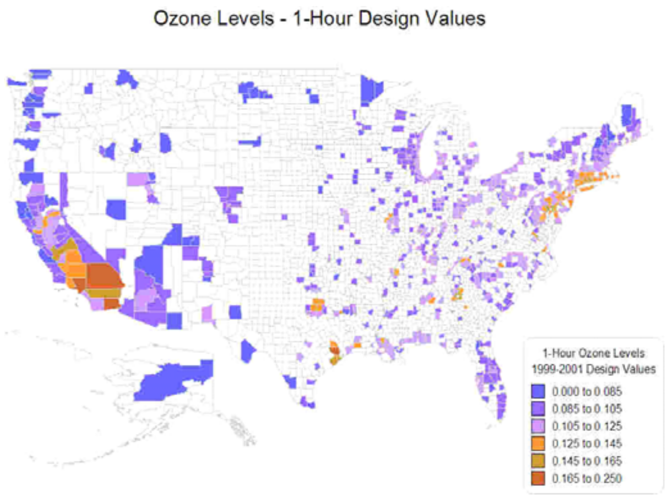
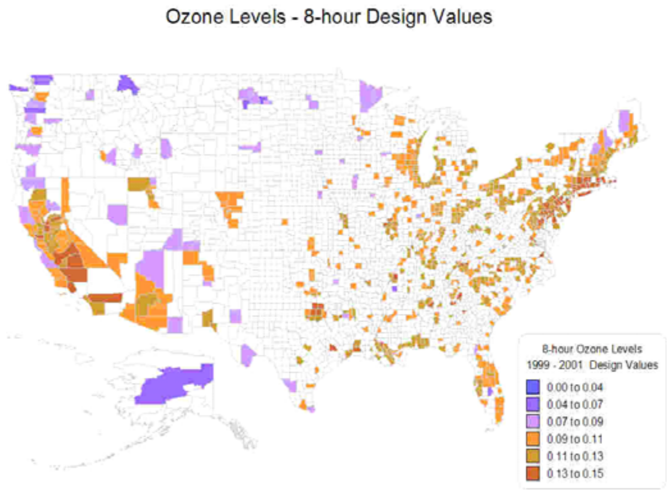


Figure III-3. Ozone Levels 8-Hour Design Values



III. Ambient Air Quality Monitoring Data 2000-2002

A. 2000-2002 Data Analysis

The purpose of this section is to provide summary information concerning analyses of 2000-2002 measured air quality data. Like the data presented in Section 2 above, the 2000-2002 analyses follow the data completeness criteria established in the relevant NAAQS. The patterns of measured air quality can be used to estimate the number of people living in areas with the potential for unhealthful concentrations of air pollution, as indicated by the NAAQS for PM10, PM2.5, and ozone. These analyses will be used to provide relevant information concerning the need for additional reductions in emissions to attain and maintain the PM2.5 and ozone NAAQS, to reduce exposures to harmful levels of particulate matter and ozone, and to provide input to estimate the effects of improvements in air quality on public health and welfare. For both PM2.5 and ozone, air quality data as of July 9, 2003 were used to calculate design values for the 2000-2002 period.

B. 2000-2002 Data Summaries

Table III-1 provides a summary of the populations living in counties at various levels of air quality, based on 2000-2002 data (as represented by a design value). Additional results are presented in the Appendix A for PM2.5 and Appendix B for ozone.

Table III-1. Population Living in Counties with Measured 2000-2002 PM2.5 and Ozone at Various Concentrations

Air Pollutant	AQ Levels Based on 2000-2002 Data	Population 2000	Co #	Population Categories	Result
PM2.5					
	Total Population > NAAQS (>15µg/m^3)	64,849,620	120	Total Monitored population	208,305,356
	Total population > 25 µg/m^3	3,254,821	2	Percent of monitored population > 25 µg/m^3	2%
	Total population > 20 µg/m^3	18,731,187	8	Percent of monitored population > 20 µg/m^3	9%
	Total population > 15 µg/m^3	64,849,620	120	Percent of monitored population > 15 µg/m^3	31%
	Total population > 10 µg/m^3	152,924,960	406	Percent of monitored population > 10 µg/m^3	73%
	Total population > 5 µg/m^3	174,470,350	519	Percent of monitored population > 5 µg/m^3	84%
Ozone 8hr					
	Total Population > NAAQS ($85 ppb)	115,287,584	297	Total Monitored population	201,084,504
	Total population $ 105 ppb	18,671,025	9	Percent of monitored population $105 ppb	9%
	Total population $ 95 ppb	48,172,440	66	Percent of monitored population $ 95 ppb	24%
	Total population $ 85 ppb	115,287,584	297	Percent of monitored population $ 85 ppb	57%
	Total population $ 75 ppb	159,509,592	503	Percent of monitored population $ 75 ppb	79%
	Total population $ 65 ppb	180,586,014	575	Percent of monitored population $ 65 ppb	90%
Ozone 1hr					
	Total Population > NAAQS ($125 ppb)	53,346,394	73	Total Monitored population	201,084,504
	Total population $ 175 ppb	3,400,578	1	Percent of monitored population $175 ppb	2%
	Total population $ 150 ppb	15,428,757	4	Percent of monitored population $150 ppb	8%
	Total population $ 125 ppb	53,346,394	73	Percent of monitored population $125 ppb	27%
	Total population $ 100 ppb	151,720,506	412	Percent of monitored population $100 ppb	75%
	Total population $ 75 ppb	187,699,461	602	Percent of monitored population $ 75 ppb	93%
	113 ppb #Total population < 125 ppb	44,923,912	132		45%
Ozone 8hr					
	Total Population > NAAQS ($85 ppb) but not exceeding 1-hr NAAQS	67,073,815	221	Total Monitored population for counties not exceeding 1-hr NAAQS	134,539,671
	Total Population $105 ppb but not exceeding 1-hr NAAQS	0	0	Percent of monitored population $105 ppb but not exceeding 1-hr NAAQS	0%
	Total Population $ 95 ppb but not exceeding 1-hr NAAQS	10,433,485	20	Percent of monitored population $95 ppb but not exceeding 1-hr NAAQS	8%
	Total Population $ 85 ppb but not exceeding 1-hr NAAQS	67,073,815	221	Percent of monitored population $85 ppb but not exceeding 1-hr NAAQS	50%

1. Population data are from the 2000 U.S. census.

2. Total population in the U.S. in 2000 was 281.4 million

IV. Description of Speciation Data and Rural/Urban Comparisons

A. Data Description, Data Acquisition and Pre-Processing

With the promulgation of the new Particulate Matter National Ambient Air Quality Standards (PM2.5 NAAQS), all future designated nonattainment areas and surrounding regions may need to reduce emission of fine particles and their precursors to permit those areas to attain the NAAQS. Efficient air quality management required knowing which sources contribute to the problem and by how much. Determining PM2.5 source contributions is complicated due to the fact that often half or more of the PM2.5 mass is composed of secondarily formed species (Schichtel & Husar, 1992), hiding their point of origin. In addition, PM2.5 has a lifetime on the order of several days (Husar, et al., 1978) enabling very distant sources to affect a region.

To help understand levels of PM2.5 and their chemical components in various regions and to arrive at a first-cut approximation of how much of those levels are locally generated versus transported, EPA has analyzed PM2.5 mass and speciation data. Graphical displays were generated to show the chemical makeup of PM2.5 across the country and by season. Then, this analysis was furthered to get an estimate of excess levels of particulate mass and chemical species in urban areas over background levels (as implied using nearby rural sites).

Two sources of ambient monitoring data were used in all the analyses. Data from EPA's PM2.5 chemical Speciation Trends Network (STN) and the Interagency Monitoring of Protected Visual Environmental (IMPROVE) aerosol monitoring network were used to assess the urban and rural PM2.5 mass and species concentrations, respectively, across the United States. Both these networks proved speciated PM2.5 data using a 1-in-3 day sampling protocol. The STN began operation in late 1999 and routinely quantifies PM2.5 mass and constituent urban and semi-urban concentrations, including numerous trace elements, ions, elemental carbon, and organic carbon. There are a total of 52 STN sites. The IMPROVE network quantifies PM2.5 mass concentrations and its constituents mostly in rural areas. Over the past few years, the IMPROVE network has expanded from its original 20 monitoring sites to well over 170 sites. For most of the analyses presented here, only the 'major' components of PM2.5 mass will be analyzed as part of the chemical constituent analyses. Major components include sulfate, ammonium, nitrate, total carbonaceous mass (based on organic and elemental carbon), and crustal material (which is based on the weighted average of 5 trace elements). More details are provided below.

Rao et. al. have previously examined these data to look at spatial variation of the chemical species in rural and urban areas as well as to estimate urban increments for 13 chosen urban-rural paired sites (Rao et. Al., 2002). All the analyses in this work were based on one year of data (and sites that had complete data for that time frame) that spanned March 2001- February 2002. The reader is referred to the Rao et. al. paper for details, but some of the methodology and the most salient results are presented below:

Since slightly different measurement protocols are used at STN and IMPROVE sites, the following adjustments to the data were made to make measurements more comparable between sites from the two different networks:

- Sulfates: The IMPROVE program estimates sulfate concentrations as three times the sulfur concentration, whereas with the STN program, sulfate concentrations are used as measured.

- Ammonium: Although directly measured ammonium as performed by STN is important in characterizing the composition of PM2.5, network-wide IMPROVE measurements are currently lacking in this area. Thus, to make comparisons of ammonium concentrations between the two networks, IMPROVE ammonium concentrations are estimated from sulfate (SO4) and nitrate (NO3) measurements, assuming: (1) all sulfates are ammonium sulfate, and (2) all nitrates are ammonium nitrate. When ammonium concentrations are compared between the two networks, STN ammonium concentrations are also estimated the same way (and the measured values are not used when comparing to IMPROVE ammonium estimates).

  Similarly, in several instances fully-neutralized (AN) ammonium sulfate and AN ammonium nitrates are used to represent the ammonium-nitrate-sulfate system instead of the individual components. In all cases when AN values are used for sulfate and nitrate, they are estimated as:

AN Ammonium Sulfate ~ 1.375 * Sulfate
AN Ammonium Nitrate ~ 1.290 * Nitrate
‘Estimated’ Ammonium ~ AN Ammonium Sulfate + AN Ammonium Nitrate - [Sulfate + Nitrate]

- Carbon: The STN and IMPROVE sites vary in their analytical and sampling procedures for organic and elemental carbon. Consequently, only total carbonaceous mass (T.M.) is considered in all analyses. T.M. is estimated as: k*OC + E.C. for both networks. Here, k is the factor for converting measured organic carbon to organic carbon mass (to account for attached hydrogen, oxygen, etc.). Though in the Rao et al. paper, different factors are used for k based on literature values, in the analyses to follow k was set equal to 1.4 based on the analytical history of IMPROVE and EPA programs. OC is also blank corrected in both networks; in the STN, network-wide, but sampler-specific correction factors are used.

- For all analyses of urban increments, all urban/rural pairings were elevation-adjusted to account for the effect of the 24-hour average sample volume density on aerosol concentrations. For the most part, these adjustments resulted only in minor changes to the reported values of component mass concentrations. The reader is referred to the Rao et al. paper for further details.

B. Urban/Rural Comparisons

Once the data were adjusted per the descriptions above, local and regional contributions to the urban centers were estimated by computing the differences between the annual average concentrations of the urban and nearby rural monitoring data. For reasons outlined in the Rao paper, it is important when comparing urban/rural sites to make sure that background levels are estimated separately for each location examined. 13 urban sites were chosen and paired with nearby rural sites. The analysis considered five urban sites in the Northeast and Mid-Atlantic States, five urban sites stretching from north to south in the mid-portion of the USA, and three urban sites in the West. These urban locations were chosen due to: (1) their data being complete for the year in question, 2) their ease in matching up with nearby IMPROVE rural sites, and 3) their high annual values of PM2.5 mass. Table IV-1 gives the 13 urban/rural pairings used in the Rao paper:

Urban Location/Site	**Elevation (m)**	**Rural Location/Site**	**Elevation (m)**	**Distance Apart (km)**
Fresno, CA	96	Pinnacles National Monument, CA	317	28
Missoula, MT	975	Monture, MT	1293	72
Salt Lake City, UT	1306	Great Basin National Park, NV	2068	277
Tulsa, OK	198	Wichita Mountains, OK	487	298
St. Louis, MO	0	Cadiz, KY Hercules-Glades, MO Bondville, IL	188 423 211	296 322 220
Birmingham, AL	174	Sipsy Wilderness, AL	279	100
Indianapolis, IN	235	Livonia, IN	298	142
Atlanta, GA	308	Okefenokee National Wildlife Refuge, GA Shining Rock Wilderness, NC	49 1621	324 236
Cleveland, OH	206	M.K. Goddard, PA	383	129
Charlotte, NC	232	Linville Gorge, NC	986	132
Richmond, VA	59	James River Face, VA	300	179
Baltimore, MD	5	Dolly Sods/Otter Creek Wilderness, WV	1158	256
Bronx, NY	0	Brigantine National Wildlife Refuge, NJ	9	165

Table IV-1. Urban/Rural Pairings for Urban Excess Calculations

Significant findings based on these urban/rural pairings included:

- The estimate for urban excess sulfate (and associated ammonium) is invariably very small in the eastern United States, which is consistent with the notion that most sulfates are transported from regional sources of SO2.

- Nitrates (and associated ammonium) are seen to be in excess in the more northern and western locations, showing a larger local contribution than sulfates or any other species except carbon. In the North and West, nitrates are in excess in urban areas by 2- 6 9G/m3.

- Although there is uncertainty in the measured mass concentration and in other measurement protocols, it is clear that carbonaceous mass is the major component of urban excess at all the sites investigated. In the Eastern sites, T.M. urban excess is in the range 4.5 - 10.5 :G/m3 on an annual basis.

In an attempt to update the analyses described in the Rao paper to the more recent air quality data, the exact urban excess procedures outlined in the paper were applied to a new grouping of urban and rural data that spanned August 2001-September 2002. These analyses are shown in Figures IV-1 through IV-5. In this new analyses, the following minor changes were made:

- One of the site pairings was altered slightly: the Missoula, MT urban site did not have completed data for the year in question so it was displaced with an urban site in Reno, NV (which was paired with the Bliss State Park, CA IMPROVE site for urban/rural comparisons).
- The urban Atlanta site was paired with a ring of rural monitors to better represent the regional contribution of the chemical species. In the previous analysis (Rao paper), the Atlanta urban site was paired with 2 rural sites: Okefenokee, GA and Shining Rock, NC using an inverse-distance weighting scheme. In this analysis, the 7 different rural sites were used to generate regional concentrations: Sispy, AL: St. Marks, FL; Okefenokee, GA; Cape Romain, SC; Linville Gorge, NC; Shining Rock, NC; and Great Smokies, TN. The last three sites were averaged to form one set of concentrations and then averaged with the other four sites using a inverse-distance weighting scheme to estimated regional concentrations.
- For the seasonal analyses, Winter was defined as Dec 2001- Feb 2002; Spring was defined as Mar 2002- May 2002; Summer was defined as Jun 2002-Aug 2002; and Fall was defined as Sep 2001-Nov 2001.

C. Spatial and Temporal Observations

As part of this revised analysis, spatial variations in annual averages of the PM2.5 chemical components are shown in Figures IV-1 and IV-2, respectively, for all urban and rural data that were complete for the new year in question, respectively. Similarly, in Figure IV-3, seasonal variations in the urban data are shown. From Figures IV-3, the following observations can be made:

- In both urban and rural areas, more sulfates (and associated ammonium) exist in the East compared to other regions of the country.

- In both urban and rural areas, more nitrates (and associated ammonium) exist in the upper Midwest compared to other regions of the country.

- In urban areas, carbon is prevalent all across the country.

- In eastern urban areas, higher mass sites are represented by the data in Birmingham, AL and Cleveland, OH.

- Crustal material is a small part of PM2.5 mass everywhere except arid regions in the Southwest.

- In rural areas, PM2.5 mass is smaller than in corresponding urban areas.

- In rural areas, carbon is less prevalent in the East when compared to the South and the West.

- In rural areas, the crustal component is small in the East, Midwest, and South.

- In the summer, approximately equal amounts of sulfates exist across the country.

- In the summer, carbon is more prevalent in the Southeast, Midwest, and Northeast.

- In the summer, more ammonium and nitrates exist in the Midwest.

- In the fall, carbon and sulfates dominate PM2.5 aerosol throughout the East, Southeast, and Midwest.

- In the winter, carbon and sulfates dominate southeast aerosols.

- In the winter, nitrates and carbon play a major role in Northeast/East coast aerosols. Additionally, there are elevated levels of nitrates in Eastern PM2.5 mass.

- In the winter, all components (except crustal) are equal in Midwest aerosols.

- In the spring, patterns are similar to those seen in the fall season, except that more nitrates (and associated ammonium) is present in the Midwest.

Re-doing the urban increment analyses with this new set of data reveals the same trends as those based on the Rao et. al. paper outlined above. These trends are shown in Figures IV-4 and IV-5. In summary:

- The urban excess of mass is consistently between 3-8 micrograms/m3 in the East based on an annual average (see Figure IV-5).

- Urban excess of sulfates are very low (or non-existent) which indicates that sulfates are a regional pollutant which is transported into urban areas.

- Carbon is a major portion of urban excess, especially in the Northeast, East Coast, and Southeast corridors. Annual urban excess estimates indicate that about half the carbon is from local sources.

Figure IV-1. Urban Speciation Patterns

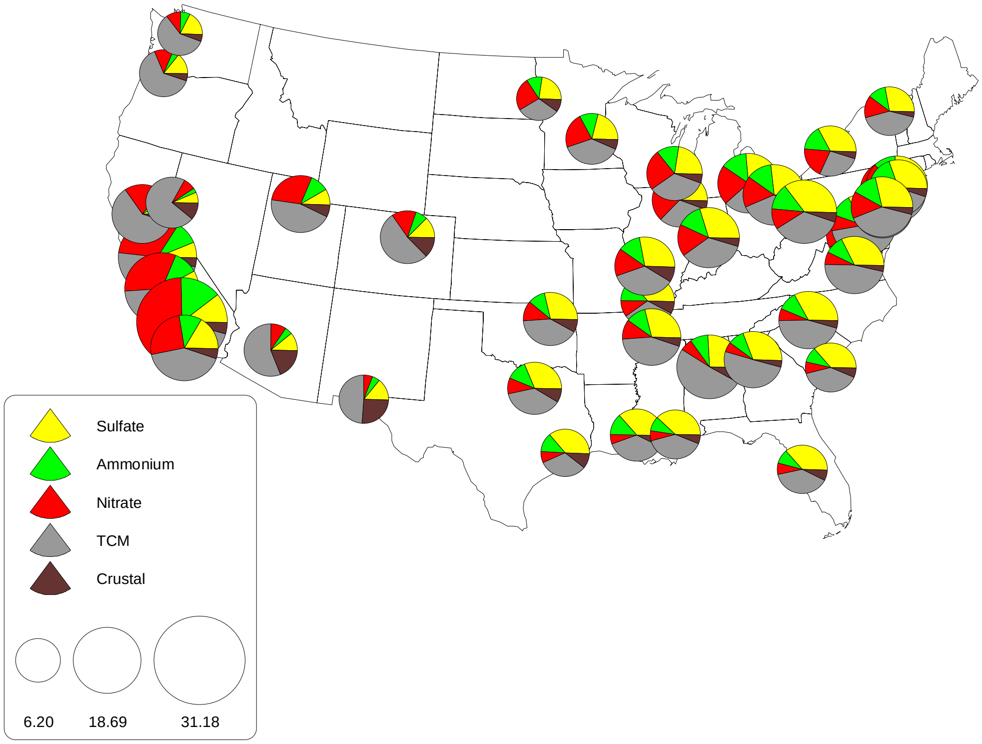


Figure IV-2. Rural Speciation Patterns

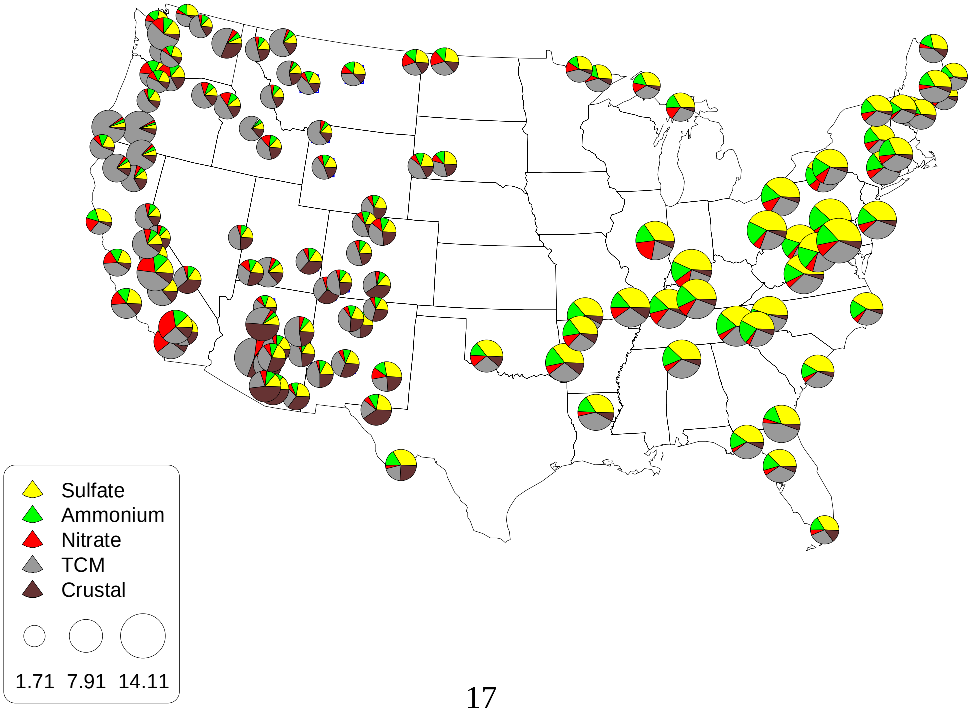


Figure IV-3. Seasonal Patterns in Urban Speciation Data

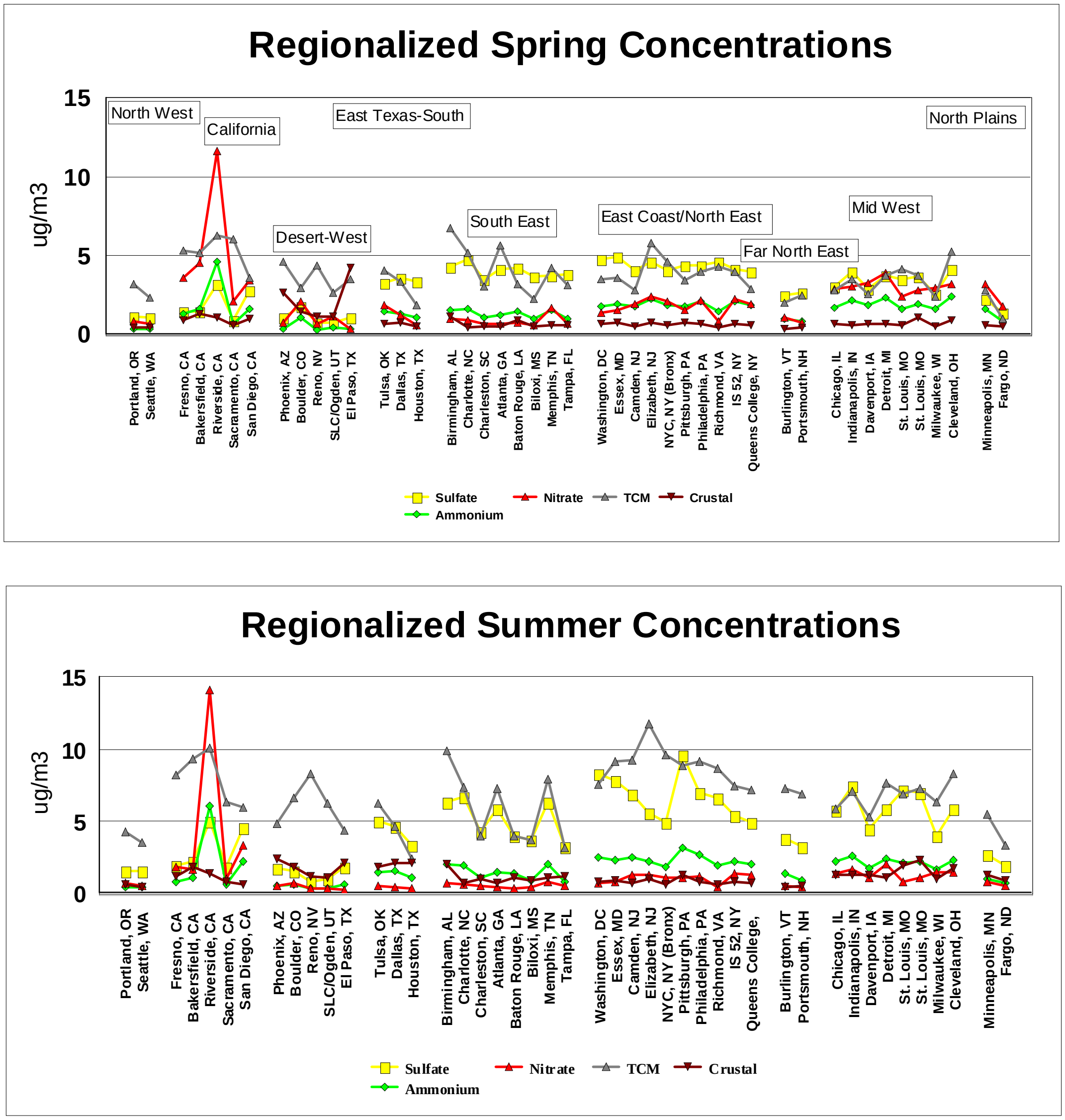
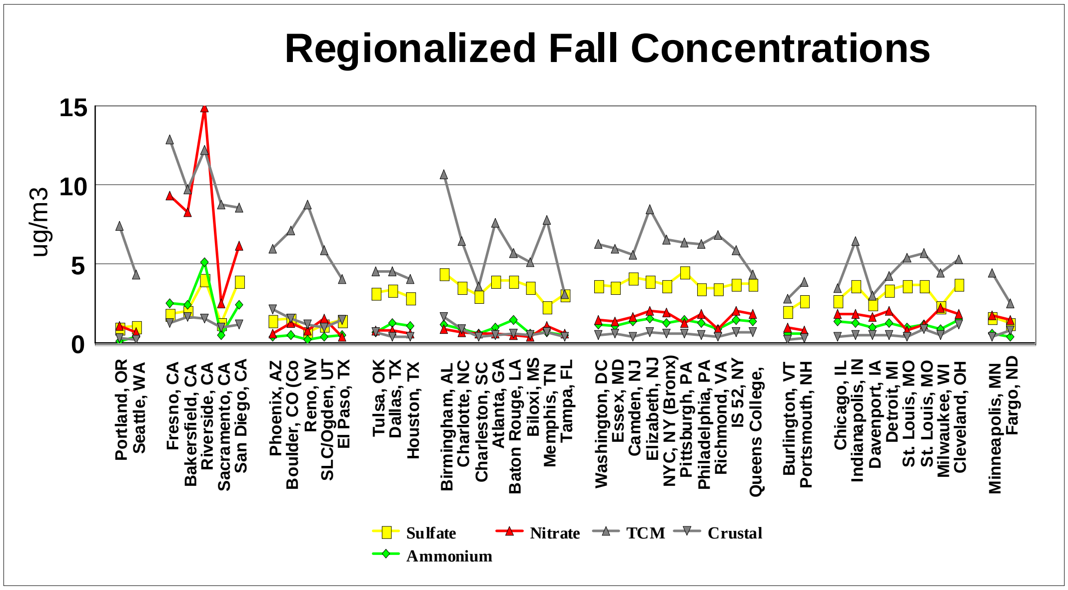


Figure IV-3. Seasonal Patterns in Urban Speciation Data (Continued)



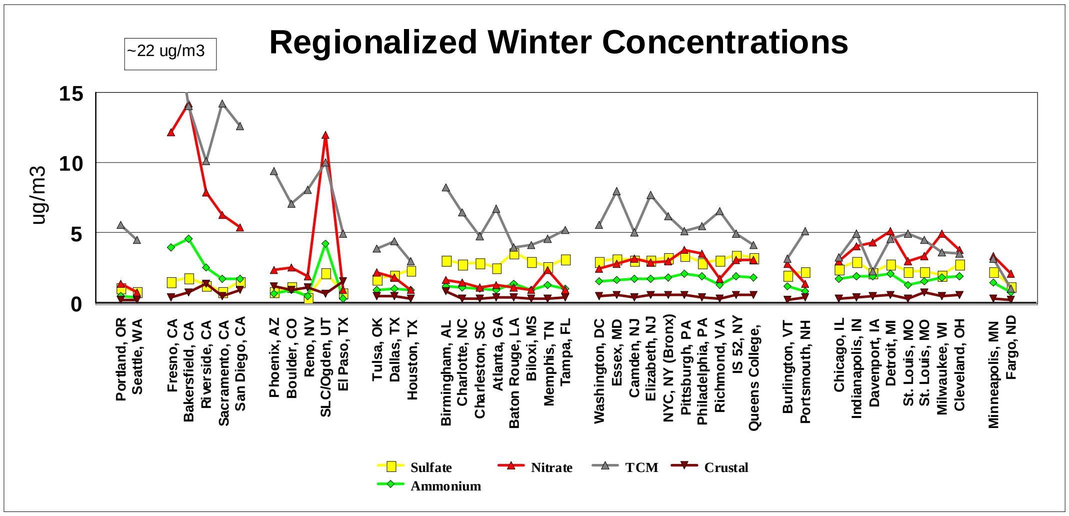
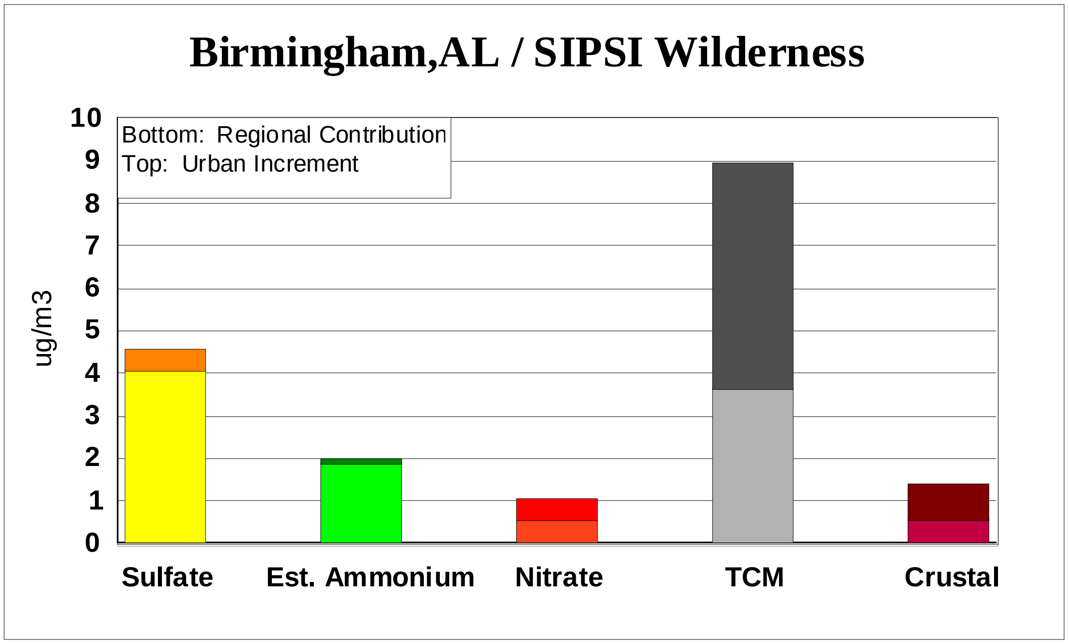


Figure IV-4. Urban Excess of Chemical Components



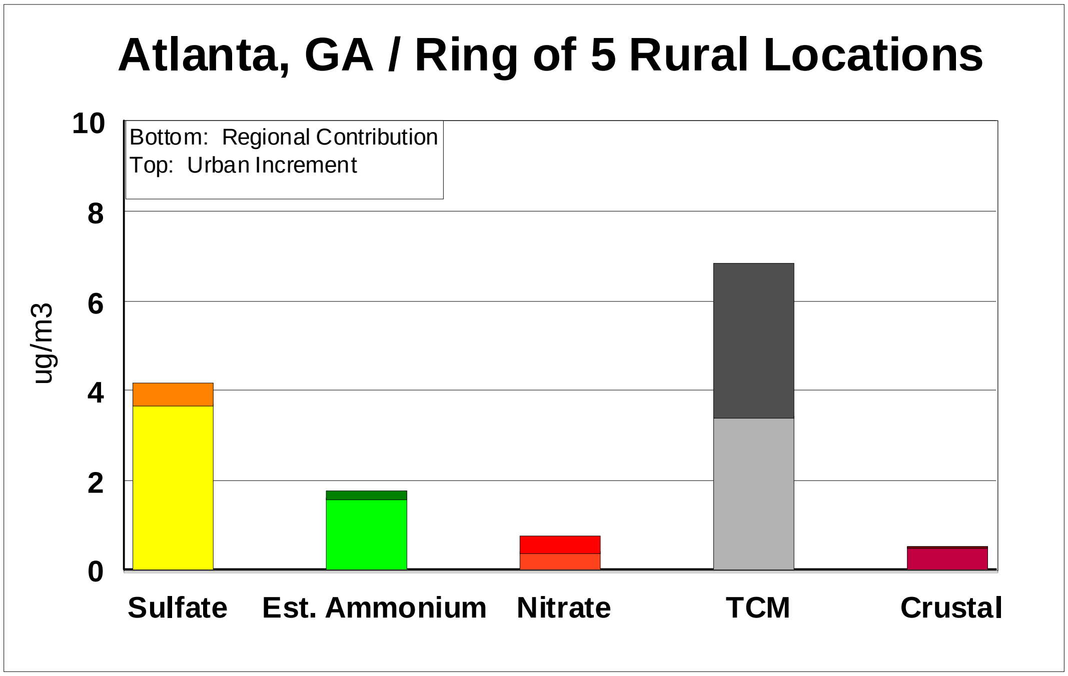
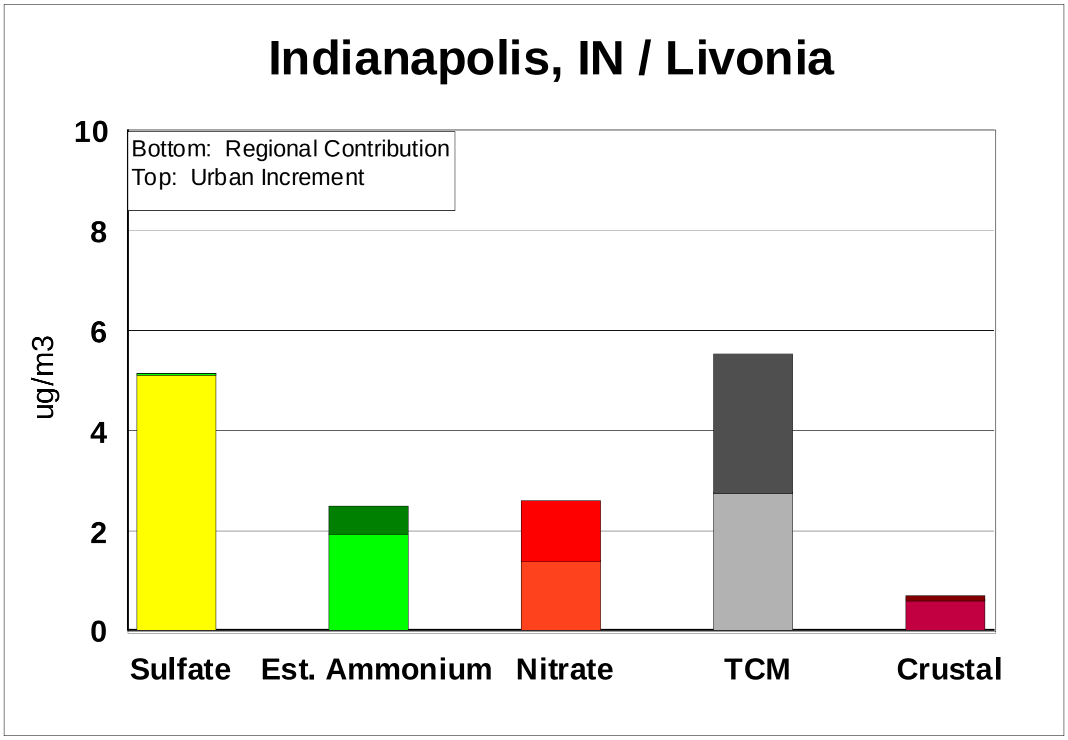


Figure IV-4. Urban Excess of Chemical Components (continued)



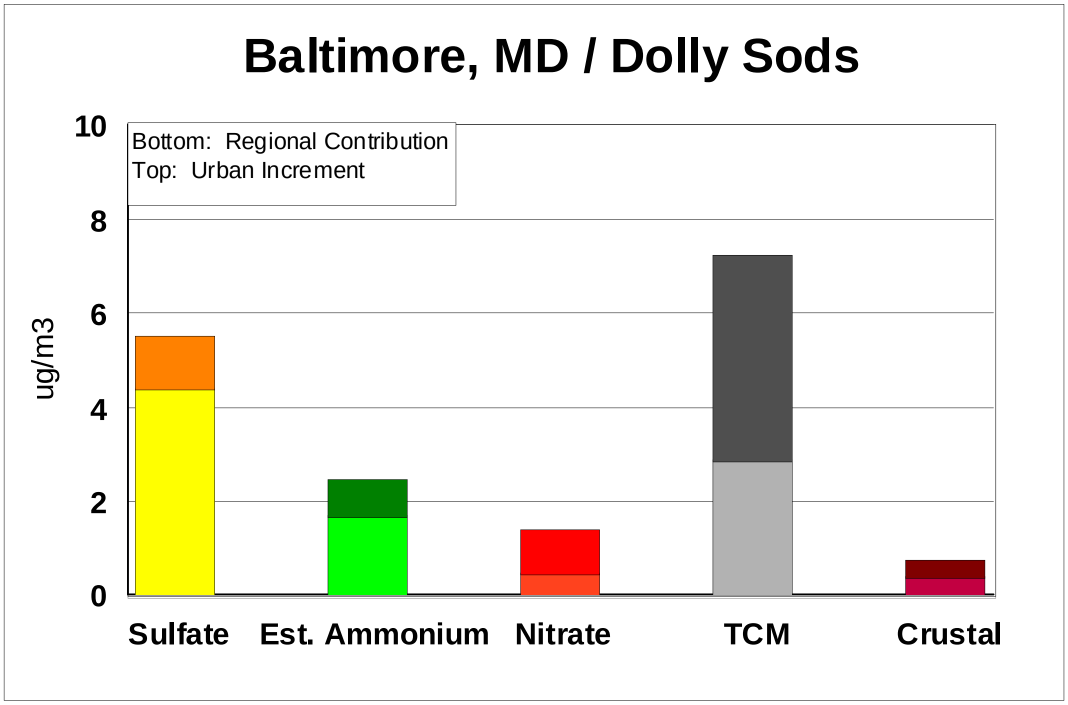
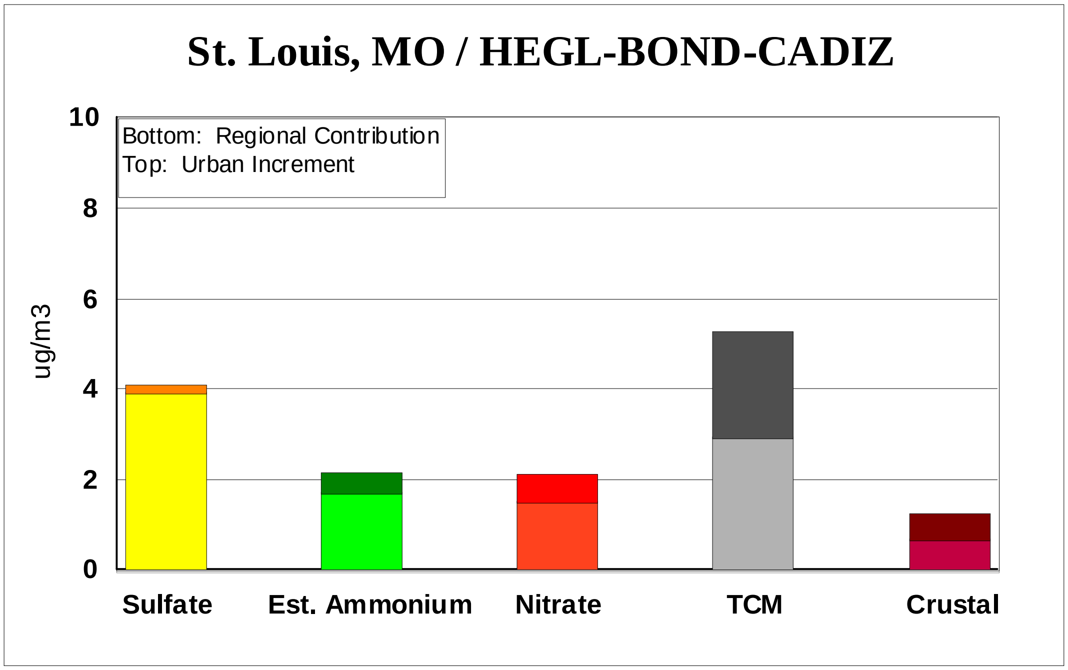


Figure IV-4. Urban Excess of Chemical Components (continued)



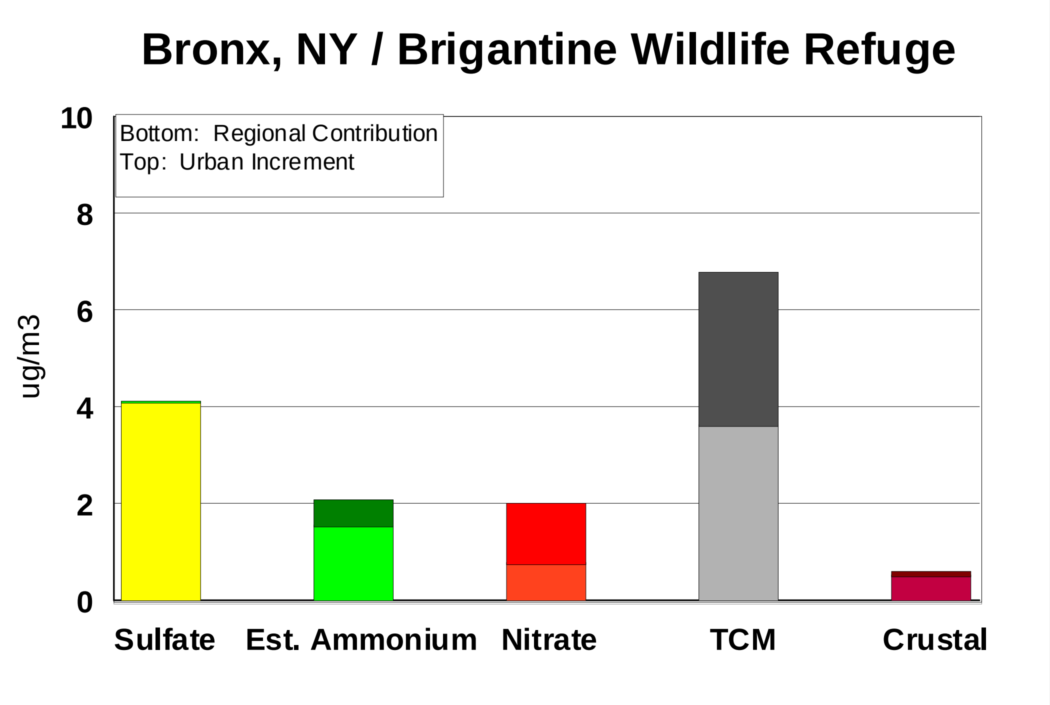
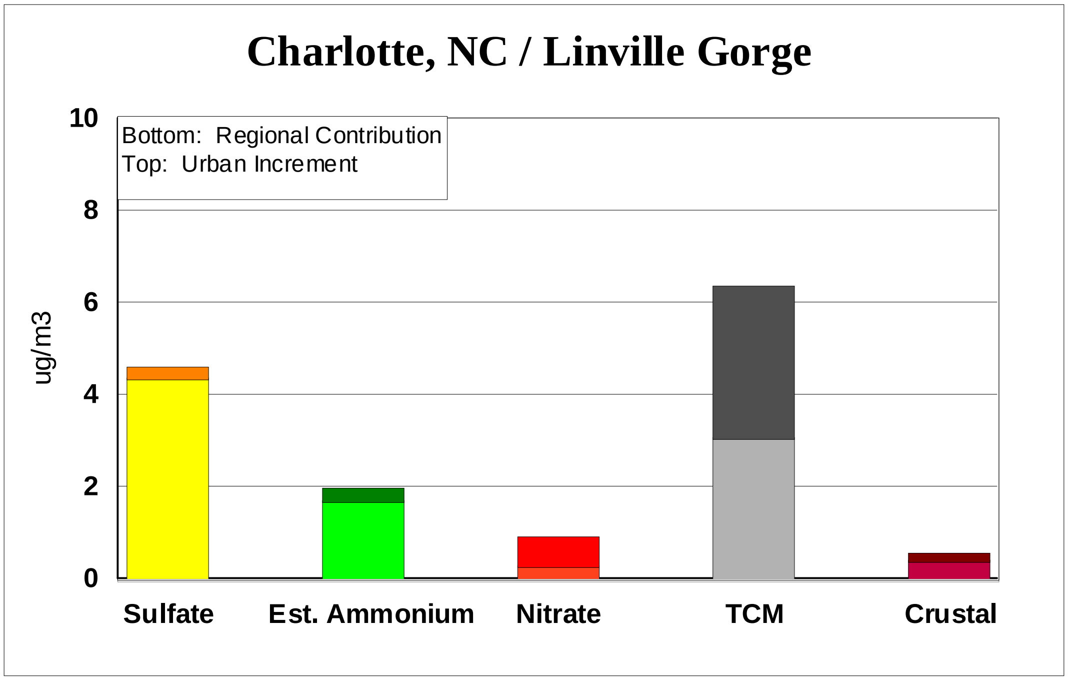


Figure IV-4. Urban Excess of Chemical Components (continued)



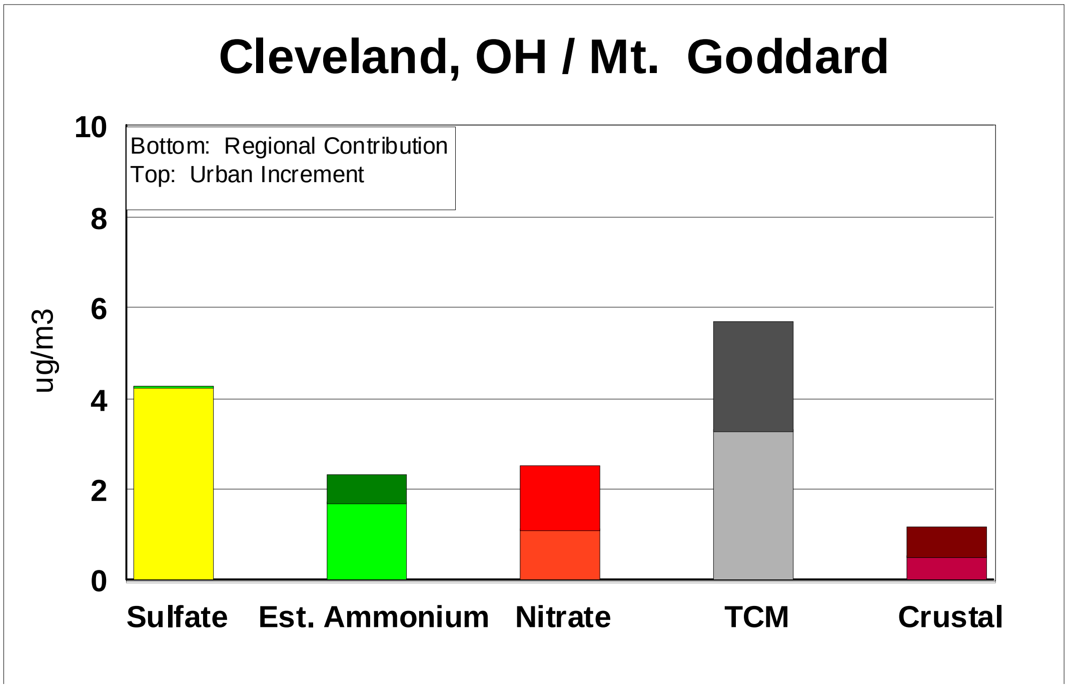
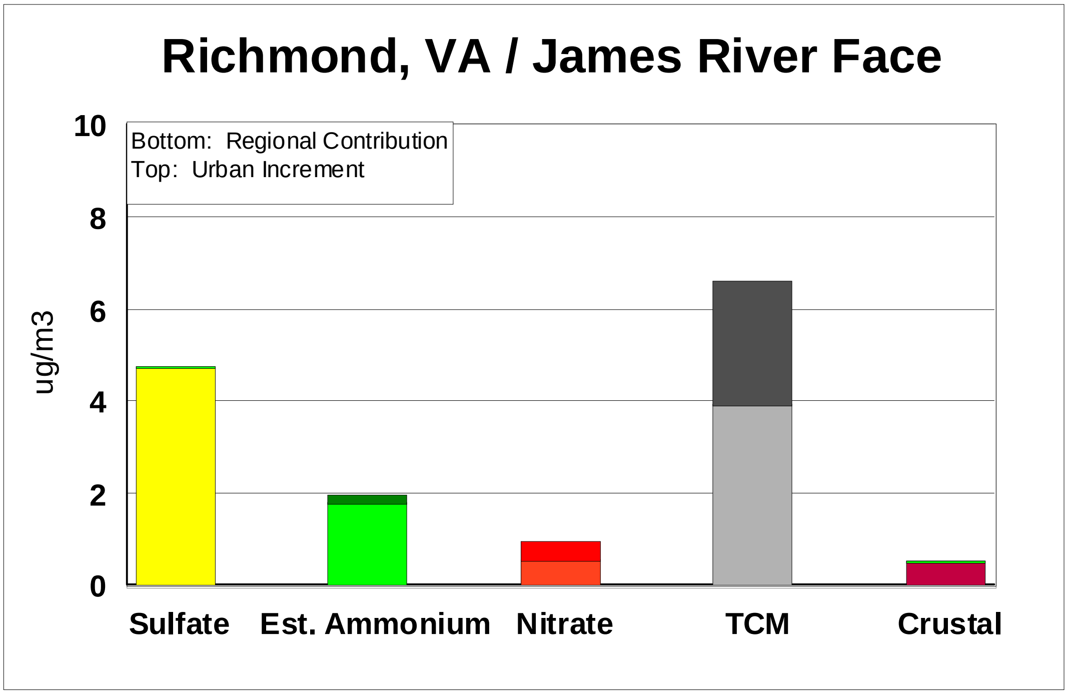


Figure IV-4. Urban Excess of Chemical Components (continued)



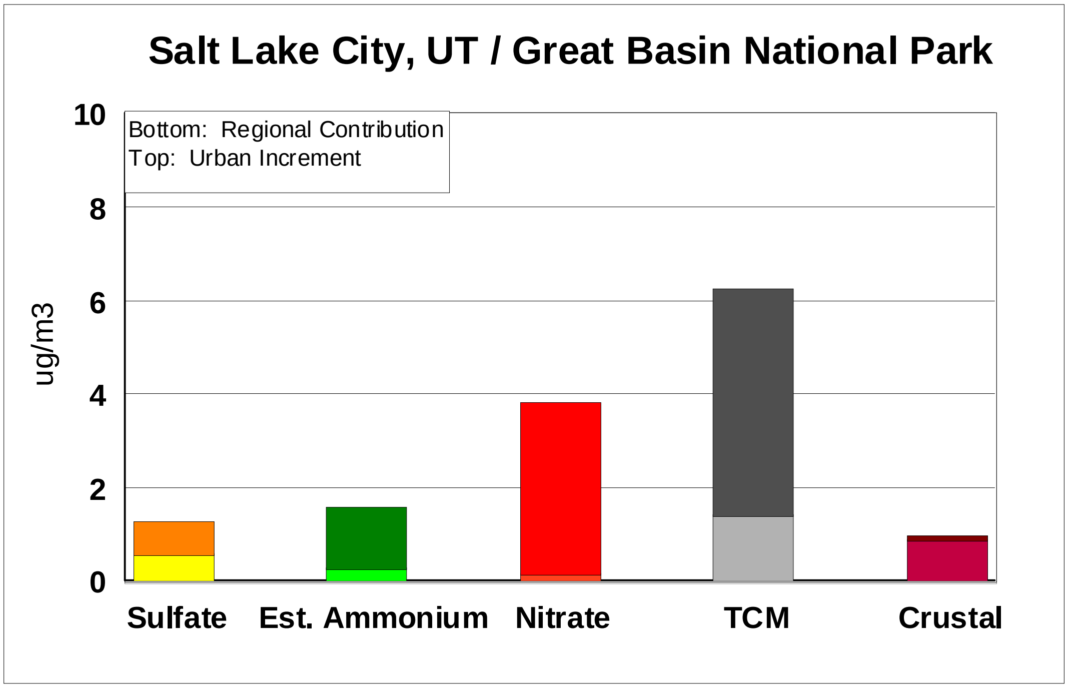
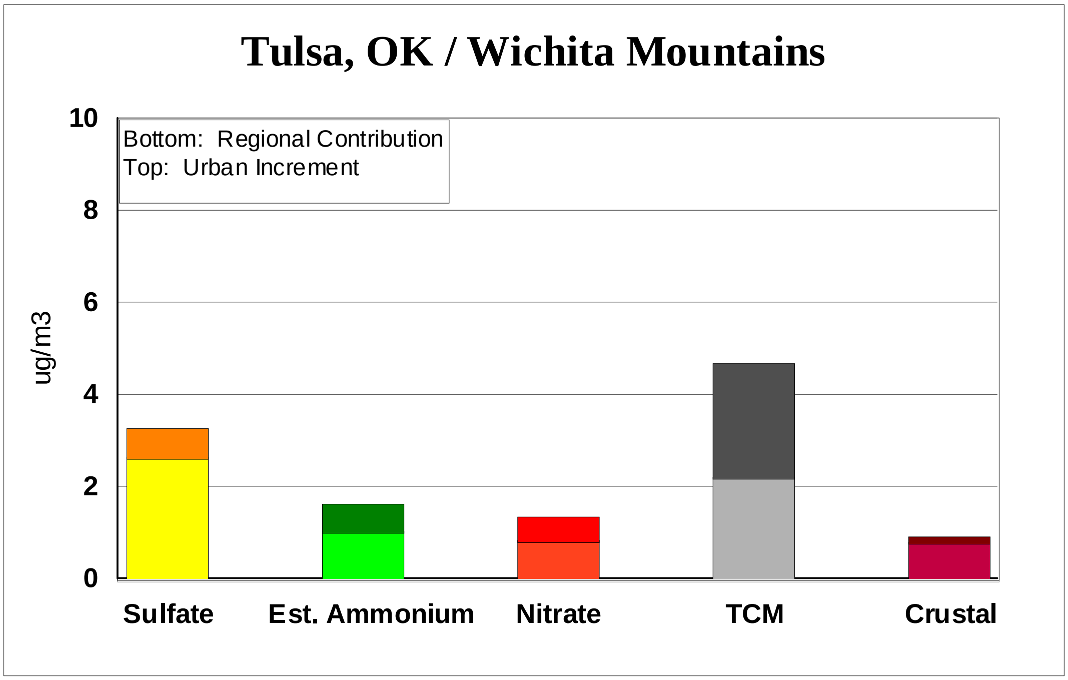


Figure IV-4. Urban Excess of Chemical Components (continued)



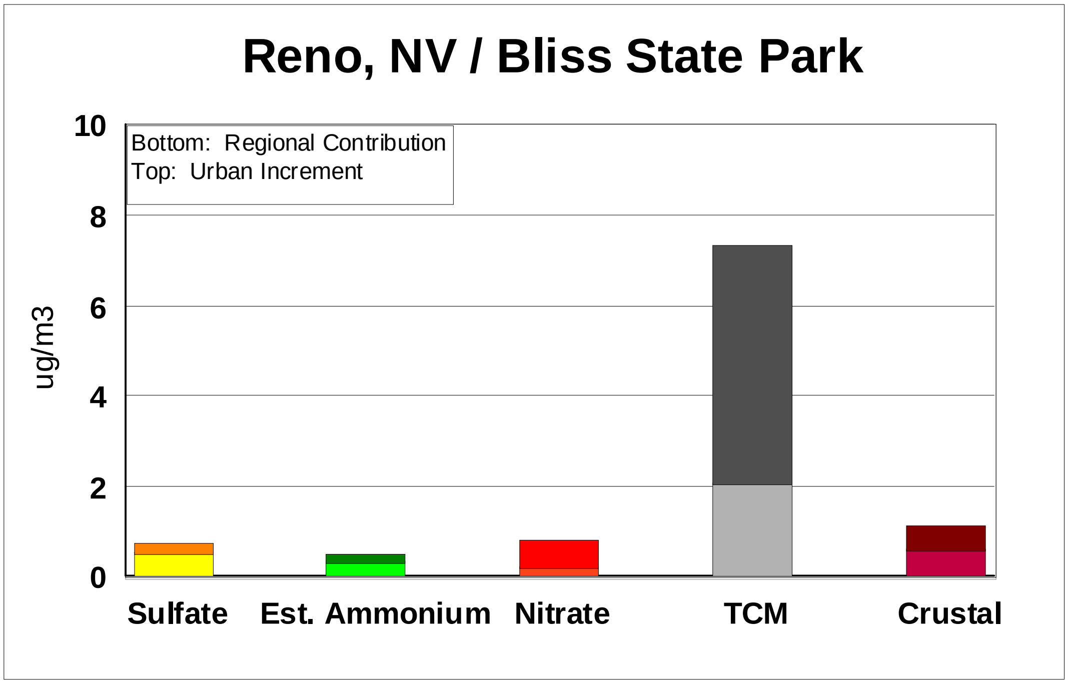


Figure IV-4. Urban Excess of Chemical Components (continued)

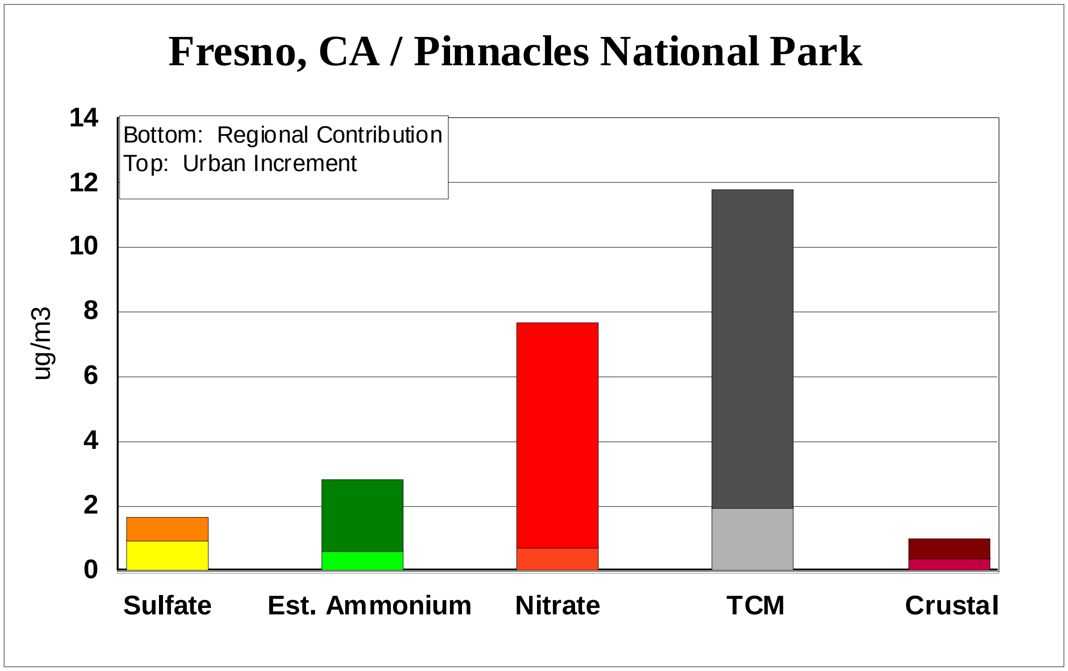
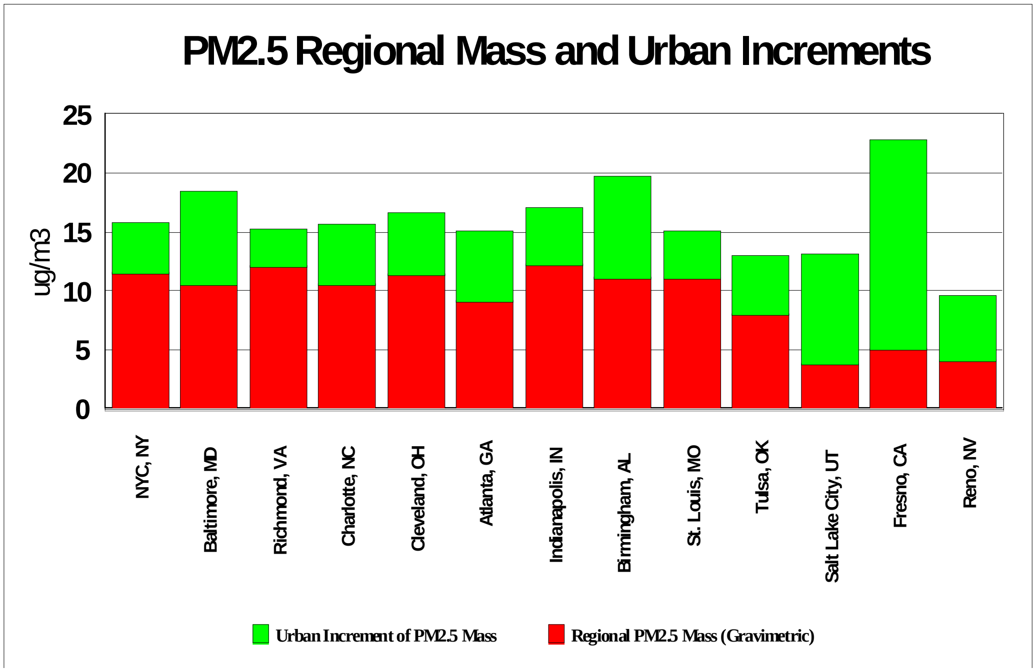


Figure IV-5. Urban Increment of Mass (based on gravimetric mass)



V. Use of Satellite Data and Correlations with Ground-Based Data

Advances in satellite sensors have provided new datasets for monitoring air quality, including the ability to visually observe transport events. Satellite sensors do not measure ground-based particulate matter (PM) directly; thus, to use satellite imagery for studying PM transport, it is also important to confirm the relationship between satellite-based data and PM2.5. In order to visualize transport of particulate matter in the eastern half of the United States, qualitative true color images and data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor on the Terra satellite were evaluated. Additionally, MODIS sensor aerosol optical depth data were quantitatively compared with ground-based particulate matter data from U.S. EPA monitoring networks covering the period from April 1 to September 30, 2002.

A. Data Description, Data Acquisition, and Pre-Processing

The ground-based data (PM10, PM2.5, and speciation of these particles) used in this analysis were from three air quality monitoring networks: Speciation Trends Network and PM2.5 Mass network (collectively referred to as STN-M in this section); and Interagency Monitoring of Protected Visual Environments (IMPROVE) network (see Section II for a description of the datasets).

NASA designs, launches, and operates a set of Earth Observing System (EOS) satellites, each with several sensors. The MODIS sensor, located on the Terra (and Aqua) satellite platforms, has 36 spectral channels (compared to 4 to 8 for most sensors), thus was designed to provide a wide variety of information for land, ocean, and atmosphere. MODIS has good spatial (1 km) and temporal (1-2 days) resolution. With the large number of spectral bands, the MODIS science team has developed 44 products (processed datasets) for a range of observations. The data products relevant to this study are:

- **MOD021KM – Level 1B Calibrated Geolocated Radiances**, 1 km resolution, used to produce red-green-blue (RGB) “true color” imagery and conduct qualitative analysis; and

- **MOD04 – Level 2 Aerosol Products**, geospatial information with aerosol optical depth and cloud fraction, for both qualitative and quantitative analysis.

Aerosol optical depth (AOD or $\mathbf{J}_a$) is a dimensionless measure of extinction, the amount of light extinguished or scattered by particles in the air. Aerosol optical depth derived from satellites provides a measure of the particles through the entire column of air, from surface to satellite. Optical depth of aerosols typically ranges from 0 to about 5, with values over 1 generally being classified as heavy haze. It is easiest to calculate aerosol optical depth over water where the surface is dark and uniform, but optical depths over land have been derived. The key steps are: removal of pixels that contain clouds; grouping of pixels in a 10 x 10 km grid; filtering of the brightest and darkest pixels to eliminate any remaining clouds, shadows, or other contamination; and calculation of aerosol optical depth using one of four models, depending on location, season, and the ratio of scattering in the red and blue wavelengths. The derivation of aerosol optical depth for the MODIS sensor is described in Kaufman and Tanré (1998) and Remer, et al. (2001).

The satellite data were processed from the NASA hierarchal data format to images for qualitative analysis and to into SAS® datasets for statistical analysis. Details on this processing can be found in Engel-Cox, et al. (2003). Linear projection was used for all images, and country boundaries, coastlines, and latitude and longitude lines were added.

B. Qualitative Image Analysis

Analysis was conducted on data from April 1 to September 30, 2002, the most recent summer season with both EPA and satellite data. Three specific high PM events were selected for visualization and qualitative analysis. These were not the only PM events during this time frame, but represent examples of types of transport events.

RGB images created from the L1B data for three events examined in this study document the existence and transport of air pollution, specifically smoke and haze. These are further illustrated with the images of the aerosol optical depth data. In the following sections, a general discussion of these images is presented, and three events involving haze and smoke are discussed in more detail.

1. Discussion of Qualitative Image Analysis

Figure V-1(a) is the RGB image from July 6, 2002, and Figure V-1(b) is the aerosol optical depth from the same date. The atmosphere above the U.S. on that day was a mix of smoke, haze, clouds, and clear skies. Starting with Figure V-1(a) from east to west, there is a large plume of smoke from Eastern Canada dropping south into the Eastern United States. This is the smooth slightly yellowish-white plume over New York and Pennsylvania. There is also moderately dense bluish-white haze in the southeast (Louisiana to Georgia) and Midwest (Arkansas to Illinois). Some of this haze appears to be below scattered cirrus clouds. Bright white clouds can be seen scattered throughout as well as snow on the Canadian Rockies. The two bands of brightness over the ocean on both east and west coasts are *sunglint*, the reflection of the sun off the surface of the ocean. The vertical discontinuities splitting the country into thirds mark the swaths of the satellite as it takes sequential images orbiting over the poles. The swaths are approximately 90 minutes apart.

Even without looking at the aerosol optical depth or ground based data, this image provides information on the general air quality on this day as well as its potential transport. Both the northeast and southeast are likely experiencing decreased visibility and increased PM levels. A review of the STN-M data shows, for example, elevated levels of sulfate and PM2.5 in Birmingham and elevated PM10 in Pittsburgh at this time. The satellite data represent scattering in a total column of atmosphere, so there remains some question about the height of the pollutants (e.g., whether the smoke from the fires is only at high levels in the troposphere or whether it is reaching ground level). This emphasizes the importance of combining the satellite image with ground based observations. More importantly, images such as these document the source of certain pollutants, such as the build up of haze in the Midwest or the fires in Canada potentially causing increases in PM levels in the northeast. Even though MODIS images are daily, motion can still be observed when viewing a sequence of images (see Sections V.B.2 through V.B.4).

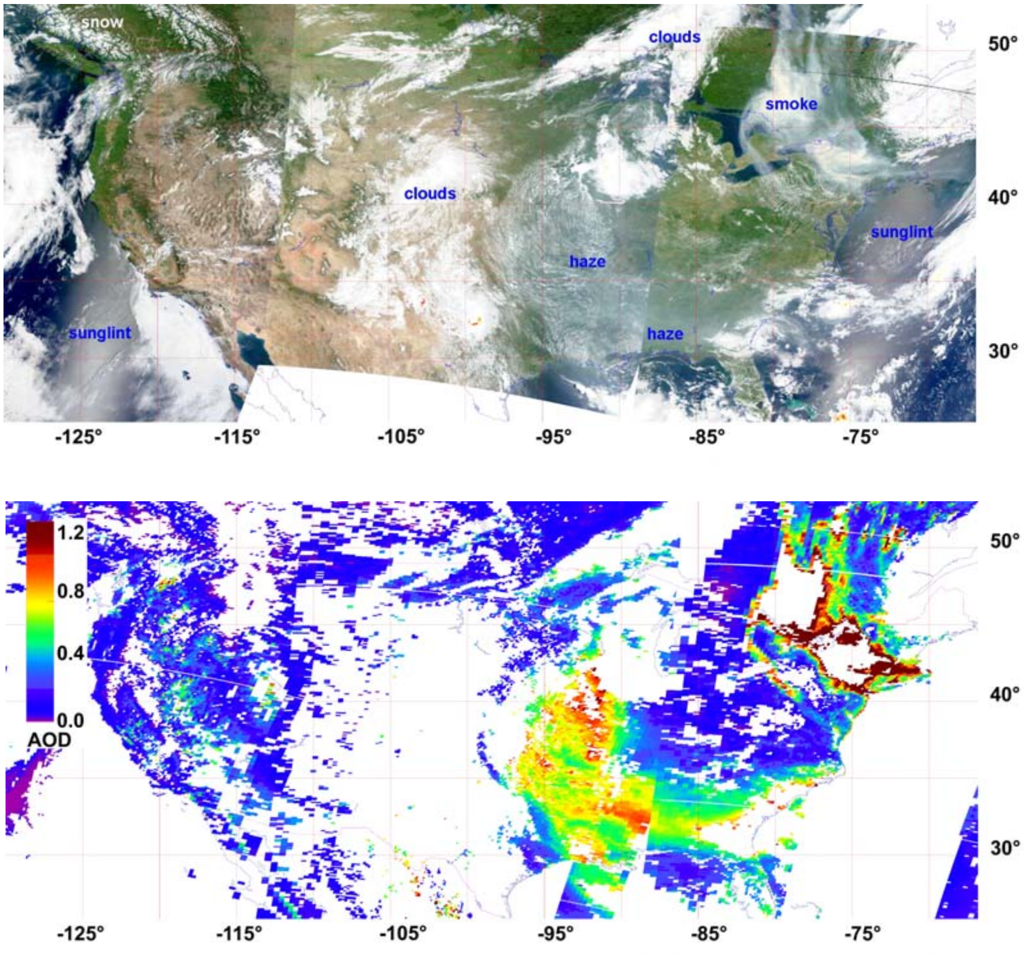


Figure V-1. (a) MODIS Level 1b RGB composite image, July 6, 2002 (upper); (b) MODIS Level 2 aerosol optical depth, July 6, 2002 (lower).

Figure V-1(b) is the aerosol optical depth for the same day. Blue represents low aerosol optical depth (clearer air) increasing through the color scale to dark red representing higher aerosol optical depth (the numerical correlation between aerosol optical depth and ground-based observations is discussed in Section V.C). White indicates no data usually because of cloud cover; also, the area over the ocean influenced by sunglint is a section of no data. The satellite clearly measures both the smoke plume in the northeast and the haze in the Midwest. However, note that the middle of the smoke plume is white (no data). Either the algorithm used to calculate areas of clouds mistakes the dense smoke for cloud, masking it from the aerosol optical depth calculation, or else the aerosol optical depth algorithm is screening out these values. As will be discussed later, very high aerosol optical depth values are eliminated from the dataset. Note also that the pixel size changes shape. Each pixel represents 10 km square at nadir; however, areas near the edge of the swath experience distortion.

Overall, qualitatively, the two images in Figure V-1 support each other in documenting air pollution, particularly in the eastern portion of the continent.

In the west coast, the aerosol optical depth data are more erratic. Data seem to be masked in cloud free areas where there is an abrupt change in terrain, such as the area of forest in Montana. Other times, it provides no data over large areas of dry terrain (high surface reflectance). A review of all the images shows that the dataset west of about 90 to 100/W appears to be consistently patchy. Based on the review of the aerosol optical depth algorithm, the causes of increased masking in the west are likely a combination of difficulties in the cloud masking (due to assumptions of surface reflectance, cloud edges, and cloud-surface contrast), overscreening of valid pixels in regions of less vegetation and high reflectance, and use of the smoke model in areas that may be experiencing other types of pollution.

Another way to view these data is to overlay the Level 2 aerosol optical depth data on the Level 1b RGB image. Figure V-2 is such an image from September 10, 2002. As discussed above, several areas with cloud free skies do not appear to have returned aerosol optical depth data, notably over the Blue Ridge Mountains and in patchy regions in the West.

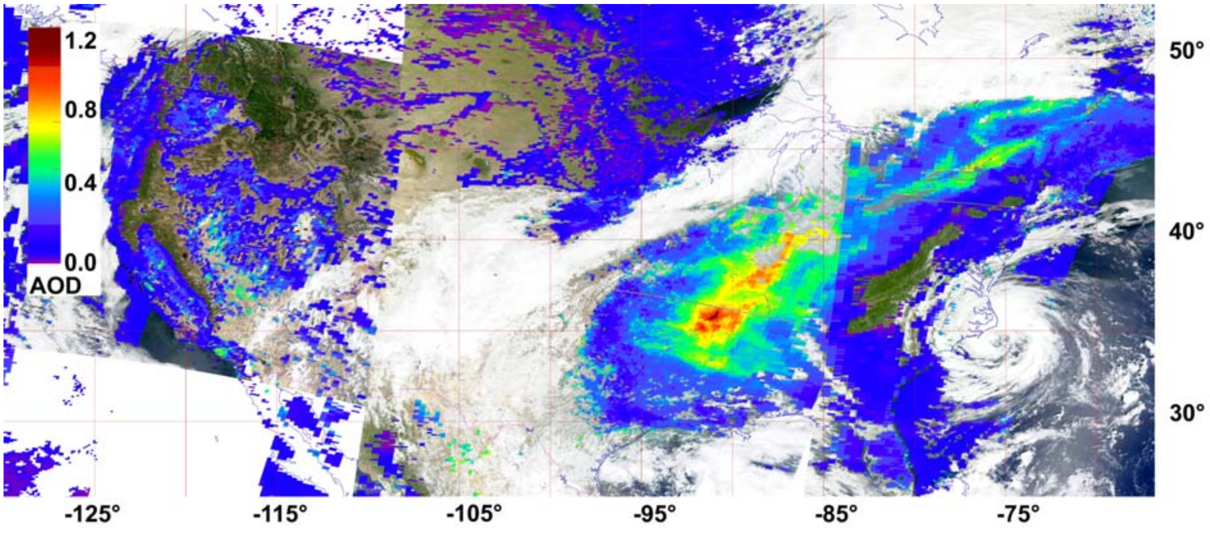


Figure V-2. MODIS Level 1b RGB and MODIS Level 2 aerosol optical depth, September 10, 2002.

2. Midwest-East Haze Event: June 20-28, 2002

During late June 2002, the central and eastern United States experienced a haze event from a combination of anthropogenic air pollutants and some smoke. Figure V-3 shows the series of L1B images from June 20-28, 2002. As discussed in Section B.1, the bright white is clouds and the bluish tint is haze. Both the Level 1B (Figure V-3) and Level 2 images (Figure V-4) document the build up of aerosols in the Midwest from June 20-22, then their transport across the northeast from June 23-26. The final two images, June 27 and 28, appear to be the beginning of smoke transported from fires in Canada into the northern Midwest of the United States.

This series from June 20-26 qualitatively documents a haze transport event from the Midwest into the northeast. The imagery also documents the geographical scale of the smoke transport on June 27-28.

Close examination of the imagery reveals that some areas with apparent high haze levels and no clouds do not have aerosol optical depth values. For example, on June 20, southern Michigan and northern Indiana appear hazy and relatively cloud free but no aerosol optical depth was provided. This can be seen in the same region on June 22 and to a lesser extent on June 23. These data are being eliminated in either the cloud or aerosol optical depth screening.

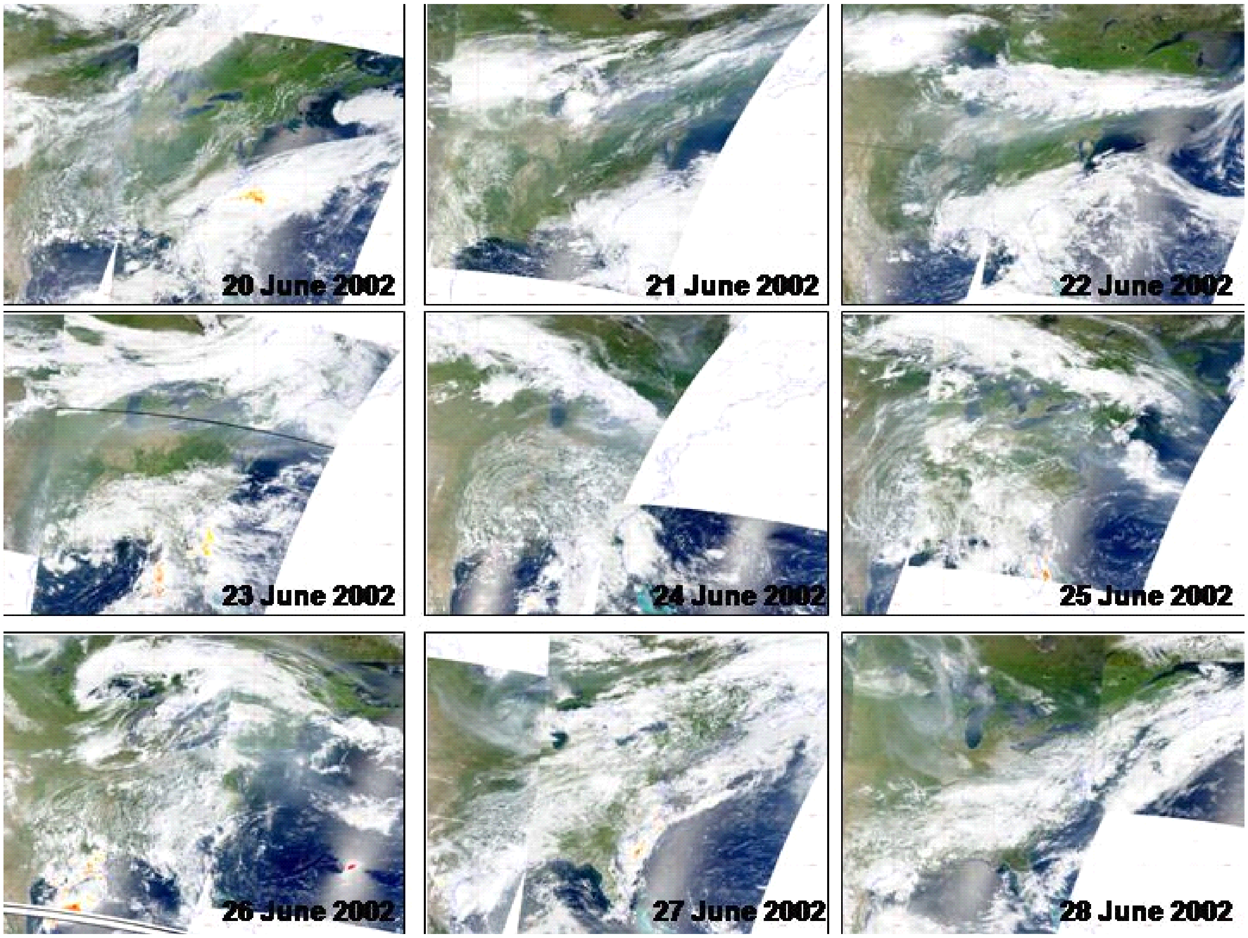


Figure V-3. MODIS Level 1b RGB composite images, June 20-28, 2002.

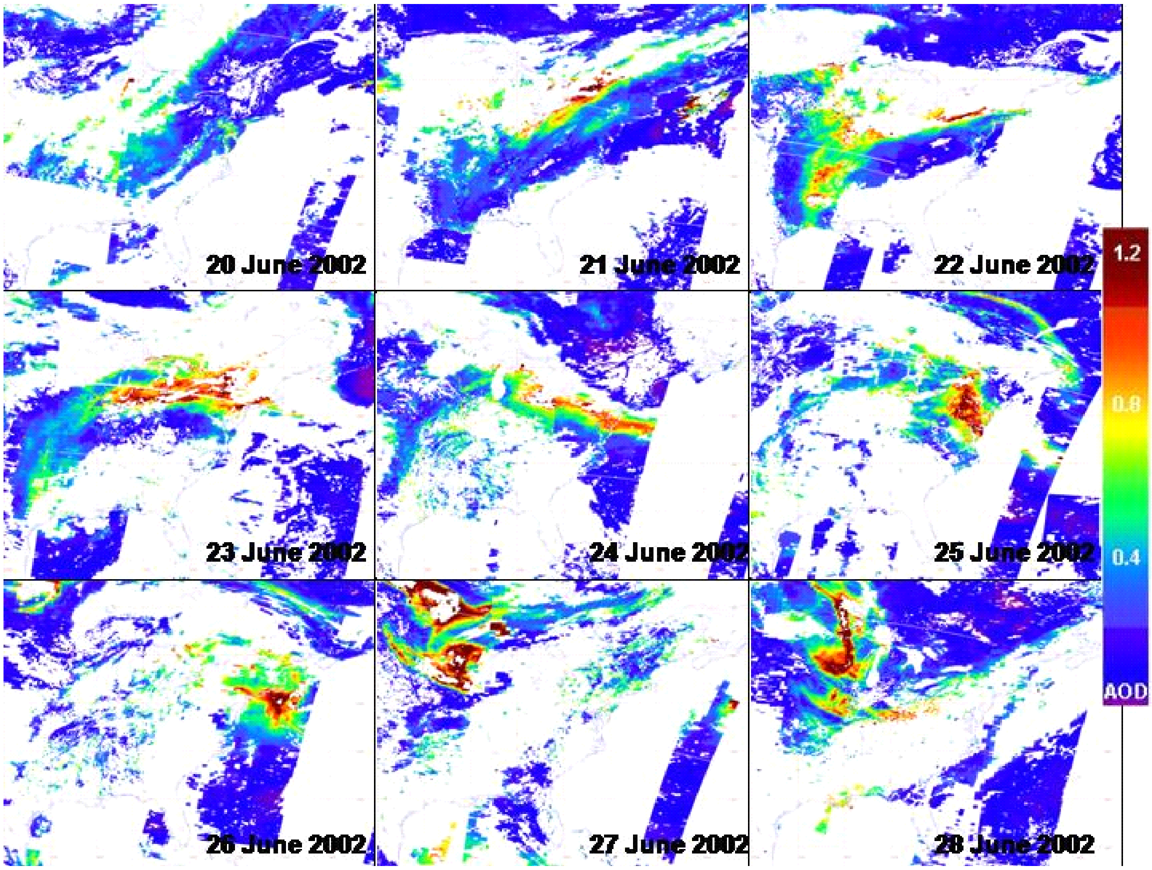


Figure V-4. MODIS Level 2 aerosol optical depth images, June 20-28, 2002.

3. Northeast Fire Event: July 4-9, 2002

A smoke transport event is documented in the MODIS imagery in early July 2002. Figure V-5 is the Level 1B RGB image from July 4-9, 2002, and Figure V-6 is the corresponding Level 2 aerosol optical depth data. The first two images in each figure, July 4 and 5, consist primarily of urban haze in the east, southeast, and Midwest. This haze event persists in the southeast and southern Midwest throughout the remaining days, July 7 through 9. However, the northeast and mid-Atlantic become dominated by smoke transported into the region from July 6 through July 8. By July 9, the smoke (and the southern haze) has dissipated toward the east over the Atlantic.

This series from July 6 through 8 qualitatively documents this smoke transport event from major fires in Canada. The imagery also documents the geographical scale of haze, particularly from July 4 through 8.

Close examination of the imagery reveals that the areas with very dense smoke levels do not have aerosol optical depth values. This can be seen very clearly in the smoke plume on July 6, 7, and 8. In the Level 1B images, the plume appears very white, like a cloud, but with a slight brown tint and with a "smooth" appearance (as opposed to the rougher texture of the clouds). In the Level 2 images, the centers of the plumes appear blank (white) with no data.

Due to the dense nature of these high smoke plumes, these sections are being eliminated by either the cloud mask or aerosol optical depth algorithm or a combination of both. Conversations with NASA staff and a brief review of ground-based aerosol optical depth data have indicated that the aerosol optical depths in these plumes range as high as 5. Note that aerosol optical depth data are returned over the ocean even near coastal regions where no data are being returned over the land. This is indicative of the difference in the cloud and/or aerosol optical depth algorithms over the land versus over the ocean.

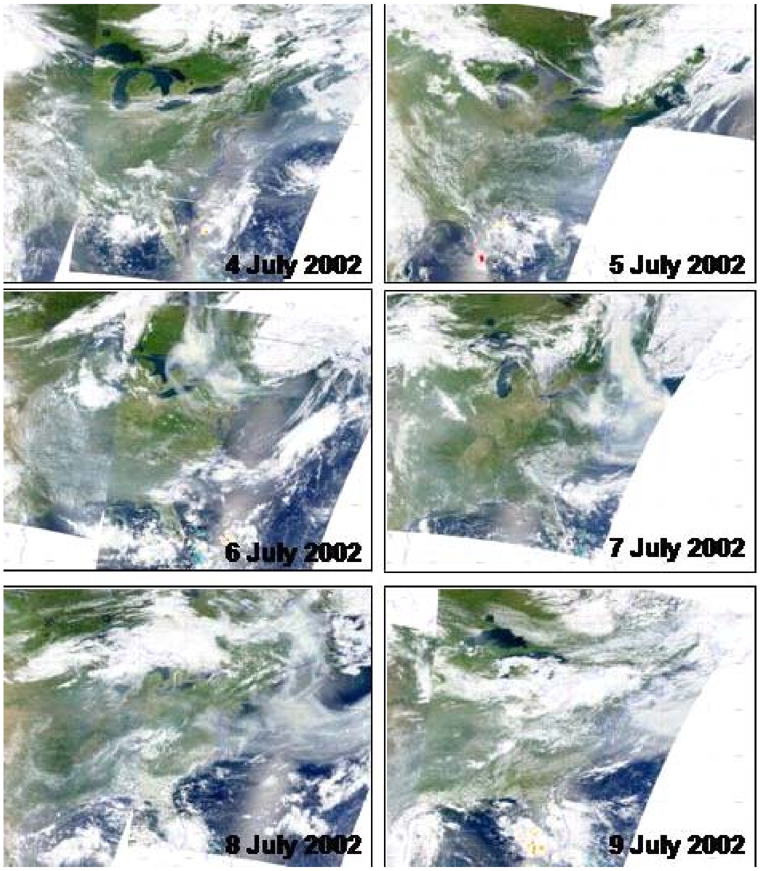


Figure V-5. MODIS Level 1b RGB composite images, July 4-9, 2002.

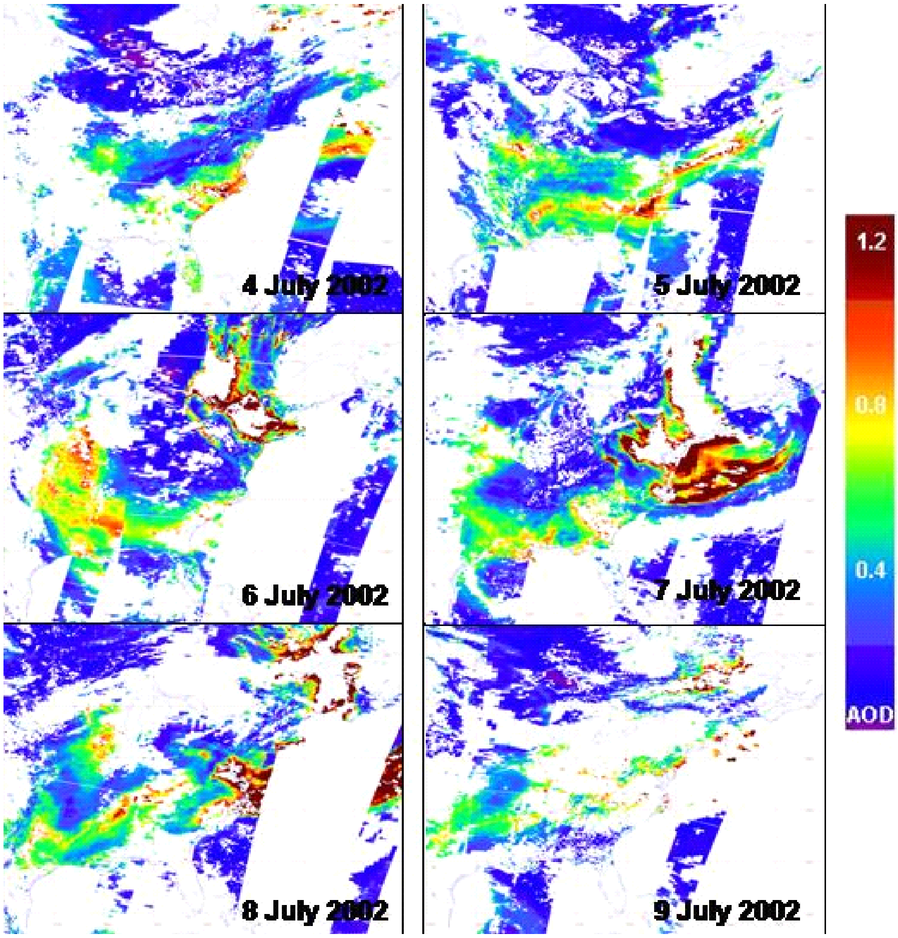


Figure V-6. MODIS Level 2 aerosol optical depth images, July 4-9, 2002.

4. Midwest-South East Haze Event: September 8-14, 2002

The imagery from early September reveals the beginning of a haze event that becomes influenced by a strong tropical low pressure system. Figure V-7 is the Level 1B imagery and Figure V-8 is the Level 2 imagery for September 8-14, 2002. Haze collects in the Midwest over September 8 and 9. A tropical storm (Gustav) approaches the mid-Atlantic, coming just onshore on September 10. The haze plume divides with the majority traveling south and west toward Texas and a small remnant moving northeast. On September 11 and 12, the Midwest plume, combined with additional pollutants from Texas and the southeast, is transported to the east. September 13 has another low pressure system forcing collection of pollutants in Texas and Louisiana, which are obscured by cloud cover on September 14.

This series reveals the geographic extent and the complex transport of pollutants during this event.

Close examination of the imagery reveals several areas without aerosol optical depth data that appear to be cloud free but also haze-free. September 8 and 9 are cloud free and haze-free over the northeast and the Blue Ridge Mountains, respectively. September 10 also has a clean area between the tropical storm and the haze plume (see also Figure V-2). Yet, there is no aerosol optical depth data provided for these regions although they are surrounded by very low aerosol optical depth data (less than 0.1). September 12 has a very large area of apparently clean air in the northeast, particularly obvious in the Level 2 imagery as a large region of low aerosol optical depths 0.2 (blue), an outline of AOD near 0 (purple), surrounding a center of blank data. It is not understood why these areas are not assigned values.

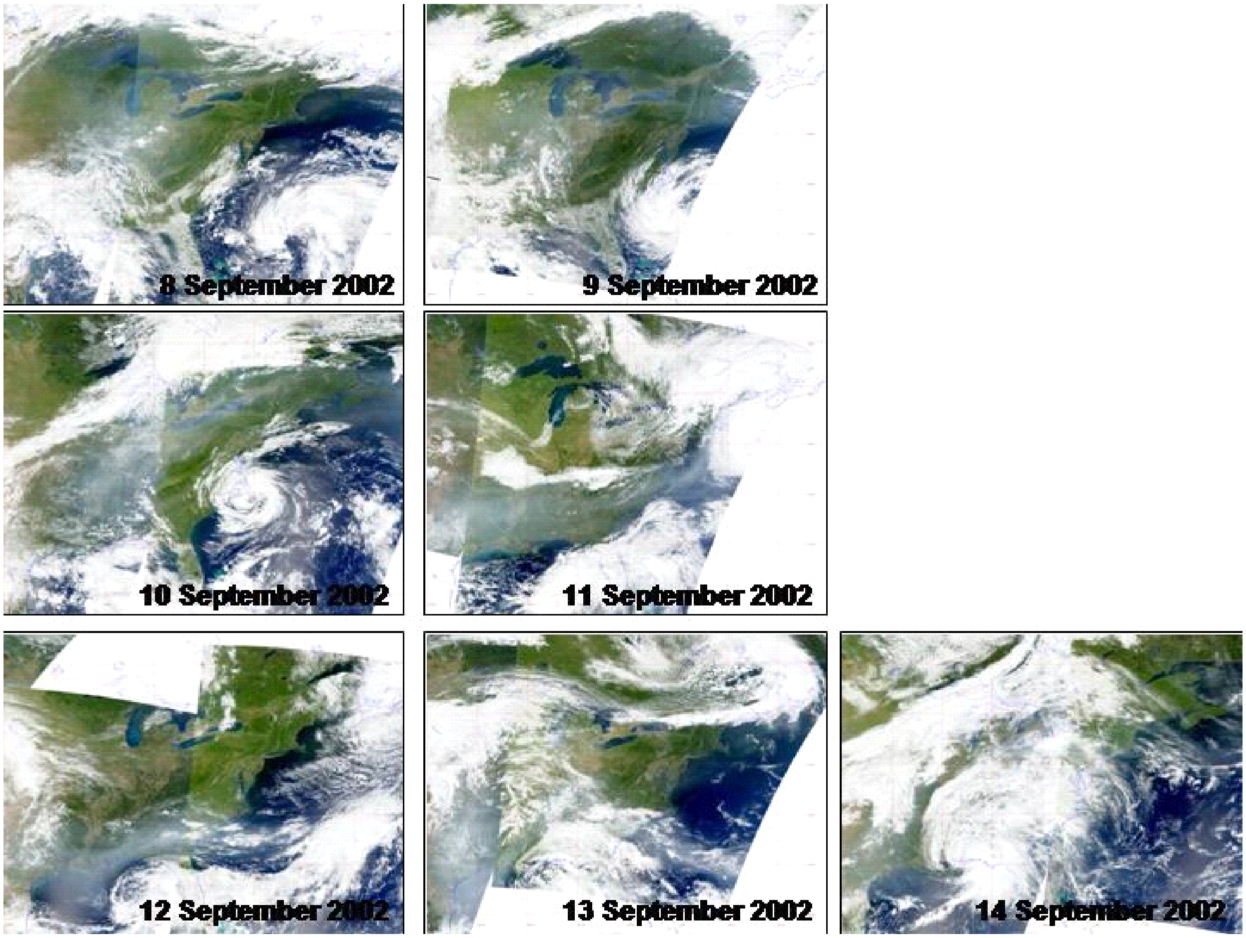


Figure V-7. MODIS Level 1b RGB composite images, September 8-14, 2002.

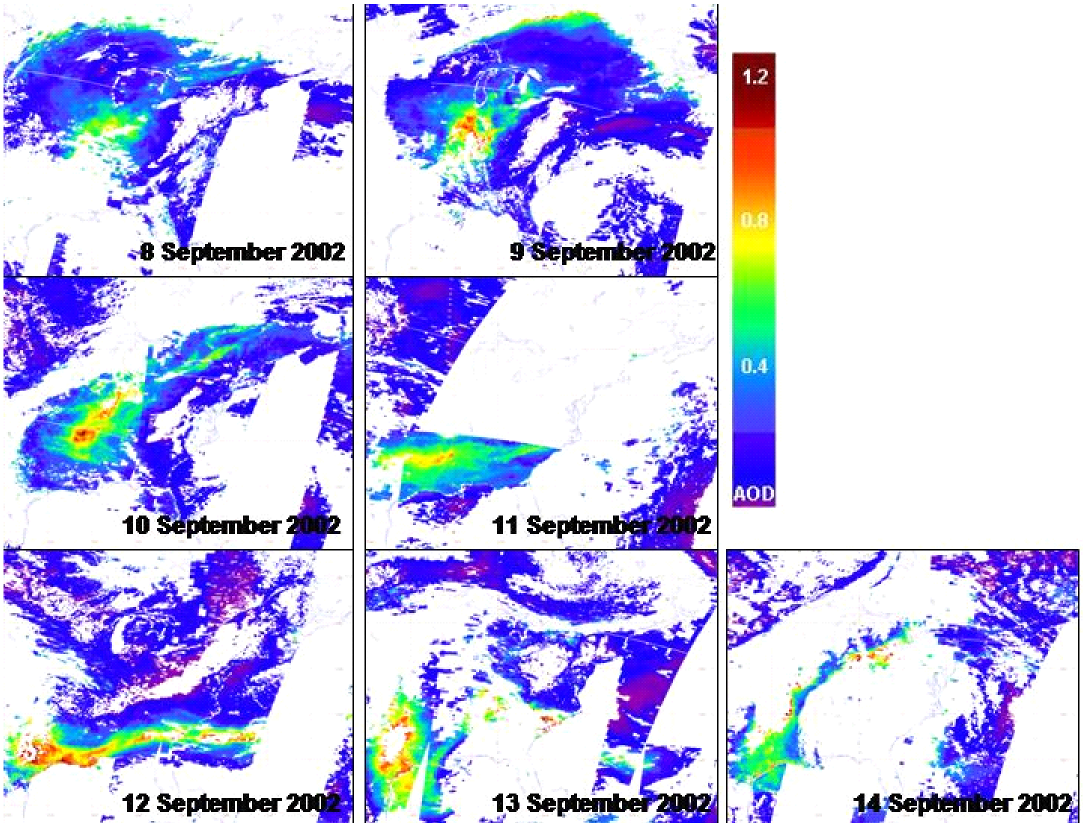


Figure V-8. MODIS Level 2 aerosol optical depth images, September 8-14, 2002.

C. Quantitative Data Analysis

For the quantitative analysis, satellite and ground-based data from April 1, 2002, to September 30, 2002, were prepared; then, two types of statistical analyses were performed to determine the associations between satellite readings and ground-based measurements. First, an analysis was performed using all of the data from both STN-M and IMPROVE sites, searching for overall patterns of association between satellite readings and ground-based readings. The second analysis focused on a few cities and parks across the country. For these cities and parks, more detailed time-series and correlation analyses were performed in order to assess the ability of the MODIS satellite to detect significant air quality events.

The first analysis examined the overall associations between satellite readings and ground-based measurements by calculating correlations (r). Correlations measure the strength of (linear) association between two variables. They are a simple measure summarizing how well one variable can be used to predict another variable. Correlation values near zero indicate that the two quantities examined (for example, satellite readings of aerosol optical depth and ground readings of aluminum mass) are not linearly associated with each other. Values close to 1 indicate that an increase in one variable is strongly associated with a linear increase in the other variable. Values close to -1 indicate a strong but decreasing relationship (an increase in one variable is associated with a linear decrease in the other variable). In all analyses, the influence of each observation used to calculate correlation was weighted by the inverse of the percentage of cloud cover. In other words, satellite observations taken under conditions with more cloud cover are given less credence than those observations taken under clear conditions.

To examine overall correlations, observations from 1,157 STN-M sites and 181 IMPROVE sites were used. Selected top overall correlations found between aerosol optical depth and the STN-M and IMPROVE variables at all of these sites appear in Table V-1. Overall, both aerosol optical depth readings and mass concentration readings are most strongly correlated with daily PM2.5 readings.

Table V-1. Selected top correlations across all sites with MODIS Aerosol Optical Depth

Variable	Network	Correlation	Total Number of Observations
PM2.5 - Local Conditions (LC) (daily)	STN-M	0.428	35619
PM2.5 - LC (hourly)	STN-M	0.396	13967
Sulfate PM2.5 LC (daily)	STN-M	0.373	3292
Organic Carbon PM2.5 LC (daily)	STN-M	0.361	3284
Sulfate: Fine	IMPROVE	0.349	2891

The aggregation performed over all sites in constructing these tables tends to distort the geospatial details of the relationships. For instance, correlations between aerosol optical depth and daily PM2.5 levels are high in some geographical areas and low in others, but the overall correlation gives no information about these differences. In order to examine these differences more closely, we calculated the correlation separately for each STN-M and IMPROVE site and examined the smoothed spatial surface of correlations across the entire United States. Only sites with more than five valid pairs of observations were used to calculate the correlation surface in all cases. The spatial smoothing was performed using ordinary kriging techniques.

Figure V-9 shows the correlations between aerosol optical depth and hourly PM2.5 readings across the United States. The non-uniformity of the correlations across space is clearly illustrated in the figure. In the eastern half of the United States, the correlations are strong, demonstrating that aerosol optical depth is a good indicator of PM2.5 levels. However, in the western United States aerosol optical depth readings and PM2.5 readings are only weakly correlated.

These variations are likely due to the difficulty the satellite algorithm has in determining accurate aerosol optical depth readings over regions of low reflectance (light color terrain), specifically arid areas. There may also be some differences in the model used to calculate aerosol optical depth west of 100/W. More detailed discussion of these differences can be found in the technical report (Engel-Cox, et al., 2003).

The key finding is that the site-specific correlations in the eastern half of the United States are typically 0.6 to 0.8, which represents a good correlation for evaluating regional PM.

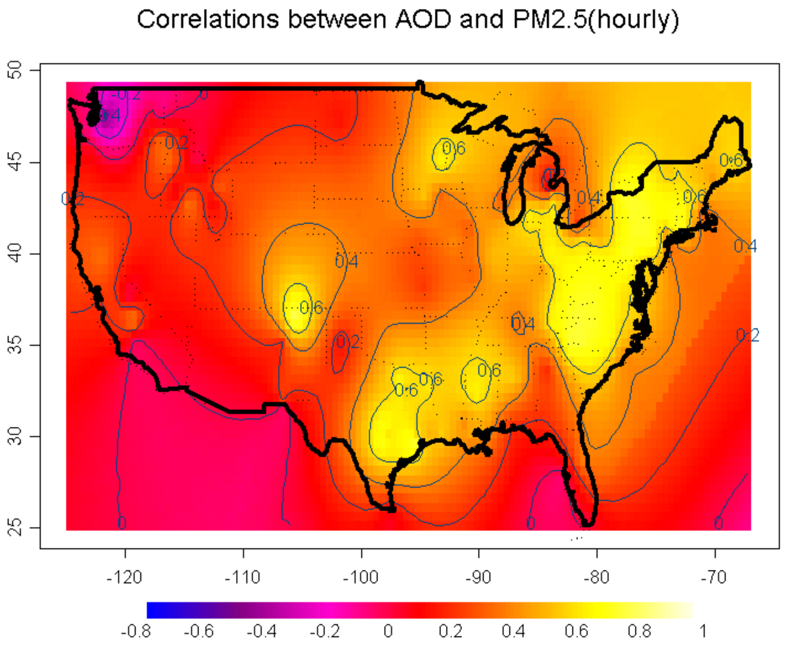


Figure V-9. Correlations between aerosol optical depth and hourly PM2.5 readings across the U.S.

The large scale spatial analyses of correlations give some indication that satellite measurements and ground-based monitor readings are not related in the same way in all areas of the U.S. In order to more fully understand the relationships in some areas, the focus was on a few cities and National Parks to reflect a range of variables, including geographical location, coastal/inland, climate, and terrain. For each of the cities, an analysis was first performed similar to the one performed over all of the sites; and correlations were calculated between satellite measurements and ground-based measurements in order to find the ground-readings most strongly associated with the two types of satellite measurements. Correlations of satellite aerosol optical depth with PM2.5 readings for individual monitors are shown in Table V-2. More results can be found in the technical report (Engel-Cox, et al., 2003).

Table V-2. Correlations between Aerosol Optical Depth and PM2.5 by site

State	City	Site Number	Correlation of AOD with PM2.5 - Local Conditions (daily)
ALABAMA	BIRMINGHAM	10730023	0.471
ALABAMA	BIRMINGHAM	10732003	0.671
COLORADO	DENVER	80310002	0.547
DISTRICT OF COLUMBIA	WASHINGTON	110010042	0.739
INDIANA	INDIANAPOLIS	180970042	0.583
INDIANA	INDIANAPOLIS	180970043	0.469
INDIANA	INDIANAPOLIS	180970066	0.318
INDIANA	INDIANAPOLIS	180970078	0.190
INDIANA	INDIANAPOLIS	180970079	0.560
INDIANA	INDIANAPOLIS	180970081	0.590
INDIANA	INDIANAPOLIS	180970083	0.548
MISSOURI	ST LOUIS	295100007	0.558
MISSOURI	ST LOUIS	295100085	0.529
MISSOURI	ST LOUIS	295100086	0.452
MISSOURI	ST LOUIS	295100087	0.489
NEW YORK	BRONX	360050083	0.554
NORTH CAROLINA	CHARLOTTE	371190010	0.733
NORTH CAROLINA	CHARLOTTE	371190041	0.732
NORTH CAROLINA	CHARLOTTE	371190042	0.726
PENNSYLVANIA	PITTSBURGH	420030008	0.447
PENNSYLVANIA	PITTSBURGH	420030021	0.485
TEXAS	DALLAS	481130035	0.632
TEXAS	DALLAS	481130050	0.655
TEXAS	DALLAS	481130057	0.687
TEXAS	DALLAS	481130069	0.497
TEXAS	DALLAS	481130087	0.413
TEXAS	HOUSTON	482010051	0.942
TEXAS	HOUSTON	482010055	0.928
TEXAS	HOUSTON	482010062	0.698
TEXAS	HOUSTON	482010075	0.887
TEXAS	HOUSTON	482011035	0.912

D. Application of Satellite Data to Air Quality Policy

EPA established its ground-based air monitoring networks to meet several goals including monitoring compliance with ambient air quality requirements and evaluating trends and abatement strategies. When comparing ground-based values to satellite imagery and data, the key question is how satellite data can be used to support and enhance EPA air quality monitoring and modeling.

The MODIS imagery and aerosol optical depth data have relevance to ambient air quality monitoring. The ability to visualize regional scale events with both L1B and L2 data can be used effectively to understand the scope of regional haze and smoke. This is important to understanding the impact of large events on pollutant levels at the local level. Visualization can validate that a large scale event (as opposed to an urban scale) is occurring and document the duration and geographic scale of that event. Even without a precise correlation with a ground-based concentration, the larger scale visualization of PM improves understanding and prediction of PM concentrations, especially when used in conjunction with the point-based monitoring of individual stations in a number of states. The satellite data also greatly enhance knowledge of PM levels in areas where there are no ground-based monitors. Although single monitor correlations may not always be valid, the complete geospatial coverage at 10 x 10 km scale of the MODIS data at 0.6 to 0.8 correlation in the eastern United States is capable of producing a relative index of severity of PM2.5 concentrations, if not a specific ground-level index.

This review documented that the MODIS aerosol algorithms as they are used now perform best east of about 100/W, including the Midwest and east coast. Satellite data are particularly suited to monitoring regional and synoptic scale air pollution events. The limitation of the satellite data for use with the transport rule is that satellite data cannot identify a specific type of source (e.g., mobile, stationary, biogenic). However, satellite data can effectively be used to understand the geospatial source regions and document the occurrence and intensity of the transport of PM2.5 across state boundaries.

VI. Inter-Site Correlation of PM2.5 Mass and Component Species

A. Background and Data Description

Average PM2.5 concentrations fluctuate from day-to-day and among seasons in response to complex atmospheric interactions that occur among meteorological conditions and source emissions. The degree of spatial homogeneity of PM2.5 concentrations is governed in large part by the spatial homogeneity of the component species of PM2.5. Generally, concentrations from monitoring stations that are close to one another (e.g. within 10 to 50 kilometers) have similar temporal patterns with a strong tendency to rise and fall in unison. Stations that are separated by large distances (over 500 kilometers) generally do not track as well since the air mass surrounding the stations may be quite different with respect to pollutant loading.

The correlation coefficient is a convenient quantitative measure of the linear association between two variables, and the square of the correlation coefficient denoted R^2, measures how much of the total variability in the data is explained by a simple linear model. For example, a correlation coefficient of 0.7 means that approximately 50 percent of the variation in concentration at one site can be explained by variation at the other site. It should be noted that a large correlation coefficient does not mean that the magnitude of the concentrations among stations are the same – only that the concentrations have essentially the same temporal pattern.

Concentrations of PM2.5 and component species from the IMPROVE and STN monitoring networks operating in the eastern half of the US (displayed in Figure VI-1) were used to calculate the correlation coefficient among station pairs as a function of distance separating the stations. The data base consisted of daily average concentrations of PM2.5 and each of the major component species (i.e., sulfates, nitrates, organic carbon, elemental carbon and crustal mass). For analysis purposes, the data were partitioned into four calender quarters using the most recently available and quality assured data. The four quarters were composed of daily concentrations taken during the Fall of 2001, and the Winter, Spring and Summer of 2002 (October 2001 through September 2002).

The nominal sampling schedule for both networks is one sample every third day which results in approximately 30 sampled days per quarter. To avoid problems with missing values, a thin plate spline was used to impute values for stations not reporting a valid measurement for a given day. The number of missing values varied by species and quarter but averaged about 5 percent overall.

The number of pairs of monitoring stations involved in these calculation is quite large. Since there are approximately 50 IMPROVE sites and 150 STN sites monitoring in operation during this time period, there are approximately 3500 correlation coefficients produced for each species. Since it is impractical to examine individual pairs of stations, the data were grouped into distance categories and aggregate statistics computed using the data within each category. The downside with aggregation schemes, is that unique features associated with a particular geographic area or monitoring site (e.g urban site located near a particular source) cannot be accounted for.

B. Results

The results for each pollutant species are displayed in the form of box plots that show the median, the inter-quartile range and data span. Figure VI-2 displays box-plot for the correlation coefficient using the PM2.5 mass concentration data. Results are only shown for separation distances less than 400 kilometers. In this example, the data are grouped in bins of size 50 resulting in approximately 40 to 80 data values per bin.

PM2.5 inter-station correlations are quite high at distances within 100 kilometers. Median concentrations range from 0.8 to above 0.9 among the four quarters. The correlation coefficients decrease slowly with increasing distance with median values dropping into the 0.6 to 0.7 range at distances of approximately 400 kilometers. The inter-quartile range, which is a measure of the spread in the correlation coefficient, tends to increase with distance. The spread in values indicates that individual station pairs, even within the same distance bin, can have quite different degrees of correlation. Part of the data spread can be attributed to expected stochastic variability but much of this variation is likely the result of unique aspects of individual pairings, for example, geographic orientation and location with respect to meteorological conditions and source impact.

Figure VI-3 displays similar plots for sulfate concentrations. Generally, the correlation pattern for sulfates is quite similar to that for PM2.5. Correlation coefficients are generally highest during the fall quarter and decrease slowly to a median of about 0.8 near 300 to 400 kilometers. Summer season correlation coefficients are also very high but tend to decrease slightly faster than during the fall season.

For nitrates (FigureVI-4) correlation coefficients are smaller than those for PM2.5 or sulfates and vary somewhat among the four quarters. Warm season correlations, when nitrates are lowest, tend to be low (about 0.4) for stations separated by 300 kilometers or more. Cool season correlations for nitrates are larger than warm season correlations and range from about 0.5 to 0.6 for stations separated by 300 kilometers or more.

For organic carbon (Figure VI-5) correlation coefficients range from about 0.4 to 0.6 for separation distances above 300 kilometers. Like sulfates, the organic carbon correlations appear to decrease more rapidly during the summer season compared with the other three seasons. For both organic carbon and nitrates, inter-quartile ranges appear to be somewhat larger than for PM2.5 and sulfates indicating greater variation among station pairs for these species.

For elemental carbon (Figure VI-6) correlation coefficients are relatively small and show little tendency to decrease with increasing separation distance. Correlation values during the fall season are highest (median about 0.6) but are frequently below 0.4 to 0.3 for the other three quarters.

For crustal matter (Figure VI-7), correlation coefficients tend to decrease slowly with increasing separation distance. Also, they tend to be somewhat higher than might be expected given that crustal matter is assumed to be locally generated. Values during the fall months (lowest crustal values) range from about 0.8 for the most closely paired stations to about 0.6 for stations separated by 300 kilometers or more. Correlations for the summer season (highest crustal values) are generally the lowest ranging from about 0.6 to about 0.5 at 300 kilometers and more.

The formation rate and relative stability for the major PM2.5 species help explain the observed correlation patterns. For sulfate, which is one of the major contributors to PM2.5 mass, the conversion of SO2 to sulfate occurs slowly over relatively large distances downwind of major emission sources of SO2. Slow conversion of SO2 to sulfate over large travel distances promotes greater spatial homogeneity and thus can lead to large correlation among distant monitoring stations. For nitrates, evidence suggests that higher inter-station correlations in winter are associated with increased stability of nitrate (longer travel distances) when conditions are cool compared with warm seasons when nitrates are much less stable.

The formation of secondary organic carbon from natural sources helps maintain a relatively homogeneous regional component (higher correlation) that is offset somewhat by higher organic carbon in urban areas associated with local carbon sources. For elemental carbon, it is believed that most of the contributions come from nearby sources (e.g, agricultural burning, mobile sources) and hence the relatively low correlation among stations that are separated by modest distances.

The correlation pattern for crustal is less easily understood. Daily and quarterly average spatial plots of crustal matter exhibit sharp gradients, a pattern which is usually associated with a less homogeneous air mass. Preliminary analysis prior to this study showed that crustal concentrations near urban areas varied significantly which suggests that local sources (wind blown dust and soil re-entrainment , local industrial activity) may be responsible. EPA plans to further study these correlation patterns for crustal matter, to determine if they may be artifacts of common meteorological patterns (e.g., windy vs calm days).

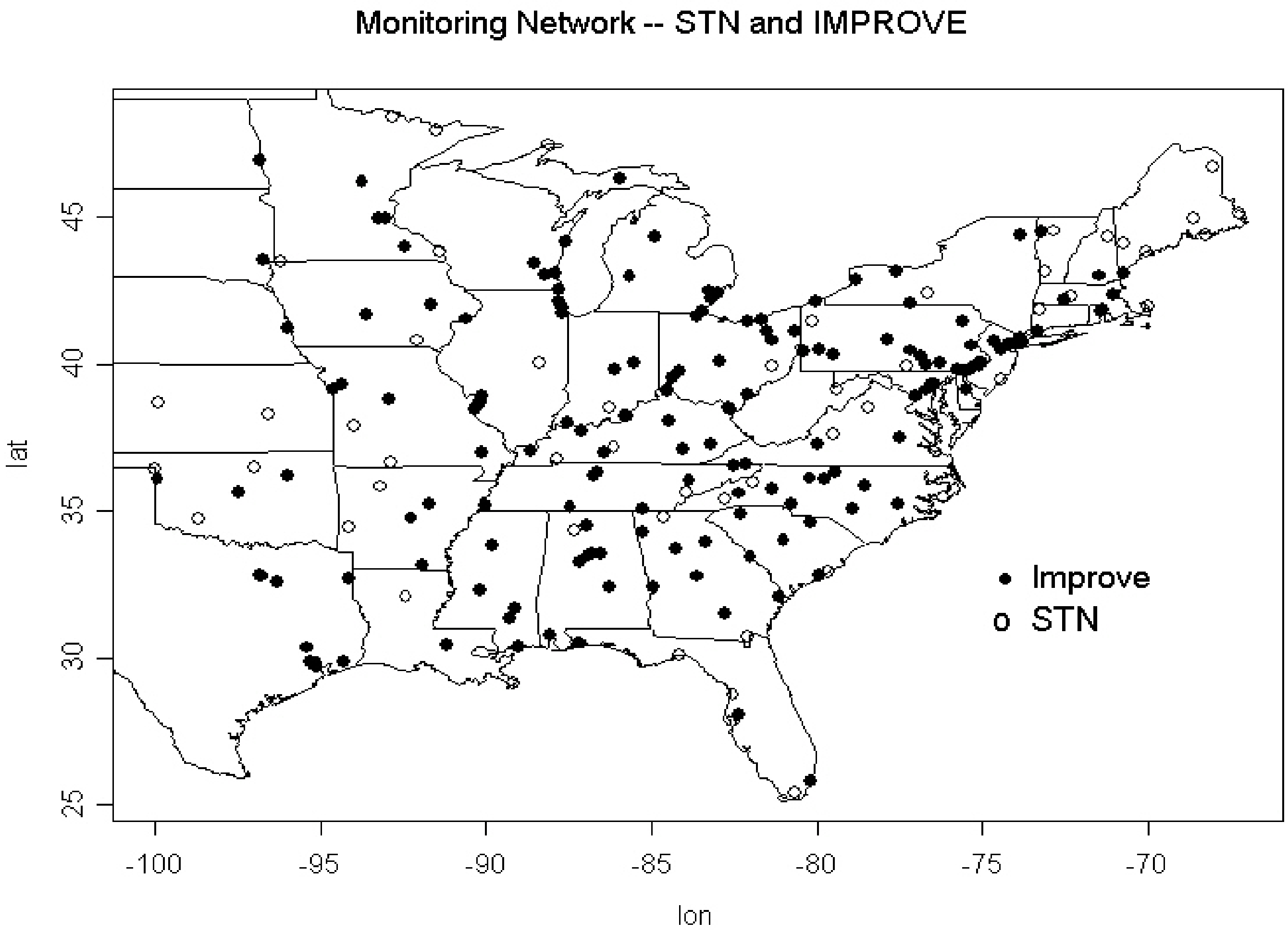


Figure VI-1. Ambient Monitoring Stations

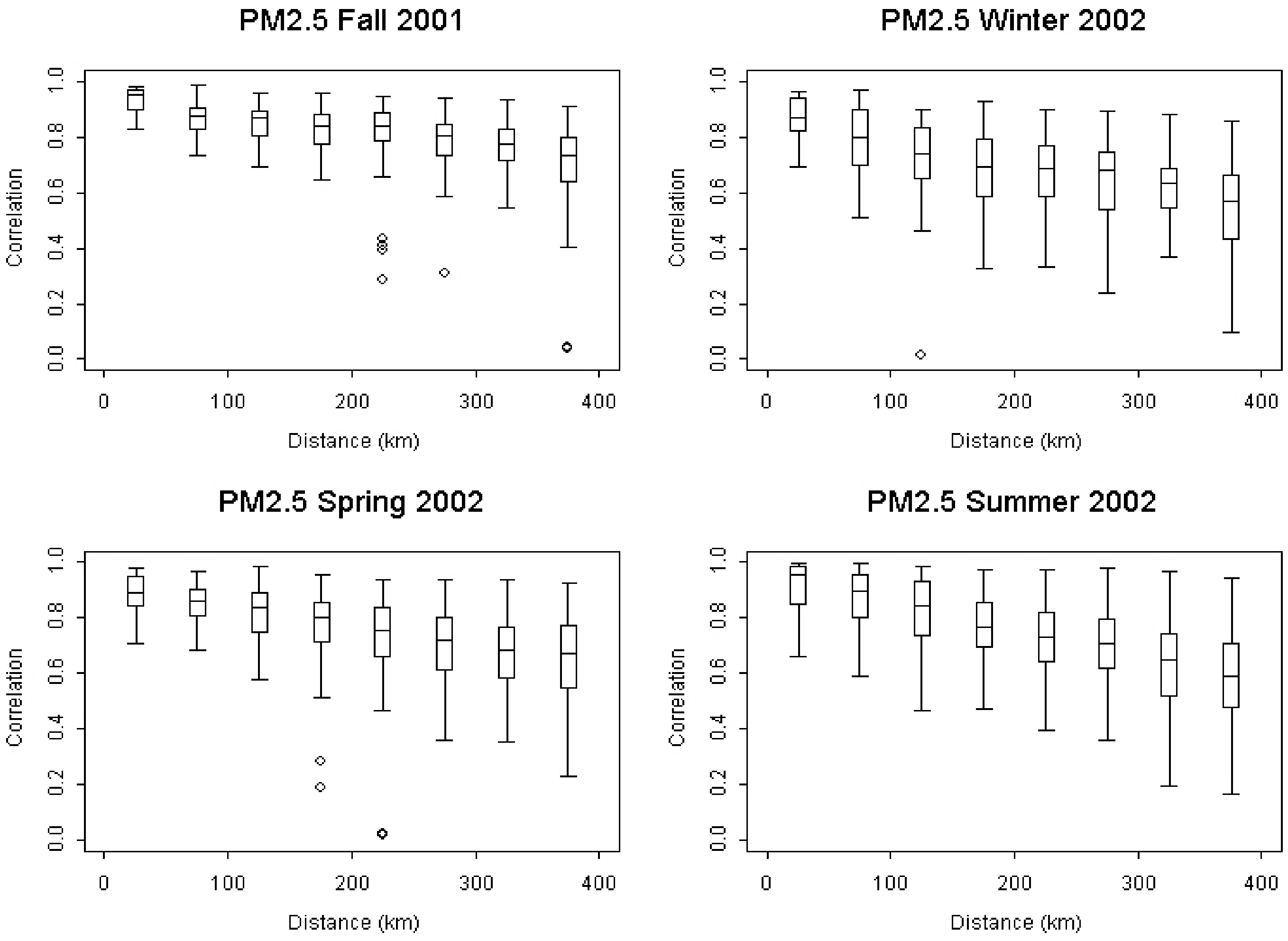


Figure VI-2. Correlation of PM2.5 vs Distance Separating Monitoring Stations

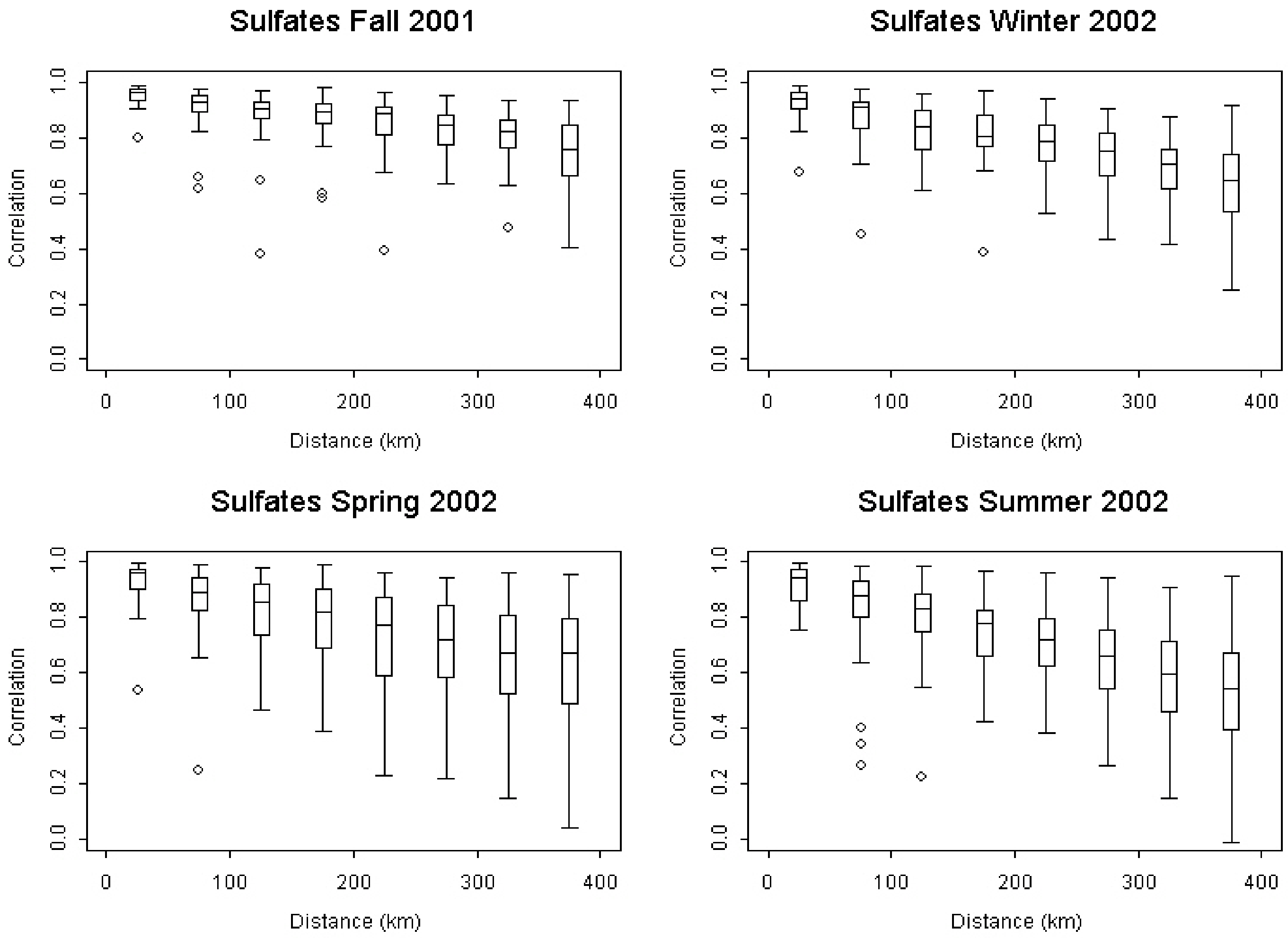


Figure VI-3. Correlation of Sulfate vs Distance Separating Monitoring Stations

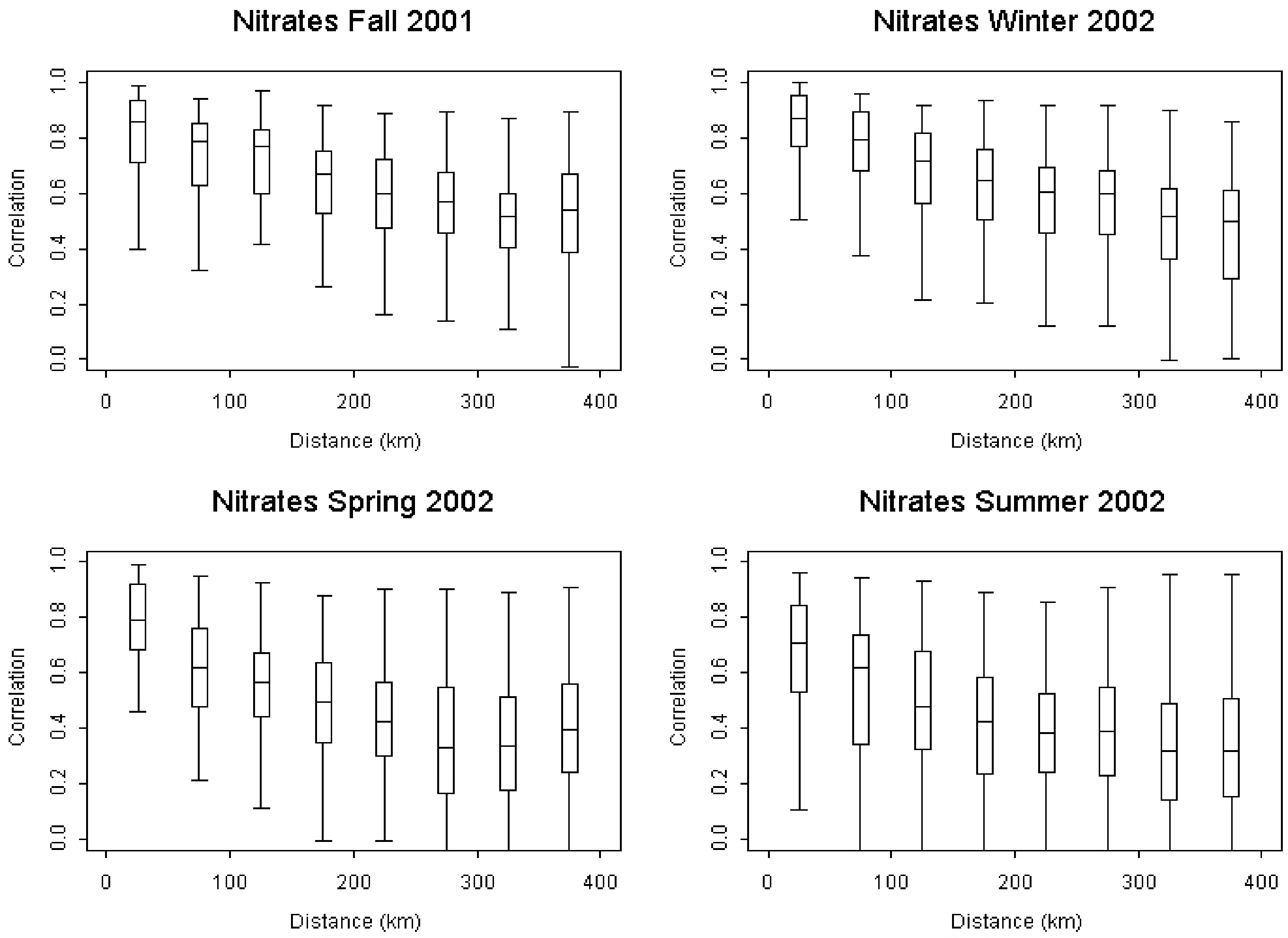
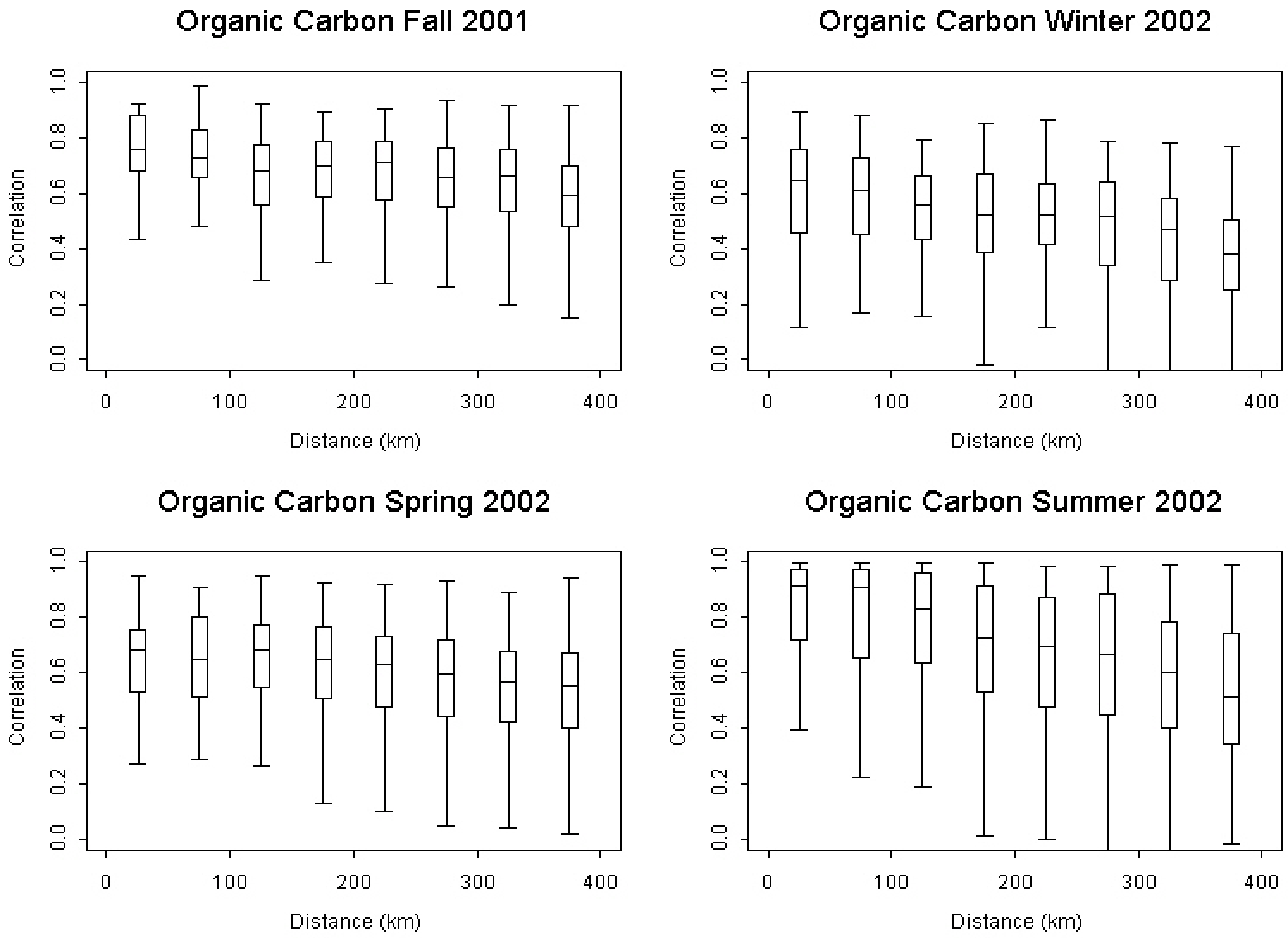


Figure VI-4. Correlation of Nitrate vs Distance Separating Monitoring Stations



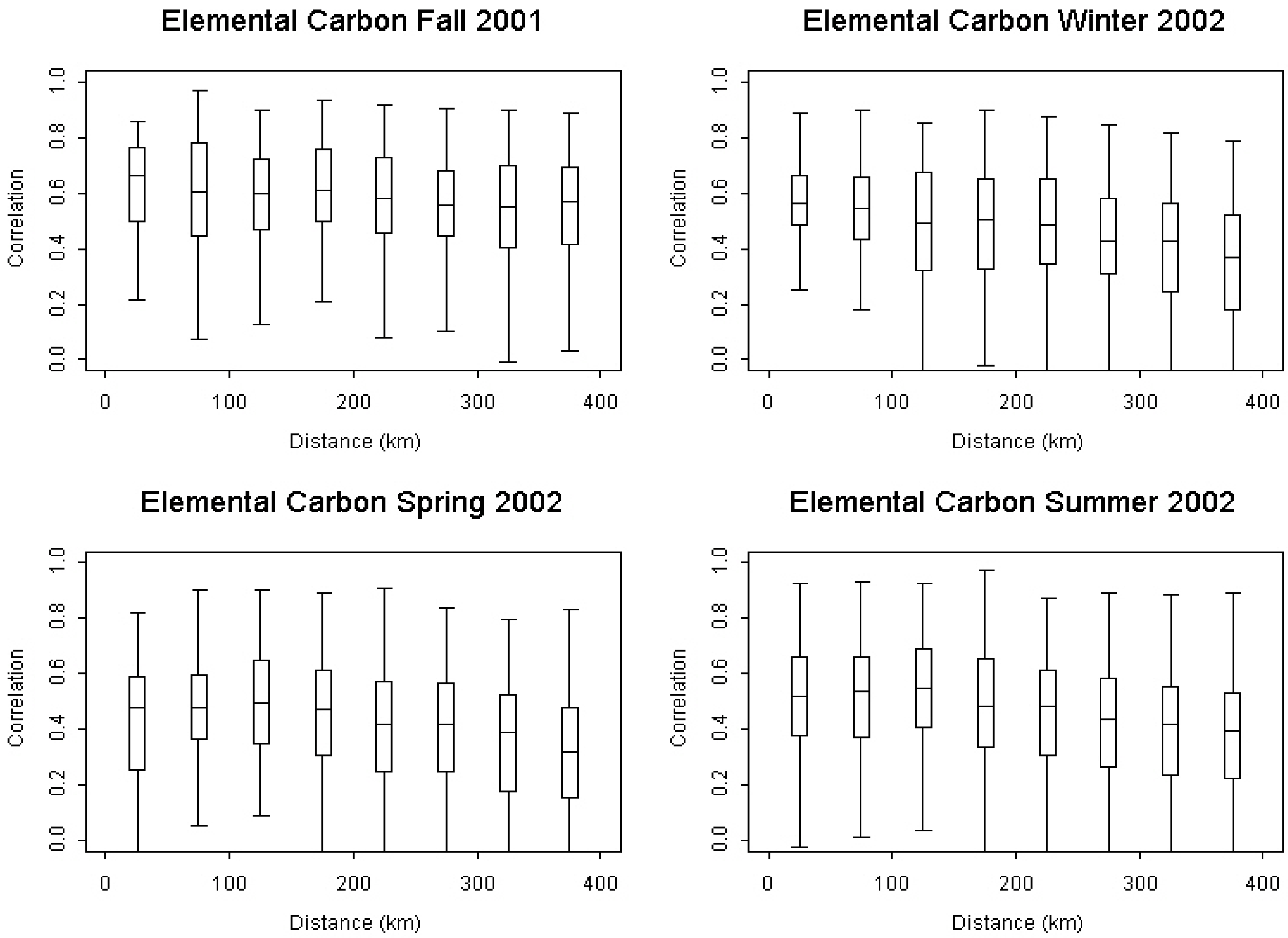
Organic Carbon Fall 2001

Organic Carbon Winter 2002

Organic Carbon Spring 2002

Organic Carbon Summer 2002

Figure VI-5. Correlation of Organic Carbon vs Distance Separating Monitoring Stations

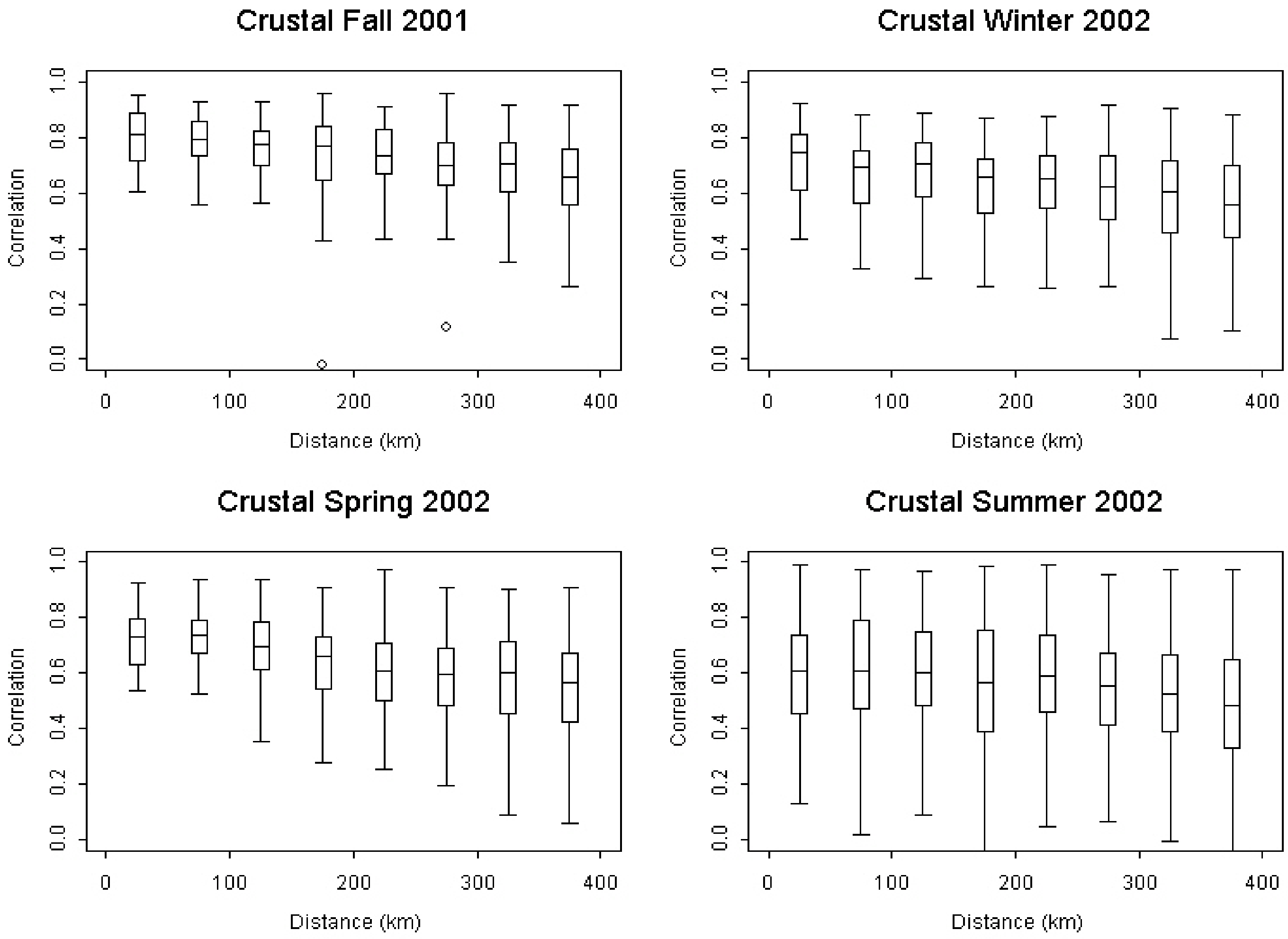

Elemental Carbon Fall 2001

Elemental Carbon Winter 2002

Elemental Carbon Spring 2002

Elemental Carbon Summer 2002

Figure VI-6. Correlation of Elemental Carbon vs Distance Separating Monitoring Stations



Crustal Fall 2001

Crustal Winter 2002

Crustal Spring 2002

Crustal Summer 2002

Figure VI-7. Correlation of Crustal vs Distance Separating Monitoring Stations

VII. Source Apportionment/Back Trajectory Analyses

Source apportionment is a modeling technique that uses the constituent species of PM2.5 to determine the major sources of particulate air pollution in a region over time. A wide variety of studies have been conducted using source apportionment models. This section explains source apportionment tools, presents a summary of recent research, and discusses a detailed source apportionment study on eight cities in the eastern half of the United States.

A. Summary of Key Source Apportionment Tools

The main goal for source apportionment is to describe and quantify the major source categories contributing to the observed concentrations of fine particulate matter in the atmosphere. Note that the intention is not to find every source contributing to a site, just the larger ones. This is done by modeling the PM2.5 mass concentration and 10 to 30 constituent species as a mixture from the major sources that varies from day-to-day. One of the key assumptions of source apportionment analysis is that individual sources contribute to the species mass concentrations at the receptor with fixed proportions between the various species. This assumption should be at least approximately true for most species and sources considered in the referenced study. Source apportionment decomposes data into a matrix of pollutant profiles and a matrix of relative contributions. The matrix of pollutant profiles identifies, for each source, the relative mass of the various PM2.5 species detected at the monitor and identified as originating at the source. The matrix of relative contributions identifies the relative strength of each of the identified sources on each monitored day. Because of measurement error, the tools used for source apportionment can detect only sources with a significant contribution to one or more of the fitting species.

The primary tools that are used to apportion the mass concentrations include the following:

- **Positive Matrix Factorization (PMF or PMF2)** uses constrained, weighted least squares estimation to apportion the species masses. The input data include the species masses and the uncertainties associated with each measurement. The main outputs are the source profiles and the associated time series (the day-by-day apportioning of species mass). Secondary output includes various model diagnostics.

- **Multilinear Engine (ME) and Positive Matrix Factorization (3-dimensional) (PMF3)** generalize the standard PMF model. The ME model also allows for known constraints and an even broader range of models. The output for both is similar to the PMF output.

- **UNMIX** apportions the data based on the “edges” produced in the data when one or more of the sources do not significantly contribute to the total mass of any species being modeled.

- **Chemical Mass Balance (CMB)** apportions the mass using historical emission source profiles that are assumed known and weighted regression methods. The output does not include the source profiles, since they are required inputs.

There are a variety of secondary tools and methods used in conjunction with the source apportionment tools to investigate and possibly refine the source apportionment. The most common pairing is source apportionment data with meteorological data based on back trajectory methods, such as Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model. In this case, the source apportionment output is paired with the output from a meteorological model that indicates a likely path back in time for a packet of air arriving at the receptor location during the sampling period. Inferences on the source location(s) are made by comparing the paths that correspond to high source strengths with all paths generated from the modeled period and/or the paths that correspond to low source strength periods. Since the inference is generally made through a probabilistic framework, the output is sometimes referred to as a probability field. These methods are also referred to as (conditional) ensemble back trajectory methods.

B. Summary of Source Apportionment Research

In support of the IAQR proposal, a literature compilation was completed to summarize where some of the source apportionment research has been conducted and its general findings. The literature included in the compilation was not exhaustive but was selected as representative of recent source apportionment research, focusing primarily (but not exclusively) on the PMF and UNMIX source apportionment models applied to data in the eastern United States. Figure VII-1 shows the locations of the various source apportionment studies and Table VII-1 lists the location names. Detailed summaries of the articles can be found in Coutant, et al. (2003a).

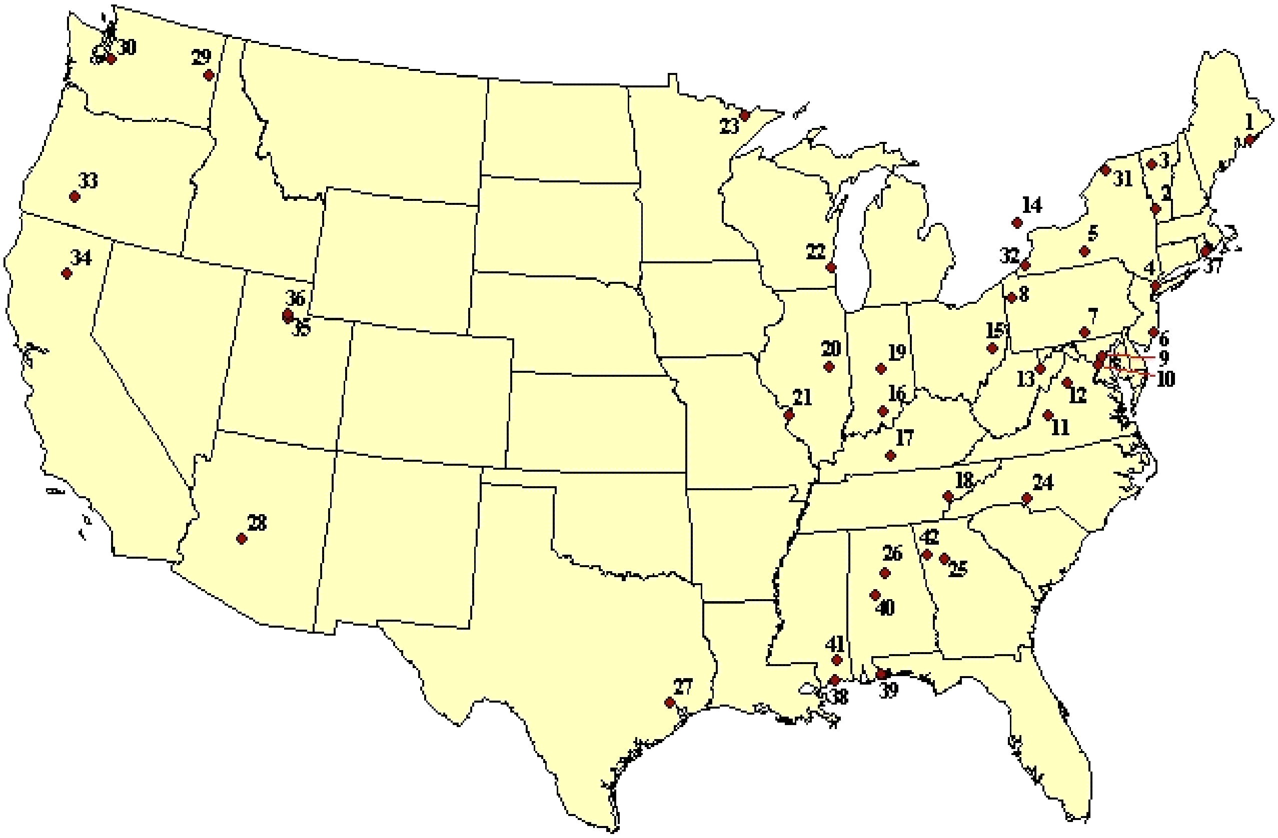


Figure VII-1. Map of source apportionment studies involving PM2.5

Table VII-1. Location of source apportionment studies involving PM2.5

Label	Location or Nearest City	Label	Location or Nearest City	Label	Location or Nearest City
1	Acadia National Park, ME	15	Quaker City, OH	29	Spokane, WA
2	Lye Brook Wilderness, VT	16	Livonia, IN	30a-c	Seattle, WA
3a-d	Underhill, VT	17	Mammoth Cave National Park, KY	31	Potsdam, NY
4	Bronx, NY	18	Great Smoky Mountains National Park, TN	32	Stockton, NY
5	Connecticut Hill, NY	19	Indianapolis, IN	33	Crater Lake National Park, OR
6a-c	Brigantine National Wildlife Refuge, NJ	20	Bondville, IL	34	Lassen Volcano National Park, CA
7	Arendtsville, PA	21	St. Louis, MO	35	Salt lake City, UT
8	M.K. Goddard, PA	22	Milwaukee, WI	36	Bountiful, UT
9	Fort Meade, MD	23	Boundary Waters Canoe Area, MN	37	Narragansett, RI
10a-d	Washington, DC	24	Charlotte, NC	38	Gulfport, MS
11	Jefferson/James River Face Wilderness, VA	25a-c	Atlanta, GA	39	Pensacola, FL
12	Shenandoah National Park, VA	26	Birmingham, AL	40	Centreville, AL
13	Dolly Sods/Otter Creek Wilderness, WV	27	Houston, TX	41	Oak Grove, MS
14	Toronto, ON	28	Phoenix, AZ	42	Yorkville, GA

1. Overview of the Sources

The authors of the studies identified and named sources using different nomenclature, but these sources can be grouped into categories. Each of these source categories is discussed below.

Sulfate Dominated Source

A sulfate dominated source was identified as the largest or one of the largest sources in nearly every study, often consisting of over 50 percent of the source of PM2.5 at some locations during some seasons. In a few cases, there was a known local source of sulfate, but most of the eastern studies (in conjunction with back trajectory analysis) pointed to coal-fired power plants in the Midwest. The studies with multiple years of data also tended to identify a winter and summer signature to the sulfate source, with the summer version apportioning more mass. The studies speculate that the two profiles represent two extremes in the atmospheric chemistry between the source regions and the receptor. Note that the source category is often referred to by its dominant species, sulfate, but the "sulfate source" is often associated with significant amounts of organic carbon and is usually the single largest source of selenium and other trace elements.

Secondary Organic Matter

Secondary organic matter was also a major source for nearly all sites. As with sulfate, the source is sometimes named after the dominant species since it is often formed through a secondary process in the atmosphere rather than being emitted directly. This case is even further complicated by the fact that the particulate organic carbon is itself a mix of many species that are not usually measured separately. Some studies associated the secondary organic matter with mobile sources. Only a few studies are able to separate the mobile source into gasoline sources and diesel sources.

Nitrate Dominated Source

Among the eastern sites, a nitrate dominated source is also found to be a major source, often the second largest source. The back trajectory analyses sometimes show an association with agricultural areas that would have high ammonia emissions. However, the interpretation of this nitrate dominated sources is not consistent from study to study. Some authors associate this source type with NOx point sources and motor vehicles from major cities that are sufficiently far from the receptor for the NOx to oxidize and react with ammonia. Other authors associate this source type with motor vehicles from nearby highways.

Biomass Burning

The biomass burning category includes the wood smoke and forest fire categories identified at several sites. The size of the source varies considerably from site to site, but usually as expected (e.g., larger in rural areas and in the northwest).

Sometimes, this category also includes fireworks. This is because the source is characterized by organic carbon and potassium. Usually an explicit reference to fireworks is based on a 4th of July spike in the source strength, but may also be supported by trace metals, particularly copper, found in the profile. The source profiles are similar enough and the source strength small enough that the models do not generally separate biomass burning from fireworks.

Industrial

This category includes a variety of small sources characterized by elemental carbon and trace metals, such as smelters and incinerators that may or may not have been found at the various sites. Frequently, the industrial sources are associated with known local sources or, in the case of the northeast, known smelters in Canada. These sources also tend to be distinctive enough for the models to separate them into several small sources within a site.

Crustal and Salt

The crustal source category is identified for all sites, but is usually small, 0.1 to 1.5 µg/m^3. There are three notable rural exceptions: M.K. Goddard, Pennsylvania; Quaker City, Ohio; and Livonia, Indiana, each with 7.8 µg/m^3 or more. The Phoenix site is also apportioned a larger crustal source, 2.8 µg/m^3.

Other/Not Identified

Four of the six CASTNET sites (Arrentsville, Pennsylvania; Connecticut Hill, New York; Quaker City, Ohio; and Bondville, Illinois) have large (> 3.0 µg/m^3) unidentified sources. The particular study was concerned with light extinction; since these were not significantly associated with light extinction, it was not felt necessary to identify those sources. Otherwise, sources greater than 1.0 µg/m^3 are identified. The remaining miscellaneous sources are generally under 1.0 µg/m^3 also.

2. Source Locations and Time Series Analyses

The compilation concentrated on the source apportionment models of Positive Matrix Factorization (PMF), its variations, and UNMIX. In each study, PMF or UNMIX was used as the sole source apportionment tool and/or as a check on the results of the other model. More importantly, nearly all studies agreed that source apportionment models cannot stand alone for many of the desired uses. In fact, additional supporting evidence is frequently needed to complete the source identification process. Thus, the models are usually used in conjunction with other tools, commonly back trajectory analyses via a meteorological model such as HYSPLIT.

Back trajectory analyses for the eastern sites associate the sulfate with the Ohio River Valley area. Industrial sources are also frequently associated with known source areas. Several studies noted transport across the Canadian border, specifically sulfates from the Midwestern United States into Canada, and smelter emissions from Canada into the northeastern United States.

All of the studies looked at long-term average source contributions and most looked at seasonal (3-month) average contributions. There was very little analysis of daily or weekly events, with a few exceptions, such as Saharan dust, fireworks, or local events that changed emissions patterns temporarily. In several cases where datasets covering very long time periods were evaluated, reductions in emissions could be seen for power plants, fuel oil, and smelters. These were attributed to increased emission controls, fuel switching (e.g., from oil to natural gas), and meteorological conditions (e.g., warmer winters in the late 1990s). More detail about these can be found in Coutant, et al. (2003a).

3. Methodologies and Technical Approaches

The technical approach varied significantly among the various studies. Some studies, through preplanned additional data collection, have also used tools such as scanning electron microscope analysis of the particulate matter or specialized tracers to gain a greater understanding of specific PM2.5 sources. Typically, however, the data used are very similar to data from IMPROVE or IMPROVE protocol sites or more recently from EPA's Speciation Trends Network, with a few super sites having specialized data.

PMF, its variations, and UNMIX represent very different approaches to source apportionment. Data preprocessing for missing data and identification of outliers is not standardized. Profile interpretation is essentially a matter of "expert opinion." Even the derivation and processing of the back trajectories varies significantly among the studies surveyed.

Where both models have been used, PMF has been used to model more sources than UNMIX. However, PMF is typically used to model more species, so it should be able to identify more sources. This is probably driven by the fact that multiple modeling steps are sometimes required to model a large number of species with UNMIX. The results then need to be merged into a single solution. PMF is generally not used in this manner, except for apportioning the total mass.

The preprocessing of the data for use in the models is dependent on the amount of data available and the particular study goals. For example, if long-term trends are a part of the study goals, then isolated events are sometimes screened. Missing data, or rather incomplete data, are sometimes handled by data imputation and sometimes deletion of the data. Data that are below minimum detection are fairly consistently handled by MDL/2 substitution.

Analyses of the time series output, particularly back trajectory methods, are frequently being used to aid interpretation. However, this adds an additional layer of divergent methods and models. ATAD and HYSPLIT are the two most common models used to generate the individual back trajectories. The methods for implementing these models vary in the choices of starting times and heights and in other technical aspects. The processing of the back trajectories also varies considerably in the definition of high and low day source strength, the base unit used from the trajectories (hour or number of end points), the metric used to measure the relative likeliness of the source location, and the contouring methods.

C. Eight City Report

In order to assess the contributions of pollutant sources, both local and distant, to local pollutant levels, a source apportionment and back trajectory study was conducted at eight cities across the eastern United States (Coutant, et al., 2003b). The purpose of the study was to determine the types and locations of sources of PM2.5 detected in the eight cities. Each of the eight cities was analyzed separately. The first analysis performed in each city, the source apportionment analysis, used PMF to identify the pollutant profiles (chemical makeup or signature) of the major sources of pollution at the receptor site and determine the signal strength from each source on each monitored day. After identifying the chemical makeup and daily strength of each source, several data-analytic techniques were employed to determine the categories that each source represented. The second analysis performed in each city, the back trajectory analysis, combined the information on source strength obtained from the back trajectory analysis with information on air packet transport patterns to determine likely locations from which the pollution came. This analysis allowed identification of likely source regions of different classes of PM2.5.

The following sections give a more detailed description of the two analyses performed in the study. Section VII.C.1 describes the data on which the source apportionment analysis and back trajectory analysis were performed and describes the locations at which data were collected. Section VII.C.2 describes the source apportionment part of the study while Section VII.C.3 describes the back trajectory analysis. Finally, Section VII.C.4 presents conclusions.

1. Data Sources and Study Cities

The source apportionment and back trajectory study analyzed speciated PM2.5 data from eight of EPA's Trends Sites located in Birmingham, Alabama; Bronx, New York; Charlotte, North Carolina; Houston, Texas; Indianapolis, Indiana; Milwaukee, Wisconsin; St. Louis, Missouri; and Washington, D.C. These sites are all in urban areas. The results of the study indicate that these sites are influenced strongly by both local sources of PM2.5 as well as long-range transport of PM2.5.

The source apportionment results presented in this report are based on speciated PM2.5 measurements. Speciated PM2.5 measurements are measurements detailing the mass of each constituent of PM2.5. In other words, rather than only containing the total PM2.5 mass (total weight of particles less than 2.5 μm in diameter), the data contain the amount of the total mass composed of sulfate, nitrate, ammonium, and several other elements and compounds. The measurements are from integrated 24-hour collection periods typically collected every three days using filter-based methods. Specifically, the PM2.5 speciation sites use X-Ray Fluorescence (XRF), Ion Chromatography (IC), and Thermal-Optical Analysis (TOR) analyses done on Teflon, nylon, and quartz filters, respectively. The species used were PM2.5 total mass (both from the speciation monitor and a co-located FRM when available), sulfate, nitrate, ammonium, Al, As, Ba, Br, Ca, Cl, Cr, Cu, Elemental Carbon (E.C.), Fe, Pb, Mn, Ni, Organic Carbon (OC), K, K^+, Se, Si, Na, S, Sn, Ta, Ti, V, and Zn. The inclusion of both the mass measurements and both the sulfur and sulfate measurements effectively doubles the weight given to these species and provides a means for evaluating the error in the apportionment.

The initial data for the project were for Bronx, St. Louis, and Houston and came from the AQS database[1] in January 2002. This was supplemented with data from the New York Department of Environmental Conservation website[2]. AQS data for Milwaukee and Washington, D.C., were obtained in September 2002 and the AQS data for Birmingham, Charlotte, and Indianapolis were added in January 2003. The uncertainty estimates for measurements at all the sites are based in part on the co-located data within the original AIRS database (commonly referred to as the Mini-Trends sites). Table V-2 summarizes the time periods over which monitor readings were recorded at each of the eight sites.

Table VII-2. Dates modeled for each of the eight sites

Site	Start Date	End Date	Days Modeled	Sampling Frequency
Birmingham, AL	1/13/2001	8/9/2002	186	1-in-3 day
Bronx, NY	9/3/2000	1/29/2002	160	1-in-3 day
Charlotte, NC	1/13/2001	8/6/2002	143	1-in-3 day
Houston, TX	8/17/2000	7/7/2001	121	1-in-3 day /daily
Indianapolis, IN	12/20/2000	8/6/2002	155	1-in-3 day
Milwaukee, WI	12/14/2000	9/8/2002	172	1-in-3 day
St. Louis, MO	8/4/2000	7/12/2001	112	1-in-3 day
Washington, D.C.	4/7/2001	8/6/2002	124	1-in-3 day

In addition to speciated PM2.5 data, local meteorological data were obtained for characterization of sources and verification of source category identifications. Local meteorological data were obtained for each site from the NOAA archives. Table VII-3 indicates the site location and the distance to the nearest NOAA MET station with sufficient data to use in the analysis.

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[1] http://www.epa.gov/ttn/airs/airsaqs/sysoverview.htm

[2] http://www.dec.state.ny.us/website/dar/baqs/pm25mon.html

Table VII-3. Nearest NOAA meteorological station*

Site	Site Lat.	Site Long.	Nearest Available Meteorological Station			
			WBAN Number	MET Station Name	MET Station Location	Distance (miles)
Birmingham, AL	33.55	-86.82	13876	Birmingham, AL	International Airport	25.6
Bronx, NY	40.87	-73.88	94741	Teterboro, NJ	Teterboro Airport	25.9
Charlotte, NC	35.24	-80.79	13881	Charlotte, NC	Douglas International Airport	14.8
Houston, TX	29.90	-95.33	53910	Houston, TX	Hooks Memorial Airport	9.6
Indianapolis, IN	39.81	-86.11	53842	Indianapolis, IN	Eagle Creek Airpark	21.8
Milwaukee, WI	43.06	-87.91	4840	Fond Du Lac, WI	Fond Du Lac County Airport	33.6
St. Louis, MO	38.66	-90.20	53904	St. Charles, MO	St. Charles Smart Airport	7.4
Washington, D.C.	38.92	-77.01	13743	Washington, D.C.	Ronald Reagan Nat'l Airport**	27.5

* Subsequent to the study, errors have been found in the Lat/Long data within the NOAA data. The sites used may not be the nearest stations.

** Second nearest used because of MET station data problems.

Finally, back trajectory data were collected for use in the back trajectory analysis. This type of data is discussed in more detail in Section VII.C.3.

2. Source Apportionment Analysis

The first analysis performed on the data at each site was a source apportionment analysis, described in Section VII.A. The source apportionment analysis was performed in three steps. First, some preliminary procedures were performed to identify possible patterns in the data. Next, PMF was applied to decompose the data into pollutant profile and relative contribution matrices. Finally, the pollutant profiles identified in the second step were compared against known pollutant profiles in the speciate database to determine source categories.

Preliminary Procedures

The first step in source apportionment is to examine plots of the speciated PM2.5 data. Scatter plots of concentrations of one species versus another were examined as a part of the site selection, but they are also useful after the sites have been selected as a first analysis tool. There are a few patterns that can be observed in these plots that give insight into the data. Plots that are nearly linear indicate that the significant sources produce these species in the same ratio, and it is likely that there is only one major source of the pair. Wedge-shaped plots indicate at least two major sources of the pair of species. The edges of the plots are produced from the two major sources of the species pair with the most disparate ratios between the two species. Considerations such as these give the first indication of which species will be useful in the source apportionment fitting and a lower bound for the number of sources that affect the receptor.

Source Apportionment

The next step in analyzing the data is to use source apportionment techniques to identify the number of sources at each site, the pollutant profiles of those sources, and the relative contributions of those sources on the monitored days. For this purpose, two source apportionment tools were used: UNMIX and PMF.

The main source apportionment tool used in the analysis was PMF. PMF starts with the matrix of speciated PM2.5 data by date and decomposes it into two other matrices with all positive entries. One of these matrices, the pollutant profile matrix, has a row for each source and a column for each species. Each row represents the average apportioned mass of each species of PM2.5 at a given source. The other matrix, the relative contribution matrix, has a row for each day of data analyzed and a column for each source. Each row represents the relative strengths of each source on a given day. Essentially, these two matrices provide two pieces of information for each source: a source profile and a time series of each source's strength at the receptor. In this report, a source profile is a list of the mean species concentrations from the source at the receptor.

PMF was set to search for 5 to 10 source solutions at all sites. The program was run from at least six different random starting points and the best fitting solution was used. Analysis of the solutions led to the use of between 6 and 8 sources depending on the site. A statistical algorithm was implemented for the selection of the number of sources for Birmingham, Charlotte, Indianapolis, Milwaukee, and Washington, D.C. This algorithm is based on the Bayesian Information Criterion (BIC) that is frequently used for time series model selection (Wei, 1990).

In addition to model fitting, a residual analysis and goodness-of-fit tests were performed on the PMF decompositions. Modeling error was assessed by examining the difference between the apportioned values for the FRM mass and the mass from the speciation monitor (except in Houston, which did not have a co-located FRM) and the difference between three times the sulfur concentration (the apportioned XRF sulfur mass) and the sulfate concentration (the apportioned IC sulfate mass). The two mass values should differ only by measurement error as should the sulfur-sulfate pair under the assumption that all of the sulfur is present in the form of sulfate. The differences give a direct means of estimating the errors in the apportioned masses of the species (assuming that the other species are similar). For each site, Table VII-4 shows an estimate of the relative error of the mean of the apportioned FRM mass and the speciation mass.

Table VII-4. Model error estimates

Site	Mass CV
Bronx, NY	45%
Birmingham, Al	24%
Charlotte, NC	43%
Houston, TX	84%
St. Louis, MO	21%
Milwaukee, WI	47%
Washington, D.C.	47%
Indianapolis, IN	32%

Source Characterization and Identification

The source apportionment output yields a chemical profile for each source (or source category) and a time series for the mass. While the profile is unique for the source, it does not explicitly identify the source. Two main methods were employed to identify the sources from the PMF output. Both of these methods were applied to each source identified at each of the eight sites. First, an automated method was used to match the output with source profiles in the SPECIATE database.[3] The matching algorithm produces up to ten possible source matches with specific sources from the speciate database. The second "method" is informed opinion. Using the automated matching, past experience, and discussions with local individuals, most of the profiles can be identified with specific source categories.

The final identifications are a merging of all the various analyses and review by source apportionment experts and local representatives, and represent the best current understanding of the sources. This section discusses the primary characteristics of the sources identified.

Ammonium nitrate – As the name implies, the "source profiles" for this category are dominated by ammonium and nitrate. Ammonium nitrate is formed from a combination of ammonia (with a large portion coming from agricultural sources) and NO_x (with substantial portions from both utilities and mobile sources). Some of the profiles contain coal burning tracers and some of the preliminary transport analyses seem to indicate a relationship to coal burning, but these only reveal that coal burning is part of the source. Apportionment of these species may be possible by restricting the analyses to periods with cooler temperatures.

Canadian fires – In July 2002, there were major fires in Canada. The plume from these fires can be seen in satellite photos and the source is clearly tied to this event. It would be expected that any wood smoke during the rest of the year would also be apportioned to this source, but the source is so strongly dominated by the single event that it is difficult to tell.

Coal combustion- This is the major source of sulfate for all sites and the major source. Differences in fuel sources and distances to the source contribute to the site-to-site variations in

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[3] http://www.epa.gov/ttnchie1/software/speciate/index.html

the profiles. The coal combustion source is also a major source of Se, a coal burning tracer.

Crustal – All sites are apportioned a crustal source. The profiles match the profiles found in the SPECIATE database quite well.

Industrial sources – These are expected to vary considerably from site to site. Most of the time they probably represent a mix of a strong local set of industrial emissions and small amounts of any similar sources/mixes that happen to be in the region. In Houston, the wind data suggest a relationship with the industries in the ship channel. In Bronx, the back trajectory analyses suggest a regional mixture of sources from along the east coast.

Marine and industrial salts- These sources have sea spray components (including trace metals) and source regions that extend into the ocean. There appear to be inland sources also. This leads to the industrial salt characterization. It is likely that neither category is large enough or distinctive enough for the tools to separate.

Mobile sources- These include both gas and diesel mobile sources. The sources in this study are the dominant sources of organic carbon and, hence, are expected to be mostly associated with gasoline combustion. Local mobile sources would generally be expected to be stronger during the week compared with weekends. However, the delays in transport would obscure that relationship if a significant portion is not local.

Oil combustion- Two oil combustion sources were identified. They are carbon and sulfate sources, which are also the major sources of Ba, Ni, and V.

Road construction- This was identified for the Washington, D.C., site. The source profile is a mix of crustal components and diesel mobile (EC dominant). The source is stronger during weekdays and lasts for several months.

Smelting and steel production – These are characterized by their metal content and distinguished from incinerators by the lack of carbon. The profiles may also show power production components either due to direct coal burning or coal burning by the electrical source that varies with production. In St. Louis the local wind pattern associates the source strengths with known local sources.

Vegetative burning and fireworks- The July 4th source events clearly dominate the source strength pattern. Both source categories are high in organic carbon and are major sources of potassium. The fireworks are probably responsible for the copper and other trace metal components. However, the other similarities in the profiles and indications of small amounts of source activity during other times of the year suggest that vegetative burning is included in this source category.

Zinc and other sources identified by species- These are each characterized by being a major contributor of a specific species or containing an unusual amount of the species. In St. Louis, there is a zinc refinery in a direction indicated by the local wind data and, hence, this zinc source is identified. However, zinc is also found in incinerator and recycling emissions and these may be included in that profile and in the zinc source found in Birmingham. The other sources only identified by species are a lead source for Birmingham and a chlorine source for Milwaukee.

Source Apportionment Results

Source identifications, along with apportioned mass, are presented in Table VII-5. Any mention of explicit sources within the source identifications is included only as an example of a local source with the characteristics similar to what the study has found. Additional analysis would be needed to relate an effect at the receptor to an explicit source. Only boxes containing numbers represent sources identified at their respective sites.

Table VII-5. Summary of the mean apportioned mass concentration across sites

Major Source Categories	Mean Apportioned Mass Concentration: :g/m^3 (%total)			
	Birmingham	**Bronx**	**Charlotte**	**Houston**
Ammonium Nitrate	1.84 (9.4%)	4.09 (25.4%)	1.21 (7.5%)	
Canadian Fires				
Coal Combustion	7.27 (37.2%)	5.29 (32.9%)	5.71 (35.4%)	5.54 (39.1%)
Crustal	1.27 (6.5%)	0.97 (6.0%)	0.57 (3.5%)	0.77 (5.4%)
Industrial	1.50 (7.7%)	1.82 (11.3%)		0.87 (6.1%)
Marine		0.30 (1.9%)	0.08 (0.5%)	0.29 (2.0%)
Metal production			0.67 (4.2%)	
Mobile Source or Grain dust				1.04 (7.3%)
Mobile sources	6.51 (33.4%)	2.49 (15.5%)	3.87 (24.0%)	5.19 (36.7%)
Oil combustion		1.22 (7.6%)	1.87 (11.6%)	
Vegetative Burning and Fireworks	1.15 (5.9%)		0.48 (3.0%)	0.49 (3.5%)
Total mass conc. being apportioned (:g/m^3)	19.53	16.08	16.15	14.16

Major Source Categories	Mean Apportioned Mass Concentration: :g/m^3 (%total)			
	Indianapolis	**Milwaukee**	**St. Louis**	**Washington**
Ammonium Nitrate	3.58 (20.7%)	4.07 (28.1%)	5.02 (29.2%)	1.23 (7.4%)
Canadian Fires	0.25 (1.5%)			1.11 (6.7%)
Coal Combustion	8.67 (50.1%)	4.54 (31.3%)	5.74 (33.4%)	7.70 (46.2%)
Crustal	0.51 (3.0%)	0.31 (2.1%)	1.43 (8.3%)	1.47 (8.8%)
Industrial		2.66 (18.4%)		
Marine	0.47 (2.7%)			
Metal production			2.20 (12.8%)	
Mobile Source or Grain dust				
Mobile sources	3.21 (18.5%)	2.46 (17.0%)	2.92 (17.0%)	4.72 (28.3%)
Oil combustion				
Vegetative Burning and Fireworks	0.69 (4.0%)	0.35 (2.5%)		0.53 (3.2%)
Total mass conc. being apportioned (:g/m^3)	17.29	14.47	17.19	16.67

3. Meteorological Summaries and Back Trajectory Analysis

Once the source categories are identified, it is possible to combine the source apportionment output with meteorological information to gain more insight into the exact nature of each source. Two different types of meteorological data are used in this analysis: local meteorological data and back trajectory information. Using local meteorological data, it is possible to make simple summary statistics that can reveal patterns in the source's strength related to wind direction, temperature, and pressure. It is also simple to examine seasonal patterns and weekday/weekend effects using simple summary statistics. Back trajectory information giving the likely spatial path followed by air particles in the days before arriving at the receptor can be used to search more globally for source regions for each of the identified sources. As a final check on two of the types of sources identified, sulfate and nitrate sources, source regions identified by the back trajectory analysis are compared to emissions inventories.

Local Meteorological Data

At each site and for each source, the source strength on each day was paired with local meteorological variables from the closest national weather station (see Table VII-3). In addition, variables for the day of the week and the season of the year were added to the analysis.

Pollution roses were created for each source at each site. Pollution roses show the mean source strength relative to the overall source strength by direction and wind category: 1 to 5 mi/hr, 5 to 10 mi/hr, and 10+ mi/hr. Figure VII-2 shows a pollution rose for a zinc source identified at the St. Louis site (there is a zinc smelter in the vicinity). The rose clearly indicates that the zinc signature is strongest when the wind is blowing from the east.

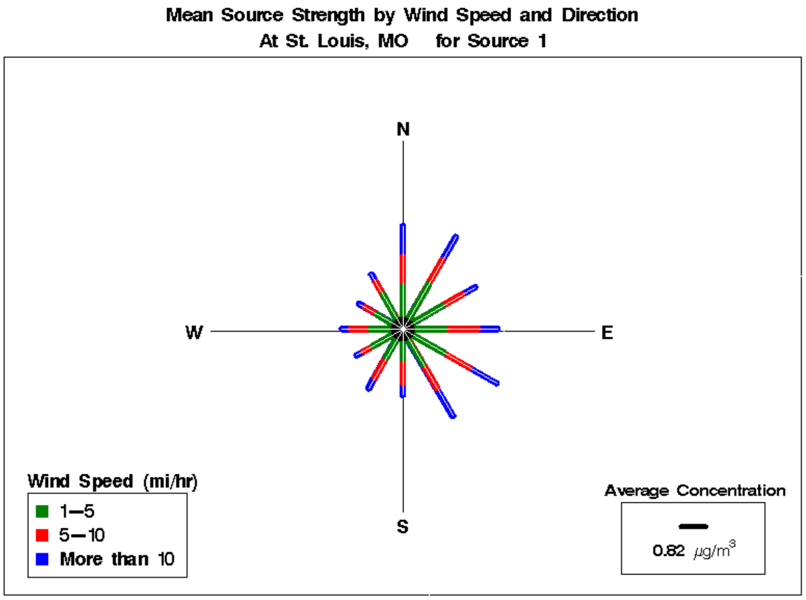

Figure VII-2. Pollution rose for St. Louis, Missouri, zinc source.

The local meteorological data were also used to compare the source strength with temperature and pressure. The temperature comparison was made seasonally, and the pressure comparison is over the entire modeling period. While the source strengths are rarely related to the pressure, it was felt to be a good check because high pressure systems tend to concentrate the pollution. Hence, a strong correlation would indicate that the source strength is being driven by the meteorological conditions rather than increased source activity and/or favorable wind directions, which would violate the assumptions made in the back trajectory and pollution rose analyses. A summary of the relationship between source strength and temperature and pressure may be found in Coutant, et al. (2003b).

In addition to comparing source strength to meteorological conditions, an investigation was conducted into the differences in source strength between weekdays and weekends. This analysis was performed by calculating the mean source strength on all weekday days and calculating the mean source strength on all weekend days. A table summarizing the results for each source in each city and a similar analysis performed to compare source strength across seasons can be found in Coutant, et al. (2003b).

Back Trajectory Analysis

Back trajectory analysis is a technique used to find probable source regions for each source identified in the source apportionment analysis. The back trajectory analysis uses the source strengths reported by the PMF model along with computer simulations of air flow patterns to determine likely source locations from which air packets may have traveled to the receptor. The simulations are performed using NOAA's HYSPLIT model, which can track packets of air backwards in time over long distances. By examining the locations from which packets of air came on days when the receptor registers a high source strength, likely source locations can be identified.

For each source at a site, four 72-hour back trajectories were calculated for each day on which a speciated PM2.5 reading was taken. These back trajectories were then divided into three groups: days when the source's strength was high (the days with the largest 20 percent source strength), low (the lowest 20 percent), and medium (all other trajectories). The conceptual model is based on the assumption that on high source strength days the air must pass over the source. Likewise, on the majority of the low source strength days, the path most likely did not pass over the source location. The analysis tries to find areas that are associated with sources by considering where the various back trajectories from the high strength days cross.

Two methods were used to present the information from the back trajectory analysis: incremental probability fields and source contribution functions. In each case, a fine grid (approximately 80km × 80km grid cells) is created covering the region spanned by the majority of trajectories. To create an incremental probability field each grid cell is considered separately. In each grid cell, the number of hours that "high strength" back trajectories spent crossing the cell is divided by the total number of hours in back trajectories classified as high. Next, the ratio of the total number of hours that back trajectories spent crossing the cell to the total number of hours in any back trajectory is subtracted from this number. The larger (more positive) this number, the more likely the existence of a source in that cell. Figure VII-3 illustrates an incremental probability field for a source identified in Birmingham, Alabama. To create a source contribution function, each cell is again considered separately. In each cell, the number of hours high back trajectories spent in the cell is divided by the total number of hours any back trajectory spent in the cell. The larger this ratio is, the more likely the existence of a source in that cell. Figure VII-4 illustrates a source contribution function for a source identified in Birmingham, AL. Note that both the incremental probability plot and source contribution plot have been rescaled so that the results may be compared across sites. Details of the rescaling may be found in Coutant, et al. (2003b).

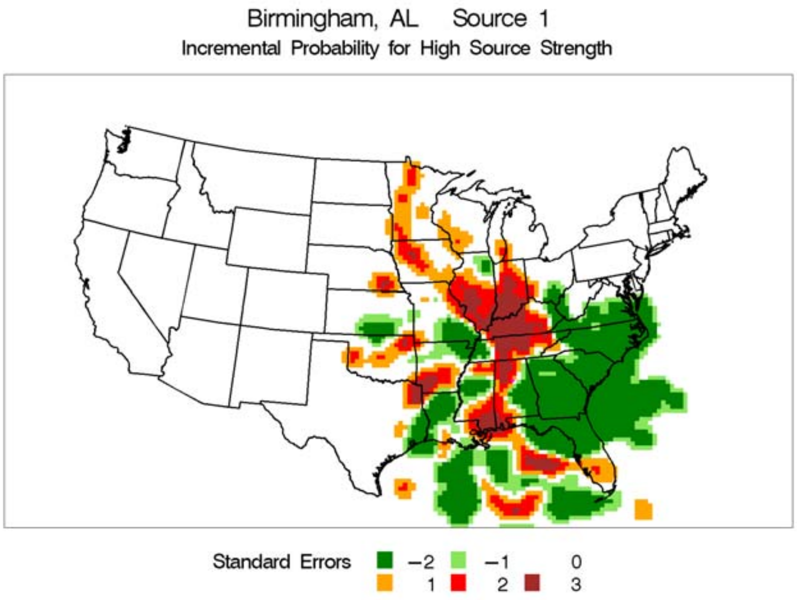

Figure VII-3. Incremental probability contour plot for Birmingham, Alabama, Source 1 - Ammonium Nitrate

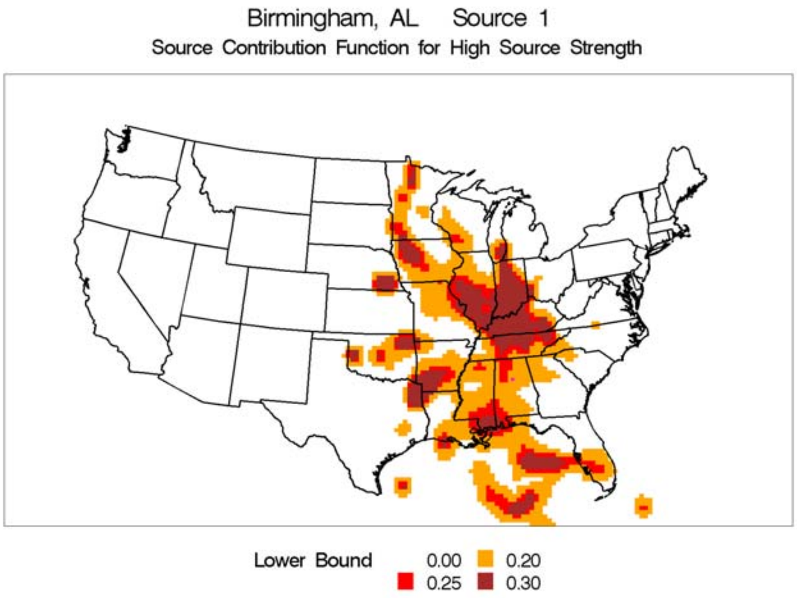

Figure VII-4. Source contribution contour plot for Birmingham, Alabama, Source 1 - Ammonium Nitrate.

Pollution roses and back trajectory analyses are not well suited for certain source categories. Consider a source like crustal dust. The source is “located” virtually everywhere on land, but may require particular winds to create a strong source-day at the receptor. Inland areas may seem not to be associated with a high source day because air from an inland area may be associated with winds that are too low. At the same time, a grid cell over the ocean could be associated with the source, because air passing over the grid cell is associated with strong winds. Another problem occurs if the major source within the source category is located within the receptor grid (or even within a few grid cells) since the source contribution function could appear to be less than 20 percent everywhere. Finally, since the analysis is based on 80 km grid cells, local sources may not be indicated.

4. Conclusions

This source apportionment and back trajectory study analyzed speciated PM2.5 data from eight of EPA’s Trends Sites. For each site, the PM2.5 was apportioned into six to eight sources. While the species were chosen to be consistent across the sites, the number of sources used in the modeling was allowed to vary between sites. Eight sources may be the limit of the model for the amount of data that were available. There were several commonly identified sources, each of which was expected to affect the receptor.

- For each site, a coal combustion source was identified with a mean mass concentration of between 4.5 and 7.7 μg/m^3. The back trajectory analyses for these sources are somewhat mixed. The back trajectory analysis corresponds well to the utility plants in the Midwest, Southeast, and eastern seashore. To some extent in St. Louis and to a greater extent in Houston, the high concentrations of sulfate are partially related to the effects of high pressure systems.

- For each site, a mobile source was identified with a mean mass concentration of 2.5 to 6.5 μg/m^3.

- Each site also had a small crustal dirt source with a mean mass concentration between 0.3 μg/m^3 and 1.5 μg/m^3. The 1.5 μg/m^3 source is for Washington, D.C.; it also contains diesel components and is probably tied to a large road construction project under way during the period modeled.

- Houston had a very small nitrate source that was associated with a marine profile. The other sites had nitrate sources that ranged from 1.2 to 5.0 μg/m^3.

- Bronx, Charlotte, Houston, and Indianapolis each had small marine and industrial salt sources. The largest is for Indianapolis, but the source profile shows signs of nitrate substitution for the chlorine during transport.

- A source clearly dominated by fireworks was found for Birmingham, Charlotte, Houston, Indianapolis, Milwaukee, and Washington, D.C.

- Sources that appear to be related to industrial activity were found in Birmingham, Bronx, and Houston.

- Both Bronx and Charlotte had oil combustion sources with mass concentrations of 1.2 and 1.9 µg/m^3, respectively.

- Charlotte and St. Louis had zinc sources with each having mass concentrations of 0.9 µg/m^3. The pollution rose for the St. Louis source is consistent with a local zinc refinery. In addition, St. Louis had a copper smelting (0.6 µg/m^3) and steel production (0.8 µg/m^3) source.

- Finally, there was a huge spike in the PM2.5 mass on July 7, 2002, in Washington, D.C., that is associated with Canadian forest fires. This source is apportioned over 1.0 µg/m^3 of the 16.6 µg/m^3 of mass observed during the modeled period. The Indianapolis site was also affected by these fires, but to a much lesser extent.

The various analyses are generally self-consistent, consistent among analysis types, consistent with expectations for the sites, and consistent from site-to-site. Taken together, they show that a monitoring and modeling combination provides an effective means of understanding the source categories affecting urban areas. The coal combustion sources account for about one-third of the PM2.5. The next largest portion is either from nitrate or mobile sources. All three of these source categories show transport components.

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Appendix A

Detailed Listing by County of PM2.5 Air Quality Data

Analysis of 1999-2001 data and 2000-2002 data and associated 2000 populations

Table A-1. Counties with 1999- 2001 PM2.5 Annual Design Values Greater Than 15 ug/m^3 and Associated Populations.

FIPS Code	State	County	1999-2001 Design Value	Population 2000	Data Completeness Status*
01027	AL	Clay County	15.5	14,254	NA
01033	AL	Colbert County	15.3	54,984	NA
01049	AL	DeKalb County	16.8	64,452	NA
01069	AL	Houston County	16.3	88,787	NA
01073	AL	Jefferson County	21.6	662,047	NA
01089	AL	Madison County	15.5	276,700	NA
01097	AL	Mobile County	15.3	399,843	NA
01101	AL	Montgomery County	16.8	223,510	NA
01103	AL	Morgan County	19.1	111,064	NA
01113	AL	Russell County	18.4	49,756	NA
01117	AL	Shelby County	17.2	143,293	NA
01121	AL	Talladega County	17.8	80,321	NA
05035	AR	Crittenden County	15.3	50,866	NAL
05119	AR	Pulaski County	15.9	361,474	NAL
06007	CA	Butte County	15.4	203,171	NA
06019	CA	Fresno County	24	799,407	NA
06025	CA	Imperial County	15.7	142,361	NA
06029	CA	Kern County	23.7	661,645	NA
06031	CA	Kings County	16.6	129,461	NA
06037	CA	Los Angeles County	25.9	9,519,338	NA
06047	CA	Merced County	18.9	210,554	NA
06059	CA	Orange County	22.4	2,846,289	NA
06065	CA	Riverside County	29.8	1,545,387	NA
06071	CA	San Bernardino County	25.8	1,709,434	NA
06073	CA	San Diego County	17.1	2,813,833	NA
06077	CA	San Joaquin County	16.4	563,598	NA
06099	CA	Stanislaus County	19.7	446,997	NA
06107	CA	Tulare County	24.7	368,021	NA
09009	CT	New Haven County	16.8	824,008	NA
10003	DE	New Castle County	16.6	500,265	NA
11001	DC	District of Columbia	16.6	572,059	NA
13021	GA	Bibb County	17.6	153,887	NA
13051	GA	Chatham County	16.5	232,048	NA
13059	GA	Clarke County	18.6	101,489	NA
13063	GA	Clayton County	19.2	236,517	NA
13067	GA	Cobb County	18.6	607,751	NA
13089	GA	DeKalb County	19.6	665,865	NA
13095	GA	Dougherty County	16.6	96,065	NA
13115	GA	Floyd County	18.5	90,565	NA
13121	GA	Fulton County	21.2	816,006	NA
13139	GA	Hall County	17.2	139,277	NA
13215	GA	Muscogee County	18	186,291	NA
13223	GA	Paulding County	16.8	81,678	NA
13245	GA	Richmond County	17.4	199,775	NA
13303	GA	Washington County	16.5	21,176	NA
13319	GA	Wilkinson County	18.1	10,220	NA
17031	IL	Cook County	18.8	5,376,741	NA
17043	IL	DuPage County	15.4	904,161	NA
17115	IL	Macon County	15.4	114,706	NAL
17119	IL	Madison County	17.3	258,941	NA

FIPS Code	State	County	1999-2001 Design Value	Population 2000	Data Completeness Status*
17163	IL	St. Clair County	17.4	256,082	NA
17197	IL	Will County	15.9	502,266	NA
18019	IN	Clark County	17.3	96,472	NA
18039	IN	Elkhart County	15.1	182,791	NAL
18043	IN	Floyd County	15.6	70,823	NA
18067	IN	Howard County	15.4	84,964	NAL
18089	IN	Lake County	16.3	484,564	NA
18097	IN	Marion County	17	860,454	NA
18157	IN	Tippecanoe County	15.4	148,955	NAL
18163	IN	Vanderburgh County	16.9	171,922	NAL
18167	IN	Vigo County	15.4	105,848	NAL
21013	KY	Bell County	16.8	30,060	NAL
21019	KY	Boyd County	15.5	49,752	NA
21029	KY	Bullitt County	16	61,236	NA
21037	KY	Campbell County	15.5	88,616	NA
21059	KY	Daviess County	15.8	91,545	NAL
21067	KY	Fayette County	16.8	260,512	NA
21111	KY	Jefferson County	17.1	693,604	NA
21117	KY	Kenton County	15.9	151,464	NA
21145	KY	McCracken County	15.1	65,514	NA
21195	KY	Pike County	16.1	68,736	NA
21227	KY	Warren County	15.4	92,522	NA
24005	MD	Baltimore County	16	754,292	NAL
24033	MD	Prince George's County	17.3	801,515	NAL
24510	MD	Baltimore city	17.8	651,154	NA
25025	MA	Suffolk County	16.1	689,807	NAL
26163	MI	Wayne County	18.9	2,061,162	NA
28035	MS	Forrest County	15.2	72,604	NAL
28049	MS	Hinds County	15.1	250,800	NA
28067	MS	Jones County	16.6	64,958	NA
28075	MS	Lauderdale County	15.3	78,161	NAL
28087	MS	Lowndes County	15.1	61,586	NAL
29510	MO	St. Louis city	16.3	348,189	NA
30053	MT	Lincoln County	16.4	18,837	NA
34017	NJ	Hudson County	17.5	608,975	NA
34039	NJ	Union County	16.3	522,541	NA
36005	NY	Bronx County	16.4	1,332,650	NAL
36061	NY	New York County	17.8	1,537,195	NA
37001	NC	Alamance County	15.3	130,800	NA
37025	NC	Cabarrus County	15.7	131,063	NA
37035	NC	Catawba County	17.1	141,685	NA
37051	NC	Cumberland County	15.4	302,963	NA
37057	NC	Davidson County	17.3	147,246	NA
37063	NC	Durham County	15.3	223,314	NA
37067	NC	Forsyth County	16.2	306,067	NA
37071	NC	Gaston County	15.3	190,365	NA
37081	NC	Guilford County	16.3	421,048	NA
37087	NC	Haywood County	15.4	54,033	NA
37111	NC	McDowell County	16.2	42,151	NA
37119	NC	Mecklenburg County	16.8	695,454	NA
37121	NC	Mitchell County	15.5	15,687	NA
37183	NC	Wake County	15.3	627,846	NA

FIPS Code	State	County	1999-2001 Design Value	Population 2000	Data Completeness Status*
37191	NC	Wayne County	15.3	113,329	NA
39017	OH	Butler County	17.4	332,807	NA
39035	OH	Cuyahoga County	20.3	1,393,978	NA
39049	OH	Franklin County	18.1	1,068,978	NA
39061	OH	Hamilton County	19.3	845,303	NA
39081	OH	Jefferson County	18.9	73,894	NA
39087	OH	Lawrence County	17.4	62,319	NAL
39093	OH	Lorain County	15.1	284,664	NA
39095	OH	Lucas County	16.7	455,054	NAL
39099	OH	Mahoning County	16.4	257,555	NA
39113	OH	Montgomery County	17.6	559,062	NA
39133	OH	Portage County	15.3	152,061	NA
39145	OH	Scioto County	20	79,195	NA
39151	OH	Stark County	18.3	378,098	NA
39153	OH	Summit County	17.3	542,899	NA
39155	OH	Trumbull County	16.2	225,116	NA
42003	PA	Allegheny County	21	1,281,666	NA
42011	PA	Berks County	15.6	373,638	NA
42021	PA	Cambria County	15.3	152,598	NA
42043	PA	Dauphin County	15.5	251,798	NA
42071	PA	Lancaster County	16.9	470,658	NA
42101	PA	Philadelphia County	16.6	1,517,550	NA
42125	PA	Washington County	15.5	202,897	NA
42129	PA	Westmoreland County	15.6	369,993	NA
42133	PA	York County	16.3	381,751	NA
45045	SC	Greenville County	17	379,616	NA
45063	SC	Lexington County	15.6	216,014	NA
45079	SC	Richland County	15.4	320,677	NA
45083	SC	Spartanburg County	15.4	253,791	NA
47037	TN	Davidson County	17	569,891	NA
47065	TN	Hamilton County	18.9	307,896	NA
47093	TN	Knox County	20.4	382,032	NA
47145	TN	Roane County	17	51,910	NA
47157	TN	Shelby County	15.6	897,472	NA
47163	TN	Sullivan County	17	153,048	NA
47165	TN	Sumner County	15.7	130,449	NA
48201	TX	Harris County	15.1	3,400,578	NAL
51520	VA	Bristol city	16	17,367	NA
51770	VA	Roanoke city	15.2	94,911	NA
54003	WV	Berkeley County	16	75,905	NA
54009	WV	Brooke County	17.4	25,447	NA
54011	WV	Cabell County	17.8	96,784	NA
54029	WV	Hancock County	17.4	32,667	NA
54039	WV	Kanawha County	18.4	200,073	NA
54051	WV	Marshall County	16.5	35,519	NA
54069	WV	Ohio County	15.7	47,427	NA
54107	WV	Wood County	17.6	87,986	NA
	Counties:	**149**	**Total**	**74,237,509**	

* Where NA = Meets the Appendix N completeness criteria or an approved substitution technique; NAL = does not meet criteria

Table A.2. Summary of PM2.5 Counties with 1999-2001 Data Not Meeting the Completeness Criteria: 20 Counties with at least one sample in each of 10 of the 12 quarters for the 3-year period (1999-2001)

FIPS Code	State	County	1999-2001 Design Value	Population 2000
05035	AR	Crittenden County	15.3	50,866
05119	AR	Pulaski County	15.9	361,474
17115	IL	Macon County	15.4	114,706
18039	IN	Elkhart County	15.1	182,791
18067	IN	Howard County	15.4	84,964
18157	IN	Tippecanoe County	15.4	148,955
18163	IN	Vanderburgh County	16.9	171,922
18167	IN	Vigo County	15.4	105,848
21013	KY	Bell County	16.8	30,060
21059	KY	Daviess County	15.8	91,545
24005	MD	Baltimore County	16	754,292
24033	MD	Prince George's County	17.3	801,515
25025	MA	Suffolk County	16.1	689,807
28035	MS	Forrest County	15.2	72,604
28075	MS	Lauderdale County	15.3	78,161
28087	MS	Lowndes County	15.1	61,586
36005	NY	Bronx County	16.4	1,332,650
39087	OH	Lawrence County	17.4	62,319
39095	OH	Lucas County	16.7	455,054
48201	TX	Harris County	15.1	3,400,578

Note: These counties did not meet strict application of Appendix N completeness criterua nor were they able to utilize an approved data substitution technique; however, the 20 counties listed were deemed sufficiently complete to be included in the IAQR analyses. Additional counties did not meet completeness criteria (strict Appendix N interpretation, or an approved data substitution technique) but were deemed unusable for the analyses.

Table A-3. Counties with 2000- 2002 PM2.5 Annual Design Values Greater Than 15 **:**G/m^3 and Associated Populations

FIPS Code	State	County	2000-2002 Design Value	Population 2000
01049	ALABAMA	DE KALB	15.4	64,452
01055	ALABAMA	ETOWAH	16.5	103,459
01073	ALABAMA	JEFFERSON	19	662,047
01101	ALABAMA	MONTGOMERY	15.2	223,510
01113	ALABAMA	RUSSELL	16.4	49,756
01121	ALABAMA	TALLADEGA	15.7	80,321
06019	CALIFORNIA	FRESNO	21.9	799,407
06025	CALIFORNIA	IMPERIAL	15.6	142,361
06029	CALIFORNIA	KERN	22.8	661,645
06031	CALIFORNIA	KINGS	19	129,461
06037	CALIFORNIA	LOS ANGELES	24.4	9,519,338
06047	CALIFORNIA	MERCED	17.6	210,554
06059	CALIFORNIA	ORANGE	20.3	2,846,289
06065	CALIFORNIA	RIVERSIDE	28.9	1,545,387
06071	CALIFORNIA	SAN BERNARDINO	25.9	1,709,434
06073	CALIFORNIA	SAN DIEGO	16.4	2,813,833
06077	CALIFORNIA	SAN JOAQUIN	15.3	563,598
06099	CALIFORNIA	STANISLAUS	17.7	446,997
06107	CALIFORNIA	TULARE	23.2	368,021
09009	CONNECTICUT	NEW HAVEN	16.5	824,008
10003	DELAWARE	NEW CASTLE	16.5	500,265
11001	DISTRICT OF COLUMBIA	WASHINGTON	16.4	572,059
13021	GEORGIA	BIBB	16.4	153,887
13059	GEORGIA	CLARKE	17	101,489
13063	GEORGIA	CLAYTON	17.3	236,517
13067	GEORGIA	COBB	17.1	607,751
13089	GEORGIA	DE KALB	17.3	665,865
13115	GEORGIA	FLOYD	16.2	90,565
13121	GEORGIA	FULTON	19.3	816,006
13135	GEORGIA	GWINNETT	16.7	588,448
13139	GEORGIA	HALL	16.1	139,277
13215	GEORGIA	MUSCOGEE	16.3	186,291
13223	GEORGIA	PAULDING	15.2	81,678
13245	GEORGIA	RICHMOND	16	199,775
13295	GEORGIA	WALKER	16.4	61,053
13319	GEORGIA	WILKINSON	16.1	10,220
17031	ILLINOIS	COOK	18.1	5,376,741
17043	ILLINOIS	DU PAGE	15.2	904,161
17119	ILLINOIS	MADISON	17.5	258,941
17163	ILLINOIS	ST CLAIR	17	256,082
17197	ILLINOIS	WILL	15.5	502,266
18019	INDIANA	CLARK	17.2	96,472
18035	INDIANA	DELAWARE	15.1	118,769
18037	INDIANA	DUBOIS	16.7	39,674
18039	INDIANA	ELKHART	15.5	182,791

FIPS Code	State	County	2000-2002 Design Value	Population 2000
18043	INDIANA	FLOYD	15.5	70,823
18067	INDIANA	HOWARD	15.1	84,964
18089	INDIANA	LAKE	17.7	484,564
18097	INDIANA	MARION	17	860,454
18163	INDIANA	VANDERBURGH	15.7	171,922
18167	INDIANA	VIGO	15.2	105,848
21013	KENTUCKY	BELL	16.2	30,060
21019	KENTUCKY	BOYD	15.7	49,752
21029	KENTUCKY	BULLITT	15.8	61,236
21037	KENTUCKY	CAMPBELL	15.3	88,616
21067	KENTUCKY	FAYETTE	16.5	260,512
21093	KENTUCKY	HARDIN	15.1	94,174
21111	KENTUCKY	JEFFERSON	17.3	693,604
21117	KENTUCKY	KENTON	15.7	151,464
24003	MARYLAND	ANNE ARUNDEL	15.8	489,656
24005	MARYLAND	BALTIMORE	15.1	754,292
24033	MARYLAND	PRINCE GEORGES	17.4	801,515
24510	MARYLAND	BALTIMORE (CITY)	17	651,154
26115	MICHIGAN	MONROE	15.6	145,945
26163	MICHIGAN	WAYNE	19.9	2,061,162
29510	MISSOURI	ST LOUIS (CITY)	15.7	348,189
30053	MONTANA	LINCOLN	16.4	18,837
34017	NEW JERSEY	HUDSON	15.5	608,975
34039	NEW JERSEY	UNION	15.9	522,541
36005	NEW YORK	BRONX	16.1	1,332,650
36061	NEW YORK	NEW YORK	17.6	1,537,195
37025	NORTH CAROLINA	CABARRUS	15.1	131,063
37035	NORTH CAROLINA	CATAWBA	16.4	141,685
37057	NORTH CAROLINA	DAVIDSON	16.7	147,246
37067	NORTH CAROLINA	FORSYTH	15.6	306,067
37111	NORTH CAROLINA	MC DOWELL	15.6	42,151
37119	NORTH CAROLINA	MECKLENBURG	15.8	695,454
39017	OHIO	BUTLER	16.7	332,807
39035	OHIO	CUYAHOGA	19.1	1,393,978
39049	OHIO	FRANKLIN	17.1	1,068,978
39061	OHIO	HAMILTON	18.6	845,303
39081	OHIO	JEFFERSON	18.2	73,894
39087	OHIO	LAWRENCE	16.7	62,319
39099	OHIO	MAHONING	15.7	257,555
39113	OHIO	MONTGOMERY	15.6	559,062
39133	OHIO	PORTAGE	15.1	152,061
39145	OHIO	SCIOTO	17.5	79,195
39151	OHIO	STARK	17.9	378,098
39153	OHIO	SUMMIT	16.9	542,899
39155	OHIO	TRUMBULL	15.6	225,116
42003	PENNSYLVANIA	ALLEGHENY	21.4	1,281,666
42007	PENNSYLVANIA	BEAVER	16	181,412
42011	PENNSYLVANIA	BERKS	16.7	373,638
42021	PENNSYLVANIA	CAMBRIA	15.8	152,598

FIPS Code	State	County	2000-2002 Design Value	Population 2000
42043	PENNSYLVANIA	DAUPHIN	15.6	251,798
42045	PENNSYLVANIA	DELAWARE	15.7	550,864
42071	PENNSYLVANIA	LANCASTER	17.1	470,658
42101	PENNSYLVANIA	PHILADELPHIA	16.8	1,517,550
42125	PENNSYLVANIA	WASHINGTON	15.7	202,897
42129	PENNSYLVANIA	WESTMORELAND	15.6	369,993
42133	PENNSYLVANIA	YORK	17.1	381,751
45045	SOUTH CAROLINA	GREENVILLE	15.3	379,616
47037	TENNESSEE	DAVIDSON	15.3	569,891
47065	TENNESSEE	HAMILTON	16.9	307,896
47093	TENNESSEE	KNOX	18.4	382,032
47107	TENNESSEE	MC MINN	16.1	49,015
47145	TENNESSEE	ROANE	15.4	51,910
47163	TENNESSEE	SULLIVAN	15.7	153,048
51520	VIRGINIA	BRISTOL	15.3	17,367
51770	VIRGINIA	ROANOKE (CITY)	15.1	94,911
51775	VIRGINIA	SALEM	15.3	24,747
54003	WEST VIRGINIA	BERKELEY	16.2	75,905
54009	WEST VIRGINIA	BROOKE	16.8	25,447
54011	WEST VIRGINIA	CABELL	17.3	96,784
54029	WEST VIRGINIA	HANCOCK	17.5	32,667
54039	WEST VIRGINIA	KANAWHA	17.8	200,073
54049	WEST VIRGINIA	MARION	15.7	56,598
54051	WEST VIRGINIA	MARSHALL	16	35,519
54069	WEST VIRGINIA	OHIO	15.3	47,427
54107	WEST VIRGINIA	WOOD	17	87,986
Counties:	**120**	**Total population**		**64,849,620**

Table A-4. Summary of Counties Potentially Violating the PM2.5 NAAQS for 2000-2002 with Incomplete Data

FIPS Code	State	County	2000-2002 Design Value	Population 2000
01103	ALABAMA	MORGAN	18	111,064
05001	ARKANSAS	ARKANSAS	15.3	20,749
05003	ARKANSAS	ASHLEY	16.7	24,209
13153	GEORGIA	HOUSTON	15.5	110,765
18157	INDIANA	TIPPECANOE	15.4	148,955
21059	KENTUCKY	DAVIESS	15.8	91,545
21193	KENTUCKY	PERRY	15.6	29,390
25025	MASSACHUSETTS	SUFFOLK	15.1	689,807
29125	MISSOURI	MARIES	19.6	8,903
37081	NORTH CAROLINA	GUILFORD	15.1	421,048
39023	OHIO	CLARK	15.4	144,742
39093	OHIO	LORAIN	15.1	284,664
42041	PENNSYLVANIA	CUMBERLAND	15.8	213,674
47009	TENNESSEE	BLOUNT	15.9	105,823
Counties:	**14**	**Total population**		**2,405,338**

Note: These counties did not meet Appendix N completeness criteria nor were they able to utilize an approved data substitution technique. Several of the incomplete counties listed have subsequently demonstrated attainment of the annual standard via merging of sites. Data listed may not be representative due to data capture limitations.

Table A-5. Counties Within 10% of the Annual PM2.5 NAAQS for 2000-2002 with Complete Data

FIPS Code	State	County	Design Value	Population 2000
01027	ALABAMA	CLAY	14.1	14,254
01053	ALABAMA	ESCAMBIA	13.7	38,440
01089	ALABAMA	MADISON	14.9	276,700
01117	ALABAMA	SHELBY	15	143,293
02090	ALASKA	FAIRBANKS NORTH STAR	13.6	82,840
05091	ARKANSAS	MILLER	13.6	40,443
05119	ARKANSAS	PULASKI	14.6	361,474
06007	CALIFORNIA	BUTTE	14.6	203,171
06111	CALIFORNIA	VENTURA	14.8	753,197
09001	CONNECTICUT	FAIRFIELD	13.7	882,567
10005	DELAWARE	SUSSEX	14.2	156,638
17115	ILLINOIS	MACON	14.5	114,706
17111	ILLINOIS	MC HENRY	13.6	260,077
17113	ILLINOIS	MC LEAN	14.2	150,433
17143	ILLINOIS	PEORIA	14.2	183,433
18003	INDIANA	ALLEN	14.8	331,849
18091	INDIANA	LA PORTE	13.6	110,106
18127	INDIANA	PORTER	14.3	146,798
18141	INDIANA	ST JOSEPH	14.1	265,559
20209	KANSAS	WYANDOTTE	13.5	157,882
21047	KENTUCKY	CHRISTIAN	14.1	72,265
21073	KENTUCKY	FRANKLIN	14.4	47,687
21101	KENTUCKY	HENDERSON	14.8	44,829
21151	KENTUCKY	MADISON	14.4	70,872
21195	KENTUCKY	PIKE	14.6	68,736
21227	KENTUCKY	WARREN	14.5	92,522
22033	LOUISIANA	EAST BATON ROUGE	13.6	412,852
24043	MARYLAND	WASHINGTON	14.8	131,923
25013	MASSACHUSETTS	HAMPDEN	13.8	456,228
26065	MICHIGAN	INGHAM	13.5	279,320
26077	MICHIGAN	KALAMAZOO	15	238,603
26081	MICHIGAN	KENT	13.9	574,335
26099	MICHIGAN	MACOMB	13.5	788,149
26139	MICHIGAN	OTTAWA	13.5	238,314
26147	MICHIGAN	ST CLAIR	14	164,235
28035	MISSISSIPPI	FORREST	13.8	72,604
28049	MISSISSIPPI	HINDS	13.8	250,800
28067	MISSISSIPPI	JONES	15	64,958
28075	MISSISSIPPI	LAUDERDALE	13.7	78,161
28121	MISSISSIPPI	RANKIN	13.6	115,327
29095	MISSOURI	JACKSON	13.9	654,880
29097	MISSOURI	JASPER	14	104,686
29099	MISSOURI	JEFFERSON	14.9	198,099
29183	MISSOURI	ST CHARLES	14.6	283,883
29189	MISSOURI	ST LOUIS	14.5	1,016,315
29186	MISSOURI	STE GENEVIEVE	14.1	17,842
34015	NEW JERSEY	GLOUCESTER	14.2	254,673

FIPS Code	State	County	Design Value	Population 2000
34021	NEW JERSEY	MERCER	14.5	350,761
34041	NEW JERSEY	WARREN	13.6	102,437
36029	NEW YORK	ERIE	15	950,265
36047	NEW YORK	KINGS	14.6	2,465,326
36085	NEW YORK	RICHMOND	14.4	443,728
37001	NORTH CAROLINA	ALAMANCE	14.4	130,800
37021	NORTH CAROLINA	BUNCOMBE	14.2	206,330
37033	NORTH CAROLINA	CASWELL	14	23,501
37051	NORTH CAROLINA	CUMBERLAND	14.7	302,963
37063	NORTH CAROLINA	DURHAM	14.7	223,314
37071	NORTH CAROLINA	GASTON	14.7	190,365
37087	NORTH CAROLINA	HAYWOOD	14.6	54,033
37121	NORTH CAROLINA	MITCHELL	14.8	15,687
37135	NORTH CAROLINA	ORANGE	13.6	118,227
37183	NORTH CAROLINA	WAKE	14.6	627,846
37191	NORTH CAROLINA	WAYNE	14.6	113,329
39085	OHIO	LAKE	13.8	227,511
39095	OHIO	LUCAS	14.9	455,054
41039	OREGON	LANE	13.7	322,959
42077	PENNSYLVANIA	LEHIGH	14.3	312,090
42091	PENNSYLVANIA	MONTGOMERY	14.2	750,097
45043	SOUTH CAROLINA	GEORGETOWN	13.5	55,797
45047	SOUTH CAROLINA	GREENWOOD	14.1	66,271
45063	SOUTH CAROLINA	LEXINGTON	14.6	216,014
45079	SOUTH CAROLINA	RICHLAND	13.8	320,677
45083	SOUTH CAROLINA	SPARTANBURG	14.5	253,791
47113	TENNESSEE	MADISON	13.5	91,837
47119	TENNESSEE	MAURY	13.6	69,498
47141	TENNESSEE	PUTNAM	14.4	62,315
47157	TENNESSEE	SHELBY	14.9	897,472
47165	TENNESSEE	SUMNER	14.3	130,449
48037	TEXAS	BOWIE	14.3	89,306
48113	TEXAS	DALLAS	13.6	2,218,899
48201	TEXAS	HARRIS	14.1	3,400,578
49035	UTAH	SALT LAKE	14.6	898,387
51013	VIRGINIA	ARLINGTON	14.9	189,453
51041	VIRGINIA	CHESTERFIELD	14.2	259,903
51059	VIRGINIA	FAIRFAX	13.9	969,749
51087	VIRGINIA	HENRICO	14	262,300
51107	VIRGINIA	LOUDOUN	13.8	169,599
54033	WEST VIRGINIA	HARRISON	14.5	68,652
54061	WEST VIRGINIA	MONONGALIA	15	81,866
54081	WEST VIRGINIA	RALEIGH	13.5	79,220
55079	WISCONSIN	MILWAUKEE	13.7	940,164
Counties:	**91**	**Total population**		**31,645,778**

Table A-6. Counties Attaining the PM2.5 NAAQS for 2000-2002 with Complete Data

FIPS Code	State	County	2000-2002 Design Value	Population 2000
1003	ALABAMA	BALDWIN	11.8	140,415
1027	ALABAMA	CLAY	14.1	14,254
1053	ALABAMA	ESCAMBIA	13.7	38,440
1089	ALABAMA	MADISON	14.9	276,700
1097	ALABAMA	MOBILE	13.2	399,843
1117	ALABAMA	SHELBY	15	143,293
1119	ALABAMA	SUMTER	13.1	14,798
2020	ALASKA	ANCHORAGE	6.4	260,283
2090	ALASKA	FAIRBANKS NORTH STAR	13.6	82,840
2110	ALASKA	JUNEAU	6.1	30,711
2170	ALASKA	MATANUSKA-SUSITNA	6	59,322
4013	ARIZONA	MARICOPA	10	3,072,149
4023	ARIZONA	SANTA CRUZ	12	38,381
5031	ARKANSAS	CRAIGHEAD	12.8	82,148
5051	ARKANSAS	GARLAND	12	88,068
5089	ARKANSAS	MARION	9.4	16,140
5091	ARKANSAS	MILLER	13.6	40,443
5107	ARKANSAS	PHILLIPS	12.9	26,445
5113	ARKANSAS	POLK	11.7	20,229
5115	ARKANSAS	POPE	12.9	54,469
5119	ARKANSAS	PULASKI	14.6	361,474
5131	ARKANSAS	SEBASTIAN	13	115,071
5143	ARKANSAS	WASHINGTON	11.6	157,715
6001	CALIFORNIA	ALAMEDA	12.3	1,443,741
6007	CALIFORNIA	BUTTE	14.6	203,171
6009	CALIFORNIA	CALAVERAS	9	40,554
6011	CALIFORNIA	COLUSA	9.7	18,804
6013	CALIFORNIA	CONTRA COSTA	11.3	948,816
6017	CALIFORNIA	EL DORADO	7.8	156,299
6023	CALIFORNIA	HUMBOLDT	8.8	126,518
6053	CALIFORNIA	MONTEREY	8.6	401,762
6057	CALIFORNIA	NEVADA	8.6	92,033
6061	CALIFORNIA	PLACER	12.4	248,399
6067	CALIFORNIA	SACRAMENTO	12.7	1,223,499
6075	CALIFORNIA	SAN FRANCISCO	12	776,733
6079	CALIFORNIA	SAN LUIS OBISPO	9.9	246,681
6081	CALIFORNIA	SAN MATEO	11.2	707,161
6083	CALIFORNIA	SANTA BARBARA	9.9	399,347
6085	CALIFORNIA	SANTA CLARA	11.8	1,682,585
6087	CALIFORNIA	SANTA CRUZ	8.5	255,602
6089	CALIFORNIA	SHASTA	9.6	163,256
6095	CALIFORNIA	SOLANO	12.6	394,542
6097	CALIFORNIA	SONOMA	10.5	458,614
6101	CALIFORNIA	SUTTER	11.8	78,930
6111	CALIFORNIA	VENTURA	14.8	753,197
6113	CALIFORNIA	YOLO	10.5	168,660
8005	COLORADO	ARAPAHOE	8.9	487,967
8013	COLORADO	BOULDER	9.5	291,288

FIPS Code	State	County	Design Value	Population 2000
8031	COLORADO	DENVER	10.9	554,636
8041	COLORADO	EL PASO	7.7	516,929
8039	COLORADO	ELBERT	4.3	19,872
8051	COLORADO	GUNNISON	6.5	13,956
8067	COLORADO	LA PLATA	5.3	43,941
8069	COLORADO	LARIMER	8.2	251,494
8077	COLORADO	MESA	7.7	116,255
8101	COLORADO	PUEBLO	8	141,472
8123	COLORADO	WELD	9.6	180,936
9001	CONNECTICUT	FAIRFIELD	13.7	882,567
9003	CONNECTICUT	HARTFORD	12.7	857,183
9011	CONNECTICUT	NEW LONDON	11.8	259,088
10001	DELAWARE	KENT	13.4	126,697
10005	DELAWARE	SUSSEX	14.2	156,638
12001	FLORIDA	ALACHUA	10.7	217,955
12011	FLORIDA	BROWARD	8.7	1,623,018
12017	FLORIDA	CITRUS	9.6	118,085
12031	FLORIDA	DUVAL	10.8	778,879
12033	FLORIDA	ESCAMBIA	12.1	294,410
12057	FLORIDA	HILLSBOROUGH	12	998,948
12071	FLORIDA	LEE	8.9	440,888
12073	FLORIDA	LEON	13	239,452
12083	FLORIDA	MARION	10.4	258,916
12086	FLORIDA	Miami-Dade	10.1	2,253,362
12095	FLORIDA	ORANGE	10.9	896,344
12099	FLORIDA	PALM BEACH	8	1,131,184
12103	FLORIDA	PINELLAS	11.3	921,482
12105	FLORIDA	POLK	11.1	483,924
12115	FLORIDA	SARASOTA	9.9	325,957
12117	FLORIDA	SEMINOLE	9.8	365,196
12111	FLORIDA	ST LUCIE	9	192,695
12127	FLORIDA	VOLUSIA	9.7	443,343
15003	HAWAII	HONOLULU	4.9	876,156
15009	HAWAII	MAUI	4.8	128,094
16001	IDAHO	ADA	9.7	300,904
16005	IDAHO	BANNOCK	9.7	75,565
16017	IDAHO	BONNER	8.7	36,835
16019	IDAHO	BONNEVILLE	7.6	82,522
16027	IDAHO	CANYON	10.2	131,441
16055	IDAHO	KOOTENAI	9.6	108,685
16069	IDAHO	NEZ PERCE	9.4	37,410
16079	IDAHO	SHOSHONE	12.9	13,771
16083	IDAHO	TWIN FALLS	7.2	64,284
17001	ILLINOIS	ADAMS	13	68,277
17019	ILLINOIS	CHAMPAIGN	13.2	179,669
17097	ILLINOIS	LAKE	13.1	644,356
17115	ILLINOIS	MACON	14.5	114,706
17111	ILLINOIS	MC HENRY	13.6	260,077
17113	ILLINOIS	MC LEAN	14.2	150,433
17143	ILLINOIS	PEORIA	14.2	183,433
17157	ILLINOIS	RANDOLPH	12.9	33,893

FIPS Code	State	County	Design Value	Population 2000
17167	ILLINOIS	SANGAMON	13.4	188,951
18003	INDIANA	ALLEN	14.8	331,849
18091	INDIANA	LA PORTE	13.6	110,106
18127	INDIANA	PORTER	14.3	146,798
18141	INDIANA	ST JOSEPH	14.1	265,559
19013	IOWA	BLACK HAWK	11.4	128,012
19033	IOWA	CERRO GORDO	10.4	46,447
19045	IOWA	CLINTON	12.1	50,149
19063	IOWA	EMMET	8.7	11,027
19103	IOWA	JOHNSON	11.3	111,006
19113	IOWA	LINN	11.2	191,701
19153	IOWA	POLK	10.6	374,601
19155	IOWA	POTTAWATTAMIE	10.3	87,704
19163	IOWA	SCOTT	12.7	158,668
19169	IOWA	STORY	10	79,981
19177	IOWA	VAN BUREN	10.3	7,809
19193	IOWA	WOODBURY	9.9	103,877
20091	KANSAS	JOHNSON	11.9	451,086
20107	KANSAS	LINN	10.7	9,570
20173	KANSAS	SEDGWICK	11.3	452,869
20177	KANSAS	SHAWNEE	10.9	169,871
20191	KANSAS	SUMNER	10.4	25,946
20209	KANSAS	WYANDOTTE	13.5	157,882
21043	KENTUCKY	CARTER	13.1	26,889
21047	KENTUCKY	CHRISTIAN	14.1	72,265
21073	KENTUCKY	FRANKLIN	14.4	47,687
21101	KENTUCKY	HENDERSON	14.8	44,829
21151	KENTUCKY	MADISON	14.4	70,872
21195	KENTUCKY	PIKE	14.6	68,736
21227	KENTUCKY	WARREN	14.5	92,522
22017	LOUISIANA	CADDO	13.1	252,161
22019	LOUISIANA	CALCASIEU	12	183,577
22033	LOUISIANA	EAST BATON ROUGE	13.6	412,852
22047	LOUISIANA	IBERVILLE	12.9	33,320
22051	LOUISIANA	JEFFERSON	12.5	455,466
22055	LOUISIANA	LAFAYETTE	11.5	190,503
22071	LOUISIANA	ORLEANS	12.8	484,674
22073	LOUISIANA	OUACHITA	12	147,250
22079	LOUISIANA	RAPIDES	12	126,337
22087	LOUISIANA	ST BERNARD	11.3	67,229
22105	LOUISIANA	TANGIPAHOA	12	100,588
22109	LOUISIANA	TERREBONNE	10.9	104,503
22121	LOUISIANA	WEST BATON ROUGE	13.1	21,601
23001	MAINE	ANDROSCOGGIN	10.5	103,793
23003	MAINE	AROOSTOOK	11.2	73,938
23005	MAINE	CUMBERLAND	11.3	265,612
23009	MAINE	HANCOCK	6.1	51,791
23011	MAINE	KENNEBEC	10.2	117,114
23017	MAINE	OXFORD	10	54,755
23019	MAINE	PENOBSCOT	9.8	144,919
23031	MAINE	YORK	9.5	186,742

FIPS Code	State	County	Design Value	Population 2000
24015	MARYLAND	CECIL	13.4	85,951
24031	MARYLAND	MONTGOMERY	13.4	873,341
24043	MARYLAND	WASHINGTON	14.8	131,923
25013	MASSACHUSETTS	HAMPDEN	13.8	456,228
25015	MASSACHUSETTS	HAMPSHIRE	8.8	152,251
25027	MASSACHUSETTS	WORCESTER	12.2	750,963
26005	MICHIGAN	ALLEGAN	12.3	105,665
26021	MICHIGAN	BERRIEN	12.6	162,453
26049	MICHIGAN	GENESEE	12.9	436,141
26065	MICHIGAN	INGHAM	13.5	279,320
26077	MICHIGAN	KALAMAZOO	15	238,603
26081	MICHIGAN	KENT	13.9	574,335
26099	MICHIGAN	MACOMB	13.5	788,149
26121	MICHIGAN	MUSKEGON	12.2	170,200
26139	MICHIGAN	OTTAWA	13.5	238,314
26145	MICHIGAN	SAGINAW	10.8	210,039
26147	MICHIGAN	ST CLAIR	14	164,235
26161	MICHIGAN	WASHTENAW	13.4	322,895
27037	MINNESOTA	DAKOTA	10.9	355,904
27053	MINNESOTA	HENNEPIN	11.1	1,116,200
27123	MINNESOTA	RAMSEY	12.6	511,035
27139	MINNESOTA	SCOTT	10.9	89,498
27137	MINNESOTA	ST LOUIS	8.5	200,528
28001	MISSISSIPPI	ADAMS	11.6	34,340
28011	MISSISSIPPI	BOLIVAR	13.2	40,633
28033	MISSISSIPPI	DE SOTO	13.1	107,199
28035	MISSISSIPPI	FORREST	13.8	72,604
28045	MISSISSIPPI	HANCOCK	10.7	42,967
28047	MISSISSIPPI	HARRISON	11.7	189,601
28049	MISSISSIPPI	HINDS	13.8	250,800
28059	MISSISSIPPI	JACKSON	12.2	131,420
28067	MISSISSIPPI	JONES	15	64,958
28075	MISSISSIPPI	LAUDERDALE	13.7	78,161
28081	MISSISSIPPI	LEE	13.1	75,755
28121	MISSISSIPPI	RANKIN	13.6	115,327
28123	MISSISSIPPI	SCOTT	12.1	28,423
28149	MISSISSIPPI	WARREN	12.8	49,644
29021	MISSOURI	BUCHANAN	12.6	85,998
29037	MISSOURI	CASS	11.4	82,092
29039	MISSOURI	CEDAR	11.7	13,733
29047	MISSOURI	CLAY	13	184,006
29077	MISSOURI	GREENE	12.4	240,391
29095	MISSOURI	JACKSON	13.9	654,880
29097	MISSOURI	JASPER	14	104,686
29099	MISSOURI	JEFFERSON	14.9	198,099
29137	MISSOURI	MONROE	11.2	9,311
29183	MISSOURI	ST CHARLES	14.6	283,883
29189	MISSOURI	ST LOUIS	14.5	1,016,315
29186	MISSOURI	STE GENEVIEVE	14.1	17,842
30013	MONTANA	CASCADE	6	80,357
30029	MONTANA	FLATHEAD	8.3	74,471

FIPS Code	State	County	Design Value	Population 2000
30031	MONTANA	GALLATIN	9.2	67,831
30047	MONTANA	LAKE	10	26,507
30049	MONTANA	LEWIS AND CLARK	8.6	55,716
30063	MONTANA	MISSOULA	11.4	95,802
30081	MONTANA	RAVALLI	10.7	36,070
30087	MONTANA	ROSEBUD	7.1	9,383
30089	MONTANA	SANDERS	6.5	10,227
30111	MONTANA	YELLOWSTONE	7.5	129,352
31025	NEBRASKA	CASS	10.3	24,334
31055	NEBRASKA	DOUGLAS	11	463,585
31079	NEBRASKA	HALL	8.6	53,534
31109	NEBRASKA	LANCASTER	9.9	250,291
31111	NEBRASKA	LINCOLN	7	34,632
31157	NEBRASKA	SCOTTS BLUFF	6.1	36,951
32003	NEVADA	CLARK	10.9	1,375,765
32031	NEVADA	WASHOE	9.5	339,486
34015	NEW JERSEY	GLOUCESTER	14.2	254,673
34021	NEW JERSEY	MERCER	14.5	350,761
34023	NEW JERSEY	MIDDLESEX	12.7	750,162
34041	NEW JERSEY	WARREN	13.6	102,437
35001	NEW MEXICO	BERNALILLO	6.4	556,678
35005	NEW MEXICO	CHAVES	6.7	61,382
35013	NEW MEXICO	DONA ANA	11.2	174,682
35017	NEW MEXICO	GRANT	6	31,002
35025	NEW MEXICO	LEA	6.7	55,511
35045	NEW MEXICO	SAN JUAN	6.4	113,801
35043	NEW MEXICO	SANDOVAL	4.9	89,908
35049	NEW MEXICO	SANTA FE	4.9	129,292
36001	NEW YORK	ALBANY	10.8	294,565
36007	NEW YORK	BROOME	11.5	200,536
36013	NEW YORK	CHAUTAUQUA	11.3	139,750
36027	NEW YORK	DUTCHESS	11.3	280,150
36029	NEW YORK	ERIE	15	950,265
36031	NEW YORK	ESSEX	6.4	38,851
36047	NEW YORK	KINGS	14.6	2,465,326
36055	NEW YORK	MONROE	11.6	735,343
36059	NEW YORK	NASSAU	12.3	1,334,544
36063	NEW YORK	NIAGARA	12.6	219,846
36065	NEW YORK	ONEIDA	12	235,469
36067	NEW YORK	ONONDAGA	11.8	458,336
36071	NEW YORK	ORANGE	11.7	341,367
36085	NEW YORK	RICHMOND	14.4	443,728
36093	NEW YORK	SCHENECTADY	11	146,555
36089	NEW YORK	ST. LAWRENCE	8.6	111,931
36101	NEW YORK	STEUBEN	9.9	98,726
36103	NEW YORK	SUFFOLK	12.5	1,419,369
37001	NORTH CAROLINA	ALAMANCE	14.4	130,800
37021	NORTH CAROLINA	BUNCOMBE	14.2	206,330
37033	NORTH CAROLINA	CASWELL	14	23,501
37037	NORTH CAROLINA	CHATHAM	12.8	49,329
37051	NORTH CAROLINA	CUMBERLAND	14.7	302,963
37061	NORTH CAROLINA	DUPLIN	12.6	49,063

FIPS Code	State	County	Design Value	Population 2000
37063	NORTH CAROLINA	DURHAM	14.7	223,314
37071	NORTH CAROLINA	GASTON	14.7	190,365
37087	NORTH CAROLINA	HAYWOOD	14.6	54,033
37107	NORTH CAROLINA	LENOIR	12	59,648
37121	NORTH CAROLINA	MITCHELL	14.8	15,687
37123	NORTH CAROLINA	MONTGOMERY	13	26,822
37129	NORTH CAROLINA	NEW HANOVER	11.4	160,307
37133	NORTH CAROLINA	ONSLOW	11.6	150,355
37135	NORTH CAROLINA	ORANGE	13.6	118,227
37139	NORTH CAROLINA	PASQUOTANK	12	34,897
37147	NORTH CAROLINA	PITT	12.9	133,798
37173	NORTH CAROLINA	SWAIN	13.4	12,968
37183	NORTH CAROLINA	WAKE	14.6	627,846
37191	NORTH CAROLINA	WAYNE	14.6	113,329
38013	NORTH DAKOTA	BURKE	5.6	2,242
38015	NORTH DAKOTA	BURLEIGH	6.6	69,416
38017	NORTH DAKOTA	CASS	7.9	123,138
38057	NORTH DAKOTA	MERCER	6	8,644
39085	OHIO	LAKE	13.8	227,511
39095	OHIO	LUCAS	14.9	455,054
40019	OKLAHOMA	CARTER	10.3	45,621
40031	OKLAHOMA	COMANCHE	9.4	114,996
40039	OKLAHOMA	CUSTER	9	26,142
40047	OKLAHOMA	GARFIELD	10.2	57,813
40071	OKLAHOMA	KAY	10.6	48,080
40097	OKLAHOMA	MAYES	11.9	38,369
40101	OKLAHOMA	MUSKOGEE	12.1	69,451
40109	OKLAHOMA	OKLAHOMA	10.7	660,448
40115	OKLAHOMA	OTTAWA	11.9	33,194
40119	OKLAHOMA	PAYNE	10.2	68,190
40121	OKLAHOMA	PITTSBURG	11.4	43,953
40143	OKLAHOMA	TULSA	12.6	563,299
41003	OREGON	BENTON	7.6	78,153
41009	OREGON	COLUMBIA	6.5	43,560
41025	OREGON	HARNEY	9.4	7,609
41029	OREGON	JACKSON	12	181,269
41035	OREGON	KLAMATH	11.8	63,775
41037	OREGON	LAKE	7.7	7,422
41039	OREGON	LANE	13.7	322,959
41043	OREGON	LINN	8.5	103,069
41047	OREGON	MARION	8.4	284,834
41051	OREGON	MULTNOMAH	9	660,486
41059	OREGON	UMATILLA	9	70,548
41061	OREGON	UNION	6.8	24,530
41065	OREGON	WASCO	8.3	23,791
41067	OREGON	WASHINGTON	9.8	445,342
42001	PENNSYLVANIA	ADAMS	13.3	91,292
42069	PENNSYLVANIA	LACKAWANNA	12.4	213,295
42077	PENNSYLVANIA	LEHIGH	14.3	312,090
42079	PENNSYLVANIA	LUZERNE	12.9	319,250
42091	PENNSYLVANIA	MONTGOMERY	14.2	750,097
42099	PENNSYLVANIA	PERRY	12.7	43,602
72021	PUERTO RICO	BAYAMON	7	224,044

FIPS Code	State	County	Design Value	Population 2000
72053	PUERTO RICO	FAJARDO	5.2	40,712
72057	PUERTO RICO	GUAYAMA	6.9	44,301
72059	PUERTO RICO	GUAYANILLA	7.2	23,072
72061	PUERTO RICO	GUAYNABO	9.6	100,053
72097	PUERTO RICO	MAYAGUEZ	8.1	98,434
72113	PUERTO RICO	PONCE	7.6	186,475
72127	PUERTO RICO	SAN JUAN	9.4	434,374
44003	RHODE ISLAND	KENT	9	167,090
44007	RHODE ISLAND	PROVIDENCE	11.3	621,602
44009	RHODE ISLAND	WASHINGTON	8.8	123,546
45013	SOUTH CAROLINA	BEAUFORT	11.4	120,937
45019	SOUTH CAROLINA	CHARLESTON	12.4	309,969
45025	SOUTH CAROLINA	CHESTERFIELD	12.7	42,768
45037	SOUTH CAROLINA	EDGEFIELD	13.3	24,595
45041	SOUTH CAROLINA	FLORENCE	13.3	125,761
45043	SOUTH CAROLINA	GEORGETOWN	13.5	55,797
45047	SOUTH CAROLINA	GREENWOOD	14.1	66,271
45063	SOUTH CAROLINA	LEXINGTON	14.6	216,014
45073	SOUTH CAROLINA	OCONEE	11.6	66,215
45079	SOUTH CAROLINA	RICHLAND	13.8	320,677
45083	SOUTH CAROLINA	SPARTANBURG	14.5	253,791
46011	SOUTH DAKOTA	BROOKINGS	9.1	28,220
46099	SOUTH DAKOTA	MINNEHAHA	9.6	148,281
46103	SOUTH DAKOTA	PENNINGTON	7.9	88,565
47045	TENNESSEE	DYER	12.7	37,279
47099	TENNESSEE	LAWRENCE	12.6	39,926
47113	TENNESSEE	MADISON	13.5	91,837
47119	TENNESSEE	MAURY	13.6	69,498
47125	TENNESSEE	MONTGOMERY	13.3	134,768
47141	TENNESSEE	PUTNAM	14.4	62,315
47157	TENNESSEE	SHELBY	14.9	897,472
47165	TENNESSEE	SUMNER	14.3	130,449
48037	TEXAS	BOWIE	14.3	89,306
48061	TEXAS	CAMERON	9.7	335,227
48085	TEXAS	COLLIN	11.6	491,675
48113	TEXAS	DALLAS	13.6	2,218,899
48141	TEXAS	EL PASO	10.1	679,622
48167	TEXAS	GALVESTON	11.1	250,158
48183	TEXAS	GREGG	12.6	111,379
48201	TEXAS	HARRIS	14.1	3,400,578
48303	TEXAS	LUBBOCK	7.5	242,628
48439	TEXAS	TARRANT	12.3	1,446,219
48453	TEXAS	TRAVIS	11.5	812,280
48479	TEXAS	WEBB	10.8	193,117
49011	UTAH	DAVIS	10	238,994
49035	UTAH	SALT LAKE	14.6	898,387
49045	UTAH	TOOELE	8.1	40,735
49049	UTAH	UTAH	11.2	368,536
49057	UTAH	WEBER	10.3	196,533
50003	VERMONT	BENNINGTON	10.2	36,994
50007	VERMONT	CHITTENDEN	9.3	146,571
50021	VERMONT	RUTLAND	11.6	63,400

FIPS Code	State	County	Design Value	Population 2000
50023	VERMONT	WASHINGTON	10.6	58,039
51013	VIRGINIA	ARLINGTON	14.9	189,453
51036	VIRGINIA	CHARLES CITY	13.3	6,926
51550	VIRGINIA	CHESAPEAKE	13	199,184
51041	VIRGINIA	CHESTERFIELD	14.2	259,903
51059	VIRGINIA	FAIRFAX	13.9	969,749
51650	VIRGINIA	HAMPTON	12.9	146,437
51087	VIRGINIA	HENRICO	14	262,300
51107	VIRGINIA	LOUDOUN	13.8	169,599
51700	VIRGINIA	NEWPORT NEWS	12.4	180,150
51710	VIRGINIA	NORFOLK	13.3	234,403
51139	VIRGINIA	PAGE	13.4	23,177
51810	VIRGINIA	VIRGINIA BEACH	12.8	425,257
53005	WASHINGTON	BENTON	7.2	142,475
53011	WASHINGTON	CLARK	10.1	345,238
53033	WASHINGTON	KING	11.8	1,737,034
53053	WASHINGTON	PIERCE	11.7	700,820
53061	WASHINGTON	SNOHOMISH	11.8	606,024
53063	WASHINGTON	SPOKANE	10.4	417,939
53067	WASHINGTON	THURSTON	9.8	207,355
53073	WASHINGTON	WHATCOM	7.8	166,814
54033	WEST VIRGINIA	HARRISON	14.5	68,652
54055	WEST VIRGINIA	MERCER	13.4	62,980
54061	WEST VIRGINIA	MONONGALIA	15	81,866
54081	WEST VIRGINIA	RALEIGH	13.5	79,220
54089	WEST VIRGINIA	SUMMERS	10.4	12,999
55009	WISCONSIN	BROWN	11.6	226,778
55025	WISCONSIN	DANE	12.8	426,526
55027	WISCONSIN	DODGE	11.4	85,897
55029	WISCONSIN	DOOR	7.6	27,961
55031	WISCONSIN	DOUGLAS	8	43,287
55043	WISCONSIN	GRANT	11.7	49,597
55055	WISCONSIN	JEFFERSON	11.8	74,021
55059	WISCONSIN	KENOSHA	11.9	149,577
55071	WISCONSIN	MANITOWOC	10.1	82,887
55079	WISCONSIN	MILWAUKEE	13.7	940,164
55087	WISCONSIN	OUTAGAMIE	11.1	160,971
55089	WISCONSIN	OZAUKEE	11.3	82,317
55109	WISCONSIN	ST CROIX	9.9	63,155
55125	WISCONSIN	VILAS	5.8	21,033
55133	WISCONSIN	WAUKESHA	13.4	360,767
55139	WISCONSIN	WINNEBAGO	10.8	156,763
55141	WISCONSIN	WOOD	10.4	75,555
56005	WYOMING	CAMPBELL	6.3	33,698
56021	WYOMING	LARAMIE	5.1	81,607
56033	WYOMING	SHERIDAN	11.1	26,560
Counties:	**404**	**Total population**		**110,864,052**

Table A-7. Counties with Design Values Below the PM2.5 NAAQS for 2000-2002 with Incomplete Data

FIPS Code	State	County	2000-2002 Design Value	Population 2000
01033	ALABAMA	COLBERT	13.7	54,984
01069	ALABAMA	HOUSTON	14.1	88,787
01125	ALABAMA	TUSCALOOSA	13.9	164,875
01127	ALABAMA	WALKER	14.9	70,713
02130	ALASKA	KETCHIKAN GATEWAY	5.3	14,070
02290	ALASKA	YUKON-KOYUKUK	2	6,551
04003	ARIZONA	COCHISE	7.8	117,755
04005	ARIZONA	COCONINO	7.1	116,320
04007	ARIZONA	GILA	9.7	51,335
04019	ARIZONA	PIMA	7.2	843,746
04021	ARIZONA	PINAL	8.1	179,727
05035	ARKANSAS	CRITTENDEN	14	50,866
05045	ARKANSAS	FAULKNER	13.1	86,014
05069	ARKANSAS	JEFFERSON	15	84,278
05093	ARKANSAS	MISSISSIPPI	13.2	51,979
05139	ARKANSAS	UNION	13.5	45,629
05145	ARKANSAS	WHITE	12.9	67,165
06027	CALIFORNIA	INYO	7.8	17,945
06033	CALIFORNIA	LAKE	4.9	58,309
06045	CALIFORNIA	MENDOCINO	7	86,265
06049	CALIFORNIA	MODOC	7	9,449
06051	CALIFORNIA	MONO	14.1	12,853
06063	CALIFORNIA	PLUMAS	14.2	20,824
08001	COLORADO	ADAMS	11.7	363,857
08007	COLORADO	ARCHULETA	6.8	9,898
08029	COLORADO	DELTA	7.7	27,834
08035	COLORADO	DOUGLAS	5.7	175,766
08107	COLORADO	ROUTT	7.5	19,690
08113	COLORADO	SAN MIGUEL	5.7	6,594
12005	FLORIDA	BAY	11.2	148,217
12009	FLORIDA	BREVARD	8.7	476,230
12081	FLORIDA	MANATEE	9.9	264,002
12113	FLORIDA	SANTA ROSA	9.3	117,743
13051	GEORGIA	CHATHAM	14.7	232,048
13095	GEORGIA	DOUGHERTY	15	96,065
13127	GEORGIA	GLYNN	12.5	67,568
13185	GEORGIA	LOWNDES	13.2	92,115
13303	GEORGIA	WASHINGTON	15	21,176
16015	IDAHO	BOISE	10.5	6,670
16021	IDAHO	BOUNDARY	9.4	9,871
16029	IDAHO	CARIBOU	4.7	7,304
16057	IDAHO	LATAH	6.6	34,935
16077	IDAHO	POWER	14.7	7,538
16085	IDAHO	VALLEY	10.2	7,651
17089	ILLINOIS	KANE	14.6	404,119
17099	ILLINOIS	LA SALLE	14.8	111,509
17161	ILLINOIS	ROCK ISLAND	13.6	149,374
17201	ILLINOIS	WINNEBAGO	14.6	278,418

FIPS Code	State	County	2000-2002 Design Value	Population 2000
18065	INDIANA	HENRY	13.4	48,508
18083	INDIANA	KNOX	13.8	39,256
18095	INDIANA	MADISON	15	133,358
18147	INDIANA	SPENCER	15	20,391
19137	IOWA	MONTGOMERY	10	11,771
19139	IOWA	MUSCATINE	13.3	41,722
21125	KENTUCKY	LAUREL	13	52,715
21145	KENTUCKY	MC CRACKEN	14.1	65,514
22029	LOUISIANA	CONCORDIA	13.1	20,247
23013	MAINE	KNOX	6.6	39,618
24025	MARYLAND	HARFORD	14	218,590
25003	MASSACHUSETTS	BERKSHIRE	12.4	134,953
25005	MASSACHUSETTS	BRISTOL	12.2	534,678
25009	MASSACHUSETTS	ESSEX	11.3	723,419
25017	MASSACHUSETTS	MIDDLESEX	10.8	1,465,396
25021	MASSACHUSETTS	NORFOLK	11.5	650,308
25023	MASSACHUSETTS	PLYMOUTH	11.6	472,822
26007	MICHIGAN	ALPENA	8.9	31,314
26017	MICHIGAN	BAY	11	110,157
26033	MICHIGAN	CHIPPEWA	8.1	38,543
26055	MICHIGAN	GRAND TRAVERSE	8.7	77,654
26125	MICHIGAN	OAKLAND	15	1,194,156
27035	MINNESOTA	CROW WING	11.8	55,099
27041	MINNESOTA	DOUGLAS	7.2	32,821
27047	MINNESOTA	FREEBORN	13.1	32,584
27061	MINNESOTA	ITASCA	9	43,992
27067	MINNESOTA	KANDIYOHI	10.2	41,203
27075	MINNESOTA	LAKE	6.6	11,058
27085	MINNESOTA	MC LEOD	11	34,898
27095	MINNESOTA	MILLE LACS	7.7	22,330
27103	MINNESOTA	NICOLLET	10.8	29,771
27109	MINNESOTA	OLMSTED	11.4	124,277
27111	MINNESOTA	OTTER TAIL	9.5	57,159
27145	MINNESOTA	STEARNS	10.4	133,166
27163	MINNESOTA	WASHINGTON	11.8	201,130
27171	MINNESOTA	WRIGHT	11.5	89,986
28087	MISSISSIPPI	LOWNDES	14.1	61,586
28109	MISSISSIPPI	PEARL RIVER	12.4	48,621
29019	MISSOURI	BOONE	12.4	135,454
29091	MISSOURI	HOWELL	14.3	37,238
29129	MISSOURI	MERCER	11.7	3,757
30093	MONTANA	SILVER BOW	9.1	34,606
31027	NEBRASKA	CEDAR	8.5	9,615
31031	NEBRASKA	CHERRY	4.5	6,148
31049	NEBRASKA	DEUEL	5.7	2,098
31153	NEBRASKA	SARPY	10.5	122,595
31177	NEBRASKA	WASHINGTON	10	18,780
32005	NEVADA	DOUGLAS	3.5	41,259
33001	NEW HAMPSHIRE	BELKNAP	10.8	56,325
33005	NEW HAMPSHIRE	CHESHIRE	12	73,825
33007	NEW HAMPSHIRE	COOS	9.7	33,111
33009	NEW HAMPSHIRE	GRAFTON	8.3	81,743

FIPS Code	State	County	2000-2002 Design Value	Population 2000
33011	NEW HAMPSHIRE	HILLSBOROUGH	11.3	380,841
33013	NEW HAMPSHIRE	MERRIMACK	10	136,225
33015	NEW HAMPSHIRE	ROCKINGHAM	11.4	277,359
33019	NEW HAMPSHIRE	SULLIVAN	9.7	40,458
34001	NEW JERSEY	ATLANTIC	11.4	252,552
34003	NEW JERSEY	BERGEN	14.2	884,118
34007	NEW JERSEY	CAMDEN	14.8	508,932
34013	NEW JERSEY	ESSEX	15	793,633
34027	NEW JERSEY	MORRIS	12.8	470,212
34029	NEW JERSEY	OCEAN	11.6	510,916
34031	NEW JERSEY	PASSAIC	13.4	489,049
36081	NEW YORK	QUEENS	13.8	2,229,379
36119	NEW YORK	WESTCHESTER	12.7	923,459
37065	NORTH CAROLINA	EDGECOMBE	13.1	55,606
37099	NORTH CAROLINA	JACKSON	13.7	33,121
37155	NORTH CAROLINA	ROBESON	13.7	123,339
37189	NORTH CAROLINA	WATAUGA	10.7	42,695
38007	NORTH DAKOTA	BILLINGS	4.9	888
38035	NORTH DAKOTA	GRAND FORKS	8.2	66,109
38053	NORTH DAKOTA	MC KENZIE	5.3	5,737
38089	NORTH DAKOTA	STARK	5.7	22,636
38091	NORTH DAKOTA	STEELE	6.5	2,258
39009	OHIO	ATHENS	13	62,223
39135	OHIO	PREBLE	13.8	42,337
40015	OKLAHOMA	CADDO	8.8	30,150
40017	OKLAHOMA	CANADIAN	9.3	87,697
40021	OKLAHOMA	CHEROKEE	12.1	42,521
40081	OKLAHOMA	LINCOLN	10	32,080
40117	OKLAHOMA	PAWNEE	9.1	16,612
40125	OKLAHOMA	POTTAWATOMIE	10.8	65,521
40133	OKLAHOMA	SEMINOLE	9.9	24,894
41017	OREGON	DESCHUTES	8.5	115,367
41033	OREGON	JOSEPHINE	13.5	75,726
42017	PENNSYLVANIA	BUCKS	14.3	597,635
42027	PENNSYLVANIA	CENTRE	12.4	135,758
42029	PENNSYLVANIA	CHESTER	14.6	433,501
42049	PENNSYLVANIA	ERIE	13.7	280,843
42085	PENNSYLVANIA	MERCER	14.6	120,293
42095	PENNSYLVANIA	NORTHAMPTON	14.6	267,066
72069	PUERTO RICO	HUMACAO	5.6	59,035
72081	PUERTO RICO	LARES	6	34,415
45015	SOUTH CAROLINA	BERKELEY	10.2	142,651
45029	SOUTH CAROLINA	COLLETON	11.1	38,264
45051	SOUTH CAROLINA	HORRY	10.6	196,629
45075	SOUTH CAROLINA	ORANGEBURG	11.9	91,582
45091	SOUTH CAROLINA	YORK	14.3	164,614
46013	SOUTH DAKOTA	BROWN	8.5	35,460
46071	SOUTH DAKOTA	JACKSON	5.4	2,930
46093	SOUTH DAKOTA	MEADE	6.2	24,253
48029	TEXAS	BEXAR	10.1	1,392,931
48039	TEXAS	BRAZORIA	10.1	241,767

FIPS Code	State	County	2000-2002 Design Value	Population 2000
48043	TEXAS	BREWSTER	6.2	8,866
48055	TEXAS	CALDWELL	9.6	32,194
48135	TEXAS	ECTOR	7.4	121,123
48139	TEXAS	ELLIS	11.8	111,360
48203	TEXAS	HARRISON	12.4	62,110
48215	TEXAS	HIDALGO	10.7	569,463
48243	TEXAS	JEFF DAVIS	3.9	2,207
48245	TEXAS	JEFFERSON	11.4	252,051
48257	TEXAS	KAUFMAN	12.6	71,313
48315	TEXAS	MARION	11.4	10,941
48309	TEXAS	MC LENNAN	10.2	213,517
48339	TEXAS	MONTGOMERY	12	293,768
48355	TEXAS	NUECES	10.3	313,645
48361	TEXAS	ORANGE	11.7	84,966
48375	TEXAS	POTTER	6.7	113,546
49003	UTAH	BOX ELDER	9.4	42,745
49005	UTAH	CACHE	13	91,391
78001	VIRGIN ISLANDS	ST CROIX	6.9	49,725
78005	VIRGIN ISLANDS	ST THOMAS	7.5	44,372
51680	VIRGINIA	LYNCHBURG	14.7	65,269
51760	VIRGINIA	RICHMOND (CITY)	14.5	197,790
53001	WASHINGTON	ADAMS	7.5	16,428
53009	WASHINGTON	CLALLAM	11.8	64,525
53015	WASHINGTON	COWLITZ	8.8	92,948
53027	WASHINGTON	GRAYS HARBOR	8.3	67,194
53031	WASHINGTON	JEFFERSON	9	25,953
53041	WASHINGTON	LEWIS	10.3	68,600
53045	WASHINGTON	MASON	6.2	49,405
53057	WASHINGTON	SKAGIT	6.8	102,979
53059	WASHINGTON	SKAMANIA	6.8	9,872
53065	WASHINGTON	STEVENS	9.7	40,066
53071	WASHINGTON	WALLA WALLA	6.8	55,180
53075	WASHINGTON	WHITMAN	6.3	40,740
53077	WASHINGTON	YAKIMA	10.2	222,581
55003	WISCONSIN	ASHLAND	6.2	16,866
55105	WISCONSIN	ROCK	13.4	152,307
56009	WYOMING	CONVERSE	3.5	12,052
56013	WYOMING	FREMONT	13.4	35,804
56039	WYOMING	TETON	8	18,251
Counties:	**190**	**Total population**		**18,624,625**

Appendix B

Detailed Listing by County of Ozone Air Quality Data

Analysis of 1999-2001 data and 2000-2002 data and associated 2000 populations

Table B-1. Counties with Design Values above the level of the 8-hour Ozone Standard (1999-2001)

FIPS Code	State	County	1999- 2001 Design Value	Population 2000
1073	ALABAMA	JEFFERSON	0.091	662,047
01089	ALABAMA	MADISON	0.087	276,700
01101	ALABAMA	MONTGOMERY	0.085	223,510
01117	ALABAMA	SHELBY	0.096	143,293
04013	ARIZONA	MARICOPA	0.085	3,072,149
05035	ARKANSAS	CRITTENDEN	0.092	50,866
05119	ARKANSAS	PULASKI	0.087	361,474
06005	CALIFORNIA	AMADOR	0.091	35,100
06009	CALIFORNIA	CALAVERAS	0.094	40,554
06017	CALIFORNIA	EL DORADO	0.104	156,299
06019	CALIFORNIA	FRESNO	0.108	799,407
06025	CALIFORNIA	IMPERIAL	0.092	142,361
06029	CALIFORNIA	KERN	0.109	661,645
06031	CALIFORNIA	KINGS	0.098	129,461
06037	CALIFORNIA	LOS ANGELES	0.105	9,519,338
06039	CALIFORNIA	MADERA	0.088	123,109
06043	CALIFORNIA	MARIPOSA	0.091	17,130
06047	CALIFORNIA	MERCED	0.101	210,554
06057	CALIFORNIA	NEVADA	0.096	92,033
06061	CALIFORNIA	PLACER	0.101	248,399
06065	CALIFORNIA	RIVERSIDE	0.111	1,545,387
6067	CALIFORNIA	SACRAMENTO	0.099	1,223,499
06071	CALIFORNIA	SAN BERNARDINO	0.129	1,709,434
06073	CALIFORNIA	SAN DIEGO	0.094	2,813,833
06099	CALIFORNIA	STANISLAUS	0.091	446,997
06103	CALIFORNIA	TEHAMA	0.086	56,039
06107	CALIFORNIA	TULARE	0.104	368,021
06109	CALIFORNIA	TUOLUMNE	0.092	54,501
06111	CALIFORNIA	VENTURA	0.101	753,197
09001	CONNECTICUT	FAIRFIELD	0.097	882,567
09003	CONNECTICUT	HARTFORD	0.088	857,183
09007	CONNECTICUT	MIDDLESEX	0.099	155,071
09009	CONNECTICUT	NEW HAVEN	0.097	824,008
09011	CONNECTICUT	NEW LONDON	0.090	259,088
09013	CONNECTICUT	TOLLAND	0.090	136,364
10001	DELAWARE	KENT	0.093	126,697
10003	DELAWARE	NEW CASTLE	0.097	500,265
10005	DELAWARE	SUSSEX	0.095	156,638
11001	DISTRICT OF COLUMBIA	WASHINGTON	0.094	572,059
12033	FLORIDA	ESCAMBIA	0.088	294,410
13021	GEORGIA	BIBB	0.098	153,887
13067	GEORGIA	COBB	0.096	607,751

FIPS Code	State	County	1999- 2001 Design Value	Population 2000
13077	GEORGIA	COWETA	0.096	89,215
13089	GEORGIA	DE KALB	0.102	665,865
13097	GEORGIA	DOUGLAS	0.098	92,174
13113	GEORGIA	FAYETTE	0.099	91,263
13121	GEORGIA	FULTON	0.107	816,006
13135	GEORGIA	GWINNETT	0.094	588,448
13151	GEORGIA	HENRY	0.107	119,341
13215	GEORGIA	MUSCOGEE	0.090	186,291
13223	GEORGIA	PAULDING	0.092	81,678
13245	GEORGIA	RICHMOND	0.087	199,775
13247	GEORGIA	ROCKDALE	0.104	70,111
13261	GEORGIA	SUMTER	0.086	33,200
17031	ILLINOIS	COOK	0.088	5,376,741
17083	ILLINOIS	JERSEY	0.089	21,668
18003	INDIANA	ALLEN	0.087	331,849
18019	INDIANA	CLARK	0.086	96,472
18057	INDIANA	HAMILTON	0.091	182,740
18059	INDIANA	HANCOCK	0.089	55,391
18081	INDIANA	JOHNSON	0.087	115,209
18089	INDIANA	LAKE	0.090	484,564
18091	INDIANA	LA PORTE	0.085	110,106
18095	INDIANA	MADISON	0.087	133,358
18097	INDIANA	MARION	0.088	860,454
18109	INDIANA	MORGAN	0.087	66,689
18123	INDIANA	PERRY	0.090	18,899
18127	INDIANA	PORTER	0.090	146,798
18129	INDIANA	POSEY	0.086	27,061
21015	KENTUCKY	BOONE	0.085	85,991
21019	KENTUCKY	BOYD	0.086	49,752
21029	KENTUCKY	BULLITT	0.085	61,236
21047	KENTUCKY	CHRISTIAN	0.085	72,265
21061	KENTUCKY	EDMONSON	0.088	11,644
21089	KENTUCKY	GREENUP	0.086	36,891
21111	KENTUCKY	JEFFERSON	0.089	693,604
21117	KENTUCKY	KENTON	0.086	151,464
21139	KENTUCKY	LIVINGSTON	0.087	9,804
21149	KENTUCKY	MC LEAN	0.086	9,938
21185	KENTUCKY	OLDHAM	0.091	46,178
21199	KENTUCKY	PULASKI	0.086	56,217
21213	KENTUCKY	SIMPSON	0.088	16,405
22005	LOUISIANA	ASCENSION	0.086	76,627
22015	LOUISIANA	BOSSIER	0.090	98,310

FIPS Code	State	County	1999- 2001 Design Value	Population 2000
22019	LOUISIANA	CALCASIEU	0.086	183,577
22033	LOUISIANA	EAST BATON ROUGE	0.091	412,852
22047	LOUISIANA	IBERVILLE	0.086	33,320
22051	LOUISIANA	JEFFERSON	0.089	455,466
22063	LOUISIANA	LIVINGSTON	0.088	91,814
22089	LOUISIANA	ST CHARLES	0.086	48,072
22095	LOUISIANA	ST JOHN THE BAPTIST PAR	0.086	43,044
22121	LOUISIANA	WEST BATON ROUGE	0.088	21,601
23009	MAINE	HANCOCK	0.089	51,791
23031	MAINE	YORK	0.086	186,742
24003	MARYLAND	ANNE ARUNDEL	0.103	489,656
24005	MARYLAND	BALTIMORE	0.093	754,292
24009	MARYLAND	CALVERT	0.089	74,563
24013	MARYLAND	CARROLL	0.093	150,897
24015	MARYLAND	CECIL	0.106	85,951
24017	MARYLAND	CHARLES	0.096	120,546
24021	MARYLAND	FREDERICK	0.091	195,277
24025	MARYLAND	HARFORD	0.104	218,590
24029	MARYLAND	KENT	0.100	19,197
24031	MARYLAND	MONTGOMERY	0.089	873,341
24033	MARYLAND	PRINCE GEORGES	0.097	801,515
24043	MARYLAND	WASHINGTON	0.085	131,923
25001	MASSACHUSETTS	BARNSTABLE	0.096	222,230
25005	MASSACHUSETTS	BRISTOL	0.093	534,678
25009	MASSACHUSETTS	ESSEX	0.086	723,419
25013	MASSACHUSETTS	HAMPDEN	0.085	456,228
25015	MASSACHUSETTS	HAMPSHIRE	0.087	152,251
25017	MASSACHUSETTS	MIDDLESEX	0.088	1,465,396
25027	MASSACHUSETTS	WORCESTER	0.085	750,963
26005	MICHIGAN	ALLEGAN	0.087	105,665
26019	MICHIGAN	BENZIE	0.089	15,998
26021	MICHIGAN	BERRIEN	0.087	162,453
26027	MICHIGAN	CASS	0.087	51,104
26049	MICHIGAN	GENESEE	0.086	436,141
26099	MICHIGAN	MACOMB	0.088	788,149
26105	MICHIGAN	MASON	0.091	28,274
26121	MICHIGAN	MUSKEGON	0.092	170,200
26147	MICHIGAN	ST CLAIR	0.085	164,235
26163	MICHIGAN	WAYNE	0.088	2,061,162
28033	MISSISSIPPI	DE SOTO	0.086	107,199
28045	MISSISSIPPI	HANCOCK	0.087	42,967
28047	MISSISSIPPI	HARRISON	0.089	189,601

FIPS Code	State	County	1999- 2001 Design Value	Population 2000
28059	MISSISSIPPI	JACKSON	0.087	131,420
28081	MISSISSIPPI	LEE	0.086	75,755
29099	MISSOURI	JEFFERSON	0.089	198,099
29183	MISSOURI	ST CHARLES	0.090	283,883
29186	MISSOURI	STE GENEVIEVE	0.085	17,842
29189	MISSOURI	ST LOUIS	0.088	1,016,315
34001	NEW JERSEY	ATLANTIC	0.091	252,552
34007	NEW JERSEY	CAMDEN	0.103	508,932
34011	NEW JERSEY	CUMBERLAND	0.097	146,438
34015	NEW JERSEY	GLOUCESTER	0.101	254,673
34017	NEW JERSEY	HUDSON	0.093	608,975
34019	NEW JERSEY	HUNTERDON	0.100	121,989
34021	NEW JERSEY	MERCER	0.105	350,761
34023	NEW JERSEY	MIDDLESEX	0.103	750,162
34025	NEW JERSEY	MONMOUTH	0.094	615,301
34027	NEW JERSEY	MORRIS	0.097	470,212
34029	NEW JERSEY	OCEAN	0.109	510,916
34031	NEW JERSEY	PASSAIC	0.089	489,049
36013	NEW YORK	CHAUTAUQUA	0.089	139,750
36027	NEW YORK	DUTCHESS	0.087	280,150
36029	NEW YORK	ERIE	0.092	950,265
36045	NEW YORK	JEFFERSON	0.087	111,738
36063	NEW YORK	NIAGARA	0.087	219,846
36071	NEW YORK	ORANGE	0.087	341,367
36079	NEW YORK	PUTNAM	0.089	95,745
36081	NEW YORK	QUEENS	0.086	2,229,379
36085	NEW YORK	RICHMOND	0.098	443,728
36103	NEW YORK	SUFFOLK	0.091	1,419,369
36119	NEW YORK	WESTCHESTER	0.092	923,459
37003	NORTH CAROLINA	ALEXANDER	0.087	33,603
37027	NORTH CAROLINA	CALDWELL	0.087	77,415
37033	NORTH CAROLINA	CASWELL	0.090	23,501
37051	NORTH CAROLINA	CUMBERLAND	0.088	302,963
37059	NORTH CAROLINA	DAVIE	0.096	34,835
37063	NORTH CAROLINA	DURHAM	0.087	223,314
37065	NORTH CAROLINA	EDGECOMBE	0.087	55,606
37067	NORTH CAROLINA	FORSYTH	0.094	306,067
37069	NORTH CAROLINA	FRANKLIN	0.086	47,260
37077	NORTH CAROLINA	GRANVILLE	0.088	48,498
37081	NORTH CAROLINA	GUILFORD	0.090	421,048
37087	NORTH CAROLINA	HAYWOOD	0.087	54,033
37099	NORTH CAROLINA	JACKSON	0.085	33,121

FIPS Code	State	County	1999- 2001 Design Value	Population 2000
37101	NORTH CAROLINA	JOHNSTON	0.087	121,965
37109	NORTH CAROLINA	LINCOLN	0.091	63,780
37119	NORTH CAROLINA	MECKLENBURG	0.101	695,454
37145	NORTH CAROLINA	PERSON	0.089	35,623
37157	NORTH CAROLINA	ROCKINGHAM	0.085	91,928
37159	NORTH CAROLINA	ROWAN	0.099	130,340
37179	NORTH CAROLINA	UNION	0.087	123,677
37183	NORTH CAROLINA	WAKE	0.094	627,846
37199	NORTH CAROLINA	YANCEY	0.089	17,774
39003	OHIO	ALLEN	0.086	108,473
39007	OHIO	ASHTABULA	0.089	102,728
39017	OHIO	BUTLER	0.089	332,807
39023	OHIO	CLARK	0.087	144,742
39025	OHIO	CLERMONT	0.089	177,977
39027	OHIO	CLINTON	0.095	40,543
39041	OHIO	DELAWARE	0.091	109,989
39055	OHIO	GEAUGA	0.093	90,895
39057	OHIO	GREENE	0.085	147,886
39061	OHIO	HAMILTON	0.086	845,303
39083	OHIO	KNOX	0.090	54,500
39085	OHIO	LAKE	0.091	227,511
39087	OHIO	LAWRENCE	0.086	62,319
39089	OHIO	LICKING	0.088	145,491
39095	OHIO	LUCAS	0.085	455,054
39097	OHIO	MADISON	0.088	40,213
39103	OHIO	MEDINA	0.086	151,095
39113	OHIO	MONTGOMERY	0.087	559,062
39133	OHIO	PORTAGE	0.092	152,061
39151	OHIO	STARK	0.088	378,098
39153	OHIO	SUMMIT	0.092	542,899
39155	OHIO	TRUMBULL	0.088	225,116
39165	OHIO	WARREN	0.088	158,383
39167	OHIO	WASHINGTON	0.088	63,251
39173	OHIO	WOOD	0.085	121,065
40143	OKLAHOMA	TULSA	0.087	563,299
42003	PENNSYLVANIA	ALLEGHENY	0.092	1,281,666
42005	PENNSYLVANIA	ARMSTRONG	0.092	72,392
42007	PENNSYLVANIA	BEAVER	0.089	181,412
42011	PENNSYLVANIA	BERKS	0.095	373,638
42017	PENNSYLVANIA	BUCKS	0.105	597,635
42021	PENNSYLVANIA	CAMBRIA	0.088	152,598
42043	PENNSYLVANIA	DAUPHIN	0.094	251,798

FIPS Code	State	County	1999- 2001 Design Value	Population 2000
42045	PENNSYLVANIA	DELAWARE	0.094	550,864
42049	PENNSYLVANIA	ERIE	0.087	280,843
42055	PENNSYLVANIA	FRANKLIN	0.092	129,313
42059	PENNSYLVANIA	GREENE	0.092	40,672
42069	PENNSYLVANIA	LACKAWANNA	0.086	213,295
42071	PENNSYLVANIA	LANCASTER	0.096	470,658
42077	PENNSYLVANIA	LEHIGH	0.096	312,090
42085	PENNSYLVANIA	MERCER	0.088	120,293
42091	PENNSYLVANIA	MONTGOMERY	0.100	750,097
42095	PENNSYLVANIA	NORTHAMPTON	0.097	267,066
42101	PENNSYLVANIA	PHILADELPHIA	0.088	1,517,550
42125	PENNSYLVANIA	WASHINGTON	0.088	202,897
42129	PENNSYLVANIA	WESTMORELAND	0.086	369,993
42133	PENNSYLVANIA	YORK	0.090	381,751
44003	RHODE ISLAND	KENT	0.094	167,090
44007	RHODE ISLAND	PROVIDENCE	0.087	621,602
44009	RHODE ISLAND	WASHINGTON	0.092	123,546
45001	SOUTH CAROLINA	ABBEVILLE	0.085	26,167
45003	SOUTH CAROLINA	AIKEN	0.086	142,552
45007	SOUTH CAROLINA	ANDERSON	0.090	165,740
45021	SOUTH CAROLINA	CHEROKEE	0.087	52,537
45023	SOUTH CAROLINA	CHESTER	0.085	34,068
45031	SOUTH CAROLINA	DARLINGTON	0.086	67,394
45077	SOUTH CAROLINA	PICKENS	0.087	110,757
45079	SOUTH CAROLINA	RICHLAND	0.093	320,677
45083	SOUTH CAROLINA	SPARTANBURG	0.093	253,791
47001	TENNESSEE	ANDERSON	0.090	71,330
47009	TENNESSEE	BLOUNT	0.096	105,823
47037	TENNESSEE	DAVIDSON	0.087	569,891
47065	TENNESSEE	HAMILTON	0.092	307,896
47075	TENNESSEE	HAYWOOD	0.089	19,797
47089	TENNESSEE	JEFFERSON	0.096	44,294
47093	TENNESSEE	KNOX	0.096	382,032
47141	TENNESSEE	PUTNAM	0.087	62,315
47149	TENNESSEE	RUTHERFORD	0.086	182,023
47155	TENNESSEE	SEVIER	0.098	71,170
47157	TENNESSEE	SHELBY	0.093	897,472
47163	TENNESSEE	SULLIVAN	0.090	153,048
47165	TENNESSEE	SUMNER	0.093	130,449
47187	TENNESSEE	WILLIAMSON	0.088	126,638
47189	TENNESSEE	WILSON	0.087	88,809
48039	TEXAS	BRAZORIA	0.091	241,767

FIPS Code	State	County	1999- 2001 Design Value	Population 2000
48085	TEXAS	COLLIN	0.099	491,675
48113	TEXAS	DALLAS	0.093	2,218,899
48121	TEXAS	DENTON	0.101	432,976
48139	TEXAS	ELLIS	0.088	111,360
48167	TEXAS	GALVESTON	0.098	250,158
48183	TEXAS	GREGG	0.095	111,379
48201	TEXAS	HARRIS	0.110	3,400,578
48245	TEXAS	JEFFERSON	0.085	252,051
48339	TEXAS	MONTGOMERY	0.092	293,768
48439	TEXAS	TARRANT	0.097	1,446,219
48453	TEXAS	TRAVIS	0.088	812,280
51013	VIRGINIA	ARLINGTON	0.092	189,453
51033	VIRGINIA	CAROLINE	0.085	22,121
51036	VIRGINIA	CHARLES CITY	0.087	6,926
51041	VIRGINIA	CHESTERFIELD	0.086	259,903
51059	VIRGINIA	FAIRFAX	0.095	969,749
51087	VIRGINIA	HENRICO	0.090	262,300
51107	VIRGINIA	LOUDOUN	0.086	169,599
51113	VIRGINIA	MADISON	0.087	12,520
51153	VIRGINIA	PRINCE WILLIAM	0.085	280,813
51161	VIRGINIA	ROANOKE	0.086	85,778
51179	VIRGINIA	STAFFORD	0.085	92,446
51510	VIRGINIA	ALEXANDRIA	0.088	128,283
51650	VIRGINIA	HAMPTON	0.087	146,437
51800	VIRGINIA	SUFFOLK	0.086	63,677
54011	WEST VIRGINIA	CABELL	0.088	96,784
54039	WEST VIRGINIA	KANAWHA	0.090	200,073
54107	WEST VIRGINIA	WOOD	0.088	87,986
55029	WISCONSIN	DOOR	0.093	27,961
55055	WISCONSIN	JEFFERSON	0.086	74,021
55059	WISCONSIN	KENOSHA	0.095	149,577
55061	WISCONSIN	KEWAUNEE	0.089	20,187
55071	WISCONSIN	MANITOWOC	0.092	82,887
55079	WISCONSIN	MILWAUKEE	0.089	940,164
55089	WISCONSIN	OZAUKEE	0.095	82,317
55101	WISCONSIN	RACINE	0.087	188,831
55105	WISCONSIN	ROCK	0.086	152,307
55117	WISCONSIN	SHEBOYGAN	0.095	112,646
55133	WISCONSIN	WAUKESHA	0.086	360,767
	Counties: 291		**Total Population:**	**110,747,890**

Table B-2. Counties with Design Values at or below the level of the 8-hour Ozone Standard (1999-2001)

FIPS Code	State	County	1999-2001 Design Value	Population 2000
01027	ALABAMA	CLAY	0.084	14,254
01051	ALABAMA	ELMORE	0.079	65,874
01079	ALABAMA	LAWRENCE	0.082	34,803
01119	ALABAMA	SUMTER	0.075	14,798
02290	ALASKA	YUKON-KOYUKUK	0.051	6,551
04003	ARIZONA	COCHISE	0.070	117,755
04005	ARIZONA	COCONINO	0.072	116,320
04019	ARIZONA	PIMA	0.072	843,746
04025	ARIZONA	YAVAPAI	0.081	167,517
05097	ARKANSAS	MONTGOMERY	0.069	9,245
05101	ARKANSAS	NEWTON	0.078	8,608
06001	CALIFORNIA	ALAMEDA	0.066	1,443,741
06007	CALIFORNIA	BUTTE	0.081	203,171
06011	CALIFORNIA	COLUSA	0.077	18,804
06013	CALIFORNIA	CONTRA COSTA	0.082	948,816
06021	CALIFORNIA	GLENN	0.077	26,453
06027	CALIFORNIA	INYO	0.079	17,945
06033	CALIFORNIA	LAKE	0.063	58,309
06041	CALIFORNIA	MARIN	0.051	247,289
06045	CALIFORNIA	MENDOCINO	0.055	86,265
06053	CALIFORNIA	MONTEREY	0.063	401,762
6055	CALIFORNIA	NAPA	0.066	124,279
06059	CALIFORNIA	ORANGE	0.077	2,846,289
06069	CALIFORNIA	SAN BENITO	0.072	53,234
06075	CALIFORNIA	SAN FRANCISCO	0.046	776,733
06077	CALIFORNIA	SAN JOAQUIN	0.084	563,598
06079	CALIFORNIA	SAN LUIS OBISPO	0.072	246,681
06081	CALIFORNIA	SAN MATEO	0.049	707,161
06083	CALIFORNIA	SANTA BARBARA	0.080	399,347
06085	CALIFORNIA	SANTA CLARA	0.076	1,682,585
06087	CALIFORNIA	SANTA CRUZ	0.065	255,602
06089	CALIFORNIA	SHASTA	0.077	163,256
06095	CALIFORNIA	SOLANO	0.077	394,542
06097	CALIFORNIA	SONOMA	0.069	458,614
06101	CALIFORNIA	SUTTER	0.083	78,930
06113	CALIFORNIA	YOLO	0.082	168,660
08001	COLORADO	ADAMS	0.065	363,857
08005	COLORADO	ARAPAHOE	0.076	487,967
08013	COLORADO	BOULDER	0.072	291,288
08031	COLORADO	DENVER	0.070	554,636
8041	COLORADO	EL PASO	0.068	516,929
08059	COLORADO	JEFFERSON	0.081	527,056

FIPS Code	State	County	1999-2001 Design Value	Population 2000
08067	COLORADO	LA PLATA	0.062	43,941
08069	COLORADO	LARIMER	0.074	251,494
08083	COLORADO	MONTEZUMA	0.069	23,830
08123	COLORADO	WELD	0.070	180,936
12001	FLORIDA	ALACHUA	0.078	217,955
12003	FLORIDA	BAKER	0.075	22,259
12009	FLORIDA	BREVARD	0.076	476,230
12011	FLORIDA	BROWARD	0.075	1,623,018
12031	FLORIDA	DUVAL	0.074	778,879
12057	FLORIDA	HILLSBOROUGH	0.083	998,948
12059	FLORIDA	HOLMES	0.074	18,564
12071	FLORIDA	LEE	0.075	440,888
12073	FLORIDA	LEON	0.077	239,452
12081	FLORIDA	MANATEE	0.082	264,002
12083	FLORIDA	MARION	0.078	258,916
12086	FLORIDA	Miami-Dade	0.074	2,253,362
12095	FLORIDA	ORANGE	0.081	896,344
12097	FLORIDA	OSCEOLA	0.077	172,493
12099	FLORIDA	PALM BEACH	0.075	1,131,184
12101	FLORIDA	PASCO	0.079	344,765
12103	FLORIDA	PINELLAS	0.082	921,482
12105	FLORIDA	POLK	0.079	483,924
12111	FLORIDA	ST LUCIE	0.072	192,695
12115	FLORIDA	SARASOTA	0.084	325,957
12117	FLORIDA	SEMINOLE	0.078	365,196
12127	FLORIDA	VOLUSIA	0.074	443,343
13051	GEORGIA	CHATHAM	0.076	232,048
13057	GEORGIA	CHEROKEE	0.076	141,903
13085	GEORGIA	DAWSON	0.083	15,999
13127	GEORGIA	GLYNN	0.073	67,568
15003	HAWAII	HONOLULU	0.044	876,156
17001	ILLINOIS	ADAMS	0.074	68,277
17019	ILLINOIS	CHAMPAIGN	0.080	179,669
17043	ILLINOIS	DU PAGE	0.068	904,161
17049	ILLINOIS	EFFINGHAM	0.081	34,264
17065	ILLINOIS	HAMILTON	0.077	8,621
17089	ILLINOIS	KANE	0.077	404,119
17097	ILLINOIS	LAKE	0.080	644,356
17111	ILLINOIS	MC HENRY	0.083	260,077
17115	ILLINOIS	MACON	0.078	114,706
17117	ILLINOIS	MACOUPIN	0.080	49,019
17119	ILLINOIS	MADISON	0.082	258,941

FIPS Code	State	County	1999-2001 Design Value	Population 2000
17143	ILLINOIS	PEORIA	0.078	183,433
17157	ILLINOIS	RANDOLPH	0.078	33,893
17163	ILLINOIS	ST CLAIR	0.082	256,082
17167	ILLINOIS	SANGAMON	0.075	188,951
17197	ILLINOIS	WILL	0.079	502,266
17201	ILLINOIS	WINNEBAGO	0.076	278,418
18043	INDIANA	FLOYD	0.082	70,823
18051	INDIANA	GIBSON	0.071	32,500
18141	INDIANA	ST JOSEPH	0.084	265,559
18163	INDIANA	VANDERBURGH	0.084	171,922
18167	INDIANA	VIGO	0.079	105,848
18173	INDIANA	WARRICK	0.081	52,383
19045	IOWA	CLINTON	0.079	50,149
19085	IOWA	HARRISON	0.074	15,666
19113	IOWA	LINN	0.073	191,701
19147	IOWA	PALO ALTO	0.069	10,147
19153	IOWA	POLK	0.060	374,601
19163	IOWA	SCOTT	0.079	158,668
19169	IOWA	STORY	0.066	79,981
19181	IOWA	WARREN	0.067	40,671
20107	KANSAS	LINN	0.079	9,570
20173	KANSAS	SEDGWICK	0.081	452,869
20209	KANSAS	WYANDOTTE	0.080	157,882
21013	KENTUCKY	BELL	0.082	30,060
21043	KENTUCKY	CARTER	0.083	26,889
21059	KENTUCKY	DAVIESS	0.079	91,545
21067	KENTUCKY	FAYETTE	0.081	260,512
21083	KENTUCKY	GRAVES	0.083	37,028
21091	KENTUCKY	HANCOCK	0.083	8,392
21101	KENTUCKY	HENDERSON	0.077	44,829
21113	KENTUCKY	JESSAMINE	0.078	39,041
21145	KENTUCKY	MC CRACKEN	0.084	65,514
21195	KENTUCKY	PIKE	0.078	68,736
21209	KENTUCKY	SCOTT	0.072	33,061
21221	KENTUCKY	TRIGG	0.082	12,597
22011	LOUISIANA	BEAUREGARD	0.078	32,986
22017	LOUISIANA	CADDO	0.083	252,161
22043	LOUISIANA	GRANT	0.081	18,698
22055	LOUISIANA	LAFAYETTE	0.083	190,503
22071	LOUISIANA	ORLEANS	0.076	484,674
22073	LOUISIANA	OUACHITA	0.080	147,250
22077	LOUISIANA	POINTE COUPEE	0.075	22,763

FIPS Code	State	County	1999-2001 Design Value	Population 2000
22087	LOUISIANA	ST BERNARD	0.081	67,229
22093	LOUISIANA	ST JAMES	0.083	21,216
22101	LOUISIANA	ST MARY	0.083	53,500
23005	MAINE	CUMBERLAND	0.080	265,612
23011	MAINE	KENNEBEC	0.075	117,114
23013	MAINE	KNOX	0.080	39,618
23017	MAINE	OXFORD	0.061	54,755
23021	MAINE	PISCATAQUIS	0.065	17,235
25025	MASSACHUSETTS	SUFFOLK	0.084	689,807
26037	MICHIGAN	CLINTON	0.082	64,753
26063	MICHIGAN	HURON	0.083	36,079
26065	MICHIGAN	INGHAM	0.083	279,320
26077	MICHIGAN	KALAMAZOO	0.082	238,603
26081	MICHIGAN	KENT	0.084	574,335
26091	MICHIGAN	LENAWEE	0.083	98,890
26113	MICHIGAN	MISSAUKEE	0.082	14,478
26125	MICHIGAN	OAKLAND	0.084	1,194,156
26139	MICHIGAN	OTTAWA	0.084	238,314
27003	MINNESOTA	ANOKA	0.071	298,084
27137	MINNESOTA	ST LOUIS	0.067	200,528
27163	MINNESOTA	WASHINGTON	0.075	201,130
28001	MISSISSIPPI	ADAMS	0.082	34,340
28011	MISSISSIPPI	BOLIVAR	0.082	40,633
28049	MISSISSIPPI	HINDS	0.080	250,800
28075	MISSISSIPPI	LAUDERDALE	0.079	78,161
28089	MISSISSIPPI	MADISON	0.079	74,674
28149	MISSISSIPPI	WARREN	0.078	49,644
29039	MISSOURI	CEDAR	0.084	13,733
29047	MISSOURI	CLAY	0.084	184,006
29077	MISSOURI	GREENE	0.075	240,391
29137	MISSOURI	MONROE	0.081	9,311
29165	MISSOURI	PLATTE	0.081	73,781
29510	MISSOURI	ST LOUIS (CITY)	0.081	348,189
30029	MONTANA	FLATHEAD	0.054	74,471
31055	NEBRASKA	DOUGLAS	0.062	463,585
31109	NEBRASKA	LANCASTER	0.053	250,291
32003	NEVADA	CLARK	0.080	1,375,765
32005	NEVADA	DOUGLAS	0.072	41,259
32031	NEVADA	WASHOE	0.073	339,486
32033	NEVADA	WHITE PINE	0.072	9,181
32510	NEVADA	CARSON CITY	0.068	52,457
33003	NEW HAMPSHIRE	CARROLL	0.066	43,666

FIPS Code	State	County	1999-2001 Design Value	Population 2000
33005	NEW HAMPSHIRE	CHESHIRE	0.072	73,825
33009	NEW HAMPSHIRE	GRAFTON	0.068	81,743
33011	NEW HAMPSHIRE	HILLSBOROUGH	0.083	380,841
33013	NEW HAMPSHIRE	MERRIMACK	0.070	136,225
33015	NEW HAMPSHIRE	ROCKINGHAM	0.081	277,359
33017	NEW HAMPSHIRE	STRAFFORD	0.075	112,233
33019	NEW HAMPSHIRE	SULLIVAN	0.072	40,458
35001	NEW MEXICO	BERNALILLO	0.075	556,678
35013	NEW MEXICO	DONA ANA	0.080	174,682
35015	NEW MEXICO	EDDY	0.068	51,658
35043	NEW MEXICO	SANDOVAL	0.072	89,908
35045	NEW MEXICO	SAN JUAN	0.073	113,801
35061	NEW MEXICO	VALENCIA	0.069	66,152
36001	NEW YORK	ALBANY	0.080	294,565
36005	NEW YORK	BRONX	0.083	1,332,650
36015	NEW YORK	CHEMUNG	0.079	91,070
36031	NEW YORK	ESSEX	0.078	38,851
36041	NEW YORK	HAMILTON	0.077	5,379
36043	NEW YORK	HERKIMER	0.072	64,427
36053	NEW YORK	MADISON	0.078	69,441
36065	NEW YORK	ONEIDA	0.076	235,469
36067	NEW YORK	ONONDAGA	0.081	458,336
36091	NEW YORK	SARATOGA	0.084	200,635
36093	NEW YORK	SCHENECTADY	0.075	146,555
36111	NEW YORK	ULSTER	0.081	177,749
36117	NEW YORK	WAYNE	0.081	93,765
37011	NORTH CAROLINA	AVERY	0.075	17,167
37021	NORTH CAROLINA	BUNCOMBE	0.083	206,330
37029	NORTH CAROLINA	CAMDEN	0.080	6,885
37037	NORTH CAROLINA	CHATHAM	0.081	49,329
37061	NORTH CAROLINA	DUPLIN	0.082	49,063
37107	NORTH CAROLINA	LENOIR	0.082	59,648
37117	NORTH CAROLINA	MARTIN	0.079	25,593
37129	NORTH CAROLINA	NEW HANOVER	0.075	160,307
37131	NORTH CAROLINA	NORTHAMPTON	0.082	22,086
37147	NORTH CAROLINA	PITT	0.084	133,798
37173	NORTH CAROLINA	SWAIN	0.073	12,968
38007	NORTH DAKOTA	BILLINGS	0.058	888
38017	NORTH DAKOTA	CASS	0.063	123,138
38057	NORTH DAKOTA	MERCER	0.056	8,644
39035	OHIO	CUYAHOGA	0.083	1,393,978
39049	OHIO	FRANKLIN	0.084	1,068,978

FIPS Code	State	County	1999-2001 Design Value	Population 2000
39081	OHIO	JEFFERSON	0.084	73,894
39093	OHIO	LORAIN	0.081	284,664
39109	OHIO	MIAMI	0.084	98,868
39135	OHIO	PREBLE	0.078	42,337
40027	OKLAHOMA	CLEVELAND	0.079	208,016
40031	OKLAHOMA	COMANCHE	0.081	114,996
40109	OKLAHOMA	OKLAHOMA	0.080	660,448
41005	OREGON	CLACKAMAS	0.068	338,391
41009	OREGON	COLUMBIA	0.053	43,560
41039	OREGON	LANE	0.054	322,959
41047	OREGON	MARION	0.060	284,834
42013	PENNSYLVANIA	BLAIR	0.084	129,144
42027	PENNSYLVANIA	CENTRE	0.080	135,758
42033	PENNSYLVANIA	CLEARFIELD	0.083	83,382
42073	PENNSYLVANIA	LAWRENCE	0.078	94,643
42079	PENNSYLVANIA	LUZERNE	0.084	319,250
42081	PENNSYLVANIA	LYCOMING	0.076	120,044
42099	PENNSYLVANIA	PERRY	0.084	43,602
42117	PENNSYLVANIA	TIOGA	0.081	41,373
45011	SOUTH CAROLINA	BARNWELL	0.083	23,478
45019	SOUTH CAROLINA	CHARLESTON	0.078	309,969
45029	SOUTH CAROLINA	COLLETON	0.079	38,264
45037	SOUTH CAROLINA	EDGEFIELD	0.080	24,595
45087	SOUTH CAROLINA	UNION	0.081	29,881
45089	SOUTH CAROLINA	WILLIAMSBURG	0.073	37,217
45091	SOUTH CAROLINA	YORK	0.082	164,614
47099	TENNESSEE	LAWRENCE	0.083	39,926
48029	TEXAS	BEXAR	0.082	1,392,931
48061	TEXAS	CAMERON	0.064	335,227
48141	TEXAS	EL PASO	0.075	679,622
48215	TEXAS	HIDALGO	0.075	569,463
48355	TEXAS	NUECES	0.081	313,645
48361	TEXAS	ORANGE	0.074	84,966
48469	TEXAS	VICTORIA	0.079	84,088
48479	TEXAS	WEBB	0.066	193,117
49011	UTAH	DAVIS	0.079	238,994
49035	UTAH	SALT LAKE	0.079	898,387
49049	UTAH	UTAH	0.078	368,536
49057	UTAH	WEBER	0.075	196,533
50003	VERMONT	BENNINGTON	0.079	36,994
50007	VERMONT	CHITTENDEN	0.075	146,571
51061	VIRGINIA	FAUQUIER	0.082	55,139

FIPS Code	State	County	1999-2001 Design Value	Population 2000
51069	VIRGINIA	FREDERICK	0.083	59,209
51139	VIRGINIA	PAGE	0.082	23,177
51163	VIRGINIA	ROCKBRIDGE	0.080	20,808
51197	VIRGINIA	WYTHE	0.081	27,599
53009	WASHINGTON	CLALLAM	0.045	64,525
53011	WASHINGTON	CLARK	0.059	345,238
53033	WASHINGTON	KING	0.069	1,737,034
53039	WASHINGTON	KLICKITAT	0.065	19,161
53053	WASHINGTON	PIERCE	0.067	700,820
53057	WASHINGTON	SKAGIT	0.048	102,979
53063	WASHINGTON	SPOKANE	0.068	417,939
53067	WASHINGTON	THURSTON	0.057	207,355
53073	WASHINGTON	WHATCOM	0.050	166,814
54025	WEST VIRGINIA	GREENBRIER	0.083	34,453
54029	WEST VIRGINIA	HANCOCK	0.082	32,667
54069	WEST VIRGINIA	OHIO	0.082	47,427
55009	WISCONSIN	BROWN	0.081	226,778
55021	WISCONSIN	COLUMBIA	0.078	52,468
55025	WISCONSIN	DANE	0.078	426,526
55027	WISCONSIN	DODGE	0.082	85,897
55037	WISCONSIN	FLORENCE	0.075	5,088
55039	WISCONSIN	FOND DU LAC	0.080	97,296
55073	WISCONSIN	MARATHON	0.076	125,834
55085	WISCONSIN	ONEIDA	0.073	36,776
55087	WISCONSIN	OUTAGAMIE	0.079	160,971
55109	WISCONSIN	ST CROIX	0.073	63,155
55111	WISCONSIN	SAUK	0.077	55,225
55123	WISCONSIN	VERNON	0.072	28,056
55125	WISCONSIN	VILAS	0.072	21,033
55127	WISCONSIN	WALWORTH	0.084	93,759
55131	WISCONSIN	WASHINGTON	0.084	117,493
55139	WISCONSIN	WINNEBAGO	0.080	156,763
56039	WYOMING	TETON	0.067	18,251
78003	VIRGIN ISLANDS	ST JOHN	0.047	4,197
	Counties: 286		**Total Population:**	**72,695,359**

Table B-3. Counties with incomplete data for calculating the 8-hour Ozone Design Value (1999-2001)

FIPS Code	State	County	Population 2000
01003	ALABAMA	BALDWIN	140,415
01033	ALABAMA	COLBERT	54,984
01055	ALABAMA	ETOWAH	103,459
01061	ALABAMA	GENEVA	25,764
01097	ALABAMA	MOBILE	399,843
01103	ALABAMA	MORGAN	111,064
01125	ALABAMA	TUSCALOOSA	164,875
01127	ALABAMA	WALKER	70,713
04007	ARIZONA	GILA	51,335
04017	ARIZONA	NAVAJO	97,470
04021	ARIZONA	PINAL	179,727
04027	ARIZONA	YUMA	160,026
06051	CALIFORNIA	MONO	12,853
06063	CALIFORNIA	PLUMAS	20,824
06093	CALIFORNIA	SISKIYOU	44,301
08035	COLORADO	DOUGLAS	175,766
09005	CONNECTICUT	LITCHFIELD	182,193
12005	FLORIDA	BAY	148,217
12021	FLORIDA	COLLIER	251,377
12023	FLORIDA	COLUMBIA	56,513
12055	FLORIDA	HIGHLANDS	87,366
12069	FLORIDA	LAKE	210,528
12109	FLORIDA	ST JOHNS	123,135
12113	FLORIDA	SANTA ROSA	117,743
12129	FLORIDA	WAKULLA	22,863
13059	GEORGIA	CLARKE	101,489
13111	GEORGIA	FANNIN	19,798
13213	GEORGIA	MURRAY	36,506
15001	HAWAII	HAWAII	148,677
16001	IDAHO	ADA	300,904
16023	IDAHO	BUTTE	2,899
16027	IDAHO	CANYON	131,441
16039	IDAHO	ELMORE	29,130
17023	ILLINOIS	CLARK	17,008
17113	ILLINOIS	MC LEAN	150,433
17161	ILLINOIS	ROCK ISLAND	149,374
18011	INDIANA	BOONE	46,107
18015	INDIANA	CARROLL	20,165
18035	INDIANA	DELAWARE	118,769
18039	INDIANA	ELKHART	182,791
18055	INDIANA	GREENE	33,157
18063	INDIANA	HENDRICKS	104,093
18069	INDIANA	HUNTINGTON	38,075

FIPS Code	State	County	Population 2000
18071	INDIANA	JACKSON	41,335
18145	INDIANA	SHELBY	43,445
19017	IOWA	BREMER	23,325
19137	IOWA	MONTGOMERY	11,771
19177	IOWA	VAN BUREN	7,809
20087	KANSAS	JEFFERSON	18,426
20191	KANSAS	SUMNER	25,946
20195	KANSAS	TREGO	3,319
21037	KENTUCKY	CAMPBELL	88,616
21093	KENTUCKY	HARDIN	94,174
21127	KENTUCKY	LAWRENCE	15,569
21177	KENTUCKY	MUHLENBERG	31,839
21193	KENTUCKY	PERRY	29,390
21227	KENTUCKY	WARREN	92,522
22057	LOUISIANA	LAFOURCHE	89,974
23019	MAINE	PENOBSCOT	144,919
23023	MAINE	SAGADAHOC	35,214
24510	MARYLAND	BALTIMORE (CITY)	651,154
25003	MASSACHUSETTS	BERKSHIRE	134,953
25021	MASSACHUSETTS	NORFOLK	650,308
26055	MICHIGAN	GRAND TRAVERSE	77,654
26153	MICHIGAN	SCHOOLCRAFT	8,903
26161	MICHIGAN	WASHTENAW	322,895
27017	MINNESOTA	CARLTON	31,671
27037	MINNESOTA	DAKOTA	355,904
27075	MINNESOTA	LAKE	11,058
27095	MINNESOTA	MILLE LACS	22,330
27139	MINNESOTA	SCOTT	89,498
28003	MISSISSIPPI	ALCORN	34,558
28107	MISSISSIPPI	PANOLA	34,274
29037	MISSOURI	CASS	82,092
29095	MISSOURI	JACKSON	654,880
30063	MONTANA	MISSOULA	95,802
33001	NEW HAMPSHIRE	BELKNAP	56,325
33007	NEW HAMPSHIRE	COOS	33,111
34003	NEW JERSEY	BERGEN	884,118
34013	NEW JERSEY	ESSEX	793,633
36055	NEW YORK	MONROE	735,343
36061	NEW YORK	NEW YORK	1,537,195
36075	NEW YORK	OSWEGO	122,377
36083	NEW YORK	RENSSELAER	152,538
37151	NORTH CAROLINA	RANDOLPH	130,454
38025	NORTH DAKOTA	DUNN	3,600
38065	NORTH DAKOTA	OLIVER	2,065
38091	NORTH DAKOTA	STEELE	2,258

FIPS Code	State	County	Population 2000
39091	OHIO	LOGAN	46,005
39099	OHIO	MAHONING	257,555
39159	OHIO	UNION	40,909
40001	OKLAHOMA	ADAIR	21,038
40017	OKLAHOMA	CANADIAN	87,697
40019	OKLAHOMA	CARTER	45,621
40021	OKLAHOMA	CHEROKEE	42,521
40043	OKLAHOMA	DEWEY	4,743
40067	OKLAHOMA	JEFFERSON	6,818
40071	OKLAHOMA	KAY	48,080
40077	OKLAHOMA	LATIMER	10,692
40085	OKLAHOMA	LOVE	8,831
40087	OKLAHOMA	MC CLAIN	27,740
40095	OKLAHOMA	MARSHALL	13,184
40097	OKLAHOMA	MAYES	38,369
40101	OKLAHOMA	MUSKOGEE	69,451
40111	OKLAHOMA	OKMULGEE	39,685
40115	OKLAHOMA	OTTAWA	33,194
40121	OKLAHOMA	PITTSBURG	43,953
41029	OREGON	JACKSON	181,269
41043	OREGON	LINN	103,069
42001	PENNSYLVANIA	ADAMS	91,292
42029	PENNSYLVANIA	CHESTER	433,501
42089	PENNSYLVANIA	MONROE	138,687
45015	SOUTH CAROLINA	BERKELEY	142,651
45025	SOUTH CAROLINA	CHESTERFIELD	42,768
45045	SOUTH CAROLINA	GREENVILLE	379,616
45073	SOUTH CAROLINA	OCONEE	66,215
46099	SOUTH DAKOTA	MINNEHAHA	148,281
46103	SOUTH DAKOTA	PENNINGTON	88,565
47031	TENNESSEE	COFFEE	48,014
47043	TENNESSEE	DICKSON	43,156
47045	TENNESSEE	DYER	37,279
47063	TENNESSEE	HAMBLEN	58,128
47121	TENNESSEE	MEIGS	11,086
47125	TENNESSEE	MONTGOMERY	134,768
47131	TENNESSEE	OBION	32,450
47145	TENNESSEE	ROANE	51,910
48043	TEXAS	BREWSTER	8,866
48203	TEXAS	HARRISON	62,110
48221	TEXAS	HOOD	41,100
48251	TEXAS	JOHNSON	126,811
48257	TEXAS	KAUFMAN	71,313
48315	TEXAS	MARION	10,941
48367	TEXAS	PARKER	88,495

FIPS Code	State	County	Population 2000
48397	TEXAS	ROCKWALL	43,080
48423	TEXAS	SMITH	174,706
49003	UTAH	BOX ELDER	42,745
49005	UTAH	CACHE	91,391
49037	UTAH	SAN JUAN	14,413
51085	VIRGINIA	HANOVER	86,320
53015	WASHINGTON	COWLITZ	92,948
53041	WASHINGTON	LEWIS	68,600
53045	WASHINGTON	MASON	49,405
54003	WEST VIRGINIA	BERKELEY	75,905
54061	WEST VIRGINIA	MONONGALIA	81,866
55045	WISCONSIN	GREEN	33,647
55095	WISCONSIN	POLK	41,319
56005	WYOMING	CAMPBELL	33,698
72033	PUERTO RICO	CATANO	30,071
	Counties: 148	**Total Population:**	**17,641,255**

Table B-4. Counties with Design Values above the level of the 8-hour Ozone Standard (2000-2002).

FIPS Code	State	County	2000-2002 Design Value	Population 2000
01073	ALABAMA	JEFFERSON	0.088	662,047
01103	ALABAMA	MORGAN	0.085	111,064
01117	ALABAMA	SHELBY	0.092	143,293
04013	ARIZONA	MARICOPA	0.085	3,072,149
05035	ARKANSAS	CRITTENDEN	0.094	50,866
05119	ARKANSAS	PULASKI	0.086	361,474
06005	CALIFORNIA	AMADOR	0.088	35,100
06007	CALIFORNIA	BUTTE	0.089	203,171
06009	CALIFORNIA	CALAVERAS	0.092	40,554
06017	CALIFORNIA	EL DORADO	0.106	156,299
06019	CALIFORNIA	FRESNO	0.115	799,407
06025	CALIFORNIA	IMPERIAL	0.087	142,361
06029	CALIFORNIA	KERN	0.112	661,645
06031	CALIFORNIA	KINGS	0.099	129,461
06037	CALIFORNIA	LOS ANGELES	0.113	9,519,338
06039	CALIFORNIA	MADERA	0.091	123,109
06043	CALIFORNIA	MARIPOSA	0.089	17,130
06047	CALIFORNIA	MERCED	0.101	210,554
06057	CALIFORNIA	NEVADA	0.098	92,033
06061	CALIFORNIA	PLACER	0.101	248,399
06065	CALIFORNIA	RIVERSIDE	0.113	1,545,387
6067	CALIFORNIA	SACRAMENTO	0.100	1,223,499
06071	CALIFORNIA	SAN BERNARDINO	0.128	1,709,434
06073	CALIFORNIA	SAN DIEGO	0.095	2,813,833
06099	CALIFORNIA	STANISLAUS	0.095	446,997
06107	CALIFORNIA	TULARE	0.105	368,021
06109	CALIFORNIA	TUOLUMNE	0.091	54,501
06111	CALIFORNIA	VENTURA	0.097	753,197
09001	CONNECTICUT	FAIRFIELD	0.098	882,567
09003	CONNECTICUT	HARTFORD	0.090	857,183
09007	CONNECTICUT	MIDDLESEX	0.097	155,071
09009	CONNECTICUT	NEW HAVEN	0.098	824,008
09011	CONNECTICUT	NEW LONDON	0.089	259,088
09013	CONNECTICUT	TOLLAND	0.094	136,364
10001	DELAWARE	KENT	0.092	126,697
10003	DELAWARE	NEW CASTLE	0.096	500,265
10005	DELAWARE	SUSSEX	0.094	156,638
11001	DISTRICT OF COLUMBIA	WASHINGTON	0.095	572,059
13021	GEORGIA	BIBB	0.092	153,887
13067	GEORGIA	COBB	0.098	607,751
13077	GEORGIA	COWETA	0.093	89,215
13089	GEORGIA	DE KALB	0.095	665,865
13097	GEORGIA	DOUGLAS	0.095	92,174

FIPS Code	State	County	2000-2002 Design Value	Population 2000
13113	GEORGIA	FAYETTE	0.090	91,263
13121	GEORGIA	FULTON	0.099	816,006
13135	GEORGIA	GWINNETT	0.089	588,448
13151	GEORGIA	HENRY	0.098	119,341
13213	GEORGIA	MURRAY	0.087	36,506
13223	GEORGIA	PAULDING	0.090	81,678
13245	GEORGIA	RICHMOND	0.087	199,775
13247	GEORGIA	ROCKDALE	0.096	70,111
17031	ILLINOIS	COOK	0.088	5,376,741
17083	ILLINOIS	JERSEY	0.089	21,668
17163	ILLINOIS	ST CLAIR	0.085	256,082
18003	INDIANA	ALLEN	0.088	331,849
18011	INDIANA	BOONE	0.088	46,107
18019	INDIANA	CLARK	0.090	96,472
18055	INDIANA	GREENE	0.089	33,157
18057	INDIANA	HAMILTON	0.093	182,740
18059	INDIANA	HANCOCK	0.092	55,391
18063	INDIANA	HENDRICKS	0.088	104,093
18069	INDIANA	HUNTINGTON	0.086	38,075
18071	INDIANA	JACKSON	0.085	41,335
18081	INDIANA	JOHNSON	0.087	115,209
18089	INDIANA	LAKE	0.092	484,564
18091	INDIANA	LA PORTE	0.092	110,106
18095	INDIANA	MADISON	0.091	133,358
18097	INDIANA	MARION	0.090	860,454
18109	INDIANA	MORGAN	0.088	66,689
18127	INDIANA	PORTER	0.090	146,798
18129	INDIANA	POSEY	0.087	27,061
18141	INDIANA	ST JOSEPH	0.090	265,559
18145	INDIANA	SHELBY	0.093	43,445
21013	KENTUCKY	BELL	0.086	30,060
21015	KENTUCKY	BOONE	0.086	85,991
21019	KENTUCKY	BOYD	0.088	49,752
21029	KENTUCKY	BULLITT	0.085	61,236
21037	KENTUCKY	CAMPBELL	0.094	88,616
21047	KENTUCKY	CHRISTIAN	0.085	72,265
21111	KENTUCKY	JEFFERSON	0.085	693,604
21117	KENTUCKY	KENTON	0.088	151,464
21185	KENTUCKY	OLDHAM	0.087	46,178
21227	KENTUCKY	WARREN	0.086	92,522
22033	LOUISIANA	EAST BATON ROUGE	0.086	412,852
22047	LOUISIANA	IBERVILLE	0.086	33,320

FIPS Code	State	County	2000-2002 Design Value	Population 2000
22051	LOUISIANA	JEFFERSON	0.085	455,466
22121	LOUISIANA	WEST BATON ROUGE	0.085	21,601
23005	MAINE	CUMBERLAND	0.086	265,612
23009	MAINE	HANCOCK	0.093	51,791
23031	MAINE	YORK	0.090	186,742
24003	MARYLAND	ANNE ARUNDEL	0.102	489,656
24005	MARYLAND	BALTIMORE	0.093	754,292
24013	MARYLAND	CARROLL	0.092	150,897
24015	MARYLAND	CECIL	0.104	85,951
24017	MARYLAND	CHARLES	0.094	120,546
24021	MARYLAND	FREDERICK	0.091	195,277
24025	MARYLAND	HARFORD	0.104	218,590
24029	MARYLAND	KENT	0.102	19,197
24031	MARYLAND	MONTGOMERY	0.089	873,341
24033	MARYLAND	PRINCE GEORGES	0.095	801,515
24043	MARYLAND	WASHINGTON	0.087	131,923
25001	MASSACHUSETTS	BARNSTABLE	0.093	222,230
25005	MASSACHUSETTS	BRISTOL	0.090	534,678
25009	MASSACHUSETTS	ESSEX	0.090	723,419
25013	MASSACHUSETTS	HAMPDEN	0.092	456,228
25015	MASSACHUSETTS	HAMPSHIRE	0.088	152,251
25017	MASSACHUSETTS	MIDDLESEX	0.089	1,465,396
25025	MASSACHUSETTS	SUFFOLK	0.089	689,807
25027	MASSACHUSETTS	WORCESTER	0.085	750,963
26005	MICHIGAN	ALLEGAN	0.092	105,665
26019	MICHIGAN	BENZIE	0.086	15,998
26021	MICHIGAN	BERRIEN	0.087	162,453
26027	MICHIGAN	CASS	0.090	51,104
26091	MICHIGAN	LENAWEE	0.085	98,890
26099	MICHIGAN	MACOMB	0.088	788,149
26105	MICHIGAN	MASON	0.087	28,274
26121	MICHIGAN	MUSKEGON	0.089	170,200
26125	MICHIGAN	OAKLAND	0.086	1,194,156
26139	MICHIGAN	OTTAWA	0.085	238,314
26147	MICHIGAN	ST CLAIR	0.088	164,235
26161	MICHIGAN	WASHTENAW	0.087	322,895
26163	MICHIGAN	WAYNE	0.085	2,061,162
28033	MISSISSIPPI	DE SOTO	0.086	107,199
29047	MISSOURI	CLAY	0.085	184,006
29099	MISSOURI	JEFFERSON	0.086	198,099
29183	MISSOURI	ST CHARLES	0.090	283,883
29189	MISSOURI	ST LOUIS	0.089	1,016,315

FIPS Code	State	County	2000-2002 Design Value	Population 2000
29510	MISSOURI	ST LOUIS (CITY)	0.088	348,189
33011	NEW HAMPSHIRE	HILLSBOROUGH	0.085	380,841
34001	NEW JERSEY	ATLANTIC	0.091	252,552
34003	NEW JERSEY	BERGEN	0.091	884,118
34007	NEW JERSEY	CAMDEN	0.103	508,932
34011	NEW JERSEY	CUMBERLAND	0.098	146,438
34015	NEW JERSEY	GLOUCESTER	0.104	254,673
34017	NEW JERSEY	HUDSON	0.087	608,975
34019	NEW JERSEY	HUNTERDON	0.096	121,989
34021	NEW JERSEY	MERCER	0.104	350,761
34023	NEW JERSEY	MIDDLESEX	0.101	750,162
34025	NEW JERSEY	MONMOUTH	0.097	615,301
34027	NEW JERSEY	MORRIS	0.098	470,212
34029	NEW JERSEY	OCEAN	0.115	510,916
34031	NEW JERSEY	PASSAIC	0.088	489,049
36013	NEW YORK	CHAUTAUQUA	0.092	139,750
36027	NEW YORK	DUTCHESS	0.093	280,150
36029	NEW YORK	ERIE	0.097	950,265
36031	NEW YORK	ESSEX	0.086	38,851
36045	NEW YORK	JEFFERSON	0.091	111,738
36055	NEW YORK	MONROE	0.085	735,343
36063	NEW YORK	NIAGARA	0.091	219,846
36079	NEW YORK	PUTNAM	0.092	95,745
36085	NEW YORK	RICHMOND	0.096	443,728
36103	NEW YORK	SUFFOLK	0.097	1,419,369
36119	NEW YORK	WESTCHESTER	0.090	923,459
37003	NORTH CAROLINA	ALEXANDER	0.091	33,603
37021	NORTH CAROLINA	BUNCOMBE	0.085	206,330
37027	NORTH CAROLINA	CALDWELL	0.086	77,415
37033	NORTH CAROLINA	CASWELL	0.091	23,501
37051	NORTH CAROLINA	CUMBERLAND	0.087	302,963
37059	NORTH CAROLINA	DAVIE	0.095	34,835
37063	NORTH CAROLINA	DURHAM	0.091	223,314
37065	NORTH CAROLINA	EDGECOMBE	0.088	55,606
37067	NORTH CAROLINA	FORSYTH	0.094	306,067
37069	NORTH CAROLINA	FRANKLIN	0.091	47,260
37077	NORTH CAROLINA	GRANVILLE	0.094	48,498
37081	NORTH CAROLINA	GUILFORD	0.093	421,048
37087	NORTH CAROLINA	HAYWOOD	0.087	54,033
37099	NORTH CAROLINA	JACKSON	0.086	33,121
37101	NORTH CAROLINA	JOHNSTON	0.085	121,965
37109	NORTH CAROLINA	LINCOLN	0.094	63,780

FIPS Code	State	County	2000-2002 Design Value	Population 2000
37119	NORTH CAROLINA	MECKLENBURG	0.102	695,454
37145	NORTH CAROLINA	PERSON	0.090	35,623
37157	NORTH CAROLINA	ROCKINGHAM	0.090	91,928
37159	NORTH CAROLINA	ROWAN	0.101	130,340
37179	NORTH CAROLINA	UNION	0.088	123,677
37183	NORTH CAROLINA	WAKE	0.094	627,846
37199	NORTH CAROLINA	YANCEY	0.087	17,774
39003	OHIO	ALLEN	0.088	108,473
39007	OHIO	ASHTABULA	0.094	102,728
39017	OHIO	BUTLER	0.089	332,807
39023	OHIO	CLARK	0.090	144,742
39025	OHIO	CLERMONT	0.090	177,977
39027	OHIO	CLINTON	0.096	40,543
39035	OHIO	CUYAHOGA	0.086	1,393,978
39041	OHIO	DELAWARE	0.089	109,989
39055	OHIO	GEAUGA	0.099	90,895
39057	OHIO	GREENE	0.086	147,886
39061	OHIO	HAMILTON	0.089	845,303
39081	OHIO	JEFFERSON	0.086	73,894
39083	OHIO	KNOX	0.090	54,500
39085	OHIO	LAKE	0.092	227,511
39087	OHIO	LAWRENCE	0.086	62,319
39089	OHIO	LICKING	0.090	145,491
39093	OHIO	LORAIN	0.085	284,664
39095	OHIO	LUCAS	0.089	455,054
39097	OHIO	MADISON	0.089	40,213
39099	OHIO	MAHONING	0.087	257,555
39103	OHIO	MEDINA	0.087	151,095
39109	OHIO	MIAMI	0.087	98,868
39113	OHIO	MONTGOMERY	0.086	559,062
39133	OHIO	PORTAGE	0.091	152,061
39151	OHIO	STARK	0.089	378,098
39153	OHIO	SUMMIT	0.095	542,899
39155	OHIO	TRUMBULL	0.090	225,116
39165	OHIO	WARREN	0.089	158,383
39167	OHIO	WASHINGTON	0.087	63,251
39173	OHIO	WOOD	0.086	121,065
40143	OKLAHOMA	TULSA	0.085	563,299
42003	PENNSYLVANIA	ALLEGHENY	0.095	1,281,666
42005	PENNSYLVANIA	ARMSTRONG	0.091	72,392
42007	PENNSYLVANIA	BEAVER	0.090	181,412
42011	PENNSYLVANIA	BERKS	0.092	373,638

FIPS Code	State	County	2000-2002 Design Value	Population 2000
42017	PENNSYLVANIA	BUCKS	0.104	597,635
42021	PENNSYLVANIA	CAMBRIA	0.088	152,598
42027	PENNSYLVANIA	CENTRE	0.085	135,758
42029	PENNSYLVANIA	CHESTER	0.095	433,501
42033	PENNSYLVANIA	CLEARFIELD	0.087	83,382
42043	PENNSYLVANIA	DAUPHIN	0.091	251,798
42045	PENNSYLVANIA	DELAWARE	0.095	550,864
42049	PENNSYLVANIA	ERIE	0.088	280,843
42055	PENNSYLVANIA	FRANKLIN	0.094	129,313
42059	PENNSYLVANIA	GREENE	0.090	40,672
42069	PENNSYLVANIA	LACKAWANNA	0.085	213,295
42071	PENNSYLVANIA	LANCASTER	0.094	470,658
42077	PENNSYLVANIA	LEHIGH	0.093	312,090
42085	PENNSYLVANIA	MERCER	0.092	120,293
42091	PENNSYLVANIA	MONTGOMERY	0.097	750,097
42095	PENNSYLVANIA	NORTHAMPTON	0.092	267,066
42101	PENNSYLVANIA	PHILADELPHIA	0.098	1,517,550
42125	PENNSYLVANIA	WASHINGTON	0.088	202,897
42129	PENNSYLVANIA	WESTMORELAND	0.086	369,993
42133	PENNSYLVANIA	YORK	0.092	381,751
44003	RHODE ISLAND	KENT	0.097	167,090
44007	RHODE ISLAND	PROVIDENCE	0.091	621,602
44009	RHODE ISLAND	WASHINGTON	0.093	123,546
45001	SOUTH CAROLINA	ABBEVILLE	0.085	26,167
45003	SOUTH CAROLINA	AIKEN	0.088	142,552
45007	SOUTH CAROLINA	ANDERSON	0.088	165,740
45021	SOUTH CAROLINA	CHEROKEE	0.087	52,537
45031	SOUTH CAROLINA	DARLINGTON	0.086	67,394
45077	SOUTH CAROLINA	PICKENS	0.085	110,757
45079	SOUTH CAROLINA	RICHLAND	0.093	320,677
45083	SOUTH CAROLINA	SPARTANBURG	0.090	253,791
47001	TENNESSEE	ANDERSON	0.092	71,330
47009	TENNESSEE	BLOUNT	0.094	105,823
47065	TENNESSEE	HAMILTON	0.093	307,896
47075	TENNESSEE	HAYWOOD	0.086	19,797
47089	TENNESSEE	JEFFERSON	0.095	44,294
47093	TENNESSEE	KNOX	0.096	382,032
47121	TENNESSEE	MEIGS	0.093	11,086
47141	TENNESSEE	PUTNAM	0.086	62,315
47155	TENNESSEE	SEVIER	0.098	71,170
47157	TENNESSEE	SHELBY	0.090	897,472
47163	TENNESSEE	SULLIVAN	0.092	153,048

FIPS Code	State	County	2000-2002 Design Value	Population 2000
47165	TENNESSEE	SUMNER	0.088	130,449
47187	TENNESSEE	WILLIAMSON	0.087	126,638
47189	TENNESSEE	WILSON	0.085	88,809
48029	TEXAS	BEXAR	0.086	1,392,931
48039	TEXAS	BRAZORIA	0.086	241,767
48085	TEXAS	COLLIN	0.093	491,675
48113	TEXAS	DALLAS	0.091	2,218,899
48121	TEXAS	DENTON	0.099	432,976
48139	TEXAS	ELLIS	0.086	111,360
48167	TEXAS	GALVESTON	0.089	250,158
48183	TEXAS	GREGG	0.088	111,379
48201	TEXAS	HARRIS	0.107	3,400,578
48251	TEXAS	JOHNSON	0.089	126,811
48339	TEXAS	MONTGOMERY	0.091	293,768
48367	TEXAS	PARKER	0.086	88,495
48439	TEXAS	TARRANT	0.098	1,446,219
48453	TEXAS	TRAVIS	0.085	812,280
51013	VIRGINIA	ARLINGTON	0.096	189,453
51036	VIRGINIA	CHARLES CITY	0.090	6,926
51041	VIRGINIA	CHESTERFIELD	0.086	259,903
51059	VIRGINIA	FAIRFAX	0.097	969,749
51069	VIRGINIA	FREDERICK	0.085	59,209
51087	VIRGINIA	HENRICO	0.090	262,300
51107	VIRGINIA	LOUDOUN	0.090	169,599
51113	VIRGINIA	MADISON	0.085	12,520
51153	VIRGINIA	PRINCE WILLIAM	0.085	280,813
51161	VIRGINIA	ROANOKE	0.087	85,778
51179	VIRGINIA	STAFFORD	0.086	92,446
51510	VIRGINIA	ALEXANDRIA	0.090	128,283
51650	VIRGINIA	HAMPTON	0.089	146,437
51800	VIRGINIA	SUFFOLK	0.088	63,677
54011	WEST VIRGINIA	CABELL	0.088	96,784
54029	WEST VIRGINIA	HANCOCK	0.085	32,667
54039	WEST VIRGINIA	KANAWHA	0.085	200,073
54069	WEST VIRGINIA	OHIO	0.085	47,427
54107	WEST VIRGINIA	WOOD	0.088	87,986
55029	WISCONSIN	DOOR	0.091	27,961
55059	WISCONSIN	KENOSHA	0.100	149,577
55061	WISCONSIN	KEWAUNEE	0.088	20,187
55071	WISCONSIN	MANITOWOC	0.088	82,887
55079	WISCONSIN	MILWAUKEE	0.091	940,164
55089	WISCONSIN	OZAUKEE	0.093	82,317

FIPS Code	State	County	2000-2002 Design Value	Population 2000
55101	WISCONSIN	RACINE	0.093	188,831
55117	WISCONSIN	SHEBOYGAN	0.099	112,646
	Counties: 297		**Total Population:**	**115,287,584**

Table B-5. Counties with Design Values at or below the level of the 8-hour Ozone Standard (2000-2002).

FIPS Code	State	County	2000-2002 Design Value	Population 2000
01003	ALABAMA	BALDWIN	0.082	140,415
01027	ALABAMA	CLAY	0.082	14,254
01051	ALABAMA	ELMORE	0.080	65,874
01079	ALABAMA	LAWRENCE	0.078	34,803
01089	ALABAMA	MADISON	0.082	276,700
01097	ALABAMA	MOBILE	0.081	399,843
01101	ALABAMA	MONTGOMERY	0.081	223,510
01119	ALABAMA	SUMTER	0.076	14,798
02290	ALASKA	YUKON-KOYUKUK	0.051	6,551
04003	ARIZONA	COCHISE	0.069	117,755
04005	ARIZONA	COCONINO	0.073	116,320
04019	ARIZONA	PIMA	0.073	843,746
04025	ARIZONA	YAVAPAI	0.082	167,517
05097	ARKANSAS	MONTGOMERY	0.069	9,245
05101	ARKANSAS	NEWTON	0.078	8,608
06001	CALIFORNIA	ALAMEDA	0.081	1,443,741
06011	CALIFORNIA	COLUSA	0.076	18,804
06013	CALIFORNIA	CONTRA COSTA	0.078	948,816
06021	CALIFORNIA	GLENN	0.074	26,453
06027	CALIFORNIA	INYO	0.081	17,945
06033	CALIFORNIA	LAKE	0.064	58,309
06041	CALIFORNIA	MARIN	0.047	247,289
06045	CALIFORNIA	MENDOCINO	0.055	86,265
06053	CALIFORNIA	MONTEREY	0.064	401,762
06055	CALIFORNIA	NAPA	0.063	124,279
06059	CALIFORNIA	ORANGE	0.075	2,846,289
06069	CALIFORNIA	SAN BENITO	0.081	53,234
06075	CALIFORNIA	SAN FRANCISCO	0.044	776,733
06077	CALIFORNIA	SAN JOAQUIN	0.081	563,598
06079	CALIFORNIA	SAN LUIS OBISPO	0.073	246,681
06081	CALIFORNIA	SAN MATEO	0.052	707,161
06083	CALIFORNIA	SANTA BARBARA	0.082	399,347
06085	CALIFORNIA	SANTA CLARA	0.082	1,682,585
06087	CALIFORNIA	SANTA CRUZ	0.064	255,602
06089	CALIFORNIA	SHASTA	0.074	163,256
06095	CALIFORNIA	SOLANO	0.072	394,542
06097	CALIFORNIA	SONOMA	0.063	458,614
06101	CALIFORNIA	SUTTER	0.084	78,930
06103	CALIFORNIA	TEHAMA	0.083	56,039
06113	CALIFORNIA	YOLO	0.083	168,660
08001	COLORADO	ADAMS	0.064	363,857
08005	COLORADO	ARAPAHOE	0.076	487,967
08013	COLORADO	BOULDER	0.073	291,288

FIPS Code	State	County	2000-2002 Design Value	Population 2000
08031	COLORADO	DENVER	0.072	554,636
08035	COLORADO	DOUGLAS	0.080	175,766
08041	COLORADO	EL PASO	0.070	516,929
08059	COLORADO	JEFFERSON	0.083	527,056
08067	COLORADO	LA PLATA	0.058	43,941
08069	COLORADO	LARIMER	0.078	251,494
08083	COLORADO	MONTEZUMA	0.069	23,830
08123	COLORADO	WELD	0.066	180,936
12001	FLORIDA	ALACHUA	0.075	217,955
12003	FLORIDA	BAKER	0.072	22,259
12005	FLORIDA	BAY	0.081	148,217
12009	FLORIDA	BREVARD	0.076	476,230
12011	FLORIDA	BROWARD	0.071	1,623,018
12031	FLORIDA	DUVAL	0.069	778,879
12033	FLORIDA	ESCAMBIA	0.084	294,410
12057	FLORIDA	HILLSBOROUGH	0.079	998,948
12059	FLORIDA	HOLMES	0.072	18,564
12071	FLORIDA	LEE	0.069	440,888
12073	FLORIDA	LEON	0.072	239,452
12081	FLORIDA	MANATEE	0.076	264,002
12083	FLORIDA	MARION	0.075	258,916
12086	FLORIDA	Miami-Dade	0.069	2,253,362
12095	FLORIDA	ORANGE	0.078	896,344
12097	FLORIDA	OSCEOLA	0.073	172,493
12099	FLORIDA	PALM BEACH	0.068	1,131,184
12101	FLORIDA	PASCO	0.077	344,765
12103	FLORIDA	PINELLAS	0.076	921,482
12105	FLORIDA	POLK	0.077	483,924
12111	FLORIDA	ST LUCIE	0.068	192,695
12113	FLORIDA	SANTA ROSA	0.084	117,743
12115	FLORIDA	SARASOTA	0.081	325,957
12117	FLORIDA	SEMINOLE	0.078	365,196
12127	FLORIDA	VOLUSIA	0.072	443,343
13051	GEORGIA	CHATHAM	0.070	232,048
13057	GEORGIA	CHEROKEE	0.078	141,903
13085	GEORGIA	DAWSON	0.083	15,999
13127	GEORGIA	GLYNN	0.073	67,568
13215	GEORGIA	MUSCOGEE	0.083	186,291
13261	GEORGIA	SUMTER	0.081	33,200
15003	HAWAII	HONOLULU	0.043	876,156
17001	ILLINOIS	ADAMS	0.077	68,277
17019	ILLINOIS	CHAMPAIGN	0.076	179,669
17043	ILLINOIS	DU PAGE	0.071	904,161

FIPS Code	State	County	2000-2002 Design Value	Population 2000
17049	ILLINOIS	EFFINGHAM	0.077	34,264
17065	ILLINOIS	HAMILTON	0.080	8,621
17089	ILLINOIS	KANE	0.077	404,119
17097	ILLINOIS	LAKE	0.084	644,356
17111	ILLINOIS	MC HENRY	0.083	260,077
17115	ILLINOIS	MACON	0.077	114,706
17117	ILLINOIS	MACOUPIN	0.080	49,019
17119	ILLINOIS	MADISON	0.084	258,941
17143	ILLINOIS	PEORIA	0.079	183,433
17157	ILLINOIS	RANDOLPH	0.079	33,893
17167	ILLINOIS	SANGAMON	0.077	188,951
17197	ILLINOIS	WILL	0.080	502,266
17201	ILLINOIS	WINNEBAGO	0.075	278,418
18043	INDIANA	FLOYD	0.083	70,823
18051	INDIANA	GIBSON	0.071	32,500
18163	INDIANA	VANDERBURGH	0.083	171,922
18167	INDIANA	VIGO	0.079	105,848
18173	INDIANA	WARRICK	0.084	52,383
19017	IOWA	BREMER	0.072	23,325
19045	IOWA	CLINTON	0.078	50,149
19085	IOWA	HARRISON	0.077	15,666
19113	IOWA	LINN	0.071	191,701
19147	IOWA	PALO ALTO	0.066	10,147
19153	IOWA	POLK	0.060	374,601
19163	IOWA	SCOTT	0.079	158,668
19169	IOWA	STORY	0.064	79,981
19177	IOWA	VAN BUREN	0.074	7,809
19181	IOWA	WARREN	0.063	40,671
20107	KANSAS	LINN	0.076	9,570
20173	KANSAS	SEDGWICK	0.081	452,869
20191	KANSAS	SUMNER	0.080	25,946
20195	KANSAS	TREGO	0.066	3,319
20209	KANSAS	WYANDOTTE	0.081	157,882
21043	KENTUCKY	CARTER	0.080	26,889
21059	KENTUCKY	DAVIESS	0.077	91,545
21061	KENTUCKY	EDMONSON	0.084	11,644
21067	KENTUCKY	FAYETTE	0.078	260,512
21083	KENTUCKY	GRAVES	0.081	37,028
21089	KENTUCKY	GREENUP	0.083	36,891
21091	KENTUCKY	HANCOCK	0.083	8,392
21093	KENTUCKY	HARDIN	0.081	94,174
21101	KENTUCKY	HENDERSON	0.079	44,829

FIPS Code	State	County	2000-2002 Design Value	Population 2000
21113	KENTUCKY	JESSAMINE	0.079	39,041
21139	KENTUCKY	LIVINGSTON	0.084	9,804
21145	KENTUCKY	MC CRACKEN	0.082	65,514
21149	KENTUCKY	MC LEAN	0.084	9,938
21193	KENTUCKY	PERRY	0.075	29,390
21195	KENTUCKY	PIKE	0.078	68,736
21199	KENTUCKY	PULASKI	0.081	56,217
21209	KENTUCKY	SCOTT	0.070	33,061
21213	KENTUCKY	SIMPSON	0.083	16,405
21221	KENTUCKY	TRIGG	0.075	12,597
22005	LOUISIANA	ASCENSION	0.082	76,627
22011	LOUISIANA	BEAUREGARD	0.074	32,986
22015	LOUISIANA	BOSSIER	0.084	98,310
22017	LOUISIANA	CADDO	0.079	252,161
22019	LOUISIANA	CALCASIEU	0.081	183,577
22043	LOUISIANA	GRANT	0.078	18,698
22055	LOUISIANA	LAFAYETTE	0.081	190,503
22057	LOUISIANA	LAFOURCHE	0.080	89,974
22063	LOUISIANA	LIVINGSTON	0.084	91,814
22071	LOUISIANA	ORLEANS	0.071	484,674
22073	LOUISIANA	OUACHITA	0.078	147,250
22077	LOUISIANA	POINTE COUPEE	0.071	22,763
22087	LOUISIANA	ST BERNARD	0.079	67,229
22089	LOUISIANA	ST CHARLES	0.081	48,072
22093	LOUISIANA	ST JAMES	0.076	21,216
22095	LOUISIANA	ST JOHN THE BAPTIST PAR	0.081	43,044
22101	LOUISIANA	ST MARY	0.077	53,500
23011	MAINE	KENNEBEC	0.078	117,114
23013	MAINE	KNOX	0.083	39,618
23017	MAINE	OXFORD	0.060	54,755
26037	MICHIGAN	CLINTON	0.082	64,753
26049	MICHIGAN	GENESEE	0.084	436,141
26063	MICHIGAN	HURON	0.082	36,079
26065	MICHIGAN	INGHAM	0.082	279,320
26077	MICHIGAN	KALAMAZOO	0.081	238,603
26081	MICHIGAN	KENT	0.082	574,335
26113	MICHIGAN	MISSAUKEE	0.078	14,478
28001	MISSISSIPPI	ADAMS	0.080	34,340
28011	MISSISSIPPI	BOLIVAR	0.077	40,633
28045	MISSISSIPPI	HANCOCK	0.082	42,967
28047	MISSISSIPPI	HARRISON	0.081	189,601
28049	MISSISSIPPI	HINDS	0.076	250,800

FIPS Code	State	County	2000-2002 Design Value	Population 2000
28059	MISSISSIPPI	JACKSON	0.082	131,420
28075	MISSISSIPPI	LAUDERDALE	0.076	78,161
28081	MISSISSIPPI	LEE	0.081	75,755
28089	MISSISSIPPI	MADISON	0.076	74,674
28149	MISSISSIPPI	WARREN	0.078	49,644
29037	MISSOURI	CASS	0.079	82,092
29039	MISSOURI	CEDAR	0.083	13,733
29077	MISSOURI	GREENE	0.076	240,391
29137	MISSOURI	MONROE	0.079	9,311
29165	MISSOURI	PLATTE	0.084	73,781
29186	MISSOURI	STE GENEVIEVE	0.084	17,842
30029	MONTANA	FLATHEAD	0.052	74,471
31055	NEBRASKA	DOUGLAS	0.068	463,585
31109	NEBRASKA	LANCASTER	0.054	250,291
32003	NEVADA	CLARK	0.082	1,375,765
32005	NEVADA	DOUGLAS	0.072	41,259
32031	NEVADA	WASHOE	0.073	339,486
32033	NEVADA	WHITE PINE	0.072	9,181
33003	NEW HAMPSHIRE	CARROLL	0.067	43,666
33005	NEW HAMPSHIRE	CHESHIRE	0.073	73,825
33009	NEW HAMPSHIRE	GRAFTON	0.068	81,743
33013	NEW HAMPSHIRE	MERRIMACK	0.074	136,225
33015	NEW HAMPSHIRE	ROCKINGHAM	0.083	277,359
33017	NEW HAMPSHIRE	STRAFFORD	0.077	112,233
33019	NEW HAMPSHIRE	SULLIVAN	0.073	40,458
35001	NEW MEXICO	BERNALILLO	0.075	556,678
35013	NEW MEXICO	DONA ANA	0.080	174,682
35015	NEW MEXICO	EDDY	0.070	51,658
35043	NEW MEXICO	SANDOVAL	0.072	89,908
35045	NEW MEXICO	SAN JUAN	0.076	113,801
35061	NEW MEXICO	VALENCIA	0.069	66,152
36001	NEW YORK	ALBANY	0.083	294,565
36005	NEW YORK	BRONX	0.081	1,332,650
36015	NEW YORK	CHEMUNG	0.081	91,070
36041	NEW YORK	HAMILTON	0.079	5,379
36043	NEW YORK	HERKIMER	0.074	64,427
36053	NEW YORK	MADISON	0.080	69,441
36065	NEW YORK	ONEIDA	0.078	235,469
36067	NEW YORK	ONONDAGA	0.083	458,336
36071	NEW YORK	ORANGE	0.084	341,367
36081	NEW YORK	QUEENS	0.074	2,229,379
36093	NEW YORK	SCHENECTADY	0.076	146,555

FIPS Code	State	County	2000-2002 Design Value	Population 2000
36111	NEW YORK	ULSTER	0.081	177,749
36117	NEW YORK	WAYNE	0.083	93,765
37011	NORTH CAROLINA	AVERY	0.079	17,167
37037	NORTH CAROLINA	CHATHAM	0.083	49,329
37061	NORTH CAROLINA	DUPLIN	0.081	49,063
37107	NORTH CAROLINA	LENOIR	0.081	59,648
37117	NORTH CAROLINA	MARTIN	0.081	25,593
37129	NORTH CAROLINA	NEW HANOVER	0.079	160,307
37131	NORTH CAROLINA	NORTHAMPTON	0.084	22,086
37147	NORTH CAROLINA	PITT	0.083	133,798
37173	NORTH CAROLINA	SWAIN	0.074	12,968
38007	NORTH DAKOTA	BILLINGS	0.059	888
38017	NORTH DAKOTA	CASS	0.062	123,138
38057	NORTH DAKOTA	MERCER	0.058	8,644
39049	OHIO	FRANKLIN	0.084	1,068,978
39135	OHIO	PREBLE	0.082	42,337
40027	OKLAHOMA	CLEVELAND	0.077	208,016
40031	OKLAHOMA	COMANCHE	0.079	114,996
40087	OKLAHOMA	MC CLAIN	0.079	27,740
40109	OKLAHOMA	OKLAHOMA	0.082	660,448
41005	OREGON	CLACKAMAS	0.065	338,391
41009	OREGON	COLUMBIA	0.057	43,560
41029	OREGON	JACKSON	0.069	181,269
41039	OREGON	LANE	0.058	322,959
41047	OREGON	MARION	0.059	284,834
42013	PENNSYLVANIA	BLAIR	0.084	129,144
42073	PENNSYLVANIA	LAWRENCE	0.078	94,643
42079	PENNSYLVANIA	LUZERNE	0.084	319,250
42081	PENNSYLVANIA	LYCOMING	0.079	120,044
42099	PENNSYLVANIA	PERRY	0.083	43,602
42117	PENNSYLVANIA	TIOGA	0.084	41,373
45011	SOUTH CAROLINA	BARNWELL	0.083	23,478
45019	SOUTH CAROLINA	CHARLESTON	0.074	309,969
45023	SOUTH CAROLINA	CHESTER	0.084	34,068
45029	SOUTH CAROLINA	COLLETON	0.080	38,264
45037	SOUTH CAROLINA	EDGEFIELD	0.083	24,595
45087	SOUTH CAROLINA	UNION	0.081	29,881
45089	SOUTH CAROLINA	WILLIAMSBURG	0.073	37,217
45091	SOUTH CAROLINA	YORK	0.084	164,614
47037	TENNESSEE	DAVIDSON	0.080	569,891
47099	TENNESSEE	LAWRENCE	0.078	39,926
47149	TENNESSEE	RUTHERFORD	0.084	182,023

FIPS Code	State	County	2000-2002 Design Value	Population 2000
48061	TEXAS	CAMERON	0.064	335,227
48141	TEXAS	EL PASO	0.081	679,622
48215	TEXAS	HIDALGO	0.075	569,463
48221	TEXAS	HOOD	0.084	41,100
48245	TEXAS	JEFFERSON	0.084	252,051
48257	TEXAS	KAUFMAN	0.070	71,313
48355	TEXAS	NUECES	0.081	313,645
48361	TEXAS	ORANGE	0.081	84,966
48397	TEXAS	ROCKWALL	0.083	43,080
48423	TEXAS	SMITH	0.084	174,706
48469	TEXAS	VICTORIA	0.076	84,088
48479	TEXAS	WEBB	0.066	193,117
49005	UTAH	CACHE	0.069	91,391
49011	UTAH	DAVIS	0.082	238,994
49035	UTAH	SALT LAKE	0.081	898,387
49049	UTAH	UTAH	0.078	368,536
49057	UTAH	WEBER	0.076	196,533
50003	VERMONT	BENNINGTON	0.080	36,994
50007	VERMONT	CHITTENDEN	0.077	146,571
51033	VIRGINIA	CAROLINE	0.083	22,121
51061	VIRGINIA	FAUQUIER	0.081	55,139
51139	VIRGINIA	PAGE	0.080	23,177
51163	VIRGINIA	ROCKBRIDGE	0.079	20,808
51197	VIRGINIA	WYTHE	0.081	27,599
53009	WASHINGTON	CLALLAM	0.043	64,525
53011	WASHINGTON	CLARK	0.059	345,238
53033	WASHINGTON	KING	0.068	1,737,034
53039	WASHINGTON	KLICKITAT	0.065	19,161
53053	WASHINGTON	PIERCE	0.067	700,820
53057	WASHINGTON	SKAGIT	0.047	102,979
53063	WASHINGTON	SPOKANE	0.070	417,939
53067	WASHINGTON	THURSTON	0.058	207,355
53073	WASHINGTON	WHATCOM	0.051	166,814
54025	WEST VIRGINIA	GREENBRIER	0.082	34,453
54061	WEST VIRGINIA	MONONGALIA	0.081	81,866
55009	WISCONSIN	BROWN	0.081	226,778
55021	WISCONSIN	COLUMBIA	0.076	52,468
55025	WISCONSIN	DANE	0.076	426,526
55027	WISCONSIN	DODGE	0.079	85,897
55037	WISCONSIN	FLORENCE	0.069	5,088
55039	WISCONSIN	FOND DU LAC	0.077	97,296
55045	WISCONSIN	GREEN	0.074	33,647

FIPS Code	State	County	2000-2002 Design Value	Population 2000
55073	WISCONSIN	MARATHON	0.072	125,834
55085	WISCONSIN	ONEIDA	0.068	36,776
55087	WISCONSIN	OUTAGAMIE	0.075	160,971
55105	WISCONSIN	ROCK	0.084	152,307
55109	WISCONSIN	ST CROIX	0.072	63,155
55111	WISCONSIN	SAUK	0.073	55,225
55123	WISCONSIN	VERNON	0.071	28,056
55125	WISCONSIN	VILAS	0.068	21,033
55127	WISCONSIN	WALWORTH	0.082	93,759
55131	WISCONSIN	WASHINGTON	0.081	117,493
55133	WISCONSIN	WAUKESHA	0.081	360,767
55139	WISCONSIN	WINNEBAGO	0.078	156,763
56039	WYOMING	TETON	0.065	18,251
	Counties: 309		**Total population:**	**72,585,880**

Table B-6. Counties with incomplete data for calculating the 8-hour Ozone Design Value (2000-2002).

FIPS Code	State	County	Population 2000
01033	ALABAMA	COLBERT	54,984
01055	ALABAMA	ETOWAH	103,459
01061	ALABAMA	GENEVA	25,764
01125	ALABAMA	TUSCALOOSA	164,875
01127	ALABAMA	WALKER	70,713
04007	ARIZONA	GILA	51,335
04017	ARIZONA	NAVAJO	97,470
04021	ARIZONA	PINAL	179,727
04027	ARIZONA	YUMA	160,026
06051	CALIFORNIA	MONO	12,853
06063	CALIFORNIA	PLUMAS	20,824
06093	CALIFORNIA	SISKIYOU	44,301
09005	CONNECTICUT	LITCHFIELD	182,193
12021	FLORIDA	COLLIER	251,377
12023	FLORIDA	COLUMBIA	56,513
12055	FLORIDA	HIGHLANDS	87,366
12069	FLORIDA	LAKE	210,528
12109	FLORIDA	ST JOHNS	123,135
12129	FLORIDA	WAKULLA	22,863
13059	GEORGIA	CLARKE	101,489
13111	GEORGIA	FANNIN	19,798
15001	HAWAII	HAWAII	148,677
16001	IDAHO	ADA	300,904
16023	IDAHO	BUTTE	2,899
16027	IDAHO	CANYON	131,441
16039	IDAHO	ELMORE	29,130
17023	ILLINOIS	CLARK	17,008
17113	ILLINOIS	MC LEAN	150,433
17161	ILLINOIS	ROCK ISLAND	149,374
18015	INDIANA	CARROLL	20,165
18035	INDIANA	DELAWARE	118,769
18039	INDIANA	ELKHART	182,791
18123	INDIANA	PERRY	18,899
19137	IOWA	MONTGOMERY	11,771
20087	KANSAS	JEFFERSON	18,426
21127	KENTUCKY	LAWRENCE	15,569
21177	KENTUCKY	MUHLENBERG	31,839
23019	MAINE	PENOBSCOT	144,919
23021	MAINE	PISCATAQUIS	17,235
23023	MAINE	SAGADAHOC	35,214
24009	MARYLAND	CALVERT	74,563
24510	MARYLAND	BALTIMORE (CITY)	651,154
25003	MASSACHUSETTS	BERKSHIRE	134,953

FIPS Code	State	County	Population 2000
25021	MASSACHUSETTS	NORFOLK	650,308
26055	MICHIGAN	GRAND TRAVERSE	77,654
26153	MICHIGAN	SCHOOLCRAFT	8,903
27003	MINNESOTA	ANOKA	298,084
27017	MINNESOTA	CARLTON	31,671
27037	MINNESOTA	DAKOTA	355,904
27075	MINNESOTA	LAKE	11,058
27095	MINNESOTA	MILLE LACS	22,330
27137	MINNESOTA	ST LOUIS	200,528
27139	MINNESOTA	SCOTT	89,498
27163	MINNESOTA	WASHINGTON	201,130
28003	MISSISSIPPI	ALCORN	34,558
28107	MISSISSIPPI	PANOLA	34,274
29095	MISSOURI	JACKSON	654,880
30063	MONTANA	MISSOULA	95,802
32510	NEVADA	CARSON CITY	52,457
33001	NEW HAMPSHIRE	BELKNAP	56,325
33007	NEW HAMPSHIRE	COOS	33,111
34013	NEW JERSEY	ESSEX	793,633
36061	NEW YORK	NEW YORK	1,537,195
36075	NEW YORK	OSWEGO	122,377
36083	NEW YORK	RENSSELAER	152,538
36091	NEW YORK	SARATOGA	200,635
37029	NORTH CAROLINA	CAMDEN	6,885
37151	NORTH CAROLINA	RANDOLPH	130,454
38025	NORTH DAKOTA	DUNN	3,600
38065	NORTH DAKOTA	OLIVER	2,065
38091	NORTH DAKOTA	STEELE	2,258
39091	OHIO	LOGAN	46,005
39159	OHIO	UNION	40,909
40001	OKLAHOMA	ADAIR	21,038
40017	OKLAHOMA	CANADIAN	87,697
40019	OKLAHOMA	CARTER	45,621
40021	OKLAHOMA	CHEROKEE	42,521
40043	OKLAHOMA	DEWEY	4,743
40067	OKLAHOMA	JEFFERSON	6,818
40071	OKLAHOMA	KAY	48,080
40077	OKLAHOMA	LATIMER	10,692
40085	OKLAHOMA	LOVE	8,831
40095	OKLAHOMA	MARSHALL	13,184
40097	OKLAHOMA	MAYES	38,369
40101	OKLAHOMA	MUSKOGEE	69,451
40111	OKLAHOMA	OKMULGEE	39,685
40115	OKLAHOMA	OTTAWA	33,194
40121	OKLAHOMA	PITTSBURG	43,953

FIPS Code	State	County	Population 2000
41043	OREGON	LINN	103,069
42001	PENNSYLVANIA	ADAMS	91,292
42089	PENNSYLVANIA	MONROE	138,687
45015	SOUTH CAROLINA	BERKELEY	142,651
45025	SOUTH CAROLINA	CHESTERFIELD	42,768
45045	SOUTH CAROLINA	GREENVILLE	379,616
45073	SOUTH CAROLINA	OCONEE	66,215
46099	SOUTH DAKOTA	MINNEHAHA	148,281
46103	SOUTH DAKOTA	PENNINGTON	88,565
47031	TENNESSEE	COFFEE	48,014
47043	TENNESSEE	DICKSON	43,156
47045	TENNESSEE	DYER	37,279
47063	TENNESSEE	HAMBLEN	58,128
47125	TENNESSEE	MONTGOMERY	134,768
47131	TENNESSEE	OBION	32,450
47145	TENNESSEE	ROANE	51,910
48043	TEXAS	BREWSTER	8,866
48203	TEXAS	HARRISON	62,110
48315	TEXAS	MARION	10,941
49003	UTAH	BOX ELDER	42,745
49037	UTAH	SAN JUAN	14,413
51085	VIRGINIA	HANOVER	86,320
53015	WASHINGTON	COWLITZ	92,948
53041	WASHINGTON	LEWIS	68,600
53045	WASHINGTON	MASON	49,405
54003	WEST VIRGINIA	BERKELEY	75,905
55055	WISCONSIN	JEFFERSON	74,021
55095	WISCONSIN	POLK	41,319
56005	WYOMING	CAMPBELL	33,698
72033	PUERTO RICO	CATANO	30,071
78003	VIRGIN ISLANDS	ST JOHN	4,197
	Counties: 119	**Total Population:**	**13,211,040**