Executive Summary

The Southern Appalachian ecosystem is widely recognized as one of the most diverse in a temperate region. The headwaters of nine major rivers lie within the boundaries of the Southern Appalachians, making it a source of drinking water for much of the Southeast.

The Assessment area (fig.1) includes parts of the Appalachian Mountains and Shenandoah Valley extending southward from the Potomac River to northern Georgia and the northeastern corner of Alabama. It includes seven states, 135 counties, and covers approximately 37 million acres. The Southern Appalachians are one of the world's finest remaining ecological regions. Early in the 20th century, the Appalachian landscape and natural resources were being exploited; croplands, pastures, and hillsides were eroding; and timberlands were being cut with little thought for sustaining the resources. National forests and national parks were created to preserve and restore the natural resources in the region. The seven national forests in conjunction with three national parks, the Blue Ridge Parkway, and the Appalachian Trail form the largest contiguous block of public lands east of the Mississippi River.

This comprehensive, interagency assessment, began in the summer of 1994 and was completed in May 1996. It was designed to collect and analyze ecological, social, and economic data. The information provided will facilitate an ecosystem-based approach to management of the natural resources on public lands within the assessment area.

Public participation has been, and will continue to be, an important part of the assessment. One of the first actions of the assessment was to conduct a series of town hall meetings at which the public gave suggestions on the major themes and questions to be addressed. These questions, supplemented by additional concerns expressed by land managers and policy makers, form the structure for the assessment.

The questions helped to organize the Atmospheric Team's analysis and to focus the response. These questions are answered and all of the key findings are presented in Chapter 2 through Chapter 6 of this report. The following summary lists the questions and some of the key findings. Also presented are the current trends and future patterns anticipated for the Southern Appalachians.

Question 1:

What are the major air pollutants which could impact the Southern Appalachians, and what areas receive the greatest exposure?

Question 2:

What is the current concentration of particulate matter in the air of the Southern Appalachians?

Question 3:

How good is visibility in the Southern Appalachians, and how does air pollution affect visibility?

Question 4:

To what extent are aquatic resources in the Southern Appalachian Assessment area being affected by acid deposition?

Question 5:

What impact does ground-level ozone have on forests?

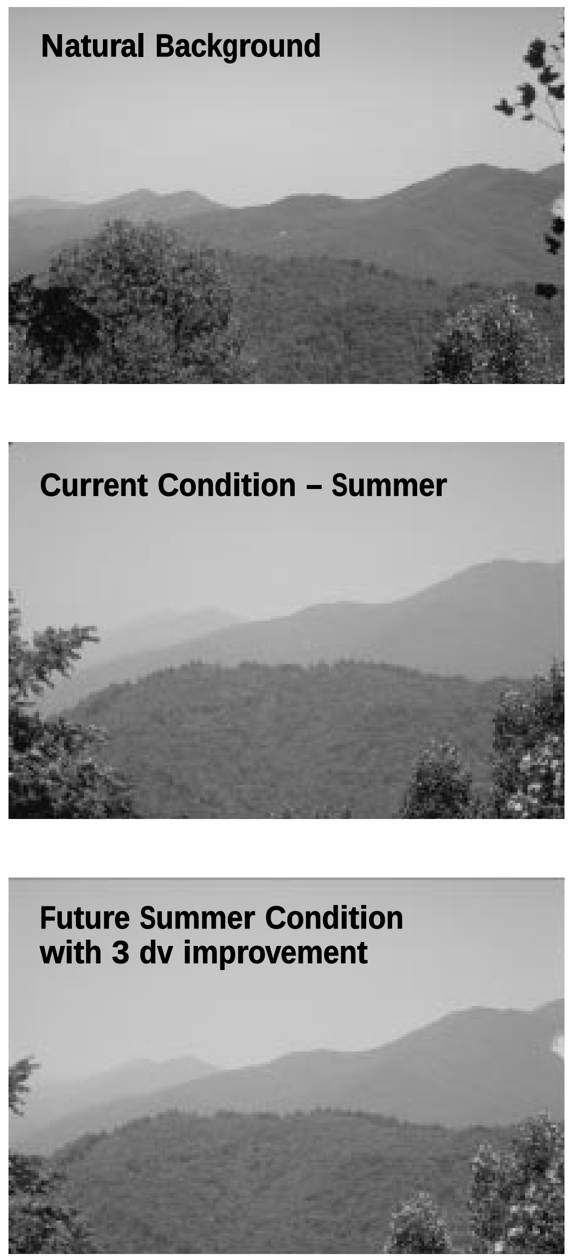
The major types of air pollution emissions addressed in this report are particulate matter, nitrogen oxides, volatile organic compounds, and sulfur dioxide. These pollutants are important because the secondary pollutants formed from these primary pollutants are suspected of causing visibility reductions, ozone impacts to vegetation, and acid deposition impacts to terrestrial and aquatic environments in the Southern Appalachians. Particulate-matter concentrations in the region are fairly uniform and meet government air-quality standards. Visibility in the region has decreased since the 1940s as haziness has intensified. Sulfur dioxide emissions are believed to be primarily responsible for the regional haze throughout the region, although some other pollutants have a small contribution to regional haze. The Southeast has the poorest visibility in the eastern United States. Furthermore, visibility is poorest during the summer months when the greatest number of people are viewing scenery in the mountains. Acid deposition is being deposited in the SAA region, and headwater streams are most susceptible to acidification. However, sulfates, and base-cations (chemicals which can offset the effect of acidic deposition) are both decreasing in rainfall, and therefore pH has not improved over 13 years. Loadings of nitrate and ammonium in precipitation are also a concern to watersheds because these compounds also lead to acidification of headwater streams. Acidifying compounds which begin as nitrogen oxide emissions may have greater impacts after the year 2010 because nitrogen oxide emissions are expected to increase. Nitrogen oxides are also contributing factors to ground level ozone, which can cause growth reductions and physiological stress to trees. One area, Whitetop Mountain in Virginia, is classified as violating government air-quality standards for ozone. The areas with the greatest potential for growth loss due to ozone exposures are in the northern and southern tips of the Southern Appalachians and wherever sensitive hardwood trees are located at higher elevations.

Current Trends and Future Patterns

Sulfur Dioxide and Visibility Impairment

Sulfur dioxide emissions increased nationally between the 1940s and 1970s, but current national emissions have returned to about the same levels as in 1940. Despite the national trends, sulfur dioxide emissions in and near the Southern Appalachians increased slightly between 1985 and 1994. Therefore, visibility is not as good as it was 50 years ago. Visibility in the Southeast degraded between the 1950s and 1970s, improved between the 1970s and 1980s, and has not improved since the 1980s. Current visibility data show that the standard visual range (approximately 25 miles) is far below the estimated annual average natural

Figure 2 The photographs depict what a 3-deciview decrease in haziness (visibility improvement) would look like compared with the current median summer condition and natural background visibility. The view is James River Face Wilderness in Virginia.



background of 93 ± 30 miles (fig. 2). Sulfur dioxide, a gas which is transformed in the atmosphere to form particles, is the largest contributor to reduced visibility. The primary sources of sulfur emissions are power plants both within and outside the SAA region. The poorest visibility occurs during the summer and spring months when relative humidity is the highest, and these seasons coincide with many outdoor recreation activities, especially the viewing of scenery. Photographic scenes of Class I wildernesses taken since the late 1980s show that the worst visibility conditions occur within the northern and southern portions of the SAA area. Since the late 1940s, haze in the southeastern United States has increased dramatically in all seasons of the year, but by far the most significant rise has been the summer haze which has about doubled. This increase in haziness leads to reduced visibility. The National Park Service has documented that reduced visibility negatively affects public enjoyment of scenic mountain vistas.

Visibility is expected to improve with a reduction of sulfur dioxide emissions that come with full implementation of the Clean Air Act (CAA) Amendments of 1990. Estimates predict a 2- to 3- deciview improvement in visibility (fig. 2). Will the predicted improvement in visibility as a result of CAA regulations be noticeable to the public and will the public be satisfied? Continued monitoring of visibility and public opinion on observed conditions will be needed in order to answer the question.

Acid Deposition and Aquatic Effects

Besides improvements in visibility, reductions in sulfur dioxide emissions are predicted to also reduce the amount of acid deposition within the Southern Appalachians. Sulfate deposition is greatest at the highest elevations and in the northern portion of the Southern Appalachians (fig. 3). The high-elevation sites typically have soils which are derived from materials that have a low buffering capacity. In

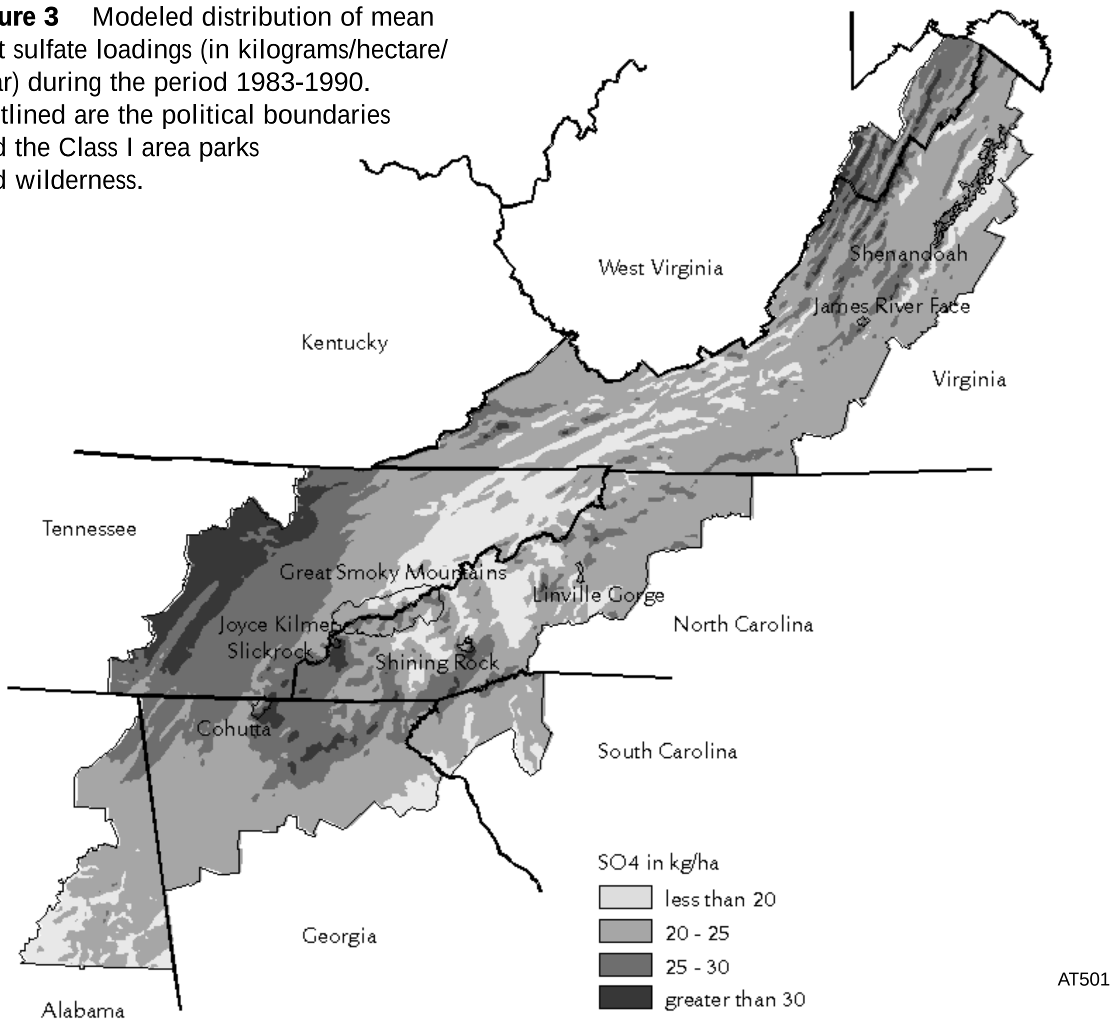


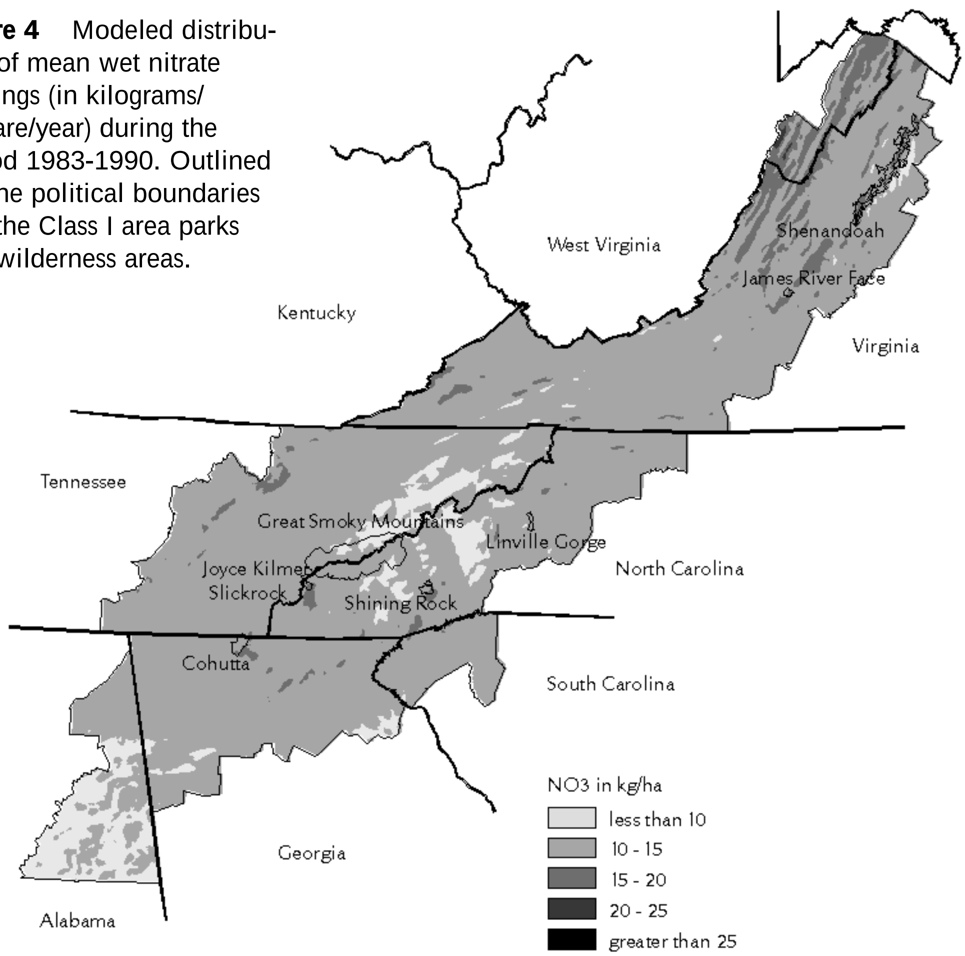
Figure 3 Modeled distribution of mean wet sulfate loadings (in kilograms/hectare/year) during the period 1983-1990. Outlined are the political boundaries and the Class I area parks and wilderness.

the mid-Appalachians, implementation of the Clean Air Act (CAA) Amendments should maintain the same proportion of chronically acidic streams as in 1985, unless nitrogen saturation occurs. Under current deposition levels, streams in the Southern Blue Ridge are susceptible to acidification (Fig. 5.7). Streams in the northern portion of Southern Appalachian and upper reaches of the southern portion of the assessment area, particularly in Class I areas, are more sensitive than those surveyed by the National Stream Survey. The Direct Delay Response Program estimated that a 30- to 50-percent reduction in sulfate deposition would prevent further acidification of streams in the Southern Blue Ridge. The 1990 CAA Amendments are predicted to accomplish a reduction of sulfate in that range. However, even under reduced sulfate deposition, streams in poorly buffered watersheds could remain acidified. In watersheds that are losing the capacity to buffer incoming sulfur, streams may continue to acidify, despite reduced sulfate input.

Nitrate loadings from rainfall are highest in the northern portion of the SAA and at some high elevation sites (fig. 4). Emissions of nitrogen oxides are expected to increase after the year 2010 if the population continues to grow. As mentioned previously, nitrate deposition can increase stream acidity and can increase the amount of aluminum released from the soils. Some high-elevation sites in the Southern Appalachians are saturated with nitrogen compounds, and this saturation will lead to further chronic and episodic acidifying events. The problems with nitrate acidification may also be exacerbated in watersheds that are defoliated by large populations of gypsy moths because the feeding by the gypsy moths leads to increased nitrogen being deposited on the soils.

Episodic or chronic acidification of streams can lead to elevated levels of aluminum which in turn could reduce survival and diversity of macroinvertebrate and fish populations in sensitive streams. The Southern Appalachians are a popular region for people to fish, and acid deposition will continue to reduce the number

Figure 4 Modeled distribution of mean wet nitrate loadings (in kilograms/hectare/year) during the period 1983-1990. Outlined are the political boundaries and the Class I area parks and wilderness areas.



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of streams suitable for fishing in some locations of the SAA region.

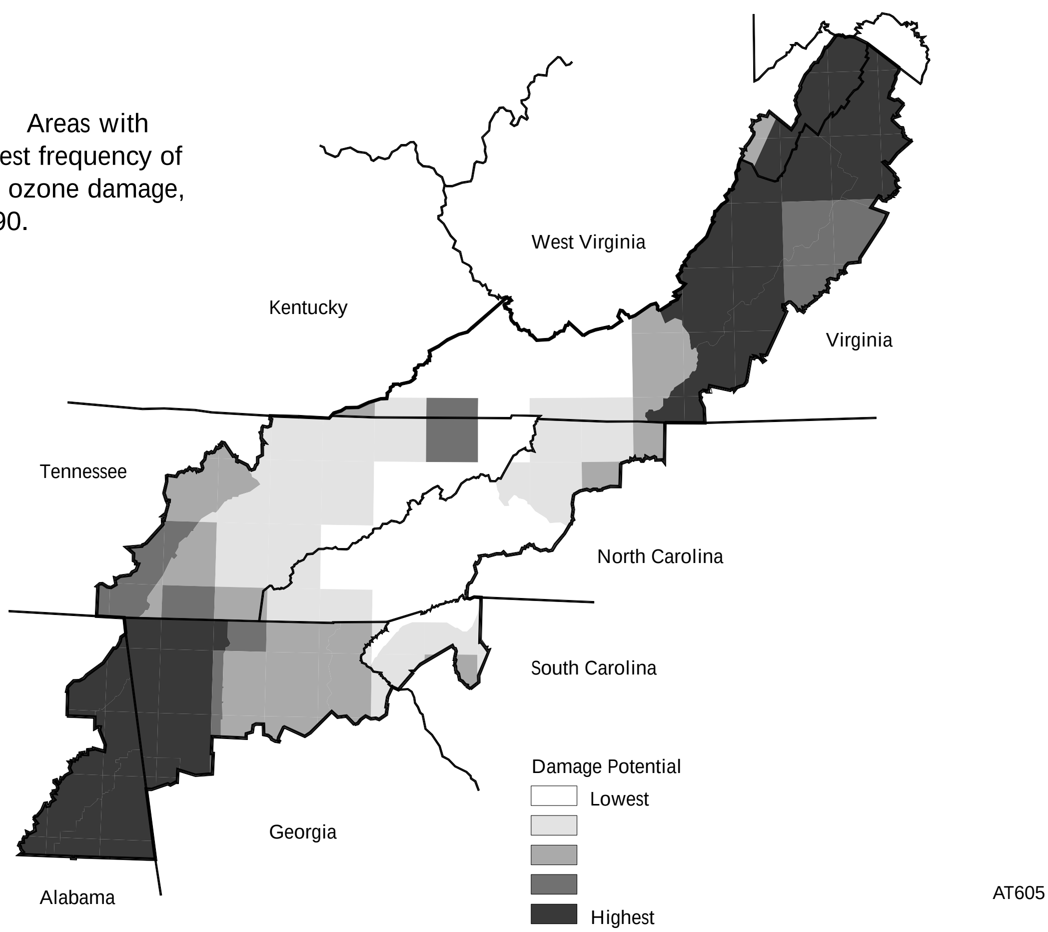
Ozone and Potential Vegetation Damage

Releases of nitrogen oxides and volatile organic compounds also contribute to increased ozone formation within the Southern Appalachians. As with other pollutants, some of the ozone in the mountains is formed locally, but most of the precursors are transported into the region from surrounding urban areas. Current ozone exposures are causing visible symptoms on the foliage of sensitive species, and this common injury can be found yearly in numerous locations. Current monitored concentrations of ozone frequently exceed concentrations found at pristine sites. Vegetation found at high-elevation sites below the spruce/fir ecosystem may have more favorable moisture conditions resulting in greater sensitivity to ozone exposures than at lower-elevation sites.

No published reports or data exist to document the amount of growth loss (damage) caused by ambient ozone exposures to trees throughout the Southern Appalachians. The approach used by the Atmospheric Team identified areas where ozone damage had the greatest potential to occur. These areas were identified by examining data on ozone exposures and soil moisture. The ozone exposures were divided into four levels which represented broad groupings of tree species. Throughout the SAA area, ozone exposures and soil moisture availability are sufficient to cause growth losses to the highly sensitive species for most years. Low moisture in the mid-1980s may have resulted in significant growth loss to vegetation, and ozone is believed to have only a minimal role in any growth loss between 1985 and 1988. Between 1983 and 1990, vegetation in the northern and southern portions of the SAA area may have experienced the greatest frequency of growth reduction from ozone exposures (fig. 5).

What are the implications of ozone exposures on the health of forests in the Southern Appalachians? The forest products industry may be concerned if reduced growth decreases the amount of available timber in the future. Ozone exposures could also be reducing the genetic diversity within a species, as seen with white

Figure 5 Areas with the greatest frequency of potential ozone damage, 1983-1990.



pines. Furthermore, little is known about what effect ozone exposures may have on rare and endangered plant species that are found in the Southern Appalachians.

Particulate Matter and Prescribed Burning

There is a growing interest among land managers to increase the amount of prescribed fires in the region for numerous purposes, such as habitat improvement for rare and endangered species. For urban areas within or adjacent to the Southern Appalachians, a small or moderate increase in prescribed fires should not cause a problem with the annual National Ambient Air Quality Standards (NAAQS) for particulate matter. For those rural areas where prescribed fire is common, there is a potential to violate the 24-hour air-quality standard within one mile of a prescribed fire. The U.S. Environmental Protection Agency (EPA) is examining the current NAAQS for particulate matter. A tighter standard may result in prescribed fire activities receiving greater attention from air regulatory agencies.

Many forest ecologists state that there is a need to return fire to its historical role in the ecosystem, reducing combustible fuel and enhancing wildlife and plant habitat, especially for fire-dependent, pine ecosystems. This policy would be accomplished through an increased level of prescribed burning. Is there an upper level of prescribed fire over a given time period that would exceed NAAQS for particulate matter? To answer this question, an increased level of particulate monitoring would be needed in rural areas; most particulate monitors are currently located in urban areas.

Regional Cooperation

There are several themes common to both this summary and the following chapters. Airborne emissions and the resulting impacts to forested ecosystems are a regional problem requiring regional solutions. Air pollution impacts to natural resources within the Southern Appalachians are caused by industrial or utility sources and mobile sources within and external to the SAA area. Federal land managers of Class I wildernesses and national parks and state and local air quality agencies within the SAA region have come to the same conclusion. To address this problem, the Southern Appalachian Mountain Initiative (SAMI) was formed. SAMI stakeholders include a wide array of federal, state, local, industrial and environmental representatives, and concerned citizens. SAMI may implement emission management options to help reduce airborne emissions, perhaps beyond what is mandated by the 1990 CAA Amendments. It is hoped that these further reductions will benefit the highly sensitive, high-elevation Class I areas and reduce pollution impacts throughout the Southern Appalachians.

General Conclusions

This study, as it applies to air quality issues and their impact to forest ecosystems, is a broad-scale assessment. As such, these findings stated should be used cautiously when applied to more localized areas such as a county or mountain. What holds true for the entire Southern Appalachians, or a portion of the Southern Appalachians, may not hold true for a specific site in the region.

The northern portion of the Southern Appalachians in West Virginia and in Virginia appears to be exposed to higher concentrations of pollutants which affect natural resources. Visibility is worse in these areas; the frequency of ozone damage is likely to be greater; acid deposition is higher; and the soils have low buffering capacity, so adverse effects are more likely. This pattern is also true for visibility and potential damage from ozone in the southern portion of the assessment area in northern Georgia and Alabama.

There are exceptions to these conclusions: it appears that the highest elevations throughout the Southern Appalachians are receiving the greatest amount of acid deposition, and plants at the highest elevations may be more sensitive to ozone exposures than similar vegetation growing at lower elevations because environmental conditions are favorable for the update of ozone. Finally, yearly variation in meteorology does have an influence on the amount of ozone formation, the amount of acid deposition in the rainfall, and the degree of visibility impairment; therefore, effects to natural resources will vary between years.