Southern Appalachian Mountains Initiative: An Overview

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ABSTRACT

The Southern Appalachian Mountains Initiative (SAMI) is a voluntary partnership of state and federal agencies, industry, environmental groups, academia, and interested public. SAMI was established to identify and recommend air emissions management strategies to remedy existing and prevent future adverse air quality impacts to natural resources in Southern Appalachia, with particular focus on Class I national park and wilderness areas. SAMI's integrated assessment is focusing simultaneously on ozone, visibility impairment, and acid deposition. Computer models are linking emissions, atmospheric transport, exposures, environmental effects, and socioeconomic consequences. SAMI's Policy Committee is designing emissions management strategies to be evaluated by these linked models. Strategies represent air regulatory requirements being implemented at the time of SAMI's formation, expected emissions reductions under recent federal regulatory actions, and alternative strategies being considered by SAMI's Policy Committee. SAMI's Integrated Assessment is designed to answer policy questions and to provide guidance to SAMI's policy recommendations for regional, state, and/or community-based air quality management actions.

INTRODUCTION

The Southern Appalachian Mountains Initiative (SAMI) is a voluntary partnership led by eight states (AL, GA, KY, NC, SC, TN, VA, and WV) surrounding the Southern Appalachian Mountains. Representatives of the states, Environmental Protection Agency, National Park Service, US Forest Service, industry, environmental groups, academia, and the public are participants. SAMI is focusing simultaneously on four air quality issues in the Southern Appalachian Mountains: visibility impairment, acid deposition impacts to aquatic and forest ecosystems, and ozone impacts to forest ecosystems.

SAMI was established in 1992 in response to concerns that declining air quality in the Southern Appalachian Mountains was adversely affecting the natural resources of the mountains, particularly in the Class I national parks and wilderness areas. The SAMI states recognize that local and regional emissions are contributing to declining air quality trends and that regional cooperation will be required to recommend and accomplish air quality improvements in the Southern Appalachian Mountains. SAMI is an example of regional air quality management planning. SAMI participants have widely divergent policy viewpoints but are working together cooperatively to identify and recommend air emissions management strategies. SAMI's Policy Committee is designing alternative strategies to be evaluated in the Integrated Assessment and will recommend strategies to the Operations Committee and Governing Body for implementation.

SAMI is unique in providing a regional forum for concensus-based decisions for both the assessment design and policy recommendations. The State representatives are the voting members of the Operations Committee and Governing Body; representatives of the states, Environmental Protection Agency (EPA) and Federal Land Management agencies, industry, environmental organizations, and academia participate on all SAMI committees and subcommittees. Although policy decisions may be slower in a concensus-based forum, the collaborative discussions are hoped to generate broadly supported recommendations for regional, state, and or community-based actions.

REGULATORY RELEVANCE

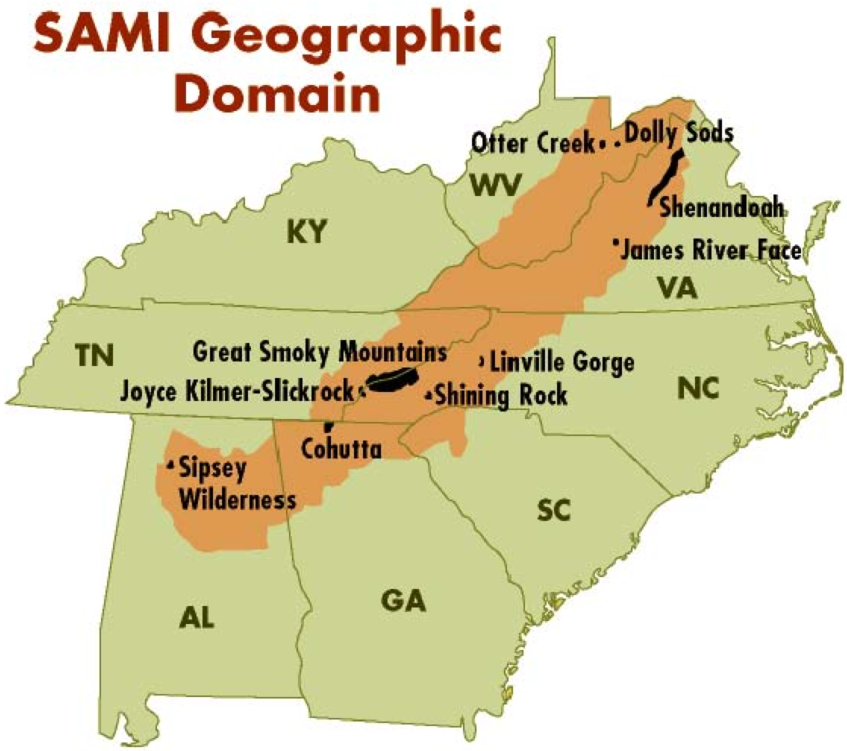
SAMI is focused on air quality impacts to natural resources in the Southern Appalachian Mountains, particularly the 10 Class I areas. Under the Prevention of Significant Deterioration statutes of the 1977 Clean Air Act Amendments, resources in areas designated as Class I are afforded special air quality protection. In the early 1990s, Federal Land Management agencies documented adverse effects to air quality and natural resources in the Class I areas in the Southern Appalachian Mountains[1]. The 1990 Clean Air Act Amendments required emissions reductions to be implemented by the year 2000, but it was unclear when SAMI was formed whether these emissions reductions would be sufficient to protect the natural resources of the Southern Appalachian Mountains, particularly in the Class I areas.

Since SAMI was formed, several federal regulatory actions have the potential to improve air quality in the SAMI region. In 1997, the national standards for ozone and fine particulate matter were revised, and EPA called for regional reductions of nitrogen oxide (NOx) emissions from utility and industrial sources throughout the eastern US through revised State Implementation Plans (NOx SIP call). NOx reductions from mobile sources are required to begin by 2004 under the Tier II mobile and low sulfur fuel rules that were finalized in 1999. Regional haze rules that were finalized in 1999 require states to monitor fine particles that impair visibility and to submit plans for regulatory implementation by 2003-04. SAMI's integrated assessment is evaluating costs and benefits assuming that these federal regulatory requirements are implemented. The assessment is also considering alternative emissions management strategies that SAMI might recommend for regional, state, or community-based actions to protect the natural resources in the SAMI region.

INTEGRATED ASSESSMENT

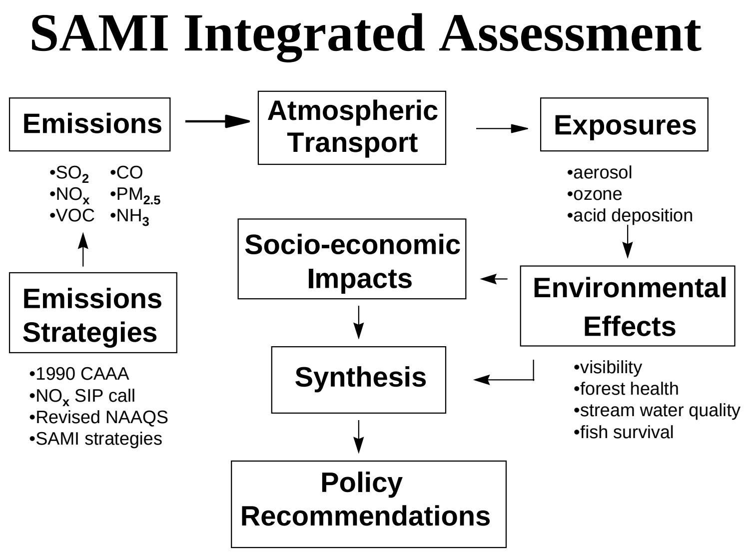
SAMI's Technical Oversight Committee and its subcommittees have designed and are managing the Integrated Assessment of air quality impacts to natural resources in the Southern Appalachian Mountains[2]. The SAMI geographic domain and the locations of the 10 Class I areas are illustrated in Figure 1.

Figure 1. Geographic Domain of Southern Appalachian Mountains Initiative including 10 Class I national parks and wilderness areas



Computer models link emissions inventories, atmospheric transport, environmental effects, and socioeconomic consequences to evaluate the impacts of ozone, aerosols, and acid deposition (Figure 2).

Figure 2. SAMI Integrated Assessment Framework



Emissions management strategies developed by the Policy Committee are evaluated in the linked assessment models, and the results are provided back to the Policy Committee for evaluation and policy recommendations.

Emissions inventories are being developed for the eastern United States for major precursors of ozone, aerosols, and acid deposition[3]. The air quality model will evaluate emissions inventories for two future years, 2010 and 2040. Emissions inventories are also being developed for 2000, 2020, and 2030 to better estimate future emissions trends.

An episodic atmospheric modeling approach is being applied to represent the complex meteorology and atmospheric transport in the mountainous terrain and the gaseous, aerosol, cloud, and deposition processes that control air quality in the Southern Appalachian Mountains[4]. Air quality is being modeled for 68 days in nine week-long episodes selected from the period of record 1991 to 1995. Results for the 68 modeling days will be combined to represent the seasonal and annual air quality metrics that are most relevant for evaluating environmental impacts. Atmospheric modeling results for 2010 and 2040 will define the magnitudes of change in air quality metrics that should be expected for SAMI emissions strategies.

Environmental effects models will evaluate changes in visibility and in aquatic and forest ecosystems in future years in response to changes in aerosol mass, acid deposition, and ozone. The sensitivity of aquatic and forest ecosystems in the Southern Appalachian Mountains to acid deposition and the current geographic distribution of sensitive resources will be described. The current geographic distribution of forest ecosystems sensitive to ozone and the potentially interactive effects of ozone and acid deposition for forest ecosystems will also be described. These models will demonstrate responses to SAMI emissions strategies for the specific resources that are modeled. Regional changes in resources as a function of

SAMI emissions strategies will be interpreted from these model results. Visibility, aquatic, and forest resource benefits of SAMI emissions strategies will be summarized for Policy Committee evaluation.

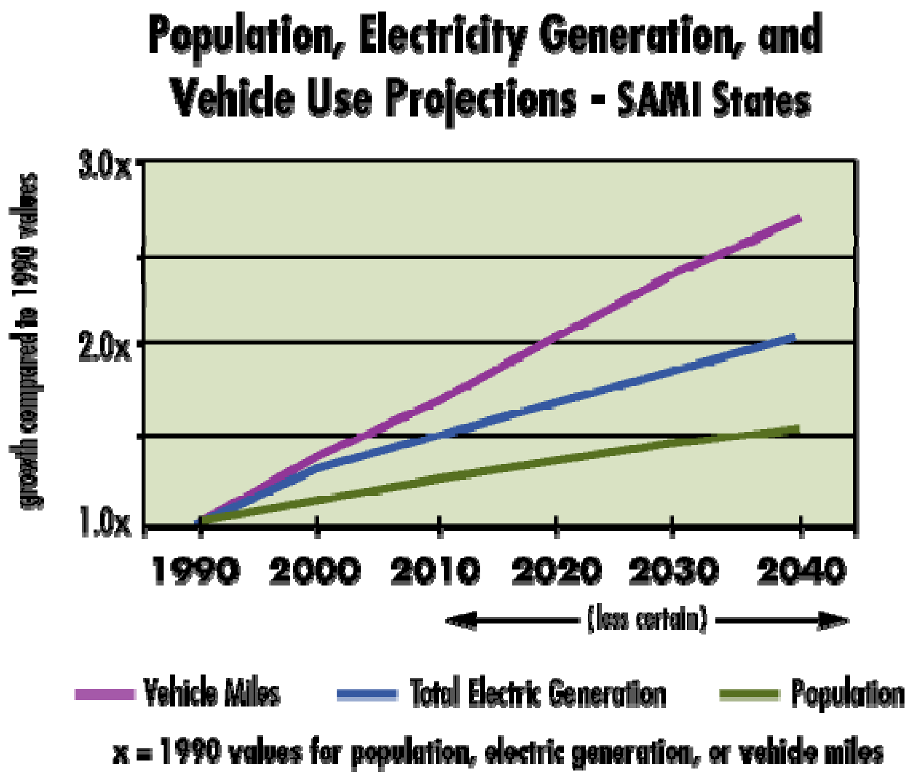
The direct costs of emissions controls and the socioeconomic consequences of the SAMI emissions strategies will also be characterized. SAMI's socioeconomic analyses will not be a comprehensive tally of socioeconomic indicators but will characterize the costs and benefits for selected natural resources, human health, and regional economic indicators. SAMI's stakeholders are likely to place differing values on protection of the natural resources, so SAMI's consensus-based design includes key issues for all SAMI stakeholders.

STRATEGY DESIGN

SAMI's Policy Committee is designing emissions strategies that test alternative assumptions concerning future trends for growth in electric utility generation and transportation demand, adaptation of new technologies and air regulatory actions. Population projections are based on Bureau of Economic Analysis and available state projections. Emissions inventories are projected for each strategy for two future years: 2010 and 2040. Up to nine emissions strategies are being developed to represent a continuum of regulatory, technology, and demand management options.

Two emission projection cases represent implementation of federal air regulations independent of any SAMI action. For these two cases, fossil fuel electricity generation and transportation demand from 1990 to 2040 are projected to grow without any major changes in current population growth patterns, land use policies, or lifestyle behaviors (Figure 3). Only technologies currently available are considered in these two cases.

Figure 3. Trends in future population, fossil fuel electricity generation, and highway vehicle use in the SAMI states between 1990 and 2040



In Figure 3, growth of population, electric generation, and vehicle miles traveled is expressed as a fractional increase relative to levels in 1990. By 2010 the population of the eight SAMI states is projected to be 23% greater than in 1990 while fossil fuel electricity generation and vehicle miles traveled are projected to increase by 70% and 66%, respectively. These trends drive the emissions results because population is used to estimate growth and emissions for a number of area and nonroad sources, vehicle use is used to estimate highway vehicle emissions, and electric utility generation is used to calculate utility emissions.

The first emissions case that SAMI is evaluating represents implementation of air emissions reductions under the 1990 Clean Air Act Amendments, including compliance with the maximum 1-hour ozone standard, reductions of sulfur dioxide (SO2) and NOx from utility sources under Title IV, and reductions of NOx and volatile organic compounds (VOC) from mobile sources under the Tier I rules and National Low Emissions Vehicle programs.

The second emissions case represents regional NOx reductions for utility and industrial sources equivalent to the NOx SIP call and NOx and VOC reductions from mobile sources under the Tier II and low sulfur fuel rules are fully implemented by 2010. Because the SAMI states are still evaluating how the revised 8-hour ozone standard, the revised fine particulate matter (PM2.5) standard, and the regional haze rules will be implemented, these regulatory actions are not included in this second emissions case. SAMI will consider the likely emissions changes under these regulatory actions in other emissions strategies.

SAMI's Policy Committee is also designing emissions strategies that are focused within just the eight SAMI states and that assume emissions reductions for all source sectors beyond current federal requirements. One SAMI strategy represents maximum emissions reductions achievable in the SAMI states by regulatory controls and assuming currently available technologies and no constraints on implementation. A second SAMI strategy considers the constraints to implementation that are posed by maintaining electric reliability, feasible penetration of alternative low emissions vehicles in the mobile sector, etc. Assumed penetration rates for clean technologies by 2040 are higher in the two SAMI strategies than for the two emissions cases representing implementation of federal regulations. Assumptions for future population growth patterns, land use policies, electric generation, and vehicle use are the same across the four emissions cases defined above, with the exception that the rates of growth of vehicle miles traveled are reduced by 25% and 10%, respectively, in the first and second SAMI strategies.

SAMI is also considering what future emissions reductions might be feasible in the SAMI states if incentive programs were implemented to reduce energy and vehicle usage by changing consumer behaviors. Additional emissions inventories may be considered once the continuum of emissions under the above strategies has been evaluated.

EMISSIONS INVENTORY

SAMI's emissions inventories for precursors of ozone, aerosols, and acid deposition characterize utility, industrial, highway vehicle, non-road engines, and area (e.g. small point, agricultural) source categories. Inventories have been developed for the 1990 base year[5] and for specific episodes in 1991 through 1995. Inventories projected for 2010 and 2040[3] will provide inputs to air quality modeling runs of SAMI strategies. Because effects models require air quality inputs for all years 1990-2040, emissions inventories are also being developed for 2000, 2020, and 2030 for selected SAMI strategies. These future emissions trends will assist the design of air quality trends used in the environmental effects models. Direct costs of emissions controls, both capital expenditures and annual operational expenses, will also be provided for the SAMI strategies.

Each inventory includes point source and county-level records for the following emissions:

- • sulfur dioxide (SO_2)
- • nitrogen oxide (NO_x)
- • carbon monoxide (CO)
- • particles less than 10 and less than 2.5 microns (PM_{10} and $PM_{2.5}$)
- • ammonia (NH_3)
- • volatile organic compounds (VOC)

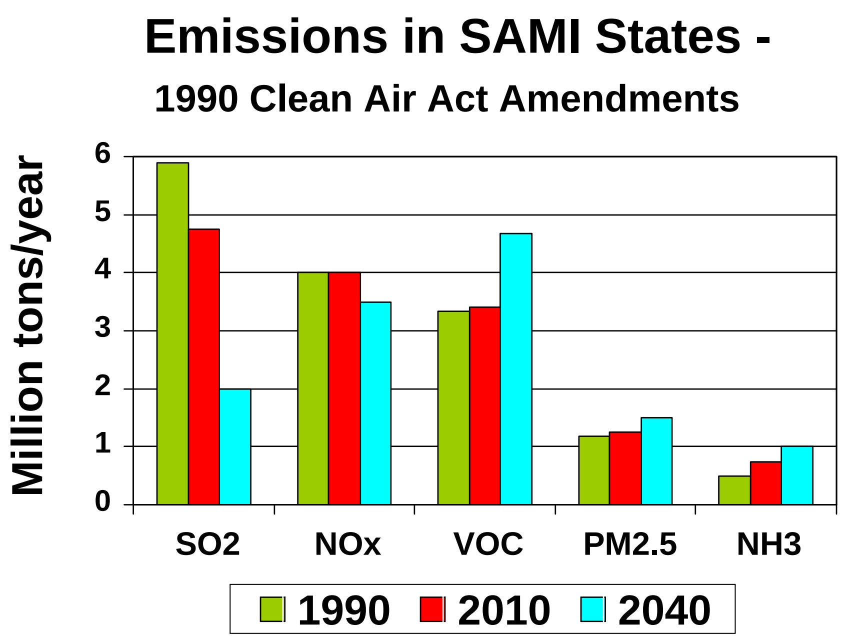
- elemental carbon (EC)
- primary sulfate and nitrate (SO_4 and NO_3)

Biogenic emissions are not included in this inventory, however biogenic emissions are calculated in the photochemical modeling.

Emissions Inventory Projections

Population, fossil fuel electric generation, and vehicle miles traveled are projected to steadily increase in the SAMI states between 1990 and 2040 (Figure 3). Emissions of SO2 and NOx are projected to decrease in 2010 and 2040 in the SAMI states (Figure 4), despite rapid growth in demand[4]. VOC emissions are projected to decrease slightly between 1990 and 2010, while primary emissions of fine particles and NH3 emissions are projected to increase (Figure 4). Because the economies of the SAMI states are growing more rapidly than in the other eastern states represented in SAMI's inventory, emissions improvements in the SAMI states are projected to be less than rates of improvement in eastern US as a whole. Projections for population growth, technology, regulations, land use, and behaviors are more certain in 2010 than in 2040, so emission projections are also more certain in 2010 than in 2040.

Figure 4. Emissions projections for 1990, 2010, and 2040 for the SAMI states, assuming implementation of the 1990 Clean Air Act Amendments



SO2 emissions levels under the two emissions cases representing federal regulations are the same. Between 1990 and 2010 SO2 emissions in the eight SAMI states are projected to decrease by 20% (Figure 4). Utility controls under Title IV of the 1990 Clean Air Act Amendments are primarily responsible for this reduction. SO2 emissions in 2040 are forecast to be much lower than 2010 levels due to new source review requirements under the 1977 Clean Air Act Amendments. Seventy three percent of the current electric generating units are projected to be either repowered (41%) or retired (32%) and replaced with new, cleaner facilities by 2040[3].

NOx emissions in the SAMI states under the emission case that represents implementation of the 1990 Clean Air Act Amendments are not projected to change between 1990 and 2010 (Figure 4). NOx reductions from utility and highway vehicles under Title IV and Title I of the 1990 Clean Air Act Amendments are projected to be offset by NOx increases from the non-road mobile and area source sectors. Under the case representing regional NOx reductions from utilities, industries, and highway vehicles, NOx emissions in the SAMI states in 2010 are estimated to be 15% lower on an annual basis than in 1990. For just the five summer months targeted for seasonal NOx reductions, NOx emissions in 2010 are projected to be 40% lower than for the case representing the 1990 Clean Air Act Amendments (Figure 5) [3].

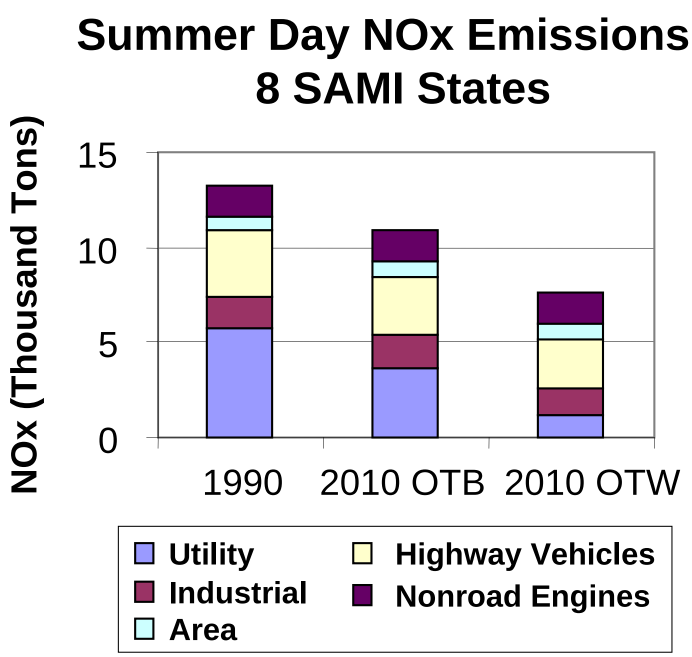


Figure 5. Summer Day NOx Emissions in the eight SAMI states assuming implementation of the 1990 Clean Air Act Amendments (OTB) and implementation of regional NOx reductions from utility, industrial, and mobile sources (OTW).

ATMOSPHERIC MODELING

Episode Selection

SAMI is modeling 68 days in nine episodes that were selected to represent air quality and meteorological events for a five-year period (1991-1995). The air quality and meteorological records for Great Smoky Mountain National Park (Look Rock, Cove Mt, and Elkmont) and Shenandoah National Park (Big Meadows) were the basis of episode selection. Days with valid monitoring data were classified based on magnitude of exposure and predisposing meteorological conditions for each of three air quality metrics[6]:

- • seasonal (April-October), 24-hr cumulative ozone exposures using the W126 metric[7] (where all hourly values are accumulated but values less than 0.10 ppm are weighted less than full value)
- • annual and summer distribution of daily aerosol mass (sulfate, nitrate, organics, soil)
- • annual cumulative wet deposition of sulfate, nitrate, calcium, and magnesium

Unique to SAMI, episodes were selected to represent the full range of meteorological and air quality conditions that contribute to the seasonal and annual air quality metrics that are relevant to environmental effects, rather than focusing on just those episodes with the highest air quality exposures, as is the case in most air quality modeling for regulatory application.

For each of the SAMI strategies, results for the nine episodes will be synthesized to project 2010 and 2040 air quality metrics appropriate for SAMI's environmental effects assessments:

- • growing season (April-October) cumulative 24-hr W126 ozone exposure
- • annual distribution for daily aerosol mass and species composition
- • annual cumulative total (wet plus dry deposition of sulfate, nitrate, and other ions; cloud deposition will not be an atmospheric model output but will be estimated as appropriate to the specific watersheds modeled).

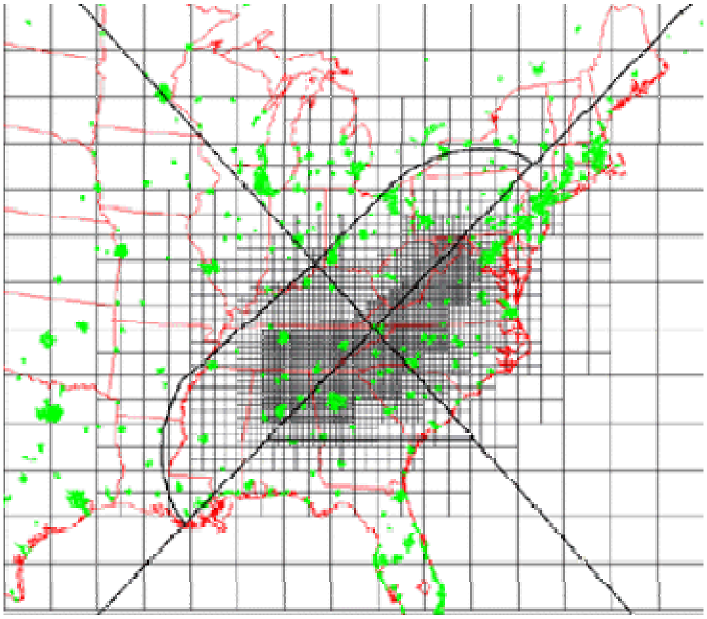
The selected 68 modeling days represent, with known frequency of occurrence, all other days in the 1991-1995 record for Great Smoky Mountains National Park (GRSM) and Shenandoah (SHEN). Appropriate seasonal or annual air quality metrics will be constructed by weighting the contribution of each episode to the air quality metric by the frequency of occurrence of those episodic conditions over the 1991 - 1995 period of interest. Based on the episode weighting for these two national parks, air quality metrics will be derived for the other SAMI Class I areas and the SAMI geographic domain.

Photochemical Modeling

The atmospheric modeling is linking meteorological projections from the Regional Atmospheric Modeling System (RAMS3b)[8] with emissions projections from EMS-95[9] to drive ozone, aerosol, cloud, and deposition modules in the Urban to Regional Multiscale Model (URM)[10].

A nested spatial domain has been selected to provide coverage of the Southern Appalachian Mountains and surrounding urban areas at a 12-km scale within 36-km, 48-km, and 96-km nested grids across the eastern US and northeastern Canada[4]. Grid resolutions decrease at greater distances from the Southern Appalachian Mountains (Figure 6).

Figure 6. Atmospheric modeling domain for the Urban to Regional Multiscale Model (URM)



For each episode and emissions strategy, total anthropogenic and biogenic emissions are projected based on the episode-specific emissions inventory and RAMS3a meteorology files. URM files provide hourly and daily ozone, aerosol, and deposition metrics for the full eastern United States modeling domain. Model performance is evaluated by comparing model outcomes to observational data across the southeastern US, with particular focus on performance within the fine grid of the SAMI modeling domain.

By March 2000, performance of the integrated ozone, aerosol, and deposition modules has been demonstrated for 4 of the 9 episodes with the remaining episodes to be completed by July 2000. Air quality modeling results for the two cases representing federal regulations are due summer 2000. URM model performance for ozone is well within performance criteria established by EPA for regulatory modeling[4]. National model performance criteria for aerosols and deposition do not exist. SAMI evaluations indicate that the URM model is able to track the chemical and physical processes controlling aerosol formation and deposition[11].

Geographic Sensitivities

Sensitivity analyses using the atmospheric model are projecting changes in air quality metrics for selected SAMI receptor sites as a function of emissions reductions for specific source categories and specific geographic sectors surrounding the Southern Appalachian Mountains. The geographic sectors are outline in bold lines in Figure 6. These sensitivity analyses are providing information to assist SAMI's Policy Committee in understanding source-receptor relationships.

Regulatory Application
SAMI's atmospheric modeling will define air quality changes in response to SAMI emissions strategies. The air quality benefits derived in the Southern Appalachian Mountains from emissions cases representing federal regulations can be interpreted directly from the atmospheric modeling results. The geographic sensitivity analyses will provide information on benefits from emissions reductions for specific source categories and geographic sectors and will allow interpretation of source contributions to air quality at specific SAMI receptors. The SAMI episodes were selected for relevance to the mountainous areas and seasonal and annual air quality metrics. The SAMI air quality modeling results will not be directly applicable to demonstrate the benefits in urban areas of regional NOx reductions nor compliance with the 8-hr ozone and 24-hr fine particulate matter standards.

The SAMI modeling is particularly appropriate to address changes in aerosol mass and visibility under the regional haze rules, and the SAMI states may choose to apply SAMI results for their state modeling requirements. The organization known as Southeastern State Air Resource Managers (SESARM) has the responsibility for regional planning to implement the regional haze rules. Although SESARM's primary mission are those air quality issues impacting the eight states within the boundaries of EPA's Region 4, the states of Virginia and West Virginia have been included for the purposes of regional haze planning. Because the SAMI states are also the regional planning states and because the SESARM Director serves as the SAMI Policy Committee Chair, SAMI's aerosol modeling results are intended to be relevant to SESARM's regional haze implementation planning.

EFFECTS

SAMI's effects assessments are linking changes in air quality resulting from emissions strategies to changes in the natural resources across the Southern Appalachian Mountains. Assessments are being conducted in two phases. Phase I analyses focused on specific sites (for visibility and acid deposition) or specific tree species (for ozone) and are complete [7, 12,13,14]. These analyses provided SAMI with early guidance for design of emissions strategies by defining the possible reductions in air quality exposures that will be needed to detect responses for sensitive species and watersheds. The SAMI Phase I analyses suggest that reductions in exposures below 1990 levels will be required to protect sensitive resources in the Class I areas.

SAMI's Phase II Effects Assessments will characterize resource responses to changes in air quality across the SAMI region and specifically for the ten Class I areas. Changes in air quality projected by the atmospheric model results will be tested in the environmental effects models.

Ozone and Acid Deposition
SAMI's Phase II approach to assess ozone and acid deposition impacts on forest and aquatic resources will:
- • characterize resource sensitivity to air pollutant exposures

- • apply resource response models to representative sites
- • extrapolate the responses modeled for representative sites to responses of resources with similar sensitivity in the SAMI region
- • interpret and display regional changes in resources in response to changes in air quality exposures

Stream water quality will be used as an indicator of habitat suitability for aquatic life and response to acid deposition[15]. Forest nutrient status and forest productivity will be used as indicators of forest response to acid deposition and ozone, respectively.

Visibility

SAMI's visibility assessment is projecting changes in light extinction, deciviews, and visual range in responses to changes in aerosol mass, size, and composition. SAMI's Phase I analyses[12] relied on aerosol and visibility monitoring records from the Interagency Monitoring of Protected Visual Environments (IMPROVE) sites in the SAMI region, with particular attention to trends at Look Rock in Great Smoky Mountain National Park. Phase I analyses also used measurements from the Southeastern Aerosol and Visibility Study (SEAVS) conducted at Look Rock in the Great Smoky Mountains National Park in July and August 1995. SAMI's Phase II assessment will project visibility as a function of aerosol values provided by the atmospheric model outputs as well from monitoring records. The classification scheme assigns selected episode days to one of five classes based on aerosol mass, including days with the 20% highest and the 20% lowest aerosol mass. This classification system is similar to that used in the regional haze rules except that the regional haze rules use visibility instead of aerosol mass as the basis for classifying days.

Socioeconomic Consequences

The social and economic impacts of SAMI recommendations will be examined. The potentially large number of socioeconomic indicators have been narrowed to the six most significant [15]:

- • fishing
- • hiking/ enjoying scenery
- • stewardship/ sense of place
- • human mortality
- • regional competition/ jobs
- • lifestyle changes

SYNTHESIS

SAMI's integrated assessment is considering both spatial and temporal trends for emissions, exposures, environmental effects and socioeconomic consequences. Discrete databases will be linked to a common SAMI website (saminet.org). The spatial displays will link alternative emissions strategies in the SAMI states to air quality exposures across the southeastern US and environmental effects and socioeconomic consequences within the SAMI domain. The temporal displays will allow comparison of baseyear, 2010, and 2040 trends.

Linked databases will include:

- • population trends for every decade 1990 - 2040
- • emissions inventories for 1990, 2010 and 2040 for two cases representing implementation of federal regulations and for SAMI strategies
- • emissions trends for 2000, 2020, 2030 for selected strategies
- • meteorological and air quality files for Great Smoky Mountains National Park and Shenandoah National Park for 1991-1995 used as basis for episode selection
- • meteorological observations and model results for nine episodes
- • emission modeling files for nine episodes, for base year, and for 2010 and 2040 inventories
- • air quality modeling files for nine episodes for base year and for 2010 and 2040 inventories
- • projected seasonal, or annual air quality metrics based on modeled episodes
- • observed episodic, seasonal, or annual air quality metrics
- • meteorological and air quality files used for acid deposition and ozone effects models (observation or model based)
- • forest resource data bases for response modeling and for classification of forest sensitivity to ozone and/or acid deposition
- • aquatic resource data bases for response modeling and classification of stream sensitivity to acid deposition
- • forest and aquatic response model results for projected future years for SAMI strategies
- • regional projections of forest and aquatic resource responses in Class I areas and SAMI region under alternative emissions strategies
- • visibility projection for future years and alternative emissions strategies
- • visibility visualization tools such as Win Haze to illustrate changes
- • direct costs of emissions controls
- • socioeconomic consequences of selected emissions strategies and future years

SCHEDULE

SAMI participants have access to modeling results as soon as they are completed. Emission inventories for 2010 and 2040 On the Books and On the Way emissions cases and Phase I effects analyses are complete. Additional emissions strategy inventories and atmospheric model results will be available at end of 2000. Effects and socioeconomic components will be completed in 2001.

Acknowledgments

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References

1) 1) Shaver, C.L.; Tonnessen, K.A.; Maniero, T.G. *Ecologial Applications*. 1994, 4(4), 690-701.
2) 2) Brewer, P. F., Southern Appalachian Mountains Initiative, A Regional Partnership for Air Quality Management, In Proceedings of Annual Meeting of Air and Waste Management Association, St. Louis, Missouri, June 1999.
3) 3) Ogburn, C., Boothe, L., Mullen, M., Brewer, P.F. Emissions Inventories for the Southern Appalachian Mountains Initiative. In Proceedings of Annual Meeting of the Air and Waste Management Association, Salt Lake City, UT, June 2000.
4) 4) Odman, T., Boylan, J., Wilkinson, J., Yang, Y-J, and Russell, A. G. Ozone Modeling for the Southern Appalachian Mountains Initiative. In Proceedings of the Annual Meeting of the Air and Waste Management Association, Salt Lake City, UT, June 2000.
5) 5) E.H. Pechan and Associates, Inc. Development of the SAMI 1990 Base Year Emissions Inventory, Report prepared for the Southern Appalachian Mountains Initiative, January 1999.
6) 6) Systems Applications International, Inc. Episode Selection for the Integrated Analysis of Ozone, Visibility, and Acid Deposition for the Southern Appalachian Mountains; Prepared for the Southern Appalachian Mountains Initiative, June 1998.
7) 7) Lefohn, A. The Identification of Ozone Exposures That Result in Vegetation Visible Injury and Growth Loss for Specific Species Grown in the Southern Appalachian Mountain Region; Prepared for the Southern Appalachian Mountains Initiative, Final Report, September 1998.
8) 8) Norris, W.B., Doty, K.G. Meteorological Modeling protocol, Prepared for Southern Appalachian Mountains Initiative, May 1998.
9) 9) Russell, A.G., McNider, R., Moody, J., Wilkinson, J. Emissions Modeling protocol, Prepared for Southern Appalachian Mountains Initiative, May 1998.
10) 10) Russell, A.G., McNider, R., Moody, J., Wilkinson, Air quality modeling protocol, Prepared for Southern Appalachian Mountains Initiative, April 1997.
11) 11) Boylan, J., Wilkinson, J., Yang, Y-J, Odman, T., and Russell, A. G. Particulate Matter and Acid Deposition Modeling for the Southern Appalachian Mountains Initiative. In Proceedings of the Annual Meeting of the Air and Waste Management Association, Salt Lake City, UT, June 2000.
12) 12) Copeland, S. Phase I Visibility Effects Analysis; Prepared for the Southern Appalachian Mountains Initiative, Final Report June 1999.
13) 13) Cosby, B.; Sullivan, T. Application of the MAGIC Model to Selected Catchments: Phase I Southern Appalachian Mountains Initiative; Prepared for the Southern Appalachian Mountains Initiative, Final Report, March 1999.
14) 14) Munson, R. Application of the NuCM Model to Noland Divide, White Oak Run, and Shaver Hollow for SAMI Phase I; Prepared for the Southern Appalachian Mountains Initiative, Final Report, March 1999.

15) 15) Brewer, P., Sullivan, T., Cosby, B. J., Munson, R. Acid Deposition Effects to Forests and Streams in the Southern Appalachian Mountains. In Proceedings of Air and Waste Management Association, Salt Lake City, UT, June 2000.
16) 16) GHL Incorporated; Mathtech, Incorporated. Options for Performing SAMI's Socioeconomic Assessment; Prepared for the Southern Appalachian Mountains Initiative, August 1998.

Key Words

Photochemical modeling, ozone, visibility, acid deposition, effects, emissions inventory