



VISTAS Monitoring Strategy
October 21, 2002
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This document describes the plans of the southeast regional planning organization, VISTAS (Visibility Improvement - States and Tribal Associations of the Southeast) to enhance ambient monitoring in the region to support activities associated with the management of regional haze, visibility and other related air quality issues in the VISTAS region.

Background:

The VISTAS region includes the states of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and West Virginia, and the Tribe of the Eastern Band of the Cherokees. The State implementation plans (SIP's) and Tribal Implementation Plans (TIP's) that describe how the States and Tribes will meet the goals of the regional haze rule are due to be submitted to the U.S. Environmental Protection Agency (EPA) by December 31, 2008.

VISTAS will be conducting the regional technical analysis to determine what controls and strategies are appropriate to meet the goals of the rule. The individual SIP's and TIP's will be based in large part on this regional technical analysis. VISTAS plans to use an atmospheric model as one part of the technical analysis to demonstrate the effects of various control measures toward achieving the goals of the regional haze rule.

Objectives:

The overall objective of the VISTAS monitoring efforts is to enhance existing monitoring activity to create a more complete database that is sufficient to evaluate the atmospheric model performance. Most ambient monitoring in the region is designed around the needs of the states to demonstrate compliance with the NAAQS. The species monitored that are most closely related to regional haze are primarily sampled and reported as 24 hour average data. Related gaseous data, while available as hourly concentrations, are typically not collocated with the particulate samplers. The atmospheric model will generate hourly predictions and a comprehensive suite of collocated, hourly ambient data is needed to ensure adequate characterization of the diurnal profiles of the various species.

The atmospheric modeling results will be used to test and evaluate control strategies to support the development of appropriate control measures. The appropriate controls will be important elements in the SIP's and TIP's intended to ensure the Class I areas in the southeast achieve visibility improvement goals. The modeling results need a thorough evaluation so the States and Tribes are comfortable using the analysis in their rulemaking efforts. The availability and comprehensiveness of the monitoring data is critical to the model performance evaluation.

This modeling analysis may also be used as a basis to understand what controls are needed to attain the fine particle standard in the southeast. VISTAS, in coordination with the four other regional planning organizations and the Environmental Protection Agency (EPA) expect that 2002 will be selected as the base year for atmospheric modeling. Although the comprehensive data collection described below will not be initiated until 2003, the data is expected to be most useful for model performance evaluation.

This monitoring strategy addresses the following specific needs:

- Spatial representation across significant portions of the VISTAS region
- Representation of source areas contributing to air quality at Class I areas in VISTAS region
- Temporal resolution of the data to support model evaluation
- Additional analysis at existing IMPROVE sites
- Additional upper air meteorology
- Intensive monitoring

I. Spatial representation:

The Interagency Monitoring of Protected Visual Environments (IMPROVE) network operates particle monitors at 15 of the 18 Class I areas in the VISTAS region (Table 1 and Figure 2). These existing monitors provide good spatial coverage ranging from Everglades National Park in south Florida to Dolly Sods Wilderness Area in northern West Virginia and from Sipsey Wilderness in the west to Swan Quarter Wildlife Refuge Area in eastern North Carolina.

IMPROVE measures particles for 24-hours samples every third day with data at some sites beginning in 1988. Relative humidity and light extinction are currently measured at only three sites (see Table 1). Image spectra are available for seven sites, but only one IMPROVE camera is currently operating in the VISTAS region.

In addition to the data available from the IMPROVE Network, VISTAS intends to utilize other available speciated particulate data collected as part of the Speciation Trends Network, the EPA Super Site studies, the Southeastern Aerosol Research and Characterization (SEARCH) initiative, and other intensive particulate studies conducted in the VISTAS region.

VISTAS does not recommend additional monitoring locations for spatial representation at this time. However, as discussed below in Section IV, VISTAS has identified priorities to expand analysis of ammonium and to measure relative humidity and light extinction at additional IMPROVE sites.

II. Source Areas:

The States are monitoring fine and coarse particle mass and speciated fine particle mass in several urban areas in each state (Figure 2). These samplers provide information on the magnitude and composition of particles in the source areas that can contribute to air quality and visibility in the Class I areas. Relatively few rural sites representing transport or receptor areas are included in the network. The measurements at the Speciation Trends Network sites are 24-hour averages every 3rd or every 6th day (Figure 2). No additional funding by VISTAS is recommended for this category of measurements.

There are a number of sites where continuous PM_{2.5} mass is monitored (Table 2). These data provide temporal resolution of fine particle mass but are predominantly in urbanized areas, do not separate contributions from individual species, and are generally not collocated with speciation samplers.

Four Urban/ Rural monitoring site pairs, operated by SEARCH and primarily located in the Gulf coastal plain, have been established and have collected continuous speciated particulate, gaseous, and surface meteorological data to provide characterization of regional fine particulate composition.

III. Temporal Resolution:

VISTAS has participated in two separate efforts to determine what ambient data is most needed for model evaluation, one with modeling experts familiar with the southeastern United States, and one with modeling experts who have modeled all parts of the country. Both of these efforts reached the same conclusions:

- Temporal Resolution – The modelers recognized the need for highly time resolved, speciated measurements of chemical composition as the single greatest need for accurately modeling fine particle formation and transport. One-in-three or one-in-six day sampling of PM constituents is not sufficient for model evaluation.
- Speciated PM_{2.5} measurements - At a minimum, daily speciation is needed and preferably semi-continuous measurements of sulfate, nitrate, and carbon.
- Species – Along with the constituent components of PM, desired gas phase measurements include NH₃, HNO₃, NO, real NO₂ (NO₂ is frequently contaminated by PAN and Nitric Acid), and NO_Y. H₂O₂ and gas phase speciated VOCs are useful for ozone and particulate modeling, but only if measured correctly (some data quality concerns have been noted with VOCs and H₂O₂ is difficult to measure).
- A few sites with all of these measurements are better for model evaluation than several sites with only one or two of the measurements.

In response to this guidance, VISTAS intends to develop a few existing sites as “Focus Sites” where a complete suite of meteorological and air quality data will be collected on an hourly or daily basis as appropriate to support the model performance evaluation.

Candidate “Focus Sites” were prioritized based on several criteria:

- 1) Existing suite of monitoring in operation
- 2) Physical infrastructure (space, shelter, power) sufficient to support added monitors
- 3) Geographic distribution (coastal, piedmont, mountains)
- 4) Both source and receptor locations
- 5) Site accessibility
- 6) Labor costs (installation, operation, maintenance, and data archiving) funded either as state contribution or by VISTAS.
- 7) Availability of State and federal co-funding or in-kind services.

8) Relative locations of other cooperative monitoring programs

Based on these criteria, VISTAS plans to build upon the existing monitoring at the following four "Focus Sites":

- Cape Romain Wildlife Refuge, SC
- Millbrook, NC
- Look Rock, Great Smoky Mountains National Park, TN
- South Decalb, Atlanta, GA

The monitoring data and equipment proposed for these Focus Sites are listed in Table 3, along with the current or proposed funding sources. Highest priority is placed on continuous monitoring for SO₄, NO₃, and carbon particulate and for gaseous precursors (SO₂, NO_y, CO). EPA's PM_{2.5} program has approved funds for NC and SC to each purchase continuous monitors for SO₄, NO₃, and carbon in 2002. As part of its Air Quality Trends monitoring program, EPA also intends to fund continuous monitors in Atlanta, GA; however, funds have not been approved for release. Therefore the Atlanta site will not be available as a full VISTAS Focus site in 2003. Many of the gaseous measurements identified for Focus sites are already in place in Atlanta.

The current technology for semi-continuous monitoring of PM_{2.5} species is still undergoing field test, most notably at a number of the Super Sites. VISTAS intends to operate a limited number of alternative method semi-continuous speciation monitors to compare measurement results.

IV. Additional Measurements at existing IMPROVE sites

Ammonium is currently analyzed from filter samples at Great Smoky Mountains (GRSM), Shenandoah (SHEN) National Parks and Dolly Sods (DOSO) Wilderness Area. At all other sites in the network, IMPROVE assumes that measured sulfate is fully neutralized (two ammonium ions for each sulfate ion) and that all measured nitrate is ammonium nitrate. IMPROVE measurements at GRSM, SHEN, and DOSO indicate that sulfate is not fully neutralized and that molar ratios of ammonium to sulfate can approach 1.0 on many days. Because amount of water absorbed by sulfate aerosols, and thus the light scattering, is greater for the more acidic aerosols (lower molar ratio of ammonium to sulfate), VISTAS planned to expand the ammonium analyses to the following additional 10 IMPROVE sites in the VISTAS region:

- Sipsey Wilderness Area, AL
- Everglades National Park, FL
- Chassahowitzka National Wildlife Refuge Area, FL
- Cohutta Wilderness Area, GA
- Mammoth Cave National Park, KY
- Shining Rock Wilderness Area, NC
- Linville Gorge Wilderness Area, NC
- Swan Quarter Wildlife Refuge Area, NC
- Cape Romain National Wildlife Refuge Area, SC
- James River Face Wilderness Area, VA

In Quarter 4, 2002, VISTAS contracted to support expanded analysis of ammonium at the IMPROVE sites in the VISTAS region. The IMPROVE contract laboratory will perform the

analysis on the October 1, 2002 through December 31, 2003 IMPROVE samples. Data will be submitted directly to UC-Davis for inclusion in the IMPROVE database.

VISTAS has also placed priority on expanding the number of IMPROVE sites where relative humidity and light extinction is measured. Relative humidity is a critical factor in the calculation of light extinction from reconstructed fine mass. Relative humidity measurements are inexpensive to add if power, data acquisition systems and phone lines for remote data access have already been installed.

Light extinction measured by nephelometer or transmissometer provides a semi-continuous indicator of air quality and also a benchmark for comparison of light extinction calculated from reconstructed particle mass and relative humidity. Experience with the installation and operation of nephelometers is limited in the region and the support for their operation may need to be contracted.

V. Additional upper Air Meteorology

In the future, VISTAS would like to add upper air measurements (e.g. radar profiler) to improve understanding of vertical structure for temperature, winds. Priorities for additional profilers in the VISTAS region will be evaluated as part of the VISTA Data Analysis contract with Air Resource Specialists. The VISTAS Focus sites are candidates for radar profilers. A radar profiler is already operated near the Millbrook site. VISTAS does not have funding in the 2002 budget for these measurements and is developing cooperative agreements with other organizations to provide these data.

Mineral Management Services will install and operate a radar profiler on the Gulf Coast beginning 2003. NOAA will provide labor for data access and analysis and there will be no direct cost to VISTAS. In addition, NOAA is requesting federal appropriations to expand their upper air monitoring beginning in FY2004. VISTAS will continue to evaluate priorities and opportunities to improve and expand upper air measurements in the southeastern US.

VI. Intensive monitoring

VISTAS will develop a separate proposal and justification for intensive monitoring if appropriate in summer 2004.

Table 1. IMPROVE Visibility monitoring at Class I areas in VISTAS region.

| Class I Area | Geographic Area | IMPROVE Start | Light extinction | | Relative Humidity | Photographic Images | Additional Monitoring data available |
|--------------------------------------------------|-----------------------------|---------------------------------|--------------------------------------|------------------------------|--------------------|----------------------------------|---------------------------------------------------------------------------------------------------|
| | | | Instrument | Date | | | |
| Sipsey Wilderness Area, AL | Western VISTAS region | 1992 | | | | 11/88-4/95 | |
| Everglades National Park, FL | Southern coastal | Partial 1988-1991, 2000-present | | | | 12/82-8/88 | |
| St. Marks National Wildlife Refuge Area, FL | Southern coastal (Gulf) | 2000 | | | | | |
| Chassahowitzka National Wildlife Refuge Area, FL | Southern coastal (Gulf) | 1993 | | | | 4/95-present | |
| Cohutta Wilderness Area, GA | Southern Appalachia | 2000 | | | 2002 | 11/88-2/92 | |
| Okefenokee Wildlife Refuge Area, GA | Southern coastal plain | 1991 | Nephelometer | 12/92-9/97 | 1993-1997 | 4/92-11/92 | |
| Wolf Island National Wildlife Refuge Area, GA | Southern coastal (Atlantic) | None | | | | | |
| Mammoth Cave National Park, KY | Western VISTAS region | 1991 | Nephelometer | 3/93-Present | 1993-present | 3/92-5/97 HiRes 12/01-present | O ₃ , SO ₂ , CO, NO/NO _y , Met., NADP, NDDN, MDN |
| Joyce Kilmer-Slickrock Wilderness Area, NC | Southern Appalachia | None, represented by GRSM | | | | 11/88-10/92 | |
| Shining Rock Wilderness Area, NC | Southern Appalachia | 1994 | Nephelometer | 6/94-9/99 | 1994-1999 | 10/88-9/92 6/94-10/99 | |
| Linville Gorge Wilderness Area, NC | Southern Appalachia | 2000 | | | | 12/88-9/92 | |
| Swan Quarter Wildlife Refuge Area, NC | Northern coastal (Atlantic) | 2000 | | | | | |
| Cape Romain National Wildlife Refuge Area, SC | Coastal (Atlantic) | 1994 | | | 1/99-present (FRM) | 3/95-1/00 | |
| Great Smoky Mountains National Park, TN | Southern Appalachia | 1988 | Neph. | 3/93-present | 1993-present | 1/84-10/95 | O ₃ , SO ₂ , CO, NO/NO _y , Met., NADP, NDDN, MDN |
| James River Face Wilderness Area, VA | Southern Appalachia | 1994 | Neph. | 12/2000 - present | 2000 to present | 1/89-9/95 | |
| Shenandoah National Park, VA | Southern Appalachia | 1988 | Nephelometer Transmissometer. | 9/96-present 6/91-Present | 1988-present | 7/91-4/95 | O ₃ , tSO ₂ , CO, NO/NO _y , VOC Met, MDN, CASTNet, Wet Dep, CFCs |
| Dolly Sods Wilderness Area, WV | Southern Appalachia | 1991 | Nephelometer | 3/93-11/97 | | 4/87-11/88 4/89-12/94 | Colo EPA Spec. filters |
| Otter Creek Wilderness Area, WV | Southern Appalachia | None, represented by DOSO | | | | | |

Table 2. Sites in VISTAS states with continuous PM2.5 measurements

| State | AIRS ID | Site name or Street Address | Methodology | ACTIVE |
|-------------|-------------|------------------------------------------|--------------|--------|
| AL | 01-073-0023 | NORTH BIRMINGHAM | | |
| | 01-073-1005 | | | Y |
| | 01-097-1006 | PROVIDENCE | | Y |
| | 01-097-2003 | WYLAM | | Y |
| | 01-097-2006 | HOOVER | | Y |
| | 01-097-5002 | PINSON | | Y |
| | 01-097-5003 | CORNER | | Y |
| | 01-097-0003 | IROQUOIS AND AZALEA CHICKASAW,MOBILE CO. | 722 | |
| | FL | 12-011-1002 | DAVIE | TEOM |
| 12-025-1016 | | NW 20 ST AND 12 AVE,FIRE STATION | TEOM | |
| 12-033-0004 | | ELLYSON INDUSTRIAL PARK-COPTER ROAD | TEOM | |
| 12-057-0030 | | | | Y |
| 12-095-2002 | | MORRIS BLVD. | TEOM | |
| 12-099-1004 | | 3700 BELEVEDERE ROAD | 750 | |
| 12-103-0018 | | 7200-22 AVENUE NORTH | TEOM | |
| MS | | 28-047-0008 | GULFPORT YC | TEOM |
| | 28-049-0018 | COURT AND FARRISH STREETS | TEOM | Y |
| NC | 37-051-0009 | W OWEN SCHOOL | TEOM | Y |
| | 37-067-0022 | HATTIE AVENUE | TEOM | Y |
| | 37-081-0013 | 205 WILOUGHBY BLVD | TEOM | Y |
| | 37-119-0041 | 1120 EASTWAY DRIVE | TEOM | Y |
| | 37-129-0002 | | | Y |
| | 37-173-0002 | BRYSON | | Y |
| | 37-183-0014 | MILLBROOK | 789 | Y |
| SC | 45-007-0003 | POWDERSVILLE | TEOM | Y |
| | 45-029-0002 | ASHTON | TEOM | Y |
| | 45-037-0001 | TRENTON | TEOM | Y |
| | 45-063-0009 | CAYCE | 791 | N |
| | 45-073-0001 | LONGCREEK | TEOM | Y |
| | 45-077-0002 | CLEMSON | TEOM | Y |
| | 45-079-0018 | OLYMPIA | TEOM | Y |
| | 45-083-0008 | PECAN | 750 | N |
| | 45-025-0001 | CHESTERFIELD | TEOM 30° SES | Y |
| | 45-019-0046 | CAPE ROMAIN | TEOM 30° SES | Y |
| | 45-083-0009 | N. SPARTANBURG FS | 791 | N |
| TN | 47-037-0023 | 105 SOUTH 17TH ST @ LOCKELAND SCHOOL | TEOM | |
| | 47-009-0101 | LOOK ROCK, GSMNP | TEOM 30° SES | Y |
| | 47-093-1013 | AIR LAB | | Y |
| VA | 51-059-1005 | ANNANDALE | | Y |
| | 51-087-0014 | MATH and SCIENCE CENTER | | Y |
| | 51-650-0004 | VA SCHOOL | | Y |

Table 3: VISTAS Focus Sites: existing and proposed monitoring capabilities supporting regional haze activities

| Monitoring equipment for VISTAS "Focus Sites" | | | | | | |
|------------------------------------------------------------------------------------------|--------------------------------|-------------------------|----------------------|-------------------|-----------------------------|----------------------------------|
| x = existing monitoring; X or BOLD – Focus site monitoring or analysis added 2003 | | | | | | |
| Measurement Parameter | Sample Period | Instrument Type | Focus Sites | | | |
| | | | Cape Romain NWR, SC | Millbrook, NC | Great Smoky Mtns. NP, TN/NC | FUTURE: So. Dekalb (Atlanta, GA) |
| Meteorology | | | | | | |
| temperature | hourly | RM YOUNG | X | x | x | x |
| Relative Humidity | hourly | RM YOUNG | X | x | x | x |
| wind direction/speed | hourly | RM YOUNG | x | x | x | x |
| precipitation | hourly | NovaLynx | x | x | x | x |
| Solar Radiation TUVR | hourly | Eppley PSP TUVR | | x | x | x-Nearby site (Conyers) |
| Barometric Pressure | hourly | RM YOUNG | | | x | x |
| Upper air | | Radar profiler or SODAR | | x radar profiler | | x SODAR |
| PM2.5 mass | 24-hr | | x- IMPROVE 1:3 | x- R&P 1:1 | x- IMPROVE 1:3 | x- Andersen 1:3 |
| PM10 mass | 24-hr, | Wedding or IMPROVE | x- IMPROVE 1:3 | x- Wedding 1:6 | x- IMPROVE 1:3 | IMPROVE 1:3 |
| Speciated PM2.5 (SO ₄ , NO ₃ , OC, EC, soil) | 24-hr | | x-IMPROVE 1:3 | x-R&P 1:3 | x- IMPROVE 1:3 | x- Andersen 1:3 |
| NH ₄ analyses from speciated PM2.5 filter | 24-hr | | X-IMPROVE 1:3 | x- R&P 1:3 | x- IMPROVE 1:3 | x- Andersen 1:3 |
| Continuous | | | | | | |
| Continuous PM2.5 Mass | hourly | TEOM | X | x | x | x |
| Continuous PM10 Mass | hourly | | | x | | |
| Continuous SO ₄ | hourly | R&P | X | X | X | Future |
| Alternative SO ₄ | hourly | Harvard | | X | x | |
| Continuous NO ₃ | hourly | R&P | X | X | X | Future |
| Alternative NO ₃ /NH ₄ | hourly | Edgerton | | X | X | |
| Continuous OC/EC | hourly | R&P | X | X | X | Future |
| Alternative EC | hourly | Aethalometer | X | X | X | X |
| Gases - | | | | | | |
| SO ₂ | hourly | | x | x | x ⁴ | |
| Ozone | hourly | | x | x | x | x |
| NO/NO _y | hourly | | X | x | x ⁴ | x |
| Real NO ₂ | hourly | Thermo | | | | x |
| CO | hourly | | X | | x ⁴ | |
| NH ₃ | hourly | Thermo | | x | | |
| VOC | hourly or 24-hour ^a | cannister | | x | | x |

| | | | Cape Romain, SC | Millbrook, NC | Great Smoky Mtns, TN | South Dekalb, GA |
|------------------------------|--------|--|--------------------------------------|--------------------------------------|----------------------|------------------|
| Optical | | | | | | |
| nephelometer | 15 min | | proposed – VISTAS³ | proposed – VISTAS³ | X | |
| camera | 15 min | | | | X | |
| Deposition Monitoring | | | | | | |
| NADP (wet) | | | X | | X | |
| NDDN (dry) | | | | | X | |
| MADPro (cloud) | | | | | X | |

³ Support funding allocated in VISTAS monitoring budget

⁴ Support from VISTAS for National Park Service operation for 2003

^a hourly (June, July, Aug) or 24-hr every 6th day (year-round)

Figure 1: Locations of PM_{2.5} speciation sampling sites in the VISTAS region

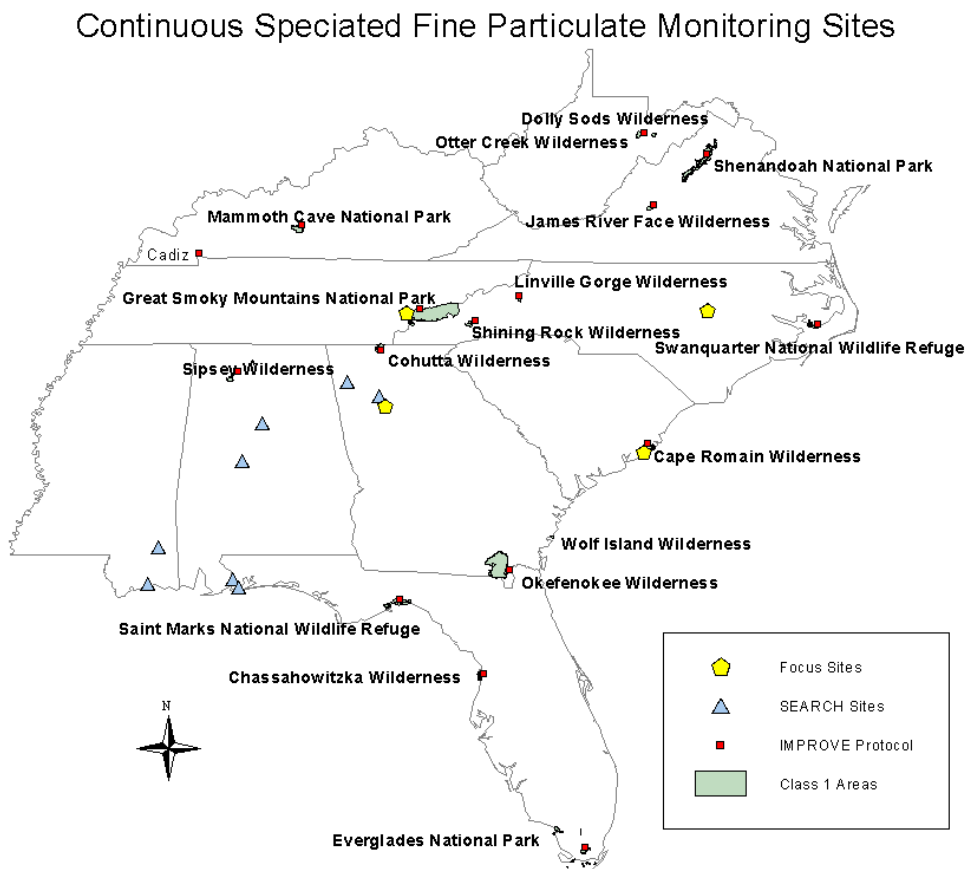


Figure 2: Frequency of sampling and sponsor of PM2.5 speciation sampling sites in the VISTAS region

