MANE-VU Technical Work Plan

MANE-VU Technical Support Workplan
March 21, 2003

Preface

In September, 2002, the Mid-Atlantic/Northeast Visibility Union (MANE-VU) hosted a technical coordination workshop to discuss future monitoring, data analysis and modeling planning efforts. The Technical Support Committee (TSC) co-chairs that were in attendance at that meeting agreed to expand the context of the "modeling workplan" document that was being developed by the RPO's modeling workgroup to include aspects of monitoring, data analysis and emissions inventory development. The workshop attendees agreed that all aspects of the RPO's technical work should be coordinated and that the development of a cohesive technical workplan would ensure this result.

This document is a preliminary draft of the MANE-VU technical support workplan. This document is intended to serve as a blueprint for the technical work that states and tribes in the MANE-VU RPO will endeavor to carry out over the next several years in support of SIP planning efforts. OTC, MARAMA and NESCAUM will carry out or oversee the work described in this document in their coordinating roles in the RPO, under the guidance of state and tribal staff through the technical support committee.

In addition to this document, a communications scoping study was prepared by NESCAUM with oversight of the MANE-VU communications committee. The scoping study outlines the outreach and communications strategy for the RPO and identifies major tasks to be performed by the regional organizations under the guidance of the MANE-VU communications committee.

A long-range strategy[1] has been developed and is updated annually by OTC. The long-range strategy describes the major task areas described in this workplan and the communications scoping study, as well as overarching planning efforts that will be facilitated by the RPO to assist states and tribes in their efforts to comply with the requirements of the regional haze rule.

Introduction

A program of technical work has been identified by the working groups of the MANE-VU TSC that will assist states and tribes during the regional haze SIP development process. Due to the regional nature of visibility impairment stemming from sulfate hazes that afflict broad regions of the East Coast, a coordinated effort, across disciplines, was deemed necessary.

[1] Available online at: http://www.mane-vu.org/pdf/MANEVU_2001LRStrategy-Final.pdf

Previous studies have described how the combined emissions of numerous SO_2 sources throughout the Eastern U.S. are largely responsible for the significant visibility degradation experienced at Northeastern Class I areas – and across the region – on the twenty percent worst visibility days.[2] The task before the MANE-VU jurisdictions, therefore, is to collect, refine and quantitatively document this information for use in the regional planning process.

A key goal of the regional planning process is to produce consistent reasonable progress goals, and emission reduction strategies for achieving those goals, across RPO boundaries. The ability to effectively communicate the results of the tasks described in this document will play a major role in the success or failure in this process. Clear arguments demonstrating the relative effects (in terms of visibility, acid deposition, ecosystem protection, public health, and other socio-economic benefits) of various emissions reduction strategies will be needed in order to find agreement between policy makers.

In this document we describe specific tasks and provide details on the suggested approach for achieving each task. The tasks are divided into categories that include: emissions inventory, meteorological modeling, air quality modeling, monitoring and data analysis, documentation and finally a miscellaneous category that covers technical training, outreach, and other considerations.

The intention of including all of the technical tasks in a single document is to ensure that our technical agenda is coordinated, but also balanced to provide the best possible support for what is likely to be a "weight of evidence" argument that stringent emissions controls will be needed in order to provide reasonable progress toward our national visibility goals.

A. Regional Emissions Inventory

A1. Complete data exchange protocol

The RPOs are working to generate data exchange protocols for the many types of data the RPOs will share. The intent is to create a common "language" of emissions inventory exchange. In the fall of 2002 the RPOs had a number of calls to discuss each of the protocols. Additional work will be continued in 2003 to implement the products of the data exchange calls. MANE-VU intends to follow protocols. Protocol topics are currently under development.

A2. Compile base year (2002) inventory inside MANE-VU for 2002 NEI/PEI

The objective of this project is to compile a comprehensive 2002 annual base year emissions inventory (EI) for the MANE-VU region to support the modeling of speciated particulate matter with an diameter less than or equal to 2.5 micrometers ($PM_{2.5}$) for Regional Haze purposes. This inventory should also support analysis of air quality monitoring data (e.g., receptor analysis). The emissions will be reported by emissions inventory source category (i.e., point, area, highway mobile and off road mobile) by county for each State and Tribe participating in MANE-VU. This inventory will be used in creating a modeling inventory under other work tasks.

The goal is for the EI to consist of all primary and precursor emissions necessary to accurately model PM including primary $PM_{2.5}$ and PM_{10}, ammonia (NH_3), oxides of sulfur (SO_x), volatile organic compounds (VOCs), NO_x and CO for the point, area, and mobile (non-road and on-road) source categories. The final scope of this project will depend on costs, available funds, and relevant work produced by the MANE-VU States and Tribes, by other RPOs, and by EPA.

[2] For more information, see *Regional Haze and Visibility in the Northeast and Mid-Atlantic States* and *A Basis for the Control of BART-Eligible Sources* prepared by NESCAUM at: http://www.nescaum.org/committees/haze.html

The first draft of the 2002 National Emissions Inventory (NEI) may be available late in year 4 (2003), and the final version is expected in year 5 (June 2004). Preliminary work will include setting the scope of work and beginning to obtain available data. The bulk of the work on this project will be in year 5 (2004).

A2a. Compile point and area data

States have historically contributed in a major way to the development of point source data in urban areas. The importance of area sources, and particularly suburban and rural area sources on emissions of regional haze pollutants, makes it desirable to include local data generated by the state, local and tribal agencies for these area sources as well. States and tribes will, as their available resources permit, improve EPA's area source inventory for their jurisdictions, based on locally representative activity data collected. This will represent a significant effort, but the results will significantly improve the data available for regional modeling. MARAMA will compile the NEI and state/local/tribal improvements as the basis for a regional modeling inventory.

A2b. Compile CEM & hourly point source data

Traditionally, air quality modelers have relied on annual or seasonal emissions inventories to develop hourly emissions estimates. Modelers would convert the annual or seasonal estimates to hourly estimates based on monthly, weekly, and diurnal profiles. The use of annual resolution emissions data to produce hourly estimates of emissions based on temporal profiles results in inaccuracies. Many of these inaccuracies can be corrected for the electric utilities that monitor emissions using continuous emission monitors (CEMs). The CEM data collected each hour will greatly benefit modeling efforts. MANE-VU will work with other RPOs and EPA to use CEM data consistently in developing its modeling inventory. (See discussion of Data Exchange Protocols in Section A1, above.)

A2c. Prepare Mobile 6 Input Files

MANE-VU will use the EPA mobile model, MOBILE6.2, to develop the 2002 on-road mobile source inventory for SO2, NOx, VOC, CO, NH3, PM2.5 and PM10 and their associated speciated allocation and temporal adjustment factors for the MANE-VU States. Some MANE-VU states will develop vehicle miles traveled (VMT) and MOBILE input files. 2002 mobile files may be prepared as projections from previous years (1999, 2000 or 2001). This will allow modeling to begin earlier. Where state data is not available, MANE-VU will use the EPA 1999 NEI files as the basis for developing the MANE-VU 2002 on-road mobile-source inventory. As appropriate MANE-VU will compile all input files needed to run the MOBILE model via the emissions model (model to be specified by MANE-VU). Also as appropriate, MANE-VU will process other input files through the MOBILE model to create area source input data files for the emissions model. MARAMA will prepare these foundation files using contractor assistance.

A2d. Prepare Off-road mobile source files for Non-Road model

MANE-VU will use the EPA's non-road mobile model, NONROAD, to develop the 2002 nonroad mobile source inventory for SO2, NOx, VOC, CO, NH3, PM2.5 and PM10 and their associated speciated allocation and temporal adjustment factors (to the extent practicable) for the MANE-VU States. MARAMA will prepare these foundation files using contractor assistance.

A3. Finalize plans for housing/storage of modeling inventory

MANE-VU will work with other RPOs to establish and take part in a National Modeling Inventory clearing house. However if RPOs choose to host their own sites, MARAMA will establish an on-line repository for the modeling inventory for easy access, provided funds are available (funds have not yet been allotted to this task). Most parts of the modeling inventory (e.g. point, area, mobile, non-road for different states and tribes) will become available at different times. The need for an inventory repository will become urgent by the end of year 4. In addition, subsequent versions of the modeling inventory may be produced as a result of QA and improvement efforts. This repository will serve as a clearinghouse of the modeling inventories. [see also task C1 for related modeling data storage issues]

A4. Obtain base year (2002) inventory outside MANE-VU

It is important to consider the effect of emissions from other RPOs on Class I areas in MANE-VU. Regional transport is a factor that all RPOs must address. Because MANE-VU is located east of the industrial areas of the mid-west, regional transport is a particular concern. The Data Exchange Protocol initiated by the Inter-RPO Emissions Inventory discussion group is the first step in obtaining base year inventories from other RPOs. MARAMA will work with other RPOs to compile a common 2002 emissions inventory for the area covered by the eastern modeling grid.

A5. Compile Canadian emissions

It is important to consider the effect of emissions from Canada on the visibility in MANE-VU. This effort will depend on assistance from Environment Canada and US EPA to assure consistency of the data and methodologies among the multiple state and provincial jurisdictions.

Emissions inventory protocols may need to be developed to meet the needs of proposed future modeling applications. This would involve the identification of temporal and spatial factors for emission inventory to modeling conversion.

One of the challenges is that much of the Canadian data was collected under confidentiality agreements and the EPA cannot ensure confidentiality if it uses the data. This problem may be overcome somewhat if the Canadian data is gridded in a manner which does not divulge individual facilities before it is passed on for use to EPA. Another challenge is the fact that Environment Canada and EPA data is collected at different intervals. If there is a problem combining data from different years (e.g. 1995 in Canada, and 1996 in US), perhaps some form of correction will be necessary. This could include forecasting or hindcasting of data with available growth surrogates. MANE-VU assumes EPA will provide Canadian data with appropriate adjustments for use by all RPOs.

A6. Compile '02 land use and gridded surrogate data

Currently, 1999 land use and gridded surrogate information is available from the Midwest RPO for the common RPO national grid. While the national grid has been established at 36km horizontal resolution, the 1999 surrogate data has been developed at 4km resolution to permit nesting of higher resolution grids within the 36km framework. EPA has plans to develop a similar set of land use and gridded surrogate data for 2001. Eventually, MANE-VU will need to have data that accurately reflects the modeling base year (i.e. 2002). This is an ideal candidate for a jointly funded contract among the five RPOs. NESCAUM will take the lead on this task for MANE-VU.

A7. Evaluate chemical speciation mapping from SMOKE/EMS2001 through CTM chemical mechanism

This will be an inter-RPO effort. NESCAUM will take the lead working with other RPOs, EPA, FLMs and other interested parties to evaluate and improve chemical speciation mapping between the emissions models and the chemical mechanisms used in the chemical transport models. It is anticipated that a speciated PM mapping between emissions chemical transport models will be required at a similar level that exists for VOCs. The Inter-RPO modeling and emissions workgroups have taken the lead in this joint effort to develop a complete species mapping for several chemical mechanisms and emissions models that should be completed in July 2003.

A8. Obtain/improve biogenic data

Forests and crops emit a variety of complex but reactive organic species. The importance of biogenic VOC in ozone formation processes in many locations has been known for a long time. Some of these natural organic emissions may play an active role in the secondary formation of organic aerosol that contributes to haze. This is particularly true in humid climates which are characteristic of summer months in the Northeast. Under these conditions, particles formed can easily grow to size ranges associated with efficient light scattering. Fertilized soils can also be sources of NO_x and NH_3.

There is significant uncertainty in the specific natural emissions that participate in the formation of atmospheric fine particulate, the mechanisms that produce fine particulate, and the interaction between atmospheric NH_3 and natural systems. Additional information will be needed to reduce these uncertainties. Much work is being completed to improve our understanding of both agricultural and natural soils as a source and/or sink for NH_3. Most of this work is being completed either under the direction of, or in close coordination with, researchers at USDA. MANE-VU assumes that EPA, working with the RPOs, will provide biogenic data for use in the 2002 inventory.

A9. Quality assure 2002 base year inventory

The purpose of quality assuring the base year inventory is to ensure the development of a complete, accurate, and consistent emission inventory. Under this task, MARAMA will develop a QA plan, which would be incorporated into the work plan. The QA plan would be consistent with the recommendations in the EPA emissions inventory guidance and the EIIP QA guidance. The QA plan would include tasks associated with obtaining State, Tribal, and stakeholder review of the EI. The QA plan would address the maintenance (revisions/updates/corrections) of EI documentation.

A10. Process emission inventory data for the base year—prepare emission inputs for the chemical transport models. (EMS2001 and/or SMOKE processing.)(nested down to 12 km)

The Sparse Matrix Operator Kernel Emissions processing system (SMOKE) will be used to transform emissions data for use by chemical transport models. Emissions must be speciated, temporally allocated, spatially allocated (gridded) and, for point sources, divided into low level and elevated sources. Concentrated point source emissions may require plume-in-grid treatment to properly account for the complex chemistry that can occur immediately after release in the absence of adequate mixing with ambient air. Speciation is critical especially for the VOC functional groups that can be different in the emissions processor and the chemical transport models chemistry module. Observed concentrations of organic material may represent altogether different groups of species that are reported by either the emissions models or the chemical transport models. The species mapping discussed in section A7 will address these issues. In temporally allocating emission the preprocessor applies assumptions concerning the typical operating schedule of sources in a given category based on source classification codes. Source specific data can be entered where available. Area source emissions are generally prepared at the county level and must be allocated to the modeling grid system based on a surrogate parameter (typically population, vehicle miles traveled, or agricultural acreage).

A11a. Develop future base year(s) emission inventories with growth data

MARAMA will coordinate the preparation of a regional future base case emissions inventory using methods consistent with EIIP recommendations and approved by the Emissions Inventory Work Group. Consistency with other RPOs will be a goal pursued through inter-RPO discussions. In order to estimate future years inventories, growth factors will be applied the base year emissions inventory. These projections will reflect emissions control programs already adopted as well as anticipated growth in population and other economic indicators. As recommended by EIIP, appropriate methods will be used for each source sector.

A11b. Develop future year(s) emission inventories with control options and prepare emission inputs for chemical transport models. (EMS2001 and/or SMOKE processing.)(Nested down to 12 km)

Similar procedures as described in A10 will be followed to properly speciate and allocate future year emissions for chemical transport modeling. These future year emissions will include projected base case emissions and as well as proposed control options for including in SIPS.

A12. Document Emissions Preparations

All emissions preparations will be documented consistent with the QA plan and in a form sufficient for submission with State and Tribal implementation plans.

B. Meteorology

B1. Assess adequacy of meteorological monitoring network for data analysis

Section 51.308(g)(iii) of the Regional Haze rule requires states to submit a report that includes the change in visibility impairment for the most impaired and least impaired days over the past 5-years. A major factor in visibility impairment is meteorology. Therefore, a climatological analysis of meteorological conditions over the past 5-year period relative to earlier periods (all years going back to the first year of the baseline period) should be part of every periodic report.

An assessment needs to be performed which will identify the minimum set of meteorological parameters needed to perform an adequate climatological analysis. For each Class I area, the assessment should identify the "long term" monitoring site and associated existing archive for each parameter that should be used in future analyses. If no monitoring site or archive exists, the assessment should include recommendations on siting "long term" monitors, monitoring equipment to be used and creation of the associated archive.

B2. Episode selection (year, seasons, etc.)

While the overall approach to episode selection may evolve as analytical tools improve, the current approach MANE-VU will adopt with respect to episode selection is to conduct a full year of visibility modeling for the region using REMSAD or a model of similar complexity and computational efficiency. In addition, shorter duration episodes will be selected for more detailed analysis using CMAQ, PMCAMx or similar grid model. This proposed combination approach to grid modeling will allow for a comprehensive understanding of the impact on annual aggregate visibility statistics as a result of proposed emission control scenarios, as well as provide an accounting of the models sensitivity to specific emissions reductions and quantification of model uncertainty.

The time period has yet to be finalized, but is likely to involve an agreement across RPOs to focus on a single year period of time between January 1, 2002 and September 1, 2003. A proposal discussed at the November 2001 inter-RPO technical meeting in St. Louis was to adopt the calendar year 2002 as the focus of haze modeling exercises. Subsequent discussions have raised the possibility of shifting the 12-month period into the spring 2003 months due to the potential availability of enhanced monitoring results for that time. As the RPOs are able to assess what observations exist for the complete time period of interest and determine the extent to which those observations will aid in model validation, it is likely that the groups will come to consensus on a 12-month period for model simulations. MANE-VU proposes to follow the recommendations of the inter-RPO modeling group on this issue.

B3. Prepare Eastern domain MM5 data for 2002

A National domain with 36km horizontal resolution has been identified for all common RPO modeling. MANE-VU is likely to use a smaller, eastern domain for SIP modeling to allow greater resolution and nesting over urban areas. Nesting down to 12km (and possibly 4km in some urban locations) is likely along the Eastern Seaboard. Final decisions regarding the exact location of an eastern domain, the horizontal and vertical resolution as well as the location of high resolution nests will all be determined through practice modeling exercises which are ongoing. Once these decisions have been made, Meteorological input data will need to be processed for the resulting grid and quality assured in order to drive the chemical transport models.

The University of Maryland Department of Meteorology has the most experience with the NCAR/PSU community meteorological model, MM5, of all participating agencies in MANE-VU having developed meteorological fields for the OTC ozone workplan. Through this work, UMD has developed a novel advection scheme for more accurately calculating wind speeds in the turbulent boundary layer along the East Coast. Working through their cooperative agreement with the Maryland Department of the Environment, they are the likely choice for developing 2002 meteorological data for regional haze modeling.

B4. Evaluate MM5 data (including validation against met. network observations)

Similar to UMD's role in developing meteorological data inputs for the chemical transport models used for OTC's ozone workplan, the New York Department of Environmental Conservation has played a key role in quality assuring the modeled results against network monitors. We anticipate that NYDEC will continue this role in quality assuring 2002 results, which will consist of comparisons to the Rawinsonde network, radar profilers which were operational during 2002 and a few aircraft flights operated by UMD, Purdue University and Brookhaven National Laboratories, for which wind speed data is available.

B5. Process for chemical transport model(s)

The final processing of data for CTMs generally involves the use of a preprocessor or a conversion program which uses MM5 model output to produce properly formatted meteorological input data for specific CTMs. MCIP is the meteorological pre-processor for the CMAQ model whereas the "mm5toremsad" script is capable of extracting the required data inputs to drive the REMSAD model.

B6. Document meteorological preparations for SIP

All meteorological preparations will be documented, including quality assurance procedures, in a form sufficient for submission with State and Tribal implementation plans.

C. Modeling

C1. Create and maintain a modeling data and information clearinghouse

The Inter-RPO modeling workgroup has reviewed a file sharing system based on the NetCDF format. This particular system (The LAS system) offers the ability to visualize and compare data sets residing in different locations on the internet, and limiting the size of data needing to be transferred by retrieving only those fields and time periods of interest. This ability means that using such a system, future RPO modeling data would not need to be centralized in order to be shared, just accessible to the internet and properly formatted. The biggest difficulty is likely to be getting the data from its native format to NetCDF.

Such a file sharing system is only one component of data sharing, and does not fill the need for sharing complete data sets. Discussions will continue with the Inter-RPO modeling group to pursue some form of file sharing system, as well as establish protocols for ftp transferability of larger data sets that will need to be shared in the future.

C2. Prepare a draft modeling protocol

A next step in the model coordination process on the intra-RPO level will be to convene a series of conference calls to develop a specific testing protocol for the performance evaluation, sensitivity testing and control strategy testing.

This protocol will provide specific details as to how each set of experiments will be carried out. While the actual performance of these tests must wait for the development of emissions and meteorological inputs and improvements in existing PM models, a protocol outlining the anticipated testing will allow the RPO modelers to prepare for the specific tasks it will be asked to perform.

It is anticipated that the modeling workgroup of the MANE-VU TSC will develop this document jointly with input from the other two working groups.

C3. Replicate platform in multiple locations

Different modeling platforms will be identified for specific modeling tasks listed in the protocol. Currently, NESCAUM has REMSAD operating on a linux workstation and has plans to install and test SMOKE and CMAQ in a linux framework over the next two years. University of Maryland has capacity to utilize CMAQ, UAMV, SMOKE and MM5 on a Sun workstation. NYDEC is operating REMSAD, EMS95, and UAMV on a Sun workstation. Delaware currently operates CMAQ on a Sun workstation and has plans to install and test MM5. To the extent that specific tasks in the modeling protocol are to be performed by different agencies, intercomparison experiments will be performed to ensure comparability of results across platforms similar to those documented in

NESCAUM technical memoranda #2 and #5[3]. Agencies developing capacity in any of these modeling systems will be expected to demonstrate platform comparability following procedures demonstrated in these memoranda prior to performing specific elements of the modeling protocol.

C4. Complete Haze/PM model testing and evaluation per protocol (intercompare platforms and conduct performance evaluation)

The value of modeled results can only be as great as determined through a comprehensive performance evaluation. Model performance must be assessed with regard to overall ability to reproduce ambient concentrations of fine particles and reconstructed extinction, its ability to track speciated components of fine particulate, such as sulfates or organic compounds explicitly, and its sensitivity to changes in precursor species emissions. These abilities should be tested through a combination of operational, diagnostic, mechanistic and probabilistic tests (Seigneur et al., 1998). Operational tests address the predictive capability of the model in reproducing ambient concentrations PM2.5, or extinction. Diagnostic tests look at speciated components of PM to make sure the model is getting the right overall numbers for the right reasons (i.e. ensure that the fractional contribution to the total PM concentration agree with observed ratios of the components). Mechanistic tests ensure that the models have an appropriate degree of sensitivity to changes in precursor emissions. Finally, probabilistic tests establish the degree of analytical uncertainty due to the algorithms themselves. Measurement uncertainties expressed as a range of possible input values will produce a corresponding range of concentration estimates that reflect a combination of measurement uncertainty and model error, thus providing a truer estimate of analytical accuracy.

The specific statistical tests and metrics to be used and diagnostic analyses to be performed will be outlined in the modeling protocol to be developed by the MANE-VU modeling palaver over the coming year.

C5. Model control measure options per protocol

A complete modeling protocol will include details regarding the models to be used, configuration and set up details, input data and boundary conditions, as well as testing protocols and details on testing specific control measures. Consistent procedures will be established for comparing base case results to various emission control scenarios.

C6. Prepare test and evaluation report

Results of the comprehensive performance evaluation, including a description of the evaluation procedure, will be documented in a test and evaluation report to be provided to the states and tribes for use in SIP preparations.

C7. Complete modeling report summarizing findings

Results of the modeled simulations, including a description of the modeling protocol, will be documented in a final modeling report to be provided to the states and tribes for use in SIP preparations.

[3] Available online at: http://www.nescaum.org/committees/haze.html

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D. Monitoring & Data Analysis

A broad range of enhanced monitoring and data analysis activities has been proposed. These proposed activities have been prioritized and organized into five project areas: (1) continued support for several ongoing regional and national data collection, archival, analysis and display systems; (2) continuation and expansion of regional enhanced monitoring initiatives; (3) continuation and enhancement of ongoing receptor modeling source attribution analyses; (4) analysis and summarization of various "intensive" haze-related monitoring activities conducted over the preceding (2002) year; and ultimately, (5) a series of additional transport-related analyses and summary reports intended to provide "weight of evidence" technical support for regional "contribution assessments" and regional haze State (and potentially Tribal) implementation plan (SIP) submittals.

D1. Continue Regional/National Data Collection/Archival/Analysis and Display Systems

D1a. Continued participation in the VIEWS data archive
NESCAUM will continue MANE-VU participation in the national effort to develop an online data access and analysis tool. Future enhancements of the VIEWS system could include additional tools and available datasets (e.g., trajectory ensembles, radar profiler data, and the continuous speciated data recommended below).

D1b. CAMNET maintenance
CAMNET represents a valuable outreach and education tool that combines visibility scene monitoring with the Internet. Air Resources Specialists maintain and support CAMNET sites after initial installation.

D1c. Contractor-assisted profiler coordination and data management
Radar profiler systems are complex and require experienced technical review beyond what is often available locally to assure proper operation. MANE-VU contracted with Sonoma Technology Inc. (STI) during 2002 to visit 3 profiler sites in the MANE-VU domain that were not part of other networks. The purpose of these site visits was to review the overall operation of the profiler systems, both hardware and software, and to correct major problems.

MANE-VU's experience with the external review and coordination of non-NOAA (National Oceanic and Atmospheric Administration) radar wind profilers in the region during the summer of 2002 demonstrated the critical importance of continuing this oversight if it is expected that data from the Ft. Meade (MD), Rutgers (NJ) and Stow (MA) profilers will be used in any future modeling or analysis tasks. STI produced detailed reports from these visits which indicated several major problems at all three sites. Based on this experience, and given that from March 2003 until the return of AIRMAP (a collaborative New England air quality and climate research effort led by NOAA and the University of New Hampshire) in the summer of 2004, these three State-owned profilers and the NOAA Pease (NH) profiler will be the only systems in operation in the MANE-VU domain, we recommend that similar site visits be performed prior to the 2004 AIRMAP intensive measurement period in the New England region. A combination of site visits and level 0.5 (automated) and possibly limited level 1.0 (manually screened) data validation will be the focus of this task.

D2. Continue and Extend Enhanced Air Quality Monitoring (and Data Management)

D2a. Continuous sulfate and sulfur dioxide measurements at rural, high-elevation sites
Many of the enhanced measurements made during summer 2002 were the result of

Supersite, AIRMAP, and PM health Center programs or through other leveraged opportunities. Year-round continuous sulfate (SO_4) and sulfur dioxide (SO_2) measurements at two rural, high-elevation sites are proposed. One site might Mt. Washington, NH or the Lye Brook Wilderness in VT and the second is planned for Dans Ridge, Maryland (about 2800 feet elevation) approximately 80 miles southeast of Pittsburgh. Some additional equipment will be purchased in to complement purchases made in 2002 and leveraged equipment and logistical support provided by the MD Department of the Environment.

D2b. FRM (XRF) filter analysis and data analysis

In 2000, NESCAUM States sent Federal Reference Method (FRM) filters to RTI for speciated analysis under the CARAPACE project. The filters covered over 50 sites and two regional episodes (July 1999 and February 2000). Analysis of these data could identify regional signatures impacting the Northeast and Mid-Atlantic. The results of this study, to be reported in a technical memo, will aid in selecting other episodes during the baseline period (2000-2004) for which archived filters are available.

D2c. Upper atmospheric chemical measurements

Very little data is available on the size distribution or chemical properties of fine particles above ground level. MANE-VU conducted limited summertime aerial sampling during Year 3 from an instrumented aircraft operated by the University of Maryland. MANE-VU proposes to complement these measurements with additional wintertime measurements. We are considering a variety of platforms including tethered balloons, kites or additional aircraft measurements.

D3. Continue and Extend Source Apportionment/Receptor Model Analyses

D3a. Source apportionment phase 2 project.

MANE-VU will continue to collaborate with MRPO in funding and managing source apportionment projects. An ongoing project includes a refined receptor model analyses for four eastern IMPROVE sites. MARAMA will take the lead to facilitate the multi-State "user group" process through which the project will be guided, and to support an external peer review of the results.

D3b. Paired Aerosol/Trajectory Database Tool project.

MANE-VU will continue to collaborate with MRPO in funding and managing an ongoing project developing a paired aerosol/trajectory database tool. MARAMA will take the lead to facilitate the multi-State "user group" process through which the work is guided, and to support an external peer review of the deliverables.

D3c. Source apportionment projects summary reports

Experience from the phase 1 and 2 source apportionment projects and the database tool project indicates that the results are both technically informative, but also technically complex. Substantial additional effort is needed to summarize and communicate these results in clear, simple terms to decision-makers, stakeholders and the public. The paired aerosol/trajectory database tool under development will greatly facilitate the ensemble trajectory analysis of aerosol data and receptor model results, but it will not conduct these needed analyses nor write the needed summary reports. Some of this analysis process and report writing can be contributed by the individual State and Tribal users of the analysis tools, but a substantial measure of staff support is needed to facilitate these efforts and to develop the needed "communicable" summary reports. MARAMA will lead this effort.

D3d. Phase 3 contract(s) and inter-RPO coordination

Given the progress achieved in phase 1 and 2, the productive inter-RPO nature of

interest and funding support, and the resultant generation of as many questions as answers, it can be anticipated that a substantial "phase 3" receptor modeling effort will flow directly from the ongoing phase 2 projects. For the paired aerosol/trajectory query tool in particular, the contract specifications include the potential (compatible database infrastructure) to extend the use of this tool to other IMPROVE sites, future data and ensemble trajectories (from multiple trajectory models) as they periodically become available. Ultimately, our plans envision the transfer and expansion of this technology to the inter-RPO VIEWS system. This technology development and transfer will depend on clear reports and guidance from MANE-VU users, and will also require additional contractual support to move from a demonstration project to a more generic, universally accessible analysis tool.

D4. "2002 Intensive": Data Synthesis, Analysis and Summary Report(s)

D4a. Analysis of summer 2002 aircraft data (contracts and management)
Year 3 funds covered 56 flight hours over eight different days, but were insufficient to support anything much more than a cursory examination of the data. Year 4 funds will be used to examine the data in depth. Data collected include particle counts and size, aerosol absorption, scattering and chemistry (PIXE), meteorological parameters (relative humidity (RH), pressure, and temperature), trace gases (CO, SO_2, O_3). The data cover both horizontal transects and vertical profiles and may be compared to surface and satellite data.

D4b. Acquisition, management and distribution of other regional 2002 data
This project will focus on the acquisition of monitored data collected by IMPROVE, Speciation Trends Sites, Supersites, University of Maryland, AIRMAP, the PM Health Centers and other available data networks operational during 2002. A database(s) incorporating the various datasets will be developed and made available for interested parties.

D4c. Analysis and summary report of 2002 regional PM and haze data
The MANE-VU long range strategy points to an increased emphasis in data analysis activities in year 4 and 5 as monitoring becomes de-emphasized after the base year 2002. In coordination with other data analysis efforts, a detailed analysis of the 2002 data will be conducted. This analysis will cover the entire calendar year, but will make use of specialized, shorter-term measurements, such as the aircraft data and AIRMAP campaign. The final product of this analysis will be a comprehensive report that will investigate the conditions and factors contributing to the twenty percent worst and twenty percent best visibility days.

D5. Contribution Assessment Analysis and Regional Summary Report

D5a. Update of MANE-VU trajectory analysis
Previous studies have identified the twenty percent worst and best days between 1997 and 1999 and associated these days with a set of back trajectories that cover a wide portion of the Eastern U.S. The proposed project would update and expand on this work in several ways:

- Inclusion of 2000 and 2001 data
- Inclusion of Dolly Sods, Shenandoah, and James River Face Class I areas
- Inclusion of trajectories for middle 60% of days (not just focused on best and worst visibility conditions)
- Performance of residence time analysis on the data allowing the calculation of incremental probabilities associated with the 20 percent best/worst days.

D5b. Trajectory cluster analysis
While the worth of updating the more traditional back trajectory analysis is self explanatory (in terms of increasing statistics, extending the temporal and spatial range, etc), the addition of trajectory cluster analysis will provide an independent and complementary means of assessing the role of transport in visibility degradation. Cluster analysis necessarily requires one look at a random or unbiased collection of back trajectories in order to categorize the general patterns of meteorological transport. Once clusters have been calculated and general patterns of transport have been established, more interesting analyses can be performed to determine the relative frequency of a particular cluster being associated with good or poor visibility conditions.

It is also desirable to better understand meteorological conditions that result in average visibility conditions. This will allow us to look for meteorological contrasts between average conditions and good or poor conditions. This may put us in a better position to understand factors that significantly differ on those days when visibility exhibits extreme behavior.
The cluster analysis will build off the development of the large trajectory database in the previous project. The HYSPLIT trajectory database which has been generated and the ATAD trajectory database (developed independently by the National Park Service) serve as the basis for the identification of predominant meteorological pathways that affect MANE-VU Class I areas more generally (as opposed to just on the best or worst visibility days). The clustering algorithm can be used in a variety of analyses including:

- Calculation of cluster-specific percentage contribution to 20% worst or best days
- Calculation of cluster-specific percentage contribution to “high” and “low” days associated with receptor model source profiles
- Trends in cluster contribution to worst visibility days/“high” source profile days

In addition, the clustering algorithm or further development of clustering datasets might complement the paired aerosol/trajectory query tool (currently being developed for the source apportionment project by CAPITA; see tasks D3a and b) in a number of ways. For example, the results of cluster analyses may be gridded so that the query tool can then perform automated calculation of the above bulleted analyses for any site during any time.

D5c. Comparison and synthesis of gridded, receptor and trajectory model results
A variety of analytical techniques have (or will be) applied to understanding the nature and extent of visibility impairment in the MANE-VU region. This project aims to examine several tools, including Eulerian grid models, Lagrangian trajectory models, and receptor-based techniques, and then compare the results against one another. Understanding the differences in available modeling results and whether they can be explained in the context of each model’s uncertainties will be a key component to building a weight of evidence argument in support of visibility protection.

D5d. Summary report on inter-State and inter-RPO transport
MANE-VU is the most transport-affected of the RPOs (i.e., impacts on MANE-VU Class I areas from sources external to MANE-VU). However, the haze regulations and associated EPA guidance are vague on the degree of specificity required to identify, or subsequent mechanisms to reduce inter-RPO transport from specific upwind RPOs, States or sources. A number of factors have made this concern of increasing importance in the short-term. NESCAUM will explore the transport issue using a number of techniques building off of the work in the previous projects with the final objective to build a weight of evidence argument that reflects the results of modeling, monitoring and available emissions inventory information. This will be incorporated into an accessible format and published as a MANE-VU report on inter-State and inter-RPO transport.

D6. CALPUFF modeling and interpretation

This project will include CALPUFF modeling on two regional domains that cover the Northern and Southern portions of the MANE-VU region. The goal of this research will be to understand specifically the impact of Eastern U.S. power plants on the visibility in Class I areas within MANE-VU and nearby regions. Researchers at the Vermont DEC plan to use CALPUFF with multi-year CALMET fields created from surface and upper air measurements combined with CEMS hourly emission data for between 500 and 1000 electric generating units located in a domain covering the NESCAUM states (ME, NH, VT, MA, CT, RI, NY, NJ) and the MARAMA states MD, DE, NJ, PA, DC, and northern VA). The CALPUFF outputs would be used to examine the relative potential for impact of these generating units on the Class I areas located in ME, NH, VT, and NJ. ERM, under contract to the Maryland DEP, has performed CALPUFF modeling on a more southerly domain which encompasses Brigantine Wilderness Area in New Jersey, Shenandoah National Park in Virginia, James River Face and Dolly Sods/Otter Creek Wilderness areas in West Virginia as well as Lye Brook, which is located in a region of overlap between the northerly and southerly domains. The intercomparison of results for Lye Brook (and Brigantine) will serve to tie the analyses together and results will be used as part of a weight of evidence approach to build MANE-VU's contributions assessment. Future CALPUFF modeling options will be considered that build off the current work being performed independently by these two groups to develop a coordinated research plan.

D7. Document weight of evidence in a contribution assessment

This task will be performed in anticipation of SIP submittals, but will largely build upon the reports produced in tasks D3b and c, D4c, D5d, D6 as well as previous reports and documents produced by MANE-VU and its supporting agencies. This will involve a massive synthesis and interpretation effort to serve as (1) a conceptual model for visibility impairment in the Northeast and Mid-Atlantic, (2) a foundation upon which to set reasonable progress goals for the Class I areas in the MANE-VU region (see task D8), and (3) a justification for specific control strategies approved by the MANE-VU Board.

D8. Set reasonable progress goals

The MANE-VU TSC will need to review EPA guidance and come to consensus on procedures for calculation of natural visibility conditions and baseline conditions. Once these have been established, the setting of reasonable progress goals can proceed via EPA guidance and in consultation with the MANE-VU Board. Factors that may influence the setting of reasonable progress goals include the timing of proposed emissions reductions and subsequent visibility improvement and the magnitude of required emissions reduction within and external to the MANE-VU region in order to achieve mandated visibility improvements.

E. Documentation

A12. Document Emissions Preparations
[see section A12]

B6. Document meteorological preparations for SIP
[see section B]

C2. Prepare a draft modeling protocol
[see section C]

C6. Prepare test and evaluation report
[see section C]

C7. Complete modeling report summarizing findings
[see section C]

D7. Document weight of evidence (contribution assessment)
[see section D]

E1. Develop a "conceptual description" of the regional haze problem

A conceptual description of the regional haze problem in the Eastern United States has already been developed for use in past MANE-VU reports on Regional Haze (e.g. NESCAUM, 2000; NESCAUM, 2001). In addition, the topic for the 2002 Air and Waste Management Association's Critical Review was selected as *Visibility: Science and Regulation* (Watson, 2002). This document provides an excellent foundation for a national understanding of visibility issues contrasting visibility in the East versus West.

As MANE-VU continues to produce reports that document our understanding of visibility impairment and other impacts associated with emissions of PM precursor pollutants, additional resources will become available for producing a final conceptual description when SIPs are due.

E2. Document other data inputs to models

The production of meteorological and emissions data inputs for air quality models will be documented under section A12 and B6 of this workplan. Any other data inputs that may be used (e.g. meteorological or chemical observations which may be used to "nudge" the model) will be similarly documented to ensure that all information used in the modeling process has clear explanation as to its origin and accuracy.

E3. Document tracking progress mechanism (if different from EPA guidance)

MANE-VU will continue to follow revisions and clarifications to U.S. EPA guidance on tracking progress as well as calculating natural background conditions for Class I areas under the regional haze rule. These guidance documents do allow for alternative means of calculating reasonable progress and natural background metrics provided the techniques are technically robust and well documented. Should MANE-VU decide to adopt an alternative approach to these calculations, the approach and justification will be documented for submission with SIPs.

F5. Peer Review modeling and weight of evidence approaches

[See Section F]

F. Technical Training, Outreach, Other Considerations

F1. Provide training and technical seminars for tools (emissions, modeling, etc.)

MARAMA will organize and support training for member agency staff and facilitate regional coordination meetings. Approximately five meetings/workshops/training opportunities will be supported per year. The total number will be determined based on need, cost, and availability of training opportunities. Workshop and meeting topics may include emissions inventory coordination, emissions modeling, monitoring, data analysis, modeling, or other topics as needed. The schedule of events may include a separate public meeting to brief stakeholders. MARAMA will coordinate and conduct the training activities, and will facilitate technical meetings including

logistics, assisting in agenda development, and timely distribution of materials.

The overall goals for MANE-VU workshops and specialty meetings include:

- Provide basic training opportunities for new staff at MANE-VU member agencies
- Provide targeted, advanced training for MANE-VU members in needed modeling, data analysis, and emissions inventory skills
- Provide forums for technical work groups and stakeholders to interact, share and develop information
- Facilitate coordinated SIP development
- Encourage knowledge and use of best science
- Collaborate with other RPOs and other multi-State organizations to create maximum opportunities and most economical approaches

F2. Solicit stakeholder input and report on progress on the modeling and analytical effort

Stakeholder engagement will be an ongoing activity of the RPO to ensure that stakeholders review technical work products and to identify common areas of interest where future projects might be jointly pursued. Meetings of the Technical Support Committee will be the primary mechanism to provide opportunity for stakeholders interaction. In addition, technical reports will be circulated for stakeholder review and comments.

F3. Technical consideration of welfare benefits of improved visibility

In addition to the explicit visibility benefits associated with the regional haze rule and resulting emission reduction strategies, numerous secondary benefits will accrue. These include reduced acidification of forests, soils, and surface waters, improved public health in urban areas as well as in the parks, increased tourism and associated economic benefits. All of these secondary benefits need to quantified, when possible, and included in SIPs to provide additional context and justification for additional emission control programs needed to achieve visibility goals.

F4. Annual Science and Data Analysis meeting

Co-sponsored by MANE-VU and MARAMA, this meeting is to provide an opportunity for researchers and air quality managers in the region to interact and to discuss multi-pollutant air pollution information and issues. The goal is to ensure that policy makers understand the latest scientific research on ozone, fine particulates, and haze, and to help researchers understand the type of information that policy makers need.

F5. Peer review modeling and weight of evidence approaches

A program of analytical work will be described in the modeling protocol. This work, when completed, along with 'weight of evidence' data analyses will be documented in MANE-VU technical reports which are all subjected to external reviews that include interested states, tribes, FLMs and stakeholder groups. Prior to the inclusion of these works in SIPs, MANE-VU will seek advice from national experts on visibility issues to ensure that the best science is utilized in designing control strategies for dealing with visibility impairment under the haze rule. The exact process for soliciting this input and the mechanisms for incorporating advice will be developed while technical work progresses over the next two years.

F6. Develop forecasting capability for Haze

An important step in the efforts to improve visibility in our national parks and wilderness areas will be developing the capability to forecast periods of impaired visibility. In doing so, we not only solidify our understanding of the factors that lead to poor visibility in the region, but build the capacity to provide information in order to better serve the public interests (e.g. recreationalists or populations sensitive to fine particle pollution). While developing a forecast system is beyond the

scope of the regional haze program, it is understood that the technical work being performed for visibility protection under the haze rule[4] will serve as the foundation for other technical projects like this in the future.

[4] It should be noted that current efforts through the PM mapping program at U.S. EPA have a PM forecasting component that will also serve to advance haze-forecasting efforts considerably.

Task	Task Descripton	Organization	2003												2004												2005												2006											
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
A	**Emissions Inventory**																																																
A1	data exchange protocol	M, IRPO																																															
A2	2002 inventory	M, TSC																																															
A2a	point and area sources	M																																															
A2b	CEM & hourly pnt sources	M																																														
A2c	input for MOBILE 6	M																																															
A2d	input for NONROAD	M																																															
A3	inventory storage plan	M, IRPO																																															
A4	obtain extra-MV inventory	EPA																																															
A5	compile Canadian emissions	EPA																																															
A6	compile 2002 surrogates	N																																															
A7	chem. speciation mapping	IRPO																																															
A8	biogenics	EPA																																															
A9	QA 2002 inventory	M																																															
A10	emissions modeling	N																																															
A11a	future inventory/growth data	M																																															
A11b	future inv/control scenarios	M,N,TSC																																															
A12	document emissions prep	M																																															
B	**Meteorology**																																																
B1	monitoring network review	TSC																																															
B2	episode selection	IRPO																																															
B3	eastern domain MM5	UMD																																															
B4	QA eastern domain MM5	NY,TSC																																															
B5	pre-process MM5 for CTM	N, TSC																																															
B6	document met prep	N																																															
C	**Modeling**																																																
C1	modeling info clearinghouse	N, IRPO																																															
C2	modeling protocol	N, TSC																																															
C3	replicate platforms	TSC																																															
C4	model evaluation	N, TSC																																															
C5	modeling	N, TSC																																															
C6	evaluation report	N, TSC																																															
C7	model results report	N																																															

Task	Task Descripton	Org. Respons	2003												2004												2005												2006											
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
D	**Monitoring & Data Analysis**																																																
D1	*data collection/display sys*																																																
D1a	VIEWS	N, IRPO																																															
D1b	CAMNET	N																																															
D1c	radar profiler coodination	N																																															
D2	*additional monitoring*																																																
D2a	visibility supersites	N																									?	?	?	?	?	?	?	?	?														
D2b	retrospective FRM analysis	N																																															
D2c	upper air measurements	N																																															
D3	*source apportionment project*																																																
D3a	phase 2	M																																															
D3b	trajectory/database tool	M																																															
D3c	summary reports	M																																															
D3d	phase 3	M																																															
D4	*2002 Intensive*																																																
D4a	aircraft data analysis	N,UMD																																															
D4b	2002 database	N																																															
D4c	2002 "year in review" report	N																																															
D5	*Contribution Assessment*																																																
D5a	update trajectory analysis	N																																															
D5b	cluster analysis	N																																															
D5c	compare grid/traj/receptor models	N																																															
D5d	synthesis report on	N																																															
D6	CALPUFF project	UMD, VT					?	?	?	?	?	?	?	?	?	?	?	?	?	?	?																													
D7	mega-synthesis report																																																
D8	reasonable progress goals																																															

Task	Task Descripton	Org. Respons	2003												2004												2005												2006											
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
E	**Documentation**																																																
E1	conceptual description																																																
E2	document data inputs		*As Needed*																																														
E3	tracking progress																																																
F	**Technical Training & Outreach**																																															
F1	Training/workshops	M																																														
F2	stakeholder feedback	O,M,N																																														
F3	secondary benefits analysis																																															
F4	annual science meeting	M																																														
F5	peer review																																															
F6	forecasting capability	EPA																																														