National Park Service

Air Resources Division

July, 1995

Enhanced Monitoring at Mammoth Cave and Great Smoky Mountains National Parks

Background:

Enhanced air pollution monitoring was initiated in Spring 1995 at MACA and GRSM under a joint agreement between NPS and TVA as ground stations to participate in the SOS Nashville Intensive. NPS agreed to continue the operation of the stations during the winter 1995-96 with the expectation that TVA would participate in operation of the sites during the summer of 1996. Many of the other SOS ground stations were expected to operate also during 1996.

Monitoring and research objectives:

Since the concentrations of the pollutants other than ozone are generally believed to be will below the national standards, the intent of this monitoring is research oriented rather than regulatory. Both the MACA and GRSM monitoring stations measure ozone concentrations near or above the NAAQS level of 0.12 ppm. New continuous measurements of NO_y, NO, NO_x, CO, and SO_2 compliment the filter measurements using IMPROVE that determines sulfate, nitrate, etc. The enhanced monitoring is expected to meet the following objectives:

- Determine background levels of additional primary pollutants and some of their oxidation products. *NO_y and SO_2 are associated with direct biological and health impacts; they are also precusors to acid deposition species.*

- Use the ozone precursor and indicator species to determine the limiting species for ozone formation, estimate the local ozone production vs transported ozone, and estimate the impact to the parks by control strategies at up wind urban areas.

- To use NO_y, CO, and SO_2 as tracers to identify transport source regions, types of

sources (urban, stationary, mobile, etc.), and transport patterns.

- To use the data in conjunction with other programs to understand what control strategies should be used in upwind urban and industrial areas to reduce ozone concentrations at the parks.

- To increase our understanding of the interaction between pollutants and the effect of those pollutants on visibility and on biological systems. *Interaction with other programs is required to fully meet this objective.*

Measurements:

The following measurements are proposed for the enhanced monitoring site:

ozone, carbon monoxide (CO), nitrogen oxide (NO), reacted nitrogen oxides (NO_y), sulfur dioxide ($SO_{2)}$, meteorology including temperature, wind direction and speed, relative humidity, solar radiation, speciated volatile organic compounds (VOC)

It may be desirable to include the measurement of the following species:

NO_2, carbonyls, peroxides

Operations:

The monitoring site at the stations will be a cooperatively operated site including participation from NPS, TVA, and university researchers. Core operations would continue to be handled by an NPS site operator and Park staff. Enhanced monitors and analyzers for measuring non-criteria air pollutants would be operated and maintained by TVA researchers with the help of the NPS site operator. Air Resource Specialists (ARS) will continue to provide maintenance and repair for the ozone analyzer and transfer standard, the meteorological sensors, and the datalogger system. TVA will maintain, repair, and calibrate, the CO, NO_y, and SO_2 analyzers. University of Maimi will maintain and assure operation of the VOC sampling system and provide analysis of the cannister samples taken at the stations.

Data handling:

The NPS will continue to provide QC/QA, data validation, and database storage for ozone. The NO_y, CO, and SO_2 data will be collected, processed, validated, and put into a suitable database format by TVA for later inclusion in the DPC's database. If possible the DPC will poll the site for NO_y, CO, and SO_2 data as a backup. All possible data will be submitted to the EPA AIRS database. All validated data will be routinely provided to associated researchers and will be publically available upon request. A format for reporting data in databases, tables, and/or graphs should be determined by researchers and NPS staff so that the DPC can provide final data in accessible form.

Term of Measurements:

Since trends require a long-term record, ozone measurements at the site will continue indefinitely. The continuous measurements of NO, NO_y, CO, and SO2 would be operated for a 3 year period depending on funding availability. Non-continuous measurements, such as canister sampling for VOC's, would be mostly during the high ozone season. Additional measurements or extended operation will depend on the interest and support of the research community and the participation in regional air pollution studies.

QC/QA:

Ozone and meteorological data will be collected to meet EPA regulations and standards. Measurement of enhanced species shall be to the best equivalent standards and recognized practice within the research community. Intercomparison of instruments and comparisons to alternative methods should be made for the enhanced instrumentation so that estimates of instrument accuracy can be made. Standard operating procedures will be written and sent to knowledgeable researchers or agencies for review and comment.

Analysis of Data and Information Reporting:

Analysis of the data may include the following:

- Identification and characterization of major high ozone episodes including a meteorogical description, inclusion of ozone data from other regional stations to view regional ozone changes over the period of the episode, back trajectory analysis for air masses to help determine source regions and transport paths and times, comparison to low pollution periods before and after the episodes to estimate the regional background of ozone and hence the net change during the episode, development of an emperical model for the stations that relates meteorological and other parameters to predict ozone concentrations, comparison of observed and modeled ozone concentrations to prior years of data.

- Use NO, NO_y, NOx data along with VOC and solar radiation to estimate ozone formation potential of air masses, to estimate the degree of "aging" and transport time from major sources, to compare the ozone production rate to predicted values and to use ozone productions rate as a tool to estimate transport times and source regions, to determine the frequency of plume hits, there source directions, and the percentage of time of influence, to compare fresh nitrogen oxides to the amount of nitrate to indicate the degree of "aging" of polluted air masses

- Use SO_2 and CO data as tracer of major combustion source plume and of urban plumes to characterize the different concentrations and amount of time when these plumes are contributing to ozone enhancement, use the data to identify periods of regional backgound air and thus estimate the relative contributions to ozone impacts on the parks, use ratios of these species with Noy as indicators and identifiers of sources and source regions, determine the degree of aging of air masses from SO2 to sulfate ratios and to estimate the distances of transport

- VOC data can be use to estimate the ozone formation potential of different air masses, to estimate local VOC sources compared to more distant sources, mobile vs stationary sources, biogenic vs anthropogenic sources, some VOC’s can be used as tracers that will help identify source regions

- The data from these sites and others can be compared and used as input to computer models. Modeling could help us further define source regions and estimate the effects of different control strategies. An effort should be made to get appropriate models run.

Every effort should be made to get results from the analysis above published in peer-review journals either separately or in combination with other researchers. This serves to scientifically validate the findings and to make the results more widely known. In addition, a broader report focusing on the results and the implications for the parks should be prepared. Included should be suggestions on control strategies that would improve air quality within the parks. All of the results should be in the context of the broader regional SOS study that has a strong potential to better understand the chemistry and transport of pollutants over a wider range.

Why does the National Park Service need to do this research?

With all the other pressing needs of the NPS, it is tempting to push this kind of research into the background. But the kind of external threat poised by air pollution is a time bomb that could effect the natural resources in the parks for a long time. Most of the laws and the focus of other agencies is on pollution levels in urban areas. Since ozone formation and the maximum ozone concentrations often are downwind of their urban precurser sources, control strategies typically do not consider rural and distance natural areas. MACA is a good example of this; MACA ozone exceedances got the county designated non-attainment, yet the county does not have major emission sources that would cause the ozone to go so high. The sources are many miles away and are already existing sources not new sources. Proving where the real sources are, understanding the chemistry and how the air was transport to the park, and proving the need for emission controls are all tasks that fall on the agency that cares the most - - NPS. The fact that the pollution comes from sources far upwind and is not under control of activities within the park means that a higher standard of proof, scientific understanding, and persuation is required.

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