PM_{10} AIR QUALITY ASSESSMENT FOR THE JEFFERSON COUNTY, OHIO AIR QUALITY CONTROL REGION

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ABSTRACT

A receptor modeling study was performed to evaluate contributions to PM_{10} in Jefferson County, Ohio for the 1990 calendar year. Ambient samples were taken with a PM_{10} dichotomous sampler at five monitor sites. Depending on the monitor site, 24-hour samples were collected every third or sixth day. A subset of these samples was analyzed for elements, carbon, and ion concentrations.

The Chemical Mass Balance (CMB) receptor model (RM) was used to apportion PM_{10} to sources. Source profiles developed from geological samples collected in the study area were included in the CMB analysis. The Industrial Source Complex Short Term (ISCST) dispersion model (DM) was applied to site-specific meteorological data.

There were no recorded violations of the 24-hour or annual PM_{10} NAAQS during the study period. Both models performed well. The overall results for the CMB source apportionments were consistent. Dispersion model results were shown to be consistent with the majority of the physical data produced during the study period. The two models were reconciled; thus, the dispersion model was determined to be appropriate for SIP development. Steel plants within the study area were identified as major contributors to PM_{10} concentrations therein.

INTRODUCTION

The United States Environmental Protection Agency (USEPA) designated the Mingo Junction/Steubenville area of Jefferson County, Ohio as a Group I area for Particulate Matter -

10 μm (PM_{10}), requiring the State of Ohio (OEPA) to prepare a State Implementation Plan (SIP) to provide for attainment and maintenance of the PM_{10} National Ambient Air Quality Standards (NAAQS). An air quality study was undertaken to provide OEPA with a basis for revising the SIP. The study included: collection of ambient samples; collection of meteorological data; development of site-specific profiles; receptor modeling; and dispersion modeling. The study was limited, however, by the amount and type of data collected -- few carbon analyses and limited source specific profiles. The study area is depicted in Figure 1.

Both source-oriented dispersion models and receptor models have been used to apportion atmospheric constituents to sources. Current scientific understanding is that both approaches are necessary, either operating independently[1] to engender the reconciliation of model results, or operating together[2,3] so that strengths of one model compensate for weaknesses of the other. Receptor models use the chemical and physical characteristics of gases and particles measured at source and receptor to identify sources and to quantify their contributions to the receptor. The characteristics must be such that: they are present in different proportions in different source emissions; proportions remain relatively constant for each source type; and changes in the proportions between source and receptor are negligible or can be accounted for.

Types of receptor models include: chemical mass balance (CMB); principal components analysis (PCA, otherwise known as factor analysis); and multiple linear regression (MLR). Extensive discussions of each of these models, operating separately and together, are found in Watson *et al.*,[4] Chow,[2] Hopke,[5] and Javitz and Watson.[6] The CMB model, as specified by EPA guidance for SIP development,[7] was applied here. The Industrial Source Complex Short Term (ISCST) model, an advanced Gaussian dispersion model, was used for the study's dispersion modeling. The model was designed to be used to assess the air quality impact of emissions from a wide variety of sources and is capable of processing multiple emission points and receptor points. Some advanced features of this model include: building downwash; stack tip downwash; transitional plume rise; and urban or rural dispersion coefficients. Options employed for this study were rural dispersion coefficients and options conforming to the regulatory default. This paper summarizes a report prepared under contract to the Ohio EPA which documents the study methods and results.[8]

EXPERIMENTAL METHODS

Data Collection and Analysis

The monitoring network established for this study consisted of six dichotomous samplers located at five sites in Ohio and West Virginia; one of the monitoring sites was set up as a collocated site. The initial sampling schedule coincided with the six-day USEPA monitoring requirements. During the third quarter, the sampling frequency was increased at the 814 Adams monitoring site to every third day. Mingo Junction was the site with the collocated monitors. Coarse and fine fraction samples were collected over 24-hour periods from January 11, 1990 to December 25, 1990. Samples were initially collected using Teflon filters. After implementation of the modified monitoring schedule in the third quarter, quartz filters were used at the

collocated monitor on alternating sampling days. Monitoring was conducted by the North Ohio Valley Air Authority (NOVAA). Also collected during this study were site-specific meteorological data. The West Virginia Air Pollution Control Commission (WVAPCC) operated two meteorological stations. One station, located nearest the monitors, was selected as being most representative of the study area. A third NOVAA-operated meteorological station was not considered a reliable source of meteorological data. Locations of monitor sites and meteorological towers are shown in Figure 2.

Sample analysis was performed by the Desert Research Institute (DRI). No exceedances of the 150 $\mu g/m^3$ 24-hour PM_{10} standard were recorded during the study period. On two occasions, high concentrations occurred at several sites, indicating regional-scale events. An isolated fugitive dust episode was indicated on 3/15/90 when a high coarse fraction concentration of 111.57 $\mu g/m^3$ was measured at the sewage plant. On 8/3/90 there was disagreement between the collocated monitors; however, an inordinately high fine mass concentration was measured at one of the monitors, and the sample was believed to be contaminated.

Of the 593 samples collected, 248 were selected for elemental composition analysis based on procedures suggested by the USEPA.[1] PM_{10} concentrations and meteorological data were evaluated during the selection process. The goals of the selection process were to select samples with: 1) high PM_{10} concentrations; 2) contributions from various sources; and 3) representative background PM_{10} concentrations. Twenty-four-hour PM_{10} concentrations were reviewed and ranked on a quarterly basis. Concentrations were ranked for the whole network and by monitoring site to ensure that samples from each site were considered for analysis. Samples having lower concentrations were also selected to provide a data set more representative of the annual average. Meteorological data were reviewed for the sampling days associated with high PM_{10} concentrations to allow selection of samples reflecting various source interactions and background concentrations. Precipitation data were also considered in this process.

A total of 196 (98 coarse fraction and 98 fine fraction) sample pairs were analyzed by x-ray fluorescence (XRF). Teflon filters were analyzed for Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Y, Zr, Mo, Pd, Ag, Cd, In, Sn, Sb, Ba, La, Au, Hg, Tl, Pb, and U, using an energy dispersive x-ray fluorescence (EDXRF) analyzer. A total of 52 (26 coarse fraction and 26 fine fraction) quartz fiber sample pairs were analyzed by thermal/optical reflectance (TOR) for elemental and organic carbon and ion chromatography for NO_3^- and $SO_4^=$.

Emission Inventory

The PM_{10} emission inventory consisted of 40 facilities and 308 emission sources located in Jefferson County, Ohio and Brooke and Hancock Counties, West Virginia. The majority of emissions were from the steel industry (56%) and electric-generating utilities (32%); many of the facilities line the banks of the Ohio River. The spatial distribution of the facilities is shown in Figure 3. Total Suspended Particulate (TSP) data prepared for the 1979 Ohio SIP submittal were used to estimate emissions of mobile and area sources not included in the point source

inventory. TSP data from the SIP were modified to reflect population growth, and the PM_{10} fraction. The data were available for Jefferson and Brooke Counties. To identify emission sources which were not accounted for in existing inventories, the study area was surveyed. Potential sources identified were: paved and unpaved roads and parking lots; automobile, train, truck, and barge traffic; playgrounds and baseball fields; construction sites; and strip mines. Other identified sources, such as mobile sources and roadway dust, were accounted for in the mobile and area source inventory. Monitoring sites considered to have a high possibility of being impacted by such non-inventoried sources were Mingo Junction City Building, Mingo Sewage Treatment Plant, and Follansbee. All sites were near roadways for which emissions (both roadway and mobile source) were more likely to be underestimated in the inventory. Other potential sources of PM_{10} were: a build-up of materials on the roof of the Mingo Junction City Building; old lagoons filled with sand and organic matter at the Mingo Sewage Treatment Plant; and a dusty parking lot around the truck depot at the Follansbee monitor.

Site-Specific Profiles

Sixty-four grab samples of fugitive particulate matter were collected from industrial and non-industrial sites within the study area. Samples were collected in ziplock bags, using a small broom, sieve, and/or trowel. Sample bags were labeled with a description of the sample location from which the sample was taken, date and time sample was collected, and the name of the person collecting the sample. Ten of the samples (or combinations thereof) were selected for analysis: 1) paved road dust (PVRD); 2) gravel road dust (GRRD); 3) access road dust from a steel plant (ACRD); 4) soil (SOIL); 5) dust from the roof of the building where the Mingo Junction monitors were located (RFDST); 6) storage piles at a slag processing plant (SSLAG); 7) storage piles from a steel scrap and slag separating plant (IMSTOR); 8) an old lagoon at the sewage treatment plant (SLDGSD); 9) storage piles at a steel plant (SINFINE); and 10) road dust from near WTOV (TVBACK). The geological profiles were characterized by high levels of Al, Si, Ca, and Fe. Lead was enriched (around 0.1%) in the paved road dust (PVRD), Mingo roof dust (RFDST), and fine sinter (SINFINE) profiles. Iron and calcium were enriched in the roof dust (RFDST) and fine sinter (SINFINE) profiles. These differences were not great enough to statistically distinguish the geological profiles.

Chemical Profiles

Other chemical profiles used were compiled from DRI's library[9-13] and the Air Emissions Species Manual.[14] A series of source profiles was compiled for CMB source apportionment of the samples. Profiles represented the following source emission categories: primary geological material (site-specific profiles); steel production; primary motor vehicle emissions (combinations of Phoenix roadway and test facility emissions); and residential wood combustion. Additionally, profiles were included to represent secondary ammonium sulfate (AMSUL), secondary ammonium nitrate (AMNIT), and secondary organic carbon (OC). A profile for limestone (LIME) was included to account for "excess" calcium. Profiles representing emissions from coal-fired power plants (CFPP), oil-fired power plants (OFPP), aluminum reduction potline

(ARPL), coal dust (COALDST), coal fly ash (COALFLY), and mineral products (MINP) were taken from the USEPA source library.

Steel plant profiles were derived from source samples collected at the Geneva Steel Plant near Orem, Utah.[8] The profiles included were: coke battery fugitives (CKBAT); blast furnace fugitives (BLSTFR); open hearth stacks (OPHRTH); sinter stack (SINTER); coke oven stacks (CKSTK); and open hearth roof monitor fugitives (OHROOF). Although the six profiles represent various processes, their elemental compositions are similar enough so that only one profile could be used in a given CMB. However, their sulfate, elemental and organic carbon contents do vary and these differences were useful for distinguishing individual steel source contributions to ambient samples in which these species were measured.

The primary motor vehicle emission profiles used in the source apportionments were taken from DRI's Phoenix Urban Haze Study.[10] Profiles representing various mixes of diesel and gasoline-powered vehicle emissions were derived from inspection and maintenance tests. A profile derived from roadside samples (PHRD) contained more Pb, Br, and elemental carbon than the dynamometer profiles; the PHRD profile seemed to better represent ambient conditions in Phoenix. PHRD also seemed to give generally reasonable results for the Ohio samples. Because local motor vehicle mixes differ, proper quantification of their contributions requires profiles determined specifically for local conditions.

Residential wood combustion profiles were determined during the Denver Brown Cloud study.[11] These profiles represent various fuel types and burning conditions for fireplaces and wood stoves. Their most distinguishing features are greater abundance of water soluble K, elemental carbon, and organic carbon. Unfortunately, these species were not routinely measured in the Ohio samples. Also, wood fuel types differ from East to West; hardwoods, like oak, which are prevalent in the East, are generally not burned in the West.

RESULTS AND CONCLUSIONS

Model Results

The CMB modeling procedure requires: identification of contributing source types; selection of chemical species to be included; estimation of the fractions of each chemical species contained in each source type (i.e., source compositions); estimation of the uncertainties of both ambient concentrations and source compositions; and solution of the chemical mass balance equations. These procedures are described in an applications and validation protocol[8] and consist of seven steps: 1) determination of model applicability; 2) development of initial source contribution estimates; 3) examination of model outputs and performance measures; 4) identification of deviations from model assumptions; 5) identification and correction of model input errors; 6) verification of the consistency and stability of source contribution estimates; and 7) evaluation of the results of the CMB analysis, with respect to other PM_{10} source assessment methods.

Several samples in both the $PM_{2.5}$ and coarse (PM_{10} minus $PM_{2.5}$) size fractions were used to calculate initial source contribution estimates. These initial tests were intended to determine which profiles best explained the data. Motor vehicle exhaust, secondary ammonium sulfate, and geological profiles were sufficient to account for most of the PM_{10} mass in the majority of samples. Steel production and wood-burning profiles were included in a number of samples. Oil-fired power plant emissions were present in several samples, at levels less than 1 $\mu g/m^3$. Coal dust and coal fly ash contributions, although possibly present, could not be resolved in this analysis due to collinearity with soil and other source profiles. The performance measures for each of the $PM_{2.5}$ and coarse CMB runs were averaged by site. Performance measures were generally within acceptable limits, especially R^2 and CHI-SQUARE which measure goodness of fit to chemical species.

One of the basic assumptions of the CMB model[15] is that all sources which may significantly contribute to the receptor have been identified and their emissions characterized. This assumption is generally verified if the PERCENT MASS performance measure is near 100% and the other model performance measures are within range. There were a number of cases in this study where the measured mass was underestimated by more than 20%. This could have resulted from contributions to species which were not measured in these samples (eg., nitrate, elemental carbon, organic carbon, and phosphate). Except for geological profiles, the profiles used in this study were not determined specifically for Jefferson County sources; nonetheless, the list is fairly complete. Given the constraints imposed by the experimental design, it is probable that this assumption was adequately complied with. The number of chemical species in the CMB always exceeded the number of source types; satisfying another assumption of the model. It was necessary to group specific profiles into source types defined as geological material, motor vehicle exhaust, and vegetative burning to eliminate collinear profiles. Another assumption of the model is that measurement uncertainties are random, uncorrelated, and normally distributed. The effects of deviations from this assumption have not been extensively studied. Non-randomness and correlation among measurement errors would result in biases in the calculated concentrations, with respect to measured concentrations. The calculated and measured PM_{10}, $PM_{2.5}$, and coarse particle mass concentrations for each CMB were compared for the 196 calculations performed in this study. These differences are significant in many cases and are probably due to two factors: 1) the source profiles of major source types were not determined specifically for this study; and 2) nitrate, sulfate, organic carbon, and elemental carbon -- major components of PM_{10} which are extremely useful in distinguishing source types by CMB -- were not routinely measured in this study. In summary, the CMB model assumptions for this study have been met to the extent that source contributions from the major source types can be considered reasonable.

One hundred and ninety-six separate CMBs were performed on $PM_{2.5}$ and coarse (PM_{10} minus $PM_{2.5}$) samples for the six sites. The stability of these solutions was tested periodically by adding or dropping fitting species and examining changes in the source contribution estimates. In those cases where the presence or absence of a single species made a large difference in the source contribution estimates, the species was left in the fit when all performance measures were

within target ranges. The species was deleted from the fit when this deletion would bring performance measures into acceptable target ranges.

The overall results for the CMB source apportionments were consistent. Primary motor vehicle and secondary ammonium sulfate were the dominant contributors to the $PM_{2.5}$ aerosol. Steel emissions were also significant contributors to $PM_{2.5}$. Wood burning and oil combustion were occasionally detected. Geological material was the major contributor to the coarse aerosol fraction. This was consistent with the known size distributions for these source types. Steel production emissions often contributed significantly to the coarse aerosol. The averages and standard deviations of PM_{10} concentrations were: 46 ± 26 $\mu g/m^3$ for 18 samples at Steubenville; 66 ± 23 $\mu g/m^3$ for 25 samples at Follansbee; 60 ± 4 $\mu g/m^3$ for 2 samples at Mingo #1; 60 ± 27 $\mu g/m^3$ for 11 samples at Mingo #2; and 49 ± 22 $\mu g/m^3$ for 15 samples at the WTOV tower.

Primary geological material, primary motor vehicle exhaust, and secondary sulfate were the major contributors to PM_{10} at the five sites. Motor vehicle exhaust and secondary sulfate were dominant at all sites except at the sewage treatment plant, where the primary geological contribution was greatest. Motor vehicles contributed from 19% (12 $\mu g/m^3$) of PM_{10} at the Sewage Plant to 49% (35 $\mu g/m^3$) at Follansbee. Geological material contributed from 15% (10 $\mu g/m^3$) of PM_{10} at Follansbee to 35% (22 $\mu g/m^3$) at the Sewage Plant. Primary motor vehicle contributions tended to be unusually high, especially to $PM_{2.5}$ samples at Follansbee. This may have resulted from the lack of organic and elemental carbon, important indicators of motor vehicle exhaust. Motor vehicle contributions were based almost entirely on Pb and Br in the Phoenix PHRD profile. If Pb and Br were higher in Ohio than in Phoenix motor vehicle exhaust, motor vehicle contributions to Ohio aerosol, based on the Phoenix motor vehicle profile would have been artificially high. Secondary ammonium sulfate was a major contributor to PM_{10} at all sites. Secondary ammonium sulfate contributed from 21% (13 $\mu g/m^3$) of PM_{10} at the Sewage Plant to 35% (15 $\mu g/m^3$) at WTOV. Steel plant emissions contributed from 6% (3.4 $\mu g/m^3$) of PM_{10} at Mingo #2 to 13% (9.3 $\mu g/m^3$) at Follansbee.

The highest PM_{10} concentration measured during the study was 131 $\mu g/m^3$ at the Sewage Plant on 3/15/90. Primary geological material contributed most of this. Using SOIL and LIME, the geological contribution to PM_{10} in this sample was 93 ± 13 $\mu g/m^3$. This was the largest geological contribution of the study. The steel contribution (19.4 ± 3.5 $\mu g/m^3$) to PM_{10} in this sample was also one of the largest of the study. PM_{10} levels were consistently highest at all sites during the summer and fall months. Secondary ammonium sulfate contributions were also highest during this period which is characterized by high temperatures, humidity, and photochemical activity. The largest geological contributions occurred at all sites on 3/15/90, 4/23/90, and during the month of November, 1990.

The ISCST model was employed for the dispersion modeling analysis; modeling was performed in accordance with USEPA guidance.[16] The receptor grid input to the model consisted of the five dichotomous monitoring site locations. This selection of receptors allowed for comparison of dispersion modeling results to monitored concentrations and receptor modeling results. Site-specific surface meteorological data were combined with mixing heights from the

Pittsburgh National Weather Service (NWS) for use with the model. To compensate for the use of an emission inventory of annual average emissions rather than a 24-hour emission inventory, days with similar meteorology (windspeed, cloudcover, stability) were aggregated. A review of meteorological data resulted in four groups of days to be modeled. The first group consisted of eight days with neutral stability and a few hours of stable conditions in the late evening or early morning. The second group, consisting of seven days, was similar to the first, except that the second group had more stable hours. A third group consisted of days with unstable afternoons; this group had five days. Each of these groups consisted of days with <0.1 inches of rain. The fourth group consisted of rain days; there were six days in this group, with >0.1 inches of rain. There were six days which were not included in any of the four groups. The pre-processed meteorological data were input to the model, and days to be processed were set using the IDAY array.

To facilitate the comparison of DM and RM results, the emission inventory was divided into source groups similar to those used for the CMB. Emission sources were grouped into five general categories. Modeled emission source categories were: plant access roads; steel related sources; flyash, lime and coal; other mineral products; and combustion sources. The dispersion model performed well for this analysis. The model overpredicted the average concentration at Adams (4.2 $\mu g/m^3$), Mingo #2 (7.6 $\mu g/m^3$), and WTOV (8.2 $\mu g/m^3$) and underpredicted at the Sewage Plant (14.5 $\mu g/m^3$) and Follansbee (9.1 $\mu g/m^3$). The Mingo #2 and Follansbee sites had the highest predicted average concentrations.

Model Reconciliation

The goals of the model reconciliation are threefold: 1) both models should predict measured mass well; 2) both models should identify the same source groups as the major contributor; and 3) contributions from each source group should be in agreement for both models. USEPA guidance[1] recommending the use of an eight-step protocol to reconcile the receptor and dispersion model results was followed.

From a previously established PM_{10} monitoring network, OEPA established that the PM_{10} background concentration for the study area was 28 $\mu g/m^3$. A background concentration for the CMB model was also needed. Windroses for CMB analysis days were reviewed. Days with persistent winds were selected as possible background days. Persistent-wind days were defined as those days with winds from one 22.5 degree sector, or from two adjacent sectors, for greater than 50% of the time, with winds from any other direction for less than 25% of the time. From these wind directions, it was determined whether any receptors were upwind of the local sources and were, thus, candidates for background receptors. For receptors chosen as candidates, source group contributions were reviewed to determine if there was any local source influence on the receptor. Receptors with strong local source influence were not chosen. Source groups consistently appearing were chosen as background source groups. Contributions from the background source groups were then averaged to determine the background concentrations for each source group.

Predominant westerly winds on 4/11/90 and 1/11/90 indicated that the ADAMS and WTOV sites were good background sites for these days. Other days had predominant winds from the south, southeast, or southwest. The sewage treatment plant was selected as a background site for these days. On 1/11/90, both Adams and WTOV were evaluated as background sites. On 4/11/90, only WTOV was evaluated as a background site since there was not a CMB analysis for Adams. No data were evaluated for 2/4/90 and 5/29/90 since there was no upwind receptor. Data for days with predominant SW winds, 3/12/90, 12/1/90, and 12/25/90, were not evaluated due to downwind sources. The sewage plant was evaluated as a background site on 1/17/90, 1/23/90, 3/15/90, 9/14/90, and 11/1/90. No data were evaluated for 11/22/90 since there was not a CMB analysis for the sewage plant.

CMB source contributions were reviewed for background receptors to determine if they were influenced by local sources. The CMB showed a significant impact from local sources at the sewage plant receptor on 3/15/90 and 11/1/90; consequently, these receptors were not included in the background calculation. Other receptors showed little influence from local sources. Source categories from the CMB analysis were averaged for each background receptor. Average contributions from each source category were: SOIL 4.4; TVBACK 0.03; LIME 1.59; OPHRTH 0.16; OHROOF 0.45; SINTER 0.03; AMSUL 8.29; PHRD 5.83; WFIREC1 (a composite of two Denver fireplace profiles) 1.94. The total contribution was 22.74. Source categories included as background were SOIL, AMSUL, and PHRD. Background concentrations applied to the CMB results were: SOIL 4.0; AMSUL 8.0; and PHRD 6.0.

Both DM and CMB predictions were compared to the ambient data. For DM results, the RAM area source predictions determined by OEPA were added to the ISCST predictions. These values were then compared to the ambient data minus background concentration. DM predictions were compared for each site, and for high ambient concentrations. Next, DM and CMB results were reviewed to determine which source groups were major contributors to PM_{10} concentrations. DM results were reviewed on an aggregate basis for each site. DM source categories with the highest concentrations were identified for each aggregate day at each monitoring site. For the CMB, the group with the highest concentration was identified on a daily basis at each site. CMB source groups with concentrations in the range of the maximum concentration were also identified. Using these methods, identification of the same source group(s) by the DM and CMB models would indicate that both models were in agreement. Individual contributions from each model were also compared. CMB results $\pm$ standard error minus background were compared to the aggregate DM results $\pm$ 30%. If the source contribution estimates for each model overlapped, the models were considered to be in agreement.

ISCST and RAM results were analyzed to determine if the models were over- or underpredicting ambient data. The average concentration at each monitoring site was calculated for the DM predictions and the measured values. The 28 $\mu g/m^3$ background value was subtracted from the measured value, prior to comparing the average concentrations. Results of this comparison show that the DM overpredicted at Adams, Mingo #2, and WTOV, but underpredicted at Sewage Plant and Follansbee. A comparison of all sites shows that the model

closely predicted the overall average. These results are summarized in Table I. Underprediction at the Sewage Plant and Follansbee monitors was attributed to fugitive emissions which were underestimated in the inventory. Emissions from nearby storage piles, as well as mobile source emissions (automobile, truck, railroad, and barge), were probably underestimated.

In some cases, the summed estimated source contributions (predicted mass) did not agree with the measured mass. Measured mass was much greater than predicted mass (for both $PM_{2.5}$ and PM_{10}) at Mingo #2 on 1/11 and at Sewage Treatment Plant on 6/4. Measured and predicted mass agreed well for the coarse size fraction in these samples. This strongly suggests that the measured $PM_{2.5}$ masses for these samples were not correct and, thus, demonstrates the value of CMB analysis as a Level III data validation tool.

In a number of cases, predicted $PM_{2.5}$ mass significantly exceeded measured $PM_{2.5}$ mass. Examples are: 4/23 at Follansbee, 5/29 at Follansbee, Sewage Treatment Plant, and WTOV, and 6/4 at Follansbee. It is suspected that this disagreement results from an overprediction of the motor vehicle contribution. Lead and Br are the principal identifying species for this source in these samples. It is likely that the actual Pb and Br contents of local motor vehicle emissions contributing to these samples were different from those measured in Phoenix (PHRD).

A comparison of the DM and RM results for first and second quarter data was performed to determine if the models were attributing PM_{10} concentrations to the same major source groups. This comparison was made on a daily basis rather than through the aggregate day DM procedure described previously. Common source groups were identified as major PM_{10} contributors for over 50% of the samples. The data was further reviewed to determine when the model predictions for source group contributions were in agreement. Eleven percent of the source group contributions were in agreement. To improve on these results, input data for the DM and RM were reviewed for data entry errors and other inadvertent errors. ISCST inputs were updated to correspond with the newly revised emission inventory. Changes to the model inputs included correction of UTM coordinates, area source dimensions, and emission rates. In addition, it was discovered that 24 emission points had been omitted from the previous inventory; these were added to the ISCST input file. The model was re-run after these changes were made. No inadvertent errors were detected in the CMB input files.

After ISCST was re-run and the CMB results for the third and fourth quarters were available, model results were re-compared. To obtain a better basis for comparison, an aggregate comparison was made. DM and RM (minus background) results were compared for each of the four meteorological regimes described previously. Average DM results were used to compensate for the lack of a 24-hour PM_{10} emissions inventory. This did not, however, produce the expected increase either in the percent of sources predicted as major PM_{10} contributors or in the percent of source group contributions in agreement between both models. It is highly probable that much of the disagreement resulted from the use of source profiles developed for other studies instead of site-specific profiles, particularly for the steel plant and primary motor vehicle source groups. Although the limited carbon data available was helpful in fitting the steel plant source groups, the CMB model could not differentiate these source

groups. Since the CMB model was not distinguishing between the steel plant source groups, the source group categories used for the model comparison were modified. This modification resulted in a comparison of the models on a more basic level. The modified source group categories were: steel (OPHRTH, OHROOF, BLSTFR, SINTER, SINFINE, SSLAG, IMSTOR, CKSTK, CKBAT, CKDST, AMSUL); soil (SOIL, LIME, COALDST, COALFLY); mineral products (MINP); combustion (CFPP, OFPP, AMNIT); and motor vehicle (PHRD).

Source categories related to the steel industry were combined into one source group. Since many of the steel plant emission points were combustion-related sources, some of which were controlled by desulfurization units, there was an indication that much of the secondary ammonium sulfate originated from steel plants.

Coal-fired power plant flyash, coal dust, limestone, and roadway (plant roads) contributions were often indistinguishable from the general primary geological source category. For this reason, these contributions were attributed to the soil source group which was developed from site-specific profiles. Sand and gravel handling, concrete batch plant, and asphalt batch plant source categories were attributed to the mineral products group. Coal and oil combustion were attributed to coal- and oil-fired power plant operations, respectively. The RAM area source contribution remained as an estimate of primary motor vehicle exhaust emissions.

Using the modified source groups, a comparison of the model results was performed. Both models showed considerable agreement in the identification of major source groups. The models indicated that the steel source groups were the primary contributors for over 50% of the samples at each monitor. These results are summarized in Table II. Comparison of model predictions of source group concentrations was not as successful as identification of major contributors. However, the comparison was not made with aggregate source groups. The Follansbee and Mingo #2 sites had the greatest number of source groups showing agreement between the models. Since these sites recorded some of the highest concentrations, it was significant that they showed agreement. Overall, 72 source groups showed agreement between the model predictions. The two models were successfully reconciled, and ISCST was determined to be appropriate for development of a control strategy for the SIP.

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Table I. Dispersion model/ambient data comparison.

Site	DM ($\mu g/m^3$)	Measured-Background ($\mu g/m^3$)
814 Adams	13.66	9.47
Mingo #2	28.92	21.37
WTOV	17.35	9.18
Sewage Plt.	9.17	23.71
Follansbee	21.17	30.25
All Sites	18.05	18.80

Table II. Percent of samples identified by both models as having the steel source group as the primary contributor to PM_{10}.

Site	% of Samples
814 Adams	71.4
Mingo #2	82.4
WTOV	63.6
Sewage Plt.	57.1
Follansbee	100

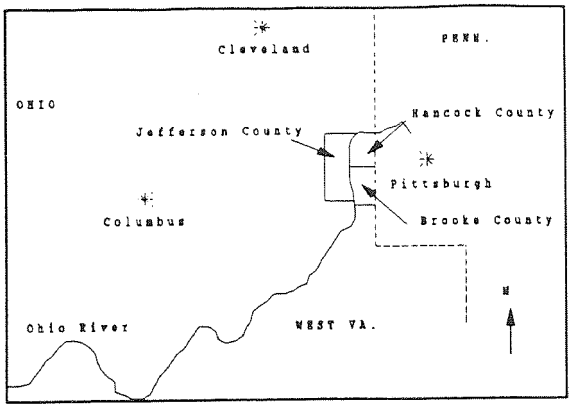

Figure 1. Jefferson county's setting in eastern Ohio.

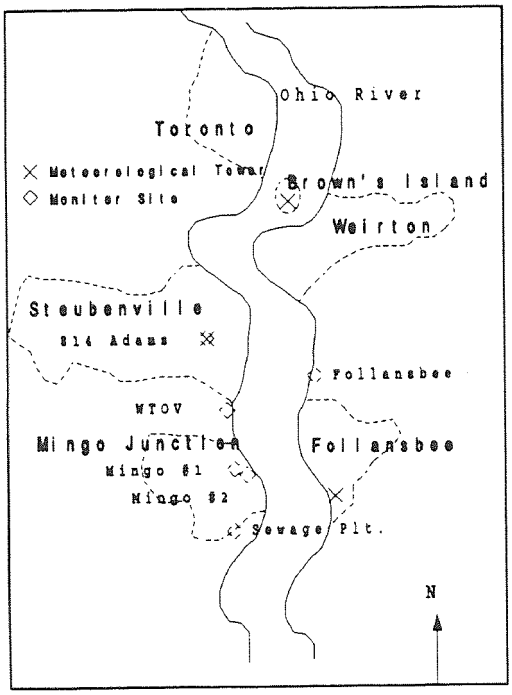

Figure 2. Locations of monitor sites and meteorological towers.

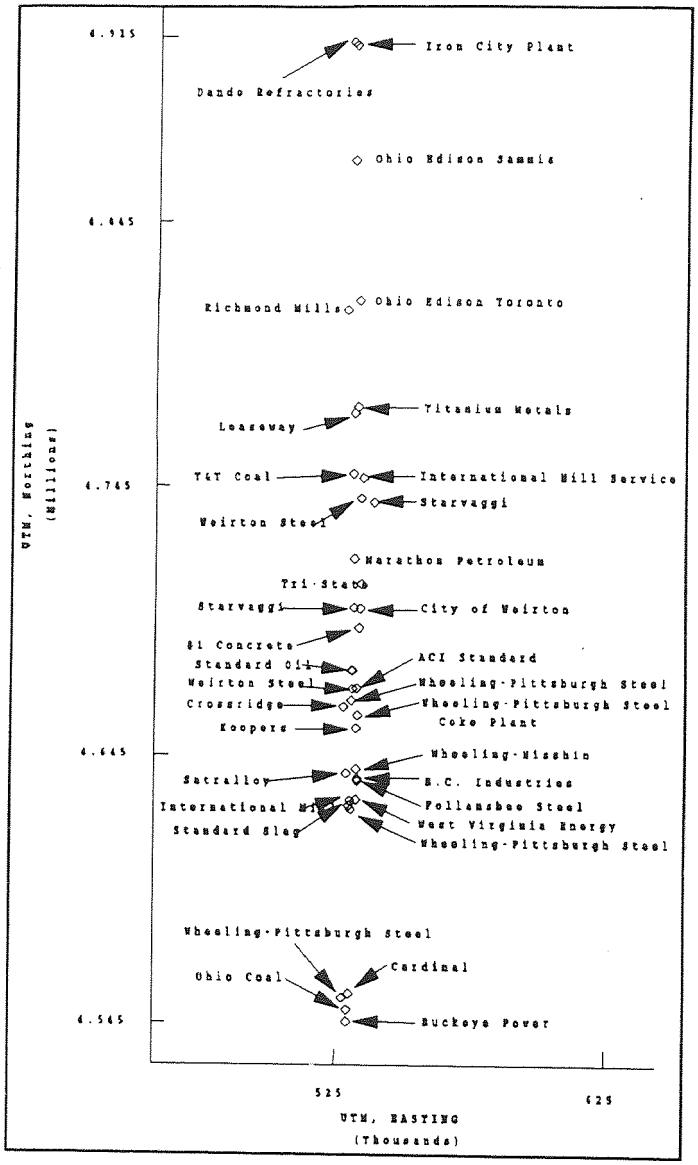

Figure 3. Spatial distributions of modeled facilities.