4.0 CONSTRUCTING THE WEIGHTED EMISSIONS SCORE

The emissions of PM2.5-related pollutants are an important factor considered in the designations process. PM2.5 concentrations are formed through complex processes, with contributions both from direct emissions and from multiple secondarily-formed pollutants. In order to compare overall emissions among counties within a metropolitan area, EPA developed a metric called the weighted emissions score. This chapter discusses the methodology used to develop this metric

The first section presents the basis for the weighted emissions score metric. The second section focuses on the calculation method for the Weighted Emissions Score (WES). The WES is based on the urban excess (Chapter 3) and the countywide emissions. The final section describes the sorting method used to determine the cumulative emissions scores which were used to rank metropolitan area and nearby counties in relation to one another.

4.1 Basis and Assumptions

Nonattainment problems are caused by a combination of regional and local emissions. In the designation process, EPA evaluated all the counties in a particular metropolitan area (based on the 1999 and 2003 definitions), plus all counties adjacent to the metropolitan area. For each metro area with a violating monitor, the emissions from this set of counties were evaluated for their contribution to nearby, or "local," PM2.5 concentrations. Because PM2.5 components such as sulfates and nitrates are formed through atmospheric processes and can be transported many miles, sources of emissions outside the set of counties comprised of the metropolitan area and adjacent counties were considered to affect the regional concentration for a particular site.

For the purposes of developing a simplified emissions metric, only the pollutants SO2, NOx, direct carbon, and direct crustal emissions were considered in the methodology. Ammonia is recognized as a key pollutant in the formation of ammonium sulfate and nitrate. However, for the purposes of developing this metric, it was assumed that ammonia emissions were associated with the formation of ammonium sulfate (through reactions with SO2) and ammonium nitrate (through reactions with NOx). Similarly, some volatile organic compounds are recognized as precursors to secondary aerosol formation, and others participate in the formation of ozone which is an important element in the oxidation of sulfur and nitrogen oxides and related atmospheric chemistry processes. However, because of the lack of speciated VOC inventories and the uncertainty about what proportion of VOC emissions in a particular county might participate in PM formation most directly, VOCs also were not included in the weighted emissions score methodology. The county emissions used in this analysis were taken from the 2001 National Emission Inventory, version 3.

4.2 Calculating the Weighted Emissions Scores

Step 1. The counties to be analyzed in relation to each metro area were first identified. These counties included the counties in the 1999 C/MSA, those included the 2003 metro area definition, and any counties adjacent to those in either the 1999 or 2003 definitions.

Step 2. For each metropolitan area, the urban excess PM2.5 mass was calculated according to the methodology described in chapter 3. According to this methodology, the regional concentration is subtracted from the urban concentration for sulfates, nitrates, direct carbon, and direct inorganic (or "crustal") PM2.5. The resulting concentrations, when added together, comprise the estimated urban excess PM2.5 for the area.

Step 3. The percentage that each PM2.5 component comprises of the total urban excess mass is then calculated. These percentages varied from metro area to metro area, and they served as a factor for "weighting" emissions of the pollutants associated with each PM2.5 component.

Step 4. The next step involves calculating, for each pollutant, the percentage of CMSA emissions attributable to each county.

Step 5. The county's percentage of CMSA emissions for the four pollutants was then multiplied by the corresponding PM2.5 component percentage of urban excess mass.

The calculation of the weighted emissions score is represented by the following formula:

[(County SO2 tons / CMSA SO2 tons) *
(% sulfate comprises of urban excess PM2.5)]

+ [(County NOx tons / CMSA NOx tons) *
(% nitrate comprises of urban excess PM2.5)]

+ [(County carbon tons / CMSA carbon tons) *
(% carbon comprises of urban excess PM2.5)]

+[(County crustal tons / CMSA crustal PM2.5 tons) *
(% crustal PM2.5 comprises of urban excess PM2.5)]

Step 6. This score was calculated for each county in the CMSA, and then the county scores were sorted from highest to lowest. The sum of these CMSA county scores was 100.

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1 Myoseon Jang, N.M. Czoschke, S. Lee, and R.M. Kamens. "Heterogeneous Atmospheric Aerosol Production by Acid Catalyzed Particle-Phase Reactions." Science, Volume 298, 25 October 2002, pp. 874-877.

Step 7. The weighted emissions score was then calculated for the other counties identified in step 1 that were outside of the 1999 metro area boundary. In the formula above, the CMSA emissions totals for each pollutant were used as the denominator in the equation. In this way, adjacent counties were compared with CMSA counties in a consistent manner. These "adjacent" counties were then sorted from highest to lowest to identify which of these counties had higher relative contributions to local PM2.5.

4.3. Comparing Weighted Emissions Scores Among Counties

The weighted emissions score was developed as a basic analytical tool used to compare emissions across multiple counties in a metropolitan area. It should be regarded simply as one way to assess multiple emissions all contributing to the "emissions" factor identified in EPA guidance. In addition, the weighted emissions score was not given more significance than the other factors in the analytical process. The assessment of potential nonattainment area counties was based on all of the information available to the Agency for all of the factors identified in EPA guidance. Final decisions on attainment and nonattainment areas were based on the collective assessment of all of the nine technical factors. EPA recognizes that there are particular uncertainties associated with this metric. However, EPA believes that it serves as a useful tool for comparing county emissions of multiple pollutants in a simplified way.