Responses to CASAC Questions on the PM PA from Consultant Dr. David Parrish

Questions from Dr. Steven Packham

The first 5 questions deal with health effects of PM. These are far outside my area of expertise, so I cannot respond.

The final question is more general: *"Could you provide additional information on any adverse public health, welfare, social, economic, or energy effects which may result from various strategies for attainment and maintenance of such national ambient air quality standards?"*

I am not knowledgeable regarding general adverse effects on public health, welfare, social, economic, or energy effects due to attainment and maintenance of national ambient air quality standards. If there were some specific adverse energy effect that was of particular focus, I could possibly contribute.

Questions from Dr. James Boylan

Chapter 2 – PM Air Quality

Is the discussion on sources of emissions accurate and complete? If not, what additional information needs to be included?

I would characterize Section 2.1.1 as an accurate and complete summary of PM emission sources. It is certainly not a comprehensive discussion, as that would require many volumes of the size of the PM PA.

One significant shortcoming is that the uncertainty of the emissions estimates should be clearly discussed and defined to the extent possible. The words "approximately" and "estimate" are used throughout (e.g., The National Emissions Inventory (NEI) is a comprehensive and detailed *estimate* of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants …."), but such terms are not clearly defined. The following sentence is the first quantitative emission estimate in the Section: "Based on the 2014 NEI, approximately 5.4 million tons/year of PM2.5 were estimated to be directly emitted to the atmosphere from a number of source sectors in the U.S." In the absence of defined confidence limits for quantitative numbers, specifying 5.4 million tons/year with one decimal place generally indicates that the number is 5.4 ± 0.1 million tons, which corresponds to an accuracy of about 2%. This is not an accurate description of the uncertainty embedded in the NEI, which I believe is much larger. I think that a few paragraphs should be devoted to a discussion of emission inventory uncertainty; this discussion might be based on material in Miller et al. (2006) or a similar, more recent emission inventory assessment.

Is the discussion on ambient monitoring accurate and complete? If not, what additional information needs to be included?

As above, Section 2.2 gives an accurate and complete summary of PM ambient monitoring, but cannot be considered comprehensive given the tremendous amount of available material. The discussion does appropriately focus on the routine monitoring networks, but in addition to the instrumentation utilized in these networks, there also exists a wide variety of research instrumentation designed for characterizing

many properties of ambient PM. These instruments are generally deployed in short-term intensive field studies, but their description cannot be realistically discussed in this PM PA.

Again, the one significant shortcoming that I can identify is the lack of a general overview of the uncertainty (accuracy and precision) of the ambient measurements produced by the monitoring networks. It would be useful to include a few paragraphs devoted to this issue.

Is the discussion on ambient measurement correlations and trends accurate and complete? If not, what additional correlations and trends need to be included?

The trends in emissions discussed in Section 2.3.1 are based on emission inventories, and hence subject to the same uncertainties embedded in the NEI that are mentioned above. However, the relative trends (e.g., those given in Table 2-1) are expected to be more accurate than the absolute trends illustrated in Figure 2-7).

Figure 2.8 seems to indicate that the accumulated PM2.5 monitoring data is a tremendous resource for informing us about the sources of PM2.5 in the US. For example, the 2015-2017 annual average PM2.5 is remarkably uniform (8-10 μg/m3) across the state of Texas, including the Houston and Dallas urban areas, the Haynesville oil and gas basin on the Louisiana border, and the relatively rural southern Gulf Coast. Perhaps a more in-depth analysis of such spatial patterns could inform the most effective approach to reducing PM2.5 concentrations.

Figure 2.9 would be more informative if the meaning of the upper and lower limits of the shaded region were defined in the figure caption. (Similarly for Figure 2.17.)

To what extent are biases associated with PM_{10}, $PM_{2.5}$, and ultrafine measurements discussed? How would differing $PM_{2.5}$ biases associated with FRM vs. FEM continuous measurements (e.g., FEMs typically show higher $PM_{2.5}$ concentrations compared to FRMs) impact the evidence-based and risk-based $PM_{2.5}$ assessments in Chapter 3?

As noted above, discussion of the accuracy (which would include biases) and precision of the measurements are missing from this section. If it is true that FEMs typically show higher PM2.5 concentrations compared to FRMs, then that is an important issue to include in the discussion of measurement accuracy. That discussion of biases would provide the basis from which the health effects community could address the impact on the evidence-based and risk-based PM2.5 assessments in Chapter 3.

Is the discussion on hybrid modeling approaches accurate and complete? If not, what additional information needs to be included?

I am ignorant regarding hybrid modeling approaches. Judging from the literature references, this is a rapidly developing research field, so it is difficult to judge the accuracy and completeness of the discussion. A discussion that is accurate and complete at the time of writing, may be out of date quickly. From my reading of Section 2.3.3 and my understanding of ambient PM2.5 concentrations, the summary of the hybrid modeling approaches given in Section 2.3.3.1.4 is accurate and complete, at least at the time of its writing.

Is the discussion on performance methods for evaluating hybrid modeling methods accurate and complete? If not, what additional information needs to be included?

Figure 2-28 gives the annual average PM2.5 predictions throughout the U.S. from the four hybrid modeling examples (for 2011?). It is possible to match these predictions with the annual average measured ambient PM2.5 on a site-by-site basis for all U.S. monitoring sites. Then a direct model-measurement comparison for each of the models could be shown as correlation plots and those comparisons discussed from a quantitative statistical basis. I believe that this additional information needs to be included. However, it must be recognized that this is not an independent test of the model performance, as the measurements themselves were incorporated into the modeling that gave the results, and the comparisons will not provide an objective basis for selecting the "best" model, because the models incorporate the measurements in different ways, and are measurement dependent to different degrees. Nevertheless, such a comparison is worth including.

Is the discussion on background concentrations accurate and complete? If not, what additional information needs to be included?

Section 2.4 is an accurate and reasonably complete summary of PM emission sources. One shortcoming of this section is a failure to clearly distinguish between the background concentration as measured as an annual average (relevant for the annual NAAQS) and as the 98th percentile of 24-hour averages (relevant for the 24- hour NAAQS). It is likely that very different sources contribute the background contribution to these two NAAQS relevant averages. Most of the discussion is focused on the background contribution to the annual average, with little discussion on the shorter term average.

For the annual average, the measurement based discussion in Section 2.4.3 provides the best guidance, as the CTMs only poorly simulate SOA formation. The lower limit of the zero-out modeling estimate quoted from the last review of the PM NAAQS (a range from 0.5 - 3 μg/m3) is likely too low for this reason. Similarly, Section 2.4.2.2 is based on such CTM calculations, and do not include SOA in these estimates.

I do not believe that the statement on page 2-49 accurately applies to 24-hour averages: "As described further below, contributions to background PM in the U.S. result mainly from sources within North America. Contributions from intercontinental events have also been documented (e.g., transport from dust storms occurring in deserts in North Africa and Asia), but these events are less common and represent a relatively small fraction of background PM in most places." For 24-hour periods, dust transport (and wildfire smoke transport as well) can contribute a large fraction of the background PM.

I suggest that Section 2.4 be revised, either by or in consultation with a PM expert, to provide a more up-to-date summary of background PM contributions, with separate discussion of the two statistics (annual average and 98th percentile of 24-hour averages). In addition, a short discussion of the likely influence of the changing global climate on background PM should be included. This influence is highly uncertain, but the background PM will depend on changing land-use (including possible desertification), occurrence and intensity of wildfires, agricultural practices, emissions of biogenic hydrocarbons, and others, both within and outside the US.

Chapter 3 – Review of the Primary $PM_{2.5}$ Standards and Appendix C - Supplemental Information Related to the Human Health Risk Assessment

Chapter 3 and Appendix C deal with health effects of PM. These are far outside my area of expertise, so I cannot respond.

References

Miller, C.A., G. Hidy, J. Hales, C.E. Kolb, A.S. Werner, B. Haneke, D. Parrish, H.C. Frey, L. Rojas-Bracho, M. Deslauriers, B. Pennell, J.D. Mobley (2006) Air Emission Inventories in North America: A Critical Assessment, *J. Air & Waste Manage. Assoc., 56*, 1115–1129.