MPCA RESPONSE TO COMMENTS ON DRAFT
BEST AVAILABLE RETROFIT TECHNOLOGY MODELING PROTOCOL FOR MINNESOTA
(Available for Public Comment October 10-November 4, 2005)

Background

Comments were received on the draft protocol from the following organizations:

- U.S. Forest Service;
- Minnesota Chamber of Commerce;
- Minnesota Power;
- Marathon Petroleum Company;
- MidWest Regional Planning Organization;
- State of Iowa; and
- U.S. EPA Region V

Suggested clarifications on the content/appearance of the protocol.

1. **Switch Settings.** Include a table summarizing the switch settings used in the CALPUFF modeling.
   Response. The MPCA will include tables summarizing the switch settings in CALPUFF.

2. **Domains.** One commenter was unclear about the size of the domains and thought the proposed 4-km domain was in fact the 12-km domain. Another commenter was unclear of the size and location of the domains used to generate the background values in Table 7.
   Response. The MPCA has determined a 12-km domain will be sufficient for this subject-to-BART modeling and no longer intends to create a 4-km domain. The MPCA will attempt to clarify the extent and grid-scale of the domain.

3. **Pre- and Post-Control Comparison.** One commenter requested clarification whether the 98th percentile value would be used for both the subject-to-BART modeling and the BART-analysis modeling.
   Response. The MPCA will deem a facility subject-to-BART when the modeling indicates the 98th percentile value over the 3-year modeling period (and each of the 3 years) is greater-than or equal-to 0.5 deciviews. For facilities performing a BART-analysis, and for the MPCA making a BART-determination, the MPCA will clarify the intent to compare the following when assessing the change in visibility due to BART controls:
   a. the deciview change of the 98th percentile value between the pre- and post- control run; and
   b. the difference in the number of days the 0.5 deciview threshold is exceeded between the pre-and post- control run.

4. **Background light extinction calculations for 20% best days.** One commenter requested the MPCA to show the calculations that produced the background light extinction representative of the 20 percent best days.
   Response. The calculation method was provided in the draft protocol as Appendix D, which is an excerpt from the North Dakota protocol describing the method. MPCA will include the calculations directly in the protocol in lieu of enclosing it as an appendix.

5. **Deviations from the MPCA protocol.** One commenter requested the MPCA to indicate in the protocol that if facilities choose to deviate from the MPCA protocol—when conducting the BART-analysis modeling—that the facility contact the federal land manager's for their approval of the deviation from the MPCA protocol.
   Response. The MPCA will not deviate from the final MPCA protocol in the pre- and post-control modeling that will be submitted as part of the SIP. Facilities may deviate from the MPCA protocol while conducting their own modeling—for the BART analysis—to examine visibility impacts from potential control technologies, however, they run the risk of having differing answers from the MPCA when it makes the final BART-determination and submits the final regional haze SIP. Because facility-conducted modeling will not be part of the SIP, the MPCA will not "approve" any modeling conducted by the facility for the BART-analysis, nor will they seek "approval" from the FLMs. The MPCA will request that facilities fill out a form (in the final modeling protocol) identifying any deviations from the MPCA BART modeling protocol while conducting their analysis.

6. **Other clarifications and typographical errors.** One commenter requested the MPCA to clarify some statements and correct errors in the protocol.
   Response. The MPCA will make the following clarifications and corrections to the BART protocol (note: The following references are to the draft. Figure, page and section numbers may change in the final protocol):
   a. Figure 1, modify so that labels appear for all sources depicted;
   b. Section VII, item 5, clarify that the regional modeling—with an eularian grid model with full chemistry—will include all estimated emissions, both natural and man-made. It will not be limited to only sources subject-to-BART;
   c. Figure 2, modify to exclude the scale;
   d. Page 13, clarify the reference to "regional scale modeling for the Regional Haze SIP";
   e. Page 14, modify the sentence "No observation data was used in the CALMET modeling" to "No supplemental observation data was used in the CALMET modeling", or something of that nature;
   f. Page 14, clarify what modeling was referenced in the sentence, "This was the case in the CALMET modeling."; and
   g. On page 18, change Figure 4 to Figure 5.

7. **Ammonia in postutil.** One commenter asked how the MPCA proposes to handle the discrepancy created by introducing time varying ammonia background concentrations within CALPUFF, while recomputing the $HNO_3/NH_4/NO_3$ concentrations within POSTUTIL from a single ammonia value.
   Response. The MPCA will use time varying—seasonal domain average—ammonia concentrations within POSTUTIL that mimics that in CALPUFF.

Suggested changes to options chosen in the CALMET modeling.

1. **Gridded Cloud Cover.** One commenter was skeptical about the choice to employ the gridded cloud cover data in CALMET (ICLOUD = 3). The commenter states that they have limited experience with the option, and in the case it was used (possibly in mountainous area), created what they considered unrepresentative results for sulfate and nitrate. The commenter states that if the MPCA elects to employ the gridded cloud fields in developing CALMET data, the MPCA should closely scrutinize the model outputs to ensure the modeled CALPUFF/CALPOST predictions are realistic.
   Response. At this time, the MPCA continues to propose using CALMET data with the ICLOUD=3 option. It is not clear whether there were other extenuating factors as to why the poor results occurred for the one case the commenter references. As noted in item 2, below, the MPCA proposes using CALMET data processed without supplementing observations. If the MPCA did not use gridded cloud data with the NOOBS option, the model would be run with constant clear skies throughout the 3-year model period. Consultation with the CALPUFF model developer validates the choice to include gridded cloud cover data in CALMET.

2. **NOOBS.** Two commenters are concerned about the use of NOOBS—no supplementation of observed meteorological data—in the processing the MM5 data with CALMET. They state that if 36km MM5 data is used to create 12km meteorological data sets for use in CALPUFF, surface and upper air observations should be added in the CALMET windfields to improve the accuracy. The commenter would accept the use of NOOBS if the MM5 data were developed at a 12km grid.
   Response. The MPCA will continue to conduct the BART modeling with the NOOBS option with 36km MM5 interpolated to 12km. There are differing opinions by technical experts as to whether the NOOBS approach is sufficient for the purposes of the subject-to-BART and BART-determination modeling, when finer grids are interpolated down from 36km MM5 using CALMET. The MPCA believes there are stronger arguments for not supplementing the meteorological data with observations, and there appears to be no evidence to the contrary at this time.

Suggested changes to the data and methods used in the CALPUFF/CALPOST modeling.

1. **Speciated Particulate Emissions and Primary Sulfate.** One commenter expressed concern about particle speciation discussed in the protocol. The commenter endorses particle speciation in CALPUFF modeling. The commenter notes that the protocol suggests that particle speciation might be done by the MPCA in CALPOST. The commenter also pointed out that a Table in the protocol indicates that the MPCA only intends to model $PM_{2.5}$ emissions and not the coarser fraction $PM_{2.5}$ to PM_{10}. The

commenter also states that many sources emit primary sulfate (SO_4) and the emissions of primary SO_4 emissions should be included in the CALPUFF modeling where appropriate.
Response. The section of the protocol that suggests that particle speciation might be done by the MPCA in CALPOST is an error. The MPCA put that section in the protocol as a placeholder for consideration, and failed to remove it from the draft protocol before it was distributed for comment. In the subject-to-BART modeling the MPCA intends to include two particulate categories: fine particles ($PM_{2.5}$) and coarse particles ($PM_{2.5}$ to PM_{10}) within CALPUFF. Facilities were asked to submit both PM_{10} and $PM_{2.5}$ emissions in the BART request for information. Where a facility was unable to provide $PM_{2.5}$ emissions, the MPCA scaled the PM_{10} to $PM_{2.5}$ using the $PM_{2.5}/PM_{10}$ ratio calculated by the MPCA for the 2002 emissions inventory. Thus, the fine particulates are the calculated $PM_{2.5}$, and PM_{10} emissions are the reported PM_{10} emissions minus the calculated $PM_{2.5}$. AP-42/FIRE $PM_{2.5}$ and PM_{10} emission factors were used to calculate $PM_{2.5}$ and PM_{10}, respectively, in the 2002 emissions inventory. Stack tests were also used to calculate PM_{10} emissions. The MPCA did not include SO_4 in the BART request for information from the BART-eligible facilities. The MPCA has reviewed stack test methods used to collect PM_{10} ($PM_{2.5}$) and assumes that all primary sulfate is accounted for in the calculated $PM_{2.5}$ emissions.

2. **Dispersion Coefficients.** Two commenters disagreed with the MPCA's proposal to use AERMOD-type dispersion coefficients as a general modeling recommendation because AERMOD had not yet been approved by the U.S.EPA as a "guideline" model. One commenter stated that they would retract their stance when AERMOD is approved for general use by U.S.EPA. The other commenter stated that Pasquill-Gifford dispersion coeffients—which are in the ISC model—should be used because the implementation of the turbulence based dispersion coefficients (AERMOD-type) in Calpuff is different than that in the U.S. EPA approved AERMOD. A third commenter requested clarification whether other protocols included the AERMOD-type dispersion coefficients, and if not, why not.
Response. The U.S.EPA has approved AERMOD as a "guideline" model, which was published in the Federal Register November 9, 2005. AERMOD is intended to replace the ISC3 model. However, the MPCA will use the Pasquill-Gifford dispersion coefficients—in ISC—because the implementation of the turbulence based dispersion coefficients in CALPUFF is different than that in the U.S. EPA approved AERMOD and the U.S. EPA is reluctant to stand behind the approach using the "AERMOD-type" dispersion coefficients.

3. **Ozone, Ammonia and Hydrogen Peroxide data**. Two commenters requested that the MPCA use actual monitoring data for ambient ozone concentrations instead of using the modeled ozone concentrations proposed in the protocol. One commenter was concerned whether modeled ammonia is the best way to determine NH_3 concentrations. Because of a lack of ammonia data, the commenter recommended using observed monitoring data from the Bondville, Illinois site, which the commenter regards as a rural site without direct ammonia source influences. A third commenter suggested that the ammonia emissions reflect only Minnesota, instead of the entire domain.

Response. The MPCA was aware that the proposed ozone concentrations for the then proposed 4km domain—obtained from modeled data—appeared to be too high before public notice of the draft BART modeling protocol. It wasn't until after the draft BART modeling protocol was public noticed, however, that the MPCA was able to fix the error. There was a math error in the utility the MPCA used to extract the modeled ozone concentrations. This is the same utility used to extract the ammonia concentrations, as well. The corrected concentrations of ozone, ammonia are provided in the revised Table 7, below.

Table 7. Ozone, Ammonia Concentrations –Domain Seasonal Average—ppb				
	Jan-Mar	**Apr-Jun**	**Jul-Sep**	**Oct-Dec**
Ozone	26.8	36.7	34.9	23.2
NH_3	0.5	0.9	1.0	0.9

Hydrogen peroxide concentrations have been removed from the protocol because aqueous phase chemistry is not part of the CALPUFF modeling. The aqueous phase chemistry option MAQCHEM is a feature that the CALPUFF model developers recommend be turned off (which is the default). Thus, the hydrogen peroxide background concentrations will not be used in the BART modeling and are removed from the table.

Because commenters requested that actual ozone monitoring data be used in lieu of modeled ozone concentrations, the MPCA compared ozone monitoring data for the years 2002 and 2003 collected in Ely and Fond du Lac, Minnesota. Performance evaluations—modeled-to-observed—of the modeling output used to develop the domain seasonal averages are very good. Thus, the MPCA will use the modeled ozone values that are averaged over the 12-km domain. The modeled data provides ozone values for the colder months, when no monitoring data is available.

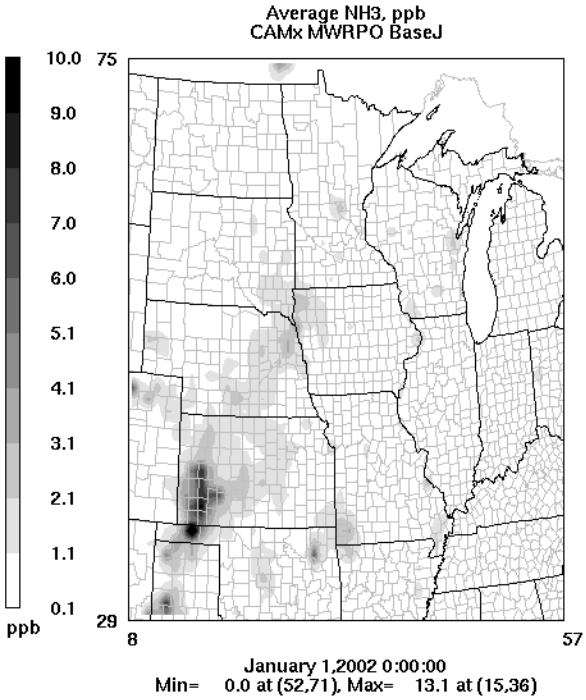
Because a commenter specifically suggested using the Bondville, Illinois observed ammonia values, the MPCA compared available ammonia monitoring data for late-2003 to mid-2005. Data is collected from the monitors every six days. The comparison was made using data from the Bondville site—and also from one southern Minnesota ammonia monitor—to modeled concentrations extracted from the 12-km grid cells in which those two monitors reside and in the 3x3 12-km grid cells surrounding the monitor. These results are tabulated below:

Seasonal Average Monitored/Modeled Ammonia Concentrations (ppbv)				
Monitor Location	**Jan-Mar**	**Apr-Jun**	**Jul-Sep**	**Oct-Dec**
MN2 – Great River r I				
#of observed>detection limit	16	30	29	16
observed	0.8	2.8	2.8	1.7
modeled at grid cell of obs	0.6	2.2	2.2	1.9

modeled 3x3	0.7	1.9	2.1	2.0
IL – Bondville				
#of observed>detection limit	12	28	30	21
observed	0.8	1.8	1.6	1.5
modeled at grid cell of obs	0.2	1.5	0.4	2.7
modeled 3x3	0.2	1.1	0.4	1.7

The monitor to model concentration comparison has fairly good agreement at the monitor site/grid cell location and the 3x3 grid cells surrounding the site. In addition, one must remember that the monitors collect data every six days, while the model simulates concentrations every day. The model can also simulate low concentrations that are below the monitors detectable limits. The model can capture spatial variations in ammonia concentrations that a monitor can not. Below are four plots of the modeled ammonia for each season, which were used for extracting the domain-wide averages. For all these reasons, the MPCA is comfortable with the domain-wide average for ammonia extracted from the model rather than using a particular monitored ammonia concentration.

Quarter 1 of 2002



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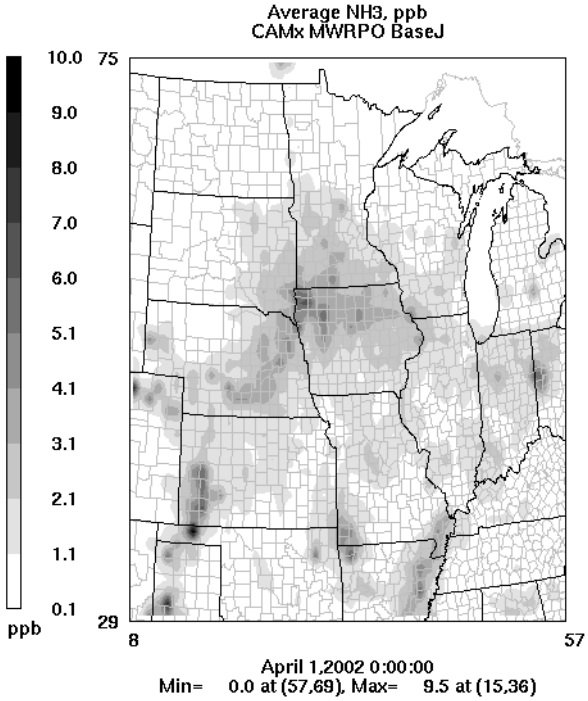

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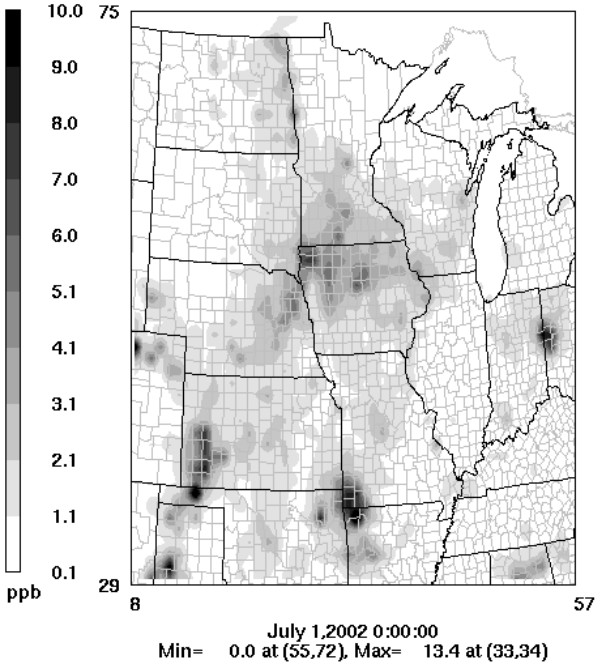

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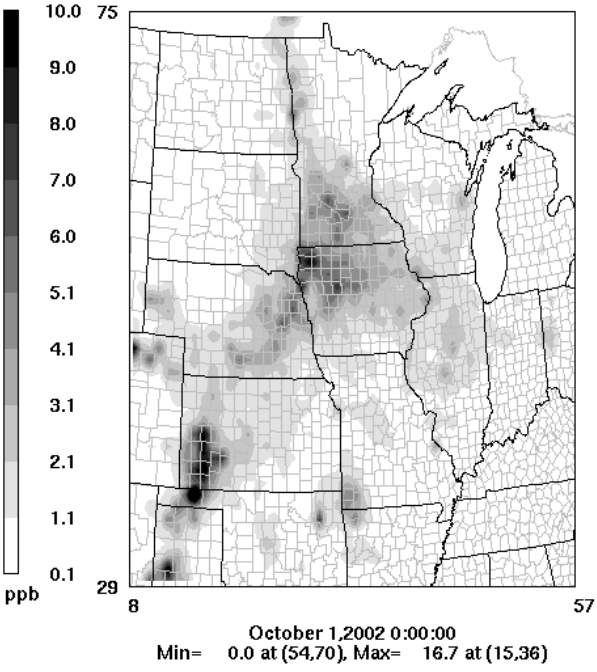

4. **Relative humidity**.
    a. **Hourly vs. Monthly Relative Humidity.** One commenter noted that all recent Class I visibility analyses conducted under the PSD program have used hourly average relative humidity, which can be accomodated by CALPUFF. The commenter stated that they understand that the use of monthly average relative humidity values require less intensive computing than the hourly averages and the size of the (12-km) domain suggests that it makes sense to use the monthly average values. The commenter states that results using monthly relative humidity values should be similar as those with hourly values as long as Method 6 is opted in CALPOST (which the MPCA proposes to use in the draft protocol). The commenter would like the MPCA to allow either monthly or hourly averages in subsequent rounds of BART modeling.

    Response. The MPCA will use monthly average relative humidity for both the subject-to-BART and the final modeling of the degree-of-visibility-improvement submitted in the SIP. The final U.S. EPA BART guidance (July 6, 2005), states that the monthly relative humidity should be used rather than the daily average humidity, which "effectively lowers the peak values in daily model averages." As mentioned above, facilities conducting modeling as part of their BART-analysis may deviate some from the modeling protocol. The MPCA asks that facilities fill out a form avaliable in the final modeling protocol specifying any deviations from the protocol.

    b. **Source of f(RH) Curves.** One commenter wanted clarification whether the U.S.EPA f(RH) curves or the FLAG f(RH) curves would be used in the BART modeling. The commenter emphasized it is important to use the updated light extinction methods if the U.S.EPA f(RH) curves are used as the data are intended to be used together.

    Response. Neither curves will be used. The BART modeling will use the values available in the U.S. EPA's "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule", September 2003.

5. **Subject-to-BART Threshold.** One commenter said that a value lower than 0.5 deciview is more appropriate for determining sources subject-to-BART.
    Response. The MPCA is aware the State has the discretion to set the "contribution" threshold lower than 0.5 deciview and is aware of a number of existing sources in relatively close proximity to Class I areas. The MPCA will use a contribution threshold of 0.5 deciview. However, if the modeling shows a number of sources are causing impacts at levels just below 0.5 deciview, the MPCA may consider re-adjusting the contribution threshold of 0.5 deciview. The MPCA also believes that the U.S. EPA will expect a review of all sources (BART-eligible and non-BART-eligible existing point, area and mobile sources) for emissions reductions in establishing its 2018 reasonable progress goal. Thus, the BART implementation process should be viewed in concert with other actions that are required in the development of a regional haze SIP. The MPCA expects the totality of these activities will appropriately address sources contributing to visibility impairment in Class I areas. Note: This response, and a

response to a comment supporting a comparison threshold greater than 0.5 deciview, are provided in "MPCA Response to Comments on Proposed Best Available Retrofit Technology Strategy for Minnesota" (December 15, 2005), available at http://www.pca.state.mn.us/air/regionalhaze.html .

6. **98th Percentile Threshold**. One commenter said that the State should not only look at the 98th percentile value over the three year period, but should also look at the 98th percentile for each of the three years. Over the three year period, the 98th percentile is the 21st day; while the 98th percentile is the 7th day during each year. Thus, to determine subject-to-BART status, one would look at the 22nd highest value over the three year period, and the 8th highest value each year (assuming there are 365 days per year). The commenter indicted that this method is described in a U.S. EPA draft Q and A document for Source-by-Source BART rule of July 6, 2005.
Response. The MPCA will look at both the 98th percentile over the entire 3-year period and each individual year. Although the CALMET data used by the MPCA in 2002 consists of 365 days, 2003 has 363 and 2004 has 364 days. Because the U.S. EPA considers the 98th percentile to be based on 365 days, the MPCA will consider a facility subject-to-BART if the count of days over the 0.5 deciview threshold is 21 or greater over the three-year period, and/or 7 or greater each year (as opposed to 22 or 8).

7. **Natural Visibility Conditions.**
   a. **Definition of Natural Visibility Conditions**. One commenter urges the MPCA to define natural visibility conditions in a way consistent with those in the PSD program. In the PSD program, the default natural conditions are based on annual values, while in the BART protocol, the default natural conditions are based on the 20 percent best visibility days. The 20 percent best visibility days reflect cleaner air.

   Response. The MPCA initially considered basing natural visiblity conditions as indicated above for the PSD program. However, the U.S. EPA BART guidelines explicitly state that States should use the "natural visibility baseline for the 20 percent best visibility days for comparison to the 'cause or contribute' applicability thresholds". Furthermore, the State of North Dakota shared with the MPCA a discussion that they had with the U.S. EPA and the National Park Service on August 30, 2005. In that discussion, U.S. EPA and the National Park Service confirmed that the natural background should reflect the 20% best days for both the BART screening and the degree-of-improvement modeling. The method for determining these values, which is outlined in the proposed BART modeling protocol, was agreed upon among the State of North Dakota, U.S. EPA and the National Park Service. Subsequently, this method has been substantiated by other sources and has been adopted by other organizations for BART purposes.

   b. **Scaling Factors.** The same commenter as above suggested improving the protocol by calculating monthly scaling factors instead of annual scaling factors, using the monthly *f*(RH) values.

   Response. The MPCA will continue to use scaling factors derived from the annual average *f*(RH) for each Class I area. A closer look at this option revealed that there is

no significant difference between the resulting scaled emissions using the two methods.

Comments "c" through "e" below were made by one commenter in reference to a January 31, 2005 version of the draft "BART Modeling Protocol for VISTAS"

c. **Organic Carbon Multiplier Adjustment.** The commenter recommends increasing the measured—monitored—organic carbon concentration from 1.4 to a larger value, such as 1.8 to 2.1.

Response. The MPCA will continue to use the organic carbon mass multiplier for the average natural levels of aerosol components in the "Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Program" (U.S.EPA 2003). Although a subgroup af the IMPROVE steering committee proposes an organic carbon concentration of 1.8 in the new recommended IMPROVE alogrithm, the MPCA does not intend to make this adjustment for the reasons discussed in item "f", below.

d. **20% Haziest Days Adjustment.** The commenter recommends making a statistical adjustment to the 20 percent haziest days, which are only relevant for assessing the benefits of the application of BART. According to the VISTAS document referenced above, the result of the adjustment would be a slight increase in default haziness on those days. Although, this would reduce the "absolute deciview impact of a sources emissions, it has no effect on the change in haziness (in dv) imputed to application of BART at a source and therefore is not of great practical importance for the BART assessment process."

Response. The MPCA is not sure what the commenter expects from the MPCA in response to this comment. The document referenced states that the change has no practical importance for BART assessments, so the MPCA will not change the proposed protocol to include adjustments for the 20 percent haziest days.

e. **Rayleigh Adjustment.** One commenter requested adjustments to the Rayleigh scattering coefficient, instead of using the default of 10 Mm^{-1}; the default being applicable at an elevation of 1600 meters, or 5000 feet. The commenter indicated that the relative impact of a source would be overstated by using the default Rayleigh value.

Response. Revised Rayleigh values—along with the IMPROVE light extinction algorithm, discussed in item f, below—were developed and approved by the IMPROVE steering committee. Although very likely, this doesn't necessarily result in guaranteed approval by the U.S. EPA for regulatory use. The new values are based on atmospheric density, which depends on elevation and temperature. The MPCA foresees two problems with using the new Rayleigh values. First, they have yet to be approved by the U.S. EPA. Second, the MPCA would be mixing-and-matching the new Rayleigh values with the old IMPROVE algorithm for reasons discussed in item f, below. The MPCA continues to propose to use the current Rayleigh value of 10Mm^{-1} for BART modeling.

f. **IMPROVE Extinction Algorithm Changes.** One commenter requests changes to the light extinction estimation algorithm in CALPOST to reflect work that's being conducted by various groups to refine that calculation.

Response. A working group of the IMPROVE Steering Committee comprised of visibility researchers from industry, government, university, and research institutions has developed a revised extinction algorithm. The revised algorithm, approved by the IMPROVE Steering Committee and potentially accepted by the U.S.EPA, may be an option for states in lieu of the current IMPROVE algorithm in estimating natural visibility for Regional Haze purposes. Like the Rayleigh values listed above, the revised algorithm has been widely distributed for public perusal and subsequent vote by the IMPROVE Steering Committee for IMPROVE use. Upon approval, a U.S. EPA contractor will likely then develop new *f*(RH) growth curves for use in the algorithm. Evaluation of the new algorithm by the IMPROVE working group indicates that, except for the Southeast part of the United States—where sulfate haze is a significant issue—the revised equation likely won't make much if any difference in light extinction. In some instances, it could be interpreted that the old equation may perform better. Due to the lack of approval by the U.S. EPA, the MPCA will not use it in the BART modeling. In addition, the MPCA has no intention of pursuing a revision to the CALPOST code to accommodate the change. The MPCA continues to propose the use of the existing IMPROVE light extinction algorithm for BART.

Encouraging Remarks.

1. **Consistency.** One commenter indicated that incorporating consistency with other BART protocols should provide for a more seamless analysis, especially for sources that might impact Class I areas in more than one state.
   Response. The MPCA agrees, however, there undoubtedly will be differences among the various states. In regard to some of our surrounding states, North Dakota, Iowa and Wisconsin all have variations in their approach that also differs from the Minnesota approach.
2. **MM5 Data Used.** One commenter supports the use of the most recent MM5 meteorological data and the switch settings outlined in the draft protocol.
3. **Ammonia and Hydrogen Peroxide values.** One commenter supported the use of model-generated ammonia and hydrogen peroxide values in the modeling because monitoring data for these compound are scarce.
   Response. Although the MPCA generated modeled hydrogen peroxide values for the modeling domains, the MPCA is removing this compound from the protocol for reasons discussed above.
4. **CALPOST Method 6.** One commenter supported the use of CALPOST Method 6, which is the recommended method in the BART guidance.
5. **State Modeling.** Once commenter was encouraged by the MPCA's proposal to conduct the modeling to determine sources subject-to-BART, which will ensure consistency among all eligible sources and minimizes review.