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Date: July 27, 2007

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Re: **Comments on Draft CRGNSA Modeling Report**

The USDA Forest Service appreciates the opportunity to provide comments on the draft modeling report for the Columbia River Gorge National Scenic Area. The Forest Service recognizes the difficulty of accurately replicating observations of regional haze including its aerosol components, and temporal and spatial trends, in the terrain unique to the Columbia River Gorge. The nature of performing gridded numerical modeling of air quality is reliant upon the accuracy of the emissions, meteorology, and chemistry provided to the model. Compiling and replicating this input information is recognized as a very complex task in its own right.

The Forest Service's review initially focused on ensuring the methodology, input data, and assumptions were clearly communicated. Hence, several comments are focused at this level. A few comments also pertain to the accuracy of the emission inventory. A few comments relate to interpretation and application of the uncertainty information obtained during performance review. Finally, and perhaps most significant, several comments relate to the discussion of the results and conclusions drawn from the results.

Thank you for consideration of these comments. We appreciate your hard work.
Should you have any questions, please contact me at your convenience.

Best regards,

Richard (Rick) L. Graw
Air Resource Management Specialist

USFS Comments on the Draft Modeling Report for the Columbia River Gorge Air Quality Study.

Section 2. Meteorological Modeling

It would be helpful to communicate how much of the variability in observed haze is attributed to changes in meteorology. Understandably, some of this variability is related to meteorological influences on emissions (e.g., ammonia, biogenic emissions, and wind blown dust), atmospheric chemistry (e.g., ammonium nitrate formation), and transport and dispersion. Could the author's elaborate on these concepts in this section and present temporal plots of these for each episode? This information will help calibrate the reader's perspective on the causes of the variability of haze.

It would also be helpful to attempt to isolate the effects of "meteorology" on haze. This may be accomplished by running the model for each episode with the diurnal variation in emissions held constant for one day, across all days in the episode, and plotting the 24-hour average light extinction including aerosol components similar to that shown in Figures 4-7 and 4-14.

The result will illustrate how much variation in each event, at each site is due solely to meteorology. If the same emission rates are used in both the August and November episodes, one would also get a feel for how much variability in haze is caused by seasonal differences in meteorology.

The concept can be explored further by evaluating individual meteorological parameters. Or as an alternative, it would be helpful to have a table listing the various meteorological parameters along with the qualitative effect of the model's ability to predict haze. For example, for Run 6 - August episode, what is the expected effect of the model's underestimation of daytime temperature, and overestimate of night time temperature on visibility, and why? Similarly what's the effect of the model overestimate of humidity in August (increase in sulfates and nitrates, and SOA production?) How much?

On several of the figures in this section (e.g., figure 2-8), its difficult to visually evaluate the comparison between modeled and observed wind direction because of the "chart painting" associated with the variations around winds from the north. To aid in the interpretation, it would be helpful when displaying time series plots of wind direction, to use a 0-540°, which avoids this problem.

Section 3. Emissions Processing

How much of the variation in the observed haze is a function of changes in emissions? This is addressed somewhat in the "what-if" scenarios, but could be enhanced. One possible approach is to rerun the model using a constant diurnal set of meteorology for each episode. The 24-hour reconstructed light extinction at each site could then be plotted, which would graphically represent the amount of change due solely to changes in emissions.

This information, in combination with an understanding of how much change results solely from meteorology would be very useful in terms of calibrating the reader's expectations of how much change in haze could be expected solely from changes in emissions, and hence sets the stage for the "what-if" scenarios.

Following this, it would be helpful to understand the relative fraction of any given pollutant, by region and its contribution to the overall amount of pollutant in the modeling domain, including the amount entering from the boundaries of the modeling domain. The figures prepared and presented by Chris Swab on the July 11, 2007 Gorge Technical Team call were very helpful in this regard. Hence, I'd like to see these included in the report along with a discussion. This information helps readers understand how much of the total amount of haze causing pollution is being evaluated in a specific emissions control strategy.

Page 3-10, Section 3.2.3.2 Biogenic Emissions.

The preliminary modeling results have demonstrated that in the August 2004 case study, secondary organic aerosols (SOAs) from biogenic emissions were identified as the major contributing source. It would be helpful to see a graph showing the spatial distribution of individual species, along with a table documenting the modeled emission rates.

It's unclear whether or not the biogenic emissions have been overestimated or not as the individual emission rates are not presented for each species. Since Douglas Fir is the dominant species in the Cascades and Western Oregon and Washington, this species was specifically considered.

Pressley et al (2004) measured the emission factor for monoterpenes from Douglas Fir and western hemlock. They discovered that the emission rate of monoterpenes from these species could result in a domain-wide 20% in biogenic VOC emissions. Since this paper was issued, the USEPA has updated the emission factors for Douglas fir in the BEIS3 model to reflect the sizeable decrease in emissions, in which monoterpene emissions were reduced from a value of 1.41 $ugCg^{-1}h^{-1}$ to 0.39 $ugCg^{-1}h^{-1}$ based (Schwede et al. 2004), a decrease by a factor of 3.6.

What is the temporal distribution of biogenic emissions for each episode? A graph would be helpful to understand this.

Page 3-15, Section 3.2.3.7 Other Fire Emission Estimates.

It is unclear if the use of the WRAP 2002 data for emissions from prescribed burns is accurate. In figures 3-3 through 3-16, it appears that there is an obvious discontinuity in the way in which these emissions are represented in Oregon as compared with Washington. In Oregon the emissions appear to be county wide, where as Washington they appear to be represented as point sources. Hence, the location of the point source, when combined with meteorology may greatly influence the results of the modeling.

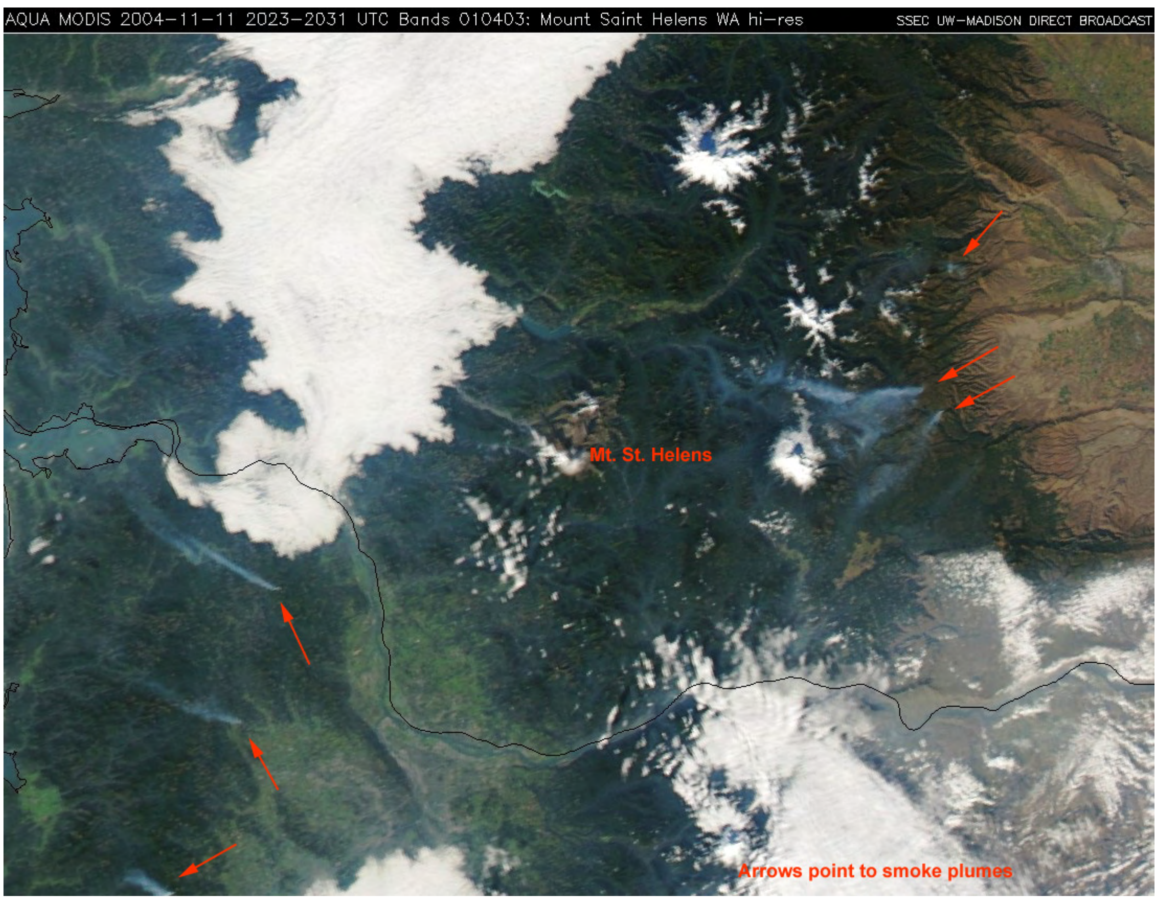
A search of the USAQ, a daily diary of air quality in the U.S. using information from NASA satellites, ground-based lidar, EPA monitoring networks, and other monitors reveals several

smoke plumes in Washington and Oregon during November 11-13, 2004 period. Interpretation and analysis is provided by the staff of the University of Maryland, Baltimore County, Atmospheric Lidar Group. The following text and satellite images can be found at their website at **http://alg.umbc.edu/usaq/archives/2004_11.html**
The figure was placed on the SWCAA Gorge Reports website, but in talking with Jim Wilkenson, it appears these fires were not included in the emission inventory.

The text from the USAQ website reads as show below.

November 11, 2004

The clouds have mostly cleared in Washington and northern Oregon, revealing 6-10 smoke plumes, which may have been the source of the high-moderate PM2.5 concentrations over the last several days. The smoke also seems to be accumulating over the Pacific just offshore.

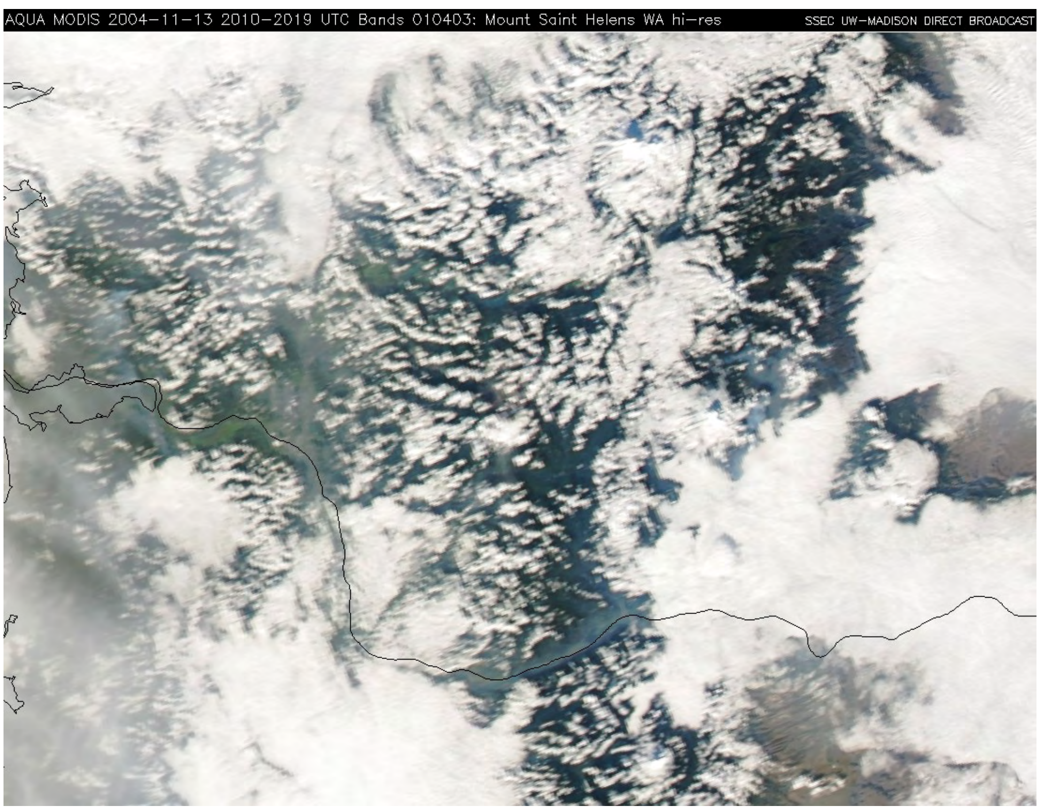


November 12, 2004

Southern **California** still has moderate AQI. Western **Washington**, near Seattle, is also under code yellow. There are still some scattered fires in **Florida** (MODIS RapidFire).

November 13, 2004

Smoky conditions are still evident in Washington & Oregon. Please look carefully in the UW MODIS image below (top left) the grayish matter beneath the clouds is smoke. Most of the PM monitors were not operational in Washington, which makes it hard to decipher the air quality index for that region. Parts of California & Oregon had moderate AQI due to local fires (smoke/haze seen in the top right image). The rest of the nation experienced mostly good air quality conditions.



November 15, 2004

Mt St Helens, in Washington, is still releasing steam and ash. This image is from the **USGS** and was taken November 12th.

Sction 3.2.3.6 Wildfire Emissions Estimates

The fuel-loading value of 39 ton/acre of fuel consumed for all fires appears to apply to all locations. This is a very high estimate especially for fires east of the Cascades where a value anywhere from 5-15 t/a depending on species is more appropriate. Alternatively, the emission factors seem too low. The authors used a value of 11.7 lb/t PM2.5 whereas the USDA Forest Service uses a value of 18-22 lbs/ton depending on species and flaming/smoldering ratio (personal communication with Janice Peterson – USDA FS, PNW Laboratory).

Page 3-1, 3rd paragraph.

Why were no plume-in-grid sources modeled? Why would you use this feature?

Page 3-4, Section 3.2.1 36-Km Domain.

Add a paragraph explaining why you need to process the emissions at different resolution and domains. Why use more refined techniques in the 12-km data, but not the 36-km data. This would also help the reader understand why the emissions are different from the two resolutions for the state-wide emissions.

This section is also confusing as the text assumes the reader is familiar with SMOKE and EGAS. Please explain the EGAS model using a flow chart to show inputs. An example would be helpful. Also, please elaborate on how growth and control modules with growth factors are used to process offshore point and other anthropogenic point source emissions using SMOKE and EGAS.

Page 3-18, Section 3.2.3.14 4-Km SMOKE Results

Please label the X-axis to indicate GMT, otherwise one would assume local time, in which case the emission distribution doesn't make sense. For example, one would expect a morning and late afternoon peak in the distribution of CO emissions from mobile sources. Similarly, NOx emissions from fire (i.e., prescribed burning) are expected to peak in the late afternoon, not at 2300 local time.

Also, what is the basis for the hourly distribution of emissions?

Page 3-19. In reference to Table 3-7, what is meant by OVOCs?

Page 3-20, Figures 3-3 to 3-16. The figures are too small to easily distinguish the location of point source emissions, especially the locations of fires in Washington. There appear to be red dots in Figure C, but it's unclear.

Additionally, it would be helpful if all the figures (A through E) had the same scale on the ordinate axis.

Page 3-41, Table 3-7.

The table appears to contain duplicate information (see Pages 3-41 and 3-43). The information for Lincoln, Linn, Marion, Morrow, Multnomah, Polk, and Sherman counties are all repeated. Since the counties appear to be listed in alphabetical order, perhaps it would be best to eliminate these counties listed on Page 3-41 from the beginning of the list.

Page 3-55, Section 3.3.1 PGE Boardman Emissions Estimates.

Please present both the 2004 and 2018 emission rates for this facility. Also, it would be helpful to see the temporal trend in emissions from this source for each episode.

Page 3-55. Section 3.3.2 Fort James Camas Emissions Estimates.

Please present both the 2004 and 2018 emission rates for this facility. Also, it would be helpful to see the temporal trend in emissions from this source for each episode.

Section 3.3.4 Ammonia Emissions

The author's state that ammonia emission adjustments were made for Oregon and Washington for 2004 and applied the same values to 2018, following the WRAP (zero growth rates). However, the same was not true for surrounding states. For example, the 12 km NH3 emission inventory for Idaho shows large reductions for areas sources (shown below) between 2004 and 2018. What's the basis for this difference? Why are there equal amounts of NH_3 from area sources for August and November in the 2018 inventory?

Source Type	August 2004	August 2018	November 2004	November 2018
Area	213	6	87	6
Road	4	5	4	6
Point	3	5	3	5
Fire	6	9	4	4

Since NH_3 emissions vary as function of temperature and wind speed, it would be helpful to see the temporal trend in NH_3 emissions from this source for each episode. Perhaps the author's could plot a mean hourly value for each PSAT region would be illustrative.

SECTION 4. CAMx BASE YEAR MODELING

4.3.1.2 Translating CAMx PM Concentrations to Visibility Metrics.

Page 4-6. A table would be helpful which describes the possible sources of emissions and assumptions associated with each species of aerosol light extinction (i.e., ammonium sulfate, ammonium nitrate, organic carbon, elemental carbon, primary fine particulate, and course mass particulate).

Section 4.3.3.1 Performance Goals and Benchmarks.

Page 4-17, Table 4-5 presents several statistical methods along with their mathematical description. Please provide a "plain English" explanation of each of these measures and appropriate use.

Section 4.3.4.4 Improvement of CAMx SOA module.

Page 4-24. When discussing the locations of the monitoring sites in the CRG, why mention that there were no CASTNET monitoring sites in the Gorge, or present a symbol for this on Figure 4-3? If you want to include a discussion of deposition, why not mention the NADP wet deposition monitor at Mt. Zion?

Page 4-48, Figure 4-17 and 4-18. The top and bottom graph appear to have different scale (i.e., Julian day starts on 1) than the middle two figures (Julian day begins day 309). Since these figures are referred to comparison with Figures 4-16, it would be helpful if they had the same scale on the abscissa for ease of comparison (i.e., all graphs should begin on Jday = 309).

Section 4.4 CAMx 2004 Base Case Results

It would be helpful to have the following information summarized in a table for ease of reference when evaluating model results.

August Episode

- underestimation daytime temperature,
- overestimate night time temperature
- overestimate humidity
- possible overestimate of biogenic emissions from Douglas Fir
- sulfates are underpredicted
- nitrates is underpredicted
- Organic carbon is over predicted
- primary fine particulate underpredicted
- Elemental carbon overpredicted at Gorge Study sites
- Coarse mass is underpredicted

November Episode

- Maximum temperatures remained too cool during haze period
- Humidity was not high enough in early morning.
- Overprediction in 24-hour light scattering near Portland, and underprediction in eastern gorge.
- Large bias (overprediction) in sulfates
- Large error in nitrates
- Large bias (overprediction) in elemental carbon.
- Large bias (overprediction) in primary fine particulate (PM2.5)

Section 4.4.1

The temporal trends of organic aerosol components at Mt. Zion, as shown in Figure 4-8 don't follow the temporal trends of organic carbon shown in Figure 4-7. Why the difference?

Section 4.4.2 Page 4-39, second paragraph

The author's discuss what would happen if NH_3 emissions are doubled. However, what would be the effect if they are halved? Is the formation of ammonia nitrate still NH3 limited? Below what concentration is it not limited?

Section 4.4.2.1

The label on the ordinate axis is illegible in several of the figures, including Figure 4-12 and 4-13.

Section 5.0 Base Year Source Attribution Modeling

In light of the uncertainties of the model (e.g., sulfates, nitrates, primary fine particulate, and coarse mass are all underpredicted in August), what aspects of this analysis do the author's have a high degree of confidence and why? Please comment on both the August and November episode.

Section 5.1 PSAT Application for August 2004

Please elaborate on which source region the SOA biogenic emissions are coming from?

Section 6.0 CAMx Future Year Modeling

Figure 6-4 presents the results of the five "what-if" scenarios for Mt. Zion and Wishram.

Case 1 – zero emissions from the PGE Boardman Power Plant
Case 2 - zero emissions from ammonia emissions originating east of the Gorge
Case 3 – zero on-road mobile source emissions in the Portland/Vancouver area
Case 4 – zero major point source emissions
Case 5 – zero major point source emissions from within the Gorge

Much discussion is needed to further elaborate on these results in detail. Why on some days do eliminating emissions from some sources result in increases in haze? Why does eliminating all major point source emissions result in no changes in haze?

Perhaps it would be helpful if the reader understood what fraction of the total emissions in the modeling domain is being evaluated in each of these "what-if" scenarios.

6.2.2 Trend Line Calculation Methodology

The trend lines shown in Figure 6-5 and 6-6 are somewhat misleading as they imply a linear change between the two points. The lines should be removed, or at least a footnote should be added which clarifies this point. Also, it would be helpful if error bars were drawn around each point, so the reader understands the differences between the model predictions and the associated uncertainty.

Section 7.0 Discussion (Suggested)

It would be very helpful to the readers if the author's added a section devoted to a discussion of the modeling results. To clarify, this discussion should not focus on model performance, but rather on answering the objectives of the study, with appropriate references to the evidence.

The discussion should address the following questions:

What's the cause of the haze during the August episode?
Where's it coming from?
How do we know this?
How much confidence do we have in the results?

What's the cause of the haze during the November episode?
Where's it coming from?
How do we know this?
How much confidence do we have in the results?

Is the amount of haze going to improve, get worse, or remain the same in the next 10 years?
How do we know this?
How much confidence do we have in the results?.

How much variability in the observed haze is due to meteorology and how much is due to emissions (annually, and during a given episode)?
How do we know this?
How much confidence do we have in the results?

What can be done to reduce haze in the future?
Why do the emission control scenarios do so little to effect the amount of haze?
How do we know this?
How much confidence can we have in the results?

Based upon the modeling, is there any other suggested control strategies that should be investigated?
Why do you think so (e.g., based upon what evidence)?

Section 8.0 Conclusions

The report documents extensive uncertainties in the model performance including episodic vs. annual modeling, typical vs. actual emission estimates, meteorological uncertainties, emission uncertainties, air quality model uncertainties, and monitoring uncertainties. In light of these uncertainties, please comment on how much confidence readers can have in each of the analyses performed to meet the stated objectives: trend lines, source apportionment assessment, and the "what-if" scenarios? Which results do the authors have the greatest confidence? Which results are most uncertain?

The overall “story” that unfolds needs to be more clearly communicated. The authors seem to focus more on model performance than conveying the results for which the modeling tool is employed. For example, the author’s do not summarize what the primary cause of haze is during the August episode. Please state the primary emission source and region of origin.

One such “big picture” is as follows:

(1) Most of the variation in haze is caused by changes in meteorology.
   a. Meteorology affects emission rates from some sources (agricultural NH3, biogenics, wind blown dust, perhaps even power plant emissions)
   b. Meteorology affects chemical transformation and growth of secondary aerosols such as ammonium nitrate
   c. Meteorology affects haze via transport and dispersion

(2) Haze was 6-8 times worse in the November episode as compared with the August episode. Emissions from upwind regions during the August episode were more than twice that of November episode. Hence, meteorology is the driving factor causing elevated haze levels during the winter.

(3) During the August episode, organic carbon, sulfates, nitrates, elemental carbon, and coarse particulates are all contributing species. While the model is showing organic carbon as the primary contributing species, there’s too much uncertainty to know this for certain. Much of the contribution to the haze arrives from outside Oregon and Washington, but the Portland metropolitan area contributes a substantial amount. Local sources of course particulate such as wind blown dust and dust from construction activities are also contributors. Fires and biogenic emissions from natural sources (e.g., Terpene emissions from trees) also contribute to the haze.

(4) During the November episode, ammonium sulfate and ammonium nitrate aerosols are the primary contributor to haze. The cooler, more humid conditions of this period are particularly favorable for haze formation. Most of these pollutants affecting the Wishram monitoring site, originate east of the Gorge. However, at the Mt. Zion monitoring site, both the Portland metropolitan area, and areas east of the Gorge are the locations in which these pollutants originate. Much of the nitrate affecting the Mt. Zion site originates from

(5) Considering the expected growth in population, and reductions in emissions due to future regulations, including implementing the presumptive BART limits at the PGE Boardman facility will result in no noticeable change in haze in the Columbia River Gorge in foreseeable future (2018).

(6) Five emission control scenarios were evaluated for their effectiveness at reducing haze during the August and November haze episodes. These scenarios are as follows:

Case 1 – zero emissions from the PGE Boardman Power Plant
Case 2 - zero emissions from ammonia emissions originating east of the Gorge
Case 3 – zero on-road mobile source emissions in the Portland/Vancouver area
Case 4 – zero major point source emissions
Case 5 – zero major point source emissions from within the Gorge

(7) None of the emission control scenarios will have noticeable changes in the amount of haze in the August episode, except a slight improvement on one day in the episode if there were no point source emissions from within the Gorge, and this would only be apparent at the eastern end of the Gorge.

(8) However, during the November episode some of these emission control scenarios may reduce haze slightly on a few days. However, the results vary by day and locations within the Gorge.

(9) If there were no emissions from on-road mobile sources in the Portland/Vancouver area, haze would decrease slightly on some of the days with higher amounts of haze, most notably in the western Gorge.

(10) If there were zero emissions from the PGE power plant, haze would be improved slightly in the eastern end of the Gorge, as compared if BART controls were installed which meet the presumptive limits.

(11) If there were no ammonia emissions from east of the Gorge, this would improve visibility slightly, but only on a few days.

(12) Major point source emissions do not seem to have any affect on haze in the Gorge during the August or November episodes.

(13) Point source emissions within the Gorge do not seem to have any affect on haze in the Gorge during the August or November episodes.

(14) Based upon the modeling results, it may be worthwhile evaluating the following control scenarios….(fill in the blank).