Chapter 8: Modeling Assessment

Section 8.1 Modeling Requirements

40 CFR part 51, appendix W, includes modeling guidelines for conducting regional-scale modeling for PM and visibility. The EPA recommends using either the CMAQ, CAM_x, or REMSAD model. Modeling for regional haze was performed by CENRAP contractors for nine CENRAP states, including Louisiana, using CMAQ and CAM_x.

The Community Multiscale Air Quality (CMAQ) model is an Eulerian model that simulates the atmospheric and surface processes affecting transport, transformation, and deposition of air pollutants and their precursors.

The Comprehensive Air Quality Model with extensions (CAM_x) is a computer modeling system which integrates assessment of photochemical and particulate air pollution.

Section 8.2 Models Selected

The model selection is a complex technical evaluation that begins by selection of the modeling system. CENRAP used the following models for use in modeling particulate matter and regional haze in the central states:

- <u>Meteorological Model:</u> The Pennsylvania State University/National Center for Atmospheric Research Mesoscale Meteorological Model (MM5 Version 3.6 MPP) is a non-hydrostatic, prognostic meteorological model routinely used for urban- and regional-scale photochemical, fine particulate and regional haze regulatory modeling studies.

- <u>Emissions Model</u>: The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is an emissions modeling system that generates hourly gridded speciated emission inputs of mobile, nonroad mobile, area, point, fire and biogenic emission sources for photochemical grid models.

- <u>Air Quality Models</u>:
    - The US EPA's Models-3/Community Multiscale Air Quality (CMAQ) modeling system is a 'One-Atmosphere' photochemical grid model capable of addressing ozone, particulate matter, visibility and acid deposition at a regional scale for extended periods of time.
    - Environ's Comprehensive Air Quality Model with Extensions (CAMx) modeling system is also a state-of-science 'One-Atmosphere' photochemical

grid model capable of addressing ozone, particulate matter, visibility and acid deposition at a regional scale for extended period of time.

The EPA's 2007 modeling guidance recommends modeling an entire year or at a minimum several days in each quarter of a year to adequately represent the range of meteorological conditions that contribute to elevated levels of fine particulate matter. The year 2002 was selected by CENRAP as the modeling year for this demonstration. Meteorological inputs were developed for 2002 using the meteorological model. Emission inventories were also developed for 2002 and process through the emissions model. These inputs were used in the air quality model to predict fine particle mass and visibility. The model results for 2002 were compared with observed meteorological and air quality data to evaluate model performance. Several configurations of the meteorological and air quality model were evaluated to select a configuration that gave the best overall performance for the CENRAP region. The complete modeling protocol used for this analysis can be found in the technical support document which is located in Appendix B.

8.3 Model Inputs

- **Selection of Episodes**: The calendar year 2002 was selected for us as the base year for CENRAP regional haze annual modeling consistent with EPA guidance. The Technical Support Document provides more complete information on the selection of 2002.
- **Emissions Inventories:** The emissions inventory includes VOC, NOx, CO, SO_2, PM_{10}, $PM_{2.5}$ and NH_3 emissions from all anthropogenic and biogenic sources. The emission inventory information submitted by state, tribal and local agencies to the 2002 National Emissions Inventory (NEI) formed the basis of the 2002 CENRAP emissions inventory. The NEI data was supplemented with the non-point source emissions inventories developed for CENRAP by Sonoma Technology. These CENRAP-specific inventories addressed agricultural and prescribed burning, onroad and offroad mobile sources, agricultural tilling and livestock dust, and agricultural ammonia. In addition, Pechan assisted CENRAP by quality-assuring the emissions inventory and preparing day-and hour-specific emissions for electric generating units (EGUs) based on Continuous Emission Monitor (CEM) data for the model performance evaluation.

Emissions inputs for the air quality model were prepared using the SMOKE emissions modeling system. The CENRAP modeling emissions inventory consists of several distinct datatsets: the 2002 base case for model performance evaluation, 2002 typical, 2018 base case, and the 2018 control strategy scenario. Its spatial extent is the RPO 36 km modeling domain, which covers the continental US plus portions of Canada and Mexico. The inventory was refined through several rounds of CENRAP workgroup review and revision, beginning with the initial Base A version and culminating in the Base G inventory. The TSD provides the methodologies for this process.

- **Meteorology**: CENRAP used the MM5 model and the TSD provides the methodologies that were used for this process.

8.4 Model Performance Evaluation

Model evaluations compared concentrations of various pollutants simulated by CMAQ and CAMx with observations from:

1. Interagency Monitoring of PROtected Visual Environments (IMPROVE)
2. Clean Air Status and Trends Network (CASTNet)
3. Speciated Trends Network (STN)
4. Aerometric Information Retrieval Systems (AIRS)
5. South Eastern Aerosol Research and Characterization (SEARCH)

The CMAQ and CAMx models were evaluated against ambient measurements of PM species, gas-phase species and wet deposition. Numerous iterations of CMAQ and CAMx 2002 base case simulations and model performance evaluations were conducted during the course of the CENRAP modeling study, most of which have been posted on the CENRAP modeling website and presented in previous reports and presentations for CENRAP. In general, the model performance of the CMAQ and CAMx models for sulfate (SO4) and elemental carbon (EC) was good. Model performance for nitrate (NO3) was variable, with a summer underestimation and winter overestimation bias. Performance for organic mass carbon (OMC) was also variable, with the inclusion of the SOAmods enhancement in CMAQ version 4.5 greatly improving the CMAW summer OMC model performance. Model performance for Soil and coarse mass (CM) was generally poor. Part of the poor performance for Soil and CM is believed to be due to measurement-model incommensurability where by the IMPROVE measured values are due in part to local fugitive dust sources that are not captured in the model's emission inputs and 36 km grid resolution. Detailed information on the model performance evaluations are found in the TSD.

Model performance for Breton was also mixed. Although the modeling performance met EPA's established performance goals, sulfates were almost always greatly overpredicted by the models. Nitrates were often predicted where actual monitoring indicated none. Model performance for Soil, EC, OC and CM was much better than for sulfates and nitrates. Detailed information on the model performance can be found in the TSD.

Figure 8.1 (page 8-5) presents a comparison of the observed and 2002 Base G modeled daily extinction for Breton. In addition to depicting less than ideal model performance, this figure also shows that SO4 is the main contributor to visibility impairment at Breton. Detailed information on Base G Model Evaluation is found in the TSD.

Figure 8.1 Comparison of observed and 2002 Base G modeled daily extinction For Breton Island, Louisiana and Worst 20% days in 2002

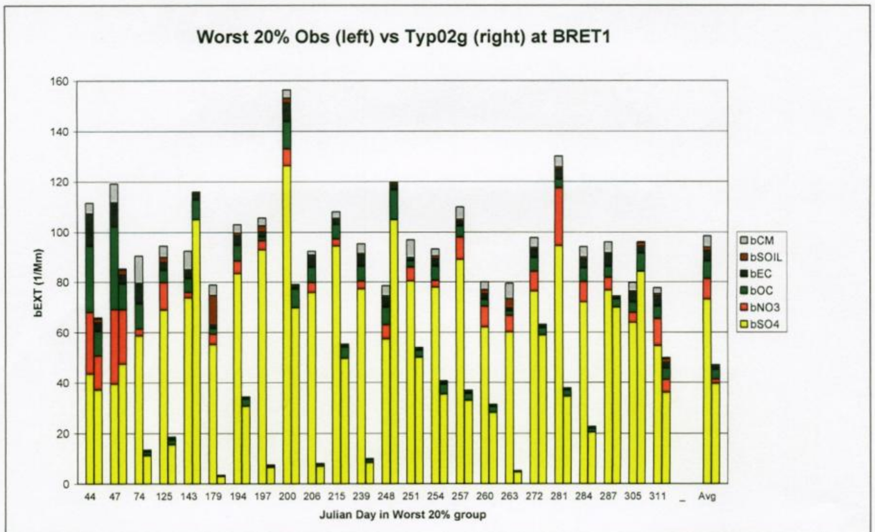

Figure D-3c. Comparison of observed (left) and 2002 Base G modeled (right) daily extinction for Breton Island (BRET), Louisiana and Worst 20% (W20%) days in 2002.

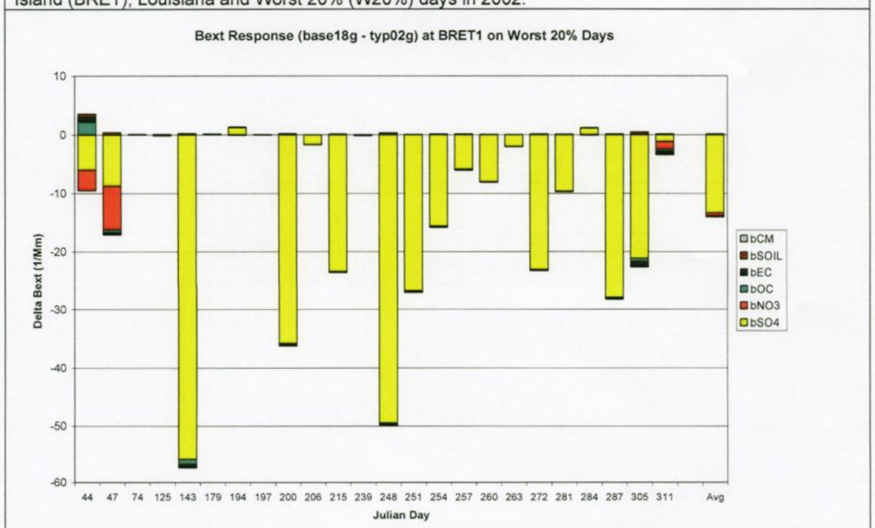

Figure D-3d. Differences in modeled 2002 and 2018 Base G CMAQ results (2018-2002) daily extinction for Breton Island (BRET), Louisiana and Worst 20% (W20%) days in 2002.

8.5 Base G Model Simulations

The 2018 Base G modeling run reflects emissions growth and "on the books" controls, which are state and federal controls that will be implemented between the 2002 base year and the 2018 future year. The 2018 emissions for EGUs were based on simulations of the Integrated Planning Model (IPM) that took into the account the effects of the Clean Air Interstate Rule (CAIR) trading program. In addition, reductions anticipated from BART controls for EGUS in Oklahoma, Arkansas, Kansas and Nebraska were included. Emission for onroad and nonroad mobile sources were based on activity growth and emissions factors from the EPA MOBILE6 and NONROAD models, respectively, which reflected emissions reductions from the Tier-2 and Tier-4 mobile source rules. Area sources and non-EGU point sources were grown to 2018 levels.

The results from the 2002 and 2018 CMAQ and CAMx simulations were used to project 2018 PM levels from which 2018 visibility estimates were obtained. The two important regional haze metrics are the average visibility for the worst 20% and the best 20% days from the 2000-2004 five-year Baseline. The results of the CENRAP 2018 visibility projections follow EPA guidance procedures.

The 2018 visibility projections for the worst 20% days are compared against a 2018 point on the Uniform Rate of Progress (URP) glidepath or the "2018 URP point." The 2018 URP point is obtained by constructing a linear visibility glidepath in deciviews from the observed 2000-2004 Baseline for the worst 20% days to the 2064 Natural Conditions. The 2018 URP point is where the linear glidepath crosses the year 2018. Figure 8.2 includes the 2018 visibility projection for Breton. As seen in these figures, the 2018 visibility projection at Breton is slightly above the URP glidepath and there is no degradation on the best visibility days.

Figure 8.2 URP Glidepath for 20% Worst and Best Days

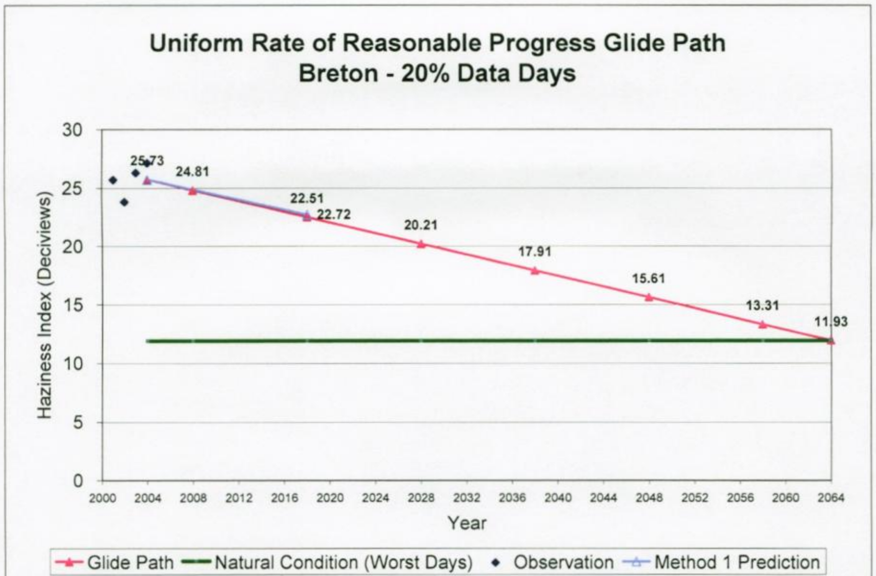

Figure D-3a. 2018 Visibility Projections and 2018 URP Glidepaths in deciview for Breton Island (BRET), Louisiana and Worst 20% (W20%) days using 2002/2018 Base G CMAQ 36 km modeling results.

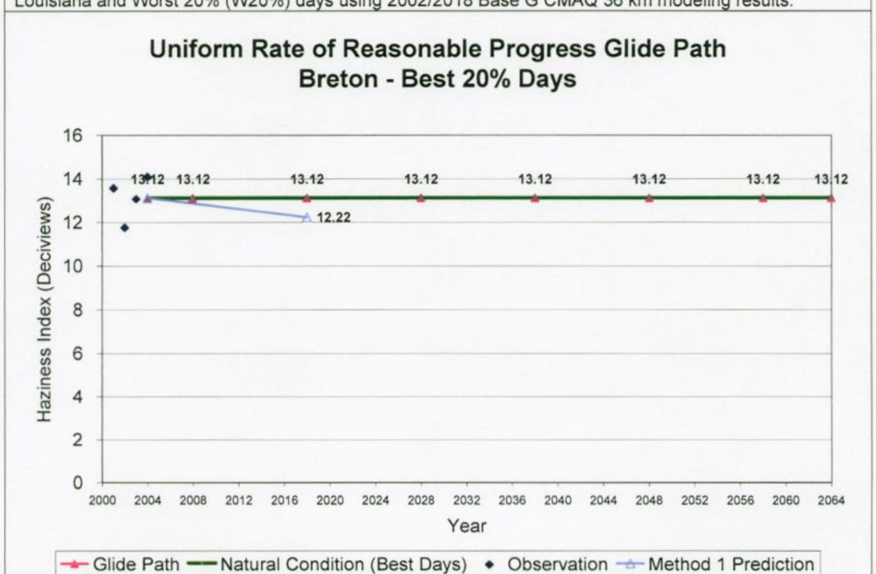

Figure D-3b. 2018 Visibility Projections and 2018 URP Glidepaths in deciview for Breton Island (BRET), Louisiana and Best 20% (B20%) days using 2002/2018 Base G CMAQ 36 km modeling results.