UDAQ Ozone SIP SMAT-CE Configuration
Utah Division of Air Quality

1.0 Introduction

As part of the state implementation plan (SIP), UDAQ conducted a photochemical modeling experiment as a tool to predict future ozone concentrations, determine source regions that contribute to ozone, and estimate the impact of emission sources categories. To assess whether the modeled maximum daily 8-hour (MD8A) ozone for the Wasatch Front nonattainment area meets attainment, a model attainment test was completed by UDAQ utilizing the Software for Model Attainment Test - Community Edition (SMAT-CE) developed by the EPA. Following EPA's draft 2018 "Modeling Guidance for Demonstrating Air Quality Goals for Ozone", SMAT-CE was run with the purpose to simulate base year and future year ozone concentrations to demonstrate attainment of the ozone NAAQS (EPA). The following sections describe the determination of SMAT-CE inputs, how SMAT-CE calculates future year ozone, and how SMAT-CE was configured in the case of UDAQ's SIP modeled attainment test.

2.0 SMAT-CE Inputs and Methodology

2.1 SMAT-CE

Utah DAQ used the Software for Model Attainment Test - Community Edition (SMAT-CE) v. 1.6 utility from the EPA. Although not the most recent version of SMAT-CE, v. 1.6 produces the same results as the latest v. 2.1 build with the only difference being the updated ambient monitoring dataset in v. 2.1. The SMAT-CE utility faithfully follows EPA guidance on conducting a modeled attainment test for MD8A ozone.

2.2 Determination of Baseline design value (BDV)

SMAT-CE requires the input of 3-year design values to calculate the baseline design value (BDV) for monitoring sites. The baseline design value for each monitoring site is the anchor point for estimating future year projected concentrations. Because the modeling is being used in a relative sense to determine how the modeled emissions changes will affect air quality design values in an area, it is important to match the baseline design value as closely as possible to the base year for which future year to base year ratios will be assessed. In determining the baseline year design value, EPA's draft 2018 "Modeling Guidance for Demonstrating Air Quality Goals for Ozone" recommends using ambient design values that are consistent with the official design values as calculated according to 40 CFR part 50 Appendix P for the MD8A ozone NAAQS. Design values for all ozone monitoring sites in the Wasatch Front nonattainment area are utilized in the modeling process as the starting point for projecting future ozone concentrations.

Utah DAQ used the most up-to-date AQS ozone monitoring data for its baseline design value calculations. EPA guidance recommends using the average of the three design value periods to formulate the baseline design value, which includes the base emissions inventory year. Design values were derived by averaging the 4th maximum measured ozone concentrations for three 3-year periods (in accordance with the form of the federal ozone NAAQS). Therefore, using 2017 as the baseline inventory year, the base design value periods 2015-2017, 2016-2018, and 2017-2019 were averaged to construct a BDV (2015-

2019) and get a representative estimate of Utah air quality. This BDV results in a weighted 5-year design 2017 Wasatch Front nonattainment area MD8A ozone SIP value, centered and weighted more heavily on the 2017 base year values. To illustrate this, **Table 1** presents a weighted 5-year average BDV using all validated data for the nonattainment area controlling monitors, which include Hawthorne, Bountiful, and Herriman. This table includes DV's adjusted by the exclusion of flagged wildfire smoke impacted MD8A ozone values. The exclusion of wildfire impacted ozone concentrations and subsequent adjustment of DV's is described further in the "Analysis in Support of Exceptional Event Flagging and Exclusion from Modeling for Weight of Evidence Analysis" documentation.

Table 1

Design Value Calculations for WF Controlling Monitors

Site-Specific Baseline Design Values:		**3-Year Average of 4th High 8 Hour Average**			**BDV** *Flagged Data* ***Included***	**BDV** *Flagged Data* ***Excluded***
Location	**County**	**2015-2017**	**2016-2018**	**2017-2019**		
Bountiful Viewmont	Davis	75	78	77	**76**	**75**
Hawthorne	Salt Lake	78	76	76	**76**	**75**
Herriman #3	Salt Lake	76	77	75	**76**	**74**

Table 1. Weighted average of 3-year DV's centered on the baseline inventory year 2017 to construct a five year average Baseline Design Value (BDV) for the Wasatch Front nonattainment area with *flagged data included* and *flagged data excluded*.

3.0 SMAT-CE Configuration

3.1 SMAT-CE Grid Cell Array

SMAT-CE offers multiple configurations for testing MD8A ozone model attainment. The configuration UDAQ chose for our SMAT-CE model attainment test closely follows EPA's suggested guidance in section 4.2 "Modeled Attainment Test for the Primary Ozone Standard'' of the EPA's 2018 document "Modeling Guidance for Demonstrating Air Quality Goals for Ozone". In addition, we chose SMAT-CE options to best suit UDAQ's modeling domain and resolution as well as capture the most representative model response to changes in emissions.

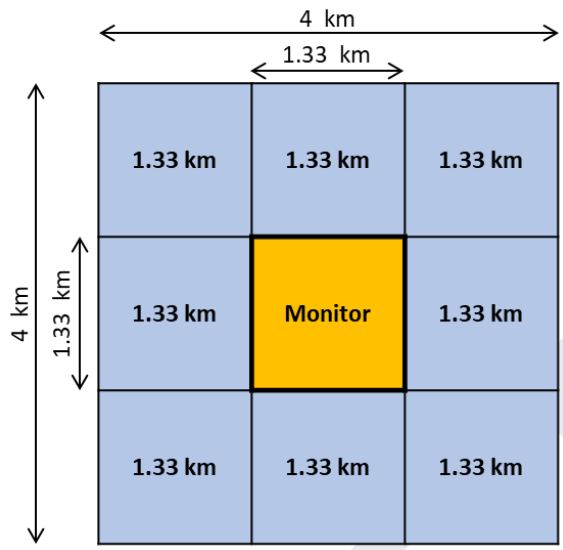

Figure 1. Example of the 3x3 grid cell array (1.33 km grid resolution) with UDAQ monitor centered used in SMAT-CE to calculate RRF.

A grid of 3x3 (9) cells immediately surrounding the monitors was used for RRF calculations. This grid cell array size follows EPA's recommendation to consider the model response in grid cells surrounding the monitor sites and help alleviate any artificial or small scale variations that could impact the assessment of modeled ozone. UDAQ's grid resolution is relatively high at 1.33 km, implying a 3x3 grid cell array of 4 km x 4 km centered around monitor location as illustrated in Figure 1. Due to the topography of the Wasatch Front, if a larger window was chosen the grid cell window could extend into upper elevation areas, where ozone concentrations are naturally higher and therefore bias the RRF calculation.

3.2 Temporal Adjustment and Spatial Statistic at Monitor

Since the grid cell window was small in extent, Utah DAQ felt comfortable using the max-paired in space statistic for computing RRF values. UDAQ believes the max-paired in space statistic for calculating the RRF is the most appropriate option when considering the modeled ozone assessment for two main reasons. First, limitations in the inputs and model physics can affect the model precision at any one grid cell. Therefore, being able to sample grid-cells immediately surrounding the monitor can potentially alleviate the model imprecision. Second, monitors and emission sources may be located close to the edge of grid cells, which means the modeled ozone in the monitor grid cell may not be the most representative of the monitor. By allowing SMAT-CE to select grid cells with the maximum MD8A ozone value (in the 3x3 grid), for the base year and match that cell in space in the future modeled year, a more representative selection of modeled maximum daily ozone for the monitoring site is possible and diminishes the potential for inappropriate results if only monitored grid cells were chosen.

3.3 Determination of Relative Response Factor (RRF)

Since the SIP modeling is used in a relative sense, SMAT-CE calculates the relative response factor (RRF) for modeled grid cells, which is used to estimate ozone values in the future year. The RRF for each monitoring site is the fractional change (percent change) in ozone concentrations that is simulated by the

photochemical model due to emissions changes between the base and future year emission inventories. SMAT-CE formulates the RRF based on the average ozone from the modeled high ozone days in grid cells surrounding the monitoring site. EPA's modeling guidance suggests using the highest 10 modeled ozone days in the base year simulation at each monitoring site to calculate the RRF's. Following EPA's guidance, UDAQ chose to utilize the top 10 high ozone days in the RRF formulation, where the average MD8A ozone concentrations are calculated using the future year and base year modeled ozone for the top 10 high ozone days in the modeled 2017 base year. High ozone days were selected in SMAT-CE based on the criteria that modeled ozone MD8A concentrations at monitors are >= 60 ppb. If there are not 10 modeled episode days with MD8A ozone >= 60 ppb at a monitor, UDAQ uses all available days >= 60 ppb for monitors that have at least 5 days above this threshold criteria. An RRF and future design value (FDV) is not calculated for sites that have less than 5 days with modeled 2017 base year ozone concentrations >= 60 ppb and therefore are not included in our analysis.

The modeling analysis produces base case RRFs for each grid cell in the modeling domain during each day over the modeling period. SMAT-CE then uses the calculated RRF for each monitoring site and the 5-year weighted BDV derived from the 3-year design value inputs to formulate the future year ozone concentrations. In general, the RRF for each monitor is equal to the mean 2023 attainment year modeled MD8A ozone concentration divided by the mean 2017 base year modeled MD8A concentration calculated from the days included in the analysis at each receptor, as demonstrated in Equation 1. The future year ozone or future year design value (FDV) is then determined in SMAT-CE by multiplying the RRF by the BDV for each monitor as given in Equation 2.

Equation 1

$$RRF = \frac{Mean\ Future\ Year\ 2023\ Modeled\ MD8A\ O3\ (ppb)}{Mean\ Base\ Year\ 2017\ Modeled\ MD8A\ O3\ (ppb)}$$

Equation 1. Relative Response Factor (RRF) equation used in the SMAT-CE test for model attainment of MD8A ozone.

Equation 2

$$FDV\ (ppb) = RRF \times BDV\ (ppb)$$

Equation 2. Future Design Value equation used in SMAT-CE test for model attainment of MD8A ozone.

3.4 Summary of SMAT-CE Configuration

In **Table 2** below, we provide a list of different options in SMAT-CE used to complete our ozone SIP model attainment demonstration. Options not listed should be assumed to be default.

Table 2

SMAT-CE Option	Setting
MD8A O3 Monitor Data File	monitor_dv_2017_2019_WF.csv
Model Data/Baseline File	CAMx_SIP_WF4_BY.csv
Model Data/Forecast File	CAMx_SIP_WF4_FY.csv
Baseline Design Value Monitor Data Years	
O3 Monitor Data Years	2015 - 2019 (5-year weighted)
Model/RRF Data Options	
Grid Cell Array size	3x3
Temporal Adjustment	Max-paired in space
Use top "x" modeled O3 days (RRF)	10
Minimum allowable threshold value (ppb)	60
Min number of days at or above minimum allowable threshold	5
Subrange start and end of model episode in RRF	6/26/2017-8/01/2017 - 36 days

Table 2. SMAT-CE configuration options used by UDAQ for the ozone SIP model attainment test

References

Office of Air Quality Planning and Standards. (November, 2018). *Modeling Guidance for Demonstrating Air Quality Goals for Ozone, PM2.s and Regional Haze.* Air Quality Assessment Division. Environmental Protection Agency. https://www.epa.gov/sites/default/files/2020-10/documents/o3-pm-rh-modeling_guidance-2018.pdf

EPA. *Appendix P to Part 50, Title 40*. Environmental Protection Agency. https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-50/appendix Appendix%20P%20to%20Part%2050