APPENDIX I

TNRCC MEMO, ANALYSIS IN TEXAS OF RESULTS FROM THE SEASONAL MODELING FOR REGIONAL AIR QUALITY (SMRAQ), 4/5/00

REGIONAL STRATEGY

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Texas Natural Resource Conservation Commission

INTEROFFICE MEMORANDUM

To: Jim Thomas, P.E., Director
Technical Analysis Division

Date: April 5, 2000

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Subject: Analysis in Texas of Results From the Seasonal Modeling for Regional Air Quality (SMRAQ)

The SMRAQ was sponsored by ten states. The work was directed by a group of scientists from state and federal agencies, electric utilities, and consultants. The purpose of SMRAQ was to investigate the scientific issues involved with modeling ozone over a season consisting of 120 consecutive days instead of using a specific episode covering from three to ten days. The modeling covered the eastern portion of the United States and was performed over the period from May 15, 1995 to September 15, 1995. The modeling domain is illustrated in Figure 1. Horizontal grid cells were 36 kilometers x 36 kilometers with 22 vertical layers. The Multi-scale Air Quality Simulation Platform (MAQSIP) was used for the photochemical model and the Fifth Generation Penn State/NCAR Mesoscale Model (MM5) was used for developing meteorological data. The Sparse Matrix Operator Kernel Emissions model was used to process emissions inventory data. The emissions data were based on those developed for the Ozone Transport Assessment Group.

MAQSIP is a state-of-the-science photochemical grid model that has a number of enhancements that allow it to be used for seasonal modeling. After extensive evaluation and minor modifications to the modeling system, it was possible to obtain good model performance. Basically, the model can replicate the nature of the ozone over the areas and periods that were modeled. After the base case was run, 50 percent and 80 percent across-the-board reductions of nitrogen oxides (NO_x) were run.

The modeling results from the across-the-board reductions of NO_x was analyzed over a number of assessment regions located in Texas. Table 1 is a list of the areas that were used as assessment regions along with the number of grid cells covered in each area. These areas are illustrated in Figure 2.

Re: Analysis in Texas of Results From the SMRAQ

Table 1. Assessment areas for SMRAQ modeling

Source or Assessment area	Number of counties	Number of grid cells
Houston/Galveston (HG)	8	23
Dallas/Fort Worth (DFW)	11	21
Beaumont/Port Arthur (BPA)	3	8
Corpus Christi	2	5
Austin	5	11
Longview-Marshall (LM)	3	6
San Antonio (SA)	4	10
Tyler	1	3
Victoria	1	4

Analysis of Results

The modeling provides 1-hour concentrations that were then processed to determine rolling 8-hour concentrations. There are many statistical and graphical ways to analyze these modeling results for control strategy evaluation and impact of source areas on assessment regions. Each metric will be determined for model results over each assessment region. The obvious approach is to compare the maximum concentration obtained from the reduction scenario to the base case concentration. The 8-hour standard for ozone is defined as the average over three consecutive years of the fourth highest 8-hour average for each year. Thus, the fourth highest 8-hour average over a season would be a good value to use to estimate the 8-hour average to compare to the standard.

Since the 1-hour ozone standard is defined in terms of the fourth exceedance over a three year period, the number of exceedance of the standard for the season is an important metric to review. Comparing the number of exceedances in the base case to the number obtained with a control strategy can provide some indication of how much affect the control has on the ability of the assessment region to attain the standard. This sort of analysis is more meaningful for a whole season than for a few days in an episode. Similarly, for 8-hour averages, the number of exceedances of the 8-hour standard is important. Tabular results are important, but concentration maps over the modeled are can provide insight into the impact of the control strategies and impact of source areas on areas that were not covered by the assessment regions.

Across-the-Board Reduction Modeling

Table 2 lists the metrics used for analysis of the original SMRAQ modeling that included the across-the-board

reductions of NO_x. Each metric in Table 2 was determined for each assessment area for the base case and each across-the-board reduction. Also, or these metrics over each grid cell in each assessment region, the largest difference between the base case value and reduction value was determined.

Table 2. Metrics used for across-the-board reductions

Metric 1 (M1)	Maximum 1-hour concentration
Metric 2 (M2)	Maximum 8-hour concentration
Metric 3 (M3)	Fourth highest 8-hour concentration

Table 3 summarizes the results for Metrics 1 through 3 over all of the assessment areas.

Table 3. Metrics 1, 2, and 3 from SMRAQ over all assessment areas

	Base Case Concentration parts per billion (ppb)	50 Percent Reduction Concentration ppb	80 Percent Reduction Concentration ppb
Austin			
M1 max 1-hour	111.7	96.8	68.3
M2 max 8-hour	107.2	93.4	64.7
M3 4th max 8-hour	89.5	72.4	51.1
Beaumont/Port Arthur			
M1 max 1-hour	147.3	115.0	81.9
M2 max 8-hour	128.6	100.7	71.0
M3 4th max 8-hour	109.7	86.9	60.5
Corpus Christi			
M1 max 1-hour	107.0	79.5	51.7
M2 max 8-hour	100.7	75.3	49.5

Re: Analysis in Texas of Results From the SMRAQ

	Base Case Concentration ppb	50 Percent Reduction Concentration ppb	80 Percent Reduction Concentration ppb
M3 4th max 8-hour	77.5	60.2	43.2
Dallas/Fort Worth			
M1 max 1-hour	137.8	129.3	88.5
M2 max 8-hour	113.8	104.4	73.8
M3 4th max 8-hour	94.0	82.2	63.5
Houston/Galveston			
M1 max 1-hour	185.1	160.6	110.5
M2 max 8-hour	175.7	142.7	101.9
M3 4th max 8-hour	143.0	127.1	92.1
Longview-Marshall			
M1 max 1-hour	137.7	97.0	62.2
M2 max 8-hour	124.7	88.3	56.9
M3 4th max 8-hour	104.0	75.1	48.5
San Antonio			
M1 max 1-hour	103.5	90.6	64.5
M2 max 8-hour	91.7	74.8	54.0
M3 4th max 8-hour	83.3	66.1	47.2
Tyler			
M1 max 1-hour	128.2	92.9	57.2
M2 max 8-hour	114.2	80.9	55.2
M3 4th max 8-hour	102.6	74.9	47.6
	Base Case Concentration ppb	50 Percent Reduction Concentration ppb	80 Percent Reduction Concentration ppb
Victoria			

Re: Analysis in Texas of Results From the SMRAQ

	Base Case Concentration ppb	50 Percent Reduction Concentration ppb	80 Percent Reduction Concentration ppb
M1 max 1-hour	120.7	101.9	71.0
M2 max 8-hour	108.1	93.0	64.7
M3 4th max 8-hour	90.3	69.6	48.7
Rural - excludes all of the assessment areas above			
M1 max 1-hour	147.5	118.8	79.7
M2 max 8-hour	130.9	104.0	70.4
M3 4th max 8-hour	115.8	91.7	59.1

Concentration maps allow one to make a visual analysis of the modeling and the response to various control options. These maps provide the concentration or number of exceedances for each grid cell modeled for the season. Table 4 lists the 1-hour and 8-hour concentration maps generated for across-the-board modeling.

Table 4. Concentration maps for analysis of SMRAQ Emission Reduction Modeling

Map 1	Highest 1-hour concentration for the base case
Map 2	Number of days the 1-hour concentration was > 124 ppb
Map 3	Highest 1-hour concentration after 50 percent across-the-board reductions
Map 4	Highest value when 1-hour base concentrations are subtracted from 1-hour concentrations after 50 percent across-the-board reductions (subtract Map 1 from Map 3)
Map 5	Number of days the 1-hour concentration was > 124 ppb after 50 percent across-the-board reductions
Map 6	Difference in the number of days when 1-hour concentration > 124 ppb between base case and after 50 percent reductions (subtract Map 5 from Map 2)
Map 7	Highest 1-hour concentration after 80 percent across-the-board reductions
May 8	Highest value when 1-hour base concentrations are subtracted from 1-hour concentrations after 80 percent across-the-board reductions (subtract Map 1 from Map 7)

Re: Analysis in Texas of Results From the SMRAQ

May 9	Number of days the 1-hour concentration was > 124 ppb after 80 percent across-the-board reductions
Map 10	Difference in the number of days when 1-hour concentration > 124 ppb between base case and after 80 percent reductions across-the-board (subtract Map 9 from Map 2)
Map 11	Highest 8-hour concentration for the base case
Map 12	Number of days the 8-hour concentration was >84 ppb
Map 13	Fourth highest 8-hour concentration for the base case
Map 14	Highest 8-hour concentration after 50 percent across-the-board reductions
Map 15	Highest value when 8-hour base concentrations are subtracted from concentrations after 50 percent across-the-board reductions (subtract Map 11 from Map 14)
Map 16	Number of days the 8-hour concentration was >84 ppb after 50 percent across-the-board reductions
Map 17	Difference in the number of days when 8-hour concentration > 84 ppb between base case and after 50 percent reductions (subtract Map 16 from Map 12)
Map 18	Fourth highest 8-hour concentration after 50 percent across-the-board reductions
Map 19	Highest value when fourth highest 8-hour base concentrations are subtracted from fourth highest 8-hour concentrations after 50 percent across-the-board reductions (subtract Map 13 from Map 18)
Map 20	Highest 8-hour concentration after 80 percent across-the-board reductions
Map 21	Highest value when 8-hour base concentrations are subtracted from 8-hour concentrations after 80 percent across-the-board reductions (subtract Map 11 from Map 20)
Map 22	Number of days the 8-hour concentration was > 84 ppb after 80 percent across-the-board reductions
Map 23	Difference in the number of days when 8-hour concentration > 84 ppb between base case and after 80 percent reductions (subtract Map 22 from Map 12)
Map 24	Fourth highest 8-hour concentration after 80 percent across-the-board reductions
Map 25	Highest value when fourth highest 8-hour base concentrations are subtracted from fourth highest 8-hour concentrations after 80 percent across-the-board reductions (subtract Map 13 from Map 24)

Re: Analysis in Texas of Results From the SMRAQ

Conclusions

1-hour results

A review of the 1-hour base case results shown in Map 1 and Map 2 indicates that there are exceedances of the 1-hour standard over HG, BPA, DFW, and northeast Texas in the vicinity of Longview. The most exceedances are in the HG area. As shown in Table 3, the maximum 1-hour concentrations are 185.1 ppb in the HG area, 147.3 ppb in the BPA area, 137.8 ppb in the DFW area, 137.7 ppb in the LM area, and 128.2 ppb in the Tyler area.

After the 50 percent across-the-board reductions were applied, the maximum 1-hour concentrations and the number of exceedances of the standard were significantly reduced in all areas. After this reduction, the maximum 1-hour concentration was less than the standard in all areas except where it was 129.3 ppb in the DFW and 160.6 ppb in the HG area.

After the 80 percent across-the-board reductions were applied, the maximum 1-hour concentrations were below the standard in all locations.

8-hour results

A review of the 8-hour base case results shown in Map 11 and Map 12 indicates that there are exceedances of the 8-hour standard over a large area in the eastern part of Texas. Map 13 indicates that there are large areas of the state where the fourth highest 8-hour concentration exceeds the proposed 8-hour standard. Table 3 shows that the maximum 8-hour concentration exceeds the proposed 8-hour standard in all analysis areas and that the fourth highest 8-hour concentration exceeds the proposed 8-hour standard in all analysis areas except SA and Corpus Christi. The fourth highest 8-hour concentration was 89.5 ppb in Austin, 109.7 ppb in the BPA area, 94.0 ppb in the DFW area, 143.0 ppb in the HG area, 104.0 ppb in the LM area, 83.3 ppb in SA, 102.6 ppb in Tyler, and 90.3 ppb in Victoria.

After the 50 percent across-the-board reduction, there are large significant reductions in the 8-hour concentrations across the state. After the reduction, the maximum 8-hour concentration was below the proposed 8-hour standard in Corpus Christi, SA, and Tyler. After the reduction, the fourth highest 8-hour concentration was 72.4 ppb in Austin, 86.9 ppb in the BPA area, 82.2 in the DFW area, 127.1 in the HG area, 75.1 in the LM area, 74.9 in Tyler and 69.9 in Victoria. Thus, this level of reduction would show that the fourth highest 8-hour concentration was below the proposed 8-hour standard in all areas except the BPA and HG areas.

After the 80 percent across-the-board reduction, the largest 8-hour concentration was below the proposed 8-hour standard in all areas except the HG area. After the reductions, the highest 8-hour concentration in the HG area was 101.9 ppb and the fourth highest 8-hour concentration was 92.1 ppb.

Attachments

Re: Analysis in Texas of Results From the SMRAQ

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