Final Report

Impact of Updates to On-Road Mobile Source Emission Factor Models (EMFAC) for the Los Angeles Region: Ozone Model Sensitivity and Ambient/Inventory Reconciliation CRC Project No. A-38

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October 21, 2003

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EXECUTIVE SUMMARY

The CRC-A38 study evaluates whether improvements to the on-road vehicle emission inventories for Los Angeles have improved agreement between ozone models and ambient data, and whether the response of ozone models to emission reductions has been altered by the emission inventory updates. Past studies, such as the 1987 SCAQS[1] field study, raised concerns that VOC emissions from vehicles were under-represented in the Los Angeles emission inventories. When the SCAQMD[2] modeled an August 26-28, 1987 ozone episode from the SCAQS for the 1997 AQMP,[3] the on-road vehicle VOC emissions were doubled in order to obtain acceptable model performance for ozone.

On-road vehicle emission inventories for Los Angeles are based on computer models called EMFAC developed by the California Air Resource Board (ARB). Numerous revisions to EMFAC have been released since the 1987 SCAQS field study with the most recent version being EMFAC2002. Most of the revisions increased ozone precursor (VOC, NOx and CO)[4] emissions, although there were some decreases after EMFAC2000. Over the same time period, the measured atmospheric concentrations of ozone precursors have steadily decreased in the Los Angeles area. The changes in modeled and measured precursor levels both might be expected to improve agreement between the models and the real world for ozone precursors. However, improving agreement for the VOC/NOx ratio depends upon the relative changes in the modeled and ambient VOC and NOx levels. The VOC/NOx ratio is important to both ozone formation and the sensitivity of ozone to emission reductions for Los Angeles where both modeling and ambient data analyses show that ozone is very sensitive to both VOC and NOx emissions.

Emission Inventory Changes

The 1997 summer emission inventories for EMFAC7G, EMFAC2000, EMFAC2001 and EMFAC2002 are compared in Figures ES-1 and ES-2, and changes relative to EMFAC7G are shown in Table ES-1. The VOC and CO emissions for five Counties in the Southern California Association of Governments (SCAG)[5] were highest with EMFAC2000, lowest with EMFAC7G and intermediate for EMFAC2001 and EMFAC2002. NOx emissions for the five SCAG Counties showed a different trend and were lower for EMFAC2001 and EMFAC2002 than for EMFAC7G, but still highest for EMFAC2000. The different trend across models for NOx than for VOC emissions was traced to changes in vehicle activity data for Riverside and San Bernardino Counties. VMT[6] was substantially reduced between EMFAC7G and EMFAC2000 for Riverside and San Bernardino Counties, especially for heavy-duty vehicles in San Bernardino County. For Los Angeles County, the activity data (VMT and vehicle population) were more consistent across models and the trends in total emissions more closely reflect the underlying trends in emission factors. Los Angeles County emissions for all three

[1] Southern California Air Quality Study
[2] South Coast Air Quality Management District
[3] Air Quality Management Plan
[4] Volatile organic compound, nitrogen oxides and carbon monoxide
[5] Los Angeles, Orange, Ventura, Riverside and San Bernardino. Imperial County also is a SCAG member but has fewer emissions in the Los Angeles basin than the other five counties.
[6] Vehicle miles traveled

precursors increased substantially from EMFAC7G to EMFAC2000, then declined in EMFAC2001 and declined again in EMFAC2002 (except for NOx). The differing assumptions among these versions of EMFAC are summarized in the report.

Table ES-1. Emission changes relative to EMFAC7G for summer 1997 emission inventories.

	EMFAC2000	EMFAC2001	EMFAC2002
Five SCAG Counties (Los Angeles, Orange, Ventura, Riverside and San Bernardino)			
VOC	48%	24%	18%
NOx	2%	−16%	−15%
CO	62%	34%	26%
Los Angeles County			
VOC	92%	54%	44%
NOx	48%	18%	19%
CO	115%	69%	57%

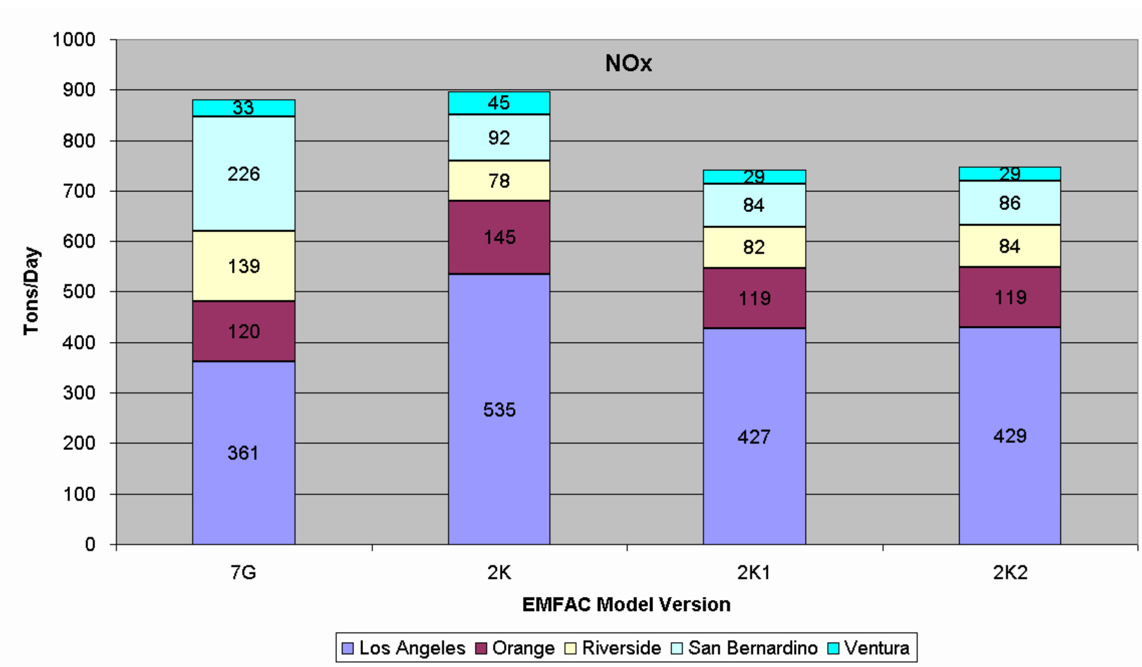


Figure ES-1. Comparison of 1997 NOx emission inventories for five SCAG Counties with different versions of EMFAC.

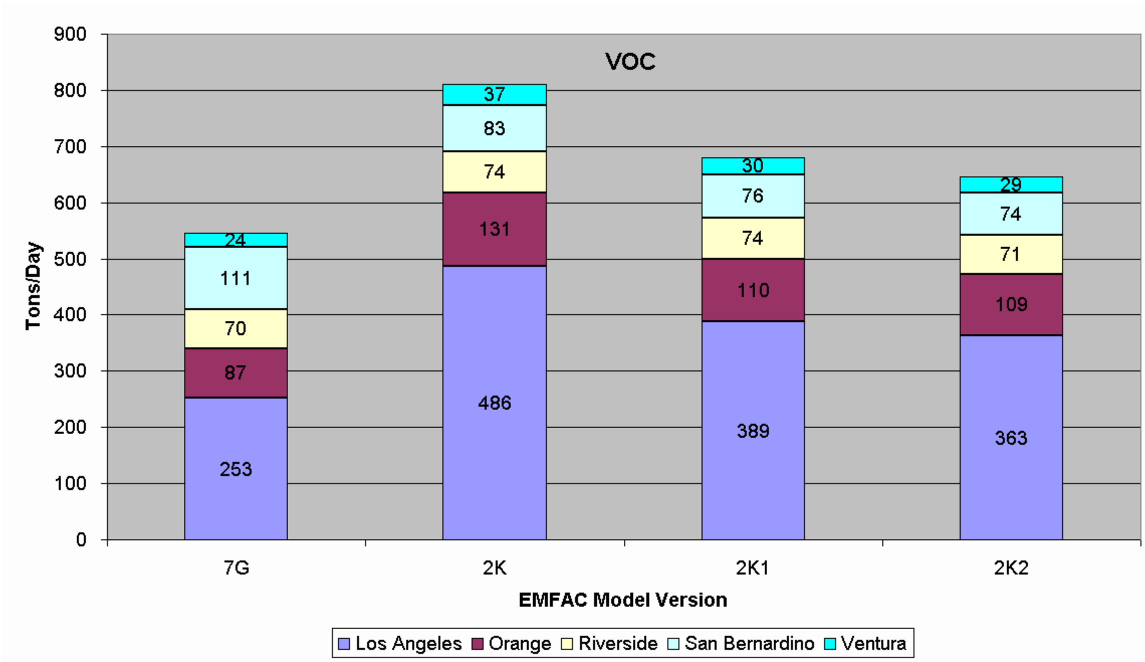


Figure ES-2. Comparison of 1997 VOC emission inventories for five SCAG Counties with different versions of EMFAC.

Modeled and Ambient VOC/NOx Ratios

Ozone modeling was completed for an August 1997 SCOS[7] episode as described in more detail below. The modeled precursor concentrations and VOC/NOx ratios with EMFAC7G and EMFAC2001 were compared to ambient data. The mean measured VOC/NOx ratio for 1997 was 3.9 ± 0.4 compared to a mean predicted ratio with EMFAC2001 of 3.7 ± 0.2 with the Carbon Bond 4 (CB4) chemical mechanism and 3.2 ± 0.2 with the SAPRC99[8] mechanism. With EMFAC7G, the mean predicted VOC/NOx ratios for 1997 were 4.0 ± 0.1 with CB4 and 2.9 ± 0.4 with SAPRC99. The EMFAC2001 VOC concentrations are higher relative to EMFAC7G. Because the EMFAC2001 NOx concentrations also are higher, the EMFAC2001 VOC/NOx ratios are, on average, comparable to the ratios predicted by EMFAC7G. The agreement with ambient data is improved or degraded by EMFAC2001 depending upon whether the CB4 or SAPRC99 chemical mechanism is used. We do not interpret the results of this study as indicating that either the CB4 or SAPRC99 mechanism is more or less "correct" as any such conclusion should be based on the results of several studies.

The good agreement found here between modeled and ambient VOC/NOx ratios for 1997, in contrast with earlier comparisons based on the 1987 SCAQS, indicates that agreement between the models and the atmosphere has improved. However, it is not clear that EMFAC2001 gives better agreement than EMFAC7G for 1997. We also remodeled the 1987 SCAQS episode using EMFAC7G and EMFAC2001 emission inventories. There was good agreement between the measured VOC/NOx ratio (8.2 ± 0.8) and the modeled ratios, with better agreement using EMFAC2001 emissions (7.9 ± 1.4) than EMFAC7G emissions (6.8 ±

7 Southern California Ozone Study
8 1999 version of the Statewide Air Pollution Research Center mechanism

1.4). The most significant change between the ambient/inventory reconciliation for the 1987 SCAQS and 1997 SCOS studies is that the ambient ratio has dropped by about a factor of 2 between 1987 and 1997, from about 8 to about 4, due to greater reductions in VOC emissions relative to NOx. Good ambient/inventory agreement was found for VOC/NOx ratios in both 1987 and 1997 when a recent emission factor model (EMFAC2001) was used.

The modeled VOC/NOx ratios for 1997 with the CB4 photochemical mechanism are consistently about 10 percent higher than with SAPRC99. Possible causes include: (1) greater removal of modeled VOCs with SAPRC99 because the mechanism is more reactive; (2) inconsistencies between the CB4 and SAPRC99 emissions processing; and (3) inconsistencies between the way the ambient data (VOC samples) were converted to lumped species and the emissions processing. This difference is sufficiently large and consistent, and the VOC/NOx ratio is sufficiently important, that further investigation is recommended to confirm the cause(s).

The difference in the way carbon is accounted for in the CB4 and SAPRC99 mechanisms (third point in the last paragraph) is an essential difference between a lumped molecule (SAPRC99) and a lumped structure (CB4) approach to mechanism condensation. For example, SAPRC99 assigns both propene and 1-pentene to OLE1 on 1:1 basis, so the number of olefin groups is accounted for but the number of carbon atoms may not be accounted for. One approach to conserving carbon is to give OLE1 the average number of carbon atoms for the propene and 1-pentene it is representing here. However, the propene/1-pentene ratio likely varies both within and between the emission inventory an ambient VOC samples. Therefore, SAPRC99 is unlikely to correctly count the amount of carbon in emissions and ambient data, which will likely bias comparisons of VOC/NOx ratios in terms of molesC/mole. The CB4 lumped structure mechanism is better able than a lumped molecule mechanism to simultaneously count both functional groups and total carbon. In the example above, CB4 assigns propene to OLE plus PAR and 1-pentene to OLE plus 3 PAR. Since OLE has 2 carbons and PAR has 1 carbon, the CB4 approach conserves both the number of olefin groups and the total carbon.

Modeled and Ambient VOC Speciation

Modeled VOC composition for the August 1997 SCOS episode was evaluated against ambient data. With CB4, there generally is good agreement during the daylight hours for alkanes, aromatics and isoprene with both EMFAC7G and EMFAC2001. Spatial variations among sampling locations are larger than the differences resulting from different EMFAC versions. Predicted alkene levels are up to factor of two higher during the late afternoon and evening hours. Predicted formaldehyde levels are higher by up to a factor of two during the afternoon and about a factor of five higher overnight. With SAPRC99, there were larger differences from measured values than for CB4. This may be due partly to the greater number of species in the SAPRC99 mechanism, which reduces opportunities for compensating over- and under-predictions. As for CB4, agreement was better for primary VOCs than for compounds with significant secondary contributions. Agreement with observations for formaldehyde and acetaldehyde is better than for CB4 during midday, but predicted values are factors of two to four higher overnight. Modeled higher aldehydes (i.e., larger than acetaldehyde) are consistently lower than measurements at all sites and hours.

Overall, the agreement between modeled and observed VOC species was reasonable for CB4 but not quite so good for SAPRC99. Issues worth further consideration are (1) the tendency for formaldehyde to be over-predicted by both mechanisms, and especially by CB4 and at night with both mechanisms; (2) the tendency for SAPRC99 to predict lower VOC concentrations than CB4, and (3) the tendency for SAPRC99 to substantially under-predict higher carbonyls (RCHO). Understanding biases for carbonyls, including formaldehyde, is important because these compounds are reactive and initiate photochemistry via photolysis, because they are secondary species and thus indicative of photochemical reaction, and because they are air-toxics. The tendency for SAPRC99 to predict lower VOC concentrations than CB4 is consistent with the tendency toward lower VOC/NOx ratios with SAPRC99, discussed above, and may indicate some problem in how the mechanism is being applied or the results interpreted. One potential issue (discussed in the report conclusions) that should be considered is how carbon is being accounted for in applying the fixed-parameter version of the SAPRC99 mechanism, because the species comparisons (and VOC/NOx comparisons) are made on a carbon (ppbC) basis.

Ozone Model Performance for 1997

Ozone modeling was performed for the August 3-7, 1997 SCOS period using the Comprehensive Air Quality model with extensions (CAMx) with MM5 meteorology and ARB emission inventories. The on-road vehicle emissions provided by the ARB were EMFAC2001 based and were adjusted to other model versions using “EMFAC emission ratios,” that is ratios of emissions between different EMFAC versions. Modeling was completed with emissions based on EMFAC7G, EMFAC2001 and EMFAC2002. The changes in modeling inventories due to EMFAC versions were consistent with the changes presented above in Figures ES-1 and ES-2. Notably, the domain total NOx emissions decreased from EMFAC7G to EMFAC2001/2002 due to the changes in activity data for San Bernardino and Riverside Counties discussed above. This NOx decrease was concentrated in grid cells for San Bernardino and Riverside Counties and this influenced model performance for ozone.

Modeled ozone levels were higher with EMFAC2001/2002 than with EMFAC7G, and were higher with SAPRC99 than with CB4. The main findings from the statistical evaluation of 1-hour ozone performance are as follows.

- Ozone levels were higher with EMFAC2001 and EMFAC2002 than with EMFAC7G. Ozone difference between EMFAC2001 and EMFAC2002 were relatively small. Both EMFAC2001 and EMFAC2002 tended to over-predict ozone for this episode.

- Model performance was always poorer with SAPRC99 than CB4 chemistry for a given set of EMFAC emissions. The reason for this was consistently higher ozone levels with SAPRC99 than CB4 which compounded tendencies to over-predict ozone for this episode.

- The only scenario to meet all the EPA performance goals for 1-hour ozone modeling was with CB4 chemistry and EMFAC7G emissions. Model performance with EMFAC2001/EMFAC2002 and CB4 chemistry was close to meeting EPA performance goals, but there was an over-prediction tendency. Model performance with SAPRC99 chemistry only came close to meeting performance goals with EMFAC7G, and was poor with EMFAC2001/EMFAC2002 due to the tendency for SAPRC99 to over-predict ozone for this episode.

There are no established statistical performance goals for 8-hour ozone so the same statistical measures were calculated for 8-hour as for 1-hour ozone. In general, the 8-hour performance statistics were slightly poorer than for 1-hour ozone because of a slightly greater tendency toward over-prediction. EPA's guidance for 8-hour ozone modeling emphasizes evaluating whether ozone model results are consistent with a conceptual understanding of how the high ozone levels were formed (the conceptual model). The CAMx/MM5 modeling for the August 1997 SCOS episode showed generally good agreement in the spatial and temporal distributions of high ozone levels.

The better performance for 1-hour ozone with EMFAC7G than EMFAC2001/2002 was partly due to the higher NOx emissions with EMFAC7G in downwind areas (San Bernardino and Riverside Counties, discussed above), which tended to suppress some of the highest modeled ozone levels. As discussed above, this NOx emission inventory difference is due to large differences in activity assumptions that were introduced between EMFAC7G and EMFAC2000.

For this particular episode, model performance was clearly poorer with SAPRC99 than with CB4 chemistry. However, we do not conclude from this that either mechanism is more or less "correct" since any such evaluation should be based on a number of model applications.

Ozone Sensitivity to Emission Reductions for 1997

We conducted emissions sensitivity tests to characterize ozone response to reductions of up to 75 percent in anthropogenic NOx and VOC emissions for 1997 (CO emissions were reduced concurrently with VOC emissions). The results showed consistently that Los Angeles ozone levels are more VOC-limited. This means that reducing VOC emissions always reduces ozone, whereas reducing NOx may increase or decrease ozone depending upon the level of NOx reduction. This kind of response to VOC and/or NOx emission reductions results from the well-understood "NOx inhibition" effect. The NOx inhibition effect was observed consistently for:

- 1-hour and 8-hour ozone.
- CB4 and SAPRC99 chemical mechanisms.
- EMFAC versions 7G, 2001 and 2002.
- Receptor locations at the peak location (which moves as emissions are reduced), Azusa (mid-basin), Riverside (downwind) and Crestline (far downwind).

The response of peak 1-hour ozone to emission reductions is shown as an EKMA diagram in Figure ES-3 for EMFAC2001 emissions and CB4 chemistry. We obtained similar EKMA diagrams using all versions of EMFAC (7G, 2001 and 2002) and both the CB4 and SAPRC99 mechanisms. Starting from the base-case (top right), when VOC emissions are decreased the peak ozone also decreases, but when NOx emissions are decreased the peak ozone increases at first before decreasing at higher NOx reduction levels. This increase in ozone when NOx is reduced is the NOx inhibition effect. There are two mechanisms involved in NOx inhibition. First, NO directly removes ozone by the titration reaction $NO + O_3 \rightarrow NO_2 + O_2$. Consequently, if NO emissions are reduced, less ozone is destroyed by this titration reaction and ozone concentrations are higher. Second, the NO_2 formed from the ozone titration removes radicals by the reaction $NO_2 + OH \rightarrow HNO_3$. If NOx emissions are reduced, the NO_2 concentration is lower, the radical concentration is higher, and formation of new ozone proceeds faster.

The NOx inhibition effect has implications for ozone control strategy development. As shown in Figure ES-3, reducing NOx emissions increases peak ozone until NOx emissions have been reduced by about 25 to 50%, depending upon the VOC emissions level. The dashed line (A) in Figure ES-3 links points of maximum peak ozone for a given VOC emissions level. When NOx emissions are reduced to below line (A), the peak ozone starts to fall again and returns to the level with 100% of the NOx emissions at dashed line (B). In other words, for any combination of VOC and NOx emissions lying above line (B), the NOx reduction may be considered counter-productive for ozone because peak ozone would have been lower with zero NOx reduction. So, with base case VOC emission levels NOx reduction is counter-productive for less than 50% NOx reduction. Similarly, NOx reduction is counter-productive at less than 75% reduction with 40% reduced VOC emission levels.

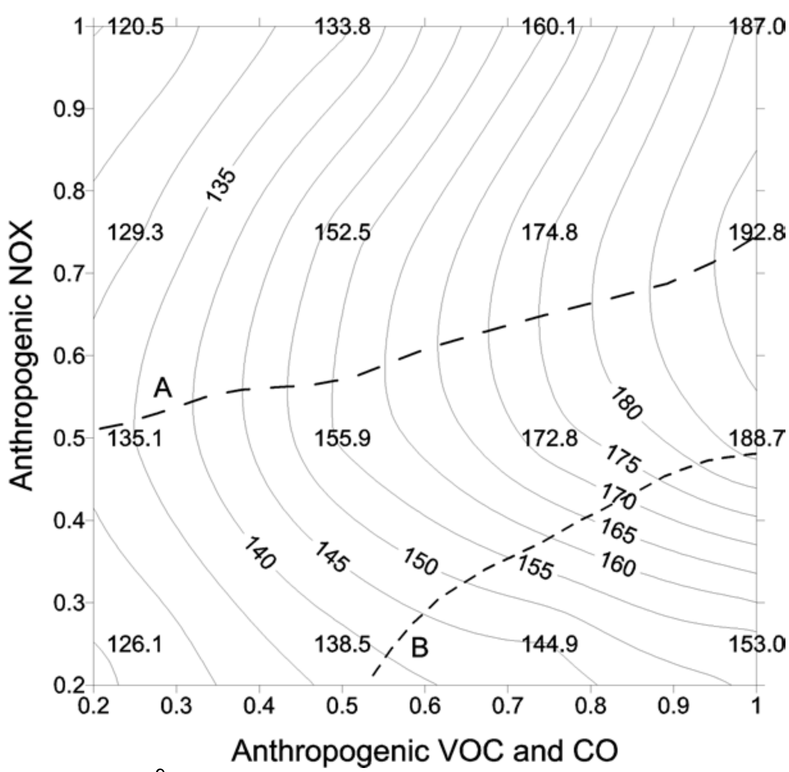


Figure ES-3. EKMA diagram[9] for the basin-wide peak 1-hour ozone over August 5-7, 1997 with EMFAC 2001 emissions and CB4 chemistry. Line A is the "ridgeline" with maximum ozone and line B has the same ozone as 100% NOx (i.e., no NOx control, for a given VOC/CO reduction).

[9] The EKMA diagram was constructed from 16 model runs. The results of the 16 simulations are shown by the values arranged in a regular grid. The contours were constructed by interpolating these values.

The levels of NOx reduction that are counter-productive and produce maximum ozone are summarized below. These findings were very consistent with different EMFAC versions and different chemical mechanisms, and the stated ranges reflect the small differences among the six different EMFAC/chemical mechanism scenarios considered.

- *Levels of NOx reductions that are counter-productive for reducing peak ozone*. With 1997 base case VOC emission levels, less than 55-60 percent NOx reduction is counter-productive for 1-hour ozone, and less than 45-50 percent NOx reduction is counter-productive for 8-hour ozone. With 50 percent reduced VOC emissions, NOx reduction is counter-productive for both 1-hour and 8-hour ozone for NOx reductions of less than 75%, and possibly up to 85% for 1-hour ozone.

- *Levels of NOx reduction that produce the highest peak ozone levels*. With 1997 base case VOC emission levels, the highest 1-hour ozone occurs with 25-35 percent NOx reduction, and the highest 8-hour ozone occurs for 45-50 percent NOx reduction. With 50 percent reduced VOC emissions, 45-50 percent NOx reduction produces the highest 1-hour and 8-hour ozone levels. The ranges reflect the small differences among the EMFAC/chemical mechanism scenarios considered.

The finding that NOx emission reductions of less than 50 to 75 percent from 1997 levels tend to increase modeled peak ozone levels has implications for air quality planning and ozone attainment. Reducing NOx emission levels (to help attain particulate matter standards, for example) will mean that VOC levels must be reduced even more steeply than if no NOx reductions were implemented. Maintaining a careful balance of VOC and NOx reductions will be necessary to avoid slowing, or even reversing, recent progress toward attaining the 1-hour ozone standard. The VOC-limited nature of the Los Angeles atmosphere indicated by this modeling (and by other studies) suggests that the reductions in ambient ozone levels seen in Los Angeles in the late-1990s are attributable to VOC reductions.

Ozone Model Performance for 1987

Ozone modeling was performed for the August 26-28, 1987 SCAQS period using the UAM databases developed by the SCAQMD with emission inventories from the SCAQMD and ARB. The meteorology for August 1987 used here is the same as in the 1997, 1999 and draft 2003 AQMPs. The emission inventories used here were not from the draft 2003 AQMP since those data were not available in time for this study. When the SCAQMD modeled this episode for the 1997 and 1999 AQMPs, the on-road vehicle VOC emissions from EMFAC7G were doubled in order to obtain acceptable model performance for ozone. We did not double on-road vehicle VOC emissions, and found that ozone model performance improved using EMFAC2001 compared to EMFAC7G, but that peak ozone was still under-predicted with EMFAC2001 on both August 27 and 28. Model performance did not meet all established statistical objectives on either August 27 or 28 with either EMFAC7G or EMFAC2000. In general, the ozone increases from EMFAC7G to EMFAC2001 tended to be much smaller than the discrepancies between modeled and observed values in either case.

SCAQMD recently released a draft 2003 AQMP with UAM results based on EMFAC2002 emission inventories. The SCAQMD did not double the on-road vehicle VOC emissions in the draft 2003 AQMP. The SCAQMD used the same meteorological inputs for the UAM in both the 1997 and 2003 AQMPs. The new SCAQMD UAM results show much improved model performance for ozone over the previous 1997 AQMP modeling, although it is difficult to directly compare model performance statistics between the 1997 and draft 2003 AQMPs because the SCAQMD changed the way model performance statistics are calculated. The draft 2003 AQMP simulations produce much higher peak ozone levels either the A-38 simulations or previous AQMPs. For August 28th, the predicted peak of 319 ppb is higher than the observed peak of 290 ppb and much higher than the 1997 AQMP modeled peak of 223 ppb. It is unclear why the draft 2003 AQMP simulation predicts much higher ozone levels than other simulations. Comparing the emission totals for different modeling studies does not suggest an explanation. A more detailed comparison of the emission inventories is needed to investigate the reasons for these differences in model performance for ozone.

1.0 INTRODUCTION

Emission inventories are used in ozone air quality planning to identify which sources to control, evaluate the effectiveness of proposed control programs, and predict future air quality through photochemical modeling. This information is used to develop air quality management plans for attaining air quality standards. To achieve the least costly emissions reductions, the plans must be based upon emission inventories that are complete and accurate. However, the uncertainties associated with emission inventories are difficult to characterize since most emission estimates are based upon models, engineering analyses and limited test data rather than on systematic measurements of actual "real world" emissions. Incorrect estimation of emissions and/or the benefits of emission controls may lead to ineffective or excessively costly control strategies and false expectations for improvement in future air quality. The objectives of this study are to evaluate whether improvements to the on-road vehicle emission inventories for Los Angeles have improved agreement between ozone models and ambient data, and whether the response of ozone models to emission reductions has changed.

The on-road mobile source emission inventories for Los Angeles are based on computer models developed by the California Air Resource Board (CARB), called EMFAC. Past studies for Los Angeles raised concerns about the accuracy of EMFAC. For example, a study which compared EMFAC7C emission factors to emissions measured in a highway tunnel found that the measured carbon monoxide (CO) and volatile organic compound (VOC) emission rates were about 2.7 and 3.8 times higher, respectively, than model predictions, while measured nitrogen oxide (NOx) emission rates agreed reasonably well with model predictions (Ingalls et al., 1989). In examining the basic conclusions of this Southern California Air Quality Study (SCAQS) tunnel study, Pierson et al. (1990) cited other roadway studies as well as dynamometer and ambient air studies which all suggested that vehicle CO and VOC emission rates were generally underestimated by the models of the time. By comparing modeled VOC /NOx ratios to ambient ratios measured during the SCAQS field study, Fujita et al. (1992) similarly concluded that the emission inventories were low in VOCs, and that this was most likely because on-road mobile source VOC emissions were underestimated. When the South Coast Air Quality Management District (SCAQMD) modeled an August 26-28, 1987 ozone episode from the SCAQS field study, they doubled the on-road vehicle VOC emissions from EMFAC7G in order to obtain acceptable ozone model performance (SCAQMD 2003; page V-3-41) for the 1997 and 1999 Air Quality management Plans (AQMPs).

Recognizing the need to better quantify mobile source emissions, the CARB initiated a long-term research program to improve emission inventory estimates. Numerous revisions to the EMFAC model have been released since the 1987 SCAQS field study with the most recent version being EMFAC2002. Most of the revisions have resulted in upward adjustments to VOC, NOx and CO emissions (see section 2 for a summary of changes between EMFAC7G and EMFAC2002). Over the same time period, the measured atmospheric concentrations of these primary pollutants have steadily decreased in the Los Angeles area (Fujita et al., 2003). Since VOC inventories have been increasing while ambient levels are decreasing, better agreement might be expected between modeled and observed VOC levels when the updated models are compared to more recent ambient data. However, comparisons of modeled to ambient precursor data often focus on the VOC/NOx ratio because this provides a more robust comparison as it mostly factors out the effects of dispersion and is strongly related to ozone formation (NRC, 1991). Whether the newer EMFAC models improve agreement for VOC/NOx ratios depends upon the relative changes in the modeled and ambient VOC/NOx ratios. Changes in the emissions VOC/NOx ratio also are important to the sensitivity of ozone to emission reductions (NRC, 1991), especially for Los Angeles where both modeling (Yarwood et al., 2003) and ambient data analyses (Blanchard and Tanenbaum, 2003; Fujita et al., 2003) show that ozone is very sensitive to both VOC and NOx emissions.

This report evaluates the impact of changes between the EMFAC7G, EMFAC2001 and EMFAC2002 emission factor models using ambient data from an August 3-7 ozone episode period during the 1997 Southern California Ozone Study (SCOS). The SCOS97 is the most important field study for the Los Angeles area since the 1987 SCAQS study, mentioned above. Section 2 of the report shows the impact of the EMFAC updates on ozone model performance for the August, 1997 SCOS episode, and then evaluates how the EMFAC updates change the modeled response of ozone to VOC and NOx emission reductions. The analyses consider effects on both 1-hour and 8-hour ozone levels, and compare the model performance and emission reduction responses with two different chemical mechanisms, namely the Carbon Bond 4 mechanism (CB4; Gery et al., 1989) and the 1999 version of the Statewide Air Pollution Research Center mechanism (SAPRC99: Carter et al., 2000).

Ozone modeling also was conducted for the August, 1987 SCAQS episode used by the SCAQMD in the 1997, 1999 and draft 2003 AQMPs. As for the August 1997 SCOS episode, we evaluated whether the EMFAC updates from EMFAC7G to EMFAC2001 improved ozone model performance and the reconciliation between modeled and ambient VOC/NOx ratios. These results are presented at the end of section 2.

The effects of EMFAC updates on emissions/ambient reconciliation for ozone precursors are considered in sections 3 and 4 of the report, once again using data from the SCOS97. Section 3 compares modeled and observed NOx and VOC concentrations and VOC/NOx ratios for EMFAC7G and EMFAC2001 using model results from section 2. Section 4 compares the modeled and observed speciation of VOCs for EMFAC7G and EMFAC2001 in terms of the CB4 and SAPRC99 chemical mechanisms using model results from section 2.

2.0 OZONE MODELING

2.1 OVERVIEW OF EMFAC VERSIONS

EMFAC is the computer model developed by the California Air Resources Board (CARB) to estimate emission factors for on-road mobile sources. These emission factors are used as inputs for air quality and emission inventory modeling. Version 7G of EMFAC was used to generate the emission inventories for the 1997 Los Angeles Air Quality Management Plan (AQMP) and the following State Implementation Plan (SIP) and transportation conformity analyses. The latest version, called EMFAC2002, will be used for the new 2003 Los Angeles AQMP. This section briefly discusses the development of the emission factor/inventory models from EMFAC7G to EMFAC2002, and presents the comparison of the 1997 emission inventories estimated by these models for the South Coast Area of Government. The description is based on information provided by the CARB at http://www.arb.ca.gov/msei/on-road/on-road.htm.

EMFAC7G (MVEI7G)

In October 1996, CARB released a slightly more integrated version of emission factor/inventory model called MVEI7G. Unlike the stand-alone EMFAC7F model, MVEI7G consisted of a series of models that included a revised emission factor model (EMFAC7G), an I/M benefit based baseline emission rate model (CAIMFAC), a model-year vehicle travel data model (WEIGHT7G), and a county-specific vehicle activity model (BURDEN7G). The MVEI7G model provides emission estimates for 10 different vehicle classes and 3 technology groups that resulted in 17 vehicle class and technology combinations, and reflects a fleet of 35 model years for cars and 25 model years for trucks. With the emission factors and activity data included in the BURDEN7G model, the MVEI7G model can directly estimate the on-road mobile source emission inventories. MVEI7G was used to develop the 1997 South Coast AQMP/SIP.

EMFAC2000 to EMFAC2002

With the increasing stringency in emission standards that resulted in rapid development in vehicular technologies, and the expansion of “real-world” emissions databases, CARB updated its emission inventory model to provide more accurate emission estimates for on-road mobile sources. As a result of the effort, CARB released several newer versions of the model, including the EMFAC2000, EMFAC2001, and EMFAC2002 models, since the release of the MVEI7G model.

Following the integration concept of the MVEI7G model, EMFAC2000 incorporates algorithms from the WEIGHT, CALIMFAC, EMFAC, and BURDEN models into a single comprehensive emission inventory model. The EMFAC 2000 model series provides emission estimates for13 different vehicle classes and 277 technology groups, and reflects a fleet spanning 45 model years. The major revisions of these emission inventory models are summarized below.

EMFAC2000. The EMFAC2000 model was released by CARB in November 2000. EMFAC2000 was used to develop the San Francisco Bay Area's Ozone Attainment Plan and SIP revision. The major revisions in EMFAC2000 compared to MVEI7G were as follows[1]:

- County specific fleet characterization
- Expanded age distribution
- Addition of school bus and motor home classes
- Twenty-four hourly periods of analysis
- Monthly inventory estimation
- Addition of evaporative "liquid leakers"
- Added "smoking" vehicles to PM inventory
- Switch to cycle based (UDDS) heavy-duty vehicle inventory (i.e., accounting "off-cycle" NOx emissions)
- Updated I/M benefit estimates

EMFAC2001. The EMFAC2001 model has three important public versions; namely, Versions 2.06, 2.07 and 2.08, released by the CARB in July 2001, October 2001, and May 2002, respectively[1]. EMFAC2001 Version 2.06 was used in support of the Santa Barbara SIP revision, Version 2.07 was used in the benefit analysis for the zero-emission vehicle (ZEV) amendments, and Version 2.08 is the official EMFAC2001 version and was used as the basis of the 2002 California Almanac of Emissions and Air Quality[1]. Some of the combined major revisions in these models as compared to the EMFAC2000 were as follows:

- Corrected diurnal emissions equation
- Corrected hot soak normalization issue
- Corrected non-catalyst equipped/catalyst equipped fleet split
- Added additional chassis dynamometer data for heavy-duty gasoline powered trucks
- Included LEV II and TIER2 programs
- Added evaporative emissions for ZEVs
- Added new standards for urban buses
- Modified air conditioning correction factors
- Updated idle emission rates
- Corrected gasoline and diesel tech fraction problem
- Updated school bus activity estimates
- Updated unregistered vehicle estimates
- Revised activity (Santa Barbara / North Central Coast / Bay Area MTC / San Diego / and portion of San Joaquin Valley)
- Corrected anomaly in the I/M benefits calculation
- Adjusted the fuel correction factors for low sulfur diesel
- Corrected the benefit estimate for USEPA 2007+ heavy-duty standards

EMFAC2002. The EMFAC2002 model was release by CARB in October 2002. CARB submitted a request for approval to the EPA on December 2002 to use the EMFAC2002 model

[1] CARB Presentation at a EMFAC 2002 Workshop, June 2002.

for SIP development and transportation conformity processes in California. The major revisions in EMFAC2002 model as compared to the EMFAC2001 model were as follows[2]:

- Revised implementation schedule LEVII
- Correct usage rates for school buses
- Correct monthly average gasoline RVP
- Extended idle for school Buses
- Correction to 2007+ HDD PM emission rates
- Extended idle for heavy-duty trucks
- Modification of passenger car mileage accrual rates
- Update speed distribution
- Update vehicle miles traveled
- Update population and registration distributions
- Revise Phase 3 gasoline fuel correction factor start date
- Standards-ratio factors for tire wear and brake wear PM
- Revising the cut-points for the Enhanced I/M program

Impacts on Emission Inventories

The summer 1997 CO, VOC and NOx emission inventories for several of the SCAG counties with different EMFAC models are compared in Figures 2-1 to 2-3, respectively. The major emission impacts of changing from EMFAC7G to the EMFAC2000 series models for these counties in the Southern California Association of Governments (SCAG) were on the NOx emissions for Los Angeles, Riverside and San Bernardino counties, as shown in more detail in Table 2-1 and Figure 2-4.

The NOx emission inventory for Los Angeles County estimated by EMFAC2000, EMFAC2001 and EMFAC2002 increased by 48%, 18% and 19%, respectively, compared to EMFAC7G. The smaller percentage increases for EMFAC2001 and EMFAC2002 than for EMFAC2000 are due to:

(1) Accounting for low-sulfur fuel correction factors;
(2) Revising the benefit estimate of the US EPA 2007 HD vehicle emission standards;
(3) Removing "inadvertently" added diesel start emissions, and;
(4) Changing activity data.

[2] CARB Presentation at EMFAC 2002 Workshop, November 2002.

Table 2-1. NOx emission inventories for Los Angeles, Riverside and San Bernardino counties for 1997 with different versions of EMFAC.

County	NOx (tons/day)			
	7G	2000	2001	2002
Los Angeles-HDV	115.9	203.0	163.6	179.3
Los Angeles- LDV	245.6	332.4	263.8	250.1
Riverside-HDV	64.4	28.9	28.7	36.0
Riverside-LDV	74.8	49.2	53.5	48.2
San Bernardino-HDV	119.0	37.5	33.3	38.8
San Bernardino-LDV	107.0	54.6	50.9	47.4

The trend in NOx emissions with model version was different for Riverside and San Bernardino Counties than for Los Angeles County. Compared to EMFAC7G, the NOx emission inventories estimated by EMFAC2000 through EMFAC2002 decreased by about 40% for Riverside County, and about 60% for San Bernardino County. The Los Angeles County trend (discussed above) was more consistent with expectations based on the documented differences between model versions, and so reasons for the different NOx trends in Riverside and San Bernardino Counties were investigated. The substantial NOx reductions for Riverside and San Bernardino Counties were found to be due to major changes in the activity data for these counties. Table 2-2 compares the VMT and vehicle population data used in EMFAC7G (actually BURDEN7G) and the EMFAC 2000 series models (shown for EMFAC2001). As shown in this table, VMT was substantially reduced for both Riverside and San Bernardino counties, especially the HDV VMT for San Bernardino County.

Table 2-2. VMT and vehicle population data for 1997 for Riverside and San Bernardino counties used in EMFAC7G and EMFAC2001.

County	Vehicle	VMT		Vehicle Population	
	Class	7G	2001	7G	2001
Los Angeles	HDV	6,795,000	8,716,000	79,289	136,346
	LDV	171,357,000	177,721,000	5,455,225	5,349,634
Riverside	HDV	5,671,000	2,174,000	33,657	41,167
	LDV	44,157,000	35,937,000	856,075	873,031
San Bernardino	HDV	11,540,000	2,387,000	69,474	46,276
	LDV	70,123,000	33,675,000	1,748,939	930,438

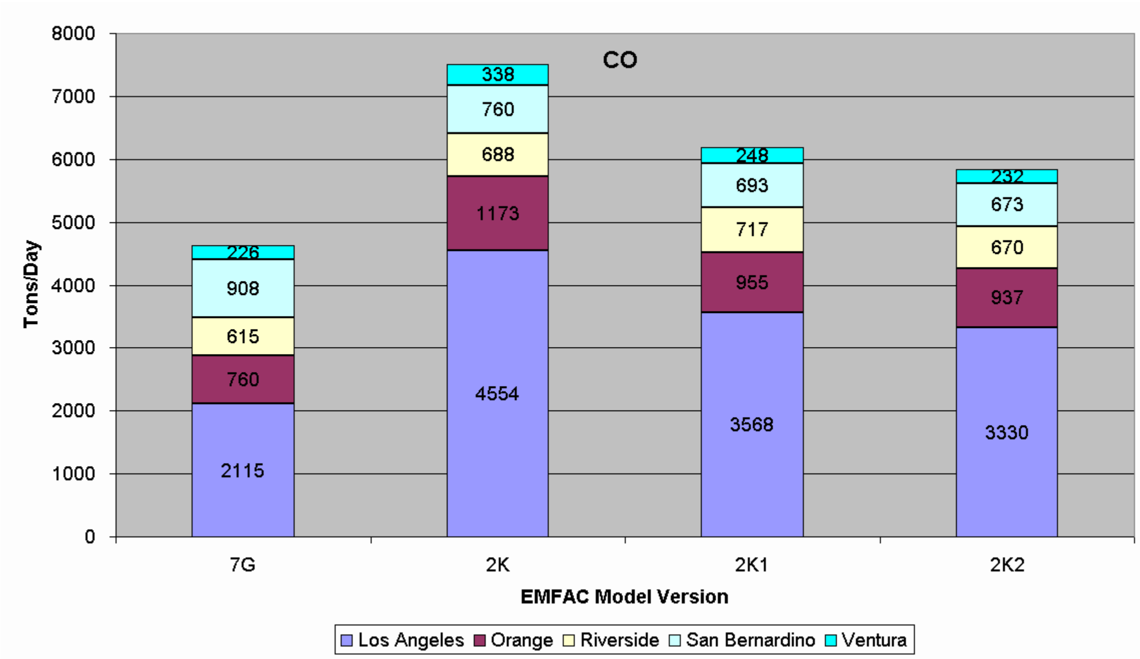


Figure 2-1. Comparison of 1997 CO emission inventories for SCAG Counties with different versions of EMFAC.

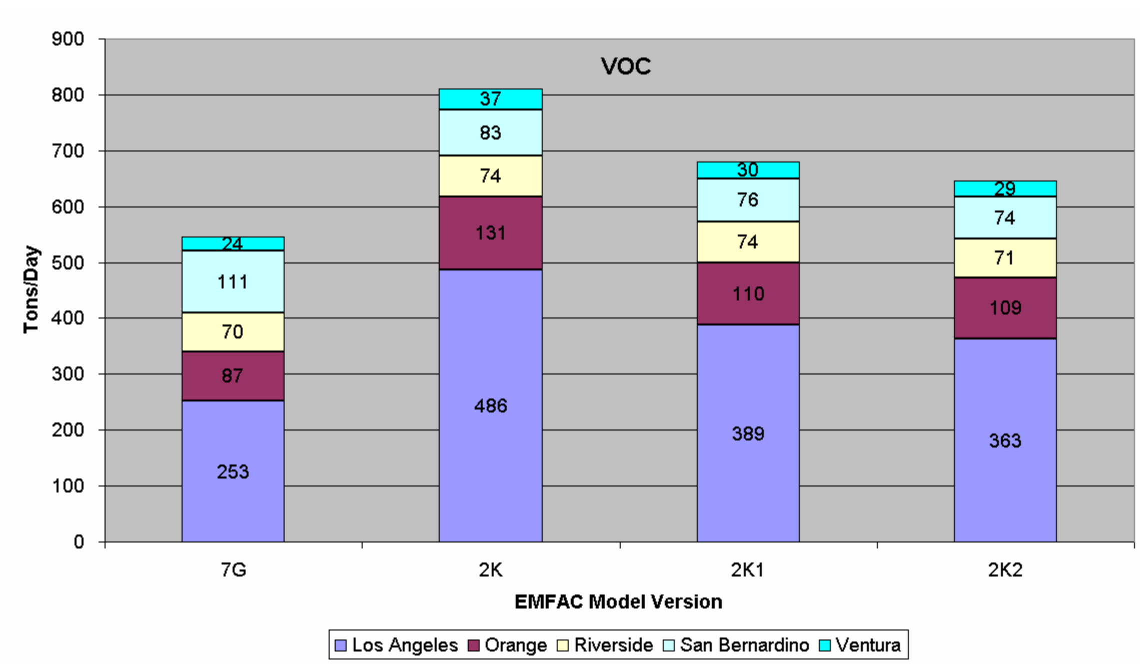


Figure 2-2. Comparison of 1997 VOC emission inventories for SCAG Counties with different versions of EMFAC.

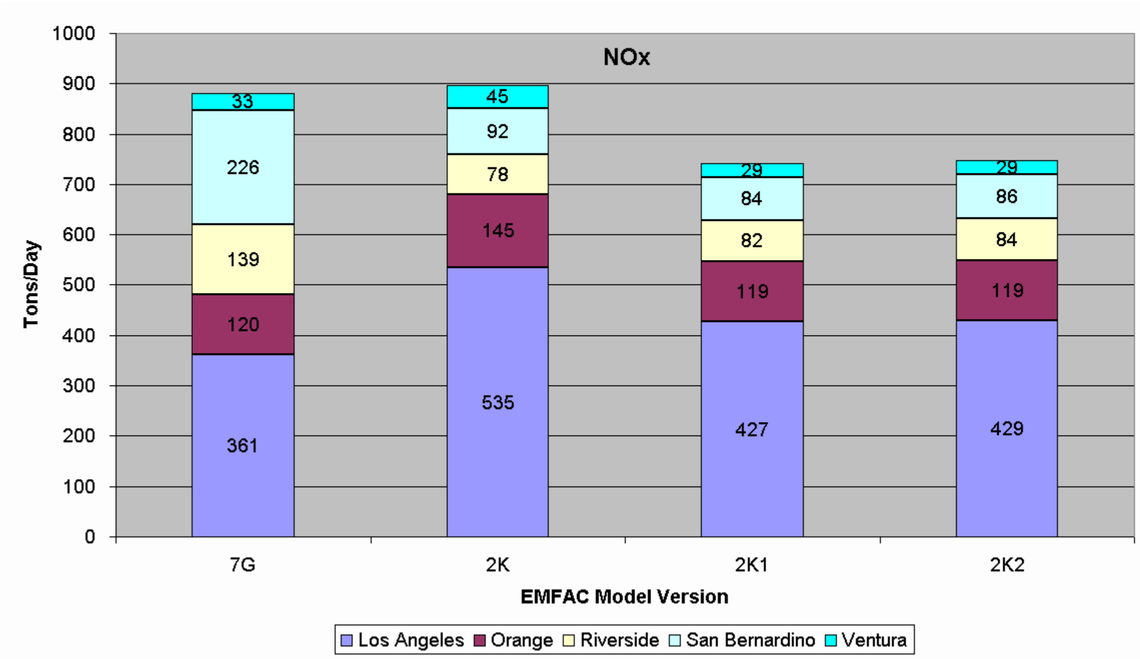


Figure 2-3. Comparison of 1997 NOx emission inventories for SCAG counties with different versions of EMFAC.

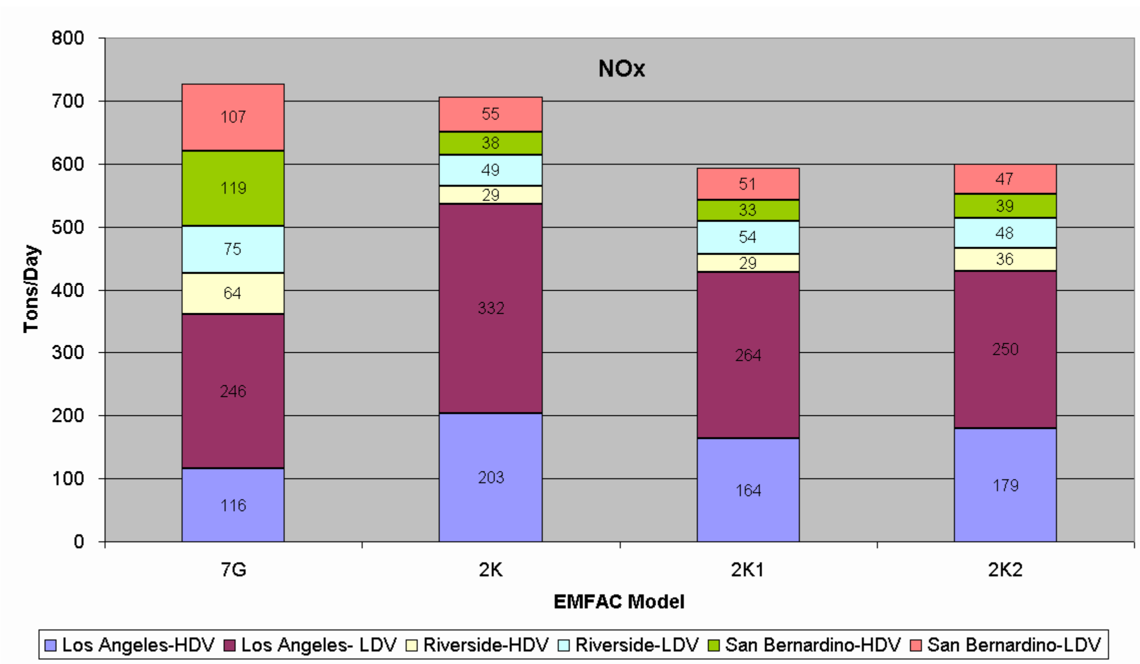


Figure 2-4. Comparison of 1997 NOx emission inventories for light-duty and heavy-duty vehicles in Los Angeles, Riverside and San Bernardino counties with different versions of EMFAC.

2.2 OZONE MODELING FOR THE AUGUST 1997 SCOS EPISODE

The August 3–7, 1997 ozone episode began with warm temperatures at the surface and aloft and weak pressure gradients directed offshore opposing onshore sea breezes. August 3 was the first model spin-up day and is not discussed. Ozone concentrations were relatively low on August 4 in most locations with the highest ozone occurring inland in the mountains and passes consistent with onshore flow. On August 5, temperatures increased reaching 29 °C at Los Angeles International Airport (LAX) and 49 °C at Palm Springs. The offshore pressure gradient increased in intensity and the episode maximum ozone concentration was 187 ppb at Riverside, consistent with continued weak onshore flow. By August 6, the offshore pressure gradients had weakened and inland temperatures cooled (43 °C at Palm Springs). The maximum ozone on August 6 occurred in the mountains at Crestline. On August 7, pressure gradients turned onshore and the onshore winds strengthened so that the highest ozone concentrations occurred far inland. The meteorological patterns during the August 3–7, 1997 period fit a typical pattern for Los Angeles ozone episodes. High ozone levels occurred because the period was relatively stagnant, tending to trap ozone and precursors within the Los Angeles basin.

Models

Photochemical ozone modeling for the August 3-7, 1997 SCOS period was performed with version 3.10 of the Comprehensive Air-quality Model with extensions (CAMx; ENVIRON, 2002). CAMx simulates the emission, dispersion, reaction, and removal of ozone precursors and ozone in an Eulerian (grid) framework. The modeling domain covered 65 by 40, 5-km grid cells as shown in Figure 2-5. This domain was selected to be consistent with past modeling for air quality management plans in the LA area (SCAQMD 1997, 1999). CAMx was run with 10 layers extending between a surface layer of 60 m and a model top at 4 km.

Meteorological input data for CAMx were developed using the Penn State/NCAR Mesoscale Model, version 5 (MM5). The MM5 is a non-hydrostatic, prognostic meteorological model that simulates atmospheric properties based on fundamental equations, but also permits assimilation of observed data to nudge the simulated meteorological fields toward the data (Dudhia, 1993). MM5 was run with assimilation of SCOS measurement data assembled by the CARB (i.e., radar wind profiler upper-air data and surface site data) and Eta Data Analysis System data from the National Centers for Environmental Prediction (NOAA-ARL, 2002). The CAMx modeling grid was closely matched to the MM5 grid and, in particular, CAMx layer interfaces exactly matched MM5 layer interfaces to facilitate direct mapping of meteorological parameters from MM5 to CAMx. The photochemistry of ozone formation was simulated in CAMx using two different condensed chemical mechanisms:

- The Carbon Bond 4 (CB4) mechanism (Gery et al., 1989) with updates for low-NO_x conditions and isoprene reactions (ENVIRON, 2002) which contains 37 species and 96 reactions.

- The fixed stoichiometry version of the SAPRC99 mechanism (Carter, 2000) with 74 species and 211 reactions.

Two chemical mechanisms were used to investigate whether modeled effects of the different mobile source emissions models were sensitive to the representation of atmospheric chemistry. The CAMx initial and boundary conditions were set to relatively clean values of 40 ppb ozone, 3 ppb NOx, 103 ppbC VOC and 200 ppb CO.

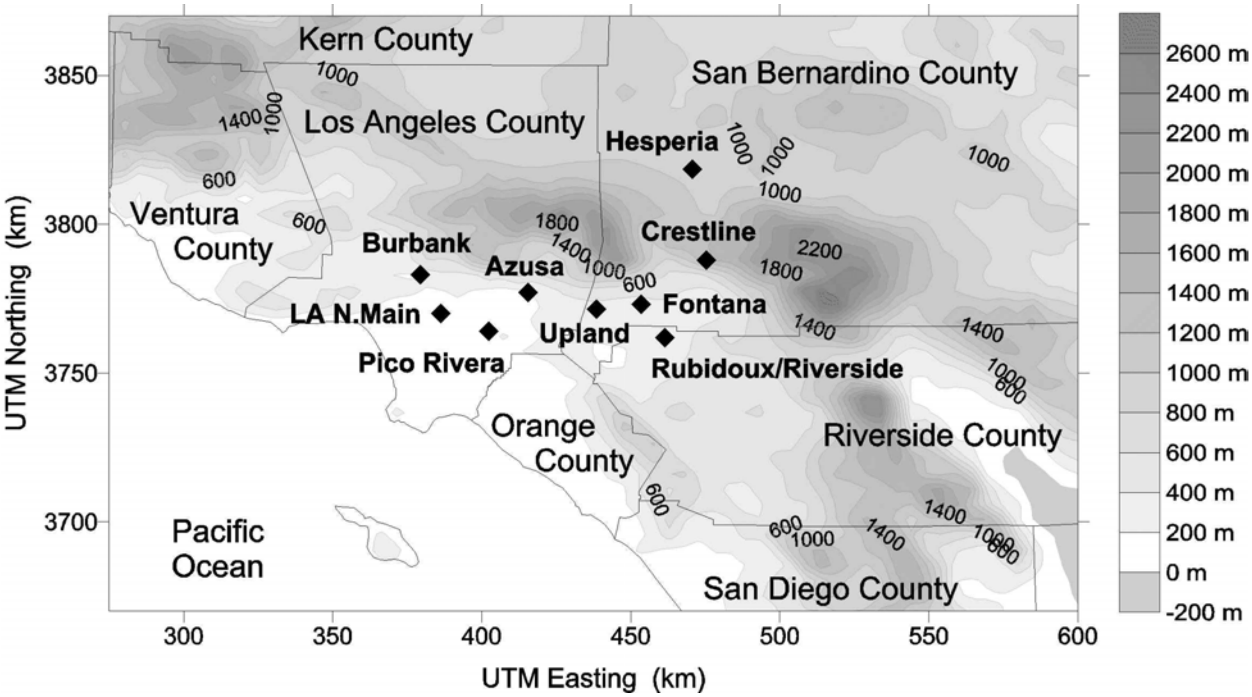


Figure 2-5. Air quality modeling domain for the CAMx and UAM simulations showing terrain elevation and selected monitoring locations.

Emission Inventories

The 1997 emission inventory was provided by the CARB (Allen, 2001) and emission totals for August 6, 1997 are summarized in Table 2-3. Emissions from on-road motor vehicles (MVs) are estimated to account for about two-thirds of the anthropogenic NOx and one-half of the anthropogenic VOC emissions in this modeling domain. In California, VOC emissions are often characterized as reactive organic gases but for simplicity the term VOC is used here. This 1997 emission inventory was provided by CARB in 2002 and is continually being updated.

The MV emissions provided by the CARB were based on the EMFAC2001 emission factor model (version 2.02; CARB, 2001a) and transportation model activity data for a 1997 weekday. The CARB provided separate emissions files for light- and heavy-duty vehicles for each county in the Southern California Association of Governments (SCAG) area (Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties). Outside the SCAG area, light- and heavy-duty MV emissions were combined in a single emissions file. Within each MV emissions file, the emissions were resolved by pollutant type (VOC, NOx, carbon monoxide [CO]) and emissions mode (start, gasoline exhaust, diesel exhaust, several gasoline evaporative emissions modes). Mobile source emissions had some day-to-day variation because of temperature effects.

The other anthropogenic emissions included non-road mobile sources, area sources, and point sources. There were some day-to-day variations for shipping, aircraft emissions, and point sources. Wildfire emissions were included based on acreage burned and made significant contributions to emission totals on August 5–7, 1997 because of a wildfire in northern Ventura County. However, this wildfire had little impact on ozone levels in the LA basin because the emissions and subsequent ozone formation occurred far from the basin. Biogenic VOC emissions were estimated using the BEIGIS model (CARB, 2001b) and varied between 361 and 494 tons/day depending on the day-specific temperatures.

The emission totals presented in Table 2-3 are calculated from CAMx-ready emission files for the modeling domain shown in Figure 2-5. This has the advantage of ensuring that the totals represent exactly the emissions that were used in the modeling. The only difficulty is in calculating VOC emission totals in tons because the CAMx-ready emission files are in moles. The conversion from moles to tons is not well-defined for either of the lumped mechanisms used here (CB4 and SAPRC99) because the lumped VOC species represent actual species with a range of molecular weights. Table 2-3 was prepared from the CB4 emissions files following the established convention of converting moles to tons by assuming VOC molecular weights of 16 grams per Carbon. This overstates the mass of compounds that have C:H ratios lower than 4:1, but understates the mass of compounds that contain atoms other than C and H, such as oxygenates. Since the VOC tons would differ for the same emissions speciated as CB4 or SAPRC99, emission totals for CB4 speciated VOC emissions are used throughout this report.

Table 2-3. Emission totals (tons/day) for the CAMx-CB4 modeling of August 3-7, 1997.

	Sunday 3-Aug-97	Monday 4-Aug-97	Tuesday 5-Aug-97	Wednesday 6-Aug-97	Thursday 7-Aug-97
NOx					
On-road Mobile	674.5	923.8	985.7	950.2	938.0
Other surface	400.8	470.5	471.1	471.1	471.1
Point source	129.1	132.9	116.2	120.5	129.6
Wildfire	4.4	0.9	47.5	234.7	105.6
Biogenic	0.0	0.0	0.0	0.0	0.0
Total	1208.8	1528.1	1620.5	1776.4	1644.3
VOC					
On-road Mobile	746.2	813.9	913.7	854.0	791.1
Other surface	918.4	781.6	812.8	792.4	763.7
Point source	9.0	9.2	8.6	8.8	9.2
Wildfire	24.3	4.9	260.6	1286.3	576.2
Biogenic	361.3	381.8	494.2	419.8	313.7
Total	2059.3	1991.5	2489.8	3361.2	2453.9
CO					
On-road Mobile	6031.2	7015.6	7458.9	7277.2	6918.3
Other surface	2598.8	1157.4	1157.4	1157.4	1157.4
Point source	42.2	45.1	43.4	43.8	44.6
Wildfire	169.7	33.9	1825.7	9018.8	4058.2
Biogenic	0.0	0.0	0.0	0.0	0.0
Total	8841.9	8252.0	10485.4	17497.3	12178.6

Notes:
1. On-road mobile emissions are from EMFAC2001.
2. Other surface emissions include off-road mobile and area sources.
3. VOC is the sum of CB4 species assuming molecular weights of 16 per Carbon to account for average carbon/hydrogen/oxygen ratios in VOC.
4. NOx includes HONO emissions.

Adjusting Emissions for Different Versions of EMFAC

The on-road mobile source emission inventories provided by the CARB (Allen, 2001) were based on EMFAC 2001. The objective of this study was to evaluate impacts of using different EMFAC versions. In general, on-road mobile source emissions are calculated by multiplying an emission factor (e.g., g/mile) by an activity factor (e.g., vehicle miles traveled, or VMT). Ideally, we would have held VMT constant and multiplied by emission factors from the different versions of EMFAC. In practice, this approach could not be used for several reasons:

1. The activity data used by the CARB were not available, only the emissions were provided.

2. The multiplication of VMT by emission factors is a complex calculation for the Los Angeles on-road vehicle inventories and was performed by the CARB using the Direct Travel Impact Model (DTIM) from the California Department of Transportation. EMFAC7G works with DTIM version 3, whereas EMFAC2001 and EMFAC2002 work with DTIM version 4. Therefore, differences between DTIM3 and DTIM4 would confound differences between EMFAC7G and EMFAC2002/2002.

3. The CARB adjusted the emissions calculated using EMFAC2001/DTIM4 in a post-processing step. The objective of the post-processing was to make the emissions totals calculated by EMFAC2001/DTIM4 consistent with emission totals calculated by EMFAC2001. EMFAC2001 can calculate emission totals, in addition to emission factors, using built in activity data (this corresponds to the older BURDEN methodology used until EMFAC7G). The CARB decided that the EMFAC total emissions for certain emission categories were preferable and therefore adjusted the EMFAC/DTIM emissions to match. No documentation was available for this adjustment, and therefore developing corresponding adjustments for EMFAC7G and EMFAC2002 would have been impossible.

An alternate approach was used to develop on-road mobile source emission inventories for modeling that reflected the EMFAC7G and EMFAC2002 models. Ratios of emission totals were calculated between different EMFAC versions (e.g., EMFAC7G/EMFAC2001 emission ratios) and multiplied into the EMFAC2001-based emission inventories. The EMFAC emission ratios were specific to:

- Pollutant (VOC, NOx, CO)
- County
- Vehicle type (light-duty and heavy-duty vehicles)

- Emissions mode:
    - Catalyst cold exhaust
    - Catalyst hot exhaust
    - Non-catalyst cold exhaust
    - Non-catalyst hot exhaust
    - Hot soak
    - Diurnal
    - Diesel exhaust
    - Running evaporatives
    - Resting evaporatives
    - Multi-day resting evaporatives
    - Multi-day diurnal

Applying separate EMFAC emission ratios for light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs) was possible only for the five counties within the Southern California Association of Governments (SCAG) area, i.e., Los Angeles, Orange, Ventura, San Bernardino and Riverside. For counties outside the SCAG area, the LDV and HDV emissions were adjusted using combined ratios.

The main advantages of preparing EMFAC7G and EMFAC2002 emissions using "EMFAC emission ratios" are simplicity and a direct relationship to emission totals reported by the EMFAC models for each county. A possible disadvantage is that the EMFAC emission ratios reflect changes both in emission factors and activity data built into EMFAC. The merits of this approach are unclear because of the complicated methodology used by the CARB to calculate the base EMFAC2001 emissions. The potential problem is that activity is not held constant across versions of EMFAC. However, because CARB post-processed the EMFAC2001/DTIM4 based emissions to match EMFAC2001 emissions for some categories (discussed above), matching the EMFAC activity and emission factor changes may be the appropriate methodology. At any rate, the EMFAC emission ratios were used because the approach was feasible with the available information.

The results of applying EMFAC emission ratios to the EMFAC2001/DTIM4 based modeling emissions are shown in Table 2-4, which reports the on-road mobile source emission totals (tons/day) for Tuesday, August 5, 1997. As noted above, the VOC emissions in Table 2-4 are for the CB4 mechanism for consistency. Minor differences in the EMFAC2001 total emissions between Table 2-4 and 2-5 are due to rounding. The results can be summarized as follows:

Changes from EMFAC7G to EMFAC2001

- 30% decrease in NOx
- 21% increase in VOC
- 28% increase in CO

Changes from EMFAC2001 to EMFAC2002

- No change in NOx (to the nearest percent)
- 17% increase in VOC
- 8% increase in CO

Table 2-4. On-road mobile source emission totals (tons/day) for the CAMx-CB4 modeling of Tuesday August 5, 1997 with different versions of EMFAC.

	NOx	VOC	CO	VOC/NOx[4]
EMFAC2001				
Los Angeles LDV	301.3	473.7	3889.0	
Orange LDV	99.6	146.1	1262.4	
Riverside LDV	67.4	92.1	682.1	
San Bernardino LDV	63.9	93.8	694.5	
Ventura LDV	20.4	35.8	248.2	
Los Angeles HDV	197.0	24.4	201.6	
Orange HDV	42.8	5.9	44.5	
Riverside HDV	71.4	6.4	73.8	
San Bernardino HDV	73.7	6.5	67.3	
Ventura HDV	11.7	2.1	15.7	
Imperial LDV + HDV	0.7	0.5	5.4	
Kern LDV + HDV	8.5	5.4	66.7	
San Diego LDV + HDV	27.4	21.1	208.0	
Total	**985.8**	**913.8**	**7459.2**	**3.0**
EMFAC7G				
Los Angeles LDV	277.5	312.6	2268.6	
Orange LDV	119.8	120.3	1018.5	
Riverside LDV	94.5	81.2	592.6	
San Bernardino LDV	134.8	126.3	898.2	
Ventura LDV	28.8	28.4	232.7	
Los Angeles HDV	139.4	12.9	79.9	
Orange HDV	29.5	2.8	18.4	
Riverside HDV	160.7	8.1	56.8	
San Bernardino HDV	263.7	15.9	98.8	
Ventura HDV	7.3	0.6	3.6	
Imperial LDV + HDV	0.5	0.2	1.6	
Kern LDV + HDV	1.3	0.4	3.8	
San Diego LDV + HDV	25.1	14.3	117.6	
Total	**1282.9**	**724.0**	**5391.1**	**1.9**
EMFAC2002				
Los Angeles LDV	319.6	564.3	4290.2	
Orange LDV	103.7	166.9	1330.3	
Riverside LDV	74.9	106.7	765.4	
San Bernardino LDV	68.6	108.4	743.8	
Ventura LDV	22.4	42	276.6	
Los Angeles HDV	181.4	25.2	182.1	
Orange HDV	41.8	5.4	36.1	
Riverside HDV	57.6	6.0	59.3	
San Bernardino HDV	64.5	6.5	54.9	
Ventura HDV	10.4	1.9	13.6	
Imperial LDV + HDV	0.8	0.7	7.8	
Kern LDV + HDV	8.9	6.4	72.2	
San Diego LDV + HDV	28.7	26.4	239.5	
Total	**983.3**	**1066.8**	**8071.8**	**3.6**

Notes:
1. LDV is light-duty vehicles and HDV is heavy-duty vehicles.
2. VOC is the sum of CB4 species assuming molecular weights of 16 per Carbon to account for average carbon/hydrogen/oxygen ratios in VOC.
3. NOx includes HONO emissions.
4. VOC/NOx ratio in molesC/moles.

Table 2-5. Ratios of on-road mobile source emissions for SCAG counties in the CAMx modeling domain for August 5, 1997 with different versions of EMFAC.

	NOx	VOC	CO
EMFAC7G/EMFAC2001			
Los Angeles	0.84	0.65	0.57
Orange	1.05	0.81	0.79
Riverside	1.84	0.91	0.86
San Bernardino	2.90	1.42	1.31
Ventura	1.12	0.77	0.90
SCAG Total	**1.32**	**0.80**	**0.73**
EMFAC2002/EMFAC2001			
Los Angeles	1.01	1.18	1.09
Orange	1.02	1.13	1.05
Riverside	0.95	1.14	1.09
San Bernardino	0.97	1.15	1.05
Ventura	1.02	1.16	1.10
SCAG Total	**1.00**	**1.17**	**1.08**

Notes:
1. EMFAC2001 is the denominator because the base emissions (Table 2-3) were for EMFAC2001.
2. VOC is the sum of CB4 species assuming molecular weights of 16 per Carbon to account for average carbon/hydrogen/oxygen ratios in VOC.
3. NOx includes HONO emissions.

Model Performance for Ozone

Model performance for ozone was evaluated using hourly ozone data from 48 sites in the modeling domain. The U.S. Environmental Protection Agency (EPA) established statistical performance goals for 1-hour ozone modeling for three statistical measures (EPA, 1996):

- Accuracy of the predicted peak 1-hour ozone. The ratio of the highest predicted 1-hour ozone to the highest observed 1-hour ozone. The EPA goal is within +/- 20% error.

- Normalized bias for observed values above 60 ppb – a measure of whether the model tends to over or under-predict high 1-hour ozone values. The EPA goal is within +/- 15% normalized bias.

$$Normalized\ Bias = 100\left(\frac{1}{N}\right)\sum\left(O_{tl} - E_{tl}\right)/O_{tl}$$

  Where O_{tl} and E_{tl} are, respectively, the observed and estimated hourly ozone concentration at site l and time t (i.e., matched by time and location).

- Gross error for observed values above 60 ppb – a measure of overall agreement for high ozone values calculated from the un-signed differences between O_{tl} and E_{tl}. The EPA goal is less than 35% normalized gross error.

$$Normalized\ Gross\ Error = 100\left(\frac{1}{N}\right)\sum |O_{tl} - E_{tl}| / O_{tl}$$

There are no similar statistical performance goals for 8-hour ozone performance. EPA's modeling guidance for 8-hour ozone (EPA, 1999) emphasizes consideration of whether model results are consistent with a conceptual understanding of what happened during the episode period. The modeled geographic distribution of high ozone levels is discussed relative to the conceptual model for the episode presented above.

Six modeling scenarios were evaluated:

1. CB4 chemistry with EMFAC7G emissions.
2. CB4 chemistry with EMFAC2001 emissions.
3. CB4 chemistry with EMFAC2002 emissions.
4. SAPRC99 chemistry with EMFAC7G emissions.
5. SAPRC99 chemistry with EMFAC2001 emissions.
6. SAPRC99 chemistry with EMFAC2002 emissions.

Statistical Evaluation of Ozone Model Performance

Modeled 1-hour ozone levels were statistically evaluated using metrics recommended by the EPA as reported in Table 2-6a and shown graphically for easier comparison in Figure 2-6. In Table 2-6, performance measures that are outside the range of EPA goal are shaded. Statistical measures were calculated for the three days after the spin-up period, August 5-7, 1997. The statistical measures shown in Table 2-6 reflect the errors in the ozone predictions due to all components in the modeling system, not just the EMFAC model. The main findings from the 1-hour ozone statistics are as follows:

- The only scenario to meet all the EPA performance goals on August 5-7 was with CB4 chemistry and EMFAC7G emissions. The normalized bias was very low on all three days at between 1% and 4%. The gross error was well within the target range of 35% at between 22% and 28%.

- The model performance for EMFAC7G emissions with SAPRC99 chemistry did not meet the EPA goal because the normalized bias was too high on August 6 and 7 meaning that the ozone levels with SAPRC99 were systematically higher than observed.

- Model performance was always poorer with SAPRC99 than CB4 chemistry for a given set of EMFAC emissions. The reason for this was higher ozone levels with SAPRC99 than CB4, as shown by more positive normalized bias measures. The normalized bias with SAPRC99 was greater than 15% (and thus outside the range of the EPA goal) in 8 of 9 cases, the exception being with EMFAC7G emissions on August 5 when the bias was 13.5%.

- Model performance was very similar for EMFAC2001 and EMFAC2002 with either CB4 chemistry or SAPRC99 chemistry (although poorer with SAPRC99 than CB4, as discussed above.)

- For EMFAC2001 and EMFAC2002 with CB4 chemistry, 8 of 9 model performance measures were inside the EPA goal. The measure that did not meet the EPA goal was the accuracy of the peak on August 6, which was too high. The accuracy of the peak is the least robust measure of the total model performance because it rests on a single pair of values. However, the normalized bias was systematically high for both EMFAC2001 and EMFAC2002 indicating a tendency toward ozone over-prediction.

- For EMFAC2001 and EMFAC2002 with SAPRC chemistry, only 2 of 9 model performance measures were inside the EPA goal, which is poor performance.

Model performance statistics for 8-hour ozone are shown in Table 2-6b. In general, the 8-hour model performance was slightly poorer than for 1-hour ozone because of a slightly greater tendency toward over-prediction, but showed the same trends as described above for 1-hour ozone.

Graphical Evaluation of Ozone Model Performance

The spatial distributions of daily maximum 1-hour ozone levels with CB4 chemistry and EMFAC2001 emissions are shown along with the observed values at all monitoring sites in Figure 2-7. The CB4 chemistry/EMFAC2001 emissions scenario is shown and discussed first because:

- The EMFAC2001 emissions were the base emissions provided by the CARB and thus contain no additional uncertainties from “EMFAC emission ratio” adjustments.

- Model performance with CB4 was much better than with SAPRC99.

August 5, 1997: The observed ozone peak on August 5 was 187 ppb at Riverside (Rubidoux). CAMx/CB4/EMFAC2001 predicted a maximum of 139 ppb at this location. The predicted peak was 172 ppb (8 percent lower than the observed peak) to the north of Azusa in an area of the San Gabriel Mountains without monitors approximately 60-km to the northwest of Riverside. The distribution of both modeled and observed maximum ozone levels shows relatively little transport of high ozone levels through the mountain passes to the north and east of the Los Angeles basin (the terrain displayed in Figure 2-5 shows the location of the passes). This pattern is consistent with the conceptual model for this day presented above and is due to offshore pressure gradient opposing the onshore sea breeze. Model performance on this day is reasonable, but the peak is under-predicted.

August 6, 1997: The observed ozone peak on August 6 was 154 ppb at Crestline (Lake Gregory). CAMx/CB4/EMFAC2001 predicted a maximum of 166 ppb at this location. The predicted peak was 187 ppb (21 percent higher than the unpaired peak) just to the north of Redlands approximately 25-km to the southeast of Crestline. High ozone levels were also observed in the San Fernando Valley on this day, 134 ppb at Simi Valley and 132 ppb at Santa Clarita, where CAMx predicted 129 ppb and 145 ppb, respectively. The distribution of both modeled and observed maximum ozone levels shows some transport of high ozone levels through the mountain passes due to a weakening of the offshore pressure gradient, as discussed above in the conceptual model. The spatial distribution of modeled ozone is very good on this day, but the peak is over-predicted.

August 7, 1997: The observed ozone peak on August 7 was 150 ppb at Lake Elsinore. CAMx/CB4/EMFAC2001 predicted a maximum of 97 ppb at this location. The predicted peak was 163 ppb (8 percent higher than the unpaired peak) near Redlands/San Bernardino and approximately 60-km to the northeast of Lake Elsinore. The Lake Elsinore monitor is isolated from other monitors so that it is difficult to interpret the difference between the modeled and observed levels in this area. Apart from the peak at Lake Elsinore, the highest observed ozone levels were in the San Bernardino area and through the passes (near Banning, Crestline and Santa Clarita) and the modeling reproduced this pattern. The high ozone levels through the mountain passes are due to a return to onshore pressure gradients on this day, as discussed above in the conceptual model. The spatial distribution of modeled ozone is good on this day, with the exception of the observed peak at Lake Elsinore.

The impact of changing from the CB4 to the SAPRC99 chemical mechanism can be seen by comparing Figure 2-8 to Figure 2-7. Figure 2-8 shows the spatial distributions of daily maximum 1-hour ozone levels with SAPRC99 chemistry and EMFAC2001 emissions as well as the observed values. Modeled ozone levels were higher throughout the modeling domain with SAPRC99 than with CB4, but the spatial distributions of high ozone are similar. The statistical evaluation of 1-hour ozone levels presented above showed that ozone levels were systematically over-predicted with the SAPRC99 chemistry. The locations of the modeled peak ozone were similar between SAPRC99 and CB4 on August 5 and 6, but on August 7 the modeled peak with SAPRC99 occurred further west (upwind) than with CB4 in poorer agreement with the observations showing that the highest ozone levels occurred far downwind through the mountain passes. The movement of ozone and/or precursors out over the Pacific Ocean on August 5 and 6 is more pronounced with SAPRC99 than with CB4, and the ozone levels at Catalina Island are better reproduced by SAPRC99. This is a chemistry effect since the meteorology is the same in both cases. This is part of a modeled ozone re-circulation mechanism since the high ozone levels over the Pacific Ocean are brought back onshore by the sea breeze.

The emission inventory (Table 2-3) includes emissions from wildfires that are dominated by a large fire in northeastern Ventura County. The emissions attributed to this fire caused significant ozone production on August 6 as seen in the ozone isopleth plots in Figures 2-7 and 2-8. The wildfire emissions caused the isolated area of high ozone near the top left corner of the modeling domain, and modeled ozone levels exceed 140 ppb with SAPRC99 and 120 ppb with CB4. However, these emissions are separated from the LA basin by mountains and had no adverse impact on the study results.

Time series comparisons of hourly ozone for August 5-7 at several locations are shown in Figures 2-9 and 2-10 for CB4 and SAPRC99, respectively. The locations were selected to include upwind locations nearer the coast (Los Angeles North Main Street and Burbank), mid-basin sites (Azusa and Fontana) and downwind locations in and through the Cajon pass

(Crestline and Hesperia). With CB4 chemistry and EMFAC2001 emissions, the timing of the daily maximum ozone is fairly good at all sites on all days. There is some tendency for maximum ozone levels to be over-predicted at the mid-basin sites from LA North Main to Fontana. Ozone levels were similar with EMFAC7G to EMFAC2001 emissions at the sites in Los Angels County (Burbank, LA North Main an Azusa) but lower with EMFAC7G at sites in San Bernardino County (Fontana, Crestline) and similar at Hesperia. The lower ozone at Fontana and Crestline results from the higher NOx emissions with EMFAC7G in San Bernardino County, discussed above (Tables 2-1 and 2-3). Modeled ozone levels with SAPRC99 (Figure 2-10) are higher than with CB4 (Figure 2-9) at all sites, as discussed above. The timing of the daily maximum ozone is very similar between SAPRC99 and CB4. As for CB4, ozone levels with SAPRC99 were similar with EMFAC7G to EMFAC2001 in Los Angeles County, but lower in San Bernardino County due to higher NOx emissions. The time series of ozone with EMFAC2002 emissions are not shown because they were nearly identical to EMFAC2001 for both CB4 and SAPRC99.

The impact of EMFAC version on spatial distributions of daily maximum 1-hour ozone levels is compared for August 6 in Figure 2-11 for the CB4 chemistry, and Figure 2-12 for the SAPRC99 chemistry. The daily maximum ozone levels are almost the same with EMFAC2001 and EMFAC2002. The main differences between EMFAC7G and EMFAC2001 are in the San Bernardino and Riverside County areas where maximum ozone levels are distinctly lower with EMFAC2001 than EMFAC7G. The lower ozone levels in San Bernardino and Riverside Counties result from higher NOx emissions with EMFAC7G (Tables 2-1 and 2-3), which suppress ozone. Suppression of high ozone by NOx implies that in these downwind areas the ozone formation is VOC-limited, and this is confirmed by emissions sensitivity tests described below.

Model Performance for Ozone Precursors

A detailed evaluation of modeled versus observed ozone precursor data is presented in sections 3 and 4 of this report. The evaluation for VOC/NOx ratio is summarized here. It can be difficult to compare modeled and observed precursor levels on an absolute basis because the precursor concentrations show strong diurnal cycles and are strongly influenced by emission rate, dispersion and chemistry. To mitigate these factors, morning VOC/NOx ratios are often evaluated to minimize differences in dispersion and the effects of chemical reaction. Another advantage of evaluating VOC/NOx ratio is that ozone formation has been shown to depend strongly upon this attribute of the emission inventory in ways that are well-understood.

Observed VOC/NOx ratios were calculated from PAMS data for four locations: LA North Main, Pico Rivera and Azusa in Los Angeles County and Upland in San Bernardino County (see Figure 2-5 for site locations). The average 6-9 a.m. VOC/NOx ratio from the ambient data for August 4-7 was 3.9 ± 0.4. This episodic ratio is consistent with the long term 1999-2000 average 6-9 a.m. VOC/NOx ratio at the same sites of 4.0 ± 0.2. The corresponding modeled VOC/NOx ratio with CB4 and EMFAC2001 was 3.7 ± 0.2, which is not significantly different from the observed ratio. The modeled VOC/NOx ratio with EMFAC2002 was nearly the same, but the modeled ratio with EMFAC7G was lower (about 3.4) primarily due to a very low ratio at the Upland site in San Bernardino County. The large difference between the modeled VOC/NOx ratio with EMFAC7G at Upland from all other sites is not reasonable and shows that the methodology used to calculate the EMFAC7G modeling emission inventory produced unreasonable results.

The modeled VOC/NOx ratio with SAPRC99 and EMFAC2001 was 3.2 $\pm$ 0.2, which is lower than the CB4 value of 3.7 $\pm$ 0.2 discussed above. The lower VOC/NOx ratio with SAPRC99 may be due partly to chemical differences related to the more reactive SAPRC99 chemistry, but a contributing factor also seems to be the way carbon is counted in assigning compounds to the lumped molecule classes of the SAPRC99 fixed parameter mechanism. This issue deserves further investigation.

Table 2-6a. Summary of 1-hour ozone model performance measures.

Performance Measure	August 5th	August 6th	August 7th
CB4 Chemistry, EMFAC7G Emissions			
Peak Observation (ppb)	187.0	154.0	150.0
Peak Prediction (ppb)	163.6	168.7	159.7
Accuracy of Peak (%)	-12.5	9.5	6.5
Normalized Bias (%)	1.3	3.6	3.4
Normalized Gross Error (%)	22.6	25.1	28.0
CB4 Chemistry, EMFAC2001 Emissions			
Peak Observation (ppb)	187.0	154.0	150.0
Peak Prediction (ppb)	171.6	187.0	162.6
Accuracy of Peak (%)	-8.2	21.4	8.4
Normalized Bias (%)	6.9	10.7	9.5
Normalized Gross Error (%)	23.2	26.5	29.9
CB4 Chemistry, EMFAC2002 Emissions			
Peak Observation (ppb)	187.0	154.0	150.0
Peak Prediction (ppb)	174.1	189.8	163.7
Accuracy of Peak (%)	-6.8	23.2	9.1
Normalized Bias (%)	7.8	12.0	10.3
Normalized Gross Error (%)	23.8	27.4	30.5
SAPRC99 Chemistry, EMFAC7G Emissions			
Peak Observation (ppb)	187.0	154.0	150.0
Peak Prediction (ppb)	179.1	184.6	177.8
Accuracy of Peak (%)	-4.2	19.9	18.5
Normalized Bias (%)	13.5	17.5	18.9
Normalized Gross Error (%)	27.7	32.6	33.8
SAPRC99 Chemistry, EMFAC2001 Emissions			
Peak Observation (ppb)	187.0	154.0	150.0
Peak Prediction (ppb)	187.9	210.1	183.7
Accuracy of Peak (%)	0.5	36.4	22.5
Normalized Bias (%)	19.6	25.4	25.5
Normalized Gross Error (%)	30.1	36.1	37.2
SAPRC99 Chemistry, EMFAC2002 Emissions			
Peak Observation (ppb)	187.0	154.0	150.0
Peak Prediction (ppb)	190.1	210.1	187.0
Accuracy of Peak (%)	1.7	36.4	24.7
Normalized Bias (%)	20.6	26.8	26.5
Normalized Gross Error (%)	30.9	37.3	37.9

Notes:
1. Statistical measures were calculated for valid pairs with observed values > 60 ppb at 48 stations.
2. Shaded values fall outside the range of the EPA goal.

Table 2-6b. Summary of 8-hour ozone model performance measures.

Performance Measure	August 5th	August 6th	August 7th
CB4 Chemistry, EMFAC7G Emissions			
Peak Observation (ppb)	117.8	117.9	114
Peak Prediction (ppb)	126.8	128.3	138.1
Accuracy of Peak (%)	7.7	8.9	21.1
Normalized Bias (%)	3.8	6.1	4.6
Normalized Gross Error (%)	15.4	16.4	21.2
CB4 Chemistry, EMFAC2001 Emissions			
Peak Observation (ppb)	117.8	117.9	114
Peak Prediction (ppb)	132.4	146.2	145.5
Accuracy of Peak (%)	12.5	24.0	27.6
Normalized Bias (%)	10.4	14.0	10.8
Normalized Gross Error (%)	17	21.3	25.2
CB4 Chemistry, EMFAC2002 Emissions			
Peak Observation (ppb)	117.8	117.9	114
Peak Prediction (ppb)	134.5	148.6	146.5
Accuracy of Peak (%)	14.2	26.0	28.5
Normalized Bias (%)	11.4	15.2	11.5
Normalized Gross Error (%)	17.8	22.4	25.7
SAPRC99 Chemistry, EMFAC7G Emissions			
Peak Observation (ppb)	117.8	117.9	114
Peak Prediction (ppb)	141.5	143.7	152.9
Accuracy of Peak (%)	20.2	21.9	34.1
Normalized Bias (%)	16.5	20.6	19.4
Normalized Gross Error (%)	21.4	26.1	28.8
SAPRC99 Chemistry, EMFAC2001 Emissions			
Peak Observation (ppb)	117.8	117.9	114
Peak Prediction (ppb)	147.4	161.4	163.1
Accuracy of Peak (%)	25.2	36.9	43.1
Normalized Bias (%)	23.7	29.2	26.1
Normalized Gross Error (%)	26.9	33.2	33.7
SAPRC99 Chemistry, EMFAC2002 Emissions			
Peak Observation (ppb)	117.8	117.9	114
Peak Prediction (ppb)	149.4	163.9	164.6
Accuracy of Peak (%)	26.9	39.1	44.4
Normalized Bias (%)	24.8	30.5	27.0
Normalized Gross Error (%)	28	34.5	34.4

Notes:

3. Statistical measures were calculated for valid pairs with observed values > 60 ppb at 48 stations.
4. Shaded values fall outside the range of the EPA goals for 1-hour ozone, although has not proposed using these criteria for 8-hour ozone.

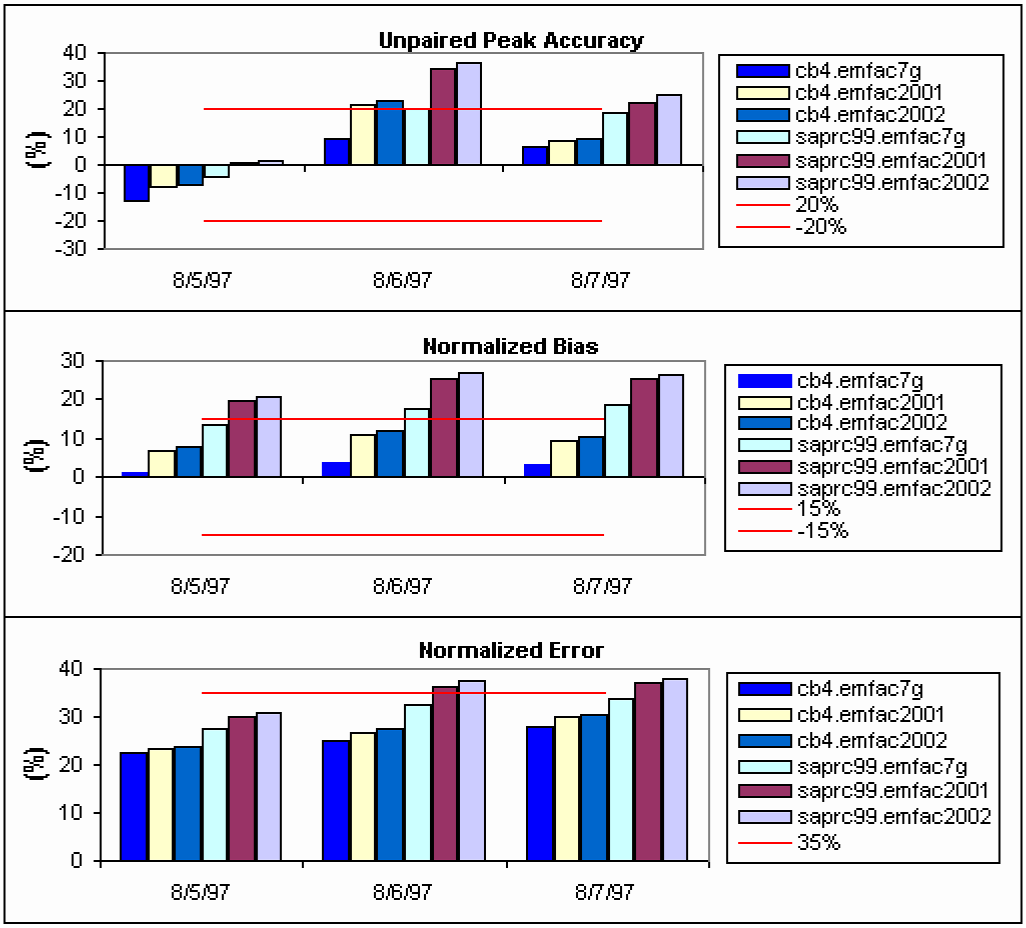


Figure 2-6. Graphical summary of 1-hour ozone model performance measures.

EMFAC2001
CB4
August 5, 1997

EMFAC2001
CB4
August 6, 1997

EMFAC2001
CB4
August 7, 1997

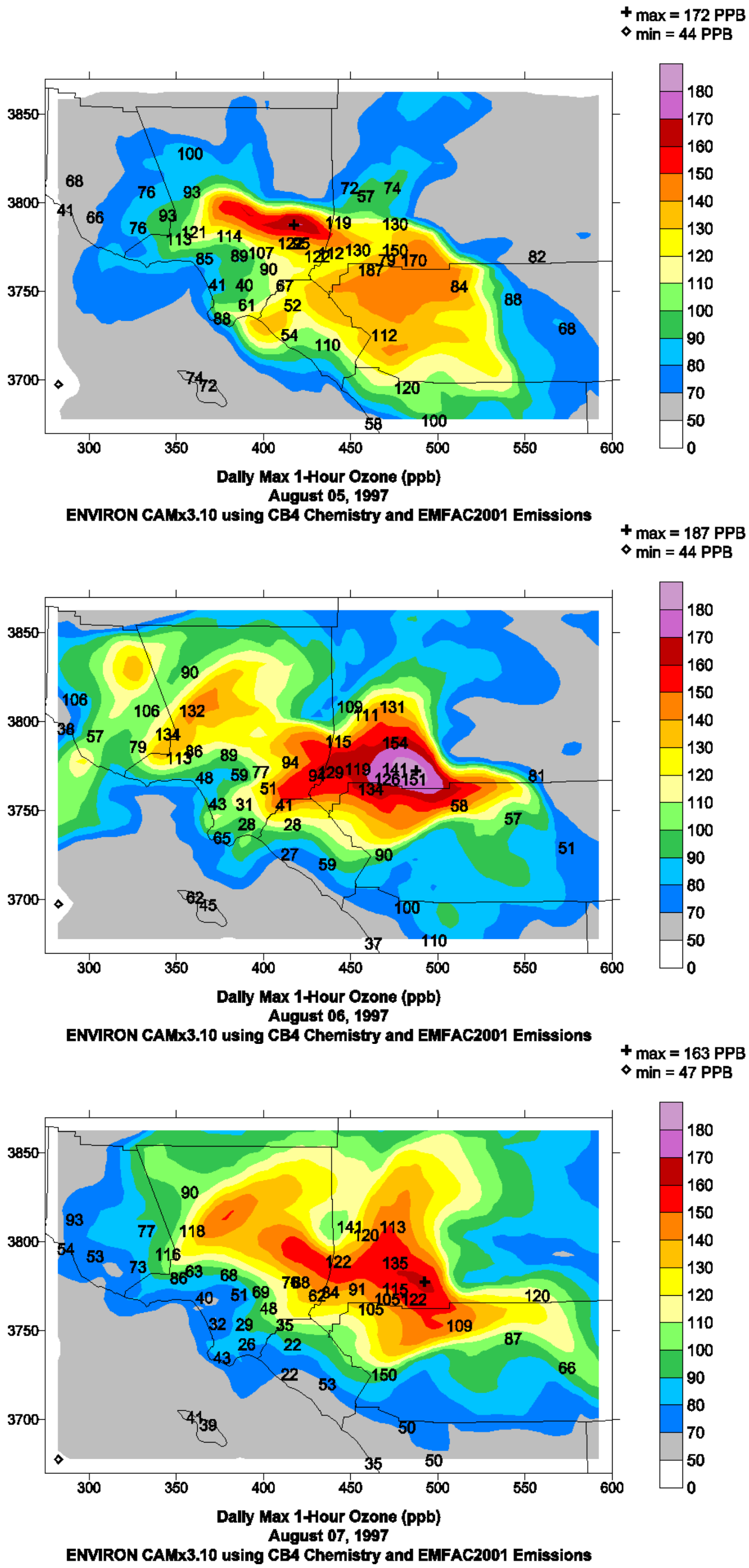
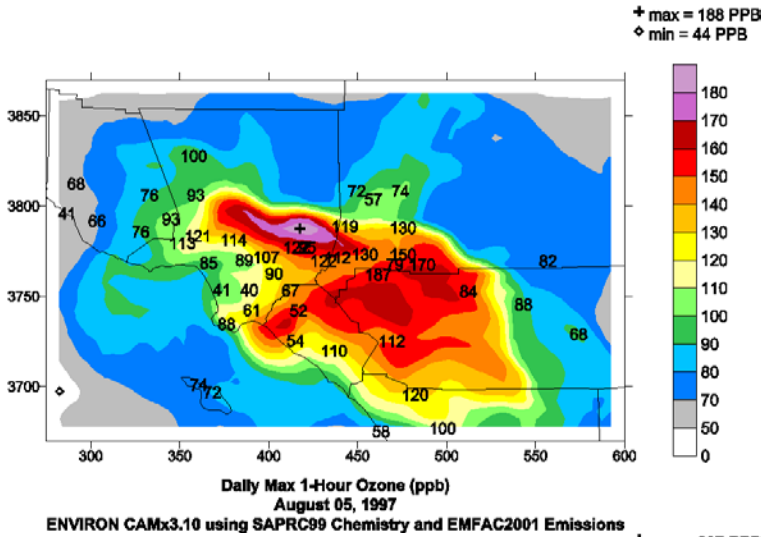
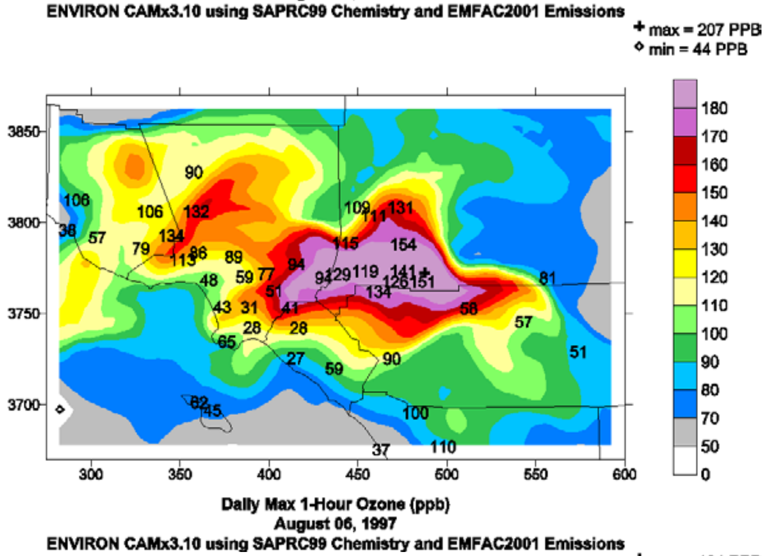


Figure 2-7. Comparison of daily maximum 1-hour ozone levels with EMFAC2001 emissions and CB4 chemistry for August 5-7, 1997.

EMFAC2001
SAPRC99
August 5, 1997



EMFAC2001
SAPRC99
August 6, 1997



EMFAC2001
SAPRC99
August 7, 1997

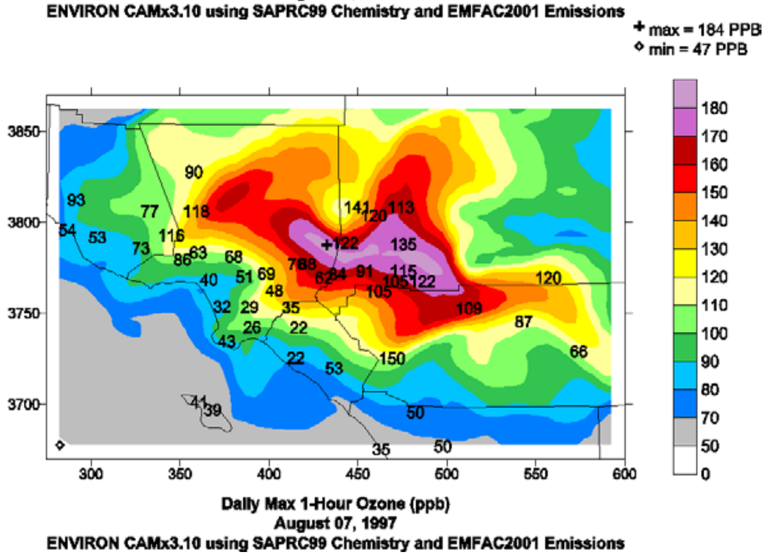


Figure 2-8. Comparison of daily maximum 1-hour ozone levels with EMFAC2001 emissions and SAPRC99 chemistry for August 5-7, 1997.

CAMx/CB4 with EMFAC2001 and EMFAC7G

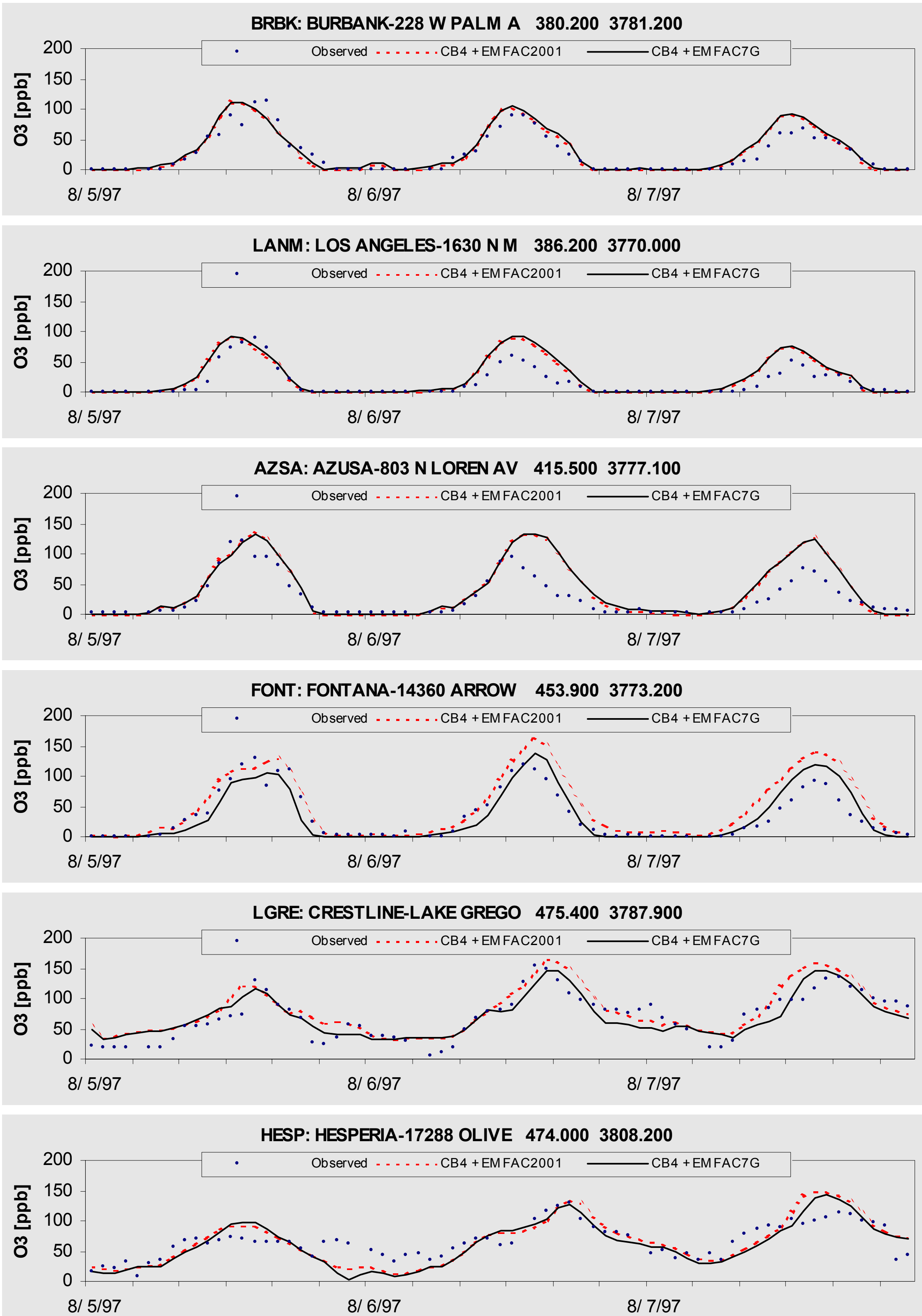


Figure 2-9. Time series comparison of CAMx-CB4 ozone with EMFAC2001 and EMFAC7G emissions to observed values for August 5-7, 1997.

CAMx/SAPRC99 with EMFAC2001 and EMFAC7G

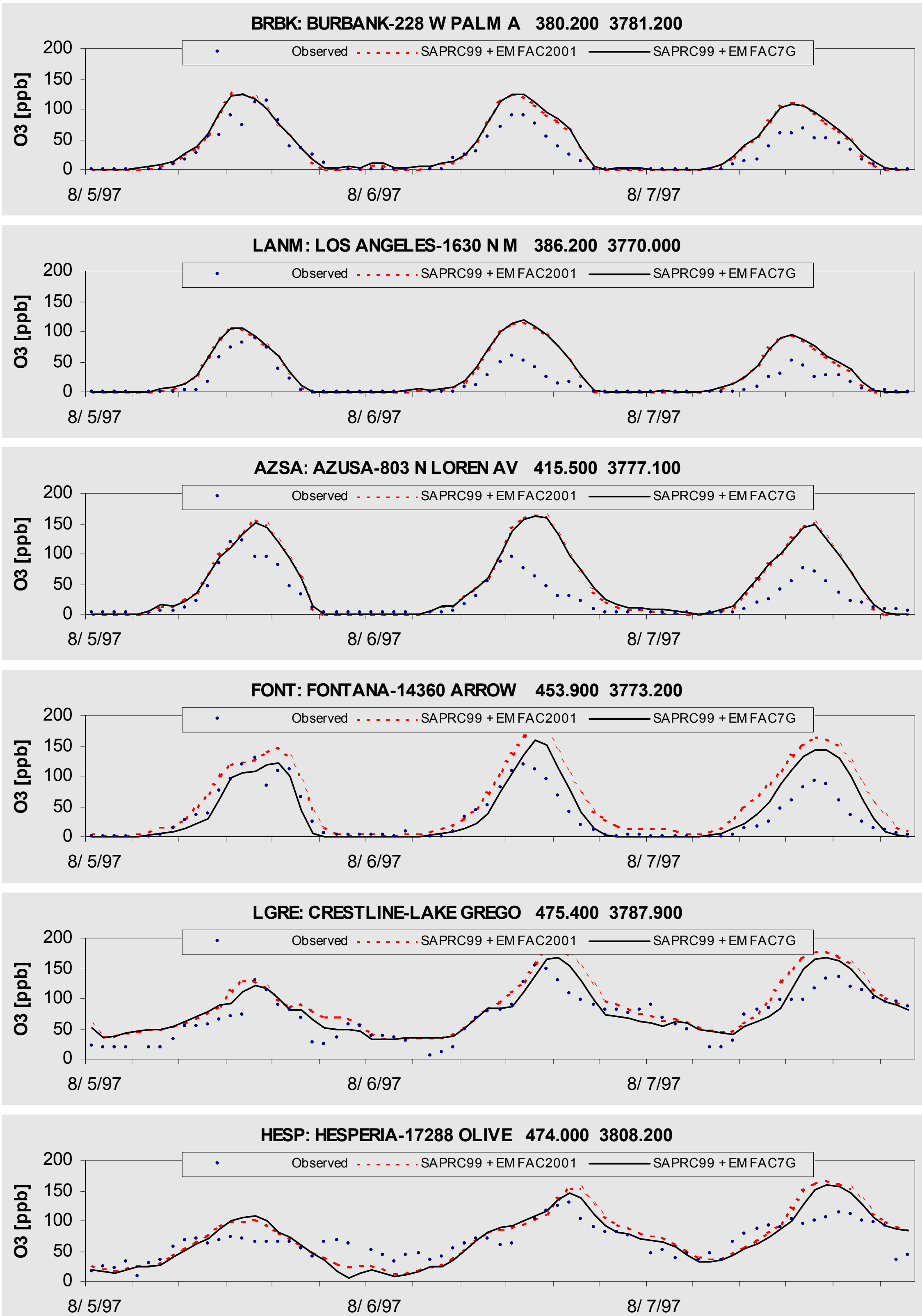


Figure 2-10. Time series comparison of CAMx-SAPRC99 ozone with EMFAC2001 and EMFAC7G emissions to observed values for August 5-7, 1997.

EMFAC7G
CB4
August 6, 1997

EMFAC2001
CB4
August 6, 1997

EMFAC2002
CB4
August 6, 1997

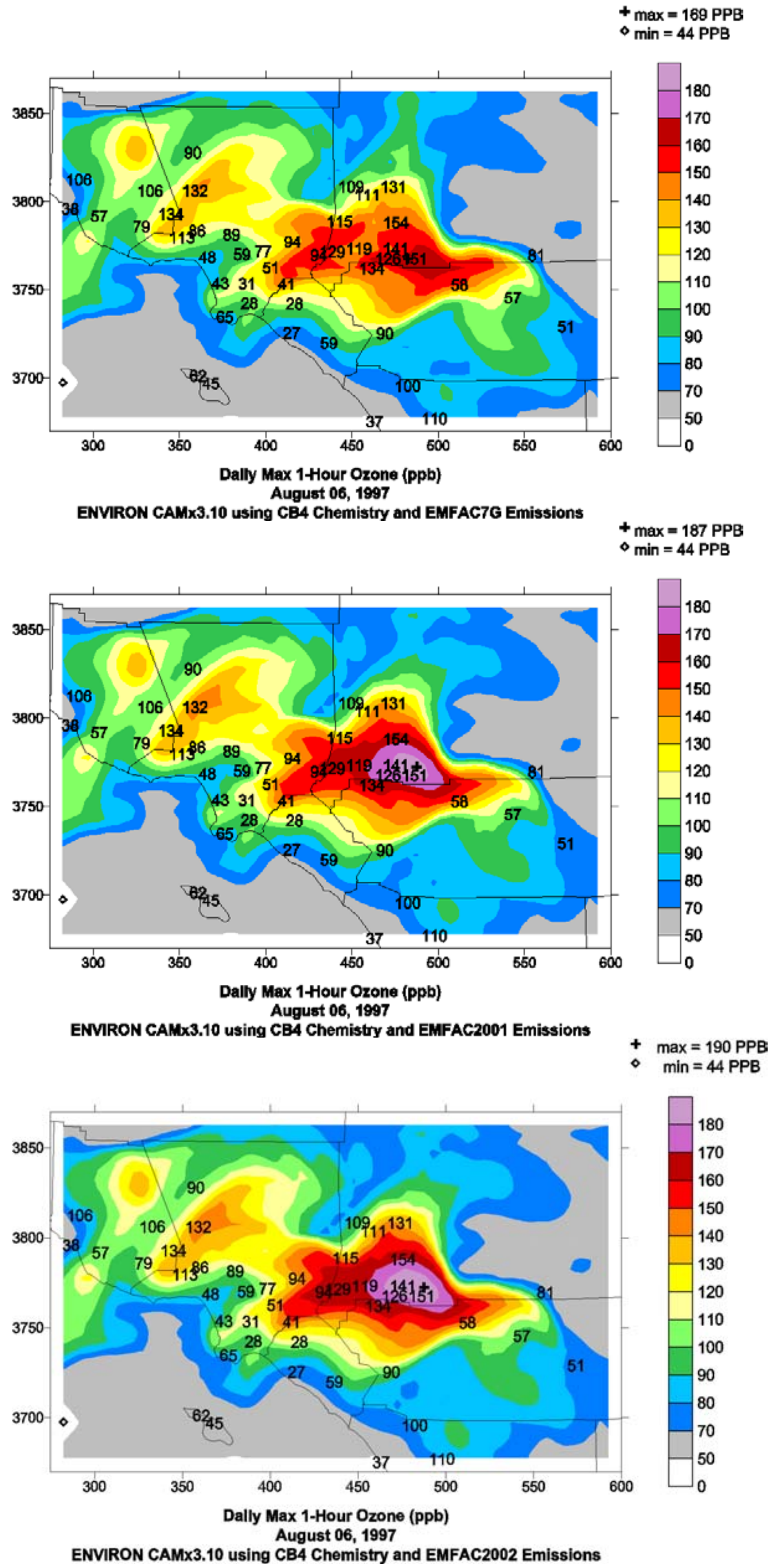
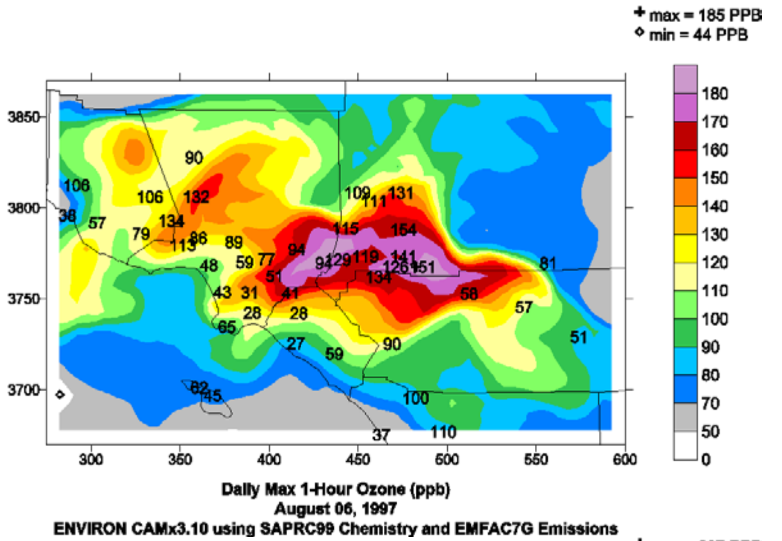
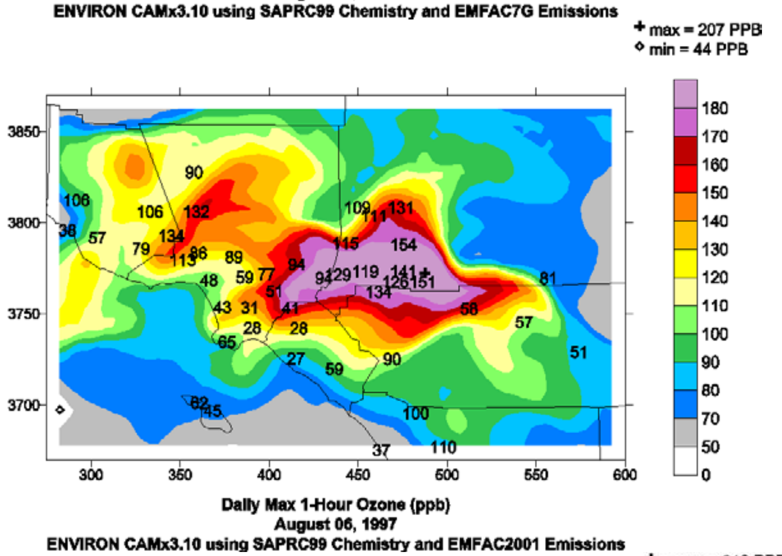


Figure 2-11. Comparison of daily maximum 1-hour ozone levels for August 6, 1997 with different EMFAC versions and CB4 chemistry.

EMFAC7G
SAPRC99
August 6, 1997



EMFAC2001
SAPRC99
August 6, 1997



EMFAC2002
SAPRC99
August 6, 1997

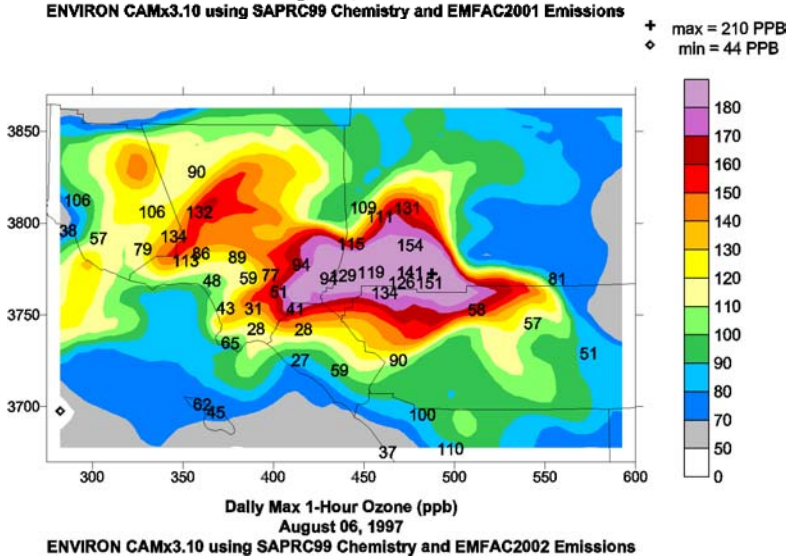


Figure 2-12. Comparison of daily maximum 1-hour ozone levels for August 6, 1997 with different EMFAC versions and SAPRC99 chemistry.

2.3 OZONE RESPONSE TO EMISSION REDUCTIONS FOR 1997 (EKMA DIAGRAMS)

To fully understand the impact of changes to EMFAC on ozone control strategies, the sensitivity ozone to emission reductions was investigated for reduction levels ranging from the base case all the way down to the deep (75%) reduction levels. The following matrix of 16 across the board reductions to anthropogenic VOC/CO and NOx emissions was completed for each scenario:

	100	X	X	X	X
NOx	75	X	X	X	X
level	50	X	X	X	X
(%)	25	X	X	X	X
		25	50	75	100
		VOC level (%)			

CO emissions were reduced concurrent with VOC emissions. Six sets of 16 matrix runs were completed for the following cases for a total of 96 runs:

- EMFAC7G emissions with CB4 chemistry
- EMFAC2001 emissions with CB4 chemistry
- EMFAC2002 emissions with CB4 chemistry
- EMFAC7G emissions with SAPRC99 chemistry
- EMFAC2001 emissions with SAPRC99 chemistry
- EMFAC2002 emissions with SAPRC99 chemistry

The emissions sensitivity analysis for EMFAC2001 was based directly on emission inventories provided by the ARB. The sensitivity analysis for EMFAC7G and EMFAC2002 relies upon our approach to adjusting emissions for different versions of EMFAC as described above.

The results were analyzed to show the impact of emission reductions on 1-hour and 8-hour ozone levels using EKMA diagrams. EKMA stands for the Empirical Kinetics Modeling Approach and an EKMA diagram shows how the maximum ozone level changes as VOC and NOx emissions are reduced, as illustrated in Figure 2-13. This figure shows the peak 1-hour ozone over the three-day period of August 5-7, 1997 with EMFAC 2001 emissions and CB4 chemistry. The axes are labeled with the scaling factors applied to the anthropogenic emissions[3] in the 1997 base case, which ranged between 1.0 and 0.25 (zero to 75% reduction). The peak ozone levels for the 16 matrix runs are shown as numbers in the figure. The isopleths in the figure were constructed by Kriging (an interpolation method) the sixteen values over a domain ranging from zero to 80% emissions reduction. This includes a small extrapolation outside the range of reductions evaluated, from 75% to 80%reduction. Kriging was selected as the interpolation method because it generally leads to "well-behaved" isopleth lines that are easy to follow. However, the construction of isopleths involves interpolation and therefore uncertainty.

[3] The wildfire emissions shown in Table 2-3 were scaled along with the anthropogenic emissions so that the peak ozone associated with the wildfire (over 120 ppb on August 6^{th}) would not become the limiting factor in the EKMA diagram.

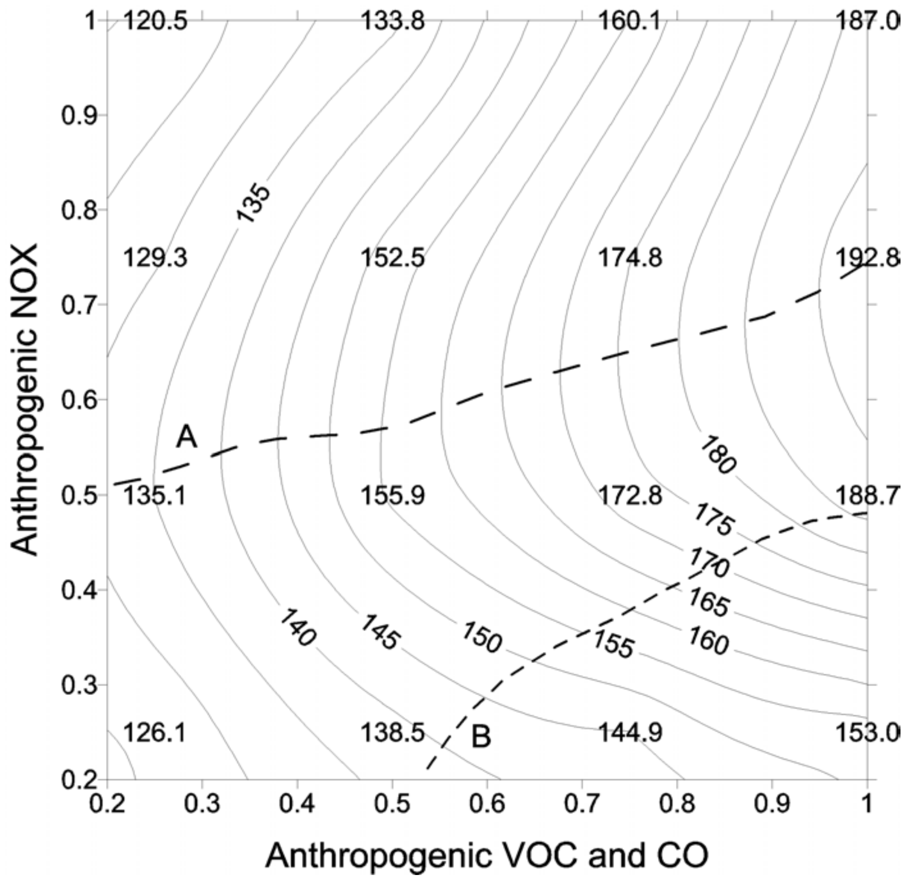


Figure 2-13. EKMA diagram for the basin-wide peak 1-hour ozone over August 5-7, 1997 with EMFAC 2001 emissions and CB4 chemistry.

The response of 1-hour ozone to emission reductions with EMFAC2001 emissions and CB4 chemistry (Figure 2-13) shows the effect of NO_x inhibition on ozone formation. Starting from the base-case (top right), when VOC emissions are decreased the peak ozone also decreases, but when NOx emissions are decreased the peak ozone increases at first before decreasing at higher NOx reduction levels. This increase in ozone when NOx is reduced is referred to as the NOx inhibition effect. There are two mechanisms involved in NO_x inhibition, as summarized in NRC (1991). First, NO directly removes ozone by the titration reaction $NO + O_3 \rightarrow NO_2 + O_2$. Consequently, if NO emissions are reduced, less ozone is destroyed by this titration reaction and ozone concentrations are higher. Second, the NO_2 formed from the ozone titration removes radicals by the reaction $NO_2 + OH \rightarrow HNO_3$. If NO_x emissions are reduced, the NO_2 concentration is lower, the radical concentration is higher, and formation of new ozone proceeds faster.

The NOx inhibition effect has implications for ozone control strategy development. As shown in Figure 2-13, reducing NOx emissions increases peak ozone until NOx emissions have been reduced by about 25 to 50%, depending upon the VOC emissions level. The dashed line (A) in Figure 2-13 links points of maximum peak ozone for a given VOC emissions level. This is often referred to as the ridgeline of the EKMA diagram. When NOx emissions are reduced to below the ridgeline, the peak ozone starts to fall again and returns to the level with 100% of the NOx emissions at dashed line (B). In other words, for any combination of VOC and NOx emissions lying above line B, the NOx reduction may be considered counter-productive for ozone because peak ozone would have been lower with zero NOx reduction. So, with base case VOC emission levels NOx reduction is counter-productive for less than 50% NOx reduction. Similarly, NOx reduction is counter-productive at less than 75% reduction with 40% reduced VOC emission levels.

The EKMA diagram shown in Figure 2-13 was for the peak ozone location, which is likely to change as emissions are reduced. Therefore, EKMA diagrams also were constructed for several fixed locations to show the effects of emission reductions at fixed locations. The three sites selected were Azusa (a mid-basin site), Riverside-Rubidoux (downwind in a high ozone location) and Crestline (far downwind in a mountain pass). Site locations are shown in Figure 2-5.

The EKMA diagrams also are composites over days to limit the number of displays. The time-series plots for base cases (Figures 2-9 and 2-10) show which days had the highest 1-hour ozone at each site:

- Azusa: The maximum modeled 1-hour ozone were similarly high on August 5-7, 1997.
- Riverside-Rubidoux: The time-series for Riverside is not included, but modeled 1-hour ozone levels at Riverside were similar to Fontana and were similarly high on August 6 and 7, 1997.
- Crestline: Modeled 1-hour ozone levels were similarly high on August 6 and 7, 1997.

The highest modeled peak 1-hour ozone levels with base emissions were on August 6, 1997, with the peak near Redlands, which is east of San Bernardino on the way to the Banning pass.

EKMA diagrams are shown in Figures 2-14 through 2-25 for 1-hour and 8-hour ozone, with CB4 and SAPRC99 chemistry and with EMFAC7G, EMFAC2001 and EMFAC2002 emissions. The EMFAC2001/CB4 diagrams are discussed first and then differences are noted for the other diagrams. EKMA diagrams for 1-hour ozone are discussed before EKMA diagrams for 8-hour ozone.

EKMA Diagrams 1-hour Ozone with EMFAC2001 and CB4

The EKMA diagrams for 1-hour ozone with EMFAC 2001 emissions and CB4 chemistry are shown in Figure 2-14. The peak ozone diagram at top left in Figure 2-14 was shown in Figure 2-13 and discussed above. Decreasing VOC always decreases the peak ozone. Decreasing NOx always initially increases the peak ozone until the NOx reductions reach line A in Figure 2-13. These findings indicate that the peak ozone is VOC-limited and shows a strong NOx inhibition effect (discussed above). Reducing NOx emissions beyond line A in Figure 2-13 reduces peak ozone, and peak ozone levels are the same as with base NOx emissions at line B. Reducing NOx emissions is counter-productive for reducing peak ozone above line B. With base VOC emissions, reducing NOx emissions leads to maximum peak ozone at about 30 percent reduction and is counter-productive at less than about 50 percent NOx reduction. With 50 percent reduced VOC emissions, reducing NOx emissions leads to maximum peak ozone at about 45 percent reduction and is counter-productive at less than >75 percent (about 80 percent) NOx reduction. These ranges of NOx emission reductions that increase peak 1-hour ozone levels are summarized in Table 2-7.

Figure 2-14 also shows the EKMA diagrams for fixed monitor locations for 1-hour ozone with EMFAC2001 emissions and CB4 chemistry. The Azusa site is more strongly VOC-limited than the peak ozone. With base VOC emissions, reducing NOx emissions leads to maximum peak ozone at about 50 percent reduction and is still counter-productive by 15 ppb at 75 percent NOx reduction (the highest level modeled). With 50 percent reduced VOC emissions, reducing NOx emissions leads to maximum peak ozone at about 55 percent reduction and is still counter-productive by 32 ppb at 75 percent NOx reduction. The Riverside and Crestline sites have similar EKMA diagrams that also indicate VOC-limited ozone formation at these downwind sites. With base VOC emissions, reducing NOx emissions leads to maximum peak ozone at about 25 percent reduction and is counter-productive at less than about 40 percent NOx reduction. With 50 percent reduced VOC emissions, reducing NOx emissions leads to maximum peak ozone at about 40 to 45 percent reduction and is counter-productive at less than about 65 to 70 percent NOx reduction.

Table 2-7. Ranges of NOx reductions that increase peak 1-hour ozone levels with base and 50% reduced VOC emissions.

Scenario	Base VOC Emissions		50 Percent Reduced VOC Emissions	
	NOx Reduction with Highest Ozone	NOx Reduction Counter-Productive at Less Than	NOx Reduction with Highest Ozone	NOx Reduction Counter-Productive at Less Than
EMFAC2001/CB4	30%	50%	45%	>75%
EMFAC2001/S99	25%	50%	45—50%	>75%
EMFAC2002/CB4	25%	50%	45—50%	>75%
EMFAC2002/S99	25%	50%	45—50%	>75%
EMFAC7G/CB4	35%	55%	50%	75%
EMFAC7G/S99	25—30%	60%	50%	>75%

Notes: Emission reductions are for all anthropogenic emissions, across the board.
CO emissions were reduced concurrently with VOC emissions.
See discussion of lines A and B in Figure 2-13 to understand how values are determined.
S99 means SAPRC99 chemical mechanism.

EKMA Diagrams 1-hour Ozone with EMFAC2001 and SAPRC99

Comparing Figure 2-15 to Figure 2-14 shows the effect of changing to SAPRC99 from CB4 chemistry for 1-hour ozone with EMFAC2001 emissions. Ozone levels are always higher with the SAPRC99 chemistry than with CB4 chemistry. This is consistent with the base emission results discussed above, but also shows that SAPRC99 leads to higher ozone than CB4 with reduced emissions (at up to 75 percent reduction). The shapes of the EKMA diagrams are remarkably similar with SAPRC99 and CB4 chemistry. This shows that SAPRC99 and CB4 have similar relative responses to VOC and NOx emissions reductions. SAPRC99 shows responses to emissions reductions that are VOC-limited and NOx inhibited, just as CB4. The ranges of NOx emission reductions that increase peak 1-hour ozone levels are summarized in Table 2-7, and are essentially identical to those found with the CB4 mechanism and EMFAC2001 emissions.

EKMA Diagrams 1-hour Ozone with Different EMFAC Versions

Changing the emissions model from EMFAC2001 to EMFAC2002 has very little impact on the EKMA diagrams for 1-hour ozone: Compare Figures 2-14 and 2-22 for CB4 chemistry and 2-15 and 2-23 for SAPRC99 chemistry. Ozone levels are slightly higher with EMFAC2002 than EMFAC2001. The ranges of NOx reductions that increase peak 1-hour ozone levels (Table 2-7) are almost the same for EMFAC2002 and EMFAC2001.

Changing the emissions model from EMFAC2001 to EMFAC7G has some impact on the EKMA diagrams for 1-hour ozone: Compare Figures 2-14 and 2-18 for CB4 chemistry and 2-15 and 2-19 for SAPRC99 chemistry. Ozone levels are lower with EMFAC7G than EMFAC2001. The EKMA diagrams for locations in San Bernardino and Riverside Counties (Riverside, Crestline and probably the peak 1-hour ozone location) are more strongly NOx inhibited/VOC-limited for the base case with EMFAC7G than EMFAC2001. This is consistent with the EMFAC7G emission inventory, which has higher NOx emissions than EMFAC2001 in San Bernardino and Riverside Counties, as discussed above. This difference is consistent for both CB4 and SAPRC99. However, the ranges of NOx reductions that increase peak 1-hour ozone levels (Table 2-7) are almost the same for EMFAC7G and EMFAC2001.

EKMA Diagrams 8-hour Ozone

The EKMA diagrams for 8-hour ozone with EMFAC2001 emissions and CB4 chemistry are shown in Figure 2-16. The 8-hour ozone diagrams have many similarities to the 1-hour ozone diagrams shown in Figure 2-14: All four locations are VOC-limited/NOx inhibited for the base case; Azusa is more strongly VOC-limited/NOx inhibited than the other locations further downwind; the Riverside and Crestline receptors have similarly shaped EKMA diagrams. Complete sets of EKMA diagrams are included for 8-hour ozone in Figures 2-16, 2-17, 2-20, 2-21, 2-4 and 2-25.

The ranges of NOx reductions that increase peak 8-hour ozone levels are shown in Table 2-8, which corresponds to Table 2-7 for peak 1-hour ozone. With base VOC emission levels, NOx reductions are counter-productive to deeper reduction levels for peak 8-hour ozone (60—65 percent) than for peak 1-hour ozone (50—60 percent), and the highest ozone occurs at greater NOx reduction levels (45—50 percent rather than 25—35 percent).

There is less difference in the levels of NOx reduction that increase peak 1-hour and 8-hour ozone when VOC emission levels are reduced 50 percent. The maximum ozone occurs with 45—50% reduction for both 1-hour and 8-hour ozone. NOx reduction is counter-productive at less than 75 percent reduction for 8-hour ozone which is not as deep as the >75 percent level determined for 1-hour ozone.

Table 2-8. Ranges of NOx reductions that increase peak 8-hour ozone levels with base and 50% reduced VOC emissions.

Scenario	Base VOC Emissions		50 Percent Reduced VOC Emissions	
	NOx Reduction with Highest Ozone	NOx Reduction Counter-Productive at Less Than	NOx Reduction with Highest Ozone	NOx Reduction Counter-Productive at Less Than
EMFAC2001/CB4	45—50%	60%	45—50%	75%
EMFAC2001/S99	45%	60—65%	50%	75%
EMFAC2002/CB4	45—50%	60%	50%	75%
EMFAC2002/S99	50%	60—65%	50%	75%
EMFAC7G/CB4	45%	60—65%	45%	75%
EMFAC7G/S99	45—50%	65%	45—50%	75%

Notes: Emission reductions are for all anthropogenic emissions, across the board.
CO emissions were reduced concurrently with VOC emissions.
See discussion of lines A and B in Figure 2-13 to understand how values are determined.
S99 means SAPRC99 chemical mechanism.

Summary of Ozone Sensitivities to Emission Reductions

We conducted emissions sensitivity tests to characterize ozone response to reductions of up to 75 percent in anthropogenic NOx and VOC emissions for 1997 (CO emissions were reduced concurrently with VOC emissions). The results showed consistently that Los Angeles ozone levels are VOC-limited. This means that reducing VOC emissions always reduces ozone, whereas reducing NOx may increase or decrease ozone depending upon the level of NOx reduction. This kind of response to VOC and/or NOx emission reductions results from the well-understood "NOx inhibition" effect (NRC, 1991). The NOx inhibition effect was observed consistently for:

- 1-hour and 8-hour ozone.
- CB4 and SAPRC99 chemical mechanisms.
- EMFAC versions 7G, 2001 and 2002.
- Receptor locations at the peak location (which moves as emissions are reduced), Azusa (mid-basin), Riverside (downwind) and Crestline (far downwind).

We quantified levels of NOx reduction that are counter-productive for reducing peak ozone (meaning that the NOx reduction results in higher peak ozone than with zero NOx reduction). With base case VOC emission levels, less than 55—60 percent NOx reduction is counterproductive for 1-hour ozone, and less than 45—50 percent NOx reduction is counterproductive for 8-hour ozone. With 50 percent reduced VOC emissions, less than 75 percent NOx reduction is counterproductive for both 1-hour and 8-hour ozone. The ranges reflect the small differences among the EMFAC/chemical mechanism scenarios considered.

We quantified the levels of NOx reduction that produce the highest peak ozone levels. With base case VOC emission levels, the highest 1-hour ozone occurs with 25—35 percent NOx reduction, and the highest 8-hour ozone occurs for 45—50 percent NOx reduction. With 50 percent reduced VOC emissions, 45—50 percent NOx reduction produces the highest 1-hour and 8-hour ozone levels. The ranges reflect the small differences among the EMFAC/chemical mechanism scenarios considered.

EKMA diagrams for 1-hour ozone August 5-7, 1997 EMFAC 2001 emissions and CB4 Chemistry

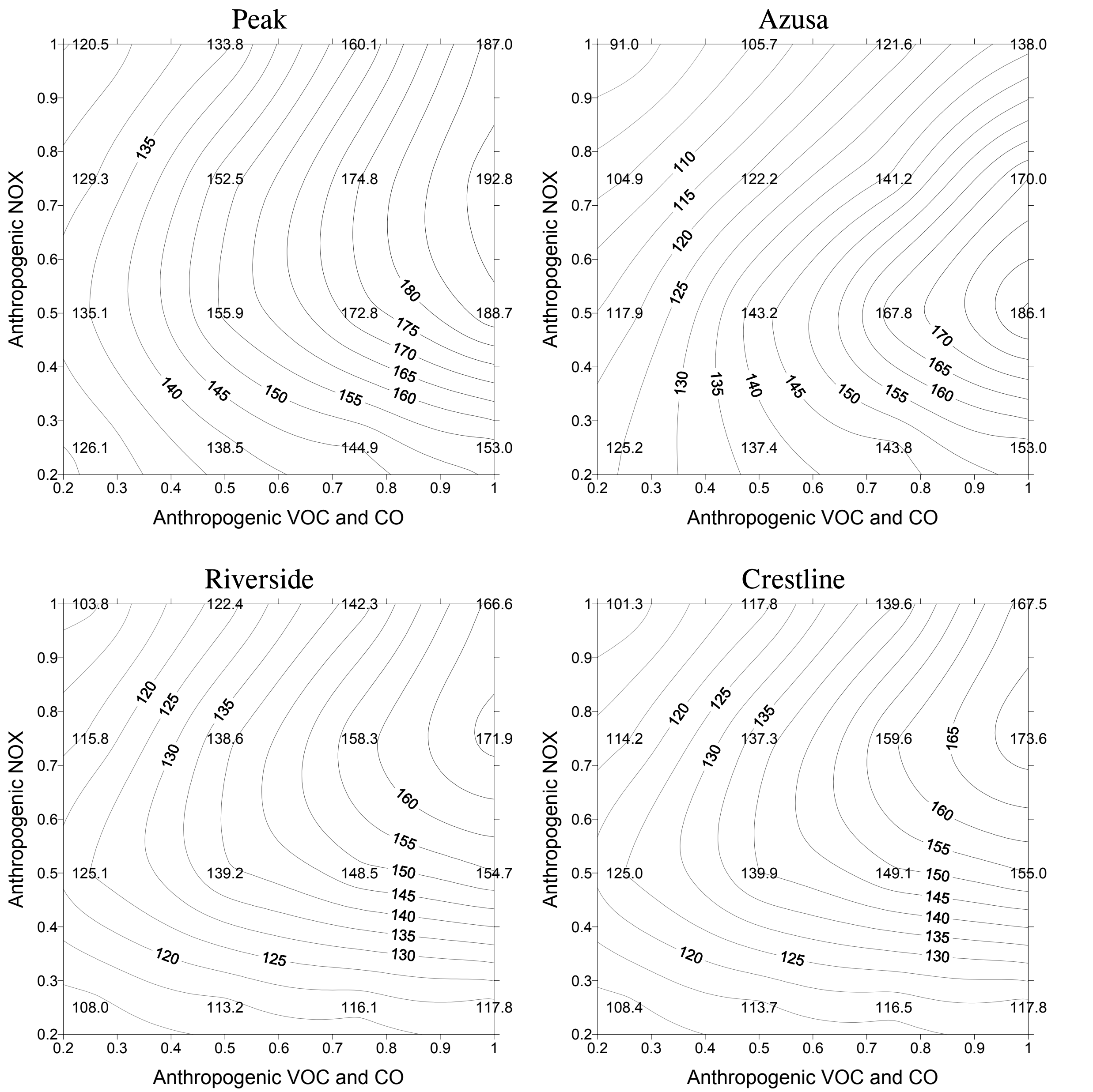


Figure 2-14. EKMA diagrams for maximum 1-hour ozone over August 5-7, 1997 with EMFAC 2001 emissions and CB4 chemistry.

EKMA diagrams for 1-hour ozone August 5-7, 1997 EMFAC 2001 emissions and SAPRC99 Chemistry

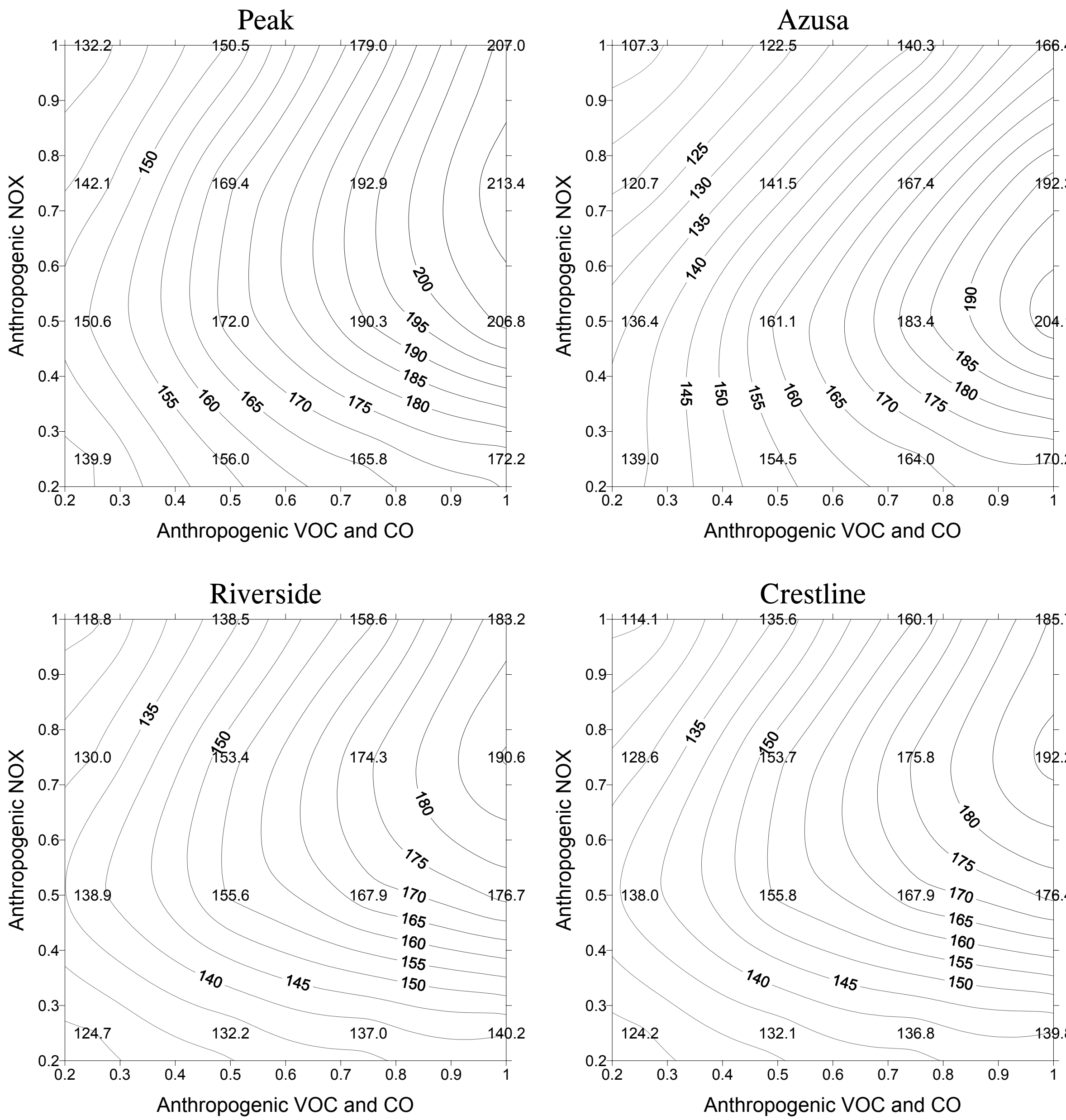


Figure 2-15. EKMA diagrams for maximum 1-hour ozone over August 5-7, 1997 with EMFAC 2001 emissions and SAPRC99 chemistry.

EKMA diagrams for 8-hour ozone August 5-7, 1997 EMFAC 2001 emissions and CB4 Chemistry

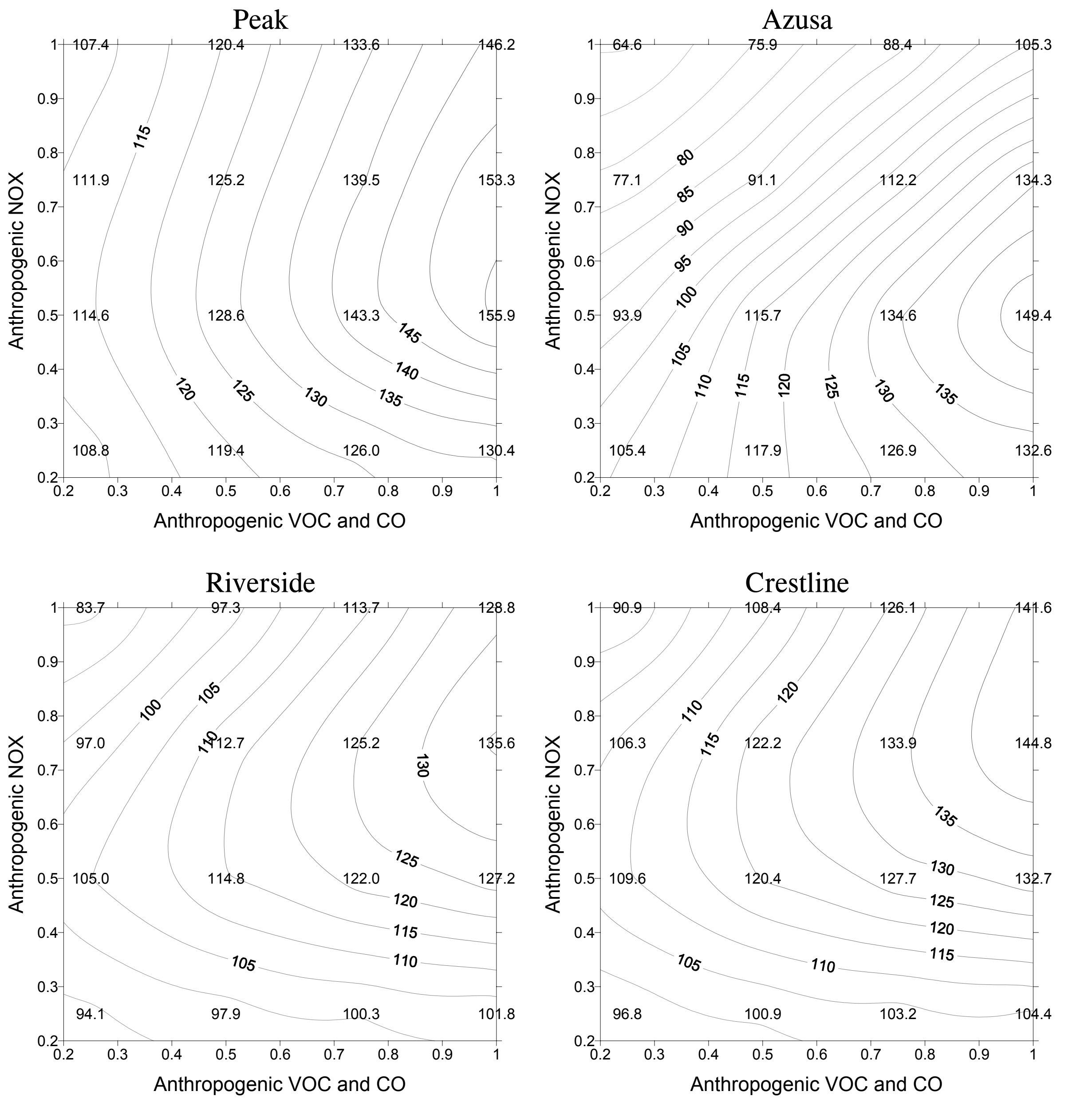


Figure 2-16. EKMA diagrams for maximum 8-hour ozone over August 5-7, 1997 with EMFAC 2001 emissions and CB4 chemistry.

EKMA diagrams for 8-hour ozone August 5-7, 1997 EMFAC 2001 emissions and SAPRC99 Chemistry

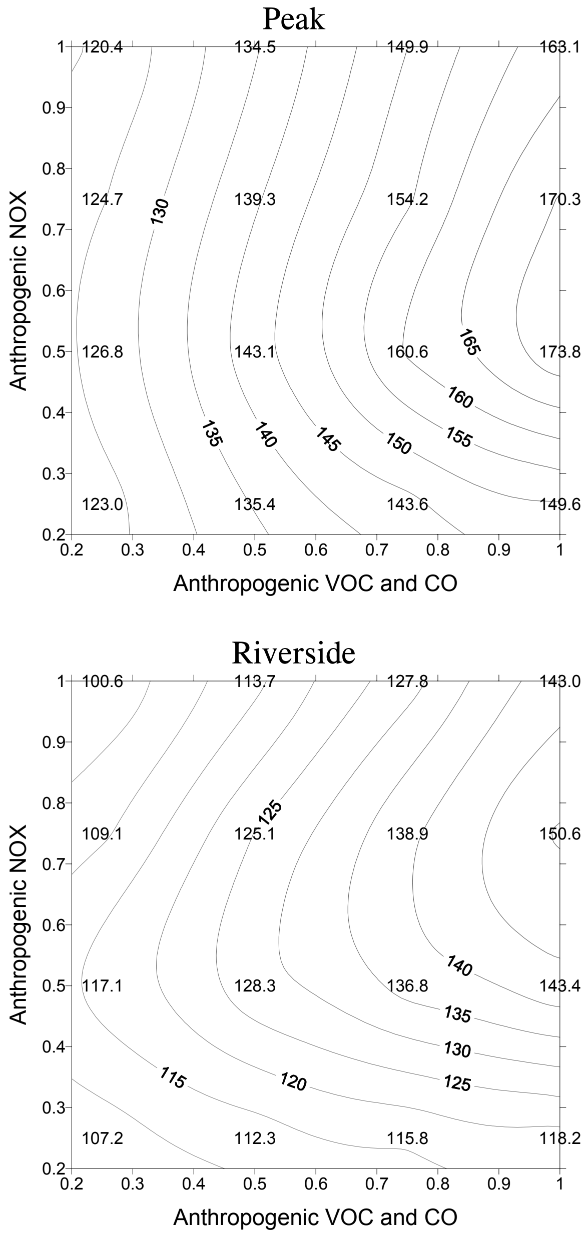


Figure 2-17. EKMA diagrams for maximum 8-hour ozone over August 5-7, 1997 with EMFAC 2001 emissions and SAPRC99 chemistry.

EKMA diagrams for 1-hour ozone August 5-7, 1997 EMFAC7G emissions and CB4 Chemistry

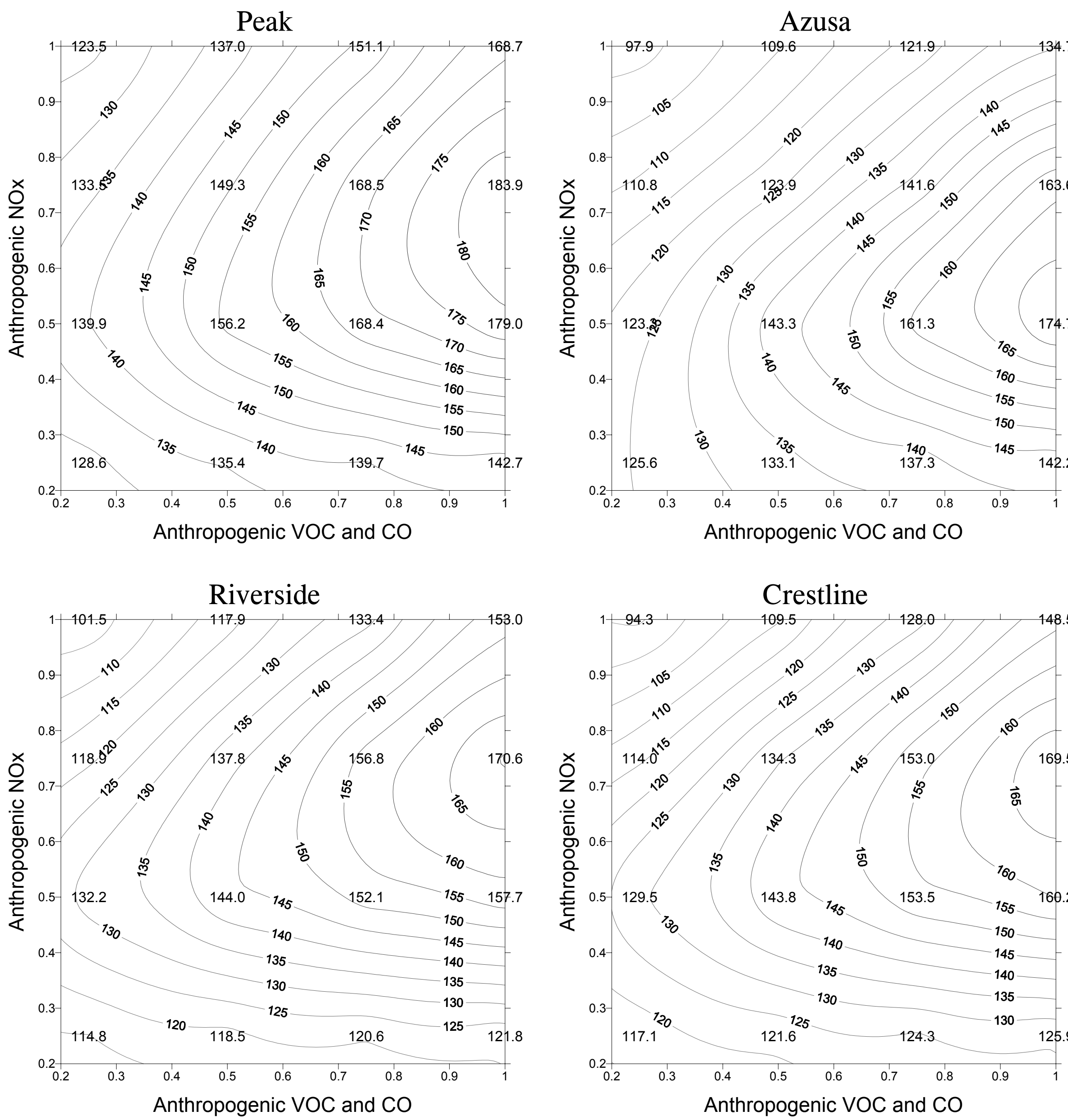


Figure 2-18. EKMA diagrams for maximum 1-hour ozone over August 5-7, 1997 with EMFAC7G emissions and CB4 chemistry.

EKMA diagrams for 1-hour ozone August 5-7, 1997 EMFAC7G emissions and SAPRC Chemistry

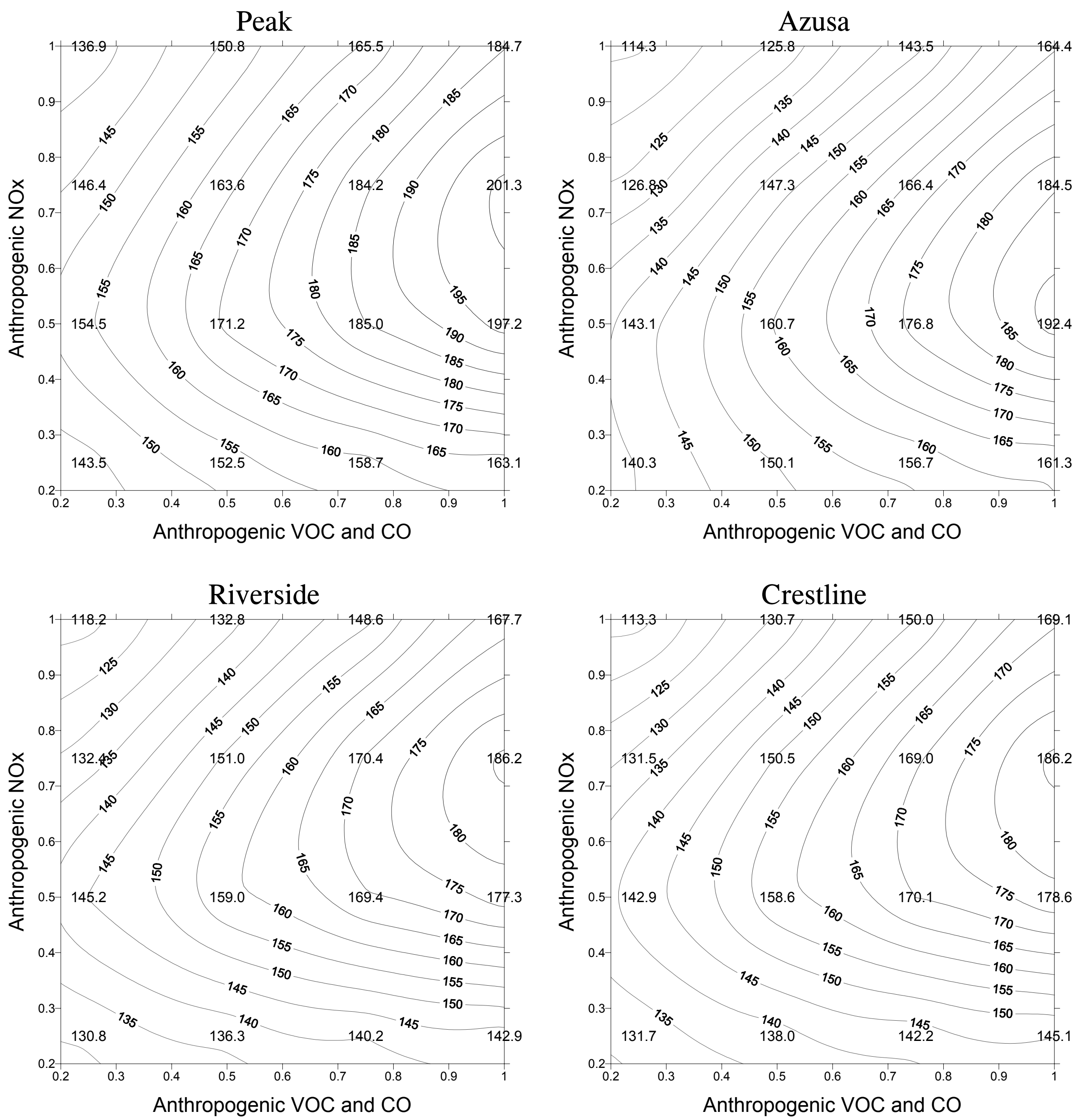


Figure 2-19. EKMA diagrams for maximum 1-hour ozone over August 5-7, 1997 with EMFAC7G emissions and SAPRC99 chemistry.

EKMA diagrams for 8-hour ozone August 5-7, 1997
EMFAC7G emissions and CB4 Chemistry

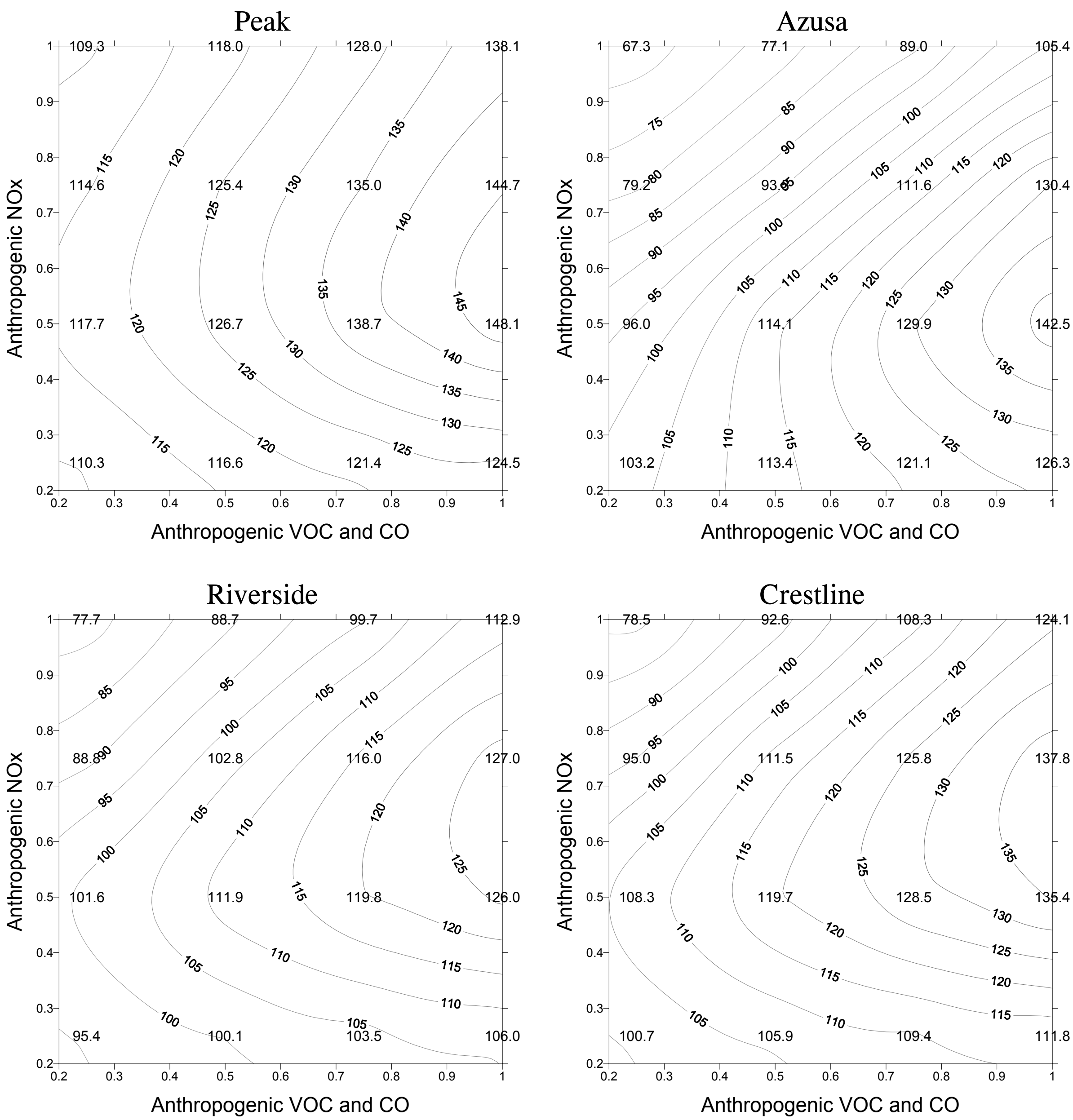


Figure 2-20. EKMA diagrams for maximum 8-hour ozone over August 5-7, 1997 with EMFAC7G emissions and CB4 chemistry.

EKMA diagrams for 8-hour ozone August 5-7, 1997 EMFAC7G emissions and SAPRC Chemistry

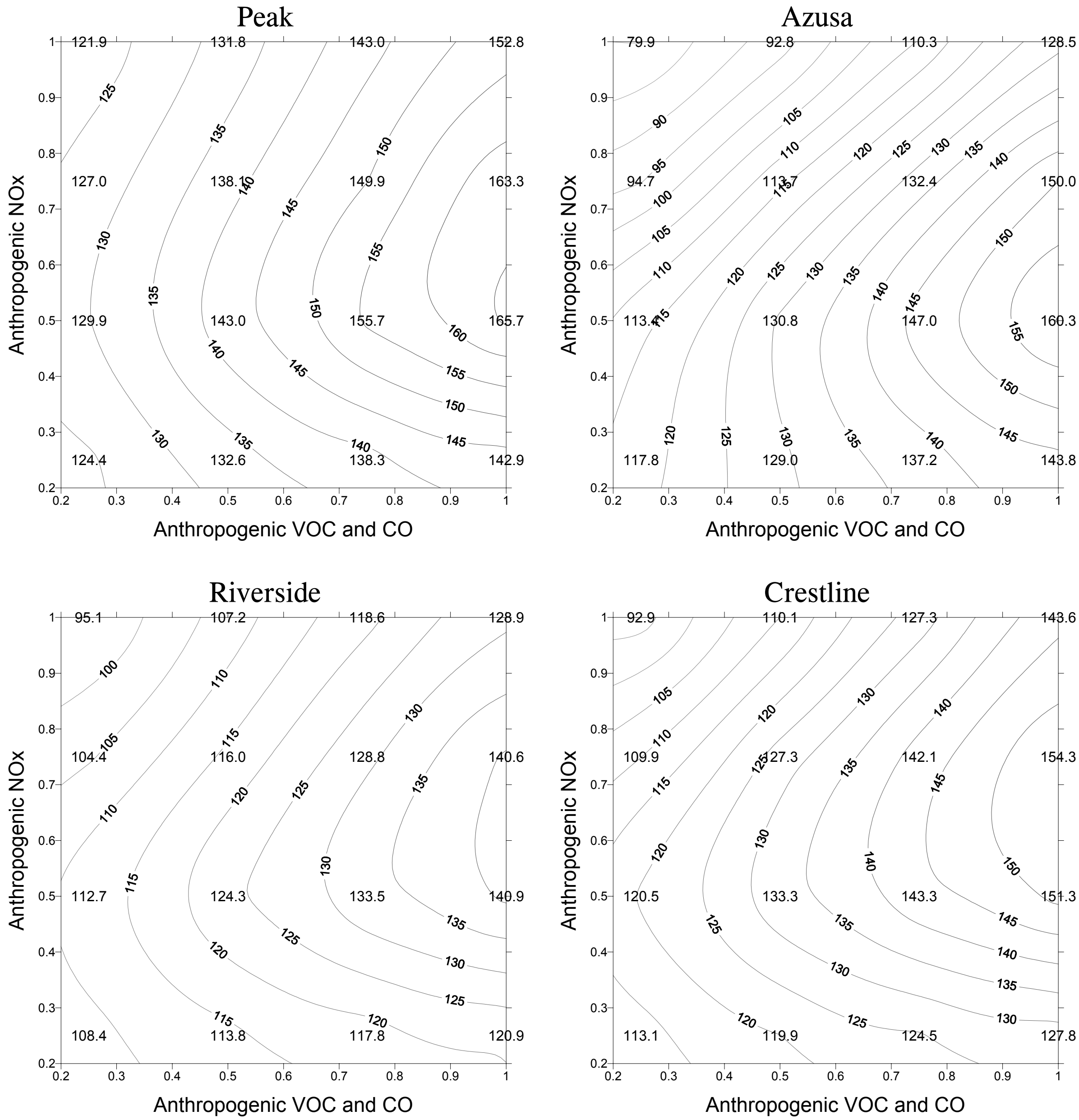


Figure 2-21. EKMA diagrams for maximum 8-hour ozone over August 5-7, 1997 with EMFAC7G emissions and SAPRC99 chemistry.

EKMA diagrams for 1-hour ozone August 5-7, 1997 EMFAC2002 emissions and CB4 Chemistry

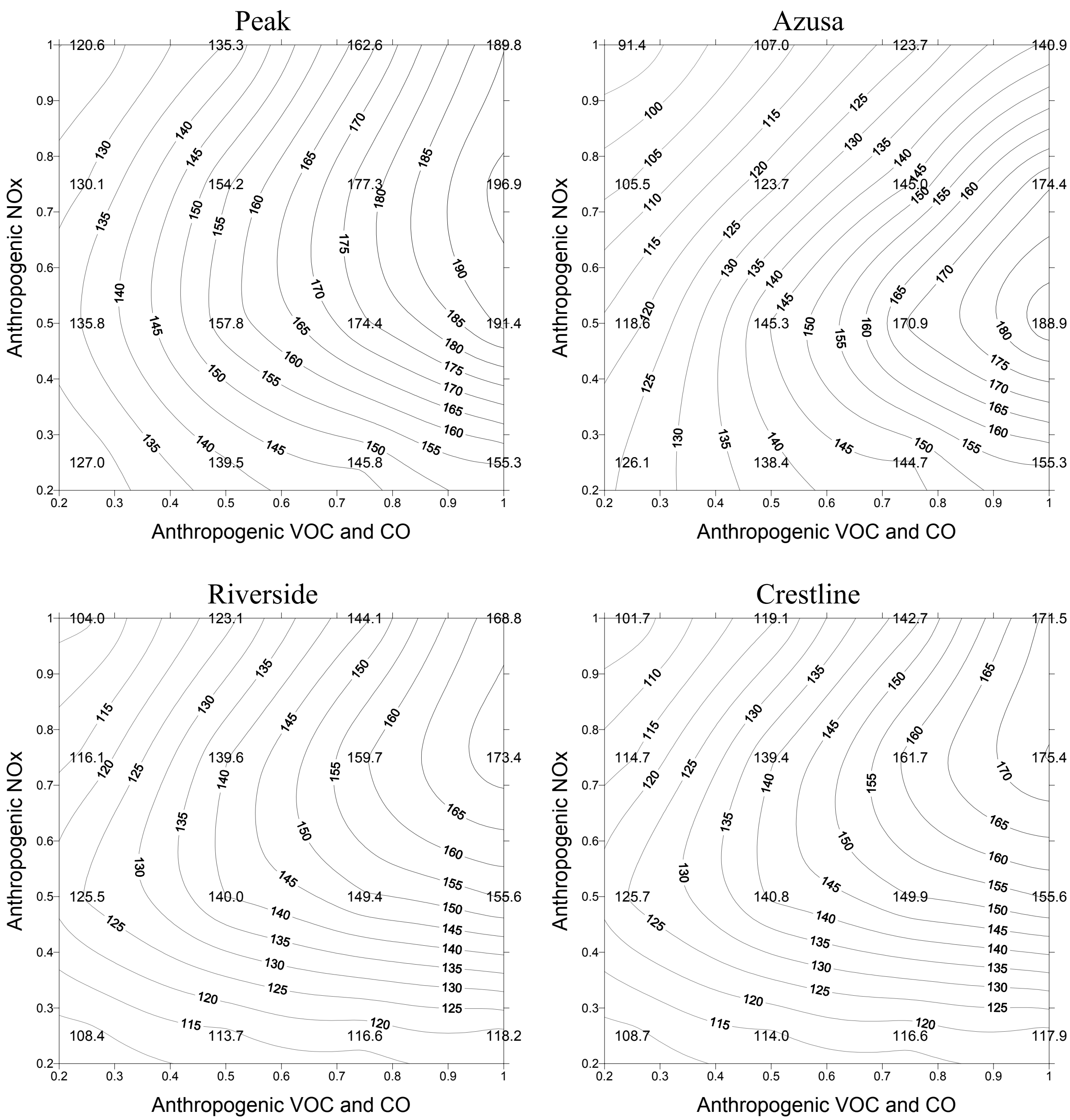


Figure 2-22. EKMA diagrams for maximum 1-hour ozone over August 5-7, 1997 with EMFAC2002 emissions and CB4 chemistry.

EKMA diagrams for 1-hour ozone August 5-7, 1997 EMFAC2002 emissions and SAPRC99 Chemistry

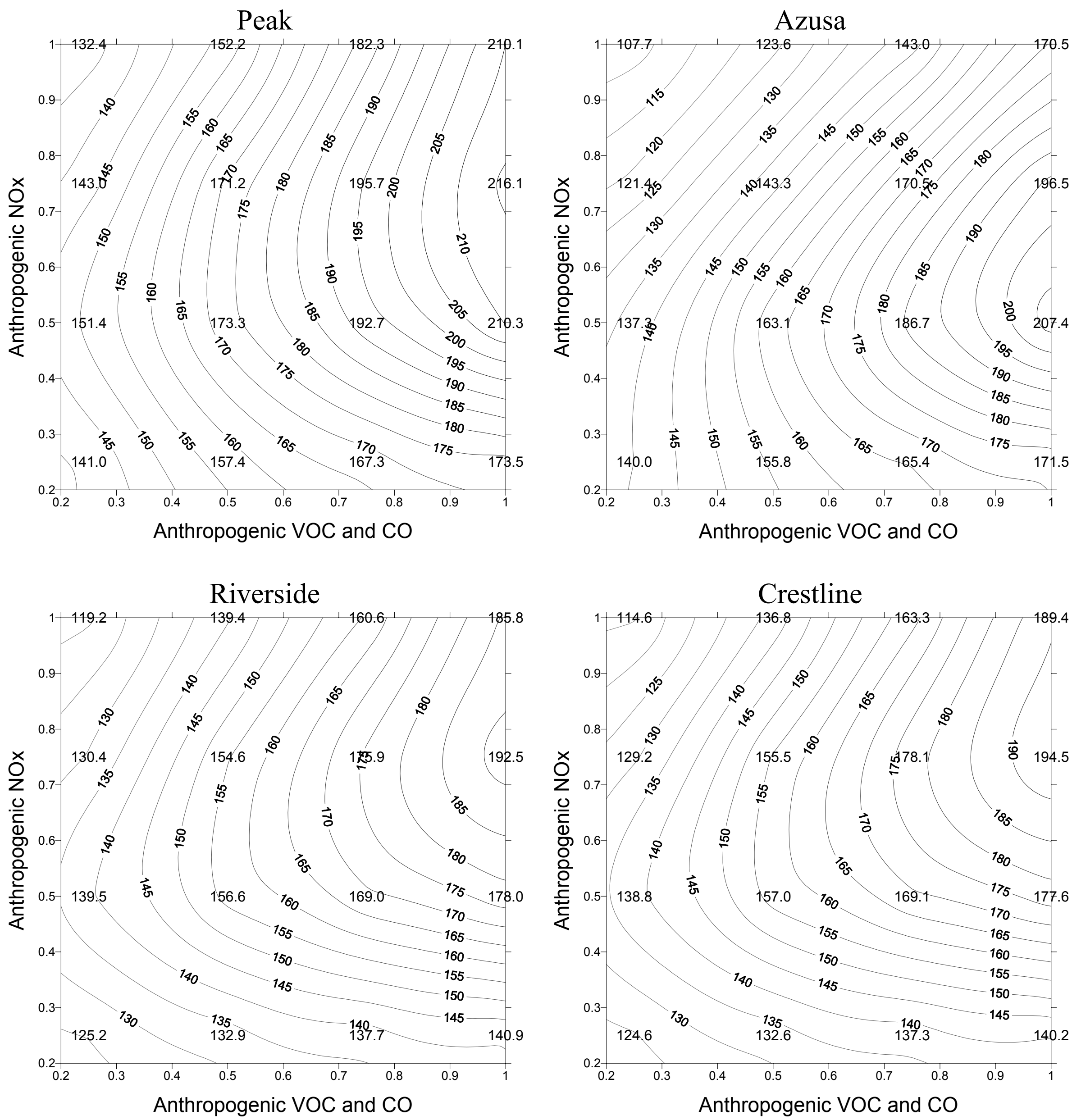


Figure 2-23. EKMA diagrams for maximum 1-hour ozone over August 5-7, 1997 with EMFAC2002 emissions and SAPRC99 chemistry.

EKMA diagrams for 8-hour ozone August 5-7, 1997
EMFAC2002 emissions and CB4 Chemistry

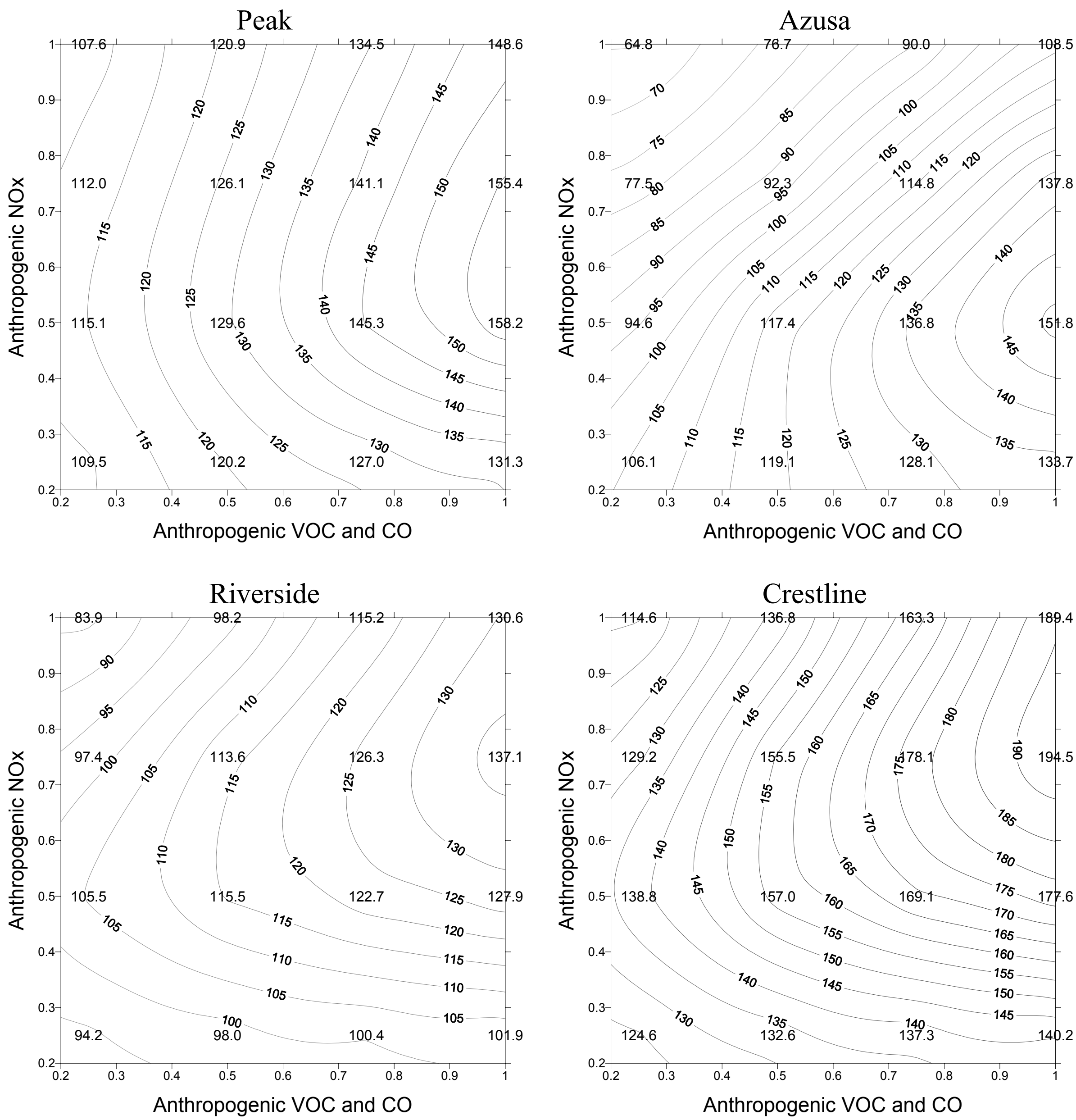


Figure 2-24. EKMA diagrams for maximum 8-hour ozone over August 5-7, 1997 with EMFAC2002 emissions and CB4 chemistry.

EKMA diagrams for 1-hour ozone August 5-7, 1997 EMFAC2002 emissions and SAPRC99 Chemistry

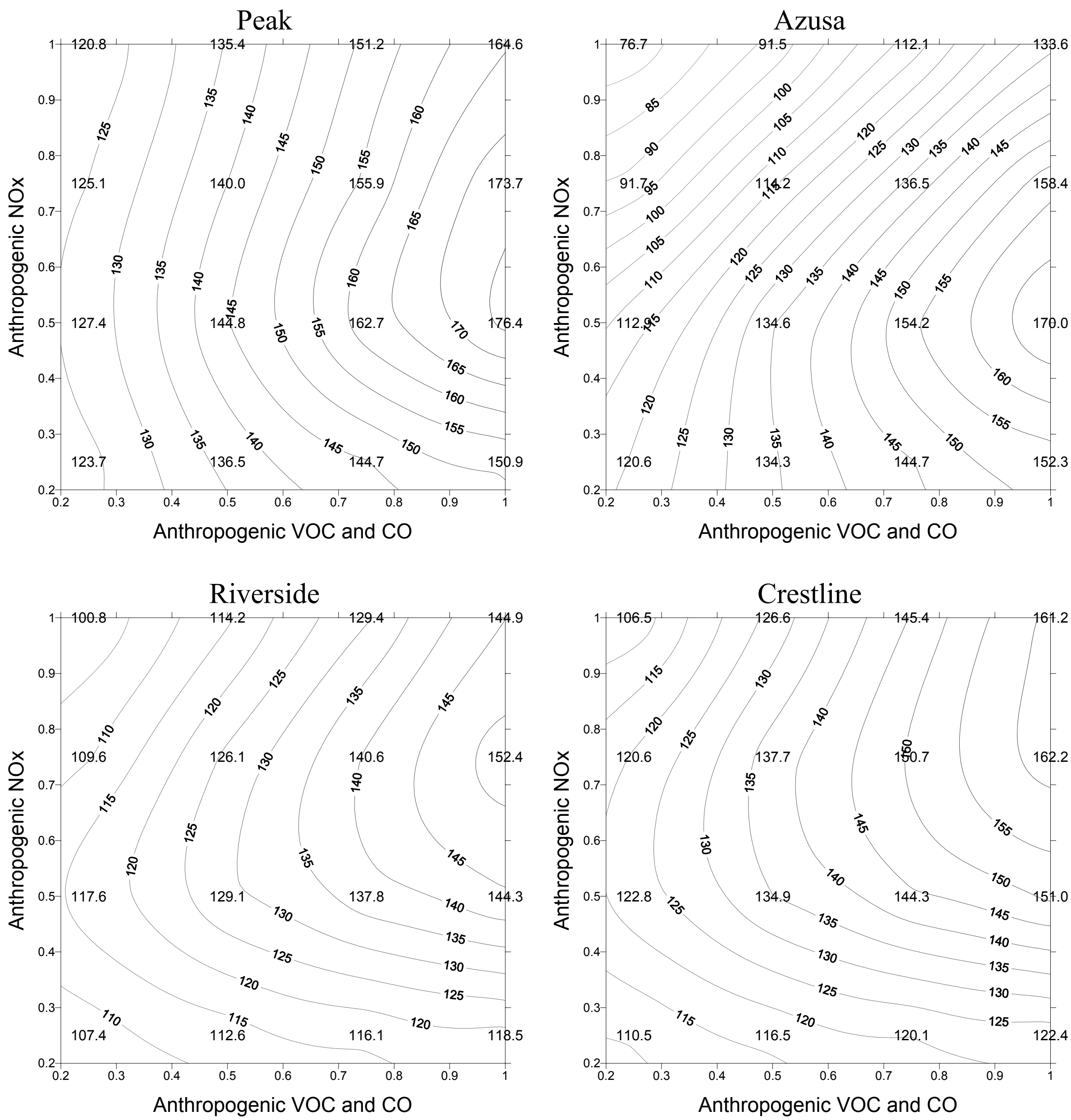


Figure 2-25. EKMA diagrams for maximum 8-hour ozone over August 5-7, 1997 with EMFAC2002 emissions and SAPRC99 chemistry.

2.4 OZONE MODELING FOR THE AUGUST 1987 SCAQS EPISODE

The ozone episode of August 27-28, 1987 has been part of the ozone modeling in the last three Los Angeles AQMPs. The SCAQMD modeled this episode for the 1997 AQMP with version IV of the Urban Airshed Model (UAM) and with on-road mobile source emissions based on EMFAC7G. The same modeling results from the 1997 AQMP also appeared in the 1999 amendment to the 1997 AQMP (SCAQMD, 1999). The starting point for the August 1987 SCAQS episode modeling completed in this study was the 1997/1999 AQMP modeling. The draft 2003 AQMP was released when this study was nearly completed (SCAQMD, 2003), and results from the latest draft 2003 AQMP are included in the comparisons below.

Air Quality Model: UAM

The draft 2003 AQMP uses the same UAM model (EPA's version 6.22 of the UAM) and meteorological inputs as the earlier AQMPs (SCAQMD, 1997), but has completely new emission inventories that were developed by the CARB and the SCAQMD (SCAQMD, 2003). In the past, EPA had recommended the use of the UAM for urban ozone modeling applications, and the SCAQMD has used the UAM since the 1989 AQMP. However, in 2003 the EPA revised the modeling guidelines and dropped the recommendation in "Appendix A" to use UAM and instead described several criteria for selecting a suitable ozone model in "Appendix W" (EPA, 2003). In the 2003 AQMP, the SCAQMD evaluated several ozone models for an August 3-7, 1997 ozone episode and decided to continue using the UAM because they were able to obtain better model performance with UAM, especially for the ozone peak.

Emission Inventories

The 1997 AQMP had on-road mobile source emissions based on EMFAC7G, biogenic emissions from the SCAQMD's Veggies model, and other emissions (off-road and stationary source) emissions developed by the SCAQMD. However, for the 1997 AQMP the SCAQMD doubled the on-road vehicle VOC emissions in order to obtain acceptable model performance for the base year (1987).

The draft 2003 AQMP has on-road mobile source emissions from EMFAC2002, biogenic emissions from the CARB's BEIGIS model, and other emissions (off-road and stationary source) emissions developed by the CARB and SCAQMD. The emission inventories from the 1997 and draft 2003 AQMPs are compared in Table 2-9.

The emission inventories developed for this study were based on the 1997 AQMP. The emission inventories described as A-38 EMFAC7G are identical to the 1997 AQMP emissions. The emission inventories described as A-38 EMFAC2001 are the 1997 AQMP emissions with the on-road mobile emissions adjusted by the ratio of EMFAC2001 to EMFAC7G emissions, as described above. The CRC A-38 emission totals also are reported in Table 2-9.

Table 2-9. Comparison of UAM domain emission totals (tons/day) for August 27, 1987.

	VOC [3]	NOx	CO	VOC/NOx [4]
1997 AQMP and CRC A-38/EMFAC7G [1]				
On-Road	1055	904	9630	3.4
Off-Road + Stationary	1188	728	1959	4.7
Biogenic	161	0	0	N/A
Total	**2405**	**1632**	**11589**	**4.2**
CRC A-38/EMFAC2001 [1]				
On-Road	1722	949	14290	5.2
Off-Road + Stationary	1188	728	1942	4.7
Biogenic	161	0	0	N/A
Total	**3071**	**1677**	**16232**	**5.3**
2003 AQMP [2]				
On-Road	1629	1369	16636	3.4
Stationary	1118	778	1383	4.1
Biogenic	262	0	0	N/A
Total	**3009**	**2147**	**18019**	**4.0**

Notes:
1. 1997 AQMP and CRC A-38 totals were calculated from UAM-ready emissions files.
2. 2003 AQMP emissions are from SCAQMD (2003) Tables 3-2 A and B and are modeling domain totals.
3. VOC totals from UAM-ready files were calculated as the total moles C of VOC times 16 g per mole C.
4. VOC/NOx ratio of model ready emissions (molesC/moles).

Model Performance

Model performance statistics for four simulations are compared in Table 2-10. The four simulations are:

1997 AQMP with EMFAC7G emissions. Model performance results reported in the 1997 and 1999 AQMPs with EMFAC7G (SCAQMD, 1997). Note that in the 1997 AQMP, the SCAQMD obtained model performance meeting EPA goals only after doubling the on-road mobile source VOC emissions (SCAQMD, 2003; page V-3-41). Table 2-10 shows the model performance without doubling the on-road mobile source VOC emissions.

2003 draft AQMP with EMFAC2002 emissions. Model performance results reported in the 2003 draft AQMP (SCAQMD, 2003). The 2003 draft AQMP does not report basin-wide model performance statistics, but rather reports statistics for several sub-domains (Figure 2-26). Table 2-10 reports the 2003 draft AQMP statistics for zone 4 which contains the locations of the highest observed ozone levels on August 27, 1987 (Riverside-Rubidoux) and August 28, 1987 (Glendora).

CRC project A-38 with EMFAC7G emissions. Re-run of the 1997 AQMP simulation for this project to test whether the results reported by the SCAMD are reproduced.

CRC project A-38 with EMFAC2001 emissions. The 1997 AQMP simulation with on-road mobile source emissions adjusted to EMAFC2001 levels.

Table 2-10a. Statistical model performance measures for ozone on August 27, 1987.

Performance Measure	EPA Goal	1997 AQMP EMFAC7G	2003 AQMP EMFAC2002	CRC A-38 EMFAC7G	CRC A-38 EMFAC2001
Observed Peak (ppb)		240	240	240	240
Modeled Peak (ppb)		170	227	169	203
Unpaired peak (%)	< ± 20%	-30	-5	-31	-25
Threshold for Stats.		80	80	80	80
Norm. Bias	< ± 15%	-35	-25	-35	-30
Norm. Error	< 35%	39	35	39	34

Notes:
1. Shaded values are outside the target range shown under "EPA Goal."
2. The 1997 AQMP modeled peak and observed peaks were reported to the nearest 10 ppb.
3. The 2003 draft AQMP statistics are for model performance zone 4.
4. A threshold of 80 ppb was used to calculate statistical measures.

Table 2-10b. Statistical model performance measures for ozone on August 28, 1987.

Performance Measure	EPA Goal	1997 AQMP EMFAC7G	2003 AQMP EMFAC2002	CRC A-38 EMFAC7G	CRC A-38 EMFAC2001
Observed Peak (ppb)		290	290	290	290
Modeled Peak (ppb)		223	319	226	241
Unpaired peak (%)	< ± 20%	-23	10	-22	-17
Threshold for Stats.		80	100	80	80
Norm. Bias (%)	< ± 15%	-26	-5	-20	-15
Norm. Error (%)	< 35%	29	23	27	24

Notes:
1. Shaded values are outside the target range shown under "EPA Goal."
2. The 1997 AQMP modeled peak and observed peaks were reported to the nearest 10 ppb.
3. The 2003 AQMP statistics are for model performance zone 4.
4. SCAQMD calculated the 2003 draft AQMP statistics for August 28 with a threshold of 100 ppb, which differs from the other cases where 80 ppb was used.

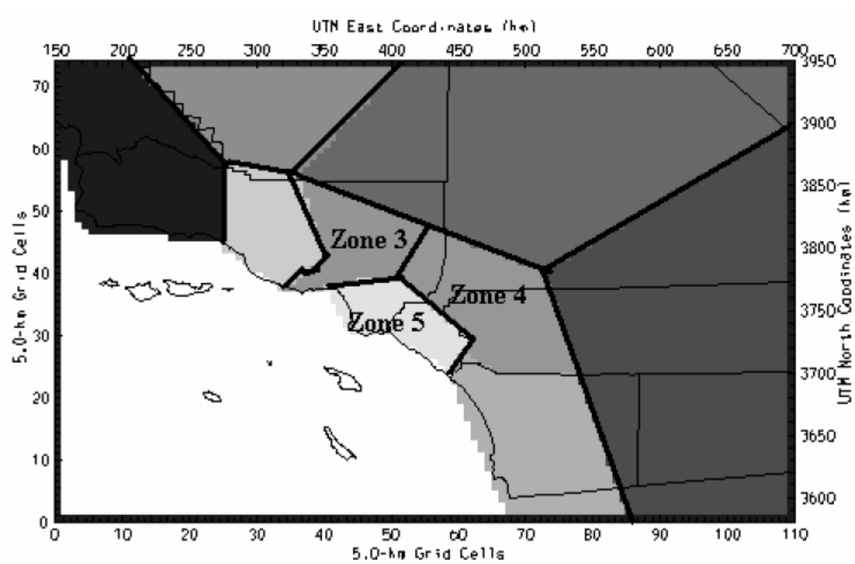
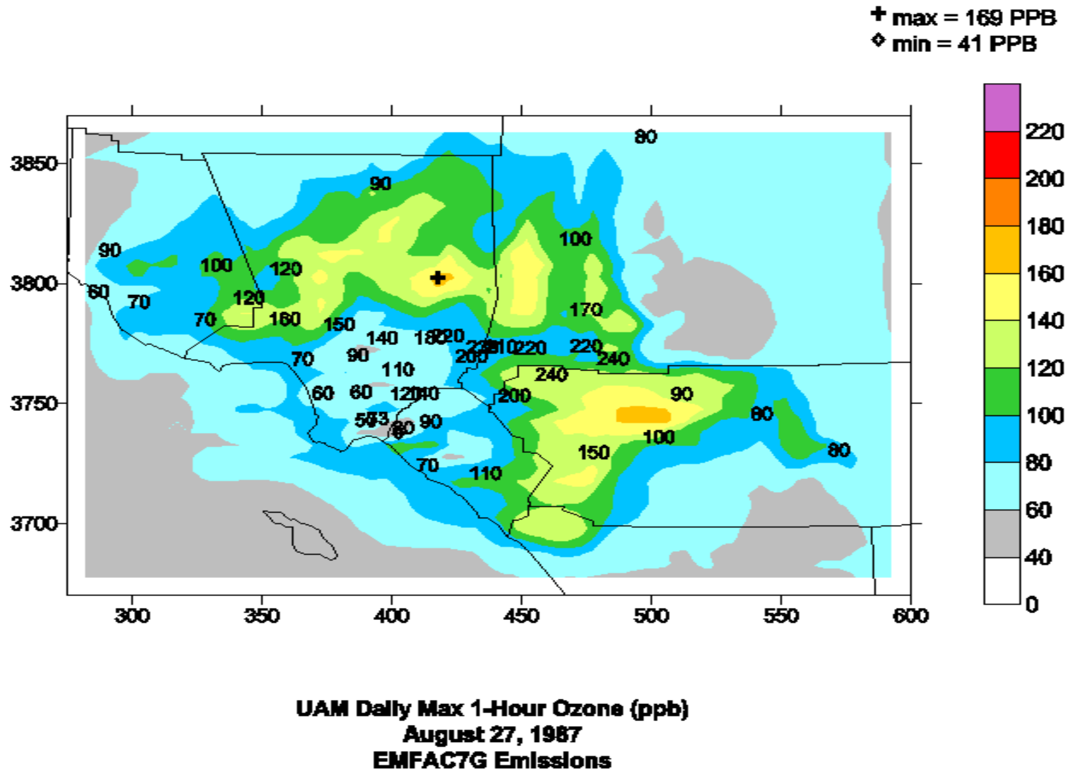


Figure 2-26. Model performance zones used by the SCAQMD in the 2003 draft AQMP (from SCAQMD, 2003).

(a) EMFAC7G



(b) EMFAC2001

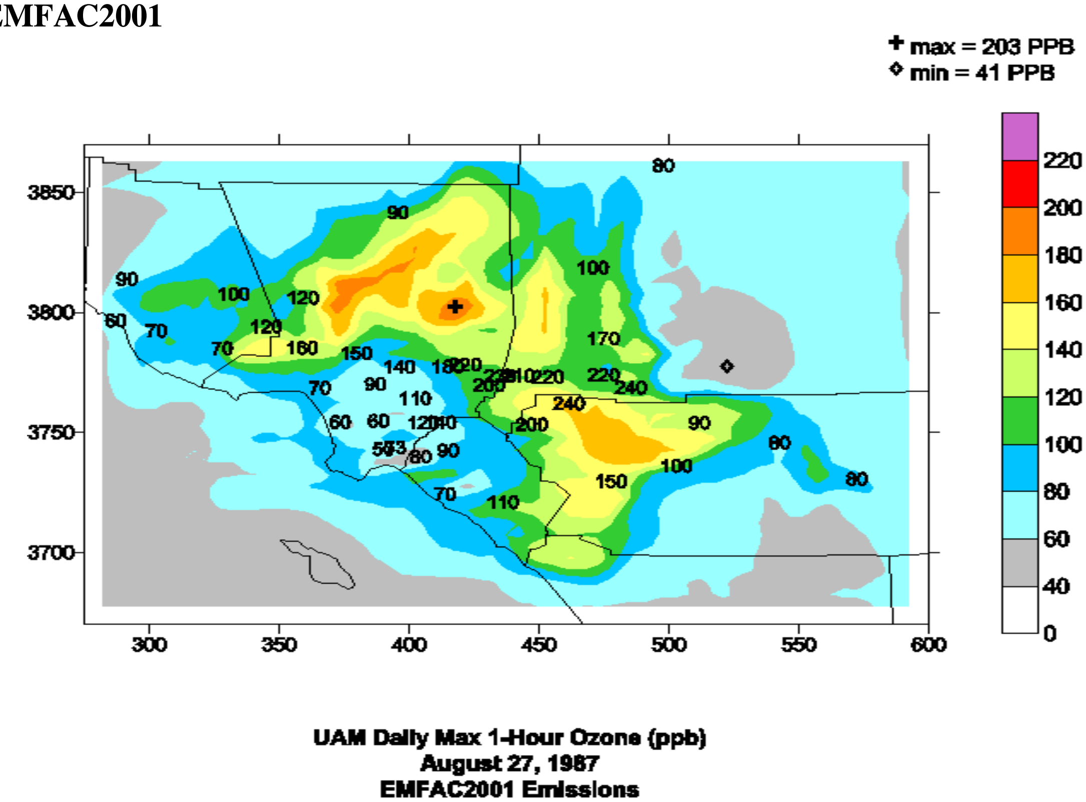
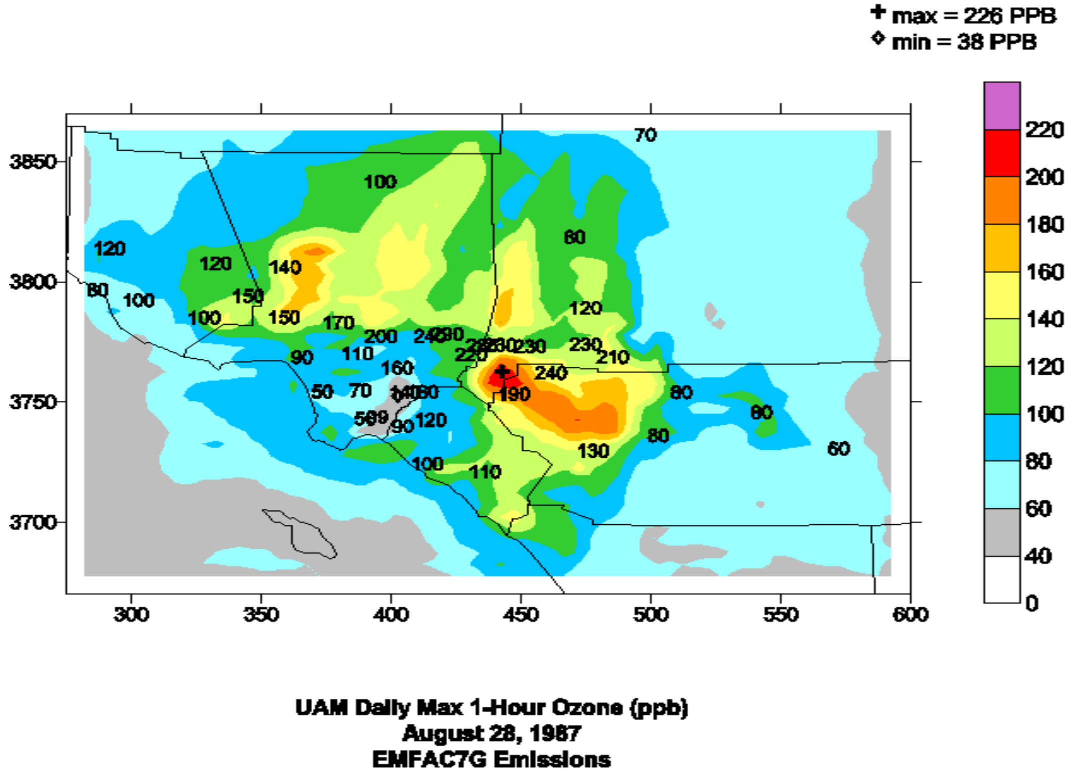


Figure 2-27. Comparison of UAM daily maximum ozone for August 27, 1987 with on-road mobile emissions from EMFAC7G and EMFAC2001.

(a) EMFAC7G



(b) EMFAC2001

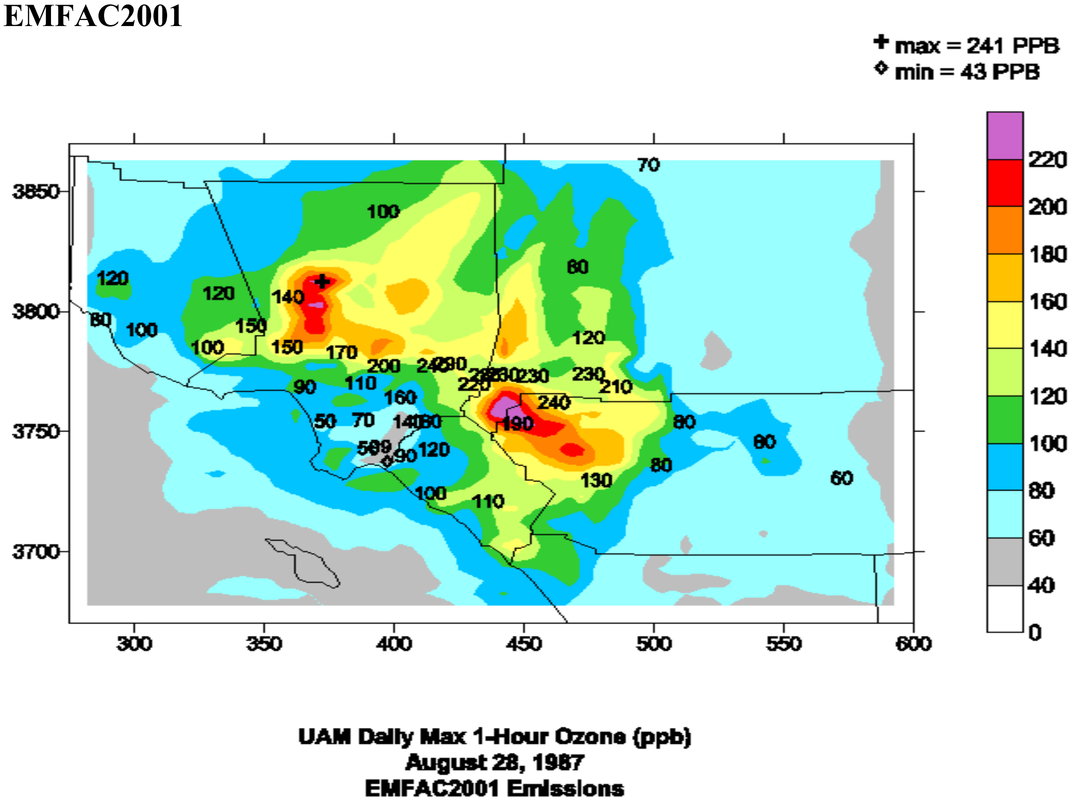


Figure 2-28. Comparison of UAM daily maximum ozone for August 28, 1987 with on-road mobile emissions from EMFAC7G and EMFAC2001.

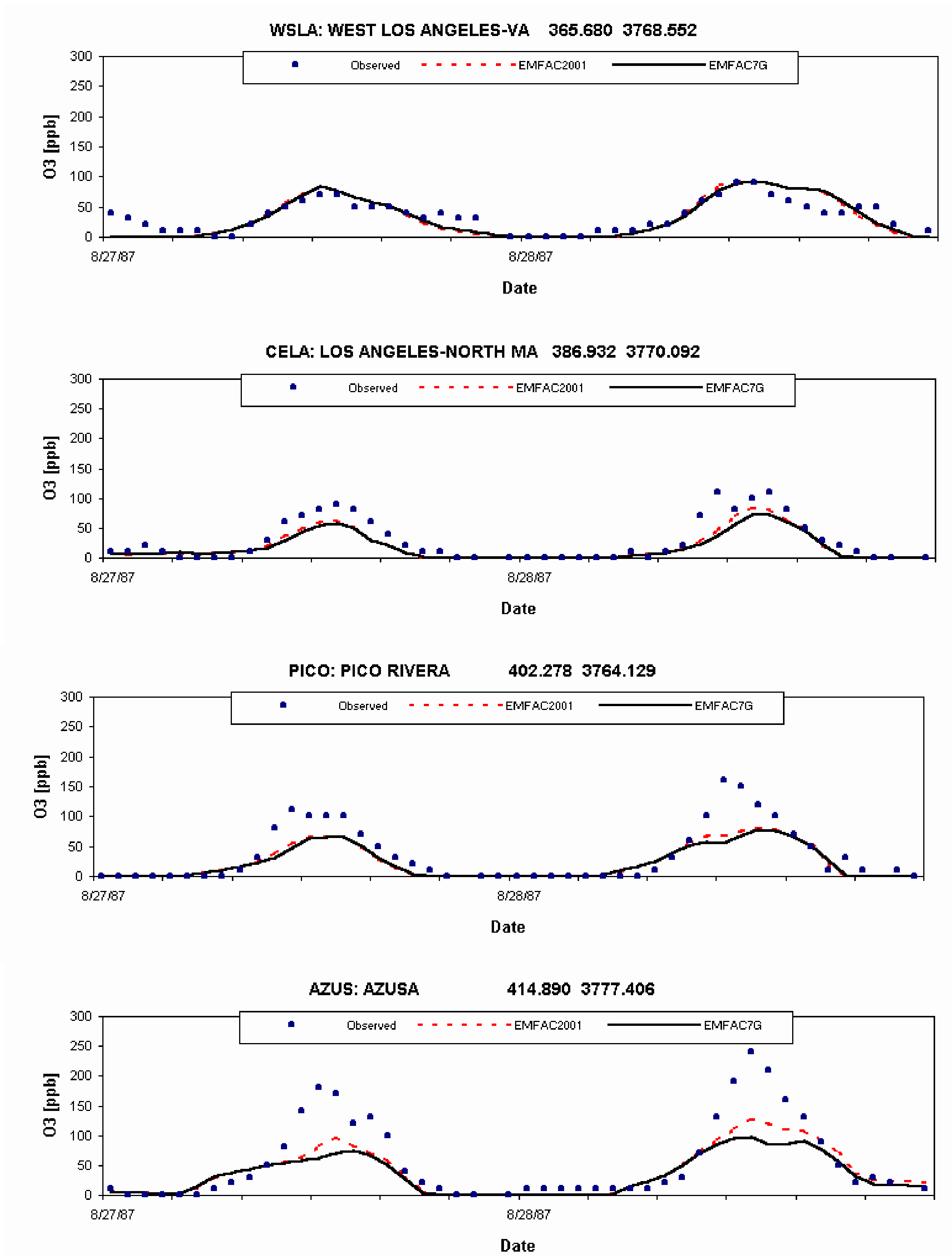


Figure 2-29. Time series comparison of UAM ozone with on-road mobile emissions from EMFAC7G and EMFAC2001 to observed values for August 27-28, 1987.

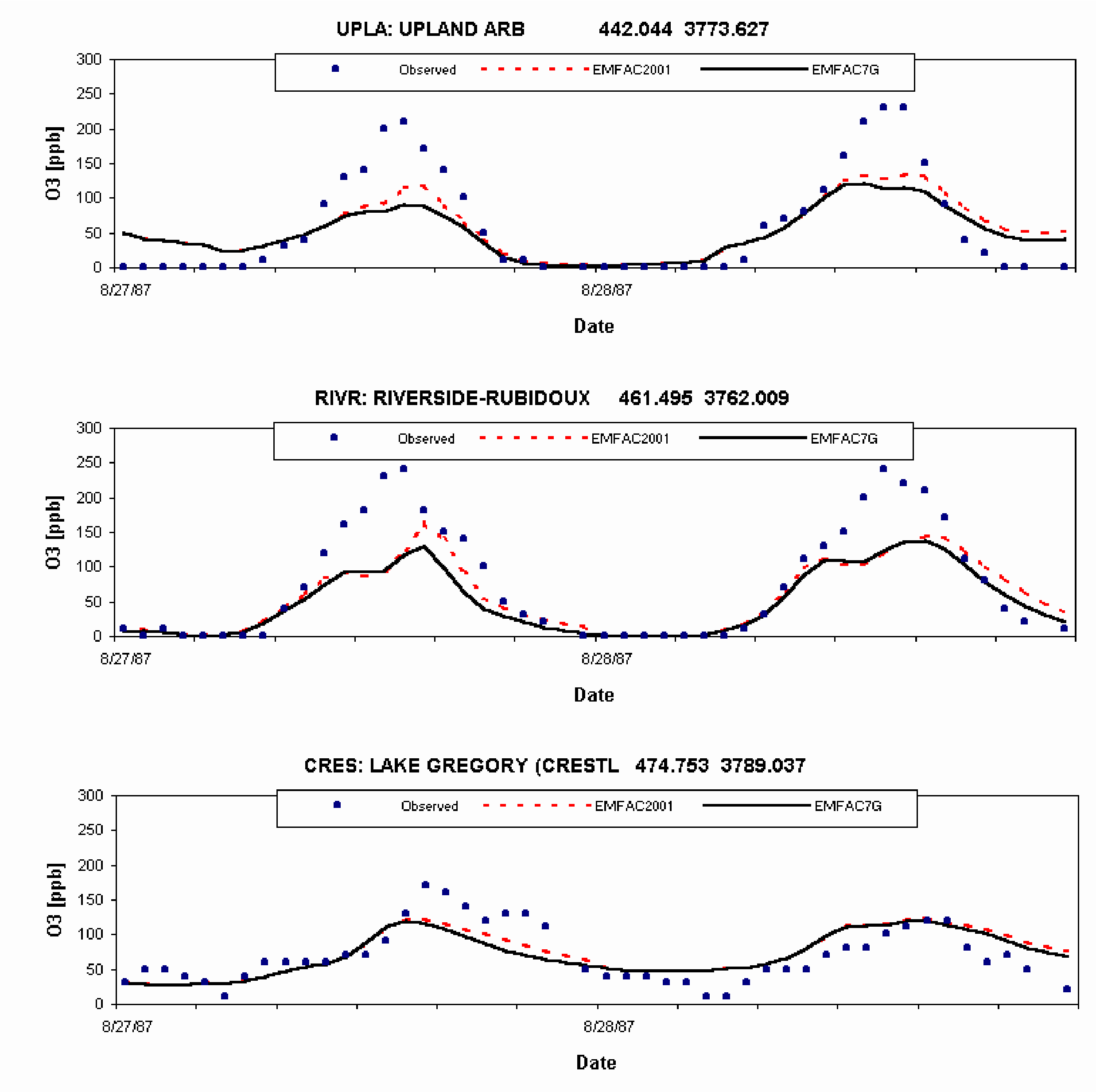


Figure 2-29. (Concluded)

Ozone Model Performance

Model performance for the CRC A-38 EMFAC7G simulation was very similar to that reported in the 1997 AQMP (Table UT1). Good agreement is expected because these two simulations should have identical input data. The agreement was good for all statistical measures except the normalized bias on August 28, where the SCAQMD reported –26% but this study calculated –20%. Because all other statistical measures agreed well, this discrepancy is attributed to some difference in the database of observed ozone values rather than any difference in the model results. The performance statistics for the CRC A-38 simulations were calculated using ozone observations provided by the CARB whereas the SCAQMD uses their own observation database. The difference may be as simple as the SCAQMD rounding ozone data to the nearest 10 ppb, whereas the CARB data reports ozone to the nearest ppb.

Ozone levels in the CRC A-38 simulations were higher with EMFAC2001 than EMFAC7G (compare Figures 2-27 and 2-28), which generally improved agreement with the observations. The model performance statistics for ozone were improved using EMFAC2001 compared to EMFAC7G. However, the basin-wide peak ozone was still under-predicted with EMFAC2001 on both August 27 and 28. Ozone time-series comparisons for several monitoring sites across the air basin (Figure 2-29) also show the tendency for higher ozone with EMFAC2001, but confirm that the ozone increases tended to be much smaller than the discrepancies between modeled and observed values. There is a large ozone under-prediction bias for the CRC A-38 simulations with both EMFAC2001 than EMFAC7G on August 27, but on August 28 the ozone bias and peak accuracy meet the EPA goals with EMFAC2001, whereas they fail with EMFAC7G. The poorer model performance on August 27 may be because of insufficient model spin-up time. The model is started at mid-afternoon on August 26, so the morning of August 27 is less than 24 hours into the simulation.

SCAQMD recently released a draft 2003 AQMP with UAM results based on EMFAC2002 emission inventories. The new UAM results show much improved model performance for ozone over the previous 1997 AQMP modeling (Table 2-10). It is difficult to directly compare model performance statistics between the 1997 and draft 2003 AQMPs because the SCAQMD changed the way model performance statistics are calculated. The 1997 AQMP presented basin-wide statistics, whereas the draft 2003 AQMP uses the model performance zones shown in Figure 2-26. The draft 2003 AQMP statistics shown in Table 2-10 are for zone 4 where the highest ozone levels occurred.

The draft 2003 AQMP simulations produce much higher peak ozone levels than any other simulation, especially on August 28 where the predicted peak of 319 ppb is higher than the observed peak of 290 ppb, and much higher than the 1997 AQMP modeled peak of 223 ppb. The draft 2003 AQMP simulation predicts higher ozone in general than the other simulations as shown by the normalized bias, which is less negative for the draft 2003 AQMP simulation than other simulations. However, the draft 2003 AQMP simulation still exhibits an under-prediction tendency (for zone 4) even though the peak ozone on August 28 is over-predicted. The draft 2003 AQMP simulation is the only model results shown in Table 2-10 that comes close to meeting the EPA statistical performance goals for 1-hour ozone.

It is unclear why the draft 2003 AQMP simulation predicts much higher ozone levels than the other simulations. The summary of domain-wide emission totals shown in Table 2-9 does not explain why the draft 2003 AQMP simulation predicts much higher ozone than the CRC A-38/EMFAC 2001 simulation. A more detailed comparison of the emission inventories is needed to investigate the reasons for these differences in model performance for ozone.

Precursor Model Performance

The ambient VOC/NOx ratios for the 1987 SCAQS episode have been characterized by Fujita et al. (1992) and are shown in table 4-5 of this report. The VOC/NOx ratio is an important attribute of the emissions inventory and is closely related to modeled ozone levels. The modeled and observed VOC/NOx ratios for the CRC A-38 simulations are compared to the SCAQS ambient data in Table 2-11. The average morning (7-8 am) VOC/NOx ratios are higher with EMFAC2001 (VOC/NOx = 7.9) than EMFAC7G (VOC/NOx = 6.8) and are in better agreement with observed average value of 8.2. With EMFAC2001, the modeled morning VOC/NOx values are not significantly different from the observed values.

Table 2-11. Comparison of observed 7-8 am VOC/NOx ratios from the 1987 Southern California Air Quality Study to modeled ratios with EMFAC7G and EMFAC2001.

Site	NOx (ppb)	VOC (ppbC)	VOC/NOx
Observed mean			**8.2 ± 0.8**
EMFAC2001			
Anaheim	65	583	8.98
Azusa	54	460	8.45
Burbank	72	588	8.22
Los Angeles	148	932	6.31
Claremont	38	364	9.46
Hawthorne	94	664	7.06
Long Beach	183	1038	5.69
Rubidoux	52	469	9.00
Mean			**7.9 ± 1.4**
EMFAC7G			
Anaheim	65	458	7.03
Azusa	49	379	7.67
Burbank	65	455	7.01
Los Angeles	137	746	5.44
Claremont	38	361	9.44
Hawthorne	85	472	5.54
Long Beach	173	859	4.95
Rubidoux	62	429	6.95
Mean			**6.8 ± 1.4**

Notes: The observed mean VOC/NOx ratio is from Fujita et al. (1992) and is shown below in Table 4-5.
The ranges for VOC/NOx ratio means are ±1 standard deviation.

3.0 RECONCILIATION OF 1997 MODELED AND AMBIENT OZONE PRECURSORS

In this section, changes between EMFAC7G and EMFAC2001 for total on-road ROG and NOx emissions in the SoCAB are reconciled with ambient data obtained during the 1997 Southern California Ozone Study – North American Research Strategy for Tropospheric Ozone (SCOS97). Ambient nonmethane hydrocarbons (NMHC) and nonmethane organic compounds (NMOC) levels and NMHC/NOx and NMOC/NOx ratios are compared to corresponding values from CAMx simulations of the August 3-7, 1997 SCOS episode using CB4 or SAPRC chemical mechanisms with EMFAC7G and EMFAC2001 mobile emissions.

3.1 RELEVANT AIR QUALITY MEASUREMENTS DURING THE SCOS97 FIELD STUDY

During the summer of 1997, the California Air Resources Board (CARB), the South Coast Air Quality Management District (SCAQMD), the San Diego County Air Pollution Control District, the Santa Barbara County Air Pollution Control District, the Ventura County Air Pollution Control District, the Mohave Desert Air Quality Management District, the United States Environmental Protection Agency (U.S. EPA), the United States Navy, and the United States Marine Corps co-sponsored the Southern California Ozone Study – NARSTO (SCOS97). The SCOS97 was conducted in order to update and improve the existing emission, meteorological, and air quality databases and model applications for representing urban-scale ozone episodes in southern California, and to quantify the contributions of ozone generated from emissions in one southern California air basin to U.S. and California ambient ozone standard exceedances in neighboring air basins.

The Air Pollution Control Districts measure ambient ozone concentrations with instruments made by several different manufacturers. All analyzers employ the UV photometric technique to determine ozone concentration and have been designated as EPA Equivalent Methods. The following analyzers were deployed in the networks: Thermo Environmental Inc., model 49, Dasibi Environmental, model 1003, Advanced Pollution Instrumentation, Inc., model 400, and Dasibi model 1003AH (at the supplemental sites). The general methods for measurement for the different analyzers are similar. The analyzers consist of a sample chamber illuminated with a continuous ultraviolet (UV) lamp with frequency at 394 nm. The air sample is first introduced to the chamber after passing through a molybdenum oxide scrubber to catalytically convert ozone to oxygen. A sensing system measures the amount of radiation that passes through the chamber without ozone in it. Then the sample is introduced to the chamber with ambient ozone in it. The difference between the UV light passing through the chamber without ozone and with ozone is proportional to the amount of ambient ozone. Some analyzers also contain sensors to measure temperature and pressure in the sample chamber so that ozone readings can be referenced to ambient conditions. Other analyzers require the measurements to be referenced to fixed conditions as determined by the average absolute pressure and temperature in the analyzer sample chamber so that ozone concentrations are given at approximately ambient conditions.

The Air Pollution Control Districts measure ambient NO/NO_X concentrations with instruments made by several different manufacturers. These analyzers measure the concentration of nitric oxide (NO) and total oxides of nitrogen (NO_X) by a chemiluminescence method and nitrogen dioxide (NO_2) by difference between NO_X and NO. Each analyzer has been designated as an EPA Reference Method. The following analyzers are deployed in the networks: Thermo Environmental Inc., model 14B/D, Thermo Environmental Inc., model 42, Advanced Pollution Instrumentation, Inc., model 200A, TEI Model 42 NO/NO_X (at the supplemental sites). When NO and ozone are mixed, a gas-phase reaction occurs that produces a characteristic luminescence with an intensity that is linearly proportional to the concentration of NO. A photomultiplier tube senses the luminescence generated by the reaction. Other oxides of nitrogen can also be measured by first reducing them to NO with a molybdenum converter heated to 325 °C and then measuring the result by chemiluminescence as NO_X. The analyzer switches between measuring NO and NO_X and electronically computes difference between NO_X and NO. The difference can in some cases be attributed to NO_2 as the other major constituent of NO_X. The instrument can also convert other nitrogenous species, such as nitric acid and PAN, to NO. Nitric acid and nitrate particles can be removed from the sample by installing a nylon filter on the sample inlet.

The Photochemical Assessment Monitoring Stations (PAMS) in the study region provided the foundation for the SCOS VOC measurements. PAMS ozone precursor monitoring is conducted annually in California during the peak ozone season (July 1 to September 30). There were five PAMS sites (Hawthorne, Burbank, Pico Rivera, Azusa and Upland) in operation in the South Coast Air Basin during SCOS. The PAMS network is based on an array of site locations relative to ozone precursor source areas and predominant wind directions associated with high ozone events. Specific monitoring objectives are to characterize precursor emission sources within the area (Type 2 sites), transport of ozone and its precursors into (Type 1 site) and out of the area (Type 3 and 4 sites), and the photochemical processes related to ozone nonattainment, as well as developing an initial urban toxic pollutant database.

South Coast Air Quality Management District (SCAQMD) collects eight 3-hour hydrocarbon samples (midnight-3 am, 3-6 am, 6-9 am, 9-noon, noon-3 pm, 3-6 pm, 6-9 pm, and 9-midnight PDT) every day at Type 2 sites (central business district, Burbank and Pico Rivera) and every third day at all other PAMS sites (Hawthorne – Type 1; Azusa – Type 3; Upland – Type 4). Sampling for carbonyl compounds is required at Type 2 sites only. In addition, one 24-hour sample is required every sixth day year-round at Type 2 sites and during the summer monitoring period at all other sites. EPA Compendium Methods TO-14A and TO-11A (USEPA, 1999) are used in the PAMS program for sampling and analysis of speciated hydrocarbons and carbonyl compounds, respectively. The database consists of 55 individual hydrocarbons, total nonmethane organic compounds (NMOC), and three carbonyl compounds (formaldehyde, acetaldehyde, and acetone).

As a supplement to the PAMS regularly scheduled sampling, several other organizations participated during SCOS in collecting data for a wide range of volatile organic compounds using a variety of sample collection and analysis methods. The SCOS field measurement program was conducted during a four-month period from June 16, 1997 to October 15, 1997. Supplemental speciated VOC measurement were made during intensive operational periods (IOPs) on a forecast basis for up to four consecutive days. Six IOPs (1- 7/14; 2 – 8/4, 8/5, 8/6, 8/7; 3 – 8/22, 8/23; 4 – 9/3, 9/4, 9/5, 9/6; 5 – 9/27, 9/28, 9/29; and 6 – 10/3, 10/4) were called during the study. Field operators from the University of California, Riverside College of Engineering – Center for Environmental Research and Technology (CE-CERT) collected VOC samples in the SoCAB during SCOS97 IOPs at Azusa, Anaheim, Burbank, Los Angeles – N. Main, and Los Angeles – ARCO Plaza. Supplemental canister samples were collected during SCOS IOP days that did not coincide with the PAMS third day schedule. VOC samples were also collected during SCOS at the following background locations: San Nicolas Island, Catalina Island, Point Conception, Rosarito Beach and SE Mexicali. The VOC samples that were collected specifically for SCOS IOPs were analyzed at Desert Research Institute (DRI), Biospheric Research Corporation (BRC), Atmospheric Assessment Associates, Inc. (AtmAA), and Atmospheric Analysis and Consulting, Inc. (AAC).

Hydrocarbon speciation measurements consisted of canister sampling followed by gas chromatographic analysis with flame ionization detection according to procedures consistent with EPA Compendium Method TO-14A (USEPA, 1999a). Laboratories employed commercial gas chromatographic systems equipped with flame ionization detectors (GC-FID), a cryogenic concentration step, and computerized data acquisition systems. Automated, semi-continuous hydrocarbon speciation was obtained by SCAQMD at the Pico Rivera PAMS site using an Entech 2000 preconcentrator and HP5890 gas chromatograph. The average detection limit for PAMS target compounds is 0.2 ppbC.

Derivation of carbonyl compounds by 2,4-dinitrophenylhydrazine (DNPH) followed by liquid chromatography and UV detection is a widely used method for measuring ambient carbonyl compounds. Collection of carbonyl compounds by this method is based on the acid-catalyzed derivatization of carbonyls by nucleophilic addition of the DNPH to a C=O bond, followed by 1,2-elimination of water to form 2,4-dinitrophenylhydrazone. The DNPH-hydrazones, formed during sampling, are non-volatile and remain on the reagent-impregnated cartridge. The yellow to deep-orange colored DNPH-hydrazones have UV absorption maxima in the 360-375 nm range and are analyzed by a high performance liquid chromatography (HPLC) method coupled with UV detection. Although C_1-C_7 carbonyl compounds are typically measured by this method, the PAMS program requires state and local agencies to report only formaldehyde, acetaldehyde and acetone. Despite the widespread use of the DNPH methods, interferences and sampling artifacts have been associated with the methods. The analytical method is well established, and questions regarding the accuracy of the DNPH method are mainly concerned with sampling. The major concerns are: 1) incomplete collection of carbonyls, 2) loss of carbonyl compounds by physical processes such as adsorption or chemical reaction with copollutants such as ozone, 3) generation of carbonyl compounds as sampling artifacts (Apel et al, 1998), and 4) variable blanks resulting from contamination of the reagent and sampling equipment.

Several terms are used inconsistently and interchangeably to describe different fractions of atmospheric organic material. The following terms are defined as they are used throughout this report.

- Volatile organic compounds (VOC): All gaseous organic compounds that are present in the ambient air could be considered VOCs irrespective of their photochemical reactivity or ability of measurement methods to quantify their concentrations. However, methane, ethane, acetone, and some others nonreactive species are excluded in EPA's formal definition of VOC. In practice, VOC is used interchangeably with reactive organic gases (ROG).

- Hydrocarbons: Organic compounds that consist only of carbon and hydrogen atoms. Subclasses of hydrocarbons include alkanes, alkenes, alkynes, and aromatic hydrocarbons. Paraffins and olefins are synonymous with alkanes and alkenes, respectively. All of the 55 target PAMS compounds are hydrocarbons. They typically comprise about 70 to 80 percent of total VOC in urban areas. This fraction is less in afternoon samples relative to morning samples and in downwind locations due to photochemical reactions that convert hydrocarbons to oxidized species such as carbonyl compounds and organic acids.

- Nonmethane hydrocarbons (NMHC, also termed "light" hydrocarbons): C_2 through C_{11} (light) hydrocarbons collected in stainless steel canisters and measured by gas chromatography with flame ionization detection (GC-FID) by EPA method TO-14A (U.S. EPA, 1999). Known halocarbons and oxygenated compounds (e.g., aldehydes, ketones, ethers and alcohols) are excluded from NMHC.

- Carbonyls: Aldehydes and ketones, the most common being formaldehyde, acetylaldehyde, and acetone. Carbonyls are operationally defined as C_1 through C_7 oxygenated compounds measured by collection on acidified 2,4-dinitrophenylhydrazine (DNPH)-impregnated C_{18} or silica gel cartridges and analyzed by high performance liquid chromatography with UV detection (HPLC/UV). PAMS data normally include only formaldehyde, acetaldehyde, and acetone.

- Non-methane organic compounds (NMOC): Sum of quantifiable peaks by EPA method TO-14A, including unidentified but excluding halocarbons, or by continuous instruments with flame ionization detection. Measured NMOC will be lower for laboratories employing water management. NMOC also refers to the sum of NMHC plus carbonyl compounds by TO-11.

- Reactive organic gases (ROG): Organic gases with potential to react ($<$30 day half-life) with the hydroxyl radical and other chemicals, resulting in ozone and secondary organic aerosol. The most reactive chemicals are not necessarily the largest contributors to undesirable end-products, however, as this depends on the magnitude of their emissions as well as on their reactivity. ROG is commonly used in connection with emission inventory data.

3.2 QUALITY OF AMBIENT DATA

External quality assurance audits and laboratory comparisons were conducted as part of the quality assurance program for SCOS. The results of these performance audits and comparisons and operational protocols are documented elsewhere (Fujita et al., 2003). This section summarizes the relevant quality assurance results for SCOS ozone, NOx and VOC measurements.

The SCOS data quality objectives for both ozone and NOx measurements (Fujita et al., 1997a) are ± 15%, ± 15%, and greater than 80% for precision, accuracy and data completeness, respectively. QA personnel from the ARB conducted system and performance audits during SCOS at the four monitoring sites of interest for this present analysis. The results summarized in Table 3-1 show that the measurements of ozone and NOx at these monitoring sites met the SCOS data quality objectives.

The SCOS97 data quality objectives for VOC measurements (Fujita et al., 1997) are ± 5%, ± 15%, and greater than 90% for precision, accuracy and data completeness, respectively. Target detection limits were 0.1 ppbC, 1 ppbv, and 0.01 ppbv for C_2-C_{11} hydrocarbons, carbonyl compounds, and halogenated compounds, respectively. DRI conducted performance audits for measurement of carbonyl compounds and organized measurement comparisons for various VOC measurements. The results show that measurements of volatile organic compounds (VOC) made during SCOS97 are generally consistent with specified data quality objectives (Fujita et al., 1999; Fujita et al., 2003).

The hydrocarbon comparison involved nine laboratories and consisted of two sets of collocated ambient samples. Participating laboratories include the ARB, U.S. EPA, BRC, DRI, SDAPCD, SCAQMD, VCAPCD, Bay Area Air Quality Management District (BAAQMD), and ManTech Environmental Technology, Inc. Each participating laboratory supplied two cleaned, evacuated 6-liter canisters to the ARB, Monitoring and Laboratory Division. EPA, BRC, and DRI supplied additional canisters for collection of duplicate and background samples. ARB filled the two sets of canisters to 20-25 psi with ambient air from the Los Angeles area using a manifold sampling system supplied by DRI. One set of canisters was collected in the morning in an area heavily influenced by mobile source emission (Los Angeles – N. Main). The other set was collected in the afternoon in a downwind area with maximum ozone levels (Azusa). Duplicate samples were collected for EPA, ARB, and DRI (total of eleven simultaneous canister samples at each site). Background samples were also collected during the afternoon at Santa Monica Beach. The protocol for the comparison study is described in Fujita et al. (1999). The coefficients of variation among laboratories for the sum of the 55 PAM target compounds and total NMHC ranged from ± 5 to 15 percent for ambient samples from Los Angeles and Azusa. All laboratories consistently identified abundant hydrocarbons, but discrepancies occurred for olefins greater than C4 and for hydrocarbons greater than C8.

The laboratory performance audit for the measurement of carbonyl compounds consisted of passing a known volume of a standard mixture of carbonyls onto a DNPH cartridge. The standard mixture was prepared at DRI in a 33-liter stainless steel tank. The SCAQMD, SDAPCD, VCAPCD, AtmAA, and AAC participated in the audit. A dilution apparatus was provide for the audit with the transfer canister containing the standard mixture of carbonyl compounds. Each laboratory collected two replicate samples from the transfer canister. The audit protocol specified a 3-hour sampling period using two DNPH cartridges in series at a nominal flow rate of 1 liter of ambient air per minute. The purpose of the first cartridge was to scrub the incoming ambient air. The standard mixture was added between the two cartridges through a sampling tee at a nominal flow rate of 5 milliliters per minute. At least two blanks were collected during the audit. Each laboratory collected two samples and passed the standard mixture and gas dilution system on to the next laboratory. The transfer canisters were replaced as necessary. The contents of the transfer canisters were analyzed at DRI by DNPH/HPLC prior to shipment and upon its return. Each laboratory performed two replicate measurements for each of the two samples in order to determine analytical precision. Data were reported to the ARB and were forwarded to DRI for analysis once DRI's data for the initial and final standard mixing ratios were sent to the ARB. The values reported by most of the laboratories were within 10 to 20 percent of those of the reference laboratory.

A field measurement comparison was also conducted during SCOS97 involving collocated carbonyl sampling at Azusa on September 23 and 24. Participants included DRI, AtmAA, AAC, SCAQMD, and VCAPCD. The comparisons consisted of collocated samplings at the Azusa monitoring station through a common sampling manifold that was provided at the site. Collocated sampling was conducted on two consecutive non-IOPs days. A total of four 3-hour samples were collected according to the following schedule: first day – 1300 to 1600, and 1700 to 2000 PDT; second day – 0600 to 0900 and 0900 to 1200. A duplicate sample was collected during the 0900-1200 sampling period of the second day by groups that have the ability to collect parallel samples. A backup cartridge, placed in series with the primary sample, was collected during the 1300 to 1600 period of the first sampling day and 0600-0900 period of the second day of sampling. A minimum of two field blanks was collected during the comparison, one for each day of sampling. Results of field measurement comparisons showed larger variations among the laboratories ranging from 20 to 40 percent for C1 to C3 carbonyl compounds. The greater variations observed in the field measurement comparison may reflect potential sampling artifacts, which the performance audits did not address.

3.3 AMBIENT VERSUS MODEL RECONCILIATION

Uncertainties in the estimation of emissions have been one of the major limitations to producing reliable air quality model results. Modeling sensitivity studies for Los Angeles have shown greatly improved model performance (i.e., closer agreement between observed and predicted ozone levels) when the "official" on-road motor vehicle ROG emissions were increased by substantial margins (Wagner and Wheeler, 1993; Chico et al., 1993; Harley et al., 1992). These results were also supported by on-road tunnel measurements, apportionment of ambient NMHC and reconciliation of ambient and emission inventory data, which all indicated that on-road NMHC and carbon monoxide (CO) emissions were historically underestimated (Ingalls et al., 1989; Pierson et al., 1990; Fujita et al., 1992). Modifications that were incorporated over the past decade into successive versions of EMFAC have substantially increased hydrocarbon and NOx emissions (for a common base year). During the same time, ambient CO, HC, and ratios of HC to NOx have declined significantly. While advances have been made in emission inventory methodology and will continue to be made in the future, the evidence that emission inventories in urban areas were underestimated in past inventories underscores the need for on-going verification of emission inventories. The SCOS97 provided an opportunity to update the ambient versus emission inventory reconciliation in the SoCAB.

For the current evaluation, we compared ambient NMHC and NMOC mixing ratios and NMHC/NOx and NMOC/NOx ratios to corresponding values from CAMx simulations of the August 3-7, 1997 SCOS episode. Four sets of simulations were performed by ENVIRON using CB4 and SAPRC chemical mechanisms with EMFAC7G and EMFAC2001 based emissions. The ambient NMHC and NMOC in these comparisons are sums of the CB4 and SAPRC99 lumped species, which were derived from the ambient speciated VOC data. Table 3-2a, 3-2b and 3-2c show the ambient values, modeled values and modeled/measured ratios, respectively, for O_3, NO, NO_2, NOx, NMHC, NMOC, NMHC/NOx and NMOC/NOx for CAMx simulations using CB4. Table 3-3a, 3-3b and 3-3c show the corresponding results for CAMx simulations using SAPRC99. Scatterplots of modeled (with CB4) versus ambient mixing ratios are shown for ozone, NO, NO_2 and NOx in Figure 3-1a and for NMHC, NMOC, NMHC/NOx and NMOC/NOx in Figure 3-1b. Figures 3-2a and 3-2b show the corresponding scatterplots of the modeled data with SAPRC99. The tables show the mean mixing ratios and modeled/measured ratios by site and sampling period during the episode while the scatterplots show all of the daily data. Note that ratios are not meaningful during periods of the day when ambient levels of pollutants (e.g., NO and ozone) are at or near zero. The data are also summarized by time period in Tables 3-4a and 3-4b for simulations with CB4 and SAPRC99 mechanism, respectively.

In general, the predicted total NMHC are in reasonable agreement with measured values with mean 0600 to 0900 predicted/measured ratios among the four sites and standard errors of 0.86 $\pm$ 0.13, 0.95 $\pm$ 0.13 for CB4 with EMFAC7G and EMFAC2001, respectively, and 0.74 $\pm$ 0.10 and 0.79 $\pm$ 0.11 for SAPRC99 with EMFAC7G and EMFAC2001, respectively. Similar results were obtained for NMOC and other time periods during the sampling periods from 0600 to 1800. The agreement between predicted and measured values varies among the four sampling locations with Azusa having lower predicted/measured ratios and Pico Rivera and Upland having higher ratios. Modeled NMHC and NMOC mixing ratios are about 20 percent higher for EMFAC2001 relative to EMFAC7G.

Modeled NO_2 and NOx mixing ratios are generally in good agreement with ambient measurements during the 0600 to 1800 sampling periods. The modeled overnight levels are higher than measured values but with higher variability. NO, a directly emitted pollutant, exhibits greater spatial gradients with sharply decreasing mixing ratios with distance from the roadway. These gradients are greater at night due to less vertical mixing and near roadways with higher volumes of diesel truck traffic. Fujita et al. (2002) found that NO concentrations were 1-2 orders of magnitude higher on freeways than on surface streets or at the SCAQMD Azusa monitoring station and other regional/background sites while CO and hydrocarbon levels were about a factor of 2-3 higher on freeways.

The predicted NO mixing ratios are particularly variable between EMFAC7G and EMFAC2001 for Upland. The EMFAC7G-based NO exceeds both ambient and EMFAC2001-based NO by a factor of 3 to 4 for both CB4 and SAPRC99 simulations. This high sensitivity is because of the location of the Upland monitor near the edge of the highly urbanized area where, in the model, NO emissions titrate ozone levels to near zero on most nights. Consequently, the evening and early morning modeled NO concentrations are very sensitive to the NO emission rate and whether the NO-O_3 titration completely removes NO or O_3. The NO sensitivity is compounded for NOx because of rapid nighttime removal mechanisms for NO_2 (i.e., conversion to nitric acid via N_2O_5) that only operate if there is zero NO. The sensitivity of NO and NOx at Upland results in differences between EMFAC7G and EMFAC2001 in the scatterplots for NO, NOx, NMHC/NOx and NMOC/NOx.

Aside from the aforementioned subset of NOx data for Upland, the measured and predicted NMHC/NOx and NMOC/NOx ratios are in good agreement. Table 3-5 shows the mean ambient NMHC/NOx ratios during the morning commute period at four sites and the corresponding ratios derived from CAMx simulations using CB4 and SAPRC99 with EMFAC2001 emissions. The four-site mean ambient ratio and standard error is 3.9 ± 0.4 and the corresponding mean predicted ratio is 3.7 ± 0.2 for CB4 and 3.2 ± 0.2 for SAPRC99. Table 3-4 shows that the ambient NMHC/NOx ratios in 1997 decreased by about half during the previous decade. We also show the mean NHMC/NOx ratios during the two PAMS seasons in 1999 and 2000 to show that the mean NMHC/NOx ratios during the SCOS episode are representative of the entire ozone season, which runs from June 1 to September 30. Samples are collected daily at Pico Rivera and every third day at the other three sites. The two-year mean ratio is 4.0 ± 0.2.

The CB4 NMHC/NOx ratios are consistently about 10 percent higher than SAPRC99 ratios. Possible causes include: (1) greater removal of modeled VOCs with SAPRC99 because the mechanism is more reactive; (2) inconsistencies between the CB4 and SAPRC99 emissions processing; and (3) inconsistencies between the way the ambient data (VOC samples) were converted to lumped species and the emissions processing.

EMFAC2001 NMHC and NMOC mixing ratios are about 20 percent higher relative to EMFAC7G. Because the EMFAC2001 NOx mixing ratios are also higher, the EMFAC2001 NMHC/NOx ratios are, on average, comparable to the ratios predicted by EMFAC7G. The version of EMFAC either improves or degrades comparison with ambient data depending upon whether CB4 or SAPRC99 is used. The mean predicted VOC/NOx ratios for 1997 with EMFAC7G were 4.0 " 0.1 with CB4 and 2.9 " 0.4 with SAPRC99. Overall, there is little difference in NMHC/NOx ratio between EMFAC2001 and EMFAC7G and both agree well with the ambient data.

In contrast to the SCAQS "top down" evaluation, which indicated that hydrocarbon emissions were underestimated by a factor of two to three relative to NOx, our current analysis shows no significant differences in NMHC/NOx or NMOC/NOx ratios derived from ambient and emission inventory data. The most significant change between the ambient/inventory reconciliation for SCAQS and SCOS97 is that the ambient ratio has dropped by about a factor of 2 between 1987 and 1997 due to greater reduction of VOC emissions relative to NOx. The changes in on-road motor vehicle emissions, shown in Figures 3-3 and 3-4, by EMFAC versions show that while both HC and NOx emissions increased substantially for a common base year, the HC/NOx ratio remained nearly constant. Thus, good ambient/inventory agreement was found for VOC/NOx ratios in both 1987 and 1997 when a recent emission factor model (EMFAC2001) was used.

Table 3-1. Results of SCOS97 performance audits for measurement of O_3, NO_2, and CO at Azusa, Los Angeles-North Main, Pico Rivera and Upland. Results are given in percentages from reference values.

Site	Site Name	Operator	O_3	NO_2	CO	Date	Auditor
AZUS	AZUSA-803 N LOREN AVE	SCAQMD	-5.0	-6.6	--	7/21/1997	ARB
LANM	LOS ANGELES-1630 N MAIN ST	SCAQMD	-1.6	-9.9	2.3	1/30/1997	ARB
PICO	PICO RIVERA-3713 SAN GABRIEL	SCAQMD	-3.3	-10.1	-1.2	7/28/1997	ARB
UPLA	UPLAND-1350 SAN BERNARDINO AVE	SCAQMD	-5.9	-4.4		5/29/1997	ARB

Table 3-2a. Mean and standard errors of ambient O_3, NO, NO_2, NOx, NMHC, NMOC, NMHC/NOx and NMOC/NOx during August 3-7, 1997 SCOS episode. NMHC and NMOC are sums of CB4 lumped chemical species.

Data Source	Site	Start (PDT)	NMHC (ppbC)	NMOC (ppbC)	O3 (ppb)	NO (ppb)	NO2 (ppb)	NOx (ppb)	NMHC/ NOx	NMOC/ NOx
Measured Ambient Values and Ratios										
SCOS97	AZUS	3	558 ± 70	582 ± 67	2.6 ± 0.4	43.1 ± 12.1	46.1 ± 5.1	89.3 ± 14.3	6.5 ± 0.9	6.8 ± 1.0
SCOS97	AZUS	6	819 ± 114	864 ± 119	3.8 ± 0.5	78.1 ± 9.9	56.6 ± 7.9	134.7 ± 16.4	5.5 ± 0.7	5.8 ± 0.7
SCOS97	AZUS	13	402 ± 64	449 ± 67	85.2 ± 9.5	5.9 ± 0.9	49.5 ± 6.7	55.4 ± 7.1	6.6 ± 0.4	7.4 ± 0.4
SCOS97	AZUS	17	242 ± 46	267 ± 50	36.3 ± 6.3	17.0 ± 7.2	41.8 ± 5.4	58.8 ± 9.9	3.7 ± 0.8	4.1 ± 0.9
SCOS97	LANM	3	325 ± 52	382 ± 76	0.4 ± 0.2	48.0 ± 23.3	40.9 ± 5.9	88.9 ± 27.8	3.4 ± 0.7	2.8 ± 0.2
SCOS97	LANM	6	766 ± 95	873 ± 130	0.3 ± 0.1	104.6 ± 19.4	51.5 ± 6.8	156.1 ± 26.2	4.3 ± 0.3	4.9 ± 0.2
SCOS97	LANM	13	344 ± 60	436 ± 0	60.1 ± 9.4	5.7 ± 1.1	33.5 ± 2.6	39.2 ± 1.7	9.2 ± 2.6	12.7 ± 0.0
SCOS97	LANM	17	302 ± 62	354 ± 102	20.2 ± 4.3	10.8 ± 3.6	37.2 ± 4.7	48.0 ± 6.9	5.7 ± 0.7	6.9 ± 0.4
PAMS	AZUS	0	518 ± 5		3.7 ± 0.4	42.7 ± 14.7	52.3 ± 6.4	94.9 ± 19.3	7.6 ± 2.5	
PAMS	AZUS	3	483 ± 90		2.6 ± 0.4	43.1 ± 12.1	46.1 ± 5.1	89.3 ± 14.3	5.5 ± 0.6	
PAMS	AZUS	6	692 ± 80		3.8 ± 0.5	78.1 ± 9.9	56.6 ± 7.9	134.7 ± 16.4	4.6 ± 0.4	
PAMS	AZUS	9	368 ± 17		25.2 ± 3.4	28.8 ± 2.4	70.3 ± 7.2	99.0 ± 8.8	3.4 ± 0.1	
PAMS	AZUS	12	288 ± 38		81.6 ± 10.5	5.8 ± 0.5	56.0 ± 6.6	61.8 ± 6.2	4.3 ± 0.2	
PAMS	AZUS	15	156 ± 34		66.9 ± 10.2	9.8 ± 3.6	39.7 ± 5.0	49.5 ± 8.1	2.9 ± 0.5	
PAMS	AZUS	18	214 ± 56		22.9 ± 2.7	19.4 ± 8.4	44.8 ± 8.3	64.3 ± 13.5	3.0 ± 1.0	
PAMS	AZUS	21	320 ± 121		5.1 ± 0.8	26.3 ± 14.5	50.4 ± 11.4	76.8 ± 23.6	3.1 ± 0.1	
PAMS	PICO	0	363 ± 118	375 ± 122	2.9 ± 1.2	35.3 ± 8.2	36.5 ± 4.5	71.8 ± 12.0	6.0 ± 1.7	6.2 ± 1.7
PAMS	PICO	3	416 ± 195	428 ± 200	2.1 ± 0.1	48.3 ± 16.6	33.0 ± 5.0	81.3 ± 21.5	5.0 ± 0.6	5.1 ± 0.7
PAMS	PICO	6	432 ± 157	444 ± 162	3.1 ± 0.9	113.3 ± 24.9	40.3 ± 6.2	153.6 ± 29.7	2.9 ± 0.7	3.0 ± 0.7
PAMS	PICO	9	402 ± 93	421 ± 97	22.8 ± 5.4	40.4 ± 17.4	66.5 ± 15.7	106.9 ± 30.5	3.9 ± 0.3	4.1 ± 0.3
PAMS	PICO	12	232 ± 45	251 ± 48	61.2 ± 11.6	6.1 ± 2.2	39.5 ± 7.7	45.6 ± 8.3	5.0 ± 1.2	5.4 ± 1.1
PAMS	PICO	15	182 ± 33	192 ± 32	50.5 ± 11.4	7.3 ± 3.8	23.8 ± 2.0	31.1 ± 4.4	6.4 ± 1.5	6.7 ± 1.5
PAMS	PICO	18	152 ± 16	158 ± 15	20.5 ± 4.1	8.1 ± 3.7	28.9 ± 5.5	37.0 ± 6.6	5.2 ± 1.2	5.4 ± 1.2
PAMS	PICO	21	205 ± 27	209 ± 26	5.1 ± 1.8	27.9 ± 13.3	36.7 ± 7.1	64.6 ± 17.1	4.5 ± 1.7	4.6 ± 1.8
PAMS	UPLA	0	280 ± 53		11.9 ± 1.4	5.3 ± 0.9	35.8 ± 2.8	41.1 ± 3.2	7.0 ± 0.8	
PAMS	UPLA	3	248 ± 7		12.8 ± 3.0	4.0 ± 2.9	30.1 ± 1.1	34.1 ± 3.9	8.2 ± 0.2	
PAMS	UPLA	6	350 ± 60		10.8 ± 2.0	45.8 ± 5.9	45.8 ± 2.8	91.6 ± 7.9	3.9 ± 0.8	
PAMS	UPLA	9	203 ± 38		36.0 ± 4.6	8.1 ± 2.6	53.1 ± 5.1	61.2 ± 7.6	3.5 ± 0.1	
PAMS	UPLA	12	187 ± 15		83.1 ± 12.5	1.0 ± 0.5	43.1 ± 1.7	44.1 ± 1.6	4.1 ± 0.5	
PAMS	UPLA	15	150 ± 22		83.3 ± 6.4	1.1 ± 0.6	33.3 ± 2.7	34.3 ± 2.0	4.2 ± 0.3	
PAMS	UPLA	18	192 ± 33		30.1 ± 6.6	5.2 ± 1.2	45.6 ± 8.2	50.8 ± 7.7	3.3 ± 0.3	
PAMS	UPLA	21	380 ± 121		9.3 ± 2.4	29.2 ± 12.6	45.6 ± 10.2	74.8 ± 22.7	4.2 ± 0.2	
Number of Observations										
SCOS97	AZUS	3	3	3	4	4	4	4	3	3
SCOS97	AZUS	6	3	3	4	4	4	4	3	3
SCOS97	AZUS	13	3	3	4	4	4	4	3	3
SCOS97	AZUS	17	3	3	4	4	4	4	3	3
SCOS97	LANM	3	3	2	4	4	4	4	3	2
SCOS97	LANM	6	3	2	4	4	4	4	3	2
SCOS97	LANM	13	2	1	4	4	4	4	2	1
SCOS97	LANM	17	3	2	4	4	4	4	3	2
PAMS	AZUS	0	2	0	4	4	4	4	2	0
PAMS	AZUS	3	3	0	4	4	4	4	3	0
PAMS	AZUS	6	3	0	4	4	4	4	3	0
PAMS	AZUS	9	3	0	4	4	4	4	3	0
PAMS	AZUS	12	3	0	4	4	4	4	3	0
PAMS	AZUS	15	3	0	4	4	4	4	3	0
PAMS	AZUS	18	3	0	4	4	4	4	3	0
PAMS	AZUS	21	2	0	4	4	4	4	2	0
PAMS	PICO	0	3	3	4	4	4	4	3	3
PAMS	PICO	3	3	3	4	4	4	4	3	3
PAMS	PICO	6	4	4	4	4	4	4	4	4
PAMS	PICO	9	4	4	4	4	4	4	4	4
PAMS	PICO	12	3	3	4	4	4	4	3	3
PAMS	PICO	15	4	4	4	4	4	4	4	4
PAMS	PICO	18	3	3	4	4	4	4	3	3
PAMS	PICO	21	3	3	4	4	4	4	3	3
PAMS	UPLA	0	3	0	4	4	4	4	3	0
PAMS	UPLA	3	3	0	4	4	4	4	3	0
PAMS	UPLA	6	3	0	4	4	4	4	3	0
PAMS	UPLA	9	3	0	4	4	4	4	3	0
PAMS	UPLA	12	2	0	4	4	4	4	2	0
PAMS	UPLA	15	3	0	4	4	4	4	3	0
PAMS	UPLA	18	3	0	4	4	4	4	3	0
PAMS	UPLA	21	3	0	4	4	4	4	3	0

Table 3-2b. Mean and standard errors of modeled O_3, NO, NO_2, NOx, NMHC, NMOC, NMHC/NOx and NMOC/NOx for CAMx simulations of the August 3-7, 1997 SCOS episode using CB4 chemical mechanism and EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	NMHC (ppbC)	NMOC (ppbC)	O3 (ppb)	NO (ppb)	NO2 (ppb)	NOx (ppb)	NMHC/ NOx	NMOC/ NOx
EMFAC 7G									
AZUS	3	371 ± 38	411 ± 40	0.7 ± 0.7	18.4 ± 7.2	54.7 ± 6.4	74.7 ± 13.3	3.2 ± 1.1	4.7 ± 0.1
AZUS	6	335 ± 71	372 ± 77	8.3 ± 1.1	39.5 ± 9.4	47.4 ± 5.3	87.9 ± 14.7	2.8 ± 0.9	4.2 ± 0.2
AZUS	13	182 ± 10	209 ± 11	118.0 ± 4.0	3.9 ± 0.2	23.2 ± 1.6	27.3 ± 1.7	4.8 ± 1.6	7.3 ± 0.2
AZUS	17	207 ± 19	230 ± 21	65.1 ± 7.0	3.1 ± 0.2	42.7 ± 4.3	46.0 ± 4.5	3.3 ± 1.1	5.0 ± 0.2
LANM	3	345 ± 44	417 ± 60	1.9 ± 1.2	19.1 ± 6.8	49.2 ± 2.4	69.9 ± 8.4	4.6 ± 0.2	5.0 ± 0.2
LANM	6	514 ± 33	583 ± 57	4.7 ± 0.5	73.9 ± 10.5	57.1 ± 4.1	132.6 ± 14.5	3.5 ± 0.1	3.9 ± 0.2
LANM	13	175 ± 9	186 ± 0	80.9 ± 5.3	5.7 ± 0.1	25.0 ± 1.9	31.0 ± 1.9	5.6 ± 0.1	6.4 ± 0.0
LANM	17	288 ± 19	322 ± 32	27.9 ± 2.7	10.7 ± 1.3	59.9 ± 5.2	71.2 ± 6.3	3.8 ± 0.0	4.1 ± 0.0
AZUS	0	357 ± 0		2.4 ± 2.4	17.9 ± 9.0	58.8 ± 12.9	78.2 ± 22.0	3.7 ± 0.0	
AZUS	3	371 ± 38		0.7 ± 0.7	18.4 ± 7.2	54.7 ± 6.4	74.7 ± 13.3	4.3 ± 0.1	
AZUS	6	335 ± 71		8.3 ± 1.1	39.5 ± 9.4	47.4 ± 5.3	87.9 ± 14.7	3.8 ± 0.1	
AZUS	9	309 ± 10		41.9 ± 3.7	23.6 ± 4.4	45.6 ± 6.0	69.5 ± 10.3	3.9 ± 0.2	
AZUS	12	219 ± 13		104.3 ± 3.3	5.8 ± 0.6	29.2 ± 2.6	35.2 ± 3.1	5.8 ± 0.1	
AZUS	15	168 ± 10		109.7 ± 7.5	3.6 ± 0.2	25.1 ± 1.7	28.8 ± 1.9	5.6 ± 0.1	
AZUS	18	247 ± 37		38.7 ± 6.5	2.5 ± 0.7	55.9 ± 8.5	58.9 ± 9.0	4.2 ± 0.3	
AZUS	21	318 ± 123		3.4 ± 3.4	20.0 ± 7.7	69.3 ± 12.5	90.8 ± 20.4	4.3 ± 0.9	
PICO	0	326 ± 158	360 ± 171	4.8 ± 4.8	34.3 ± 17.6	55.6 ± 16.3	91.9 ± 34.6	5.3 ± 1.7	5.9 ± 2.0
PICO	3	328 ± 76	364 ± 82	3.1 ± 2.5	18.5 ± 10.3	47.4 ± 7.4	67.4 ± 16.8	5.2 ± 0.8	5.8 ± 0.9
PICO	6	377 ± 44	418 ± 48	7.8 ± 1.2	45.1 ± 11.9	50.1 ± 4.5	96.3 ± 16.1	4.0 ± 0.2	4.5 ± 0.3
PICO	9	313 ± 28	351 ± 31	42.8 ± 1.6	23.7 ± 3.9	47.2 ± 4.7	71.2 ± 8.3	4.4 ± 0.2	5.0 ± 0.2
PICO	12	190 ± 12	216 ± 14	100.1 ± 4.3	4.9 ± 0.1	24.1 ± 1.9	28.8 ± 2.1	6.5 ± 0.3	7.4 ± 0.3
PICO	15	137 ± 5	154 ± 6	83.5 ± 8.3	3.7 ± 0.3	20.2 ± 1.0	24.0 ± 1.1	5.7 ± 0.1	6.4 ± 0.2
PICO	18	193 ± 23	212 ± 25	27.5 ± 5.1	4.7 ± 2.8	51.7 ± 9.4	56.8 ± 11.3	4.2 ± 0.4	4.6 ± 0.5
PICO	21	357 ± 55	391 ± 60	3.1 ± 3.1	26.8 ± 13.0	63.1 ± 10.8	91.8 ± 23.5	3.2 ± 0.2	3.7 ± 0.2
UPLA	0	303 ± 118		0.0 ± 0.0	85.5 ± 35.3	74.2 ± 12.3	163.0 ± 48.3	2.3 ± 0.4	
UPLA	3	381 ± 13		0.0 ± 0.0	133.0 ± 20.2	75.6 ± 5.3	220.5 ± 21.5	1.6 ± 0.1	
UPLA	6	452 ± 21		2.5 ± 0.0	220.6 ± 11.4	82.2 ± 3.6	306.9 ± 15.0	1.4 ± 0.1	
UPLA	9	289 ± 9		30.6 ± 2.5	55.8 ± 7.2	59.8 ± 4.1	116.4 ± 11.3	2.3 ± 0.2	
UPLA	12	180 ± 27		98.7 ± 4.8	7.7 ± 0.6	35.8 ± 2.6	43.7 ± 3.0	4.0 ± 0.1	
UPLA	15	175 ± 9		112.9 ± 3.5	4.7 ± 0.1	37.7 ± 1.5	42.8 ± 1.6	4.0 ± 0.1	
UPLA	18	255 ± 21		35.2 ± 3.5	4.5 ± 1.8	71.3 ± 5.1	76.8 ± 6.1	3.2 ± 0.1	
UPLA	21	374 ± 70		0.0 ± 0.0	60.9 ± 19.8	79.9 ± 8.3	143.3 ± 27.6	2.6 ± 0.2	
EMFAC 2001									
AZUS	3	423 ± 49	463 ± 50	0.1 ± 0.1	22.7 ± 7.0	56.8 ± 5.3	81.2 ± 12.2	4.5 ± 0.3	5.0 ± 0.3
AZUS	6	393 ± 87	432 ± 93	7.5 ± 1.1	47.1 ± 10.1	50.4 ± 5.2	98.6 ± 15.1	4.0 ± 0.1	4.4 ± 0.1
AZUS	13	220 ± 13	250 ± 15	120.3 ± 3.6	4.3 ± 0.2	27.1 ± 1.9	31.6 ± 2.0	6.7 ± 0.2	7.6 ± 0.2
AZUS	17	255 ± 28	281 ± 31	63.6 ± 7.0	3.5 ± 0.3	47.1 ± 5.0	50.9 ± 5.3	5.0 ± 0.2	5.5 ± 0.2
LANM	3	396 ± 53	473 ± 73	0.1 ± 0.1	27.1 ± 7.5	52.3 ± 2.4	81.2 ± 8.2	4.6 ± 0.3	5.0 ± 0.4
LANM	6	636 ± 42	707 ± 74	4.7 ± 0.6	90.6 ± 11.7	62.3 ± 4.5	154.8 ± 16.0	3.7 ± 0.2	4.0 ± 0.3
LANM	13	210 ± 14	216 ± 0	80.1 ± 5.0	6.4 ± 0.1	27.7 ± 2.1	34.4 ± 2.1	6.0 ± 0.1	6.7 ± 0.0
LANM	17	362 ± 26	401 ± 44	25.6 ± 2.3	13.1 ± 1.7	63.6 ± 5.6	77.3 ± 6.9	4.4 ± 0.1	4.7 ± 0.1
AZUS	0	413 ± 0		1.2 ± 0.0	24.2 ± 0.0	61.8 ± 0.0	87.8 ± 0.0	3.8 ± 0.0	
AZUS	3	423 ± 49		0.1 ± 0.1	22.7 ± 7.0	56.8 ± 5.3	81.2 ± 12.2	4.5 ± 0.3	
AZUS	6	393 ± 87		7.5 ± 1.1	47.1 ± 10.1	50.4 ± 5.2	98.6 ± 15.1	4.0 ± 0.1	
AZUS	9	367 ± 16		43.0 ± 2.9	25.1 ± 4.0	50.2 ± 6.4	75.6 ± 10.2	4.3 ± 0.2	
AZUS	12	263 ± 17		107.0 ± 2.9	6.4 ± 0.5	33.7 ± 2.8	40.2 ± 3.2	6.1 ± 0.1	
AZUS	15	206 ± 14		110.6 ± 7.3	4.0 ± 0.2	28.6 ± 2.0	32.8 ± 2.1	6.0 ± 0.1	
AZUS	18	305 ± 51		36.4 ± 6.5	3.6 ± 1.2	61.2 ± 9.5	65.3 ± 10.5	4.7 ± 0.3	
AZUS	21	379 ± 164		2.8 ± 2.8	28.0 ± 10.4	72.3 ± 12.7	102.0 ± 23.3	4.6 ± 0.8	
PICO	0	368 ± 191	403 ± 205	4.2 ± 4.2	42.3 ± 21.7	58.0 ± 16.4	102.4 ± 38.8	5.2 ± 1.6	5.8 ± 1.8
PICO	3	368 ± 89	404 ± 96	2.1 ± 2.0	24.1 ± 12.9	50.1 ± 7.3	75.9 ± 19.1	5.1 ± 0.7	5.7 ± 0.8
PICO	6	443 ± 53	487 ± 58	6.9 ± 1.0	55.2 ± 13.9	54.2 ± 4.9	110.7 ± 18.4	4.1 ± 0.2	4.5 ± 0.3
PICO	9	374 ± 34	414 ± 38	43.5 ± 1.1	26.2 ± 4.0	52.4 ± 5.2	78.9 ± 8.9	4.8 ± 0.2	5.3 ± 0.2
PICO	12	225 ± 17	253 ± 19	100.7 ± 3.8	5.5 ± 0.0	27.3 ± 2.3	32.6 ± 2.6	6.9 ± 0.3	7.7 ± 0.3
PICO	15	163 ± 7	180 ± 9	82.5 ± 8.0	4.1 ± 0.4	22.4 ± 1.1	26.6 ± 1.2	6.1 ± 0.1	6.8 ± 0.2
PICO	18	231 ± 31	251 ± 33	25.5 ± 5.1	6.6 ± 4.0	54.9 ± 9.9	62.0 ± 12.6	4.6 ± 0.4	5.0 ± 0.5
PICO	21	416 ± 67	452 ± 72	2.6 ± 2.6	34.8 ± 15.7	65.0 ± 10.8	101.7 ± 26.4	3.4 ± 0.2	3.7 ± 0.2
UPLA	0	303 ± 116		2.4 ± 2.4	24.5 ± 12.3	61.1 ± 12.5	87.4 ± 25.2	4.4 ± 0.7	
UPLA	3	387 ± 17		0.0 ± 0.0	31.5 ± 7.8	59.3 ± 4.7	97.3 ± 11.6	3.6 ± 0.2	
UPLA	6	402 ± 25		5.3 ± 0.1	68.7 ± 4.4	57.1 ± 2.7	127.3 ± 7.0	3.0 ± 0.1	
UPLA	9	268 ± 16		50.1 ± 1.5	18.4 ± 1.8	40.2 ± 2.4	58.9 ± 4.1	4.3 ± 0.2	
UPLA	12	191 ± 31		114.0 ± 4.9	4.7 ± 0.2	25.8 ± 2.4	30.6 ± 2.6	6.4 ± 0.0	
UPLA	15	186 ± 10		128.5 ± 3.4	2.9 ± 0.2	25.9 ± 1.0	29.0 ± 1.2	6.3 ± 0.2	
UPLA	18	268 ± 27		51.9 ± 5.1	1.5 ± 0.4	53.2 ± 4.0	55.4 ± 4.3	4.7 ± 0.2	
UPLA	21	394 ± 79		1.0 ± 0.6	24.2 ± 9.6	74.3 ± 8.5	100.3 ± 17.9	3.9 ± 0.2	

Table 3-2c. Modeled/measured ratios of O_3, NO, NO_2, NOx, NMHC, NMOC, NMHC/NOx and NMOC/NOx for CAMx simulations of the August 3-7, 1997 SCOS episode using CB4 chemical mechanism and EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	NMHC	NMOC	O3	NO	NO2	NOx	NMHC/ NOx	NMOC/ NOx
EMFAC 7G									
AZUS	3	0.71 ± 0.18	0.75 ± 0.17	0.36 ± 0.36	1.44 ± 1.22	1.19 ± 0.08	0.97 ± 0.34	0.67 ± 0.08	0.72 ± 0.09
AZUS	6	0.46 ± 0.17	0.48 ± 0.18	2.20 ± 0.14	0.54 ± 0.14	0.90 ± 0.16	0.69 ± 0.15	0.71 ± 0.09	0.74 ± 0.09
AZUS	13	0.49 ± 0.11	0.49 ± 0.10	1.44 ± 0.16	0.70 ± 0.09	0.49 ± 0.06	0.51 ± 0.06	0.98 ± 0.07	1.00 ± 0.06
AZUS	17	0.89 ± 0.11	0.90 ± 0.10	1.92 ± 0.33	0.39 ± 0.17	1.04 ± 0.08	0.85 ± 0.15	1.35 ± 0.40	1.36 ± 0.39
LANM	3	1.12 ± 0.23	1.17 ± 0.39	3.49 ± 2.79	0.71 ± 0.27	1.28 ± 0.17	1.02 ± 0.27	1.49 ± 0.27	1.79 ± 0.20
LANM	6	0.69 ± 0.10	0.69 ± 0.17	12.00 ± 3.04	0.74 ± 0.09	1.15 ± 0.11	0.89 ± 0.10	0.83 ± 0.07	0.79 ± 0.01
LANM	13	0.53 ± 0.12	0.43 ± 0.00	1.44 ± 0.21	1.14 ± 0.24	0.76 ± 0.07	0.79 ± 0.04	0.65 ± 0.17	0.50 ± 0.00
LANM	17	1.00 ± 0.12	0.96 ± 0.19	1.65 ± 0.48	1.39 ± 0.41	1.64 ± 0.10	1.53 ± 0.13	0.68 ± 0.09	0.59 ± 0.03
AZUS	0	0.68 ± 0.00		0.42 ± 0.42	0.24 ± 0.15	0.79 ± 0.27	0.52 ± 0.20	0.36 ± 0.36	
AZUS	3	0.86 ± 0.27		0.36 ± 0.36	1.44 ± 1.22	1.19 ± 0.08	0.97 ± 0.34	0.79 ± 0.10	
AZUS	6	0.53 ± 0.18		2.20 ± 0.14	0.54 ± 0.14	0.90 ± 0.16	0.69 ± 0.15	0.82 ± 0.09	
AZUS	9	0.84 ± 0.06		1.84 ± 0.47	0.81 ± 0.13	0.64 ± 0.04	0.69 ± 0.06	1.13 ± 0.07	
AZUS	12	0.80 ± 0.16		1.35 ± 0.18	1.04 ± 0.16	0.54 ± 0.07	0.58 ± 0.06	1.35 ± 0.07	
AZUS	15	1.16 ± 0.21		1.78 ± 0.34	0.57 ± 0.19	0.65 ± 0.04	0.61 ± 0.06	2.04 ± 0.43	
AZUS	18	1.26 ± 0.21		1.73 ± 0.31	0.35 ± 0.18	1.31 ± 0.21	1.05 ± 0.27	1.83 ± 0.69	
AZUS	21	0.99 ± 0.01		0.86 ± 0.86	1.90 ± 1.05	1.57 ± 0.43	1.49 ± 0.50	1.42 ± 0.31	
PICO	0	1.49 ± 0.91	1.58 ± 0.96	14.42 ± 14.42	0.91 ± 0.58	1.51 ± 0.32	1.22 ± 0.47	1.15 ± 0.01	1.24 ± 0.02
PICO	3	1.02 ± 0.25	1.10 ± 0.27	1.30 ± 1.00	0.29 ± 0.11	1.43 ± 0.03	0.86 ± 0.06	1.11 ± 0.23	1.19 ± 0.25
PICO	6	1.13 ± 0.28	1.24 ± 0.32	3.13 ± 1.06	0.42 ± 0.07	1.29 ± 0.09	0.67 ± 0.09	1.92 ± 0.73	2.10 ± 0.82
PICO	9	0.88 ± 0.16	0.94 ± 0.16	2.14 ± 0.39	0.76 ± 0.17	0.81 ± 0.15	0.77 ± 0.13	1.15 ± 0.05	1.23 ± 0.05
PICO	12	0.91 ± 0.24	0.95 ± 0.24	1.84 ± 0.36	0.63 ± 0.08	0.66 ± 0.10	0.67 ± 0.07	1.43 ± 0.25	1.49 ± 0.24
PICO	15	0.84 ± 0.17	0.87 ± 0.16	2.01 ± 0.60	0.55 ± 0.19	0.86 ± 0.04	0.82 ± 0.10	1.13 ± 0.35	1.17 ± 0.35
PICO	18	1.27 ± 0.04	1.34 ± 0.04	1.68 ± 0.67	0.57 ± 0.27	1.85 ± 0.26	1.63 ± 0.31	0.97 ± 0.36	1.01 ± 0.37
PICO	21	1.76 ± 0.23	1.90 ± 0.24	3.10 ± 3.10	2.59 ± 1.19	1.89 ± 0.48	1.82 ± 0.65	0.93 ± 0.28	0.87 ± 0.44
UPLA	0	1.11 ± 0.07		0.00 ± 0.00	13.38 ± 5.08	2.05 ± 0.14	3.72 ± 0.86	0.38 ± 0.13	
UPLA	3	1.54 ± 0.07		0.00 ± 0.00	76.13 ± 46.98	2.53 ± 0.25	6.88 ± 1.21	0.19 ± 0.01	
UPLA	6	1.39 ± 0.30		0.26 ± 0.04	5.05 ± 0.66	1.80 ± 0.05	3.40 ± 0.21	0.41 ± 0.10	
UPLA	9	1.53 ± 0.30		0.89 ± 0.13	10.92 ± 4.18	1.16 ± 0.14	2.02 ± 0.35	0.66 ± 0.06	
UPLA	12	0.98 ± 0.22		1.26 ± 0.18	11.71 ± 7.48	0.84 ± 0.07	0.99 ± 0.08	0.99 ± 0.14	
UPLA	15	1.25 ± 0.26		1.38 ± 0.11	2.20 ± 0.22	1.16 ± 0.12	1.26 ± 0.10	0.96 ± 0.10	
UPLA	18	1.38 ± 0.16		1.27 ± 0.17	0.97 ± 0.34	1.68 ± 0.22	1.58 ± 0.16	0.97 ± 0.09	
UPLA	21	1.15 ± 0.27		0.00 ± 0.00	2.83 ± 0.89	1.93 ± 0.29	2.22 ± 0.43	0.62 ± 0.09	
EMFAC 2001									
AZUS	3	0.81 ± 0.21	0.84 ± 0.20	0.04 ± 0.04	1.58 ± 1.27	1.24 ± 0.07	1.04 ± 0.33	0.71 ± 0.07	0.75 ± 0.08
AZUS	6	0.54 ± 0.21	0.56 ± 0.21	1.99 ± 0.10	0.65 ± 0.17	0.96 ± 0.17	0.78 ± 0.17	0.75 ± 0.10	0.78 ± 0.10
AZUS	13	0.59 ± 0.13	0.59 ± 0.12	1.46 ± 0.16	0.78 ± 0.10	0.57 ± 0.08	0.59 ± 0.07	1.03 ± 0.07	1.04 ± 0.06
AZUS	17	1.09 ± 0.11	1.09 ± 0.11	1.87 ± 0.32	0.44 ± 0.20	1.14 ± 0.09	0.94 ± 0.17	1.51 ± 0.44	1.50 ± 0.43
LANM	3	1.28 ± 0.27	1.33 ± 0.46	0.50 ± 0.50	1.17 ± 0.52	1.36 ± 0.19	1.21 ± 0.34	1.49 ± 0.30	1.79 ± 0.28
LANM	6	0.86 ± 0.13	0.84 ± 0.21	10.59 ± 2.51	0.91 ± 0.10	1.25 ± 0.11	1.04 ± 0.11	0.88 ± 0.08	0.83 ± 0.03
LANM	13	0.64 ± 0.15	0.50 ± 0.00	1.42 ± 0.20	1.28 ± 0.27	0.84 ± 0.08	0.88 ± 0.05	0.71 ± 0.19	0.53 ± 0.00
LANM	17	1.26 ± 0.15	1.20 ± 0.22	1.51 ± 0.43	1.71 ± 0.51	1.74 ± 0.11	1.66 ± 0.14	0.79 ± 0.10	0.68 ± 0.02
AZUS	0	0.79 ± 0.00		0.29 ± 0.29	0.43 ± 0.24	1.12 ± 0.05	0.78 ± 0.16	0.76 ± 0.00	
AZUS	3	0.99 ± 0.32		0.04 ± 0.04	1.58 ± 1.27	1.24 ± 0.07	1.04 ± 0.33	0.84 ± 0.09	
AZUS	6	0.62 ± 0.22		1.99 ± 0.10	0.65 ± 0.17	0.96 ± 0.17	0.78 ± 0.17	0.88 ± 0.10	
AZUS	9	1.00 ± 0.08		1.87 ± 0.43	0.87 ± 0.13	0.71 ± 0.04	0.76 ± 0.06	1.25 ± 0.09	
AZUS	12	0.97 ± 0.20		1.38 ± 0.18	1.14 ± 0.14	0.62 ± 0.08	0.67 ± 0.07	1.43 ± 0.08	
AZUS	15	1.42 ± 0.25		1.79 ± 0.33	0.64 ± 0.22	0.74 ± 0.04	0.70 ± 0.07	2.21 ± 0.46	
AZUS	18	1.54 ± 0.23		1.62 ± 0.31	0.49 ± 0.26	1.44 ± 0.24	1.17 ± 0.30	2.03 ± 0.75	
AZUS	21	1.15 ± 0.07		0.70 ± 0.70	2.69 ± 1.44	1.63 ± 0.44	1.68 ± 0.58	1.49 ± 0.28	
PICO	0	1.69 ± 1.08	1.78 ± 1.13	9.54 ± 9.54	0.84 ± 0.58	1.18 ± 0.45	1.02 ± 0.50	0.77 ± 0.39	0.82 ± 0.41
PICO	3	1.12 ± 0.26	1.20 ± 0.28	0.84 ± 0.82	0.41 ± 0.11	1.52 ± 0.03	0.98 ± 0.08	1.09 ± 0.24	1.17 ± 0.26
PICO	6	1.34 ± 0.34	1.44 ± 0.38	2.78 ± 0.90	0.53 ± 0.10	1.39 ± 0.11	0.77 ± 0.11	1.97 ± 0.76	2.13 ± 0.83
PICO	9	1.05 ± 0.20	1.11 ± 0.20	2.17 ± 0.37	0.85 ± 0.18	0.90 ± 0.18	0.86 ± 0.16	1.24 ± 0.04	1.30 ± 0.04
PICO	12	1.08 ± 0.30	1.11 ± 0.29	1.84 ± 0.35	0.71 ± 0.09	0.75 ± 0.11	0.76 ± 0.09	1.50 ± 0.27	1.54 ± 0.25
PICO	15	0.99 ± 0.20	1.03 ± 0.19	1.99 ± 0.58	0.61 ± 0.21	0.95 ± 0.04	0.91 ± 0.12	1.21 ± 0.39	1.25 ± 0.38
PICO	18	1.51 ± 0.05	1.57 ± 0.06	1.57 ± 0.65	0.81 ± 0.39	1.96 ± 0.28	1.78 ± 0.35	1.06 ± 0.39	1.09 ± 0.39
PICO	21	2.05 ± 0.26	2.19 ± 0.28	2.63 ± 2.63	3.57 ± 1.69	1.94 ± 0.48	2.03 ± 0.74	0.98 ± 0.30	1.04 ± 0.32
UPLA	0	1.12 ± 0.06		0.20 ± 0.20	3.78 ± 1.89	1.67 ± 0.19	2.00 ± 0.44	0.71 ± 0.23	
UPLA	3	1.56 ± 0.07		0.00 ± 0.00	19.22 ± 11.93	1.99 ± 0.21	3.06 ± 0.59	0.43 ± 0.02	
UPLA	6	1.24 ± 0.29		0.54 ± 0.08	1.58 ± 0.23	1.25 ± 0.04	1.41 ± 0.11	0.87 ± 0.23	
UPLA	9	1.43 ± 0.32		1.46 ± 0.18	3.81 ± 1.71	0.79 ± 0.12	1.04 ± 0.21	1.23 ± 0.04	
UPLA	12	1.04 ± 0.25		1.46 ± 0.20	6.78 ± 4.05	0.60 ± 0.07	0.70 ± 0.07	1.58 ± 0.19	
UPLA	15	1.32 ± 0.27		1.57 ± 0.12	1.34 ± 0.18	0.79 ± 0.07	0.86 ± 0.06	1.50 ± 0.16	
UPLA	18	1.45 ± 0.14		1.87 ± 0.26	0.34 ± 0.09	1.26 ± 0.18	1.15 ± 0.14	1.43 ± 0.12	
UPLA	21	1.20 ± 0.26		0.11 ± 0.06	0.94 ± 0.42	1.80 ± 0.29	1.58 ± 0.33	0.93 ± 0.10	

Table 3-3a. Mean and standard errors of ambient O_3, NO, NO_2, NOx, NMHC, NMOC, NMHC/NOx and NMOC/NOx during August 3-7, 1997 SCOS episode. NMHC and NMOC are sums of SAPRC99 lumped chemical species.

Data Source	Site	Start (PDT)	NMHC	NMOC	O3	NO	NO2	NOx	NMHC/ NOx	NMOC/ NOx
Measured Ambient Values and Ratios										
SCOS97	AZUS	3	494 ± 71	554 ± 62	2.6 ± 0.4	43.1 ± 12.1	46.1 ± 5.1	89.3 ± 14.3	5.8 ± 0.8	6.5 ± 1.0
SCOS97	AZUS	6	689 ± 86	829 ± 112	3.8 ± 0.5	78.1 ± 9.9	56.6 ± 7.9	134.7 ± 16.4	4.6 ± 0.5	5.6 ± 0.7
SCOS97	AZUS	13	315 ± 53	428 ± 63	85.2 ± 9.5	5.9 ± 0.9	49.5 ± 6.7	55.4 ± 7.1	5.2 ± 0.4	7.0 ± 0.4
SCOS97	AZUS	17	198 ± 37	259 ± 48	36.3 ± 6.3	17.0 ± 7.2	41.8 ± 5.4	58.8 ± 9.9	3.0 ± 0.6	4.0 ± 0.9
SCOS97	LANM	3	291 ± 39	368 ± 72	0.4 ± 0.2	48.0 ± 23.3	40.9 ± 5.9	88.9 ± 27.8	3.1 ± 0.8	2.7 ± 0.2
SCOS97	LANM	6	701 ± 71	834 ± 121	0.3 ± 0.1	104.6 ± 19.4	51.5 ± 6.8	156.1 ± 26.2	4.0 ± 0.3	4.7 ± 0.2
SCOS97	LANM	13	310 ± 38	418 ± 0	60.1 ± 9.4	5.7 ± 1.1	33.5 ± 2.6	39.2 ± 1.7	8.3 ± 1.9	12.2 ± 0.0
SCOS97	LANM	17	270 ± 55	339 ± 96	20.2 ± 4.3	10.8 ± 3.6	37.2 ± 4.7	48.0 ± 6.9	5.1 ± 0.5	6.6 ± 0.3
PAMS	AZUS	0	523 ± 5		3.7 ± 0.4	42.7 ± 14.7	52.3 ± 6.4	94.9 ± 19.3	7.6 ± 2.5	
PAMS	AZUS	3	488 ± 91		2.6 ± 0.4	43.1 ± 12.1	46.1 ± 5.1	89.3 ± 14.3	5.5 ± 0.6	
PAMS	AZUS	6	699 ± 82		3.8 ± 0.5	78.1 ± 9.9	56.6 ± 7.9	134.7 ± 16.4	4.7 ± 0.5	
PAMS	AZUS	9	371 ± 17		25.2 ± 3.4	28.8 ± 2.4	70.3 ± 7.2	99.0 ± 8.8	3.5 ± 0.1	
PAMS	AZUS	12	289 ± 39		81.6 ± 10.5	5.8 ± 0.5	56.0 ± 6.6	61.8 ± 6.2	4.3 ± 0.2	
PAMS	AZUS	15	157 ± 34		66.9 ± 10.2	9.8 ± 3.6	39.7 ± 5.0	49.5 ± 8.1	2.9 ± 0.5	
PAMS	AZUS	18	215 ± 56		22.9 ± 2.7	19.4 ± 8.4	44.8 ± 8.3	64.3 ± 13.5	3.0 ± 1.0	
PAMS	AZUS	21	323 ± 122		5.1 ± 0.8	26.3 ± 14.5	50.4 ± 11.4	76.8 ± 23.6	3.1 ± 0.0	
PAMS	PICO	0	353 ± 113	377 ± 123	2.9 ± 1.2	35.3 ± 8.2	36.5 ± 4.5	71.8 ± 12.0	5.8 ± 1.6	6.2 ± 1.7
PAMS	PICO	3	407 ± 189	429 ± 200	2.1 ± 0.1	48.3 ± 16.6	33.0 ± 5.0	81.3 ± 21.5	4.9 ± 0.6	5.1 ± 0.7
PAMS	PICO	6	423 ± 150	446 ± 163	3.1 ± 0.9	113.3 ± 24.9	40.3 ± 6.2	153.6 ± 29.7	2.8 ± 0.7	3.0 ± 0.8
PAMS	PICO	9	380 ± 89	423 ± 97	22.8 ± 5.4	40.4 ± 17.4	66.5 ± 15.7	106.9 ± 30.5	3.7 ± 0.3	4.1 ± 0.3
PAMS	PICO	12	212 ± 42	252 ± 48	61.2 ± 11.6	6.1 ± 2.2	39.5 ± 7.7	45.6 ± 8.3	4.6 ± 1.2	5.4 ± 1.1
PAMS	PICO	15	171 ± 35	193 ± 32	50.5 ± 11.4	7.3 ± 3.8	23.8 ± 2.0	31.1 ± 4.4	6.1 ± 1.6	6.8 ± 1.5
PAMS	PICO	18	147 ± 18	159 ± 15	20.5 ± 4.1	8.1 ± 3.7	28.9 ± 5.5	37.0 ± 6.6	5.1 ± 1.2	5.4 ± 1.2
PAMS	PICO	21	204 ± 29	210 ± 26	5.1 ± 1.8	27.9 ± 13.3	36.7 ± 7.1	64.6 ± 17.1	4.5 ± 1.7	4.6 ± 1.8
PAMS	UPLA	0	283 ± 54		11.9 ± 1.4	5.3 ± 0.9	35.8 ± 2.8	41.1 ± 3.2	7.1 ± 0.8	
PAMS	UPLA	3	250 ± 8		12.8 ± 3.0	4.0 ± 2.9	30.1 ± 1.1	34.1 ± 3.9	8.3 ± 0.2	
PAMS	UPLA	6	355 ± 60		10.8 ± 2.0	45.8 ± 5.9	45.8 ± 2.8	91.6 ± 7.9	3.9 ± 0.8	
PAMS	UPLA	9	205 ± 39		36.0 ± 4.6	8.1 ± 2.6	53.1 ± 5.1	61.2 ± 7.6	3.5 ± 0.1	
PAMS	UPLA	12	188 ± 15		83.1 ± 12.5	1.0 ± 0.5	43.1 ± 1.7	44.1 ± 1.6	4.2 ± 0.5	
PAMS	UPLA	15	151 ± 22		83.3 ± 6.4	1.1 ± 0.6	33.3 ± 2.7	34.3 ± 2.0	4.3 ± 0.3	
PAMS	UPLA	18	193 ± 33		30.1 ± 6.6	5.2 ± 1.2	45.6 ± 8.2	50.8 ± 7.7	3.3 ± 0.3	
PAMS	UPLA	21	385 ± 123		9.3 ± 2.4	29.2 ± 12.6	45.6 ± 10.2	74.8 ± 22.7	4.2 ± 0.2	
Number of Observations										
SCOS97	AZUS	3	3	3	4	4	4	4	3	3
SCOS97	AZUS	6	3	3	4	4	4	4	3	3
SCOS97	AZUS	13	3	3	4	4	4	4	3	3
SCOS97	AZUS	17	3	3	4	4	4	4	3	3
SCOS97	LANM	3	3	2	4	4	4	4	3	2
SCOS97	LANM	6	3	2	4	4	4	4	3	2
SCOS97	LANM	13	2	1	4	4	4	4	2	1
SCOS97	LANM	17	3	2	4	4	4	4	3	2
PAMS	AZUS	0	2	0	4	4	4	4	2	0
PAMS	AZUS	3	3	0	4	4	4	4	3	0
PAMS	AZUS	6	3	0	4	4	4	4	3	0
PAMS	AZUS	9	3	0	4	4	4	4	3	0
PAMS	AZUS	12	3	0	4	4	4	4	3	0
PAMS	AZUS	15	3	0	4	4	4	4	3	0
PAMS	AZUS	18	3	0	4	4	4	4	3	0
PAMS	AZUS	21	2	0	4	4	4	4	2	0
PAMS	PICO	0	3	3	4	4	4	4	3	3
PAMS	PICO	3	3	3	4	4	4	4	3	3
PAMS	PICO	6	4	4	4	4	4	4	4	4
PAMS	PICO	9	4	4	4	4	4	4	4	4
PAMS	PICO	12	3	3	4	4	4	4	3	3
PAMS	PICO	15	4	4	4	4	4	4	4	4
PAMS	PICO	18	3	3	4	4	4	4	3	3
PAMS	PICO	21	3	3	4	4	4	4	3	3
PAMS	UPLA	0	3	0	4	4	4	4	3	0
PAMS	UPLA	3	3	0	4	4	4	4	3	0
PAMS	UPLA	6	3	0	4	4	4	4	3	0
PAMS	UPLA	9	3	0	4	4	4	4	3	0
PAMS	UPLA	12	2	0	4	4	4	4	2	0
PAMS	UPLA	15	3	0	4	4	4	4	3	0
PAMS	UPLA	18	3	0	4	4	4	4	3	0
PAMS	UPLA	21	3	0	4	4	4	4	3	0

Table 3-3b. Mean and standard errors of modeled O_3, NO, NO_2, NOx, NMHC, NMOC, NMHC/NOx and NMOC/NOx for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism and EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	NMHC	NMOC	O3	NO	NO2	NOx	NMHC/ NOx	NMOC/ NOx
EMFAC 7G									
AZUS	3	286 ± 7	336 ± 10	1.1 ± 0.9	6.1 ± 3.3	58.5 ± 7.4	66.1 ± 10.4	3.9 ± 0.4	4.6 ± 0.5
AZUS	6	267 ± 29	314 ± 33	10.1 ± 1.1	31.9 ± 4.2	49.7 ± 3.0	82.5 ± 6.8	3.3 ± 0.1	3.9 ± 0.1
AZUS	13	150 ± 6	219 ± 12	136.3 ± 6.4	3.7 ± 0.2	25.4 ± 2.0	29.2 ± 2.1	4.9 ± 0.2	7.2 ± 0.2
AZUS	17	184 ± 15	242 ± 19	86.3 ± 7.5	2.6 ± 0.2	44.0 ± 4.3	46.8 ± 4.5	3.9 ± 0.2	5.1 ± 0.3
LANM	3	284 ± 15	340 ± 2	3.2 ± 2.2	11.3 ± 3.3	51.6 ± 2.7	64.4 ± 4.7	4.3 ± 0.3	5.0 ± 0.6
LANM	6	437 ± 4	501 ± 7	5.9 ± 0.7	67.0 ± 8.4	62.2 ± 4.4	130.8 ± 12.4	3.1 ± 0.1	3.5 ± 0.2
LANM	13	164 ± 5	217 ± 14	99.2 ± 7.4	5.1 ± 0.2	26.8 ± 2.1	32.1 ± 2.1	4.9 ± 0.2	6.6 ± 0.2
LANM	17	271 ± 15	329 ± 27	40.7 ± 4.9	7.8 ± 1.0	64.3 ± 5.7	72.7 ± 6.5	3.5 ± 0.0	4.1 ± 0.1
AZUS	0	320 ± 0		2.8 ± 2.8	12.4 ± 6.3	67.3 ± 15.9	81.4 ± 22.4	3.2 ± 0.0	
AZUS	3	286 ± 7		1.1 ± 0.9	6.1 ± 3.3	58.5 ± 7.4	66.1 ± 10.4	3.9 ± 0.4	
AZUS	6	267 ± 29		10.1 ± 1.1	31.9 ± 4.2	49.7 ± 3.0	82.5 ± 6.8	3.3 ± 0.1	
AZUS	9	253 ± 16		50.3 ± 4.5	20.5 ± 4.0	47.7 ± 6.7	68.5 ± 10.6	3.3 ± 0.2	
AZUS	12	179 ± 9		119.9 ± 4.2	5.4 ± 0.5	31.5 ± 2.9	37.1 ± 3.4	4.5 ± 0.2	
AZUS	15	143 ± 4		132.8 ± 10.0	3.3 ± 0.2	26.6 ± 1.9	30.0 ± 2.0	4.5 ± 0.2	
AZUS	18	219 ± 29		54.9 ± 6.7	1.5 ± 0.3	57.4 ± 8.8	59.4 ± 9.1	3.7 ± 0.3	
AZUS	21	283 ± 97		4.5 ± 4.2	13.1 ± 6.1	78.8 ± 14.9	93.5 ± 20.9	3.8 ± 0.9	
PICO	0	303 ± 131	346 ± 151	5.0 ± 5.0	29.7 ± 15.2	63.2 ± 19.4	95.0 ± 35.3	4.9 ± 1.8	5.6 ± 2.0
PICO	3	275 ± 63	311 ± 71	4.6 ± 2.4	11.4 ± 10.1	48.8 ± 8.9	61.6 ± 18.2	5.2 ± 0.8	5.9 ± 1.0
PICO	6	327 ± 35	379 ± 59	10.0 ± 1.4	38.5 ± 11.3	54.2 ± 6.4	93.8 ± 17.4	3.6 ± 0.3	4.2 ± 0.4
PICO	9	269 ± 23	337 ± 30	52.6 ± 2.1	20.6 ± 3.9	50.7 ± 5.9	71.5 ± 9.7	3.8 ± 0.2	4.8 ± 0.2
PICO	12	160 ± 8	222 ± 12	116.5 ± 5.9	4.7 ± 0.2	26.2 ± 2.3	30.8 ± 2.6	5.2 ± 0.2	7.3 ± 0.3
PICO	15	130 ± 2	174 ± 5	103.7 ± 9.9	3.3 ± 0.3	21.6 ± 1.1	25.0 ± 1.2	5.2 ± 0.2	7.0 ± 0.2
PICO	18	191 ± 22	227 ± 24	38.0 ± 4.9	3.0 ± 1.9	54.9 ± 10.1	58.4 ± 11.4	4.0 ± 0.4	4.8 ± 0.5
PICO	21	337 ± 47	333 ± 26	3.3 ± 3.3	21.5 ± 11.7	71.6 ± 12.9	95.0 ± 23.9	3.0 ± 0.1	3.5 ± 0.2
UPLA	0	297 ± 114		0.0 ± 0.0	77.4 ± 32.7	85.1 ± 15.0	166.0 ± 48.6	2.2 ± 0.4	
UPLA	3	325 ± 23		0.0 ± 0.0	123.5 ± 12.9	84.3 ± 6.7	212.6 ± 19.7	1.4 ± 0.1	
UPLA	6	385 ± 10		3.1 ± 0.1	206.3 ± 7.6	92.0 ± 3.6	302.6 ± 11.2	1.2 ± 0.1	
UPLA	9	244 ± 14		37.7 ± 3.5	49.9 ± 7.3	65.7 ± 4.3	116.3 ± 11.2	2.0 ± 0.2	
UPLA	12	139 ± 14		113.7 ± 4.8	6.9 ± 0.2	37.8 ± 2.4	45.0 ± 2.6	3.2 ± 0.1	
UPLA	15	144 ± 6		133.0 ± 6.1	3.8 ± 0.1	40.1 ± 1.6	44.2 ± 1.7	3.2 ± 0.1	
UPLA	18	220 ± 12		51.7 ± 5.0	2.6 ± 1.1	73.6 ± 6.0	77.2 ± 6.6	2.7 ± 0.1	
UPLA	21	335 ± 59		0.2 ± 0.2	51.5 ± 18.6	91.4 ± 9.7	145.7 ± 27.9	2.3 ± 0.2	
EMFAC 2001									
AZUS	3	314 ± 8	365 ± 11	0.2 ± 0.2	10.0 ± 4.3	61.1 ± 6.6	72.8 ± 10.7	4.0 ± 0.5	4.7 ± 0.5
AZUS	6	304 ± 34	353 ± 39	9.2 ± 1.1	39.0 ± 5.5	53.2 ± 3.1	93.4 ± 8.0	3.4 ± 0.1	3.9 ± 0.1
AZUS	13	172 ± 8	248 ± 15	139.6 ± 6.7	4.1 ± 0.2	29.5 ± 2.3	33.8 ± 2.3	4.9 ± 0.2	7.1 ± 0.2
AZUS	17	216 ± 21	278 ± 26	85.8 ± 7.7	2.9 ± 0.2	48.5 ± 5.1	51.6 ± 5.3	4.1 ± 0.2	5.3 ± 0.3
LANM	3	314 ± 16	371 ± 3	1.2 ± 1.2	18.4 ± 4.7	55.3 ± 3.4	75.4 ± 5.5	4.1 ± 0.4	4.7 ± 0.7
LANM	6	523 ± 7	586 ± 12	5.1 ± 0.4	82.7 ± 9.7	68.2 ± 5.1	152.8 ± 14.2	3.2 ± 0.1	3.6 ± 0.3
LANM	13	189 ± 7	243 ± 19	99.1 ± 7.2	5.6 ± 0.2	29.6 ± 2.3	35.5 ± 2.3	5.1 ± 0.1	6.7 ± 0.1
LANM	17	326 ± 20	389 ± 35	38.1 ± 4.8	9.2 ± 1.3	69.0 ± 6.0	78.9 ± 7.1	3.8 ± 0.0	4.4 ± 0.0
AZUS	0	360 ± 0		1.7 ± 1.7	18.4 ± 9.2	70.8 ± 15.2	91.0 ± 24.7	3.3 ± 0.0	
AZUS	3	314 ± 8		0.2 ± 0.2	10.0 ± 4.3	61.1 ± 6.6	72.8 ± 10.7	4.0 ± 0.5	
AZUS	6	304 ± 34		9.2 ± 1.1	39.0 ± 5.5	53.2 ± 3.1	93.4 ± 8.0	3.4 ± 0.1	
AZUS	9	291 ± 22		51.2 ± 4.1	22.1 ± 3.9	53.0 ± 7.2	75.4 ± 11.0	3.5 ± 0.2	
AZUS	12	205 ± 11		123.2 ± 4.3	6.0 ± 0.5	36.3 ± 3.2	42.6 ± 3.6	4.5 ± 0.1	
AZUS	15	166 ± 6		135.2 ± 10.3	3.6 ± 0.2	30.2 ± 2.1	34.0 ± 2.3	4.7 ± 0.1	
AZUS	18	260 ± 39		52.8 ± 6.8	2.0 ± 0.5	63.1 ± 10.0	65.7 ± 10.5	4.0 ± 0.3	
AZUS	21	327 ± 128		3.8 ± 3.7	20.4 ± 8.3	82.5 ± 15.3	104.7 ± 23.7	3.9 ± 0.8	
PICO	0	334 ± 156	377 ± 176	4.4 ± 4.4	37.5 ± 19.0	65.8 ± 19.6	105.6 ± 39.5	4.8 ± 1.6	5.4 ± 1.8
PICO	3	299 ± 72	335 ± 80	2.9 ± 2.0	15.7 ± 13.1	52.8 ± 9.0	70.1 ± 20.9	4.9 ± 0.8	5.5 ± 0.9
PICO	6	373 ± 42	424 ± 69	8.9 ± 1.2	47.8 ± 13.6	59.3 ± 7.1	108.3 ± 20.1	3.6 ± 0.2	4.1 ± 0.3
PICO	9	310 ± 28	382 ± 35	53.1 ± 2.0	23.0 ± 4.2	56.6 ± 6.5	80.0 ± 10.5	3.9 ± 0.2	4.9 ± 0.2
PICO	12	180 ± 10	247 ± 15	117.9 ± 5.7	5.2 ± 0.2	29.7 ± 2.7	34.7 ± 2.9	5.2 ± 0.2	7.2 ± 0.3
PICO	15	147 ± 3	194 ± 6	103.5 ± 10.0	3.6 ± 0.3	23.8 ± 1.2	27.6 ± 1.3	5.3 ± 0.2	7.0 ± 0.1
PICO	18	219 ± 28	256 ± 31	35.7 ± 5.1	4.1 ± 2.7	58.9 ± 10.8	63.6 ± 12.7	3.9 ± 0.1	4.5 ± 0.1
PICO	21	382 ± 55	370 ± 28	2.9 ± 2.9	29.2 ± 14.1	73.7 ± 12.9	105.0 ± 26.7	3.5 ± 0.5	4.0 ± 0.6
UPLA	0	398 ± 0		0.0 ± 0.0	27.9 ± 1.6	86.2 ± 1.8	116.6 ± 0.2	3.4 ± 0.0	
UPLA	3	319 ± 23		0.0 ± 0.0	30.7 ± 2.9	72.2 ± 4.6	102.0 ± 8.1	3.1 ± 0.1	
UPLA	6	331 ± 11		7.2 ± 0.5	60.3 ± 1.3	67.7 ± 1.0	129.7 ± 1.1	2.6 ± 0.1	
UPLA	9	219 ± 18		59.4 ± 6.1	17.5 ± 3.0	45.5 ± 2.8	63.3 ± 5.8	3.5 ± 0.2	
UPLA	12	142 ± 16		128.9 ± 7.8	4.6 ± 0.5	28.9 ± 3.2	30.5 ± 2.9	4.6 ± 0.1	
UPLA	15	145 ± 6		146.8 ± 8.0	2.1 ± 0.0	28.7 ± 1.4	31.3 ± 1.6	4.7 ± 0.1	
UPLA	18	223 ± 15		69.6 ± 8.5	1.0 ± 0.1	56.9 ± 5.9	58.6 ± 5.9	3.8 ± 0.2	
UPLA	21	344 ± 63		3.2 ± 1.9	19.8 ± 10.4	85.8 ± 14.8	107.5 ± 25.1	3.3 ± 0.2	

Table 3-3c. Modeled/measured ratios of O_3, NO, NO_2, NOx, NMHC, NMOC, NMHC/NOx and NMOC/NOx for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism and EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	NMHC	NMOC	O3	NO	NO2	NOx	NMHC/ NOx	NMOC/ NOx
EMFAC 7G									
AZUS	3	0.60 ± 0.07	0.62 ± 0.06	0.52 ± 0.46	0.15 ± 0.05	1.26 ± 0.02	0.78 ± 0.13	0.69 ± 0.06	0.72 ± 0.05
AZUS	6	0.41 ± 0.11	0.41 ± 0.11	2.72 ± 0.06	0.44 ± 0.10	0.94 ± 0.16	0.66 ± 0.12	0.73 ± 0.09	0.72 ± 0.10
AZUS	13	0.51 ± 0.11	0.54 ± 0.11	1.67 ± 0.21	0.66 ± 0.08	0.54 ± 0.07	0.55 ± 0.06	0.96 ± 0.06	1.02 ± 0.05
AZUS	17	0.97 ± 0.11	0.98 ± 0.12	2.57 ± 0.44	0.30 ± 0.12	1.07 ± 0.08	0.86 ± 0.15	1.43 ± 0.40	1.45 ± 0.43
LANM	3	1.00 ± 0.12	0.96 ± 0.18	5.92 ± 4.85	0.53 ± 0.28	1.34 ± 0.19	1.00 ± 0.31	1.60 ± 0.43	1.87 ± 0.36
LANM	6	0.64 ± 0.06	0.61 ± 0.10	15.03 ± 4.06	0.67 ± 0.05	1.25 ± 0.10	0.88 ± 0.08	0.78 ± 0.04	0.76 ± 0.02
LANM	13	0.52 ± 0.07	0.49 ± 0.00	1.79 ± 0.31	1.01 ± 0.20	0.81 ± 0.07	0.82 ± 0.05	0.62 ± 0.10	0.55 ± 0.00
LANM	17	1.06 ± 0.15	1.03 ± 0.21	2.45 ± 0.80	1.01 ± 0.29	1.76 ± 0.11	1.56 ± 0.14	0.70 ± 0.07	0.62 ± 0.04
AZUS	0	0.61 ± 0.00		0.65 ± 0.65	0.23 ± 0.13	1.20 ± 0.13	0.72 ± 0.15	0.63 ± 0.00	
AZUS	3	0.63 ± 0.11		0.52 ± 0.46	0.15 ± 0.05	1.26 ± 0.02	0.78 ± 0.13	0.72 ± 0.07	
AZUS	6	0.41 ± 0.10		2.72 ± 0.06	0.44 ± 0.10	0.94 ± 0.16	0.66 ± 0.12	0.72 ± 0.08	
AZUS	9	0.69 ± 0.05		2.20 ± 0.53	0.71 ± 0.14	0.67 ± 0.05	0.68 ± 0.07	0.96 ± 0.08	
AZUS	12	0.65 ± 0.13		1.55 ± 0.23	0.96 ± 0.11	0.58 ± 0.08	0.61 ± 0.07	1.04 ± 0.05	
AZUS	15	0.98 ± 0.17		2.17 ± 0.45	0.52 ± 0.17	0.68 ± 0.04	0.64 ± 0.06	1.65 ± 0.31	
AZUS	18	1.12 ± 0.20		2.47 ± 0.38	0.20 ± 0.10	1.34 ± 0.20	1.06 ± 0.26	1.61 ± 0.62	
AZUS	21	0.89 ± 0.03		1.11 ± 1.07	1.15 ± 0.76	1.80 ± 0.53	1.53 ± 0.51	1.23 ± 0.32	
PICO	0	1.39 ± 0.79	1.50 ± 0.86	14.92 ± 14.92	0.79 ± 0.49	1.71 ± 0.40	1.26 ± 0.47	1.08 ± 0.06	1.16 ± 0.06
PICO	3	0.89 ± 0.25	0.95 ± 0.27	2.02 ± 0.97	0.16 ± 0.11	1.47 ± 0.10	0.81 ± 0.13	1.14 ± 0.29	1.23 ± 0.31
PICO	6	1.00 ± 0.25	0.86 ± 0.21	4.08 ± 1.41	0.37 ± 0.08	1.39 ± 0.13	0.66 ± 0.11	1.70 ± 0.58	0.93 ± 0.36
PICO	9	0.82 ± 0.17	0.91 ± 0.18	2.62 ± 0.45	0.64 ± 0.13	0.88 ± 0.18	0.77 ± 0.16	1.05 ± 0.05	1.18 ± 0.05
PICO	12	0.86 ± 0.23	0.99 ± 0.24	2.17 ± 0.46	0.60 ± 0.08	0.71 ± 0.10	0.71 ± 0.07	1.27 ± 0.22	1.46 ± 0.22
PICO	15	0.85 ± 0.16	0.98 ± 0.17	2.52 ± 0.75	0.49 ± 0.18	0.92 ± 0.04	0.85 ± 0.11	1.09 ± 0.32	1.26 ± 0.36
PICO	18	1.30 ± 0.05	1.42 ± 0.03	2.26 ± 0.77	0.34 ± 0.18	1.96 ± 0.27	1.67 ± 0.31	0.97 ± 0.37	1.04 ± 0.37
PICO	21	1.68 ± 0.21	1.83 ± 0.38	3.33 ± 3.33	1.87 ± 0.84	2.15 ± 0.58	1.88 ± 0.67	0.85 ± 0.25	0.76 ± 0.36
UPLA	0	1.09 ± 0.06		0.00 ± 0.00	12.09 ± 4.71	2.34 ± 0.19	3.80 ± 0.86	0.36 ± 0.13	
UPLA	3	1.30 ± 0.06		0.00 ± 0.00	102.55 ± 51.95	3.09 ± 0.06	7.58 ± 0.40	0.17 ± 0.01	
UPLA	6	1.15 ± 0.20		0.28 ± 0.06	4.92 ± 0.93	2.01 ± 0.10	3.40 ± 0.34	0.35 ± 0.08	
UPLA	9	1.30 ± 0.29		0.98 ± 0.20	12.62 ± 4.66	1.39 ± 0.15	2.29 ± 0.39	0.56 ± 0.05	
UPLA	12	0.75 ± 0.14		1.29 ± 0.21	12.76 ± 7.14	0.92 ± 0.11	1.07 ± 0.11	0.77 ± 0.12	
UPLA	15	1.02 ± 0.22		1.53 ± 0.16	1.77 ± 0.00	1.24 ± 0.17	1.32 ± 0.15	0.76 ± 0.08	
UPLA	18	1.20 ± 0.17		1.80 ± 0.40	0.62 ± 0.25	1.53 ± 0.12	1.44 ± 0.05	0.83 ± 0.10	
UPLA	21	1.04 ± 0.27		0.02 ± 0.02	1.61 ± 0.14	1.89 ± 0.19	1.85 ± 0.19	0.55 ± 0.08	
EMFAC 2001									
AZUS	3	0.66 ± 0.08	0.67 ± 0.06	0.10 ± 0.10	0.27 ± 0.08	1.33 ± 0.02	0.85 ± 0.12	0.71 ± 0.06	0.72 ± 0.04
AZUS	6	0.47 ± 0.12	0.46 ± 0.12	2.45 ± 0.03	0.54 ± 0.13	1.01 ± 0.18	0.75 ± 0.15	0.75 ± 0.09	0.73 ± 0.10
AZUS	13	0.59 ± 0.13	0.61 ± 0.12	1.70 ± 0.22	0.74 ± 0.09	0.62 ± 0.08	0.63 ± 0.07	0.96 ± 0.07	1.01 ± 0.05
AZUS	17	1.14 ± 0.11	1.12 ± 0.13	2.55 ± 0.44	0.34 ± 0.14	1.18 ± 0.09	0.95 ± 0.17	1.53 ± 0.42	1.52 ± 0.45
LANM	3	1.11 ± 0.13	1.05 ± 0.20	2.47 ± 2.43	0.93 ± 0.52	1.44 ± 0.22	1.18 ± 0.38	1.54 ± 0.42	1.77 ± 0.37
LANM	6	0.76 ± 0.08	0.72 ± 0.12	13.11 ± 3.31	0.83 ± 0.07	1.37 ± 0.11	1.03 ± 0.09	0.80 ± 0.05	0.76 ± 0.03
LANM	13	0.60 ± 0.09	0.54 ± 0.00	1.78 ± 0.30	1.11 ± 0.23	0.90 ± 0.08	0.91 ± 0.05	0.64 ± 0.12	0.56 ± 0.00
LANM	17	1.27 ± 0.18	1.22 ± 0.24	2.30 ± 0.76	1.18 ± 0.34	1.89 ± 0.12	1.69 ± 0.15	0.77 ± 0.08	0.67 ± 0.03
AZUS	0	0.68 ± 0.00		0.39 ± 0.39	0.33 ± 0.18	1.27 ± 0.10	0.81 ± 0.16	0.64 ± 0.00	
AZUS	3	0.69 ± 0.12		0.10 ± 0.10	0.27 ± 0.08	1.33 ± 0.02	0.85 ± 0.12	0.73 ± 0.07	
AZUS	6	0.46 ± 0.12		2.45 ± 0.03	0.54 ± 0.13	1.01 ± 0.18	0.75 ± 0.15	0.74 ± 0.09	
AZUS	9	0.79 ± 0.07		2.22 ± 0.49	0.78 ± 0.14	0.75 ± 0.06	0.76 ± 0.08	1.01 ± 0.08	
AZUS	12	0.75 ± 0.15		1.59 ± 0.22	1.07 ± 0.11	0.67 ± 0.09	0.71 ± 0.08	1.05 ± 0.05	
AZUS	15	1.14 ± 0.19		2.21 ± 0.45	0.58 ± 0.19	0.78 ± 0.04	0.72 ± 0.07	1.70 ± 0.32	
AZUS	18	1.32 ± 0.21		2.38 ± 0.38	0.27 ± 0.14	1.48 ± 0.23	1.17 ± 0.29	1.72 ± 0.65	
AZUS	21	1.01 ± 0.02		0.94 ± 0.92	1.88 ± 1.08	1.88 ± 0.54	1.72 ± 0.58	1.26 ± 0.28	
PICO	0	1.54 ± 0.92	1.64 ± 0.99	13.25 ± 13.25	0.99 ± 0.62	1.78 ± 0.40	1.40 ± 0.53	1.06 ± 0.03	1.13 ± 0.02
PICO	3	0.95 ± 0.26	1.01 ± 0.28	1.24 ± 0.80	0.25 ± 0.13	1.60 ± 0.11	0.92 ± 0.15	1.08 ± 0.28	1.15 ± 0.30
PICO	6	1.15 ± 0.30	0.96 ± 0.23	3.61 ± 1.19	0.46 ± 0.11	1.52 ± 0.15	0.76 ± 0.13	1.69 ± 0.59	1.89 ± 0.71
PICO	9	0.94 ± 0.20	1.03 ± 0.20	2.64 ± 0.44	0.73 ± 0.16	0.98 ± 0.21	0.87 ± 0.18	1.08 ± 0.05	1.19 ± 0.04
PICO	12	0.98 ± 0.27	1.11 ± 0.28	2.19 ± 0.46	0.66 ± 0.09	0.81 ± 0.12	0.80 ± 0.09	1.28 ± 0.23	1.44 ± 0.22
PICO	15	0.97 ± 0.19	1.10 ± 0.20	2.51 ± 0.75	0.54 ± 0.19	1.01 ± 0.05	0.94 ± 0.12	1.13 ± 0.34	1.28 ± 0.37
PICO	18	1.49 ± 0.04	1.60 ± 0.05	2.14 ± 0.76	0.47 ± 0.25	2.10 ± 0.31	1.82 ± 0.35	0.42 ± 0.21	0.47 ± 0.24
PICO	21	1.91 ± 0.24	2.03 ± 0.42	2.87 ± 2.87	2.83 ± 1.32	2.22 ± 0.58	2.09 ± 0.75	0.87 ± 0.26	0.76 ± 0.37
UPLA	0	1.11 ± 0.00		0.00 ± 0.00	4.30 ± 0.08	2.17 ± 0.01	2.52 ± 0.01	0.44 ± 0.00	
UPLA	3	1.27 ± 0.06		0.00 ± 0.00	22.35 ± 11.25	2.47 ± 0.09	3.35 ± 0.14	0.38 ± 0.01	
UPLA	6	1.00 ± 0.18		0.68 ± 0.17	1.42 ± 0.33	1.44 ± 0.08	1.42 ± 0.18	0.73 ± 0.19	
UPLA	9	1.18 ± 0.29		1.65 ± 0.35	4.40 ± 2.09	0.93 ± 0.17	1.19 ± 0.28	0.99 ± 0.03	
UPLA	12	0.77 ± 0.15		1.49 ± 0.25	8.11 ± 4.30	0.68 ± 0.11	0.45 ± 0.22	1.14 ± 0.16	
UPLA	15	1.03 ± 0.21		1.73 ± 0.18	0.88 ± 0.00	0.86 ± 0.12	0.91 ± 0.09	1.11 ± 0.12	
UPLA	18	1.21 ± 0.16		2.51 ± 0.53	0.23 ± 0.06	1.12 ± 0.06	1.03 ± 0.03	1.17 ± 0.14	
UPLA	21	1.06 ± 0.26		0.35 ± 0.18	0.39 ± 0.20	1.68 ± 0.09	1.29 ± 0.13	0.80 ± 0.11	

Table 3-4a. Mean and standard errors of ambient O_3, NO, NO_2, NOx, NMHC, NMOC, NMHC/NOx and NMOC/NOx by time period and corresponding modeled values and ratios for CAMx simulations of the August 3-7, 1997 SCOS episode using CB4 chemical mechanism and EMFAC7G and EMFAC2001 mobile emissions.

Start (PDT)	NMHC	NMOC	O3	NO	NO2	NOx	NMHC/ NOx	NMOC/ NOx
Measured Ambient Values and Ratios								
0, 3	394 ± 37	447 ± 64	4.9 ± 0.9	33.7 ± 5.1	40.1 ± 2.0	73.8 ± 6.5	6.1 ± 0.4	5.5 ± 0.7
6	601 ± 66	679 ± 108	4.4 ± 0.9	84.0 ± 8.3	50.1 ± 3.0	134.1 ± 9.8	4.2 ± 0.3	4.3 ± 0.6
9	332 ± 45	421 ± 97	28.0 ± 2.9	25.7 ± 6.7	63.3 ± 5.9	89.0 ± 11.6	3.6 ± 0.1	4.1 ± 0.3
12, 13, 15	238 ± 22	300 ± 42	71.5 ± 3.9	5.3 ± 0.8	39.8 ± 2.3	45.1 ± 2.5	5.3 ± 0.5	7.1 ± 0.8
17, 18	220 ± 22	248 ± 39	26.0 ± 2.5	12.1 ± 2.5	39.7 ± 3.0	51.8 ± 4.3	4.2 ± 0.4	5.3 ± 0.6
21	299 ± 55	209 ± 26	6.5 ± 1.1	27.8 ± 7.0	44.2 ± 5.4	72.0 ± 11.2	4.0 ± 0.6	4.6 ± 1.8
Number of Observations								
0, 3	23	11	32	32	32	32	23	11
6	16	9	20	20	20	20	16	9
9	10	4	12	12	12	12	10	4
12, 13, 15	23	11	32	32	32	32	23	11
17, 18	15	8	20	20	20	20	15	8
21	8	3	12	12	12	12	8	3
Modeled EMFAC 7G								
0, 3	350 ± 20	388 ± 33	1.5 ± 0.6	39.6 ± 8.6	58.4 ± 3.2	104.4 ± 12.3	3.9 ± 0.3	5.3 ± 0.4
6	401 ± 26	444 ± 47	6.4 ± 0.6	83.7 ± 16.5	56.8 ± 3.5	142.3 ± 20.2	3.3 ± 0.2	4.2 ± 0.2
9	304 ± 11	351 ± 31	38.4 ± 2.2	34.4 ± 5.4	50.9 ± 3.2	85.7 ± 8.4	3.6 ± 0.3	5.0 ± 0.2
12, 13, 15	177 ± 6	190 ± 9	101.0 ± 2.8	4.9 ± 0.3	27.6 ± 1.2	32.7 ± 1.4	5.5 ± 0.2	6.9 ± 0.2
17, 18	238 ± 13	231 ± 16	38.9 ± 3.8	5.1 ± 0.9	56.3 ± 3.5	61.9 ± 4.0	4.0 ± 0.2	4.7 ± 0.2
21	353 ± 38	334 ± 30	2.4 ± 1.6	35.9 ± 9.3	70.8 ± 6.0	108.7 ± 14.6	3.3 ± 0.3	3.6 ± 0.3
Modeled EMFAC 2001								
0, 3	392 ± 28	435 ± 44	1.3 ± 0.6	27.7 ± 3.6	56.7 ± 2.6	86.2 ± 6.0	4.5 ± 0.2	5.2 ± 0.3
6	453 ± 33	517 ± 53	6.4 ± 0.5	61.8 ± 5.6	54.9 ± 2.1	118.0 ± 7.6	3.8 ± 0.1	4.3 ± 0.1
9	340 ± 21	414 ± 38	45.5 ± 1.4	23.2 ± 2.1	47.6 ± 3.0	71.2 ± 5.0	4.5 ± 0.1	5.3 ± 0.2
12, 13, 15	207 ± 7	224 ± 11	105.5 ± 3.3	4.9 ± 0.2	27.3 ± 0.8	32.2 ± 1.0	6.3 ± 0.1	7.1 ± 0.2
17, 18	284 ± 18	300 ± 28	40.6 ± 4.1	5.6 ± 1.2	56.0 ± 3.2	62.2 ± 4.0	4.7 ± 0.1	5.1 ± 0.2
21	398 ± 46	382 ± 33	2.1 ± 1.2	29.0 ± 6.5	70.5 ± 5.8	101.3 ± 11.9	3.8 ± 0.2	3.7 ± 0.3
Modeled EMFAC 7G/Measured								
0, 3	1.08 ± 0.11	1.10 ± 0.20	2.07 ± 1.49	9.59 ± 5.74	1.43 ± 0.12	1.93 ± 0.42	0.79 ± 0.11	1.18 ± 0.15
6	0.86 ± 0.13	0.86 ± 0.19	3.54 ± 1.00	1.46 ± 0.43	1.21 ± 0.09	1.27 ± 0.25	1.00 ± 0.22	1.36 ± 0.41
9	1.06 ± 0.14	0.94 ± 0.16	1.62 ± 0.25	4.16 ± 1.91	0.87 ± 0.09	1.16 ± 0.22	1.00 ± 0.08	1.23 ± 0.05
12, 13, 15	0.82 ± 0.08	0.66 ± 0.11	1.56 ± 0.11	2.11 ± 0.96	0.74 ± 0.04	0.78 ± 0.05	1.14 ± 0.12	1.01 ± 0.16
17, 18	1.16 ± 0.07	1.08 ± 0.09	1.65 ± 0.18	0.74 ± 0.15	1.50 ± 0.10	1.33 ± 0.11	1.16 ± 0.18	1.04 ± 0.21
21	1.34 ± 0.17	1.90 ± 0.24	1.32 ± 1.05	2.44 ± 0.56	1.80 ± 0.22	1.85 ± 0.30	0.94 ± 0.16	0.80 ± 0.39
Modeled EMFAC 2001/Measured								
0, 3	1.18 ± 0.12	1.24 ± 0.23	1.64 ± 1.41	3.31 ± 1.54	1.47 ± 0.07	1.44 ± 0.18	0.91 ± 0.09	1.18 ± 0.15
6	0.95 ± 0.13	1.01 ± 0.22	3.21 ± 0.86	0.86 ± 0.11	1.16 ± 0.07	0.96 ± 0.08	1.13 ± 0.22	1.39 ± 0.41
9	1.15 ± 0.13	1.11 ± 0.20	1.83 ± 0.20	1.84 ± 0.67	0.80 ± 0.07	0.88 ± 0.09	1.24 ± 0.03	1.30 ± 0.04
12, 13, 15	0.95 ± 0.09	0.78 ± 0.13	1.61 ± 0.10	1.57 ± 0.53	0.73 ± 0.03	0.76 ± 0.03	1.31 ± 0.13	1.06 ± 0.17
17, 18	1.37 ± 0.07	1.30 ± 0.10	1.69 ± 0.17	0.76 ± 0.17	1.51 ± 0.10	1.34 ± 0.12	1.36 ± 0.20	1.14 ± 0.23
21	1.51 ± 0.20	2.19 ± 0.28	1.15 ± 0.88	2.40 ± 0.76	1.79 ± 0.22	1.76 ± 0.30	1.09 ± 0.15	1.04 ± 0.32

Table 3-4b. Mean and standard errors of ambient O_3, NO, NO_2, NOx, NMHC, NMOC, NMHC/NOx and NMOC/NOx by time period and corresponding modeled values and ratios for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism and EMFAC7G and EMFAC2001 mobile emissions.

Start (PDT)	NMHC	NMOC	O3	NO	NO2	NOx	NMHC/ NOx	NMOC/ NOx
Measured Ambient Values and Ratios								
0, 3	380 ± 35	438 ± 62	4.9 ± 0.9	33.7 ± 5.1	40.1 ± 2.0	73.8 ± 6.5	5.9 ± 0.4	5.4 ± 0.7
6	564 ± 57	660 ± 102	4.4 ± 0.9	84.0 ± 8.3	50.1 ± 3.0	134.1 ± 9.8	3.9 ± 0.3	4.2 ± 0.5
9	325 ± 43	423 ± 97	28.0 ± 2.9	25.7 ± 6.7	63.3 ± 5.9	89.0 ± 11.6	3.6 ± 0.1	4.1 ± 0.3
12, 13, 15	220 ± 18	293 ± 39	71.5 ± 3.9	5.3 ± 0.8	39.8 ± 2.3	45.1 ± 2.5	4.9 ± 0.4	7.0 ± 0.8
17, 18	205 ± 19	242 ± 36	26.0 ± 2.5	12.1 ± 2.5	39.7 ± 3.0	51.8 ± 4.3	3.9 ± 0.4	5.2 ± 0.6
21	302 ± 56	210 ± 26	6.5 ± 1.1	27.8 ± 7.0	44.2 ± 5.4	72.0 ± 11.2	4.0 ± 0.6	4.6 ± 1.8
Number of Observations								
0, 3	23	11	32	32	32	32	23	11
6	16	9	20	20	20	20	16	9
9	10	4	12	12	12	12	10	4
12, 13, 15	23	11	32	32	32	32	23	11
17, 18	15	8	20	20	20	20	15	8
21	8	3	12	12	12	12	8	3
Modeled EMFAC 7G								
0, 3	287 ± 14	334 ± 16	2.0 ± 0.7	34.2 ± 8.7	63.9 ± 4.0	100.4 ± 12.2	3.7 ± 0.3	4.3 ± 0.3
6	330 ± 16	384 ± 19	8.0 ± 0.8	75.1 ± 15.6	61.5 ± 4.0	138.4 ± 19.8	2.9 ± 0.2	3.4 ± 0.2
9	246 ± 12	309 ± 15	46.8 ± 2.7	30.3 ± 5.0	54.7 ± 3.8	85.4 ± 8.6	3.1 ± 0.3	3.9 ± 0.3
12, 13, 15	149 ± 3	209 ± 5	119.4 ± 3.2	4.5 ± 0.2	29.5 ± 1.3	34.2 ± 1.4	4.5 ± 0.1	6.3 ± 0.2
17, 18	214 ± 9	265 ± 11	54.3 ± 4.6	3.5 ± 0.6	58.8 ± 3.7	62.9 ± 4.0	3.5 ± 0.1	4.4 ± 0.2
21	304 ± 25	355 ± 29	2.7 ± 1.7	28.7 ± 8.5	80.6 ± 7.1	111.4 ± 14.7	3.1 ± 0.3	3.6 ± 0.3
Modeled EMFAC 2001								
0, 3	307 ± 15	354 ± 18	1.5 ± 0.6	18.5 ± 3.1	62.4 ± 3.3	82.7 ± 6.2	4.0 ± 0.2	4.6 ± 0.2
6	359 ± 20	413 ± 22	8.0 ± 0.5	53.4 ± 5.0	59.9 ± 2.3	114.7 ± 7.1	3.2 ± 0.1	3.7 ± 0.1
9	263 ± 17	329 ± 21	54.6 ± 2.2	20.5 ± 2.1	51.0 ± 3.5	71.9 ± 5.5	3.7 ± 0.1	4.6 ± 0.1
12, 13, 15	166 ± 4	230 ± 6	124.7 ± 3.7	4.3 ± 0.2	29.4 ± 0.9	33.9 ± 1.1	4.9 ± 0.1	6.8 ± 0.1
17, 18	246 ± 13	300 ± 14	56.6 ± 5.0	3.8 ± 0.8	58.8 ± 3.5	63.2 ± 4.0	4.0 ± 0.1	4.9 ± 0.1
21	335 ± 30	386 ± 34	3.3 ± 1.5	22.3 ± 5.7	79.7 ± 7.0	103.9 ± 12.1	3.4 ± 0.2	4.0 ± 0.2
Modeled EMFAC 7G/Measured Ratios								
0, 3	0.86 ± 0.10	0.88 ± 0.19	2.53 ± 1.62	8.56 ± 5.54	1.54 ± 0.14	1.78 ± 0.41	0.75 ± 0.12	1.08 ± 0.18
6	0.74 ± 0.10	0.63 ± 0.11	4.67 ± 1.32	1.18 ± 0.40	1.27 ± 0.10	1.14 ± 0.24	0.91 ± 0.18	1.27 ± 0.36
9	0.92 ± 0.13	0.91 ± 0.18	2.02 ± 0.31	3.94 ± 2.00	0.94 ± 0.12	1.15 ± 0.25	0.88 ± 0.08	1.18 ± 0.05
12, 13, 15	0.73 ± 0.07	0.73 ± 0.11	1.86 ± 0.15	1.73 ± 0.79	0.78 ± 0.05	0.80 ± 0.05	0.98 ± 0.10	1.04 ± 0.16
17, 18	1.13 ± 0.06	1.16 ± 0.10	2.34 ± 0.25	0.50 ± 0.11	1.53 ± 0.10	1.31 ± 0.11	1.10 ± 0.17	1.09 ± 0.22
21	1.25 ± 0.17	1.83 ± 0.38	1.62 ± 1.23	1.54 ± 0.39	1.95 ± 0.27	1.75 ± 0.29	0.83 ± 0.15	0.94 ± 0.28
Modeled EMFAC 2001/Measured Ratios								
0, 3	0.95 ± 0.11	0.95 ± 0.21	1.81 ± 1.37	2.14 ± 1.16	1.45 ± 0.12	1.23 ± 0.17	0.79 ± 0.11	1.04 ± 0.17
6	0.79 ± 0.11	0.71 ± 0.12	4.19 ± 1.12	0.73 ± 0.10	1.26 ± 0.08	0.92 ± 0.08	0.99 ± 0.17	1.25 ± 0.36
9	0.97 ± 0.12	1.03 ± 0.20	2.22 ± 0.26	1.75 ± 0.71	0.88 ± 0.09	0.92 ± 0.11	1.03 ± 0.03	1.19 ± 0.04
12, 13, 15	0.82 ± 0.07	0.81 ± 0.13	1.92 ± 0.14	1.39 ± 0.48	0.79 ± 0.04	0.80 ± 0.03	1.07 ± 0.10	1.04 ± 0.16
17, 18	1.28 ± 0.07	1.32 ± 0.10	2.37 ± 0.24	0.52 ± 0.12	1.58 ± 0.12	1.35 ± 0.13	1.24 ± 0.17	1.14 ± 0.23
21	1.36 ± 0.20	2.03 ± 0.42	1.48 ± 1.05	1.82 ± 0.64	1.95 ± 0.27	1.74 ± 0.33	0.94 ± 0.13	0.95 ± 0.29

Table 3-5. Comparisons of reconciliation of ambient and predicted inventory derived NMHC/NOx ratios from the 1987 Southern California Air Quality Study and the 1997 Southern California Ozone Study.

	SCAQS Summer 1987 [1]			SCOS97-NARSTO August 4-7 1997 [2]					1999-2000
	07-08	07-08	07-8	06-09	06-09	06-09	06-09	06-09	06-09
Locations	Observed	Inventory (EMFAC7E)	Observed/ Predicted	PAMS Observed	CAMx CB4/E2K1	Observed/ Predicted	CAMx S99/E2K1	Observed/ Predicted	PAMS Observed
Anaheim	8.2 ± 0.6	4.7	1.7						
Azusa	7.5 ± 0.4	5.3	1.4	4.6	4.0	1.2	3.4	1.4	4.4
Burbank	8.7 ± 0.7	4.6	1.9						
Los Angeles	8.8 ± 1.0	4.9	1.8	4.3	3.7	1.2	3.2	1.4	3.8
Claremont	8.0 ± 0.5	5.2	1.5						
Hawthorne	8.9 ± 1.1	3.4	2.6						
Long Beach	7.9 ± 0.9	3.3	2.4						
Rubidoux	7.8 ± 0.7	2.3	3.4						
Pico Rivera				2.9	4.1	0.7	3.6	0.8	3.7
Upland				3.9	3.0	1.3	2.6	1.5	4.0
Mean	8.2 ± 0.8	4.2 ± 0.4	2.1 ± 0.2	3.9 ± 0.4	3.7 ± 0.2	1.1 ± 0.1	3.2 ± 0.2	1.3 ± 0.2	4.0 ± 0.2

1. Data from Fujita et al., 1992. The inventory ratios are an average of 9 grid cells centered on the monitor location and are based on EMFAC7E. They are included here to show how the current evaluation compares to earlier studies for Los Angeles.
2. Data from this study. The predicted ratios are the CAMx air quality model predictions for each monitor location.

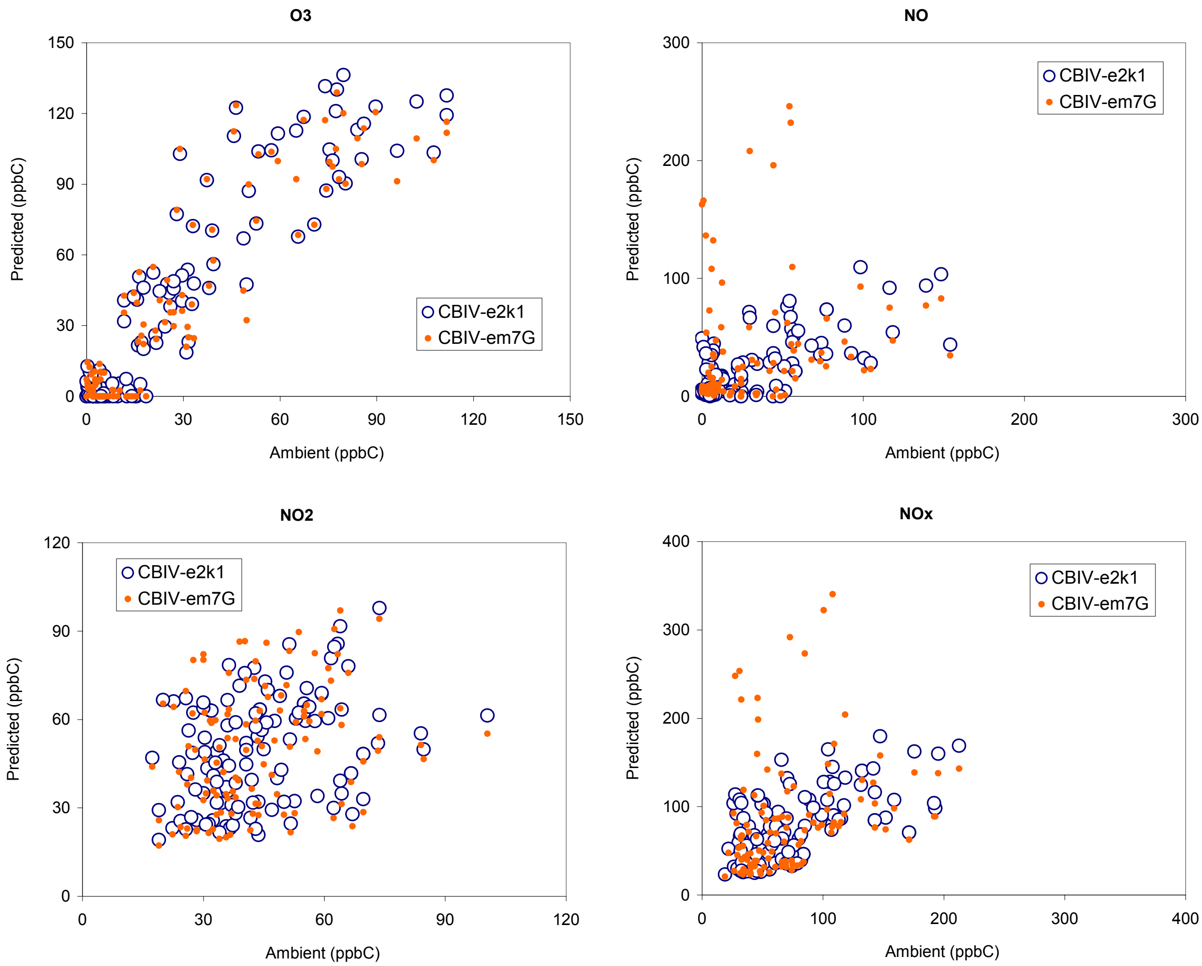


Figure 3-1a. Scatterplots of modeled versus ambient mixing ratios of ozone, NO, NO_2 and NOx for CAMx simulations of the August 3-7, 1997 SCOS episode using CB4 chemical mechanism with EMFAC7G and EMFAC2001 based mobile emissions.

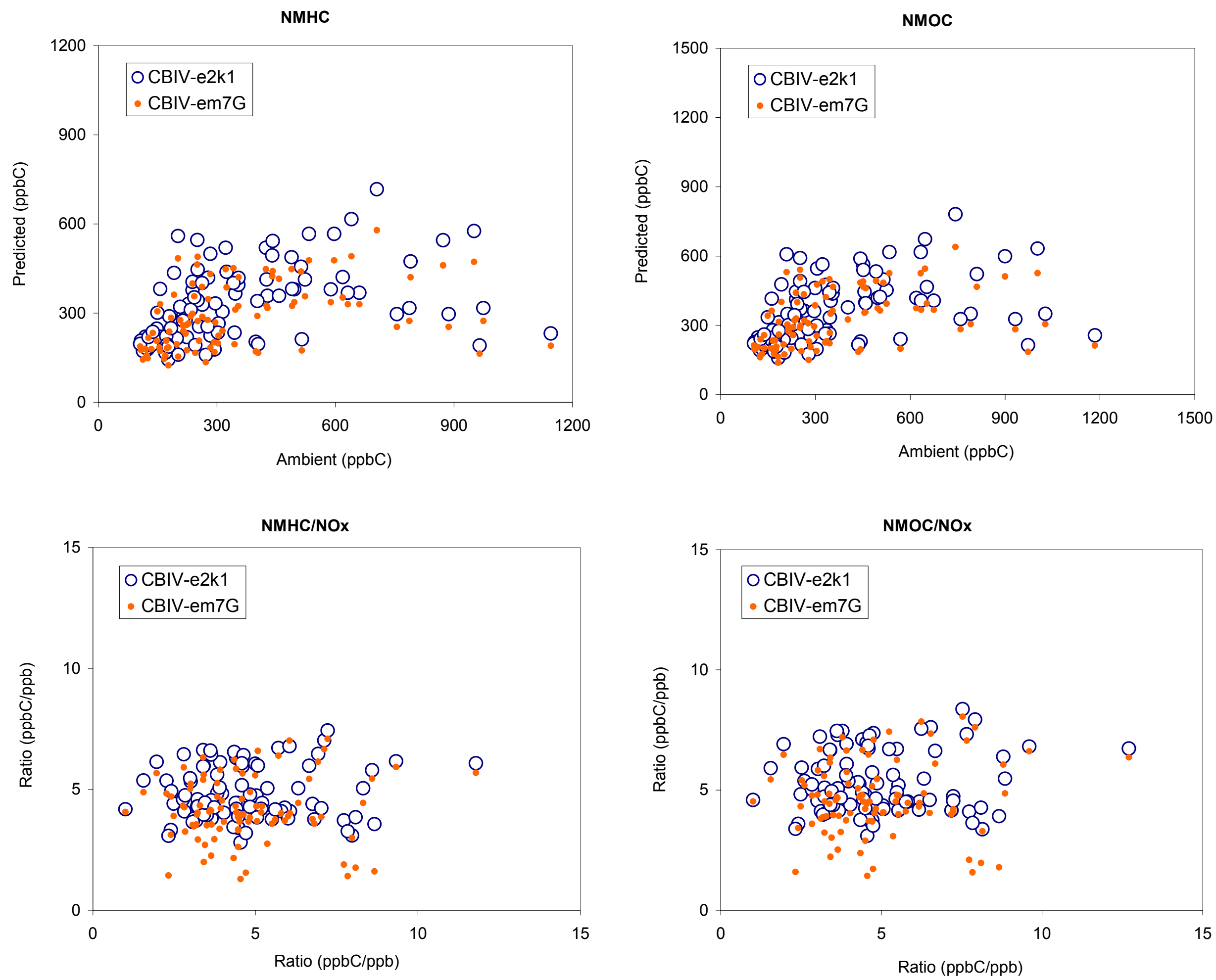


Figure 3-1b. Scatterplots of modeled versus ambient mixing ratios of NMHC, NMOC, NMHC/NOx and NMOC/NOx for CAMx simulations of the August 3-7, 1997 SCOS episode using CB4 chemical mechanism with EMFAC7G and EMFAC2001 based mobile emissions.

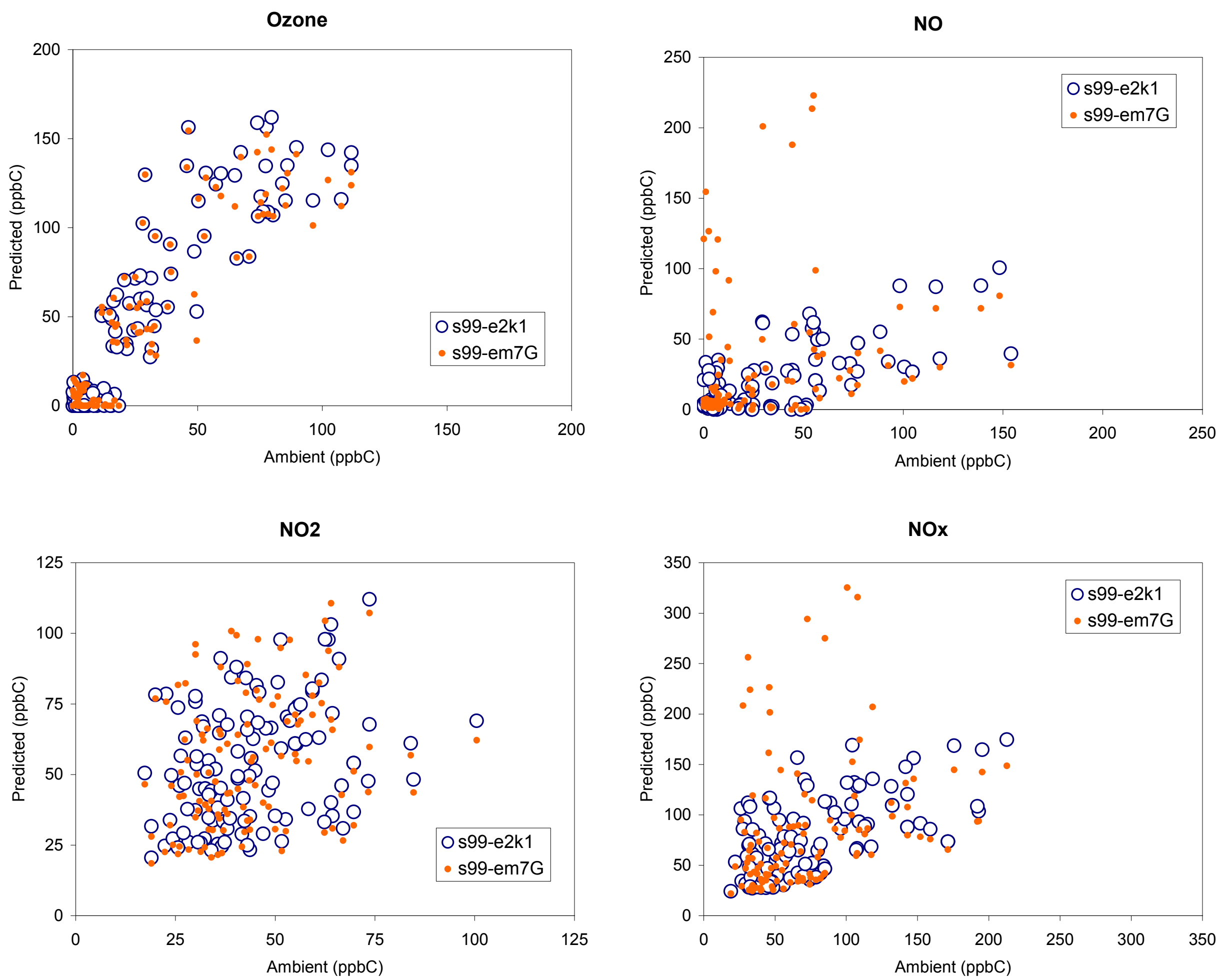


Figure 3-2a. Scatterplots of modeled versus ambient mixing ratios of ozone, NO, NO_2 and NOx for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism with EMFAC7G and EMFAC2001 based mobile emissions.

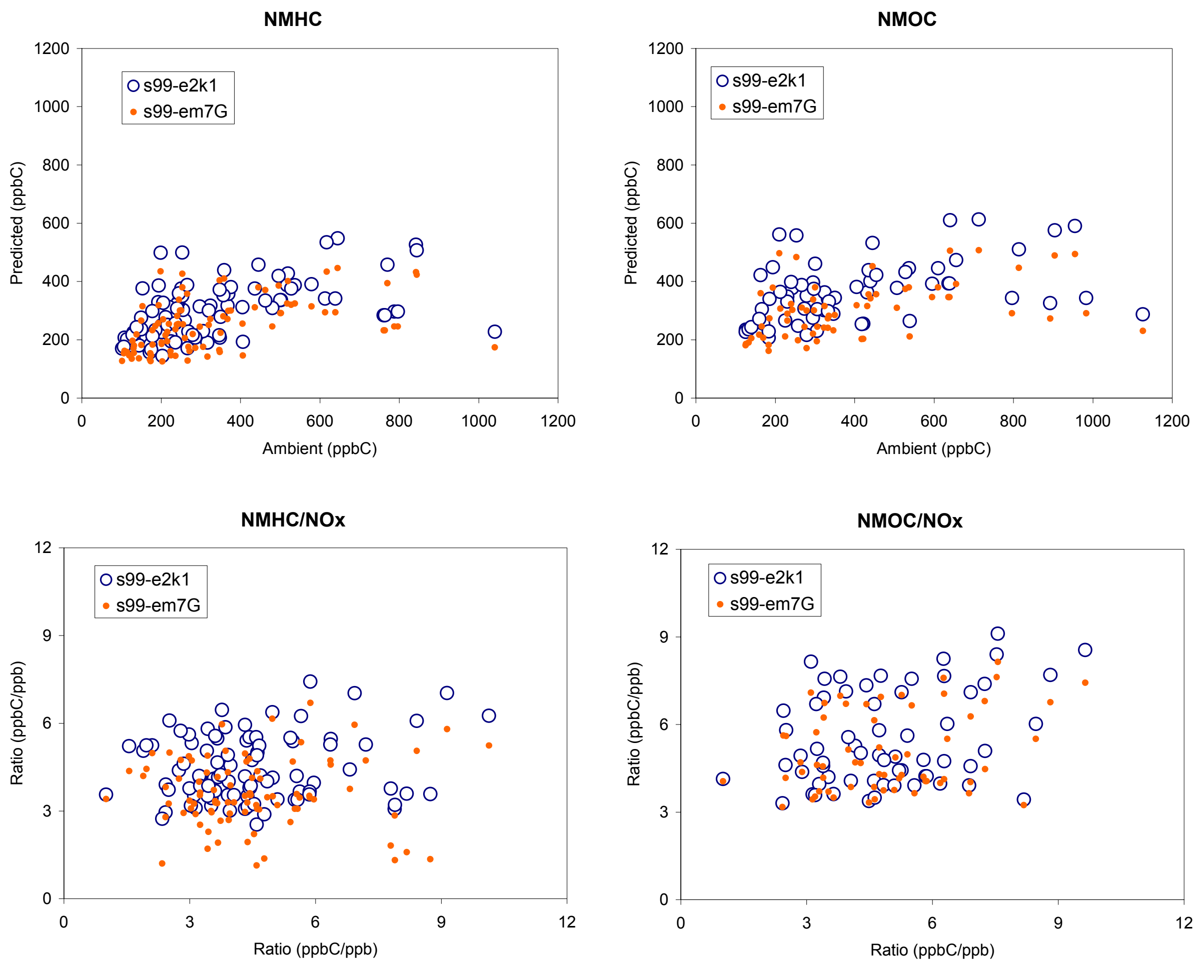
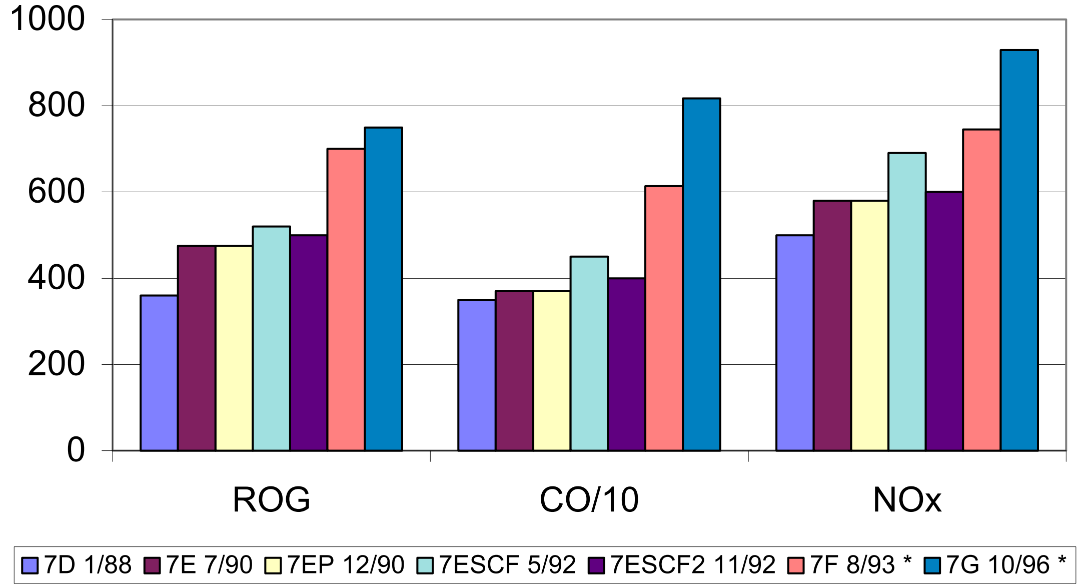


Figure 3-2b. Scatterplots of modeled versus ambient mixing ratios of NMHC, NMOC, NMHC/NOx and NMOC/NOx for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism with EMFAC7G and EMFAC2001 based mobile emissions.



* Estimates for EMFAC7F and 7G are based on changes for summer ROG and NOx, and winter CO inventories.

Figure 3-3. On-road motor vehicle emissions by EMFAC versions in the South Coast Air Basin for a common base year of 1990.

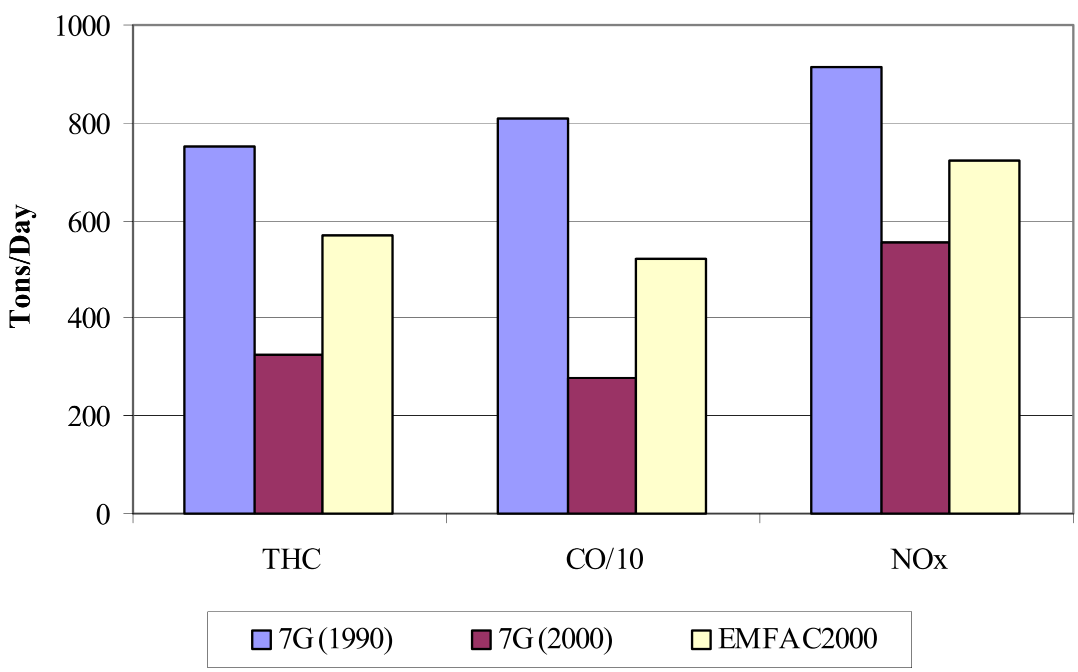


Figure 3-4. On-road motor vehicle emissions by EMFAC versions in the South Coast Air Basin for 1990 and 2000.

4.0 RECONCILIATION OF 1997 MODELED AND AMBIENT VOC SPECIATION

The chemical mechanisms that are used in photochemical air quality models are a hybrid of explicit chemistry, surrogate approximations, and lumped or generalized chemistry designed to simulate the features of urban smog chemistry. These mechanisms are lumped, or approximated by a smaller number of reactions, by one of several strategies: mathematical lumping, molecular lumping, or structural lumping. The Carbon Bond-IV (CB4) and SAPRC99 (Statewide Air Pollution Research Center) are two common mechanisms that have been developed for urban smog and regional atmospheric modeling. The chemical species and surrogates that are explicitly represented in CB4 and SAPRC99 are listed in Tables 4-1 and 4-2, respectively. In this task, we reconcile the modeled and ambient CB4 and SAPRC99 lumped species for CAMx simulations of the August 3-7, 1997 SCOS episode with EMFAC7G and EMFAC2001 based mobile emissions. This task replaces the originally proposed comparisons of the VOC speciation profiles for on-road motor vehicles and fuel that were used by the ARB for input into the SCOS97 photochemical modeling to other available profiles.

Four sets of simulations were performed by ENVIRON using CB4 and SAPRC chemical mechanisms with EMFAC7G and EMFAC2001 based emissions. Tables 4-3a, 4-3b and 4-3c show the ambient values, modeled values and modeled/measured ratios, respectively, for lumped species for CAMx simulations using CB4. Tables 4-4a, 4-4b and 4-4c show the corresponding results for CAMx simulations using SAPRC99. The data in these tables are mean values for each site and time period during the episode. Table 4-5 shows the overall mean among the four sites for each sampling period. Scatterplots of modeled (with CB4) versus ambient mixing ratios of lumped species are shown for PAR, ETH, OLE and ISOP in Figure 4-1a and for TOL, XYL, FORM and ALD2 in Figure 4-1b. The corresponding scatterplots of the ambient versus modeled data with SAPRC99 are shown in Figure 4-2a for ALK1, ALK2, ALK3, ALK4 and ALK5, and in Figure 4-2b for ETHE, ISOP, OLE1, OLE2, ARO1 and ARO2, and in Figure 4-2c for HCHO, CCHO, ACET and RCHO. Dots and circles indicate data for EMFAC7G and EMFAC2001, respectively. Dots are within the circle if there is negligible difference in emission estimates between the two EMFAC versions. Data for individual samples are presented in four appendices corresponding to the four sets of simulations.

For CAMx simulations with the CB4 mechanism, there is generally good agreement during the daylight hours between modeled and measured values for PAR, TOL, XYL, and ISOP with both EMFAC7G and EMFAC2001 based emissions. The agreement between predicted and measured values varies among the four sampling locations with generally lower predicted/measured ratios at Azusa (ranging from 0.4 to 0.8) and higher ratios at Pico Rivera (ranging from 1.0 to 1.6) and Upland (ranging from 1.0 to 3.7). These spatial variations are larger than the differences resulting from different EMFAC versions. Predicted ETH and OLE levels are about 30 to 50 percent and about a factor of two higher, respectively, during the late afternoon and evening hours. Predicted and measured values for isoprene were not statistically different during the middle of the day when emissions of isoprene are at their maximum. The predicted formaldehyde mixing ratios are higher by about 50 percent to a factor of two during the afternoon period and about a factor of five higher overnight. The scatterplots for formaldehyde shows that the overpredictions are due primarily to an offset in the intercept of about 5 ppb, which equals its boundary condition. However, the photochemical lifetime of formaldehyde is too short for the boundary conditions to influence the formaldehyde predicted at urban monitoring sites.

The results from the CAMx simulations with SAPRC99 chemical mechanism show larger differences from measured values than with CB4. This may be due partly to the greater number of species in the SAPRC99 mechanism, which reduces opportunities for compensating over- and under-predictions, but we cannot show that this is the main explanation for our finding. As for CB4, agreement is better for the primary NMHCs than for NMOCs with significant contribution of secondary species. The spatial variations in the ratios of predicted to measured species concentrations that were noted above for the CB4 results are larger with SAPRC99. With the exception of ALK1 (ethane), all predicted hydrocarbon species are lower than measured values at Azusa (0.2 to 0.6) during the 6-9 a.m. The corresponding predicted/measured ratios increase progressively from Azusa to Los Angeles – North Main (0.5 to 1.1) to Pico Rivera (0.5 to 2.1) to Upland (0.8 to 3.5). The ratios are generally lower for ALK4 and OLE1 and higher for ALK1. Agreement with observations for HCHO (formaldehyde) and CCHO (acetaldehyde) is better during midday. Predicted values are factors of two to four higher during overnight. Modeled RCHO (higher aldehydes) is consistently lower than measurements at all sites and hours. The scatterplots for HCHO and CCHO show that the overpredictions are due primarily to an offset in the intercept of about 5 ppb. Alternatively, the emission inventory for aldehydes is poorer than for primary NMHCs or the models does not properly describe secondary formation of aldehydes.

Table 4-1. Carbon Bond IV lumped species assignments and species factors.

Species Name	NR	OLE	PAR	TOL	XYL	FORM	ALD2	ETH	ISOP
PAMS Species in ppbC									
ethene								1.00	
acetylene			1.00						
ethane	0.70		0.30						
Propene		0.67	0.33						
n-propane			1.00						
isobutane			1.00						
1-butene		0.50	0.50						
n-butane			1.00						
t-2-Butene							1.00		
c-2-butene							1.00		
isopentane			1.00						
1-pentene		0.40	0.60						
n-pentane			1.00						
isoprene									1.00
t-2-Pentene			0.20				0.80		
c-2-pentene			0.20				0.80		
2,2-dimethylbutane			1.00						
cyclopentane			1.00						
2,3-dimethylbutane	0.17		0.83						
2-methylpentane			1.00						
3-methylpentane			1.00						
2-methyl-1-pentene		0.33	0.67						
n-hexane			1.00						
Methylcyclopentane			1.00						
2,4-dimethylpentane			1.00						
benzene	0.83		0.17						
cyclohexane			1.00						
2-methylhexane			1.00						
2,3-dimethylpentane			1.00						
3-methylhexane			1.00						
2,2,4-trimethylpentane			1.00						
n-heptane			1.00						
methylcyclohexane			1.00						
2,3,4-trimethylpentane			1.00						
toluene				1.00					
2-methylheptane			1.00						
3-methylheptane			1.00						
n-octane			1.00						
ethylbenzene			0.13	0.88					
mp-xylene					1.00				
styrene		0.13		0.88					
o-xylene					1.00				
n-nonane			1.00						
isopropylbenzene			0.22	0.78					
n-propylbenzene			0.22	0.78					
m-ethyltoluene			0.11		0.89				
p-ethyltoluene			0.11		0.89				
1,3,5-trimethylbenzene			0.11		0.89				
o-ethyltoluene			0.11		0.89				
1,2,4-trimethylbenzene			0.11		0.89				
n-decane			1.00						
1,2,3-trimethylbenzene			0.11		0.89				
m-diethylbenzene			0.20		0.80				
p-diethylbenzene			0.20		0.80				
n-undecane			1.00						

Table 4-1 Continued. Carbon Bond IV lumped species assignments and species factors.

Species Name	NR	OLE	PAR	TOL	XYL	FORM	ALD2	ETH	ISOP
Non PAMS Species in ppbC									
methyl-t-butylether	0.20		0.80						
i-Butene		0.50	0.50						
1,3-Butadiene		0.50					0.50		
3-Methyl-1-butene		0.40	0.60						
2-Methyl-1-butene		0.40	0.60						
2-Methyl-2-butene			0.60				0.40		
Cyclopentene			0.60				0.40		
4-Methyl-1-pentene		0.33	0.67						
1-Hexene		0.33	0.67						
trans-2-Hexene			0.67				0.33		
2-Methyl-2-pentene			0.67				0.33		
cis-2-Hexene			0.67				0.33		
2,4,4-Trimethyl-1-pentene		0.25	0.75						
2,5-Dimethylhexane			1.00						
2,4-Dimethylhexane			1.00						
2,3-Dimethylhexane			1.00						
3-Ethylhexane			1.00						
2,2,4-Trimethylhexane			1.00						
ETBE	0.17		0.83						
Carbonyl Compounds in ppbv									
formaldehyde						1.00			
acetaldehyde							2.00		
acetone			3.00						
propanal			1.00				2.00		
crotonaldehyde							4.00		
methyethylketone			4.00						
methacrolein			3.00				2.00		
butanal			2.00				2.00		
benzaldehyde			5.00				2.00		
m-Tolualdehyde			6.00				2.00		
C5 crbonyls			3.00				2.00		
C6 crbonyls			4.00				2.00		
C7 crbonyls			5.00				2.00		
>C7 crbonyls			6.00				2.00		

Table 4-2. SAPRC99 lumped species assignments and species factors.

Species Name	Lumped Species	Species Factor
PAMS Species in ppbC		
ethene	ETHE	1
acetylene	ALK2	1
ethane	ALK1	1
Propene	OLE1	1
n-propane	ALK2	1
isobutane	ALK3	1
1-butene	OLE1	1
n-butane	ALK3	1
t-2-Butene	OLE2	1
c-2-butene	OLE2	1
isopentane	ALK4	1
1-pentene	OLE1	1
n-pentane	ALK4	1
isoprene	ISOP	1
t-2-Pentene	OLE2	1
c-2-pentene	OLE2	1
2,2-dimethylbutane	ALK3	1
cyclopentane	ALK4	1
2,3-dimethylbutane	ALK3	1
2-methylpentane	ALK4	1
3-methylpentane	ALK4	1
2-methyl-1-pentene	OLE2	1
n-hexane	ALK4	1
Methylcyclopentane	ALK5	1
2,4-dimethylpentane	ALK4	1
benzene	ARO1	1
cyclohexane	ALK5	1
2-methylhexane	ALK4	1
2,3-dimethylpentane	ALK4	1
3-methylhexane	ALK4	1
2,2,4-trimethylpentane	ALK4	1
n-heptane	ALK5	1
methylcyclohexane	ALK5	1
2,3,4-trimethylpentane	ALK5	1
toluene	ARO1	1
2-methylheptane	ALK5	1
3-methylheptane	ALK5	1
n-octane	ALK5	1
ethylbenzene	ARO1	1
mp-xylene	ARO2	1
styrene	OLE2	1
o-xylene	ARO2	1
n-nonane	ALK5	1
isopropylbenzene	ARO1	1
n-propylbenzene	ARO1	1
m-ethyltoluene	ARO2	1
p-ethyltoluene	ARO2	1
1,3,5-trimethylbenzene	ARO2	1
o-ethyltoluene	ARO2	1
1,2,4-trimethylbenzene	ARO2	1
n-decane	ALK5	1
1,2,3-trimethylbenzene	ARO2	1
m-diethylbenzene	ARO2	1
p-diethylbenzene	ARO2	1
n-undecane	ALK5	1

Species Name	Lumped Species	Species Factor
Non PAMS Species in ppbC		
i-Butene	OLE2	1
1,3-Butadiene	OLE2	1
3-Methyl-1-butene	OLE1	1
2-Methyl-1-butene	OLE1	1
2-Methyl-2-butene	OLE2	1
Cyclopentene	OLE2	1
4-Methyl-1-pentene	OLE1	1
1-Hexene	OLE1	1
trans-2-Hexene	OLE2	1
2-Methyl-2-pentene	OLE2	1
cis-2-Hexene	OLE2	1
2,4,4-Trimethyl-1-pentene	OLE1	1
2,5-Dimethylhexane	ALK5	1
2,4-Dimethylhexane	ALK5	1
2,3-Dimethylhexane	ALK5	1
3-Ethylhexane	ALK5	1
2,2,4-Trimethylhexane	ALK5	1
ETBE	ALK5	1
Carbonyl Compounds in ppbv		
formaldehyde	HCHO	1
acetaldehyde	CCHO	2
acetone	ACET	3
propanal	RCHO	3
crotonaldehyde	RCHO	4
methyethylketone	MEK	4
butanal	RCHO	4
methacrolein	METH	5
benzaldehyde	BALD	7
m-Tolualdehyde	RCHO	8
C5 crbonyls	RCHO	5
C6 crbonyls	RCHO	6
C7 crbonyls	RCHO	7
>C7 crbonyls	RCHO	8

SAPRC99 Species	Average # of C
HCHO	1
CCHO	2
RCHO	3.66
ACET	3
MEK	4.03
BALD	7.15
ETHE	2
ISOP	5
ALK1	1.88
ALK2	2.65
ALK3	2.92
ALK4	4.36
ALK5	6.42
ARO1	7.27
ARO2	8.58
OLE1	3.99
OLE2	5.67

Table 4-3a. Measured lumped species mixing ratios with standard errors for the August 3-7, 1997 SCOS episode using CB4 chemical mechanism.

Data Source	Site	Start (PDT)	OLE (ppbC)	PAR (ppbC)	TOL (ppbC)	XYL (ppbC)	FORM (ppbC)	ALD2 (ppbC)	ETH (ppbC)	ISOP (ppbC)
SCOS97	AZUS	3	9.2 ± 1.5	388.7 ± 44.8	53.8 ± 10.7	58.3 ± 9.6	4.7 ± 2.2	19.3 ± 3.0	15.9 ± 2.2	0.3 ± 0.1
SCOS97	AZUS	6	14.8 ± 2.1	581.1 ± 81.3	80.9 ± 12.4	78.5 ± 13.0	11.6 ± 1.2	33.4 ± 3.7	26.2 ± 3.1	0.3 ± 0.3
SCOS97	AZUS	13	3.6 ± 0.7	304.5 ± 46.0	34.5 ± 7.3	26.5 ± 3.6	8.8 ± 0.6	38.5 ± 4.1	10.0 ± 2.1	3.5 ± 1.4
SCOS97	AZUS	17	3.9 ± 0.6	166.8 ± 32.2	23.9 ± 5.1	25.6 ± 3.9	5.3 ± 0.7	19.5 ± 3.1	7.2 ± 1.3	3.7 ± 0.4
SCOS97	LANM	3	7.1 ± 1.4	222.4 ± 36.7	28.3 ± 4.8	33.6 ± 4.9	7.6 ± 1.6	18.6 ± 2.4	12.8 ± 2.4	0.2 ± 0.1
SCOS97	LANM	6	18.9 ± 0.9	516.5 ± 76.8	69.1 ± 8.6	78.0 ± 7.6	11.8 ± 1.3	33.2 ± 5.6	34.3 ± 1.9	0.1 ± 0.1
SCOS97	LANM	13	5.3 ± 1.1	254.7 ± 53.1	30.2 ± 2.4	26.8 ± 0.7	5.8 ± 0.0	25.9 ± 0.0	7.6 ± 0.6	1.5 ± 0.3
SCOS97	LANM	17	7.4 ± 1.7	204.5 ± 40.0	29.7 ± 6.1	31.4 ± 7.4	6.5 ± 1.7	20.1 ± 1.7	11.4 ± 2.7	1.9 ± 0.6
PAMS	AZUS	0	9.5 ± 2.9	324.3 ± 6.3	69.2 ± 0.1	65.7 ± 1.0			20.5 ± 0.0	1.8 ± 0.9
PAMS	AZUS	3	5.9 ± 1.2	308.0 ± 53.6	62.7 ± 14.9	61.2 ± 13.2			17.5 ± 3.5	1.0 ± 0.5
PAMS	AZUS	6	9.6 ± 0.9	436.5 ± 45.0	98.2 ± 16.5	85.3 ± 13.5			28.3 ± 3.2	2.0 ± 0.4
PAMS	AZUS	9	4.1 ± 0.2	243.5 ± 10.1	46.4 ± 3.9	34.7 ± 2.8			16.2 ± 1.5	3.0 ± 0.5
PAMS	AZUS	12	2.0 ± 0.3	194.8 ± 24.1	35.8 ± 5.5	22.1 ± 3.1			11.9 ± 2.2	3.0 ± 0.3
PAMS	AZUS	15	1.4 ± 0.1	100.9 ± 23.1	19.9 ± 5.3	15.1 ± 3.0			6.6 ± 1.4	3.2 ± 0.3
PAMS	AZUS	18	2.8 ± 0.5	128.9 ± 34.0	31.2 ± 10.5	27.5 ± 6.6			9.5 ± 1.9	2.8 ± 0.4
PAMS	AZUS	21	4.2 ± 1.8	187.8 ± 61.5	46.8 ± 25.3	50.2 ± 22.0			14.0 ± 5.2	2.0 ± 0.1
PAMS	PICO	0	6.1 ± 2.0	252.1 ± 79.0	31.9 ± 10.8	40.0 ± 12.9	3.8 ± 1.3	8.3 ± 2.4	7.9 ± 2.7	1.1 ± 0.3
PAMS	PICO	3	7.3 ± 2.9	280.6 ± 135.8	35.5 ± 11.8	40.3 ± 14.2	3.7 ± 1.8	7.6 ± 3.2	10.7 ± 4.4	1.1 ± 0.5
PAMS	PICO	6	9.1 ± 2.8	286.7 ± 105.2	42.3 ± 13.7	46.0 ± 15.7	4.0 ± 2.2	7.5 ± 3.6	14.3 ± 4.8	3.1 ± 0.9
PAMS	PICO	9	7.1 ± 1.7	273.9 ± 61.7	45.5 ± 9.6	37.0 ± 8.5	8.0 ± 2.4	11.5 ± 3.2	11.6 ± 3.8	4.0 ± 0.5
PAMS	PICO	12	3.9 ± 0.8	163.6 ± 33.0	28.0 ± 6.5	18.2 ± 2.6	7.7 ± 2.3	11.0 ± 2.9	4.4 ± 1.0	4.0 ± 0.6
PAMS	PICO	15	3.4 ± 0.6	130.8 ± 32.7	19.0 ± 2.9	16.0 ± 1.3	4.1 ± 1.2	5.9 ± 1.3	3.3 ± 0.5	3.2 ± 0.2
PAMS	PICO	18	3.1 ± 0.7	103.4 ± 11.9	16.7 ± 3.4	17.1 ± 4.5	2.1 ± 0.6	4.1 ± 0.9	4.6 ± 1.3	1.1 ± 0.2
PAMS	PICO	21	5.0 ± 0.8	130.2 ± 16.7	22.3 ± 2.9	26.6 ± 4.0	1.1 ± 0.6	2.7 ± 0.6	7.3 ± 1.4	0.7 ± 0.2
PAMS	UPLA	0	4.9 ± 1.8	174.8 ± 35.2	35.9 ± 5.9	37.0 ± 6.2			11.9 ± 1.8	0.5 ± 0.3
PAMS	UPLA	3	2.5 ± 0.2	155.1 ± 7.0	32.5 ± 0.9	33.3 ± 0.2			9.8 ± 0.6	0.3 ± 0.3
PAMS	UPLA	6	5.1 ± 1.3	210.9 ± 32.7	44.1 ± 7.4	46.9 ± 10.8			18.4 ± 3.8	8.0 ± 2.5
PAMS	UPLA	9	2.2 ± 0.5	130.4 ± 23.6	26.3 ± 5.1	18.8 ± 5.4			9.0 ± 1.4	6.5 ± 0.4
PAMS	UPLA	12	1.3 ± 0.3	127.7 ± 11.9	20.8 ± 1.8	10.0 ± 1.2			7.9 ± 0.6	7.7 ± 0.1
PAMS	UPLA	15	1.1 ± 0.1	101.8 ± 14.8	16.7 ± 2.8	8.5 ± 1.9			5.7 ± 0.9	7.3 ± 0.6
PAMS	UPLA	18	2.2 ± 0.1	120.9 ± 22.6	23.0 ± 3.3	19.9 ± 3.6			8.9 ± 0.9	6.1 ± 0.7
PAMS	UPLA	21	5.9 ± 2.0	237.9 ± 76.1	51.9 ± 17.1	44.5 ± 15.8			19.1 ± 6.0	2.3 ± 0.9
SCOS97	AZUS	3	3	3	3	3	3	3	3	3
SCOS97	AZUS	6	3	3	3	3	3	3	3	3
SCOS97	AZUS	13	3	3	3	3	3	3	3	3
SCOS97	AZUS	17	3	3	3	3	3	3	3	3
SCOS97	LANM	3	3	3	3	3	2	2	3	3
SCOS97	LANM	6	3	3	3	3	2	2	3	3
SCOS97	LANM	13	2	2	2	2	1	1	2	2
SCOS97	LANM	17	3	3	3	3	2	2	3	3
PAMS	AZUS	0	2	2	2	2	0	0	2	2
PAMS	AZUS	3	3	3	3	3	0	0	3	3
PAMS	AZUS	6	3	3	3	3	0	0	3	3
PAMS	AZUS	9	3	3	3	3	0	0	3	3
PAMS	AZUS	12	3	3	3	3	0	0	3	3
PAMS	AZUS	15	3	3	3	3	0	0	3	3
PAMS	AZUS	18	3	3	3	3	0	0	3	3
PAMS	AZUS	21	2	2	2	2	0	0	2	2
PAMS	PICO	0	3	3	3	3	3	3	3	3
PAMS	PICO	3	3	3	3	3	3	3	3	3
PAMS	PICO	6	4	4	4	4	4	4	4	4
PAMS	PICO	9	4	4	4	4	4	4	4	4
PAMS	PICO	12	3	3	3	3	3	3	3	3
PAMS	PICO	15	4	4	4	4	4	4	4	4
PAMS	PICO	18	3	3	3	3	3	3	3	3
PAMS	PICO	21	3	3	3	3	3	3	3	3
PAMS	UPLA	0	3	3	3	3	0	0	3	3
PAMS	UPLA	3	3	3	3	3	0	0	3	3
PAMS	UPLA	6	3	3	3	3	0	0	3	3
PAMS	UPLA	9	3	3	3	3	0	0	3	3
PAMS	UPLA	12	2	2	2	2	0	0	2	2
PAMS	UPLA	15	3	3	3	3	0	0	3	3
PAMS	UPLA	18	3	3	3	3	0	0	3	3
PAMS	UPLA	21	3	3	3	3	0	0	3	3

Table 4-3b. Modeled lumped species mixing ratios with standard errors for CAMx simulations of the August 3-7, 1997 SCOS episode using CB4 chemical mechanism with EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	OLE	PAR	TOL	XYL	FORM	ALD2	ETH	ISOP
EMFAC 7G									
AZUS	3	10.6 ± 2.4	264.1 ± 20.9	40.5 ± 4.5	38.0 ± 5.0	9.0 ± 0.5	16.8 ± 1.3	15.4 ± 3.0	2.7 ± 2.5
AZUS	6	9.9 ± 2.9	230.7 ± 50.3	40.5 ± 6.4	36.8 ± 7.0	9.3 ± 0.9	16.2 ± 2.7	15.2 ± 3.8	0.5 ± 0.0
AZUS	13	1.3 ± 0.0	149.7 ± 9.1	18.5 ± 0.5	6.2 ± 0.1	9.1 ± 0.4	12.6 ± 0.9	4.8 ± 0.1	1.7 ± 0.2
AZUS	17	3.9 ± 0.5	152.8 ± 14.1	23.1 ± 1.5	15.1 ± 1.9	8.1 ± 0.6	11.2 ± 1.0	7.7 ± 0.7	4.2 ± 1.0
LANM	3	8.8 ± 2.6	247.7 ± 25.0	39.2 ± 5.7	34.8 ± 6.8	9.1 ± 0.6	15.6 ± 1.6	13.8 ± 3.0	1.4 ± 1.3
LANM	6	14.5 ± 1.8	366.0 ± 20.3	56.0 ± 3.9	54.2 ± 4.4	11.6 ± 0.7	21.9 ± 2.1	21.9 ± 2.2	1.8 ± 0.5
LANM	13	2.3 ± 0.0	135.0 ± 9.5	19.2 ± 0.9	9.9 ± 0.1	6.9 ± 0.0	8.7 ± 0.0	5.5 ± 0.2	3.1 ± 0.3
LANM	17	7.8 ± 0.7	200.2 ± 12.1	33.0 ± 1.7	27.2 ± 2.4	8.3 ± 0.7	12.2 ± 1.1	12.7 ± 0.9	7.1 ± 1.6
AZUS	0	9.6 ± 0.0	258.7 ± 0.0	38.4 ± 0.0	34.9 ± 0.0			14.5 ± 0.0	0.5 ± 0.0
AZUS	3	10.6 ± 2.4	264.1 ± 20.9	40.5 ± 4.5	38.0 ± 5.0			15.4 ± 3.0	2.7 ± 2.5
AZUS	6	9.9 ± 2.9	230.7 ± 50.3	40.5 ± 6.4	36.8 ± 7.0			15.2 ± 3.8	1.7 ± 1.2
AZUS	9	6.0 ± 0.3	226.5 ± 7.6	36.6 ± 1.1	24.5 ± 0.6			12.8 ± 0.7	2.1 ± 0.3
AZUS	12	1.8 ± 0.1	177.0 ± 11.3	23.5 ± 1.2	8.8 ± 0.5			6.5 ± 0.4	1.8 ± 0.1
AZUS	15	1.9 ± 0.1	133.7 ± 9.2	17.1 ± 0.3	7.7 ± 0.3			4.8 ± 0.0	2.4 ± 0.3
AZUS	18	5.7 ± 1.0	178.4 ± 26.5	28.1 ± 3.0	21.2 ± 3.8			10.0 ± 1.4	3.8 ± 1.1
AZUS	21	8.8 ± 4.0	224.3 ± 91.6	37.1 ± 8.6	32.4 ± 12.8			13.7 ± 4.4	1.8 ± 1.7
PICO	0	9.0 ± 4.7	229.3 ± 123.5	40.4 ± 11.1	33.5 ± 12.5	8.2 ± 1.6	13.8 ± 4.8	13.6 ± 5.4	0.4 ± 0.4
PICO	3	9.5 ± 3.1	227.9 ± 57.9	41.0 ± 6.1	34.7 ± 6.7	8.3 ± 0.9	13.7 ± 2.2	14.2 ± 3.8	1.1 ± 1.0
PICO	6	9.8 ± 1.7	269.8 ± 32.7	43.2 ± 4.0	37.4 ± 4.3	9.5 ± 0.7	16.2 ± 1.7	15.5 ± 2.3	0.9 ± 0.3
PICO	9	5.7 ± 0.6	232.9 ± 22.7	36.7 ± 2.0	23.5 ± 1.9	10.3 ± 0.7	16.6 ± 1.5	12.1 ± 1.0	2.5 ± 0.4
PICO	12	1.6 ± 0.1	152.2 ± 10.6	21.4 ± 0.8	7.4 ± 0.6	8.9 ± 0.4	12.2 ± 0.9	5.2 ± 0.2	2.3 ± 0.3
PICO	15	1.9 ± 0.1	104.3 ± 5.1	16.7 ± 0.5	7.3 ± 0.3	6.1 ± 0.4	7.7 ± 0.5	4.4 ± 0.0	2.6 ± 0.3
PICO	18	4.9 ± 0.8	134.5 ± 16.6	25.3 ± 2.1	17.3 ± 2.4	6.1 ± 0.6	8.7 ± 0.8	8.6 ± 1.0	2.6 ± 0.7
PICO	21	10.5 ± 1.9	253.8 ± 39.9	40.6 ± 4.9	35.0 ± 5.9	8.4 ± 1.1	13.9 ± 2.1	15.6 ± 2.3	1.0 ± 0.4
UPLA	0	8.4 ± 3.6	214.2 ± 92.0	36.0 ± 7.7	30.1 ± 9.6			13.8 ± 4.6	0.3 ± 0.0
UPLA	3	10.9 ± 1.1	273.5 ± 7.4	39.3 ± 2.0	37.6 ± 2.0			17.6 ± 1.5	0.2 ± 0.0
UPLA	6	16.0 ± 0.9	305.1 ± 15.2	51.7 ± 2.0	51.1 ± 1.9			26.6 ± 1.3	1.5 ± 0.5
UPLA	9	7.3 ± 0.3	201.9 ± 6.0	35.7 ± 1.3	25.9 ± 1.3			14.9 ± 0.3	2.8 ± 0.3
UPLA	12	2.1 ± 0.2	142.1 ± 21.7	19.4 ± 3.0	8.1 ± 0.9			6.2 ± 1.1	2.2 ± 0.1
UPLA	15	2.8 ± 0.2	135.9 ± 7.1	17.9 ± 1.2	9.7 ± 0.6			6.0 ± 0.3	2.9 ± 0.4
UPLA	18	7.0 ± 0.5	181.3 ± 17.2	28.6 ± 0.7	22.8 ± 1.8			12.0 ± 0.6	3.4 ± 0.5
UPLA	21	11.7 ± 2.4	262.5 ± 52.3	42.2 ± 5.1	38.1 ± 7.1			18.1 ± 3.2	0.9 ± 0.5
EMFAC 2001									
AZUS	3	10.8 ± 2.5	301.3 ± 27.2	48.2 ± 6.6	44.3 ± 7.0	9.1 ± 0.5	18.0 ± 1.5	15.4 ± 3.2	2.7 ± 2.5
AZUS	6	10.5 ± 3.1	270.1 ± 60.4	50.4 ± 9.1	45.0 ± 9.3	9.5 ± 1.0	17.6 ± 3.1	15.8 ± 4.0	0.6 ± 0.0
AZUS	13	1.6 ± 0.0	180.3 ± 11.7	23.2 ± 0.9	8.2 ± 0.2	9.7 ± 0.5	14.5 ± 1.1	5.3 ± 0.1	1.8 ± 0.2
AZUS	17	4.5 ± 0.6	186.6 ± 20.5	30.6 ± 2.6	20.8 ± 3.0	8.4 ± 0.7	12.8 ± 1.3	8.4 ± 0.9	4.3 ± 1.0
LANM	3	9.5 ± 2.8	283.7 ± 30.0	46.2 ± 7.4	40.8 ± 8.5	9.2 ± 0.7	16.8 ± 1.9	14.3 ± 3.2	1.5 ± 1.4
LANM	6	16.4 ± 2.0	446.8 ± 26.1	76.1 ± 5.3	71.4 ± 5.8	12.1 ± 0.8	24.7 ± 2.5	24.0 ± 2.4	2.4 ± 0.0
LANM	13	2.7 ± 0.1	161.4 ± 13.9	23.7 ± 0.2	12.8 ± 0.3	7.1 ± 0.0	9.7 ± 0.0	5.9 ± 0.1	3.2 ± 0.4
LANM	17	9.0 ± 0.8	248.6 ± 16.8	45.5 ± 2.7	38.0 ± 3.3	8.7 ± 0.8	14.1 ± 1.5	14.1 ± 1.0	7.2 ± 1.6
AZUS	0	10.1 ± 0.0	298.2 ± 0.0	47.1 ± 0.0	42.3 ± 0.0			14.9 ± 0.0	0.6 ± 0.0
AZUS	3	10.8 ± 2.5	301.3 ± 27.2	48.2 ± 6.6	44.3 ± 7.0			15.4 ± 3.2	0.2 ± 0.1
AZUS	6	10.5 ± 3.1	270.1 ± 60.4	50.4 ± 9.1	45.0 ± 9.3			15.8 ± 4.0	1.6 ± 1.1
AZUS	9	6.4 ± 0.3	267.8 ± 11.8	46.3 ± 1.9	30.9 ± 1.2			13.3 ± 0.7	2.1 ± 0.3
AZUS	12	2.1 ± 0.1	211.7 ± 14.0	29.4 ± 1.6	11.4 ± 0.7			7.0 ± 0.5	1.9 ± 0.2
AZUS	15	2.2 ± 0.1	163.2 ± 12.7	22.1 ± 0.6	10.7 ± 0.4			5.3 ± 0.1	2.5 ± 0.3
AZUS	18	6.5 ± 1.3	217.6 ± 36.2	37.5 ± 5.0	28.8 ± 5.7			10.9 ± 1.7	4.2 ± 1.2
AZUS	21	9.6 ± 4.8	265.5 ± 119.3	46.4 ± 14.5	40.3 ± 18.0			14.6 ± 5.3	2.0 ± 2.0
PICO	0	9.4 ± 5.2	259.9 ± 147.2	46.2 ± 15.6	38.4 ± 16.4	8.3 ± 1.7	14.8 ± 5.6	13.9 ± 5.9	0.5 ± 0.5
PICO	3	9.9 ± 3.2	256.2 ± 67.0	46.7 ± 8.2	39.7 ± 8.6	8.3 ± 0.9	14.6 ± 2.5	14.5 ± 3.9	1.2 ± 1.1
PICO	6	10.7 ± 1.8	315.7 ± 39.2	53.6 ± 5.5	46.1 ± 5.6	9.7 ± 0.7	17.7 ± 1.9	16.3 ± 2.4	0.9 ± 0.3
PICO	9	6.3 ± 0.6	275.6 ± 27.4	46.5 ± 2.9	30.3 ± 2.4	10.9 ± 0.8	18.5 ± 1.7	12.8 ± 1.0	2.6 ± 0.4
PICO	12	1.8 ± 0.1	179.6 ± 14.1	25.8 ± 1.4	9.5 ± 0.8	9.3 ± 0.5	13.7 ± 1.1	5.6 ± 0.2	2.4 ± 0.3
PICO	15	2.1 ± 0.1	122.9 ± 7.1	20.4 ± 0.4	9.9 ± 0.5	6.3 ± 0.5	8.6 ± 0.7	4.7 ± 0.0	2.7 ± 0.4
PICO	18	5.5 ± 1.0	158.5 ± 21.7	31.7 ± 3.3	23.0 ± 3.6	6.2 ± 0.6	9.5 ± 0.9	9.3 ± 1.2	2.7 ± 0.8
PICO	21	11.5 ± 2.1	294.0 ± 48.4	49.7 ± 6.5	43.1 ± 7.3	8.6 ± 1.1	15.2 ± 2.4	16.6 ± 2.5	1.1 ± 0.5
UPLA	0	6.6 ± 2.5	218.6 ± 93.2	37.5 ± 8.2	29.4 ± 8.8			10.6 ± 2.7	0.3 ± 0.0
UPLA	3	8.2 ± 1.1	285.0 ± 10.8	42.3 ± 2.5	37.0 ± 2.6			12.5 ± 1.4	0.1 ± 0.0
UPLA	6	9.7 ± 0.9	282.7 ± 18.4	49.6 ± 2.5	43.6 ± 2.4			15.4 ± 1.2	1.1 ± 0.2
UPLA	9	4.3 ± 0.4	195.8 ± 11.3	34.9 ± 2.3	21.3 ± 2.0			9.6 ± 0.6	2.4 ± 0.4
UPLA	12	1.4 ± 0.1	154.8 ± 25.3	21.1 ± 3.5	7.2 ± 1.0			5.0 ± 1.0	2.0 ± 0.1
UPLA	15	1.9 ± 0.1	148.1 ± 7.8	19.4 ± 1.1	8.8 ± 0.6			4.6 ± 0.2	2.8 ± 0.4
UPLA	18	5.6 ± 0.5	194.4 ± 22.0	31.7 ± 1.3	23.4 ± 2.1			9.9 ± 0.6	3.1 ± 0.4
UPLA	21	10.2 ± 2.2	280.0 ± 59.4	46.8 ± 6.5	40.0 ± 7.9			15.5 ± 2.6	1.0 ± 0.5

Table 4-3c. Modeled/measured ratios with standard errors for CAMx simulations of the August 3-7, 1997 SCOS episode using CB4 chemical mechanism with EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	OLE	PAR	TOL	XYL	FORM	ALD2	ETH	ISOP
EMFAC 7G									
AZUS	3	1.34 ± 0.56	0.71 ± 0.15	0.85 ± 0.27	0.72 ± 0.22	10.60 ± 9.24	0.91 ± 0.13	1.06 ± 0.36	5.15 ± 3.93
AZUS	6	0.77 ± 0.35	0.44 ± 0.17	0.56 ± 0.19	0.54 ± 0.21	0.83 ± 0.16	0.52 ± 0.15	0.64 ± 0.24	0.61 ± 0.00
AZUS	13	0.41 ± 0.10	0.52 ± 0.11	0.61 ± 0.17	0.24 ± 0.04	1.05 ± 0.09	0.34 ± 0.05	0.54 ± 0.13	0.82 ± 0.45
AZUS	17	1.03 ± 0.07	0.96 ± 0.13	1.05 ± 0.19	0.60 ± 0.02	1.57 ± 0.17	0.59 ± 0.05	1.11 ± 0.11	1.09 ± 0.14
LANM	3	1.29 ± 0.35	1.17 ± 0.21	1.48 ± 0.35	1.10 ± 0.32	1.26 ± 0.34	0.86 ± 0.20	1.16 ± 0.34	3.65 ± 3.28
LANM	6	0.77 ± 0.12	0.74 ± 0.12	0.84 ± 0.13	0.71 ± 0.11	1.00 ± 0.17	0.69 ± 0.18	0.65 ± 0.09	11.63 ± 0.00
LANM	13	0.46 ± 0.10	0.56 ± 0.15	0.64 ± 0.02	0.37 ± 0.01	1.20 ± 0.00	0.34 ± 0.00	0.73 ± 0.09	2.34 ± 0.80
LANM	17	1.12 ± 0.15	1.03 ± 0.12	1.17 ± 0.17	0.92 ± 0.12	1.34 ± 0.25	0.61 ± 0.01	1.20 ± 0.19	4.13 ± 0.57
AZUS	0	1.44 ± 0.00	0.78 ± 0.00	0.55 ± 0.00	0.52 ± 0.00			0.71 ± 0.00	0.17 ± 0.00
AZUS	3	2.16 ± 0.94	0.95 ± 0.26	0.77 ± 0.28	0.73 ± 0.27			1.02 ± 0.40	0.14 ± 0.03
AZUS	6	1.11 ± 0.44	0.57 ± 0.19	0.47 ± 0.17	0.49 ± 0.19			0.59 ± 0.22	1.17 ± 0.95
AZUS	9	1.48 ± 0.14	0.94 ± 0.07	0.80 ± 0.09	0.72 ± 0.07			0.81 ± 0.10	0.71 ± 0.11
AZUS	12	0.93 ± 0.17	0.95 ± 0.19	0.70 ± 0.14	0.42 ± 0.08			0.60 ± 0.14	0.62 ± 0.08
AZUS	15	1.33 ± 0.08	1.45 ± 0.30	0.97 ± 0.22	0.55 ± 0.10			0.80 ± 0.14	0.76 ± 0.08
AZUS	18	2.05 ± 0.16	1.52 ± 0.26	1.14 ± 0.36	0.81 ± 0.09			1.08 ± 0.08	1.32 ± 0.24
AZUS	21	2.08 ± 0.07	1.16 ± 0.11	0.98 ± 0.35	0.66 ± 0.03			1.01 ± 0.06	0.84 ± 0.83
PICO	0	2.32 ± 1.39	1.53 ± 1.04	1.97 ± 0.70	1.25 ± 0.50	3.30 ± 0.65	2.50 ± 1.19	2.69 ± 1.20	0.53 ± 0.52
PICO	3	1.50 ± 0.37	1.03 ± 0.23	1.39 ± 0.35	1.02 ± 0.23	3.24 ± 1.04	2.29 ± 0.57	1.70 ± 0.47	1.11 ± 1.06
PICO	6	1.26 ± 0.24	1.22 ± 0.31	1.30 ± 0.30	1.05 ± 0.26	2.52 ± 0.79	6.44 ± 4.35	1.36 ± 0.31	0.36 ± 0.14
PICO	9	0.91 ± 0.16	0.95 ± 0.17	0.90 ± 0.15	0.72 ± 0.12	1.59 ± 0.35	1.75 ± 0.36	1.43 ± 0.45	0.64 ± 0.04
PICO	12	0.44 ± 0.12	1.04 ± 0.28	0.89 ± 0.28	0.42 ± 0.07	1.36 ± 0.37	1.24 ± 0.25	1.34 ± 0.38	0.59 ± 0.06
PICO	15	0.61 ± 0.10	0.95 ± 0.22	0.93 ± 0.10	0.46 ± 0.03	1.93 ± 0.49	1.46 ± 0.23	1.41 ± 0.21	0.81 ± 0.06
PICO	18	1.67 ± 0.29	1.31 ± 0.13	1.58 ± 0.17	1.11 ± 0.23	3.20 ± 0.76	2.35 ± 0.50	2.11 ± 0.44	2.44 ± 0.67
PICO	21	2.17 ± 0.30	1.97 ± 0.26	1.85 ± 0.23	1.34 ± 0.18	4.87 ± 0.54	6.34 ± 2.69	2.21 ± 0.36	1.66 ± 0.64
UPLA	0	1.58 ± 0.15	1.24 ± 0.11	1.09 ± 0.08	0.88 ± 0.04			1.25 ± 0.15	0.42 ± 0.00
UPLA	3	4.49 ± 0.54	1.77 ± 0.06	1.21 ± 0.09	1.13 ± 0.06			1.80 ± 0.06	0.29 ± 0.00
UPLA	6	3.68 ± 1.07	1.54 ± 0.32	1.25 ± 0.25	1.23 ± 0.31			1.61 ± 0.41	0.35 ± 0.25
UPLA	9	3.69 ± 0.78	1.66 ± 0.31	1.48 ± 0.33	1.66 ± 0.51			1.75 ± 0.29	0.43 ± 0.07
UPLA	12	1.70 ± 0.56	1.14 ± 0.28	0.95 ± 0.23	0.84 ± 0.19			0.78 ± 0.09	0.28 ± 0.01
UPLA	15	2.67 ± 0.37	1.42 ± 0.29	1.18 ± 0.32	1.31 ± 0.36			1.13 ± 0.24	0.40 ± 0.06
UPLA	18	3.22 ± 0.10	1.57 ± 0.20	1.29 ± 0.18	1.21 ± 0.16			1.36 ± 0.08	0.55 ± 0.07
UPLA	21	2.35 ± 0.56	1.28 ± 0.28	1.06 ± 0.37	1.02 ± 0.23			1.12 ± 0.28	0.40 ± 0.25
EMFAC 2001									
AZUS	3	1.36 ± 0.58	0.82 ± 0.18	1.02 ± 0.35	0.85 ± 0.28	10.58 ± 9.20	0.97 ± 0.14	1.06 ± 0.37	5.22 ± 3.87
AZUS	6	0.81 ± 0.37	0.52 ± 0.20	0.70 ± 0.26	0.66 ± 0.26	0.85 ± 0.17	0.56 ± 0.17	0.66 ± 0.25	0.61 ± 0.00
AZUS	13	0.48 ± 0.12	0.63 ± 0.13	0.77 ± 0.22	0.33 ± 0.06	1.11 ± 0.09	0.39 ± 0.05	0.59 ± 0.15	0.86 ± 0.47
AZUS	17	1.17 ± 0.08	1.17 ± 0.13	1.37 ± 0.22	0.82 ± 0.02	1.65 ± 0.17	0.67 ± 0.05	1.20 ± 0.11	1.12 ± 0.15
LANM	3	1.38 ± 0.37	1.34 ± 0.24	1.75 ± 0.45	1.30 ± 0.40	1.28 ± 0.36	0.93 ± 0.22	1.21 ± 0.37	3.91 ± 3.39
LANM	6	0.88 ± 0.13	0.91 ± 0.15	1.14 ± 0.19	0.94 ± 0.15	1.04 ± 0.18	0.78 ± 0.21	0.71 ± 0.11	12.24 ± 0.00
LANM	13	0.52 ± 0.12	0.67 ± 0.20	0.79 ± 0.05	0.48 ± 0.02	1.23 ± 0.00	0.37 ± 0.00	0.79 ± 0.08	2.42 ± 0.84
LANM	17	1.29 ± 0.17	1.27 ± 0.14	1.62 ± 0.22	1.29 ± 0.17	1.39 ± 0.25	0.70 ± 0.01	1.33 ± 0.21	4.18 ± 0.57
AZUS	0	1.52 ± 0.00	0.90 ± 0.00	0.68 ± 0.00	0.63 ± 0.00			0.73 ± 0.00	0.22 ± 0.00
AZUS	3	2.19 ± 0.96	1.08 ± 0.31	0.93 ± 0.36	0.86 ± 0.34			1.02 ± 0.40	0.16 ± 0.03
AZUS	6	1.18 ± 0.46	0.67 ± 0.23	0.59 ± 0.22	0.60 ± 0.24			0.61 ± 0.23	1.16 ± 0.93
AZUS	9	1.59 ± 0.14	1.11 ± 0.09	1.02 ± 0.11	0.90 ± 0.09			0.84 ± 0.11	0.70 ± 0.11
AZUS	12	1.07 ± 0.20	1.14 ± 0.23	0.88 ± 0.18	0.55 ± 0.11			0.65 ± 0.16	0.65 ± 0.09
AZUS	15	1.55 ± 0.09	1.76 ± 0.35	1.25 ± 0.28	0.76 ± 0.13			0.88 ± 0.16	0.79 ± 0.08
AZUS	18	2.32 ± 0.21	1.83 ± 0.29	1.48 ± 0.41	1.08 ± 0.10			1.17 ± 0.06	1.44 ± 0.29
AZUS	21	2.22 ± 0.19	1.35 ± 0.19	1.17 ± 0.32	0.80 ± 0.01			1.05 ± 0.00	0.97 ± 0.96
PICO	0	2.45 ± 1.53	1.75 ± 1.22	2.27 ± 0.94	1.44 ± 0.65	3.32 ± 0.70	2.68 ± 1.35	2.76 ± 1.30	0.59 ± 0.58
PICO	3	1.56 ± 0.37	1.15 ± 0.25	1.54 ± 0.34	1.14 ± 0.23	3.24 ± 1.04	2.41 ± 0.58	1.72 ± 0.47	1.14 ± 1.07
PICO	6	1.38 ± 0.26	1.43 ± 0.37	1.61 ± 0.39	1.29 ± 0.33	2.56 ± 0.80	7.11 ± 4.84	1.43 ± 0.33	0.36 ± 0.14
PICO	9	1.01 ± 0.19	1.13 ± 0.20	1.13 ± 0.19	0.92 ± 0.16	1.67 ± 0.37	1.94 ± 0.39	1.53 ± 0.50	0.64 ± 0.05
PICO	12	0.51 ± 0.15	1.23 ± 0.35	1.09 ± 0.36	0.55 ± 0.11	1.43 ± 0.38	1.39 ± 0.28	1.46 ± 0.44	0.61 ± 0.06
PICO	15	0.70 ± 0.12	1.12 ± 0.27	1.14 ± 0.14	0.63 ± 0.05	1.99 ± 0.49	1.63 ± 0.25	1.53 ± 0.24	0.83 ± 0.06
PICO	18	1.87 ± 0.34	1.54 ± 0.16	1.97 ± 0.18	1.47 ± 0.32	3.28 ± 0.79	2.59 ± 0.57	2.26 ± 0.49	2.55 ± 0.72
PICO	21	2.37 ± 0.31	2.28 ± 0.31	2.26 ± 0.27	1.64 ± 0.22	4.97 ± 0.56	6.97 ± 3.00	2.35 ± 0.37	1.79 ± 0.68
UPLA	0	1.27 ± 0.20	1.27 ± 0.10	1.14 ± 0.08	0.86 ± 0.02			0.97 ± 0.04	0.33 ± 0.00
UPLA	3	3.40 ± 0.50	1.84 ± 0.07	1.31 ± 0.11	1.11 ± 0.07			1.27 ± 0.08	0.18 ± 0.00
UPLA	6	2.27 ± 0.73	1.44 ± 0.32	1.21 ± 0.26	1.06 ± 0.28			0.94 ± 0.27	0.22 ± 0.14
UPLA	9	2.23 ± 0.59	1.61 ± 0.33	1.46 ± 0.37	1.40 ± 0.49			1.14 ± 0.24	0.38 ± 0.07
UPLA	12	1.14 ± 0.39	1.24 ± 0.31	1.03 ± 0.26	0.74 ± 0.19			0.63 ± 0.09	0.25 ± 0.01
UPLA	15	1.82 ± 0.26	1.54 ± 0.31	1.27 ± 0.33	1.17 ± 0.30			0.86 ± 0.17	0.39 ± 0.06
UPLA	18	2.58 ± 0.11	1.67 ± 0.18	1.42 ± 0.16	1.23 ± 0.14			1.12 ± 0.05	0.51 ± 0.06
UPLA	21	2.02 ± 0.45	1.35 ± 0.27	1.15 ± 0.38	1.06 ± 0.23			0.96 ± 0.24	0.43 ± 0.28

Table 4-4a. Measured lumped species mixing ratios with standard errors for the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism.

Data Source	Site	Start (PDT)	HCHO	CCHO	RCHO	ACET	MEK	BALD	ETHE	ISOP
Measured Ambient Values and Ratios										
SCOS97	AZUS	3	4.7 ± 2.2	5.6 ± 1.9	23.7 ± 3.3	15.8 ± 7.0	9.5 ± 6.9	1.1 ± 0.3	15.9 ± 2.2	0.3 ± 0.1
SCOS97	AZUS	6	11.6 ± 1.2	11.7 ± 0.6	37.1 ± 4.7	49.4 ± 9.6	27.7 ± 14.3	2.6 ± 0.2	26.2 ± 3.1	0.3 ± 0.3
SCOS97	AZUS	13	8.8 ± 0.6	14.5 ± 1.9	53.0 ± 5.3	28.8 ± 5.4	5.2 ± 0.7	2.0 ± 0.1	10.0 ± 2.1	3.5 ± 1.4
SCOS97	AZUS	17	5.3 ± 0.7	7.1 ± 1.2	29.2 ± 4.0	14.8 ± 4.4	4.1 ± 1.7	0.7 ± 0.1	7.2 ± 1.3	3.7 ± 0.4
SCOS97	LANM	3	7.6 ± 1.6	7.0 ± 1.0	21.2 ± 2.3	19.1 ± 5.2	3.0 ± 0.9	1.3 ± 0.1	12.8 ± 2.4	0.2 ± 0.1
SCOS97	LANM	6	11.8 ± 1.3	11.0 ± 1.5	33.0 ± 8.5	27.9 ± 9.2	4.5 ± 1.7	2.1 ± 0.4	34.3 ± 1.9	0.1 ± 0.1
SCOS97	LANM	13	5.8 ± 0.0	8.6 ± 0.0	32.7 ± 0.0	18.7 ± 0.0	3.3 ± 0.0	0.9 ± 0.0	7.6 ± 0.6	1.5 ± 0.3
SCOS97	LANM	17	6.5 ± 1.7	6.7 ± 0.5	25.4 ± 0.3	13.6 ± 2.4	2.2 ± 0.4	0.7 ± 0.1	11.4 ± 2.7	1.9 ± 0.6
PAMS	AZUS	0							20.5 ± 0.0	1.8 ± 0.9
PAMS	AZUS	3							17.5 ± 3.5	1.0 ± 0.5
PAMS	AZUS	6							28.3 ± 3.2	2.0 ± 0.4
PAMS	AZUS	9							16.2 ± 1.5	3.0 ± 0.5
PAMS	AZUS	12							11.9 ± 2.2	3.0 ± 0.3
PAMS	AZUS	15							6.6 ± 1.4	3.2 ± 0.3
PAMS	AZUS	18							9.5 ± 1.9	2.8 ± 0.4
PAMS	AZUS	21							14.0 ± 5.2	2.0 ± 0.1
PAMS	PICO	0	3.8 ± 1.3	5.8 ± 1.8		14.7 ± 6.3			7.9 ± 2.7	1.1 ± 0.3
PAMS	PICO	3	3.7 ± 1.8	5.5 ± 2.4		12.8 ± 6.7			10.7 ± 4.4	1.1 ± 0.5
PAMS	PICO	6	5.3 ± 2.4	6.9 ± 3.0		17.6 ± 9.8			14.3 ± 4.8	3.1 ± 0.9
PAMS	PICO	9	8.0 ± 2.4	10.3 ± 3.0		24.9 ± 7.6			11.6 ± 3.8	4.0 ± 0.5
PAMS	PICO	12	7.7 ± 2.3	10.0 ± 2.9		22.6 ± 7.2			4.4 ± 1.0	4.0 ± 0.6
PAMS	PICO	15	4.1 ± 1.2	5.2 ± 1.4		12.2 ± 4.2			3.3 ± 0.5	3.2 ± 0.2
PAMS	PICO	18	2.1 ± 0.6	3.3 ± 0.9		6.4 ± 1.8			4.6 ± 1.3	1.1 ± 0.2
PAMS	PICO	21	1.6 ± 0.4	2.2 ± 0.4		4.8 ± 0.3			7.3 ± 1.4	0.7 ± 0.2
PAMS	UPLA	0							11.9 ± 1.8	0.5 ± 0.3
PAMS	UPLA	3							9.8 ± 0.6	0.3 ± 0.3
PAMS	UPLA	6							18.4 ± 3.8	8.0 ± 2.5
PAMS	UPLA	9							9.0 ± 1.4	6.5 ± 0.4
PAMS	UPLA	12							7.9 ± 0.6	7.7 ± 0.1
PAMS	UPLA	15							5.7 ± 0.9	7.3 ± 0.6
PAMS	UPLA	18							8.9 ± 0.9	6.1 ± 0.7
PAMS	UPLA	21							19.1 ± 6.0	2.3 ± 0.9
Number of Observations										
SCOS97	AZUS	3	3	3	3	3	3	3	3	3
SCOS97	AZUS	6	3	3	3	3	3	3	3	3
SCOS97	AZUS	13	3	3	3	3	3	3	3	3
SCOS97	AZUS	17	3	3	3	3	3	3	3	3
SCOS97	LANM	3	2	2	2	2	2	2	3	3
SCOS97	LANM	6	2	2	2	2	2	2	3	3
SCOS97	LANM	13	1	1	1	1	1	1	2	2
SCOS97	LANM	17	2	2	2	2	2	2	3	3
PAMS	AZUS	0	0	0	0	0	0	0	2	2
PAMS	AZUS	3	0	0	0	0	0	0	3	3
PAMS	AZUS	6	0	0	0	0	0	0	3	3
PAMS	AZUS	9	0	0	0	0	0	0	3	3
PAMS	AZUS	12	0	0	0	0	0	0	3	3
PAMS	AZUS	15	0	0	0	0	0	0	3	3
PAMS	AZUS	18	0	0	0	0	0	0	3	3
PAMS	AZUS	21	0	0	0	0	0	0	2	2
PAMS	PICO	0	3	3	0	3	0	0	3	3
PAMS	PICO	3	3	3	0	3	0	0	3	3
PAMS	PICO	6	3	3	0	3	0	0	4	4
PAMS	PICO	9	4	4	0	4	0	0	4	4
PAMS	PICO	12	3	3	0	3	0	0	3	3
PAMS	PICO	15	4	4	0	4	0	0	4	4
PAMS	PICO	18	3	3	0	3	0	0	3	3
PAMS	PICO	21	2	2	0	2	0	0	3	3
PAMS	UPLA	0	0	0	0	0	0	0	3	3
PAMS	UPLA	3	0	0	0	0	0	0	3	3
PAMS	UPLA	6	0	0	0	0	0	0	3	3
PAMS	UPLA	9	0	0	0	0	0	0	3	3
PAMS	UPLA	12	0	0	0	0	0	0	2	2
PAMS	UPLA	15	0	0	0	0	0	0	3	3
PAMS	UPLA	18	0	0	0	0	0	0	3	3
PAMS	UPLA	21	0	0	0	0	0	0	3	3

Table 4-4a (continued). Measured lumped species mixing ratios with standard errors for the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism.

Site	Start (PDT)	OLE1	OLE2	ALK1	ALK2	ALK3	ALK4	ALK5	ARO1	ARO2
AZUS	3	10.5 ± 1.9	13.6 ± 2.5	24.6 ± 0.6	56.3 ± 6.1	35.3 ± 3.5	149.7 ± 22.9	63.8 ± 11.1	62.4 ± 12.1	61.5 ± 10.1
AZUS	6	16.1 ± 2.3	23.0 ± 3.6	25.1 ± 2.1	89.4 ± 5.8	40.1 ± 3.7	207.8 ± 27.1	87.6 ± 15.6	90.3 ± 13.7	82.8 ± 13.8
AZUS	13	4.0 ± 0.7	4.8 ± 1.1	13.0 ± 3.0	37.4 ± 7.1	22.0 ± 4.0	118.1 ± 16.5	34.7 ± 6.2	40.0 ± 8.2	27.9 ± 3.7
AZUS	17	4.0 ± 0.5	5.0 ± 1.5	7.7 ± 1.8	21.2 ± 3.5	11.7 ± 2.5	55.4 ± 11.6	27.3 ± 5.7	27.2 ± 5.4	27.2 ± 4.1
LANM	3	8.1 ± 1.5	7.9 ± 1.5	17.2 ± 2.9	37.4 ± 4.5	20.3 ± 1.5	82.4 ± 12.2	33.8 ± 4.5	35.1 ± 5.9	35.4 ± 5.2
LANM	6	21.1 ± 0.5	24.8 ± 2.7	37.7 ± 7.1	98.3 ± 17.0	42.1 ± 2.4	198.8 ± 25.1	75.9 ± 10.5	86.6 ± 10.1	81.8 ± 8.1
LANM	13	6.5 ± 1.4	5.4 ± 0.6	13.2 ± 2.3	40.4 ± 7.1	36.3 ± 4.3	101.6 ± 15.1	33.3 ± 3.1	36.1 ± 4.1	28.2 ± 0.5
LANM	17	8.0 ± 1.7	9.7 ± 2.6	10.6 ± 2.7	23.0 ± 3.4	17.4 ± 2.9	88.8 ± 17.6	31.9 ± 6.5	34.9 ± 7.5	33.0 ± 7.8
AZUS	0	15.3 ± 5.8	6.2 ± 0.2	24.4 ± 0.9	55.9 ± 3.6	34.5 ± 1.4	158.0 ± 6.9	59.2 ± 4.4	78.3 ± 0.4	69.3 ± 1.1
AZUS	3	8.6 ± 1.9	4.9 ± 1.7	25.6 ± 2.0	54.0 ± 6.7	34.7 ± 4.5	150.0 ± 29.5	55.8 ± 11.6	71.4 ± 16.3	64.5 ± 13.9
AZUS	6	13.1 ± 1.3	13.3 ± 1.9	26.8 ± 3.1	87.5 ± 5.2	43.2 ± 3.5	207.3 ± 21.9	81.4 ± 16.8	106.3 ± 18.2	89.9 ± 14.3
AZUS	9	5.7 ± 0.3	4.0 ± 0.2	17.5 ± 0.5	53.9 ± 3.7	29.1 ± 1.2	113.5 ± 5.0	38.1 ± 1.7	53.2 ± 4.2	36.5 ± 3.0
AZUS	12	3.2 ± 0.5	0.0 ± 0.0	16.9 ± 2.8	39.0 ± 3.6	26.5 ± 1.3	93.4 ± 14.5	27.9 ± 3.9	43.9 ± 7.0	23.4 ± 3.2
AZUS	15	2.2 ± 0.2	0.0 ± 0.0	7.9 ± 1.5	16.9 ± 2.6	12.7 ± 2.4	49.6 ± 11.9	17.6 ± 5.6	24.2 ± 6.0	16.0 ± 3.1
AZUS	18	3.9 ± 0.6	1.7 ± 0.9	9.9 ± 2.2	20.4 ± 4.3	12.8 ± 2.4	59.4 ± 15.0	30.1 ± 12.7	35.7 ± 10.7	29.1 ± 6.9
AZUS	21	6.0 ± 2.4	2.8 ± 1.8	12.1 ± 4.0	40.0 ± 4.9	19.2 ± 7.1	88.0 ± 35.0	32.5 ± 11.0	54.3 ± 27.7	52.6 ± 22.8
PICO	0	10.2 ± 3.2	5.5 ± 1.8	25.7 ± 13.3	50.3 ± 14.6	35.9 ± 12.0	93.5 ± 36.1	42.4 ± 15.0	37.7 ± 12.3	42.8 ± 13.8
PICO	3	12.2 ± 5.0	4.5 ± 1.6	47.9 ± 34.7	48.8 ± 26.0	50.8 ± 29.8	100.3 ± 43.5	45.4 ± 17.3	43.0 ± 14.3	42.7 ± 15.0
PICO	6	15.6 ± 4.9	4.7 ± 1.6	30.7 ± 16.3	57.2 ± 16.9	39.2 ± 15.8	110.7 ± 41.0	47.5 ± 16.4	51.9 ± 16.7	48.6 ± 16.5
PICO	9	13.0 ± 3.1	2.6 ± 0.5	21.2 ± 7.8	50.3 ± 10.9	31.8 ± 8.1	104.9 ± 24.8	47.0 ± 9.4	54.9 ± 11.9	39.0 ± 9.0
PICO	12	7.5 ± 1.6	1.6 ± 0.1	8.0 ± 2.1	27.5 ± 7.7	17.0 ± 3.1	59.9 ± 11.5	29.2 ± 5.4	33.1 ± 7.6	19.3 ± 2.7
PICO	15	5.9 ± 1.0	1.3 ± 0.1	4.9 ± 0.8	46.1 ± 31.2	10.7 ± 2.5	36.2 ± 3.4	20.6 ± 2.4	22.4 ± 3.3	17.0 ± 1.4
PICO	18	5.1 ± 1.1	1.6 ± 0.4	4.7 ± 1.1	32.5 ± 17.9	9.0 ± 0.4	32.3 ± 8.0	18.0 ± 2.7	20.4 ± 4.1	18.1 ± 4.8
PICO	21	8.4 ± 1.5	2.4 ± 0.5	10.9 ± 1.8	20.1 ± 3.7	15.9 ± 2.3	56.4 ± 7.5	25.4 ± 3.8	28.1 ± 3.2	28.2 ± 4.2
UPLA	0	8.0 ± 3.7	1.8 ± 0.8	11.7 ± 2.3	22.8 ± 3.3	18.3 ± 3.4	96.9 ± 20.4	28.8 ± 6.1	43.0 ± 7.8	38.9 ± 6.5
UPLA	3	3.7 ± 0.4	0.2 ± 0.2	12.3 ± 0.4	19.5 ± 0.5	15.7 ± 0.5	87.4 ± 5.2	26.5 ± 1.0	40.0 ± 0.8	34.9 ± 0.2
UPLA	6	7.5 ± 1.9	2.3 ± 1.2	11.3 ± 0.6	28.9 ± 2.6	22.0 ± 2.5	116.1 ± 20.2	36.3 ± 6.1	54.5 ± 8.9	49.1 ± 11.4
UPLA	9	3.0 ± 0.6	1.8 ± 1.0	7.8 ± 1.4	23.7 ± 4.1	15.7 ± 2.2	66.6 ± 12.1	20.2 ± 4.9	30.8 ± 5.7	19.7 ± 5.6
UPLA	12	2.2 ± 0.7	0.0 ± 0.0	9.7 ± 0.1	23.7 ± 1.0	16.5 ± 0.6	67.7 ± 7.0	15.9 ± 2.9	26.9 ± 2.3	10.4 ± 1.3
UPLA	15	1.6 ± 0.1	0.0 ± 0.0	7.7 ± 1.4	21.3 ± 4.6	14.7 ± 1.0	50.3 ± 7.8	12.4 ± 1.5	20.8 ± 3.5	8.9 ± 2.1
UPLA	18	3.2 ± 0.2	0.3 ± 0.3	8.5 ± 1.8	18.9 ± 3.7	13.6 ± 4.6	65.7 ± 10.4	18.5 ± 3.2	28.5 ± 4.5	20.9 ± 3.7
UPLA	21	8.8 ± 2.9	3.5 ± 1.8	12.0 ± 3.4	28.6 ± 8.4	24.7 ± 7.8	136.1 ± 43.9	40.3 ± 14.1	62.9 ± 20.3	46.3 ± 16.6
AZUS	3	3	3	3	3	3	3	3	3	3
AZUS	6	3	3	3	3	3	3	3	3	3
AZUS	13	3	3	3	3	3	3	3	3	3
AZUS	17	3	3	3	3	3	3	3	3	3
LANM	3	3	3	3	3	3	3	3	3	3
LANM	6	3	3	3	3	3	3	3	3	3
LANM	13	2	2	2	2	2	2	2	2	2
LANM	17	3	3	3	3	3	3	3	3	3
AZUS	0	2	2	2	2	2	2	2	2	2
AZUS	3	3	3	3	3	3	3	3	3	3
AZUS	6	3	3	3	3	3	3	3	3	3
AZUS	9	3	3	3	3	3	3	3	3	3
AZUS	12	3	3	3	3	3	3	3	3	3
AZUS	15	3	3	3	3	3	3	3	3	3
AZUS	18	3	3	3	3	3	3	3	3	3
AZUS	21	2	2	2	2	2	2	2	2	2
PICO	0	3	3	3	3	3	3	3	3	3
PICO	3	3	3	3	3	3	3	3	3	3
PICO	6	4	4	4	4	4	4	4	4	4
PICO	9	4	4	4	4	4	4	4	4	4
PICO	12	3	3	3	3	3	3	3	3	3
PICO	15	4	4	4	4	4	4	4	4	4
PICO	18	3	3	3	3	3	3	3	3	3
PICO	21	3	3	3	3	3	3	3	3	3
UPLA	0	3	3	3	3	3	3	3	3	3
UPLA	3	3	3	3	3	3	3	3	3	3
UPLA	6	3	3	3	3	3	3	3	3	3
UPLA	9	3	3	3	3	3	3	3	3	3
UPLA	12	2	2	2	2	2	2	2	2	2
UPLA	15	3	3	3	3	3	3	3	3	3
UPLA	18	3	3	3	3	3	3	3	3	3
UPLA	21	3	3	3	3	3	3	3	3	3

Table 4-4b. Modeled lumped species mixing ratios with standard errors for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism with EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	HCHO	CCHO	RCHO	ACET	MEK	BALD	ETHE	ISOP
EMFAC 7G									
AZUS	3	7.0 ± 0.3	7.6 ± 0.2	7.0 ± 0.2	12.6 ± 1.2	6.0 ± 0.6	0.9 ± 0.1	12.4 ± 0.5	0.1 ± 0.0
AZUS	6	7.2 ± 0.3	7.8 ± 0.5	6.7 ± 1.1	10.7 ± 1.2	4.7 ± 0.4	0.9 ± 0.2	12.7 ± 1.6	0.5 ± 0.0
AZUS	13	7.5 ± 0.5	9.8 ± 0.6	9.0 ± 0.5	17.0 ± 2.0	10.7 ± 1.3	0.7 ± 0.0	4.1 ± 0.1	1.5 ± 0.2
AZUS	17	7.2 ± 0.6	8.6 ± 0.5	8.4 ± 0.5	13.5 ± 1.1	8.0 ± 0.7	0.9 ± 0.1	7.0 ± 0.7	3.4 ± 0.7
LANM	3	6.9 ± 0.2	6.5 ± 0.1	4.9 ± 0.4	10.5 ± 0.8	3.8 ± 0.6	0.8 ± 0.0	11.0 ± 0.8	0.0 ± 0.0
LANM	6	9.1 ± 0.0	8.9 ± 0.0	7.9 ± 0.2	16.1 ± 0.1	5.7 ± 0.2	1.4 ± 0.1	19.5 ± 0.4	1.0 ± 0.1
LANM	13	6.2 ± 0.8	7.3 ± 0.5	7.5 ± 0.2	11.7 ± 1.7	7.1 ± 1.0	0.7 ± 0.0	4.8 ± 0.2	2.9 ± 0.2
LANM	17	7.2 ± 0.7	7.7 ± 0.4	8.1 ± 0.2	11.3 ± 1.2	5.7 ± 0.6	1.1 ± 0.1	12.1 ± 0.9	6.4 ± 1.4
AZUS	0							14.0 ± 0.0	0.3 ± 0.0
AZUS	3							12.4 ± 0.5	0.1 ± 0.0
AZUS	6							12.7 ± 1.6	0.5 ± 0.0
AZUS	9							10.8 ± 0.6	1.9 ± 0.4
AZUS	12							5.4 ± 0.2	1.7 ± 0.2
AZUS	15							4.2 ± 0.1	2.0 ± 0.3
AZUS	18							9.4 ± 1.3	2.8 ± 0.7
AZUS	21							13.3 ± 4.2	1.3 ± 1.3
PICO	0	7.1 ± 1.6	7.2 ± 1.3		10.0 ± 6.6			13.3 ± 5.0	0.3 ± 0.3
PICO	3	6.4 ± 0.7	6.4 ± 0.5		8.5 ± 3.0			11.1 ± 1.9	0.1 ± 0.0
PICO	6	7.7 ± 0.6	7.5 ± 0.6		13.1 ± 2.2			13.4 ± 1.4	0.5 ± 0.1
PICO	9	8.1 ± 0.5	10.0 ± 0.7		15.3 ± 2.0			10.4 ± 0.7	2.4 ± 0.4
PICO	12	7.0 ± 0.4	9.0 ± 0.5		14.8 ± 1.4			4.3 ± 0.2	1.9 ± 0.3
PICO	15	5.1 ± 0.4	6.7 ± 0.3		10.9 ± 1.4			3.8 ± 0.1	2.3 ± 0.3
PICO	18	5.1 ± 0.5	6.3 ± 0.3		8.1 ± 0.8			8.2 ± 1.0	2.3 ± 0.6
PICO	21	7.1 ± 1.0	7.0 ± 0.6		12.0 ± 1.6			15.1 ± 2.3	0.9 ± 0.4
UPLA	0							13.3 ± 4.2	0.2 ± 0.0
UPLA	3							15.2 ± 0.1	0.1 ± 0.0
UPLA	6							24.6 ± 0.4	0.9 ± 0.1
UPLA	9							13.6 ± 0.8	2.6 ± 0.4
UPLA	12							4.9 ± 0.5	1.9 ± 0.2
UPLA	15							5.4 ± 0.3	2.6 ± 0.3
UPLA	18							11.4 ± 0.5	2.9 ± 0.4
UPLA	21							17.5 ± 3.0	0.5 ± 0.3
EMFAC 2001									
AZUS	3	7.1 ± 0.4	7.8 ± 0.3	7.2 ± 0.2	12.7 ± 1.2	6.1 ± 0.7	1.0 ± 0.1	12.1 ± 0.5	0.1 ± 0.0
AZUS	6	7.3 ± 0.3	8.0 ± 0.5	7.1 ± 1.1	10.7 ± 1.2	4.9 ± 0.4	1.0 ± 0.2	13.1 ± 1.7	0.5 ± 0.0
AZUS	13	7.9 ± 0.5	11.1 ± 0.8	10.3 ± 0.6	17.9 ± 2.1	11.3 ± 1.4	0.8 ± 0.0	4.5 ± 0.1	1.6 ± 0.2
AZUS	17	7.6 ± 0.7	9.4 ± 0.6	9.4 ± 0.7	14.1 ± 1.3	8.4 ± 0.7	1.0 ± 0.1	7.6 ± 0.8	3.4 ± 0.8
LANM	3	6.9 ± 0.2	6.7 ± 0.1	5.0 ± 0.4	10.4 ± 0.8	3.8 ± 0.6	0.8 ± 0.0	11.2 ± 0.9	0.1 ± 0.0
LANM	6	9.4 ± 0.0	9.4 ± 0.1	8.6 ± 0.3	16.2 ± 0.1	5.8 ± 0.2	1.7 ± 0.1	21.1 ± 0.5	1.0 ± 0.1
LANM	13	6.4 ± 0.8	7.9 ± 0.7	8.1 ± 0.3	12.1 ± 1.8	7.3 ± 1.1	0.8 ± 0.1	5.2 ± 0.2	3.0 ± 0.2
LANM	17	7.5 ± 0.7	8.1 ± 0.5	8.7 ± 0.4	11.5 ± 1.3	5.8 ± 0.7	1.3 ± 0.1	13.2 ± 1.0	6.4 ± 1.4
AZUS	0							14.2 ± 0.0	0.4 ± 0.0
AZUS	3							12.1 ± 0.5	0.1 ± 0.0
AZUS	6							13.1 ± 1.7	0.5 ± 0.0
AZUS	9							11.3 ± 0.8	1.9 ± 0.4
AZUS	12							5.8 ± 0.3	1.7 ± 0.2
AZUS	15							4.6 ± 0.1	2.1 ± 0.3
AZUS	18							10.2 ± 1.6	3.0 ± 0.8
AZUS	21							14.0 ± 5.1	1.6 ± 1.5
PICO	0	7.2 ± 1.7	7.3 ± 1.4		10.0 ± 6.6			13.6 ± 5.5	0.4 ± 0.4
PICO	3	6.4 ± 0.7	6.5 ± 0.5		8.5 ± 3.0			11.2 ± 2.0	0.1 ± 0.1
PICO	6	7.8 ± 0.6	7.9 ± 0.6		13.2 ± 2.3			14.0 ± 1.5	0.6 ± 0.1
PICO	9	8.5 ± 0.5	10.9 ± 0.8		15.9 ± 2.1			11.1 ± 0.7	2.4 ± 0.4
PICO	12	7.3 ± 0.4	9.9 ± 0.7		15.3 ± 1.5			4.7 ± 0.2	2.0 ± 0.3
PICO	15	5.3 ± 0.4	7.2 ± 0.4		11.2 ± 1.5			4.1 ± 0.1	2.4 ± 0.3
PICO	18	5.2 ± 0.5	6.4 ± 0.3		8.1 ± 0.8			8.7 ± 1.2	2.4 ± 0.7
PICO	21	6.4 ± 1.0	6.7 ± 0.4		10.4 ± 0.5			16.0 ± 2.5	1.0 ± 0.4
UPLA	0							12.4 ± 0.0	0.1 ± 0.0
UPLA	3							10.3 ± 0.3	0.1 ± 0.0
UPLA	6							13.5 ± 0.5	0.8 ± 0.1
UPLA	9							8.4 ± 0.9	2.3 ± 0.4
UPLA	12							3.8 ± 0.5	1.8 ± 0.2
UPLA	15							3.9 ± 0.2	2.5 ± 0.3
UPLA	18							9.2 ± 0.5	2.7 ± 0.4
UPLA	21							14.8 ± 2.5	0.6 ± 0.3

Table 4-4b (continued). Modeled lumped species mixing ratios with standard errors for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism with EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	OLE1	OLE2	ALK1	ALK2	ALK3	ALK4	ALK5	ARO1	ARO2
EMFAC 7G										
AZUS	3	5.3 ± 0.1	3.7 ± 0.8	27.5 ± 0.4	43.1 ± 1.2	22.8 ± 0.4	67.8 ± 2.5	44.4 ± 1.9	32.1 ± 0.2	22.7 ± 0.2
AZUS	6	5.5 ± 0.5	4.9 ± 0.4	26.2 ± 1.4	40.9 ± 2.8	21.6 ± 1.5	56.2 ± 10.0	39.9 ± 6.3	32.6 ± 2.8	23.6 ± 2.0
AZUS	13	0.8 ± 0.0	0.6 ± 0.0	22.3 ± 0.7	37.2 ± 1.4	13.1 ± 0.2	28.7 ± 2.3	22.4 ± 1.3	14.5 ± 0.4	4.0 ± 0.1
AZUS	17	2.6 ± 0.3	2.0 ± 0.2	21.9 ± 0.3	36.8 ± 1.8	12.8 ± 0.7	34.3 ± 4.2	32.4 ± 4.3	18.6 ± 1.4	11.2 ± 1.4
LANM	3	5.3 ± 0.9	3.1 ± 0.6	29.4 ± 1.2	45.8 ± 2.0	25.7 ± 2.3	63.1 ± 1.4	43.6 ± 1.6	32.7 ± 2.8	22.2 ± 2.4
LANM	6	9.4 ± 0.3	11.3 ± 0.2	33.8 ± 0.6	60.8 ± 0.4	29.6 ± 1.5	101.5 ± 1.5	80.5 ± 1.6	48.5 ± 1.3	38.3 ± 0.8
LANM	13	1.7 ± 0.1	1.6 ± 0.1	22.4 ± 0.2	36.5 ± 0.6	13.2 ± 0.9	28.5 ± 2.5	28.9 ± 1.1	15.6 ± 0.7	7.6 ± 0.2
LANM	17	5.6 ± 0.5	6.7 ± 0.9	24.4 ± 0.3	45.5 ± 0.6	15.7 ± 0.5	49.8 ± 4.4	53.7 ± 3.2	27.7 ± 1.4	21.7 ± 1.9
AZUS	0	6.2 ± 0.0	6.4 ± 0.0	27.6 ± 0.0	48.5 ± 0.0	22.4 ± 0.0	75.6 ± 0.0	54.6 ± 0.0	34.0 ± 0.0	25.1 ± 0.0
AZUS	3	5.3 ± 0.1	3.7 ± 0.8	27.5 ± 0.4	43.1 ± 1.2	22.8 ± 0.4	67.8 ± 2.5	44.4 ± 1.9	32.1 ± 0.2	22.7 ± 0.2
AZUS	6	5.5 ± 0.5	4.9 ± 0.4	26.2 ± 1.4	40.9 ± 2.8	21.6 ± 1.5	56.2 ± 10.0	39.9 ± 6.3	32.6 ± 2.8	23.6 ± 2.0
AZUS	9	3.3 ± 0.4	2.8 ± 0.3	27.4 ± 0.5	44.6 ± 2.4	19.0 ± 0.3	53.9 ± 4.0	43.1 ± 4.5	29.4 ± 1.7	16.1 ± 1.5
AZUS	12	1.1 ± 0.1		23.9 ± 0.7	41.4 ± 1.9	15.0 ± 0.4	35.8 ± 2.8	28.9 ± 2.2	18.6 ± 0.8	5.6 ± 0.3
AZUS	15	1.2 ± 0.0		21.3 ± 0.4	34.2 ± 0.8	11.5 ± 0.4	26.0 ± 2.5	22.1 ± 0.9	13.3 ± 0.1	5.4 ± 0.2
AZUS	18	3.8 ± 0.7	2.7 ± 0.4	22.6 ± 0.7	39.9 ± 3.3	14.4 ± 0.8	43.5 ± 7.7	41.1 ± 8.1	23.2 ± 2.5	16.1 ± 2.9
AZUS	21	6.1 ± 2.8	5.2 ± 4.7	24.3 ± 2.4	42.9 ± 8.0	19.0 ± 1.1	62.6 ± 29.3	49.2 ± 25.0	32.0 ± 6.9	24.7 ± 9.2
PICO	0	6.9 ± 2.9	5.8 ± 5.6	27.4 ± 5.5	46.3 ± 13.3	24.2 ± 4.4	68.3 ± 43.2	45.3 ± 30.5	36.3 ± 9.6	26.2 ± 8.1
PICO	3	5.6 ± 1.2	3.3 ± 2.3	28.3 ± 3.6	45.5 ± 7.6	26.1 ± 3.4	58.7 ± 20.0	37.4 ± 14.2	34.0 ± 4.7	22.9 ± 2.8
PICO	6	6.2 ± 0.7	5.8 ± 1.2	31.4 ± 2.0	51.8 ± 4.2	26.4 ± 1.7	73.8 ± 11.0	52.4 ± 8.4	37.3 ± 3.0	25.7 ± 2.2
PICO	9	3.5 ± 0.4	2.8 ± 0.4	29.2 ± 1.6	49.0 ± 2.9	20.6 ± 0.6	55.8 ± 7.0	47.9 ± 6.3	30.5 ± 1.8	16.4 ± 1.5
PICO	12	1.0 ± 0.1	0.7 ± 0.0	23.5 ± 0.4	38.1 ± 1.1	14.4 ± 0.4	28.7 ± 2.8	24.9 ± 2.0	16.8 ± 0.7	5.0 ± 0.3
PICO	15	1.3 ± 0.1	1.2 ± 0.1	20.6 ± 0.3	31.1 ± 0.1	11.5 ± 0.6	19.4 ± 1.5	19.4 ± 0.9	13.1 ± 0.5	5.5 ± 0.3
PICO	18	3.7 ± 0.6	3.1 ± 0.8	22.3 ± 0.8	37.4 ± 3.1	15.3 ± 0.8	31.1 ± 4.7	31.7 ± 6.4	21.5 ± 1.9	13.8 ± 1.9
PICO	21	8.1 ± 1.4	9.4 ± 2.1	28.8 ± 1.5	51.7 ± 4.2	22.8 ± 1.7	73.5 ± 13.6	60.0 ± 9.7	36.3 ± 4.3	27.4 ± 4.5
UPLA	0	5.7 ± 1.9	5.6 ± 4.1	57.3 ± 29.5	41.3 ± 8.2	22.0 ± 3.2	58.9 ± 29.6	37.4 ± 19.1	30.9 ± 5.9	21.8 ± 5.5
UPLA	3	5.8 ± 0.5	6.0 ± 0.0	57.7 ± 5.9	44.5 ± 1.4	22.5 ± 1.1	70.5 ± 6.9	45.0 ± 3.3	32.0 ± 1.1	22.1 ± 1.2
UPLA	6	10.4 ± 0.5	13.5 ± 0.4	38.7 ± 0.9	49.1 ± 0.6	22.3 ± 0.7	84.0 ± 2.8	57.9 ± 1.4	44.5 ± 1.5	36.0 ± 1.8
UPLA	9	4.8 ± 0.5	5.4 ± 0.9	28.3 ± 0.3	37.3 ± 1.6	16.6 ± 1.1	50.7 ± 3.2	36.3 ± 2.1	29.0 ± 2.2	18.6 ± 1.8
UPLA	12	1.4 ± 0.0		21.4 ± 1.9	30.0 ± 3.9	12.0 ± 1.5	28.6 ± 2.7	18.2 ± 1.9	14.0 ± 1.7	5.3 ± 0.2
UPLA	15	2.0 ± 0.1		21.2 ± 1.3	30.7 ± 1.2	10.7 ± 0.3	28.4 ± 2.4	19.5 ± 1.1	13.7 ± 0.7	7.3 ± 0.5
UPLA	18	4.9 ± 0.3	3.6 ± 0.0	22.8 ± 0.2	36.3 ± 0.9	13.8 ± 0.4	46.5 ± 5.0	36.1 ± 3.5	23.3 ± 0.5	17.4 ± 1.1
UPLA	21	8.0 ± 1.6	11.0 ± 0.8	37.5 ± 6.5	46.3 ± 4.7	20.1 ± 1.2	75.6 ± 16.9	55.2 ± 12.8	35.7 ± 3.9	28.7 ± 4.9
EMFAC 2001										
AZUS	3	5.7 ± 0.1	4.4 ± 0.9	27.6 ± 0.4	42.7 ± 1.2	24.1 ± 0.5	81.7 ± 3.3	50.2 ± 1.7	34.8 ± 0.2	26.1 ± 0.4
AZUS	6	6.3 ± 0.6	6.2 ± 0.5	26.4 ± 1.4	40.9 ± 2.8	22.8 ± 1.6	71.3 ± 12.1	48.1 ± 7.5	36.9 ± 3.4	29.1 ± 2.8
AZUS	13	1.1 ± 0.0	0.8 ± 0.0	22.5 ± 0.7	37.6 ± 1.4	14.5 ± 0.1	40.3 ± 3.4	26.6 ± 1.6	17.1 ± 0.6	5.4 ± 0.1
AZUS	17	3.3 ± 0.4	2.5 ± 0.2	22.1 ± 0.3	37.2 ± 1.8	14.1 ± 0.7	48.2 ± 7.0	39.3 ± 5.5	22.6 ± 2.0	15.4 ± 2.1
LANM	3	6.0 ± 1.0	4.4 ± 0.6	29.5 ± 1.2	45.9 ± 2.0	27.1 ± 2.3	77.1 ± 1.5	49.1 ± 1.7	35.5 ± 2.9	25.7 ± 2.6
LANM	6	11.7 ± 0.3	15.0 ± 0.3	34.3 ± 0.6	61.2 ± 0.5	32.1 ± 1.4	134.8 ± 3.2	99.0 ± 2.4	58.6 ± 1.2	51.1 ± 1.1
LANM	13	2.2 ± 0.1	2.2 ± 0.1	22.6 ± 0.2	36.9 ± 0.6	14.7 ± 0.7	40.6 ± 4.1	33.1 ± 1.4	18.1 ± 0.6	9.8 ± 0.2
LANM	17	7.0 ± 0.7	8.8 ± 1.1	24.7 ± 0.3	45.9 ± 0.7	17.2 ± 0.5	70.5 ± 6.5	65.9 ± 4.2	34.3 ± 1.9	30.2 ± 2.6
AZUS	0	7.0 ± 0.0	7.6 ± 0.0	27.7 ± 0.0	48.3 ± 0.0	24.0 ± 0.0	93.7 ± 0.0	63.3 ± 0.0	38.4 ± 0.0	30.7 ± 0.0
AZUS	3	5.7 ± 0.1	4.4 ± 0.9	27.6 ± 0.4	42.7 ± 1.2	24.1 ± 0.5	81.7 ± 3.3	50.2 ± 1.7	34.8 ± 0.2	26.1 ± 0.4
AZUS	6	6.3 ± 0.6	6.2 ± 0.5	26.4 ± 1.4	40.9 ± 2.8	22.8 ± 1.6	71.3 ± 12.1	48.1 ± 7.5	36.9 ± 3.4	29.1 ± 2.8
AZUS	9	4.0 ± 0.5	3.5 ± 0.5	27.6 ± 0.5	44.6 ± 2.5	20.3 ± 0.5	70.1 ± 6.3	51.6 ± 5.7	34.1 ± 2.4	20.7 ± 2.2
AZUS	12	1.4 ± 0.1		24.1 ± 0.8	41.7 ± 1.9	16.5 ± 0.5	49.2 ± 4.0	34.1 ± 2.6	21.7 ± 1.0	7.5 ± 0.5
AZUS	15	1.5 ± 0.1		21.5 ± 0.4	34.6 ± 0.9	12.9 ± 0.2	37.4 ± 4.0	26.5 ± 1.2	16.0 ± 0.2	7.5 ± 0.3
AZUS	18	4.8 ± 0.9	3.8 ± 0.5	22.9 ± 0.8	40.2 ± 3.4	15.8 ± 0.9	60.0 ± 12.0	50.0 ± 10.2	28.1 ± 3.7	21.9 ± 4.2
AZUS	21	7.2 ± 3.6	6.7 ± 6.1	24.5 ± 2.5	43.0 ± 8.3	20.6 ± 2.1	81.0 ± 41.5	58.3 ± 30.8	36.9 ± 10.3	30.8 ± 13.3
PICO	0	7.6 ± 3.5	7.2 ± 6.9	27.6 ± 5.6	46.2 ± 13.5	25.6 ± 5.4	82.5 ± 54.1	51.2 ± 35.1	39.3 ± 12.1	30.1 ± 11.2
PICO	3	6.1 ± 1.4	4.5 ± 2.8	28.4 ± 3.6	45.5 ± 7.6	27.2 ± 3.7	69.6 ± 24.1	41.8 ± 15.8	36.2 ± 5.5	25.8 ± 4.0
PICO	6	7.3 ± 0.8	7.6 ± 1.4	31.6 ± 2.0	51.9 ± 4.2	28.1 ± 1.7	93.1 ± 14.0	62.0 ± 10.1	42.4 ± 3.8	32.0 ± 3.2
PICO	9	4.3 ± 0.5	3.7 ± 0.5	29.4 ± 1.6	49.2 ± 2.9	22.0 ± 0.7	73.2 ± 9.2	56.9 ± 7.2	35.4 ± 2.3	21.4 ± 2.0
PICO	12	1.3 ± 0.1	0.9 ± 0.0	23.7 ± 0.4	38.5 ± 1.1	15.7 ± 0.5	38.9 ± 4.0	28.7 ± 2.3	19.1 ± 0.9	6.4 ± 0.4
PICO	15	1.6 ± 0.1	1.6 ± 0.1	20.8 ± 0.3	31.4 ± 0.1	12.4 ± 0.5	26.9 ± 2.3	22.8 ± 1.1	15.1 ± 0.4	7.4 ± 0.4
PICO	18	4.4 ± 0.8	4.2 ± 1.2	22.4 ± 0.8	37.6 ± 3.2	16.1 ± 0.9	41.5 ± 6.9	37.9 ± 7.7	24.9 ± 2.5	18.3 ± 2.9
PICO	21	9.3 ± 1.7	11.5 ± 2.6	29.1 ± 1.6	51.9 ± 4.2	24.3 ± 2.1	91.7 ± 17.6	69.1 ± 11.3	41.2 ± 5.2	33.9 ± 5.6
UPLA	0	5.6 ± 0.0	6.5 ± 0.0	86.5 ± 0.0	46.6 ± 0.0	25.7 ± 0.0	93.3 ± 0.0	57.6 ± 0.0	35.1 ± 0.0	25.7 ± 0.0
UPLA	3	3.9 ± 0.5	4.0 ± 0.0	57.5 ± 5.9	42.1 ± 1.3	23.2 ± 1.2	76.9 ± 8.1	47.0 ± 3.3	31.2 ± 1.2	21.6 ± 1.3
UPLA	6	6.1 ± 0.5	7.4 ± 0.5	37.9 ± 0.9	42.7 ± 0.6	22.0 ± 0.8	78.3 ± 3.5	53.8 ± 1.7	37.4 ± 1.6	29.2 ± 1.7
UPLA	9	2.9 ± 0.5	2.7 ± 0.5	27.9 ± 0.4	33.9 ± 1.8	16.5 ± 1.3	49.3 ± 5.0	34.3 ± 3.0	25.5 ± 2.7	14.6 ± 2.0
UPLA	12	1.0 ± 0.0		21.4 ± 1.9	29.4 ± 3.9	12.7 ± 1.6	33.0 ± 3.6	18.9 ± 2.4	14.3 ± 2.0	4.5 ± 0.3
UPLA	15	1.4 ± 0.1		21.2 ± 1.3	30.1 ± 1.1	11.6 ± 0.2	32.7 ± 2.8	20.2 ± 1.1	13.6 ± 0.6	6.3 ± 0.4
UPLA	18	4.1 ± 0.3	2.3 ± 0.0	22.7 ± 0.1	34.9 ± 0.9	14.6 ± 0.2	52.4 ± 7.0	38.4 ± 4.2	23.5 ± 0.8	17.4 ± 1.3
UPLA	21	7.2 ± 1.5	8.7 ± 0.4	37.4 ± 6.5	44.4 ± 4.3	21.1 ± 1.4	84.8 ± 20.3	59.2 ± 14.1	36.3 ± 4.3	29.7 ± 5.4

Table 4-4c. Modeled/measured ratios with standard errors for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism with EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	HCHO	CCHO	RCHO	ACET	MEK	BALD	ETHE	ISOP
EMFAC 7G									
AZUS	3	9.07 ± 8.06	2.06 ± 1.06	0.31 ± 0.05	2.44 ± 1.90	2.23 ± 1.53	0.96 ± 0.27	0.82 ± 0.15	0.56 ± 0.29
AZUS	6	0.64 ± 0.09	0.67 ± 0.08	0.19 ± 0.05	0.24 ± 0.07	0.34 ± 0.21	0.37 ± 0.11	0.52 ± 0.13	0.58 ± 0.00
AZUS	13	0.86 ± 0.08	0.71 ± 0.14	0.17 ± 0.02	0.67 ± 0.23	2.16 ± 0.54	0.35 ± 0.02	0.45 ± 0.11	0.74 ± 0.40
AZUS	17	1.40 ± 0.14	1.28 ± 0.18	0.30 ± 0.03	1.19 ± 0.47	3.31 ± 1.79	1.20 ± 0.03	1.01 ± 0.10	0.88 ± 0.11
LANM	3	0.94 ± 0.17	0.95 ± 0.12	0.23 ± 0.01	0.58 ± 0.11	1.31 ± 0.18	0.63 ± 0.07	0.91 ± 0.15	0.13 ± 0.06
LANM	6	0.78 ± 0.08	0.82 ± 0.11	0.26 ± 0.07	0.65 ± 0.21	1.47 ± 0.52	0.73 ± 0.19	0.57 ± 0.04	3.85 ± 0.00
LANM	13	0.94 ± 0.00	0.79 ± 0.00	0.22 ± 0.00	0.53 ± 0.00	1.82 ± 0.00	0.77 ± 0.00	0.63 ± 0.08	2.05 ± 0.65
LANM	17	1.16 ± 0.20	1.16 ± 0.02	0.32 ± 0.01	0.85 ± 0.06	2.61 ± 0.14	1.60 ± 0.15	1.14 ± 0.18	3.68 ± 0.53
AZUS	0							0.68 ± 0.00	0.12 ± 0.00
AZUS	3							0.78 ± 0.18	0.10 ± 0.02
AZUS	6							0.48 ± 0.12	0.25 ± 0.04
AZUS	9							0.68 ± 0.08	0.62 ± 0.11
AZUS	12							0.50 ± 0.13	0.56 ± 0.08
AZUS	15							0.69 ± 0.12	0.65 ± 0.07
AZUS	18							1.01 ± 0.07	0.98 ± 0.16
AZUS	21							0.98 ± 0.06	0.63 ± 0.62
PICO	0	2.84 ± 0.63	1.98 ± 0.84		1.54 ± 1.23			2.62 ± 1.11	0.39 ± 0.39
PICO	3	2.44 ± 0.82	1.63 ± 0.54		0.82 ± 0.17			1.42 ± 0.50	0.03 ± 0.02
PICO	6	2.01 ± 0.67	1.48 ± 0.45		0.97 ± 0.25			1.21 ± 0.31	0.19 ± 0.03
PICO	9	1.25 ± 0.27	1.22 ± 0.28		0.74 ± 0.13			1.28 ± 0.44	0.59 ± 0.05
PICO	12	1.09 ± 0.27	1.08 ± 0.25		0.79 ± 0.19			1.14 ± 0.33	0.54 ± 0.06
PICO	15	1.62 ± 0.40	1.56 ± 0.35		1.14 ± 0.25			1.22 ± 0.19	0.71 ± 0.06
PICO	18	2.69 ± 0.65	2.18 ± 0.56		1.53 ± 0.49			1.99 ± 0.40	2.15 ± 0.55
PICO	21	4.00 ± 0.39	3.02 ± 0.36		2.17 ± 0.03			2.14 ± 0.36	1.45 ± 0.57
UPLA	0							1.21 ± 0.13	0.25 ± 0.00
UPLA	3							1.57 ± 0.11	0.16 ± 0.00
UPLA	6							1.46 ± 0.31	0.14 ± 0.05
UPLA	9							1.61 ± 0.32	0.40 ± 0.07
UPLA	12							0.62 ± 0.02	0.25 ± 0.02
UPLA	15							1.01 ± 0.22	0.35 ± 0.05
UPLA	18							1.29 ± 0.07	0.47 ± 0.06
UPLA	21							1.09 ± 0.28	0.23 ± 0.14
EMFAC 2001									
AZUS	3	9.04 ± 8.02	2.10 ± 1.07	0.32 ± 0.05	2.44 ± 1.90	2.27 ± 1.55	1.00 ± 0.28	0.80 ± 0.15	0.63 ± 0.33
AZUS	6	0.65 ± 0.09	0.69 ± 0.08	0.20 ± 0.06	0.24 ± 0.07	0.35 ± 0.21	0.42 ± 0.12	0.53 ± 0.14	0.59 ± 0.00
AZUS	13	0.91 ± 0.09	0.80 ± 0.16	0.20 ± 0.02	0.71 ± 0.24	2.28 ± 0.57	0.42 ± 0.03	0.50 ± 0.13	0.78 ± 0.42
AZUS	17	1.47 ± 0.15	1.40 ± 0.20	0.33 ± 0.03	1.23 ± 0.48	3.44 ± 1.85	1.42 ± 0.06	1.09 ± 0.09	0.90 ± 0.11
LANM	3	0.95 ± 0.18	0.97 ± 0.12	0.24 ± 0.01	0.58 ± 0.12	1.31 ± 0.18	0.67 ± 0.08	0.93 ± 0.15	0.19 ± 0.09
LANM	6	0.81 ± 0.09	0.87 ± 0.13	0.28 ± 0.08	0.65 ± 0.21	1.51 ± 0.54	0.85 ± 0.23	0.62 ± 0.05	3.99 ± 0.00
LANM	13	0.96 ± 0.00	0.83 ± 0.00	0.24 ± 0.00	0.55 ± 0.00	1.87 ± 0.00	0.87 ± 0.00	0.68 ± 0.07	2.12 ± 0.68
LANM	17	1.21 ± 0.21	1.22 ± 0.01	0.34 ± 0.02	0.86 ± 0.05	2.67 ± 0.13	1.84 ± 0.16	1.25 ± 0.19	3.73 ± 0.54
AZUS	0							0.69 ± 0.00	0.15 ± 0.00
AZUS	3							0.76 ± 0.18	0.11 ± 0.02
AZUS	6							0.49 ± 0.13	0.25 ± 0.04
AZUS	9							0.71 ± 0.10	0.63 ± 0.12
AZUS	12							0.55 ± 0.15	0.59 ± 0.08
AZUS	15							0.76 ± 0.13	0.67 ± 0.07
AZUS	18							1.09 ± 0.05	1.05 ± 0.18
AZUS	21							1.01 ± 0.01	0.74 ± 0.73
PICO	0	2.86 ± 0.66	2.02 ± 0.87		1.54 ± 1.23			2.68 ± 1.20	0.45 ± 0.44
PICO	3	2.44 ± 0.81	1.64 ± 0.55		0.82 ± 0.17			1.42 ± 0.48	0.05 ± 0.02
PICO	6	2.03 ± 0.68	1.53 ± 0.46		0.97 ± 0.25			1.26 ± 0.33	0.20 ± 0.03
PICO	9	1.30 ± 0.28	1.32 ± 0.30		0.76 ± 0.14			1.36 ± 0.48	0.61 ± 0.05
PICO	12	1.14 ± 0.28	1.19 ± 0.27		0.82 ± 0.20			1.23 ± 0.37	0.56 ± 0.06
PICO	15	1.68 ± 0.40	1.66 ± 0.36		1.17 ± 0.25			1.33 ± 0.21	0.73 ± 0.06
PICO	18	2.77 ± 0.68	2.25 ± 0.58		1.54 ± 0.50			2.12 ± 0.45	2.26 ± 0.59
PICO	21	4.11 ± 0.41	3.10 ± 0.36		2.17 ± 0.03			2.26 ± 0.36	1.60 ± 0.62
UPLA	0							0.95 ± 0.00	0.16 ± 0.00
UPLA	3							1.06 ± 0.09	0.10 ± 0.00
UPLA	6							0.81 ± 0.18	0.12 ± 0.04
UPLA	9							1.01 ± 0.26	0.35 ± 0.08
UPLA	12							0.48 ± 0.03	0.23 ± 0.02
UPLA	15							0.74 ± 0.15	0.34 ± 0.05
UPLA	18							1.04 ± 0.04	0.44 ± 0.06
UPLA	21							0.92 ± 0.23	0.25 ± 0.17

Table 4-4c (continued). Modeled/measured ratios with standard errors for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism with EMFAC7G and EMFAC2001 mobile emissions.

Site	Start (PDT)	OLE1	OLE2	ALK1	ALK2	ALK3	ALK4	ALK5	ARO1	ARO2
EMFAC 7G										
AZUS	3	0.53 ± 0.10	0.27 ± 0.04	1.12 ± 0.03	0.78 ± 0.06	0.66 ± 0.06	0.47 ± 0.06	0.74 ± 0.12	0.56 ± 0.11	0.39 ± 0.07
AZUS	6	0.37 ± 0.09	0.23 ± 0.06	1.06 ± 0.11	0.47 ± 0.06	0.55 ± 0.09	0.30 ± 0.10	0.52 ± 0.19	0.39 ± 0.10	0.31 ± 0.09
AZUS	13	0.22 ± 0.05	0.15 ± 0.04	1.99 ± 0.60	1.09 ± 0.26	0.64 ± 0.12	0.26 ± 0.05	0.70 ± 0.17	0.41 ± 0.11	0.15 ± 0.02
AZUS	17	0.65 ± 0.05	0.45 ± 0.10	3.19 ± 0.76	1.81 ± 0.23	1.18 ± 0.21	0.65 ± 0.07	1.24 ± 0.14	0.73 ± 0.12	0.42 ± 0.02
LANM	3	0.66 ± 0.09	0.40 ± 0.04	1.86 ± 0.43	1.26 ± 0.15	1.28 ± 0.16	0.79 ± 0.09	1.32 ± 0.12	0.97 ± 0.14	0.65 ± 0.13
LANM	6	0.45 ± 0.02	0.47 ± 0.05	0.96 ± 0.16	0.65 ± 0.10	0.70 ± 0.01	0.53 ± 0.07	1.10 ± 0.15	0.57 ± 0.06	0.48 ± 0.05
LANM	13	0.27 ± 0.05	0.30 ± 0.02	1.74 ± 0.30	0.92 ± 0.16	0.35 ± 0.01	0.27 ± 0.07	0.86 ± 0.12	0.42 ± 0.02	0.26 ± 0.00
LANM	17	0.73 ± 0.08	0.76 ± 0.15	2.57 ± 0.51	2.07 ± 0.29	0.97 ± 0.22	0.59 ± 0.08	1.77 ± 0.23	0.85 ± 0.13	0.70 ± 0.09
AZUS	0	0.65 ± 0.00	0.99 ± 0.00	1.17 ± 0.00	0.93 ± 0.00	0.62 ± 0.00	0.46 ± 0.00	0.86 ± 0.00	0.43 ± 0.00	0.36 ± 0.00
AZUS	3	0.68 ± 0.14	0.86 ± 0.14	1.09 ± 0.08	0.82 ± 0.09	0.68 ± 0.09	0.49 ± 0.08	0.87 ± 0.18	0.50 ± 0.12	0.39 ± 0.09
AZUS	6	0.43 ± 0.09	0.39 ± 0.09	1.00 ± 0.13	0.47 ± 0.06	0.51 ± 0.07	0.29 ± 0.09	0.57 ± 0.22	0.34 ± 0.10	0.29 ± 0.08
AZUS	9	0.59 ± 0.05	0.71 ± 0.09	1.57 ± 0.08	0.84 ± 0.08	0.66 ± 0.02	0.48 ± 0.05	1.13 ± 0.10	0.56 ± 0.04	0.44 ± 0.02
AZUS	12	0.36 ± 0.08		1.53 ± 0.34	1.09 ± 0.16	0.57 ± 0.04	0.42 ± 0.11	1.11 ± 0.26	0.45 ± 0.10	0.25 ± 0.05
AZUS	15	0.56 ± 0.03		2.92 ± 0.63	2.12 ± 0.31	0.97 ± 0.16	0.57 ± 0.12	1.47 ± 0.33	0.61 ± 0.13	0.36 ± 0.07
AZUS	18	0.97 ± 0.07	1.05 ± 0.00	2.57 ± 0.62	2.11 ± 0.36	1.22 ± 0.23	0.78 ± 0.11	1.75 ± 0.46	0.77 ± 0.20	0.58 ± 0.06
AZUS	21	0.99 ± 0.07	1.30 ± 0.86	2.18 ± 0.52	1.07 ± 0.07	1.12 ± 0.36	0.69 ± 0.06	1.42 ± 0.29	0.71 ± 0.23	0.48 ± 0.03
PICO	0	1.04 ± 0.53	1.45 ± 1.39	2.65 ± 1.37	1.44 ± 1.00	1.06 ± 0.34	1.24 ± 0.82	1.80 ± 1.32	1.48 ± 0.52	0.91 ± 0.30
PICO	3	0.58 ± 0.17	0.58 ± 0.24	1.73 ± 0.97	1.34 ± 0.38	0.91 ± 0.37	0.66 ± 0.10	0.85 ± 0.07	0.97 ± 0.29	0.67 ± 0.21
PICO	6	0.48 ± 0.10	1.62 ± 0.55	2.07 ± 0.76	1.04 ± 0.16	0.96 ± 0.26	0.91 ± 0.29	1.39 ± 0.38	0.92 ± 0.23	0.70 ± 0.18
PICO	9	0.32 ± 0.07	1.16 ± 0.21	2.18 ± 0.75	1.12 ± 0.24	0.78 ± 0.18	0.61 ± 0.13	1.12 ± 0.22	0.63 ± 0.12	0.48 ± 0.10
PICO	12	0.16 ± 0.04	0.46 ± 0.04	3.65 ± 1.31	1.75 ± 0.65	0.92 ± 0.18	0.56 ± 0.17	0.98 ± 0.26	0.60 ± 0.18	0.28 ± 0.05
PICO	15	0.24 ± 0.04	0.97 ± 0.08	4.75 ± 1.00	1.80 ± 0.67	1.23 ± 0.22	0.56 ± 0.09	0.98 ± 0.11	0.61 ± 0.06	0.33 ± 0.02
PICO	18	0.75 ± 0.12	2.16 ± 0.65	5.17 ± 0.96	1.90 ± 0.69	1.71 ± 0.06	1.04 ± 0.21	1.76 ± 0.25	1.10 ± 0.11	0.84 ± 0.18
PICO	21	0.99 ± 0.13	4.14 ± 0.89	2.72 ± 0.26	2.74 ± 0.49	1.51 ± 0.27	1.31 ± 0.18	2.40 ± 0.34	1.30 ± 0.13	0.99 ± 0.13
UPLA	0	0.73 ± 0.24	7.47 ± 6.42	4.78 ± 0.97	1.86 ± 0.10	1.29 ± 0.25	0.60 ± 0.10	1.32 ± 0.23	0.80 ± 0.11	0.62 ± 0.01
UPLA	3	1.62 ± 0.27	8.60 ± 0.00	4.72 ± 0.52	2.28 ± 0.06	1.43 ± 0.05	0.80 ± 0.04	1.70 ± 0.10	0.80 ± 0.01	0.63 ± 0.03
UPLA	6	1.55 ± 0.32	4.02 ± 0.91	3.47 ± 0.29	1.73 ± 0.16	1.04 ± 0.13	0.78 ± 0.15	1.69 ± 0.30	0.86 ± 0.14	0.81 ± 0.17
UPLA	9	1.78 ± 0.42	2.22 ± 0.92	3.84 ± 0.58	1.70 ± 0.36	1.10 ± 0.18	0.82 ± 0.17	2.08 ± 0.58	1.03 ± 0.25	1.15 ± 0.38
UPLA	12	0.72 ± 0.22		2.20 ± 0.18	1.28 ± 0.22	0.74 ± 0.12	0.43 ± 0.08	1.20 ± 0.34	0.53 ± 0.11	0.52 ± 0.08
UPLA	15	1.25 ± 0.18		3.08 ± 0.89	1.64 ± 0.47	0.74 ± 0.06	0.60 ± 0.14	1.64 ± 0.27	0.71 ± 0.18	0.94 ± 0.27
UPLA	18	1.53 ± 0.02	3.64 ± 0.00	3.02 ± 0.80	2.09 ± 0.42	1.51 ± 0.73	0.72 ± 0.06	2.01 ± 0.19	0.86 ± 0.14	0.88 ± 0.13
UPLA	21	1.08 ± 0.27	2.09 ± 0.01	3.46 ± 0.60	1.96 ± 0.58	1.10 ± 0.44	0.63 ± 0.12	1.65 ± 0.40	0.73 ± 0.26	0.75 ± 0.18
EMFAC 2001										
AZUS	3	0.58 ± 0.11	0.32 ± 0.04	1.12 ± 0.03	0.77 ± 0.06	0.70 ± 0.06	0.57 ± 0.07	0.84 ± 0.14	0.60 ± 0.12	0.45 ± 0.08
AZUS	6	0.42 ± 0.11	0.29 ± 0.08	1.07 ± 0.11	0.47 ± 0.06	0.58 ± 0.09	0.37 ± 0.12	0.63 ± 0.23	0.45 ± 0.12	0.39 ± 0.11
AZUS	13	0.29 ± 0.07	0.19 ± 0.05	2.01 ± 0.61	1.10 ± 0.26	0.71 ± 0.13	0.36 ± 0.08	0.84 ± 0.21	0.48 ± 0.13	0.20 ± 0.03
AZUS	17	0.81 ± 0.07	0.58 ± 0.13	3.22 ± 0.77	1.83 ± 0.23	1.29 ± 0.22	0.90 ± 0.08	1.50 ± 0.16	0.88 ± 0.13	0.57 ± 0.02
LANM	3	0.75 ± 0.09	0.56 ± 0.04	1.86 ± 0.43	1.26 ± 0.15	1.35 ± 0.16	0.97 ± 0.11	1.49 ± 0.14	1.05 ± 0.15	0.76 ± 0.14
LANM	6	0.55 ± 0.03	0.62 ± 0.08	0.97 ± 0.17	0.66 ± 0.10	0.76 ± 0.01	0.70 ± 0.09	1.36 ± 0.19	0.69 ± 0.08	0.64 ± 0.07
LANM	13	0.34 ± 0.07	0.40 ± 0.03	1.75 ± 0.31	0.93 ± 0.16	0.39 ± 0.02	0.38 ± 0.10	0.98 ± 0.15	0.49 ± 0.04	0.34 ± 0.01
LANM	17	0.92 ± 0.10	0.99 ± 0.20	2.60 ± 0.51	2.09 ± 0.29	1.06 ± 0.22	0.83 ± 0.11	2.17 ± 0.27	1.05 ± 0.15	0.97 ± 0.13
AZUS	0	0.74 ± 0.00	1.18 ± 0.00	1.18 ± 0.00	0.92 ± 0.00	0.67 ± 0.00	0.57 ± 0.00	1.00 ± 0.00	0.49 ± 0.00	0.44 ± 0.00
AZUS	3	0.73 ± 0.16	1.04 ± 0.19	1.09 ± 0.08	0.81 ± 0.09	0.72 ± 0.09	0.58 ± 0.10	0.99 ± 0.21	0.55 ± 0.13	0.45 ± 0.11
AZUS	6	0.50 ± 0.11	0.50 ± 0.12	1.01 ± 0.13	0.47 ± 0.06	0.54 ± 0.08	0.37 ± 0.11	0.69 ± 0.26	0.39 ± 0.11	0.36 ± 0.10
AZUS	9	0.71 ± 0.08	0.88 ± 0.12	1.58 ± 0.08	0.84 ± 0.08	0.70 ± 0.03	0.62 ± 0.08	1.35 ± 0.13	0.65 ± 0.05	0.57 ± 0.03
AZUS	12	0.46 ± 0.10		1.54 ± 0.34	1.10 ± 0.16	0.63 ± 0.05	0.57 ± 0.15	1.31 ± 0.31	0.53 ± 0.12	0.34 ± 0.07
AZUS	15	0.72 ± 0.04		2.94 ± 0.64	2.15 ± 0.31	1.08 ± 0.18	0.82 ± 0.16	1.76 ± 0.39	0.74 ± 0.15	0.50 ± 0.09
AZUS	18	1.20 ± 0.11	1.49 ± 0.00	2.59 ± 0.62	2.13 ± 0.36	1.33 ± 0.23	1.06 ± 0.13	2.11 ± 0.54	0.91 ± 0.21	0.78 ± 0.07
AZUS	21	1.14 ± 0.15	1.70 ± 1.10	2.19 ± 0.51	1.07 ± 0.08	1.20 ± 0.33	0.87 ± 0.12	1.67 ± 0.39	0.79 ± 0.21	0.59 ± 0.00
PICO	0	1.16 ± 0.63	1.81 ± 1.71	2.66 ± 1.39	1.44 ± 1.00	1.12 ± 0.39	1.49 ± 1.03	2.04 ± 1.52	1.61 ± 0.63	1.04 ± 0.41
PICO	3	0.63 ± 0.17	0.80 ± 0.27	1.74 ± 0.97	1.34 ± 0.38	0.94 ± 0.38	0.78 ± 0.12	0.95 ± 0.07	1.02 ± 0.29	0.74 ± 0.20
PICO	6	0.57 ± 0.12	2.18 ± 0.75	2.08 ± 0.76	1.05 ± 0.16	1.03 ± 0.29	1.16 ± 0.38	1.65 ± 0.46	1.05 ± 0.27	0.87 ± 0.23
PICO	9	0.39 ± 0.09	1.52 ± 0.28	2.20 ± 0.76	1.13 ± 0.24	0.84 ± 0.19	0.80 ± 0.18	1.33 ± 0.26	0.73 ± 0.14	0.63 ± 0.13
PICO	12	0.20 ± 0.06	0.62 ± 0.06	3.68 ± 1.33	1.77 ± 0.66	1.02 ± 0.22	0.76 ± 0.23	1.13 ± 0.31	0.69 ± 0.22	0.36 ± 0.06
PICO	15	0.30 ± 0.05	1.29 ± 0.11	4.78 ± 1.01	1.82 ± 0.68	1.33 ± 0.25	0.78 ± 0.13	1.15 ± 0.13	0.71 ± 0.08	0.44 ± 0.03
PICO	18	0.90 ± 0.15	2.90 ± 0.90	5.21 ± 0.97	1.91 ± 0.69	1.79 ± 0.06	1.38 ± 0.29	2.10 ± 0.31	1.27 ± 0.11	1.11 ± 0.25
PICO	21	1.14 ± 0.14	5.07 ± 1.09	2.74 ± 0.26	2.75 ± 0.49	1.60 ± 0.29	1.63 ± 0.22	2.76 ± 0.38	1.48 ± 0.15	1.22 ± 0.16
UPLA	0	0.36 ± 0.00	9.23 ± 0.00	5.73 ± 0.00	1.66 ± 0.00	1.07 ± 0.00	0.74 ± 0.00	1.58 ± 0.00	0.66 ± 0.00	0.57 ± 0.00
UPLA	3	1.11 ± 0.23	5.66 ± 0.00	4.70 ± 0.52	2.15 ± 0.05	1.47 ± 0.05	0.88 ± 0.04	1.77 ± 0.09	0.78 ± 0.02	0.62 ± 0.03
UPLA	6	0.91 ± 0.19	2.23 ± 0.59	3.40 ± 0.29	1.50 ± 0.14	1.03 ± 0.13	0.73 ± 0.15	1.58 ± 0.30	0.73 ± 0.12	0.66 ± 0.15
UPLA	9	1.11 ± 0.33	1.10 ± 0.47	3.78 ± 0.57	1.55 ± 0.35	1.10 ± 0.19	0.81 ± 0.20	1.99 ± 0.62	0.92 ± 0.25	0.94 ± 0.36
UPLA	12	0.51 ± 0.16		2.20 ± 0.18	1.25 ± 0.22	0.78 ± 0.12	0.50 ± 0.11	1.26 ± 0.38	0.54 ± 0.12	0.44 ± 0.08
UPLA	15	0.90 ± 0.13		3.07 ± 0.89	1.60 ± 0.46	0.80 ± 0.07	0.69 ± 0.15	1.69 ± 0.26	0.71 ± 0.17	0.81 ± 0.22
UPLA	18	1.29 ± 0.02	2.32 ± 0.00	3.00 ± 0.80	2.01 ± 0.41	1.58 ± 0.75	0.81 ± 0.05	2.13 ± 0.17	0.87 ± 0.13	0.87 ± 0.11
UPLA	21	0.97 ± 0.22	1.66 ± 0.03	3.45 ± 0.60	1.88 ± 0.57	1.14 ± 0.45	0.70 ± 0.11	1.75 ± 0.41	0.74 ± 0.25	0.77 ± 0.18

Table 4-5a. Mean and standard errors of ambient lumped species mixing ratios by time period and corresponding modeled values for CAMx simulations of the August 3-7, 1997 SCOS episode using CB4 chemical mechanism and EMFAC7G and EMFAC2001 mobile emissions.

Start (PDT)	OLE	PAR	TOL	XYL	FORM	ALD2	ETH	ISOP
Measured Ambient Values and Ratios								
0, 3	6.4 ± 0.7	260.6 ± 25.1	42.6 ± 4.1	45.3 ± 3.8	4.7 ± 0.9	13.0 ± 2.1	13.1 ± 1.1	0.7 ± 0.1
6	11.4 ± 1.4	398.9 ± 46.9	65.4 ± 7.4	65.6 ± 6.7	8.2 ± 1.7	21.8 ± 5.0	23.7 ± 2.4	2.7 ± 0.9
9	4.7 ± 0.9	221.7 ± 31.1	40.0 ± 4.9	30.9 ± 4.4	8.0 ± 2.4	11.5 ± 3.2	12.2 ± 1.8	4.5 ± 0.5
12, 13, 15	2.7 ± 0.3	168.9 ± 17.5	25.3 ± 2.1	17.8 ± 1.5	6.5 ± 0.9	18.0 ± 4.5	6.9 ± 0.7	4.1 ± 0.4
17, 18	3.9 ± 0.6	144.9 ± 14.9	24.9 ± 2.7	24.3 ± 2.5	4.4 ± 0.8	13.9 ± 3.1	8.3 ± 0.9	3.1 ± 0.5
21	5.1 ± 0.8	185.0 ± 33.1	39.5 ± 9.0	39.2 ± 7.7	1.1 ± 0.6	2.7 ± 0.6	13.4 ± 2.9	1.6 ± 0.4
Number of Observations								
0, 3	23	23	23	23	11	11	23	23
6	16	16	16	16	9	9	16	16
9	10	10	10	10	4	4	10	10
12, 13, 15	23	23	23	23	11	11	23	23
17, 18	15	15	15	15	8	8	15	15
21	8	8	8	8	3	3	8	8
Modeled EMFAC 7G								
0, 3	9.8 ± 0.8	248.9 ± 14.9	39.6 ± 1.7	35.6 ± 2.0	8.9 ± 0.3	15.7 ± 1.0	14.9 ± 1.0	1.1 ± 0.5
6	11.9 ± 1.1	279.8 ± 18.9	46.2 ± 2.4	42.9 ± 2.8	10.0 ± 0.6	17.7 ± 1.5	18.7 ± 1.6	1.3 ± 0.3
9	6.3 ± 0.3	221.7 ± 9.7	36.4 ± 0.9	24.6 ± 0.9	10.3 ± 0.7	16.6 ± 1.5	13.1 ± 0.6	2.5 ± 0.2
12, 13, 15	1.9 ± 0.1	139.8 ± 4.9	19.1 ± 0.5	8.1 ± 0.3	7.8 ± 0.4	10.3 ± 0.7	5.3 ± 0.2	2.4 ± 0.1
17, 18	5.9 ± 0.5	169.4 ± 9.2	27.6 ± 1.2	20.7 ± 1.5	7.2 ± 0.5	10.1 ± 0.7	10.2 ± 0.6	4.2 ± 0.6
21	10.6 ± 1.3	249.7 ± 28.2	40.3 ± 2.9	35.5 ± 4.0	7.6 ± 1.1	12.0 ± 1.5	16.1 ± 1.7	1.2 ± 0.4
Modeled EMFAC 2001								
0, 3	9.5 ± 0.9	276.9 ± 17.4	45.5 ± 2.4	39.8 ± 2.6	8.7 ± 0.4	16.1 ± 1.3	14.0 ± 1.0	1.1 ± 0.5
6	11.5 ± 1.1	317.0 ± 23.8	55.9 ± 3.6	50.0 ± 3.7	10.1 ± 0.6	19.2 ± 1.6	17.4 ± 1.4	1.5 ± 0.3
9	5.7 ± 0.4	249.4 ± 16.0	43.0 ± 2.2	27.8 ± 1.8	10.9 ± 0.8	18.5 ± 1.7	12.0 ± 0.7	2.4 ± 0.2
12, 13, 15	2.0 ± 0.1	164.2 ± 6.2	23.1 ± 0.7	9.9 ± 0.4	8.1 ± 0.5	11.7 ± 0.8	5.4 ± 0.2	2.4 ± 0.1
17, 18	6.2 ± 0.5	201.1 ± 12.3	35.4 ± 1.9	26.8 ± 2.2	7.7 ± 0.5	11.9 ± 0.9	10.5 ± 0.7	4.3 ± 0.6
21	10.6 ± 1.4	281.6 ± 34.0	47.8 ± 4.1	41.2 ± 4.9	7.7 ± 1.1	13.0 ± 1.6	15.7 ± 1.6	1.3 ± 0.5
Modeled EMFAC 7G/Measured								
0, 3	2.08 ± 0.31	1.16 ± 0.12	1.19 ± 0.13	0.94 ± 0.09	5.06 ± 2.70	1.63 ± 0.34	1.44 ± 0.18	1.89 ± 0.92
6	1.50 ± 0.34	0.92 ± 0.14	0.91 ± 0.13	0.82 ± 0.12	1.51 ± 0.40	1.16 ± 0.33	0.99 ± 0.16	1.52 ± 0.95
9	1.92 ± 0.45	1.16 ± 0.15	1.04 ± 0.14	1.00 ± 0.20	1.59 ± 0.35	1.75 ± 0.36	1.34 ± 0.22	0.60 ± 0.05
12, 13, 15	0.97 ± 0.17	0.95 ± 0.10	0.84 ± 0.07	0.55 ± 0.08	1.52 ± 0.19	1.03 ± 0.19	0.94 ± 0.10	0.82 ± 0.13
17, 18	1.82 ± 0.22	1.28 ± 0.09	1.25 ± 0.10	0.93 ± 0.08	2.13 ± 0.41	1.25 ± 0.36	1.37 ± 0.13	1.91 ± 0.37
21	2.21 ± 0.21	1.51 ± 0.19	1.34 ± 0.22	1.05 ± 0.14	4.87 ± 0.54	3.66 ± 0.40	1.50 ± 0.26	0.98 ± 0.34
Modeled EMFAC 2001/Measured								
0, 3	1.93 ± 0.26	1.28 ± 0.13	1.36 ± 0.15	1.05 ± 0.11	5.06 ± 2.69	1.74 ± 0.37	1.35 ± 0.18	1.94 ± 0.93
6	1.31 ± 0.21	1.02 ± 0.15	1.08 ± 0.15	0.93 ± 0.13	1.54 ± 0.40	3.52 ± 2.28	0.90 ± 0.13	1.54 ± 1.00
9	1.55 ± 0.24	1.27 ± 0.14	1.20 ± 0.13	1.06 ± 0.16	1.67 ± 0.37	1.94 ± 0.39	1.21 ± 0.22	0.58 ± 0.06
12, 13, 15	0.91 ± 0.12	1.10 ± 0.12	1.01 ± 0.08	0.63 ± 0.06	1.58 ± 0.19	1.15 ± 0.21	0.96 ± 0.11	0.85 ± 0.14
17, 18	1.85 ± 0.17	1.50 ± 0.10	1.57 ± 0.11	1.18 ± 0.09	2.20 ± 0.42	1.40 ± 0.40	1.42 ± 0.15	1.96 ± 0.38
21	2.20 ± 0.19	1.70 ± 0.22	1.57 ± 0.26	1.21 ± 0.17	4.97 ± 0.56	3.98 ± 0.42	1.50 ± 0.29	1.07 ± 0.38

Table 4-5b. Mean and standard errors of ambient lumped species mixing ratios by time period and corresponding modeled values for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism and EMFAC7G and EMFAC2001 mobile emissions.

Start (PDT)	HCHO	CCHO	RCHO	ACET	MEK	BALD	ETHE	ISOP
Measured Ambient Values and Ratios								
0, 3	4.7 ± 0.9	5.9 ± 0.9	22.7 ± 2.0	15.3 ± 2.9	6.9 ± 4.1	1.2 ± 0.2	13.1 ± 1.1	0.7 ± 0.1
6	9.3 ± 1.5	9.7 ± 1.3	35.5 ± 3.9	32.1 ± 7.2	18.4 ± 9.7	2.4 ± 0.2	23.7 ± 2.4	2.7 ± 0.9
9	8.0 ± 2.4	10.3 ± 3.0		24.9 ± 7.6			12.2 ± 1.8	4.5 ± 0.5
12, 13, 15	6.5 ± 0.9	9.3 ± 1.5	47.9 ± 6.3	20.1 ± 3.3	4.8 ± 0.7	1.7 ± 0.3	6.9 ± 0.7	4.1 ± 0.4
17, 18	4.4 ± 0.8	5.6 ± 0.8	27.7 ± 2.4	11.3 ± 2.2	3.4 ± 1.0	0.7 ± 0.1	8.3 ± 0.9	3.1 ± 0.5
21	1.6 ± 0.4	2.2 ± 0.4		4.8 ± 0.3			13.4 ± 2.9	1.6 ± 0.4
Number of Observations								
0, 3	11	11	5	11	5	5	23	23
6	8	8	5	8	5	5	16	16
9	4	4	0	4	0	0	10	10
12, 13, 15	11	11	4	11	4	4	23	23
17, 18	8	8	5	8	5	5	15	15
21	2	2	0	2	0	0	8	8
Modeled EMFAC 7G								
0, 3	7.3 ± 0.3	7.5 ± 0.3	6.3 ± 0.4	12.2 ± 0.9	5.5 ± 0.4	0.9 ± 0.0	12.3 ± 0.6	0.1 ± 0.0
6	8.5 ± 0.4	8.4 ± 0.4	7.1 ± 0.4	13.2 ± 0.8	5.6 ± 0.3	1.1 ± 0.1	16.2 ± 1.1	0.6 ± 0.1
9	8.1 ± 0.3	9.9 ± 0.3	9.4 ± 0.4	13.7 ± 0.8	7.4 ± 0.4	1.1 ± 0.0	11.2 ± 0.6	2.1 ± 0.2
12, 13, 15	6.8 ± 0.2	8.7 ± 0.3	8.0 ± 0.2	14.9 ± 0.6	9.2 ± 0.4	0.7 ± 0.0	4.5 ± 0.1	2.0 ± 0.1
17, 18	6.7 ± 0.3	7.9 ± 0.3	8.2 ± 0.3	12.0 ± 0.6	6.7 ± 0.4	0.9 ± 0.0	9.4 ± 0.5	3.4 ± 0.4
21	7.5 ± 0.6	7.9 ± 0.5	8.0 ± 0.7	12.3 ± 1.4	6.0 ± 0.6	1.1 ± 0.1	14.6 ± 1.2	0.7 ± 0.2
Modeled EMFAC 2001								
0, 3	7.0 ± 0.2	7.3 ± 0.2	6.4 ± 0.4	12.0 ± 0.9	5.6 ± 0.4	0.9 ± 0.1	11.4 ± 0.5	0.1 ± 0.0
6	7.9 ± 0.2	8.2 ± 0.2	7.3 ± 0.4	12.8 ± 0.7	5.6 ± 0.3	1.1 ± 0.1	14.6 ± 0.8	0.6 ± 0.1
9	8.0 ± 0.3	10.3 ± 0.4	10.2 ± 0.5	14.0 ± 0.9	7.8 ± 0.5	1.2 ± 0.1	10.0 ± 0.5	2.0 ± 0.2
12, 13, 15	7.0 ± 0.2	9.5 ± 0.3	9.0 ± 0.3	15.5 ± 0.6	9.7 ± 0.4	0.8 ± 0.0	4.5 ± 0.1	2.0 ± 0.1
17, 18	6.8 ± 0.3	8.3 ± 0.3	8.8 ± 0.3	12.2 ± 0.6	6.9 ± 0.4	1.0 ± 0.0	9.7 ± 0.6	3.5 ± 0.5
21	7.4 ± 0.6	8.0 ± 0.5	8.3 ± 0.7	12.2 ± 1.4	6.1 ± 0.7	1.1 ± 0.1	14.3 ± 1.2	0.8 ± 0.3
Modeled EMFAC 7G/Measured								
0, 3	3.83 ± 2.17	1.54 ± 0.36	0.28 ± 0.03	1.27 ± 0.54	1.86 ± 0.87	0.83 ± 0.17	1.13 ± 0.17	0.21 ± 0.07
6	1.19 ± 0.33	1.01 ± 0.21	0.22 ± 0.04	0.61 ± 0.15	0.79 ± 0.34	0.52 ± 0.12	0.87 ± 0.14	0.53 ± 0.30
9	1.25 ± 0.27	1.22 ± 0.28		0.74 ± 0.13			1.20 ± 0.22	0.55 ± 0.05
12, 13, 15	1.25 ± 0.16	1.16 ± 0.16	0.18 ± 0.01	0.88 ± 0.12	2.10 ± 0.30	0.50 ± 0.10	0.81 ± 0.08	0.73 ± 0.11
17, 18	1.82 ± 0.34	1.59 ± 0.26	0.30 ± 0.02	1.23 ± 0.25	3.03 ± 1.00	1.36 ± 0.11	1.29 ± 0.13	1.63 ± 0.34
21	4.00 ± 0.39	3.02 ± 0.36		2.17 ± 0.03			1.46 ± 0.25	0.79 ± 0.30
Modeled EMFAC 2001/Measured								
0, 3	3.82 ± 2.16	1.56 ± 0.37	0.28 ± 0.03	1.27 ± 0.54	1.88 ± 0.88	0.87 ± 0.18	1.09 ± 0.17	0.25 ± 0.09
6	1.21 ± 0.33	1.05 ± 0.21	0.23 ± 0.04	0.62 ± 0.15	0.81 ± 0.35	0.59 ± 0.14	0.77 ± 0.11	0.54 ± 0.32
9	1.30 ± 0.28	1.32 ± 0.30		0.76 ± 0.14			1.06 ± 0.21	0.54 ± 0.06
12, 13, 15	1.30 ± 0.16	1.26 ± 0.17	0.21 ± 0.01	0.92 ± 0.12	2.20 ± 0.33	0.58 ± 0.10	0.82 ± 0.09	0.75 ± 0.12
17, 18	1.89 ± 0.35	1.67 ± 0.26	0.33 ± 0.02	1.26 ± 0.25	3.13 ± 1.03	1.59 ± 0.12	1.32 ± 0.14	1.68 ± 0.35
21	4.11 ± 0.41	3.10 ± 0.36		2.17 ± 0.03			1.45 ± 0.28	0.88 ± 0.34

Table 4-5b (continued). Mean and standard errors of ambient lumped species mixing ratios by time period and corresponding modeled values for CAMx simulations of the August 3-7, 1997 SCOS episode using SAPRC99 chemical mechanism and EMFAC7G and EMFAC2001 mobile emissions.

Start (PDT)	OLE1	OLE2	ALK1	ALK2	ALK3	ALK4	ALK5	ARO1	ARO2
Measured Ambient Values and Ratios									
0, 3	9.3 ± 1.1	5.6 ± 0.9	23.7 ± 4.7	42.6 ± 4.6	30.5 ± 4.3	112.9 ± 10.0	43.8 ± 4.2	50.2 ± 4.5	47.9 ± 4.1
6	14.7 ± 1.6	13.1 ± 2.5	26.6 ± 4.4	71.3 ± 8.1	37.4 ± 4.2	164.5 ± 16.7	64.6 ± 7.5	76.3 ± 7.9	69.1 ± 7.1
9	7.8 ± 1.9	2.8 ± 0.4	16.1 ± 3.4	43.4 ± 6.1	26.1 ± 3.8	96.0 ± 11.7	36.3 ± 5.2	47.1 ± 5.9	32.5 ± 4.6
12, 13, 15	4.2 ± 0.5	1.5 ± 0.4	9.8 ± 1.0	32.1 ± 5.5	18.5 ± 1.8	69.5 ± 6.8	23.7 ± 2.1	30.5 ± 2.5	18.8 ± 1.6
17, 18	4.9 ± 0.6	3.7 ± 1.1	8.3 ± 0.9	23.2 ± 3.5	12.9 ± 1.3	60.3 ± 6.9	25.2 ± 3.1	29.3 ± 3.0	25.6 ± 2.6
21	8.0 ± 1.2	2.9 ± 0.7	11.6 ± 1.5	28.2 ± 4.3	20.0 ± 3.3	94.2 ± 20.7	32.8 ± 5.8	47.7 ± 10.4	41.1 ± 8.1
Number of Observations									
0, 3	23	23	23	23	23	23	23	23	23
6	16	16	16	16	16	16	16	16	16
9	10	10	10	10	10	10	10	10	10
12, 13, 15	23	23	23	23	23	23	23	23	23
17, 18	15	15	15	15	15	15	15	15	15
21	8	8	8	8	8	8	8	8	8
Modeled EMFAC 7G									
0, 3	5.5 ± 0.3	4.2 ± 0.6	34.2 ± 2.9	43.7 ± 1.4	23.3 ± 0.6	63.4 ± 4.2	41.8 ± 3.0	32.3 ± 1.0	22.5 ± 0.8
6	7.2 ± 0.5	7.7 ± 0.8	31.2 ± 1.2	48.4 ± 1.8	24.4 ± 0.8	72.0 ± 4.5	52.3 ± 3.7	38.6 ± 1.5	28.8 ± 1.5
9	3.7 ± 0.3	3.5 ± 0.4	27.9 ± 0.7	42.8 ± 1.9	18.4 ± 0.6	50.5 ± 3.3	40.3 ± 3.2	28.6 ± 1.1	16.1 ± 1.0
12, 13, 15	1.3 ± 0.1	1.2 ± 0.1	22.2 ± 0.3	34.9 ± 0.7	12.6 ± 0.3	27.3 ± 1.0	22.4 ± 0.8	14.7 ± 0.4	5.5 ± 0.2
17, 18	4.1 ± 0.3	3.7 ± 0.4	22.7 ± 0.3	38.9 ± 1.1	14.0 ± 0.4	40.1 ± 2.4	38.8 ± 2.5	22.3 ± 0.9	15.9 ± 1.0
21	7.0 ± 0.7	6.9 ± 1.2	29.5 ± 2.2	45.8 ± 2.3	20.2 ± 0.7	66.1 ± 7.2	51.9 ± 5.9	33.3 ± 1.9	25.7 ± 2.1
Modeled EMFAC 2001									
0, 3	5.6 ± 0.4	4.5 ± 0.6	34.2 ± 2.9	43.1 ± 1.4	24.5 ± 0.7	74.7 ± 5.2	46.3 ± 3.4	34.2 ± 1.2	25.0 ± 1.1
6	7.3 ± 0.5	8.2 ± 0.7	31.2 ± 1.1	47.2 ± 1.9	25.6 ± 1.0	86.8 ± 6.1	59.9 ± 4.6	41.7 ± 2.0	33.2 ± 2.0
9	3.6 ± 0.3	3.3 ± 0.3	28.0 ± 0.7	41.9 ± 2.3	19.2 ± 0.8	60.8 ± 5.2	45.3 ± 4.3	30.6 ± 1.8	18.0 ± 1.4
12, 13, 15	1.4 ± 0.1	1.3 ± 0.1	22.3 ± 0.3	35.1 ± 0.7	13.7 ± 0.3	36.3 ± 1.4	25.7 ± 1.0	16.6 ± 0.5	6.7 ± 0.3
17, 18	4.7 ± 0.4	4.3 ± 0.6	22.8 ± 0.3	38.9 ± 1.1	15.2 ± 0.4	53.4 ± 3.4	46.2 ± 3.2	26.2 ± 1.3	20.6 ± 1.5
21	7.5 ± 0.8	7.4 ± 1.4	29.6 ± 2.1	45.3 ± 2.4	21.4 ± 0.9	80.2 ± 9.4	58.9 ± 6.9	36.6 ± 2.4	30.2 ± 2.8
Modeled EMFAC 7G/Measured									
0, 3	0.75 ± 0.11	1.69 ± 0.77	2.16 ± 0.38	1.22 ± 0.16	0.92 ± 0.10	0.63 ± 0.09	1.07 ± 0.14	0.74 ± 0.10	0.53 ± 0.06
6	0.65 ± 0.13	1.19 ± 0.37	1.73 ± 0.30	0.88 ± 0.13	0.77 ± 0.08	0.58 ± 0.10	1.08 ± 0.16	0.64 ± 0.09	0.53 ± 0.07
9	0.84 ± 0.24	1.24 ± 0.26	2.50 ± 0.44	1.21 ± 0.17	0.84 ± 0.10	0.63 ± 0.08	1.41 ± 0.23	0.73 ± 0.10	0.67 ± 0.15
12, 13, 15	0.43 ± 0.08	0.53 ± 0.10	2.73 ± 0.33	1.40 ± 0.17	0.79 ± 0.07	0.47 ± 0.04	1.08 ± 0.09	0.54 ± 0.04	0.37 ± 0.06
17, 18	0.92 ± 0.09	1.32 ± 0.32	3.30 ± 0.38	2.00 ± 0.16	1.32 ± 0.16	0.76 ± 0.06	1.71 ± 0.12	0.86 ± 0.06	0.68 ± 0.06
21	1.02 ± 0.10	2.74 ± 0.64	2.86 ± 0.31	2.03 ± 0.35	1.26 ± 0.20	0.90 ± 0.14	1.87 ± 0.24	0.94 ± 0.15	0.77 ± 0.10
Modeled EMFAC 2001/Measured									
0, 3	0.74 ± 0.09	1.49 ± 0.53	2.27 ± 0.38	1.26 ± 0.15	1.00 ± 0.10	0.77 ± 0.10	1.23 ± 0.16	0.82 ± 0.10	0.61 ± 0.07
6	0.59 ± 0.06	1.16 ± 0.30	1.73 ± 0.30	0.84 ± 0.11	0.80 ± 0.09	0.70 ± 0.12	1.21 ± 0.17	0.68 ± 0.09	0.60 ± 0.08
9	0.70 ± 0.14	1.21 ± 0.18	2.49 ± 0.43	1.17 ± 0.16	0.87 ± 0.10	0.75 ± 0.09	1.53 ± 0.21	0.76 ± 0.09	0.70 ± 0.12
12, 13, 15	0.43 ± 0.05	0.70 ± 0.13	2.75 ± 0.34	1.40 ± 0.17	0.86 ± 0.08	0.62 ± 0.06	1.23 ± 0.10	0.61 ± 0.05	0.42 ± 0.04
17, 18	1.02 ± 0.06	1.56 ± 0.34	3.32 ± 0.38	1.99 ± 0.16	1.41 ± 0.16	1.00 ± 0.08	2.00 ± 0.14	1.00 ± 0.07	0.86 ± 0.07
21	1.07 ± 0.10	3.13 ± 0.83	2.87 ± 0.30	2.00 ± 0.35	1.33 ± 0.20	1.09 ± 0.18	2.11 ± 0.27	1.03 ± 0.17	0.89 ± 0.13

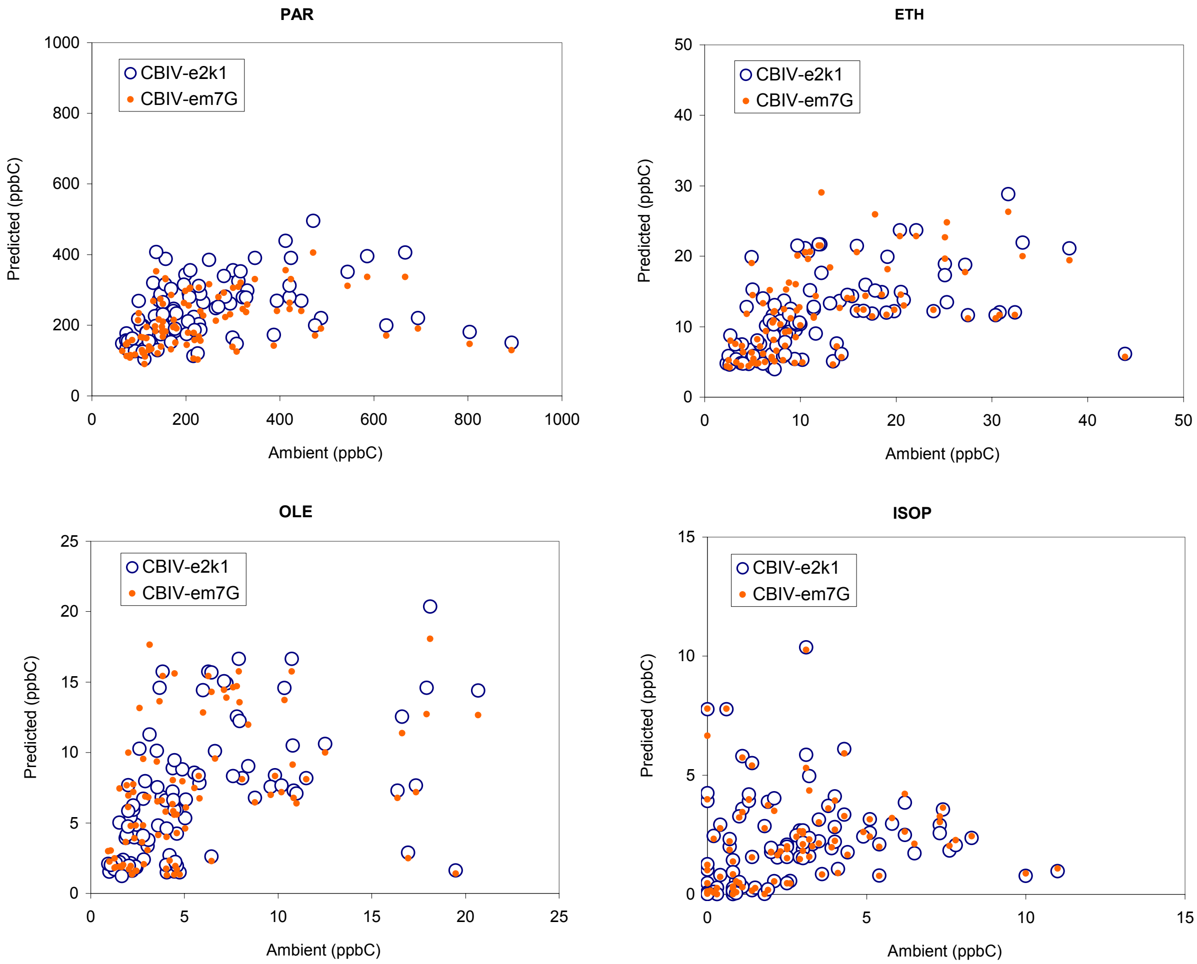


Figure 4-1a. Scatterplots of modeled versus ambient mixing ratios of CB4 lumped species, PAR, ETH, OLE and ISOP for CAMx simulations of the August 3-7, 1997 SCOS episode with EMFAC7G and EMFAC2001 based mobile emissions.

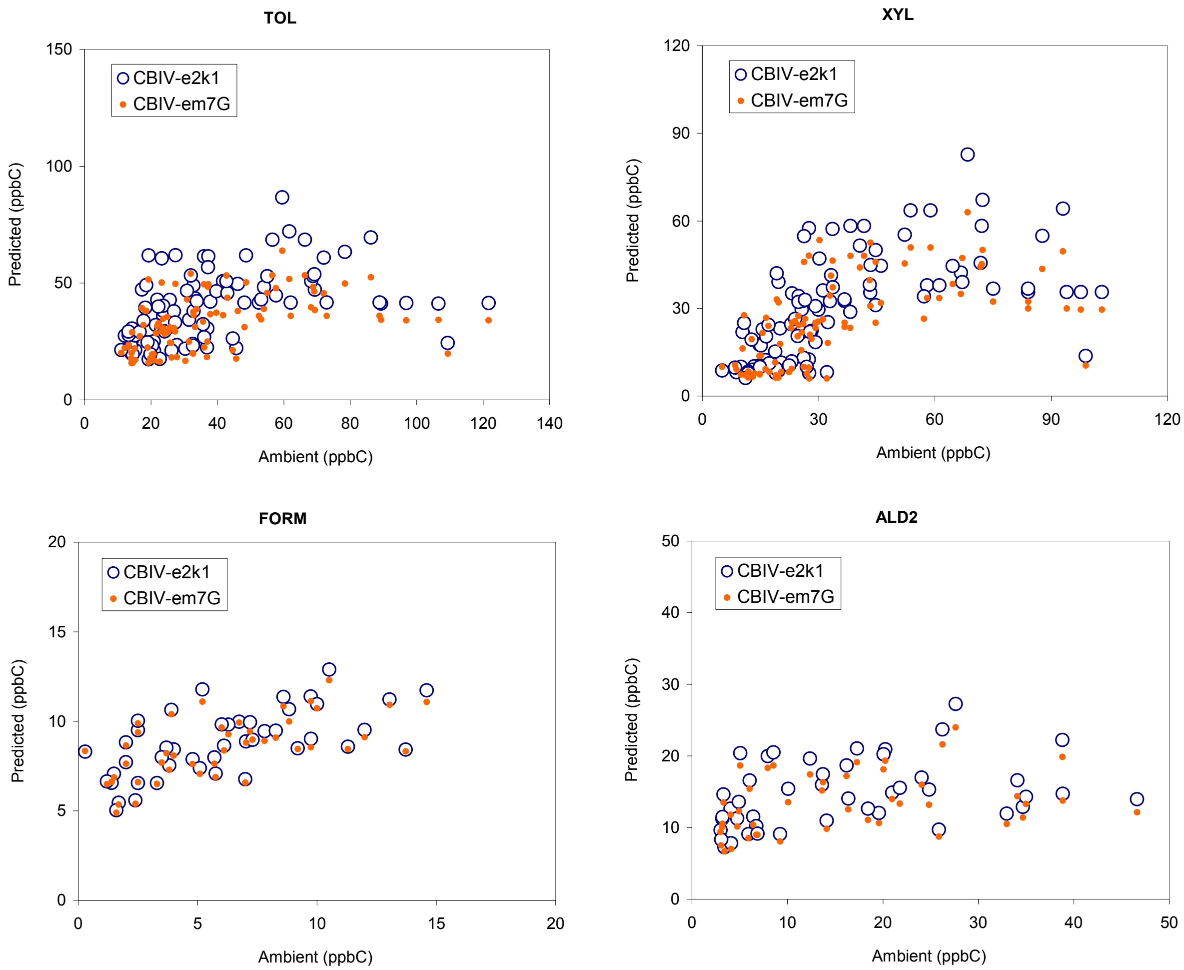


Figure 4-1b. Scatterplots of modeled versus ambient mixing ratios of CB4 lumped species, TOL, XYL, FORM, and ALD2 for CAMx simulations of the August 3-7, 1997 SCOS episode with EMFAC7G and EMFAC2001 based mobile emissions.

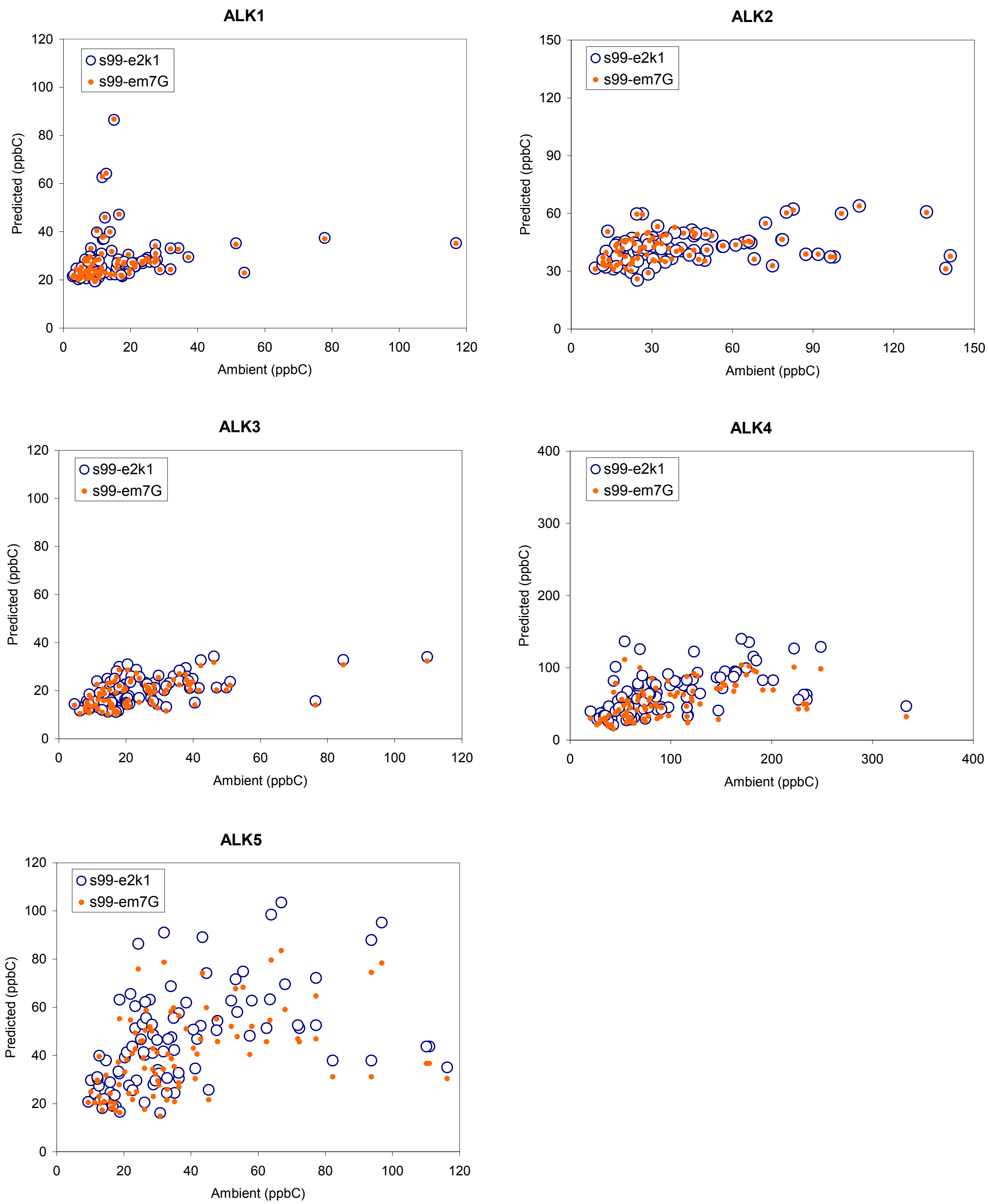


Figure 4-2a. Scatterplots of modeled versus ambient mixing ratios of SAPRC99 lumped species, ALK1, ALK2, ALK3, ALK4 and ALK5 for CAMx simulations of the August 3-7, 1997 SCOS episode with EMFAC7G and EMFAC2001 based mobile emissions.

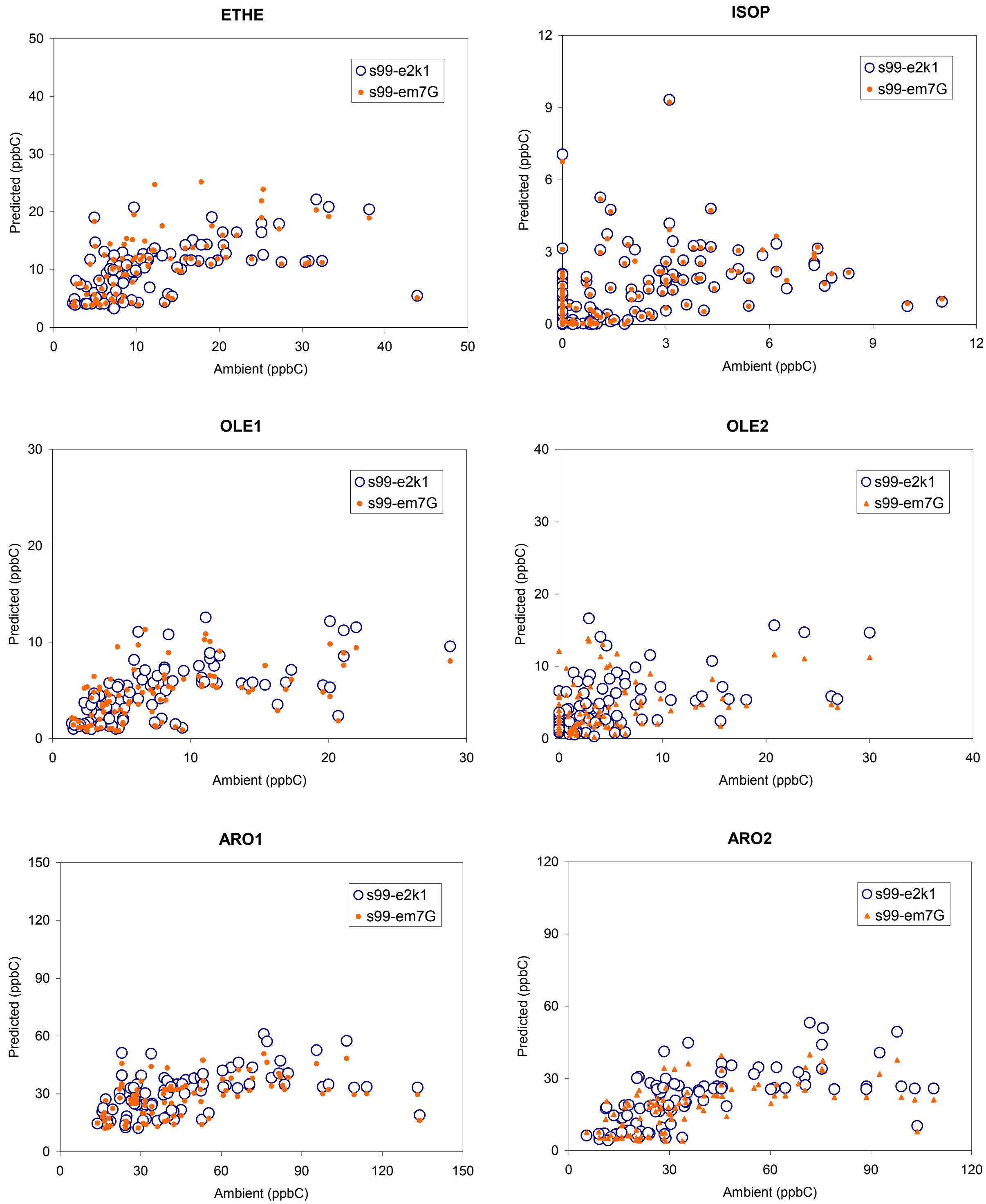


Figure 4-2b. Scatterplots of modeled versus ambient mixing ratios of SAPRC99 lumped species, ETHE, ISOP, OLE1, OLE2, ARO1 and ARO2 for CAMx simulations of the August 3-7, 1997 SCOS episode with EMFAC7G and EMFAC2001 based mobile emissions.

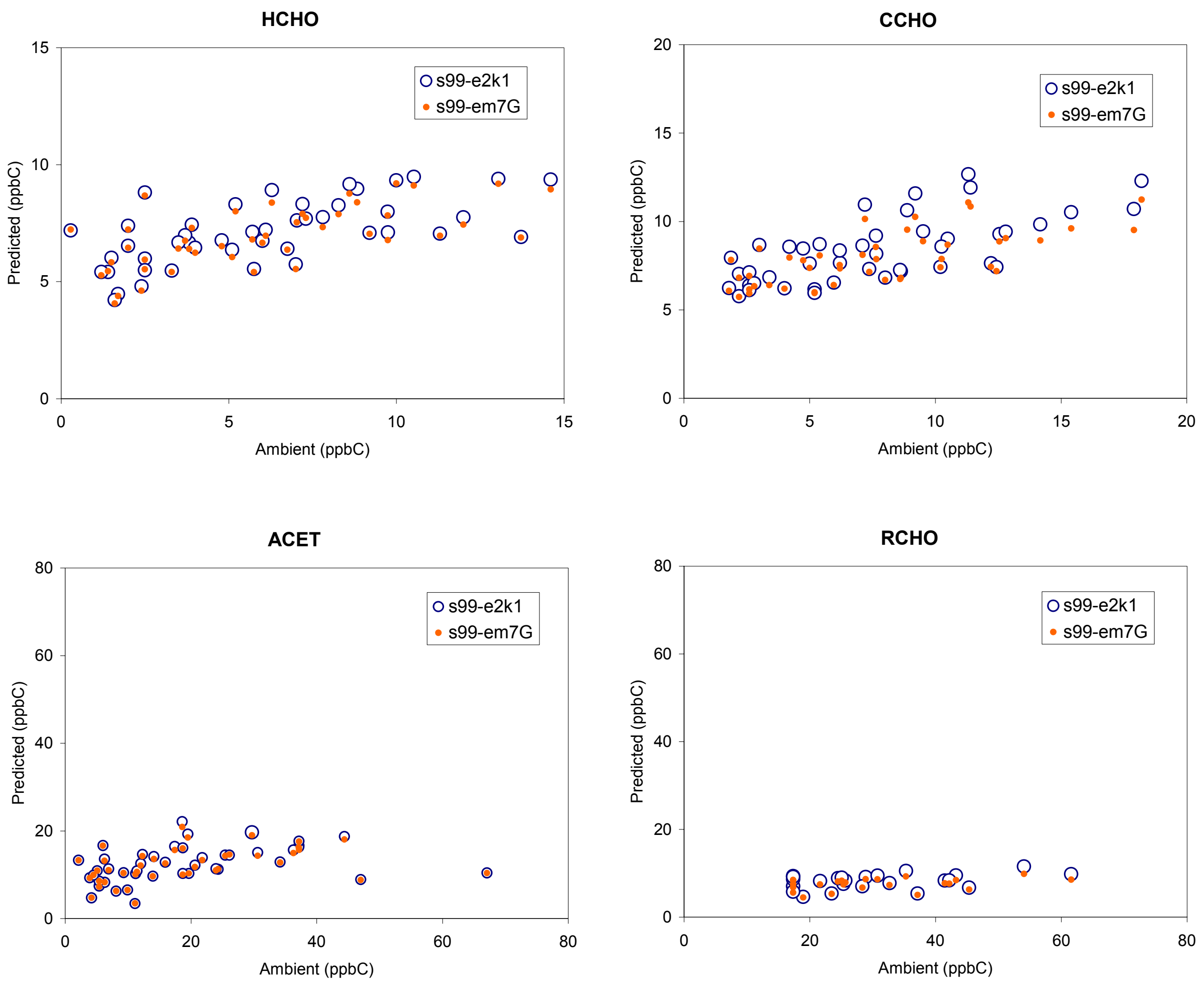


Figure 4-2c. Scatterplots of modeled versus ambient mixing ratios of SAPRC99 lumped species, HCHO, CCHO, ACET and RCHO for CAMx simulations of the August 3-7, 1997 SCOS episode with EMFAC7G and EMFAC2001 based mobile emissions.

5.0 CONCLUSIONS

Emission Inventory Changes

The 1997 typical summer day emission inventories for four different versions of EMFAC were compared in section 2 for five counties in the Southern California Association of Governments (SCAG), namely Los Angeles, Orange, Ventura, Riverside and San Bernardino. These emissions are summarized in Table 5-1. For VOC and CO, EMFAC2000 had the highest emissions and EMFAC7G the lowest emissions. NOx showed the same pattern for Los Angeles County, but a different pattern over the five SCAG Counties where EMFAC2001 and EMFAC2002 were lower than EMFAC7G. The difference in trend across models for NOx from VOC/CO was traced to changes in vehicle activity data for Riverside and San Bernardino Counties. As shown in Table 2-2, VMT was substantially reduced between EMFAC7G and EMFAC2000 for Riverside and San Bernardino Counties, especially for heavy-duty vehicles in San Bernardino County. This explains why NOx emissions barely increased from EMFAC7G to EMFAC2000 for the SCAG County total (2% increase), whereas they increased by 48% for Los Angeles County. The VOC/NOx molar ratio for the on-road vehicle inventory increased from about 2 in EMFAC7G to about 3 in EMFAC2000/EMFAC2001, and then declined slightly in EMFAC2002 (to about 2.8).

Table 5-1. Typical summer day emission inventories for 1997 from different versions of EMFAC.

	EMFAC7G	EMFAC 2000	EMFAC 2001	EMFAC 2002
Five SCAG Counties				
VOC (tons/day)	546	810	679	645
NOx (tons/day)	880	896	742	747
CO (tons/day)	4625	7513	6180	5842
VOC/NOx (ratio)	2.04	2.97	3.01	2.84
Changes from EMFAC7G				
VOC		48%	24%	18%
NOx		2%	-16%	-15%
CO		62%	34%	26%
Los Angeles County				
VOC (tons/day)	253	486	389	363
NOx (tons/day)	361	535	427	429
CO (tons/day)	2115	4554	3568	3330
VOC/NOx (ratio)	2.30	2.98	2.99	2.78
Changes from EMFAC7G				
VOC		92%	54%	44%
NOx		48%	18%	19%
CO		115%	69%	57%

Notes:
The Five SCAG Counties are Los Angeles, Orange, Ventura, Riverside and San Bernardino.
VOC/NOx ratio calculated assuming molecular weights of 14g for VOC and 46g for NOx.

Modeled and Ambient VOC/NOx Ratios

Precursor concentrations and VOC/NOx ratios from CAMx ozone modeling of the August 1997 SCOS episode were evaluated against ambient data in Section 3. The mean observed ambient VOC/NOx ratio and standard error for 1997 was 3.9 ± 0.4 and the corresponding mean predicted ratio with EMFAC2001 was 3.7 ± 0.2 for CAMx/CB4 and 3.2 ± 0.2 for CAMx/SAPRC99. The EMFAC2001 VOC mixing ratios are about 20 percent higher relative to EMFAC7G. Because the EMFAC2001 NOx mixing ratios are also higher (by about 10 to 15 percent), the EMFAC2001 VOC/NOx ratios are, on average, only about 7 percent higher than the corresponding ratios predicted by EMFAC7G. This either improves or degrades comparison with ambient data depending upon whether the CB4 or SAPRC99 chemical mechanism is used. Overall, there is little difference in VOC/NOx ratio between EMFAC2001 and EMFAC7G and both agree well with the ambient data. This finding results from the opposing changes in NOx emissions from EMFAC7G to EMFAC2001 in Los Angeles County (NOx increase) vs. San Bernardino County (NOx decrease), combined with the fact that three of the four VOC/NOx ratio sites are in Los Angeles County and one is in San Bernardino County.

The good agreement for modeled and ambient VOC/NOx ratios in 1997 contrasts with the 1987 SCAQS "top down" inventory evaluation (using EMFAC7E), which indicated that VOC emissions were underestimated by a factor of two to three relative to NOx (Fujita et al., 1992). When modeled and ambient VOC/NOx ratios were compared here (in section 2) for the August 1987 SCAQS episode, good agreement was found between the ambient ratio (8.2 ± 0.8) and the modeled ratios, with better agreement using EMFAC2001 emissions (7.9 ± 1.4) than EMFAC7G emissions (6.8 ± 1.4). The 1987 SCAQS modeling used the UAM with CB4 chemistry. The most significant change between the ambient/inventory reconciliation for the 1987 SCAQS and SCOS97 is that the ambient ratio has dropped by about a factor of 2 between 1987 and 1997, from about 8 to about 4, due to greater reductions in VOC emissions relative to NOx. Good ambient/inventory agreement was found for VOC/NOx ratios in both 1987 and 1997 when a recent emission factor model (EMFAC2001) was used.

The observed and modeled VOC/NOx ratio data for 1987 and 1997 are summarized in Table 5-2.

Table 5-2. Comparison of observed and modeled morning VOC/NOx ratios for 1987 and 1997 with different versions of EMFAC.

	1987	**1997**
Observed VOC/NOx ratio	8.2 [1]	3.9 [1]
Modeled VOC/NOx ratios with EMFAC7G		
On-road mobile emissions	3.4 [2]	1.9 [3]
Total anthropogenic emissions	4.0 [2]	2.7 [4]
Modeled ambient	6.8 [5]	4.0 [6]
Modeled VOC/NOx ratios with EMFAC2001		
On-road mobile emissions	5.2 [2]	3.0 [3]
Total anthropogenic emissions	5.0 [2]	3.6 [7]
Modeled ambient	7.9 [5]	3.7 [6]
Modeled VOC/NOx ratios with EMFAC2002		
On-road mobile emissions	3.4 [2]	3.6 [3]

	1987	1997
Total anthropogenic emissions	3.7 [2]	3.9 [4]
Modeled ambient	N/A [8]	N/A [9]

1. From Table 3-5.
2. From Table 2-9.
3. From Table 2-4.
4. From Tables 2-3 and 2-4.
5. From Table 2-11.
6. From Table 3-2b.
7. From Table 2-3.
8. Not available from the draft 2003 AQMP.
9. Not available because EMFAC2002 was not included in the Chapter 3 analyses.

The main points shown in Table 5-2 are as follows:

- The observed VOC/NOx ratio declined substantially from 1987 to 1997.
- The VOC/NOx ratio for on-road vehicle emissions declined substantially from 1987 to 1997 with EMFAC7G and EMFAC2001, but rose slightly with EMFAC2002. This apparent difference between EMFAC2002 and the other models should be investigated further to determine whether it is real or related to the different data sources used to assemble the comparison.
- The VOC/NOx ratio for total anthropogenic emissions showed similar trends to the on-road vehicle emissions. This result is expected because the non-EMFAC emissions were constant for 1997 and almost constant for 1987.
- For EMFAC7G in 1997, the modeled ambient and emissions ratios appear inconsistent because of marked differences in on-road vehicle NOx emissions between counties, as discussed in Chapters 2 and 3.
- The differences between the modeled ambient VOC/NOx ratios and the emissions ratios were greater for 1987 than 1997. Possible reasons for the difference between modeled and emissions VOC/NOx ratios in 1987 are the contributions of boundary/initial concentrations, effects of transport and effects of chemical reactions. This difference demonstrates the need to compare monitored VOC/NOx ratios to both emissions ratios and modeled ratios.

The CAMx/CB4 VOC/NOx ratios are consistently about 10 percent higher than the CAMx/SAPRC99 ratios. Possible causes include: (1) greater removal of modeled VOCs with SAPRC99 because the mechanism is more reactive; (2) inconsistencies between the CB4 and SAPRC99 emissions processing; and (3) inconsistencies between the way the ambient data (VOC samples) were converted to lumped species and the emissions processing. This difference is sufficiently large and consistent that further investigation is recommended to better understand the cause(s).

The difference in the way carbon is accounted for in the CB4 and SAPRC99 mechanisms (third point in the last paragraph) is an essential difference between a lumped molecule (SAPRC99) and a lumped structure (CB4) approach to mechanism condensation. For example, SAPRC99 assigns both propene and 1-pentene to OLE1 on 1:1 basis, so the number of olefin groups is accounted for but the number of carbon atoms may not be accounted for. One approach to conserving carbon is to give OLE1 the average number of carbon atoms for the propene and 1-pentene it is representing here. However, the propene/1-pentene ratio likely varies both within and between the emission inventory an ambient VOC samples. Therefore, SAPRC99 is unlikely to correctly count the amount of carbon in emissions and ambient data, which will likely bias comparisons of VOC/NOx ratios in terms of molesC/mole. The CB4 lumped structure mechanism is better able than a lumped molecule mechanism to simultaneously count both functional groups and total carbon. In the example above, CB4 assigns propene to OLE plus PAR and 1-pentene to OLE plus 3 PAR. Since OLE has 2 carbons and PAR has 1 carbon, the CB4 approach conserves both the number of olefin groups and the total carbon.

Modeled and Ambient VOC Speciation

Precursor concentrations and VOC/NOx ratios from CAMx ozone modeling of the August 1997 SCOS episode were evaluated against ambient data in Section 4. For CAMx/CB4, there is generally good agreement during the daylight hours between modeled and measured values for PAR (mainly alkanes), TOL (mono-alkylbenzenes), XYL (poly-alkylbenzenes), and isoprene with both EMFAC7G and EMFAC2001 based emissions. Spatial variations among sampling locations are larger than the differences resulting from different EMFAC versions. Predicted ethene and OLE (1-olefin) levels are about 30 to 50 percent and about a factor of two higher, respectively, during the late afternoon and evening hours. Predicted and measured values for isoprene were not statistically different during the middle of the day when emissions of isoprene are at their maximum. The predicted formaldehyde mixing ratios are higher than observed by about 50 percent to a factor of two during the afternoon period and about a factor of five higher overnight.

For CAMx/SAPRC99, there were larger differences from measured values than for CB4. This may be due partly to the greater number of species in the SAPRC99 mechanism, which reduces opportunities for compensating over- and under-predictions when species are lumped together. As for CB4, agreement is better for the primary VOCs than for compounds with significant contribution of secondary species. Spatial variations in the ratios of predicted to measured species concentrations were larger with SAPRC99 than for CB4. With the exception of ALK1 (ethane), all predicted hydrocarbon species are lower than measured values at Azusa (predicted/ measured ratios of 0.2 to 0.6) during 6-9 a.m. The corresponding predicted/measured ratios increase progressively from Azusa to Los Angeles – North Main (0.5 to 1.1) to Pico Rivera (0.5 to 2.1) to Upland (0.8 to 3.5). The ratios are generally lower for ALK4 (C5 to C8 alkanes) and OLE1 (1-olefins) and higher for ALK1 (ethane). Agreement with observations for formaldehyde and acetaldehyde is better than for CB4 during midday, but predicted values are factors of two to four higher overnight. Modeled RCHO (higher aldehydes) is consistently lower than measurements at all sites and hours.

Overall, the agreement between modeled and observed VOC species was reasonable for CB4 but not quite so good for SAPRC99. Issues worth further consideration are (1) the tendency for formaldehyde to be over-predicted by both mechanisms, and especially by CB4 and at night with both mechanisms; (2) the tendency for SAPRC99 to predict lower VOC concentrations than CB4, and (3) the tendency for SAPRC99 to substantially under-predict higher carbonyls (RCHO). Understanding biases for carbonyls, including formaldehyde, is important because these compounds are reactive and initiate photochemistry via photolysis, because they are secondary species and thus indicative of photochemical reaction, and because they are air-toxics. The tendency for SAPRC99 to predict lower VOC concentrations than CB4 is consistent with the tendency toward lower VOC/NOx ratios with SAPRC99, discussed above, and may indicate some problem in how the mechanism is being applied or the results interpreted.

One potential issue that should be considered is how carbon is being accounted for in applying the fixed-parameter version of the SAPRC99 mechanism, because the species comparisons (and VOC/NOx comparisons) are made on a carbon (ppbC) basis. For example, both propene and 1-pentene are lumped to OLE1, and OLE1 cannot simultaneously have both 3 and 5 carbons (it must have some average carbon number and average molecular weight). Therefore, different propene/pentene ratios between the inventory and ambient data, or between two ambient monitoring sites, can bias comparisons performed in terms of lumped molecule species on a carbon basis.

Ozone Model Performance for 1997

Ozone modeling was performed for the August 3rd-7th, 1997 SCOS period using CAMx version 3.1 with input meteorology from MM5 and emission inventories from the ARB, as described in section 2. The on-road vehicle emissions provided by the ARB were EMFAC2001 based and were adjusted to other model versions using "EMFAC emission ratios," that is ratios of emissions between different EMFAC versions. Modeling was completed with emissions based on EMFAC7G, EMFAC2001 and EMFAC2002. The changes in modeling inventories due to EMFAC versions were consistent with the changes presented above in Table 5-1, and are shown in detail in Tables 2-3 and 2-4. Notably, the domain total NOx emissions decreased from EMFAC7G to EMFAC2001/2002 due to the changes in activity data for San Bernardino and Riverside Counties discussed above. This NOx decrease was concentrated in grid cells for San Bernardino and Riverside counties and this influenced model performance for ozone.

Modeled ozone levels were higher with EMFAC2001/2002 than with EMFAC7G, and were higher with SAPRC99 than with CB4. The main findings from the statistical evaluation of 1-hour ozone performance are as follows:

- The only scenario to meet all the EPA performance goals on August 5-7 was with CB4 chemistry and EMFAC7G emissions.

- The model performance for EMFAC7G emissions with SAPRC99 chemistry did not meet the EPA goal because the normalized bias was too high on two of three days.

- Model performance was always poorer with SAPRC99 than CB4 chemistry for a given set of EMFAC emissions. The reason for this was higher ozone levels with SAPRC99 than CB4.

- Model performance was very similar for EMFAC2001 and EMFAC2002 with either CB4 chemistry or SAPRC99 chemistry (although poorer with SAPRC99 than CB4, as discussed above.)

- For EMFAC2001 and EMFAC2002 with CB4 chemistry, 8 of 9 model performance measures were inside the EPA goal. The measure that did not meet the EPA goal was the accuracy of the peak on August 6, which was too high. The accuracy of the peak is the least robust measure of the total model performance because it rests on a single pair of values. However, the normalized bias was systematically high for both EMFAC2001 and EMFAC2002 indicating a tendency toward ozone over-prediction.

- For EMFAC2001 and EMFAC2002 with SAPRC chemistry, only 2 of 9 model performance measures were inside the EPA goal, which is poor performance.

The better performance for EMFAC7G than EMFAC2001/2002 was partly due to the higher NOx emissions with EMFAC7G in downwind areas suppressing ozone formation. In general, CAMx tended toward ozone over-prediction with EMFAC2001 and EMFAC2002.

For this particular episode, model performance was clearly poorer with SAPRC99 than with CB4 chemistry. However, this finding does not support any conclusion that either mechanism is more or less "correct" since any such evaluation should be based on a number of model applications.

Ozone Sensitivity to Emission Reductions for 1997

We conducted emissions sensitivity tests to characterize ozone response to reductions of up to 75 percent in anthropogenic NOx and VOC emissions for 1997 (CO emissions were reduced concurrently with VOC emissions). The results showed consistently that Los Angeles ozone levels are VOC-limited. This means that reducing VOC emissions always reduces ozone, whereas reducing NOx may increase or decrease ozone depending upon the level of NOx reduction. This kind of response to VOC and/or NOx emission reductions results from the well-understood "NOx inhibition" effect (NRC, 1991). The NOx inhibition effect was observed consistently for:

- 1-hour and 8-hour ozone.
- CB4 and SAPRC99 chemical mechanisms.
- EMFAC versions 7G, 2001 and 2002.
- Receptor locations at the peak location (which moves as emissions are reduced), Azusa (mid-basin), Riverside (downwind) and Crestline (far downwind).

We quantified levels of NOx reduction that are counter-productive for reducing peak ozone (meaning that the NOx reduction results in higher peak ozone than with zero NOx reduction). With 1997 base case VOC emission levels, less than 55-60 percent NOx reduction is counterproductive for 1-hour ozone, and less than 45-50 percent NOx reduction is counterproductive for 8-hour ozone. With 50 percent reduced VOC emissions, NOx reduction is counter-productive for both 1-hour and 8-hour ozone for NOx reductions of less than 75%, and possibly up to 85% for 1-hour ozone. The ranges reflect the small differences among the EMFAC/chemical mechanism scenarios considered.

We quantified the levels of NOx reduction that produce the highest peak ozone levels. With 1997 base case VOC emission levels, the highest 1-hour ozone occurs with 25-35 percent NOx reduction, and the highest 8-hour ozone occurs for 45-50 percent NOx reduction. With 50 percent reduced VOC emissions, 45-50 percent NOx reduction produces the highest 1-hour and 8-hour ozone levels. The ranges reflect the small differences among the EMFAC/chemical mechanism scenarios considered.

The finding that NOx emission reductions of less than 50 to 75 percent from 1997 levels tend to increase modeled peak ozone levels has implications for air quality planning and ozone attainment. Reducing NOx emission levels (to help attain particulate matter standards, for example) will mean that VOC levels must be reduced even more steeply than if no NOx reductions were implemented. Maintaining a careful balance of VOC and NOx reductions will be necessary to avoid slowing, or even reversing, recent progress toward attaining the 1-hour ozone standard. The VOC-limited nature of the Los Angeles atmosphere indicated by this modeling suggests that the reductions in ambient ozone levels seen in Los Angeles in the late-1990s are attributable to VOC reductions.

Ozone Model Performance for 1987

Ozone modeling was performed for the August 26-28, 1987 SCAQS period using the UAM databases developed by the SCAQMD with emission inventories from the SCAQMD and ARB, as described in section 2. These emission inventories were not from the draft 2003 AQMP since those data were unavailable in time for this study. Model performance for ozone was improved using EMFAC2001 compared to EMFAC7G. However, the basin-wide peak ozone was still under-predicted with EMFAC2001 on both August 27 and 28. Ozone time-series comparisons for several monitoring sites confirmed the tendency for higher ozone with EMFAC2001, but showed that the ozone increases tended to be much smaller than the discrepancies between modeled and observed values. There is a large ozone under-prediction bias for our simulations with both EMFAC2001 than EMFAC7G on August 27, but on August 28 the ozone bias and peak accuracy meet the EPA goals with EMFAC2001, whereas they fail with EMFAC7G.

SCAQMD recently released a draft 2003 AQMP with UAM results based on EMFAC2002 emission inventories. The new SCAQMD UAM results show much improved model performance for ozone over the previous 1997 AQMP modeling, although it is difficult to directly compare model performance statistics between the 1997 and draft 2003 AQMPs because the SCAQMD changed the way model performance statistics are calculated. The draft 2003 AQMP simulations produced much higher peak ozone levels than either the simulations performed here or previous AQMPs. For August 28, the predicted peak of 319 ppb is higher than the observed peak of 290 ppb and much higher than the 1997 AQMP modeled peak of 223 ppb. It is unclear why the draft 2003 AQMP simulation predicts much higher ozone levels than other simulations. Comparison of domain-wide emission totals (see Table 2-9) does not suggest an explanation. A more detailed comparison of the emission inventories is needed to investigate the reasons for these differences in model performance for ozone.

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