Appendix V

Air Quality Management Plan

Modeling and Attainment Demonstrations

December 2012

South Coast Air Quality Management District
Cleaning the air that we breathe...
AQMD

FINAL 2012 AQMP
APPENDIX V

MODELING AND ATTAINMENT DEMONSTRATIONS

DECEMBER 2012

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MODELING OVERVIEW

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INTRODUCTION

This appendix to the Final 2012 AQMP provides the details of the modeling attainment demonstrations presented in Chapter 5 of the main document. The federal Clean Air Act (CAA) sets forth specific requirements to use air quality simulation modeling techniques to estimate future air quality in areas that do not meet the air quality standards. This Final 2012 AQMP provides the future year attainment demonstration for the 24-hour average PM2.5 standard and additional analyses to update future year projections of the annual PM2.5 and 8-hour ozone standards.

The South Coast Air Basin (Basin) is currently designated nonattainment for PM2.5, ozone (8-hours), and PM10. On April 28, 2010, CARB forwarded the District's request to U.S. EPA to redesignate the Basin as attainment for PM10. Air quality monitoring data measured from 2005 through 2007 indicated that the standard had been achieved and that the Basin has not experienced any violations of the 24-hour average PM10 standard, except during a few exceptional events. Future year projections of PM10 provided in the 2007 AQMP and the updated attainment demonstration included in the redesignation request provide the basis for a PM10 maintenance plan for the Basin. EPA's final approval of the redesignation request is currently pending.

The 2007 modeling attainment demonstrations served as an update of the 2003 AQMP ozone, PM10 and carbon monoxide plans for the South Coast Air Basin and other portions of the Southeast Desert Modified Nonattainment Area that are under the District's jurisdiction and were submitted as part of the California State Implementation Plan (SIP). The Final 2007 AQMP provided attainment demonstrations for 8-hour ozone, PM2.5, and PM10. This plan provides the attainment demonstration to address the 2006 revision to the 24-hour PM2.5 standard which reduced the level from 65 $\mu g/m^3$ to the current 35 $\mu g/m^3$. This analysis reflects the updated baseline and future year emissions inventories, estimated revisions to the attainment demonstration methodology, new technical information and enhanced air quality modeling techniques, and the control strategy provided in Chapter 4 and Appendix IV of the Final 2012 AQMP.

Note that the baseline adjustment deriving from emissions reductions from mobile source incentive programs is not yet reflected in the modeling results presented in this chapter. It is expected that controlled 24-hour PM2.5 design values will decrease approximately 0.2 - 0.3 $\mu g/m^3$ when these adjustments are included in the

model, primarily associated with ambient ammonium nitrate reductions. The Final 2012 AQMP modeling results will fully reflect the impact of this baseline adjustment.

Background

The Basin is currently designated nonattainment for PM2.5, and extreme nonattainment for ozone. The District's goal is to develop an integrated control strategy which: 1) ensures that ambient air quality standards for all criteria pollutants are met by the established deadlines in the federal Clean Air Act (CAA); and 2) achieves an expeditious rate of reduction towards the state air quality standards. The overall control strategy is designed so that efforts to achieve the standard for one criteria pollutant do not slow or counteract efforts to achieve the standard for another. A two-step modeling process, consistent with the approach used in the 2007 AQMP, has been conducted for the Final 2012 AQMP. First, future year 24-hour average PM2.5 are simulated for 2014, 2017 and 2019 to determine the earliest possible date for attainment. (If attainment cannot be demonstrated by 2014, U.S. EPA can grant up to an additional 5-years to demonstrate attainment of the 24-hour standard. However, the length of the extension is contingent upon the earliest year beyond 2014 that attainment can be demonstrated implementing all feasible control measures).

Concurrently, simulations are also conducted to confirm that the annual average PM2.5 concentrations will meet the 15 $\mu g/m^3$ standard by 2014, and demonstrate progress in following years. The update to the annual PM2.5 modeling is not intended to replace the approved modeling attainment demonstration submitted in the 2007 AQMP. The updated modeling is included to provide insight into the level of compliance with the current standard in future years, and provide a first glance at the impact that proposed revisions to lower the standard will have on attainment status. U.S. EPA recently proposed revisions to the federal annual PM2.5 standard that will lower the standard to a value between 12 and 13 $\mu g/m^3$. While the exact attainment date has not been published, the proposed rule will likely provide 5 years after designation to demonstrate attainment of new the annual standard. As with the current 24-hour PM2.5 standard, U.S. EPA can grant up to an additional 5-years to demonstrate attainment of the annual standard. That would set an attainment date no later than 2023. The annual PM2.5 simulations presented in this section for model years beyond 2014 are included to demonstrate the continued progress towards meeting the range of the new federal standard by the early 2020's.

Finally, the future year 8-hour average ozone emissions control strategy builds upon the PM2.5 strategy to demonstrate attainment of the federal 8-hour average ozone standard in 2024. There is no federal requirement to update the current ozone attainment demonstration at this time; however an update to the 8-hour average ozone SIP that demonstrates attainment of the 75 ppb standard is scheduled to be submitted no later than December 2015. The deadline for the Basin to attain the 75 ppb standard is likely to be 2032, 8-years after the attainment date for the previous 80 ppb federal standard in 2024. It is critical to conduct preliminary analyses to assess the current control strategy given the extent of required emissions reductions needed to meet the 80 ppb standard in 2024.

Model Selection

During the development of the 2003 Plan, the District convened a panel of seven experts to independently review the regional air quality modeling conducted for ozone and PM10. The consensus of the panel was for the District to move to more current state-of-the-art dispersion platforms and chemistry modules. At that time, the model selected for the 2007 AQMP ozone attainment demonstrations was the Comprehensive Air Quality Model with Extensions (CAMx) [Environ, 2002], using SAPRC99 chemistry. For PM2.5, the 2007 AQMP used the CAMx "one atmosphere" approach which coupled CB-IV gas phased chemistry and a static two-mode particle size aerosol module as the particulate modeling platform. The CAMx "one atmosphere" chemistry approach better preserved mass consistency taking advantage of an advanced dispersion platform.

In the 2007 AQMP, CAMx coupled with the SAPRC99 chemistry was simulated to demonstrate attainment of the federal ozone standard. A total of 36 days were simulated covering 6 ozone episode periods from which 19 days meeting performance criteria were selected for inclusion in the attainment demonstration. Future year ozone projections were developed using the CAMx/SAPRC99 couple supported by MM5 meteorological data fields and day specific emissions inventories.

The 2007 AQMP PM2.5 attainment demonstration incorporated the CAMx/CB-IV chemistry and aerosol modules together with the MM5 meteorological fields. The PM2.5 analyses relied on average week day and weekend day emissions profiles that were adjusted for monthly averaged temperature and humidity. The annual and episodic PM2.5 demonstrations were based on 365 days of particulate simulation. It is important to note that PM2.5 and ozone attainment demonstrations were run

independently due to differences in the computational requirements resulting from separate modeling domains and definitions of vertical structure.

In keeping with the recommendations of the expert panel as well as the Scientific Technical Peer Modeling Review Committee, the Final 2012 AQMP has continued to move forward to incorporate current state-of-the-art modeling platforms to conduct regional modeling analyses in support of the PM2.5 attainment demonstrations and ozone update. The Final 2012 AQMP PM2.5 attainment demonstration has been developed using the U.S. EPA supported Community Multiscale Air Quality (CMAQ) (version 4.7.1) air quality modeling platform with SAPRC99 chemistry, and the Weather Research and Forecasting model (WRF) (version 3.3) meteorological fields. (Comprehensive descriptions of the CMAQ modeling system are provided by U.S. EPA at their SCRAM website: http://www.epa.gov/scram001/. Additional descriptions of the SAPRC99 chemistry module are provided at the UCR website: http://www.engr.ucr.edu/~carter/SAPRC/. Documentation of the NCAR WRF model is available from UCAR website: http://www.wrf-model.org/). Supporting PM2.5 and ozone simulations were also conducted using the most current, publicly available version of CAMx (Environ, Inc, version 5.3) which also used SAPRC99 chemistry and WRF meteorology. The model analyses were conducted on an expanded domain, with increased resolution in the vertical structure for a 4 x 4 km grid size.

MODELING METHODOLOGY

Design Values

EPA guidance recommends the use of multiple year averages of design values, where appropriate, to dampen the effects of single year anomalies to the air quality trend due to factors such as adverse or favorable meteorology or radical changes in the local emissions profile. The trend in the Basin 24-hour PM2.5 design values, determined from routinely monitored Federal Reference Monitoring (FRM), from 2001 through 2011 (Figure V-1-1) depicts sharp reductions in concentrations over the period. The 24-hour PM2.5 design value for 2001 was 76 $\mu g/m^3$ while the 2008 design value (based on data from 2006, 2007 and 2008) is 53 $\mu g/m^3$. Furthermore, the most current design value computed for 2011 has been reduced to 38 $\mu g/m^3$. The annual PM2.5 design value has demonstrated a reduction of 13.6 $\mu g/m^3$ over the 10-year period from 2001 through 2011. In each case, the trend in PM2.5 levels is steadily moving in the direction of air quality improvement.

The trend of Basin ozone design values is presented in Figure V-1-2. The design values have averaged a reduction of approximately three parts per billion over the 14-year period; however the most recent design value (107 PPB) continues to exceed the 1997 8-hour ozone standard by 34 percent and the 2006 ozone standard by 43 percent.

In its modeling guidance, U.S. EPA has recommended that a multiple year weighted design value be used in attainment demonstrations. It is reasonable to use a representative design value that is not fixed in a multiple year average that overly reflects data that are not consistent with the current air quality trend or unusual weather. The PM2.5 attainment demonstrations presented in the 2007 AQMP relied on 2005 design values based on monitoring data between 2003 and 2005. In general, the 2005 design value was more consistent with the monitoring data observed in 2004, the center year in the design value calculation. The 2007 AQMP attainment demonstrations were anchored to a 2005 emissions data set and particulate speciation profiles obtained from an extensive monitoring program conducted over the course of 2005. Had the 2006 PM2.5 data been available for inclusion in the analysis, the revised weighted annual design value centered around 2005 (including data from 2004 through 2006) would be 22.7 $\mu g/m^3$, essentially the same value as the 2005 design of 22.6 $\mu g/m^3$.

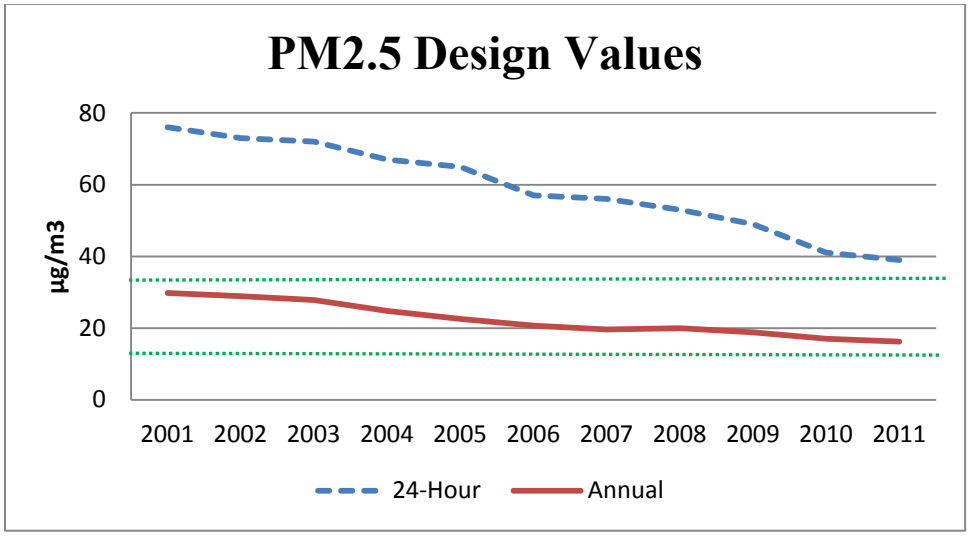


FIGURE V-1-1

South Coast Air Basin 24-Hour Average and Annual PM2.5 Design Values

(Each value represents the 3-year average of the highest annual average PM2.5 concentration). The dotted lines represent 24-hr and annual standards, respectively.

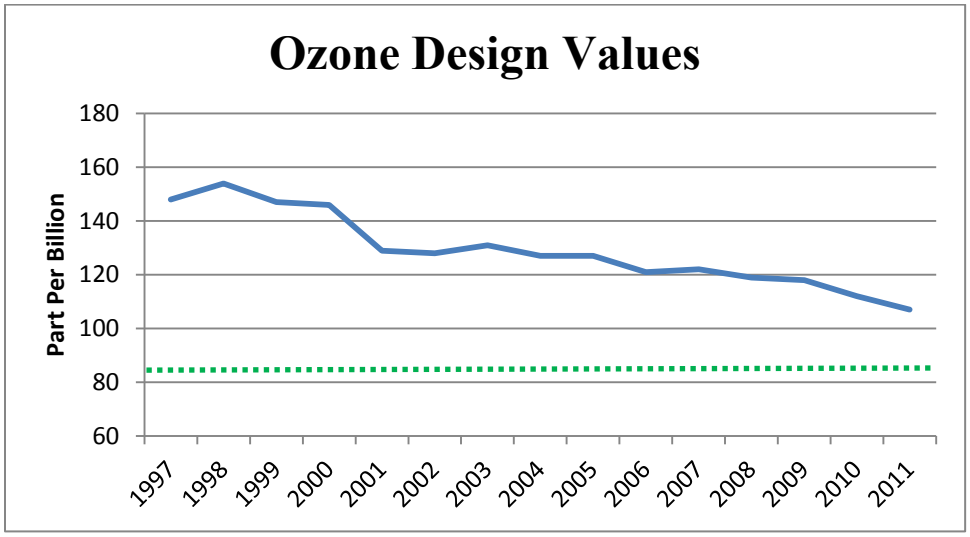


FIGURE V-1-2

South Coast Air Basin 8-Hour Average Ozone Design Values
(Each value represents the 3-year average of the 4th highest 8-Hour Average Ozone concentration) standard line needs adjustment and explanation

The Final 2012 AQMP relies on a set of 5-years of monitored particulate data centered on 2008, the base year selected for the emissions inventory development and the anchor year for the future year PM2.5 projections. In July, 2010, U.S. EPA proposed revisions to the PM2.5 24-hour average modeling attainment demonstration guidance. In the 2007 AQMP attainment demonstrations, maximum quarterly concentrations equal to or less than the yearly 24-hour average design value were incorporated in the future year design projection. Since the 24-hour attainment demonstration used the 2005 design value, the future year design projection was based on 3-years of quarterly PM2.5 data observed from 2003 through 2005. A total of 12 quarterly design values were used in the projection of the 2015 attainment demonstration.

The new guidance suggests using 5-years of data, but instead of directly using quarterly calculated design values, the procedure requires the top eight daily PM2.5 concentrations days in each quarter to reconstruct the annual 98th percentile values. The logic in the analysis is twofold. First, by selecting the top eight values in each quarter, the 98th percentile concentration is guaranteed to be included in the calculation. Second, the analysis projects future year concentrations for each of the

32 days in a year (160 days over 5-years) to test the response of future year PM2.5 to the proposed control strategy. Since the 32 days in each year include different meteorological and particulate species profiles, it is expected that those individual days will respond independently to the projected the future year emissions profile and that a new distribution of PM2.5 concentrations will result. The methodology uses the projected air quality for the 32 days in each year to build a new annual 24-hour 98th percentile concentration, not necessarily occurring on the same day exhibiting the 98th percentile in the base year. The five years of projected 98th percentile concentrations are weighted to create a new future year 24-hour PM2.5 design value to test attainment of the standard. Overall, the process is more robust in that the analysis is examining the impact of control strategy implementation on 10 times the number of days, covering a wider variety of potential meteorology and emissions combinations.

It is important to note that the use of the quarterly design values for a 5-year period centered around 2008 were also used in the projection of the future year annual average PM2.5 concentrations. The revised PM2.5 guidance did not modify the procedures used to calculate the future year annual average PM2.5 concentrations. The future year design value reflects the weighted quarterly average concentration calculated from the projections of 5-years of days (20 quarters).

The weighted 2008 24-hour and annual PM2.5 8-hour ozone design values for the Basin are presented in Chapters 5, 6, and 7 of this appendix, respectively.

Relative Response Factors and Future Year Design Values

To bridge the gap between air quality model output evaluation and applicability to the health based air quality standards, EPA guidance has proposed the use of relative response factors (RRF). The RRF concept was first used in the 2007 AQMP modeling attainment demonstrations. The RRF is simply a ratio of future year predicted air quality with the control strategy fully implemented to the simulated air quality in the base year. The mechanics of the attainment demonstration are pollutant and averaging period specific. For 24-hour PM2.5, the top 10 percentile of modeled concentrations in each quarter of the simulation year are used to determine the quarterly RRF. For the annual average PM2.5, the quarterly average RRFs are used for the future year projections. For the 8-hour average ozone simulations (to be further discussed in Chapter 10 of this document) the aggregated response of several

episode days to the implementation of the control strategy are used to develop an averaged RRF for projecting a future year design value. Simply stated, the future year design value is estimated by multiplying the non-dimensional RRF to the base year design value. Thus, the simulated improvement in air quality, based on multiple meteorological episodes, is translated to a simple metric that directly determines compliance of the standard. Equations V-1 and V-2 summarize the calculation.

Equation V-1.

RRF = Future-Year Model Prediction / Base-Year Model Prediction.

Equation V-2.

Attainment Demonstration = RRF X Design Value $\leq$ Air Quality Standard.

The modeling analyses described above use the RRF and design value approach to demonstrate future year attainment of the standards.

Regional Modeling

The Final 2012 AQMP employs the CMAQ air quality modeling platform with SAPRC99 chemistry and WRF meteorology as the primary tool used to demonstrate future year attainment of the 24-hour average PM2.5 standard. Unlike the 2007 AQMP attainment demonstrations, PM2.5 and ozone were modeled jointly in one year-long simulation covering 366 days and 8784 hours. Predicted daily maximum values of 24-hour PM2.5 and 8-hour ozone were calculated from the respective running 24-hour and 8-hour average simulated concentrations.

The Final 2012 AQMP modeling attainment demonstrations using the CMAQ platform were conducted using a vastly expanded modeling domain compared with the analysis conducted for the 2007 AQMP modeling attainment demonstration. The simulations were conducted using a Lambert Conformal grid projection where the western boundary of the domain was extended to 084 UTM, over 100 miles west of the ports of Los Angeles and Long Beach. The eastern boundary extended beyond the Colorado river, while the northern and southern boundaries of the domain extend to the San Joaquin Valley and the Northern portions of Mexico (3543 UTM). The grid size has been reduced from 5 x 5 kilometers to 4 x 4 kilometers, and the vertical

resolution has been increased to 18 layers. Figure V-1-1 depicts the modeling domain which includes a grid of 154 cells from west to east and 102 cells from south to north.

The final WRF simulated meteorological fields were generated for the identical domain, layer structure and grid size. The vertical structure of the modeling domain was increased to 18 layers after conducting several optimizing simulations. The WRF simulations were initialized from NCEP analyses and run for 4-day increments with 1-day spinup. Four dimensional data assimilation (FDDA) was conducted with vertical sounding and surface measurements. The base WRF simulation was simulated using a vertical structure that included 30 layers extending from the surface to 19 km. A systematic analysis of the impact of layer collapsing from 30 layers to a lesser number was conducted to optimize the number of levels that would best retain the WRF meteorological characterization yet provide enhanced resolution for the CMAQ air quality simulation.

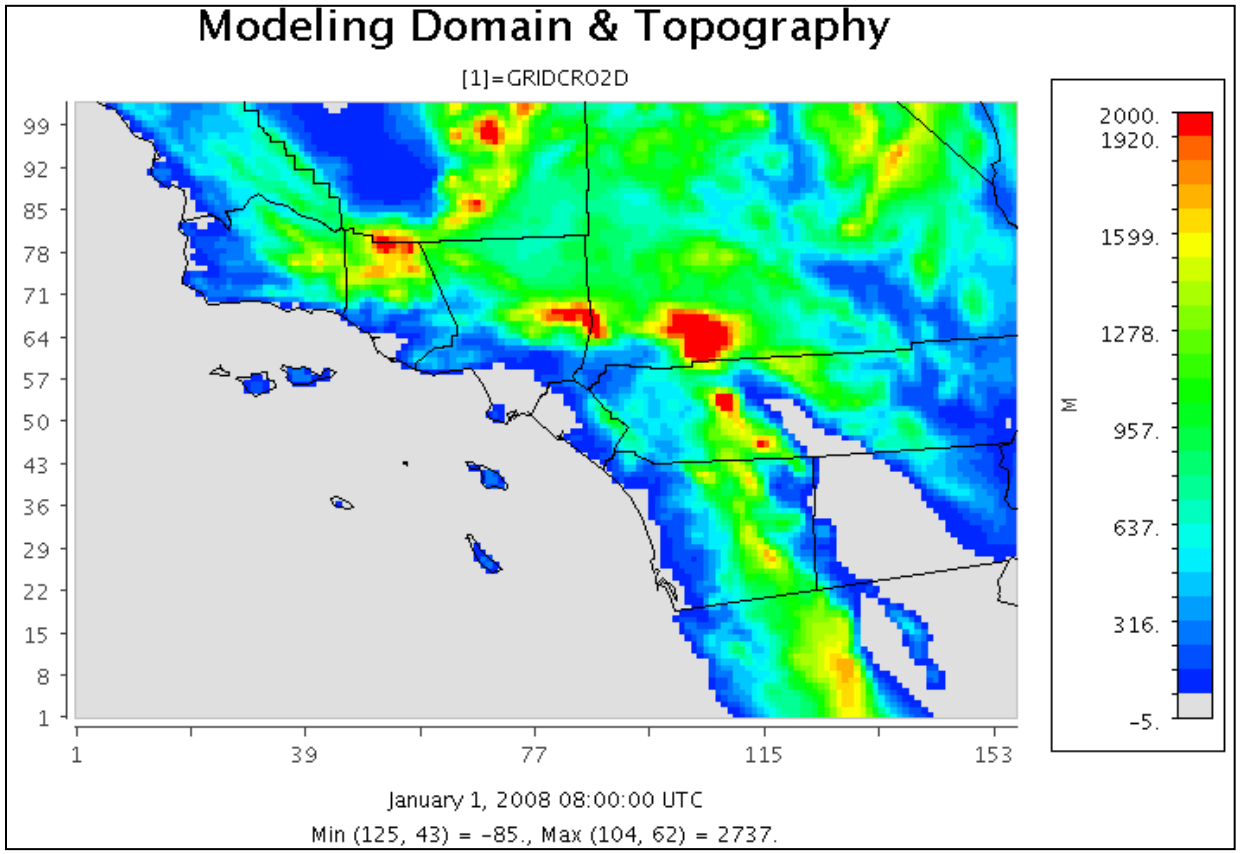


Figure V-1-3

2012 AQMP Regional Modeling Domain

Lateral and vertical boundary conditions were designated using an "U.S. EPA clean boundary profile." The analysis tested the use of MOZART (Model of Ozone and Related Chemical Tracers, [Horowitz, L.W., et. Al., 2003]), global chemical simulation model output to specify the lateral and vertical boundary conditions used for the CMAQ modeling. Grid scale matching using MOZART at 60 x 60 km compared with the CMAQ 4 x 4 km grid introduced significant uncertainty to the boundary concentration profiles and subsequent regional simulations. Background simulations including the MOZART boundary specification while excluding anthropogenic emissions depicted large variations in background concentrations. Discussions conducted at the Scientific Technical Modeling Peer Review Advisory Group suggested that a finer scale MOZART output might dampen the variable impact to the regional air quality simulations. While this recommendation was acknowledged, the resources and time requirements needed to generate new global modeling output were prohibitive. The final simulations reverted to the more stable clean boundary assumption.

The atmospheric chemistry package used in the CMAQ simulations relied on SAPRC99 gas phase chemistry coupled with Acid Deposition Model (**RADM**) aqueous chemical mechanism, AE5 aerosol chemistry, and SOAP secondary organic chemistry with the Euler Backward Iterative (EBI) gas phase chemistry solver. The aerosol size distribution algorithm utilized a tri-modal distribution to represent nuclei, fine and coarse particles. The analysis was also conducted using the CAMx modeling platform using the "one atmosphere" approach comprised of the SAPRC99 gas phase chemistry and a static two-mode particle size aerosol module as the particulate modeling platform. Parallel testing was conducted to evaluate the CMAQ performance against CAMx and the results indicated that the two model/chemistry packages performance were similar. The CAMx results are provided as a component of the weight of evidence discussion and are presented as an attachment to this document.

Weight of Evidence

PM2.5 modeling guidance strongly recommends the use of corroborating evidence to support the future year attainment demonstration. The weight of evidence demonstration for the Final 2012 AQMP includes brief discussions of the observed 24-hour PM2.5 levels, emissions trends, and future year PM2.5 predictions.

UNCERTAINTIES ASSOCIATED WITH THE TECHNICAL ANALYSIS

As with any plan update, there are uncertainties associated with the technical analysis. The following paragraphs describe the primary contributors to such uncertainties as well as some of the safeguards built in to the air quality planning process to manage and control such uncertainties.

Demographic and Growth Projections

Uncertainties exist in the demographic and growth projections for the future years. As projections are made to longer periods (i.e., over ten or more years), the uncertainty of the projections become greater. Examples of activities that may contribute to these types of uncertainties include the rate and the type of new sources locating in the Basin and their geographic distribution, future year residential construction, military base reuse and their air quality impact, and economic conditions.

Ambient Air Quality Monitoring Data

Generally, ambient air quality measurements are accurate to within plus or minus half of a unit of measurement (e.g., for ozone usually reported in units of parts-per-hundred million (pphm) would be accurate to within ±0.5 pphm or ±5 ppb). Due to this uncertainty and associated rounding conventions, the Basin's 8-hour attainment status based on ambient monitoring data would be achieved if all ozone monitors reported ozone concentration levels less than or equal to 84 ppb. Similar uncertainty is observed in particulate data measurements and laboratory analysis. For example, PM2.5 is comprised of six primary constituents ($NH4^+$, NO3, $SO4^-$, OC, EC and crustal), as well as bonded water and total mass. Each of the primary species has individual uncertainty associated with the laboratory analysis procedure used to analyze concentration, the type of filter media to collect the sample and the total mass collected can be affected by minor changes in the volumetric flow that fall within the approved instrument calibration range. As a consequence, the sum of the total species may not add up to or may exceed the filter measured mass.

Emissions Inventory

While significant improvements have been realized in mobile source emissions models, uncertainties continue to exist in the mobile source emissions inventory estimates. EMFAC2011 on-road mobile source emission estimates have improved

with each new EMFAC release. On-road mobile source emissions have inherent uncertainties with the current methodologies used to estimate vehicle miles traveled, the impacts of fuel additives such as ethanol, and day-of-week diurnal profiles of traffic volume. Stationary (or point) source emission estimates have less associated uncertainties compared to area source emission estimates. Major stationary sources report emissions annually whereas minor stationary and area source emissions are, in general, estimated based on a top down approach that relies on production, usage or activity information. Area source emissions including paved road dust and fugitive dust have significant uncertainties in the estimation of particulate ($PM_{2.5}$) emissions due to the methodologies used for estimation, temporal loading and weather impacts.

Air Quality and Meteorological Models

The air quality models used for ozone and particulate air quality analysis are state-of-the-art, comprehensive 3-dimensional models that utilize 3-dimensional meteorological models, complex chemical mechanisms that accurately simulate ambient reactions of pollutants, and sophisticated numerical methods to solve complex mathematical equations that lead to the prediction of ambient air quality concentrations. While air quality models progressively became more sophisticated in employing improved chemical reaction modules that more accurately simulate the complex ambient chemical reaction mechanisms of the various pollutants, such improved modules are still based on limited experimental data which carry associated uncertainties. In order to predict ambient air quality concentrations, air quality models rely on the application of sophisticated numerical methods to solve complex mathematical equations that govern the highly complex physical and chemical processes that also have associated uncertainties. Layer averaging of model output reduces the sensitivity of the model to changing patterns in the vertical structure.

Are There Any Safeguards Against Uncertainties?

Yes. While completely eliminating uncertainties is an impossible task, there are a number of features and practices built into the air quality planning process that manage and control such uncertainties and preserve the integrity of an air quality management plan.

The concerns regarding uncertainties in the technical analysis are reduced with future AQMP revisions. Each AQMP revision employs the best available technical information. Under state law, the AQMP revision process is a dynamic process with

revisions occurring every three years. The AQMP revision represents a "snapshot in time" providing the progress achieved since the previous AQMP revision and efforts still needed in order to attain air quality standards.

Under the federal Clean Air Act, a state implementation plan (SIP) is prepared for each criteria pollutant. The SIP is not updated on a routine basis under the federal Clean Air Act. However, the federal Clean Air Act recognizes that uncertainties do exist and provides a safeguard if a nonattainment area does not meet an applicable milestone or attain federal air quality standards by their applicable dates. Contingency (or backstop) measures are required in the AQMP and must be developed into regulations such that they will take effect if a nonattainment area does not meet an applicable milestone or attainment date. In addition, federal sanctions may be imposed until an area meets applicable milestone targets.

In September 2006, U.S. EPA released an updated guidance document on the use of modeled results to demonstrate attainment of the federal ozone, PM2.5 and regional haze air quality standards. The guidance document recognized that there will be uncertainties with the modeling analysis and recommends supplemental analysis or weight of evidence discussion that corroborates the modeling attainment analysis where attainment is likely, even if the modeled results are inconclusive. Table V-1-1, is taken directly from the modeling guidance document to illustrate the value of supplemental analyses. Where possible, the U.S. EPA recommends that at least one "mid-course" review of air quality, emissions and modeled data be conducted. A second review, shortly before the attainment date, should be conducted also. Statistical trend analyses of monitored data can also provide support for assessing the likelihood for future year attainment. The District will undertake such actions at the appropriate times.

DOCUMENT ORGANIZATION

This document provides the federal attainment demonstration for 24-hour PM2.5 and additional analyses for annual PM2.5 and ozone. Chapter 2 provides the Modeling Protocol which summarizes the key elements that have been revised relative to the 2007 AQMP Modeling protocol. Chapter 3 provides a discussion of the meteorological modeling, including model performance and the impact of modifications to the land usage profiles. Chapter 4 provides a brief summary of the modeling emissions, including characterization of the daily/diurnal emissions profiles and OGV emissions. Chapter 5 provides the 24-hour PM2.5 attainment

demonstration meeting the 2014 attainment date. The chapter includes a characterization of the particulate species profile, discussion of the revised attainment demonstration methodology, and selected future year particulate impacts. A series of alternative emissions simulations are also presented to test the sensitivity of the proposed control strategy and to simulate the impacts of CEQA alternatives to the proposed plan. Chapter 6 provides an update to projected annual PM2.5 concentrations for the different future year emissions scenarios. Similarly, Chapter 7 will provide an update to the future year 8-hour ozone projections based on the CMAQ modeling analyses. The ozone analysis includes discussions of the representativeness of the 2008 meteorological year, base-year modeling performance, and projections of future year concentrations for baseline emissions as well as the implementation of the short-term control strategy. The ozone analysis will also provide updated isopleth analyses and a discussion of future year carrying capacities for the current and proposed ozone standards. As with the particulate analyses, weight of evidence discussions for ozone will be incorporated in Chapter 5. Chapter 8 provides a brief summary of the analysis.

Table V-1-2 lists the Attachments to this document. CAMx simulation analyses will be included as an attachment in the final document.

TABLE V-1-1

Guidelines for Weight of Evidence Determinations (U.S. EPA, 2006)

Results of Modeled Attainment Test			Supplemental Analyses
Ozone	Annual PM2.5	24-Hour PM2.5	
Future Design Value < 82 ppb, all monitoring sites	Future Design Value < 14.5 $\mu g/m^3$, all monitoring sites	Future Design Value < 62 $\mu g/m^3$, all monitoring sites	Basic supplemental analyses should be completed to confirm the outcome of the modeled attainment test
Future Design Value 82 - 87 ppb, at one or more sites/grid cells	Future Design Value 14.5 – 15.5 $\mu g/m^3$, at one or more sites/grid cells	Future Design Value 62 – 67 $\mu g/m^3$, at one or more sites/grid cells	A weight of evidence demonstration should be conducted to determine if aggregate supplemental analyses support the modeled attainment test
Future Design Value > 87 ppb, at one or more sites/grid cells	Future Design Value > 15.5 $\mu g/m^3$, at one or more sites/grid cells	Future Design Value > 67 $\mu g/m^3$, at one or more sites/grid cells	More qualitative results are less likely to support a conclusion differing from the outcome of the modeled attainment test.

TABLE V-1-2

Attachments

Number	Description
	References
Attachment-1	WRF METSTAT Model Graphical Performance Statistics
Attachment-2	Quarterly CMAQ 24-Hour PM2.5 Model Performance
Attachment-3	Time Series of Observed Vs. Predicted 8-Hour Ozone
Attachment-4	Draft CEPA Source Level Emissions Reduction Summary for 2014: Annual Average Inventory
Attachment-5	Draft CEPA Source Level Emissions Reduction Summary for 2023: Annual Average Inventory
Attachment-6	CAMx Modeling (To Be Provided)

CHAPTER 2

MODELING PROTOCOL

Background

Final 2012 AQMP Modeling Protocol

BACKGROUND

One of the basic requirements of a modeling attainment demonstration is the development of a comprehensive modeling protocol that defines the scope of the regional modeling analyses including the attainment demonstration methodology, modeling and chemical platforms employed, emission inventories and physical characteristics of the domain simulated. The protocol also defines the methodology to assess model performance and the selection of the periods to be simulated. The 2007 AQMP provided a comprehensive discussion of the modeling protocol used as guidance in the development of the ozone, PM2.5, and PM10 modeling attainment demonstrations. The 2007 AQMP Modeling Protocol for Ozone and Particulate Matter Modeling in Support of the South Coast Air Quality Management District 2007 Air Quality Plan Update which is provided as Attachment-3 in Appendix V of that document serves as the foundation of the Final 2012 AQMP modeling protocol. Modifications made to that protocol to address the requirements of the Final 2012 AQMP attainment demonstrations are presented in this chapter.

The 2007 AQMP modeling protocol was finalized in May of 2006, prior to the release of U.S. EPA's "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of the Air Quality Goals for Ozone, PM2.5, and Regional Haze." Together, the two guidance documents steered the development of the 2007 ozone and PM2.5 attainment demonstrations that have since been approved by U.S. EPA in the California SIP. In a letter dated June 28, 2011, U.S. EPA issued a revision to the modeling attainment demonstration methodology for 24-hour PM2.5 entitled "Update to the 24 Hour PM2.5 NAAQS Modeled Attainment Test." The revision outlined an overhaul to the structure of the attainment demonstration but did not propose any modifications to the underlying regional modeling analyses. The revised guidance was referenced in the updated 24-hour PM2.5 implementation guidance "Implementation Guidance for the 2006 24-Hour Fine Particle (PM2.5) National Ambient Air Quality Standard" dated March 2, 2012.

FINAL 2012 AQMP MODELING PROTOCOL

Table V-2-1 provides a side-by-side comparison of the Final 2012 AQMP and 2007 AQMP modeling protocols. The differences between the modeling structure focus on a limited number of areas. In general, changes to emissions inventories, future-

year simulations and episode selection evaluation are specific to the base year selected and the level of the non-attainment designation. As such, these changes are expected to occur as part of each modeling update. The more substantive changes to the Final 2012 AQMP protocol reflect the use of CMAQ as the primary modeling platform, WRF as the meteorological modeling platform and the changes to the size of the modeling region, vertical structure and grid size.

For this set of modeling analyses, CMAQ was selected as the primary dispersion modeling platform. One element in the decision to use CMAQ as the primary modeling platform was the fact that it was a publicly available model with numerous computational features and ongoing support in the modeling community. When evaluated for possible use in the attainment demonstration, both CMAQ and CAMx exhibited similar model performance in predicting 24-hour and annual PM2.5 levels. CMAQ however tended to predict monitored ozone concentrations with higher accuracy than the CAMx simulations. The migration to WRF from MM5 as the primary meteorology modeling tool follows its ongoing use as the mainstay in weather forecasting by the NWS, and its continuing development and support by NOAA and U.S. EPA.

The most significant changes to the modeling analyses in the Final 2012 AQMP, compared with that defined in 2007 AQMP, occur in the size of the domain, reduced grid size and increased vertical structure. First and foremost, both PM2.5 and ozone will be simulated together using the same domain specification. The size of the domain has been expanded 65 km further west to attempt to incorporate clean boundaries into the modeling region, and 40 km to the south to include a greater percentage of northern Mexico emissions. Moreover, the grid size has been reduced from 5 x 5 km to 4 x 4 km. The reduced grid size better enabled the merging of the statewide emissions inventory which is set at the 4 km grid scale based on a Lambert Conformal projection. Table V-2-2 provides the characteristics of the modeling domain and Figure V-1-1 provides a comparison of the Final 2012 AQMP modeling to the PM2.5 and ozone modeling domains simulated in the 2007 AQMP attainment demonstrations.

TABLE V-2-1

Summary of Final 2012 AQMP Model Selection and Modeling Protocol

2012 AQMP	2007 AQMP Element
24-Hour PM2.5 and Annual Dispersion Platform: CMAQ (CAMx : weight of evidence discussion) Chemistry: SAPRC99 with tri-modal aerosol distribution SMAT/Sandwich approach	*PM10/PM2.5 Annual and Episodic* Dispersion Platform: CAMx Chemistry: AERO-LT with CB-IV Enhanced Fine/ Coarse scheme with CB-IV Optional One Atmosphere Aerosol chemistry
Ozone Dispersion Platform: CMAQ Chemistry: SAPRC99	*Ozone* Dispersion Platform: CAMx Chemistry: SAPRC99
Domain/ Coordinates Ozone and PM: Expanded SCOS97 Meteorology, Emissions and Model application: Lambert Conformal Grid: 4 Km X 4 Km Ozone: 18 layers PM2.5: 18 layers	*Domain/ Coordinates* Ozone: SCOS97, PM10/2.5 SCAQS87 Meteorology, Emissions and Model application: Lambert Conformal Grid: 5 Km X 5 Km Ozone: 16 layers PM10/2.5: 8 layers

Emissions Inventories
• 2008 Base year
• Day-Specific Emissions
• Shipping emissions split into 2layers
• EMFAC2011
  o 3- modules
  o Modified DTIM
• Adjustments to fugitive PM2.5 Paved road EPA with CA modifications
• Day-Specific Biogenic emissions
• Revised Mexican emissions profile
	Emissions Inventories
	• 2002 Base year
	• Enhanced aircraft/airport and shipping inventories
	• Updates for Ports of Los Angeles and Long Beach
	• EMFAC2007
	  o gross adjustments
	  o “focused” inventories
	  o Final public model
	• Adjustments to fugitive PM10/PM2.5 categories

TABLE V-2-1 (Continued)

Summary of Final 2012 AQMP Model Selection and Modeling Protocol

2012 AQMP	2007 AQMP Element
Meteorology • WRF and MM5 initialized with NCEP data with FDDA	*Meteorology* • MM5 with FDDA • Hybrid MM5/CALMET • MM5 initialized using NCEP data
Future Year Projections PM2.5/Ozone • 2014 • 2017 • 2019 • 2023 • 2030 • 2035	*Future Year Projections* Ozone • 2017 (Coachella) • 2023 PM2.5/PM10 • 2014 • 2015 (PM10) • 2020
Air Quality Model Performance PM2.5 Quarterly statistics at speciation sites: • Averages, normalized bias and normalized error • Graphical analyses: Scatter plots, time series, soccer plots • Weight of Evidence Analysis Ozone • Assess model performance based on both 1-hour and 8-hour statistics: Normalized gross bias Normalized gross error Peak prediction accuracy • 60 ppb threshold (both indices)	*Air Quality Model Performance* Ozone • Assess model performance based on both 1-hour and 8-hour statistics • 60 ppb threshold (both indices) • Weight of Evidence Analysis • Mid-Course simulations PM2.5 (annual and episodic) • Base statistics at speciation sites • Weight of evidence analysis • Mid-Course simulations 2009 2012

TABLE V-2-2

Final 2012 AQMP Modeling Domain

Projection	Lambert Conformal Projection
Latitude of Origin	37 N
Modeling Domain	156 x 102 x 18
Vertical Layer Structure	Variable up to 50 hPa (mb)
Central Meridian	120.5 W
Standard Parallel	30 N, 60 N
Horizontal Grid Size	4 km x 4 km
Southwest Origin	(-84 km, -552km)

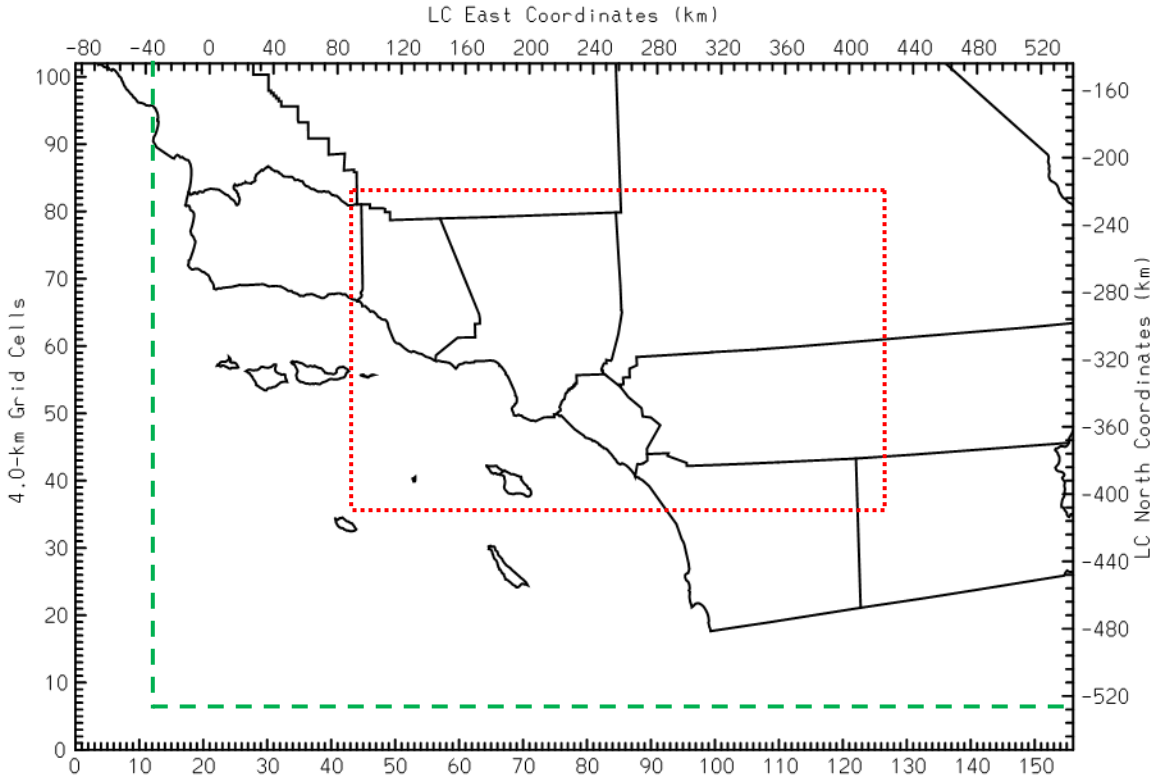


FIGURE V-2-1

Comparison of Regional Modeling Domains: Red Dotted: SCAQS87-- 2007 AQMP PM2.5, Green Dashed: SCOS97-- 2007 AQMP Ozone, Black (Outer): 2012 AQMP

One clear benefit from the modification to the grid size was the smoother coupling of the meteorological modeling field development. The WRF analyses are initialized from NECP model output at 36 km grid level, then scaled downward based on a 3:1 scaling ratio to a 12 km grid inner-modeling domain covering most of California to set the regional meteorological boundary conditions for the 4 km grid modeling domain. Finally, the layer structure in the vertical domain for the modeling region has been increased to 18 layers from the previous 16 layers used for the 2007 AQMP ozone simulations, and from the eight layers used in the CAMx PM2.5 attainment demonstration simulations. Table V-2-3 provides a definition of the 18 layer vertical structure used in the air quality simulations. Also listed is the corresponding 30 layer structure of the WRF modeling vertical domain that matches the CMAQ domain at the top height.

By and large, the greatest impact to the modeling analyses resulting from the changes summarized in the protocol and in Table V-2-2 is the impact on the computational requirements to simulate a year's air quality. Since PM2.5 is common to all multi-pollutant analyses, the Final 2012 AQMP simulations required 8 times the computational resources to complete a simulation compared with the 2007 AQMP PM2.5 attainment demonstration. Figure V-2-2 depicts a typical model simulation configuration of the computation system. A total of 15 servers and 200 CPU's were used in the simulations.

TABLE V-2-3

Final 2012 AQMP Modeling Vertical Layer Structure

WRF Layer Index	Mid-Point Height (m)		CMAQ Layer Index	Mid-Point Height (m)
30	19268		15	19268
29	17355			
28	15755			
27	14337		14	14337
26	13028			
25	11791			
24	10598			
23	9429			
22	8271		13	8271
21	7118			
20	5994			
19	4992			
18	4153			
17	3449		12	3449
16	2858			
15	2361			
14	1944		11	1944
13	1595			
12	1302			
11	1057			
10	851		10	851
9	681		9	681
8	538		8	538
7	418		7	418
6	318		6	318
5	235		5	235
4	165		4	165
3	107		3	107
2	59		2	59
1	18		1	18

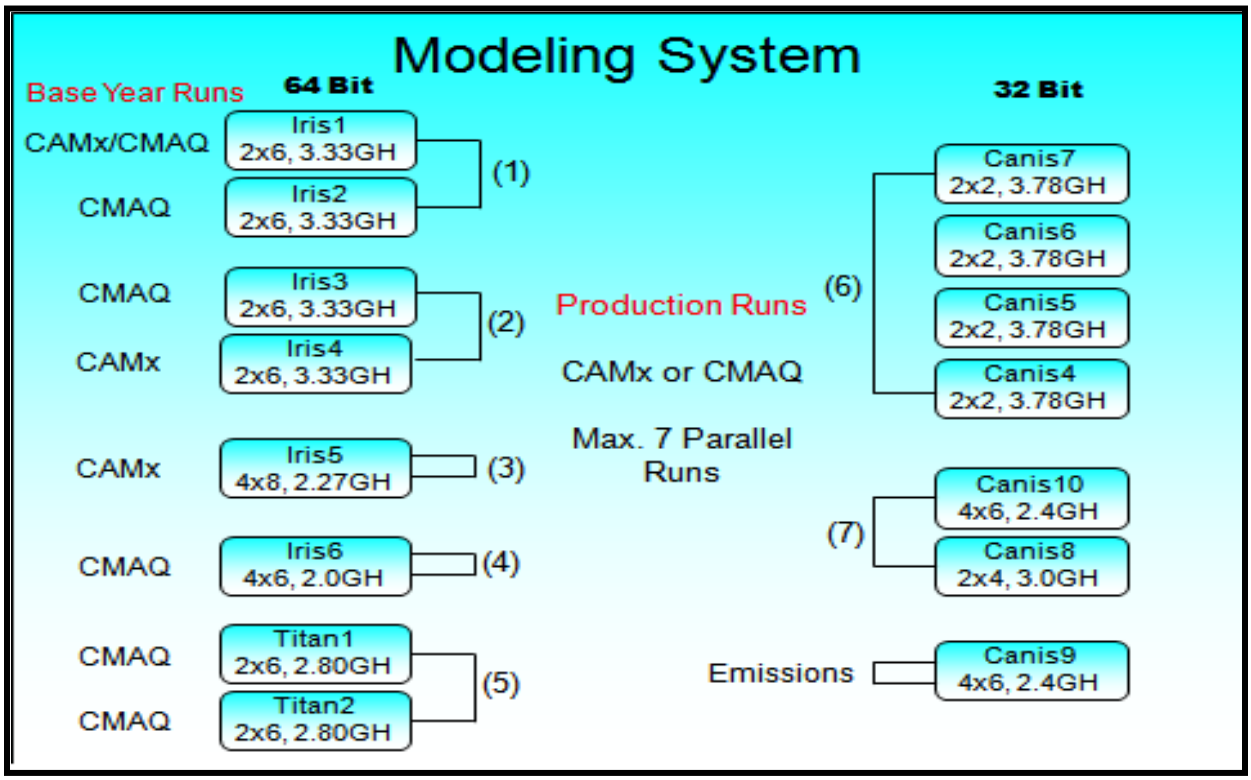


FIGURE V-2-2

Typical CMAQ/CAMx Modeling Simulation Configuration

CHAPTER 3

METEOROLOGICAL MODELING AND SENSITIVITY ANALYSES

OVERVIEW

This chapter provides a description of the meteorological modeling that serves as the foundation of the Final 2012 AQMP modeling analysis. As previously discussed, the Final 2012 AQMP regional modeling relied on WRF model applications for 2008. The previous 2007 AQMP attainment demonstrations relied on National Center for Atmospheric Research (NCAR)/Penn State University (PSU) Mesoscale Model 5 (MM5) meteorological fields. The migration to WRF was based on two factors: First, WRF is the state-of-the-art meteorological forecast model used by the NWS and scientific community. It is under continual review and benefits from updates to critical modeling parameters. Second, MM5 is no-longer supported as a regional meteorological model although it is still posted at the U.S EPA SCRAM website. In moving to a new meteorological model, several analyses were conducted to compare WRF and MM5 meteorological fields to confirm the portability of the CMAQ modeling system to the new model. This chapter describes the meteorological model, the comparison between WFR and MM5, selection of the vertical stability parameterization, land use, and initial and boundary conditions used in the 24-hour PM2.5 attainment demonstration and companion annual PM.5 and 8-hour ozone updates.

METEOROLOGICAL MODELING CONFIGURATION

WRF was employed to produce meteorological fields for chemical transport models. The WRF is a 3-D prognostic model that solves the Navier-Stokes' equation, accounts for thermodynamics, conserves mass, and incorporates radiative energy transfer. WRF has been applied to a wide range of phenomena, such as regional climate, monsoons, cyclones, mesoscale fronts, land-sea breezes and mountain-valley circulations. Among two platforms available in WRF – Advanced Research WRF (ARW) and Non-hydrostatic Mesoscale Model (NMM), ARW was chosen for the current modeling analyses.

WRF simulations were conducted with three nested domains of which grid resolutions were 36, 12 and 4 km. The innermost domain has 163 by 115 grid points in abscissa and ordinate, respectively, which spans 652 km by 460 km in east-west and north-south directions, respectively. Geographically, the domain encompasses the greater Los Angeles and suburban areas, its surrounding mountains, and seas off the coast of the Basin as shown in Figure V-3-1. The relative locations and sizes of the three nested grids are given in Figure V-3-1 as well. The model employed 30 layers vertically with the lowest computational layer being approximately 18 m above ground level (agl) and

the top layer at 50 hPa. Note that default modeling top height is 50 hPa in WRF, while that in MM5 is 100 hPa. The National Center for Environmental Prediction (NCEP) North American Model (NAM) model output (Grid 212, 40 km grid spacing), together with vertical soundings and surface measurements, were used to compile initial and boundary values for the outermost domain as well as for the Four Dimensional Data Assimilation (FDDA) to WRF. The cloud radiation, and simple ice cloud physics were chosen for simulations after carefully considering various available options in WRF. Kain-Fritsch cumulus schemes were employed to the outer two domains, while no cumulus parameterization was used for the innermost domain. The selections of PBL and LSM schemes are discussed further in the next section.

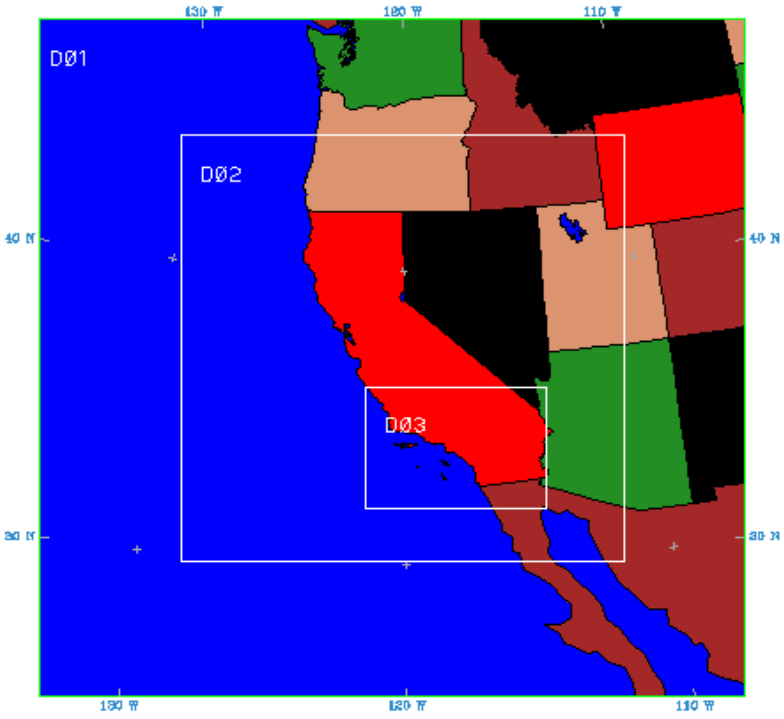


Figure V-3-1

Three nested modeling domains employed in the WRF simulations.

SENSITIVITY TESTS FOR NUMERICAL PARAMETERIZATIONS

Modeling Framework: MM5 vs. WRF

MM5 is a mesoscale meteorological model that has been applied to wide variety of phenomena and wide spectrum of geographical and climatological situations, until it was officially replaced by WRF. As evident from the development history, WRF shares a fundamental platform with MM5. MM5 uses terrain following sigma-coordinate, while WRF uses a vertical coordinate that is a hybrid of terrain following z* and pressure coordinate. Both MM5 and WRF use a non-hydrostatic equation. A hydrostatic version of MM5 is available only till MM5 version 2. The 2007 AQMP used MM5 version 3 non-hydrostatic model, while a hybrid approach using objective analysis from observations was evaluated as a weight of evidence. WRF provides similar parameterizations to those available in MM5, and more new schemes have been developed and updated constantly. Among them, we chose numerical schemes that are similar to those available in MM5 framework. In terms of planetary boundary layer (PBL) schemes, the Yon-Sei University (YSU) scheme is a continuation, but the updated version of Medium Range Forecast (MRF) scheme and Mellor-Yamada-Janjic (MYJ) turblent kinetic energy (TKE) scheme is a continuation of ETA meteorological forecast model scheme in MM5. The comparison presented in Figures V-3-2 and V-3-3 was simulated with MM5-MRF and WRF-YSU schemes. For continuity, the dates used in the simulation comparison were the primary 8-hour ozone modeling episodes evaluated in the 2007 AQMP.

Five-layer thermal diffusion scheme (also referred as ‘slab’) was used in both simulations. The two models were applied to the periods of July 14-18, August 2-8, and August 25-29, 2005, which were among highest ozone episodes that were identified and tested extensively in the 2007 AQMP. The statistical measures presented in the Figures are averages of the simulation period per episode. For example, the July simulations includes the period of July 14-18 so that it had 120 pair of hourly data, while the August episodes covered August 2-9 and 25-30 respectively. All three statistical measures should be zero in a perfect situation, therefore, the smaller the sum of the error measures were, the better the model performed against given observations. The locations of National Weather Services (NWS) METAR measurements used as the baseline for evaluations in addition to the District’s routine monitoring station data are given in Figure V-3-4.

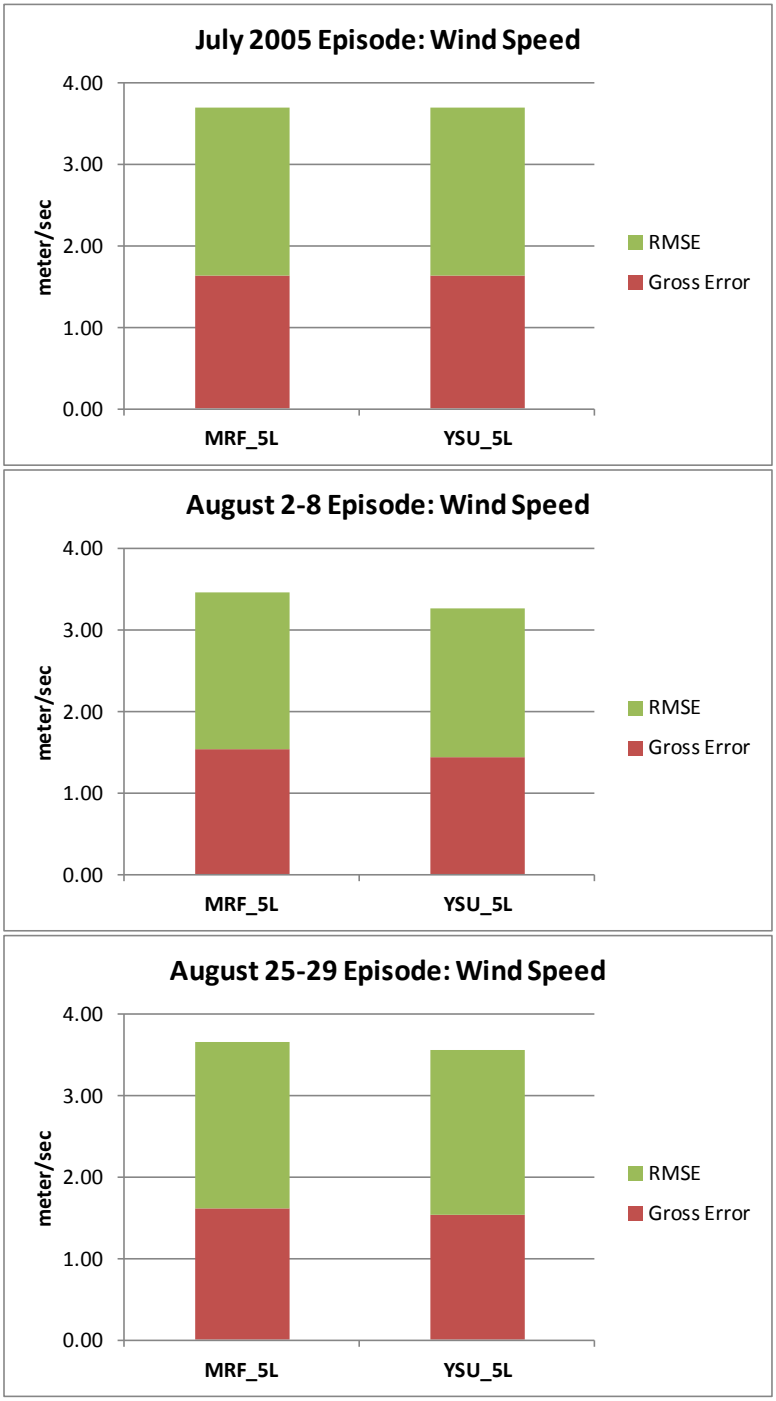


Figure V-3-2

RMSE, gross error and bias of near surface wind speeds simulated with MM5 and WRF. MM5 is noted as MRF and WRF is noted as YSU, respectively, followed by the selected PBL scheme.

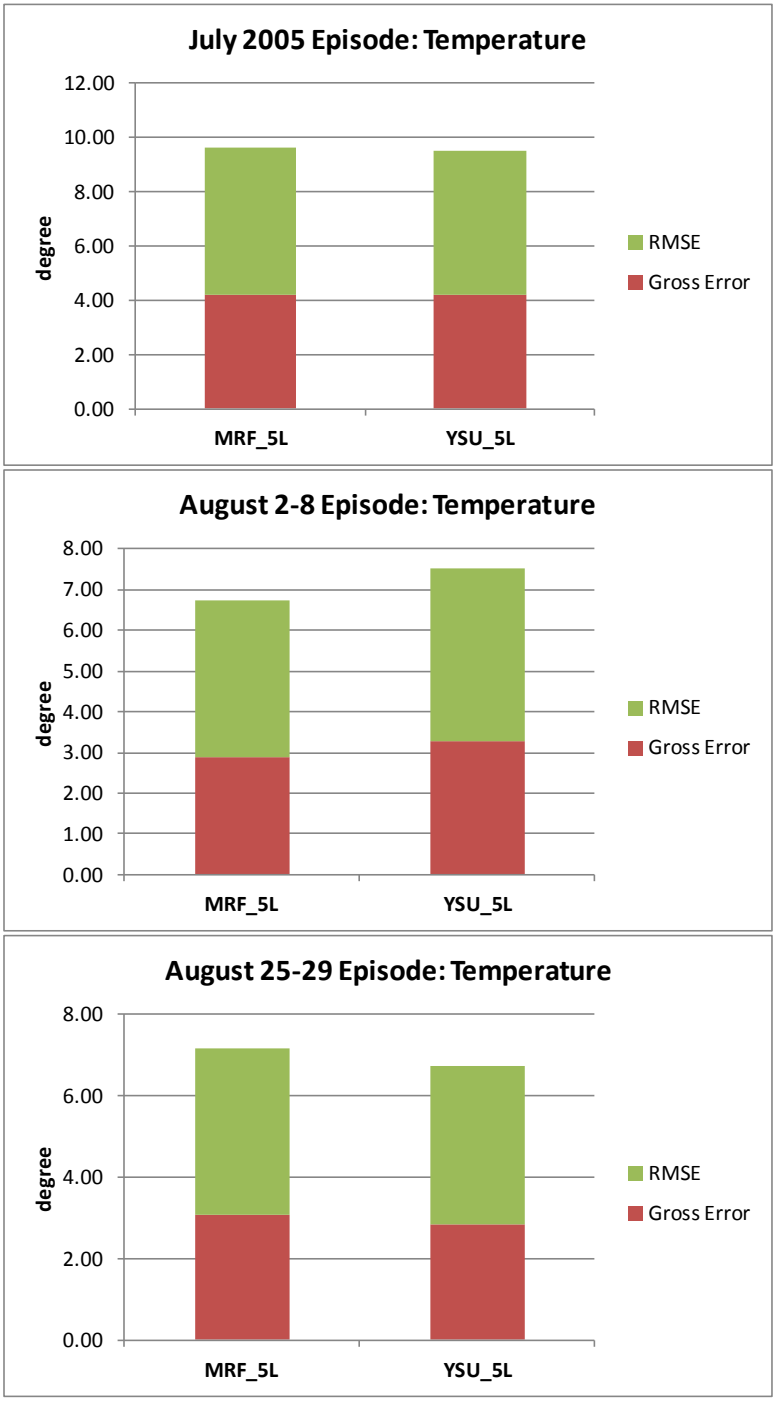


Figure V-3-3

RMSE, gross error and bias of near surface temperature simulated with MM5 and WRF. MM5 is noted as MRF and WRF is noted as YSU, respectively, followed by the selected PBL scheme.

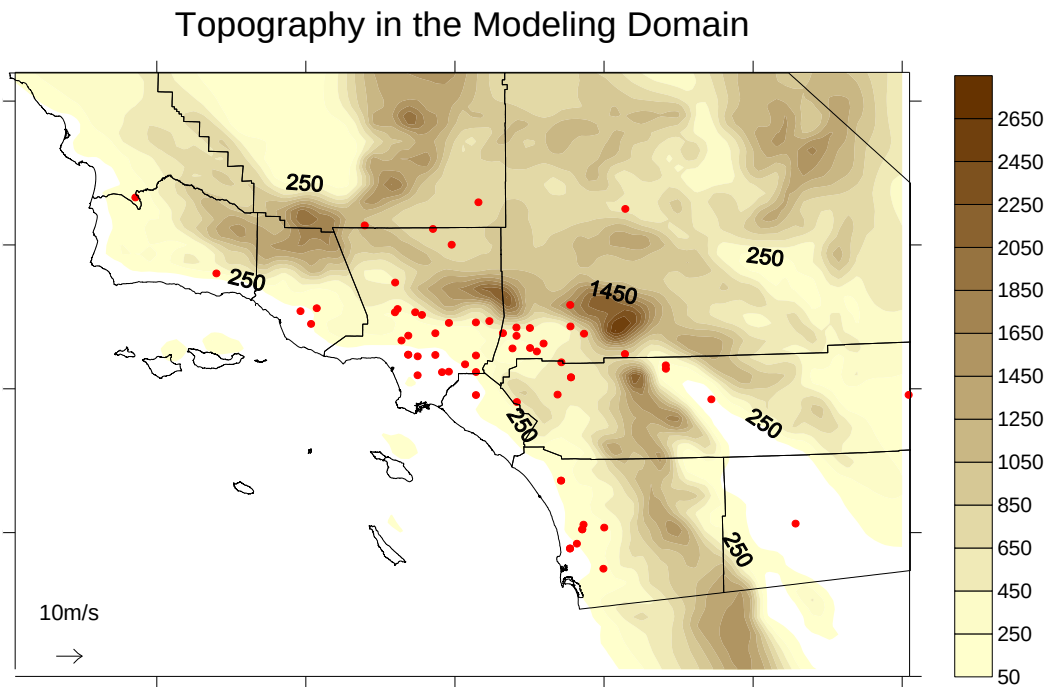


Figure V-3-4

NWS METAR stations within the innermost modeling domain.

As evident in Figures V-3-2 and V-3-3, the performance varies from case to case. In terms of wind prediction, the MM5 model with the MRF PBL scheme outperformed in the July episode, while the opposite occurred in the August 2-8 case. The difference became more distinctive in the temperature predictions. This was partly caused by the fact that a scalar variable responds to a mixing scheme more directly than a vector variable which is a combination of complex force functions. WRF represented with the YSU scheme showed far smaller errors in the latter August case, yet, it showed almost 20% larger error in the early August case. This result suggested that, even though modeling performance varies from case to case, no systematic bias existed in WRF or MM5 simulations applied in Southern California.

PBL Parameterization

WRF, like its predecessor MM5, is a community model for which source code is open to the general public such that improvements to an existing scheme or a new scheme are constantly introduced. This leads to multiple options for physical processes, dynamics, and numerical solutions. WRF version 3.3 provides 11 schemes for the PBL and four different Land Surface Models (LSM's) for application with air quality models. Each scheme has advantages and disadvantages in simulating specific phenomenon, weather

conditions and geographic regions. In addition to numerical schemes, another question is the level of data assimilation to be conducted in the retrospective modeling. Four dimensional data assimilation is a common tool to enhance modeling performance.

It has to be kept in mind that the observations used in the data assimilation should not be used to evaluate the performance of the modeling to avoid auto-correlation with the data of which signal is already embedded in the modeled field. Also, measurement data is not free of error. Different monitoring networks have different measurement protocols that include different measurement heights, averaging time periods, time stamps, etc. Given that data is highly sensitive to measurement height, especially in the surface layer, special attention is required to prepare and use surface measurements. At the same time, while data assimilation generally improves modeling performance, a strong nudging is undesirable since the nudging term is not part of fundamental governing equations and therefore, it introduces imbalance in the physics and dynamics fields.

Therefore, considering the complexity and importance of the modeling configuration, we conducted a series of sensitivity tests to optimize the configuration for the Basin. The tests included the performance of numerical parameterizations, the level of data assimilation, and the validity of measurements to evaluate the modeling performances. In terms of numerical schemes, we primarily focused on PBL and LSM, given that the majority of emissions and related air pollution episodes occur below the atmospheric boundary layer. The PBL schemes tested in this study were YSU and Mellor-Yamada-Janjic (MYJ) schemes from WRF and the Blackadar scheme from MM5. The MRF/YSU scheme has 1^{st} order closure with a non-local mixing term to accommodate large eddies developed during convective periods (Hong and Pan, 1996). During the nocturnal stable period, the YSU scheme goes back to the local approach using traditional K-theory.

MYJ has the parameterization of turbulence for both the PBL and the free atmosphere that is represented as a nonsingular implementation of the Mellor-Yamada Level 2.5 turbulence closure model. The TKE production/dissipation differential equation is solved iteratively, and the empirical constants have been revised based on Janjic (1994, 2002). A TKE based scheme has an advantage of having the explicitly predicted TKE, which is later utilized in retrieving boundary layer depth and formulating the effects of urban morphology.

Blackadar is a non-local mixing scheme that quantifies the vertical eddy fluxes of heat, moisture, and momentum using a hybrid non-local and first-order closure. For nocturnal periods, wherein the atmospheric stratification is usually stable or at most marginally

unstable, a first-order closure is used; here the eddy transfer coefficient K is a function of the Richardson number. For the free convection regime, the vertical convective transfer of heat, moisture and momentum is not determined by local gradients, but by the thermal structure of the whole mixed layer and the surface heat flux. Accordingly, the vertical exchanges are realized between the lowest layer and each level of the mixed layer, instead of between adjacent layers as assumed in the K-theory. The mixing intensity is defined as the fraction of mass exchanged per unit time between the surface layer and other PBL layers. It is directly related to the heat flux at the top of the surface layer and the vertically integrated potential temperature difference between the surface layer and the top of the mixed layer (Blackadar 1979; Zhang and Anthes 1982) .

The performances of PBL schemes were compared against METAR surface meteorological measurements at the site depicted in Figure V-3-4. As discussed in the previous section, YSU is the continuation of MRF of the MM5 model and MYJ is a successor of ETA scheme available in MM5. Blackadar scheme showed the least amount of gross error and RMSE in wind speed predictions. No significant difference existed among the other PBL schemes (Figure V-3-5). For temperature prediction, the ETA scheme showed inferior performance as denoted by the largest errors (Figure V-3-5b). The two WRF schemes – non-local K-theory (YSU) and the local TKE scheme (MYJ) essentially yielded the same result. Yet, considering low computational cast of the YSU scheme and discontinuation of Blackadar scheme in WRF, YSU was chosen as a default PBL scheme for the current attainment demonstration.

Land Surface Model

Three land surface models (LSM) were considered for WRF modeling: the five-layer thermal diffusion scheme (‘slab’ model), and the Noah and Pleim-Xiu schemes. The slab model is the simplest among the three. It calculates soil temperature as a result of thermal diffusion between layers, which are defined at the depths of 0.01, 0.02, 0.04, 0.08, and 0.16 m with the deepest layer being a fixed substrate. The Noah scheme predicts the soil temperature and moisture prognostically in four layers (Chen and Dudhia, 2001).

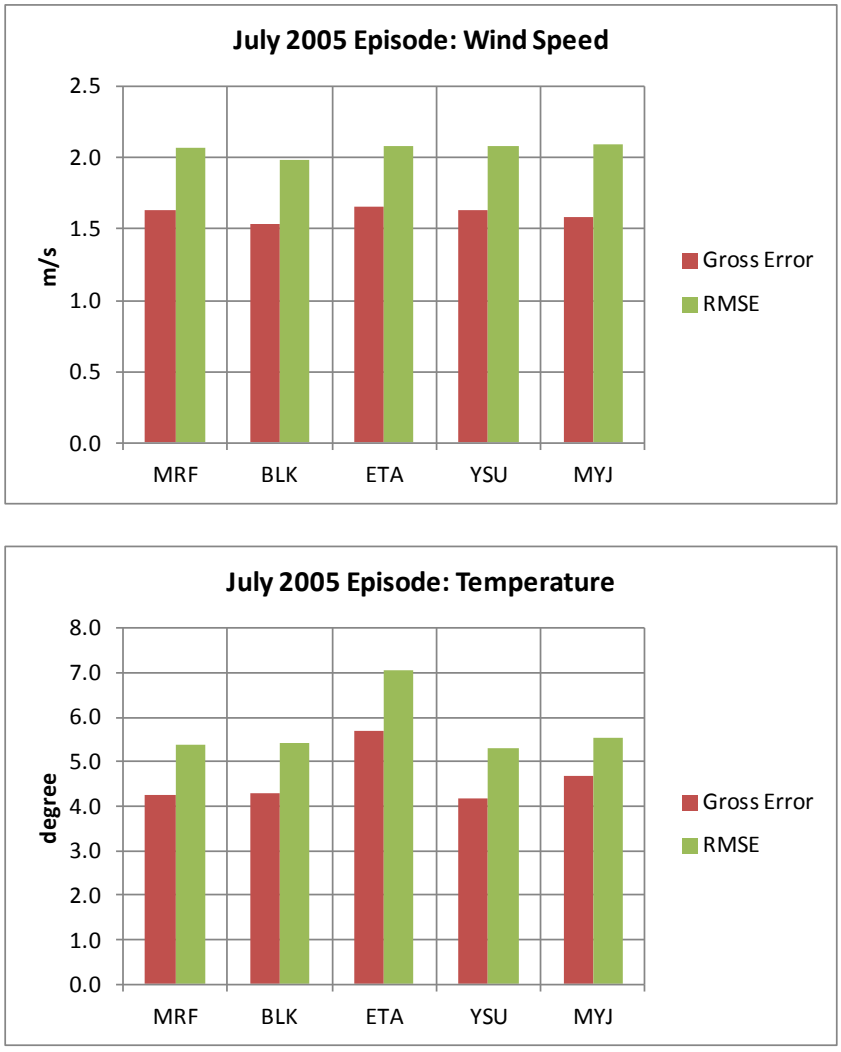


Figure V-3-5

Gross errors and RMSE's of (a) 10 m wind and (b) 2 m temperature from different PBL parameterizations applied to 2005 July Ozone episode. The errors are averages over the entire simulation period and monitoring stations.

By comparison to the effect of using different PBL schemes, modifications to the LSM caused significant responses in near surface variables. First, wind was generally over-predicted during the daytime and under-predicted during the nighttime. The difference between the two schemes was signified during the nocturnal stable period, which occurred in temperature predictions as well. As for wind, the Noah showed a better agreement with observations (Figure V-3-6a), while temperature prediction was worse (Figure V-3-6b). The 5-layer slab model agreed better with the measurements, as evident in the warmer surface temperature fields and the convective boundary layer predicted to be deeper in the Noah scheme (Figure V-3-6c).

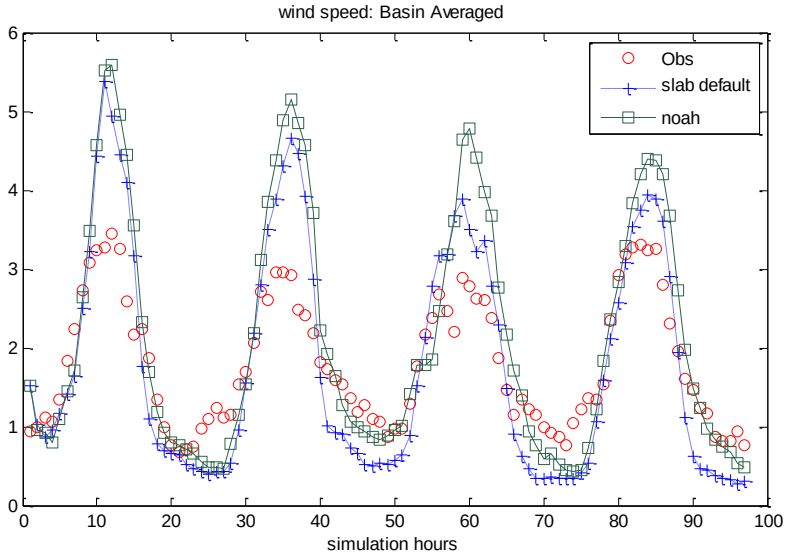


Figure V-3-6a

Time series of Basin-wide averaged wind speeds simulated with five-layer thermal diffusion (referred as 'slab' in the inset) and Noah land surface scheme for July 14-17, 2005.

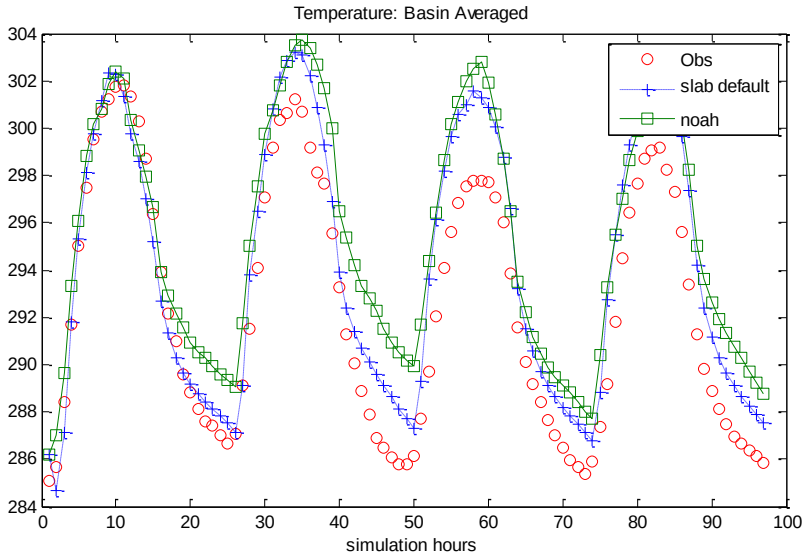


Figure V-3-6b

Time series of Basin-wide averaged temperature simulated with five-layer thermal diffusion (referred as 'slab' in the inset) and Noah land surface scheme for July 14-17, 2005.

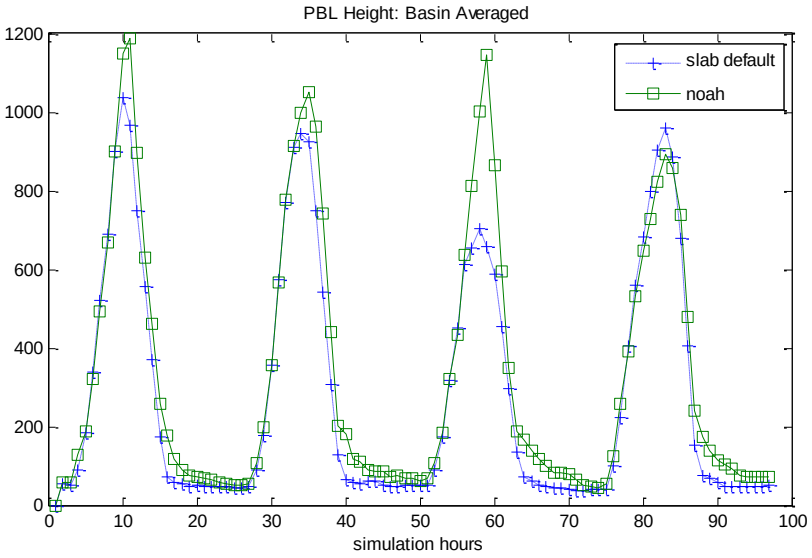


Figure V-3-6c

Time series of Basin-wide averaged mixed layer depth simulated with five-layer thermal diffusion (referred as 'slab' in the inset) and Noah land surface scheme for July 14-17, 2005.

Considering the notable performance differences in the land surface schemes, the choice of LSM was inconclusive since the one that perfomed better with respect to winds showed larger deviations in temperature. Therfore, we applied the two meteorological fields to the chemical transport model, CMAQ, to evaluate the effects on dispersion. The relatively inert characteristics of carbon monoxide (CO) make it suitable to evaluate transport only. CO concentrations predicted by CMAQ with two different meteorological fields were compared (Figure V-3-7). While differences existed in meteorological fields, the impact on dispersion was relatively small. For a six-day period from July 14 to July 19, 2005, the two schemes showed almost equivalent performance with the only exceptions in the high value range. The slab model predicted higher concentrations, which was, in part, attributed to the shallow mixing in the model relative to the Noah scheme.

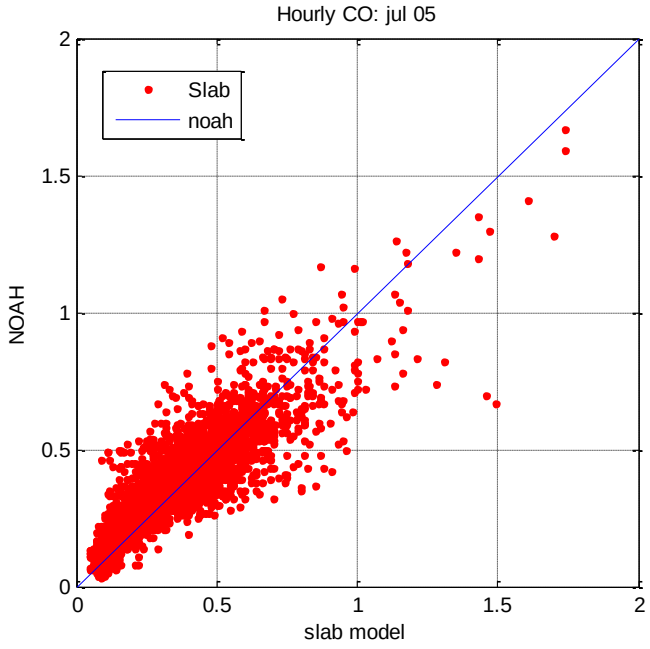


Figure V-3-7

Scatter plot of 1-hour CO concentrations simulated with the slab and the Noah scheme over the period of July 14-19, 2005.

Initial Guess Field

Global Forecast System (GFS) and North American Model (NAM), both widely used operational weather forecast models were evaluated to be used as initial guess fields for WRF. We used WRF and subsequent chemical transport modeling in the retrospective mode in the attainment demonstrations such that 3-D analysis fields were available. Therefore, analysis fields were chosen over direct forecast model output, unless a block of missing data occurred. In such case, forecast fields were used to replace the gap. The analysis fields were complied to be used as the initial value, the lateral boundary value and 3-D analysis nudging fields. In our application, the NAM provided fields compared well with the GFS fields (Figure 8). Given the fact that synoptic forcing becomes more important during winter months than in summer in Southern California, the same experiments were repeated for a month of December 2008. The performance of the two tests was essentially identical, so the NAM analysis field was selected as the primary initial guess field.

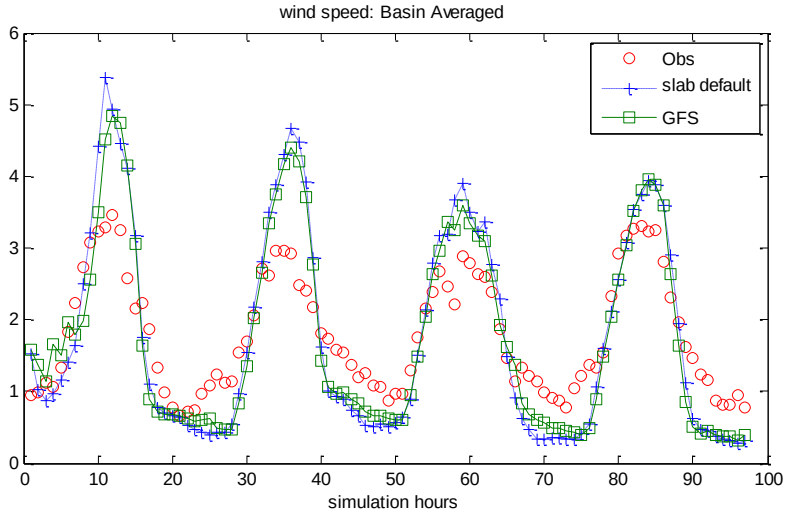


Figure V-3-8a

Time series of Basin-wide averaged wind speed simulated with initial guess fields from GFS and NAM for July 14-17, 2005.

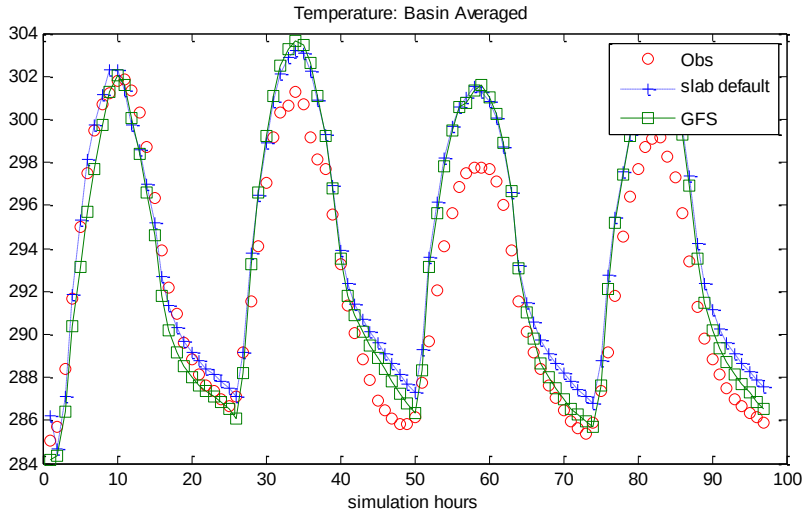


Figure V-3-8b

Time series of Basin-wide averaged temperature simulated with initial guess fields from GFS and NAM for July 14-17, 2005.

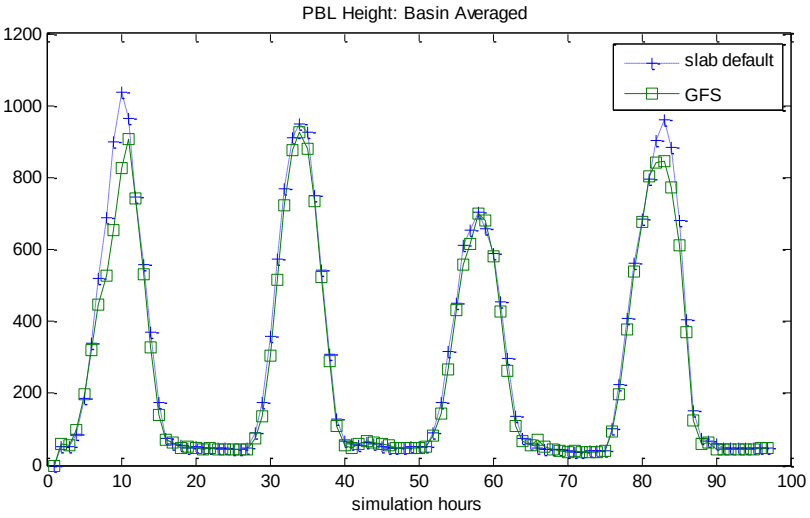


Figure V-3-8a

Time series of Basin-wide averaged temperature simulated with initial guess fields from GFS and NAM for July 14-17, 2005.

LAND USE REPRESENTATION

The land use databases available in WRF are the U.S. Geological Society (USGS) default and the Moderate Resolution Imaging Spectroradiometer (MODIS) satellite based dataset. The USGS dataset has been the default dataset for mesoscale modeling for MM5, a predecessor to WRF. While it is a ready-to-use off-the shelf database, some data representations are several-decades old and consequently do not reflect changes in the areas that have experienced rapid development in recent years. The South Coast Air Basin, especially in parts of Riverside, San Bernardino and the San Fernando Valley areas, have experienced rapid development in the last decade that turned shrub and grassland into suburban housing units and impervious land cover. Accordingly, the location and extent of urban representation is often inaccurate in the Basin. Figure V-3-9 presents the land use distribution in the innermost modeling domain. The urban category represented in dark red is confined to near downtown Los Angeles and appears at a few more spots in Orange, Riverside and San Bernardino Counties.

The majority of open space depicted in the USGS data base between urbanized Los Angeles and Riverside counties has been presented as land use category 7, 8, and 9 which are, respectively, grass, shrub, and mixed shrub/grassland (Table V-3-1). Comparing with land cover retrieved from USGS Land Use Land Cover database 2001 (Figure V-3-10), medium and low intensity developed categories identified in the recent database almost did not exist in the USGS default data. These changes in the recent years are further evident in Figure V-3-11, which are retrieved from NOAA southern coastal land cover land use (2000).

The satellite based dataset provides the most up-to-date land use representation which reflects the recent changes discussed above. The MODIS based land use given in Figure V-3-12 shows an expanded size and shape of urban use compared to Figure V-3-9. Table V-3-2 provides the MODIS index legend. Yet, while the shape and location of "urban" built-up area differs between the satellite-based and USGS dataset, both provide only a single category that represents urban built-up areas for use in the in WRF modeling. The single category specification of urban land use may not adequately characterize the diversity that exists in the "urban" area, ranging from high rises in downtown commercial districts to single story houses in suburban residential areas. According to Grimmond and Oke (1999), the surface roughness length in a residential neighborhood in San Gabriel is approximately 7 m, while that of a metropolitan downtown area in Vancouver is approximately 20 m. The surface roughness length assigned to "urban" in default WRF model is 0.8 m, which is valid only in an area in

which building height is approximately 8 m, essentially the height of a two- to three-story building.

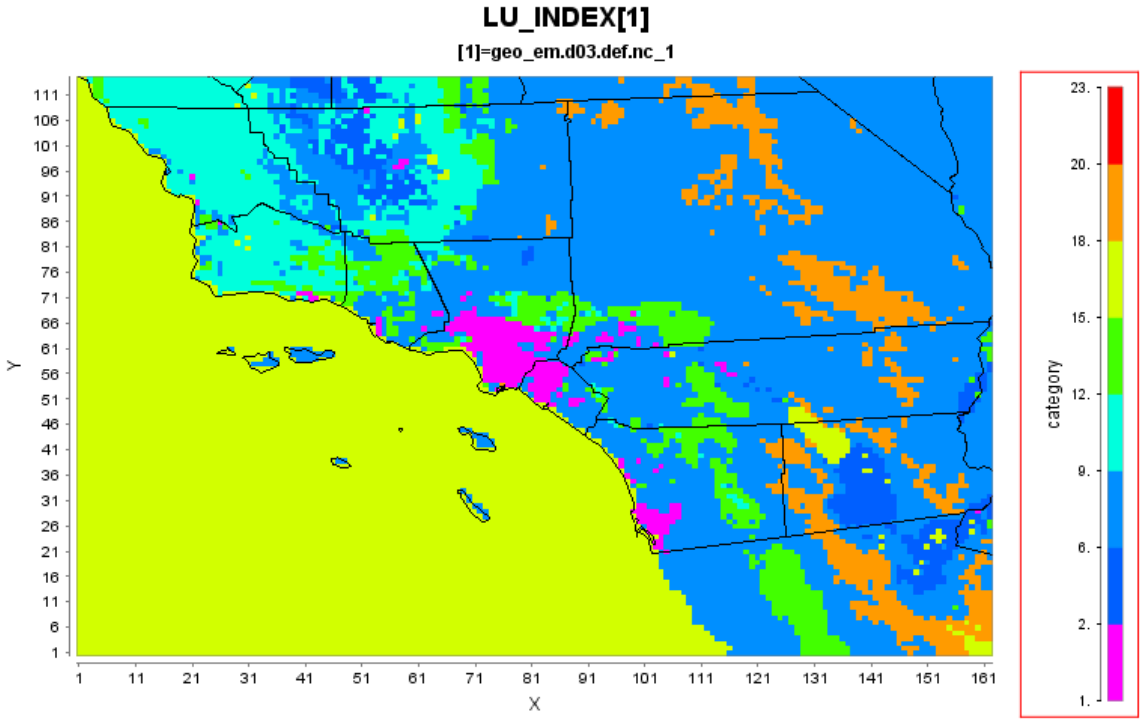


Figure V-3-9

Land use distribution based on USGS 24 category.

(The legend index is given in Table V-3-1).

This is hardly applicable to a downtown high rise district or a suburban residential neighborhood. Therefore, a need was recognized to introduce a new category that distinguishes suburban neighborhood from downtown commercial districts. The Final 2012 AQMP introduced a new category, "suburban" to reduce the gap between the highly impervious commercial area and a suburban housing neighborhood that has altered surface energy balance by artificially introducing irrigation and imperviousness. The 'urban' category was assigned with a higher surface roughness length of 1.5 m instead of the default 0.8 m to better characterize the impacts of taller buildings (e.g., high rise skyscrapers) in a commercial district. The 'suburban' category was assigned a 0.7 m roughness length considering most suburban housing is single to double story. The location and extent of the new suburban category is depicted in Figure V-3-13.

TABLE V-3-1

USGS 24-category Land Use Categories

Land Use	Land Use Description
1	Urban and Built-up Land
2	Dryland Cropland and Pasture
3	Irrigated Cropland and Pasture
4	Mixed Dryland/Irrigated Cropland and Pasture
5	Cropland/Grassland Mosaic
6	Cropland/Woodland Mosaic
7	Grassland
8	Shrubland
9	Mixed Shrubland/Grassland
10	Savanna
11	Deciduous Broadleaf Forest
12	Deciduous Needleleaf Forest
13	Evergreen Broadleaf
14	Evergreen Needleleaf
15	Mixed Forest
16	Water Bodies
17	Herbaceous Wetland
18	Wooden Wetland
19	Barren or Sparsely Vegetated
20	Herbaceous Tundra
21	Wooded Tundra
22	Mixed Tundra
23	Bare Ground Tundra
24	Snow or Ice

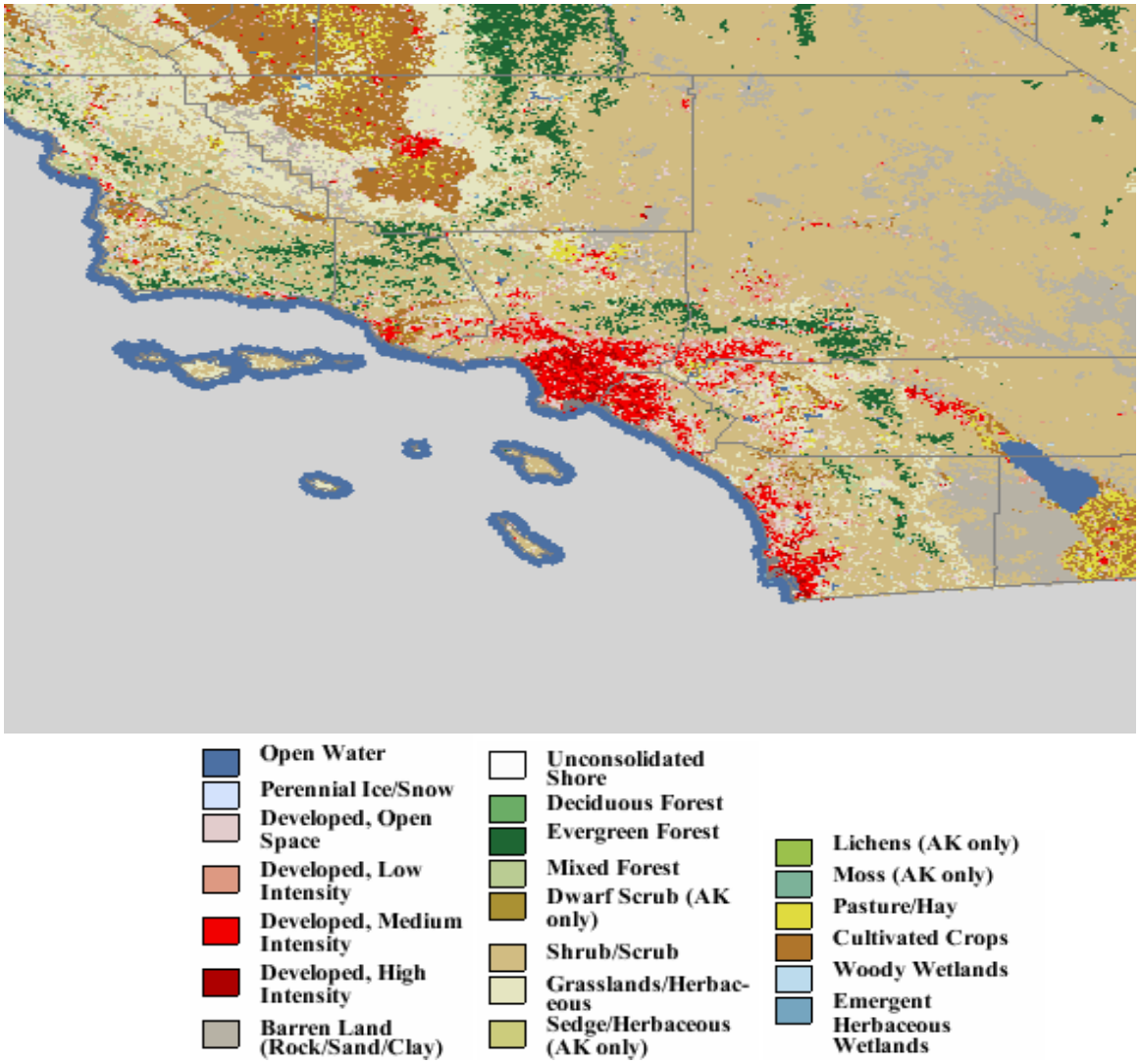


Figure V-3-10

Land use land cover data 2001 from USGS.

Figure V-3-11

NOAA Southern Coastal California Land Cover/Land Use 2000

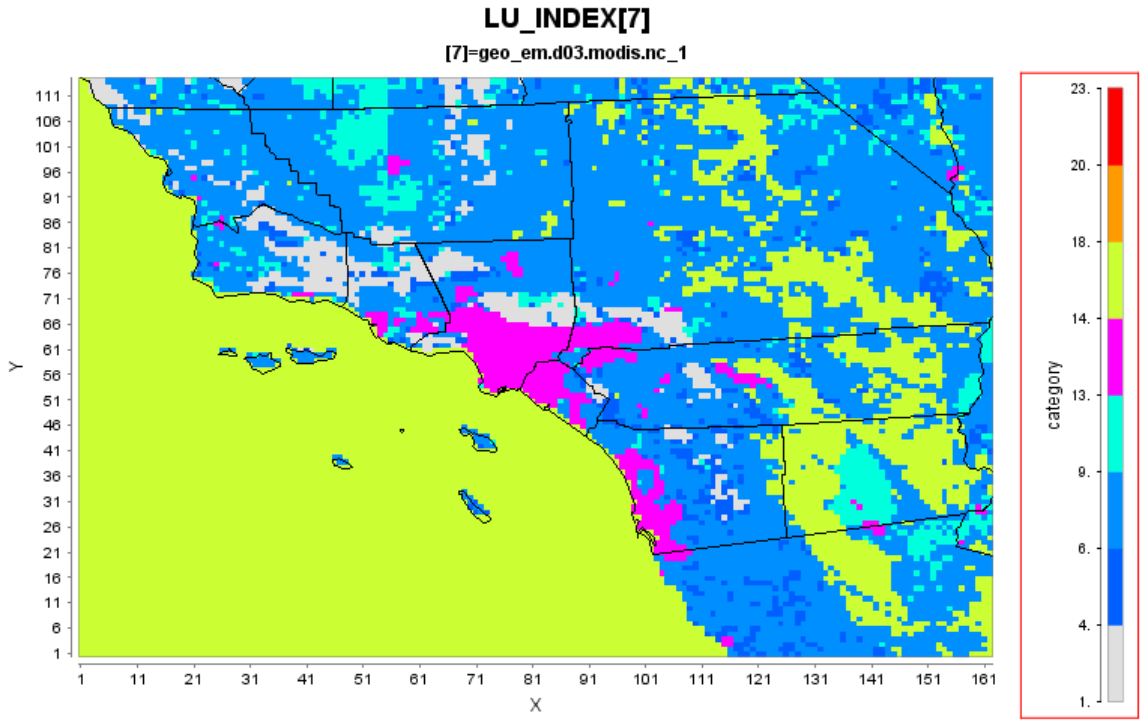


Figure V-3-12

Land use distribution based on MODIS satellite database

TABLE V-3-2

IGBP-Modified MODIS 20-category Land Use Categories

Land Use Category	Land Use Description
1	Evergreen Needleleaf Forest
2	Evergreen Broadleaf Forest
3	Deciduous Needleleaf Forest
4	Deciduous Broadleaf Forest
5	Mixed Forests
6	Closed Shrublands
7	Open Shrublands
8	Woody Savannas
9	Savannas
10	Grasslands
11	Permanent Wetlands
12	Croplands
13	Urban and Built-Up
14	Cropland/Natural Vegetation Mosaic
15	Snow and Ice
16	Barren or Sparsely Vegetated
17	Water
18	Wooded Tundra
19	Mixed Tundra
20	Barren Tundra

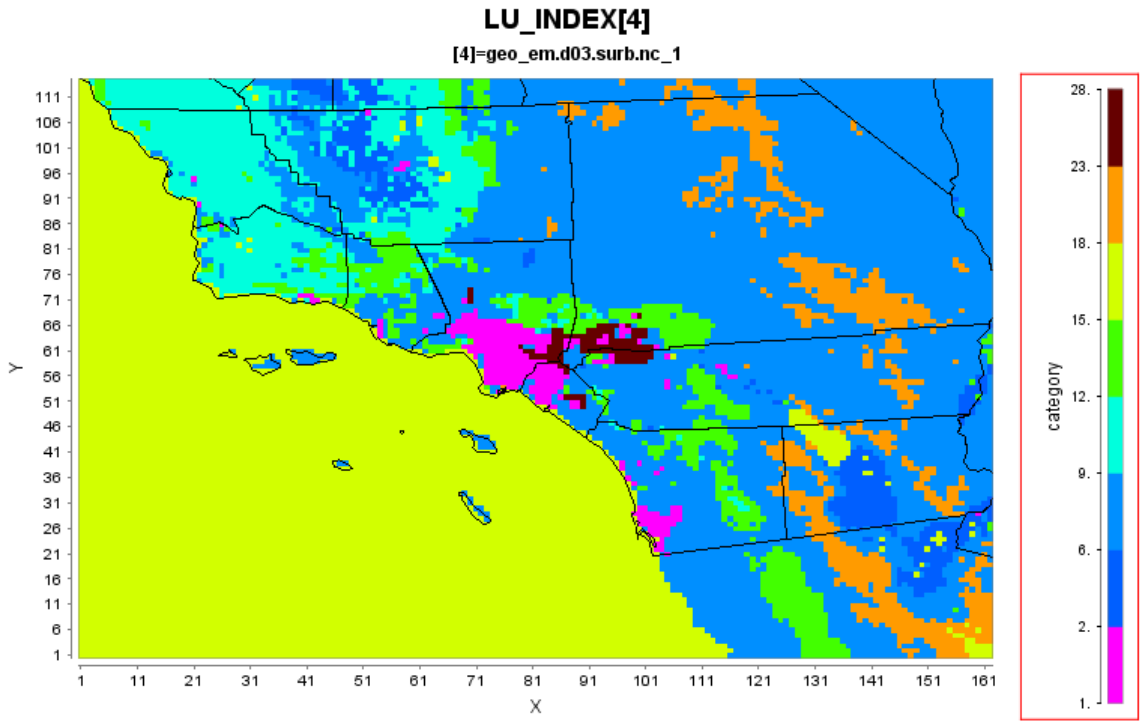


Figure V-3-13

USGS 24 land use category with added suburban category which was marked in dark brown color

In general, the updated land use showed better agreement with observations (Figure V-3-14). Over-prediction of wind was evident during the daytime when the slab model was used with the USGS default land use. This was significantly improved with the updated suburban land use. Neither temperature nor PBL show as large an improvement as seen in the winds. Compared to the Noah land surface model, the slab model showed weaker wind speed, lower temperature and consequently lower mixed layer depth during the daytime, which was consistent to the discussions presented in the previous section and Figure V-3-6. The difference between the two Noah simulations – one with the default UGSG and the other with MODIS data was induced by land use difference. The expanded urban category in the MODIS based data exerted larger amount of surface friction which resulted in weaker wind speed. This effect occurred in the slab model with suburban simulation, as well. The Noah-MODIS was distinctively differently in nocturnal temperature. The Noah-MODIS simulated warmer nocturnal condition, which is partly due to the urban heat island effect. Interestingly, this nocturnal warm temperature did not agree well with measurements. Such warmer nocturnal temperatures did not exist in the slab-suburban run. The discrepancy between the simulations appears

to have resulted more from the numerical scheme (Noah vs. slab) selected rather than land use changes. Overall, the slab model outperformed Noah scheme.

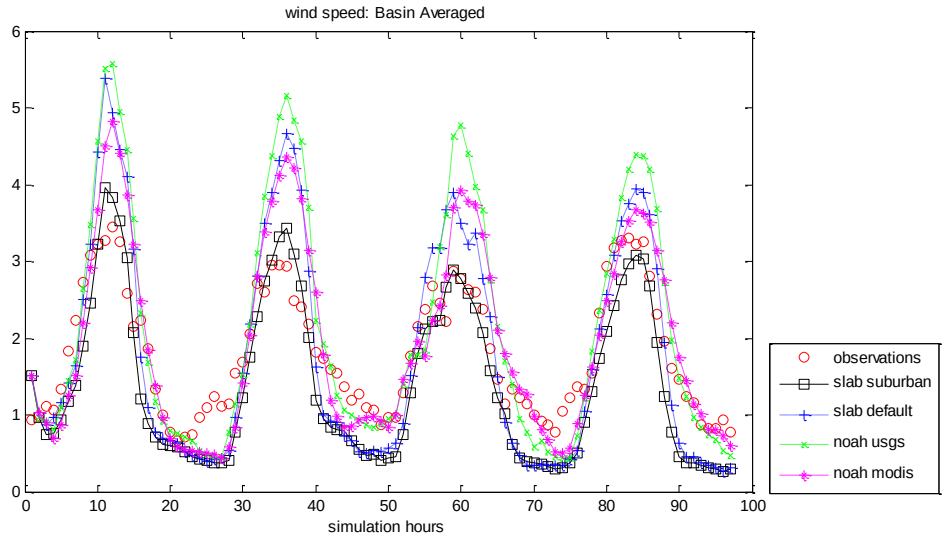


Figure V-3-14a

Time series of Basin-wide averaged wind speed for July 14-17, 2005.

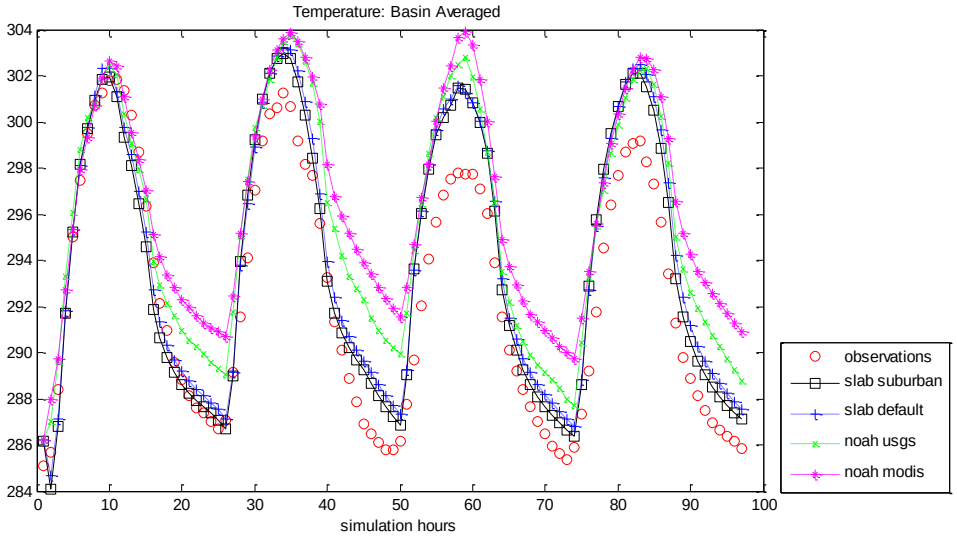


Figure V-3-14b

Time series of Basin-wide averaged temperature for July 14-17, 2005.

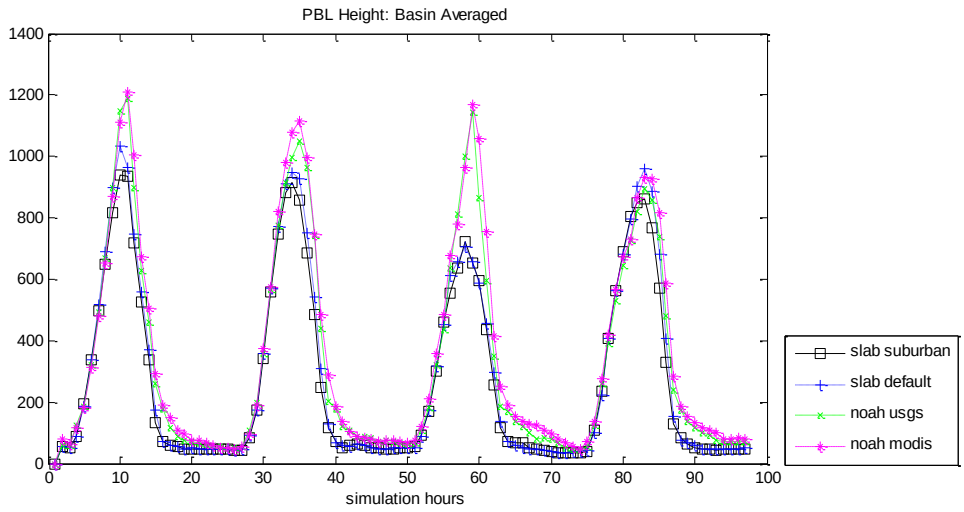


Figure V-3-14c

Time series of Basin-wide averaged mixed layer depth for July 14-17, 2005.

STATISTICAL PERFORMANCE EVALUATION

A set of statistical variables were generated using the METSTAT software to evaluate the WRF modeling performance quantitatively. The list of statistical parameters included bias, gross error and root mean square error and the Index of Agreement (IOA). The IOA was calculated following the approach of Willmont (1981). This metric condenses all the differences between model estimates and observations within a given analysis region and for a given time period (hourly and daily) into one statistical quantity. It is the ratio of the total RMSE to the sum of two differences – between each prediction and the observed mean, and each observation and the observed mean. The index of agreement has a theoretical range of 0 to 1; with a score of 1 suggesting perfect agreement.

The graphical presentation of the WRF performance evaluation for the month of June 2008 is depicted in Figure V-3-15. Shown in the figure are bias, RMSE and index of agreement for near surface wind, temperature and water vapor mixing ratio. Briefly, temperature prediction accuracy was high with an IOA greater than 0.9. The wind speed bias was nominally directed towards lower predicted speeds with a mean IOA on the order of 0.7. Wind direction was reasonably captured on the majority of days with bias falling within 15-30 degrees on average. The WRF humidity simulations depicted a

tendency to overestimate vapor content with a moderate degree of diurnal variability. The humidity IOA averaged approximately 0.5 for the June period.

The METSTAT WRF evaluation compares well to the MM5 meteorological fields generated for the 2007 AQMP attainment demonstrations. In general average IOA estimates are slightly higher for the Final 2012 AQMP WRF simulation. Gross error in the temperature prediction is approximately half of the 2007 MM5 estimates and wind speed error is approximately the same, but with the WRF tendency to be slightly under-predicted where the MM5 simulations were over-estimated. Both models exhibited IOAs of approximately 0.5 for the prediction of water vapor (absolute humidity).

Overall, the daily WRF simulation for 2008 provided representative meteorological fields that well characterized the observed conditions. These fields were used directly in the CMAQ joint particulate and ozone simulations. The fall and winter month's graphical and statistical meteorological characterization of the wind, temperature and humidity fields are presented in Attachment 1 to this document.

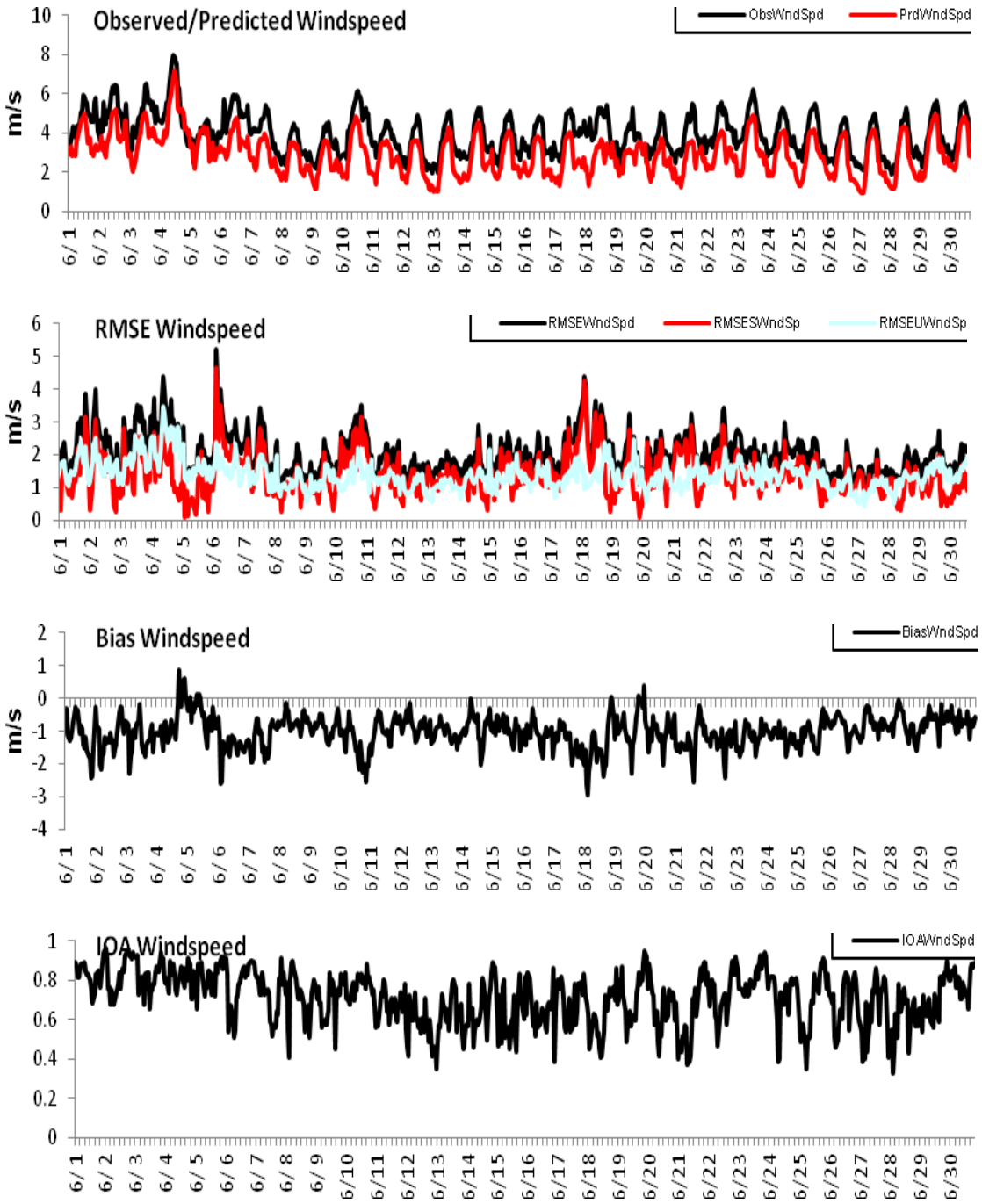


Figure V-3-15a

Time series of Basin-wide averaged wind speed error, bias and IOA for June, 2008.

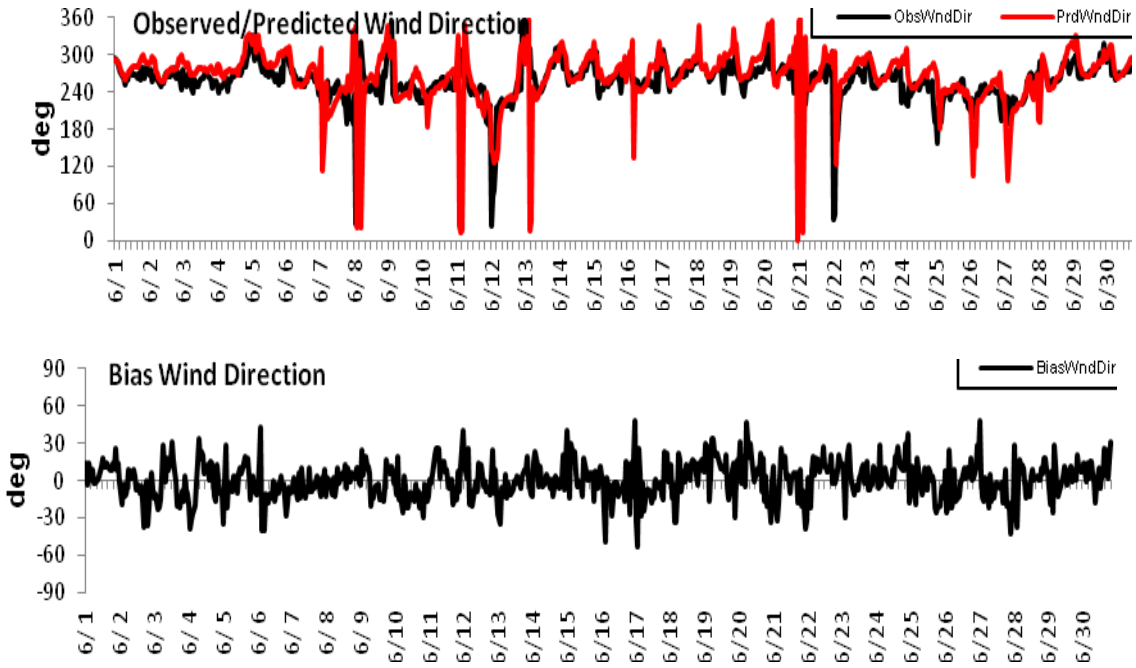


Figure V-3-15b

Time series of Basin-wide averaged wind direction and bias for June, 2008.

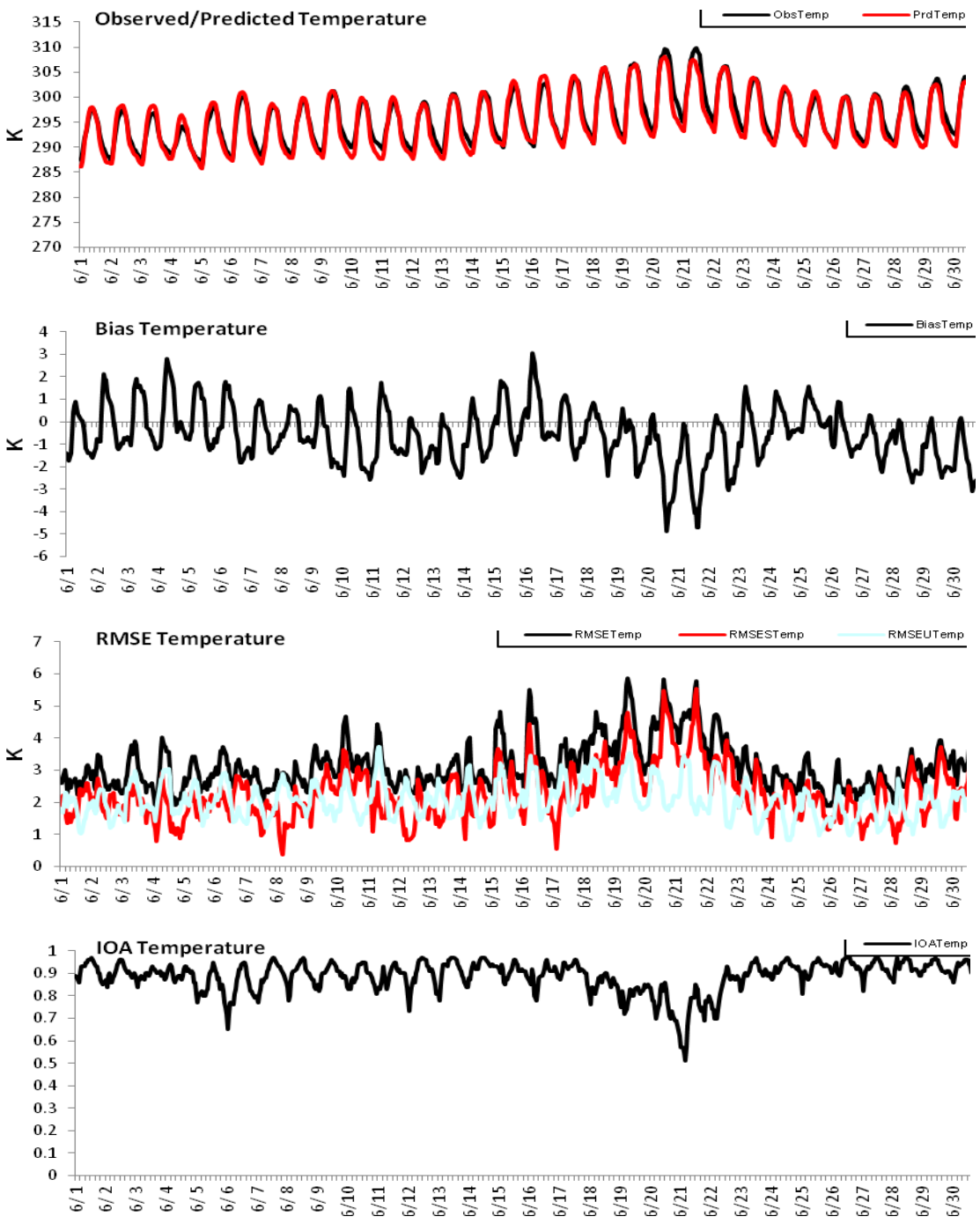


Figure V-3-15c

Time series of Basin-wide averaged temperature error, bias and IOA for June, 2008.

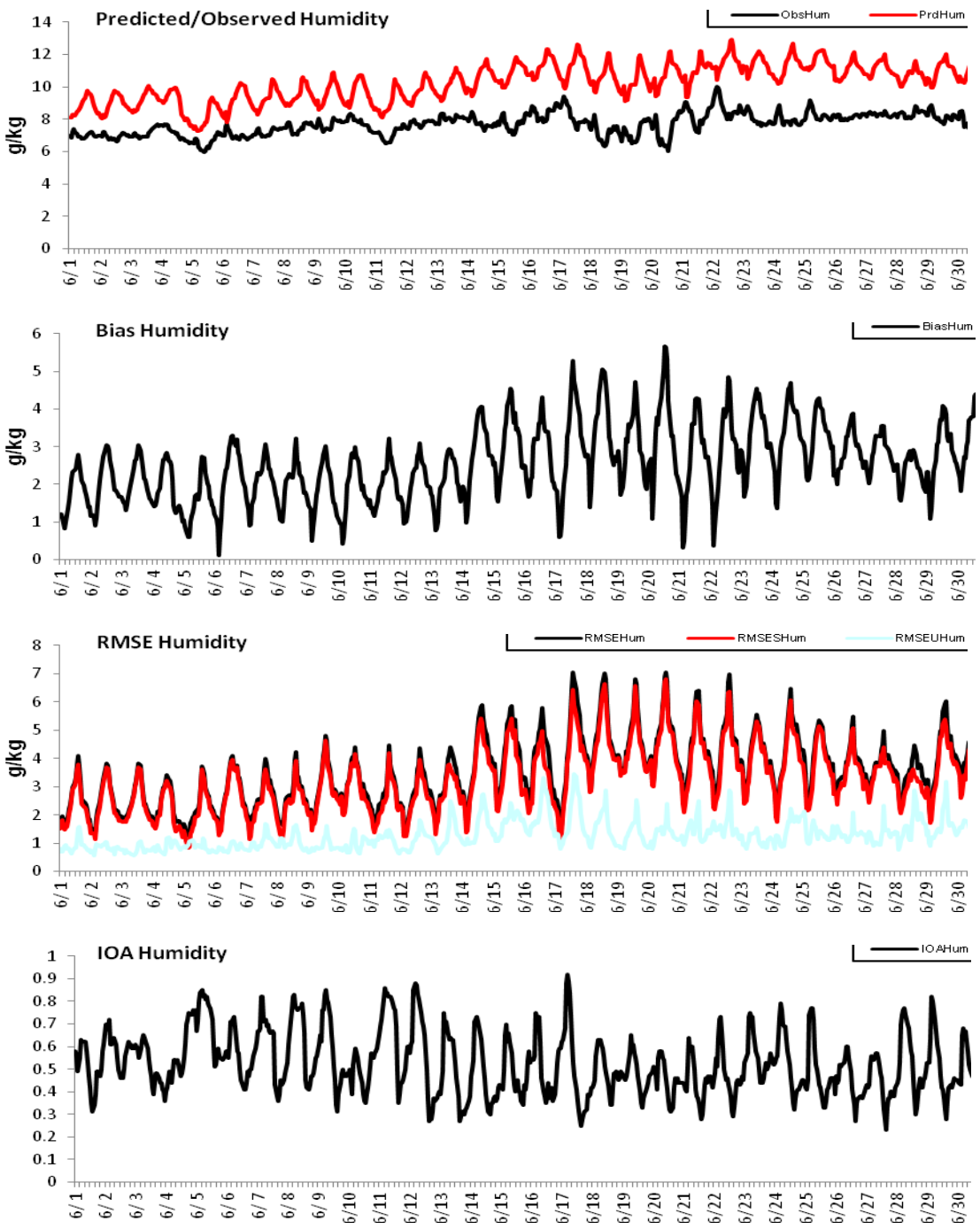


Figure V-3-15d

Time series of Basin-wide averaged humidity error, bias and IOA for June, 2008.

SENSITIVITY TESTS

A series of sensitivity tests were conducted to ensure the best performance of CMAQ. They include an inter-comparison of modeling platforms, the effect of lateral boundary values, vertical computational layer collapsing, the performance of vertical mixing schemes, and mass conservation. Among them, given the significance of the tests, the modeling platform inter-comparison and the effect of lateral boundary values are discussed here in detail.

Modeling Platform Inter-Comparison: CMAQ vs. CAMx

Comprehensive Air Quality Model with extensions (CAMx), including its predecessor Urban Airshed Model (UAM) has been applied to many air pollution episodes in California and has demonstrated its capability as a tool for attainment demonstration successfully. The District employed CAMx for the attainment demonstration in the 2007 AQMP. On the contrary, CMAQ has not been used for a regulatory purpose in the state of California nor in the Basin before. Still, it has been widely applied in other states in a regulatory context. Its large user community enables a robust evaluation of existing schemes and a fast adaption of newly developed parameterizations in the CMAQ framework. In this context, we intended to ensure that CMAQ provides the performance equal to or better than the one demonstrated in the 2007 AQMP. The options used in CMAQ were SAPRC99 chemical mechanism, Euler Backward Iterative (EBI) chemical solver, aero5 aerosol module, Piecewise Parabolic Method (PPM) advection scheme in both horizontal and vertical direction, and Asymmetric Convective Model version-2 (ACM2) vertical diffusion scheme. CAMx was configured to have the same chemical mechanism, chemistry solver, and advection and diffusion schemes.

The maximum 8-hour ozone recorded during the period from June 1st to August 31st of 2008 was 131 ppb recorded at Crestline (Figure V-3-16). The basin-wide maximum concentrations typically occur at Crestline, while Santa Clarita, Glendora, and San Bernardino valleys supplant Crestline as the maximum station when meteorological conditions favor it. In general, CMAQ reproduced the day-to-day variation reasonably well except for a few days at the end of June and the beginning of July in which a large high bias was evident. (CMAQ ozone simulation performance is discussed at length in Chapter 7). These high bias cases are further discussed in the following section. Comparing the two models, CAMx showed significantly lower predictions over the entire period. The bias was distinctive throughout the Basin as well, though the bias tended to increase in the eastern Basin. The Crestline site showed over 20 ppb differences at times, while the difference was rarely over 20 ppb at the Anaheim

location. Subsequent analysis indicated no involvement of systematic or nonsystematic errors in the input data and modeling configurations. In terms of performance statics, CMAQ yielded better agreement with observations.

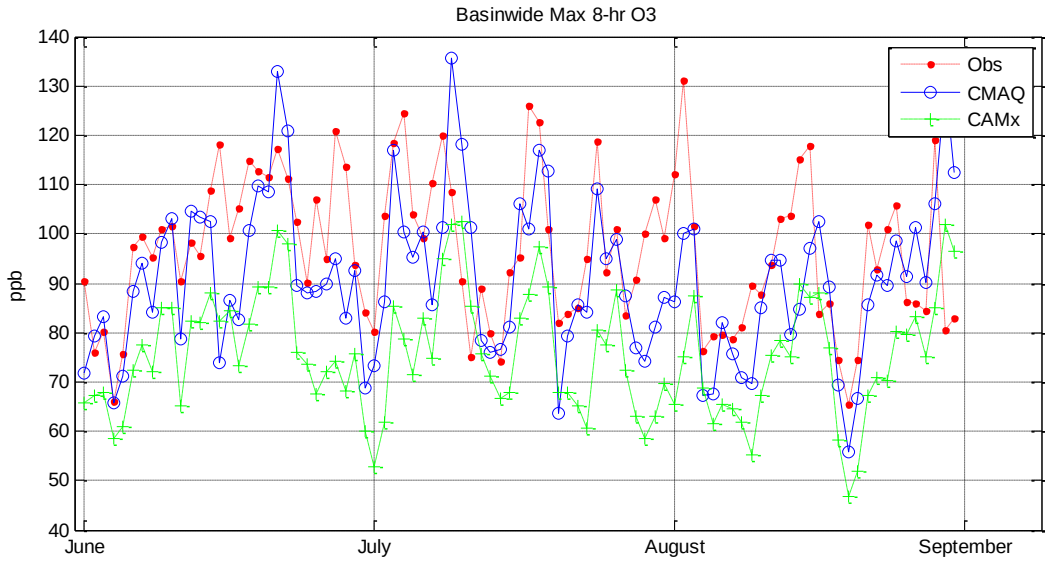


Figure V-3-16

Basin-wide maximum 8-hr ozone during the period of June 1 to August 31, 2008.

Lateral Boundary Values

Given the importance of lateral boundary values and the uncertainties associated with them, a set of lateral boundary values were tested using CMAQ. They were (1) global chemical model results, (2) U.S. EPA clean boundary values, and (3) climatological profiles retrieved from a special measurement campaign conducted in the Basin. Global chemical transport models, such as the Model for OZone and Related chemical Tracers (MOZART), GEOS-Chem, Regional Air Quality Modeling System (RAQMS), are increasing in their use to drive regional air quality model simulation. Among them, MOZART was used in the current study due to the availability of its output for the modeling year 2008 and accessibility to its interface processor that converts the MOZART output to CMAQ chemical species and format. The clean boundary values were the same ones employed in the 2007 AQMP. The details were provided in Table V-4-7, Appendix V of the 2007 AQMP (SCAQMD, 2007). Aircraft measurements

were taken during a campaign conducted covering periods of 2009 and 2010 along the coast of Southern California, extending offshore out to 100 miles over the ocean. The campaign was designed to have approximately two flights per month; the data were complied into a climatological profile of ozone and photochemical oxidants (Baxter et al, 2010).

The boundary values retrieved from MOZART are illustrated in Figures V-3-17 through V-3-19. The values were averaged along the northern, southern, eastern and western perimeters of the modeling domain to characterize the general behavior of MOZART along the lateral boundaries. Among the four sides, the east boundary showed the highest concentrations which reflect anthropogenic emissions from the Basin. The vertical variation of ozone set the lowest values in the upper boundary layer, gradually increasing in concentration with height to a maximum concentration at the model top layer. Note that the model top layer is 50 hPa (approximately 20 km) in the lower stratospheric ozone layer. CO and NO2 had the highest concentration within the boundary layer due to anthropogenic emissions at the ground level.

Through the first 10-layers, the U.S. EPA clean boundary ozone concentration split the MOZART extracted west and east values, while CO and NO2 from the clean boundary were higher than the MOZART. The climatological profiles compiled from aircraft measurements are presented in Figure V-3-20. A layer of high ozone exists around 600 m above ground level, which corresponded to the height of the sea breeze return flow. The return flow contained high levels of photochemical oxidants that were produced in the Basin during the daytime. This air mass, like the residual layer, stayed inert due to decoupling from surface emissions. This mechanism resulted in the high ozone peak aloft above the marine layer. Easterly winds measured by a radar wind profiler supported a multiple layer structure and the location of the return flow (Baxter et al, 2010). Note that the profile was taken at an Oxnard airport which is located by the shore. Figure V-3-20 suggested that seasonal variation from month to month was evident, but not significant. Therefore, the average profile for the period of May through September was selected and digitized into the modeling grids (Figure V-3-21).

The differences among the lateral boundary values were the largest in the free atmosphere and geographically near the boundaries. Figure V-3-22 illustrates the large differences aloft and the downward mixing to the surface level. The influence of ozone fumigation to ground level near the center of the Basin was several ppb in concentration as shown in Figure V-3-23. The MOZART-retrieved and aircraft-based runs predicted higher surface ozone than the clean boundary, which was attributed to the higher concentration aloft that was entrained into the lower boundary layer via convection.

The western boundary appeared to be set far enough offshore to minimize spurious influence of the boundary values transported into the Basin. Despite the large differences between the MOZART and the aircraft boundaries, surface ozone from the two simulations were almost identical (Figure V-3-23).

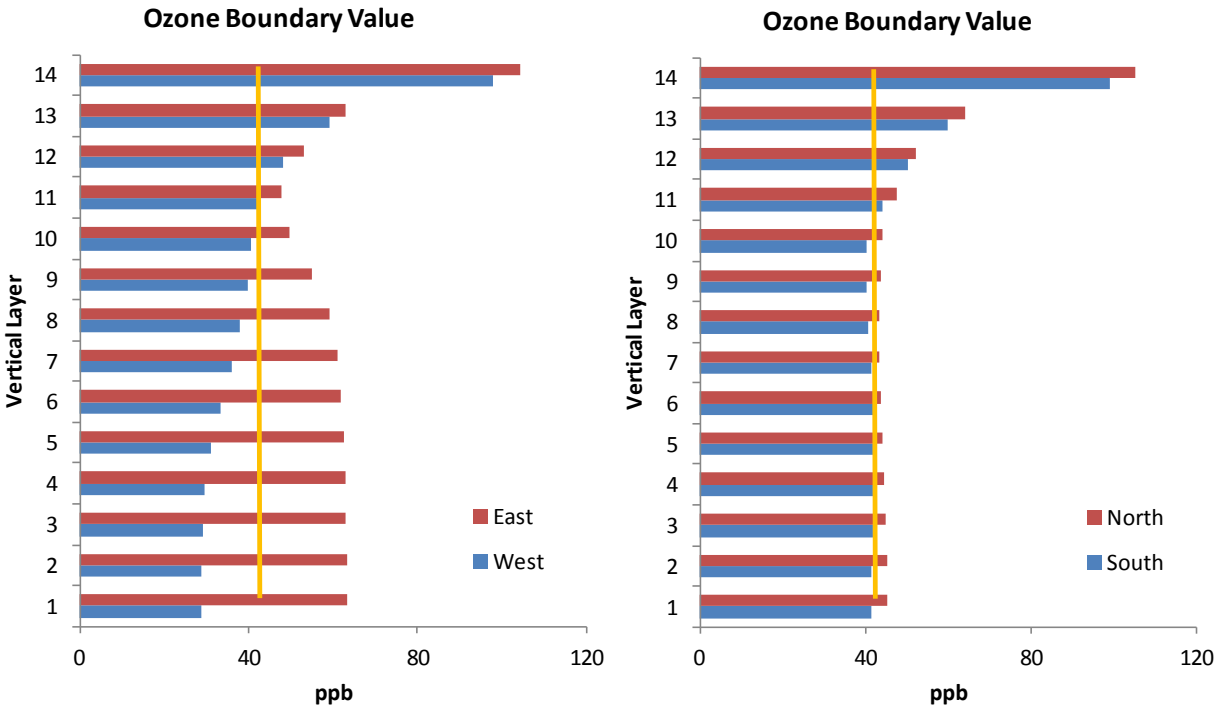


Figure V-3-17

Vertical profiles of Ozone from MOZART in a 15 layer structure. The values were averaged over the perimeter in the given direction at a given layer. The top layer corresponds to the modeling top. The solid yellow line represents the clean boundary value.

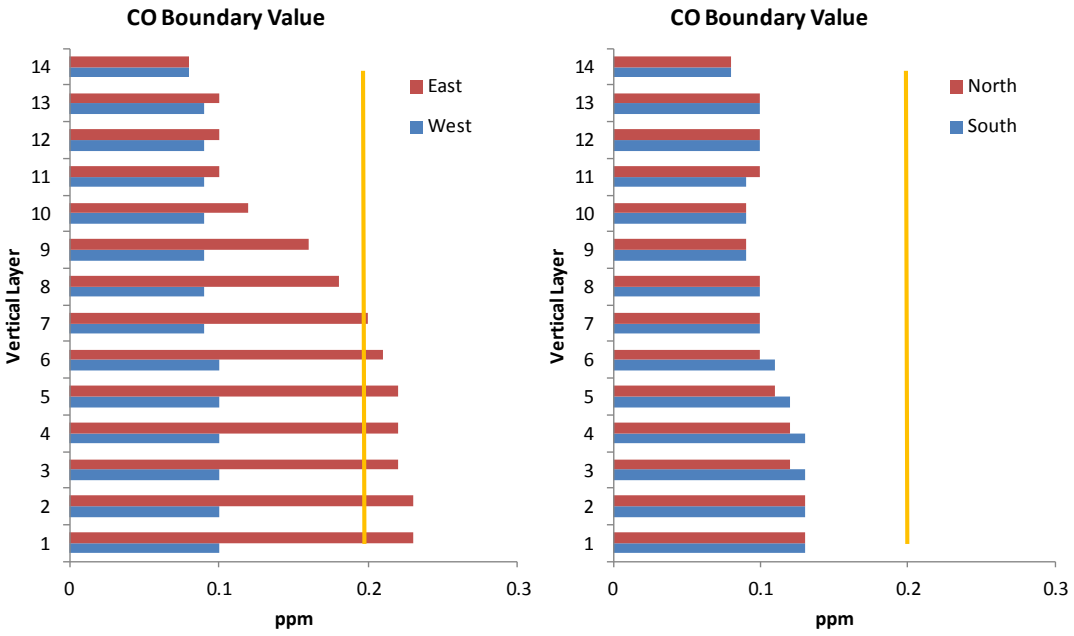


Figure V-3-18

Vertical profiles of CO from MOZART in a 15 layer structure. The values were averaged over the perimeter in the given direction at a given layer. The top layer corresponds to the modeling top. The solid yellow line represents the clean boundary value.

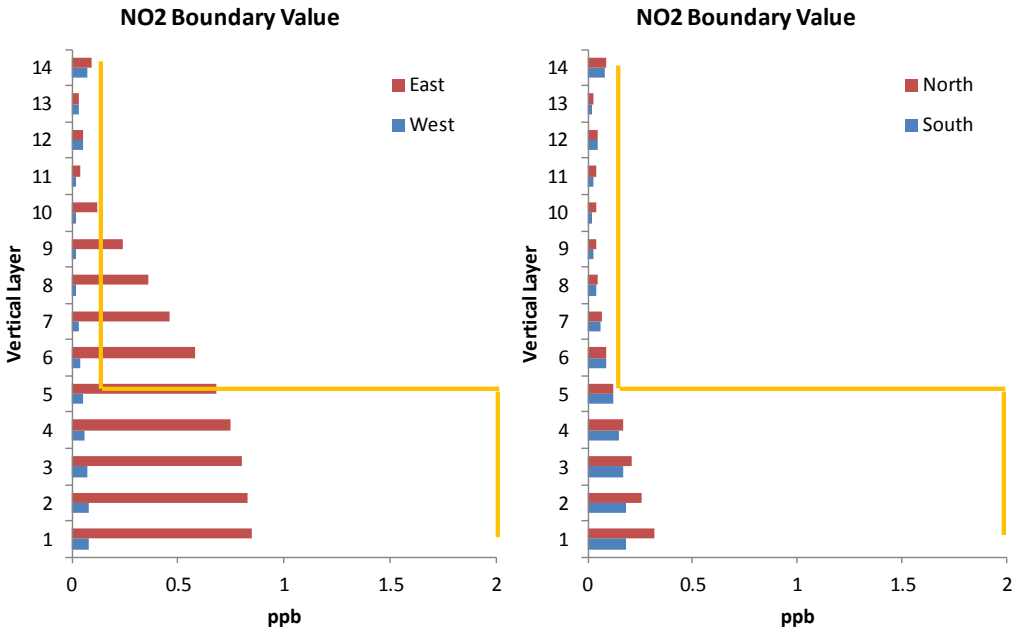


Figure V-3-19

Vertical profiles of NO2 from MOZART in a 15 layer structure. The values were averaged over the perimeter in the given direction at a given layer. The top layer corresponds to the modeling top.

The solid yellow line represents the clean boundary value.

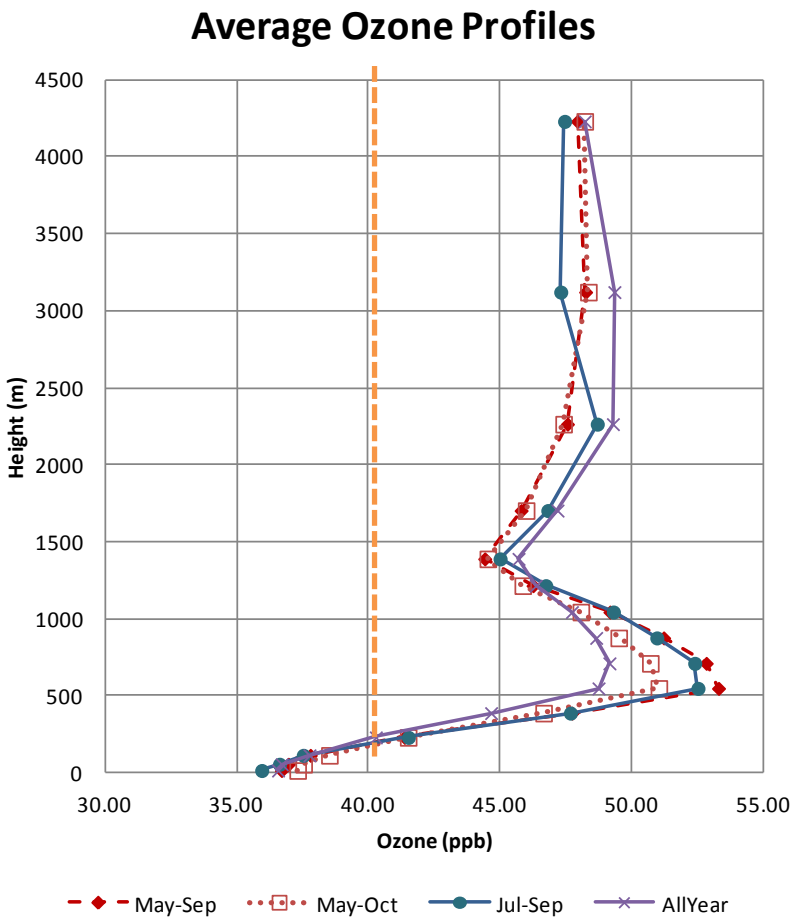


Figure V-3-20

Climatological Ozone profiles compiled from the aircraft measurements. The clean boundary value is given as broken yellow line for comparison.

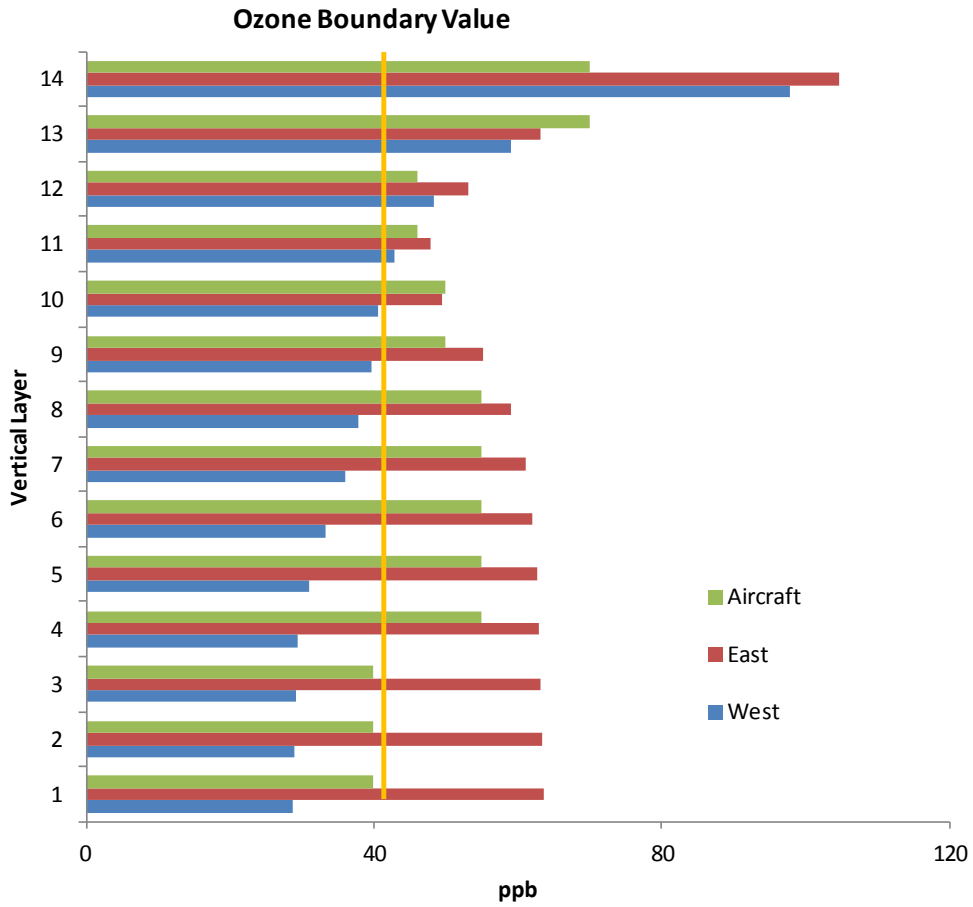


Figure V-3-21

The comparison of MOZART and aircraft-measurement based boundary values digitized in the 15 layer modeling grid. The clean boundary values are presented in yellow solid line.

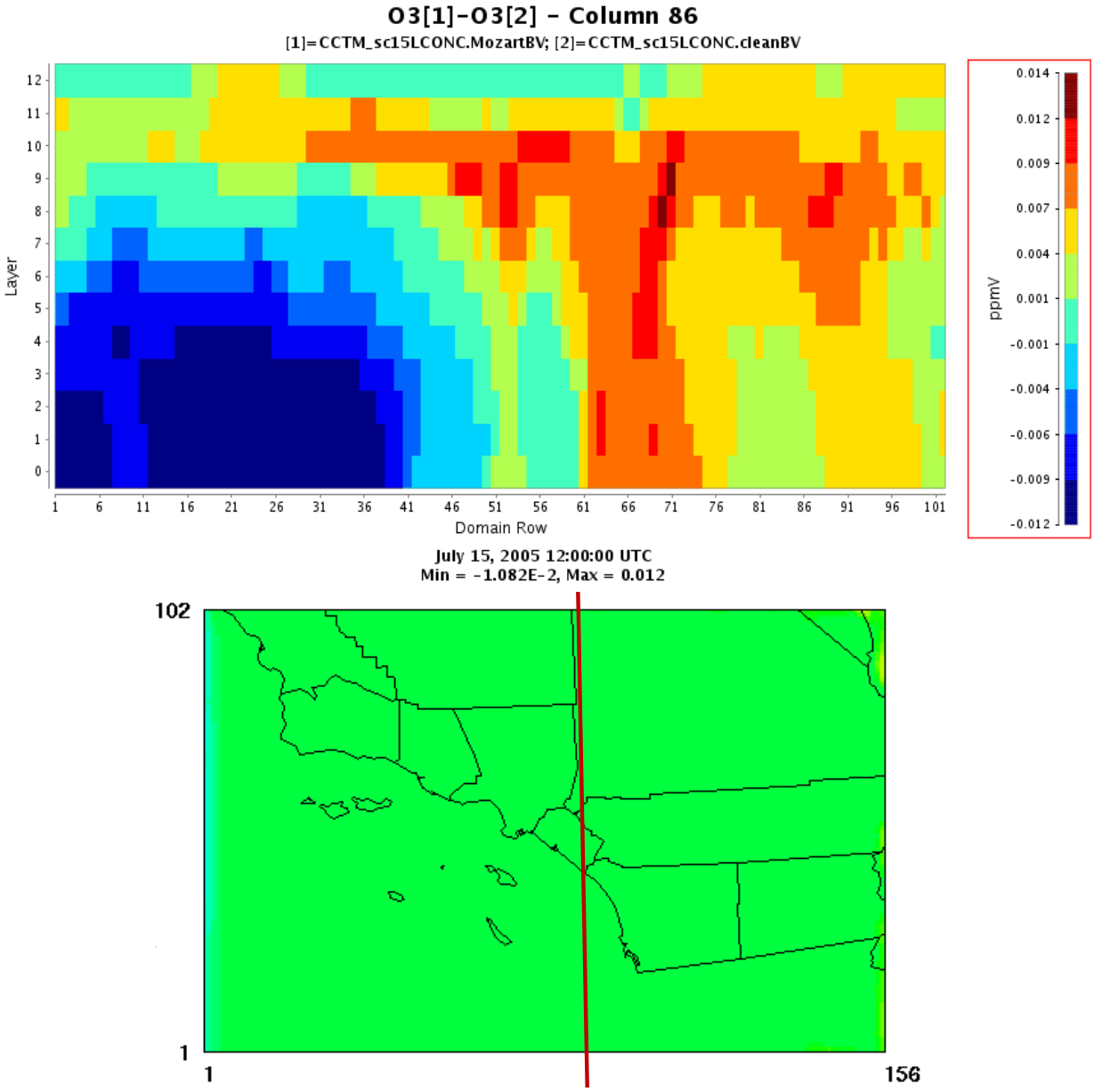


Figure V-3-22

A vertical cross-section of 1-hr ozone differences between MOZART and the clean boundary values along the red line indicated in the lower plot.

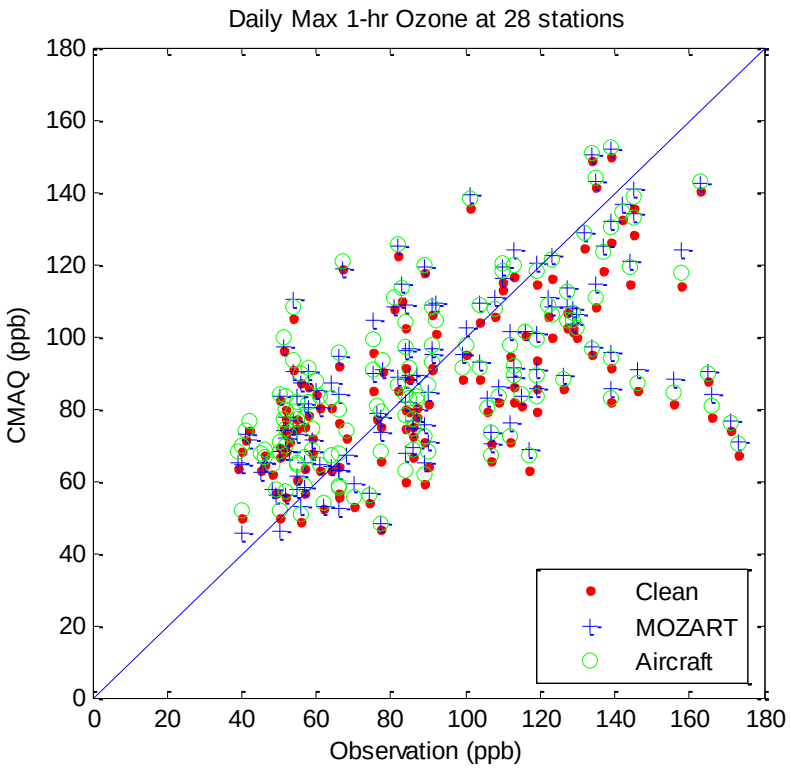


Figure V-3-23

Scatter plot of simulated and observed 1-hour maximum ozone within the Basin.

The impact of the boundary contribution was further analyzed to explore its possible role in the over-predictions identified in Figure V-3-16. The daily MOZART boundaries, shown in Figure V-3-24, contained values that were as high as 110 ppb. These are compared with published and simulated Basin summer boundary ozone values less than 50 ppb. Note that MOZART (version 4), used in the current study, was based on GEOS-5 meteorological fields. The high boundary concentrations extracted from MOZART on June 21st and July 9th coincided with the simulated high-bias episodic ozone peaks in Figure V-3-16. A set of sensitivity simulations were generated including only biogenic emissions and both clean boundary conditions and MOZART defined boundaries. A comparison of the simulation results is shown in Figure V-3-25. The higher MOZART background values seriously impacted regional ozone formation, particularly on the July 9th episode. Also, the simulation including MOZART with biogenic emissions illustrated a decreasing trend over the three month period, which was less evident in the clean boundary simulation. The general decreasing trend was expected to reflect lower biogenic emissions and deeper midsummer mixing of the atmosphere.

The spurious behavior of MOZART was partly attributed to the way the global model was applied to the CMAQ. Due to computational limitations, the CMAQ model used a single domain, but was not configured in a nested way. This abrupt scaling down from a global model to a fine scale regional grid appears to have impacted the spatially allocated background concentrations characteristic of urban emissions profiles. As a consequence, higher levels of background ozone introduced over the northern boundary resulted in erroneously higher projected surface ozone concentrations.

Figure V-3-26 presents the scatter plot of the simulations conducted using the MOZART and clean boundary assumptions. The clean boundary assumption was able to eliminate many of the severely over predicted data points that appeared in the upper portion of the one-to-one mapping line. Accordingly, the clean boundary assumption was chosen as the default lateral boundary value.

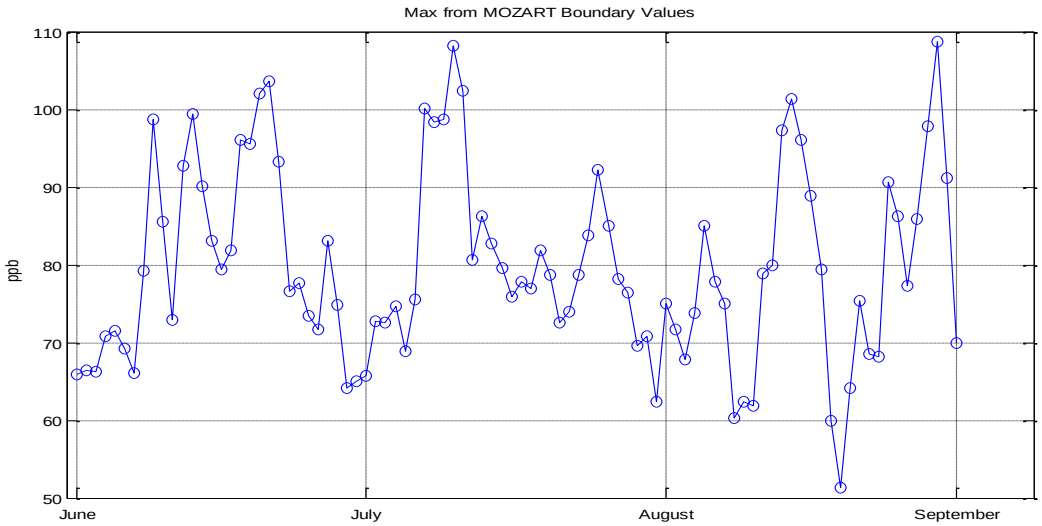


Figure V-3-24

Daily Maximum 1-hour ozone along the lateral boundaries from MOZART.

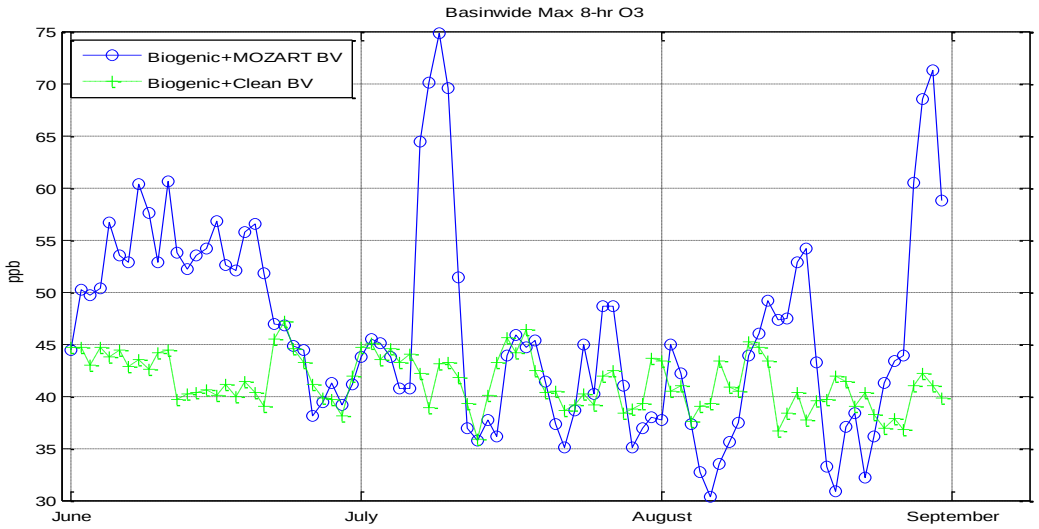


Figure V-3-25

Maximum 8-hr ozone simulated with MOZART boundary values (blue solid line with open circle) and the clean boundary (green broken line with plus mark).

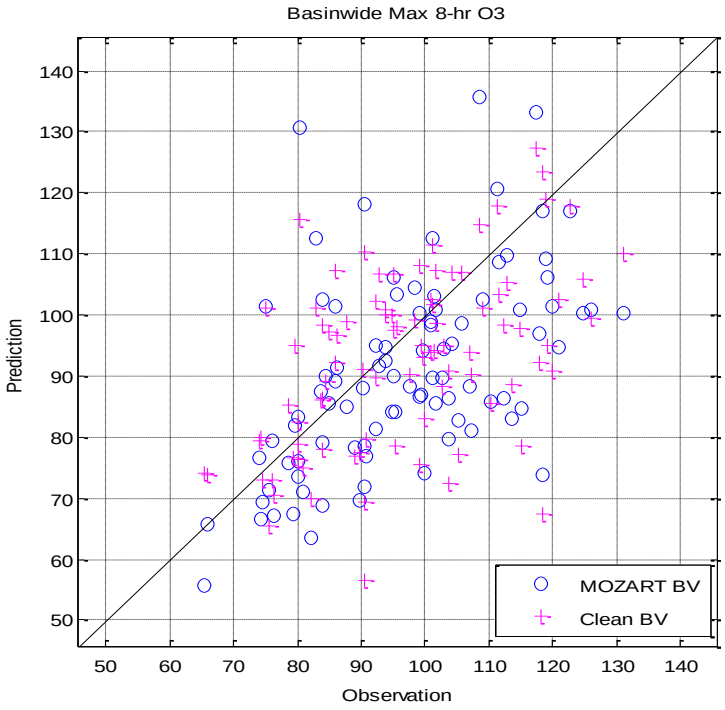


Figure V-3-26

Basin maximum 8-hour ozone simulated with MOZART and the clean boundary values

CHAPTER 4

MODELING EMISSIONS, BOUNDARY, AND INITIAL CONDITIONS

Modeling Emissions Inventory

Inventory Profile

California Environment Quality Act (CEQA) Alternative Emissions

Boundary and Initial Conditions

MODELING EMISSIONS INVENTORY

Table V-4-1 provides the baseline and controlled modeling emissions inventories used in the attainment demonstration and alternative analyses. The CMAQ simulations were based on the annual average inventory, with adjustments made for weekly and daily temperature variations. A brief characterization of the annual day emissions used for the modeling analysis follows. An extensive discussion of the overall emissions inventory is summarized in Appendix III of the Final 2012 AQMP.

INVENTORY PROFILE

Baseline modeling inventories for the historical year 2008 and the future years 2014, 2017, 2019, 2023, 2030 and 2035 are discussed in this section. The baseline emissions projection assumes no further emission controls. These projections reflect the emissions resulting from increases in population and vehicle miles traveled (VMT), as well as the implementation of all adopted rules and regulations up through June 2012. The controlled emission projections reflect the benefits of implementation of the Final 2012 AQMP control measures relative to future baseline emissions. Detailed descriptions of the control measures are provided in Chapter 4 and Appendix IV of the Final 2012 AQMP.

Appendix III contains emission summary reports by source category for the historical base year and future baseline scenarios used in this modeling analysis. Attachments 5 and 6 of this appendix contain the Controlled Emission Projection Algorithm (CEPA) emissions summary report by source category for the future (2014 and 2023) controlled scenarios for the annual average emissions inventory. It should be noted that the inventories reported here may be slightly different than those reported in the Final 2012 AQMP (Chapter 3) and Appendix III, since the inventories used for modeling reflect day-specific conditions. Day specific point, mobile and area emissions inventories were generated for each day in the 2008 base year. Mobile source emissions were temperature corrected by grid cell using a VMT weighted scheme. County-wide area source emissions were temperature corrected and gridded using the spatial emissions surrogate profiles developed for the Final 2012 AQMP.

Day specific modeling emissions inventories were generated for each day in 2008 for the CMAQ (and CAMx) simulations. Mobile source emissions were generated using CARB's EMFAC2011 emissions factors coupled with SCAG's traffic analysis zone data. Off-road emissions were calculated using CARB's off road model. It is important to note that both EMFAC2011 and the off-road models were modified to account for

CARB's emissions estimation methodology changes reflecting the 2010 adoption of the CARB on-road heavy duty vehicle and off-road mobile source rules. The on-road mobile source emission data incorporate day specific ambient temperature input to correct for evaporative emissions.

Table V-4-1

Annual Average Day Emissions Inventory (tons/day)

Year	VOC	NOX	CO	SOX	PM2.5	NH3
(a) Baseline						
2008	593	754	2880	54	80	109
2014	451	506	2095	18	70	103
2017	427	442	1862	18	70	100
2019	414	394	1708	18	70	98
2023	406	322	1584	18	70	97
2030	407	283	1502	20	72	98
2035	386	279	1473	22	72	98
(b) Controlled						
2014	451	490	2095	18	58*	103
2023	400	296	1584	18	70	97

* Winter episodic day emissions reductions

Annual Emissions Profiles

Day specific emissions were generated for all days in 2008. Figure V-4-1 illustrates the total CO and NOx emissions contained in the modeling domain for each day in 2008. CO emissions are indicative of the on-road mobile source inventory while NOx further incorporates signatures of stationary and off-road emissions. Note that the emissions totals in tons per day are roughly double the totals presented in Table V-4-1. This is because the values in Table V-4-1 represent basin-wide total emissions while those in Figure V-4-1 is the total from the modeling domain. The profile clearly depicts a changing emissions pattern with two distinct cycles represented: a weekly cycle, illustrated by Sunday through Saturday peaks and valleys, and day-to-day variations in

emissions within the weekly cycle. Figure V-4-1 also includes emissions from 2008 wild fires that occurred in the modeling domain.

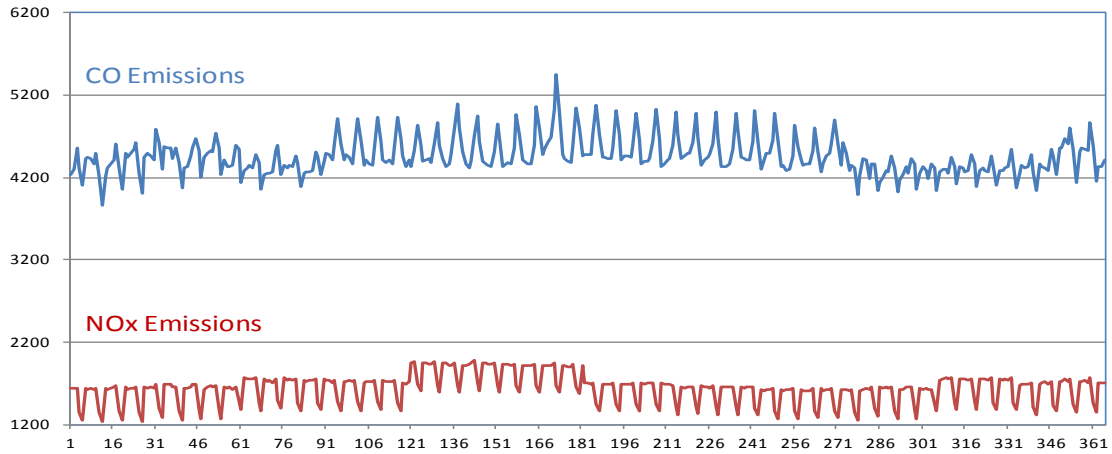


Figure V-4-1

2008 daily CO and NOx emissions in the modeling domain.

Diurnal Emissions Profiles

Where applicable, point, area and off-road mobile sources were adjusted to a day-of-week throughput profile consisting of a Monday-Friday, Saturday and Sunday schedule. Figure V-4-2 depicts the day-of-week and hour-of-day NOx emissions patterns for stationary, on-road, and off-road sources with ocean going vessels (OGVs) independently represented. The peak emissions occur mid-week (Tuesday through Thursday) while emissions on Saturday and Sunday decrease by about 30 percent. Based on CALTRANS data, NOx emissions from heavy-duty vehicles are reduced by more than 60 percent on Saturdays with further reductions occurring on Sundays. Increases in off-road mobile source activities (e.g. pleasure craft and recreational vehicles) account for the bulk of the VOC increase on both Saturdays and Sundays.

Monday and Friday are transitional days with on-road emissions slightly lower than mid-week with slightly modified diurnal profiles. Off-road emissions are relatively consistent throughout the week whereby weekend reductions in some off-road categories (e.g. construction) are replaced by weekend activity emissions (e.g. recreational vehicles and boats). In general, OGV emissions are constant with shipping activities ongoing as a function of arrivals and departures. The largest stationary source contributions (e.g.

refineries, power generation and residential combustion) represent daily usage and do not vary much over the course of the week.

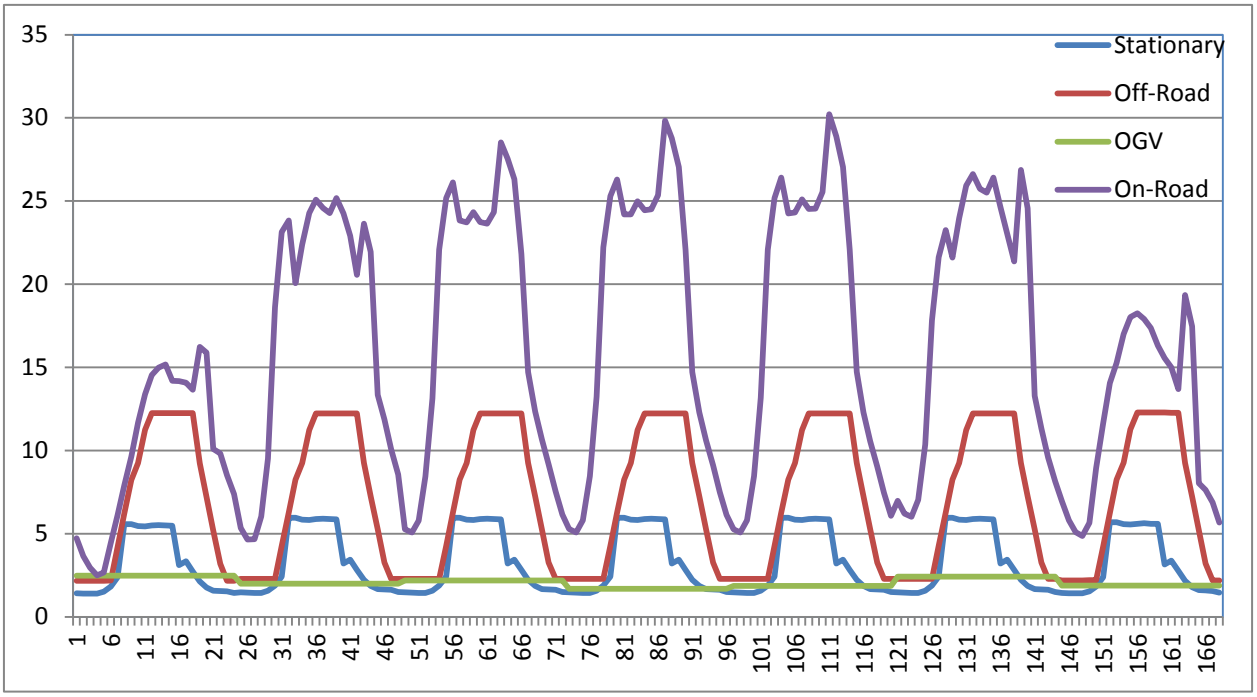


Figure V-4-2

Diurnal NOx emissions (tons per hour) in the modeling domain: Sunday - Saturday.

Spatial Distribution

Figures V-4-3 through V-4-6 provide the spatial distribution of NOx emissions for the stationary (including area sources), OGV, off-road and on-road categories. Areas sources in the modeling domain are typically assigned to a surrogate distribution profile (maintained by CARB) to allocate the daily emissions. Area source NOx emissions are included in the stationary source projection depicted in Figure V-4-3.

Paved and Unpaved Road Dust Emissions

U.S. EPA recently revised its AP-42 methodology to estimate paved road dust whereby the new method removed the factor addressing tire and break ware (to address potential double counting) but retained a California usage profile and adjustments for rain and silt loading.

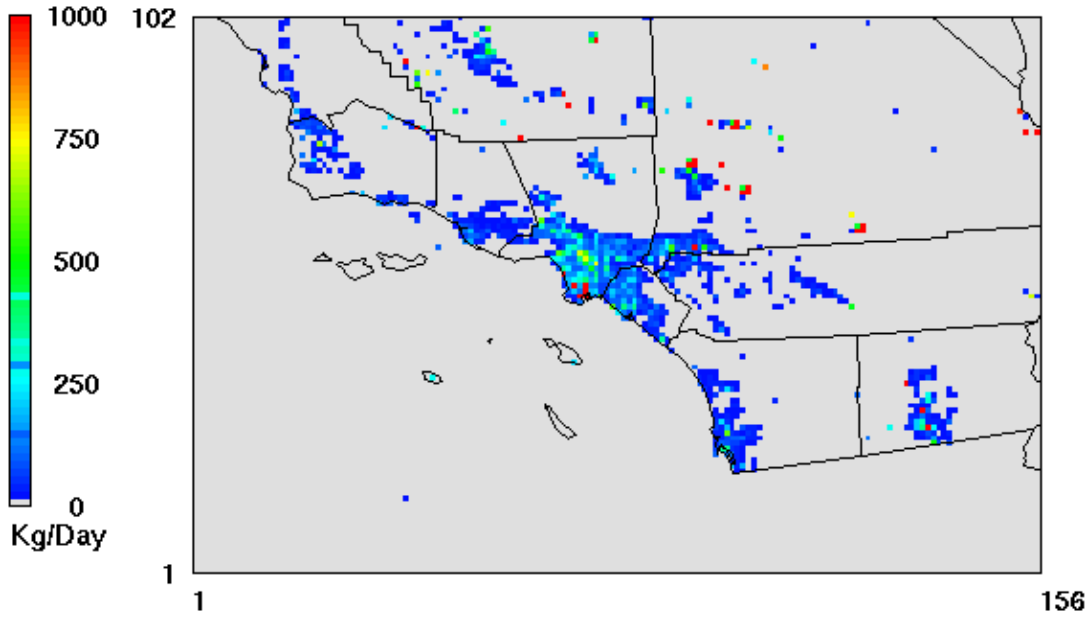


Figure V-4-3

Stationary source NOx emissions (Kg per day) in the modeling domain

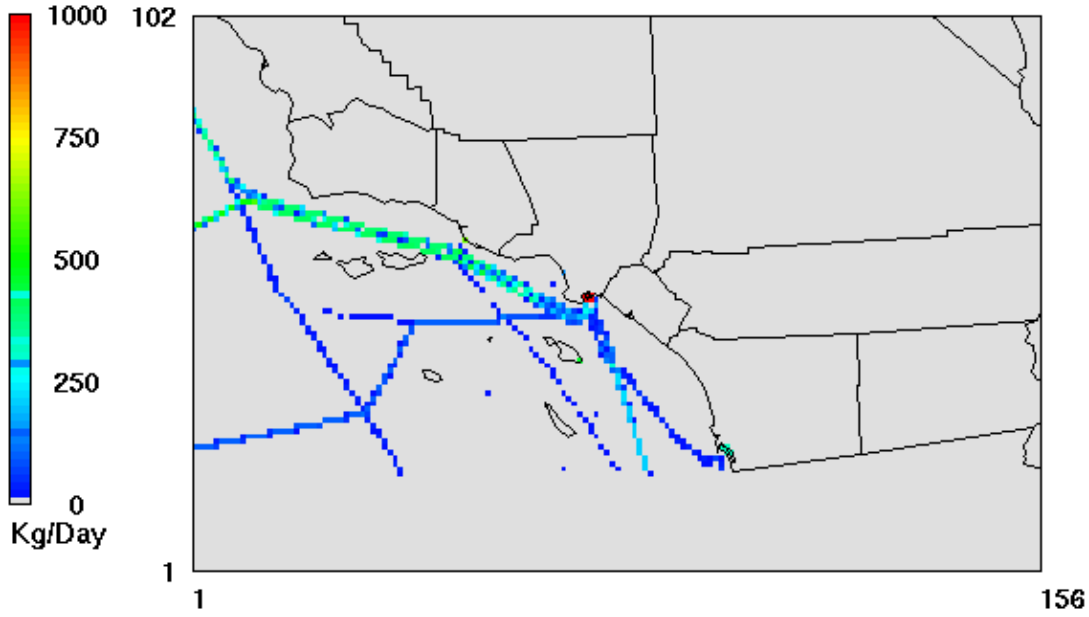


Figure V-4-4

OGV NOx emissions (Kg per day) in the modeling domain

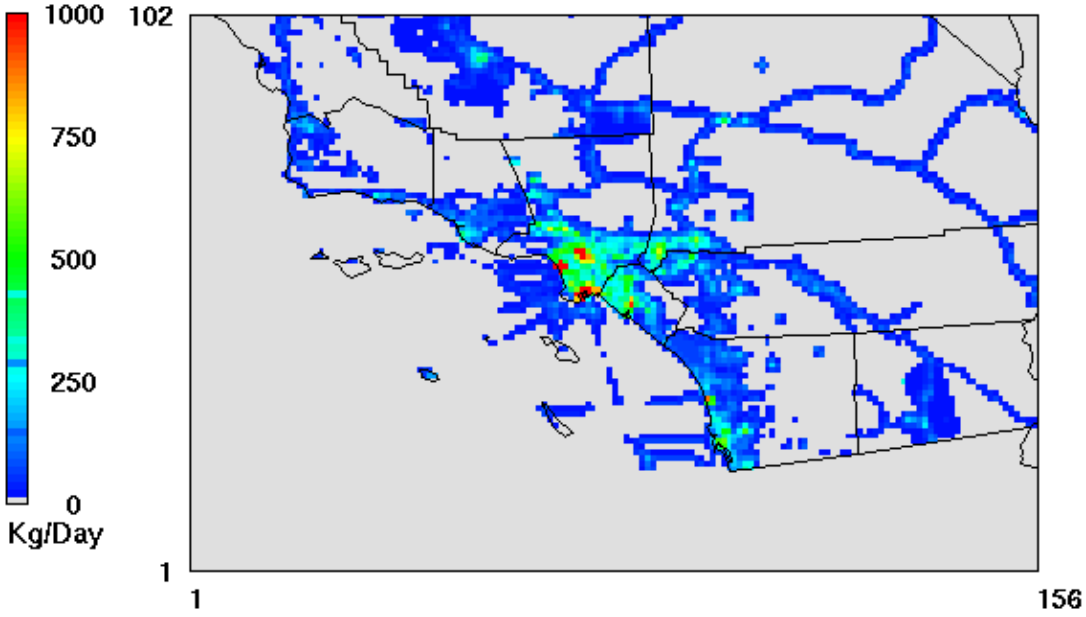


Figure V-4-5

Off-Road NOx emissions (Kg per day) in the modeling domain

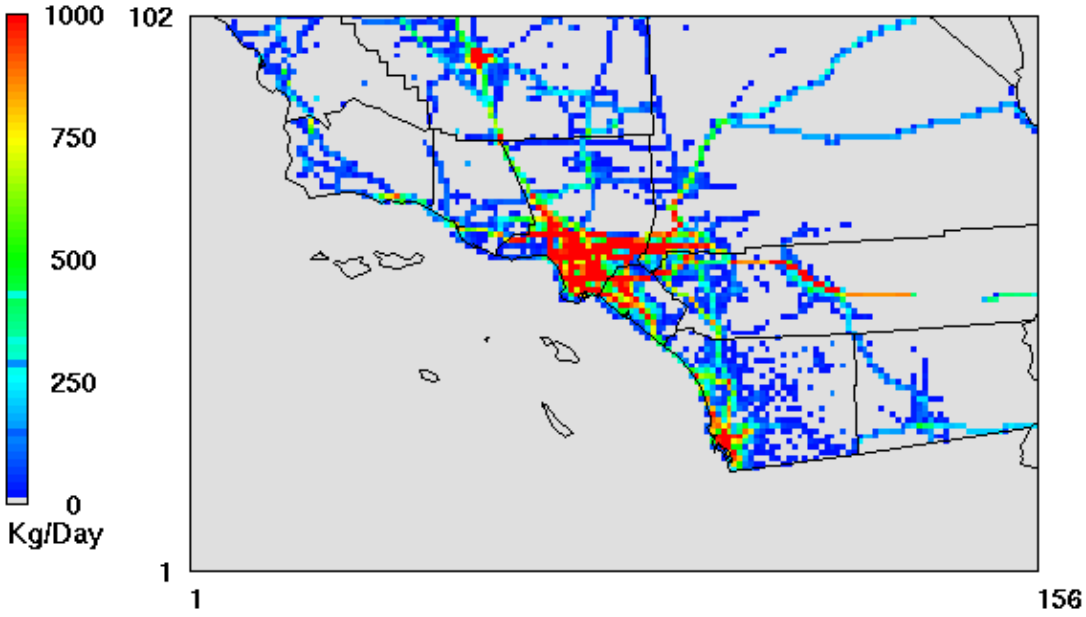


Figure V-4-6

On-Road NOx emissions (Kg per day) in the modeling domain

In addition, the base year paved road dust emissions are a function of VMT. As with the three preceding AQMPs, paved road dust emissions were adjusted to reflect a cap on emissions growth for high VMT road types in future years. Based on CARB's latest assessment (California Air Resources Board. 2012. Miscellaneous Process Methodology 7.9, Entrained Paved Road Travel, Paved Road Dust. July), the Final 2012 AQMP continued this type of adjustment by leaving paved road dust constant on all roads unless there was a change in centerline miles; any emission change in future years would be calculated using the ratio of future-to-current centerline miles (see Appendix III, Table III-2-6).

Unpaved road dust was allocated based on GIS land use profiles.

Ammonia Inventory Adjustments

Selected revisions were made to the spatial distribution and emissions categories defining the ammonia inventory. In general, the total ammonia in the inventory was reduced from 119 TPD in the 2007 AQMP inventory to 109 TPD in the Final 2012 AQMP. Shifts in ammonia emissions occurred in several categories with livestock; fertilizer and on-road emission lowered, being partially offset by increases in the industrial and composting sectors. Table V-4-2 provides a summary comparison of the 2002 and 2008 ammonia inventories form the 2007 AQMP and the Final 2012 AQMP.

Table V-4-2

Annual Average Day Ammonia Emissions Inventory (tons/day)

Source Category	2007 AQMP	Final 2012 AQMP
	2002 Inventory	**2008 Inventory**
Livestock	26	18.6
Soil	1.4	1.8
Domestic	25.1	25.1
Landfill	1.1	3.6
Composting	9.7	17.8
Fertilizer	6.1	1.5
Sewage Treatment	0.1	0.2
Wood Combustion		0.1
Industrial	13.2	20.2
On-Road Mobile	36.1	19.9
Off-Road Mobile		0.1
Total	118.8	108.9

Biogenic Emissions

Daily biogenic VOC emissions inventories were developed by CARB using the Model of Emissions of Gases and Aerosols from Nature (MEGAN) emissions model. The biogenic inventories were calibrated based on spatially resolved daily temperature. Figure V-4-7 provides the daily total emissions of isoprene and terpenes, measured in millions of moles, for the modeling domain. The trend shows higher emissions for the spring and summer months with several peaks occurring in May and later June when temperatures in Southern California were unseasonably high. The areas with the greatest contribution to the biogenic emissions inventory are depicted by the color lime green in the general land use characterization provided in Chapter 3 (Figure V-3-9).

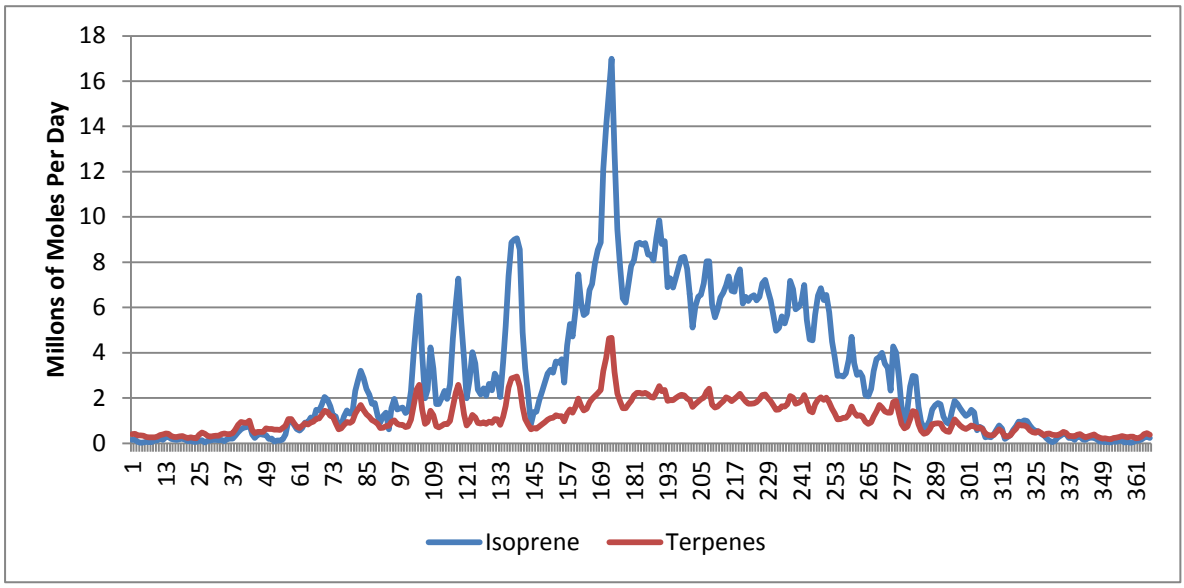


Figure V-4-7

2008 daily biogenic VOC emissions in the modeling domain:
Depicted are Isoprene and terpenes (millions of moles per day).

Ocean Going Vessels

During 2008, OGV emissions, most notably SOx, varied significantly over the course of the year. Compliance with CARB's marine vessel low sulfur fuel rule was challenged in the courts. As a consequence OGV emissions varied from a relatively low value (approximately 15 TPD) to emissions in excess of 40 TPD when compliance was not enforced and bunker fuel was in use. Figure V-4-8 depicts the vessel weighted profile of OGV SOx emissions estimated from the schedule of rule enforcement during 2008 in the compliance zone waters 24-nautical miles offshore of the Ports of Los Angeles and Long Beach. The time series accounts for port vessel arrivals and departures by day-of-week, month of year, and vessel tonnage category. The general emissions profile depicted in Figure V-4-8 was used with adjustments to the total SOx tonnage to generate the gridded SOx OGV emissions for modeling.

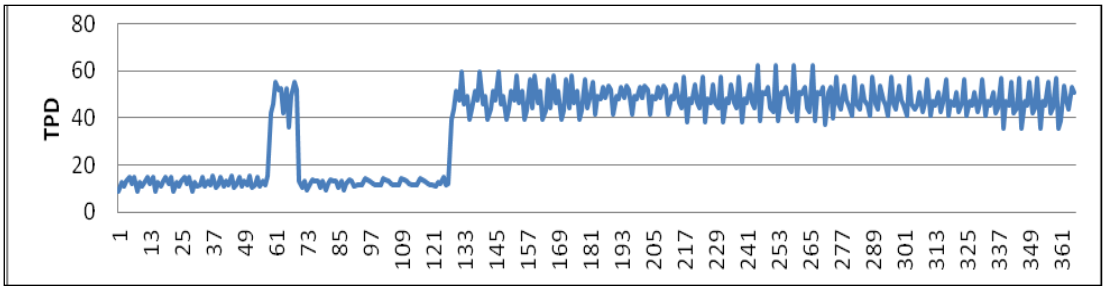


Figure V-4-8

2008 daily vessel weighted OGV SOx emissions in the modeling domain.

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) ALTERNATIVE EMISSIONS

As part of the CEQA requirements for project assessment, the analysis must consider alternatives to the proposed project and hence alternative emissions scenarios. The Final 2012 AQMP has identified three viable alternatives to the proposed plan to achieve attainment of the federal 24-hour PM2.5 standard within the prescribed time frame. The first alternative is a 2019 no-project alternative which relies on rules and regulations already in place to reduce baseline emissions to a level sufficient to attain the standard by 2019. The second alternative requires local emissions to be controlled nearby the design site in Mira Loma for a 2017 attainment year. The controls include tighter forecast triggers for restrictions on wood burning in fireplaces and woodstoves as well as open burning, and incentive-based accelerated local heavy duty truck clean up. The third alternative targets regional acceleration of heavy duty truck NOx reductions by 2017 as a replacement to the local control program. Table V-4-3 provides the CEQA alternate emissions scenarios simulated for the Program Environmental Impact Report.

BOUNDARY AND INITIAL CONDITIONS

As discussed in Chapters 2 and 3, the initial concept for establishing boundary conditions for the regional modeling analyses focused on using global chemical simulation model output to define key species concentrations at the edge of the modeling domain. MOZART was selected to provide the characterization. However after evaluation it was discontinued in favor of using an U.S. EPA “clean boundary” US EPA (1991) approach that has been incorporated in previous attainment demonstrations.

Table V-4-4 summarizes the boundary profile concentrations used in the regional simulations. The boundary conditions were adjusted to match the ROG SAPRC profile. Initial conditions were established from ambient data monitored at AQMD and other district stations in their respective monitoring networks. For the future year scenarios, the boundary, region top and ambient air quality concentrations were adjusted to reflect projected emissions reductions from the 2008 base-year.

Table V-4-3

CEQA Alternatives Annual Average Day Emissions Inventory (tons/day)

Year	VOC	NOX	CO	SOX	PM2.5	NH3
(a) Alternative 1	No Project Alternative					
2014	451	506	2095	18	70	103
2019	415	405	1716	18	70	99
(b) Alternative 2	localized PM Control					
2014	451	506	2095	18	63	103
2017	425	451	1867	18	63	97
(c) Alternative 3	Greater Reliance on NOx Reductions					
2014	451	506	2095	18	65	103
2017	420	416	1816	18	61	101
(a) Alternative 4	PM2.5 Control Strategy Only					
2014	451	506	2095	18	58	103
2017	427	452	1867	18	58	101

TABLE V-4-4

Boundary Profile Concentrations (ppb)

SAPRC99 Species	(ppb)	SAPRC99 Species	(ppb)
HCHO	0.930	ARO1	0.210
CCHO	0.530	ARO2	0.070
RCHO	0.250	OLE1	0.180
ISOP	0.020	OLE2	e-13
MEOH	0.100		
ETOH	0.050	O3	40.0
ETHE	0.180	CO	200.
ALK1	2.500		
ALK2	2.300	NO	0.100
ALK3	0.930	NO2 (surf)	2.000
ALK4	e-13	NO2 (aloft)	0.100
ALK5	e-13		

CHAPTER 5

FEDERAL 24-HOUR PM2.5 ATTAINMENT DEMONSTRATION PLAN

INTRODUCTION

The attainment demonstration presented in this chapter is applicable to the federal 24-hour PM2.5 standard. The annual PM2.5 attainment demonstration provided in the 2007 AQMP was approved by U.S. EPA on September 30, 2011. An update of the model simulation results for the annual PM2.5 standard is presented in Chapter 6.

The initial sections of this chapter describe the PM2.5 Federal Reference Method (FRM) monitoring data and sampling network, the historical trend of 24-hour PM2.5 design values, revisions to the speciated monitoring attainment test (SMAT) and Sandwich data analyses, and the CMAQ modeling methodology. The subsequent sections of this chapter provide the 24-hour PM2.5 attainment demonstration, the unmonitored area analysis, and supporting weight of evidence analyses.

24-HOUR PM2.5 Sampling

PM2.5 FRM Sampling

The district maintains a sampling network of Federal Reference Method (FRM) PM2.5 at 20 sites throughout the Basin and Coachella Valley. This network is supplemented by Federal Equivalent Method (FEM) continuous PM2.5 monitors at a subset of these locations to provide data for public reporting and for forecasting algorithms. The FRM samplers are designated as the primary samplers, and thus FRM data is used for design value calculations and the attainment demonstration.

Speciated PM2.5 Sampling.

The District adopted a Multi-Channel Fine Particulate (MCFP) sampling system for the PTEP monitoring program in 1995, and the TEP 2000 program in 1998-1999. New PM samplers, speciated air sampling system (SASS) samplers, were deployed for two years at ten sites in the Basin to conduct the Multiple Air Toxics Exposure Study III (MATES III) beginning in April, 2004. The SASS sampler collects PM2.5 particles on 47mm quartz and Teflon filters simultaneously within the same sampler for 24-hour duration for subsequent laboratory chemical analysis. After the MATES III study, PM speciation sampling was changed from a one-in-three day to a one-in-six day schedule, and reduced to four permanent speciation-sampling sites. However, a monitoring campaign at multiple sites in the Port area included PM2.5 speciation in the 2007-2008 timeframe. Furthermore, an enhanced speciation

campaign in 2009 returned to the one-in-three day schedule at seven sites for one year only.

PM2.5 speciation data measured as individual species at six sites in the District air-monitoring network during 2008 provided the PM2.5 chemical characterization for evaluation and validation of the CMAQ annual and episodic modeling. The six sites include the historical PM2.5 maximum location (Riverside-Rubidoux), the stations experiencing many of the highest county concentrations (among the 4-county jurisdiction including Fontana, North Long Beach and Anaheim) and monitoring in locations influenced by goods movement (South Long Beach) and mobile source impacts (Central Los Angeles). It is important to note that the close proximity of Mira Loma to Rubidoux and the common in-Basin airflow and transport patterns enables the use of the Rubidoux speciation data as representative of particulate speciation at Mira Loma. Both sites are directly downwind of the dairy production areas of Chino and the warehouse distribution centers located in the northwestern corner of Riverside County. Speciated data monitored at the selected sites for 2006-2007 and 2009-2010 were analyzed to corroborate the applicability of using the 2008 profiles. PM2.5 mass, ions, organic and elemental carbon, and metals, for a total of 43 chemical species, were analyzed from a one-in-six day sampling schedule at 6 sites.

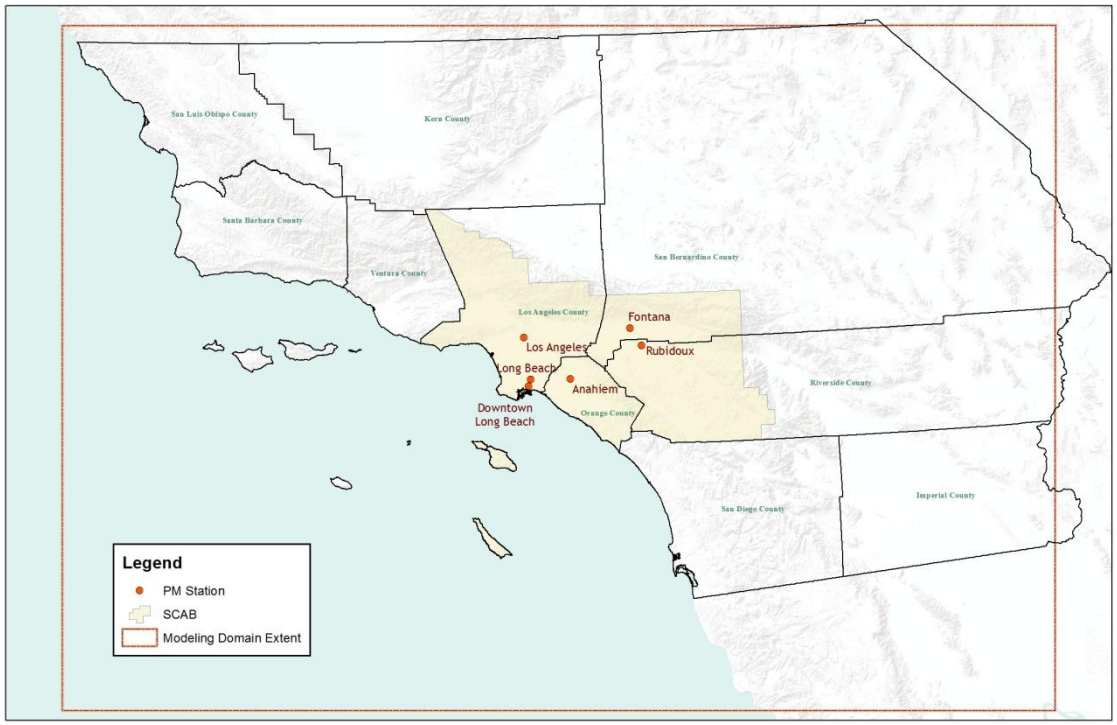


Figure V-5-1

SASS Sampling Sites in the Basin

2008 PM2.5 speciation data measured by the SASS sampler is used to derive the species fractions that are required for the PM2.5 attainment demonstration. U.S. EPA's PM2.5 modeling guidance recommends calculating future year PM2.5 design values by multiplying quarterly, species specific RRFs to the base year speciated design values for each quarter for each monitoring site. Base year design values are determined from the FRM mass data, however the FRM filters are not chemically speciated. Therefore, the guidance document recommends multiplying the species fractions that are measured in a speciation sampler such as the SASS to the FRM mass data to derive chemically speciated design values for the FRM data. In the following sections, 24-hour and annual average species concentrations measured by the SASS sampler are summarized and the chemically speciated FRM data are derived for the future year design value calculations.

As previously described in Chapter 1, U.S. EPA recently updated the 24-hour PM2.5 attainment test, replacing Section 5.2 of the 2007 PM2.5 modeling guidance. The

new guidance recommends using the 8 highest days of FRM data per quarter for each year for each FRM site for calculation of the daily design values to ensure that the 98th percentile concentration day for the year is included in the analysis. This resulted in 32 days of FRM data for each year for each site. Tables V-5-1 through V-5-7 list the 2008 FRM data subset included as a component of the attainment analysis. Data from 2006, 2007, 2009 and 2010 complete the data requirement for the revised attainment test. In total, 160 days of data at each site are included in the calculation. Table V-5-8 provides the 5-year weighted 24-hour PM2.5 design vales for the seven sites evaluated. The weighting scheme centered on 2008 is as follows: 1/3 weight for 2008; 2/9 weight each for 2007 and 2009, and 1/9 weight each for 2006 and 2010.

In some cases, the FRM and SASS monitoring locations do not overlap. (The FRM network has 21 stations where the SASS network size has varied in time, being limited to 6 sites in 2008). Five of the SASS sites are co-located with the FRM sites. The Downtown Long Beach SASS site was located near the South Long Beach FRM. Similarly, the Mira Loma FRM design site is located in the upwind adjacent grid cell to the Rubidoux SASS sampler. The PM2.5 guidance document recommends estimating speciated concentrations from a nearby speciation monitor when an FRM site does not have speciation data. Therefore, the Mira Loma FRM data is speciated using the Rubidoux SASS data and the South Long Beach FRM used the Downtown Long Beach speciation data.

Table V-5-1

2008 Eight Highest PM2.5 FRM Data for Each Quarter at Anaheim

	Q1	Q2	Q3	Q4
Highest	39.40	24.55	27.06	67.88
2nd Highest	39.24	19.06	21.39	47.78
3rd Highest	31.19	19.05	21.38	43.83
4th Highest	28.31	18.14	19.21	41.57
5th Highest	27.60	17.94	18.97	41.00
6th Highest	24.81	17.31	18.64	39.77
7th Highest	23.77	16.85	18.06	38.62
8th Highest	22.39	15.93	17.27	37.78

Table V-5-2

2008 Eight Highest PM2.5 FRM Data for Each Quarter at S. Long Beach

	Q1	Q2	Q3	Q4
Highest	37.13	19.85	24.14	60.91
2nd Highest	32.52	19.39	22.39	41.78
3rd Highest	29.21	19.22	22.14	39.57
4th Highest	27.85	18.72	20.93	38.23
5th Highest	26.93	18.64	20.76	36.60
6th Highest	21.43	17.76	20.18	36.44
7th Highest	19.85	17.39	20.14	35.36
8th Highest	19.31	17.18	19.43	31.81

Table V-5-3

2008 Eight Highest PM2.5 FRM Data for Each Quarter at N. Long Beach

	Q1	Q2	Q3	Q4
Highest	39.40	22.31	24.89	57.20
2nd Highest	38.98	19.18	23.97	45.50
3rd Highest	31.19	18.93	23.18	41.53
4th Highest	30.94	18.81	20.81	39.77
5th Highest	29.46	18.01	20.27	38.90
6th Highest	28.35	17.93	19.72	36.19
7th Highest	22.51	16.96	19.43	33.52
8th Highest	22.14	16.63	19.10	32.44

Table V-5-4

2008 Eight Highest PM2.5 FRM Data for Each Quarter at Central Los Angeles

	Q1	Q2	Q3	Q4
Highest	38.14	24.81	43.79	78.35
2nd Highest	35.78	23.98	40.37	59.92
3rd Highest	29.88	21.68	32.82	54.56
4th Highest	26.04	21.44	30.90	50.03
5th Highest	25.96	20.65	29.07	40.58
6th Highest	25.18	20.27	26.97	39.95
7th Highest	25.15	20.06	24.89	34.44
8th Highest	25.09	19.60	24.05	33.28

Table V-5-5

2008 Eight Highest PM2.5 FRM Data for Each Quarter at Fontana

	Q1	Q2	Q3	Q4
Highest	43.50	49.01	43.93	47.47
2nd Highest	36.15	24.88	32.13	47.14
3rd Highest	25.76	24.59	25.26	27.09
4th Highest	21.76	18.88	24.30	26.38
5th Highest	21.63	18.26	23.42	25.30
6th Highest	18.47	17.63	23.09	24.88
7th Highest	14.59	17.26	21.47	18.09
8th Highest	14.09	17.26	20.46	17.59

Table V-5-6

2008 Eight Highest PM2.5 FRM Data for Each Quarter at Mira Loma

	Q1	Q2	Q3	Q4
Highest	50.21	31.09	42.11	50.93
2nd Highest	47.13	25.76	33.85	46.85
3rd Highest	39.14	24.24	28.73	46.37
4th Highest	28.72	23.05	28.21	39.85
5th Highest	26.55	22.96	25.87	38.01
6th Highest	19.75	21.92	23.93	33.35
7th Highest	18.21	18.96	21.81	23.39
8th Highest	16.46	17.83	21.51	20.67

Table V-5-7

2008 Eight Highest PM2.5 FRM Data for Each Quarter at Rubidoux

	Q1	Q2	Q3	Q4
Highest	47.99	31.33	53.30	57.68
2nd Highest	44.43	30.73	41.04	57.08
3rd Highest	40.32	30.42	33.99	41.49
4th Highest	36.95	29.82	32.79	40.00
5th Highest	36.32	29.30	31.03	39.96
6th Highest	34.90	28.95	30.90	38.12
7th Highest	34.15	28.33	28.61	36.21
8th Highest	32.01	28.28	25.82	31.66

TABLE V-5-8

2008 Weighted 24-Hour PM2.5 Design Values ($\mu g/m^3$)

Monitoring Site	24-Hour PM2.5 Design
Anaheim	35.0
Los Angeles	40.1
Fontana	45.6
North Long Beach	34.4
South Long Beach	33.4
Mira Loma	47.9
Rubidoux	44.1

The revised guidance updated the quarterly species fractions on "high" days, which are required for the 24-hour modeled attainment test. The new guidance recommends using the top 10% of days in each quarter as the "high" days, resulting in 4 days per quarter for the 2008 SASS data. Figures V-5-2 through V-5-7 depict the species breakdown from the average top 4 PM2.5 concentrations for each quarter for six sites in the Basin. The data show the unadjusted direct measurements of the chemical species at each site. In general, concentrations in the fourth or first quarter are higher than that of the other quarters and secondary ammonium, nitrate and sulfate can comprise about half of the total PM2.5 concentrations. They also show that organic carbon (OC) is the highest single component, which is also close to half of the total concentration in some quarters and sites.

OC as measured by a SASS sampler is believed to be highly uncertain with a mostly positive sampling artifact. The flow rate of the SASS sampler (6.7 lpm) used to collect OC is approximately 2.5 times lower than that of the FRM sampling system (16.7 lpm), which provides the official PM2.5 mass measurement. The slower flow rate in the SASS sampler reduces the pressure drop across the filter and increases the adsorption of organic vapor on the quartz filter medium. The FRM uses a Teflon filter for mass measurements which is much less subject to organic vapor adsorption. Therefore, the OC collected by the SASS sampler is higher than that collected by the FRM sampler, often leading to an overbalance of the sum of the PM2.5 species

relative to FRM mass. There are also uncertainties in the measurements and the speciation analyses for all species; however, the greatest uncertainty in species concentration is associated with the measurement and analysis of OC.

U.S. EPA recommends estimating uncertain OC concentrations through an adjustment that is discussed as part of the "Sandwich" method in the 2007 AQMP and U.S. EPA's PM2.5 modeling guidance document (Frank, 2007). According to the "Sandwich" method, OC is estimated from the difference between the measured mass and the sum of all chemical species, water and a filter blank of 0.5 ug/m^3. The new species fractions for each quarter for each site are calculated by estimating OC, which are then applied to the 32 highest FRM data. Figures V-5-8 through V-5-13 depict the 2008 species fractional splits for the 6 primary components and water vapor for the six SASS sites after the "Sandwich" method was applied.

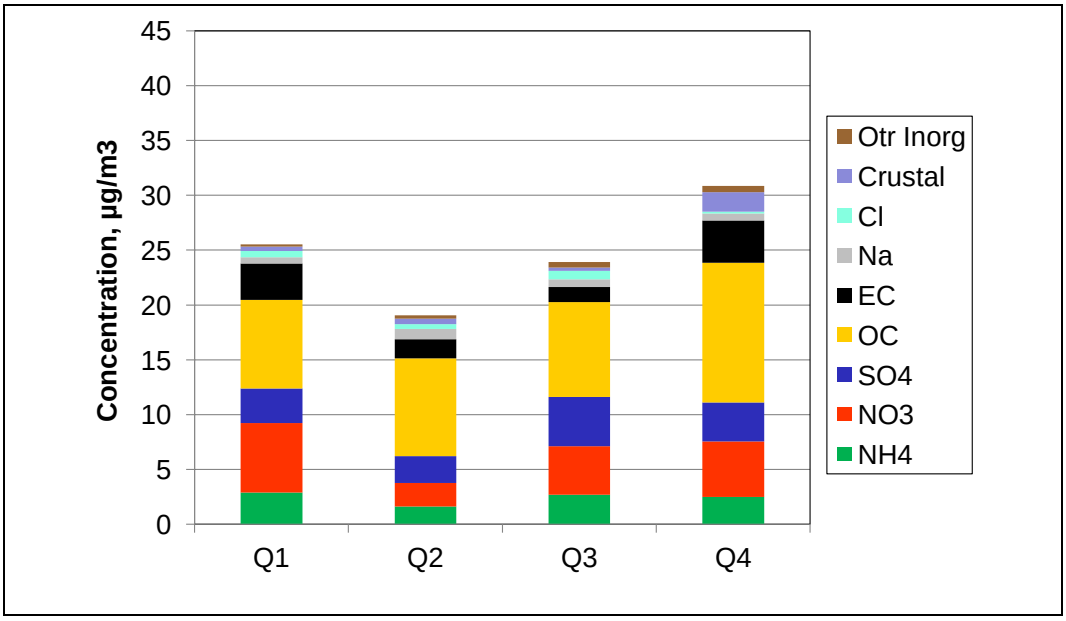


Figure V-5-2

2008 Anaheim Top 4 24-Hr PM2.5 Quarterly Average Species Concentrations

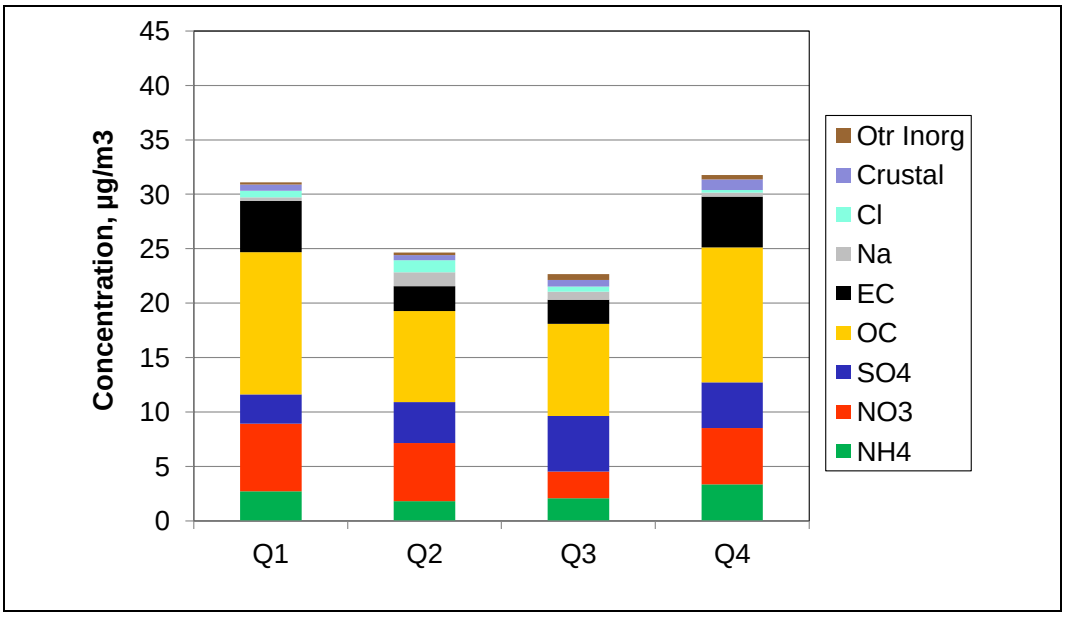


Figure V-5-3

2008 South Long Beach Top 4 24-Hr PM2.5 Quarterly Average Species Concentrations

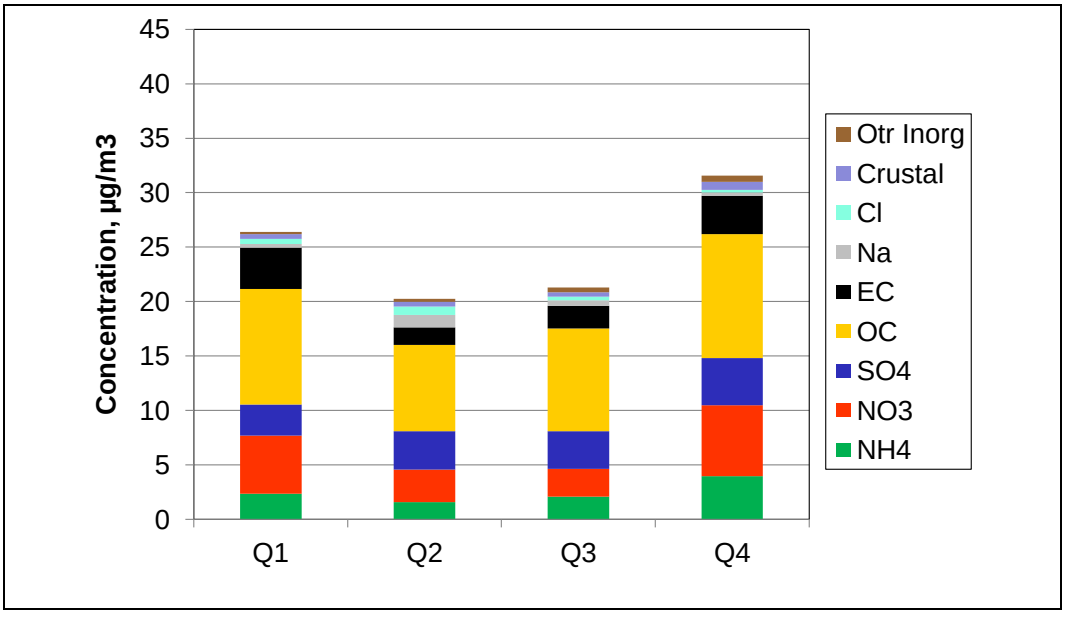


Figure V-5-4

2008 Long Beach Top 4 24-Hr PM2.5 Quarterly Average Species Concentrations

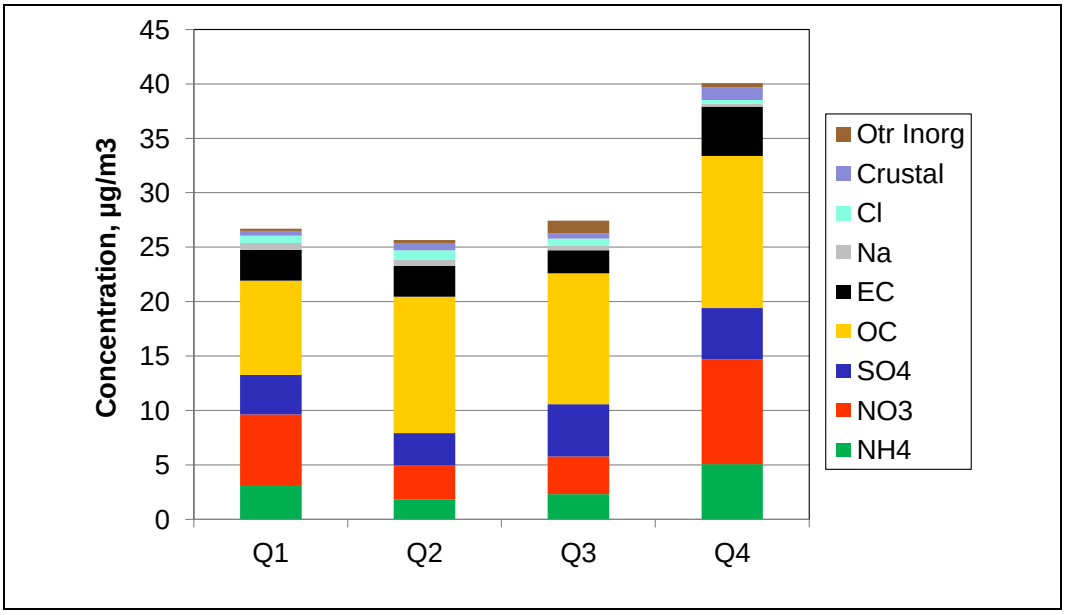


Figure V-5-5

2008 Los Angeles Top 4 24-Hr PM2.5 Quarterly Average Species Concentrations

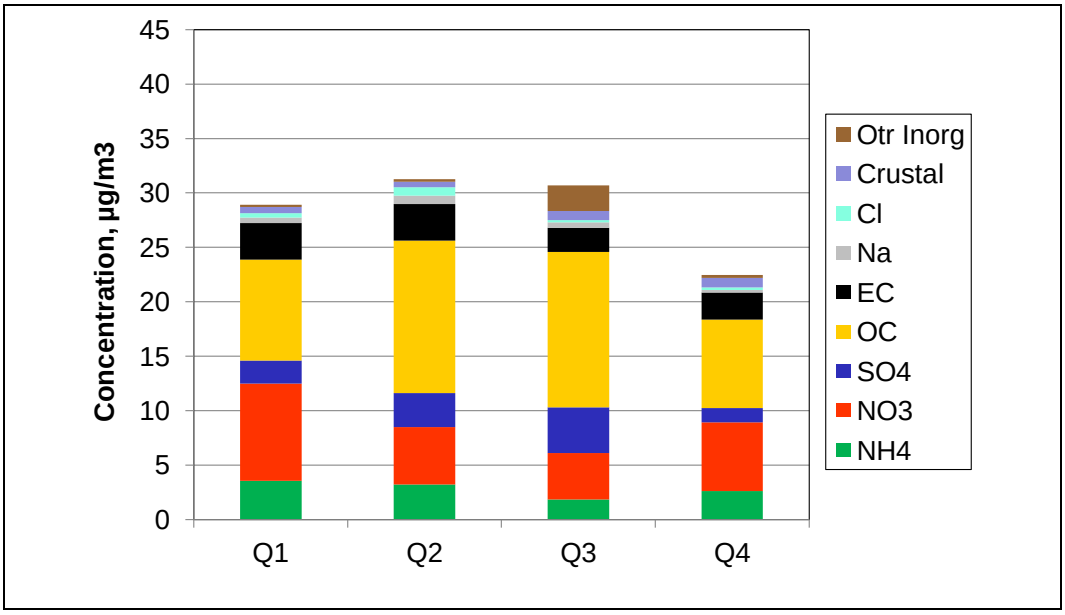


Figure V-5-6

2008 Fontana Top 4 24-Hr PM2.5 Quarterly Average Species Concentrations

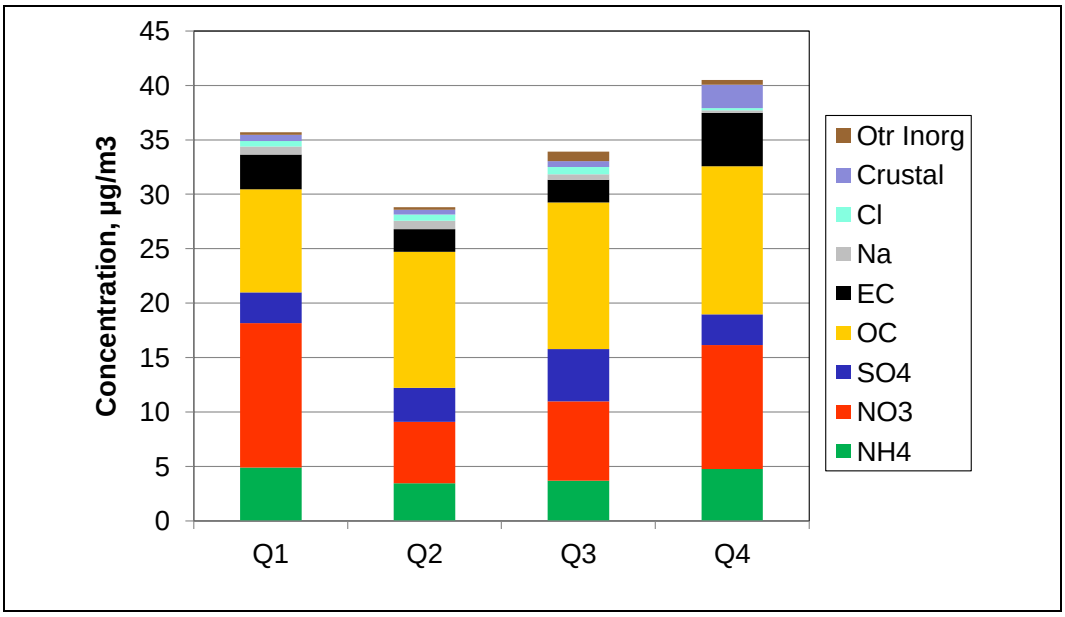


Figure V-5-7

2008 Rubidoux Top 4 24-Hr PM2.5 Quarterly Average Species Concentrations

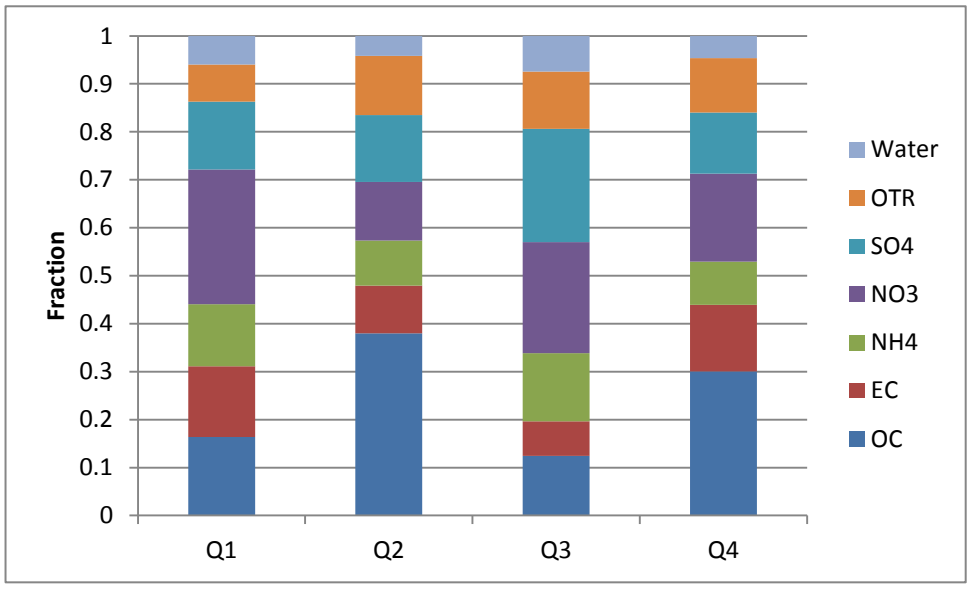


Figure V-5-8

2008 Anaheim 24-Hour PM2.5 species fractional splits after the Sandwich

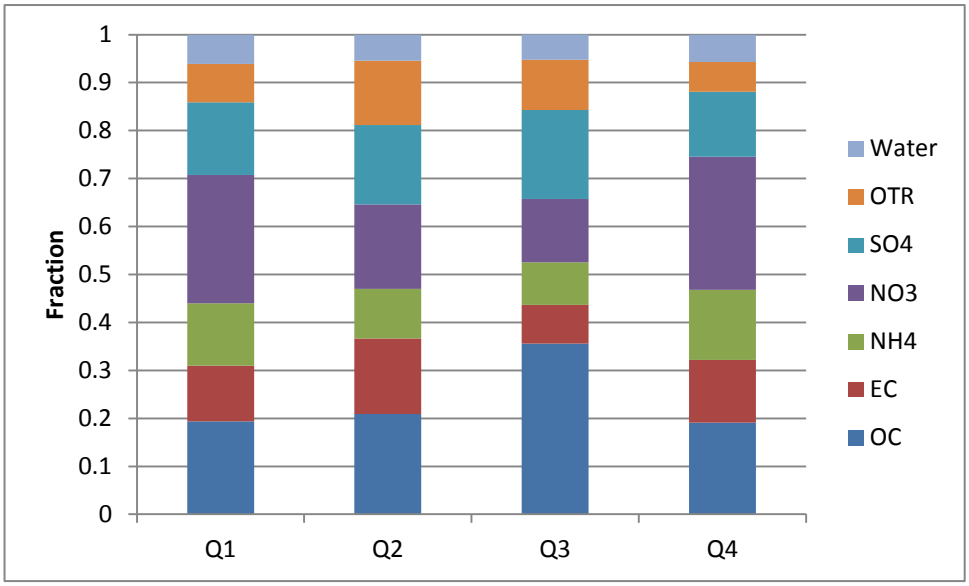


Figure V-5-9

2008 Los Angeles 24-Hour PM2.5 species fractional splits after the Sandwich

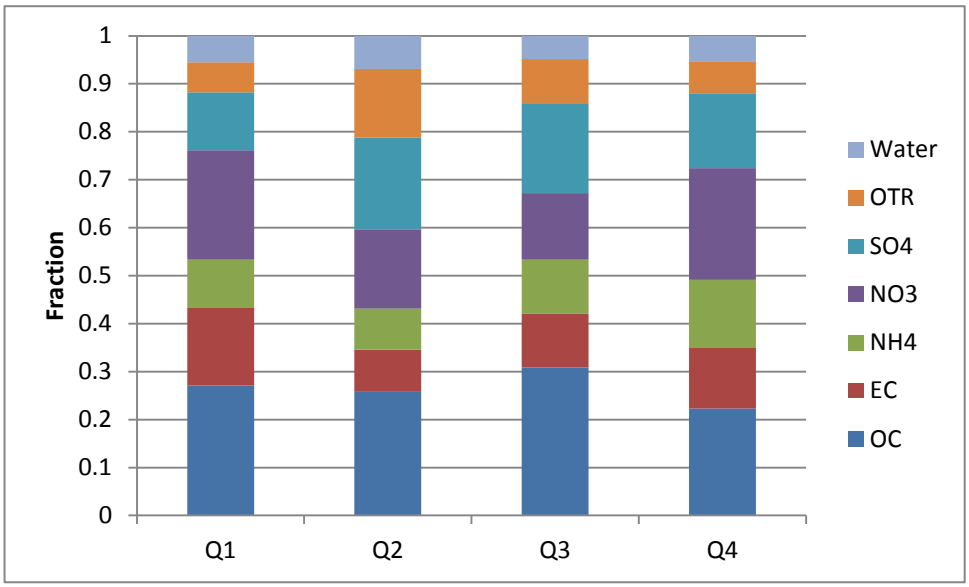


Figure V-5-10

2008 Long Beach 24-Hour PM2.5 species fractional splits after the Sandwich

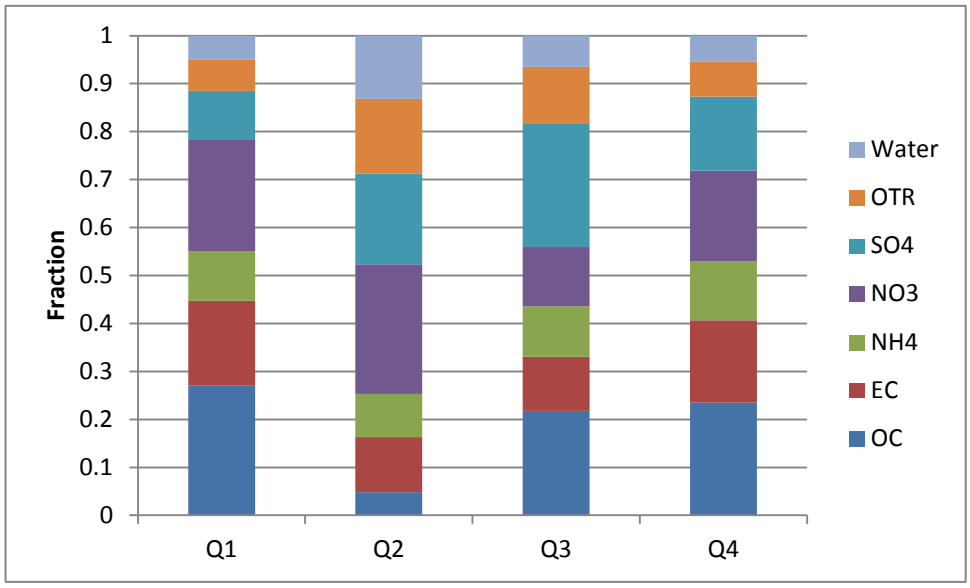


Figure V-5-11

2008 South Long Beach 24-Hour PM2.5 species fractional splits after the Sandwich

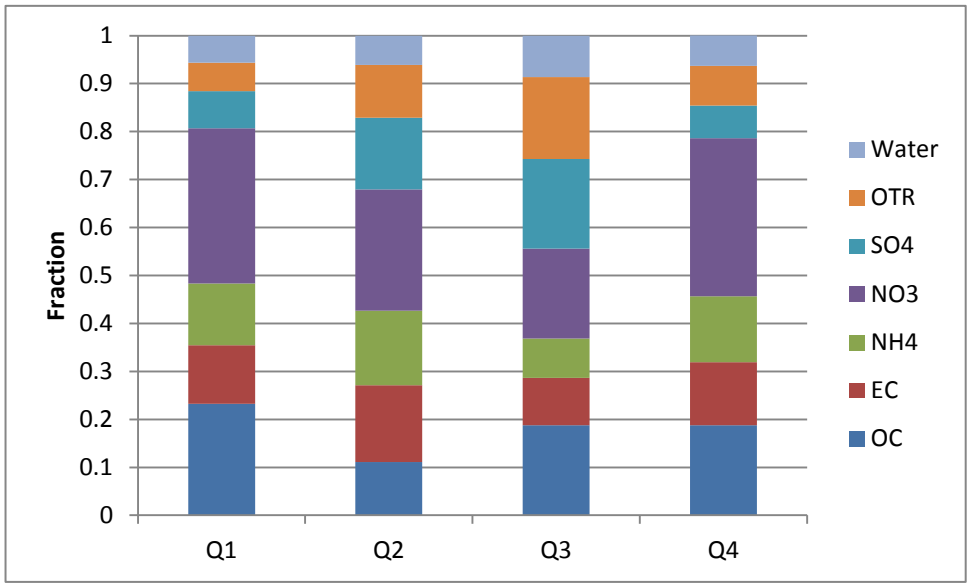


Figure V-5-12

2008 Fontana 24-Hour PM2.5 species fractional splits after the Sandwich

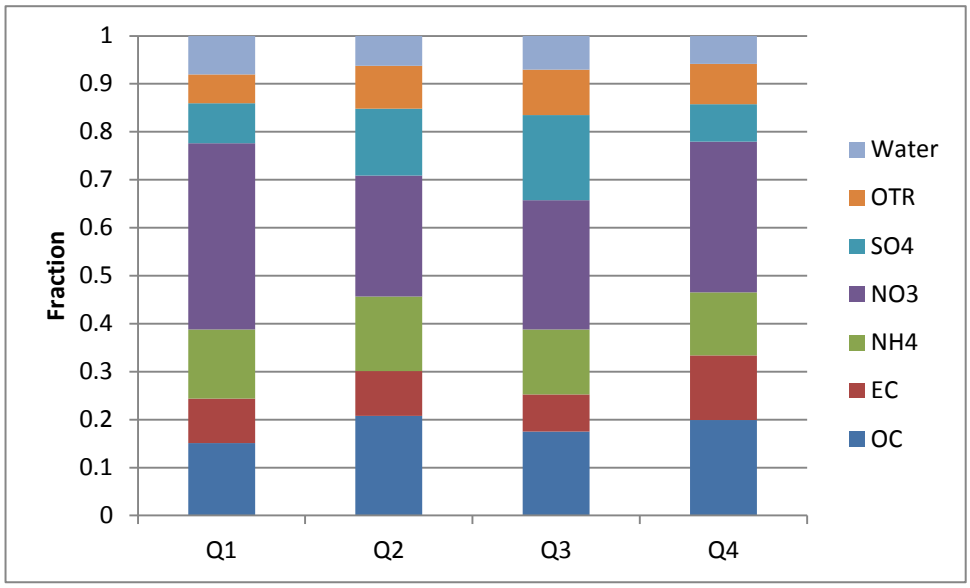


Figure V-5-13

2008 Rubidoux 24-Hour PM2.5 species fractional splits after the Sandwich

PERFORMANCE EVALUATION

EPA guidance assesses model performance on the ability to predict the PM2.5 component species and the total mass. No specific performance criteria thresholds are recommended in EPA's modeling guidance document. This is because the model uses relative response factors rather than direct predictions. Performance is evaluated by examining key statistics and graphical representations of the differences between model predicted concentrations and observations. The statistics examine model bias and error, while graphical representations of error, model prediction time series, and concentration scatter plots supplement the methods of model performance evaluation. The CMAQ modeling results presented for each station are based on the same "1-cell" basis.

PM2.5 Component Species Performance Evaluation

The CMAQ 2008 base-year 24-hour PM2.5 performance statistics are presented in Tables V-5-9 through V-5-14. The analysis includes predicted concentrations and observations for the six component species and total mass at the 6 SASS sites. (Note

that the "others" category collectively includes crustal compounds-metals, sea salt, estimated water vapor and the filter blank). Also presented in the tables are estimates of bias and error for each component at each monitoring site. Quarterly statistics are provided in Attachment 3 to this document.

Figure V-5-14 provides a "soccer goal" graphical representation of error for model performance. Figures V-5-15 through Figure V-5-18 present the time series of model predicted vs. observations for each component at the SASS monitoring sites. Figure V-5-19 through Figure V-5-24 present the scatter-plots of prediction accuracy for each component at the SASS monitoring sites.

The three western Basin Los Angeles County sites analyzed had a total mass absolute prediction accuracy that exceeded 25 percent of the observed average. Prediction accuracy estimated for the three remaining sites measured approximately 20 percent or lower. In general, normalized bias was lowest for nitrate and highest for sulfate. The only systematic bias was evident for EC, whereby the tendency was to under predict observations.

One element observed during the 2008 simulation evaluation was that the eastern portion of the Basin predicted low concentrations of secondary aerosols when high wind "Santa Ana" conditions were observed. This generalized wind condition also impacted the western portion of the Basin but to a lesser extent. The days impacted by the high winds were clustered in the first and fourth quarters. Figure V-5-25 illustrates the frequency of the observed Santa Ana wind events.

TABLE V-5-9

CMAQ 2008 Base Year Total Mass Model Predictions (µg/m^3)

Locations	Mean Observed	Mean Predicted	Mean Bias	Mean Error	Normalized Mean Bias	Normalized Mean Error
Anaheim	15.67	14.45	-1.24	6.82	-0.37	2.51
Los Angeles	17.47	12.83	-4.65	8.79	-1.79	2.95
N. Long Beach	17.68	19.78	2.11	7.67	0.89	2.71
S. Long Beach	16.76	18.68	1.92	7.51	0.76	2.71
Fontana	17.43	22.05	4.62	9.41	1.42	3.08
Rubidoux	19.42	14.71	-4.69	9.10	-1.65	2.78

TABLE V-5-10

CMAQ 2008 Base Year Ammonium Model Predictions (µg/m^3)

Locations	Mean Observed	Mean Predicted	Mean Bias	Mean Error	Normalized Mean Bias	Normalized Mean Error
Anaheim	1.48	1.78	0.30	0.56	0.20	0.38
Fontana	1.91	1.75	-0.17	0.76	-0.09	0.40
S. Long Beach	1.70	2.60	0.90	1.10	0.53	0.65
N. Long Beach	1.68	2.49	0.81	1.06	0.48	0.63
Los Angeles	1.82	2.34	0.52	0.95	0.28	0.52
Rubidoux	2.31	2.10	-0.20	0.99	-0.09	0.43

Table V-5-11

CMAQ 2008 Base Year Nitrate Model Predictions (µg/m^3)

Locations	Mean Observed	Mean Predicted	Mean Bias	Mean Error	Normalized Mean Bias	Normalized Mean Error
Anaheim	2.92	3.49	0.57	1.42	0.20	0.49
Fontana	4.39	4.32	-0.07	2.12	-0.02	0.48
S. Long Beach	2.87	2.89	0.02	1.30	0.01	0.45
N. Long Beach	3.07	3.16	0.08	1.26	0.03	0.41
Los Angeles	3.26	4.66	1.40	2.10	0.43	0.65
Rubidoux	5.17	5.02	-0.14	2.44	-0.03	0.47

TABLE V-5-12

CMAQ 2008 Base Year Sulfate Model Predictions (µg/m^3)

Locations	Mean Observed	Mean Predicted	Mean Bias	Mean Error	Normalized Mean Bias	Normalized Mean Error
Anaheim	2.50	1.76	-0.74	0.94	-0.30	0.38
Fontana	2.17	1.17	-1.00	1.03	-0.46	0.47
S. Long Beach	3.26	4.69	1.43	1.72	0.44	0.53
N. Long Beach	2.85	4.14	1.29	1.55	0.45	0.54
Los Angeles	2.69	2.22	-0.46	0.99	-0.17	0.37
Rubidoux	2.32	1.42	-0.90	1.12	-0.39	0.48

Table V-5-13

CMAQ 2008 Base Year Organic Carbon Model Predictions (µg/m^3)

Locations	Mean Observed	Mean Predicted	Mean Bias	Mean Error	Normalized Mean Bias	Normalized Mean Error
Anaheim	2.52	2.60	0.08	0.78	0.03	0.31
Fontana	2.96	1.65	-1.30	1.31	-0.44	0.44
S. Long Beach	2.53	2.85	0.33	0.75	0.13	0.30
N. Long Beach	2.57	2.55	-0.02	0.61	-0.01	0.24
Los Angeles	3.12	4.83	1.70	1.82	0.55	0.58
Rubidoux	3.03	1.85	-1.18	1.23	-0.39	0.40

TABLE V-5-14

CMAQ 2008 Base Year Elemental Carbon Model Predictions (µg/m^3)

Locations	Mean Observed	Mean Predicted	Mean Bias	Mean Error	Normalized Mean Bias	Normalized Mean Error
Anaheim	1.73	1.21	-0.53	0.73	-0.30	0.42
Fontana	2.21	1.02	-1.19	1.22	-0.54	0.55
S. Long Beach	2.28	1.83	-0.45	0.91	-0.20	0.40
N. Long Beach	2.06	1.57	-0.49	0.84	-0.24	0.41
Los Angeles	2.41	2.27	-0.14	0.61	-0.06	0.25
Rubidoux	2.15	1.14	-1.01	1.06	-0.47	0.49

Table V-5-14

CMAQ 2008 Base Year Others Predictions ($\mu g/m^3$)

Locations	Mean Observed	Mean Predicted	Mean Bias	Mean Error	Normalized Mean Bias	Normalized Mean Error
Anaheim	4.52	3.61	-0.92	2.39	-0.20	0.53
Fontana	3.83	2.92	-0.92	2.35	-0.24	0.61
S. Long Beach	5.04	4.92	-0.12	1.89	-0.02	0.38
N. Long Beach	4.53	4.77	0.25	2.19	0.05	0.48
Los Angeles	4.13	5.73	1.60	2.94	0.39	0.71
Rubidoux	4.44	3.18	-1.26	2.26	-0.28	0.51

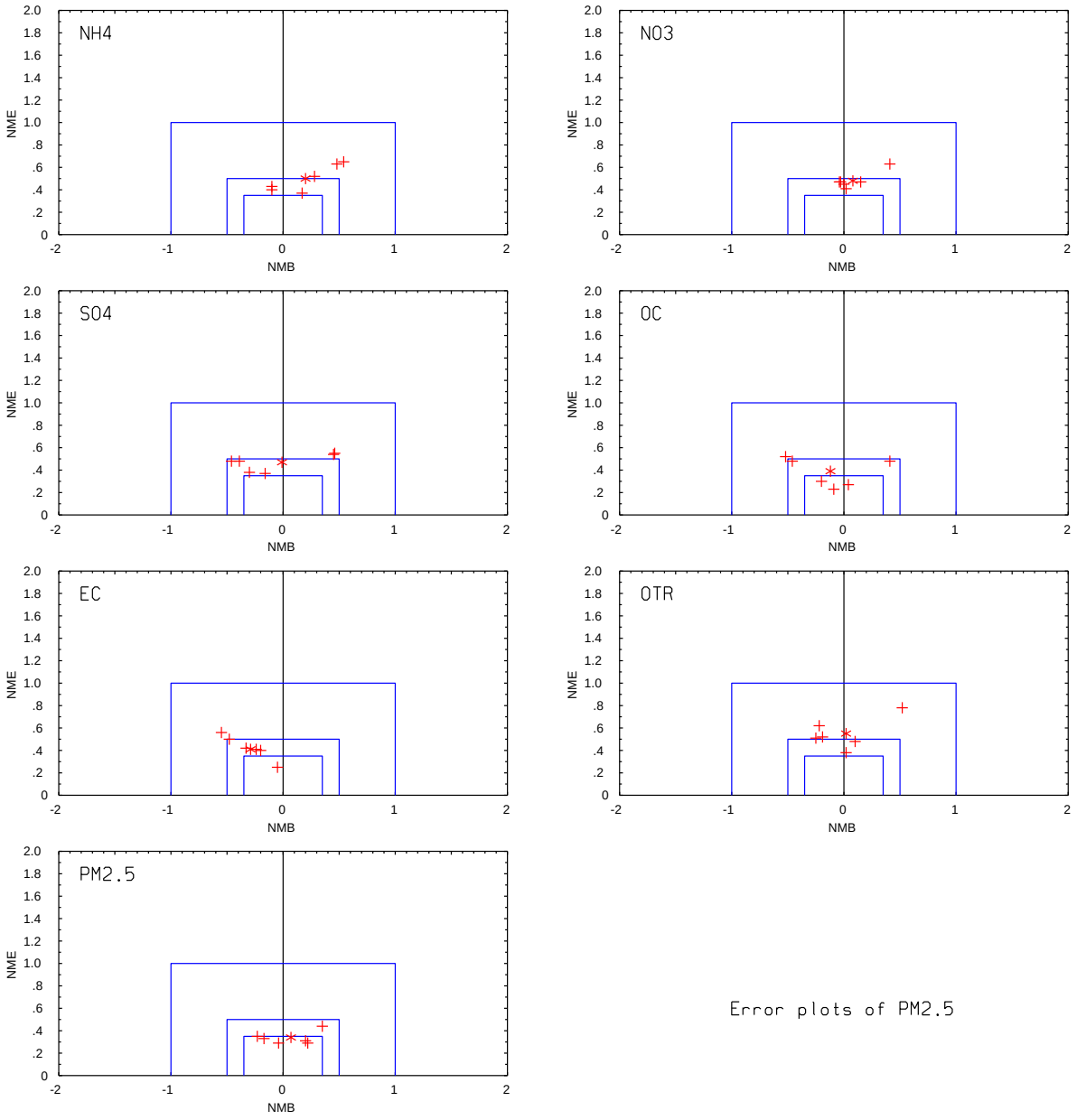


Figure V-5-12

2008 Base Year Soccer Plots of Annual Average Errors at the SASS Sampling Sites

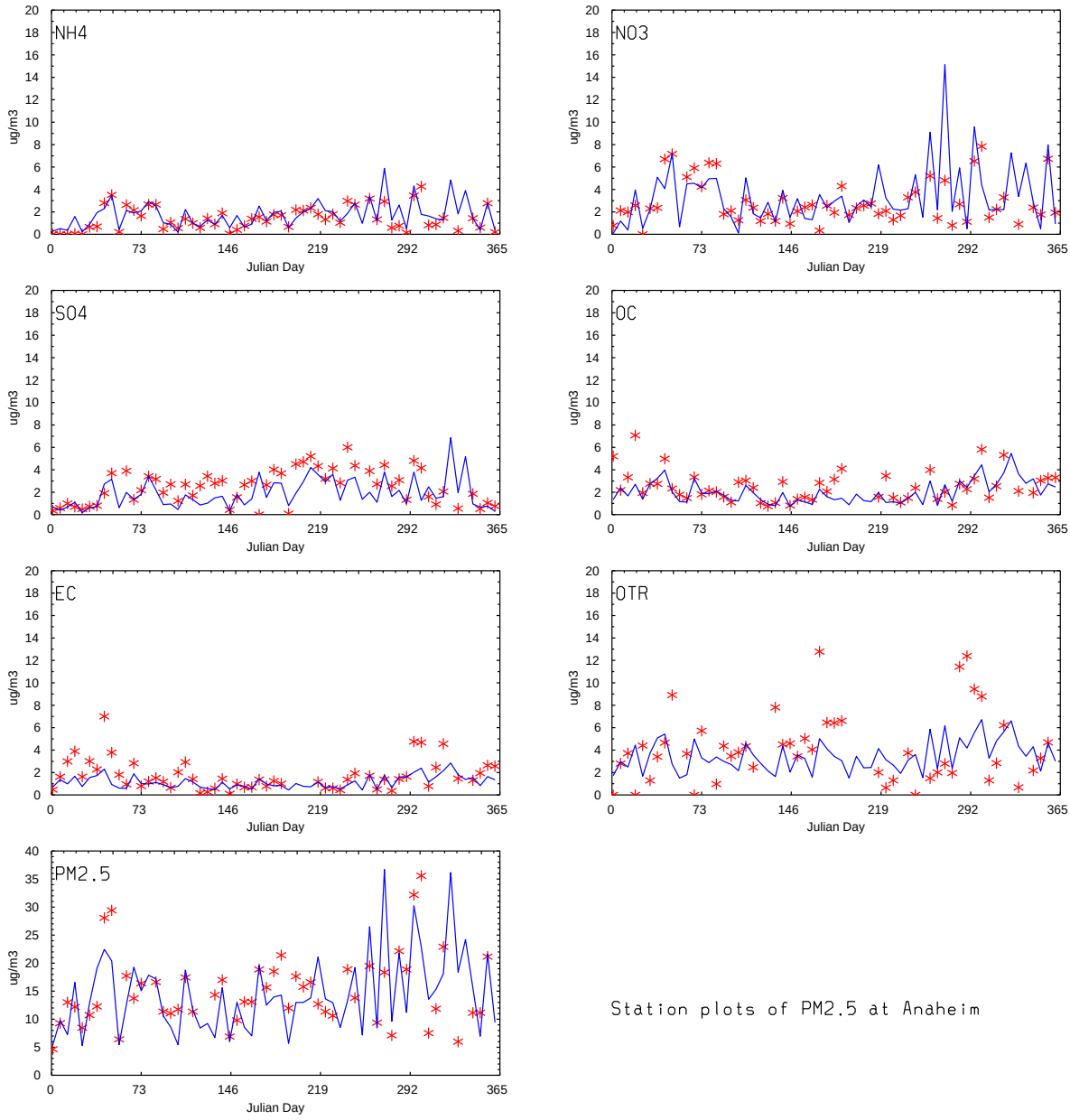


Figure V-5-13

2008 Base Year Time Series: Predicted vs. Observed at Anaheim

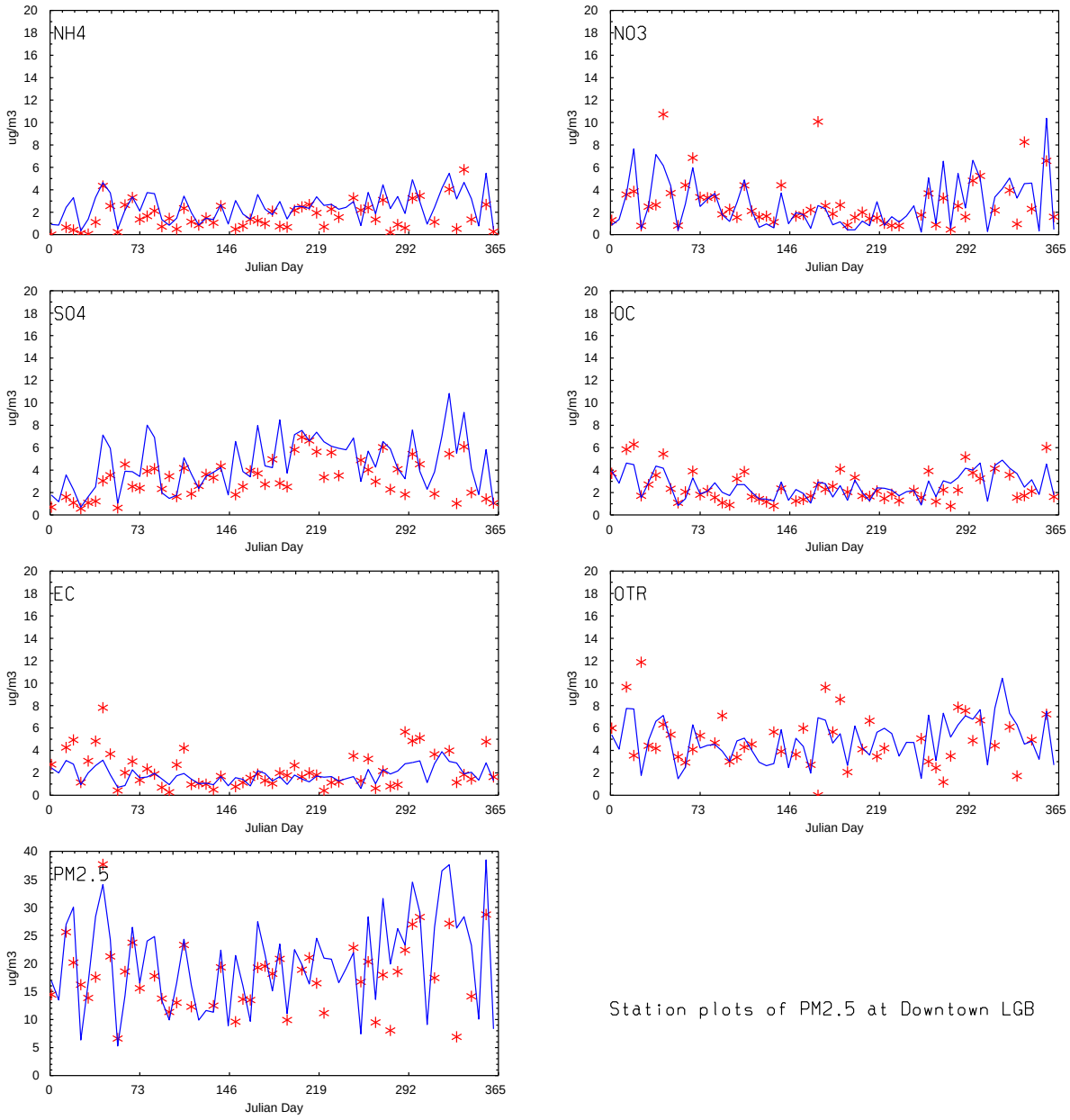


Figure V-5-14

2008 Base Year Time Series: Predicted vs. Observed at Downtown Long Beach

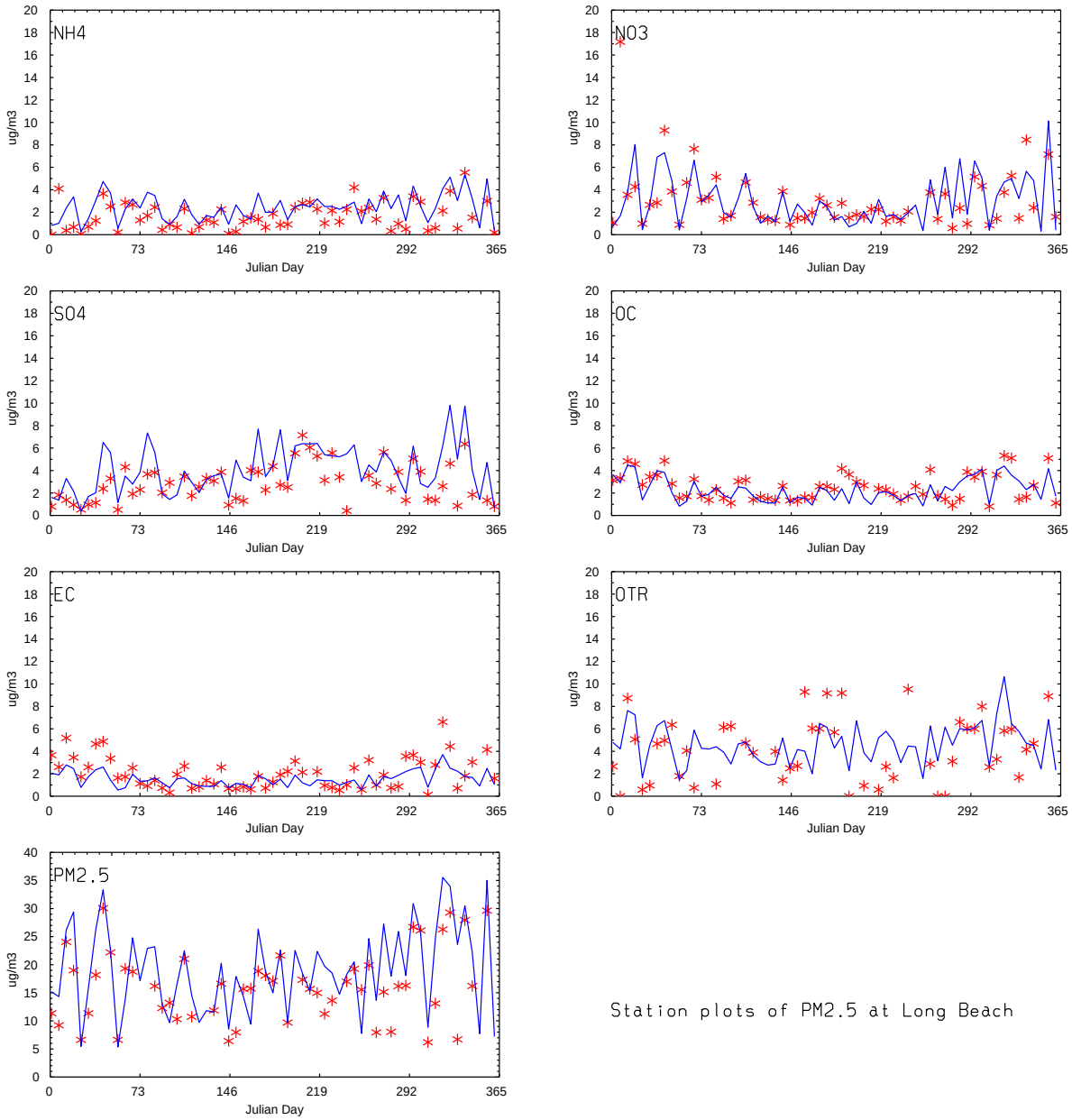


Figure V-5-15

2008 Base Year Time Series: Predicted vs. Observed at Long Beach

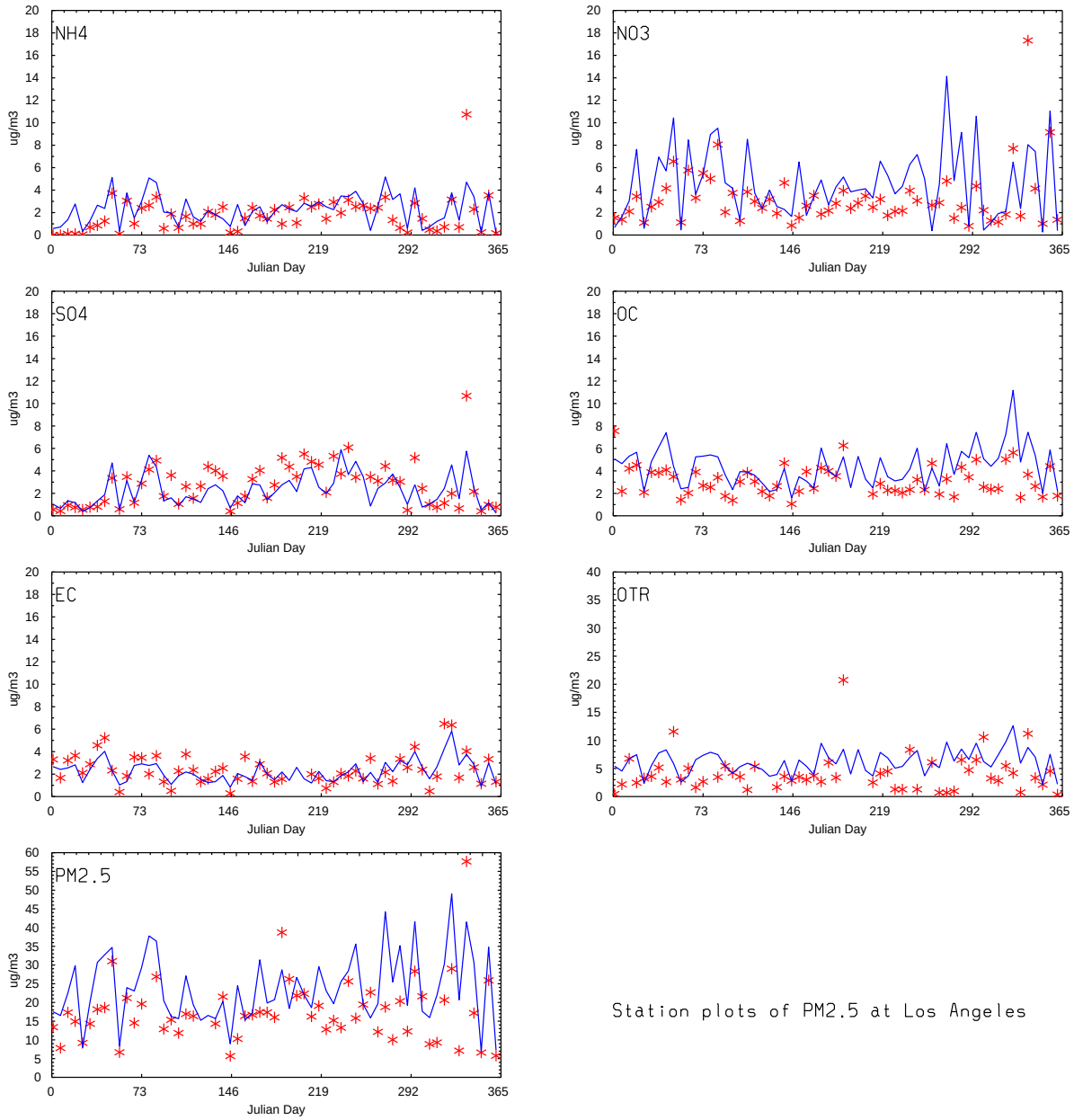


Figure V-5-16

2008 Base Year Time Series: Predicted vs. Observed at Los Angeles

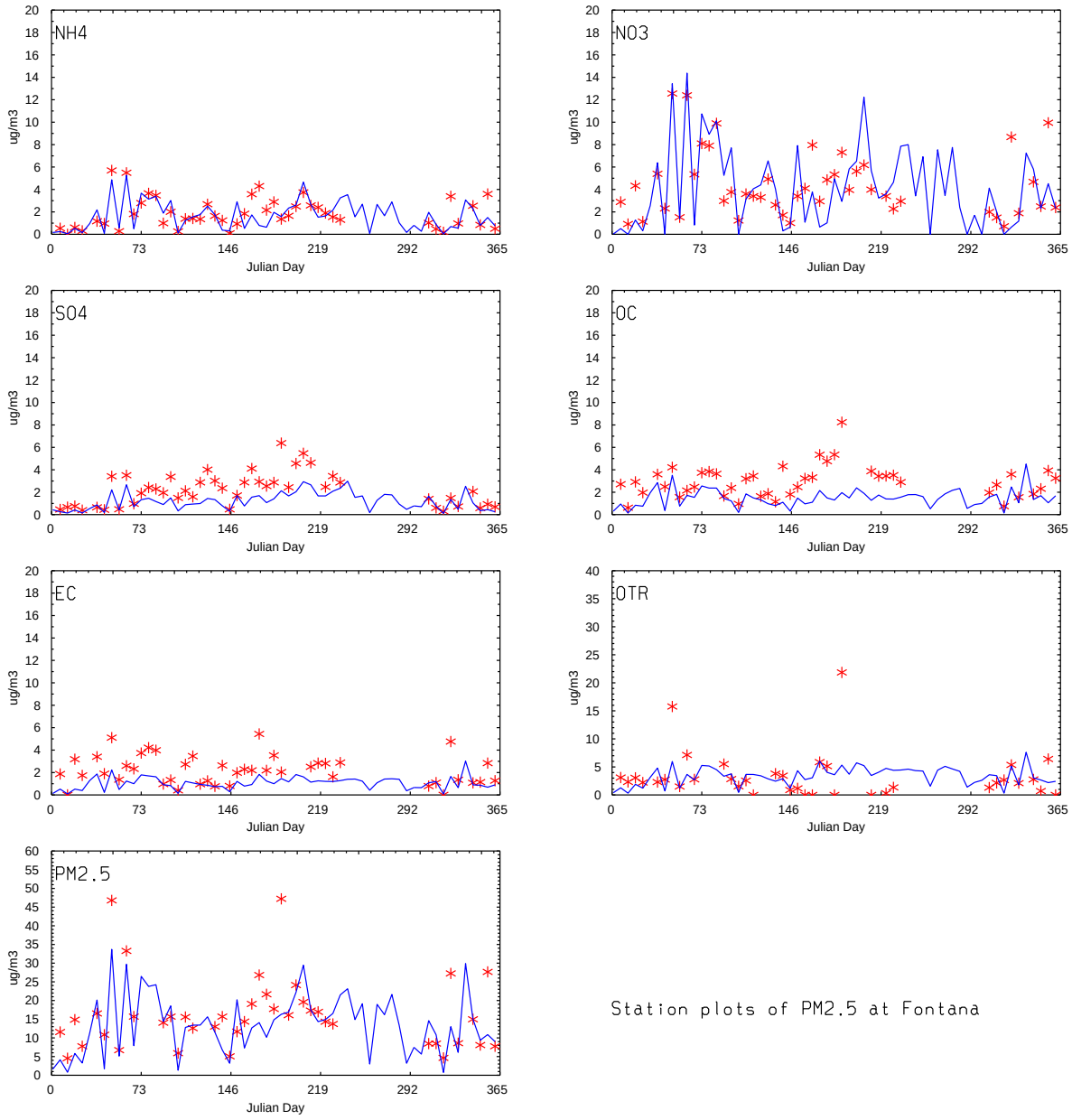


Figure V-5-17

2008 Base Year Time Series: Predicted vs. Observed at Fontana

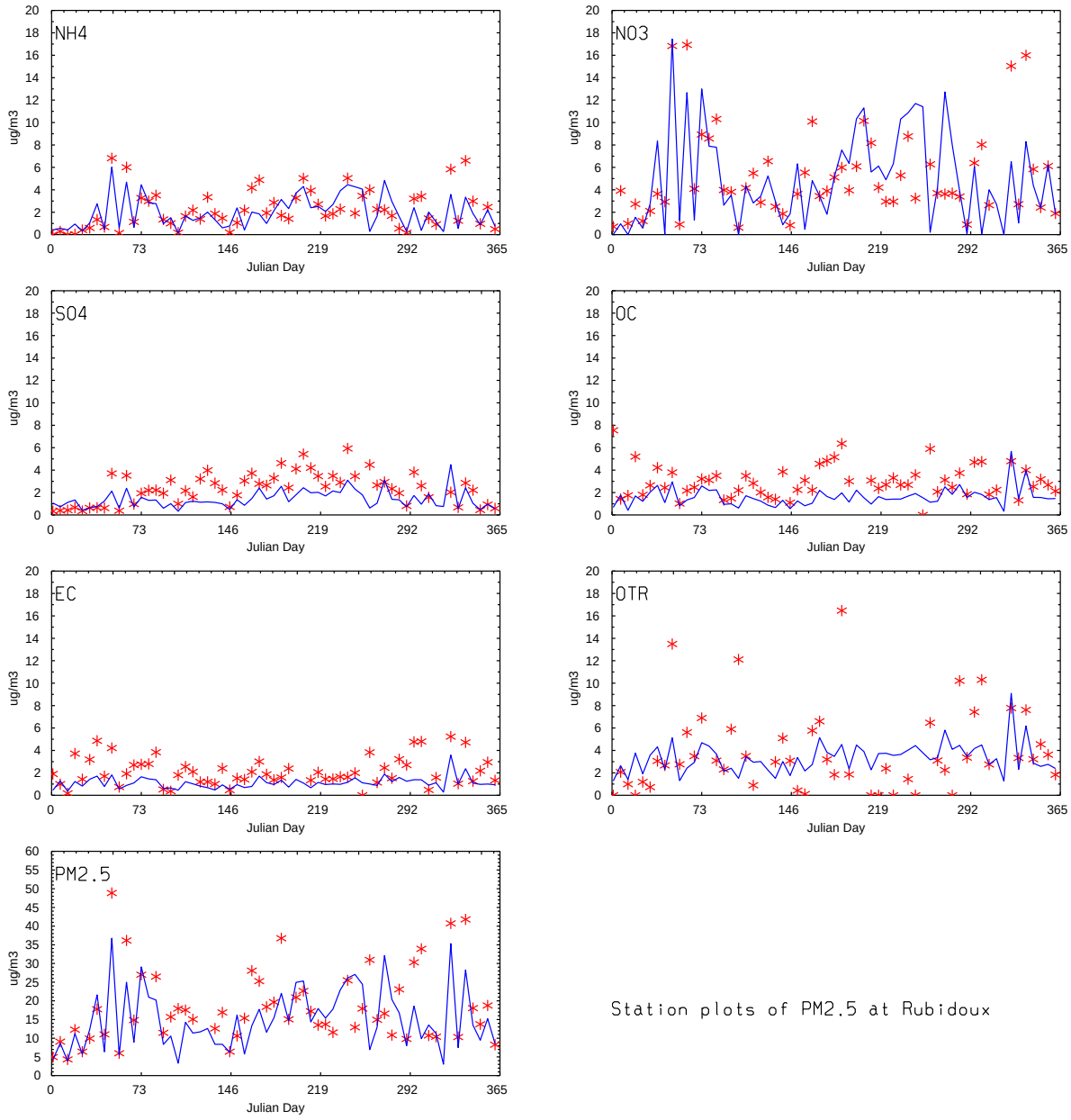


Figure V-5-18

2008 Base Year Time Series: Predicted vs. Observed at Rubidoux

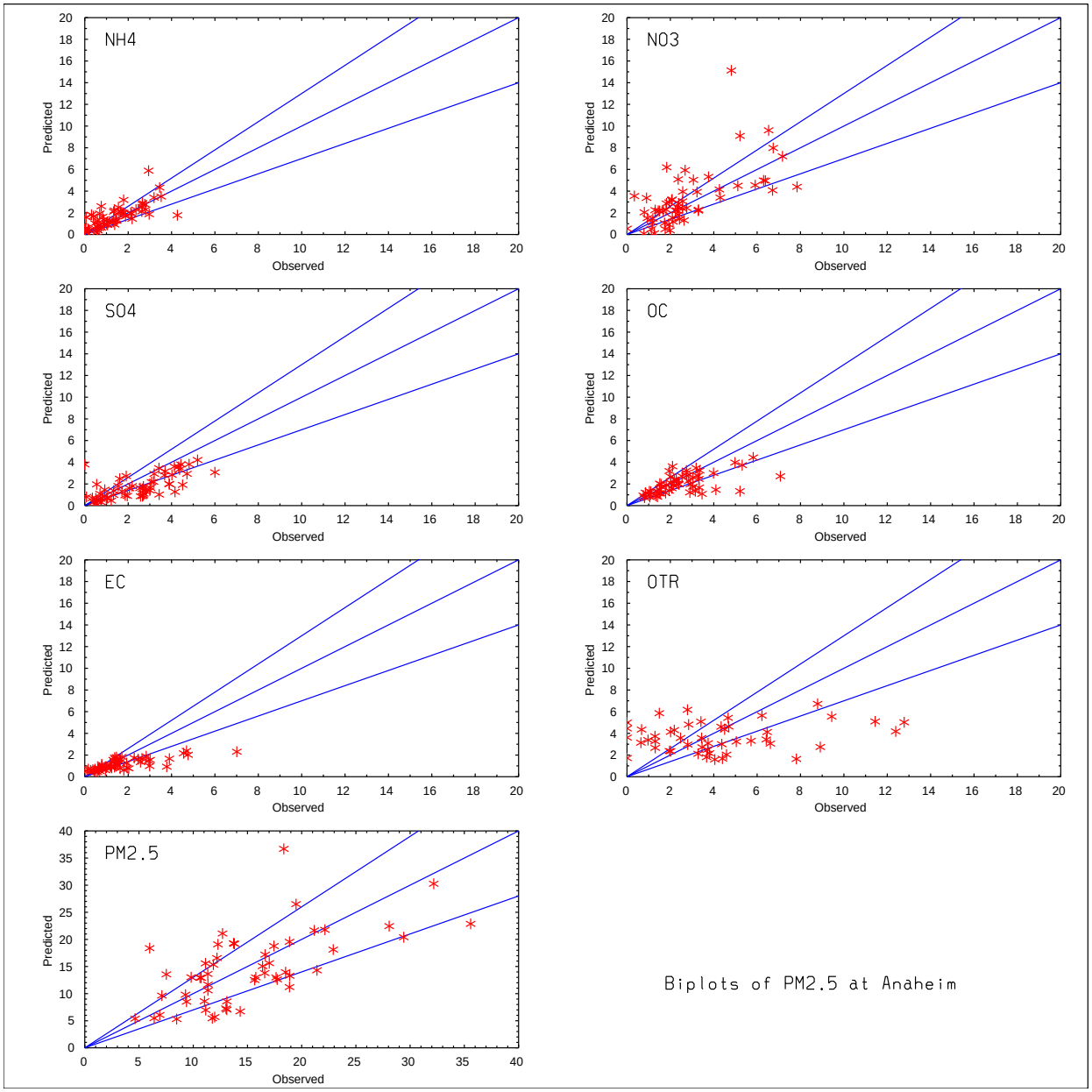


Figure V-5-19

2008 Base Year Bivariate Plots: Predicted vs. Observed at Anaheim

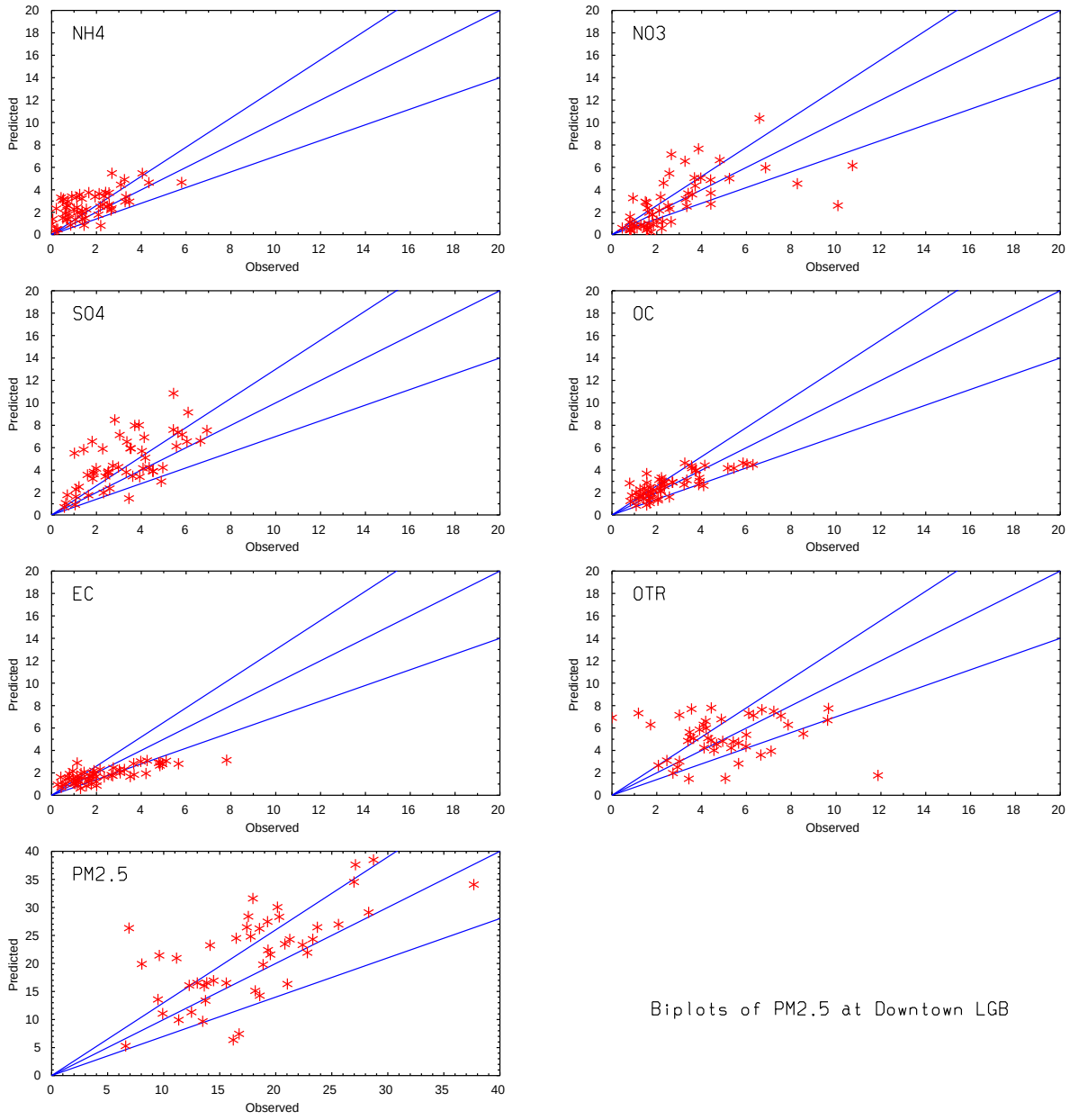


Figure V-5-20

2008 Base Year Bivariate Plots: Predicted vs. Observed at Downtown Long Beach

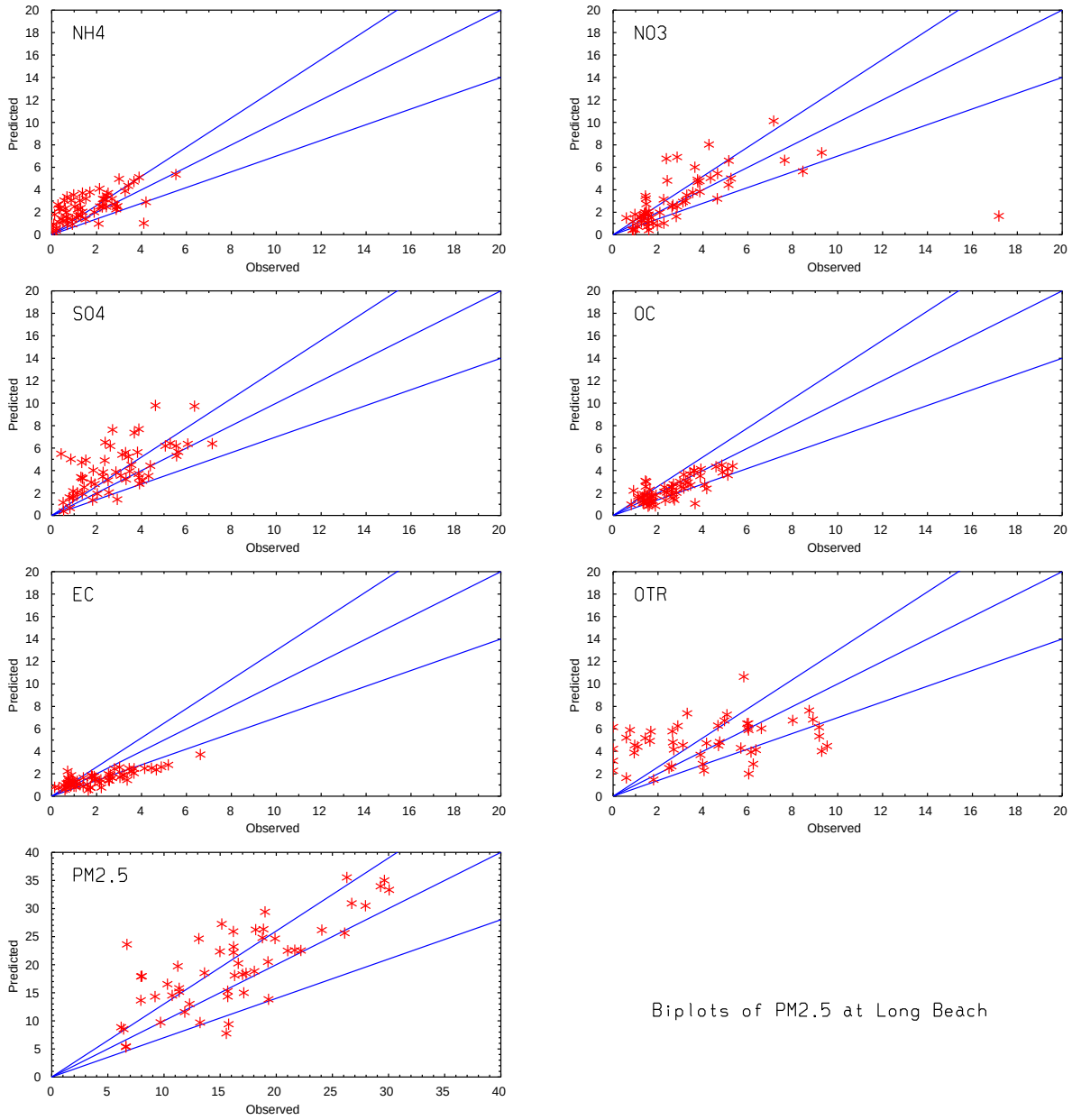


Figure V-5-21

2008 Base Year Bivariate Plots: Predicted vs. Observed at Long Beach

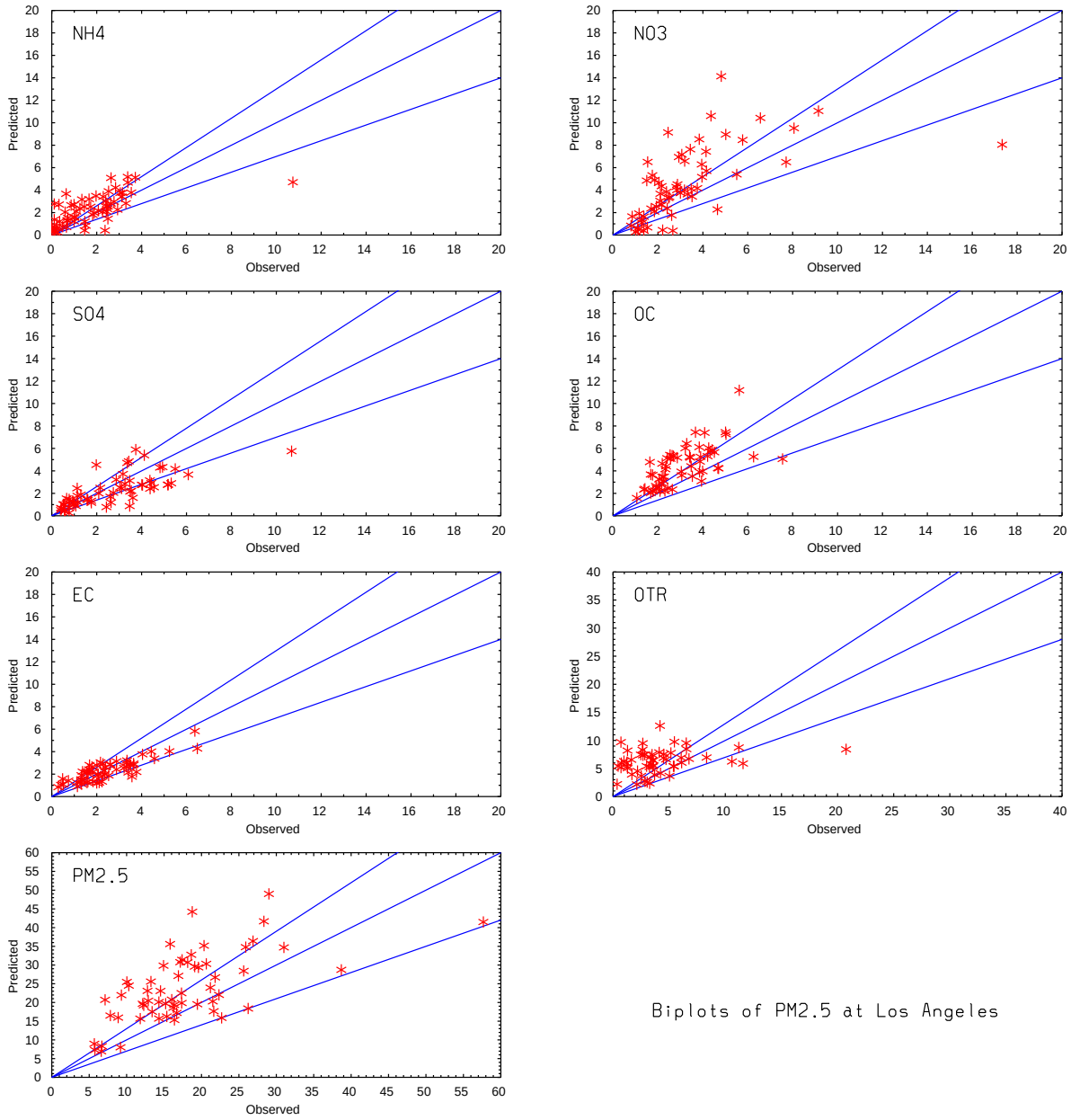


Figure V-5-22

2008 Base Year Bivariate Plots: Predicted vs. Observed at Los Angeles

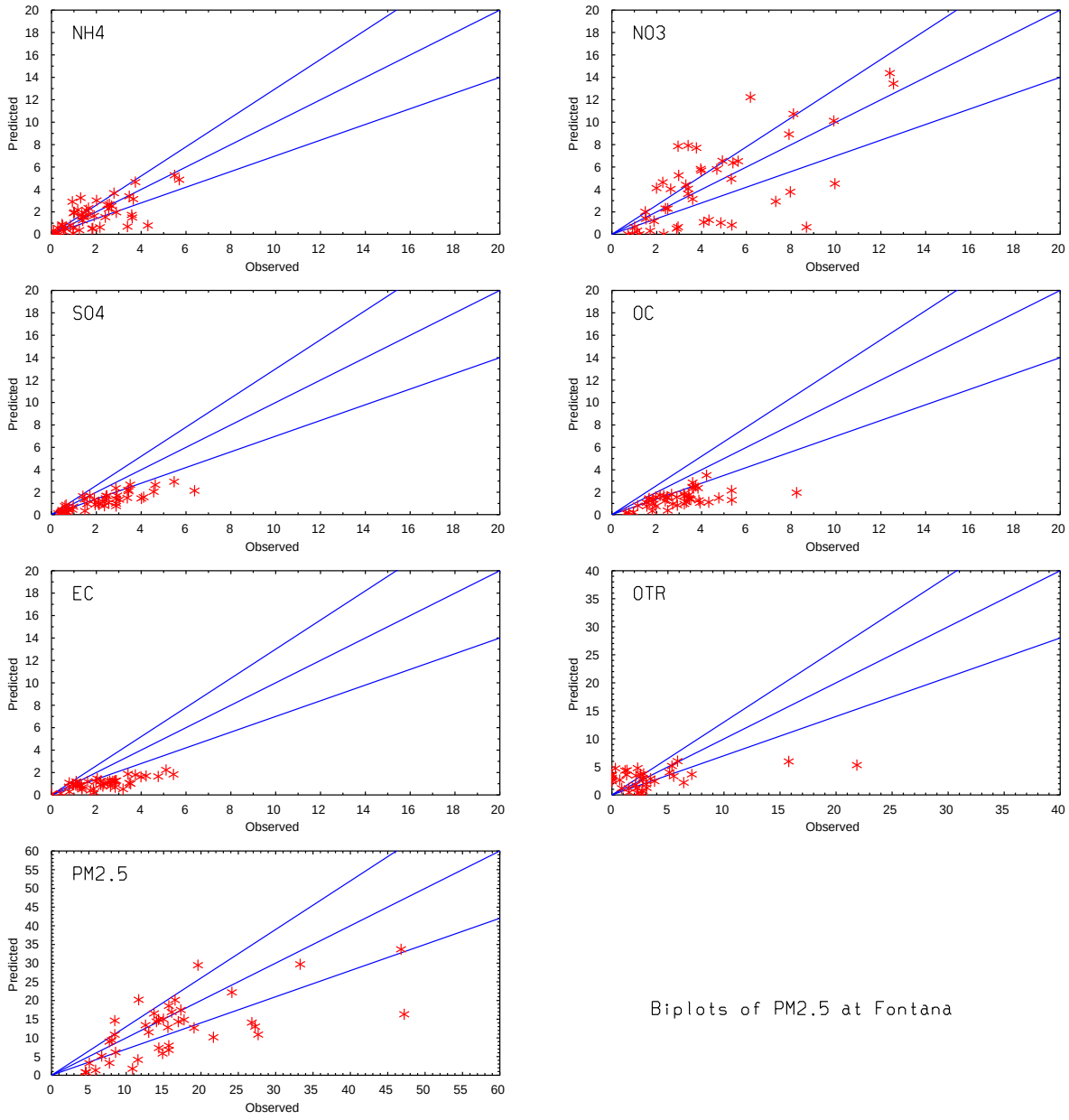


Figure V-5-23

2008 Base Year Bivariate Plots: Predicted vs. Observed at Fontana

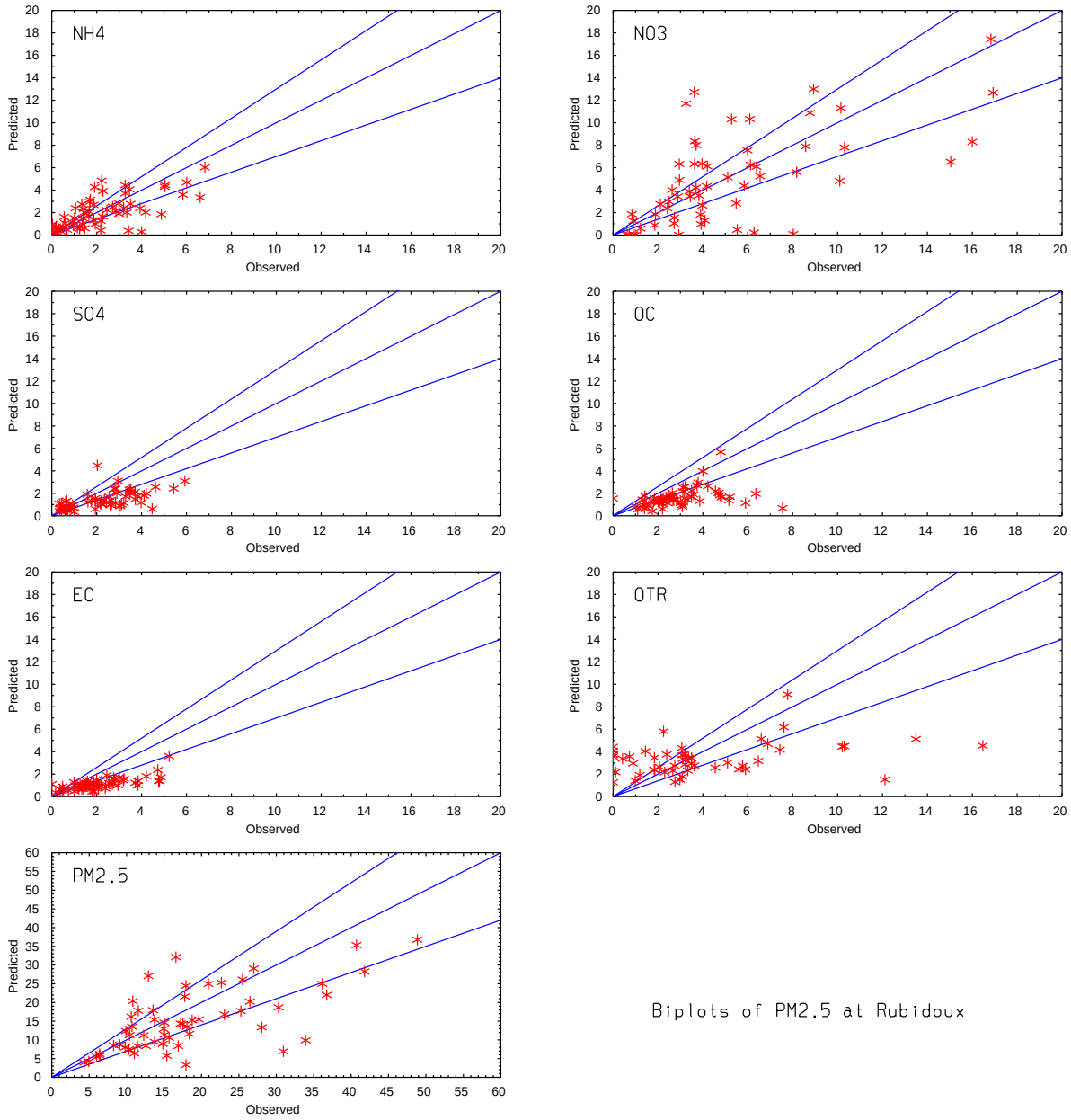


Figure V-5-24

2008 Base Year Bivariate Plots: Predicted vs. Observed at Rubidoux

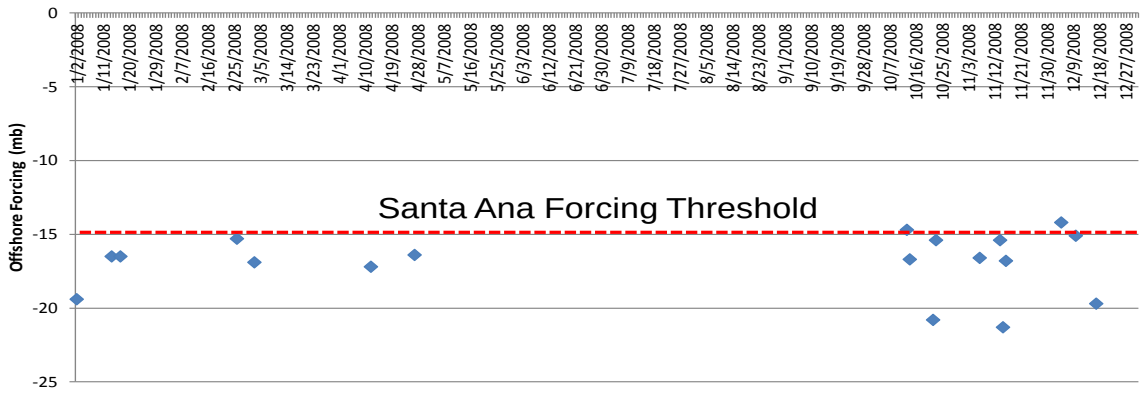


Figure V-5-25

2008 Frequency of Strong Santa Ana Wind Events

Annual Average SSI Mass Performance Evaluation

Table V-5-15 summarizes the performance of the CMAQ simulation in predicting annual average PM2.5 vs. FRM observed annual average mass at the monitoring network sites not having parallel SASS sampling. The goal of this analysis is to demonstrate that the model is consistent in the simulation of PM2.5 at the key sites and across the modeling domain. The general tendency of the simulation was to over-predict annual observed FRM PM2.5 in south central portion of metropolitan Los Angeles County and western San Gabriel Valley. Several sites in the east Basin tend to be under predicted, but by less than 30 percent. Burbank, Ontario, and Riverside Magnolia exhibited prediction accuracy within 10 percent of observations. It is important to remember that the attainment demonstration is based on a relative response factor and not direct future year simulated concentrations.

Base-Year Model Performance Stress Test Evaluation

EPA's modeling guidance as well as the Draft Modeling Protocol outline a series of basic stress tests that can be applied to the base case simulation to determine the level of sensitivity of model performance to key parameters defining the simulations. These stress tests include modifying the boundary conditions, and introducing gross changes in the meteorological and emissions profiles. The goal for these analyses is to see if any one factor is unduly biasing model performance and in doing so jeopardizing the validity of the analysis. Table V-5-16 summarizes the suite of performance stress tests applied to the CMAQ (and CAMx) PM2.5 simulations. Chapter 3 provides a summary of selected tests applied to the WRF meteorological

model. The outcome of the CMAQ testing indicated that the model responded in an expected manner to the changes in simulation parameters and emissions profiles outlined in the stress tests.

TABLE V-5-15

CMAQ Predicted and FRM Observed 2008 Base-Year Annual Average PM2.5 ($\mu g/m^3$)

Location	**Predicted**	**Observed**	**Prediction Accuracy**
Azusa	9.9	14.1	-0.30
Burbank	15.1	14.1	0.07
Compton	18.7	15.5	0.21
Mira Loma	14.1	18.2	-0.23
Mission Viejo	9.6	10.4	-0.08
Ontario	17.3	15.8	0.09
Pasadena	14.8	12.9	0.15
Pico Rivera	16.3	15	0.09
Reseda	10.7	11.9	-0.10
Riverside Magnolia	14.2	13.4	0.06
San Bernardino	13.4	13.5	-0.01

TABLE V-5-16

Selected CMAQ PM2.5 Model Performance Stress Tests

Stress Test Methodology
Boundary conditions only: no anthropogenic emissions with and selected without biogenic emissions 1. Ultra Clean Boundaries 2. EPA Clean Boundaries 3. MOZART Boundaries
Boundary conditions and anthropogenic emissions: no biogenic emissions
Boundary conditions and anthropogenic emissions: 50% biogenic emissions
Shipping emissions split by layers 1. All layer 1 2. Zero layer 1, 100% layer 2 3. 30 % layer 1, 70% layer 2
No emissions in Orange County
No emissions from the Ports of Los Angeles and Long Beach
No livestock emissions
Eliminating all anthropogenic emissions from 49 cells surrounding Mira Loma
No prescribed fires and agricultural burning
Selected restrictions on fireplace/wood stove burning 1. No Riverside and San Bernardino Counties 2. No Basin burning

24-HOUR PM2.5 MODELING APPROACH

CMAQ simulations were conducted for each day in 2008. The simulations included 8784 consecutive hours from which daily 24-hour average PM2.5 concentrations (0000-2300 hours) were calculated. A set of RRFs were generated for each future

year simulation. RRFs were generated for the ammonium ion (NH4), nitrate ion (NO3), sulfate ion (SO4), organic carbon (OC), elemental carbon (EC) and a combined grouping of crustal, sea salts and metals (Others). A total of 24 RRFs were generated for each future year simulation. Water vapor was determined using U.S. EPA's regression model approximation of the AIM model based on simulated concentrations of the ammonium, nitrate and sulfate ions.

Future year concentrations of the six component species were calculated by applying the model generated quarterly RRFs to the speciated 24-hour PM2.5 (FRM) data sorted by quarter for each of the five years used in the design value calculation. The 32 days in each year were then re-ranked to establish a new 98^{th} percentile concentration. The resulting future year 98^{th} percentile concentrations for the 5-years were subjected to weighted averaging for the attainment demonstration.

Future year PM2.5 24-hour average design values are presented for 2014, and 2019 to (1) demonstrate the future baseline concentrations if no further controls are implemented; (2) identify the amount of air quality improvement needed to advance the attainment date to 2014; and (3) confirm the attainment demonstration with implementation of the proposed PM2.5 control strategy.

FUTURE AIR QUALITY

Under the federal Clean Air Act, the Basin must comply with the federal PM2.5 air quality standards by December 2014 [Section 172(a)(2)(A)]. An extension of up-to five years (until 2019) could be granted if attainment cannot be demonstrated with implementation of all feasible measures to advance attainment.

A simulation of 2014 baseline emissions was conducted to assess the extent of the 24-hour PM2.5 problem in the Basin. The simulation used the projected emissions for 2014 which include all adopted control measures that will be implemented prior to and during 2014. The resulting 2014 future-year Basin design value (37.3 $\mu g/m^3$) failed to meet the federal standard of 35 $\mu g/m^3$. As a consequence additional controls are needed to attain the standard by 2014.

Simulation of the 2019 baseline emissions indicates that the Basin will attain the federal 24-hour PM2.5 standard in 2019 without additional controls. However, with the Final 2012 AQMP proposed PM2.5 control program in place, the 24-hour PM2.5 simulations project that the 2014 design value will be 34.3 $\mu g/m^3$, thus advancing the attainment date from 2019 to 2014.

Figure V-5-26 depicts future 24-hour PM2.5 air quality projections at the Basin design site (Mira Loma) and six other PM2.5 monitoring sites having comprehensive particulate species characterization. Shown in the figure are the baseline designs for 2008 along with projections for 2014 with and without proposed control measures in place. All of the sites with the exception of Mira Loma will meet the 24-hour PM2.5 standard by 2014 without additional control measures. With implementation of the proposed control measures, all sites in the Basin demonstrate attainment in 2014.

Table V-5-17 provides the RRFs developed from the 2008 base year and 2014 controlled simulations. Tables V-5-18 and V-5-19 provide the CMAQ/SMAT projected future year PM2.5 by component species for 2014 with (controlled) and without (base-line) proposed control measures implemented. Tables V-5-20, V-5-21 and V-5-22 provide the projected controlled future year 24-hour PM2.5 design values by component species for 2019, 2023 and 2030 Projected 24-hour PM2.5 (2019 and beyond) indicates that the Basin will remain in attainment with the standard, with the addition of the short term ozone measures but without the need for continued episodic controls being implemented.

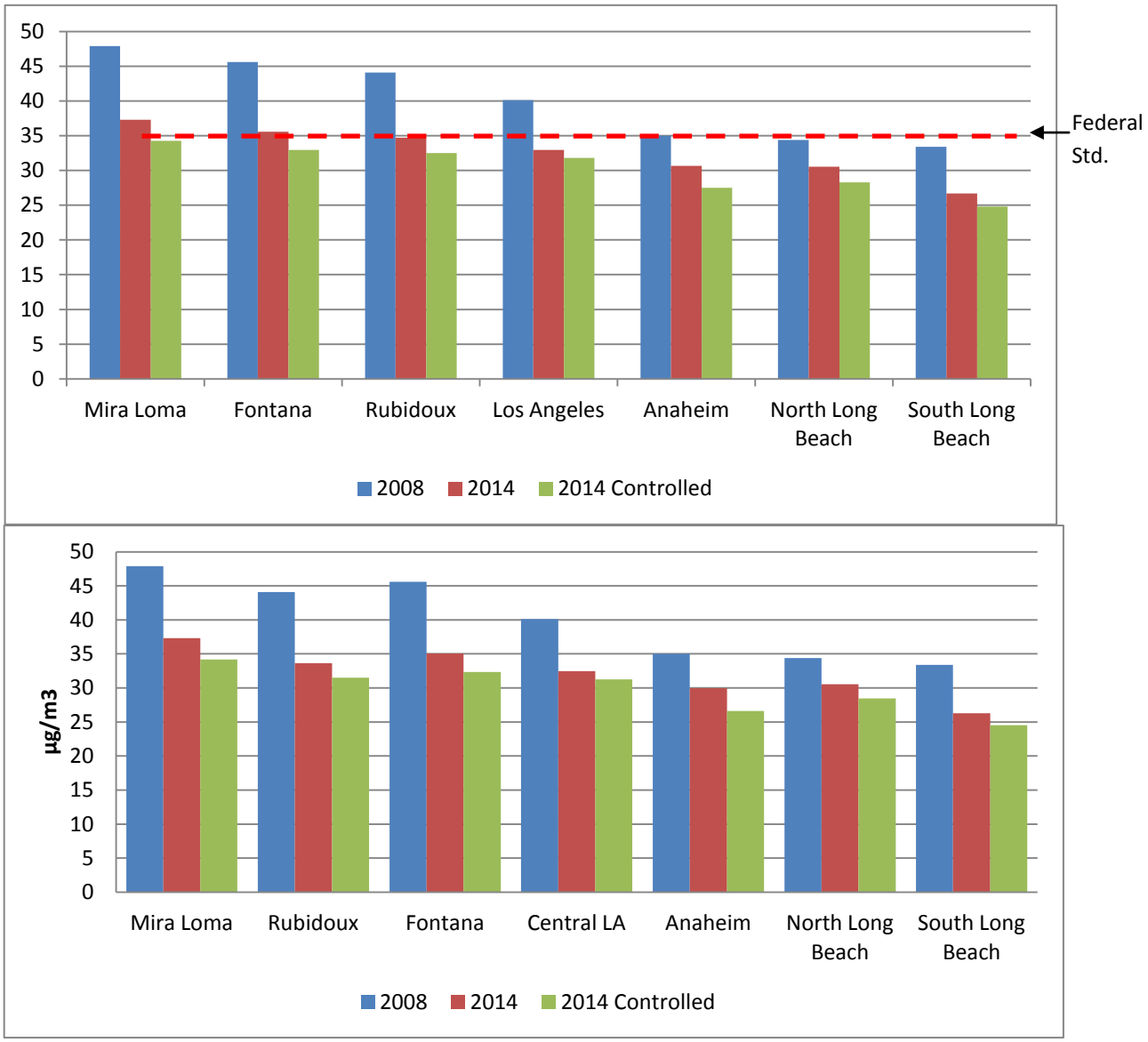


FIGURE V-5-26

Maximum 24-Hour Average PM2.5 Design Concentrations:
2008 Baseline, 2014 and 2014 Controlled

TABLE V-5-17

2014 Controlled Emissions RRFs

Station	Quarter	NH4	NO3	SO4	OC	EC	Others
Anaheim	Q1	0.81	0.95	0.48	0.65	0.52	0.87
	Q2	0.58	0.68	0.40	0.83	0.62	0.91
	Q3	0.67	0.76	0.42	0.84	0.62	0.91
	Q4	0.77	0.99	0.44	0.63	0.52	0.87
Los Angeles	Q1	0.87	0.99	0.58	0.75	0.56	0.93
	Q2	0.69	0.80	0.50	0.87	0.62	0.98
	Q3	0.71	0.83	0.49	0.88	0.62	0.98
	Q4	0.84	0.98	0.59	0.75	0.56	0.94
Fontana	Q1	0.82	0.87	0.55	0.65	0.56	0.92
	Q2	0.68	0.72	0.51	0.84	0.64	1.00
	Q3	0.63	0.68	0.46	0.84	0.64	0.97
	Q4	0.76	0.82	0.53	0.60	0.53	0.92
N. Long Beach	Q1	0.87	1.03	0.67	0.68	0.56	0.90
	Q2	0.69	0.80	0.62	0.80	0.64	0.91
	Q3	0.71	0.87	0.58	0.79	0.65	0.89
	Q4	0.81	0.97	0.66	0.65	0.55	0.90
Rubidoux	Q1	0.78	0.83	0.54	0.67	0.54	0.94
	Q2	0.62	0.65	0.49	0.86	0.61	1.03
	Q3	0.61	0.64	0.50	0.87	0.62	1.01
	Q4	0.79	0.84	0.59	0.63	0.52	0.93
S. Long Beach	Q1	0.83	1.02	0.59	0.68	0.53	0.88
	Q2	0.57	0.79	0.46	0.76	0.62	0.84
	Q3	0.70	0.89	0.55	0.78	0.63	0.89
	Q4	0.79	0.95	0.62	0.66	0.54	0.89

Table V-5-18

CMAQ 2014 24-hour PM2.5 Base-line Predictions (µg/m^3)

Locations	NH4	NO3	SO4	OC	EC	Others	Water	Blank	Mass
Anaheim	3.4	8.9	2.5	6.9	3.5	3.3	1.7	0.5	30.7
S. Long Beach	3.1	6.9	2.7	6.5	3.4	2.1	1.5	0.5	26.7
Fontana	4.7	12.0	2.0	7.3	3.7	3.2	2.2	0.5	35.6
N. Long Beach	3.6	8.5	3.2	7.4	3.4	2.1	1.9	0.5	30.5
Los Angeles	3.5	7.4	3.7	10.0	2.5	3.7	1.6	0.5	33.0
Mira Loma	5.3	14.5	2.0	6.4	2.9	3.0	2.7	0.5	37.3
Rubidoux	4.9	13.1	2.2	6.0	2.6	2.9	2.5	0.5	34.7

TABLE V-5-19

CMAQ 2014 24-hour PM2.5 Controlled Predictions (µg/m^3)

Locations	NH4	NO3	SO4	OC	EC	Others	Water	Blank	Mass
Anaheim	2.89	7.52	2.20	6.61	2.79	3.53	1.45	0.50	27.49
S. Long Beach	2.96	6.86	2.52	5.55	3.06	1.98	1.37	0.50	24.79
Fontana	4.71	11.80	1.86	5.26	3.27	3.45	2.10	0.50	32.94
N. Long Beach	3.76	8.24	3.39	5.79	2.80	2.08	1.70	0.50	28.27
Los Angeles	4.56	10.49	3.32	5.62	2.68	2.64	2.00	0.50	31.80
Mira Loma	4.92	12.84	1.96	5.61	2.88	3.24	2.33	0.50	34.28
Rubidoux	4.71	12.95	1.95	4.73	2.47	2.77	2.44	0.50	32.51

Table V-5-20

CMAQ 2019 24-hour PM2.5 Controlled Predictions (μg/m^3)

Locations	NH4	NO3	SO4	OC	EC	Others	Water	Blank	Mass
Anaheim	3.5	8.9	2.6	6.7	3.1	3.3	1.7	0.5	30.2
S. Long Beach	3.0	6.8	2.6	6.4	3.1	2.1	1.5	0.5	25.9
Fontana	4.4	11.1	2.0	7.0	3.4	3.5	2.1	0.5	33.9
N. Long Beach	3.9	8.6	3.4	7.0	2.9	2.2	1.8	0.5	30.3
Los Angeles	3.9	9.0	3.6	7.5	2.3	3.2	1.9	0.5	31.9
Mira Loma	4.7	12.4	2.1	6.8	3.2	3.6	2.1	0.5	35.4
Rubidoux	4.3	10.6	2.5	6.3	2.8	3.7	2.0	0.5	32.5

Table V-5-21

CMAQ 2023 24-hour PM2.5 Controlled Predictions (μg/m^3)

Locations	NH4	NO3	SO4	OC	EC	Others	Water	Blank	Mass
Anaheim	3.0	7.6	2.5	7.8	2.8	3.9	1.5	0.5	29.7
S. Long Beach	3.0	6.7	2.6	6.3	2.9	2.2	1.4	0.5	25.5
Fontana	3.9	9.5	2.2	7.6	3.2	3.2	1.8	0.5	32.0
N. Long Beach	3.9	8.6	3.4	6.9	2.7	2.3	1.7	0.5	30.0
Los Angeles	3.8	8.4	3.8	7.4	2.2	3.3	1.9	0.5	31.3
Mira Loma	4.2	10.6	2.3	6.9	3.1	3.9	2.2	0.5	33.7
Rubidoux	4.0	10.2	2.6	5.8	2.4	3.3	2.0	0.5	30.6

Table V-5-22

CMAQ 2030 24-hour PM2.5 Controlled Predictions (μg/m^3)

Locations	NH4	NO3	SO4	OC	EC	Others	Water	Blank	Mass
Anaheim	3.3	7.9	3.1	6.8	2.9	3.6	1.6	0.5	29.7
S. Long Beach	3.1	6.2	3.1	6.5	3.0	2.4	1.4	0.5	26.2
Fontana	3.7	8.8	2.5	7.9	3.2	3.4	1.4	0.5	31.7
N. Long Beach	3.9	8.4	3.6	7.0	2.7	2.4	1.8	0.5	30.3
Los Angeles	3.1	5.9	4.3	10.0	1.9	3.8	1.5	0.5	31.0
Mira Loma	4.0	9.8	2.6	7.2	3.1	4.2	1.9	0.5	33.4
Rubidoux	3.7	8.8	3.1	6.3	2.3	3.8	1.8	0.5	30.3

Spatial Projections of PM2.5 Design Values

Figure V-5-27 provides a Basin-wide perspective of the spatial extent of 24-hour PM2.5 levels in the base year 2008. Figures V-5-28 and V-5-29 show future predicted 24-hour design values in 2014 for base-line emissions and with the proposed control program in place. Several areas around the northwestern portion of Riverside and southwestern portion of San Bernardino Counties depict grid cells with weighted PM2.5 24-hour design values exceeding 35 $\mu g/m^3$ in 2008. By 2014, the number of grid cells with concentrations exceeding the federal standard is restricted to a small region surrounding the Mira Loma monitoring station in northwestern Riverside County. With the control program fully implemented in 2014, the Basin does not exhibit any grid cells exceeding the federal standard.

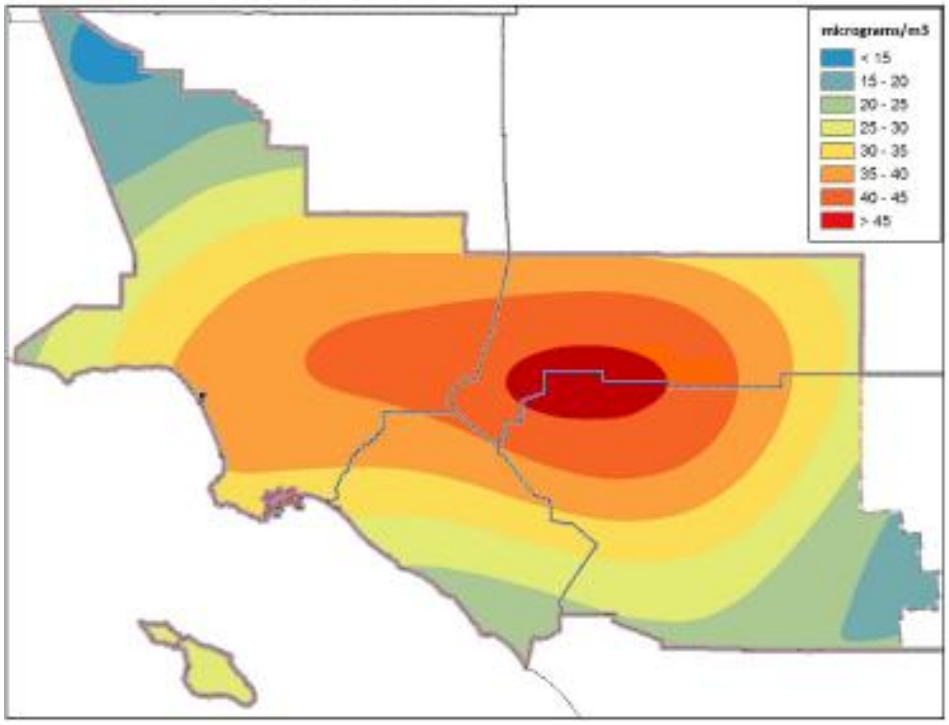


FIGURE V-5-27

2008 Base Year 24-Hour PM2.5 Design Concentrations (µg/m^3)

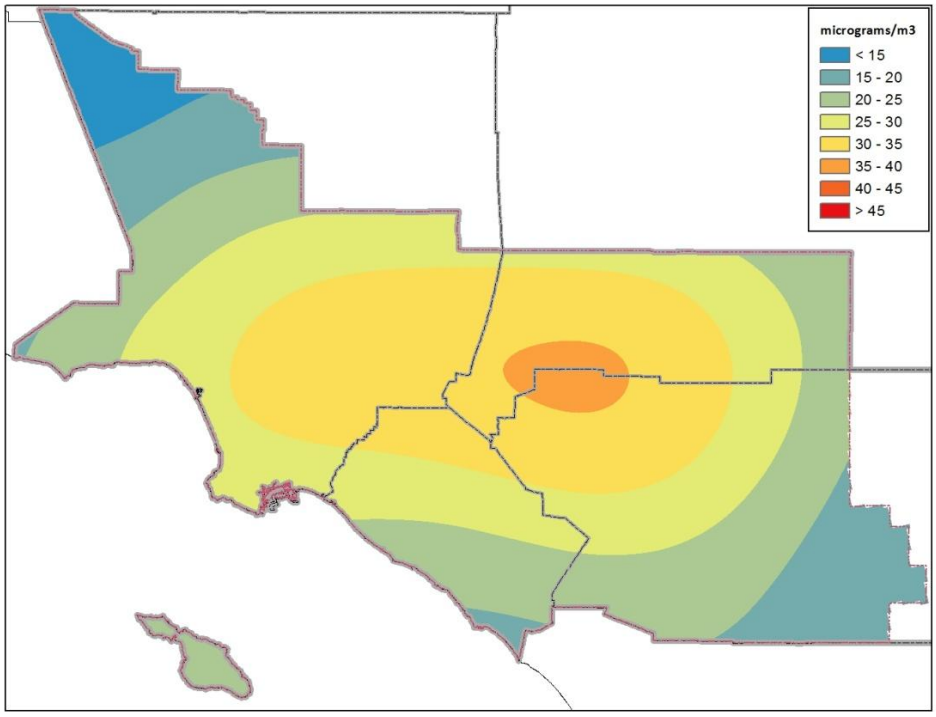


FIGURE V-5-28

2014 Baseline 24-Hour PM2.5 Design Concentrations (µg/m^3)

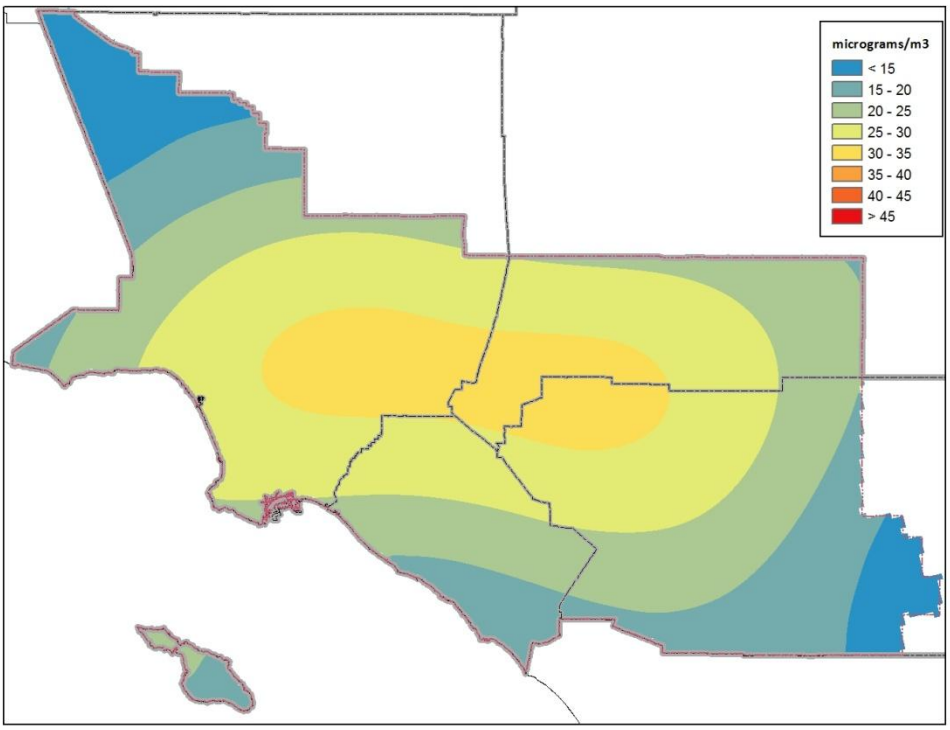


FIGURE V-5-29

2014 Controlled 24-Hour PM2.5 Design Concentrations (µg/m^3)

Unmonitored Area Analysis

U.S. EPA modeling guidance requires that the attainment demonstration include an analysis that confirms that all grid cells in the modeling domain meet the federal standard. This "unmonitored area analysis" is essential since speciation monitoring is conducted at a limited number of sites in the modeling domain. Variance in the species profiles at selected locations coupled with the differing responses to emissions control scenarios are expected to result in spatially variable impacts to PM2.5 air quality in any grid cell. As described earlier in this chapter, speciation profiles from SASS sites in adjacent or collocated grid cells are used in the formal attainment demonstration for Mira Loma and also South Long Beach. With interpolation of the SASS speciation profiles, attainment demonstrations can be directly conducted for the remaining grid cells where FRM mass data has been collected over the 5-year period (2006-2010). To date, no specific test has been proposed by U.S. EPA to address testing attainment at grid cells where no speciated and/or FRM data is available. The form of the revised attainment test adds complication in that it requires assessing the impacts for 32 days per year, for five years, at each unmonitored grid cell.

The methodology used to assess the unmonitored grid cell impact follows. First, a subset of the full modeling domain covering the Basin was selected for the analysis. The western most grid column (70) was aligned with coastal Los Angeles. The eastern most column (100) touched Banning Pass, the southern boundary was located in row 45 in Northern San Diego, and the northern most row (65) corresponding to the northern portion of the San Fernando Valley extending across the San Gabriel and San Bernardino Mts. A review of the 24-hour PM2.5 FRM data and design values from sites located outside of this inner domain indicated that concentrations were significantly lower than in those observed in the primary non-attainment portion of the Basin.

The next task included spatial interpolation (1/r) of the six SASS speciation splits to define the split profiles for each grid cell. The split percentages were then multiplied by the simulation derived RRFs, for each of the four seasons. FRM data, based on every third day sampling from 21 Basin monitoring sites were extracted from the U.S. EPA's AQS database for each year of the 5-year period. The highest 8 concentrations sampled in each quarter were selected to generate a data set that included 160 days. The data for each day were then interpolated throughout the inner-domain using a inverse distance weighted scheme (1/r) to develop a matrix of grid specific 24-hour PM2.5 concentrations for all 160 days. Note that extraction of data on a frequency of every third day was selected so that there was consistency in the numbers of FRM data samples used in the analysis. In general, the number of valid yearly samples using the third day extraction was between 100-150 days, and thus allowed the analysis to focus on the projected 3rd highest value (of the 32 days evaluated) in each year as the 98th percentile value.

The interpolated FRM data were then multiplied by the seasonally sorted, RRF-interpolated species fractions to project the future year 24-hr PM2.5 distribution for each of the five years. The attainment calculation then tested the weighted 5-year average 98th percentile concentration at each grid. Table V-5-23 provides a summary of the unmonitored area analysis. Listed are the top 15 projected grid cell center concentrations for the 2014 controlled scenario and the respective 2008 interpolated center grid concentration. The second set of columns provides the list of grid cells with the maximum projected 2014 controlled 24-hour PM2.5 design value modeled as if every grid in the Basin had Mira Loma's species profile. This calculation was conducted to test the distance weighted interpolation hypothesis and the impacts of varying species profiles and RRFs.

The interpolated 2008 grid center design values and 2014 projected determined from the unmonitored area analysis lined up closely with the station design values. The 2014 controlled maximum projected 24-hour PM2.5 design of 31.2 $\mu g/m^3$ occurred at the center of the Mira Loma grid cell (89,58). Since no cell in the modeling domain was projected to have a 2014 controlled design value above that of cell (89,58), the Basin passes the unmonitored area portion of the 24-hour PM2.5 attainment demonstration.

This analysis demonstrates that the relative response to the control program is more effective in the Eastern Basin while portions of the western Basin do not exhibit the equivalent response to the implementation of the proposed control strategy.

Table V-5-23

Unmonitored Area Analysis

Grid I	Grid J	Interpolated 2008 Design	Projected 2014 Controlled Design
89	58	44.3	31.2
95	61	40.8	30.4
90	61	42.3	29.8
91	58	41.1	29.6
89	59	40.9	29.3
90	58	40.3	29.3
94	61	39.4	29.3
92	58	40.3	29.2
92	57	40.0	29.2
87	59	41.2	29.1
88	58	40.4	29.1
91	57	39.9	29.1
89	61	41.3	29.0
90	59	40.0	29.0
91	59	39.7	29.0

CEQA ALTERNATIVE SIMULATIONS

Table V-5-24 presents the projected 24-hour PM2.5 design values for the 2014 baseline, 2014 controlled and three CEQA Alternative emissions scenarios. For a description of the alternative scenarios, please see the 2012 AQMP Program Environmental Impact Report (PEIR). All of the CEQA alternative simulations demonstrate attainment of the 24-hour PM2.5 federal standard.

Table V-5-24

CEQA Alternative Simulated 24-Hour PM2.5 Design Values

	2014	2014 Controlled	Alt-12019	Alt-2: 2017	Alt-3: 2017
Mira Loma	37.3	34.3	33.6	34.5	35.0
Rubidoux	34.7	32.5	31.1	31.6	31.6
Fontana	35.6	32.9	33.1	33.7	32.4
Central LA	33.0	31.8	31.7	32.0	31.7
Anaheim	30.7	27.5	30.0	29.9	29.7
North Long Beach	30.5	28.3	30.2	30.1	30.0
South Long Beach	26.7	24.8	25.8	25.8	25.9

WEIGHT OF EVIDENCE DISCUSSION

The weight of evidence discussion focuses on the historical trends of 24-hour PM2.5 concentrations and key precursor emissions to provide justification and confidence that the Basin will meet the federal standard by 2014.

Figure V-5-30 depicts the long term trend of observed Basin 24-hour average PM2.5 design values with the CMAQ projected design value for 2014. Also superimposed on the graph is the linear best fit trend line for the observed 24-hour average PM2.5 design values. The observed trend depicts a steady 49 percent decrease in observed design value concentrations between 2001 and 2011. The rate of improvement is just under 4 $\mu g/m^3$ per year. If the trend is extended beyond 2011, the projection suggests attainment of the PM2.5 24-hour standard in 2013, one year earlier than determined by the attainment demonstration. While the straight-line future year approximation may be optimistic, it offers insight to effectiveness of the ongoing control program and is consistent with the attainment demonstration.

Figures V-5-31 depicts the long term trend of Basin NOx emissions for the same period. Figure V-5-32 provides the corresponding emissions trend for directly emitted PM2.5. Base year NOx inventories for 2002 (from the 2007 AQMP) and 2008 experienced a 31 percent reduction while directly emitted PM2.5 experienced a 19 percent reduction over the 6-year period. The Basin 24-hour average PM2.5 design value experienced a concurrent 27 percent reduction between 2002 and 2008.

The projected trend of NOx emissions indicates that this PM2.5 precursor associated with the formation of nitrate will continue to be reduced though 2019 by an additional 48 percent. Similarly, the projected trend of directly emitted PM2.5 shows a more moderate reduction of 13 percent through 2019. However, as discussed in the 2007 AQMP and in a later section of this chapter, directly emitted PM2.5 is a more effective contributor to ambient PM2.5 than NOx on a per ton emitted basis. While the projected NOx and direct PM2.5 emissions trends decrease at a reduced rate between 2012 and 2019, it is clearly evident that the overall significant reductions will continue to result in lower nitrate and direct particulate contributions to 24-hour PM2.5 design values.

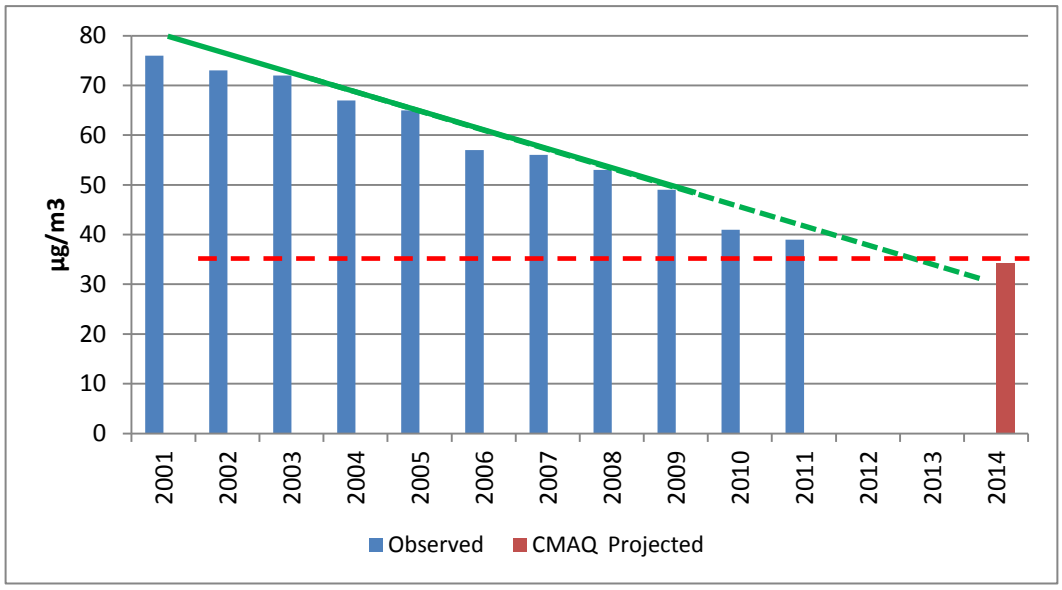


FIGURE V-5-30

Basin Observed and CMAQ Projected
Future Year PM2.5 Design Concentrations (µg/m^3)

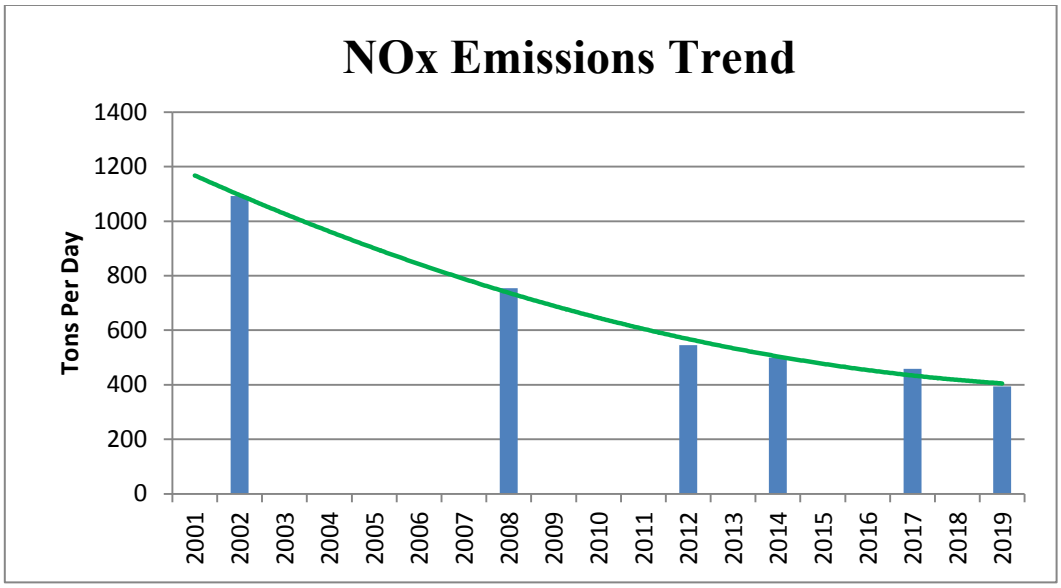


FIGURE V-5-31

Trend of Basin NOx Emissions

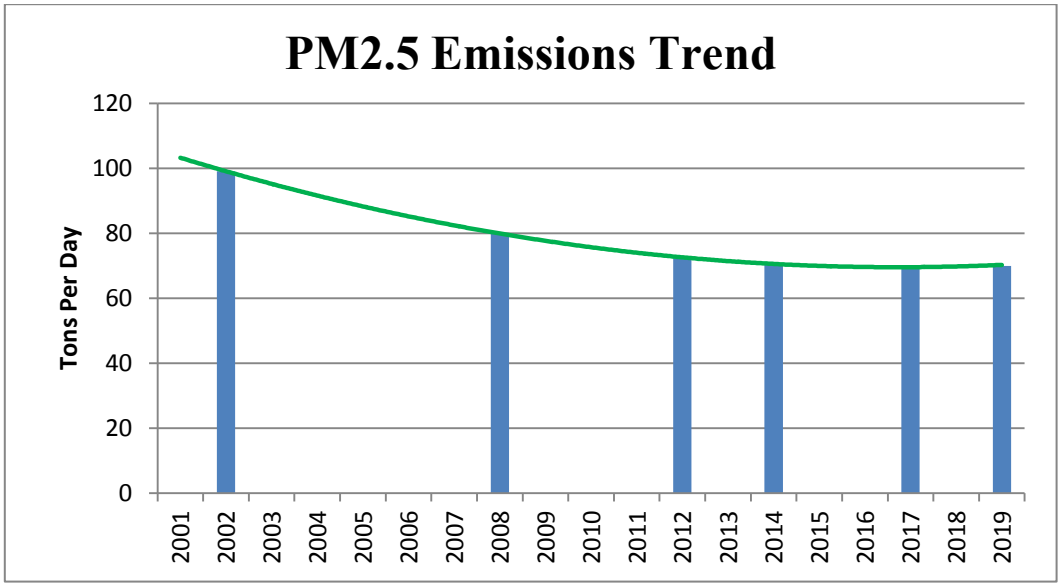


FIGURE V-5-32

Trend of Basin PM2.5 Emissions

SUMMARY AND CONTROL STRATEGY CHOICES

PM2.5 has five major emission types that contribute to the mass of the ambient aerosol including ammonia, NOx, SOx, VOC, and directly emitted PM2.5. Various combinations of reductions in these pollutants could all provide a path to clean air. The 24-hour PM2.5 attainment strategy presented in this Final 2012 AQMP relies on a dual approach to first demonstrate attainment of the federal standard by 2019 and then focuses on controls that will be most effective in reducing PM2.5 to accelerate attainment to the earliest date possible. The 2007 AQMP control measures that have been implemented will result in substantial reductions of SOx, direct PM2.5, VOC and NOx emissions. Newly proposed short-term measures, discussed in Chapter 4 and Appendix IV of the Final 2012 AQMP will provide additional regional emissions reductions targeting directly emitted PM2.5 and NOx.

It is useful to assess the relative value of per ton precursor emission reductions considering the resulting ambient microgram per cubic meter improvements in PM2.5 air quality. As presented in the weight of evidence discussion, trends of PM2.5 and NOx emissions suggest a direct response between lower emissions and improving air quality. The Final 2007 AQMP established a set of factors relating regional per ton precursor emissions reductions and the resulting ambient annual average PM2.5 improvements. The Final 2012 AQMP CMAQ simulations provided a similar set of factors, but this time based on improvements to 24-hour PM2.5 levels. The analysis determined that VOC emissions reductions have the lowest return in terms of micrograms per cubic meter PM2.5 reduced per ton of emissions reductions, about one third of that of NOx reductions. SOx emissions reductions were about 8 times more effective than NOx reductions. However, directly emitted PM2.5 emissions reductions were approximately 15 times more effective then NOx reductions. It is important to note that the contribution of ammonia emissions is embedded as a component of the SOx and NOx factors since ammonium nitrate and ammonium sulfate are the resultant particulate species formed in the atmosphere. Table V-5-25 summarizes the relative importance of precursor emissions reductions to the resulting 24-hour PM2.5 air quality improvements. (A comprehensive discussion of the emission reduction factors is presented in Attachment 8 of this document).

Emissions reductions from existing programs and implementation of the 2012 AQMP PM2.5 control measures will result in projected 24-hour PM2.5 concentrations that meet the federal standard by 2014 at all locations in the Basin. Basin-wide curtailment of wood burning and open burning when the PM2.5 air quality is projected to exceed 30 $\mu g/m^3$ in Mira Loma will effectively accelerate attainment at Mira Loma from 2019 to 2014.

TABLE V-5-25

Relative Contributions of Precursor Emissions Reductions to 2014
Simulated Controlled Future-Year 24-hour PM2.5 Concentrations

Precursor (TPD)	PM2.5 Component ($\mu g/m^3$)	Standardized Contribution to Mass
VOC	Organic Carbon	Factor of 0.3
NOx	Nitrate	Factor of 1
SOx	Sulfate	Factor of 7.8
PM2.5	Elemental Carbon & Others	Factor of 14.8

CHAPTER 6

ADDITIONAL ANALYSES: UPDATED ANNUAL PM2.5 SIMULATIONS

INTRODUCTION

As a component of the Final 2012 AQMP, concurrent simulations were also conducted to update and assess progress towards the federal annual average PM2.5 standard given the new modeling platform and emissions inventory. This update provides a confirmation that the control strategy will continue to move air quality expeditiously towards attainment of the federal standards.

ANNUAL PM2.5 MODELING APPROACH

The Final 2012 AQMP annual PM2.5 modeling employs the same approach to estimating the future year annual PM2.5 levels as was described in the 2007 AQMP attainment demonstration. Future year PM2.5 annual average air quality is determined using site and species specific quarterly averaged RRFs applied to the weighted quarterly average 2008 PM2.5 design values per U.S. EPA guidance documents.

In this application, CMAQ was used to simulate 2008 base year, 2014 base-line, and 2014 controlled annual average PM2.5 concentrations in the Basin. Projections of the annual average concentrations rely on the use of quarterly averaged PM2.5 levels, Quarterly average speciation profiles, and RRFs determined from quarterly average model simulation results. As with the 24-hour PM2.5 analysis, this analysis uses a 5-year weighted design value centered around 2008 (Table V-6-1). The future year design values reflect the weighted quarterly average concentration calculated from the projections of 5-years of days (20 quarters).

TABLE V-6-1

2008 Weighted Annual PM2.5 Design Values* (µg/m^3)

Monitoring Site	Annual*
Anaheim	13.1
Los Angeles	15.4
Fontana	15.7
North Long Beach	13.6
South Long Beach	13.2
Mira Loma	18.6
Rubidoux	16.7

* Calculated based on quarterly observed data between 2006 – 2010

ANNUAL PM2.5

Annual average PM2.5 species concentrations at the six SASS sites are shown in Figure V-6-1. The lowest annual average PM2.5 concentration was observed at Anaheim and the highest annual average concentration was observed at Rubidoux. Sulfate shows small spatial variation, between 2 and 3 $\mu g/m^3$ at all sites. The highest sulfate concentration was observed at the South Long Beach and Long Beach sites. Ammonium and nitrate show the highest concentrations at Rubidoux and Fontana and the remaining sites show similar levels. Annual average concentrations also show that OC is the most abundant component, which is approximately equivalent to half of the total concentration. As measured by the SASS sampler, OC concentrations are believed to be uncertain as explained in Chapter 5 of this appendix.

Quarterly Average Data

As discussed in Chapter 5, U.S. EPA updated the 24-hour PM2.5 attainment test in June 2011. However, U.S. EPA has not recommended any updates to the annual PM2.5 attainment test described in Section 5.1 of the 2007 PM2.5 modeling guidance. Figures V-6-2 through V-6-7 show the 2008 unadjusted SASS data, processed for quarterly average concentrations from direct measurements of the chemical species at each site. In general, the third quarter is the highest at the inland sites of Fontana and Rubidoux. The sites in the western half of the Basin tend to have the highest average levels in the fourth quarter and to some extent the first quarter. With the exception of Fontana, the lowest observed average concentrations of PM2.5 were observed in the second quarter. In general, the second quarter tends to have the lowest concentrations due to spring storms and favorable atmospheric dispersion.

Secondary ammonium, nitrate and sulfate comprise between one-third and half of the total PM2.5 concentration. The species concentrations reflect seasonal weather patterns. Sulfate is highest in the third quarter and lowest in the first quarter while nitrate is highest in the first or fourth quarter and lowest in the second or third quarter. High nitrate concentrations in the fall or winter are caused by the favorable formation of ammonium nitrate under cool temperatures, high humidity and frequent nocturnal inversions. The higher values of sulfate typically occur under conditions of strong-elevated inversions and sea breeze transport toward inland, which is the characteristic of late spring and summer. The abundance of afternoon sunlight and

the persistence of morning fog and low clouds trigger both homogeneous and heterogeneous sulfate formation reactions to produce secondary sulfate.

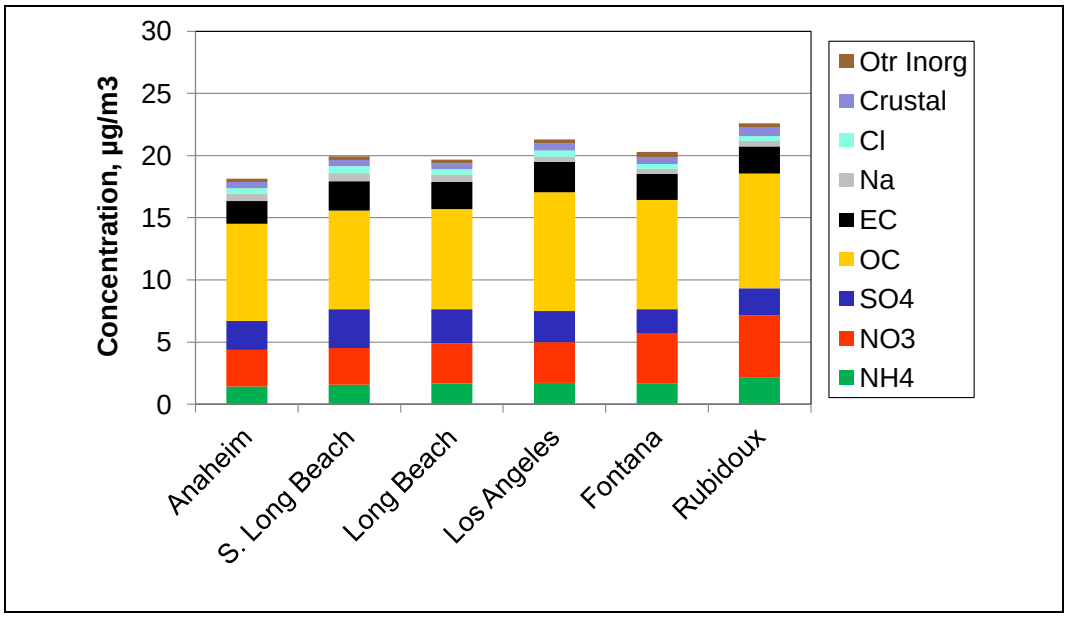


Figure V-6-1

Annual Average PM2.5 Species Concentrations at 6 SASS Sites (µg/m3)

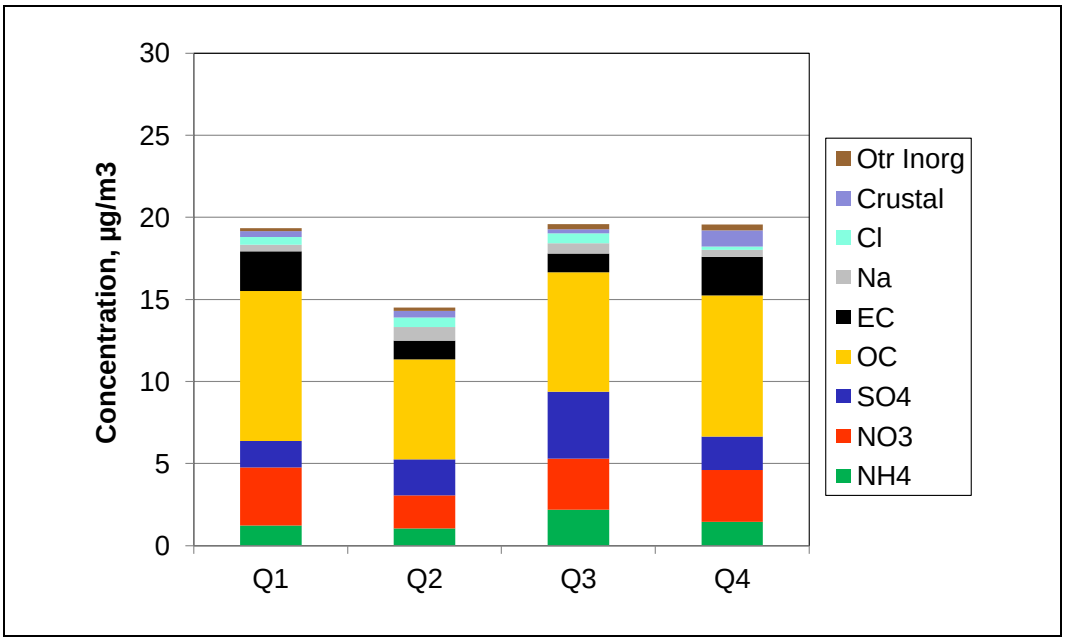


Figure V-6-2

PM2.5 Quarterly Average Species Concentrations (µg/m^3) at Anaheim

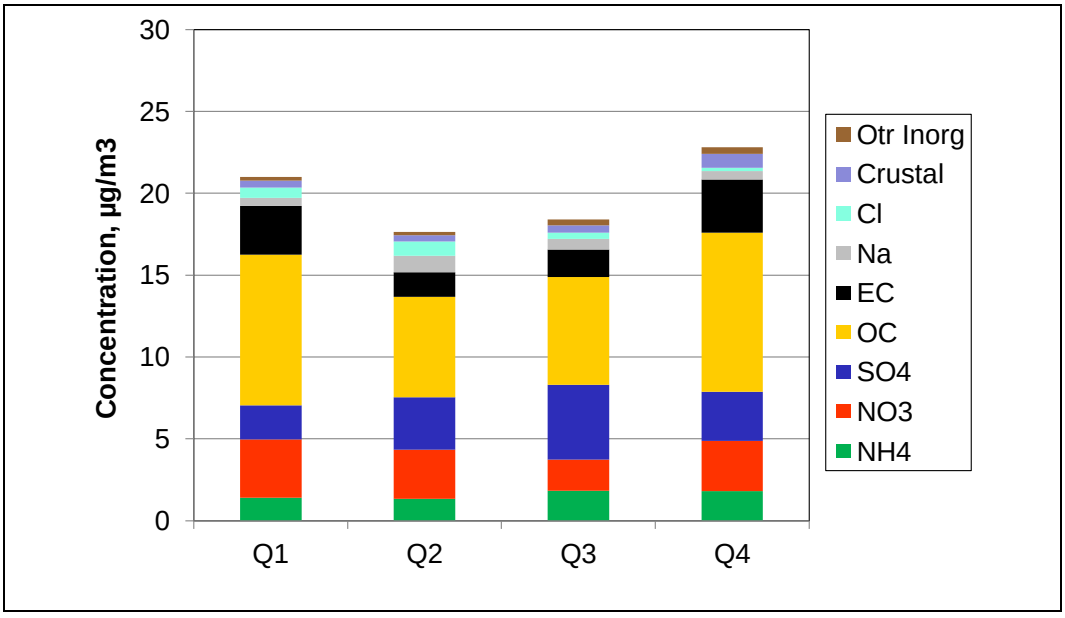


Figure V-6-3

PM2.5 Quarterly Average Species Concentrations (µg/m^3) at South Long Beach

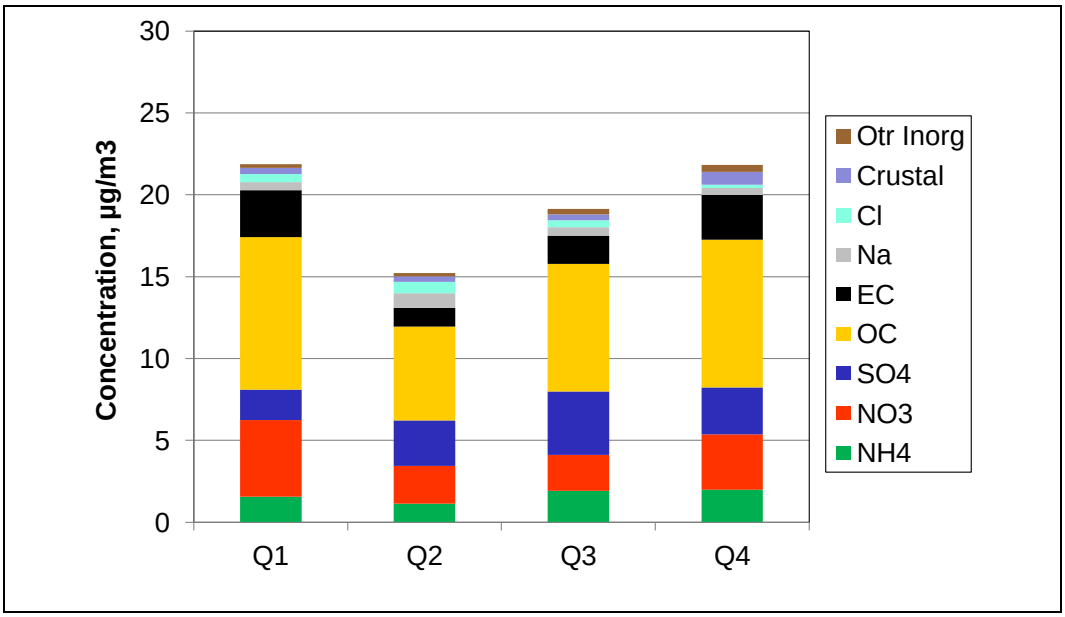


Figure V-6-4

PM2.5 Quarterly Average Species Concentrations (µg/m^3) at Long Beach

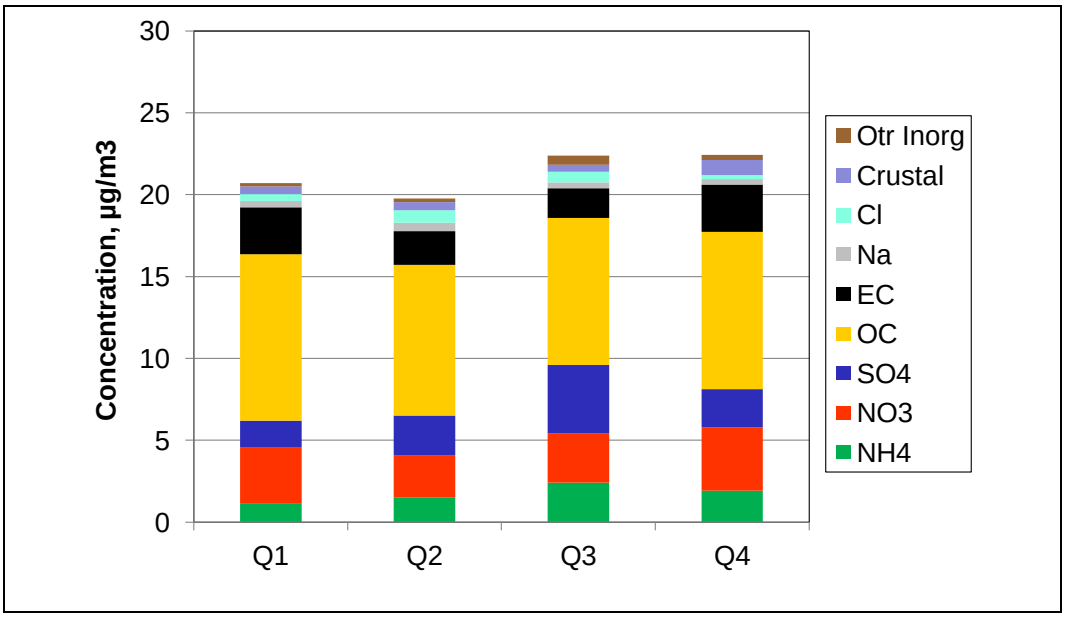


Figure V-6-5

PM2.5 Quarterly Average Species Concentrations (µg/m^3) at Downtown Los Angeles

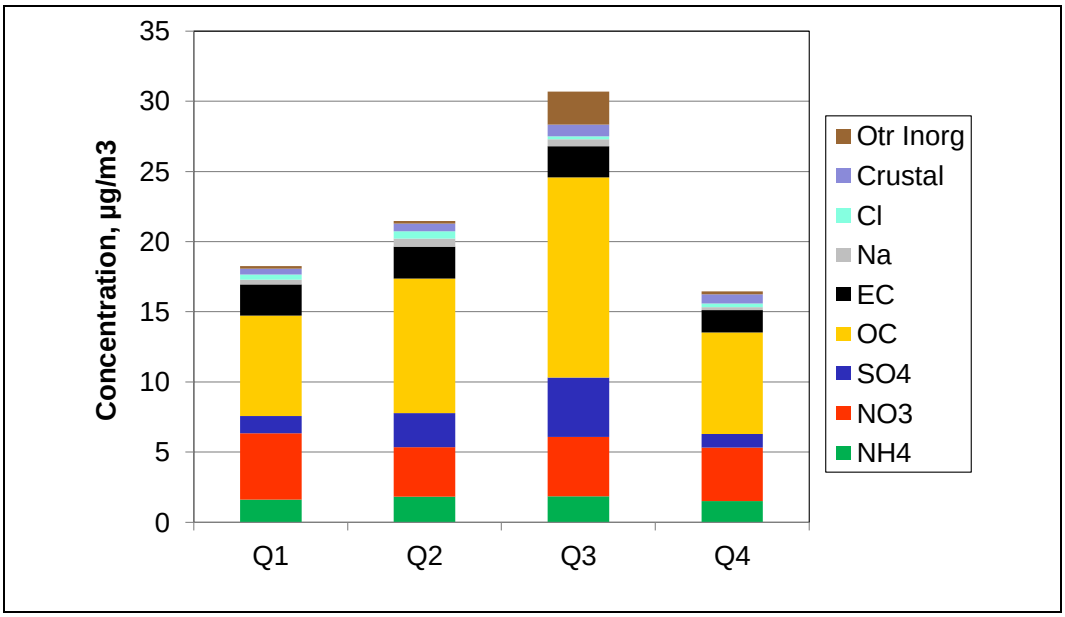


Figure V-6-6

PM2.5 Quarterly Average Species Concentrations (µg/m^3) at Fontana

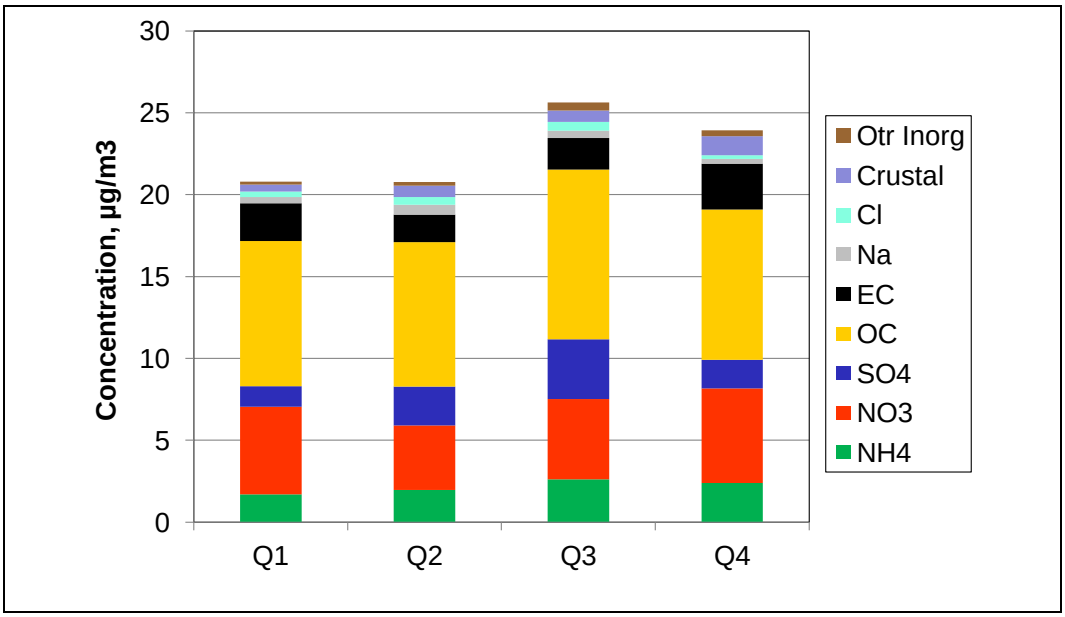


Figure V-6-7

PM2.5 Quarterly Average Species Concentrations (µg/m^3) at Rubidoux

OC comprises the greatest fraction of the mass measured in any quarter and any site and is approximately half of the total concentration in the first and fourth quarter due to poor dispersion from weak winds and low level inversions. However, OC concentrations measured with SASS sampler are believed to be highly uncertain and as a consequence are subject to the "Sandwich" method correction for component mass reconciliation. Figures V-6-8 through V-6-13 provide the corrected species fractions for each site and each quarter. Table V-6-2 lists annual and 5-year weighted quarterly average design values at each of the six SASS sites covering the period 2006 through 2010. Table V-6-3 lists the "Sandwich" applied 5-year weighted quarterly speciation FRM data for each station. As expected, the annual fractional contributions to the quarterly mass at each site differed from the "top-4" average.

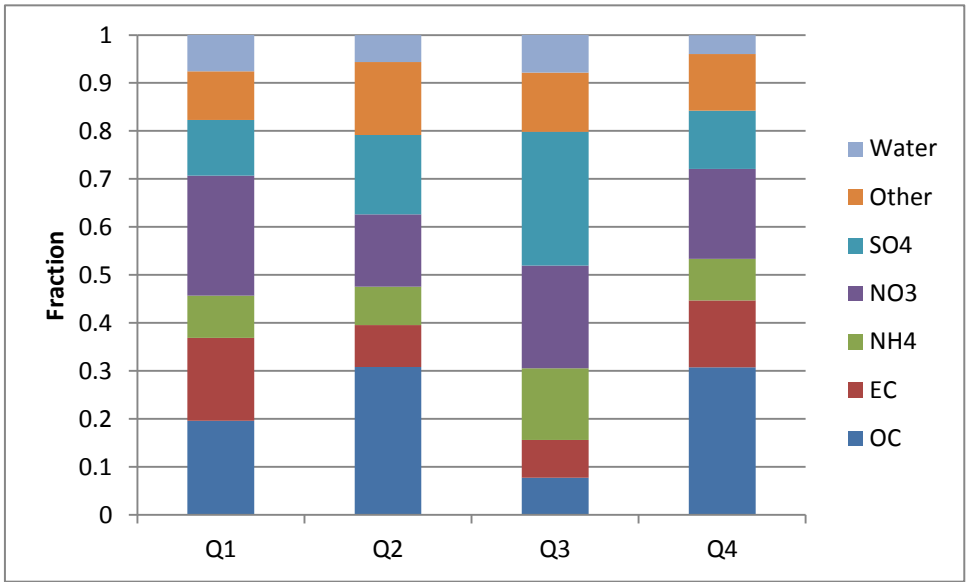


Figure V-6-8

2008 Anaheim quarterly PM2.5 species fractional splits after the "Sandwich" correction

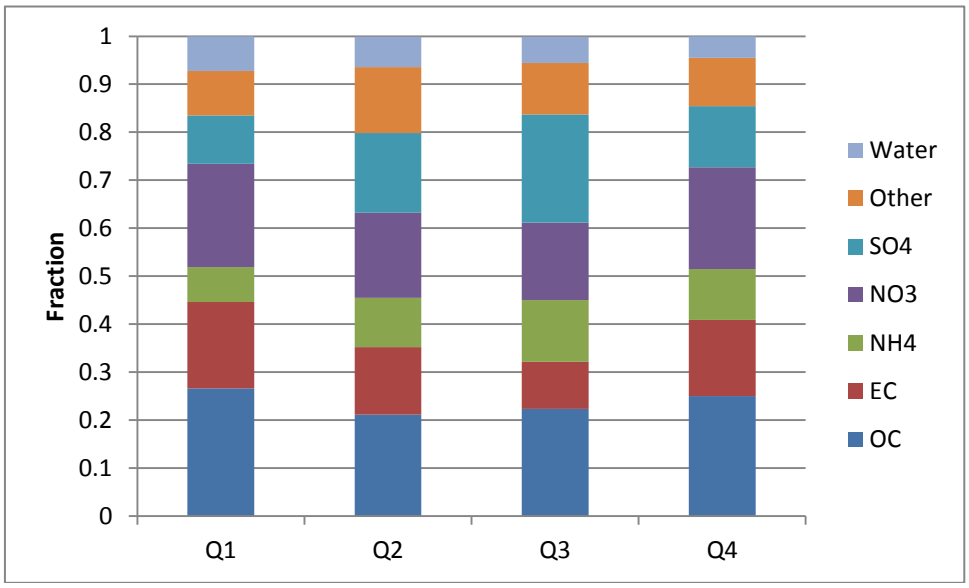


Figure V-6-9

2008 Los Angeles quarterly PM2.5 species fractional splits after the "Sandwich" correction

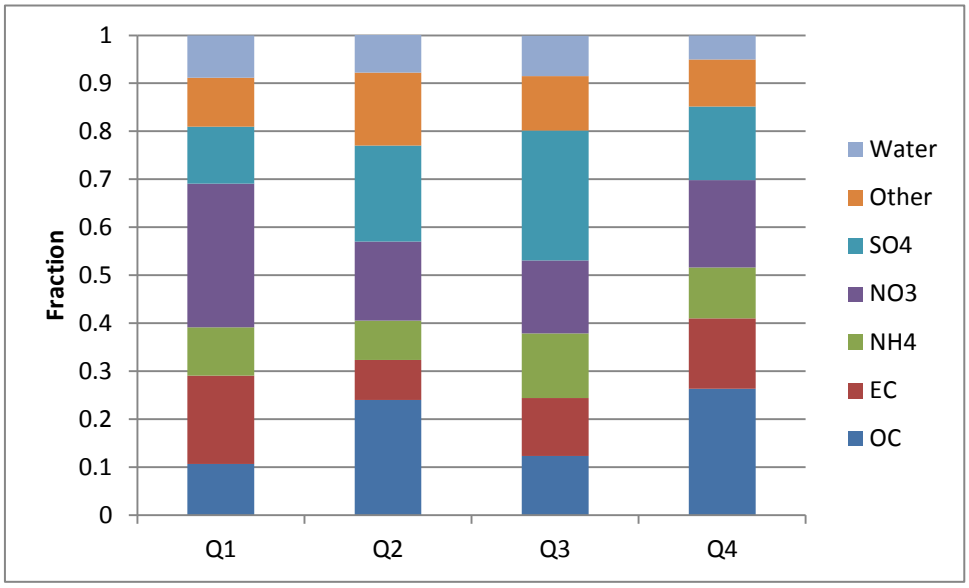


Figure V-6-10

2008 Long Beach quarterly PM2.5 species fractional splits after the "Sandwich" correction

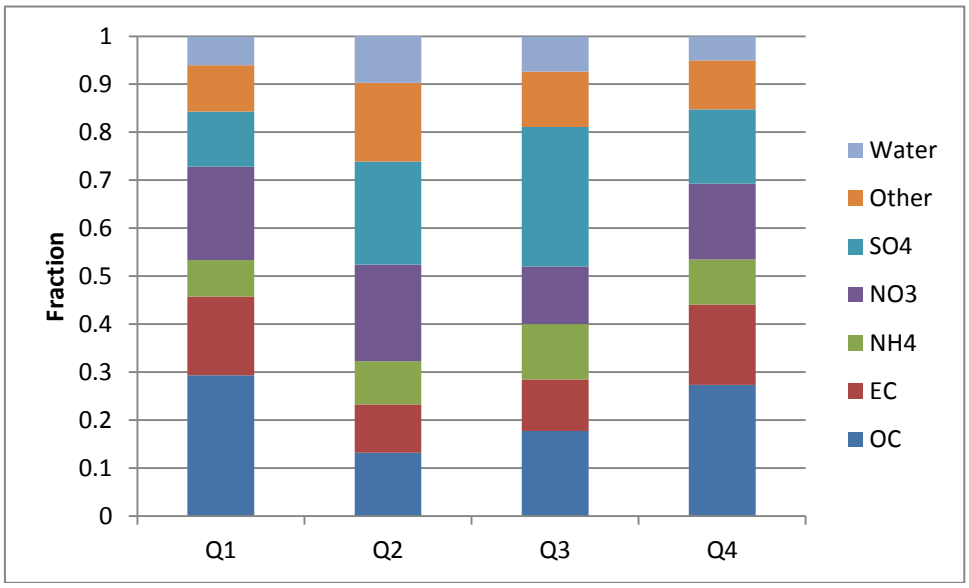


Figure V-6-11

2008 Downtown Long Beach quarterly PM2.5 species fractional splits after the "Sandwich" correction

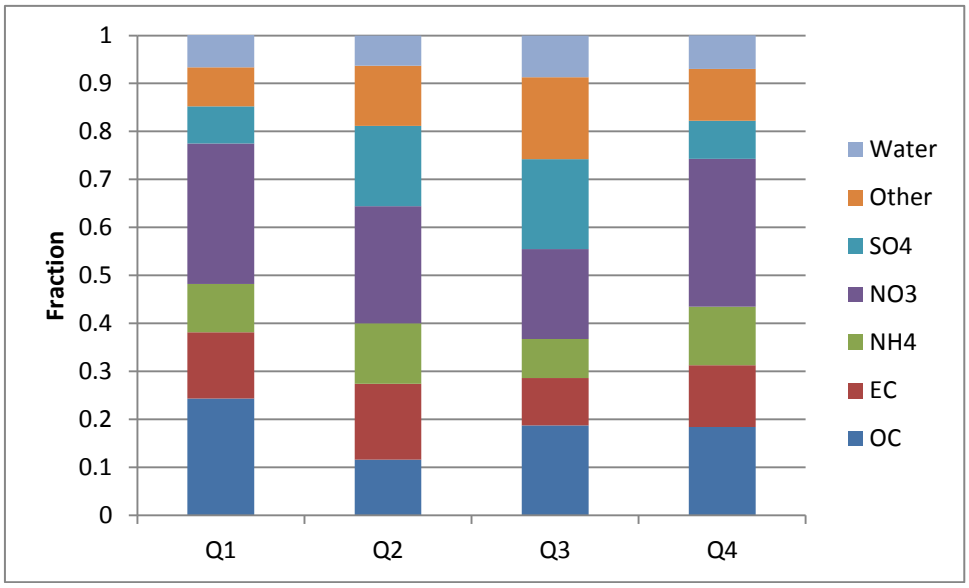


Figure V-6-12

2008 Fontana quarterly PM2.5 species fractional splits after the "Sandwich" correction

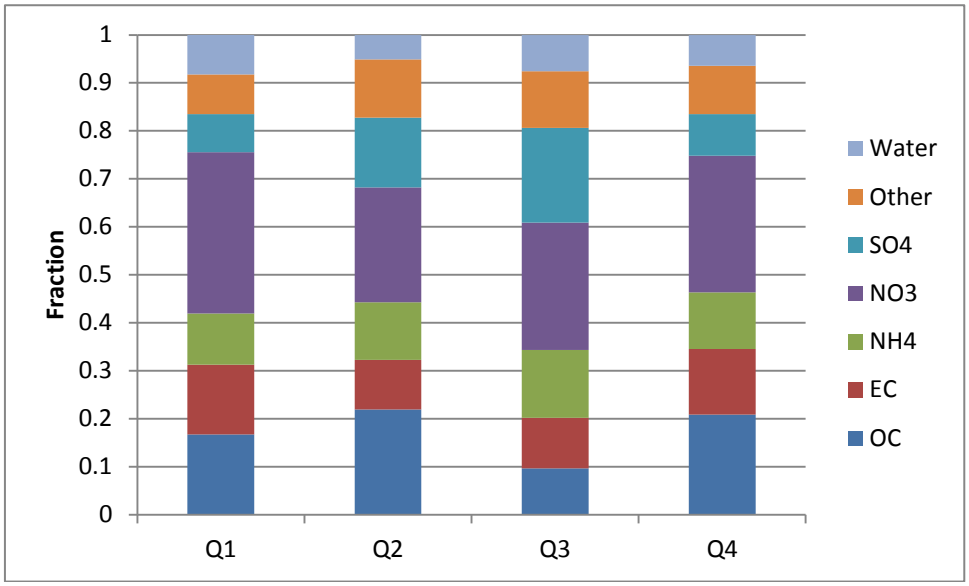


Figure V-6-13

2008 Rubidoux quarterly PM2.5 species fractional splits after the "Sandwich" correction

Table V-6-2

5-Year Weighted Annual and Quarterly PM2.5 Design Values (2006-2010)

Monitoring Site	Quarter 1 (µg/m^3)	Quarter 2 (µg/m^3)	Quarter 3 (µg/m^3)	Quarter 4 (µg/m^3)	Annual (µg/m^3)
Anaheim	13.00	11.10	12.11	16.23	13.11
S. Long Beach	12.90	11.53	12.55	15.70	13.17
Long Beach	13.81	11.81	12.46	16.45	13.63
Los Angeles	14.34	14.37	15.71	16.94	15.34
Fontana	13.77	16.21	16.98	16.18	15.79
Mira Loma	16.88	18.00	18.06	21.07	18.50
Rubidoux	14.96	18.13	16.47	17.22	16.70

Table V-6-3

"Sandwich" Applied Quarterly Speciated FRM Data

Site		Mass	OC	EC	NH4	NO3	SO4	OTR	Water	Blank
Anaheim	1q	13.00	2.45	2.16	1.10	3.13	1.45	1.26	0.97	0.50
Anaheim	2q	11.10	3.27	0.92	0.85	1.60	1.75	1.61	0.60	0.50
Anaheim	3q	12.11	0.90	0.91	1.74	2.48	3.24	1.43	0.92	0.50
Anaheim	4q	16.23	4.84	2.19	1.36	2.95	1.91	1.86	0.62	0.50
Los Angeles	1q	14.34	3.68	2.50	1.00	2.98	1.40	1.28	1.00	0.50
Los Angeles	2q	14.37	2.94	1.95	1.42	2.47	2.29	1.91	0.88	0.50
Los Angeles	3q	15.71	3.40	1.49	1.96	2.45	3.43	1.63	0.84	0.50
Los Angeles	4q	16.94	4.11	2.61	1.74	3.49	2.10	1.65	0.74	0.50
Long Beach	1q	13.81	1.42	2.45	1.34	3.99	1.58	1.35	1.18	0.50
Long Beach	2q	11.81	2.72	0.94	0.93	1.86	2.26	1.72	0.89	0.50
Long Beach	3q	12.46	1.48	1.44	1.61	1.82	3.24	1.35	1.01	0.50
Long Beach	4q	16.45	4.20	2.34	1.69	2.91	2.44	1.57	0.79	0.50
Downtown LGB	1q	12.90	3.64	2.03	0.95	2.41	1.42	1.20	0.74	0.50
Downtown LGB	2q	11.53	1.46	1.11	0.99	2.22	2.37	1.81	1.08	0.50
Downtown LGB	3q	12.55	2.14	1.29	1.39	1.45	3.50	1.39	0.88	0.50
Downtown LGB	4q	15.70	4.16	2.54	1.43	2.40	2.35	1.55	0.77	0.50
Fontana	1q	13.77	3.23	1.83	1.34	3.88	1.03	1.08	0.89	0.50
Fontana	2q	16.21	1.83	2.48	1.98	3.83	2.63	1.97	0.99	0.50
Fontana	3q	16.98	3.09	1.63	1.34	3.09	3.08	2.82	1.43	0.50
Fontana	4q	16.18	2.89	2.02	1.91	4.83	1.24	1.70	1.10	0.50
Rubidoux	1q	14.96	2.42	2.10	1.55	4.86	1.14	1.20	1.20	0.50
Rubidoux	2q	18.13	3.87	1.82	2.12	4.22	2.56	2.14	0.90	0.50
Rubidoux	3q	16.47	1.55	1.68	2.26	4.23	3.16	1.88	1.21	0.50
Rubidoux	4q	17.22	3.49	2.29	1.97	4.76	1.45	1.68	1.08	0.50
Mira Loma	1q	16.88	2.74	2.38	1.76	5.50	1.29	1.36	1.36	0.50
Mira Loma	2q	18.00	3.84	1.80	2.11	4.19	2.54	2.12	0.89	0.50
Mira Loma	3q	18.06	1.70	1.84	2.48	4.65	3.48	2.06	1.34	0.50
Mira Loma	4q	21.07	4.30	2.82	2.42	5.86	1.78	2.07	1.32	0.50

Figure V-6-14 presents the ratio of the 24-hour to annual PM2.5 fractional species contributions averaged for the six SASS sites. In general, the 24-hour PM2.5 "others" category is consistently a smaller percentage than the annual PM2.5 "others" for all seasons. However total mass for the 24-hour episodes "others" category is a factor of 1.9 higher in concentration than the annual value. In contrast, both

ammonium and nitrate have higher fractions for the episodic 24-hour PM2.5 in all quarters except the third quarter when OC (primary and secondary) becomes the dominant constituent compared with the annual fraction. The episodic sulfate in the first quarter is a higher percentage than the annual but the ratio reverses for the final three quarters. This is consistent with the SOx OGV emissions profile presented in Chapter 4 of this appendix. On average, after the first quarter, daily SOx emissions increase dramatically so that the difference between episodic and a quarterly values for the annual PM2.5 show less contrast. Overall, the average concentrations of the top-4 average 24-hour PM2.5 concentrations for the secondary aerosol components were a factor of 2.4 higher than the quarterly annual concentrations. This illustrates the combined impact of secondary aerosol formation on episodic 24-hour PM2.5 levels.

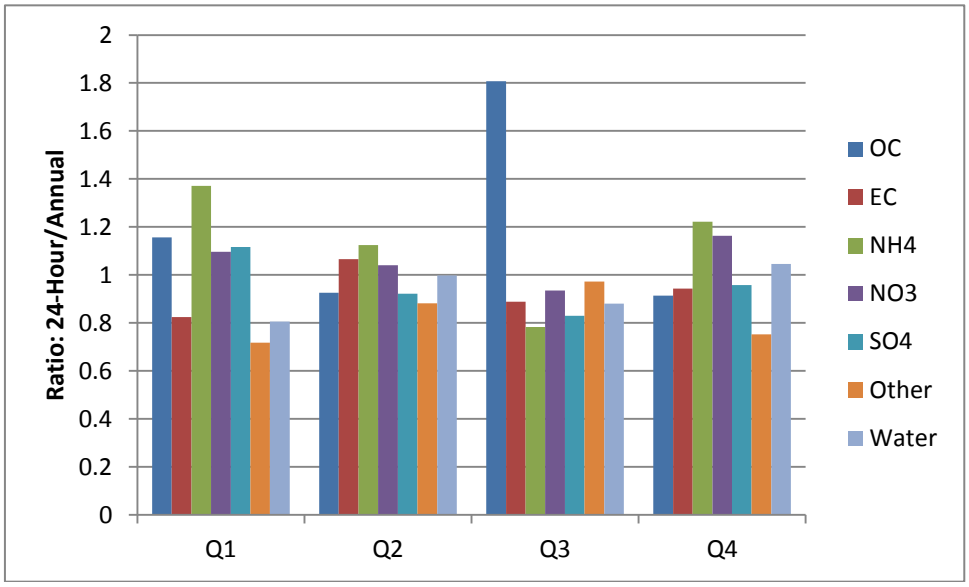


Figure V-6-14

2008 Six site SASS average quarterly ratio of 24-hour to annual species fractional contributions to PM2.5 after the "Sandwich" correction

FUTURE ANNUAL PM2.5 AIR QUALITY

The base-line projections for the annual state and federal standards are shown in Figure V-6-15. All areas will be in attainment of the federal annual standard (15 $\mu g/m^3$) by 2014. The base-line 2014 design value is projected to be 7 percent below

the federal standard. However, as shown in Figure V-6-15, the Final 2012 AQMP does not achieve the California standard of 12 µg/m^3 by 2014. Additional controls would be needed to attain this state standard at the Mira Loma station.

Tables V-6-4 through V-6-7 provide the projected future year PM2.5 annual design values by component species for 2014, 2019, 2023 and 2030 with proposed controls implemented. Projected PM2.5 levels indicate that the Basin will remain in attainment with the current standard. U.S. EPA has proposed lowering the annual PM2.5 standard to a range between 12 and 13 µg/m^3. The latest attainment date for the Basin is likely to be 2023 (with a 5-year extension). Projected PM2.5 annual design concentrations for 2023 and 2030 are expected to be below the upper range of the new proposed standard, but would exceed the lower end of the range of 12 µg/m^3 without additional controls.

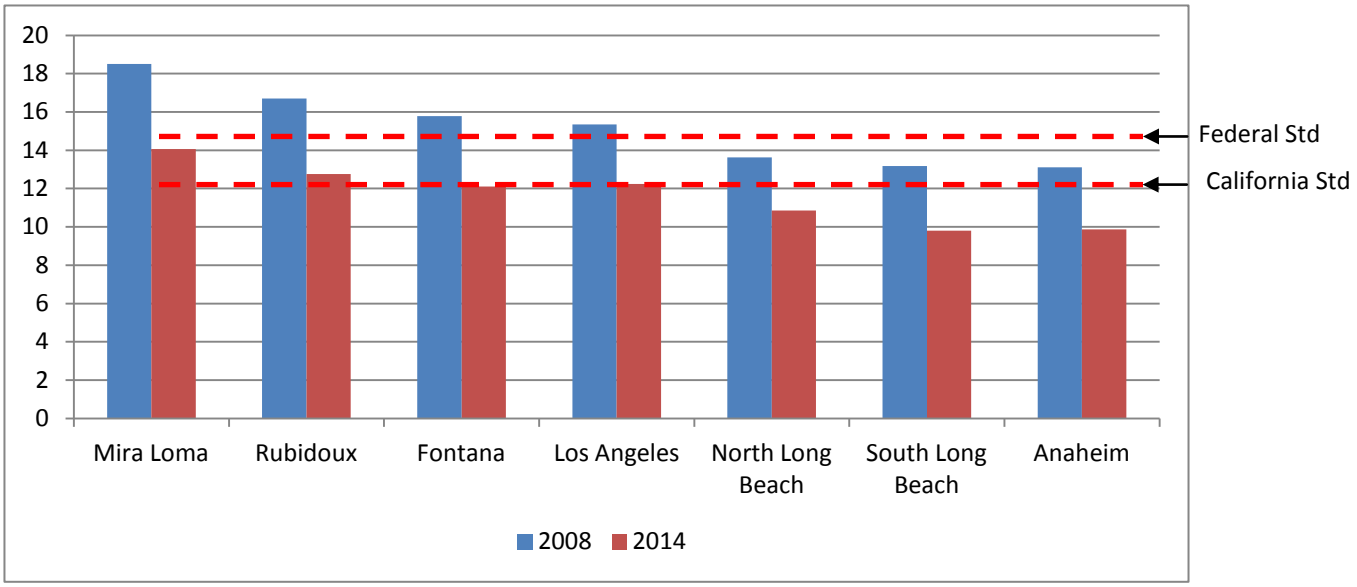


Figure V-6-15

Annual Average PM2.5 Design Concentrations:
2008 and 2014 Baseline

Table V-6-4

CMAQ 2014 Controlled Annual Design Predictions (µg/m^3)

Locations	NH4	NO3	SO4	OC	EC	Others	Water	Blank	Mass
Anaheim	0.8	2.1	1.0	2.1	0.9	1.4	0.5	0.5	9.2
S. Long Beach	0.8	2.0	1.2	2.0	1.0	1.3	0.7	0.5	9.4
Fontana	1.2	2.9	1.1	2.0	1.2	1.9	0.7	0.5	11.5
N. Long Beach	1.0	2.5	1.4	1.8	1.1	1.4	0.8	0.5	10.5
Los Angeles	1.2	2.5	1.4	2.9	1.3	1.6	0.7	0.5	11.9
Mira Loma	1.5	3.7	1.2	2.3	1.3	1.9	0.8	0.5	13.3
Rubidoux	1.4	3.3	1.3	2.2	1.2	1.7	0.7	0.5	12.1

Table V-6-5

CMAQ 2019 Controlled Annual Design Predictions (µg/m^3)

Locations	NH4	NO3	SO4	OC	EC	Others	Water	Blank	Mass
Anaheim	0.8	2.0	1.0	2.3	0.9	1.4	0.5	0.5	9.3
S. Long Beach	0.8	1.9	1.2	2.2	1.0	1.2	0.7	0.5	9.4
Fontana	1.1	2.6	1.3	2.3	1.2	1.8	0.7	0.5	11.4
N. Long Beach	1.0	2.4	1.4	1.9	1.1	1.3	0.8	0.5	10.4
Los Angeles	1.1	2.4	1.4	3.0	1.2	1.5	0.7	0.5	11.8
Mira Loma	1.4	3.3	1.4	2.6	1.3	2.0	0.8	0.5	13.3
Rubidoux	1.3	2.8	1.5	2.3	1.1	1.9	0.7	0.5	12.2

Table V-6-6

CMAQ 2023 Controlled Annual Design Predictions (µg/m^3)

Locations	NH4	NO3	SO4	OC	EC	Others	Water	Blank	Mass
Anaheim	0.7	1.7	1.1	2.2	0.8	1.5	0.5	0.5	9.0
S. Long Beach	0.8	1.8	1.2	2.2	0.9	1.3	0.6	0.5	9.2
Fontana	1.0	2.1	1.4	2.2	1.2	1.9	0.6	0.5	11.0
N. Long Beach	1.0	2.3	1.4	1.9	1.0	1.4	0.8	0.5	10.2
Los Angeles	1.0	2.1	1.5	3.0	1.1	1.6	0.6	0.5	11.4
Mira Loma	1.2	2.7	1.6	2.6	1.3	2.1	0.6	0.5	12.7
Rubidoux	1.2	2.3	1.7	2.3	1.1	2.0	0.6	0.5	11.7

Table V-6-7

CMAQ 2030 Controlled Annual Design Predictions (µg/m^3)

Locations	NH4	NO3	SO4	OC	EC	Others	Water	Blank	Mass
Anaheim	0.7	1.6	1.2	2.3	0.8	1.5	0.5	0.5	9.1
S. Long Beach	0.8	1.7	1.4	2.3	0.9	1.4	0.6	0.5	9.5
Fontana	1.0	1.9	1.6	2.3	1.2	2.1	0.7	0.5	11.3
N. Long Beach	1.0	2.1	1.6	1.9	1.0	1.4	0.7	0.5	10.2
Los Angeles	1.0	2.0	1.6	3.0	1.1	1.6	0.7	0.5	11.4
Mira Loma	1.2	2.4	1.8	2.7	1.3	2.3	0.7	0.5	13.0
Rubidoux	1.2	2.1	2.0	2.4	1.1	2.2	0.6	0.5	12.0

CEQA ALTERNATIVE SIMULATIONS

Table V-6-8 presents the projected annual PM2.5 design values for the 2014 controlled and three CEQA alternative emissions scenarios. Complete descriptions of the CEQA alternative scenarios can be found in the PEIR for the 2012 AQMP. All of the CEQA alternative simulations demonstrate attainment of the 24-hour PM2.5 federal standard.

Table V-6-8

CEQA Alternative Simulated Annual PM2.5 Design Values

	2014 Controlled	Alt-1: 2019	Alt-2: 2017	Alt-3: 2017
Anaheim	9.2	9.3	9.3	8.8
S. Long Beach	9.4	9.4	9.4	9.1
Fontana	11.5	11.4	11.4	10.7
N. Long Beach	10.5	10.4	10.4	10.1
Los Angeles	11.9	11.8	11.8	11.1
Mira Loma	13.3	13.3	13.0	12.4
Rubidoux	12.1	12.2	11.9	11.2

CHAPTER 7

Additional Analyses: Updating 8-Hour Ozone Projections

INTRODUCTION

The 2007 AQMP provided a comprehensive 8-hour ozone analysis that demonstrated future year attainment of the 1997 federal ozone standard (80 ppb) by 2023 with implementation of short-term measures and CAA Section 182(e)(5) long term emissions reductions. The analysis concluded that NOx emissions needed to be reduced approximately 76 percent and VOC emissions reduced approximately 22 percent from the 2023 baseline in order to demonstrate attainment. The 2023 baseline VOC and NOx summer planning emissions inventories included 536 and 506 TPD, respectively.

As presented in Chapter 3 of the Final 2012 AQMP, 2023 baseline emissions of both precursor pollutants are estimated to be lower than those 2023 baseline established in the 2007 AQMP. The Final 2012 AQMP baseline VOC and NOx summer planning emissions for 2023 have been revised to 438 and 319 TPD, respectively. The emissions revision incorporated changes made to the on-road truck and off-road equipment categories resulting from recent CARB rulemaking. The new emissions inventory also reflects the impact of the economic slowdown and revisions to regional growth estimates. As a consequence, it is important to revisit the baseline projections for 2023 to investigate what impact the inventory revision had on the ozone attainment demonstration and equally important, what is the impact to the size of the proposed long term NOx emissions reduction commitment.

OZONE REPRESENTATIVENESS

As a component of the PM2.5 attainment demonstration, the CMAQ modeling provided Basin-wide ozone air quality simulations for each hour in 2008. Past ozone attainment demonstrations evaluated a set of days characterized by restrictive meteorology or episodes occurring during concurrent intensive field programs. Of great importance, these episode periods needed to be rated in terms of how representative they were relative to the ozone standard being evaluated. For the now revoked 1-hour ozone standard, the attainment demonstration focused on a limited number of days closely matching the annual design value. Typically, the analysis addressed less than 5 days of simulations. The 2007 AQMP was the first to address the 8-hour ozone standard and the use of RRFs in the future year ozone projection. To provide a robust characterization of the RRFs for use in the attainment demonstration, the analysis simulated 36 days. The ozone modeling guidance recommends that a minimum of 5-days of simulations meeting modeling acceptance

criteria are used in a future year RRF calculation, but also recommends incorporating as many days as possible to fully capture both the meteorological variations in the ozone season and the response to different daily emissions profiles.

This update to the future year ozone projection focuses on 91 days of ozone air quality observed during June through August 2008. During this period, seven well defined multiday ozone episodes occurred in the Basin with 75 total days having daily Basin-wide maximum concentrations of 80 ppb or higher. More importantly, when assessed for a normalized meteorological ozone episode potential using a regression based weighting covering 30-years of data (1998-2010), as summarized in the 2003 AQMP, 8 days during the 2008 period were ranked above the 95th percentile in the long term distribution of potentials, and another 19 were ranked between the 90th and 94th percentile.

Figure V-7-1 depicts the time series of the daily Basin maximum and the Crestline (the Basin design station) daily maximum 8-hour ozone air quality during the three month period in 2008. The seven primary meteorological episodes which occur primarily between mid June and August are highlighted in the figure. It is important to note that the analysis not only focused on the seven periods or Crestline specifically. All station days meeting the acceptance criteria for calculating a daily RRF were included in the analysis. Several locations in the San Bernardino and Riverside Valleys exhibit similar transport and daily patterns of ozone formation as Crestline. The peak Basin 2008 8-hour average ozone concentration was observed at Santa Clarita on August 2nd with a value of 131 ppb along a distinctly different transport route.

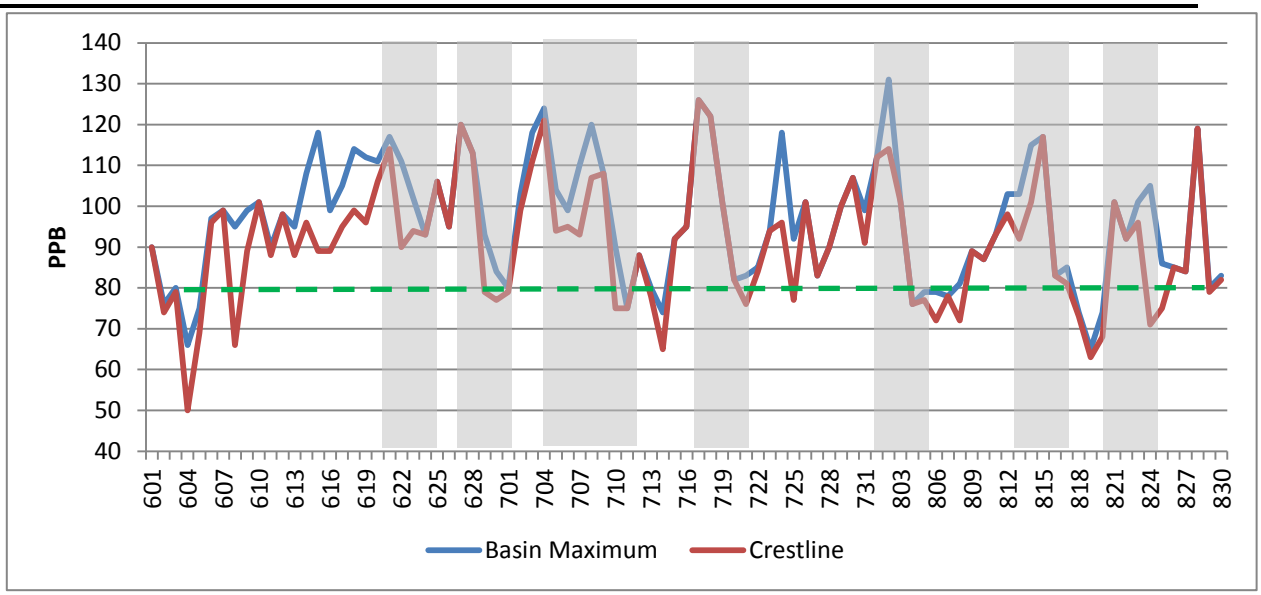


FIGURE V-7-1

Observed Basin and Crestline Daily Maximum 8-Hr Average Ozone Concentrations: June 1 through August 31, 2008. (Shaded areas indicate multiple day regional ozone episodes).

Overall, the 91 day period provides a robust description of the 2008 ozone-meteorological season. Table V-7-1 lists the number of days each Basin station exceeded the 8-hour ozone standard during the June through August 2008 period. Also listed in Table V-7-1 are the 2008, 5-year weighted design values used in the future year ozone projections.

TABLE V-7-1

2008 Basin Weighted Design Values* and Number of Days Daily Maximum Concentrations Exceeded 80 ppb

Station	2008 5-Year Weighted Design (ppb)	Number of Days in 2008 with Observed 8-Hr Average Maximum Ozone > 80 ppb
Azusa	94	16
Burbank	88	10
Reseda	94	16
Pomona	97	19
Pasadena	90	7
Santa Clarita	101	41
Glendora	106	26

Rubidoux	101	39
Perris	104	47
Lake Elsinore	99	39
Banning Airport	102	49
Upland	106	31
Crestline	116	66
Fontana	107	36
San Bernardino	109	46
Redlands	109	50

*Stations having design values greater than 80 ppb

BASE-YEAR OZONE MODEL PERFOMANCE EVALUATION

For the CMAQ performance evaluation the modeling domain is separated into nine sub-regions or zones. Figure V-7-2 depicts the sub-regional zones used for base-year simulation performance. The different zones present unique air quality profiles. In previous ozone modeling attainment demonstrations using a smaller modeling domain, the number and size of the zones were different. Seven zones represented the Basin and portions of Ventura County, the Mojave Desert and the Coachella Valley.

For the current analysis the Basin is represented by three of the zones: Zone 3 – the San Fernando Valley, Zone 4 – the Eastern San Gabriel, Riverside and San Bernardino Valleys, and Zone 5 – the Los Angeles and Orange County emissions source areas. Of the three areas, Zone 4 represents the Basin maximum ozone concentrations and the primary downwind impact zone. As such, the priority in evaluating model performance is focused on Zone 4. Zone 9 includes the Coachella Valley portion of the Salton Sea Air Basin.

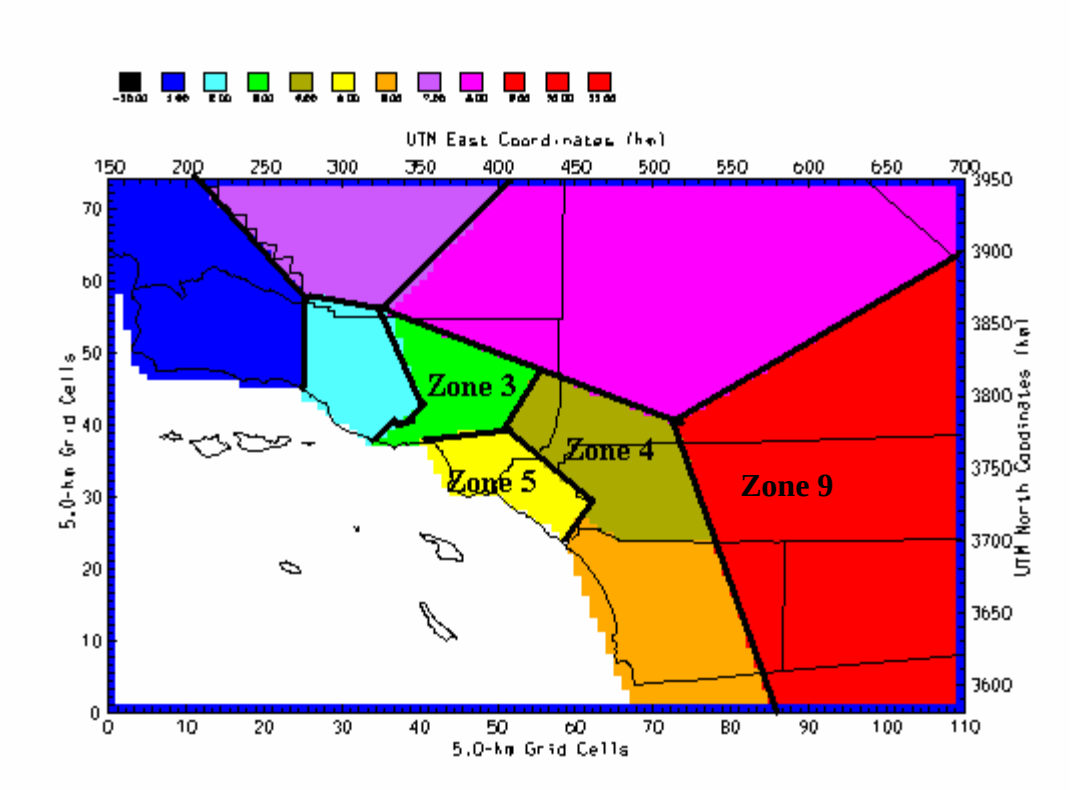


FIGURE V-7-2

Performance Evaluation Zones

Statistical Evaluation

The statistics used to evaluate 1-hour average CMAQ ozone performance do not change from previous AQMPs and include the following:

Statistic for O_3	Criteria (%)	Comparison Basis
Normalized Gross Bias	≤ ±15	Paired in space and time
Normalized Gross Error	≤ 35	Paired in space (+2 grid cells) and time
Peak Prediction Accuracy	≤ ± 20	Unpaired in space and time

The same statistics are applied to the 8-hour average ozone.

The base year average regional model performance for June through August 2008 for Zones 3, 4, and 5 are presented in Tables V-7-2 to V-7-7 for days when Basin maximum 8-hour ozone levels were at least 85 ppb. Base year 8-hour ozone performance statistics for Zone 9 in the downwind Coachella Valley portions of the Salton Sea Air Basin are provided in Table V-7-8. Performance statistics are

presented for observed concentrations of 60 ppb or greater. Data for 1- and 8-hour average ozone concentrations for the sub regional peak concentrations are both provided in the tables.

The CMAQ ozone simulations generally meet the 1-hour average unpaired peak and normalized error model performance goal in all three zones on most days. Normalized bias tended to be negative, particularly in June. Zone-5 however showed a tendency for over prediction in all three months. Zone 4 displayed the best unpaired peak performance with 54 out of 58 days meeting the 20 percent criteria. Unpaired peak performance in Zones 3 and 5 lagged, with only 76 and 79 percent of the days meeting the criteria. Overall, the 8-hour average evaluation was slightly better, however observed 8-hour ozone did not exceed the 60 ppb threshold for inclusion in the analysis on more days in Zone 5.

Table V-7-2

June 2008 Base Year 1-Hour Average Ozone Performance for Days When Regional 8-Hour Maximum ≥ 85 ppb

Date	Zone 3					Zone 4					Zone 5				
	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)
601	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
602	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
603	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
604	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
605	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
606	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
607	106	77.7	0.73	-26	26	113	106.4	0.94	-10	12	80	84.6	1.06	2	14
608	97	100.6	1.04	2	17	119	124.4	1.05	-4	14	64	96.7	1.51	34	34
609	123	81.3	0.66	-23	23	114	100.5	0.88	-16	18	84	85.1	1.01	1	11
610	123	97.5	0.79	-3	9	105	113.6	1.08	0	10	85	86.5	1.02	11	13
611	95	96.8	1.02	12	13	105	110.4	1.05	-6	10	65	77.7	1.20	8	10
612	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
613	95	101.8	1.07	9	11	113	117.2	1.04	8	15	70	82.2	1.17	6	9
614	102	97.8	0.96	12	13	117	117.7	1.01	0	13	78	84.3	1.08	10	11
612	123	91.1	0.74	-7	12	119	111.4	0.94	-12	13	96	98	1.02	6	12
616	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
617	111	84.8	0.76	-30	30	123	88.3	0.72	-35	35	83	70.6	0.85	-25	26
618	116	100.7	0.87	-19	25	122	97.9	0.80	-37	39	94	79.3	0.84	-14	17
619	87	92	1.06	-17	25	162	123.2	0.76	-18	20	118	106.9	0.91	0	22
620	95	108.1	1.14	5	18	152	135.8	0.89	-2	18	110	111.1	1.01	11	15
621	111	98.2	0.88	-10	20	176	128.9	0.73	-13	16	114	106.3	0.93	0	13
622	122	106.9	0.88	-19	20	156	149.9	0.96	-1	19	107	115.1	1.08	4	12
623	123	92.6	0.75	-29	29	123	135.9	1.10	11	21	107	121.9	1.14	13	19
624	123	79.2	0.64	-27	27	111	99.4	0.90	-9	12	78	75.1	0.96	-10	15
625	105	90.9	0.87	-1	10	111	109.7	0.99	1	19	61	78.3	1.28	21	21
626	86	92.7	1.08	0	8	122	109.6	0.90	-8	16	65	75.2	1.16	1	8
627	88	104.6	1.19	21	21	103	114	1.11	2	19	67	80.9	1.21	13	13
628	93	81.7	0.88	-5	7	133	120.9	0.91	-7	17	67	82.9	1.24	4	11
629	88	82.4	0.94	-7	10	130	111.3	0.86	-21	21	92	80.8	0.88	-9	11

*Normalized bias and normalized error calculated for hours where observations > 60 ppb

Table V-7-3

July 2008 Base Year 1-Hour Average Ozone Performance for Days When Regional 8-Hour Maximum ≥ 85 ppb

Date	Zone 3					Zone 4					Zone 5				
	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)
701	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
702	127	87.5	0.69	-12	14	124	106.8	0.86	-12	15	81	84.7	1.05	6	10
703	138	90.6	0.66	-20	21	149	143.6	0.96	2	16	100	98.6	0.99	4	18
704	110	79.9	0.73	-27	27	150	137.6	0.92	-17	21	116	97.9	0.84	-19	20
705	111	95.7	0.86	-5	23	116	122.8	1.06	-2	19	103	94.9	0.92	3	19
706	107	104.1	0.97	-7	11	110	125.8	1.14	12	18	94	107.1	1.14	23	23
707	105	106.3	1.01	-12	13	128	102.1	0.80	-25	26	85	95.7	1.13	14	15
708	123	109.5	0.89	-9	14	138	104.5	0.76	-17	19	70	81.4	1.16	12	12
709	113	104.9	0.93	-1	13	132	149.2	1.13	13	29	65	103.8	1.60	32	32
710	97	114.2	1.18	21	23	121	130.4	1.08	13	33	---	---	---	---	---
711	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
712	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
713	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
714	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
715	92	84.9	0.92	-2	16	108	102.7	0.95	-2	13	65	77.8	1.20	14	14
716	101	92.1	0.91	-1	16	114	125.2	1.10	7	17	62	90.9	1.47	24	24
717	116	82.7	0.71	-17	23	140	114.2	0.82	0	13	66	77.5	1.17	12	14
718	113	101.9	0.90	-12	20	144	138.1	0.96	11	18	67	95.1	1.42	32	32
719	111	97.4	0.88	3	9	120	131.9	1.10	13	18	78	99.9	1.28	30	30
720	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
721	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
722	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
723	93	96.2	1.03	16	16	110	120.2	1.09	2	13	65	87.6	1.35	16	17
724	128	123.1	0.96	10	15	139	144	1.04	10	20	84	93.4	1.11	16	17
725	103	98.6	0.96	-5	15	122	123.2	1.01	7	18	71	104.4	1.47	35	35
726	96	92.3	0.96	2	17	117	125.4	1.07	14	20	69	84.2	1.22	12	12
727	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
728	80	80.2	1.00	-2	9	99	96.3	0.97	-7	14	---	---	---	---	---
729	81	90.4	1.12	8	9	108	98.7	0.91	-6	15	---	---	---	---	---
730	101	97.1	0.96	5	12	119	110.6	0.93	-5	13	---	---	---	---	---
731	109	105.4	0.97	-4	8	121	107.3	0.89	-8	13	76	83.2	1.09	-3	7

*Normalized bias and normalized error calculated for hours where observations > 60 ppb

Table V-7-4

August 2008 Base Year 1-Hour Average Ozone Performance for Days When Regional 8-Hour Maximum ≥ 85 ppb

Date	Zone 3					Zone 4					Zone 5				
	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)
801	131	104.1	0.79	-14	16	138	121.5	0.88	-9	13	93	93.2	1.00	9	15
802	150	102.1	0.68	-25	26	141	148.7	1.05	1	22	104	107.1	1.03	15	18
803	110	99	0.90	-6	10	114	125.3	1.10	4	13	94	101.2	1.08	13	13
804	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
805	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
806	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
807	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
808	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
809	88	74.5	0.85	-10	10	110	92.8	0.84	-3	10	62	69.2	1.12	-11	11
810	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
811	94	93.6	1.00	13	17	110	126.4	1.15	11	19	60	88.7	1.48	18	18
812	122	98.7	0.81	-7	13	126	119.4	0.95	-2	15	75	87	1.16	4	11
813	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
814	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
815	102	99.2	0.97	0	6	131	115.9	0.88	-8	15	60	73.5	1.23	-15	15
816	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
817	82	78.8	0.96	-4	7	105	106.8	1.02	2	13	72	76.1	1.06	1	7
818	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
819	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
820	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
821	95	91	0.96	2	12	110	116.9	1.06	20	28	---	---	---	---	---
822	82	87.4	1.07	12	12	106	125	1.18	17	25	---	---	---	---	---
823	78	104.4	1.34	17	19	125	123.6	0.99	1	17	87	96.1	1.10	8	13
824	92	106.6	1.16	0	13	137	130.1	0.95	-7	22	99	116.8	1.18	25	27
825	108	97	0.90	6	22	112	120.3	1.07	11	21	79	94.8	1.20	18	18
826	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
827	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
828	117	95.1	0.81	-6	9	131	119.3	0.91	-11	14	66	79.6	1.21	10	10
829	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
830	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
831	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

*Normalized bias and normalized error calculated for hours where observations > 60 ppb

Table V-7-5

June 2008 Base Year 8-Hour Average Ozone Performance for Days When Regional 8-Hour Maximum ≥ 85 ppb

Date	Zone 3					Zone 4					Zone 5				
	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)
601	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
602	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
603	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
604	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
605	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
606	87.5	63.9	0.73	-24	24	96.1	90.2	0.94	-14	2	70.4	76.2	1.08	2	15
607	84.5	83.6	0.99	1	16	99.6	92.9	0.93	-10	4	---	---	---	---	---
608	95.2	67.5	0.71	-21	21	92.5	78	0.84	-22	8	68.4	70.6	1.03	-6	8
609	101	86.2	0.85	4	7	88	94	1.07	-3	1	68.2	75.3	1.1	7	7
610	75.5	80.9	1.07	13	13	101.5	94.3	0.93	-13	3	58.2	67.3	1.16	---	---
611	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
612	78.5	85.6	1.09	11	11	98.2	99.1	1.01	3	6	---	---	---	---	---
613	86.2	90.4	1.05	13	13	95.5	97.9	1.03	-4	6	64.1	75.4	1.18	11	11
614	100.9	77	0.76	-6	12	108.9	101	0.93	-15	2	82.4	83	1.01	4	6
612	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
616	99.1	73.6	0.74	-25	25	98	75.5	0.77	-40	25	71	62.7	0.88	-38	38
617	93.6	76.2	0.81	-18	20	105.2	77.2	0.73	-40	25	80.2	68.7	0.86	-15	17
618	61.9	74.2	1.2	0	12	114.9	96	0.84	-22	10	82.9	97.8	1.18	2	9
619	74.8	86.1	1.15	9	9	111.1	105.3	0.95	-6	6	93.9	98.5	1.05	14	15
620	79.8	74.4	0.93	-10	10	111.6	103.4	0.93	-15	4	104.2	94.5	0.91	-2	8
621	95.1	78.5	0.83	-18	18	117.2	127.3	1.09	-4	5	92.4	97.6	1.06	4	8
622	92.2	77.6	0.84	-23	23	111.4	117.9	1.06	5	10	90.1	99	1.1	13	17
623	102.6	64.8	0.63	-26	26	94.8	88.2	0.93	-17	5	64.8	65	1	-14	14
624	82.6	76.5	0.93	-5	7	90.2	91	1.01	-13	7	---	---	---	---	---
625	79.1	77.1	0.97	-2	5	106.9	93.8	0.88	-14	9	---	---	---	---	---
626	74.6	89	1.19	22	22	95	97.5	1.03	-4	11	---	---	---	---	---
627	86.5	77.4	0.89	-5	6	120.9	102.5	0.85	-14	8	60.2	68.6	1.14	-4	4
628	69.9	72.5	1.04	-2	7	113.6	88.7	0.78	-26	12	76.4	70.2	0.92	-9	9
629	72.1	72.9	1.01	0	5	93.8	101	1.08	-5	0	71.9	69.8	0.97	-3	7
630	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

*Normalized bias and normalized error calculated for hours where observations > 60 ppb

Table V-7-6

July 2008 Base Year 8-Hour Average Ozone Performance for Days When Regional 8-Hour Maximum ≥ 85 ppb

Date	Zone 3					Zone 4					Zone 5				
	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)
701	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
702	101.5	73.9	0.73	-15	17	103.6	90.8	0.88	-17	4	65.1	74.6	1.15	7	7
703	108	70.9	0.66	-19	19	118.4	123.5	1.04	-2	5	80.5	91.1	1.13	0	16
704	90.8	68.2	0.75	-24	24	124.6	105.8	0.85	-25	12	95.2	84.9	0.89	-16	17
705	87.6	79.1	0.9	-6	13	104.1	106.9	1.03	-7	6	89	77.9	0.88	0	10
706	92.2	88.3	0.96	-5	8	99.1	108.1	1.09	5	8	81.1	92.3	1.14	21	21
707	92.1	82.7	0.9	-7	9	110.4	85.5	0.77	-29	16	71.4	80.2	1.12	2	2
708	102.9	87.4	0.85	-8	10	120	90.8	0.76	-23	10	---	---	---	---	---
709	81.2	80.6	0.99	7	11	108.4	114.9	1.06	4	22	---	---	---	---	---
710	78	105.8	1.36	27	27	90.5	110.4	1.22	0	16	---	---	---	---	---
711	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
712	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
713	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
714	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
715	68	69.3	1.02	2	2	92.4	89.8	0.97	-11	5	---	---	---	---	---
716	82	72.6	0.89	-12	12	95.1	106.7	1.12	0	8	---	---	---	---	---
717	97.1	66.9	0.69	-23	24	126	99.4	0.79	-7	5	---	---	---	---	---
718	100.8	81	0.8	-12	16	122.8	117.8	0.96	3	7	---	---	---	---	---
719	89.5	86.4	0.97	6	9	101.1	111.4	1.1	8	11	---	---	---	---	---
720	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
721	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
722	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
723	74.6	79.5	1.07	15	15	94.9	99.9	1.05	-3	2	---	---	---	---	---
724	99.9	100.6	1.01	6	8	118.8	118.9	1	5	12	67.6	77.4	1.14	7	7
725	90.1	79.7	0.88	-3	8	92.4	102.3	1.11	3	9	---	---	---	---	---
726	77.6	78.4	1.01	1	8	101	102.4	1.01	5	12	---	---	---	---	---
727	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
728	62.9	68.4	1.09	5	5	90.8	79.7	0.88	-16	7	---	---	---	---	---
729	69	78.6	1.14	13	13	100	83	0.83	-18	8	---	---	---	---	---
730	84.9	81.3	0.96	2	7	107.1	90.3	0.84	-11	7	---	---	---	---	---
731	96.8	85.6	0.88	1	7	99.2	95.1	0.96	-12	2	62	71.6	1.15	-5	5

*Normalized bias and normalized error calculated for hours where observations > 60 ppb

Table V-7-7

August 2008 Base Year 8-Hour Average Ozone Performance for Days When Regional 8-Hour Maximum ≥ 85 ppb

Date	Zone 3					Zone 4					Zone 5				
	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)
801	102	81.4	0.8	-11	12	112.2	98.4	0.88	-15	3	71	75.7	1.07	-2	2
802	131.1	83	0.63	-23	23	114.1	110.1	0.96	-5	7	84	90.2	1.07	15	15
803	96.4	87.8	0.91	-3	8	101.6	107.3	1.06	0	7	75.4	88.1	1.17	13	13
804	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
805	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
806	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
807	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
808	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
809	59.9	62	1.04	---	---	89.6	77.4	0.86	-9	1	43.5	56.9	1.31	---	---
810	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
811	76	78.4	1.03	5	5	93.8	100.1	1.07	6	8	45.8	69.3	1.51	---	---
812	96	79.4	0.83	0	12	103	94.9	0.92	-7	6	60.2	77.6	1.29	18	18
813	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
814	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
815	83.9	81.1	0.97	-2	4	118	92.3	0.78	-14	4	50.3	62.1	1.23	---	---
816	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
817	71.4	69.4	0.97	-2	4	85.9	92.2	1.07	-5	1	60	64.7	1.08	---	---
818	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
819	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
820	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
821	82.2	74.8	0.91	1	8	101.8	98.7	0.97	8	17	45.9	78.9	1.72	---	---
822	71.4	76.9	1.08	15	15	92.9	106.6	1.15	11	18	51.2	71	1.39	---	---
823	66.6	88.7	1.33	28	28	101.1	101.7	1.01	-4	8	67.5	76.4	1.13	3	3
824	75.6	92.4	1.22	11	12	105.8	105.7	1	-12	7	79	100.1	1.27	24	24
825	86.1	76.4	0.89	-1	15	79.4	96.7	1.22	7	10	55.5	78.8	1.42	---	---
826	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
827	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
828	85.1	76.6	0.9	-4	5	119	94.9	0.8	-15	5	53.6	68.3	1.27	---	---
829	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
830	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
831	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

*Normalized bias and normalized error calculated for hours where observations > 60 ppb

Table V-7-8

Coachella Valley Zone-9 Base Year 8-Hour Average Ozone Performance for Days When Regional 8-Hour Maximum ≥ 85 ppb

Date	June					July					August				
	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)	Observed (ppb)	Predicted (ppb)	Unpaired Peak Ratio	Normalized Bias* (ppb)	Normalized Error* (ppb)
1	---	---	---	---	---	---	---	---	---	---	90.5	68.1	0.75	-21	21
2	---	---	---	---	---	88.1	66.6	0.76	-16	16	70.1	63.3	0.9	-10	10
3	---	---	---	---	---	85.6	77.9	0.91	1	9	---	---	---	---	---
4	---	---	---	---	---	55.2	67.1	1.22	-2	11	---	---	---	---	---
5	---	---	---	---	---	62.8	66.2	1.05	-4	4	---	---	---	---	---
6	97.5	68.7	0.7	-22	22	68	70.5	1.04	-16	16	---	---	---	---	---
7	77.4	74.4	0.96	-10	10	65.2	61.3	0.94	-14	14	---	---	---	---	---
8	70.5	54.7	0.78	-19	19	83.5	65.4	0.78	-27	27	---	---	---	---	---
9	80.2	67.4	0.84	-11	12	---	---	---	---	---	66.1	72	1.09	-3	3
10	88.1	81.1	0.92	-9	9	---	---	---	---	---	---	---	---	---	---
11	---	---	---	---	---	---	---	---	---	---	80	72.9	0.91	-2	7
12	74.4	76.9	1.03	4	6	---	---	---	---	---	80.5	75.3	0.94	-8	9
13	81.9	56.4	0.69	-24	24	---	---	---	---	---	---	---	---	---	---
14	99.2	67.7	0.68	-25	25	---	---	---	---	---	---	---	---	---	---
12	---	---	---	---	---	82.9	71.8	0.87	-11	11	96.2	74.5	0.77	-15	15
16	80.9	71.2	0.88	-15	15	90.1	77.6	0.86	-14	14					
17	71.4	75.2	1.05	-4	9	94.4	74.8	0.79	-15	15	74.2	83.7	1.13	6	7
18	91.9	69.6	0.76	-19	19	87.1	76.7	0.88	-8	11	---	---	---	---	---
19	83.6	64	0.77	-8	9	---	---	---	---	---	---	---	---	---	---
20	90.8	69.9	0.77	-19	19	---	---	---	---	---	---	---	---	---	---
21	75.5	82.1	1.09	10	15	---	---	---	---	---	70.5	68.3	0.97	-1	5
22	63.2	77.6	1.23	25	25	---	---	---	---	---	74.9	65.1	0.87	-11	12
23	75	70.8	0.94	-10	10	79.9	72.2	0.9	-7	7	62.2	73.8	1.19	3	4
24	76.8	73.6	0.96	-11	12	84.6	81.6	0.96	6	8	---	---	---	---	---
25	101.2	78.2	0.77	-19	19	65.5	73.8	1.13	10	10	---	---	---	---	---
26	93.9	81.5	0.87	-16	16	63.2	64.4	1.02	4	4	---	---	---	---	---
27	81.6	62.7	0.77	-21	21	---	---	---	---	---	---	---	---	---	---
28	78.1	63.6	0.81	-24	24	79	75.6	0.96	-5	5	74.1	71.5	0.96	-6	9
29	81.5	71	0.87	-14	14	84.8	78	0.92	-13	13	---	---	---	---	---
30	---	---	---	---	---	87.1	68.4	0.79	-22	22	---	---	---	---	---
31						82.5	75.9	0.92	-16	17	---	---	---	---	---

*Normalized bias and normalized error calculated for hours where observations > 60 ppb

Graphical Evaluation

Figures V-7-3 through V-7-8 show the diurnal trends of observed and predicted 8-hour ozone for the each day from June 1 through August 31, 2008 for six stations following a transport route from the coastal area of the Basin to inland Crestline and Banning. Supplemental diurnal observed and predicted 8-hour ozone for all remaining air quality sites are provided as Attachment 3 to this appendix. In general, the coastal-metropolitan areas of the Basin show reasonable agreement between observed and predicted diurnal distributions for June but as observations trend well below 80 ppb in July and August, the performance shifts to over prediction. The San Gabriel and San Bernardino Valley sites are relatively unbiased with mixed but reasonably good performance – over predicting on some days while displaying the reverse on others. Performance at Crestline displays a slight bias towards under prediction but several peak days are well characterized. Banning is the eastern most Basin site and furthest removed from the main source of NOx emissions. Ozone predictions at Banning track the peak concentrations well but nighttime NOx scavenging is not well represented in the simulations.

Figure V-7-9 depicts the scatter plots of observed and predicted 8-hour daily maximum ozone for Zones 3, 4 and 5 merged for the three months. A minimum observed threshold of 60 ppb is used in the data selection. V-7-10 provides the same scatter plot for Zone 9. The general tendency is for peak prediction to fall within 10 percent of the centerline perfect fit. Zone 9 tends to exhibit under prediction.

Overall, it is important to note that the effects of prediction biases or errors are mitigated by the use of relative response factors for the attainment analysis.

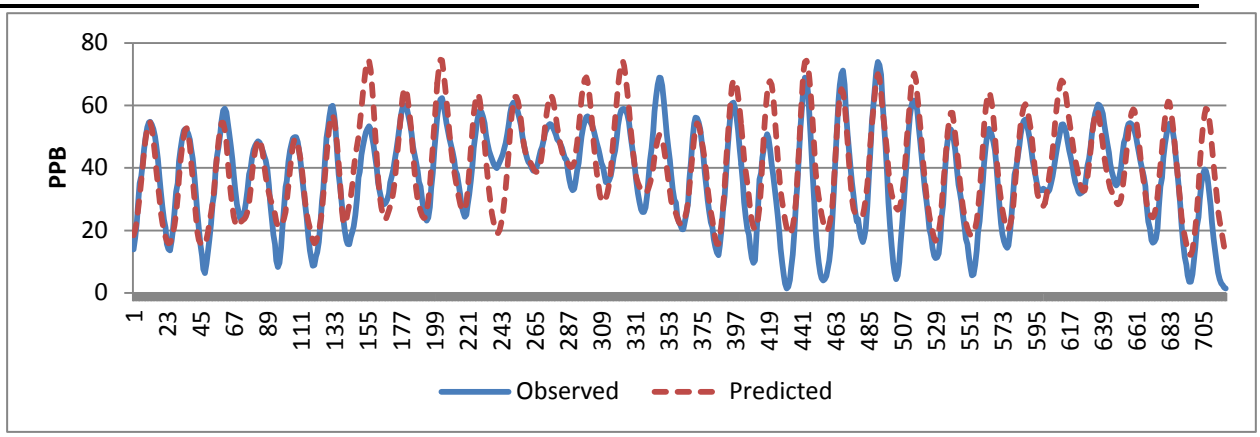


Figure V-7-3a

Time Series of Observed Vs.Predicted 8-Hour West Los Angeles Ozone: June, 2008

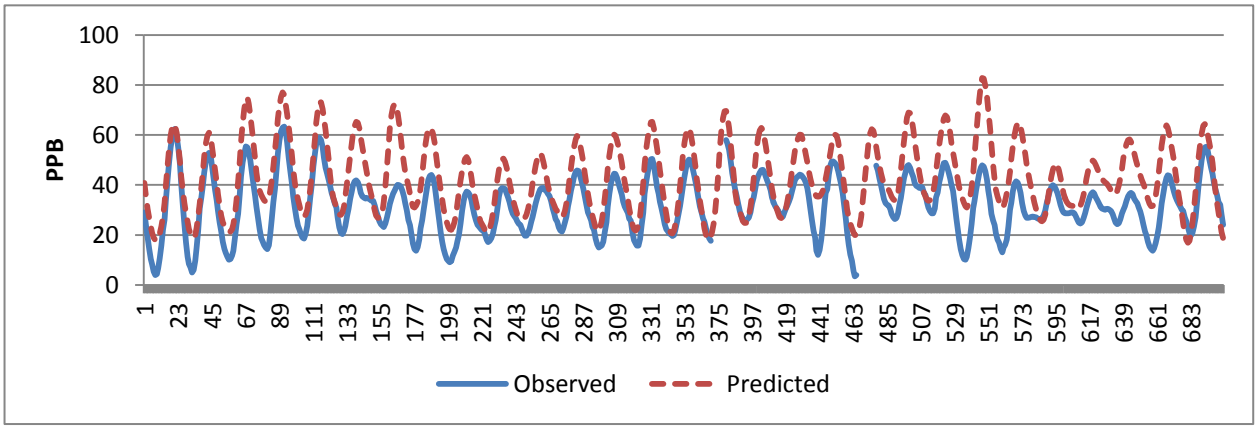


Figure V-7-3b

Time Series of Observed Vs.Predicted 8-Hour West Los Angeles Ozone: July, 2008

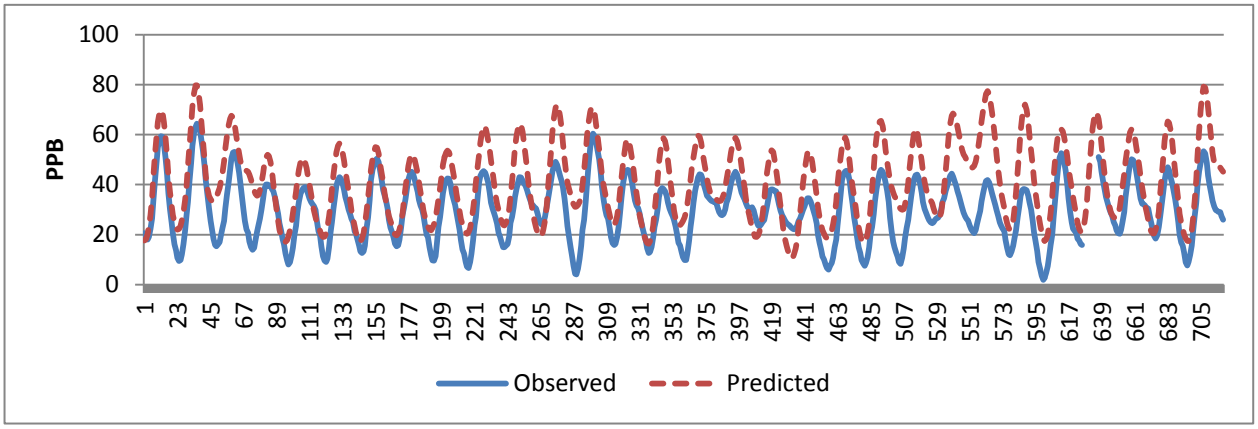


Figure V-7-3c

Time Series of Observed Vs.Predicted 8-Hour West Los Angeles Ozone: August, 2008

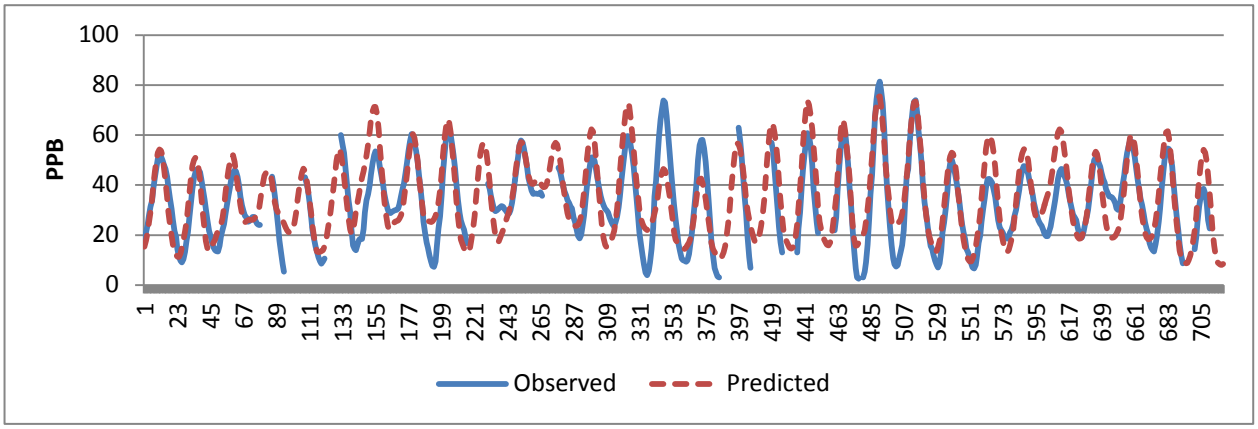


Figure V-7-4a

Time Series of Observed Vs.Predicted 8-Hour Los Angeles Ozone: June, 2008

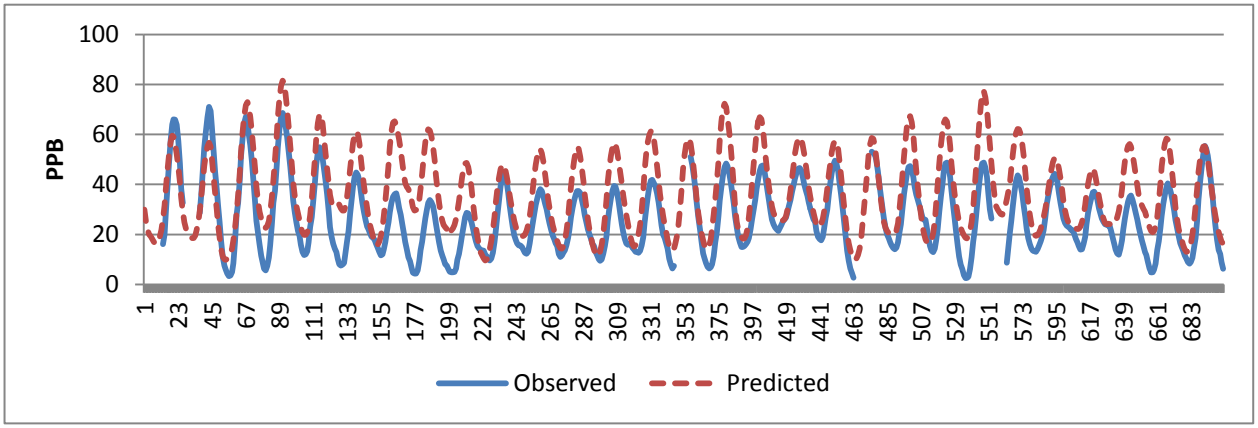


Figure V-7-4b

Time Series of Observed Vs.Predicted 8-Hour Los Angeles Ozone: July, 2008

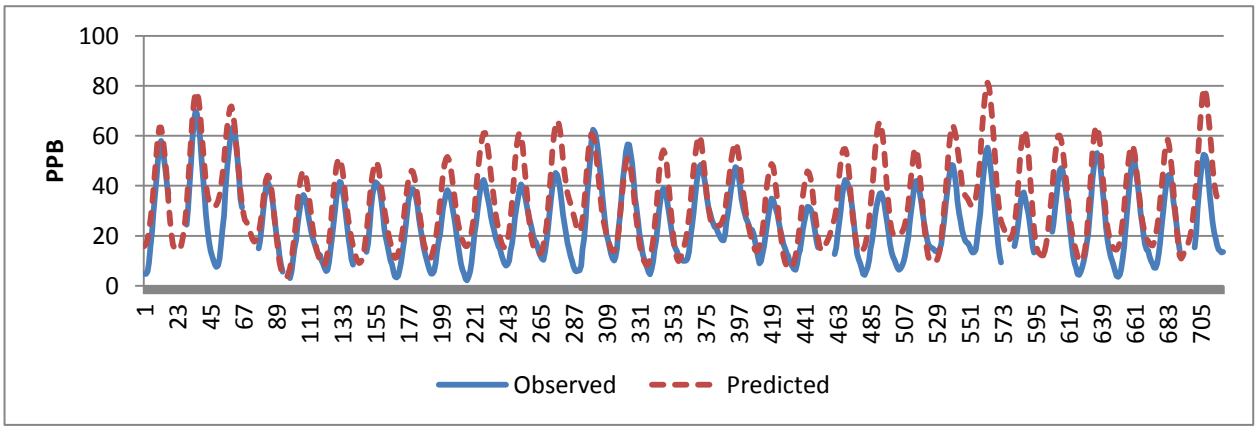


Figure V-7-4c

Time Series of Observed Vs.Predicted 8-Hour Los Angeles Ozone: August, 2008

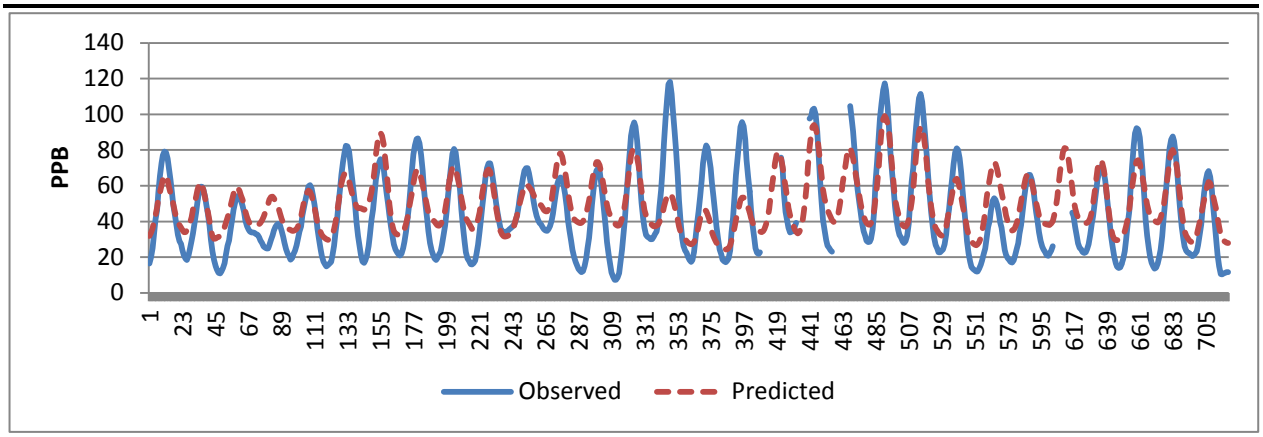


Figure V-7-5a

Time Series of Observed Vs.Predicted 8-Hour Glendora Ozone: June, 2008

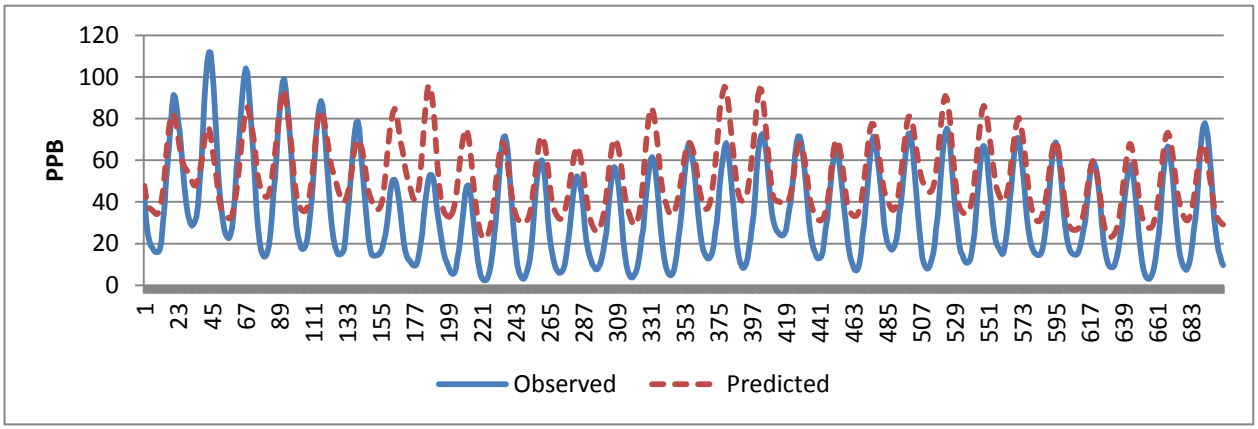


Figure V-7-5b

Time Series of Observed Vs.Predicted 8-Hour Glendora Ozone: July, 2008

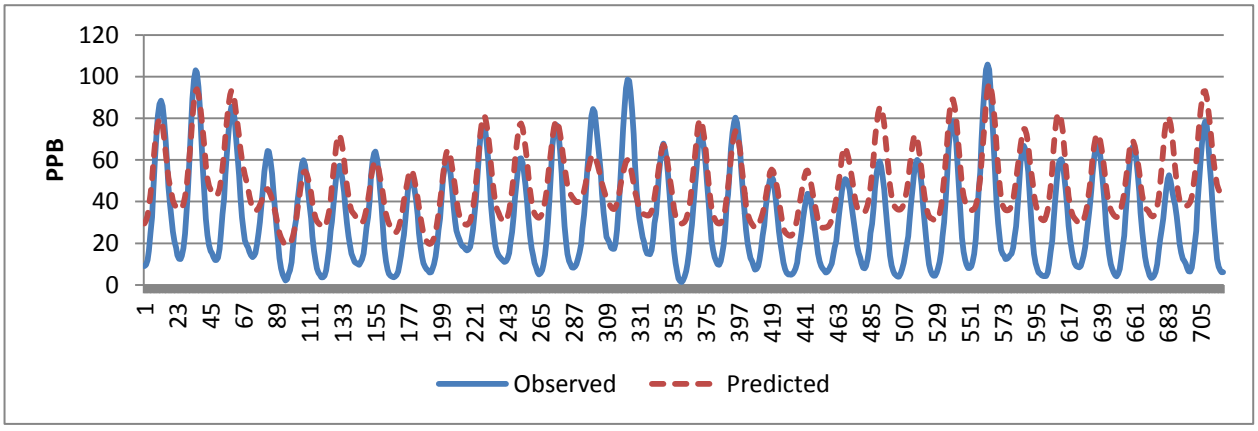


Figure V-7-5c

Time Series of Observed Vs.Predicted 8-Hour Glendora Ozone: August, 2008

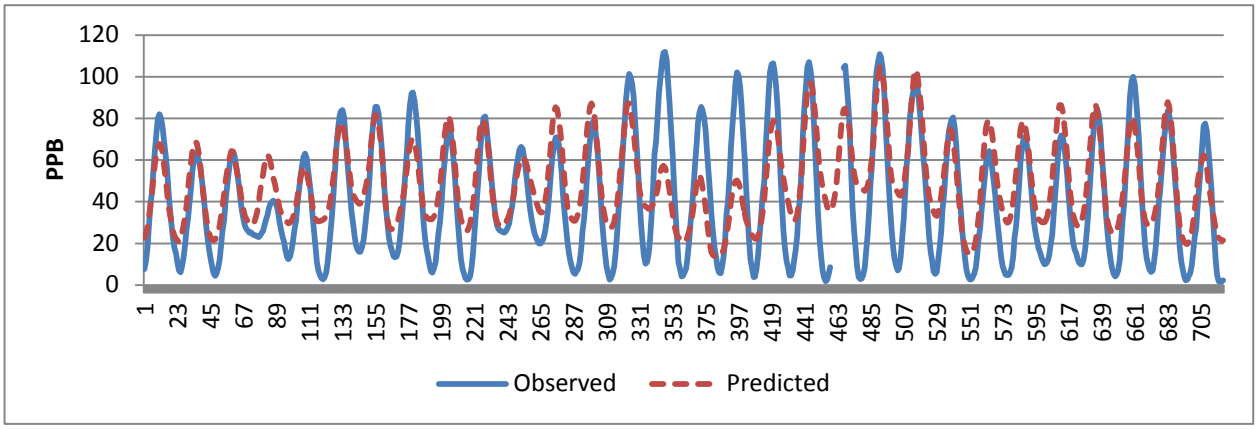


Figure V-7-6a

Time Series of Observed Vs.Predicted 8-Hour Fontana Ozone: June, 2008

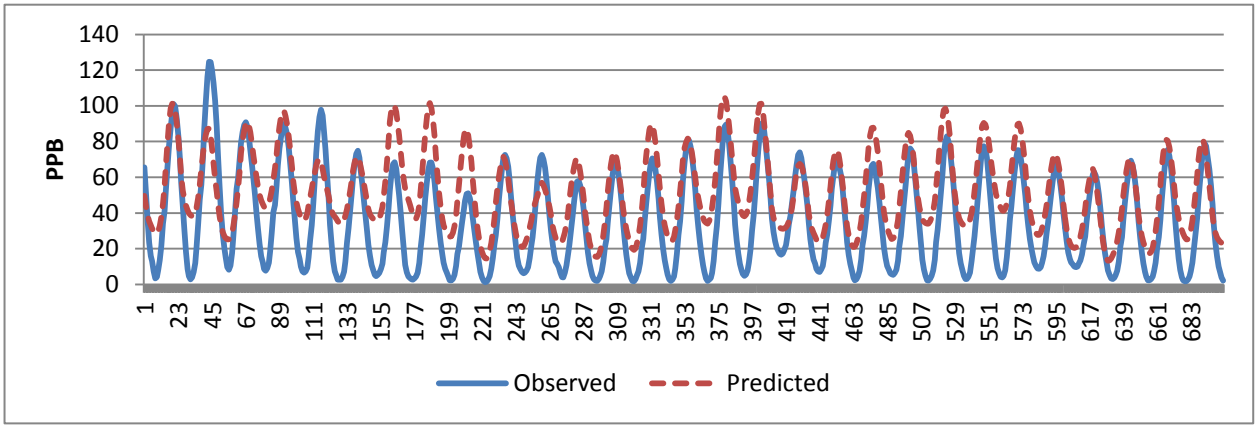


Figure V-7-6b

Time Series of Observed Vs.Predicted 8-Hour Fontana Ozone: July, 2008

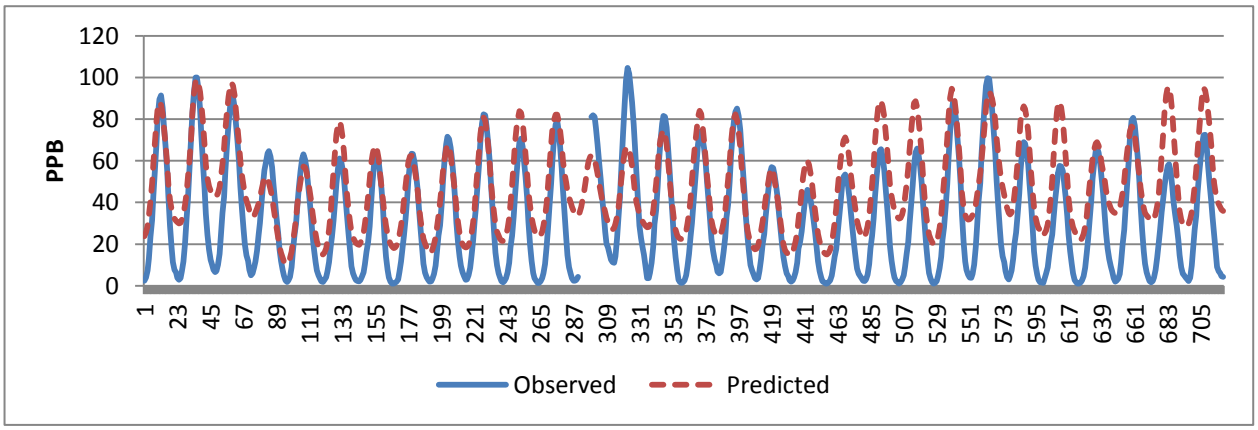


Figure V-7-6c

Time Series of Observed Vs.Predicted 8-Hour Fontana Ozone: August, 2008

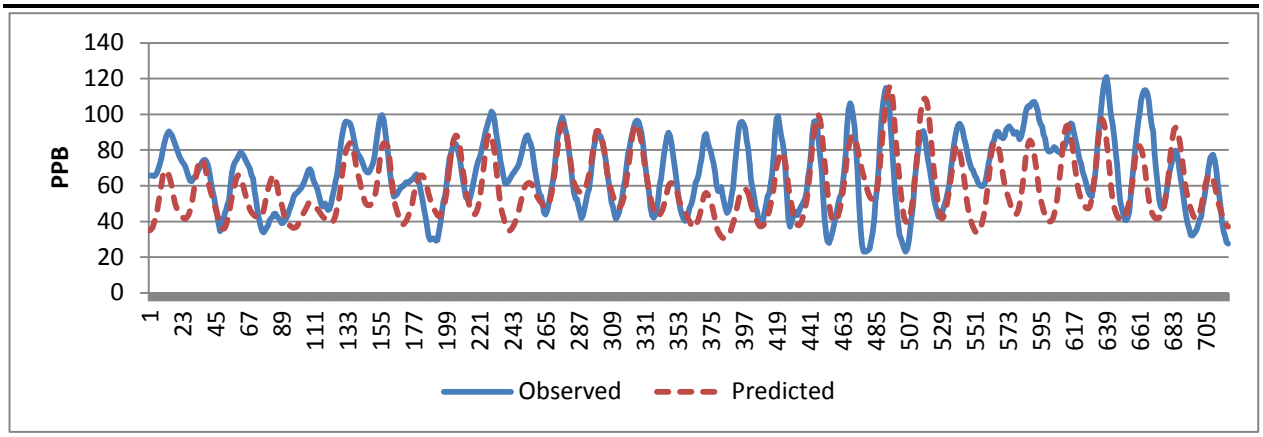


Figure V-7-7a

Time Series of Observed Vs.Predicted 8-Hour Crestline Ozone: June, 2008

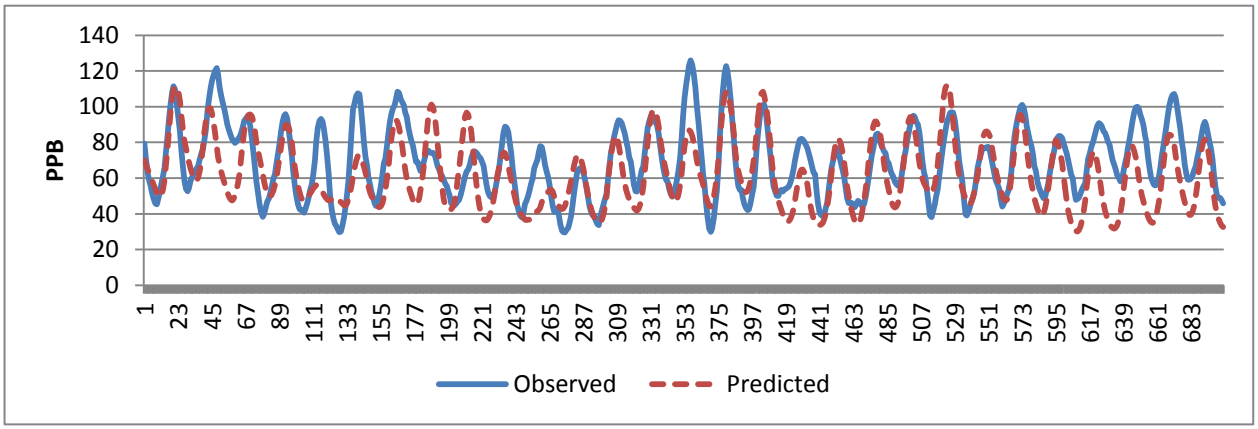


Figure V-7-7b

Time Series of Observed Vs.Predicted 8-Hour Crestline Ozone: July, 2008

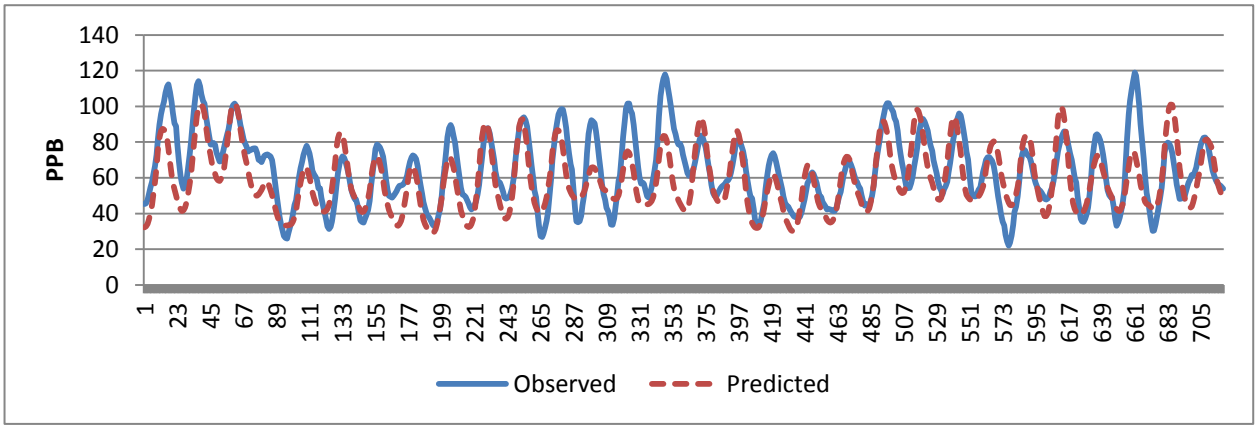


Figure V-7-7c

Time Series of Observed Vs.Predicted 8-Hour Crestline Ozone: August, 2008

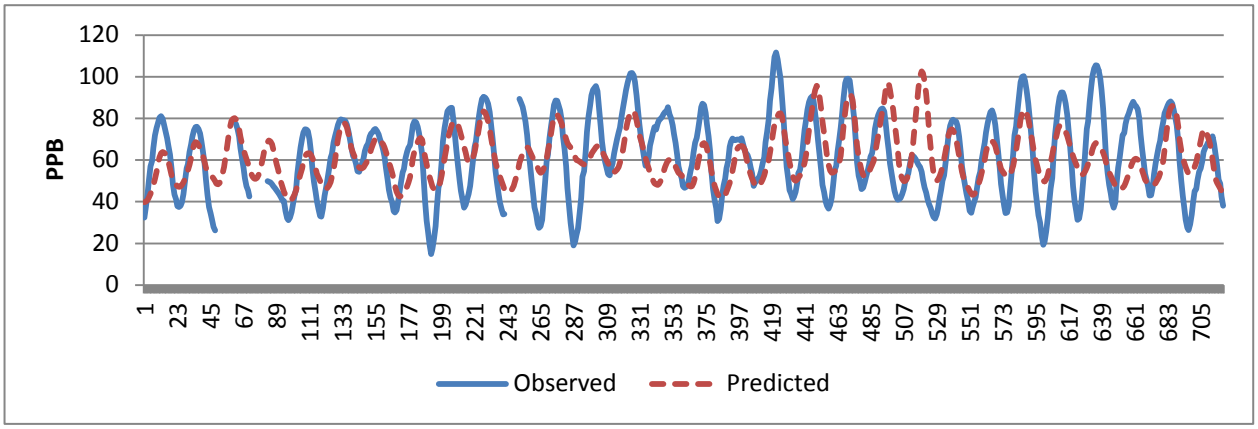


Figure V-7-8a

Time Series of Observed Vs.Predicted 8-Hour Banning Ozone: June, 2008

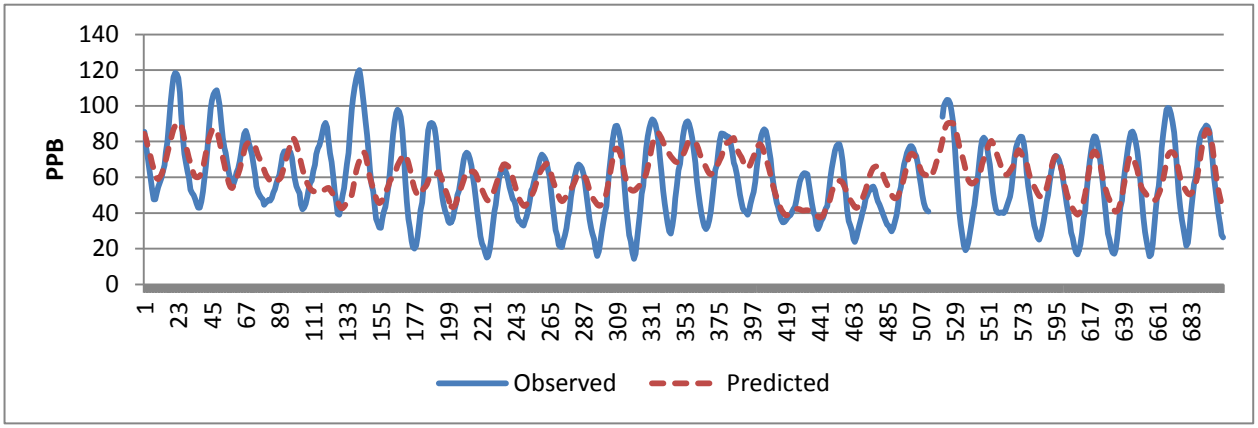


Figure V-7-8b

Time Series of Observed Vs.Predicted 8-Hour Banning Ozone: July, 2008

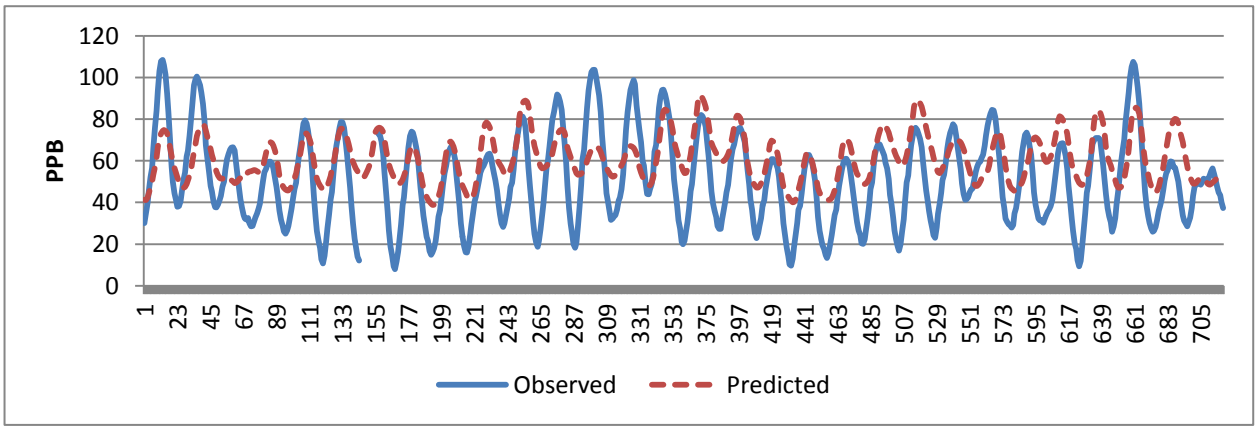


Figure V-7-8c

Time Series of Observed Vs.Predicted 8-Hour Banning Ozone: August, 2008

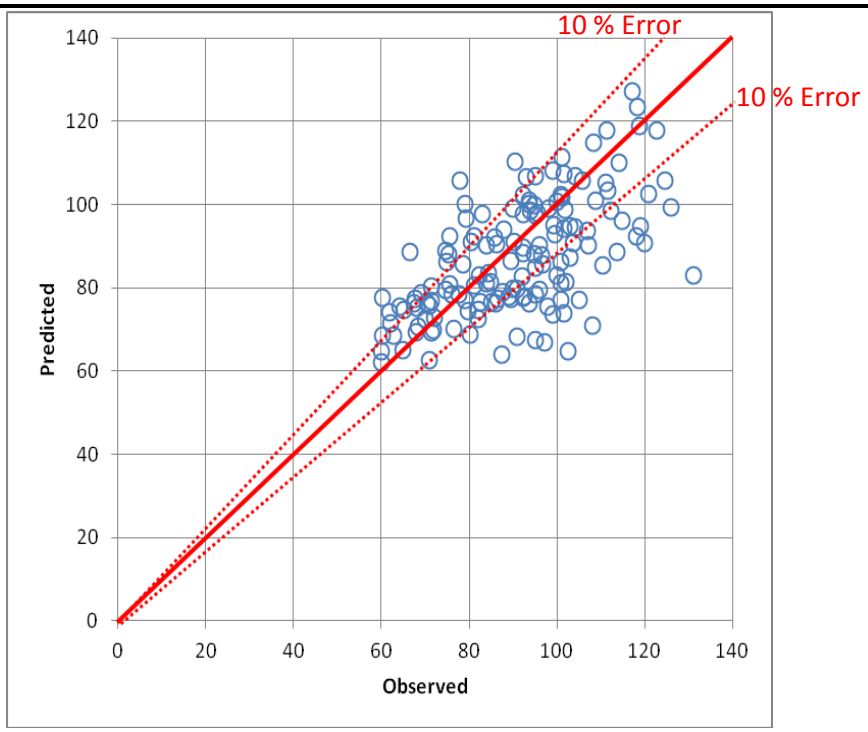


Figure V-7-9

Observed Vs.Predicted 8-Hour Sub Regional Ozone Maximums: Zones 3, 4 and 5 Combined

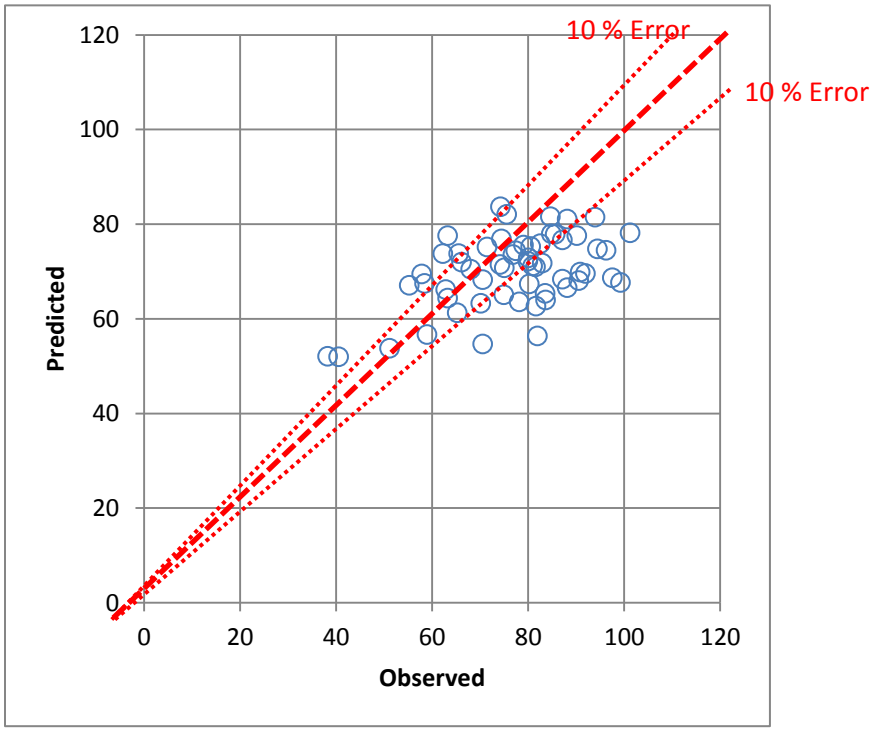


Figure V-7-10

Observed Vs.Predicted 8-Hour Sub Regional Ozone Maximums: Zones 9

OZONE MODELING APPROACH

The ozone modeling approach used in this update follows the same criteria employed for the 2007 AQMP attainment demonstration. Briefly, the set of 91 days from June 1 through August 30, 2008 were simulated as a subset of the annual PM2.5 simulations, and were analyzed to determine daily 8-hour average maximum ozone for the 2008 and 2023 emissions inventories. A separate 2023 simulation was conducted to assess future year ozone with VOC and NOx emissions specified at the levels defined by the 2007 AQMP attainment demonstration carrying capacity (420 TPD VOC and 114 TPD NOx). Finally, a set of simulations with incremental VOC and NOx emissions reductions from 2023 baseline emissions was generated to create ozone isopleths for each station in the Basin. The ozone isopleths provide updated guidance for the formulation of the future control strategies, particularly in light of the challenge of demonstrating attainment with the current 75 ppb standard in a SIP to be submitted to U.S. EPA in 2015.

The ozone RRFs were calculated using the ratio methodology described for the PM2.5 modeling. Individual station day inclusion in the analysis was determined by three basic criteria: (1) the observed ozone concentration had to be ± 30 percent of the station's weighted design value; (2) the absolute prediction accuracy of the base 2008 simulation for that day was required to be within 20 percent; and (3) the observed daily maximum concentration needed to be greater than 84 ppb. The criteria were designed to eliminate extreme values from entering the analysis and to only focus on station days were model performance met the long standing criteria for acceptance used in previous attainment demonstrations. Finally, only station days where ozone exceeded the 84 ppb threshold established to demonstrate attainment to the 1997 ozone standard as specified in the U.S. EPA Modeling Attainment Guidance Document were included in the analysis.

FUTURE OZONE AIR QUALITY

Table V-7-9 summarizes the results of the updated ozone simulations. Included in the table are the 2023 ozone baseline and 2023 controlled ozone projections from the 2007 AQMP ozone attainment demonstration modeling analysis approved by U.S. EPA as part of the SIP. The Final 2012 AQMP base year ozone simulations reflect the changes made to the 2023 base year inventory. The Final 2012 AQMP summer planning inventory has a higher ratio between VOC and NOX emissions (1.39 vs. 1.05) although total tonnages of both precursor emissions are lower than presented in the 2007 AQMP. The higher VOC to NOx ratio is indicative of a more reactive pollutant mix with average projected ozone design concentrations 9 percent higher than previously projected. One implication of this simulation is that moderate VOC emissions reductions in the years

between 2014 and 2023 will benefit regional ozone concentrations. Yet, the projected 2023 baseline design value of 108 PPB continues to exceed the federal standard by 35 percent. With the implementation of the Final 2012 AQMP short term control measures and the Section 185(e)(5) long-term control measures, (defined in this update as the difference between the Final 2012 AQMP 2023 baseline VOC and NOx emissions and the corresponding 2007 AQMP ozone attainment demonstration carrying capacity for the Basin), projected regional ozone design values closely match those defined in the 2007 AQMP ozone attainment demonstration. Regardless, it will still require a 64 percent reduction in NOx emissions and an additional 3 percent reduction in VOC emissions to attain the 1997 ozone standard. With controls in place, the updated analysis corroborates the approved 2007 AQMP ozone attainment demonstration in that it is expected that all stations in the Basin will meet the federal 8-hour ozone standard.

The east Basin stations in the San Bernardino Valley continue to have among the highest projected 8-hour controlled design values for this update. The 2023 controlled ozone design value at Glendora is also projected to exceed 80 ppb. Glendora, Upland, Fontana and San Bernardino are downwind receptors along the primary wind transport route that moves precursor emissions and developing ozone eastward by the daily sea breeze. The higher projected design value at Glendora reflects the higher VOC to NOx ratio observed in the baseline inventory relative to the 2007 AQMP 2023 baseline inventory. The 2023 controlled design at Glendora for the Final 2012 AQMP actually represents a greater response to emissions reductions than in the 2007 AQMP attainment demonstration. Future year projections of ozone for this update along the northerly transport route through the San Fernando Valley indicate that the ozone design value in the Santa Clarita Valley will be approximately 15 percent below the standard.

TABLE V-7-9

Model-Predicted 8-Hour Ozone Concentrations (ppb)

Location	2007 Ozone SIP 2023 Baseline Design	2007 Ozone SIP 2024 Controlled Design	Final 2012 AQMP Updated 2023* Baseline Design	Final 2012 AQMP Updated* 2024 Controlled Design
Azusa	82	80**	95	77
Burbank	86	70**	88	72
Reseda	86	68	90	73
Pomona	85	75	100	80
Pasadena	78	74**	92	76
Santa Clarita	95	74	94	73
Glendora	91	79	107	84
Riverside	92	78	100	77
Perris	94	78***	88	66
Lake Elsinore	80	64	85	66
Banning	88	70	94	73
Upland	92	78	106	83
Crestline	100	83	107	81
Fontana	97	81	104	81
San Bernardino	92	78	108	83
Redlands	98	81	103	77

* Informational purpose only based on preliminary emissions inventories.
** Based on the city-station specific RRF's determined from the 19 episode day average.
*** Based on the average of the RRF's determined from the stations meeting the criteria having more than 5 episode days.

Spatial Projections of 8-Hour Ozone Design Values

The spatial distribution of ozone design values for the 2008 base year is shown in Figure V-7-11. Future year ozone air quality projections for 2024 with and without implementation of all control measures are presented in Figures V-7-12 andV-7-13. The predicted ozone concentrations will be significantly reduced in the future years in all parts of the Basin with the implementation of proposed control measures in the South Coast Air Basin.

Coachella Valley

The results of the CMAQ 8-hour ozone simulations conducted for 2014 and 2019 also indicate that the two Coachella sites, Palm Springs and Indio will meet the federal standard by the 2019 attainment date. The projected 2018 8-hour ozone design for the Coachella Valley portion of the Salton Sea Air Basin will be 84 ppb.

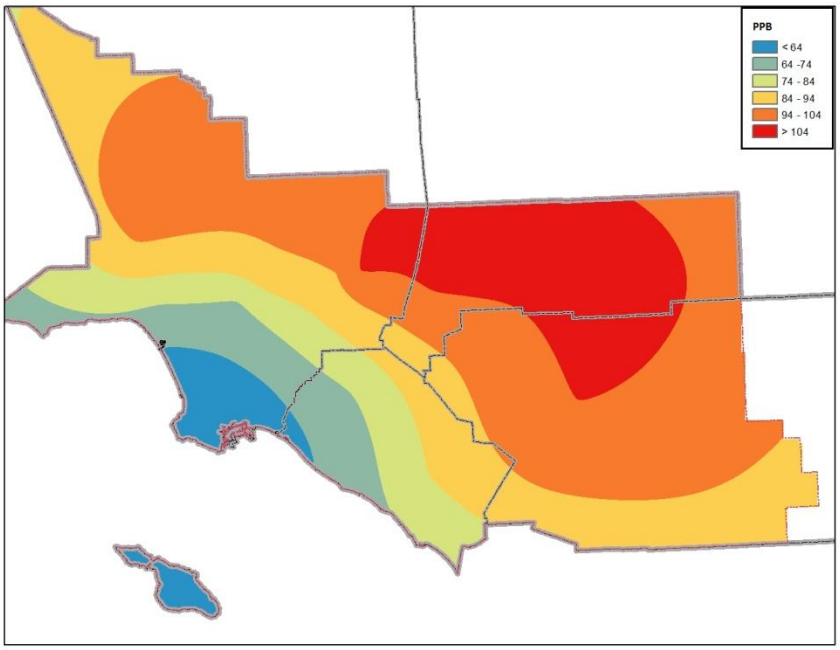


FIGURE V-7-11

2008 Baseline 8-Hour Ozone Design Concentrations (ppb)

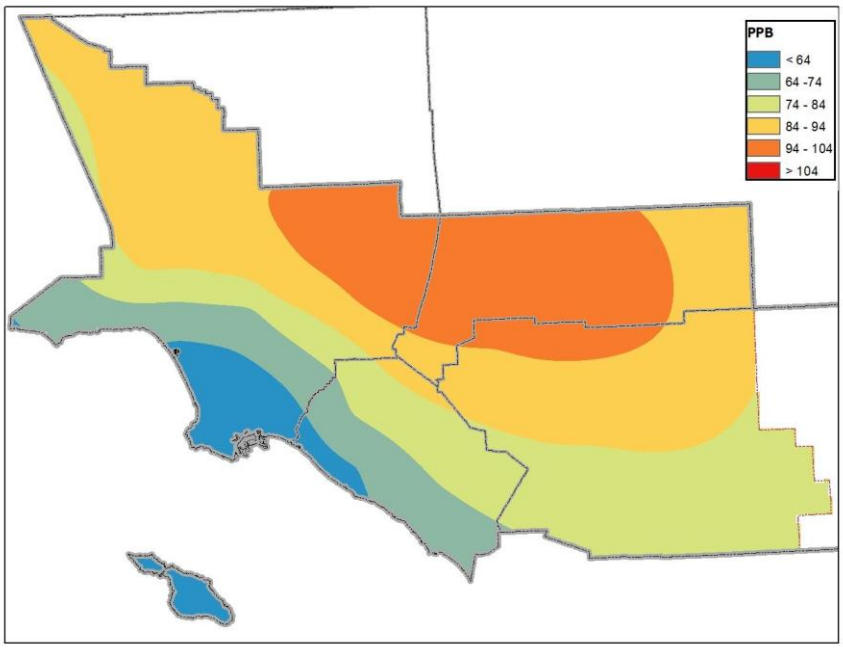


FIGURE V-7-12

Model-Predicted 2024 Baseline 8-Hour Ozone Design Concentrations (ppb)

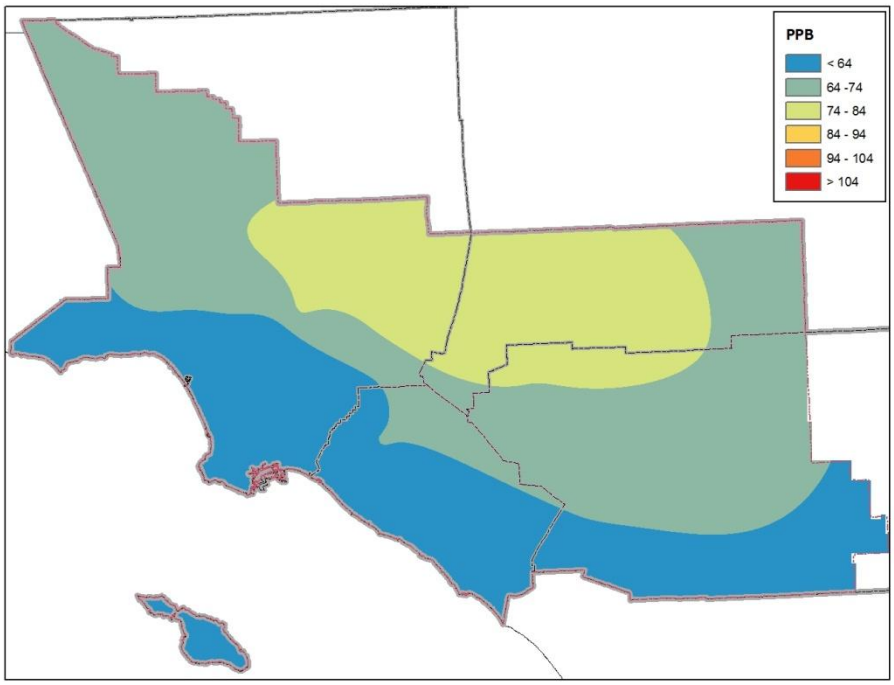


FIGURE V-7-13

Model-Predicted 2024 Controlled 8-Hour Ozone Design Concentrations (ppb)

LOOKING BEYOND 2023

The 2006 8-hour ozone standard is 75 ppb. The 2007 AQMP was focused on attainment of the 1997 8-hour ozone standard of 80 ppb. As of the writing of this document, the 2006 8-hour ozone implementation rule has not been finalized by U.S. EPA. The likely attainment date for Basin attainment of the 75 ppb standard is 2032. It is important to consider how much additional emissions reductions will be required for future attainment of this new standard. Figure V-7-14 provides the ozone isopleth for Crestline generated from the set of ozone simulations conducted during this analysis. Relying on the NOx heavy control strategy, it is projected that a reduction of NOx emissions exceeding 70 percent of the 2023 baseline (319 TPD) will be required to meet the 75 ppb standard. Additional NOx reductions will be required if the 8-hour ozone standard is lowered beyond 75 ppb.

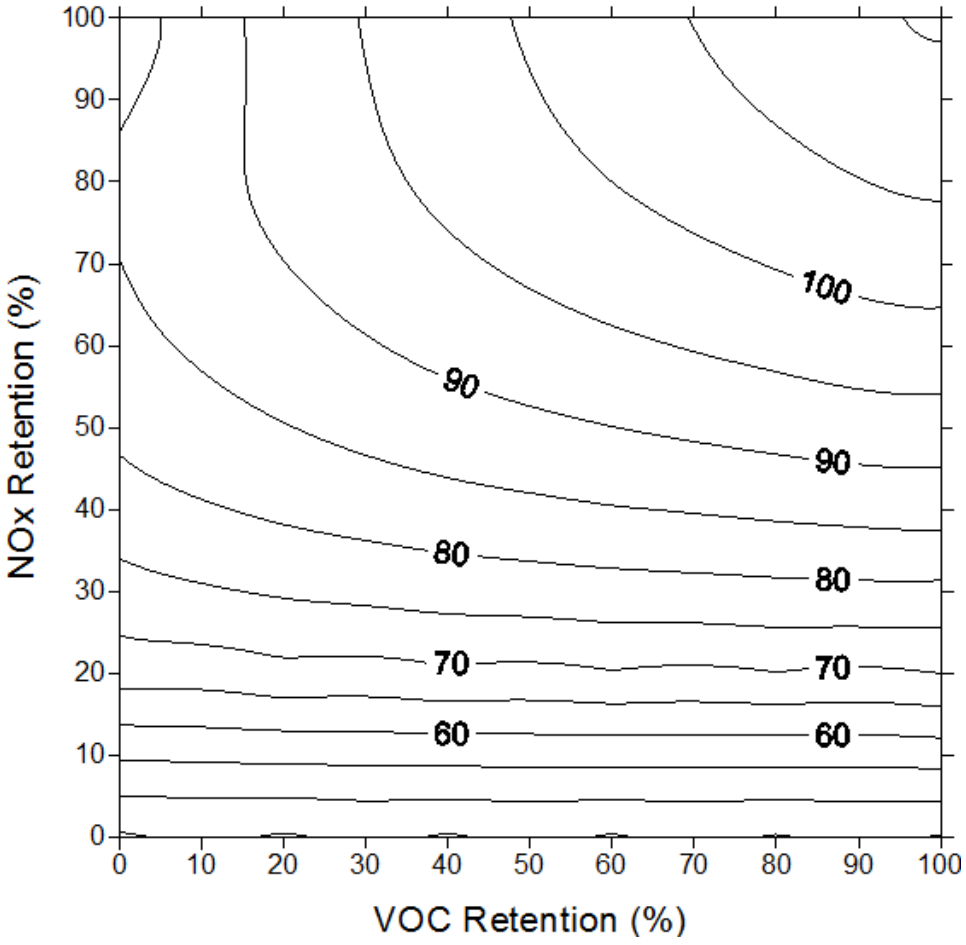


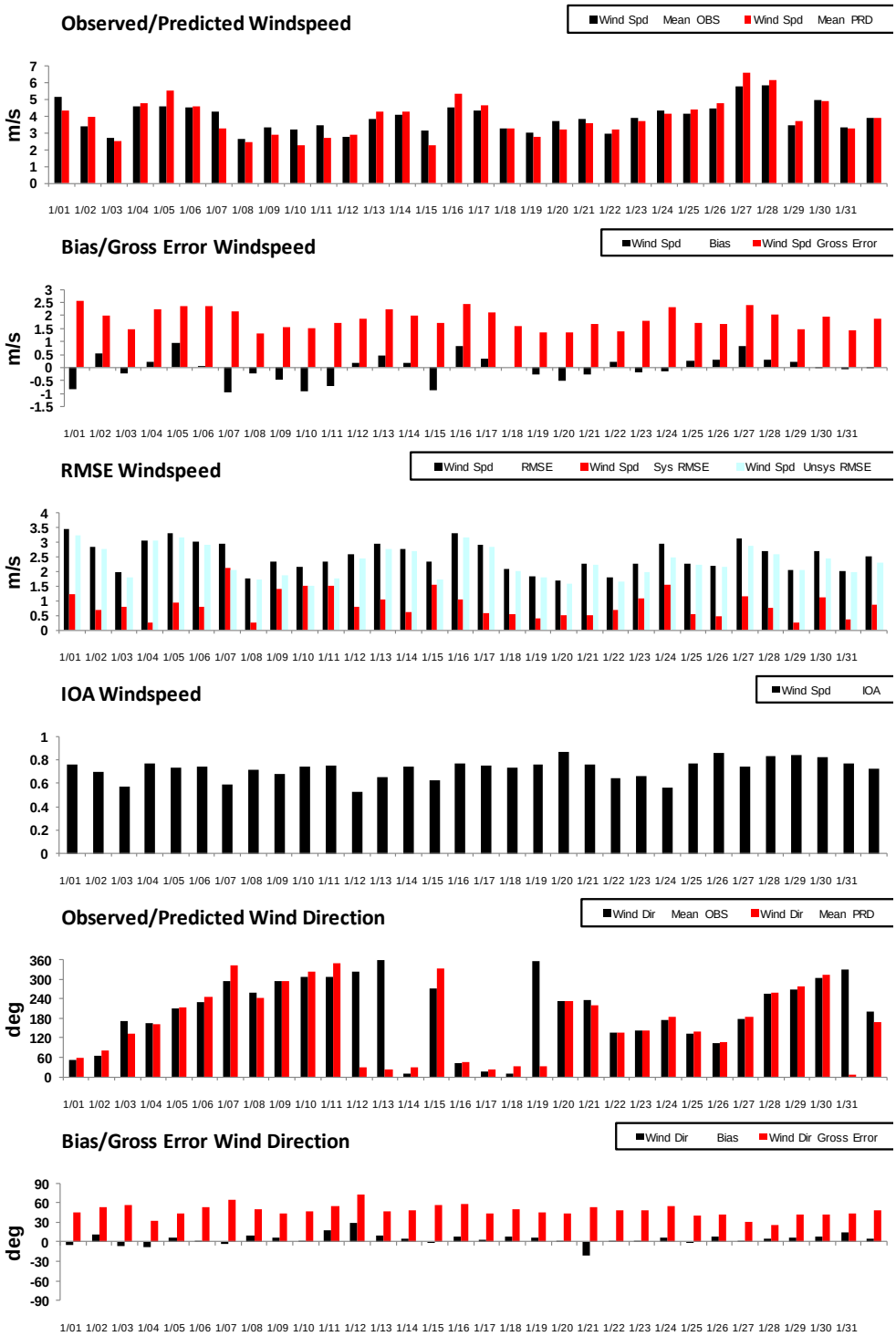
Figure V-7-14

2023 Crestline 8-Hour Ozone Isopleth

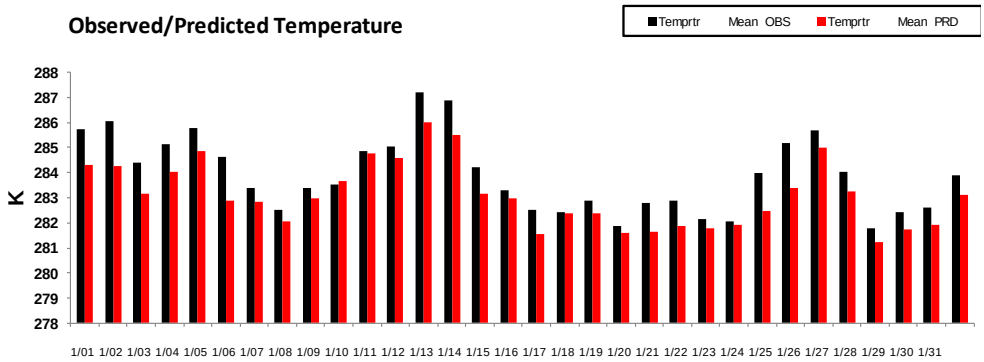
Attachment 1

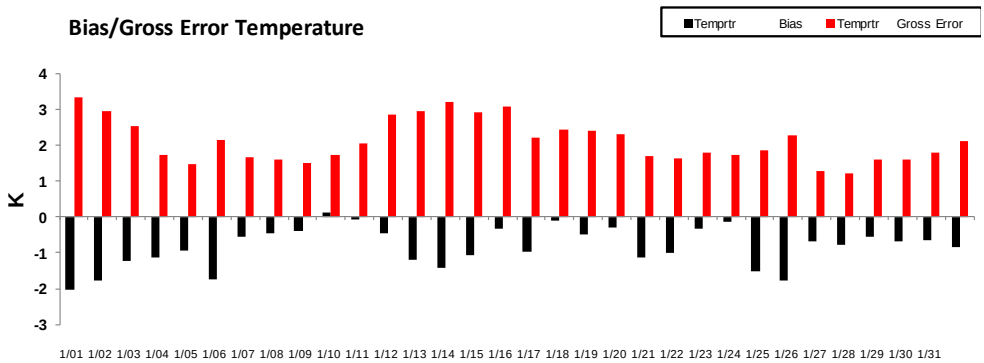
WRF METSTAT Model Graphical Performance Statistics

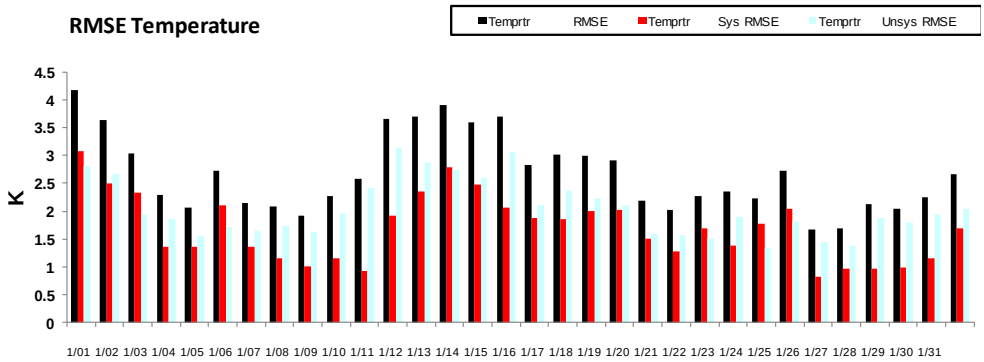
January Wind Speed & Direction

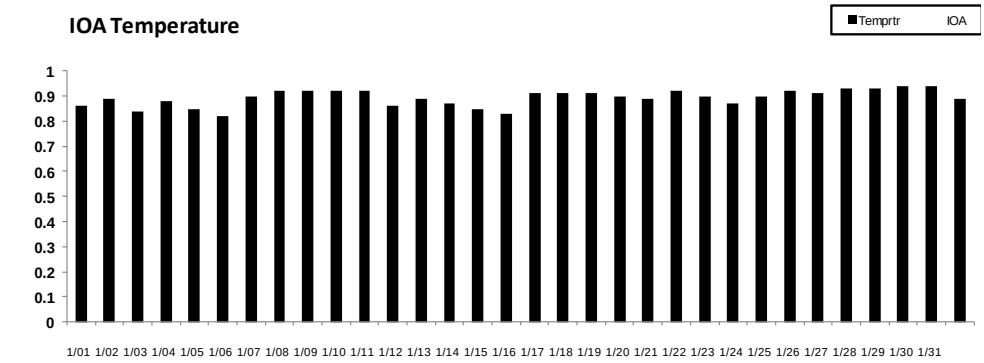


January Temperature

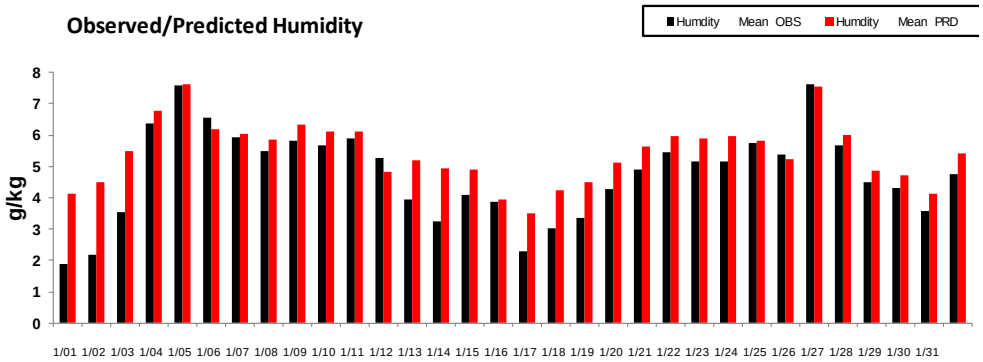


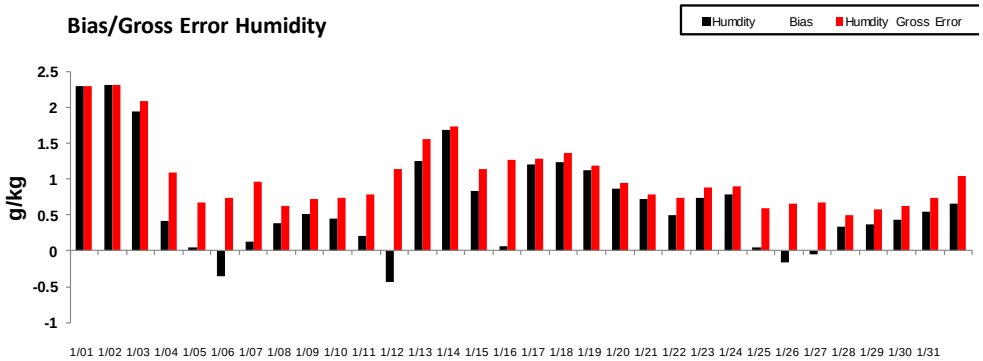


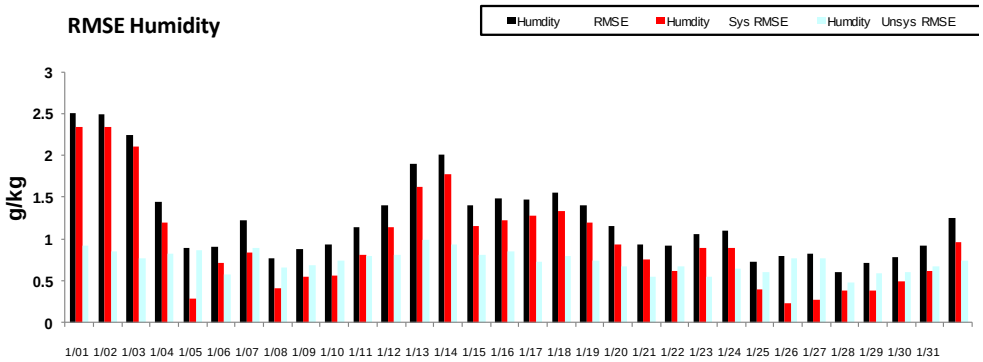


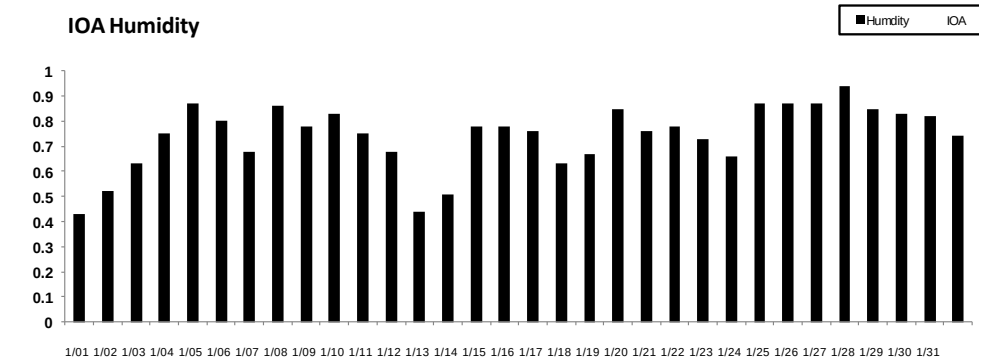


January Humidity

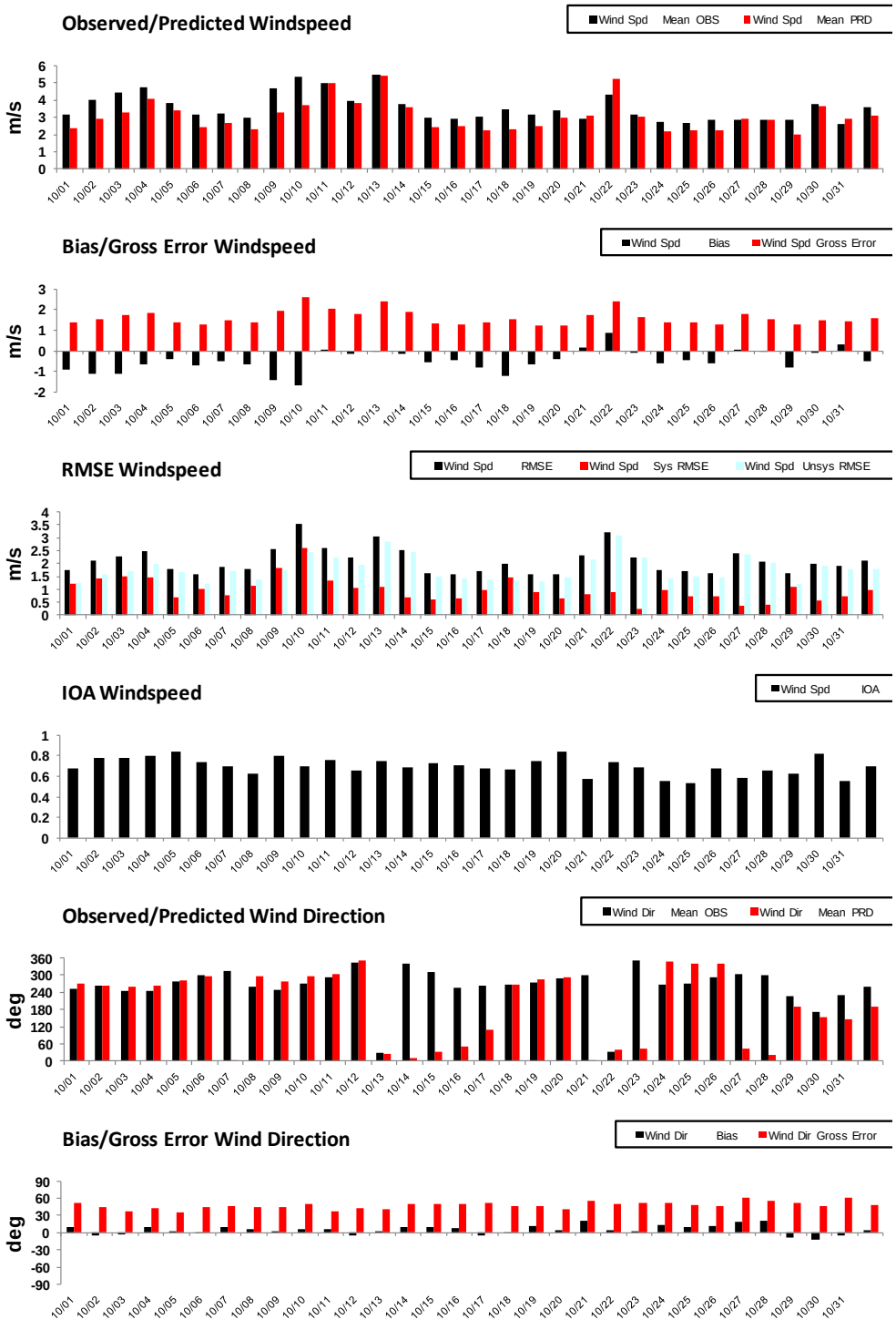




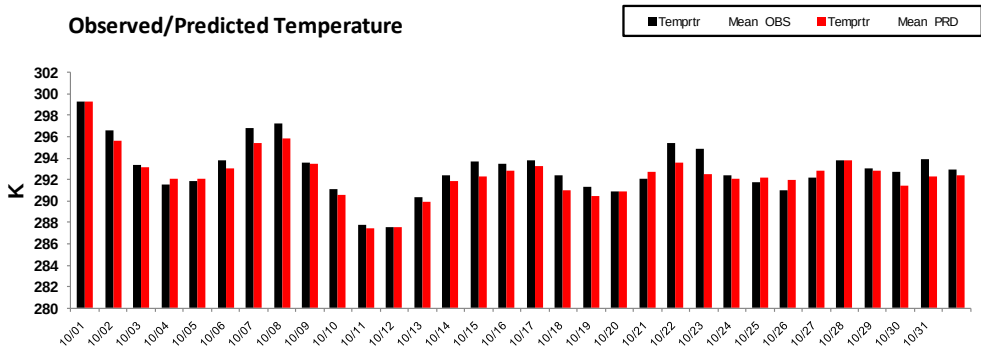


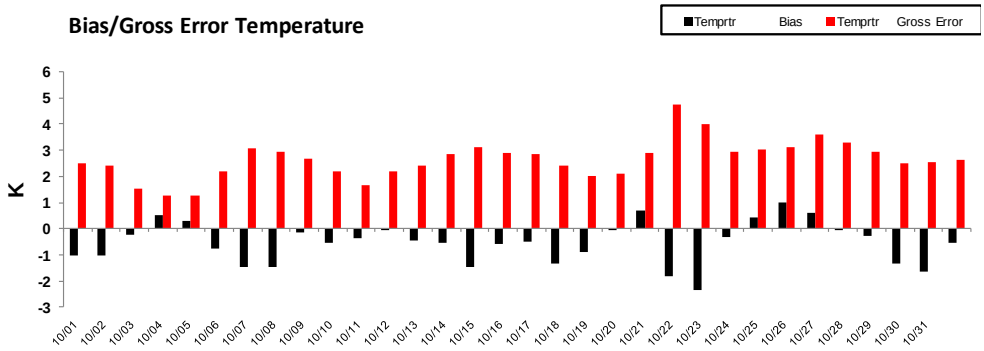


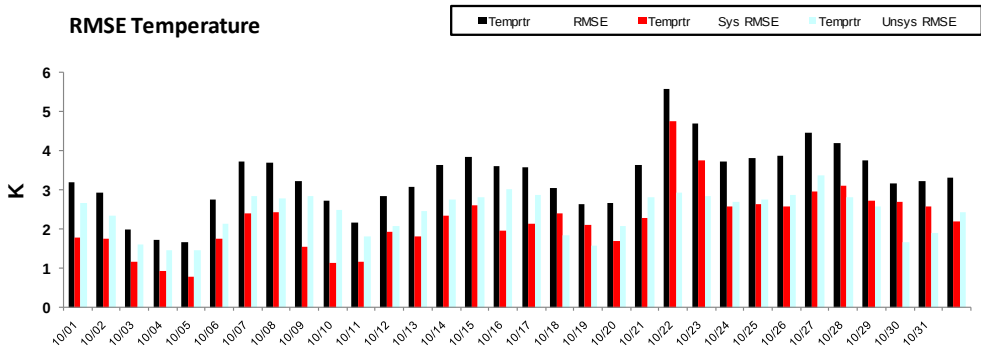
October Wind

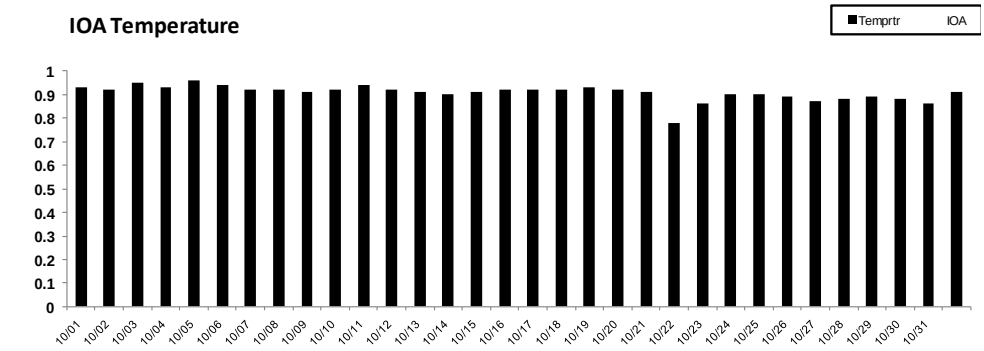


October Temperature

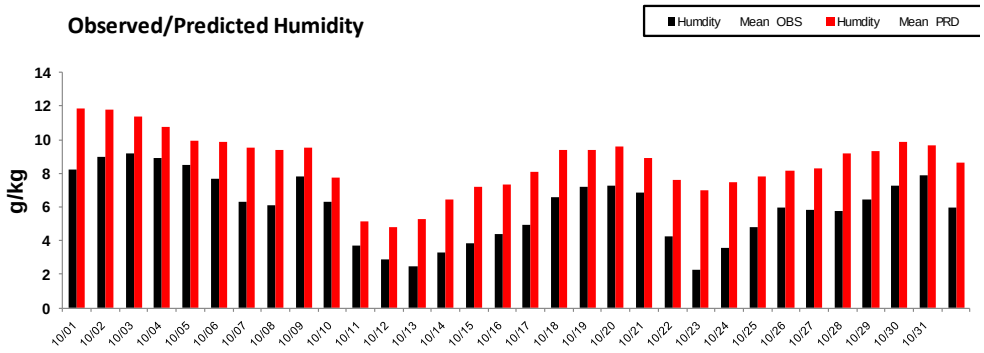


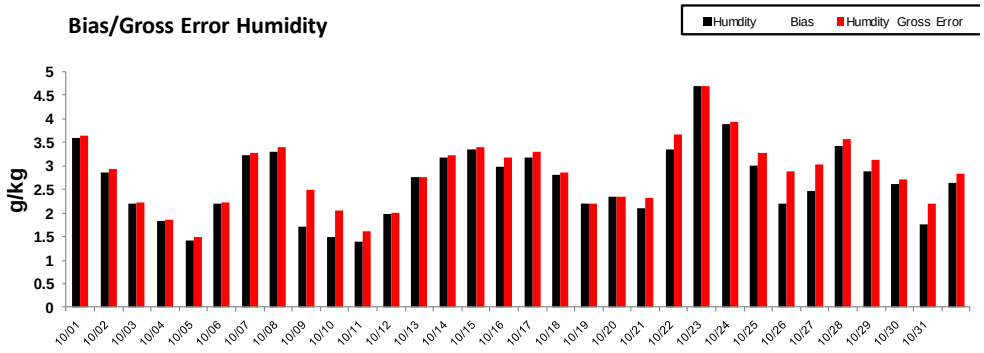


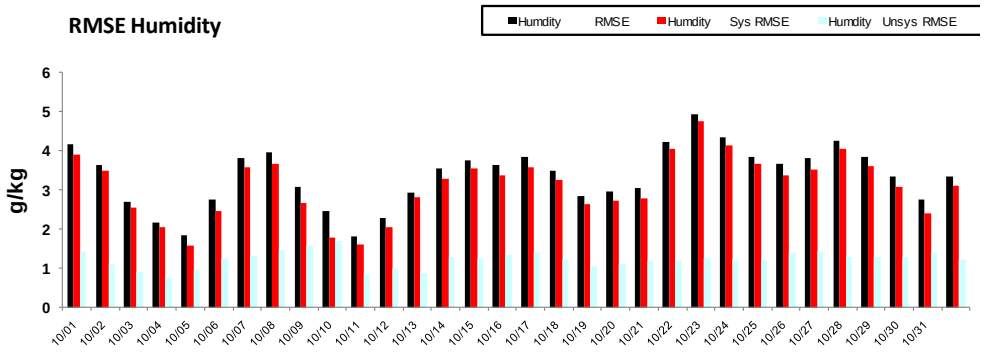


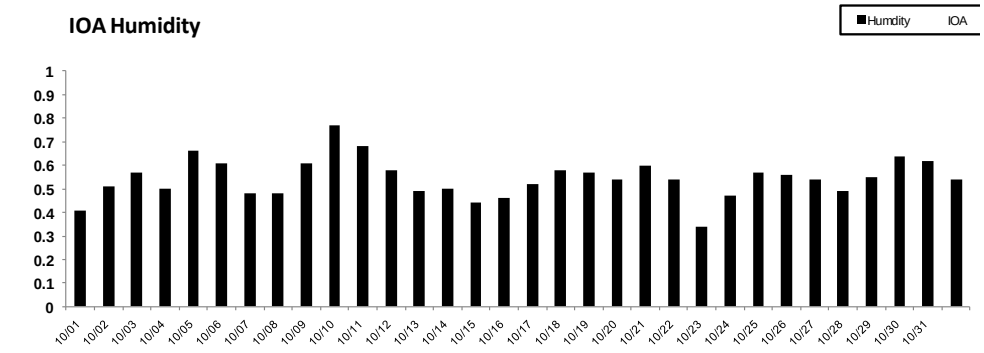


October Humidity

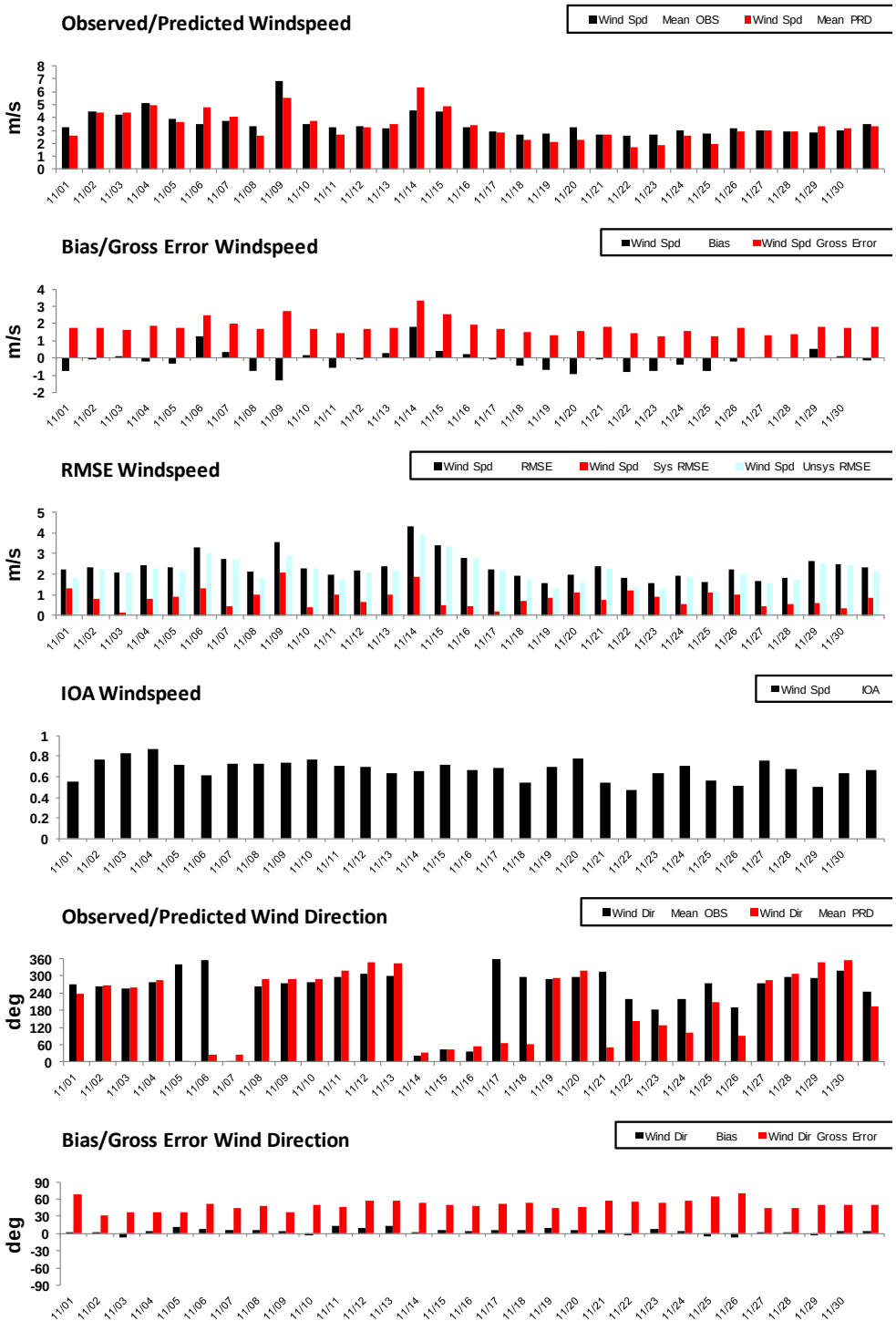




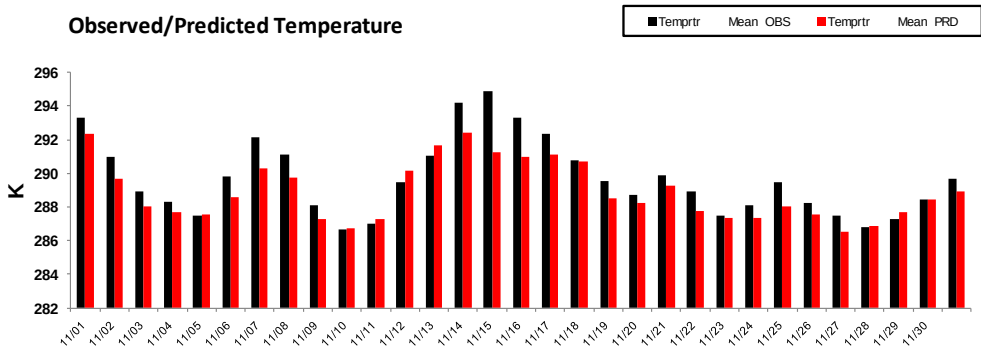


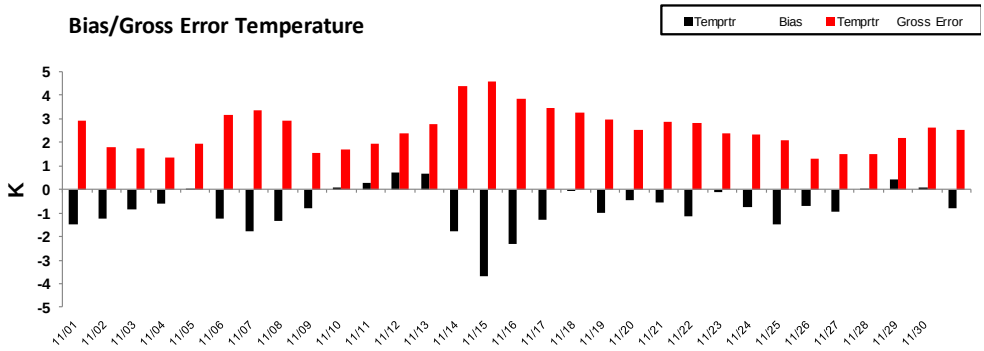


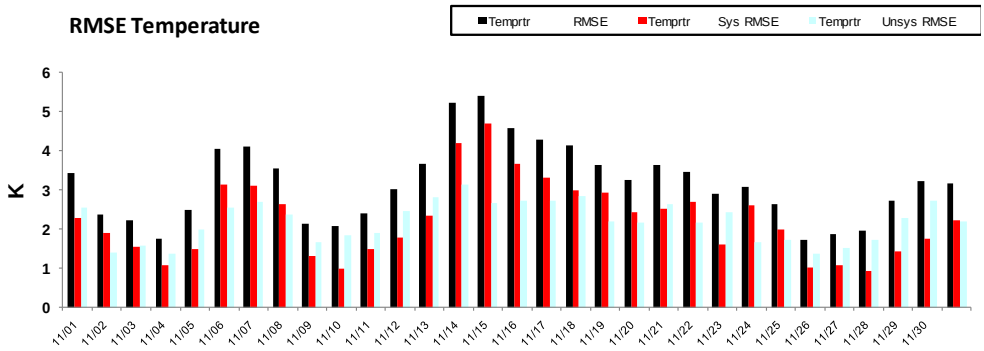
November Winds

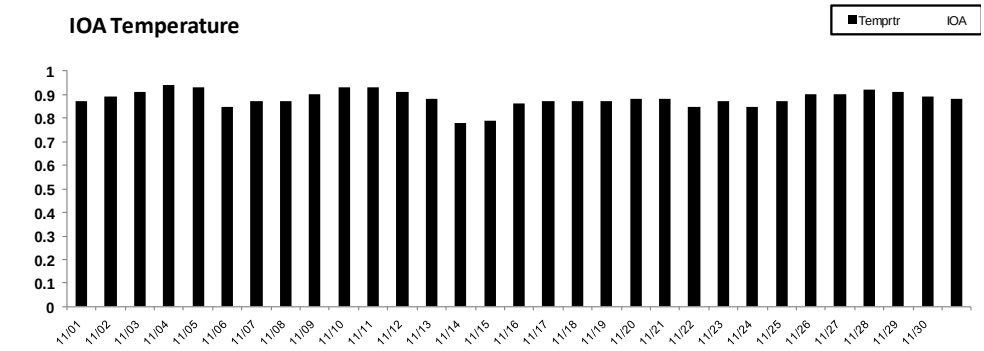


November Temperature

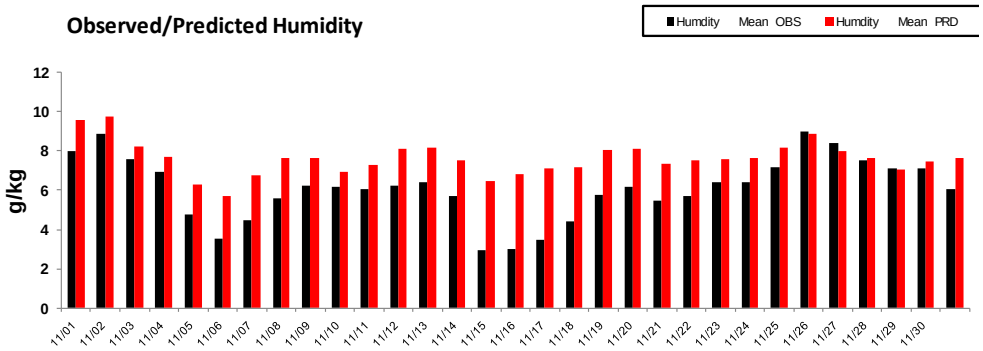


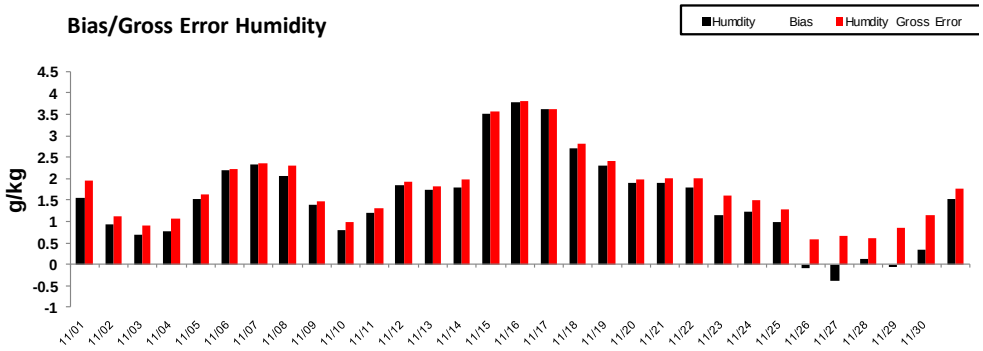


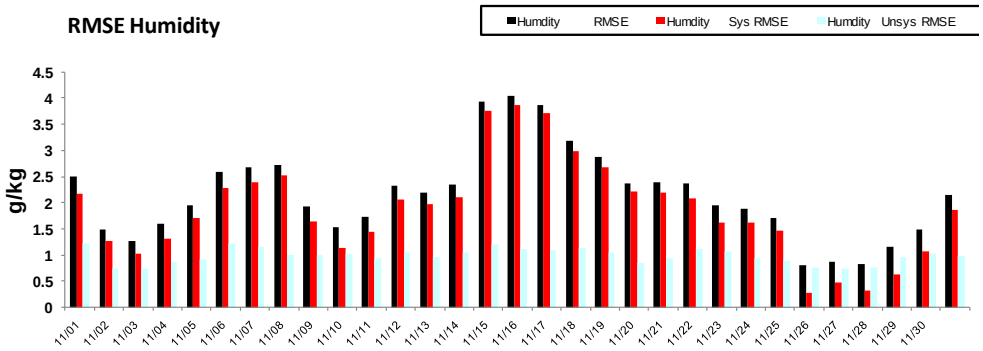


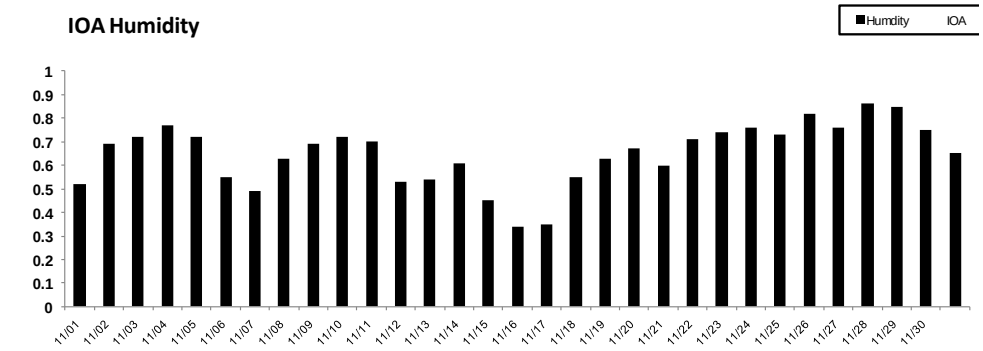


November Humidity

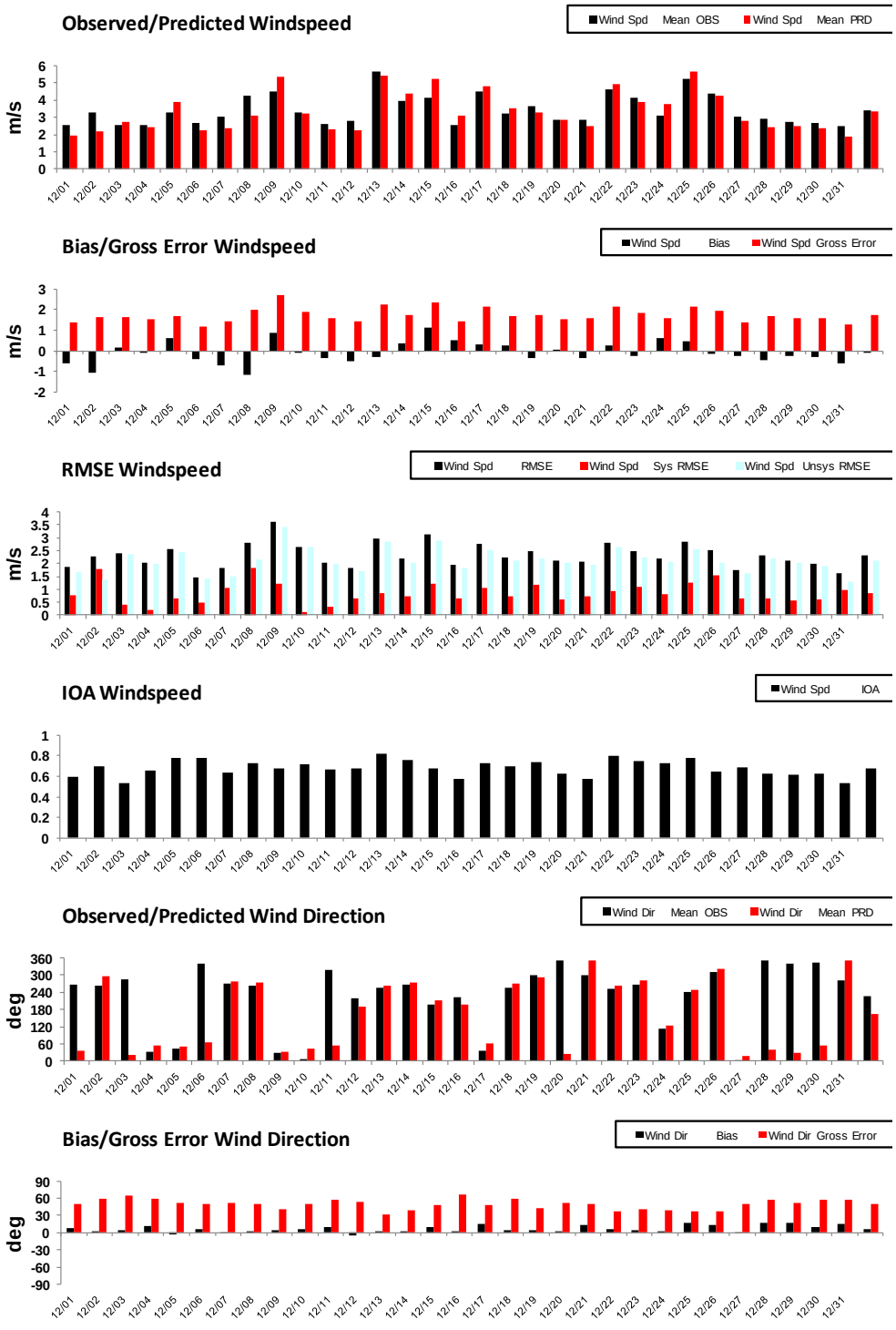




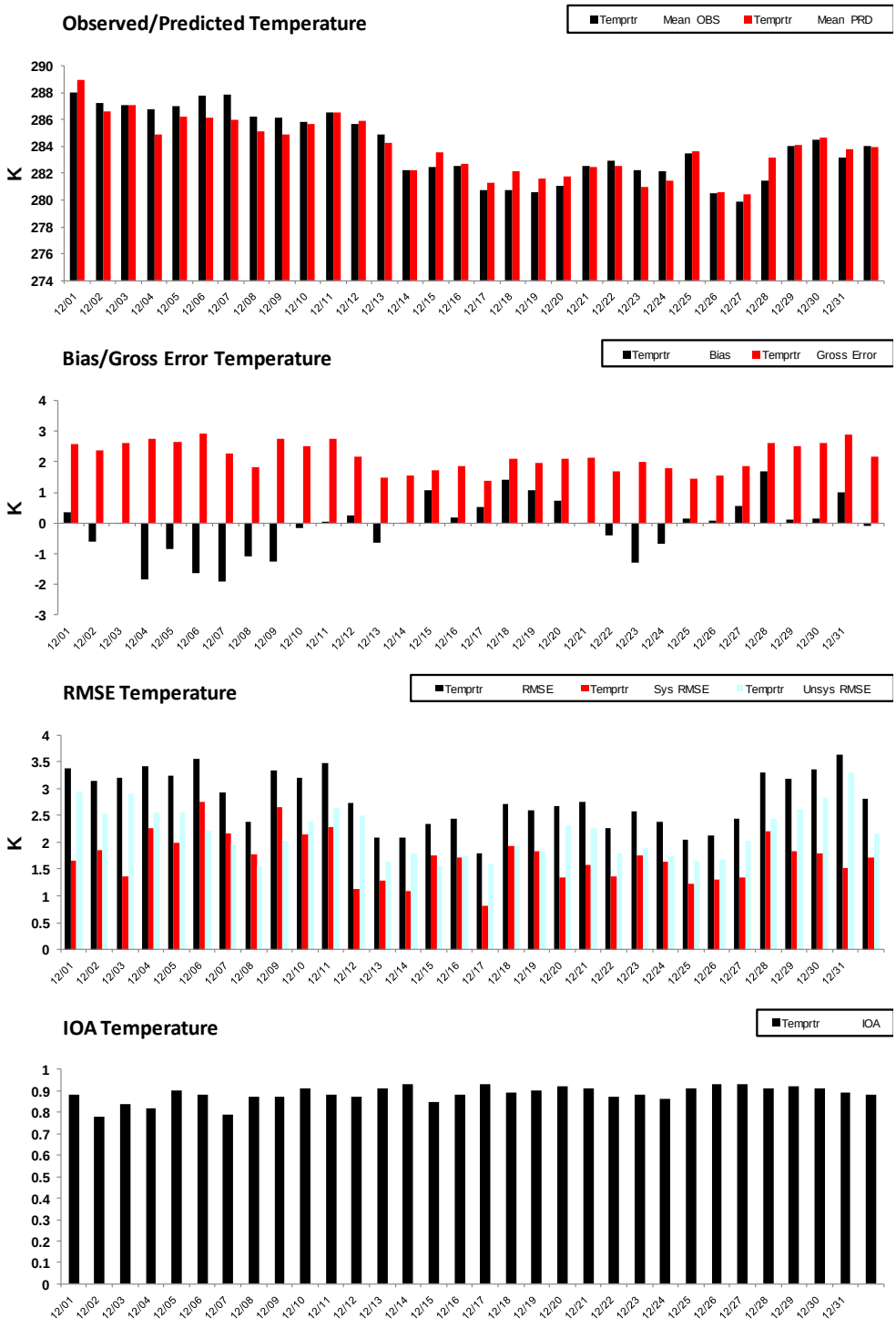




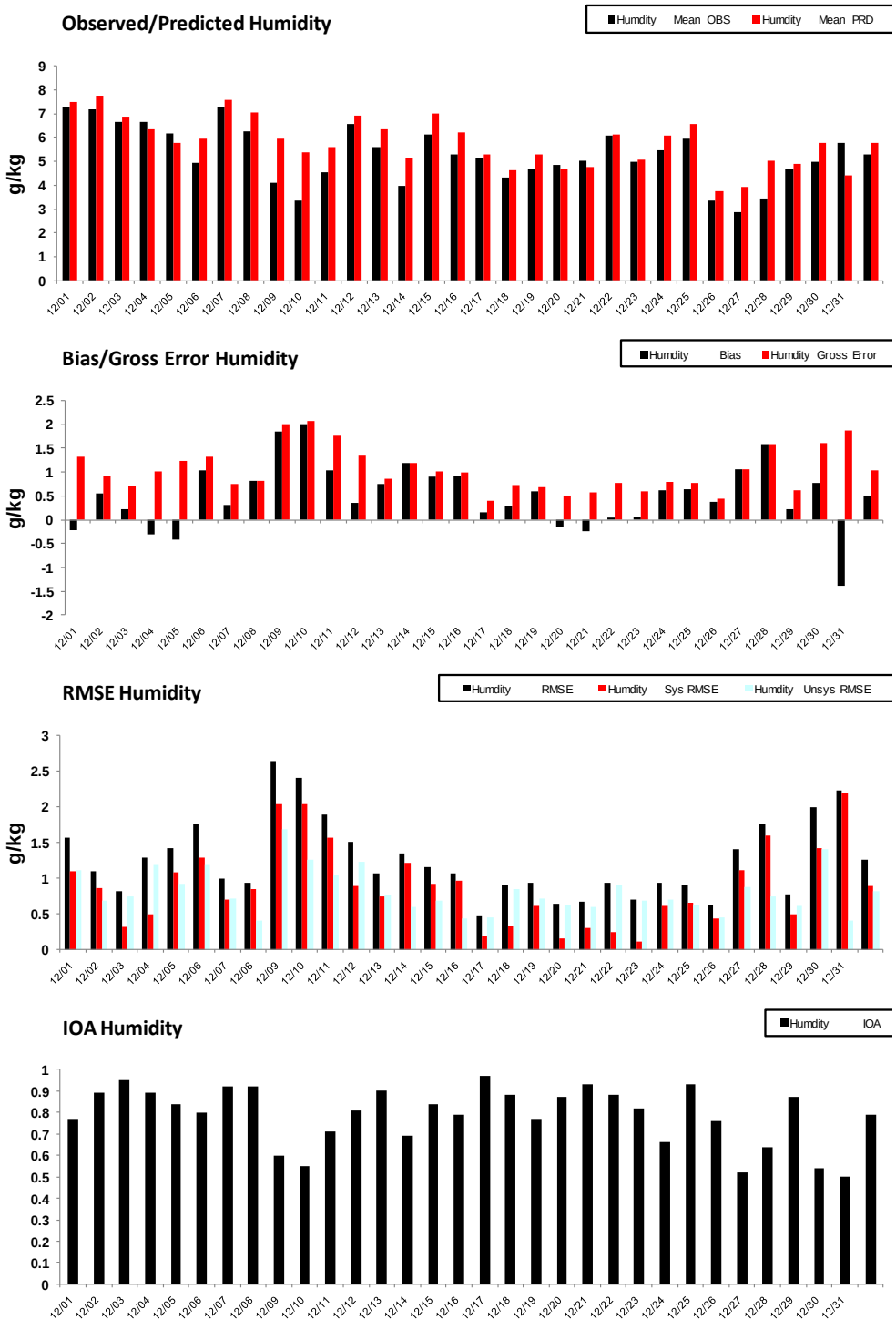
December Winds



December Temperature



December Humidity



Attachment 2

Quarterly CMAQ 24-Hour PM2.5 Model Performance

Quarter 1

(One Cell Analysis)

Mass	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	14.02	13.58	-0.73	3.49	-0.05	0.25
cela	16.44	24.50	7.17	7.33	0.44	0.45
lgbh	16.08	19.29	3.10	4.23	0.19	0.26
lbdt	18.76	20.11	1.54	4.32	0.08	0.23
font	16.60	13.37	-5.08	5.79	-0.31	0.35
rivr	16.43	13.65	-3.27	4.16	-0.20	0.25

OC	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	6.70	2.16	-4.54	4.54	-0.68	0.68
cela	7.69	4.72	-2.97	2.97	-0.39	0.39
lgbh	6.72	2.65	-4.07	4.07	-0.61	0.61
lbdt	6.93	2.87	-4.06	4.06	-0.59	0.59
font	6.16	1.53	-4.58	4.58	-0.74	0.74
rivr	6.84	1.52	-5.32	5.32	-0.78	0.78

EC	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	2.31	1.19	-1.12	1.17	-0.48	0.51
cela	2.82	2.47	-0.35	0.69	-0.12	0.25
lgbh	2.64	1.68	-0.96	1.12	-0.36	0.43
lbdt	2.95	1.96	-0.99	1.17	-0.34	0.40
font	2.60	1.00	-1.56	1.57	-0.60	0.60
rivr	2.34	0.93	-1.42	1.45	-0.60	0.62

NH4	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	1.26	1.54	0.28	0.45	0.22	0.36
cela	1.25	2.35	1.10	1.10	0.88	0.88
lgbh	1.56	2.36	0.80	1.26	0.51	0.81
lbdt	1.42	2.36	1.04	1.11	0.73	0.78
font	1.98	1.73	-0.09	0.54	-0.04	0.27
rivr	1.79	1.88	0.09	0.54	0.05	0.30

NO3	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	3.72	3.18	-0.37	1.06	-0.10	0.29
cela	3.53	5.07	1.54	1.80	0.43	0.51
lgbh	4.49	3.72	-0.77	2.00	-0.17	0.44
lbdt	3.53	3.40	0.00	1.24	0.00	0.35
font	5.55	4.76	-0.29	1.72	-0.05	0.31
rivr	5.55	5.07	-0.48	1.93	-0.09	0.35

SO4	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	1.75	1.41	-0.28	0.50	-0.16	0.29
cela	1.77	2.02	0.25	0.45	0.14	0.26
lgbh	1.99	3.18	1.19	1.38	0.60	0.69
lbdt	2.22	3.49	1.43	1.55	0.64	0.70
font	1.45	0.87	-0.53	0.56	-0.37	0.39
rivr	1.31	0.97	-0.34	0.58	-0.26	0.44

Quarter 2

(One Cell Analysis)

Mass	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	13.76	11.01	-2.41	3.27	-0.18	0.24
cela	15.09	18.94	4.32	4.67	0.29	0.31
lgbh	14.12	15.13	1.68	3.78	0.12	0.27
lbdt	15.45	16.15	2.20	3.77	0.14	0.24
font	14.99	11.73	-3.69	5.57	-0.25	0.37
rivr	16.88	11.10	-5.96	6.79	-0.35	0.40

OC	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	4.34	1.42	-2.91	2.91	-0.67	0.67
cela	6.74	3.31	-3.43	3.43	-0.51	0.51
lgbh	4.47	1.70	-2.77	2.77	-0.62	0.62
lbdt	4.46	2.01	-2.41	2.41	-0.54	0.54
font	6.92	1.19	-5.74	5.74	-0.83	0.83
rivr	6.43	1.10	-5.33	5.33	-0.83	0.83

EC	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	1.02	0.86	-0.17	0.38	-0.16	0.37
cela	1.97	1.72	-0.25	0.57	-0.13	0.29
lgbh	1.21	1.15	-0.05	0.42	-0.04	0.35
lbdt	1.44	1.39	0.00	0.57	0.00	0.40
font	2.13	0.92	-1.21	1.21	-0.57	0.57
rivr	1.62	0.74	-0.88	0.90	-0.54	0.56

NH4	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	1.05	1.22	0.17	0.37	0.16	0.35
cela	1.50	1.76	0.26	0.59	0.17	0.39
lgbh	1.09	1.90	0.81	0.83	0.75	0.76
lbdt	1.31	1.93	0.68	0.82	0.52	0.62
font	1.85	1.41	-0.44	0.95	-0.24	0.52
rivr	2.03	1.48	-0.55	0.99	-0.27	0.49

NO3	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	1.94	2.28	0.34	0.98	0.18	0.51
cela	2.63	3.61	0.99	1.44	0.38	0.55
lgbh	2.17	2.26	0.01	0.44	0.01	0.20
lbdt	2.80	1.87	-0.87	1.17	-0.31	0.42
font	3.61	3.35	-0.26	2.03	-0.07	0.56
rivr	4.03	3.60	-0.43	1.67	-0.11	0.41

SO4	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	2.30	1.47	-0.82	1.37	-0.36	0.59
cela	2.56	1.80	-0.76	0.88	-0.30	0.35
lgbh	2.81	3.41	0.72	1.18	0.26	0.42
lbdt	3.19	3.87	0.82	1.36	0.26	0.43
font	2.56	1.11	-1.45	1.45	-0.57	0.57
rivr	2.54	1.08	-1.46	1.46	-0.58	0.58

Quarter 3

(One Cell Analysis)

Mass	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	15.23	15.15	1.05	5.68	0.07	0.37
cela	20.01	25.04	5.03	8.36	0.25	0.42
lgbh	15.30	18.40	3.07	4.32	0.20	0.28
lbdt	16.87	19.86	3.03	5.74	0.18	0.34
font	21.17	17.66	-2.65	6.21	-0.13	0.29
rivr	19.30	19.85	0.51	6.82	0.03	0.35

OC	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	5.28	1.51	-3.62	3.62	-0.69	0.69
cela	6.76	3.97	-2.72	2.72	-0.40	0.40
lgbh	5.73	1.83	-3.84	3.84	-0.67	0.67
lbdt	5.03	2.13	-2.90	2.90	-0.58	0.58
font	9.73	1.60	-8.17	8.17	-0.84	0.84
rivr	7.22	1.43	-5.82	6.03	-0.81	0.84

EC	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	1.07	0.90	-0.06	0.21	-0.05	0.20
cela	1.81	1.92	0.12	0.54	0.07	0.30
lgbh	1.72	1.29	-0.41	0.65	-0.24	0.38
lbdt	1.82	1.52	-0.30	0.64	-0.16	0.35
font	2.45	1.28	-1.19	1.19	-0.49	0.49
rivr	1.77	0.95	-0.83	0.97	-0.47	0.55

NH4	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	2.00	2.20	0.28	0.60	0.14	0.30
cela	2.40	2.80	0.40	0.84	0.17	0.35
lgbh	2.14	2.54	0.40	0.79	0.19	0.37
lbdt	1.97	2.60	0.64	0.93	0.33	0.48
font	2.11	2.31	0.38	0.64	0.18	0.30
rivr	2.85	3.17	0.31	1.24	0.11	0.43

NO3	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	2.79	4.12	1.52	1.93	0.54	0.69
cela	2.98	5.19	2.23	2.55	0.75	0.86
lgbh	2.09	2.14	0.15	0.78	0.07	0.38
lbdt	1.70	1.84	0.09	1.04	0.05	0.61
font	4.46	5.46	1.70	2.80	0.38	0.63
rivr	5.38	8.36	2.78	4.00	0.52	0.74

SO4	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	3.86	2.58	-1.19	1.30	-0.31	0.34
cela	4.26	3.21	-1.07	1.58	-0.25	0.37
lgbh	4.14	5.39	1.37	1.52	0.33	0.37
lbdt	4.67	6.11	1.40	1.70	0.30	0.36
font	4.03	1.91	-1.84	1.84	-0.46	0.46
rivr	3.76	1.81	-1.94	1.94	-0.52	0.52

Quarter 4

(One Cell Analysis)

Mass	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	17.30	18.34	-0.19	5.09	-0.01	0.29
cela	18.71	26.56	7.85	10.53	0.42	0.56
lgbh	19.13	23.18	6.47	6.54	0.34	0.34
lbdt	19.86	25.17	8.66	8.66	0.44	0.44
font	12.87	11.39	-2.92	5.39	-0.23	0.42
rivr	20.05	13.57	-5.69	7.16	-0.28	0.36

OC	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	6.70	3.00	-3.87	3.87	-0.58	0.58
cela	7.39	5.52	-1.86	2.00	-0.25	0.27
lgbh	6.63	3.00	-3.52	3.54	-0.53	0.53
lbdt	6.87	3.41	-3.27	3.46	-0.48	0.50
font	5.57	1.62	-4.14	4.14	-0.74	0.74
rivr	6.92	1.84	-4.97	4.97	-0.72	0.72

EC	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	2.35	1.64	-0.79	1.01	-0.33	0.43
cela	2.89	2.91	0.02	0.60	0.01	0.21
lgbh	2.65	2.02	-0.56	1.13	-0.21	0.43
lbdt	2.99	2.41	-0.51	1.30	-0.17	0.43
font	1.59	1.04	-0.70	0.80	-0.44	0.50
rivr	2.70	1.12	-1.51	1.55	-0.56	0.57

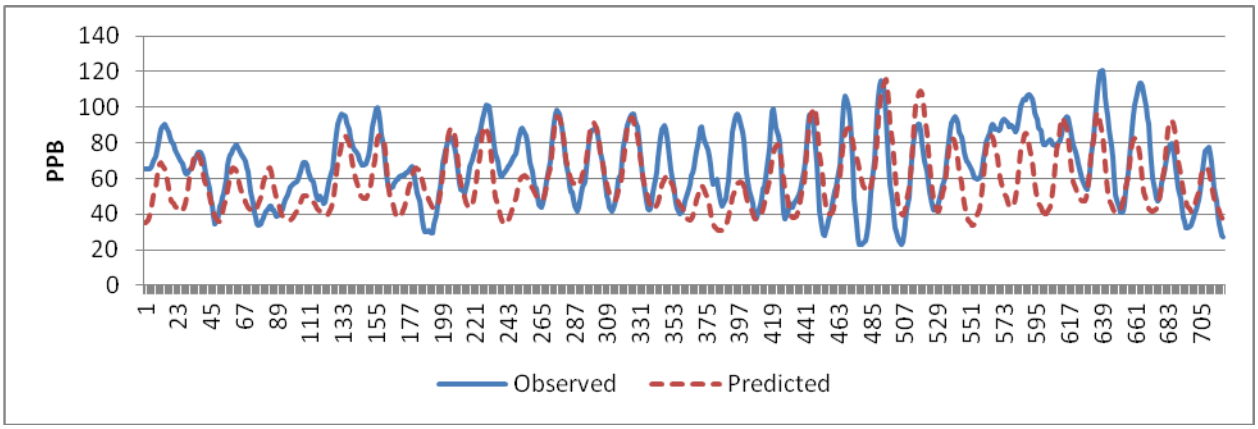
NH4	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	1.36	2.02	0.30	0.75	0.22	0.55
cela	1.93	2.20	0.28	1.22	0.14	0.63
lgbh	1.85	2.95	1.26	1.34	0.68	0.72
lbdt	2.02	3.08	1.34	1.62	0.66	0.80
font	1.50	1.18	-0.45	0.81	-0.30	0.54
rivr	2.29	1.59	-0.60	1.12	-0.26	0.49

NO3	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	3.05	3.89	0.38	1.53	0.13	0.50
cela	3.87	4.47	0.60	2.49	0.15	0.64
lgbh	3.27	3.99	0.98	1.65	0.30	0.50
lbdt	3.37	3.76	0.94	1.79	0.28	0.53
font	3.81	2.80	-1.27	2.10	-0.33	0.55
rivr	5.78	3.71	-1.73	2.81	-0.30	0.49

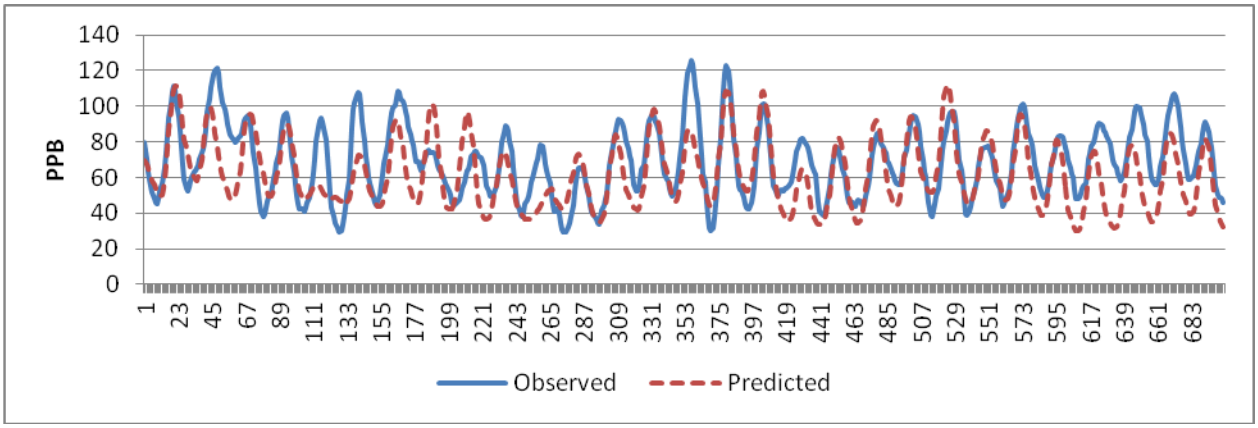
SO4	Mean_Obs	Mean_CMAQ	Mean_Bias	Mean_Err	NormMeanBias	NormMeanErr
anah	1.94	2.14	-0.40	0.86	-0.20	0.44
cela	2.33	2.13	-0.19	1.14	-0.08	0.49
lgbh	2.70	4.45	1.96	2.21	0.73	0.82
lbdt	3.09	5.08	2.33	2.46	0.75	0.80
font	0.98	0.91	-0.26	0.35	-0.27	0.36
rivr	1.76	1.20	-0.46	0.82	-0.26	0.47

Attachment 3

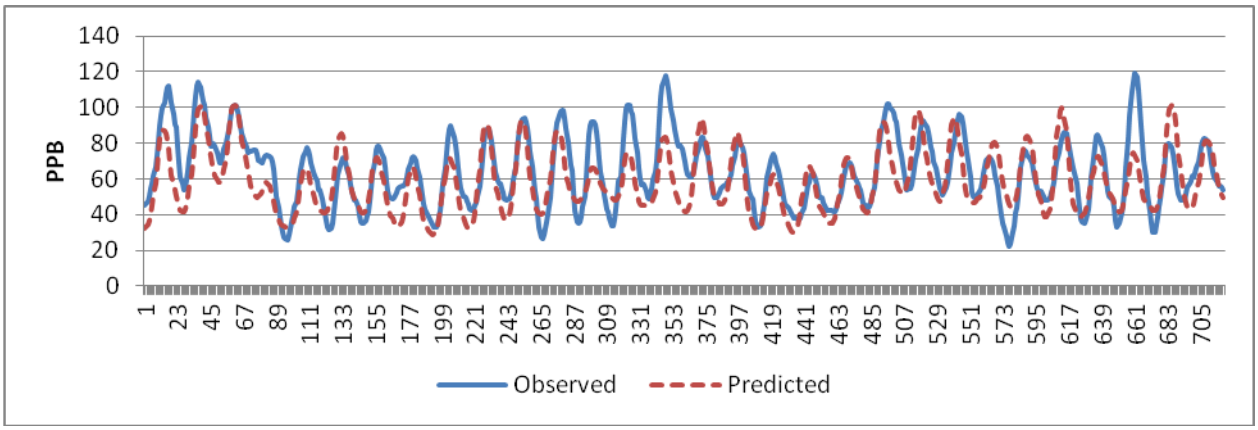
Time Series of Observed Vs.Predicted 8-Hour Ozone



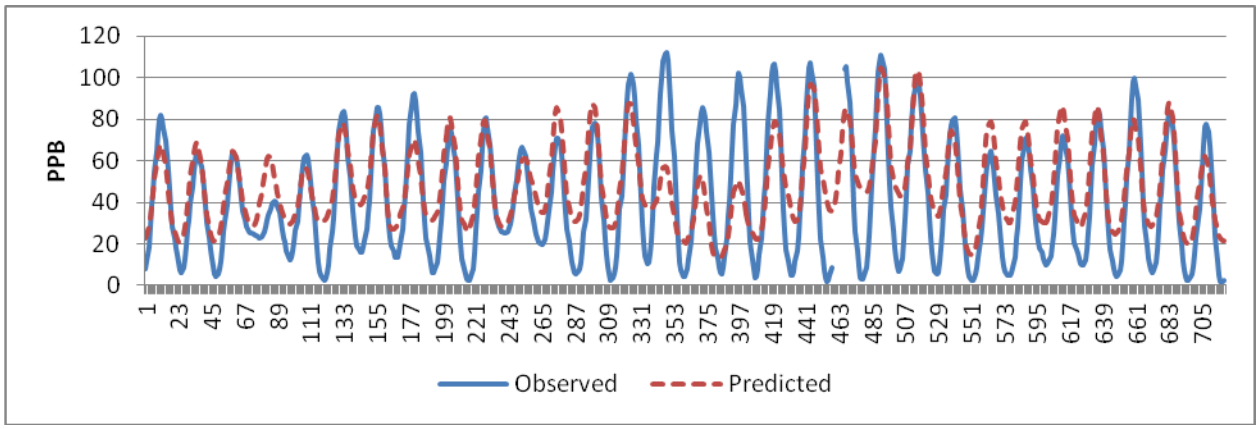
Time Series of Observed Vs.Predicted 8-Hour Crestline Ozone: June, 2008



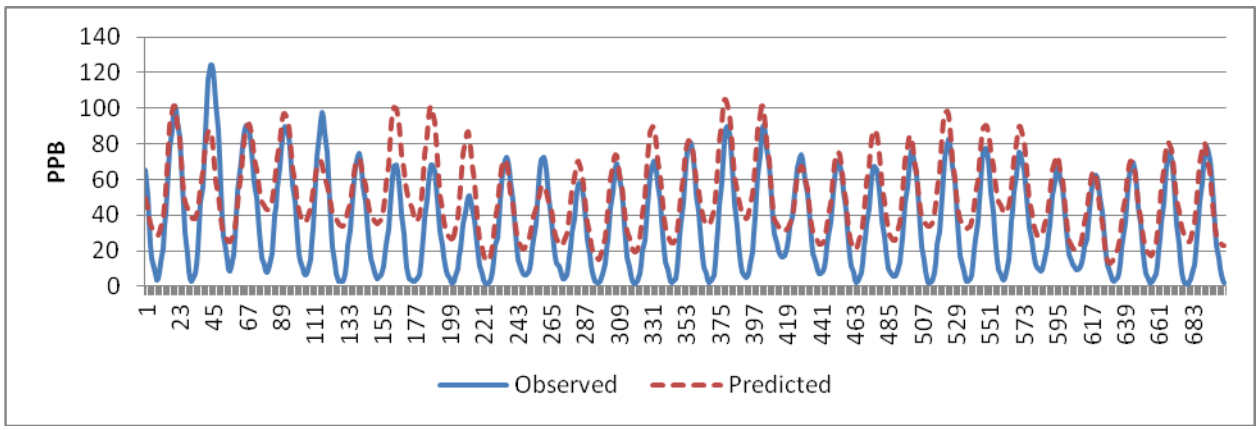
Time Series of Observed Vs.Predicted 8-Hour Crestline Ozone: July, 2008



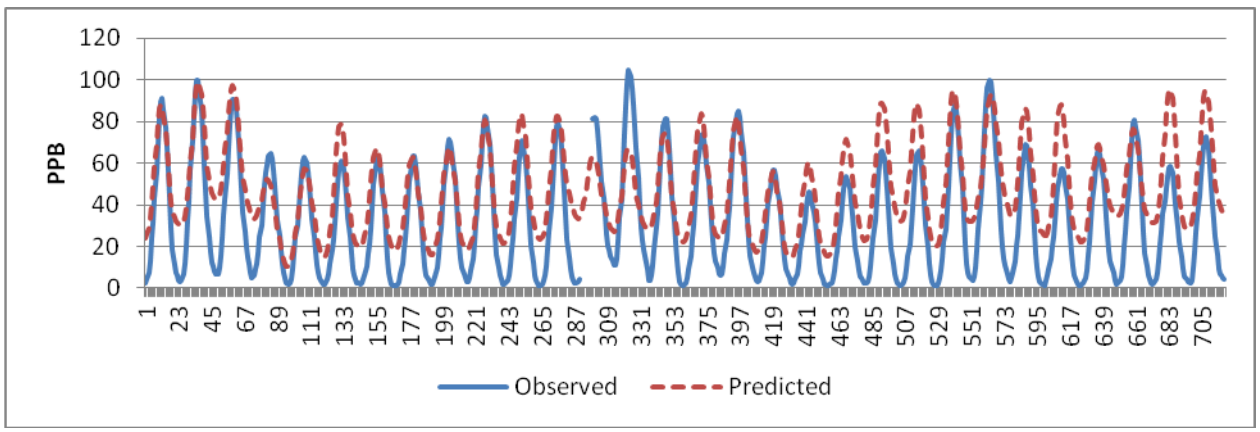
Time Series of Observed Vs.Predicted 8-Hour Crestline Ozone: August, 2008



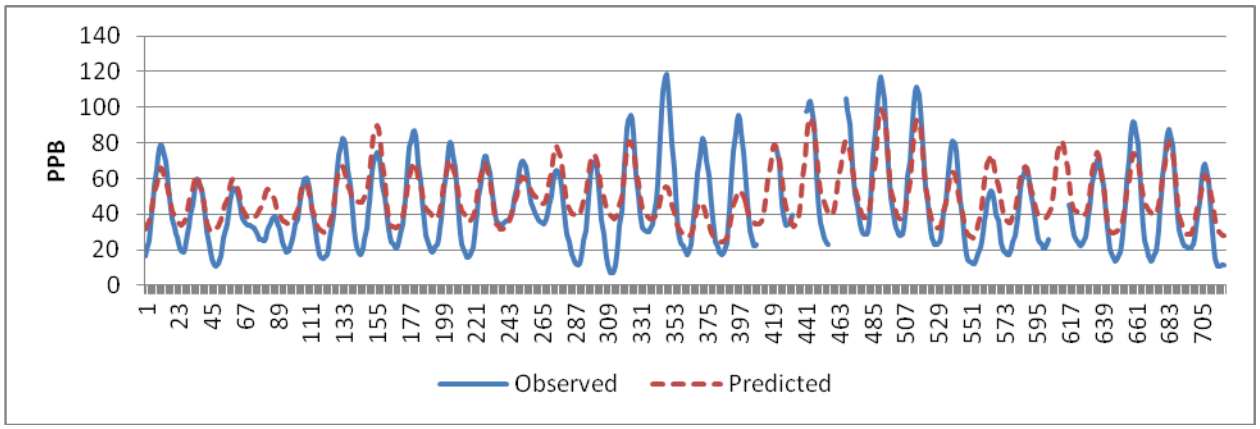
Time Series of Observed Vs.Predicted 8-Hour Fontana Ozone: June, 2008



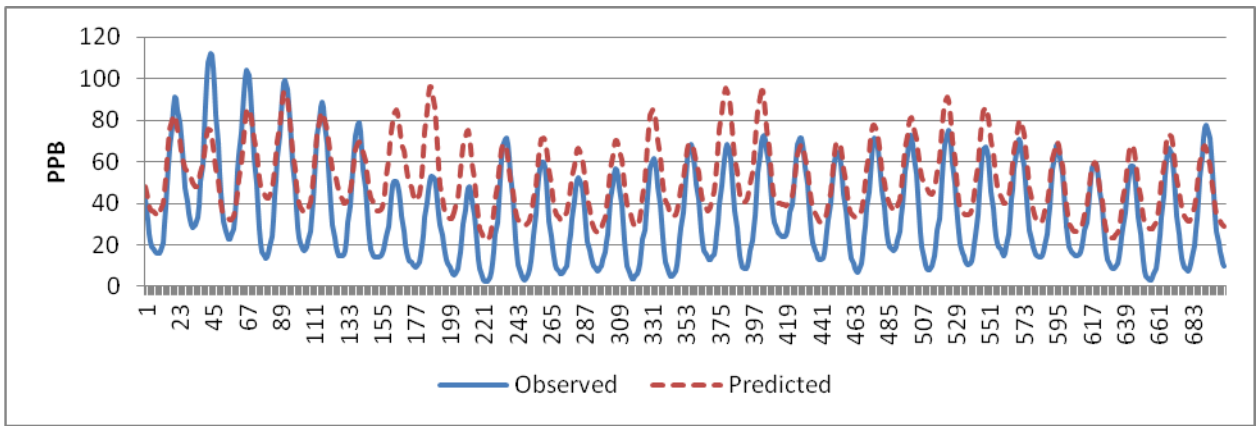
Time Series of Observed Vs.Predicted 8-Hour Fontana Ozone: July, 2008



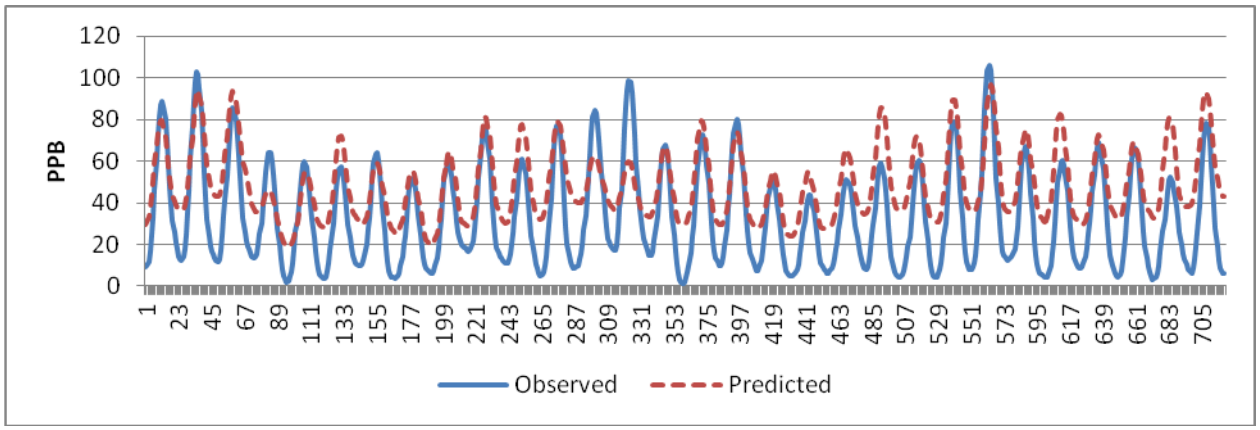
Time Series of Observed Vs.Predicted 8-Hour Fontana Ozone: August, 2008



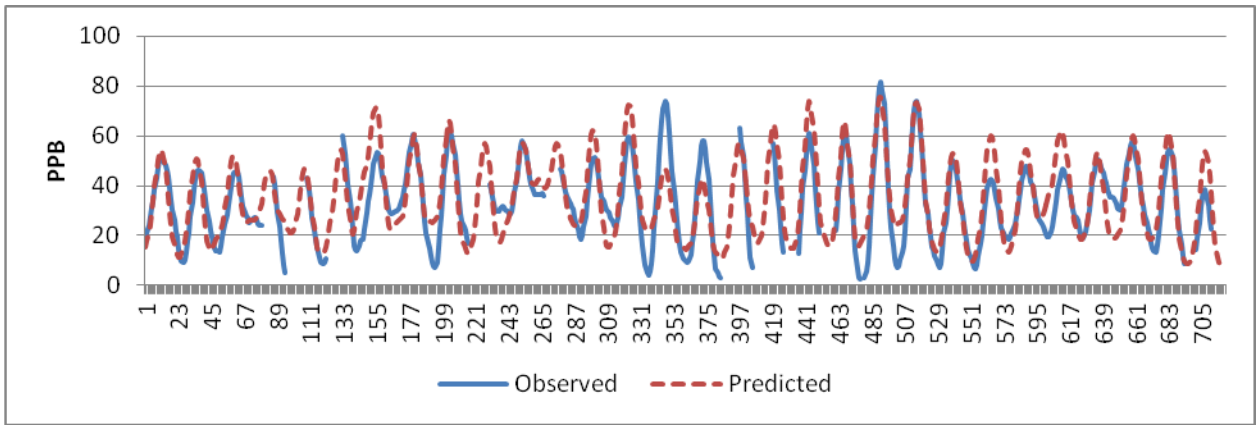
Time Series of Observed Vs.Predicted 8-Hour Glendora Ozone: June, 2008



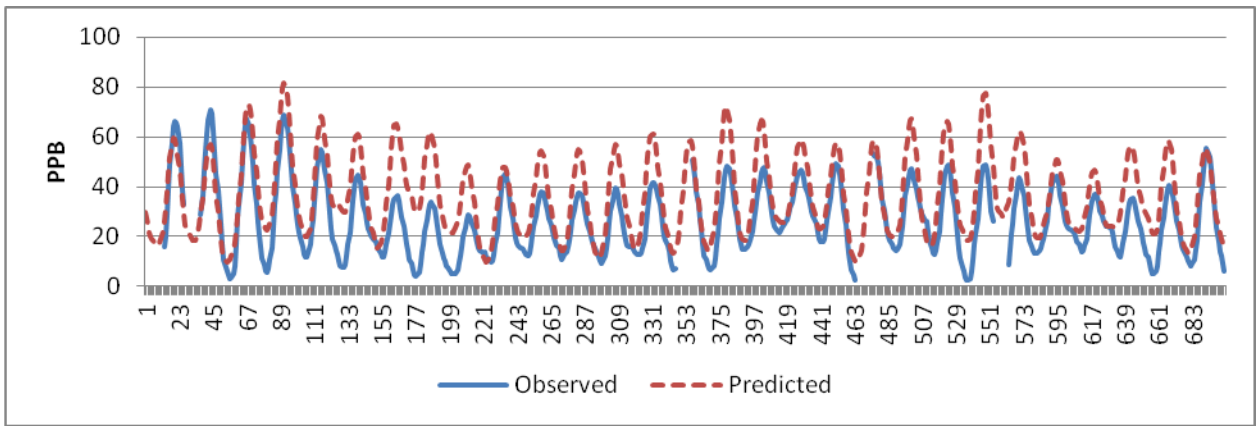
Time Series of Observed Vs.Predicted 8-Hour Glendora Ozone: July, 2008



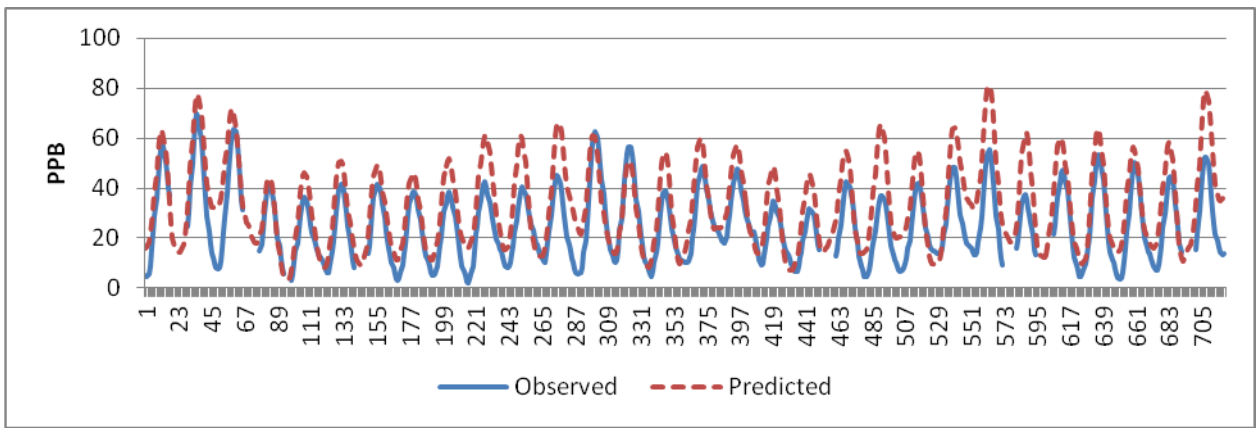
Time Series of Observed Vs.Predicted 8-Hour Glendora Ozone: August, 2008



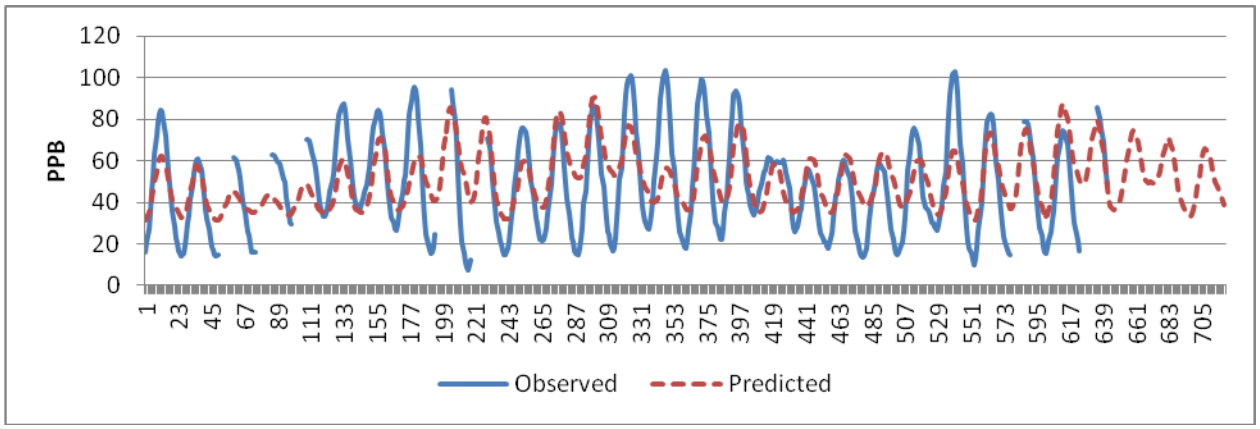
Time Series of Observed Vs.Predicted 8-Hour Los Angeles Ozone: June, 2008



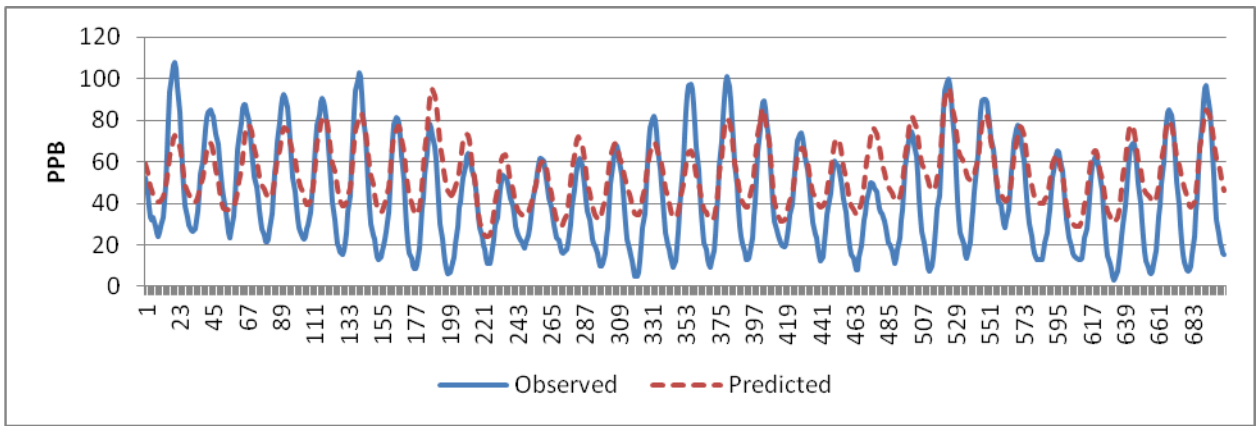
Time Series of Observed Vs.Predicted 8-Hour Los Angeles Ozone: July, 2008



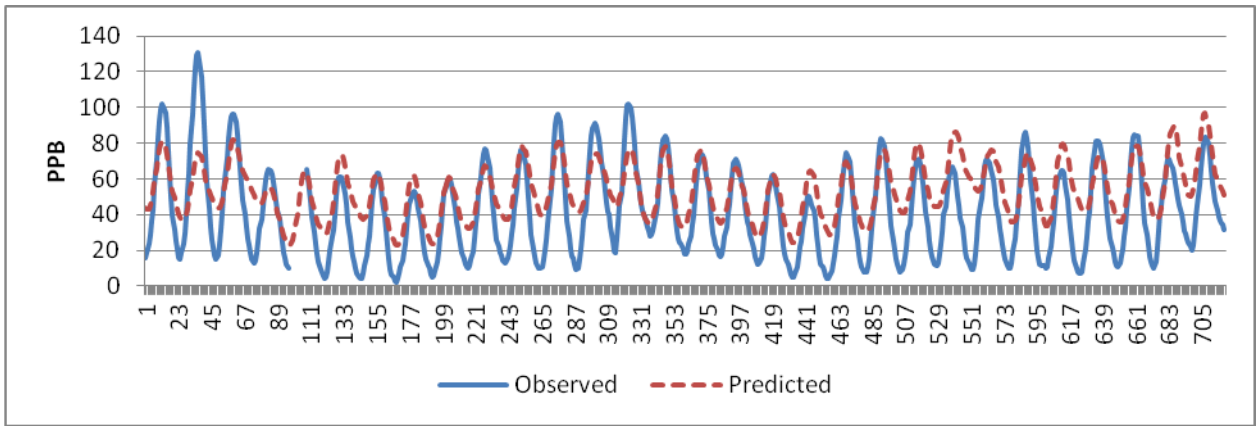
Time Series of Observed Vs.Predicted 8-Hour Los Angeles Ozone: August, 2008



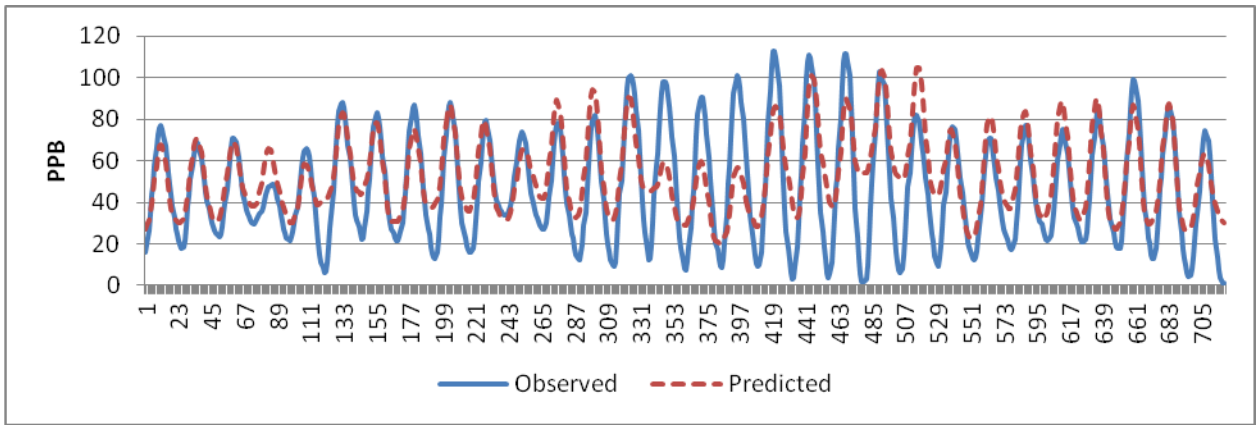
Time Series of Observed Vs.Predicted 8-Hour Santa Clarita Ozone: June, 2008



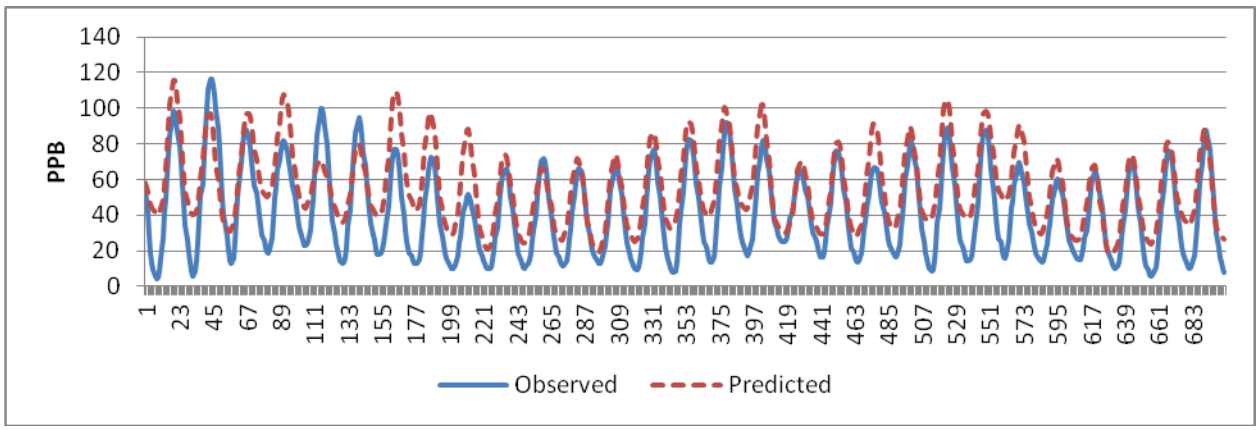
Time Series of Observed Vs.Predicted 8-Hour Santa Clarita Ozone: July, 2008



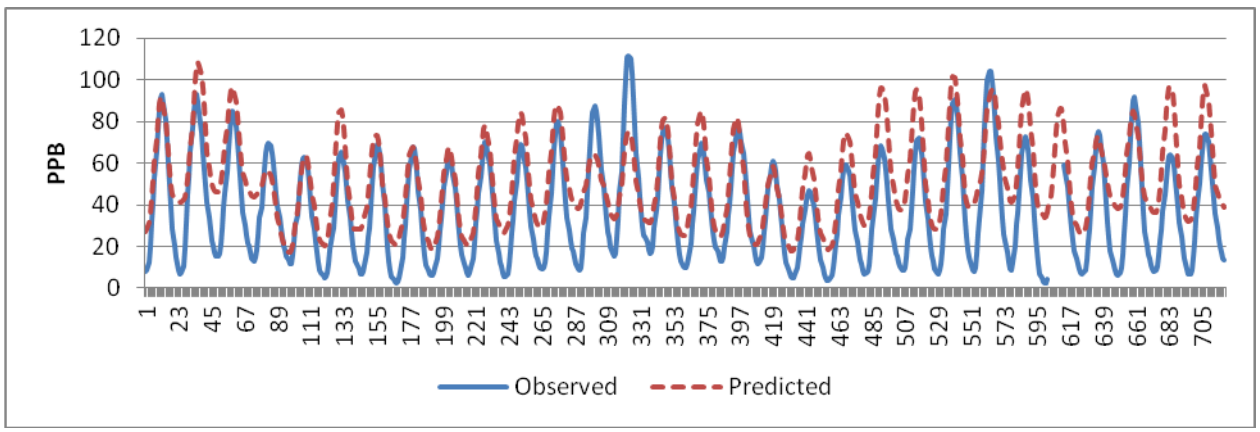
Time Series of Observed Vs.Predicted 8-Hour Santa Clarita Ozone: August, 2008



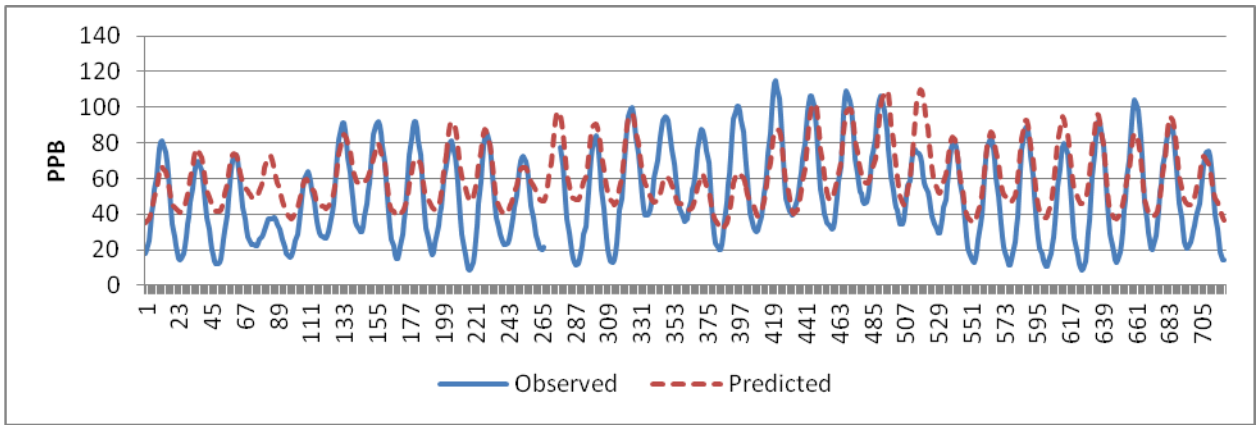
Time Series of Observed Vs.Predicted 8-Hour Rubidoux Ozone: June, 2008



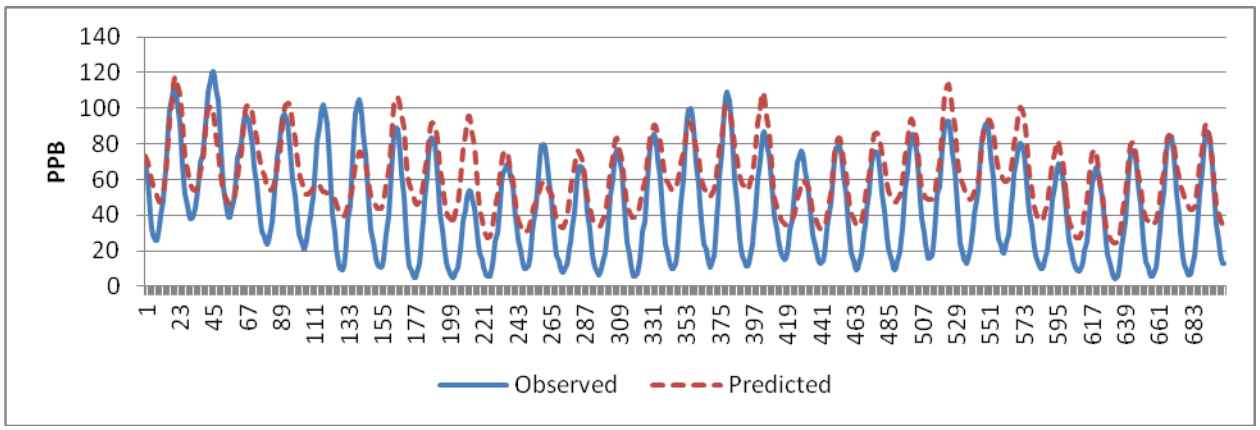
Time Series of Observed Vs.Predicted 8-Hour Rubidoux Ozone: July, 2008



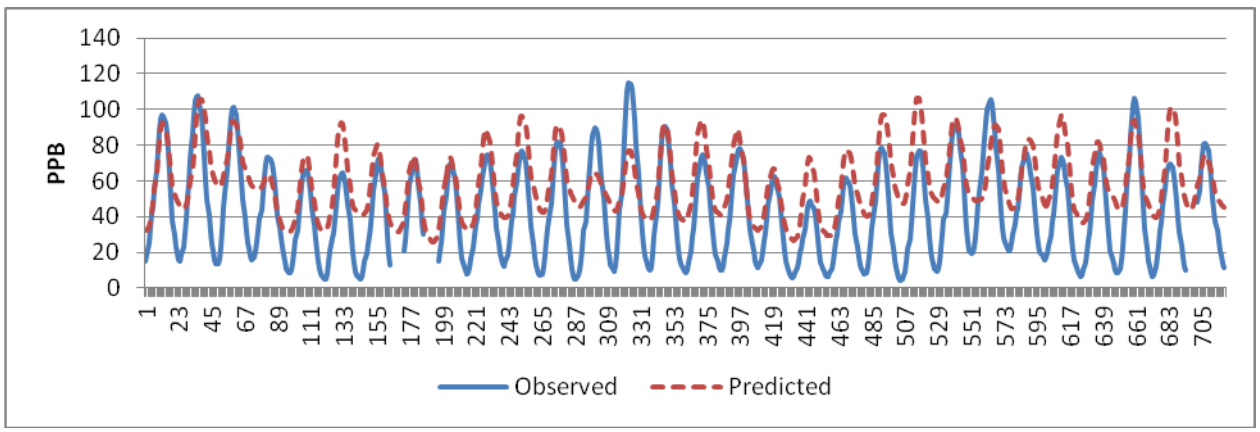
Time Series of Observed Vs.Predicted 8-Hour Rubidoux Ozone: August, 2008



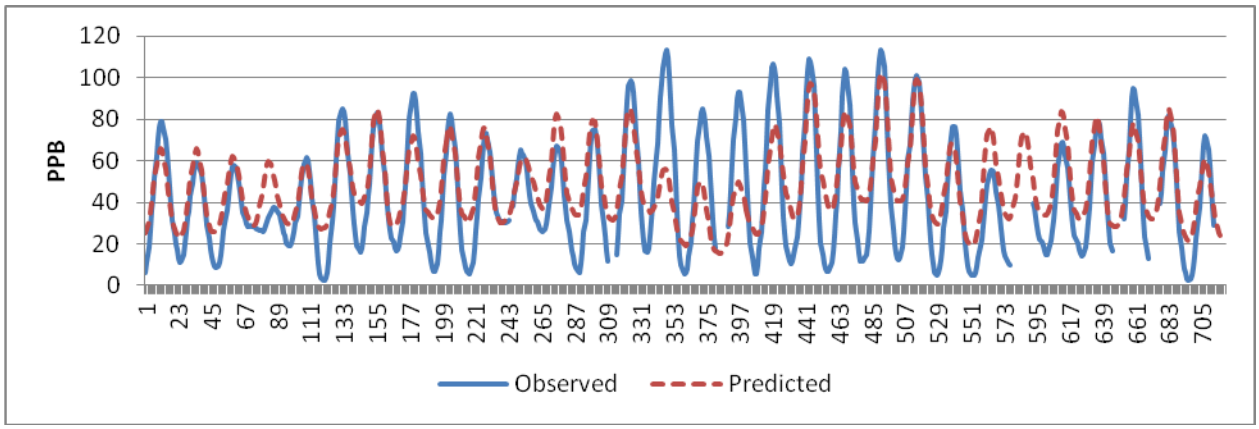
Time Series of Observed Vs.Predicted 8-Hour Redlands Ozone: June, 2008



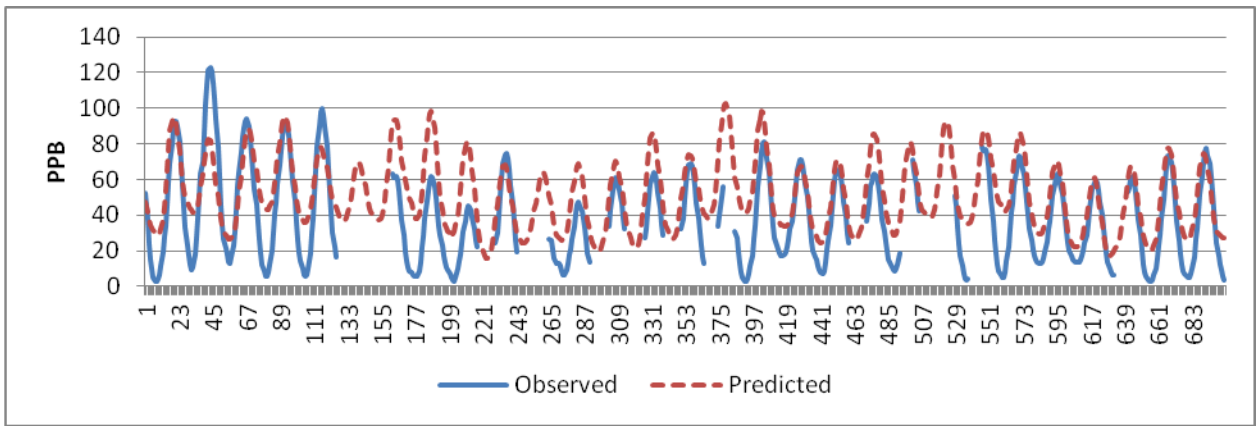
Time Series of Observed Vs.Predicted 8-Hour Redlands Ozone: July, 2008



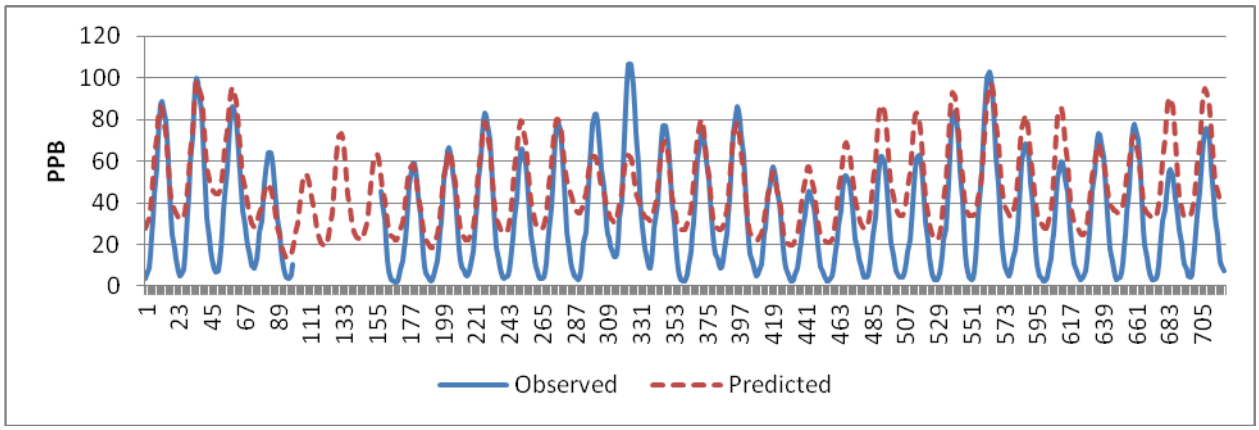
Time Series of Observed Vs.Predicted 8-Hour Redlands Ozone: August, 2008



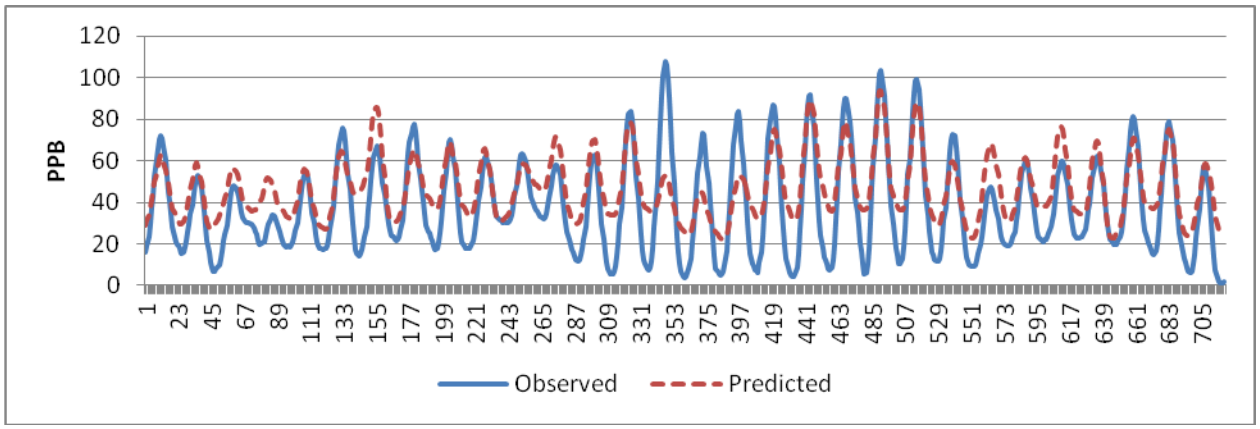
Time Series of Observed Vs.Predicted 8-Hour Upland Ozone: June, 2008



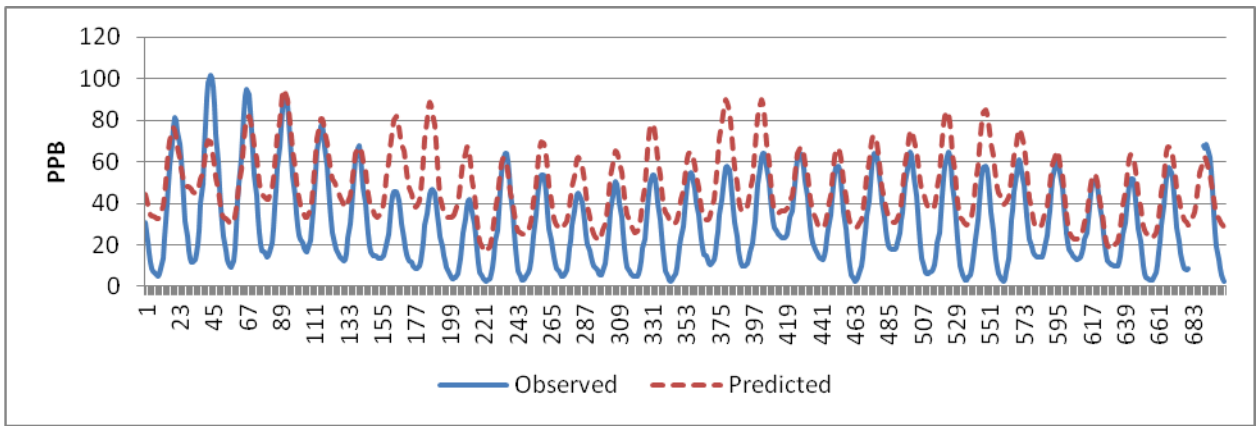
Time Series of Observed Vs.Predicted 8-Hour Upland Ozone: July, 2008



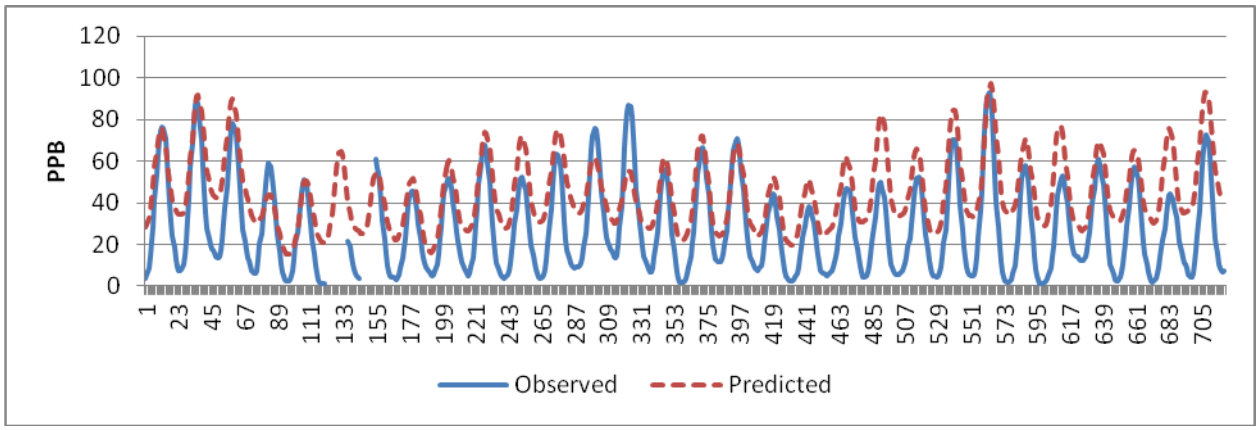
Time Series of Observed Vs.Predicted 8-Hour Upland Ozone: August, 2008



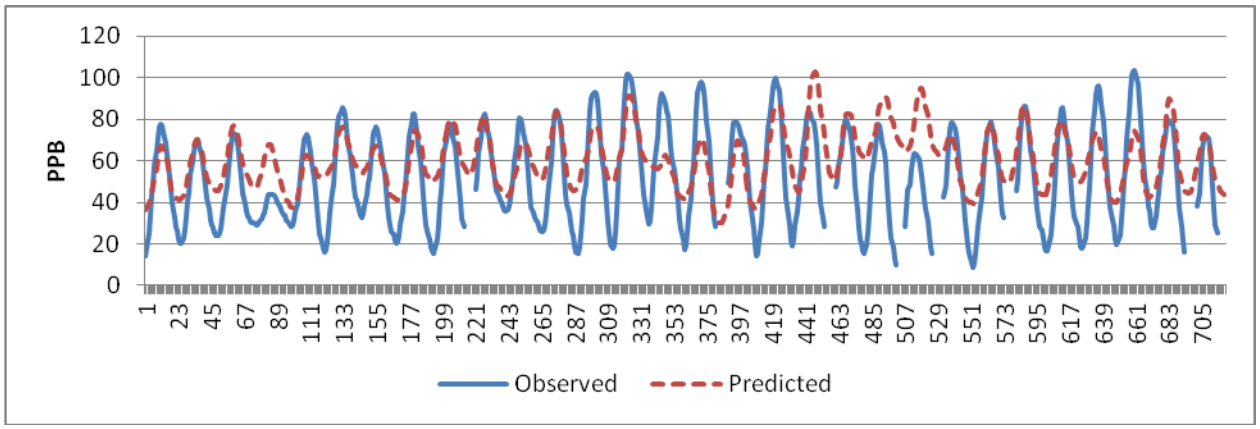
Time Series of Observed Vs.Predicted 8-Hour Azusa Ozone: June, 2008



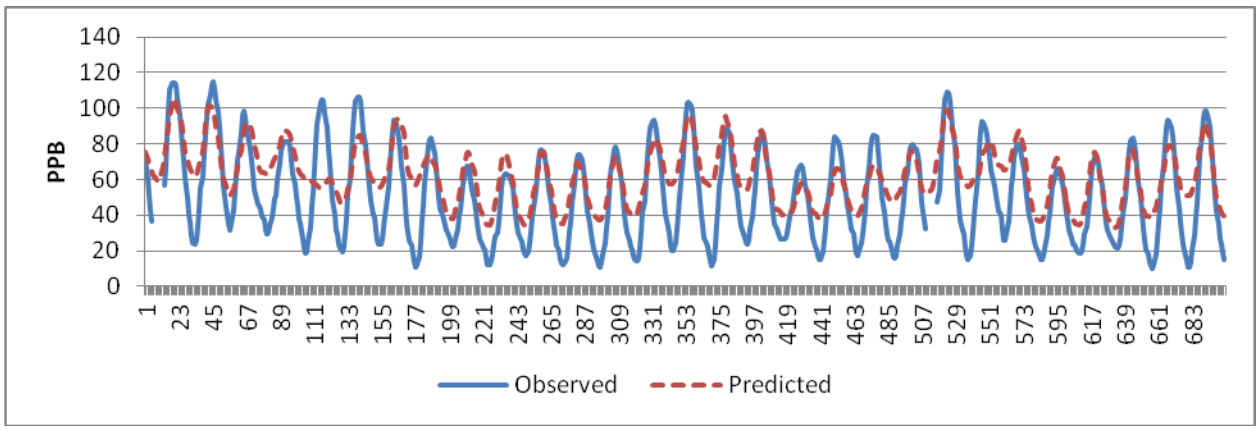
Time Series of Observed Vs.Predicted 8-Hour Azusa Ozone: July, 2008



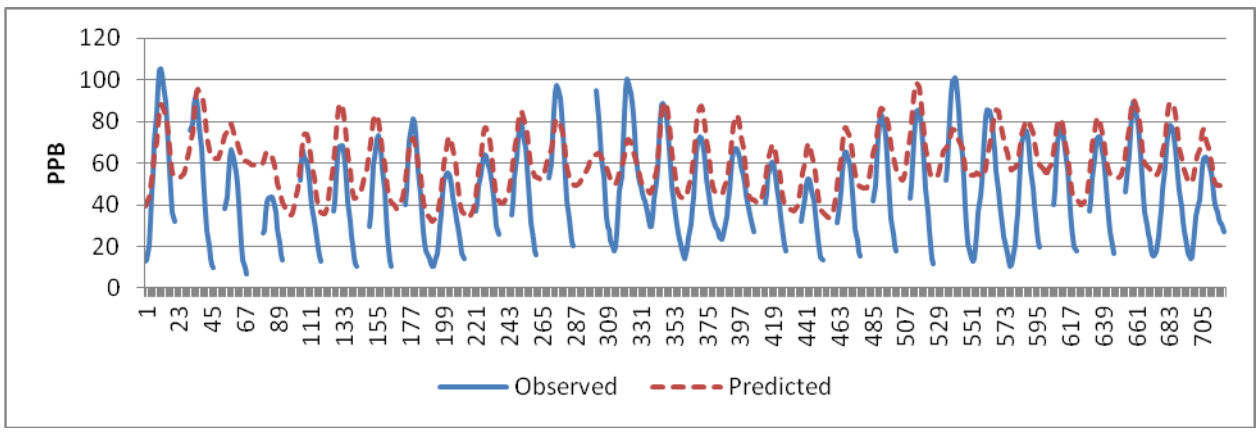
Time Series of Observed Vs.Predicted 8-Hour Azusa Ozone: August, 2008



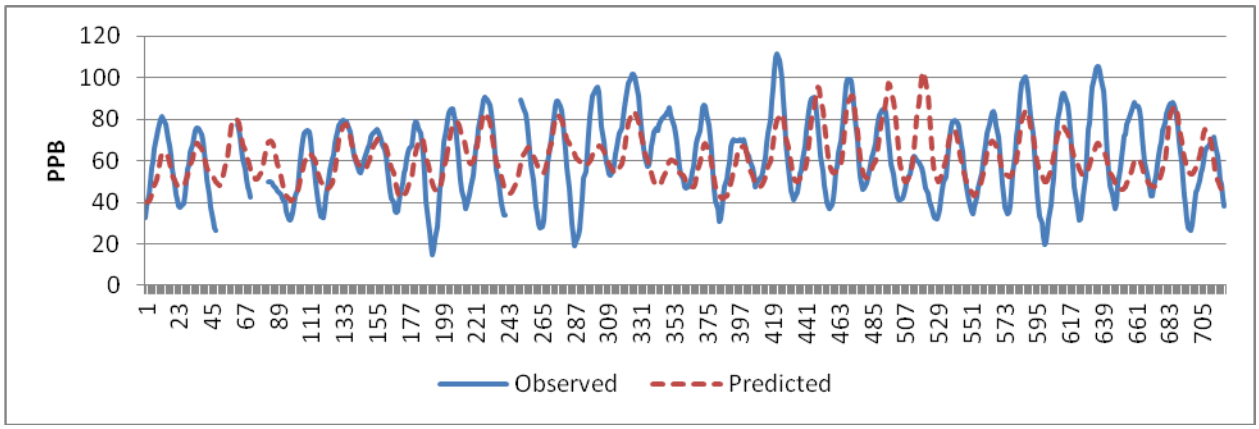
Time Series of Observed Vs.Predicted 8-Hour Perris Ozone: June, 2008



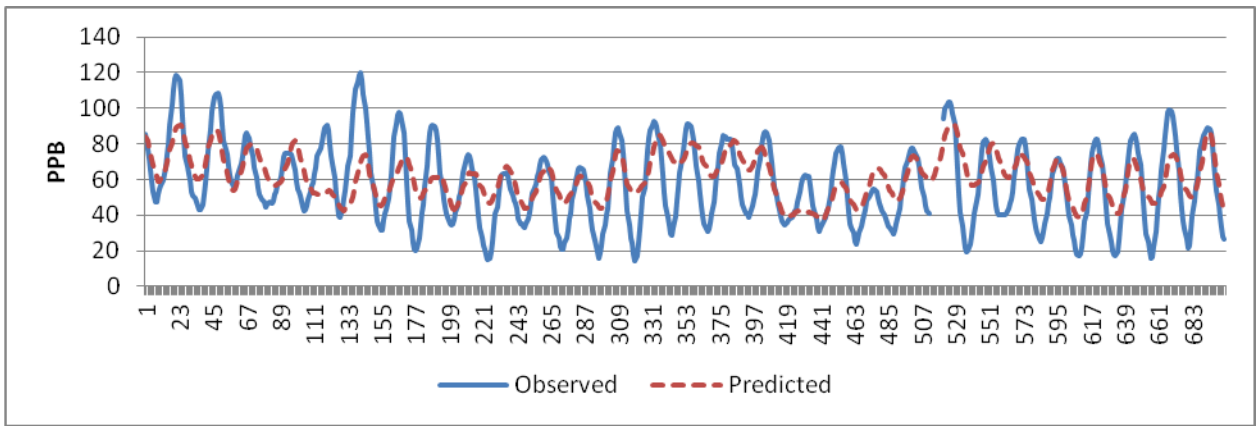
Time Series of Observed Vs.Predicted 8-Hour Perris Ozone: July, 2008



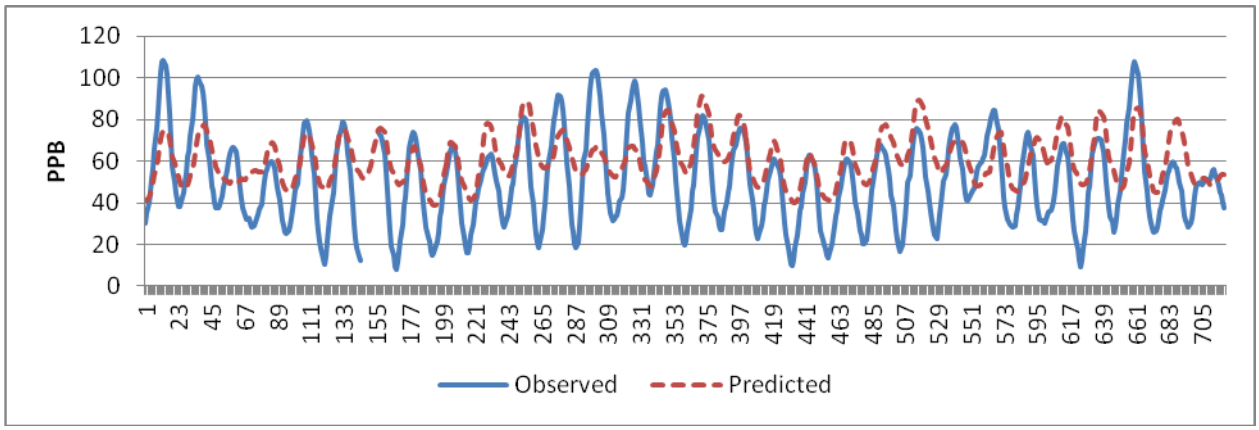
Time Series of Observed Vs.Predicted 8-Hour Perris Ozone: August, 2008



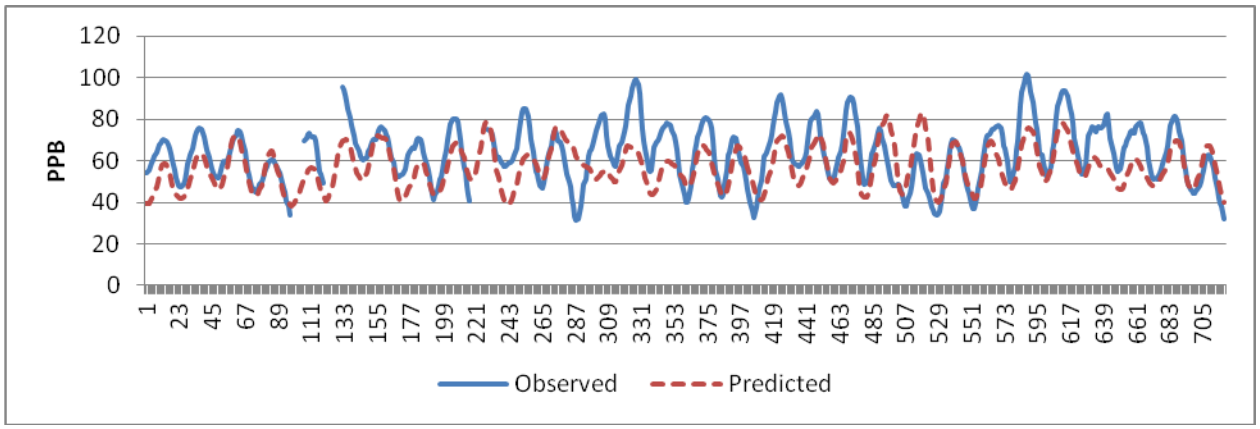
Time Series of Observed Vs.Predicted 8-Hour Banning Ozone: June, 2008



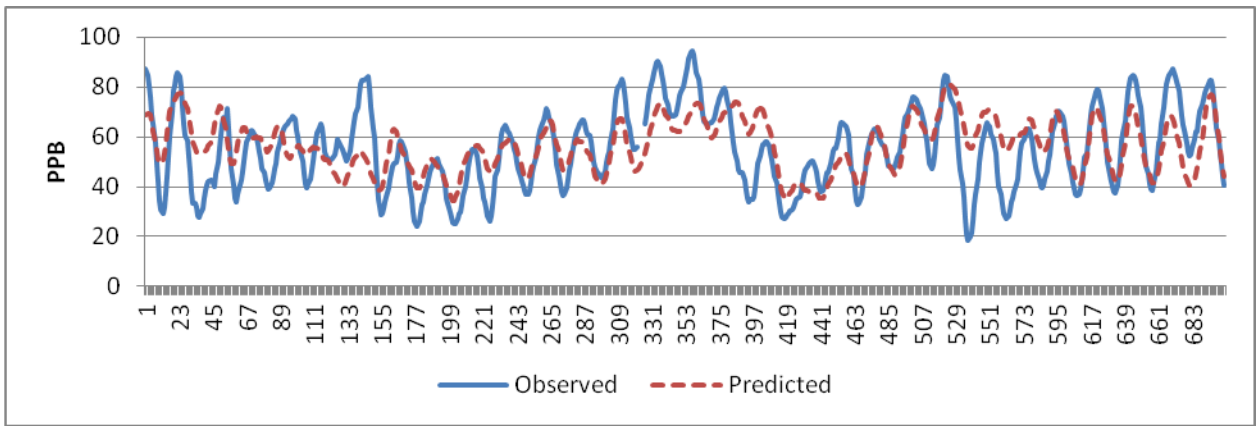
Time Series of Observed Vs.Predicted 8-Hour Banning Ozone: July, 2008



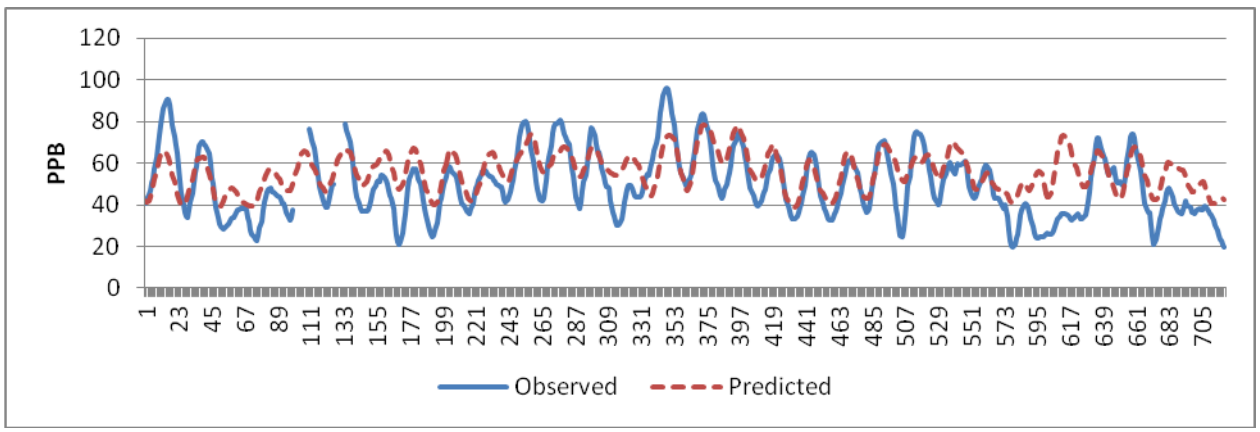
Time Series of Observed Vs.Predicted 8-Hour Banning Ozone: August, 2008



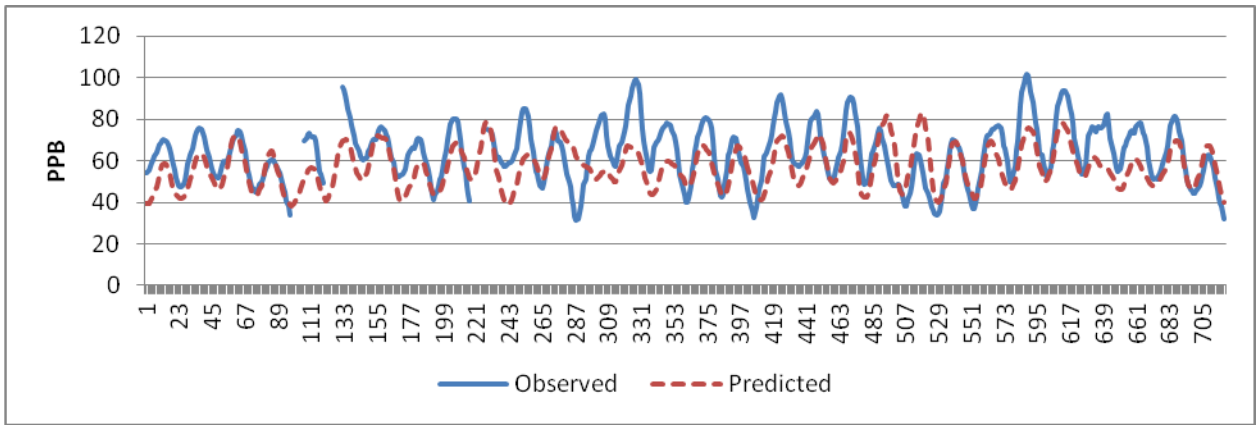
Time Series of Observed Vs.Predicted 8-Hour Palm Springs Ozone: June, 2008



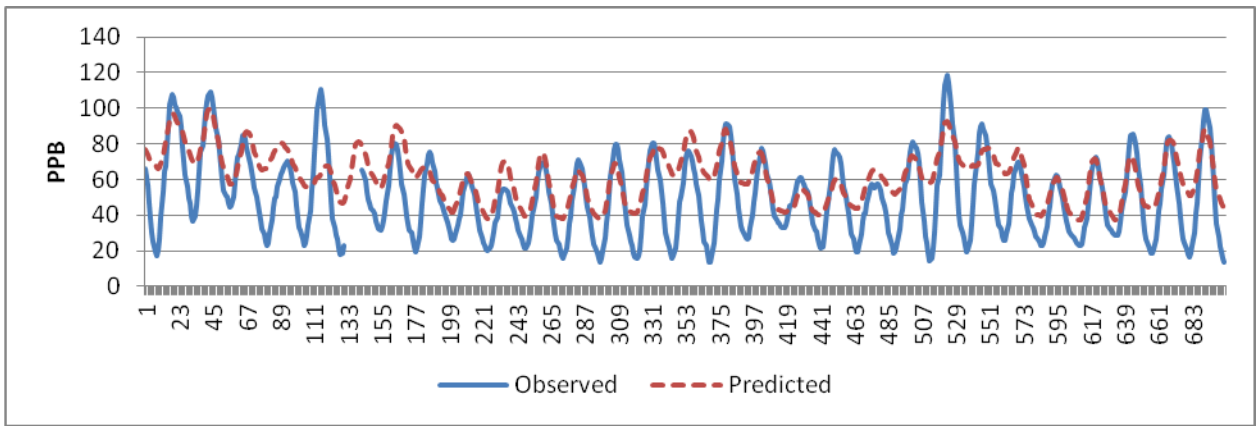
Time Series of Observed Vs.Predicted 8-Hour Palm Springs Ozone: July, 2008



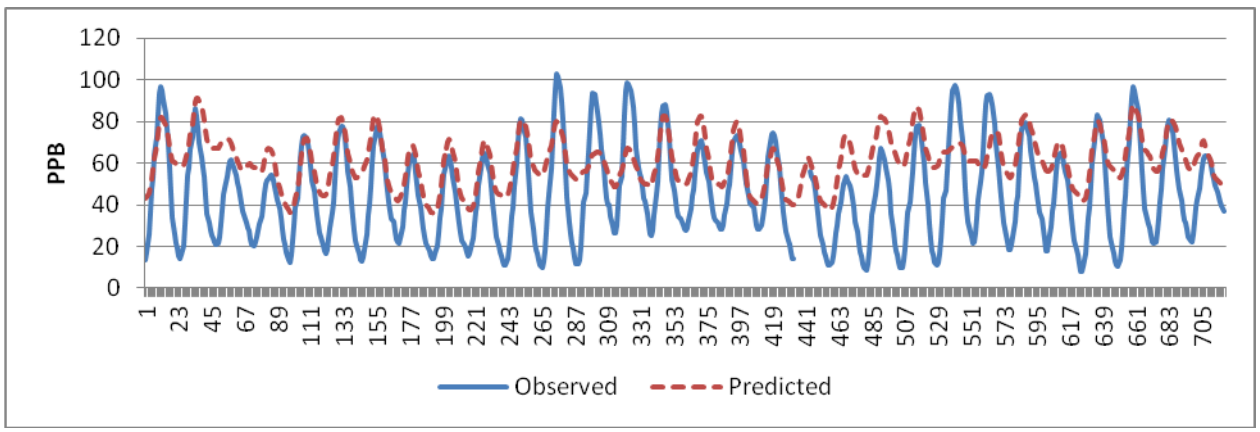
Time Series of Observed Vs.Predicted 8-Hour Palm Springs Ozone: August, 2008



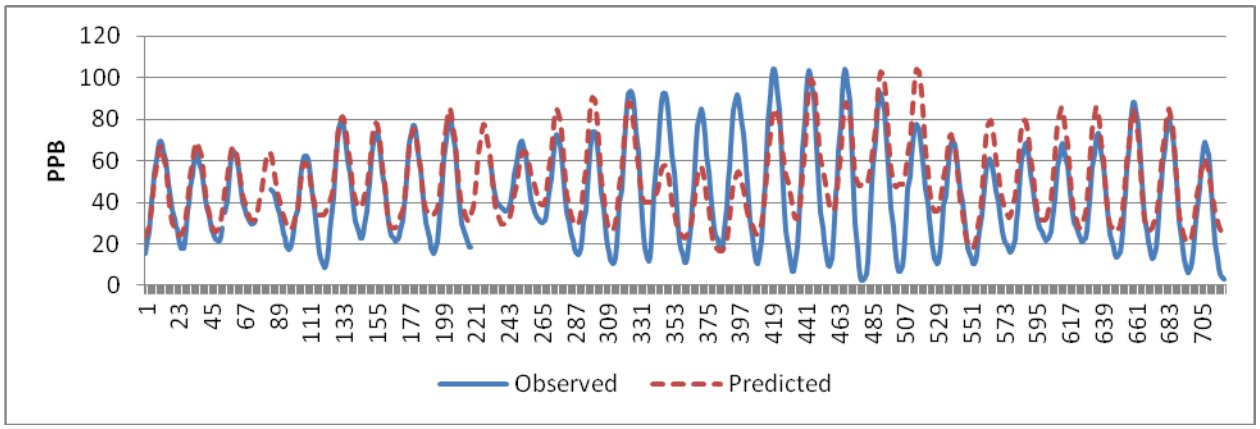
Time Series of Observed Vs.Predicted 8-Hour Lake Elsinore Ozone: June, 2008



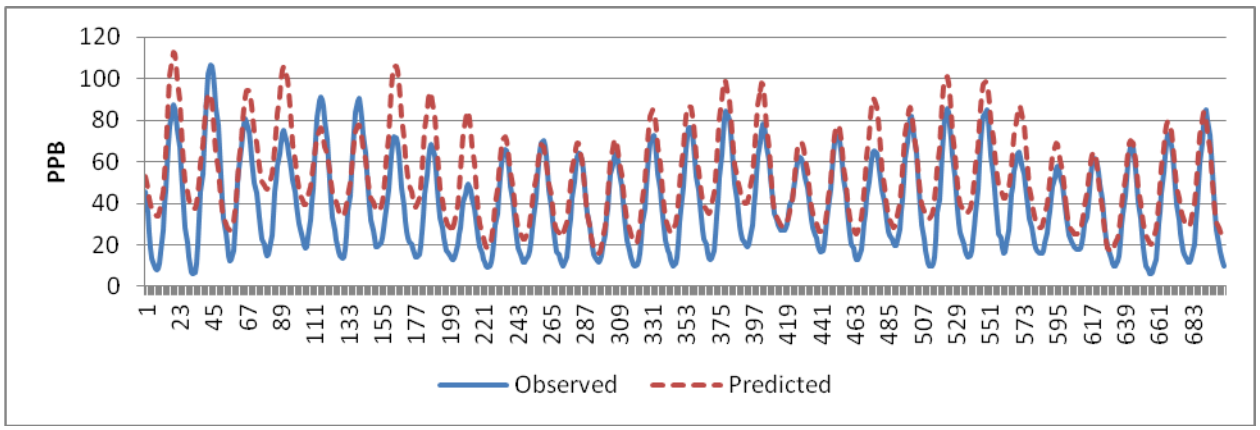
Time Series of Observed Vs.Predicted 8-Hour Lake Elsinore Ozone: July, 2008



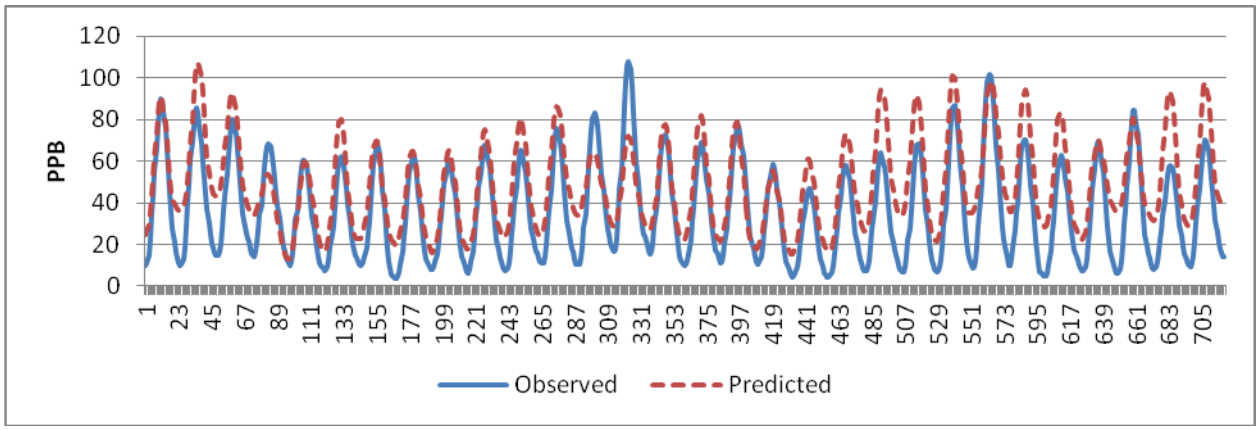
Time Series of Observed Vs.Predicted 8-Hour Lake Elsinore Ozone: August, 2008



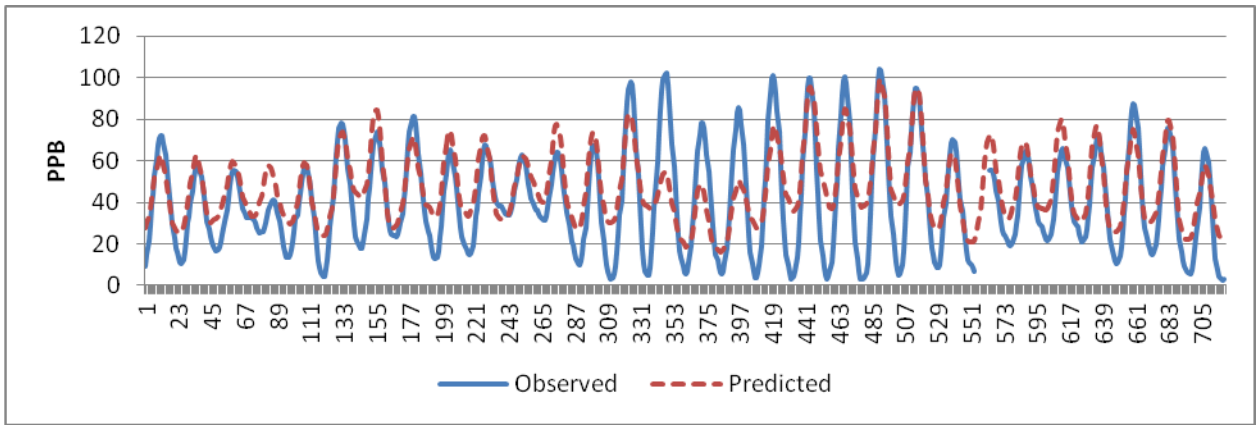
Time Series of Observed Vs.Predicted 8-Hour Mira Loma Ozone: June, 2008



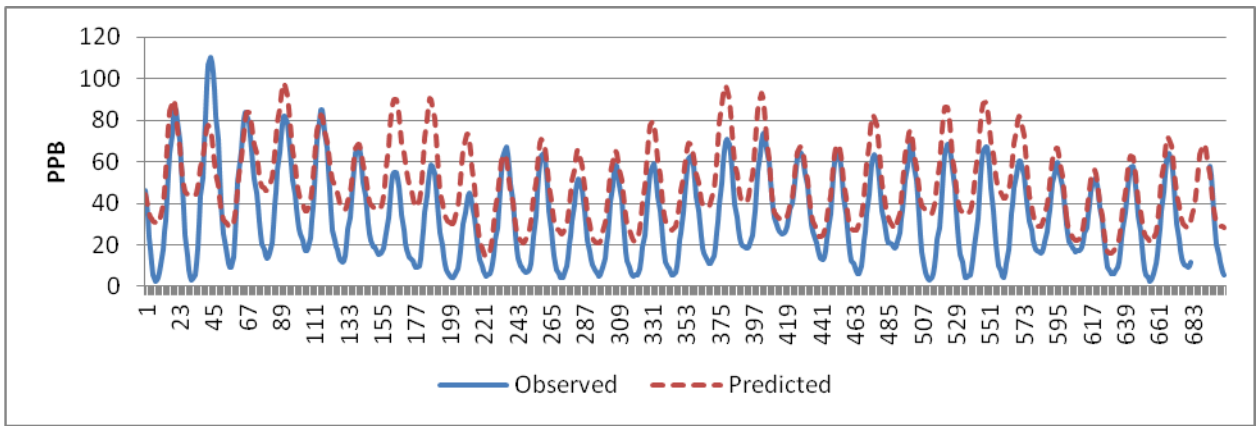
Time Series of Observed Vs.Predicted 8-Hour Mira Loma Ozone: July, 2008



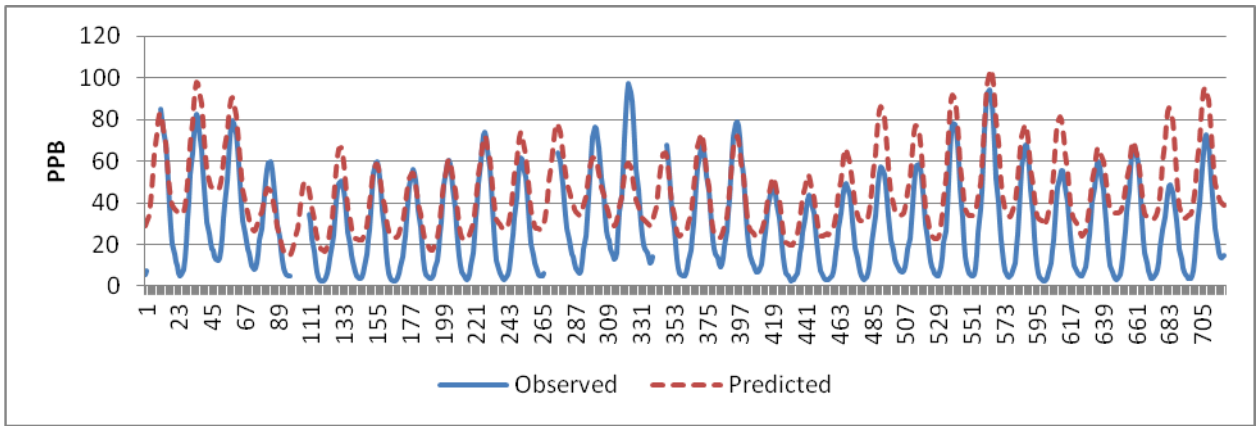
Time Series of Observed Vs.Predicted 8-Hour Mira Loma Ozone: August, 2008



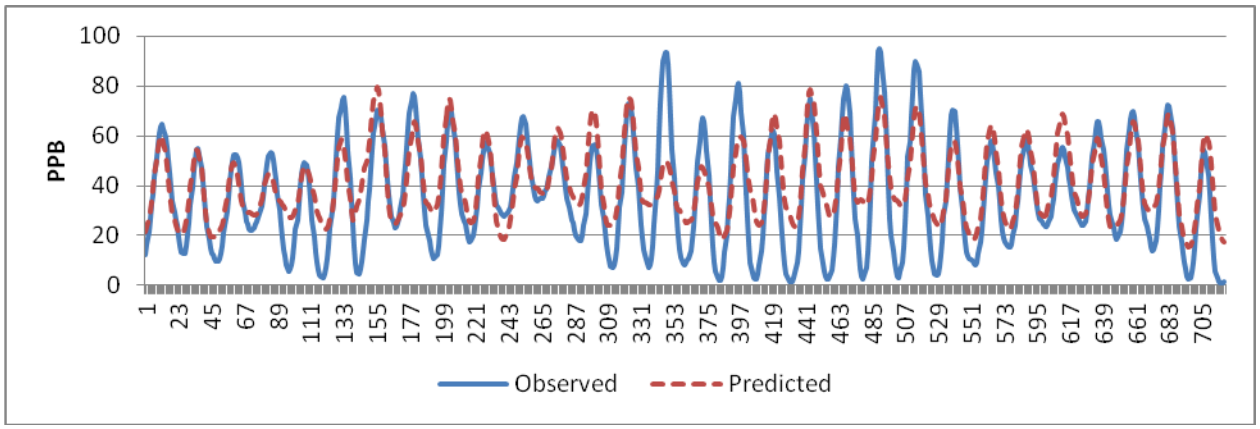
Time Series of Observed Vs.Predicted 8-Hour Pomona Ozone: June, 2008



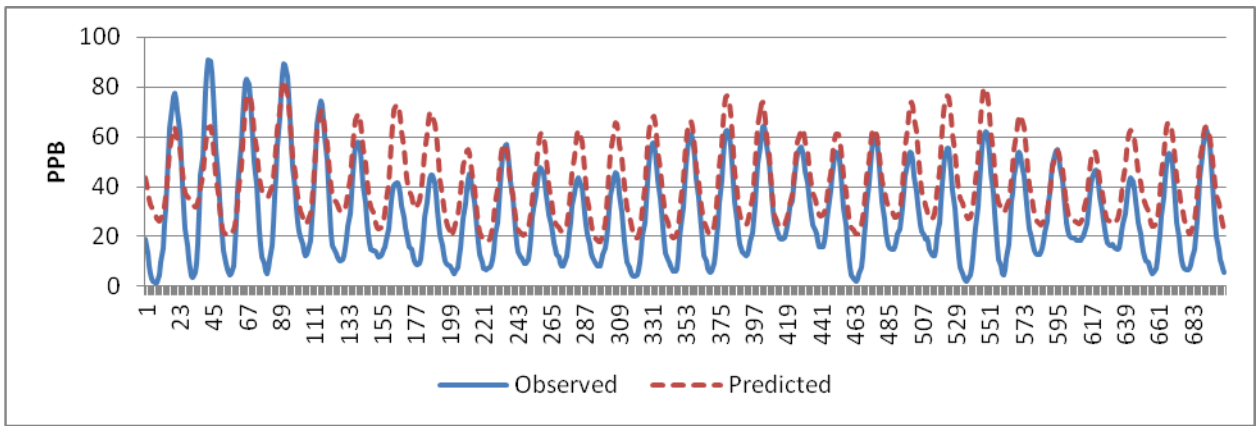
Time Series of Observed Vs.Predicted 8-Hour Pomona Ozone: July, 2008



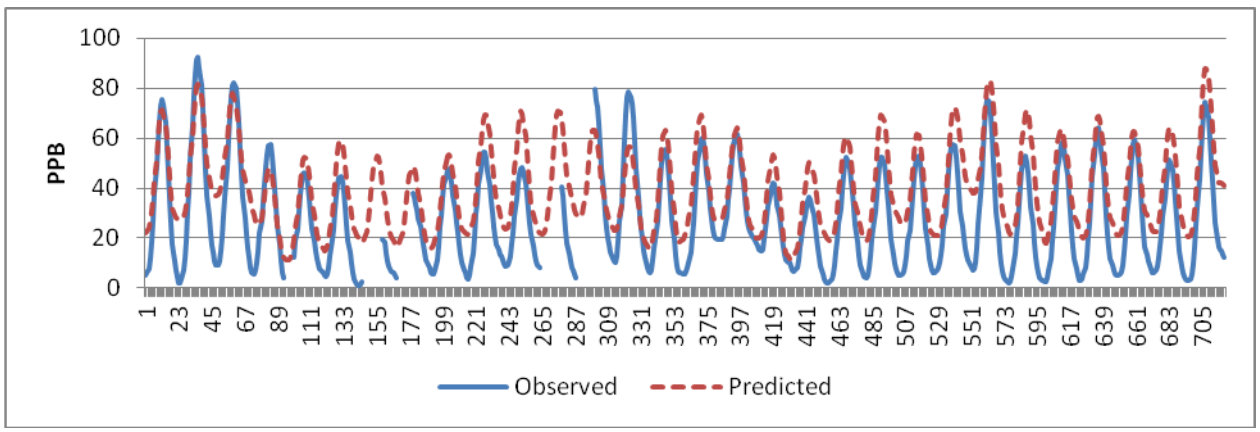
Time Series of Observed Vs.Predicted 8-Hour Pomona Ozone: August, 2008



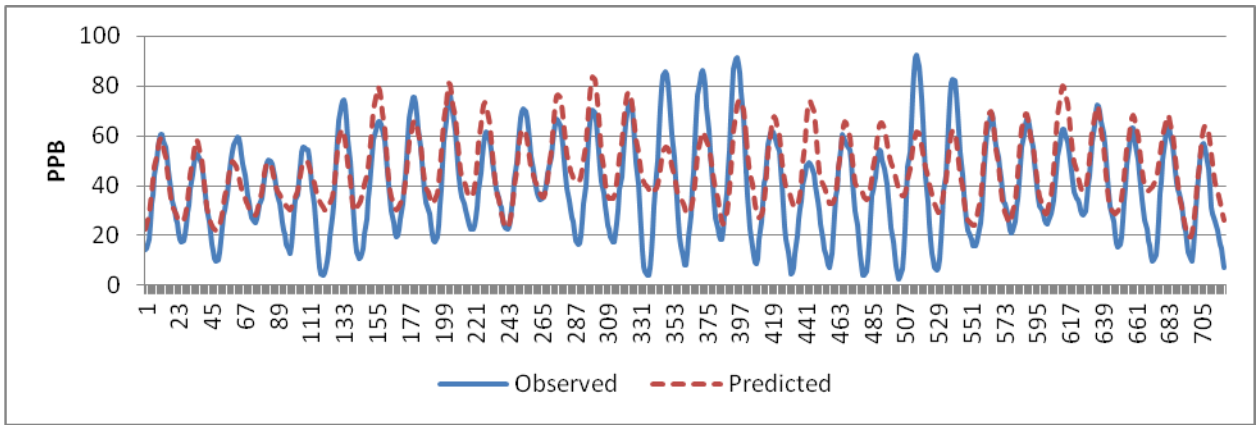
Time Series of Observed Vs.Predicted 8-Hour Burbank Ozone: June, 2008



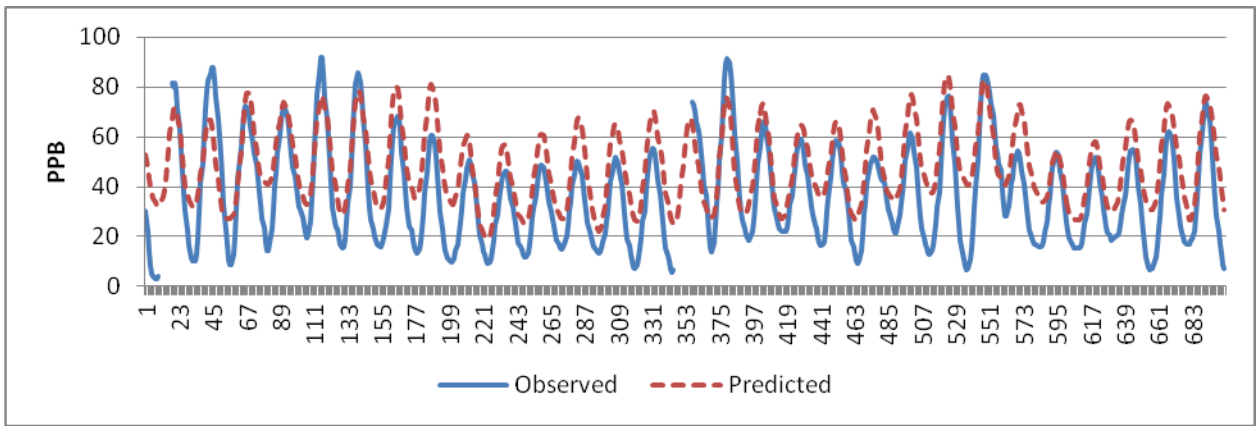
Time Series of Observed Vs.Predicted 8-Hour Burbank Ozone: July, 2008



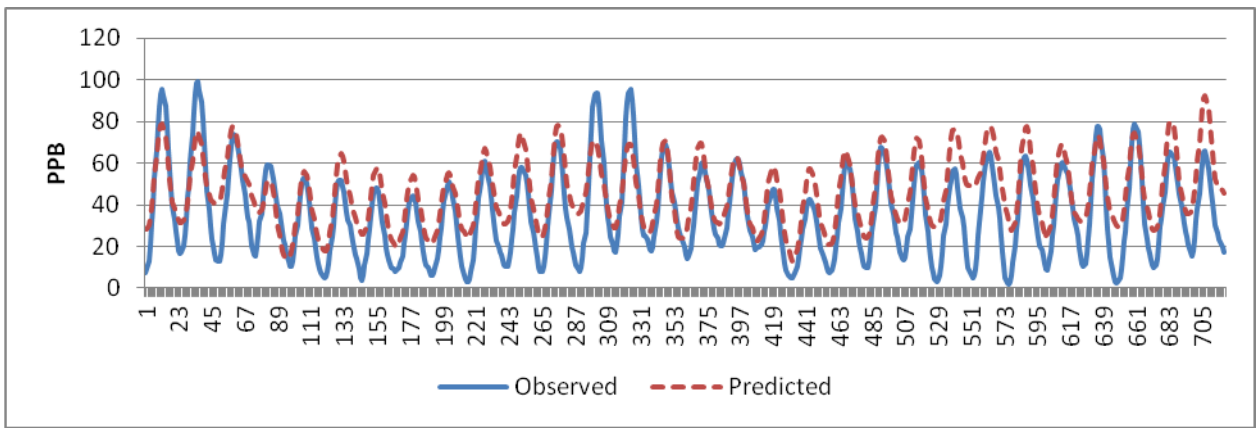
Time Series of Observed Vs.Predicted 8-Hour Burbank Ozone: August, 2008



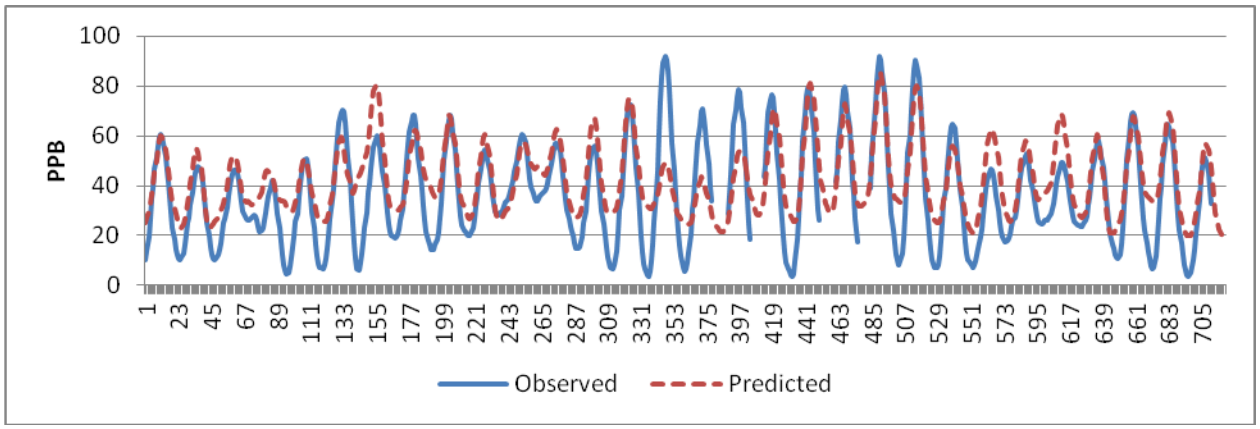
Time Series of Observed Vs.Predicted 8-Hour Reseda Ozone: June, 2008



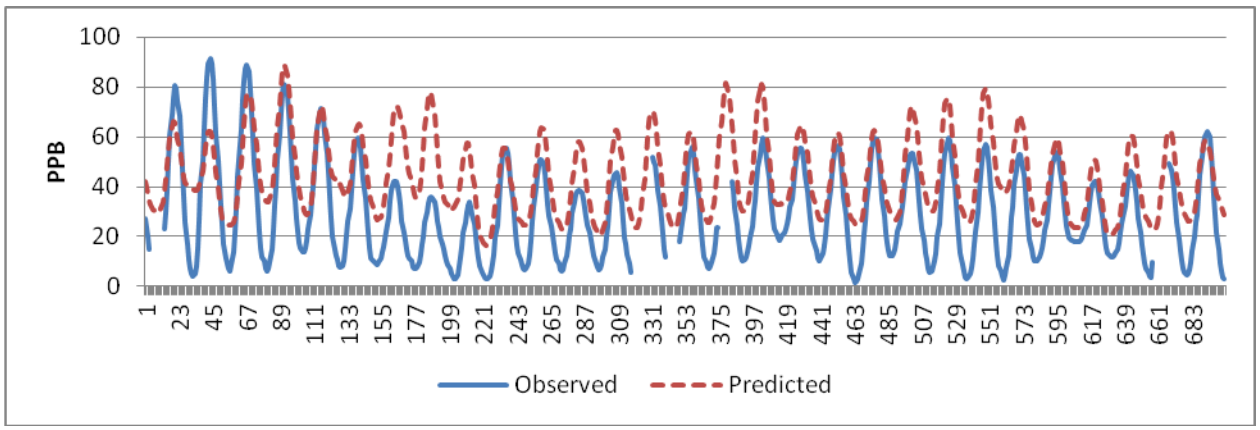
Time Series of Observed Vs.Predicted 8-Hour Reseda Ozone: July, 2008



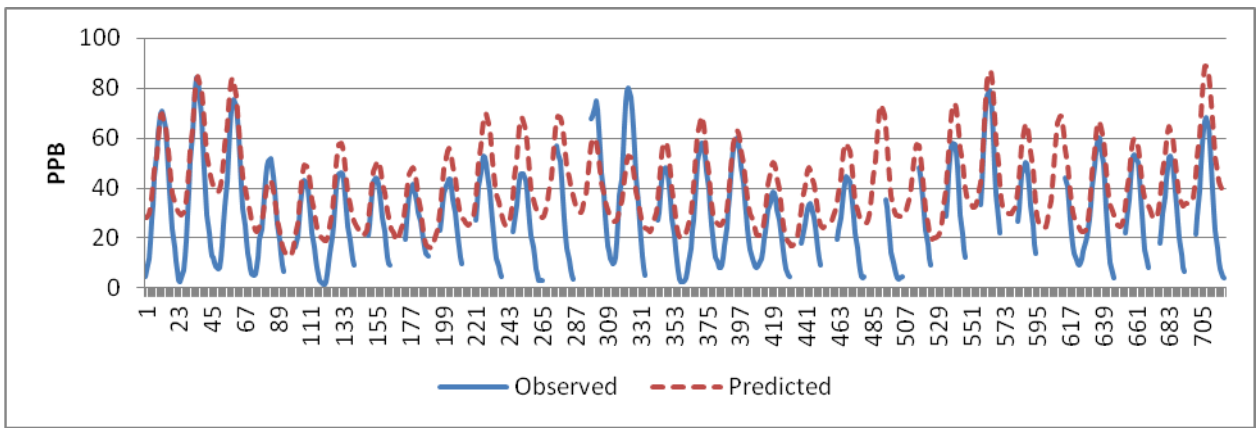
Time Series of Observed Vs.Predicted 8-Hour Reseda Ozone: August, 2008



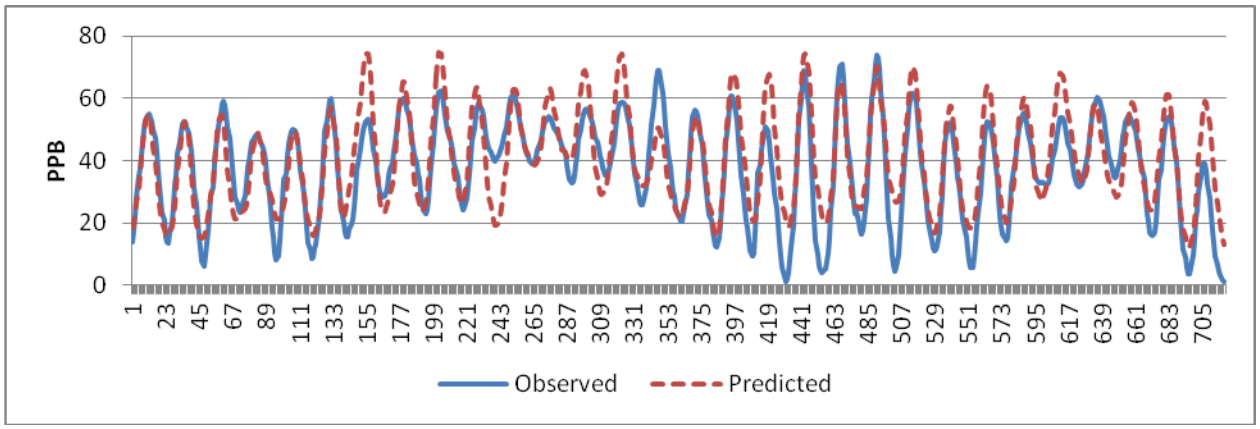
Time Series of Observed Vs.Predicted 8-Hour Pasadena Ozone: June, 2008



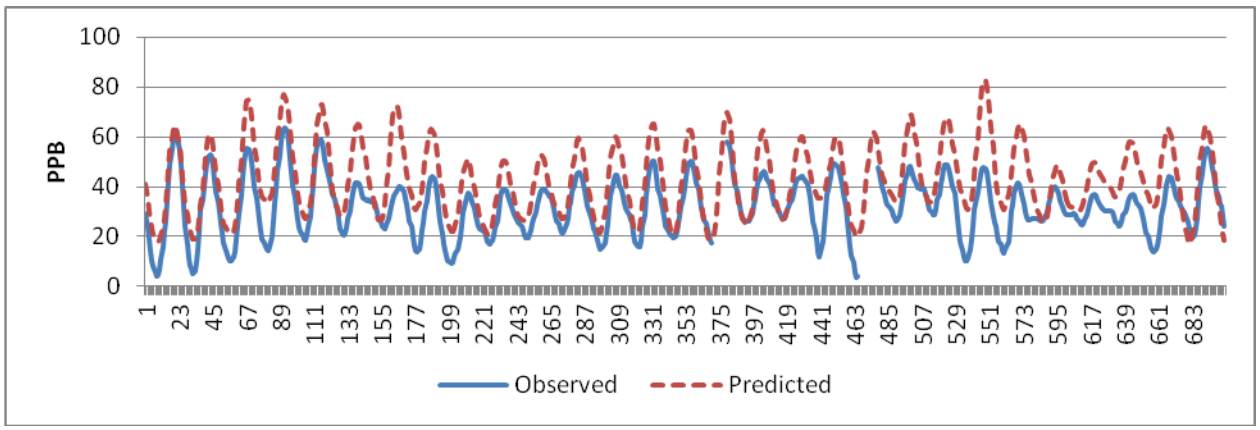
Time Series of Observed Vs.Predicted 8-Hour Pasadena Ozone: July, 2008



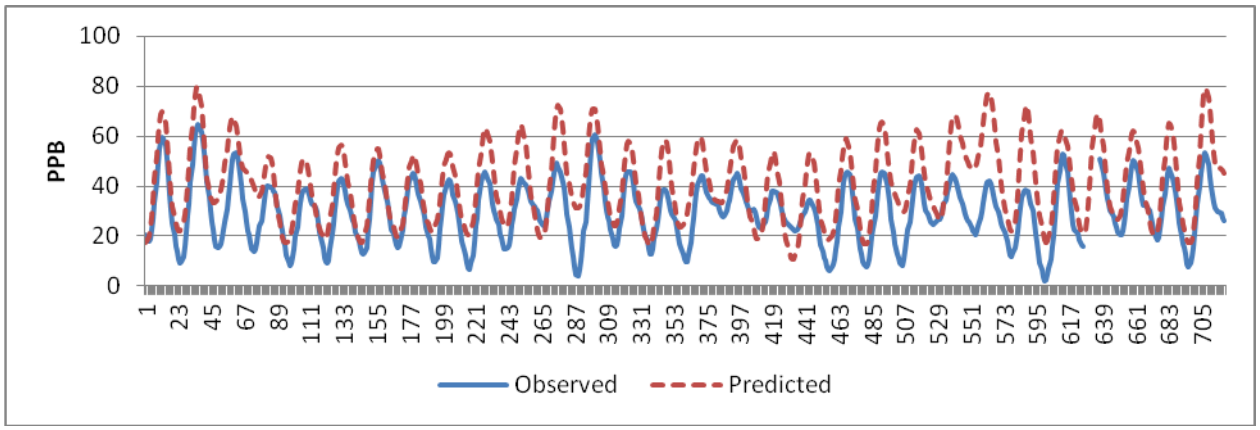
Time Series of Observed Vs.Predicted 8-Hour Pasadena Ozone: August, 2008



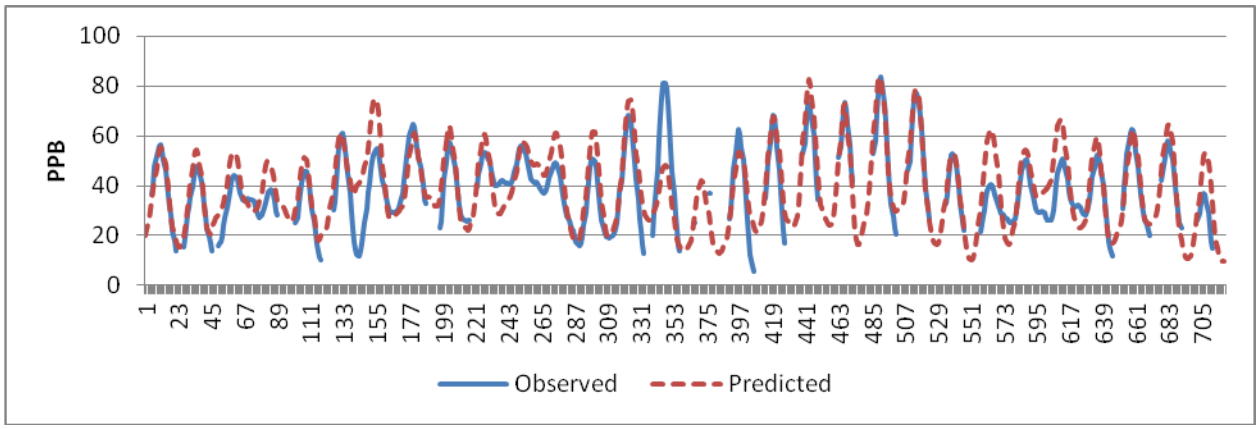
Time Series of Observed Vs.Predicted 8-Hour West Los Angeles Ozone: June, 2008



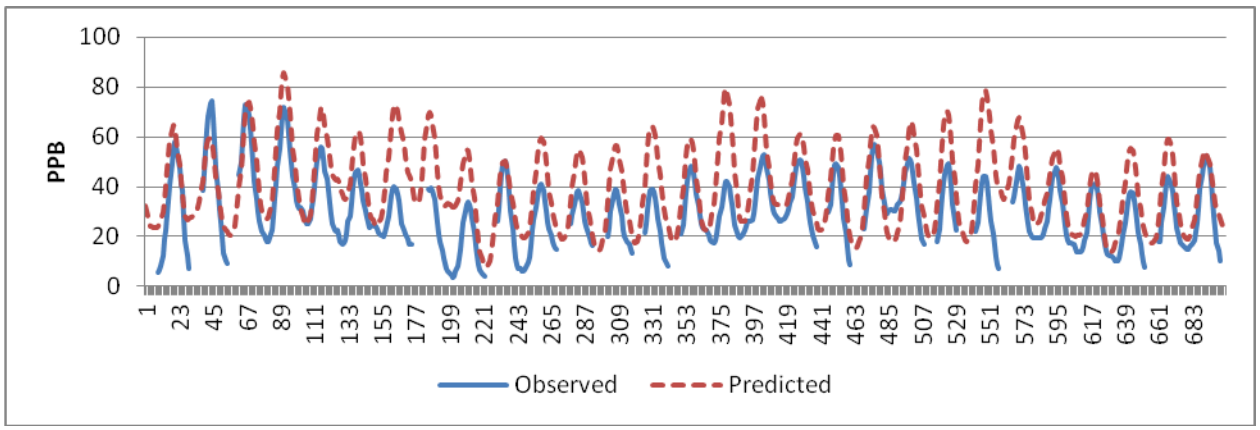
Time Series of Observed Vs.Predicted 8-Hour West Los Angeles Ozone: July, 2008



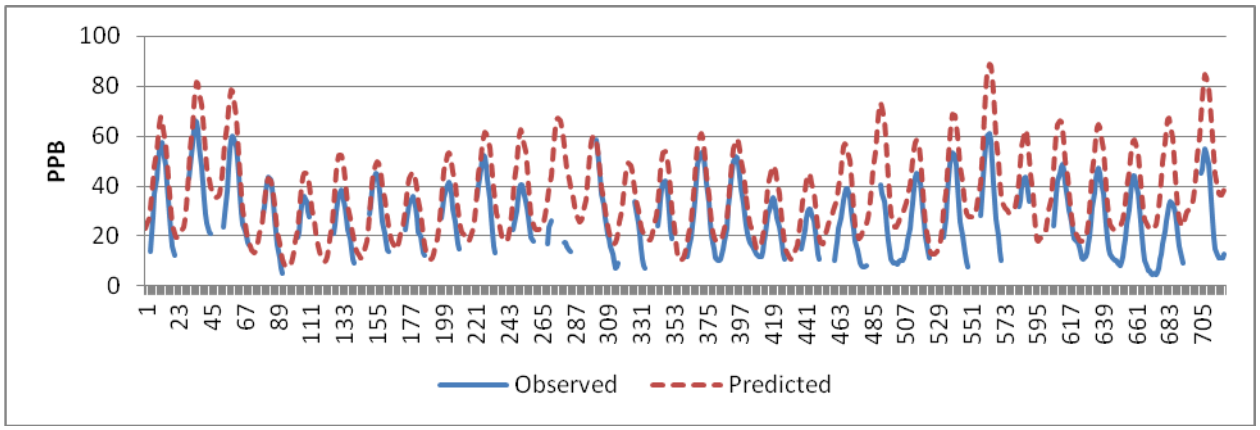
Time Series of Observed Vs.Predicted 8-Hour West Los Angeles Ozone: August, 2008



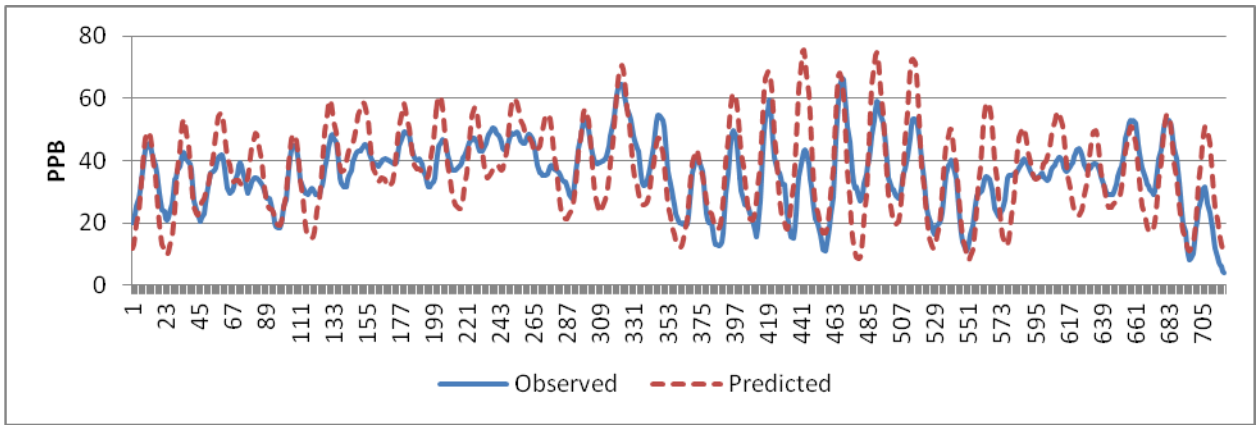
Time Series of Observed Vs.Predicted 8-Hour Pico Rivera Ozone: June, 2008



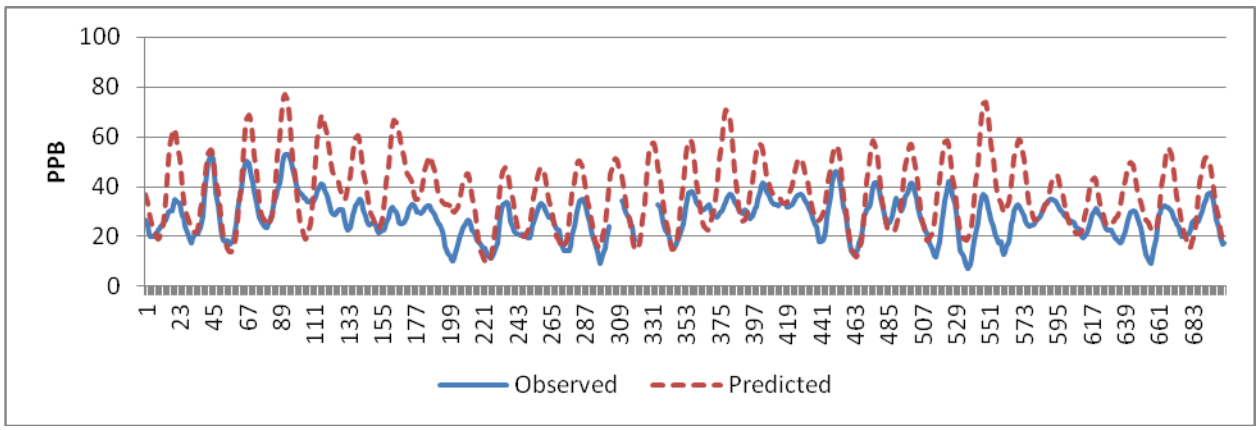
Time Series of Observed Vs.Predicted 8-Hour Pico Rivera Ozone: July, 2008



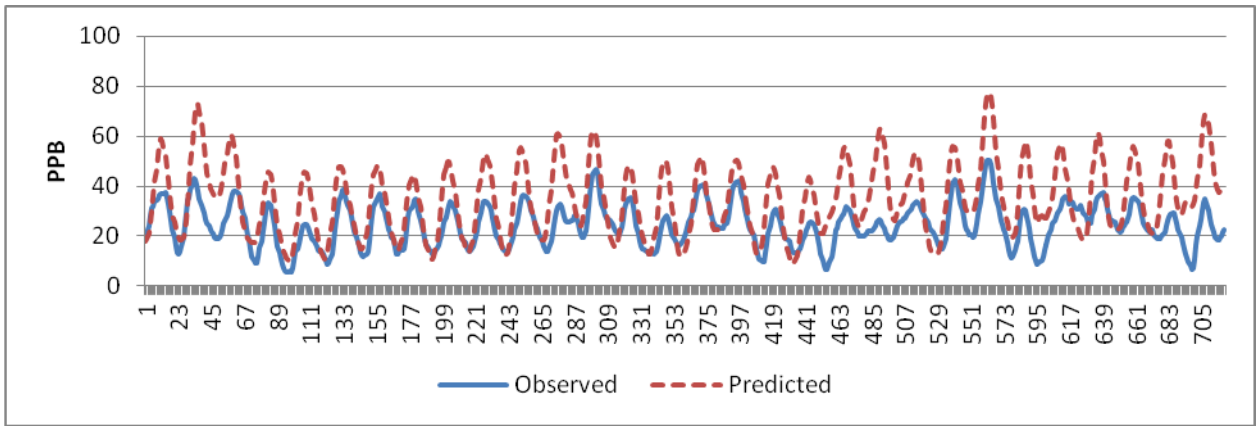
Time Series of Observed Vs.Predicted 8-Hour Pico Rivera Ozone: August, 2008



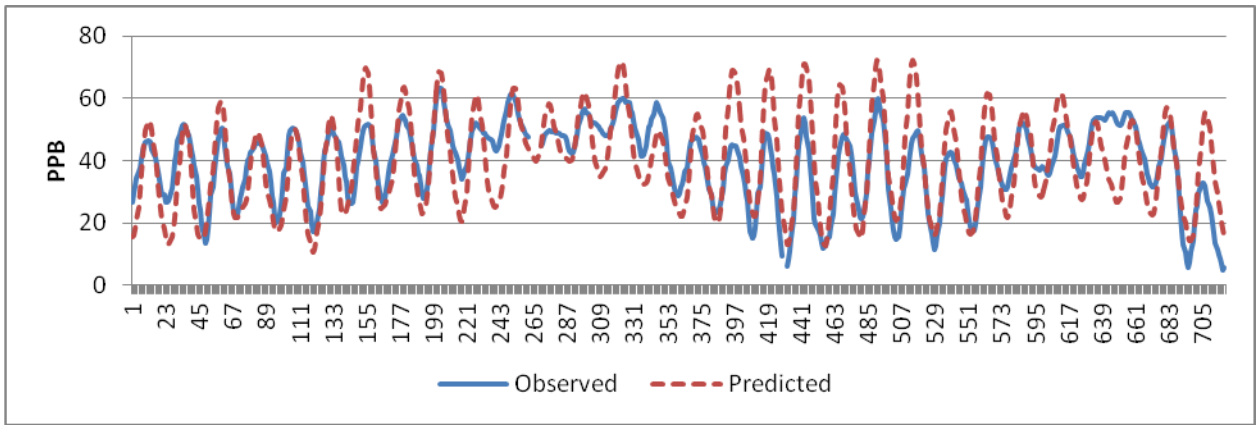
Time Series of Observed Vs.Predicted 8-Hour Long Beach Ozone: June, 2008



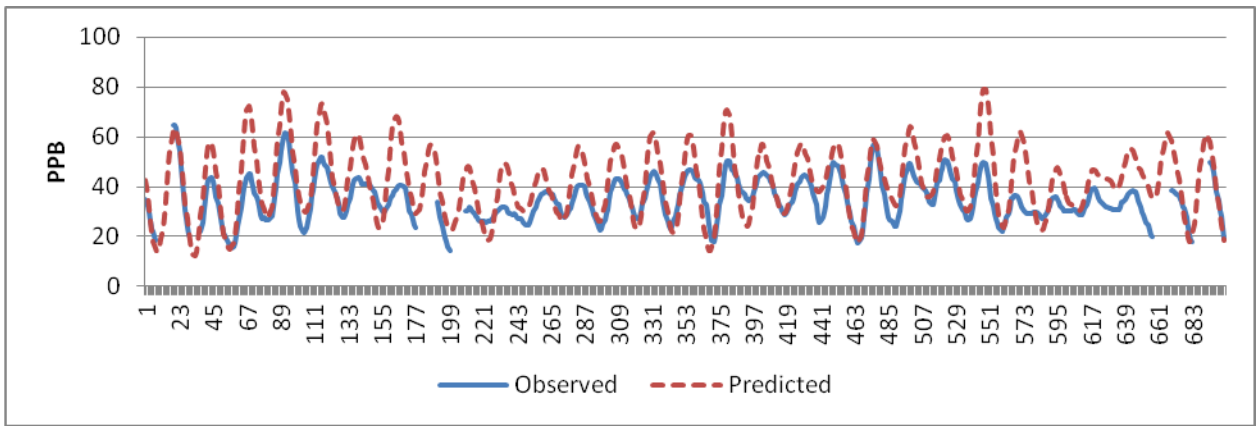
Time Series of Observed Vs.Predicted 8-Hour Long Beach Ozone: July, 2008



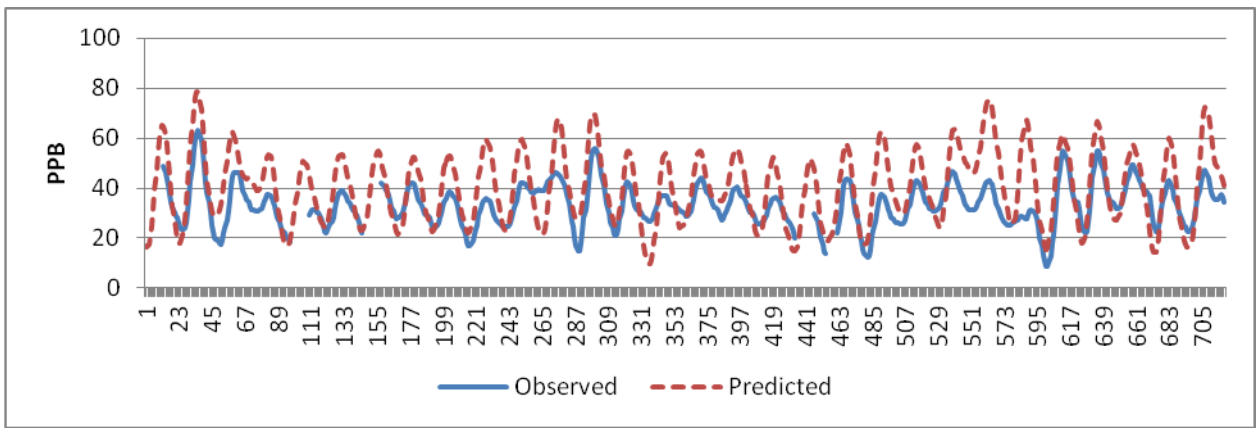
Time Series of Observed Vs.Predicted 8-Hour Long Beach Ozone: August, 2008



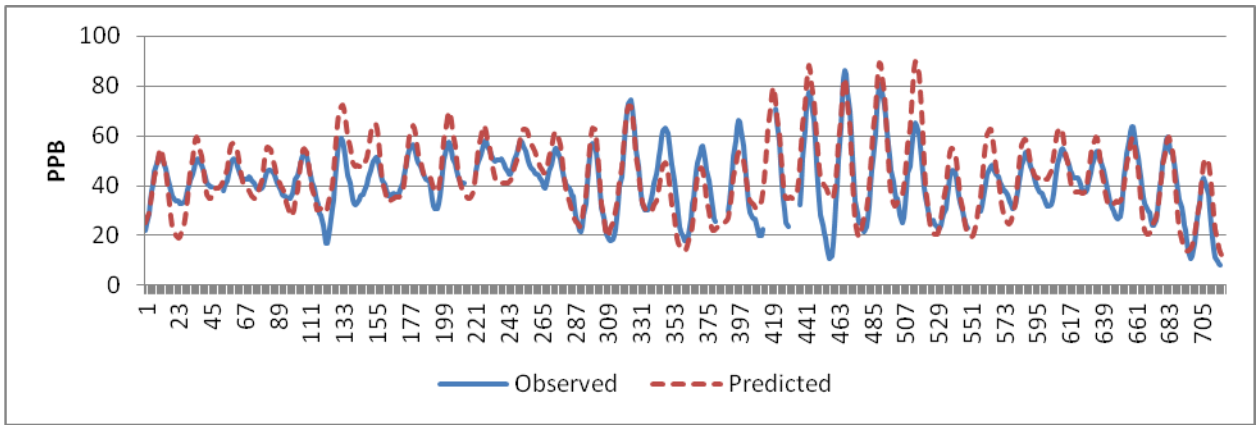
Time Series of Observed Vs.Predicted 8-Hour Los Angeles Airport Ozone: June, 2008



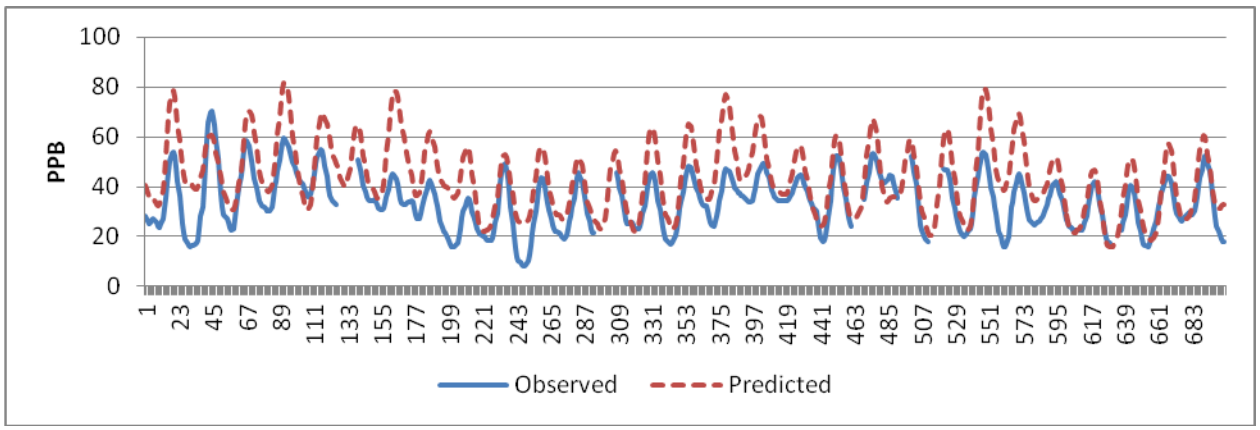
Time Series of Observed Vs.Predicted 8-Hour Los Angeles Airport Ozone: July, 2008



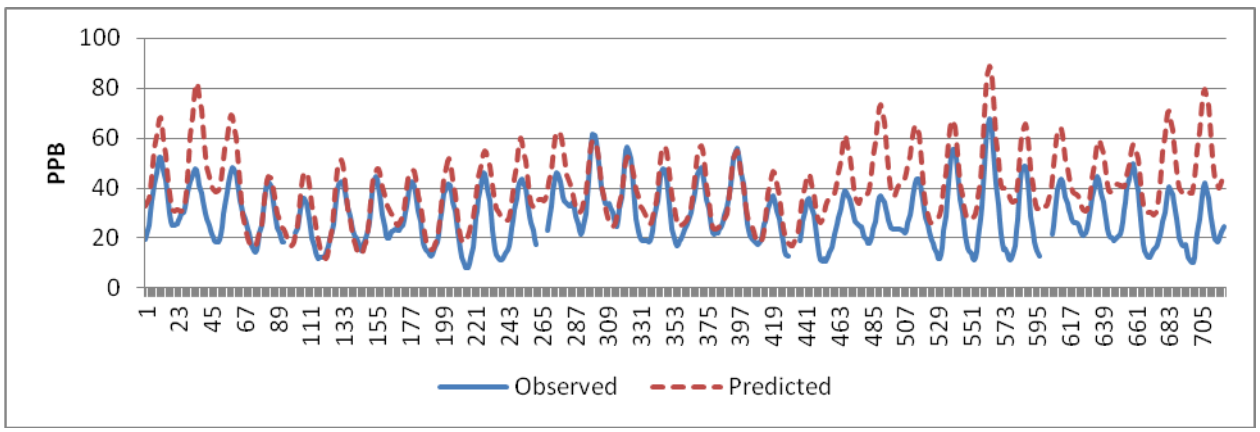
Time Series of Observed Vs.Predicted 8-Hour Los Angeles Airport Ozone: August, 2008



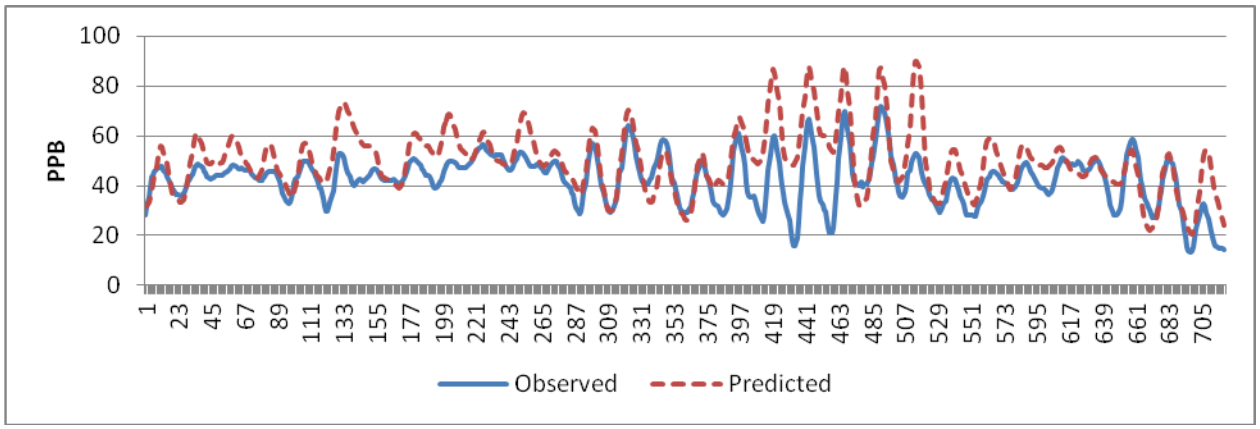
Time Series of Observed Vs.Predicted 8-Hour Anaheim Ozone: June, 2008



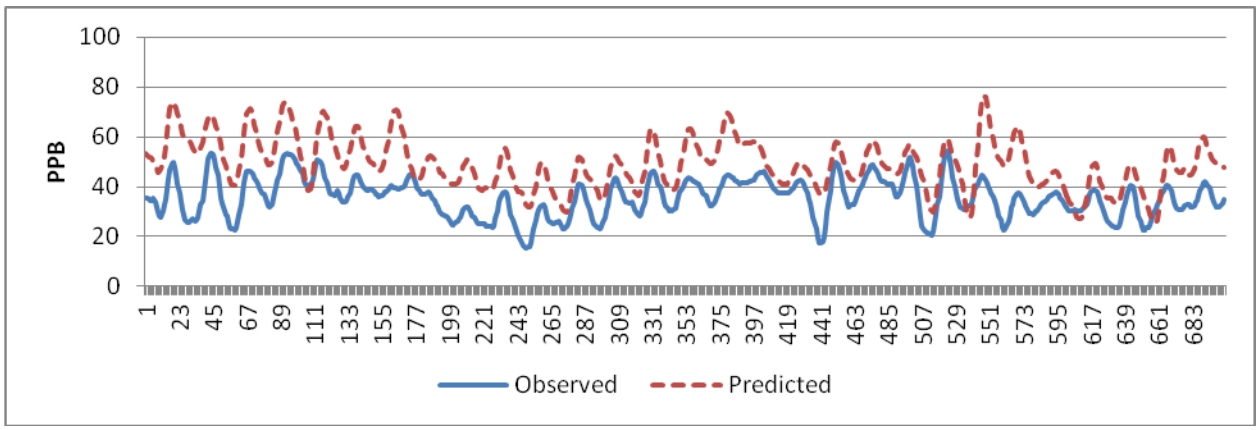
Time Series of Observed Vs.Predicted 8-Hour Anaheim Ozone: July, 2008



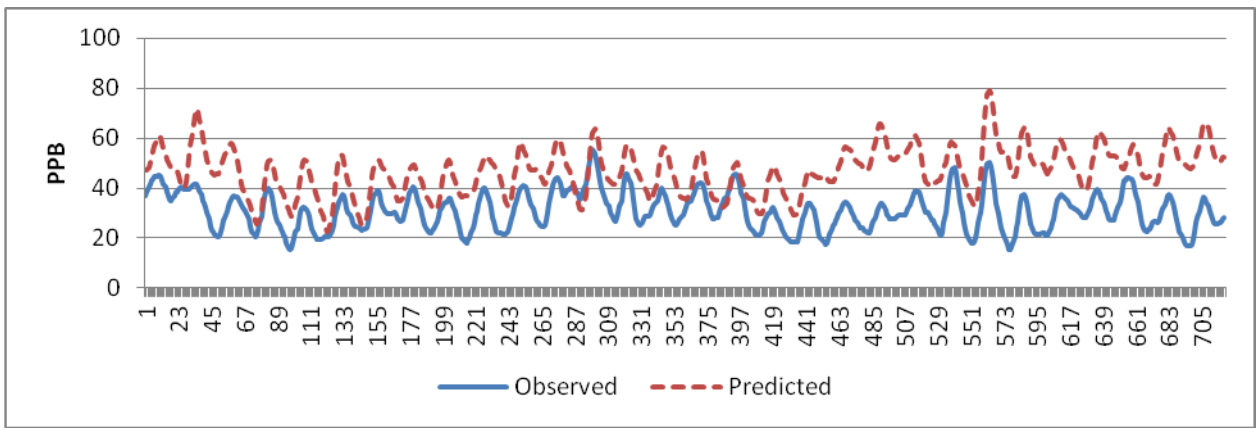
Time Series of Observed Vs.Predicted 8-Hour Anaheim Ozone: August, 2008



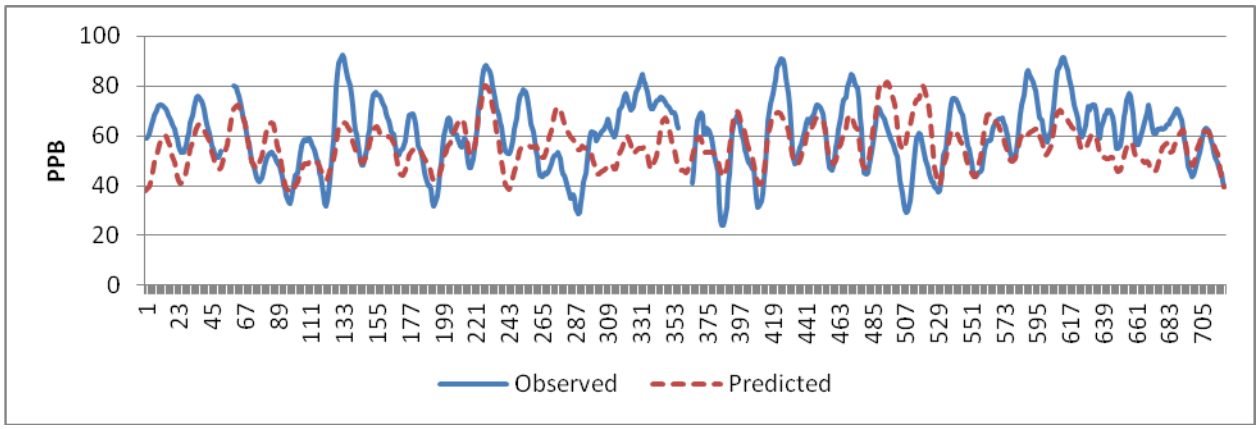
Time Series of Observed Vs.Predicted 8-Hour Costa Mesa Ozone: June, 2008



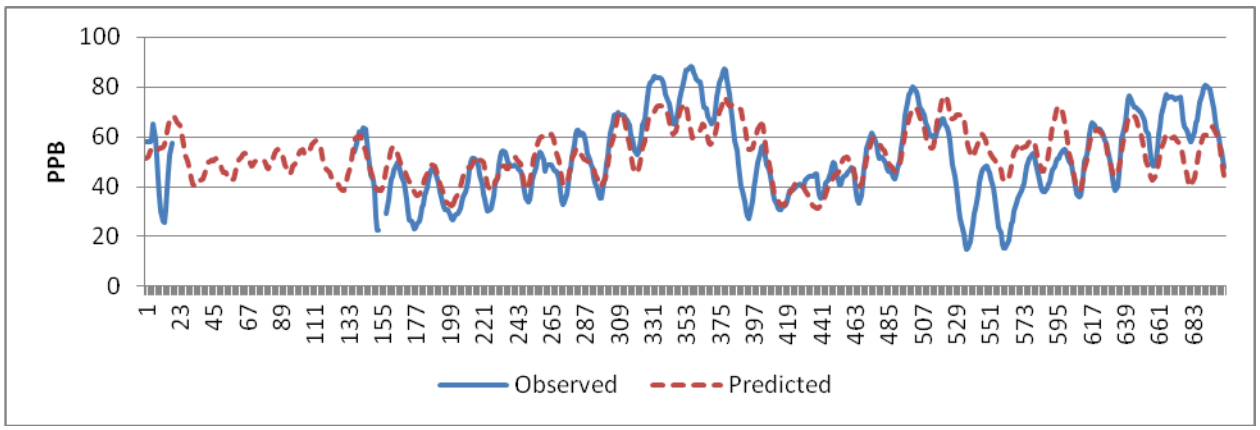
Time Series of Observed Vs.Predicted 8-Hour Costa Mesa Ozone: July, 2008



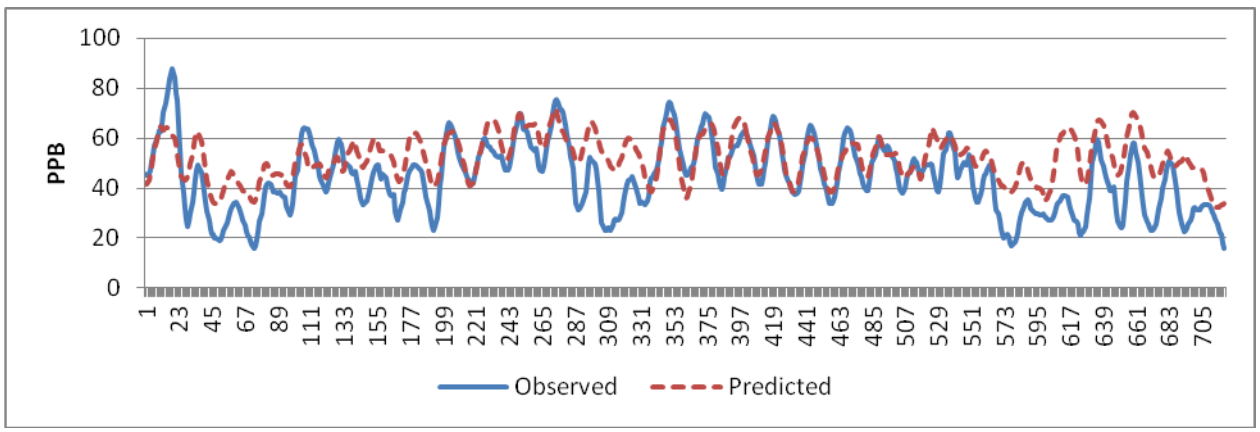
Time Series of Observed Vs.Predicted 8-Hour Costa Mesa Ozone: August, 2008



Time Series of Observed Vs.Predicted 8-Hour Indio Ozone: June, 2008



Time Series of Observed Vs.Predicted 8-Hour Indio Ozone: July, 2008



Time Series of Observed Vs.Predicted 8-Hour Indio Ozone: August, 2008

Attachment 4

Draft CEPA Source Level Emissions Reduction Summary for 2014: Annual Average Inventory

Run Date: 8/7/2012 10:35:49 AM

(PC-CEPA V4.4 / October 2008)
C:\Users\SYan\Documents\AQMP2012\CMs\DF070612\cf2014.txt
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Year 2014 Emission Reductions Excluding Natural Sources by Control Measure
in the South Coast Air Basin (Annual Average Inventory - Tons/Day)

(A) Reductions Without Overlapping/Double-Counting With Other Control Measures (1)

		(Reductions - Tons/Day)						
Measure	Name	VOC	NOx	CO	SOx	PM10	PM2.5	NH3
CMB-01A	Reclaim NOx Reduction Phase I	0.00	2.00	0.00	0.00	0.00	0.00	0.00
CTS-01	Architectural Coatings [VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTS-02	Misc. Coatings, Adhesives, Solvents & Lubricants [VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTS-03	Mold Release[VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FUG-02	LPG Transfer and Dispensing [VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FUG-03	Fugitive Emissions [VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OFRD-01	SOON [NOX]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OFRD-02	Locomotives [NOx,PM]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OFRD-03	Passenger Locomotives [NOx,PM]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grand Total (Net)		0.00	2.00	0.00	0.00	0.00	0.00	0.00

Year 2014 Emission Reductions Excluding Natural Sources by Control Measure in the South Coast Air Basin (Annual Average Inventory - Tons/Day)

(B) Reductions With Overlapping/Double-Counting With Other Control Measures (2)

		(Reductions - Tons/Day)						
Measure	Name	VOC	NOx	CO	SOx	PM10	PM2.5	NH3
CMB-01A	Reclaim NOx Reduction Phase I	0.00	2.00	0.00	0.00	0.00	0.00	0.00
CMB-03	Commercial Space Heating [Nox]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTS-01	Architectural Coatings [VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTS-02	Misc. Coatings, Adhesives, Solvents & Lubricants [VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTS-03	Mold Release[VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FUG-02	LPG Transfer and Dispensing [VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FUG-03	Fugitive Emissions [VOC]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OFRD-01	SOON [NOX]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OFRD-02	Locomotives [NOx,PM]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OFRD-03	Passenger Locomotives [NOx,PM]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grand Total (with potential overlapping)		0.00	2.00	0.00	0.00	0.00	0.00	0.00

EMISSION SUMMARY FOR
(POINT, AREA, MOBILE SOURCE, AND OFF-ROAD MV)

Baseline Emissions	VOC	NOx	CO	SOx	PM10	PM2.5	NH3
Point source	30.70	4.94	34.74	2.32	11.29	8.72	10.46
Area source	203.26	41.42	128.66	1.77	112.71	41.24	75.54
RECLAIM	0.00	26.48	0.00	7.99	0.00	0.00	0.00
Total Stationary	233.96	72.84	163.40	12.08	124.00	49.96	86.00
On-road	116.82	268.79	1164.57	2.10	25.57	12.31	16.46
Off-road	97.12	144.35	729.85	2.72	8.20	7.70	0.10
Aircraft	3.52	13.91	37.04	1.50	0.83	0.42	0.00
TOTAL	451.42	499.89	2094.86	18.39	158.60	70.40	102.56
EMISSION REDUCTIONS							
Point source	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area source	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RECLAIM	0.00	2.00	0.00	0.00	0.00	0.00	0.00
Total Stationary	0.00	2.00	0.00	0.00	0.00	0.00	0.00
On-road	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Off-road	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aircraft	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	2.00	0.00	0.00	0.00	0.00	0.00
REMAINING EMISSIONS							
Point source	30.70	4.94	34.74	2.32	11.29	8.72	10.46
Area source	203.26	41.42	128.66	1.77	112.71	41.24	75.54
RECLAIM	0.00	24.48	0.00	7.99	0.00	0.00	0.00
Total Stationary	233.96	70.84	163.40	12.08	124.00	49.96	86.00
On-road	116.82	268.79	1164.57	2.10	25.57	12.31	16.46
Off-road	97.12	144.35	729.85	2.72	8.20	7.70	0.10
Aircraft	3.52	13.91	37.04	1.50	0.83	0.42	0.00
TOTAL	451.42	497.89	2094.86	18.39	158.60	70.40	102.56
NSR/Set-Aside	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Public Funding	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GRAND TOTAL (T/D)	451.42	497.89	2094.86	18.39	158.60	70.40	102.56
Mobility Adjustments (3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(1) Emission reductions for individual measures were estimated based on the sequence of listing contained here. When the sequence changes, reductions from each measure could be affected, but the net total remain the same. The purpose of this table is to estimate total emission reductions without overlapping or double-counting between measures.
(2) Emission reductions for individual measures were estimated in the absence of other measures. Therefore, the sequence of listing does not affect the reduction estimates. The purpose of this table is to provide emission reduction estimates for Appendix IV control measure summary tables as well as cost effectiveness analysis.
(3) Mobility Adjustment includes TCM-01, ATT-01, ATT-02, ATT-05 and adjustments are reflected in the CEPA baseline beyond year 2000.

Attachment 5

Draft CEPA Source Level Emissions Reduction Summary for 2023: Annual Average Inventory

Run Date: 7/6/2012 5:44:45 PM

(PC-CEPA V4.4 / October 2008)
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Year 2023 Emission Reductions Excluding Natural Sources by Control Measure
in the South Coast Air Basin (Annual Average Inventory - Tons/Day)

(A) Reductions Without Overlapping/Double-Counting With Other Control Measures (1)

		(Reductions - Tons/Day)						
Measure	Name	VOC	NOx	CO	SOx	PM10	PM2.5	NH3
CMB-01A	Reclaim NOx Reduction Phase I	0.00	2.00	0.00	0.00	0.00	0.00	0.00
CMB-01B	Reclaim NOx Reduction Phase II	0.00	1.00	0.00	0.00	0.00	0.00	0.00
CTS-01	Architectural Coatings [VOC]	2.21	0.00	0.00	0.00	0.00	0.00	0.00
CTS-02	Misc. Coatings, Adhesives, Solvents & Lubricants [VOC]	1.00	0.00	0.00	0.00	0.00	0.00	0.00
CTS-03	Mold Release[VOC]	0.83	0.00	0.00	0.00	0.00	0.00	0.00
FUG-02	LPG Transfer and Dispensing [VOC]	1.00	0.00	0.00	0.00	0.00	0.00	0.00
FUG-03	Fugitive Emissions [VOC]	1.00	0.00	0.00	0.00	0.00	0.00	0.00
OFRD-01	SOON [NOX]	0.00	7.47	0.00	0.00	0.00	0.00	0.00
OFRD-02	Locomotives [NOx,PM]	0.00	12.71	0.00	0.00	0.35	0.32	0.00
OFRD-03	Passenger Locomotives [NOx,PM]	0.00	2.96	0.00	0.00	0.07	0.06	0.00
Grand Total (Net)		6.04	26.31	0.00	0.00	0.41	0.38	0.00

Year 2023 Emission Reductions Excluding Natural Sources by Control Measure in the South Coast Air Basin (Annual Average Inventory - Tons/Day)

(B) Reductions With Overlapping/Double-Counting With Other Control Measures (2)

		(Reductions - Tons/Day)						
Measure	Name	VOC	NOx	CO	SOx	PM10	PM2.5	NH3
CMB-01A	Reclaim NOx Reduction Phase I	0.00	2.00	0.00	0.00	0.00	0.00	0.00
CMB-01B	Reclaim NOx Reduction Phase II	0.00	1.00	0.00	0.00	0.00	0.00	0.00
CMB-03	Commercial Space Heating [Nox]	0.00	0.18	0.00	0.00	0.00	0.00	0.00
CTS-01	Architectural Coatings [VOC]	2.21	0.00	0.00	0.00	0.00	0.00	0.00
CTS-02	Misc. Coatings, Adhesives, Solvents & Lubricants [VOC]	1.00	0.00	0.00	0.00	0.00	0.00	0.00
CTS-03	Mold Release[VOC]	0.83	0.00	0.00	0.00	0.00	0.00	0.00
FUG-02	LPG Transfer and Dispensing [VOC]	1.00	0.00	0.00	0.00	0.00	0.00	0.00
FUG-03	Fugitive Emissions [VOC]	1.00	0.00	0.00	0.00	0.00	0.00	0.00
OFRD-01	SOON [NOX]	0.00	7.47	0.00	0.00	0.00	0.00	0.00
OFRD-02	Locomotives [NOx,PM]	0.00	12.71	0.00	0.00	0.35	0.32	0.00
OFRD-03	Passenger Locomotives [NOx,PM]	0.00	2.96	0.00	0.00	0.07	0.06	0.00
Grand Total (with potential overlapping)		6.04	26.31	0.00	0.00	0.41	0.38	0.00

EMISSION SUMMARY FOR
(POINT, AREA, MOBILE SOURCE, AND OFF-ROAD MV)

Baseline Emissions	VOC	NOx	CO	SOx	PM10	PM2.5	NH3
Point source	35.66	5.15	36.63	2.48	12.44	9.40	12.60
Area source	217.69	35.16	129.42	2.02	123.22	44.07	70.51
RECLAIM	0.00	26.48	0.00	6.08	0.00	0.00	0.00
Total Stationary	253.36	66.79	166.05	10.57	135.66	53.47	83.11
On-road	67.25	125.04	590.62	1.87	21.49	9.92	13.37
Off-road	81.11	114.93	784.67	3.90	6.36	6.01	0.13
Aircraft	4.53	15.60	42.33	1.77	0.93	0.51	0.00
TOTAL	406.24	322.37	1583.67	18.12	164.44	69.92	96.60
EMISSION REDUCTIONS							
Point source	1.83	0.00	0.00	0.00	0.00	0.00	0.00
Area source	4.20	0.18	0.00	0.00	0.00	0.00	0.00
RECLAIM	0.00	3.00	0.00	0.00	0.00	0.00	0.00
Total Stationary	6.04	3.18	0.00	0.00	0.00	0.00	0.00
On-road	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Off-road	0.00	23.13	0.00	0.00	0.41	0.38	0.00
Aircraft	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	6.04	26.31	0.00	0.00	0.41	0.38	0.00
REMAINING EMISSIONS							
Point source	33.83	5.15	36.63	2.48	12.44	9.40	12.60
Area source	213.49	34.98	129.42	2.02	123.22	44.07	70.51
RECLAIM	0.00	23.48	0.00	6.08	0.00	0.00	0.00
Total Stationary	247.32	63.62	166.05	10.57	135.66	53.47	83.11
On-road	67.25	125.04	590.62	1.87	21.49	9.92	13.37
Off-road	81.11	91.80	784.67	3.90	5.95	5.63	0.13
Aircraft	4.53	15.60	42.33	1.77	0.93	0.51	0.00
TOTAL	400.21	296.06	1583.67	18.12	164.02	69.54	96.60
NSR/Set-Aside	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Public Funding	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GRAND TOTAL (T/D)	400.21	296.06	1583.67	18.12	164.02	69.54	96.60
Mobility Adjustments (3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(1) Emission reductions for individual measures were estimated based on the sequence of listing contained here. When the sequence changes, reductions from each measure could be affected, but the net total remain the same. The purpose of this table is to estimate total emission reductions without overlapping or double-counting between measures.
(2) Emission reductions for individual measures were estimated in the absence of other measures. Therefore, the sequence of listing does not affect the reduction estimates. The purpose of this table is to provide emission reduction estimates for Appendix IV control measure summary tables as well as cost effectiveness analysis.
(3) Mobility Adjustment includes TCM-01, ATT-01, ATT-02, ATT-05 and adjustments are reflected in the CEPA baseline beyond year 2000.

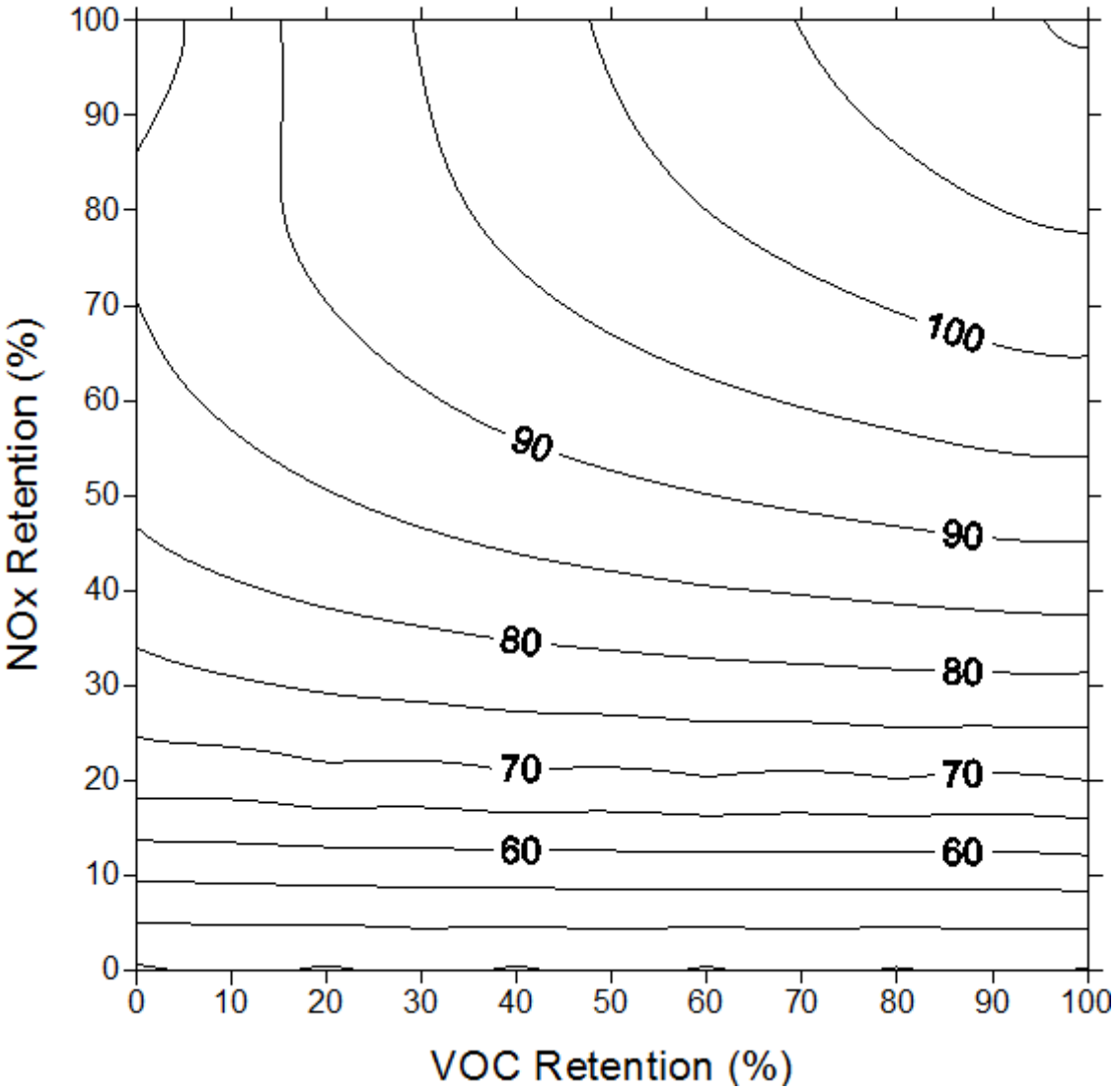
Attachment 6

CAMx Modeling (To Be Provided)

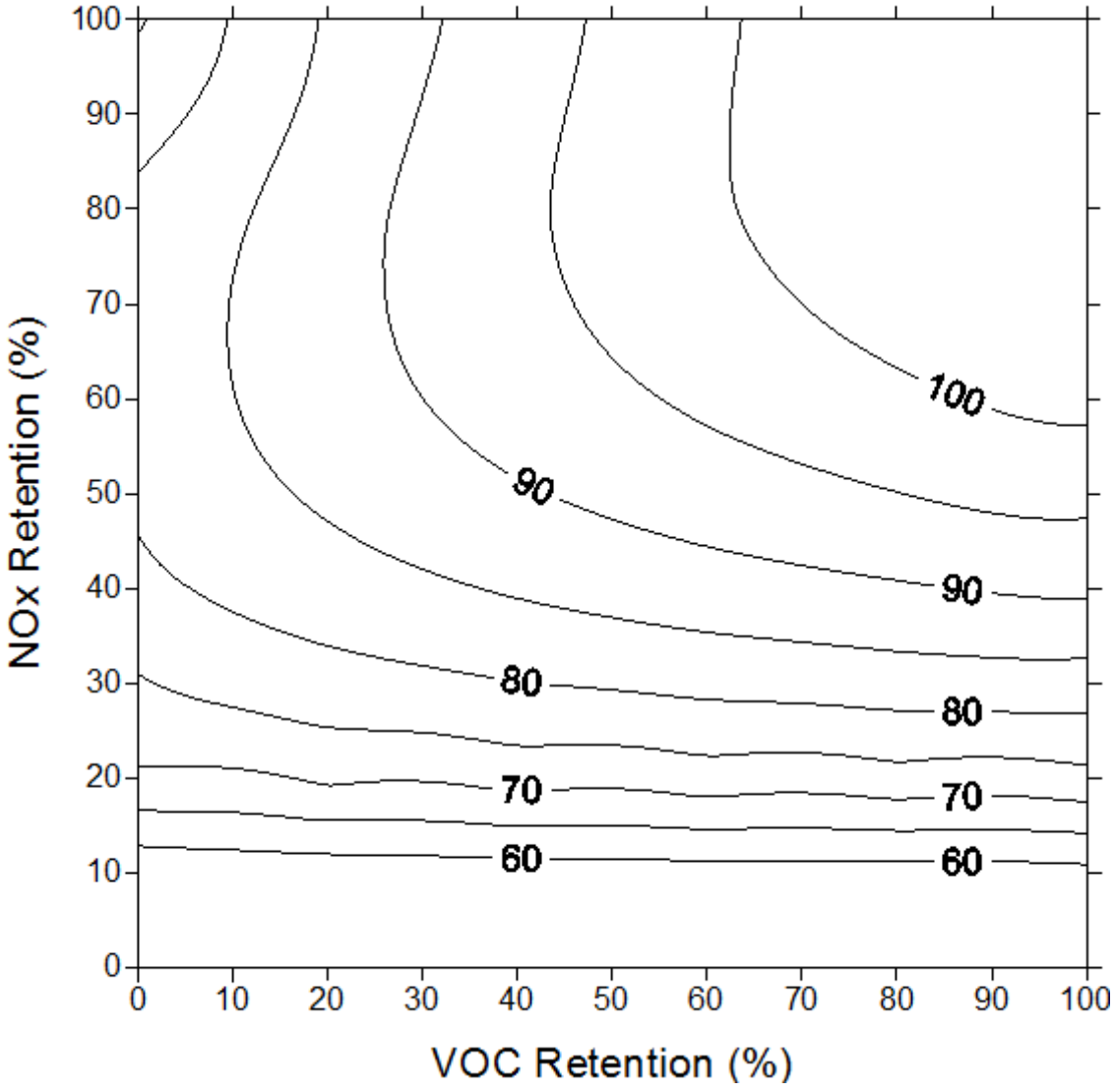
Attachment 7

2023 8-Hour Ozone Isopleths

The ozone isopleths, commonly referred as Empirical Kinetics Modeling Approach (EKMA) plots show ozone concentrations predicted under a given combination of VOC and NOx emissions. The upper right corner represents the projected VOC and NOx emissions in 2023 with full implementation of all adopted control measures (baseline). Moving down and left on each figure corresponds to relative emissions reductions of NOx (down) and VOC (left). The lines within each figure represent the ozone design value at that location for a given amount of NOx and VOC. The shape of the EKMA plots are different at different locations in the Basin due to the complex photochemical reactions involved in ozone formation. These O3 isopleths are an important tool to provide guidance in the choice of control strategies by indicating the amount of reductions needed to meet the current and future air quality standards.



2023 Crestline 8-Hour Ozone Isopleth



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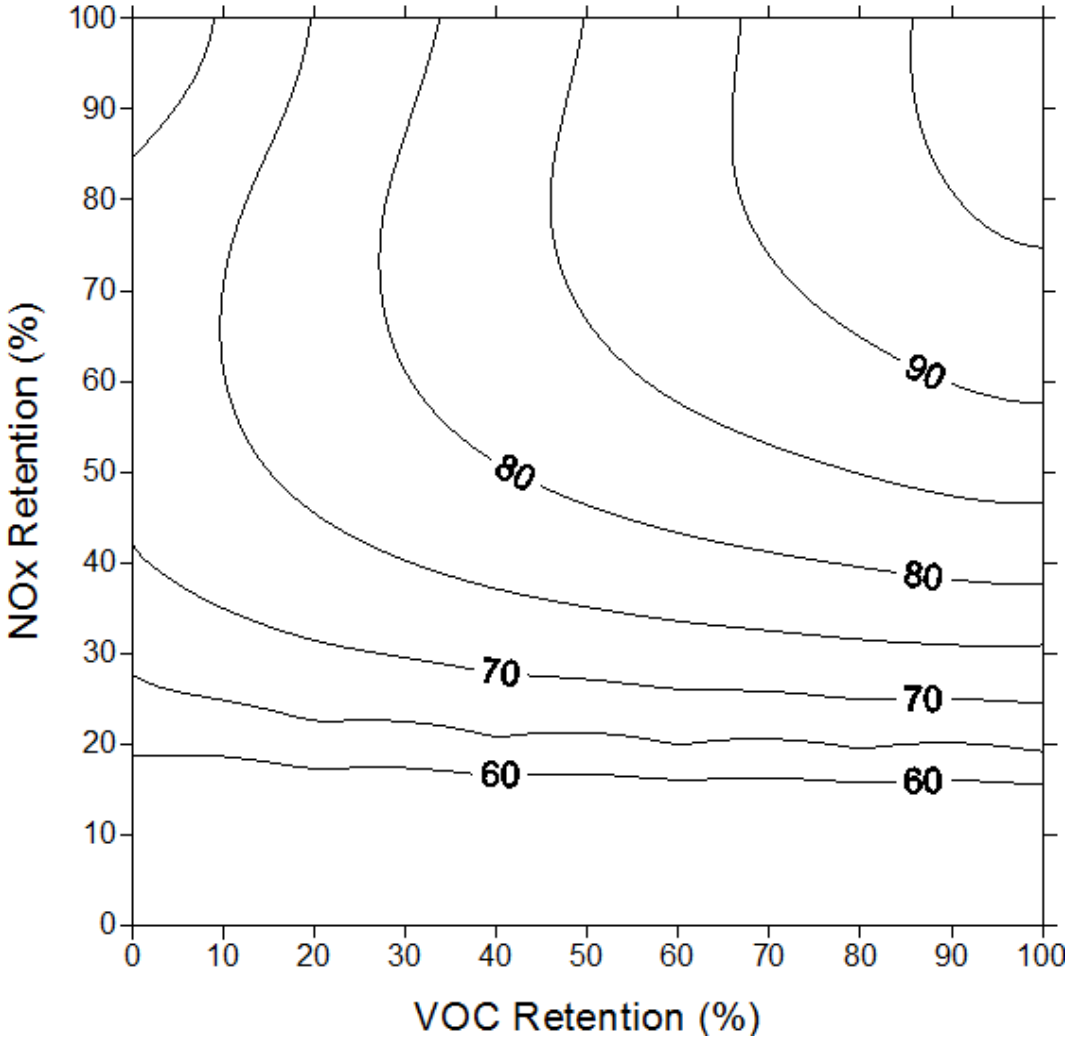

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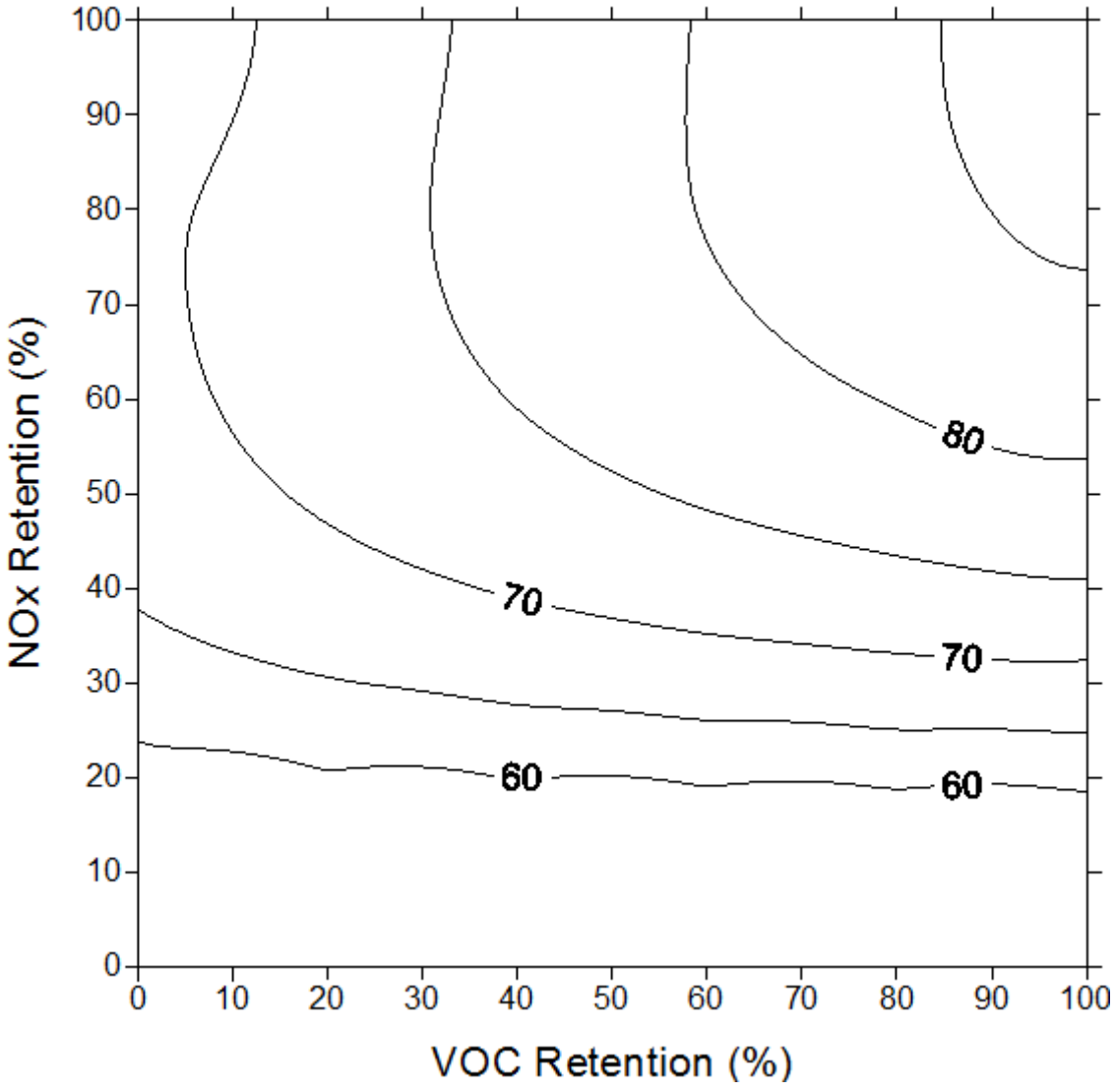

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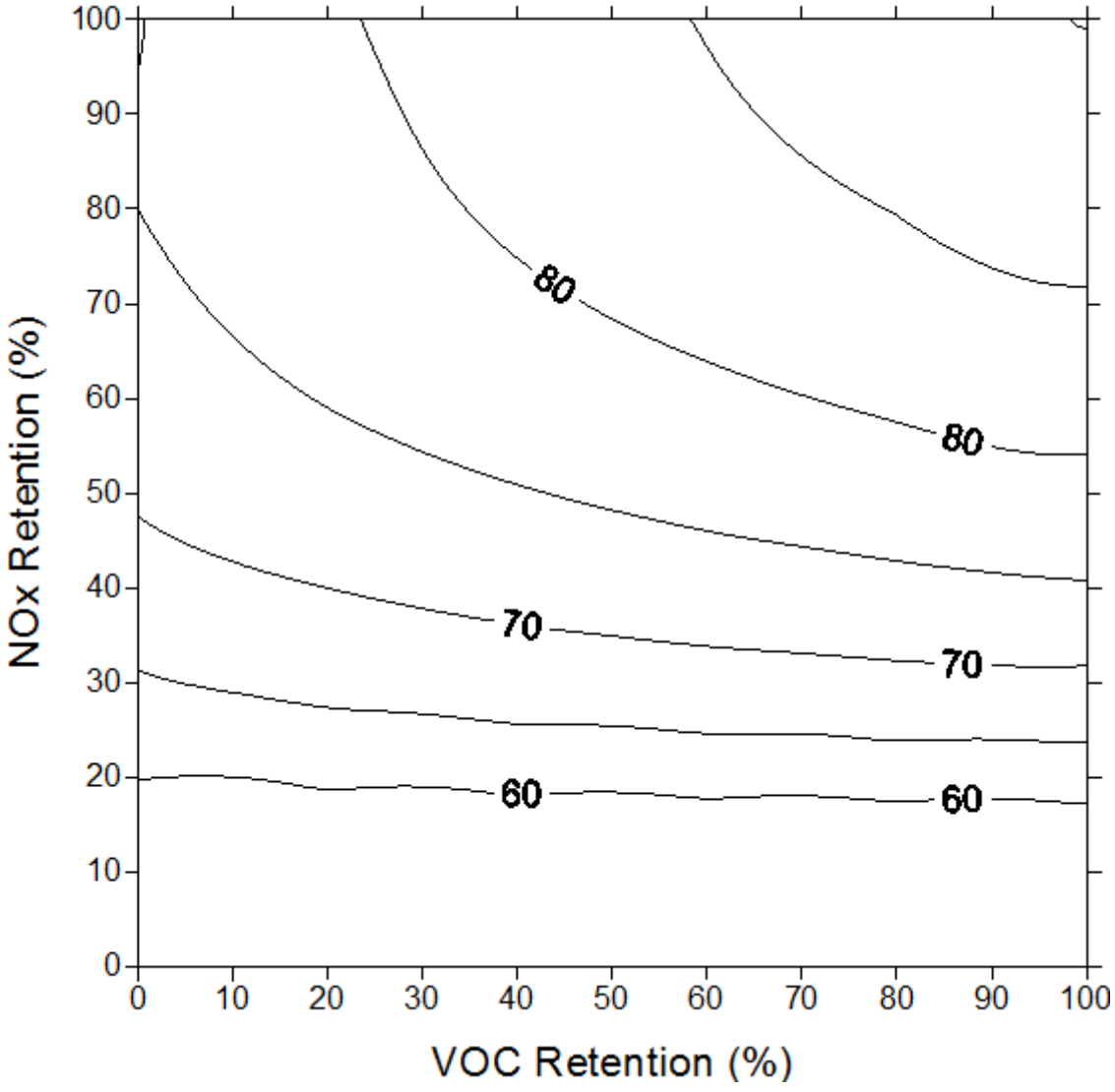

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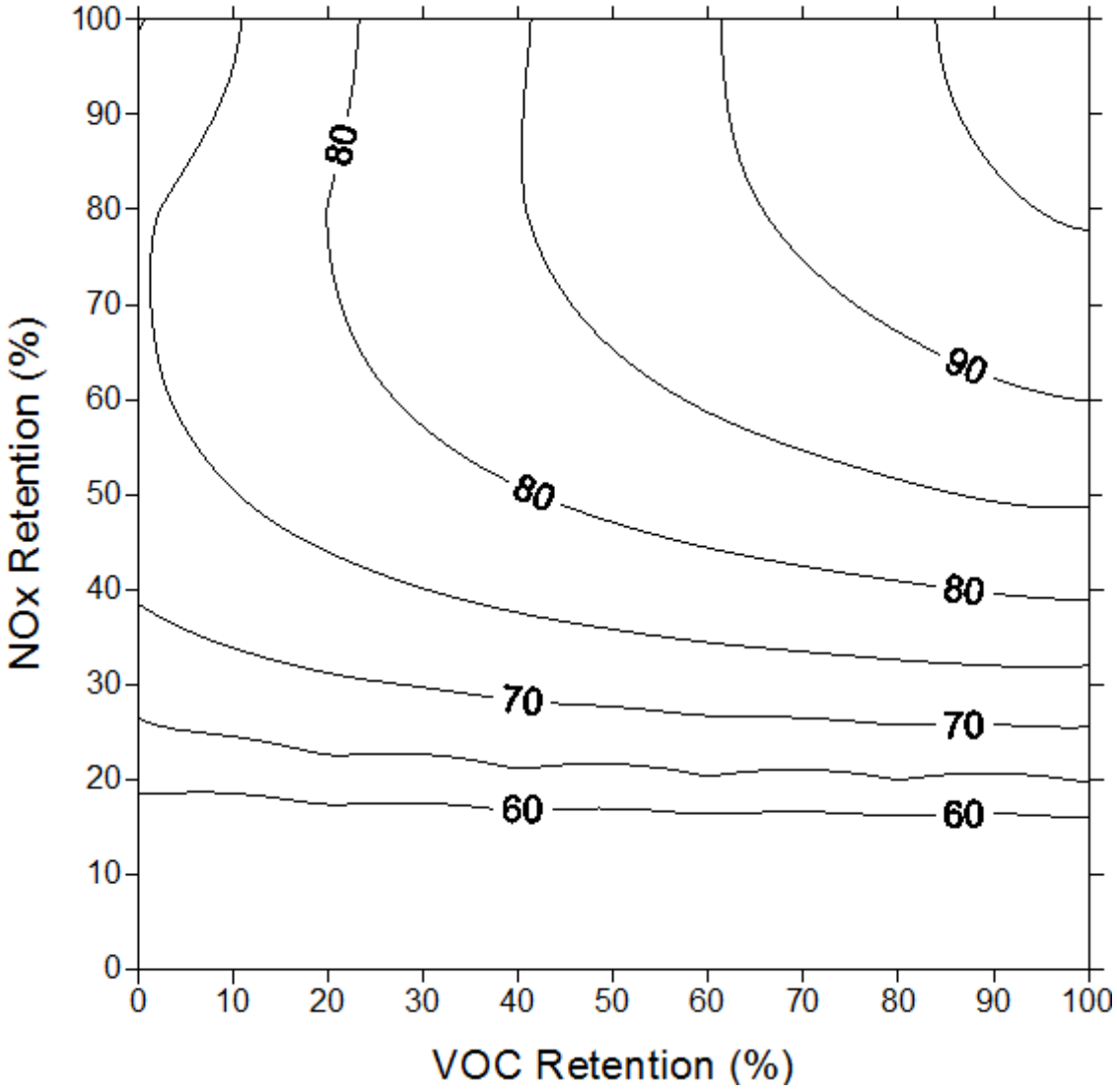

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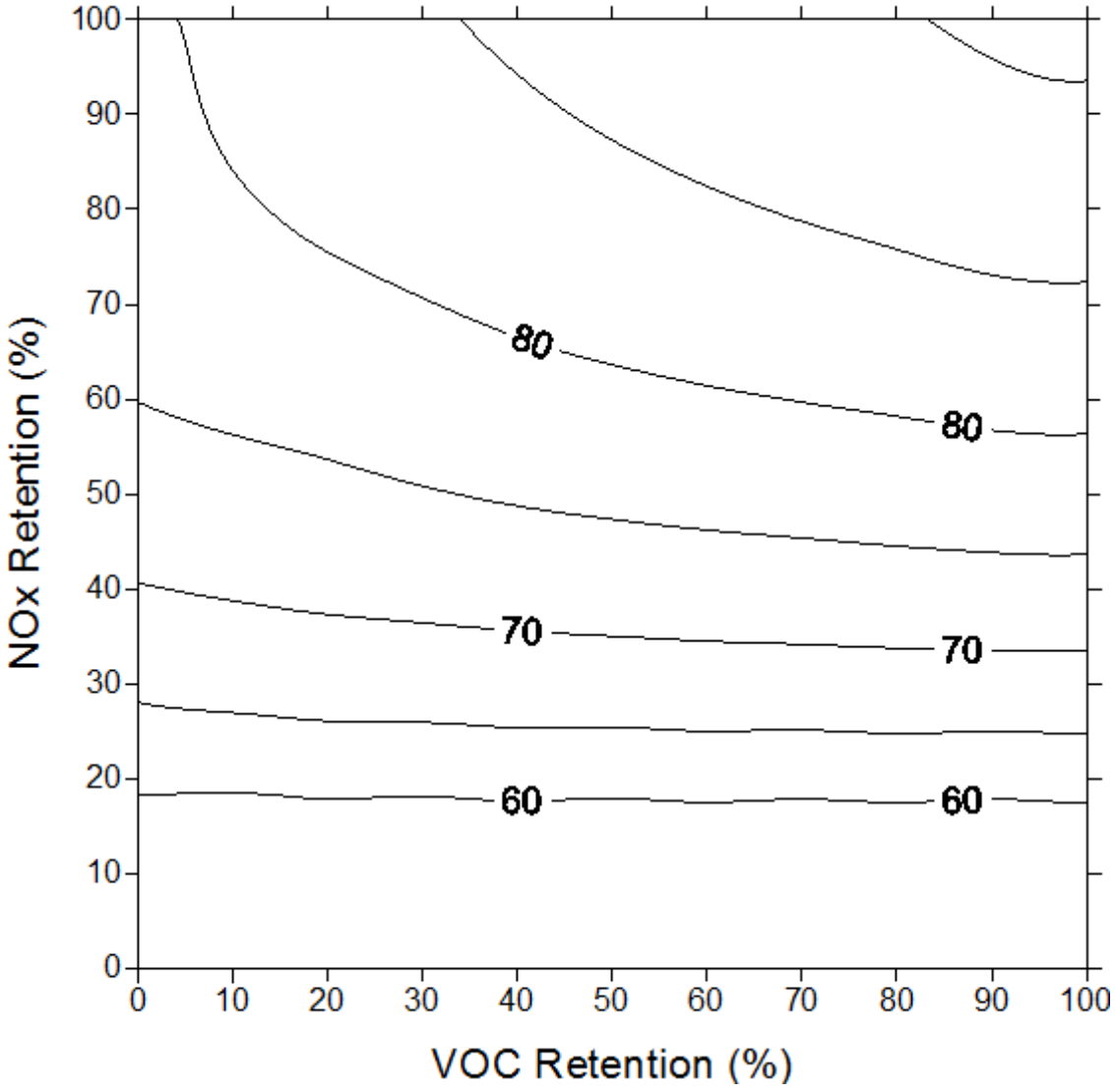

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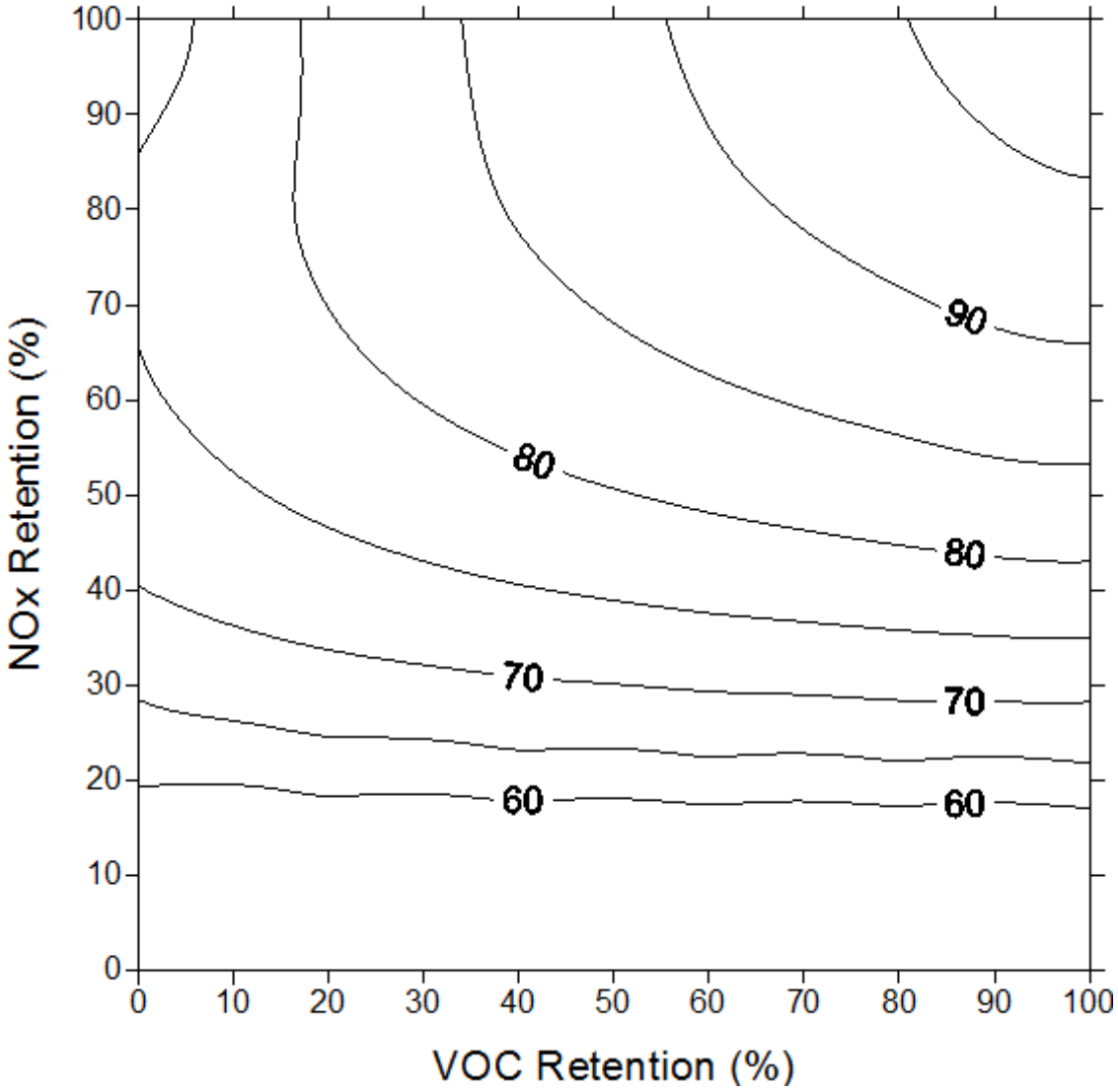

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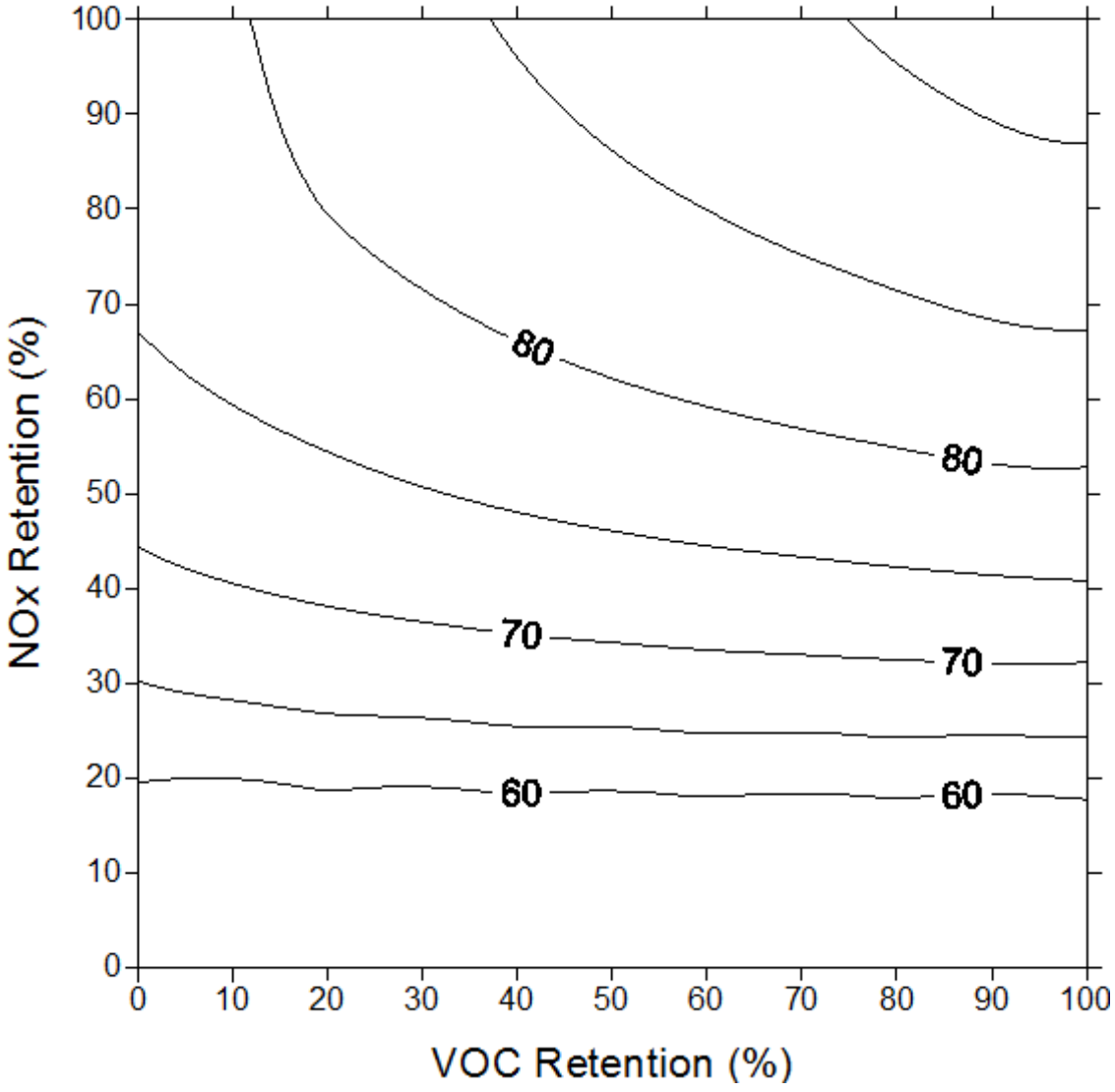

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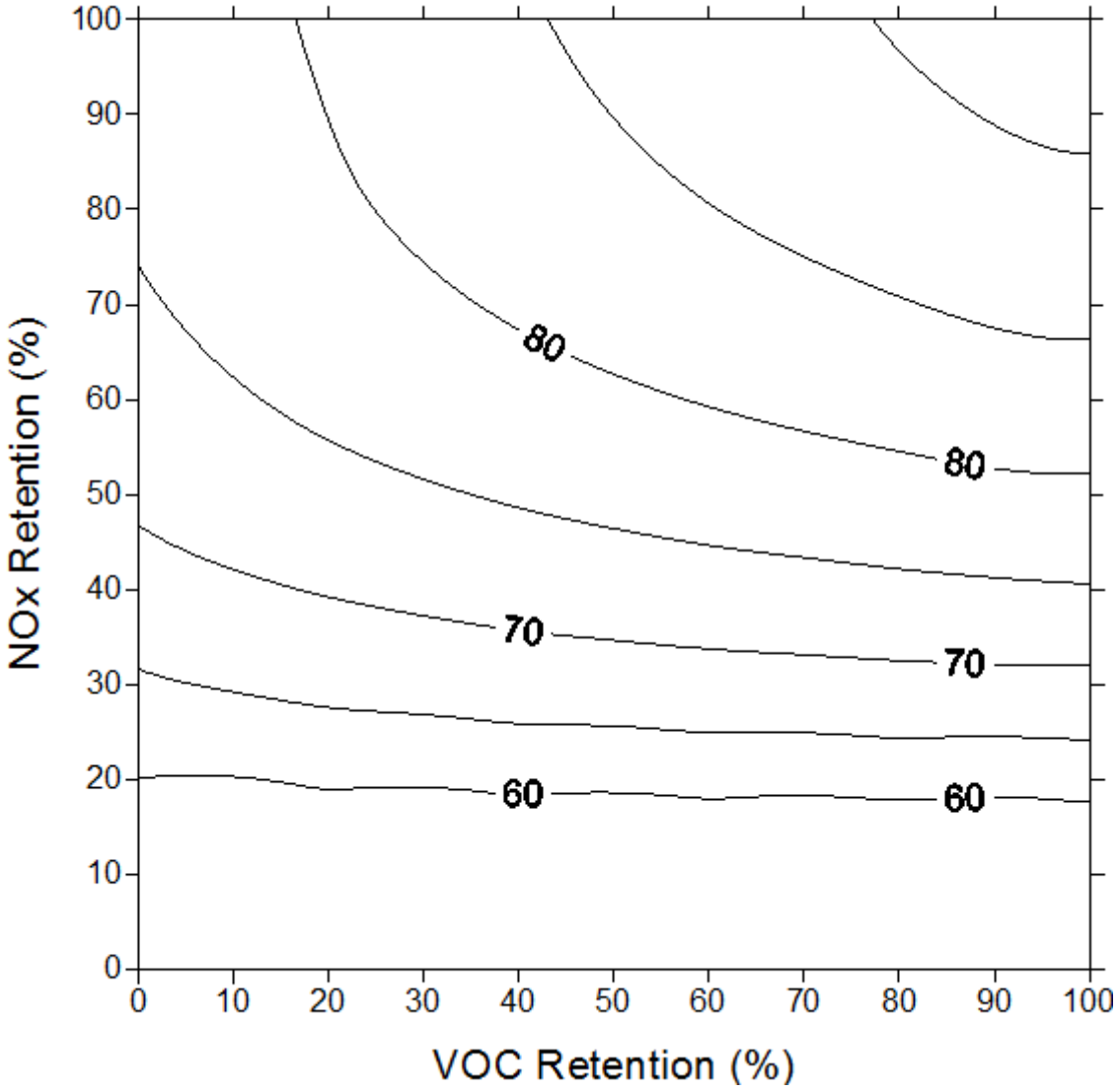

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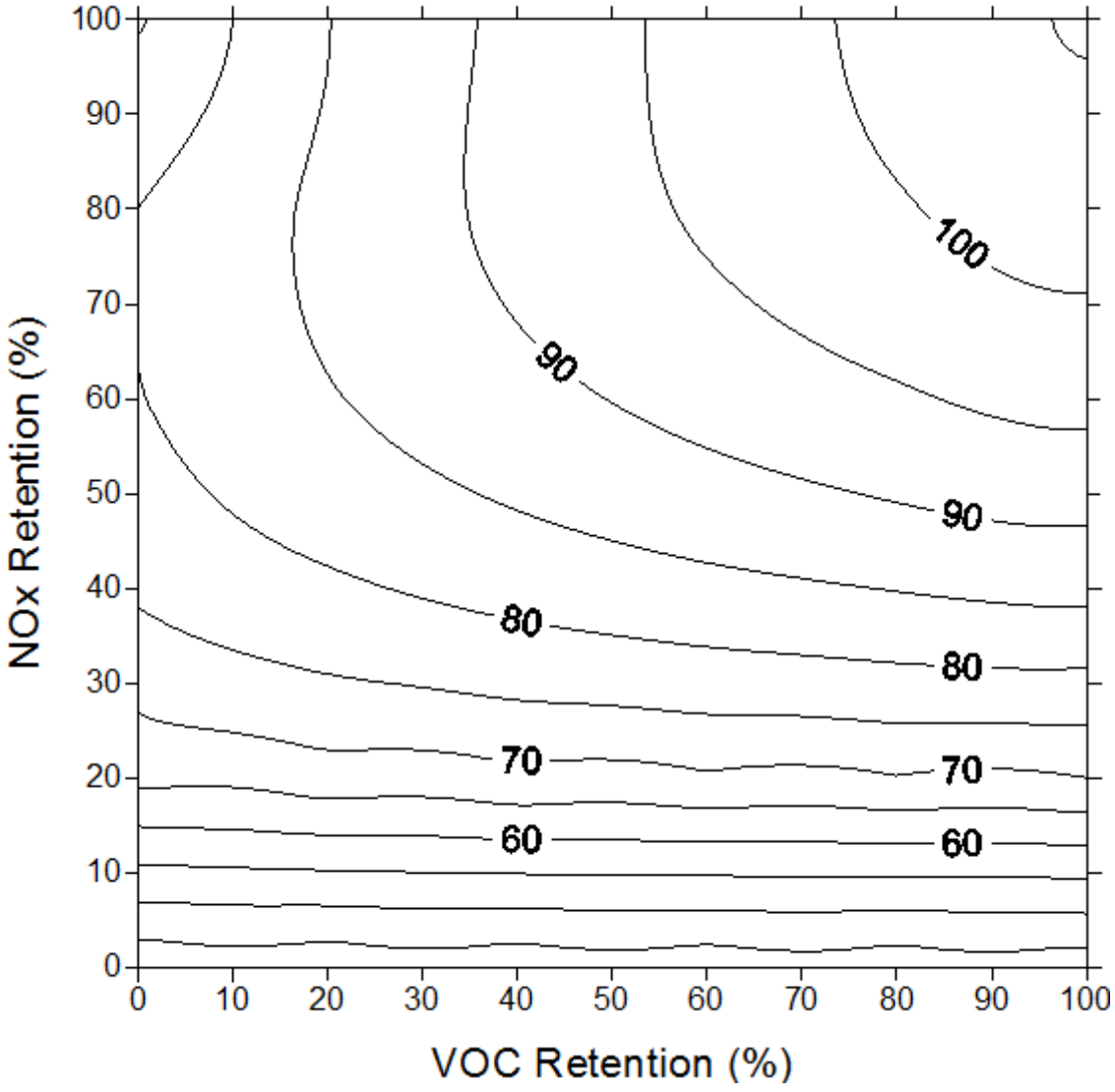

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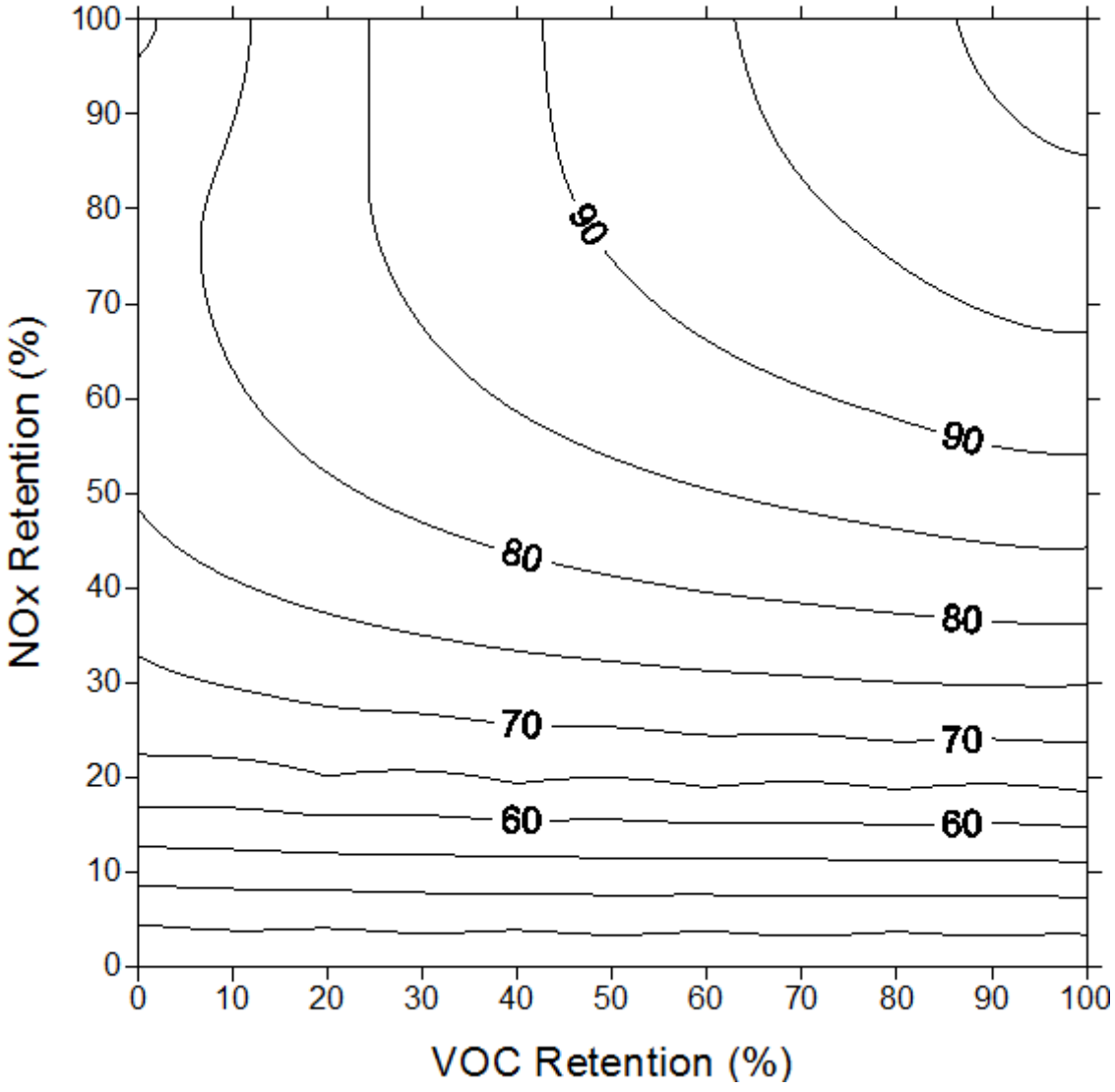

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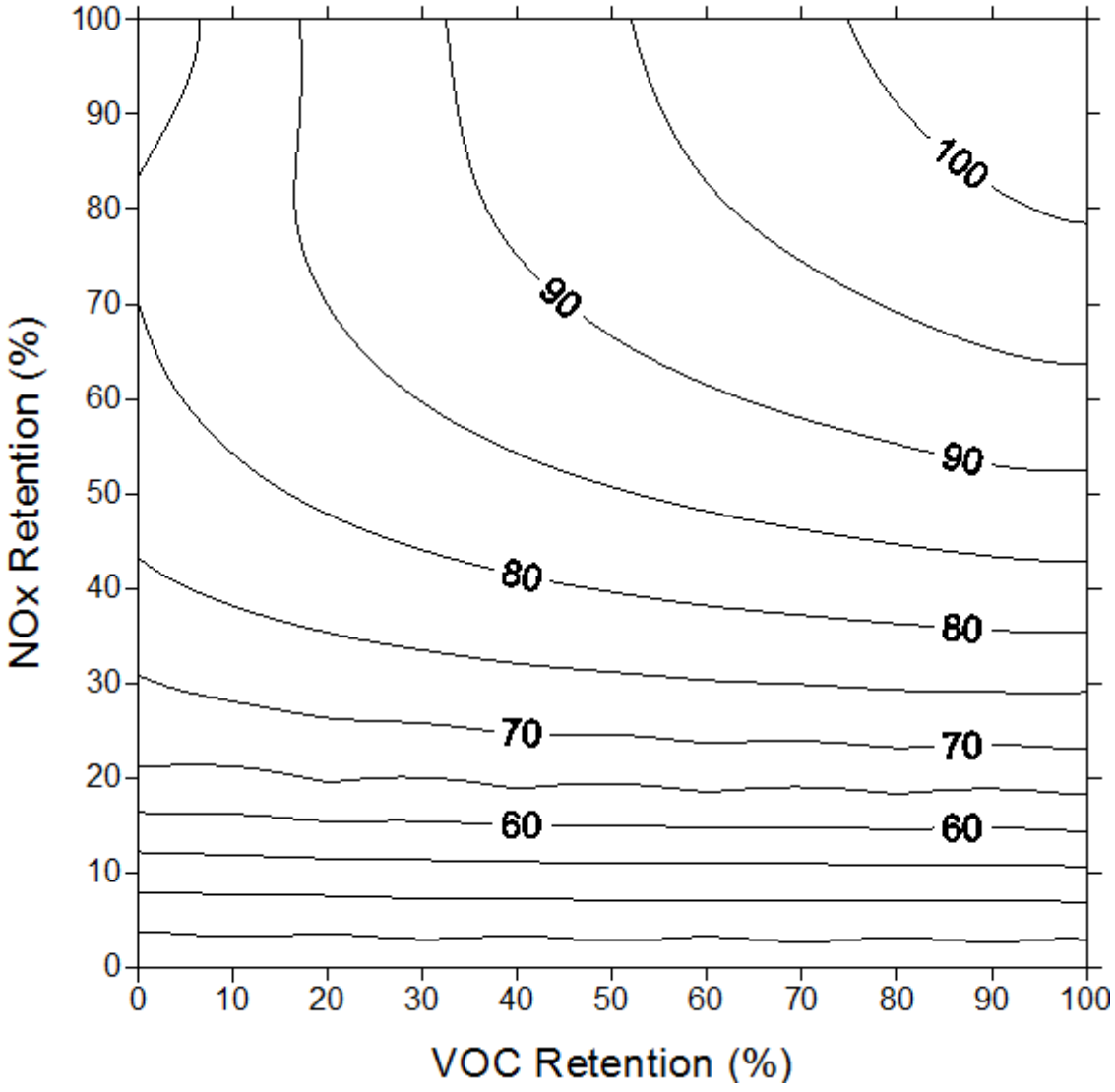

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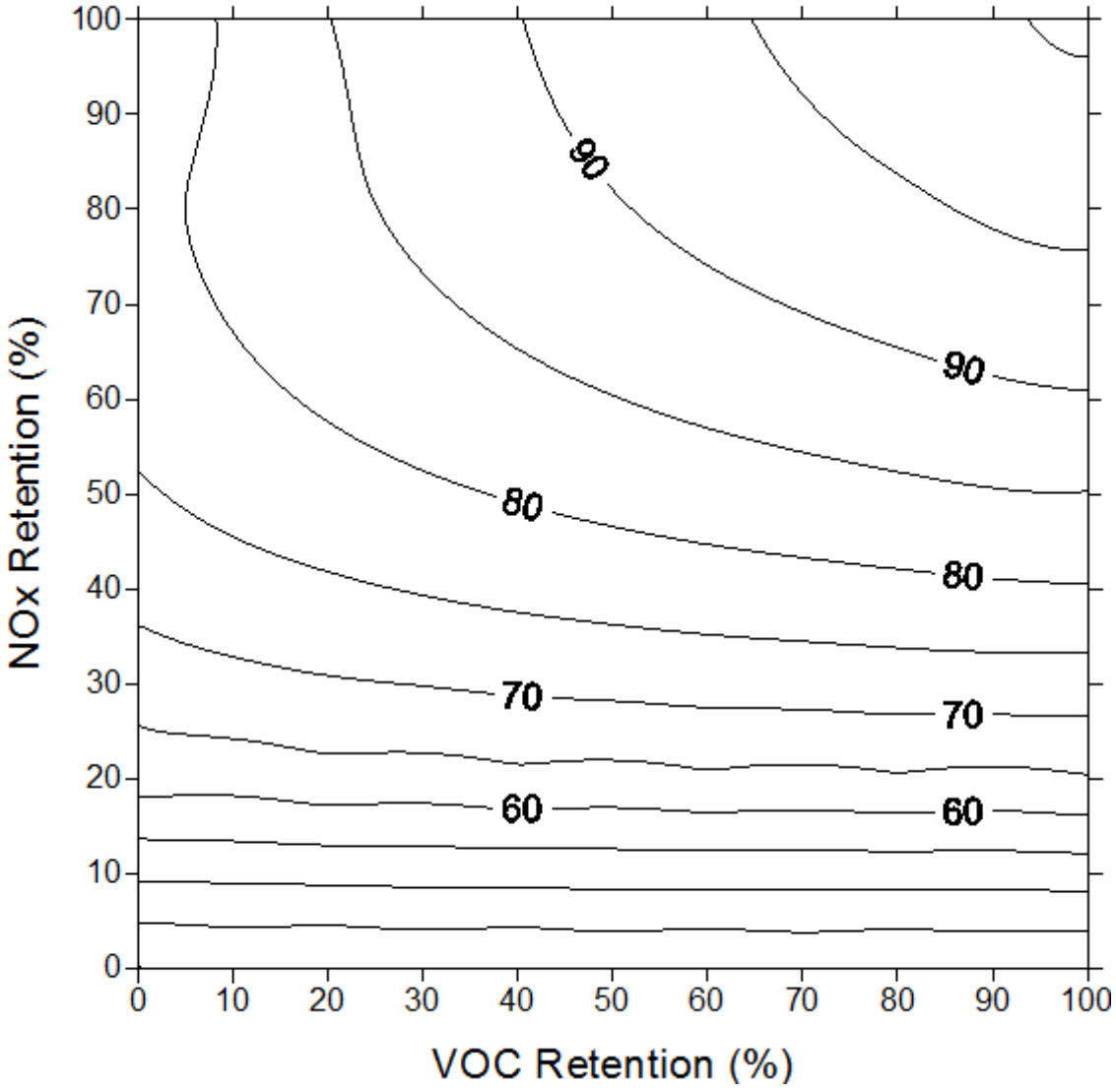

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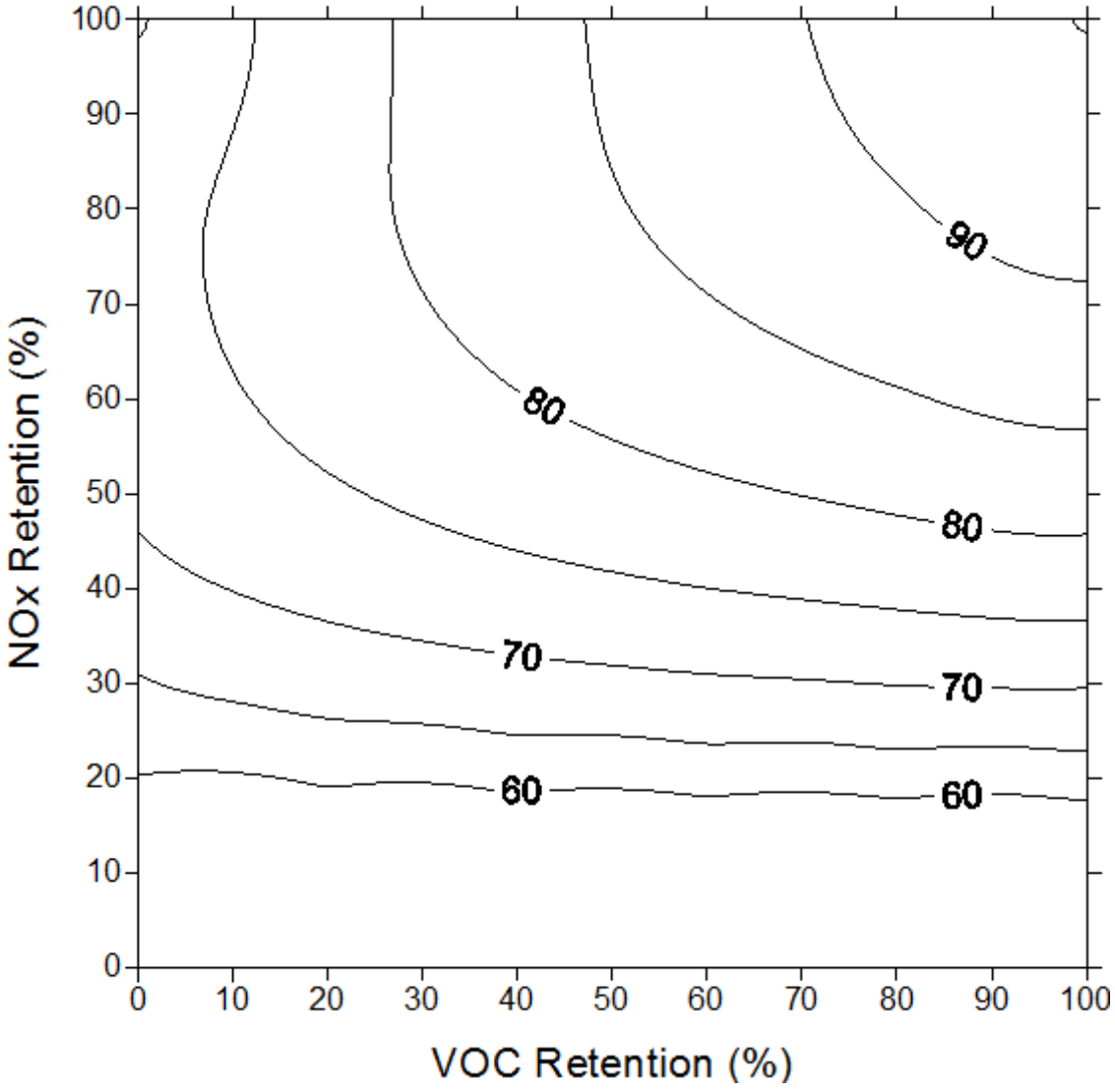

2023 Miraloma 8-Hour Ozone Isopleth

Attachment-8

Relative Contributions of Precursor Emissions Reductions to Simulated Controlled Future-Year 24-hour PM2.5 Concentrations

Relative Contributions of Precursor Emissions Reductions to Simulated Controlled Future-Year 24-hour PM2.5 Concentrations

The concept of establishing relative weights of precursor emissions to simulated reductions in predicted PM2.5 was introduced in the 2007 AQMP. The procedure estimated per ton reductions of the five main contributing emissions to corresponding regional reductions of PM2.5 species concentrations. The five major precursors that contribute to the development of the ambient PM2.5 aerosol include ammonia, NOx, SOx, VOC, and directly emitted PM2.5. The contribution of ammonia emissions was embedded as a component of the SOx and NOx factors since ammonium nitrate and ammonium sulfate are the resultant particulates formed in the ambient chemical process. Various combinations of reductions in these pollutants could all provide a path to clean air.

In the 2007 AQMP the relative weights of the precursor emissions to reductions in PM2.5 species concentrations were calculated on a regional basis. Overall emissions reductions from the base year (2005) to the controlled 2014 emissions scenario were divided into the respective projected species concentration reductions averaged for a set of representative air quality stations distributed throughout the Basin. The analysis did not focus directly on the site reporting the maximum observed PM2.5 impact (Riverside-Rubidoux). The Final 2007 AQMP established a set of factors to relate regional per ton precursor emissions reductions to PM2.5 air quality improvements based on the annual average concentration. One TPD reduction of NOx was projected to reduce regional annual PM2.5 by 0.00345 $\mu g/m^3$. The Basin averaged conversion factors resulting from this analysis were submitted as part of the 2007 SIP (Appendix C, of the CARB staff report, "PM2.5 Reasonable Further Progress Calculations"[1]) and approved by U.S. EPA. The normalized-equivalent NOx emissions conversion factors for annual PM2.5 in 2014 were as follows: VOC: 0.43, NOx: 1.0, directly emitted PM2.5: 9.86 and SOx: 15.03.

The Draft Final 2012 AQMP provides a similar set of factors, but this time directed at 24-hour PM2.5 based on the 2012 CMAQ simulation results for the precursor emission reductions from 2008 to the controlled 2014 scenario. The projected reductions in 24-hour PM2.5 component species concentrations from implementation

[1] http://www.arb.ca.gov/planning/sip/2007sip/southcoast/staffrepappc.pdf

of the control strategy in 2014 were averaged for six regionally representative locations having speciated data. These sites included Riverside-Rubidoux, downtown Los Angeles, Fontana, Long Beach, South Long Beach and Anaheim.

Riverside-Rubidoux was the historic PM2.5 maximum concentration location in the Basin (annual and 24-hour) and is located less than 8 km downwind of the Mira Loma monitoring station. Rubidoux and Mira Loma share a common emissions profile that is dominated by local dairy emissions coupled with mobile source emissions reflecting both freeway traffic and an emerging warehouse distribution center truck profile. The Fontana site shares the traffic and warehouse emissions profiles together with local emissions from industrial activities. The Fontana site will periodically be impacted from transported emissions from the dairy farms as well. Both Fontana and Rubidoux are downwind receptors of regional emissions from the major metropolitan sources that have incorporated a mix of primary and reactive chemical species.

By comparison, the metropolitan central Los Angeles site reflects a mix of emissions from heavy local and freeway traffic, railway and goods movement operations and significant industrial activities from a varying profile of small to large sources. The Long Beach site is in close proximity to three heavily traveled freeways including the commuter impacted I405 and the heavy diesel truck impacted I710. The site is also located directly downwind of refineries and rail transfer facilities. The South Long Beach monitor is directly impacted from goods movement trucking and rail emissions as well as the ocean going vessel (OGV) emissions emanating from the Ports of Los Angeles and Long Beach. The Anaheim site reflects a neighborhood profile including both freeway and local-residential traffic and light to moderate industrial activities. Both Anaheim and Los Angeles are downwind of OGV and port emissions. Typical Basin wind flow places Los Angeles as a receptor of these source emissions during the morning hours after which the rotation of the sea breeze targets the Anaheim area in the afternoon and early evening hours.

Calculation of the Draft Final 2012 AQMP relative contributions of the precursor emissions to the regionally averaged reductions in the component 24-hour PM2.5 species followed the procedure as in the 2007 SIP. Table 1 summarizes the relative precursor contributions to 2014 24-hour PM2.5 from 1-TPD emissions reduction to simulated reductions of VOC, NOx, SOx and directly emitted PM2.5. (Again, it is

important to note that the reductions of ammonium are incorporated together with bonded water in the estimation of reduced regional sulfate and nitrate). Compared with the annual Basin averaged conversion factors included in the 2007 AQMP, 1-TPD of directly PM2.5 emissions reductions resulted in 6 times more reduction of mass for the 24-hour PM2.5. For the 2014 controlled scenario, 1-TPD of directly emitted PM2.5 resulted in an average 0.2132 $\mu g/m^3$ improvement in ambient PM2.5. 1-TPD reductions of VOC, NOx and SOx emissions resulted in between 2 to 4 times more mass reduction for the 24-hour PM2.5 than estimated for the Basin annual average concentration.

Table 2 provides the normalized NOx-equivalent conversion factors that relate the precursor emissions to PM2.5 species reduction factors to a common currency, NOx emissions. The 24-hour PM2.5 factors place a greater weight on the reduction of directly emitted particulate while maintaining the emissions contribution factor for VOC and nominally lowering the factor for SOx compared with the 2007 SIP factors for annual PM2.5. Overall the normalized-equivalent NOx emissions conversion factors for 24-hour PM2.5 for the 2014 controlled scenario were: VOC: 0..3, NOx: 1.0, SOx: 7.8 and directly emitted PM2.5: 14.8. As with the annual estimation, the factors are valid for the 2014 controlled emissions scenario. Figure 1 depicts the relative PM2.5 reductions for ammonium nitrate, ammonium sulfate, organic carbon and particulates projected from the 2008 base year to the simulated 2014 control scenario.

TABLE 1

Relative Contributions of Precursor Emissions Reductions to 2014 Simulated Controlled Future-Year 24-hour PM2.5 Concentrations

PRECURSOR	**PM2.5 COMPONENT ($\mu g/m^3$)**	**DRAFT FINAL 2012 AQMP BASIN AVERAGED 24-HOUR PM2.5 CONVERSION FACTORS: 1-TPD EMISSIONS TO PM2.5 CONCENTRATION ($\mu g/m^3$)**
VOC	Organic Carbon	0.0046
NOx	Nitrate	0.0144
SOx	Sulfate	0.1115
PM2.5	Elemental Carbon & Others	0..2132

TABLE 2

Normalized NOx-Equivalent Conversion Factors

PRECURSOR	PM2.5 COMPONENT ($\mu g/m^3$)	DRAFT FINAL 2012 AQMP STANDARDIZED CONTRIBUTION TO AMBIENT 24-HOUR PM2.5 MASS
VOC	Organic Carbon	Factor of 0.3
NOx	Nitrate	Factor of 1.0
SOx	Sulfate	Factor of 7.8
PM2.5	Elemental Carbon & Others	Factor of 14.8

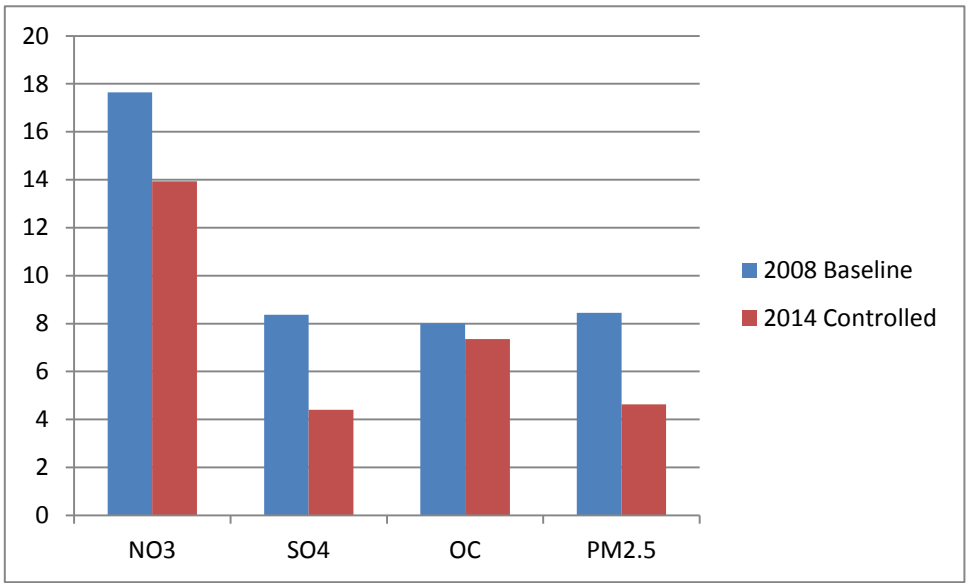

FIGURE 1

Simulated 2014 Controlled Future-Year 24-hour PM2.5 Concentrations by Species