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Governor

THE CENTRAL CALIFORNIA OZONE STUDY

PIER FINAL PROJECT REPORT

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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Energy Commission), annually awards up to $62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Energy-Related Environmental Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies

The Central California Ozone Study is the final report for the Central California Ozone Study, Interagency Agreement 700-98-027, between the Energy Commission and the California Air Resources Board, conducted by the California Air Resources Board, San Joaquin Valley Study Agency, and their contractors. This project contributes to the Energy-Related Environmental Research program.

For more information on the PIER Program, please visit the Energy Commission's website www.energy.ca.gov/pier/ or contract the Energy Commission at (916) 654-5164.

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Abstract

The Central California Ozone Study (CCOS) is one component of the Central California Air Quality Studies (CCAQS), which were conducted to understand the causes of air pollution in central California. The other component of CCAQS is the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS). The field campaigns for both studies were conducted in 2000, and data analysis and modeling for both studies are now in progress. An agreement was made between the Energy Commission and the California Air Resources Board to conduct air quality studies through the California Air Resources Board, San Joaquin Valleywide Study Agency, and their contractors. As a part of this agreement, a comprehensive database of aerometric data was collected for central California for the summer of 2000. This data gathering effort also included aircraft measurements of plumes from two major utility stack sources (at Moss Landing and Pittsburg) in central California. As a separate effort, the stack emissions of oxides of nitrogen and volatile organic compounds from these two facilities were characterized. The analysis of the aircraft data, together with improved treatment of stack plumes in grid-based photochemical models, revealed that individual plumes did not have a significant impact on the regional air quality of central California. Using the meteorological and air quality data collected during the summer of 2000, prognostic meteorological fields were developed for two ozone episodes. Subsequent air quality modeling that utilized the actual meteorological measurements and prognostic simulations formed the basis for the recent one-hour ozone State Implementation plan for the San Joaquin Valley. This interagency agreement also forged a coordination mechanism to conduct joint future air quality studies in central California.

Keywords: Central California Ozone Study, CCOS, Central California Air Quality Studies (CCAQS), Moss Landing, Pittsburg, NOx, volatile organic compounds, VOCs, ozone

Executive Summary

Introduction

The San Joaquin Valley of California and its surrounding areas (such as the Sacramento Valley, the coastal regions, and mountainous areas) experience elevated one-hour ozone concentrations during the ozone season, typically from June to September. The time span is even longer for elevated eight-hour ozone concentrations. These areas, except for the coastal regions, report several violations of national and state ambient air quality standards for both one-hour and eight-hour ozone each year.

Long-range transport of pollutants, including transport between air basins, plays an important role in these elevated ozone events. The current understanding of pollutant transport needs improvement, especially in estimating the contributions of power plant plumes since elevated plumes have the potential to travel long distances, producing air quality impacts in regions far from their release.

The Central California Ozone Study (CCOS) is one component of the Central California Air Quality Studies (CCAQS). The other component is the California Regional Particulate Matter Air Quality Study (CRPAQS). This document describes the research projects conducted under an interagency agreement between the Energy Commission and the California Air Resources Board to support CCOS.

The San Joaquin Valleywide Air Pollution Study Agency (Study Agency), a joint powers authority, governs CCAQS. The Study Agency has a governing board, a Policy Committee, and two Technical Committees (one for CCOS and another for CRPAQS). The Policy and Technical committees are made up of four main entities. They are the California Air Resources Board (ARB), the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), the federal government, and industry. The Policy Committee includes senior managers from the four entities. The Technical Committee includes technical experts from the four main entities, other air quality management districts, and academia. The exact composition of these committees varies with time, but the four main entities are always represented.

The field study portion of CCOS, conducted during the summer of 2000, is complete, and nearly all field data are stored in the CCAQS database. A detailed description of the field study and measurements are provided in Appendices A–C. The CCOS is now in the modeling and data analysis phase. One of the episodes captured during the field study, the period July 30–August 2, 2000, is being modeled extensively and formed the basis for the one-hour ozone State Implementation Plan (SIP) for the San Joaquin Valley (SJV) nonattainment area.

Objectives

The California Energy Commission has three objectives for this project. They are:

- To assure that appropriate data are collected and analytical models are developed to use in gaining a better understanding of ozone dynamics in central California;
- To develop a better understanding of the role of thermal power plant plumes in contributing to regional air quality problems in the study region, including development of data and methods needed to assure the proper treatment of these plumes in the models used to develop air quality management plans; and
- To provide the technical information necessary to develop interbasin/ interpollutant offset rules for the central California region.

Outcomes

This project produced the most comprehensive database on summertime meteorology in the northern and central California region. These data have facilitated the application of state-of-the-science prognostic meteorological models in the region. The results of these simulations were used in the one-hour ozone SIP for the San Joaquin Valley nonattainment area.

This project also advanced the understanding of power plant plume impacts on Central California's air quality. The modeling studies indicated that the impact of these plumes on air quality was minimal to moderate, but far less than that observed in the eastern United States.

Conclusions

This work resulted in perhaps the most complete database of meteorological and air quality measurement available for any region in the world. Several simulations using a prognostic meteorological model (MM5) were completed using the measurements. Using the results of these simulations, researchers carried out air quality simulations to assess the impact of emission control scenarios on one-hour ozone concentrations observed in central California. Results of these simulations were used in the preparation of the recent Ozone SIP for the San Joaquin Valley. The next stage of meteorological modeling is to model the entire summer of 2000 to support a seasonal air quality modeling effort.

The plume measurements using both aircraft and conventional methods revealed that California plumes tend to be small and less reactive compared to those in the other parts of the United States. The inclusion of a plume-in-grid treatment in grid-based photochemical models did not produce results significantly different than those produced by the conventional treatment of the plumes.

This study's researchers are aware of two protocols currently under development to assess interbasin/interpollutant transport offsets. The first is a draft protocol currently being refined by the United States Environmental Protection Agency (EPA). The second is a draft protocol being developed by the CCOS Technical Committee. Neither of these protocols are currently available in a form suitable to submit as part of this report. However, the second protocol is now part of a larger interagency effort to outline procedures to access interbasin transport for eight-hour ozone SIP purposes. Once completed, it will become the standard transport

assessment protocol for central and northern California. Modeling efforts based on this protocol will proceed after the conclusion of seasonal air quality modeling for the entire summer of 2000.

The staff of the Energy Commission participated in both the Technical and Policy committees of the San Joaquin Valleywide Air Pollution Study Agency.

Recommendations

Although the improved treatment of emissions from the largest utility point sources did not have a significant impact on one-hour ozone concentrations in central California, this study's researchers encourage the Energy Commission to investigate if these improved treatments would make any significant impacts on both eight-hour ozone and 24-hour particulate matter concentrations.

This study's researchers also encourage the Energy Commission to participate in the development and application of transport assessment protocols developed by both the EPA and CCAQS. Due to the variability in meteorology, it is reasonable to expect that the direction and the magnitude of the transport would vary throughout the year. Thus, care should be exercised when generating a standard list of interbasin/interpollutant offsets. This list should also be updated periodically as new information becomes available.

The researchers strongly encourage continued participation by the Energy Commission in the Policy and Technical committees of the Study Agency. This continued participation will be beneficial to the Study Agency and the Energy Commission, and would provide a coordinating mechanism for air quality studies conducted by both entities.

Benefits to California

This effort resulted in perhaps the most comprehensive database of aerometric data collected in any region of the world. This data will allow California to conduct in-depth investigations to understand the causes of air pollution and the efficacy of plausible control strategies.

This study also illustrated that the impact of individual utility point sources on the regional air quality in central California is less significant than that found for other regions in the United States. Improved coordination between two major entities conducting air quality studies was forged as a result of this collaborative study.

1.0 Introduction

1.1. Background and Overview

The San Joaquin Valley of California and its surrounding areas (such as the Sacramento Valley, the coastal regions, and mountainous areas) experience elevated one-hour ozone concentrations during the ozone season, typically from June to September. The time span is even longer for elevated eight-hour ozone concentrations. These areas, except for the coastal regions, report several violations of the national and state ambient air quality standards for both one-hour and eight-hour concentrations each year.

Long-range transport of pollutants, including transport between air basins, plays an important role in these elevated ozone events. However, our current understanding of long-range transport needs improvement, especially in estimating the contributions of power plant plumes, since the elevated plumes have the potential to travel long distances and to produce air quality impacts in regions far from their release.

The Central California Ozone Study (CCOS) is one component of the Central California Air Quality Studies (CCAQS). The other component is the California Regional Particulate Matter Air Quality Study (CRPAQS). This document describes the research projects conducted under an interagency agreement between the California Energy Commission and the California Air Resources Board to support CCOS.

A joint powers authority known as the San Joaquin Valleywide Air Pollution Study Agency (Study Agency) manages CCAQS. This Study Agency has a governing board, a Policy Committee, and two Technical Committees (one for CCOS and another for CRPAQS). The Policy and Technical Committees are made up of four main blocks. They are the California Air Resources Board (ARB), the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), the federal government, and industry. The Policy Committee includes senior managers from the four blocks. The Technical Committee includes technical experts from the four main blocks, other air quality management districts, and academia. The exact composition of these committees varies with time, but the four main blocks are always represented.

The field study portion of CCOS, conducted during the summer of 2000, is complete, and nearly all field data are stored in the CCAQS database. A detailed description of the field study and measurements are provided in Appendices A–C. The CCOS is now in the modeling and data analysis phase. One of the episodes captured during CCOS, the period July 30–August 2, 2000, is being modeled extensively and formed the basis for the one-hour ozone State Implementation Plan (SIP) for the San Joaquin Valley (SJV) nonattainment area.

1.2. Project Objectives

The California Energy Commission has three objectives for this project. They are:

- To assure that appropriate data are collected and analytical models are developed to use in gaining a better understanding of the dynamics of the ozone problem in central California;
- To develop a better understanding of the role of the thermal power plant plumes in contributing to regional air quality problems in the study region, including development of

data and methods needed to assure the proper treatment of these plumes in the models used to develop air quality management plans; and

- To provide the technical information needed for the development of interbasin/interpollutant offset rules for the central California region.

These project objectives are the basis for the technical tasks outlined in the interagency agreement.

1.3. Report Organization

Section 2 of this report provides a description of each technical task and the method used. Section 3 provides results from each technical task. Section 4 contains conclusions and recommendations. Reports relevant to technical tasks are included either as references or appendices.

2.0 Project Approach

This section lists the technical tasks developed to address the overall objectives of the projects and the methods used to carry them out. More details can be found in the appropriate appendices, as indicated in each subsection.

2.1. Evaluation of Transport of Pollutants Between Different Regions in the CCOS Area and from Power Plant Plumes in the Same Region

The main objective of this work is to provide an understanding of the transport of pollutants in the central California region.

2.1.1. Field Plan and Collection of Data

This task required the contractor to prepare a Field Plan documenting plans to collect high-quality surface and upper air meteorological data to apply and evaluate a sophisticated non-hydrostatic meteorological model. The Technical Committee (TC) designed the meteorological measurement network and the Desert Research Institute (DRI) documented it. The three documents produced by DRI are attached as Appendices A–C, and focus on the design of the field study, details of the field operations plan, and a summary of the field operations after the field study was completed.

The National Oceanic and Atmospheric Administration (NOAA) carried out the field measurements. The measurements conducted by NOAA are documented in Appendix D, *Meteorological Support for the Central California Ozone Study.* In brief, the Regional Weather and Climate Applications Division of NOAA's Environmental Technology Laboratory deployed an array of wind profilers, SOnic Detection And Ranging (SODAR) equipment, and surface meteorological stations in and around the Central Valley of California. In particular, from June 1, 2000 to October 15, 2000, six 915-megahertz (MHz) radar wind profilers with Radio-Acoustic Sounding System (RASS) and supporting surface meteorological stations were deployed together with a 449-MHz wind profiler, RASS, and surface meteorology site. In addition, three Doppler SODARs, collocated with wind profilers, were deployed within the Central Valley. One stand-alone Doppler SODAR with supporting surface meteorology was deployed in the Sierra Nevada foothills, and one Doppler SODAR collocated with a wind profiler/surface meteorology site was deployed in the San Francisco Bay area.

All data collected during the field operations are now housed in the CCAQS database. The database can be accessed at www.arb.ca.gov/airways/ccaqs.htm. The data have gone through various initial levels of quality assurance and quality control (QA/QC), and final QA/QC of the data will be conducted in the near future.

2.1.2. Modeling and Analysis

This task required the contractor to use a state-of-the-science non-hydrostatic meteorological model to produce realistic three-dimensional estimates of meteorological variables (such as winds and turbulence) in the region. This requirement was satisfied by using the Mesoscale Meteorology Model Version 5 (MM5) (Stauffer et al., 1995) to generate meteorological fields for two ozone episodes captured during the CCOS measurement period. They were the July–August 2000 and September 2000 episodes.

The July–August 2000 episode is the basis for the extreme ozone attainment demonstration plan for the San Joaquin Valley recently submitted to the U.S. Environmental Protection Agency (EPA). It is also being considered as one of the episodes that will be extensively modeled for the eight-hour ozone SIPs in northern California (including the mountainous area in the Sierra Nevada mountain range).

The data and results used for the MM5 simulations can be found at www.arb.ca.gov/eos/ARB_Modeling. There were no manuscripts prepared for publication at the time of this report.

2.2. Characterization of Emissions from Power Plant Plumes

The purpose of this project was to better characterize the emissions of oxides of nitrogen (NO_X) and volatile organic compounds (VOCs) from power plants in the study domain.

This project was carried out by the University of California, Riverside, College of Engineering–Center for Environmental Research and Technology (CE-CERT). Initially, they were contracted to perform field-testing at up to five stationary gas-fired combustion power generation facilities. CE-CERT was able to complete testing at two of the facilities before the onset of the California energy crisis, which impaired access to additional facilities. The two facilities tested were the Southern Energy California Unit #1 in Moss Landing and Unit #6 in Pittsburg.

The Unit #1 in Moss Landing is a natural gas-fired steam turbine used to produce electricity. The unit is owned and operated by Duke Energy. It has a generating capacity of 700 megawatts (MW), and was operating at approximately 80% of capacity during testing. The Unit #6 in Pittsburg is also a natural gas-fired steam turbine used to produce electricity. The unit is owned and operated by Southern Energy California. It has a generating capacity of 400 MW, and was operating at approximately 69% of capacity during testing.

2.3. Enhancement of Existing Photochemical Models to Properly Consider Power Plant Plumes

This task has two major subtasks. The first major subtask was the measurement of the evolution of the chemistry in power plant plumes using aircraft. Two power plants have been selected for this study: the Pittsburg power plant located in the Sacramento river delta and the Moss Landing power plant located on the Pacific Coast near Monterey.

Aircraft measurements in power plant plumes are challenging, because of the difficulties in measuring relatively modest point source plumes in the presence of large sources of pollution and variable background, and because of the meandering of the plumes. Therefore, a simulation study was conducted to develop the quantitative information required to plan power plant plume aircraft measurements during CCOS 2000. A state-of-the-science reactive plume model was used to simulate the evolution of the Pittsburg and Moss Landing plumes for a range of meteorological conditions (early morning, midday, and afternoon) for atmospheric conditions conducive to plume transport into the San Joaquin Valley. The subcontractor, Atmospheric and Environmental Research, Inc. (AER), conducted this simulation study. More information on this study can be found in Appendix G, titled *Planning Study for Power Plant Plume Measurements During CCOS 2000.*

Tennessee Valley Authority conducted the actual aircraft measurements of the plumes. Those measurements, together with the modeling interpretation by AER, is described in *Aircraft Measurements of Power Plant Plumes During CCOS and Their Use for the Evaluation of the SCICHEM Model* (EPRI, 2003).

The second major subtask was the improvement and evaluation of a state-of-the-science reactive plume sub-model embedded into a three-dimensional photochemical air quality model. The criteria for the sub-model were that it be fully documented, use open source code, and be available for use in SIPs. AER, as a subcontractor to the Electric Power Research Institute (EPRI), performed this subtask. The final report for that study can be found in Appendix H, titled *Plume-in-Grid Modeling in Central California Using CMAT-APT (Comprehensive Multiscale Air Quality Model with Advanced Plume Treatment).*

Specifically, several improvements were made to the plume-in-grid (PinG) model, the Community Multiscale Air Quality (CMAQ) (Byun and Ching, 1999) modeling system with Advanced Plume Treatment (APT) or CMAQ-APT (Karamchandani et al., 2000, 2002). These modifications include an optional treatment for the effects of building downwash in the embedded plume model, the Second-order Closure Integrated puff model (SCIPUFF) (Sykes and Henn, 1995) with CHEMistry (SCICHEM), and modifications necessitated by updates in the latest versions of CMAQ (version 4.3, released in September 2003) and SCICHEM (version 1601, released in January 2004). The Young & Boris chemistry solver (Young and Boris, 1977) was also implemented in the current version of CMAQ-APT to retain compatibility between the host and plume models.

CMAQ-APT was applied over the CCOS domain in central California for the July–August, 2000 ozone episode. The ten largest NO_x–emitting plants (with a total of 56 stacks) in the CCOS domain were explicitly simulated with PinG treatment. These included the Pittsburg, Moss Landing, and Contra Costa power plants, the Martinez Refinery, and several cement plants and other facilities in central California. A "background" simulation was also conducted in which the emissions from these stacks were neglected. Differences in the results between the background simulation and the base and APT simulations provide a measure of the contribution of these point sources to ozone (O_3) and nitric acid (HNO_3) concentrations with and without PinG treatment.

2.4. Analysis of Interbasin/Interpollutant Offsets in the Central California Region

This project requires a contractor to prepare a protocol outlining a methodology to be used for the analysis of interbasin/interpollutant offsets in the central California region. The contractor is then required to develop rules for interbasin/interpollutant offsets in the central California region.

This study's researchers are aware of two protocols currently under development to assess interbasin/interpollutant transport/offsets. The first is a draft protocol currently being refined by the EPA. The second is a draft protocol being developed by the CCOS Technical Committee. Neither of these protocols are currently available in a form suitable to submit as part of this report. However, the second protocol is now part of a larger interagency effort to outline procedures to access interbasin transport for eight-hour ozone SIP purposes. Once completed, it will become the standard transport assessment protocol for central and northern California.

After the development of appropriate protocols, this study's researchers recommend modeling analyses for the summer of 2000 as a whole to assess transport. These analyses will be feasible after the completion of the CCOS seasonal modeling effort by the University of California, Berkeley, and the Lawrence Berkeley National Laboratory.

2.5. California Energy Commission Participation in the Technical and Policy Committees for CCOS

The technical tasks outlined in this report were carried out under the guidance of the Technical Committee (TC) of the Central California Ozone Study. The TC provided recommendations to the Policy Committee on the selection of subcontractors. The original contract manager for the Energy Commission, Mr. Guido Franco, and his replacement, Ms. Marla Mueller, participated in some meetings of each committee to ensure close coordination between CCOS and the objectives of the interagency agreement.

3.0 Project Outcomes

3.1. Evaluation of Transport of Pollutants Between Different Regions in the CCOS Area and from Power Plant Plumes in the Same Region

3.1.1. Field Plan and Collection of Data

This project has yielded the best set of comprehensive meteorological observations made in any part of the country for an entire summer (summer of 2000). The database now contains several million meteorological data points that can be used in data analysis and meteorological modeling. This database can be found at www.arb.ca.gov/airways/ccaqs.htm. Several simulations using the prognostic meteorological model MM5 (Stauffer et al., 1995) were carried out using the measurements.

3.1.2. Modeling and Analysis

This project's results are the generation of meteorological fields for two ozone episodes during the summer of 2000 using the comprehensive prognostic meteorological model MM5 (Stauffer et al., 1995). The modeling results are available at www.arb.ca.gov/eos/ARB_Modeling. Using the results of these meteorological simulations, this study's researchers carried out air quality simulations to assess the impact of emission control scenarios on one-hour ozone concentrations observed in central California. Results of these simulations were used in the preparation of the recent one-hour Ozone SIP for the San Joaquin Valley. NOAA (using their congressional year marks) is now conducting prognostic meteorological modeling for the entire summer of 2000 using these data to support photochemical modeling of ozone for an entire summer by a team of researchers from the University California at Berkeley and the Lawrence Berkeley National Laboratory.

3.2. Characterization of Emissions from Power Plant Plumes

This project resulted in the source testing of two facilities that use natural gas-fired steam turbines to produce electricity. Results from the field testing include flow rates, temperatures, and moisture content of effluent streams–as well as emissions concentrations and mass flow rates of carbon monoxide (CO), carbon dioxide (CO_2), nitric oxide (NO), nitrogen dioxide (NO_2), particulate matter (PM_{10}), aldehydes and ketones, toxics such as chlorinated hydrocarbons, and C_1-C_4 hydrocarbons.

The results for Unit #1 in Moss Landing can be found in Appendix E, titled *Emissions from an Electrical Power Generating Unit (Moss Landing Unit #1).* The results for Unit #6 can be found in Appendix F, titled *Emissions from an Electrical Power Generating Unit (Pittsburg Unit #6).*

Both these power plants also have Continuous Monitoring Systems (CMS) to ensure that emissions conform to permit limits. These measurements are conducted at 15-minute intervals and represent the actual operating conditions. The source testing, the other hand, represent a snapshot of the operating conditions at the time of testing. The latter information is then used to assure the proper functioning of the CMS units. Due to its representative nature of CMS measurements, hourly averaged CMS data are used for day-specific photochemical modeling. It is also important to mention that source testing provides additional information on reactive organic gas and toxic air contaminants that CMS does not provide. That information is used in

the estimation of emission factors for both photochemical modeling and community health investigations.

3.3. Enhancement of Existing Photochemical Models to Properly Consider Power Plant Plumes

The aircraft measurements conducted by the Tennessee Valley Authority found the characteristics of the Pittsburg and Moss Landing plumes to be significantly different from those in the eastern United States. Specifically, California plumes did not produce excess ozone until the plumes were very diluted. The SCICHEM modeling results were not in agreement with the measurements. This disparity may have been due either to deficiencies in model inputs, or to corruption of plumes as the result of incorporating emissions from other sources in the path of the plume (which was not considered in the modeling). The prior applications of the SCICHEM model to much larger power plant plumes in the eastern United States appears to be successful.

The plume-in-grid (PinG) simulations by AER indicated that ozone concentrations in the APT simulation show both slight decrements and increments with respect to the base simulation. The maximum decrement and increment under ozone production conditions are about 10 and 6 ppb, respectively. Significantly larger differences between the APT and base simulations (between 30 and 40 ppb ozone) were seen in the previous CMAQ-APT application over the northeastern United States. However, in that study, NO_x emissions from the largest point sources were one to two orders of magnitude higher than those in the CCOS domain. The APT algorithm was also found to have an effect on the nitric acid concentrations simulated. In general, it produces slightly less nitric acid than the non-APT version. This may lead to slightly less ammonium nitrate formation in APT runs. The current runs did not have a particulate matter component.

In summary, for the relatively small point sources found in California, compared to those in the eastern United States, the current treatment of plumes in the photochemical models may be adequate for the modeling of one-hour ozone concentrations. However, the Energy Commission should continue to investigate if the PinG treatment of plumes would have any significant impact on the eight-hour ozone and the particulate matter concentrations.

3.4. Analysis of Interbasin/Interpollutant Offsets in the Central California Region

No products are available at this time. Protocols prepared by the EPA and the Air Resources Board may become available in the near future.

3.5. California Energy Commission Participation in the Technical and Policy Committees for CCOS

The Energy Commission staff participated in some meetings of the CCOS Technical and Policy committees.

4.0 Conclusions and Recommendations

4.1. Conclusions

This work resulted in perhaps the most complete database of meteorological and air quality measurement available for any region in the world. Several simulations using the prognostic meteorological model MM5 were carried out using the measurements. Using the results of these MM5 simulations, this study's researchers carried out air quality simulations to assess the impact of emission control scenarios on one-hour ozone concentrations observed in central California. Results of these simulations were used in the preparation of the recent one-hour ozone SIP for the San Joaquin Valley. The next stage of meteorological modeling is to conduct prognostic modeling for the entire summer of 2000 to support a seasonal air quality modeling effort.

The plume measurements using aircrafts and conventional methods revealed that California plumes to be small and less reactive compared to those in the other parts of the United States. The inclusion of the plume-in-grid treatment in grid-based photochemical models did not produce results significantly different from those produced by the conventional treatment of the plumes.

Progress was made towards developing a standard protocol to assess inter/intra basin transport in central California. Modeling efforts based on this protocol will proceed after the conclusion of seasonal air quality modeling for the entire summer of 2000.

The staff of the Energy Commission participated in both the Technical and Policy Committees of the San Joaquin Valleywide Air Pollution Study Agency. This participation was beneficial to both the Study Agency and the Energy Commission.

4.2. Recommendations

While the improved treatment of emissions from the largest utility point sources did not have a significant impact on the one-hour ozone concentrations in central California, this study's researchers encourage the Energy Commission to investigate if the plume-in-grid treatment would have any significant impacts on both eight-hour ozone and 24-hour particulate matter concentrations.

The Energy Commission should continue to participate in the development and application of transport assessment protocols from both EPA and CCAQS. Due to the variability in meteorology, it is reasonable to expect that the direction and the magnitude of the transport would vary throughout the year. Thus, care should be exercised when generating a standard list of interbasin/interpollutant offsets. This list should also be updated periodically as new information become available.

This study's researchers strongly encourage continued participation of the Energy Commission in the Policy and Technical Committees of the San Joaquin Valleywide Air Pollution Study Agency. This continued participation will be beneficial to both the Study Agency and the Energy Commission, and would provide a coordinating mechanism for air quality studies conducted by both entities.

4.3. Benefits to California

This effort resulted in perhaps the most comprehensive database of aerometric data collected in any region of the world. These data will allow California to conduct in-depth investigations to understand the causes of air pollution, the efficacy of plausible control strategies, and to develop SIPs for the study domain.

Moreover, a better understanding of transport of pollutants between air basins has been gained and has resulted in the initiation of more refined transport analyses. Regional air pollution and efficacy of control strategies depend on meteorology in the region, transport of pollutants to/from other basins, natural and anthropogenic sources of precursors, and how these interact to produce air pollutants. Thus, a good understanding of the regional meteorology and of all emissions sources is critical. SIPs identify what control strategies are or will be implemented to bring regional air quality into compliance with National Ambient Air Quality Standards (NAAQS). For example, the need for any additional controls of new and/or existing power plants will be identified in the context of all sources within the region and the efficacy and economics of such controls in improving air quality in the region. This project has resulted in a very significant improvement in the understanding of the regional air pollution and this knowledge is currently being used in the development of SIPs.

In addition, the comprehensive database developed during the Central California Ozone Study will be used in the development of a seasonal ozone model that will be used to gain a broader understanding of the formation of air pollution in the study domain. This is very important in understanding the transport issues, especially as they apply to the new eight-hour ozone NAAQS.

Emissions from power plants and how these emissions move within the power plant plumes, travel downwind, and interact to form air pollutants were also studied. This study indicated that the impact of individual utility point sources on the regional air quality of central California is less significant than that found for other regions in the United States.

An important collaboration between two major entities conducting air quality studies (i.e. the Energy Commission and the California Air Resources Board) was also forged as a result of this study. This collaboration is now continuing beyond this study.

5.0 References

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6.0 Glossary

ARB – Air Resources Board

APT - Advanced Plume Treatment

CCAQS – Central California Air Quality Studies

CCOS – Central California Ozone Study

CMAQ – Community Multiscale Air Quality

CMAQ-APT – Community Multiscale Air Quality (CMAQ) modeling system with Advanced Plume Treatment (APT)

CRPAQS – California Regional Particulate-Matter Air Quality Study

DRI – Dessert Research Institute

EPRI – Electric Power Research Institute

NAAQS – National Ambient Air Quality Standards

NOAA – National Oceanic and Atmospheric Administration

PC – Policy Committee

PinG – Plume in Grid

QA/QC – Quality Assurance and Quality Control

RASS – Radio-Acoustic Sounding System

SCIPUFF – Second-order Closure Integrated Puff Model

SCICHEM – Second-order Closure Integrated Puff Model (SCIPUFF) with CHEMistry

SIP – State Implementation Plan

SJV – San Joaquin Valley

SJVUAPCD – San Joaquin Valley Unified Air Pollution Control District

SODAR – SOnic Detection And Ranging

TC – Technical Committee

Appendix A. Central California Ozone Study Volume 1: Field Study Plan

Appendix B. Central California Ozone Study Volume 2: Field Operations Plan

Appendix C. Central California Ozone Study Volume 3: Summary of Field Operations

Appendix D. Meteorological Support for the Central California Ozone Study

Appendix E. Emissions from an Electrical Power Generating Unit (Moss Landing Unit #1)

Appendix F. Emissions from an Electrical Power Generating Unit (Pittsburg Unit #6)

Appendix G. Planning Study for Power Plant Plume Measurements During CCOS 2000

Appendix H. Plume-in-Grid Modeling in Central California Using CMAQ-APT (Comprehensive Multiscale Air Quality Model with Advanced Plume Treatment)