Technical Proposal

Central California Ozone Study (CCOS)
Request for Proposals

Understanding Relationships between Changes in Ambient Ozone and Precursor Concentrations and Changes in VOC and NOx Emissions from 1990 to 2004 in Central California

prepared for

San Joaquin Valleywide Air Pollution Study Agency
c/o
California Air Resources Board
1001 "I" Street
Sacramento, California 95814

submitted by

Charles L. Blanchard
526 Cornell Avenue
Albany, CA 94706

Telephone: (510) 525-6231
Fax: (510) 528-2834
Email: cbenvair@pacbell.net

28 September 2005

Official Authorized to Bind this Proposal:
Name: Charles L. Blanchard, Ph.D.

Signature:

TABLE OF CONTENTS

Section Page

1 INTRODUCTION

The study team of Envair, Desert Research Institute, and Alpine Geophysics is pleased to submit this proposal in response to the San Joaquin Valleywide Air Pollution Study Agency and California Air Resources Board Request for Proposals entitled "Understanding Relationships between Changes in Ambient Ozone and Precursor Concentrations and Changes in VOC and NOx Emissions from 1990 to 2004 in Central California." The principal investigator, Dr. Charles Blanchard of Envair, is joined in the proposed effort by Ms. Shelley Tanenbaum of Envair, Dr. Eric Fujita and Mr. David Campbell of the Desert Research Institute, and Dr. Jim Wilkinson and Ms. Cyndi Loomis of Alpine Geophysics, LLC. This team offers a wealth of experience in each of the areas of expertise required by the work specified in the RFP, including the statistical analysis of air quality measurements, the design and interpretation of air quality field programs, and the development and evaluation of emission modeling systems and emission inventories. We believe that this experience is unmatched.

In this section, we provide a brief motivation for the proposed research activities, summarize the objectives of the study, and introduce the key members of the study team.

1.1 BACKGROUND

From the perspective of air quality management, arguably the principal question of interest is: "Which emission control measures would improve air quality most rapidly and most effectively?" The answer varies, depending upon the air pollutants of concern and the areas affected. In California, substantial efforts have been directed toward reducing ozone levels throughout the state, especially in the Los Angeles, San Diego, San Francisco, and Sacramento metropolitan areas and in the San Joaquin Valley. Yet, these different areas exhibit rather different historical trends in ozone levels, raising questions about the effectiveness of air quality management programs in areas where reductions in ozone levels have not been as obvious as in other areas. For example, the 2005 issue of the "California Alamanac" reports that population-weighted exposure to ozone concentrations above the state 1-hour ozone standard (0.09 ppmv) declined from 1990 to 2003 in each of the areas listed above except the San Joaquin Valley. The pronounced decline in the South Coast air basin (Los Angeles area) from 22.10 ppmv-hours/person in 1990 to 8.92 ppmv-hours/person in 2003 demonstrates clear improvement in ozone exposure, whereas no such improvement is apparent in the San Joaquin Valley trend from 5.21 ppmv-hours/person in 1990 to 5.24 ppmv-hours/person in 2003 (Alexis and Cox, 2005).

Comparisons of emission trends with ambient air quality trends at an air-basin level of aggregation may obscure important local changes, but the large-scale comparisons do serve to illustrate why the rates of progress in improving ozone levels may be of concern in some areas. For example, Table 1 documents a perplexing comparison between the South Coast Air Basin (SoCAB) and the San Joaquin Valley (SJV). In both areas, emissions of carbon monoxide (CO) declined by approximately 60 percent between 1990 and the present, and maximum ambient concentrations of CO declined by about the same amount (~60 percent) in the two areas. In both areas, substantial, albeit somewhat different, decreases occurred in the emissions of both oxides of nitrogen (NO_x) and reactive organic gases (ROG). In both areas, ambient NO_2 levels declined by approximately the same magnitude as did NO_x emissions (~35 to 40%). Yet, maximum 1-hour and 8-hour ozone levels declined appreciably in the SoCAB while remaining virtually unchanged in the SJV (Table 1).[1]

Table 1. Comparisons of current and 1990 emissions levels and ambient air pollutant concentrations in the South Coast Air Basin (SoCAB) and the San Joaquin Valley (SJV). Source: California Almanac of Emissions and Air Quality, 2005.

Metric	SoCAB				SJV		
	1990	Current*	Decrease (%)		1990	Current*	Decrease (%)
Emissions (tons per day) and emissions change (percent decrease)							
CO	10322	3953	62		3336	1384	59
NOx	1588	970	39		811	479	41
ROG	1775	710	60		642	386	40
Ambient concentrations (ppmv) and ambient concentration change (percent decrease)							
CO max 8 hr	16.8	7.3	57		11.5	4.1	64
NO2 max annual	0.055	0.035	36		0.031	0.020	35
O3 max 1 hr	0.33	0.16	52		0.17	0.16	6
O3 max 8 hr	0.193	0.15	22		0.123	0.13	-6

* Current means 2005 estimated emissions levels, 2004 ambient ozone measurements, and 2003 ambient CO measurements.

The simple summary shown in Table 1 indicates that emissions of CO have declined in both the SoCAB and in the SJV, in spite of growth and development in each area. Similarly, emissions of NO_x and ROG have declined in both areas, again despite growth and development.[2] So, the broad-brush comparison of ozone changes shown in Table 1 appears oddly inconsistent with expectations. Of course, carbon monoxide is a primary, and largely unreactive, air pollutant, while ozone is a secondary pollutant, which may respond in rather complex ways to changes in emissions of primary pollutants.

As noted in the 2005 California Almanac, California's population grew by 42 percent in the twenty years from 1984 through 2003, and vehicle miles traveled (VMT) increased by 90 percent (Alexis and Cox, 2005). Major improvements in air quality occurred in spite of growth. Yet, the markedly different responses in primary and secondary pollutants in different regions, such as is illustrated in Table 1, indicate that more detailed analysis is needed to explain ozone trends. If growth and development is a factor in the differences, full understanding of the ozone trends will

[1] Some alternative measures of ozone air quality, such as the population exposure statistics cited here, yield the same conclusion, while other measures suggest that changes have occurred in the duration, frequency, or spatial extent of high ozone levels in the San Joaquin Valley.
[2] Fuel-based estimates of emission changes may differ from those tabulated here.

likely require characterization of emissions and ambient concentration changes on a subregional or site-specific scale of spatial resolution.

The analysis of trends in air pollutant levels provides one (but not the only) method for evaluating the effectiveness of emission control programs. Yet, the methods employed for analyzing trends may reveal or obscure important findings. For example, basin-average trends do not necessarily represent subregional or site-specific trends in ambient pollutant levels. Indeed, ozone trends have been shown to differ from monitor to monitor. For example, in analyzing ozone trends at sites in and near the Sacramento metropolitan area, Fujita et al. (2003) showed that annual 1-hour maximum ozone levels declined by 1.1 ppbv per year at Sacramento-Del Paso and by 1.6 ppbv per year at Folsom from 1990 to 2002, but increased by 1.0 ppbv per year at Cool (near Auburn, elevation ~460 m) from 1996 to 2002. Such differences in site-specific trends potentially reflect differential changes in the emissions affecting each site, but could also be related to changes in the rates of ozone formation and accumulation in the urban plume.

As a result of the SJVAQS and the CCOS, much is now known about the types of meteorological conditions that are conducive to ozone formation and to the occurrence of high ozone levels in central California (e.g., Fujita et al., 1999). Since different types of meteorological conditions yield different movements of ozone precursors from specific source areas to particular receptors, one potentially insightful way to evaluate ozone and ozone precursor trends is to stratify the ozone and ozone precursor measurements by type of meteorological condition prior to determining trends. The utility of this approach requires that different types of meteorological conditions can be associated with different areas of emission source influence. When such stratification and association proves possible, then subregional or site-specific trends in ozone metrics potentially may be linked to the emission changes occurring in different source areas of influence. For example, downward ozone or ozone precursor trends under meteorological conditions conducive to the transport of pollutants from one area to another would suggest that reductions of emissions in the upwind area had been effective; in contrast, upward trends in ozone or ozone precursors under highly stagnant meteorological conditions might indicate that local-scale emissions had increased over time. To make such analyses quantitative, the met-stratified ozone trends need to be tied to changes in ambient ozone precursor levels and to area-specific changes in ozone precursor emissions. This last step necessitates preparation of a gridded, time-resolved emission inventory backcast and forecast to cover the entire time period of interest.

The work proposed here is intended to clarify the relationships between trends in emissions of ozone precursors, trends in ambient concentrations of ozone precursors, and trends in ozone levels in central California. The spatial scales of interest include basinwide, subregional, and site-specific (local) scales. The proposed effort would build on previous work as much as possible. Because the prospects for providing useful insights into the effectiveness of implemented emission controls is promising but by no means certain, the work would be phased. Phase II will be contingent upon successful completion of Phase I, demonstration of the utility of Phase II, and funding resources.

1.2 STUDY OBJECTIVES

The primary objective of this study is to advance the present understanding of air quality in central California, with specific emphasis on ozone formation and ozone levels in the San Joaquin Valley. The geographic domain of interest includes the entire region of the Central California Ozone Study, which in addition to the San Joaquin Valley incorporates the Sacramento Valley, the San Francisco Bay area, and the central California coast.

The specific technical questions to be addressed, as listed in the RFP, are:

Phase I. Clarify the relationships expected to exist between trends in ambient data and trends in emissions inventories:

1. What basinwide, subregional, and site-specific ambient data trends exist?
2. What emission sources are adequately characterized at the basinwide, subregional, and site-specific level to facilitate trend analyses at each level (e.g., based on a multi-month or seasonal gridded inventory for the 2002 base year inventory)?
3. How well are emission trends at the basinwide, subregional, and site-specific level expected to correlate with basinwide, subregional, and site-specific ambient trends?
4. What categories of emissions are expected to track ambient trends best at each basinwide, subregional, and site-specific analysis resolution?
5. Based on the findings, what relationships between trends in ambient data and emissions data are expected to be elucidated in Phase II?
6. What uncertainties are associated with the proposed Phase II approach?
7. Specifically how might Phase II findings be used as a basis to reach ambient 1-hour and 8-hour ozone attainment levels?
8. Do Phase I findings justify proceeding with Phase II?

Phase II. Elucidate relationships between ambient trends and emission trends and provide suggested strategies for reaching 1-hour and 8-hour ozone attainment:

1. Based on Phase I findings, what basinwide, subregional, and site-specific emission data trends exist (e.g., based on multi-season and multi-year gridded inventories spanning 1990 through 2004)?
2. What relationships exist between trends in ozone precursors and trends in ambient ozone concentrations over the 1990 through 2004 period?
3. What findings can be used towards reaching ambient 1-hour and 8-hour ozone attainment levels?

1.3 THE STUDY TEAM

The proposed project participants bring extensive experience with air quality in central California, from the 1990 San Joaquin Valley Air Quality Study to the 1995 Integrated Monitoring Study and the ongoing Central California Ozone Study and the Central California PM10/PM2.5 Air Quality Study.

Dr. Charles Blanchard, a principal of Envair with over 15 years of experience in the study of photochemical air pollution, will be the prime contractor and will serve as the principal investigator. He will assume the overall responsibility for the technical direction and administration of the study. Dr. Blanchard will be joined in this effort by Ms. Shelley Tanenbaum of the Envair group, Dr. Eric Fujita and Mr. David Campbell of the Desert Research Institute, and Ms. Cyndi Loomis and Dr. Jim Wilkinson of Alpine Geophysics, LLC.

Envair is an unincorporated association dedicated to carrying out contract research and offering consulting services in the environmental and earth sciences. Because Envair is an unincorporated association of individual researchers, the proposed work would be conducted as a contract with the principal investigator, Dr. Charles Blanchard. Dr. Blanchard has carried out previous research studies under contract with the California Air Resources Board in this manner.

Since individuals associated with Envair hold no financial interest in the activities of other Envair participants, the legal counsel for the San Joaquin Valleywide Air Pollution Study Agency has advised us that no conflict of interest exists as a result of the service of another Envair member (Dr. Steve Reynolds) as Research Program Evaluator for the Central California Ozone Study. None of the proposed participants from Envair participated in planning activities for either the Central California Ozone Study or the Central California PM10/PM2.5 Air Quality Study. Alpine Geophysics, LLC does not believe that it, or its staff, has any conflicts of interest. The Desert Research Institute is a part of the University of Nevada, which is exempt from the conflict of interest provisions of Government Code Section 1090.

As requested in the RFP, we certify that the individuals and organizations offering to perform the contracted services have not been disqualified as participants in federally funded projects.

1.4 ADMINISTRATIVE MATTERS

Our complete proposal package includes the following documents:

- Cover letter
- Technical proposal
- Price/cost proposal (includes a complete set of Price/Cost Proposal forms and explanations of estimated costs)

An original plus two hard copies of each document, as well as an electronic copy of each document, is included in the proposal package.

We affirm that the terms and conditions of this proposal and associated scope of work shall remain fixed for a period of ninety (90) days from the date this response is due at the ARB offices in Sacramento, CA (September 28, 2005).

1.5 STRUCTURE OF THE PROPOSAL

The remainder of the technical proposal discusses the proposed technical approach, management and staffing, schedule, and study team qualifications. This information will be found in the following sections:

- Section 2. Technical Approach
- Section 3. Schedule and Key Milestones
- Section 4. Project Management and Staffing
- Section 5. Team Qualifications
- Section 6. References
- Appendix. Resumes for Study Participants

2 TECHNICAL APPROACH

This section discusses key technical issues and the proposed technical approach. Our work plan follows the tasks and objectives of the study as identified in the RFP:

Phase I. Clarify the relationships expected to exist between trends in ambient data and trends in emissions inventories

- Task 1. Acquire data and prepare a final work plan for Phase I
- Task 2. Analyze trends in ambient air pollutant levels
- Task 3. Elucidate expected relationships between trends in emissions and in ambient pollutant concentrations
- Task 4. Document Phase I findings and prepare a final work plan for Phase II

Phase II. Elucidate relationships between ambient trends and emission trends and provide suggested strategies for reaching 1-hour and 8-hour ozone attainment

- Task 5. Analyze trends in emissions
- Task 6. Relate emissions trends to ambient pollutant trends
- Task 7. Prepare a final report and a journal paper
- Task 8. Provide data, documentation, and software
- Task 9. Attend meetings (at start and after Task 1, Task 4, and Task 7)

In this section we provide a summary of the technical work that will be carried out in each task of the proposed study.

During the past 15 years, many studies have substantially advanced current scientific understanding of ozone formation in the San Joaquin Valley. A considerable body of knowledge has developed as a result of the 1990 San Joaquin Valley Air Quality Study (SJVAQS), continuing work throughout the 1990s, the Central California Ozone Study of 2000, and subsequent analyses. Our approach is to build upon previous work.

We also recognize that the prospects for successfully addressing each of the specific technical questions listed above are not presently known; indeed, the RFP recognizes this uncertainty by splitting the work into phases, the second of which is contingent upon the results of the first. Our proposed work plan allows for additional mid-course changes. Specifically, we will develop draft and final work plans for both Phases I and II, responding to suggestions from the Program Manager and Technical Committee. The technical approach discussed in this proposal is intended to be a starting point. It identifies issues to be addressed and suggests promising analyses. We expect to make changes in the approach throughout the project as we obtain interim results and as we interact with the Program Manager, Technical Committee, and the staff of the California Air Resources Board and air quality districts.

2.1 TASK 1. ACQUIRE DATA AND PREPARE A FINAL WORK PLAN FOR PHASE I

2.1.1 Acquire and Review Emissions Estimates

We believe that we can provide a thorough and highly cost-effective review and acquisition of emissions estimates because Ms. Loomis and Dr. Wilkinson of Alpine Geophysics have such extensive experience with inventories, especially with the CCOS emission inventory. Dr. Wilkinson recently completed a review and assessment of the CCOS inventory for the Bay Area Air Quality Management District. Therefore, we propose to prepare a short summary of inventory issues based upon the project team's previous experience, with Dr. Fujita providing additional input to Alpine Geophysics. We will schedule one or more meetings or conference calls with CARB or air district staff to discuss issues of concern and to obtain their recommendations as to which issues should be addressed prior to proceeding with Task 5, should Phase II be authorized.

Specifically, Alpine Geophysics will collect annual emissions data and estimates for 2002, twelve backcast years, (1990-2001), and two forecast years for 2003 and 2004. We envision these emissions estimates coming from ARB's CEIDARS-CEFS data bases. (Please note that if the forecast and backcast files are available and the Technical Committee concurs, we would be able to reduce our proposed level of effort in Task 5a, because in that task we have included the time needed for Alpine Geophysics to carry out forecasts and backcasts of the annual 2002 inventory as specified in the RFP).

Our team is aware that CARB can prepare representative weekday emissions estimates for each month of the year. At project kickoff, the study team in consultation with CARB, will determine if there is value in comparing the monthly estimates derived from a representative weekday and those derived from the annual inventory.

Alpine Geophysics will collect historical emissions estimates for

* point sources (per Task 5a)
* pesticide application emissions (per Task 5a)
* growth, control, and effectiveness factors by source category and year
* area source spatial surrogates by source category and year
* as needed, wildfire emissions or other categories that may bear on historical emissions

We will prepare a succinct questionnaire to be distributed to district and CARB emissions staff to help us draw on their expertise in identifying suspected problems in the California emissions inventory (EI). We will then work with CARB and district staff to develop a consensus identification of major issues, and if possible, how these issues might be corrected. Finally, we will prepare a written summary of suspect problems based on our discussions with district and CARB staff, the peer-reviewed literature, and readily available, relevant study documentation. This summary will be incorporated into the work plan (Task 1d) and the Phase I report (Task 4).

2.1.2 Acquire Ambient Data

Much of the ambient data needed for the analyses has already been acquired by DRI and Envair during the course of previous projects. We also have access to validation results in many cases. We will update databases through 2004 as needed, and coordinate and consolidate our files for use in Task 2.

2.1.3 Acquire Meteorological and Other Data

We will acquire long-term meteorological measurements for the period 1990 through 2004, as needed. We may defer acquisition of some data until completion of the draft work plan for Phase II and the specification of the approach to be taken for utilizing meteorological information in Task 2.

2.1.4 Prepare Phase I Final Work Plan

Drs. Blanchard and Fujita will collaborate in the preparation of a draft work plan for Phase I. Beginning with the approach outlined in this proposal, we will consult with the Program Manager and provide a specific set of recommended steps for each task.

2.2 TASK 2. ANALYZE TRENDS IN AMBIENT AIR POLLUTANT LEVELS

2.2.1 Feasibility

In this task, we propose to generate a set of trend analyses that could serve two purposes. If Phase II were approved, these analyses would be used in Task 6. Otherwise, the trend analyses would yield new insights into the areas of emission influence for each monitoring location, and would provide the basis for a Phase I report.

Our proposed approach draws on methods that we have previously utilized, such as described in Section 6 of Lehrman et al. (2004) or Fujita et al. (2003), adapting such techniques to the proposed work. We consider the techniques discussed here to be a starting point and are ready to modify the approach as we obtain interim results and as we discuss strengths and shortcomings with the Program Manager and Technical Committee.

Previous work suggests that it is possible to reveal areas of emission influence, as well as the dependence of ozone formation and accumulation on precursor levels, by studying differences in trends among monitoring locations, the shift of a basin's determining design-value from one location to another, or other manifestations of spatial variations in ozone and ozone precursor trends. As previously noted, differential ozone trends at monitors downwind of Sacramento (Fujita et al., 2003) imply emissions-trend variations or changes in ozone formation rates on a spatial scale of roughly 10 to 30 km in that area. Of further interest is the change over time in the location of peak Fresno-area ozone levels, or the apparent southward movement of highest ozone levels in the South Bay portion of the Bay area.

Our (Envair) previous work shows that ozone trends from 1980 to 2000 varied considerably among monitoring stations in California (Figure 1, reproduced from Lehrman et al., 2004). We also found that population changes between 1990 and 2000 varied spatially (Figure 2). Finally, we found statistically significant correlations ($p<0.05$) between the population growth around each monitoring site (at both 20 and 50 km scales) and the site's trends in monthly-average CO, monthly average NO_x, and annual 4^{th}-highest 8-hour maxima (Figure 3). Downward trends were greater at sites having the least population growth, and were not as great (or were upward for ozone) at sites having the greatest nearby population growth. The results suggest the influence of near-site emission sources, but the correlations are not especially strong ($r^2 < 0.2$), implying the importance of other, unexplained, factors as well.

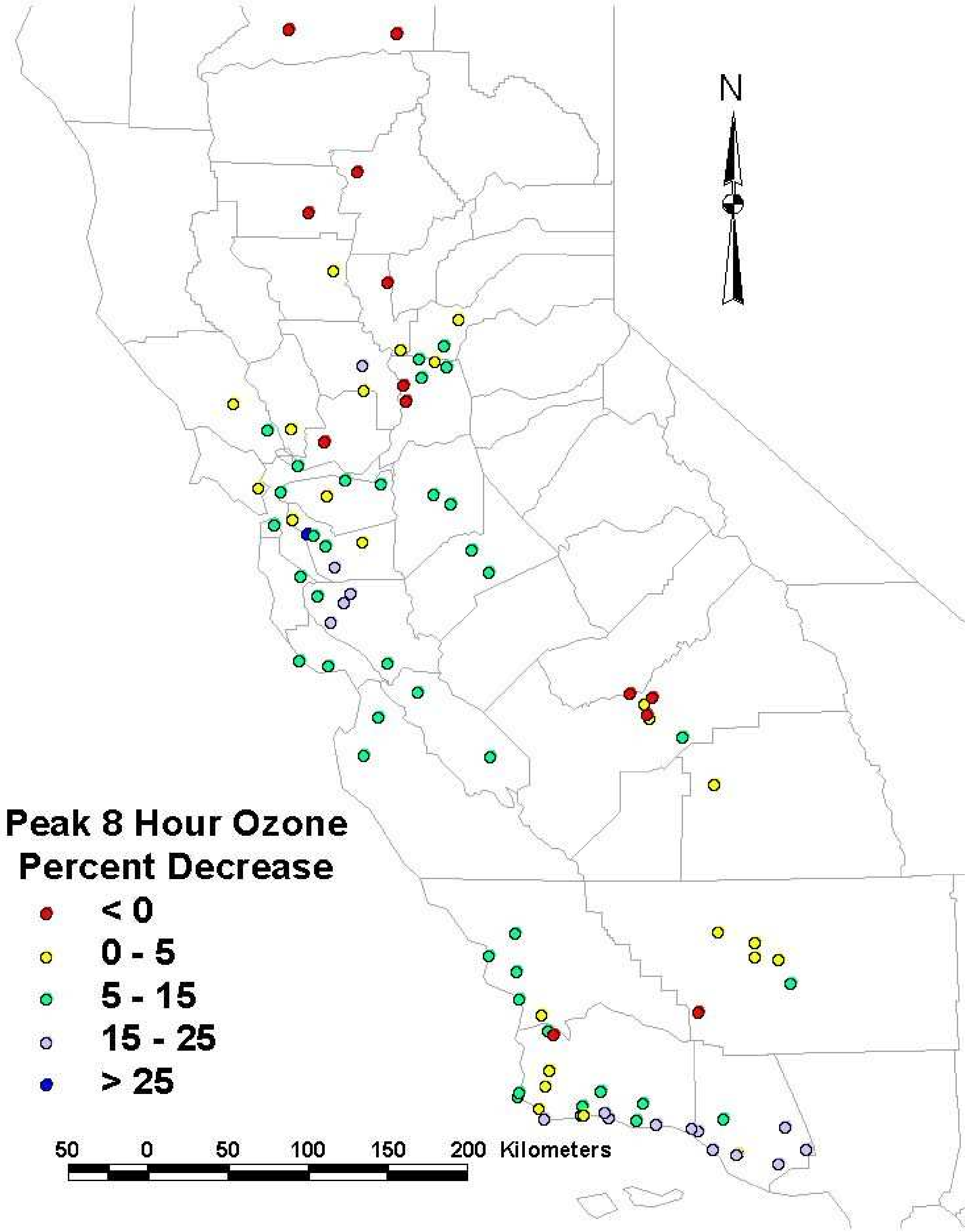


Figure 1. Reductions of annual 4th-highest peak 8-hour ozone (percent decrease per decade). The monitoring record for each site spanned at least ten years within the period 1980 to 2000. Values less than zero (<0) are upward trends. Source: Lehrman et al., 2004.

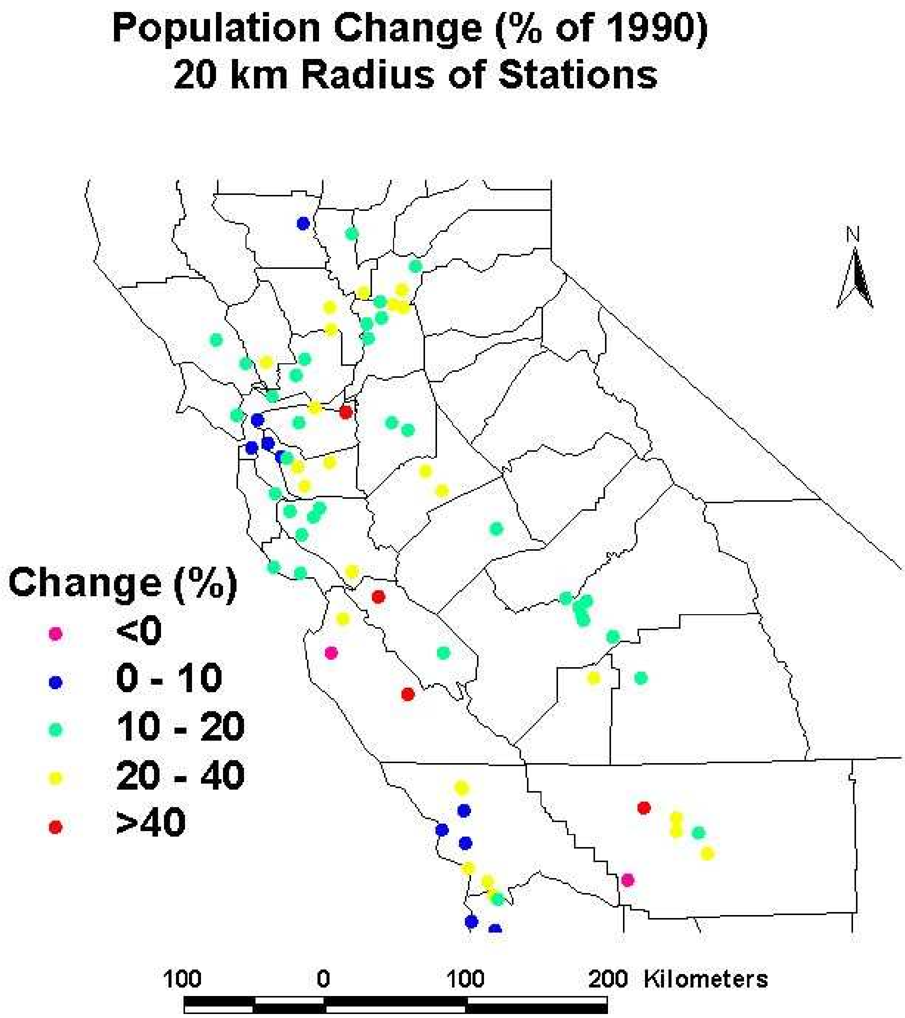


Figure 2. Population increases from 1990 to 2000 within 20 km of each ozone monitoring site. Values less than zero (<0) are decreases. Source: Lehrman et al., 2004.

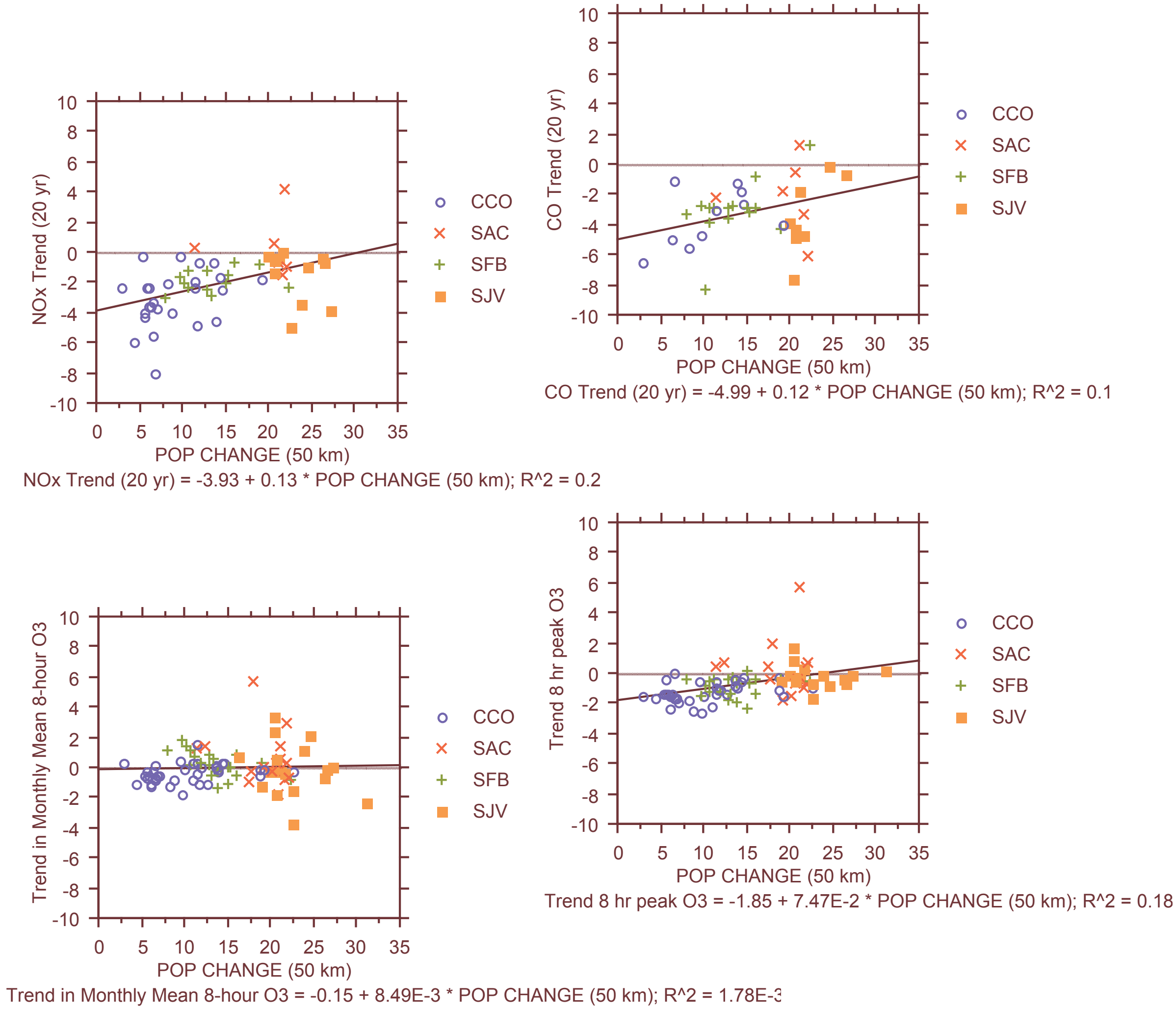


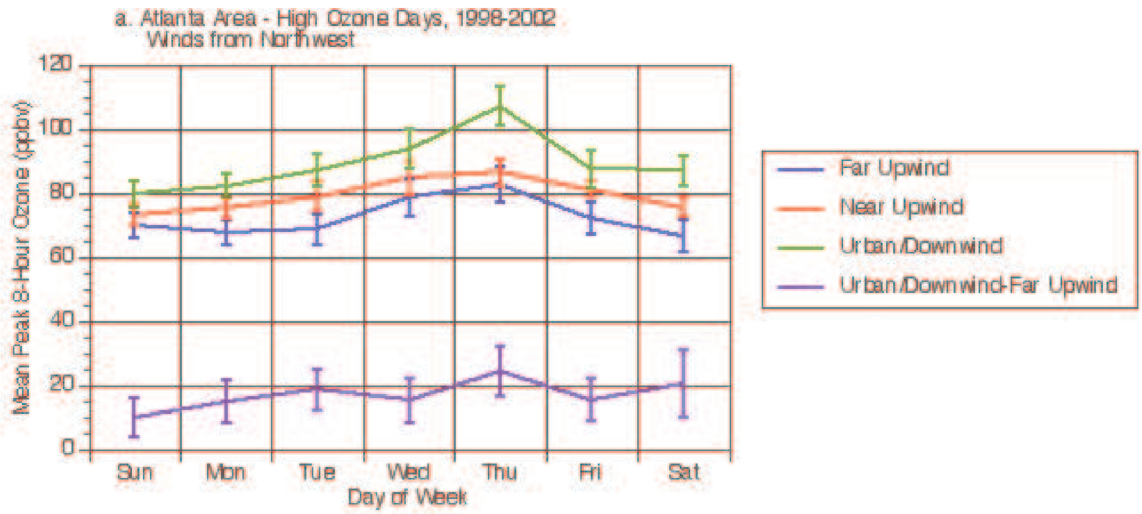
Figure 3. Comparisons of ambient air quality trends with population changes. Each symbol represents one monitoring location, disaggregated by air basin (CCO = north and south central coast, SAC = Sacramento Valley, SFB = San Francsico Bay area, SJV = San Joaquin Valley). Air quality trends were determined for the full period of record at each site and are expressed as percent per year (negative values are downward trends). Population changes were determined from the differences in the 1990 and 2000 populations within 50 km of each monitoring location and are expressed as percent per decade (all are positive, denoting increasing population). The correlations between population changes within 50 km and the trends in the annual 4th-highest 8-hour ozone, monthly average NO_x, and monthly average CO are statistically significant ($p<0.05$).

An obvious extension of our analyses is to include either directional information (from which directions do emissions influence a monitor?) and/or information on estimated emission changes (we had used population change as a surrogate for local emission changes in our analyses). As noted in the RFP, statistical clustering methods (Larsen, 1999; Davis et al., 1998) provide a means for classifying days into groups of days or hours when a site might be influenced by emissions from identifiable source regions. Clustering algorithms that utilize pressure or temperature gradients, or wind speed and direction, are most likely to separate days into groups on the basis of airflow patterns, and, hence, separate the data into subsets having different source influences. Daily maximum ozone in the San Francisco Bay area was well explained (R^2 up to 0.83) by the procedures employed by Larsen (1999).

Meteorological analysis has often been conducted for the purpose of determining which weather conditions are most conducive to ozone formation, or for reducing the meteorological "noise" in a longer-term ozone trend analysis (e.g., Cox and Chu, 1993). For the present proposed work, our objective would be somewhat different, namely, to stratify days according to transport conditions, permitting assessment of the relative magnitudes of local or regional influences, or otherwise elucidating source-receptor relationships of interest.

An example using a simpler approach shows the potential information to be gained. This example is drawn from an assessment of day-of-week variations in ozone levels in the Atlanta area (Blanchard and Tanenbaum, 2005), but appears to us to be equally applicable to trend analysis (e.g., substitute years for days-of-the-week in the example). As shown in Figure 4, Blanchard and Tanenbaum (2005) used surface wind directions, along with multilevel trajectories from the NOAA HYSPLIT model, to identify sets of days with consistent air movement from specific directional sectors. Within a given set of days, it was possible to consider sites as upwind, within, and downwind of Atlanta. By comparing ozone levels at sites upwind, within, and downwind of Atlanta, Blanchard and Tanenbaum (2005) showed that upwind sites exhibited about 70 to 80 percent of the ozone levels observed downwind, demonstrating the dominance of regional ozone transport over local ozone formation. Of further interest, the mean amount of ozone formed in the urban plume, defined as the difference between ozone levels at the urban and downwind sites and those at the far upwind location, did not show a statistical variation among different days of the week (Figure 4). The weekly pattern was largely determined by the day-of-week variations in the regional ozone levels.

By substituting years for day-of-week in this example, it is possible to separate regional trends from trends in local ozone formation. For illustrative purposes, we re-analyzed the Atlanta data (Figure 5). Because we had only three years with measurements at all sites, it was not possible to identify trends. However, Figure 5 shows that year-to-year variations at the urban/downwind sites (which included the Atlanta design value monitor) resulted from interannual variations in regional ozone levels, rather than changes in the amount of ozone formed in the urban plume. This example demonstrates the potential use of meteorological data to better interpret interannual ozone variations and ozone trends.



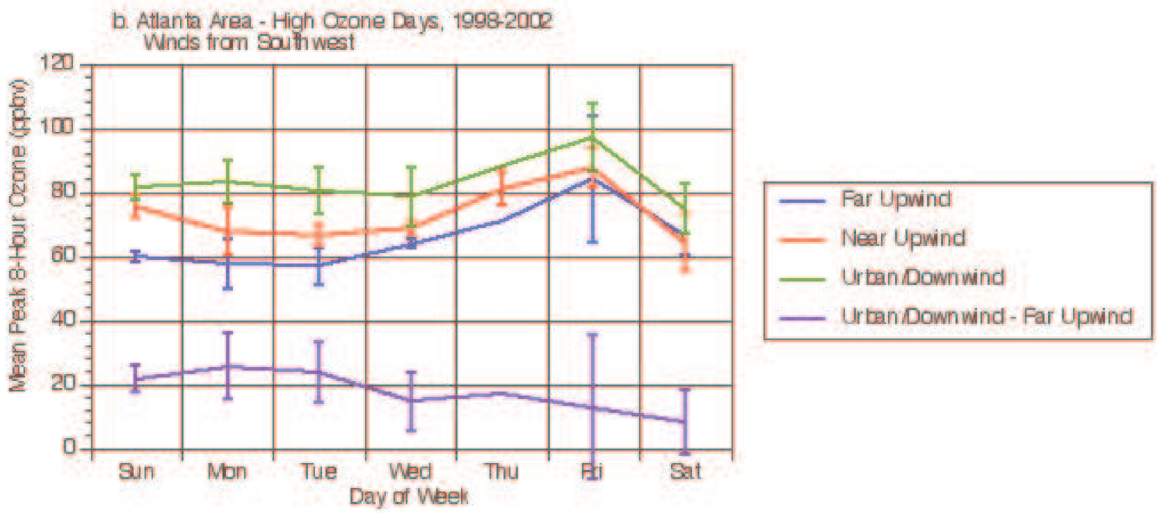


Figure 4. Example analysis from Blanchard and Tanenbaum (2005). Mean daily 8-hour ozone maxima by day of week averaged from the top 21 high-ozone days at downwind sites (Conyers and Gwinnett), 1998-2002. The data have been averaged across monitoring locations representing far upwind, near upwind, and urban/downwind locations. The error bars are one standard error of the mean. No error bars are shown for averages based on one sampling day. (a) The days with winds from the northwest had 24-hour vector-average surface wind directions of 270 to 360 degrees. The far upwind site was Sand Mountain (CASTNet). The near upwind sites were Douglasville (130970004) and Yorkville (132230003; PAMS Type 1). The urban sites were Jefferson Street (SEARCH), Georgia Tech, and Confederate Avenue (131210048). The downwind sites were DeKalb (130891002; PAMS Type 2) and Conyers (132470001; PAMS type 3). (b) The days with winds from the southwest had 24-hour vector-average surface wind directions of 180 to 270 degrees. The far and near upwind sites were Centreville (SEARCH) and Douglasville (130970004), respectively. The urban/downwind sites were Jefferson Street (SEARCH), Tucker (130893001; PAMS type 2A), and Gwinnett (131350002).

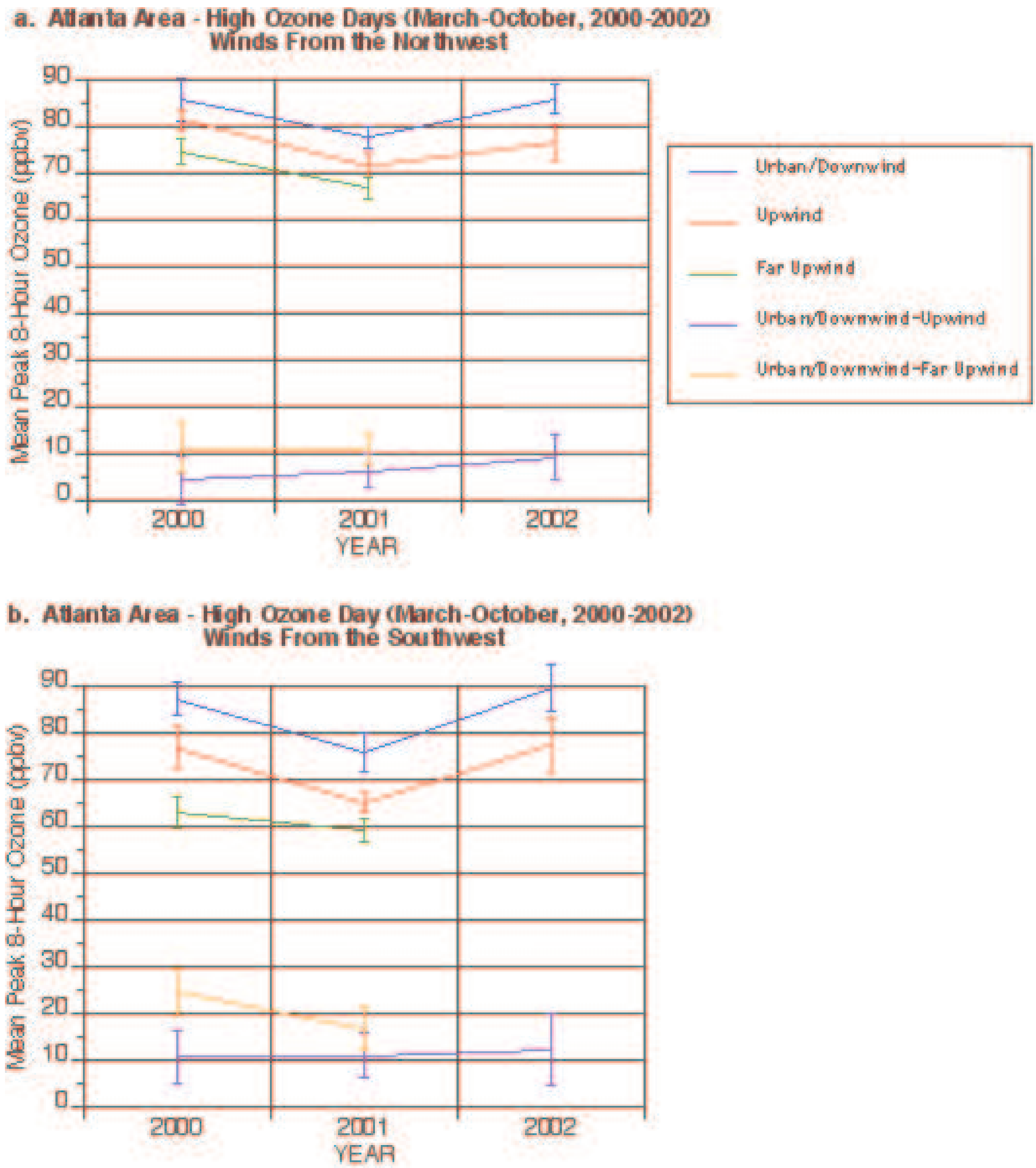


Figure 5. Example re-analysis of data Blanchard and Tanenbaum (2005). Mean daily 8-hour ozone maxima by year averaged from the top 21 high-ozone days at downwind sites (Conyers and Gwinnett), 2000-2002. The data have been averaged across monitoring locations representing far upwind, near upwind, and urban/downwind locations. The error bars are one standard error of the mean. No error bars are shown for averages based on one sampling day. (a) The days with winds from the northwest had 24-hour vector-average surface wind directions of 270 to 360 degrees. (b) The days with winds from the southwest had 24-hour vector-average surface wind directions of 180 to 270 degrees.

2.2.2 Key Aspects of Trend Analysis

Key aspects of analyses of trends in ambient air pollutant concentrations include:

- Air quality metrics (indicators) and species of interest
- Spatial and temporal domains and scales
- Selection of data subsets for analysis
- Statistical tests of trend

We discuss each in turn and summarize our approach to Task 2. We note that we would work with the Program Manager and Technical Committee to define the final approach to the trend analyses (see Task 1d), but the following discussion provides a starting point.

2.2.3 Air Quality Metrics (Indicators) and Species of Interest

We will analyze trends in the ambient concentrations of both ozone and selected primary pollutants. Primary pollutants will include CO, NO_x, and total nonmethane organic compounds (NMOC) or the sum of species (PAMS target compounds). We also propose to analyze trends in the ratios of CO/NO_x and $NMOC/NO_x$. In addition, we will consider the utility of analyzing trends in classes of NMOCs (e.g., alkanes, alkenes, aromatics) or some individual species (e.g., benzene), and will include trend analyses for such classes or species as deemed useful. Finally, we suggest considering trends in coefficient of haze (CoH). CoH is a measure of light absorbance, strongly linked with ambient concentrations of black carbon. Black carbon, in turn, derives primarily from vehicle exhaust, with some uncertainty about the relative contributions of diesel engines and gasoline engines. Despite the uncertainty, CoH potentially provides as interesting a surrogate for exhaust emissions as does CO. In previous work, we have found that CoH levels dropped sharply beginning in the early 1990s (Figure 6). Trends in CoH often coincide with CO trends, with some differences (Figure 7).

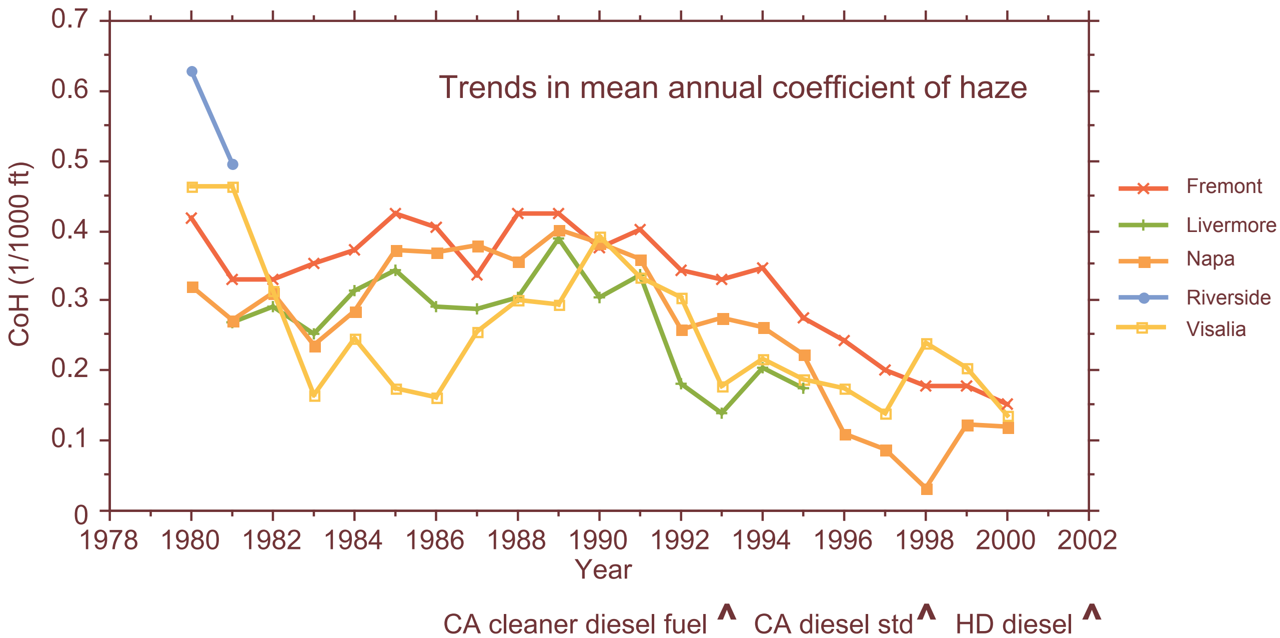


Figure 6. Trends in mean annual coefficient of haze (light absorbance) at five locations, indicating downward trends in ambient levels of black carbon.

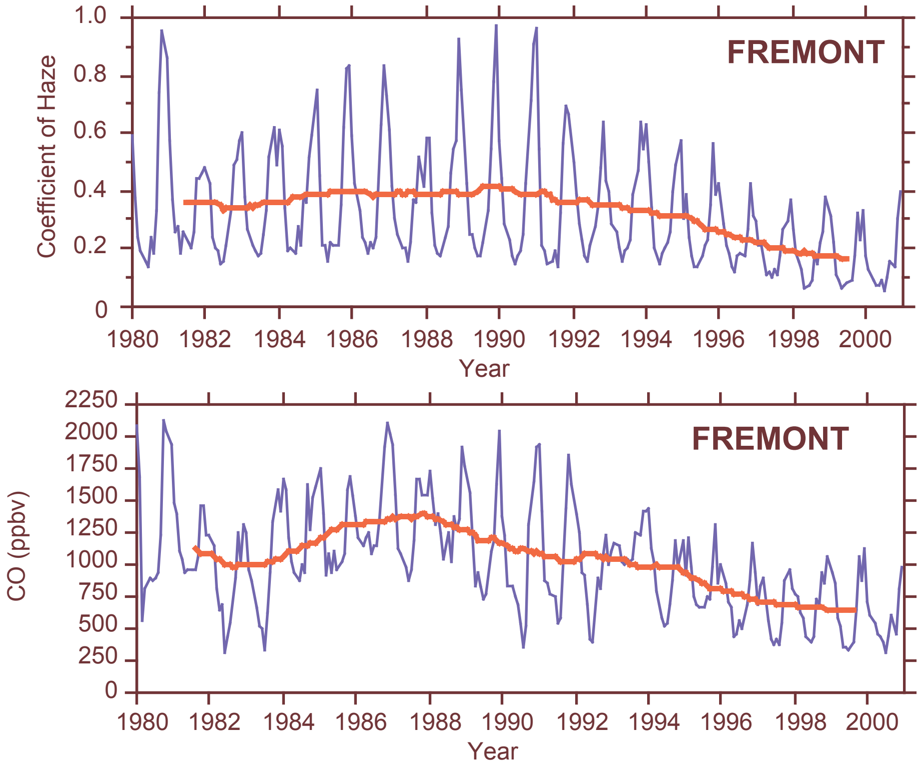


Figure 7. Trends in monthly-average coefficient of haze (top) and carbon monoxide (bottom) levels at Fremont, California.

Besides identifying the species, we also need to specify other characteristics of our metrics. For ozone precursors or other primary pollutants, we have typically used metrics that incorporate as much of the available data as possible, e.g., monthly averages of all hourly CO concentrations at a site. However, this approach is not necessarily appropriate for ozone, for which it is usually more desirable to focus on some subset of days of greater regulatory interest, i.e., high ozone days. As a result, we will evaluate the need to match the selection of primary-pollutant metrics to ozone metrics. As an example, if we select the top 30 peak ozone days per year and determine, e.g., peak 8-hour ozone on such days, we will consider using the same set of days for determining a mean CO or mean NO_x concentration. It may be best to utilize more than one metric for the primary species and to compare the resulting trends.

For ozone, metrics (indicators) that are not restricted to extreme values are needed. Because of the regulatory significance of peak values, we propose constructing indicators from peak ozone concentrations (rather than, e.g., 24-hour mean values). We also suggest including at least one indicator such as the annual 4^{th}-highest 8-hour ozone maximum (this value is not as extreme as, say, the annual 1-hour ozone maximum). Otherwise, several indicators are of possible interest, including but not limited to:

- Top x peak ozone values per year, where "x" would usually be in the range of 10 to 30, or might be of the form of the top 10 through 30 peak values. The peak could refer to either the 1-hour or 8-hour peaks. We suggest the top 30 8-hour peaks per site and year, but would discuss the choice with the Program Manager. For reference, in 2003, the San Joaquin Valley air basin experienced 137 days with peak 1-hour ozone greater than the state standard, and 134 days in excess of the federal 8-hour standard. The Sacramento Valley showed 51 days over the state standard and 40 days above the national 8-hour standard (Alexis and Cox, 2005).
- Top x per day of week per site and year. In previous work, we have used the top 3 peak ozone days per day of week per site (~21 days per year, sometimes more due to ties) so as to obtain an even distribution of days per week, if needed. Twenty-one days is 11.4% of an ozone season from May through October (184 days), or 9.8% of a season from April through October.
- Exposure to concentrations over a threshold (i.e., summing all hourly concentrations less the threshold value). This metric facilitates construction of population exposure metrics.

In selecting the value(s) of "x" above, we will also consider the number of meteorological classifications into which we may wish to split our data. Larger numbers of classifications will likely merit increasing "x" as much as is reasonable to ensure that each category includes an adequate number of days.

A further consideration is whether a metric such as the top 30 is computed for a site based upon the top 30 peak values at that site or based upon the 30 days having the highest basinwide peak values. These two calculations have different uses. The latter is more useful if we are comparing spatial patterns of high ozone concentrations (e.g., especially for use in the Lagrangian sense illustrated in Figures 4 and 5). However, the former is more useful if we wish to characterize trends at individual sites.

We propose using at least three ozone metrics for completeness.

To complete the specification of metrics, we must also consider the spatial and temporal domains of interest, as well as the spatial and temporal resolution desired. We must also consider the methods to be used for stratifying data into subsets (meteorological classification).

2.2.4 Spatial and Temporal Domains and Resolution

We will use the spatial and temporal domains specified in the RFP, namely, the CCOS domain and the period 1990 to 2004. While we have some preference for utilizing at least a 20-year record for trend analyses, ten years often suffices for obtaining detectable changes. Commencing with 1990 provides a greater emphasis on more recent years, which is perhaps of greater relevance to current air quality management programs.

Spatial resolution is straightforward. All trend tests will be carried out for individual monitors, and we will determine trends for all monitors in the CCOS domain. While it is relatively easy to write computer programs and apply them to all monitoring sites (batch mode), we have typically found it helpful to subsequently restrict the interpretation of results to sites having at least ten years data. This "ten-year" rule has no theoretical basis, but we have found that it has been a useful restriction in previous work. Note that the PAMS record now extends from 1994 to 2005. We will explicitly include all monitoring sites identified in the RFP.

Subregional or basin trends will be developed through aggregation of station trends or of station data, depending upon need. For example, median trends within a basin may be determined from the stations' trends, but the trend in the basin maximum (or, e.g., max top 30) must be assessed by applying a trend test to the appropriate basinwide metrics. Population exposure may be constructed by spatial interpolation of station exposure metrics (e.g., ppbv-hours over a threshold) to a grid (or census divisions).

We will use the subregions identified in the RFP.

Temporal resolution involves two choices. The first is the selection of the hours within a day. As already noted, the regulatory significance of peak ozone values merits the use of daily maximum 1-hour and 8-hour ozone concentrations. For primary pollutants, we must decide which hours to use. In recent work, Envair compared weekday to weekend concentrations of primary pollutants hour-by-hour, using three-hour averages, and using daytime (6 am to 3 pm) averages. For the present project, daytime averages of CO, NO_x, and other species may provide the best indication of changes in mass loadings during time periods of relevance to ozone formation. We will provide a recommendation in the draft project plan.

The second aspect of temporal resolution is aggregation of daily statistics, which is primarily a question of using annual, monthly, or daily averages in trend analyses. Annual metrics implicitly incorporate seasonal variation, whereas monthly or daily metrics exhibit seasonal changes that usually must be explicitly modeled in some manner. We propose to approach this choice sequentially, beginning with annual statistics (e.g., means of the top 30 peak 8-hour ozone days per year at each site). We will assess the utility of also developing trends from monthly data. Since Task 5a involves the preparation of month-specific emission inventories, it may be valuable to develop monthly-average concentrations for primary pollutants, particularly CO and NO_x, for later comparison with the emissions.

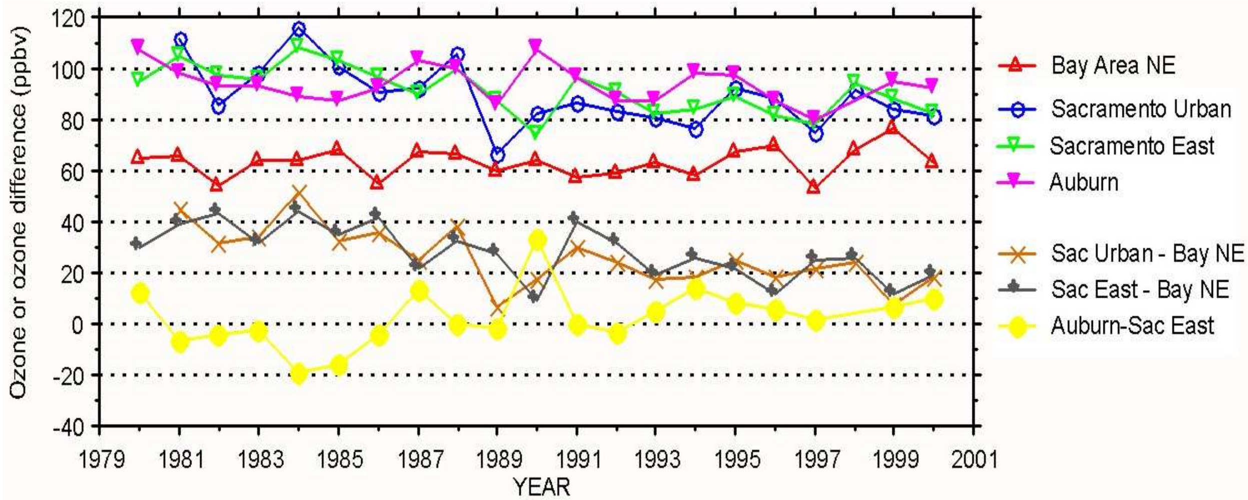
Finally, aggregation of daily peak values is also a function of the meteorological classification scheme.

2.2.5 Selection of Data Subsets

The objective of selecting subsets of data is to group days having similar source-receptor characteristics.

We suggest developing an initial screening selection of days using the simple method discussed in relation to Figures 4 and 5 (surface wind direction and trajectory analysis), to be followed by a more sophisticated clustering approach. For example, consider a selection of days from each year when surface winds and trajectory analyses indicate airflow through the Carquinez Strait toward the Sacramento metropolitan area and into the Sierra foothills. Fujita et al. (2003) found that days favoring such transport were not usually high ozone days in the Sacramento area, while the higher ozone days typically did not exhibit such a transport path. However, assuming that we can identify an adequate number of high-ozone days having winds from the appropriate sector, we would carry out an analysis of the accumulation of ozone concentrations along a transect defined by monitor locations. In this case, such a transect would begin with upwind sites at, e.g., Vacaville, Bethel Island, Pittsburg, and/or Davis, continue with urban Sacramento sites, then near-downwind (e.g., Folsom, Citrus Heights), and finish with far downwind (e.g., Auburn, Cool, Placerville). Analogous to Figures 4 and 5, we would use differences in the ozone metrics to define the contributions of upwind ozone, ozone formed between the urban Sacramento core and the near downwind, and ozone formed between the near and far downwind sites (with possible adjustment for dispersion). We believe that a transport-based screening approach will both yield useful results and will help us evaluate the capability of meteorological classification schemes to stratify data according to transport directions and distances. We re-analyzed data from Lehrman et al. (2004), and found that even without explicit meteorological information, the spatial patterns of the observed trends demonstrate the occurrence of changes in the contributions of regional ozone and locally formed ozone in the Sacramento metropolitan area (Figure 8), consistent with the findings of Fujita et al. (2003).

By stratifying the measurements according to surface and upper-level wind direction, a more explicitly Lagrangian analysis will result. We will include analyses of ozone precursors (or other primary pollutants), so that we can identify changes in the spatial patterns that are most closely related to changes in emissions within specific source areas. The locations of PAMS Type 1, 2, and 3 monitors near Sacramento, Fresno, and Bakersfield provide an opportunity to examine the chemical evolution of plumes through each of these areas (including information on ozone precursors as well as on ozone), provided meteorological information is used to identify and verify the transport direction and distance.



Location	Slope (ppbv/year)	r^2
Bay Area NE	+0.2	0.03
Sacramento Urban	-1.1	0.31
Sacramento East	-1.0	0.43
Auburn	-0.4	0.10
Sacramento Urban – Bay Area NE	-1.4	0.49
Sacramento East – Bay Area NE	-1.1	0.45
Auburn – Sacramento East	+0.7	0.14

Figure 8. Trends in annual averages of the top 30 daily peak 8-hour ozone maxima and differences among trends. For each year, the top 30 days peak 8-hour days were identified from the data for all monitoring sites in the Sacramento Valley. Annual averages were then computed for each year for each monitoring site using the same 30 days for each site. Sub-regional averages were determined from sites having data from most of the period from 1980 to 2000 (the records for some pairs of sites were considered complementary, covering different portions of the period). The Bay area NE sites were Bethel Island, Pittsburg, and Concord. The urban Sacramento sites were Del Paso Manor and El Camino. Sacramento east (or suburban sites) were Folsom (city yard), Folsom (Natoma), North Highlands, Rocklin, and Roseville. Downward trends occurred at Sacramento sites and at Auburn, but a slight upward trend occurred at the Bay area NE sites. The differences between Sacramento and Bay area NE concentrations show strong downward trends ($r^2 \sim 0.5$), indicating that local ozone formation declined over time. The difference between ozone levels at Auburn and those at suburban Sacramento sites increased slightly over time (negative values imply that decreases due to dispersion exceeded increases due to ozone formation). Either the distribution of emissions changed over time, or the rate of ozone formation in the urban plume decreased.

Having first examined one or more transport analyses, we will proceed with meteorological classification, and will subsequently attempt to relate the findings to gridded emission changes or to trends in precursor levels along the transect. For meteorological classification, we propose to build upon existing work. Fujita et al. (1999) reviewed past meteorological classification efforts as applied to central California. We suggest considering three recent sets of clustering, or classification, schemes that have been developed for central California. These are the DRI CCOS clustering algorithm (Fujita et al., 1999; 2001), the analyses of Larsen (1999), and the CART analyses reported in Lehrman et al. (2004).

The DRI clustering algorithm split a set of high-ozone days (which had been selected based upon threshold levels identified by the Bay area, Sacramento, and San Joaquin air districts) into three clusters, defined by the spatial patterns of ozone concentrations. The predictor variables included pressure gradients and surface and 850 mb temperature, wind speed, wind direction. For comparison, eight subjective meterological types were identified from weather maps. The CCOS clusters relate to, but do not correspond one-to-one with, different synoptic meteorological types (e.g., location of eastern Pacific high, etc.).

The classification approach of Larsen (1999) also utilizes meteorological variables that one would expect to correlate with transport direction and distance (e.g., pressure gradients between Oakland and Medford, Reno, and Fresno; vector components of surface wind speed and direction; 850 mb temperature at Oakland). The purpose of clustering was to divide days into groups for further analysis of meteorological influence on ozone formation; days within a group tended to be exhibit similar source-receptor relationships.

The CART classifications (carried out by Dr. David Fairley and reported in Lehrman et al., 2004) were intended to characterize the representativeness of the CCOS episodes with respect to ozone levels occurring in other time periods. The CART analyses classified daily maximum ozone levels in six sub-regions using meteorological parameters, of which the most important as predictors of ozone levels proved to be 0400 PST 500 mb height at Redding, 0400 PST 850 mb temperature at Oakland, synoptic weather type (troughing, ridging, zonal, flat), and previous-day ozone. The CART analyses yielded seven terminal nodes (i.e., they split the data into seven types of conditions).

We suggest using one of the existing classification schemes, if feasible, applying the scheme of choice to the larger data set that would now include data through 2004. That is, the coefficients associated with predictors (clustering) or the splitting criteria (CART) that were determined in previous work would be applied to all days in the updated data sets. Clustering and CART operate differently, but both techniques are capable of yielding useful classifications. A key difference is that CART uses discrete values for both predictor and classification variables, whereas clustering utilizes continuous values for predictors. Also, clustering typically places objects into groups that are indicated by the data, rather than defined a priori. CART was originally designed to reveal predictors of a known discrete outcome (one of the original applications discussed by Breiman et al., 1984, was the use of CART for qualitatively predicting next-day ozone levels in Los Angeles as nonalert, first-stage alert, or second-stage alert days).

We propose selecting a classification scheme according to the ability to split days into groups having different transport characteristics. To do this, we would compare the classifications with our assessment of surface transport (discussed above). For the purposes of the proposed work, classifications are of greatest value if they can divide the data into days having different transport directions or residence times.

We are prepared to carry out a new classification procedure if needed, utilizing the meteorological variables that have already been shown to be most useful for predicting ozone levels. We have statistical software packages available for this purpose. Once the data have been separated into subsets, we would apply statistical tests of trend.

2.2.6 Statistical Tests of Trend

A variety of statistical tests of trend are available, both parametric and nonparametric. The RFP specifies reporting trends in units of ppbv or ppbC per year and states that "straight-line" models are not useful. We have previously found that simple t-tests of trend applied to log-transformed data provide easily-communicated tests of trend, along with well-defined confidence intervals (e.g., Figure 9). The trend lines are not linear (though linear models also fit the results shown in Figure 9); trends are reported in units of percent per year, though graphs such as Figure 9 can be represented in concentration rather than log-transformed units. For annual metrics and time series shorter than 20 years, we have not typically found evidence for step-changes or nonmonotonic changes.

For monthly-resolution data, more complex statistical models may be needed to describe the temporal record. For example, we have previously examined monthly averages of a variety of measurements at several monitoring sites in California having long-term records (Figure 10). As an example, the full regression equation for PM_{10} nitrate was:

$$
\begin{aligned}
\ln(PM_{10}\text{ nitrate}) = {} & a_0 + a_1(\text{precipitation}) + a_2*\ln(NO_x) + a_3*I_{cool}*\ln(NO_x) \\
& + a_4*\text{time} + a_5*I_{cool}*\text{time} + a_6(\text{temperature}) \\
& + b_1*\sin((2\pi*\text{time-1980})/4) + b_2*\cos((2\pi*\text{time-1980})/4) \\
& + b_3*\sin((2\pi*\text{time-1980})/5) + b_4*\cos((2\pi*\text{time-1980})/5) \\
& + b_5*\sin((2\pi*\text{time-1980})/6) + b_6*\cos((2\pi*\text{time-1980})/6) \\
& + c_1*\sin((2\pi*\text{month-1})/12) + c_2*\cos((2\pi*\text{month-1})/12) \\
& + d_1*\ln(CO) + d_2*\ln(CoH)
\end{aligned}
$$

where:
time = calendar year + (month-1)/12
I_{cool} = 1 for January, February, March, October, November, and December
= 0 for March - September
and $\ln(PM_{10}$ nitrate), $\ln(NO_x)$, ln(CO), and ln(CoH) are monthly averages

The cool-season indicator, I_{cool}, was used to differentiate warm-season and cool-season trends or relations to NO_x. Not all components were statistically significant for all sites' regressions.

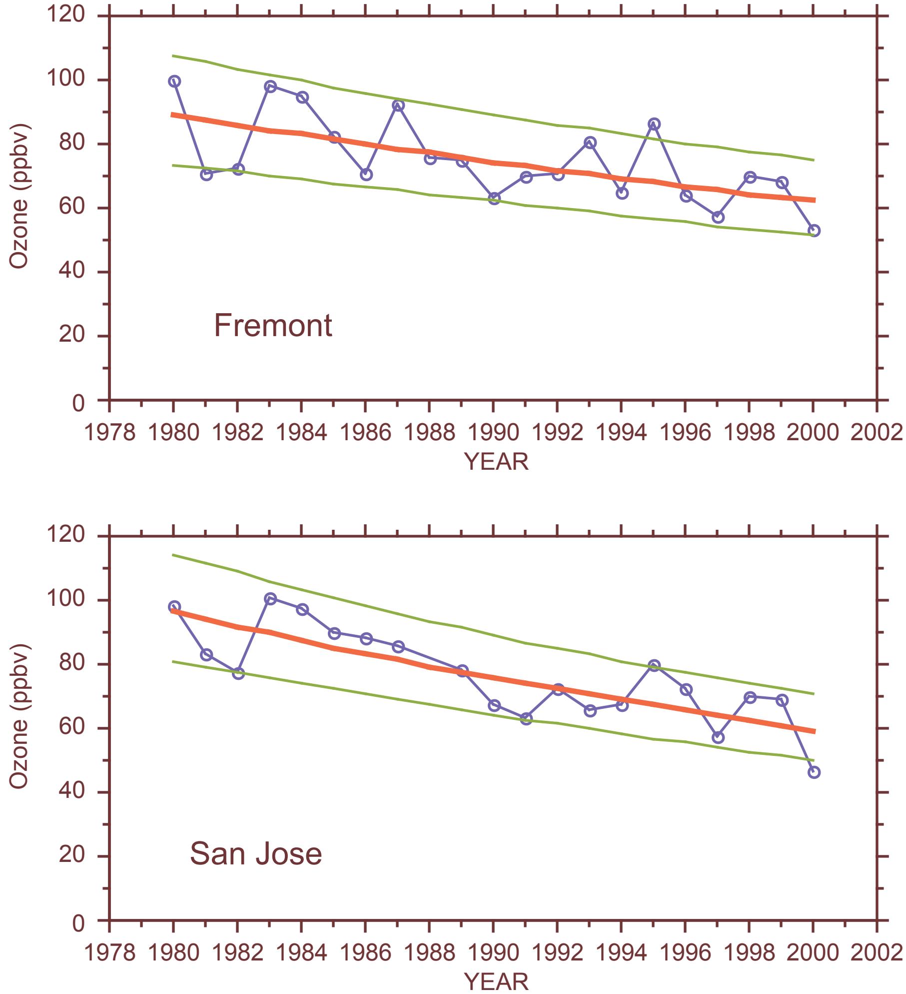


Figure 9. Annual 4th-highest 8-hour daily maximum ozone concentrations at Fremont and San Jose, 1980-2000. The trend line shows the least-squares regression of the log-transformed annual statistic against year. The 10th and 90th percentile prediction intervals for the annual data about the trend line are shown. Source: Lehrman et al. (2004).

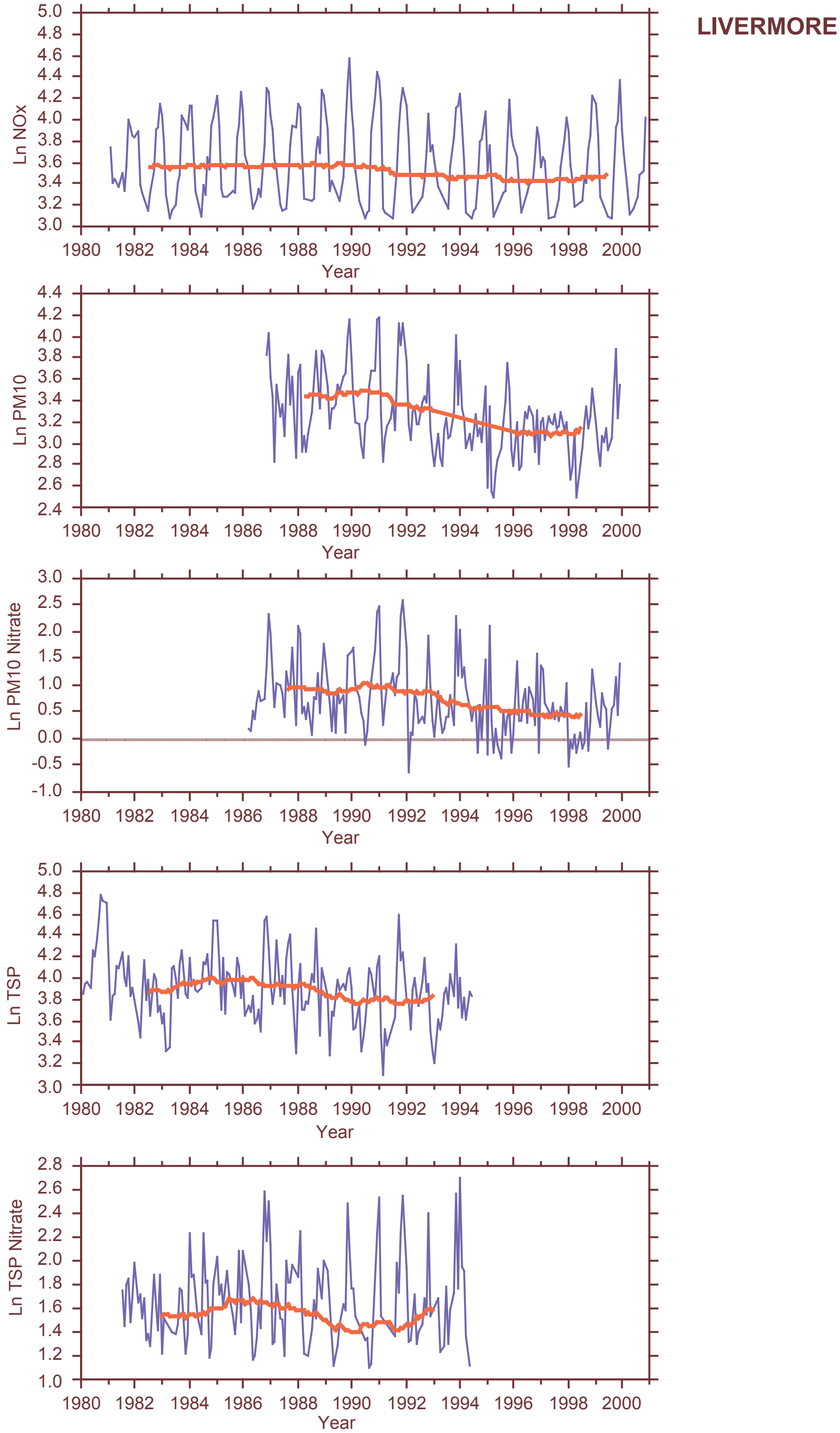


Figure 10. Natural logarithm of monthly-average NO_x, PM_{10}, PM_{10} nitrate, TSP, and TSP nitrate at Livermore during the years 1980-2000. The 3-year moving average is superimposed. Units are ppbv for NO_x and μg m^{-3} for other compounds.

To make the most efficient use of project resources, we propose a two-stage approach to the analyses of ambient pollutant trends. As stated in the RFP, "The Contractor shall carry out ambient trends analyses for ozone, NO_x, CO, and where appropriate, VOC at pertinent sites in accordance with the final work plan." We therefore propose to conduct the Task 2 trend analyses on annual-resolution metrics using appropriate statistical tests of trend, such as t-tests of concentration or log-transformed measurements, or a nonparametric procedure such as the Mann-Kendall or Kendall tau test along with Sen's slope estimator (Gilbert, 1987). The selected test would be applied on a site-by-site basis. For each site, we would apply the statistical test first to unstratified data (not disaggregated according to meteorological conditions). Then, we would apply the test to data that were disaggregated by meteorological conditions. For each site, differences in trends occurring under different meteorological regimes would be documented.

Any attempt to evaluate trends using monthly-resolution data would be deferred to Phase II, Task 6. The trend methods to be used when comparing ambient data and emissions estimates will be specified in the Phase II work plan. We would consider modifications of the statistical model described above for monthly-resolution data, in which predictor variables could include monthly-average emission values.

2.2.7 Other Considerations

The RFP also requests recommendations pertaining to the choice of meteorological inputs for the emissions estimates and an approach for locating of areas of emission influence around each monitor with reference to the CCOS modeling system. We suggest moving these considerations out of Task 2 and into Tasks 3 and 5, each of which includes more specific focus on emissions estimates.

2.3 TASK 3. ELUCIDATE EXPECTED RELATIONSHIPS BETWEEN TRENDS IN EMISSIONS AND IN AMBIENT POLLUTANT CONCENTRATIONS

Two considerations are key for this task. The first is the existence of statistically significant trends in ozone precursors, as elucidated in Task 2. If ozone precursor levels cannot be shown to have changed, we do not expect to find changes in ozone levels, nor should we expect to find a relationship between emission trends and ozone trends. However, the presence or absence of precursor trends, and their consistency with emission trends, would still be of interest.

The second consideration is the result obtained from meteorological classification. The presence of different trends in ozone precursors or ozone levels under different meteorological regimes would provide an opportunity for comparison with the emission changes occurring within different areas of influence. However, even if the ambient trends do not vary among meteorological types, it may still be possible to obtain useful comparisons with emission trends. In this case, we would assess the potential for comparing the site-to-site variations in trends with the changes in emissions within areas potentially affecting each site.

The approach for this task will largely involve synthesizing findings from Tasks 1 and 2. Part of this assessment will include the requested identification of CCOS modeling system grid cells likely to affect peak ozone levels under the major airflow categories.

2.4 TASK 4. DOCUMENT PHASE I FINDINGS AND PREPARE A FINAL WORK PLAN FOR PHASE II

As requested, we will prepare a draft report documenting Phase I findings. This report will include our recommendations regarding the feasibility of Phase II. Provided Phase I indicates that Phase II is feasible, we will also prepare a work plan for Phase II. We will also meet with the Technical Committee to discuss the draft report and work plan.

Should Phase II be infeasible, or should the Technical Committee decide not to authorize Phase II, we would not conduct Tasks 5 and 6. However, Tasks 7, 8, and 9, while listed within Phase II, are needed in part or in whole even if Phase II is not authorized. That is, we believe that Phase I will merit a journal publication (Task 7), and we would provide data, documentation, and software for all Phase I activities (Task 8). Three of the four meetings specified in Task 9 will occur during Phase I.

2.5 TASK 5. ANALYZE TRENDS IN EMISSIONS

2.5.1 Prepare Month-Specific Gridded Emissions Inventories

Several possible levels of effort could be applied to this task. This work would be primarily conducted by Alpine Geophysics, which will develop the initial routines for preparing gridded, monthly inventories, incorporate historical emissions data into inventories, execute the emissions modeling system to prepare gridded, monthly inventories, and prepare spatial maps by month depicting ozone precursor emissions estimates.

The RFP states "Emissions from stationary aggregated and area-wide source categories should be backcasted for each year and month back to 1990 to incorporate the latest emission inventory methodologies available." Based on this statement, it appears that the project team, not CARB, will be responsible for backcasting/forecasting emissions. Our scope of work assumes that Alpine Geophysics will carry out the backcasting and forecasting. However, as we noted earlier, Task 1a requests that we obtain backcasted/forecasted inventories. If annual backcasted/forecasted inventories are available from CARB and the Technical Committee approves their use, we can reduce the level of effort for Task 5a (as discussed in the cost proposal). In this case, Alpine Geophysics would generate monthly inventories from each of the annual backcasted/forecasted inventories.

We assume that monthly inventories for May through October will be needed. If twelve monthly inventories per year are needed, the resources required to complete the effort will be greater (as discussed in the cost proposal).

The CARB currently uses EMS-95 to prepare gridded inventories, and we assume that this will hold true for the present project. We also assume that the grid domain will be based on the current CCOS modeling domain.

We will use ARB's EMFAC2002 mobile source modeling system to estimate monthly, county-wide on-road mobile source emissions estimates. The county-wide estimates will be spatially allocated to grid cells based on the current gridded VMT available from the CCOS. If historical gridded VMT are available with supporting grid and map projection parameters, historical gridded VMT can be used to spatially allocate the monthly, county-wide on-road mobile source emissions estimates. Monthly average temperatures and relative humidities, as developed during the course of this study, will be used to drive the EMFAC2002 model. We suggest using year-specific monthly meteorological data, rather than default meteorology.

CARB uses BEIGIS to estimate biogenic emissions estimates. The current BEIGIS landuse setup is representative of conditions for year 2000. Though historical landuse datasets are available, none have been adapted for use in BEIGIS. Hence, we will use the BEIGIS landuse setup as is for all forecast and backcast years. However, we will use monthly average temperatures and solar radiation when applying the environmental correction algorithms to estimate biogenic emissions. This approach does not account for such factors as urban encroachment, year-to-year crop change, wetlands recovery, or forest management practices, but we believe that this simplification is necessary.

2.5.2 Analyze Emissions Trends

Monitor-specific emission trends will be developed for each station from the gridded inventory and from the areas of influence associated with airflow categories, as identified in Task 3. The effort will be coordinated among Envair, DRI, and Alpine Geophysics. DRI will provide GIS support, as needed, for this task.

2.6 TASK 6. RELATE EMISSIONS TRENDS TO AMBIENT POLLUTANT TRENDS

The specific approach for relating the ambient trends to the emissions trends will be delineated in the work plan for Phase II, once the results of Phase I have been established. We anticipate using monthly resolution (to match the resolution of the inventories), with the need to adopt statistical models such as discussed in Section 2.2.6. As specified in the RFP, we will characterize the levels of certainty associated with our findings.

2.7 TASK 7. PREPARE FINAL REPORT AND JOURNAL ARTICLE

Reporting for the study will consist of the work plans for Phases I and II, progress reports, a draft final report, a final report, and draft and final journal manuscripts. We would welcome contributions from CARB staff and the members of the Technical Committee to efforts to prepare the manuscript if so desired. At a minimum, we would assume the Technical Committee would review and provide comments on the manuscript. The project budget includes time required to prepare the manuscript for submission, but, as stated in the RFP, page charges and other publication costs would be covered by us. Drs. Blanchard and Fujita each have established a record of publication of project results in the peer-review literature.

2.8 TASK 8. PROVIDE DATA, DOCUMENTATION, AND SOFTWARE

The members of the study team have experience in developing joint project documentation. Dr. Blanchard will be responsible for assuring the all writing assignments are clear and will review all project reports.

Copies of modeling software, input and output files will be provided to the program manager according to the approved schedule.

2.9 TASK 9. ATTEND MEETINGS

We will plan to attend four meetings in Sacramento: at the start of the project, and at or near completion of Tasks 1, 4, and 7.

3 SCHEDULE AND KEY MILESTONES

As indicated in the RFP, all work will be completed, including the provision of all deliverables, within 14 months from the initiation of the study. However, we propose modifying the schedule listed in the RFP, in part because the RFP schedule only provides 6 weeks between submittal of the Phase I final work plan and submittal of the Phase I final report, which is not enough time for completion of Tasks 2 and 3. Assuming a start date of mid-October, we will conduct the proposed study in accordance with the following schedule:

Task	Deliverable/Milestone	Delivery Date
	Contract initiation	mid-October, 2005
	Startup meeting	late October, 2005
1	Submit Phase I draft work plan	late November, 2005
1	Task 1 meeting	early-December, 2005
1	Submit Phase I final work plan	January 15, 2006 (or 30 days after receipt of comments)
2,3	Complete Tasks 2 and 3	mid-January to mid-April, 2006
4	Submit Phase I draft final report and Phase II draft work plan	May 1, 2006
4	Task 4 meeting	mid-May, 2006
4	Submit Phase I final report and Phase II final work plan	June 30, 2006 (or 30 days after receipt of comments)
5,6	Complete Tasks 5 and 6	July to September 2006
7	Submit draft final report and draft manuscript	October 2006
7	Task 7 meeting	November 2006
7,8	Submit final report and final pre-publication version of manuscript	December 31, 2006

The proposed schedule provides three months for finalizing the Phase I work plan, three months to complete Tasks 2 and 3, and 2.5 months to finalize the Phase I report and Phase II work plan. It also provides three months for completion of Tasks 5 and 6, as well as three months for drafting and finalizing the project report and manuscript.

We reserve the right to modify the schedule to accommodate delays in contract initiation or receipt of comments on draft work plans or draft reports. Provision of the final report at the end of 14 months is also contingent upon receipt of comments on the draft final report and draft manuscript within 30 days of submittal.

4 PROJECT MANAGEMENT AND STAFFING

This section discusses the administration and staffing of the proposed study.

Dr. Charles L. Blanchard, a principal of Envair, will serve as the principal contact person for the proposed study. Pertinent contact information is as follows:

Address: Dr. Charles L. Blanchard
526 Cornell Avenue
Albany, CA 94706

Telephone: (510) 525-6231
Facsimile: (510) 528-2834
E-Mail: cbenvair@pacbell.net

Dr. Blanchard will be the principal investigator for the study. Since Envair is an unincorporated association, contracting is with a member of the Envair group, not with Envair itself. For this procurement, Dr. Blanchard would be the prime contractor.

In his role as the prime contractor, Dr. Blanchard will issue subcontracts to the other team members.

In his role as the principal investigator, Dr. Blanchard will assume overall responsibility for the technical direction of the work and administrative matters. He will be the primary point of contact for the program manager and Technical Committee. He will also conduct major portions of the study, work with the program manager to assure that there is understanding and agreement concerning the approaches that are being adopted by the study team in performing the study, facilitate the resolution of problems should they arise during the conduct of the work, review all project reports, and be responsible for submitting the progress reports and the draft and final reports.

Other members of the team will be responsible for conducting analyses in specific areas. Our initial assignment of personnel hours is shown in Table 2. Table 2 shows the level of effort associated with completion of both Phases I and II. We anticipate adjusting these hours somewhat, depending upon the scope of work adopted in the final work plans for Phases I and II. Further discussion is contained in the cost proposal.

Table 2. Assignment of labor hours to tasks. Hours may be shifted among personnel as needed to complete tasks efficiently.

	Envair		DRI		Alpine Geophysics		
Task	C Blanchard	S Tanenbaum	E. Fujita	D. Campbell	C. Loomis	J. Wilkinson	Subtask hours
1a	4		16		45	45	110
1b		24		16			40
1c		24		16			40
1d	32		32				64
2	120	160					280
3	80						80
4	40		40				80
5a					275	275	550
5b	16	40	16	40			112
6	80	160					240
7	80	24	32				136
8	4	24		8	35	35	106
9	32		8				40
Total hours	488	456	144	80	355	355	1878

3.1 ENVAIR

Dr. Charles Blanchard has been a principal of Envair since its founding in 1990. His recent research interests include studies of weekday and weekend air pollutant levels, using these comparisons to evaluate how changes in precursor species affect secondary air pollutant concentrations. His most recent projects on weekend air pollutant effects include analyses of ambient measurements from 23 states in New England, the Midwest, the mid-Atlantic, and isolated urban areas in the western and southern U.S. Currently, he is also preparing an historical record of fine PM mass concentrations in California for the California Air Resources Board, accounting for differences in measurement methods and accuracy of the different monitoring programs.

Dr. Blanchard served as the lead author for the chapter on "Spatial and Temporal Characterization of Particulate Matter" in "Particulate Matter Science for Policy Makers: a NARSTO Assessment", published by Cambridge University Press. During the past three years, he has provided statistical and modeling analyses of measurements from the Southeast Aerosol Research and Characterization (SEARCH) network, and has analyzed ozone and secondary particulate matter formation for both SEARCH and the Lake Michigan Air Directors Consortium. He has conducted analyses of air pollutant trends, patterns, and sources in California and throughout the U.S. since 1988.

Dr. Blanchard evaluated, developed, and applied methods for using ambient measurements to characterize the relative effectiveness of VOC and NO_x control strategies for reducing ozone concentrations. He has applied ozone observation-based methods for the Bay Area Air Quality Management District, the San Joaquin Valleywide Air Pollution Study Agency, the Texas Natural Resource Conservation Commission, the Lake Michigan Air Directors Consortium, the Coordinating Research Council, and the American Petroleum Institute. Other areas of interest are the statistical design of acid-deposition, particulate, and other air pollution monitoring networks, sponsored by the U.S. EPA, the Atmospheric Environment Service (Canada), and the California Air Resources Board, and the application of statistical methods to attainment demonstration requirements for the NAAQS.

He holds an M.S. and Ph.D. in Energy and Resources and an M.A. in Statistics from the University of California, Berkeley.

Ms. Shelley Tanenbaum has worked with Envair since 1993. She has most recently participated in studies of weekday and weekend air pollutant levels, co-authoring publications on the weekend effect in southern California, Atlanta, and other metropolitan areas. She has extensive experience with database, statistical, and graphics programming, and has carried out much of the statistical analysis needed for preparing an historical record of fine PM mass concentrations in California. She holds a B.A. in Mathematics and an M.A. in Energy and Resources from the University of California, Berkeley.

3.2 Desert Research Institute

Dr. Eric M. Fujita is a Research Professor at the Division of Atmospheric Sciences at Desert Research Institute. Dr. Fujita has over 25 years of experience in managing and conducting air quality studies. Dr. Fujita has 45 peer-reviewed publications, 78 contract and grant final reports, and has given 87 presentations at technical conferences and symposia. He is the principal author of the field study plans for the 2000 Central California Ozone Study and 1997 Southern California Ozone Study (SCOS97-NARSTO). His research interests include chemical characterization of emission sources, reconciliation of emission inventory estimates for VOC, NOx and PM with long-term trends in ambient ozone and PM, and measurement and characterization of exposure to toxic air contaminants. Dr. Fujita performed source apportionment analysis of fine particles in Colorado's Northern Front Range, California's South Coast Air Basin and San Francisco Bay Area, Phoenix, and Bangkok Thailand. Current research includes quantifying the relative contribution of gasoline and diesel exhaust to ambient PM and measuring air toxic exposures from mobile sources. Exposure studies include a survey of the spatial and temporal variations of black carbon and PM concentrations at the Roseville Railyard, exposures to mobile source air toxics in high-end microenvironments in Houston, Atlanta and Chicago, and on-road and near-road exposure to PM and air toxics in the South Coast Air Basin. Dr. Fujita also performed volatile organic compound source apportionment studies for the 1987 Southern California Air Quality Study (SCAQS), 1990 San Joaquin Valley Air Quality Study (SJVAQS), 1993 Coastal Oxidant Assessment for Southeast Texas (COAST), 1995 Boston and Los Angeles Study, 1996 Phoenix Ozone Study, NARSTO-Northeast 1995 Summer Ozone Study, 1995/96 Washington Ozone Transport Study, 1996 El Paso/Juarez Ozone Study, and 1998 Central Texas On-Road Hydrocarbon Study. He has conducted similar studies in Houston and Mexicali, Mexico. Dr. Fujita also coordinated laboratory comparisons of VOC measurements during the SCOS97-NARTSO, COAST and NARSTO-Northeast ozone studies. Prior to coming to DRI, Dr. Fujita was an Air Pollution Research Specialist for the Research Division of the California Air Resources Board where he initiated and managed extramural research in emission inventory development, air quality measurements, and atmospheric processes. These studies included developing emission factors for mobile and stationary sources and assessing the effectiveness of emission control measures. Other studies included examining gas and aerosol measurement methods and characterization of organic compounds in ambient air and emission sources. He holds a doctorate in Environmental Science and Engineering from UCLA.

Mr. David E. Campbell is an Assistant Research Scientist at DRI whose current research interests are the characterization and apportionment of gaseous and aerosol pollutants from mobile sources. He will assist Dr. Fujita with compilation of necessary datasets and execution of relevant receptor models. Research activities prior to joining DRI included monitoring and analysis of visibility reducing particles for the NPS/IMPROVE program. Mr. Campbell is experienced in the validation and analysis of large data sets using database, spreadsheet, and GIS. He is also familiar with all commonly used methods for collection and characterization of ambient aerosols. For 13 years Mr. Campbell worked for the primary contractor responsible for IMPROVE program sample collection and data analysis (Crocker Nuclear Lab, UC Davis). His duties included aerosol sampler design, testing, construction, installation, auditing and maintenance; gravimetric, elemental, and optical analysis of filter samples; development and application of quality control procedures; analysis of historical data for quality assurance. In addition, he participated in the evaluation of the Federal Reference Method PM2.5 samplers used by EPA's PM2.5 speciation network.

3.3 Alpine Geophysics, LLC

Ms. Cyndi F. Loomis: Ms. Loomis, Senior Scientist, specializes in emissions inventory preparation and emissions modeling for regional and urban scale photochemical and particulate modeling applications, environmental database design and implementation, and the statistical analysis of sampling data. She has experience using all of the major emissions modeling systems, including SMOKE, EMS-2001, EMS-95, EMS-95/PM, GEMAP, EPS and FREDS. Most recently she has designed and developed the EMS-2001/MOBILE6.2 modeling package for the development of on-road motor vehicle emissions for particulate and photochemical modeling. She is currently developing particulate inventories for national scale modeling, utilizing the EMS-2001/MOBILE6.2 modeling system. She is also involved in the development and QA of SIP quality inventories for particulate and photochemical modeling in California. She has employed and evaluated the emissions modeling procedures used in SMOKE, Models-3/CAMQ, and the EMS-95 systems.

Ms. Loomis was been involved in, and developed inventories for, numerous projects requiring both particulate and photochemical inventories. These projects utilized emissions data from a wide variety of sources including the OTAG emissions databases, the EPA's NEI and NET inventories, data acquired from state and local jurisdictions, continuous emissions monitoring (CEM) data, and facility supplied emissions data. She has also developed emissions modeling inventories for use in air quality planning for a number of projects including: Peninsular Florida Ozone Study (PFOS), CCOS (California Air Resource Board), Southern Appalachian Mountain Initiative (SAMI), Pittsburgh-Beaver Valley Ozone Modeling Study, Pennsylvania Stakeholders Ozone Modeling Study, Cincinnati-Hamilton Ozone SIP Modeling Study, Lower Lake Michigan Ozone SIP Modeling Study, Stakeholder participation in the OTAG/EPA NOx SIP Call Modeling, the South Central Coast Air Basin of California, Ventura County, and Santa Barbara County. These emissions were synthesized from a variety of sources, including emissions inventories developed for OTAG, state and local agency records, and CEM data provide by local utilities.

Dr. James G. Wilkinson: Dr. Wilkinson, Senior Engineer, specializes in the development and application of computer-based emissions and aerosol/photochemical modeling systems. His research interests include the design, development, implementation, and evaluation of emissions modeling systems. Dr. Wilkinson is responsible for the development of spatially and temporally resolved emissions estimates, using such tools as EPS2.0 and EMS-95, which are suitable for use in three dimensional aerosol dynamics and photochemical air quality models. He has worked on a large number of ozone, acid deposition, and/or visibility/regional haze studies in regions including the: California South Coast Air Basin, South Central Coast Air Basin, San Joaquin Valley (i.e., the SARMAP domain), San Diego Air Basin, Pittsburgh-Beaver Valley nonattainment area, Lehigh Valley (PA) airshed, Lake Michigan ozone nonattainment area, OTAG modeling domain, Northeastern U.S., Atlanta, GA nonattainment area; Houston, Texas

COAST airshed; Mexico-United States Border Region; and the Southern Appalachian Mountains Initiative (SAMI).

As part of his Ph.D. studies, Dr. Wilkinson was SAMI's lead emissions modeler and active in the SAMI ozone/PM modeling as well. He is responsible for the preparing the air quality model's emissions inputs including spatially and temporally resolved, as well as speciated VOCs and size resolved aerosol precursors for NH_3, SO_2, SO_4, NO_3, EC, OC, and crustals (Na, Ca, Mg, and K), onroad and nonroad mobile source emissions estimates. Mr. Wilkinson has applied the following emissions estimation tools: MOBILE5a, MOBILE5a_h, MOBILE5b, MOBILE5C, PART5, EMFAC7f, EMFAC7g, EFMAC2002, DTIM2, BURDEN/IRS, Cal-MoVEM, MoVEM, OFFROAD, FIRE, FOFEM, NONROAD, EPS2.0, and EMS-95. He has also evaluated the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system for use in air quality modeling studies.

5 TEAM QUALIFICATIONS

The study team consisting of Envair and Desert Research Institute brings a wealth of pertinent experience to the project. This section provides an overview of each organization and brief summaries of previous projects.

5.1 ENVAIR

Envair is an unincorporated association dedicated to carrying out contract research and offering consulting services in the environmental and earth sciences. Envair offers technical consulting in air quality and atmospheric sciences, with emphasis on atmospheric modeling and data analysis; development of procedures useful in regulatory analysis; management of research-oriented technical studies, including large, combined monitoring, modeling, and data analysis programs; and policy analysis studies and policy-oriented consulting in the environmental sciences. Envair maintains offices in the San Francisco Bay Area (Albany and San Rafael), Pasco, Washington, and Placitas, New Mexico.

Examples of recent projects follow.

Spatial and Temporal Characterization of Fine Particulate Matter Mass Concentrations in California, 1980-2002 (Contract 03-250)

Client: California Air Resources Board

Period of Performance: 2004-2005
Contract Value: $34,915

Contact: Dr. Nehzat Motallebi
California Air Resources Board
Research Division
1001 I Street
Sacramento CA 95812
(916) 324-1744
nmotalle@arb.ca.gov

Systematic measurement of fine PM mass concentrations began nationally with implementation of the Federal Reference Method (FRM) network in 1998 and 1999. However, a variety of other monitoring networks have measured fine PM mass concentrations, other PM size fractions, and related pollutants during various periods of time and at varying numbers of sites in California from 1980 through 2002. We developed an historical record of fine PM mass concentrations by combining data from different monitoring programs, accounting for differences in measurement methods and accuracy. The product of this work was a database consisting of estimates of monthly-average fine PM mass concentrations and their uncertainties at monitoring sites in California for the period from 1980 through 2002.

We investigated the comparability of $PM_{2.5}$ mass concentration measurements from different monitoring networks, reconstructed FRM-equivalent $PM_{2.5}$ mass concentrations from other types of measurements, and estimated the associated uncertainties. We established conversion factors to standardize fine mass measurements from other networks to FRM equivalents. The other networks include the California Air Resources Board (CARB) dichotomous sampler network and a variety of special studies conducted prior to implementation of the FRM network.

Where alternative measurements of fine PM mass were not available, we reconstructed fine mass from PM components measured in other size fractions, light absorption, or light scattering.

This project demonstrate our capabilities in statistical analysis of measurement conmparability and database preparation.

Application of the Smog Production Algorithm to Routine Monitoring Data Collected in Central California, 1990-2000 and Analyses of the 1980-2000 Trends and Historical Ozone and Precursor Relations at all Sites in Central California (Contract 01-2CCOS)

Client: Technical & Business Systems

Period of Performance: 2001-2003
Contract Value: $26,586

Contact: Mr. Don Lehrman
859 Second Street
Santa Rosa CA 95404
(707) 526-2775
donl@tbsys.com

Dr. Blanchard worked under subcontract to Technical & Business Systems, Inc., Santa Rosa CA, on this project for the California Air Resources Board, Sacramento, CA. For the first task, he analyzed ambient monitoring data from all stations in central California to characterize ozone responses to changes in VOC and NO_x levels. The ambient data were used to characterize where and when ozone formation was limited by VOC or NO_x. Results from the special study during 2000 were compared with data from other ozone seasons to assess the representativeness of the special-study period. More severe ozone episodes (peak hourly ozone levels exceeding 120 ppbv) exhibited more site-hours during which ozone formation was NO_x-limited than did moderate ozone episodes (peak hourly levels of 80 to 120 ppbv), implying that ozone control strategies may differ among episodes.

For the second task, Dr. Blanchard analyzed the 1980-2000 trends and historical ozone and precursor relations at all sites in central California (to provide an historical characterization of use for interpreting the CCOS findings). This information helped to characterize the representativeness of the ozone season during 2000 and to provide empirical evidence for the responses of ozone to changing precursor levels. The majority of monitoring sites in the San Francisco Bay area and the South Central Coast showed reductions of annual 4th-highest peak 8-hour ozone in the range of 15 to 25 percent per decade over 1980-2000. However, sites in the Central Valley showed either small (less than 5 percent) decadal reductions or increasing peak 8-hour ozone levels.

These projects demonstrate our capabilities in statistical analysis of ambient air quality monitoring data, the assessment of responses of secondary air pollutant concentrations to changes in different primary pollutant emissions, and meteorological analyses of secondary pollutant formation.

Weekend/Weekday Differences in Ambient Concentrations of Primary and Secondary Air Pollutants in Five Areas– The Northeastern US, Gulf Coast, Dallas-Fort Worth, Denver, and Phoenix

(Final report title: ***Weekend/Weekday Differences in Ambient Concentrations of Primary and Secondary Air Pollutants in Atlanta, Baltimore, Chicago, Dallas-Fort Worth, Denver, Houston, New York, Phoenix, Washington, and Surrounding Areas***)

Client: National Renewable Energy Laboratory (LDX-4-44213-01)

Period of Performance: May 2004 – April 2005
Contract Value: $51,178

Contact: Dr. Douglas Lawson
1617 Cole Boulevard
Golden CO 80401-3393
(303) 275-4429
Doug_Lawson@nrel.gov

Our analysis establishes the existence of statistically significant reductions of ambient concentrations of NO_x, CO, and hydrocarbon compounds on Sundays compared with Wednesdays in the northeastern U.S., the Gulf Coast of Texas and Louisiana, Dallas-Fort Worth, Phoenix, and Denver; in contrast, Sunday ozone levels are not significantly different. Trajectories (NOAA Hysplit model) have been used to define upwind and downwind directions, so that the effects of the urban plumes on downwind areas may be studied. These trajectory analyses have been carried out for Phoenix, Dallas-Fort Worth, and southern Lake Michigan (illustrating the transport of the Chicago-Gary plume across Lake Michigan as it differs on Wednesdays and Sundays).

These studies demonstrate our capabilities for conducting statistical analyses, source apportionment for secondary compounds, and trajectory analyses.

Weekday/Weekend Differences in Air Pollutant Levels – Los Angeles and Atlanta: Differences Between Weekday And Weekend Air Pollutant Levels In Southern California (A36A-2); Identification of Trends in Ambient NO_x and Particulate Nitrate Concentrations (A43c); and Weekend/Weekday Differences in Ambient Ozone and Particulate Matter Concentrations in Atlanta and the Southeastern United States(A-47).

Client: Coordinating Research Council

Period of Performance: 12/99-10/00; 4/02-9/02; 11/03-11/05
Contract(s) Value: $68,000

Contact: Mr. Brent Bailey
3650 Mansell Road, Suite 140
Alpharetta GA 3022-3068
(678) 795-0506
bkbailey@crcao.com

From December 1999 through October 2000, Dr. Blanchard conducted a study of **"Differences Between Weekday And Weekend Air Pollutant Levels In Southern California"** (published in Journal of the Air & Waste Management Association, July 2003). He analyzed ambient pollutant concentrations for the period 1991 – 1998 to characterize changes between weekdays and weekend days. Despite statistically significant lower NO_x levels on weekends, 20 of 28 monitoring sites in the South Coast Air Basin showed statistically significant higher mean ozone levels on Sundays than on weekdays. The mean weekend concentration declines of 25-41% for NO_x and 16-30% for VOCs were either ineffective or even counterproductive for lowering weekend ozone concentrations, indicating that larger emission reductions will be required for meeting the ozone standard in southern California.

From April – September, 2002, Dr. Blanchard completed a study of **"Identification of Trends in Ambient NO_x and Particulate Nitrate Concentrations,"** which confirmed the existence of long-term reductions in ambient concentrations of NO_x and particulate nitrate in urban locations in California.

We recently completed a study of **"Weekend/Weekday Differences in Ambient Ozone and Particulate Matter Concentrations in Atlanta and the Southeastern United States."** The final report is complete and a manuscript is in press. This study establishes the existence of statistically significant reductions of ambient concentrations of NO_x, CO, and hydrocarbon compounds on Sundays compared with Wednesdays in Atlanta; in contrast, Sunday ozone levels are not significantly different. Trajectories (NOAA Hysplit model) have been used to define upwind and downwind directions, so that the effects of the urban plume on downwind areas may be studied and contrasted on Wednesdays and Sundays.

These studies demonstrate our capabilities for conducting statistical analyses, source apportionment for secondary compounds, and trajectory analyses.

Analyses of Ambient Monitoring Data From Illinois, Indiana, Michigan, Missouri, Ohio, and Wisconsin

Client: Lake Michigan Air Directors Consortium

Period of Performance: May 2003 – February 2004 and March 2005
Contract(s) Value: $35,000

Contact: Mr. Michael Koerber
2250 East Devon Ave, Suite 250
Des Plaines IL 60018
(847) 296-2181
koerber@ladco.org

Dr. Blanchard completed two reports for the Lake Michigan Air Directors Consortium, Des Plaines, IL. One project used ambient monitoring data from the six states in the Midwest Regional Planning Organization to characterize ozone responses to changes in VOC and NO_x levels ("VOC and NO_x Limitation of Ozone Formation at Monitoring Sites in Illinois, Indiana, Michigan, Missouri, Ohio, and Wisconsion, 2000-2002"). The ambient data indicated that ozone formation within many of the metropolitan areas studied, especially the Chicago-Gary metropolitan area, was VOC limited and that regional rather than local NO_x reductions should be examined further for the purpose of decreasing peak 8-hour ozone concentrations. The other project used PM data and two thermodynamic equilibrium models (SCAPE2 and ISORROPIA) to characterize changes in fine particulate matter concentrations in response to changes in ambient concentrations of PM precursors ("The Effects of Changes in Sulfate, Ammonia, and Nitric Acid on Fine PM Composition at Monitoring Sites in Illinois, Indiana, Michigan, Missouri, Ohio, and Wisconsion, 2000-2002"). The PM measurements and models indicated that mean annual fine PM mass concentrations would decrease by about 2 to 3 $\mu g\ m^{-3}$ at ten monitoring sites in response to a 50 percent reduction in sulfate, and by about 1.5 to 2 $\mu g\ m^{-3}$ in response to a 50 percent reduction in ambient nitric acid concentrations. During March 2005, we updated the PM analyses with a new set of ambient monitoring data from ten sites in the Midwest.

These projects demonstrate our capabilities in statistical analysis of ambient air quality monitoring data and the assessment of responses of secondary air pollutant concentrations to changes in different primary pollutant emissions (using both ambient data and equilibrium models), completed within a short time (10 months and one month).

Understanding the Effectiveness of Precursor Reductions in Lowering 8-hour Ozone Concentrations: Central California

Client: American Petroleum Institute

Period of Performance: 2000-2001
Contract Value: $90K

Contact: Dr. Steve Ziman
ChevronTexaco
100 Chevron Way
Richmond, CA 94802
510-242-1530
sdzi@chevrontexaco.com

Recent empirical and modeling analyses have indicated that attainment of the new federal 8-hour 0.08 ppm (or 84 ppb) ozone standard may be very difficult or even impossible in many locations. Data analysts have shown that the number of occurrences of higher hourly average ozone concentrations decreased faster than the occurrences of mid-level hourly average concentrations (i.e., 0.06-0.09 ppm). The frequency of mid-level concentrations continued to decrease but at a much slower rate than the higher hourly average concentrations. The concentrations in the 30-50 ppb range at times increased due to the slowing down effect from the top of the distribution. In other instances, these concentrations increased due to a reduction in NO_x scavenging. Such results suggest that different emission control strategies may be required to reduce peak 8-hour ozone levels than those that have successfully reduced peak hourly ozone concentrations, and very large reductions of anthropogenic emissions might be needed. To determine the feasibility of attaining the new standard, and to identify the best control strategies for moving toward attainment, it is necessary to understand the physical and chemical mechanisms underlying the observed ozone trends, and to use this understanding in assessing the future response of ambient 8-hour ozone levels to possible control strategies.

Analyses of ambient ozone data and photochemical modeling were used to examine the technical feasibility of attaining the federal 8-hour ozone standard in central California (Reynolds, Blanchard, and Ziman, *JAWMA,* February 2003). Various combinations of volatile organic compound (VOC) and oxides of nitrogen (NO_X) emission reductions were effective in lowering modeled peak 1-hour ozone concentrations. VOC emission reductions had only a modest impact on modeled peak 8-hour ozone concentrations. NO_X emission reductions generally lowered 8-hour ozone concentrations, but their effectiveness was partially, or in some cases, wholly offset by an increase in the number of NO cycles and, hence, the ozone produced per NO. Substantial NO_X emission reductions - 70 to 90% - were required to reduce peak 8-hour ozone concentrations to the level of the standard throughout the central California modeling domain.

Understanding the Effectiveness of Precursor Reductions in Lowering 8-hour Ozone Concentrations: The Eastern United States

Client: American Petroleum Institute

Period of Performance: 2002-2003
Contract Value: $83K

Contact: Mr. Richard Karp
American Petroleum Institute
1220 L Street, NW
Washington, DC 20005
(202) 682-8067
karpr@api.org

While the previous data analyses and modeling discussed above provide possible explanations of 1- and 8-hour ozone trends in central California, a key issue is the applicability of these findings to other areas. Of particular interest is the eastern United States, where ozone formation results from various combinations of anthropogenic and natural emissions sources under a range of meteorological conditions. Based on the soundness of existing photochemical applications at the outset of this study and the availability of a suitable model code with process analysis capabilities, photochemical modeling was conducted using CAMx (version 3.10) with inputs developed by the U.S. Environmental Protection Agency (EPA) to support initial analyses in 2002 associated with the Clear Skies Initiative. The July 5-15, 1995 episode was selected for modeling because relatively high ozone levels were reported in the northeast during this period.

For the eastern U.S., CAMx sensitivity runs were performed using an array of anthropogenic VOC and NO_X emissions reductions. These results have been used to develop EKMA-like ozone isopleth diagrams indicating the change in ozone associated with prescribed changes in anthropogenic VOC and NO_X emissions. Such diagrams have been developed based on the peak 1- and 8-hour average ozone levels calculated in several subregions in the northeast corridor, Atlanta, and Chicago. We have also examined modeling results in a number of other urban areas in the eastern U.S.

Various combinations of VOC and NO_x controls were somewhat effective in reducing peak 1-hour ozone concentrations. However, VOC emissions reductions were found to have only a modest impact on peak 8-hour ozone concentrations, due to the contributions of CO, biogenic VOCs, and less reactive anthropogenic VOCs. Reductions of NO_x reduced 8-hour ozone concentrations, but their effectiveness was reduced by the increase in NO cycles, and hence, in the ozone produced per NO. These modeling results provide a possible physical explanation for recent analyses that have reported more prominent trends in peak 1-hour ozone levels than in peak 8-hour ozone concentrations or in occurrences of mid-level (60 – 90 ppbv) ozone concentrations.

Under conditions that yielded peak 8-hour ozone levels comparable to the 1999-2001 measured design values, NO_X emissions must be reduced by 46 to 85% from 1996 base case values to obtain calculated peak 8-hour ozone values consistent with the level of the 8-hour standard. Under conditions that yielded the highest 8-hour ozone concentrations, anthropogenic NO_X emissions must be reduced by 59 to 86% from 1996 base case values in areas of the Northeast, Atlanta, and Chicago. Similar results were obtained in an earlier study for central California. Such findings have serious implications for the technical attainability of the 8-hour ozone standard. A paper summarizing the results of this study has been published in the Journal of the Air & Waste Management Association (November 2004).

This project demonstrates the utility of process analysis capabilities to develop a better understanding of the response of calculated air quality values to changes in precursor emissions. Such analyses may be important in helping to assess the adequacy of calculated impacts of future emission controls on regional haze. They may also be quite useful in diagnosing and rectifying model performance problems.

Nonattainment Classification Methods for the 8-Hour Ozone Standard (Contract 2003-100638)

Client: American Petroleum Institute

Period of Performance: May 2003 – December 2003
Contract Value: $10,080 (overall data analysis was $42,177)

Contact: Mr. Richard Karp
1220 L Street, NW
Washington DC 20005
(202) 682-8067

This separate data analysis task was carried out following completion of the larger project "**Understanding The Effectiveness Of Precursor Reductions In Lowering 8-Hour Ozone Concentrations.**" For the latter, Dr. Blanchard carried out a combined modeling and data analysis study for the American Petroleum Institute, Washington, DC from 2000-2003. Monitoring data from California and the eastern United States were used to evaluate trends in ozone and precursor species from 1980 to 2000. The attainability of the 8-hour ozone standard was evaluated by using comparisons of the ambient data trends with photochemical modeling that incorporated process analysis. Model predictions indicated that the 8-hour ozone standard was not attainable in many areas by means of VOC emission reductions, but that 8-hour ozone concentrations would respond to reductions of NO_x emissions by 80 percent or more from 1996 levels.

For the separate task "**Nonattainment Classification Methods for the 8-Hour Ozone Standard,**" Dr. Blanchard (1) compared projected emission reductions with model-predicted control requirements, (2) compared trends in 1-hour and 8-hour ozone design values, and (3) summarized variability in ozone design values over recent three-year time periods. In nearly all areas studied, the adopted and projected NO_x emission reductions fell short of model-predicted control requirements, and the needed NO_x reductions would not be implemented by 2010. Both 1-hour and 8-hour ozone design values declined in all areas studied, but the 8-hour ozone design values declined at a slower rate than did the 1-hour design values. From 1997 through 2002, 8 of 12 MSAs and CMSAs exhibited more than one 8-hour ozone classification.

This task demonstrates Envair capabilities in statistical analysis of ambient air quality monitoring data and the assessment of responses of secondary air pollutant concentrations to changes in different primary pollutant emissions, completed within a short time (8 months).

Houston SIP Consent Decree – Transient High Ozone Events (URS Corp subcontract and BCCA-AG)

Client: Business Coalition for Clean Air Appeals Group

Period of Performance: 11/2001-12/2002
Contract Value: $22,495 (URS Corp subcontract) and $27,056 (BCCA-AG)

Contact: Mr. Robert Nolan
1221 McKinney Street, #1600
Houston TX 77010
(281) 870-6084
robert.m.nolan@exxonmobil.com

In 2001, a court-ordered consent decree required the Texas Commission on Environmental Quality (then the Texas Natural Resource Conservation Commission) and business organizations to improve the Houston SIP through additional study of transient high ozone events. Such observed transient events, with hourly ozone increases sometimes exceeding 100 ppbv per hour, were not successfully reproduced by existing gridded three-dimensional photochemical air quality simulation models. Therefore, modeling did not adequately support ozone control plans. Dr. Blanchard analyzed the spatial and temporal distributions of transient high ozone events and demonstrated that meteorological variations alone did not account for the existence of the ozone transients. Dr. Blanchard further analyzed surface hydrocarbon measurements. High-ozone transients were particularly linked with the occurrence of elevated concentrations of reactive hydrocarbon species, especially propylene, ethylene, and butadienes.

Results were presented at workshops organized by the Texas Commission on Environmental Quality.

This project demonstrates Envair capabilities in statistical and meteorological analyses, graphical presentations, and the assessment of responses of secondary air pollutant concentrations to changes in different primary pollutant emissions.

5.2 Desert Research Institute (DRI)

The Desert Research Institute (DRI) is the nonprofit research campus of the Nevada System of Higher Education. The following project summaries provide an overview of relevant recent work by DRI members of the project team.

- **Characterizing Exhaust Emissions From Light-Duty Gasoline Vehicles In The Kansas City Metropolitan Area** sponsored by U.S. Environmental Protection Agency and consortium of other sponsors (6/04 to 6/06). A research team of Eastern Research Group, Bevilacqua Knight Inc, Desert Research Institute and NuStats Partners L.P. are conducting a program to evaluate exhaust emissions from light-duty gasoline vehicles. The program consists of measuring particulate matter (PM) and other toxic components in exhaust emissions of 480 randomly selected, light-duty vehicles in the Kansas City Metropolitan Area. Data obtained from this program will be used to evaluate and update existing and future mobile source emission models, evaluate existing emission inventories and assess the representativeness of previous PM emissions studies.
- **State Implementation Plan (SIP) Planning Service for the Sacramento Ozone Nonattainment Area**, sponsored by the Sacramento Metropolitan AQMD. This objective of this project was to provide a comprehensive assessment of ozone attainment in the Sacramento region nonattainment area. This project addressed trends in ozone and ozone precursors, probabilities of pollutant transport from the San Francisco Bay Area to the Sacramento region and episode selection for State Implementation Plan (SIP) modeling. A protocol for the SIP modeling was developed and CAMx modeling was performed for two separate ozone episodes in support of SIP planning.
- **Weekend/Weekday Ozone Observations in the South Coast Air Basin**, sponsored by the Department of Energy, Office of Heavy Vehicle Technologies through the National Renewable Energy Laboratory and Coordinating Research Council (December 1999 to May 2002). The Desert Research Institute (DRI) and Sonoma Technology, Inc. (STI) are conducting a study of the causes of elevated ozone levels on weekends in the South Coast (Los Angeles) Air Basin (SoCAB). In the initial phase of the study, the spatial, temporal and statistical distributions of ozone, carbon monoxide, total non-methane hydrocarbons and nitrogen oxides were examined for routine monitoring sites in the SoCAB with continuous data from 1981 to 1998 to determine day-of-the-week variations in the temporal and spatial patterns of VOC and NOx emissions. In the second phase, a field measurement program was conducted in September-October 2000 to collect and assemble air quality and emission activity databases to examine relationships between emission patterns and key air quality parameters relevant to the weekend ozone effect.
- **Validation And Application Protocol For Source Apportionment Of Photochemical Assessment Monitoring Stations (PAMS Ambient Volatile Organic Compouund (VOC) Data**, sponsored by the U.S. Environmental Protection Agency, EPA STAR Grant #GR826237-01-0. The objectives of this research project were to review the applicability of the Chemical Mass Balance (CMB) receptor modeling and available source composition profiles for estimating source contributions to ambient VOCs using data from the Photochemical Assessment Monitoring Station (PAMS) networks and to develop a protocol

for validation of ambient and source composition input data and for evaluation and interpretation of model outputs. The guidance includes a summary of the fundamentals of CMB, descriptions of the features of CMB Version 8 (Watson et al., 1997), and sample CMB Version 8 VOC source and ambient input data files, default source and fitting species selection files, and a current library of available source VOC composition profiles in CMB8-ready format. The applications and validation protocol provides recommended procedures for validating ambient VOC data, assigning uncertainties to ambient and source measurements, selecting and evaluating source composition profiles and fitting species, evaluating and validating model outputs, and analyzing and interpreting the CMB source contribution estimates and associated uncertainties.

- **Environmental Justice Saturation Monitoring of Selected Pollutants in Wilmington** sponsored by the California Air Resources Board and the California Energy Commission. (DRI's proposal was selected and pending contract award, 1/06 to 12/08)). The community of Wilmington, near Los Angeles, is the focus of a major study being developed by the ARB involving various measurement and modeling objectives. The Desert Research Institute will conduct a field measurement program to characterize exposures to selected pollutants in the Wilmington area. The study will be conducted in three phases. In the initial phase, the precision, accuracy, sampling rates of passive sampling methods will be evaluated in the laboratory using a flow through chamber with known pollutant concentrations. In phase 2, all sampling methods that are proposed for the saturation monitoring program will be tested in Wilmington prior to initiation of the full field study. Measurements will likely include passive monitors for NO, NO2, NOx, SO2, BTEX (benzene, toluene, ethylbenzene, xylenes), formaldehyde, and acrolein, odor-causing sulfides, and low-volume aerosol sampler for fine particulate matter mass and light absorption. Phase 3, saturation monitoring, will be conducted over a period of one year starting in the summer of 2006 and will consist of a two tiered approach. Tier 1 will consist of four consecutive weeks of monitoring during each quarter of the year at up to twenty sites to establish seasonal average variations in neighborhood-scale exposures among the various census tracts in Wilmington and at various mobile and stationary source hot spots. Tier 1 will consist of one-week integrated passive and low-volume aerosol samples. Tier 2 measurements will supplement the Tier 1 saturation monitoring program with daily sampling for PM and BTEX and continuous CO, VOC and PM2.5 mass measurements at selected hotspot locations during two-week sampling periods in both summer and fall/winter. DRI will provide overall coordination of the study, which also includes complementary studies by other investigators of the pollutant gradients in the areas using a mobile monitoring platform and exposures to ultrafine particles.
- **Roseville Railyard Air Monitoring Project** (RRAMP) sponsored by the Placer County Air Pollution Control District in cooperation with the Union Pacific Railroad (UPRR), Sacramento Metro AQMD, and USEPA Region IX (3/05 to 5/05). The purpose of the project is to monitor for diesel locomotive emissions at the UPRR's J.R. Davis Rail Yard, located in Roseville, CA. The main monitoring segment of the study is scheduled to occur in the summer months when persistent wind conditions favorable to upwind/downwind monitoring are most reliable. Using upwind/downwind monitoring, PCAPCD expects to detect differences between upwind and downwind measurements that are attributable to the emissions at the railyard. However, for this approach to be successful, there needs to be a screening assessment of conditions primarily in the downwind area to assure that the

downwind site location is not too close to the facility (such that the emissions plume stays aloft and does not impact the site) or too far from the facility (such that the dilution of the plume renders the plume signal undetectable). DRI conducted surveys of the spatial variations in pollutant concentrations around the Rail Yard. This information was used by PCAPCD to select appropriate upwind and downwind monitoring locations for the RRAMP.

- **MOBILE6 Emissions Model, CRC E-64**, sponsored by the Coordinating Research Council. In this project, DRI prepared a guidance document for Validation of EPA's MOBILE 6. This document describes the technical basis, assumptions, limitations, and data requirements of methods for reconciling ambient measurements with modeled mobile source emissions inventories of carbon monoxide (CO), volatile organic compounds (VOC) and nitrogen oxides (NOx). The methods described in this document focus primarily on those that rely on data that are routinely collected by local air pollution monitoring networks. They are used to ascertain whether the total regional inventories of pollutant emissions associated with mobile sources are reasonable. The methods described are intended to be included in a guidance document to be prepared for the State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (STAPPA/ALAPCO) under the auspices of the Emission Inventory Improvement Program (EIIP).
- **Evaluation of Receptor Models, CRC A-34**, sponsored by the Coordinating Research Council. ENVIRON and DRI evaluated the ability of receptor models, such as the Chemical Mass Balance (CMB) model, to estimate what sources contribute to ambient levels of volatile organic compounds (VOCs). A photochemical grid model was used to simulate the detailed VOC composition of an urban atmosphere and keep track of the contributions of 22 source categories to 55 VOC species. The modeled VOC species concentrations at several receptor locations were independently analyzed by DRI using the CMB model. The CMB source contributions were compared to the known source contributions from the photochemical grid model to provide a rigorous analysis of how well the CMB model performed under realistic conditions.
- **Evaluation of EMFAC models against Ambient Data**, **CRC A-38**, sponsored by the Coordinating Research Council. Studies comparing emission inventories to ambient data have questioned the accuracy of mobile source emission factor models, such as EMFAC and MOBILE. In response, the ARB and EPA continually update the models. ENVIRON and DRI evaluate EMFAC versions 2000, 2002 and 2003 for Los Angeles using data from the 1997 Southern California Ozone Study (SCOS). ENVIRON conduct ozone modeling using CAMx with both CB4 and SAPRC99 chemical mechanisms. DRI performed an ambient/inventory reconciliation and a VOC fingerprint analysis. ENVIRON and DRI jointly evaluated the significance of the results for air quality modeling and control strategy development.
- **Exposure to Air Toxics in Mobile Source Dominated Microenvironments sponsored by the Health Effects Institute (**1/04 to 6/06). The study focuses on in-cabin exposure of commuters and residents living near major roadways in California's South Coast Air Basin. Desert Research Institute conducted the summer phase of the measurement program during September 2004 and fall-winter phase during November and December 2004. Measurements included acetaldehyde, acrolein, benzene, 1,3-butadiene, ethylbenzene, formaldehyde, n-hexane, MTBE, naphthalene, styrene, toluene and xylene and speciated particulate and semi-

volatile organic aerosols. Continuous measurements of PM, black carbon, CO, CO2, NOx, VOC, and particle size distributions were made in a mobile sampling van to characterize spatial gradients in air pollutant concentrations. The exposure measurements will be compared to the annual and seasonal average concentrations derived from the Multiple Air Toxics Exposure Study–III (MATES–III), which is being conducted by the South Coast Air Quality Management District (SCAQMD) from February 2004 to March 2005.

- **Section 211(b) Tier 2 High-End Exposure Screening Study of Baseline and Oxygenated Gasoline** sponsored by the American Petroleum Institute (1/02 to 12/05). In this study, the Desert Research Institute and Southwest Research Institute are conducting a study of the upper-end distribution of inhalation exposures to evaporative and combustion emissions of baseline- and oxygenated gasoline. First, DRI and SwRI conducted exposure measurements under controlled conditions to establish quantitative relationships between tailpipe and evaporative emission rates to exposure levels in vehicle cabin and attached residential garage. In the main study, exposures levels are being measured in several high-end exposure microenvironments in Atlanta, Chicago, and Houston during winter and summer conditions. A number of key variables (including CO, BTEX, formaldehyde, 1,3-butadiene, MTBE, ethanol) are measured in ambient air within microenvironments, in subjects' personal breathing zones and breath.
- **Contributions of Compression-Ignition versus Spark-Ignition Exhaust to Ambient PM in the South Coast Air Basin**, sponsored by the National Renewable Energy Laboratory (April 2001 to November 2002). The purpose of this study is to apportion the contributions of tailpipe emissions from gasoline-powered and diesel-powered motor vehicles to ambient concentrations of PM2.5 in the South Coast Air Basin (SoCAB) and to examine the range of uncertainties that may be associated with the methods and procedures for sample collection, chemical analysis, and source apportionment. This study calls for two research groups, Desert Research Institute (DRI) and University of Wisconsin Madison (UWM), working cooperatively on sample collection and quality assurance aspects of the study, but working independently, at least initially, on chemical analysis and data analysis. DRI will use sample collection and analysis methods and CMB procedures that are consistent with those employed in the Northern Front Range Air Quality Study, and the second group will adhere to methods and procedures used in the PM source apportionment study in Los Angeles. Dynamometer tests were conducted during summer 2001 by the Environmental Protection Agency and Clean Air Vehicle Technology Center CAVTC for light-duty SI and CI vehicles and by West Virginia University (WVU) for medium-duty to heavy-duty CI vehicles. In addition to regulated gaseous pollutants, filter samples were collected for determining gravimetric mass, elemental and organic carbon, elements, ions and both particulate and semi-volatile organic compounds. DRI will also monitor PM mass and elemental carbon continuously during the dynamometer tests. DRI and UWM collected daily 24-hour ambient PM samples at two locations in the SoCAB over a period of one month and at various locations and roadway loops with varying proportional contributions of SI and CI vehicles. Other chemical characterization include fuel and lube oil from the test vehicles and road dust.

5.3 Alpine Geophysics

Alpine Geophysics, LLC is a nationwide environmental consulting firm offering highly specialized research and engineering services in the atmospheric, hydrologic, and geophysical sciences. Founded in California in 1985 and presently headquartered in Denver, CO, the firm is managed by eight (8) senior professionals. The firm has two science divisions: the Atmospheric Sciences Group and the Hydrologic Sciences Group.

The *Atmospheric Sciences Group* (ASG) at Alpine offers extensive "hands-on" experience in a wide range of air quality services, particularly in the areas of emissions, meteorological, photochemical and particulate matter (PM) modeling. Alpine's ASG has an accumulated experience-base in excess of 30 years, which includes specialized expertise in: (1) photochemical and PM/haze modeling; (2) mesoscale meteorological modeling; (3) emissions estimation, modeling and inventory development; (4) ozone State Implementation Plan (SIP) regulatory modeling and attainment demonstration analyses; (5) design and management of field monitoring programs in support of air quality modeling studies; (6) receptor modeling and aerometric data analysis; (7) training programs for regulatory/industry modeling staff; and (8) custom design and installation of environmental modeling computer systems. In addition to its advanced atmospheric modeling expertise, the ASG also offers considerable competency in computer simulation, database management, statistical and interpretive analysis, and environmental systems development.

Examples of project experience pertinent to emissions modeling and inventory evaluation follow.

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
TS-40 SARMAP 1-hour Ozone SIP Model Development and Application	$426,000	May 1990 To June 1998	In support of the San Joaquin Valley (i.e., SARMAP) 1-hr ozone SIP, AG played a significant role as a modeling and management contractor in four (4) principal areas: (a) participation in the SARMAP field study design; (b) management of the SARMAP emissions model development program and emissions data base collection activities; (c) Prime Management Contractor for the overall SARMAP ozone and meteorological model development program; and (d) independent Model Evaluation Contractor for the SARMAP emissions (EMS-95), meteorological (MM5), and photochemical (SAQM) models. As the Management Contractor, AG was responsible for managing the continued development of the SAQM, MM5 and EMS-95 models. These model development activities included detailed aerometric analyses of surface and aloft data collected during the July and August 1990 SARMAP intensive field programs. As the Model Evaluation Contractor, AG tested the full modeling system (EMS-95, MM5, and SAQM) as thoroughly as the SARMAP database would support. An added goal of this program was to continue the development and testing of the EMS-95 Emissions Modeling System (EMS-95) and implement new extensions to the model that would further generalize its applicability to alternative photochemical models and to the estimation of PM-10 emissions in addition to the more conventional ozone precursor species. Specific work elements included: a) Evaluation of the scientific and operational formulations of the EMS; b) Identification and implementation of needed improvements to the EMS-95 code; c) Evaluation of the performance of individual process modules; d) Corroboration of the full EMS-95 output on an independent computer systems; e) Performance of an independent appraisal of EMS emissions estimates for different base case ozone modeling episodes and for alternate chemical mechanisms; f) Performance of extensive sensitivity analyses; and g) Training for agency staff. As the result of these evaluations, Alpine Geophysics has acquired an intimate working knowledge of the EMS-95 modeling systems, a capability that is in all probability unique. Alpine currently maintains the EMS-95 modeling system as	California Air Resources Board Andrew Ranzieri (916) 324-4069 2020 L Street PO Box 2815 Sacramento, CA 95812-2815

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
			publicly available (free) software and has the system under a carefully managed software control system to ensure that continuing updates to the model are properly and thoroughly implemented, documented, and freely distributed.	
TS-140 Modeling Assistance to the Kansas Department of Health and Environment Contract Number State of Kansas: 33135 Contract No. State of Missouri: C900760001	$126,000	Dec. 1998 To Jun. 2001	Under subcontract to ENVIRON International Corporation, Alpine Geophysics provided technical assistance in the photochemical modeling support to the states of Kansas and Missouri in connection with the 8-hour ozone standard. Specific AG project responsibilities included: Developed the "Ozone Modeling Protocol for the Kansas City Nonattainment Area" documents; Provided on-site and telephone support to the Missouri Department of Natural Resources (MDNR) in the areas of EMS-95 and MM5 modeling support; Set up and applied the MM5 prognostic Meteorological model for the 15-24 June 1995 episode and tested the model's reliability for providing inputs to the EMS-95 emissions and CAMx photochemical models; Developed CAMx model-ready emissions files for the three modeling episodes: (a) 15-24 June 1995, (b) 10-15 July 1995; and (c) 17-22 August 1998. These modeling inventories were based on the then recently released 1996 National Emissions Trends (NET) inventory and subsequent updates to accommodate data not included in the 1996 NET inventory; Set up and exercised the CAMx photochemical model for the 15-24 June 1995 episode and evaluated the model's performance following standard EPA procedures; Developed future year (e.g., 2003 or 2007) CAMx model-ready emissions files for up to three modeling episodes. The 1996 NET inventory was projected to 2003 or 2007 using the standard (OTAG) projection and growth and control factors. The future year base case scenarios will include CAA controls, rules "on-the-books" and the National Low Emissions Vehicle (NLEV) program but not the SIP call and Tier 2 vehicle control programs;	ENVIRON Mr. Ralph Morris (415) 899-0708 Golden Gate Plaza, Suite 220 101 Rowland Way Novato, CA 94945-5010

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
			Develop up to four (4) future year emissions control strategies. These strategies might include all or portions of the EPA proposed Tier2/sulfur rule, alternative rules with a 30 ppm sulfur fuel, the EPA SIP call controls on EGU units, less stringent point source controls on EGUs, controls on non-EGUs and/or other controls on mobile and area sources; and Select one modeling episode and carry out all required future year baseline (e.g. 2003 or 2007) and control strategy simulations.	
TS-144 Evaluation of the EPA Tier2/Sulfur Program	$125,000	Jul. 1999 To Dec. 1999	On 13 May 1999, EPA published a Notice of Proposed Rulemaking (NPRM), proposing a major program aimed as significantly reducing VOC, NOx and sulfur emissions from motor vehicles. Referred to as the A Tier2/Sulfur program, this program was aimed at attaining the federal 1-hr and 8-hr National Ambient Air Quality Standards (NAAQS) for ozone. Underpinning the EPA proposal was a significant body of regional photochemical modeling which was used by the agency to justify the motor vehicle controls. Notwithstanding the significant levels of motor vehicle emissions reductions called for in the Tier 2/Sulfur program proposal, in addition to the controls set forth in the Regional NOx SIP Call, modeling performed by EPA's contractor suggested that as many as 8 urban (plus 2 rural) areas in the eastern U.S. may still not be able to attain the federal standard by the year 2007. Under Contract to General Motors and Air Improvement Resources, Inc., AG reviewed the EPA Tier 2/Sulfur modeling and identified a number of technical issues warranting further analysis and modeling. In one area in particular was the estimation of emissions from on-road motor vehicles. In this study, AG employed newer modeling methodologies to characterize important vehicle emissions processes including the rates of emissions of VOC and NOx through various pathways, the rates of deterioration of engine emissions control systems, and so on. Alpine Geophysics re-calculated the EPA Tier 2/Sulfur program ozone impact analysis to determine if the use of a more up-to-date mobile source emissions model (i.e., the AIR MOBILE model) leads to a different number of ozone nonattainment areas in the eastern U. S. in the year 2007. In addition, AG performed a high-resolution CAMx and UAM-V ozone modeling analyses in three key target areas in the east to assess the ozone impacts of the Tier 2/Sulfur program and alternatives to the EPA proposal. As part of this activity, AG developed high-resolution CAMx/UAM-V modeling inventories in the Northeast Corridor and the	Air Improvement Resources, Inc. Thomas Darlington (248) 380-3140 47298 Sunny Brook Lane Suite 103 Novi, MI 48374

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
			Lower Lake Michigan region for ozone impact modeling.	
TS-151 Modeling Assistance to the Southern Appalachian Mountains Initiative (SAMI)	$132,000	Sep. 1999 To Dec. 2000	Alpine Geophysics is under contract to the Tennessee Valley Authority (TVA) and the Southern Appalachian Mountains Initiative (SAMI) to provide emissions, photochemical, and meteorological modeling support in connection with SAMI's multiyear integrated atmospheric modeling and effects assessment. Alpine staff are working collaboratively with modelers with the Resource Management/Environmental Research & Services (RM/ER&S) of TVA to apply the EMS-95, RAMS, and URM models to three week long ozone and sulfate/nitrate episodes over the eastern U.S. Among the tasks AG staff are performing are: Demonstrate that the SAMI modeling system (EMS-95, RAMS, and URM) operates properly on AG's computer systems and produces results consistent with SAMI benchmarks; Develop three new episodes (consistent with the SAMI Modeling Protocol) that provide a level of URM model performance and reliability that justifies subsequent use in the Integrated Assessment Framework (IAF); Exercise the EMS-95 to develop emissions estimates for the following sets of pollutants: (a) NO_x, VOC, CO, SO_2 and NH_3; and (b) coarse and fine SO_4 , NO_3, Mg, Ca, K, elemental and organic carbon, Na, and PM. URM-ready inputs will be generated for all three SAMI episodes; Set up and exercise the RAMS3a model for each new episode to produce the meteorological fields needed to exercise the EMS-95 and URM models; Conduct a detailed operational and scientific evaluation of the RAMS3a model output *and* the URM-ready input fields (after mapping). The evaluation will included performance testing at all pertinent spatial scales of all state variables (e.g., surface pressure, wind, temperature, and mixing ratio), diagnosed quantities (e.g., PBL heights), as well as model estimates of cloud cover and precipitation; Prepare all necessary baseline (i.e. future year) emissions scenario inputs for the years 2010 and 2040 using EMS-95 using the data sets provided by SAMI. URM-ready point source, area source, and mobile source emissions will be developed with EMS-95 using the same methods employed to construct the base case	Tennessee Valley Authority Dr. Steve Mueller (504) 599-5197 CEB 2A P.O. Box 1010 Muscle Shoals, AL 35662-1010

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
			emissions files.	
TS-155 ARB On-Road Mobile Source Emissions Estimates for Summer 2000	$115,000	Jun. 1999 to Jul. 2002	Alpine Geophysics is under contract to the California Air Resources Board to develop on-road mobile source emissions estimates for a summer ozone season episode and a winter CO season episode for the year 2000 for the entire state of California. To accomplish this, AG has integrated transportation planning model data from thirteen MPOs and CalTrans. This integration effort involved meshing together and reconciling link/node-based networks, which were in a variety of map projections, and the associated VMT. Further, because the VMT were for an average weekday from various years spanning 1995 to 2000, the VMT had to be grown to the year 2000. Also, to account for disparities among adjoining links from differing networks, it was necessary to smooth the allocation of VMT and network interfaces. The VMT also was augmented by work done by UCDavis based on traffic counts that were taken throughout the state. Finally, AG had to determine the amount of commercial VMT that needed to be added to the entire integrated network. The resulting VMT will be input to DTIM 4 so that emissions estimates for the target episodes can be computed.	CalEPA- Air Resources Board Planning and Technical Support Division Vernon Hughes (916) 323-8374 1001 I Street PO BOX 4025 Sacramento, CA 95812-4025
TS-160	$25,841	Mar 2000 To Sep 2000	EPA Contract 68-D7-0067, Work Assignement 3-15, PO No. APR041300 Develop HDDV adjusted inventory for the western grid	Kathleen Aguilar E.H. Pechan & Associates, Inc. (703) 813-6700 x174 5528B Hempstead Way Springfield, VA 22151
TS-164	$18,987 (year 1) $18,250 (year 2)	May 2000 To Jun 2001	Prime Contract No. SP35800003990, Subcontract No. 102.2, Work Order No. 5: - Provide reports of the current EMS-95 VOC speciation profiles, and the current SCC-to-profile cross references. - Provide a written explanatin of how EMS-95 uses available speciation profiles to allocate total, or volatile, organic compound emissions to carbon bond groups.	Kathleen Aguilar E.H. Pechan & Associates, Inc. (703) 813-6700 x174

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
			- Produce reports of the current temporal profile assignments, but SCC/ASCT codes used in EMS-95. - Provide emissions summaries using EMS-95 with the updated spatial, temporal and speciation profiles, and EMS-2000, for a selected county or county group. - Prepare a brief technical memo detailing the data types and origins of data used to create spatial surrogates for both the current Pennsylvania modeling and those used to create surrogates for the NY "Unified Grid". - Update the Pennsylvania inventory used in the fine grid model for the Pennsylvania Stakeholders. - Run CAMx using the 2007 epsiode.	5528B Hempstead Way Springfield, VA 22151
TS-167	$8,000	Sep 2000 To Dec 2000	Under contract to the Lake Michigan Air Directors Consortium (LADCo), AG designed and built version three of the biogenic model for emissions (BIOME3). As part of this study, AG performed an in-depth review of the Global Biogenic Emissions Inventory System (GloBEIS). Further, AG performed a detailed literature review to determine the current state-of-the-science for biogenic VOC emissions modeling. AG delivered a complete turn-key biogenic emissions modeling system that could be used to estimate biogenic VOC and NO emissions for 95% of North America. BIOME3 was built using SAS. AG also provided a detailed training seminar in the use of BIOME3 to LADCo.	Mike Koerber 847-296-2181 Lake Michigan Air Directors Consortium 2250 East Devon Avenue, Suite 216 Des Plaines, IL 60018
TS-169 BCCA Houston SIP Evaluation	$50,011	Jan. 2001 To open	Alpine Geophysics has been retained by the BCCA Appeals Group (BCCA-AG) to review the December 2000 Houston SIP. The goal of this project is "to strengthen the scientific basis for estimating the emissions control requirements needed to provide attainment of "routine ozone" levels in the HGA region." The principal objectives of the investigation are: To clearly identify the limitations of the Sept. '93 CAMx modeling episode used in the December 2000 SIP submittal; To identify the specific cause(s) for the poor CAMx model performance and the model's insensitivity to emissions reductions; To develop a scientific basis for improving the Sept. '93 modeling system:	Baker Botts, LLC David Savage (512) 322-2654 1600 San Jacinto Center 98 San Jacinto Blvd Austin, TX 78701

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
			To implement the improvements to the Sept. '93 episode and re-evaluate the model's performance; and To utilize the improved modeling system to develop more reliable estimates of the NOx and/or VOC emissions controls needed to ameliorate "routine" (i.e., non-THOEs") 1-hr ozone exceedances in the HGA region. To accomplish the goals of this project, AG has identified the following broad tasks that have been or will be implemented under this contract: Task 1: Conduct Independent Quality Assurance Reviews of the September 1993 Episode Modeling Files and Data Sets; Task 2: Diagnose Causes for the Performance Problems in the Sept. '93 Episode and the Model's Insensitivity to NOx Emissions Controls; Task 3: Develop Improved Sept. '93 "Alternative Base and Future Base" Simulations and Re-Calculate NOx and/or VOC Control Requirements; Task 4: Evaluate the Suitability of the MM5/MAQSIP "Forecast" Simulations of the August 2000 TexAQS Period as a Foundation for a New SIP Modeling Episode. Task 5: Perform a Peer-Review of the Modeling Assumptions, Procedures, and Results Associated with TNRCC's Development of a New TexAQS 2000 Modeling Episode.	
TS-174	$11,340.00	Jun. 2001 to Sep. 2001	Under contract to EC/R on a US EPA LOE, AG provided assistance to the US EPA in their efforts to develop methods to estimate the uncertainty in the EMS-HAP emissions estimates. Further, AG provided guidance to the US EPA on how to propagate the uncertainty EMS-HAP emissions through ASPEN so that the uncertainty in the ambient air quality concentrations predicted by ASPEN could be estimated. EMS-HAP was originally designed to process the 1996 National Toxics Inventory NTI. The primary source of the air toxics emissions estimates was the 1996 NTI. These data were supplemented with data such as the following: the 1996 NTI with emissions estimates from the 1996 National Emissions Trends (NET) database; the Toxics Release Inventory (TRI); the EPA Maximum Available Control Technology (MACT) database; and state and local agency emissions estimates. The guidance that we developed focused on how to estimate uncertainties in the supporting emissions inventory data and in the resulting ASPEN-ready emissions created by EMS-HAP. To develop our guidance, Monte Carlo procedures were required, which led to our developing an understanding of how the 1996 NATA emissions estimates	Mary Eilkins EC/R Inc. 1129 Weaver Dairy Road Chapel Hill, NC 27514 (919) 933-9501 x 226

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
			were developed, and how EMS-HAP processes the emissions data. To address the large computational requirements of the Monte Carlo procedures, we changed the typical EMS-HAP processing to use only a subset of the 133 HAPs that have been defined for modeling in ASPEN. It was also necessary for the project team to dissect the inner workings of EMS-HAP in order to understand the underlying temporal allocation, spatial allocation, and speciation formulations, among others, so that we could prepare adequate guidance about uncertainties and how to estimate them.	
TS-177	$500.00	Nov 2001	Integration of the Statewide Air Pollution Research Center (SAPRC) chemical mechanism in the Sparse Matrix Operator Kernel Emission (SMOKE) emissions processor for the Community Multi-sale Air Quality (CMAQ)/Models-3 Airshed Model. (acm)	American Chemistry Council Tina Bahadori (703) 741-5214 1300 Wilson Blvd Arlington, VA 22209
TS-182	$245,000	May. 2002 To Sep. 2002	As a subcontractor to Environ, AG has prepared air quality model ready emissions estimates for use in CAMx. These emissions include estimates for point sources, area sources, on-road mobile source, day-specific commercial shipping, day-specific stationary sources, and biogenics. In particular, day-specific activity for commercial shipping was collected and used to estimate hour-to-hour variation in the shipping activity. Also, AG used BELD3/BEIS3 data coupled with BEIGIS data and the BIOME3 system to estimate biogenic NO emissions. AG prepared CAMx-ready emissions files for two base case episodes. AG also will prepare future years episodes.	BAAQMD Chris Emery 415-899-000 Dave Souten (415) 899-0711
TS-188	$2,500	Mar. 2003 To Apr. 2003	US EPA Emission Factor and Inventory Group: Completed the draft document Procedures for Developing Base Year and Future Year Mass Emission Inventories for the Non-road Diesel Engine Rulemaking, by incorporating reviewer comments and additional detail. This documentation included the creation and completion of tables that record emission inventory processing that has already been completed. In addition, compact discs of emission inventory data files were provided.	Philip A Lorang D205-01 Research Triangle Park, NC 27711 919-541-5463 lorang.phil@epa.gov

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
TS-194	$34,211	Jun. 2003 To Mar. 2004	Under contract to the Sacramento Metro Air Quality Management Division, AG estimated on-road mobile source, stationary source, area source, and biogenic emissions for two episodes and five future years per episode. The estimates were suitable for use in CAMx. As part of this effort, AG used the BEIGIS data and modeling system to prepare biogenic VOC emissions estimates. Also, AG used BELD3/BEIS3 data coupled with BEIGIS data and the BIOME3 system to estimate biogenic NO emissions	Norm Covell 777 12th Street, Third Floor Sacramento, CA 95814-1908 916-874-4800
TS-197	$125,000	Jul. 2003 To Dec. 2004	VISTAS Technical Advisor: Provided expertise in the VISTAS inventory planning and decision phases supporting emissions and air quality modeling for fine PM and visibility.	Patricia Brewer 59 Woodfin Place Asheville, NC 28801 828-251-6708
TS-199	$40,000	Sep. 2003 To Dec. 2003	Kansas: Create SMOKE/BEIS3 compatible data sets using BELD3, satellite-derived PAR; and new MM5-based temperatures. Convert MOBILE5 data sets to MOBILE6. Deliver two day training seminar.	Andy Hawkins Air, Land and Water Sciences 1000 SW Jackson, Suite 310 Topeka, KS 66612-1366 785-296-6429

Project Name	Contract Value	Study Duration	Description of Study	Client Contact
TS-200	$318,771	Oct. 2003 To Mar. 2005	Under contract to LADCo, AG is leading the effort to develop the Open Emissions Model (OPEM). This emissions modeling system will be constructed entirely in freeware/shareware open system software. OPEM will contain modeling components for area sources, point sources, on-road mobile sources, biogenics, speciation, growth & control, and a GIS component for spatial allocation of visualization of emissions estimates. The first stage of this effort has included a draft design of each system. A notable component of this draft design was a highly detailed review of the biogenic emissions estimates methods.	Mark Janssen 2250 E. Devon Avenue, Suite 250 Des Plaines, IL 60018
TS-210	$40,000	June 2004 To Dec 2004	1. Conduct Survey of Existing Data: Conduct a preliminary survey of the transportation planning organizations in California to determine what new data are available to enhance the ITN. The survey will also serve to help identify key contracts, the formats in which the data can be delivered, the media on which the data can be delivered, and the time frame which data can be delivered. Obtain working versions of the transportation data networks where possible. In conjunction with obtaining the transportation networks, obtain where possible: the link/zone-based transportation network, the link-based hourly VMT by vehicle type for the episode of interest, the link-based hourly speeds data by vehicle type, I/M program data by network, link-based vehicle mix, and the starts/parks/stables by network. 2. Mesh Transportation Networks: Mesh the transportation networks that were obtained into the existing ITN. 3. Link Uniform Mesh with VMT/Speed Data and Create Adjustment Algorithm where hourly resolved data are not available. 4. Technology Transfer to ARB 5. Final Report and Project Management.	John DaMassa Chief Modeling and Meteorology Branch Planning & Tech Support Division Air Resources Board P.O. Box 2815 Sacramento, CA 95812

6 REFERENCES

Alexis, A. and Cox, P. 2005. The California Almanac of Emissions and Air Quality – 2005 Edition. California Air Resources Board, Sacramento CA. 504 pp.

Blanchard, C.L. and Tanenbaum, S. 2005. Weekday/weekend differences in ambient air pollutant concentrations in Atlanta and the southeastern U.S. *J. Air Waste Manage Assoc*. In press.

Breimna, L., Friedman, J. H., Olshen, R. A., and Stone, C. J. 1984. Classification and Regression Trees. Wadsworth International Group, Belmont CA. 358 pp.

Cox, W.M. and Chu, S. 1993. Meteorologically adjusted ozone trends in urban areas: a probabilistic approach. *Atmos. Environ*. 27B: 425-434.

Fujita, E.M, Keislar, R.E., Stockwell, W., Moosmuller, H., DuBois, D., Koracin, D., Zielinska, B., Tanrikulu, S. and Ranzieri, A. 1999. Central California Ozone Study – Volume I. Field Study Plan. California Air Resources Board, Sacramento, CA.

Fujita, E.M, Campbell, D.E., Keislar, R.E., Bowen, W.R., Tanrikulu, S. and Ranzieri, A. 2001. Central California Ozone Study – Volume III. Summary of Field Operations. California Air Resources Board, Sacramento, CA.

Fujita, E.M, Koracin, D., Freeman, D., Keislar, R.E., Podnar D., McCord, T.E., Campbell, D.E., and Stockwell, W.R. 2003. State Implementation Plan (SIP) Planning Service for the Sacramento Ozone Nonattainment Area. Prepared for Sacramento Metropolitan Air Quality Management District, Sacramento, CA.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company, New York. 320 pp.

Larsen, L. 1999. A semi-empirical model relating meteorology and ozone in the San Francisco Bay Area. Transactions on Ecology and the Environment, vol. 29, WIT Press.

Lehrman, D., Bush, D., Knuth, B., Blanchard, C., and Fairley, D. 2004. Characterization of the CCOS 2000 Measurement Period. Contract number 01-2CCOS. Prepared for California Air Resources Board, Sacramento, CA.

Reynolds, S.D., Blanchard, C.L., and Ziman, S.D. 2003. Understanding the effectiveness of precursor reductions in lowering 8-hour ozone concentrations. *J. Air Waste Manage Assoc*. 53: 195-205.

7 RESUMES

This section contains resumes for the key participants in the study. The resumes are organized in the following order:

Envair

- Charles Blanchard

Desert Research Institute

- Eric Fujita

Alpine Geophysics

- James Wilkinson
- Cyndi Loomis

CHARLES L. BLANCHARD

526 Cornell Avenue
Albany, California 94706
Telephone: (510) 525-6231

Current and Prior Professional Activities

Environmental consultant: Principal of Envair, an unincorporated association offering contract research and consulting services in the environmental and earth sciences, 1988-2005.

Princeton University: Center for Energy and Environmental Studies, Visiting Research Fellow, 1986-88 and Department of Chemistry, Lecturer (environmental chemistry), 1987.

Lawrence Berkeley Laboratory and University of California, Berkeley: Research Assistant, 1982-86.

Education

Ph.D., University of California, Berkeley: Energy and Resources, 1986 (dissertation title: *Emission Sources Contributing to Acid Deposition in the Western United States*).
M.A., University of California, Berkeley: Statistics, 1984.
M.S., University of California, Berkeley: Energy and Resources, 1978.
B.S., Michigan State University: Biology (Lyman Briggs College) and Zoology, 1975.

Professional Memberships

Air and Waste Management Association
American Association for the Advancement of Science
American Geophysical Union
American Statistical Association

Recent Projects

- American Petroleum Institute, Washington, DC. 1999-2003. Evaluated trends in ozone and precursor species nationwide and assessed attainability of 8-hour ozone standard using comparisons of ambient data with photochemical modeling incorporating process analysis.

- California Air Resources Board, Sacramento, CA. 2000-04. Preparing an historical record of fine PM mass concentrations in California, combining data from different monitoring programs and accounting for differences in measurement methods and accuracy. Prepared analyses of historical ozone and precursor relations at sites in central California for the Central California Ozone Study (CCOS) (under subcontract to Technical & Business Systems, Inc., Santa Rosa CA).

- Coordinating Research Council, Atlanta, GA. 2003-2005. Analyzed weekday/weekend differences in primary and secondary gas-phase and particulate pollutant levels in Atlanta.

- Lake Michigan Air Directors Consortium, Des Plaines, IL. 2003-2005. Prepared analyses of ambient ozone and fine particulate matter concentrations and their relations to changes in precursor levels in the Midwest Regional Planning Organization states.

- National Renewable Energy Laboratory, Golden, CO. 2004-2005. Analyzed weekday/weekend differences in primary and secondary gas-phase and particulate pollutant levels nationwide.

- North American Research Strategy for Tropospheric Ozone (NARSTO). 2000-2003. Prepared chapter on spatial and temporal patterns of particulate matter concentration and composition for NARSTO assessment.

- Southern Company, Birmingham, AL. 2002-2004. Analyzed changes in sulfate, nitrate, and ammonium concentrations using PM measurements from the Southeastern Aerosol and Characterization (SEARCH) project. Analyzed secondary carbon formation and PM source contributions at SEARCH sites.

Recent Peer Reviewed Publications

C. L. Blanchard, S. Tanenbaum, and D. R. Lawson. 2005. Differences between weekday and weekend air pollutant levels in Atlanta, Baltimore, Chicago, Dallas-Fort Worth, Denver, Houston, New York, Phoenix, Washington DC, and surrounding areas. *J. Air Waste Manage Assoc*. Submitted.

C. L. Blanchard and S. Tanenbaum. 2005. Weekday/weekend differences in ambient air pollutant concentrations in Atlanta and the southeastern U.S. *J. Air Waste Manage Assoc*. In press.

C. L. Blanchard and G. M. Hidy. 2005. Effects of SO_2 and NO_x emission reductions on $PM_{2.5}$ mass concentrations in the southeastern United States. *J. Air Waste Manage Assoc*. 55: 265-272.

G. M. Hidy and C. L. Blanchard. 2005. The mid-latitude North American background aerosol and global aerosol variation. *J. Air Waste Manage Assoc*. In press.

S. D. Reynolds, C. L. Blanchard, and S. D. Ziman. 2004. Understanding the effectiveness of precursor reductions in lowering 8-hr ozone concentrations – Part II. The eastern United States. *J. Air Waste Manage Assoc*. 54: 1452-1470.

C. L. Blanchard. 2004. Spatial and temporal characterization of particulate matter. Chapter 6, in: P. H. McMurry, M. F. Shepherd, and J. S. Vickery, eds. Particulate Matter Science for Policy

Makers: a NARSTO Assessment. Cambridge University Press, Cambridge, United Kingdom. 510 pp.

C. L. Blanchard and G. M. Hidy. 2003. Effects of changes in sulfate, ammonia, and nitric acid on particulate nitrate concentrations in the southeastern United States. *J. Air Waste Manage Assoc*. 53: 283-290.

C. L. Blanchard and S. Tanenbaum. 2003. Differences between weekday and weekend air pollutant levels in Southern California. *J. Air Waste Manage Assoc*. 53: 816-828.

S. D. Reynolds, C. L. Blanchard, and S. D. Ziman. 2003. Understanding the effectiveness of precursor reductions in lowering 8-hour ozone concentrations. *J. Air Waste Manage Assoc*. 53: 195-205.

D. A. Hansen, E. S. Edgerton, B. E. Hartsell, J. J. Jansen, N. Kandasamy, G. M. Hidy, and C.L. Blanchard. 2003. The Southeastern Aerosol Research and Charactreization Study: Part 1 – Overview. *J. Air Waste Manage Assoc*. 53: 1460-1471.

C. L. Blanchard, G. M. Hidy, E. Edgerton, B. Hartsell, and J. Jansen. 2002. Carbon in southeastern aerosol particles. *93rd Annual Meeting of the Air and Waste Management Association*, Baltimore, Maryland, paper 43064.

C. L. Blanchard and D. Fairley. 2001. Spatial mapping of VOC and NO_x limitation of ozone formation in central California. *Atmos. Environ*. 35: 3861-3873.

C. L. Blanchard. 2001. Spatial mapping of VOC and NO_x limitation of ozone formation in six areas. *92nd Annual Meeting of the Air and Waste Management Association*, Orlando, Florida, paper 215.

C. L. Blanchard. 2001. Trends in ambient concentrations of ozone and precursor species in eight geographical regions, 1990-98. *92nd Annual Meeting of the Air and Waste Management Association*, Orlando, Florida, paper 1004.

C. L. Blanchard and T. Stoeckenius. 2000. Ozone response to precursor controls: comparison of data analysis methods with the predictions of photochemical air quality simulation models. *Atmos. Environ*. 35: 1203-1215.

C. L. Blanchard, P. M. Roth, S. J. Tanenbaum, S. D. Ziman, and J. H. Seinfeld. 2000. The use of ambient measurements to identify which precursor species limit aerosol nitrate formation. *J. Air Waste Manage. Assoc*. 50: 2073-2084.

C. L. Blanchard. 2000. Methods for attributing ambient air pollutants to emission sources. *Annual Review of Energy and the Environment* 24: 239-265.

C. L. Blanchard. 2000. Ozone process insights from field experiments - Part III: Extent of reaction and ozone formation. *Atmospheric Environment* 34: 2035-2043.

C. L. Blanchard, E. L. Carr, J. F. Collins, T. B. Smith, D. E. Lehrman, H. M. Michaels. 1999. Spatial representativeness and scales of transport during the 1995 Integrated Monitoring Study in California's San Joaquin Valley. *Atmospheric Environment* 33: 4775-4786.

C. L. Blanchard, Frederick W. Lurmann, Philip M. Roth, Harvey E. Jeffries, and Marcelo Korc. 1999. The use of ambient data to corroborate analyses of ozone control strategies. *Atmospheric Environment* 33: 369-381.

ERIC M. FUJITA

Associate Research Professor
Energy and Environmental Engineering Center, DRI

Education

D.Env.	Environmental Science and Engineering	1992	University of California, Los Angeles
M.S.	Organic Chemistry	1976	California State University, Los Angeles
B.S.	Chemistry	1973	University of California, Los Angeles

Experience

Dr. Fujita has over 19 years of experience in conducting air quality studies. His research involves the application of ambient air and source measurements to verify emissions inventory estimates and the effectiveness of emission control programs. Dr. Fujita has performed volatile organic compound source apportionment studies for the 1987 Southern California Air Quality Study (SCAQS), 1990 San Joaquin Valley Air Quality Study (SJVAQS), 1993 Coastal Oxidant Assessment for Southeast Texas (COAST), 1995 Boston and Los Angeles Study, 1996 Phoenix Ozone Study, NARSTO-Northeast 1995 Summer Ozone Study, 1995/96 Washington Ozone Transport Study, and 1996 El Paso/Juarez Ozone Study. He is currently conducting similar studies for the 1998 Central Texas On-Road Hydrocarbon Study, and PAMS data from the South Coast Air Basin. Dr. Fujita also performed the external quality assessment of the volatile organic compound measurements in many of these data analysis projects. He coordinated the laboratory comparisons of hydrocarbon measurements during the COAST and 1995/96 NARSTO-Northeast Ozone Studies and SCOS97-NARSTO. Dr. Fujita performed source apportionment analysis of fine particles in the San Francisco Bay Area, Bangkok Thailand, Phoenix and served as co-principal investigator for the Northern Front Range Air Quality study.

Prior to coming to DRI, Dr. Fujita was an Air Pollution Research Specialist for the Research Division of the California Air Resources Board where he initiated and managed extramural research in emission inventory development, air quality measurements, and atmospheric processes. These studies included developing emission factors for mobile and stationary sources and assessing the effectiveness of emission control measures. Other studies included examining gas and aerosol measurement methods and characterization of organic compounds in ambient air and emission sources. He coordinated the quality assurance and data validation efforts for the 1987 Southern California Air Quality Study (SCAQS) and conducted studies to assess the accuracy of SCAQS emission inventories. He was also involved in planning the volatile organic compound measurements for the 1990 San Joaquin Valley Air Quality Study (SJVAQS).

Professional Experience

1996-Present Associate Research Professor, Energy and Environmental Engineering Center, Desert Research Institute, Reno, NV.

1993-1996 Assistant Research Professor, Energy and Environmental Engineering Center, Desert Research Institute, Reno, NV.

1987-1992 Air Pollution Research Specialist, Atmospheric Processes Research Section, Research Division, California Air Resources Board, Sacramento, California.

1983-1987 Air Pollution Research Specialist, Acid Deposition and Aerosol Research Section, Research Division, California Air Resources Board, Sacramento, CA.

1979-1983 Air Pollution Research Specialist, Emission Control Technology Research Section, Research Division, California Air Resources Board, Sacramento, CA.

1978-1979 Associate Air Pollution Specialist, Chemical Strategy Development Section, Stationary Source Division, California Air Resources Board, Sacramento, CA.

1975-1977 Graduate Student Assistant, Aerosol Studies Section, Research Division, California Air Resources Board, El Monte, CA.

Memberships

Air and Waste Management Association
American Geophysical Union

Committees and Offices

Technical Program Committee and editor of the proceedings for the Southern California Air Quality Study Data Analysis Conference

Coordinating Research Council's Air Pollution Research Advisory Committee

Chairman of the Intersociety Subcommittee #4 on Carbon and Hydrocarbon Compounds

Member of the National Academy of Sciences National Research Council/Transportation Research Board study committee to evaluate the Congestion Mitigation and Air Quality Improvement (CMAQ) Program from October, 1999 to April, 2002.

Selected Publications: (Partial List)

Fujita, E., B. Croes, C. Bennett, D. Lawson, F. Lurmann and H. Main (1992). Comparison of Emission Inventory and Ambient Concentration Ratios of CO, NMOG, and NOx in California's South Coast Air Basin. J. Air Waste Manage. Assoc., 42, 264.

Fujita, E.M., J.G. Watson, J.C. Chow and Z. Lu (1994). Validation of the Chemical Mass Balance Receptor Model Applied to Hydrocarbon Source Apportionment in the Southern California Air Quality Study. Environ. Sci. Technol., 28, 1633-1649.

Fujita, E.M., J.G. Watson, J.C. Chow and K.L. Magliano (1995). Receptor Model and Emissions Inventory Source Apportionments of Nonmethane Organic Gases in California's San Joaquin Valley and San Francisco Bay Area. Atmos. Environ., 29(21), 3019-3035.

Fujita, E.M., Z. Lu, J. Sagebiel, N.F. Robinson, and J. G. Watson (1995). VOC Source Apportionment for the Coast Oxidant Assessment for Southeast Texas. Final report prepared for the Texas Natural Resource Conservation Commission, August 1995.

Fujita, E.M., M.C. Green, R.E. Keislar, D.R. Koracin, H. Moosmuller, and J.G. Watson (1996). 1997 Southern California Ozone Study (SCOS97) Operational Program Plan - Working Draft. Prepared for the California Air Resource Board, Sacramento, CA, February, 1996.

Fujita, E.M., Z. Lu, C. Frazier, and J.G. Watson (1997). Application of the Chemical Mass Balance Receptor Model to Apportionment of Suspended Particulate Matter in the Bangkok Metropolitan Region. Prepared for Radian International, LLC, Austin, TX, January 26, 1997.

Fujita, E. and Z. Lu (1997). Hydrocarbon Receptor Modeling for the 1996 Phoenix Ozone Study. Final Report prepared for ENSR, Camarillo, CA, March 5, 1997.

Fujita, E.M., Z. Lu, L. Sheetz, G. Harshfield, and B. Zielinska (1997). Determination of Mobile Source Emission Source Fraction Using Ambient Field Measurements. Final Report prepared for the Coordinating Research Council, Atlanta, GA, July 1997.

Fujita, E., Z. Lu, G. Harshfield, and B. Zielinska (1997). NARSTO-Northeast: Hydrocarbon and Carbonyl Measurement Audits for the 1995 Field Study. Final Report prepared for the EPRI, Palo Alto, CA, July 1997.

Fujita, E.M., Z. Lu, L. Sheetz, G. Harshfield, T. Hayes, and B. Zielinska (1997).

Hydrocarbon Source Apportionment in Western Washington. Report prepared for Washington Department of Ecology, Lacy, WA, September, 1997.

Fujita, E. (1998).
Hydrocarbon Source Apportionment for the 1996 Paso del Norte Ozone Study. EPA Contract No. 68-D3-0030. Final report prepared for U.S. Environmental Protection Agency, Dallas, TX., March 1998.

Fujita, E., and Z. Lu (1998).
Analysis of Data From the 1995 NARSTO-Northeast Study. Volume III: Chemical Mass Balance Receptor Modeling. Final report prepared for Coordinating Research Council, Atlanta, GA, July, 1998.

Fujita, E., J.G. Watson, J.C. Chow, N. Robinson, L. Richards, and N. Kumar (1998).
Northern Front Range Air Quality Study. Volume C: Source Apportionment and Simulation Methods and Evaluation. Final report prepared for Colorado State University, Fort Collins, CO, June 30, 1998.

Watson, J., E. Fujita, J.C. Chow, B. Zielinska, L. Richards, W. Neff, and D. Dietrich (1998). Northern Front Range Air Quality Study. Final report prepared for Colorado State University, Fort Collins, CO, June 30, 1998.

Fujita, E. (1998).
Emission Source Profiles Applicable to CMB Receptor Modeling of Texas PAMS VOC Data. TNRCC Contract No. 98 80078200. Final report prepared for the Texas Natural Resource Conservation Commission, Austin, TX, November 1998.

Fujita, E.M., R.E. Keislar, J.L. Bowen, W. Goliff, F. Zhang, L.H. Sheetz, M.D. Keith, J.C. Sagebiel, and B. Zielinska (1999).
1998 Central Texas On-Road Hydrocarbon Study. Draft final report prepared for the Texas Department of Transportation, Austin, TX under subcontract to PBS&J, Austin, TX, March, 1999.

Fujita, E., R. Keislar, W. Stockwell, H. Moosmuller, D. DuBois, D. Koracin, and B. Zielinska (1999).
Central California Ozone Study - Volume I Conceptual Program Plan. Prepared for the CCOS Technical Committee c/o California Air Resources Board, Sacramento, CA, September, 1999.

JAMES G. WILKINSON, PhD
SENIOR ENGINEER
ALPINE GEOPHYSICS, LLC

EDUCATION:

Ph.D, Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA, 2004.
Ph.D. Candidate, Environmental Engineering, Georgia Institute of Technology, Atlanta, GA, 1996.
B.S. (with Honors), Petroleum Engineering, Montana College of Mineral Science and Technology, Butte, MT, 1985.
A.A., Computer Science, Montana College of Mineral Science and Technology, Butte, MT, 1983.

PROFESSIONAL EXPERIENCE:

Senior Engineer, Alpine Geophysics, Atlanta, GA, 1993

Senior Engineer, Radian Corporation, Sacramento, CA, 1992-1993.

Staff Engineer, Radian Corporation, Sacramento, CA, 1989-1992.

Group Leader, Data Management, Radian Corporation, Sacramento, CA, 1988-1989.

Computer Scientist/Engineer, Radian Corporation, Sacramento, CA, 1987-1988.

Petroleum Engineer, ARCO Alaska, Inc., Anchorage, AK, 1985-1986.

FIELDS OF EXPERIENCE:

Dr. Wilkinson is a senior engineer with Alpine Geophysics. He is also a Ph.D. candidate in Environmental Engineering at the Georgia Institute of Technology. Dr. Wilkinson is currently conducting research in the areas of emissions uncertainty and economic-based incentives (e.g. market trading programs) to control regional emissions. More specifically, his current, primary research project is concerned with determining the geographic extent of areas whose sources may contribute to air quality exceedances. He is also interested in elucidating the impacts that uncertainty in biogenic emissions estimates have on urban- and regional-scale emissions control strategies.

Dr. Wilkinson is currently helping design and implement the open source emissions modeling system Consolidated Community Emissions Processing Tool (CONCEPT). CONCEPT is a PostgreSQL-based system whose goal is to house all data related to the emissions modeling process under a single data base. GIS-related functions will be managed within the same PostgreSQL data base using the PostGIS plugin.

The California Air Resources Board has commissioned Dr. Wilkinson to develop version two of the California Integrated Transportation Network (ITN). He recently completed the first version of the ITN using data from transportation demand models (TDMs) from fifteen California metropolitan planning organizations (MPOs). In version two of the ITN, TDM data from approximately twenty MPOs will be used. The ITN is a seamless representation of the on-road mobile source transportation network for all of California. On behalf of the ARB, Dr. Wilkinson has used the ITN, in conjunction with the on-road emissions factors model EMFAC2002 and the Direct Travel Impact Model (DTIM), to estimate on-road mobile source emissions for a variety of multi-day air quality modeling episodes spanning the years 2000 through 2010.

Dr. Wilkinson has completed an emissions modeling study for the Bay Area Air Quality Management District (BAAQMD). He estimated emissions for multi-day ozone episodes for base case years in July 1999 and July 2000 using the EMS-05 emissions modeling system. He also estimated emissions for future years 2002, 2005, 2007, and 2010. Dr. Wilkinson estimated emissions for area sources, stationary sources, non-road mobile sources, on-road mobile source, commercial marine shipping, and biogenics for an airshed that encompassed most of California. The emissions estimates developed by him were used to model base year air quality levels over California with particular emphasis on model performance over the San Francisco Bay Area. Further, the future year emissions estimates will be used in on-going air quality modeling efforts to develop emissions control strategies for mitigation of the one-hour and eight-hour ozone National Ambient Air Quality Standards. In an effort to understand where potential deficiencies in the emissions inventory exists, he also completed an in-depth, comparative analysis of emissions estimates among common source categories between the Central California Ozone Study (CCOS) emissions data base and the VISTAS emissions data base.

HONORS:

National Science Foundation Fellow (1994-1997)
President's Fellow (Georgia Institute of Technology, 1996-present)

SELECTED REFEREED JOURNAL PUBLICATIONS:

Boylan J. W., M. T. Odman, J. G. Wilkinson, A. G. Russell, K. G. Doty, W. B. Norris, R. T. McNider (2005). “Integrated assessment modeling of atmospheric pollutants in the Southern Appalachian Mountains. Part I: Hourly and seasonal ozone.” *Journal of the Air & Waste Management Association*. 55 (7):1019-1030

Hanna, S. R., A.G. Russell, J. G. Wilkinson, J. Vukovich and D.A. Hansen (2004). “Monte Carlo estimation of uncertainties in BEIS3 emission outputs and their effects on uncertainties in chemical transport model predictions.” *J. Geophys. Res*., Vol. 110, No. D1, D01302. 15 January.

D. Boucouvala, R. Bornstein, J. Wilkinson and D. Miller (2003). “MM5 simulations of a SCOS97-NARSTO episode.” *Atmospheric Environment*, Vol. 37, Supp. No. 2. S95-S117.

Boylan, J. B., M. T. Odman, J. G. Wilkinson, A. G. Russell, K. G. Doty, W. B. Norris and R T. McNider (2002). “Development of a comprehensive, multiscale ‘one-atmosphere’ modeling system: application to the Southern Appalachian Mountains.” *Atmospheric Environment,* Vol. 36:23, 3721-3734.

Fiore, A. M., D. J. Jacob, I. Bey, R. M. Yantosca, B. D. Field and J. G. Wilkinson (2001). “Background Ozone over the United States in summer: origin and contribution to pollution episodes.” *J. Geophys. Res*., Vol. 107, No. D15.

Mendoza, A., J. G. Wilkinson and A. G. Russell (2000). “Source Impact Quantification of Anthropogenic and Biogenic Emissions on Regional Ozone in the Mexico-U.S. Border Area using Direct Senisitivity Analysis.” *Journal of the Air & Waste Management Association*, Vol. 50, No. 1

Yang, Y. J., J. G. Wilkinson and A. G. Russell (1999). “Fast, Direct Sensitivity Analysis of Multidimensional Photochemical Models.” *Environmental Science & Technology*, Vol. 33, No. 7, 1116-1126.

Mulholland, J. A., A. J. Butler, J. G. Wilkinson, A. G. Russell and P. E. Tolbert (1998). “Temporal and Spatial Distributions of Ozone in Atlanta: Regulatory and Epidemiologic Implications.” *Journal of the Air and Waste Management*, May 1998, 48:418-426.

SELECTED REPORTS:

“Development Of The California Integrated Transportation Network (ITN).” Prepared for Mr. Vernon Hughes, Manager, Control Strategy Modeling Section, CalEPA- Air Resources Board, Planning and Technical Support Division, 1001 I Street, Sacramento, CA. Prepared by Alpine Geophysics, LLC, 7691 Alpine Road, La Honda, CA 94020. AG-TS-90/155. June 07, 2004.

“SAMI Air Quality Modeling Final Report. Prepared for the Southern Appalachian Mountains Initiative (SAMI).” Prepared by School of Civil and Environmental Engineering, Georgia Institute of Technology, 200 Bobby Dodd Way, Atlanta GA 30332-0512. July 2002. (with Odman, M. T., J. W. Boylan, A. G. Russell, S. F. Mueller, R. E. Imhoff, K. G. Doty, W. B. Norris and R. T. McNider).
environmental.gatech.edu/SAMI/Documents/Reports/final_report.pdf

“Ozone Sensitivity and Uncertainty Analysis Using DDM-3D in a Photochemical Air Quality Model,” presented at the Twenty-third NATO/CCMS International Technical Meeting On Air Pollution Modeling And Its Application, 28 September through 2 October 1998, Varna, Bulgaria, (with Y. J. Yang, M. T. Odman, and A. G. Russell).

CYNTHIA F. LOOMIS
SENIOR SCIENTIST
ALPINE GEOPHYSICS, LLC

EDUCATION:
B.S. Mathematics and Computer Science, California State University, Sacramento, 1987

PROFESSIONAL EXPERIENCE:
Senior Scientist, Alpine Geophysics, Arvada, CO, 1992-Present
Staff Scientist, Radian Corporation, Denver, CO, 1991-1992
Group Leader, Radian Corporation, Sacramento, CA, 1988-1991

FIELDS OF EXPERIENCE:
Ms. Loomis specializes in emissions inventory preparation and emissions modeling for regional and urban scale photochemical and particulate modeling applications, environmental database design and implementation, and the statistical analysis of sampling data. She has experience in using all of the major emissions modeling systems, including SMOKE, EMS-2001, EMS-95, EMS-95/PM, SMOKE, GEMAP, EPS2.0 and FREDS. She has also developed and presented user training classes in emissions modeling. Most recently, she has been the project director for the development of the CONCEPT emissions modeling system. Her areas of expertise include the following:

Emissions Inventory Modeling
Ms. Loomis has prepared emissions inventories for photochemical and particulate modeling using SMOKE, EMS-2001,EMS-95, EMS-95/PM, GEMAP, EPS 2.0 and FREDS. Ms. Loomis has been involved in all phases of emissions modeling, including the development of spatial, temporal and speciation factors for EPS 2.0, EMS-95, SMOKE, and CONCEPT modeling efforts, often in response to specific projects needs. Examples include the development of speciation profiles for oil and gas seeps off the California coast, development of speciation profiles for reformulated fuels for California and Pittsburgh, development of spatial allocation factors for agricultural emissions in the San Joaquin Valley, development of temporal allocation profiles specific to ammonia emissions, and application of specialized temporal and spatial allocation of shipping and wildfire emissions in both Florida and California.

Ms. Loomis designed and developed the on-road motor vehicle emissions estimation model of EMS-2001, integrating the MOBILE6.2 model into the EMS system. Ms. Loomis is currently developing national scale on-road motor vehicle emissions for particulate and ozone modeling, using the newly released MOBILE6.2, combined with the EMS-2001 modeling system.

Ms. Loomis has been involved in, and developed inventories for, numerous recent projects examining the effects of the 1999 NOx SIP call budgets and investigating the impacts of budget alternatives, including alternate point, area, and on-road motor vehicle control strategies. These projects have utilized emissions data from a wide variety of sources including the OTAG emissions databases, the EPA's NEI and NET inventories, data acquired from state and local jurisdictions, continuous emissions monitoring (CEM) data, and facility supplied emissions data.

Ms. Loomis has recently prepared PM-10 and ammonia emissions inventories in support of particulate modeling and research in the state of California. These inventories were prepared for the San Joaquin Valley modeling region, and have required the synthesis of emissions data from a variety of sources, including the NAPAP emission inventories, NEI, California state inventories of air toxics and criteria pollutants (CEIDARS), and other modeling inventories (SARMAP); and the calculation of emissions from available emissions factors and activity data.

Ms. Loomis has developed emission inventories to examine the air quality impacts of various alternative motor vehicle fuels and motor vehicle controls strategies, including the Northeast OTC, the Great Lakes region, the Western US, and the South Coast Air Basin in California. These inventories have included the derivation and development of alternate speciation profiles to examine the impacts of reformulated fuels, the development and application of alternate emission factors, and modeling the effects of new and proposed emission control technologies.

PROFESSIONAL SOCIETIES:
Air and Waste Management Association (AWMA)
Institute of Electrical and Electronics Engineers (IEEE)
IEEE Computer Society
Association for Computing Machinery

PUBLICATIONS (selected):
Conference Proceedings and Presentations

“Application Of The Emissions Modeling System EMS-95 To The Southern California SCAQS-97 Domain,” Ninth Joint Conference on the Applications of Air Pollution Meteorology, American Meteorological Society and the Air and Waste Management Association, 28 January - 2 February, 1996, Atlanta, (with others).

“Development of a Draft PM-10 Emissions Inventory in the SARMAP region Using EMS-95 Emissions Estimates Modeling System”, (with Robert Emigh) 1995 Emissions Inventory: Programs & Progress Specialty Conference, sponsored by AWMA, Research Triangle Park, NC.

Company Reports (selected):
“Comparison of the CAL-MoVEM and DTIM2 Motor Vehicle Emissions Estimate Models”, prepared for the California Air Resources Board (Sacramento, CA), February, 1997.

“PM10 Air Quality Models for Application in the San Joaquin Valley PM10 SIP”, (with others) prepared for the California Air Resources Board (Sacramento, CA), September 1996.

“Pittsburgh Regional Ozone Attainment Study: Emissions Modeling Results”, (with James G. Wilkinson) prepared for the Southwestern Pennsylvania Clean Air Stakeholders Group, July 1996.

“Review of Current Methodologies for Estimating Ammonia Emissions”, (with others) prepared for the California Air Resources Board (Sacramento, CA), May 1996
"Urban Airshed Modeling for 1996 in the South Central Coast Air Basin of California", (with others), report to Santa Barbara County Air Pollution Control District by Alpine Geophysics, Golden, CO., 1994