P1.9 **Aircraft observations and photochemical modeling of ozone distribution in the San Joaquin Valley of California**

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1. INTRODUCTION

Because of ocean-land thermal contrasts, complicated mountain massifs of various heights, and a summertime climatological regime favoring weak synoptic forcing, The Central Valley of California poses significant challenges to meteorological modeling and air quality predictions. Boundary-layer structure, low-level flows, and pollutant distribution patterns in the valley are quite complicated and oftentimes poorly described. Although largely rural, the valley frequently experiences high ozone levels in the summer season. Unlike many well-studied urban areas, such as the LA basin area, where high ozone levels are caused primarily by local emissions, it is unclear to what extent that high ozone levels in this mostly rural valley are caused by local emissions vs. regional transport.

To improve our understanding of ozone air quality in the Central Valley, the CCOS (Central California Ozone Study) summer 2000 filed campaign collected an extensive meteorological and air quality data set using remote sensing and *in situ* measurements at locations throughout the Central Valley. The case study presented here combined dynamical/photochemical modeling with the CCOS observations to gain a better understanding of boundary layer evolution and low-level circulations and their roles in the surface and vertical ozone distributions in the valley.

2. CASE, DATA, AND MODELS

The case of July 8-12 of 2000 was selected because the synoptic weather conditions were more or less typical for the summer season and vertical ozone profiles were made available by the Department of Energy's G-1 research aircraft in the southern part of the Central Valley, the San Joaquin Valley, during this three-day period. The aircraft flew two sampling missions, one in early morning between 0630 and 0900 LST and another in the afternoon between 1230 and 1600 LST, on each of the three days following the same path shown in Fig. 1 with vertical profiles taken at various locations along the path. Hourly surface ozone data were obtained at over 100 sites scattered across the valley. The meteorological conditions were monitored by a network of 915 MHz radar wind profiler/RASSes that provided hourly wind and virtual temperature profiles for the entire depths of the boundary layer at 15 locations in the valley. The RAMS mesoscale model (Pielke et al. 1992), configured with three nested domains with 36, 12, and 4-km horizontal resolution, was used to describe the meteorological conditions. The RAMS results were then used to drive PEGASUS chemical transport model (Fast et al. 2002) to simulate ozone distributions in the valley. The emission inventory used in the simulation was hourly species emissions data created using the SARMAP Emission Inventory Model, commonly known as GEMAP (Geocoded Emissions Modeling and Projection, Magliano 1994).

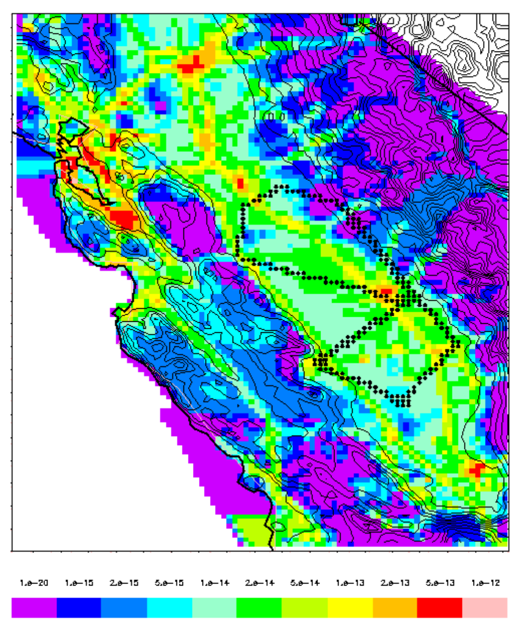

Fig. 1. The topography, aircraft sampling path, and the emissions (color shading) for the innermost domain.

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3. BOUNDARY LAYER CIRCULATIONS

Both the wind profiler network and the RAMS simulations revealed the complexity of the low-level circulation patterns in the region. Fig. 2 shows the observed and simulated horizontal winds at four different levels in early afternoon and around midnight. The prevailing flow pattern in the San Joaquin Valley was a northwesterly flow resulting from the channeling of the onshore flow through the mountain paths into the Central Valley. Although persistent in direction, the speeds of the dominant northwesterly flows experienced strong diurnal variations, with a minimum occurring in late afternoon and a peak of over 10 m/s occurring after midnight. Superimposed on these northwesterly prevailing flows were slope and canyon flows that reversed direction from day to night, contributing to a general pattern of divergence during the day and convergence at night over the valley floor. The influence of the local terrain on the circulation pattern clearly extended from surface to 1000 m; the effect was strong in the lowest 500 m, becoming weaker aloft. Fig. 3 shows a comparison of the predicted and observed hourly wind and temperature vertical profiles at Lemoore (lem) located over the valley floor in the southern part of the valley, which reveals the deepness of the thermally-driven flows as well as its strong diurnal oscillation. Both Figs 2 and 3 show that RAMS adequately captured the observed three-dimensional structure of the wind and temperature patterns and their diurnal evolution.

4. OZONE CONCENTRATIONS

The domain for the PEGASUS chemical transfer model was the same as the innermost grid (4km-grid spacing) used in RAMS simulation. Four PEGASUS simulations were performed, which included a control simulation followed by three sensitivity runs with modified emissions to examine the influence of local vs. transport, and urban vs. rural emissions on ozone concentrations in the valley. The three sensitivity runs correspond to a 50% reduction in the emissions for the entire domain, the Fresno area, which is the largest urban area source in the San Joaquin Valley, and the Bay area.

A comparison of observed and predicted surface ozone concentrations averaged over the San Joaquin Valley for the three days is shown in Fig. 4. The predicted ozone values show a smaller diurnal cycle than the observed with the daytime peak ozone concentration 10-15 ppb less than the observed and nighttime values 10-15 ppb higher. The observation show a consistent increase in ozone concentration from the first to the last day, a feature the model failed to predict. A 50% reduction of the Bay area emissions resulted in a small decrease in the peak ozone concentrations, while the same reduction of the Fresno area emissions had little impact on the averaged concentration, suggesting that transport played a larger role in determining the averaged ozone concentrations in the valley.

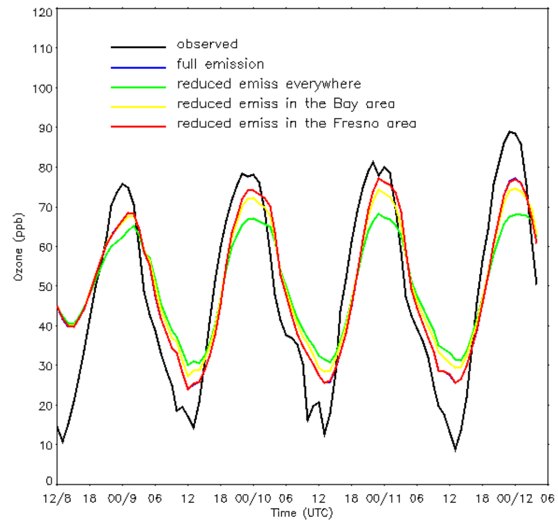

Fig. 4. Averaged surface ozone concentrations in the San Joaquin Valley.

A comparison of predicted and observed vertical ozone profiles at several points along the flight path is shown in Fig. 5. Similar to the averaged surface ozone concentrations in Fig. 4, a reduction of the Fresno area emissions made little difference in the simulated profiles, while reduction in the Bay area emissions resulted in lower values during the day. Despite the complex nature of the meteorological fields in the valley, differences in the vertical structure of the ozone profiles at different locations across the valley were found to be small, which may be attributed to strong horizontal mixing in the valley.

5. FUTURE WORK

The work is ongoing. More sensitivity analyses and process analyses are under way to help us better understand the meteorology and chemical mechanisms for ozone concentrations in the valley, and the results will be presented at the conference.

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References

Fast, Jerome, R. A. Zaveri, X. Bian, E. G. Chapman, and R. C. Easter, 2002: Effect of regional-scale transport on oxidants in the vicinity of Philadelphia during the 1999 NE-OPS field campaign. *J. Geophy. Res*., **107**, D16, 10.1029/2001JD000980,2002.

Magliano, K. L., 1994: Summary of SARMAP emissions modeling. Technical Support Division, California Air Resources Baord, Sacramento, California.

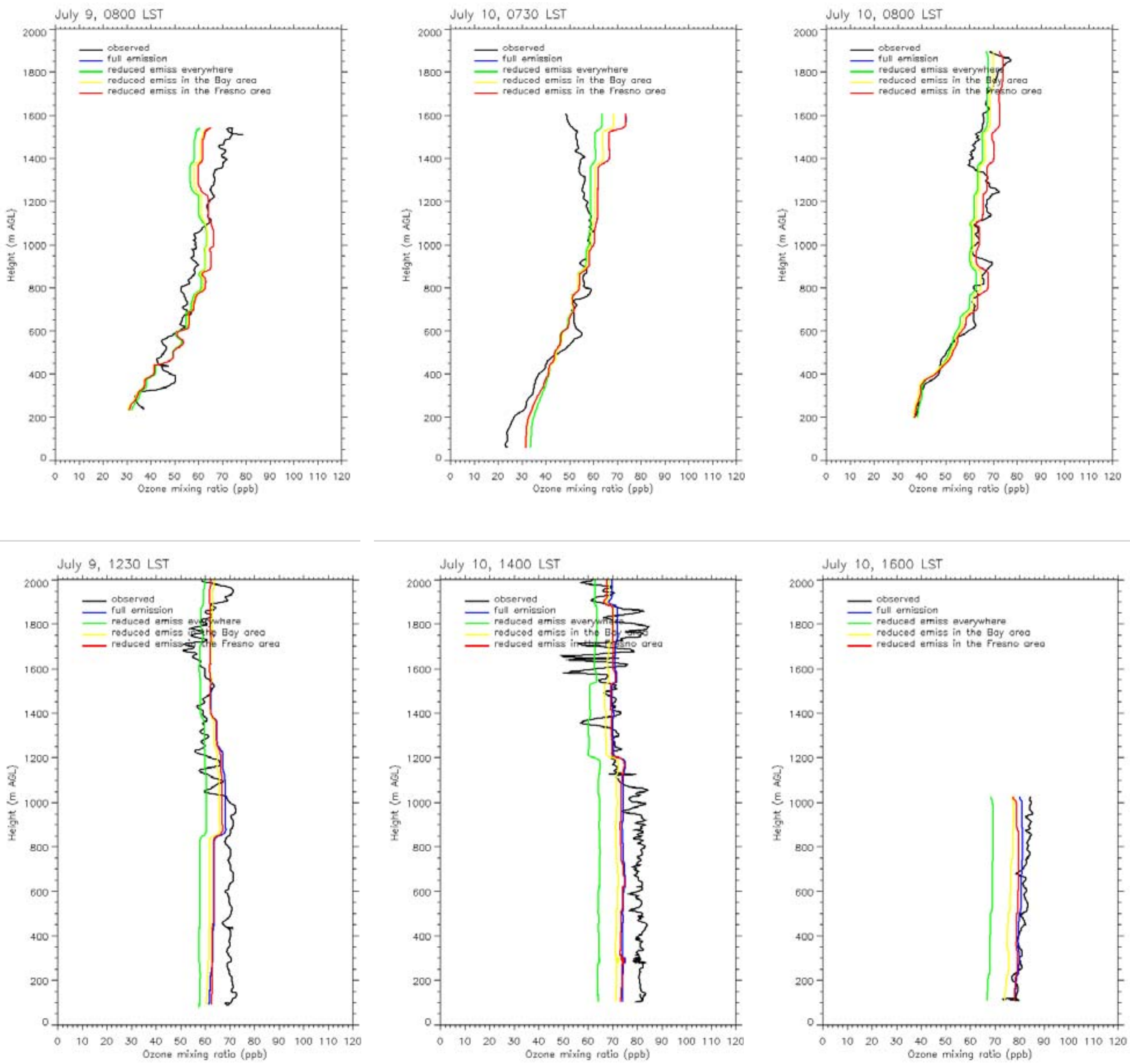

Fig. 5 Simulated and observed vertical ozone profiles in early morning (top) and afternoon (bottom) at various locations in the valley.

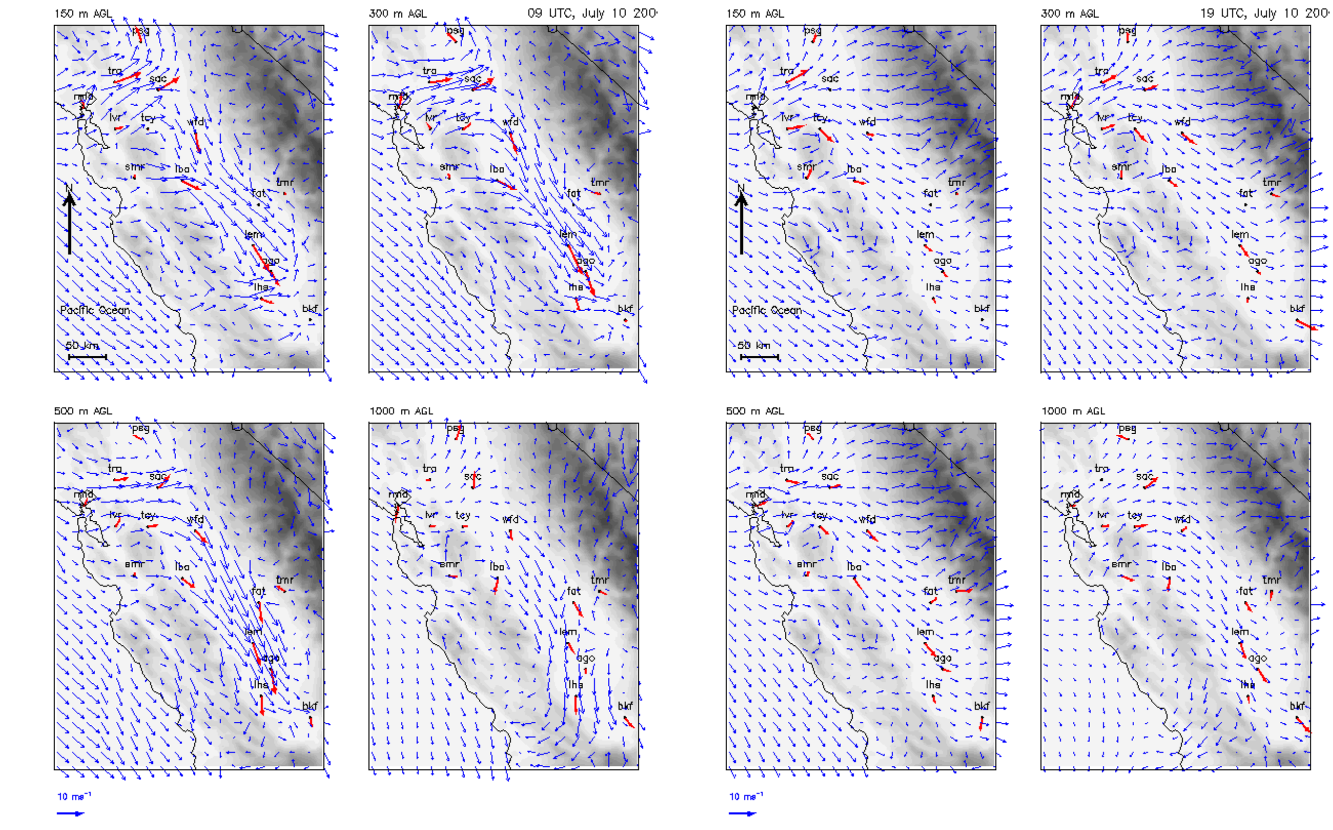

Fig. 2. Simulated (blue) and observed (red) daytime and nighttime horizontal wind vector fields in the valley.

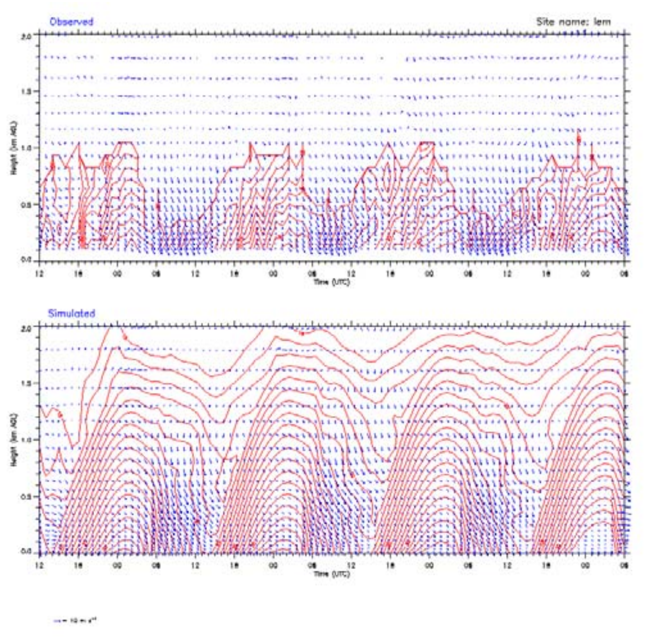

Fig. 3. Comparison of simulated and observed vertical profiles and temperature and horizontal wind at Lemoore.