Emission Inventory Validation and Improvement: A Central California Case Study

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Background (1 of 3)

Emission Inventories:

- Support air quality modeling and regulatory control strategy development
- Are continually being refined and improved
  - New emission factors
  - Updated activity data estimates
  - Improved mobile source models

Background (1 of 3)

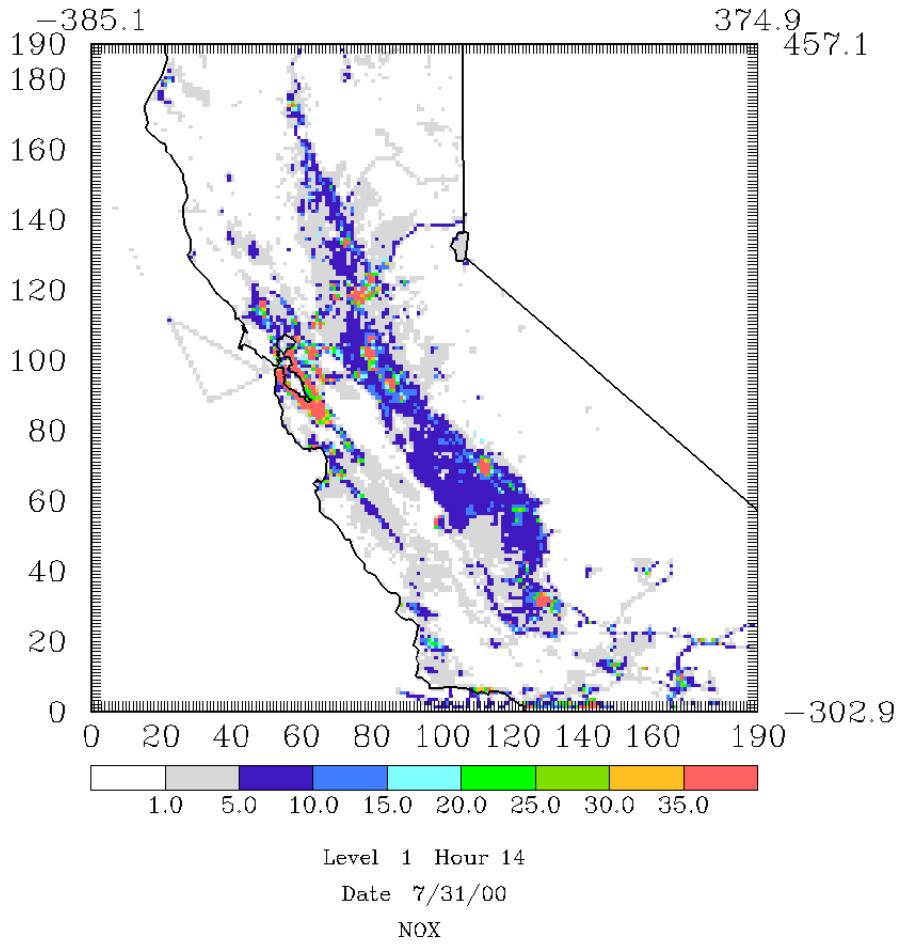
Emission Inventory Validation:

- Sanity check (common sense review)
- Bottom-up evaluations (start with activity data collection)
- Top-down evaluations (compare emission estimates to ambient air quality data)
- Photochemical modeling simulations

Background (3 of 3)

Central California Ozone Study (CCOS):

- Multi-year program of monitoring, EI development, data analysis, and air quality modeling
- CCOS EI refinements
  - EMFAC (on-road model) updates
  - OFFROAD model updates
  - Stationary source revisions
- STI performed emission reconciliation on latest CCOS EI

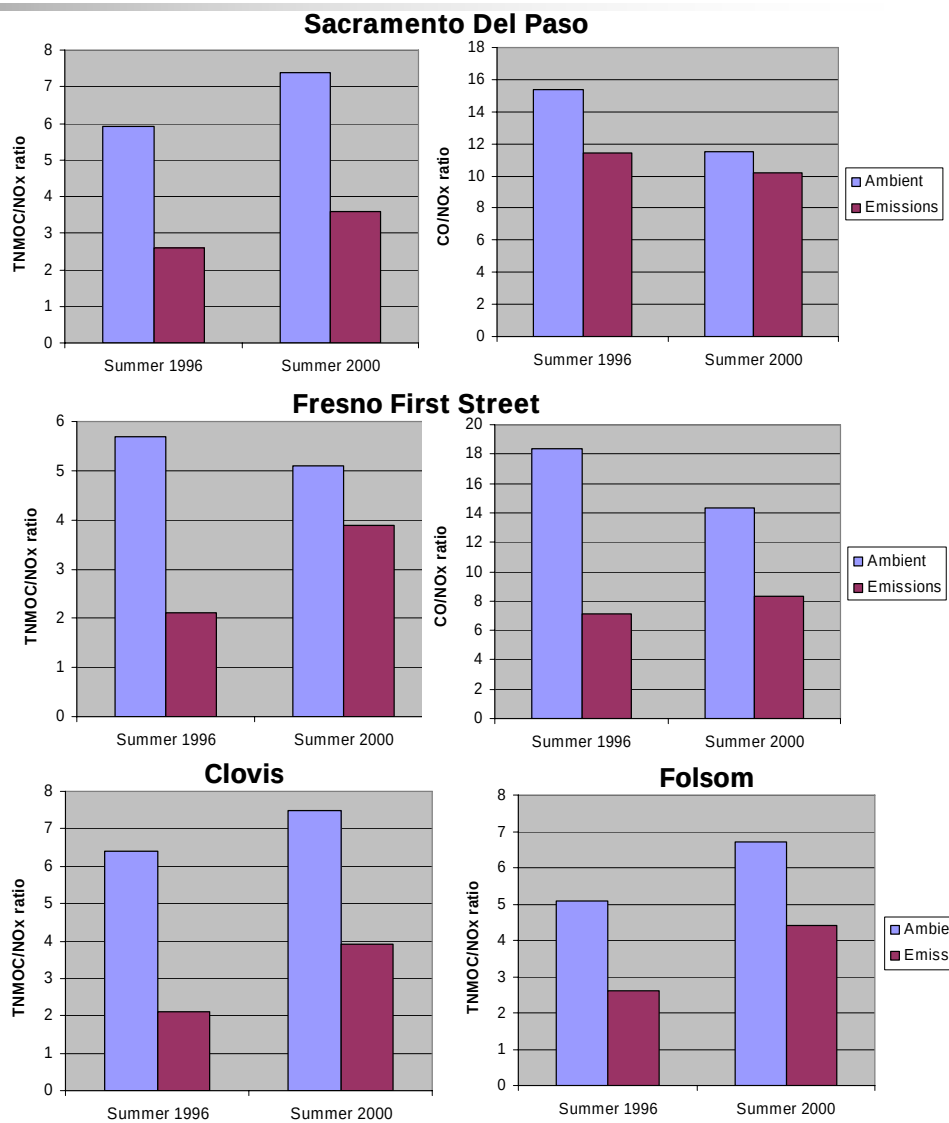


Preview of Findings (1 of 3)

- Overall, the emissions data show better agreement with ambient data than previous emission inventories have.

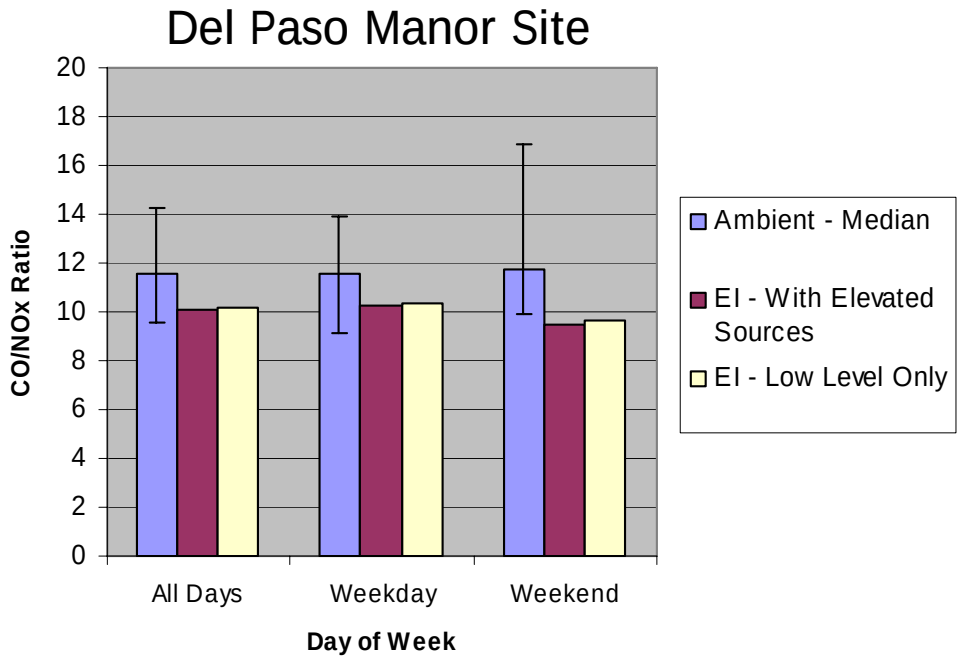
Air Basin	Ambient ratio/Emissions ratio			
	DRI 1990	DRI 1995	DRI 2000	STI 2000*
Sacramento	2.2	1.6	1.7	1.4 - 2.4
Fresno	3.6	2.6	1.9	1.4 - 7.2
Kern	--	3.9	2.9	2.6 - 4.3

*This column shows the range of results from all sites evaluated in each air basin—including both urban and rural sites.



Preview of Findings (2 of 3)

- At some sites, the emissions data correlate with ambient data as closely as could be expected given analyses limitations*.



* "ARB staff believes that an assessment such as this should only be expected to produce ambient/emissions ratios that are within approximately +/- 25 to 50% of 1.0." (ARB, 1997)

Preview of Findings (3 of 3)

- EI generally under-predicts pollutant ratios
- The EI validation techniques used in this project identified specific issues with the magnitude and spatial/temporal allocation of emissions.

Outline

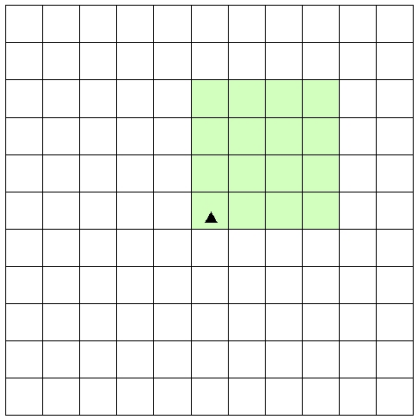
- Overview of Approach
- Sites Selected
- Results
- Findings and Recommendations
- Questions & Discussion

Overview of Approach (1 of 2)

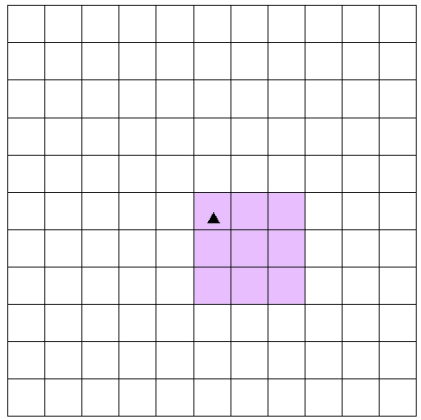
- Comparisons of ambient data to the emission inventory include:
  - TNMOC-to-NOx ratios
  - CO-to-NOx ratios
  - Ratios of individual species
  - Chemical composition of hydrocarbons

Overview of Approach (2 of 2)

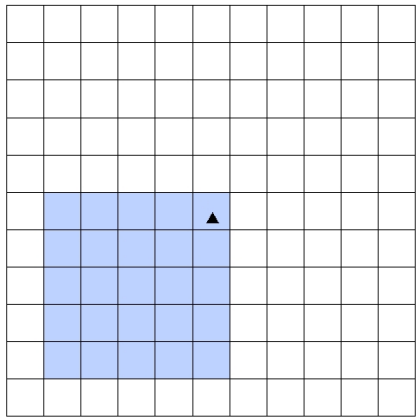
- Spatial and temporal comparisons done by:
  - Weekday vs. weekend
  - Wind quadrants



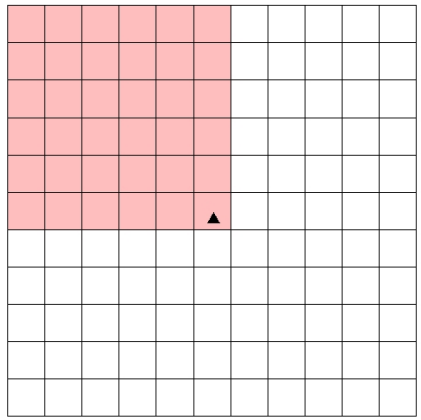
Wind Quadrant 1 (1-90°)



Wind Quadrant 2 (91-180°)



Wind Quadrant 3 (181-270°)

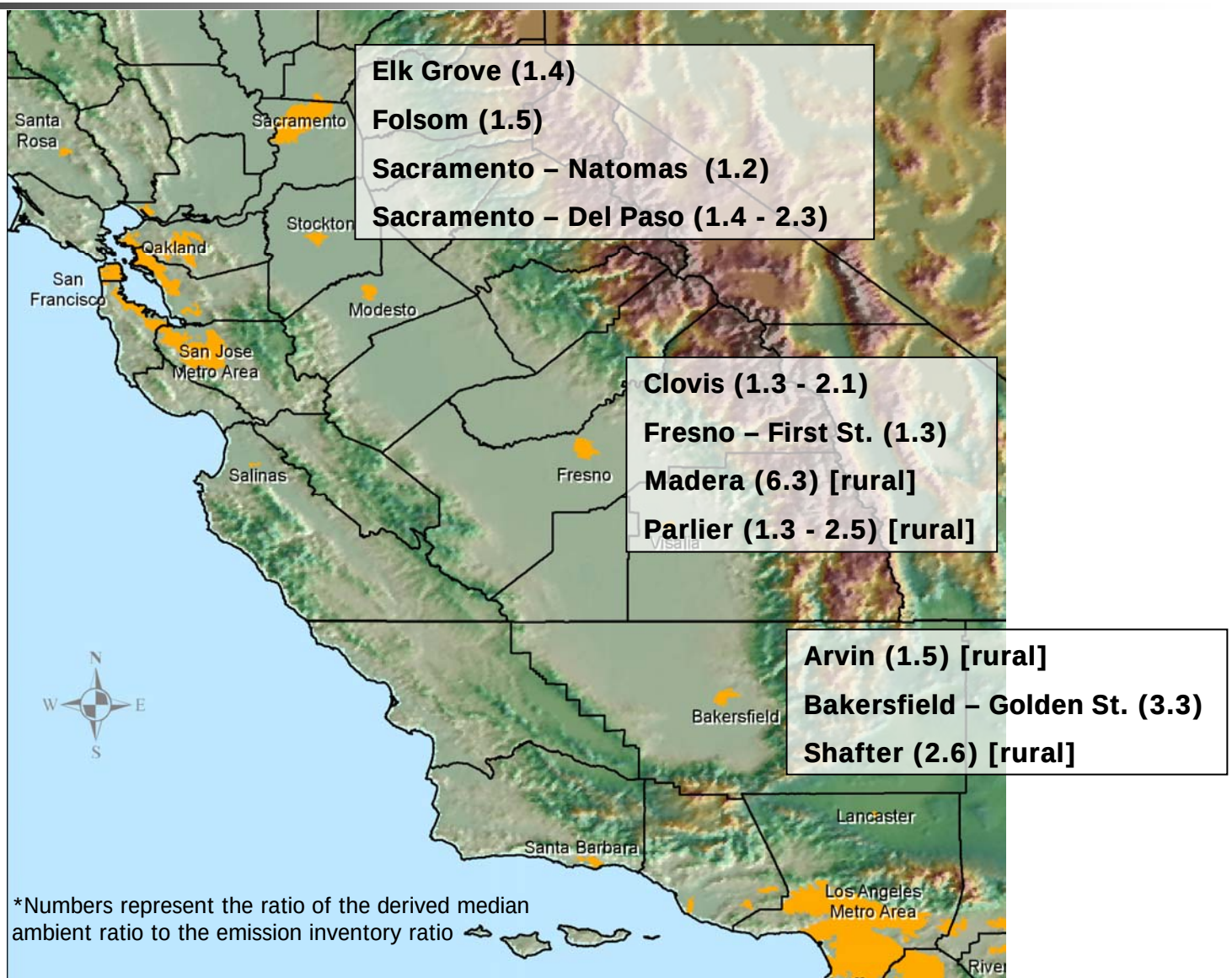


Wind Quadrant 4 (271-360°)

Monitoring Sites Selected

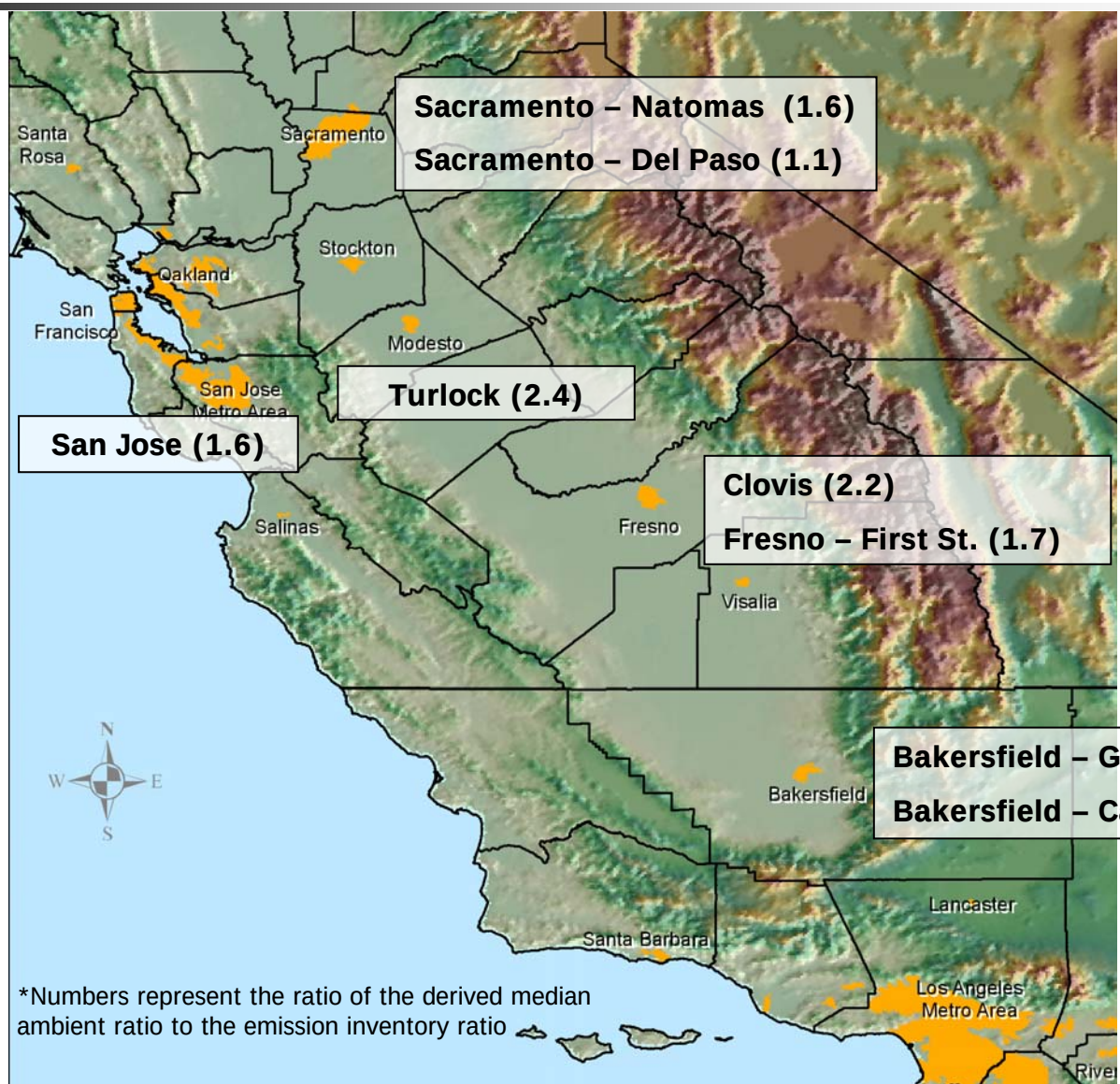
Site	Tier	District	Site Name	TNMOC/NOx	CO/NOx	Species ratios	VOC fingerprints
BGS	1	SJV	Bakersfield Stn. (Golden State)	X	X	X	X
CLO	1	SJV	Clovis Stn.	X	X	X	X
FSF	1	SJV	Fresno Stn. (First St.)	X	X		
NAT	1	Sacto	Sacramento/Natomas Stn.	X	X	X	X
SDP	1	Sacto	Sacramento Stn. (Del Paso Manor)	X		X	X
SUN	1	Bay Area	Sunol Stn.			X	
FLN	2	Sacto	Folsom Stn.	X		X	X
PLR	2	SJV	Parlier Stn.	X		X	X
ARV	3	SJV	Arvin Stn.	X	X	X	X
ELK	3	Sacto	Elk Grove Stn.	X			X
M29	3	SJV	Madera Stn.	X		X	X
SHA	3	SJV	Shafter Stn.	X		X	X
SJ4	3	Bay Area	San Jose Stn. (4th St.)		X		
TSM	3	SJV	Turlock Stn.		X		
BAC	4	SJV	Bakersfield Stn. (California Ave.)		X		
GNBY	4	Sacto	Granite Bay Stn.			X	

Comparison of TNMOC/NOx Ratios



*Numbers represent the ratio of the derived median ambient ratio to the emission inventory ratio

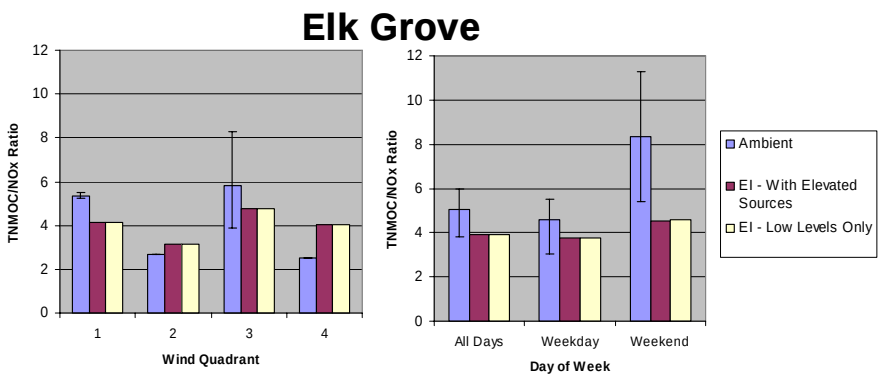
Comparison of CO/NOx Ratios



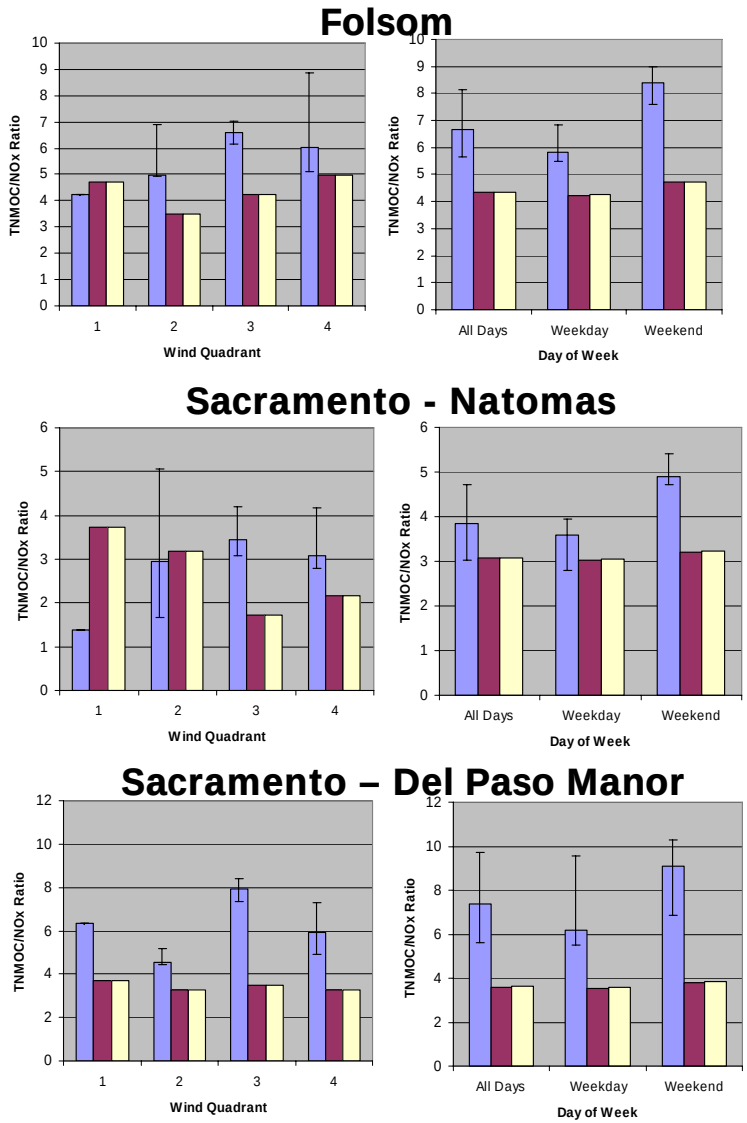
Sacramento Area (1 of 3)

TNMOC/NOx

- **Better agreement on weekdays**
- **Note poor agreement in wind quadrant 3 at Del Paso Manor**



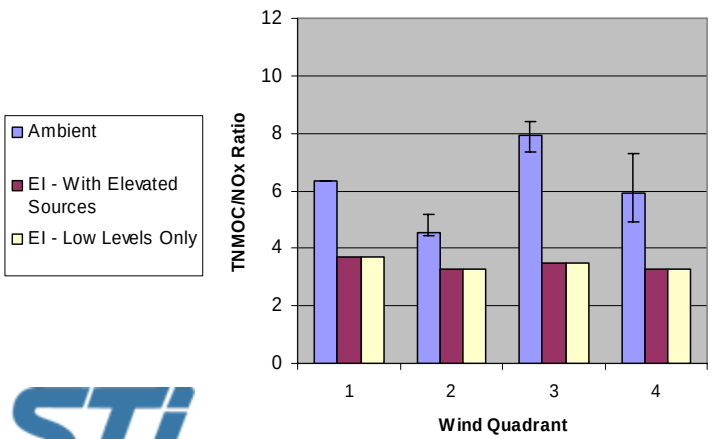
Error bars represent 25th and 75th percentiles

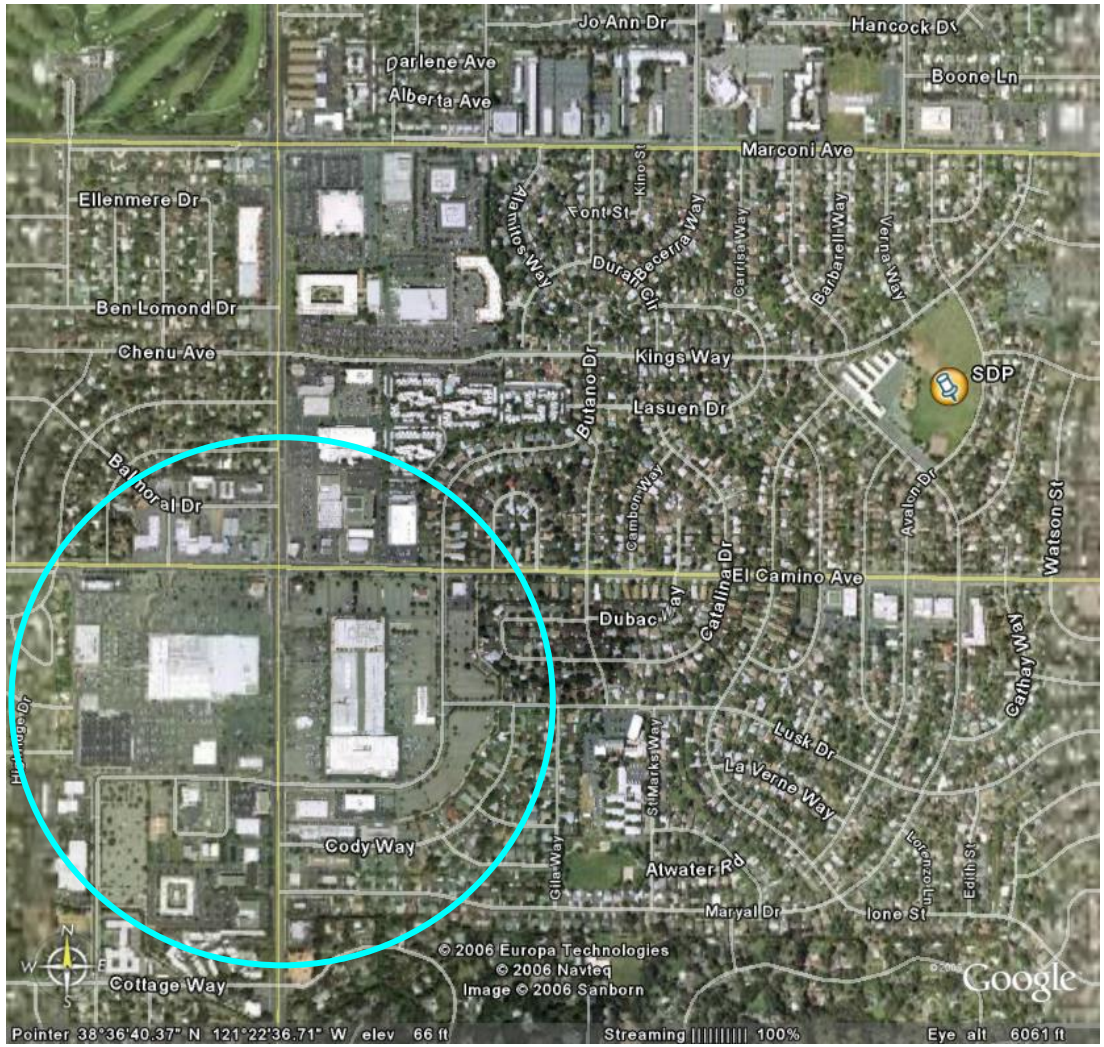


Sacramento (2 of 3)

Del Paso Manor

- **Poorest agreement in wind quadrant 3**
- **Shopping center 1km southwest of site**
- **Possible issue capturing hot soak emissions in inventory**

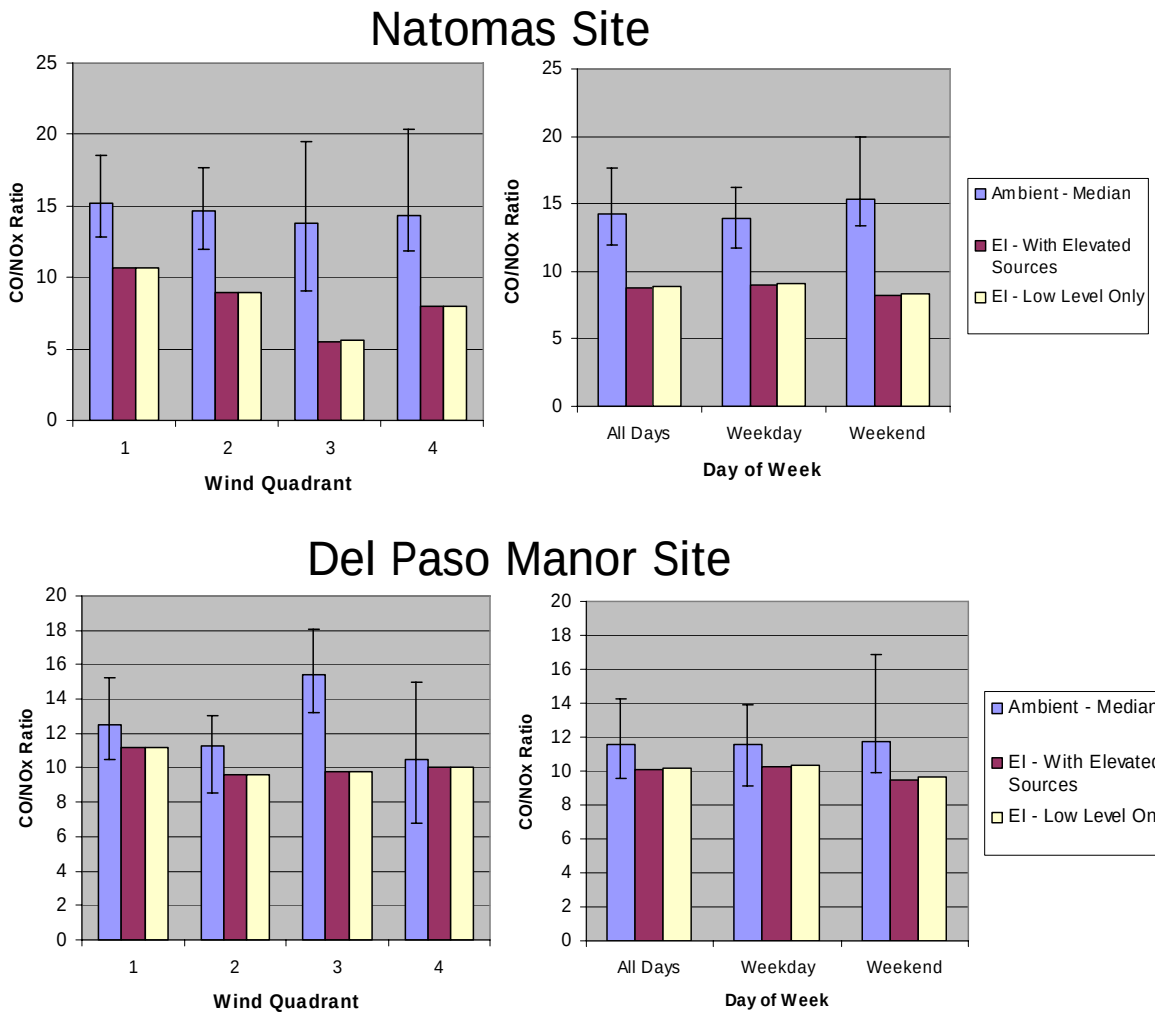




Sacramento Area (3 of 3)

CO/NOx

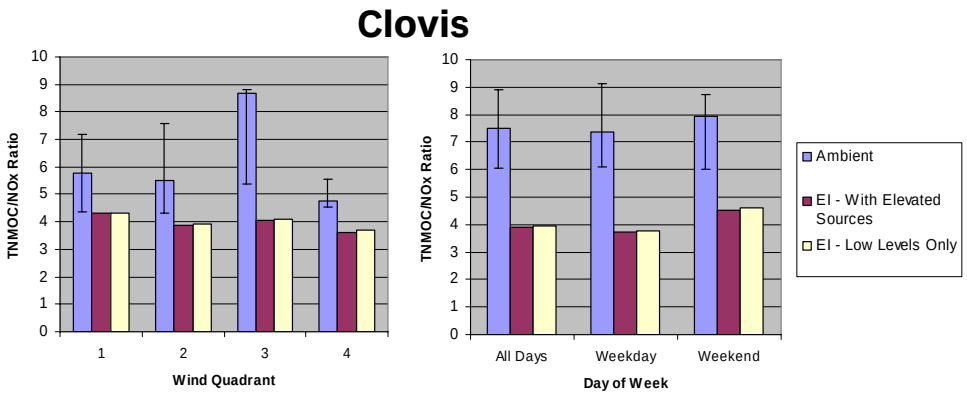
- **Weekdays and weekends are similar**
- **Agricultural or heavy duty sources appear to be misrepresented (too high) in Natomas quadrant 3**
- **Del Paso ratios agree well**

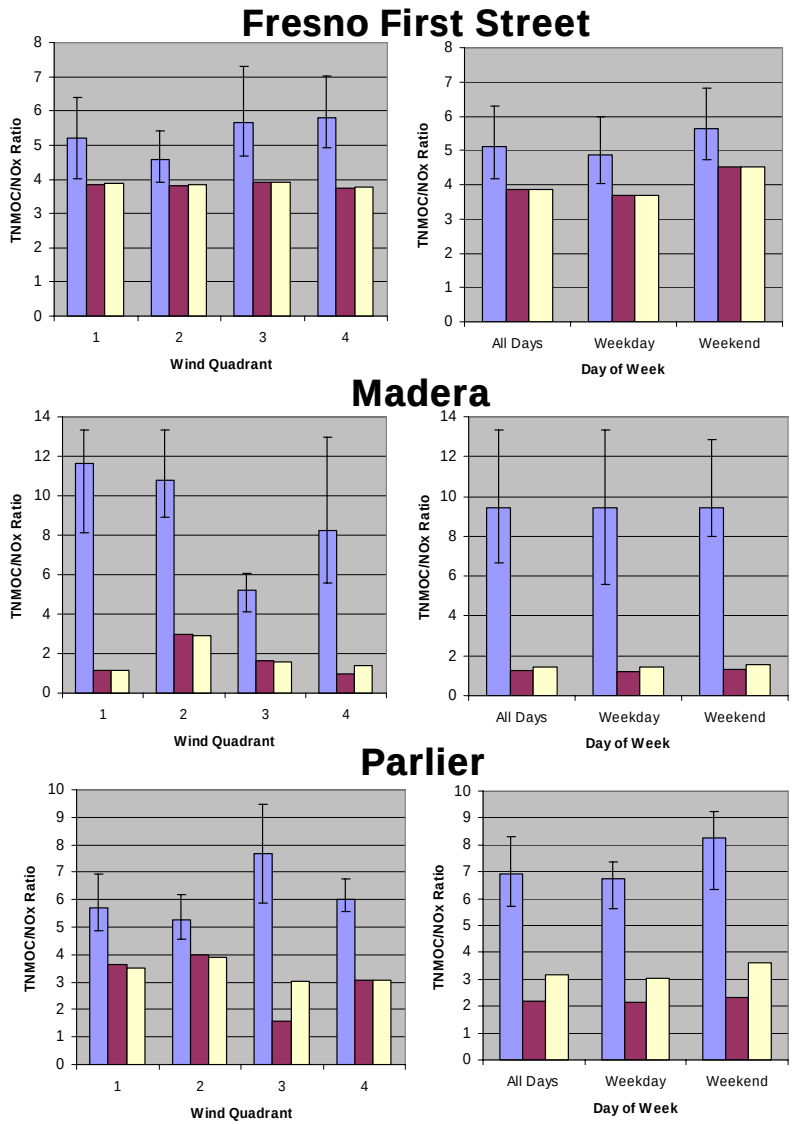


Fresno Area (1 of 2)

TNMOC/NOx

- **Weekdays and weekends are similar**
- **Changes in real world growth between Clovis and Fresno compared to surrogates (CLO-quadrant 3)**
- **Rural Madera site with low emission density (doesn't fully meet assumptions)**

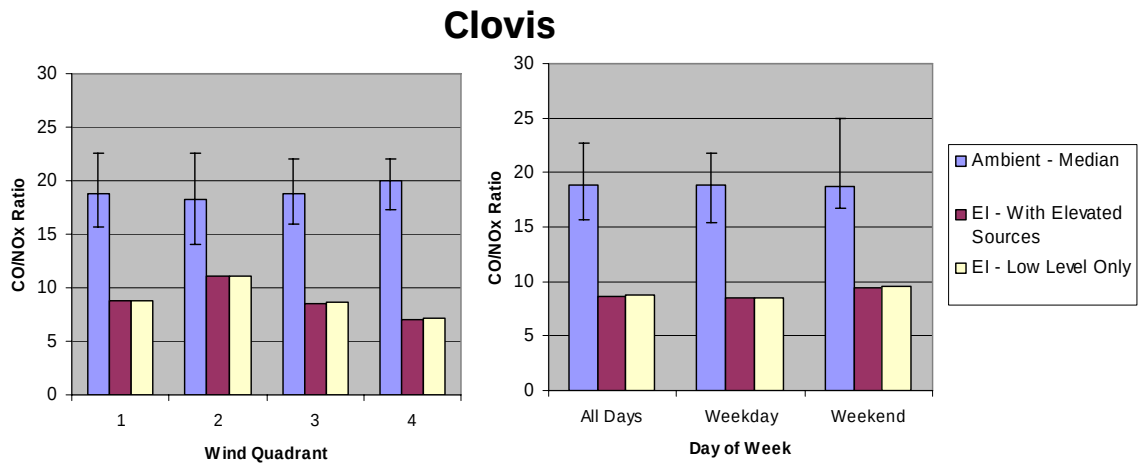


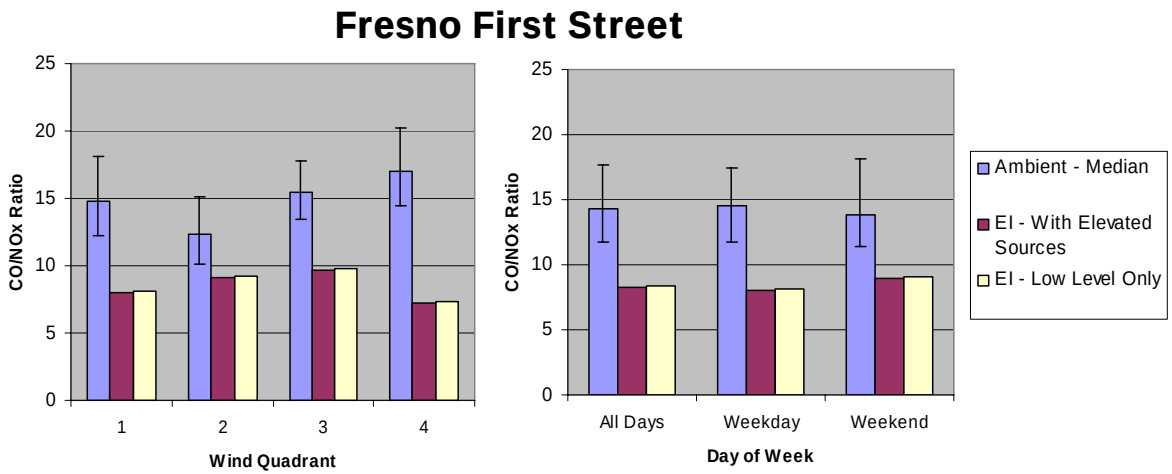


Fresno Area (2 of 2)

CO/NOx

- **Similar agreement on weekdays and weekend days**
- **Agreements not as good as in the Sacramento area**
- **May suggest overestimated heavy-duty NOx emissions in the area**

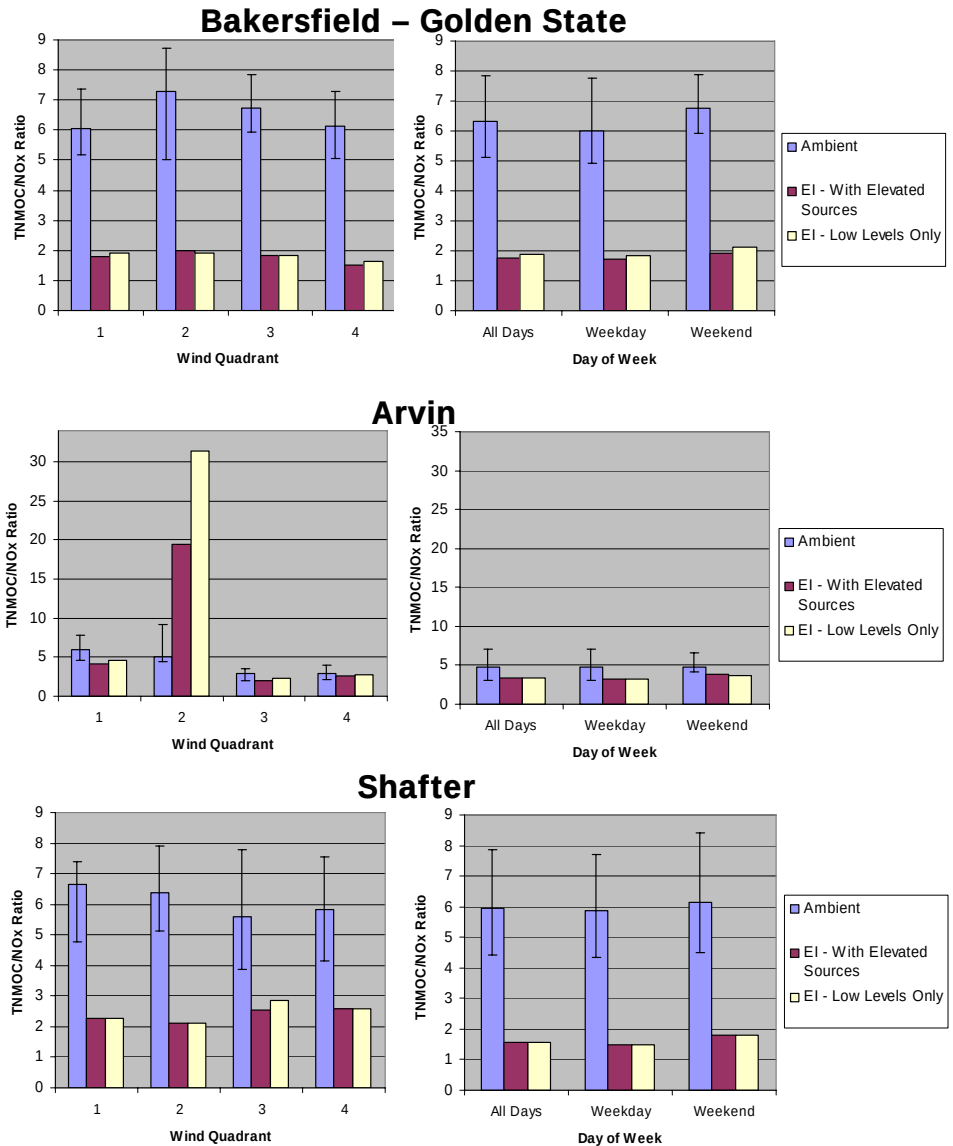




Kern County (1 of 2)

TNMOC/NOx

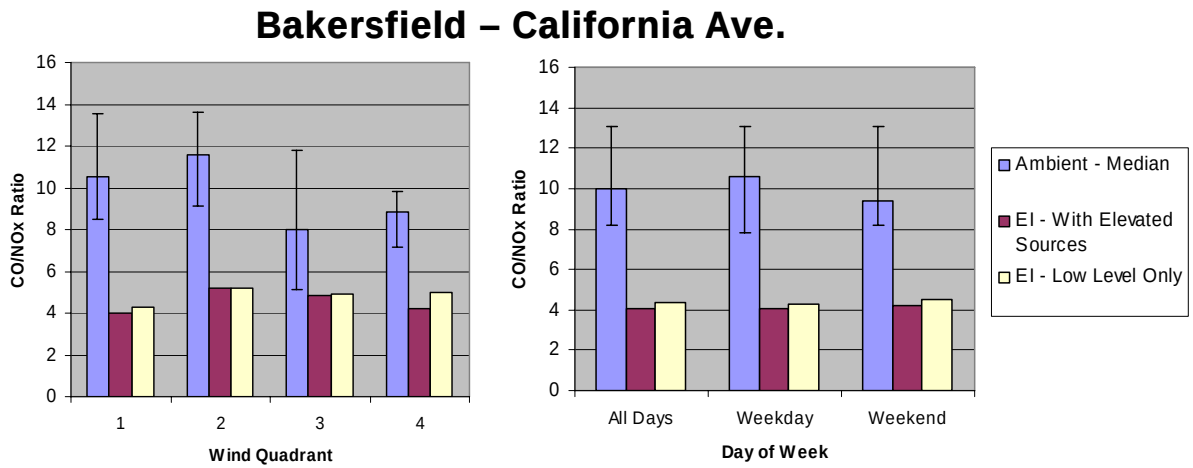
- **Ambient ratios are 2 to 4 times higher than emissions ratio (Much was worse than Sacramento/Fresno)**
- **Agreement does not vary between weekdays and weekends**
- **TNMOC emissions in quadrant 2 of Arvin are dominated by biogenics**

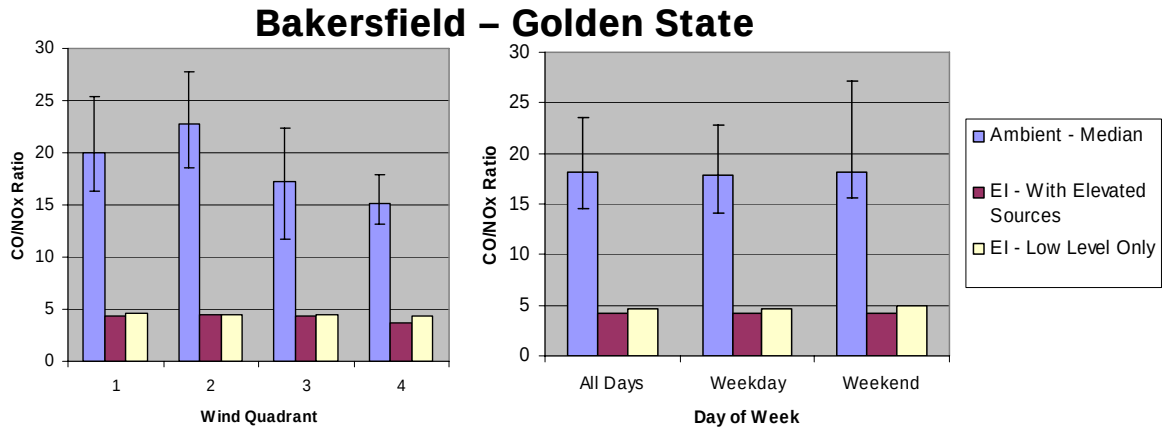


Kern County (2 of 2)

CO/NOx

- **At Calif. Ave., best agreement in wind quadrants 3 and 4**
- **Poor overall agreement at the Golden State site**

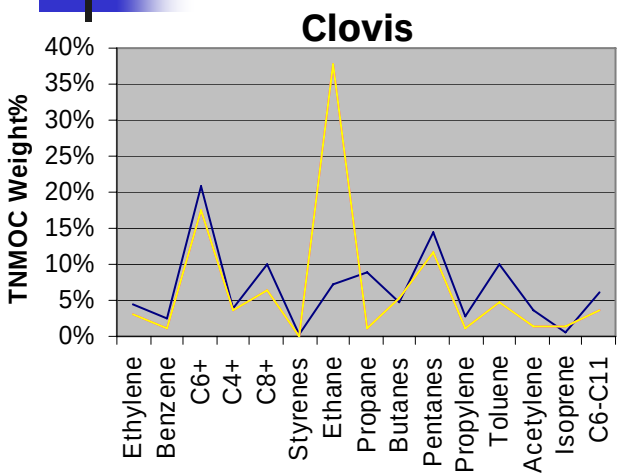


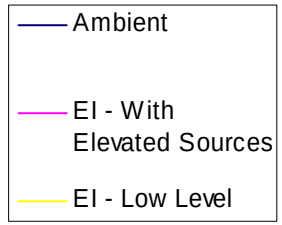


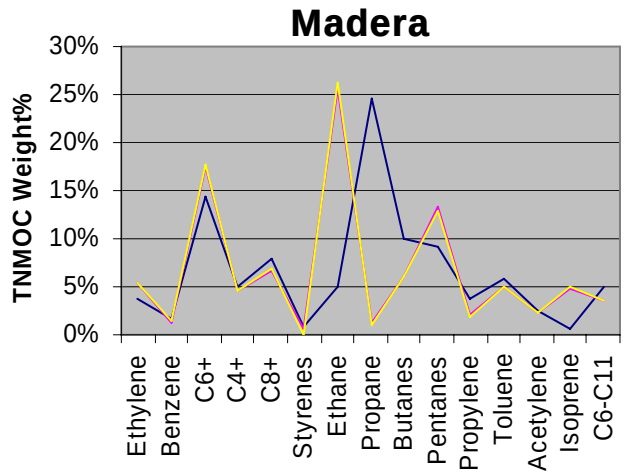
Fingerprint Comparisons (1 of 5)

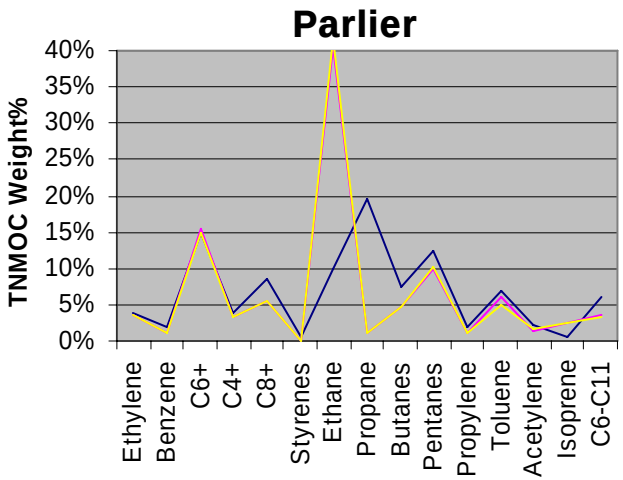
- Comparisons were performed for 10 sites
- Analyses showed:
  - Speciation of emission inventory is generally representative of the TNMOC composition detected by ambient monitoring sites
  - Ethane is consistently higher in the emission inventory
  - Propane is consistently lower in the emission inventory
  - Isoprene is consistently higher in the emission inventory

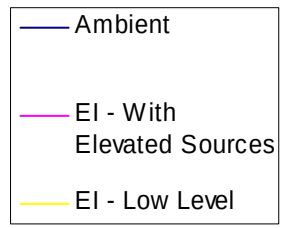
Fingerprint Comparisons (2 of 5)

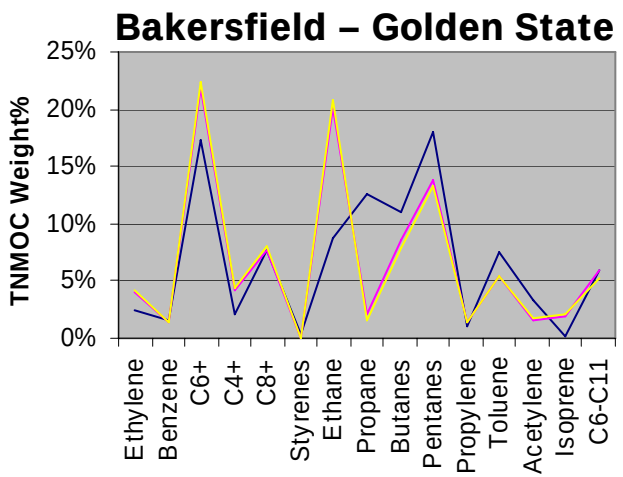






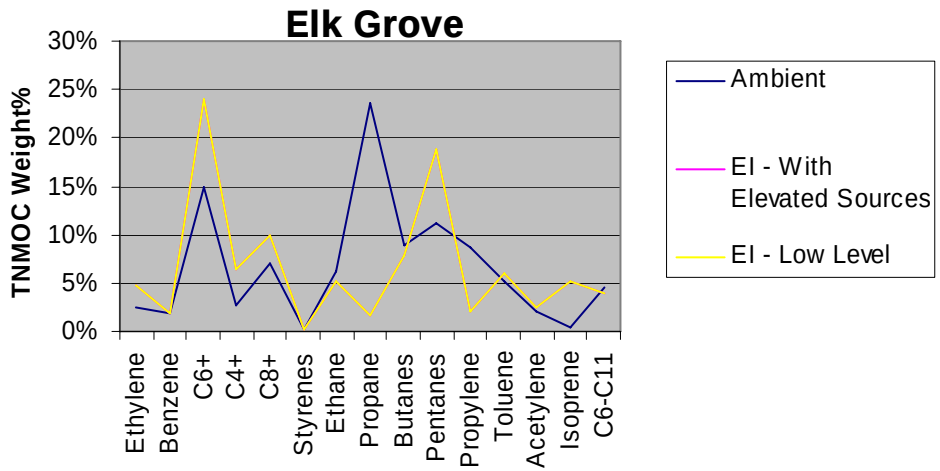


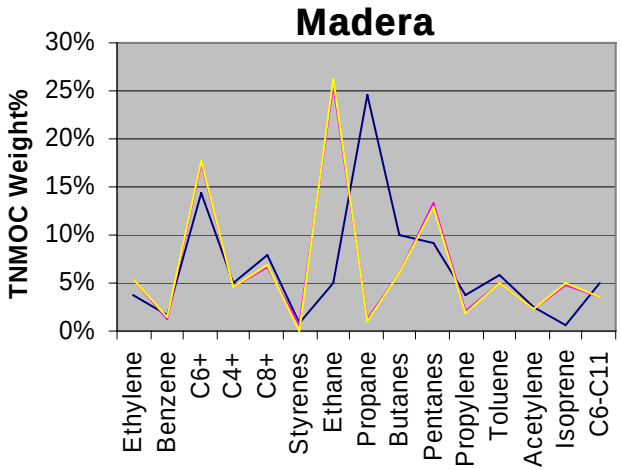


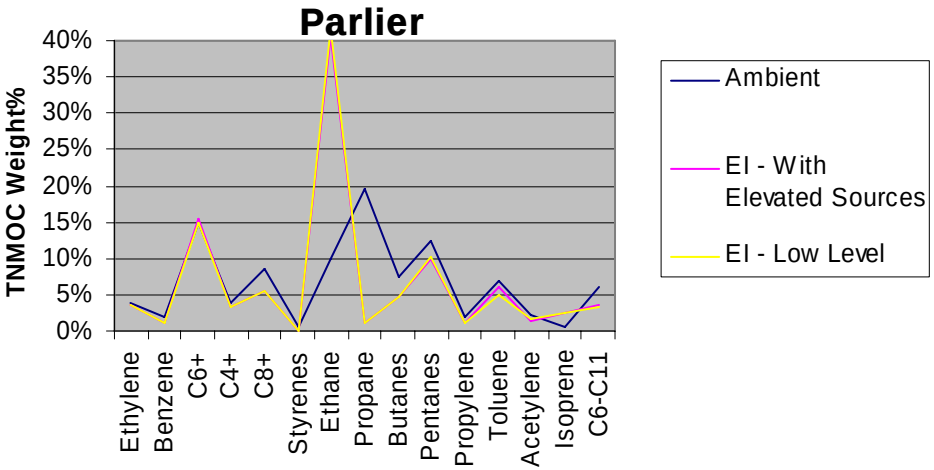


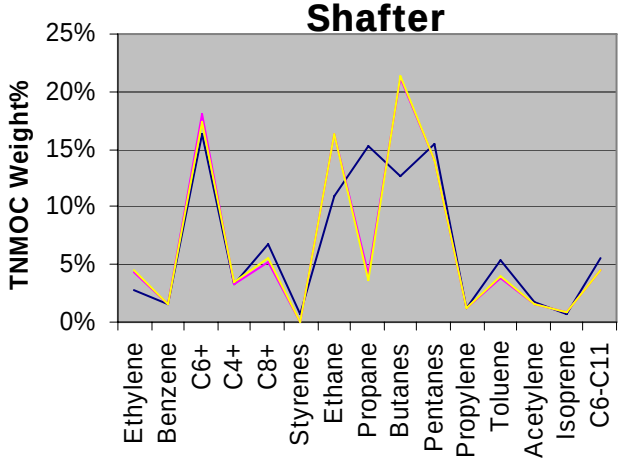
Ethane: livestock emissions spatially allocated using population density.

Fingerprint Comparisons (3 of 5)



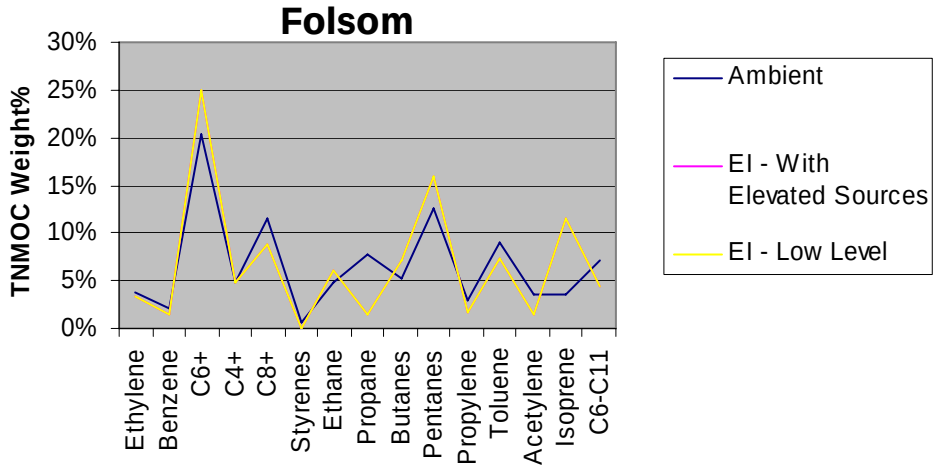


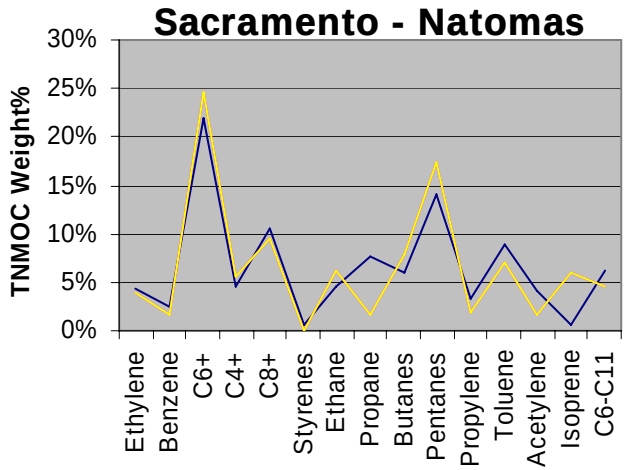


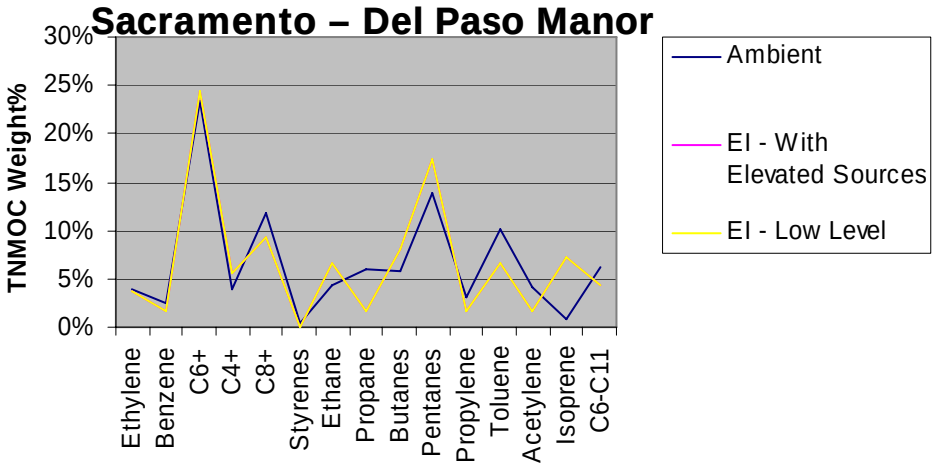


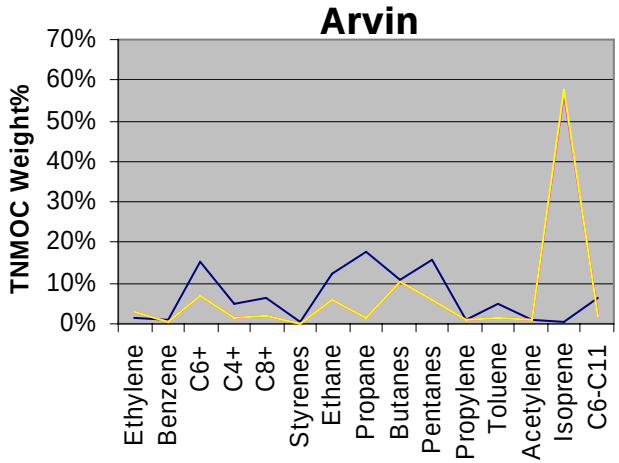
Generally Propane is associated with oil and gas extraction, except for major distribution center located at Elk Grove.

Fingerprint Comparisons (4 of 5)









Isoprene: reactivity issues; possible overestimated biogenics at Arvin.

Fingerprint Comparisons (5 of 5)

Overall Findings

- Overall, the emissions data show better agreement with ambient data than previous emission inventories have.
- At some sites, the emissions data correlate with ambient data as closely as could be expected given analyses limitations.
- EI generally under-predicts pollutant ratios
- The EI validation techniques used in this project identified specific issues with the magnitude and spatial/temporal allocation of emissions.

Sample Results

- Urbanized Sacramento area:
  - Good agreement on weekdays
  - Poorer agreement on weekends
- Urbanized Fresno area:
  - Good agreement on weekdays and weekends
- Urbanized Bakersfield:
  - Poor agreement on weekdays and weekends

Questions and Discussion