Spatial, Temporal, Chemical, and Particle Size Variations

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Air Resources Board

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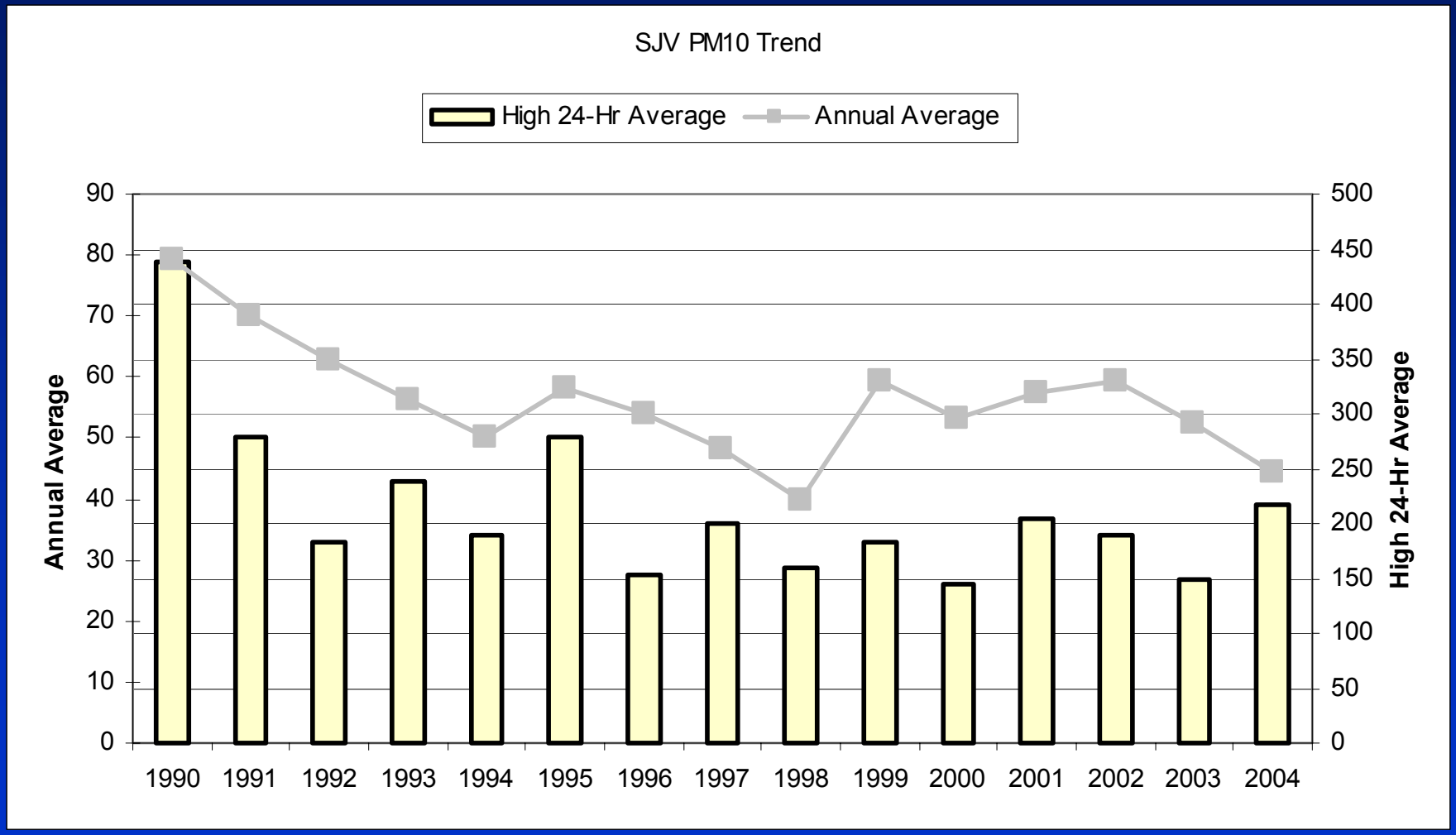
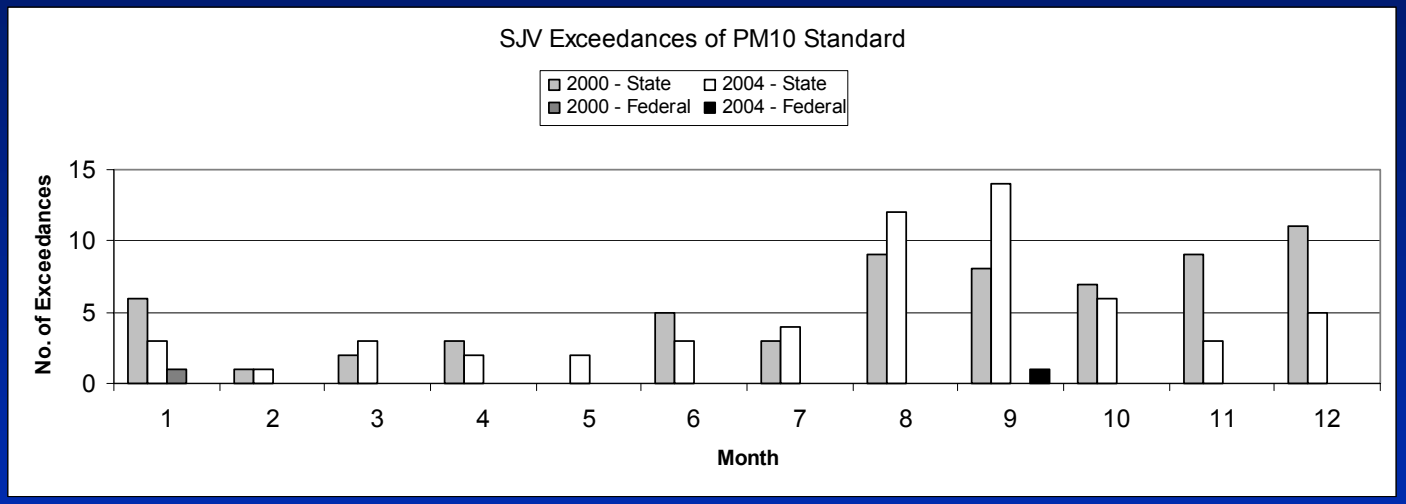
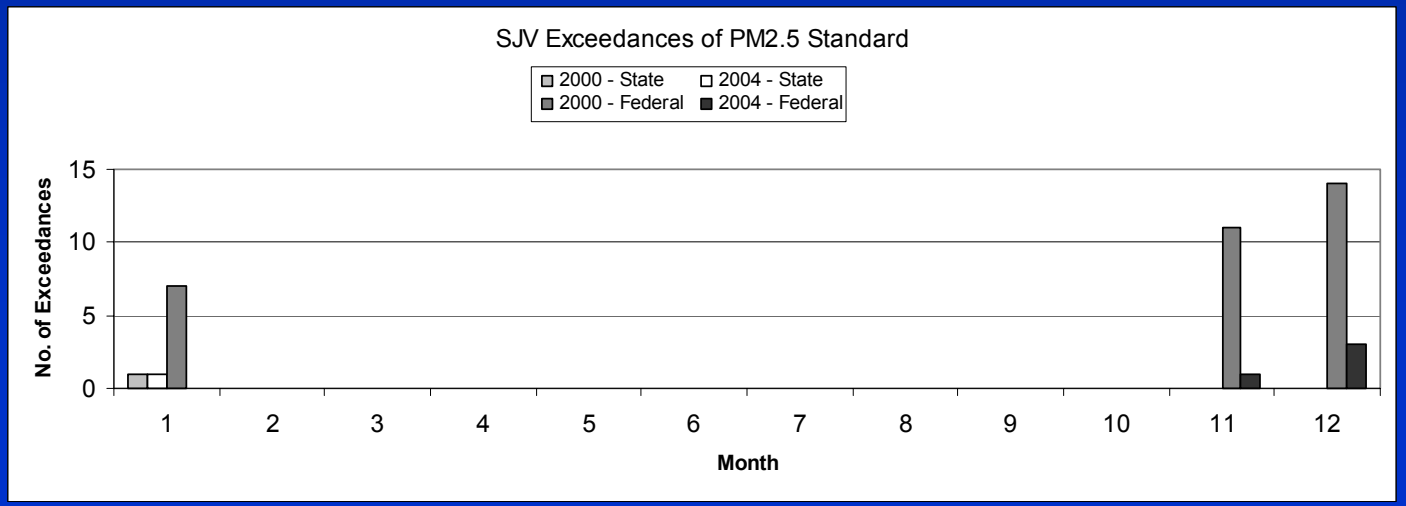
Task 2.1
[ARB]

- How does the frequency and location of excessive PM concentrations vary from year to year?
- At what locations and during what seasons are State and federal PM standards exceeded?
- How well did the 1999/2001 CRPAQS field study represent the numbers and locations of PM2.5 and PM10 exceedances found over a longer record?

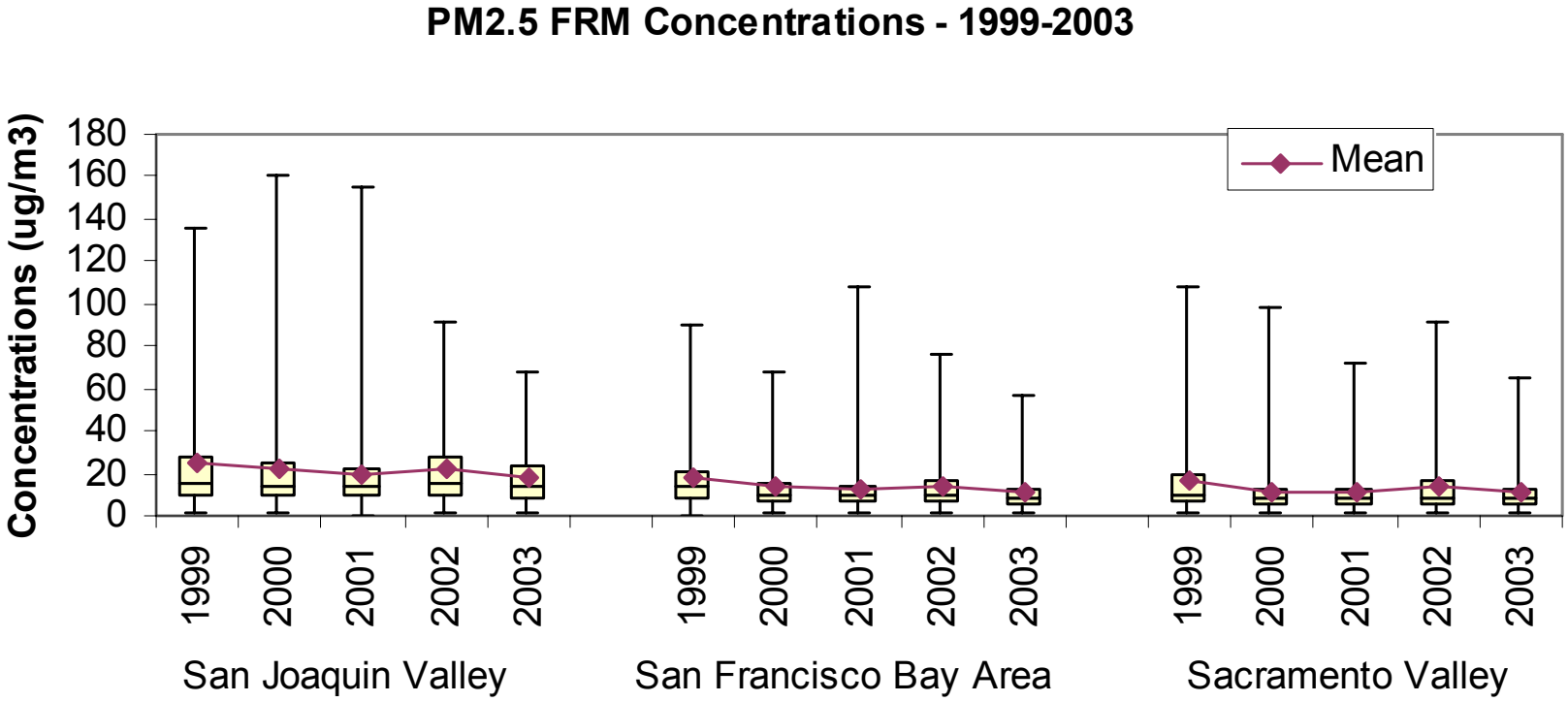

SJV PM10 Trend
High 24-Hr Average
Annual Average
Annual Average
High 24-Hr Average
0
10
20
30
40
50
60
70
80
90
0
50
100
150
200
250
300
350
400
450
500
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004

PM Standard Exceedances in SJV

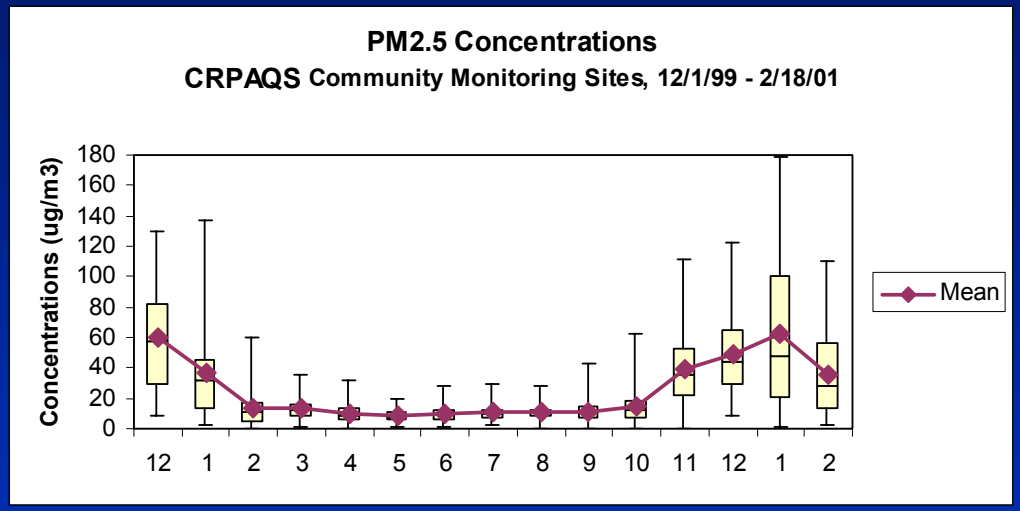


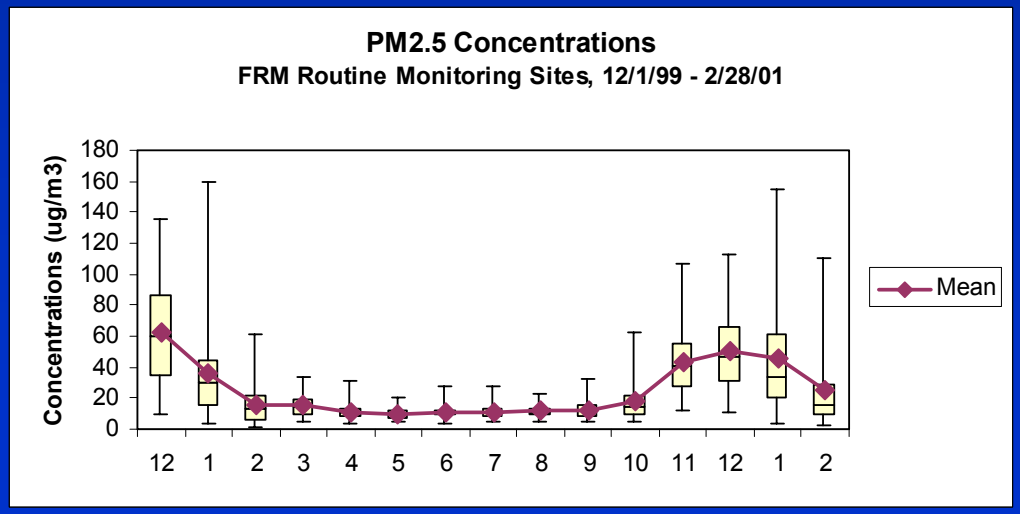


Frequency and location of excessive PM concentrations



CRPAQS v. Routine





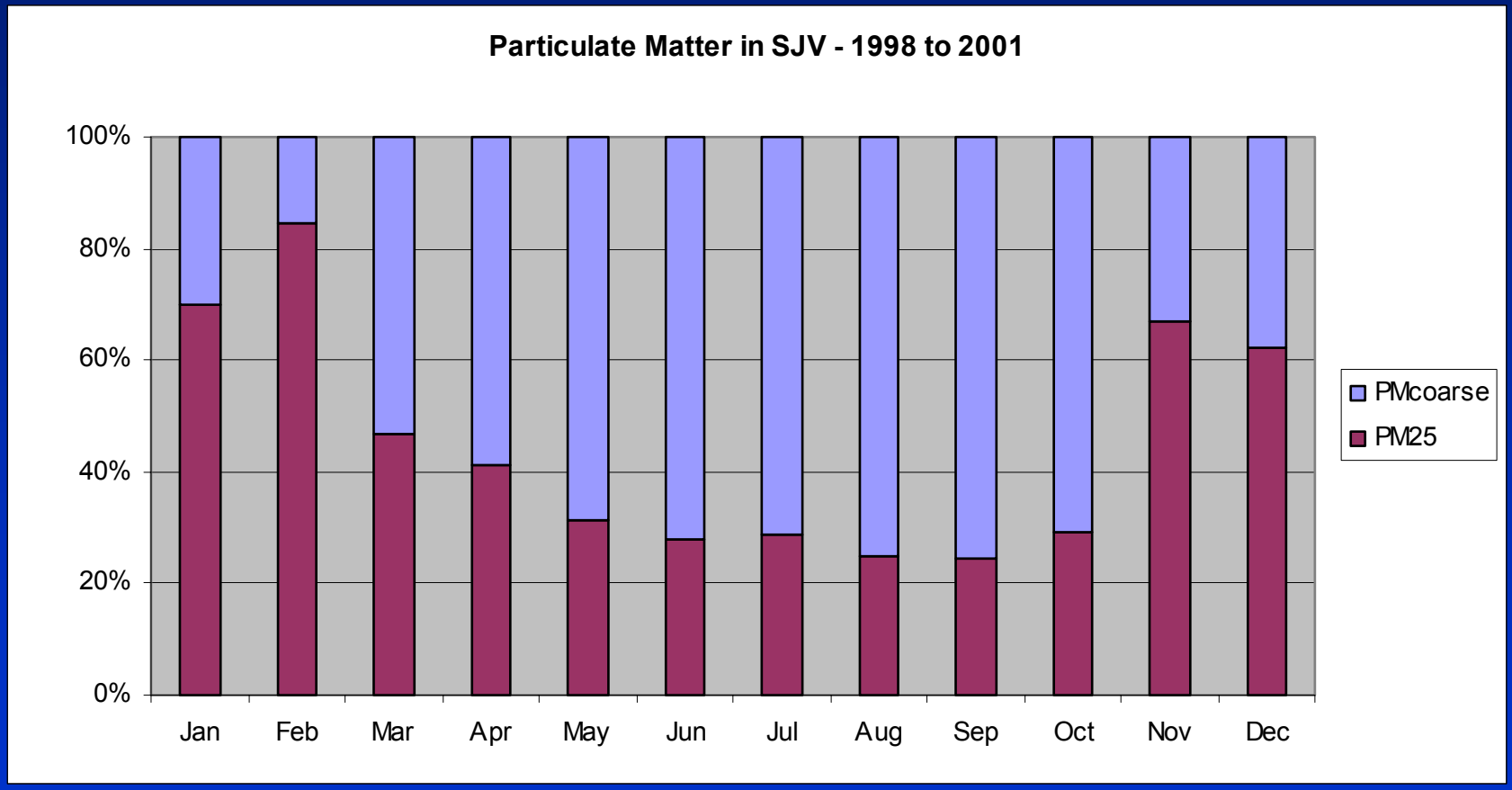
CRPAQS representative of long term exceedances?

- Exceedances have been decreasing
- More frequent sampling during CRPAQS resulted in higher concentrations.
- Monthly averages were affected, but annual averages were not

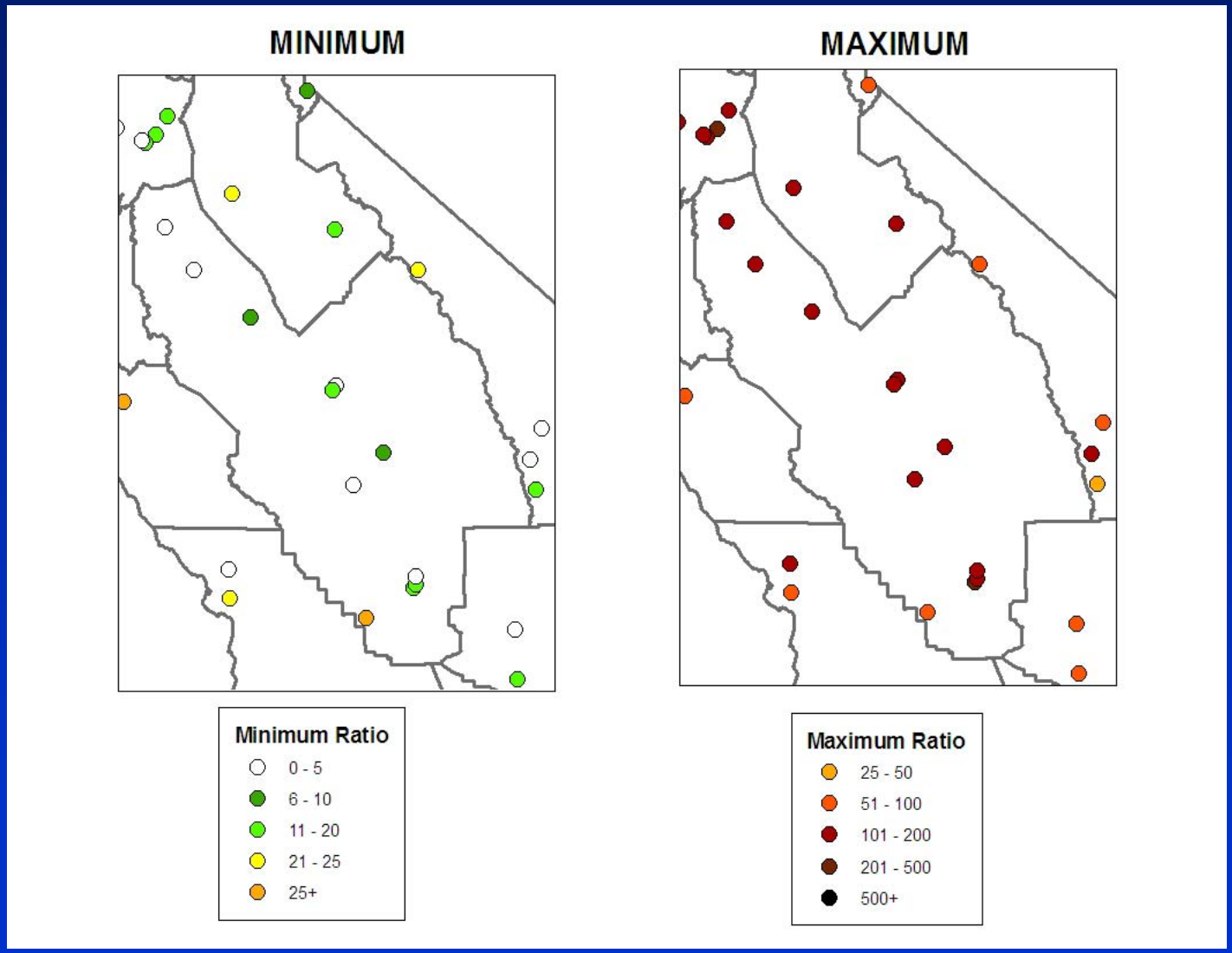
Task 2.3
[ARB]

- How much of PM10 is composed of PM2.5 and how does this relationship change by measurement site, time of day, and season?
- What meteorological and source emission characteristics are associated with differences in the ratio?
- How accurately can PM2.5 concentrations be determined from PM10 measurements
- Where and when is the coarse crustal component found in the PM2.5 size fraction?

Relationship of PM2.5 and PM10



Spatial PM2.5/PM10 Distribution CRPAQS Period



Coarse/Fine Fraction

- Determination of coarse/fine fraction is dependent on
  - Sampler bias
  - Filter handling
  - Spatial/temporal matching of monitors
- Coarse crustal or geological dust component is minor part of PM2.5
  - Less than 10%

Task 2.5
[STI/ADI]

- How do PM, precursor, and associated pollutant concentrations vary in the vertical dimension?
- To what extent are ground-based measurements at higher elevations influenced by horizontal rather than vertical phenomena?

PM variation in vertical dimension

- Significant stratification between surface measurements and elevated (tower) measurements
  - NO – at night, higher at surface than aloft
    - Local highway emissions
  - Ozone – at night, lower at surface than aloft
    - NO titration and nitrate formation at night
  - Black carbon – uniform vertical distribution
    - Regional distribution

Higher Elevation Influences

- SNFH characteristics indicative more of a surface site than towers at ANGI and WAG
  - Above inversion layer and less influenced by valley air
    - Less transport, more local sources

Task 2.8
[ADI]

- What are the particle size distributions and particle number counts?
- How do they vary in time and space?

Temporal and Spatial Characteristics

- Ultrafine particles more stable at night
  - Small mode in early morning
  - Larger mode (with larger diameter) at midday
- Diurnal pattern shows rapid rise in morning
  - Consistent with nitrate formation aloft brought to surface during rise of mixing height
- Spatial homogeneity within Valley during winter

Urban v. Rural Characteristics

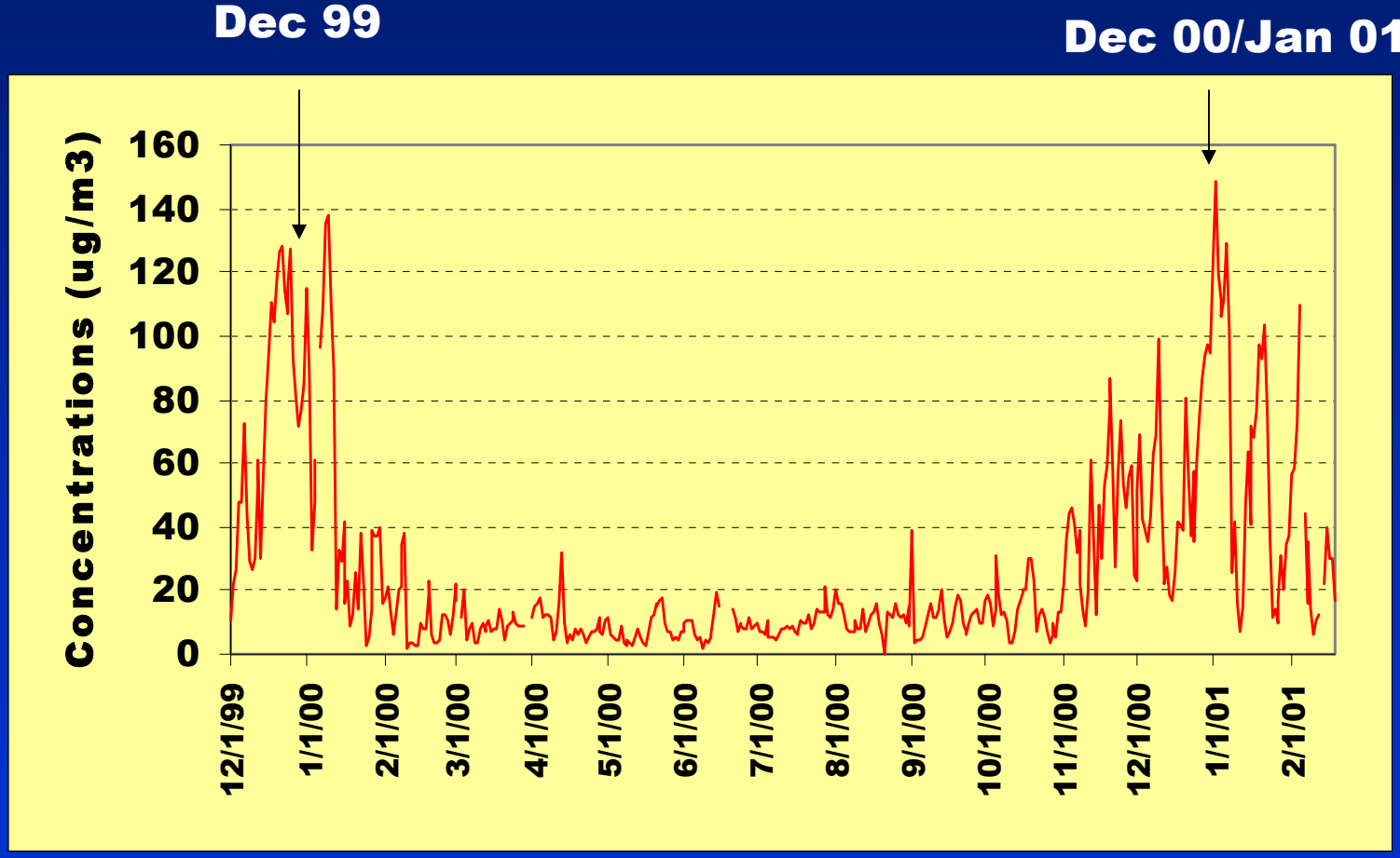
- Urban site (Fresno)
  - Single mode distribution
  - Max count in evening **after** peak traffic/commute
  - Maximum diameter greater than shown **during** traffic/commute
- Rural/Agricultural site (Angiola)
  - Bimodal distribution
  - Max peak in morning, smaller peak in evening
  - Particle diameters smaller than at urban site

Task 2.2

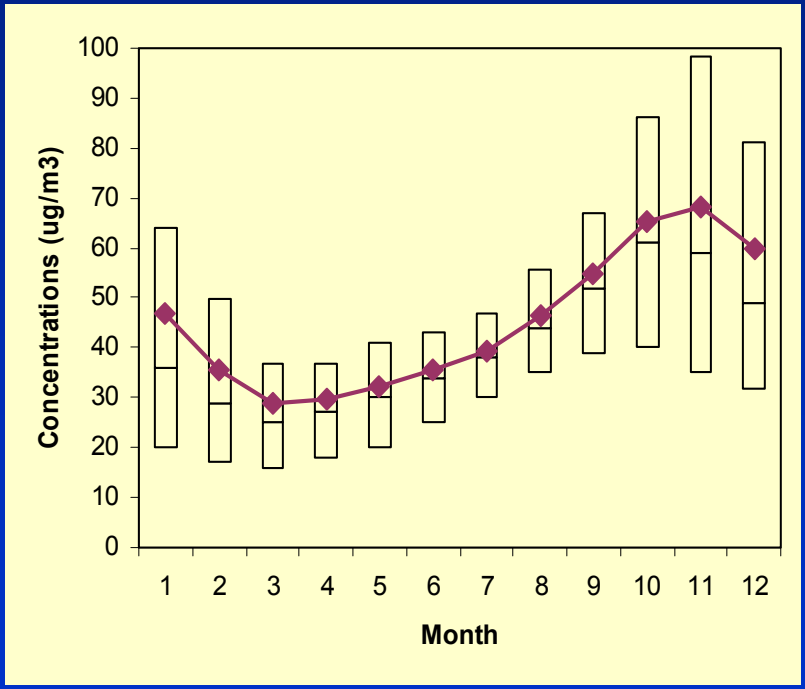
- What are seasonal, day-to-day, and diurnal variations in PM mass, chemical components, and PM precursor species?
- How do they vary spatially and by season?
- What are the relations between PM10 and PM2.5 variations and other pollutants?

PM2.5 Concentrations

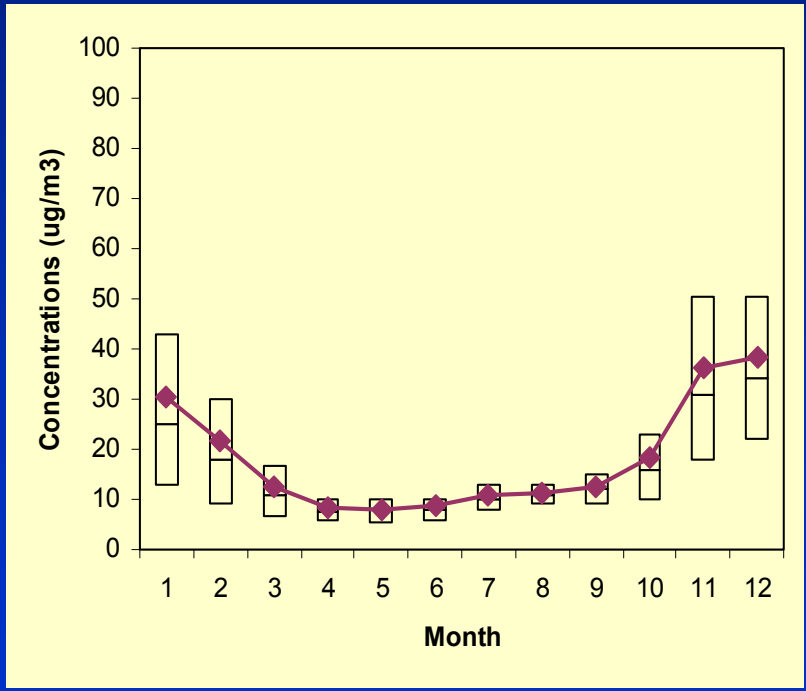
Fresno



Seasonal Patterns - Mass

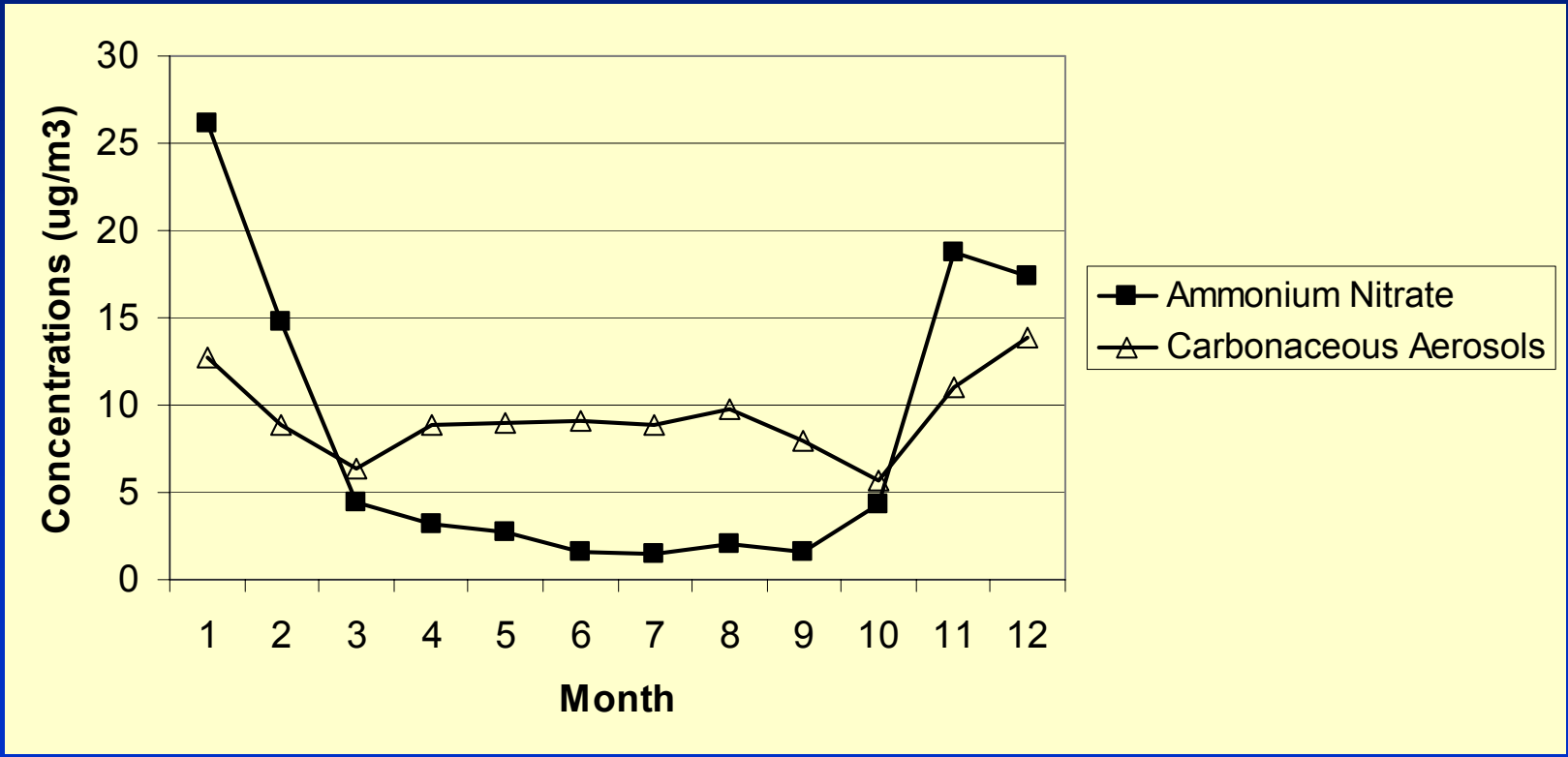


PM10

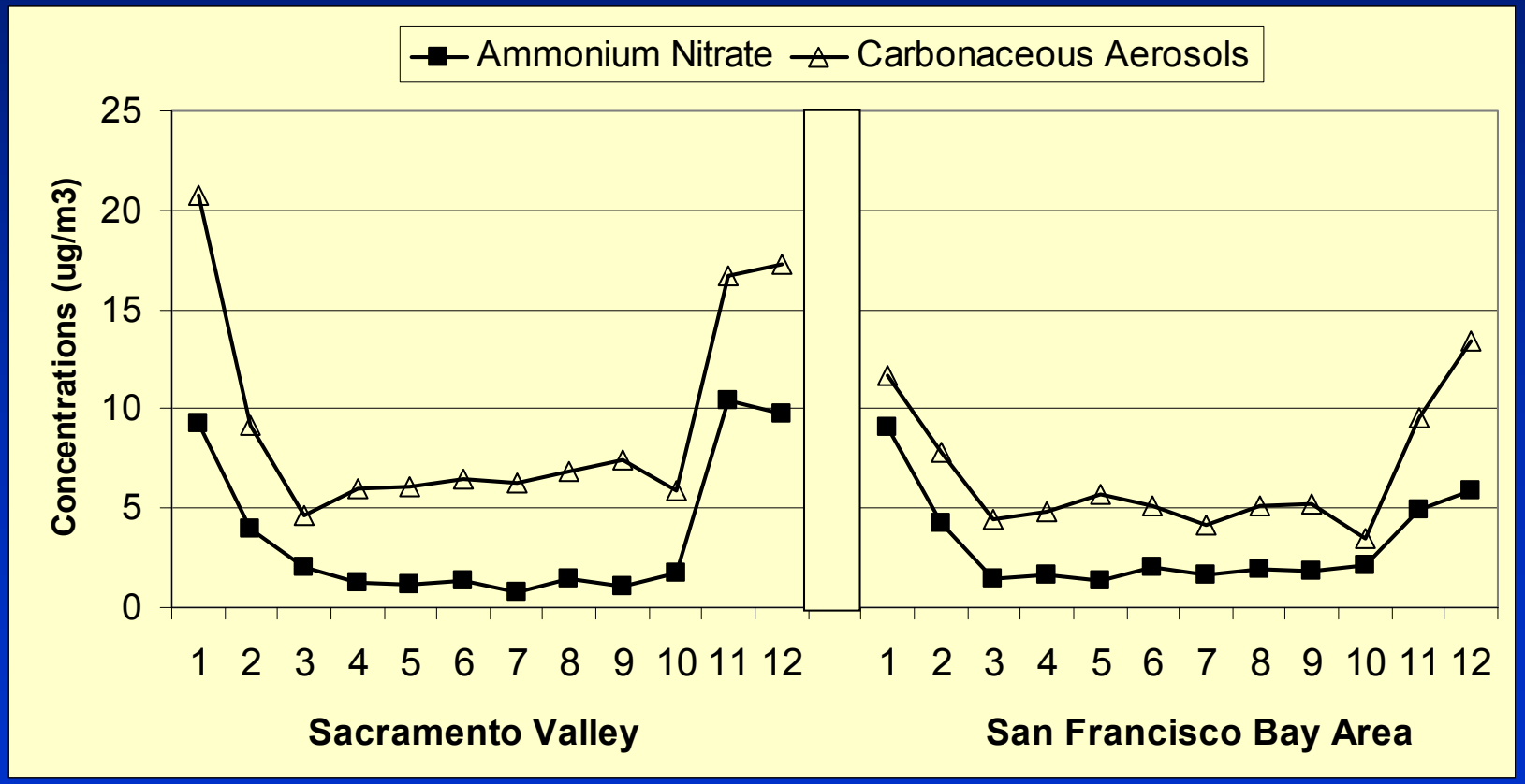


PM2.5

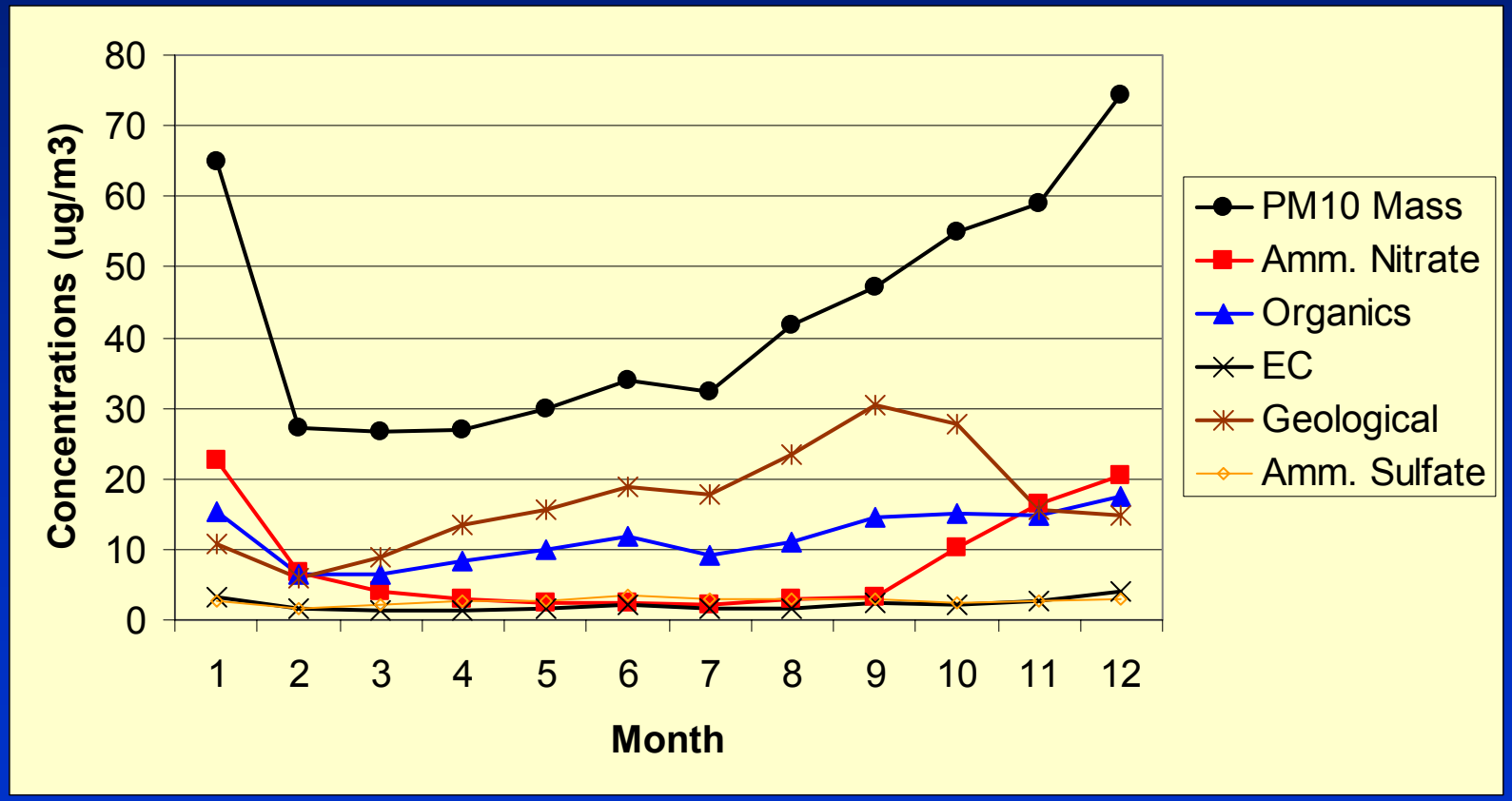
Chemical Components – PM2.5
San Joaquin Valley



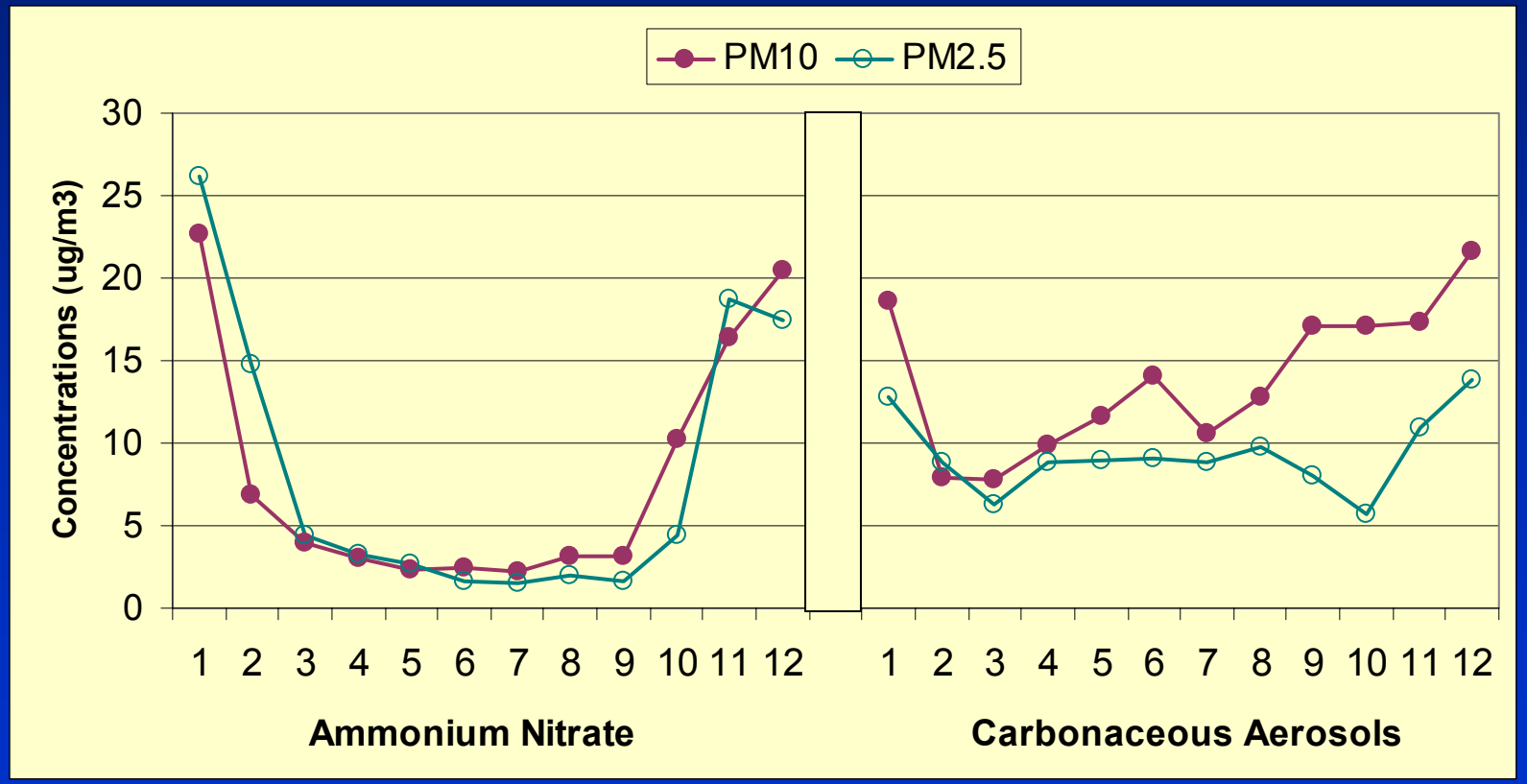
Chemical Components – PM2.5 Sacramento and Bay Area



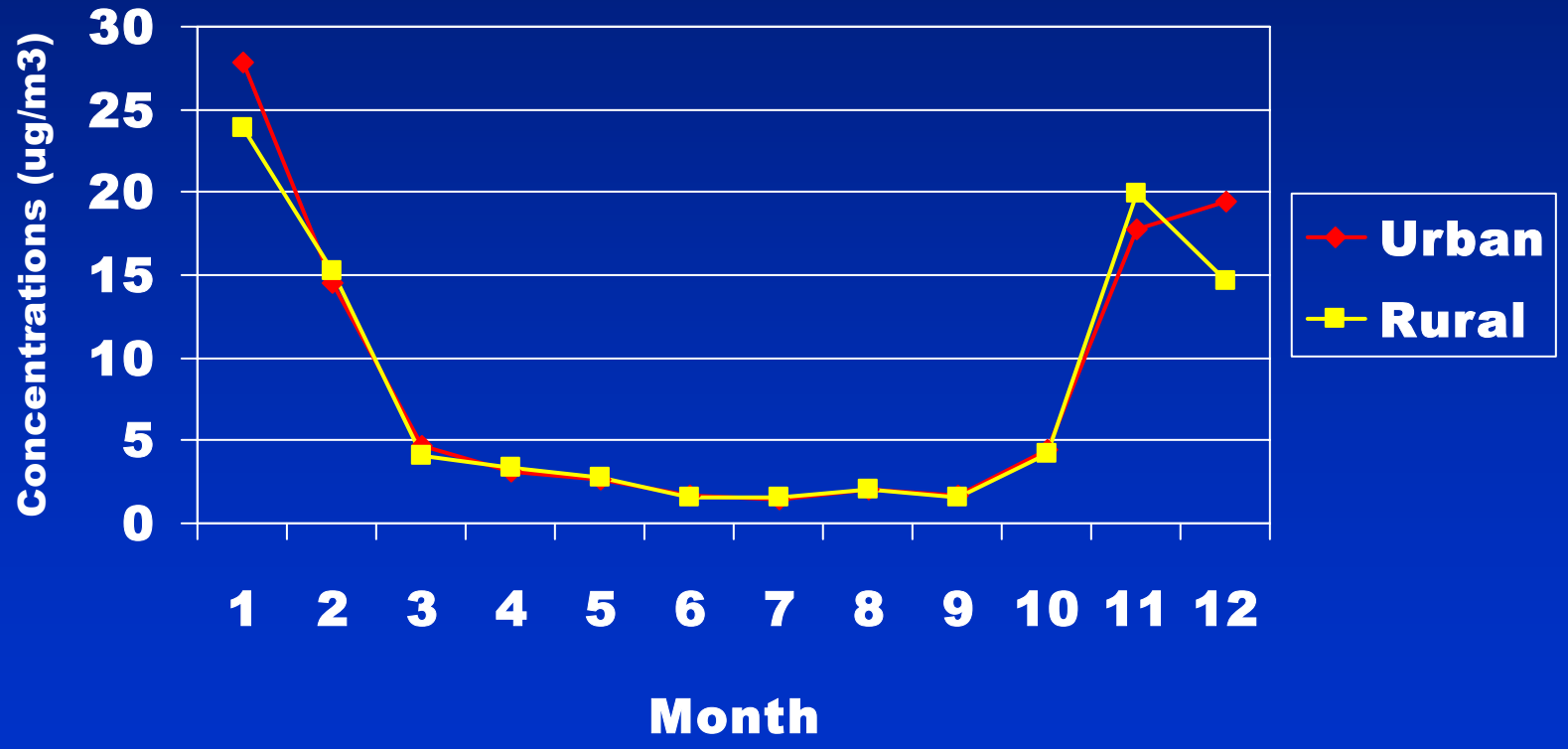
PM10 Monthly Average Chemical Components



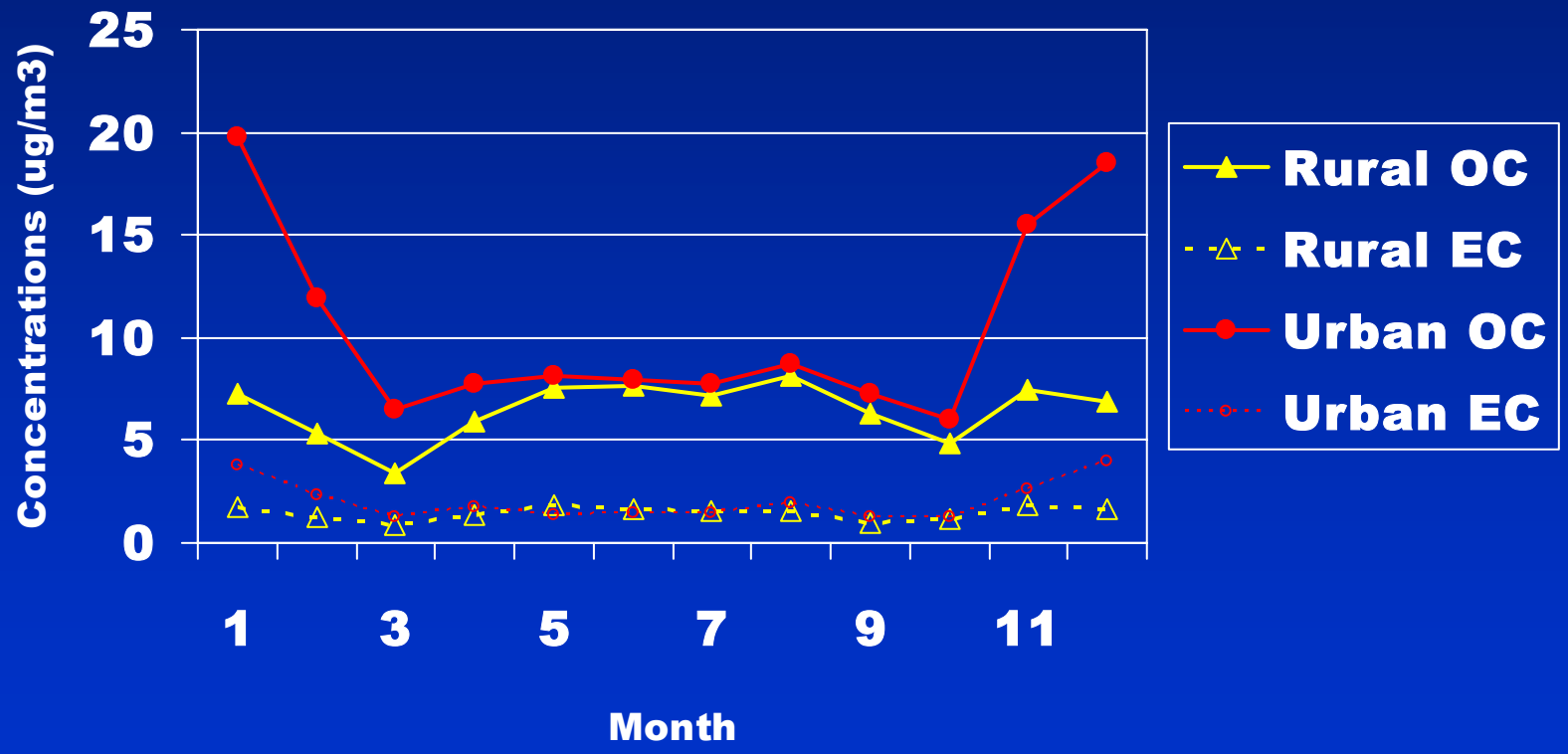
Chemical Components
PM10 vs. PM2.5



Urban vs. Rural Ammonium Nitrate



Urban Vs. Rural Carbonaceous Aerosols



PM2.5 Site-to-Site

- Concentrations lower in the northern SJV than in the central and southern
- The three highest urban sites had similar average of ~30 ug/m3
  - Bakersfield (peak - 155 ug/m3)
  - Fresno (peak – 148 ug/m3)
  - Visalia (peak - 130 ug/m3)
- The highest rural site
  - Pixley (average 28 ug/m3, peak peak 165 ug/m3)
- Rural sites on the outskirts of the Valley had lowest concentrations
- Concentrations much lower in the SFB and SV
  - Average concentration ~ 50% lower than SJV)

Fresno vs. Bakersfield

	Fresno	Bakersfield
PM2.5 Mass		
Average	27.1 ug/m3	26.3 ug/m3
Peak	148 ug/m3	155 ug/m3
Chemical Composition		
Average	60% carbonaceous 30% amm. nitrate	40% carbonaceous 40% amm. nitrate
Peak	50% carbonaceous 40% amm. nitrate	30% carbonaceous 60% amm. nitrate

Day-to-Day Variations PM2.5 Mass

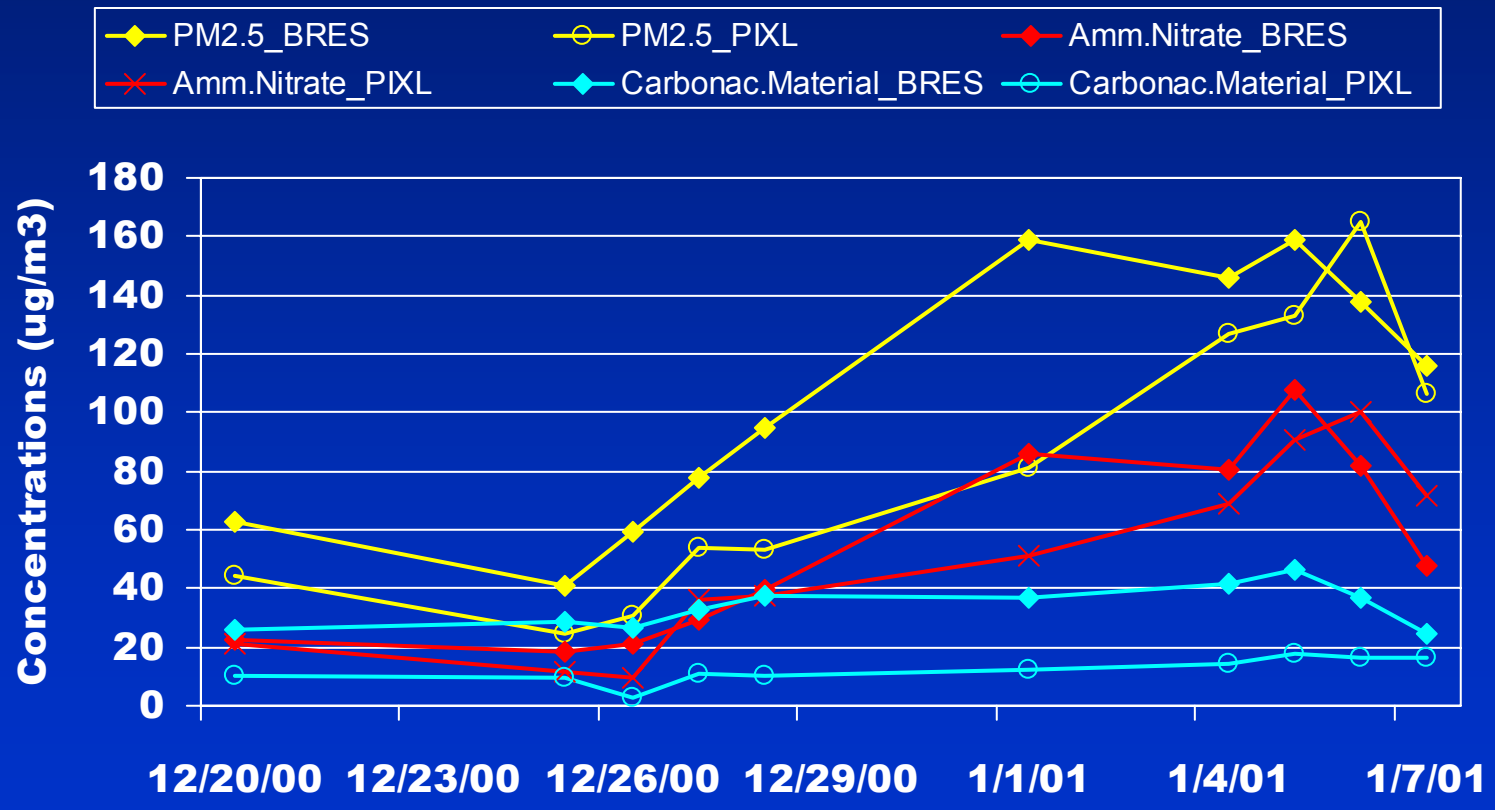
- Concentrations become more uniform as the episode progresses

	Dec 1999	Dec 2000
Most Uniform Day	12/26/99	1/6/01
Concentration Range	71 ug/m3 to 115 ug/m3	82 ug/m3 to 165 ug/m3
Coefficient of Variation	16%	20%

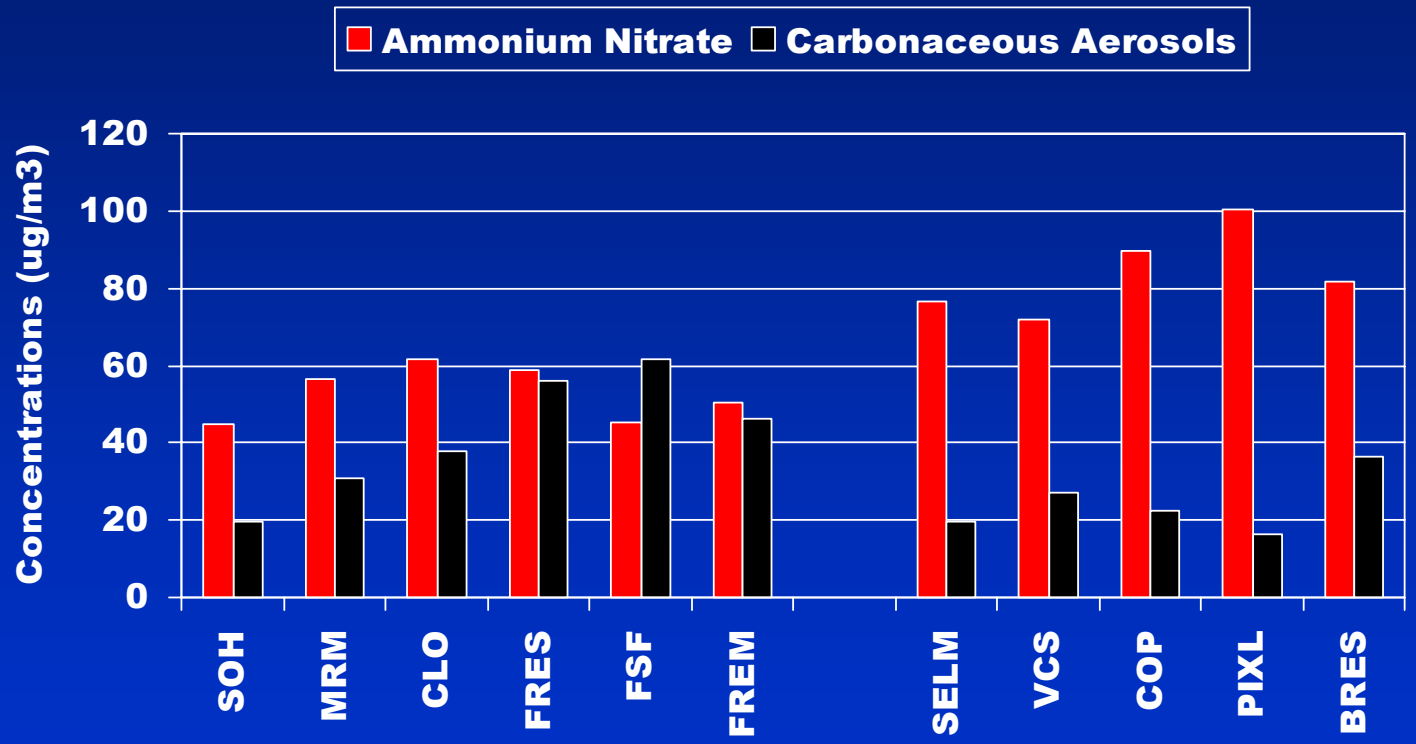
Day-to-Day Variations Chemical Components

	Ammonium Nitrate	Carbonaceous Aerosols
Spatial Variations	- Latitude dependent (increase from north to south) - Subregions with fairly uniform urban and rural concentrations	- Character dependent (higher at urban sites than rural) - Significant variations from site to site
Temporal Variations	- Decrease with time - Meteorology driven - >60% in Dec. 2000	- Vary from day to day - Emission driven - ~ 30% in Dec. 2000

Temporal Variations



Spatial Variations



	Avg. Conc. (ug/m3)	COV	Avg. Conc. (ug/m3)	COV
Ammonium Nitrate	53	13	84	13
Carbonaceous Aerosols	42	38	24	32

Diurnal Variations

	Fresno	Bakersfield	Angiola
BC	Small morning peak (7-8 am) Large evening peak (7 pm to midnight)		Flat
Nitrate	Midmorning peak (10-11 am) Evening peak (7 pm to midnight)	Midmorning peak (10am to noon)	Morning increase (10 am to noon)
PM2.5 mass	Small morning peak Large evening peak	More pronounced morning peak Large evening peak	Morning increase with a midday maximum
Particle count	Very small morning peak Very pronounced evening peak (9 pm)		Morning peak Smaller evening peak

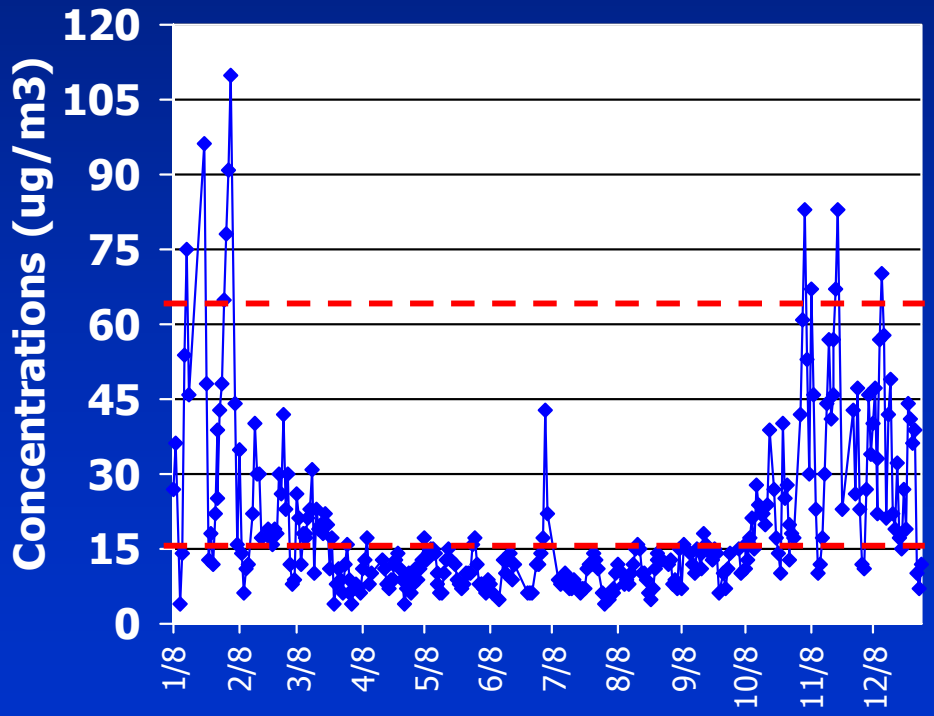
Task 2.4
[STI]

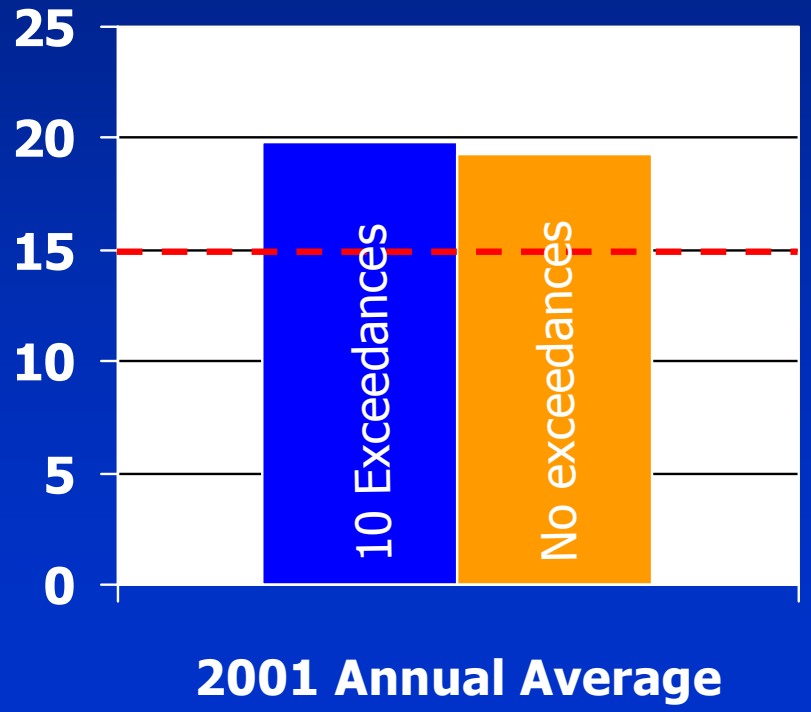
- Highest PM2.5 concentrations
  - On the Valley floor within three to five hundred meter above see level
- Background PM2.5 concentrations
  - 1.5-3.5 ug/m3 annually
  - 1-2 ug/m3 during winter
- Boundary
  - Elevated sites substantially cleaner (concentrations <1/2 of the Valley floor)

Task 2.6
[DRI/ARB]

- Annual standard controlling
- 50-75% of the annual average can be attributed to a high PM2.5 period from November to January (DRI)
- Based on the most recent years the % is lower (40-50%)

Controlling Standard
Fresno, 2001





Task 2.7-Correlation Between O3 and PM2.5

- Annual
  - No correlation
    (O3 – summer, PM2.5 - winter)
- Seasonal
  - Rural – some correlation in winter
  - Urban – some correlation in summer

Winter Average Diurnal Profiles

- Peak $PM_{2.5}$ occurs during the day in Angiola (same phase as O_3)
- Peak $PM_{2.5}$ occurs at night in Fresno and Bakersfield (out of phase with O_3)