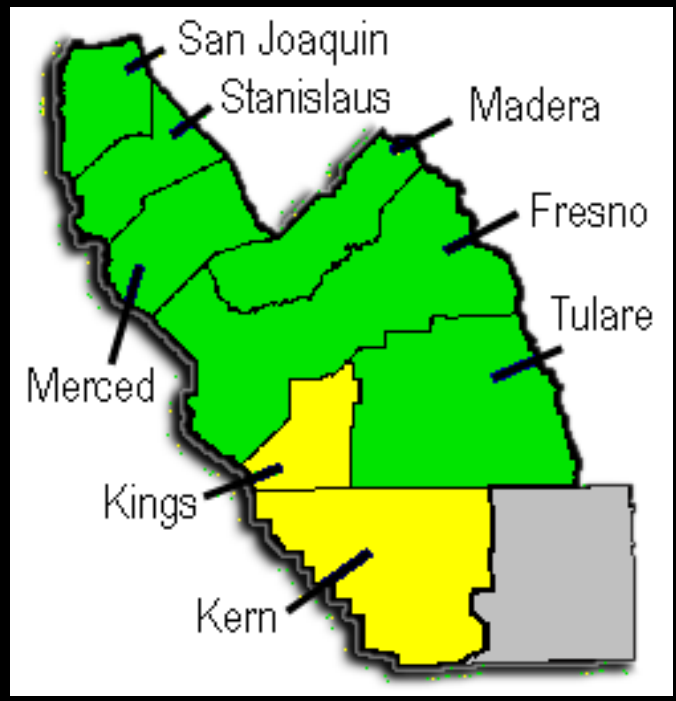
Air Quality Forecasting and Trends

CSUF Air Quality Management Certificate Program 10/20/2006



Presented by:

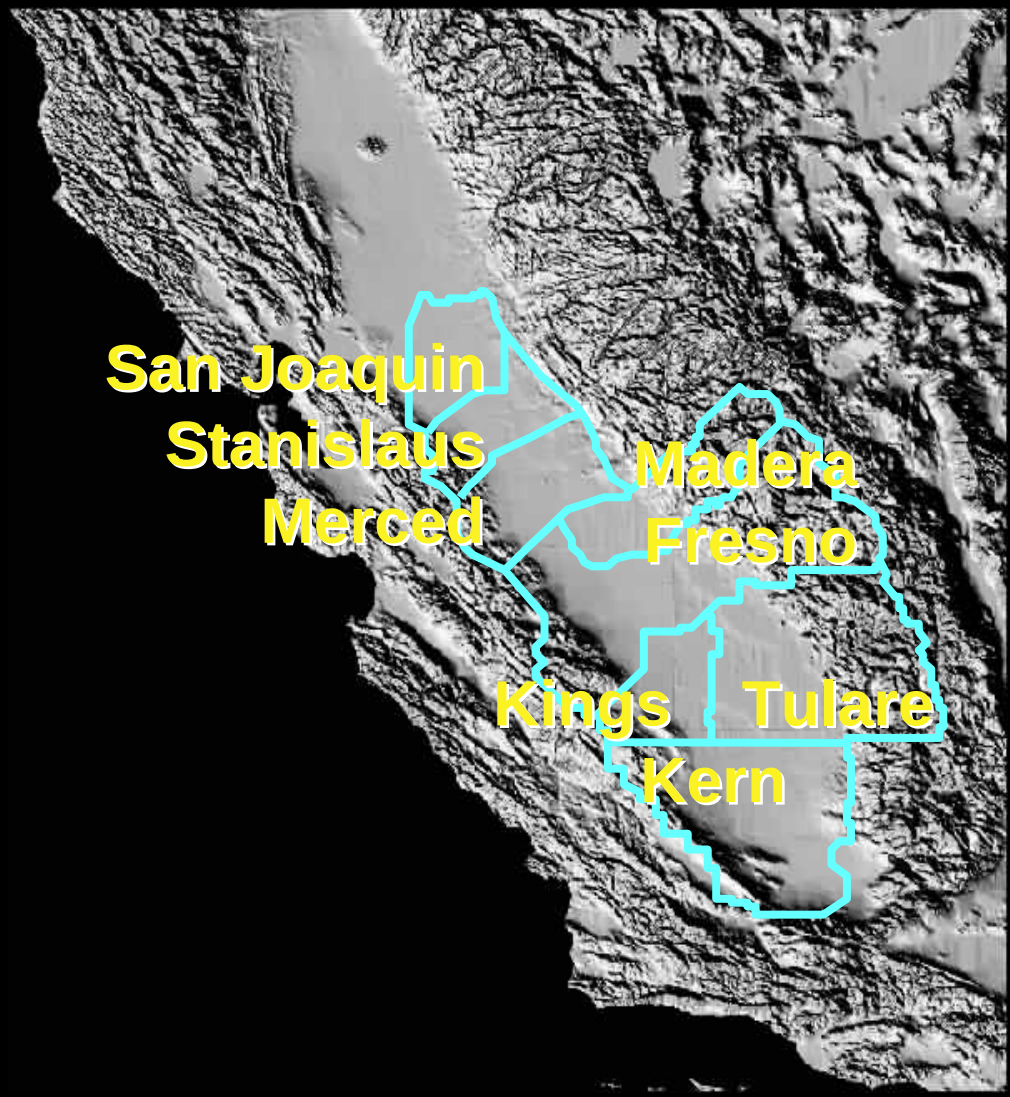
Shawn R. Ferreria

Project Planner / Atmospheric Scientist

Air Pollution Meteorology and Trends in the San Joaquin Valley

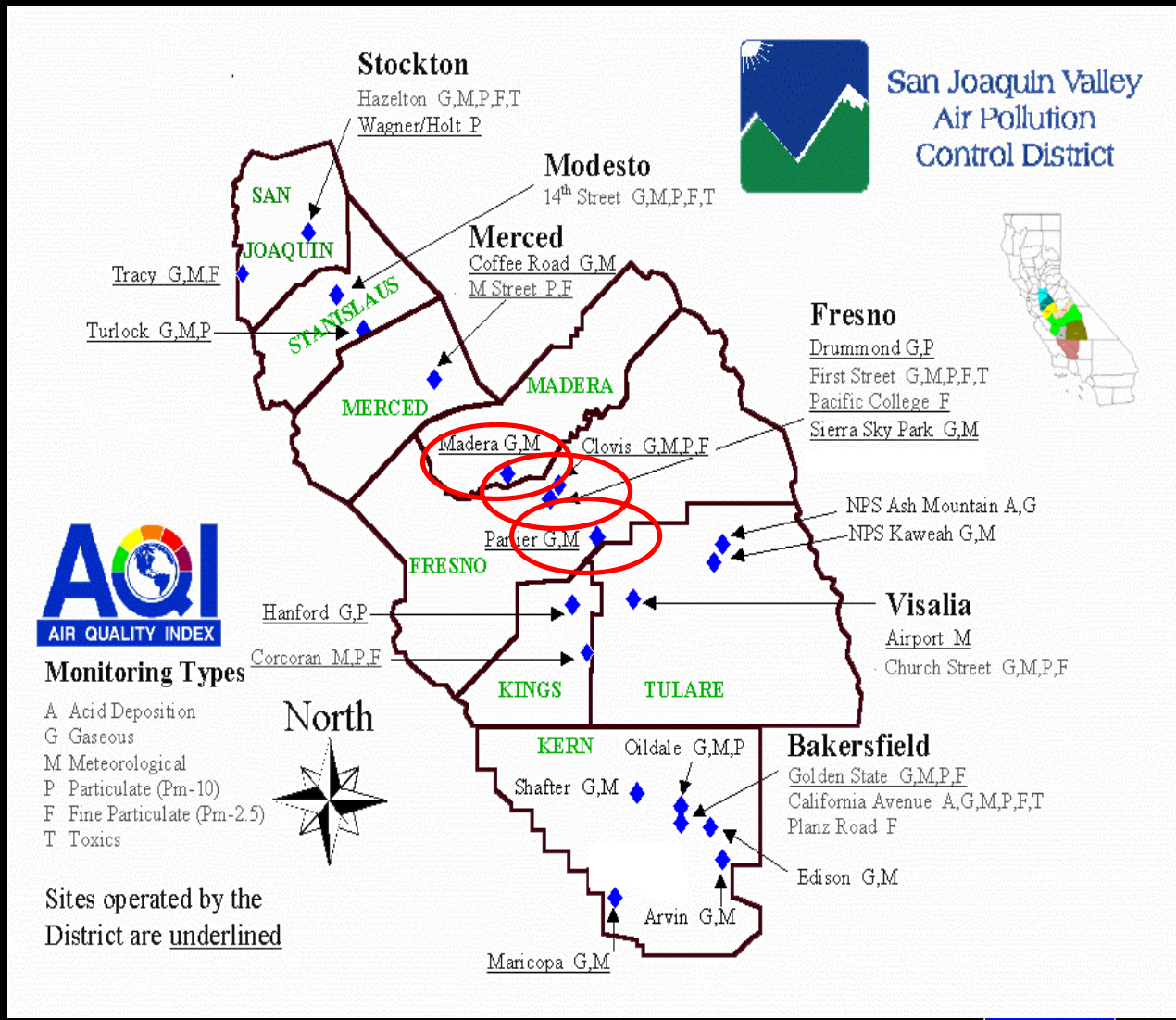
- Air Monitoring Sites
- Dispersion, Transport, and Formation of Air Pollutants
- Meteorology during high Ozone and Particulate concentrations
- Large Scale and Middle Scale Weather Systems
- Forecasting Resources and Process
- Air Quality Trends

San Joaquin Valley Air Basin



Air Monitoring Sites

- Population Exposure
- Highest Concentration
- Source Apportionment
- Special Modeling and Air Quality Analyses



San Joaquin Valley Air Monitoring Sites#

Monitoring Site	Ozone	PM10*	PM2.5*	Meteorology
Stockton Wagner - Holt		x		
Stockton Hazelton	x	x	x	x
Tracy - Airport	x	x	x	x
Modesto	x	x	x	x
Turlock	x	x	x	x
Merced M Street		x	x	
Merced Coffee	x			x
Madera	x			x
Fresno Sierra Sky Park	x			x
Clovis	x	x	x	x
Fresno - 1st	x	x	x	x
Fresno - Drummond	x	x		x
Fresno Pacific Univ			x	
Parlier	x			x
Visalia - Church	x	x	x	x
Visalia - Airport				x
Ash Mountain	x	x		x
Lower Kaweah	x			x
Hanford	x	x		x***
Corcoran		x	x	x
Shafter	x			x
Oildale	x	x		x
Bakersfield - Golden	x	x	x	x
Bakersfield - Calif.	x	x	x	x
Bakersfield - Planz			x	
Arvin	x			x
Edison	x			x
Maricopa	x			x

Updated: 10/20/2006

#- Includes SJVAPCD, CARB, and National Park Service Air Monitoring Sites

* - **Includes Filter Based and Real Time Data**

*** - Planned Met. Tower installation next 6 months

New air monitoring sites at Huron and Tranquility to be installed within the next year.

Forecasting Air Quality

Need to predict changes in:

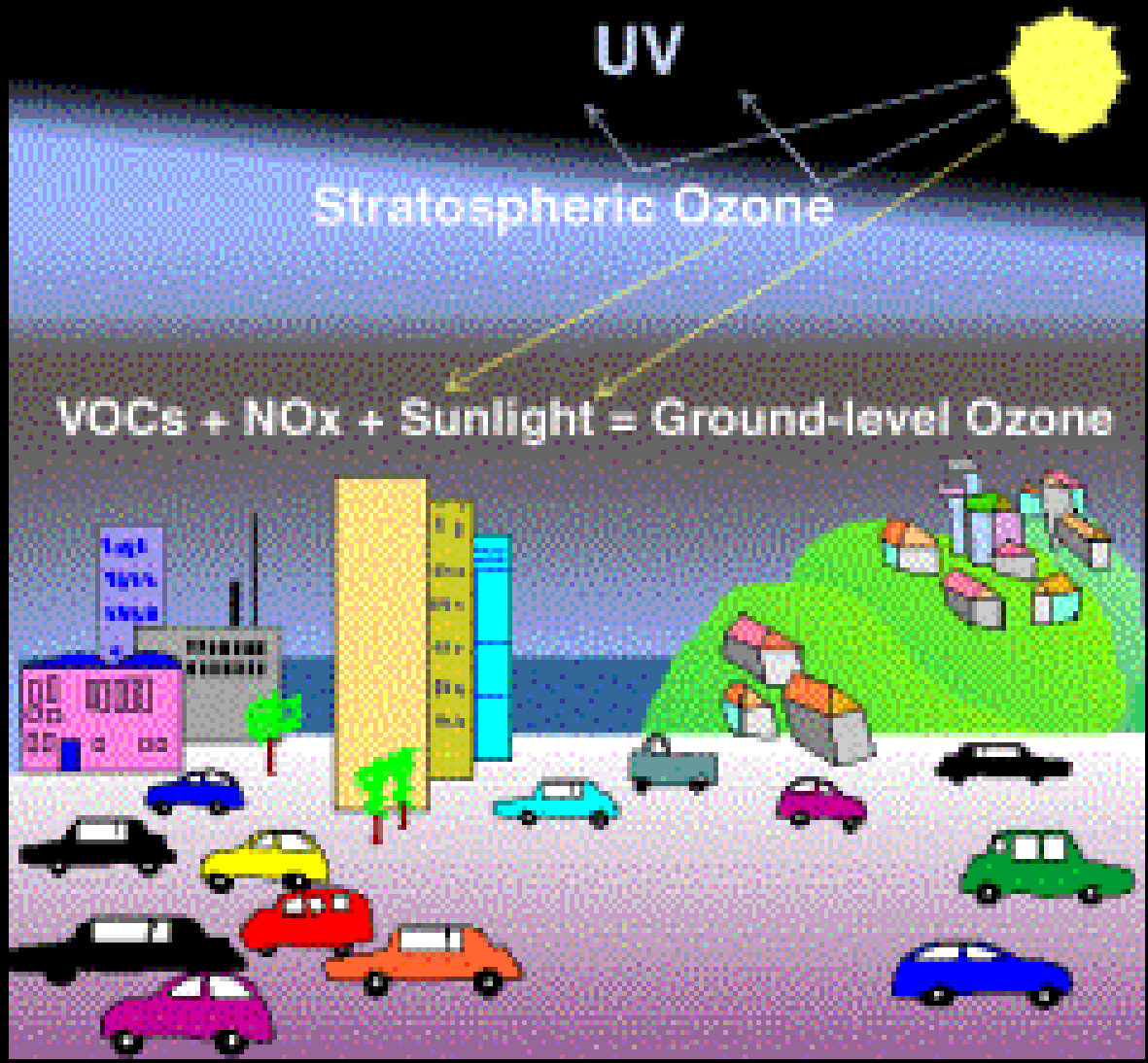
- **Atmospheric Chemistry**
- **Weather**
- **Emissions**
- **Human Behavior**

Atmospheric Chemistry

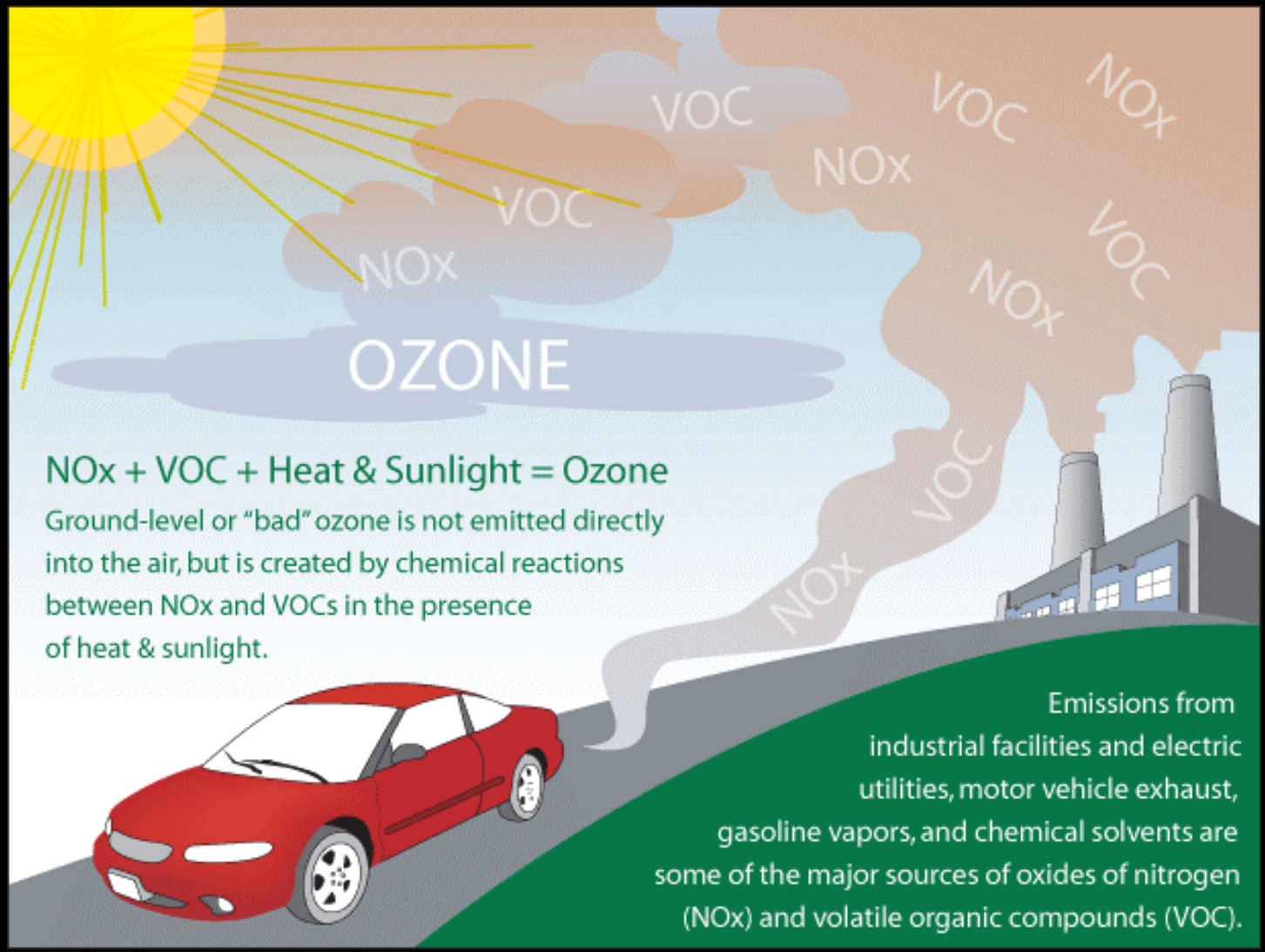
The forecaster predicts variations in:

- Ozone
- Particulate Matter

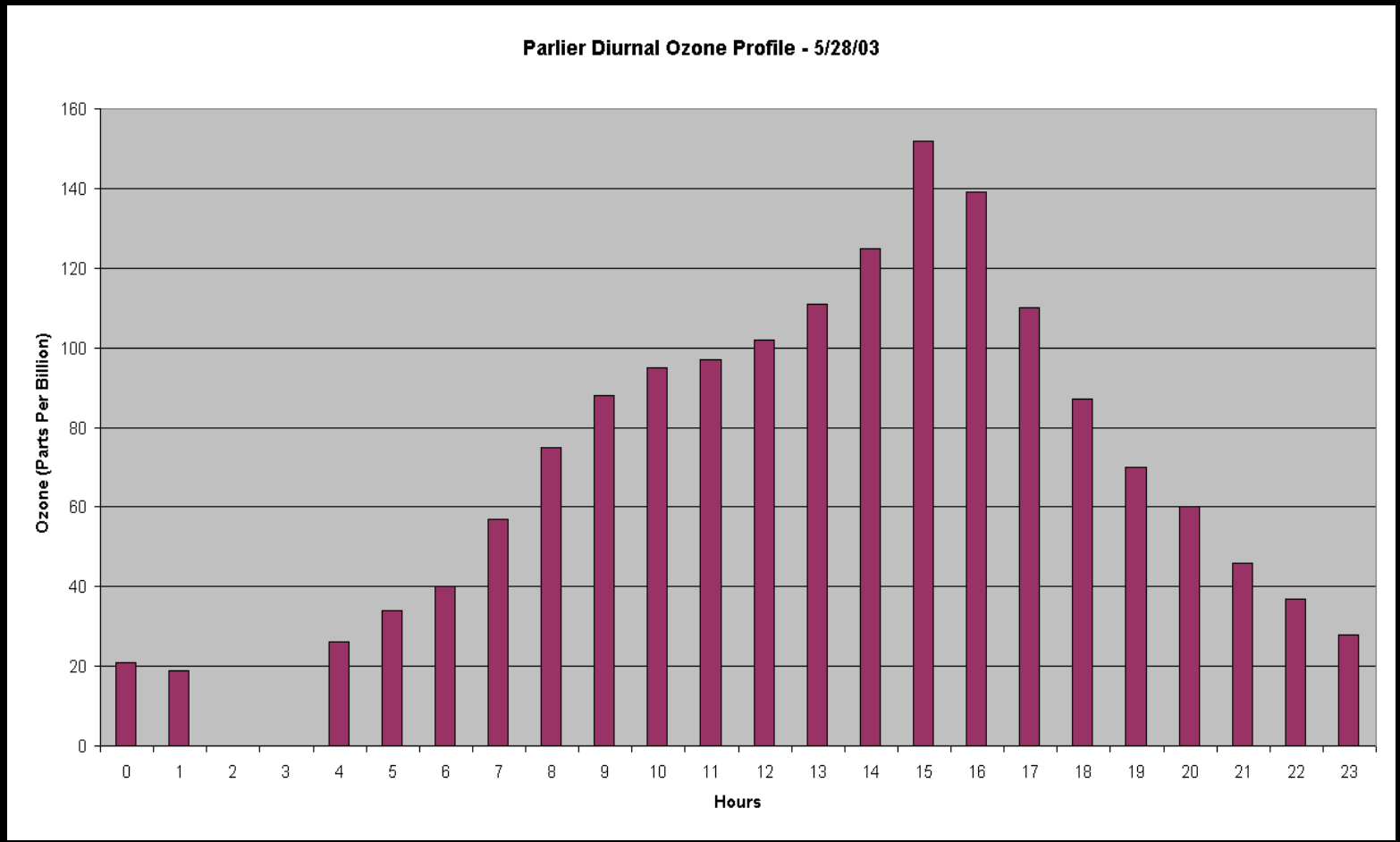
Ground Level Ozone



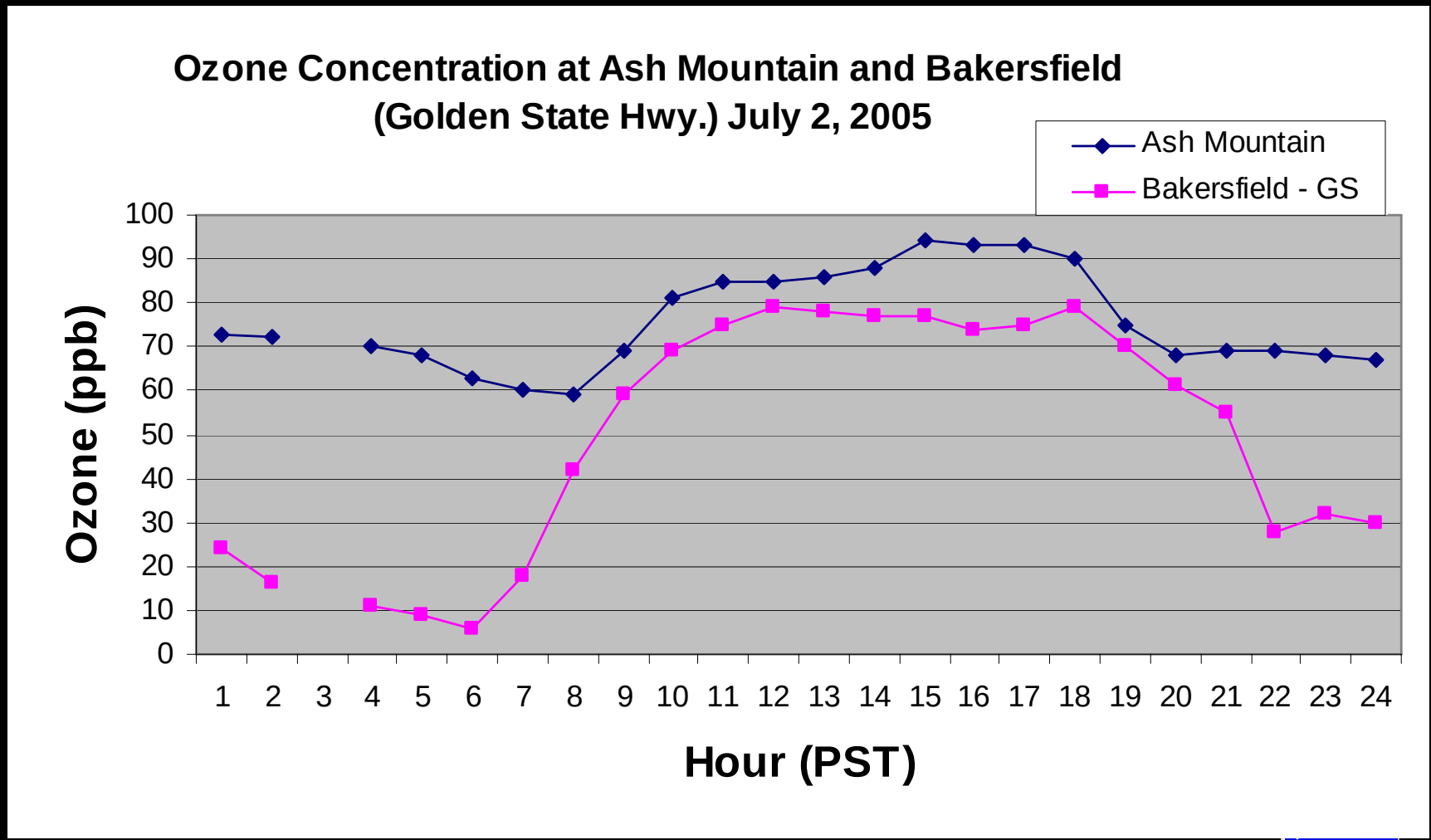
Ozone Formation



Ozone Concentration Profile



Ozone concentrations vary by time of day and location.



Particulate Matter

- Concentrations can gradually build during stagnant conditions
- Concentrations can increase rapidly during wind blown dust events and wildfires
- Concentrations can vary with time of day

Particulate Matter Comes From Many Sources

Natural

Wind Blown Dust

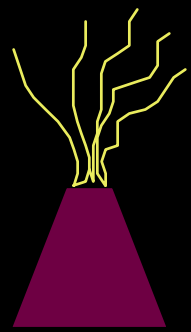
(Undisturbed Soil)

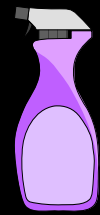
Wildfires

Man Made

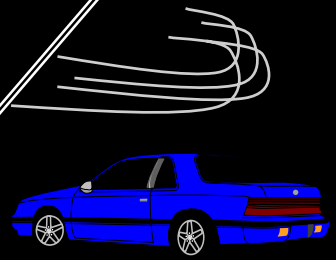
Wind Blown Dust

(Disturbed Soil)

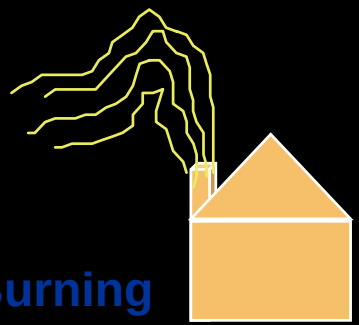




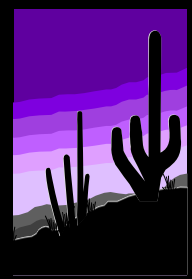
Industrial Sources



Automobiles

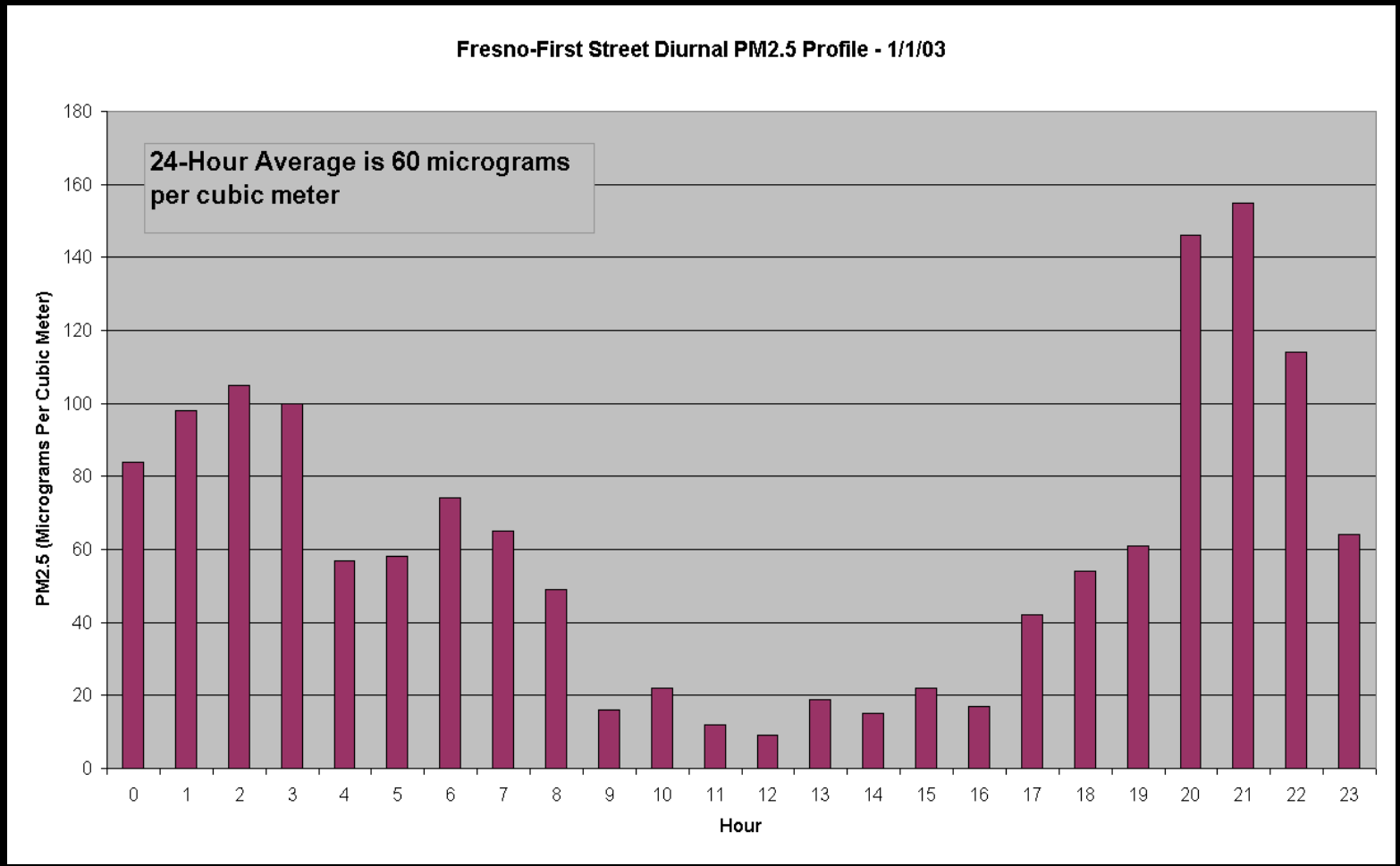


Wood Burning



Disturbed Soil

Diurnal PM2.5 Profile



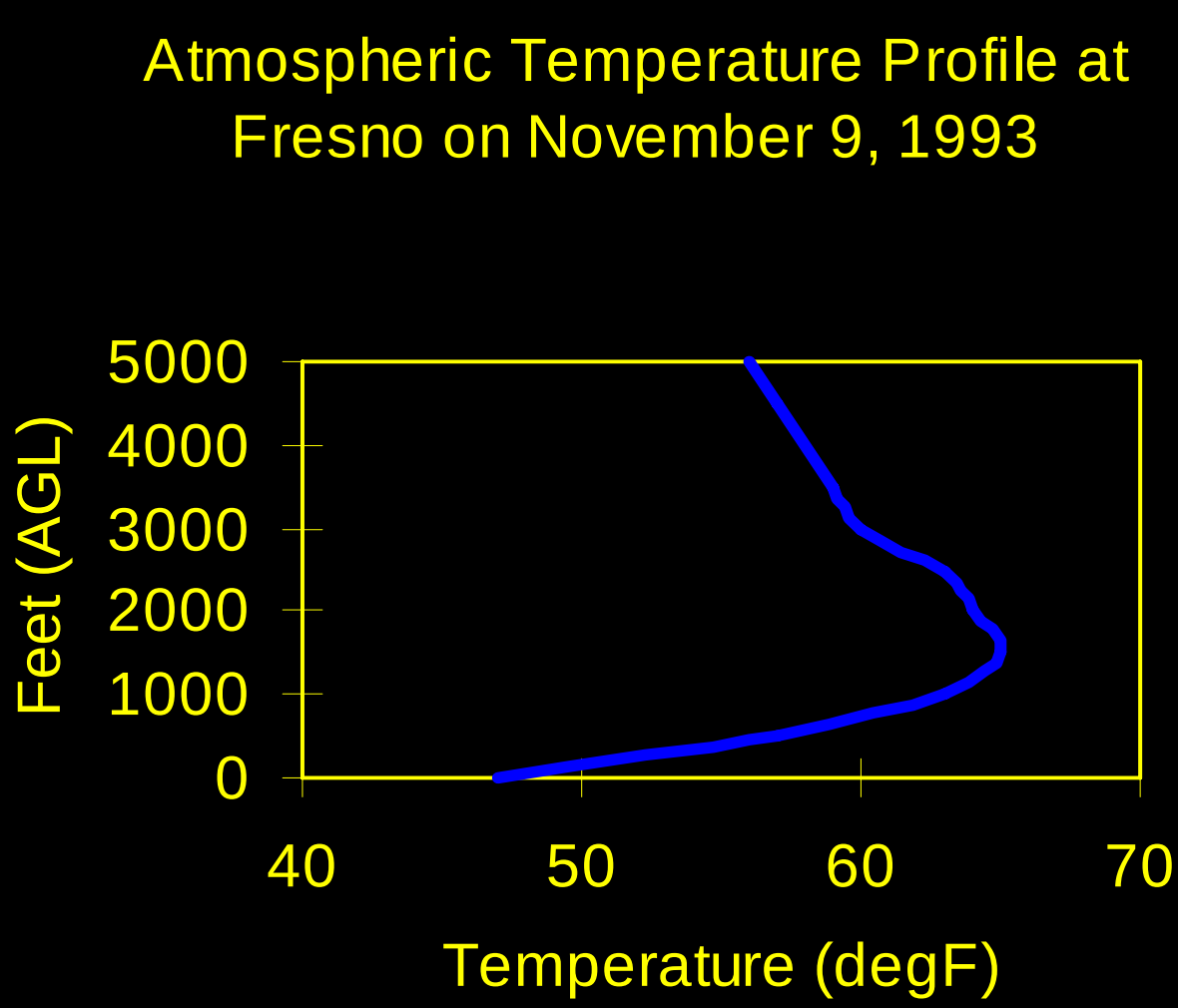
Weather Forecasting

What weather conditions influence air quality?

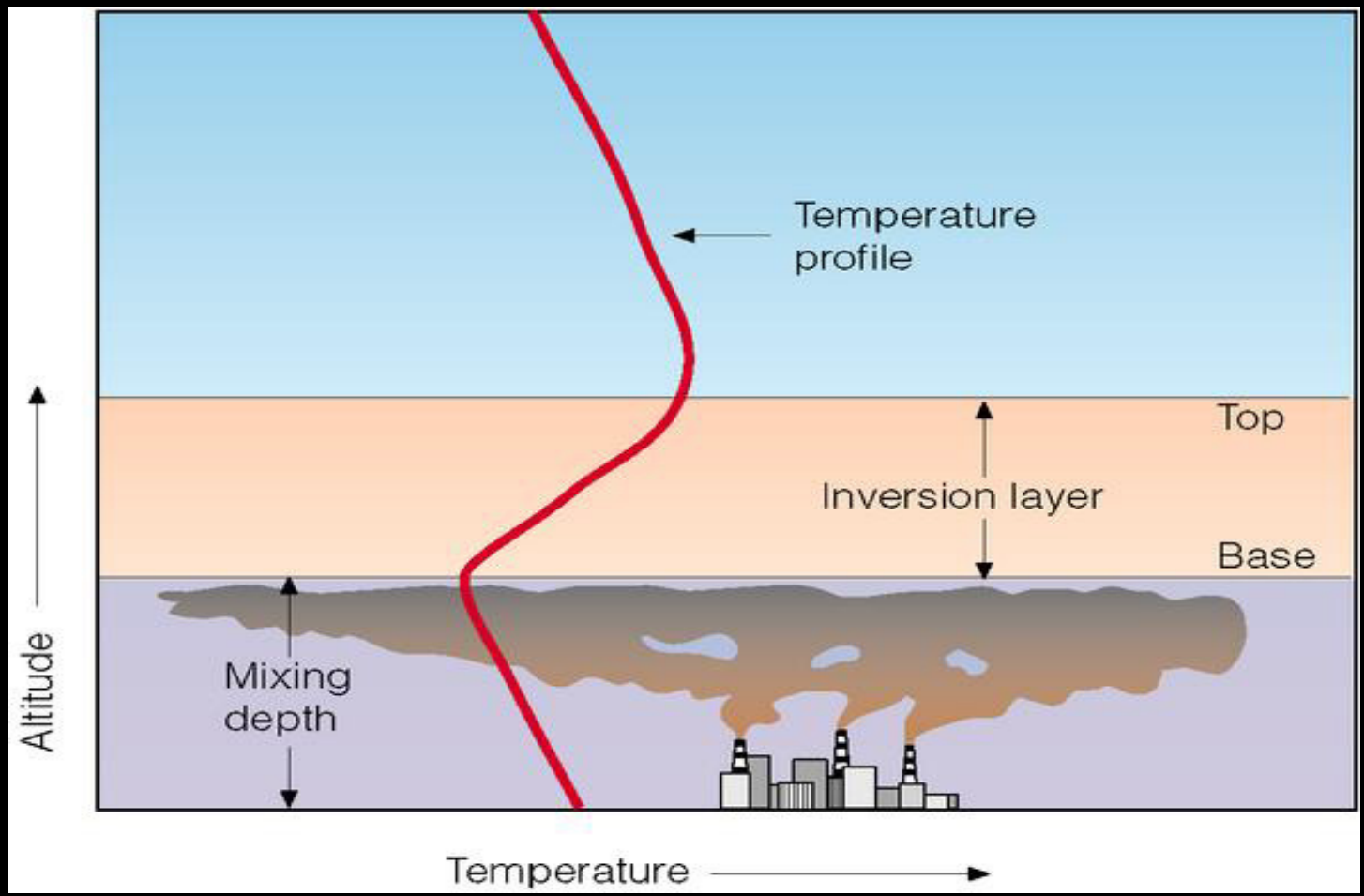
Weather Patterns Associated with Poor Air Quality

- Stagnant Conditions
- High Pressure
- Weak Pressure Gradients
- Weak Surface Winds
- Subsidence Aloft
- Temperatures Inversions

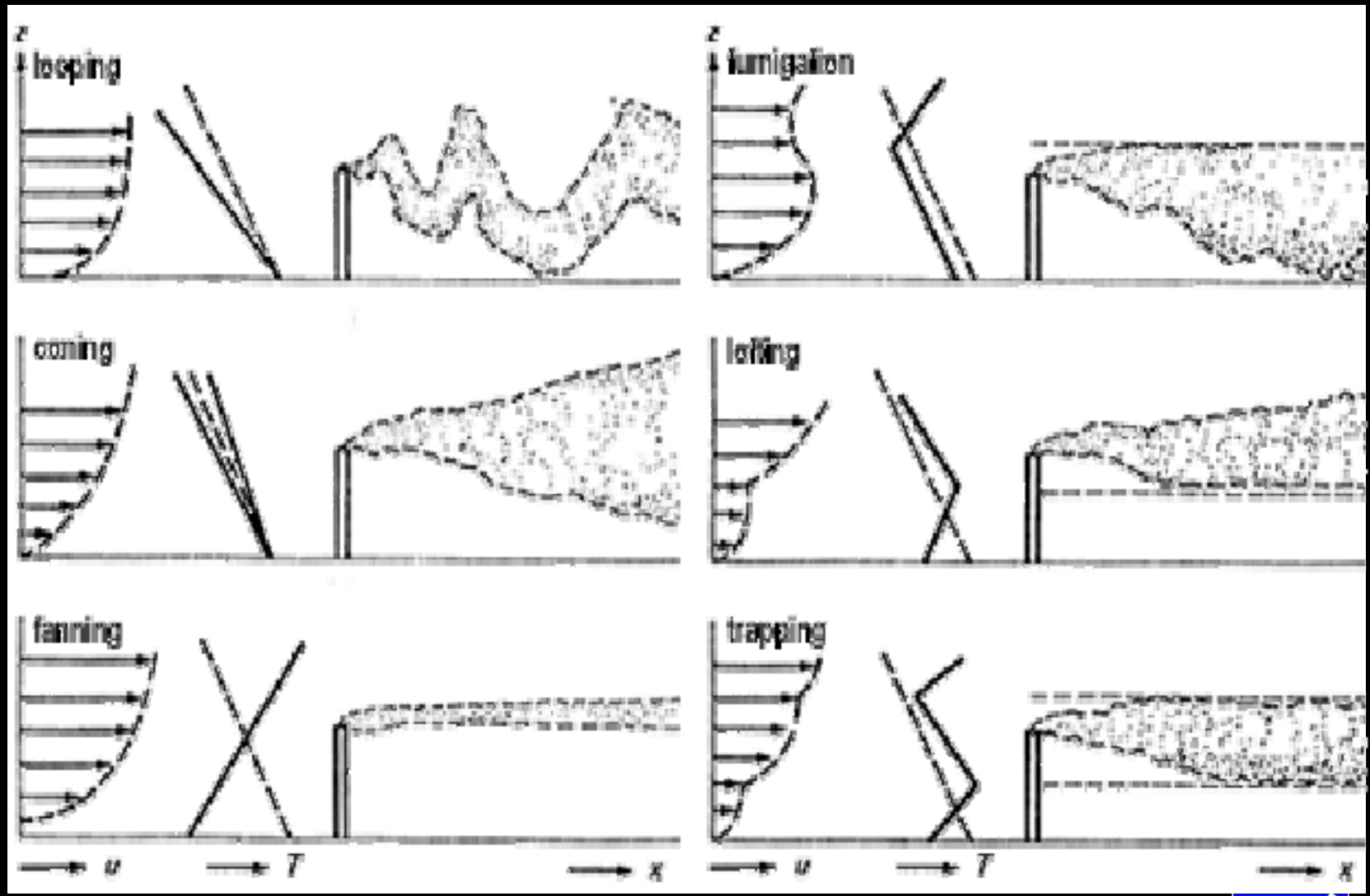
Temperature inversion during a period of high particulate concentrations



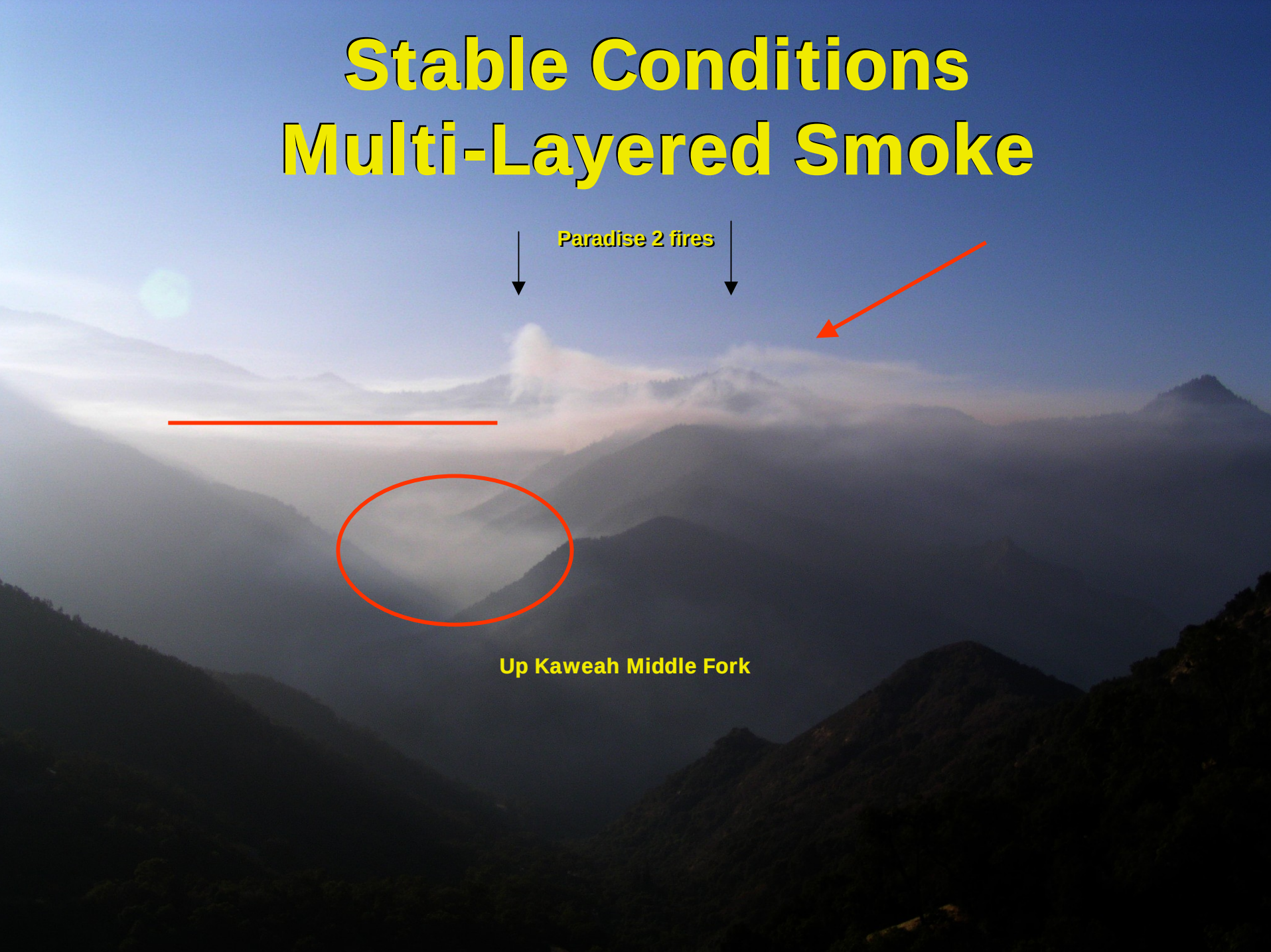
Temperature Inversion



Plume Behavior and Lapse Rate



Stable Conditions
Multi-Layered Smoke



What weather conditions influence particulate matter concentrations?

- Long periods of stagnation
- Light winds
- Poor dispersion
- Temperature inversions

Winter Stagnation

What weather conditions influence ozone concentrations?

- Cloud cover
- Winds
- Poor dispersion
- Inversion strength

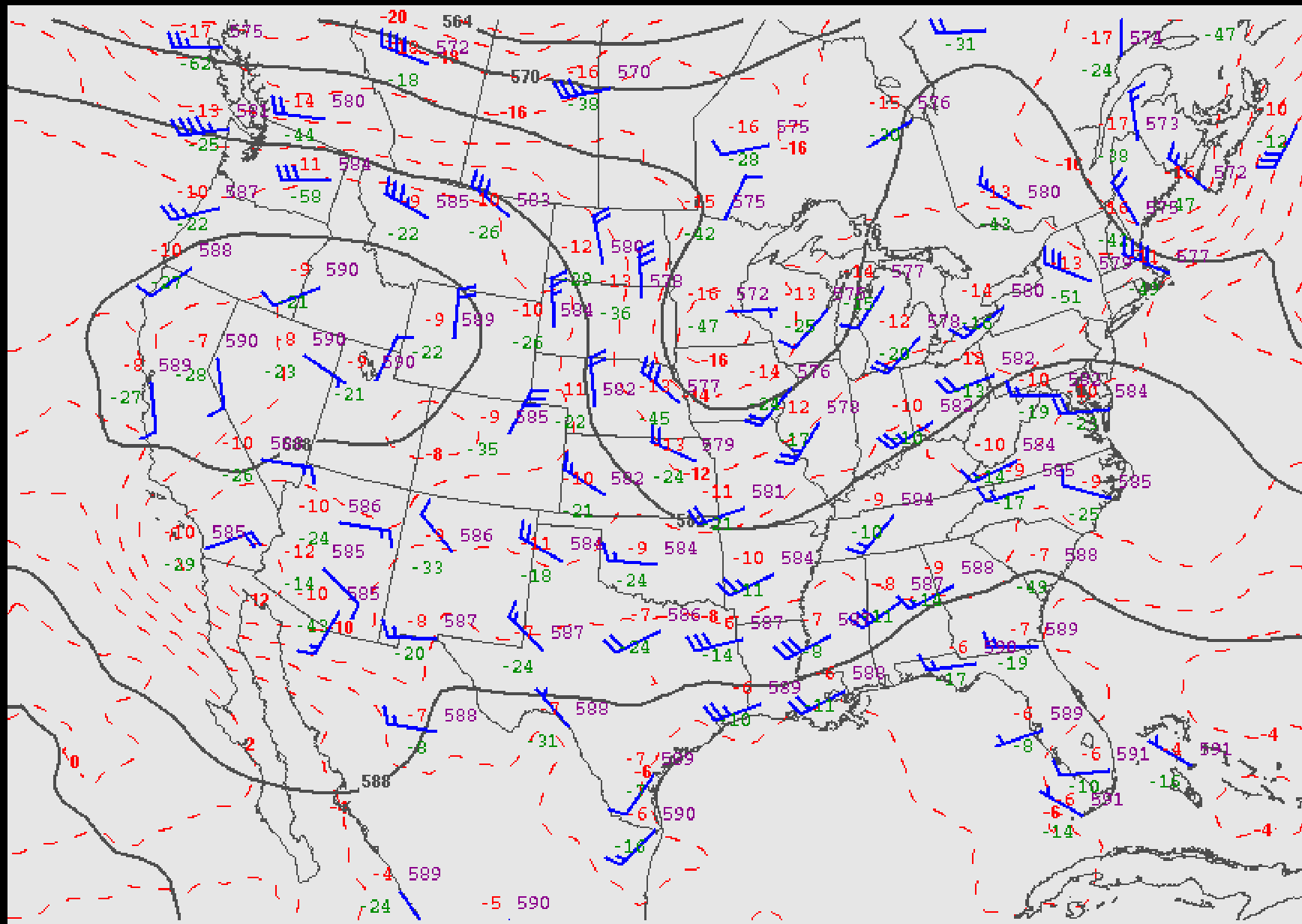
Forecasting Resources

- Weather Models
- Air Quality Models
- Satellite Images
- Web Cameras
- Local Observers (Fire Lookouts, Inspectors)
- Air Quality and Weather Data
- Regional Air Quality Studies

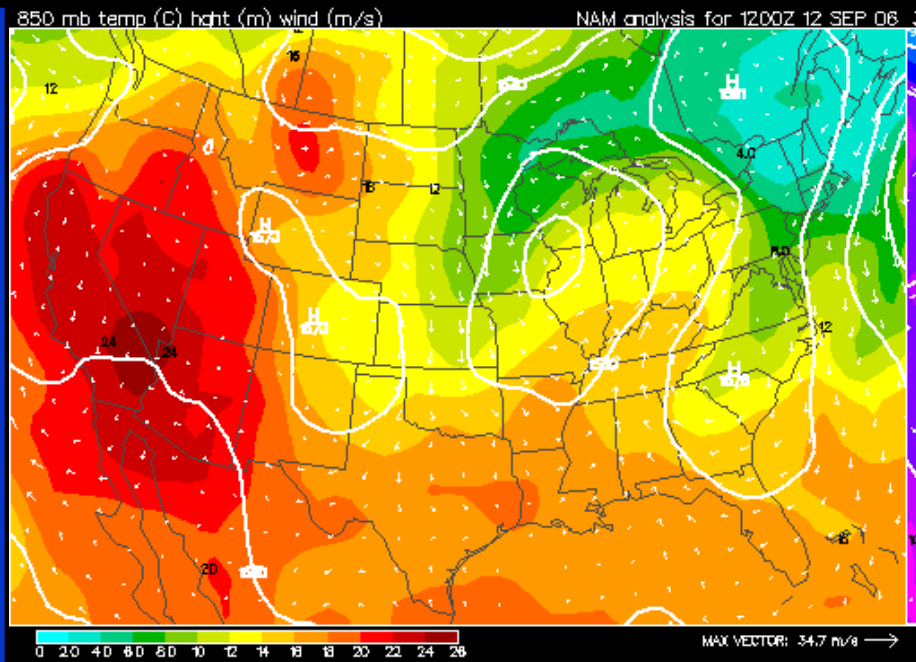
Data Sources to Assess Upper Air Transport and Dispersion

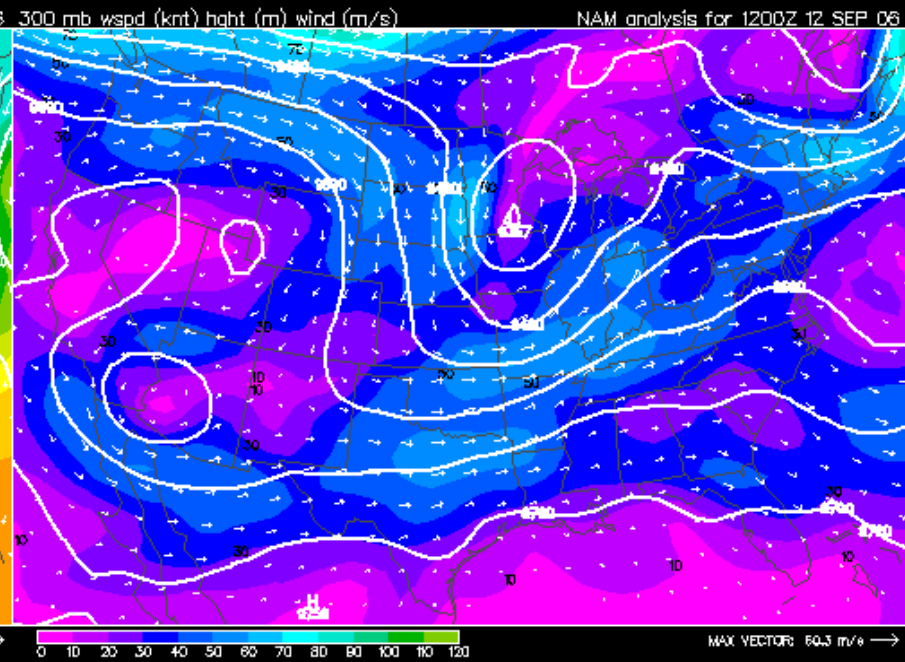
- Oakland and Vandenburg RAOB's
- CARB Aircraft Sounding
- CARB Pibal
- Lower Air Profilers
- Satellite Sounding Data (GOES)

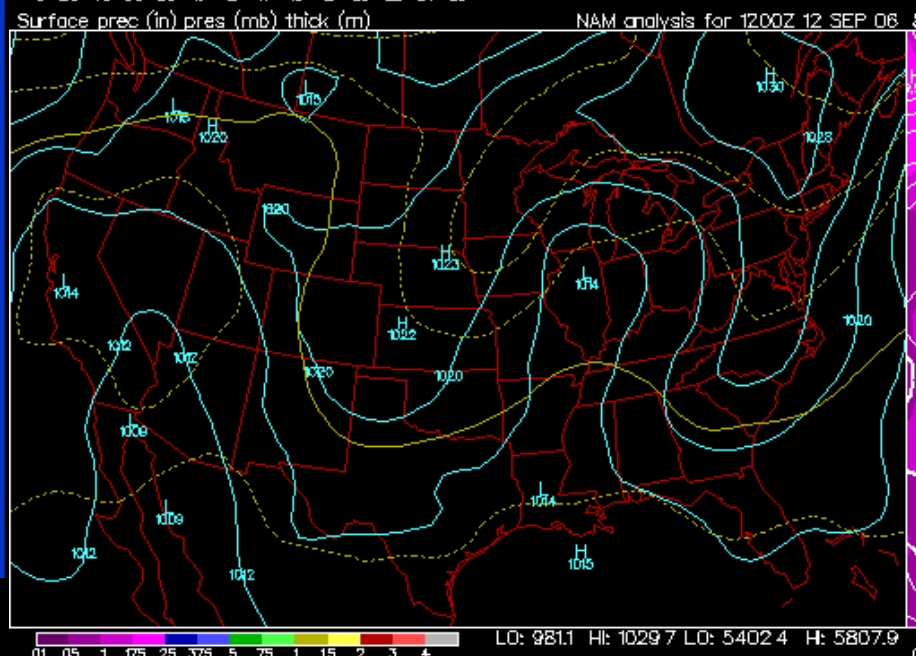
Synoptic Pattern for September 12, 2006 1 Hour Ozone Levels 131 ppb at Arvin

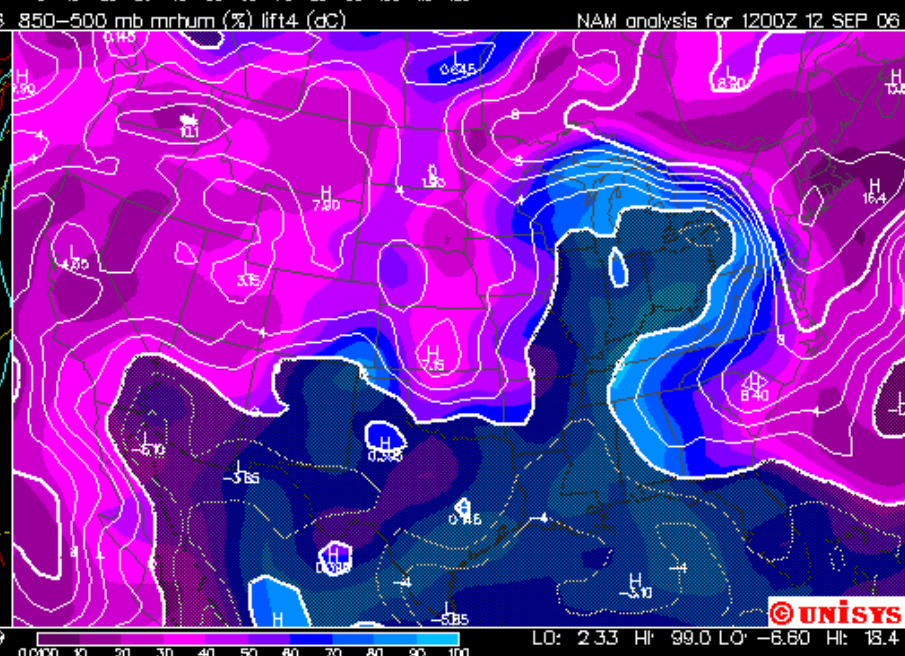


Synoptic Pattern of September 12, 2006 1 Hour Ozone Levels 131 ppb at Arvin

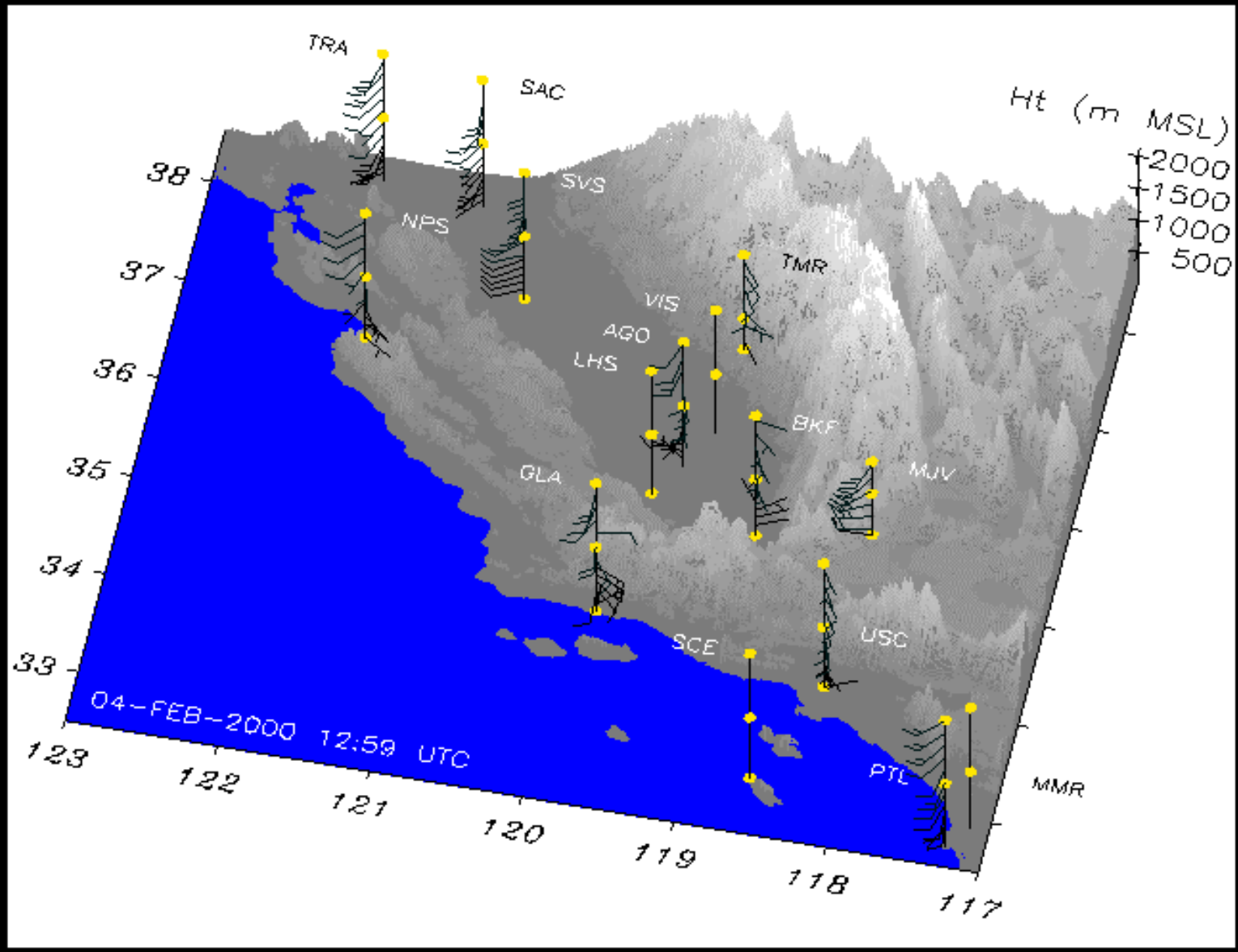




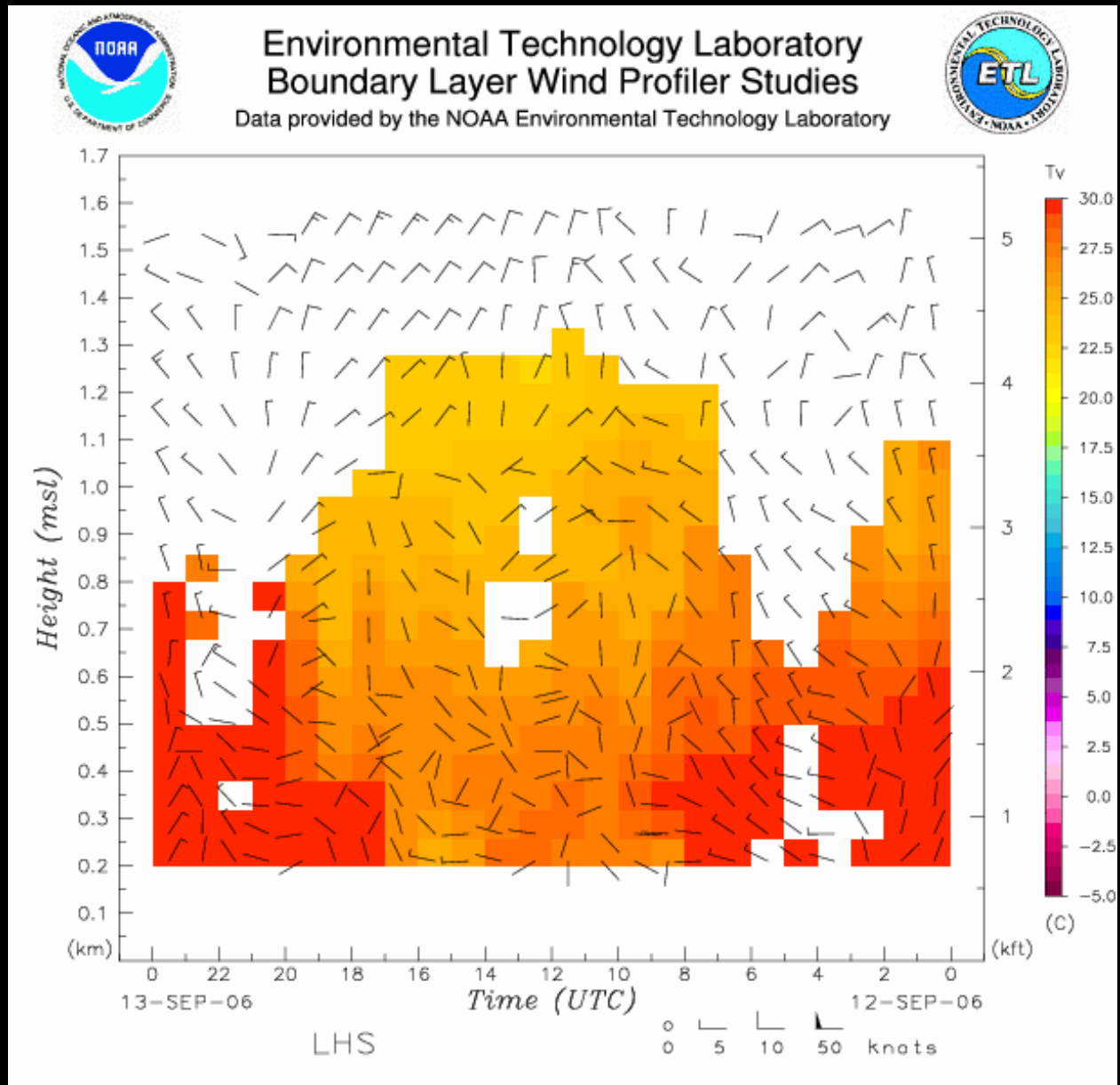




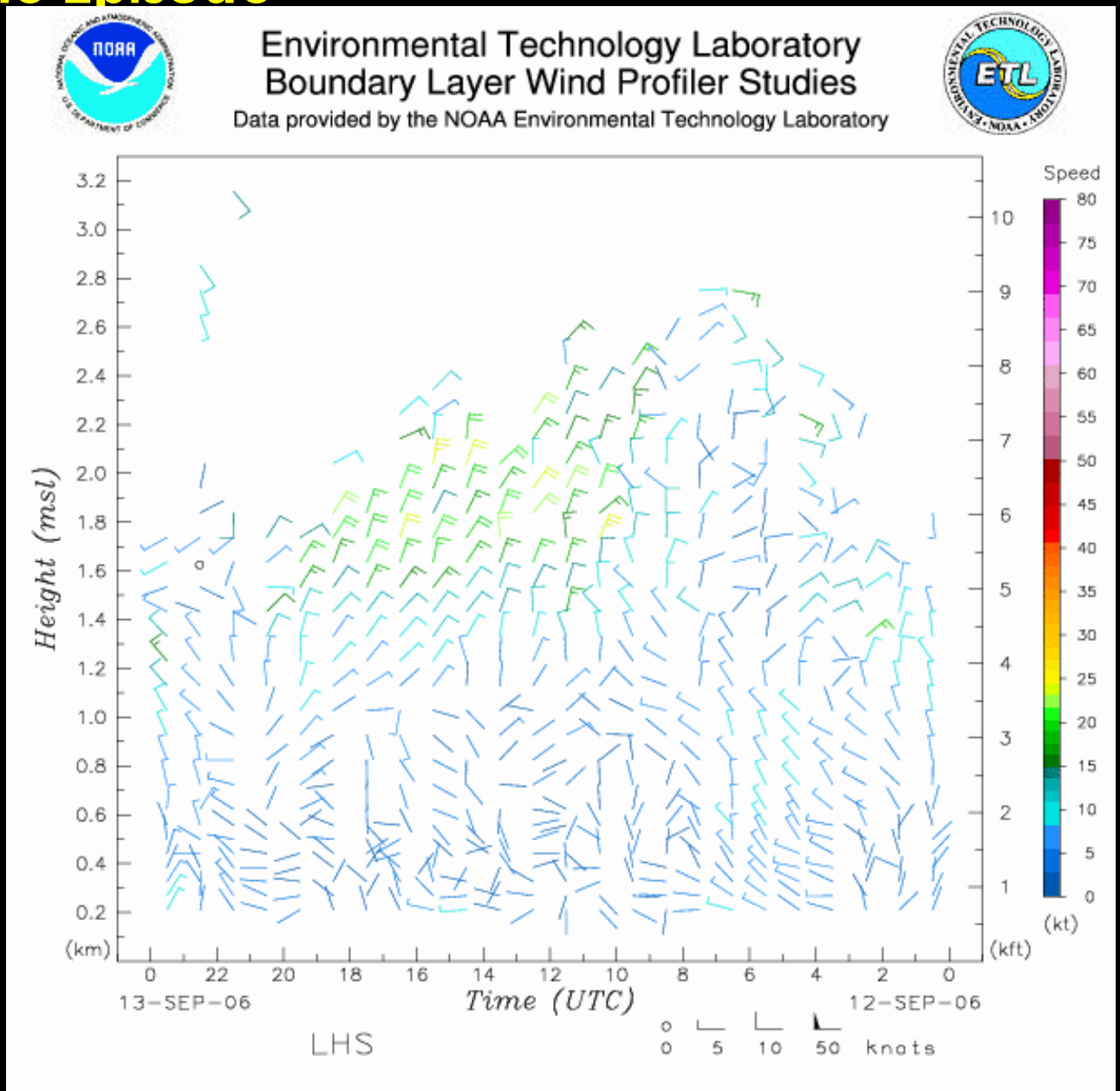
Wind Profile



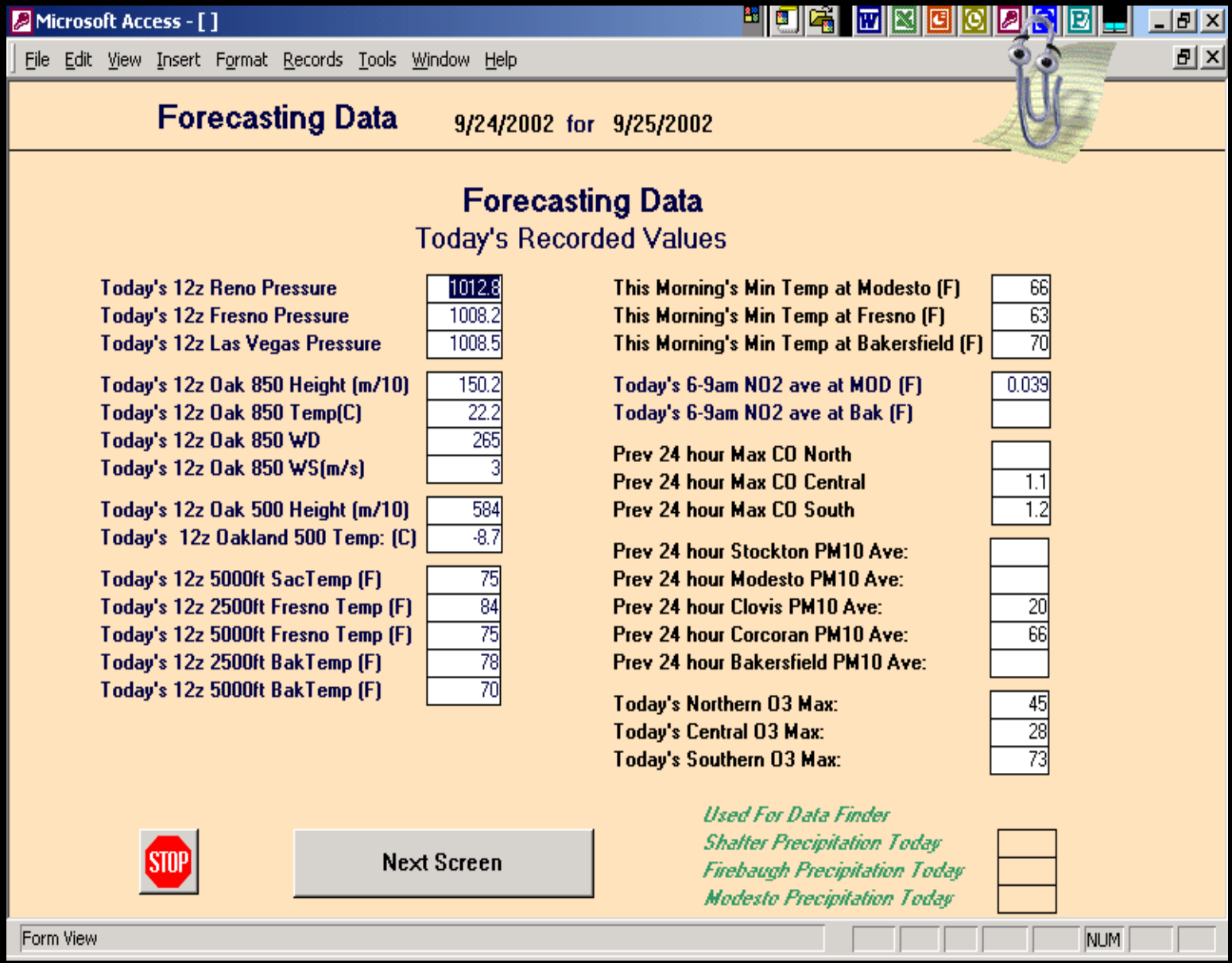
Temperature Profile At Lost Hills on September 12, 2006, Ozone Episode



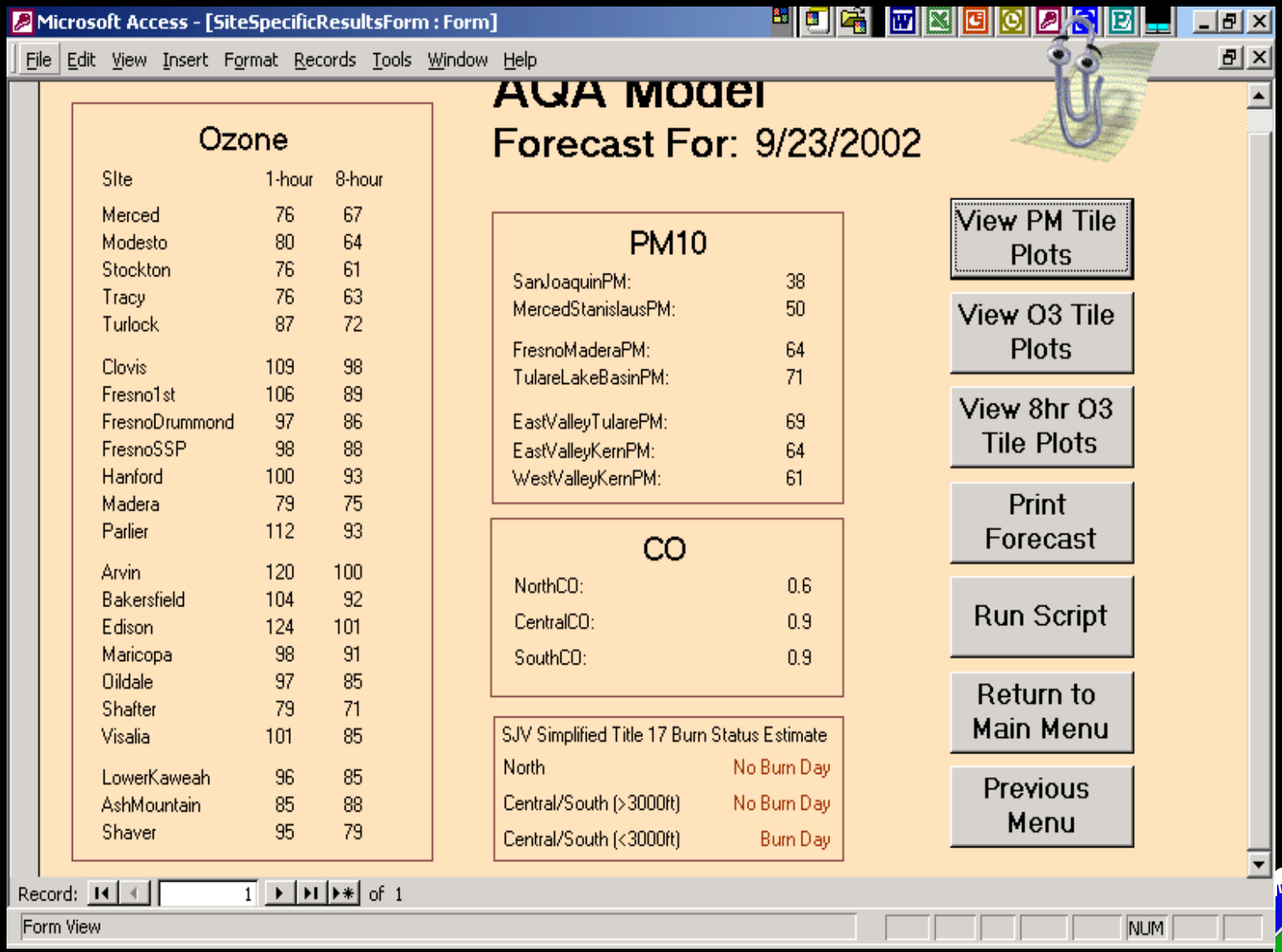
Wind Profile At Lost Hills on September 12, 2006, Ozone Episode



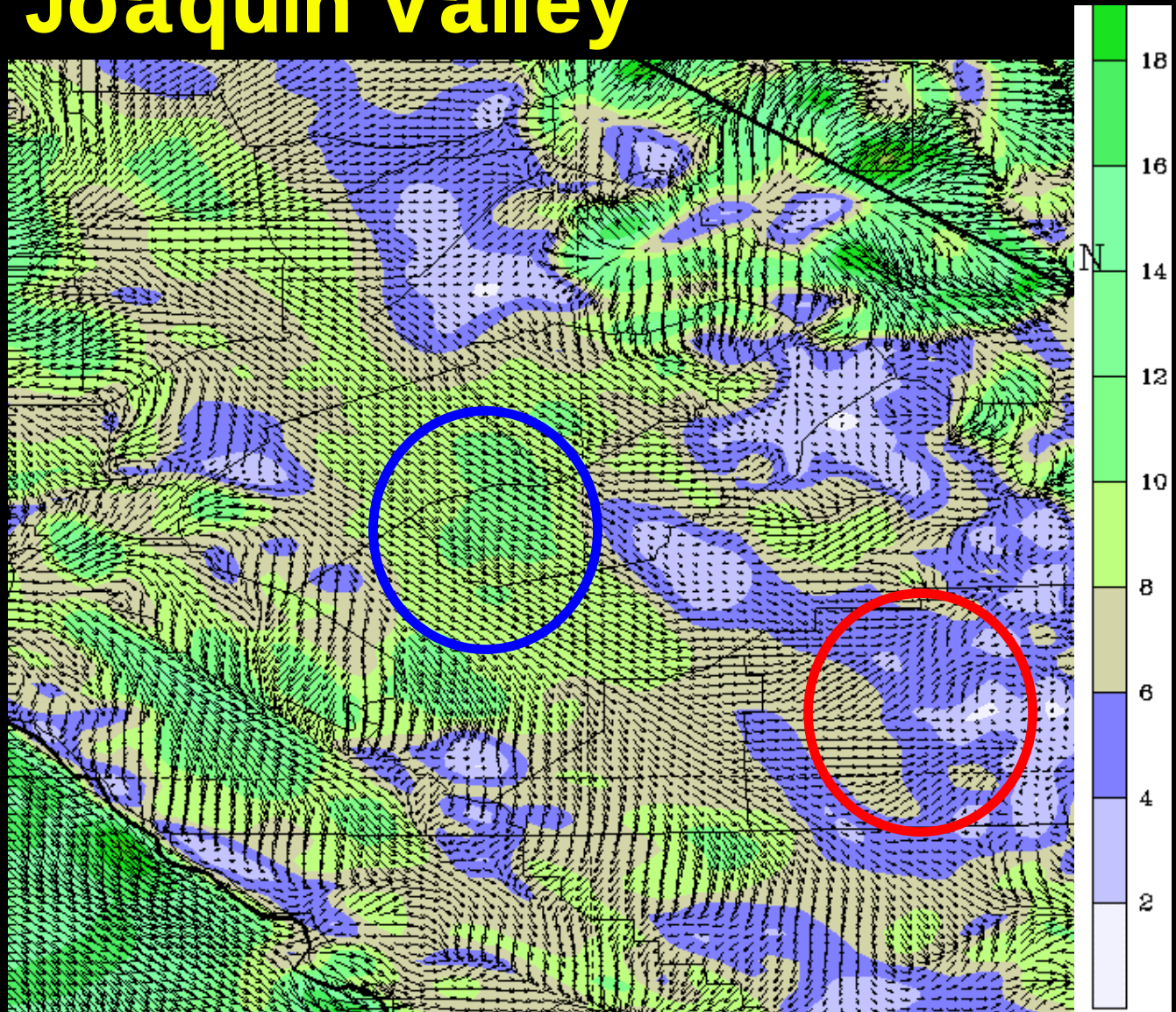
Air Quality Model – Input Screen



Air Quality Model - Output



Small Scale Weather Model Specifically Designed for the San Joaquin Valley

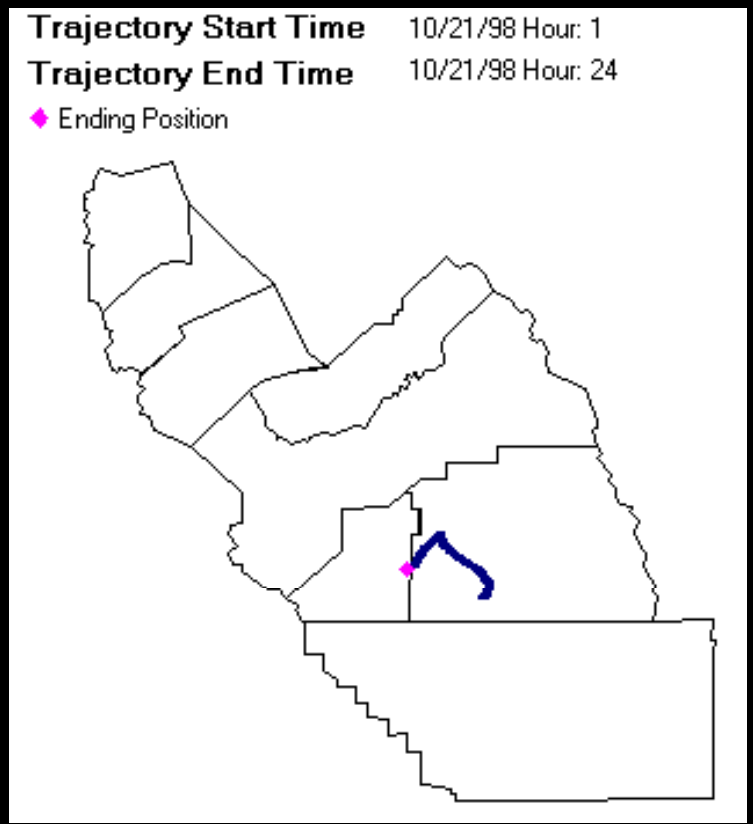


Web Camera

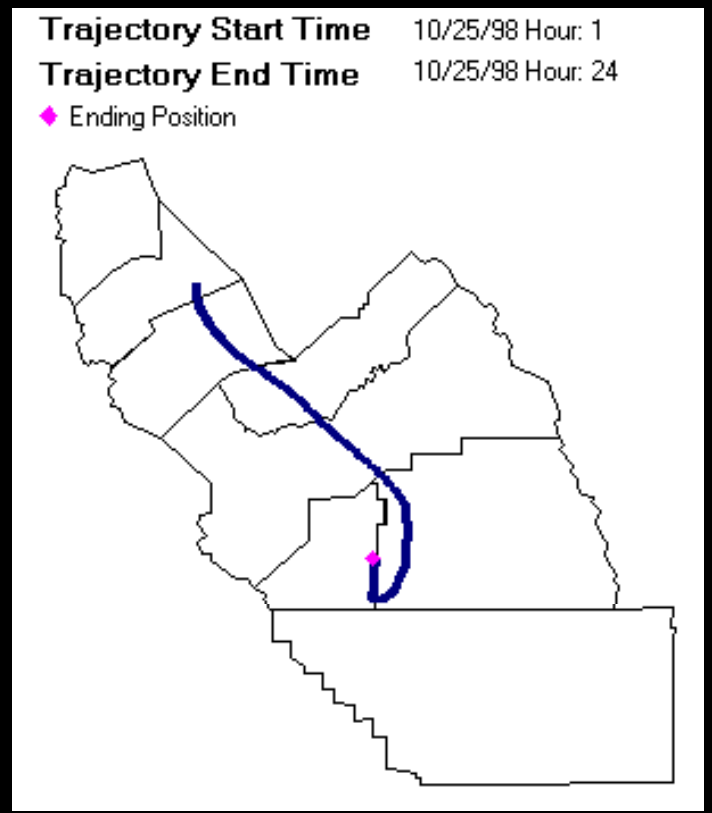
Synoptic Weather Pattern Associated Poor Dispersion and High Ozone and Particulate Concentrations

- Pattern dominated by High Pressure
- Weak Easterly Winds Aloft Opposing Normal Thermally Driven Winds
- Large Scale Weak Pressure Gradients
- Subsidence
- Warmer Temperatures Aloft
- Warm Surface Temperatures (Ozone)

Wind Trajectories During High and Low Particulate Concentrations – Generated By Computer Models

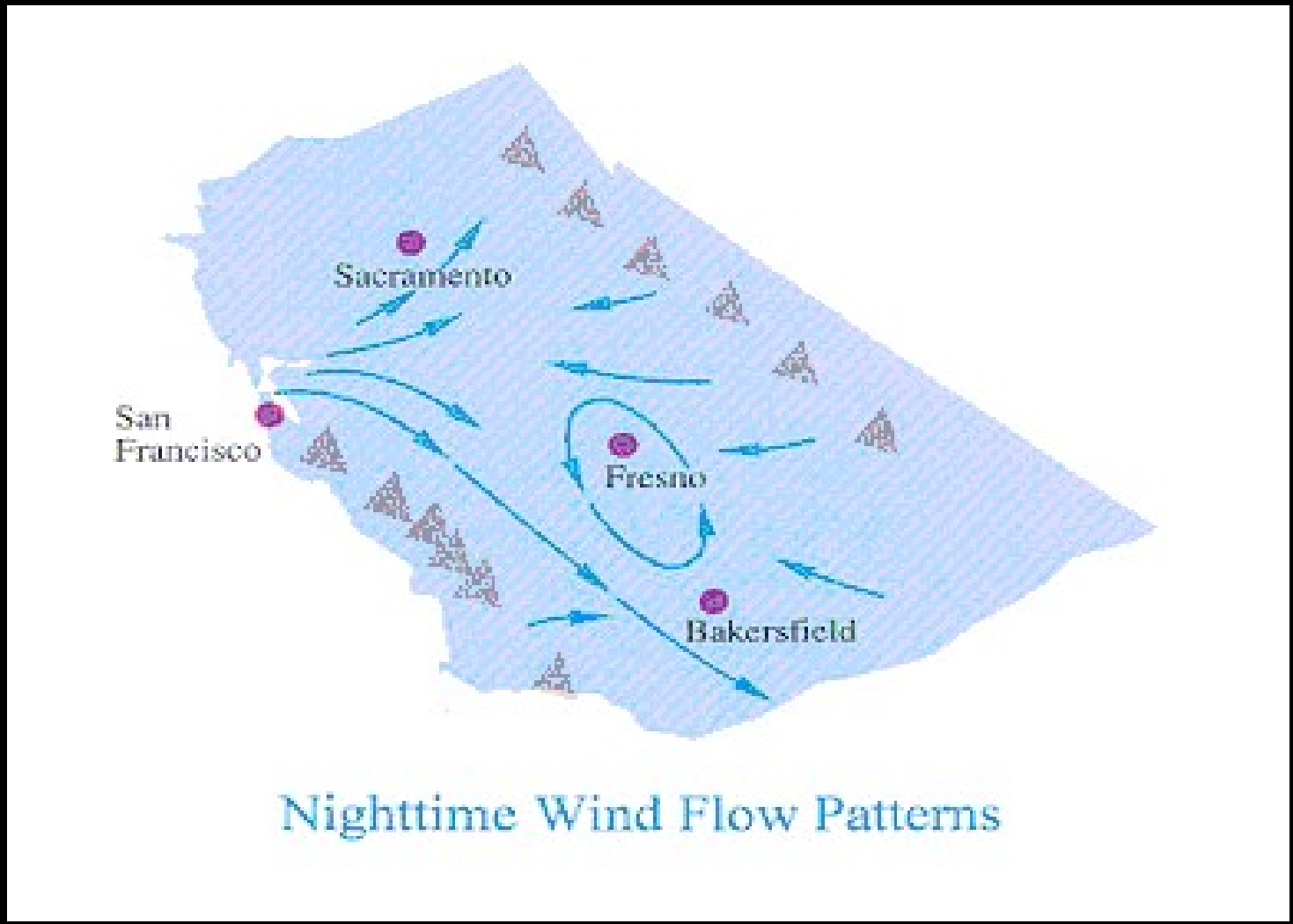


156 ug/m3

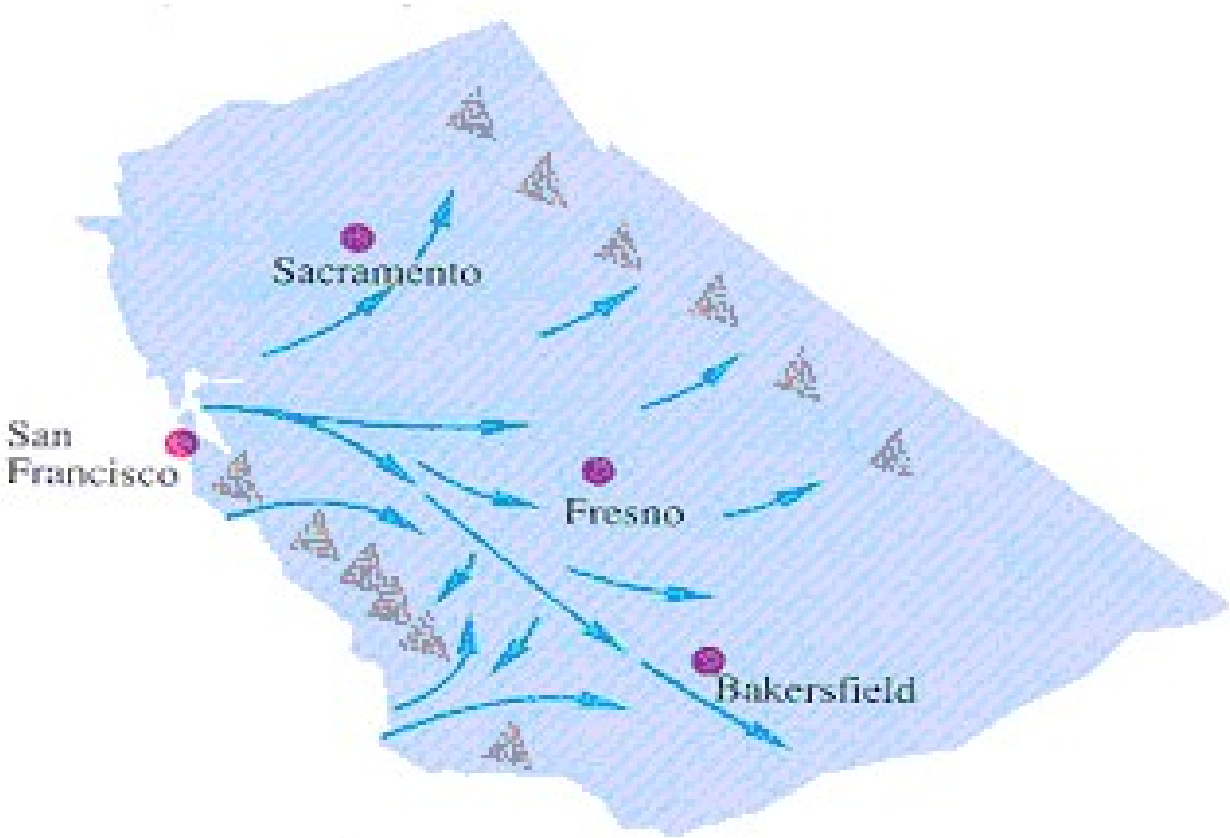


13 ug/m3

Nighttime Wind Flow for O_3 Season



Daytime Wind Flow for O_3 Season



Daytime Wind Flow Patterns

Emissions
The forecaster must predict:

- Large changes in emissions (fires, blowing dust)
- Changes in wind direction & speed during periods of high emissions

Emissions - Wildfire Smoke

Human Behavior

- Variation in activities by day of week (Driving, Fireplace Use)
- Holidays (4th of July, Thanksgiving)
- Compliance with curtailment programs

Process

- Collect Air Quality Information
- Review Current Air Quality Data
- Run the Air Quality Model and analyze the output
- Verify Past Model Performance
- Weather Data and Map Analysis
- Document in Afternoon Forecast Discussion
- Publish and Distribute the Forecast

Products

- Air Quality Index Forecast and Discussion
- Smoke Management System –

  Agricultural Burn
- Prescribed and Hazard Reduction Burn Forecast
- Spare the Air and Residential Wood Burn Declaration
- Health Advisory Issuance
- Natural Events Action Plan (NEAP)

Air Quality Index (AQI): 8-hr Ozone

Descriptors Values	Ozone (ppb)	Cautionary Statements
Good 0 – 50 GREEN	0 - 64	None
Moderate 51 – 100 YELLOW	65 - 84	Unusually sensitive people should consider reducing prolonged or heavy exertion outdoors.
Unhealthy for Sensitive Groups 101 – 150 ORANGE	85 - 104	Active children and adults, and people with lung disease, such as asthma, should reduce prolonged or heavy exertion outdoors.
Unhealthy 151 – 200 RED	105 - 124	Active children and adults, and people with lung disease, such as asthma, should avoid prolonged or heavy exertion outdoors. Everyone else, especially children, should reduce prolonged or heavy exertion outdoors.
Very Unhealthy 201 – 300 Purple	125 - 374	Active children and adults, and people with lung disease, such as asthma, should avoid all outdoor exertion. Everyone else, especially children, should avoid prolonged or heavy exertion outdoors.

Air Quality Flag Program

GOOD 0-50	No limitations.
MODERATE 51-100	Extremely sensitive children and adults, especially those with respiratory diseases such as asthma, should consider limiting outdoor exertion.
UNHEALTHY SENSITIVE GROUPS 101-150	Sensitive children and adults, especially those with respiratory diseases such as asthma, should limit prolonged outdoor exertion.
UNHEALTHY 151-200	Sensitive children and adults should avoid outdoor exertion, and everyone else should limit prolonged outdoor exertion during peak ozone periods.

MODERATE
51-100

Fireplace and Woodstove Curtailment Program

County	Prohibited	Discouraged
	2005-06 [04-05]	
Fresno	11 [2]	34 [44]
Kern (valley)	16 [2]	19 [37]
Kings	13 [0]	23 [6]
Madera	2 [0]	28 [13]
Merced	2 [0]	22 [15]
San Joaquin	1 [0]	14 [11]
Stanislaus	3 [0]	20 [28]
Tulare	9 [2]	28 [25]

Summary

- Scientific studies are the basis for the forecast.
- Statistical models provide guidance.
- New tools continue to evolve.
- Products are utilized by over a 1,000 + San Joaquin Valley citizens.
- Daily forecast products distributed by 4:30 PM.

Air Quality Trends

- Ozone – 8 Hour
- PM2.5
- Ozone

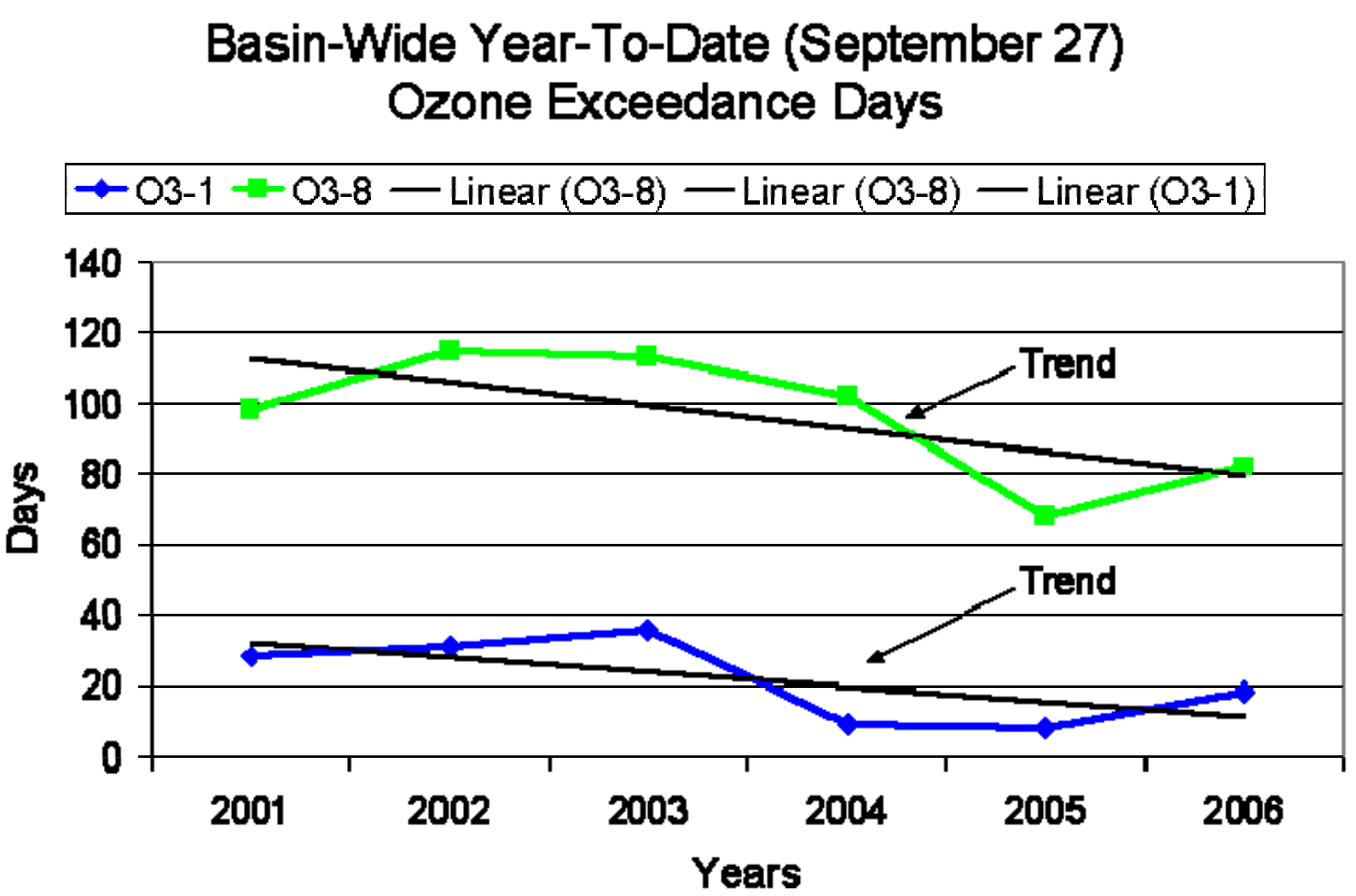
State of Air Quality
Ambient Concentrations, 1990-2005

- 8-hour ozone
  - Large number of exceedance days
  - Design value has not significantly changed since 1990
- PM2.5
  - Most sites still violate annual PM2.5 standard

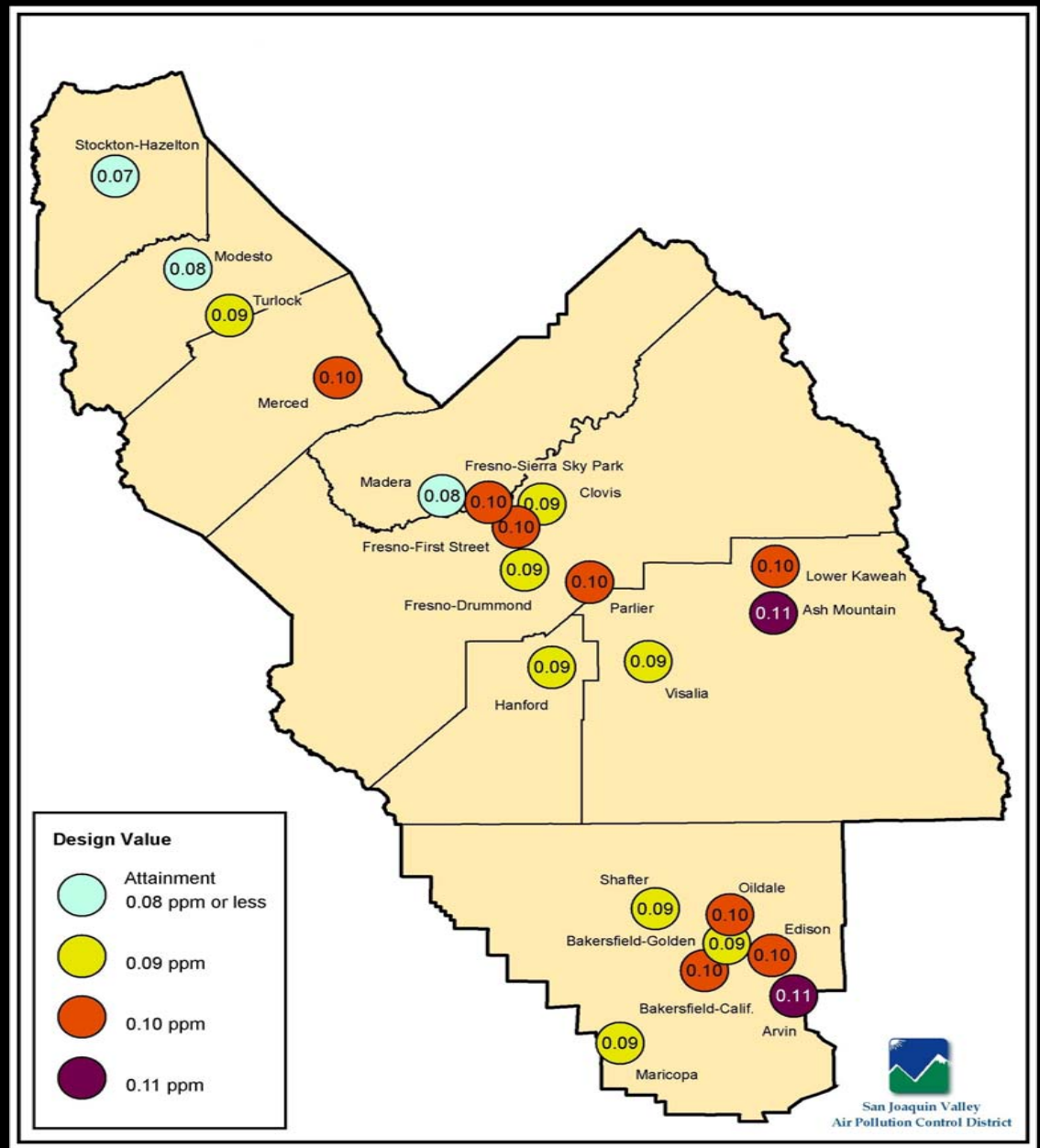
State of Air Quality – Ozone
Ambient Concentrations, 1990-2005

- 1-hour ozone
  - Number of annual of exceedance days dropped 57% (3-yr average)
- 8-hour ozone
  - Number of annual of exceedance days dropped 16% (3-yr average)

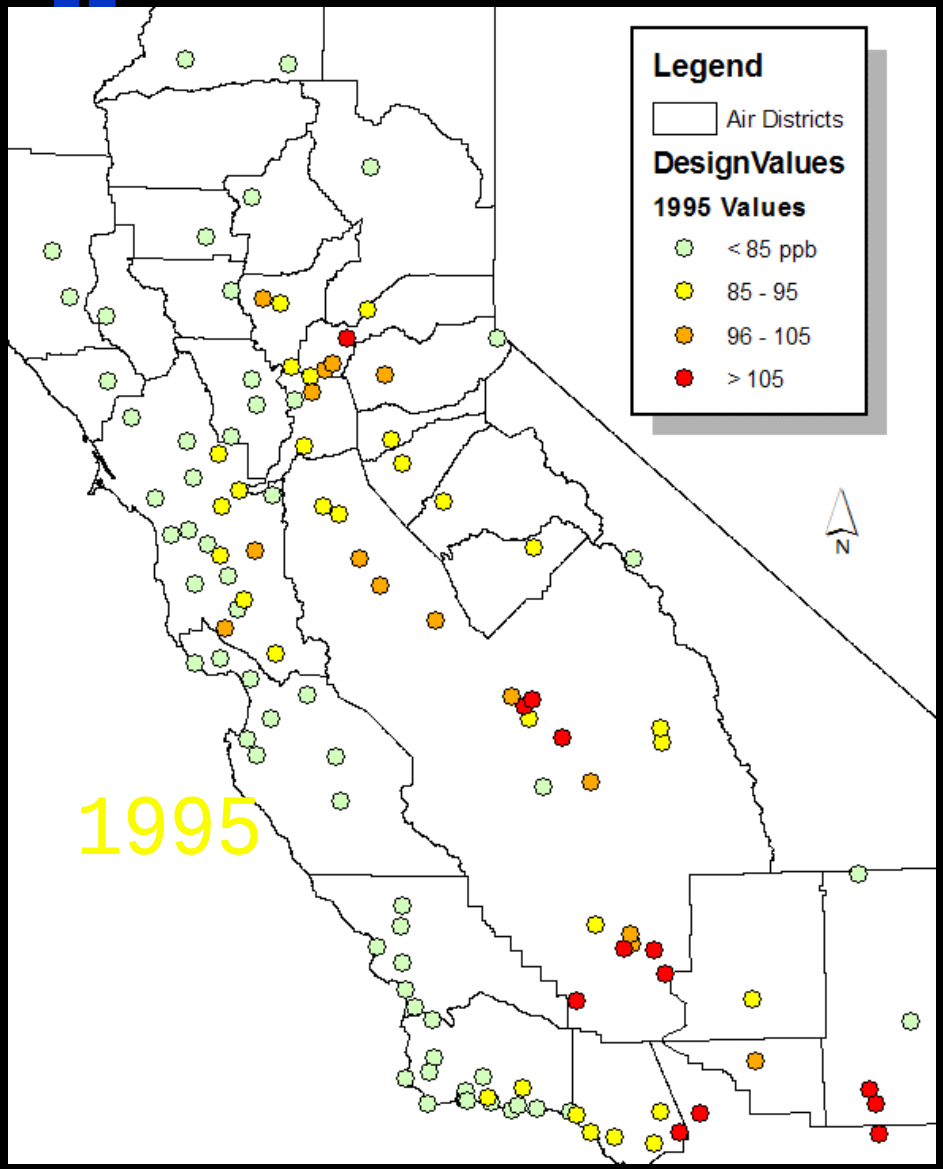
Ozone Trends in SJV

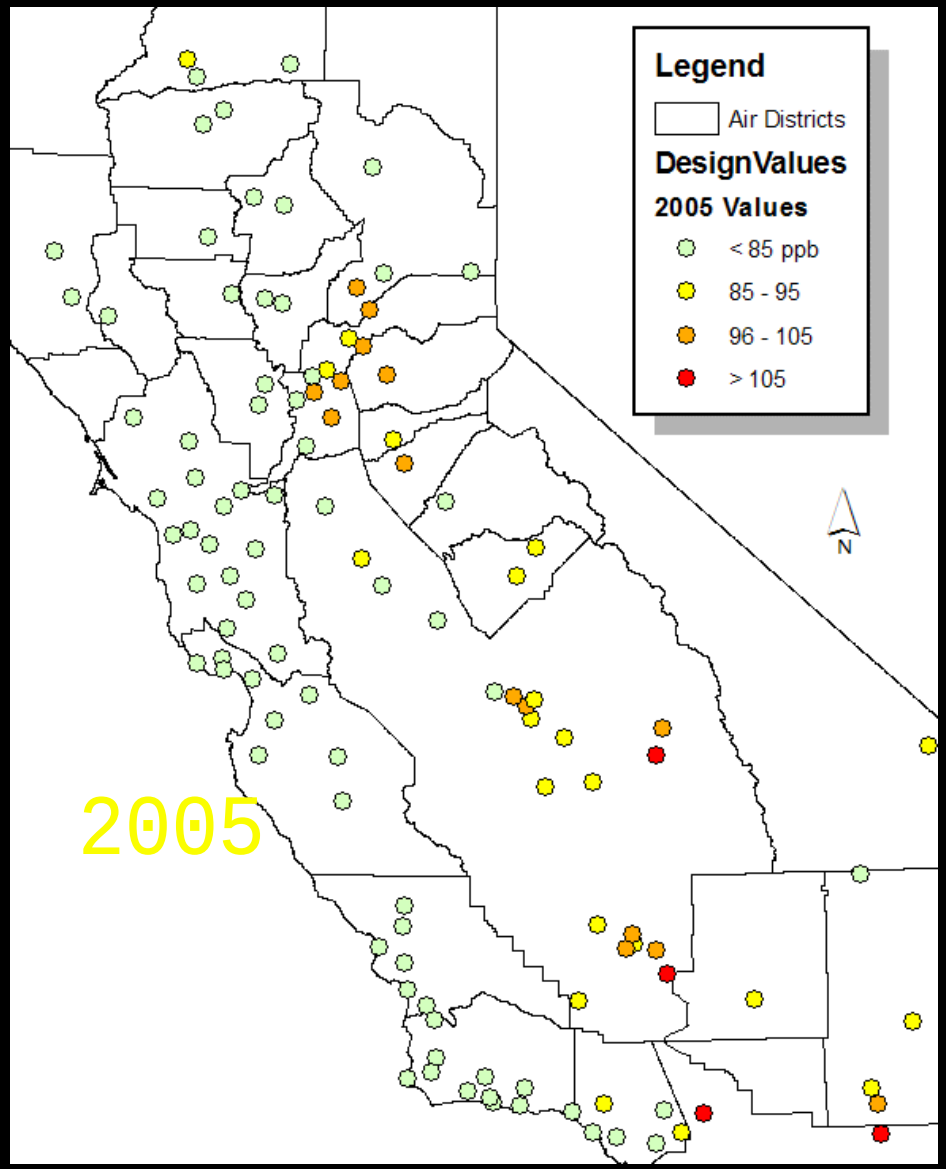


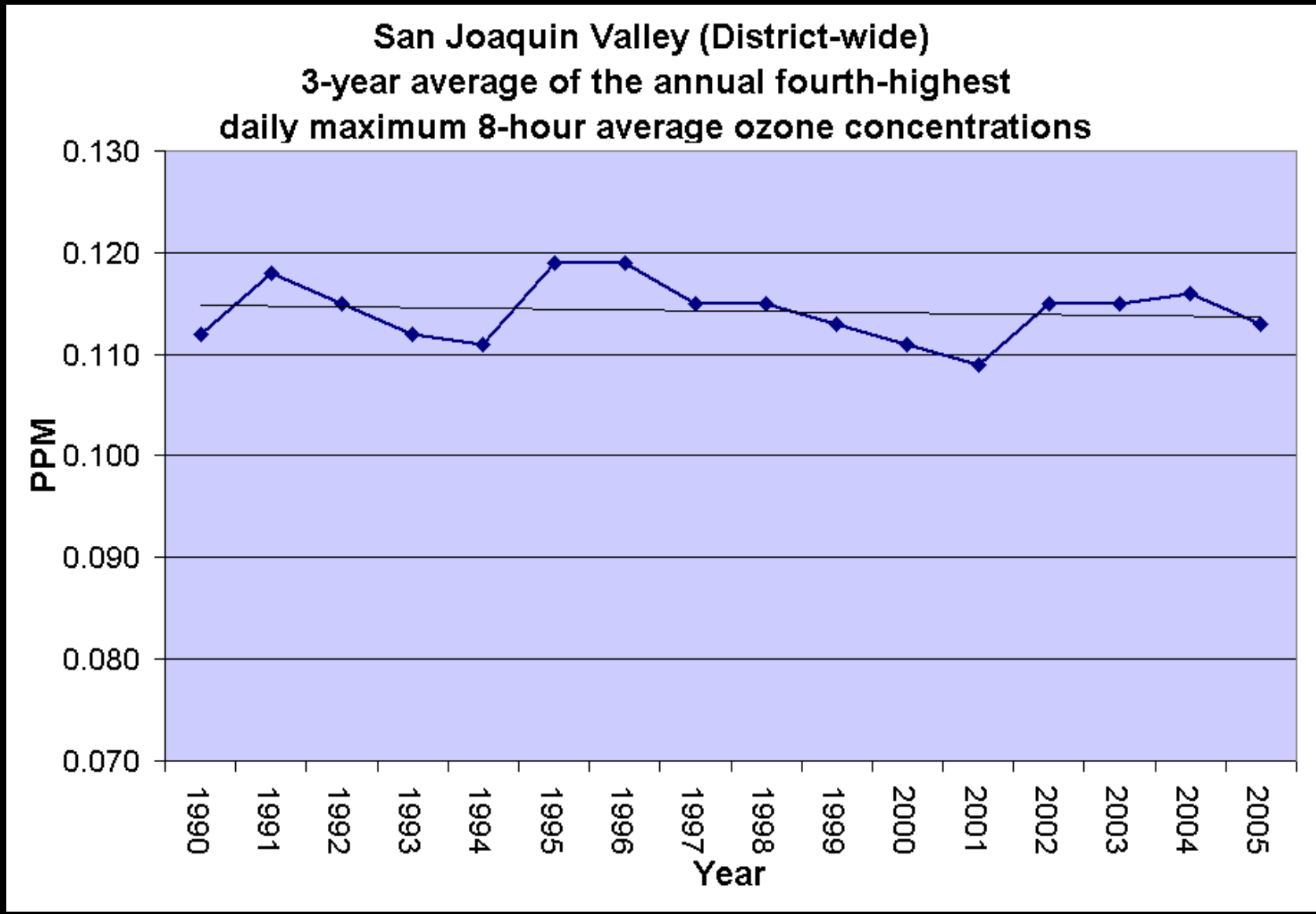
8-Hour Ozone Design Value (2005)

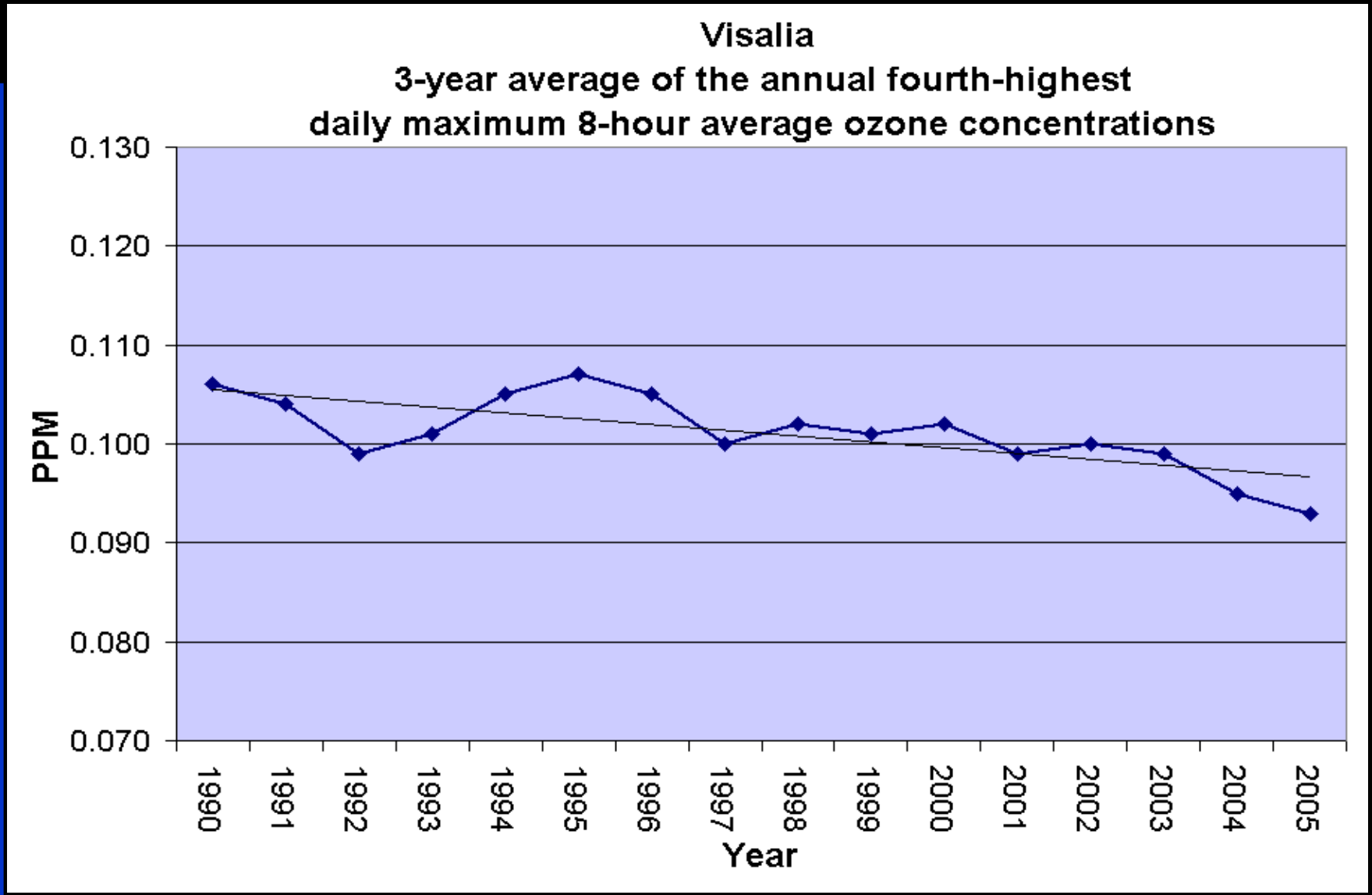


Ozone 8-Hour
Spatial Extent Reduced

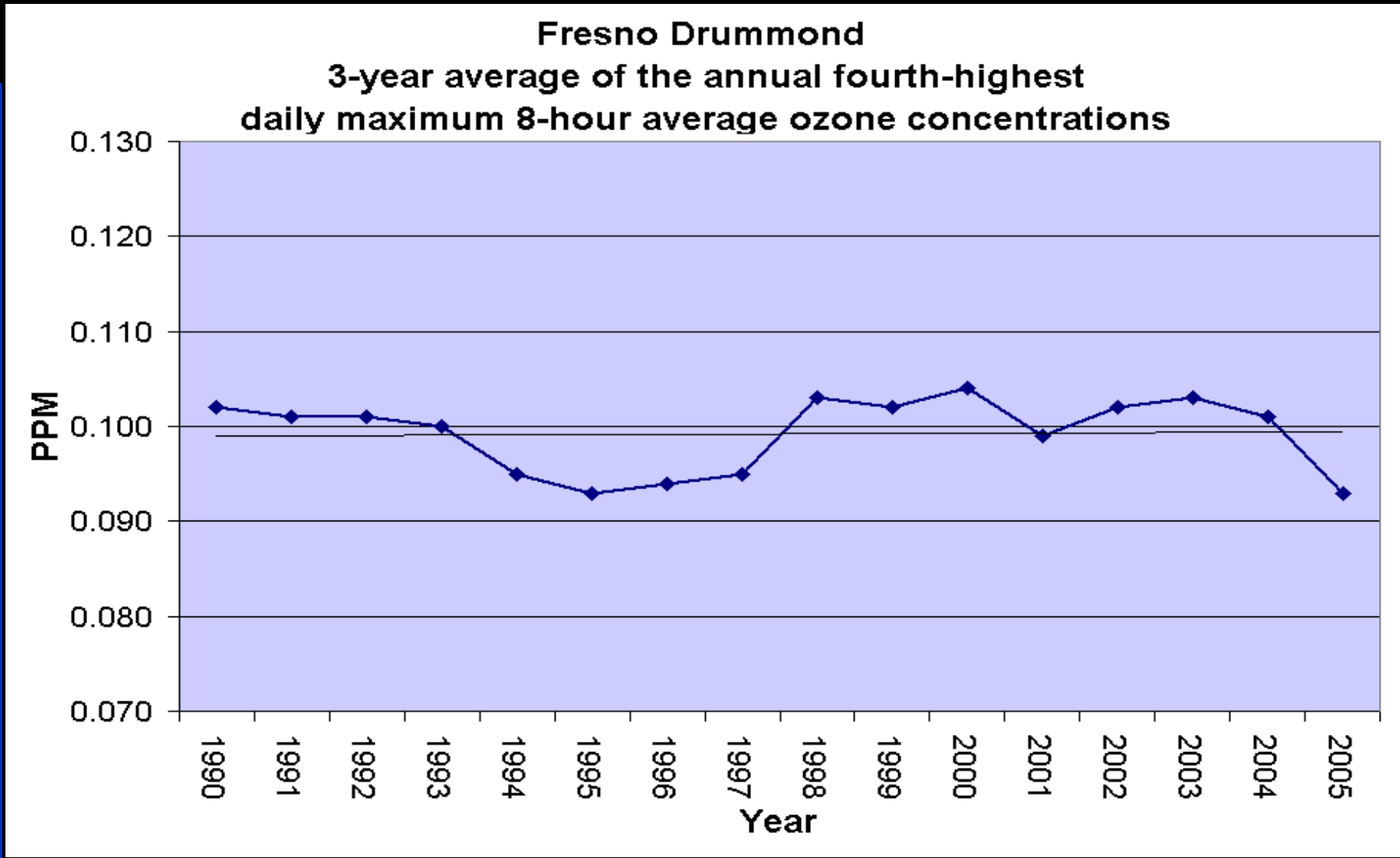




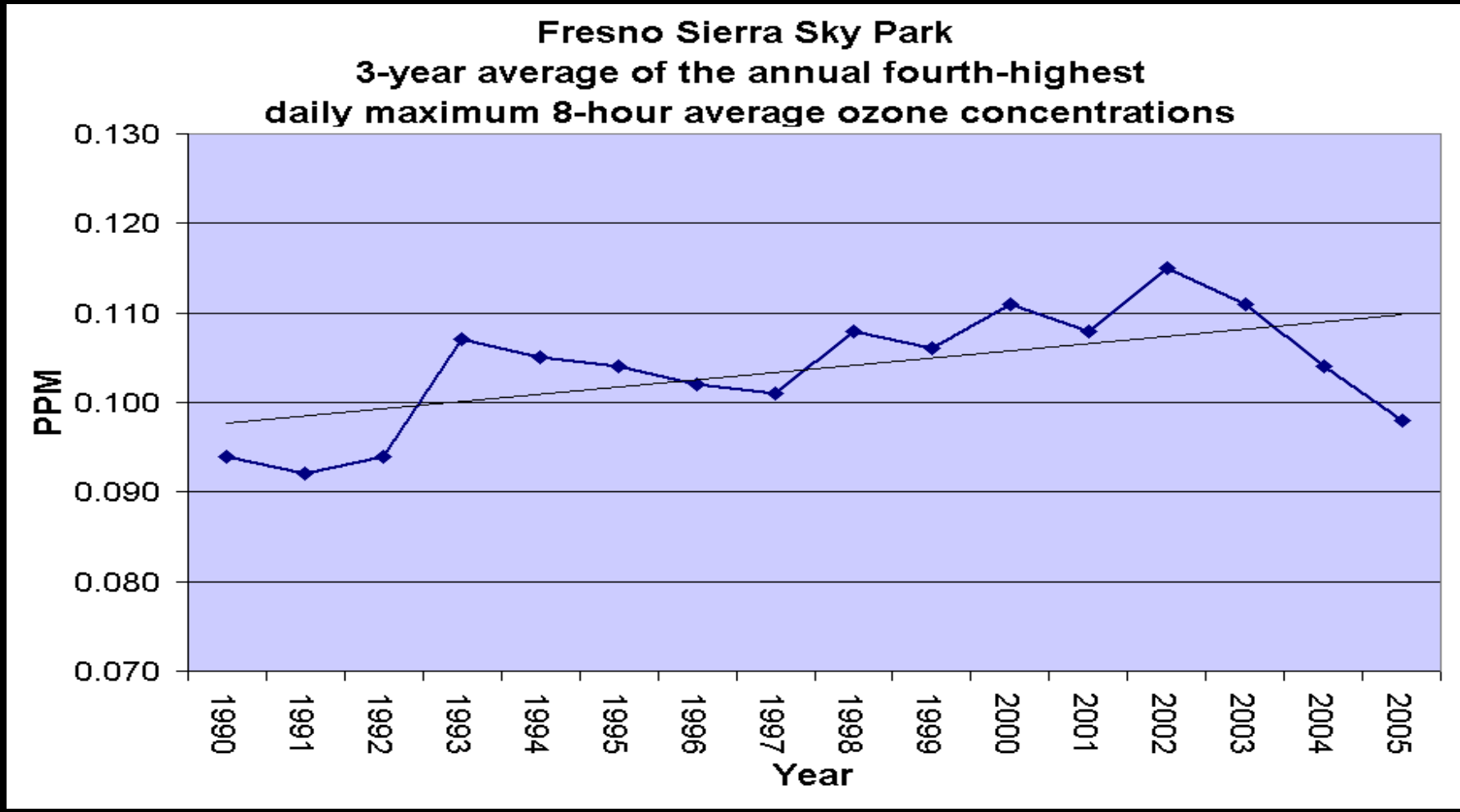

San Joaquin Valley (District-wide)
3-year average of the annual fourth-highest
daily maximum 8-hour average ozone concentrations
PPM
0.130
0.120
0.110
0.100
0.090
0.080
0.070
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year



One of seven improving sites in the SJVAB for 8-hour ozone air quality for the years 1990 to 2005.

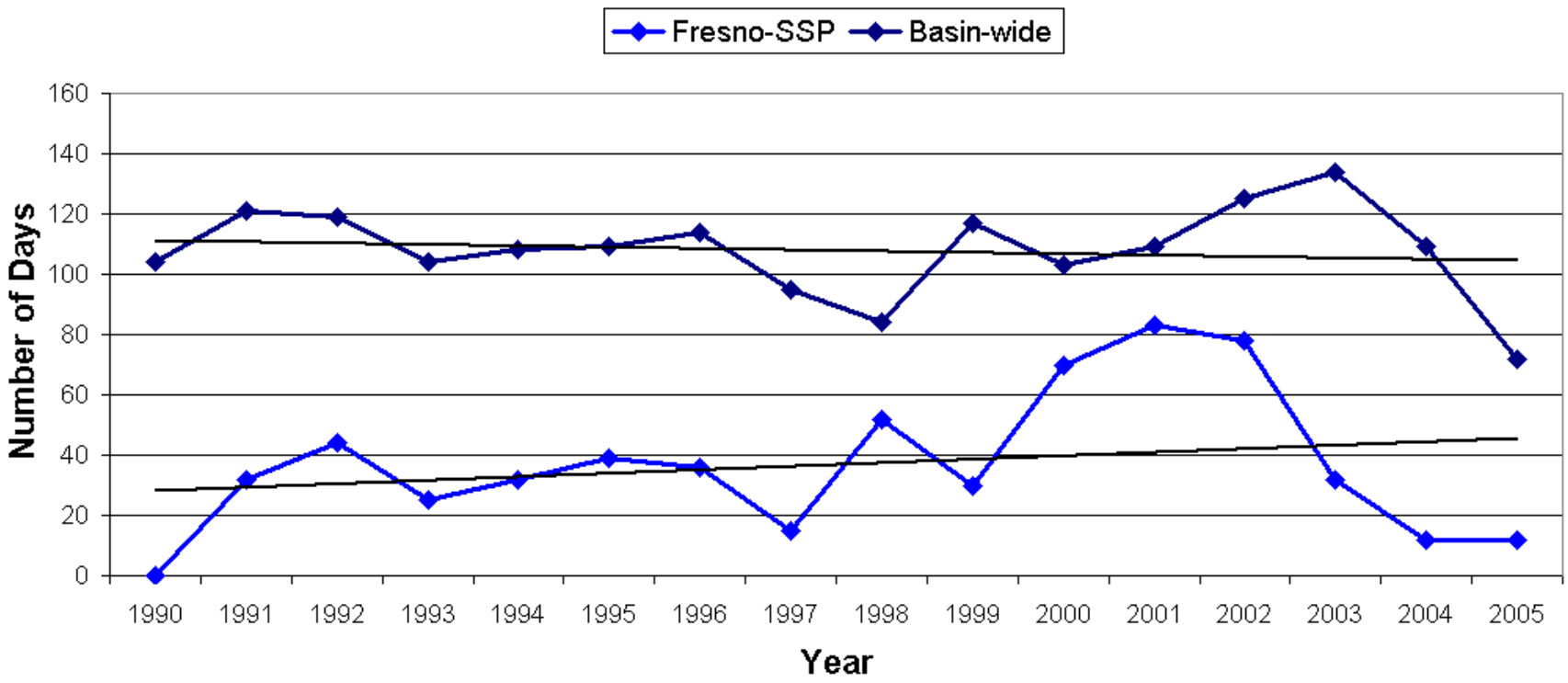


One of the eleven sites with no clear trend for the years 1990 to 2005.



The only site where 8 – hour ozone air quality is getting worse for the years 1990 to 2005.

Days Over 8-Hour Ozone Standard for Fresno-Sierra Sky Park (SSP) Site



Particulate Matter Measurements

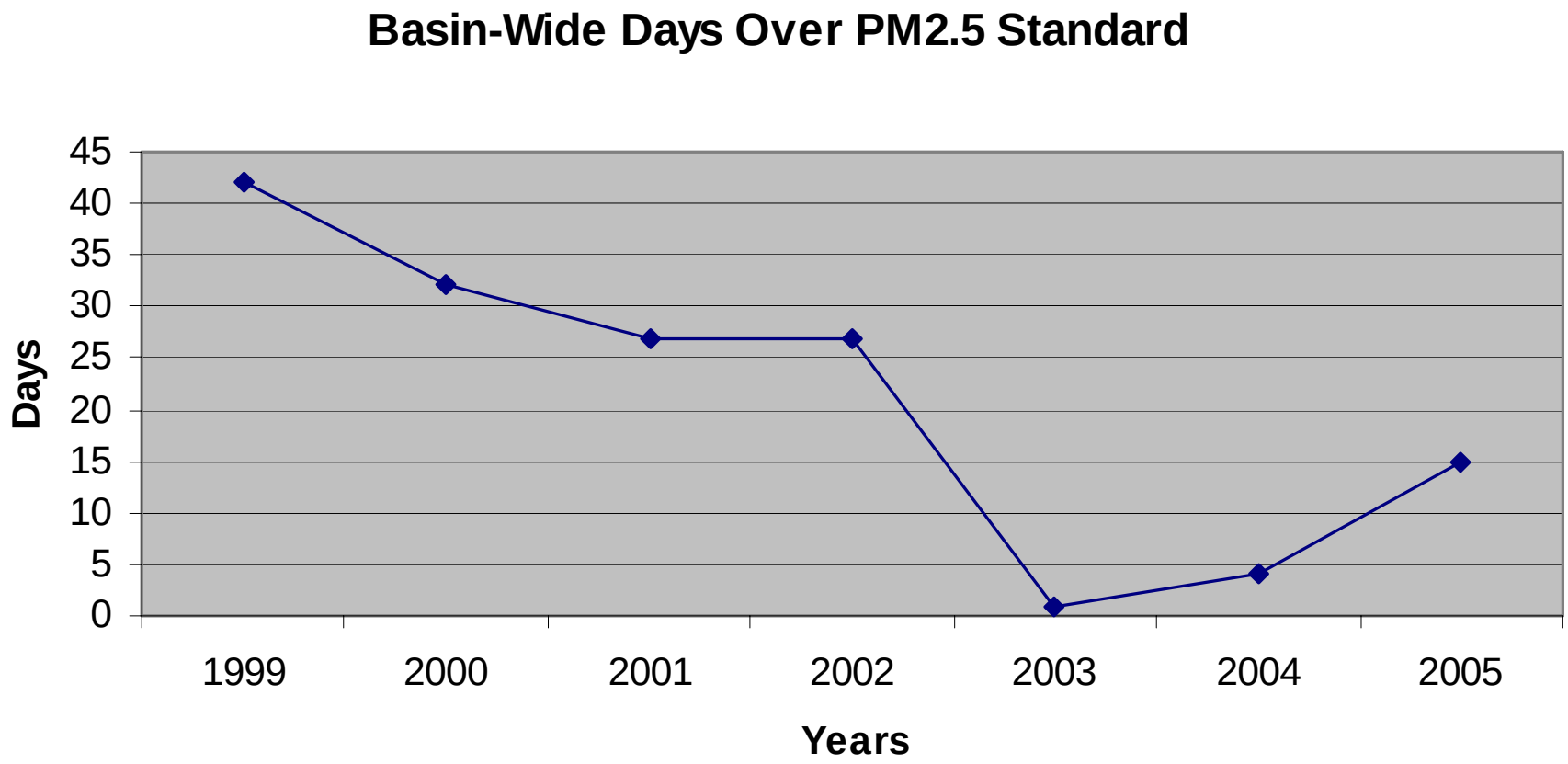
- Particulate Matter
  - PM10 attainment
  - Attainment of 24-hr PM2.5 standard
  - Annual average PM2.5 levels have improved since monitoring began in 1999

	1999	2005
PM2.5 annual average, percent over standard	87%	33%

State of Air Quality – PM10
Ambient Concentrations, 1990-2005

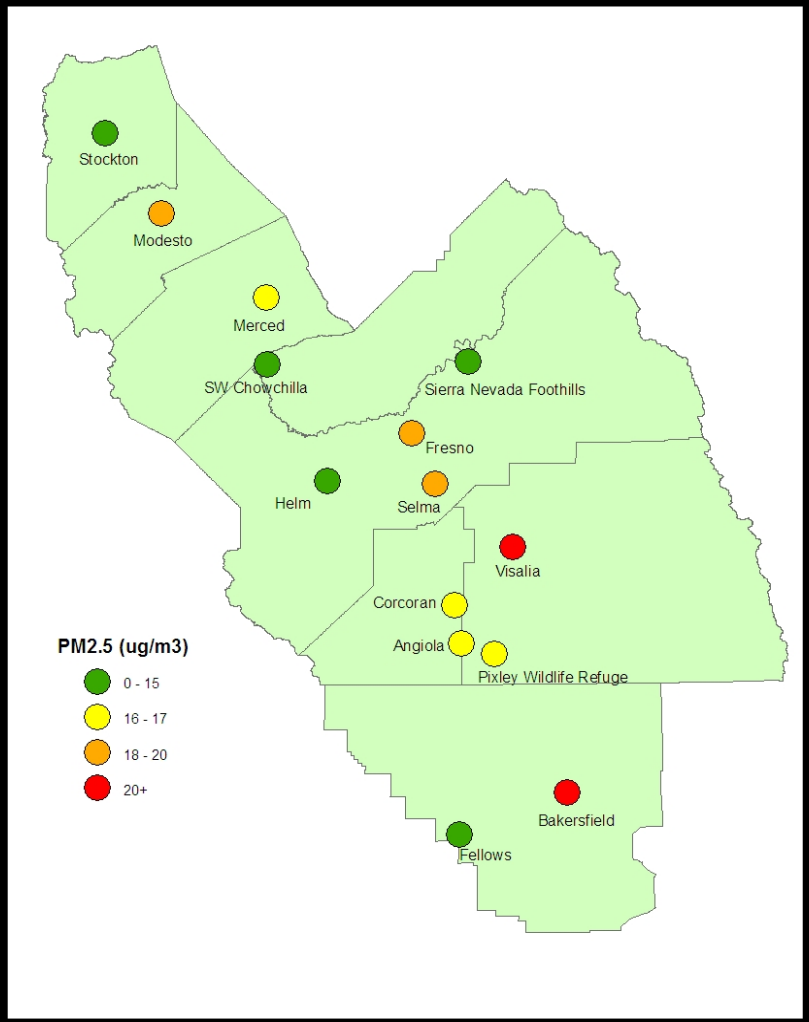
- 1990-2005
  - 24-hr design value dropped 56%
  - Highest annual average concentration dropped 39%
- 2003-2005
  - No violations of the 24-hr and annual NAAQS
  - Attainment

Trend in the Number of Days Greater Than the PM2.5 24 Hour National Standard



PM2.5 Spatial Extent Reduced

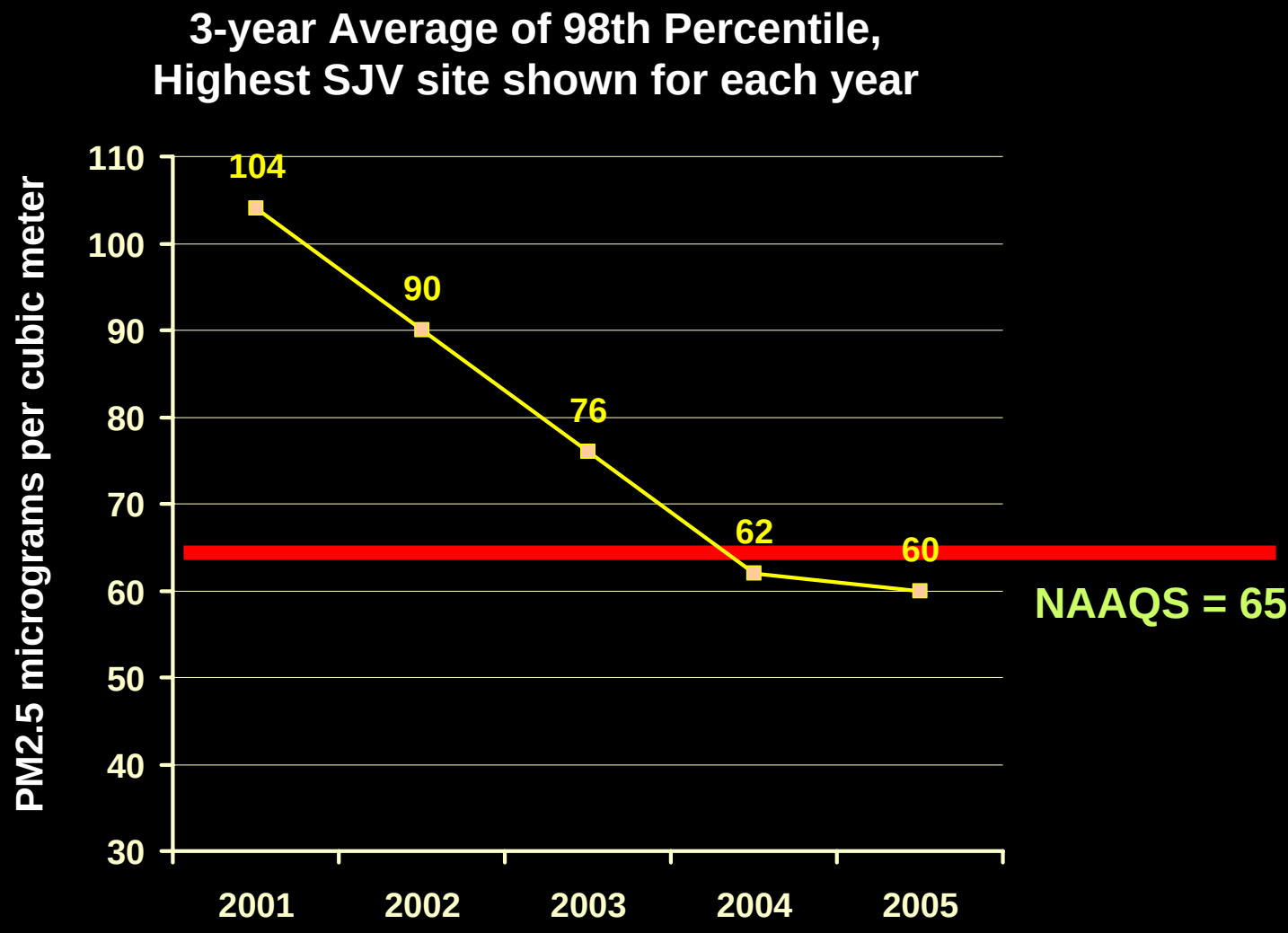
2000 PM2.5 Annual Average



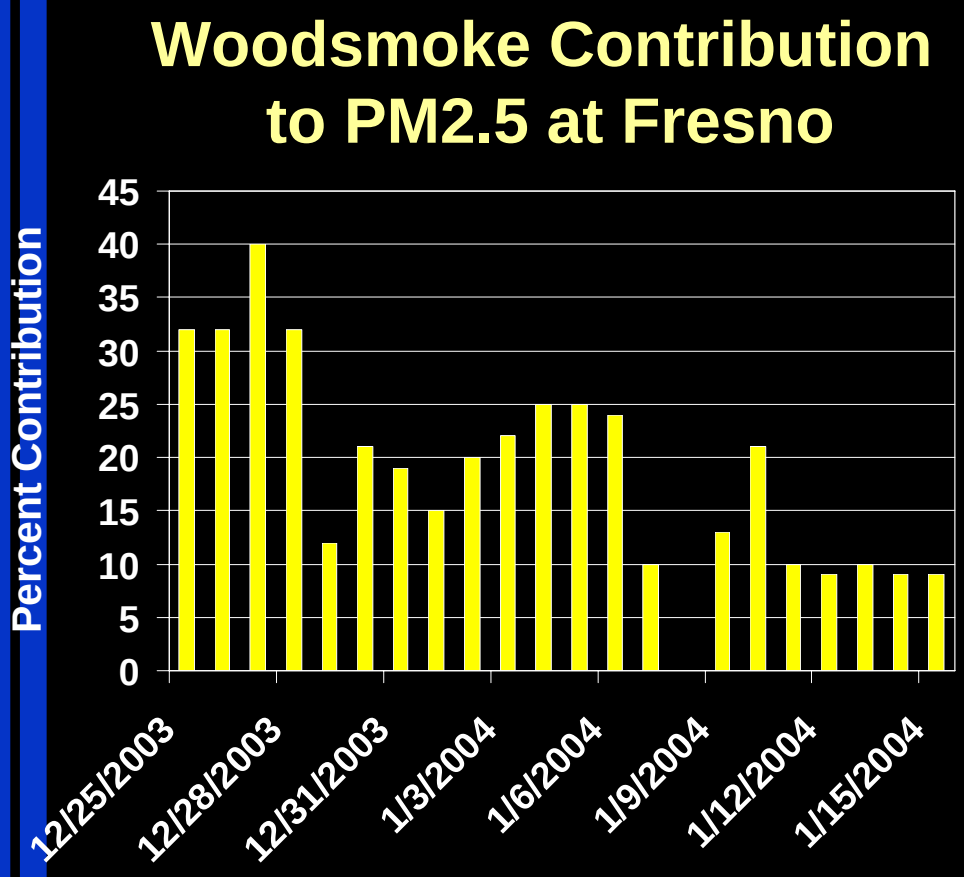
- 2003-2005 annual average all sites improved
- Modesto and Merced green
- Fresno yellow, like Corcoran
- Bakersfield and Visalia orange

Najita et. al. 2005

Attainment of 24-hr PM2.5 Standard



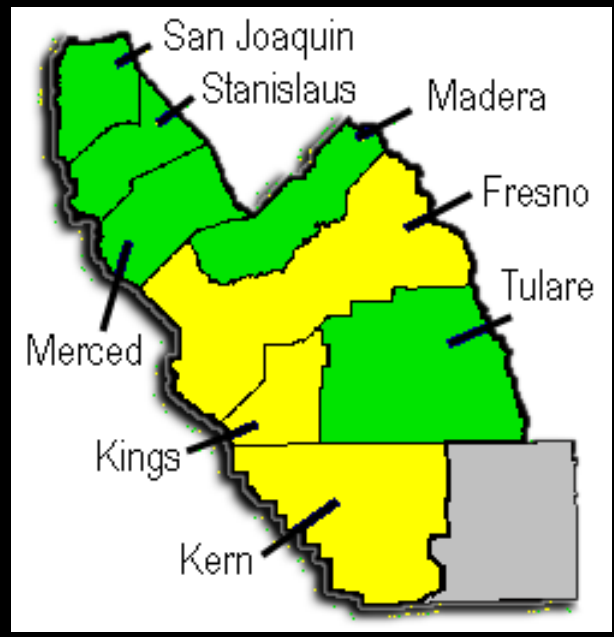
Vegetative Burning Controls



Gorin et. al. 2005

- Residential burning a significant contributor in the winter
- New markers for wood combustion helped identify impacts
- Controls include:
  - Residential wood combustion restrictions
  - Phase-out of agricultural burning
  - Smoke management program

Air Quality Analysis, “Keeping a Watchful Eye on Your Air Quality.”



Questions?

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