

Air Quality Forecasting and Trends

CSUF Air Quality Management Certificate Program 10/20/2006

The image shows four panels of information regarding fireplace and woodstove burning status. The top-left panel, titled "Fireplace/Woodstove", indicates an "Air quality forecast: good or moderate" and includes a white box with the text "Please burn cleanly". The top-right panel, also titled "Fireplace/Woodstove", indicates an "Air quality forecast: unhealthy" and features a red octagonal sign that says "Wood burning prohibited". The bottom-left panel, titled "Fireplace/Woodstove", indicates an "Air quality forecast: unhealthy for sensitive groups" and features an orange triangular sign that says "Wood burning discouraged". The bottom-right panel, titled "Fireplace/Woodstove", indicates an "Air quality forecast: unhealthy" and features a red octagonal sign that says "Wood burning prohibited". All panels include contact information for SMOG INFO (1-800 SMOG INFO or www.valleyair.org) and the text "Burning Status".



The image shows four panels of air quality status information. The top-left panel is red and labeled "Air Quality UNHEALTHY". The top-right panel is green and labeled "Air Quality GOOD". The bottom-left panel is yellow and labeled "Air Quality MODERATE". The bottom-right panel is orange and labeled "Air Quality UNHEALTHY Sensitive Groups". Each panel includes logos for the Air Quality Management District (AQMD), the California Air Resources Board (CARB), and the American Lung Association.

Presented by:

Shawn R. Ferreria

Project Planner / Atmospheric Scientist

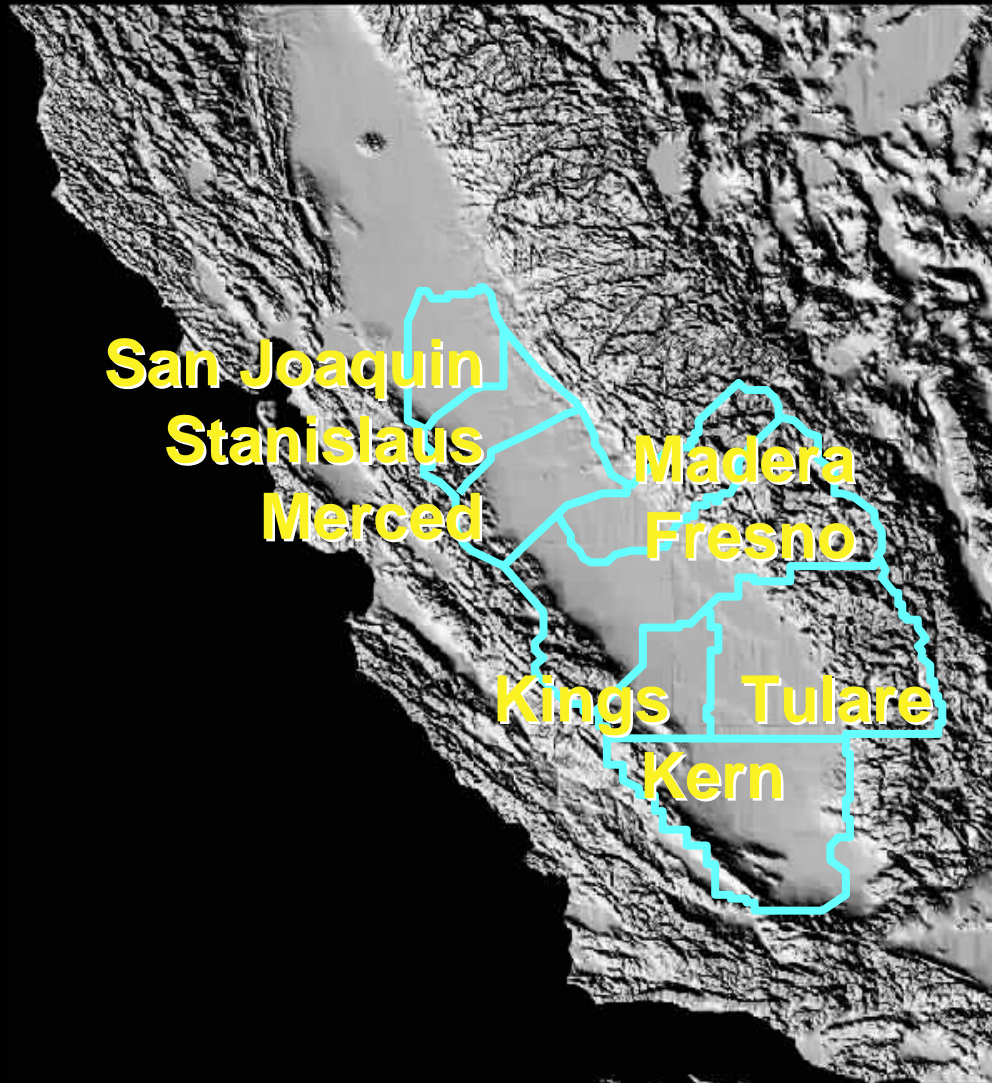


Air Pollution Meteorology and Trends in the San Joaquin Valley

- 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

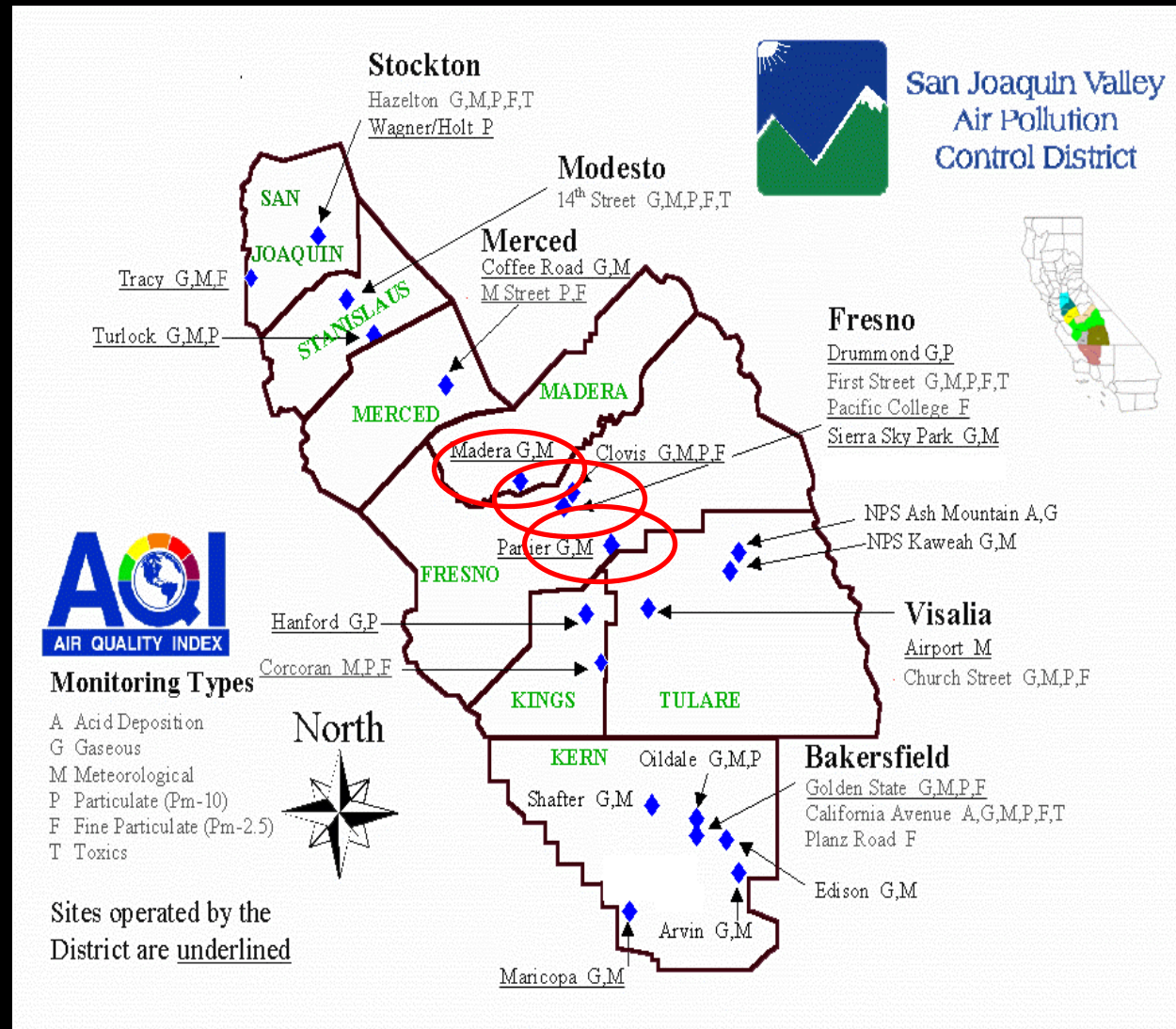


San Joaquin Valley Air Basin



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

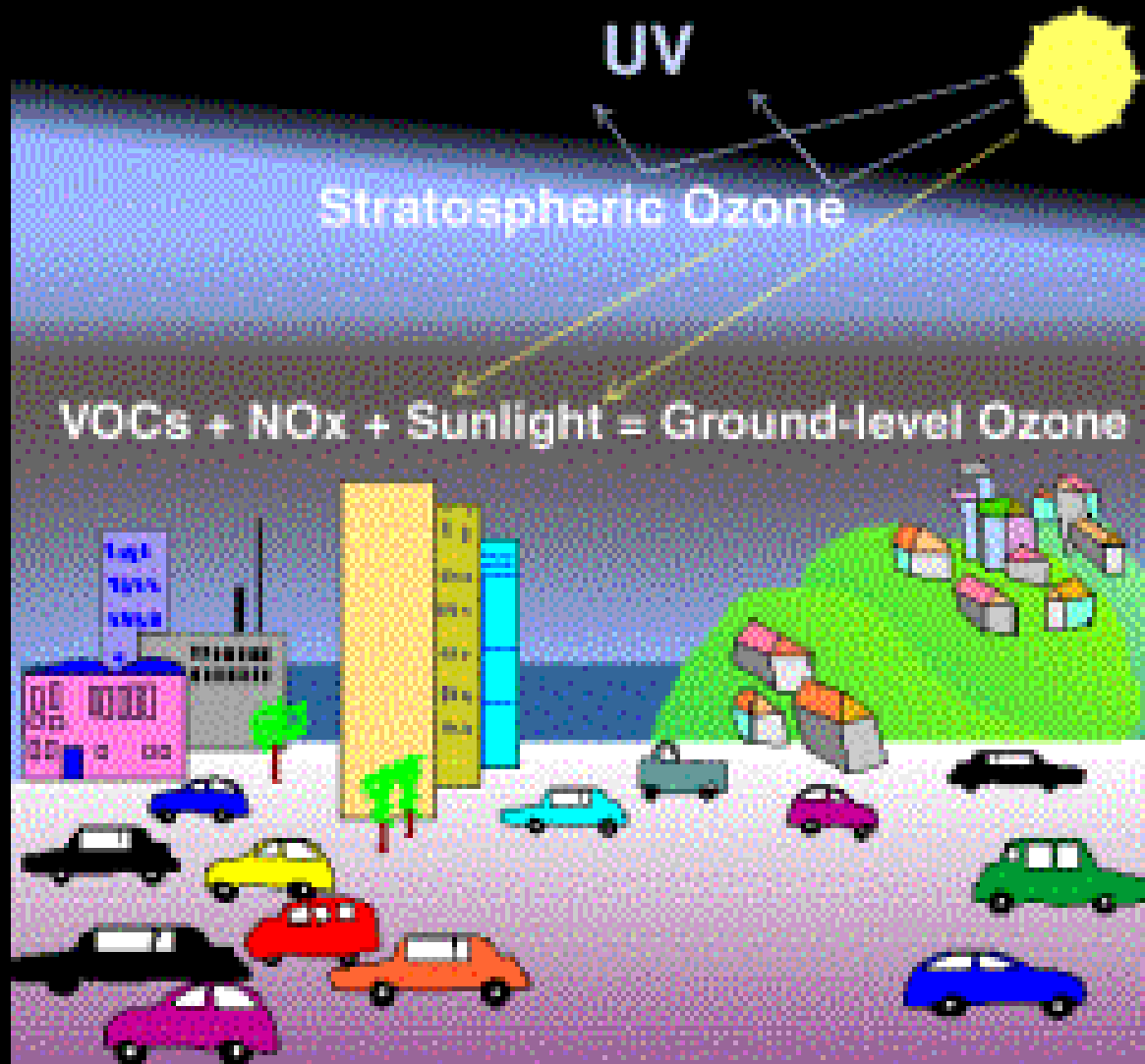
The forecaster predicts variations in:



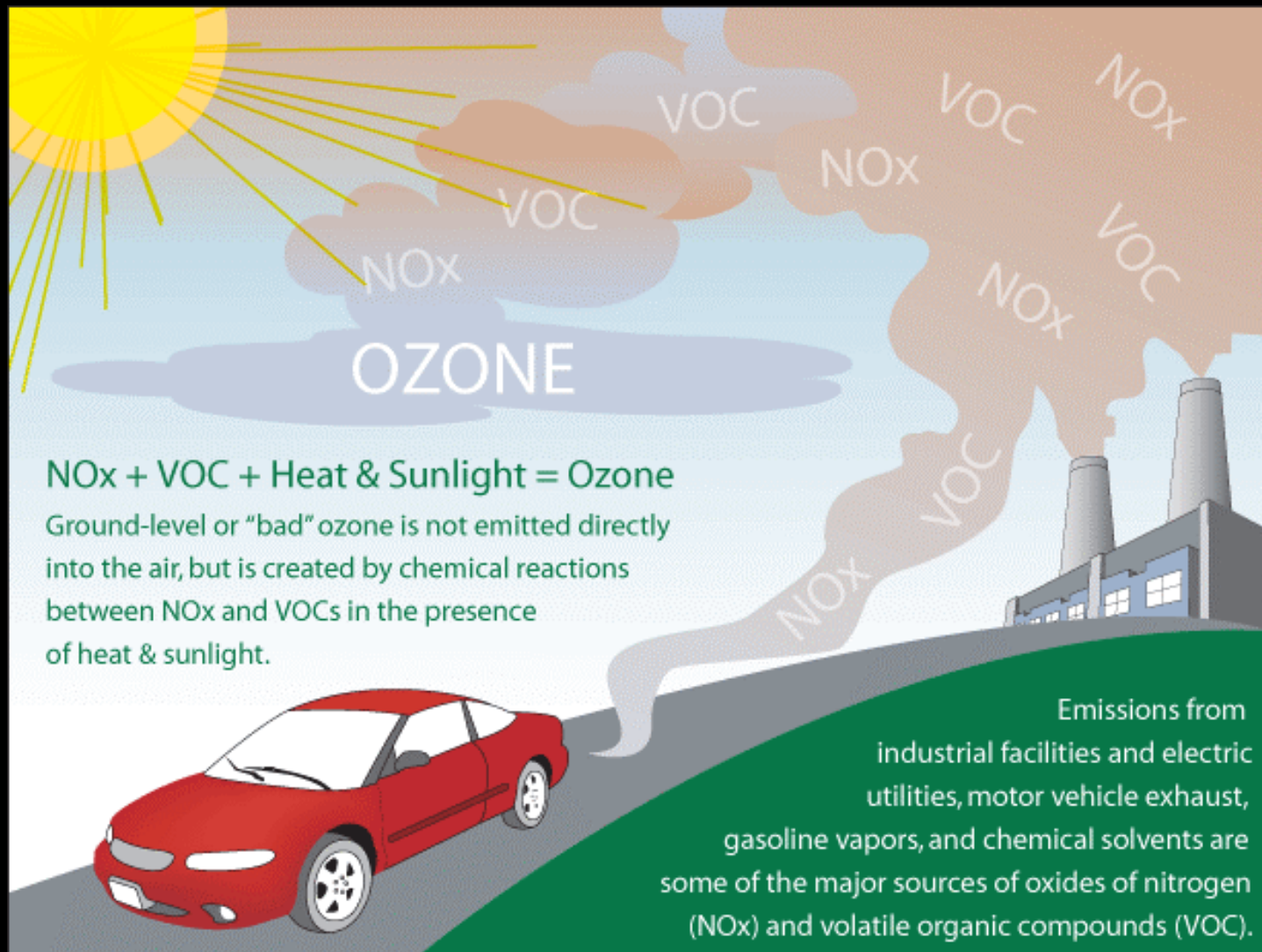
- Ozone
- Particulate Matter



Ground Level Ozone

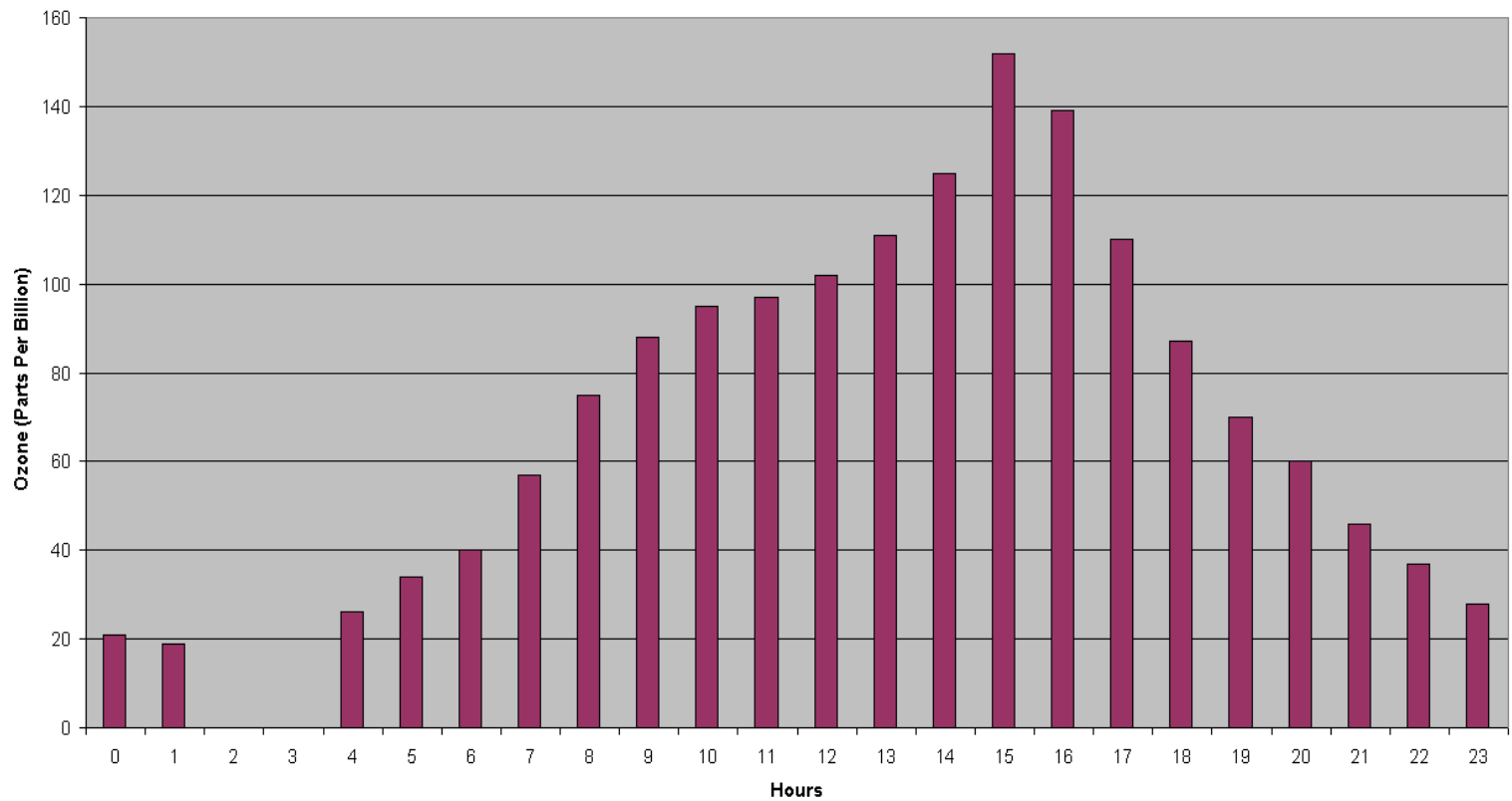


Ozone Formation

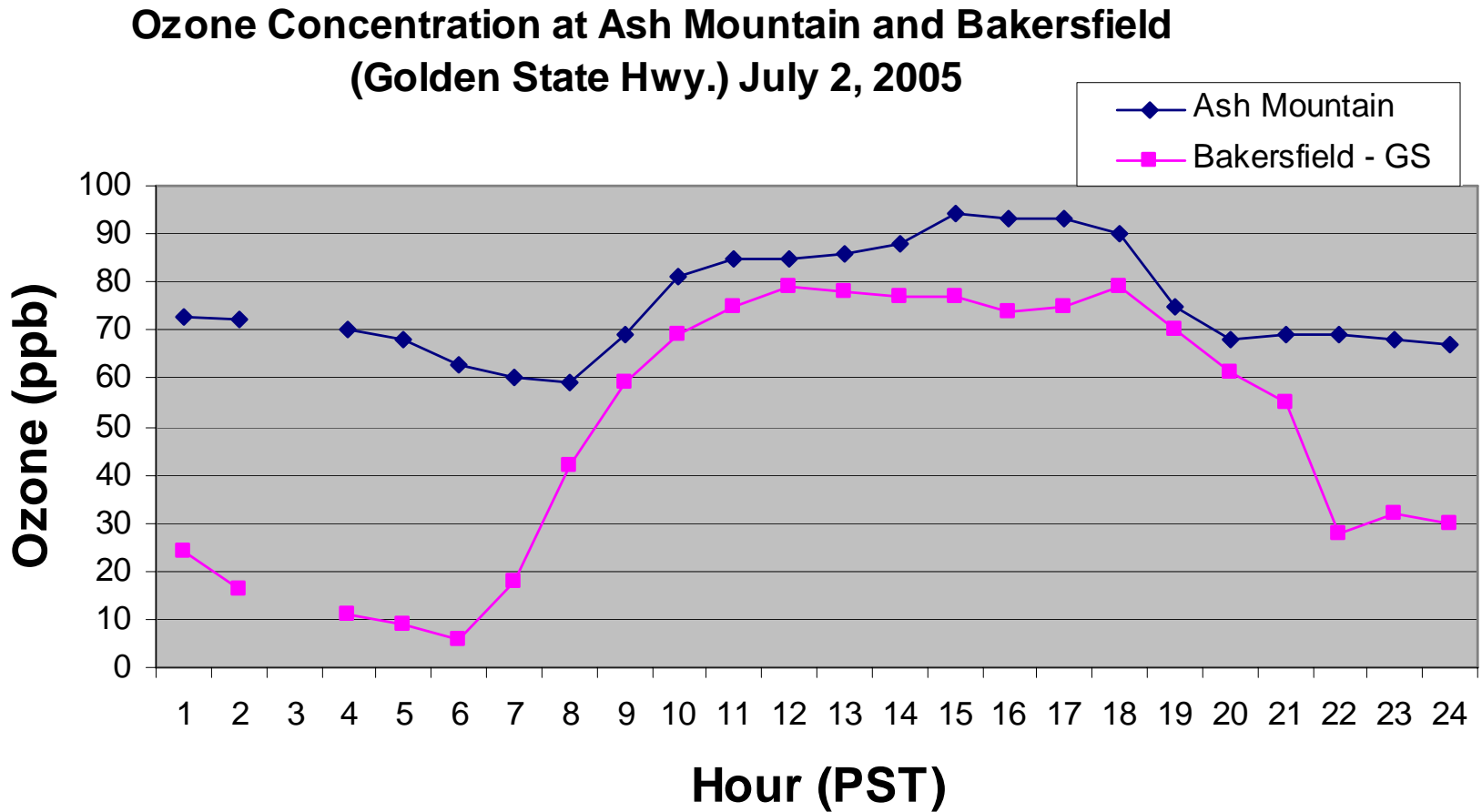


Ozone Concentration Profile

Parlier Diurnal Ozone Profile - 5/28/03



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

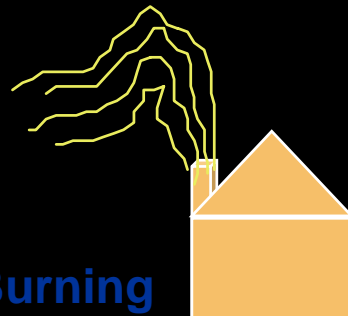
Natural

Wind Blown Dust
(Undisturbed Soil)



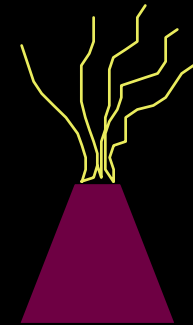
Wildfires

Wood Burning

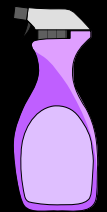


Man Made

Wind Blown Dust
(Disturbed Soil)



Industrial
Sources



Automobiles

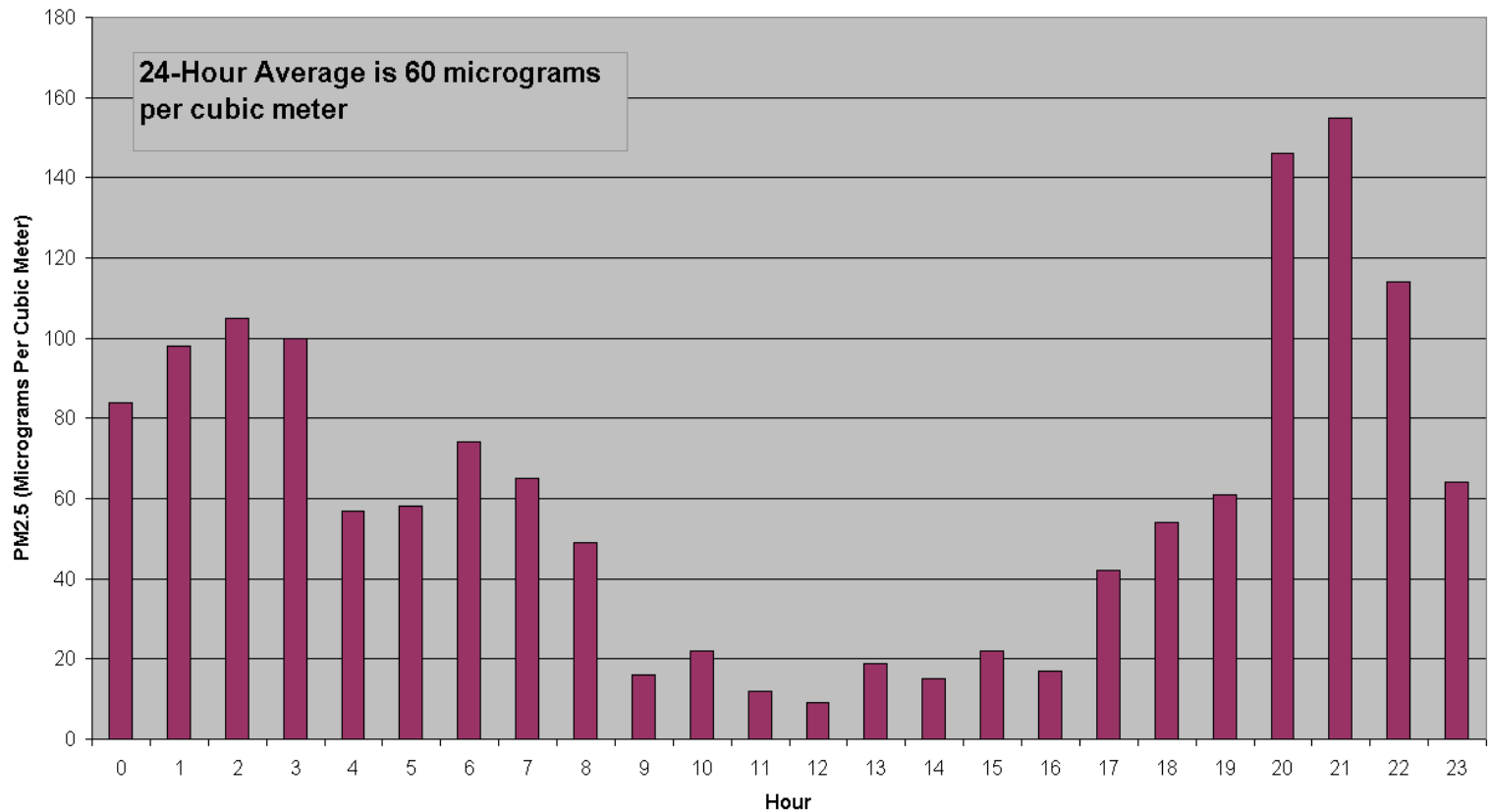


Disturbed Soil



Diurnal PM2.5 Profile

Fresno-First Street Diurnal PM2.5 Profile - 1/1/03



Weather Forecasting

What weather conditions influence air quality?



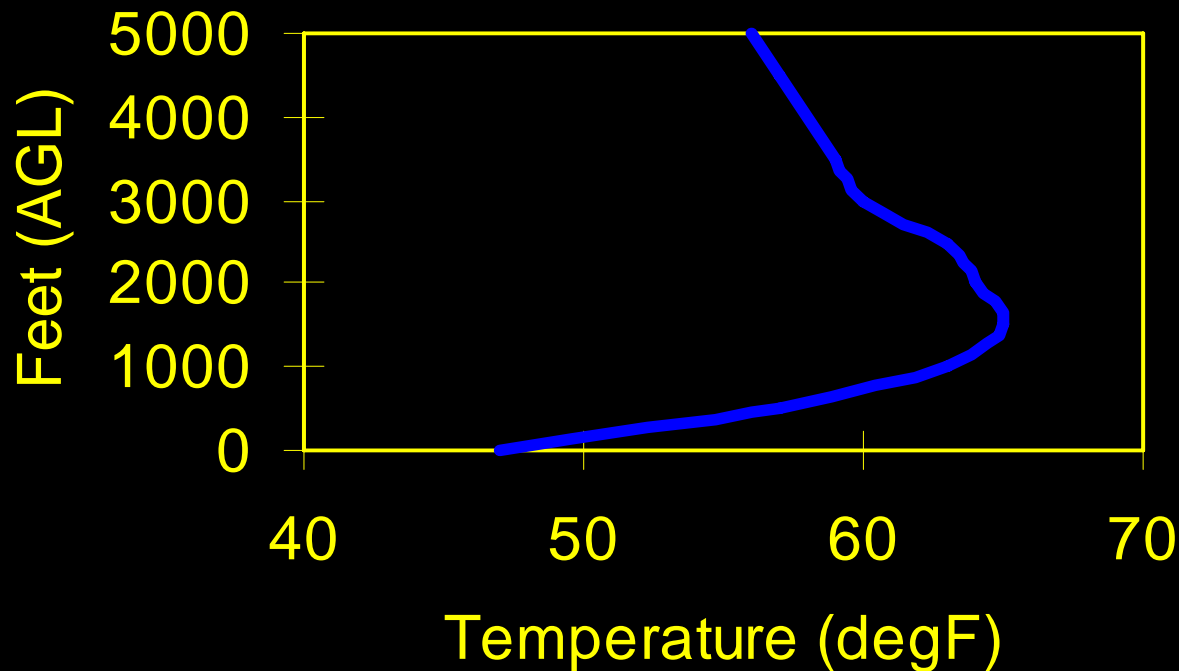
Weather Patterns Associated with Poor Air Quality

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

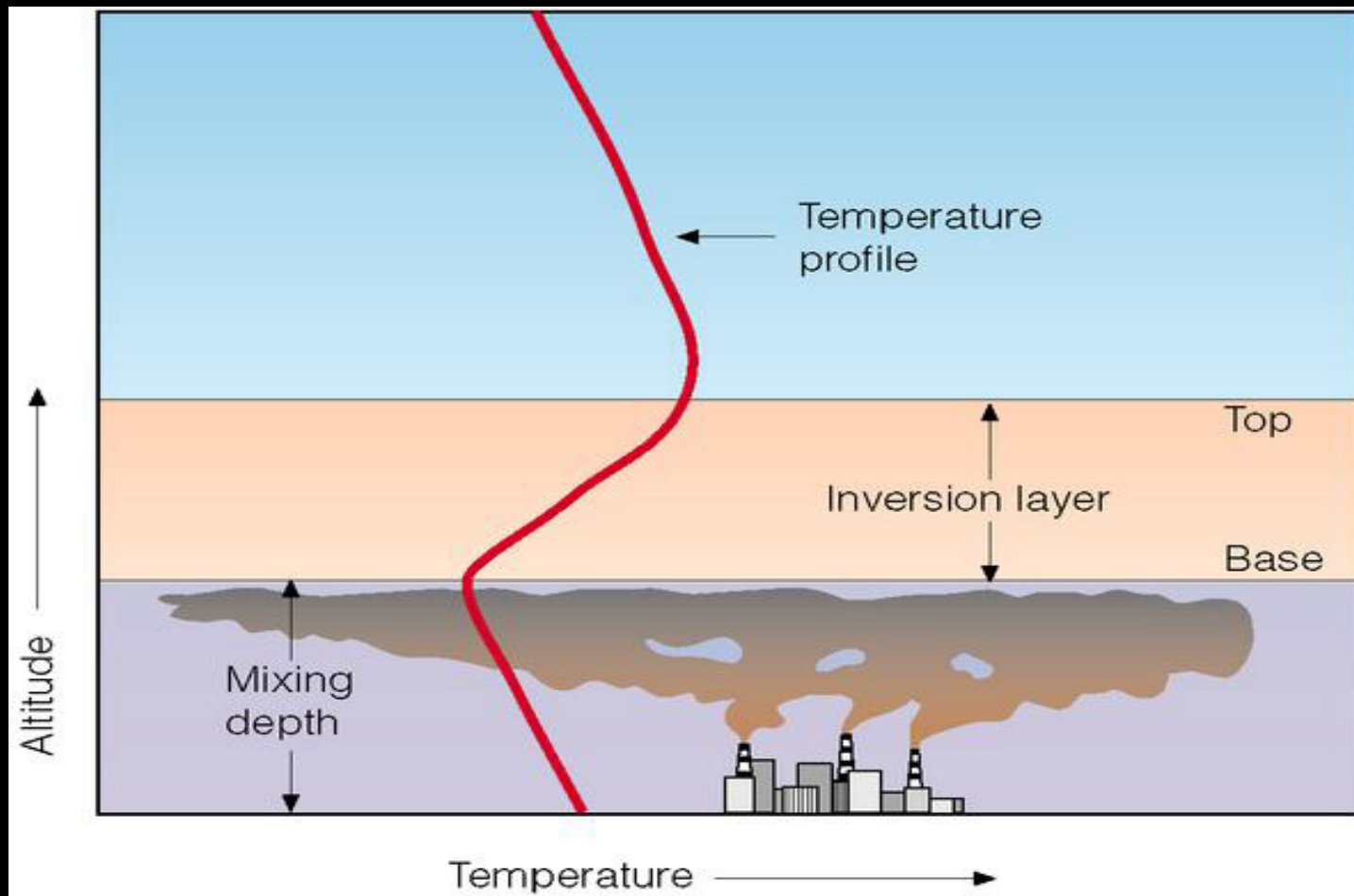


Temperature inversion during a period of high particulate concentrations

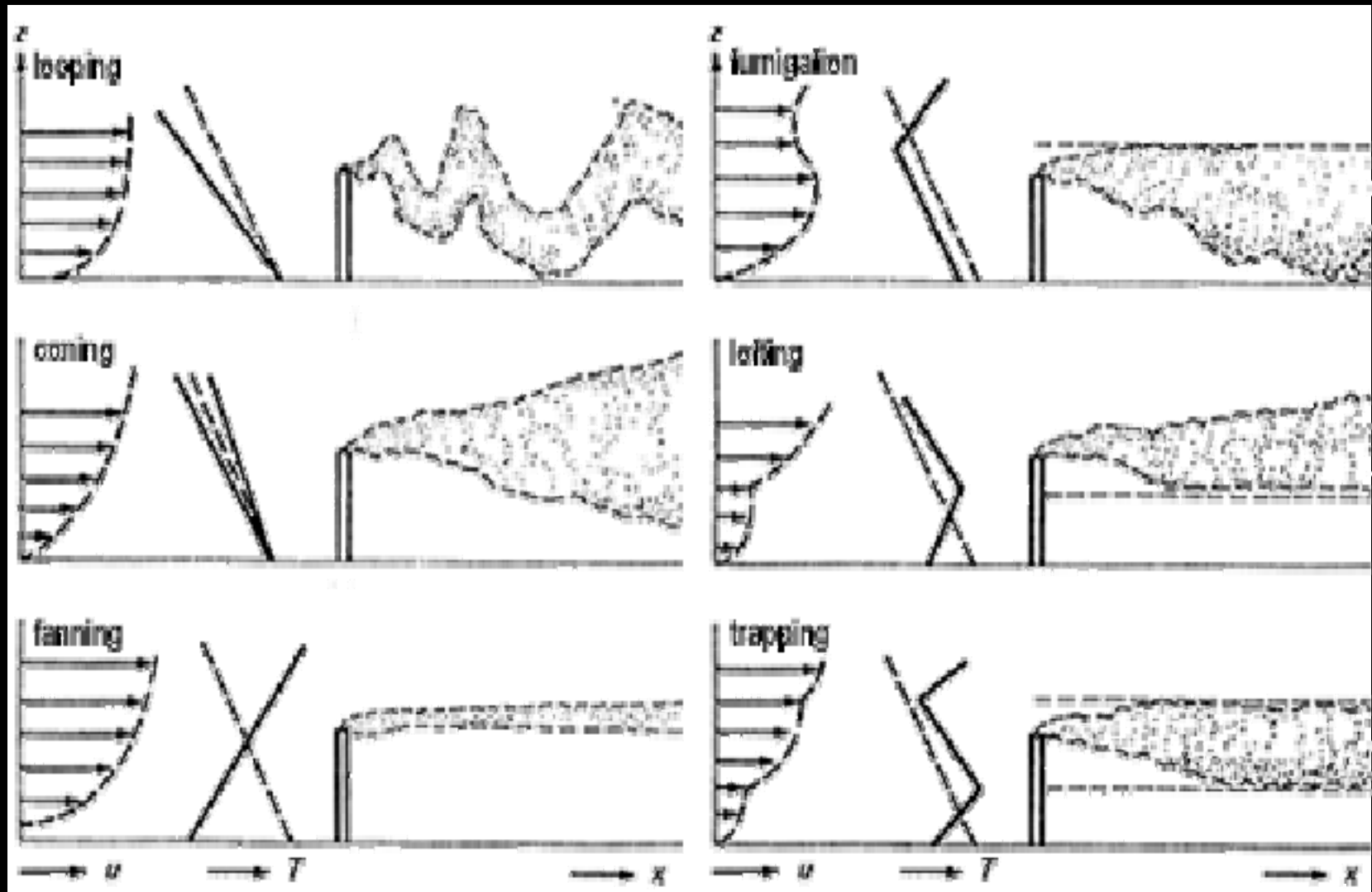
Atmospheric Temperature Profile at
Fresno on November 9, 1993



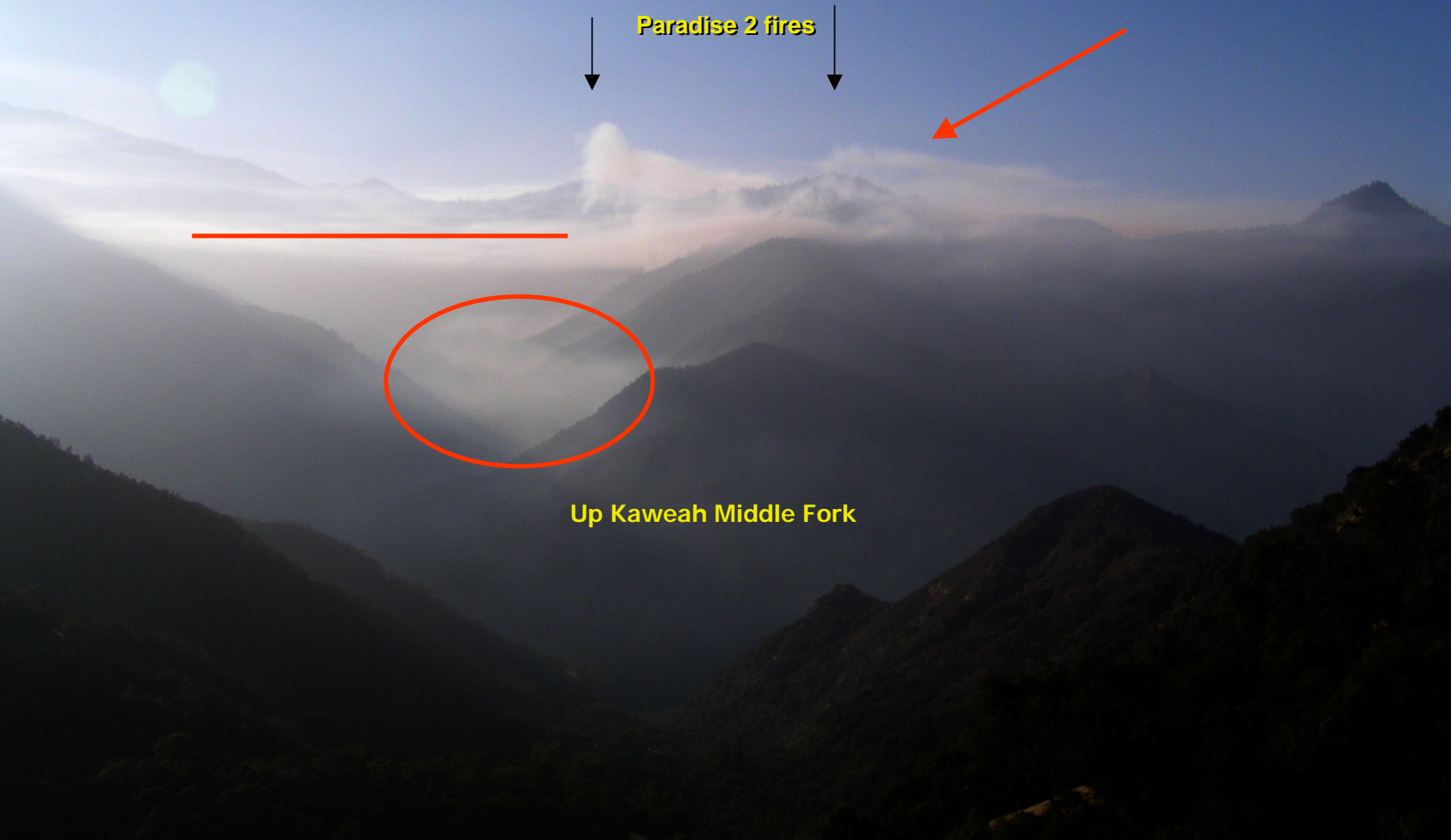
Temperature Inversion



Plume Behavior and Lapse Rate



Stable Conditions Multi-Layered Smoke



Paradise 2 fires

Up Kaweah Middle Fork

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

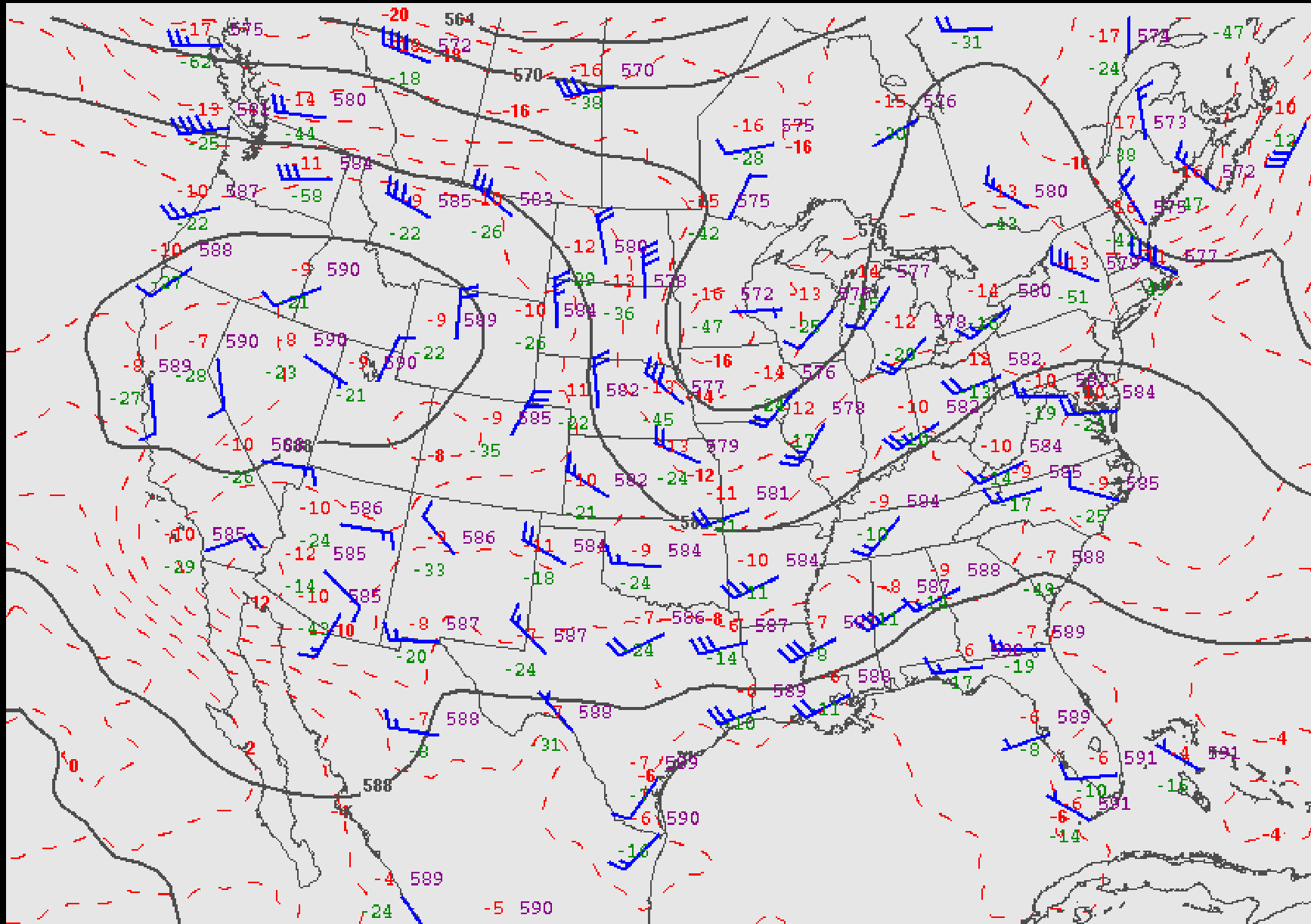


Data Sources to Assess Upper Air Transport and Dispersion

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



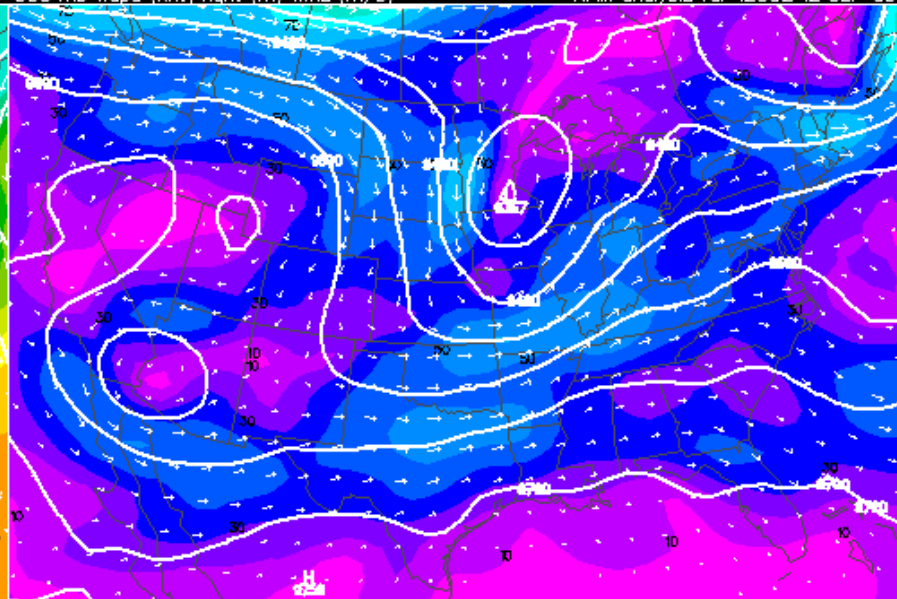
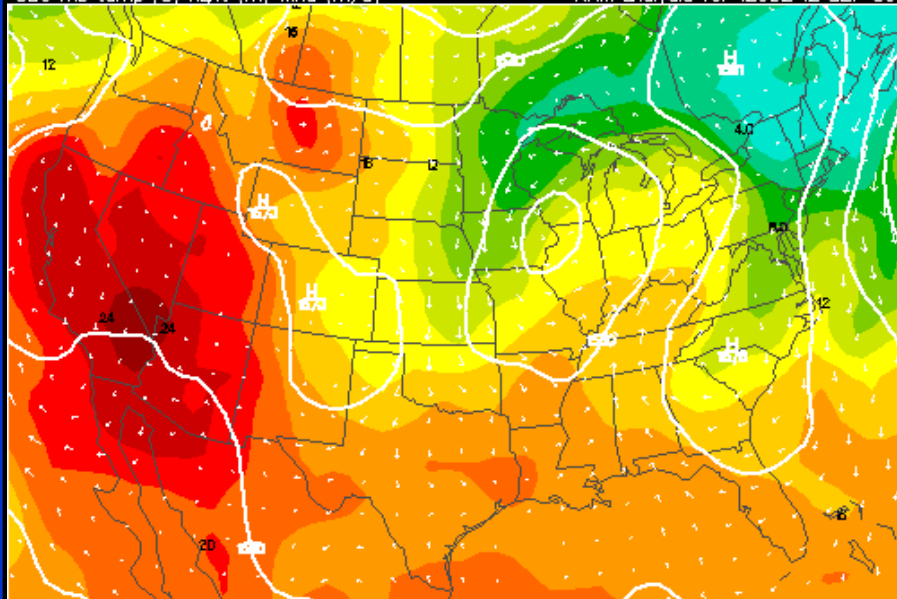
Synoptic Pattern for September 12, 2006 1 Hour Ozone Levels 131 ppb at Arvin



060912/1200 500 MB UA OBS, HGHTS, and TEMPS

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

850 mb temp (C) hght (m) wind (m/s) NAM analysis for 1200Z 12 SEP 06 300 mb wspd (krt) hght (m) wind (m/s) NAM analysis for 1200Z 12 SEP 06

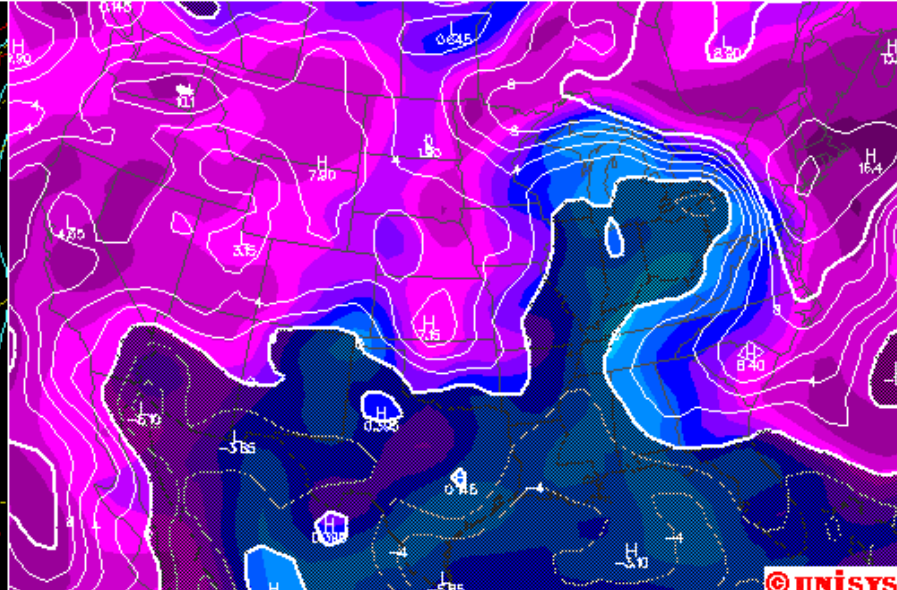
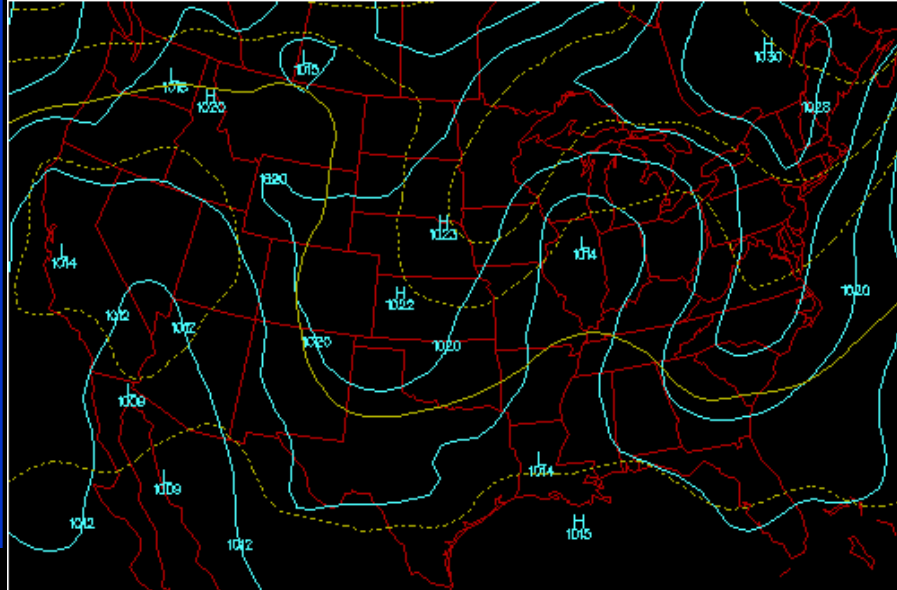


0 20 40 60 80 10 12 14 16 18 20 22 24 26 MAX VECTOR: 34.7 m/s →

0 10 20 30 40 50 60 70 80 90 100 110 120 MAX VECTOR: 60.3 m/s →

Surface prec (in) pres (mb) thick (m) NAM analysis for 1200Z 12 SEP 06

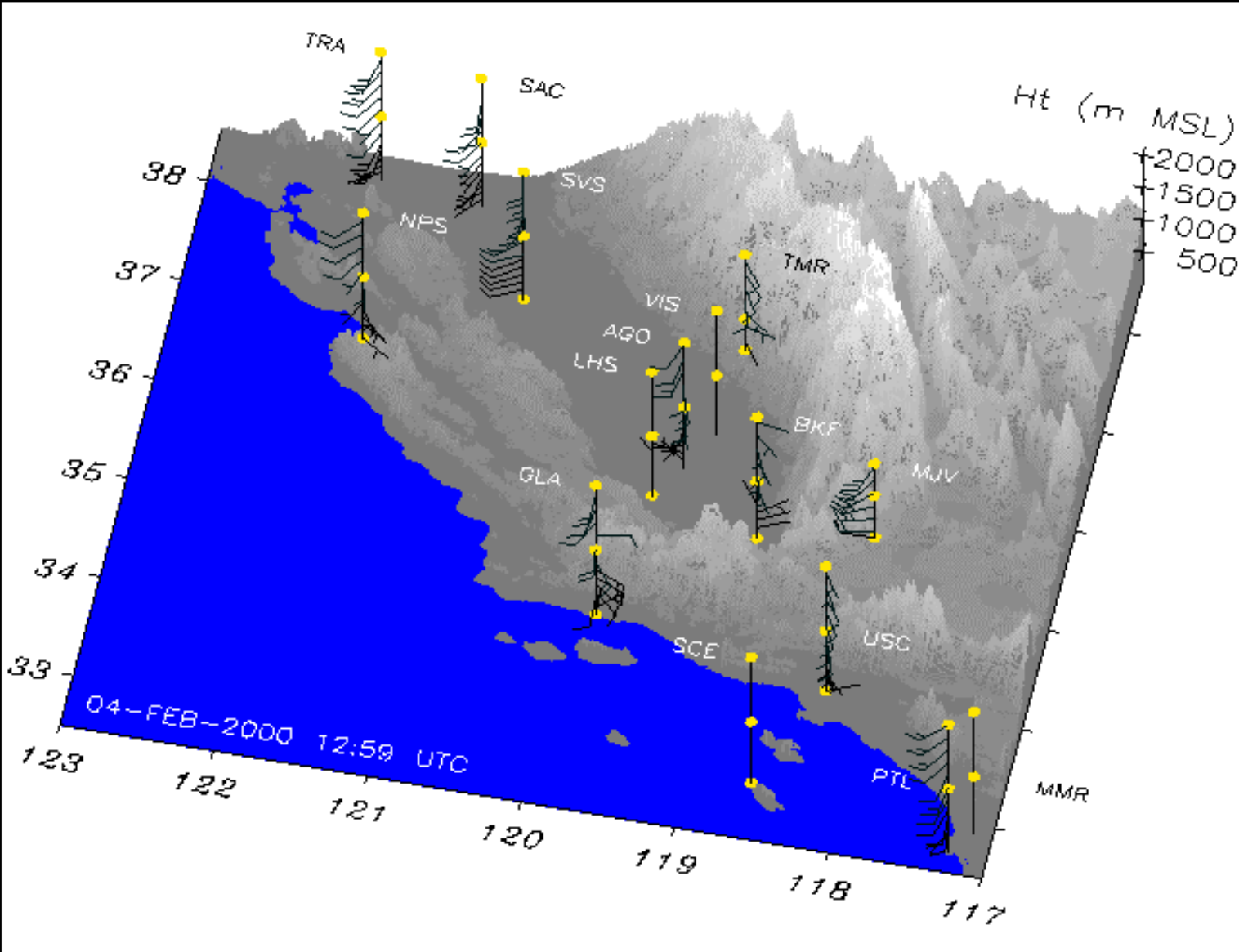
850-500 mb mtrhum (%) lift4 (dc) NAM analysis for 1200Z 12 SEP 06



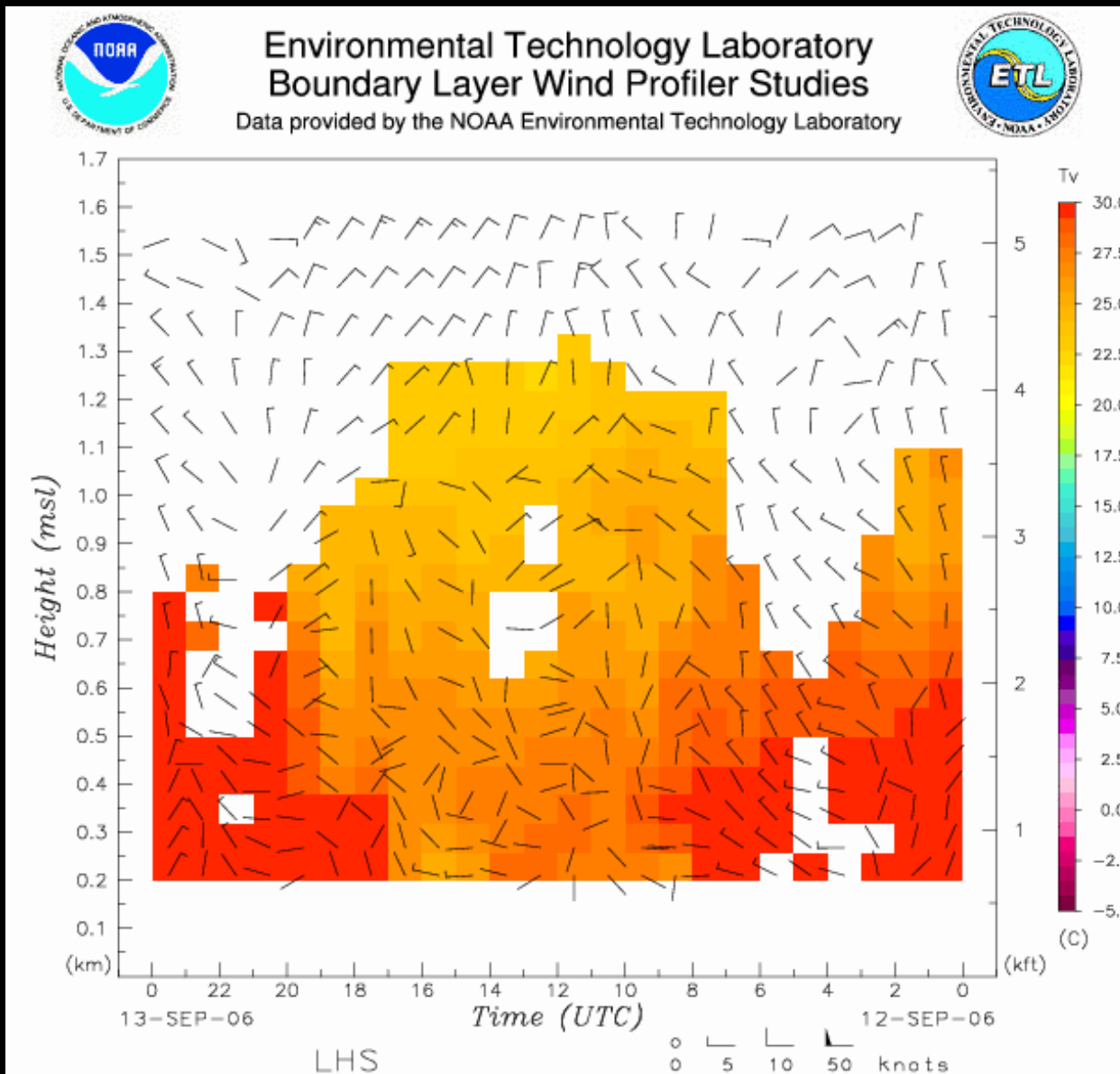
0 0.5 1 1.5 2 2.5 3 3.5 4 LO: 981.1 HI: 1029.7 LO: 5402.4 HI: 5807.9

0 10 20 30 40 50 60 70 80 90 100 LO: 2.33 HI: 99.0 LO: -6.60 HI: 18.4

Wind Profile



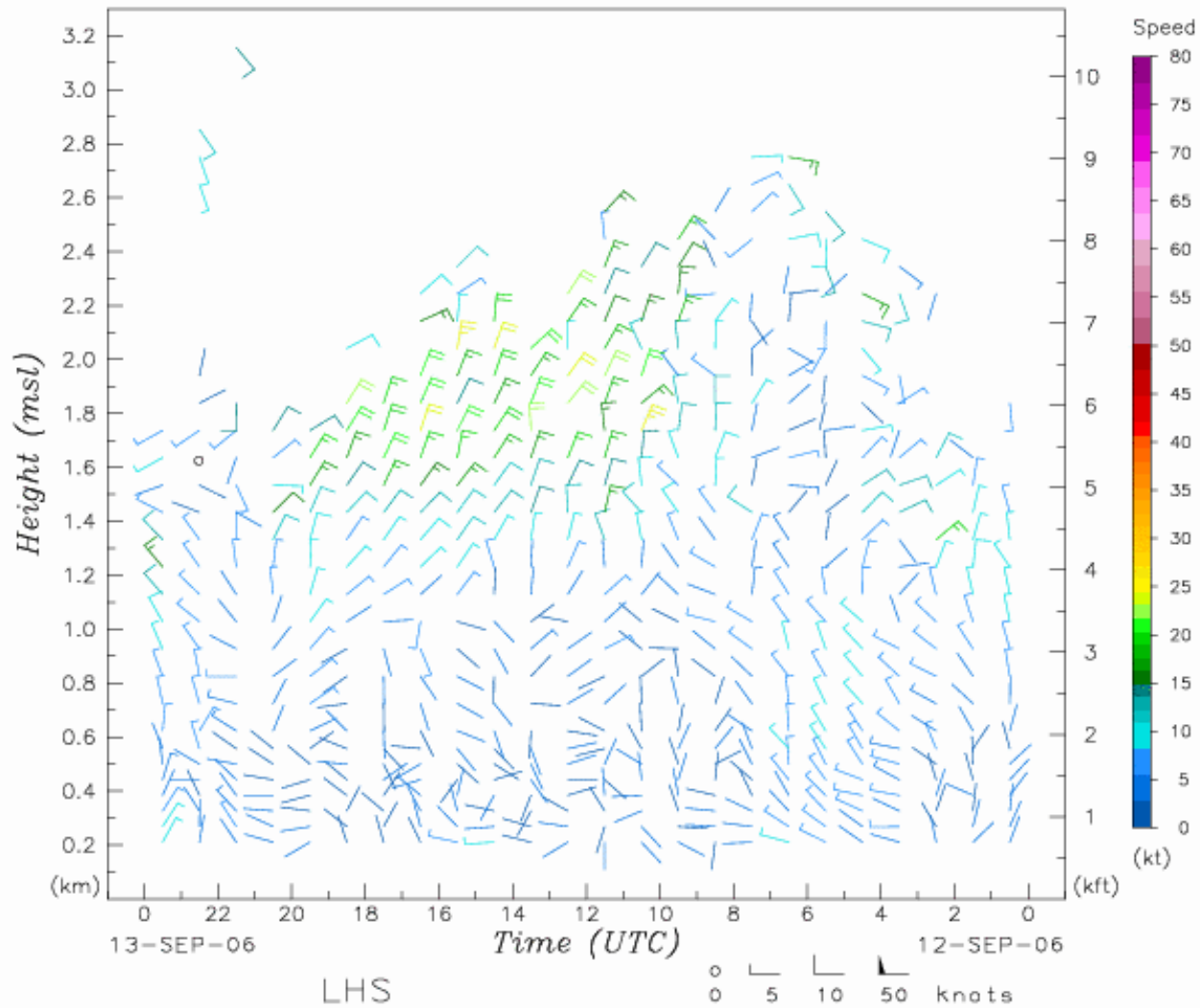
Temperature Profile At Lost Hills on September 12, 2006, Ozone Episode



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



Environmental Technology Laboratory
Boundary Layer Wind Profiler Studies
Data provided by the NOAA Environmental Technology Laboratory



Air Quality Model – Input Screen


Microsoft Access - []

File Edit View Insert Format Records Tools Window Help

Forecasting Data 9/24/2002 for 9/25/2002

Forecasting Data
Today's Recorded Values

Today's 12z Reno Pressure	<input type="text" value="1012.8"/>	This Morning's Min Temp at Modesto (F)	<input type="text" value="66"/>
Today's 12z Fresno Pressure	<input type="text" value="1008.2"/>	This Morning's Min Temp at Fresno (F)	<input type="text" value="63"/>
Today's 12z Las Vegas Pressure	<input type="text" value="1008.5"/>	This Morning's Min Temp at Bakersfield (F)	<input type="text" value="70"/>
Today's 12z Oak 850 Height (m/10)	<input type="text" value="150.2"/>	Today's 6-9am NO2 ave at MOD (F)	<input type="text" value="0.039"/>
Today's 12z Oak 850 Temp(C)	<input type="text" value="22.2"/>	Today's 6-9am NO2 ave at Bak (F)	<input type="text"/>
Today's 12z Oak 850 WD	<input type="text" value="265"/>	Prev 24 hour Max CO North	<input type="text"/>
Today's 12z Oak 850 WS(m/s)	<input type="text" value="3"/>	Prev 24 hour Max CO Central	<input type="text" value="1.1"/>
Today's 12z Oak 500 Height (m/10)	<input type="text" value="584"/>	Prev 24 hour Max CO South	<input type="text" value="1.2"/>
Today's 12z Oakland 500 Temp: (C)	<input type="text" value="-8.7"/>	Prev 24 hour Stockton PM10 Ave:	<input type="text"/>
Today's 12z 5000ft SacTemp (F)	<input type="text" value="75"/>	Prev 24 hour Modesto PM10 Ave:	<input type="text"/>
Today's 12z 2500ft Fresno Temp (F)	<input type="text" value="84"/>	Prev 24 hour Clovis PM10 Ave:	<input type="text" value="20"/>
Today's 12z 5000ft Fresno Temp (F)	<input type="text" value="75"/>	Prev 24 hour Corcoran PM10 Ave:	<input type="text" value="66"/>
Today's 12z 2500ft BakTemp (F)	<input type="text" value="78"/>	Prev 24 hour Bakersfield PM10 Ave:	<input type="text"/>
Today's 12z 5000ft BakTemp (F)	<input type="text" value="70"/>	Today's Northern O3 Max:	<input type="text" value="45"/>
		Today's Central O3 Max:	<input type="text" value="28"/>
		Today's Southern O3 Max:	<input type="text" value="73"/>
		<i>Used For Data Finder</i>	<input type="text"/>
		<i>Shafter Precipitation Today</i>	<input type="text"/>
		<i>Firebaugh Precipitation Today</i>	<input type="text"/>
		<i>Modesto Precipitation Today</i>	<input type="text"/>



Form View NUM




Air Quality Model - Output

Microsoft Access - [SiteSpecificResultsForm : Form]

File Edit View Insert Format Records Tools Window Help

AQA Model

Forecast For: 9/23/2002



Ozone		
Site	1-hour	8-hour
Merced	76	67
Modesto	80	64
Stockton	76	61
Tracy	76	63
Turlock	87	72
Clovis	109	98
Fresno1st	106	89
FresnoDrummond	97	86
FresnoSSP	98	88
Hanford	100	93
Madera	79	75
Parlier	112	93
Arvin	120	100
Bakersfield	104	92
Edison	124	101
Maricopa	98	91
Oildale	97	85
Shafter	79	71
Visalia	101	85
LowerKaweah	96	85
AshMountain	85	88
Shaver	95	79

PM10	
SanJoaquinPM:	38
MercedStanislausPM:	50
FresnoMaderaPM:	64
TulareLakeBasinPM:	71
EastValleyTularePM:	69
EastValleyKernPM:	64
WestValleyKernPM:	61

CO	
NorthCO:	0.6
CentralCO:	0.9
SouthCO:	0.9

SJV Simplified Title 17 Burn Status Estimate

North	No Burn Day
Central/South (>3000ft)	No Burn Day
Central/South (<3000ft)	Burn Day

View PM Tile Plots

View O3 Tile Plots

View 8hr O3 Tile Plots

Print Forecast

Run Script

Return to Main Menu

Previous Menu

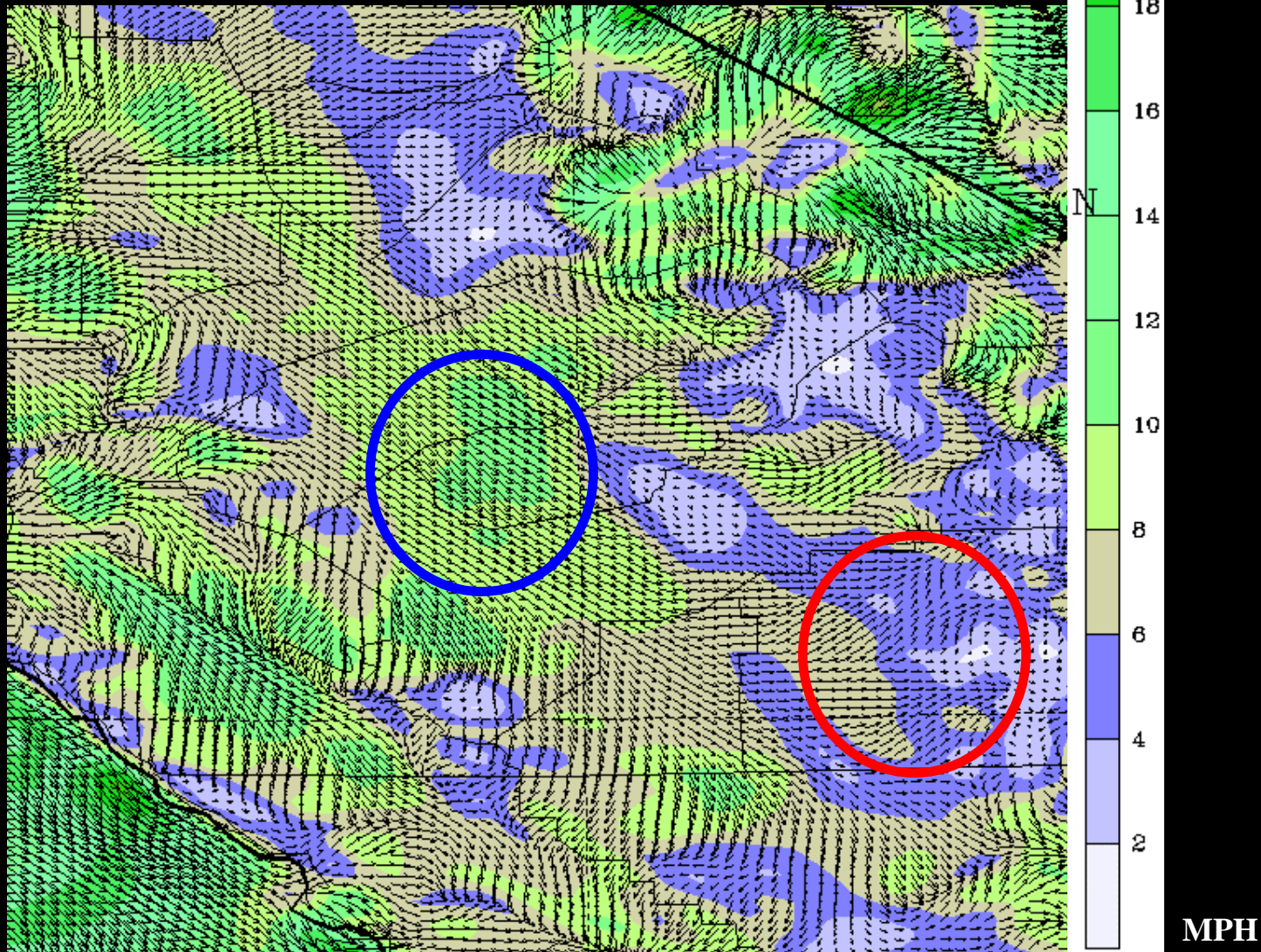
Record: 1 of 1

Form View

NUM



Small Scale Weather Model Specifically Designed for the San Joaquin Valley



Web Camera

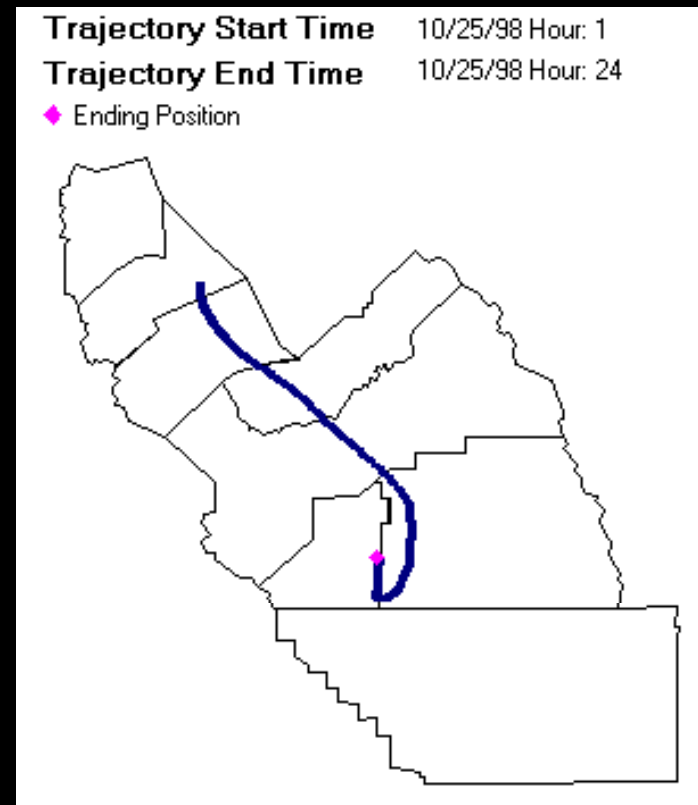
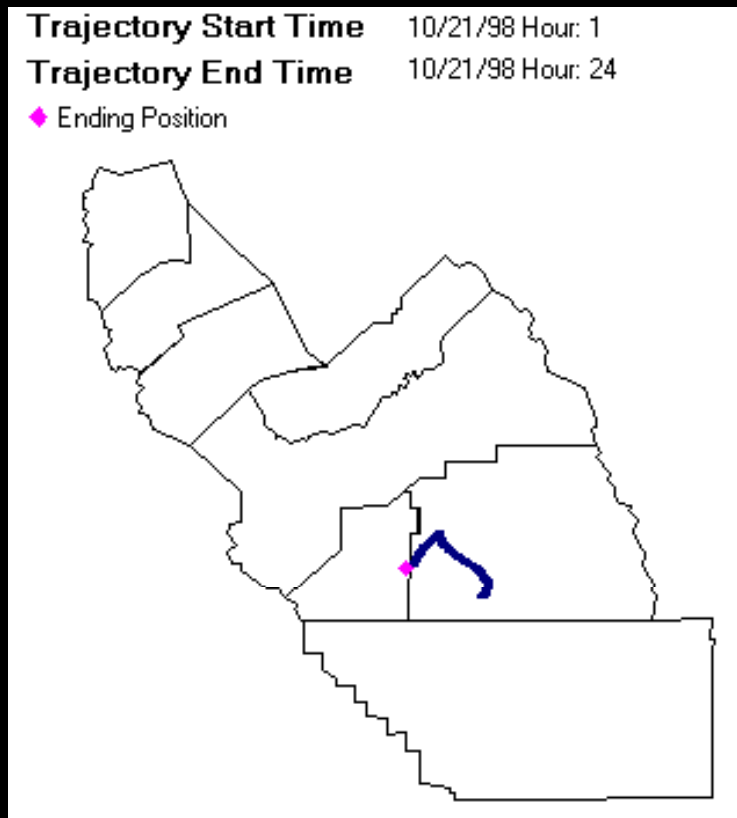


Synoptic Weather Pattern Associated Poor Dispersion and High Ozone and Particulate Concentrations

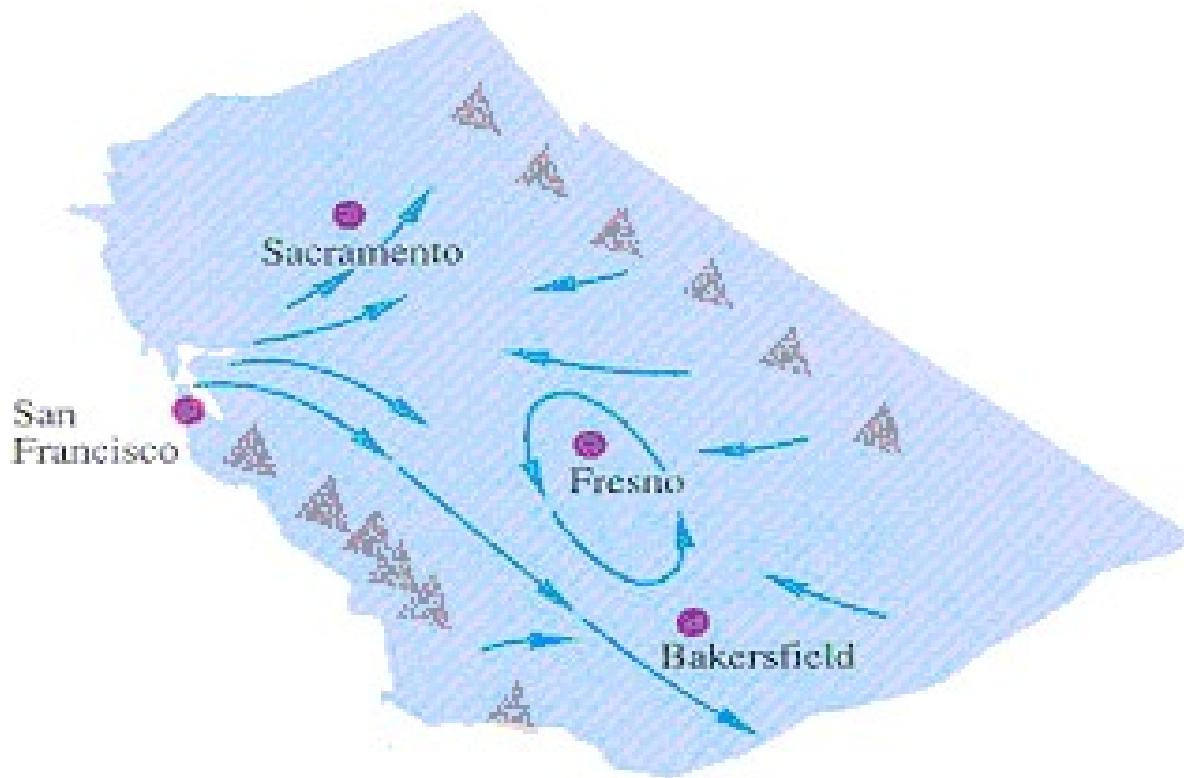
- Pattern dominated by High Pressure
- Weak Easterly Winds Aloft Opposing Normal Thermally Driven Winds
- Large Scale Weak Pressure Gradients
- Subsidence
- Warmer Temperatures Aloft
- Warm Surface Temperatures (Ozone)



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



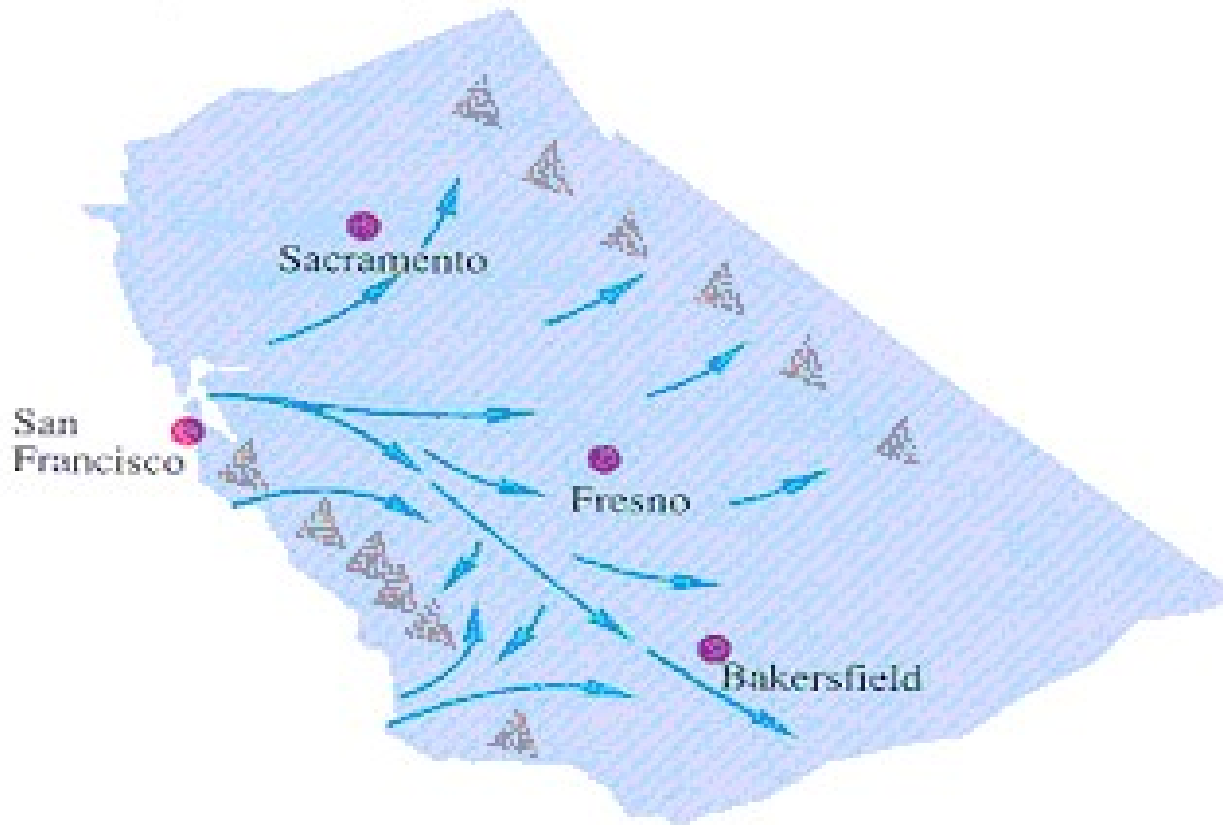
Nighttime Wind Flow for O₃ Season



Nighttime Wind Flow Patterns



Daytime Wind Flow for O₃ 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



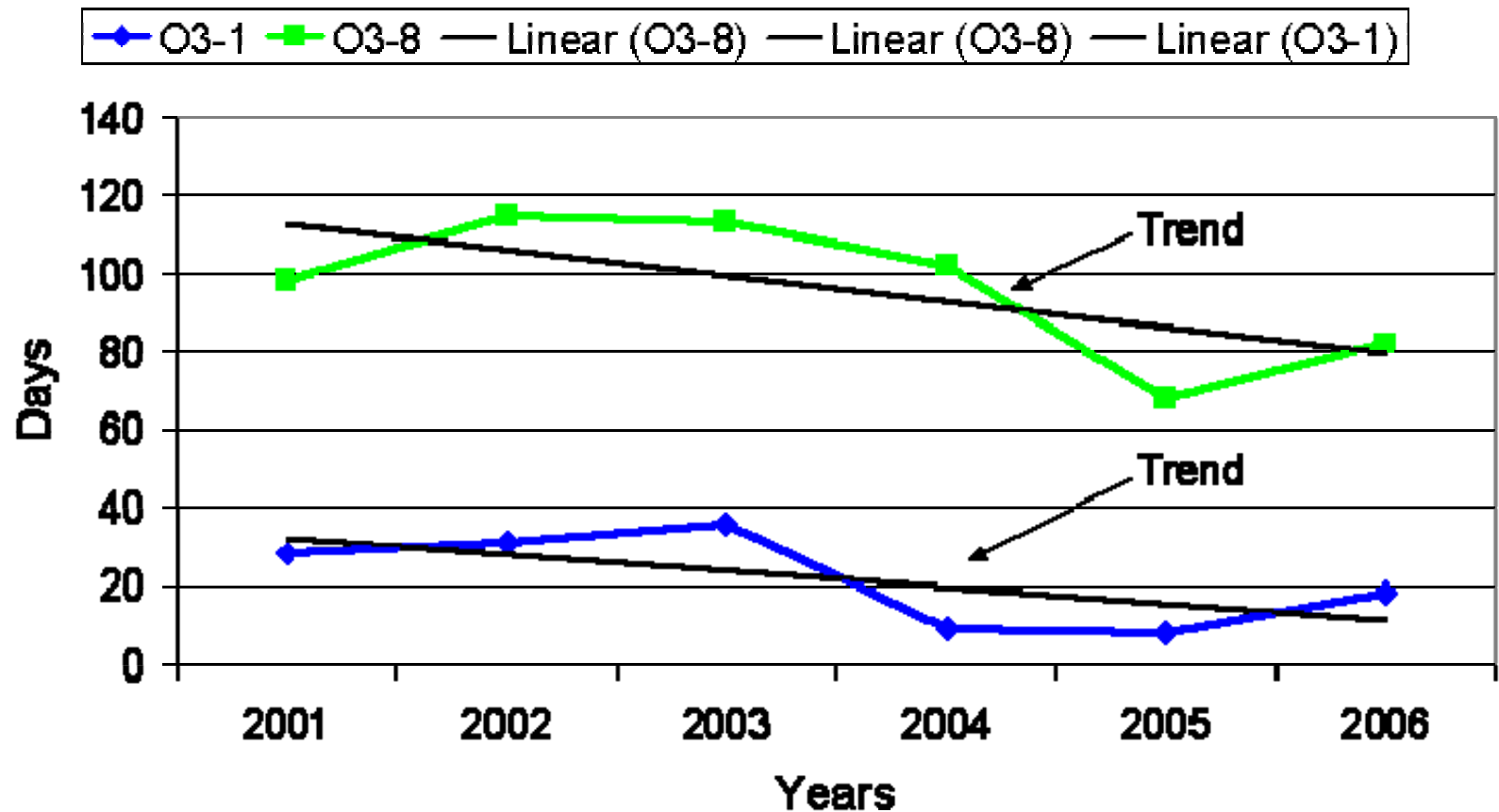
State of Air Quality – Ozone Ambient Concentrations, 1990-2005

- 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)

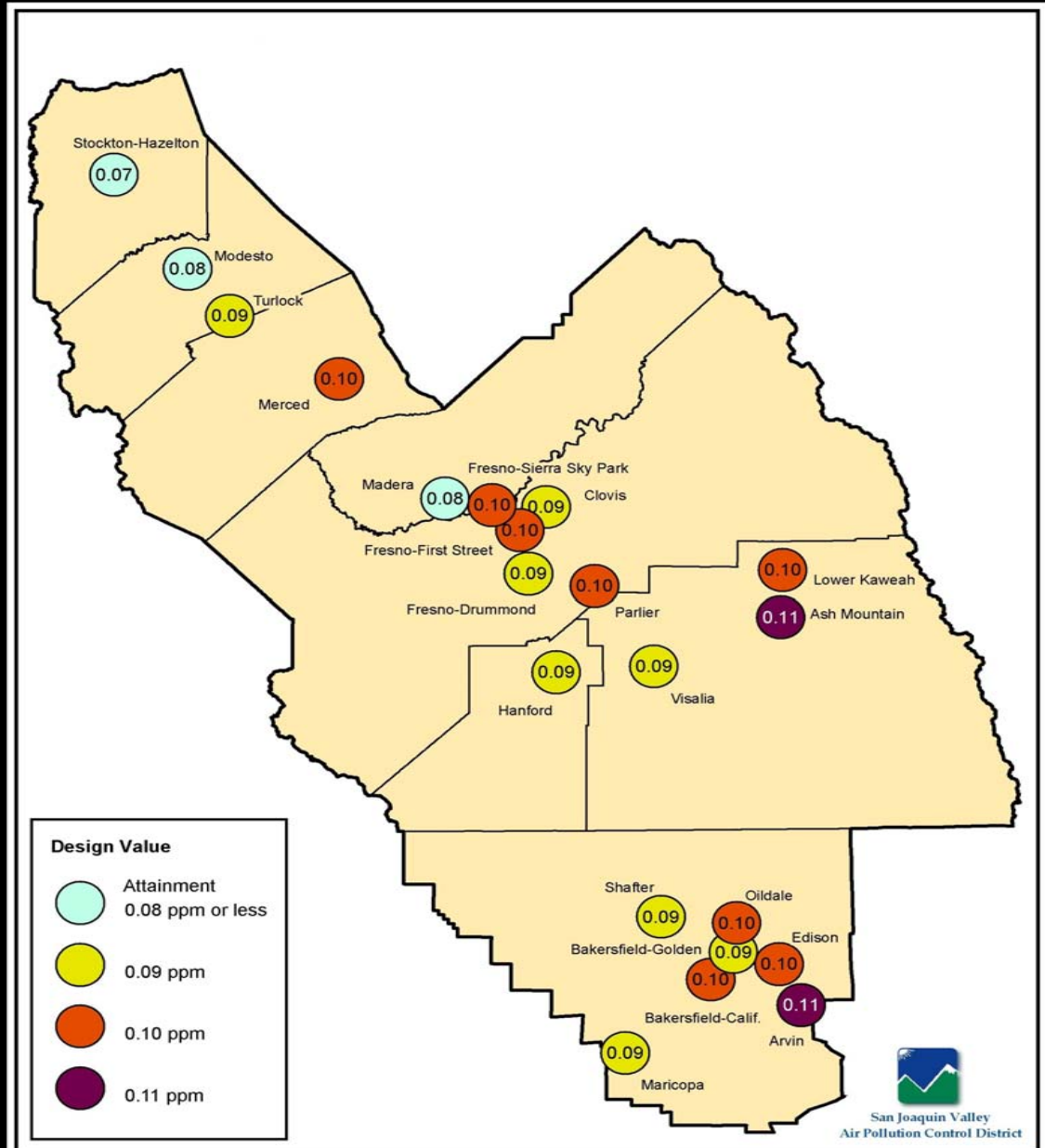


Ozone Trends in SJV

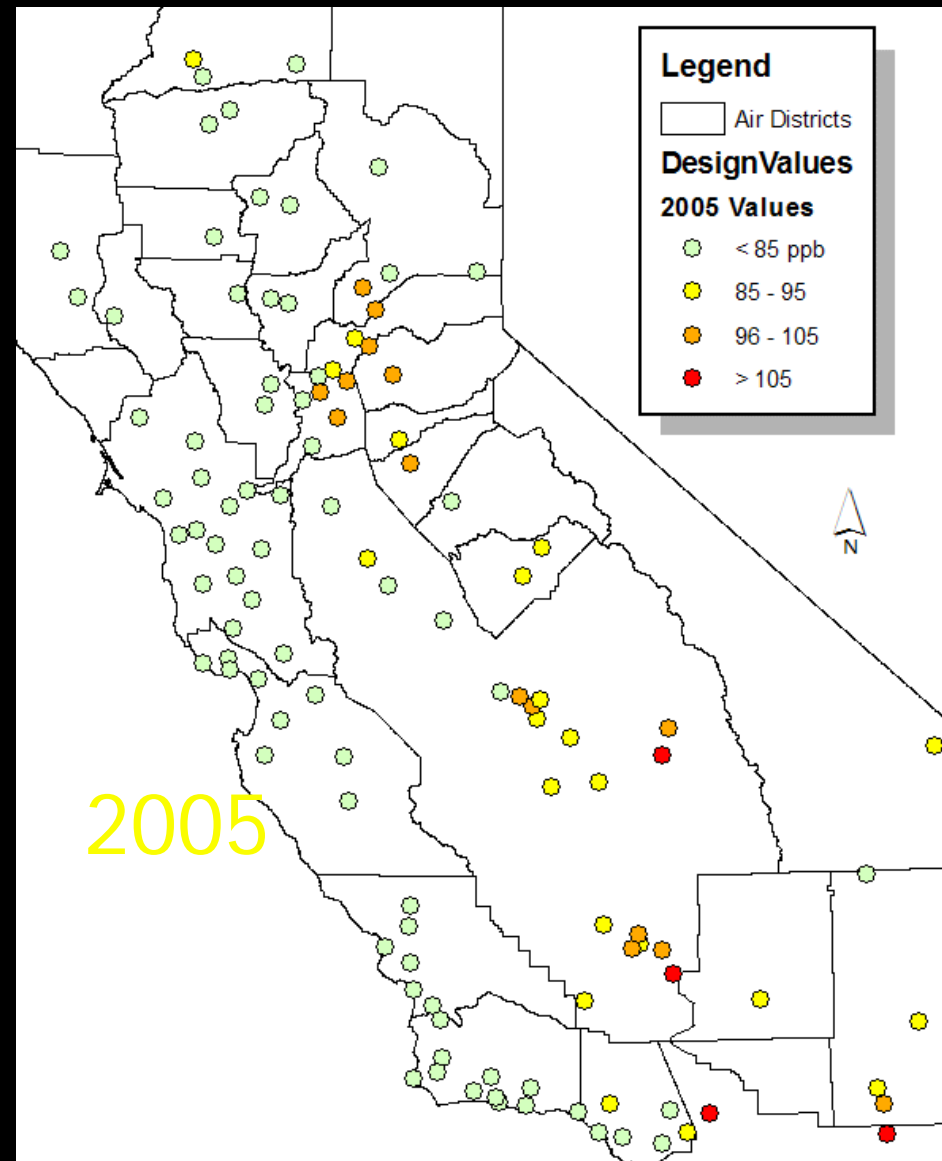
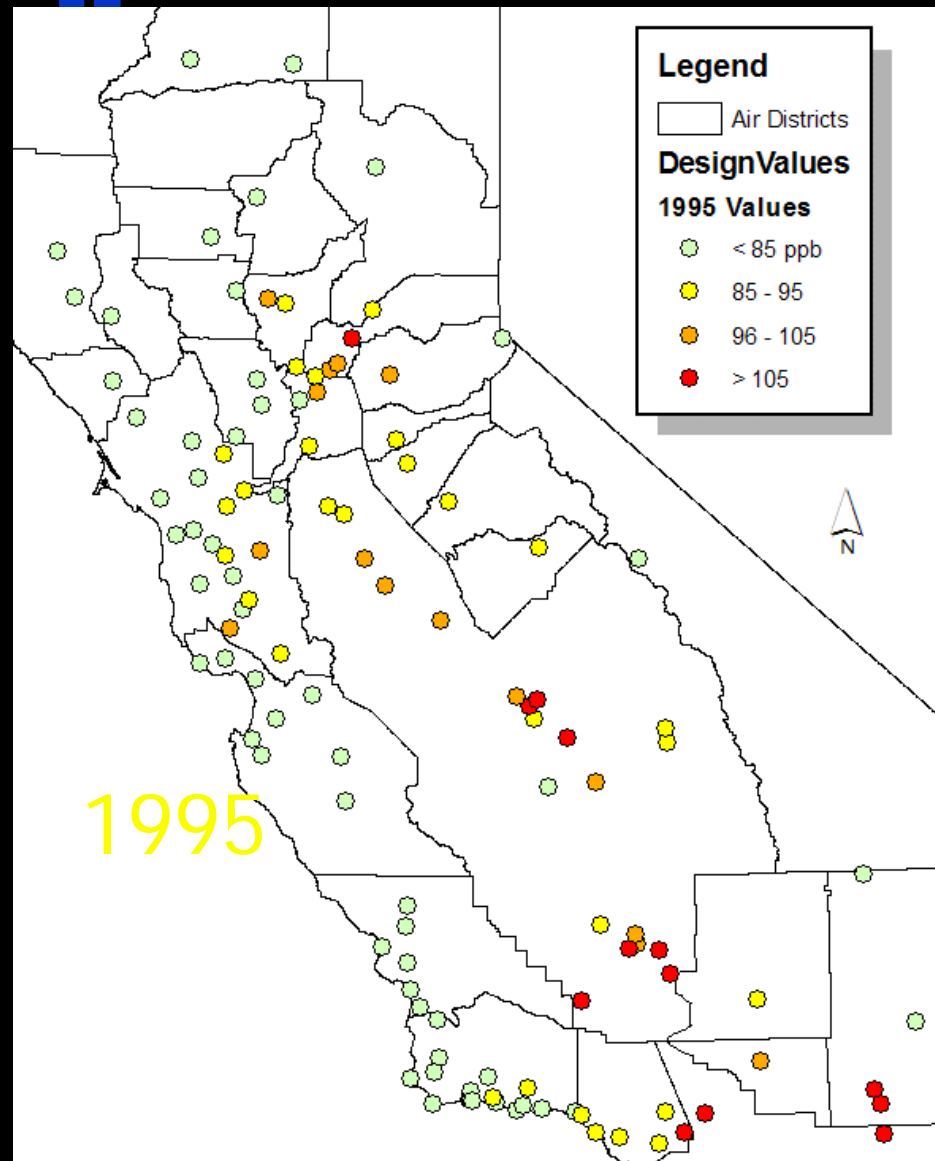
Basin-Wide Year-To-Date (September 27)
Ozone Exceedance Days



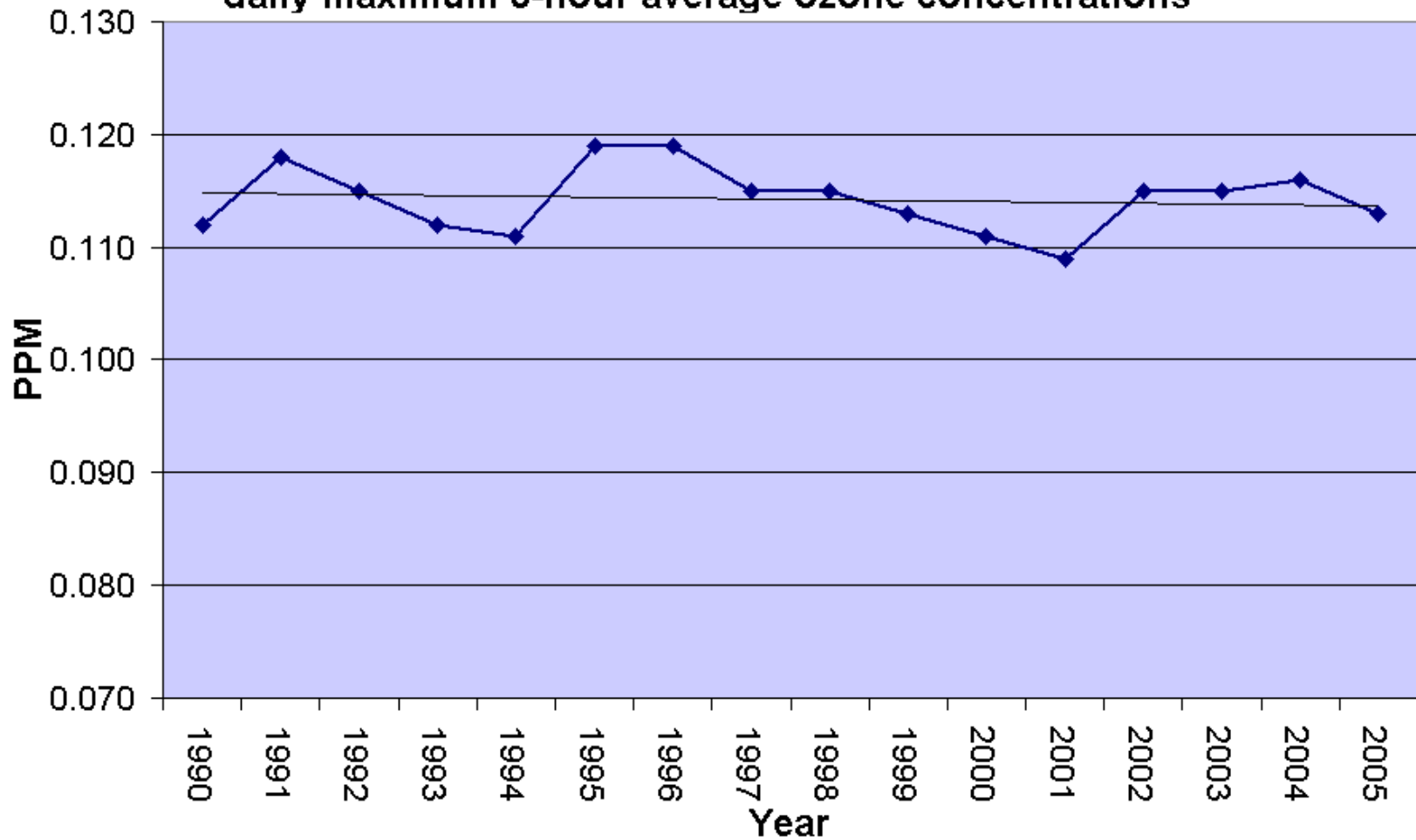
8-Hour Ozone Design Value (2005)



Ozone 8-Hour Spatial Extent Reduced

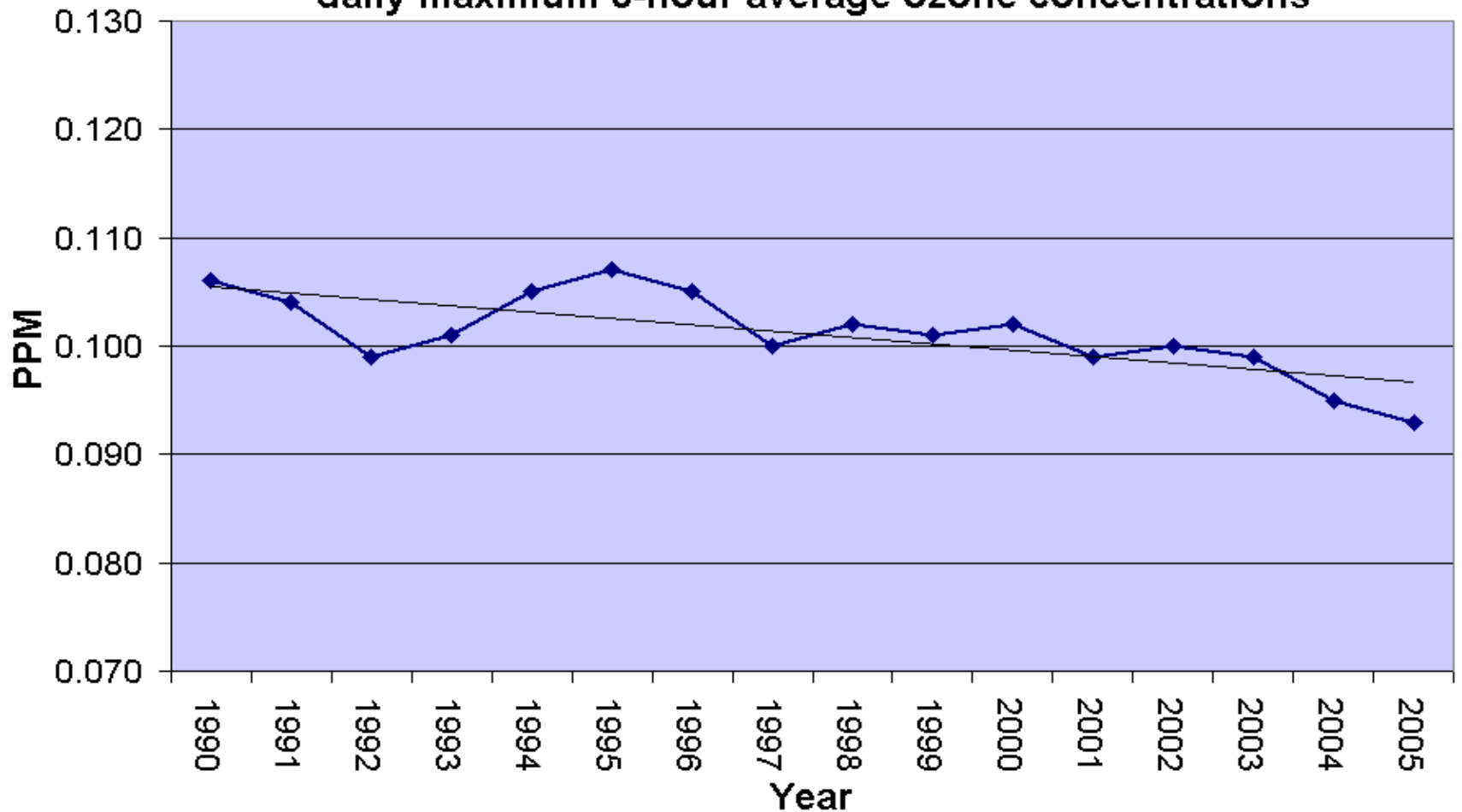


San Joaquin Valley (District-wide)
3-year average of the annual fourth-highest
daily maximum 8-hour average ozone concentrations



Visalia

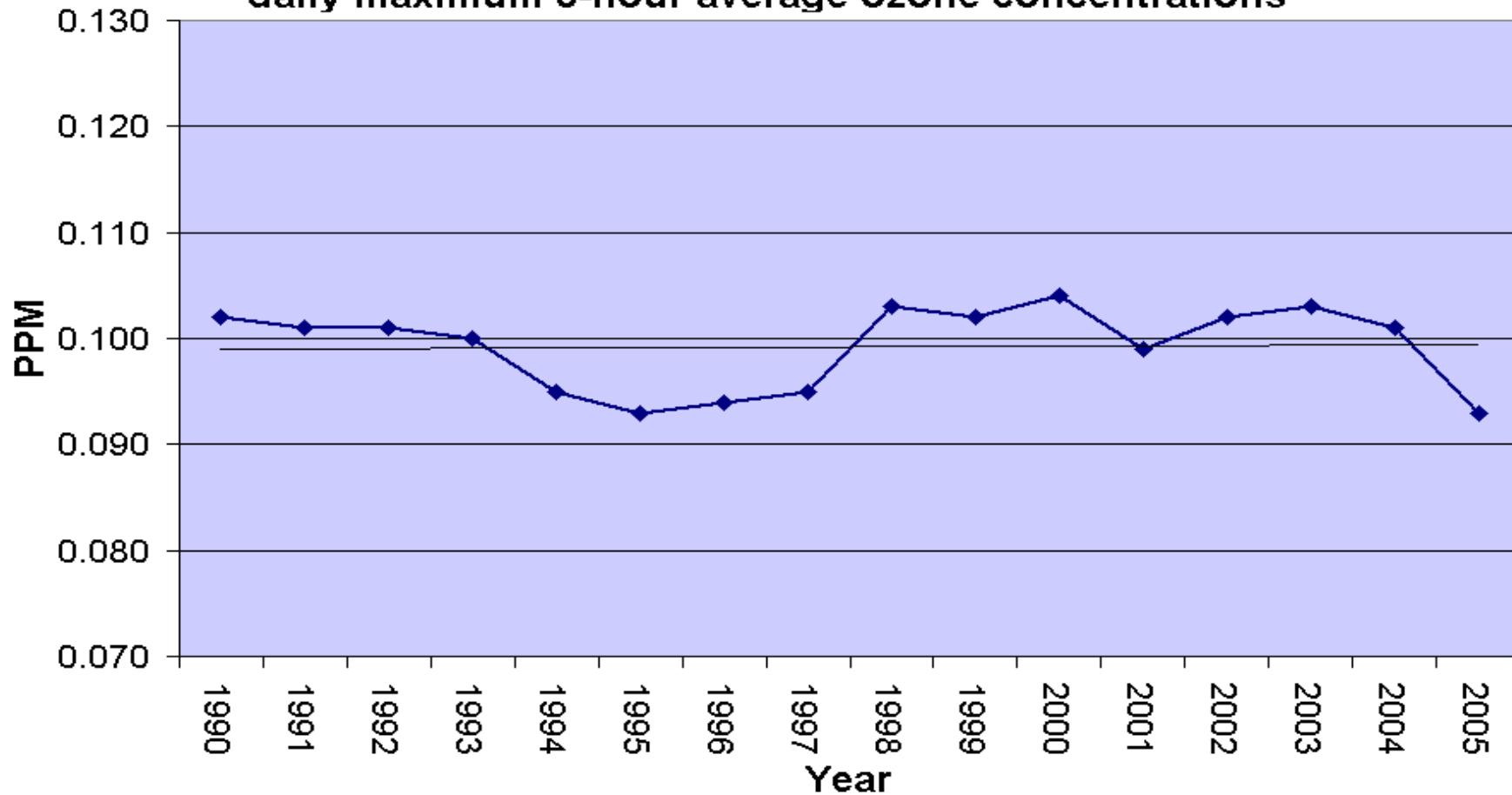
3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentrations



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



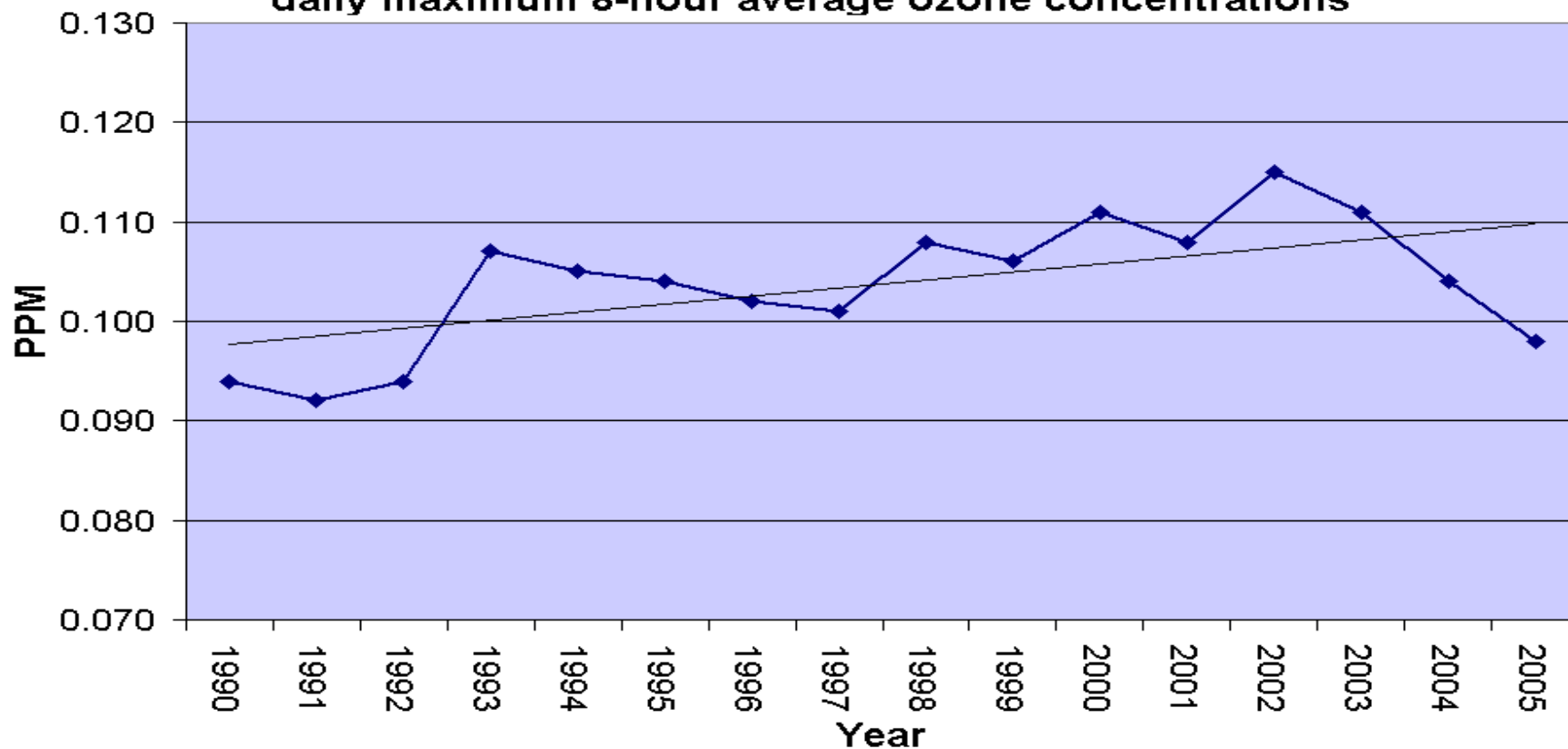
Fresno Drummond
3-year average of the annual fourth-highest
daily maximum 8-hour average ozone concentrations



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



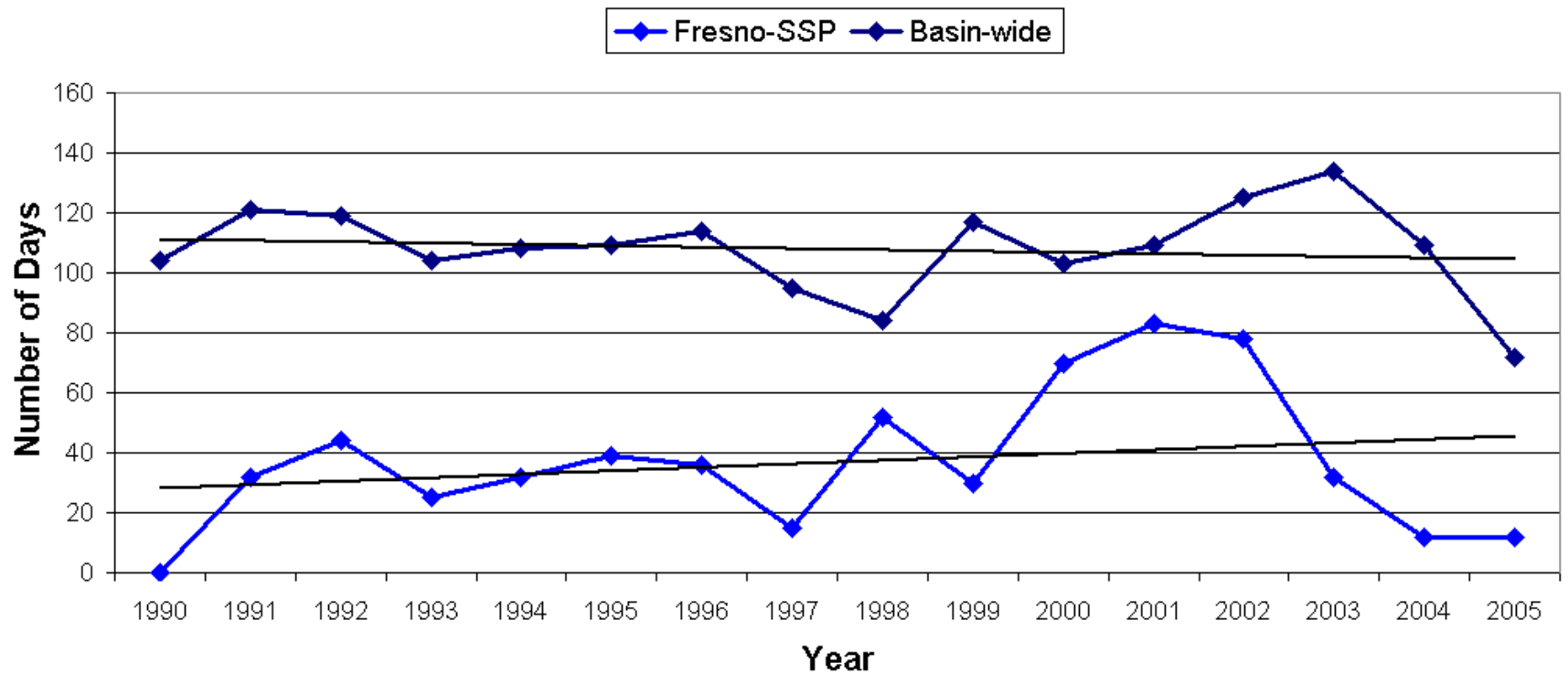
Fresno Sierra Sky Park
3-year average of the annual fourth-highest
daily maximum 8-hour average ozone concentrations



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%



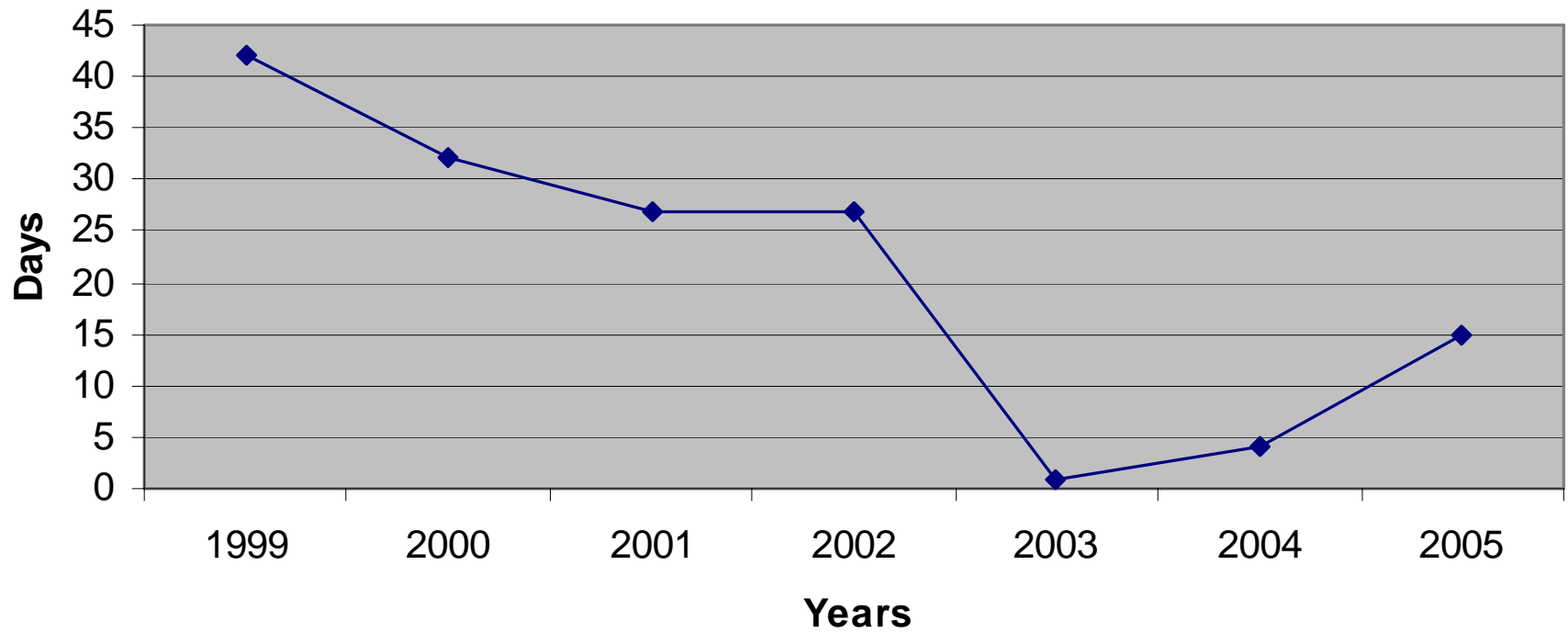
State of Air Quality – PM10 Ambient Concentrations, 1990-2005

- 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



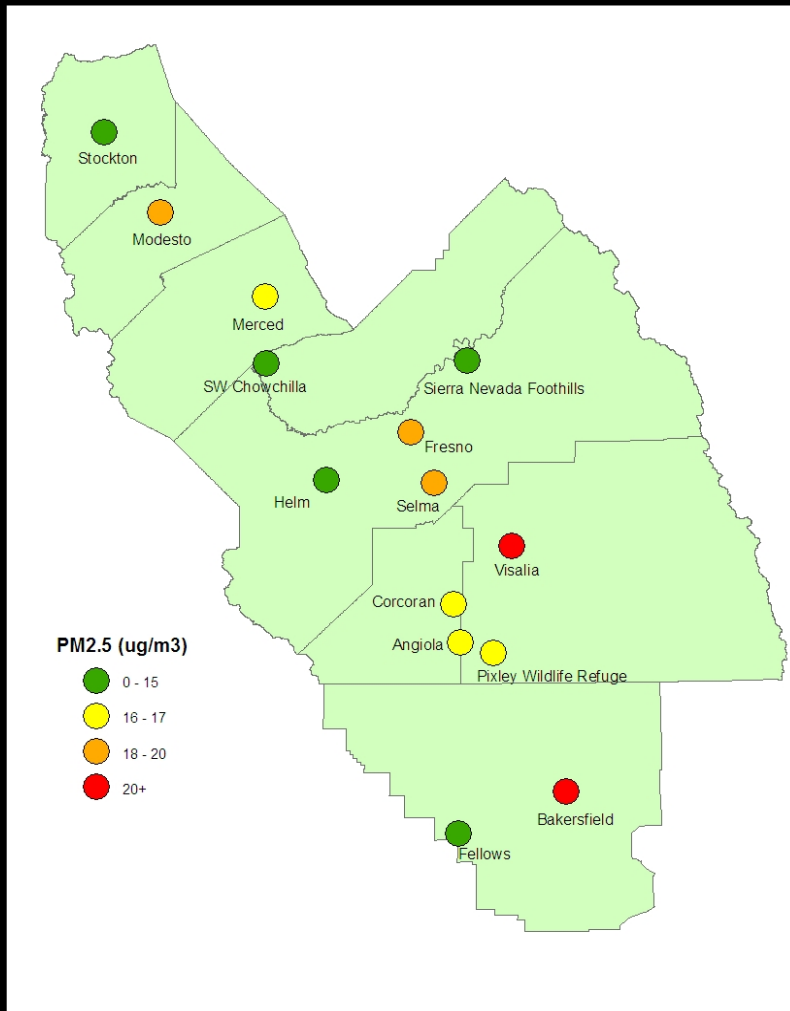
Trend in the Number of Days Greater Than the PM2.5 24 Hour National Standard

Basin-Wide Days Over PM2.5 Standard



PM2.5 Spatial Extent Reduced

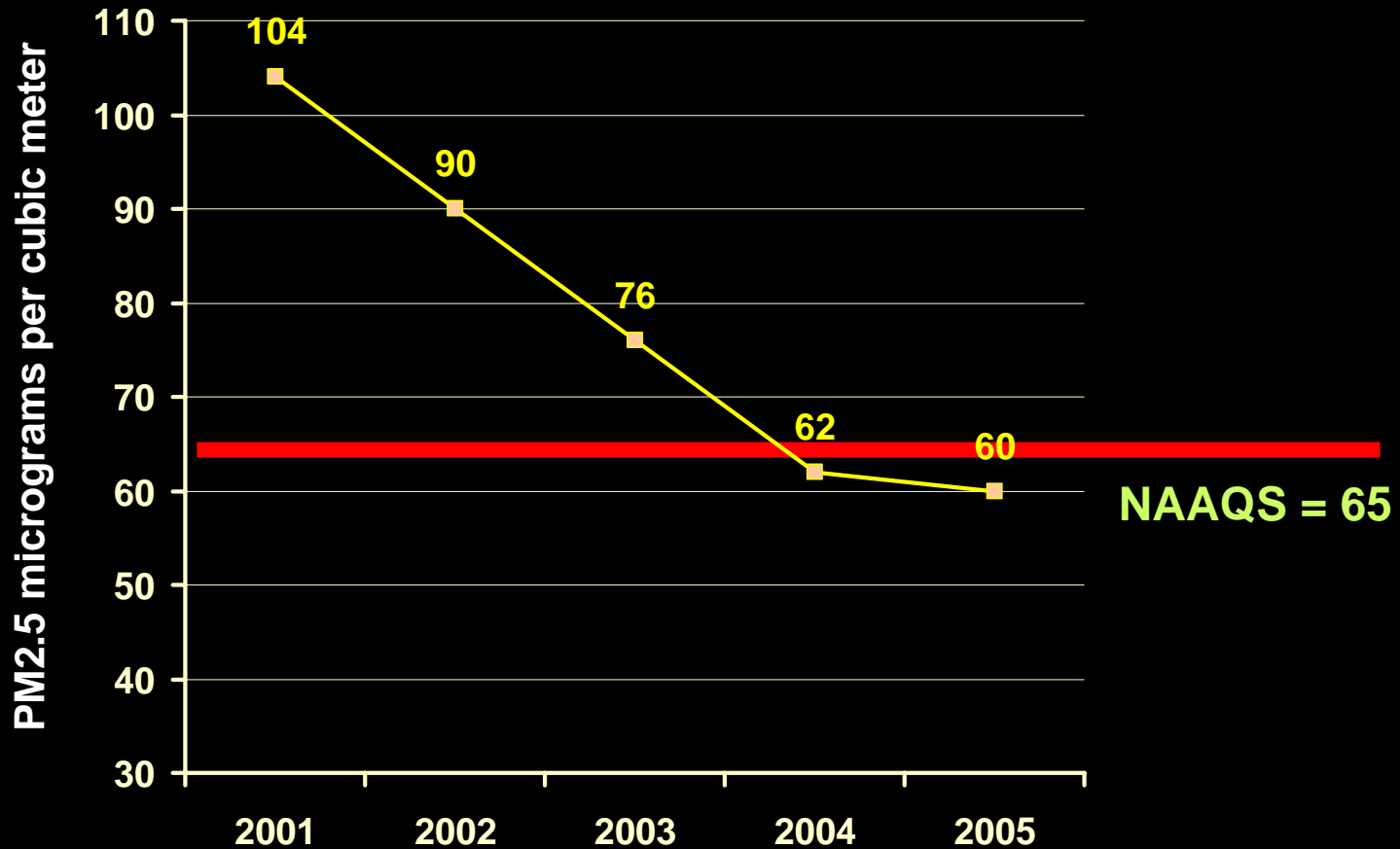
2000 PM2.5 Annual Average



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

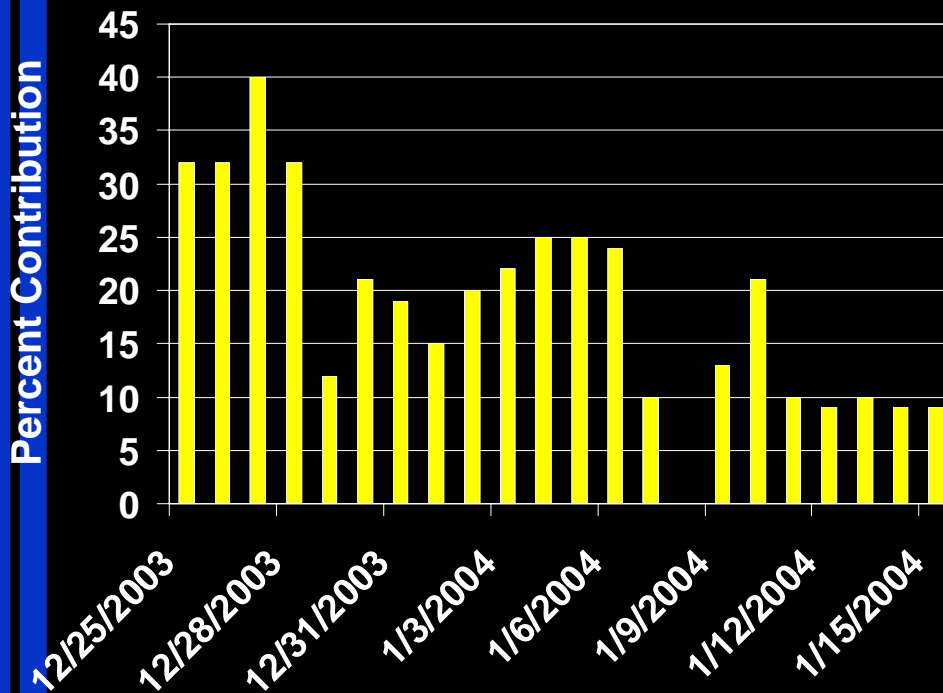
Attainment of 24-hr PM2.5 Standard

3-year Average of 98th Percentile,
Highest SJV site shown for each year



Vegetative Burning Controls

Woodsmoke Contribution to PM2.5 at Fresno



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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