

SAN JOAQUIN VALLEY 2012 PM2.5 SIP

Overview of PM2.5 Science & Research

*California Air Resources Board
January 24, 2013*



Outline

- Current scientific knowledge of 24-hour PM2.5 pollution in the San Joaquin Valley
- Use of photochemical models to determine precursor limitations
- Ongoing efforts to improve the scientific foundation

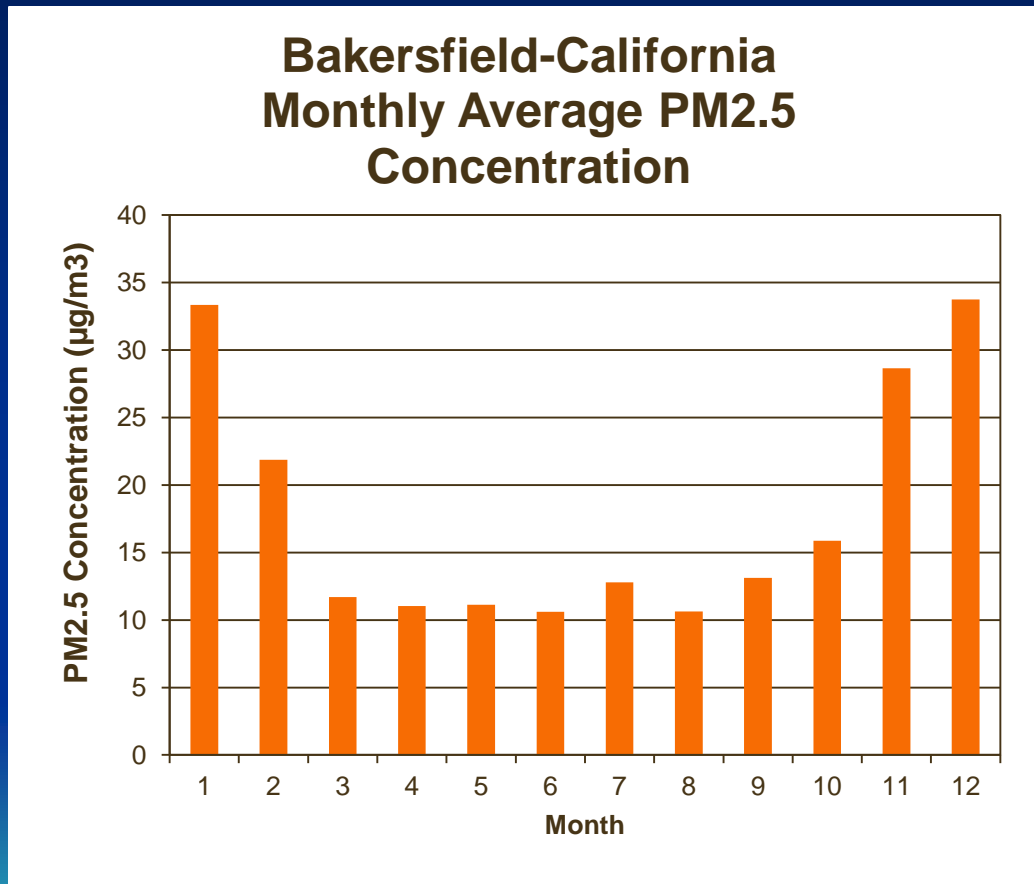
Science in the SIP Process

- Requires a strong scientific foundation
- Provides ambient measurements to expand our understanding of the nature of PM_{2.5}
- Improves the algorithms in models and their ability to simulate air quality conditions
- Supports model applications to predict future air quality and the response to controls

California Regional Particulate Matter Air Quality Study (CRPAQS)

- Major field study conducted in 2000
- Funded by a public/private partnership
- Provided the fundamental science behind annual plan and current 24-hour plan
- Most comprehensive data and science in the country on the origin and fate of PM_{2.5}
- Continues to be a cornerstone of PM_{2.5} research

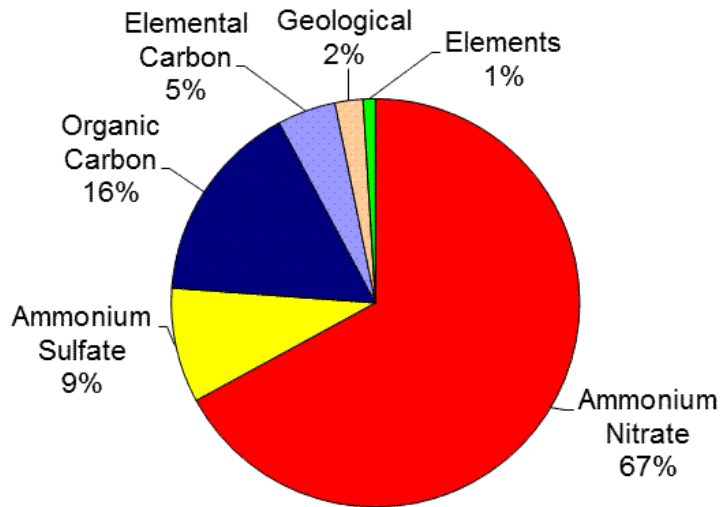
High PM2.5 Levels Occur In Winter



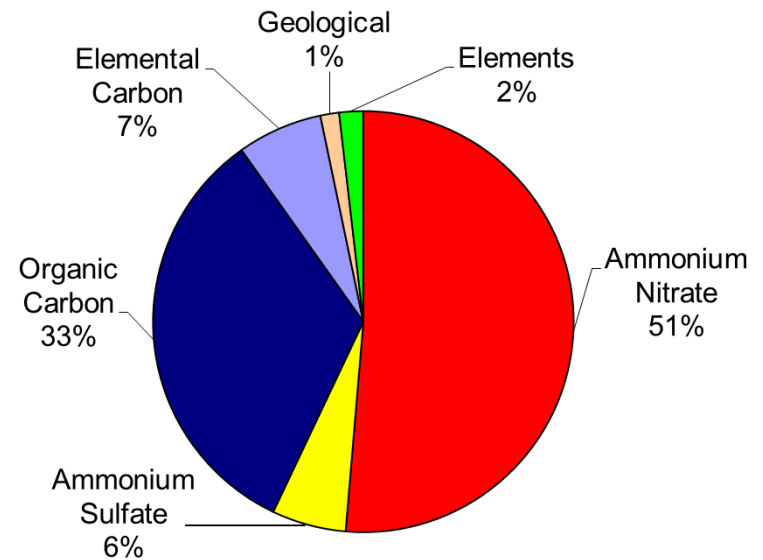
- PM2.5 builds up over several days or weeks (episode)
- Episodes generally occur during periods with:
 - stagnation
 - cool temperatures
 - high humidity
 - low mixing depths

PM2.5 Chemical Composition

2008-2010 Peak Day Composition
Bakersfield



2008-2010 Peak Day Composition
Fresno



Ammonium Nitrate

- Further oxidation of oxides of nitrogen (NO_x) leads to the formation of nitric acid
- Nitric acid reacts with ammonia to form ammonium nitrate which is regional in nature
- Reducing NO_x is most effective in reducing ammonium nitrate
- Since 2002, winter-average NO_x and ammonium nitrate have decreased by ~40%

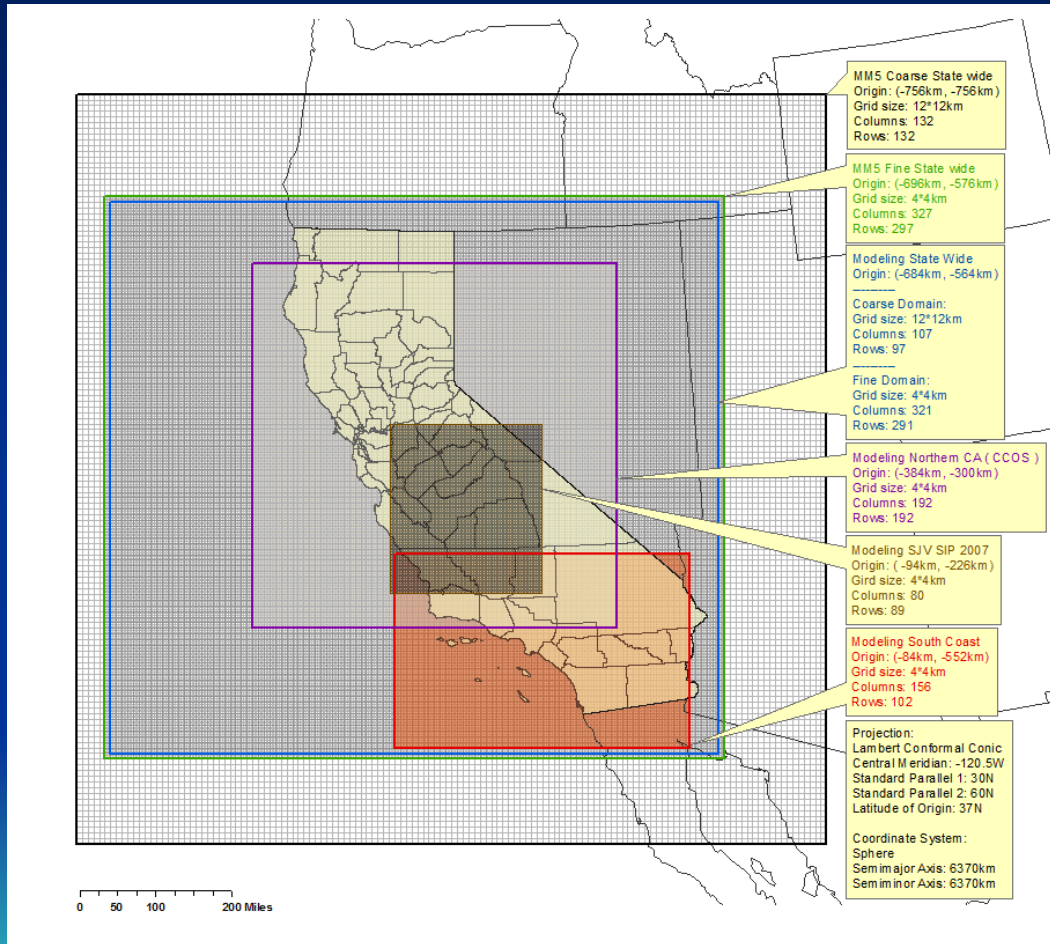
Organic Carbon

- Organic carbon can be either:
 - primary (directly emitted)
 - secondary (formed in the atmosphere)
- Primary organic carbon dominant in winter
- Concentrations are highest in urban areas (wood burning, cooking, and mobile sources)
- Since 2002, winter-average organic carbon has decreased ~50%

Use of Photochemical Models

- Identifying the most effective mix of pollutants to control
- Establishing attainment targets
- Models are best used in a relative (rather than absolute) sense
- Attainment test combines measured data and modeling to project air quality into the future

Modeling Process



Meteorology Model:

Predicts weather variables for every grid cell every few seconds for an entire year

Air Quality Model:

Predicts all components of PM_{2.5} for every grid cell every few seconds for a year

Model Performance Evaluation: Does the model replicate the observed nature of the PM_{2.5} problem?

Determining Precursor Sensitivity

- Air quality models provide the best tool to evaluate the potential effectiveness of controlling different PM_{2.5} precursors
- We have conducted model sensitivity runs for NO_x, Primary PM_{2.5}, NH₃, VOC, and SO_x
- This analysis has been done as part of previous modeling efforts for CRPAQS as well as the current PM_{2.5} plan
- The current plan integrates results of these studies in determining the most effective control approach

Effect of 25% Precursor Reductions at Bakersfield – California

Precursor	PM _{2.5} Reduction (µg/m ³)	µg/m ³ Reduction/ton
Primary PM2.5	4.44	0.34
NOx	3.75	0.08
NH ₃	0.55	0.008
SOx	0.18	0.08
VOC	-0.10	-0.001

Summary of Precursor Effectiveness

- Reductions in direct PM_{2.5} are the most beneficial
- NO_x controls also provide large benefits
- NH₃ controls offer very small benefits
- VOC controls produce very small disbenefits

Ongoing Efforts to Improve Science

- Annual science meetings:
 - *International Conference on Atmospheric Chemical Mechanisms*
 - *International Aerosol Modeling Algorithms Conference*
 - *International Conference on Meteorology Modeling*
- Field studies to improve modeling databases:
 - *U.S. EPA/ARB Advanced Monitoring Initiative (Feb. 2007)*
 - *ARCTAS (June 2008)*
 - *CalNex (May-July 2010)*
 - *Discover AQ (Jan-Feb 2013)*



NASA UC-12



NASA P-3B

- A five-year NASA campaign to improve the use of satellites to monitor air quality
- Deployment began on January 16, 2013 in the San Joaquin Valley
- ARB and EPA, together with academia, are major collaborators

San Joaquin Valley 2012 PM_{2.5} SIP



Outline

- Proposed Board Action
- Nature of Valley's PM_{2.5} Problem
- Attaining the PM_{2.5} Standard
- Future Valley SIPs

Proposed Board Action

- District adopted 2012 PM2.5 SIP on December 20, 2012
- SIP meets Clean Air Act requirements
- Staff recommending approval

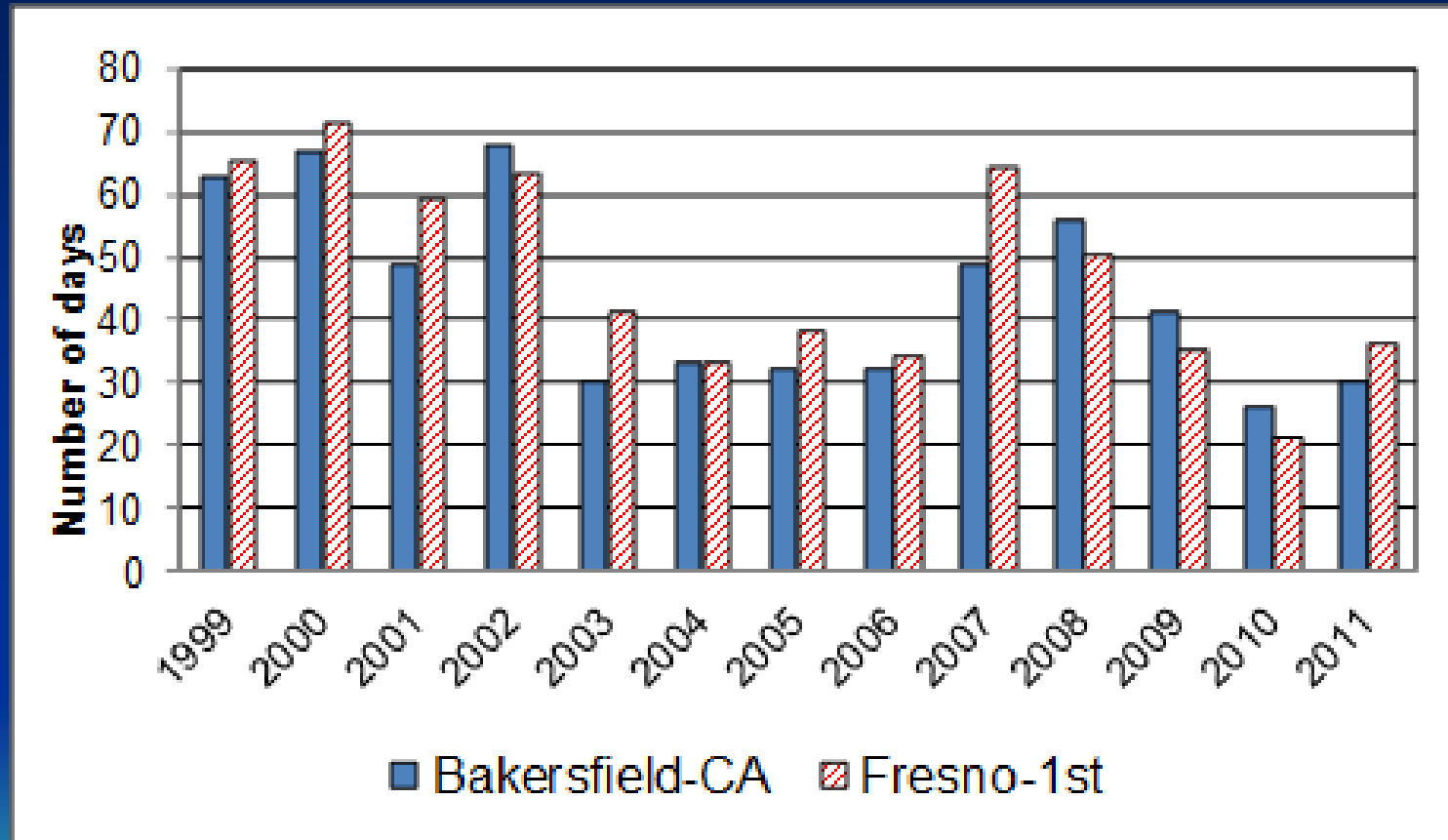
Nature of the Valley's PM2.5 Problem



Valley Conducive to Pollutant Formation

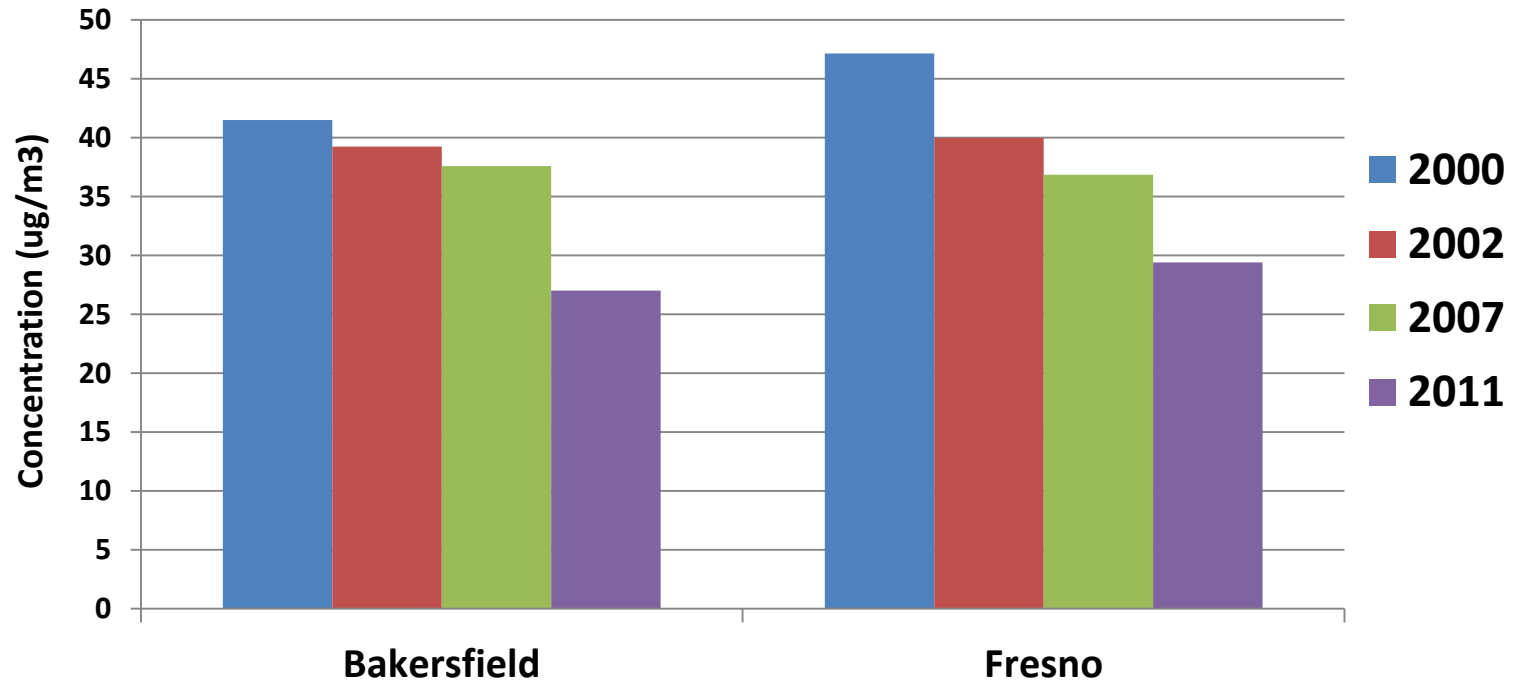
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Year to Year Variability

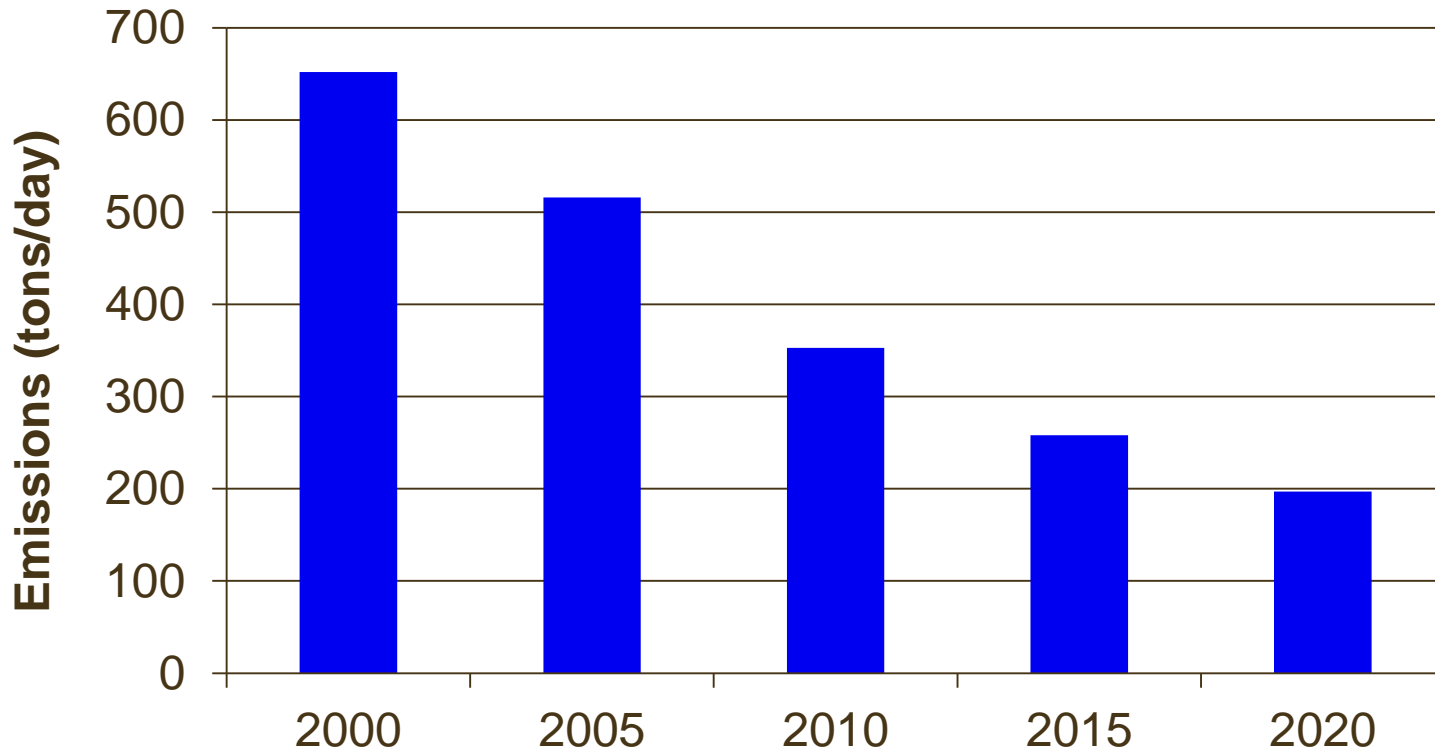


Progress Accounting for Weather

Trends in Winter-Average PM2.5 in Years with PM-Conducive Weather Conditions



Ongoing NOx Reductions



Preliminary Assessment of 2012 PM2.5 Data

- 2011 weather was very conducive to high PM2.5 concentrations
- 2012 weather was more moderate
- Most 2012 PM2.5 design values expected to improve compared to 2011

Attaining the PM_{2.5} Standard



Current PM2.5 SIP Revision

- District adopted SIP revision on December 20, 2012
- Addresses 35 ug/m³ PM2.5 standard established in 2006
- 90% of Valley attains by 2017; remaining Bakersfield site attains by 2019

Attainment Demonstration

- Ongoing ARB and District programs and enhanced wood burning rule bring Valley into attainment with exception of Bakersfield
- Commercial cooking measure brings Bakersfield into attainment

Importance of Controlling Directly Emitted PM_{2.5}

- Ammonium nitrate is decreasing Valleywide
- Directly emitted PM_{2.5} significant contributor to wintertime PM_{2.5} episodes
- Key attainment strategy:
 - Diesel engines and passenger vehicles
 - Residential wood burning
 - Commercial cooking operations

Curtailing Residential Wood Burning

- Exposure to wood smoke increases hospitalization and emergency room visits for:
 - Asthma
 - Other respiratory illnesses
 - Cardiovascular disease
- District's current rule provides significant health benefits
- Strengthening rule provides additional protection for children, asthmatics, and other sensitive populations

Reducing Commercial Cooking Emissions

- Current District rule applicable to chain driven devices
- Expands rule to under-fired devices
- Pushes technology advancement
- District working with South Coast

“Significant” PM2.5 Precursors

- Under EPA Rule, PM2.5, NOx, and SOx are presumptive “significant” precursors
- Latest science shows PM2.5, NOx and SOx are “significant” precursors for the 24-hour SIP
- Approved annual SIP determined these same precursors were “significant”

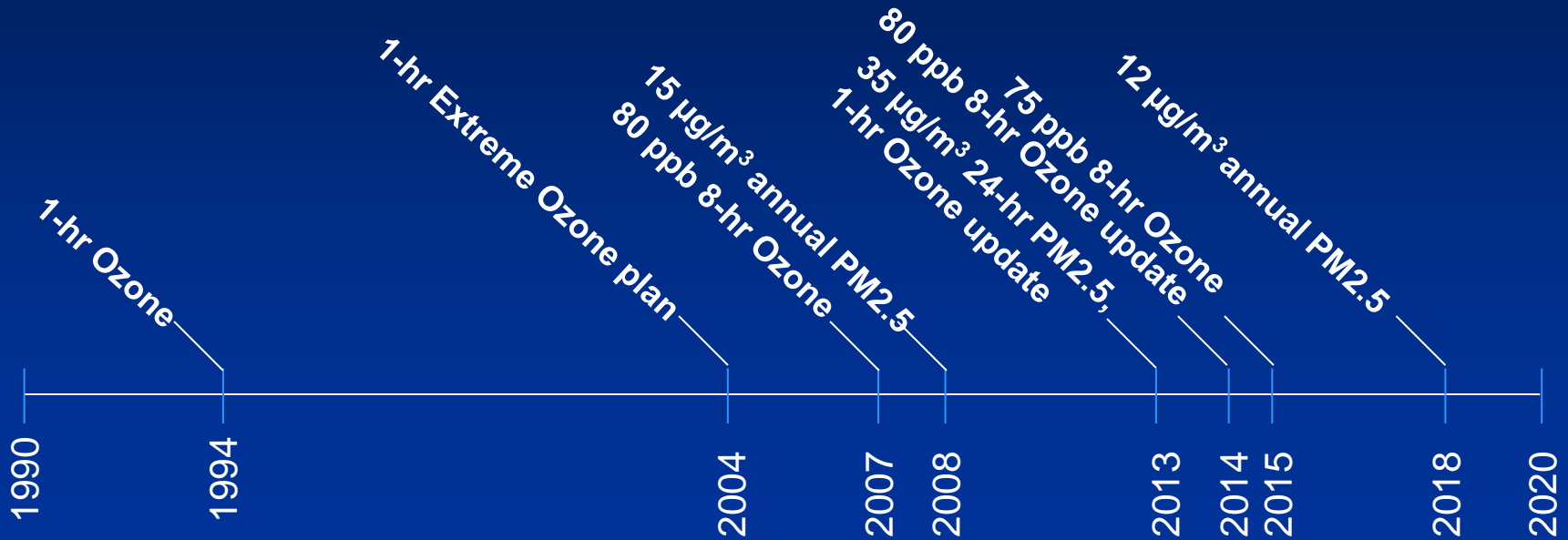
Other Clean Air Act Requirements

- ✓ Emission Inventory
- ✓ Reasonable Further Progress
- ✓ Reasonably Available Control Measures
- ✓ Contingency

Future Valley SIPs



San Joaquin Valley SIP Timeline



Multi-Pollutant Planning

- Integrate ARB planning efforts for SIPs, AB 32 Scoping Plan, and freight planning
- Multiple SIPs for ozone and PM2.5, but common strategies
- Periodic standard review by EPA required by the Clean Air Act

Recommendation

- Approve San Joaquin Valley 2012 PM2.5 Plan as a revision to the California State Implementation Plan