


Modeling Air Quality in the San Joaquin Valley



Certificate in Air Quality Management

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Modeling

Modeling is the use of mathematical equations to simulate and predict real events and processes.

- *"Prediction is very difficult, especially about the future." - Niels Bohr*

Modeling

- Used by Scientists and Engineers
- Test design concepts
- Evaluate most efficient strategies
- Function within design parameters
- Only as good as model input
- Industry standard

Air Quality Modeling Tasks

- Attainment Demonstration
 - Precursor Reductions needed to achieve health standards
 - Source categories to control
 - Area and timing of controls
- Transport Analysis
 - Trajectory analysis
 - Episode evaluation

Air Quality Modeling Tasks (cont.)

- ▣ Forecasting
 - ▣ Statistical pollutant guidance
 - ▣ Numerical pollutant guidance
 - ▣ Meteorological trend
- ▣ Smoke Management
 - ▣ Title 17 Criteria
 - ▣ Evaluation of smoke dispersion impacts

Air Quality Modeling Tasks (cont.)

- Emissions Inventory
 - Create emission estimates
 - Process emission files
- Emergency Response
 - Evaluation of impacts
 - Meteorological outlook
- Permitting/Health Risk
 - Health Risk Assessments

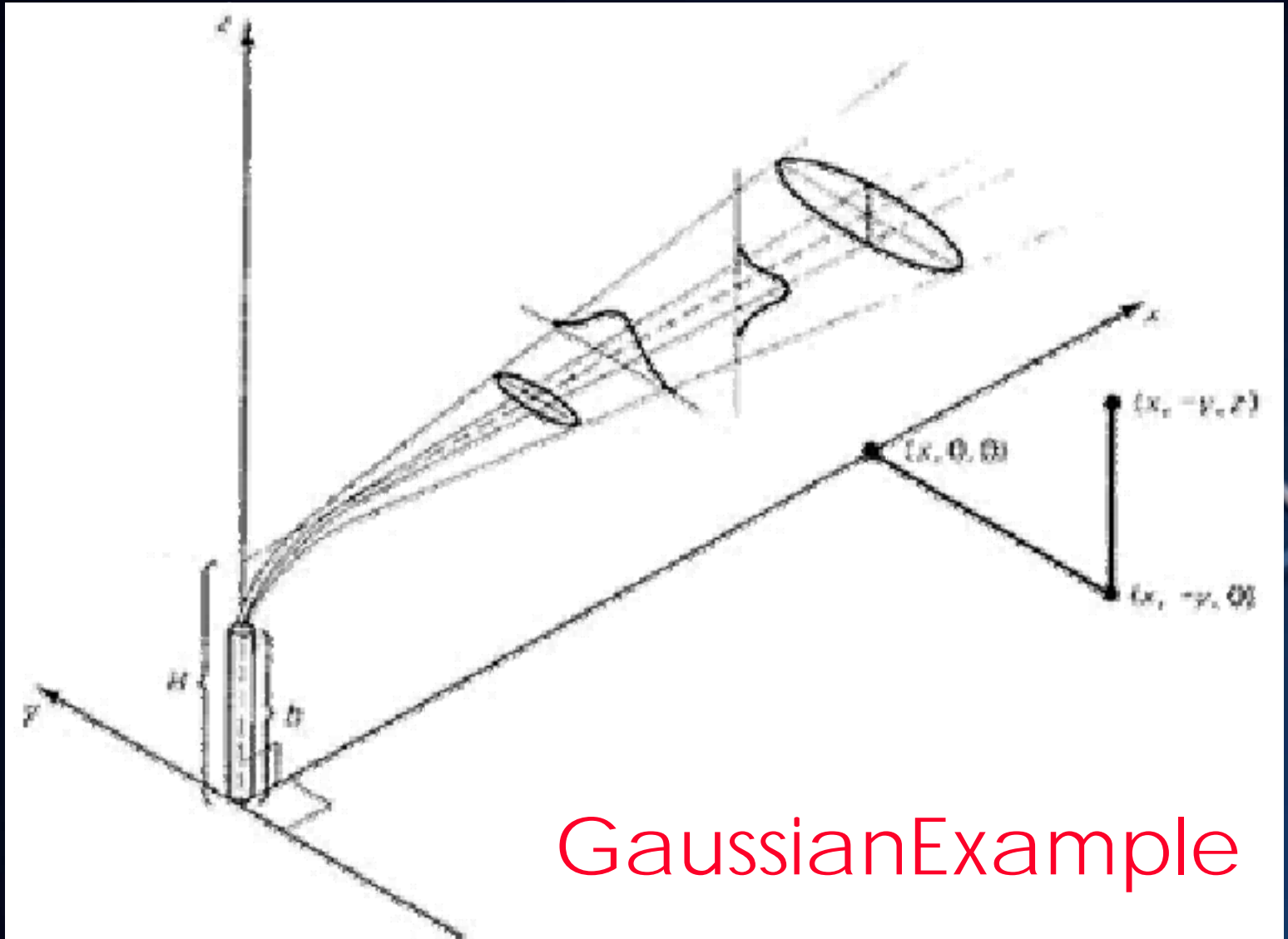
Types of Models Used in Air Quality Management

- Dispersion
- Statistical
- Meteorological
- Photochemical
- Receptor
- Emission
- Other

Dispersion Models

- Dispersion models estimate the concentration of pollutants at specified ground-level receptors surrounding an emissions source through statistical representations of air movement.
- Use: Permitting, Emergency Release, PiG
- Examples: CALPUFF, ISCST3, AERMOD

Dispersion Modeling



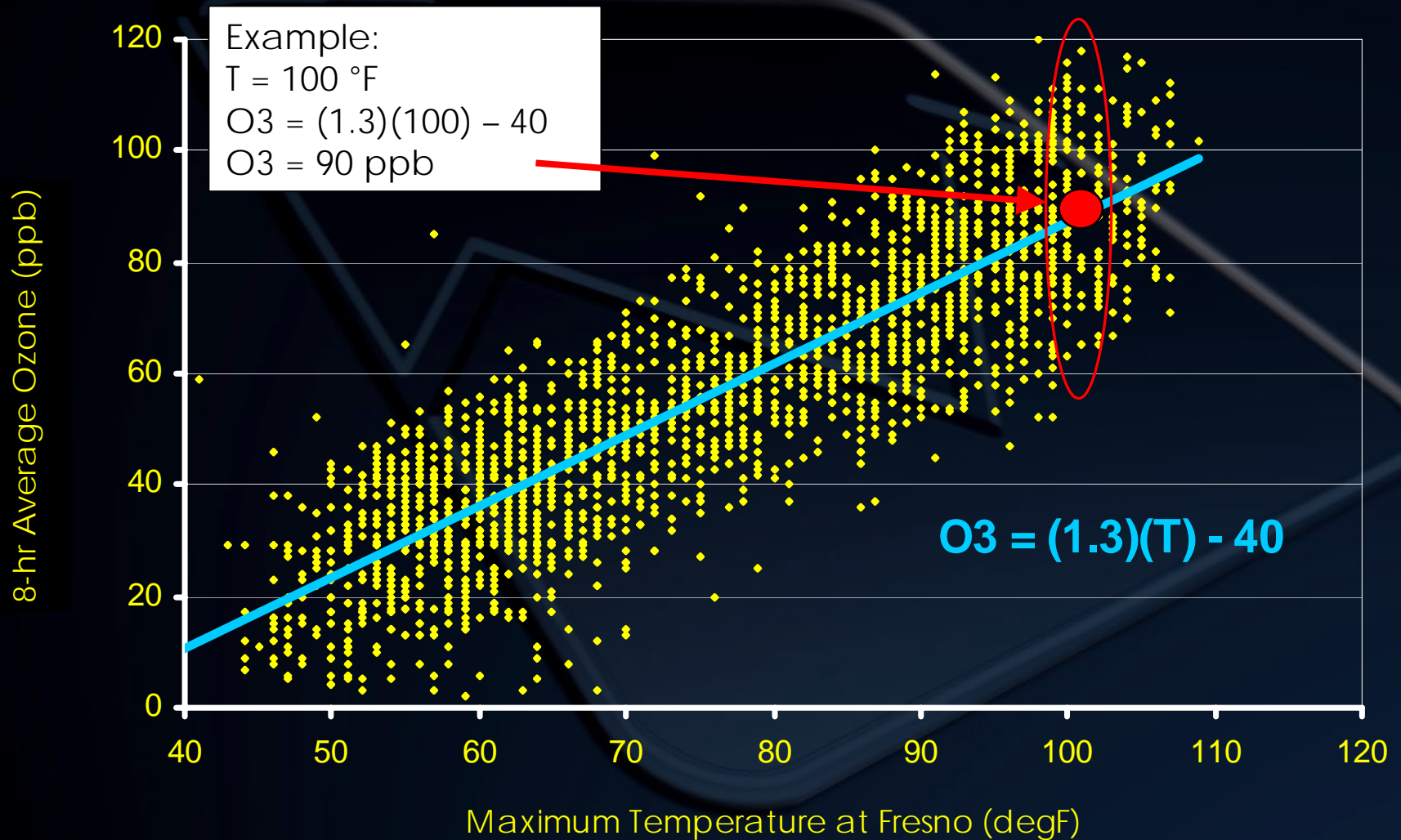
GaussianExample

Statistical Models

- Statistical models use correlations between historical weather and air quality data to produce short term forecasts based on data from observations and meteorological forecasts.
- Use: Daily AQ Forecasts
- Example: SJVAPCD's AQ forecast model

Statistical Models

Parlier 8-hour Ozone relationship to Temperature (2000-2005)



Meteorological Models

- Meteorological models simulate weather conditions, such as wind, solar radiation, humidity, and air temperature within three-dimensional grid cells used to represent the atmosphere through the use of atmospheric physics equations.
- Use: Forecasting, Input to other models (e.g., CAMx)
- Examples: NAM, GFS, MM5, RAMS, WRF

Photochemical Models

- Photochemical models calculate concentrations of pollutants by simulating the movement of air, the mixture of pollutants, the injection of emissions and the chemical changes within three-dimensional grid cells used to represent the atmosphere.
- Use: Attainment modeling, forecasting
- Examples: CAMx, CMAQ, SAQM, UAM, CALGRID

Other Models

Emission models

- Use: Create input for Photochemical Models
- Examples: GEMAP, EMS, SMOKE, CONCEPT, BEGIS, BEIS, EMFAC, URBEMIS, Fire models

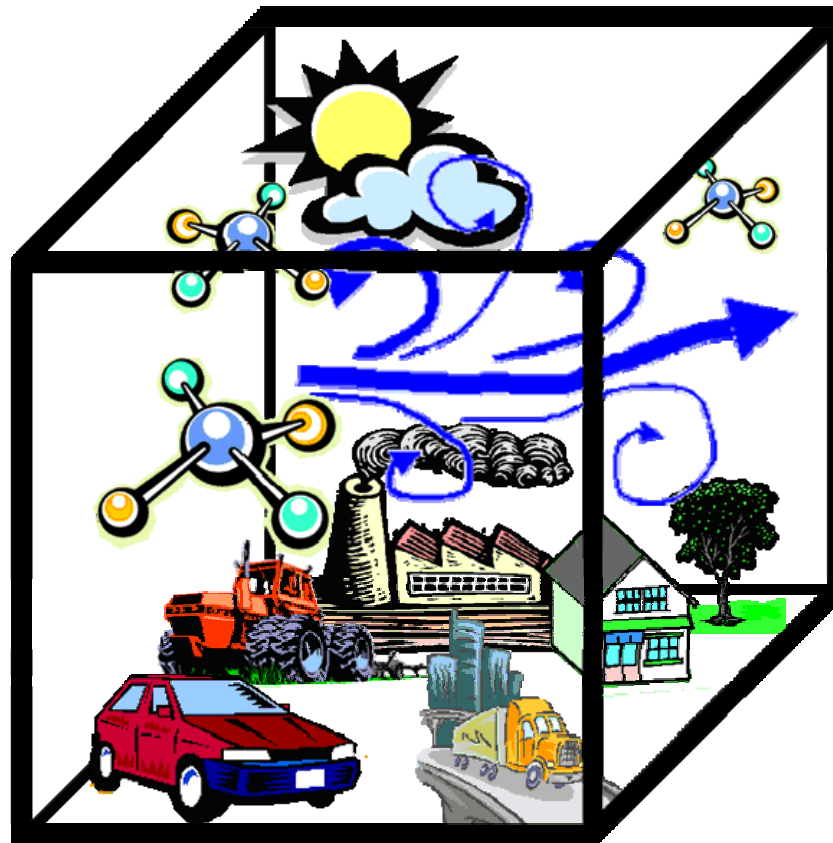
Receptor models

- Use: PM10 Attainment modeling
- Examples: CMB

Modeling with the "Big M"

- Examples: Evaluation and processing modeling files

Box Model (One Grid Cell)



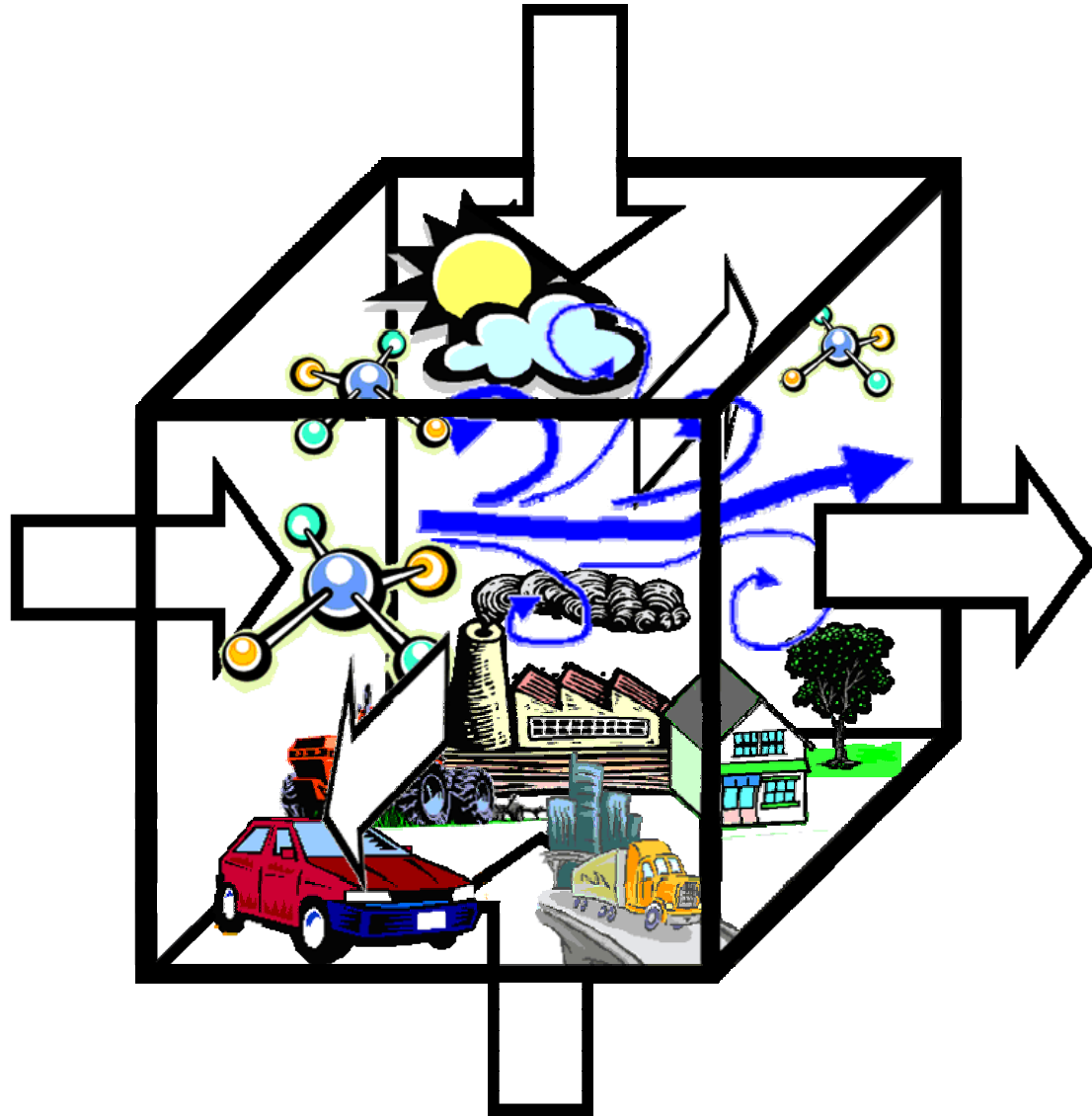
CCOS Photochemical Modeling Domain



Domain Size:

460 miles per side

Grid Model (One Grid Cell)



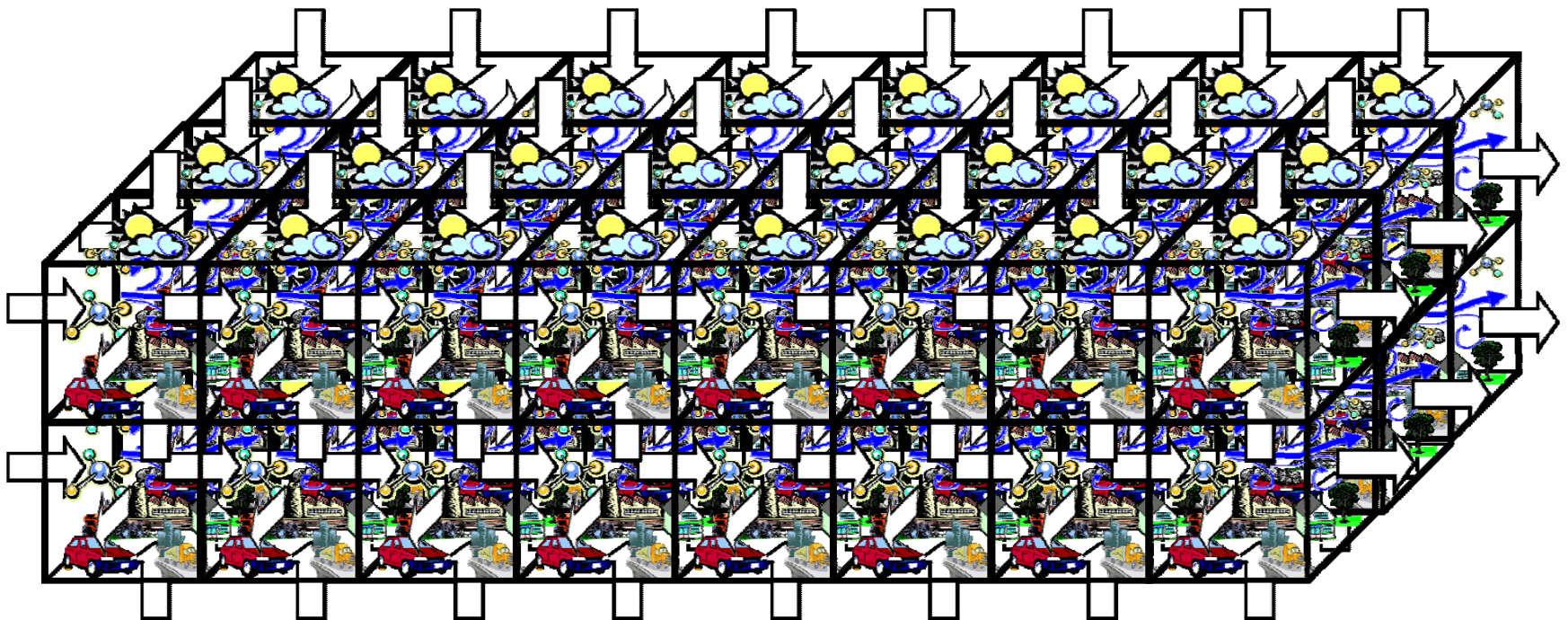
Current SIP Photochemical Modeling

Calculations

- 13 Meteorological Parameters
- 74 Chemical Species
- 211 Chemical Equations
- "All" Emissions

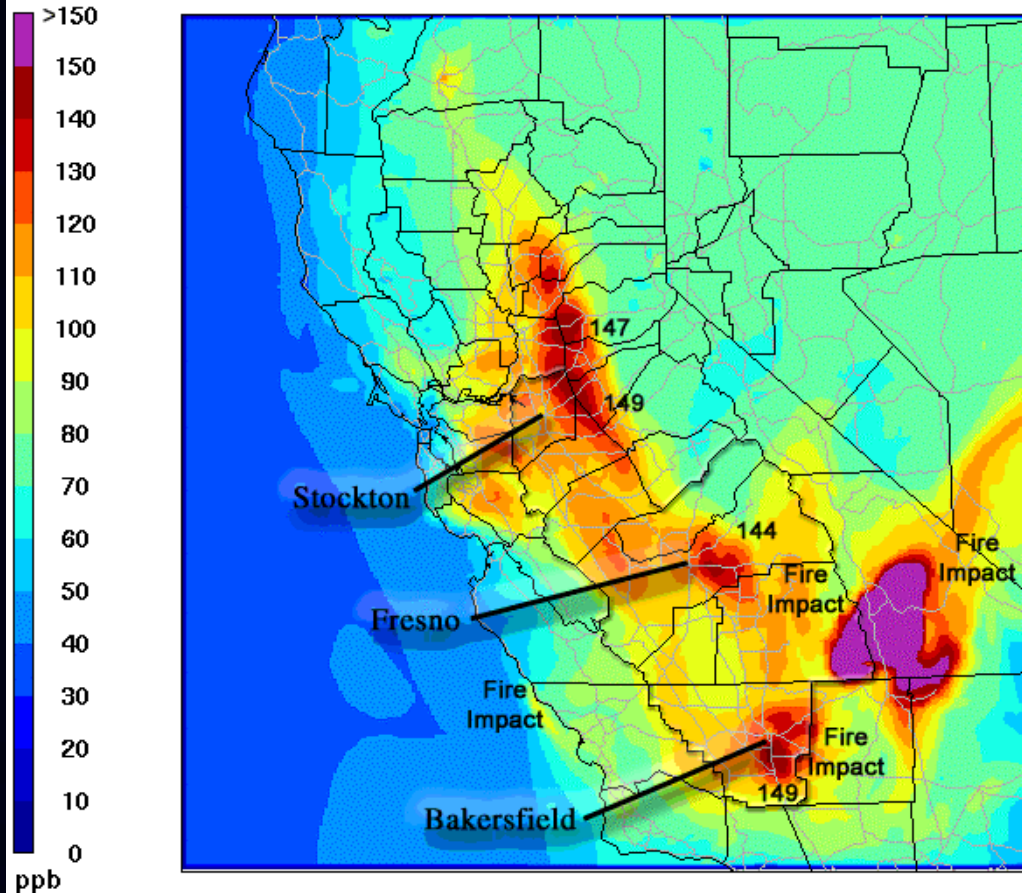
Size

- Grid Cell Size: 4km x 4km
- Domain Size: 185 x 185 x 20
- Horizontal Grid Cells: 34,255
- Total Grid Cells: 684,500



Analysis of Peak Concentrations

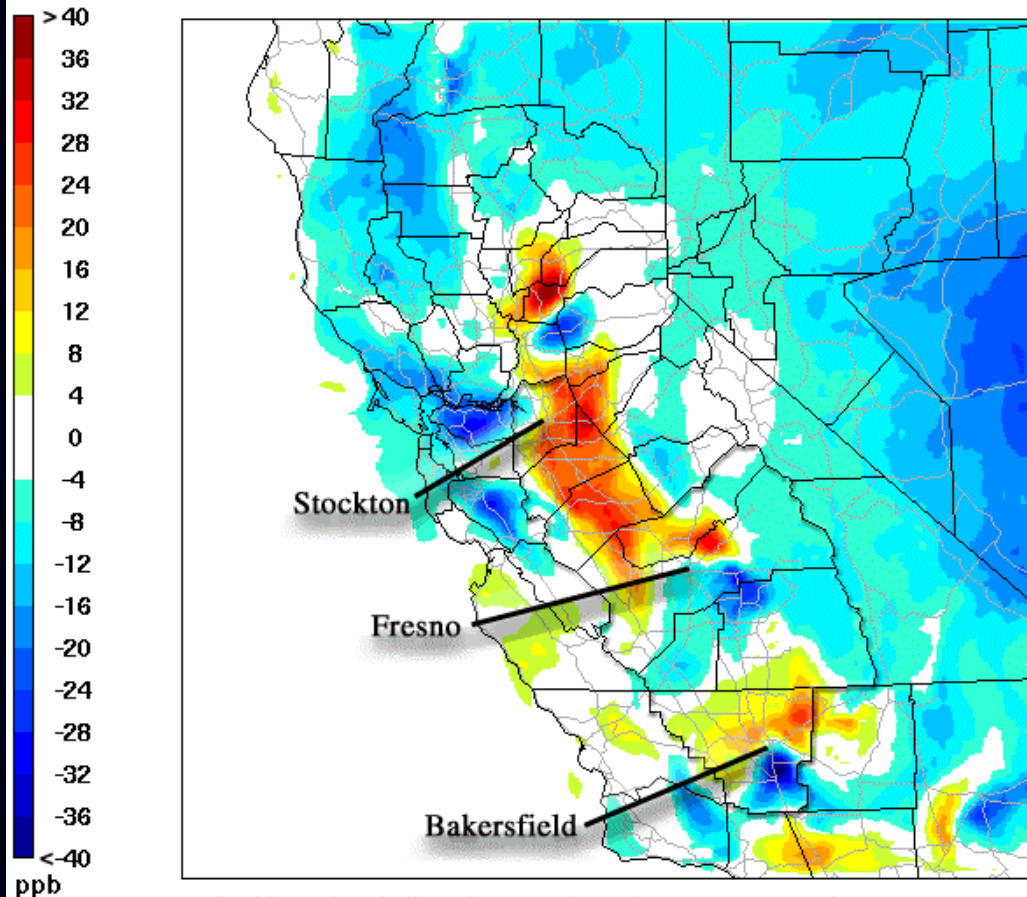
Maximum Ozone Concentration
2000 CCOS Episode
July 30 thru August 02



Maximum modeled ozone by grid cell for the July/August 2000 CCOS episode as documented for the Extreme Ozone SIP.

Analysis of Changes

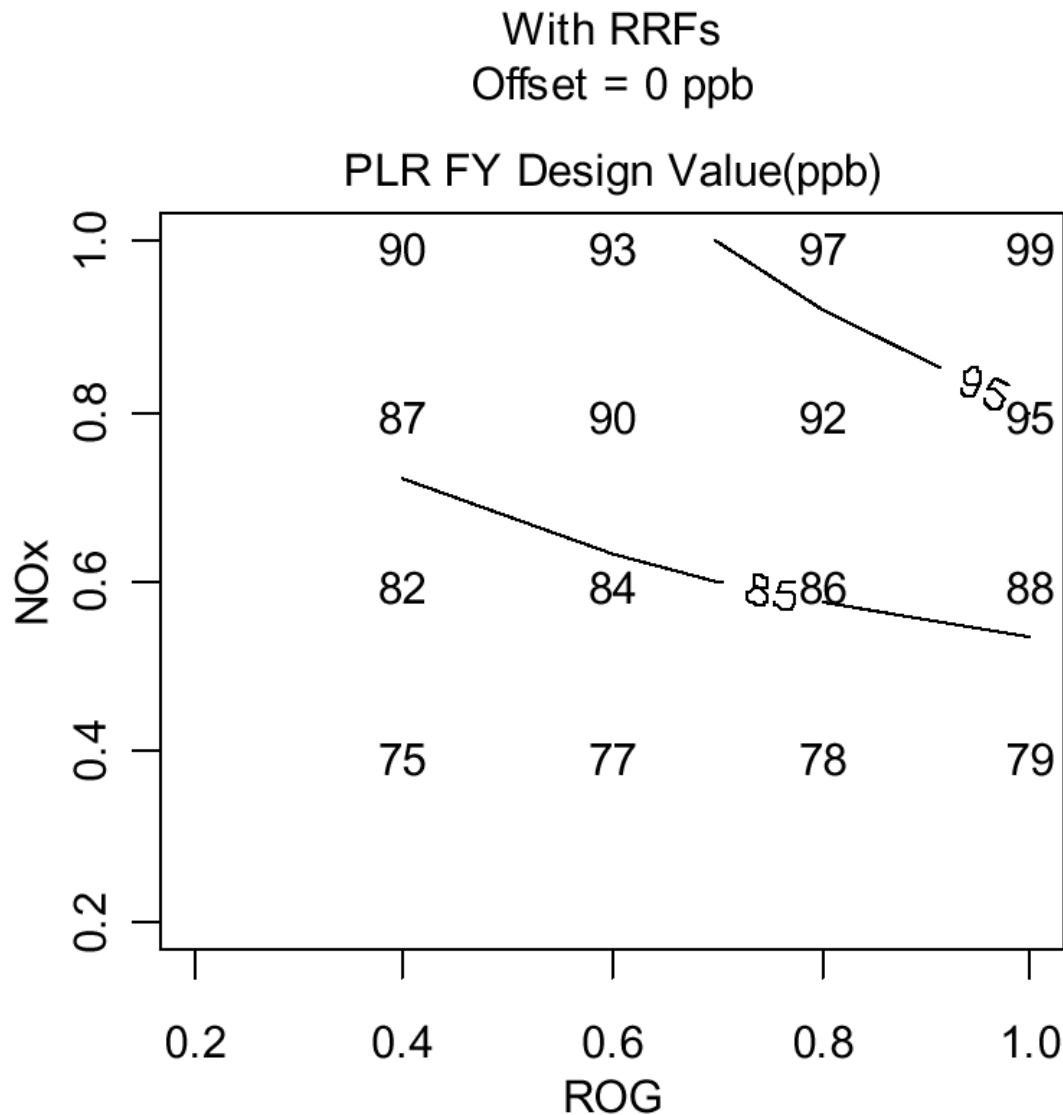
**Change in Maximum Ozone Concentration
from July 30 to August 02, 2010**



Positive values indicate increases in peak ozone concentration.
Negative values indicate decreases in peak ozone concentration.

Change from 2000 to 2010 in maximum modeled ozone concentration by grid cell for the July/August 2000 CCOS episode as documented for the Extreme Ozone SIP.

Emission Reduction Targets

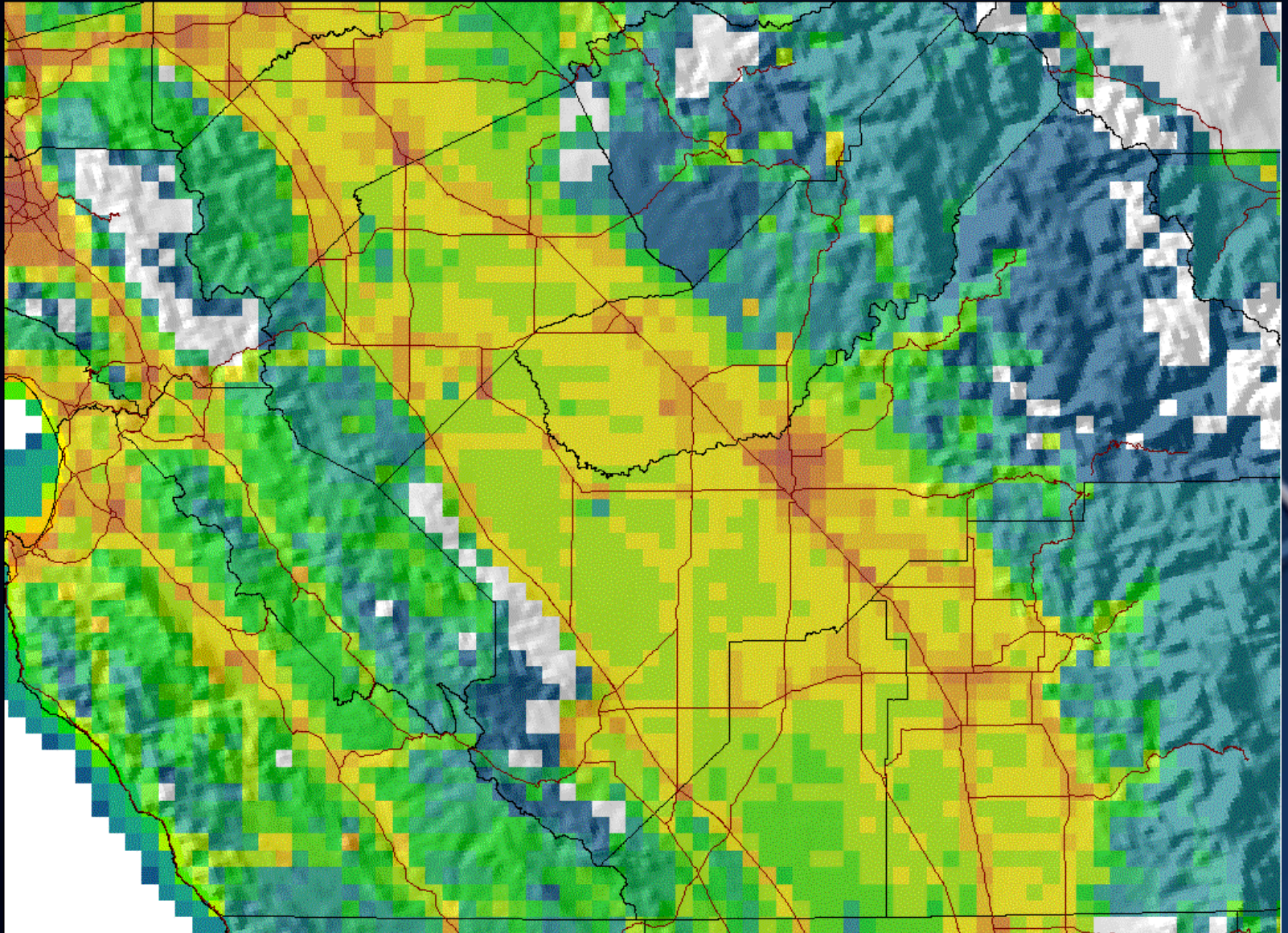


Carrying Capacity Diagrams are used to estimate the amount of NOx and VOC reductions needed to reach attainment goals.

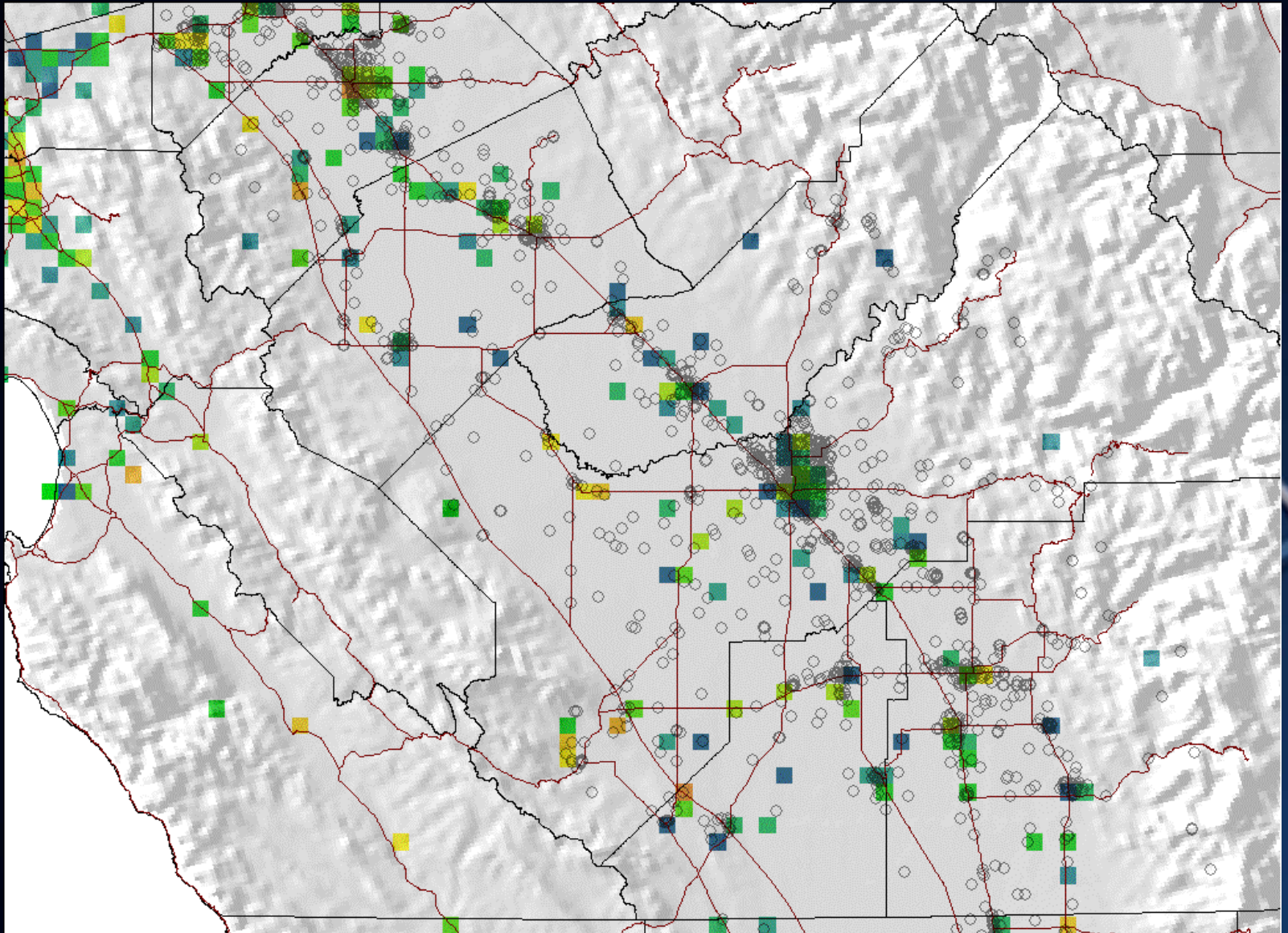
Modeling Examples

- Photochemical Model Inputs
- O₃ SIP Modeling
- O₃ SIP Modeling (SJV Only)
- 3D View of O₃ SIP Modeling
- Transport evaluation (Non-Reactive NO_x)
- Smoke Transport (CANSAC)
- National O₃ Daily Forecast Model

Area Source Gridded Inventory



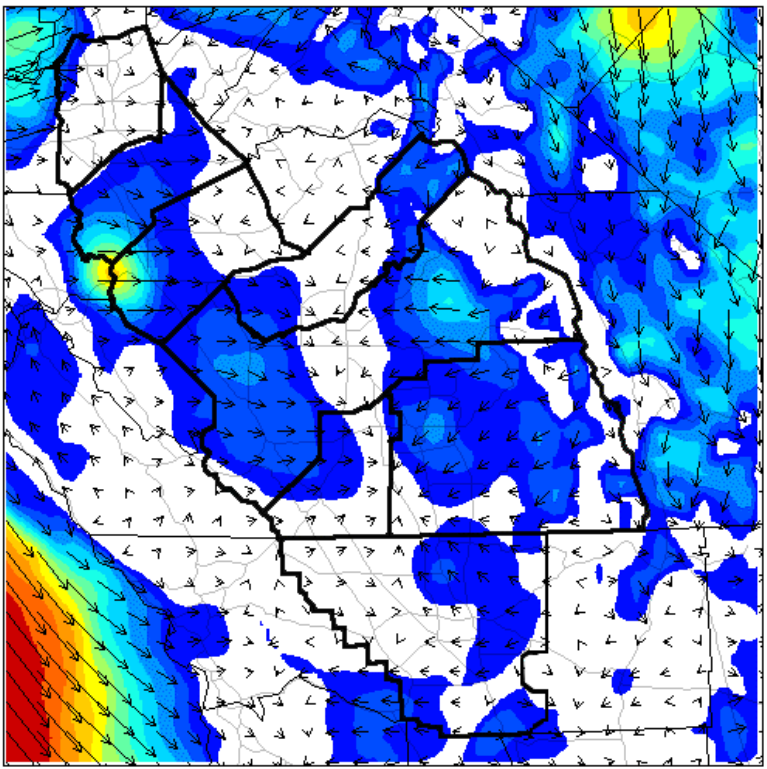
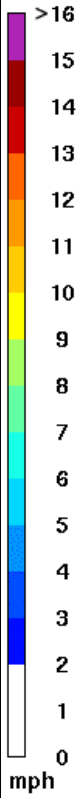
Point Source Gridded Inventory



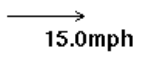
Meteorological Inputs

Modeled Wind Field
Surface Layer Winds

Every 4th vector plotted (16 km interval)

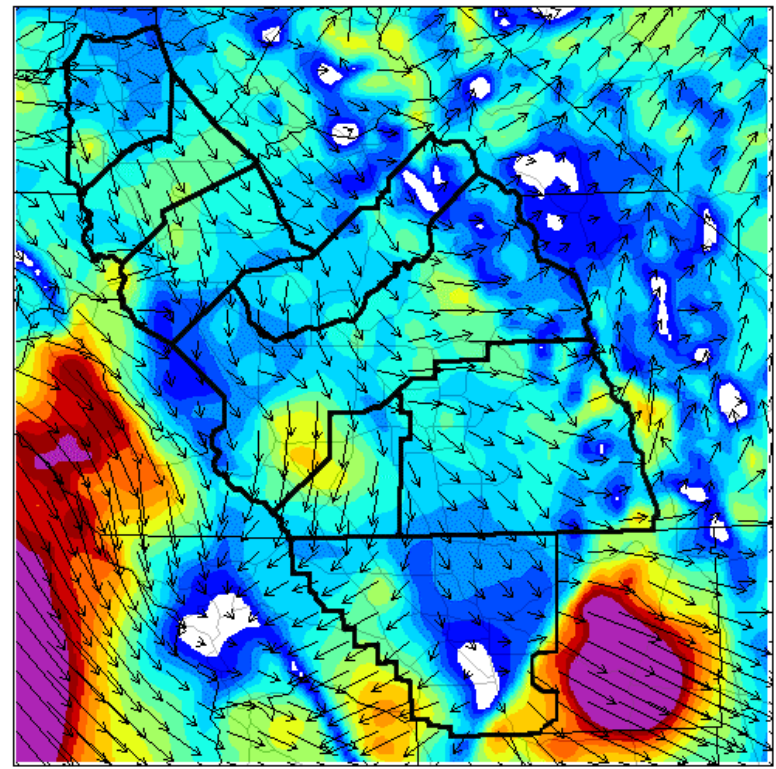


July 30,2000 5:00:00

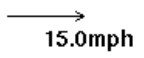


Modeled Wind Field
Surface Layer Winds

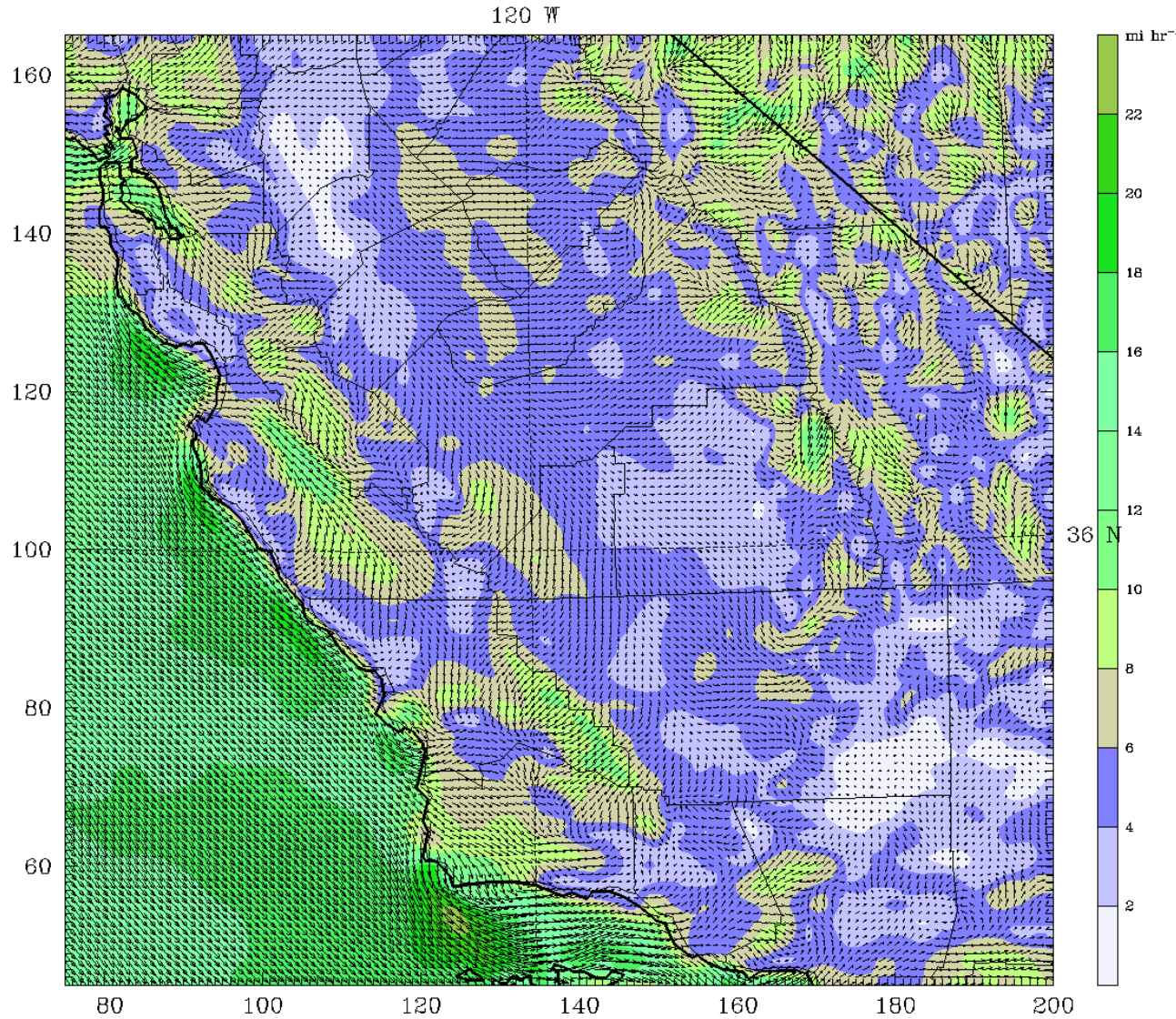
Every 4th vector plotted (16 km interval)



July 30,2000 15:00:00



CANSAC MM5 Realtime: Domain 3 (4 km) Init: 1200 UTC Wed 27 Sep 06
 Fcst: 12.00 Valid: 0000 UTC Thu 28 Sep 06 (1700 PDT Wed 27 Sep 06)
 Horizontal wind speed at height = 0.01 km sm= 1
 Horizontal wind vectors at height = 0.01 km sm= 1



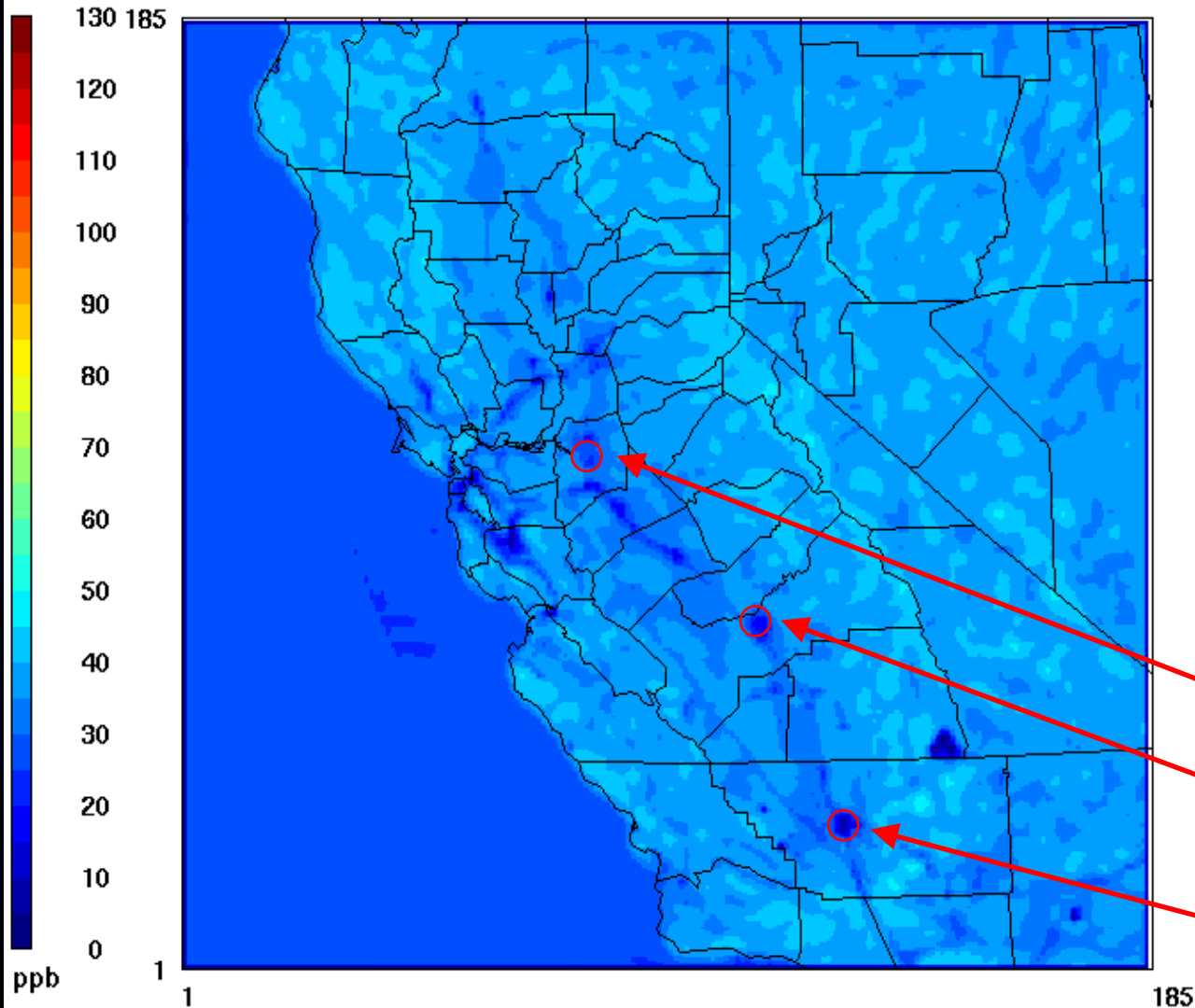
After-
 Noon
 Wind
 Field
 During
 High
 Ozone
 9/27/06

MAXIMUM VECTOR: 22.4 mi hr⁻¹ →
 Model info: V3.6.3 No Cumulus Eta PBL Simple ice 4 km, 31 levels, 12 sec



Surface Layer Ozone (1-Hour Average)

July/August 2000 Episode



July 27, 2000 6:00:00
Min= 0 at (1,1), Max= 47 at (137,17)

Ozone SIP Modeling

- ARB/SJV
- MM5
- CAMx

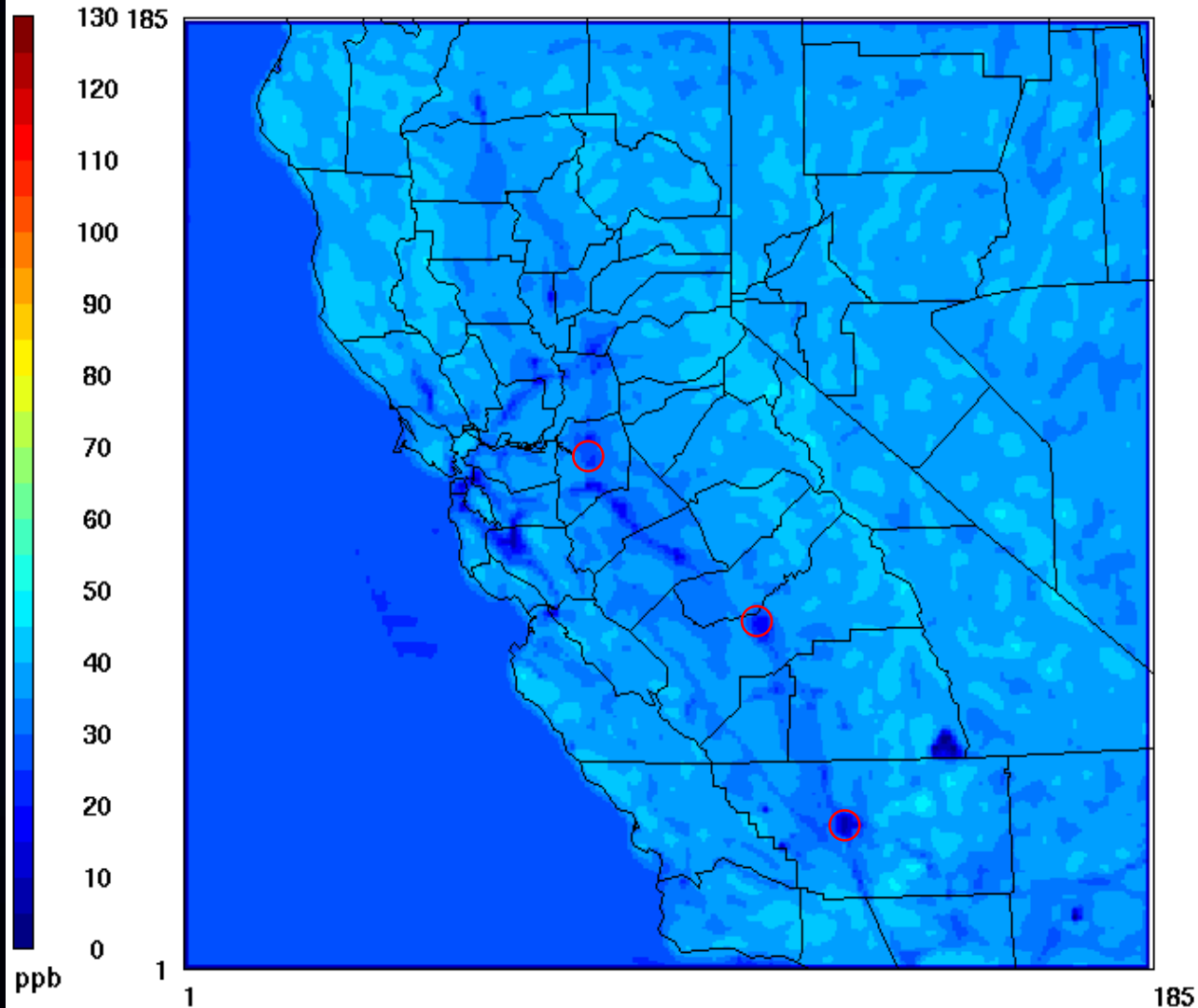
Stockton

Fresno

Bakersfield

Surface Layer Ozone (1-Hour Average)

July/August 2000 Episode



July 27, 2000 6:00:00
Min= 0 at (1,1), Max= 47 at (137,17)

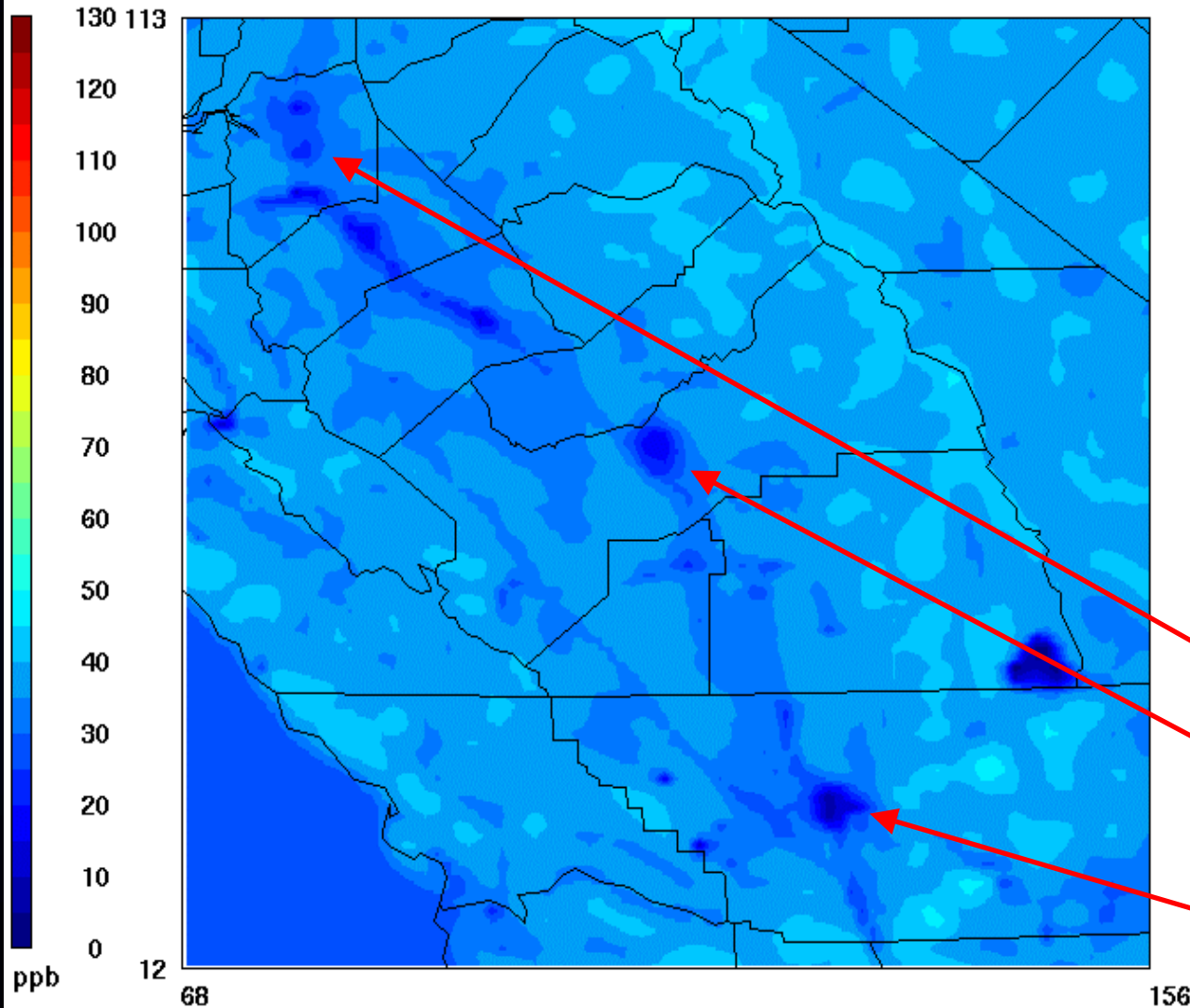
Ozone SIP Modeling

- ARB/SJV
- MM5
- CAMx



Surface Layer Ozone (1-Hour Average)

July/August 2000 Episode



July 27, 2000 6:00:00
Min= 2 at (147,46), Max= 47 at (137,17)

Ozone SIP Modeling

- ARB/SJV
- MM5
- CAMx

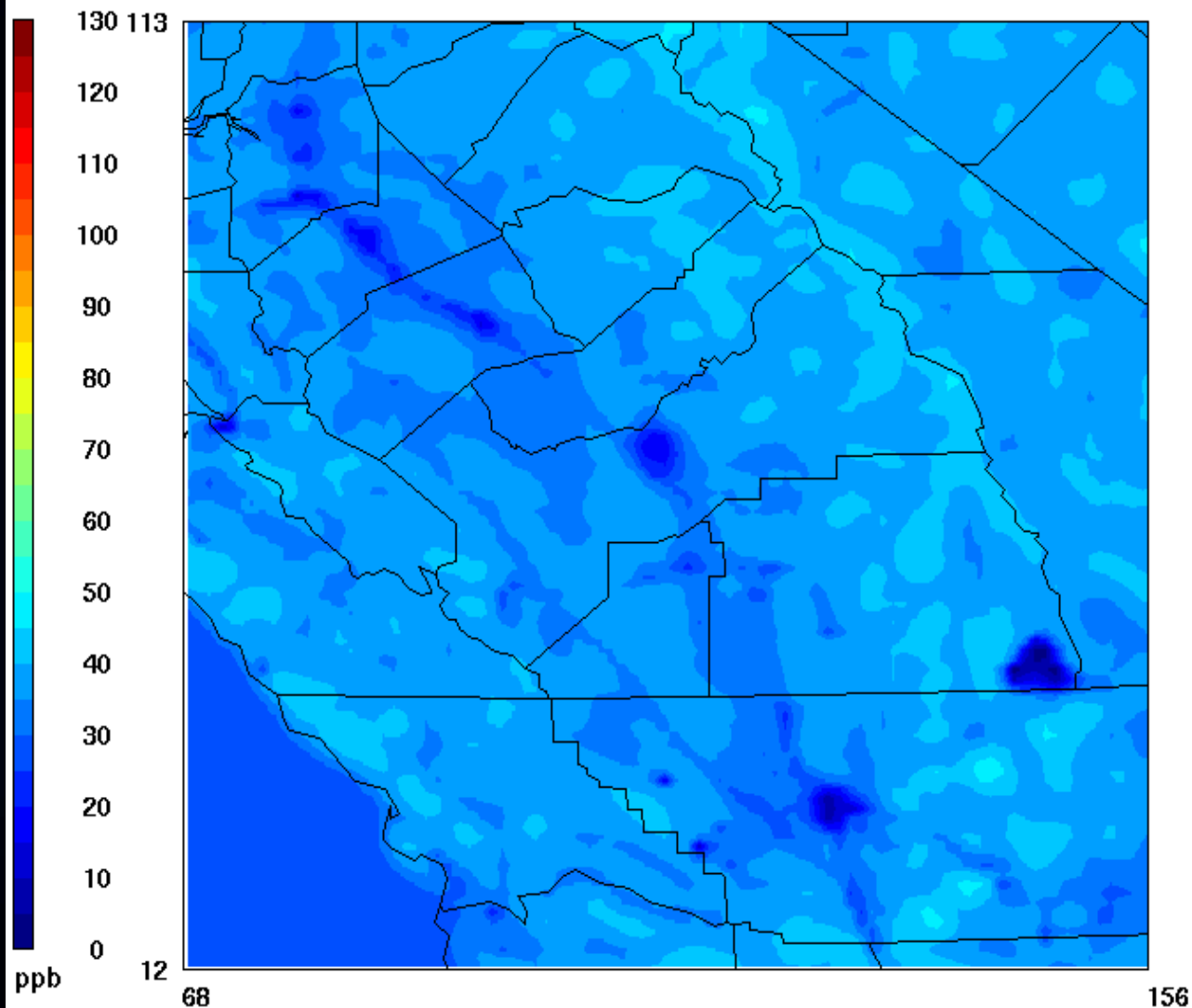
Stockton

Fresno

Bakersfield

Surface Layer Ozone (1-Hour Average)

July/August 2000 Episode



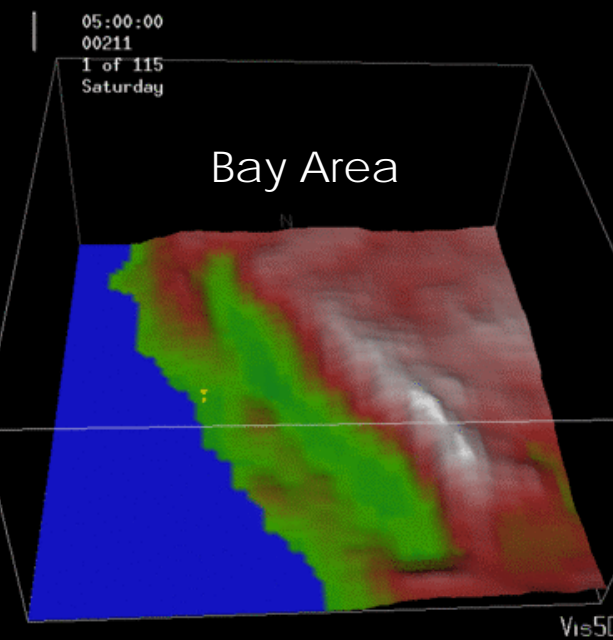
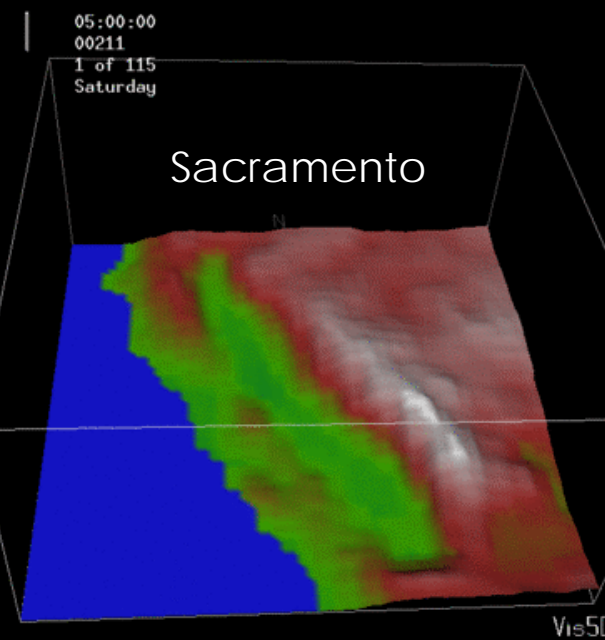
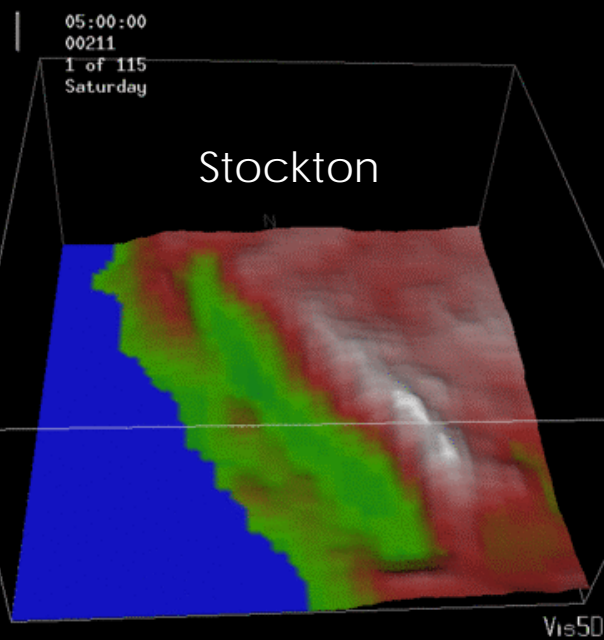
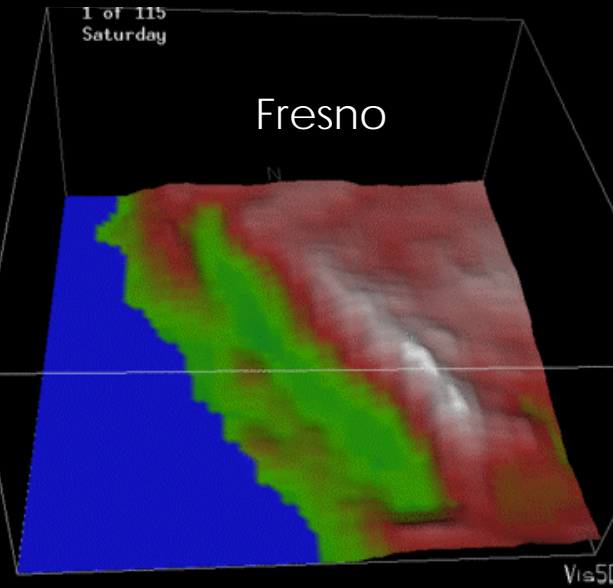
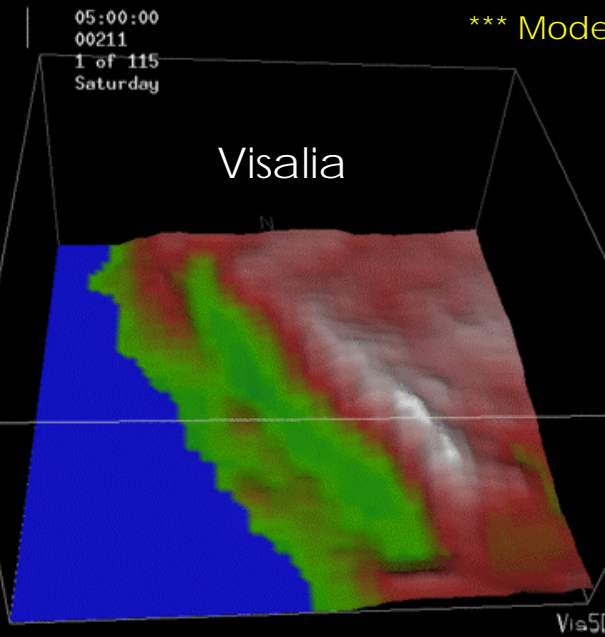
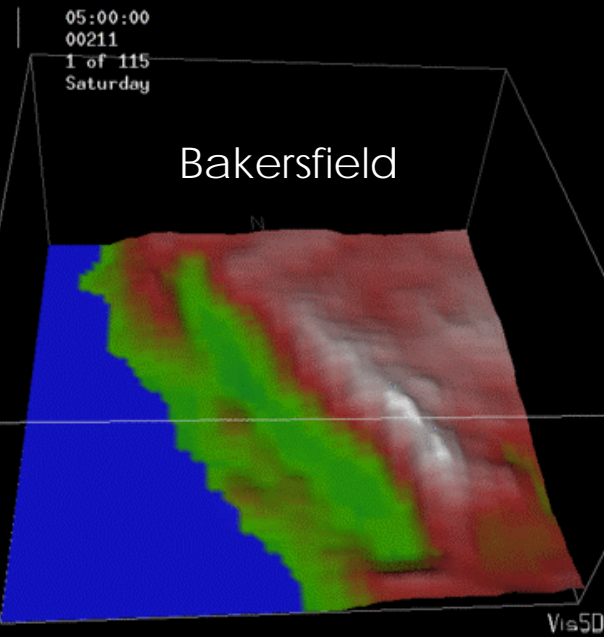
Ozone SIP Modeling

- ARB/SJV
- MM5
- CAMx



NOx Non-reactive Transport

*** Modeling and visualization completed by STI

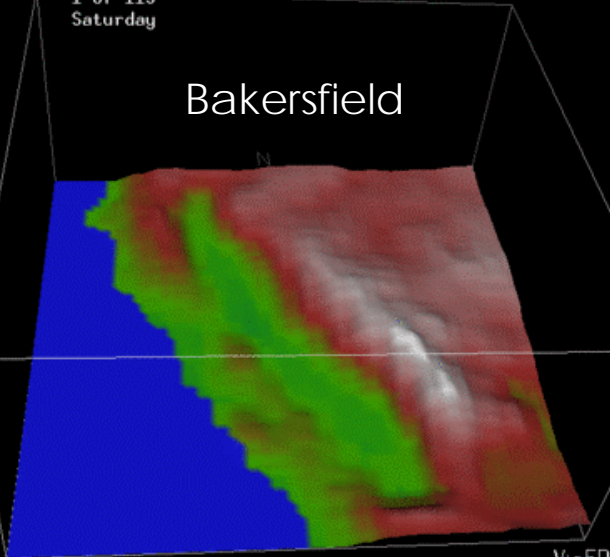


NOx Non-reactive Transport

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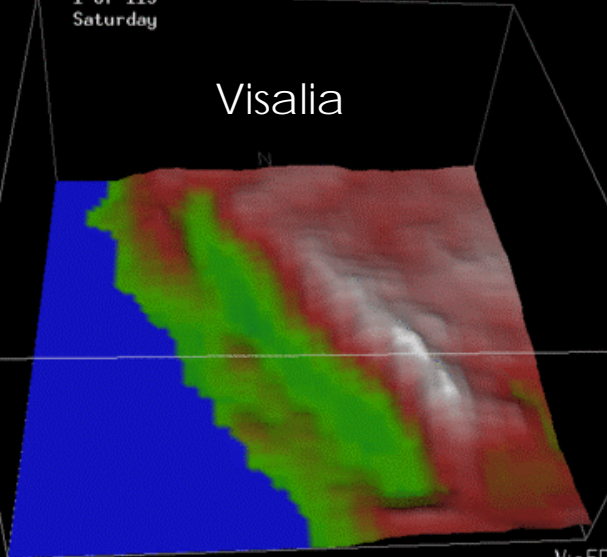
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00211
1 of 115
Saturday

Bakersfield



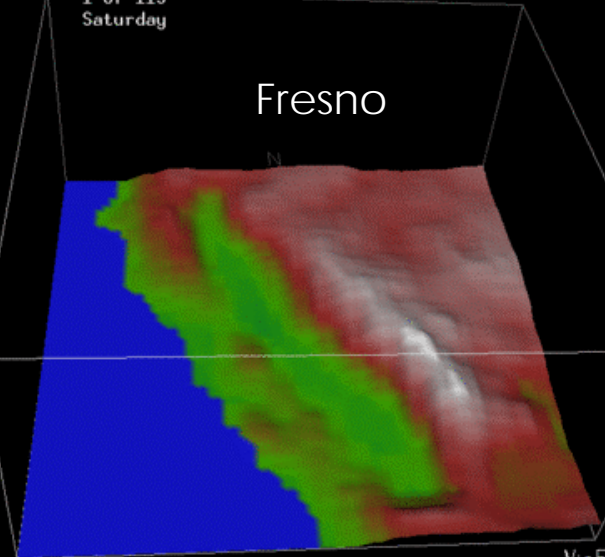
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00211
1 of 115
Saturday

Visalia



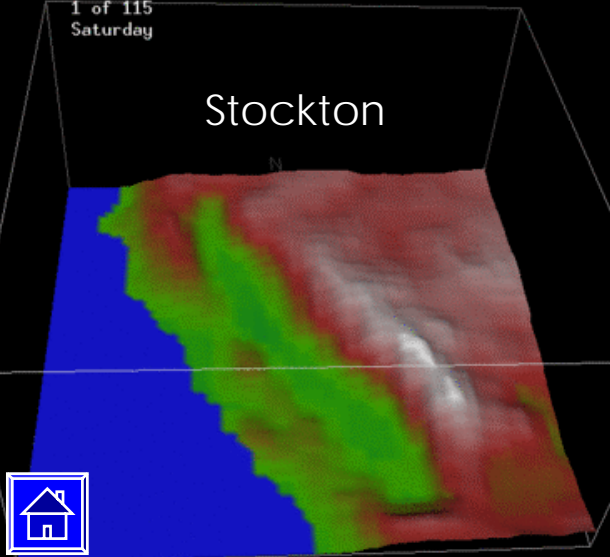
1 of 115
Saturday

Fresno



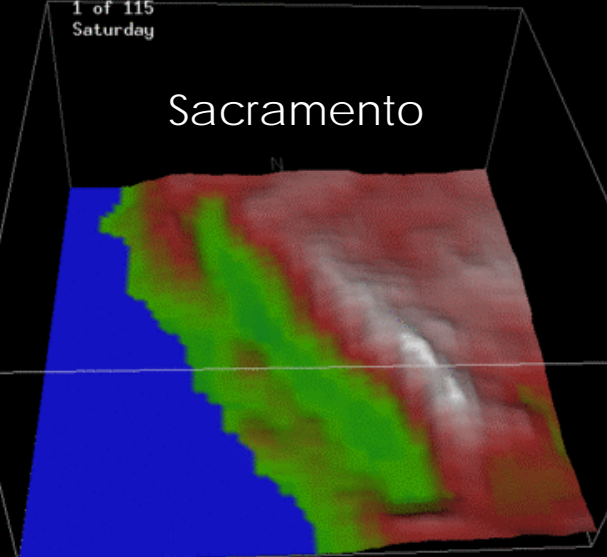
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1 of 115
Saturday

Stockton



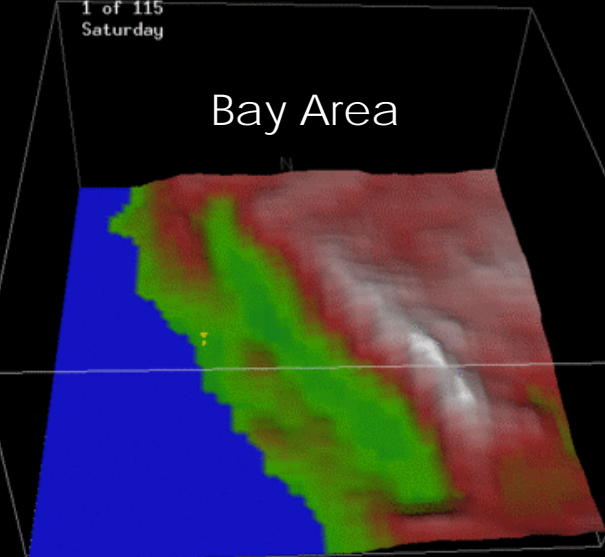
05:00:00
00211
1 of 115
Saturday

Sacramento



05:00:00
00211
1 of 115
Saturday

Bay Area



Vis5D

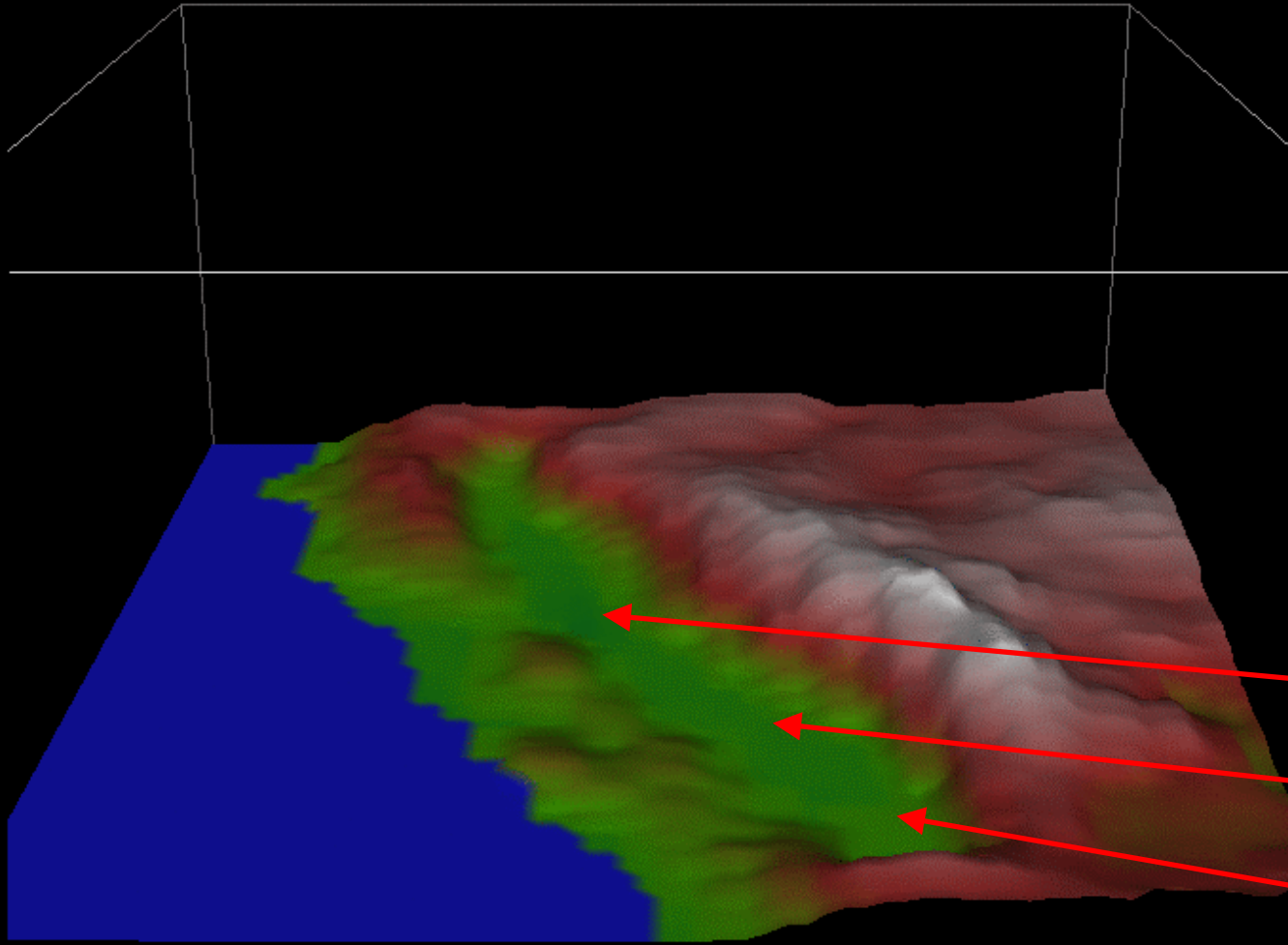
Vis5D

Vis5D

06:00:00
00211
1 of 114
Saturday

3D Ozone Plume

- STI
- MM5
- CAMx



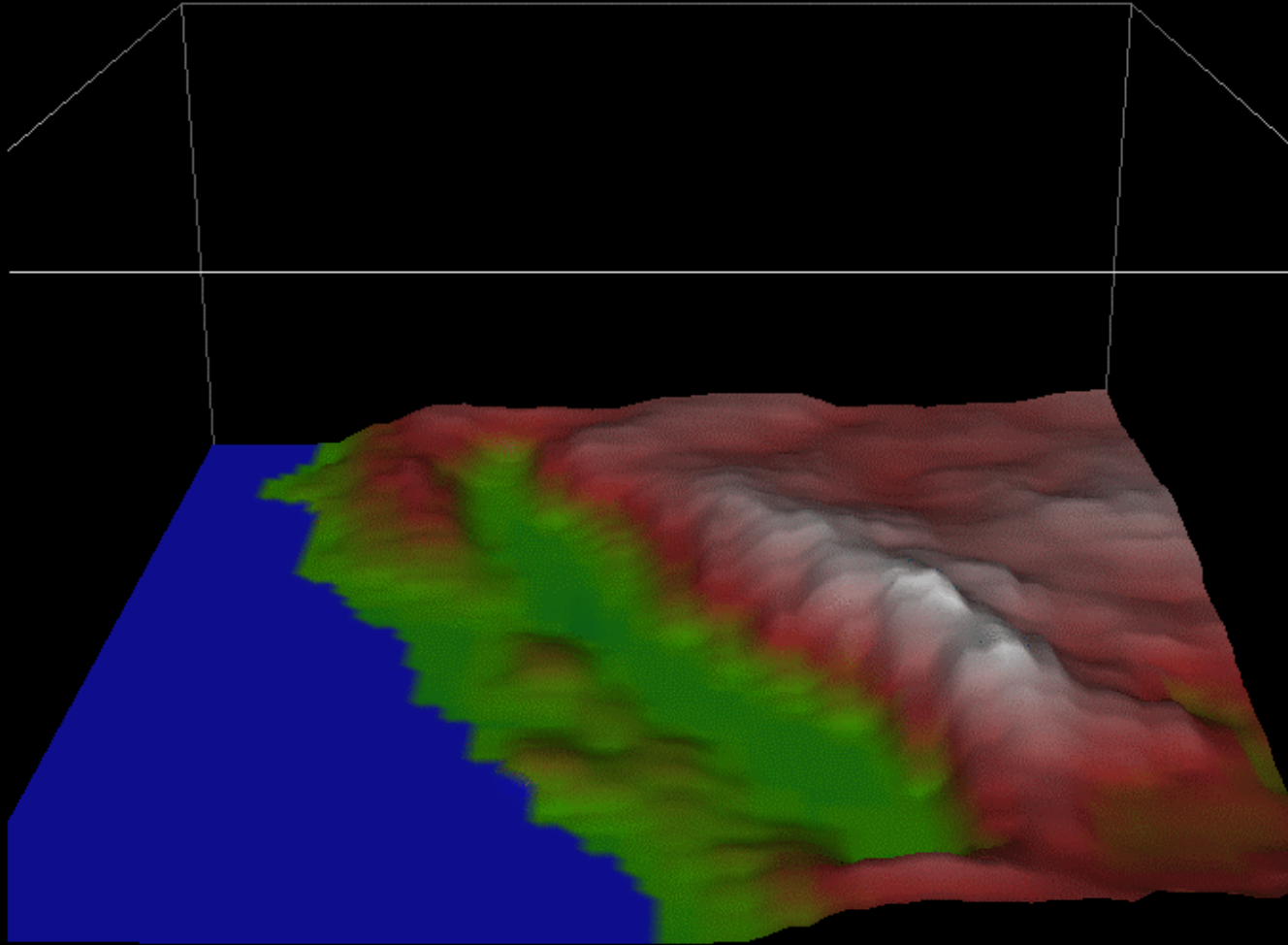
Stockton

Fresno

Bakersfield

Vis5D

06:00:00
00211
1 of 114
Saturday



3D Ozone Plume

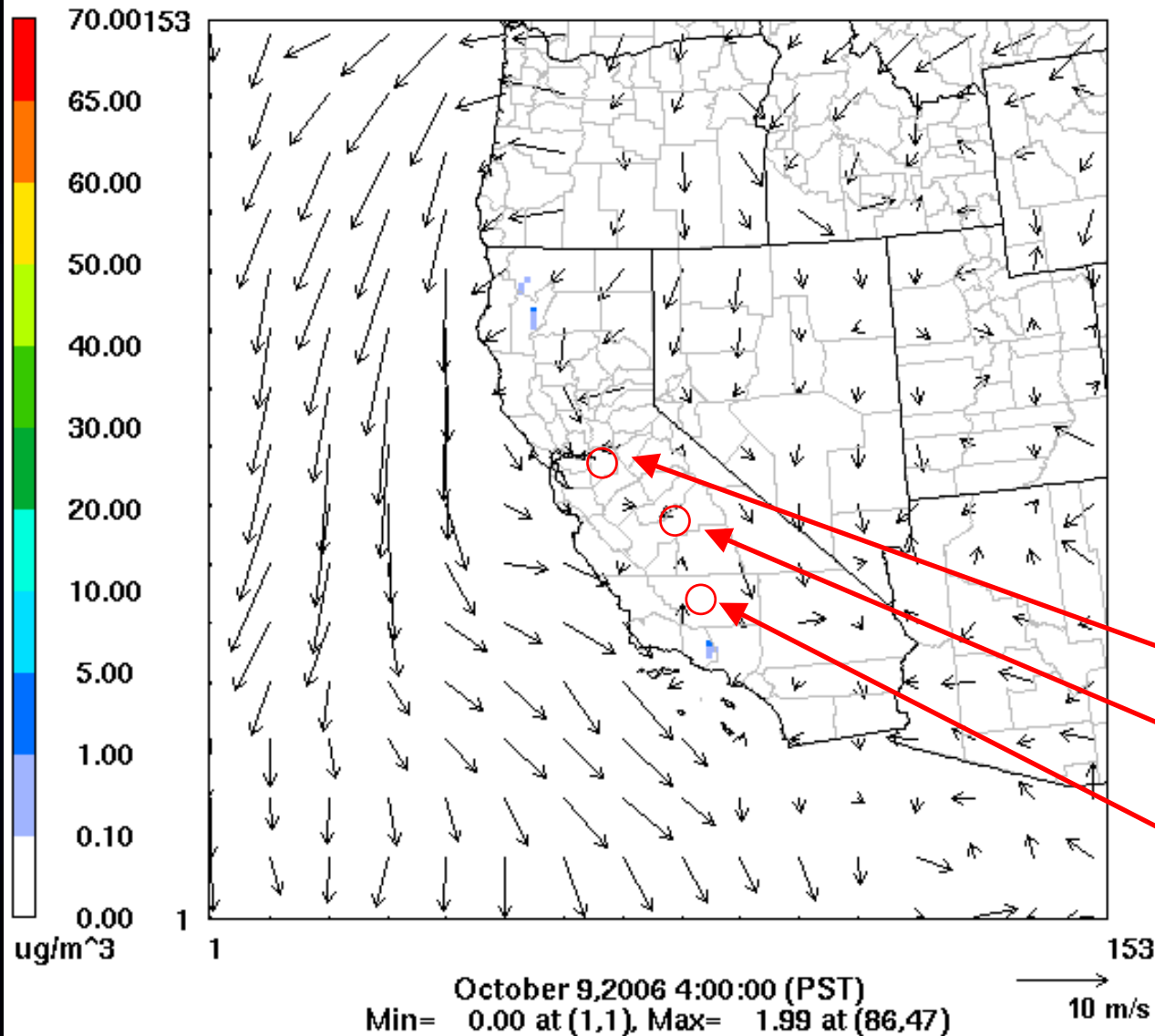
- STI
- MM5
- CAMx



Vis5D

Prescribed Fire & Wildfire Simulation

MM5 Forecast: 2006100900
PM2.5 (NAAQS = 65 micrograms/m³, 24hr avg)

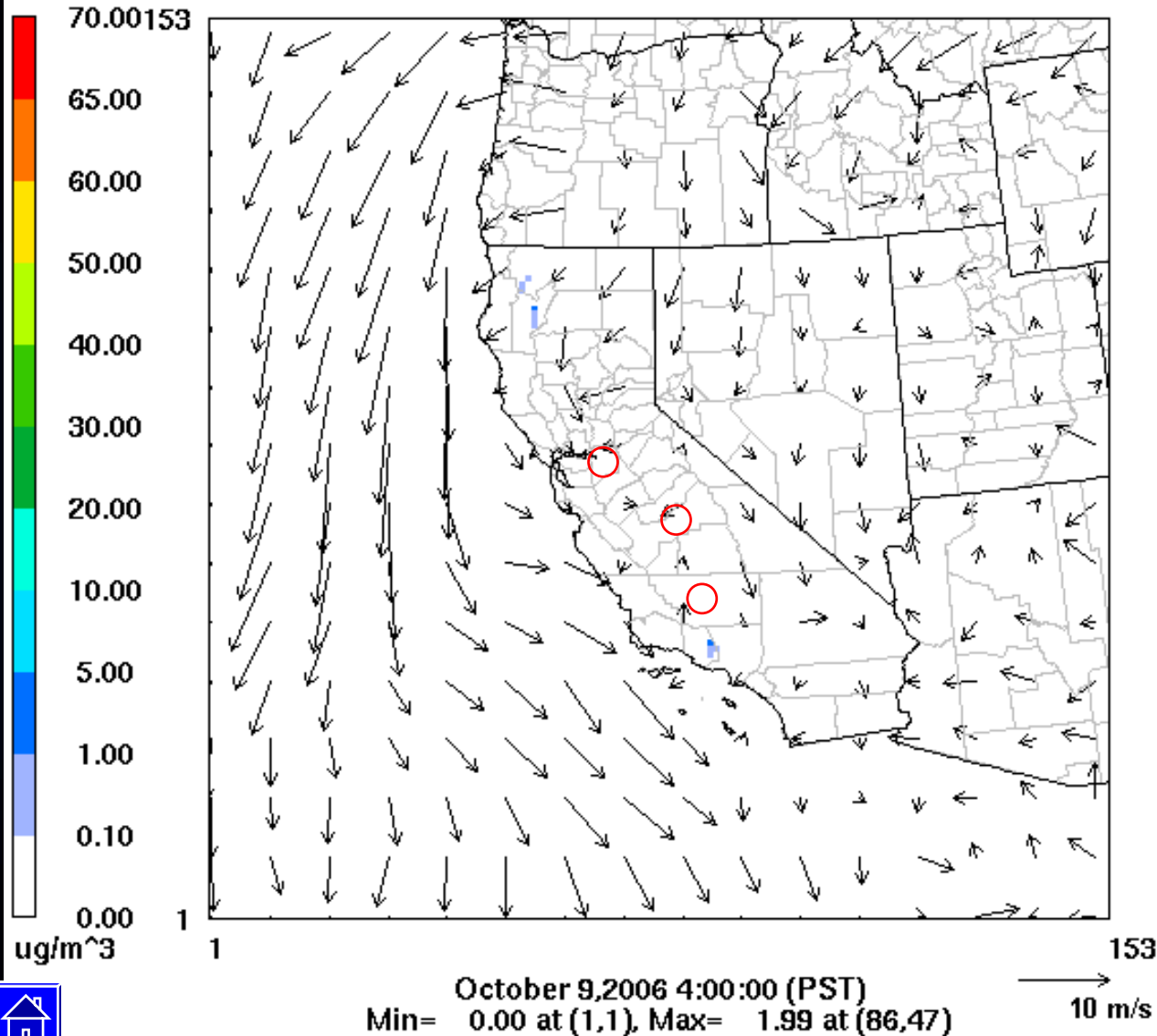


Smoke Transport Forecast

- CANSAC
 - MM5
 - Calpuff
- Stockton
- Fresno
- Bakersfield

Prescribed Fire & Wildfire Simulation

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PM2.5 (NAAQS = 65 micrograms/m³, 24hr avg)

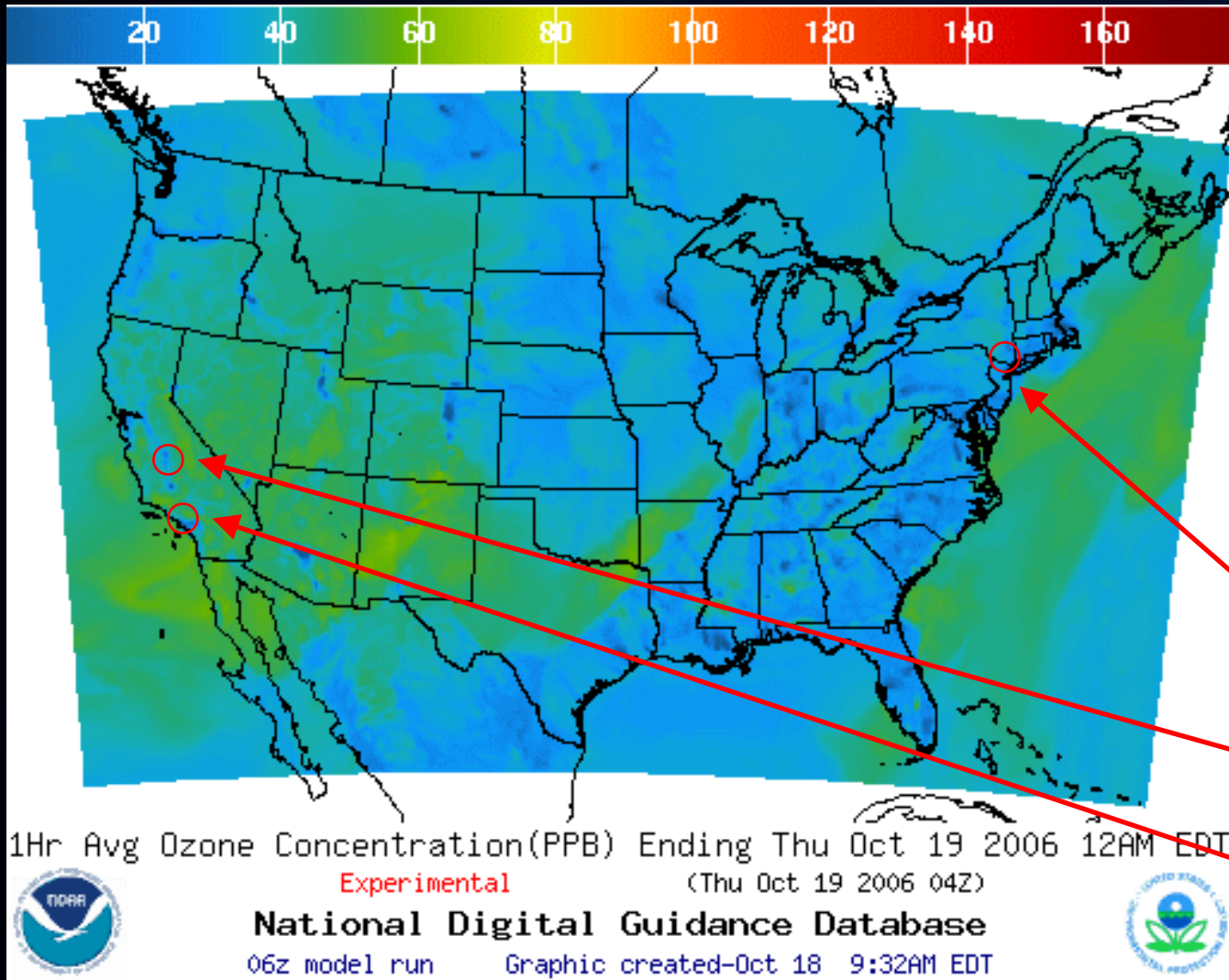


Smoke Transport Forecast

- CANSAC
- MM5
- Calpuff



National Ozone Forecast Model



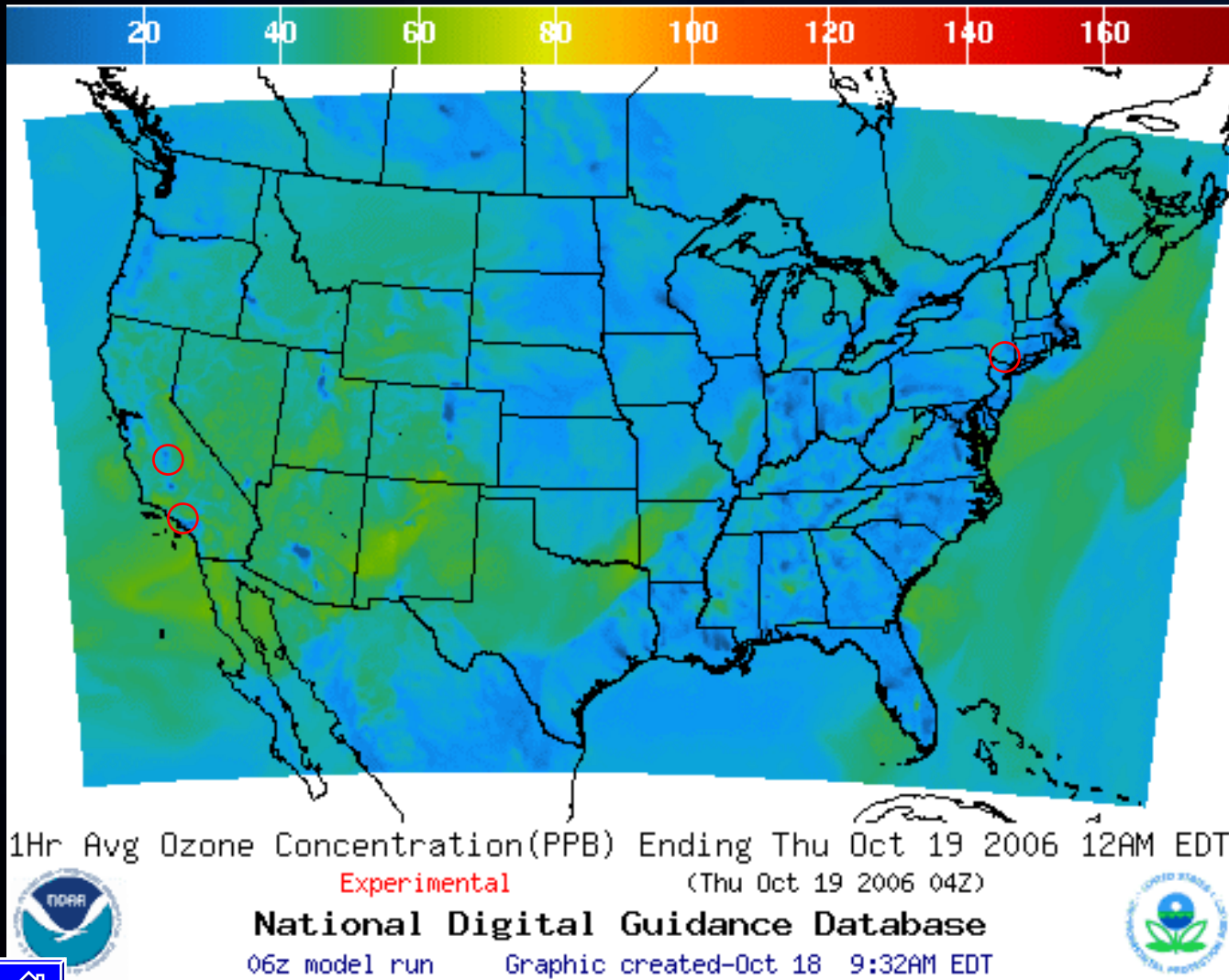
- NOAA
- WRF
- CMAQ

New York

Fresno

Los Angeles

National Ozone Forecast Model



- NOAA
- WRF
- CMAQ



Additional Information

- David Nunes
SJVAPCD
david.nunes@valleyair.org
- EPA
National Environmental Protection Agency
Good source for "approved" air quality modeling information
<http://www.epa.gov/air/aqportal/management/modeling>
- CANSAC
California and Nevada Smoke and Air Committee
California meteorological model for smoke dispersion
<http://www.cefa.dri.edu/COFF/>
- National Ozone Forecast Model
NOAA/EPA
Daily photochemical model forecast guidance. West coast is still experimental, but available.
<http://www.weather.gov/aq/>

