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

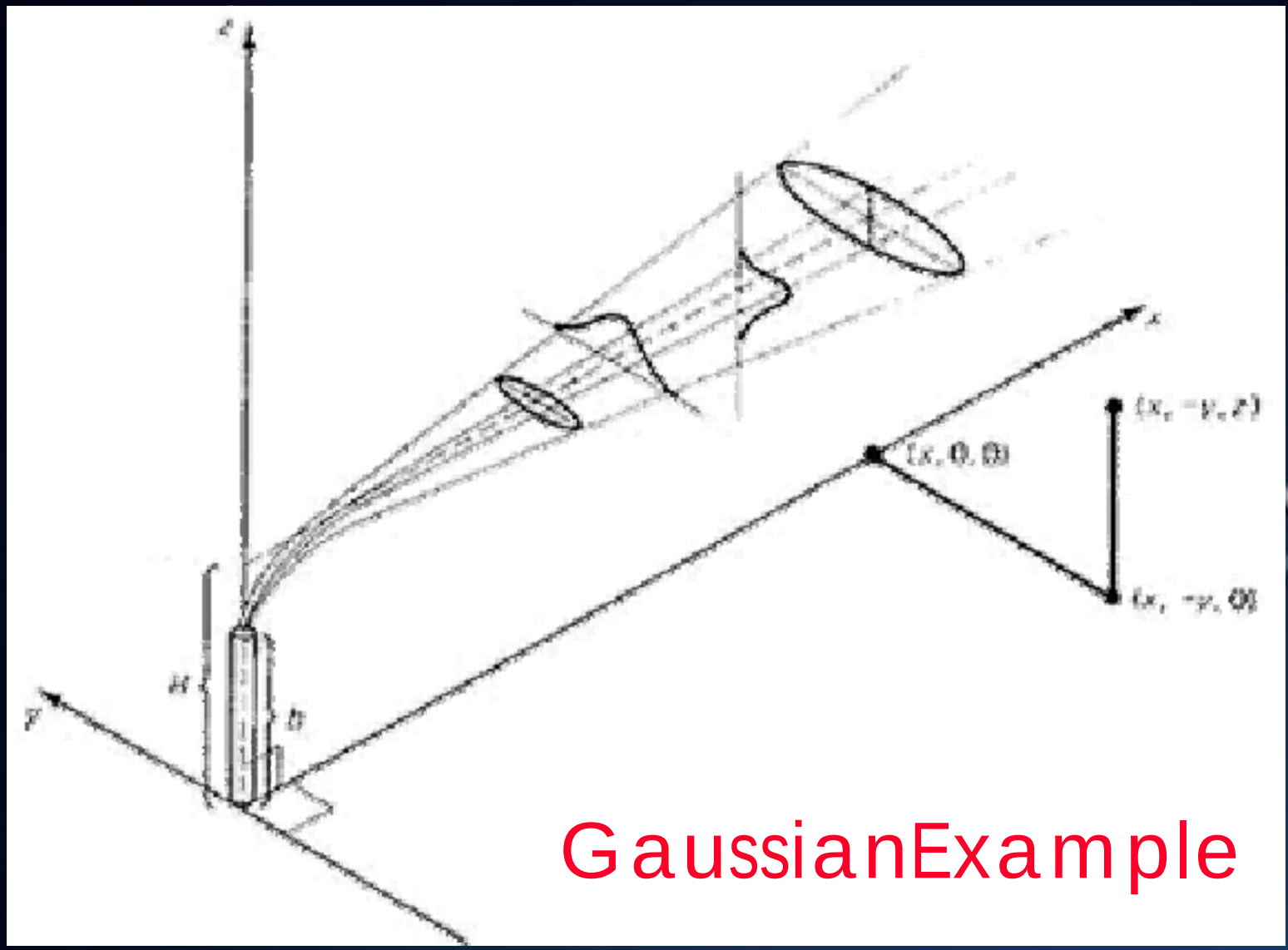
Types of Models Used in Air Quality Management

- 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

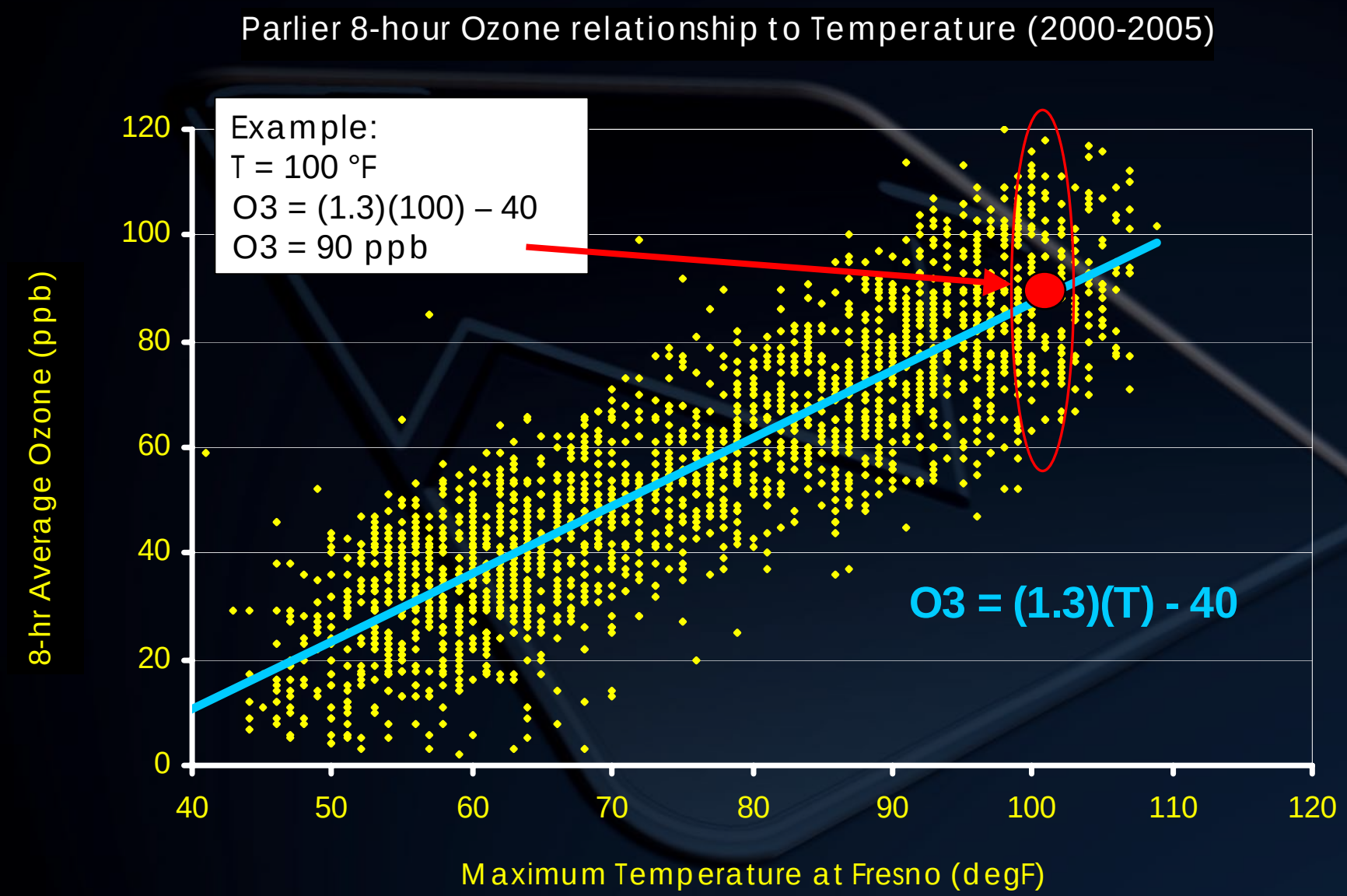
Dispersion Modeling



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



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 or 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

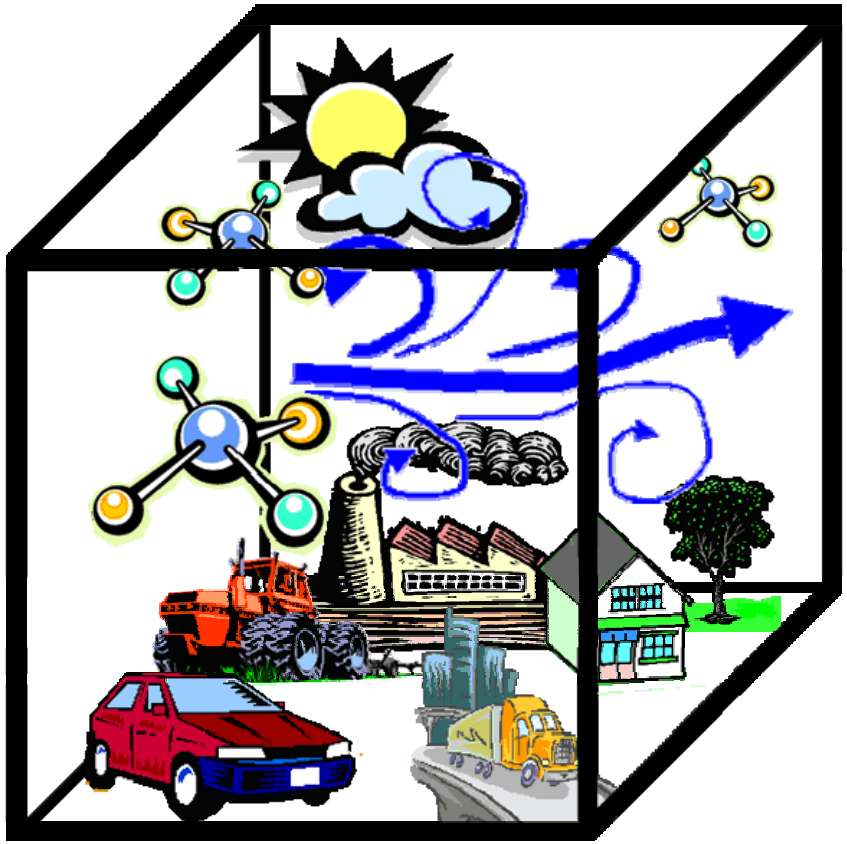
Receptor models

- Use: PM10 Attainment modeling
- Examples: CMB

Modeling with the "Big M"

- Examples: Evaluation and processing modeling files

Box Model (One Grid Cell)

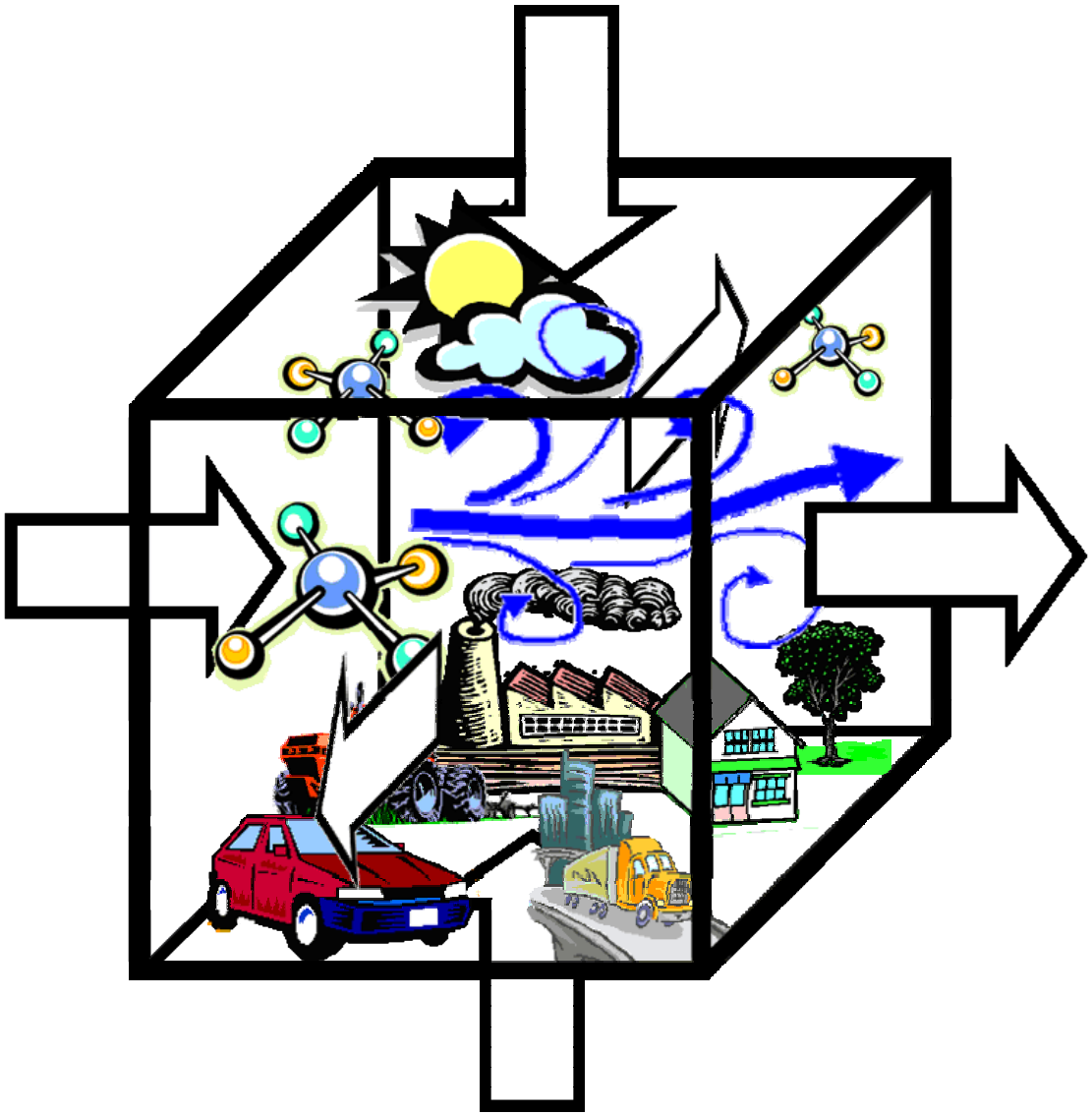


CCOS Photochemical Modeling Domain

Domain Size:

460 miles per side

Grid Model (One Grid Cell)



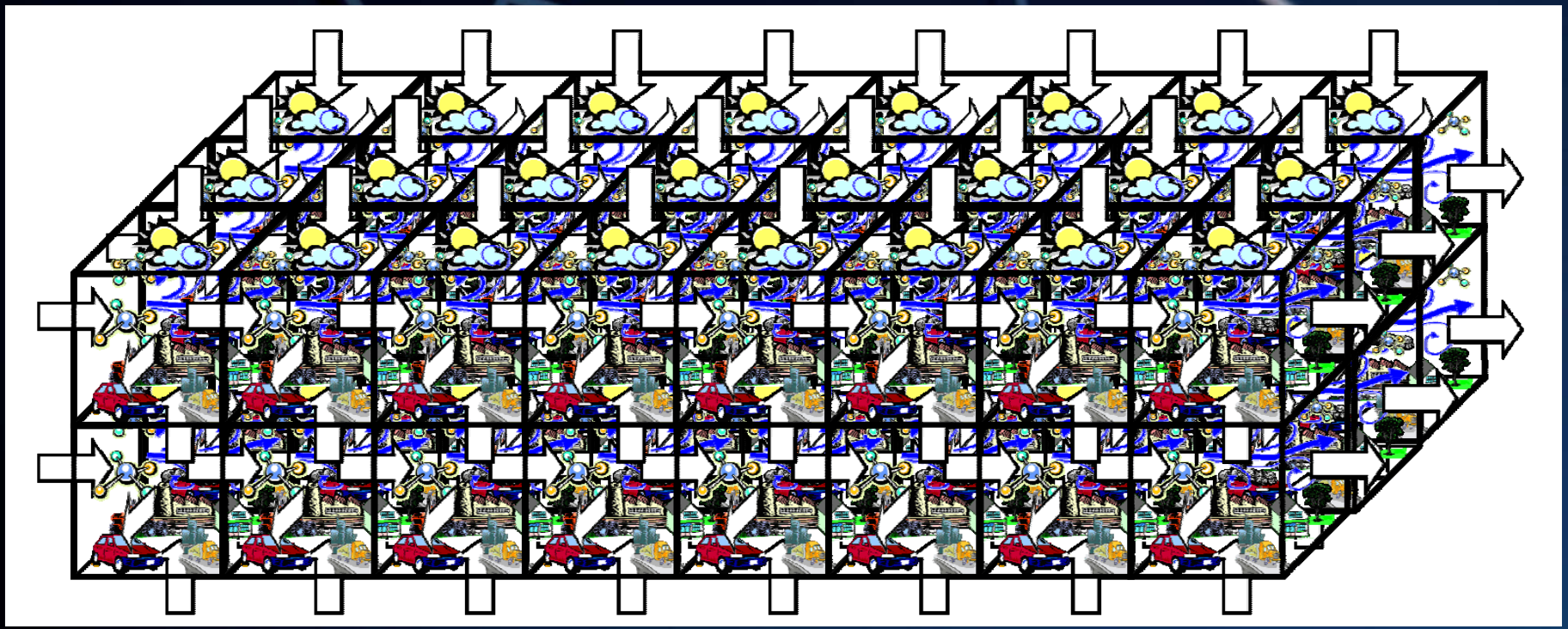
Current SIP Photochemical Modeling

Calculations

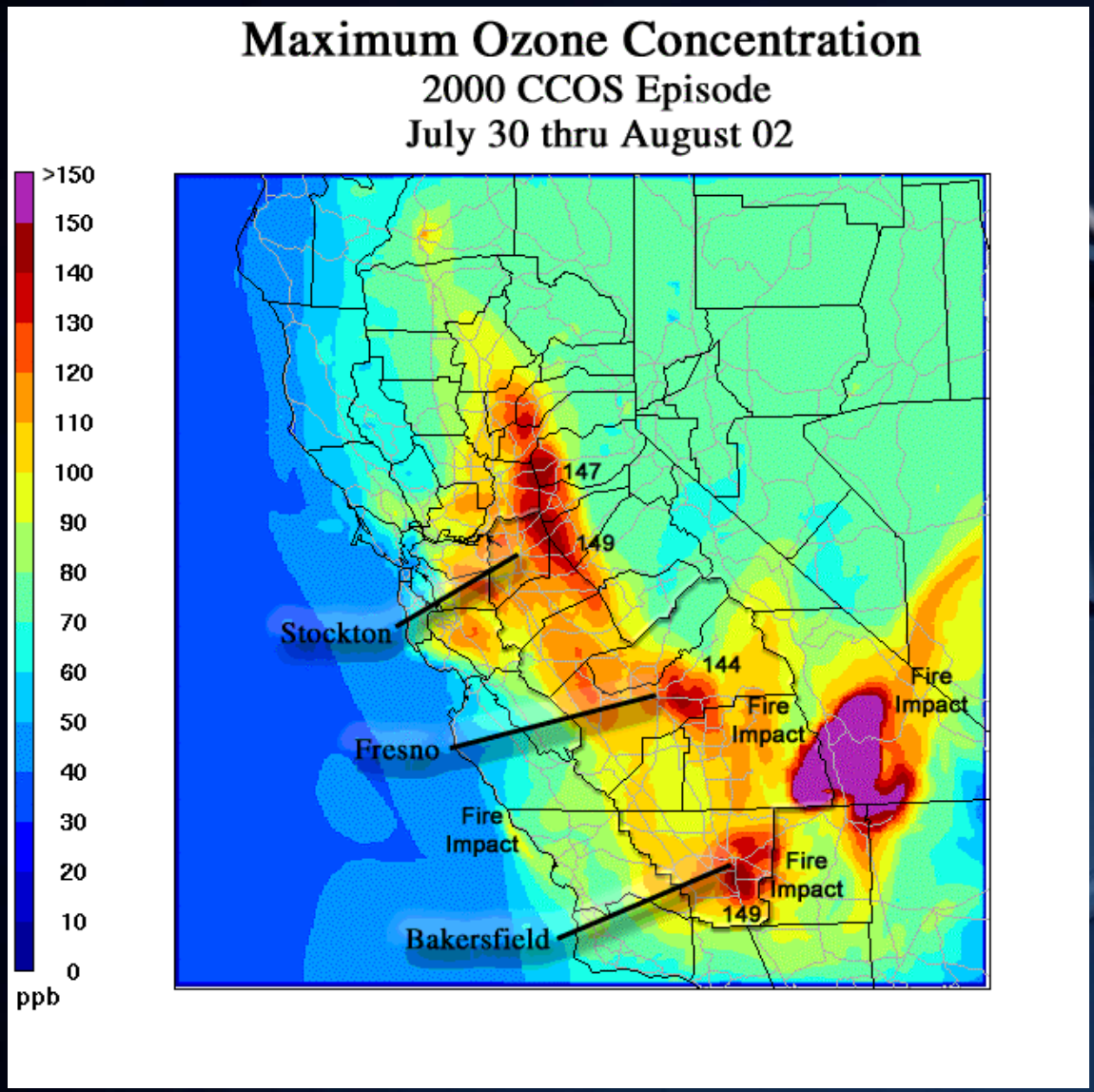
- 13 Meteorological Parameters
- 74 Chemical Species
- 211 Chemical Equations
- "All" Emissions

Size

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

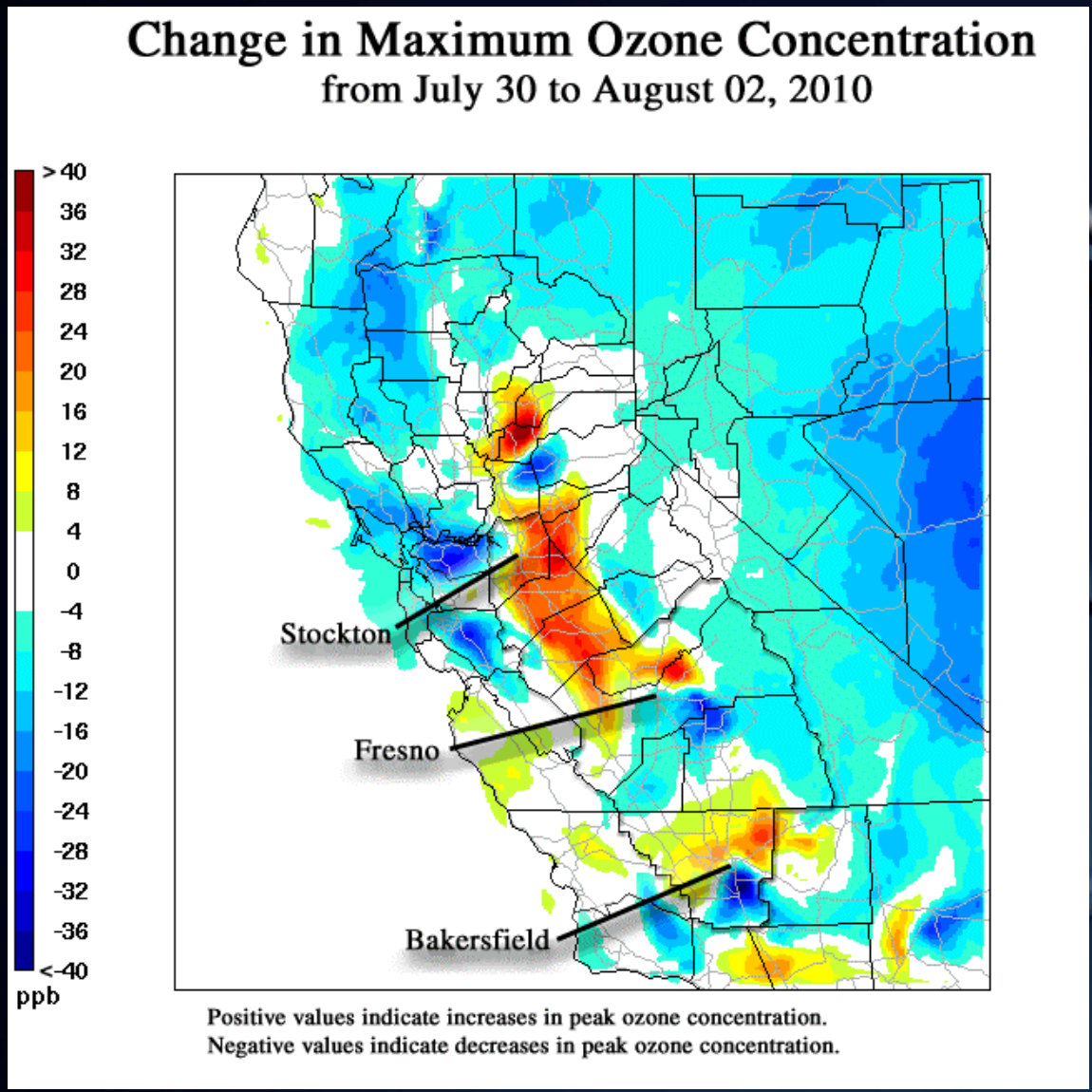


Analysis of Peak Concentrations



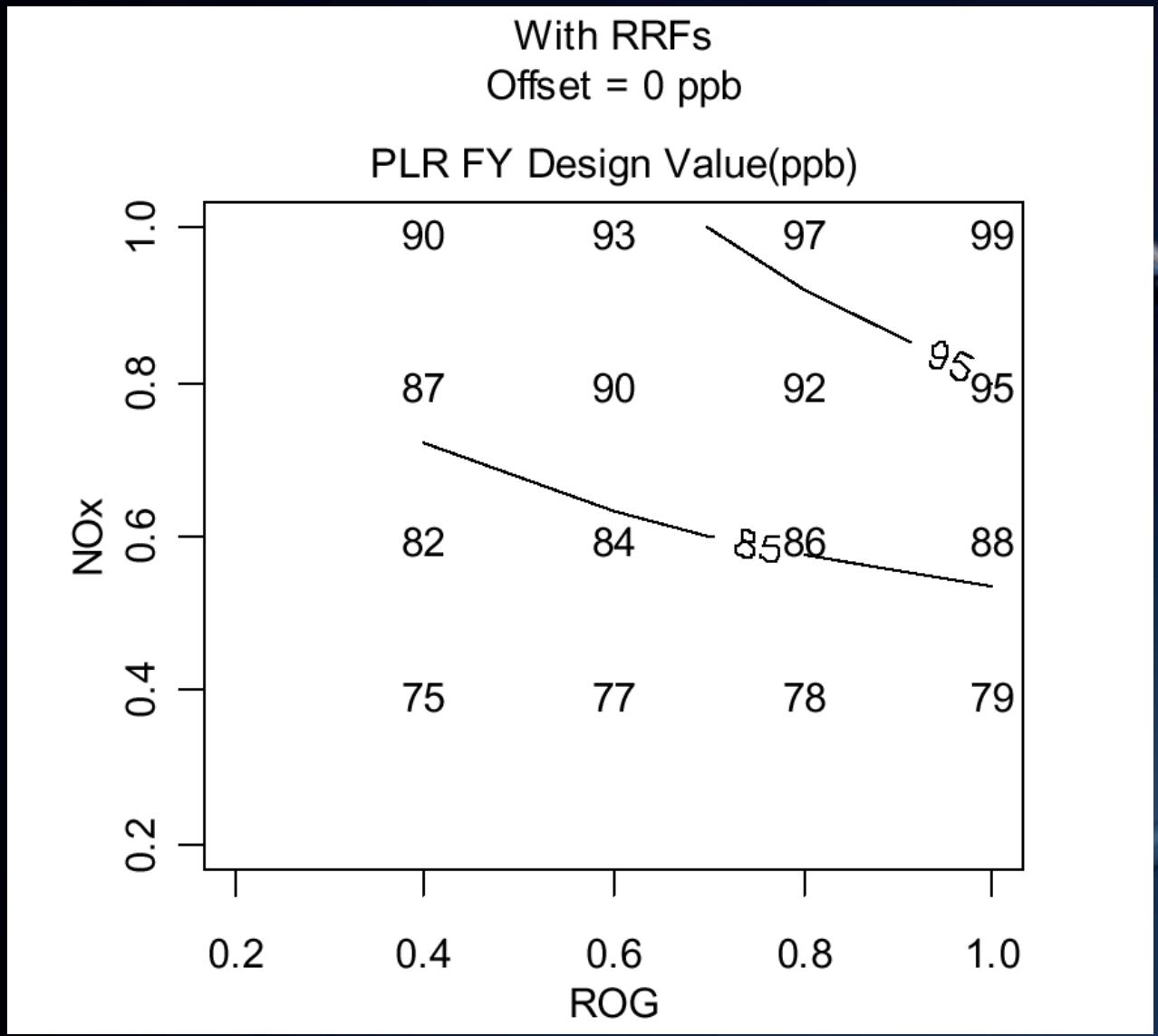
Maximum modeled ozone by grid cell for the July/August 2000 CCOS episode as documented for the Extreme Ozone SIP.

Analysis of Changes



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

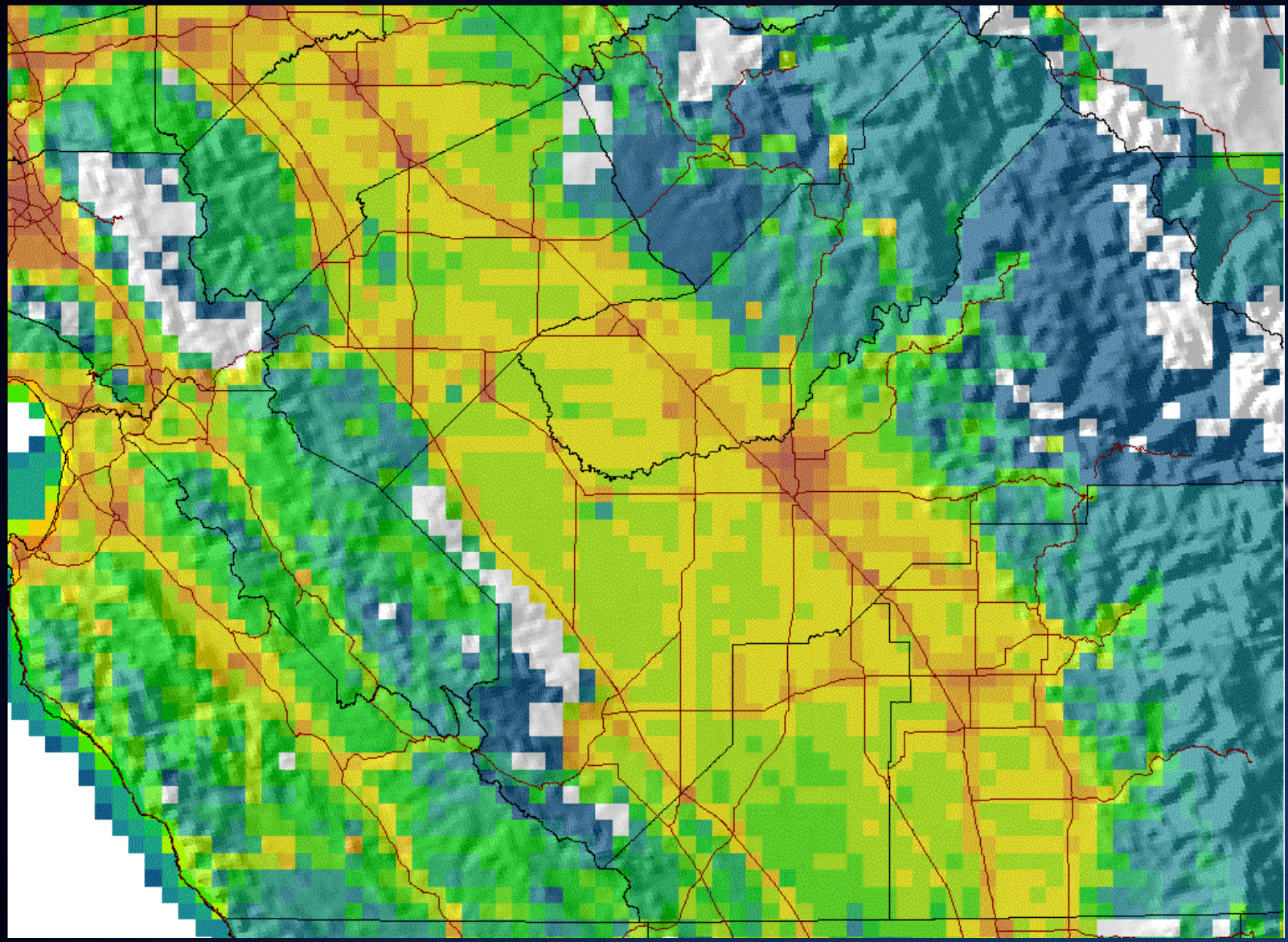


Carrying Capacity Diagrams are used to estimate the amount of NOx and VOC reductions needed to reach attainment goals.

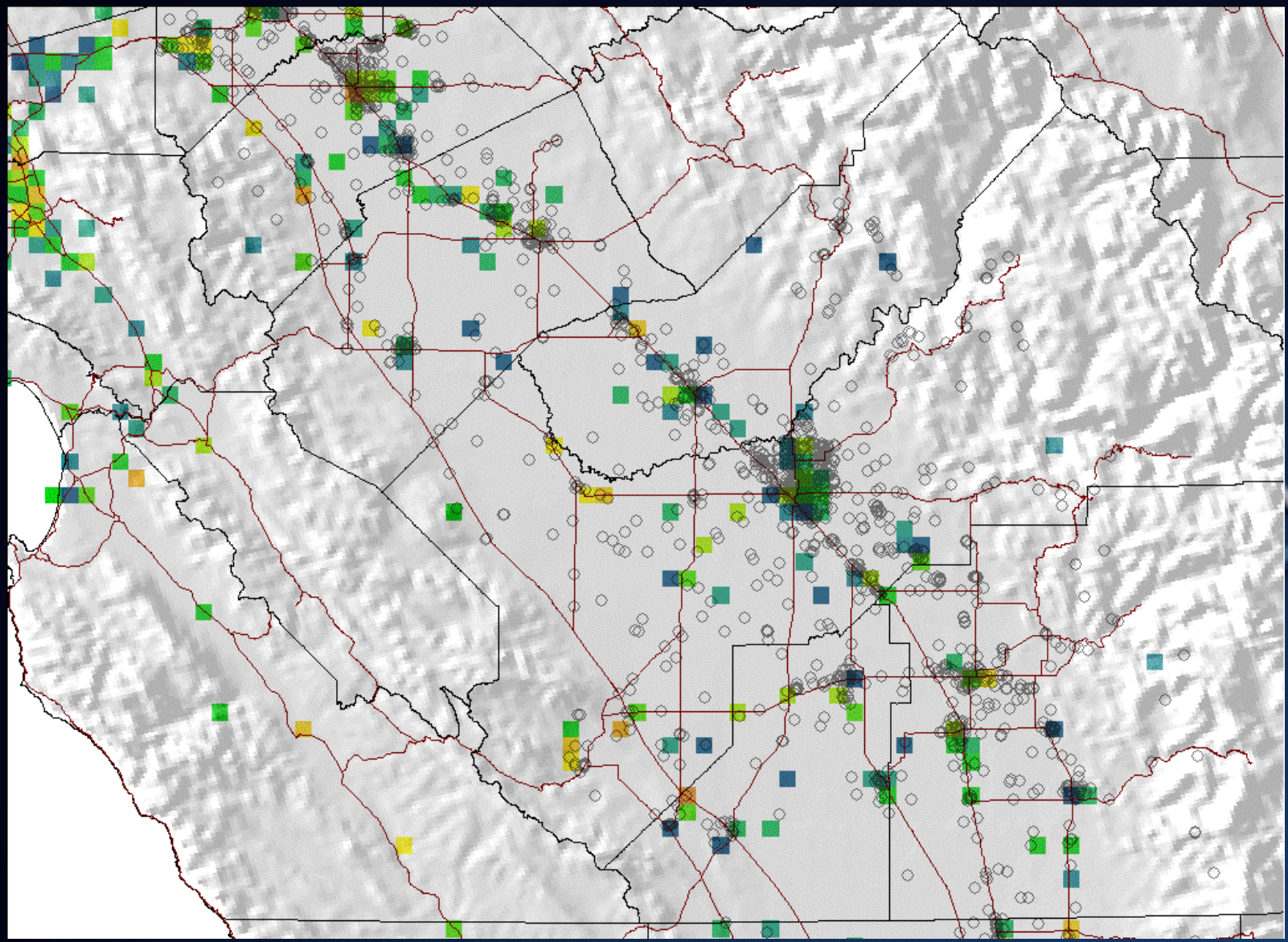
Modeling Examples

- Photochemical Model Inputs
- O_3 SIP Modeling
- O_3 SIP Modeling (SJV Only)
- 3D View of O_3 SIP Modeling
- Transport evaluation (Non-Reactive NOx)
- Smoke Transport (CANSAC)
- National O_3 Daily Forecast Model

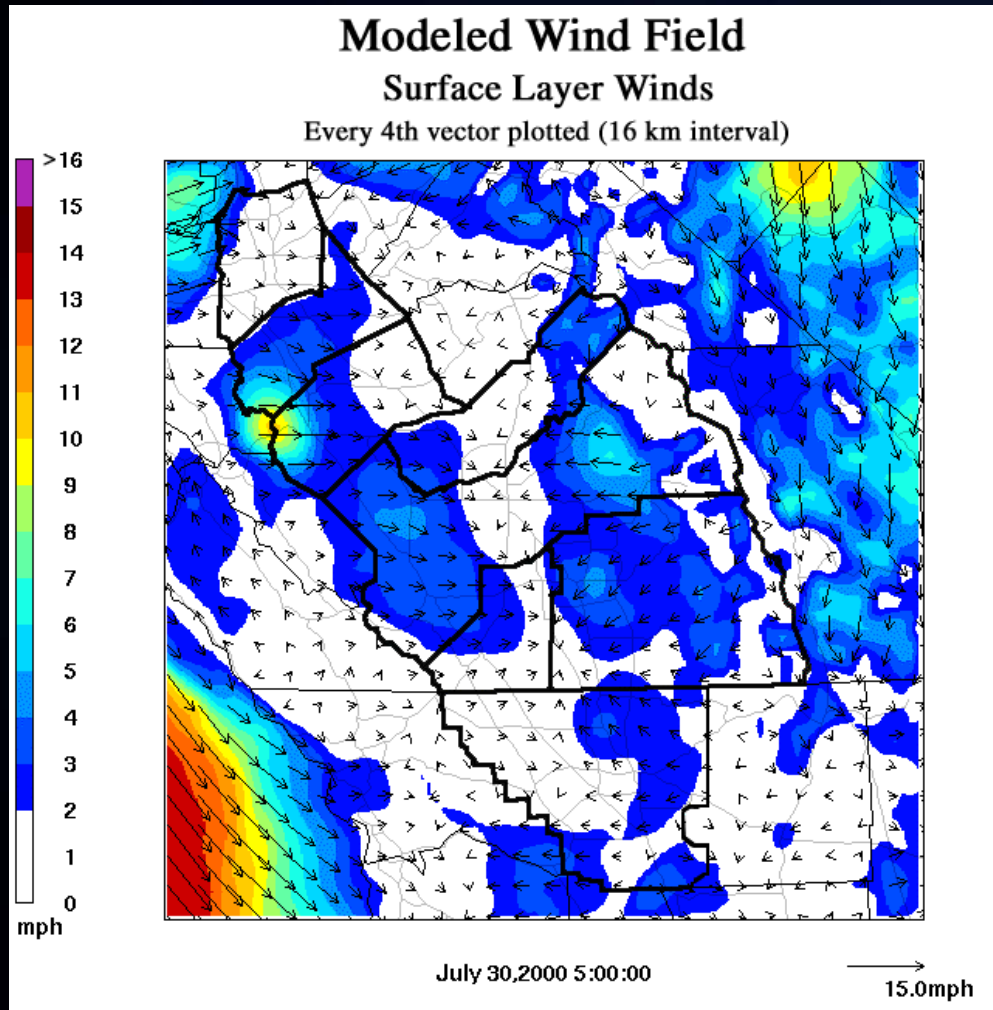
Area Source Gridded Inventory

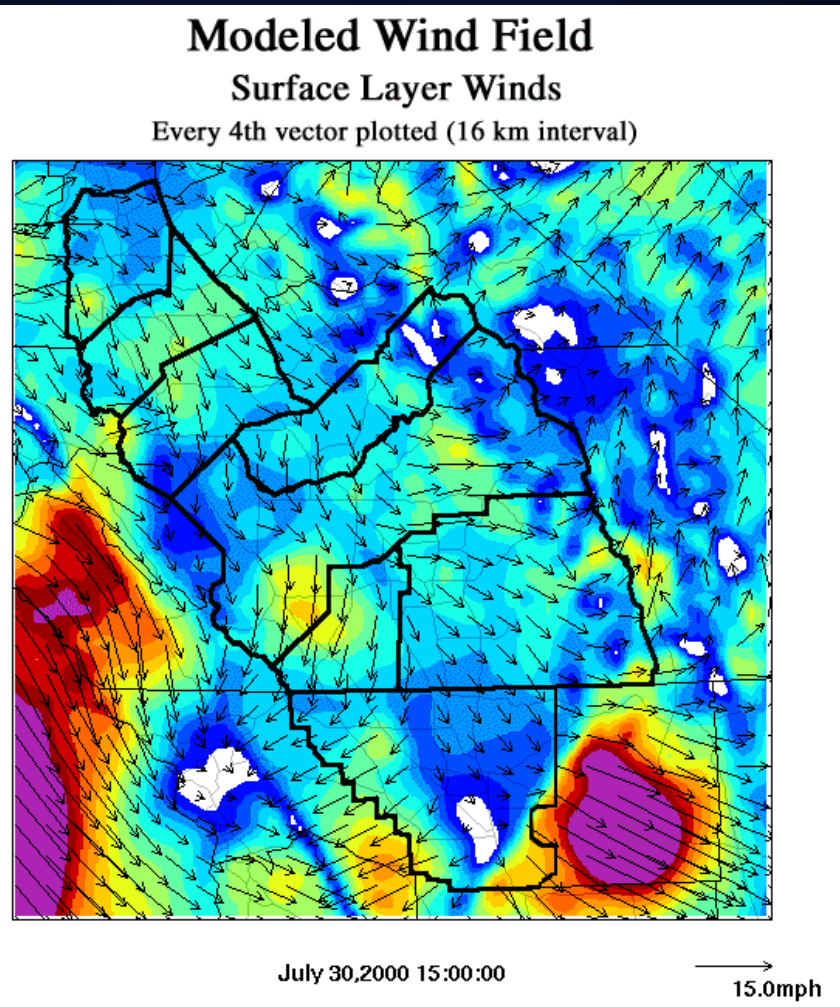


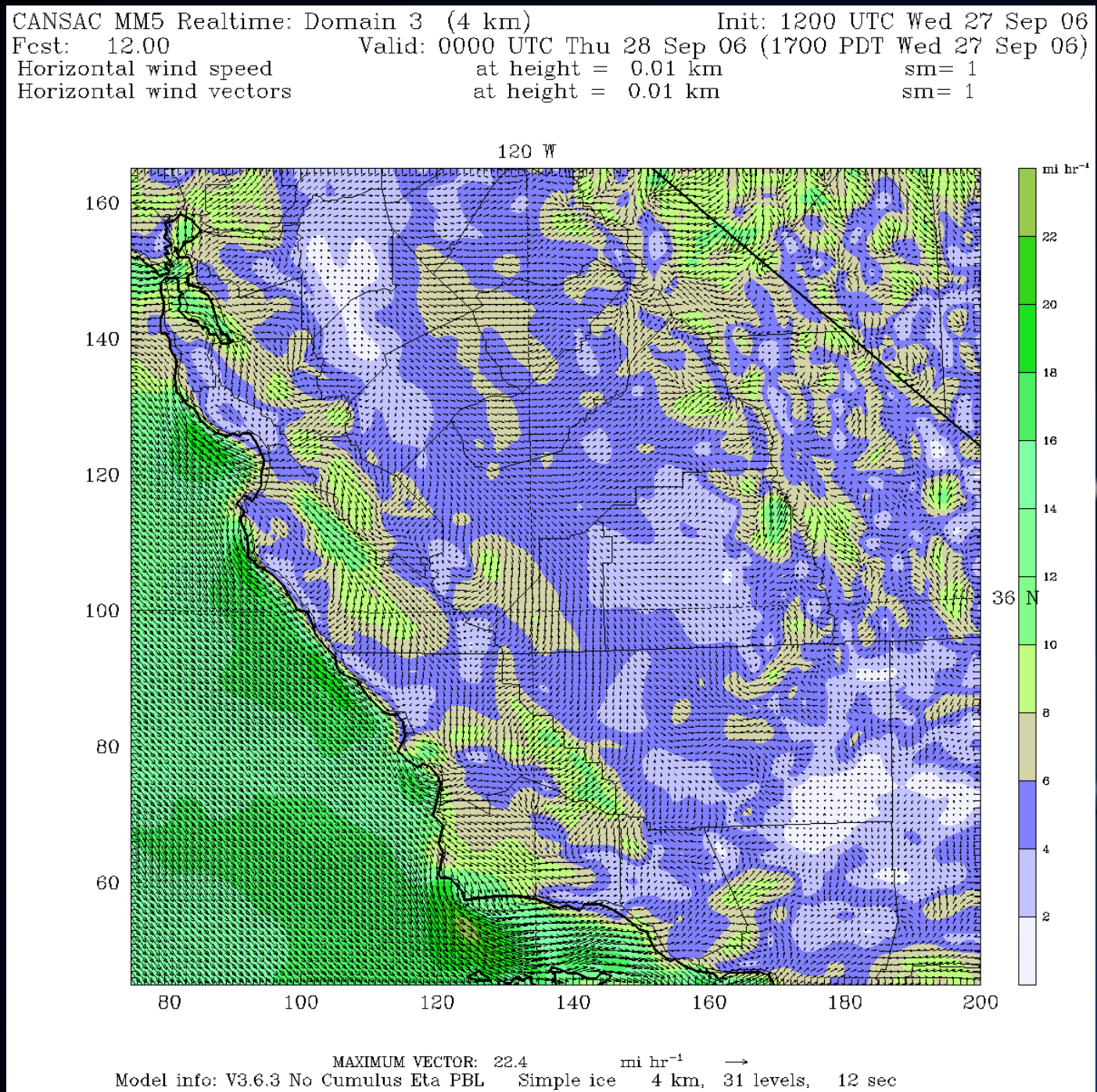
Point Source Gridded Inventory



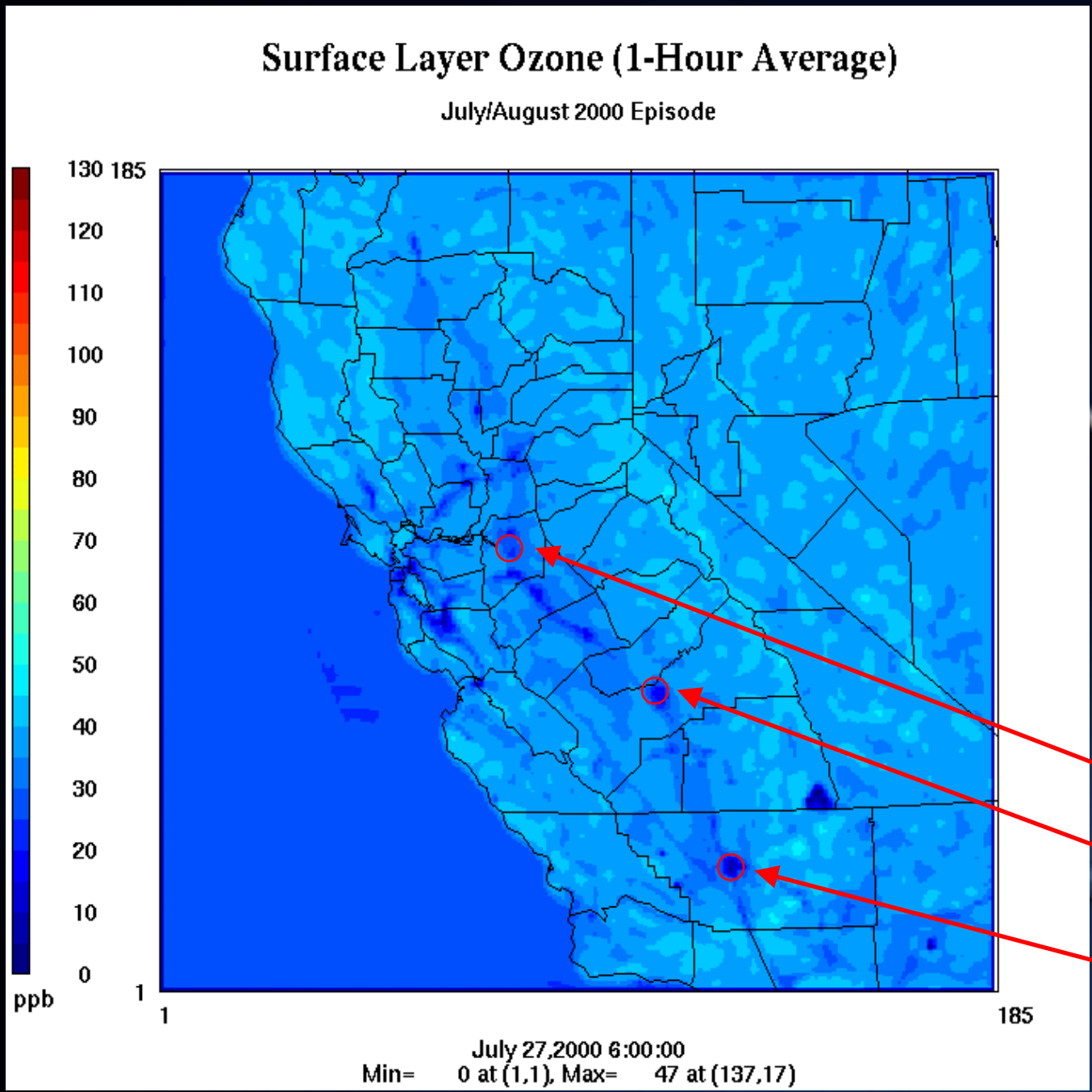
Meteorological Inputs







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



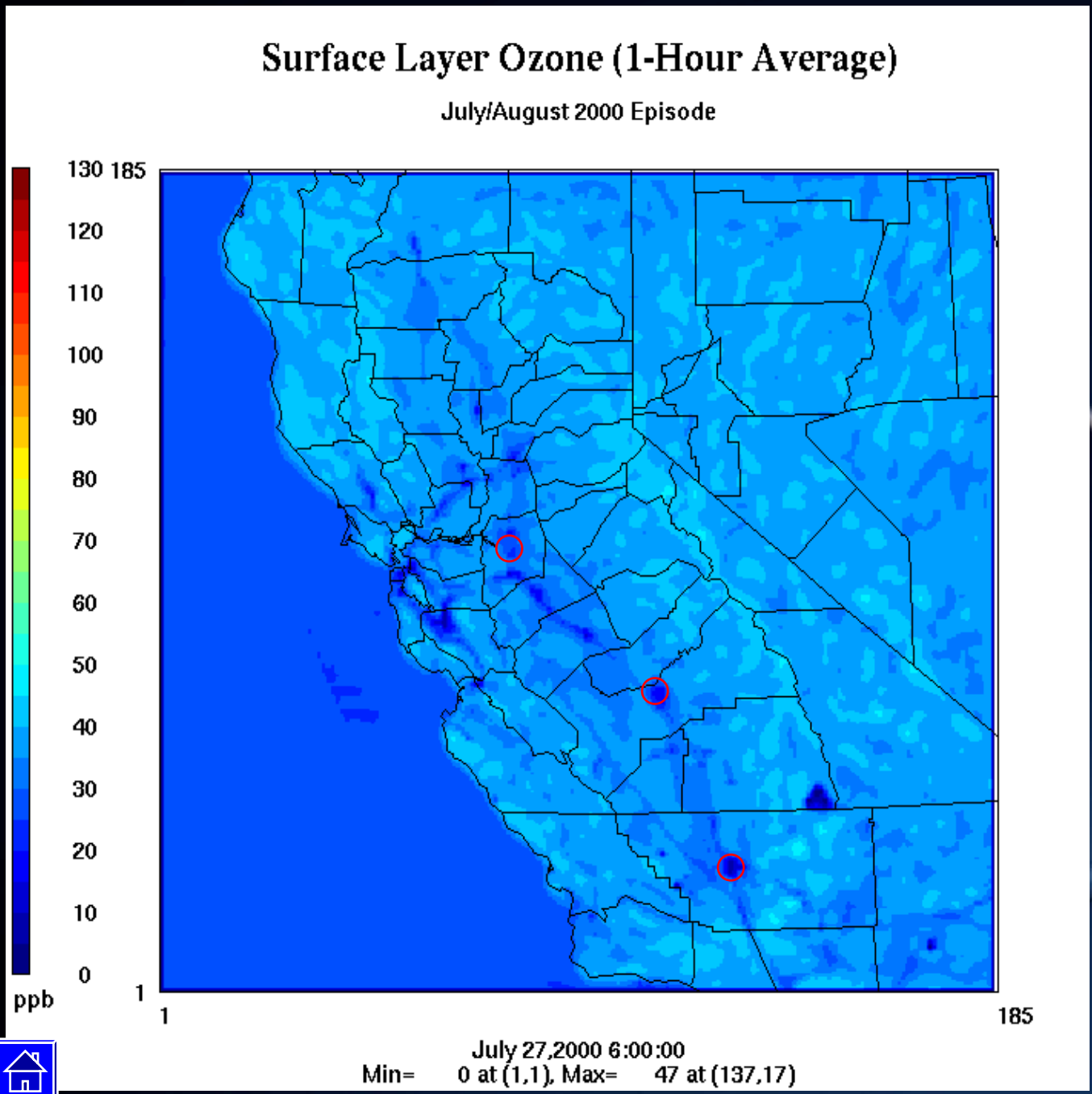
Ozone SIP Modeling

- ARB/SJV
- MM5
- CAMx

Stockton

Fresno

Bakersfield



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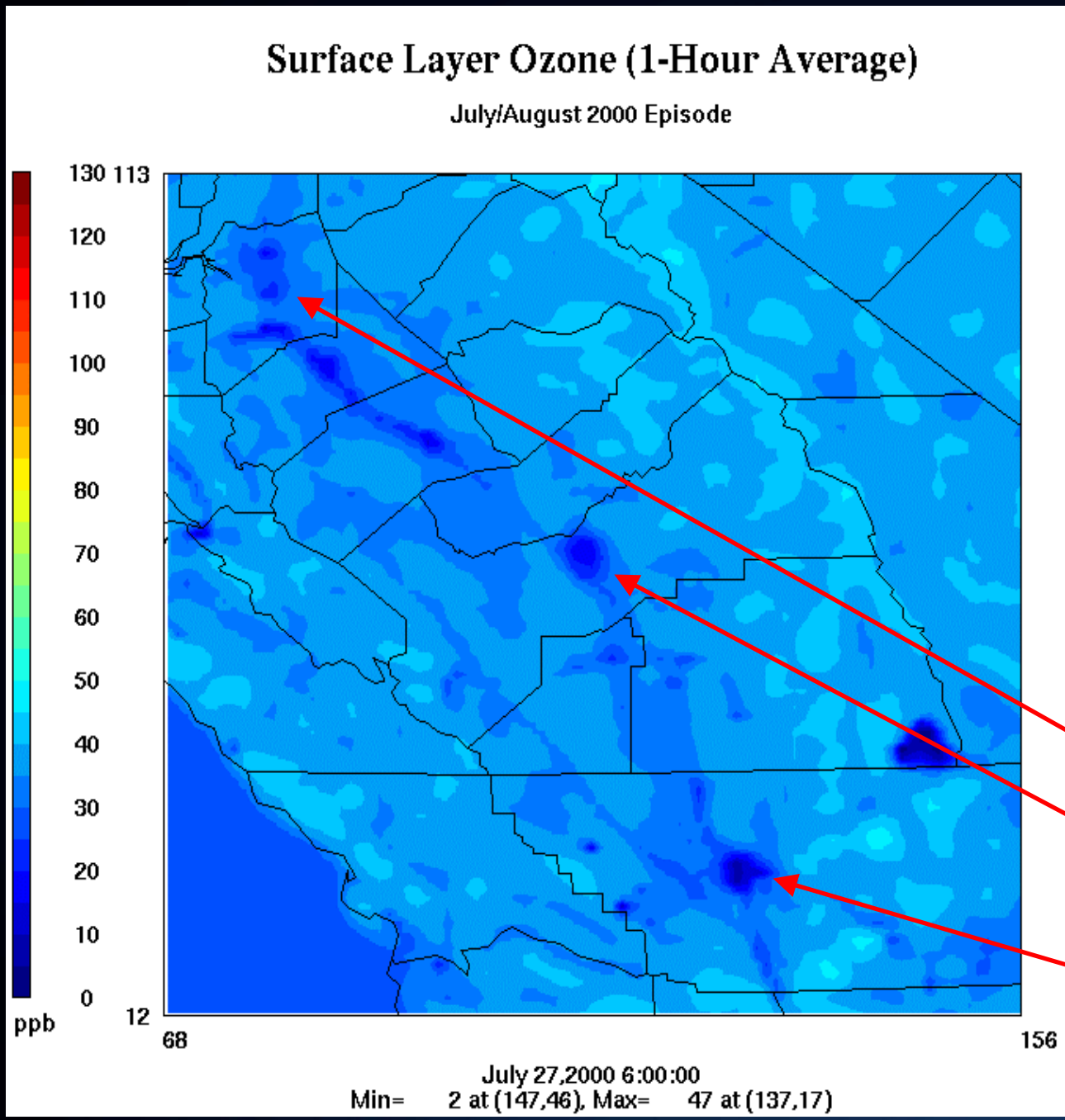

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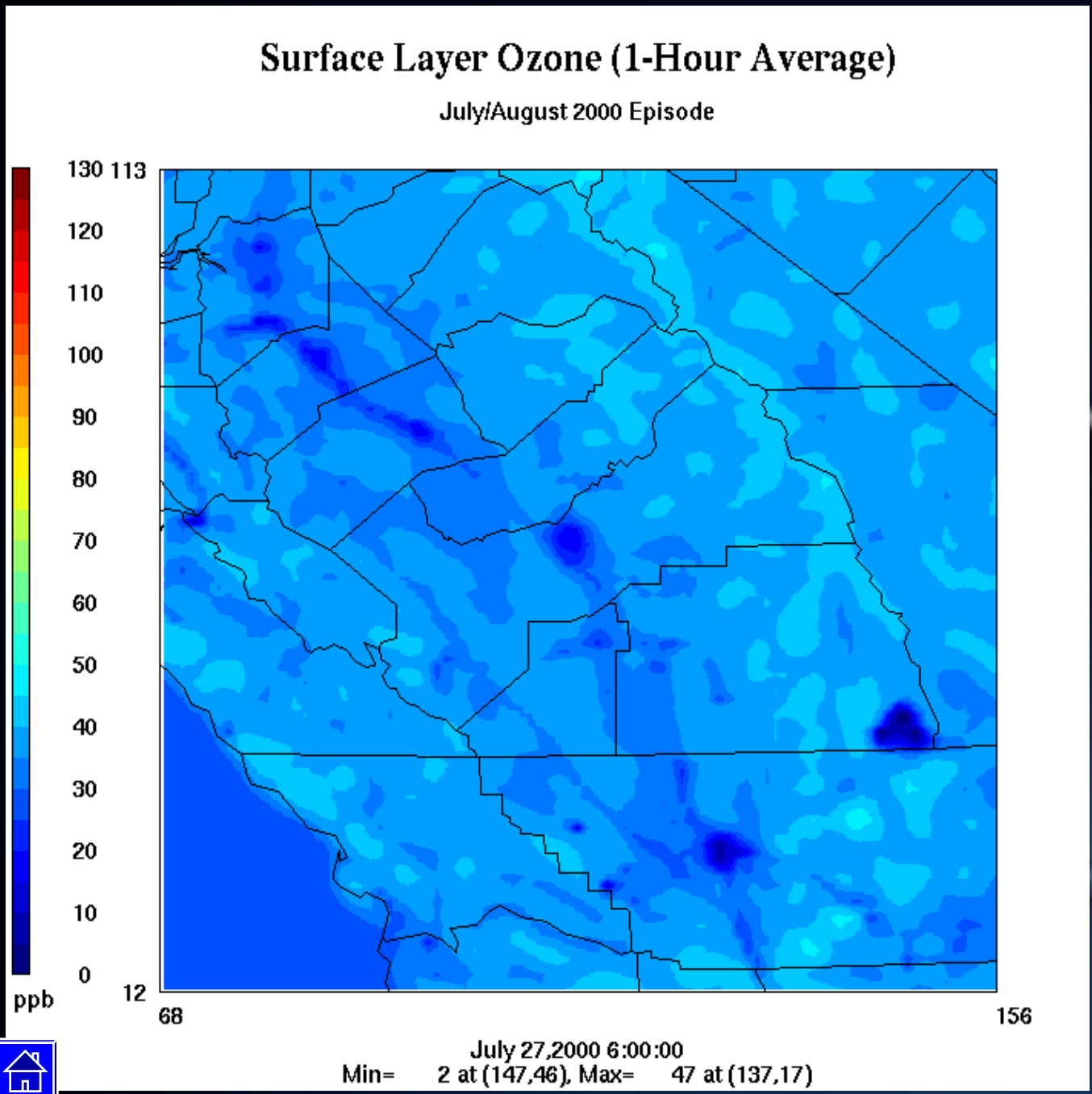
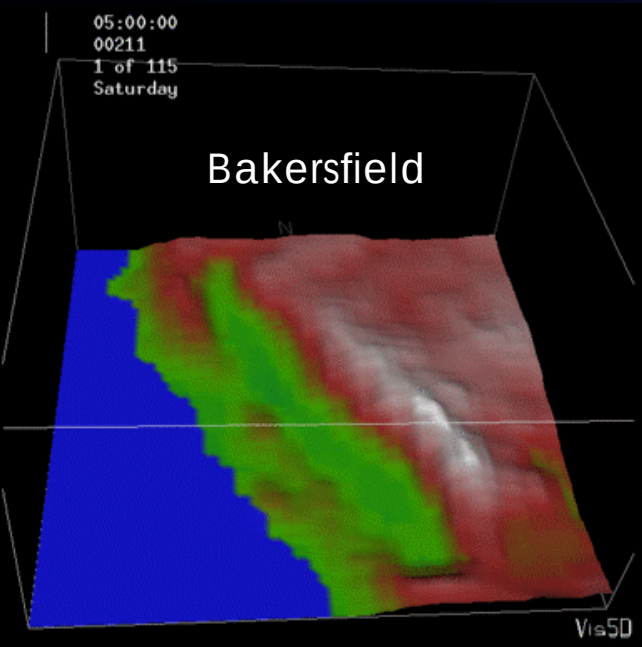


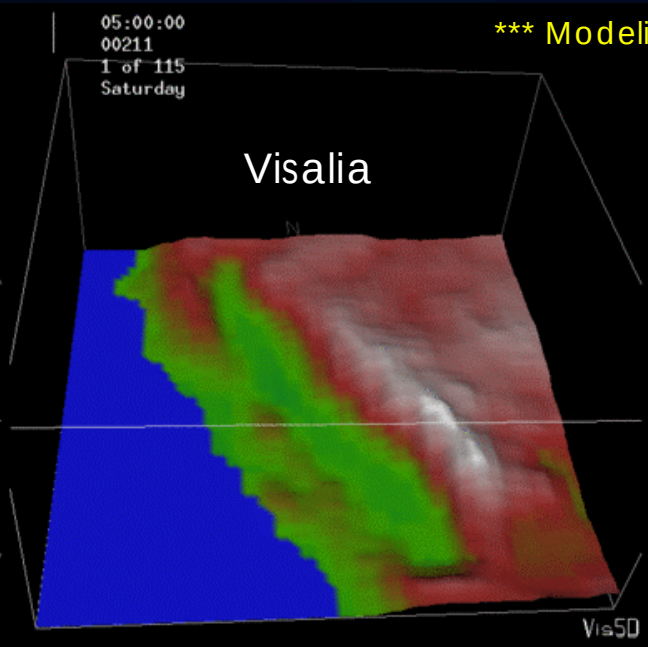
Ozone SIP Modeling

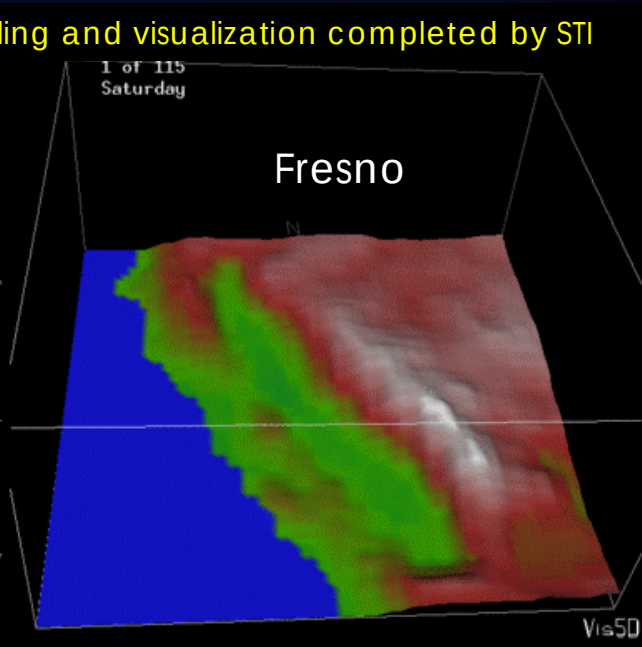
- ARB/SJV
- MM5
- CAMx

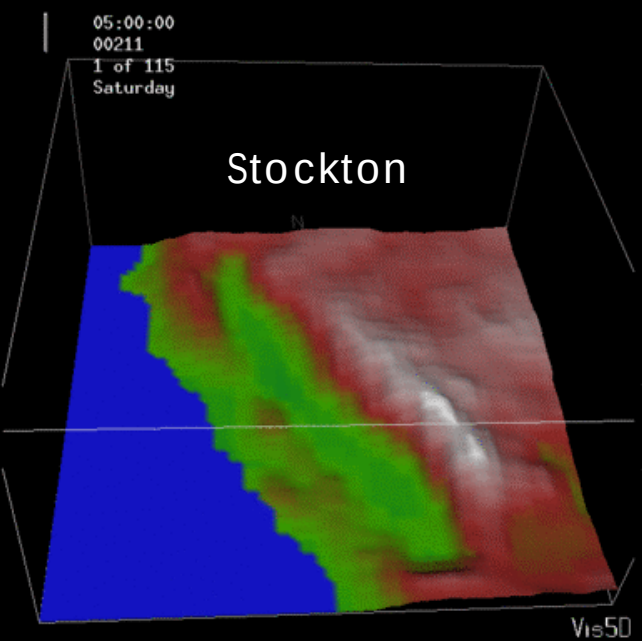
NOx Non-reactive Transport

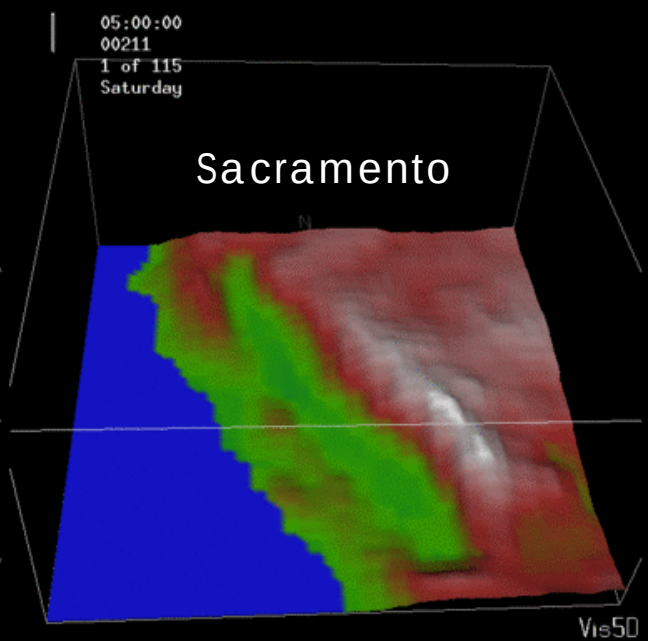
*** Modeling and visualization completed by STI

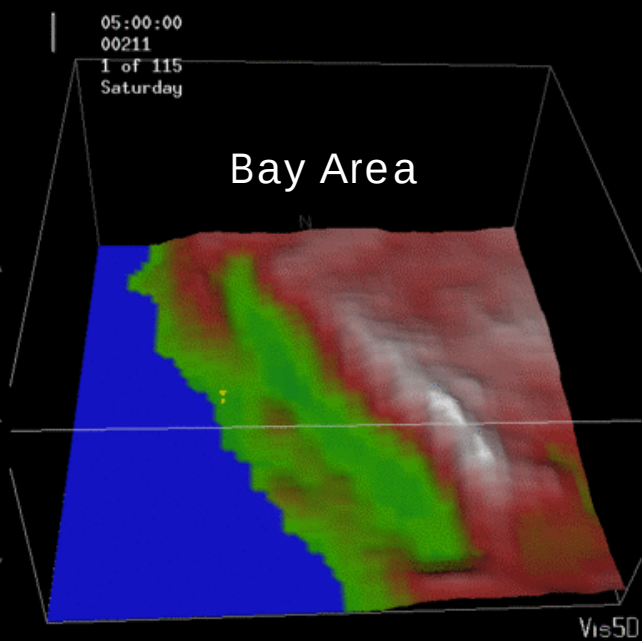












NOx Non-reactive Transport

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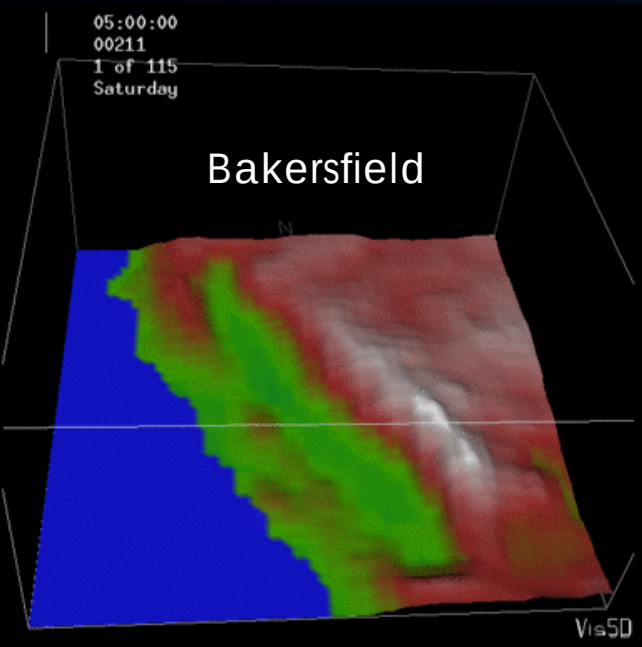
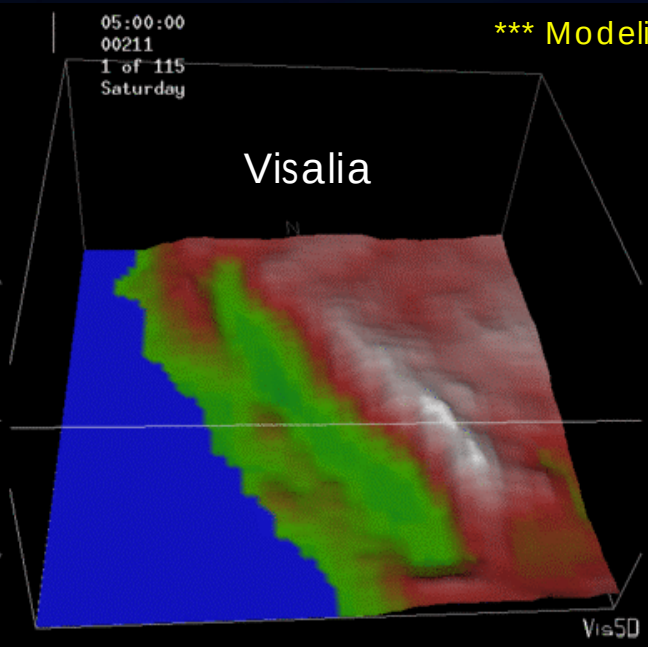
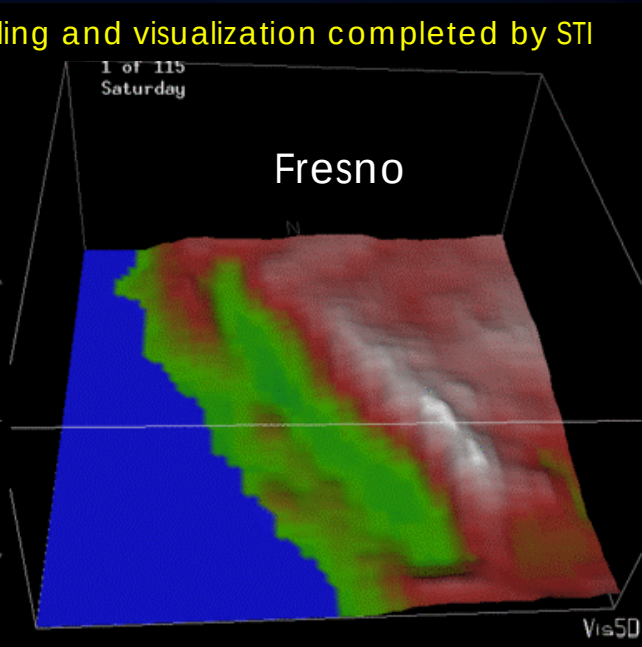
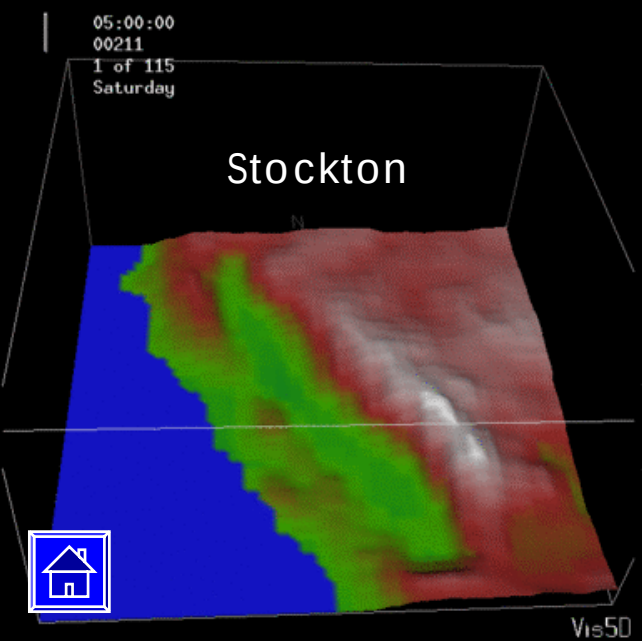
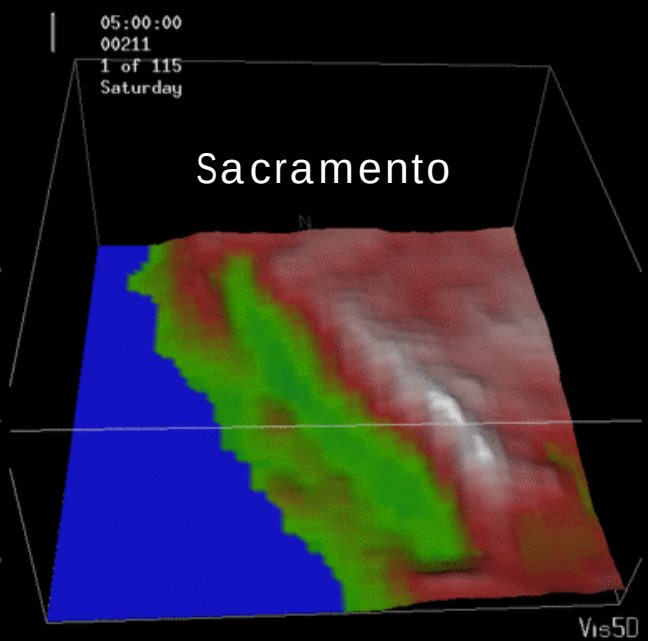
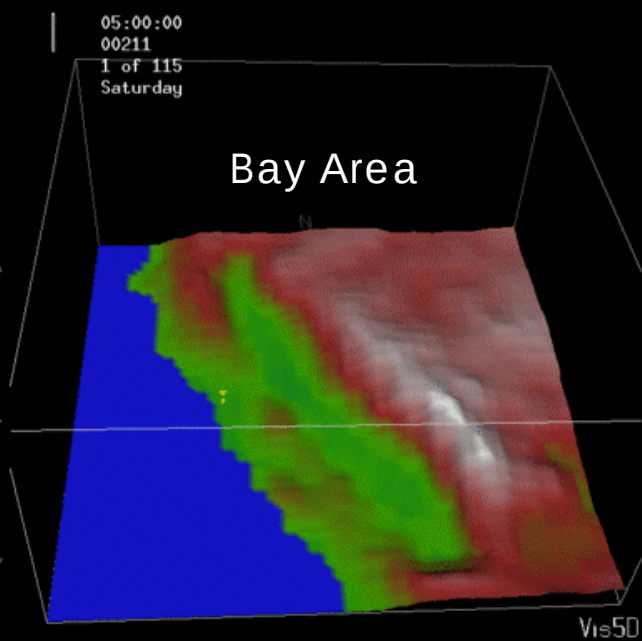




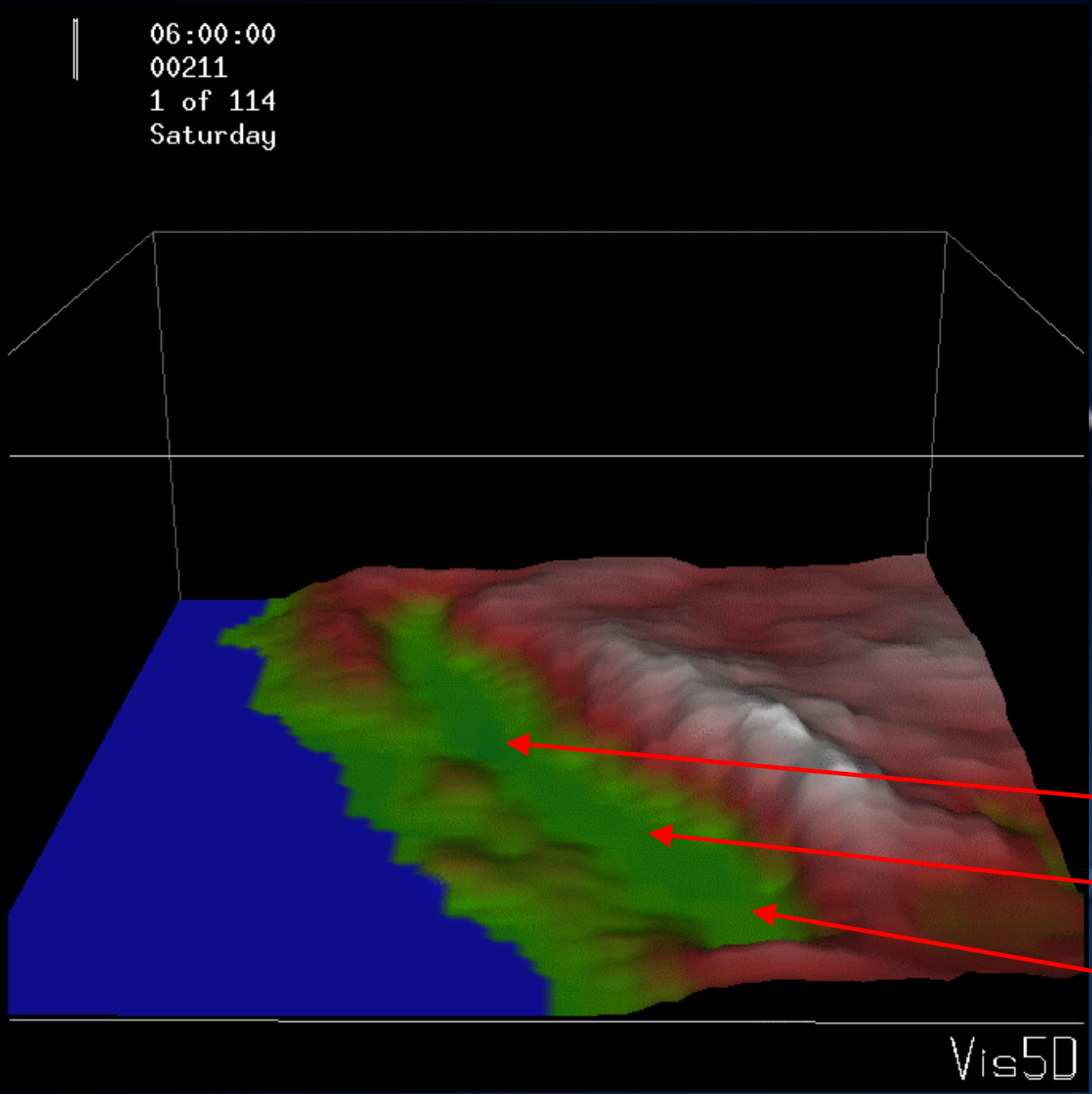






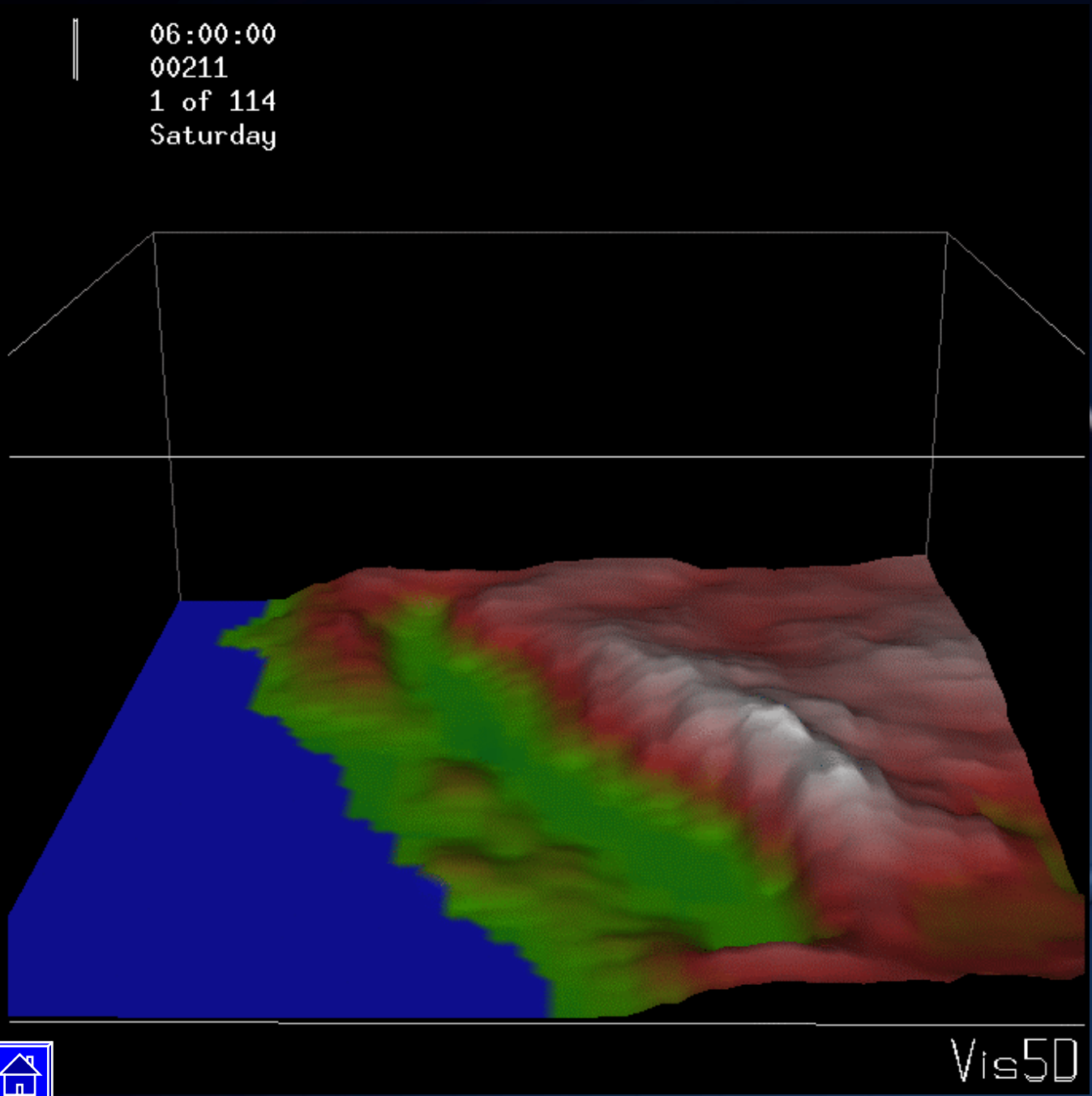


3D Ozone Plume



- STI
- MM5
- CAMx

3D Ozone Plume



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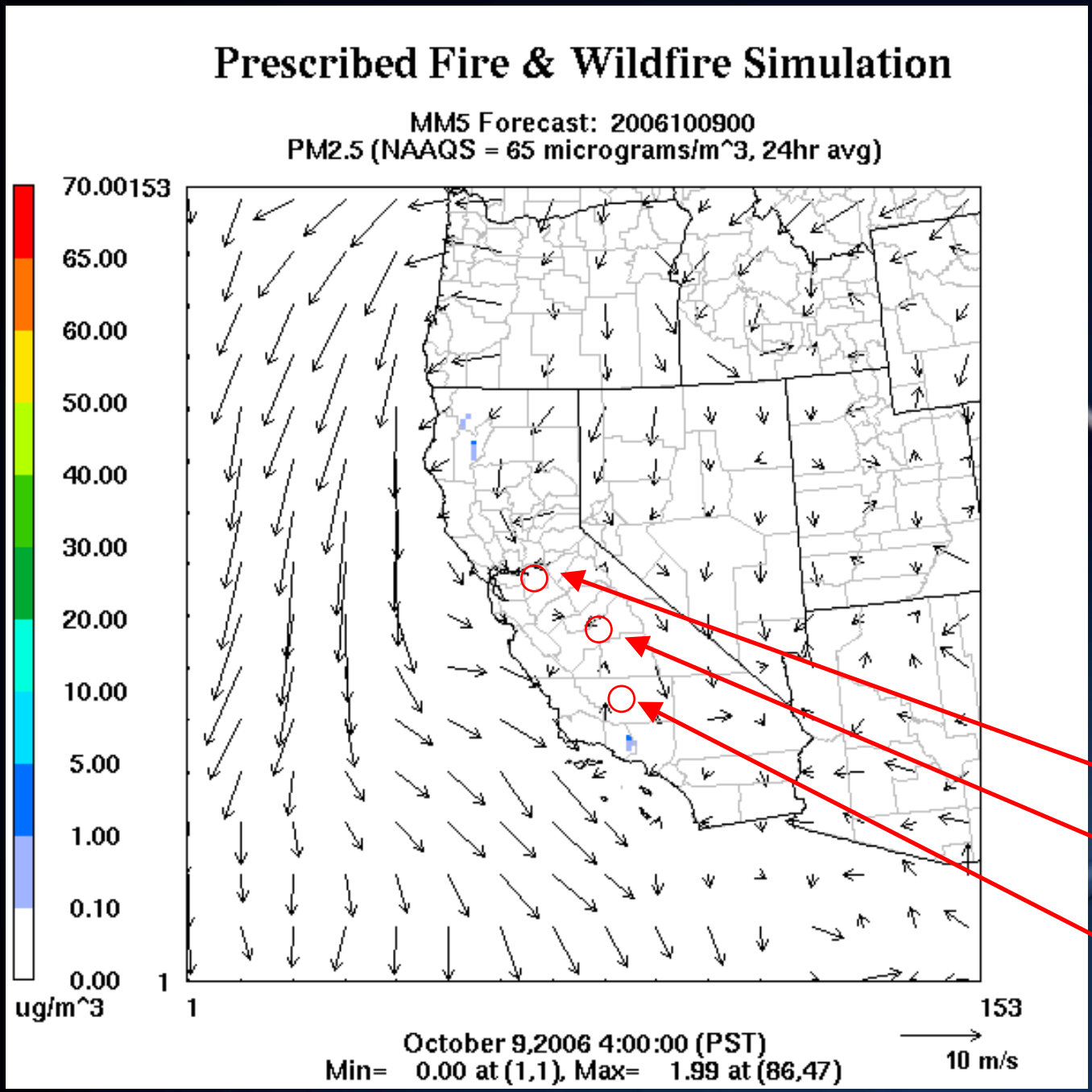


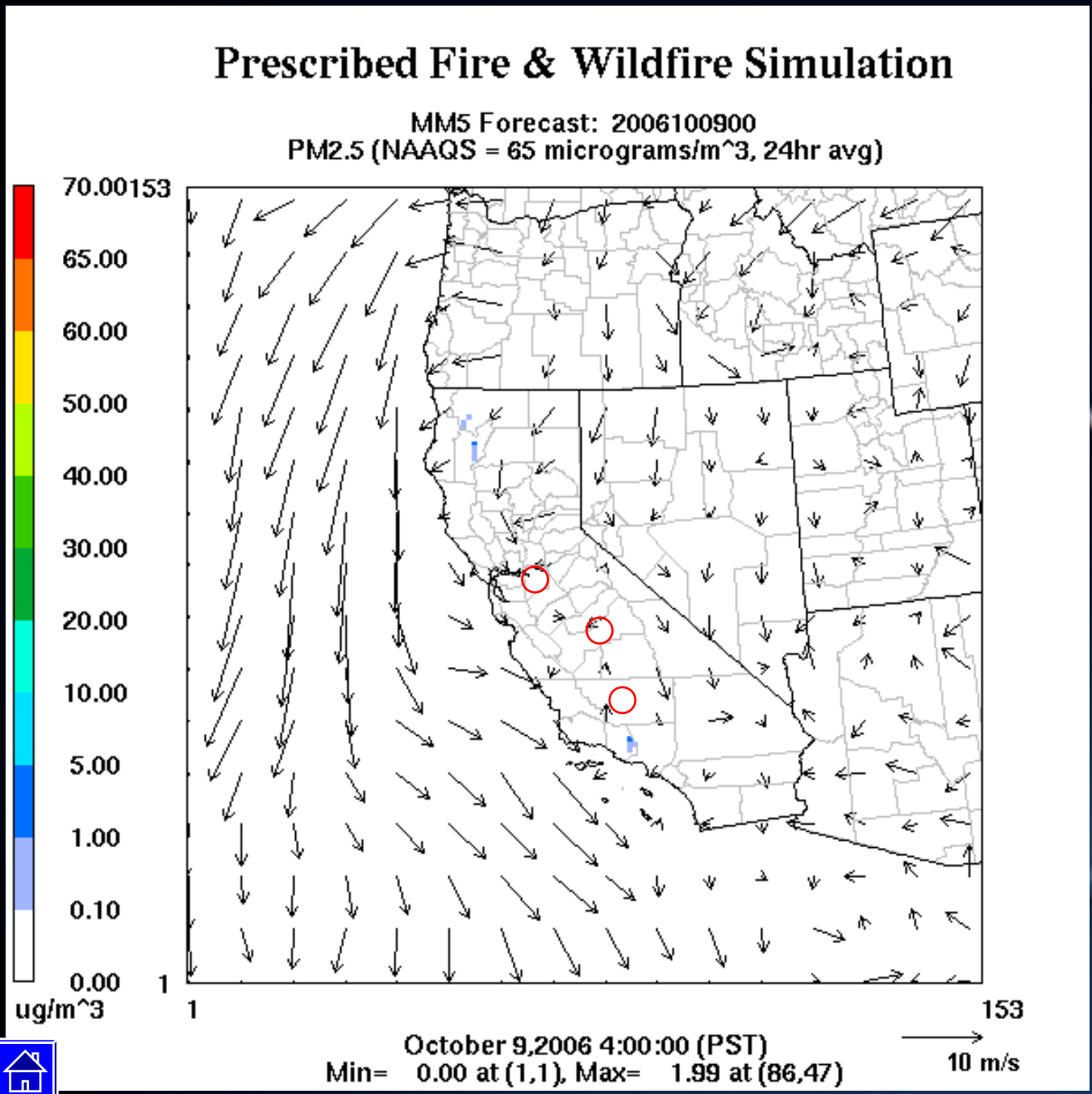
Smoke Transport Forecast

- CANSAC
- MM5
- Calpuff

Stockton

Fresno

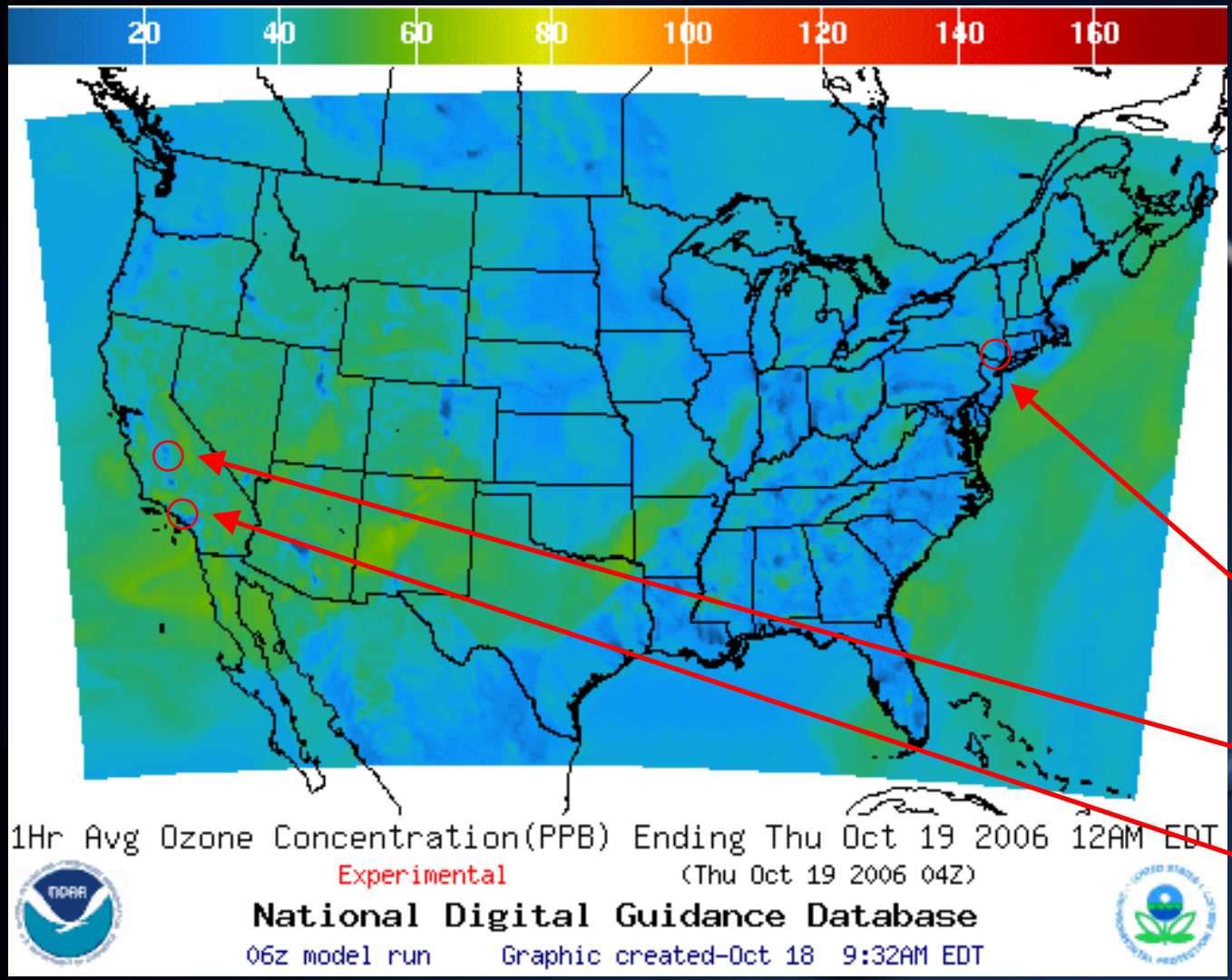
Bakersfield



Smoke Transport Forecast

- CANSAC
- MM5
- Calpuff

National Ozone Forecast Model



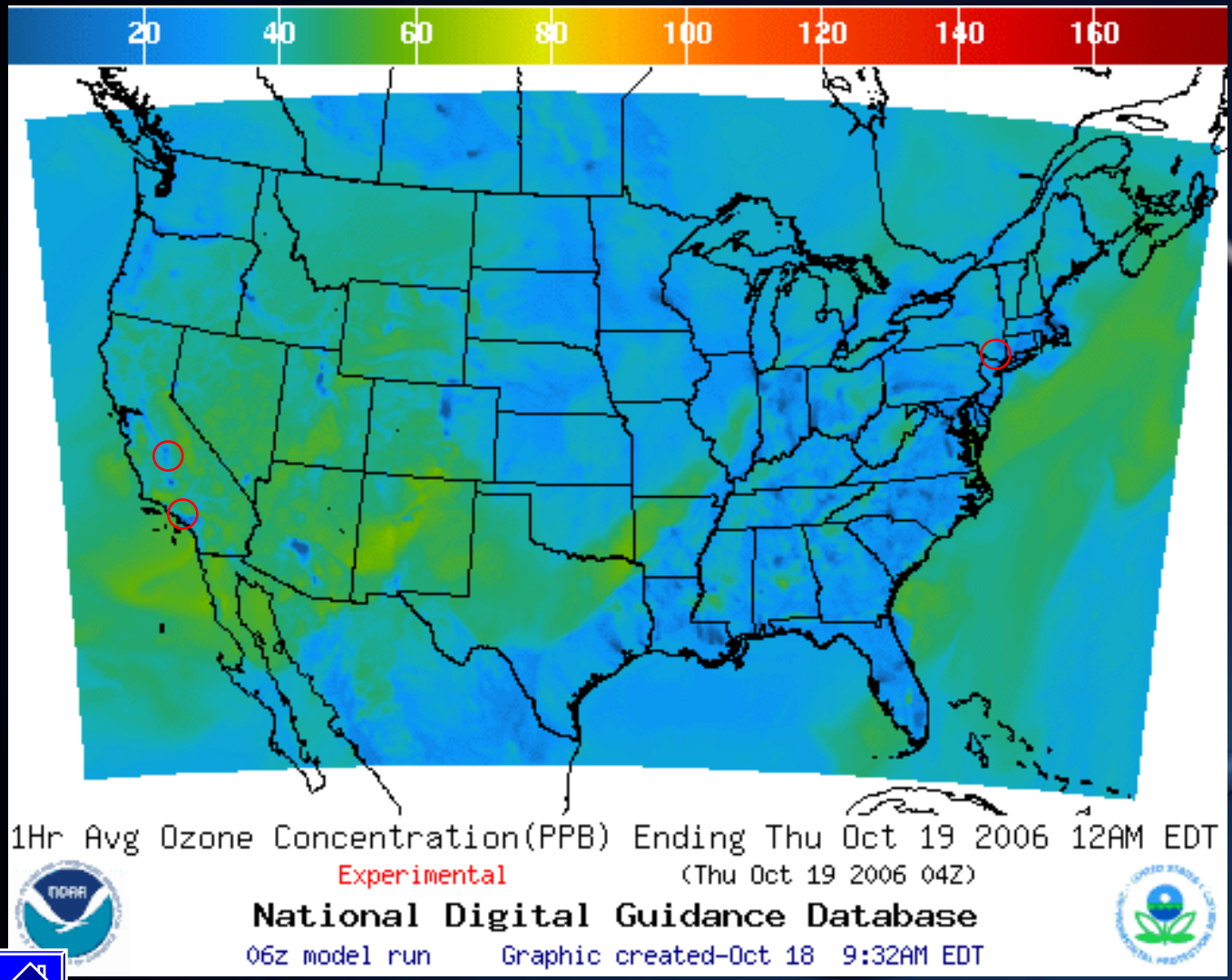
- NOAA
- WRF
- CMAQ

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/aqmportal/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/