

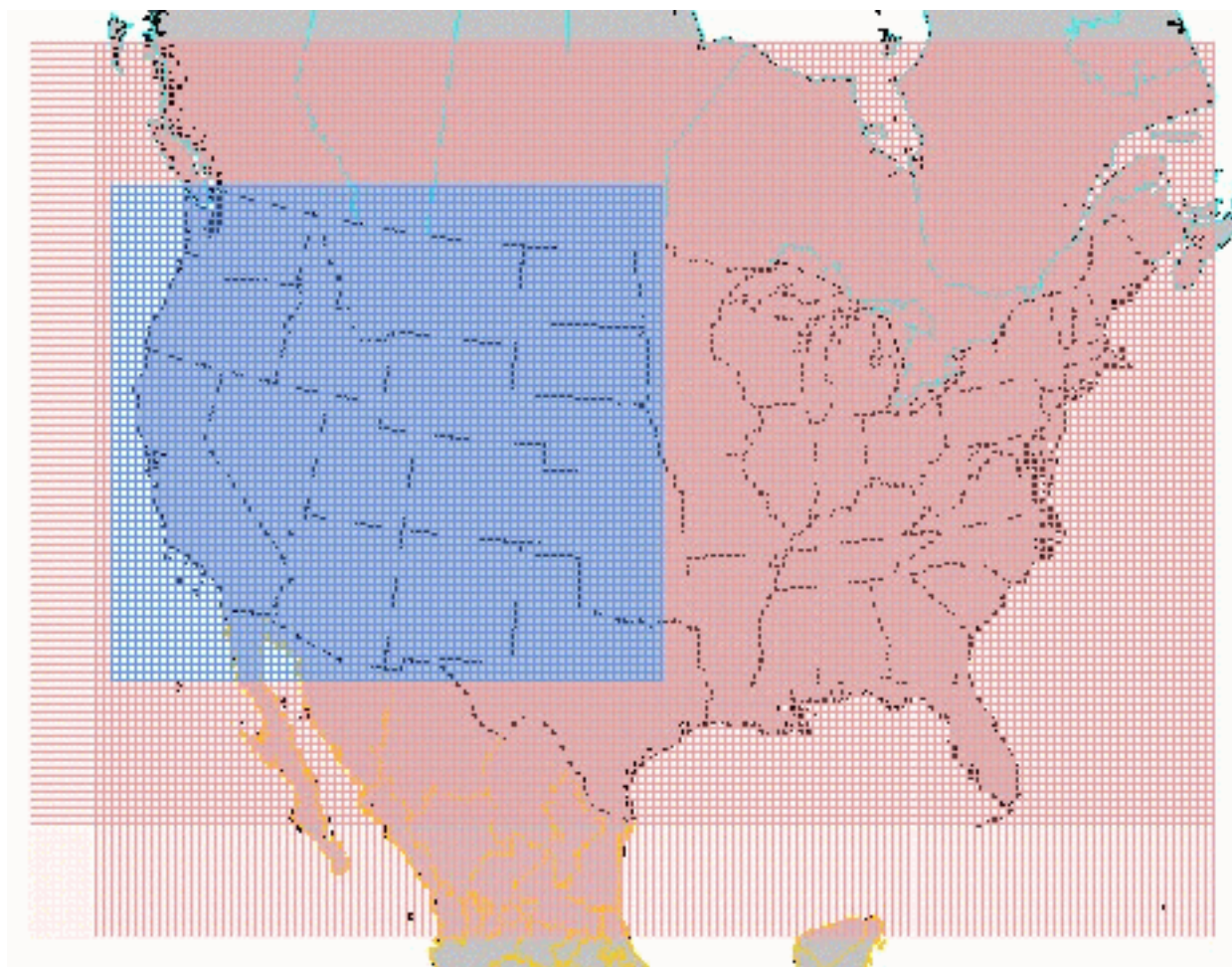
Spatial Processing and Display of WRAP Emissions Data, and Source Apportionment Modeling

**WRAP Attribution of Haze Meeting
June 22, 2005, Seattle, WA**

Gail Tonnesen, University of California Riverside

RPO Unified Modeling Grid

- Map projection is Lambert-Conformal
- 36-km coarse grid domain with high resolution, nested 12-km domain.
- 19 layers extend from the surface to 10,000 m.



Input Data to SMOKE

- Point Source are defined by Lat/Lon.
 - SMOKE assigns each point source to appropriate grid cell.
- Area source are defined by county.
 - SMOKE reads a surrogate data file that specified how to distribute county emissions to appropriate grid cell.
 - Surrogate data typically based on population density data.

SMOKE QA of Emissions

- SMOKE produces binary netCDF files that are used as inputs to the air quality model.
- SMOKE QA tools can sum the emissions by state or county. These data are tabulated and compared with the original input data as state or county totals.
 - This format is not useful for spatial visualization of the emissions data.
 - We have Post-SMOKE QA tools to generate spatial plots, these are on the webpage.

Visualizing Emissions Data

- ASCII Text Files
- Processed in SMOKE to create binary netCDF files.
- Visualize netCDF data as spatial plots in PAVE.
- Convert netCDF to ASCII ArcGIS files.
- Use ArcGIS to visualize.

PAVE/netCDF Spatial Plots

- Plots are limited to the grid definition used in the modeling system.
- Can be shown as tons per grid cell, or as emissions density, tons per square mile.
- Easy to prepare with automated scripts.
- Can show state & county boundaries, roads, or rivers.

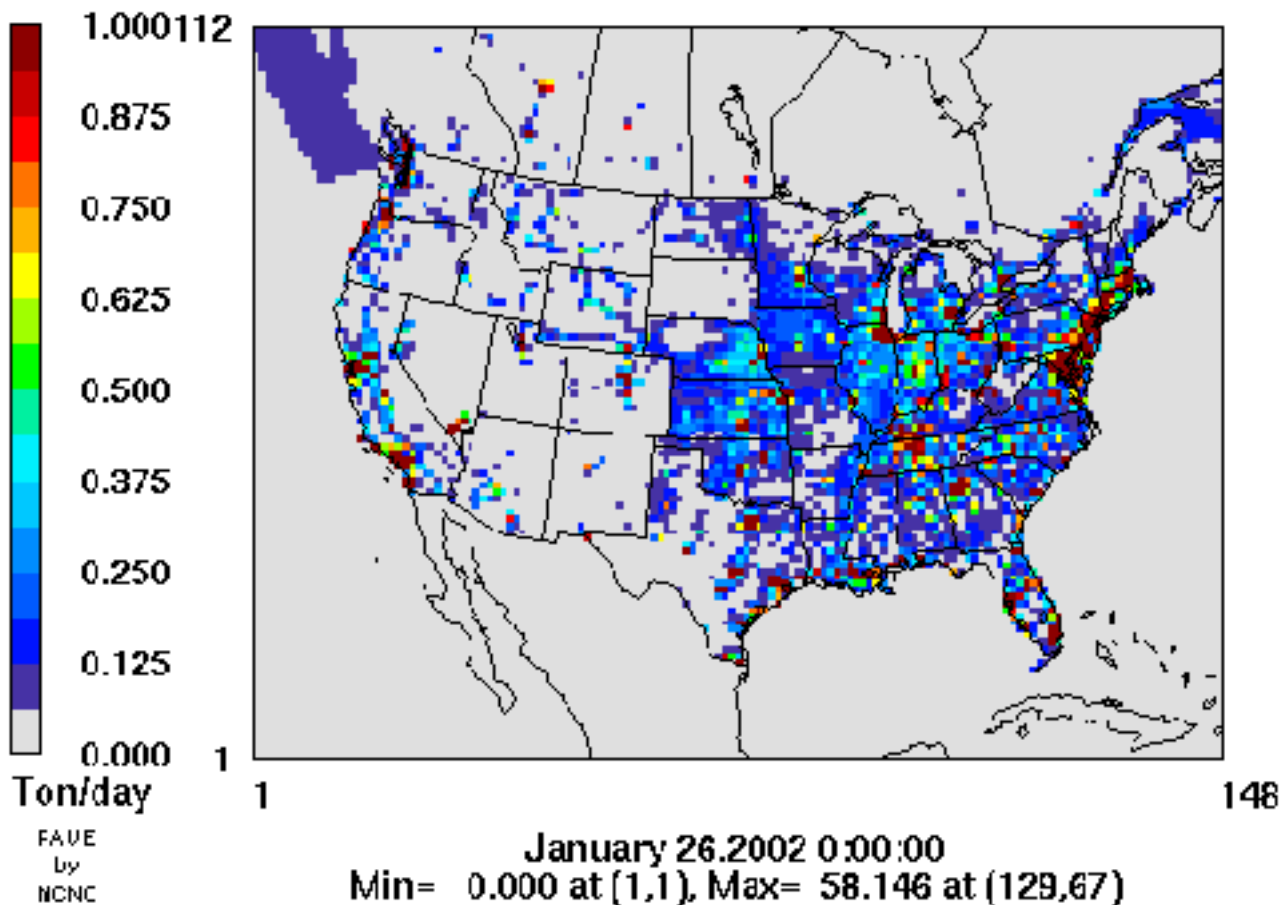
ArcGIS Spatial Plots

- Plots can be prepared using other shape files, e.g., can compute emissions as tons per county.
 - Requires some interpolation of netCDF data.
- Data can be overlaid with other ArcGIS shape files, e.g., population data sets.
- Powerful vis tool with attractive plots.

PAVE Spatial Plots: SO2 tons/day

SO2

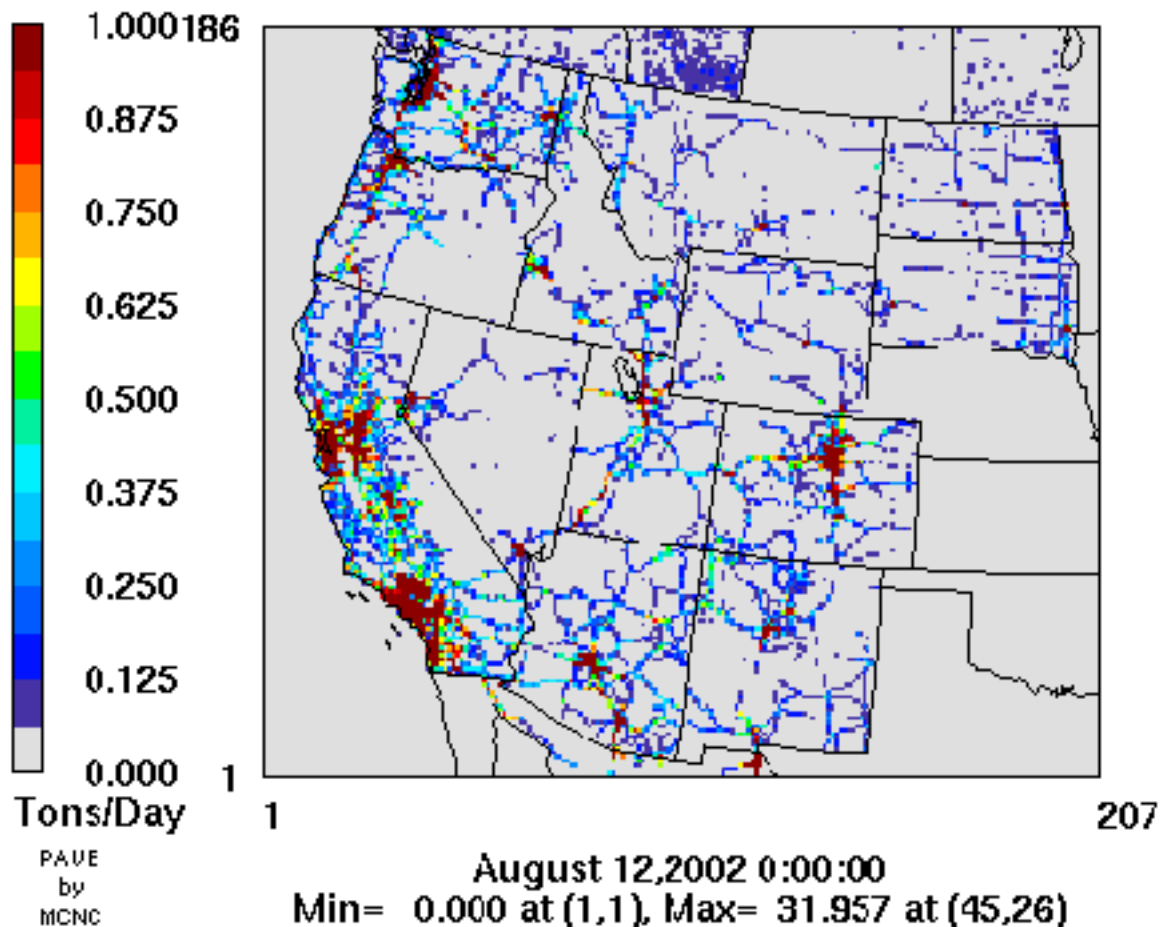
RPO36b 2002 nonroad emissions
Vertical Total



PAVE Spatial Plots: NO Emissions tons/day

NO

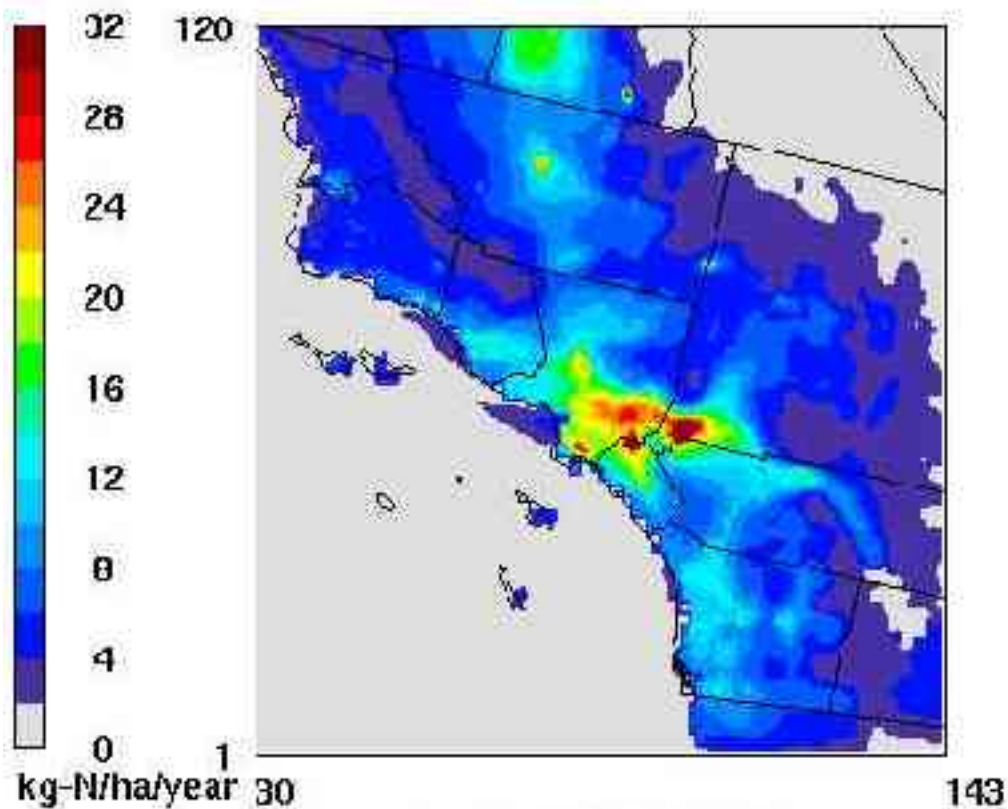
WRAP12a On Road Mobile Sources Emissions Daily Total



PAVE Spatial Plots: N deposition density

Total N Deposition

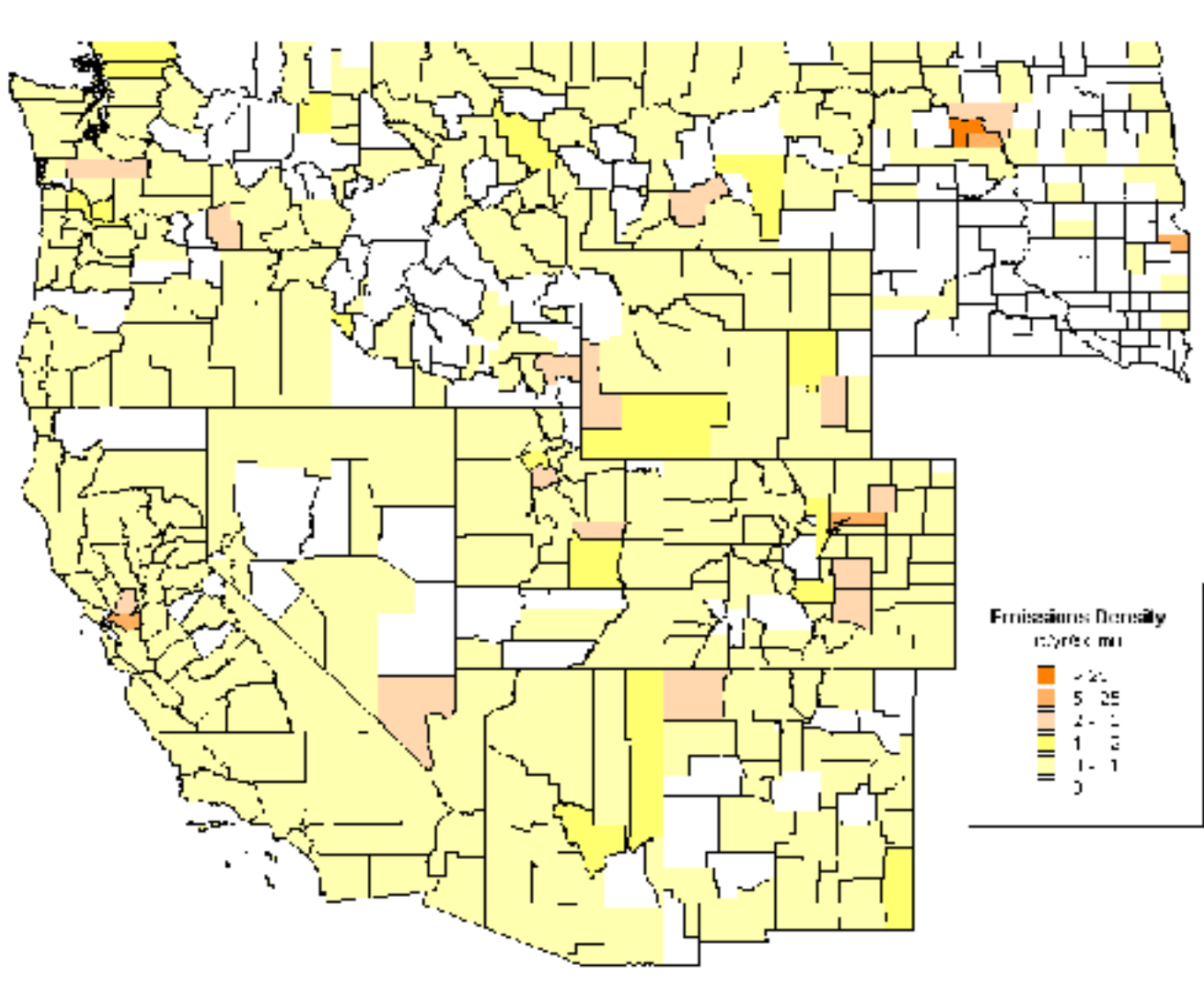
CMAQ Simulation 2002 Total



January 1, 2002 1:00:00

Min= 0 at (132,26), Max= 104 at (92,51)

ArcGIS Spatial Plots: SO₂ tons/sq mi



Advantage/Disadvantages

| ArcGIS | PAVE |
|---|--|
| More effort to convert data sets. | Easy to prepare plots. |
| More powerful in types of plots. | Limited to emissions per grid cell or emissions density per unit area. |
| Can be used with other ArcGIS data sets. | Limited to netCDF datasets. |
| More attractive and compelling plots. | Limited ability to display spatial plots. |
| Accuracy of interpolation to county boundaries? | |

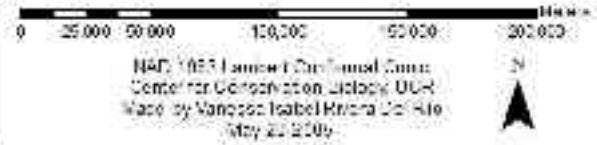
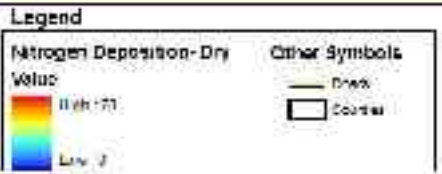
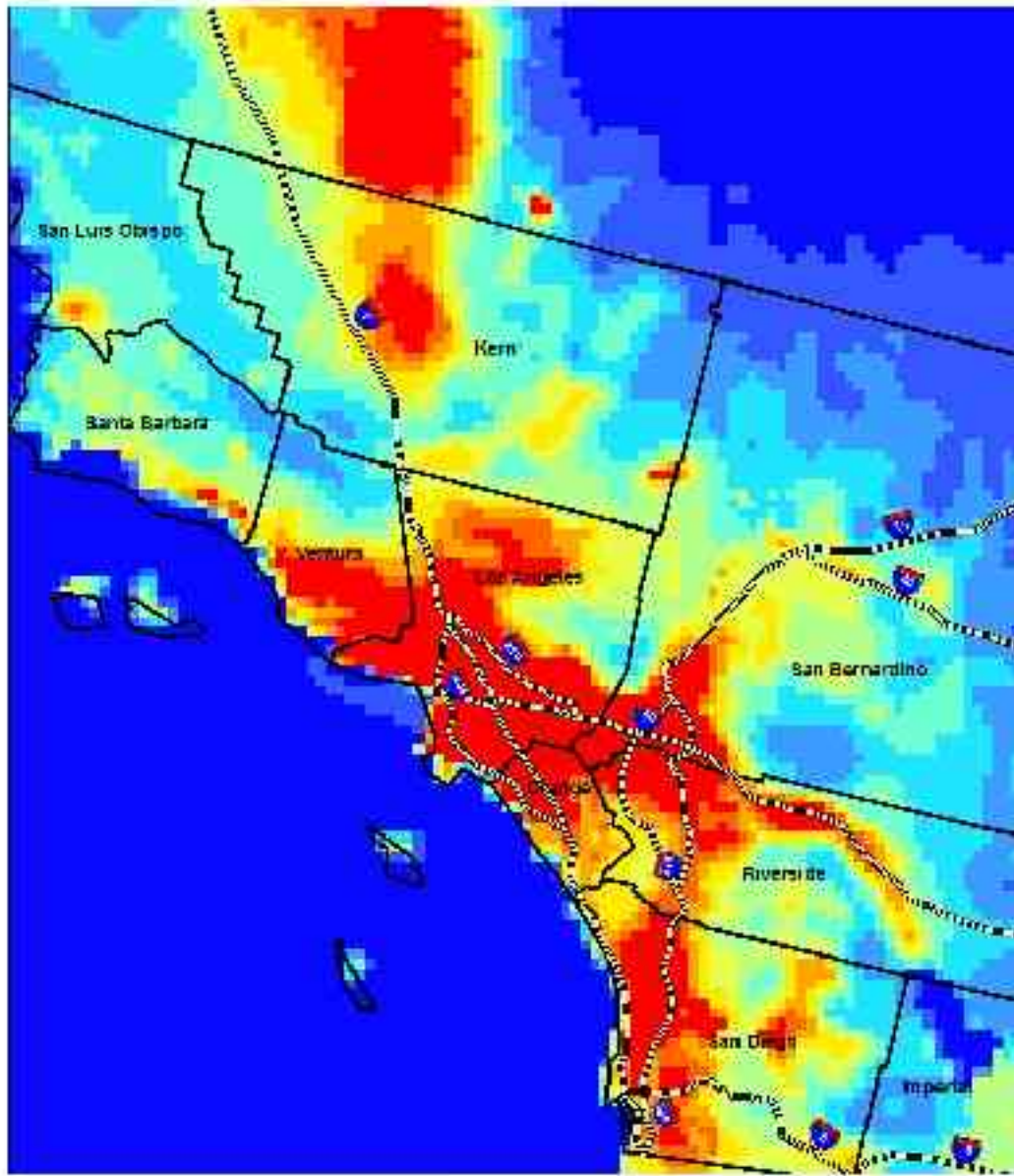
Converting Data from netCDF to ArcGIS

Example using a 4-km California domain.

2. Convert netCDF data to ASCII file.
3. Define the map projection information and origin.
4. Use ArcToolbox to rasterize the data.
5. Import ASCII data to ArcGIS.

Example view of data in southern California

The checker board pattern of the original PAVE/netCDF files is still retained in this ArcGIS plots.



Factors in Selecting a Vis Tool

- What information is needed for visual display of emissions data?
- County total emissions can be misleading, emissions density (tons/km²) is more useful.
- PAVE plots show location of data as input to the air quality model.
- ArcGIS has other advantages...?

Source Apportionment Algorithms

- Use air quality model to track the contribution of selected emissions source categories and/or source regions to PM formation at receptor sites:
 - Can track up to about 200 source in a single simulation.
 - Avoids problem of numerical noise for small sources in brute force sensitivity simulations.
 - Provides an estimate of the mass contribution from a source, not the sensitivity to a change in the source.
- This is an alternative approach to model sensitivity simulations or CALPUFF.

Source Apportionment Models

- New tracers or tags and new algorithms are added to air quality models to track the chemical conversions, transport and fate of selected emissions sources:
 - CMAQ Tagged Species Source Apportionment (TSSA).
 - CAMx PM Source Apportionment Technology (PSAT).
 - REMSAD also has a source apportionment algorithm.

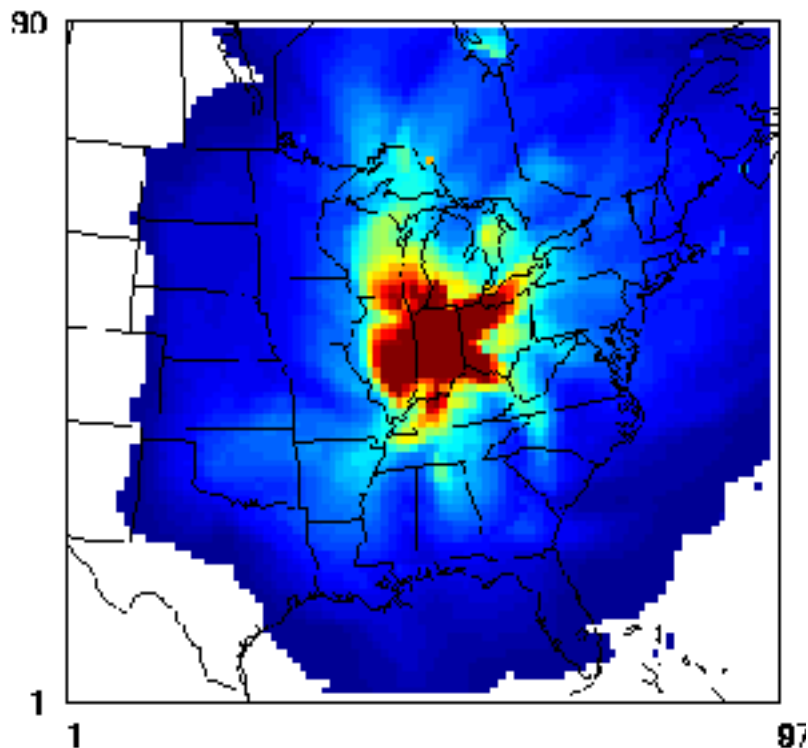
Display of Source Apportionment Results

- Results can be shown as:
 - Spatial animations showing the plume from each source.
 - Time averaged spatial plots showing a source contribution at all sites.
 - Bar plots showing contribution of all tagged sources at each individual receptor site.

MRPO Large Source: Episode Maximum SO4 PSAT versus "Zero Out"

PSAT

MRPO_Large_Source
June18-July21,2001

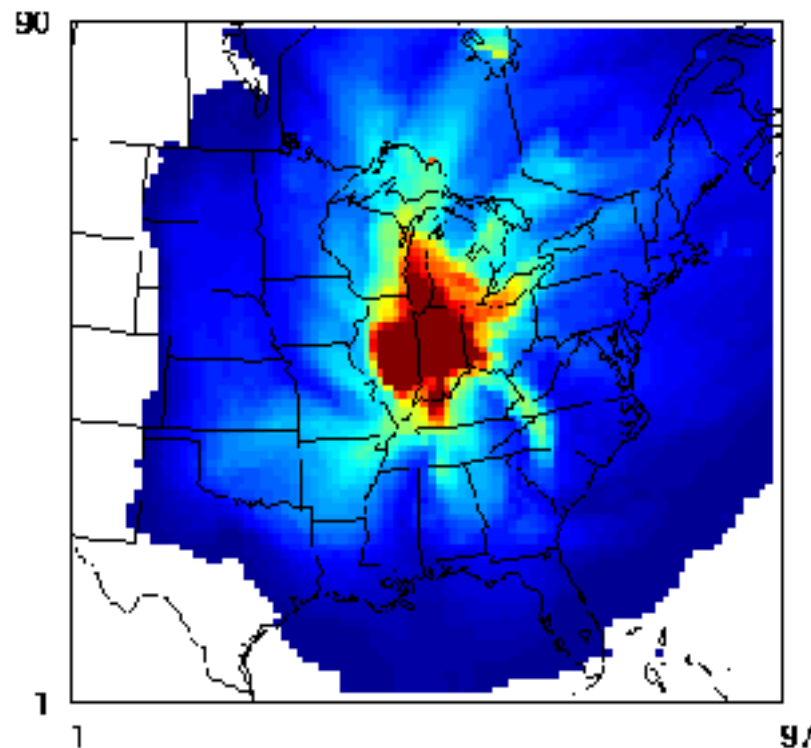


July 21,2001 23:00:00
Min=0.0 at (1,1), Max=12.1 at (52,17)

DATE
BY
MONG

Zero-Out

MRPO_Large_Source
June18-July21,2001



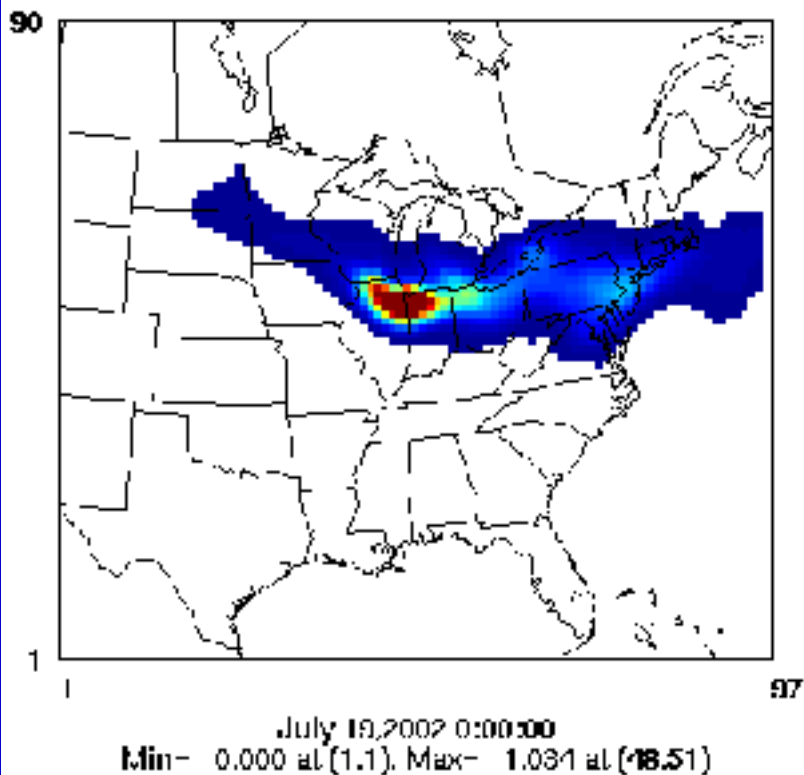
July 21,2001 23:00:00
Min=0.0 at (1,1), Max=34.5 at (52,47)

Difference due to oxidant limitation

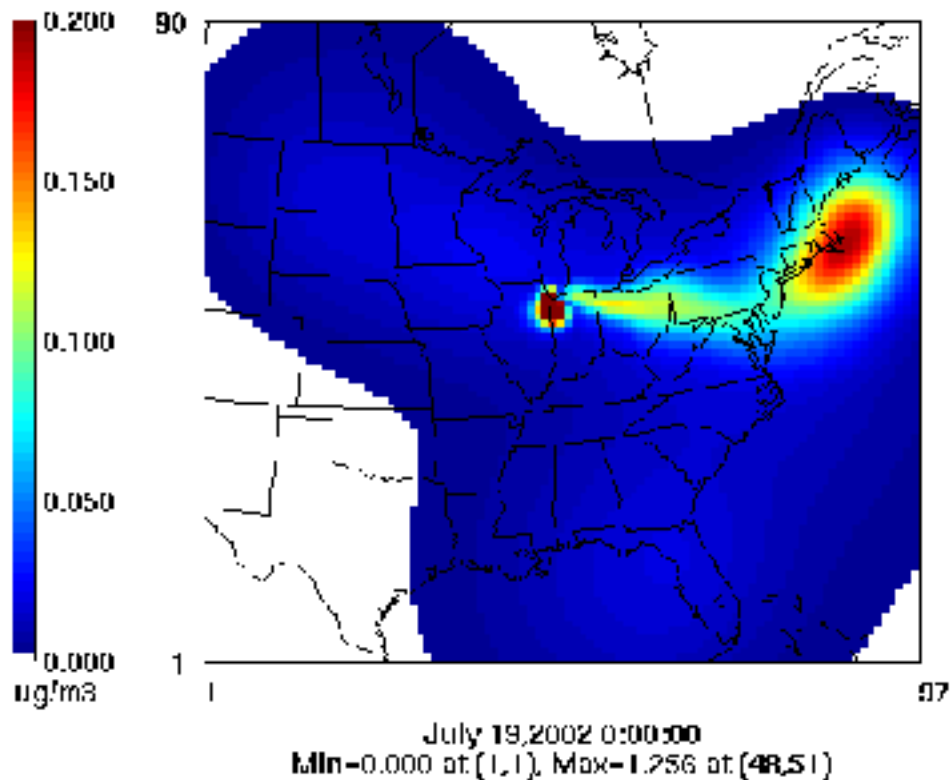
July 19, 2002 24-Hour SO₄ Concentrations IN Source (isgburn)

CALPUFF much higher concentrations away from source. Why secondary CALPUFF SO₄ peak over Cape Cod?

CAMx PSAT



CALPUFF



Comparison of CMAQ and CAMx

- Modeling in 2004 was with CMAQ TSSA using preliminary 2002 Emissions (Pre02d):
 - Originally developed and tested in CMAQ 4.2.2
 - Mass conservation errors in CMAQ 4.4 beta
 - Porting TSSA to new CMAQ 4.4 release, ready late 2005.
- We compared CMAQ/TSSA versus CAMx/PSAT results for Pre02d modeling for February and July.

CMAQ versus CAMx Results

- There are differences in the base model performance, so we expect some differences in the source apportionment results.
- At many receptor sites the rank order of the contributions was the same for the 2 models, although the mass contribution differed.
- CMAQ results should be used for relative ranking.
- Because of concerns about mass conservation in CMAQ version 4.4 beta we will use CAMx for additional source apportionment modeling in 2005.

Source Apportionment Schedule

- Final Emissions Inventory (Base02a) will be completed in late July 2005
- Additional source apportionment simulations completed in September 2005 using CAMx PSAT:
 - Need to identify what combinations of source regions and emissions categories to track.
 - Use tracers for total emissions from each of the other RPOs?
 - Max of about 200 per model simulation.
 - We can also track SOA in CAMx PSAT.

Possible CAMx/PSAT Set-up

- Source Categories
 - Point SO_x
 - Point NO_x
 - Mobile & NR SO_x
 - Mobile & NR NO_x
 - Fires SO_x
 - Fires NO_x
 - Fires OC
 - Others (Area, biogenic)
- Source Regions
 - 13 WRAP States
 - 4 RPOs
 - Canada
 - Mexico
 - Off-shore shipping

Natural Haze Modeling

- Emissions Inventory is incomplete. We have:
 - Natural fires
 - Biogenic Emissions model (natural VOC, but no NO_x)
 - Natural components of NH₃
 - Wind blown Dust
 - Boundary conditions from GEOS-CHEM
 - Sea salt
- Some missing sources include:
 - Lightning NO_x
 - Geogenic Emissions

Natural Haze Modeling (2)

- 1996 Natural modeling was very incomplete, best thought of as a model floor for ultra-clean conditions.
- 2002 Natural emissions will be more complete but still has large uncertainties, especially in NO_x which affects oxidants and OC formed from biogenic VOC:
 - Still best to think of this natural modeling as a model “floor” for clean conditions.
 - GEOS-CHEM boundary conditions is an important improvement.

Next Steps

- Decide how best to present the emissions data:
PAVE or ArcGIS?
- Define emissions source regions and source categories to be used in CAMx PSAT modeling:
 - Need source regions and emissions categories by August, 2005.