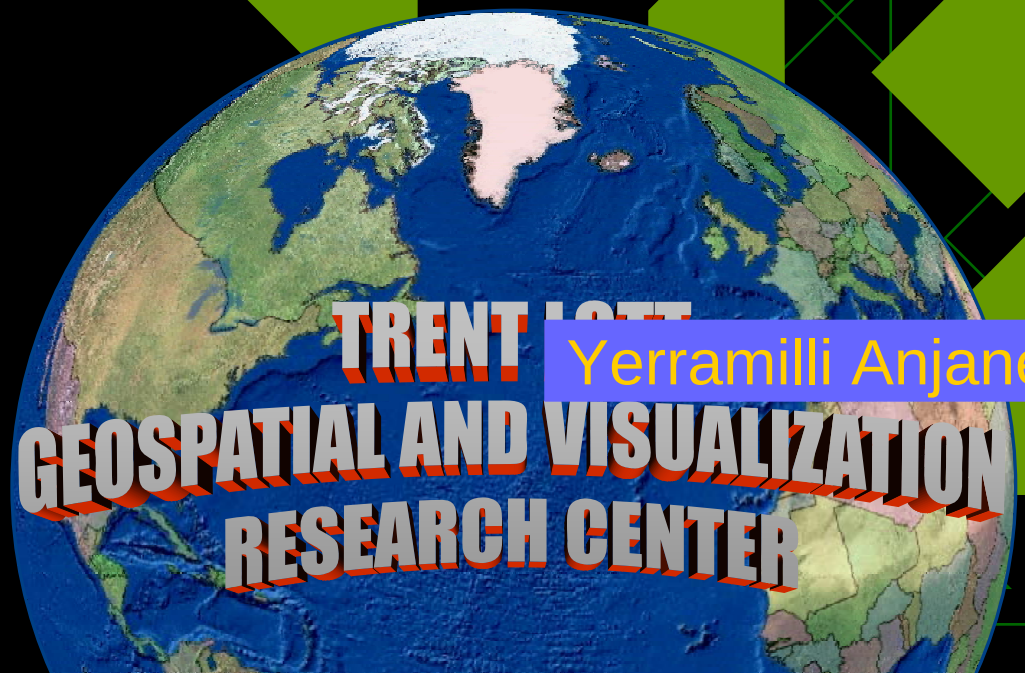
GIS assisted Emission inventory Development for Variable grid Emission database for Mississippi region

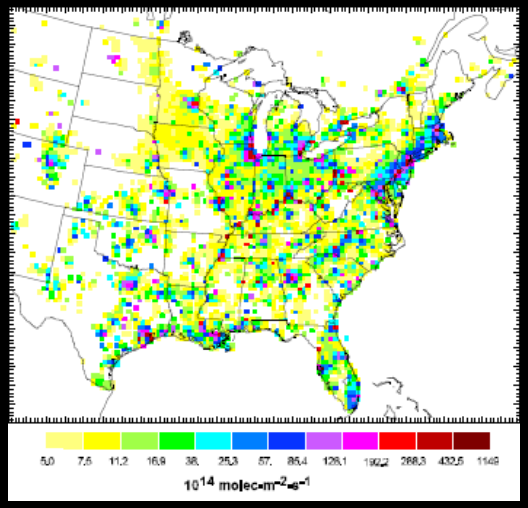


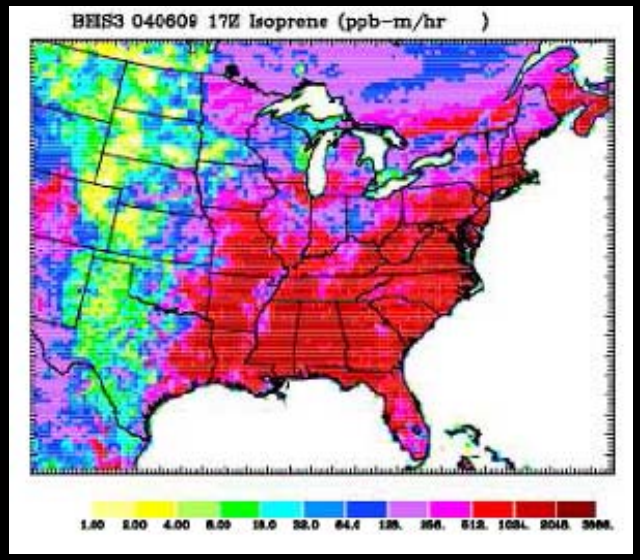
Yerramilli Anjaneyulu,

Agenda

- Micro scale – Mesoscale Modeling
- Variable grid emission inventory development requirements
- Methodological framework
- GIS layer development
- Calculation and Querying in GIS
- Output map generation
- Future scope of the work

Microscale – mesoscale Modeling

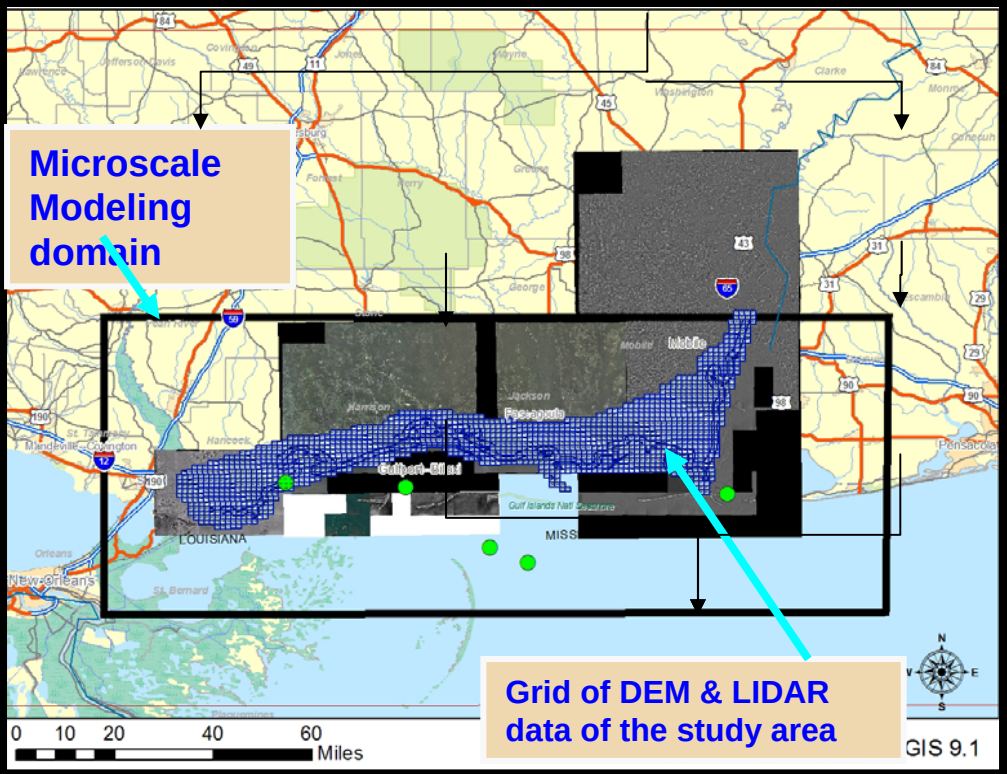


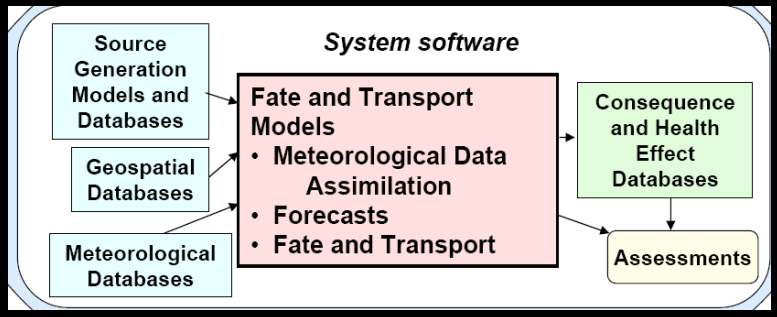


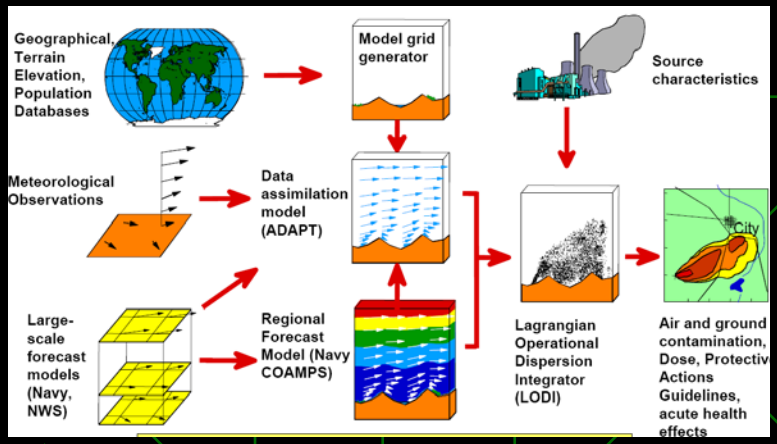
This is a study of atmospheric dispersion in the coastal zone using regional ensemble models and multi-model ensemble systems to develop the meteorological fields necessary to predict the movement and dispersal of pollutant plumes in the coastal environment.

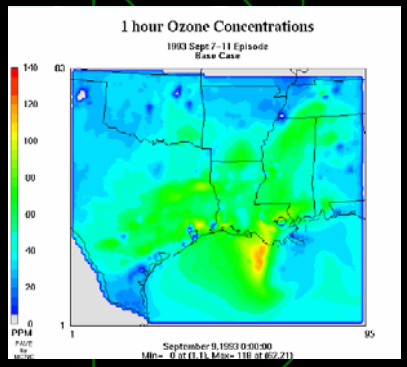
The goal of the project is to construct a dispersion forecasting capability tailored for application in the Gulf Coast region.

Microscale – Mesoscale modeling domain

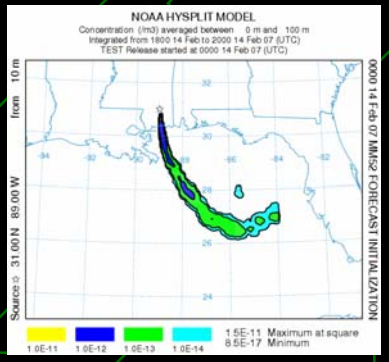








CMAQ



Hysplit

Problem Identified..

- Chemical simulations in most of the models require surface emissions in a grided format
- Simple interpolation of broader level emissions to obtain gridded data lead to erroneous results
- A GIS based methodology for distributing emissions from broader level inventory to finely grided emissions values is developed.
- Local micro-scale features such as activity and grid size is considered for modeling

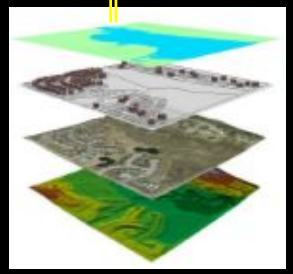
Emission estimation using GIS

- Sources of pollution and activity are generated as a thematic layers in GIS
- The sources are linked to attribute database and emission factors using SCC code
- The emission levels are calculated using activity and emission rate equation mentioned above
- Statistical local interpolation – Natural neighbor local interpolation technique has been used to generate emission prediction in local scales for which data is not available.
- Grided emission database of selected area is selected using Raster overlay method

Methodological Framework

GIS

Maps



Area

urban

rural

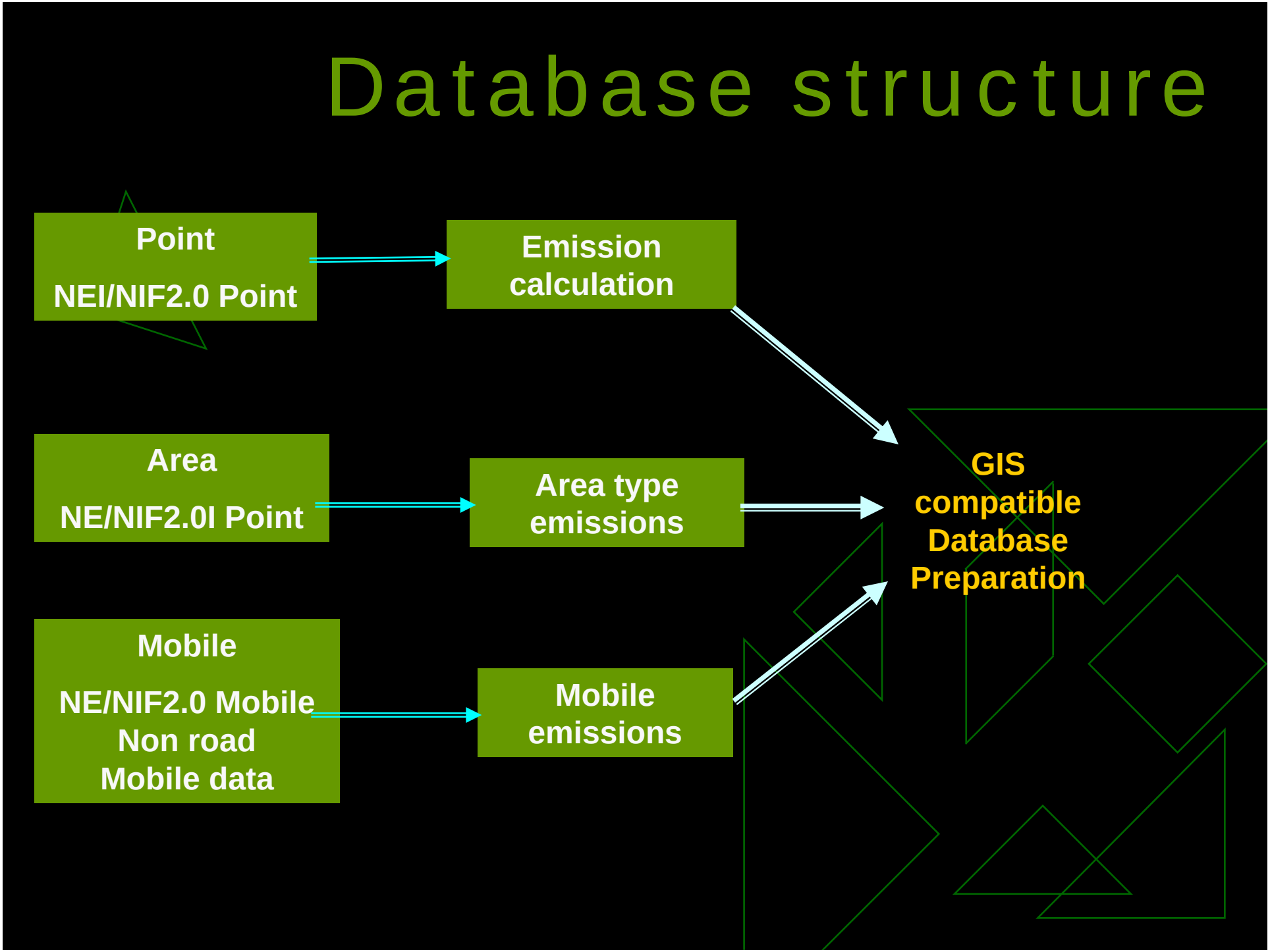
Mobile

Non-road

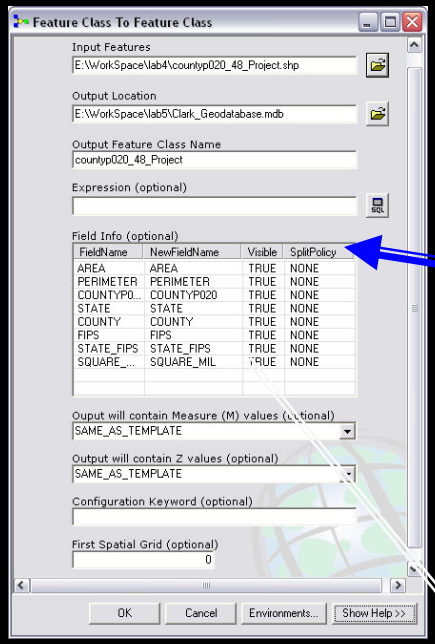
Mobile6

Point

Database structure

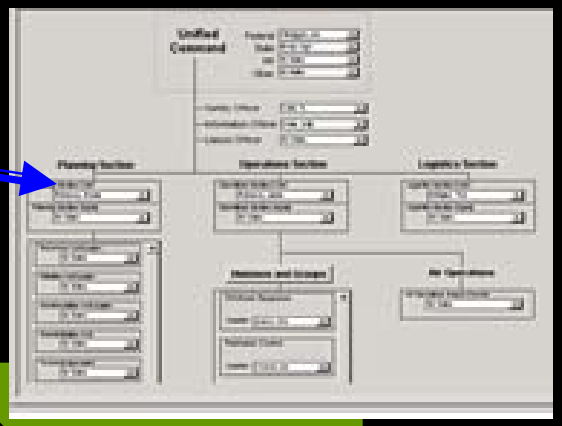


Importing Emission database and AP42 factors into GIS

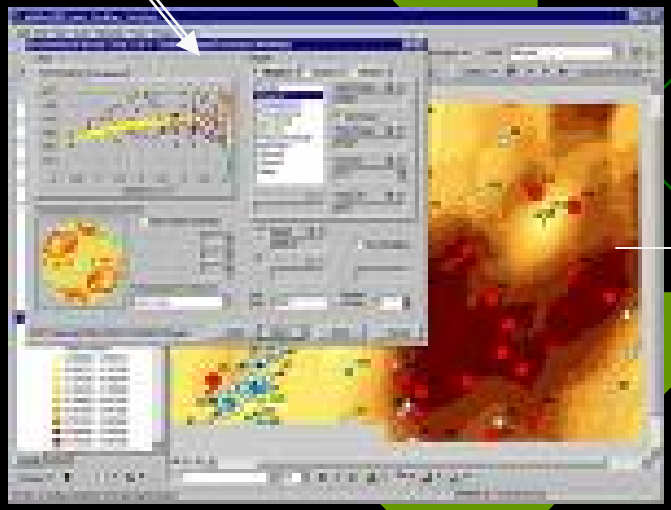


Feature locations

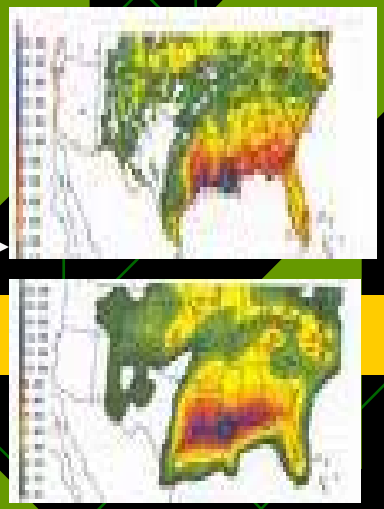
Relational Join



Emission calculation codes (AP42)



Spatial Analyst



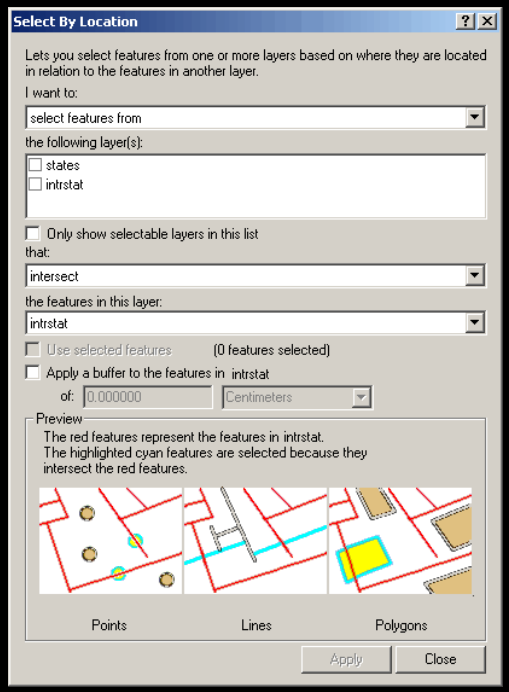
Grided Emissions

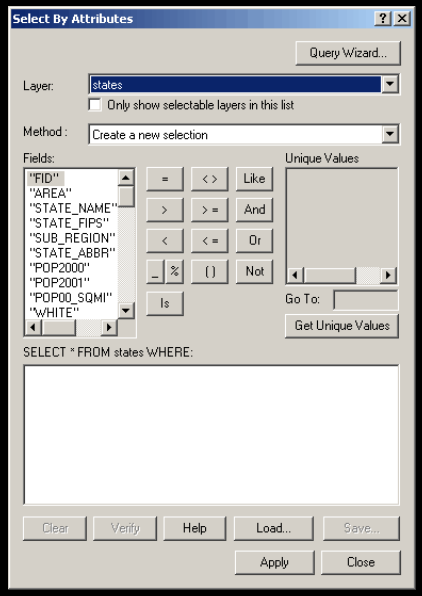
Attribute information for the feature class

- Attributes are the building blocks for computing emissions
- Each facility whether line, point, polygon are associated with descriptive attribute information namely facility type, SCC code, emission rate etc.
- It will also have control factor option for manipulating the emission levels

Linkage between feature class and emission factor

- Source Classification Codes (SCC) are used to develop linkage between feature class and facility
- It is used to allocate the emissions



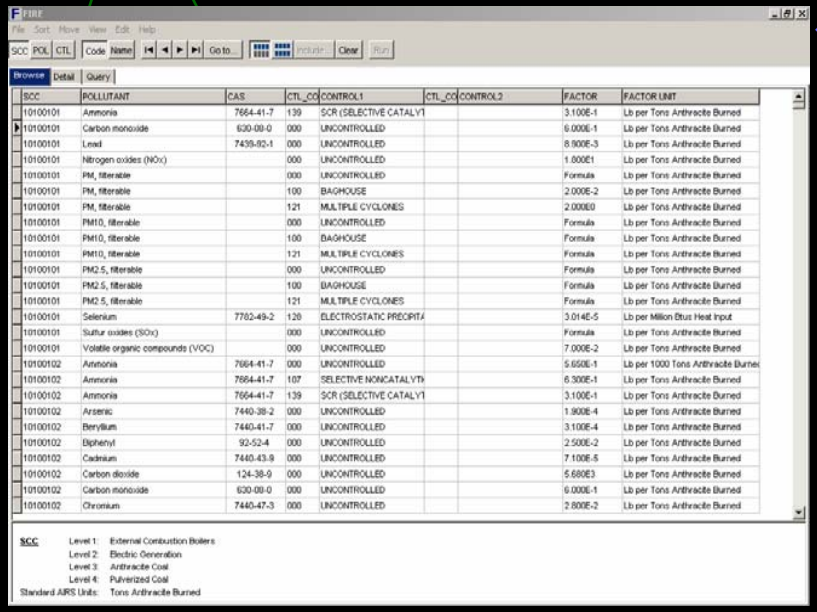


General querying and mathematical tools are used to compute emissions

Emission Inventory Sources

To start with actual 2002 data developed by the RPOs for the U.S., version 2 of the year 2000 were used in the present study. Latest point emission data from MSDEQ is used to calculate gridded point emission database

Calculation methodology



SCC	POLLUTANT	CAS	CTL_CO	CONTROL1	CTL_CO	CONTROL2	FACTOR	FACTOR UNIT
10100101	Ammonia	7664-41-7	139	SCR (SELECTIVE CATALYT			3.100E-1	Lb per Tons Anthracite Burned
10100101	Carbon monoxide	630-08-0	000	UNCONTROLLED			6.000E-1	Lb per Tons Anthracite Burned
10100101	Lead	7439-92-1	000	UNCONTROLLED			8.900E-3	Lb per Tons Anthracite Burned
10100101	Nitrogen oxides (NOx)		000	UNCONTROLLED			1.800E1	Lb per Tons Anthracite Burned
10100101	PM, filterable		000	UNCONTROLLED			Formula	Lb per Tons Anthracite Burned
10100101	PM, filterable		100	BAGHOUSE			2.000E-2	Lb per Tons Anthracite Burned
10100101	PM, filterable		121	MULTIPLE CYCLONES			2.000E0	Lb per Tons Anthracite Burned
10100101	PM10, filterable		000	UNCONTROLLED			Formula	Lb per Tons Anthracite Burned
10100101	PM10, filterable		100	BAGHOUSE			Formula	Lb per Tons Anthracite Burned
10100101	PM10, filterable		121	MULTIPLE CYCLONES			Formula	Lb per Tons Anthracite Burned
10100101	PM2.5, filterable		000	UNCONTROLLED			Formula	Lb per Tons Anthracite Burned
10100101	PM2.5, filterable		100	BAGHOUSE			Formula	Lb per Tons Anthracite Burned
10100101	PM2.5, filterable		121	MULTIPLE CYCLONES			Formula	Lb per Tons Anthracite Burned
10100101	Selenium	7782-49-2	126	ELECTROSTATIC PRECIPITA			3.014E-5	Lb per Million Btus Heat Input
10100101	Sulfur oxides (SOx)		000	UNCONTROLLED			Formula	Lb per Tons Anthracite Burned
10100101	Volatile organic compounds (VOC)		000	UNCONTROLLED			7.000E-2	Lb per Tons Anthracite Burned
10100102	Ammonia	7664-41-7	000	UNCONTROLLED			5.650E-1	Lb per 1000 Tons Anthracite Burned
10100102	Ammonia	7664-41-7	107	SELECTIVE NONCATALYTI			6.300E-1	Lb per Tons Anthracite Burned
10100102	Ammonia	7664-41-7	139	SCR (SELECTIVE CATALYT			3.100E-1	Lb per Tons Anthracite Burned
10100102	Arsenic	7440-38-2	000	UNCONTROLLED			1.900E-4	Lb per Tons Anthracite Burned
10100102	Beryllium	7440-41-7	000	UNCONTROLLED			3.100E-4	Lb per Tons Anthracite Burned
10100102	Biphenyl	92-52-4	000	UNCONTROLLED			2.500E-2	Lb per Tons Anthracite Burned
10100102	Cadmium	7440-43-9	000	UNCONTROLLED			7.100E-5	Lb per Tons Anthracite Burned
10100102	Carbon dioxide	124-38-9	000	UNCONTROLLED			5.680E3	Lb per Tons Anthracite Burned
10100102	Carbon monoxide	630-08-0	000	UNCONTROLLED			6.000E-1	Lb per Tons Anthracite Burned
10100102	Chromium	7440-47-3	000	UNCONTROLLED			2.800E-2	Lb per Tons Anthracite Burned

SCC Level 1: External Combustion Boilers
Level 2: Electric Generation
Level 3: Anthracite Coal
Level 4: Pulverized Coal
Standard AIRS Units: Tons Anthracite Burned

AP42 / FIRE database

- The general equation for emissions estimation is:

  E = A x EF x (1-ER/100)

  where:

  E = emissions;

  A = activity rate;

  EF = emission factor, and

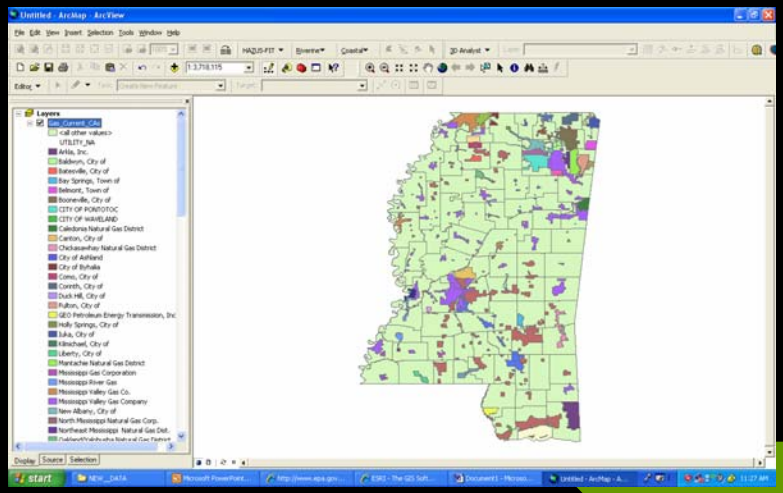
  ER =overall emission reduction efficiency, %

Activity

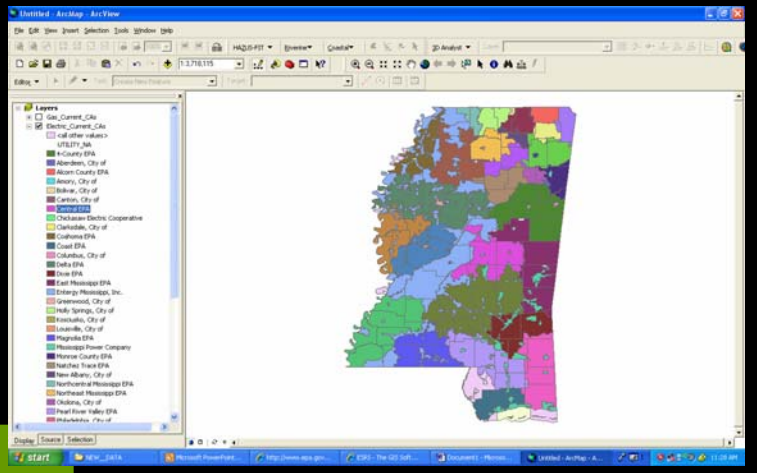
- Processes that cause emissions to be released
- Calculated using emission factor and measurable value
- Number of people per household
  - Road network (number of lanes and vehicular number)
  - Number of people in a given location
- Attribute database is created in GIS as a number of layers

Infrastructural mapping of the study area

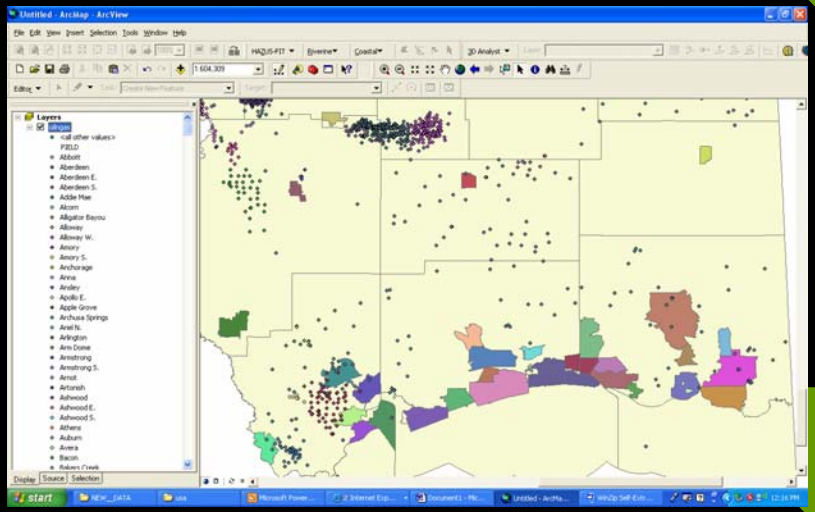
- Infrastructural facilities namely Electricity generating units, Industrial locations, live stock facilities
- Political units namely counties, municipalities, census tracts, province
- Land use, demographic profiles of the study area
- Transportation facilities etc
- Infrastructural data is important for manipulating and developing the emission database



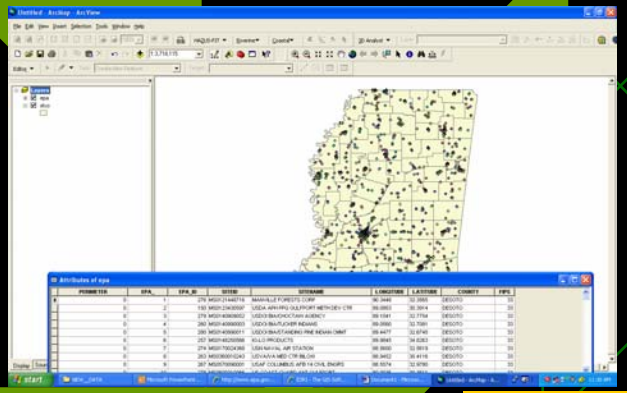
Electric generating plants



Gas based power plants

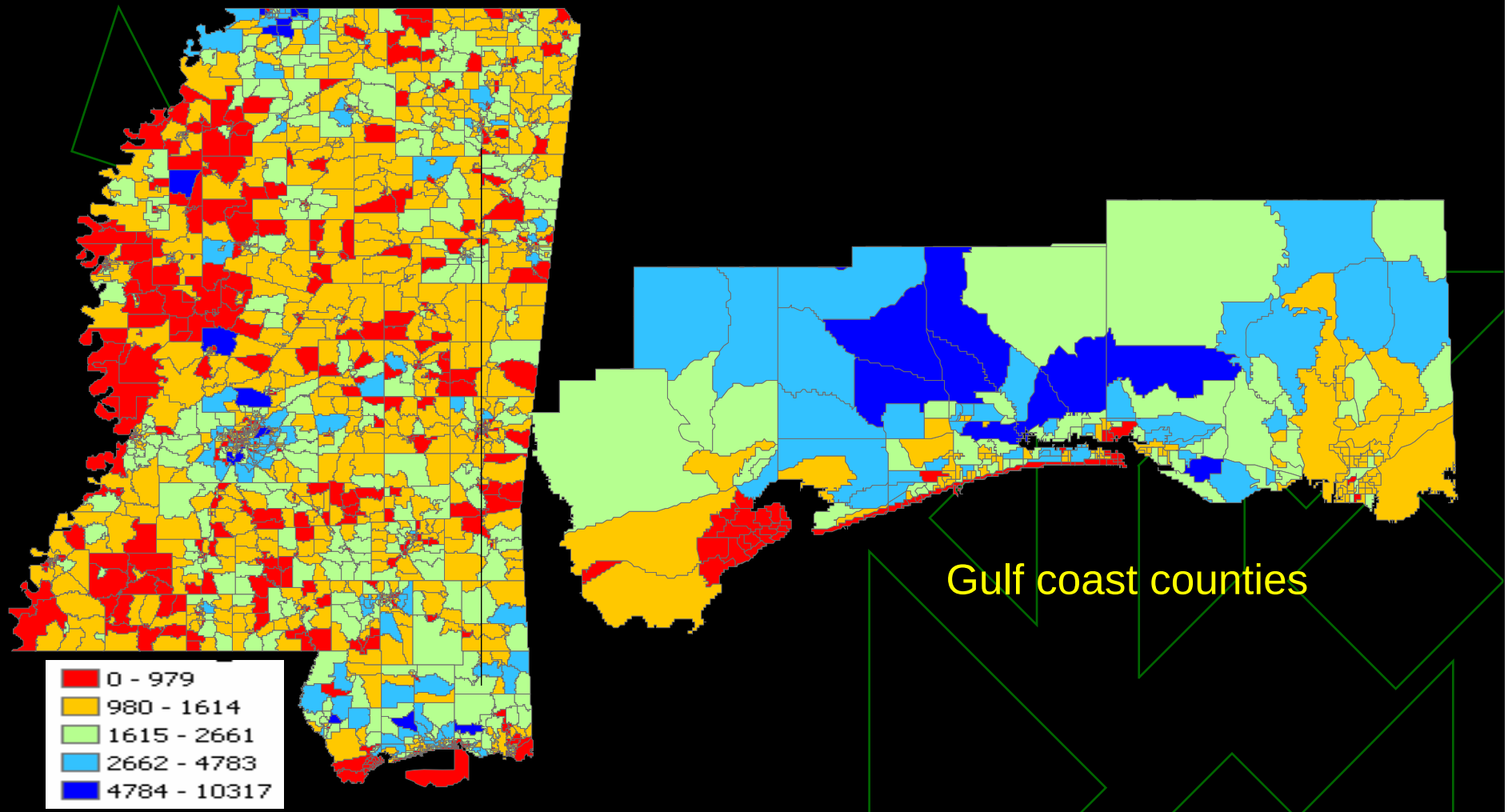


Cities

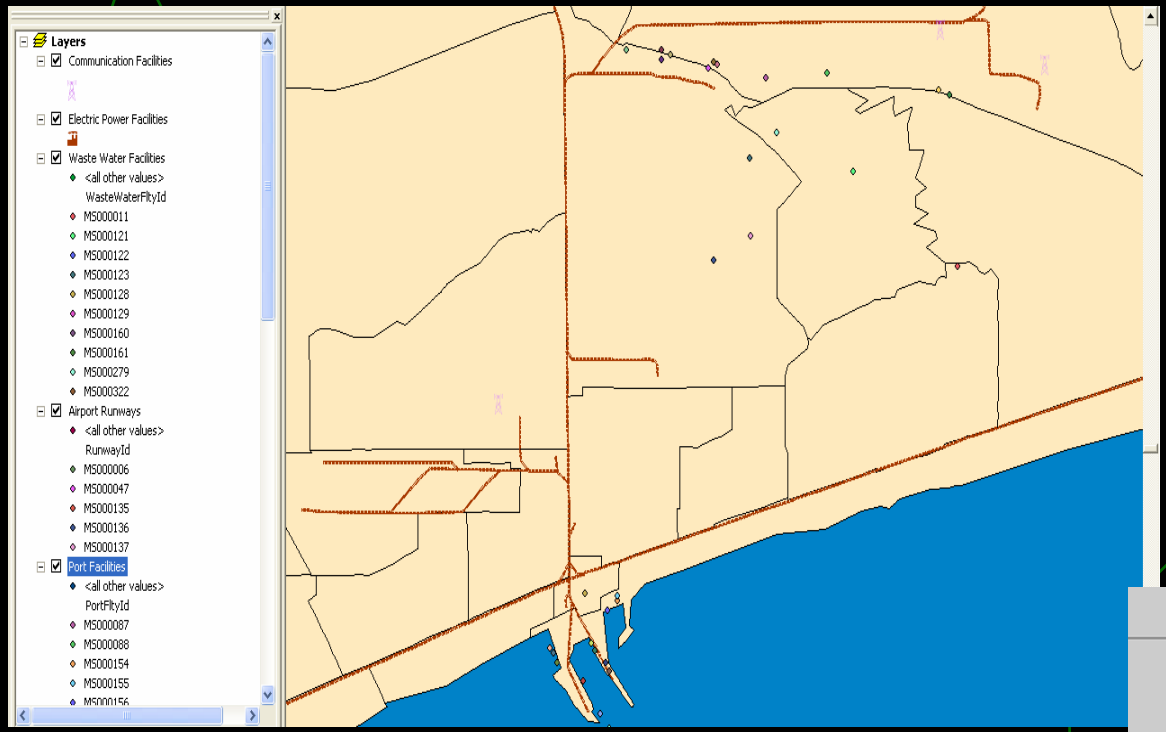


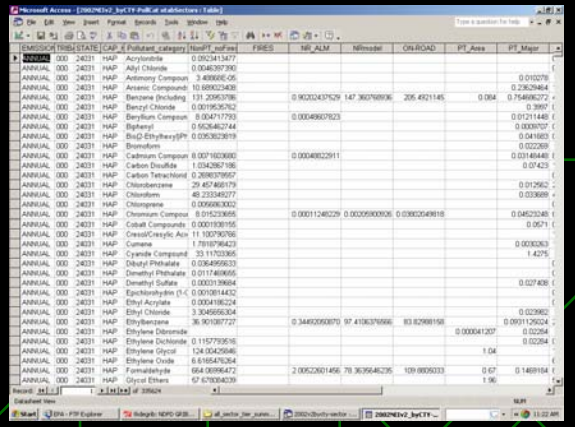
EPA FIPS code

Population size in the study area

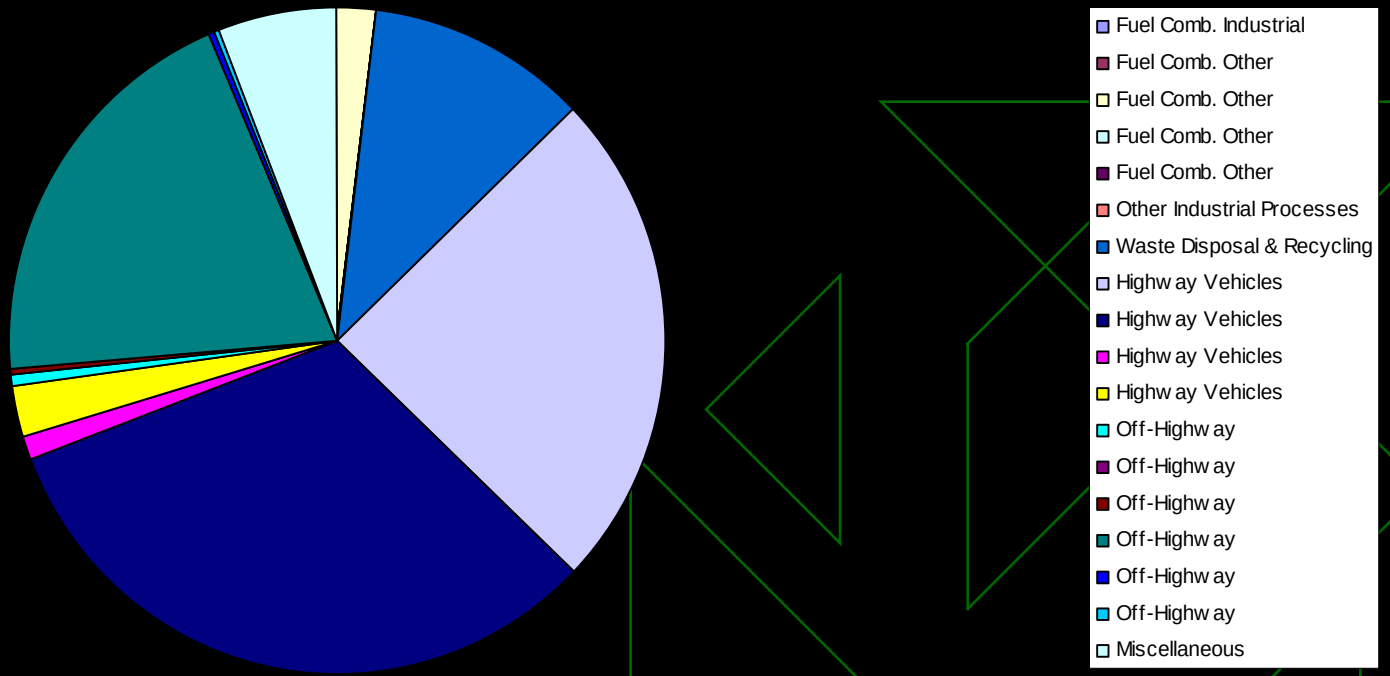


Calculation example
Emissions from Utilities

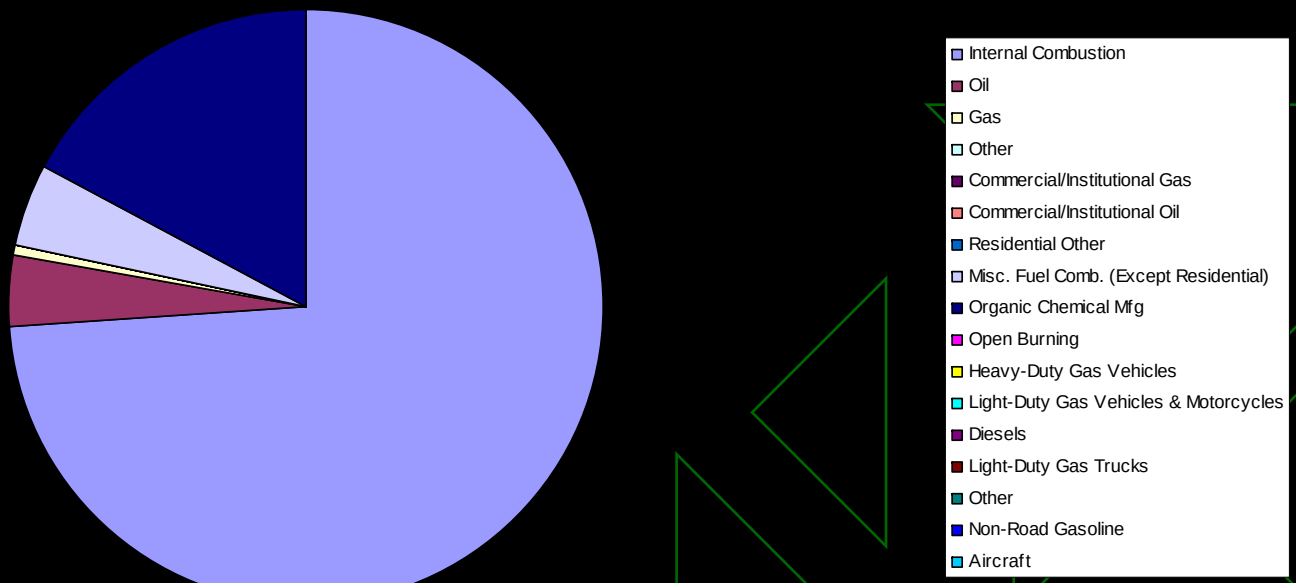




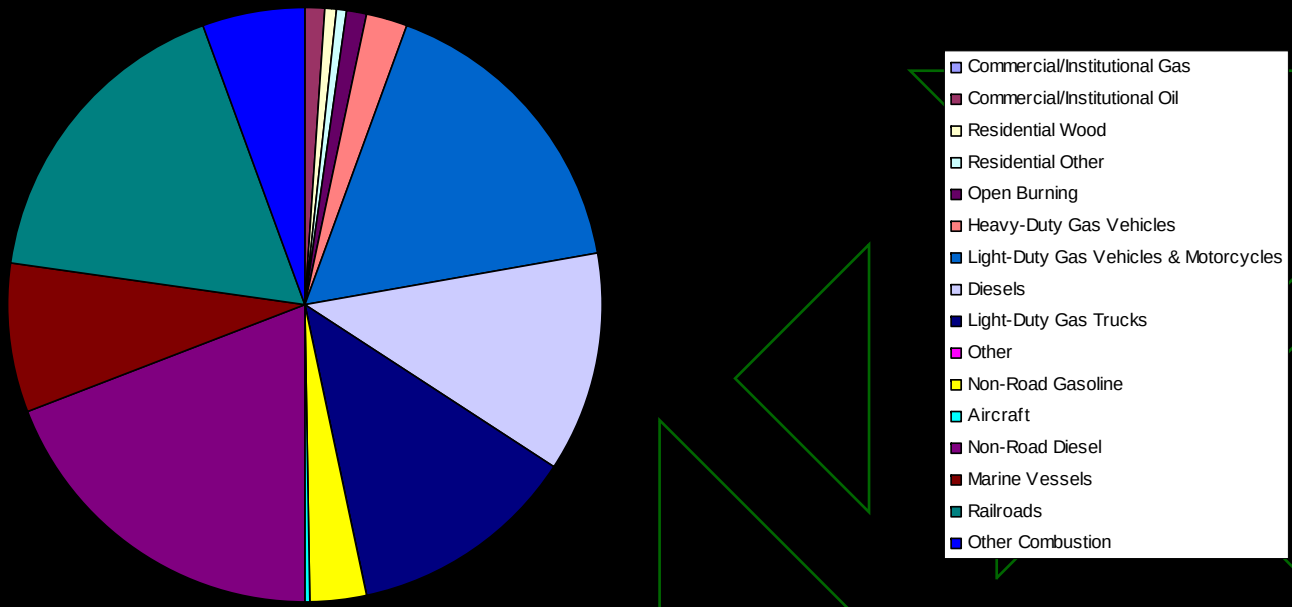
Total area based CO emissions in the study area (%)



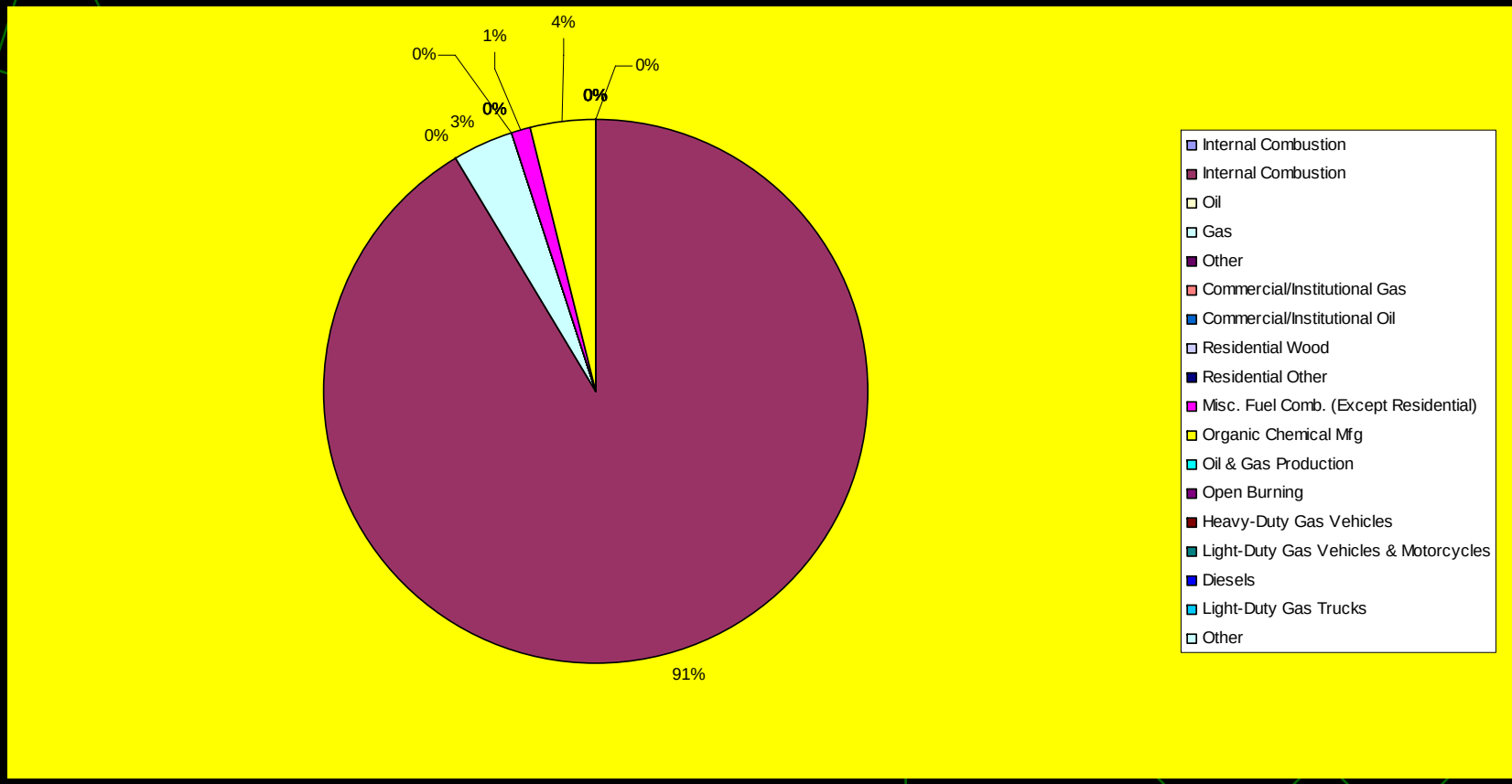
Point sources of sulfur dioxide in the study area



Area based sulfur dioxide in the study area

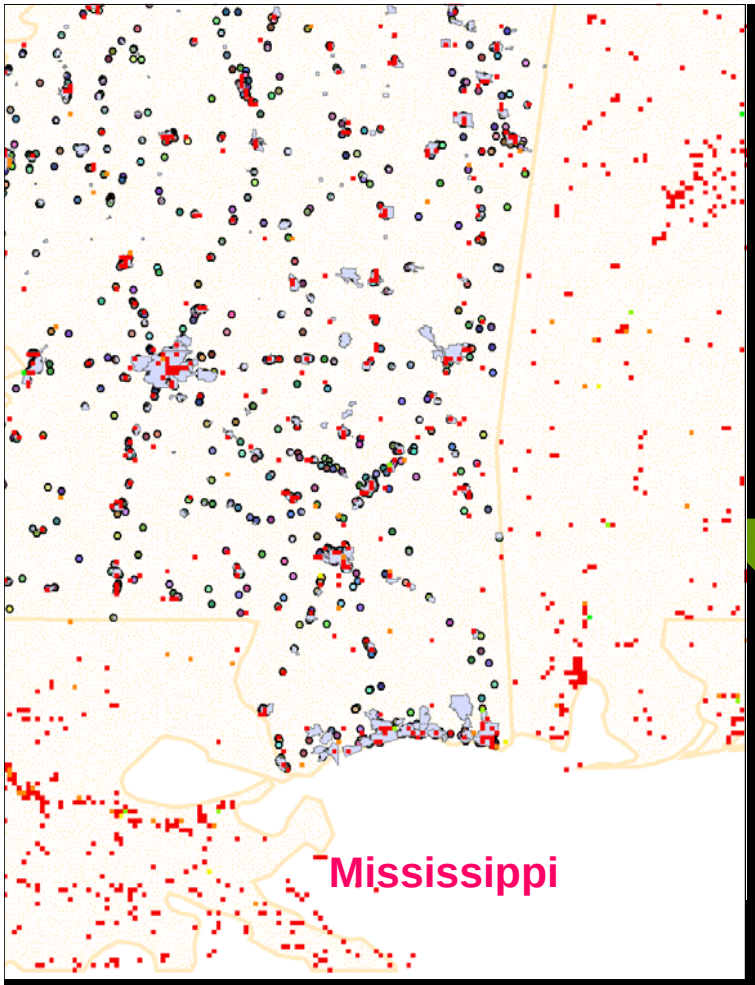


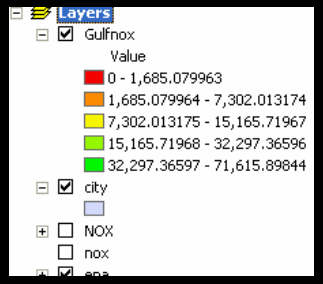
Area based Oxides of the study area

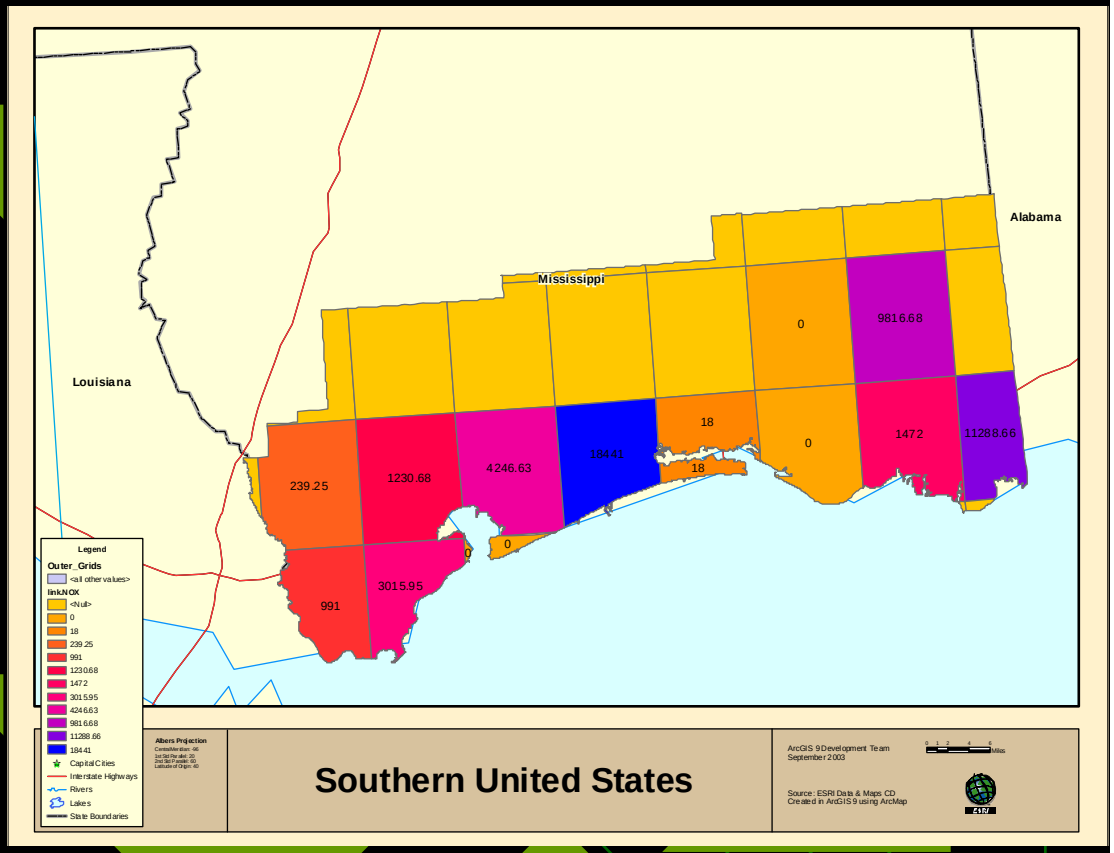


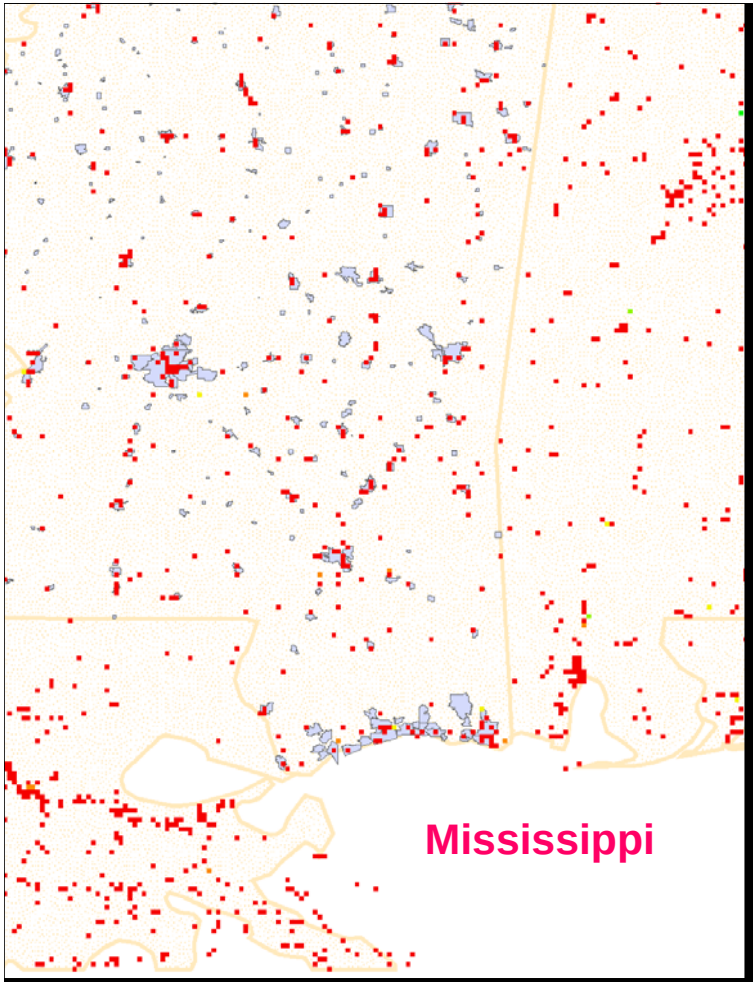
Output Map generation

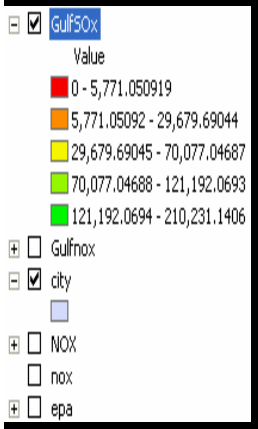
Grided emissions of Oxides of Nitrogen



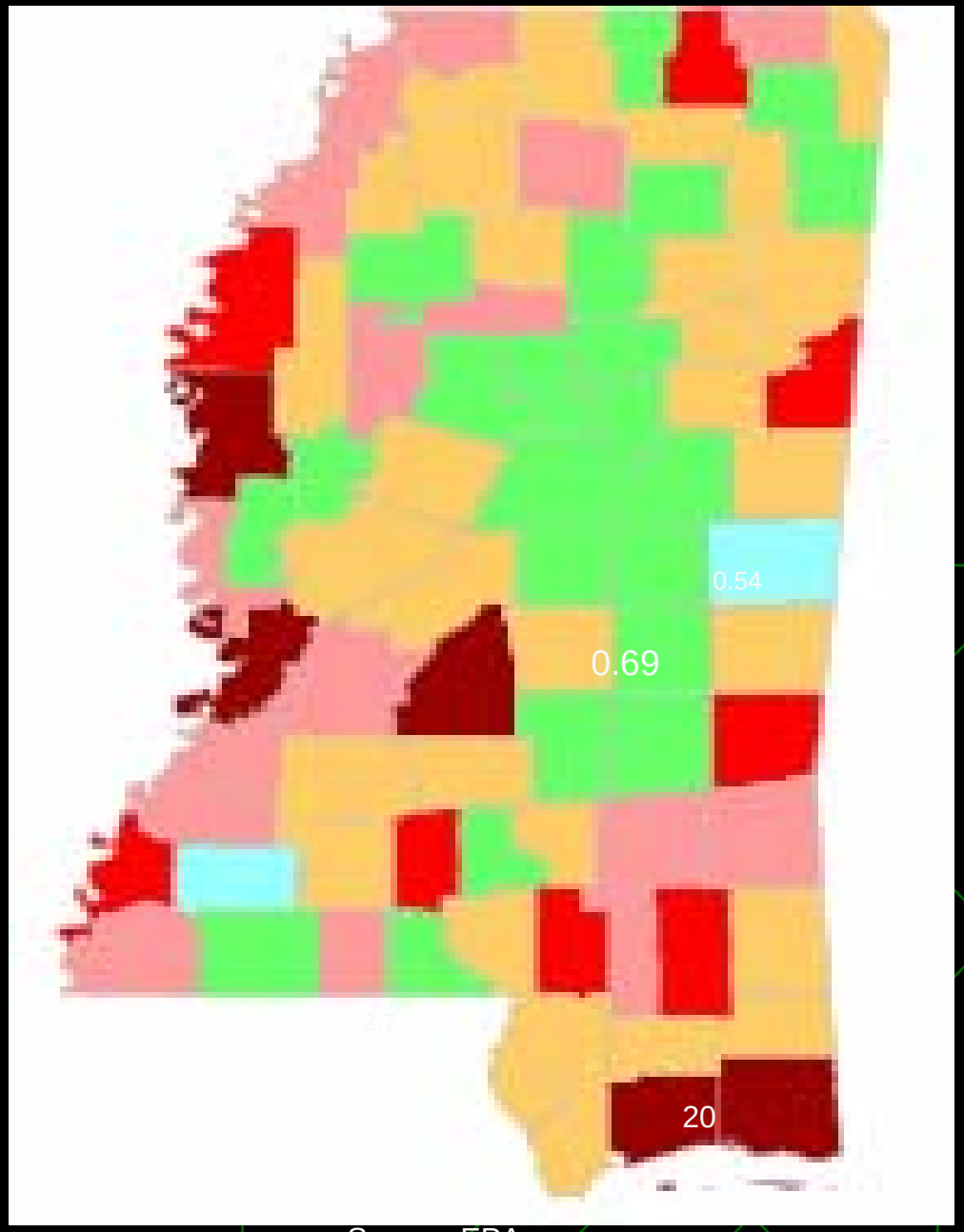




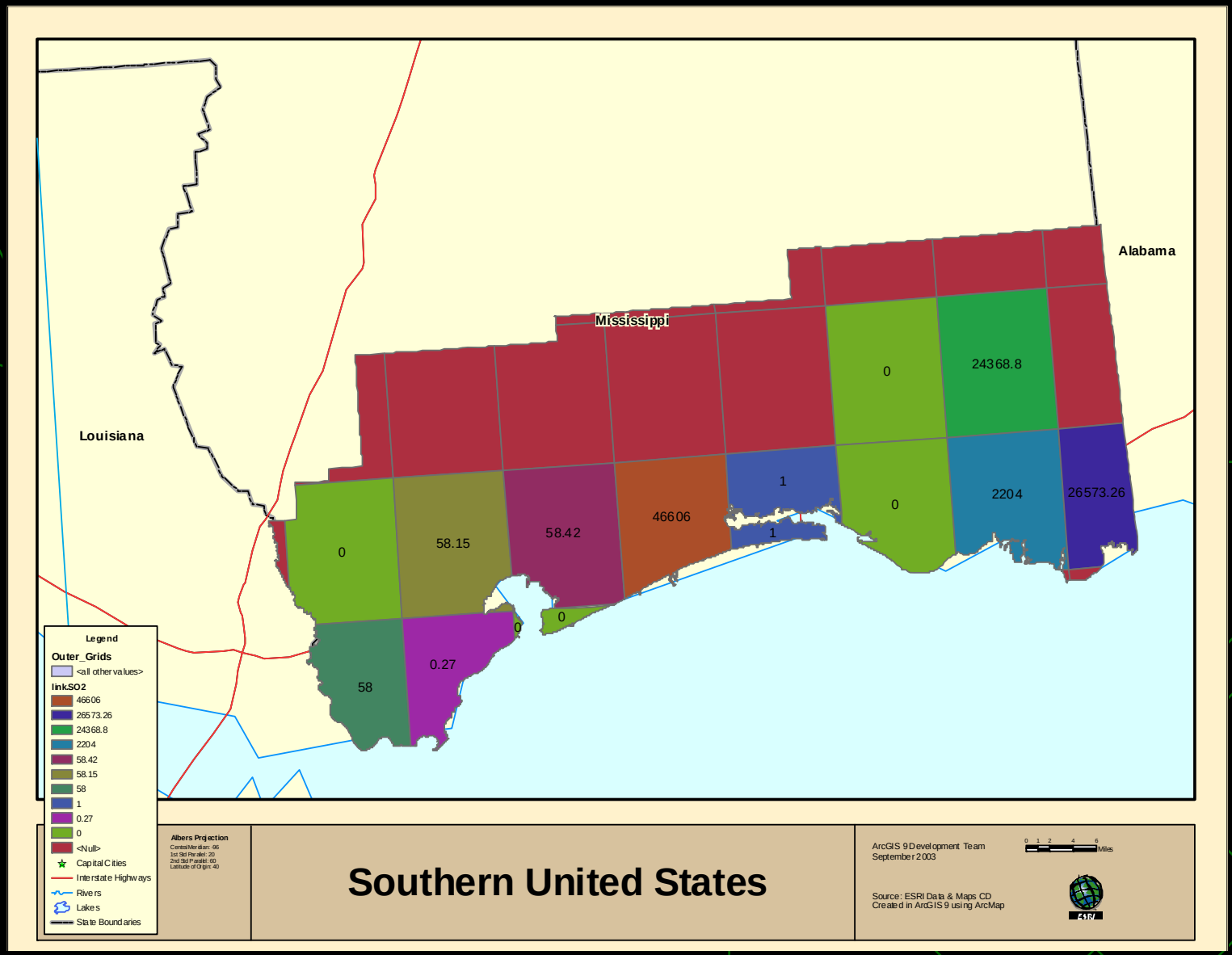




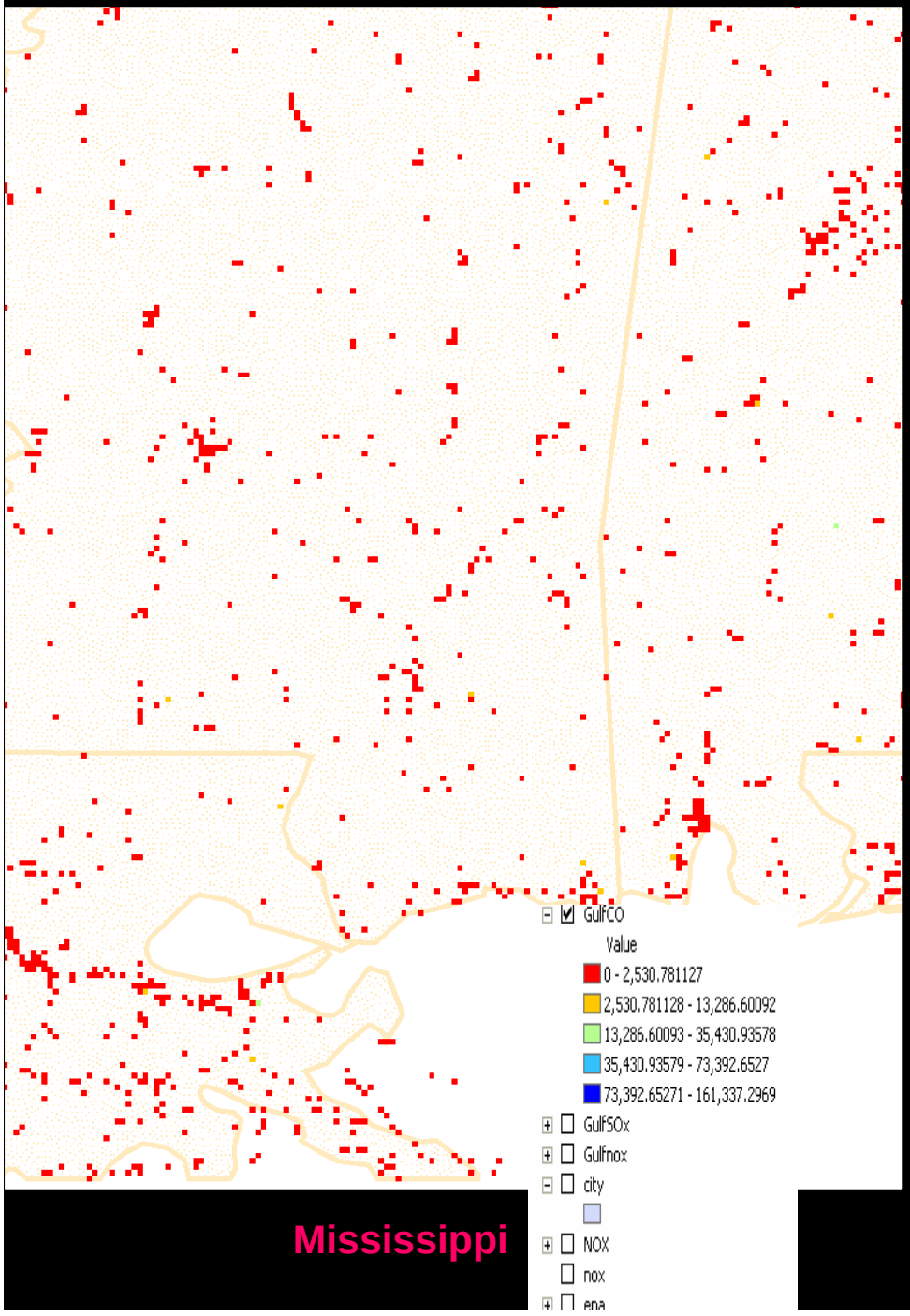
Grided emissions of Sulfur dioxide

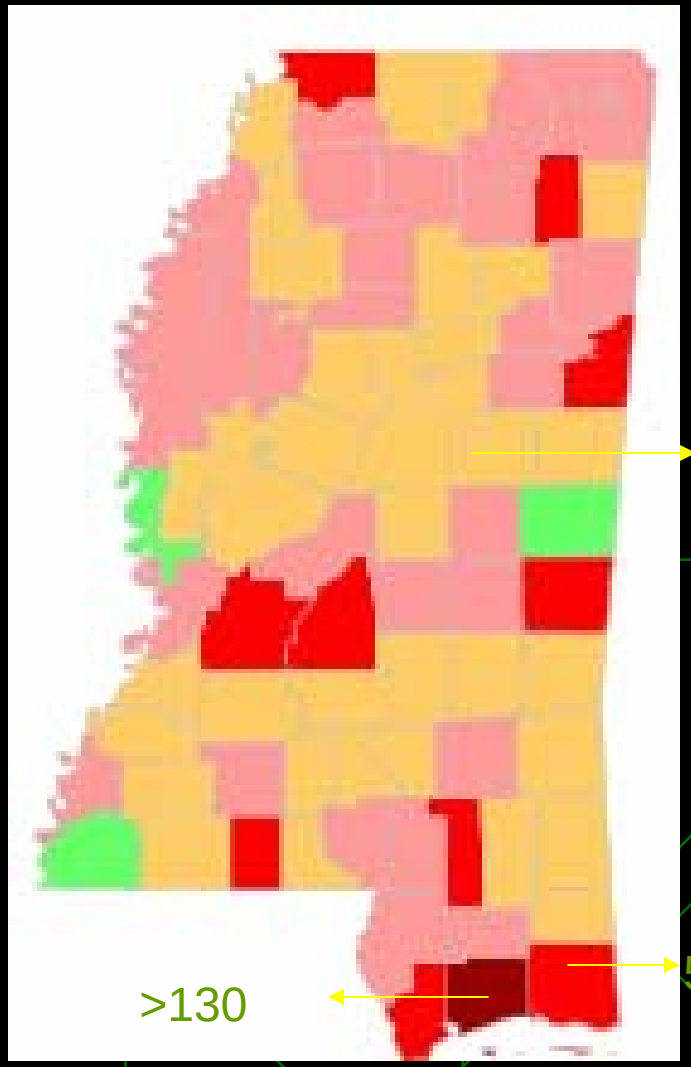


Source: EPA



Sulfur dioxide Emission database



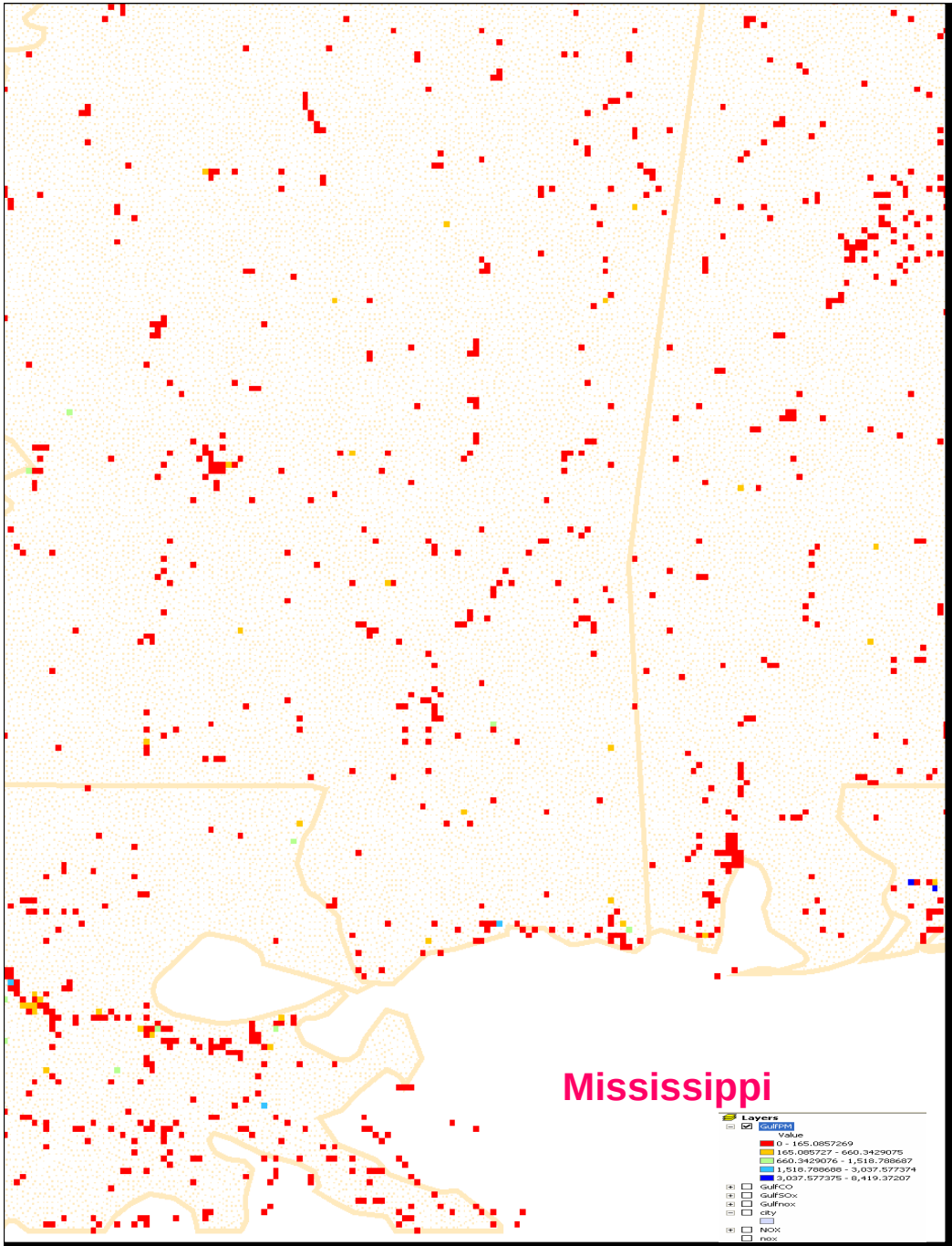


Total Carbon Monoxide emissions (Tons per SqMi)

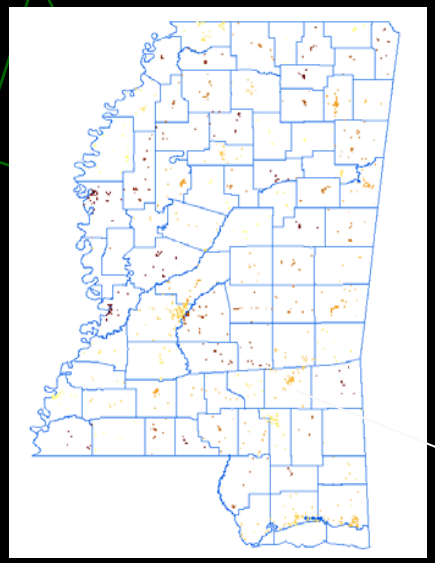
Carbon monoxide

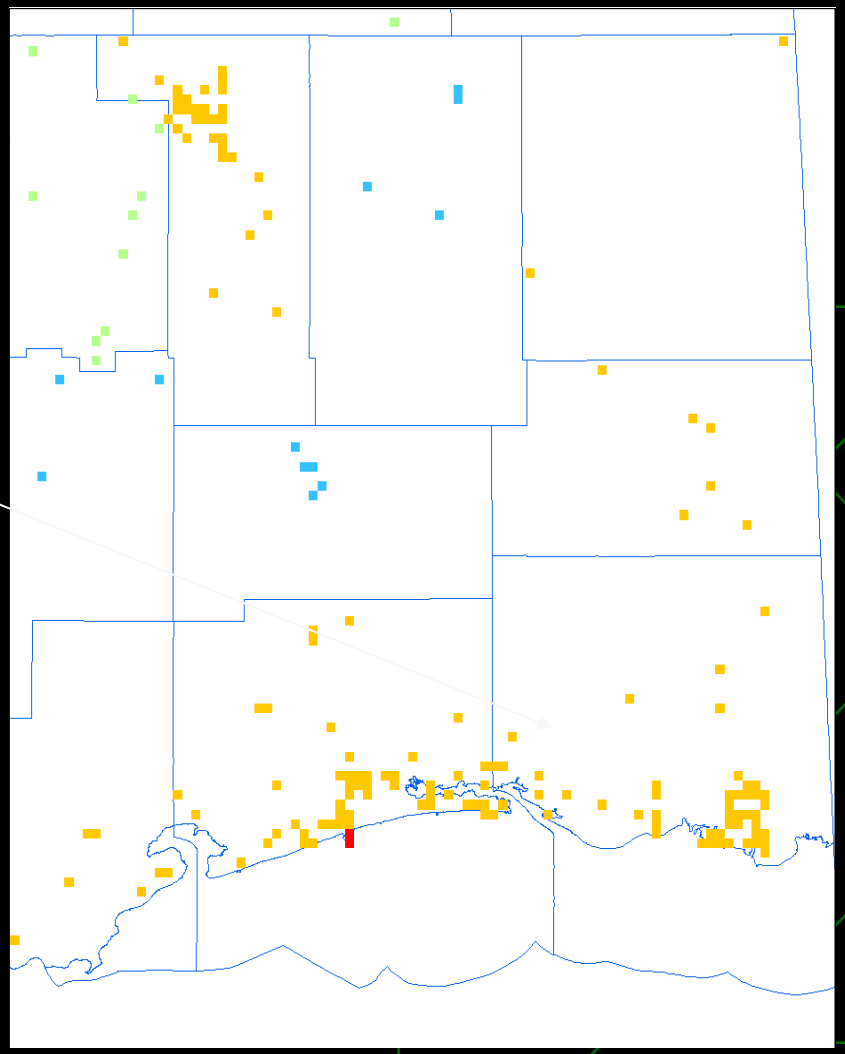
Carbon monoxide emission database

Particulate Matter PM_{10}



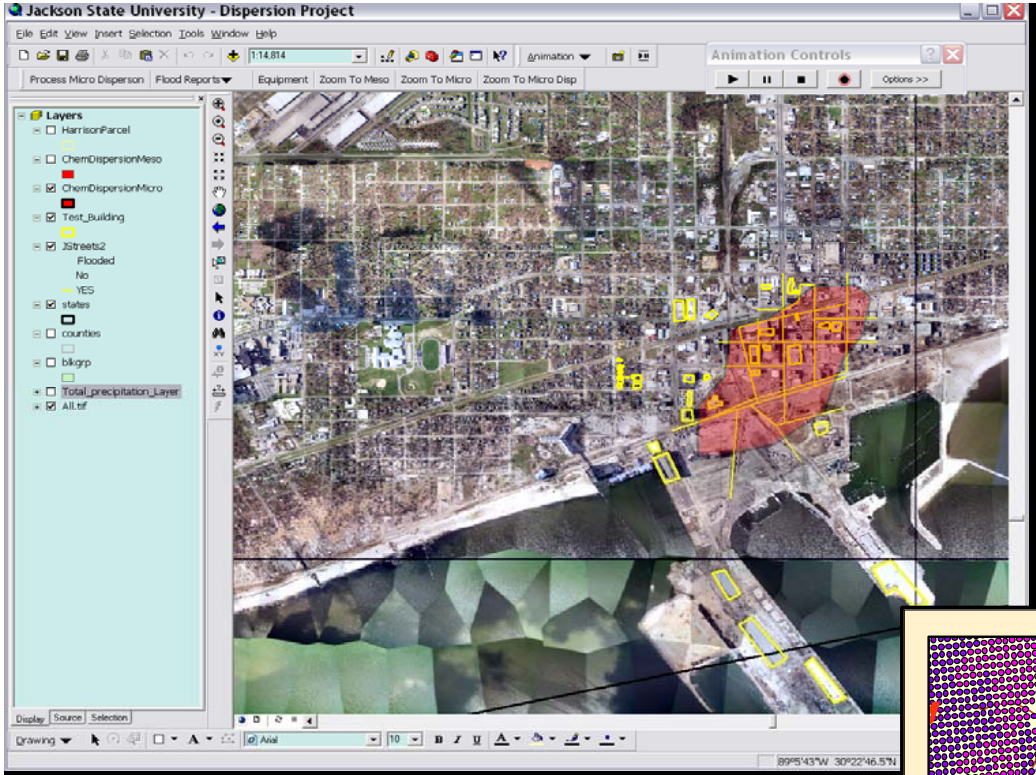
Sulfur dioxide emission quantities from Point source



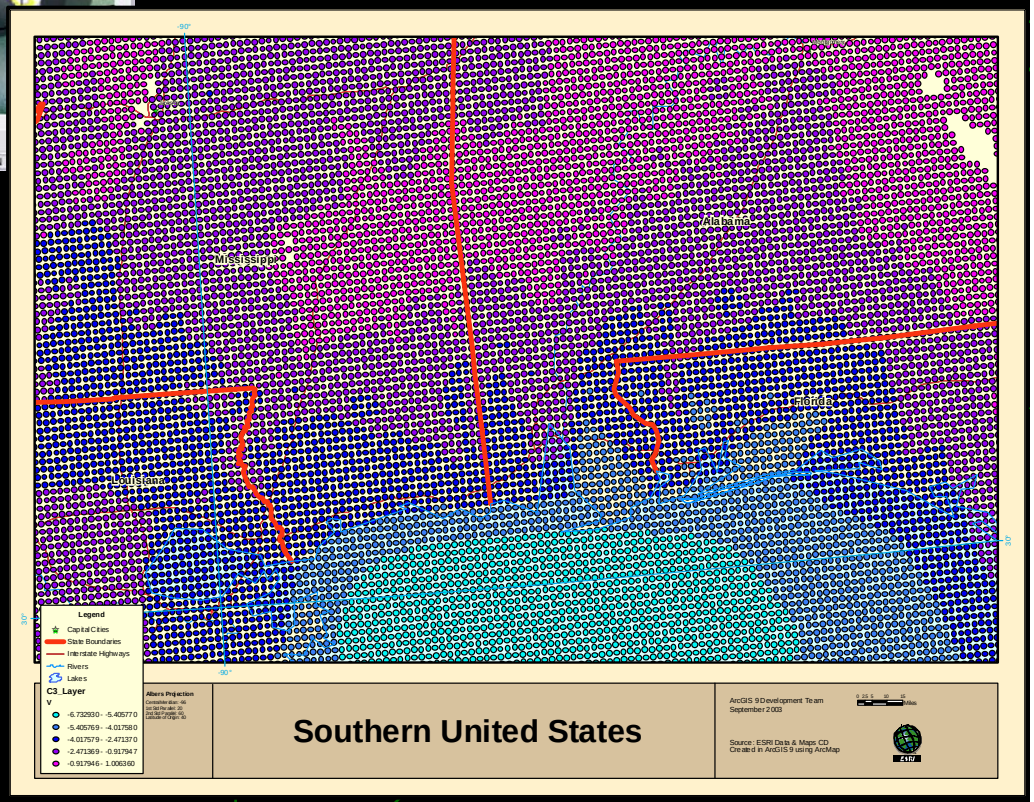


Emission estimation

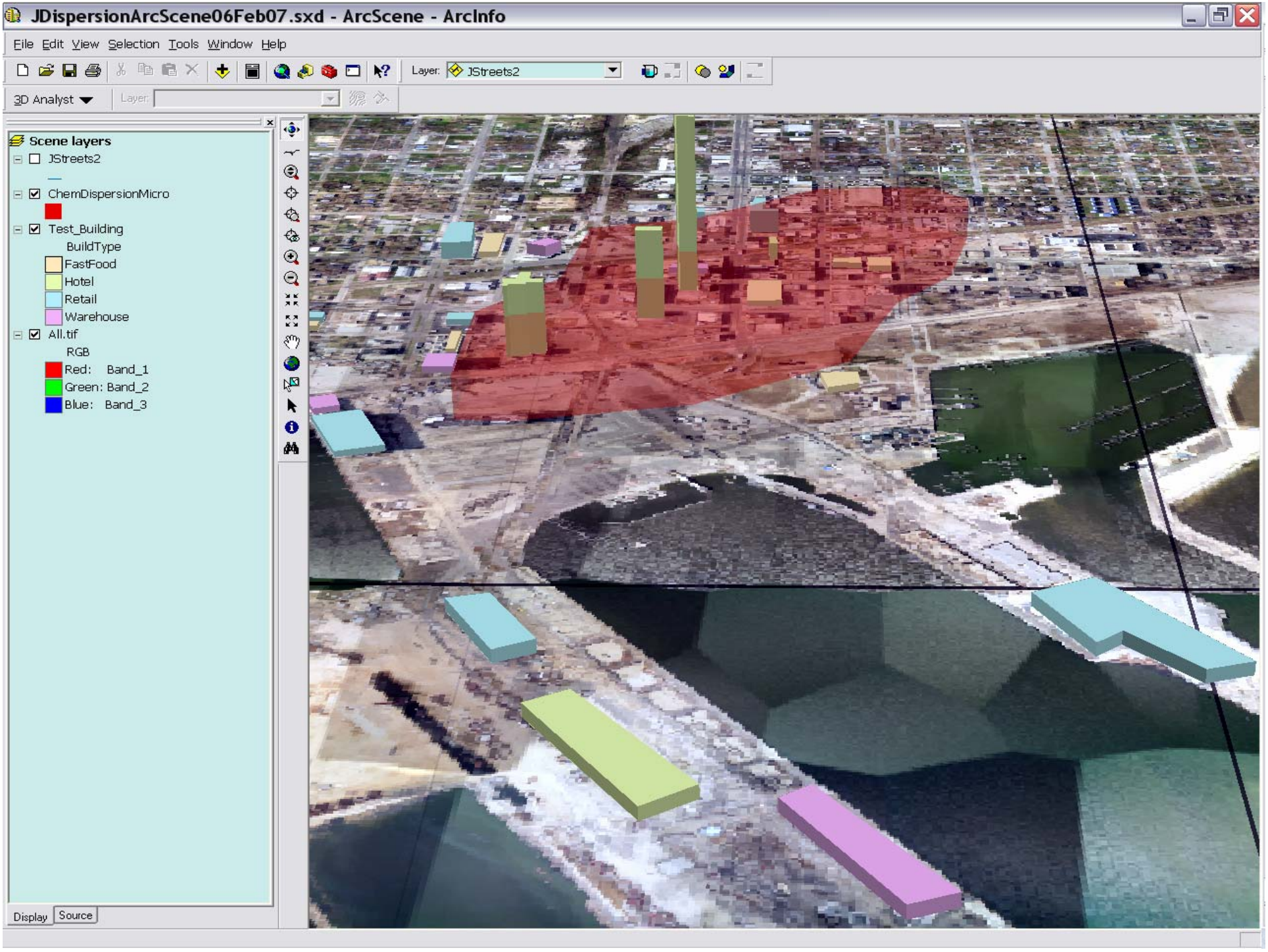
- Currently no elements are developed for automated emission estimation
- Manual commands based emission estimation algorithm is developed
- Emission levels are shown in Map as a chloropleth map.
- Feature output can be saved as dbf format for converting to other formats



Model output

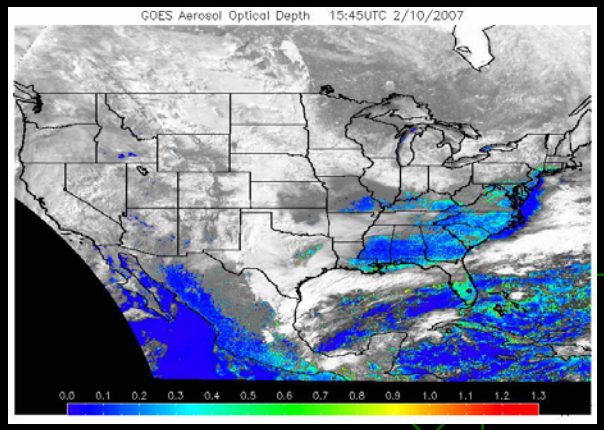


WRF output


JDispersionArcScene06Feb07.sxd - ArcScene - ArcInfo
File Edit View Selection Tools Window Help
Layer: JStreets2
3D Analyst
Layer:
Scene layers
JStreets2
ChemDispersionMicro
Test_Building
BuildType
FastFood
Hotel
Retail
Warehouse
All.tif
RGB
Red: Band_1
Green: Band_2
Blue: Band_3
Display
Source

Future Scope

- Use high resolution satellite products to correlate the emission sources and developing emission inventory
- Develop GIS assisted emission inventory preparation and processing system for directly coupling to Mesoscale models
  (Implementing Sparse matrix algorithms into GIS)
- Incorporate Biogenic emission inventory into the model and use Satellite derived products



Acknowledgements

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