High Resolution Mapping of Fossil Fuel CO_2 Emissions for NACP

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Outline

- Summary of fossil fuel CO_2 emissions
- Methods for high resolution estimates
- Comparisons of annual sums by state
- Further work: model testing in California
- Conclusions

Fossil Fuel CO_2 Emissions

Total Emissions:

- 2005 US fossil fuel CO_2 emissions ~ 1.6 Gt C
- Estimated US terrestrial C sink ~ 0.2 Gt C

Large local fluxes:

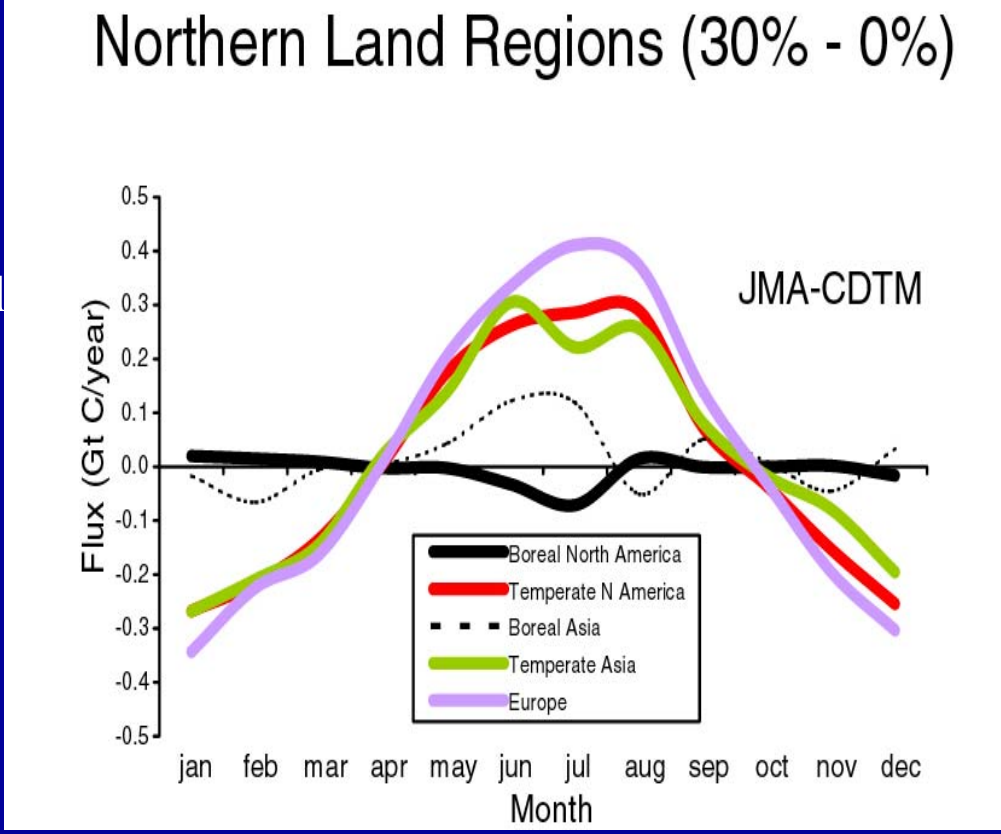
- Even at 10km, flux ~ 10 - 100 $\mu mol\ m^{-2}\ s^{-1}$

Example of Inverse Model due to Seasonal Variations in Fossil CO_2 Emissions

- Modify TRANSCOM:
  - **Impose 30% seasonal variation in fossil CO_2 emissions**
- **Response:**
  - **1 Gt C seasonal bias in global inverse estimate of continental carbon exchange**

Challenge for NACP:

- Regional inverse studies must account for fossil emissions
- Requires maps capturing spatial and temporal variations



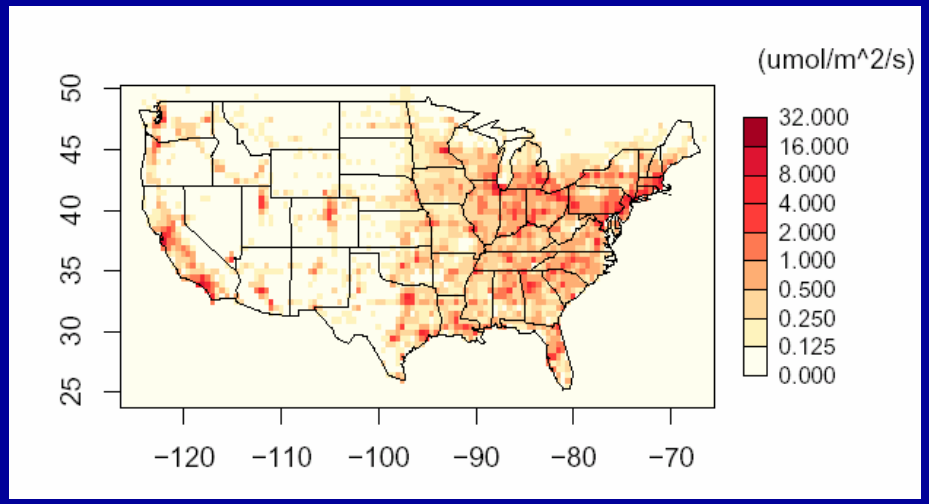
(Gurney et.al., 2005)

Approach

Fuel use in space and time

- US EPA National Emission Inventory
  - 36 km resolution
  - Diurnal, weekly, seasonal variations
- Initial work used single factor scaling to CO2 (e.g., Gerbig et.al., 2003)

Proportional scaling of 1999 NEI NOx to CO_2 emissions



Fischer et al., 2004

Improving model analysis

- Disaggregate fuel use in all use sectors
- High resolution from GIS

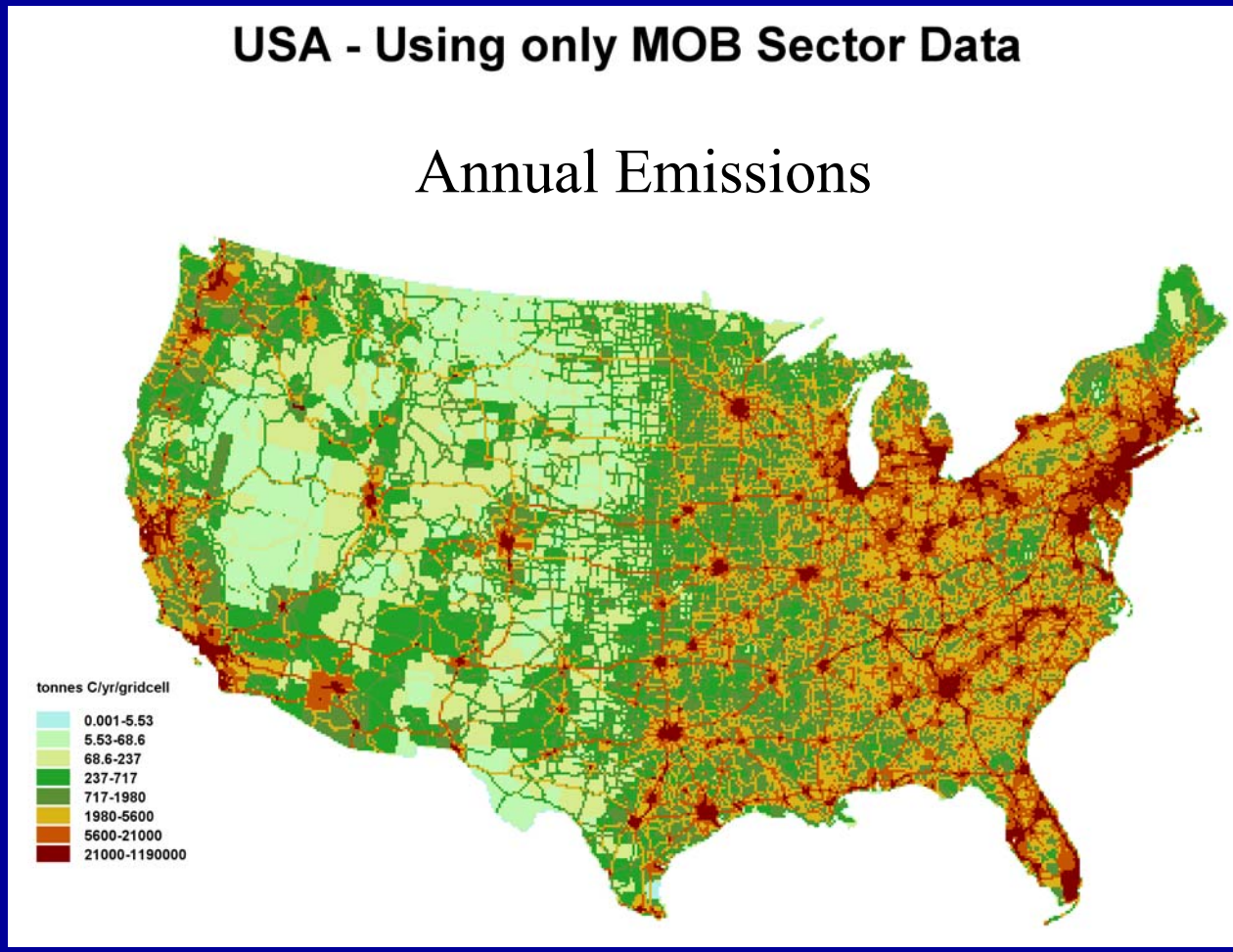
2002 Mobil CO_2 Emissions

Models

- EPA Mobil 6
  - Vehicle class specific CO_2
- NMIM
  - county
- US Road GIS

Output

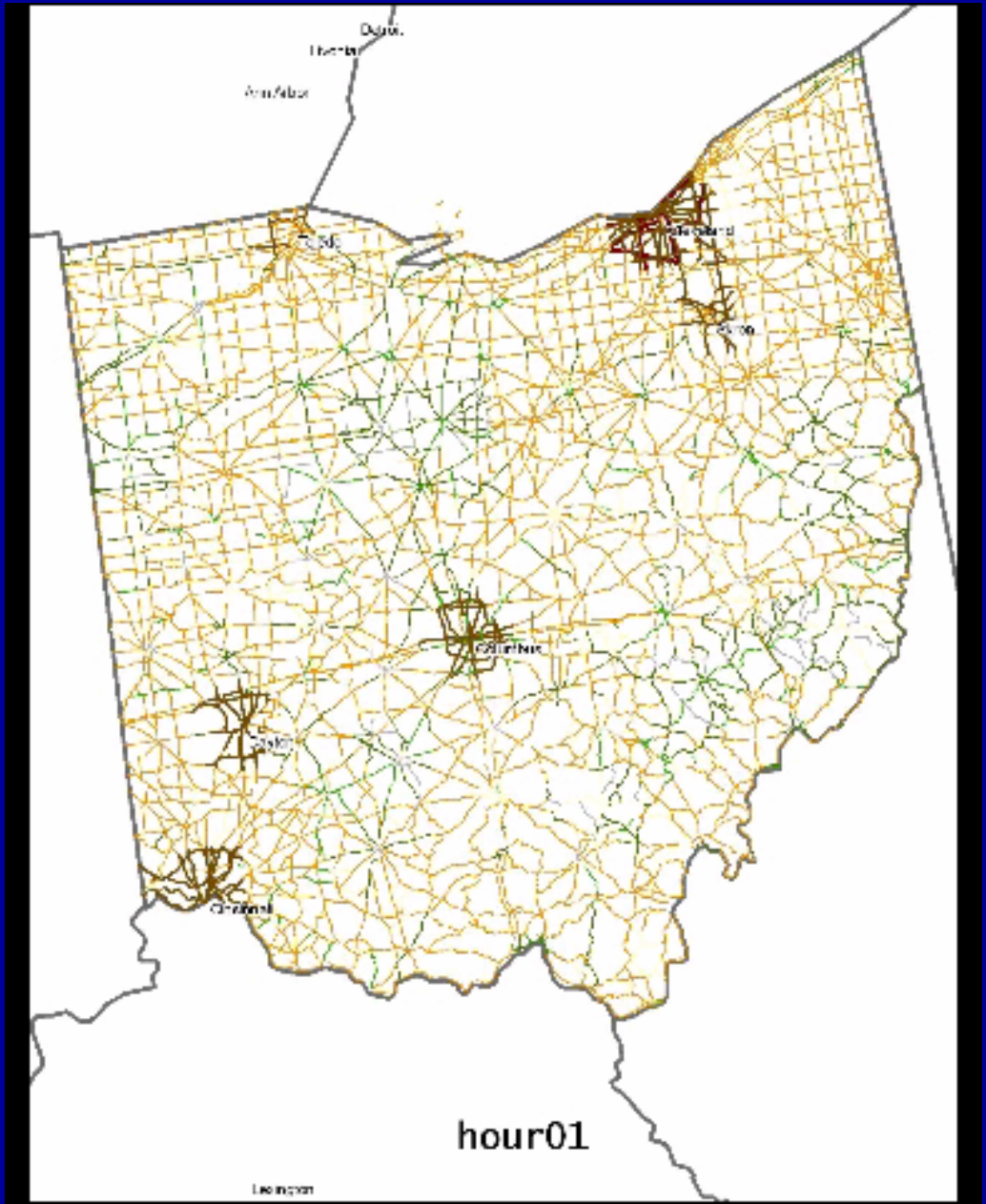
- 10 km
- hourly



localized fluxes ~ 10-100 μmol m^{-2} s^{-1}

Diurnal Variation of Ohio's Mobil CO_2

- Individual roads from GIS
- Timing of road use varies by size class



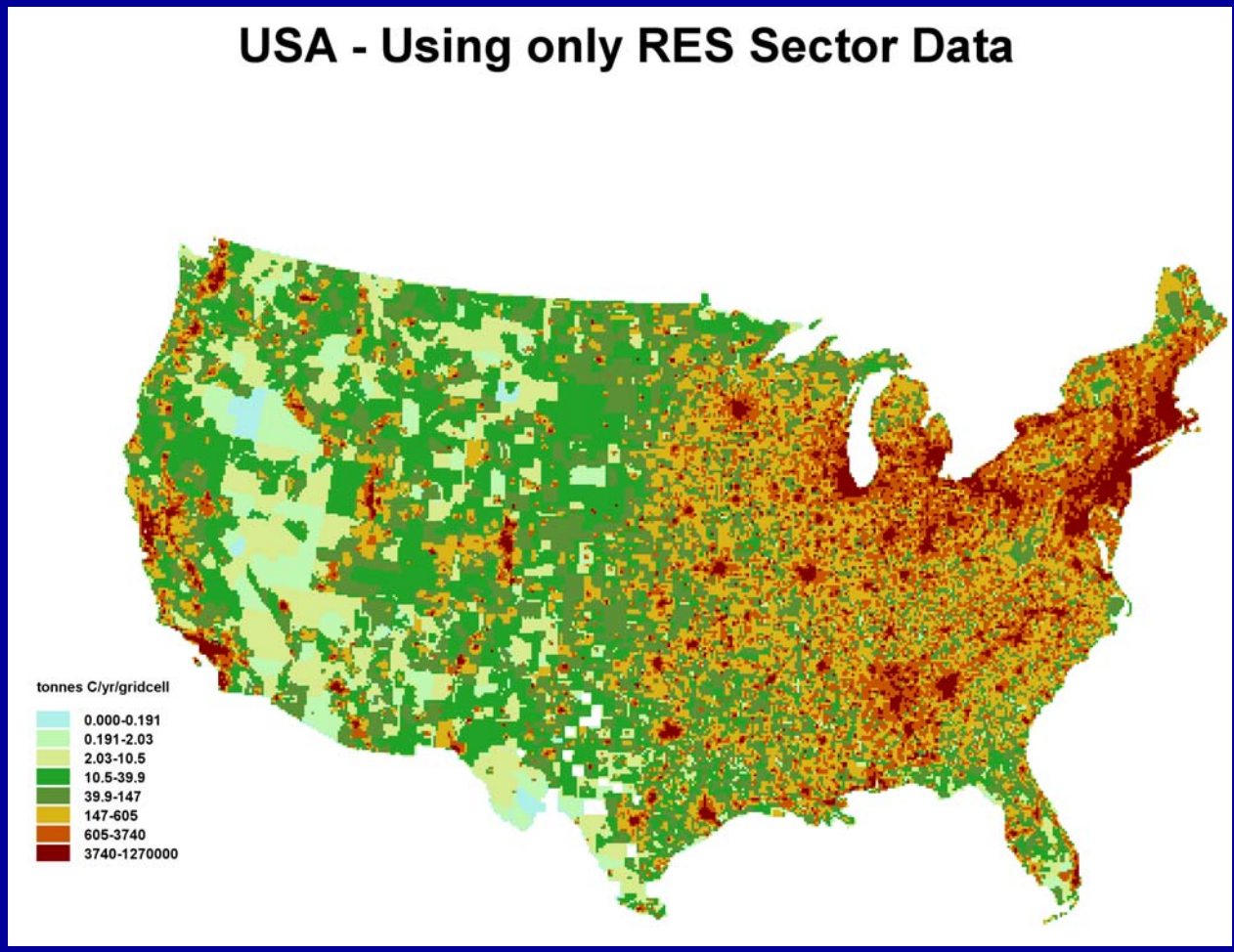
2002 Residential Emissions

Models

- EPA NEI
  - 36 km
- Emission Factors NOx, CO_2
- Census GIS

Output

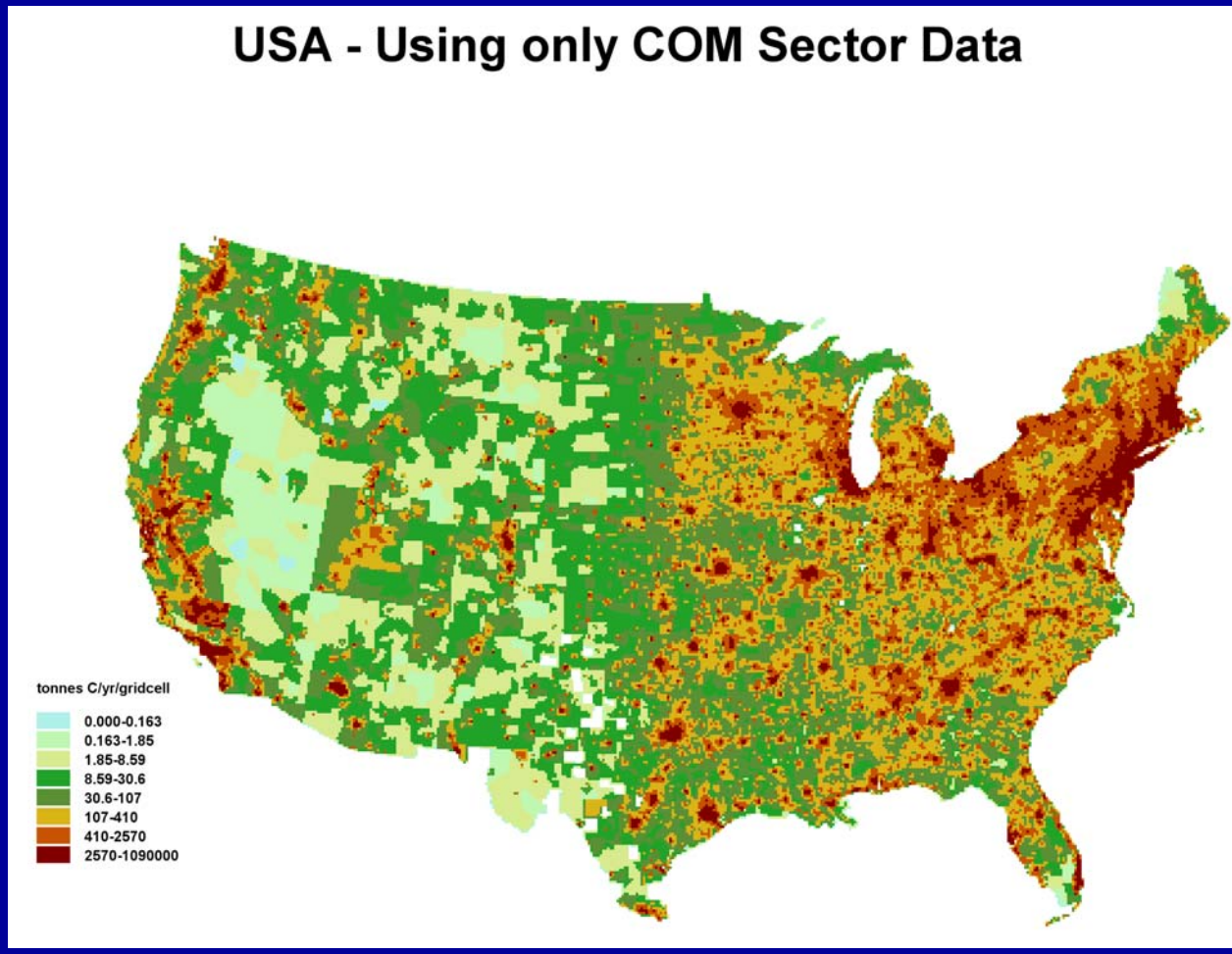
- 10km
- hourly



2002 Commercial Area Emissions

Models
- EPA NEI
  - 36 km
- Emission Factors NOx, CO_2
- Census GIS

Output
- 10km
- hourly



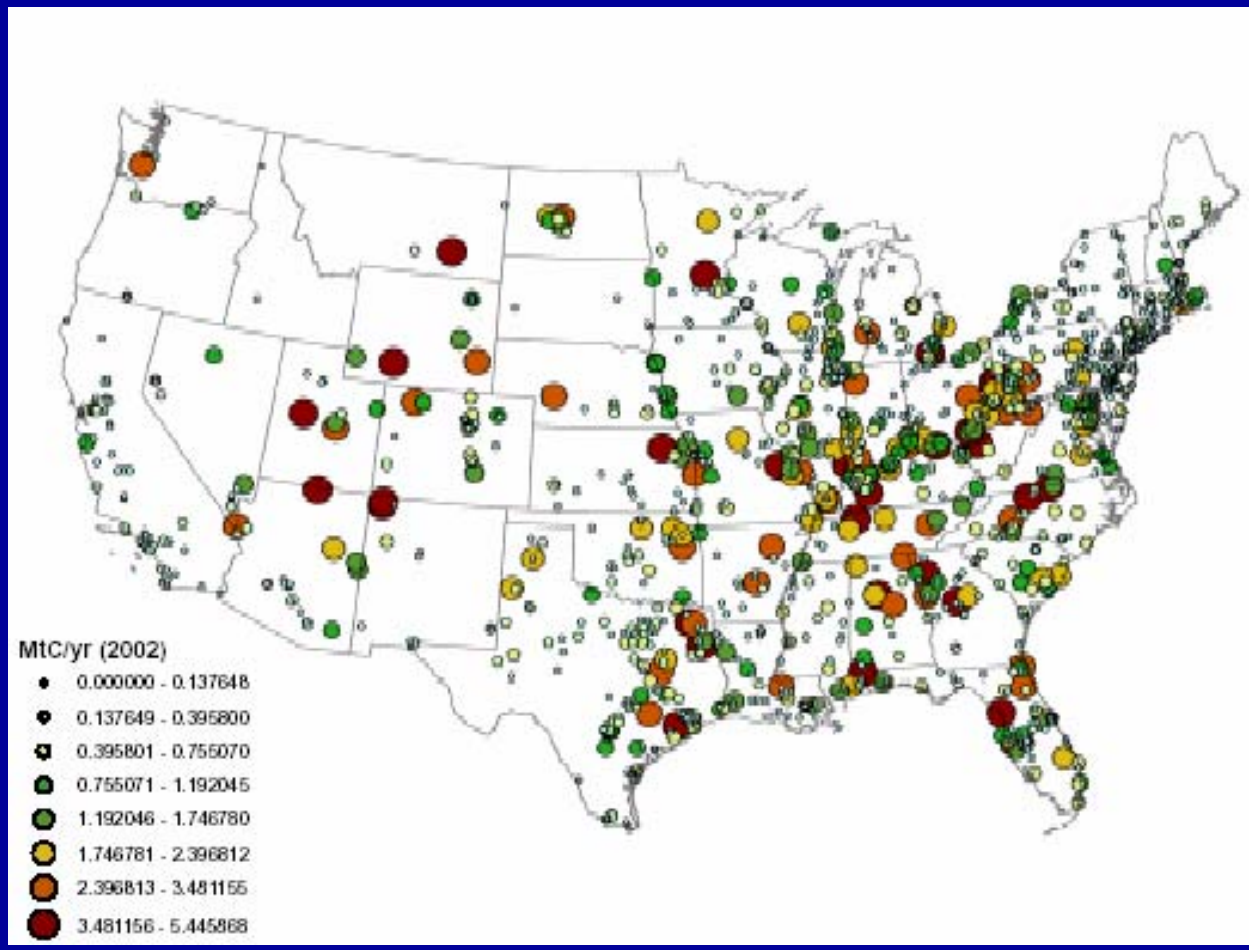
2002 Large Energy Users

Measurements!

- EPA Continuous monitoring CO_2

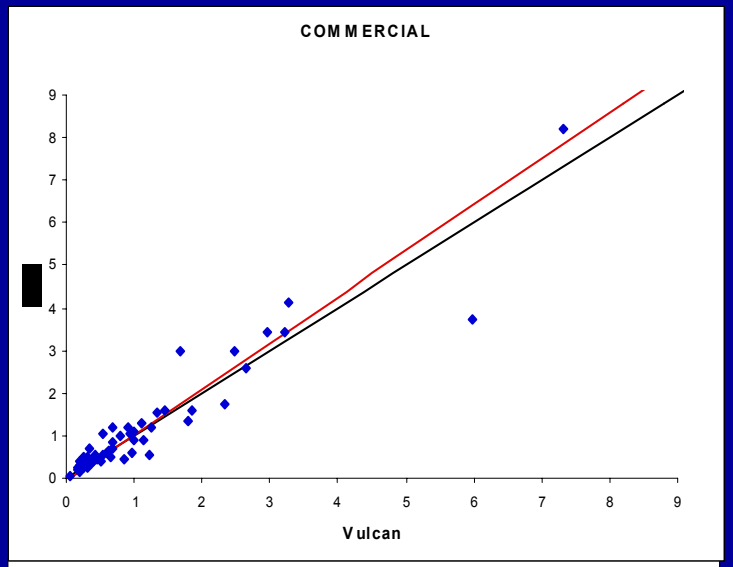
Output

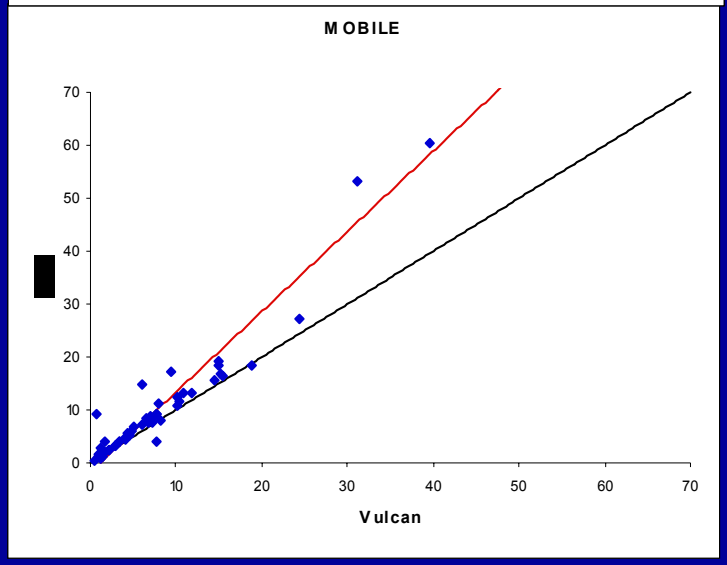
- points
- hourly



Comparison w/ EPA Annual State Level CO_2 Emissions

- Point Sources
  - Large number of small sources require special handling
  - Still, capture > 90% EPA total
- Area sources at state level
  - EPA sum and Vulcan agree to 5%
- Mobil sources
  - On-road captures ~ 90%
  - Need to add non-road sources (e.g., aircraft shipping, etc.)

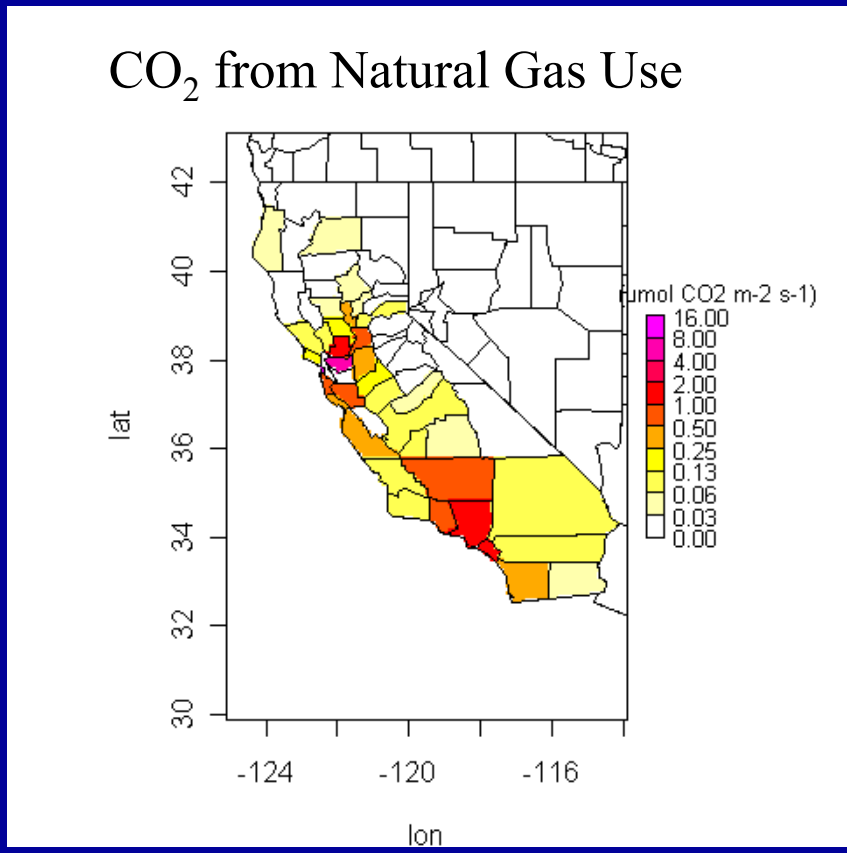




Testing Model in California

Quasi-independent CO_2 emissions by month and county

- On-road CO_2 from California Air Resources Board EMFAC model
- Natural gas consumption from California Energy Commission (CEC)
- Refinery and power plant petroleum (CEC)
- Cement production (CEC)
- Route specific CO_2 aircraft emissions for commercial (US Dept. of Transportation)
- Port and route specific marine CO2 emissions (US Waterborne Statistics)



Conclusions

- EPA NEI contains underlying significant fraction of required data to distribute fuel use
- First order high resolution fossil CO_2 maps are nearly complete
- Testing and revision will be performed using independent data for California
- Data will soon be available for atmospheric studies supporting NACP

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