Emission Impact Potential – A Method for Relating Upwind Emissions to Ambient Concentrations

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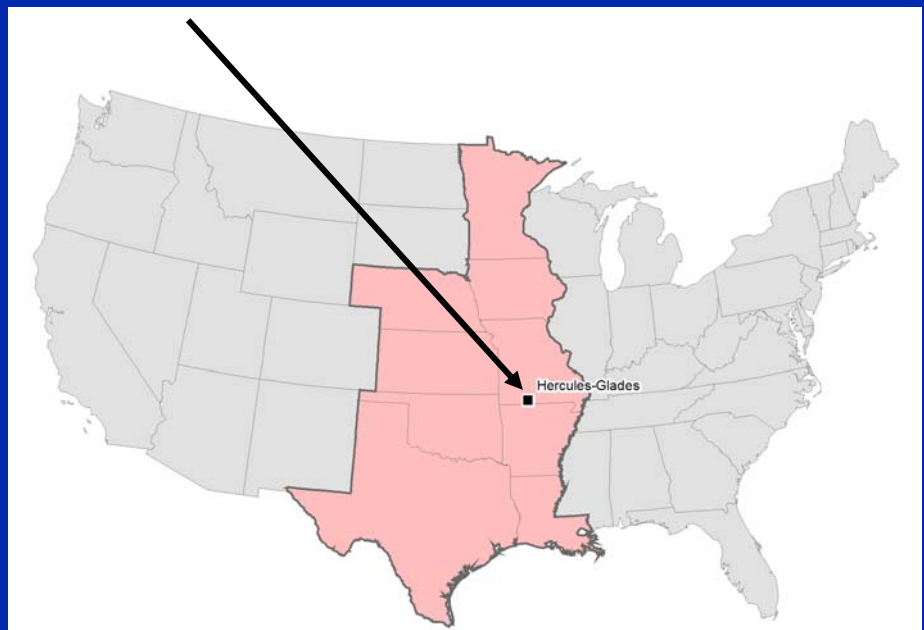
Project Objectives

- Overall – Determine the causes of atmospheric haze in visibility-protected (Class I) areas in the CENRAP states
- Specific – Understand where emissions came from on 20%-worst and 20%-best visibility days (2001 -2003)
- Test Case – Hercules Glades Wilderness, Missouri (SO_2 and NO_x)



CENRAP States

Emission Impact Potential (EIP)

EIP = Emissions at a source * Probability of Transport from the source to a receptor

Emissions

2002 emissions by source type and county (or county equivalent) for the United States, Canada, Mexico, and the Gulf of Mexico

Transport

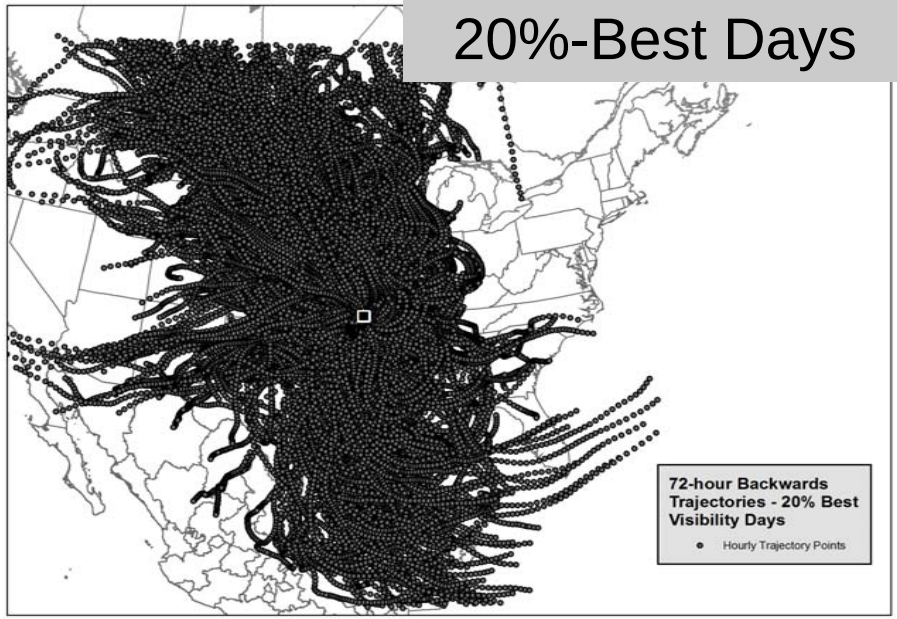
Backward wind trajectories (from emission source to receptor) estimated using the HYbrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model

Geographic Information System (GIS) technology facilitates this analysis

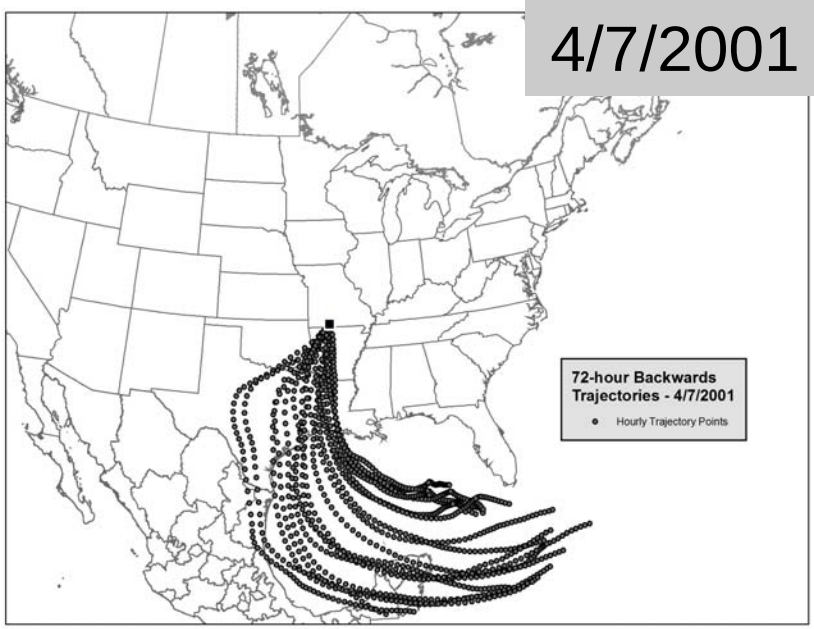
Transport Probability – 1

72-hour backwards trajectory runs were performed for each of the top 20%-best and -worst visibility days at Hercules Glades

20%-Best Days

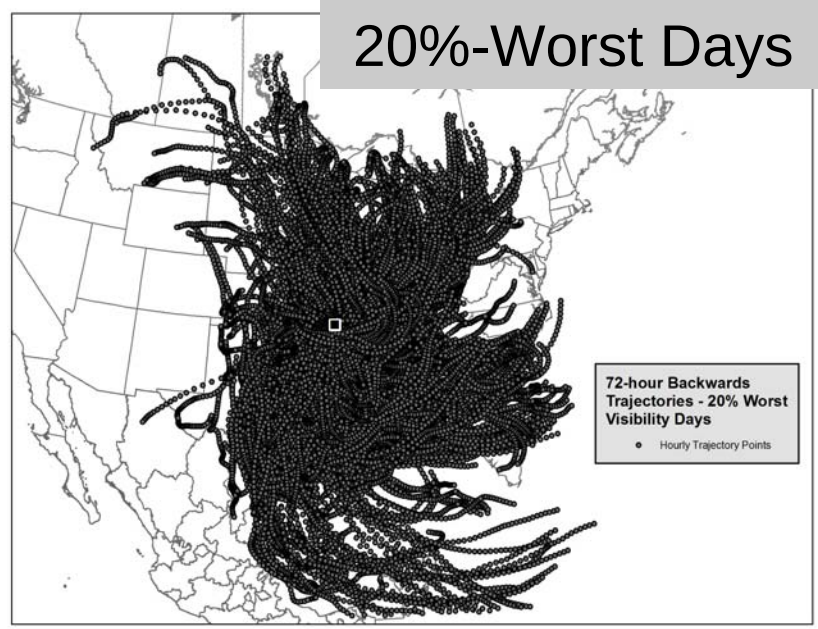


4/7/2001

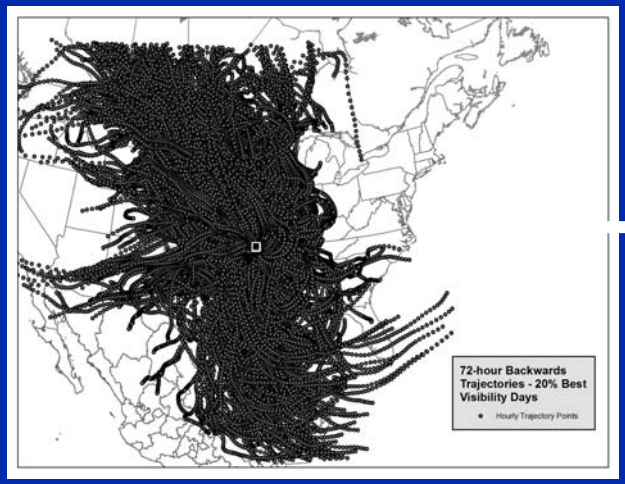


Combine dates

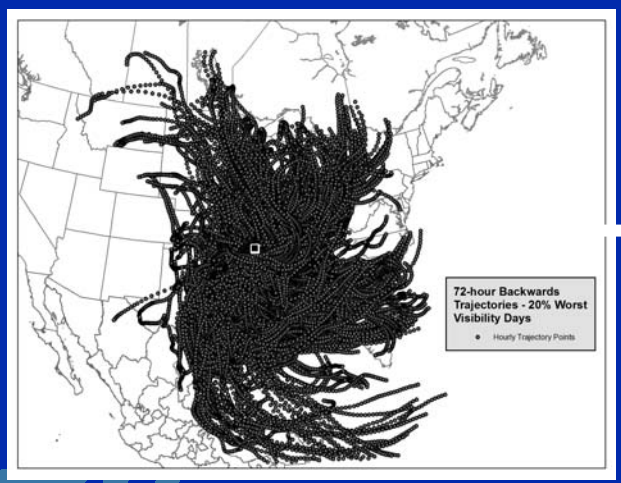
20%-Worst Days



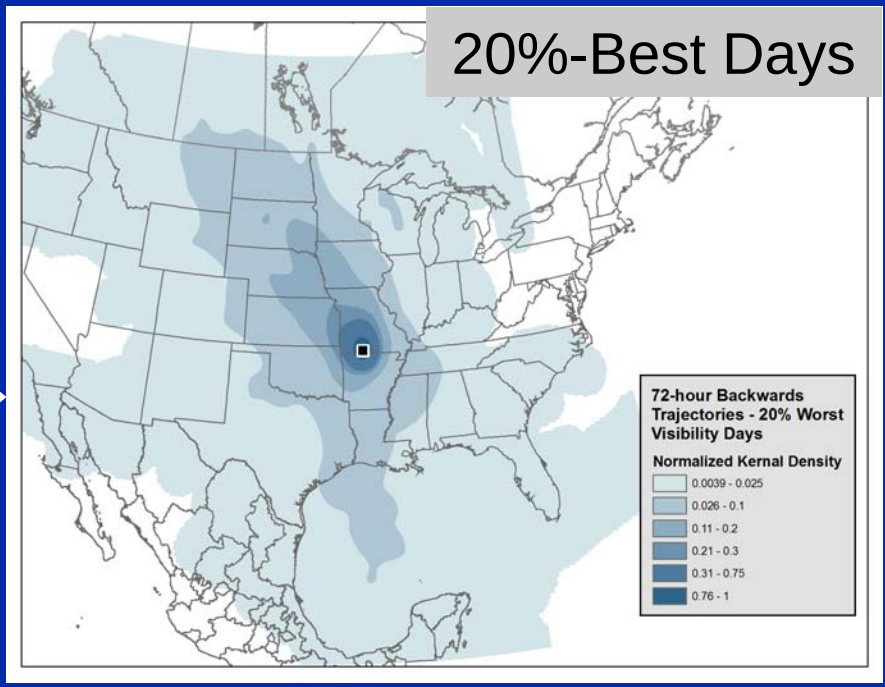
Transport Probability – 2



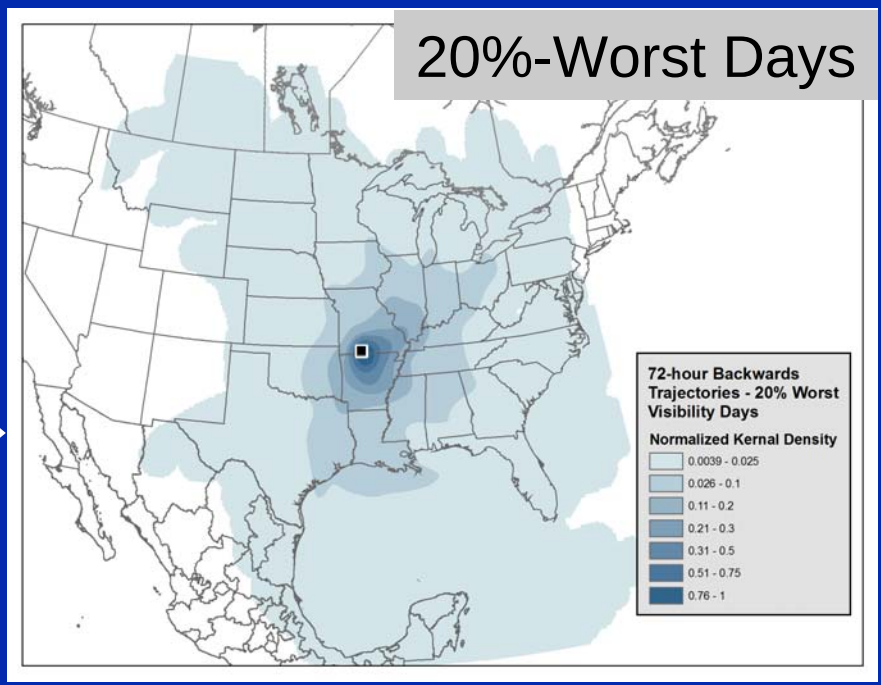
Trajectory points are converted to a normalized density within a GIS



20%-Best Days

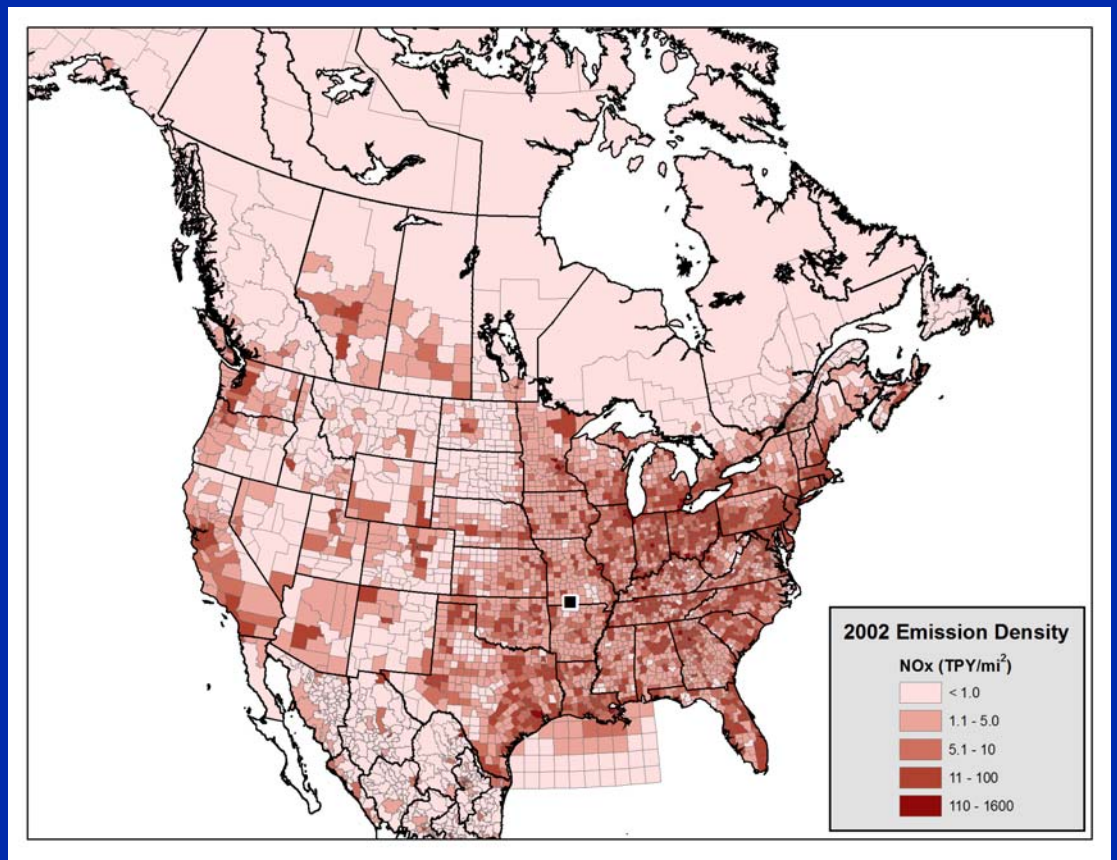


20%-Worst Days

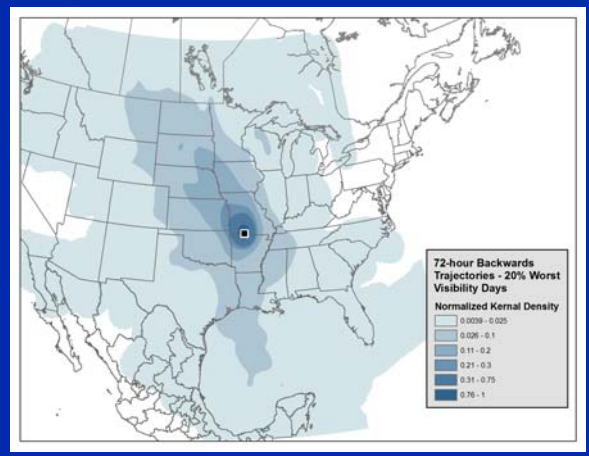


Calculating EIP

County NO_x Emissions



Transport Probability



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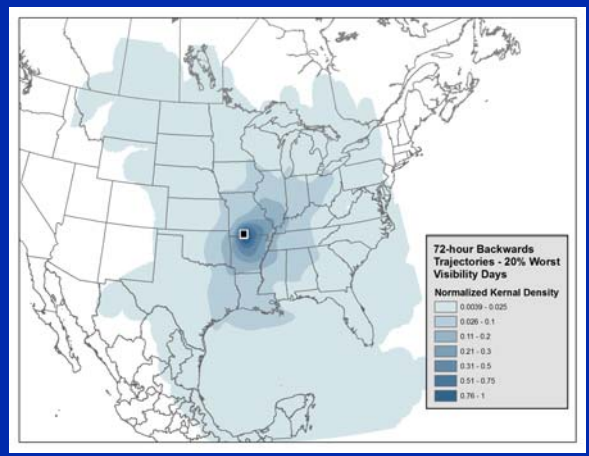

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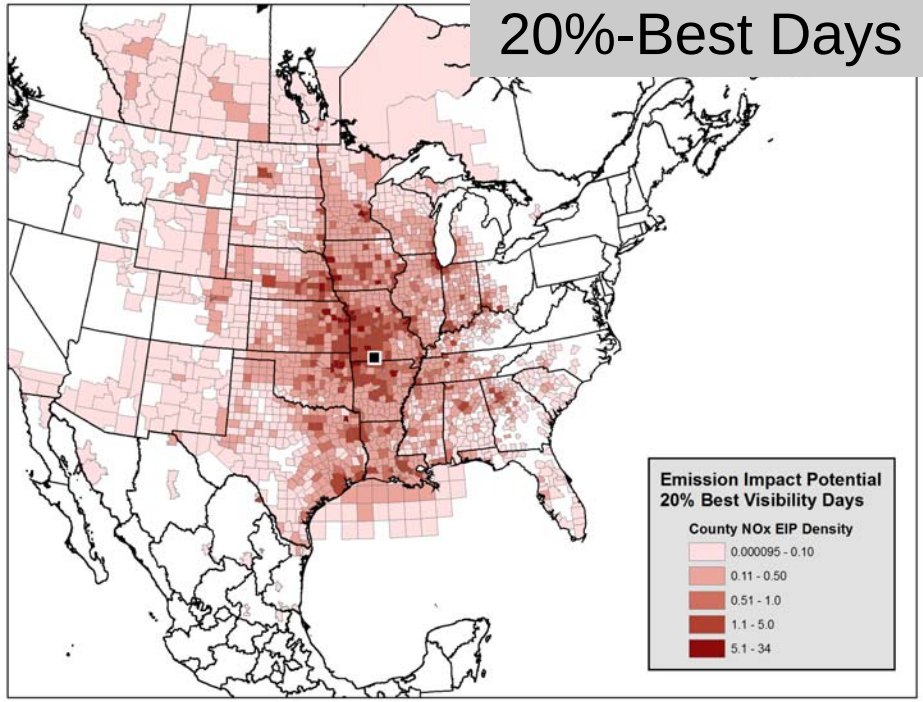
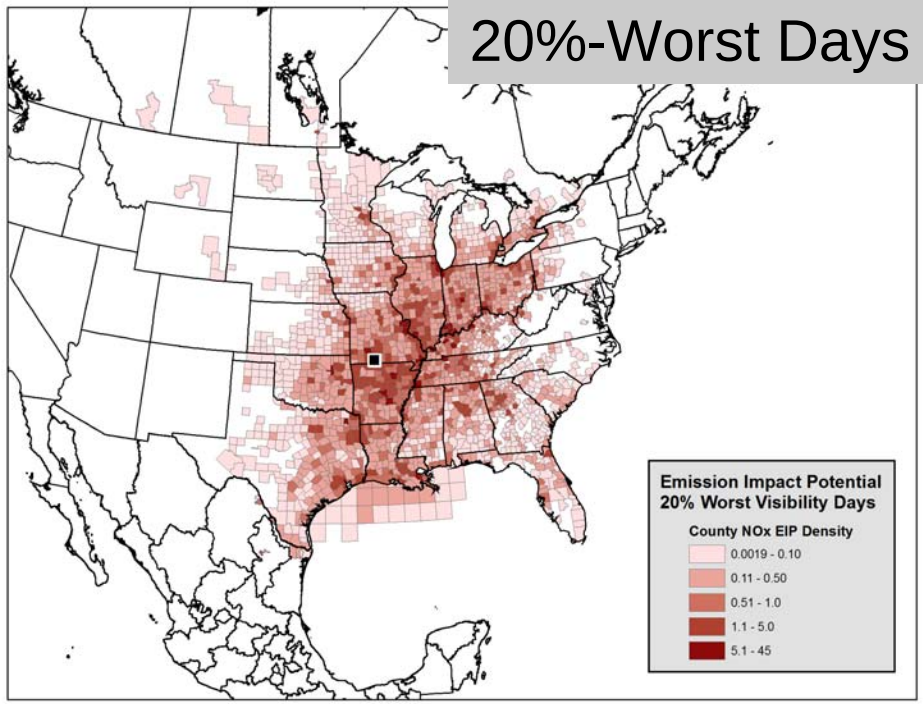
Results – NO_x EIP

- On good visibility days, the upper Midwest is an important EIP source
- On poor visibility days, the Ohio River Valley is more important
- Sources nearest the site are always important (Arkansas, Missouri)
- Substantial EIP contribution from Texas and Louisiana on both good and poor visibility days

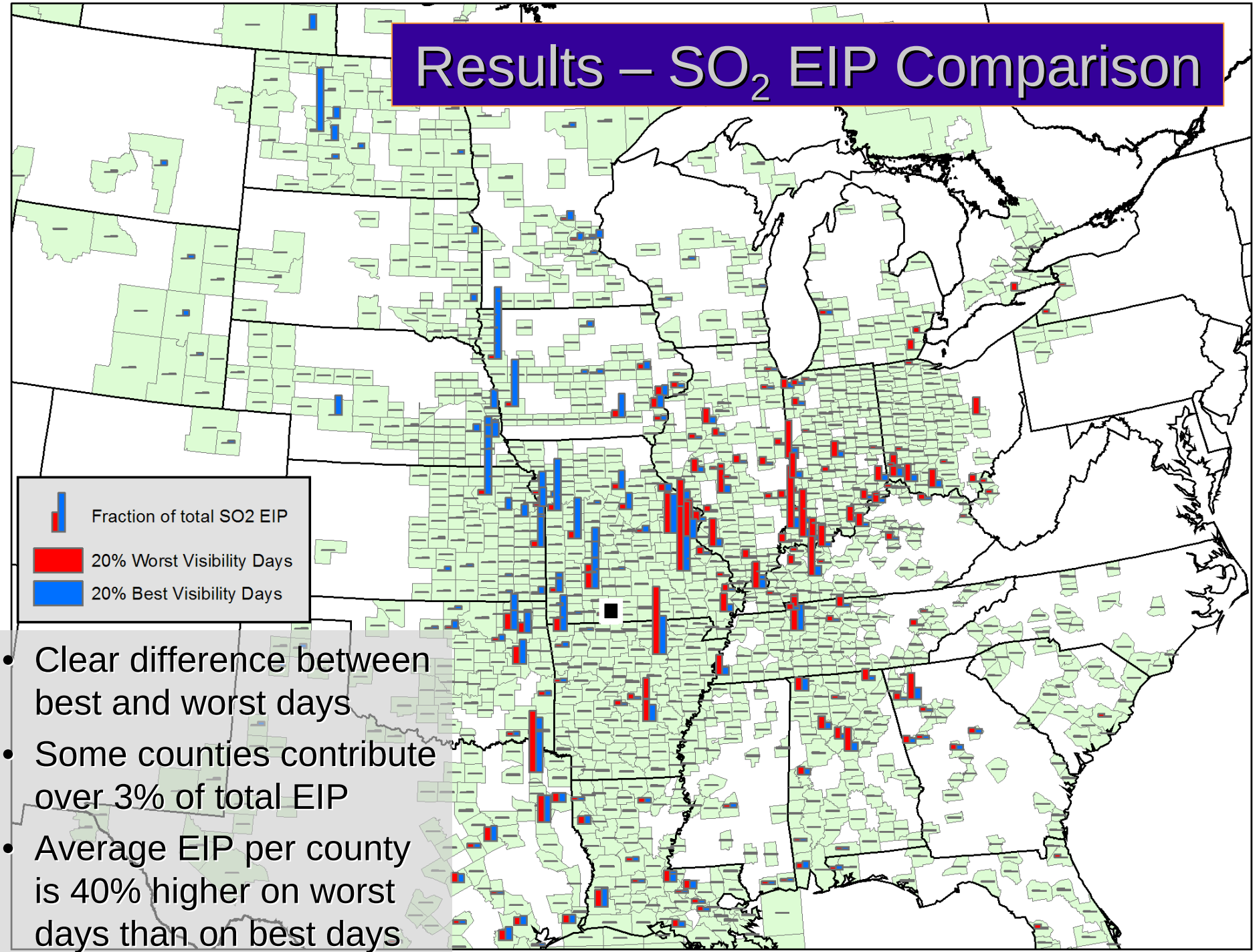
20%-Best Days



20%-Worst Days



Results – SO_2 EIP Comparison

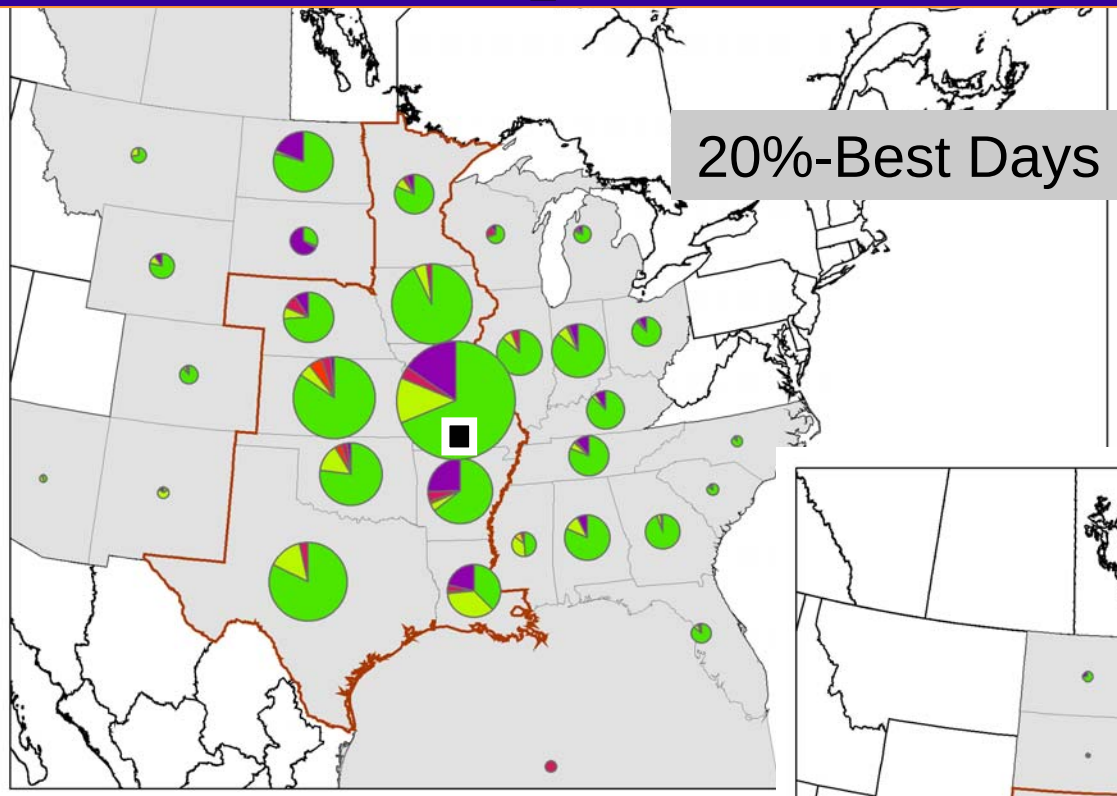


- Clear difference between best and worst days
- Some counties contribute over 3% of total EIP
- Average EIP per county is 40% higher on worst days than on best days

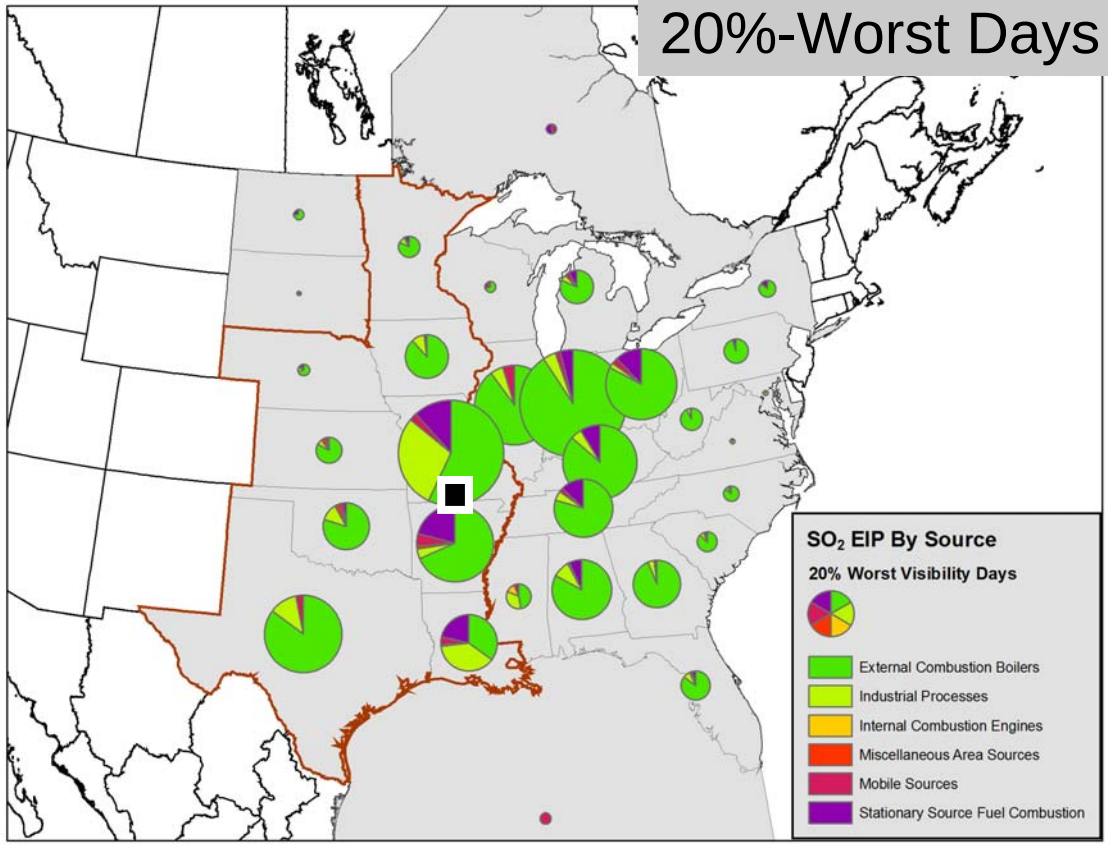
Results – SO_2 EIP by Source

- ~70% of SO_2 EIP from external combustion boilers (i.e., coal-fired power plants)
- 69% of total EIP on best days is within CENRAP
- 42% within CENRAP on worst days

20%-Best Days



20%-Worst Days



External Combustion Boilers
Industrial Processes
Internal Combustion Engines
Miscellaneous Area Sources
Mobile Sources
Stationary Source Fuel Combustion

Results – SO_2 EIP by Source

Source	Worst Days (% of total)	Best Days (% of total)
Electric Generation	69	68
Industrial Combustion	9	15
Primary Metal Production	4	2
Mineral Products	2	2
Chemical Manufacturing	2	2
Petroleum Industry	2	2
Others	12	8

SO_2 EIP contributions by source type are mostly unchanged between good and poor visibility days

Next Steps

- Daily correlation of EIP with ambient concentration
- EIP analysis for other Class I sites in CENRAP
- EIP analysis for other emissions (VOCs, $PM_{2.5}$, NH_3, toxics)
- Targeted EIP analyses
  - Total SO_2 EIP from coal combustion sources on 10% highest coal factor days identified by factor analysis
  - EIP from sources with potential for new controls
- EIP analyses of historical inventories

Advantages and Disadvantages

Advantages

- Simpler, faster, and cheaper than photochemical modeling
- Useful for developing a first-cut conceptual model and understanding general patterns
- Requires minimum of input data

Disadvantages

- Not photochemical modeling!
  - Ignores atmospheric dynamics
  - Quantitative only in a relative sense
- How well EIP correlates with ambient concentrations is not yet known