DFW Transport Assessment

Presentation to the HARC
Science Advisory Committee

June 1, 2005

Greg Yarwood and Ed Tai
ENVIRON
(gyarwood@environcorp.com)

ENVIRON

Today's Presentation

- Project Background
- H35 Phase-1
  - Transport and EGU contributions assessment
- H36
  - Control Technology Assessment for Upwind States
- H35 Phase-2
  - Improve model performance,
  - Process Analysis
  - Updated transport analysis with sensitivity studies

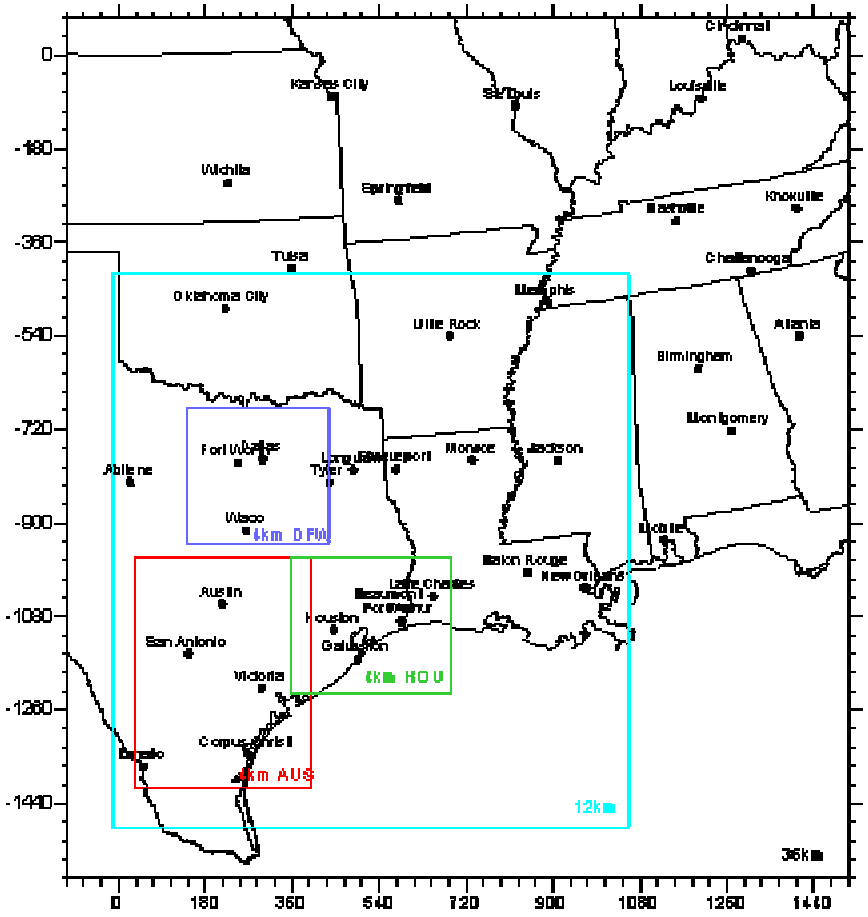
DFW SIP Modeling

- Modeling an August 13-22, 1999 episode
  - Selected after completing a conceptual model and episode selection analysis
- Extending to Sept 1, 1999
  - Less refined modeling for confirmation
- 2010 future year with national, regional and local controls in place
  - Switching to 2009 soon
  - Previously evaluated 2007 for 1-hr ozone

H35 Phase-1: Transport Assessment

- Examine nearby states' contributions to 8-hour ozone in DFW and other areas of Texas
  - Zero-out and ozone source apportionment
- Use Clean Air Interstate Rule (CAIR) methodology
    - http://www.epa.gov/interstateairquality/rule.html
- Use three different episodes in Texas
  - DFW Episode: August 13-22, 1999
  - Houston Episode: August 22-September 6, 2000
  - Austin Episode:September 13-20, 1999

Modeling Domains for H35 Phase-1



- Same 36 km and 12 km outer grids
  - Expanded 36-km grid for H35 Phase-2
- Different 4 km grids for
  - DFW
  - Houston/Beaumont
  - Austin/San Antonio

Identifying Significant Transport

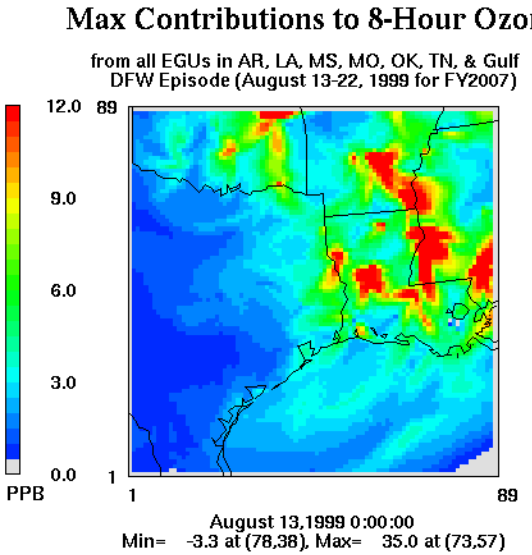
- Initial screening
  - A state is not a significant contributor if
    - Max 8-hr contribution using APCA <2ppb, or
    - Max 8-hr contribution using zero-out < 2ppb, or
    - Percent of total nonattainment < 1%
- Further analysis if fail screening
    - Exceedance of screening metrics must be “frequent and large”
    - Reviewed CAIR rule examples to quantify “frequent and large”

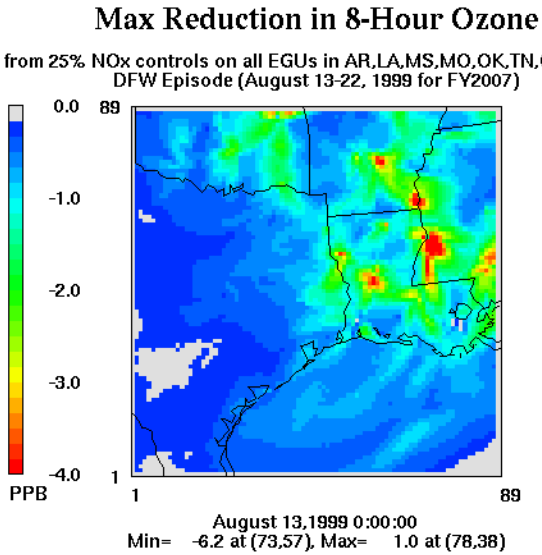
Significant States

- States significantly impacting Texas NAAs
  - Louisiana
  - Oklahoma
  - Arkansas
  - Mississippi
  - Alabama
  - Tennessee
  - Kentucky
  - Gulf of Mexico
    - The Gulf of Mexico OCS was evaluated like a state

EGU Contributions to Ozone

Max Contribution by zero-out

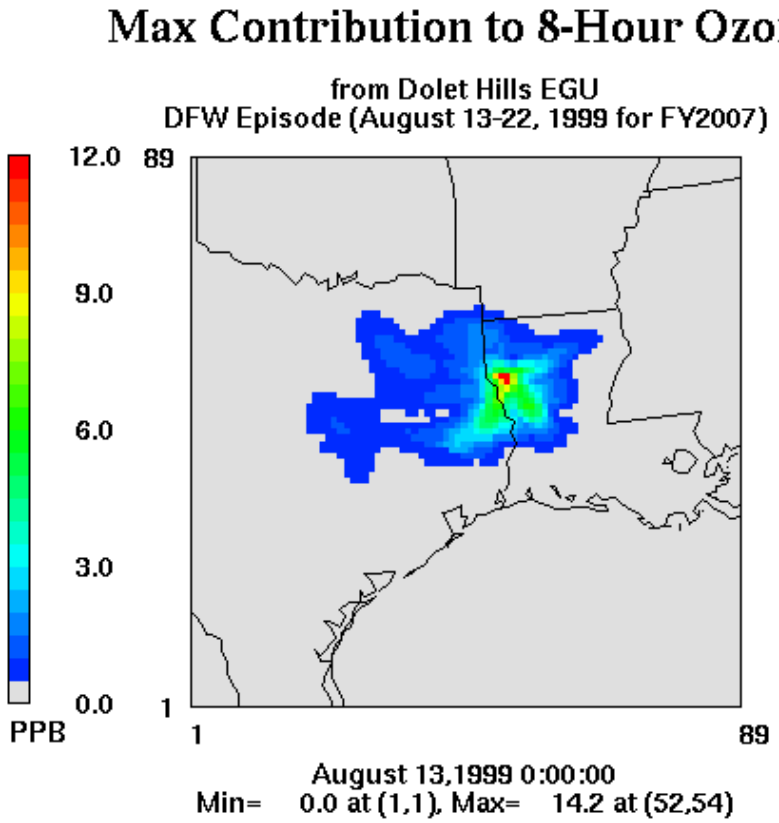




25% EGU NOx reduction

- EGU contribution from “significant states”
  - Peak 8-hr contribution were 20 ppb for Beaumont
  - Average 8-hr contribution were ~4 ppb for DFW and Houston
  - < 1 ppb benefit from 25% reduction in DFW

EGU Contribution to Ozone



- Non-Texas EGU contributions highest for sources near Texas' eastern border.
  - Dolet Hills
  - Rodemacher
  - R.S. Nelson
- Slide shows max contribution of Dolet Hills in DFW episode

H36 Control Technology Assessment

- Focus on “significant” upwind states
- Identify dominant NOx sources under state control
  - Not mobile sources
- Identify available control technologies
  - E.g. SCR, SNCR, 3-way catalyst
- Compare existing regulations in upwind states to Texas
  - NAAs versus NNAs
- Tabulate results by state
- Broad scope precluded source-by-source analysis

H36 Recommendations

- Review states' responses to CAIR
- Prioritize sources in upwind states
  - Emission/ozone contribution
  - Potential for control
- Review selected operating permits
- Evaluate benefits of "Texas controls" in upwind states

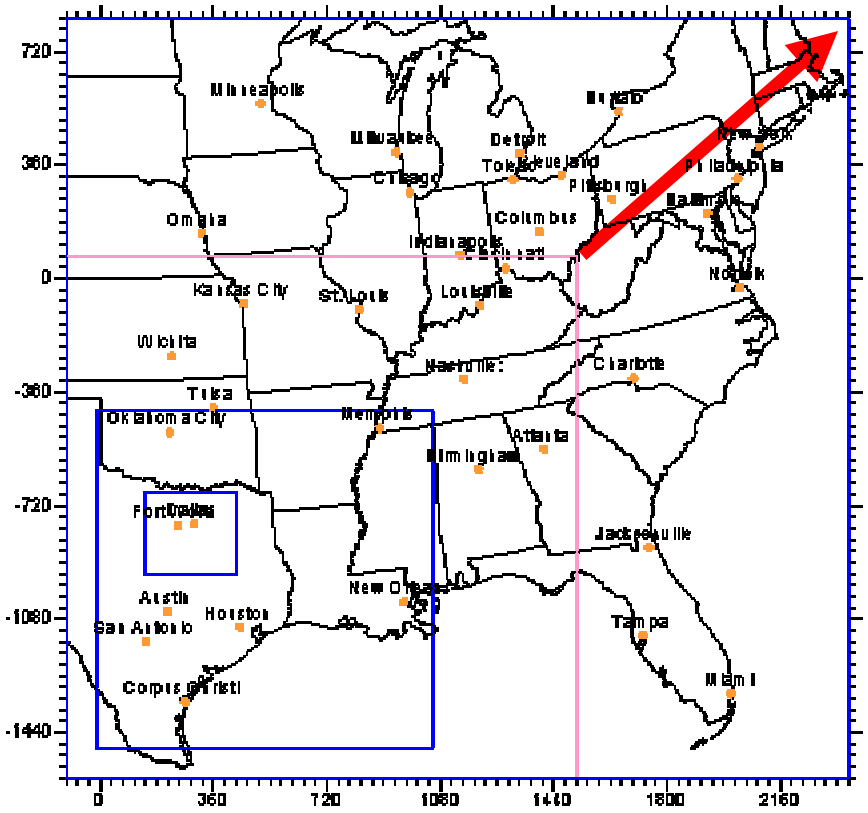
H35 Phase-2

- Improve base case model performance
  - 10 CAMx and 2 MM5 sensitivity runs
  - Revised base case called “Run 34”
- Chemical Process Analysis
  - Investigate chemistry in the updated 1999 base case
- Updated transport analysis
  - 2010 “Run 34” case with expanded grid
  - Proposed CAIR emission reductions
  - Modeling sensitivity analyses

Improved Model Performance "Run 34"

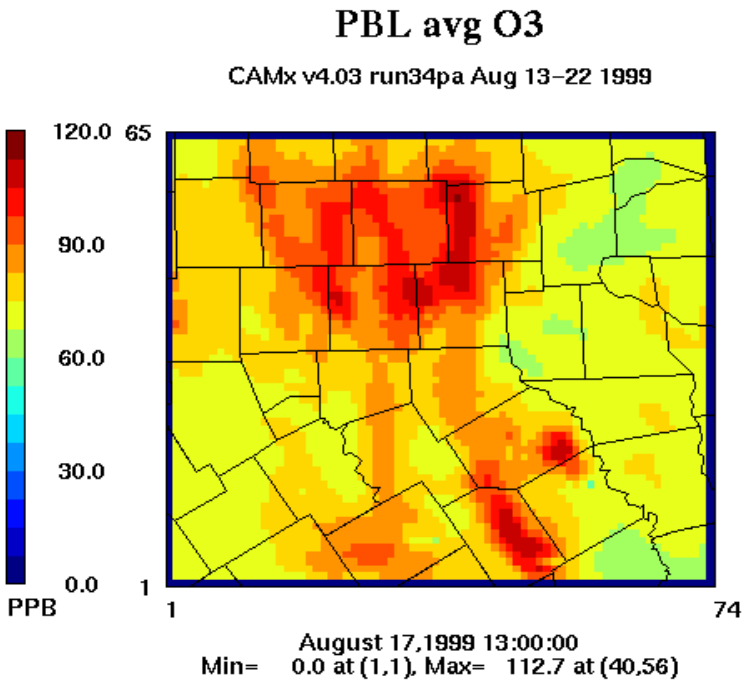
- Expanded modeling domain extending to the Atlantic Ocean and Canada
- Higher model top at about 14-km
- Meteorology from MM5 "Run 6" using the Noah/Eta PBL scheme
- Enhanced near surface mixing from the "Kv100" adjustment (from H12 project)
- Extended inorganic chemistry (CB4xi)
  - "NOx recycling" reactions for HNO_3 and RNO_3

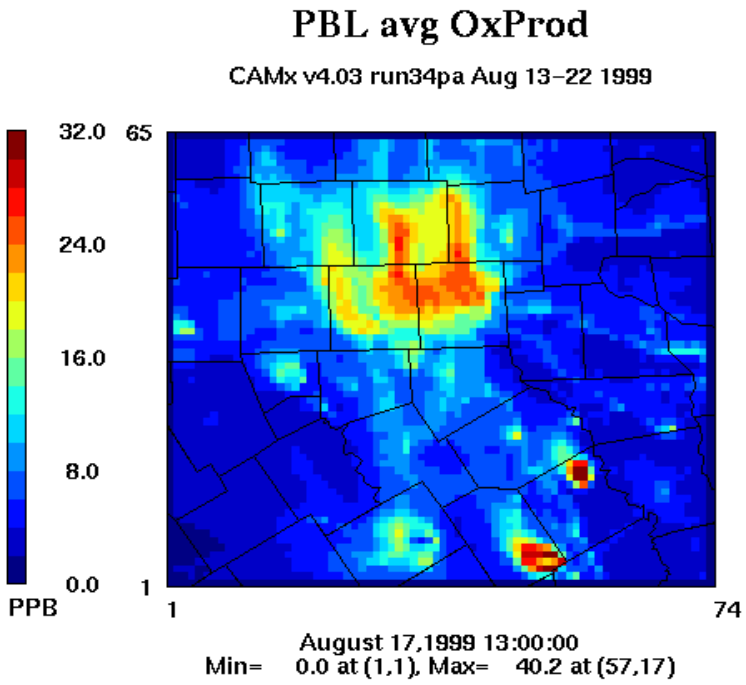
Grid Expansion



- Expanded 36-km grid
  - Include more emissions
  - Simplify boundary conditions
  - Evaluate transport from states at old boundary (e.g., FL)

Process Analysis: Ox Production

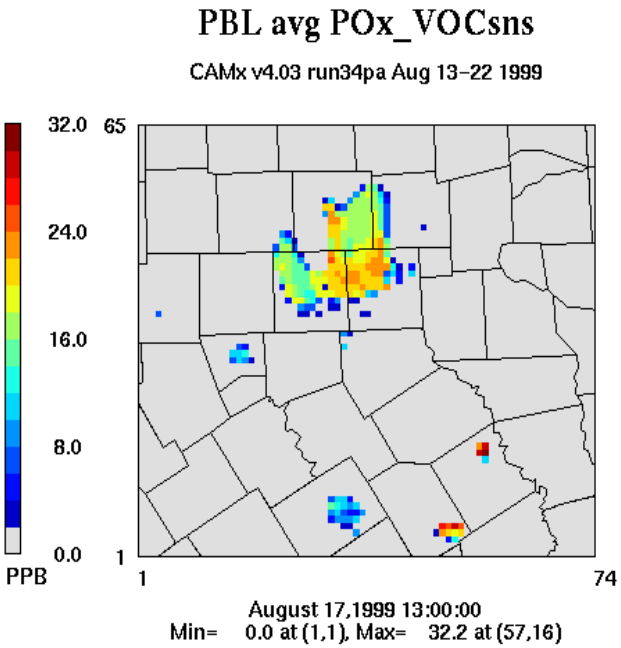


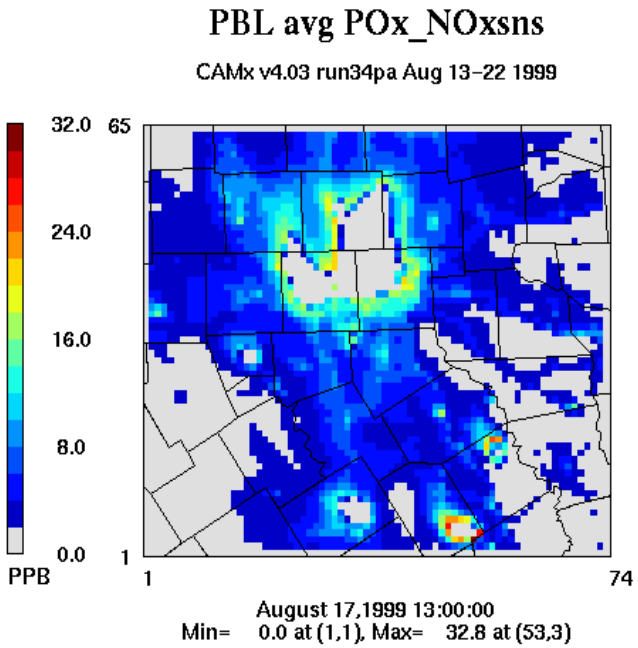


1 pm on 17 August 1999

- Ox production reveals where O_3 is produced
  - Downwind of high emission areas (urban, point source)
- PBL averages over multiple layers more representative

Process Analysis: VOC vs. NOx



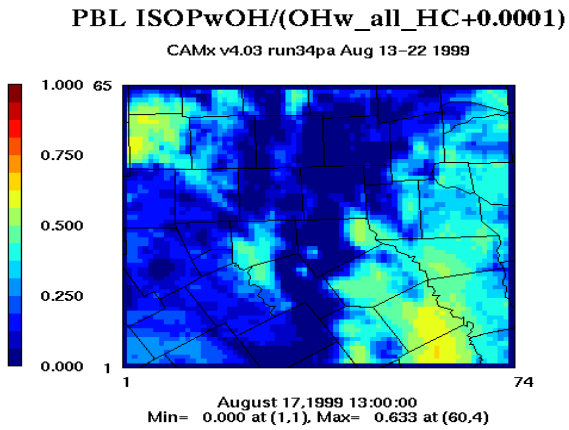


1 pm on
17 August
1999

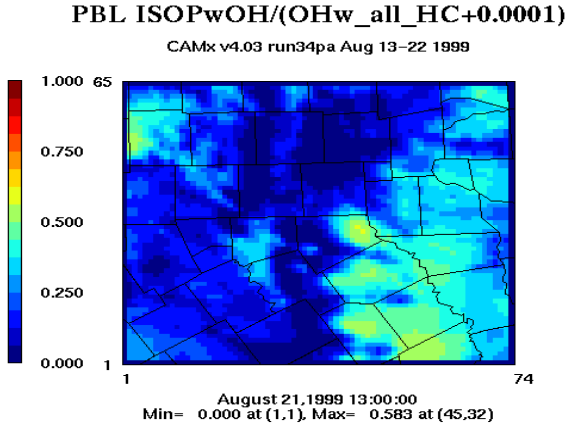
- Differentiate VOC and NOx limited areas of Ox production using instantaneous ratio of P_{H2O2}/P_{HNO3}
- Urban cores and major point sources frequently VOC limited (day-to-day variability exists)

Process Analysis: Role of Biogenics

8/17



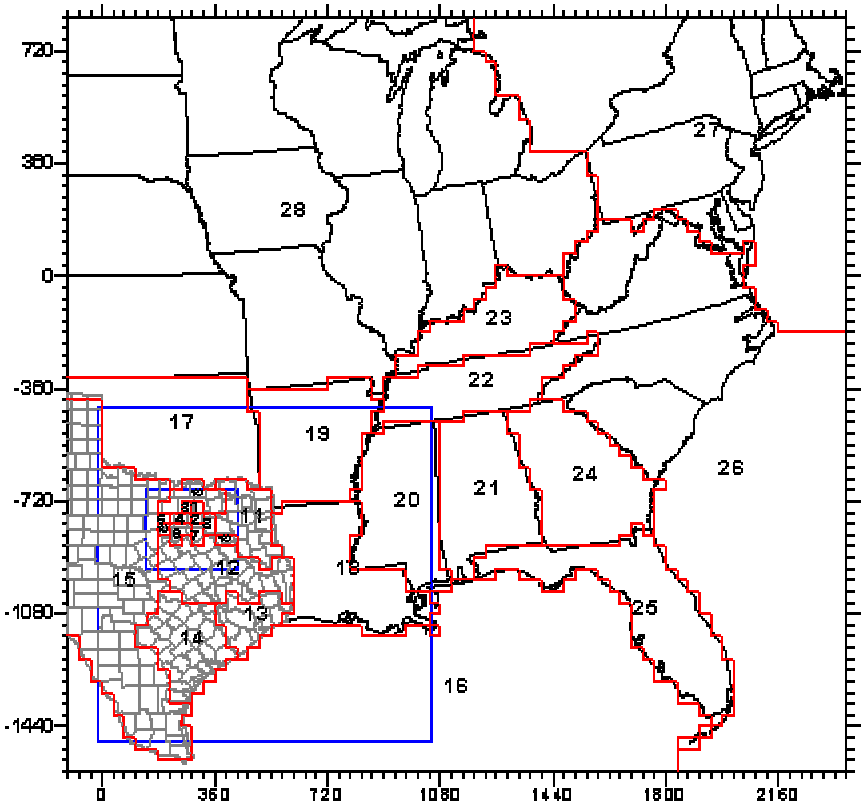
8/21



- Fraction of OH reacting with isoprene
  - Compared to all VOCs
  - Some OVOCs biogenic
  - Low biogenic influence in urban areas: landcover
- Uncertainty in urban biogenics is important
  - Difficult to characterize urban and suburban biogenics
  - Use satellite data and other available resources
  - Could influence VOC/NOx sensitivity

Updated Transport Analysis

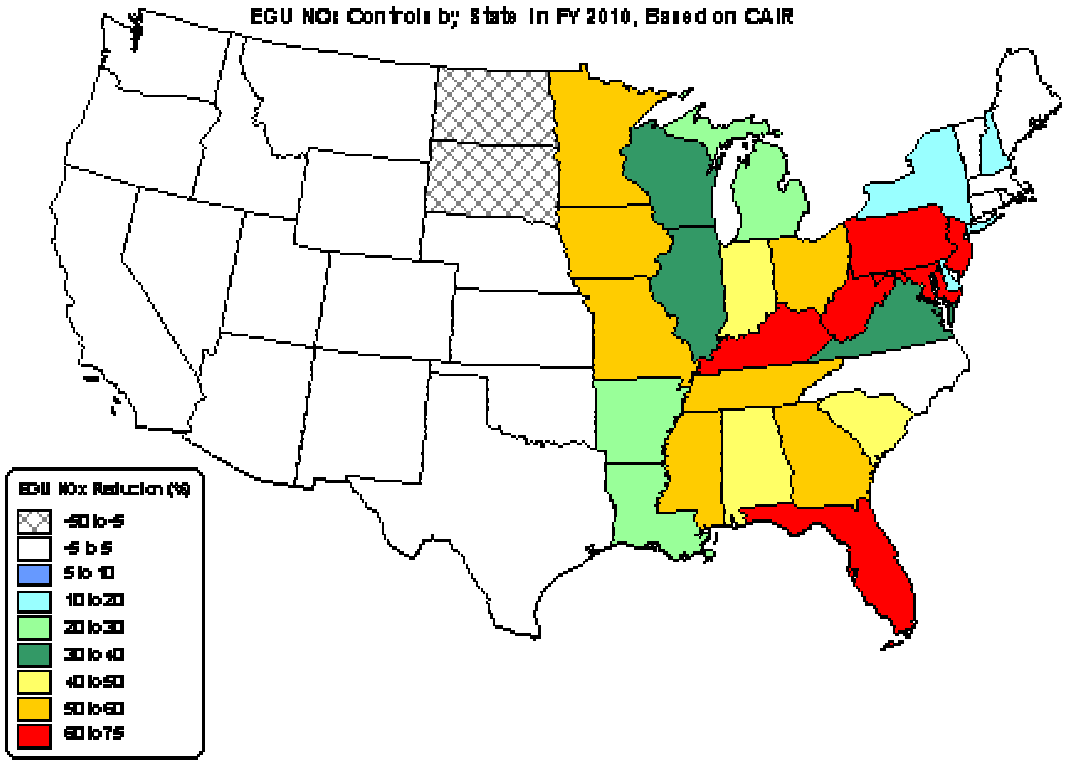
- Source regions for expanded grid transport assessment
  - Local to distant
  - Entire states of FL and GA
- Include proposed CAIR EGU NOx reductions for each state
  - States will determine specific strategies



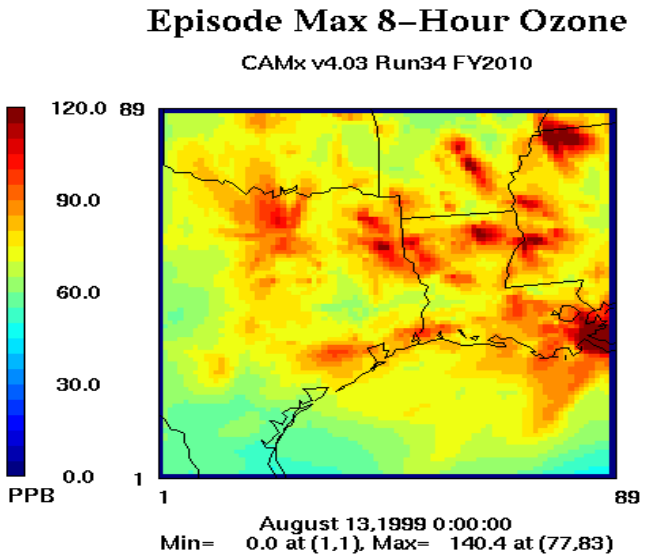
DFW 2010 Source Regions. 36 km Expanded Domain

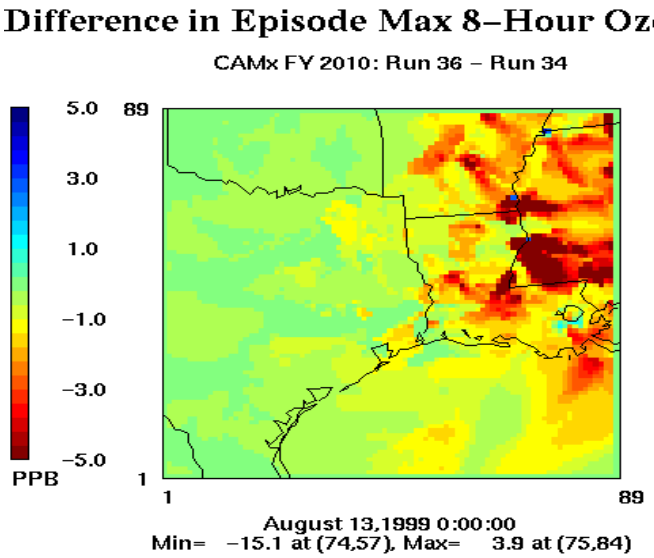
CAIR EGU NOx Reductions

- Reductions by state in 2010
  - TX 1%
  - LA 26%
  - FL and KY > 300 tons/day
  - LA, GA, TN, AL, MS > 100 tons/day



CAIR Ozone Reductions

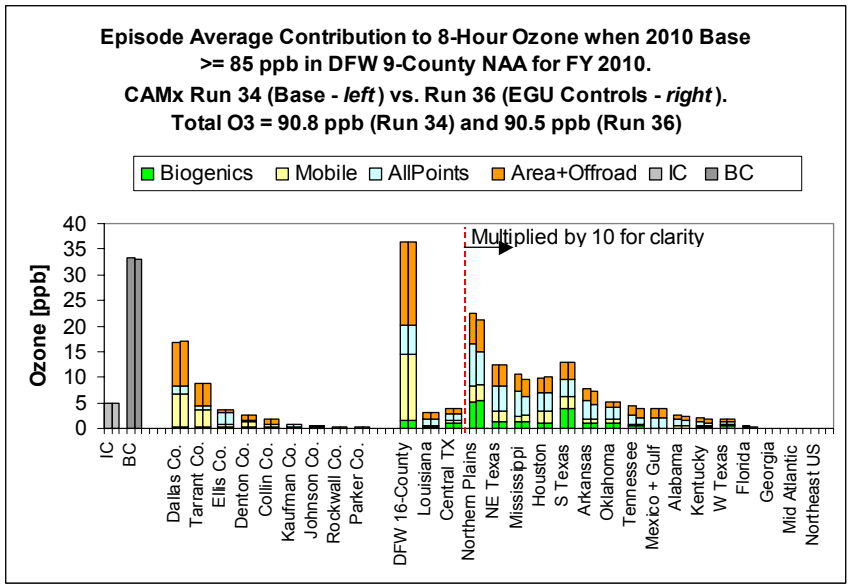


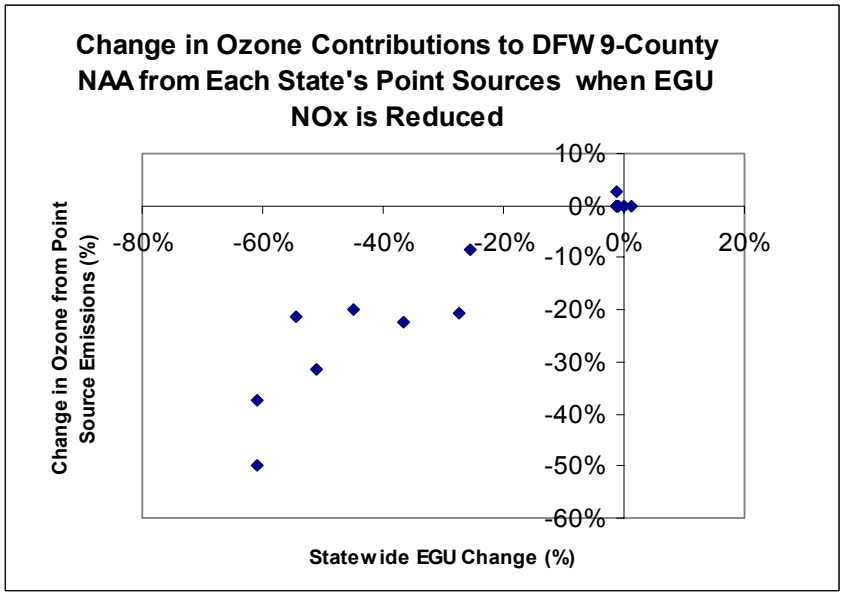


- Largest O_3 reductions occur near NOx reductions
- Also reductions in O_3transport, e.g., over Gulf
- Small benefits in DFW area
  - Strong influence of local emissions

CAIR Impact on Transport Assessment

Local contributions are most important

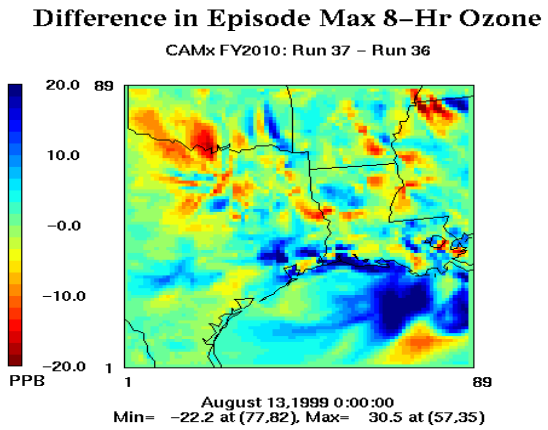


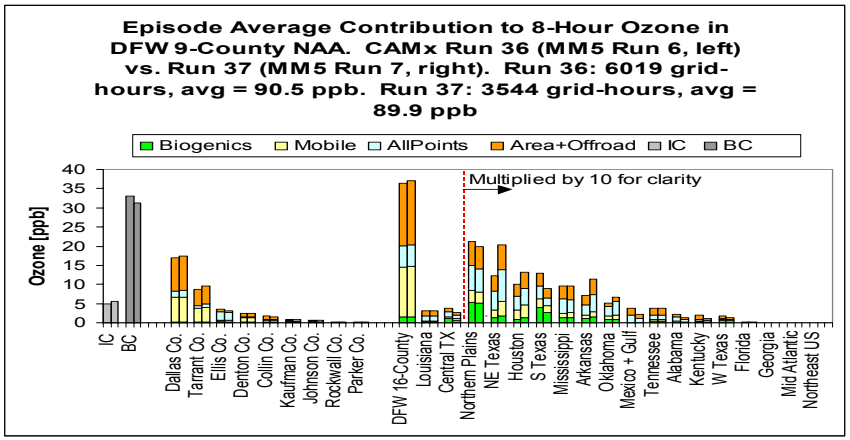


CAIR reduces point source contributions (light-blue bars) for affected source areas

Greater relative ozone reductions with greater relative emission reductions

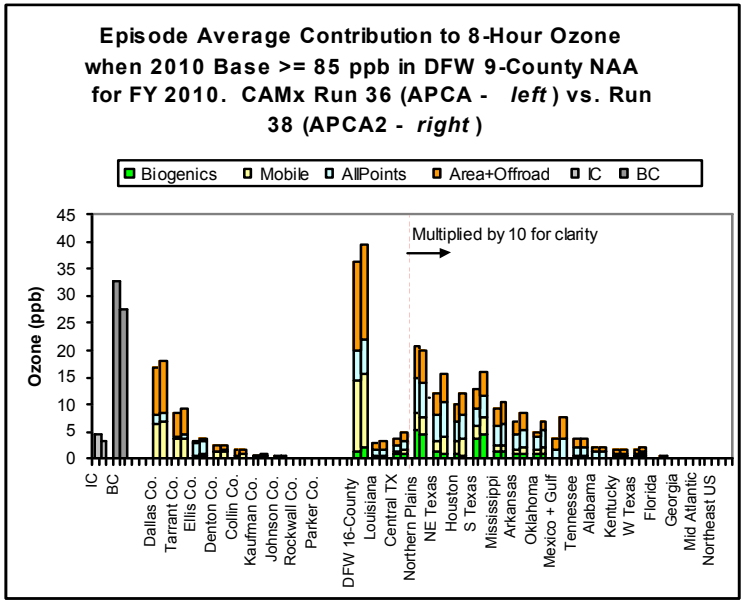
Sensitivity to MM5 Meteorology





- Changed MM5 convective scheme (KF2 to Grell)
- Ozone increases/decreases throughout domain
- Transport contributions change for several reasons
  - Upwind ozone production
  - Air transport
  - Grid cells > 85 ppb in DFW
- Overall, changes would not alter conclusions

Improved APCA Methodology



- Explicitly account for simultaneous ozone destruction and production chemistry
  - APCA2
- Greater destruction of ozone contributions over multi-day transport
- Larger contributions from local and nearby areas/states

Recommendations

- Refine and extend the H36 control technology assessment
- Improve the DFW urban/suburban biogenic emission inventory
  - Satellite data
  - MEGAN model and update emission factors?
- Analyze transport assessment results within Texas
  - Source contributions and control opportunities