Emissions from East Texas Power Plants

J.W. Peischl[1,2], T.B. Ryerson[2], J.S. Holloway[1,2], K.C. Aikin[1,2], G.J. Frost[1,2], F.C. Fehsenfeld[1,2]

[1] CIRES, University of Colorado, Boulder, CO
[2] NOAA, Earth Systems Research Laboratory, Chemical Sciences Division, Boulder, CO

Purpose:

- To assess emission ratios from Big Brown, Knox Lee, Martin Lake, Monticello, Twin Oaks, W. A. Parish, and Welsh power plants using P-3 measurements.
- To compare these emission ratios to those calculated from Continuous Emission Monitoring Systems (CEMS) installed at each plant.

Data and analysis information:

- 2000 data from 7 flights in August - September
- 2006 data from 14 flights in September - October
- P-3 data are 1-second averages:

  CO_2: non-dispersive infra-red absorption using a modified LICOR with a precision of better than ±0.4 ppmv for both years.

  NOy: NO/O_3 chemiluminescence after catalytic conversion to NO on a 300°C gold surface in the presence of 1.5% CO; precision ranging from ±0.1 – 0.5 ppbv for both years.

  SO_2: pulsed UV fluorescence; ±0.3 ppbv for both years

  CO: vacuum UV fluorescence; ±1 ppbv for both years

- Brief times (<1 hour) between emission and measurement minimized chance for differential losses of these directly emitted species.
- Least-squares fit parameters from two-sided linear regressions, weighted by each instrument's precision.
- Total reported uncertainty in emission ratios from P-3 measurements incorporates fit uncertainties *and* calibration uncertainties of the two species plotted.

Assumptions:

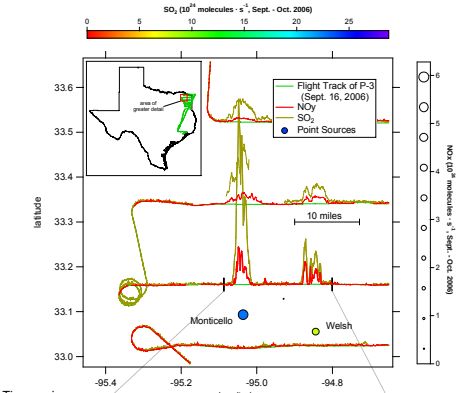
- Dilution and mixing affects all species equally, so that emission ratio is preserved during transport.
- All NOx ($NO + NO_2$) emitted from power plants was detected downwind as NOy enhancements.

Conclusions:

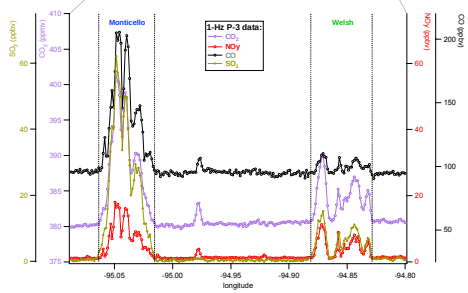
- **P-3 data and CEMS inventories show NOx emissions from several electric utility power plants have decreased substantially (25 to 80%) since 2000**
- **Annual SO_2 emissions appear to be largely unchanged since 2000**
- **Large and apparently continuous CO emissions from the Big Brown, Monticello, and Martin Lake plants have been observed on each of four study days in 2000 and 2006**
  these CO emissions, if continuous, would exceed annual inventory values for Big Brown and Martin Lake
- **W.A. Parish emits large amounts of CO on an intermittent basis**
  these CO emissions may still be consistent with inventory values
- **Emissions ratios between P-3 and hourly CEMS agree to within an average of ±10%**

Determining Emission Ratios from Airborne Data

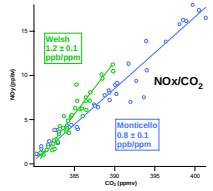
Example: P-3 data from Sept. 16th, 2006 (similar to Sept. 3, 2000 flight track, Nicks et al., 2002)

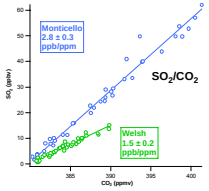


Time series of P-3 data:



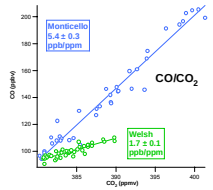
Calculated emissions ratios from P-3 data:





- slopes give estimate of emissions ratio in molecules X/molecules CO2

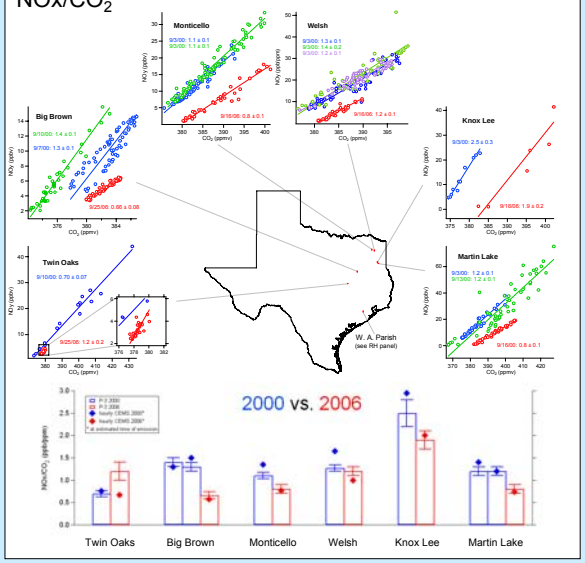
- 2-sided fits are weighted by the uncertainties of each measurement



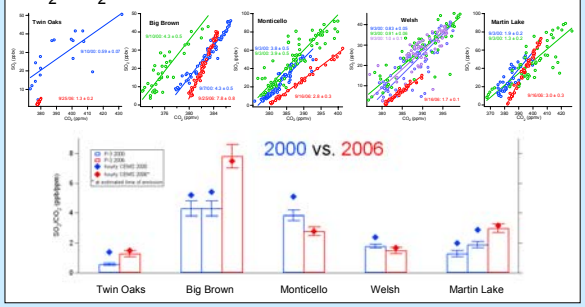
emission ratio		NOx/CO_2	SO_2/CO_2	CO/CO_2
Monticello	P-3	0.8 ± 0.1	2.8 ± 0.3	5.4 ± 0.3
	Hourly CEMS	0.8	2.8	
Welsh	P-3	1.2 ± 0.1	1.5	1.7
	Hourly CEMS	1.0	1.7	

Emission changes between 2000 and 2006

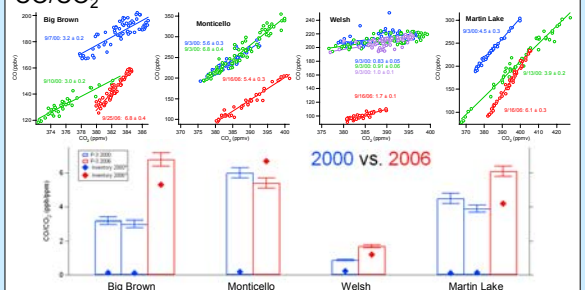
NOx/CO_2



SO_2/CO_2



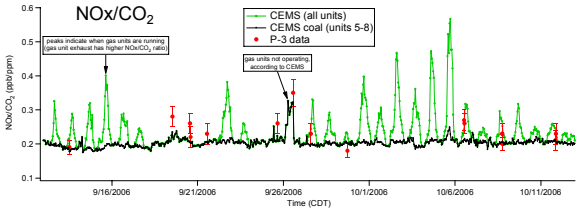
CO/CO_2



* Inventory numbers were calculated by multiplying 1999 and 2004 TCEQ point source emissions inventory CO/NOx ratios by 2000 and 2006 hourly CEMS NOx/CO_2 ratios

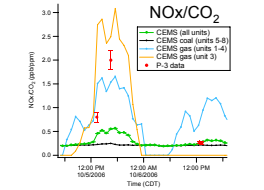
W. A. Parish Power Plant

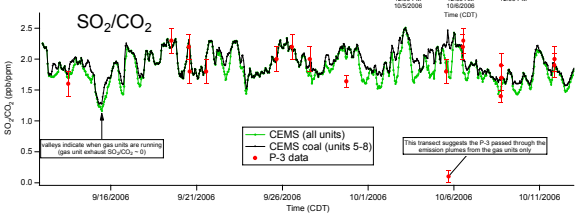
Comparing emission ratios calculated from hourly CEMS to those from P-3 data:



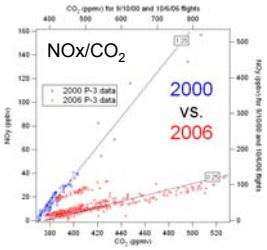
A time series of hourly Parish emission ratios from CEMS data is plotted above, with emission ratios calculated using P-3 data included for comparison. The two generally agree within the estimated uncertainties of each data set.

Two NOx/CO_2 ratios estimated from P-3 data greatly exceeded the CEMS ratios calculated using hourly data for all 8 units at Parish. The graph to the right suggests the P-3 sampled a plume dominated by emissions from the 4 gas units at Parish. The gas turbine stacks are located about half a mile from the coal boiler stacks, and are roughly half as tall.



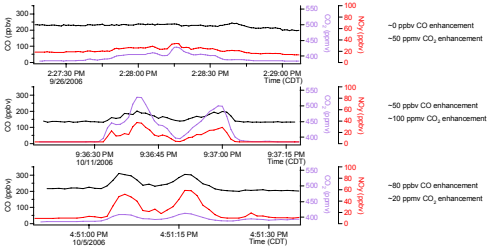


W.A. Parish NOx emissions have decreased by 80% since 2000:



- 2000: 4 P-3 transects average 1.25
- 2006: 16 P-3 transects average 0.25
- NOx reduction measured by P-3: 80%
- NOx reduction according to annual CEMS: 79%

W.A. Parish emissions of CO are highly variable in time:



References: D. K. Nicks Jr, et al., *J. Environ. Monit.*, 2003, **5**, 35-39.

Contact: jeff.peischl@noaa.gov