# Secondary Organic Aerosol Formation in a CO-Producing Coal-Fired Power Plant, a non CO-Producing one and an Urban Plume

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## CO-Producing Power Plant (Martin Lake, TX)

Figure 1: Martin Lake Power Plant

Martin Lake is a steam electric station, located in Rusk county, Texas. It has a three-unit lignite-fueled power generation station. At its completion, Martin Lake was one of the largest lignite-powered power stations in the world. Martin Lake uses a mixture of sub-bituminous and lignite coal.

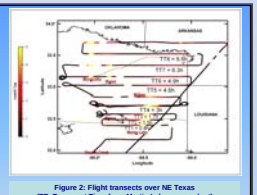


Figure 2: Flight transects over NE Texas (TT=Transport Time from Martin Lake power plant)

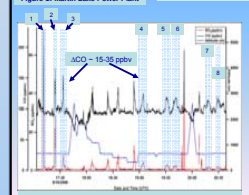



Figure 3: CO and $SO_2$ peaks for Martin Lake plume

On September 16, 2006, as part of the TexAQS/GoMACCS study, the NOAA WP-3D airplane flew over northeastern Texas to collect information from plumes generated by power plants in this area.

A plume generated by Martin Lake power plant has been studied. The plume has been transported for less than 7 hours and 7 transects from this plume have been highlighted.

To differentiate peaks and backgrounds of the plume, peaks based on SO2 peak during period SO2 20% above baseline. At least 2 minutes of data before the peak as the background value.

## Non CO-Producing Power Plant (Conesville, OH)

Figure 8: Conesville Power Plant

Conesville power plant is a steam/coal electric generation station, located in Coshocton County, Ohio.

Conesville uses bituminous coal for power generation.

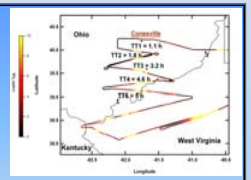


Figure 9: Flight transects over Ohio (TT=Transport Time from Conesville power plant)

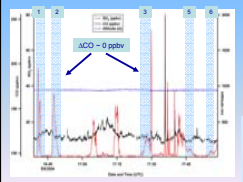



Figure 10: CO and $SO_2$ peaks for Conesville plume

On August 6, 2004, as part of the NEAQS-ITCT study, the NOAA WP-3D airplane flew over Ohio Valley to collect information from plumes generated by power plants in this area.

A plume generated by Conesville power plant has been studied. The plume has been transported for about 5 hours and 5 transects from this plume have been highlighted.

When Comparing figures 3 and 10, it is evident that Martin Lake power plant produces CO, whereas the Conesville power plant does not.

## Urban Plume from Houston

Figure 14: The city of Houston

On September 27, 2006 the NOAA WP-3D flew over the city of Houston. The transects in figure 15 are highlighted by CO concentrations to illustrate the Houston urban plume. However, on the western edge of this plume power plant plumes from Parish and Wharton power plants are present.

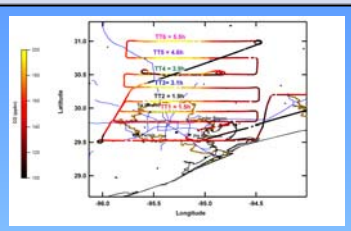


Figure 15: Flight transects over Houston

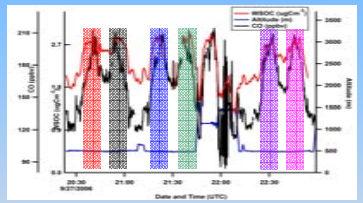


Figure 16: CO and WSOC peaks for Houston urban plume

Figure 16 shows the WSOC and CO peaks corresponding to the chosen transects for the Houston plume. The transects have been color coded for ease of recognition.

Figure 17 demonstrates the correlation and slopes of WSOC and CO for the transects over the Houston plume. The values used are a combination of peaks and backgrounds for each transect as shown in figure 16.

The slope increases slightly as the plume ages, the same trend is observed in the correlation coefficients for WSOC and CO.

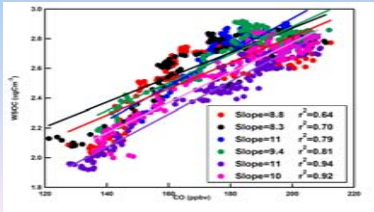
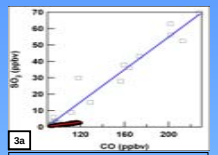
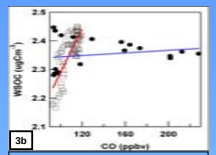



Figure 17: CO and WSOC correlation for Houston transects

## The Evolution of Martin Lake Plume



3a



3b

T~1hrs ($R^2$=0.96, Slope=0.49)
T~5hrs ($R^2$=0.79, Slope=0.08)

T~1hrs ($R^2$=0.036, Slope=0.0002)
T~5hrs ($R^2$=0.60, Slope=0.007)

Figure 3a Displays the correlation between CO and $SO_2$ in the beginning of the plume vs the same plume as it ages. Figure 3b shows the same thing for CO and WSOC. $SO_2$ decreases with plume age while WSOC increases.

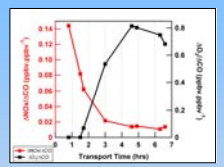


Figure 4: Photochemistry in the Plume An in crease of $O_3$ with plume age is Observes, as the titration of $NO_x$ slows.

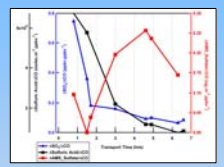


Figure 5: A decrease in $SO_2$ and $H_2SO_4$ and an increase in AMS_Sulfate values as The plume ages.

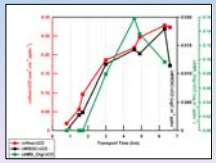


Figure 6: The volume, WSOC and Organic Aerosols increase as the plume ages.

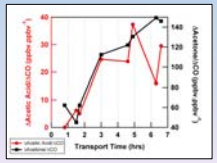


Figure 7: Oxygenated VOC-s increase as the plume age increases

## Comparison of Martin Lake and Conesville

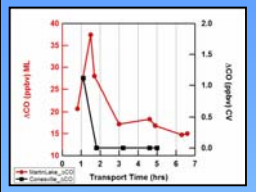
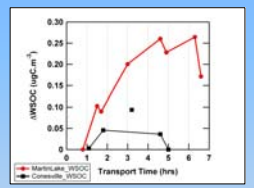
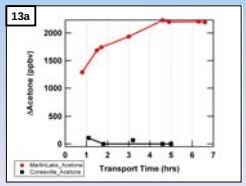


Figure 11: As previously observed, Martin Lake has high concentrations of CO which decrease as the plume ages (dilution of the plume), whereas the CO concentrations in the Conesville plume are considerably low.

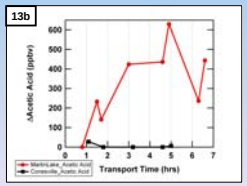
Figure 12: WSOC production is observed in the Martin Lake plume. The change in the WSOC values is about 0.3 ugCm-3 which is roughly 8% of the average WSOC concentrations throughout the transects over Martin Lake.



13a



13b



Figures 13a and 13b: There is little change in Oxygenated VOC concentrations, such as Acetone and Acetic Acid, in the Conesville plume. Whereas the change in the Martin Lake plume is about 1250 ppbv and 300 pbbv for Acetone and Acetic Acid, respectively

## Martin Lake and Houston Plumes in Perspective

The WSOC production in Martin Lake and Houston plumes is similar to that of other plumes that have been previously studied.

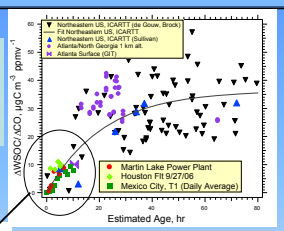



Figure 18: Change in WSOC over change in CO for various plumes

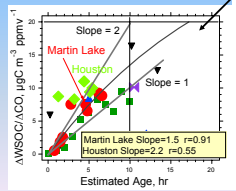



Figure 19: Close-up of Figure 18

WSOC was initially formed at ~ 1-2 ugCm-3 per ppm emitted CO per hour (Data is collected under clear sky conditions)