

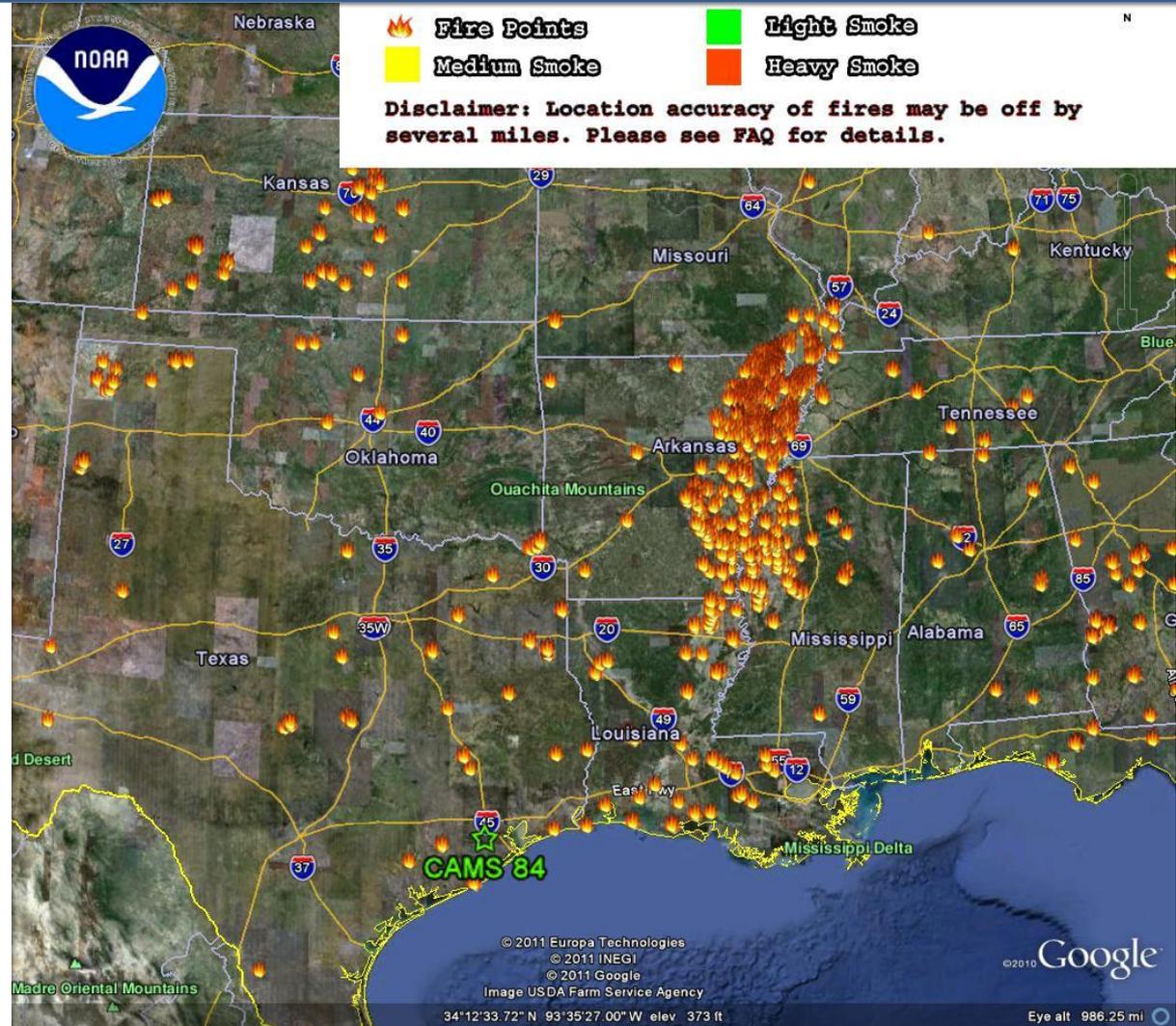
ESTIMATED IMPACTS OF WILDFIRES ON OZONE LEVELS IN HOUSTON

Albert Hendler
URS Corporation

October 19, 2011

Objective

Estimate impacts from wildfires on Houston daily maximum ozone levels for episodes during August – October 2010 that may have a regulatory consequence



Background

- Transported ozone contributes to high levels in Houston even on days that are favorable for accumulation of locally produced ozone
 - Final Rapid Science Synthesis Report: Findings from the Second Texas Air Quality Study (TexAQS 2006), August 31, 2007
- Burning biomass from as far away as Alaska and Canada has contributed measurably to ozone levels in Houston
 - Morris, G., et al. (2006) Alaskan and Canadian forest fires exacerbate ozone pollution over Houston, Texas on 19 and 20 July, 2004, *J. Geophys. Res.*, 111, D24S03
- Wildfires in the Pacific Northwest contributed to high ozone levels in Houston during the 2006 TexAQS
 - McMillan, W., et al. (2010) An observational and modeling strategy to investigate the impact of remote sources on local air quality: A Houston, Texas case study from the Second Texas Air Quality Study (TexAQS II), *J. Geophys. Res.*, 115, D01301
- High regional ozone levels in east Texas are often associated with transport from the northeast (i.e., the direction of the lower MS River valley)
 - Final Rapid Science Synthesis Report: Findings from the Second Texas Air Quality Study (TexAQS 2006), August 31, 2007

Fires in the Lower Mississippi River Valley Impacted Houston during the 2006 TexAQS



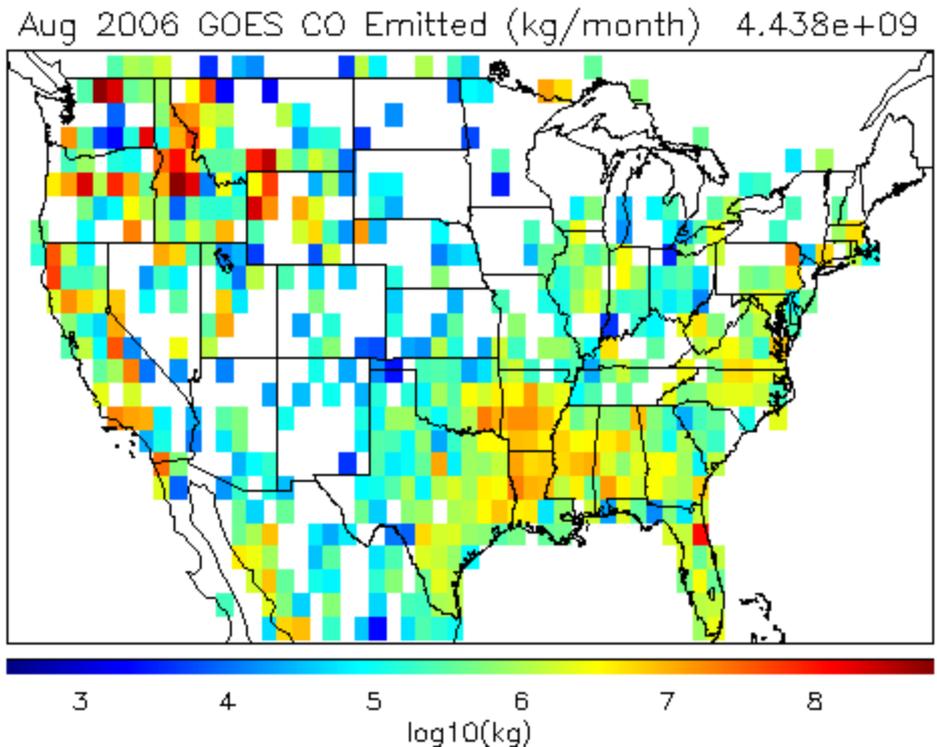
Satellite Based Characterization of influences of agricultural and wildfires on Continental US O₃ and CO transport during TexAQS II

R. Bradley Pierce (NOAA/NESDIS),
Jassim Al-Saadi (NASA/LaRC),
Chieko Kittaka (SSAI),
Shobha Kondragunta (NOAA/NESDIS),
Bryan Lambeth (TCEQ)

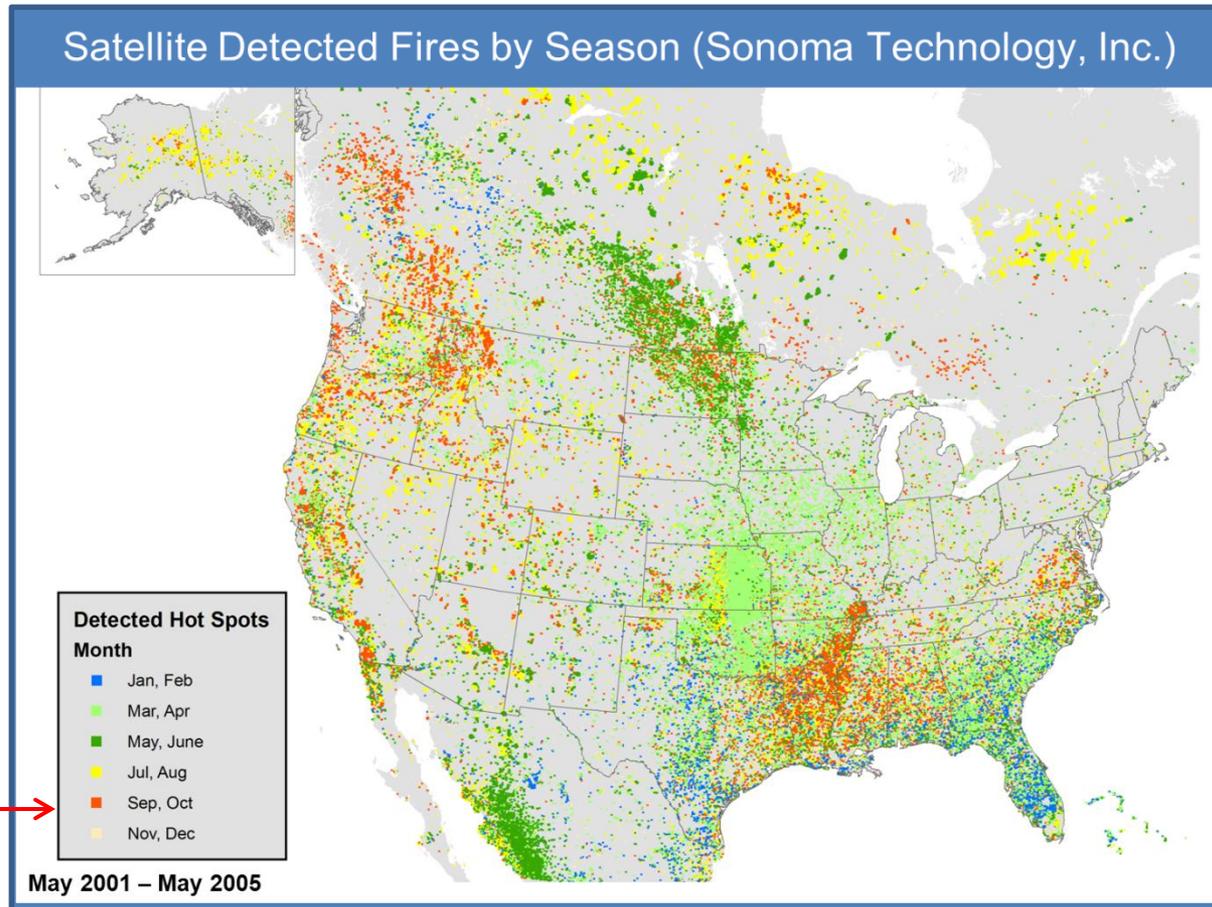
Presenter: R. Bradley Pierce
Principal Findings Data Analysis Workshop
TEXAQS II/GoMACCS
May 29-June 1, 2007



“Southwestward transport of emissions from biomass burning in the lower Mississippi Valley (LA, MS) and Southeastward transport of emissions from Pacific Northwest wildfires contributed to enhanced CO mixing ratios at the Houston Deer Park TCEQ site on Aug 30-Sep 04, 2006.”

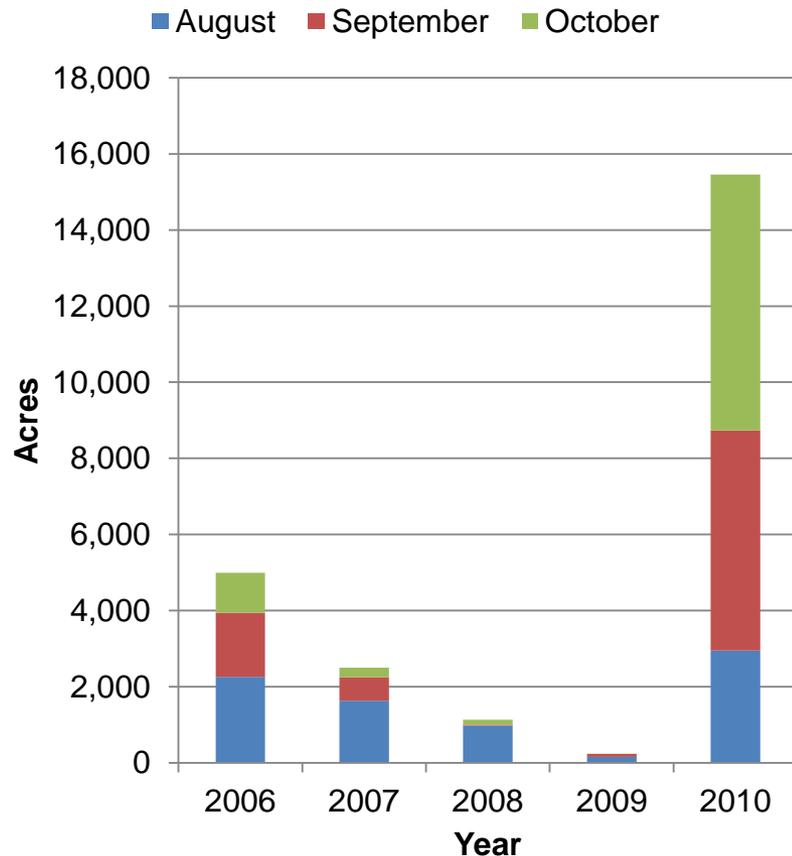


Fires are Frequently Detected in the Lower Mississippi River Valley during September-October



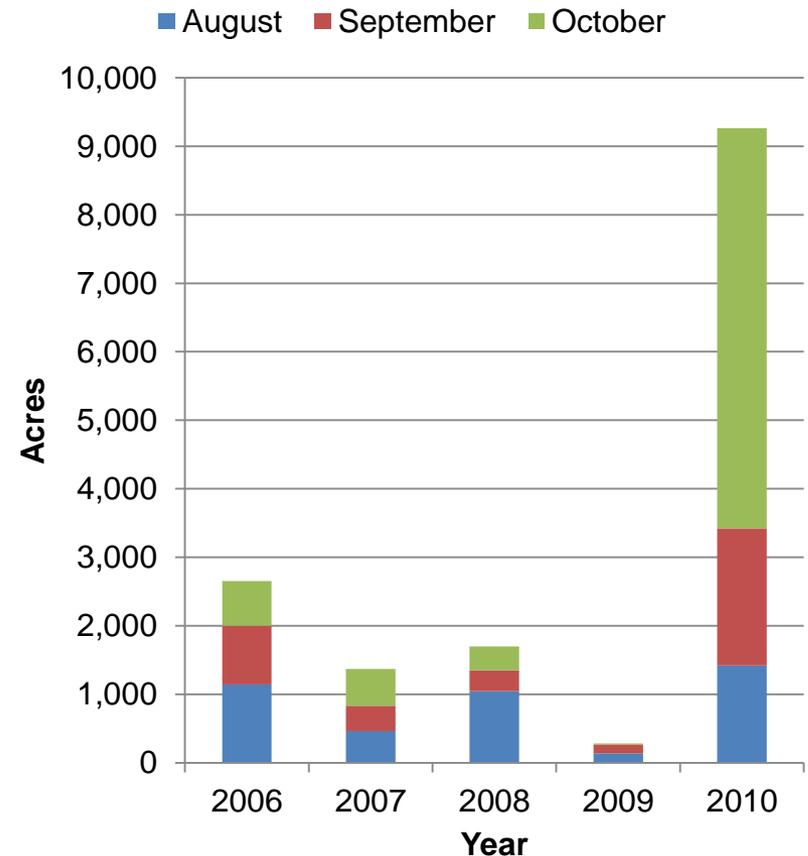
2010 was an Exceptionally Active Year for Wildfires in the Lower Mississippi River Valley

Arkansas Fires by Month



Source: Arkansas Forestry Commission

Louisiana Fire Acres by Month



Source: Louisiana Agriculture and Forestry Commission

Approach

- Select case studies that have potential regulatory significance
- Were there fires upwind?
- Did the fires produce smoke?
- Were the wind conditions favorable for transporting the smoke to southeast Texas?
- Was the smoke detected in southeast Texas?
- Did high ozone levels correlate with the presence of smoke?
- Were ozone levels in the air approaching Houston higher than in the air approaching other Texas cities that were not in the path of the fire emissions plume?
- How much of the ozone at Houston's upwind boundary can be attributed to wildfires?

Resources

- NASA Hazard System Fire and Smoke Product Archives
 - <http://www.osdpd.noaa.gov/ml/land/hms.html>
- NOAA HYSPLIT - Hybrid Single Particle Lagrangian Integrated Trajectory Model
 - <http://ready.arl.noaa.gov/HYSPLIT.php>
- EPA AIRNow-Tech
 - <http://airnowtech.org/index.cfm>
- University of Wisconsin MODIS Today
 - <http://ge.ssec.wisc.edu/modis-today/>
- USDA Fire Data in Google Earth
 - <http://activefiremaps.fs.fed.us/googleearth.php>
- NASA CALIPSO LIDAR Browse Images
 - http://www-calipso.larc.nasa.gov/products/lidar/browse_images/show_calendar.php
- NASA GIOVANNI AIRS Online Visualization and Analysis
 - <http://disc.sci.gsfc.nasa.gov/giovanni>
- EPA AQS Data Mart
 - <http://disc.sci.gsfc.nasa.gov/giovanni>
- TCEQ
 - http://www.tceq.texas.gov/agency/data/ozone_data.html
- NOAA IDEA
 - <http://www.star.nesdis.noaa.gov/smcd/spb/aq/index.php>
- University of Maryland Baltimore County Smog Blog
 - <http://alg.umbc.edu/usaq/>

Case Studies and Rational

Date	HGB Peak 8-Hr Ozone	HGB Peak Site	No. HGB Sites Above 75 ppb	No. Texas Sites Above 75 ppb
8/27/10	88 ppb	CAMS 84	5	24
9/30/10	88 ppb	CAMS 84	10	11
10/1/10	86 ppb	CAMS 84	6	6
10/7/10	92 ppb	CAMS 84	14	23

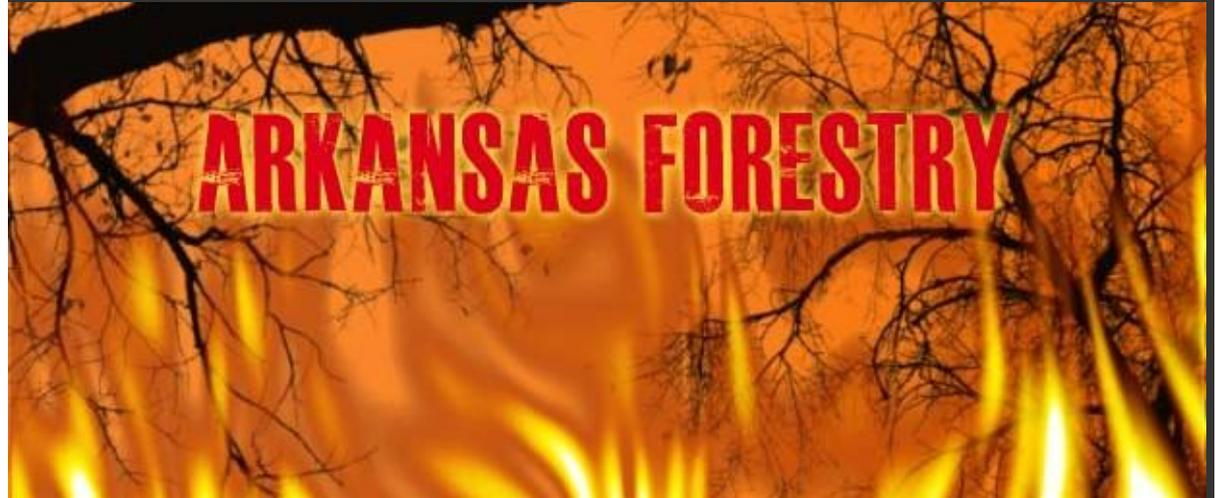
- Ozone levels were regionally elevated
 - Each case study day was part of a multi-day/multi-site episode
- Potential regulatory consequence
 - CAMS 84 (Manvel Croix Park) had highest HGB Design Value for 2008-2010 – 84 ppb
 - 8-hr max. was above the 2008-2010 design value of 84 ppb
 - 8-hr max. was above the level of the 1997 standard (84 ppb)

Description of the Fires

During August – October 2010 thousands of acres in AR, LA, and MS were burned by wildfires as moderate to severe drought conditions persisted throughout the region. States of Emergency were declared by the Governors of LA and MS. Open burning was banned in all three states.

Arkansas Forestry Reports Increases In Wildfires

– November 10, 2010 Posted in: [Featured](#), [Headline](#), [News & Events](#)



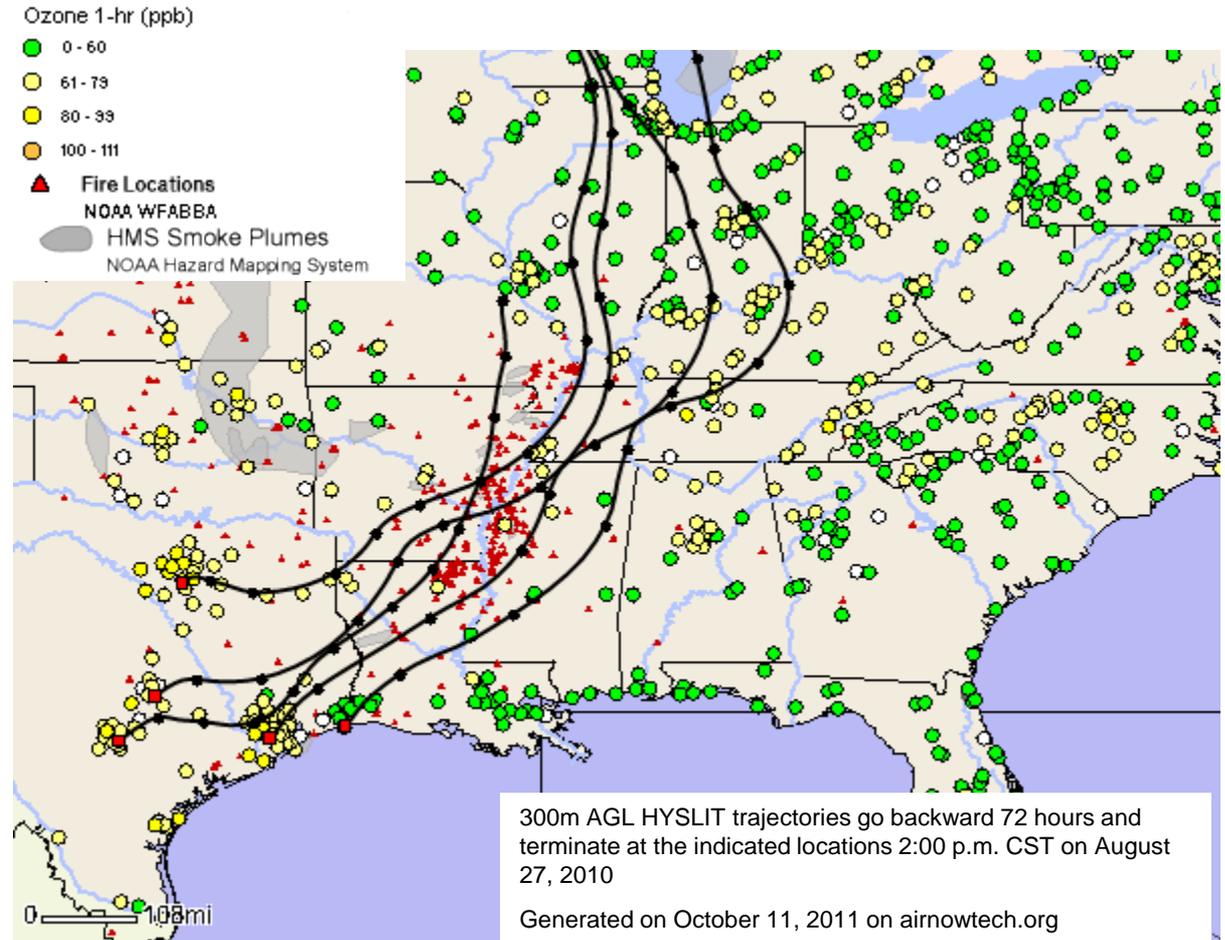
Dry conditions throughout much of the state has caused a significant increase in wild land fire activity as compared to previous years in Arkansas. According to the Forestry website over 30,000 acres have burned between January 1st and November 9th 2010, compared to just 16,000 acres in 2009.

23 counties in Arkansas are currently under a “Burn Ban” as of November 10th. Lawrence County is not under a ban currently but all surrounding counties are at this time. Burn Ban information may be obtained at www.arkfireinfo.org.

Lawrence County is one of over twenty counties in the “High” wildfire danger zone according to the Arkansas Forestry Commission.

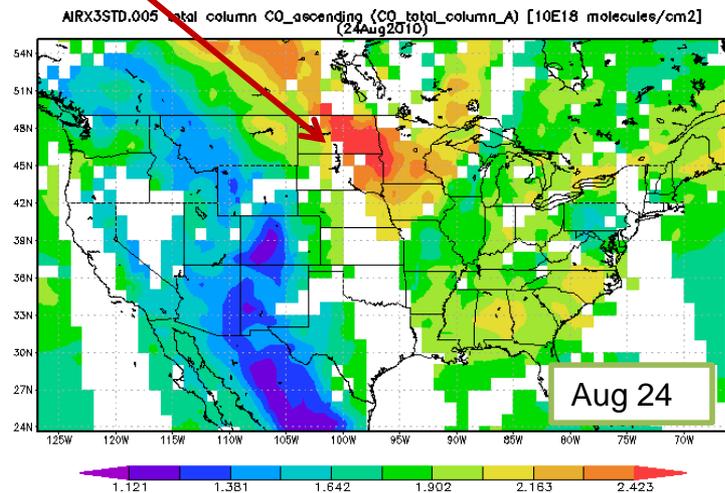
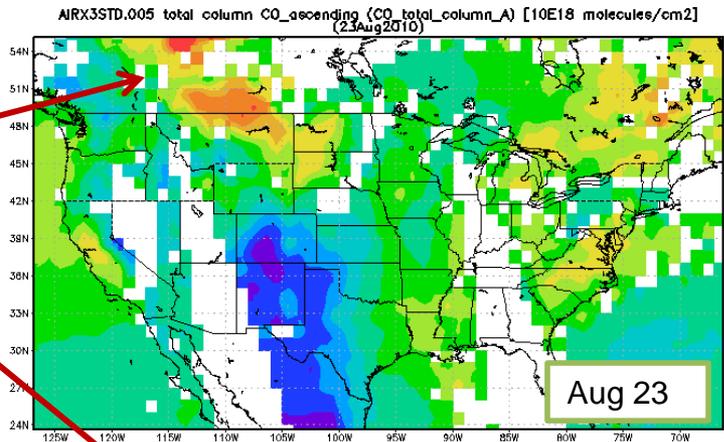
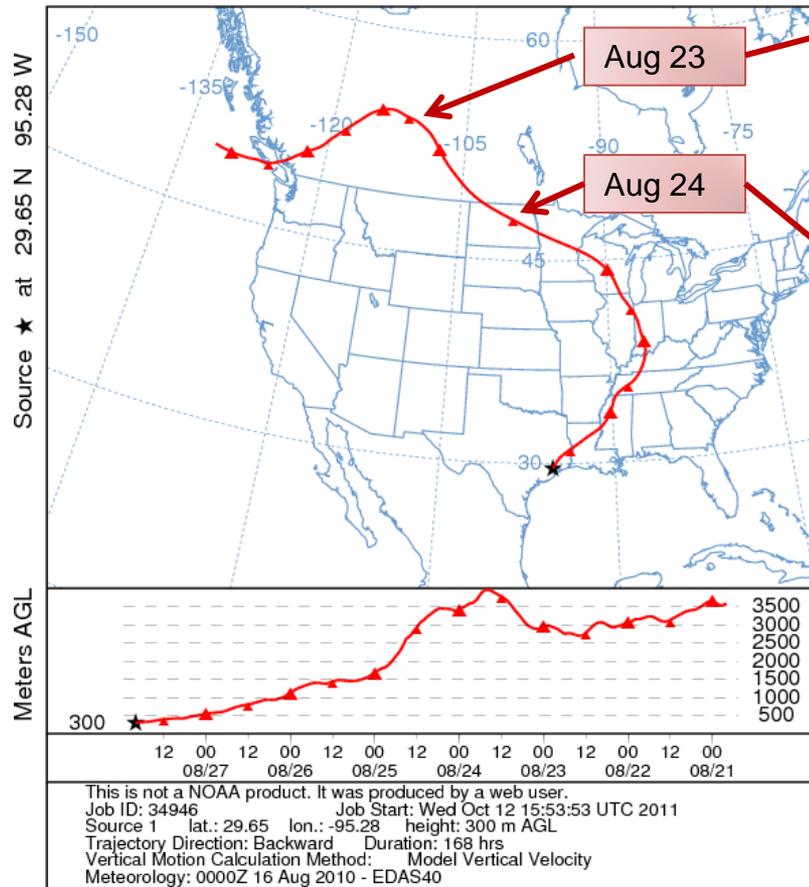
August 27, 2010 Backward Trajectories Pass through the Lower MS River Valley

Backward air trajectories from DFW, AUS, SAT and HGB converged near the fires as 24 monitors in central and east Texas recorded 8-hour average ozone levels above 75 ppb. Ozone levels exceeded 75 ppb at sites in DFW, AUS, SAT, and HGB during this regional event. BPA trajectory passed through central Mississippi, south of the fires as ozone levels there remained comparatively low.



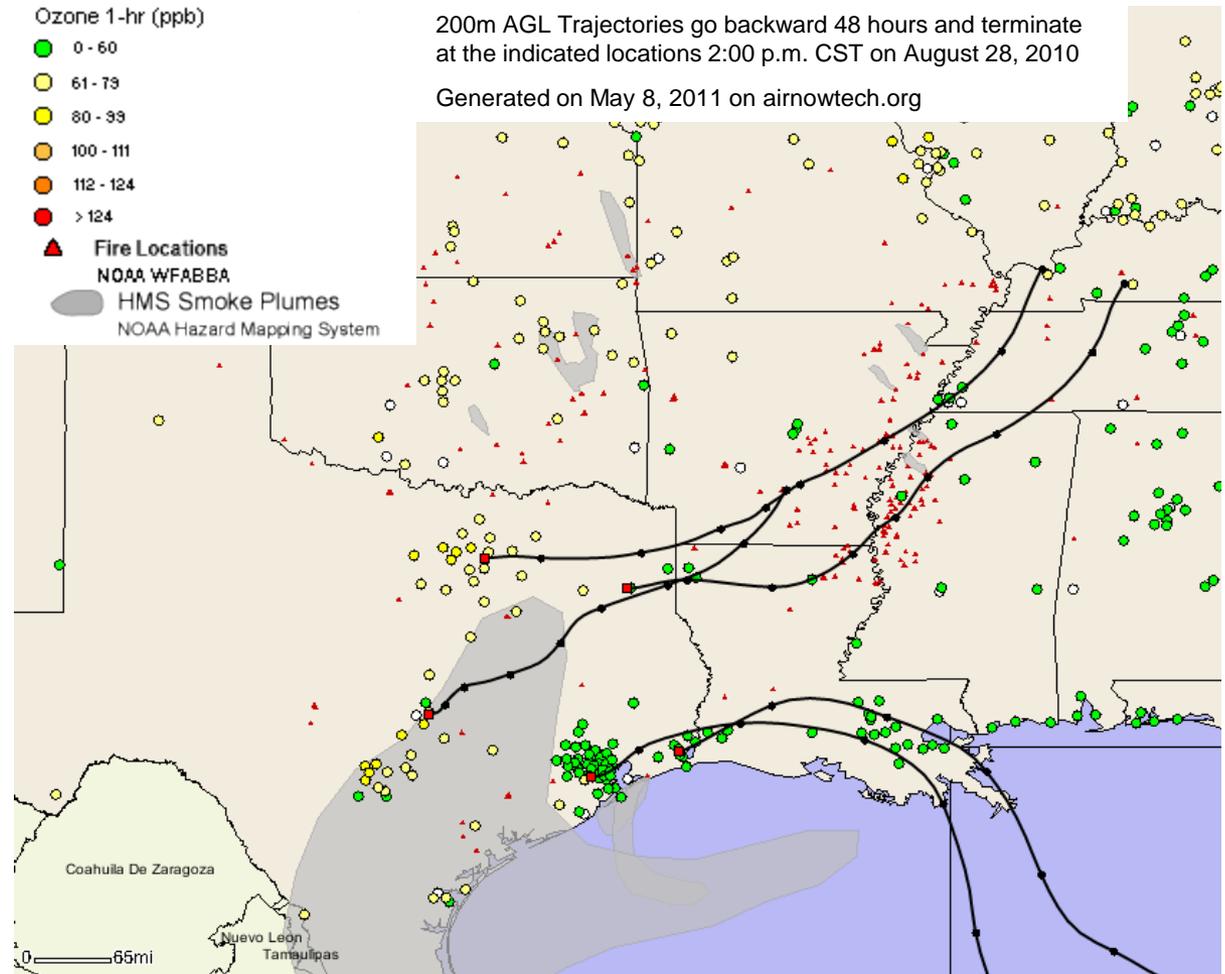
Backward Trajectories Also Pass Through Regions of High CO from Canadian Wildfires

NOAA HYSPLIT MODEL
 Backward trajectory ending at 2000 UTC 27 Aug 10
 EDAS Meteorological Data



August 28, 2010 Back Trajectories Curved to the South as Ozone Levels Receded

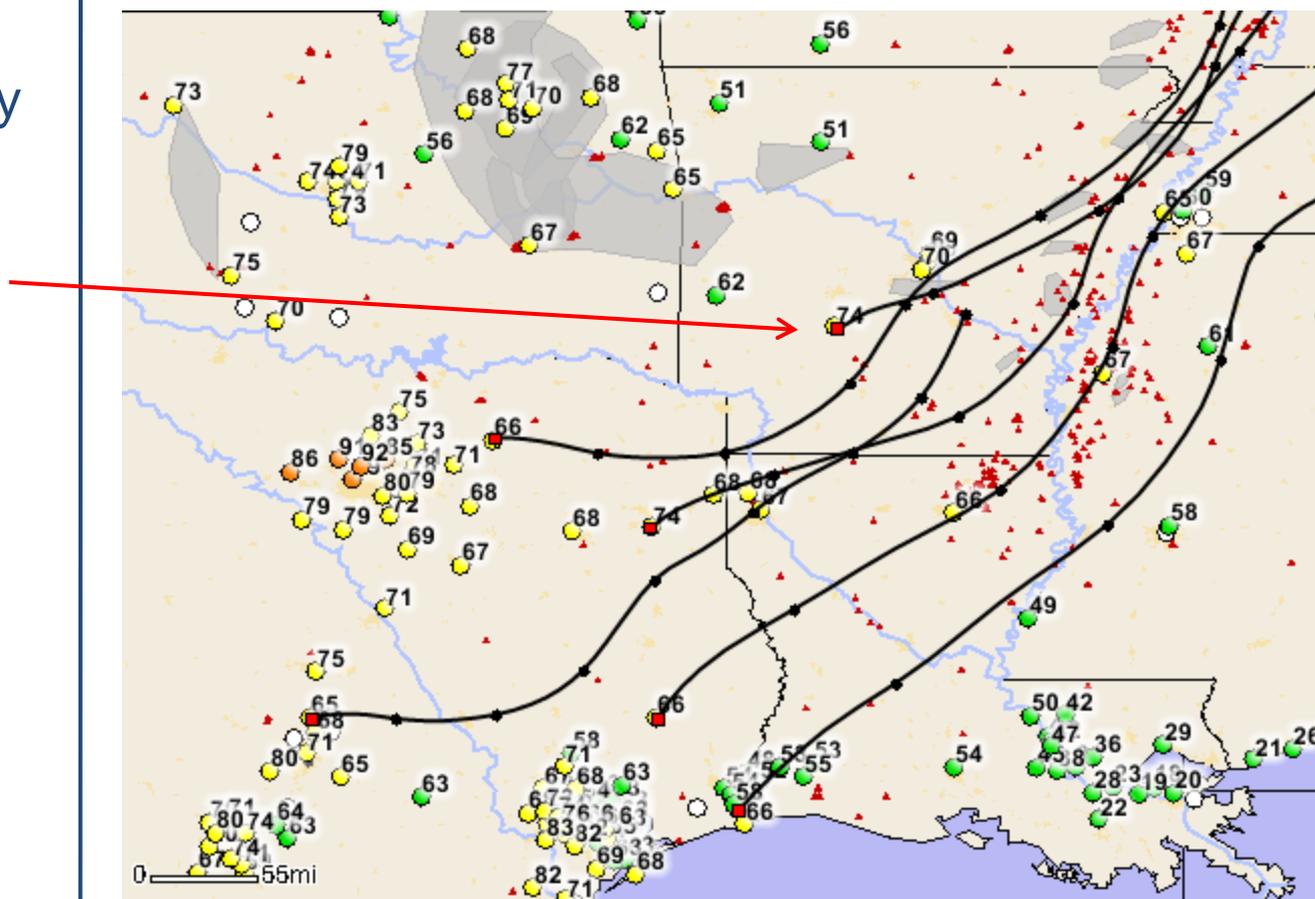
Trajectories terminating over DFW and AUS pass through the Lower Mississippi River Valley as daily maximum 8-hour ozone levels exceeded 75 ppb at 15 sites in central and north Texas. Smoke plumes over AUS and SAN were detected by the NOAA Hazard Mapping System. Trajectories drawn backward from HGB passed south of the fires and ozone levels were comparatively low.



8-Hour Average Ozone was Elevated all Along the Back Trajectory

The maximum 8-hour ozone average at the Caddo Valley, AR CASTNet site was the 3rd highest of the year (74 ppb)

Daily Maximum 8-Hour Ozone Starting at 11:00 AM CST



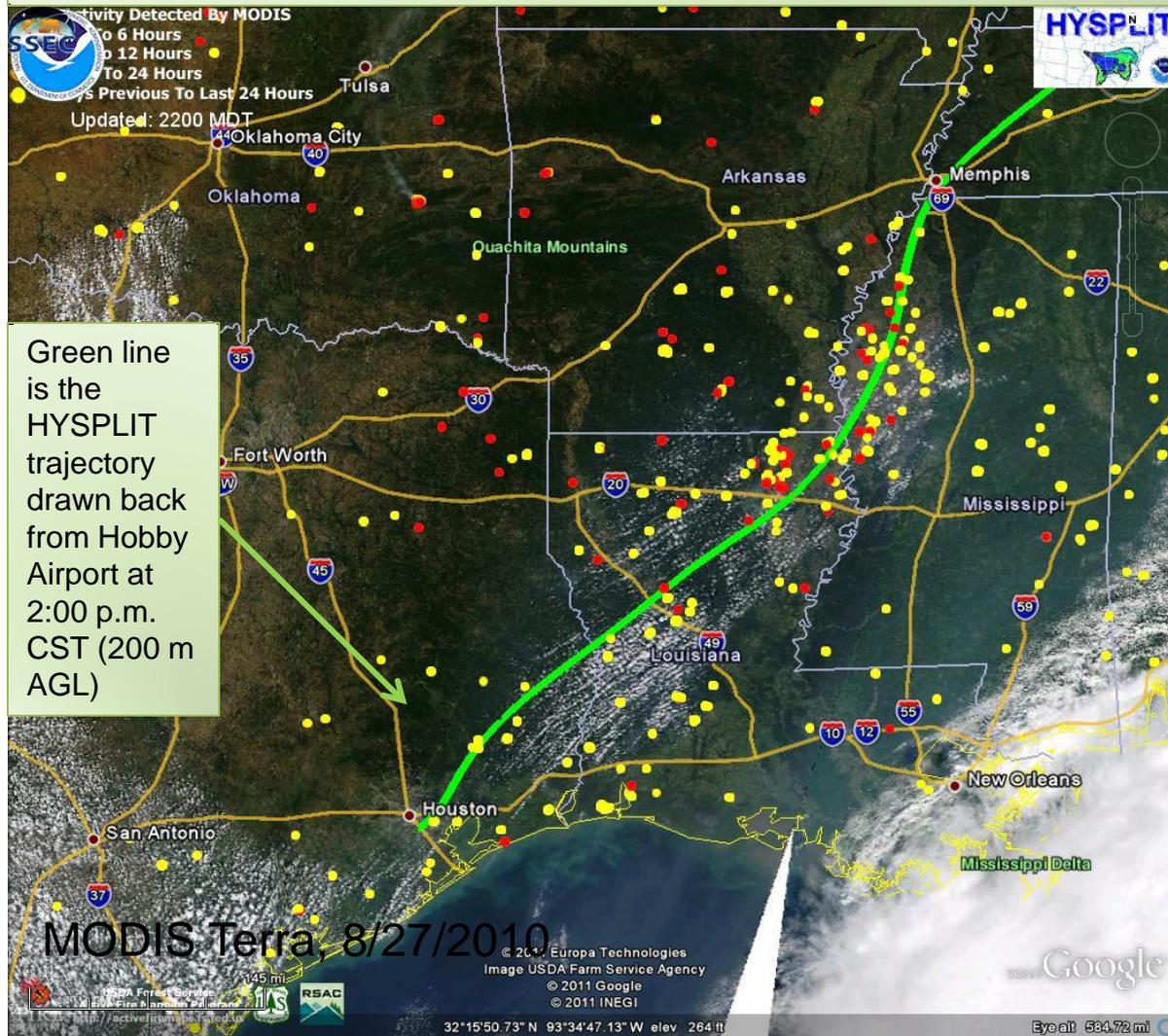
Smoke from Lower Mississippi River Valley Fires Visible in Satellite Imagery Over SE Texas

Friday, August 27, 2010
 DESCRIPTIVE TEXT
 NARRATIVE FOR
 SMOKE/DUST OBSERVED
 IN SATELLITE IMAGERY
 THROUGH 0400Z August
 28, 2010

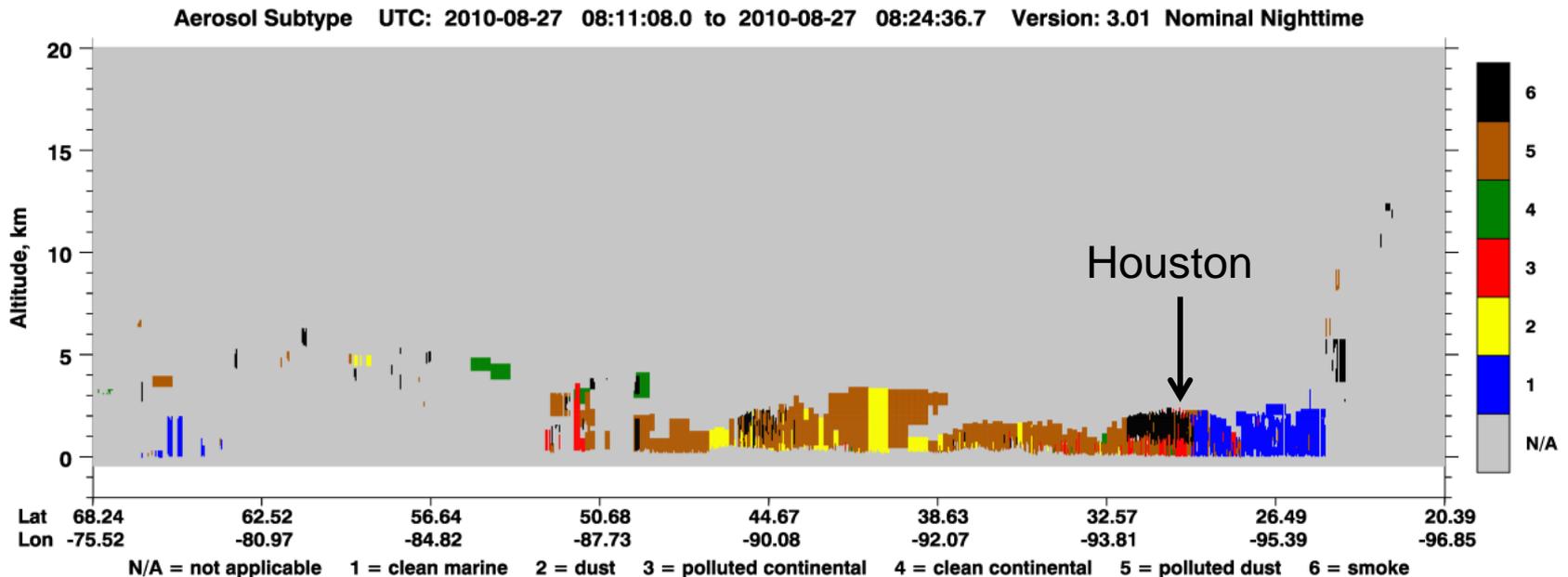
Lower Mississippi Valley:
 Smoke from numerous
 agricultural fires across
 the area mixed in with
 haze from an unknown
 origin was seen in the last
 images of the day slowing
 drifting to the southwest.
 This area of mixed
 aerosols stretches from
 Virginia, Tennessee,
 Mississippi, Arkansas,
 Louisiana, Texas and out
 into the Gulf of Mexico.

-- NOAA Smoke Text Archive
<http://www.osdpd.noaa.gov/ml/and/hms.html>

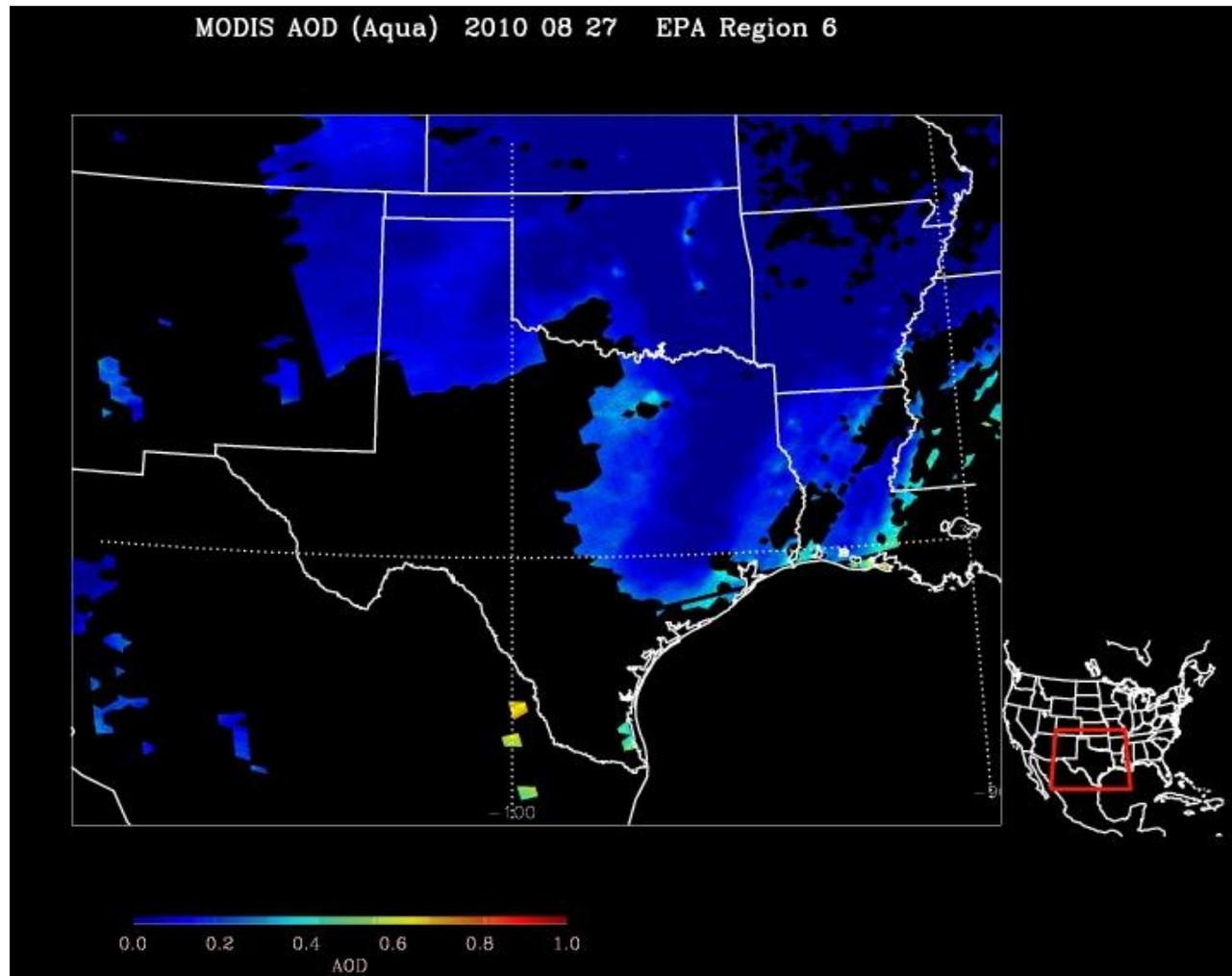
NASA Terra MODIS true color visible satellite image
 (<http://ge.ssec.wisc.edu/modis-today/index.php> with MODIS, AVHRR and GOES
 fire detections downloaded from <http://activefiremaps.fs.fed.us/googleearth.php>



CALIPSO LIDAR Shows Smoke Mixed with Polluted Continental Air Over Houston

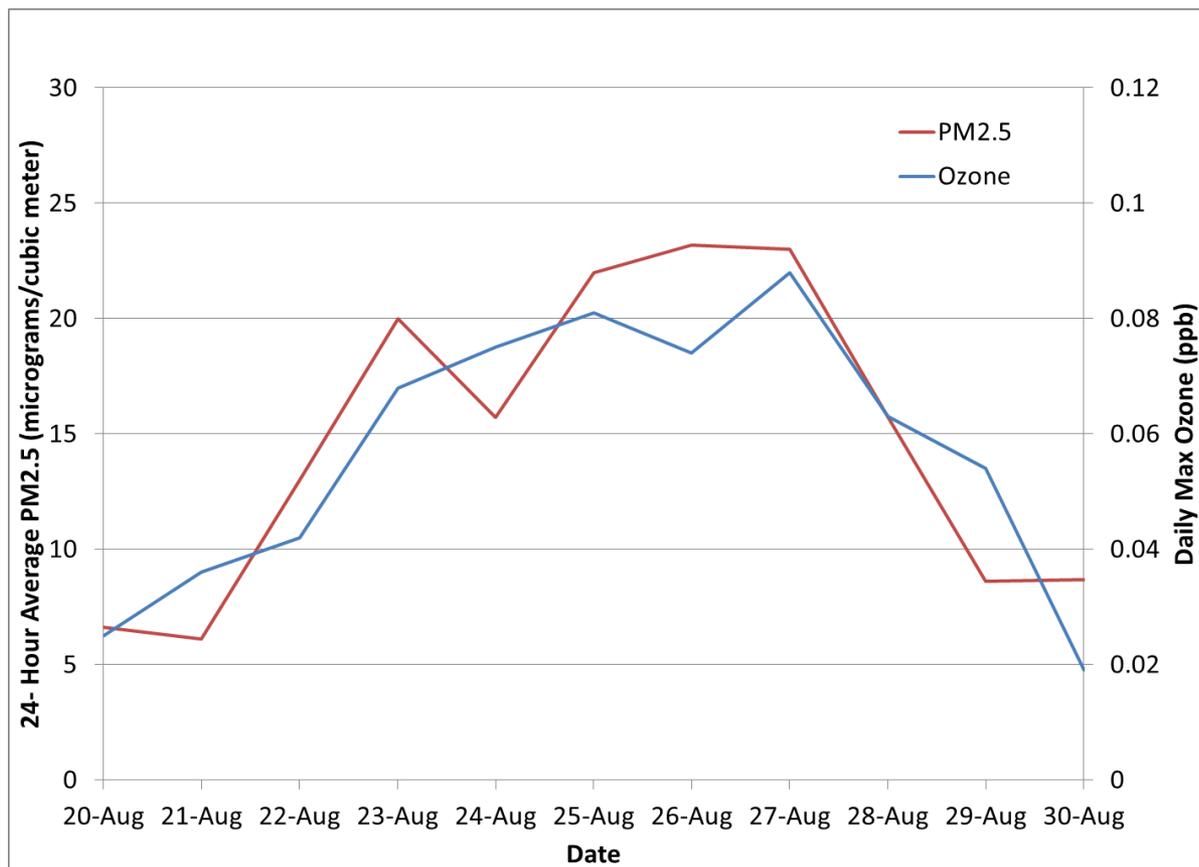


AQUA MODIS AOD Shows Transport of Haze into East Texas from the NE



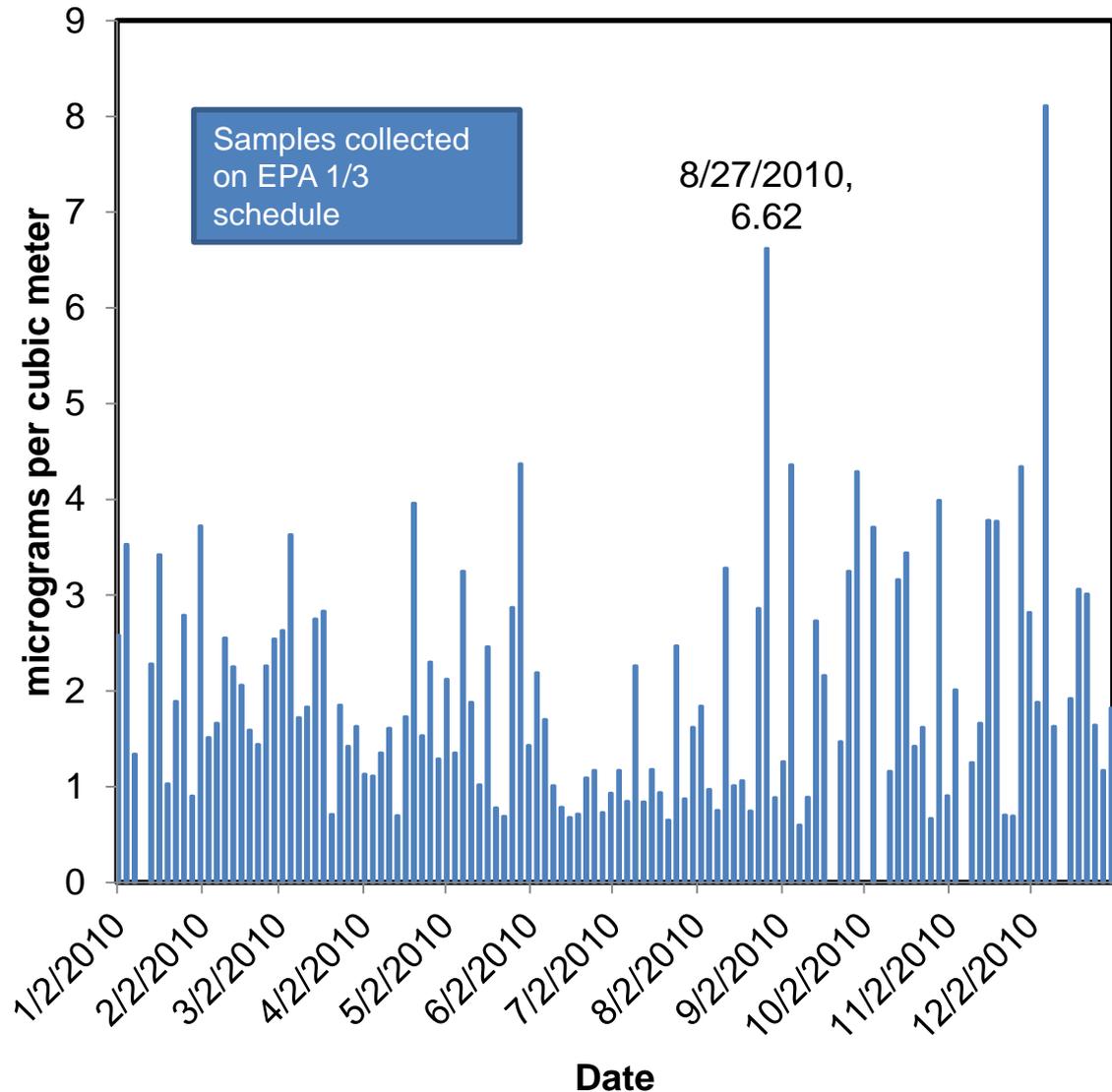
Multi-Day Episode of Elevated Ozone and PM2.5

HGB daily maximum 8-hour ozone levels tracked the trend in 24-hour average PM2.5 levels at Clinton Drive during the ramp-up, peak, and dissipation of this regional event. PM2.5 levels on August 25-27 were almost twice the annual average.



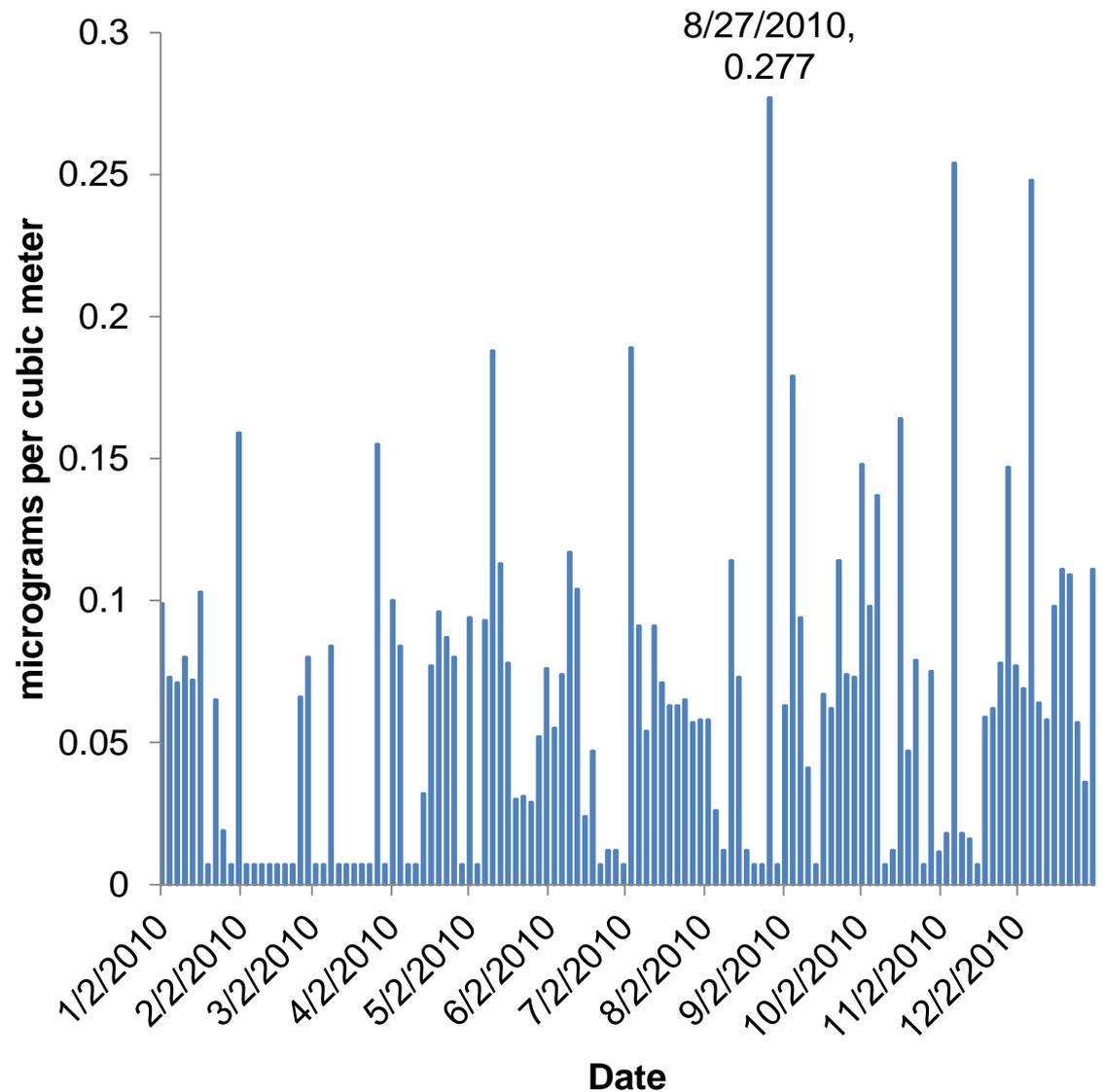
The Organic Carbon Component of PM2.5 at Deer Park was Exceptionally High

The organic carbon concentration in the PM2.5 sample collected at the Deer Park Speciation Trends Network Site on August 27, 2010 was the highest of the ozone season and 2nd highest of the year. The OC level on 8/27 was 3.3 times the annual mean of 2 micrograms per cubic meter. Organic carbon in PM2.5 is indicative of biomass combustion.



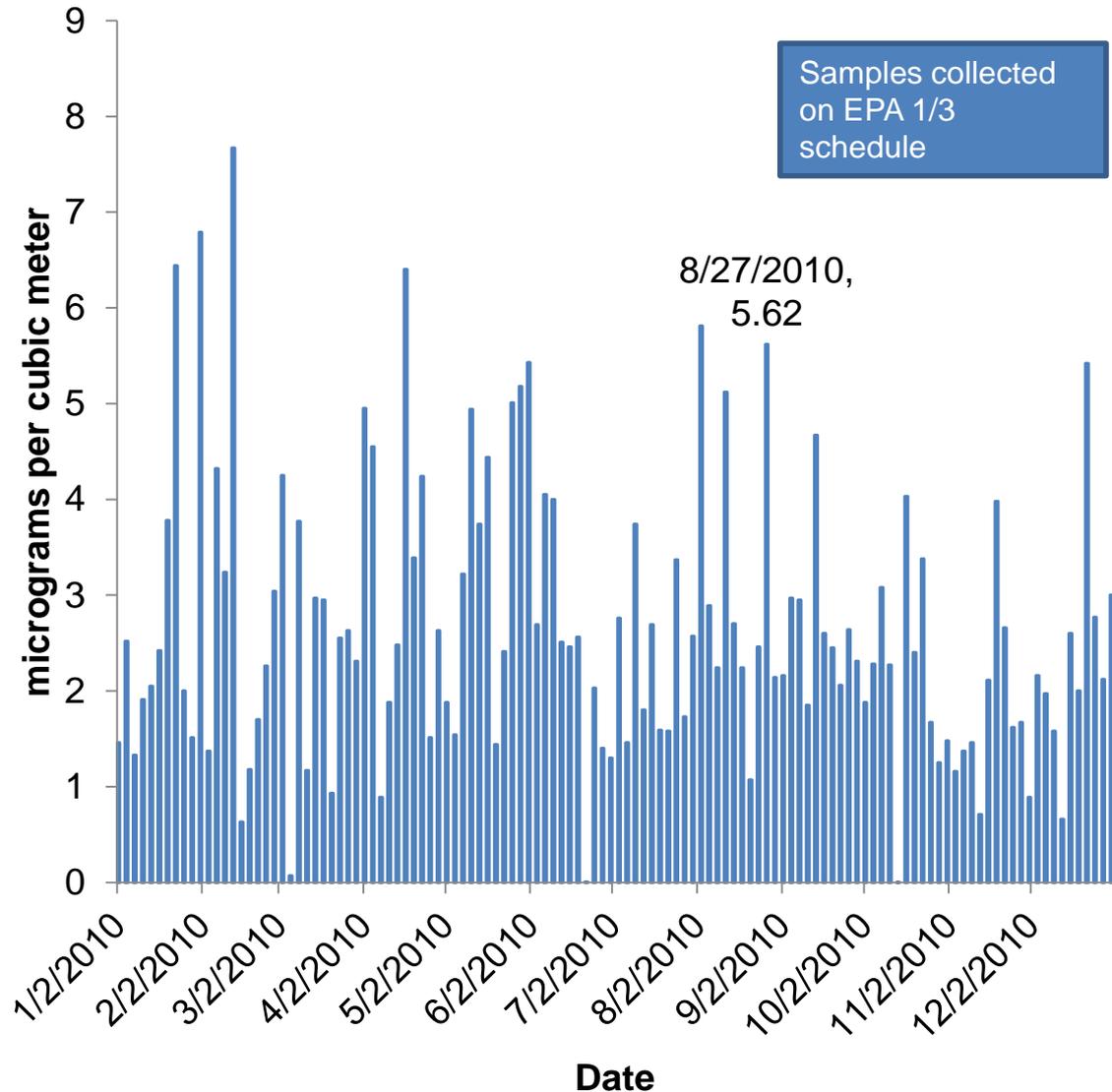
The potassium ion Component of PM2.5 at Deer Park was Exceptionally High

Ionic potassium is often used in PM2.5 source apportionment studies as a tracer for burning biomass. The potassium ion concentration in the PM2.5 sample collected at the Deer Park Speciation Trends Network Site on August 27, 2010 was the highest of the year. The K+ level on 8/27 was 4.4 times the annual mean.



The Sulfate Component of PM2.5 at Deer Park was Also Elevated

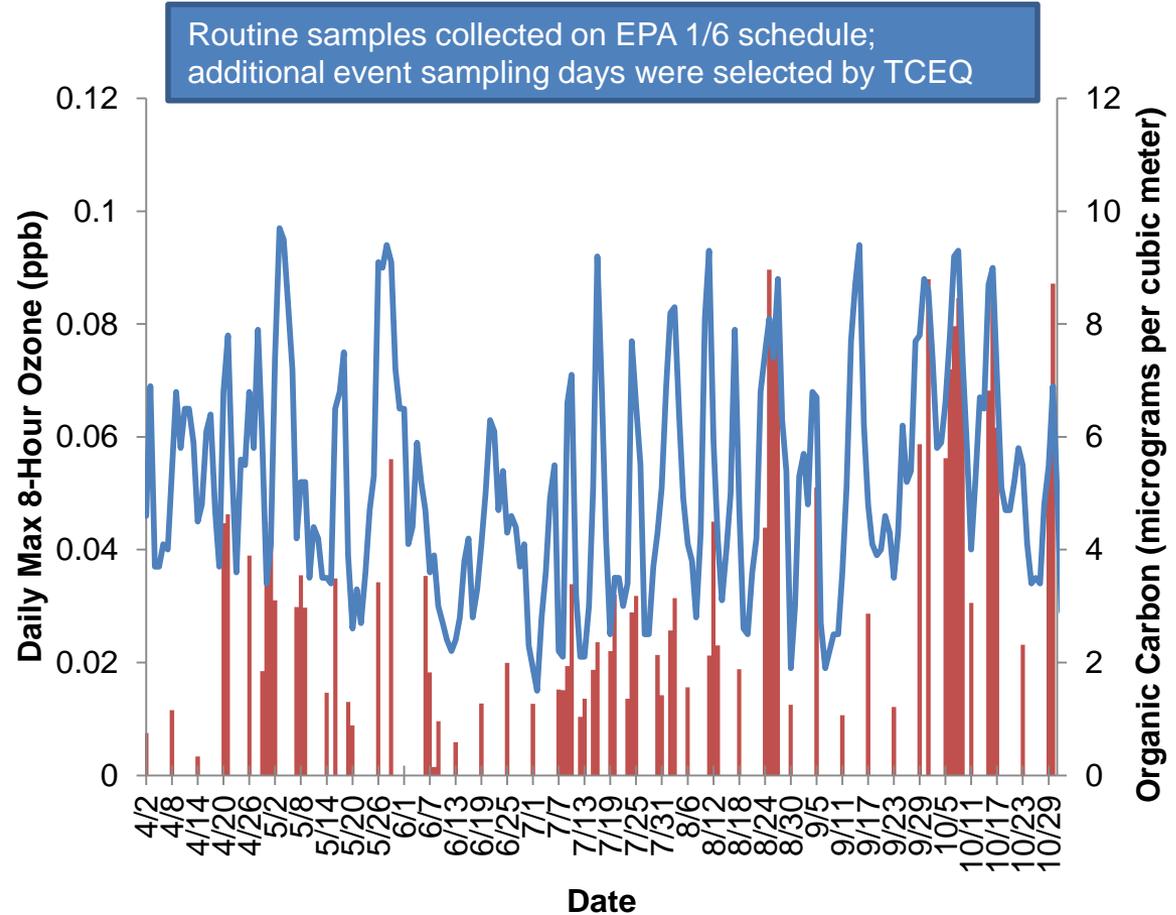
The sulfate concentration in the PM2.5 sample collected at the Deer Park Speciation Trends Network Site on August 27, 2010 was also elevated. This is consistent with the NOAA observation that smoke from the Lower Mississippi River Valley was mixed with haze from another source. The sulfate level on 8/27 was 2.1 times the annual mean of 2.66 micrograms per cubic meter. Sulfate in PM2.5 is indicative of fossil fuel combustion.



The Organic Carbon Content of PM2.5 at Clinton Drive was Exceptionally High

Organic carbon levels measured August 25, August 26, and August 27 were among the highest of the year. Elevated levels were also detected on October 1 and October 6-8, when Houston ozone levels were high and transport was through the Lower MS River Valley.

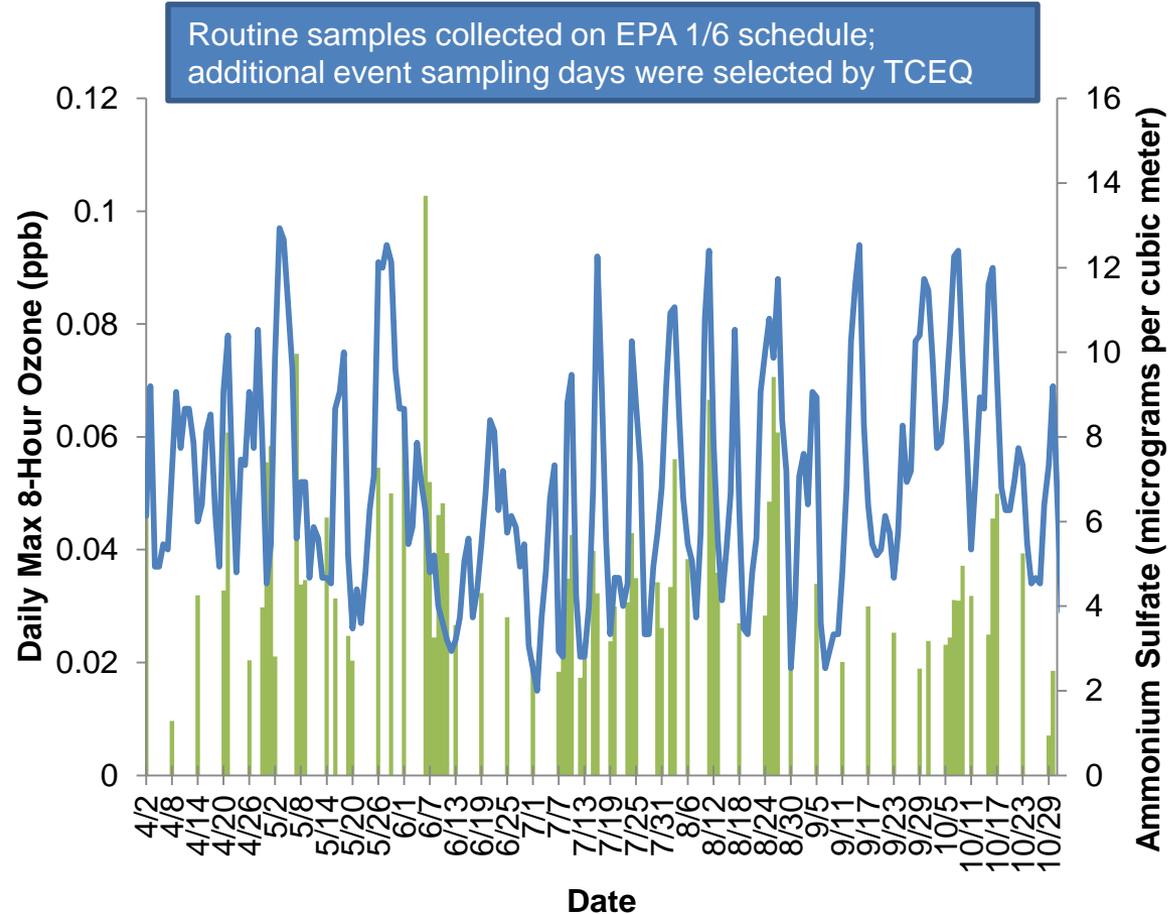
HGB Daily Maximum 8-Hour Ozone and PM2.5 Organic Carbon



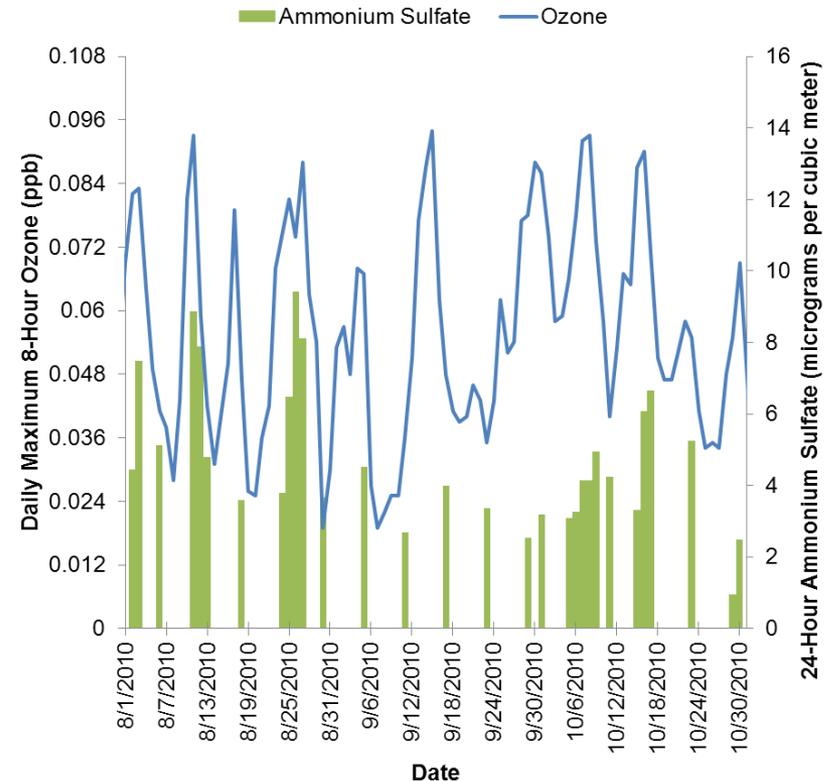
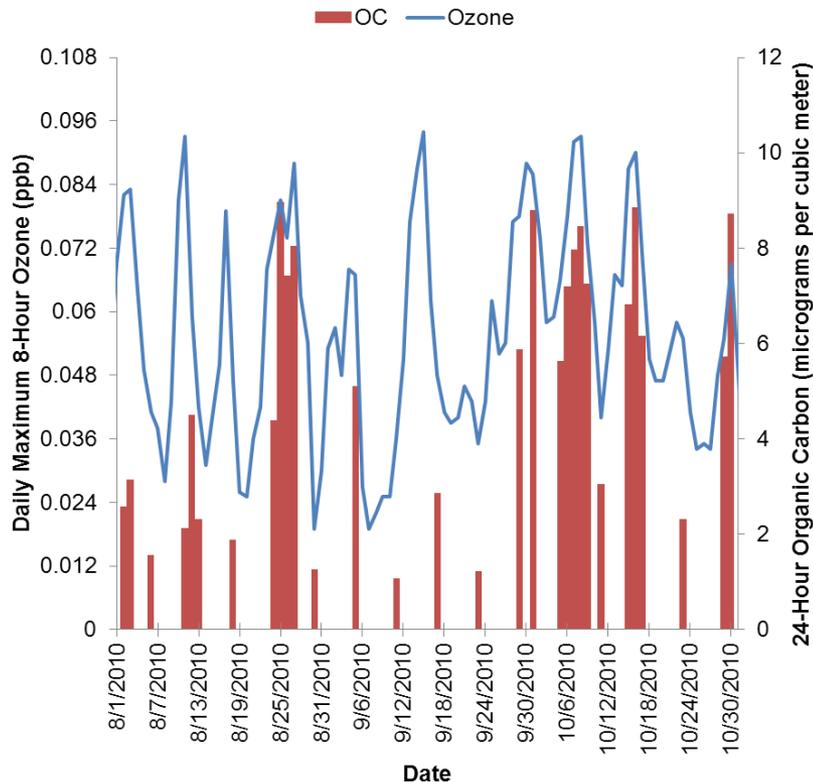
The Sulfate Component of PM2.5 at Clinton Drive was Also Elevated

Sulfate levels were elevated on August 27. This is consistent with the NOAA observation that smoke from the Lower Mississippi River Valley was mixed with haze from another source. Sulfate was also elevated during several earlier ozone episodes but not during the later smoke episodes.

HGB Daily Maximum 8-Hour Ozone and PM2.5 Ammonium Sulfate



Organic Carbon and Ammonium Sulfate Components of Clinton Drive PM2.5 during and between Multi-Day Ozone Episodes



OC levels were elevated on high ozone days if back trajectories passed through the fire region; OC is indicative of biomass combustion.

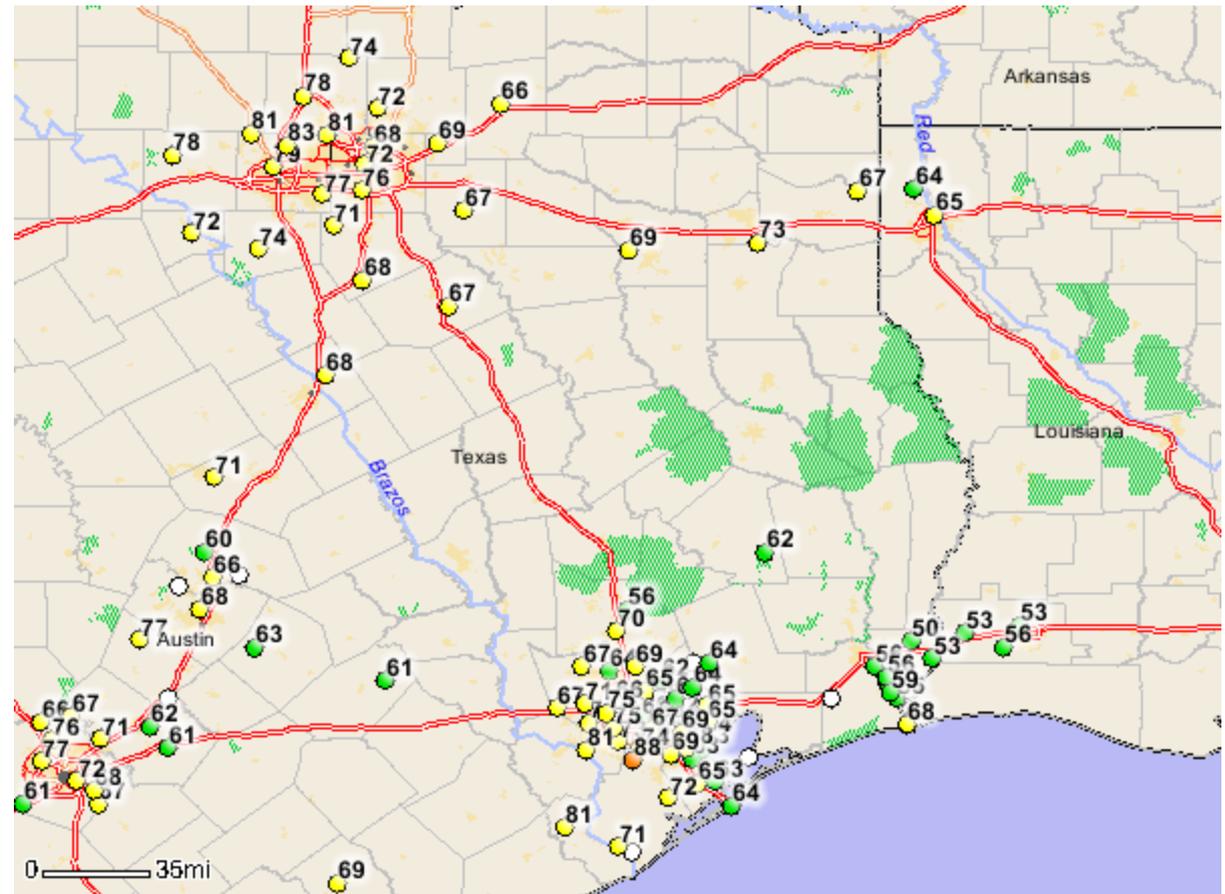
Sulfate levels were not elevated during September-October ozone episodes. Sulfate is indicative of fossil fuel combustion.

3 Independent Estimates of Fire Impacts

- Background Subtraction
 - Assumed fire impact was equal to ozone levels upwind of Houston minus ozone levels upwind of another east Texas area (BPA or DFW) from where backward trajectories did not pass through area of greatest fire activity
- Linear Regression
 - Used empirical relationship between transported ozone and PM_{2.5} organic carbon concentration at Clinton Drive
- Surrogate Day Comparison
 - Assumed fire impact was equal to ozone level upwind of Houston minus the ozone level upwind of Houston having similar weather and backward trajectory but no significant fire activity along the trajectory path

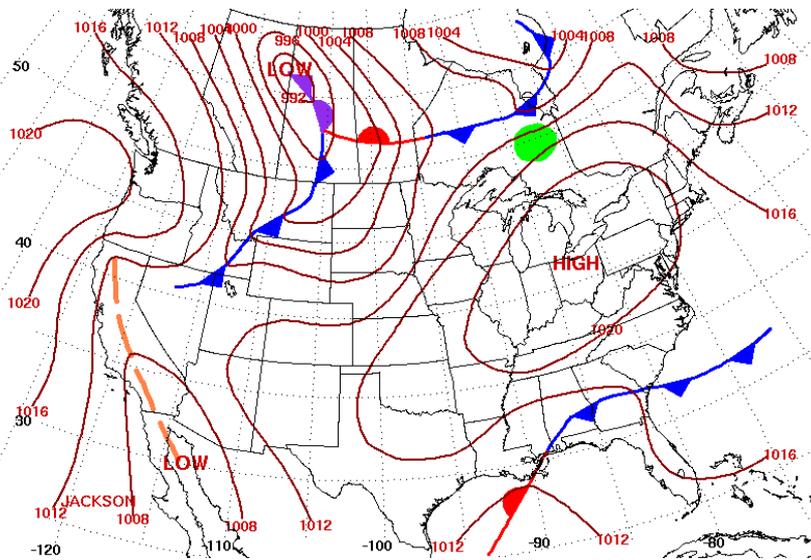
Estimate of the Fires' Impact by Background Subtraction

The background ozone levels in northeast Texas for the 8-hour period beginning 9:00 a.m. CST were above 65 ppb, consistent with the background levels in the air approaching HGB. In contrast, the background ozone levels in southeast Texas and southwest Louisiana, which were not in the direct path downwind of the fires were about 53 ppb. **The difference between the HGB and BPA background levels, which estimates the fire impact, is about 11 ppb.**



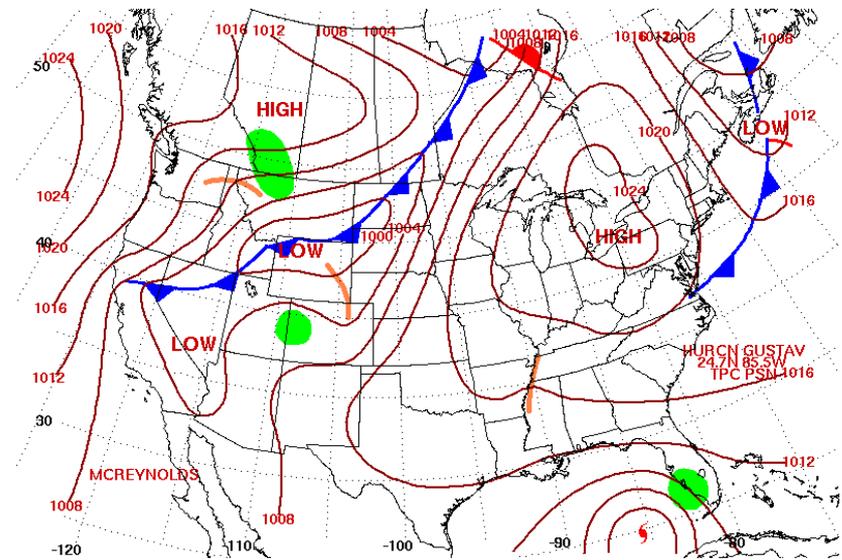
Estimate of the Fires' Impact by Surrogate Day Comparison

August 27, 2010
Maximum Temperature = 92 F
Average Wind Speed = 4.4 mph



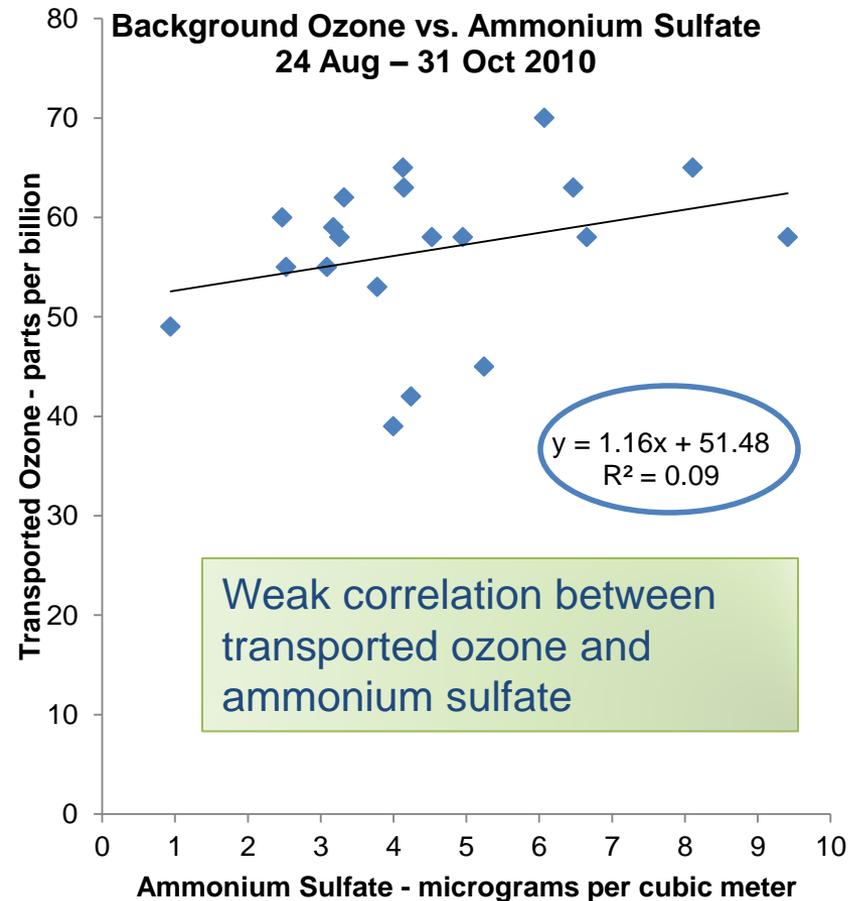
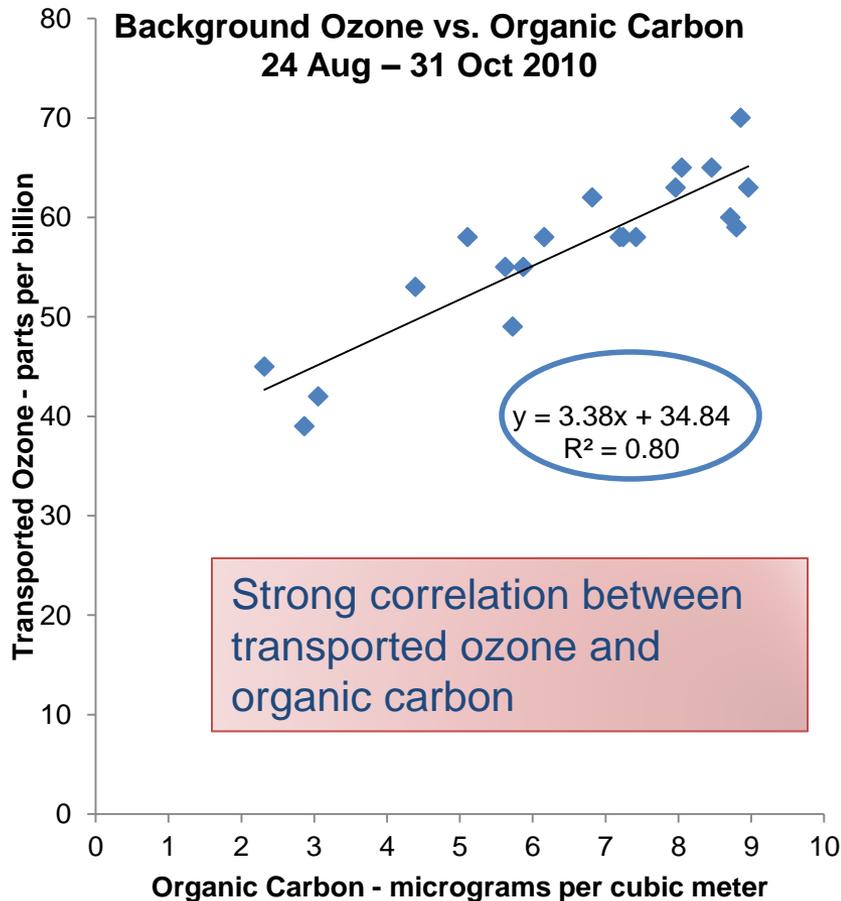
Surface Weather Map at 7:00 A.M. E.S.T.

Surrogate Day - August 31, 2008
Maximum Temperature = 92 F
Average Wind Speed = 4.4 mph



Surface Weather Map at 7:00 A.M. E.S.T.

Estimate of Fires' Impact by Linear Regression



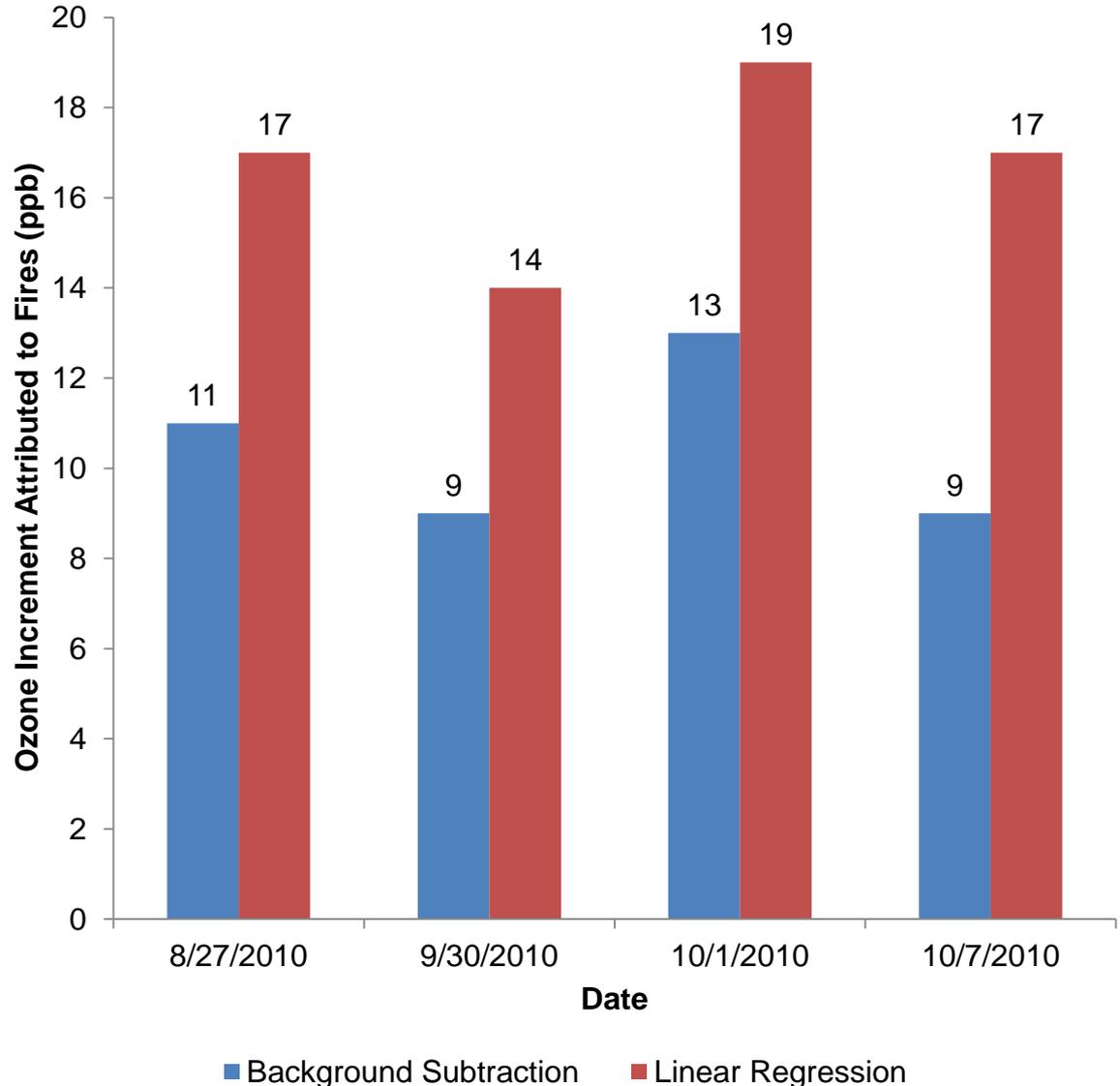
The chart and regression exclude 3 outliers when the background ozone level ranged from 15 – 25 ppb and the organic carbon content was between 1.0 and 1.3 µg/m. With the outliers included, the slope and r-square are 5.0 and 0.83, respectively

Estimate of Fires' Impact by Linear Regression

- The Clinton Drive PM2.5 organic carbon content was linearly related to the daily maximum 8-hour ozone level in the air approaching the upwind side of Houston during August 24 – October 31, 2010
- The slope of the regression line is 3.38, indicating that ozone increased by approximately 3.4 ppb for every $\mu\text{g}/\text{m}^3$ increase in organic carbon
- Therefore, the ozone attributed to the fires on any day is approximately equal to 3.4 times the difference between the organic carbon concentration on that day and the baseline organic carbon concentration
 - $\text{O}_3(\text{Fires}) = 3.4 \times [\text{OC} - \text{OC}(\text{baseline})]$
- Taking the median OC level for 2010 ($3.1 \mu\text{g}/\text{m}^3$) as the baseline, the amount of ozone attributed to the fires on 27 Aug 2010 is 17 ppb

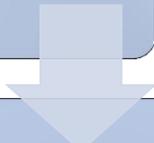
Summary of Fire Impact Estimates for All Case Studies

Background subtraction and linear regression estimated of fire impacts agree within a factor of 2. Surrogate day estimate for August 27 was 21 ppb, also within a factor of 2 of the other methods (surrogate day comparison was not done for the other case studies).



Summary of Observations (1 of 2)

Ozone levels were regionally elevated



There was widespread fire activity in the lower MS River Valley



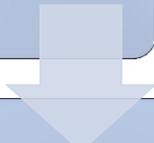
Wind conditions were favorable for transporting fire emissions to SE Texas



Smoke was detected over SE Texas, extending back to the Lower MS River Valley

Summary of Observations (2 of 2)

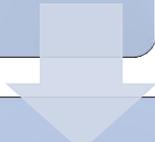
Surface measurements of PM2.5 were elevated



Daily maximum 8-hour ozone levels tracked 24-hour PM2.5 levels during each multi-day event



PM2.5 composition had high levels of organic carbon, water soluble potassium



Transported ozone correlated very well with PM2.5 organic carbon but not with sulfate

Conclusions

- Estimates of wildfire impacts on Houston ozone levels for 4 case studies during 27 August – 7 October 2010 range from 9 to 19 ppb
- At CAMS 84, which was the HGB design value monitor for 2008-2010, the annual 4th highest daily maximum would be 81 ppb but for the estimated wildfire contributions (the measured 4th high was 88 ppb)
- The 7 ppb difference at CAMS 84 that is attributed to the wildfires could be significant with respect to future NAAQS compliance determinations and attainment demonstrations
- CAMS 84 is not unique in this regard; Fire impacts are evident at other monitors on the 4 case study days and on other days that were not analyzed
- Preliminary analyses suggest that 2011 wildfires impacts on ozone levels in Houston, Beaumont-Port Arthur, and other Texas cities may also be significant

SUPPLEMENTAL SLIDES

September 30, 2010



OFFICIAL NEWS RELEASE

MISSISSIPPI FORESTRY COMMISSION
660 North St., Suite 300, Jackson, MS 39202

www.mfc.ms.gov

FOR IMMEDIATE RELEASE

September 30, 2010

Contact:
Russell Bozeman
Forest Protection and Information
(601) 359-2841

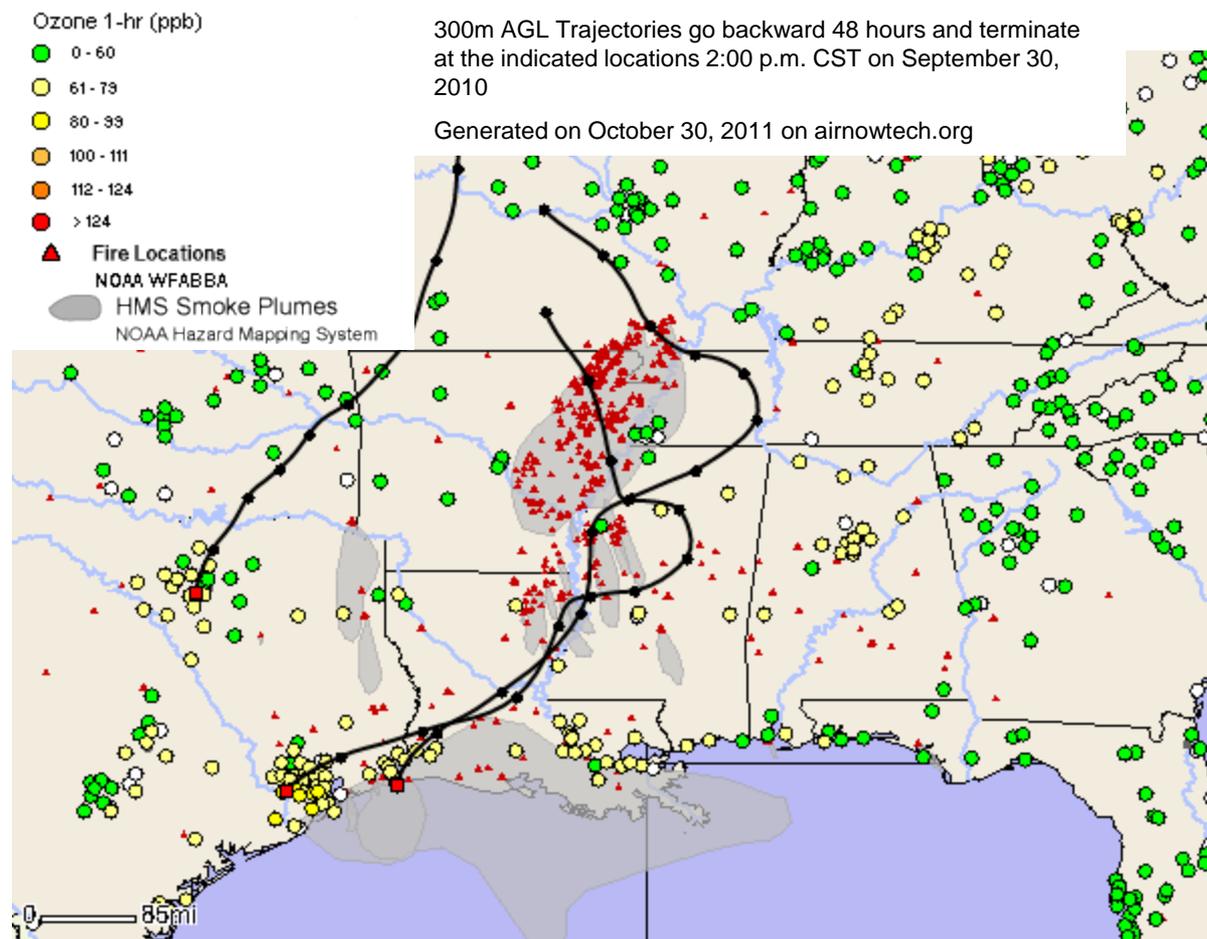
Statewide Wildland Fire Risk Alert

Jackson, MS – Effective September 30, 2010, the Mississippi Forestry Commission (MFC) is issuing a statewide Wildland Fire Alert. The MFC strongly discourages the public from all burning activities until further notice. Due to the current drought conditions and the predicted weather pattern for the next week, the fire danger rating for the state will be extremely high. Also, the National Weather Service has issued a “Fire Weather Watch” for portions of the state.

The state has experienced little to no rainfall and unseasonably high temperatures over the last several weeks, with some areas breaking records over the next few days. These conditions, combined with the high winds and low humidity expected from the approaching dry cold fronts, create an increase risk for devastating wildland fires. Most of the state’s districts have placed all their personnel “on call” for this weekend to help facilitate rapid deployment to wildland fires. Also, all MFC districts will stop issuing burn permits starting Oct. 1, 2010. Currently there are 21 counties are currently under a burn ban with more expected to join the list by Friday afternoon (Oct. 1).

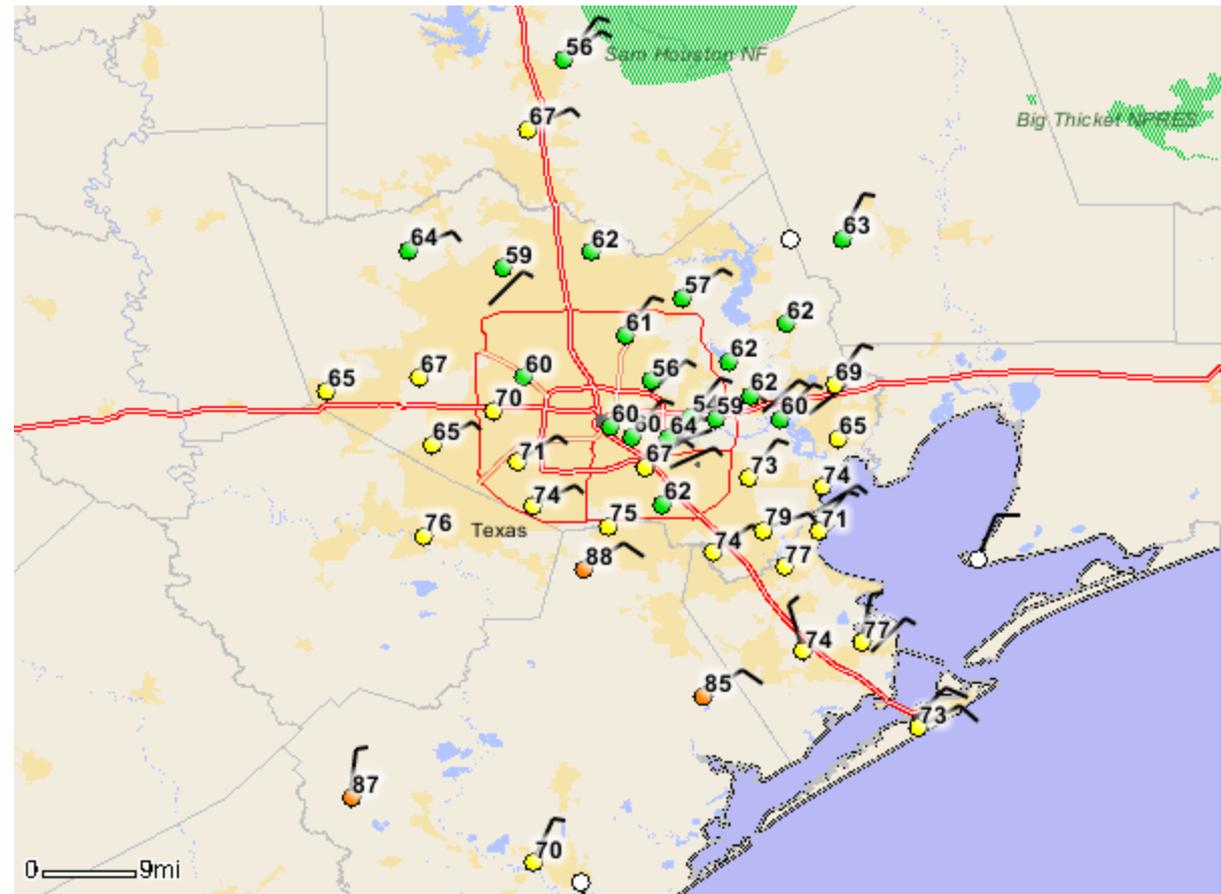
Backward Trajectories Pass Through the Lower MS River Valley

8-Hour ozone levels exceeded 75 ppb at 10 HGB sites and at Sabine Pass, in BPA, as the backward trajectories terminating 300m above these areas track back to the area of fires in the Lower Mississippi River Valley. Ozone levels were elevated all along the trajectory path



Ozone Levels in Air Entering the Region in the 8-Hour Period Beginning 10:00 a.m. CST were 63 ppb

With northeasterly winds, CAMS 84 recorded the highest 8-hour ozone level in HGB, 88 ppb. Background ozone levels on the upwind side of HGB were 63 ppb. The difference, 25 ppb is likely due to local emissions.

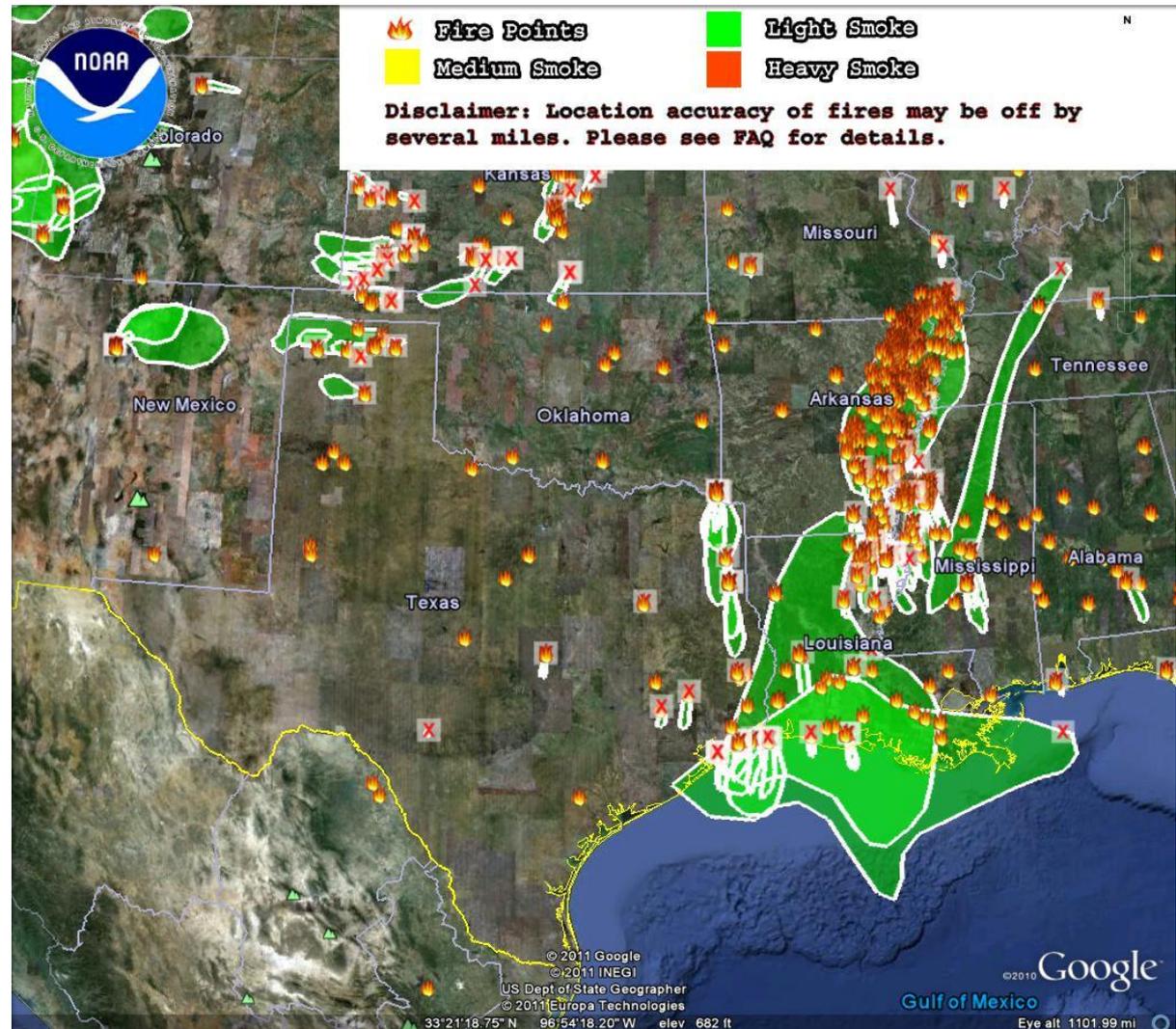


Smoke from Lower Mississippi River Valley Fires Visible in Satellite Imagery Over SE Texas

Thursday, September 30, 2010
DESCRIPTIVE TEXT
NARRATIVE FOR SMOKE/DUST
OBSERVED IN SATELLITE
IMAGERY
THROUGH 0330Z October 1,
2010

Middle and Lower Mississippi Valley/Louisiana/Southeastern Texas: A tremendous number of what are believed to be mainly agricultural burns over the Middle and Lower Mississippi Valley region were emitting many individual smoke plumes which moved to the south and consolidated into a larger mass of thin density smoke affecting southeastern Missouri, northwestern and western Mississippi, eastern Arkansas, and northeastern Louisiana. A mass of thin density remnant smoke from the previous day's agricultural fires in the Mississippi Valley, seen earlier this morning over Louisiana, moved southward and off the south Louisiana and southeast Texas coast and over the Gulf of Mexico.

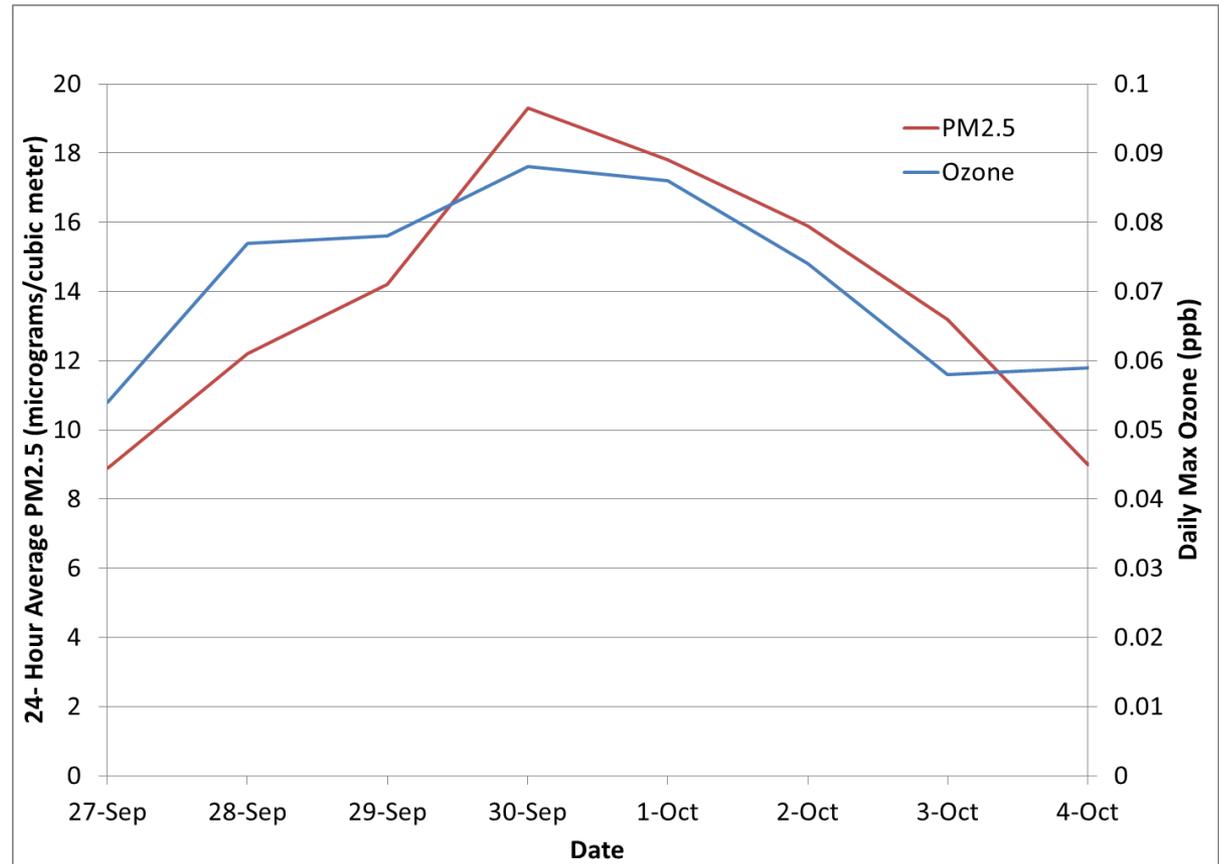
-- NOAA Smoke Text Archive
<http://www.osdpd.noaa.gov/ml/land/hms.html>



Source: NOAA Fire Products Archive,
<http://satepsanone.nesdis.noaa.gov/FIRE/fire.html>

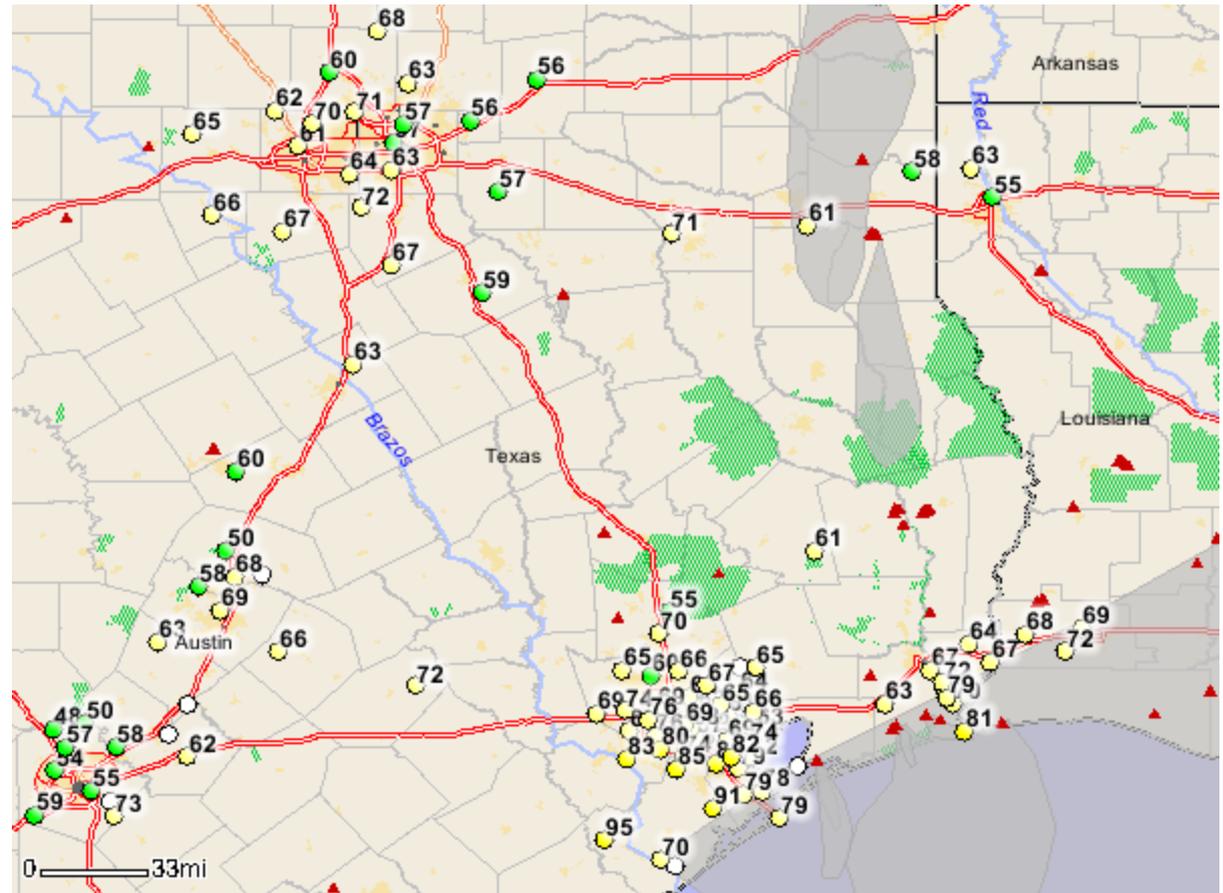
Multi-Day Episode of Elevated Ozone and PM2.5

HGB daily maximum 8-hour ozone levels track the 24-hour average PM2.5 levels at Clinton Drive during the ramp-up, peak, and dissipation of this multi-day event. No speciated PM2.5 data are available for September 30. PM2.5 speciation data from Clinton Drive show elevated organic carbon and less than average ammonium sulfate.

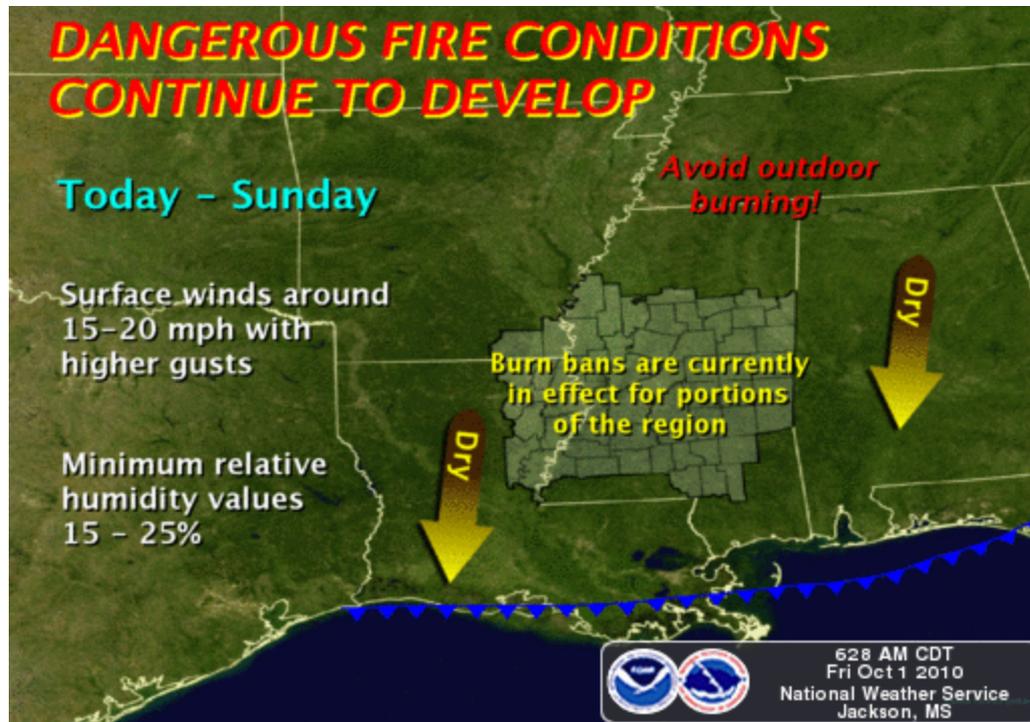


Fires Added an Estimated 9 ppb to the Ozone Transported into Houston from the NE

Background 8-hour ozone levels in the air approaching DFW were 54 ppb, which is 9 ppb less than the background level in the air approaching HGB. DFW air quality on this day does not appear to be directly impacted by the fires.

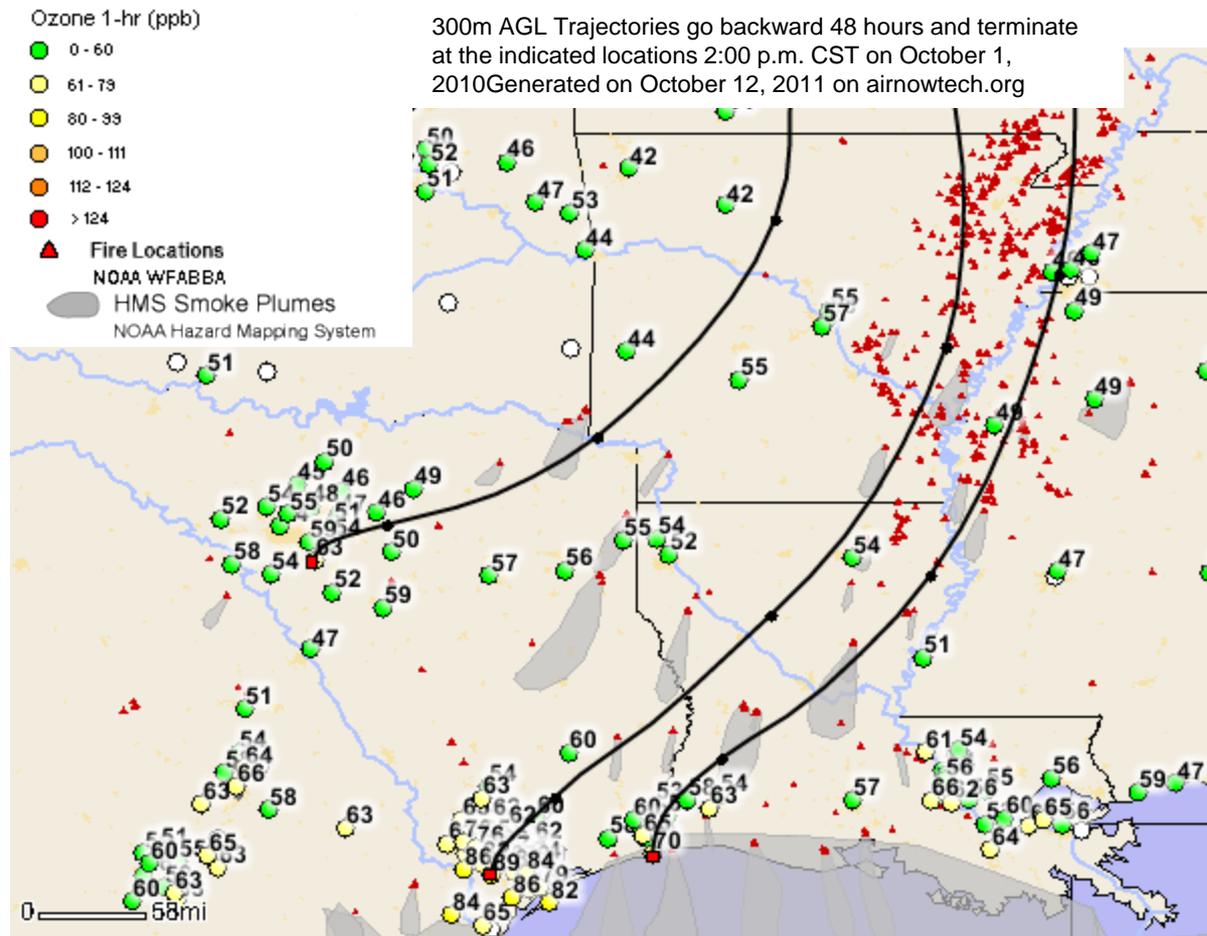


October 1, 2010



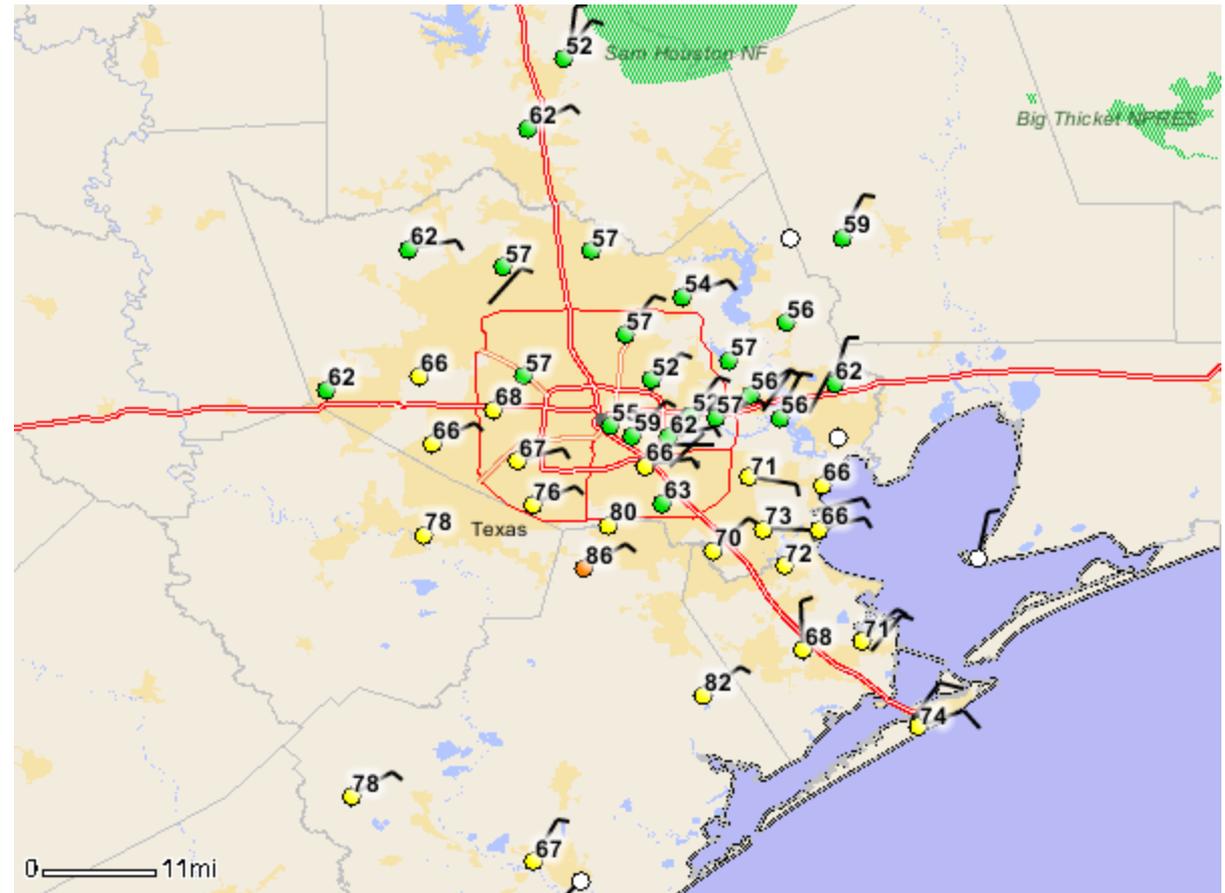
Backward Trajectories Pass Through the Lower MS River Valley

Backward trajectories track through the Lower Mississippi River Valley again. CAMS 84 recorded the highest 8-hour ozone level for the day, 86 ppb. Backward trajectories pass west of the fires and ozone levels are comparatively low.



Ozone Levels in Air Entering the Region in the 8-Hour Period Beginning 10:00 a.m. CST were 59 ppb

With northeasterly winds, CAMS 84 recorded the highest 8-hour ozone level in HGB, 86 ppb. The background ozone level on the upwind side of HGB was 59 ppb. The difference of 27 ppb appears likely due to local emissions.



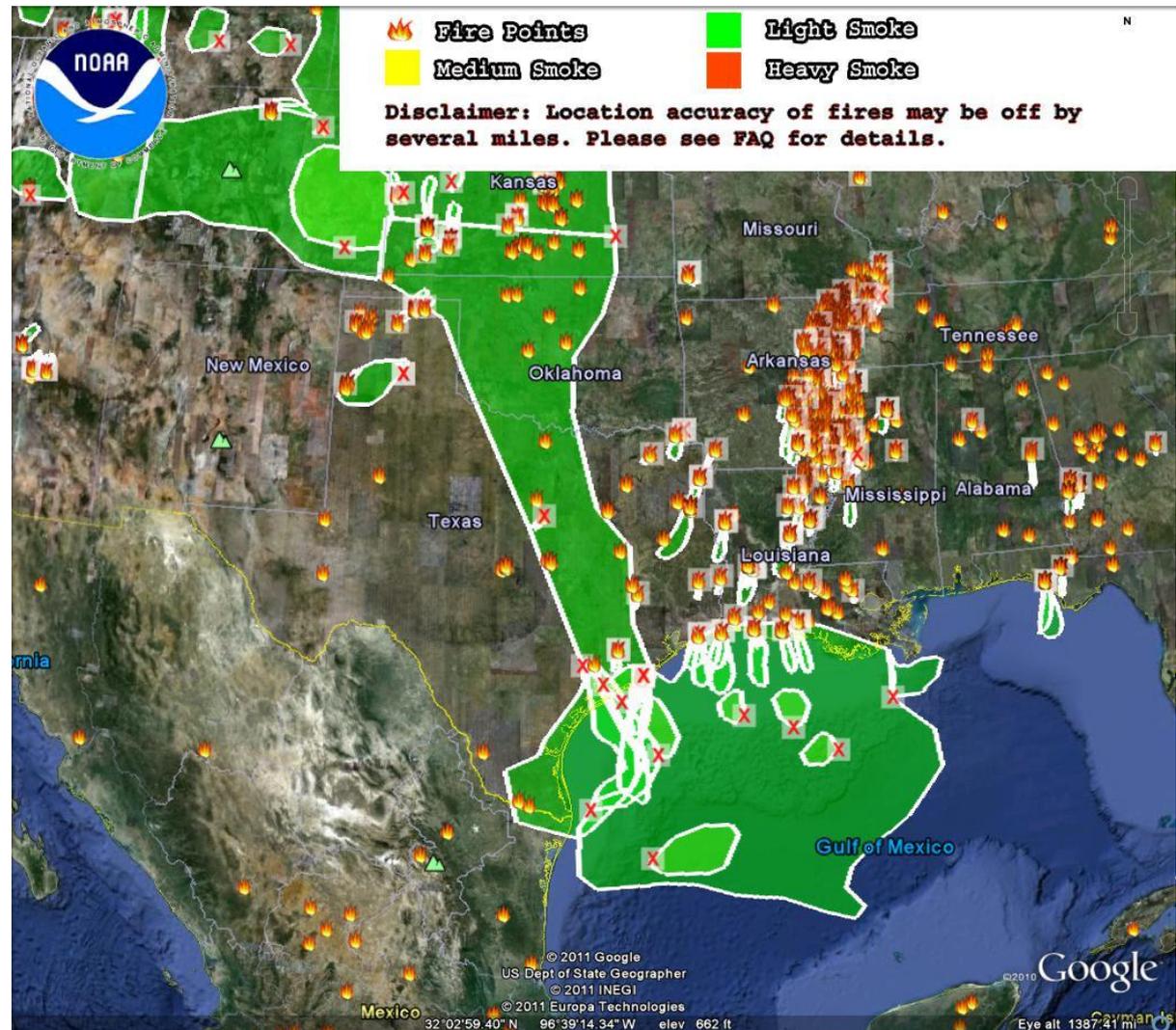
Smoke from Lower Mississippi River Valley Fires Visible in Satellite Imagery

Friday, October 1, 2010

DESCRIPTIVE TEXT
NARRATIVE FOR SMOKE/DUST
OBSERVED IN SATELLITE
IMAGERY
THROUGH 0330Z October 2,
2010

Middle and Lower Mississippi Valley/Gulf Coast Region: Again, a very large number of smoke producing fires were analyzed across the Middle and Lower Mississippi Valley region resulting a larger consolidated batch of mainly thin density smoke which moved to the south during the late afternoon. Also, an area of primarily thin density smoke combined with other aerosols was visible moving offshore over the western Gulf of Mexico. The smoke in this region was believed to be leftover from the Mississippi Valley agricultural burns which have been occurring for many days. Some contribution from fires along the coastal portions of southeastern Texas and southern Louisiana added to the mix.

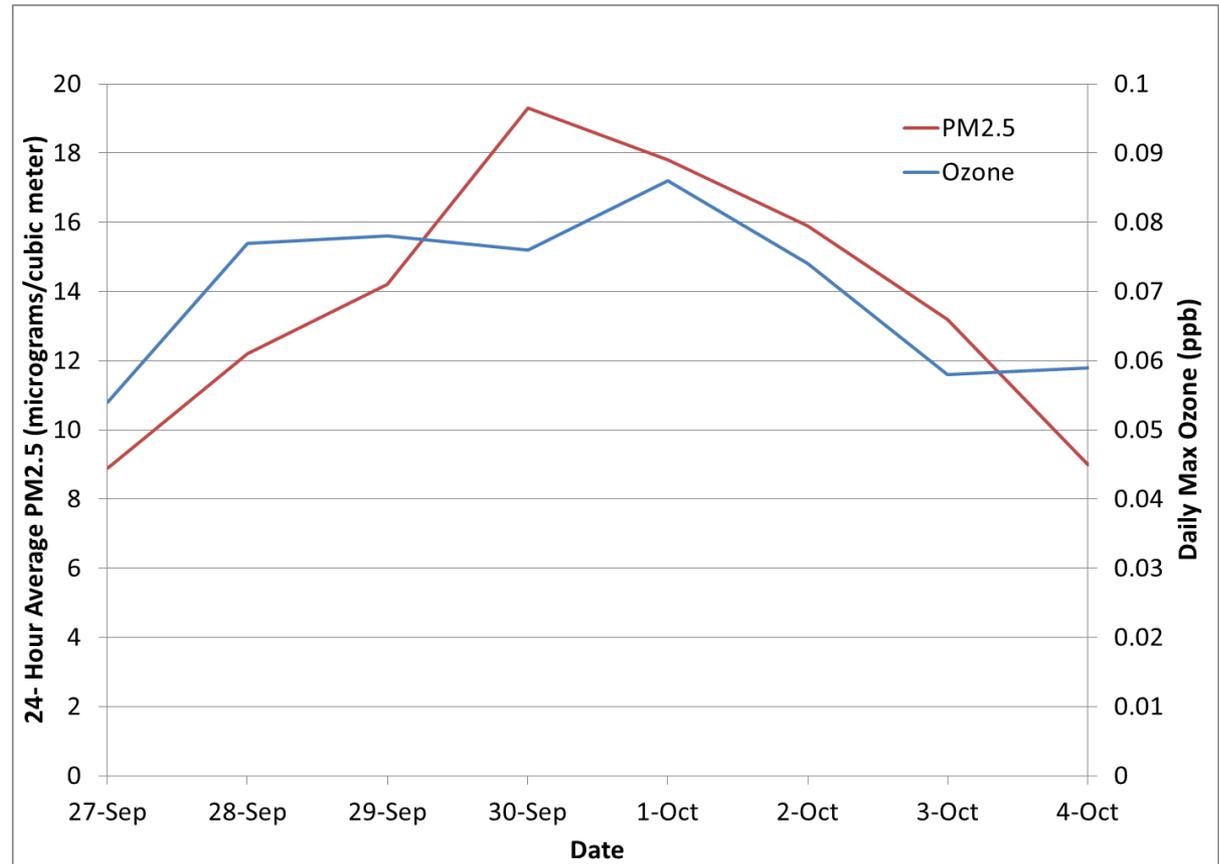
-- NOAA Smoke Text Archive
<http://www.osdpd.noaa.gov/ml/land/hms.html>



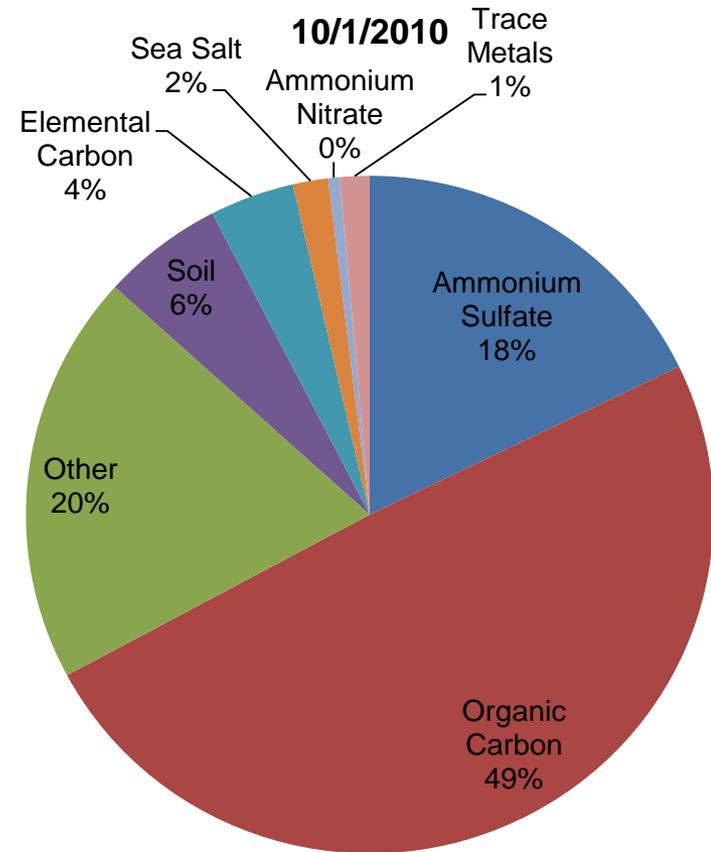
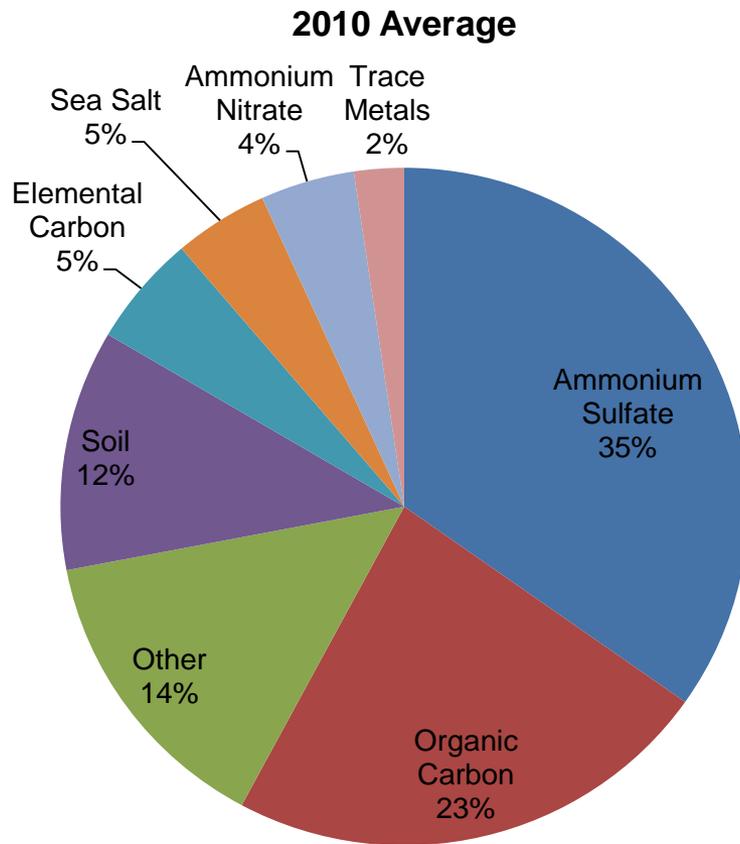
Source: NOAA Fire Products Archive,
<http://satepsanone.nesdis.noaa.gov/FIRE/fire.html>

Multi-Day Episode of Elevated Ozone and PM2.5

HGB daily maximum 8-hour ozone levels track the 24-hour average PM2.5 levels at Clinton Drive during the ramp-up, peak, and dissipation of this multi-day event.

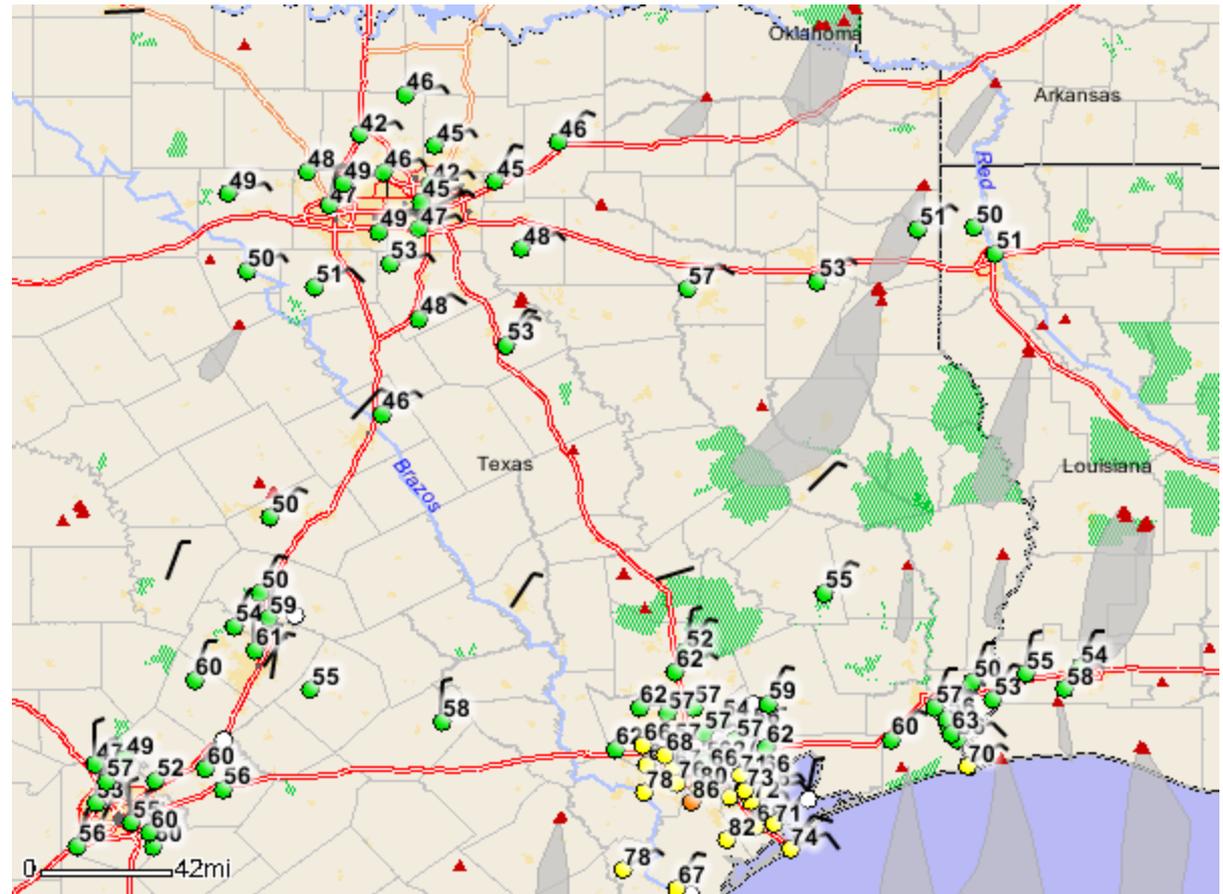


Clinton Drive PM2.5 Speciation Indicated Elevated Organic Carbon and Below Average Sulfate



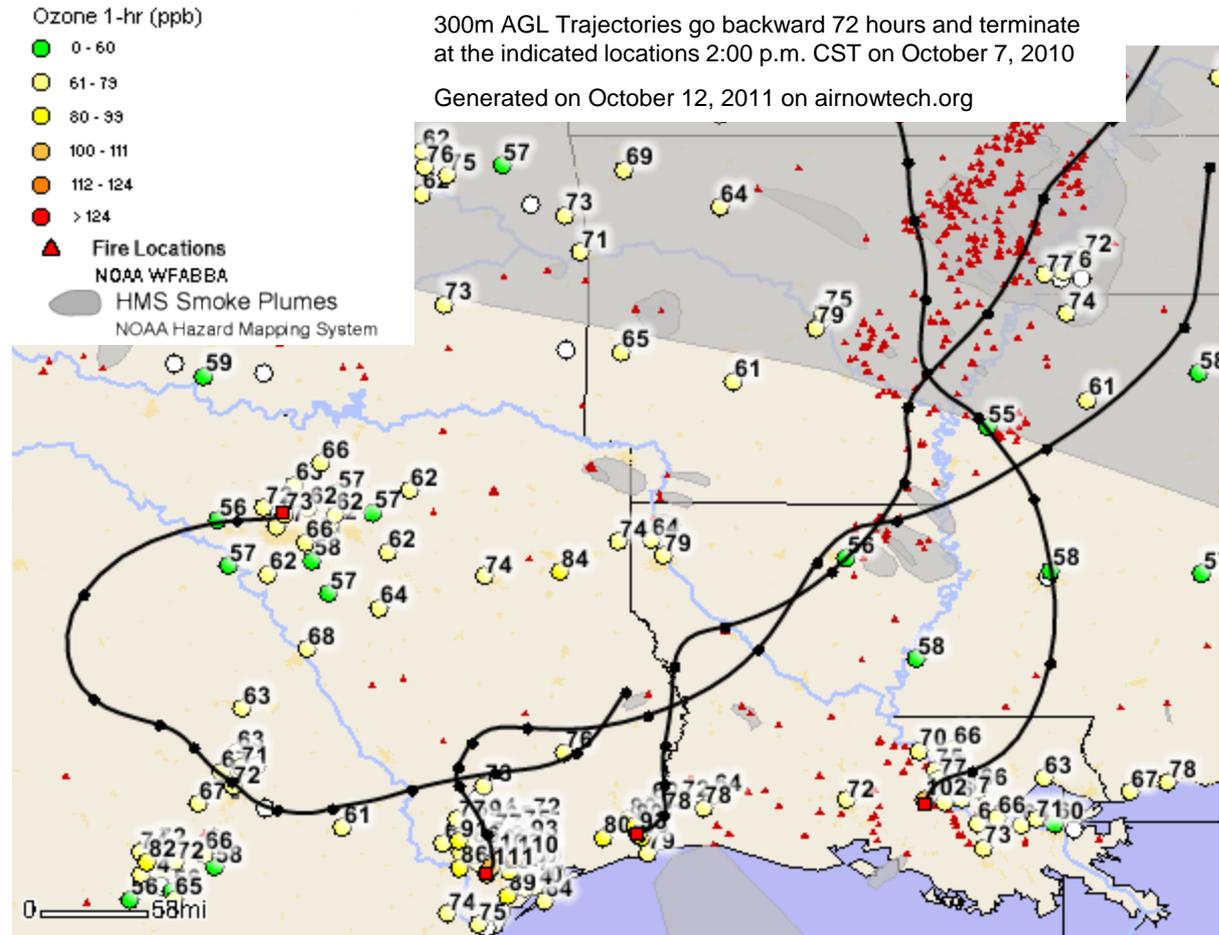
Fires Added an Estimated 13 ppb to the Ozone Transported into Houston from the NE

The background 8-hour ozone levels in the air approaching DFW was 46 ppb, which is 13 ppb less than the background level in the air approaching HGB. DFW air quality on this day does not appear to be directly impacted by the fires.



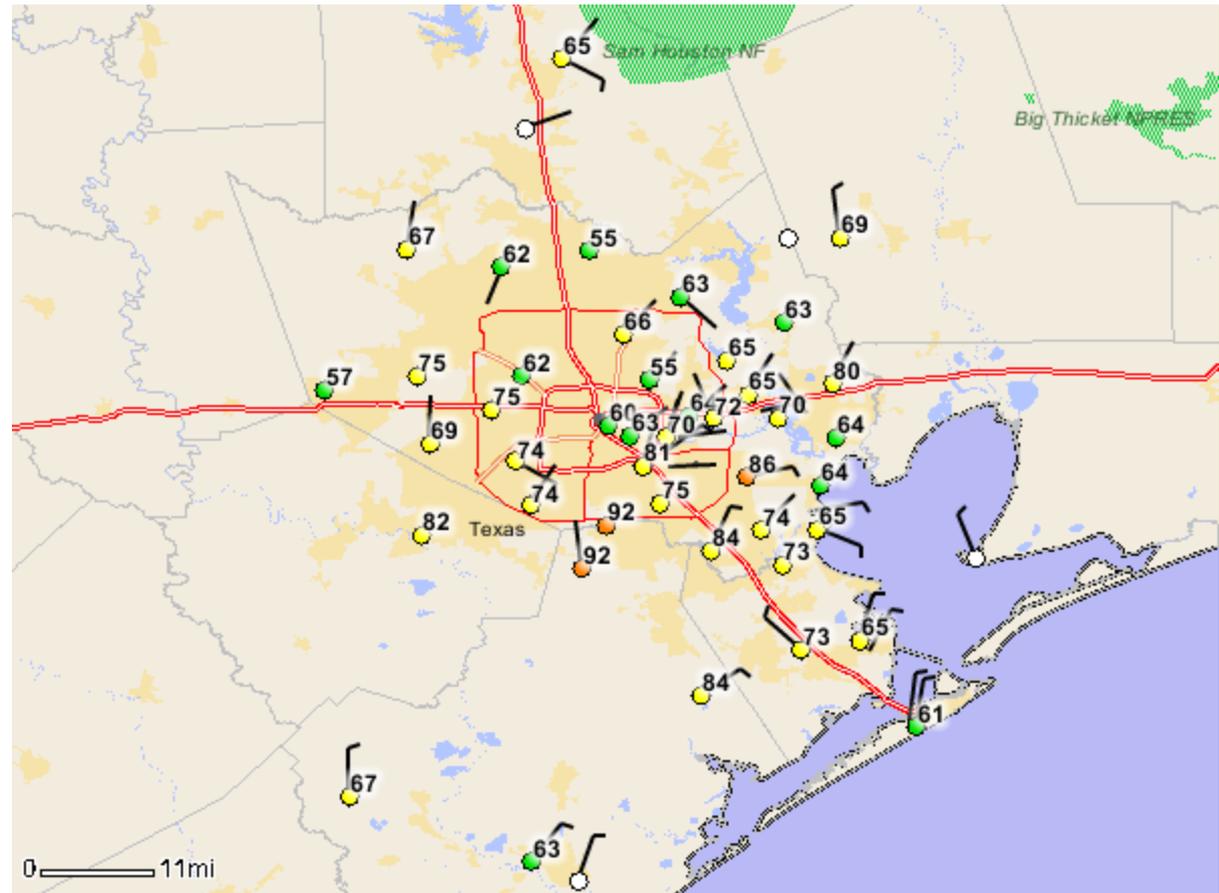
October 7, 2010 Backward Trajectories Pass through the Lower MS River Valley

23 ozone monitors in east Texas recorded 8-hour ozone averages above 75 ppb as 72-hour backward trajectories track back to the Lower Mississippi River Valley. CAMS 84 again recorded the highest level, 92 ppb.



Ozone Levels in Air Entering the Region in the 8-Hour Period Beginning 11:00 a.m. CST were 63 ppb

With northeasterly winds, CAMS 84 recorded the highest 8-hour ozone level in HGB, 92 ppb. Background ozone levels on the upwind side of HGB were about 63 ppb

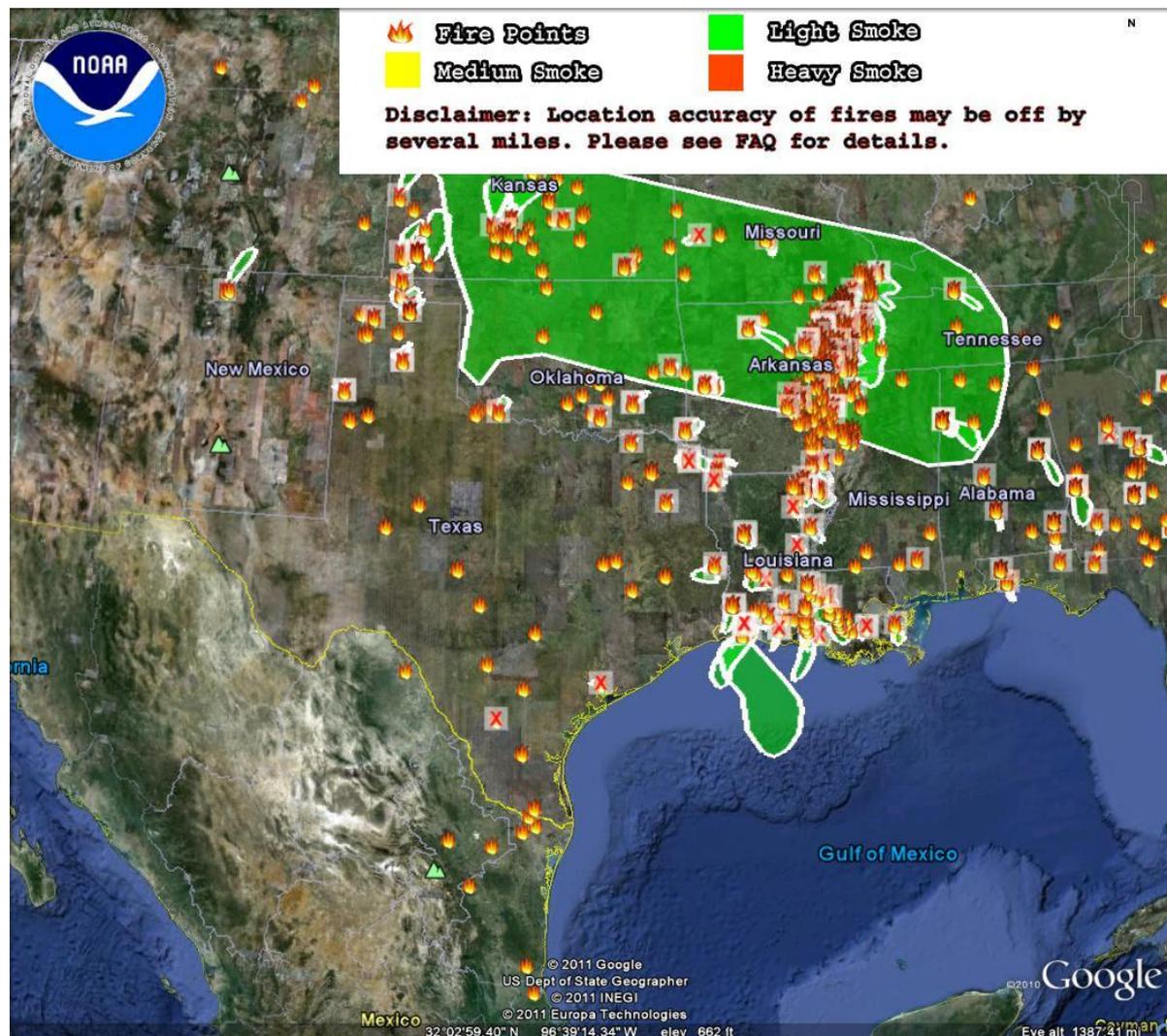


Smoke from Lower Mississippi River Valley Fires Visible in Satellite Imagery

Thursday, October 7, 2010
DESCRIPTIVE TEXT
NARRATIVE FOR
SMOKE/DUST OBSERVED IN
SATELLITE IMAGERY
THROUGH 0315Z October 8,
2010

Middle and Lower Mississippi Valley: Numerous agricultural fires were responsible for many thin to locally moderately dense smoke plumes which moved in a southeasterly direction and consolidated in some spots to form somewhat larger patches of smoke. Farther to the south, a large number of fires were also analyzed across the southern third of Louisiana. The smoke plumes from these fires moved mainly to the south with some smoke spreading over the western Gulf of Mexico.

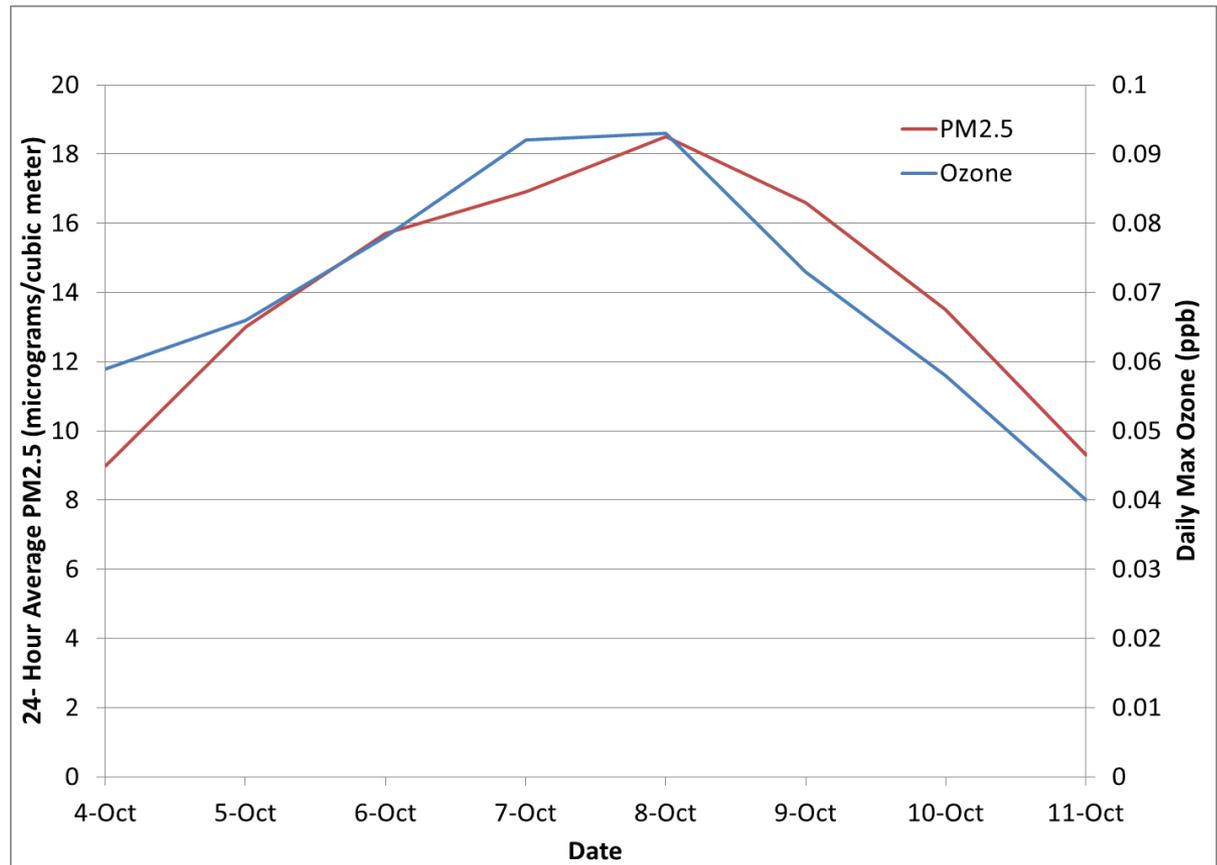
-- NOAA Smoke Text Archive
<http://www.osdpd.noaa.gov/ml/land/hms.html>



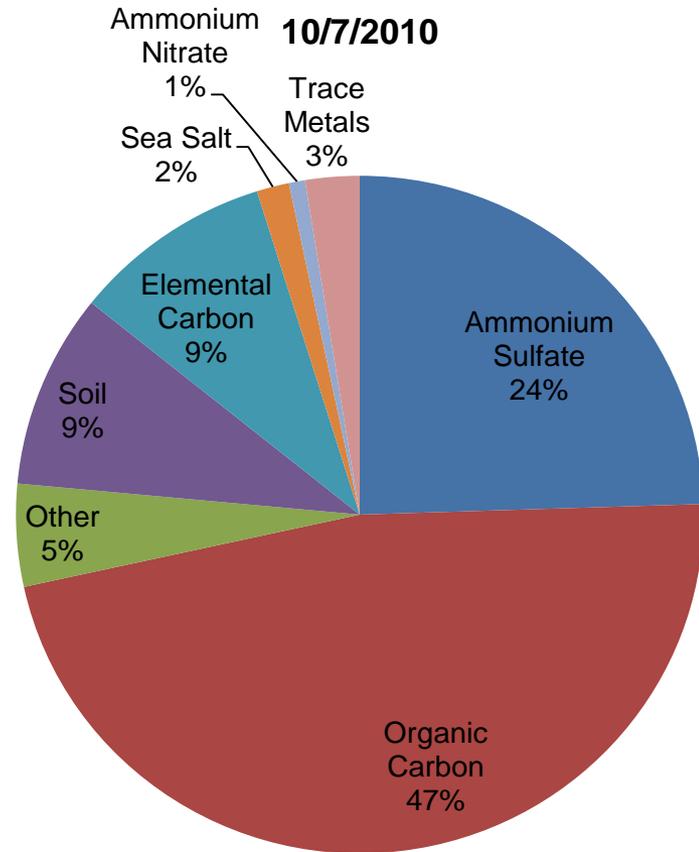
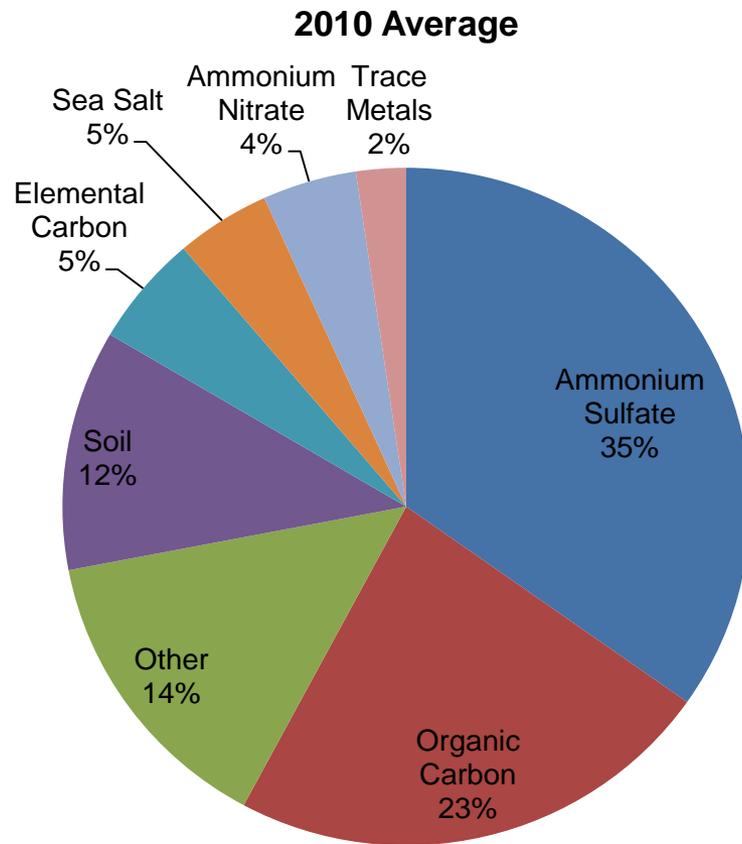
Source: NOAA Fire Products Archive,
<http://satepsanone.nesdis.noaa.gov/FIRE/fire.html>

Multi-Day Episode of Elevated Ozone and PM2.5

HGB daily maximum 8-hour ozone levels track the 24-hour average PM2.5 levels at Clinton Drive during the ramp-up, peak, and dissipation of this event.



Clinton Drive PM2.5 Speciation Indicated Elevated Organic Carbon and Average Sulfate



Fires Added an Estimated 9 ppb to the Ozone Transported into Houston from the NE

Background 8-hour ozone levels in the air approaching DFW were 54, which is 9 ppb less than the background levels in the air approaching HGB. DFW air quality on this day does not appear to be directly impacted by the fires.



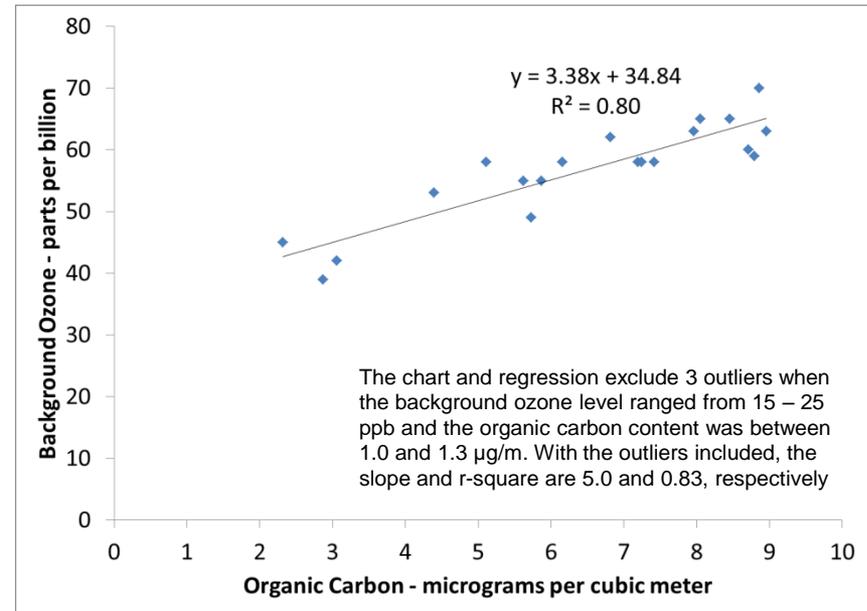
Estimated Fire Impacts based on Background Analysis

	8/27/2010	9/30/2010	10/1/2010	10/7/2010
CAMS 84 Observed Max	88	88	86	92
HGB Background	64	63	59	63
HGB Background Estimated from Fires	11	9	13	9
Estimated CAMS 84 Max O3 But For Fires	77	79	73	83

- Impacts from upwind fires were estimated for 4 days when 8-hour ozone levels at CAMS 84 exceeded the 84-ppb standard
- Each day had weather that was favorable for local ozone production and backward air trajectories that passed through the Lower Mississippi River Valley when numerous fires and widespread smoke were detected
- Background ozone levels on the upwind side of HGB ranged from 59 ppb – 64 ppb
- Background ozone levels along trajectory paths that did not pass through the Lower Mississippi River Valley were generally around 50 - 55 ppb
- The estimated impact from the fires on each day was assumed equal to the background ozone level upwind of HGB minus the background ozone levels along a trajectory path that did not pass near the fires
- The estimated fire impacts ranged from 9 ppb to 13 ppb; therefore

Estimated Fire Impacts based on Linear Regression

- The Clinton Drive PM2.5 organic carbon content was linearly related to the daily maximum 8-hour ozone level in the air approaching the upwind side of Houston during August 24 – October 31, 2010
- The slope of the regression line is 3.38, indicating that ozone increased by approximately 3.4 ppb for every $\mu\text{g}/\text{m}^3$ increase in organic carbon
- Therefore, the ozone attributed to the fires on any day is approximately equal to 3.4 times the difference between the organic carbon concentration on that day and the baseline organic carbon concentration
 - $O_3(\text{Fires}) = 3.4 \times [\text{OC} - \text{OC}(\text{baseline})]$
- Taking the median OC level for 2010 ($3.1 \mu\text{g}/\text{m}^3$) as the baseline, the amount of ozone attributed to the fires on each day of concern is given in the table to the right



	8/27/2010	9/30/2010	10/1/2010	10/7/2010
CAMS 84 Observed Max O3	88	88	86	92
HGB Background (including fire impact)	64	63	59	53
Organic Carbon ($\mu\text{g}/\text{m}^3$)	8.0	7.3*	8.8	8.0
Background O3 attributed to fires	17	14	19	17

* Average of 9/29 and 10/1 levels; no sample collected on 9/30