Technical Support Document For the Lamar Exceptional Events Occurring on:

February 8, 2013
April 9, 2013
May 1, 2013
May 24, 2013
May 25, 2013
May 28, 2013
December 24, 2013

Prepared by the
Air Pollution Control Division
Colorado Department of Public Health and Environment

April 20, 2015

Executive Summary

In 2005, Congress identified a need to account for events that result in exceedances of the National Ambient Air Quality Standards (NAAQS) that are exceptional in nature[1] (e.g., not expected to reoccur or caused by acts of nature beyond man-made controls). In response, EPA promulgated the Exceptional Events Rule (EER) to address exceptional events in 40 CFR Parts 50 and 51 on March 22, 2007 (72 FR 13560). On May 2, 2011, in an attempt to clarify this rule, EPA released draft guidance documents on the implementation of the EER to State, tribal and local air agencies for review. The EER allows for states and tribes to “flag” air quality monitoring data as an exceptional event and exclude those data from use in determinations with respect to exceedances or violations of the NAAQS, if EPA concurs with the demonstration submitted by the flagging agency.

Due to the semi-arid nature of parts of the state, Colorado is highly susceptible to windblown dust events. These events are often captured by various air quality monitoring equipment throughout the state, sometimes resulting in exceedances or violations of the 24-hour PM_{10} NAAQS. This document contains detailed information about the large regional windblown dust events that occurred in 2013. The Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD) has prepared this report for the U.S. Environmental Protection Agency (EPA) to demonstrate that the elevated PM_{10} concentrations recorded in 2013 in Lamar, Colorado, were caused by natural events.

EPA‘s June 2012 draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule states “the EPA will accept a threshold of a sustained wind of 25 mph for areas in the west provided the agencies support this as the level at which they expect stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed…”. In addition, in both eastern and western Colorado it has been shown that wind speeds of 30 mph or greater and gusts of 40 mph or greater can cause blowing dust (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). For these blowing dust events, it has been assumed that sustained winds of 30 mph and higher or wind gusts of 40 mph and higher can cause blowing dust in Colorado and the surrounding states.

The PM_{10} exceedances in Lamar throughout 2013 would not have occurred if not for the following: (a) dry soil conditions over source regions with 30-day precipitation totals below the threshold identified as a precondition for blowing dust; and (b) meteorological conditions that caused strong surface winds over the area of concern. These PM_{10} exceedances were due to exceptional events associated with regional windstorm-caused emissions from erodible soil sources outside the monitored areas. These sources are not reasonably controllable during significant windstorms under abnormally dry or moderate drought conditions.

APCD is requesting concurrence on exclusion of the PM_{10} values from the Lamar Municipal Building site (08-099-0002) on February 8, 2013, April 9, 2013, May 1, 2013, May 24, 2013, May 25, 2013, May 28, 2013 and December 24, 2013.

[1] Section 319 of the Clear Air Act (CAA), as amended by section 6013 of the Safe Accountable Flexible Efficient-Transportation Equity Act: A Legacy for Users (SAFE-TEA-LU of 2005, required EPA to propose the Federal Exceptional Events Rule (EER) no later than March 1, 2006.

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1.0 Exceptional Events Rule Requirements

In addition to the technical requirements that are contained within the EER, procedural requirements must also be met in order for EPA to concur with the flagged air quality monitoring data. This section of the report lays out the requirements of the EER and discusses how the APCD addressed those requirements.

1.1 Procedural Criteria

This section presents a review of the procedural requirements of the EER as required by 40 CFR 50.14 (Treatment of Air Quality Monitoring Data Influenced by Exceptional Events) and explains how APCD fulfills them.

The Federal EER requirements include public notification that an event was occurring, the placement of informational flags on data in EPA's Air Quality System (AQS), submission of initial event description, the documentation that the public comment process was followed, and the submittal of a demonstration supporting the exceptional events flag. APCD has addressed all of these procedural and documentation requirements.

Public notification that event was occurring (40 CFR 50.14(c)(1)(i))
APCD issued Blowing Dust Advisories for southeastern Colorado advising citizens of the potential for high wind/dust events on February 8, 2013, April 9, 2013, May 1, 2013. These areas included the town of Lamar. The advisories that were issued on February 9, 2013, April 9, 2013, April 30, 2013 can be viewed at: http://www.colorado.gov/airquality/report.aspx and are described further in Section 2.

For the events where APCD did not issue a specific Blowing Dust Advisory due to unforeseen and/or sudden weather changes, the APCD has developed and implemented processes and measures within the 2012 Natural Events Action Plan (NEAP) for Lamar (See http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=LamarNaturalEventsActionPlan2012.pdf), including public education programs and Best Available Control Measures (BACM). APCD asserts that continual public outreach and notification in the Lamar area is adequate on dates when drastic weather patterns prevented meteorologists from issuing timely advisories.

Place informational flag on data in AQS (40 CFR 50.14(c)(2)(ii))
APCD and other applicable agencies in Colorado submit data into EPA's AQS. Data from both filter-based and continuous monitors operated in Colorado are submitted to AQS.

When APCD and/or the Primary Quality Assurance Organization operating monitors in Colorado suspects that data may be influenced by an exceptional event, APCD and/or the other operating agency expedites analysis of the filters collected from the potentially-affected filter-based air monitoring instruments, quality assures the results and submits the data into AQS. APCD and/or other operating agencies also submit data from continuous monitors into AQS after quality assurance is complete.

If APCD and/or the applicable operating agency have determined a potential exists that the sample value has been influenced by an exceptional event, a preliminary flag is submitted with the measurement when the data are uploaded to AQS. The data are not official until they are certified by May 1st of the year following the calendar year in which the data were collected (40 CFR 58.15(a)(2)). The presence of the flag with a date/time stamp can be confirmed in AQS.

Notify EPA of intent to flag through submission of initial event description by July 1 of calendar year following event (40 CFR 50.14(c)(2)(iii))
In early 2011, APCD and EPA Region 8 staff agreed that the notification of the intent to flag data as an exceptional event would be done by submitting data to AQS with the proper flags and the initial event descriptions. This was deemed acceptable, since Region 8 staff routinely pull the data to review for completeness and other analyses.

On February 8, 2013, April 9, 2013, May 1, 2013, May 24, 2013, May 25, 2013, May 28, 2013 and December 24, 2013, sample values greater than 150 $\mu g/m^3$ were recorded in Lamar, Colorado during the high wind events that occurred on those days. These occurred at the monitor located in Lamar at the Municipal Building (SLAMS, 08-099-0002). This monitor is operated by APCD in partnership with local operators.

Document that the public comment process was followed for event documentation (40 CFR 50.14(c)(3)(iv))
APCD posted this report on the Air Pollution Control Division's webpage for public review. APCD opened a 30-day public comment period on March 12, 2015 and closed the comment period on April 12, 2015. A copy of the public notice certification (in cover letter), along with any comments received, will be submitted to EPA, consistent with the requirements of 40 CFR 50.14(c)(3)(iv).

> ***NOTE: No comments were received during the public comment period. Some minor non-substantial grammatical and formatting corrections were made.***

Submit demonstration supporting exceptional event flag (40 CFR 50.14(a)(1-2))
At the close of the comment period, and after APCD has had the opportunity to consider any comments submitted on this document, APCD will submit this document, along with any comments received (if applicable), and APCD's responses to those comments to EPA Region VIII headquarters in Denver, Colorado. The deadline for the submittal of this demonstration package is March 31, 2016 or one year prior to a regulatory action.

1.2 Documentation Requirements

Section 50.14(c)(3)(iv) of the EER states that in order to justify excluding air quality monitoring data, evidence must be provided for the following elements:

a. The event satisfies the criteria set forth in 40 CFR 501(j) that:
   (1) the event affected air quality,
   (2) the event was not reasonably controllable or preventable, and
   (3) the event was caused by human activity unlikely to recur in a particular location or was a natural event;
b. There is a clear causal relationship between the measurement under consideration and the event;
c. The event is associated with a measured concentration in excess of normal historical fluctuations; and
d. There would have been no exceedance or violation but for the event.

2.0 Meteorological analysis of the 2013 blowing dust events and PM_{10} Exceedances – Conceptual Model and Wind Statistics

Several powerful storm systems caused exceedances of the 24-hour PM_{10} standard in Lamar, Colorado in 2013. Exceedances were recorded in Lamar at the Lamar Municipal Building monitor. A meteorological analysis for each event is discussed further below.

EPA's June 2012, Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule states, "the EPA will accept a threshold of a sustained wind of 25 mph for areas in the west provided the agencies support this as the level at which they expect stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed…". In addition, in Colorado it has been shown that wind speeds of 30 mph or greater and gusts of 40 mph or greater can cause blowing dust (see the Lamar Blowing Dust Climatology available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). For these blowing dust events, it has been assumed that sustained winds of 30 mph and higher or wind gusts of 40 mph and higher can cause blowing dust in Colorado.

2.1 February 8, 2013 Meteorological Analysis

On February 8, 2013, a powerful winter storm system caused an exceedance of the 24-hour PM_{10} standard in Lamar, Colorado, at the Municipal Building monitor with a concentration of 159 $\mu g/m^3$. This elevated reading and the location of the monitor is plotted on a map of the Greater Lamar area in Figure 1. The exceedance in Lamar was the result of intense surface winds in advance of an approaching cold front. These surface features were associated with a strong upper-level trough that was moving across the western United States. The surface winds were predominantly out of a south to southwest direction which moved over dry soils in southeast Colorado, producing significant blowing dust.

High PM10 Natural Event in Colorado (February 8, 2013)

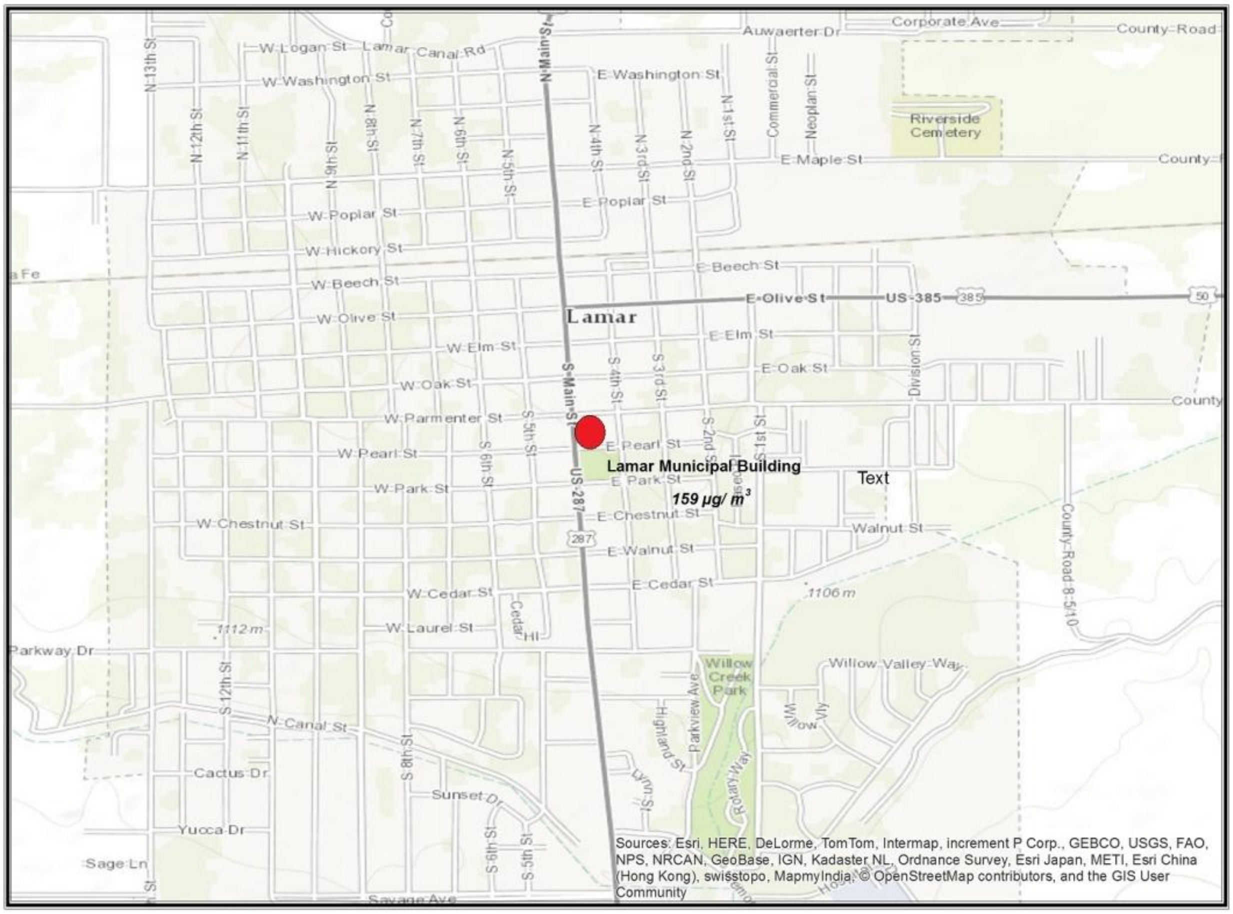


Figure 1: 24-hour PM_{10} concentrations for February 8, 2013.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The upper-level trough associated with this storm system is shown on the 700 mb and 500 mb height analysis maps at 5:00 PM MST, February 8, 2013 in Figure 2 and Figure 3, respectively. The 700 mb level is located roughly 3 kilometers above mean sea level (MSL) while the 500 mb level is approximately 6 km above MSL. These two charts show that a deep trough of low pressure was present at both the 700 and 500 mb level during the blowing dust event of February 8 and that it was moving over the southwestern United States. This is a typical upper-air pattern for blowing dust events in Colorado (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

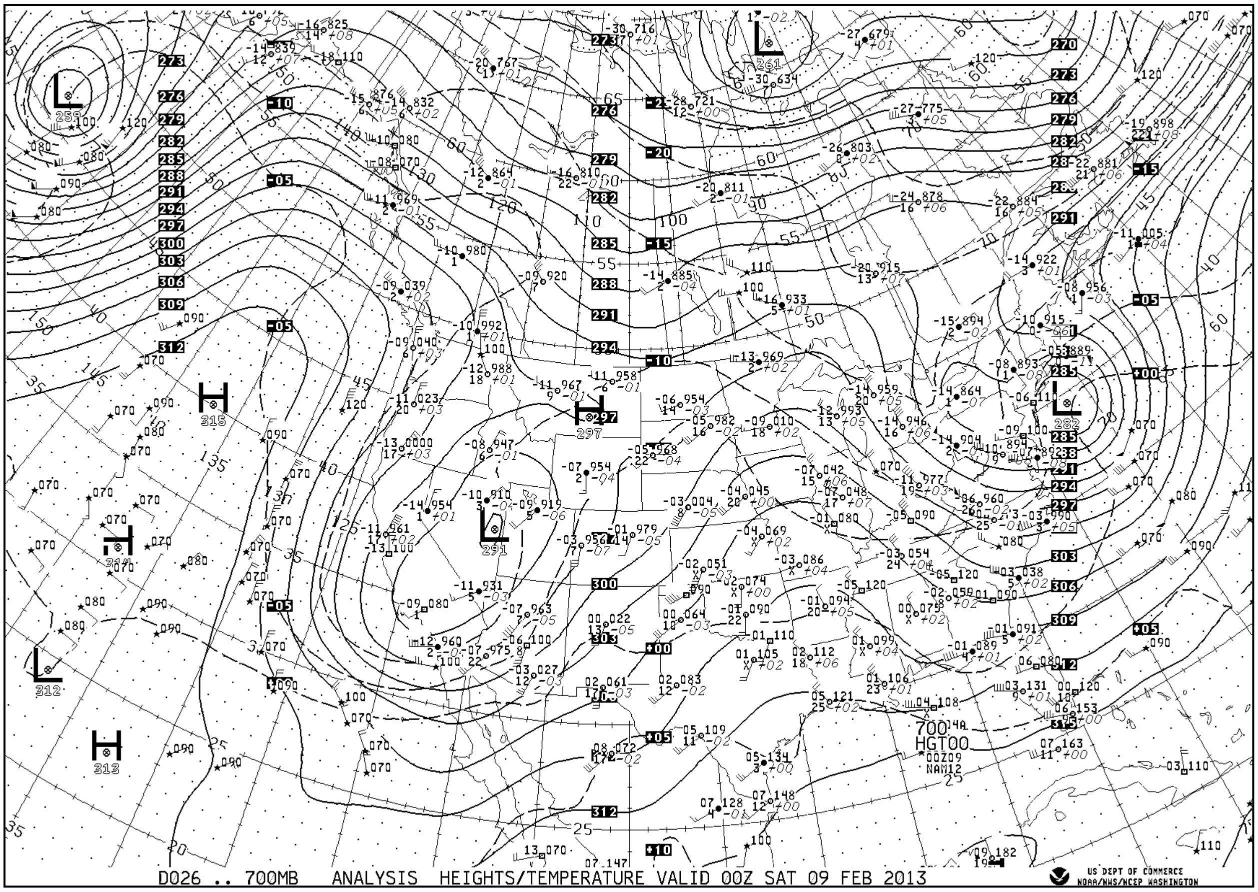


Figure 2: 700 mb (about 3 kilometers above mean sea level) analysis for 0Z February 9, 2013, or 5:00 PM MST February 8, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

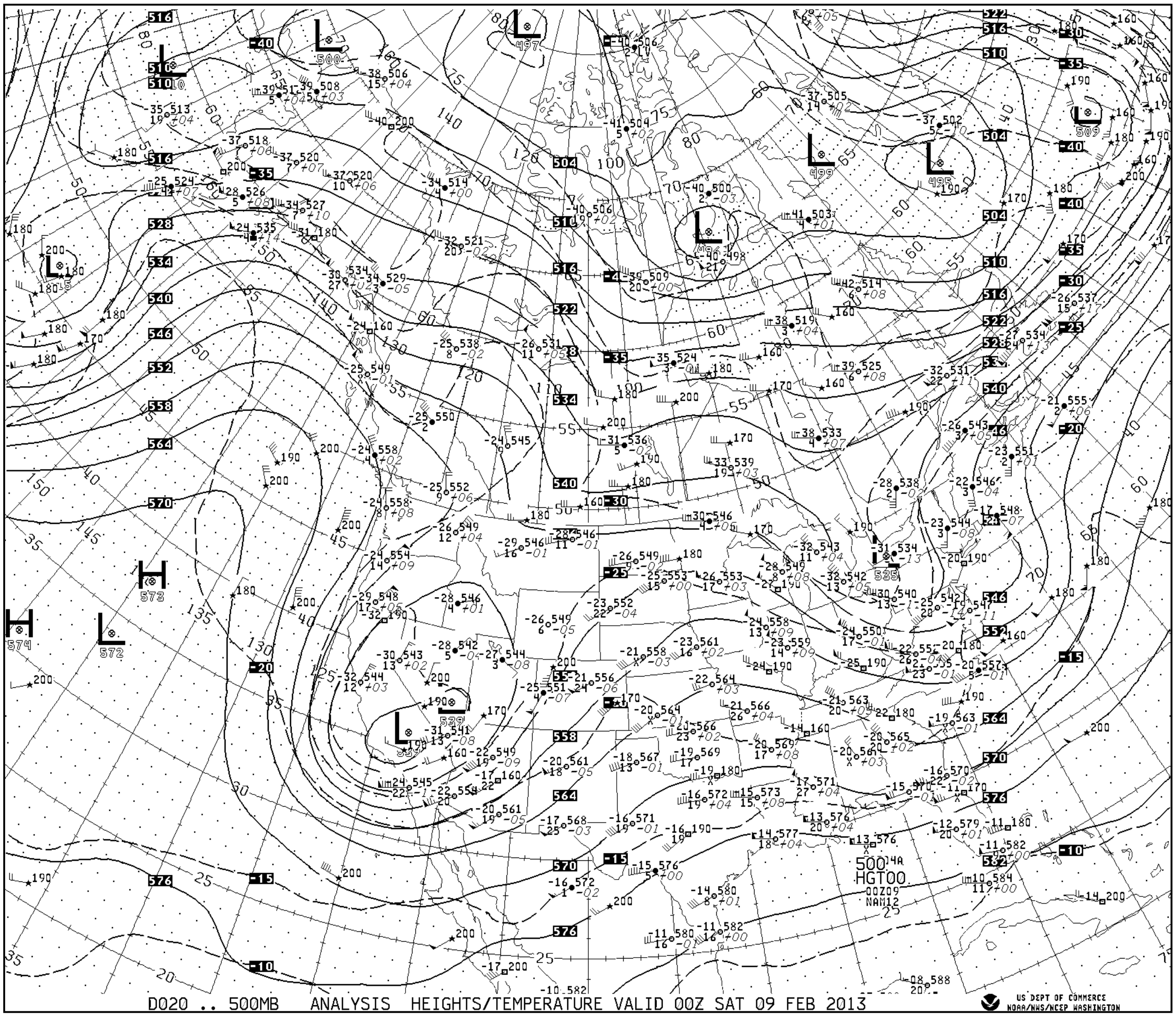


Figure 3: 500 mb (about 6 kilometers above mean sea level) analysis for 0Z February 9, 2013, or 5:00 PM MST February 8, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The surface weather associated with the storm system of February 8, 2013, is presented in Figure 4. Significant surface features impacting southeast Colorado at 2:00 PM MST (21Z) included an approaching cold front moving eastward from Arizona into New Mexico. This front was associated with a strong area of surface low pressure that was nearly stationary along the Nevada/Utah state line. The winds in eastern Colorado out ahead of this system were out of a south to southwest direction and intensifying during the afternoon hours of February 8, 2013.

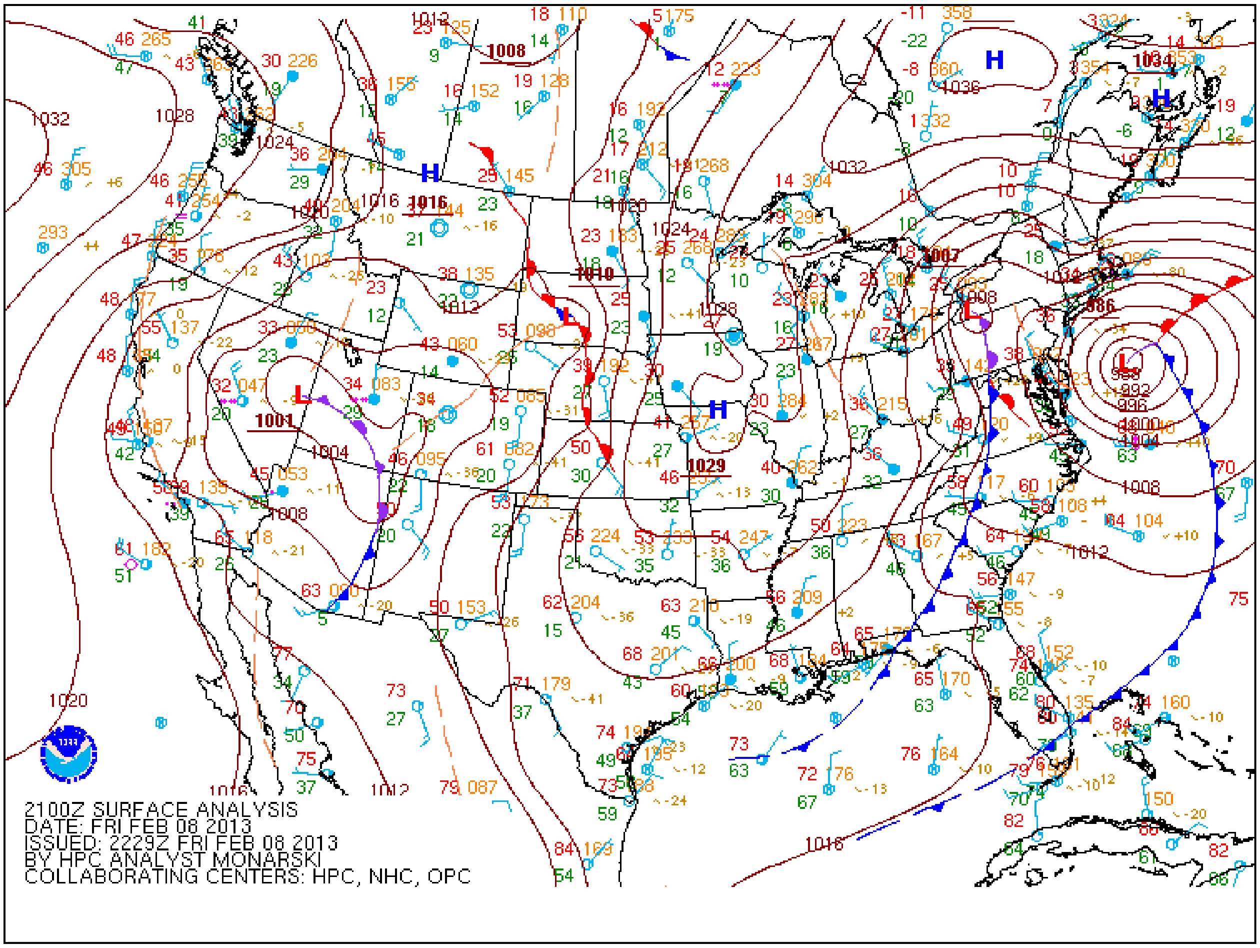


Figure 4: Surface analysis for 21Z February 8, 2013, or 2:00 PM MST February 8, 2013. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

In order to fully evaluate the synoptic meteorological scenario of February 8, 2013, regional surface weather maps are provided showing individual station observations during the height of the event in question. Figure 5 presents weather observations for eastern Colorado and adjacent states at (a) 3:10 PM and (b) 4:10 PM MST on February 8. On the map in Figure 5(a) the station observation for Lamar (LAA) shows winds sustained at 35 knots (40 mph), gusts to 44 knots (51 mph), and a reduced visibility of 2 statute miles with the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary).

One hour later at 4:10 PM MST (Figure 5(b)), visibility in Lamar continued to be highly obscured at 2 statute miles with the wind remaining very strong (sustained at 30 knots (35 mph) with gusts to 40 knots (46 mph)). Concurrently other weather stations around the region were starting to report blowing dust and reduced visibility, indicating that this dust storm was a regional event. In Burlington (ITR, located directly to the north-northeast of Lamar), the surface observation shows high winds, haze and visibility reduced to 6 statute miles.

Hourly surface observations, in table form, from Lamar and Burlington provide additional evidence that there was an extended period of high winds and haze (blowing dust) throughout eastern Colorado. Table 1 lists observations for the PM_{10} exceedance location of Lamar while Burlington observations can be found in Table 2. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) are highlighted in yellow. Collectively, Lamar and Burlington experienced many hours of reduced visibility along with sustained wind speeds and gusts at or above the thresholds for blowing dust.

Surface weather maps and hourly observations show that a regional dust storm occurred under south to southwesterly flow in advance of a cold front. This data provides clear evidence of blowing dust and winds well above the threshold speeds for blowing dust on February 8, 2013.

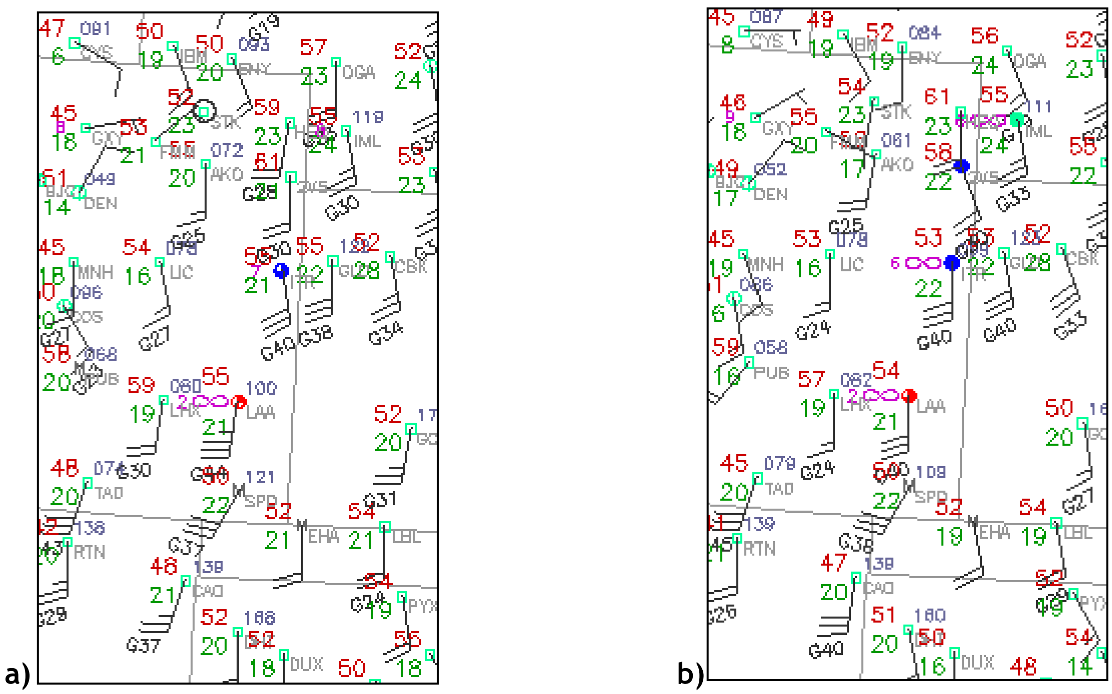


Figure 5: High Plains regional surface analysis for (a) 3:10 PM MST and (b) 4:10 PM MST, February 8, 2013.
(Source: http://www.mmm.ucar.edu/imagearchive/)

Table 1: Weather observations for Lamar, Colorado, on February 8, 2013
(Source: http://mesowest.utah.edu/)

Time MST February 8, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
4:53	31	56	10		230		10
5:53	36	50	15	22	210		10
6:53	34	54	10		210		10
7:53	41	42	18	27	200		10
8:53	46	35	22	32	190		10
9:53	51	29	28	36	190		10
10:53	52	29	31	40	190		10
11:53	56	25	30	43	180		10
12:53	58	24	39	46	190		10
13:53	57	25	39	50	190		10
14:51	55	26	30	47	190	haze	2.5
14:53	55	26	38	51	190	haze	2.5
15:06	54	28	43	54	190	haze	4
15:41	55	26	30	44	190	haze	5
15:53	54	28	35	50	190	haze	6
16:00	54	28	32	46	180	haze	2.5
16:12	54	28	30	37	180	haze	1.75
16:16	54	28	28	37	180	haze	2
16:24	54	28	27	36	180	haze	1.75
16:48	52	30	31	45	180	haze	3
16:53	52	31	31	45	180	haze	4
17:05	52	30	28	37	180	haze	2.5
17:14	52	30	29	43	180	haze	3
17:38	50	32	31	39	180		9
17:53	50	33	27	37	180		10
18:53	48	35	24	36	180		9
19:53	47	37	27	35	190		10
20:53	46	40	25	30	200		10
21:53	46	37	24	33	200		10
22:53	46	34	29	41	190		10
23:53	44	35	30	40	180		10

Table 2: Weather observations for Burlington, Colorado, on February 8, 2013.
(Source: http://mesowest.utah.edu/)

Time MST February 8, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	28	58	14		180		10
1:53	26	60	15		190		10
2:53	26	60	13		190		10
3:53	29	58	17		190		10
4:53	30	58	17		190		10
5:53	31	61	15		180		10
6:53	29	63	14		190		10
7:53	34	56	17		190		10
8:53	40	46	18		190		10
9:53	44	40	27	33	190		10
10:53	49	33	31		190		10
11:53	52	31	30	37	190		10
12:53	54	27	36	44	180		7
13:53	56	25	37	45	190		8
14:22	55	26	36	45	190	haze	5
14:53	55	27	33	43	180		7
15:00	55	26	36	46	170		7
15:18	54	28	38	45	180	haze	6
15:53	53	29	36	46	180	haze	6
16:17	52	30	36	47	190		8
16:53	49	34	32	43	180		8
17:15	48	34	32	44	180		10
17:53	44	43	28	33	170		10
18:53	43	43	24	31	170		10
19:53	42	43	30	37	180		10
20:53	41	41	28	35	180		10
21:53	38	44	22	31	180		10
22:53	35	47	17		170		10
23:53	33	51	15		140		10

Satellite imagery from February 8, 2013 provides strong supporting evidence that a dust storm caused the PM_{10} exceedance in Lamar and that it was regional in scale. Specifically, the GOES visible satellite image at 4:15 PM MST (2315Z) zoomed on eastern Colorado (Figure 6) reveals a number of faint north/south oriented dust plumes (circled in red). The National Oceanic and Atmospheric Administration (NOAA) Satellite Services Division is in agreement with the conclusion that these are indeed dust plumes. The Smoke Text Product from NOAA at 245Z, February 9, 2013 (7:45 PM MST, February 8) states:

> "An area of blowing dust originates in east-central Colorado and moves to the north. The blowing dust is observed starting at 08/2145Z and continues through sunset." (Source: http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2013/2013B090248.html)

The National Weather Service (NWS) in Pueblo also recognized blowing dust in the Area Forecast Discussion at 3:45 PM MST on February 8:

> "Have seen gusts in the 35-45 knot range over much of the eastern plains...and some areas of blowing dust have developed at mid afternoon around KLAA." (Source: http://mesonet.agron.iastate.edu/wx/afos/)

The north/south orientation of the plumes is consistent with the prevalent wind direction at the time of 180-190° (southerly) in Lamar (Table 1, 4:16 PM MST) and Burlington (Table 2, 4:17 PM MST). Also note from Table 2 at 4:17 PM MST (2 minutes after the satellite image), the weather observation from Burlington included sustained winds of 36 mph, gusts to 47 mph and a reduced visibility of 8 statute miles. This is an observation that is consistent with blowing dust conditions in southeast Colorado (30 mph sustained winds, 40 mph gusts – see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) and aligns well with the visible dust plumes located in relative close proximity to Burlington in Figure 6.

Webcam imagery was also able to capture the dust storm occurring during the afternoon of February 8. As stated in the previous paragraph, plumes of dust are evident in several parts of eastern Colorado at 4:15 PM MST from GOES visible satellite imagery (Figure 6). The web cam image (Figure 7) taken at 4:15 PM MST shows a discernible haze over the horizon at Gobblers Knob, which is located approximately 20 miles to the south of Lamar on Highway 287. At approximately the same time (4:18 PM MST), haze can be observed on the Firstview web camera in Figure 8. Firstview is located about 50 miles to the north of Lamar on Highway 40.

Satellite and webcam imagery combined with reports from NOAA offices on February 8 clearly reveal that a dust storm was taking place in southeast Colorado. This collection of data indicates that this was a regional event and therefore not controllable or preventable. The extended period of blowing dust in Lamar was the likely cause of the PM_{10} exceedance at the Municipal Building monitor.

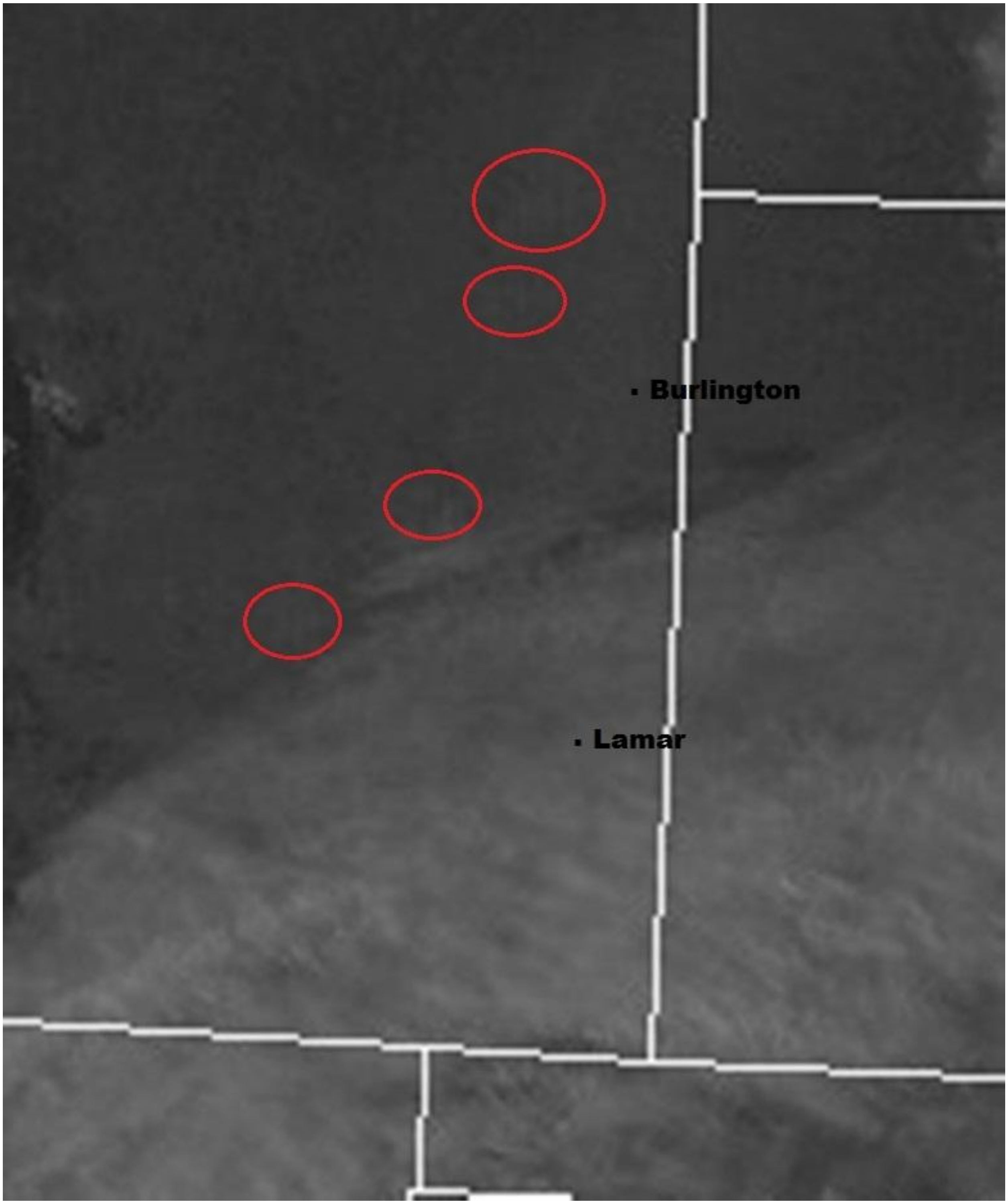


Figure 6: GOES visible satellite image at 4:15 PM MST (2315Z) February 8, 2013. (Source: http://www.mmm.ucar.edu/imagearchive/)

Figure 7: Gobblers Knob webcam image at 4:15 PM MST February 8, 2013.
(Source: http://amos.cse.wustl.edu/)

Figure 8: Firstview webcam image at 4:18 PM MST February 8, 2013.
(Source: http://amos.cse.wustl.edu/)

The synoptic weather conditions described above impacted a region that was in the midst of a severe to exceptional drought (Figure 9). Sustained drought conditions are known to make topsoil susceptible to high winds and produce blowing dust (see the following link from the National Climatic Data Center for more information: https://www.ncdc.noaa.gov/paleo/drought/drght_history.html). Figure 10 shows the total precipitation in inches from January 8, 2013 to February 7, 2013 for eastern Colorado and adjacent states. Almost the entire area from Lamar upwind (south to southwest) into northeast New Mexico received less than 0.5 inches of precipitation during the 30-day period leading up to the February 8 dust event in Lamar. Based on previous research 0.5 to 0.6 inches of precipitation over a 30-day period has been found to be the approximate threshold, below which, blowing dust exceedances at Lamar are more likely to occur when combined with high winds (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in southeast Colorado and northeast New Mexico were dry enough to produce blowing dust when winds were at or above the thresholds for blowing dust. This information, combined with other evidence provided in this report, proves that this dust storm was a natural, regional event that was not reasonably controllable or preventable.

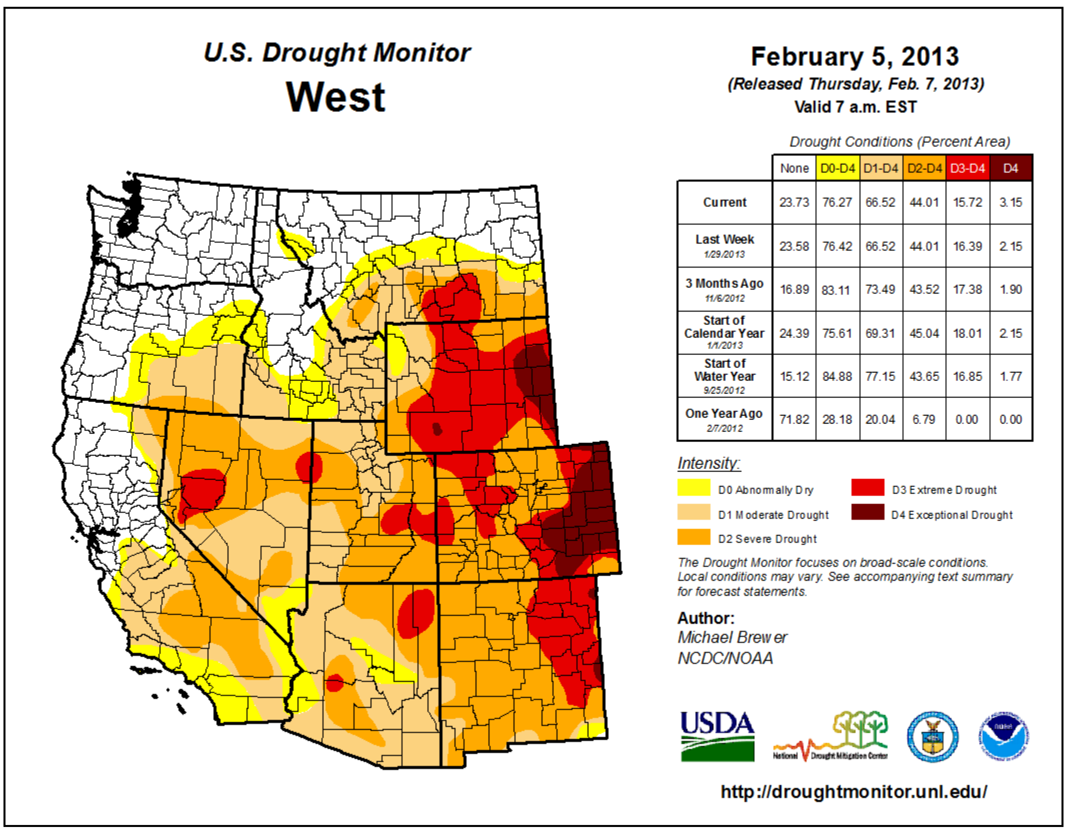


Figure 9: Drought conditions for the Western U.S. at 5:00 AM MST February 5, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

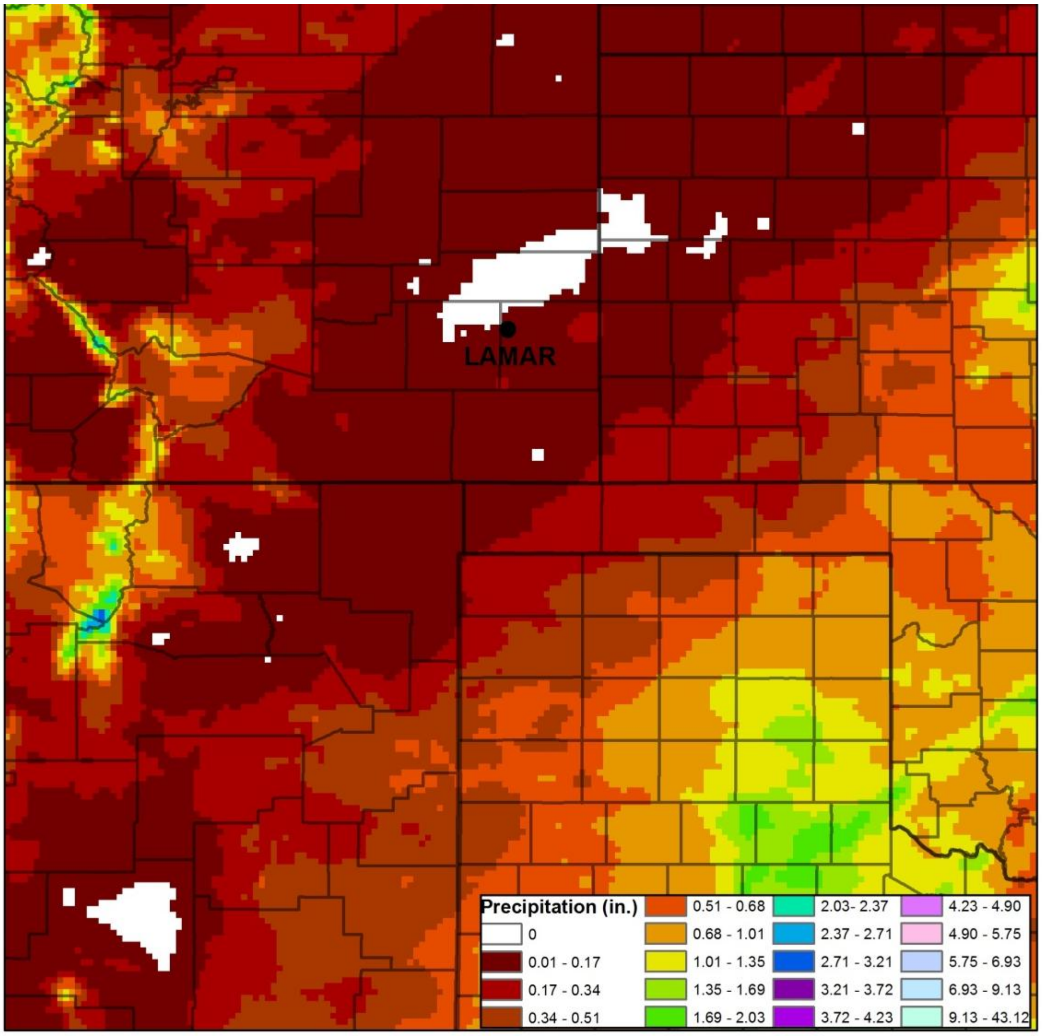


Figure 10: Total precipitation in inches for the eastern Colorado and adjacent states, January 8, 2013 – February 7, 2013.
(Source: http://prism.nacse.org/recent/).

2.2 April 9, 2013 Meteorological Analysis

On April 9, 2013, a powerful spring storm system caused an exceedance of the 24-hour PM_{10} standard in Lamar, Colorado, at the Municipal Building monitor with a concentration of 1220 µg/m3. This highly elevated reading and the location of the monitor is plotted on a map of the Greater Lamar area in Figure 11. The exceedance in Lamar was the result of intense surface winds in the wake of a passing cold front. These surface features were associated with a strong upper-level trough that was moving across the western United States. The surface winds were predominantly out of a northerly direction which moved over dry soils in eastern Colorado, producing significant blowing dust.

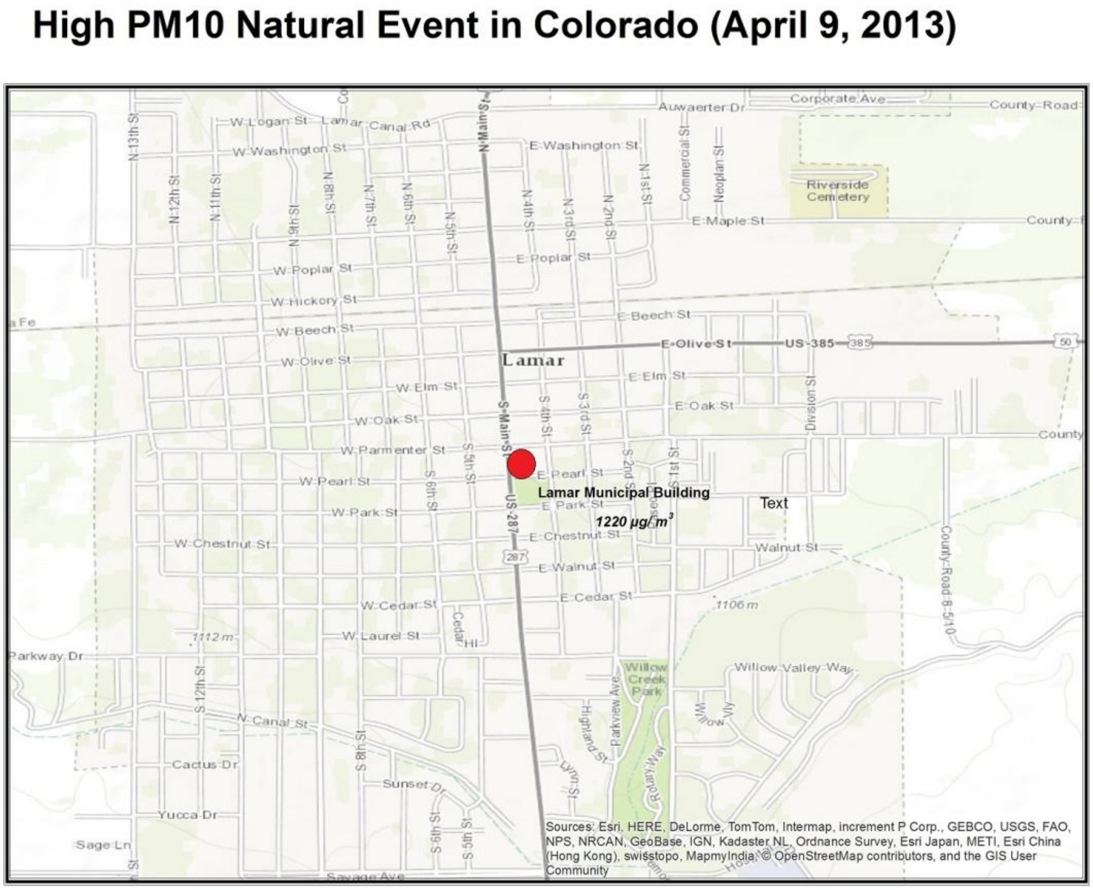


Figure 11: 24-hour PM_{10} concentrations for Lamar monitors, April 9, 2013.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The upper-level trough associated with this storm system is shown on the 700 mb and 500 mb height analysis maps at 5:00 AM MST, April 9, 2013 in Figure 12 and Figure 13, respectively. The 700 mb level is located roughly 3 kilometers above mean sea level (MSL) while the 500 mb level is approximately 6 kilometers above MSL. These two charts show that a deep trough of low pressure was present at both the 700 and 500 mb level during the blowing dust event of April 9 and that it was moving over the southwestern United States. This is a typical upper-air pattern for blowing dust events in Colorado (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

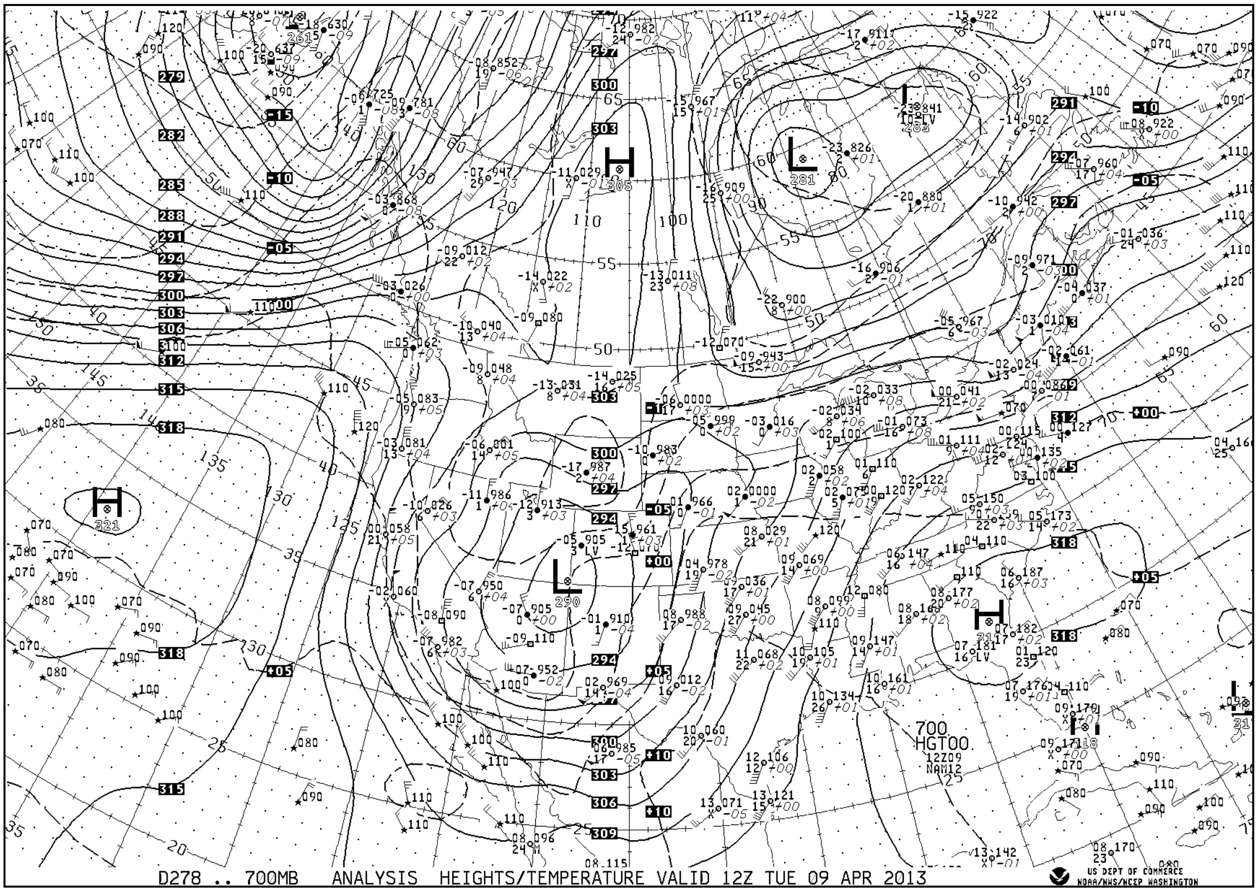


Figure 12: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z April 9, 2013, or 5:00 AM MST April 9, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

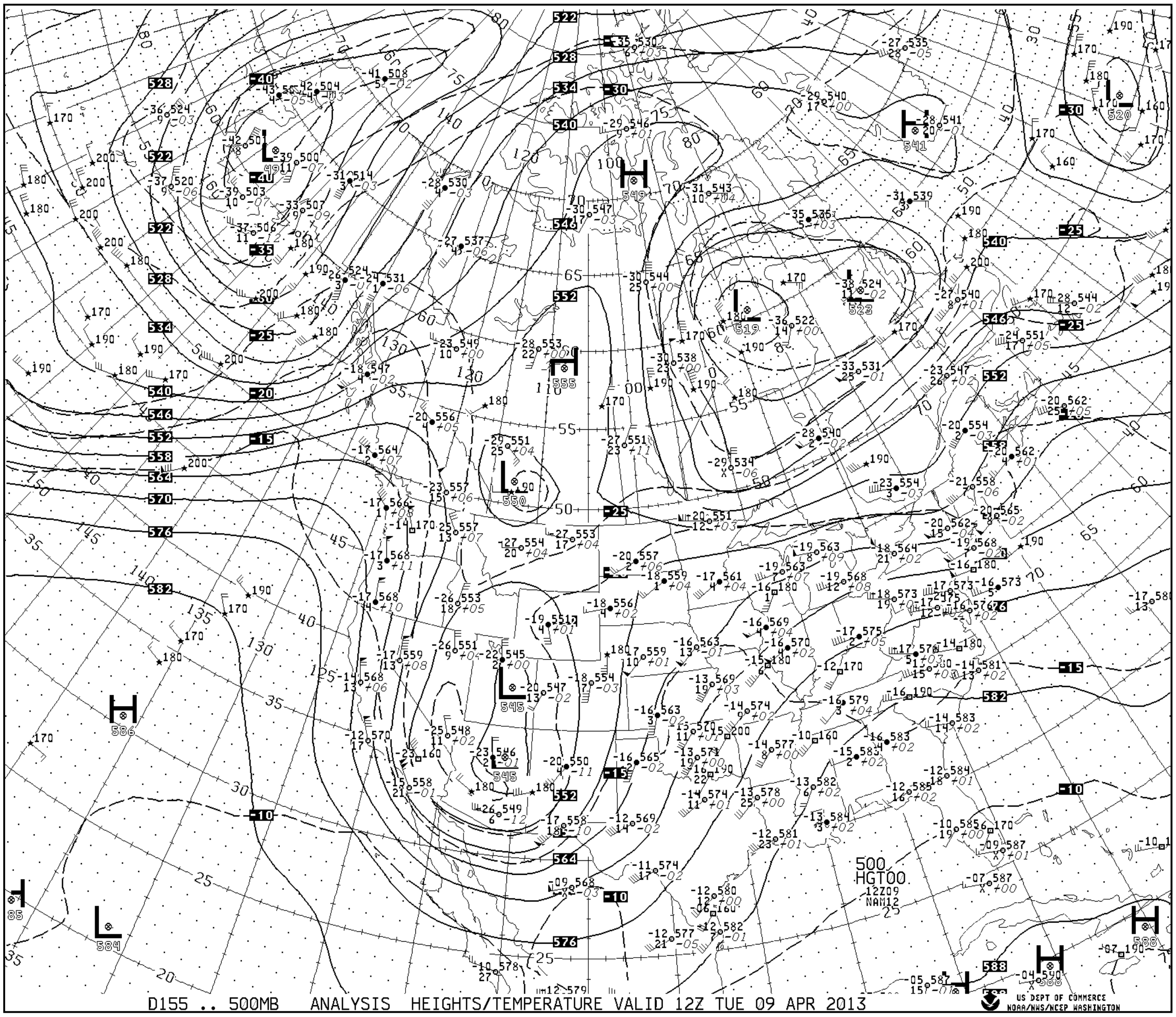


Figure 13: 500 mb (about 6 kilometers above mean sea level) analysis for 12Z April 9, 2013, or 5:00 AM MST April 9, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The surface weather associated with the storm system of April 9, 2013, is presented in Figure 14 and Figure 15. Significant surface features at 11:00 PM MST, April 8 (6Z, April 9, Figure 14) included a significant amount of “bunching” of isobars in eastern Colorado, indicating that a strong pressure gradient was in place. Wind speed is directly proportional to the pressure gradient, so a higher pressure gradient will produce stronger winds (see the following link for additional information on pressure gradient and its relationship to wind speed from the National Oceanic and Atmospheric Administration (NOAA): http://www.srh.noaa.gov/jetstream/synoptic/wind.htm). This tightening of the isobars spread southward behind a cold front which increasingly impacted southeast Colorado, including Lamar. By 5:00 AM MST (12Z, Figure 15) the pressure gradient had become very strong throughout the plains of eastern Colorado. This was in response to a building ridge of high pressure in eastern Montana interacting with a number of intense low pressure areas extending along the cold front from northeast New Mexico northeastward into central Kansas.

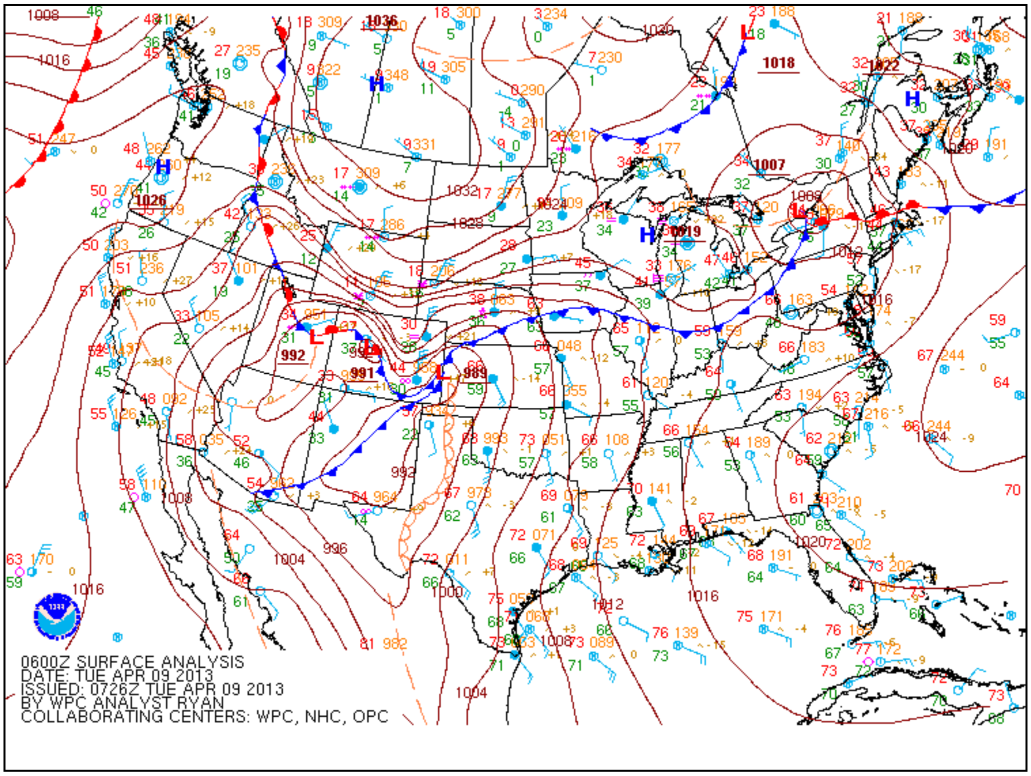


Figure 14: Surface Analysis for 6Z April 9, 2013, or 11:00 PM MST April 8, 2013. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

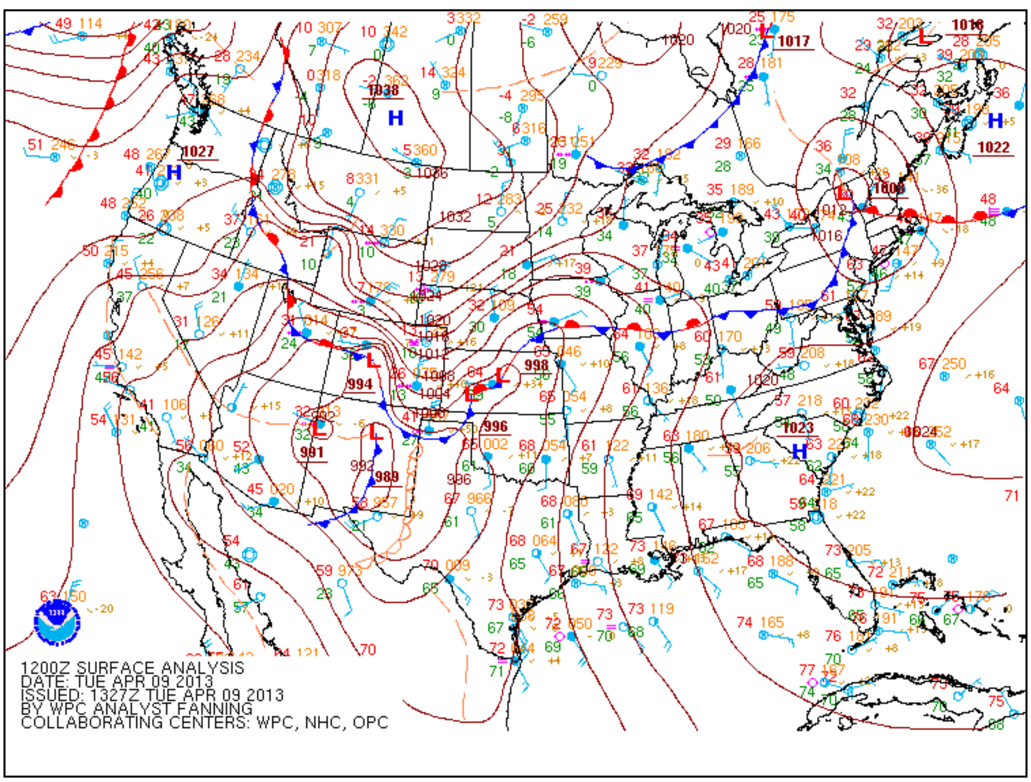


Figure 15: Surface Analysis for 12Z April 9, 2013 or 5:00 AM MST April 9, 2013. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

In order to fully evaluate the synoptic meteorological scenario of April 9, 2013, regional surface weather maps are provided showing individual station observations during the height of the event in question. Figure 16 presents weather observations for eastern Colorado and adjacent states at (a) 11:13 PM MST, April 8, and (b) 1:13 AM MST and (c) 4:13 AM MST, April 9. On the map in Figure 16(a) the station observation for Lamar (LAA) shows winds sustained at 25 knots (29 mph), gusts to 34 knots (39 mph), and a reduced visibility of 1 statute mile with the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary). Also note that in nearby La Junta (LHX) to the west of Lamar, high winds and haze were also being reported with very strong winds. This suggests that blowing dust was not localized to the Lamar area.

Two hours later at 1:13 AM MST (Figure 16 (b)), visibility in Lamar continued to be highly obscured at 1 statute mile and the wind had become considerably stronger (sustained at 40 knots (46 mph) with gusts to 50 knots (58 mph)). This is a period of time when Lamar likely received a significant amount of blowing dust, evidenced by hourly surface observations and a radar analysis to follow in this report.

At 4:13 AM MST (Figure 16(c)) there was marginal improvement in Lamar with sustained winds dropping to 25 knots (29 mph), gusts to 42 knots (48 mph) and a visibility of 3 statute miles. However, these are still observations that are largely consistent with blowing dust conditions in Lamar (30 mph sustained winds, 40 mph gusts -- see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). Also note that blowing dust conditions had spread to the south of Lamar as the cold front plunged into New Mexico, Oklahoma and Texas. High winds, haze and reduced visibility had reached Clayton, New Mexico (CAO) and Dalhart, Texas (DHT), indicating that this dust storm was a regional event.

Hourly surface observations, in table form, from Lamar and other weather stations in the region provide supporting evidence that there was an extended period of high winds and haze (blowing dust) in southeast Colorado and large sections of the High Plains. Table 3 lists observations for the PM_{10} exceedance location of Lamar while observations for Burlington and La Junta, Colorado along with Clayton, New Mexico and Dalhart, Texas can be found in Table 4 through Table 7, respectively. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) are highlighted in yellow. Collectively, these five sites experienced many hours of reduced visibility along with sustained wind speeds and gusts at or well above the thresholds for blowing dust.

Surface weather maps and hourly observations show that a regional dust storm occurred under northerly flow in the wake of a cold front. This data provides clear evidence of blowing dust and winds well above the threshold speeds for blowing dust on April 9, 2013.

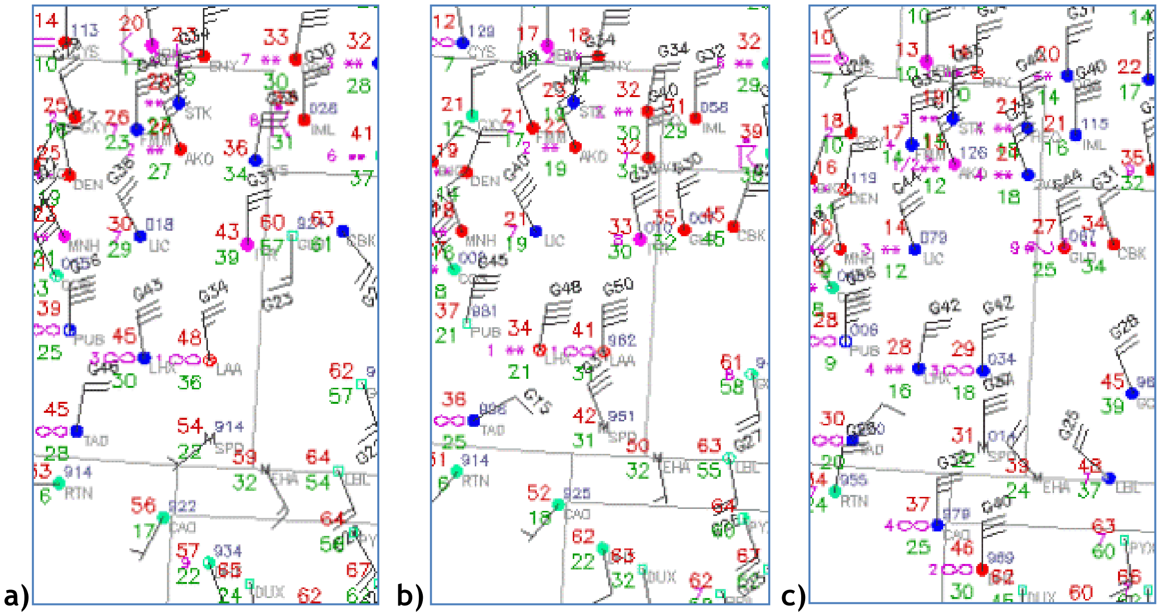


Figure 16: High Plains regional surface analysis for (a) 11:13 PM MST, April 8, 2013 and (b) 1:13 AM and (c) 4:13 AM MST, April 9, 2013.
(Source: http://www.mmm.ucar.edu/imagearchive/)

Table 3: Weather observations for Lamar, Colorado, on April 9, 2013
(Source: http://mesowest.utah.edu/)

Time MST April 9, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:27	43	70	36	50	350	haze	2
0:36	43	65	33	55	350	haze	1
0:44	43	65	40	56	360	haze	1
0:53	41	67	46	58	360	haze	1
1:15	39	70	43	58	360	haze	1
1:24	39	70	43	54	360	haze	2
1:43	37	70	37	53	360	haze	2
1:53	38	67	43	54	360	haze	2
2:12	36	69	41	55	350	haze	3
2:23	36	64	38	51	360	haze	2
2:53	32	66	29	40	360	haze	3
3:08	30	69	32	47	360	haze	3
3:20	30	64	30	45	10	haze	3
3:31	30	64	31	41	360	haze	3
3:53	29	63	31	48	360	haze	3
4:53	27	68	33	47	360	haze	4
5:53	25	62	28	46	360	haze	3
6:23	25	58	36	48	360	haze	2
6:32	25	58	32	46	10	haze	3
6:41	23	63	30	43	360	haze	3
6:53	24	59	31	44	360	haze	3
7:03	25	58	32	45	360	haze	3
7:51	21	62	31	43	360	haze	3
7:53	22	62	25	43	360	haze	3
8:33	21	62	24	40	10	haze	3
8:41	21	62	25	36	360	haze	3
8:53	22	65	27	35	10	haze	4
9:53	22	71	20	28	350	haze	6
10:53	22	62	22	32	360		8
11:53	24	54	23	30	360		7
12:16	25	49	24	32	360	haze	6
12:53	26	48	23	31	10		8

Table 4: Weather observations for Burlington, Colorado, on April 8/9, 2013 (Source: http://mesowest.utah.edu/)

Time MST April 8/9, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
21:53	57	81	17		130		10
22:26	55	77	32	38	290	squalls	10
22:43	57	82	16	31	280		10
22:53	48	86	21	28	340		10
23:05	43	87	28	36	360		10
23:53	36	89	24	36	350		10
0:53	33	88	32	41	350		8
1:13	32	93	28	38	340	lt frz rain; fog	6
1:22	32	93	29	41	350	lt frz rain; fog	6
1:42	32	93	31	44	350	lt frz rain; fog	4
1:53	32	88	30	44	350	lt frz rain; fog	4
2:04	30	93	27	39	350	lt frz rain; fog	5
2:11	30	93	30	44	350	lt frz rain; fog	5
2:49	28	93	29	47	350	lt frz rain; fog	6
2:53	29	89	33	47	350	lt frz rain; fog	6
11:49	18	79				haze	1
11:53	16	80				haze	1
12:13	16	79				mod snow	1
12:53	17	80	27	63	350	mod snow	1
13:53	17	80	27	40	350	lt snow	1
14:24	18	79	32	43	360	lt snow	1
14:38	18	79	25	39	360	lt snow	2
14:49	18	79	29	38	350	lt snow	2
14:53	17	76	25	37	350	lt snow	2
15:03	16	79	27	35	340	lt snow	1
15:42	16	79	24	32	340	lt snow	1
15:53	15	80	27	37	350	lt snow	2
16:01	16	79	21	36	360	lt snow	3

Table 5: Weather observations for La Junta, Colorado, on April 8/9, 2013
(Source: http://mesowest.utah.edu/)

Time MST April 8/9, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
21:19	55	47	33	40	340	haze	3
21:26	54	50	36	45	340	haze	2
21:31	52	54	35	45	340	haze	2
21:39	52	54	38	45	350	haze	2
21:53	48	58	38	47	350	haze	3
22:09	46	61	36	47	350	haze	2
22:30	46	61	32	38	360	haze	3
22:49	45	57	32	40	360	haze	2
22:53	44	57	43	50	360	haze	3
23:01	45	57	36	50	350	haze	3
23:11	43	61	39	52	350	haze	2
23:20	43	56	37	55	340	haze	1
23:24	43	56	40	55	350	haze	1
23:33	41	61	43	53	360	haze	1
23:41	41	61	37	53	350	haze	2
23:53	40	59	30	53	350	haze	2
23:56	39	60	46	52	360	haze	2
0:09	39	60	32	51	360	haze	4
0:27	37	65	39	48	360	lt snow	2
0:53	36	59	40	53	360	lt snow	2
1:08	34	59	47	55	10	lt snow	1
1:22	34	59	36	55	360	lt snow	1
1:31	34	55	38	48	350	lt snow	2
1:44	32	59	41	50	360	lt snow	1
1:53	32	58	39	52	360	lt snow	1
2:04	32	59	40	52	360	lt snow	1
2:24	30	59	30	44	360	lt snow	2
2:32	30	59	39	48	360	lt snow	2
2:53	30	58	36	48	360	lt snow	1
3:07	28	63	40	53	360	lt snow	2
3:49	28	59	36	48	10	lt snow	3
3:53	28	60	37	47	10	lt snow	4
4:06	28	59	31	48	10	lt snow	4
4:53	26	57	30	41	360	lt snow	6
5:53	25	55	29	38	360	haze	6

Table 6: Weather observations for Clayton, New Mexico, on April 9, 2013 (Source: http://mesowest.utah.edu/)

Time MST April 9, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:55	52	26	8		220		10
1:55	51	27	8		280		10
2:21	46	49	25	33	360	haze	5
2:52	43	56	30	38	360	haze	3
2:55	42	59	28	38	360	haze	3
3:04	41	61	29	39	350	haze	3
3:14	39	65	31	38	360	haze	3
3:55	37	61	28	37	360	haze	4
4:55	32	63	29	38	350	haze	4
5:34	30	64	31	43	350	haze	5
5:55	30	63	35	43	350	haze	5
6:55	29	63	36	50	350	haze	5
7:55	30	55	38	51	350		7
8:44	30	55	38	46	350		8
8:55	28	55	38	50	350		7
9:35	32	47	38	47	360		9
9:55	32	49	35	48	340		8
10:55	33	43	36	48	340		9
11:55	35	38	35	45	350		10
12:55	31	43	33	41	360		10
13:06	30	43	33	41	350		10
13:35	34	40	32	44	360		10
13:42	30	47	31	41	360		10
13:55	31	43	35	41	350		10
14:25	30	43	25	40	350		10
14:55	28	46	29	39	350		10
15:23	30	43	33	41	360		10
15:55	28	46	31	40	340		10
16:26	27	46	30	40	350		10
16:41	27	46	28	41	350		10
16:55	26	48	28	44	350		10

Table 7: Weather observations for Dalhart, Texas, on April 9, 2013 (Source: http://mesowest.utah.edu/)

Time MST April 9, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:52	62	21	12		170		10
1:52	64	21	14		170		10
2:52	61	27	8		160		10
3:23	48	50	32	50	360	haze	2
3:28	48	50	30	50	350	haze	2
3:52	46	53	33	46	360	haze	3
4:52	41	56	32	43	360	haze	3
5:05	39	60	31	45	360	haze	3
5:38	37	60	35	43	360	haze	3
5:49	37	56	33	45	360	haze	3
5:52	37	56	35	43	360	haze	3
5:59	37	52	31	44	360	haze	3
6:06	36	55	38	46	360	haze	2
6:52	34	59	37	47	360	haze	2
6:59	34	59	36	45	360	haze	3
7:52	35	54	35	48	360	haze	3
8:04	36	51	32	46	360	haze	3
8:20	34	55	38	50	10	haze	3
8:36	36	51	37	48	360	haze	3
8:52	34	51	38	48	360	haze	3
9:00	34	51	37	53	360	haze	3
9:12	34	51	36	47	360	haze	3
9:52	33	51	39	46	360	haze	4
10:52	33	49	38	47	10	haze	6
11:52	34	47	37	46	360		8
12:52	33	47	31	43	350		7
13:52	35	41	33	43	360		7
14:52	32	49	31	39	360		8
15:52	30	51	32	41	360		8
16:52	29	46	33	44	360		9

Radar and satellite imagery provide strong supporting evidence that a regional dust storm was taking place during the late evening of April 8, 2013 and continued through the early morning of April 9, 2013. The Goodland, Kansas radar image at 10:24 PM MST, April 8 (Figure 17) shows an extended band of 20-30dBZ radar returns stretching from Bird City, Kansas southwest to Burlington, Colorado. Two minutes after this radar image, Table 4 reveals that Burlington recorded a rapid increase in wind speed. Sustained winds jumped to 32 mph with gusts to 38 mph. Furthermore, the 10:26 PM MST observation includes “squalls”. A squall is a strong wind characterized by a sudden onset in which the wind speed increases at least 16 knots and is sustained for 22 knots or more for at least one minute (Source: http://w1.weather.gov/glossary/index.php?letter=s). Squalls often loft blowing dust as evidenced by the blowing dust event of June 13, 2014 in West Texas (see the following link for more information: http://www.srh.noaa.gov/lub/?n=events-2014-20140613-storms). By comparing the image from Figure 17 to similar radar imagery from the June 13, 2014 dust event, a strong case can be made that the radar echoes impacting Burlington in Figure 17 were an elongated and fairly significant wall of dust.

This blowing dust signature on the radar would continue for the next several hours and move in a south-southeasterly direction. At 12:45 AM MST, April 9, 2013, the thin northeast to southwest oriented line was moving through Grinnell and Russell Springs, Kansas (Figure 18). There is good reason to believe that this line of blowing dust also extended southwestward into southeast Colorado. One minute before this radar image, Lamar was reporting intense blowing dust conditions with sustained winds of 40 mph, gusts to 56 mph, haze and visibility reduced to 1 statute mile (Table 3). Why does the radar not show more intense radar echoes near Lamar at this time? The likely reason is the gap in NEXRAD coverage in southeast Colorado, with the lowest radar returns available ranging from 6,000 to 10,000 ft. above ground level (Figure 19). The radar beam could very well have been overshooting the wall of dust which was likely concentrated relatively close to the surface.

The line of blowing dust continued to push to the south-southeast, which produced observations climatologically consistent with blowing dust in Clayton, New Mexico (Table 6) and Dalhart, Texas (Table 7). By 6:45 AM MST, the first GOES visible satellite image of the day reveals the line of blowing dust moving through the Texas panhandle (Figure 20). The National Oceanic and Atmospheric Administration (NOAA) Satellite Services Division was in agreement with the conclusion that blowing dust was occurring across the region. The Smoke Text Product from NOAA at 8:00 AM MST on April 9, 2013, stated:

> "In the first visible images today, significant areas of blowing dust can be seen in the Southwest US into Mexico." (Source: http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2013/2013D091456.html)

Additionally, NOAA believed that blowing dust and sand were occurring in southeast Colorado:

> "Extensive cloudiness in the central plains obscures viewing the full extent of the blowing dust/sand but models suggest the area may extend well into the central plains effecting [sic] the majority of western Oklahoma and Kansas as well as southeastern Colorado." (Source: http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2013/2013D091456.html)

The National Weather Service (NWS) in Pueblo also recognized blowing dust in their Area Forecast Discussion at 10:11 AM MST:

> "The main impacts so far this morning have been wind...blowing dust and very cold air working its way into the plains." (Source: http://mesonet.agron.iastate.edu/wx/afos/)

Webcam imagery was also able to capture the dust storm occurring during the morning hours of April 9, 2013. Referring back to Table 3, at 6:23 AM MST Lamar was reporting sustained winds of 36 mph with gusts to 48 mph, haze and a reduced visibility of 2 statute miles. By viewing two local web cam images at around the same time we can see that a dust storm was in progress. The web cam image at Gobblers Knob (20 miles south of Lamar, Figure 21) at 6:15 AM MST shows a considerable amount of airborne dust with the horizon highly obscured.

Conditions were similar at Firstview (50 miles north of Lamar, Figure 22) at 6:19 AM MST with significant blowing dust easily discernible.

Radar, satellite and webcam imagery combined with reports from NOAA offices on April 9 clearly reveal that a dust storm was taking place in the High Plains region, including southeast Colorado. This indicates that this was a regional event and therefore not controllable or preventable. The extended period of blowing dust in Lamar was the likely cause of the PM_{10} exceedance at the Municipal Building monitor.

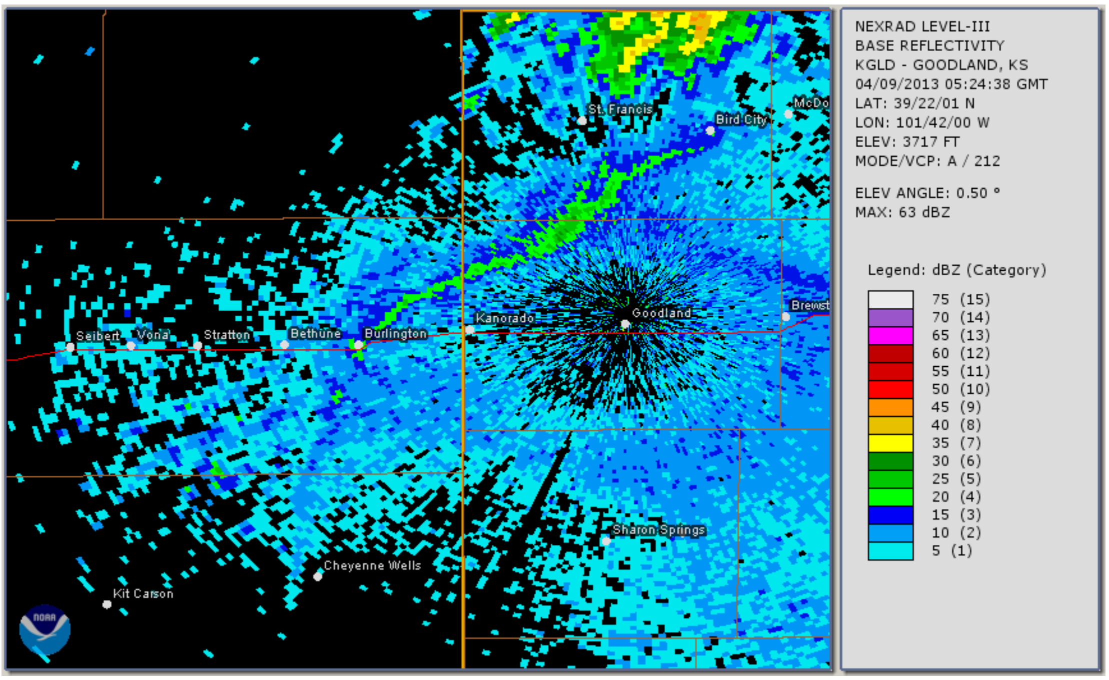


Figure 17: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Goodland, KS radar at 10:24 PM MST (524Z, April 9), April 8, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

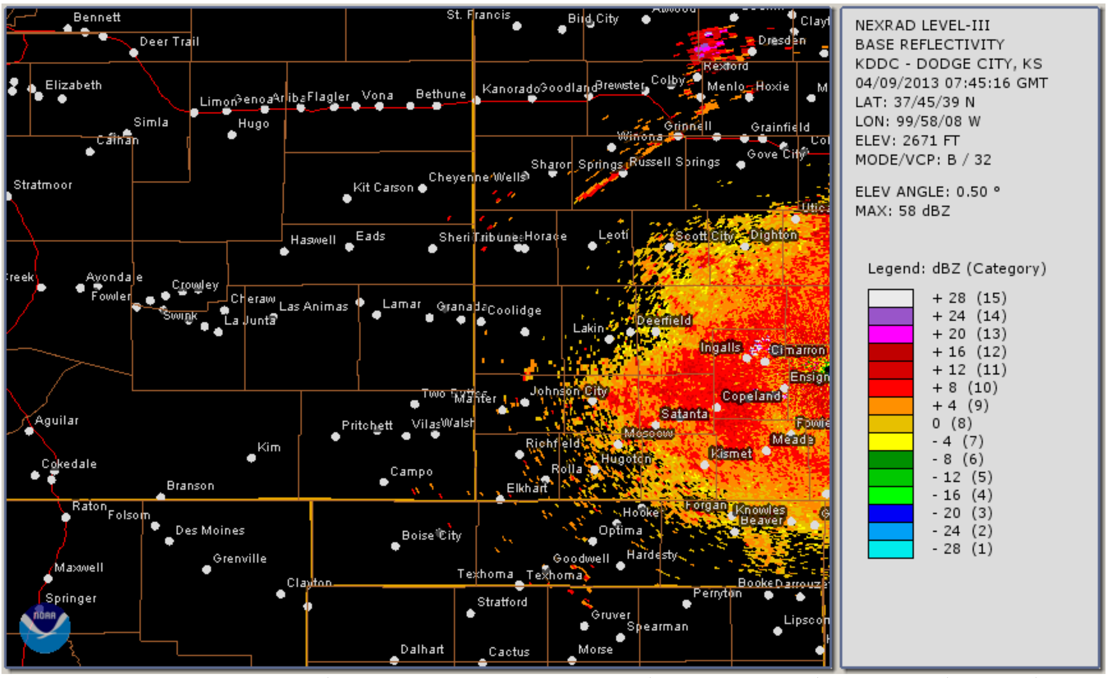


Figure 18: NEXRAD Base Reflectivity image, 0.50º elevation angle, from the Dodge City, KS radar at 12:45 AM MST (745Z), April 9, 2013. (Source: http://www.ncdc.noaa.gov/nexradinv/)

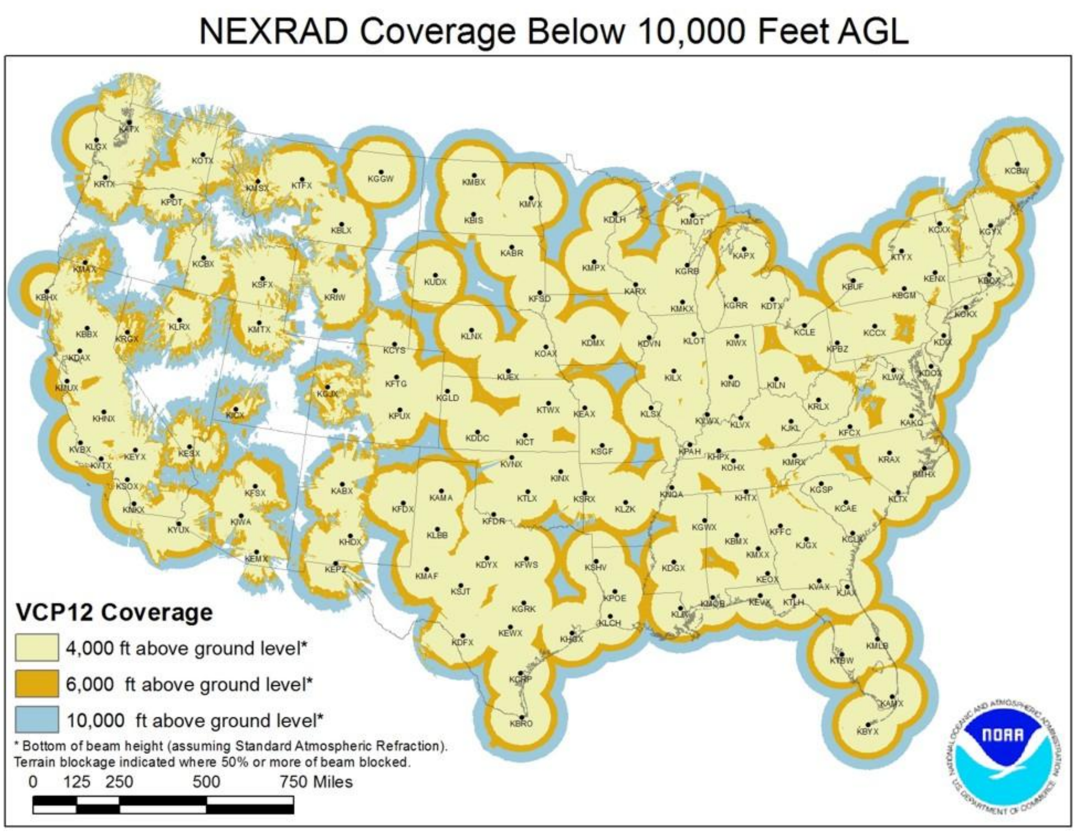


Figure 19: NEXRAD coverage below 10,000 ft. above ground level. (Source: http://www.roc.noaa.gov/WSR88D/Maps.aspx)

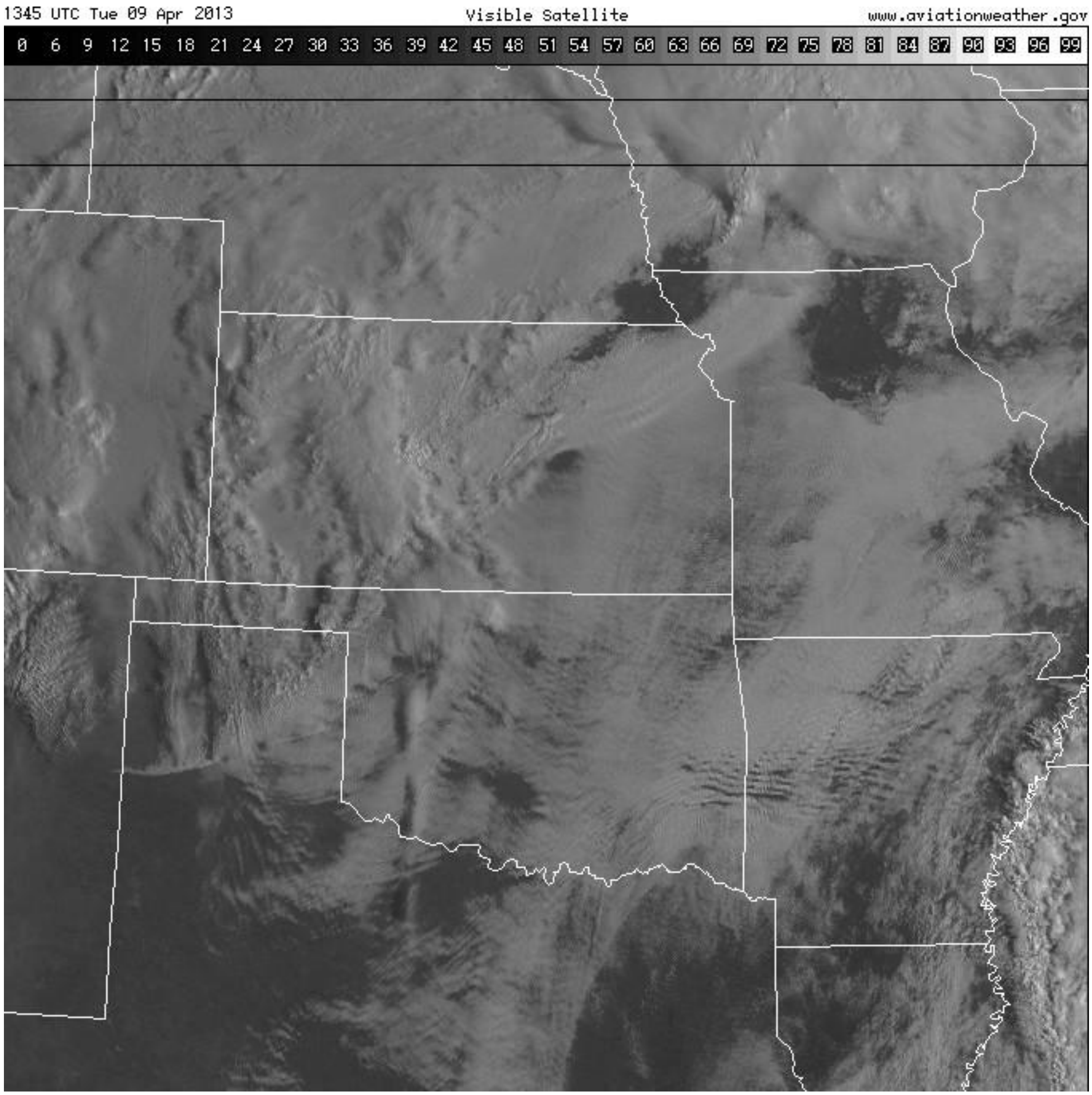


Figure 20: GOES visible satellite image centered on Wichita, KS at 6:45 AM MST (1345Z) April 9, 2013.
(Source: http://www.mmm.ucar.edu/imagearchive/)

Figure 21: Gobblers Knob webcam image at 6:15 AM MST April 9, 2013. (Source: http://amos.cse.wustl.edu/)

Figure 22: Firstview webcam image at 6:19 AM MST April 9, 2013. (Source: http://amos.cse.wustl.edu/)

The synoptic weather conditions described above impacted a region that was in the midst of an extreme to exceptional drought (Figure 23). Sustained drought conditions are known to make topsoil susceptible to high winds and produce blowing dust (see the following link from the National Climatic Data Center for more information: https://www.ncdc.noaa.gov/paleo/drought/drght_history.html). Figure 24 shows the total precipitation in inches from March 9, 2013 to April 8, 2013 for eastern Colorado and adjacent states. Note that the entire area immediately surrounding Lamar, including in the upwind direction (north) received less than 0.5 inches of precipitation during the 30-day period leading up to the April 9, 2013 dust event in Lamar. Based on previous research 0.5 to 0.6 inches of precipitation over a 30-day period has been found to be the approximate threshold, below which, blowing dust exceedances at Lamar are more likely to occur when combined with high winds (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in southeast Colorado near Lamar were dry enough to produce blowing dust when winds were at or above the thresholds for blowing dust. This information, combined with other evidence provided in this report, proves that this dust storm was a natural, regional event that was not reasonably controllable or preventable.

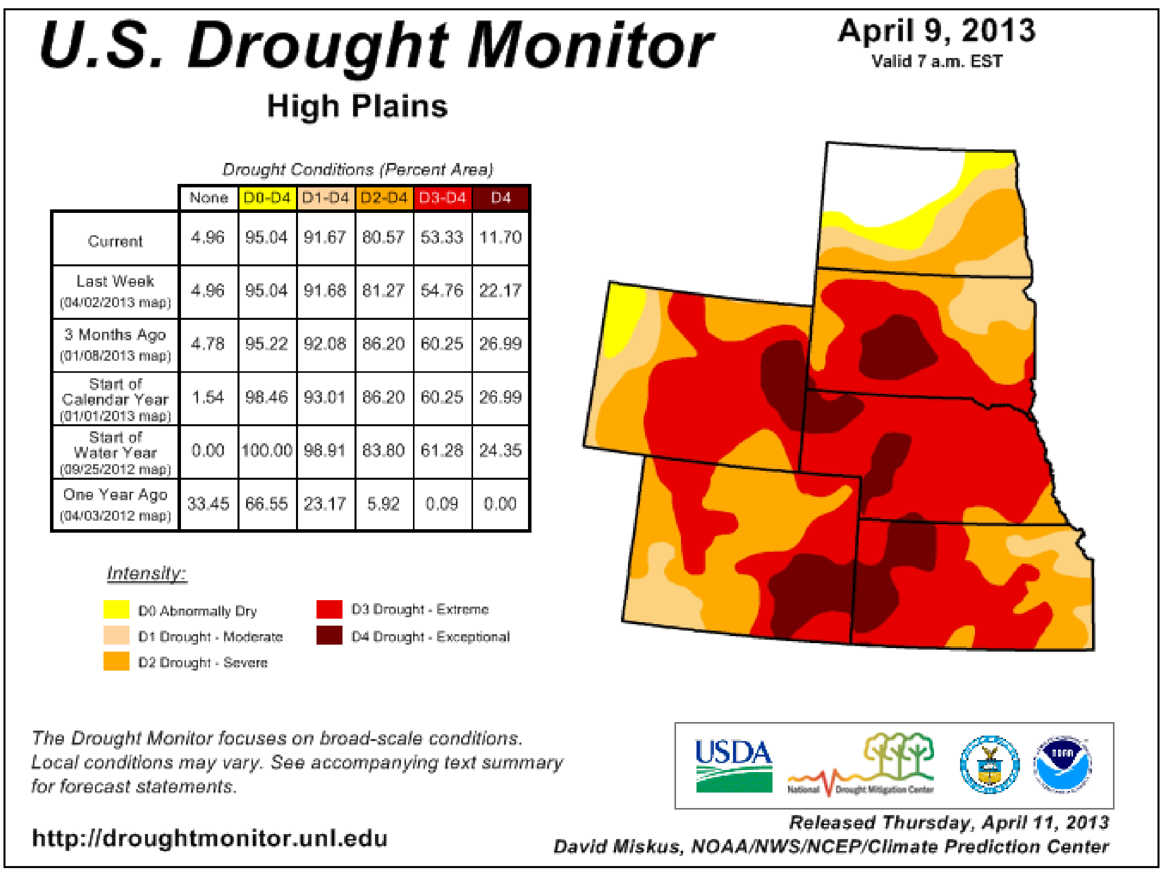


Figure 23: Drought conditions for the High Plains at 5:00 AM MST April 9, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

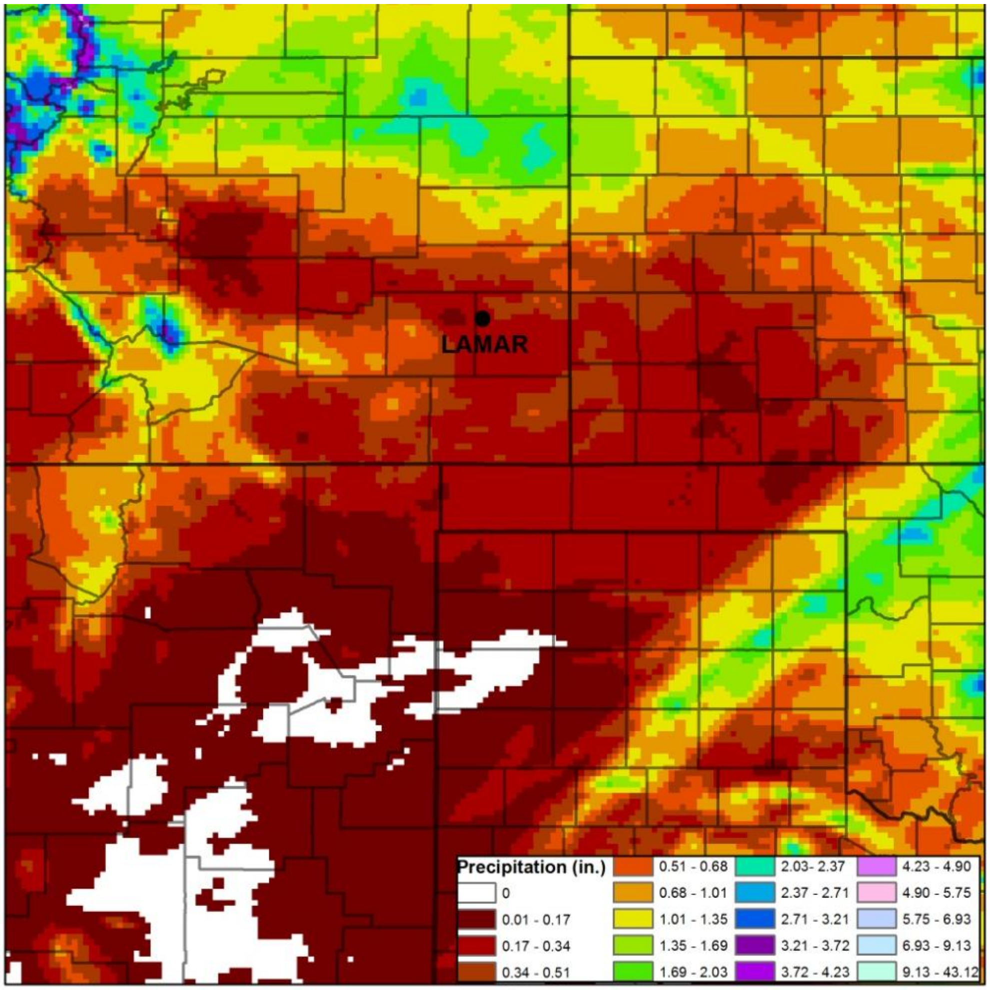


Figure 24: Total precipitation in inches for eastern Colorado and adjacent states, March 9, 2013 – April 8, 2013.
(Source: http://prism.nacse.org/recent/)

2.3 May 1, 2013 Meteorological Analysis

On May 1, 2013, a powerful spring storm system caused an exceedance of the 24-hour PM_{10} standard in Lamar, Colorado, at the Municipal Building monitor with a concentration of 207 µg/m3. This elevated reading and the location of the monitor is plotted on a map of the Greater Lamar area in Figure 25. The exceedance in Lamar was the result of intense surface winds in the wake of a passing cold front. These surface features were associated with a strong upper-level trough that was moving across the western United States. The surface winds were predominantly out of a north to northeasterly direction which moved over dry soils in eastern Colorado, producing significant blowing dust.

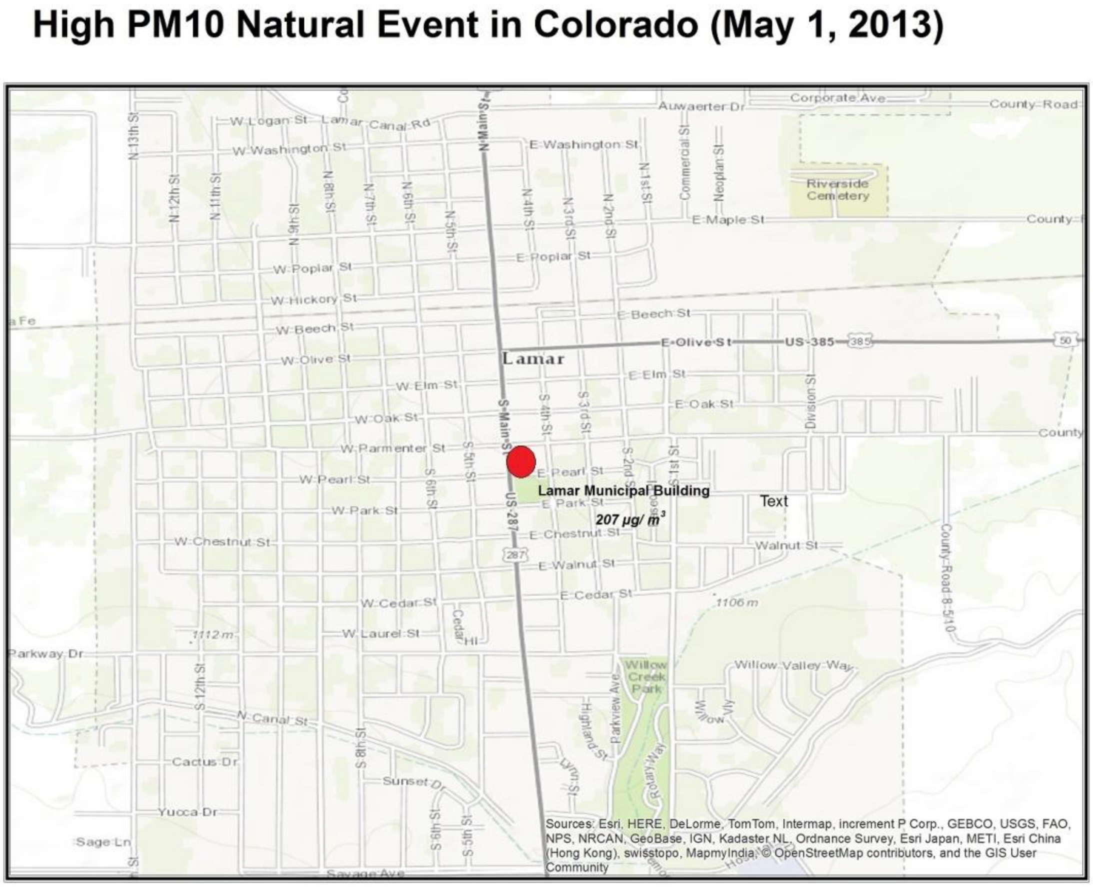


Figure 25: 24-hour PM_{10} concentration for the Lamar Municipal Building monitor, May 1, 2013.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The upper-level trough associated with this storm system is shown on the 700 mb and 500 mb height analysis maps at 5:00 AM MST, May 1, 2013 in Figure 26 and Figure 27, respectively. The 700 mb level is located roughly 3 kilometers above mean sea level (MSL) while the 500 mb level is approximately 6 kilometers above MSL. These two charts show that a deep trough of low pressure was present at both the 700 and 500 mb level during the blowing dust event of May 1, 2013, and that it was moving over the southwestern United States. This is a typical upper-air pattern for blowing dust events in Colorado (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

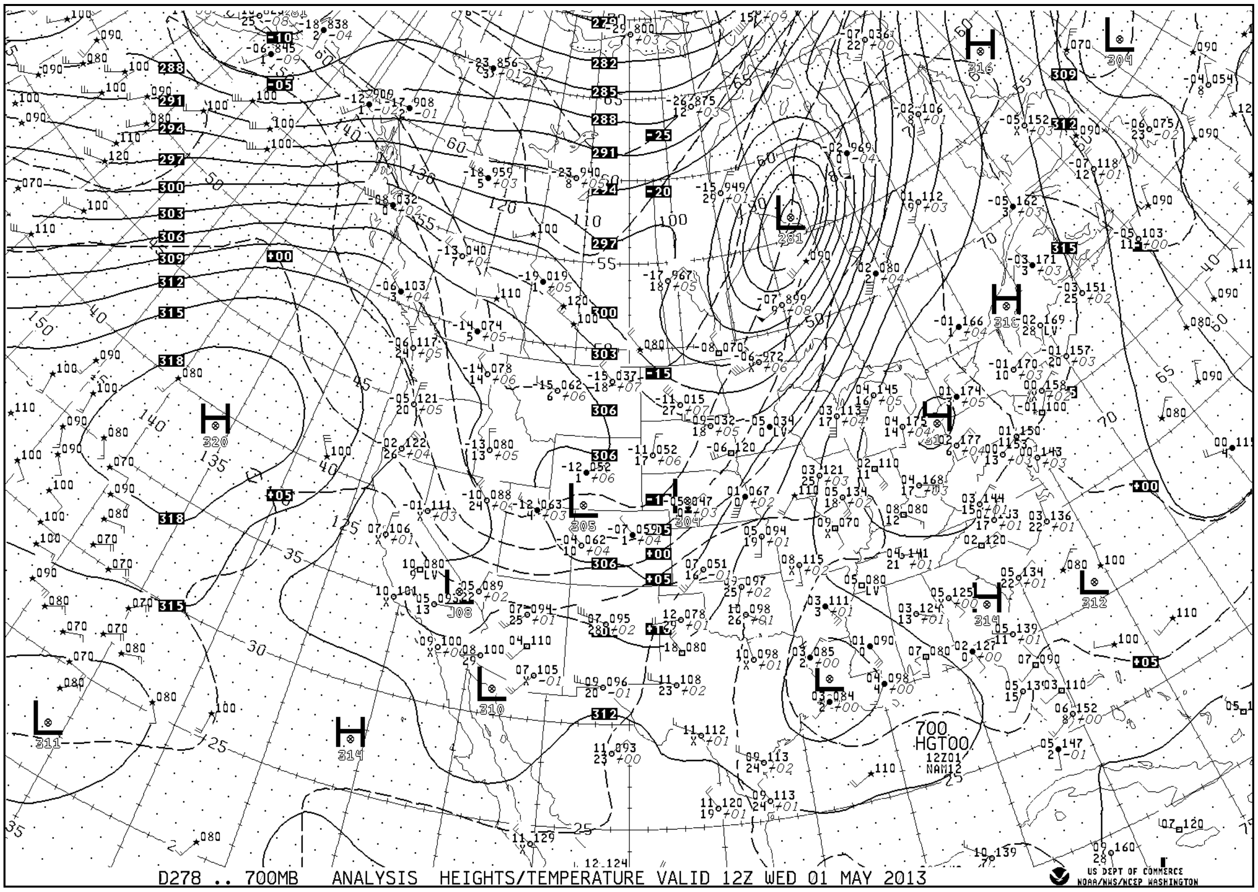


Figure 26: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z May 1, 2013, or 5:00 AM MST May 1, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

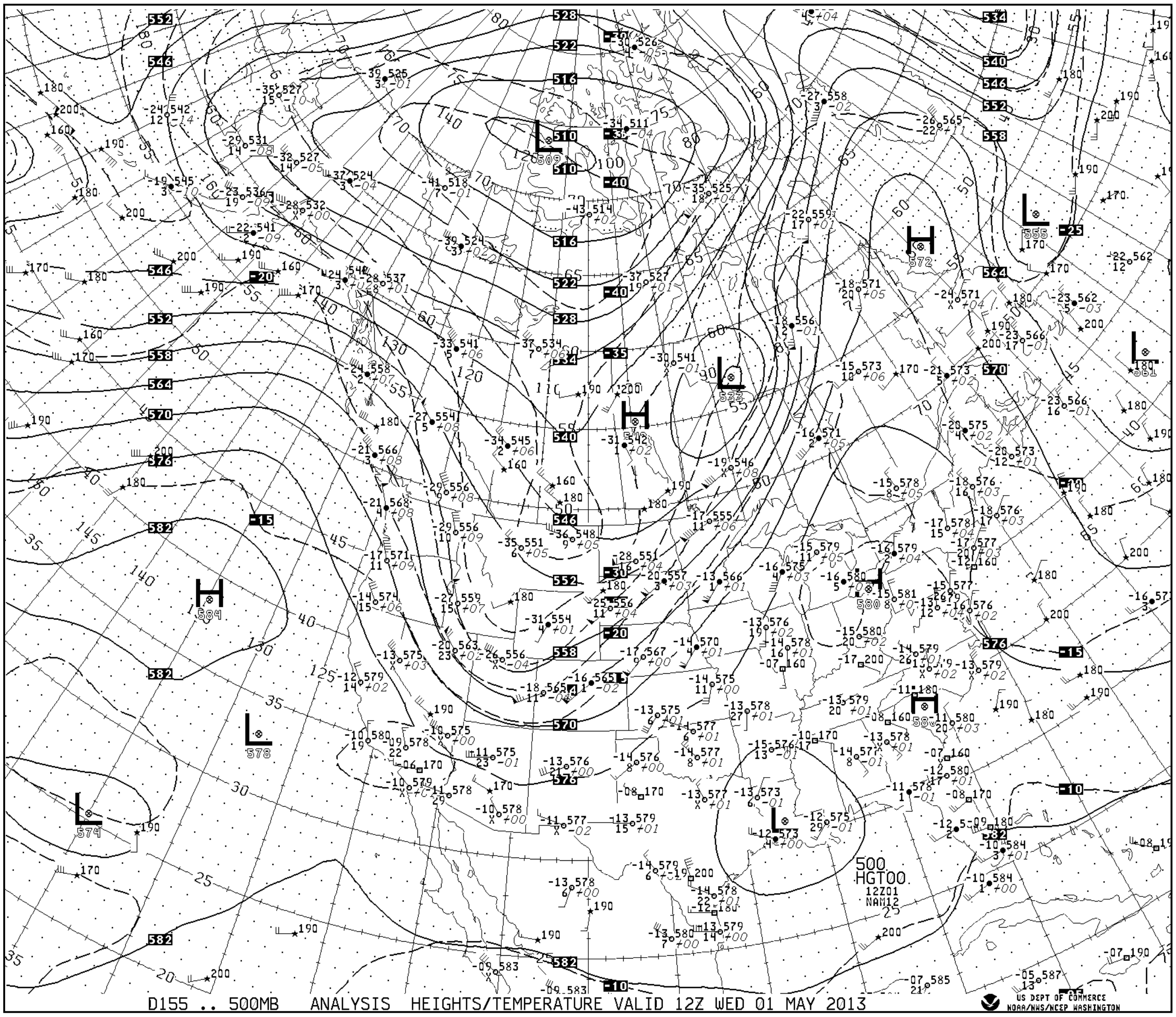


Figure 27: 500 mb (about 6 kilometers above mean sea level) analysis for 12Z May 1, 2013, or 5:00 AM MST May 1, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The surface weather associated with the storm system of May 1, 2013, is presented in Figure 28 and Figure 29. Significant surface features at 11:00 PM MST, April 30, 2013 (6Z, May 1, 2013, Figure 28) included a significant amount of “bunching” of isobars in eastern Colorado, indicating that a strong pressure gradient was in place. Wind speed is directly proportional to the pressure gradient, so a higher pressure gradient will produce stronger winds (see the following link for additional information on pressure gradient and its relationship to wind speed from the National Oceanic and Atmospheric Administration (NOAA): http://www.srh.noaa.gov/jetstream/synoptic/wind.htm). This tightening of the isobars spread southward behind a cold front which increasingly impacted southeast Colorado, including Lamar. By 5:00 AM MST (12Z, Figure 29) the pressure gradient had become very strong throughout the plains of eastern Colorado. This was in response to a building ridge of high pressure in Montana interacting with a strong low pressure area in western Oklahoma.

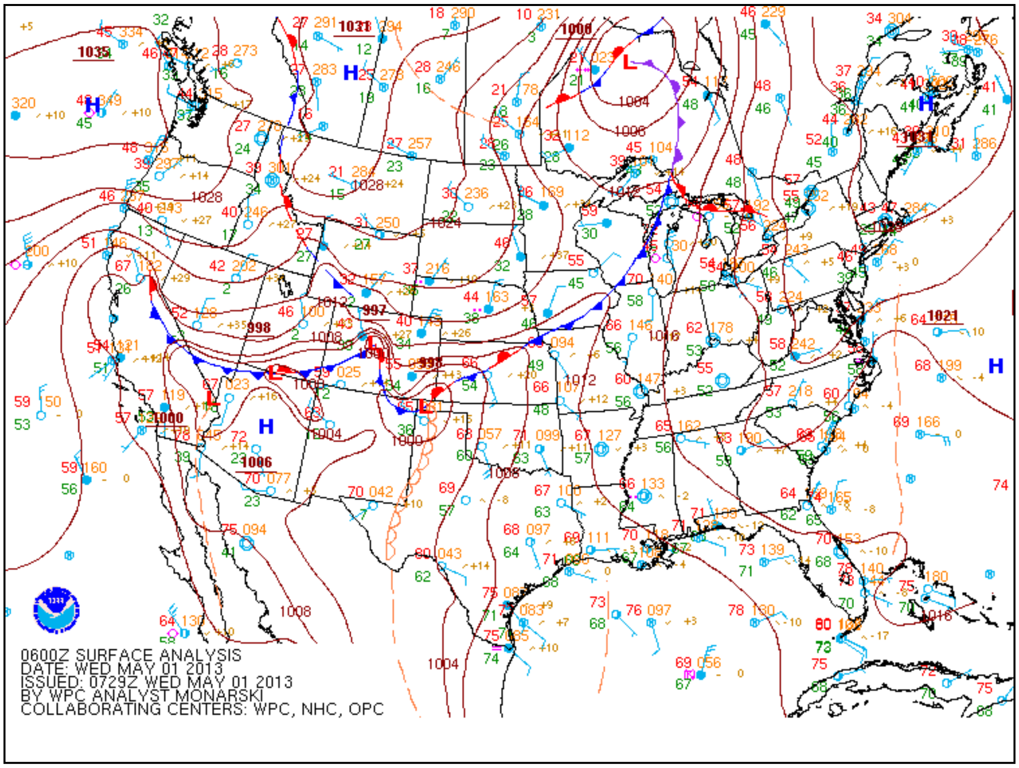


Figure 28: Surface Analysis for 6Z May 1, 2013 or 11:00 PM MST April 30, 2013. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

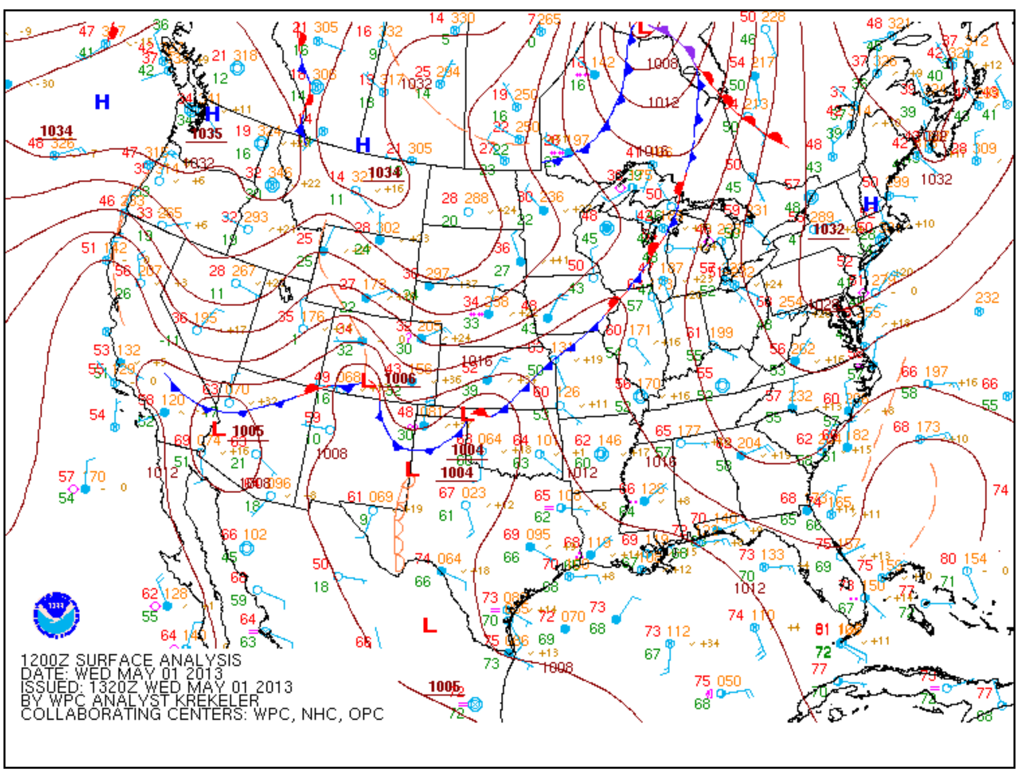


Figure 29: Surface Analysis for 12Z May 1, 2013 or 5:00 AM MST May 1, 2013. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The developing storm system shown above allowed the Navy Aerosol Analysis and Prediction System (NAAPS) to accurately forecast that blowing dust would be an issue in southeast Colorado during the early morning hours of May 1, 2013. Figure 30 shows the output from this model covering the time period from 0Z (11 PM MST, April 30), May 1 to 12Z (5 AM MST), May 1. The NAAPS system models blowing dust emissions and transport based on soil moisture content, soil erodibility factors and a variety of meteorological factors known to be conducive to blowing dust (for a description of NAAPS see: http://www.nrlmry.navy.mil/aerosol_web/Docs/globaer_model.html).

The forecast panel in the lower left of Figure 30 shows an area of highly elevated surface dust concentrations over southeast Colorado. The upper left panel also reveals above normal Total Optical Depth values attributed to dust for the same geographic area.

Forecast products from the Navy Aerosol Analysis and Prediction System model provide supporting evidence that a regional blowing dust event was anticipated and did occur on May 1, 2013.

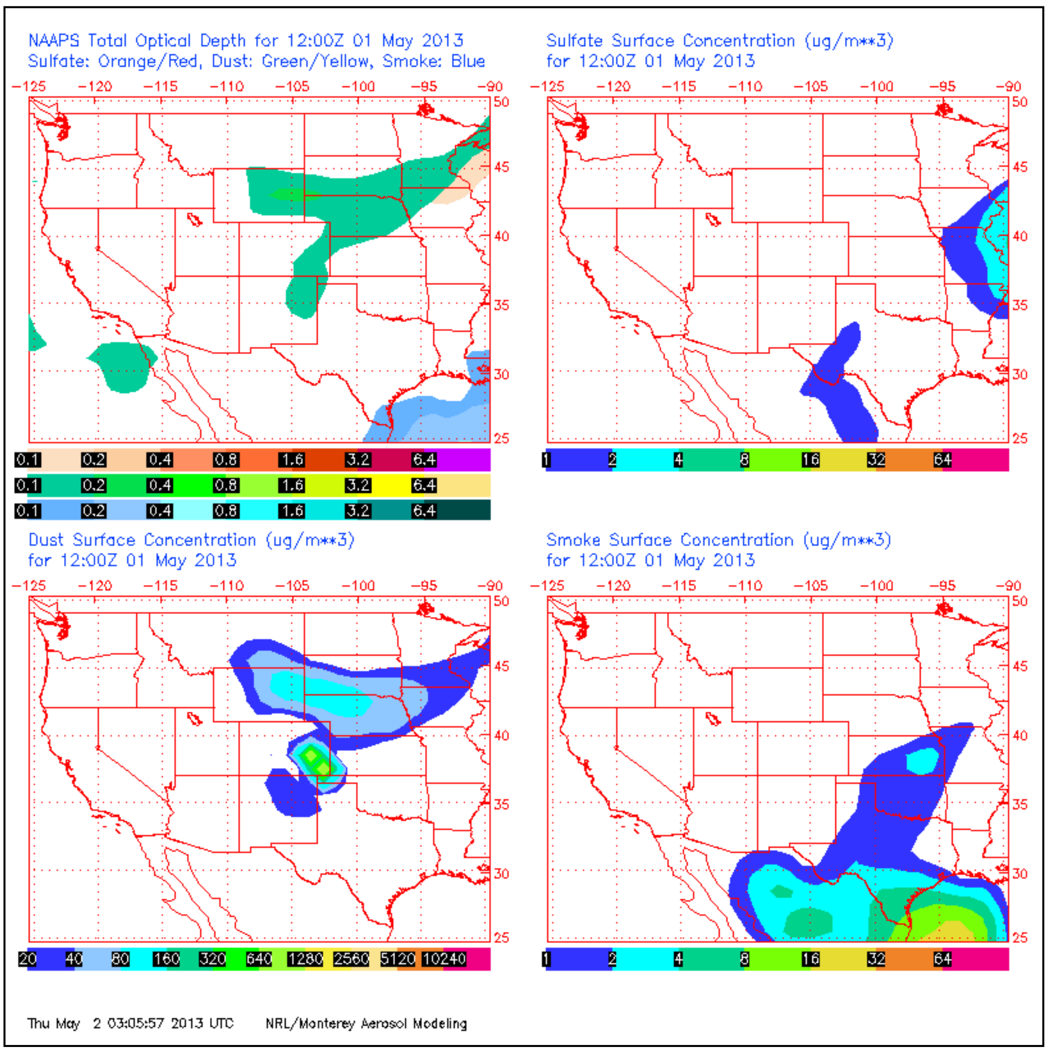


Figure 30: NAAPS forecast for 5:00 AM MST (12Z) May 1, 2013.
(Source: http://www.nrlmry.navy.mil/aerosol-bin/aerosol/display_directory_all?DIR=/web/aerosol/public_html/globaer/ops_01/wus/)

In order to fully evaluate the synoptic meteorological scenario of May 1, 2013, regional surface weather maps are provided showing individual station observations during the height of the event in question. Figure 31 presents weather observations for eastern Colorado and adjacent states at (a) 1:10 AM MST, and (b) 4:10 AM MST, May 1. On the map in Figure 31(a) the station observation for Lamar (LAA) shows winds sustained at 25 knots (29 mph), gusts to 33 knots (38 mph), and a reduced visibility of 4 statute miles with the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary).

Three hours later at 4:10 AM MST (Figure 31 (b)), visibility in Lamar continued to be obscured at 6 statute miles and the wind remained strong (sustained at 25 knots (29 mph) with gusts to 35 knots (40 mph)). These are observations that are largely consistent with blowing dust conditions in Lamar (30 mph sustained winds, 40 mph gusts -- see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). Also note that blowing dust conditions had spread to the south of Lamar as the cold front plunged into New Mexico, Oklahoma and Texas. High winds, haze and reduced visibility had reached Dalhart (DHT) and Dumas (DUX), Texas, indicating that this dust storm was a regional event.

Hourly surface observations, in table form, from Lamar and other weather stations in the region provide supporting evidence that there was an extended period of high winds and haze (blowing dust) in southeast Colorado and large sections of the High Plains. Table 8 lists observations for the PM_{10} exceedance location of Lamar while observations for Dalhart, Dumas, and Hereford, Texas can be found in Table 9 through Table 11, respectively. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) are highlighted in yellow. Collectively, these four sites experienced many hours of reduced visibility along with sustained wind speeds and gusts at or above the thresholds for blowing dust.

Surface weather maps and hourly observations show that a regional dust storm occurred under northerly flow in the wake of a cold front. This data provides clear evidence of blowing dust and winds well above the threshold speeds for blowing dust on May 1, 2013.

a) b)

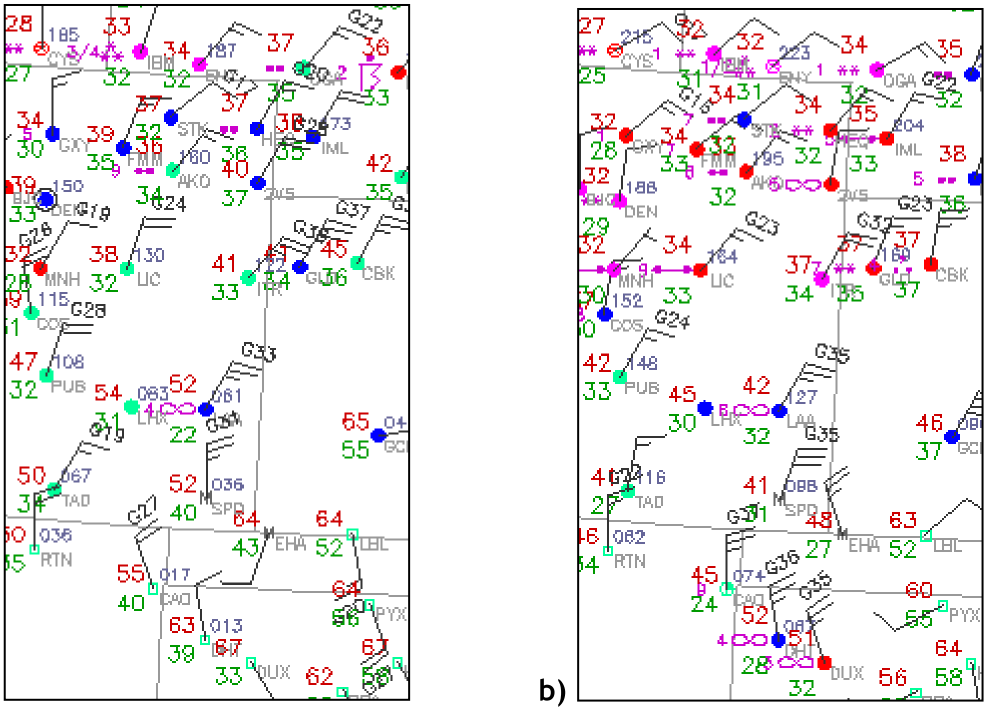


Figure 31: High Plains regional surface analysis for (a) 1:10 AM MST and (b) 4:10 AM MST, May 1, 2013.
(Source: http://www.mmm.ucar.edu/imagearchive/)

Table 8: Weather observations for Lamar, Colorado, on May 1, 2013
(Source: http://mesowest.utah.edu/)

Time MST April 30/ May 1, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:04	55	51	21	31	20	haze	5
23:53	55	47	28	36	30	haze	6
0:53	52	31	28	38	30	haze	4
1:53	45	58	28	37	20	haze	6
2:03	45	57	30	41	20	haze	6
2:53	44	60	27	38	30	haze	5
3:23	43	65	23	44	30	haze	5
3:53	42	67	27	40	30	haze	6
4:53	42	70	23	30	30		8
5:53	40	86	14	23	30		3
6:03	39	87	18	25	30		2
6:15	39	87	14		30		2
6:29	39	93	15		20		2
6:53	39	89	16		30		3
7:11	39	87	15	23	30		4
7:22	39	87	20	29	10		3
7:35	37	93	21	28	10		4
7:53	38	89	23	29	20		3
8:05	37	93	20	27	20		4
8:28	37	93	21		30		4
8:53	38	89	17	25	30		4
9:01	37	93	21	25	30		5
9:36	39	87	17		40		10
9:53	39	86	16	24	30		8
10:53	39	79	20	27	40		10
11:53	39	82	16		40		5
12:53	39	86	18	24	30		5
13:53	39	79	20	27	50		10
14:53	38	79	17	22	30		10
15:53	36	82	23	31	20		7
16:07	34	86	23	31	10		3
16:11	34	86	20	29	10		3
16:53	33	88	22	29	10		6

Table 9: Weather observations for Dalhart, Texas, on May 1, 2013
(Source: http://mesowest.utah.edu/)

Time MST May 1, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:52	63	41	9		350		10
1:52	59	55	17		350		10
2:52	56	53	25	38	340	haze	6
3:25	54	50	28	41	350	haze	5
3:52	52	39	27	41	350	haze	4
4:11	50	40	32	45	350	haze	3
4:43	48	50	35	47	360	haze	3
4:52	48	49	35	45	360	haze	3
5:15	46	53	35	45	360	haze	3
5:32	46	53	40	52	360	haze	3
5:40	46	53	35	52	360	haze	2
5:52	46	58	33	46	350	haze	3
6:52	46	60	36	48	360	haze	4
7:52	45	68	38	50	10	haze	5
8:52	46	65	32	41	360		9
9:52	49	61	32	45	10		10
10:52	51	54	33	41	10		10
11:52	51	54	36	41	10		10
12:52	51	54	33	48	10		9
13:52	47	60	32	37	20		10
14:52	47	58	30	39	20		10
15:52	45	65	32	44	10		10
16:52	43	65	30	37	10		10
17:52	41	70	32	46	20		10
18:52	40	70	33	44	10		10
19:52	37	72	36	46	10		10
20:52	35	69	39	53	10		10
21:01	36	69	35	45	20		10

Table 10: Weather observations for Dumas, Texas, on May 1, 2013 (Source: http://mesowest.utah.edu/)

Time MST May 1, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:14	67	36	14		150		10
0:34	66	36	15		150		10
0:54	67	29	15		150		10
1:14	66	29	13		140		10
1:34	64	30	9		310		10
1:54	61	43	12	17	320		10
2:14	58	55	18	27	320		10
2:34	57	57	21	28	330		10
2:54	56	60	23	27	330		10
3:14	55	57	25	36	330		7
3:34	54	56	27	35	330		7
3:54	51	47	31	40	340	haze	3
4:14	50	44	39	45	340	haze	3
4:34	47	49	35	43	340	haze	3
4:54	47	52	40	50	340	haze	3
5:14	46	54	37	47	350	haze	2
5:34	47	55	33	45	350	haze	3
5:54	47	57	33	50	350	haze	3
6:14	47	57	40	48	340	haze	4
6:34	46	60	39	47	340	haze	5
6:54	46	63	35	47	350	haze	5
7:14	45	68	44	54	350	haze	4
7:34	46	66	40	48	350		7
7:54	46	68	37	46	360		7
8:14	44	76	41	52	350		7
8:34	43	78	32	46	350		10
8:54	43	78	38	48	350		10
9:14	43	78	36	46	360		10
9:34	44	77	33	41	360		10
9:54	44	76	28	39	10		10
10:14	44	72	28	43	360		10
10:34	45	71	36	44	360		10
10:54	46	69	28	44	360		10
11:14	47	65	29	37	10		10
11:34	45	70	29	39	10		10

Table 11: Weather observations for Hereford, Texas, on May 1, 2013
(Source: http://mesowest.utah.edu/)

Time MST May 1, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:15	69	25	17	25	210		10
0:35	70	29	18	27	210		10
0:55	70	31	18		210		7
1:15	70	33	15	23	210		10
1:35	69	34	18	30	210		10
1:55	69	35	15	23	210		10
2:15	68	36	15	22	210		10
2:35	68	36	18	23	210		10
2:55	68	37	18	25	210		10
3:15	67	37	16	23	220		10
3:35	66	39	15		240		10
3:55	63	43	16		310		10
4:15	59	53	21		360		10
4:35	57	56	21	24	360		10
4:55	56	57	17	23	10		10
5:15	55	52	22	28	10		10
5:35	53	46	25	36	10	haze	5
5:55	52	41	27	37	360	haze	4
6:15	51	47	30	38	10	haze	3
6:35	52	47	28	37	10	haze	4
6:55	53	45	31	38	360	haze	4
7:15	54	45	31	37	360	haze	5
7:35	54	47	30	37	10	haze	5
7:55	54	48	29	41	10	haze	5
8:15	55	47	31	40	360	haze	5
8:35	54	49	31	37	10		7
8:55	56	47	32	39	360		7
9:15	56	48	32	43	10		7
9:35	54	54	29	40	10		7
9:55	54	53	30	38	10		10
10:15	55	51	29	36	10		10
10:35	56	50	30	36	10		10
10:55	56	50	28	36	20		10
11:15	57	49	27	37	10		10
11:35	57	48	27	36	20		10

Radar imagery provides strong supporting evidence that a regional dust storm was taking place during the late evening of April 30, 2013 and continued through the early morning of May 1. The Pueblo, Colorado radar image at 11:34 PM MST, April 30 (Figure 32) shows a suspected line of dust (circled in green) just to the northeast of the radar. The radar image from 20 minutes later (Figure 33) is much more revealing with several distinct dust plumes (circled in green) emerging to the north and northwest of Fowler, Crowley and Sugar City. These plumes remain prominent on the radar image at 12:03 AM MST, May 1 (Figure 34) before dissipating shortly thereafter. However, other areas of suspected dust on the radar would continue for nearly two more hours with the last dust signature visible on the 1:57 AM MST image (Figure 35). It should be noted that during the period of time of these radar images, Lamar (Table 8) would record sustained winds of 26-28 mph with gusts of 36-38 mph, haze and visibility reduced to 4-6 statute miles. This suggests that blowing dust was occurring throughout a large part of southeast Colorado during this period of time.

If plumes of dust were evident near the Pueblo radar during this time period, why were there no visible radar echoes closer to Lamar? The likely reason is the gap in NEXRAD coverage in southeast Colorado, with the lowest radar returns available ranging from 6,000 to 10,000 ft. above ground level (Figure 36). The radar beam could very well have been overshooting any blowing dust which was likely concentrated relatively close to the surface.

The areas of blowing dust in southeast Colorado continued to push to the south-southeast during the early morning hours of May 1. This would eventually produce observations climatologically consistent with blowing dust in Dalhart (Table 9), Dumas (Table 10) and Hereford (Table 11), Texas. By 6:45 AM MST, visible satellite imagery began to detect dust in the Texas Panhandle. One product that is derived from visible satellite imagery is the GASP (GOES Aerosol Smoke Product) Optical Depth image (see the following link for additional information on GASP: http://www.star.nesdis.noaa.gov/smcd/emb/aerosols/products_geo.php). The GASP image in Figure 37 shows highly elevated aerosol levels in western parts of the Texas Panhandle (near Hereford) with AOD values of 0.4 – 0.6. To confirm our suspicion that these enhanced AOD values are indeed dust, we simply need to look at surface weather observations in Hereford at the approximate time of the GASP image. As suspected, from 6:35 to 6:55 MST in Hereford (Table 11) the wind was sustained at 28-31 mph, with gusts of 37 to 38 mph, observed haze and a reduced visibility of 4 statute miles.

The National Oceanic and Atmospheric Administration (NOAA) Satellite Services Division was in agreement with the conclusion that blowing dust was moving south and into the Texas Panhandle. The Smoke Text Product from NOAA at 7:45 AM MST on May 1 stated:

> "Thin to moderately dense dust and sand can be seen moving south covering all the TX panhandle to around the Red River/Canyon region."
> (Source: http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2013/2013E011453.html)

The National Weather Service (NWS) in Amarillo, TX also recognized blowing dust in their Area Forecast Discussion at 5:05 AM MST:

> "For now have included BLDU (blowing dust) at the terminals over the next couple of hours although BLDU can be a possibility during the forecast period."
> (Source: http://mesonet.agron.iastate.edu/wx/afos/)

Radar and GASP satellite imagery combined with reports from NOAA offices on May 1 clearly reveal that a dust storm was taking place in the High Plains region, including southeast Colorado. This indicates that this was a regional event and therefore not controllable or preventable.

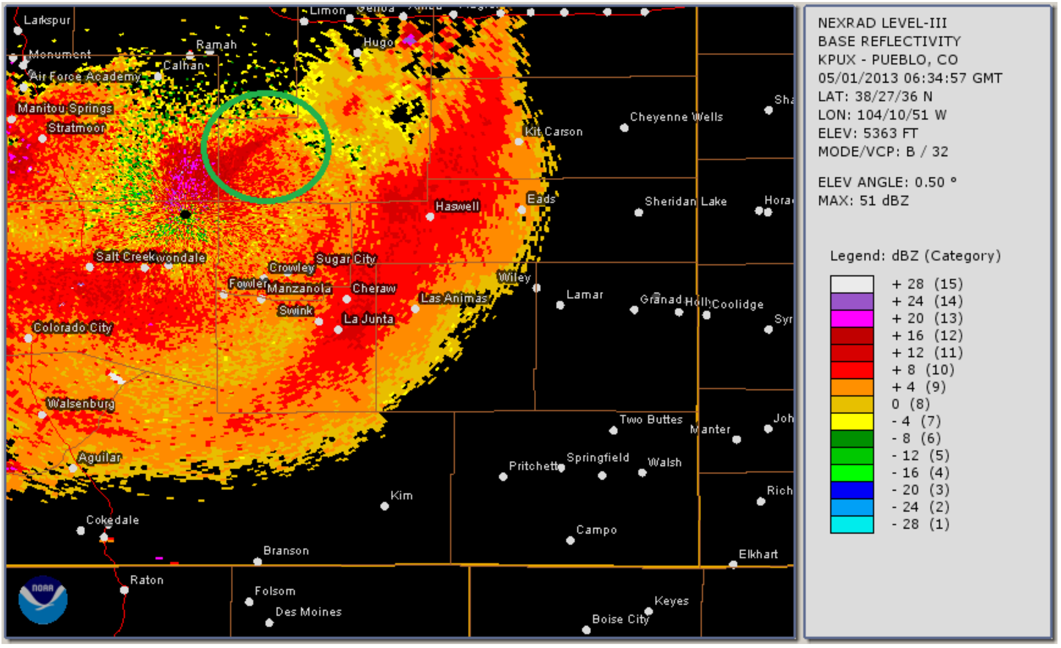


Figure 32: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 11:34 PM MST (634Z, May 1), April 30, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

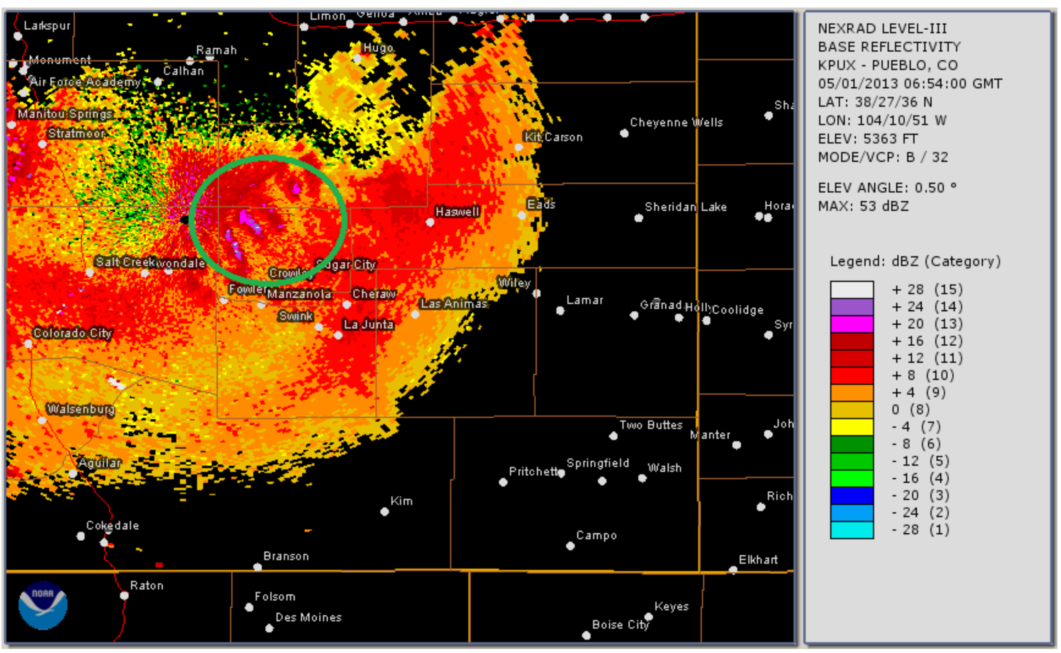


Figure 33: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 11:54 PM MST (654Z May 1), April 30, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

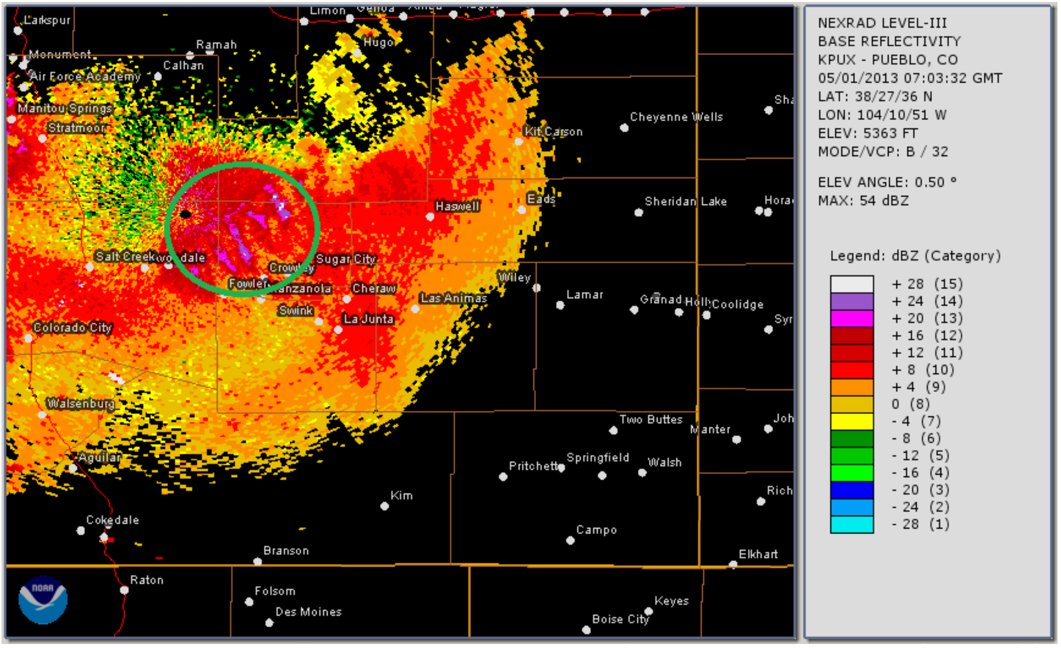


Figure 34: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 12:03 AM MST (703Z), May 1, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

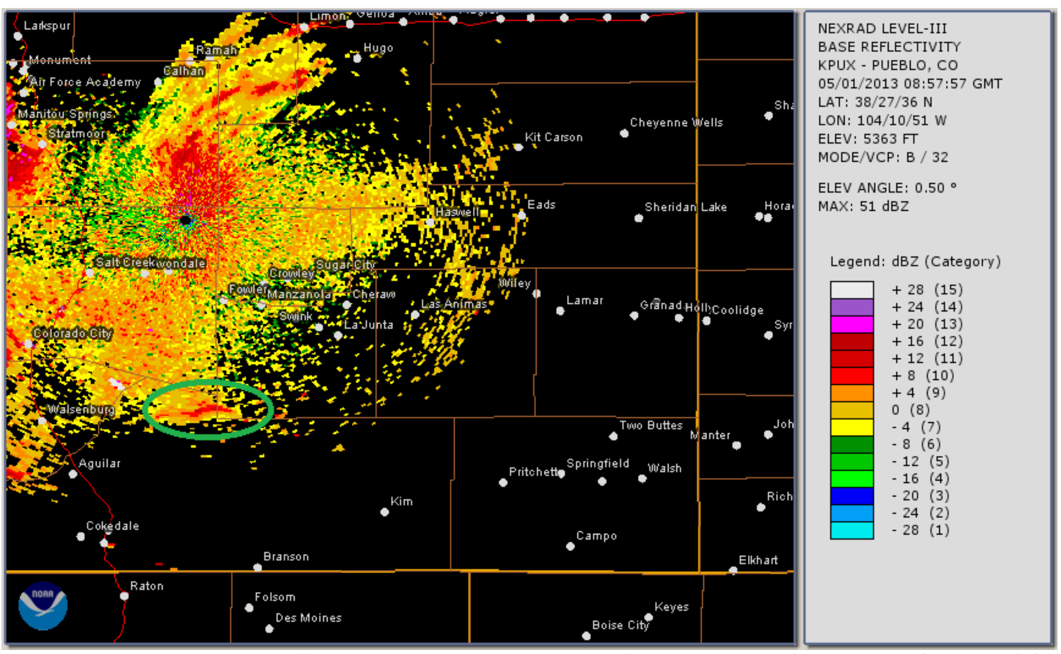


Figure 35: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 1:57 AM MST (857Z), May 1, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

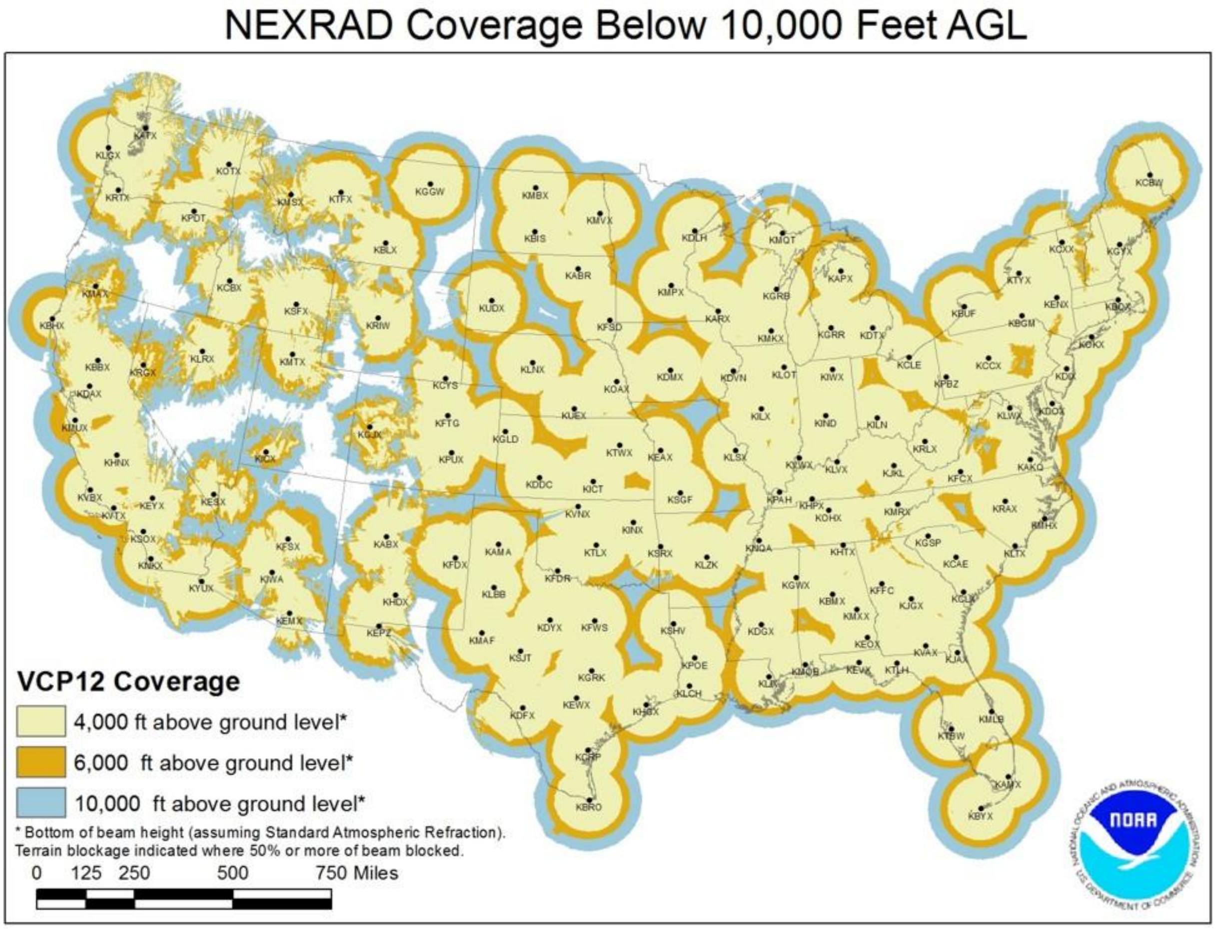


Figure 36: NEXRAD coverage below 10,000 ft. above ground level. (Source: http://www.roc.noaa.gov/WSR88D/Maps.aspx)

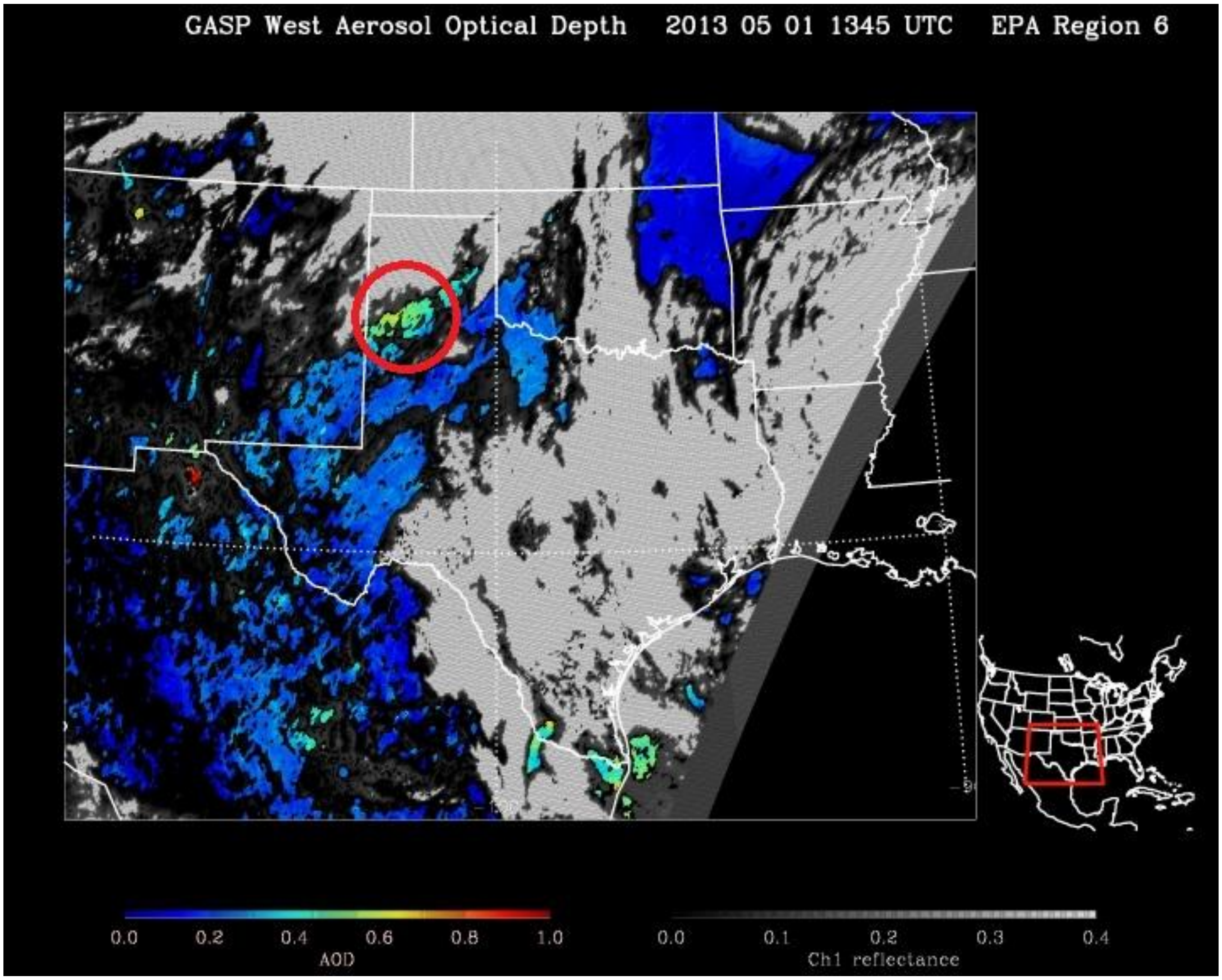


Figure 37: GASP West Aerosol Optical Depth Image at 6:45 AM MST (1345Z) May 1, 2013. (Source: http://www.star.nesdis.noaa.gov/smcd/spb/aq/index.php?product_id=2)

The synoptic weather conditions described above impacted a region that was in the midst of an exceptional drought (Figure 38). Sustained drought conditions are known to make topsoil susceptible to high winds and produce blowing dust (see the following link from the National Climatic Data Center for more information: https://www.ncdc.noaa.gov/paleo/drought/drght_history.html). Figure 39 shows the total precipitation in inches from April 1, 2013 to April 30, 2013 for Colorado. Note that a large portion of southeast Colorado received less than 0.5 inches of precipitation during the 30-day period leading up to the May 1, 2013 dust event in Lamar. Based on previous research 0.5 to 0.6 inches of precipitation over a 30-day period has been found to be the approximate threshold, below which, blowing dust exceedances at Lamar are more likely to occur when combined with high winds (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in southeast Colorado near Lamar were dry enough to produce blowing dust when winds were at or above the thresholds for blowing dust. This information, combined with other evidence

provided in this report, proves that this dust storm was a natural, regional event that was not reasonably controllable or preventable.

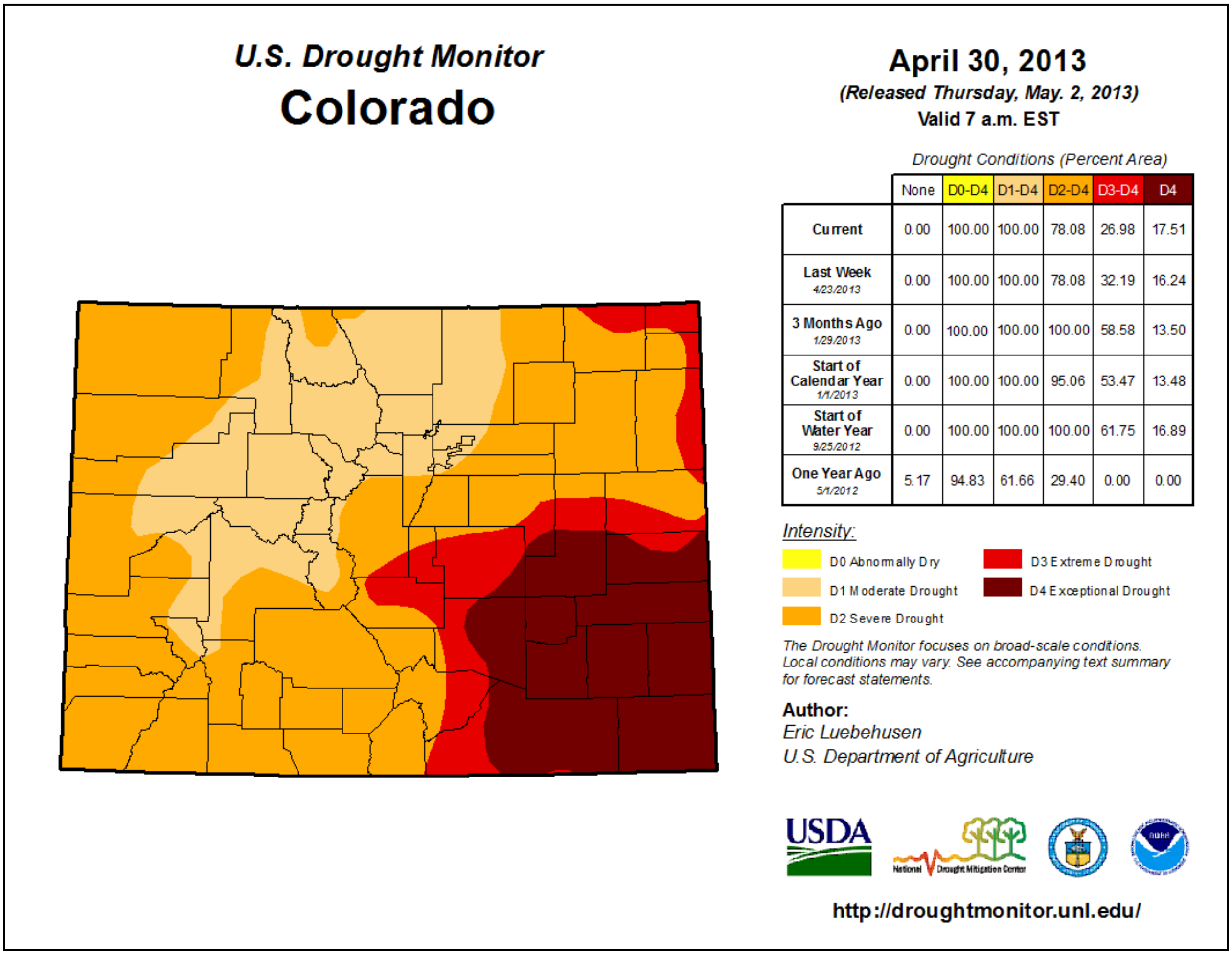


Figure 38: Drought conditions for Colorado at 5:00 AM MST April 30, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

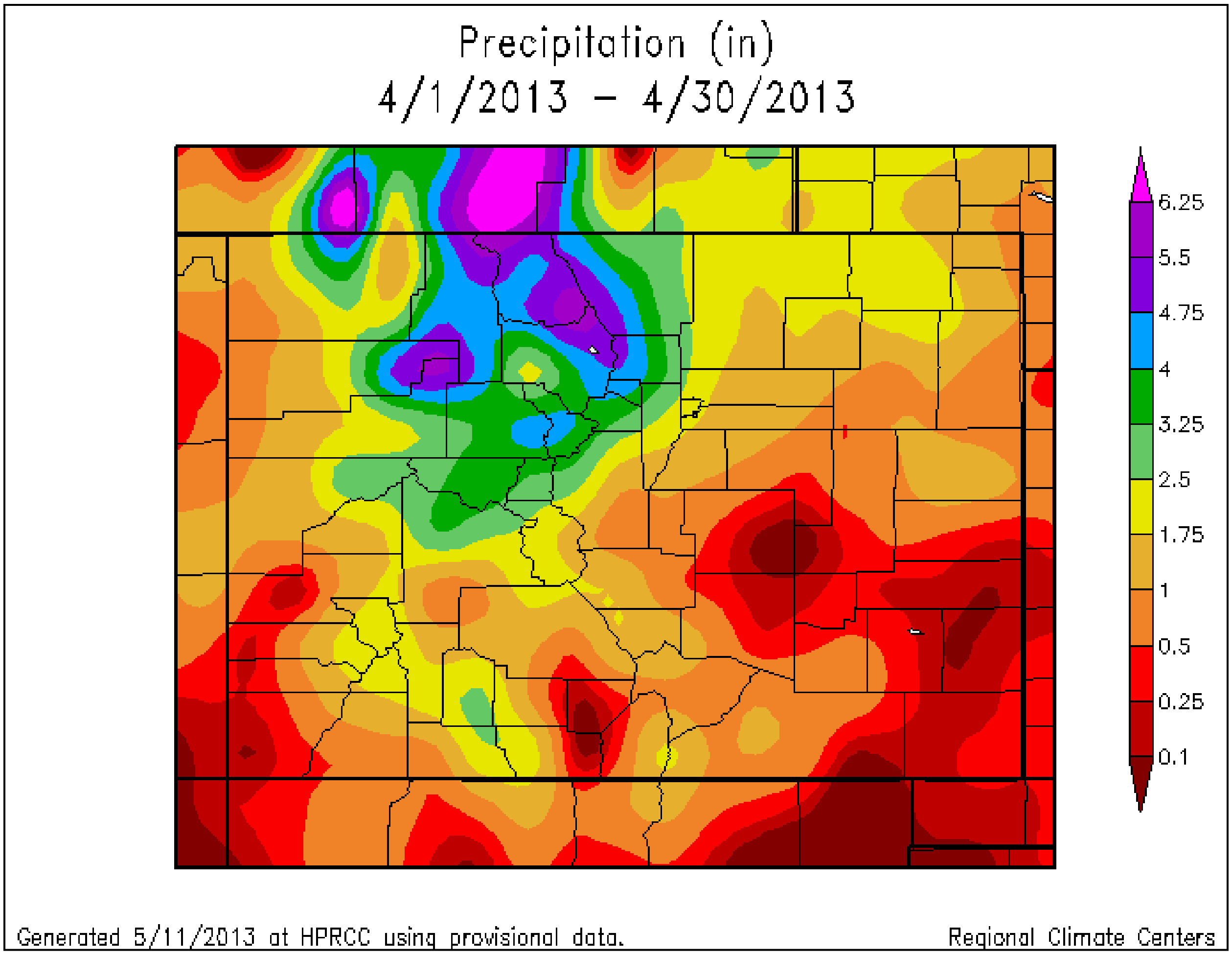


Figure 39: Total precipitation in inches for Colorado, April 1, 2013 – April 30, 2013. (Source: http://www.hprcc.unl.edu/maps/current/)

2.4 May 24, 2013 Meteorological Analysis

On May 24 of 2013, a cluster of strong to severe thunderstorms in southeast Colorado with powerful outflow winds caused an exceedance of the 24-hour PM_{10} standard in Lamar, Colorado. The Municipal Building monitor recorded a concentration of 406 µg/m3. This highly elevated reading and the location of the monitor is plotted on a map of the Greater Lamar area in Figure 40. The thunderstorms were associated with a moist, unstable atmosphere over southeast Colorado that was impacted by an upper air disturbance. This disturbance initiated thunderstorms with intense south to southwest winds which moved over drought-stricken soils. This combination of factors produced significant blowing dust in the Lamar area.

High PM10 Natural Event in Colorado (May 24, 2013)

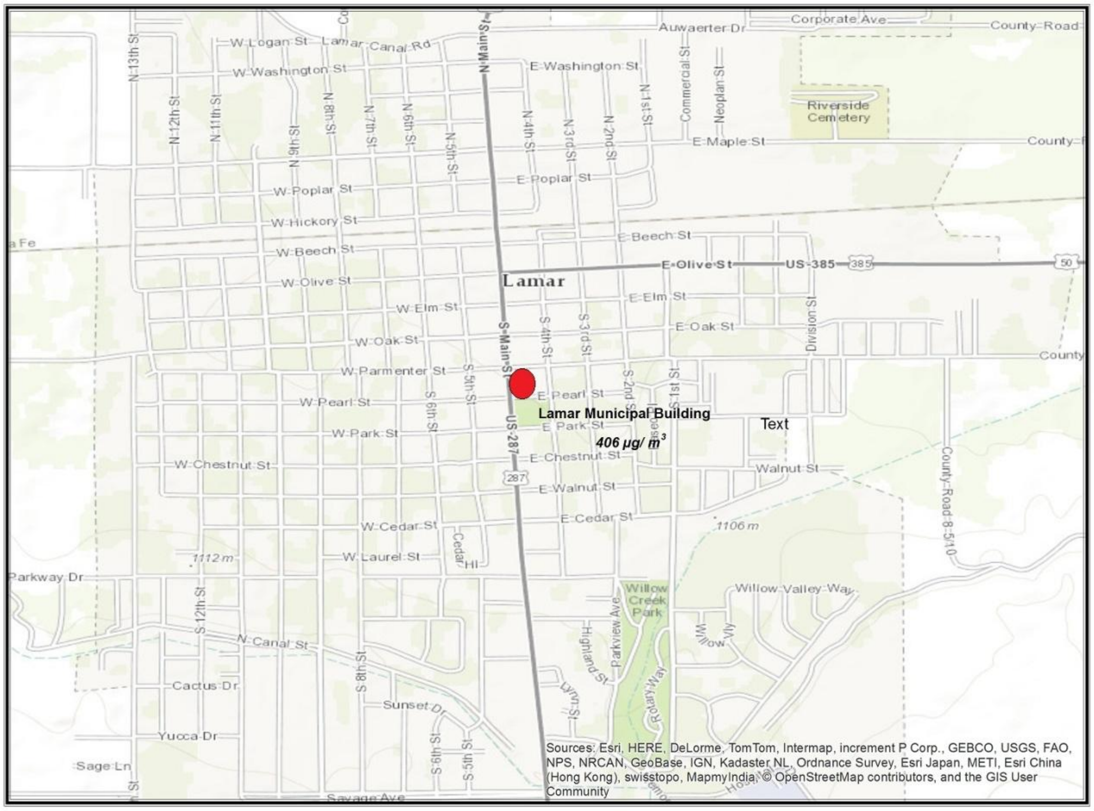


Figure 40: 24-hour PM_{10} concentrations for May 24, 2013.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The upper-level disturbance that initiated thunderstorms on May 24, 2013 is shown on the 700 mb height analysis map at 5:00 PM MST in Figure 41. The 700 mb level is located roughly 3 kilometers above mean sea level (MSL). This chart shows that a well-defined trough of low pressure was present at the 700 mb level during the initial stages of the blowing dust event of May 24. The trough was approaching a relatively moist air mass (Figure 42) that was in place over the southeastern corner of Colorado where dew points were hovering in the mid 40 degree Fahrenheit range.

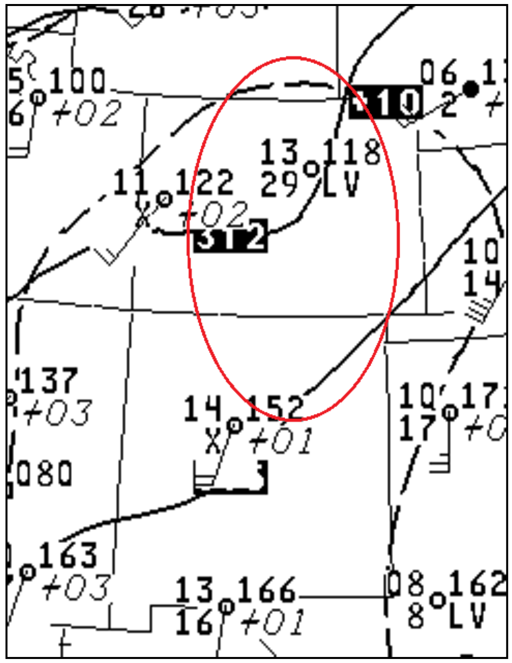


Figure 41: 700 mb (about 3 kilometers above mean sea level) analysis for 0Z May 25, 2013, or 5:00 PM MST May 24, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

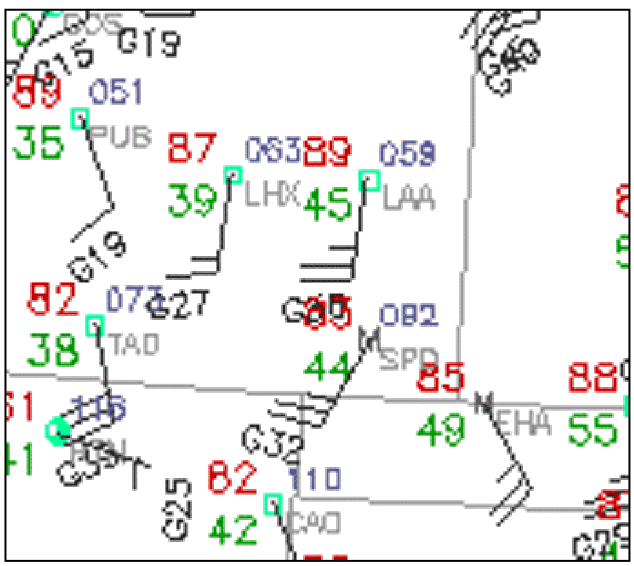


Figure 42: Southeast Colorado regional surface analysis for 0Z May 25, 2013 or 5:00 PM MST May 24, 2013.
(Source: http://www.mmm.ucar.edu/imagearchive/)

In order to fully evaluate the synoptic meteorological scenario of May 24, 2013, regional surface weather maps are provided showing individual station observations during the height of the event in question. Figure 43 presents weather observations for eastern Colorado and adjacent states at (a) 10:13 PM and (b) 11:13 PM MST on May 24. On the map in Figure 43(a) the station observation for Lamar (LAA) shows winds sustained at 35 knots (40 mph), gusts to 43 knots (50 mph), and a reduced visibility of 7 statute miles.

One hour later at 11:13 PM MST (Figure 43 (b)), visibility in Lamar had deteriorated to 5 statute miles. Included in this observation is the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary).

Hourly surface observations, in table form, from Lamar provide additional evidence that there were numerous observations of high winds and haze (blowing dust). Table 12 lists observations for the PM_{10} exceedance location of Lamar. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) are highlighted in yellow. Note the 49-minute time interval from 9:11 PM to 10:00 PM MST when sustained winds ranged from 43-50 mph, gusts ranged from 54-63 mph and visibility was largely in the 1-3 statute mile range. These wind speeds are significantly above the 30 mph sustained and 40 mph gust, wind thresholds established in the Lamar Blowing Dust Climatology referenced above.

Surface weather maps and hourly observations provide clear evidence of blowing dust and winds well above the threshold speeds for blowing dust on May 24, 2013.

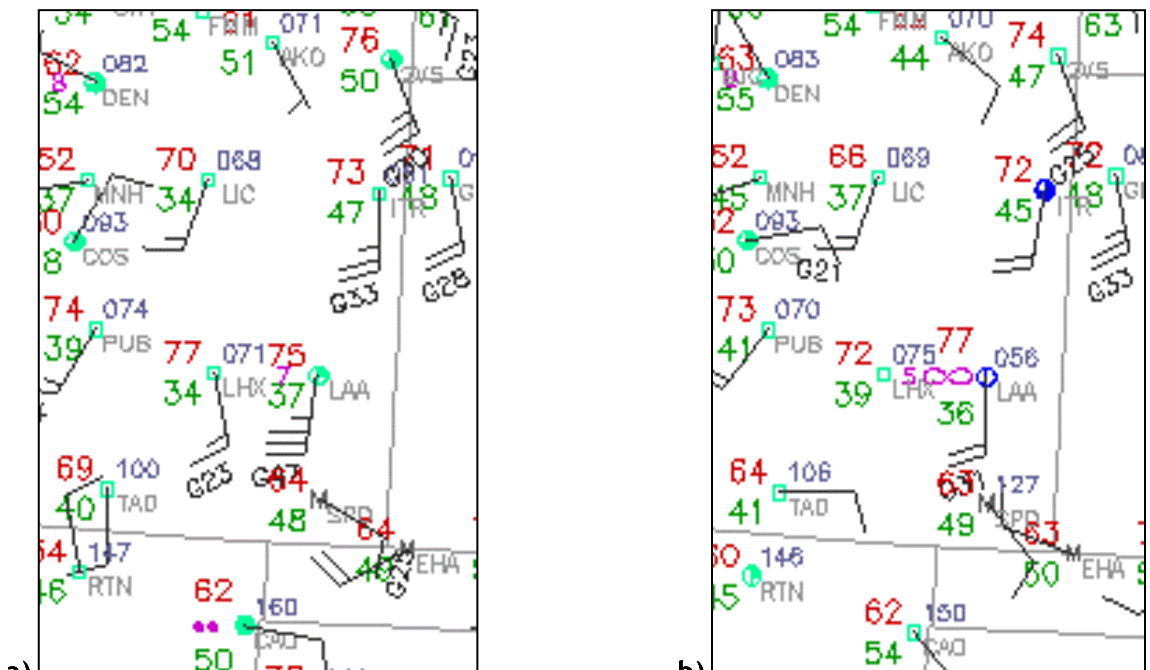


Figure 43: High Plains regional surface analysis for (a) 10:13 PM MST and (b) 11:13 PM MST, May 24, 2013.
(Source: http://www.mmm.ucar.edu/imagearchive/)

Table 12: Weather observations for Lamar, Colorado, on May 24, 2013
(Source: http://mesowest.utah.edu/)

Time MST May 24, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
3:26	61	77	18		120		7
3:33	61	77	18	28	130		7
3:46	59	82	18	28	130		7
3:53	59	83	18	28	120		7
4:53	59	87	21	25	150		5
5:53	60	83	18		130	haze	5
6:53	64	73	23	30	150		7
7:53	70	57	20		170		8
8:53	78	42	15		180		10
9:53	87	24	18	31	210		10
10:53	90	20	17	29	220		9
11:53	93	17	20	36	200		9
12:53	96	14	25	39	200		9
13:53	96	14	30	43	200		10
14:53	91	19	33	48	180		9
15:53	90	18	28	48	190		10
16:53	89	22	29	41	190		10
17:53	86	23	30	41	190		10
18:53	84	25	24	35	180		10
19:53	82	26	18		190		10
20:53	79	23	20	28	190		10
21:11	81	18	44	58	200	haze	3
21:15	81	20	50	63	200	haze	1
21:23	79	21	44	63	200	haze	1
21:33	79	23	44	60	200	haze	2
21:42	77	26	45	62	190	haze	2
21:53	76	26	43	55	190	haze	6
22:00	75	25	43	54	190		7
22:44	79	21	27	37	180	haze	3
22:50	77	22	23	36	180	haze	3
22:53	77	23	23	36	180	haze	5
23:53	73	30	30	40	170		10

The synoptic weather conditions described above impacted a region that was in the midst of an exceptional drought (Figure 44). Sustained drought conditions are known to make topsoil susceptible to high winds and produce blowing dust (see the following link from the National Climatic Data Center for more information: https://www.ncdc.noaa.gov/paleo/drought/drght_history.html). Figure 45 shows the total precipitation in inches from April 24, 2013 to May 23, 2013 for eastern Colorado and adjacent states. Note that the entire area immediately surrounding Lamar, particularly in the upwind direction (south to southwest) received less than 0.5 inches of precipitation during the 30-day period leading up to the May 24, 2013 dust event in Lamar. Based on previous research 0.5 to 0.6 inches of precipitation over a 30-day period has been found to be the approximate threshold, below which, blowing dust exceedances at Lamar are more likely to occur when combined with high winds (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in southeast Colorado near Lamar were dry enough to produce blowing dust when winds were at or above the thresholds for blowing dust.

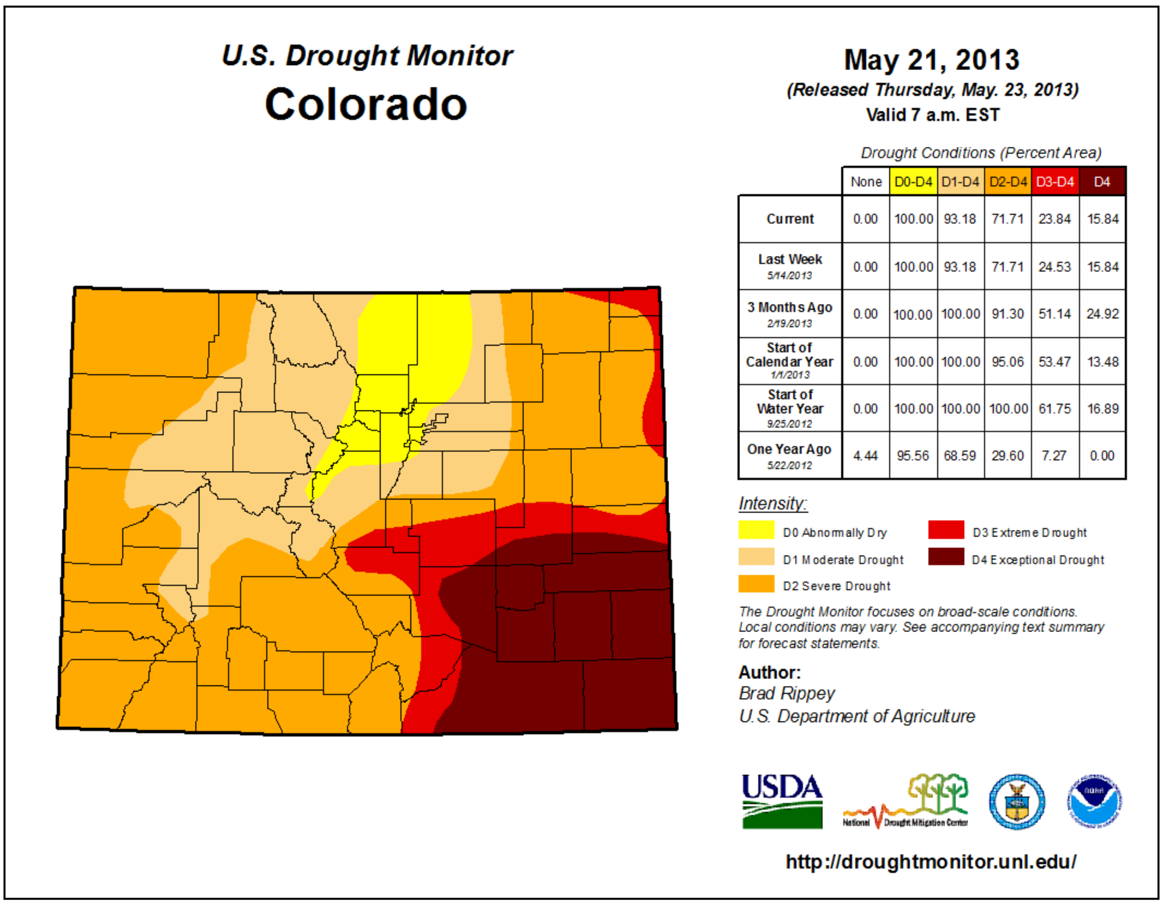


Figure 44: Drought conditions for Colorado at 5:00 AM MST May 21, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

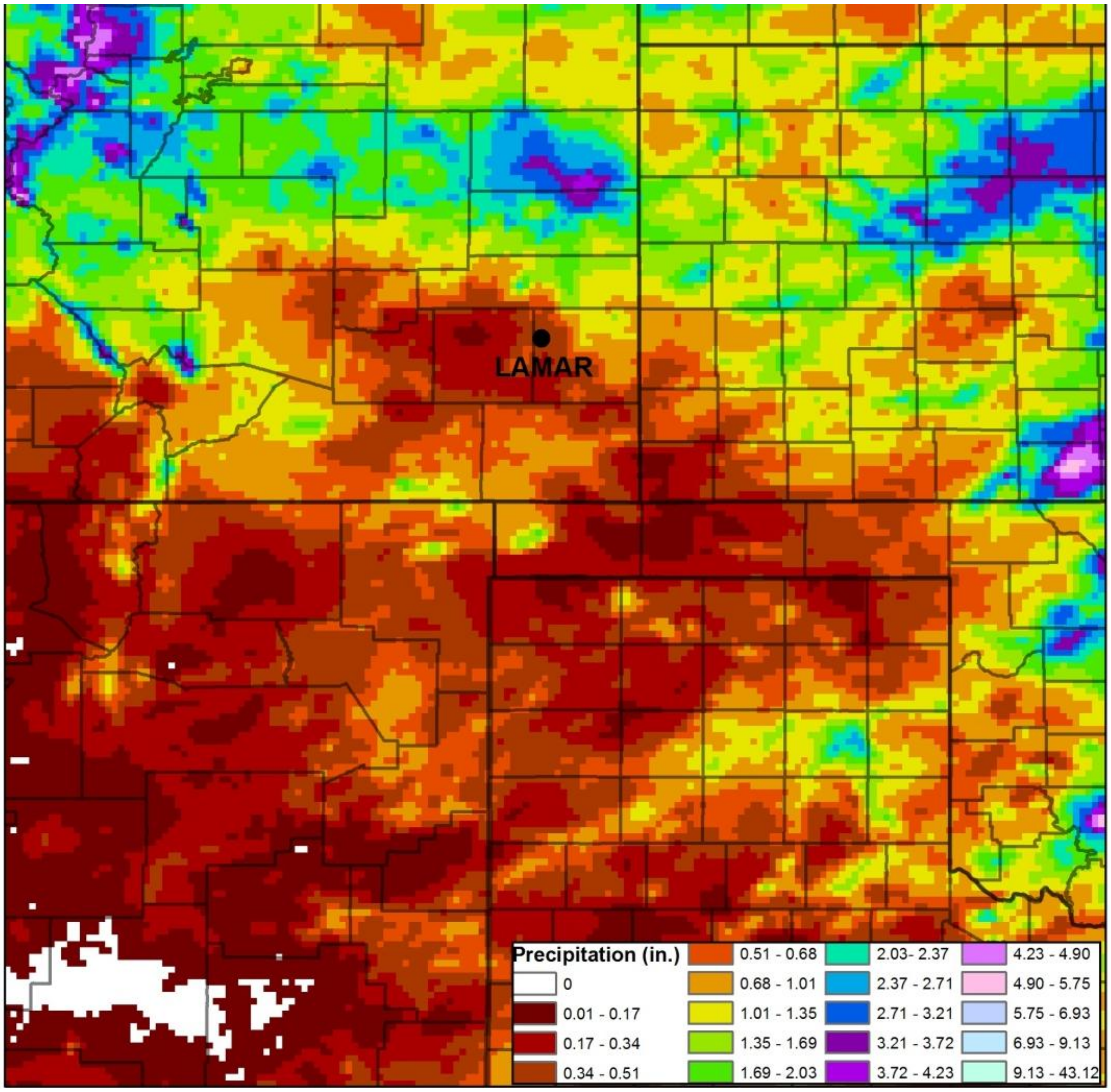


Figure 45: Total precipitation in inches for the eastern Colorado and adjacent states, April 24, 2013 – May 23, 2013.
(Source: http://prism.nacse.org/recent/).

Radar imagery combined with advisories issued by various NOAA offices on May 24, 2013 reveal that the PM_{10} exceedance in Lamar was likely caused by blowing dust created by thunderstorm downburst winds. The Arizona Department of Environmental Quality produced a comprehensive Exceptional Event report thoroughly describing the mechanisms of dust-producing thunderstorm outflow (see the reference for the State of Arizona Exceptional Event Documentation). The analysis that follows will show that the thunderstorms that impacted Lamar on May 24, 2013 were very similar to the thunderstorms described in the State of Arizona Exceptional Event Documentation which received EPA concurrence on September 6, 2012 (Source: http://www.azdeq.gov/environ/air/plan/download/epacon090612.pdf).
At 1:40 PM MST on May 24 the Storm Prediction Center (SPC) issued a Severe Thunderstorm Watch from 1:40 PM to 9:00 PM MST which included Lamar and the extreme southeast corner of Colorado (Figure 46). Included in the text of this watch was, "Upscale growth of storms

into clusters is anticipated later this evening with an increased threat for damaging winds" and "Several damaging wind gusts to 70 mph possible" (Source: http://www.spc.noaa.gov/products/watch/2013/ww0215.html).

At 6:34 PM MST the National Weather Service (NWS) office in Pueblo, CO issued a Severe Thunderstorm Warning for southwestern Baca and southeastern Las Animas counties. The hazard described by this warning was, "Quarter size hail and 60 mph wind gusts" (Source: http://mesonet.agron.iastate.edu/wx/afos/). The Pueblo radar image generated 4 minutes after the warning issuance shows a cluster of strong to severe thunderstorms along the Colorado/New Mexico state line and moving northeast at 35 mph (Figure 47).

By 7:54 PM MST the thunderstorm had weakened somewhat (Figure 48), but notice the increase in low-level radar returns of 20-30 dBZ spreading northward through Pritchett and Springfield. By 9:10 PM MST (Figure 49), those radar echoes had reached the Lamar area. This corresponds almost perfectly in time to the arrival of haze and reduced visibility in Lamar. By referring back to Table 12 we can see that between 8:53 PM and 9:11 PM MST the sustained wind and wind gusts increased from 20 to 44 mph and 28 to 58 mph, respectively, with a decrease in visibility from 10 to 2.5 statute miles. High winds, haze and reduced visibility observations consistent with blowing dust conditions in the region would continue for over one hour (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). Additionally there was decrease in temperature of 5 degrees Fahrenheit in 38 minutes without the aid of a cold front passage or any observed precipitation. This is also an indicator of thunderstorm downburst winds (Source: http://www.erh.noaa.gov/cae/svrwx/downburst.htm).

Verification that these exceptionally strong winds were indeed outflow from thunderstorms was confirmed by a Local Storm Report issued by the Pueblo NWS on Sunday, May 26 at 3:33 PM MST (Source: http://mesonet.agron.iastate.edu/wx/afos/):

```
..TIME...   ...EVENT...      ...CITY LOCATION...     ...LAT.LON...
..DATE...   ....MAG....      ..COUNTY LOCATION..ST.. ...SOURCE....
..REMARKS..

1015 PM     NON-TSTM WND GST 4 W LAMAR               38.07N 102.69W
05/24/2013  M63.00 MPH       PROWERS           CO    ASOS

GUSTS OF 58 MPH OR HIGHER OCCURRED BETWEEN ABOUT 10 PM
AND 11 PM...WITH 63 MPH BEING THE HIGHEST GUST. CAUSED BY

OUTFLOW FROM THUNERSTORMS ABOUT 30-40 MILES TO THE SOUTH.
```

NEXRAD imagery along with reports and advisories from NOAA offices indicate that a period of blowing dust occurred in Lamar during the evening hours of May 24, 2013 and likely caused the PM_{10} exceedance at the Municipal Building monitor.

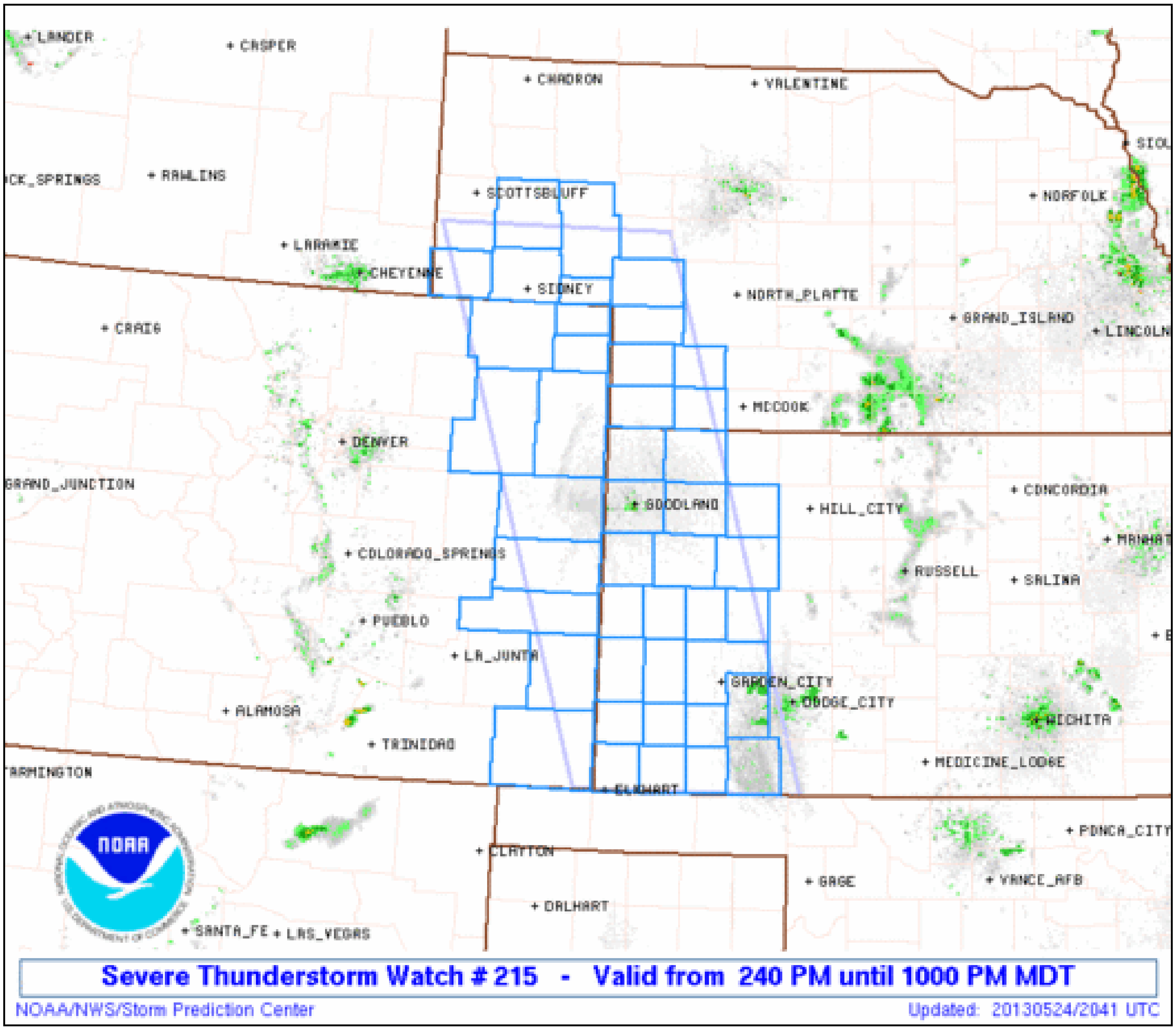


Figure 46: Severe Thunderstorm Watch #215 issued by the Storm Prediction Center, May 24, 2013.
(Source: http://www.spc.noaa.gov/products/watch/2013/ww0215.html)

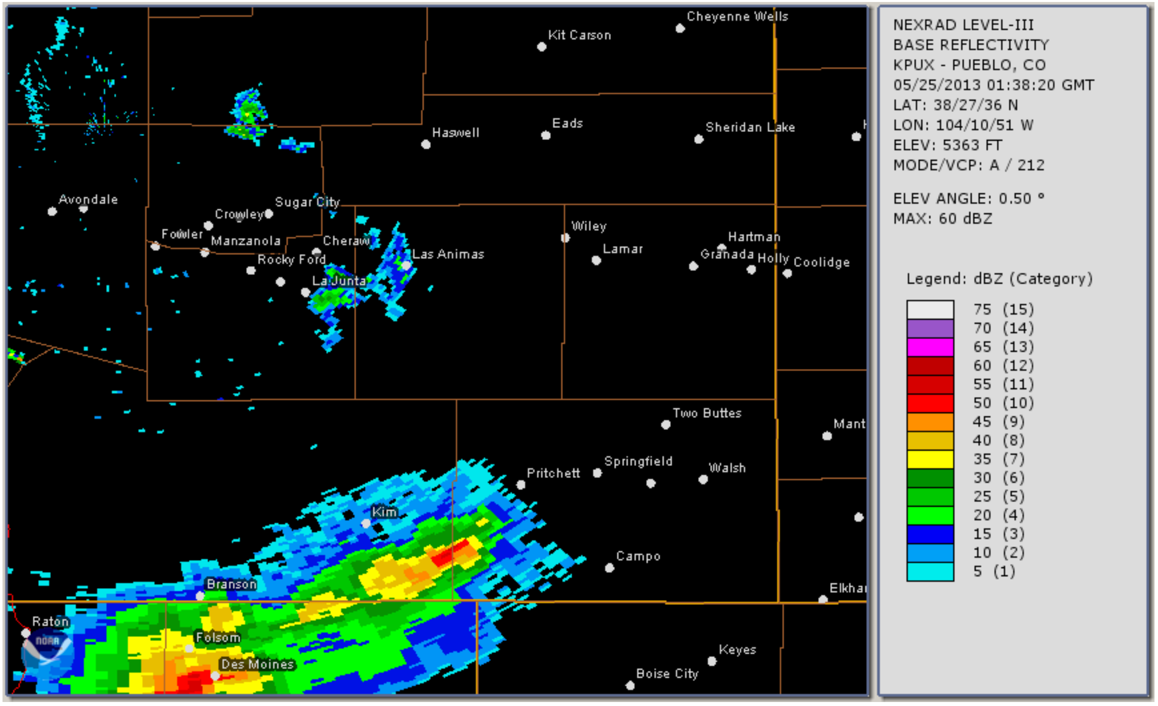


Figure 47: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 6:38 PM MST (138Z, May 25), May 24, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

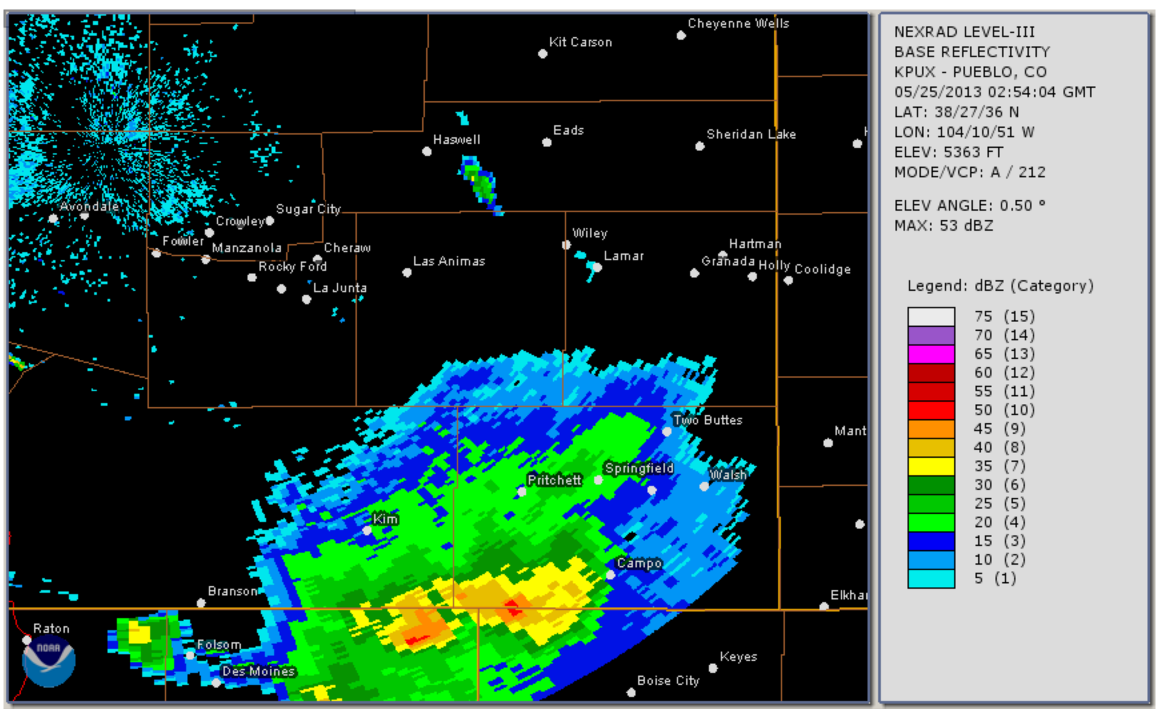


Figure 48: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 7:54 PM MST (254Z, May 25), May 24, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

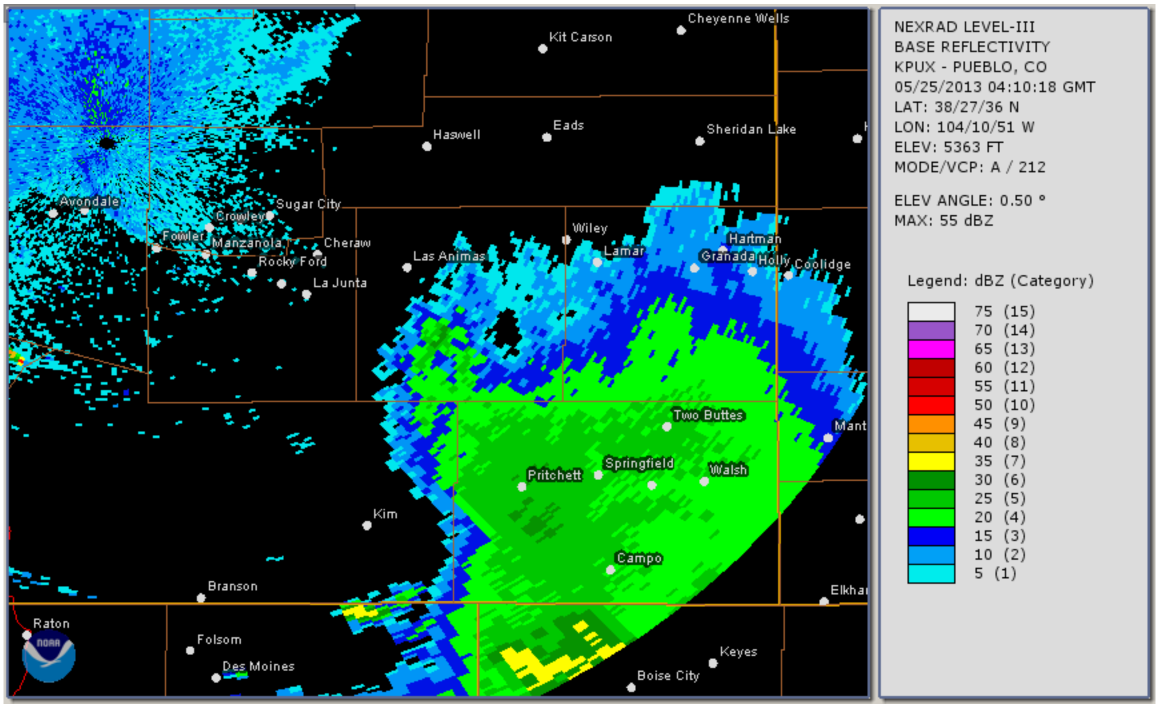


Figure 49: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 9:10 PM MST (410Z, May 25), May 24, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

2.5 May 25, 2013 Meteorological Analysis

On May 25 of 2013, a cluster of strong to severe thunderstorms in southeast Colorado with powerful outflow winds caused an exceedance of the 24-hour PM_{10} standard in Lamar, Colorado. The Municipal Building monitor recorded a concentration of 168 µg/m3. This elevated reading and the location of the monitor is plotted on a map of the Greater Lamar area in Figure 50. The thunderstorms were associated with a moist, unstable atmosphere over southeast Colorado that was impacted by an upper air disturbance. This disturbance initiated thunderstorms with intense southerly outflow winds which moved over drought-stricken soils. This combination of factors produced significant blowing dust in the Lamar area.

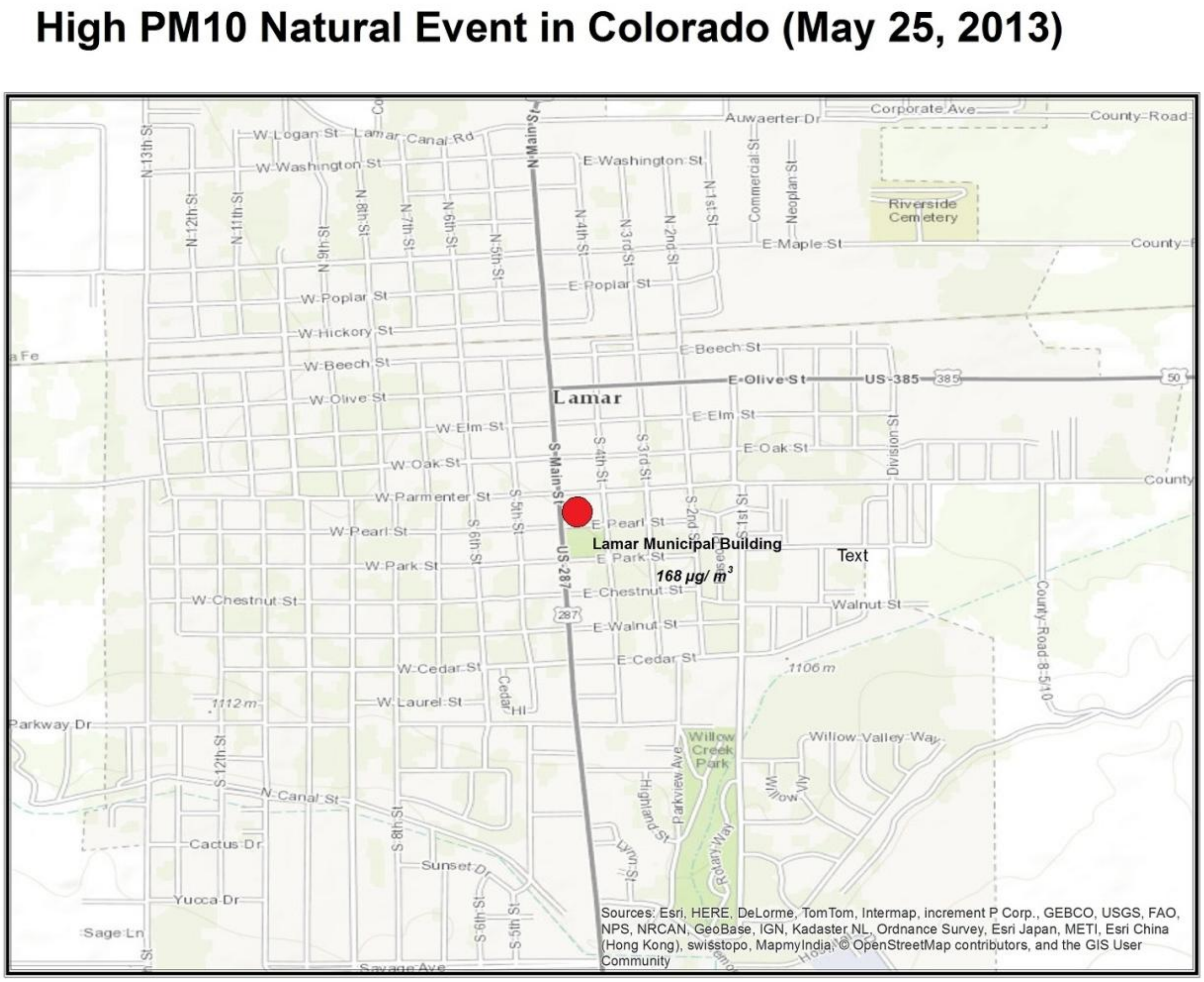


Figure 50: 24-hour PM_{10} concentrations for May 25, 2013.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The upper-level disturbance that initiated thunderstorms on May 25, 2013 is shown on the 700 mb height analysis map at 5:00 PM MST in Figure 51. The 700 mb level is located roughly 3 kilometers above mean sea level (MSL). This chart shows that a well-defined trough of low pressure was present at the 700 mb level during the initial stages of the blowing dust event of May 25. The trough was approaching a relatively moist air mass (Figure 52) that was in place over the southeastern corner of Colorado. The dew point in Lamar was dry at 16º F, but approximately 50 miles to the south in Springfield the dew point was significantly higher at 35º F indicating a "dry line" was in place between those two locations. A dry line is often a focal point for severe thunderstorm development on the Great Plains (source: http://forecast.weather.gov/glossary.php?word=dry%20line).

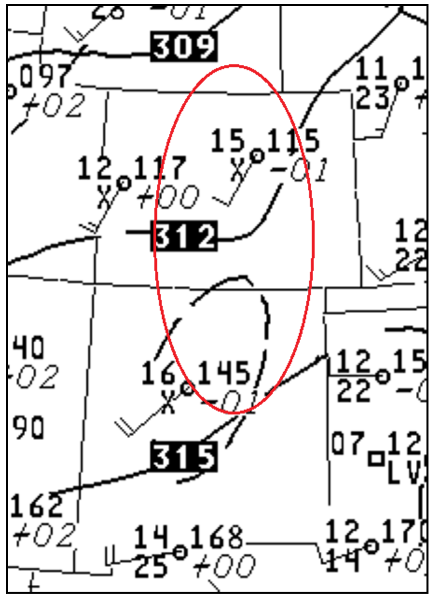


Figure 51: 700 mb (about 3 kilometers above mean sea level) analysis for 0Z May 26, 2013, or 5:00 PM MST May 25, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

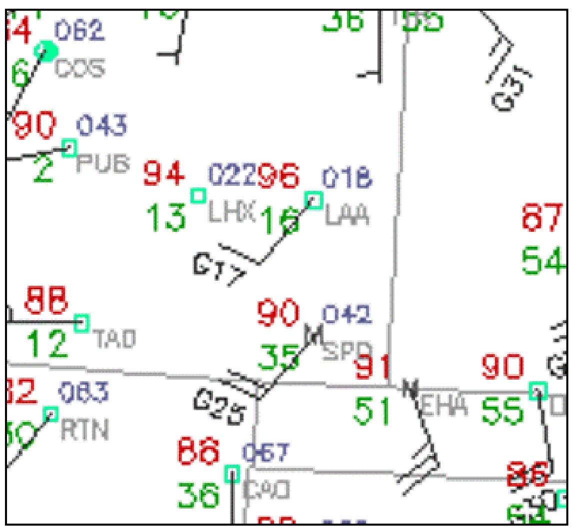


Figure 52: Southeast Colorado regional surface analysis for 0Z May 26, 2013 or 5:00 PM MST May 25, 2013.
(Source: http://www.mmm.ucar.edu/imagearchive/)

In order to fully evaluate the synoptic meteorological scenario of May 25, 2013, a regional surface weather map is provided showing individual station observations during the height of the event in question. Figure 53 presents weather observations for eastern Colorado and adjacent states at 9:13 PM on May 25. On the map in Figure 53 the station observation for Lamar (LAA) shows winds sustained at 35 knots (40 mph), gusts to 45 knots (52 mph), and a reduced visibility of 5 statute miles. Included in this observation is the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary).

Hourly surface observations, in table form, from Lamar provide additional evidence that there were numerous observations of high winds, haze and reduced visibility. Table 13 lists observations for the PM_{10} exceedance location of Lamar. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) are highlighted in yellow. Note the 73-minute time interval from 8:53 PM to 10:06 PM MST when sustained winds ranged from 35-43 mph and gusts ranged from 46-54 mph. These wind speeds are significantly above the 30 mph sustained wind and 40 mph wind gust thresholds established in the Lamar Blowing Dust Climatology referenced above.

Also note that there was a brief period of time very early on May 25 (12:25 and 12:53 AM MST from Table 13) when high winds, haze and reduced visibility were recorded in Lamar. These conditions were likely the remnants from an earlier period of strong to severe thunderstorms near Lamar the previous evening (for more information on those thunderstorms, see Section 2.4 for the Meteorological Analysis of May 24, 2013). In all likelihood this brief, but significant, period of blowing dust was also a contributor to the PM_{10} exceedance in Lamar on May 25.

Surface weather maps and hourly observations provide clear evidence of blowing dust and winds well above the threshold speeds for blowing dust on May 25, 2013.

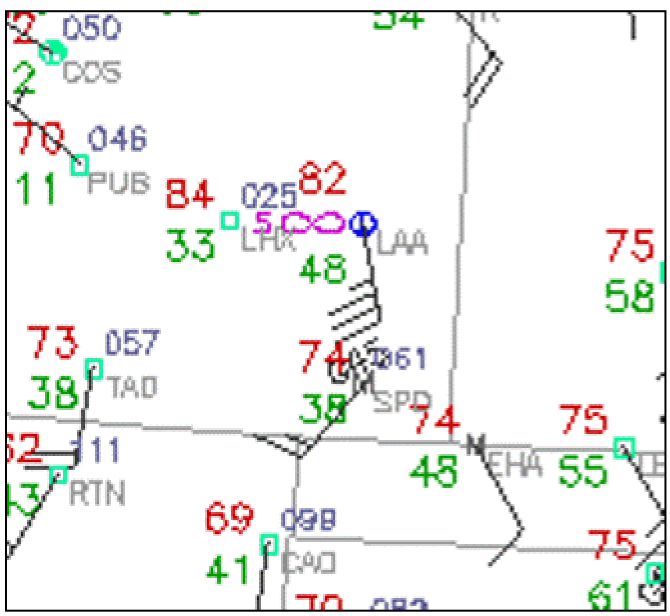


Figure 53: High Plains regional surface analysis for 9:13 PM MST, May 25, 2013. (Source: http://www.mmm.ucar.edu/imagearchive/)

Table 13: Weather observations for Lamar, Colorado, on May 25, 2013
(Source: http://mesowest.utah.edu/)

Time MST May 25, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:25	72	33	29	43	180	haze	3
0:53	68	47	29	46	180		7
1:53	68	49	24	33	200		10
2:53	68	53	24	35	200		10
3:53	69	53	5		240		10
4:53	68	50	4		290		9
5:23	73	47	15	31	240		9
5:53	73	48	20	24	230		9
6:53	78	39	27	31	240		9
7:53	83	31	23	31	240		9
8:53	85	29	13	23	210		9
9:53	88	23	7				10
10:53	89	21	0				10
11:53	94	15	9		200		10
12:53	95	12	10		270		10
13:53	98	9	15	23	200		10
14:53	99	6	13	24	260		10
15:53	96	6	6		260		10
16:53	96	5	13	20	220		10
17:53	96	5	10	16	280		10
18:53	91	7	17	27	220		9
19:53	84	15	14		170		10
20:18	88	14	30	39	200		10
20:33	84	18	31	43	180		8
20:41	82	27	36	47	180		6
20:53	82	31	43	50	180		4
21:02	82	30	40	52	170	haze	5
21:35	82	20	35	54	180		8
21:53	79	27	36	46	150		10
22:06	79	34	37	50	140		8
22:53	74	46	29	41	150		9
23:53	72	44	21	28	140		10

The synoptic weather conditions described above impacted a region that was in the midst of an exceptional drought (Figure 54). Sustained drought conditions are known to make topsoil susceptible to high winds and produce blowing dust (see the following link from the National Climatic Data Center for more information: https://www.ncdc.noaa.gov/paleo/drought/drght_history.html). Figure 55 shows the total precipitation in inches from April 25, 2013 to May 24, 2013 for eastern Colorado and adjacent states. Note that the entire area immediately surrounding Lamar, particularly in the upwind direction (predominantly south) received less than 0.5 inches of precipitation during the 30-day period leading up to the May 25, 2013 dust event in Lamar. Based on previous research 0.5 to 0.6 inches of precipitation over a 30-day period has been found to be the approximate threshold, below which, blowing dust exceedances at Lamar are more likely to occur when combined with high winds (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in southeast Colorado near Lamar were dry enough to produce blowing dust when winds were at or above the thresholds for blowing dust.

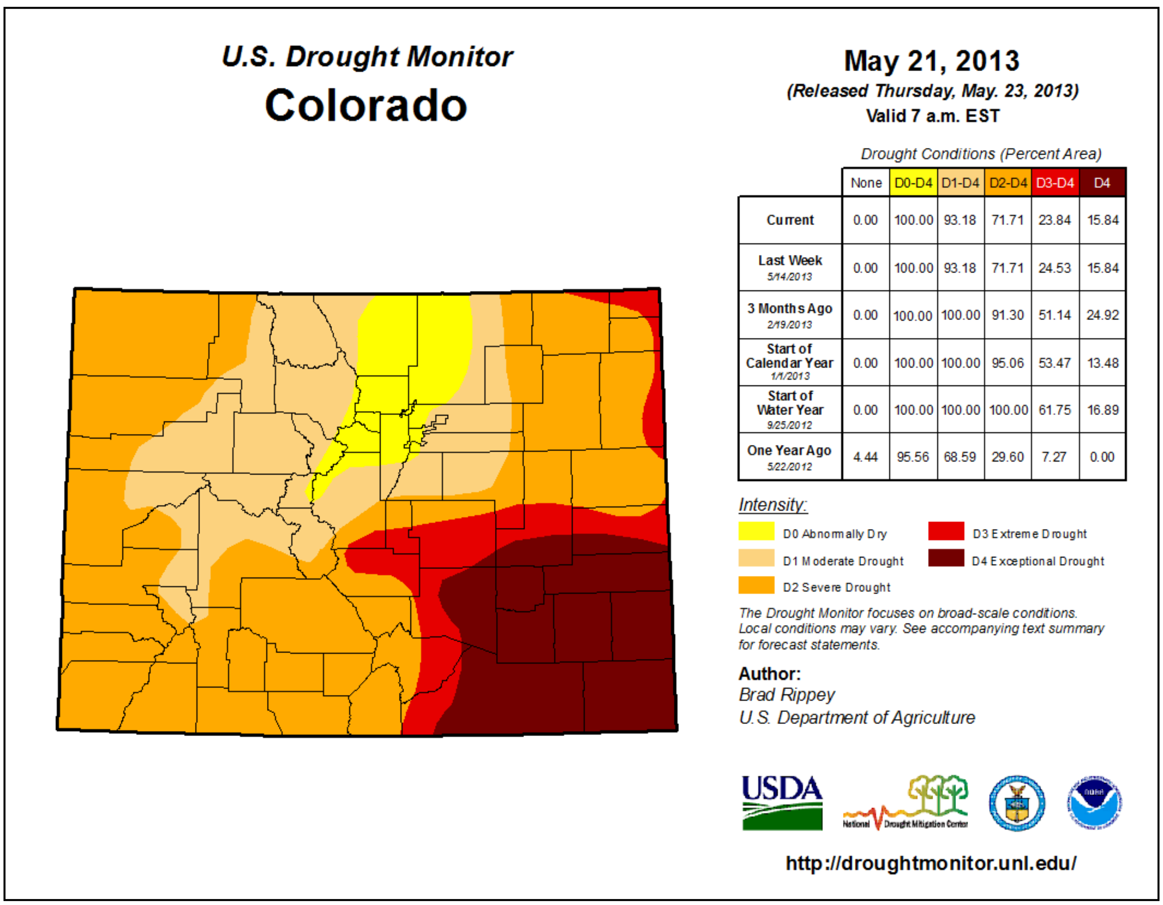


Figure 54: Drought conditions for Colorado at 5:00 AM MST May 21, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

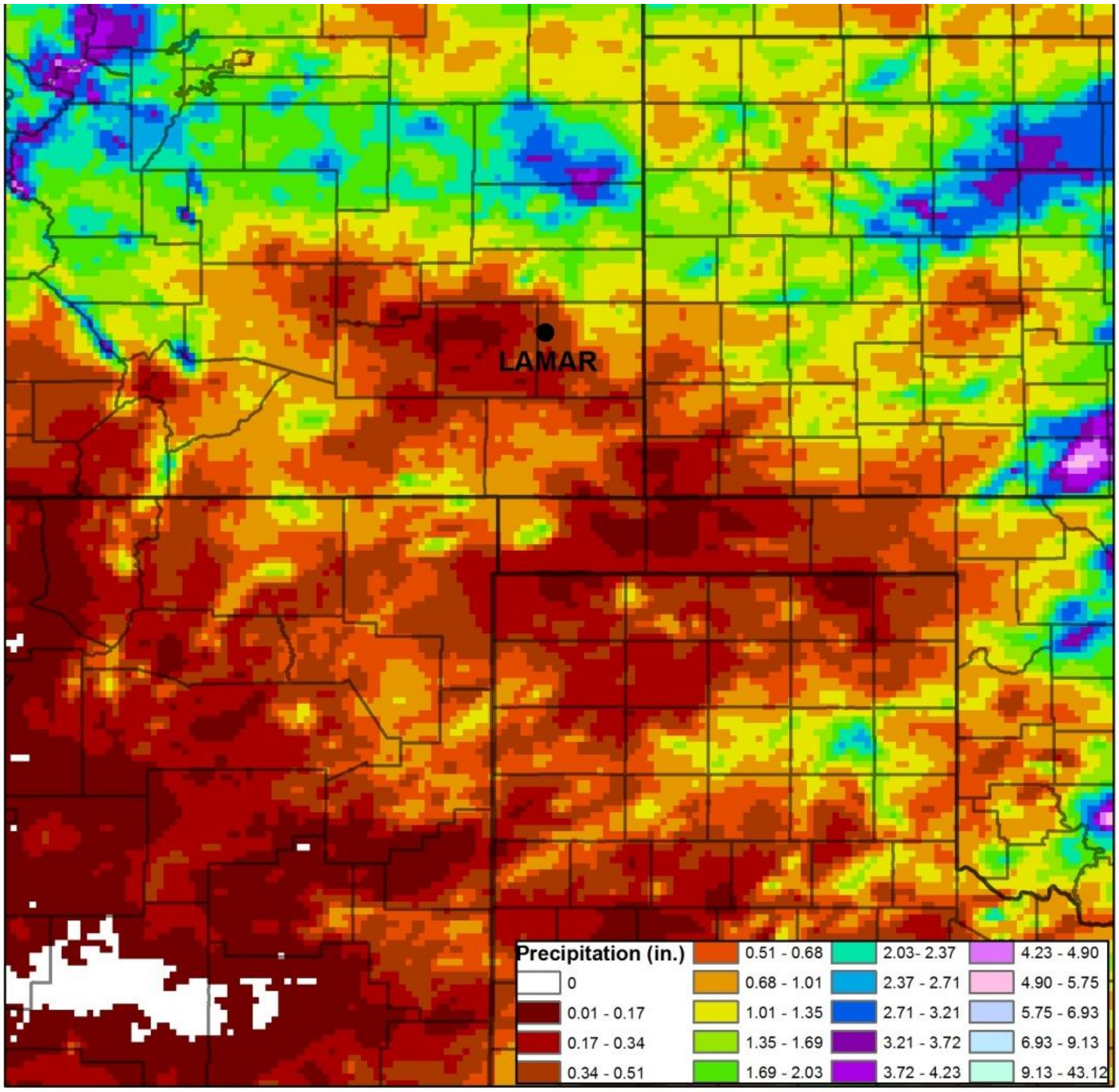


Figure 55: Total precipitation in inches for the eastern Colorado and adjacent states, April 25, 2013 – May 24, 2013.
(Source: http://prism.nacse.org/recent/).

Radar imagery combined with advisories issued by various NOAA offices on May 25, 2013 reveal that the PM_{10} exceedance in Lamar was likely caused by blowing dust created by thunderstorm downburst winds. The Arizona Department of Environmental Quality produced a comprehensive Exceptional Event report thoroughly describing the mechanisms of dust-producing thunderstorm outflow (see the reference for the State of Arizona Exceptional Event Documentation). The analysis that follows will show that the thunderstorms that impacted Lamar on May 25 were very similar to the thunderstorms described in the State of Arizona Exceptional Event Documentation which received EPA concurrence on September 6, 2012 (Source: http://www.azdeq.gov/environ/air/plan/download/epacon090612.pdf).

At 3:10 PM MST on May 25 the Storm Prediction Center (SPC) issued a Severe Thunderstorm Watch from 3:10 PM to 9:00 PM MST for southwest Nebraska and western Kansas, including those Kansas counties adjacent to Prowers County, Colorado where Lamar is located (Figure

56). Included in the text of this watch was, “Upscale growth of storms into clusters is anticipated later this evening with an increased threat for damaging winds” and “Several damaging wind gusts to 70 mph possible” (Source: http://www.spc.noaa.gov/products/watch/2013/ww0218.html).

At 7:47 PM MST the National Weather Service (NWS) office in Pueblo, CO issued a Severe Thunderstorm Warning for northeastern Baca County. The hazard described by this warning was, “Quarter size hail and 60 mph wind gusts” (Source: http://mesonet.agron.iastate.edu/wx/afos/). The Pueblo radar image generated 1 minute before the warning issuance shows the severe thunderstorm along the Colorado/Kansas state line and moving slowly to the northeast at 10 mph (Figure 57). Likely of more significance to Lamar were the still developing thunderstorm cells located along an east-west line to the south of Lamar. These storms were rapidly strengthening along the dry line described earlier in this paper.

By 8:10 PM MST thunderstorms to the south and southwest of Lamar had intensified (Figure 58) with radar echoes increasing to over 50 dBZ near the Bent/Prowers county line. This thunderstorm intensification coincided with a sharp increase in wind speeds in nearby Lamar. Eight minutes after the image of Figure 58, Table 13 reveals that Lamar recorded an increase in the sustained wind from 14 to 30 mph, with gusts reaching 39 mph. High winds, haze and reduced visibility observations consistent with blowing dust conditions in the region (See the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx) would continue for over 2 hours as the line of thunderstorms progressed slowly eastward to the south of Lamar in varying stages of weakening and intensification (Figure 59 and Figure 60). It should be noted that the wind direction in Lamar closely followed the location of the most intense thunderstorm cells. Additionally there was decrease in temperature of 6 degrees Fahrenheit in 23 minutes without the aid of a cold front passage or any observed precipitation. This is also an indicator of thunderstorm downburst winds (Source: http://www.erh.noaa.gov/cae/svrwx/downburst.htm).

NEXRAD imagery along with reports and advisories from NOAA offices indicate that a period of blowing dust occurred in Lamar during the evening hours of May 25, 2013 and likely caused the PM_{10} exceedance at the Municipal Building monitor.

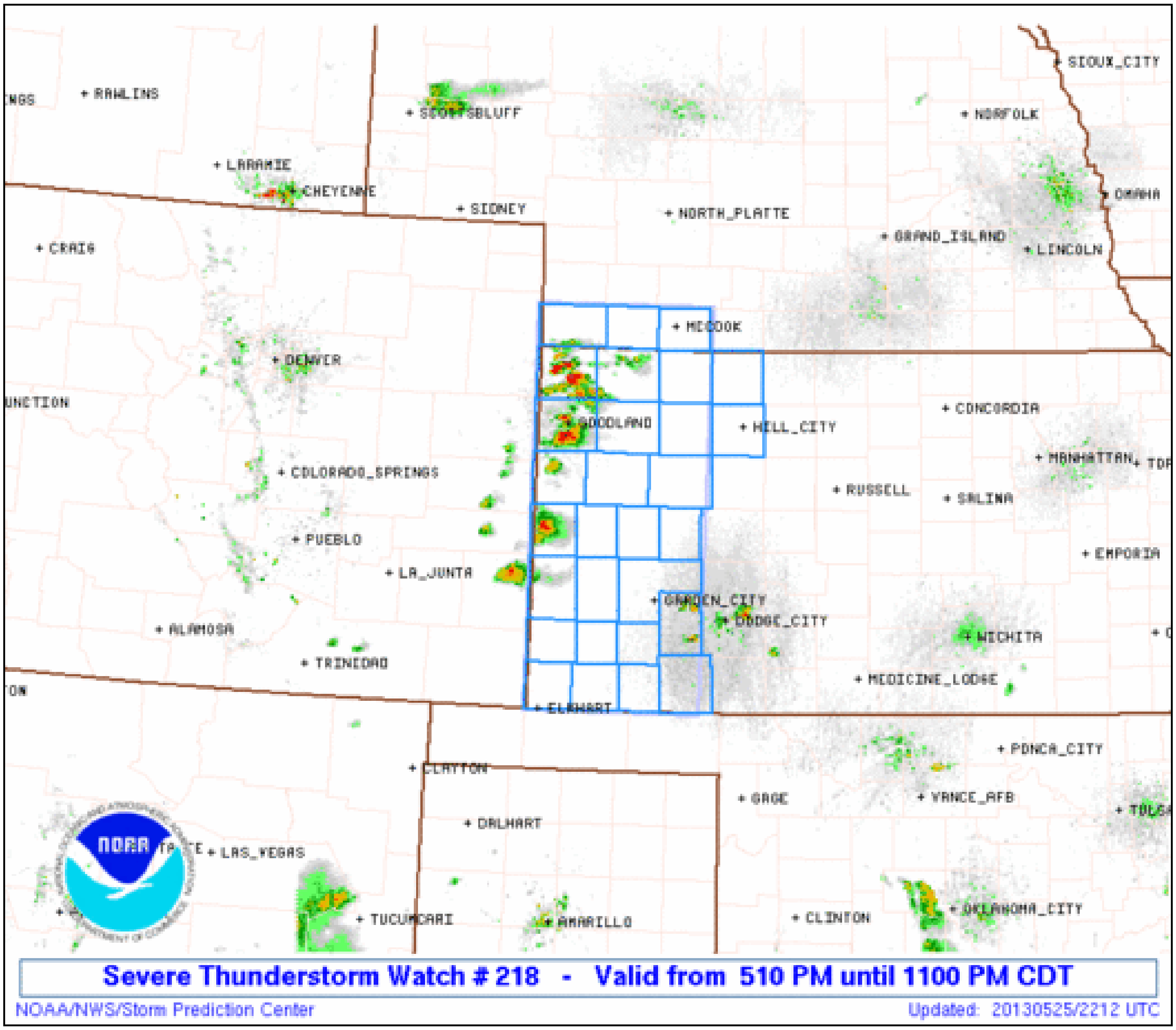


Figure 56: Severe Thunderstorm Watch #218 issued by the Storm Prediction Center, May 25, 2013.
(Source: http://www.spc.noaa.gov/products/watch/2013/ww0218.html)

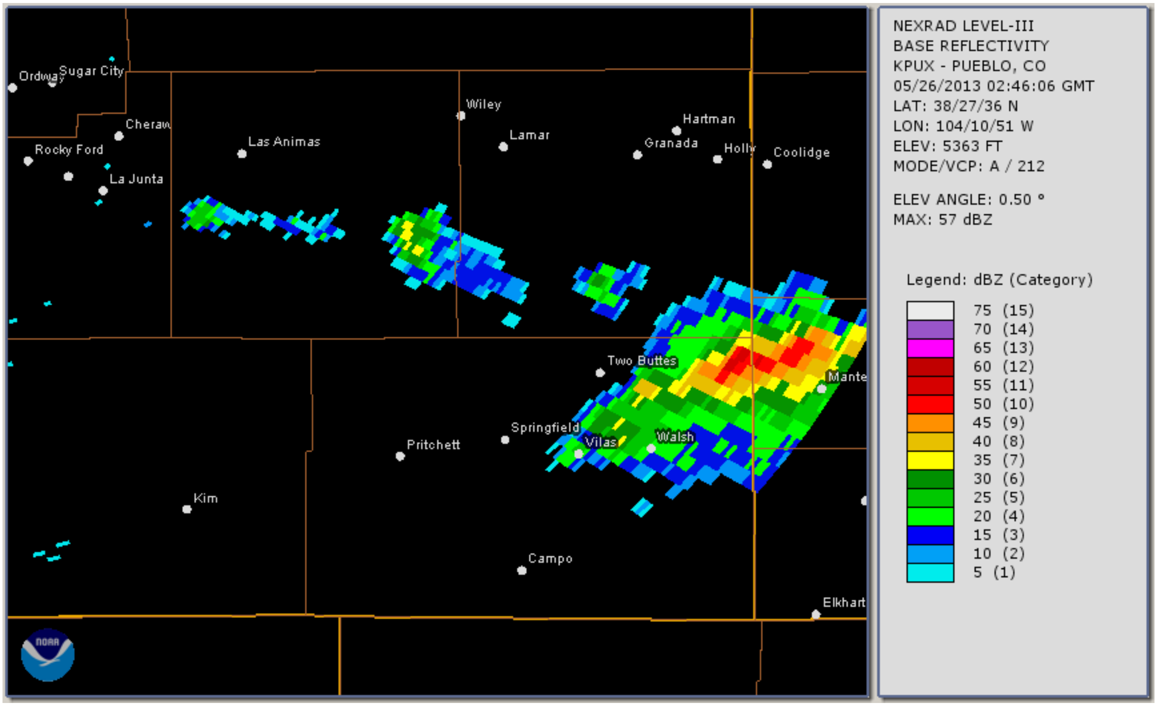


Figure 57: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 7:46 PM MST (246Z, May 26), May 25, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

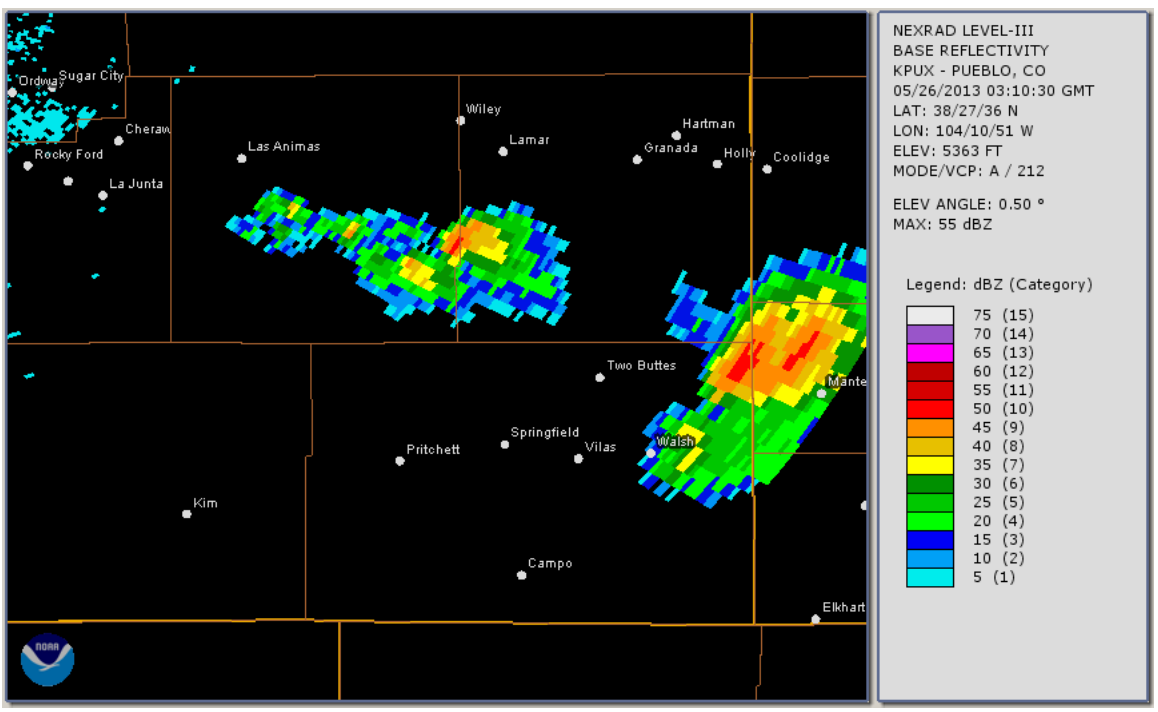


Figure 58: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 8:10 PM MST (310Z, May 26), May 25 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

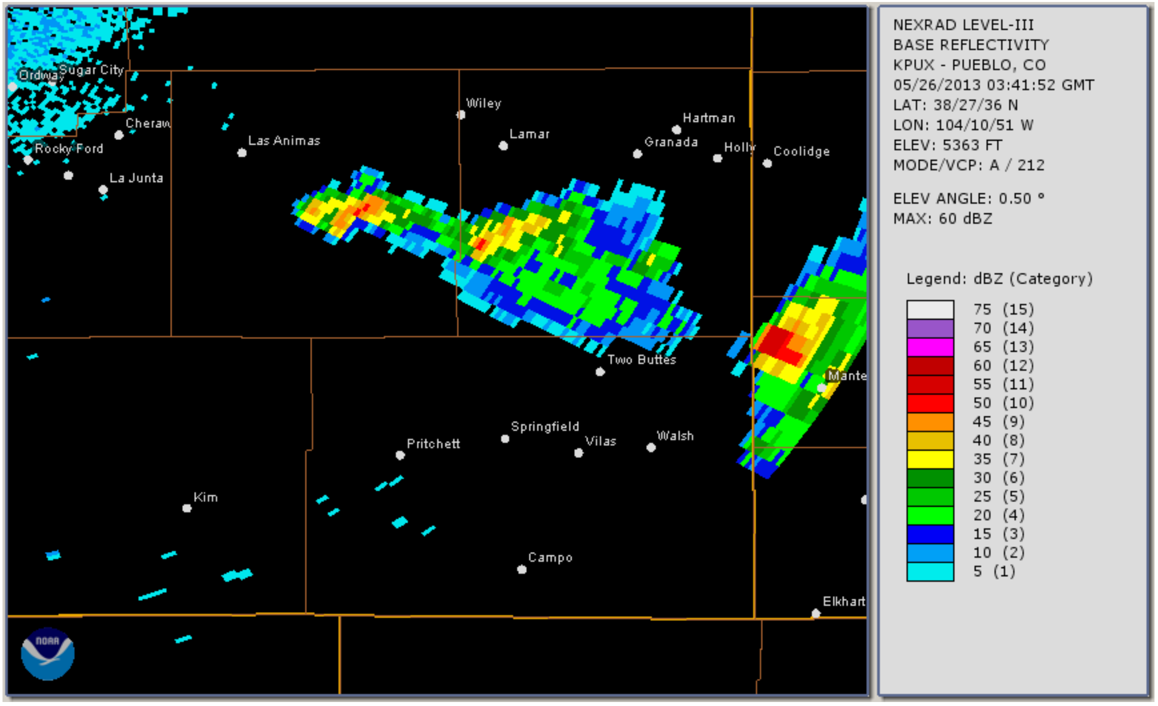


Figure 59: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 8:41 PM MST (341Z, May 26), May 25, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

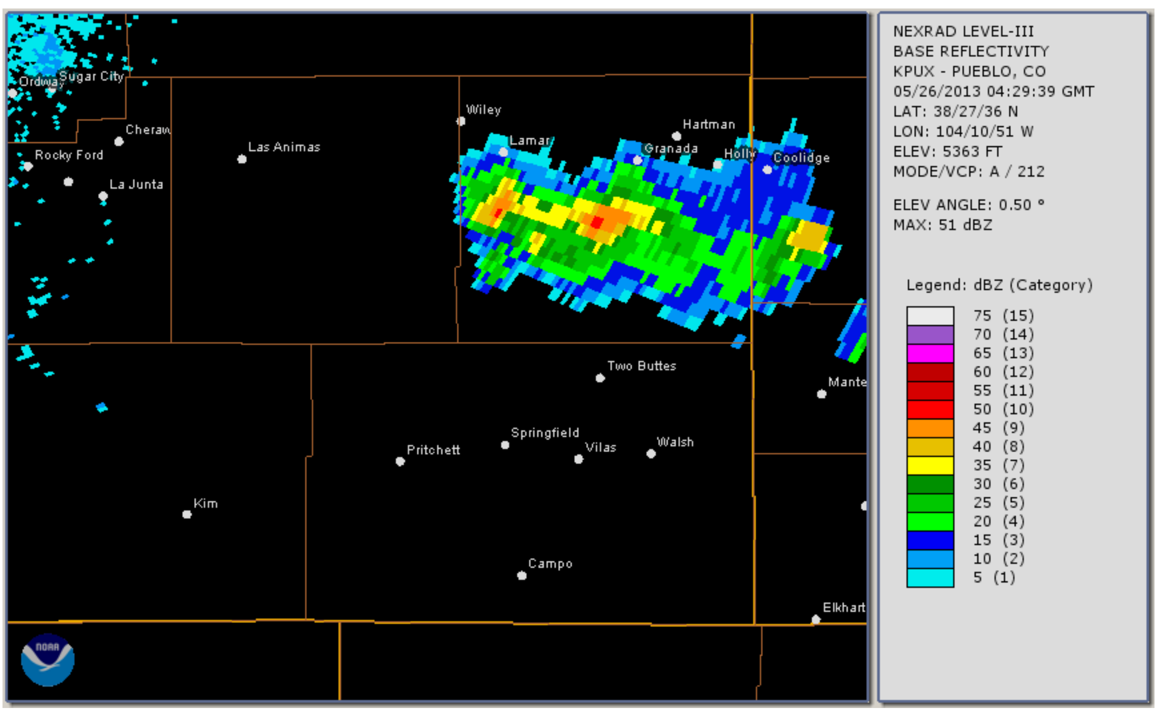


Figure 60: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 9:29 PM MST (429Z, May 26), May 25, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

2.6 May 28, 2013 Meteorological Analysis

On May 28, 2013, a cluster of strong to severe thunderstorms in the Texas Panhandle with extremely powerful outflow winds caused an exceedance of the 24-hour PM_{10} standard in Lamar, Colorado. The Municipal Building monitor recorded a concentration of 201 µg/m3. This elevated reading and the location of the monitor is plotted on a map of the Greater Lamar area in Figure 61. The thunderstorms were associated with a moist, unstable atmosphere over the Texas Panhandle that was impacted by an upper air disturbance. This disturbance initiated thunderstorms with intense outflow winds which consequently moved over drought-stricken soils. This combination of factors produced strong south to southeasterly winds in the Lamar area which ushered in a significant amount of blowing dust.

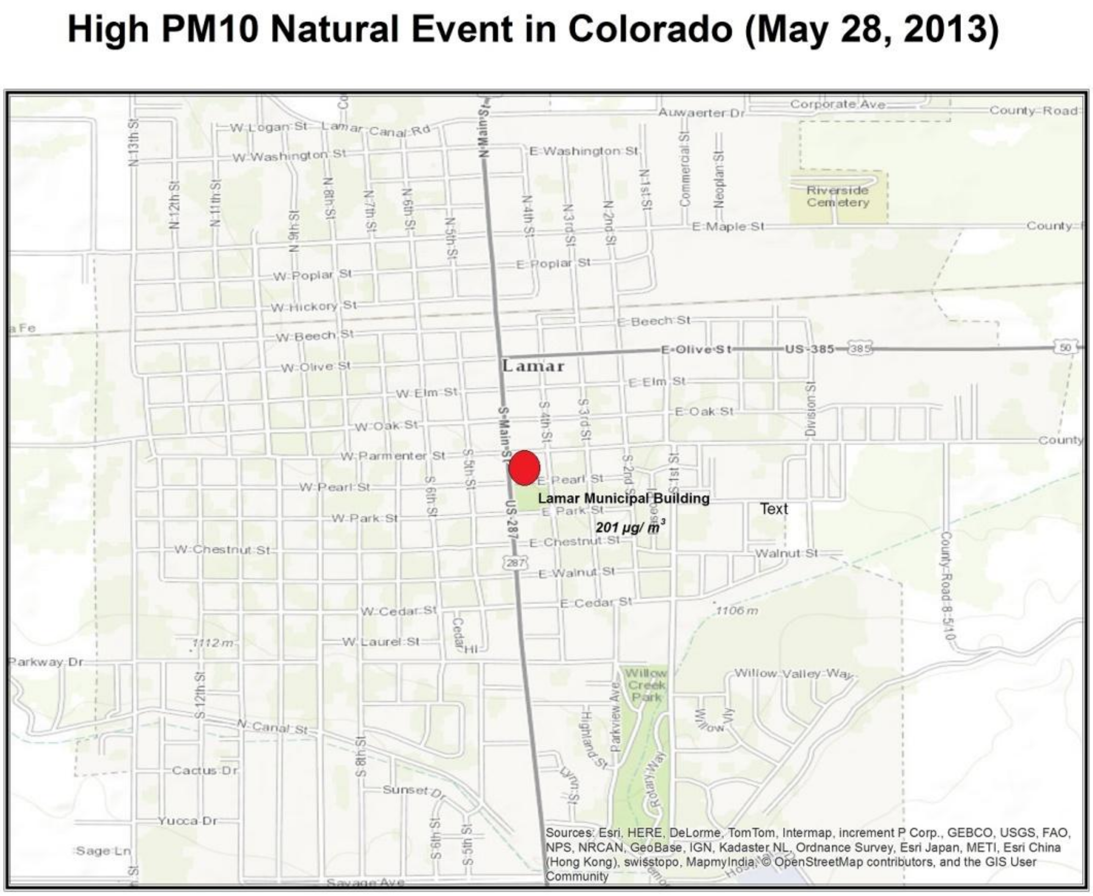


Figure 61: 24-hour PM_{10} concentrations for May 28, 2013.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The upper-level disturbance that initiated thunderstorms on May 28, 2013 is shown on the North American Regional Reanalysis (NARR) 700 mb height analysis map at 2:00 PM MST in Figure 62. The 700 mb level is located roughly 3 kilometers above mean sea level (MSL). This chart shows that a well-defined trough of low pressure (circled in red) was present at the 700 mb level during the initial stages of the blowing dust event of May 28. The trough was approaching a relatively moist air mass (Figure 63) that was over the Texas Panhandle. Surface observations at this time reveal that a "dry line" was in place over northwestern parts of the Panhandle. The dew point in Dalhart (DHT) was very dry at 12° F, but only 33 miles to the southeast in Dumas (DUX) the dew point was significantly higher at 42° F. A dry line is often a focal point for severe thunderstorm development on the Great Plains (Source: http://forecast.weather.gov/glossary.php?word=dry%20line)

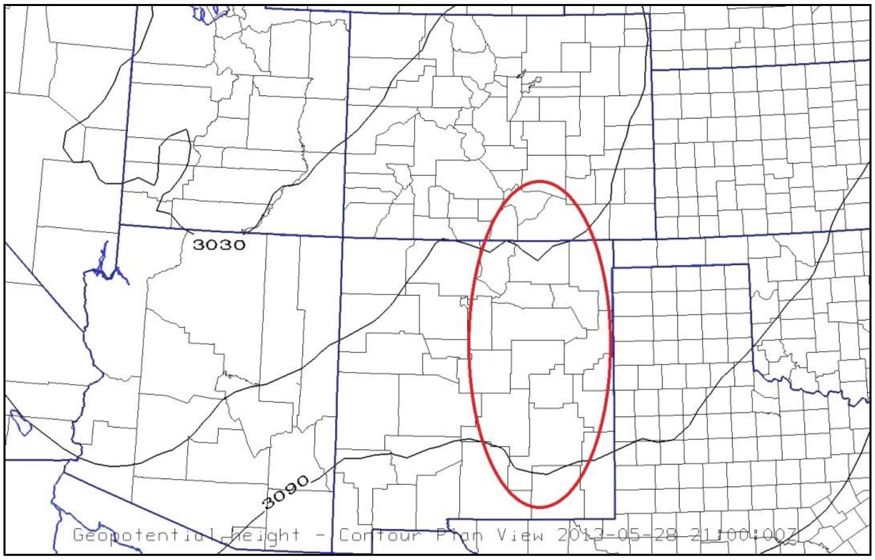


Figure 62: NARR 700 mb analysis for 21Z May 28, 2013, or 2:00 PM MST May 28, 2013. (Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

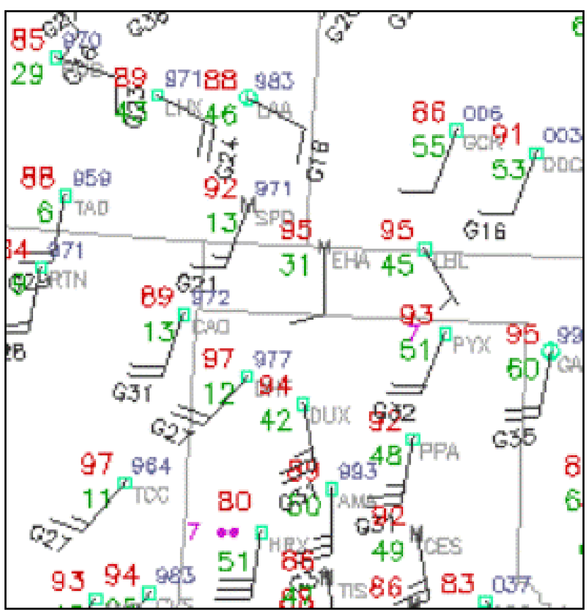


Figure 63: High Plains regional surface analysis for 21Z May 28, 2013 or 2:00 PM MST May 28, 2013.
(Source: http://www.mmm.ucar.edu/imagearchive/)

In order to fully evaluate the synoptic meteorological scenario of May 28, 2013, regional surface weather maps are provided showing individual station observations during the height of the event in question. Figure 64 presents weather observations for eastern Colorado and adjacent states at 2:13 PM, 8:13 PM and 10:13 PM MST on May 28. On the map in Figure 64(a) the station observations for Dalhart (DHT) and Dumas (DUX) in the Texas Panhandle show winds of 30-35 knots (35-40 mph), gusts to 40-41 knots (46-47 mph), and visibility reduced to 2-3 statute miles. Included at both observation sites is the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary). At the same time the wind in Lamar (LAA) was sustained at 15 knots (17 mph) out of a southerly direction with unrestricted visibility.

Six hours later, conditions had changed dramatically in southeast Colorado (Figure 64 (b)). Lamar (LAA) shows winds sustained at 30 knots (35 mph), gusts to 39 knots (45 mph), haze and a reduced visibility of 4 statute miles. This is an observation that is consistent with blowing dust conditions in southeast Colorado (30 mph sustained winds, 40 mph gusts -- see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). Two hours later at 10:13 PM MST (Figure 64 (c)) dust had reached Burlington, located 85 miles to the north-northeast of Lamar, with an observation of 35 knot (40 mph) sustained winds, gusts to 45 knots (52 mph), haze and visibility reduced to 6 statute miles.

Hourly surface observations, in table form, from Lamar and other regional weather stations provide supporting evidence that there was an extended period of high winds and haze (blowing dust) in southeast Colorado and large sections of the High Plains. Table 14 lists observations for the PM_{10} exceedance location of Lamar while observations for Burlington, CO along with Dalhart and Dumas, TX can be found in

Table 15 through Table 17, respectively. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) are highlighted in yellow. Collectively, these four sites experienced many hours of reduced visibility along with sustained wind speeds and gusts at or well above the thresholds for blowing dust.

Surface weather maps and hourly observations indicate that a regional blowing dust occurred on May 28, 2013. This data provides clear evidence of blowing dust and winds well above the threshold speeds for blowing dust supported by local climatology.

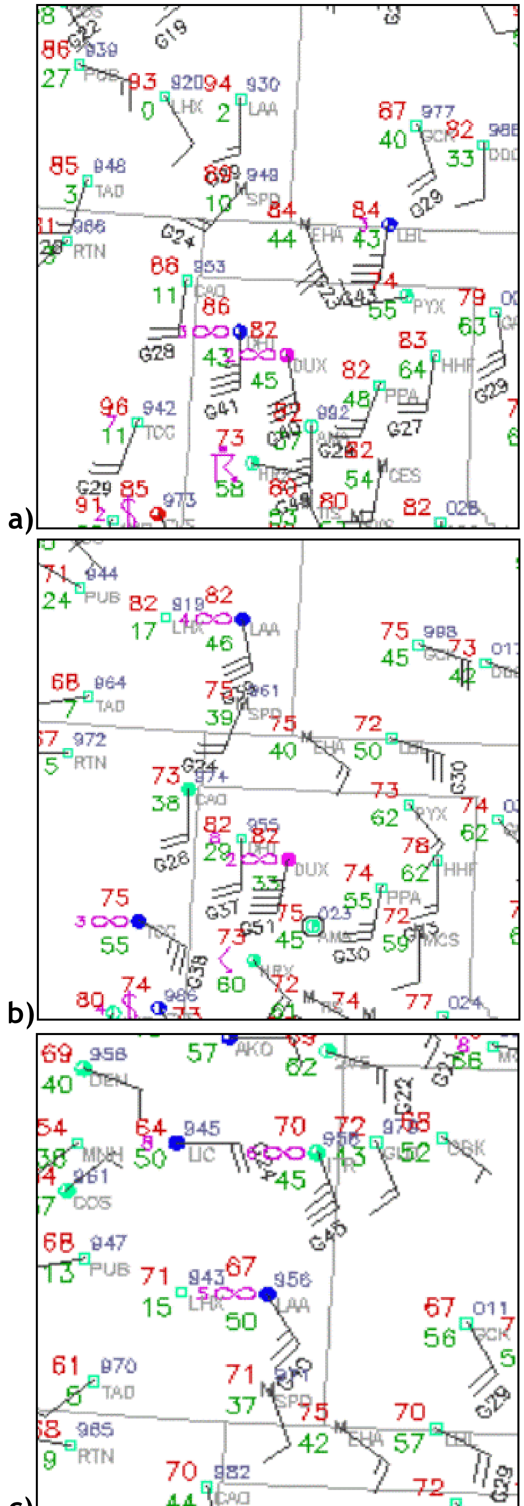


Figure 64: High Plains regional surface analysis for (a) 2:13 PM MST, (b) 8:13 PM MST and (c) 10:13 PM MST, May 28, 2013.
(Source: http://www.mmm.ucar.edu/imagearchive/)

Table 14: Weather observations for Lamar, Colorado, on May 28, 2013
(Source: http://mesowest.utah.edu/)

Time MST May 28, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	62	75	0				10
1:53	56	84	0				9
2:53	54	83	0				10
3:53	57	77	0				9
4:53	58	78	7		300		8
5:09	59	82	14		360		8
5:42	61	72	9		340		9
5:53	62	67	7		340		9
6:53	67	61	8		350		9
7:53	70	57	5		320		10
8:53	75	45	6		90		10
9:53	79	39	7		80		10
10:53	82	35	8	21	130		10
11:53	84	31	12		120		10
12:53	87	29	15	22	100		10
13:53	88	23	12	18	120		10
14:53	91	16	17	24	140		10
15:53	95	5	17	24	150		10
16:44	95	3	21	33	180		10
16:53	94	3	20	33	180		10
17:53	90	4	16		160		10
18:53	83	26	21	31	110		9
19:29	82	27	29	39	180	haze	3
19:36	82	27	37	48	180	haze	3
19:44	82	27	30	47	180	haze	1
19:53	82	27	31	41	170	haze	3
20:00	82	28	35	45	170	haze	4
20:53	79	23	29	45	160	haze	5
21:16	72	41	32	43	140	haze	2
21:32	68	49	32	44	140	haze	4
21:53	67	55	31	46	150	haze	5
22:53	67	57	24	33	150		9

Table 15: Weather observations for Burlington, Colorado, on May 28, 2013
(Source: http://mesowest.utah.edu/)

Time MST May 28, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	52	77					10
1:53	53	77	0				10
2:53	50	86	6		40		10
3:53	54	77	9		290		10
4:03	54	82	10		280	thunder	10
4:28	55	77	0			thunder	10
4:41	55	77	4		160		10
4:53	55	83	4		80		10
5:53	59	83	13		90		10
6:53	62	75	9		280		10
7:53	67	59	10		310		10
8:53	72	44	0				10
9:53	77	36	10	16	70		10
10:53	80	29	10	21	120		10
11:53	82	27	14		110		10
12:53	84	23	16	23	160		10
13:53	85	20	17	30	140		10
14:53	85	23	20	32	150		10
15:53	85	24	22	28	130		10
16:53	82	33	21		110		10
17:53	78	45	21	30	100		10
18:53	72	61	16		110		10
19:53	70	68	17		110		10
20:53	71	45	29	33	150		10
21:53	70	41	40	52	160	haze	6
22:53	67	51	37	48	170		10
23:53	64	63	36	44	180		10

Table 16: Weather observations for Dalhart, Texas, on May 28, 2013
(Source: http://mesowest.utah.edu/)

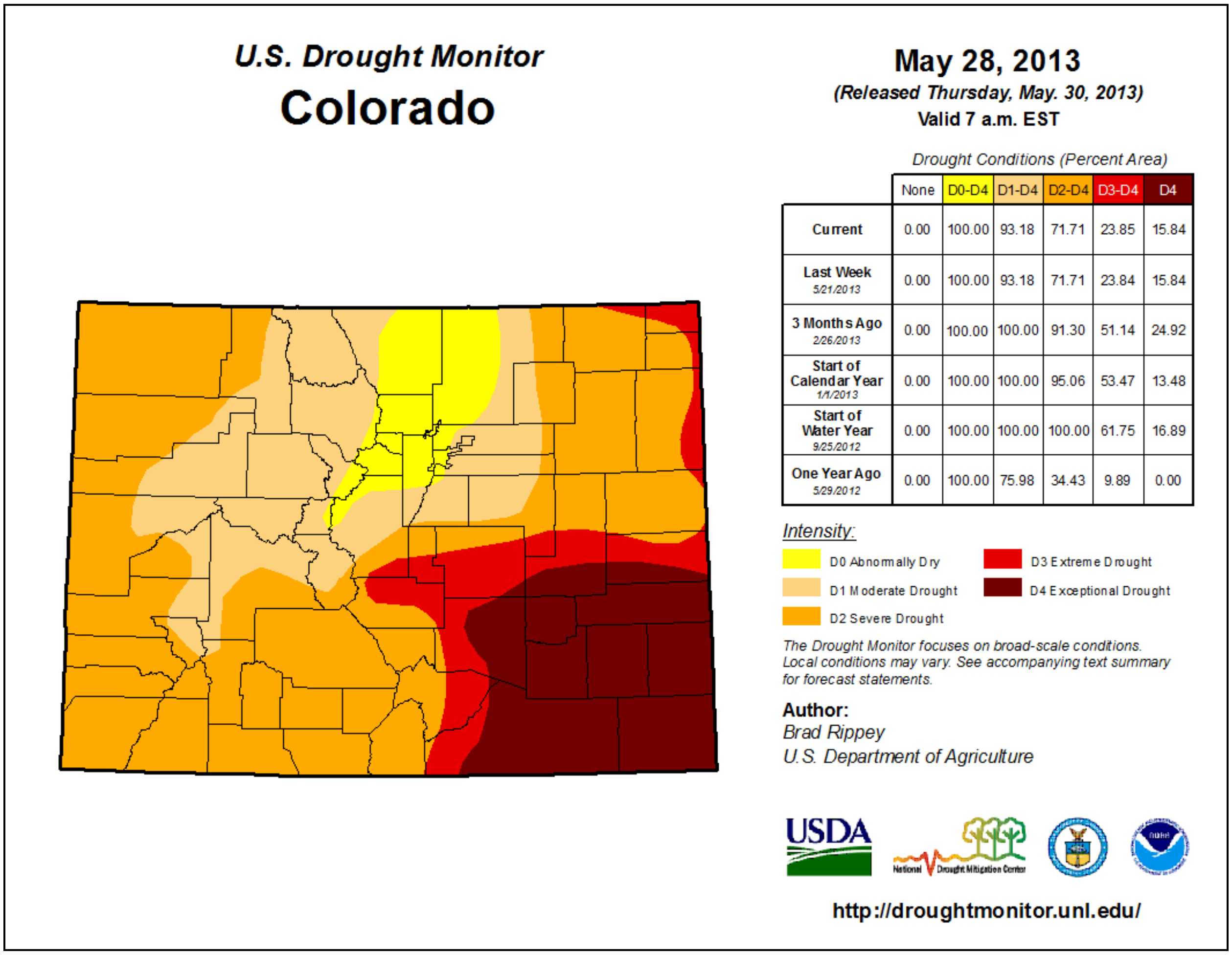
Time MST May 28, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
7:53	80	11	10		240		9
8:53	84	9	10		250		10
9:53	88	7	9		230		10
10:53	91	6	16	24	210		10
11:53	92	5	14	30	190		10
12:53	96	4	25	31	200		10
13:53	97	4	22	31	220		10
14:53	96	5	17	33	180		10
15:20	91	6	44	52	170	haze; squalls	2.5
15:29	88	29	39	52	150	haze	1
15:40	88	27	41	50	170	haze	2
15:49	90	24	37	50	170	haze	4
15:53	90	23	40	50	170	haze	4
16:17	88	22	38	51	170	haze	2
16:46	88	21	37	48	170	haze	4
16:53	87	21	36	44	180	haze	3
17:02	86	21	35	47	170	haze	2.5
17:09	86	22	40	47	180	haze	3
17:16	84	25	39	46	180	haze	2
17:53	83	23	36	46	170	haze	3
18:14	82	22	43	52	170	haze	2
18:26	81	21	39	46	170	haze	4
18:35	81	20	37	45	170	haze	4
18:53	80	20	30	44	160	haze	4
19:53	82	14	25	43	180		8
20:12	81	16	40	55	170	haze	2.5
20:16	81	17	40	52	160	haze	3
20:32	79	21	23	40	160	haze	5
20:53	81	16	27	44	160	haze	5
21:53	76	25	23	31	170		10

Table 17: Weather observations for Dumas, Texas, on May 28, 2013 (Source: http://mesowest.utah.edu/)

Time MST May 28, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
12:15	94	8	9	21	150		10
12:35	94	8	15	29	170		10
12:55	95	8	20	27	200		10
13:15	95	9	13	24	210		10
13:35	95	7	15	35	210		10
13:55	94	16	27	36	170		10
14:15	95	14	31	52	190		10
14:35	93	25	32	37	170		7
14:55	85	33	32	45	180	haze	3
15:15	78	48	31	46	180	lt rain	3
15:35	82	37	32	39	170	haze	5
15:55	84	23	30	46	170	haze	2.5
16:15	83	24	30	41	160	haze	3
16:35	84	19	31	44	170		7
16:55	82	27	36	46	170	haze	2.5
17:15	81	23	37	50	170	haze	2.5
17:35	81	21	25	36	160		7
17:55	80	24	32	47	180	haze	2.5
18:15	80	29	29	39	180	haze	5
18:35	79	25	41	50	170	haze	3
18:55	77	26	38	45	170	haze	2.5
19:15	77	25	39	50	160	haze	4
19:35	79	20	43	51	180	haze	5
19:55	82	17	50	59	190	haze	2
20:15	80	20	33	57	170	haze	3
20:35	80	22	41	58	180	haze	4
20:55	74	31	37	44	170		10
21:15	71	37	7	36	90	lt drizzle	10
21:35	73	31	21	28	110		10
21:55	74	28	13	23	100		10

The synoptic weather conditions described above impacted a region that was in the midst of an exceptional drought (Figure 65 and Figure 66). Sustained drought conditions are known to make topsoil susceptible to high winds and produce blowing dust (see the following link from the National Climatic Data Center for more information: https://www.ncdc.noaa.gov/paleo/drought/drght_history.html). Figure 67 shows the total precipitation in inches from April 28, 2013 to May 27, 2013 for eastern Colorado and adjacent states. Note that the entire area immediately surrounding Lamar, particularly in the upwind direction (south to southeast) received less than 0.5 inches of precipitation during the 30-day period leading up to the May 25, 2013 dust event in Lamar. These areas of low precipitation extend southward into the Texas Panhandle, which was likely a contributor to the blowing dust in Colorado. Based on previous research 0.5 to 0.6 inches of precipitation over a 30-day period has been found to be the approximate threshold, below which, blowing dust exceedances at Lamar are more likely to occur when combined with high winds (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in southeast Colorado and locations upwind to the south in the Texas Panhandle were dry enough to produce blowing dust when winds were above the thresholds for blowing dust.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	93.18	71.71	23.85	15.84
Last Week 5/21/2013	0.00	100.00	93.18	71.71	23.84	15.84
3 Months Ago 2/26/2013	0.00	100.00	100.00	91.30	51.14	24.92
Start of Calendar Year 1/1/2013	0.00	100.00	100.00	95.06	53.47	13.48
Start of Water Year 9/25/2012	0.00	100.00	100.00	100.00	61.75	16.89
One Year Ago 5/29/2012	0.00	100.00	75.98	34.43	9.89	0.00

Figure 65: Drought conditions for Colorado at 5:00 AM MST May 28, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

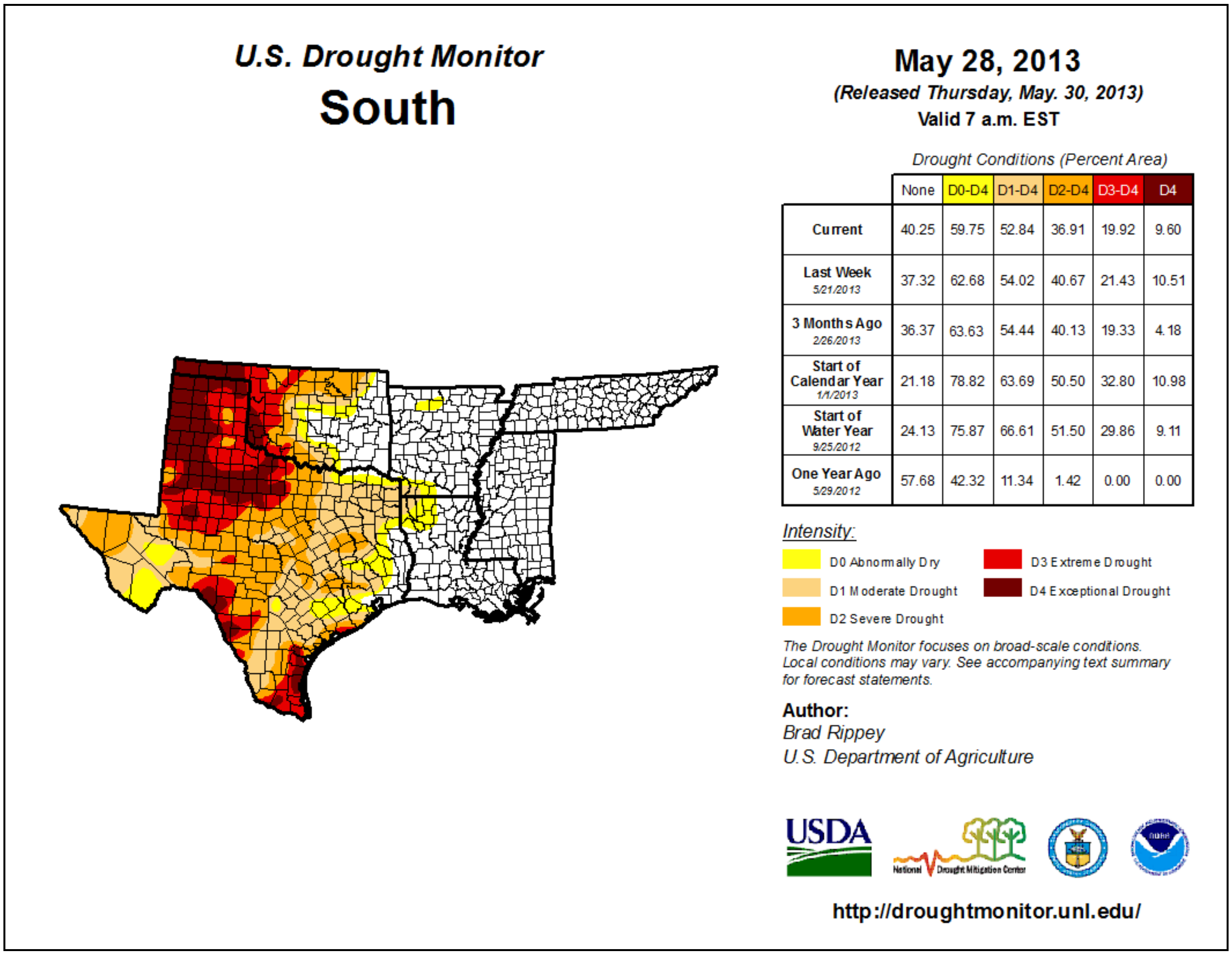


Figure 66: Drought conditions for southern U.S. states at 5:00 AM MST May 28, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

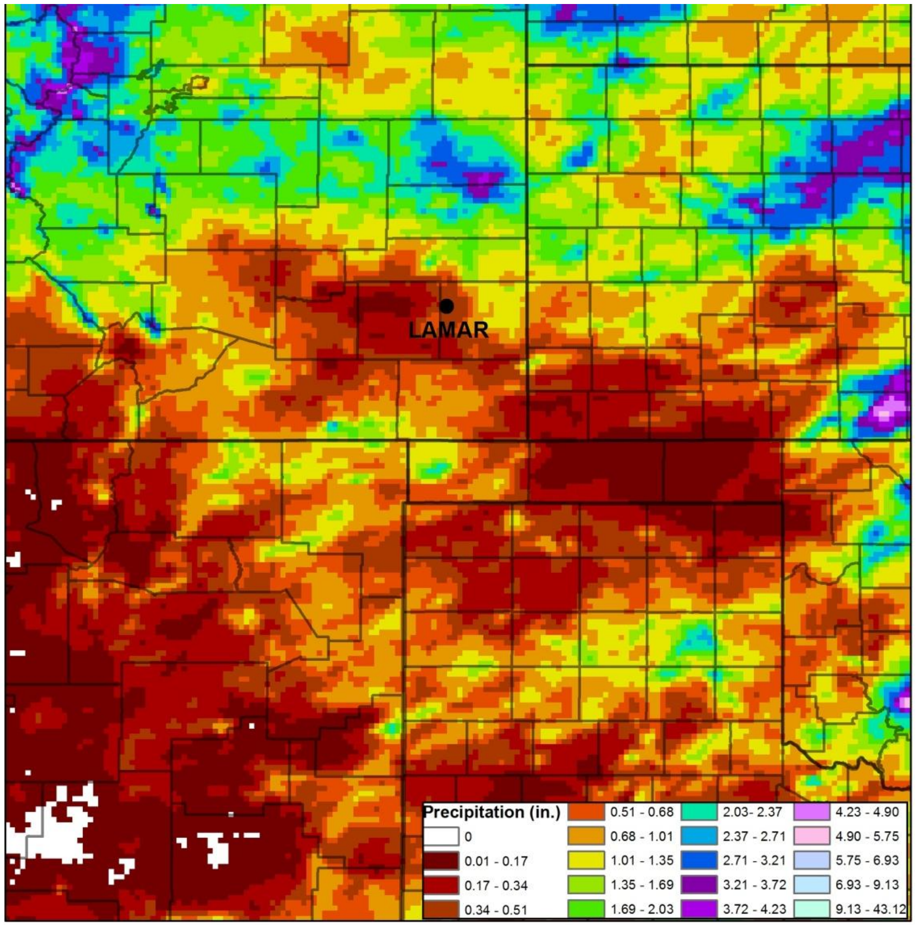


Figure 67: Total precipitation in inches for the eastern Colorado and adjacent states, April 28, 2013 – May 27, 2013.
(Source: http://prism.nacse.org/recent/).

Radar imagery combined with advisories issued by various NOAA offices on May 28, 2013 reveal that the PM_{10} exceedance in Lamar was likely caused by blowing dust created by thunderstorm downburst winds. The Arizona Department of Environmental Quality produced a comprehensive Exceptional Event report thoroughly describing the mechanisms of dust-producing thunderstorm outflow (see the reference for the State of Arizona Exceptional Event Documentation). The analysis that follows will show that the thunderstorms which impacted Lamar on May 28 were very similar to the thunderstorms described in the State of Arizona Exceptional Event Documentation which received EPA concurrence on September 6, 2012 (Source: http://www.azdeq.gov/environ/air/plan/download/epacon090612.pdf).

At 12:55 PM MST on May 28 the Storm Prediction Center (SPC) issued a Severe Thunderstorm Watch from 12:55 PM to 8:00 PM MST for southwest Kansas, northwest Oklahoma and the Texas Panhandle (Figure 68). Included in the text of this watch: “Several damaging wind gusts to 70 mph possible” (Source: http://www.spc.noaa.gov/products/watch/2013/ww0234.html).

At 6:16 PM MST the National Weather Service (NWS) office in Amarillo, TX issued a Severe Thunderstorm Warning for Deaf Smith and southwestern Oldham Counties in the Texas Panhandle. One of the hazards described by this warning was, “destructive winds in excess of

70 mph" (Source: http://mesonet.agron.iastate.edu/wx/afos/). The Amarillo NEXRAD base reflectivity image generated 16 minutes after the warning issuance (Figure 69) reveals a cluster of severe thunderstorms in northwestern Deaf Smith County moving slowly to the northeast at 15 mph. Note the band of 5-15 dBZ radar returns circled in red to the northeast of Vega. This radar return has a bow echo pattern which is often associated with strong, sometime damaging, winds that spread outward from the bottom of storms (for additional information on bow echoes from the SPC: http://www.spc.noaa.gov/misc/AbtDerechos/bowechoprot.htm). Considering the extent of the drought in the Texas Panhandle and the relatively low dBZ values on the radar return, it is reasonable to believe that this bow echo is lofted dust from thunderstorm downburst winds.

Supporting this conclusion are weather observations taken in nearby Dumas (about 40 miles northeast of the bow echo, Table 17). At 6:15 PM MST (one minute before the radar image), Dumas was reporting sustained winds of 29 mph, gusts to 39 mph with haze and visibility at 5 statute miles. Twenty minutes later, the wind had increased to 41 mph with gusts to 50 mph, haze, and visibility reduced to 3 statute miles. Additionally there was a decrease in temperature of 3 degrees Fahrenheit in 40 minutes without the aid of a cold front passage or any observed precipitation. This is also an indicator of thunderstorm downburst winds (Source: http://www.erh.noaa.gov/cae/svrwx/downburst.htm). Dalhart, TX (Table 16) located further north in the Panhandle also received several sudden increases in wind and decreases in visibility during the late afternoon and evening of May 28, 2013. This suggests that a significant area of blowing dust was travelling northward through the Texas Panhandle and moving towards southeast Colorado.

It appears that blowing dust from the thunderstorms in the Texas Panhandle arrived in Lamar at approximately 7:29 PM MST. By referring to Table 14 we can see that from 6:53 PM to 7:29 PM MST, the sustained wind and wind gusts increased from 21 to 29 mph and 29 to 39 mph, respectively, with a decrease in visibility from 9 to 3 statute miles. High winds, haze and reduced visibility observations consistent with blowing dust conditions in the region (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) would continue for over two hours in Lamar.

The Pueblo NEXRAD base reflectivity image at 8:30 PM MST (Figure 70) also captured what was likely an area of blowing dust. A line of low reflectivity echoes (circled in red) can be seen between Las Animas and Kim, Colorado. There is also a subtle bowing to this line, indicating that it was likely associated with thunderstorm outflow winds much like the imagery of Figure 69. It should be noted that in the period of time of this radar image, Lamar recorded sustained winds of 29-35 mph, gusts to 45 mph, haze and restricted visibility of 4-5 statute miles (Table 14).

If plumes of dust were evident near the Pueblo radar during this time period, why were there no visible radar echoes closer to Lamar? The likely reason is the gap in NEXRAD coverage in southeast Colorado, with the lowest radar returns available ranging from 6,000 to 10,000 ft. above ground level (Figure 71). The radar beam could very well have been overshooting any blowing dust which was likely concentrated relatively close to the surface.

NEXRAD imagery along with reports and advisories from NOAA offices indicate that blowing dust occurred in Lamar during the evening hours of May 28, 2013 and likely contributed to the PM_{10} exceedance at the Municipal Building monitor.

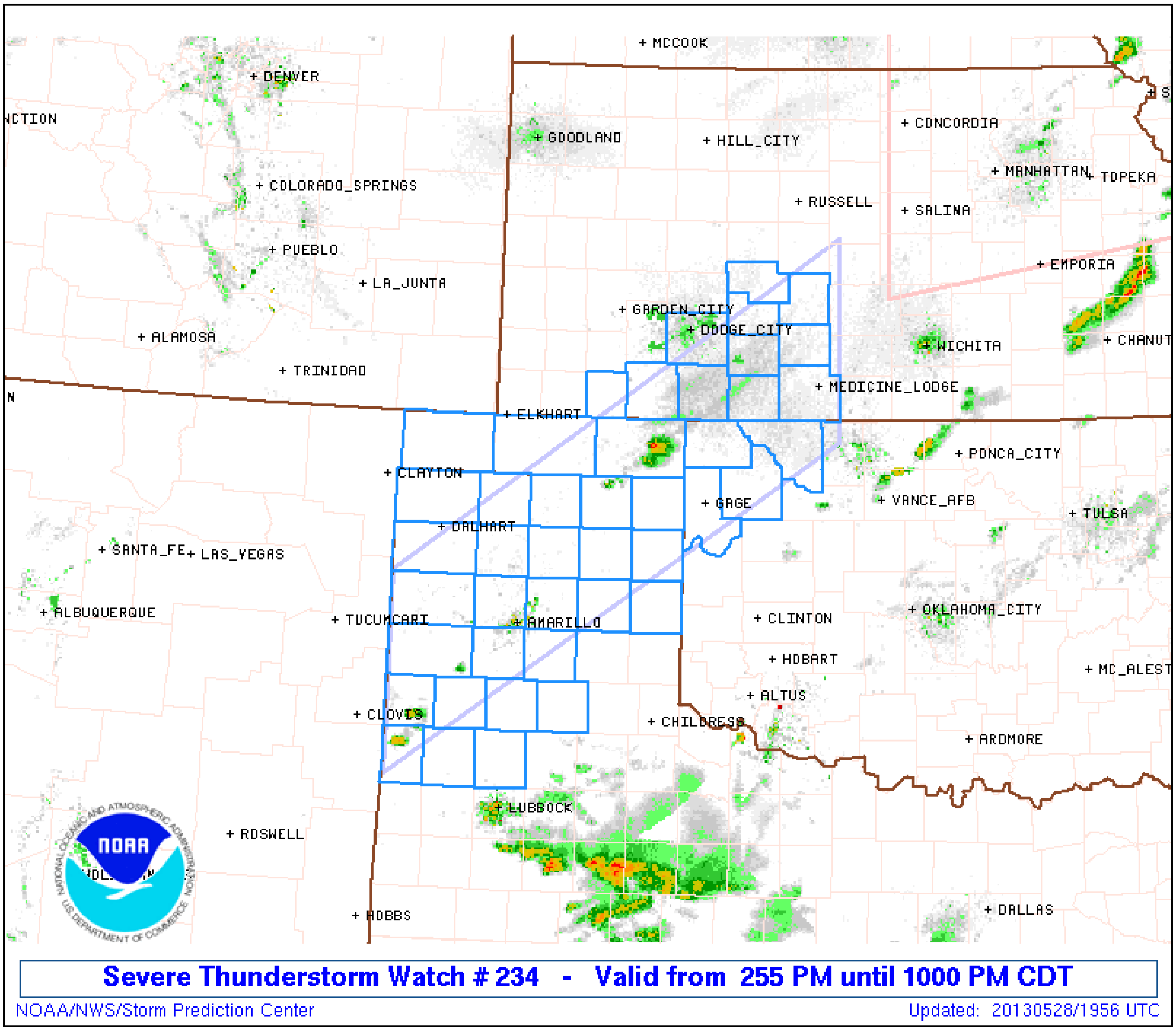


Figure 68: Severe Thunderstorm Watch #234 issued by the Storm Prediction Center, May 28, 2013.
(Source: http://www.spc.noaa.gov/products/watch/2013/ww0234.html)

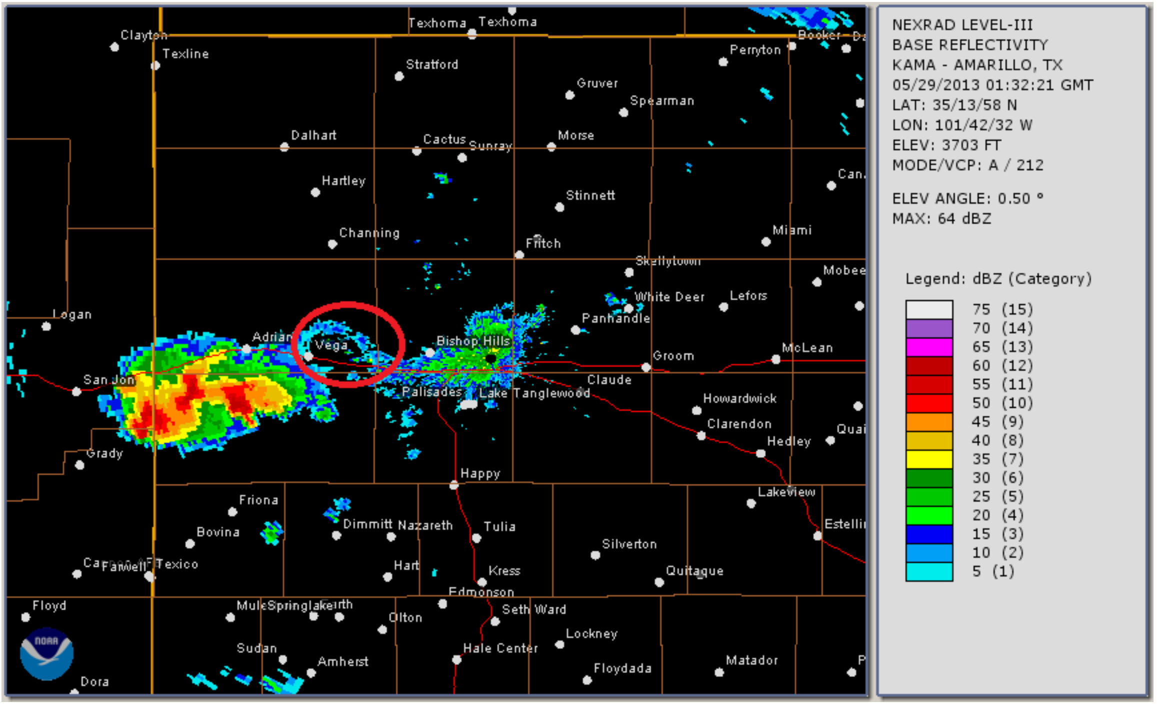


Figure 69: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Amarillo, TX radar at 6:32 PM MST (132Z, May 29), May 28, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

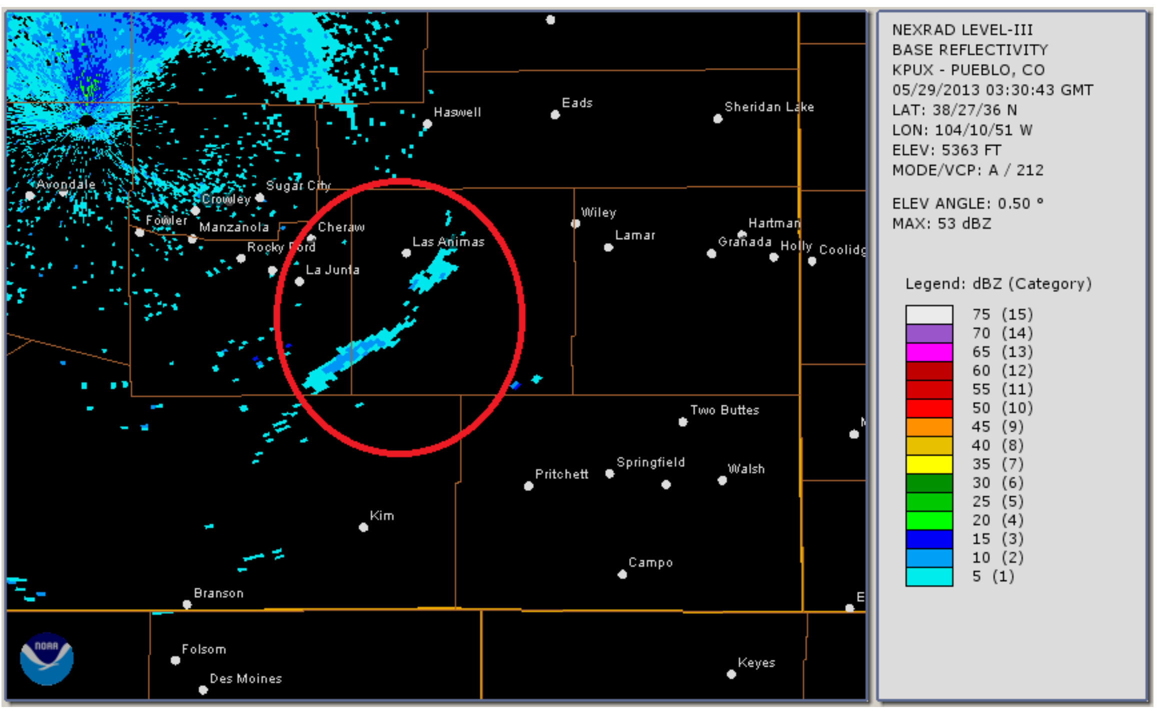


Figure 70: NEXRAD Base Reflectivity image, 0.50° elevation angle, from the Pueblo, CO radar at 8:30 PM MST (330Z, May 29), May 28, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

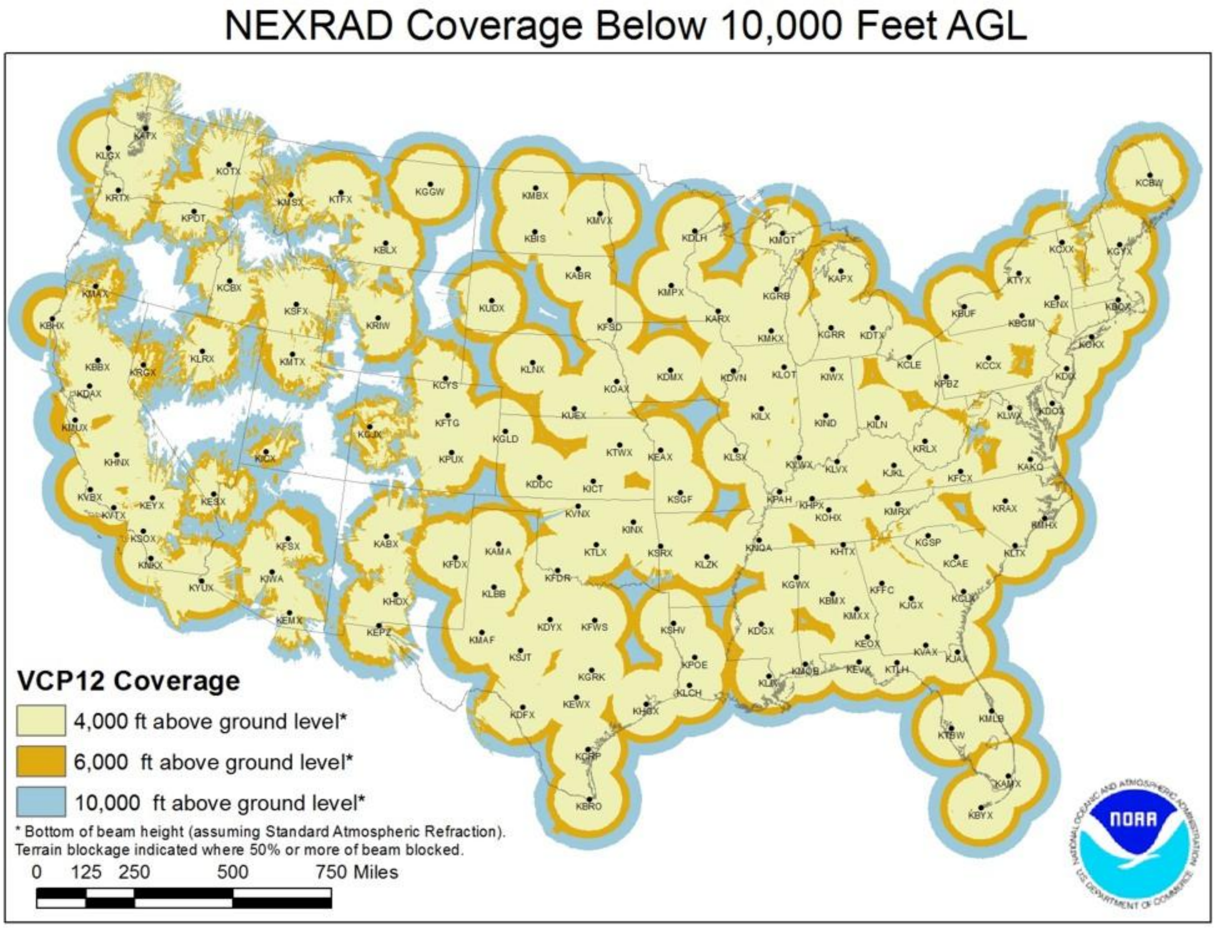


Figure 71: NEXRAD coverage below 10,000 ft. above ground level.
(Source: http://www.roc.noaa.gov/WSR88D/Maps.aspx)

Perhaps the most compelling piece of evidence is the webcam image taken at 7:15 PM MST, May 28, 2013 from Gobbler's Knob (20 miles south of Lamar, Figure 72). The image shows a considerable amount of airborne dust with the horizon highly obscured. Fourteen minutes after this image was taken (7:29 PM MST, Table 14), Lamar experienced the abrupt increase in wind and decrease in visibility as described earlier in this paper. For comparison purposes a webcam image of Gobbler's Knob at the same exact time of day, one day earlier, is shown in Figure 73 when the winds were generally light (10-14 mph sustained) and visibility was considered good (10 statute miles).

Webcam imagery from May 28, 2013 clearly indicates that a regional dust storm was occurring in southeast Colorado. This information, combined with other evidence provided in this report, proves that this dust storm was a natural, regional event that was not reasonably controllable or preventable.

Figure 72: Gobblers Knob webcam image at 7:15 PM MST May 28, 2013. (Source: http://amos.cse.wustl.edu/)

Figure 73: Gobblers Knob webcam image at 7:15 PM MST May 27, 2013. (Source: http://amos.cse.wustl.edu/)

2.7 December 24, 2013 Meteorological Analysis

On December 24, 2013, a powerful winter storm system caused an exceedance of the 24-hour PM_{10} standard in Lamar, Colorado, at the Municipal Building monitor with a concentration of 168 µg/m3. This elevated reading and the location of the monitor is plotted on a map of the Greater Lamar area in Figure 74. The exceedance in Lamar was the result of intense surface winds in the wake of a passing cold front. These surface features were associated with a strong upper-level trough that was moving across the western United States. The surface winds were predominantly out of a north to northeasterly direction which moved over dry soils in eastern Colorado, producing significant blowing dust.

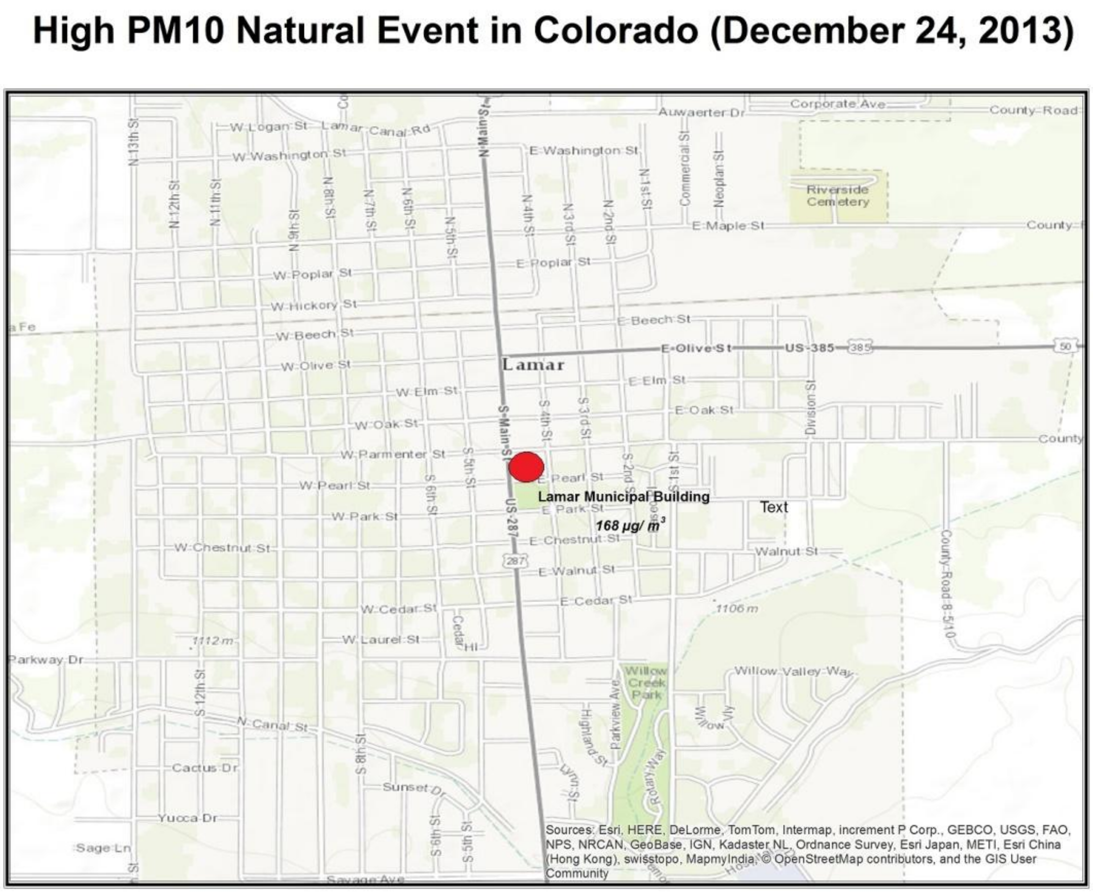


Figure 74: 24-hour PM_{10} concentration for the Lamar Municipal Building monitor, December 24, 2013.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The upper-level trough associated with this storm system is shown on the 700 mb and 500 mb height analysis maps at 5:00 PM MST, December 24, 2013 in Figure 75 and Figure 76, respectively. The 700 mb level is located roughly 3 kilometers above mean sea level (MSL) while the 500 mb level is approximately 6 kilometers above MSL. These two charts show that a deep trough of low pressure was present at both the 700 and 500 mb level during the blowing dust event of December 24, 2013, and that it was moving over the southwestern United States. This is a typical upper-air pattern for blowing dust events in Colorado (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

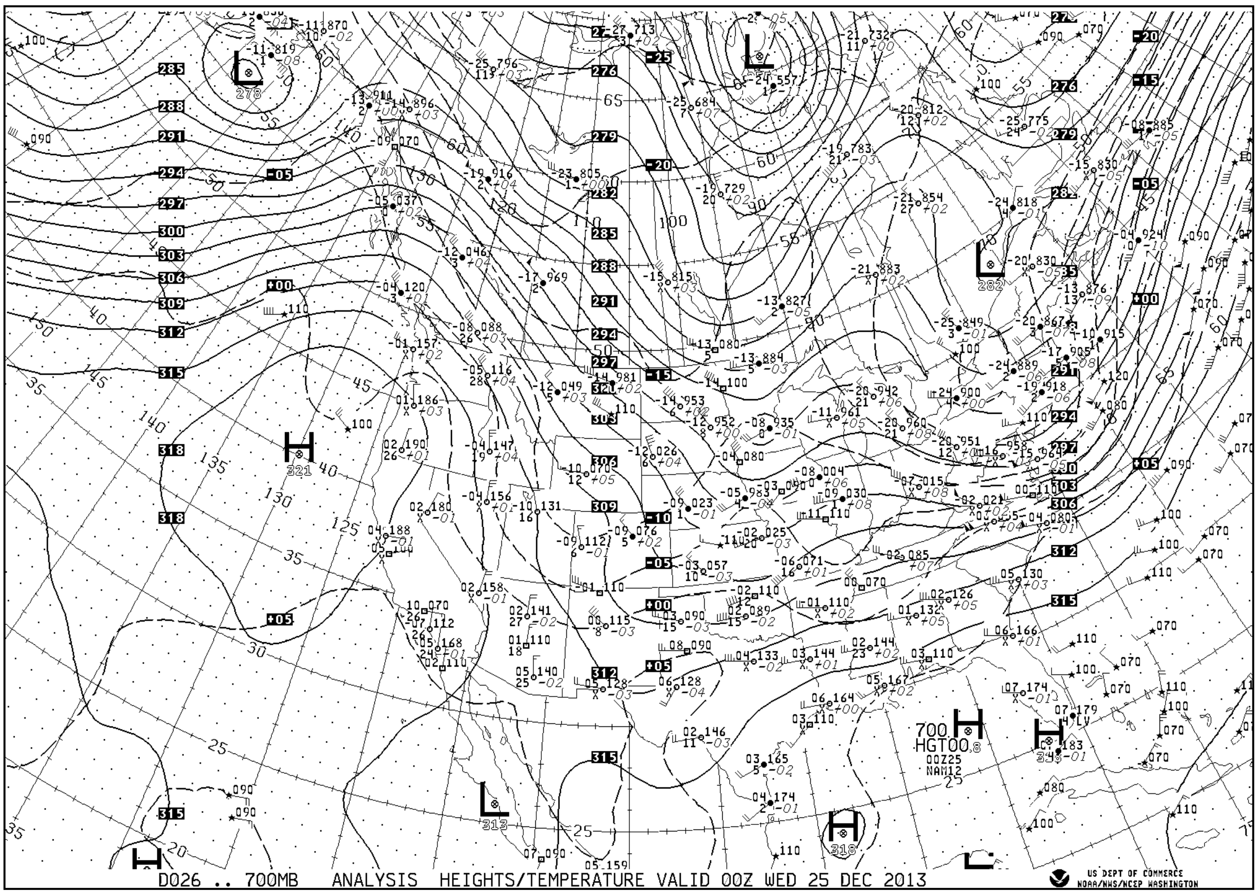


Figure 75: 700 mb (about 3 kilometers above mean sea level) analysis for 0Z December 25, 2013, or 5:00 PM MST December 24, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

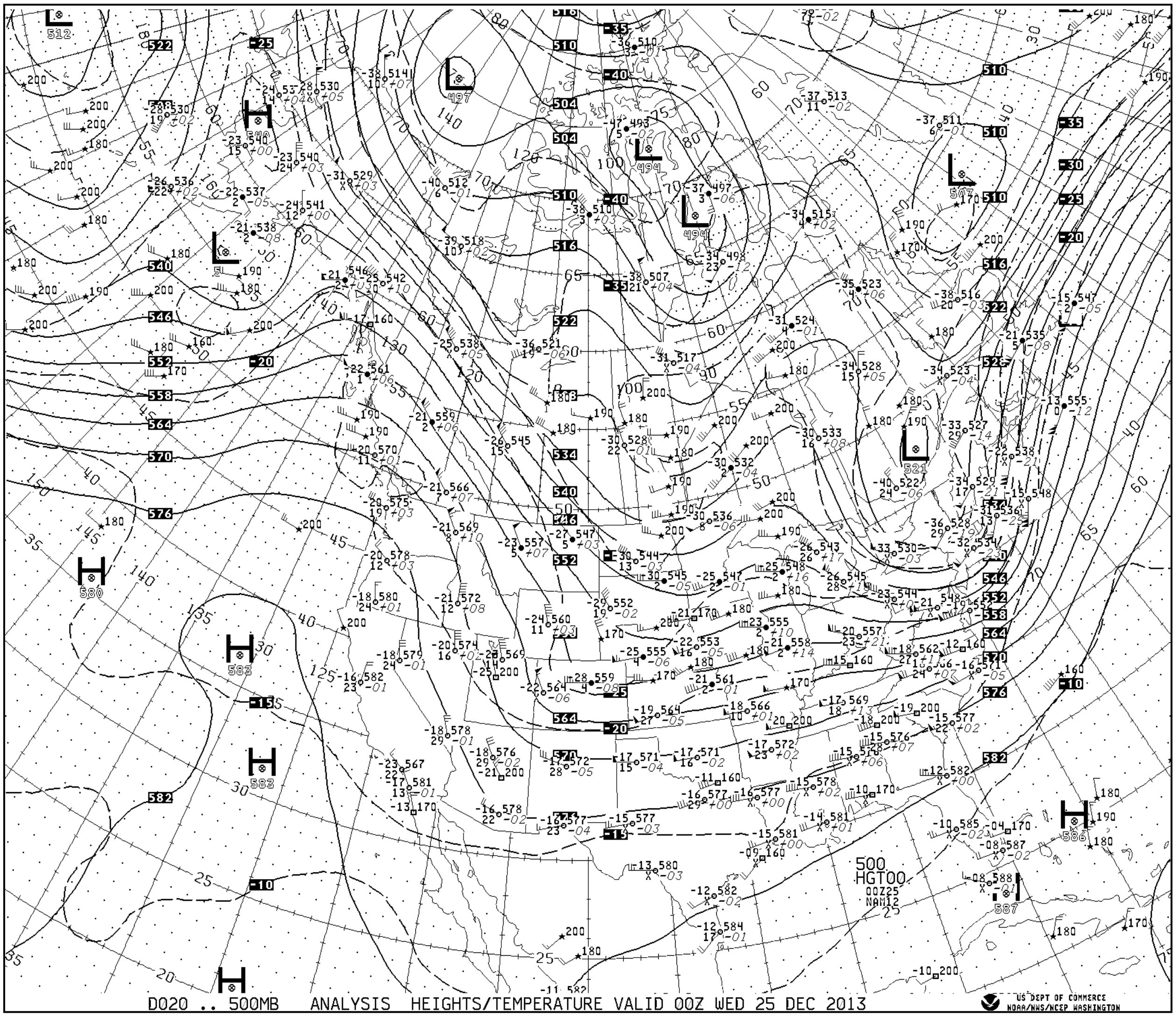


Figure 76: 500 mb (about 6 kilometers above mean sea level) analysis for 0Z December 25, 2013, or 5:00 PM MST December 24, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The surface weather associated with the storm system of December 24, 2013, is presented in Figure 77 and Figure 78. Significant surface features at 11:00 AM MST, December 24 (Figure 77) included a departing warm front moving southeastward out of Colorado and into western Kansas, while a strong cold front was entering Colorado from the north. By 5:00 PM MST (Figure 78) the cold front had cleared Colorado and moved southward into New Mexico, leaving behind gusty northerly winds across the eastern Colorado plains.

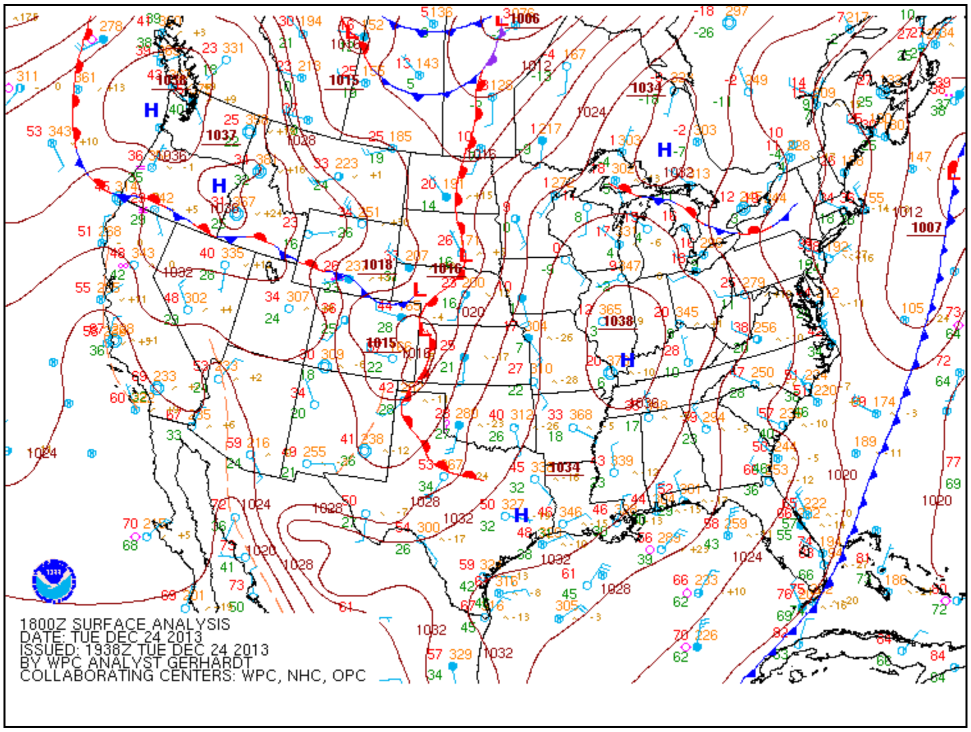


Figure 77: Surface Analysis for 18Z December 24, 2013, or 11:00 AM MST December 24, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

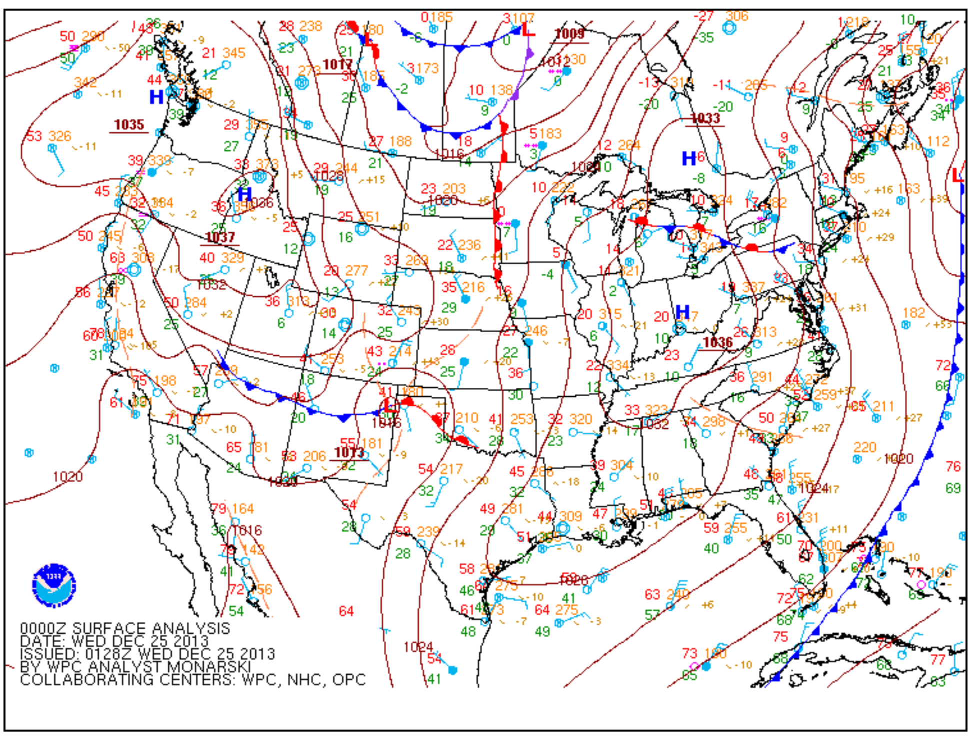


Figure 78: Surface Analysis for 0Z December 25, 2013, or 5:00 PM MST December 24, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

In order to fully evaluate the synoptic meteorological scenario of December 24, 2013, a regional surface weather map is provided showing individual station observations during the height of the event in question. Figure 79 presents weather observations for eastern Colorado and adjacent states at 3:43 PM MST, December 24. On the map in Figure 79 the station observation for Lamar (LAA) shows winds sustained at 30 knots (35 mph), gusts to 42 knots (48 mph), and a reduced visibility of 1/2 statute mile with the weather symbol of infinity (∞). The infinity sign is the weather symbol for haze. Haze is often reported during dust storms, and in dry and windy conditions haze typically refers to blowing dust (see the following link for the description of haze published by the National Oceanic and Atmospheric Administration (NOAA): http://www.crh.noaa.gov/lmk/?n=general_glossary). Also note that to the west of Lamar in nearby Pueblo (PUB), similar weather conditions were reported with high winds, haze and poor visibility. This suggests that this was a regional dust event and was not confined solely to the Lamar area.

Hourly surface observations, in table form, from Lamar and Pueblo provide supporting evidence that there was an extended period of high winds and haze (blowing dust) in southeast Colorado. Table 18 lists observations for the PM_{10} exceedance location of Lamar while Pueblo observations are found in Table 19. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2) are highlighted in yellow. Collectively, these two sites experienced an extended period of reduced visibility along with sustained wind speeds and gusts at or above the thresholds for blowing dust.

Surface weather maps and hourly observations show that a regional dust storm occurred under north to northeasterly flow in the wake of a cold front. This data provides clear evidence of blowing dust and winds above the threshold speeds for blowing dust on December 24, 2013.

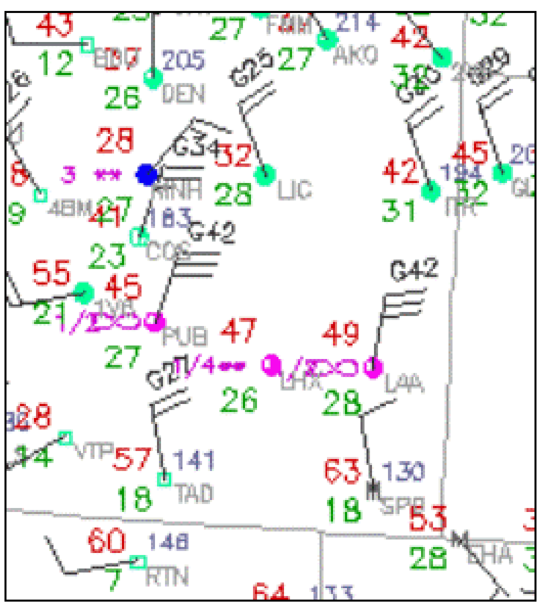


Figure 79: High Plains regional surface analysis for 3:43 PM MST, December 24, 2013. (Source: http://www.mmm.ucar.edu/imagearchive/)

Table 18: Weather observations for Lamar, Colorado, on December 24, 2013 (Source: http://mesowest.utah.edu/)

Time MST December 24, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	11	80	0				10
1:53	11	80	0				10
2:53	10	76	0				10
3:53	10	84	4		210		10
4:53	13	84	4		220		10
5:53	12	80	6		210		10
6:53	12	87	4		230		10
7:53	17	76	5		290		10
8:53	25	66	5		270		10
9:53	35	47	8		300		10
10:53	47	33	7		270		10
11:53	55	26	12		270		10
12:53	59	22	6		280		10
13:53	62	18	0				10
14:53	62	18	4		70		10
15:31	58	25	41	51	20		2
15:33	53	33	33	51	10		1
15:39	49	44	35	48	10	haze	1
15:44	48	47	37	47	20	haze	1
15:49	48	46	35	45	10	haze	1
15:51	48	46	35	45	20	haze	2
15:53	48	46	37	48	10	haze	2
16:07	46	51	28	43	20	haze	3
16:36	45	47	25	33	10		7
16:53	44	49	21	33	30		7
17:53	43	51	28	41	20		8
18:53	42	50	15	28	10		10
19:53	41	51	17	27	30		10
20:53	39	57	16	24	20		10
21:53	36	62	6		10		10
22:53	32	66	5		350		10
23:53	30	71	6		350		10

Table 19: Weather observations for Pueblo, Colorado, on December 24, 2013 (Source: http://mesowest.utah.edu/)

Time MST December 24, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:53	19	74	7		110		10
1:53	22	68	8		110		10
2:53	44	35	15		260		10
3:00	44	35	14		260		10
3:53	46	32	18	29	290		10
4:53	48	30	28		290		10
5:53	46	32	25		300		10
6:53	48	32	24		290		10
7:53	53	28	30	38	280		9
8:53	55	27	27	32	280		10
9:53	58	24	28	32	290		10
10:53	61	20	22		290		10
11:53	62	17	24	35	260		10
12:53	61	18	28	38	270		10
13:53	60	18	24		270		10
14:13	51	36	30	36	10	haze	4
14:14	50	40	30	36	20	haze	0.5
14:24	45	49	37	48	20	haze	0.5
14:41	43	53	41	46	20	lt rain	0.5
14:53	42	55	28	41	20	haze	1
15:17	41	52	35	50	20	haze	5
15:53	40	53	35	44	10		10
16:53	38	54	30	39	20		10
17:53	38	52	24	28	20		10
18:53	37	46	23	28	20		10
19:53	36	48	0				10
20:53	31	56	5		60		10
21:53	27	60	4		160		10

Satellite imagery provides strong supporting evidence that a regional dust storm was taking place during the afternoon of December 24, 2013. The GOES-East 1 km visible satellite image of Colorado at 3:45 PM MST (Figure 80) shows what appears to be a large area of dust (circled in red) moving southward through Otero and Bent Counties to the west of Lamar. Unfortunately Lamar is shrouded in cloud cover at the time of this image, obscuring any possible dust signature. However, there is strong reason to believe that Lamar was also being impacted by blowing dust at this time. By referring back to Table 18, we can see that in Lamar from 3:44 to 3:49 PM MST (the time period encompassing Figure 80) the wind was sustained at 35-37 mph with gusts of 45-47 mph, observed haze and visibility highly reduced to 1 statute mile. These are observations consistent with blowing dust conditions in southeast Colorado (30 mph sustained winds, 40 mph gusts -- see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

Another tool in identifying areas of blowing dust is the GASP (GOES Aerosol Smoke Product) Optical Depth product. GASP is derived from visible satellite imagery (see the following link for additional information on GASP: http://www.star.nesdis.noaa.gov/smcd/emb/aerosols/products_geo.php). The GASP image at 3:45 PM MST in Figure 81 reveals highly elevated aerosol levels in southeast Colorado near Lamar with AOD values of 0.4 - 0.6. To confirm our suspicion that these enhanced AOD values are indeed dust, the webcam image at Gobblers Knob (20 miles south of Lamar, Figure 82) at 4:15 PM MST verifies that there was a considerable amount of airborne dust with the horizon highly obscured.

Satellite products combined with webcam imagery of southeast Colorado on December 24, 2013 clearly reveal that a dust storm was taking place that was regional in scale and therefore not controllable or preventable.

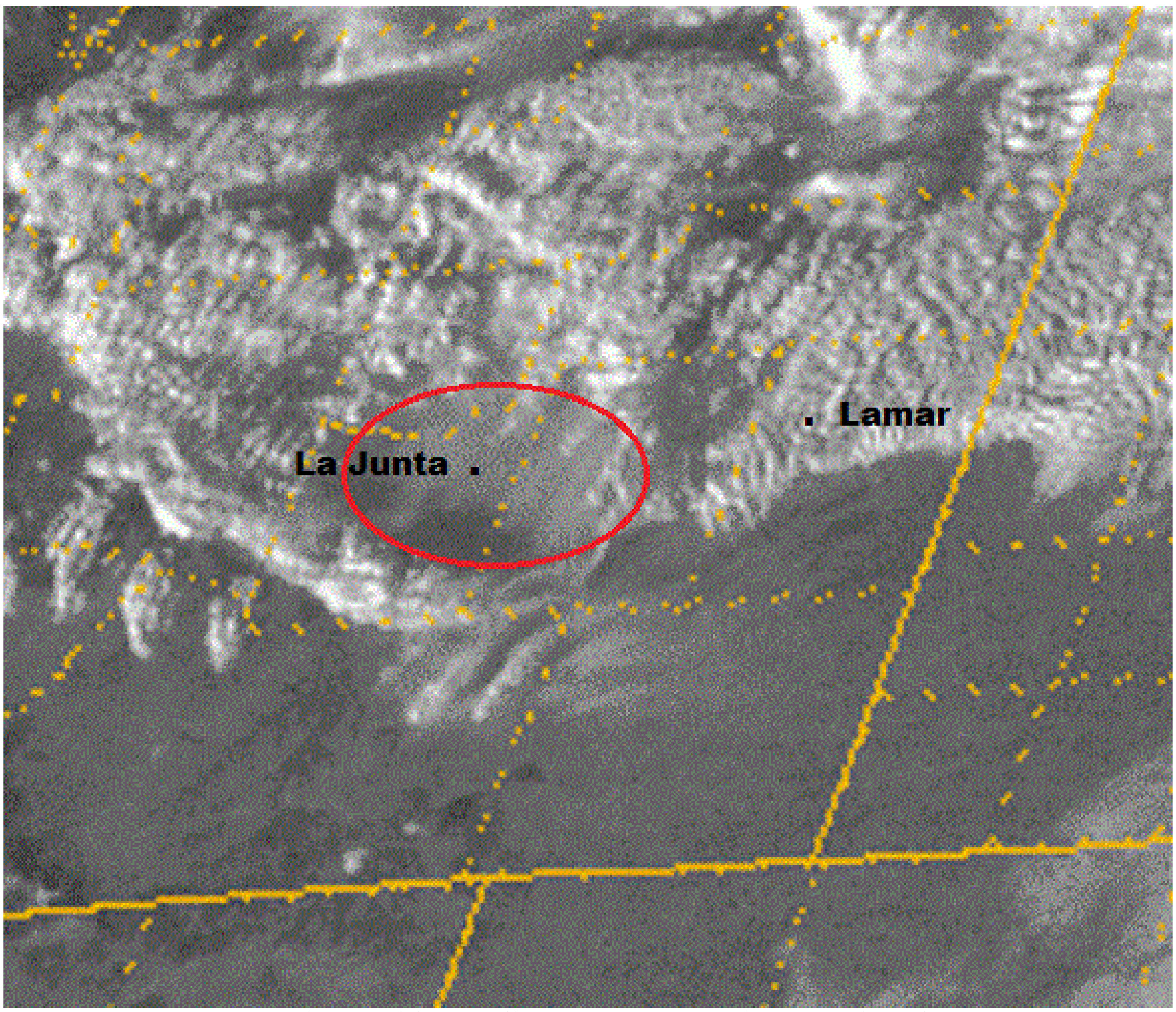


Figure 80: GOES-East 1 km visible satellite image of southeast Colorado at 3:45 PM MST, December 24, 2013.
(Source: http://rammb.cira.colostate.edu/ramsdis/online/goes-west_goes-east.asp)

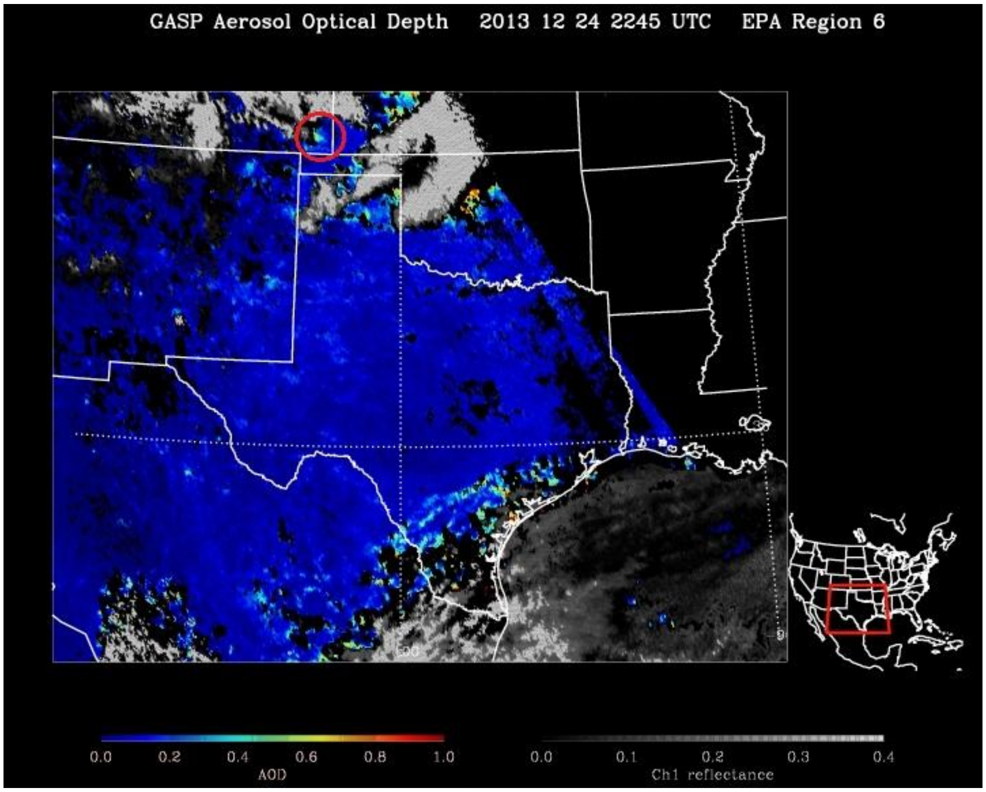


Figure 81: GASP West Aerosol Optical Depth Image at 3:45 PM MST (2245Z) December 24, 2013.
(Source: http://www.star.nesdis.noaa.gov/smcd/spb/aq/index.php?product_id=2)

Figure 82: Gobblers Knob webcam image at 4:15 PM MST December 24, 2013.
(Source: http://amos.cse.wustl.edu/)

The synoptic weather conditions described above impacted a region that was in the midst of a severe to exceptional drought (Figure 83). Sustained drought conditions are known to make topsoil susceptible to high winds and produce blowing dust (see the following link from the National Climatic Data Center for more information: https://www.ncdc.noaa.gov/paleo/drought/drght_history.html). Figure 84 shows the total precipitation in inches from November 24, 2013 to December 23, 2013 for Colorado. Note that almost the entirety of southeast Colorado received less than 0.17 inches of precipitation during the 30-day period leading up to the December 24, 2013 dust event in Lamar. Based on previous research 0.5 to 0.6 inches of precipitation over a 30-day period has been found to be the approximate threshold, below which, blowing dust exceedances at Lamar are more likely to occur when combined with high winds (see the Lamar Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2).

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in southeast Colorado near Lamar were dry enough to produce blowing dust when winds were above the thresholds for blowing dust. This information, combined with other evidence provided in this report, proves that this dust storm was a natural, regional event that was not reasonably controllable or preventable.

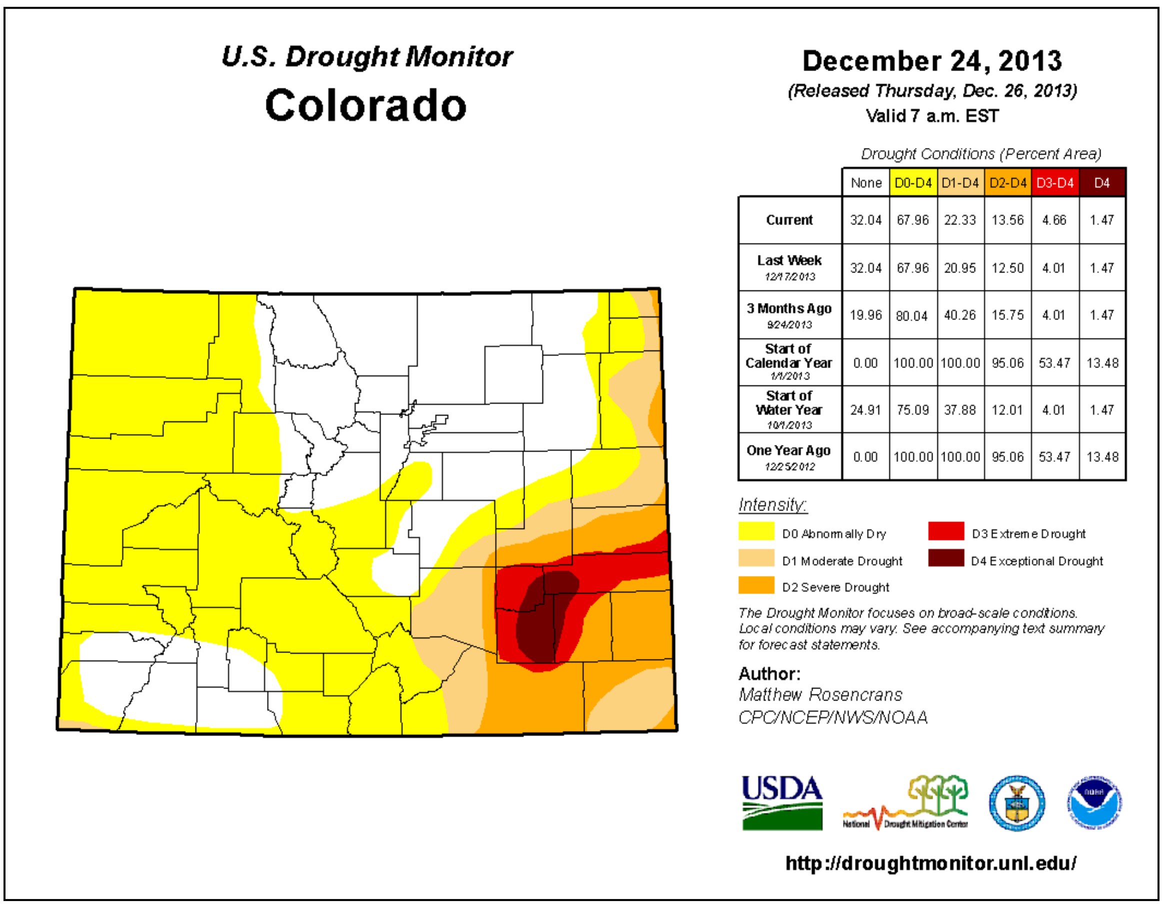


Figure 83: Drought conditions for Colorado at 5:00 AM MST December 24, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

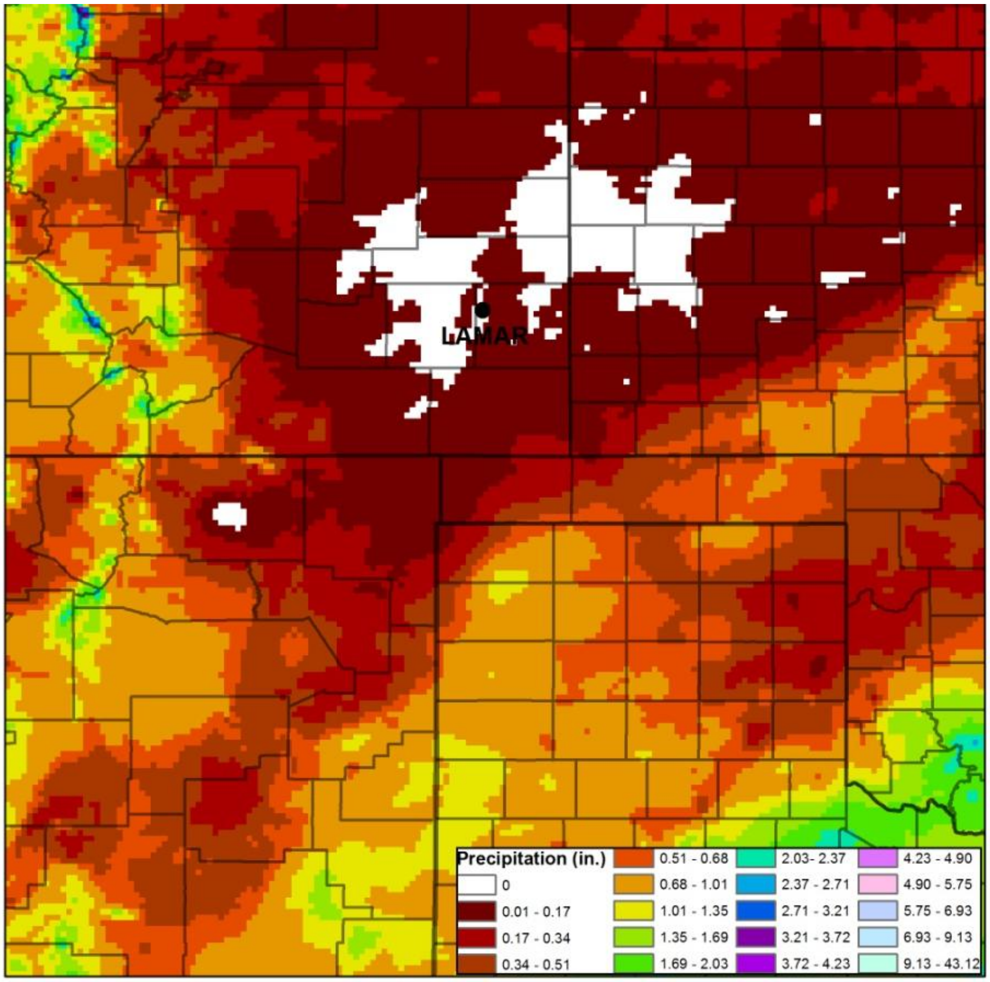


Figure 84: Total precipitation in inches for eastern Colorado and adjacent states, November 24, 2013 – December 23, 2013.
(Source: http://prism.nacse.org/recent/)

3.0 Evidence - Ambient Air Monitoring Data and Statistics

Multiple intense fronts moved across south eastern Colorado in 2013. Several of these transported blowing dust into Lamar from source regions outside of the monitoring area. Ambient air monitoring data and statistics for each event are discussed further on the following pages.

3.1 February 8, 2013 Monitoring Data and Statistics

On February 8, 2013, a powerful winter storm system caused strong southerly winds to begin blowing in southern Colorado. The southerly surface winds moving over dry soil in southeast Colorado transported blowing dust into Lamar. During this event a sample in excess of 150 μg/m^3 was recorded at the Lamar Municipal Building 08-099-0002 (159 μg/m^3).

3.1.1 Historical Fluctuations of PM_{10} Concentrations in Lamar

This evaluation of PM_{10} monitoring data for sites affected by the February 8, 2013, event was made using valid samples from PM_{10} samplers in Lamar from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Lamar since 1985. The overall data summary for the site is presented in Table 20, with all data values being presented in μg/m^3.

Table 20: February 8, 2013 - Event Data Summary

	Lamar Municipal
2/8/2013	**159**
Mean	25.5
Median	19
Mode	14
St. Dev	38.5
Var	1487.9
Minimum	1
Maximum	1220
Percentile	99.5%
Count	1997

The PM_{10} sample on February 8, 2013, at Lamar Municipal of 159 μg/m^3 exceeds the 99th percentile value for all evaluation criteria and is the 19th largest sample of the dataset. The 18 samples greater than the event sample are associated with high wind events. There are 1,997 samples in this dataset. The sample of February 8, 2013 clearly exceeds the typical samples for this site.

Figure 85 and Figure 86 graphically characterize the Lamar Municipal PM_{10} data. The first, Figure 85, is a simple time series; every sample in this dataset (2009 – 2014) greater than 150 μg/m^3 is identified. Note the overwhelming number of samples occupying the lower end of the graph; an interested reader can count the number of samples greater than 100 μg/m^3. Of the 1,997 samples in this data set, less than 2% are greater than 100 μg/m^3.

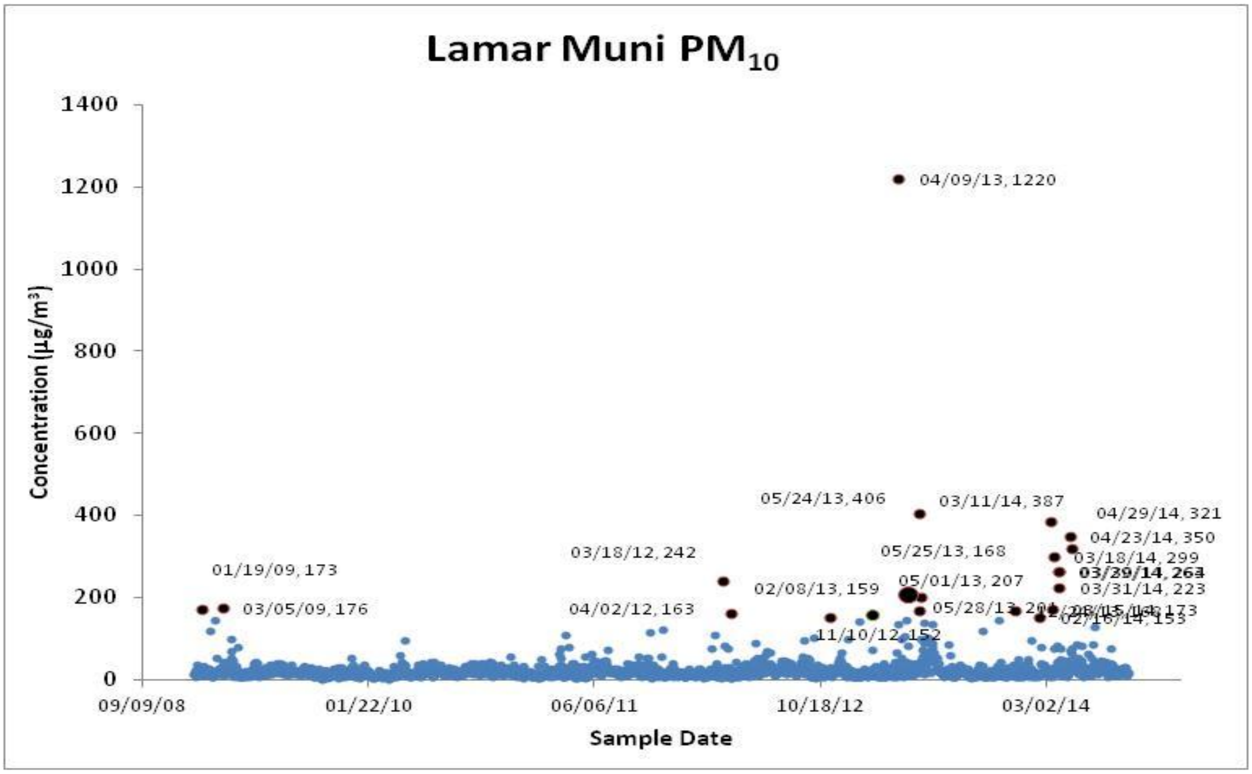


Figure 85: Lamar Municipal PM_{10} Time Series (February 8, 2013 event)

The monthly box-whisker plot, Figure 86, highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) and greater range of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on February 8, 2013. Although these high values affect the variability and central tendency (average) of the dataset they aren't representative of what is typical at the site.

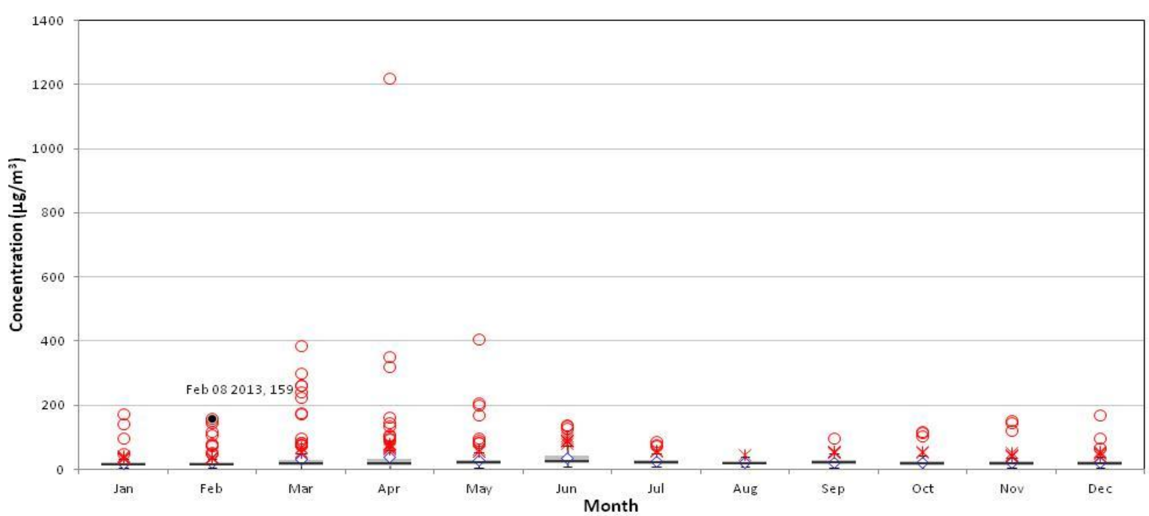


Figure 86: Lamar Municipal PM_{10} Box-Whisker Plot (February 8, 2013 event)

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The February mean (20.9 µg/m^3) is greater than the February median value (15 µg/m^3); the February mean is greater than nearly 75% of all samples in any February. The skew in the data is due to the presence of a handful of extreme values and can create the perception that those months experiencing these high wind events are somehow 'dirtier' than other months of the year. This data exposes that perception as flawed, typical data subject to local sources of variation are similar to every other month of the year. Figure 86 suggests that typical, day to day PM_{10} concentrations exposures for the months of June and September are highest among all months. The sample of February 8, 2013, clearly exceeds the typical data at this site.

3.1.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased mid morning of February 8, 2013 and stayed elevated through early evening, gusting to speeds in excess of 40 mph with sustained hourly averages in excess of 25 mph. The following two charts in Figure 87 display wind speed (mph) as a function of date from meteorological sites within the affected area for a number of days before and after the event.

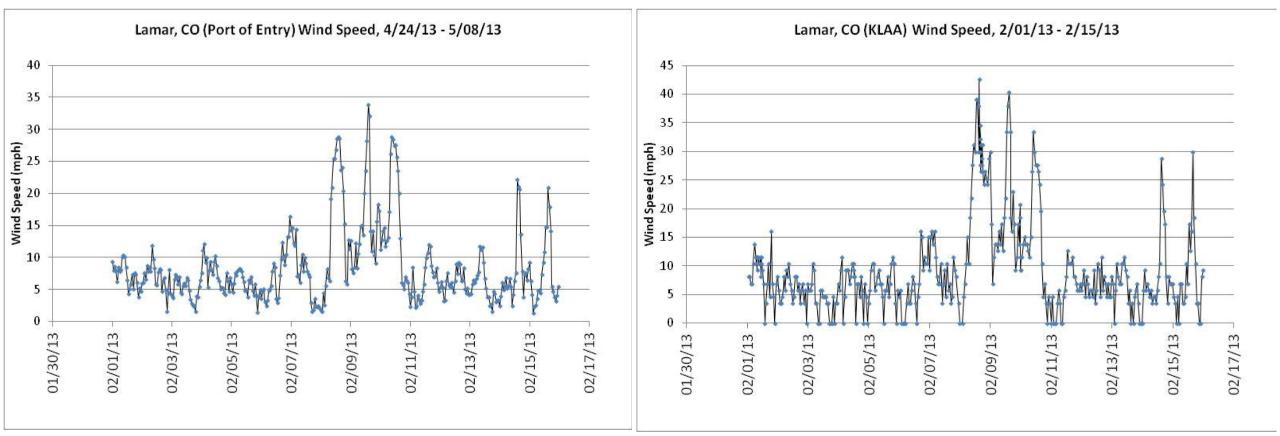


Figure 87: Wind Speed (mph), Lamar, 2/1/2013 – 2/15/2013

Figure 88 plots PM_{10} concentrations from the Lamar Municipal site for the period for seven days prior to and following the sample of February 8, 2013.

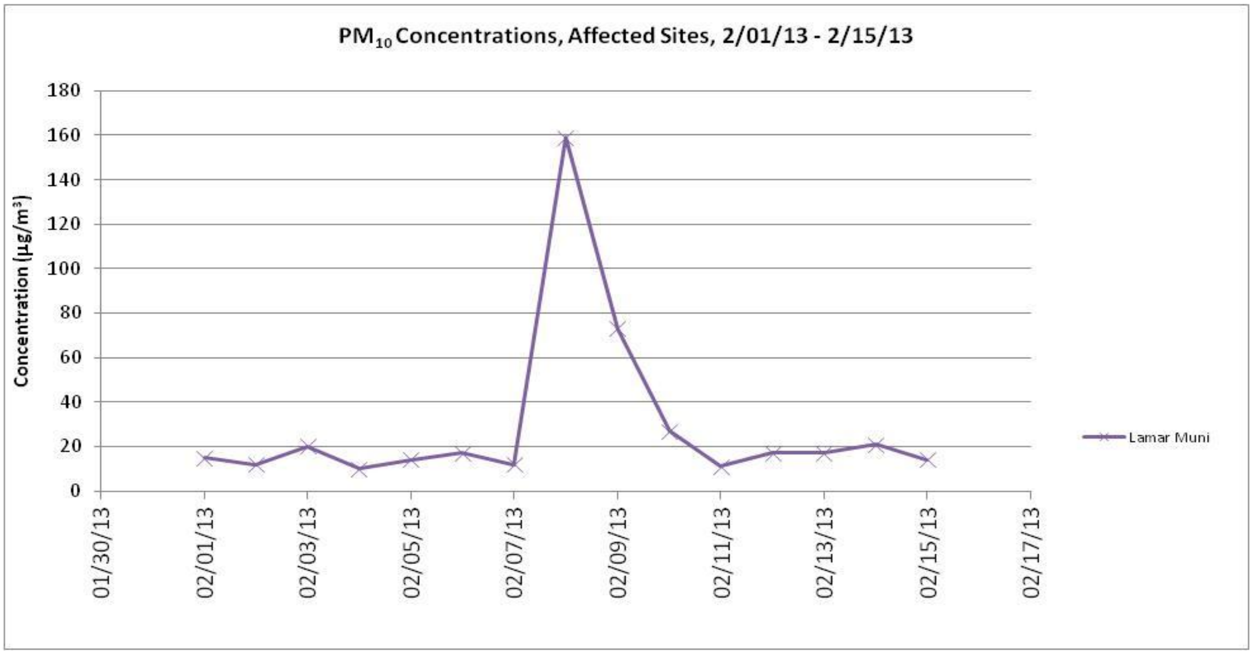


Figure 88: PM_{10} Concentrations, Lamar Municipal, 2/1/2013 – 2/15/2013

Figure 88 mimics the plots for wind speed, suggesting an association between the high winds and PM_{10} concentrations at the Lamar Municipal site; even to the extent the wind continued to blow through the early hours of February 9, 2013 affecting that day's high sample of 73 µg/m^3 (exceeding the 96th percentile for the entire data set). Although the samples were affected to differing degrees by the event (possibly reflecting the variation in contribution from local sources) the elevated concentrations are clearly associated with the elevated wind speeds. The relationship between the PM_{10} and wind speed data sets would suggest that the high winds had an effect on PM_{10} samples in Lamar on February 8, 2013.

3.1.3 Percentiles

Monthly percentile plots in Figure 89 demonstrate a high degree of association between monthly median values and relatively high monthly percentile values, e.g. the Pearson's r value between the monthly 90th percentile value at Lamar Municipal and the monthly median is 0.65. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

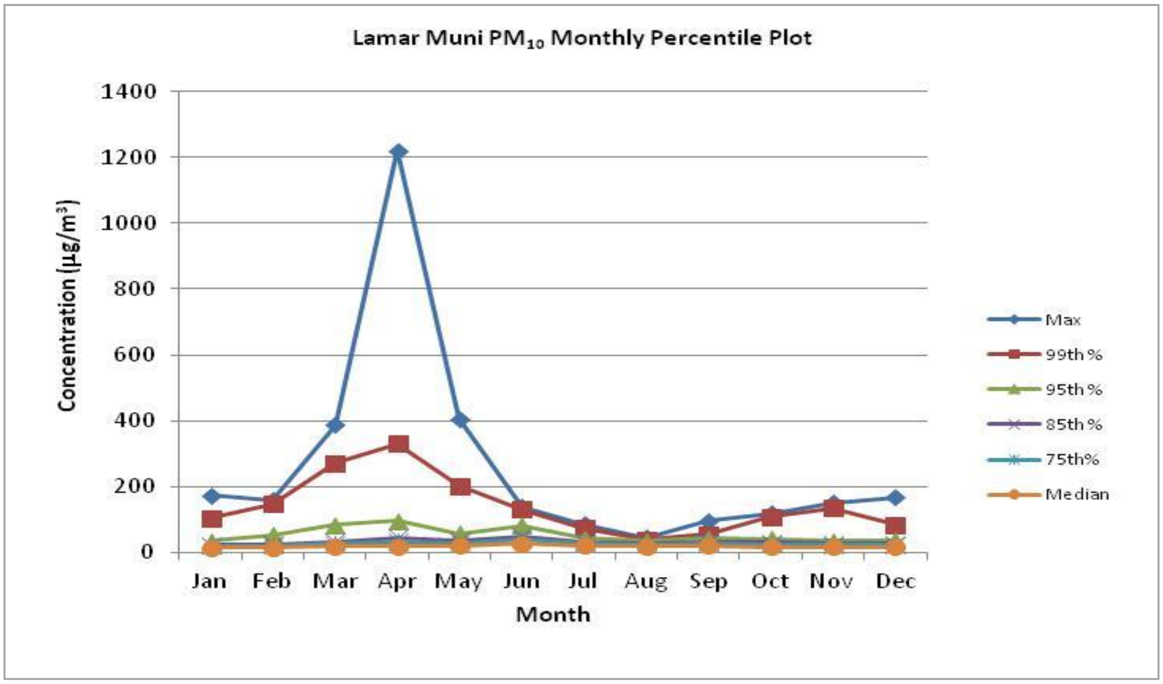


Figure 89: Monthly PM_{10} Percentile Plots (February 8, 2013 event)

It is certainly the case that monthly median values are indicative of typical, day to day concentrations. Additionally, there is a range of samples that are a product of normal variation subject to typical, day to day local effects. This range may be restricted to percentile values that are well correlated with the median. For the data set of concern (Lamar Municipal) a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75th percentile value. Nearly all of the variation in the monthly 75th percentile values of this data set can be explained by the variation in monthly medians; for Lamar Municipal the correlation between the median and monthly 75th percentile values is $r^2 = 0.9$. A reasonable estimate of the contribution to the event from local sources for this data set may be the monthly 85th percentile values, the correlation between the median and the monthly 85th percentile values is $r^2 = 0.80$. If this percentile value is taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from this monthly percentile value would be the sample contribution due to the event.

Table 21 identifies various percentile values that are representative of the maximum contribution due to local sources for the site from all February data (2009 – 2014). In Table 21 the range estimate in the 'Est. Conc. Above Typical' column is derived using the difference between the actual sample value and the 85th percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75th percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the February 8, 2013 sample at the sites listed in the table due to the high wind event.

Table 21: Estimated Maximum Event PM_{10} Contribution (February 8, 2013 event)

Site	Event Day Concentration (μg/m^3)	February Median (μg/m^3)	February Average (μg/m^3)	February 75th % (μg/m^3)	February 85th % (μg/m^3)	Est. Conc. Above Typical (μg/m^3)
Lamar Municipal	**159**	15	20.9	20.5	26	**133 - 139**

Clearly, there would have been no exceedance but for the additional contribution to the PM_{10} sample provided by the event.

3.2 April 9, 2013 Monitoring Data and Statistics

On April 09, 2013, a powerful spring storm system caused generated intense surface winds in the wake of the passing cold front. The northerly surface winds moving over dry soil in southeast Colorado transported blowing dust into Lamar. During this event a sample in excess of 150 μg/m^3 was recorded at the Lamar Municipal Building 08-099-0002 (1,220 μg/m^3).

3.2.1 Historical Fluctuations of PM_{10} Concentrations in Lamar

This evaluation of PM_{10} monitoring data for sites affected by the April 9, 2013, event was made using valid samples from PM_{10} samplers in Lamar from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Lamar since 1985. The overall data summary for the affected site is presented in Table 22, with all data values being presented in μg/m^3.

Table 22: April 09, 2013 - Event Data Summary

	Lamar Municipal
4/9/2013	**1220**
Mean	25.5
Median	19
Mode	14
St. Dev	38.5
Var	1487.9
Minimum	1
Maximum	1220
Percentile	99.5%
Count	1997

The PM_{10} sample on April 9, 2013, at Lamar Municipal of 1,220 μg/m^3 is the largest sample value of any evaluation criteria ever; there are 1,997 samples in this dataset. The sample of April 9, 2013 clearly exceeds the typical samples for this site.

Figure 90 and Figure 91 graphically characterize the Lamar Municipal PM_{10} data. The first, Figure 90, is a simple time series; every sample in this dataset (2009 – 2014) greater than 150 µg/m^3 is identified. Note the overwhelming number of samples occupying the lower end of the graph; an interested reader can count the number of samples greater than 100 µg/m^3. Of the 1,997 samples in this data set less than 2% are greater than 100 µg/m^3.

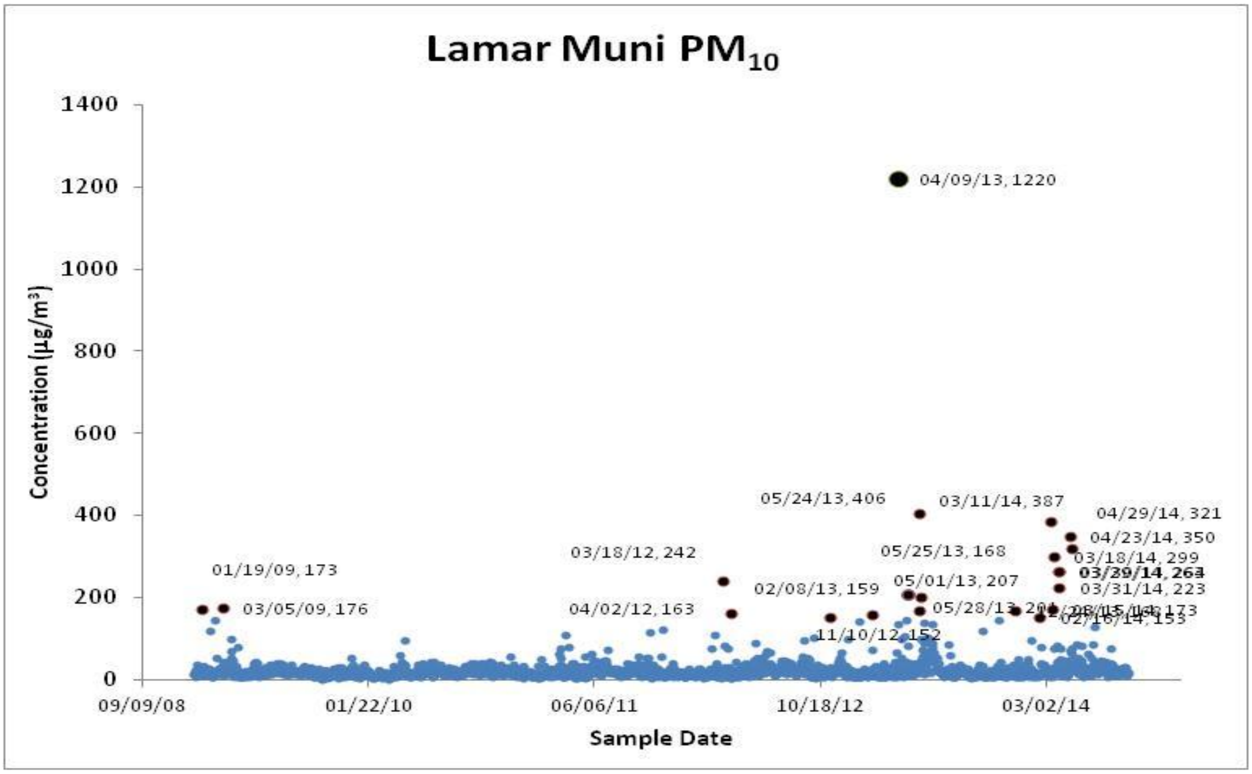


Figure 90: Lamar Municipal PM$_{10}$ Time Series (April 9, 2013 event)

The monthly box-whisker plot in Figure 91 highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) and greater range of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on April 9, 2013. Although these high values affect the variability and central tendency (average) of the dataset they aren't representative of what is typical at the site.

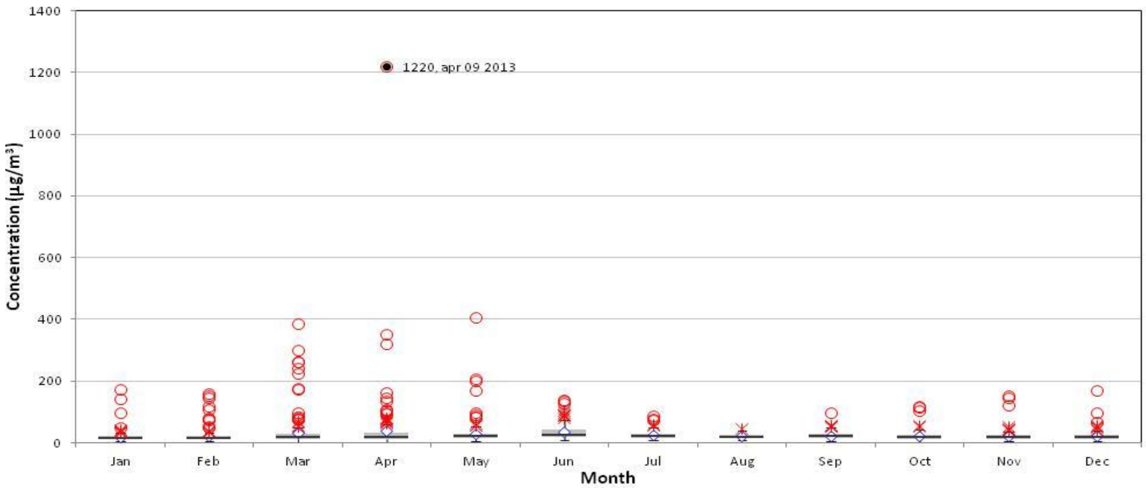


Figure 91: Lamar Municipal PM_{10} Box-Whisker Plot (April 9, 2013 event)

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The April mean (37.6 $\mu g/m^3$) is greater than the April median value (19 $\mu g/m^3$); the April mean is greater than 80% of all samples in any April. The skew in the data is due to the presence of a handful of extreme values and can create the perception that those months experiencing these high wind events are somehow 'dirtier' than other months of the year. This data exposes that perception as flawed, typical data subject to local sources of variation are similar to every other month of the year. Figure 91 suggests that typical, day to day PM_{10} concentrations exposures for the months of June and September are highest among all months. The sample of April 9, 2013, clearly exceeds the typical data at this site.

3.2.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased mid morning of April 9, 2013 and stayed elevated through early evening, gusting to speeds in excess of 40 mph with sustained hourly averages in excess of 25 mph. The following two charts in **Figure 92** display wind speed (mph) as a function of date from meteorological sites within the affected area for a number of days before and after the event.

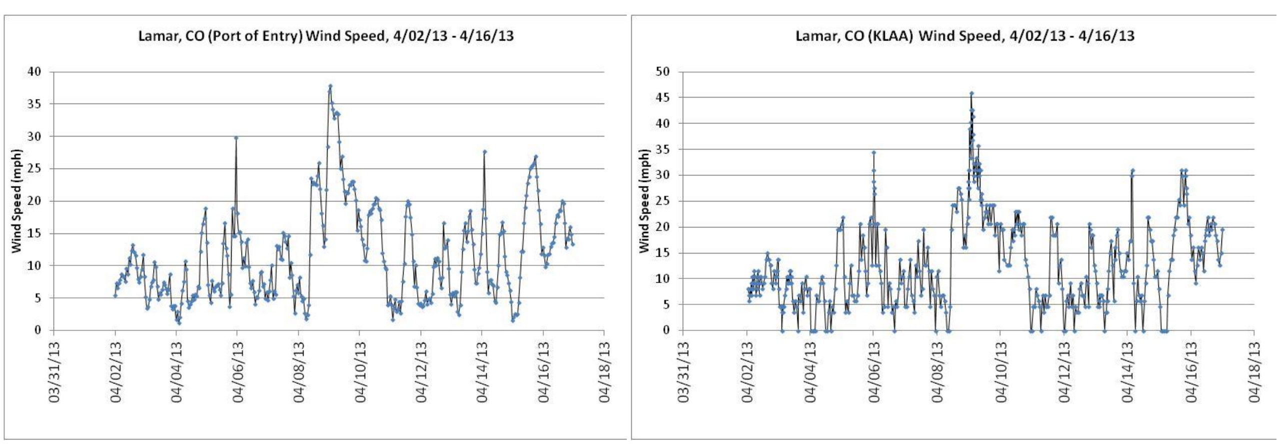


Figure 92: Wind Speed (mph), Lamar, 4/2/2013 – 4/16/2013

Figure 93 plots PM_{10} concentrations from the Lamar Municipal site for the period for seven days prior to and following the sample of April 9, 2013.

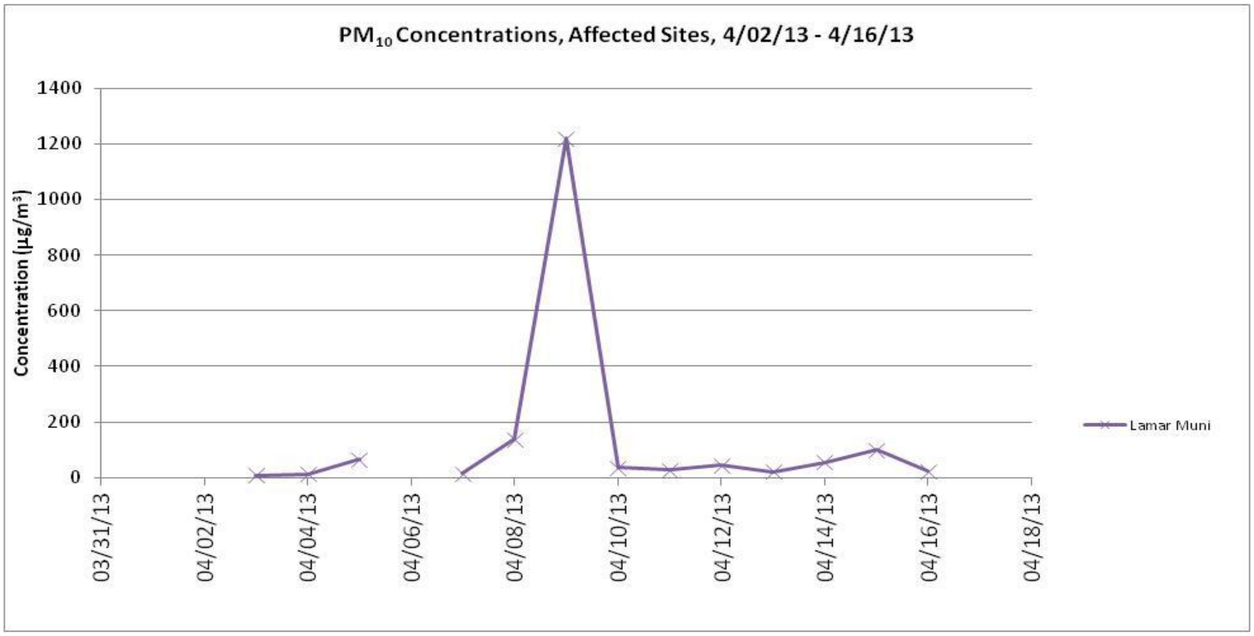


Figure 93: PM_{10} Concentrations, Lamar Municipal, 4/2/2013 – 4/16/2013

Figure 93 mimics the plots for wind speed, suggesting an association between the high winds and PM_{10} concentrations at the Lamar Municipal site; even to the extent the wind continued to blow through the early hours of April 8, 2013 affecting that day's high sample of 137μg/m^3 (exceeding the 98th percentile for the entire data set). Although the samples were affected to differing degrees by the event (possibly reflecting the variation in contribution from local sources) the elevated concentrations are clearly associated with the elevated wind speeds. The relationship between the PM_{10} and wind speed data sets would suggest that the high winds had an effect on PM_{10} samples in Lamar on April 09, 2013.

3.2.3 Percentiles

Monthly percentile plots in Figure 94 demonstrate a high degree of association between monthly median values and relatively high monthly percentile values, e.g. the Pearson's r value between the monthly 90th percentile value at Lamar Municipal and the monthly median is 0.65. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

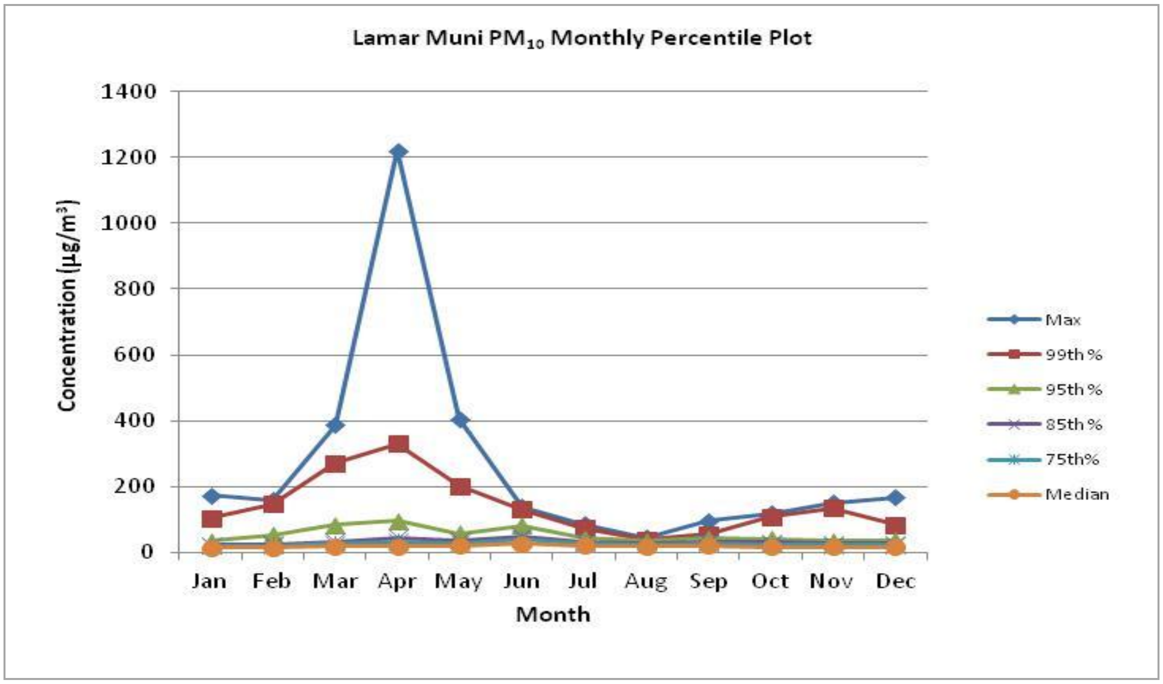


Figure 94: Monthly PM_{10} Percentile Plots (April 9, 2013 event)

It is certainly the case that monthly median values are indicative of typical, day to day concentrations. Additionally, there is a range of samples that are a product of normal variation subject to typical, day to day local effects. This range may be restricted to percentile values that are well correlated with the median. For the data set of concern (Lamar Municipal) a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75^{th} percentile value. Nearly all of the variation in the monthly 75^{th} percentile value of this data set can be explained by the variation in monthly medians; for Lamar Municipal the correlation between the median and monthly 75^{th} percentile values is $r^2 = 0.9$. A reasonable estimate of the contribution to the event from local sources for this data set may be the monthly 85^{th} percentile values and the correlation between the median and the monthly 85^{th} percentile values is $r^2 = 0.80$. If this percentile value is taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from this monthly percentile value would be the sample contribution due to the event.

Table 23 identifies various percentile values that are representative of the maximum contribution due to local sources for the site from all April data (2009 – 2014). In Table 23 the range estimate in the 'Est. Conc. Above Typical' column is derived using the difference between the actual sample value and the 85^{th} percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75^{th} percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the April 9, 2013 sample at the sites listed in the table due to the high wind event.

Table 23: Estimated Maximum Event PM_{10} Contribution, Lamar (April 9, 2013 event)

Site	Event Day Concentration (µg/m^3)	April Median (µg/m^3)	April Average (µg/m^3)	April 75th % (µg/m^3)	April 85th % (µg/m^3)	Est. Conc. Above Typical (µg/m^3)
Lamar Municipal	**1220**	19	37.7	32.8	45	**1175 – 1187**

Clearly, there would have been no exceedance but for the additional contribution to the PM_{10} sample provided by the event.

3.3 May 1, 2013 Monitoring Data and Statistics

On May 1, 2013, an intense cold front moved across Southern Colorado beginning on April 30, 2013. Strong and gusty north to northerly post-frontal winds transported blowing dust into Lamar from southwest Nebraska, northwest Kansas and eastern Colorado. The strong winds generated from the cold front's passing affected the PM_{10} sample in Lamar. During this event a sample in excess of 150 µg/m^3 was recorded at the Lamar Municipal Building 08-099-0002 (207 µg/m^3).

3.3.1 Historical Fluctuations of PM_{10} Concentrations in Lamar

This evaluation of PM_{10} monitoring data for the site affected by the May 1, 2013, event was made using valid samples from the PM_{10} sampler in Lamar from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Lamar since 1985. The overall data summary for the affected sites is presented in Table 24, with all data values being presented in µg/m^3.

Table 24: May 1, 2013 - Event Data Summary

	Lamar Municipal
5/1/2013	**207**
Mean	25.5
Median	19
Mode	14
St. Dev	38.5
Var	1487.9
Minimum	1
Maximum	1220
Percentile	99.5%
Count	1997

The PM_{10} sample on May 1, 2013, at Lamar Municipal of 207 µg/m^3 exceeds the 99th percentile value for all evaluation criteria and is the 11th largest sample of all samples from 2009 through August, 2014. All ten samples greater than the event sample are associated with high wind events. There are 1,997 samples in this dataset. The sample of May 1, 2013 clearly exceeds the typical samples for this site.

Figure 95 and Figure 96 graphically characterize the Lamar Municipal PM_{10} data. The first, Figure 95, is a simple time series; every sample in this dataset (2009 – 2014) greater than 150 µg/m^3 is identified. Note the overwhelming number of samples occupying the lower end of the graph; an interested reader can count the number of samples greater than 100 µg/m^3. Of the 1,997 samples in this data set less than 2% are greater than 100 µg/m^3.

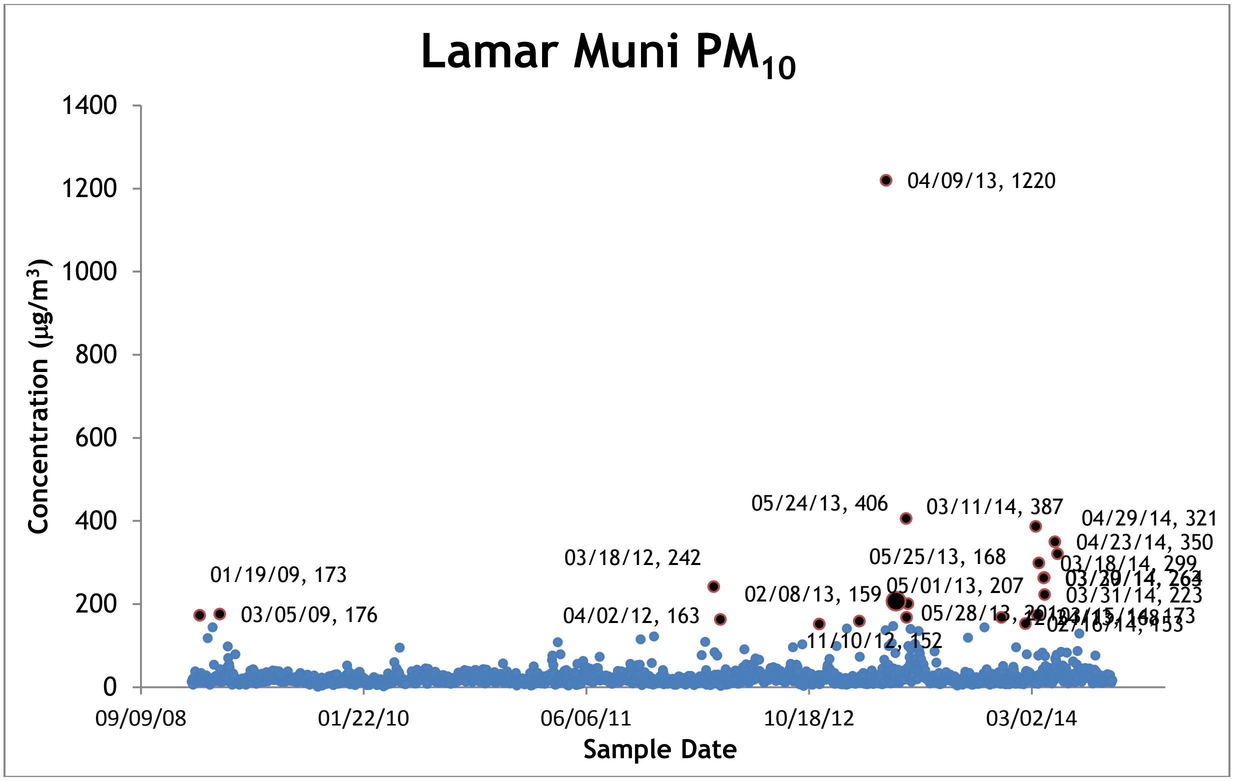


Figure 95: Lamar Municipal PM_{10} Time Series (May 1, 2013 event)

The monthly box-whisker plot in Figure 96 highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) and greater range of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on May 1, 2013. Although these high values affect the variability and central tendency (average) of the dataset they aren't representative of what is typical at the site.

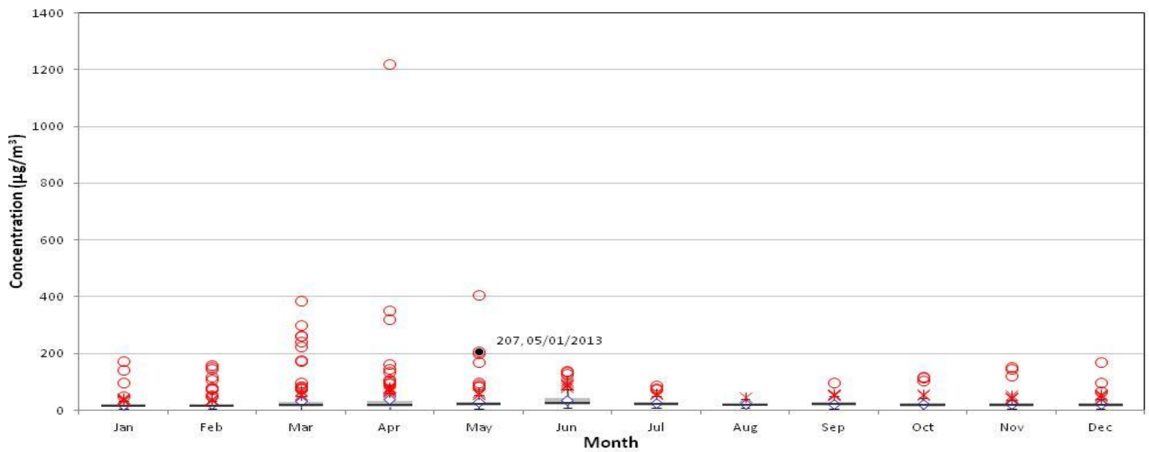


Figure 96: Lamar Municipal PM_{10} Box-Whisker Plot (May 1, 2013 event)

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The May mean (29.3 µg/m3) is greater than the May median value (22 µg/m3) and is greater than the 74% of all samples in any May. The skew in the data is due to the presence of a handful of extreme values and can create the perception that those months experiencing these high wind events are somehow 'dirtier' than other months of the year. This data exposes that perception as flawed, typical data subject to local sources of variation are similar to every other month of the year. Figure 96 suggests that typical, day to day PM_{10} concentrations exposures for the month of June and September are highest among all months. The sample of May 1, 2013, clearly exceeds the typical data at this site.

3.3.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased late in the evening of April 30, 2013 and stayed elevated through the late morning of May 1, 2013, gusting to speeds in excess of 40 mph. The following two charts in Figure 97 display wind speed (mph) as a function of date from meteorological sites within the affected areas for a number of days before and after the event.

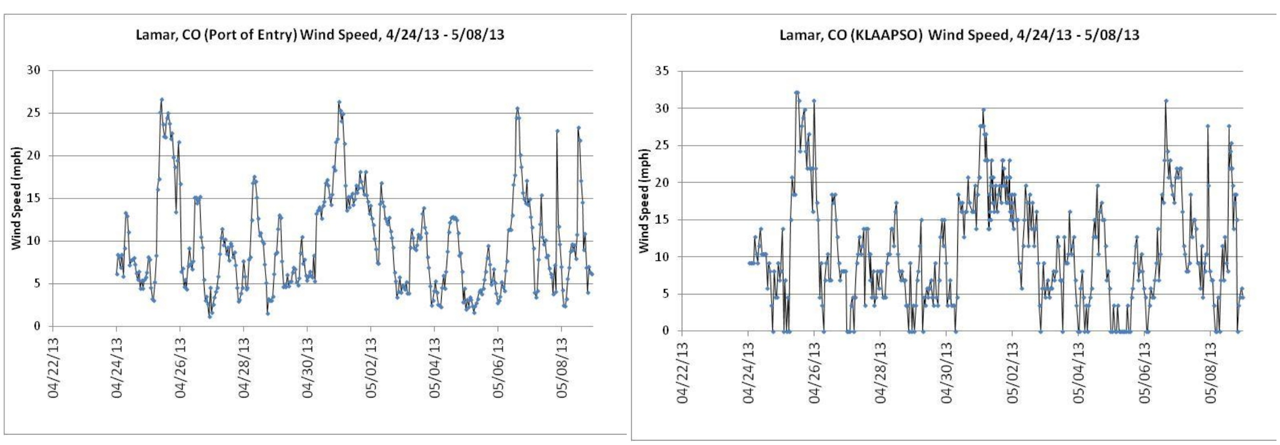


Figure 97: Wind Speed (mph), Lamar, 4/24/2013 – 5/8/2013

Figure 98 plots PM_{10} concentrations from the Lamar Municipal site for the period for seven days prior to and following the sample of May 1, 2013. It should be noted that two Alamosa monitors also reported exceedances on May 1, 2013 and are included in Figure 98 for comparison purposes only. These additional exceedances in Alamosa will be discussed in a separate Technical Support Document.

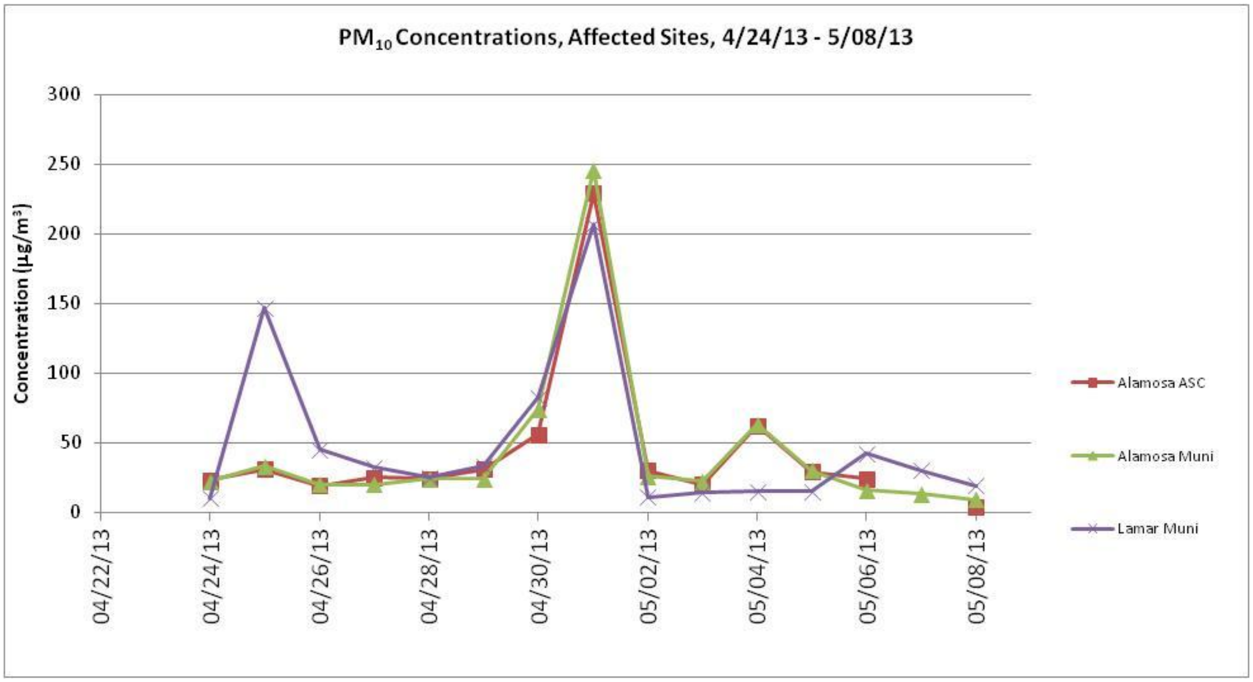


Figure 98: PM_{10} Concentrations, Lamar and Alamosa, 4/24/2013 – 5/8/2013

Figure 98 mimics the plots for wind speed, suggesting an association between the regional high winds and PM_{10} concentrations at the Lamar Municipal and Alamosa sites. Although the samples were affected to differing degrees by the event (possibly reflecting the variation in contribution from local sources) the elevated concentrations are clearly associated with the elevated wind speeds. Given the spatial dislocation of the sites the relationship between the two data sets would suggest that the regional high winds had an effect on PM_{10} samples in Lamar on May 1, 2013.

3.3.3 Percentiles

The monthly percentile plot in Figure 99 demonstrates a high degree of association between monthly median values and relatively high monthly percentile values. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

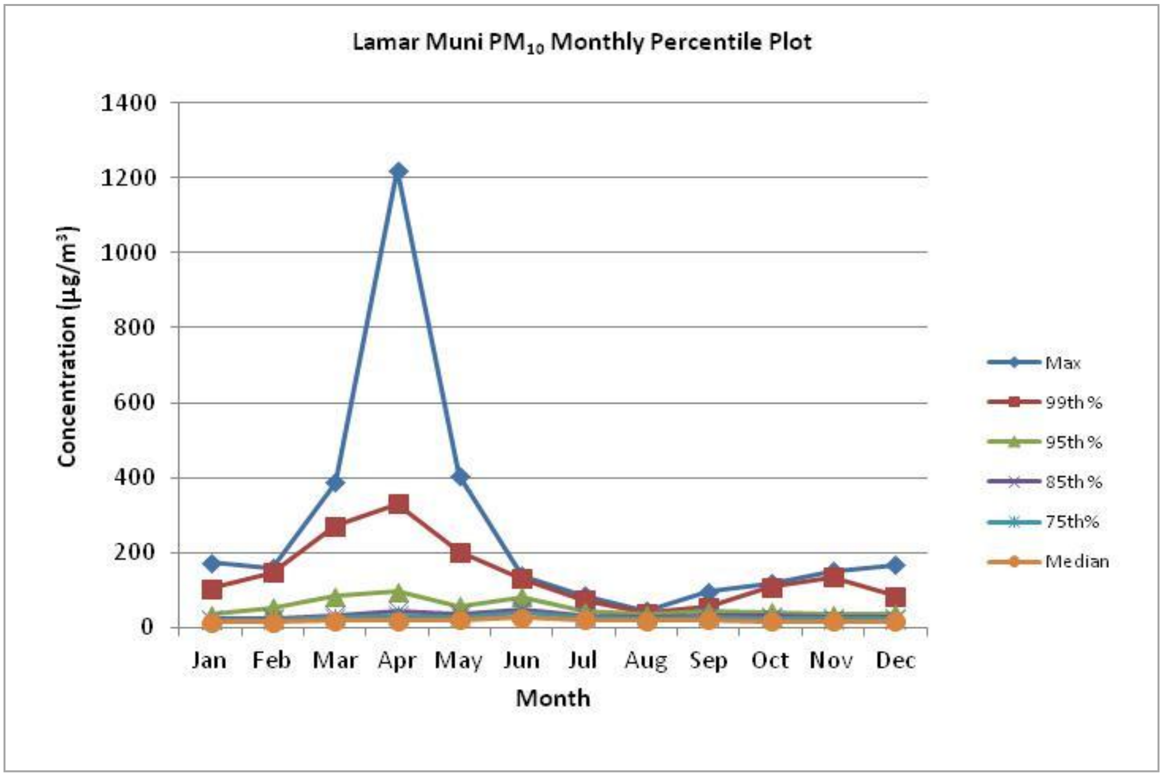


Figure 99: Monthly PM_{10} Percentile Plot (May 1, 2013 event)

It is certainly the case that monthly median values are indicative of typical, day to day concentrations. Additionally, there is a range of samples that are a product of normal variation subject to typical, day to day local effects. This range may be restricted to percentile values that are well correlated with the median. For the data set of concern (Lamar Municipal) a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75th percentile value. Nearly all of the variation in the monthly 75th percentile value of this data set can be explained by the variation in monthly medians; for this site the correlation between the median and monthly 75th percentile values was an r^2 = 0.9 (Lamar Municipal). A reasonable estimate of the contribution to the event from local sources for this data set may be the monthly 85th percentile value; for this site the correlation between the median and the monthly 85th percentile value was an r^2 = 0.80 (Lamar Municipal). If this percentile value is taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from this monthly percentile value would be the sample contribution due to the event.

Table 25 identifies various percentile values that are representative of the maximum contribution due to local sources for the site from all May data. In Table 25 the range estimate in the 'Est. Conc. Above Typical' column is derived using the difference between the actual sample value and the 85th percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75th percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the May 1, 2013 sample at the sites listed in the table due to the high wind event.

Table 25: Estimated Maximum Event PM_{10} Contribution, Lamar (May 1, 2013, event)

Site	Event Day Concentration (μg/m^3)	May Median (μg/m^3)	May Average (μg/m^3)	May 75th % (μg/m^3)	May 85th % (μg/m^3)	Est. Conc. Above Typical (μg/m^3)
Lamar Municipal	**207**	22	29.3	30	38	**169 – 177**

Clearly, there would have been no exceedance but for the additional contribution to the PM_{10} sample provided by the event.

3.4 May 24, 2013 Monitoring Data and Statistics

On May 24, 2013, a cluster of strong to severe thunderstorms in southeast Colorado with powerful outflow winds caused an exceedance of the 24-hour PM_{10} standard in Lamar, Colorado. The thunderstorms were associated with an unstable atmosphere, the disturbance caused strong south to southwest winds and resulting in significant blowing dust in the Lamar area. The strong winds blowing over dry soils affected PM_{10} samples at the site in Lamar. During this event a sample in excess of 150 μg/m^3 was recorded at the Lamar Municipal Building 08-099-0002 (406 μg/m^3).

3.4.1 Historical Fluctuations of PM_{10} Concentrations in Lamar

This evaluation of PM_{10} monitoring data for sites affected by the May 24, 2013, event was made using valid samples from PM_{10} samplers in Lamar from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Lamar since 1985. The overall data summary for the affected site is presented in Table 26, with all data values being presented in μg/m^3.

Table 26: May 24, 2013 - Event Data Summary

	Lamar Municipal
5/24/2013	**406**
Mean	25.5
Median	19
Mode	14
St. Dev	38.5
Var.	1487.9
Minimum	1
Maximum	1220
Percentile	99.5%
Count	1997

The PM_{10} sample on May 24, 2013, at Lamar Municipal of 406 μg/m^3 exceeds the 99th percentile value for all evaluation criteria and is the 2nd largest sample of the dataset. The single sample greater than the May 24, 2013 event sample was associated with a high wind event. There are 1,997 samples in this dataset. The sample of May 24, 2013 clearly exceeds the typical samples for this site.

The following plots (Figure 100 and Figure 101) graphically characterize the Lamar Municipal PM_{10} data. The first, Figure 100, is a simple time series; every sample in this dataset (2009 – 2014) greater than 150 µg/m^3 is identified. Note the overwhelming number of samples occupying the lower end of the graph; an interested reader can count the number of samples greater than 100 µg/m^3. Of the 1,997 samples in this data set less than 2% are greater than 100 µg/m^3.

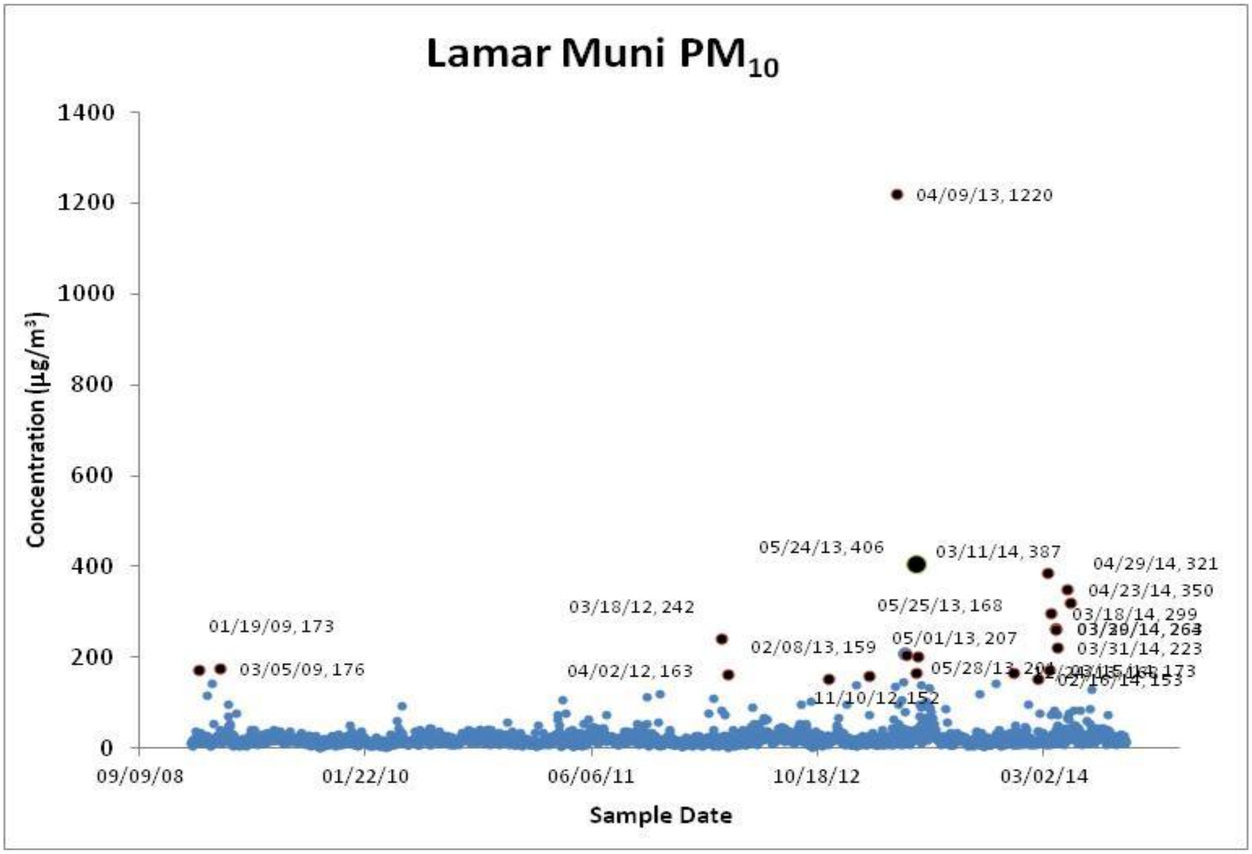


Figure 100: Lamar Municipal PM_{10} Time Series (May 24, 2013 event)

The monthly box-whisker plot in Figure 101 highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) and greater range of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on May 24, 2013. Although these high values affect the variability and central tendency (average) of the dataset they aren't representative of what is typical at the site.

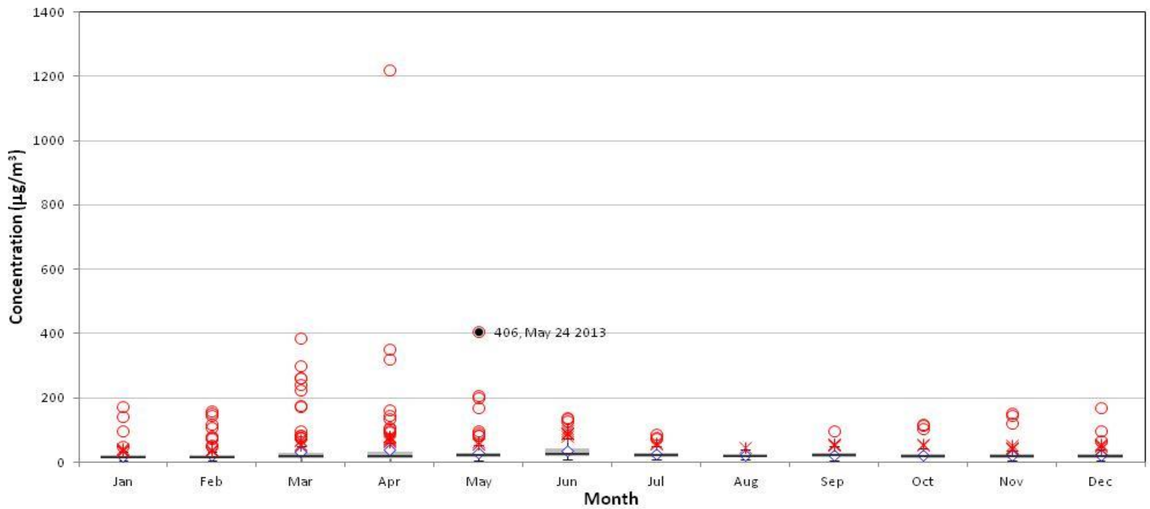


Figure 101: Lamar Municipal PM_{10} Box-Whisker Plot (May 24, 2013 event)

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The May mean (29.3 µg/m^3) is greater than the May median value (22 µg/m^3) and is greater than the 80% of all samples in any May. The skew in the data is due to the presence of a handful of extreme values and can create the perception that those months experiencing these high wind events are somehow 'dirtier' than other months of the year. This data exposes that perception as flawed, typical data subject to local sources of variation are similar to every other month of the year. Figure 101 suggests that typical, day to day PM_{10} concentrations exposures for the months of June and September are highest among all months. The sample of May 24, 2013, clearly exceeds the typical data at this site.

3.4.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased late morning of May 24, 2013 and stayed elevated through the early morning of May 25, 2013, gusting to speeds in excess of 40 mph with sustained hourly averages exceeding 25 mph. The following two charts in Figure 102 display wind speed (mph) as a function of date from meteorological sites within the affected area for a number of days before and after the event.

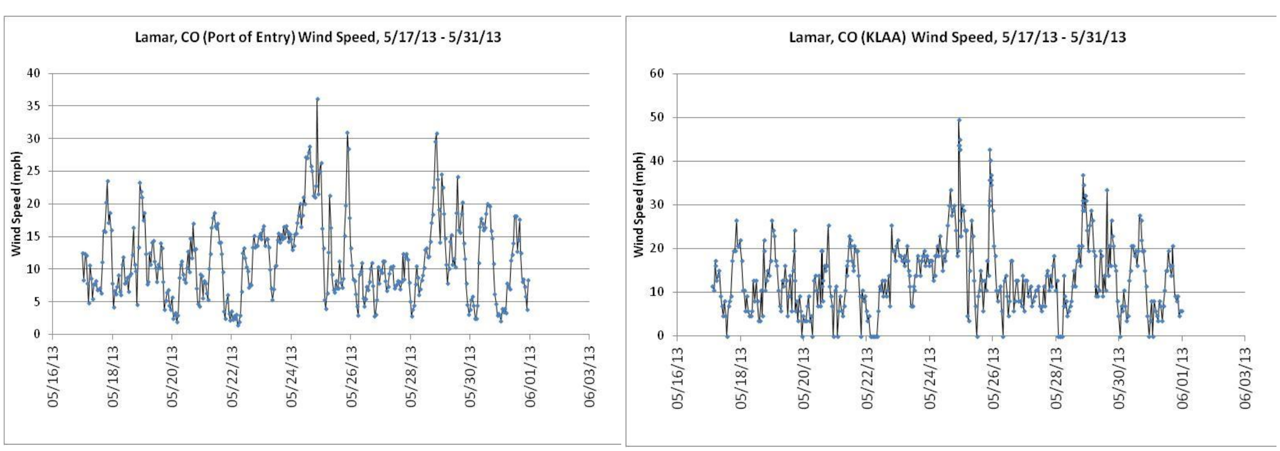


Figure 102: Wind Speed (mph), Lamar, 5/17/2013 – 05/31/2013

Figure 103 plots PM_{10} concentrations from the Lamar Municipal site for the period for seven days prior to and following the sample of May 24, 2013.

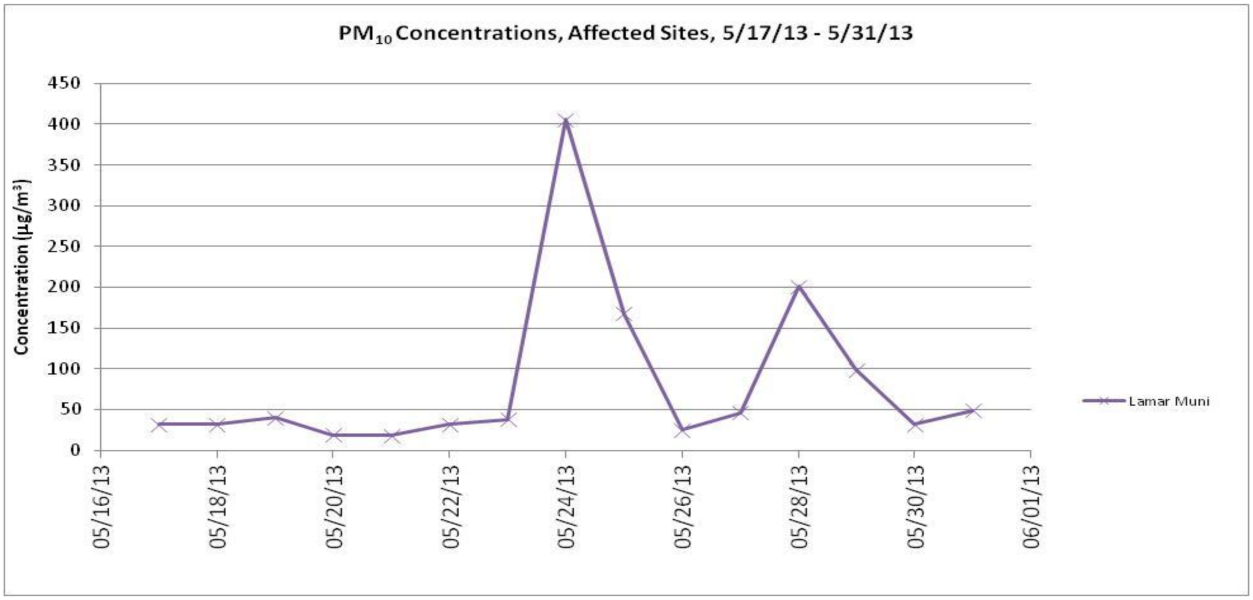


Figure 103: PM_{10} Concentrations, Lamar Municipal, 5/17/2013 – 05/31/2013

Figure 103 mimics the plots for wind speed, suggesting an association between the high winds and PM_{10} concentrations at the Lamar Municipal site, even to the extent the wind continued to blow through the early hours of May 25, 2013 contributing to that day's high sample of 168 µg/m3 (exceeding the 99th percentile for the entire data set). Although the samples were affected to differing degrees by the event (possibly reflecting the variation in contribution from local sources) the elevated concentrations are clearly associated with the elevated wind speeds. The relationship between the two data sets would suggest that the regional high winds had an effect on PM_{10} samples in Lamar On May 24, 2013.

3.4.3 Percentiles

Monthly percentile plots in Figure 104 demonstrate a high degree of association between monthly median values and relatively high monthly percentile values, e.g. the Pearson's r value between the monthly 90th percentile value at Lamar Municipal and the monthly median is 0.65. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

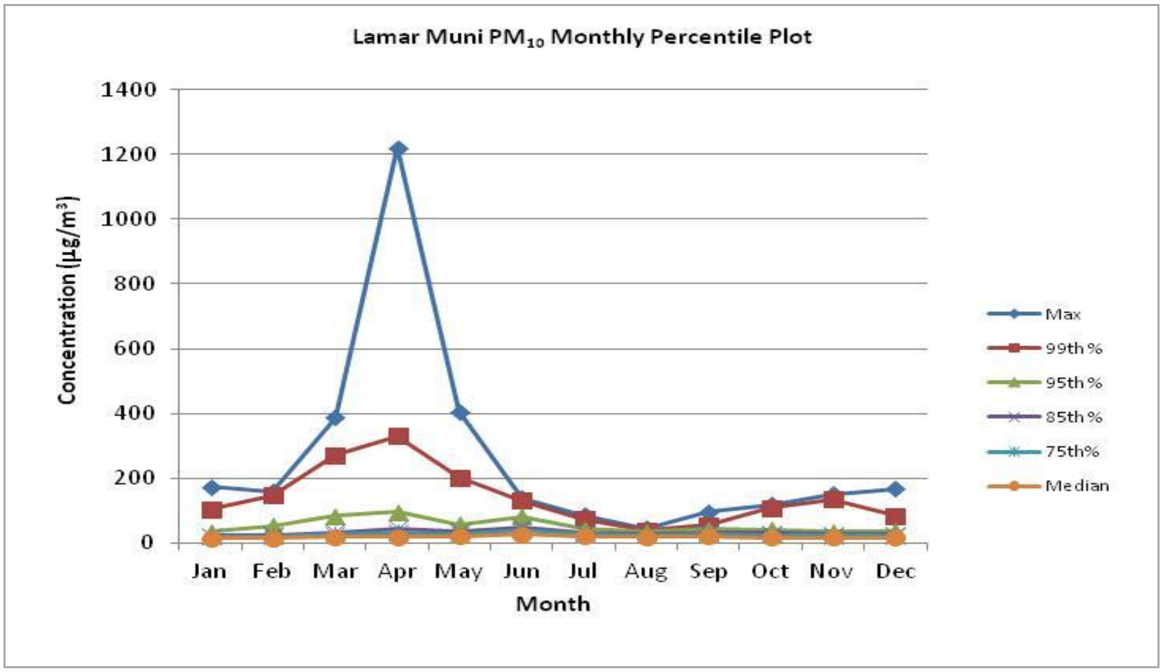


Figure 104: Monthly PM_{10} Percentile Plots (May 24, 2013 event)

It is certainly the case that monthly median values are indicative of typical, day to day concentrations. Additionally, there is a range of samples that are a product of normal variation subject to typical, day to day local effects. This range may be restricted to percentile values that are well correlated with the median. For the data set of concern (Lamar Municipal) a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75th percentile value. Nearly all of the variation in the monthly 75th percentile values of this data set can be explained by the variation in monthly medians; for Lamar Municipal the correlation between the median and monthly 75th percentile values is $r^2 = 0.9$. A reasonable estimate of the contribution to the event from local sources for this data set may be the monthly 85th percentile value; the correlation between the median and the monthly 85th percentile values is $r^2 = 0.80$. If this percentile value is taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from this monthly percentile value would be the sample contribution due to the event.

Table 27 identifies various percentile values that are representative of the maximum contribution due to local sources from all May data (2009 – 2014). In Table 27 the range estimate in the 'Est. Conc. Above Typical' column is derived using the difference between the actual sample value and the 85th percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75th percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the May 24, 2013 Lamar Municipal sample due to the high wind event.

Table 27: Estimated Maximum Event PM_{10} Contribution, Lamar (May 24, 2013 event)

Site	Event Day Concentration (µg/m^3)	May Median (µg/m^3)	May Average (µg/m^3)	May 75th % (µg/m^3)	May 85th % (µg/m^3)	Est. Conc. Above Typical (µg/m^3)
Lamar Municipal	**406**	22	29.3	30	38	**368 - 376**

Clearly, there would have been no exceedance but for the additional contribution to the PM_{10} sample provided by the event.

3.5 May 25, 2014 Monitoring Data and Statistics

On May 25, 2013, a cluster of strong to severe thunderstorms moved across southeast Colorado. The thunderstorms were associated with a moist, unstable atmosphere over southeast Colorado that was impacted by an upper air disturbance. This disturbance initiated thunderstorms with intense southerly outflow winds which moved over drought-stricken soils. This combination of factors produced significant blowing dust in the Lamar area. During this event a sample in excess of 150 µg/m^3 was recorded at the Lamar Municipal Building 08-099-0002 (168 µg/m^3).

3.5.1 Historical Fluctuations of PM_{10} Concentrations in Lamar

This evaluation of PM_{10} monitoring data for sites affected by the May 25, 2013, event was made using valid samples from PM_{10} samplers in Lamar from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Lamar since 1985. The overall data summary for the affected site is presented in Table 28, with all data values being presented in µg/m^3.

Table 28: May 25, 2013 - Event Data Summary

	Lamar Municipal
5/25/2013	**168**
Mean	25.5
Median	19
Mode	14
St. Dev	38.5
Var	1487.9
Minimum	1
Maximum	1220
Percentile	99.5%
Count	1997

The PM_{10} sample on May 25, 2013, at Lamar Municipal of 168 µg/m^3 exceeds the 99th percentile value for all evaluation criteria and is the 16th largest sample of the dataset. The 15 samples greater than the event sample are all associated with a high wind event. There are 1,997 samples in this dataset. The sample of May 25, 2013 clearly exceeds the typical samples for this site.

Figure 105 and Figure 106 graphically characterize the Lamar Municipal PM_{10} data. The first, Figure 105, is a simple time series; every sample in this dataset (2009 – 2014) greater than 150 µg/m^3 is identified. Note the overwhelming number of samples occupying the lower end of the graph; an interested reader can count the number of samples greater than 100 µg/m^3. Of the 1,997 samples in this data set less than 2% are greater than 100 µg/m^3.

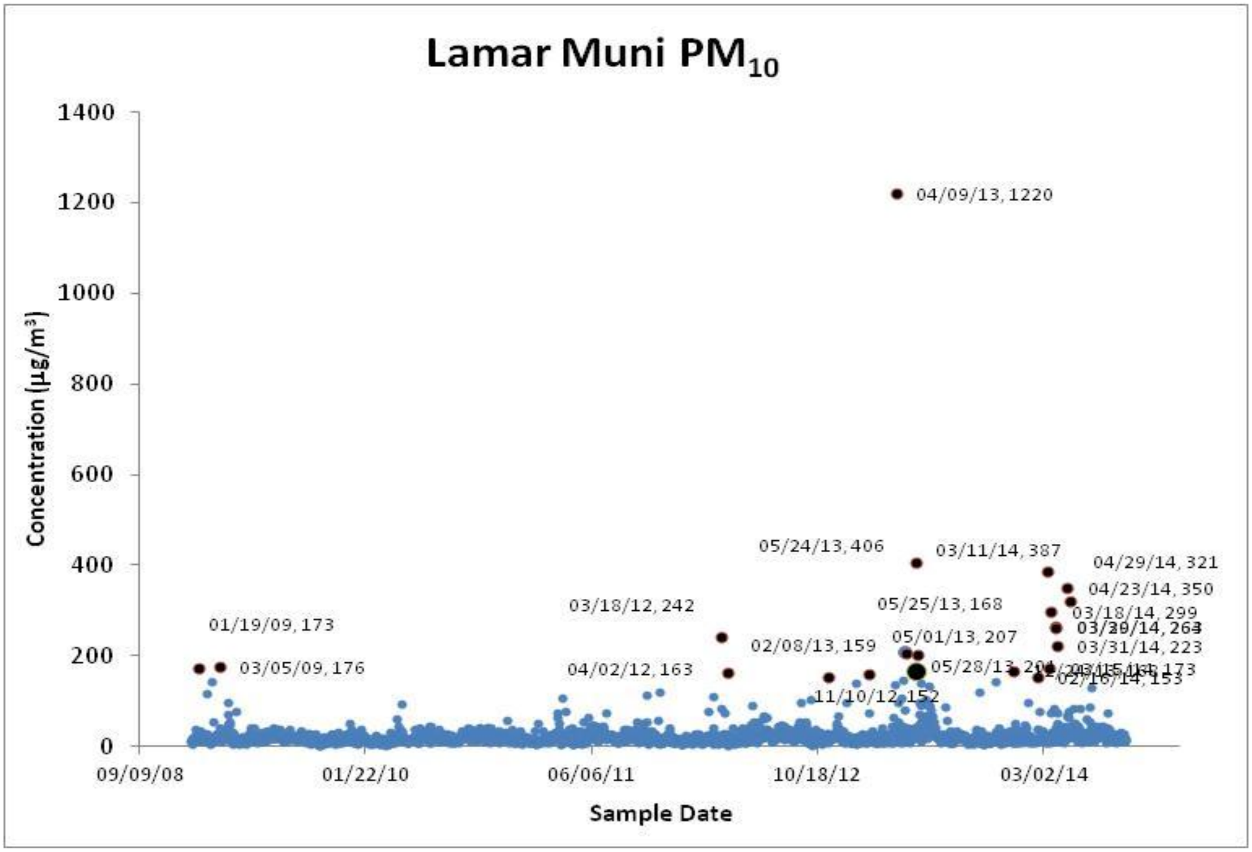


Figure 105: Lamar Municipal PM_{10} Time Series (May 25, 2013 event)

The monthly box-whisker plot, Figure 106, highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) and greater range of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on May 25, 2013. Although these high values affect the variability and central tendency (average) of the dataset they aren't representative of what is typical at the site.

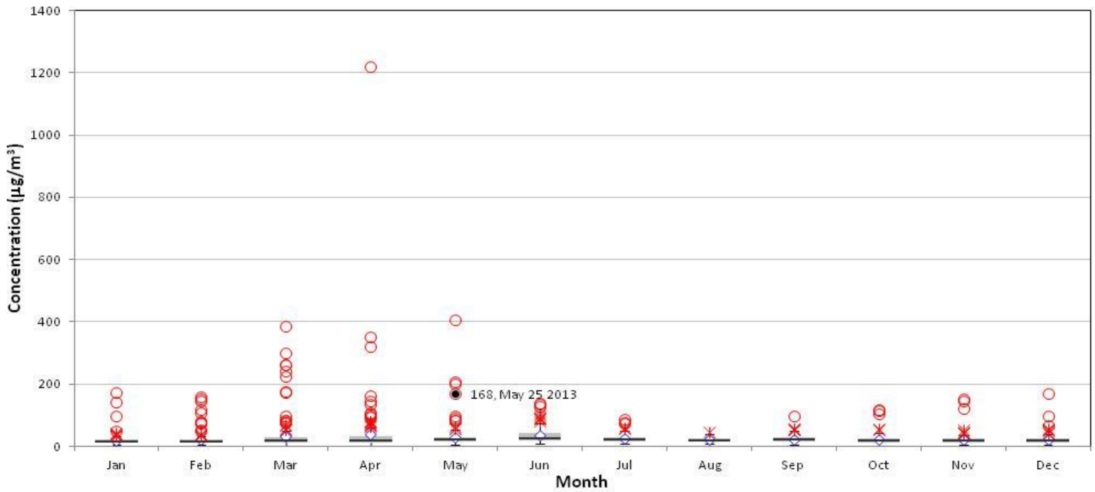


Figure 106: Lamar Municipal PM_{10} Box-Whisker Plot (May 25, 2013 event)

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The May mean (29.3 µg/m^3) is greater than the May median value (22 µg/m^3) and is greater than the 80% of all samples in any May. The skew in the data is due to the presence of a handful of extreme values and can create the perception that those months experiencing these high wind events are somehow 'dirtier' than other months of the year. This data exposes that perception as flawed, typical data subject to local sources of variation are similar to every other month of the year. Figure 106 suggests that typical, day to day PM_{10} concentrations exposures for the months of June and September are highest among all months. The sample of May 25, 2013, clearly exceeds the typical data at this site.

3.5.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased late morning of May 24, 2013 and stayed elevated through the early morning of May 25, 2013, gusting to speeds in excess of 40 mph with sustained hourly averages exceeding 25 mph. The following two charts in Figure 107 display wind speed (mph) as a function of date from meteorological sites within the affected area for a number of days before and after the event.

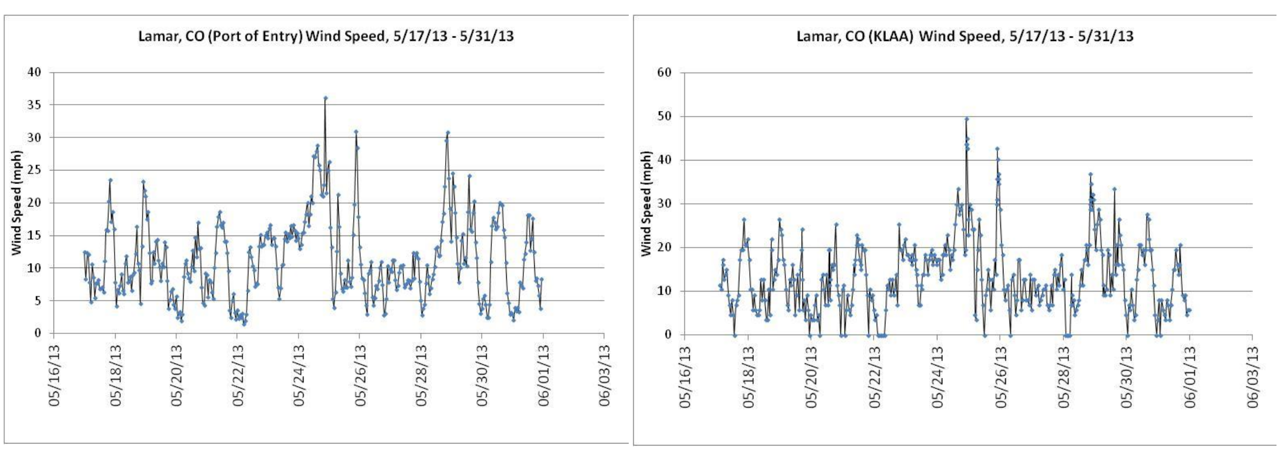


Figure 107: Wind Speed (mph), Lamar, 5/17/2013 – 05/31/2013

Figure 108 plots PM_{10} concentrations from the Lamar Municipal site for the period for seven days prior to and following the sample of May 25, 2013.

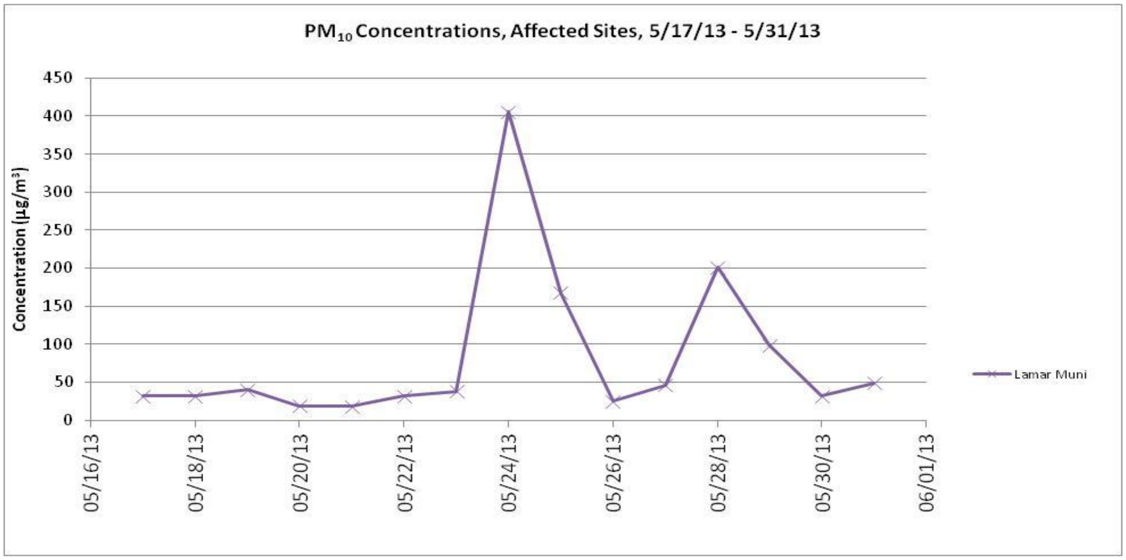


Figure 108: PM_{10} Concentrations, Lamar Municipal, 5/17/2013 – 05/31/2013

Figure 108 mimics the plots for wind speed, suggesting an association between the high winds and PM_{10} concentrations at the Lamar Municipal site, even to the extent the wind began blowing on May 24, 2013 and continued to blow through the early hours of May 25, 2013 affecting PM_{10} concentrations on both days. Although the samples were affected to differing degrees by the event (possibly reflecting the variation in contribution from local sources) the elevated concentrations are clearly associated with the elevated wind speeds. The relationship between the two data sets would suggest that the regional high winds had an effect on PM_{10} samples in Lamar on May 25, 2013.

3.5.3 Percentiles

Monthly percentile plots in Figure 109 demonstrate a high degree of association between monthly median values and relatively high monthly percentile values, e.g. the Pearson's r value between the monthly 90th percentile value at Lamar Municipal and the monthly median is 0.65. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

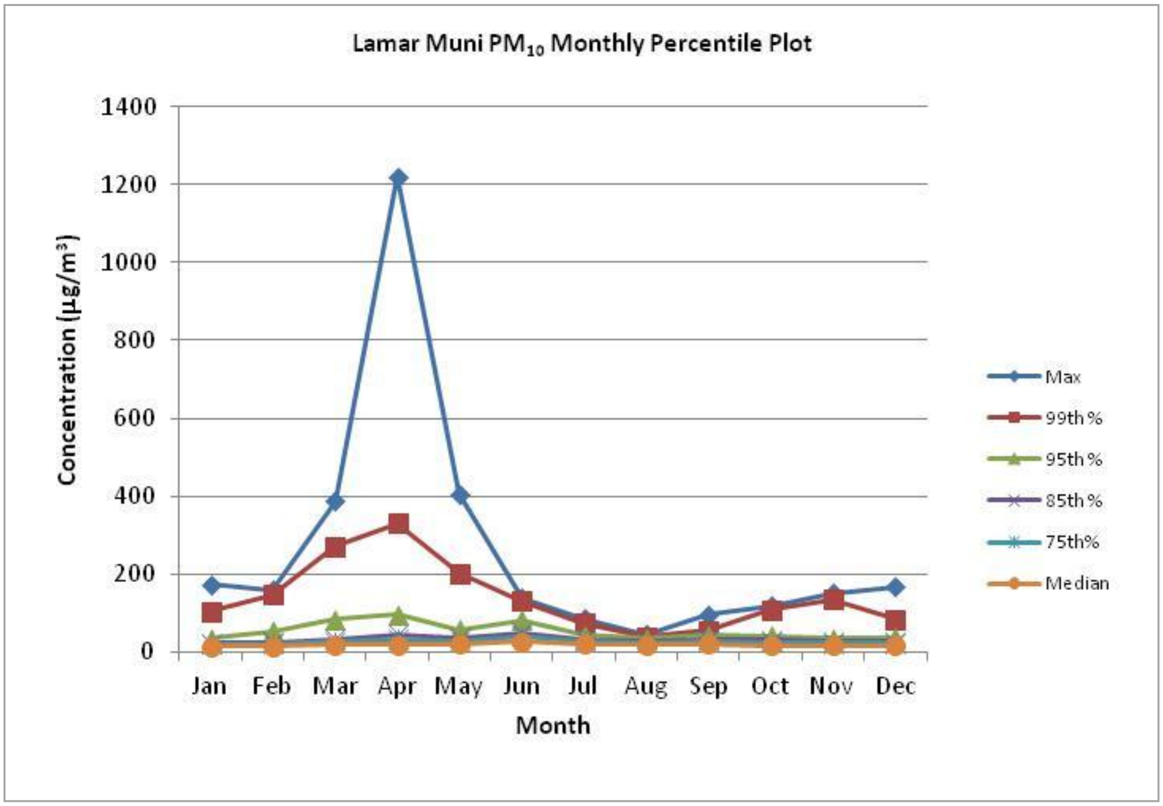


Figure 109: Monthly PM_{10} Percentile Plots

It is certainly the case that monthly median values are indicative of typical, day to day concentrations. Additionally, there is a range of samples that are a product of normal variation subject to typical, day to day local effects. This range may be restricted to percentile values that are well correlated with the median. For the data set of concern (Lamar Municipal) a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75^{th} percentile value. Nearly all of the variation in the monthly 75^{th} percentile value of this data set can be explained by the variation in monthly medians; for Lamar Municipal the correlation between the median and monthly 75^{th} percentile values is $r^2 = 0.9$. A reasonable estimate of the contribution to the event from local sources for this data set may be the monthly 85^{th} percentile value; the correlation between the median and the monthly 85^{th} percentile values is $r^2 = 0.80$. If this percentile value is taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from this monthly percentile value would be the sample contribution due to the event.

Table 29 identifies various percentile values that are representative of the maximum contribution due to local sources for the site from all May data (2009 – 2014). In Table 29 the range estimate in the 'Est. Conc. Above Typical' column is derived using the difference between the actual sample value and the 85^{th} percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75^{th} percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the May 25, 2013 Lamar Municipal sample due to the high wind event.

Table 29: Estimated Maximum Event PM_{10} Contribution, Lamar (May 25, 2013 event)

Site	Event Day Concentration (μg/m³)	May Median (μg/m³)	May Average (μg/m³)	May 75th % (μg/m³)	May 85th % (μg/m³)	Est. Conc. Above Typical (μg/m³)
Lamar Municipal	168	22	29.3	30	38	**130 – 138**

Clearly, there would have been no exceedance but for the additional contribution to the PM_{10} sample provided by the event.

3.6 May 28, 2013 Monitoring Data and Statistics

On May 28, 2013, a cluster of strong to severe thunderstorms in the Texas Panhandle produced extremely powerful outflow winds. The strong outflow winds moved across drought-stricken soil and affected PM_{10} samples at the site in Lamar. During this event a sample in excess of 150 μg/m³ was recorded at the Lamar Municipal Building 08-099-0002 (201 μg/m³).

3.6.1 Historical Fluctuations of PM_{10} Concentrations in Lamar

This evaluation of PM_{10} monitoring data for sites affected by the May 28, 2013, event was made using valid samples from PM_{10} samplers in Lamar from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Lamar since 1985. The overall data summary for the Lamar Municipal site is presented in Table 30, with all data values being presented in μg/m³.

Table 30: May 28, 2013 - Event Data Summary

	Lamar Municipal
5/28/2013	**201**
Mean	25.5
Median	19
Mode	14
St. Dev	38.5
Var	1487.9
Minimum	1
Maximum	1220
Percentile	99.5%
Count	1997

The PM_{10} sample on May 28, 2013, at Lamar Municipal of 201μg/m³ exceeds the 99th percentile value for all evaluation criteria and is the 12th largest sample of the dataset. All eleven samples greater than the event sample are associated with high wind events. There are 1,997 samples in this dataset. The sample of May 28, 2013 clearly exceeds the typical samples for this site.

Figure 110 and Figure 111 graphically characterize the Lamar Municipal PM_{10} data. The first, Figure 110, is a simple time series; every sample in this dataset (2009 – 2014) greater than 150 μg/m^3 is identified. Note the overwhelming number of samples occupying the lower end of the graph; an interested reader can count the number of samples greater than 100 μg/m^3. Of the 1,997 samples in this data set less than 2% are greater than 100 μg/m^3.

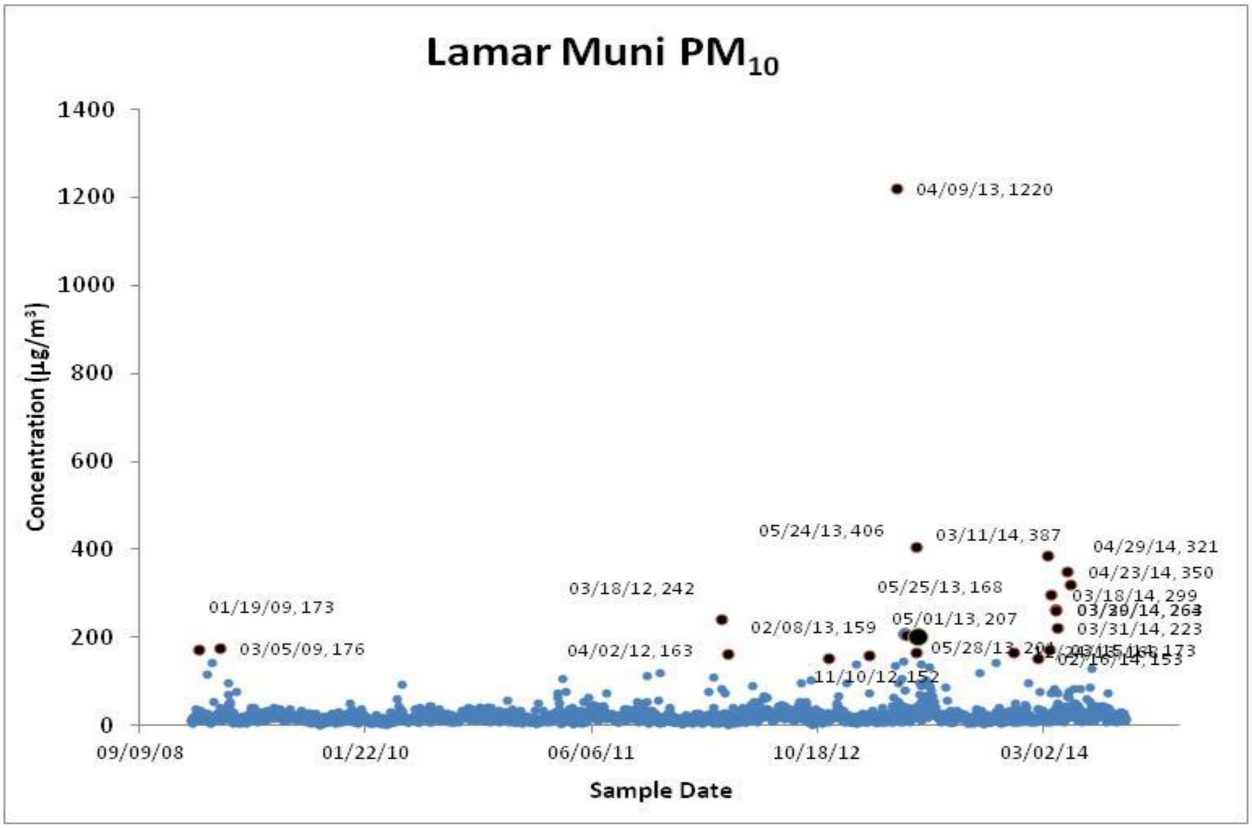


Figure 110: Lamar Municipal PM_{10} Time Series (May 28, 2013 event)

The monthly box-whisker plot in Figure 111 highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) and greater range of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on May 28, 2013. Although these high values affect the variability and central tendency (average) of the dataset they aren't representative of what is typical at the site.

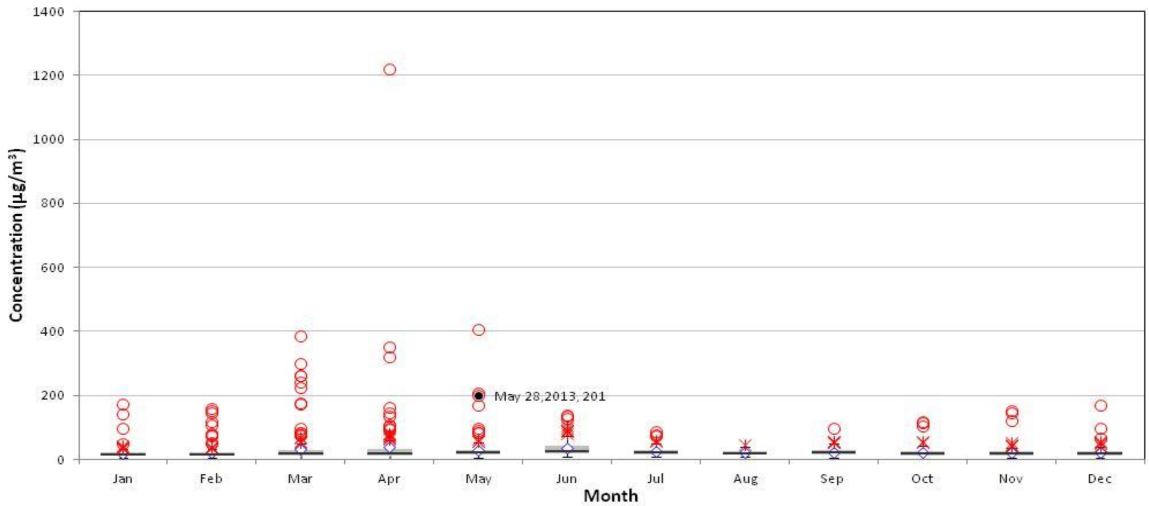


Figure 111: Lamar Municipal PM_{10} Box-Whisker Plot (May 28, 2013 event)

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The May mean (29.3 µg/m^3) is greater than the May median value (22 µg/m^3) and is greater than the 80% of all samples in any May. The skew in the data is due to the presence of a handful of extreme values and can create the perception that those months experiencing these high wind events are somehow 'dirtier' than other months of the year. This data exposes that perception as flawed, typical data subject to local sources of variation are similar to every other month of the year. Figure 111 suggests that typical, day to day PM_{10} concentrations exposures for the month of June and September are highest among all months. The sample of May 28, 2013, clearly exceeds the typical data at this site.

3.6.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased mid afternoon of May 28, 2013 and stayed elevated through the early morning of May 29, 2013, gusting to speeds in excess of 40 mph. The following two charts in **Figure 112** display wind speed (mph) as a function of date from meteorological sites within the affected area for a number of days before and after the event.

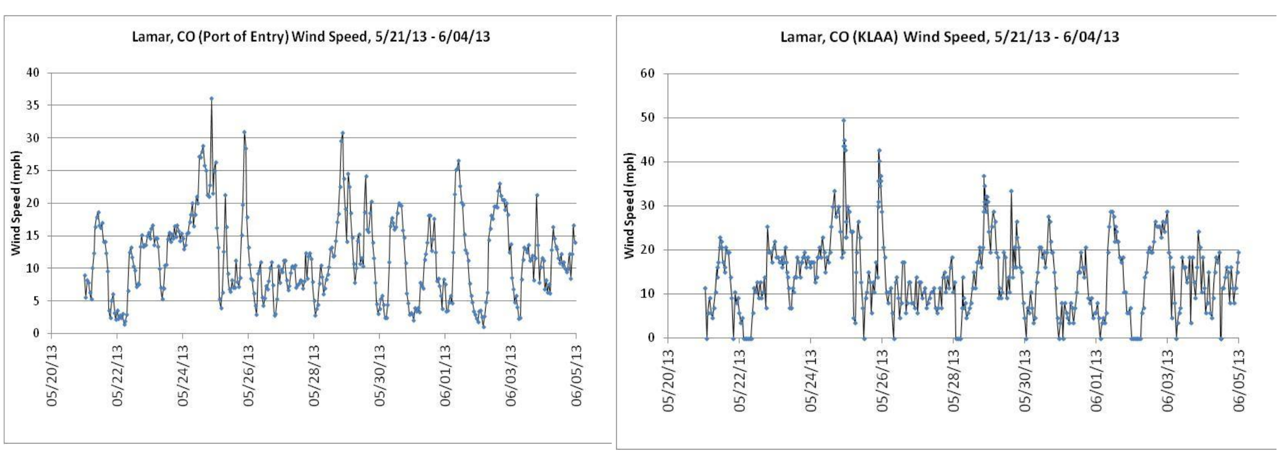


Figure 112: Wind Speed (mph), Lamar, 5/21/2013 – 6/4/2013

Figure 113 plots PM_{10} concentrations from the Lamar Municipal site for the period for seven days prior to and following the sample of May 28, 2013.

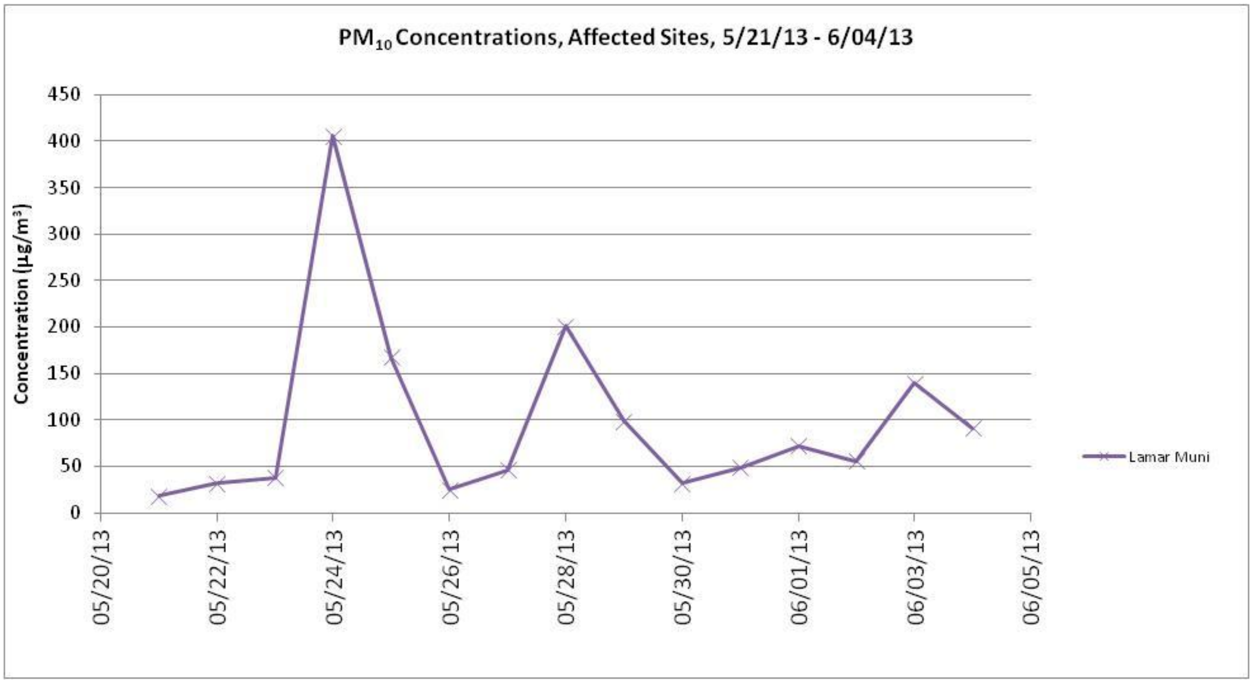


Figure 113: PM_{10} Concentrations, Lamar Municipal, 5/21/2013 – 6/4/2013

Figure 113 mimics the plots for wind speed, suggesting an association between the regional high winds and PM_{10} concentrations at the affected sites. Although the samples were affected to differing degrees by the event (possibly reflecting the variation in contribution from local sources) the elevated concentrations are clearly associated with the elevated wind speeds. The relationship between the two data sets would suggest that the regional high winds had an effect on PM_{10} samples in Lamar on May 28, 2013.

3.6.3 Percentiles

Monthly percentile plots in Figure 114 demonstrate a high degree of association between monthly median values and relatively high monthly percentile values, e.g. the Pearson's r value between the monthly 90th percentile value at Lamar Municipal and the monthly median is 0.65. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

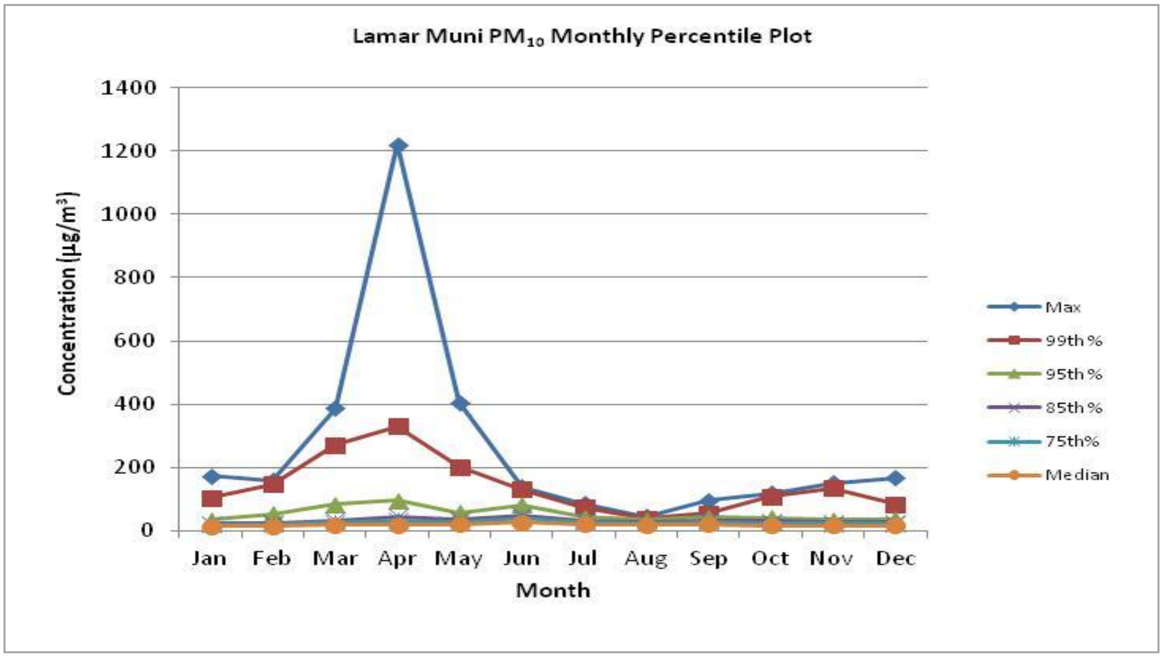


Figure 114: Monthly PM_{10} Percentile Plots

It is certainly the case that monthly median values are indicative of typical, day to day concentrations. Additionally, there is a range of samples that are a product of normal variation subject to typical, day to day local effects. This range may be restricted to percentile values that are well correlated with the median. For the data set of concern (Lamar Municipal) a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75th percentile value. Nearly all of the variation in the monthly 75th percentile values of this data set can be explained by the variation in monthly medians; for Lamar Municipal the correlation between the median and monthly 75th percentile values is $r^2 = 0.9$ (Lamar Municipal). A reasonable estimate of the contribution to the event from local sources for this data set may be the monthly 85th percentile value; the correlation between the median and the monthly 85th percentile values is $r^2 = 0.80$. If this percentile value is taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from this monthly percentile value would be the sample contribution due to the event.

Table 31 identifies various percentile values that are representative of the maximum contribution due to local sources for the site from all May data (2009 – 2014). In Table 31 the range estimate in the 'Est. Conc. Above Typical' column is derived using the difference between the actual sample value and the 85th percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75th percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the May 28, 2013 sample at the sites listed in the table due to the high wind event.

Table 31: Estimated Maximum Event PM_{10} Contribution, Lamar (May 28, 2013 event)

Site	Event Day Concentration (µg/m^3)	May Median (µg/m^3)	May Average (µg/m^3)	May 75th % (µg/m^3)	May 85th % (µg/m^3)	Est. Conc. Above Typical (µg/m^3)
Lamar Municipal	**201**	22	29.3	30	38	**163 – 171**

Clearly, there would have been no exceedance but for the additional contribution to the PM_{10} sample provided by the event.

3.7 December 24, 2013 Monitoring Data and Statistics

On December 24, 3013, a powerful winter storm moved across Southern Colorado. Strong and gusty post-frontal winds transported blowing dust into Lamar. The strong winds following the cold front affected PM_{10} samples at the site in Lamar. During this event a sample in excess of 150 µg/m^3 was recorded at the Lamar Municipal Building 08-099-0002 (168 µg/m^3).

3.7.1 Historical Fluctuations of PM_{10} Concentrations in Lamar

This evaluation of PM_{10} monitoring data for sites affected by the December 24, 3013, event was made using valid samples from PM_{10} samplers in Lamar from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Lamar since 1985. The overall data summary for the affected sites is presented in Table 32, with all data values being presented in µg/m^3.

Table 32: December 24, 2013 - Event Data Summary

	Lamar Municipal
12/24/2013	**168**
Mean	25.5
Median	19
Mode	14
St. Dev	38.6
Var.	1488.0
Minimum	1
Maximum	1220
Percentile	99.2%
Count	1997

The PM_{10} sample on December 24, 2013, at Lamar Municipal of 168 µg/m^3 exceeds the 99th percentile value for all evaluation criteria and is the 16th largest sample of the dataset. All fifteen samples greater than the event sample are associated with high wind events. There are 1,997 samples in this dataset. The sample of December 24, 2013 clearly exceeds the typical samples for this site.

Figure 115 and Figure 116 graphically characterize the Lamar Municipal PM_{10} data. The first, Figure 115, is a simple time series; every sample in this dataset (2009 – 2014) greater than 150 µg/m^3 is identified. Note the overwhelming number of samples occupying the lower end of the graph; an interested reader can count the number of samples greater than 100 µg/m^3. Of the 1,997 samples in this data set less than 2% are greater than 100 µg/m^3.

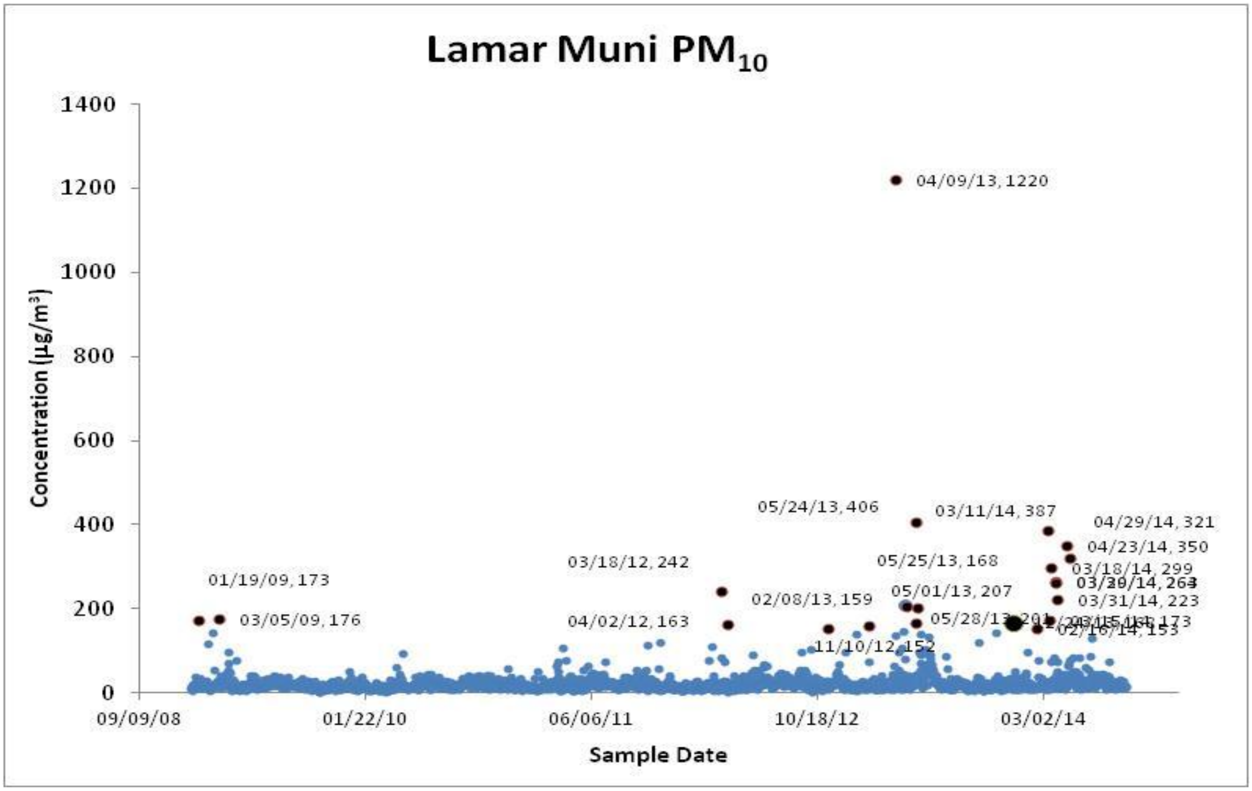


Figure 115: Lamar Municipal PM_{10} Time Series (December 24, 2013 event)

The monthly box-whisker plot in Figure 115 highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) and greater range of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on December 24, 3013. Although these high values affect the variability and central tendency (average) of the dataset they aren't representative of what is typical at the site.

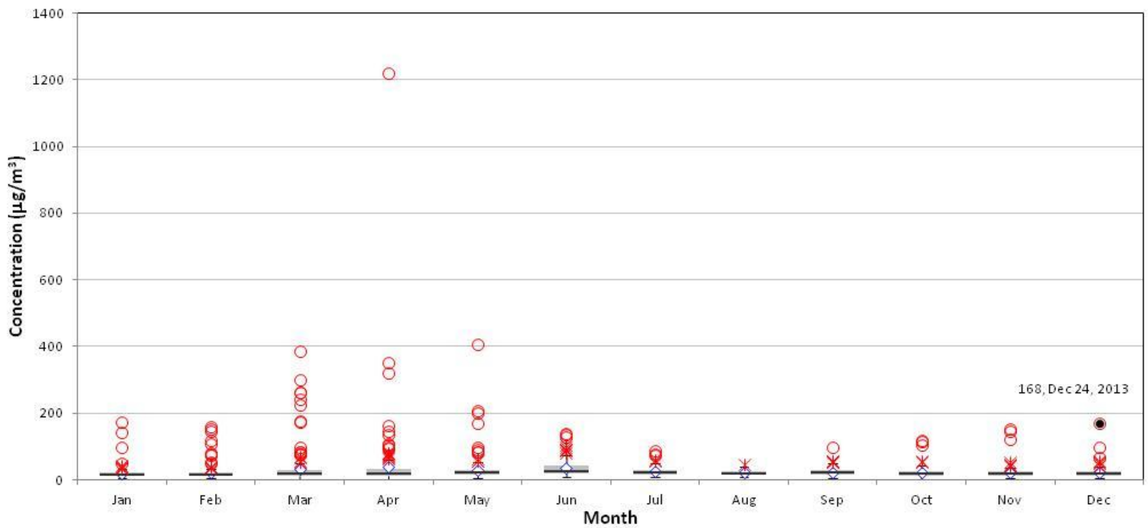


Figure 116: Lamar Municipal PM_{10} Box-Whisker Plot (December 24, 2013 event)

Note the degree to which the data in the months of fall through spring, beginning in October and extending through May, are skewed. The December mean (20.5 $\mu g/m^3$) is greater than the December median value (17 $\mu g/m^3$); the December mean is greater than the 65% of all samples in any December. The skew in the data is due to the presence of a handful of extreme values and can create the perception that those months experiencing these high wind events are somehow 'dirtier' than other months of the year. This data exposes that perception as flawed, typical data subject to local sources of variation are similar to every other month of the year. Figure 116 suggests that typical, day to day PM_{10} concentrations exposures for the month of June and September are highest among all months. The sample of December 24, 3013, clearly exceeds the typical data at this site.

3.7.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased mid afternoon of December 24, 2013 and stayed elevated through the late afternoon, gusting to speeds in excess of 40 mph. The following two charts in **Figure 117** display wind speed (mph) as a function of date from meteorological sites within the affected area for a number of days before and after the event.

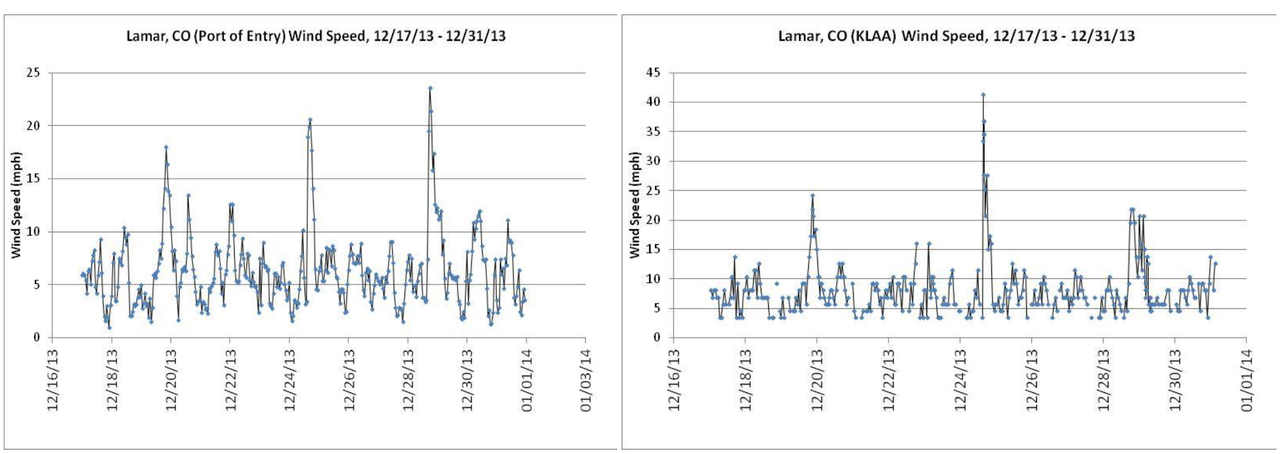


Figure 117: Wind Speed (mph), Lamar, 12/17/2013 – 12/31/2013

Figure 118 plots PM_{10} concentrations from the Lamar Municipal site for the period for seven days prior to and following the sample(s) of December 24, 3013.

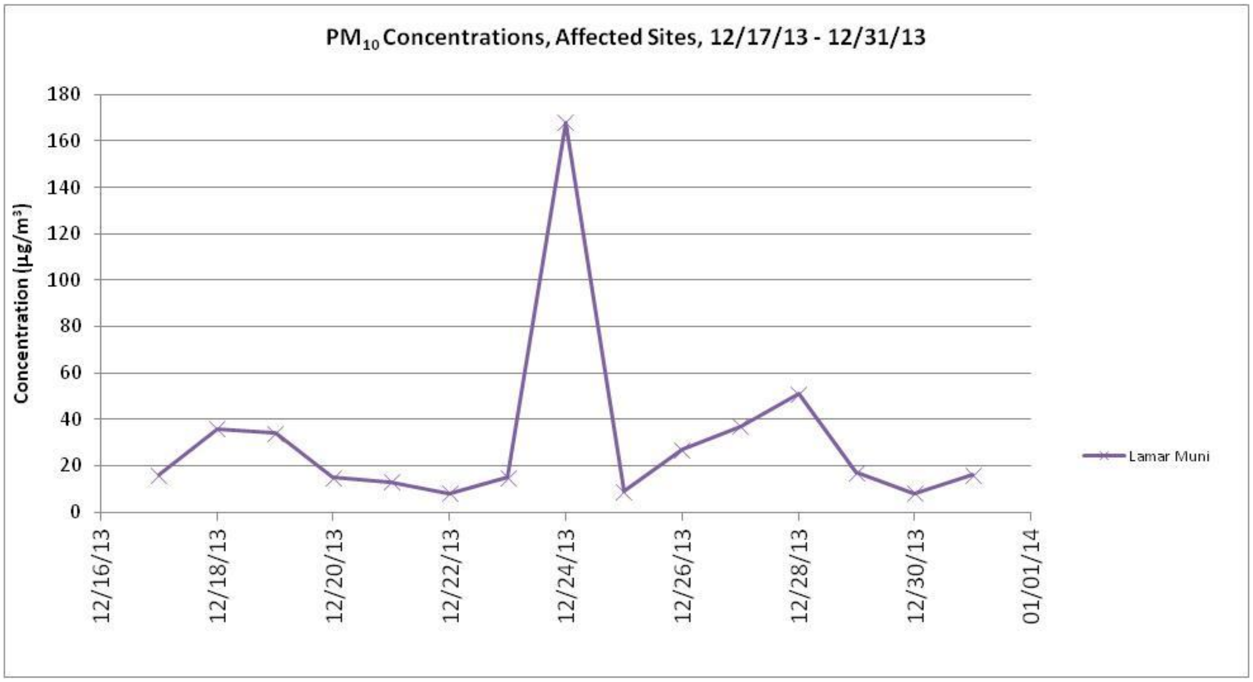


Figure 118: PM_{10} Concentrations, Lamar Municipal, 12/17/2013 – 12/31/2013

Figure 118 mimics the plots for wind speed, suggesting an association between the regional high winds and PM_{10} concentrations at the Lamar Municipal site. Although the samples over this time frame were affected to differing degrees (possibly reflecting the variation in contribution from local sources) the elevated concentrations are clearly associated with the elevated wind speeds. The relationship between the two data sets would suggest that the regional high winds had an effect on PM_{10} samples in Lamar on December 24, 2013.

3.7.3 Percentiles

Monthly percentile plots in Figure 119 demonstrate a high degree of association between monthly median values and relatively high monthly percentile values, e.g. the Pearson's r value between the monthly 90^{th} percentile value at Lamar Municipal and the monthly median is 0.65. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

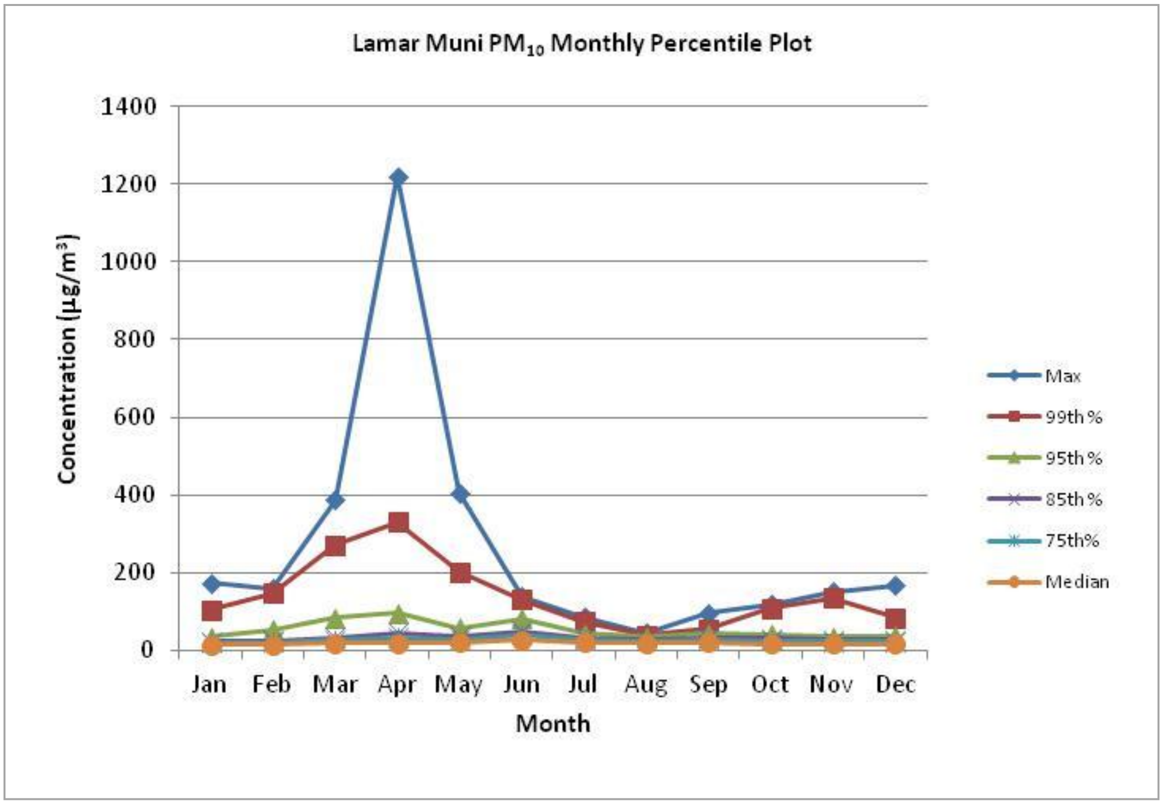


Figure 119: Monthly PM_{10} Percentile Plots

It is certainly the case that monthly median values are indicative of typical, day to day concentrations. Additionally, there is a range of samples that are a product of normal variation subject to typical, day to day local effects. This range may be restricted to percentile values that are well correlated with the median. For the data set of concern (Lamar Municipal) a conservative estimate of the percentile value that is reflective of typical, day to day variation is the 75th percentile value. Nearly all of the variation in the monthly 75th percentile values of this data set can be explained by the variation in monthly medians; for Lamar Municipal the correlation between the median and monthly 75th percentile values is $r^2 = 0.9$ (Lamar Municipal). A reasonable estimate of the contribution to the event from local sources for this data set may be the monthly 85th percentile values; the correlation between the median and the monthly 85th percentile values is $r^2 = 0.80$. If this percentile value is taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from this monthly percentile value would be the sample contribution due to the event.

Table 33 identifies various percentile values that are representative of the maximum contribution due to local sources for the site from all December data (2009 – 2014). In Table 33 the range estimate in the 'Est. Conc. Above Typical' column is derived using the difference between the actual sample value and the 85th percentile as the minimum (reasonable) event contribution estimate and the difference between the actual sample value and the 75th percentile as the maximum (conservative) event contribution estimate. This column represents the range of estimated contribution to the December 24, 2013 sample at the sites listed in the table due to the high wind event.

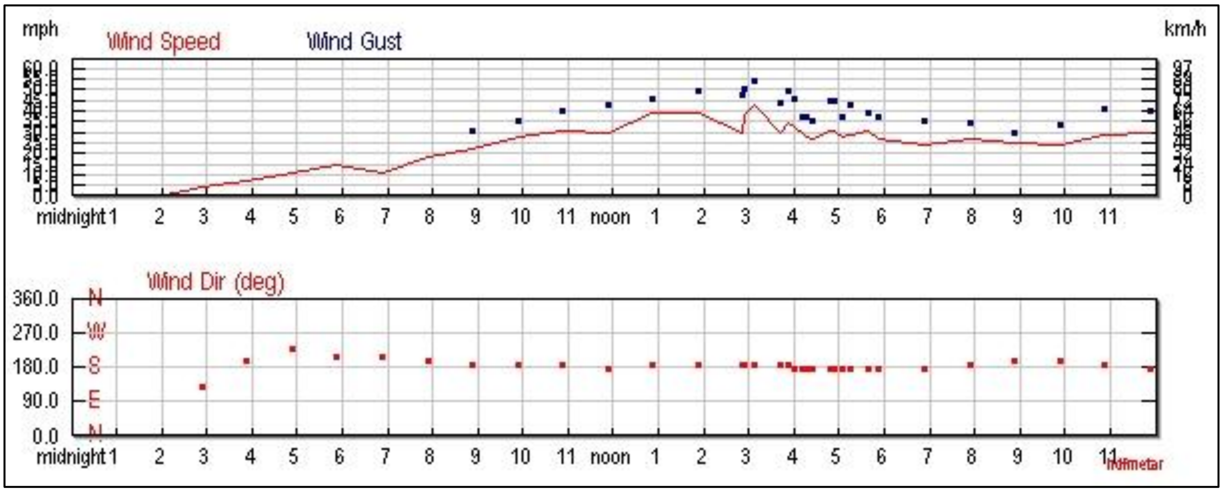
Table 33: Estimated Maximum Event PM_{10} Contribution, Lamar (December 24, 2013 event)

Site	Event Day Concentration ($\mu g/m^3$)	December Median ($\mu g/m^3$)	December Average ($\mu g/m^3$)	December 75th % ($\mu g/m^3$)	December 85th % ($\mu g/m^3$)	Est. Conc. Above Typical ($\mu g/m^3$)
Lamar Municipal	**168**	17	20.5	24	28	**140 - 144**

Clearly, there would have been no exceedance but for the additional contribution to the PM_{10} sample provided by the event.

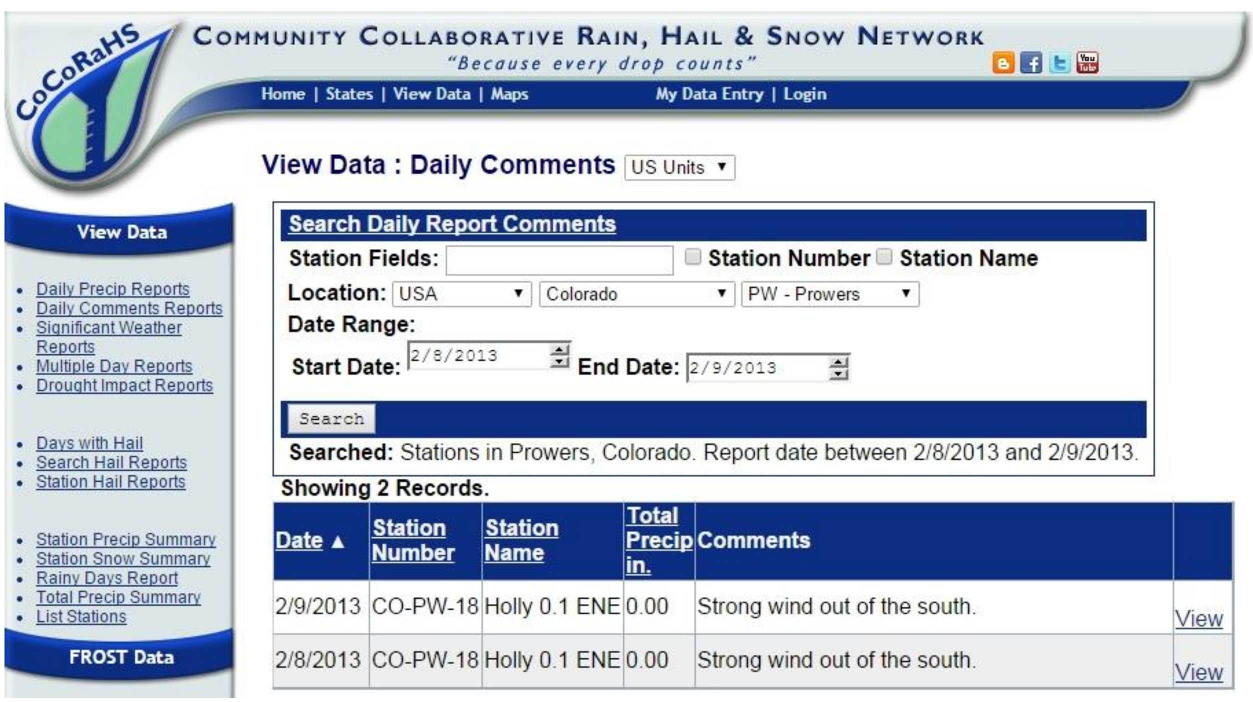
4.0 News and Credible Evidence

4.1 February 8, 2013 Event



(Source: Weather Underground, Lamar 2/8/2013)

4.2 April 9, 2013 Event



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US Units

Search Daily Report Comments

Station Fields: ☐ Station Number ☐ Station Name

Location: USA | Colorado | BA - Baca

Date Range:

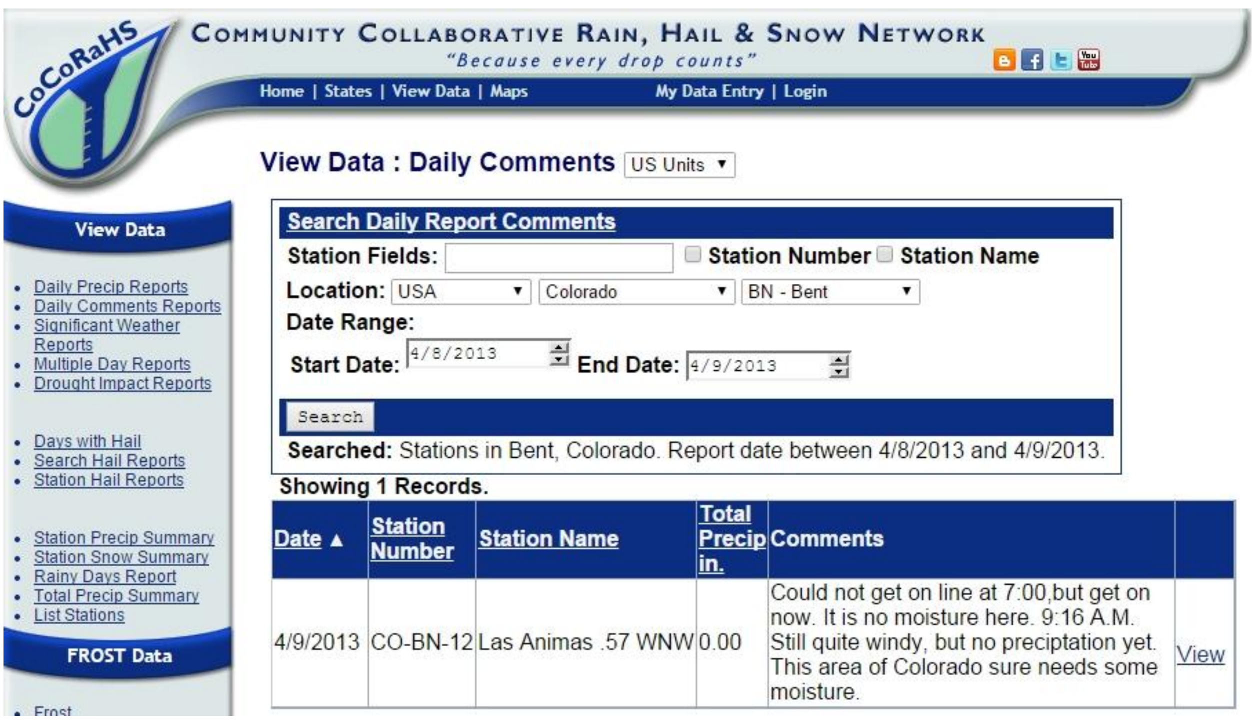
Start Date: 4/8/2013 **End Date:** 4/9/2013

Search

Searched: Stations in Baca, Colorado. Report date between 4/8/2013 and 4/9/2013.

Showing 1 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
4/9/2013	CO-BA-19	Deora 10.7 SW	0.00	Really windy today!	View



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- Total Precip Summary
- List Stations

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- Frost

View Data : Daily Comments

US Units

Search Daily Report Comments

Station Fields: ☐ Station Number ☐ Station Name

Location: USA | Colorado | BN - Bent

Date Range:

Start Date: 4/8/2013 **End Date:** 4/9/2013

Search

Searched: Stations in Bent, Colorado. Report date between 4/8/2013 and 4/9/2013.

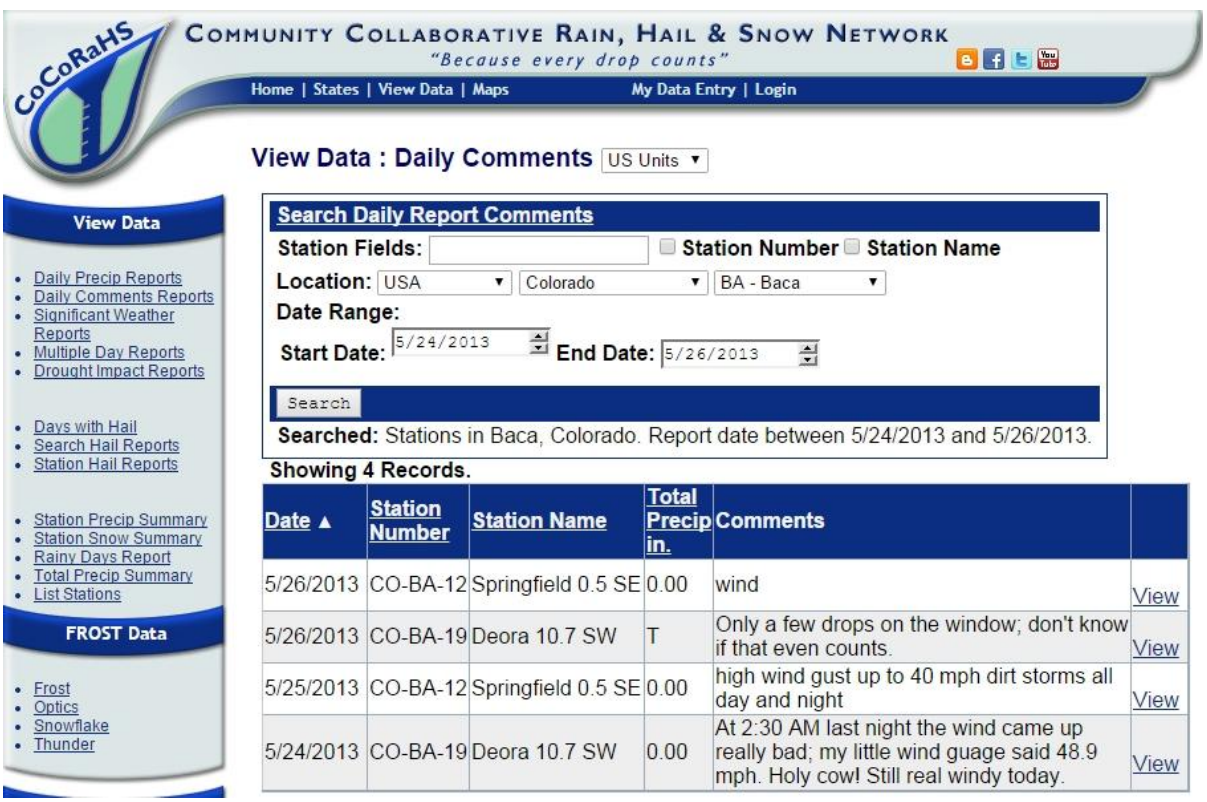
Showing 1 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
4/9/2013	CO-BN-12	Las Animas .57 WNW	0.00	Could not get on line at 7:00,but get on now. It is no moisture here. 9:16 A.M. Still quite windy, but no preciptation yet. This area of Colorado sure needs some moisture.	View

4.3 May 1, 2013 Event

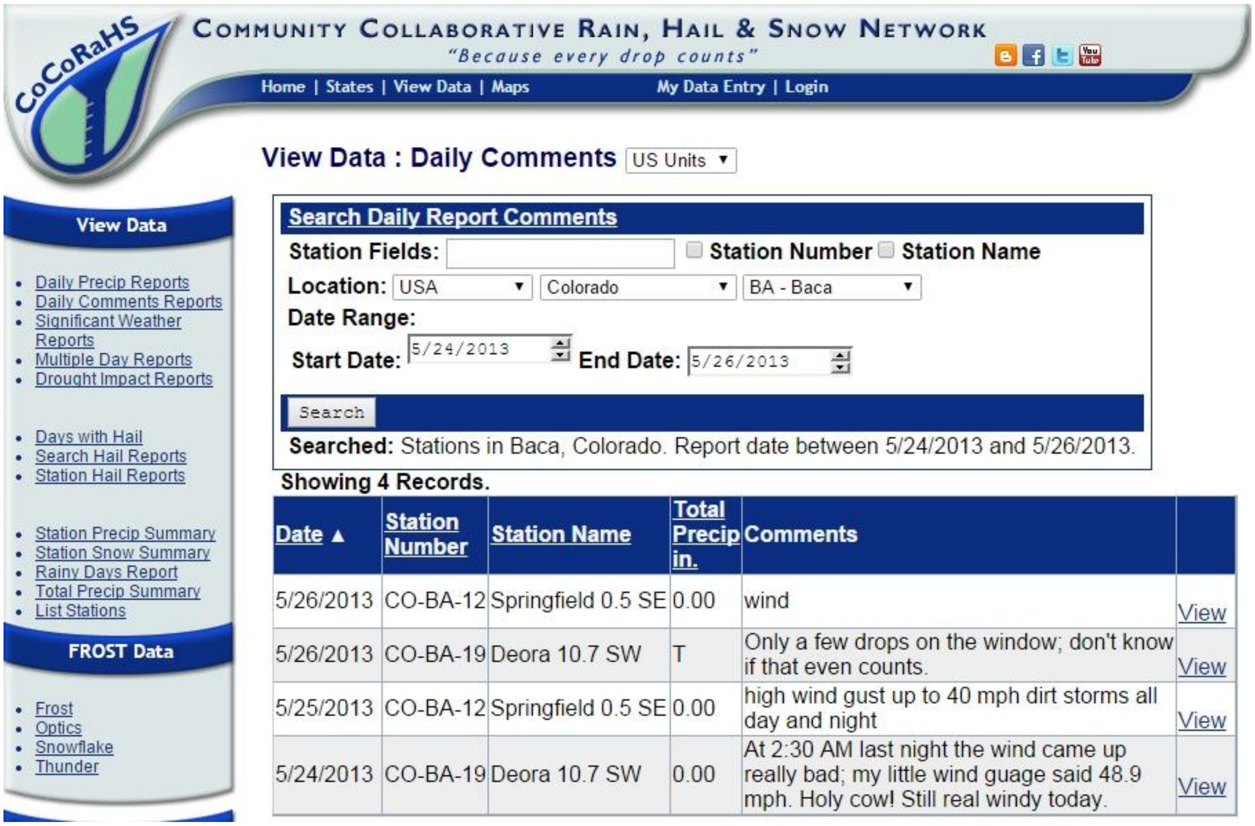
Date ▲	Station Number	Station Name	Total Precip in.	Comments	
5/2/2013	CO-BA-9	Campo 7.8 NE	0.20	Misty most of yesterday then snow fell during night.	View
5/2/2013	CO-BA-27	Stonington 8.6 SE	0.08	We had about 1 inch of snow	View
5/1/2013	CO-BA-12	Springfield 0.5 SE	0.00	High wind and blowing dirt most of the night	View

4.4 May 24, 2013 Event



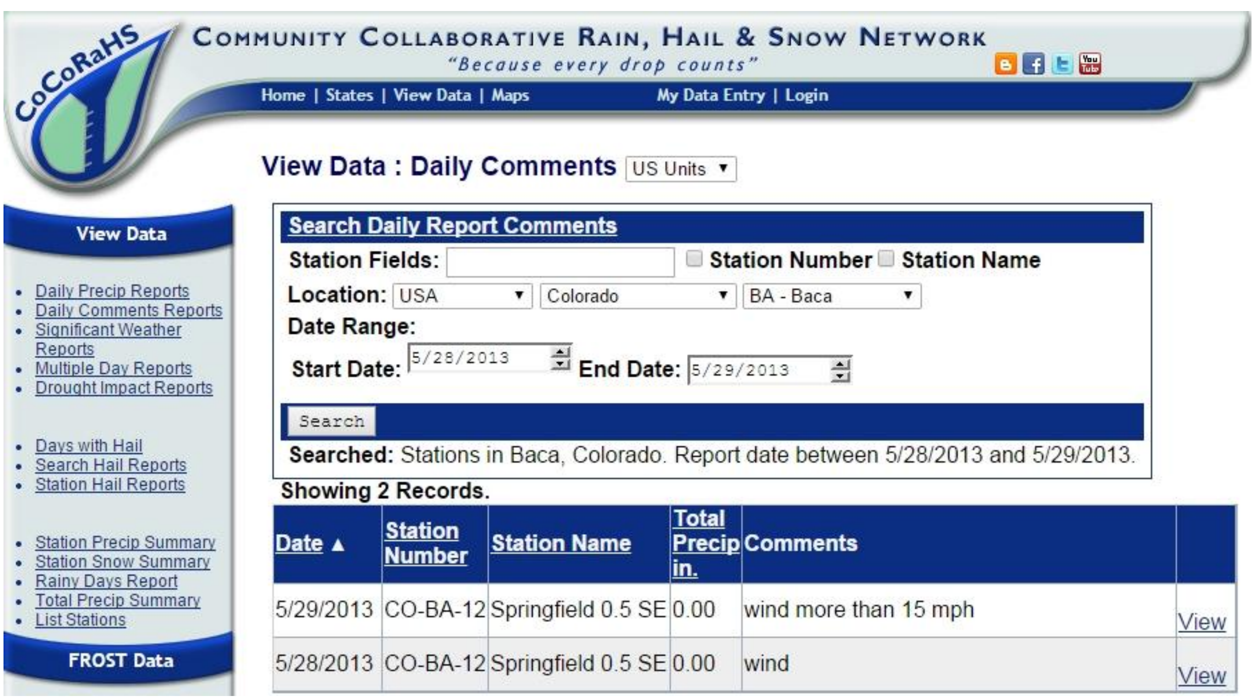
Date ▲	Station Number	Station Name	Total Precip in.	Comments	
5/26/2013	CO-BA-12	Springfield 0.5 SE	0.00	wind	View
5/26/2013	CO-BA-19	Deora 10.7 SW	T	Only a few drops on the window; don't know if that even counts.	View
5/25/2013	CO-BA-12	Springfield 0.5 SE	0.00	high wind gust up to 40 mph dirt storms all day and night	View
5/24/2013	CO-BA-19	Deora 10.7 SW	0.00	At 2:30 AM last night the wind came up really bad; my little wind guage said 48.9 mph. Holy cow! Still real windy today.	View

4.5 May 25, 2013 Event



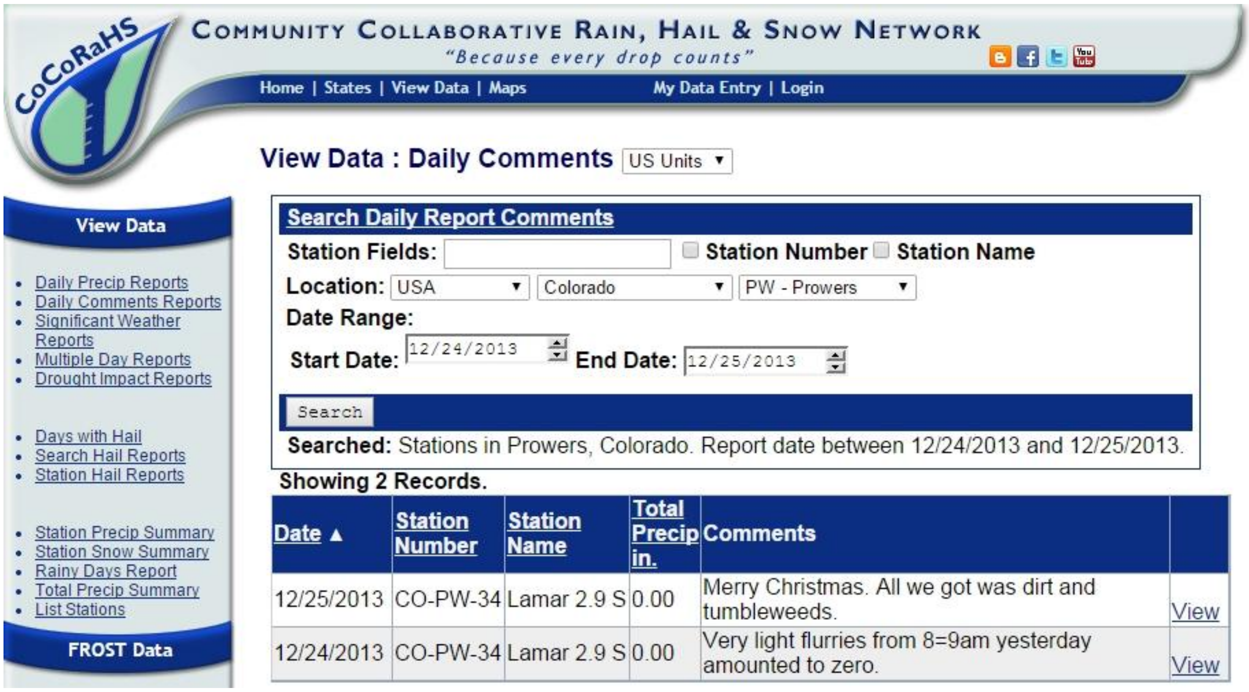
Date ▲	Station Number	Station Name	Total Precip in.	Comments	
5/26/2013	CO-BA-12	Springfield 0.5 SE	0.00	wind	View
5/26/2013	CO-BA-19	Deora 10.7 SW	T	Only a few drops on the window; don't know if that even counts.	View
5/25/2013	CO-BA-12	Springfield 0.5 SE	0.00	high wind gust up to 40 mph dirt storms all day and night	View
5/24/2013	CO-BA-19	Deora 10.7 SW	0.00	At 2:30 AM last night the wind came up really bad; my little wind guage said 48.9 mph. Holy cow! Still real windy today.	View

4.6 May 28, 2013 Event



Date ▲	Station Number	Station Name	Total Precip in.	Comments	
5/29/2013	CO-BA-12	Springfield 0.5 SE	0.00	wind more than 15 mph	View
5/28/2013	CO-BA-12	Springfield 0.5 SE	0.00	wind	View

4.7 December 24, 2013 Event



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FROST Data

Search Daily Report Comments

Station Fields: Station Number Station Name

Location: USA Colorado PW - Prowers

Date Range:

Start Date: 12/24/2013 End Date: 12/25/2013

Search

Searched: Stations in Prowers, Colorado. Report date between 12/24/2013 and 12/25/2013.

Showing 2 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
12/25/2013	CO-PW-34	Lamar 2.9 S	0.00	Merry Christmas. All we got was dirt and tumbleweeds.	View
12/24/2013	CO-PW-34	Lamar 2.9 S	0.00	Very light flurries from 8=9am yesterday amounted to zero.	View

5.0 Not Reasonably Controllable or Preventable: Local Particulate Matter Control Measures

While it is likely that some dust was generated within the local communities by gusts from the regional dust storms that passed through the area, the amount of dust generated locally was easily overwhelmed by, and largely unnoticeable as compared to the dust transported in from surrounding areas. The following sections will describe in detail the regulations and programs in place designed to control PM_{10} in each affected community. These sections will demonstrate that the events were not reasonably controllable, as laid out in Section 50.1(j) of Title 40 CFR 50, within the context of reasonable local particulate matter control measures. As shown from the meteorological and monitoring analyses (Sections 2 and 3), the source regions for the associated dust that occurred during the 2013 events in Lamar originated outside of the monitored areas.

The APCD conducted thorough analyses and outreach with local governments to confirm that no unusual anthropogenic PM_{10}-producing activities occurred in these areas and that despite reasonable control measures in place, high wind conditions overwhelmed all reasonably available controls. The following subsections describe in detail Best Available Control Measures (BACM), other reasonable control measures, applicable federal, state, and local regulations, appropriate land use management, and an in-depth analysis of potential areas of local soil disturbance for each affected community during the 2013 events. This information shall confirm that no unusual anthropogenic actions occurred in the local areas of Lamar during this time.

5.1 Regulatory Measures - State

The APCDs regulations on PM_{10} emissions are summarized in Table 34.

Table 34: State Regulations Regulating Particulate Matter Emissions

Rule/Ordinance	Description
Colorado Department of Public Health and Environment Regulation 1- Emission Control For Particulate Matter, Smoke, Carbon Monoxide, And Sulfur Oxides	Applicable sections include but are not limited to: Everyone who manages a source or activity that is subject to controlling fugitive particulate emissions must employ such control measures and operating procedures through the use of all available practical methods which are technologically feasible and economically reasonable and which reduce, prevent and control emissions so as to facilitate the achievement of the maximum practical degree of air purity in every portion of the State. Section III.D.1.a) Anyone clearing or leveling of land greater than five acres in attainment areas or one acre in non-attainment areas from which fugitive particulate emissions will be emitted are required to use all available and practical methods which are

	technologically feasible and economically reasonable in order to minimize fugitive particulate emissions.(Section III.D.2.b) Control measures or operational procedures for fugitive particulate emissions to be employed may include planting vegetation cover, providing synthetic cover, watering, chemical stabilization, furrows, compacting, minimizing disturbed area in the winter, wind breaks and other methods or techniques approved by the APCD. (Section III.D.2.b) Any owner or operator responsible for the construction or maintenance of any existing or new unpaved roadway which has vehicle traffic exceeding 200 vehicles per day in the attainment/maintenance area and surrounding areas must stabilize the roadway in order to minimize fugitive dust emissions (Section III.D.2.a.(i))
Colorado Department of Public Health and Environment Regulation 3- Stationary Source Permitting and Air Pollutant Emission Notice Requirements	Construction Permit required if a land development project exceeds 25 acres and spans longer than 6 months in duration (Section II.D.1.j) All sources with uncontrolled actual PM_{10} emissions equal to or exceeding five (5) tons per year, must obtain a permit. The new source review provisions require all new and modified major stationary sources in non-attainment areas to apply emission control equipment that achieves the "lowest achievable emission rate" and to obtain emission offsets from other stationary sources of PM_{10}.
Colorado Department of Public Health and Environment Regulation 4- New Wood Stoves and the Use of Certain Woodburning Appliances During High Pollution Days	Regulates wood stoves, conventional fireplaces and woodburning on high pollution days. Prohibits the sale and installation a wood-burning stove in Colorado unless it has been tested, certified, and labeled for emission performance in accordance with criteria and procedures specified in the Federal Regulations and meets emission standards. (Section II) Section III regulates pellet stoves. Section IV regulates masonry heaters. Section VII limits the use of stoves on high pollution days.
Colorado Department of Public Health	Implements federal standards of performance for

and Environment Regulation 6- Standards of Performance for New Stationary Sources	new stationary sources including ones that have particulate matter emissions. (Section I)
Colorado Department of Public Health and Environment Regulation 9- Open Burning, Prescribed Fire, and Permitting	Prohibits open burning throughout the state unless a permit has been obtained from the appropriate air pollution control authority. In granting or denying any such permit, the authority will base its action on the potential contribution to air pollution in the area, climatic conditions on the day or days of such burning, and the authority's satisfaction that there is no practical alternate method for the disposal of the material to be burned. Among other permit conditions, the authority granting the permit may impose conditions on wind speed at the time of the burn to minimize smoke impacts on smoke-sensitive areas. (Section III)
Colorado Department of Public Health and Environment- Common Provisions Regulation	Applies to all emissions sources in Colorado When emissions generated from sources in Colorado cross the state boundary line, such emissions shall not cause the air quality standards of the receiving state to be exceeded, provided reciprocal action is taken by the receiving state. (Section II A)
Federal Motor Vehicle Emission Control Program	The federal motor vehicle emission control program has reduced PM_{10} emissions through a continuing process of requiring diesel engine manufacturers to produce new vehicles that meet tighter and tighter emission standards. As older, higher emitting diesel vehicles are replaced with newer vehicles; the PM_{10} emissions in areas will be reduced.

5.2 Lamar Regulatory Measures and Other Programs

<u>Natural Events Action Plan (NEAP)</u>

In response to exceedances of the PM_{10} NAAQS (two in 1995 and one in 1996), the APCD, in conjunction with the City of Lamar's Public Works Department, Parks and Recreation, and Prowers County Commissioners, the Natural Resources Conservation Services, the Burlington Northern Santa Fe Railroad, and other agencies developed a Natural Events Action Plan. That Plan was presented to EPA in 1998 and subsequently approved. Since 1998, it is this plan that has assisted the area in addressing blowing dust due to uncontrollable winds.

The most recently updated NEAP for High Wind Events in Lamar, Colorado was completed in 2012. The NEAP addresses public education programs, public notification and health advisory programs, and determines and implements Best Available Control Measures (BACM) for anthropogenic sources of windblown dust in the Lamar area. The City of Lamar, Prowers County, the APCD, and participating federal agencies worked diligently to identify contributing sources and to develop appropriate BACM as required by the Natural Events Policy.

Please refer to the 2012 Revised Natural Events Action Plan For High Wind Events, Lamar, Colorado at http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=LamarNaturalEventsActionPlan2012.pdf for more detail if needed.

Control Measures from the December 2012 Maintenance Plan

Control of Emissions from Stationary Sources
Although there are few stationary sources located in the Lamar attainment/maintenance area, the State's comprehensive permit rules listed in Table 34 will limit emissions from any new source that may, in the future, locate in the area.

The EPA approval of the original PM_{10} Maintenance Plan, effective on 11/25/2005, reinstates the prevention of significant deterioration (PSD) permitting requirements in the Lamar Attainment/Maintenance area. The federal PSD requirements apply to new or modified major stationary sources which must utilize "best available control technology" (BACT).

Federal Motor Vehicle Emission Control Program (FMVECP)
The FMVECP has reduced PM_{10} emissions through a continuing process of requiring diesel engine manufacturers to produce new vehicles that meet tighter and tighter emission standards. As older, higher emitting diesel vehicles are replaced with newer vehicles through fleet turnover; tailpipe PM_{10} emissions in the Lamar area will be further reduced.

Voluntary and State-Only Measures
Additional activities in Lamar that result in the reduction of PM_{10} emissions include:

- The City of Lamar has historically cleaned their streets in town throughout the winter and spring using street sweepers. The frequency of this voluntary effort is determined by weather. In October 2013, the Public Works Director informed APCD that the streets are swept on a weekly basis unless there is snow on the streets.
- The City of Lamar and immediately surrounding areas require that new developments have paved streets. In October 2013, the City's Planning Commission is been working on making this an official city ordinance. In the past, it has been required despite the lack of official rule.

State Implementation Plan Measures
Any owner or operator responsible for the construction or maintenance of any existing or new unpaved roadway which has vehicle traffic exceeding 200 vehicles per day in the Lamar attainment/maintenance area and surrounding areas must stabilize the roadway in order to minimize fugitive dust emissions. These statewide requirements are defined in detail in the AQCC's Regulation No. 1 as listed in Table 34.

City of Lamar

The City of Lamar has been very proactive in addressing potential PM10 sources within the Lamar area including the application of grass turf at baseball fields, implementing and enhancing a street sweeping program, and chip-seal paving of many unpaved roads. The City of Lamar - Public Works Department has implemented the following BACM controls within the area:

1. *Wind Break*
Beginning in the spring of 1997, a wind break of trees was planted north of the Power Plant monitoring site (080990001). The Russian Olive tree wind break is located approximately one half mile north of the Power Plant monitoring site and will block potential contributing blowing dust sources such as the Lamar Transfer Station and other unpaved equipment traffic areas to the north. The Russian Olive is a quick growing large shrub/small tree that thrives despite the semi-arid and windy climate of Lamar. In October 2013, the Public Works Director stated that most of the trees were still alive and in place. According to section 3.5.2.1 of EPA guidance entitled "*Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures*", dated September 1992, one-row of trees is considered an effective windbreak.

In addition to the tree wind breaks, a drip irrigation system has been installed to promote sustained tree growth. In October 2013, the Public Works Director stated that the drip system was still operational but due to the drought the City has been on strict water restrictions.

2. *Landfill Controls*

The East Lamar Landfill is located approximately six (6) miles east of the city limits. The landfill has a CDPHE Permit (#09PR1379) which specifies that visible emissions shall not exceed twenty percent (20%) opacity during normal operation of the source and that fugitive PM_{10} cannot exceed 5.77 tons per year. The permit also contains a Particulate Emissions Control Plan that states that:

- No off-property transport of visible emissions shall apply to on-site haul roads.
- There shall be no off-property transport of visible emissions from haul trucks.
- All unpaved roads and other disturbed surface areas on site shall be watered as often as needed to control fugitive particulate emissions.
- Surface area disturbed shall be minimized.
- Exposed land areas to be undisturbed for more than six months shall be revegetated.

According to section 3.5.1 of the "Operations and Closure Plan for the East Lamar Landfill", the Director of the Public Works Department and/or the landfill operator is required to do the following litter control measures under high wind conditions:

- Soil cover is required to be placed on the working face of the landfill daily during periods of wind in excess of 30 mph; and,
- The landfill must be closed down when sustained winds reach 35 mph or greater.

An on-site wind gauge monitors wind speed at the landfill. Operators have radios in their equipment connecting them with the main office so that when the decision to close the landfill is made, it can take place immediately. According to the Director of Public Works, landfill operators have been directed to close the landfill at their discretion. Because trash debris (paper) begins to lift and blow into the debris fences at wind speeds of 25 to 30 mph, the operator usually closes the landfill prior to wind speeds reaching 30 mph. The City of Lamar has agreed to make the closure of the Lamar landfill mandatory when wind speeds reach 30 mph, which reduces windblown dust from the landfill as earth moving activities are reduced or eliminated during periods of shut down. In October 2013, the Public Works Director stated that all of these practices were still being enforced.

In addition, the placement of chain link fencing and various debris fences have been added to the previous litter entrapment cage. These additional fences better minimize the release of materials during high wind conditions. According to the Public Works Director, this is a dynamic process; as the debris move, the fences are moved too.

3. *Vegetative Cover/Sod*

The Lamar Recreation Department installed 100,000 square feet of turf sod at a recreational open space called Escondido Park in the early 2000s. Escondido Park is located in northwest Lamar at 11th and Logan Streets. A sprinkler system has also been installed by the Parks and Recreation Department. The sod provides a vegetative cover for the open area. This dense turf cover provides an effective control against windblown soil from the open area of the park.

In addition, the Lamar Public Works Department stabilizes the entrance road leading to and from Escondido Park with chemical soil stabilizer and chip-seal to reduce dirt tracked out onto city streets and minimize additional releases of PM_{10}. This is done on an as needed basis.

4. *Additional Public Works Projects*

The Public Works Department implemented the following projects to further reduce emissions of PM_{10}:

- The purchase of a TYMCO regenerative air street sweeper (May 2001) which is much more effective in reducing dust during street sweeping activities. The use of this sweeper allows for improved cleaning of the streets (e.g., sweeps the gutter and street);
- The fencing of an area around the City Shop at 103 North Second Street in 2011 to reduce vehicle traffic that may be responsible for lifting dust off of the dirt area between the railroad tracks and the Shop;
- The stabilization of a large dirt and mud hole in 2008 on the north side of the City Shop by installing a curb and gutter that allows for better drainage. This project is credited with keeping mud from being tracked out into the street and becoming airborne by vehicular traffic;
- The ongoing commitment to search for other stabilization projects that benefit the community and improve area air quality, and;
- The relocation of the Municipal Tree Dump in the early 2000s (formerly located in the northeastern corner of the city) to approximately six miles east of the city (now housed at the Municipal Landfill). This relocation eliminates a major source of smoke from agricultural burns that may have previously affected the community.

Regulatory Measures - City

Lamar has an ordinance that requires that all off-street parking lots shall have a dust-free surface to control PM_{10} emissions (City of Lamar Charter and Code, ARTICLE XVII, Sec. 16-17-60).

Burlington-Northern/Santa Fe Rail Line

The rail line running east-west of the Lamar Power Plant monitoring site was deemed to be an important PM_{10} source during conditions of high winds and low precipitation. Ground disturbance from vehicle traffic, which damages vegetation and breaks-up the hard soil surfaces, resulted in re-entrainment of dust from traffic, high winds or passing trains. This area is problematic in the two block area immediately west of the Power Plant monitoring site as shown in Figure 121 as Site F. Control of this open area requires a close working agreement between the Burlington-Northern/Santa Fe Railroad Company (BNSF) and the City of Lamar Public Works Department. The purpose of this BACM is to reduce the amount of particulate matter susceptible to wind erosion under high wind conditions and general re-entrainment of dust in the ambient air as a result of local train traffic passing in close proximity of the PM_{10} monitor.

In September 1997, the City chemically stabilized exposed lands north of the rail line between Fourth and Second Street where there was evidence of vehicle traffic. All other lands on either side of the rail road tracks between Main Street (Fifth) and Second Street and extending westward have either natural, undisturbed ground cover or it is used for commercial/recreation purposes that do not allow for significant re-entrainment (BNSF is responsible for maintaining 50 feet of property on either side of the main track). Most of these lands are leased by the City. After September 1997, the City negotiated the lease of these lands. Once acquired, a long term plan will be developed for these lands such as restricting vehicle access, permanently stabilizing lands with vegetation and gravel, increasing park and recreational use, and using the lands for city maintenance and storage activities. In October 2013, the Public Works Director stated that gravel is periodically added to minimize blowing dust.

According to the Manager of Environmental Operations for BNSF, the railroad company owns the main rail line and 200 feet on either side of the track. Much of this property has been sold or leased under private contracts. At this time BNSF is responsible only for the main rail line and for 50 feet of property on either side of the main track. All property sold or under contract is not the responsibility of BNSF. As a result, BNSF has stabilized the railroad corridor 50 feet on either side of the main rail line.

In May 1997, BNSF placed chips (gravel) 50 feet on either side of the main track from Main Street to Second Street (three blocks) to control fugitive dust emissions from this section of the track. Graveling exposed surfaces not exposed to regular vehicle traffic is considered a permanent mitigation measure. Details of this arrangement can be found in the documentation under the 1998 SIP Maintenance Plan submittal.

<u>Prowers County</u>

Prowers County Land Use Plan:

Beginning in 1997, Prowers County with the assistance of local officials, environmental health officers and the general public began preparing a county land use plan. The Prowers County Land Use Plan is designed to have wide-reaching authority over the myriad of land use issues involving building (construction sites), siting, health, fire, environmental codes, and other social concerns associated with the City of Lamar and Prowers County. The county land use plan, entitled "*Guidelines and Regulations for Areas and Activities of State Interest – County of Prowers – State of Colorado*", was adopted on April 19, 2004 and amended on August 17, 2006. The plan incorporates provisions to minimize airborne dust including re-vegetation of disturbance areas associated with land development. The Prowers County Land Use Master Plan can be found on the County's website at: http://www.prowerscounty.net.

Regulations and ordinances of the Land Use Plan specific to reducing blowing dust and its impacts include:

- Additional regulations on development of fragile lands and vegetation to protect topsoil;
- Development of performance standards and best management practices to prevent soil erosion;
- Development of best management practices to reduce blowing sands and movement of area sand dunes across the county;
- Development of new special use permits to address the siting of animal feedlots and feed yards;
- Development of special use permits for other future stationary sources. The special use permits will also likely include the requirement for comprehensive fugitive dust control plans for both construction and operation of facilities;
- Consideration and review of enforcement capabilities through the area zoning ordinances, and;
- Planned public review and comment processes following the legal update of the draft County Land Use Plan.

Windblown Dust from Disturbed Soils

The City of Lamar is located in Prowers County in southeastern Colorado. Situated along the Arkansas River and near the Kansas border, Lamar serves as the largest city and the agricultural center for southeast Colorado. The area surrounding Lamar consists of gently rolling to nearly level uplands where the dominant slopes are less than 3 percent. The climate is generally mild and semiarid. Annual precipitation is about 15 inches. Summers are long and have hot days and cool nights. In winter and spring, windstorms are common, especially in drier years. It is due to these high velocity dust storms and drought conditions that Lamar experiences most of the PM_{10} problems for the area. Figure 120 through Figure 145 illustrate potential areas of local soil disturbance that have been evaluated by the APCD for the Lamar Municipal PM_{10} monitor (08-099-0002).

5.3 Potential Areas of Local Soil Disturbance North of Lamar

Figure 120: North of Lamar Municipal PM_{10} monitor. (Google Earth 2012)

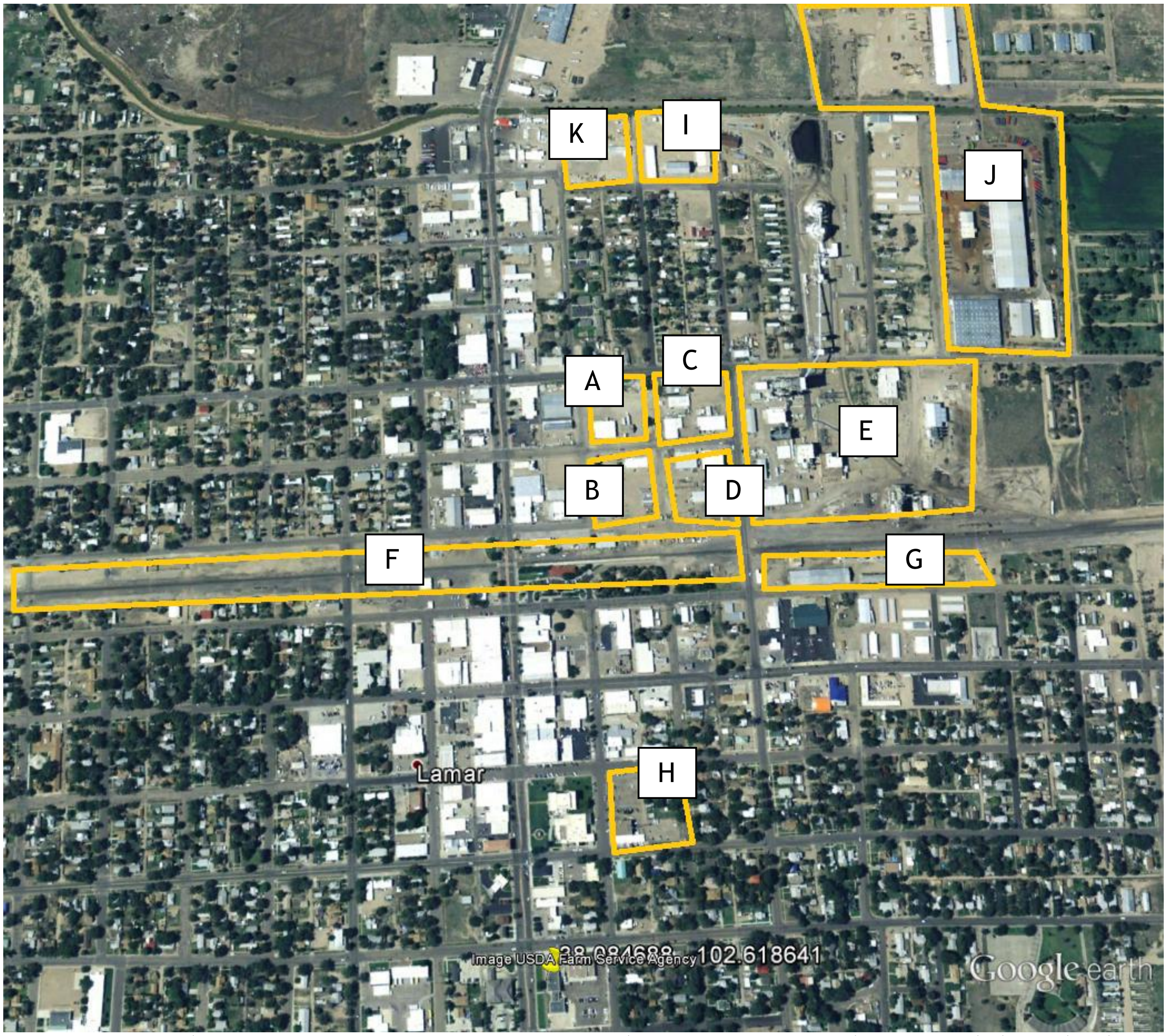

Figure 121: Relative positions of Lamar Municipal PM_{10} Monitor and potential disturbed soil. (Google Earth 2012)

Site A in Figure 121 is west of the Lamar PM_{10} monitor at 200 N 4th Street. This site is owned by “Heath & Son & Turpin Trucking”, a company that repairs large trucks and shared with “HVH Transportation Inc”, a freight service trucking company. The site consists of well maintained gravel. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by a small business to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site B in Figure 121 is west of the Lamar PM_{10} monitor. The site is shared by a few businesses. All businesses have restricted access by fences surrounding the property. “Cowboy Corral Storage” at 102 North 4th Street is one of the businesses on the lot. It has a very small gravel parking lot and is no longer in business according to the previous owner as of October 2013. The storage company has a small gravel parking lot with access being restricted by a security fence as shown in Figure 122. The lot is also shared with the “Prowers Area Transit” county bus garage. The bus garage is very small, with only four bays. The garage has a concrete slab that runs to the asphalt road to avoid the busses driving on the gravel in order to mitigate fugitive dust. The gravel lot is watered on an as-needed basis. The other business is an old feed supply company with grain storage as shown in Figure 123. The feed supply company is out of business and the grain elevators are not being utilized. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple small businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 122: Site B - Cowboy Corral Storage (Google Image 2012)

Figure 123: Site B - Feed Storage Company (Google Image 2012)

Site C in Figure 121 is west of the Lamar PM_{10} monitor at about 201 N 2^{nd} Street. The gravel parking lot on site is owned by "Heath & Son & Turpin Trucking" and is shown in Figure 124. The lot is used to store trucks when not in use. This site consists of well maintained gravel. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by a small business to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 124: Site C - Heath & Son & Turpin Trucking Storage Lot (Google Image 2012)

Site D in Figure 121 is west of the Lamar PM_{10} monitor at about 103 North 2^{nd} Street. It is the "Lamar Water Department". Also on site D is the "Lamar-Prowers County Volunteer Fire Department" at 300 E Poplar Street. Both sites have restricted access with security fences. The City of Lamar maintains their gravel lots by grating and watering them on an as needed basis. The APCD considers maintained gravel, limited access, grating, and watering to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple small businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site E in Figure 121 is the power plant that the Lamar PM_{10} monitor is located within at100 North 2nd Street. "Lamar Light and Power" historically operated a natural gas-fired boiler that produced steam for a 25 MW turbine/generator set. This boiler was constructed prior to 1972 and was grandfathered from construction permitting requirements. In the early 2000s, factors such as increasing costs of natural gas made the plant uneconomical to run. As a result, Lamar Light and Power purchased power and ran the natural gas-fired boiler very infrequently or not at all. In February 2006, APCD issued a permit for Lamar Light and Power to replace the existing natural gas-fired boiler with a coal-fired circulating fluidized bed (CFB) boiler rated at approximately 42 MW. The conversion prompted legal challenges from Lamar residents partnered and WildEarth Guardians, a New Mexico-based environmental group. Lamar Light and Power settled and agreed to shut down the coal-fired power plant. The power plant was shut down on November 11, 2011. The settlement also calls for the plant to stay offline until at least 2022, when the current agreement to supply electricity to Lamar and other communities expires.

"Lamar Light and Power" has an air quality permit (CDPHE # 05PR0027). The permit includes the following point and fugitive dust control measures:

- Limestone and ash handling, processing, and storage are controlled by high efficiency baghouses.
- Water wash-down-systems are used for flushing down any accumulated dust on walkways, platforms, and other surfaces to prevent re-entrainment of the dust into the atmosphere.
- On-site haul roads are paved, and these surfaces are inspected at least once each day in which hauling activities occur, and cleaned as needed. Various cleaning methods are used depending on the extent of dust accumulations. These activities emit less than 1 ton per year of PM_{10} and are APEN Exempt.
- All transport vehicles containing substances that potentially generate fugitive particulate matter emissions (such as trucks containing limestone, inert material, or ash) are fully enclosed, or covered with a mechanical closing lid or a tight tarp-like cover at all times while on the facility grounds except during loading / unloading operations.
- Emissions from emergency coal stockpile are effectively controlled with a water dust suppression system.

Access to the power plant is restricted by security fences. The APCD considers the enforceable conditions of the permit, including identified Best Available Control Technology (BACT) for limestone and ash handling, paving, wash-down systems, and enclosures, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. The winds speeds during the 2013 events did exceed the blowing dust thresholds of 30 mph or greater and gusts of 40 mph or greater at which the APCD expects stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed.

Site F in Figure 121 is the Burlington Northern Santa Fe railroad that runs past the Lamar PM_{10} monitor to the south. On either side of the rail road tracks is gravel as shown in Figure 125. In May 1997, Burlington Northern Santa Fe placed chips (gravel) 50 feet on either side of the main track from Main Street to Second Street (three blocks) to control fugitive dust emissions from this section of the track. Graveling exposed surfaces not exposed to regular vehicle traffic is considered a permanent mitigation measure. Also, all the train tracks are raised up on 3 inch diameter rock and tracks. Areas that are not used by the railroad are allowed to be naturally vegetated with Xeriscape. With regard to AQCC Regulation 1 requirements (Section III.D), the APCD considers gravel and 'Xeriscape' vegetation to be the appropriate available and practical method that is technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this type of source.


Figure 125: Site F - Railroad tracks with gravel on each side (Google Image 2012)

Site G in Figure 121 is Colorado Mills LLC a facility that produces sunflower oil and processes the leftover solids combined with grains and additives into feed that used locally for cattle and hogs. APDC issued the initial permit 95PR622 for this facility in 1996 to Cargill, Inc. A final approval permit and two transfers of ownership have since been issued in 1997, 1999 and 2000 respectively and the facility is now owned and operated by Colorado Mills, LLC. The permit includes the following point and fugitive dust control measures:

- Visible emissions shall not exceed 20% opacity during normal operations and 30% opacity at all other times.
- Permit limits on Particulate Matter.
- Requirement to follow the developed Operation and Maintenance plan.

This Facility was inspected by the APCD on 2/14/2012 and no visible emissions were observed. Records review revealed that Colorado Mills has been in compliance with their permitted emission limits. An Operating and Maintenance Plan was submitted to the APCD for this facility on November 21, 1996 and approved by the APCD on December 24, 1996. The General Manager of the facility stated during the inspection that Colorado Mills conducts monthly inspection and maintenance on process and control equipment at the facility and no evidence was observed during the inspection to suggest that process and control equipment at the facility are not operated and maintained in a manner consistent with good air pollution control practices for minimizing emissions. Additionally, particulate emissions from oil extraction activities, grinding of grains, extruding and materials conveyance are controlled by several cyclones. The APCD considers the enforceable conditions of the permit, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Site H in Figure 121 is southwest of the Lamar PM_{10} monitor. It is located at about 356 South 4th Street. Part of the property is owned by Century Link. Century Link has a storage lot for fleet vehicles that is well maintained gravel. Access to the storage lot is restricted by a fence as shown in Figure 126. A large part of site P is a free public gravel parking lot for the Prowers County Jail and the Prowers County Municipal Court as shown in Figure 127. The lot is maintained by the County. The parking lot is chip sealed and covered in crushed gravel. Site P, as shown in Figure 126, has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years, is in an economic recession, and is owned by multiple businesses to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 126: Site H - Century Link Fleet Storage Lot (Google Image 2012)

Figure 127: Site H - Parking lot for the Prowers County Jail and the Prowers County Municipal Court (Google Image 2012)

Site I in Figure 121 is located to the north of the Lamar Power PM_{10} monitor on the northeast corner of Washington St and 4th St. Site I is at 310 E. Washington Street. The site used to be "Big R Warehouse" but is currently owned by Prowers County and is rented out to the Colorado State Patrol for office space. The lot is covered in gravel for dust suppression, drainage, and erosion control. Within the lot, vehicle speeds are restricted to 5 mph. Access to the lot is restricted by a chain link fence. The lot is watered on an as needed basis. Site I, as shown in Figure 128, has reasonable dust control measures in place with regard to AQCC

Regulation 1 requirements (Section III.D.1(a)). The APCD considers restricted vehicle speeds in combination with maintained gravel and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 128: Site I - 310 E. Washington St., Lamar (Google Image 2012)

Site J in Figure 121 is located to the north of the Lamar Power PM_{10} monitor. Site J is "Ranco", a heavy duty construction trailer manufacturing company located at 700 Crystal St. All of the property owned by Ranco is pavement, gravel, or natural vegetation. The company informed CDPHE that there are no unnatural, disturbed, areas of dirt on the property that could contribute to the issue of blowing dust. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site K in Figure 121 is Valley Glass, located at 201 E. Washington Street. Valley Glass does commercial and residential glass work including storefronts, windows, siding and railings. The property has restricted access and a well maintained gravel parking area, as shown in Figure 129. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 129: Site K - Valley Glass, 201 E. Washington St., Lamar, CO (Google Image 2012)

Figure 130: Relative positions of Lamar Municipal PM_{10} Monitor and potential disturbed soil (further north). (Google Earth 2012)

Site L in Figure 130 is located to the northwest of the Lamar Power PM_{10} monitor. Site L is "All-Rite Paving and Redi-Mix Inc" at 200 Speculator Ave. This is a concrete batch plant with a permit from CDPHE (#12PR1396). However, this facility is considered APEN exempt and emits less than 1 ton per year of PM_{10}. This facility has a PM baghouse collection efficiency of 99%. Water spray and magnesium chloride is used on storage piles and all unpaved roads as needed. The unpaved roads at site L are covered with gravel and the vehicle speed is restricted to 10 mph at all times. The transfer of aggregate to storage bins and trucks is entirely conducted in enclosed areas. All aggregate is washed prior to storage in order to reduce dust emissions. The APCD considers the enforceable conditions of the permit, including identified continuous controls such as gravel roads with miles per hour restrictions and enclosures, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. The winds speeds during the 2013 events did exceed the blowing dust thresholds of 30 mph or greater and gusts of 40 mph or greater at which the APCD expects stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed.

Site M in Figure 130 is mined by "Carder Inc" and is located to the northwest of the Lamar Power PM10 monitor. Carder Inc mines for sand and gravel primarily for road construction. This site has a permit from CDPHE (#99PR0180F) and emits approximately 15 tons per year of PM_{10}. This is a wet mining operation so it produces minimal fugitive dust. The dust control measures that are part of the permit include watering the disturbed area as needed, re-vegetation within one year of disturbance, compacting of piles, mining moist materials, vehicles cannot exceed 10 mph on site at all times, and temporary roads are covered with gravel and watered as needed. The APCD considers the enforceable conditions of the permit, including identified continuous controls such as gravel roads with miles per hour restrictions, compaction, re-vegetation, watering, and extraction limitation, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. The winds speeds during the 2013 events did exceed the blowing dust thresholds of 30 mph or greater and gusts of 40 mph or greater at which the APCD expects stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed.

Site O in Figure 130 is located to the north of the Lamar Power PM10 monitor. Site O is mined by "All-Rite Paving and Redi-Mix Inc" at 1 Valco Road. This is a concrete batch plant with a permit from CDPHE, (#85PR108). However, this facility is considered APEN exempt and emits less than 1 ton per year of PM_{10} This facility has a PM baghouse collection efficiency of 99%. Visible emissions from this source shall not exceed 20% opacity. Water sprays and magnesium chloride are used on storage piles and all unpaved roads as needed. The unpaved roads at site O are covered with gravel and the vehicle speed is restricted to 10 mph at all times. The transfer of aggregate to storage bins and trucks is entirely conducted in enclosed areas. All aggregate is washed prior to storage in order to reduce dust emissions. Access to the site is restricted by a fence. The APCD considers the enforceable conditions of the permit, including identified continuous controls such as gravel roads with miles per hour restrictions and enclosures to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. The winds speeds during the 2013 events did exceed the blowing dust thresholds of 30 mph or greater and gusts of 40 mph or greater at which the APCD expects stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed. Additionally, the City of Lamar took over the concrete plant in the spring of 2013 and is in the process of reseeding it and turning the site into a park for fishing and wildlife with motorized vehicles being prohibited. The City of

Lamar and the Colorado Division of Parks and Wildlife are partners in this effort.

Site P in Figure 130 is Ranchers Supply Co., Inc. at 400 Crystal Street. The company started in 1961 and their products include used trucks, construction equipment, military vehicles, new and used trailers and other government surplus items. The property is used for inventory storage. To control fugitive dust emissions, onsite vehicle speeds are restricted to 10 mph. The owner states that 90% of the lot is covered in well maintained gravel. The site is watered down on an as needed basis to mitigate dust to protect assets and for pollution prevention. Also, all of the large equipment also acts as a wind block. Access to the site is restricted by a security fence. Site P, as shown in Figure 131, has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers restricted vehicle speeds in combination with maintained gravel to be the appropriate available and practical method that is technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this storage site.

Figure 131: Site P - Ranchers Supply Co., Inc. (Google Image 2012)

Site Q in Figure 130 is located to the north of the Lamar Power PM_{10} monitor. Site Q is "Ranco", a heavy duty construction trailer manufacturing company located at 700 Crystal St. All of the property owned by Ranco is pavement, gravel, or natural vegetation. The company informed APCD that there are no unnatural, disturbed, areas of dirt on the property that could contribute to the issue of blowing dust. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site R in Figure 130 is located to the north of the Lamar Power PM_{10} monitor. Site R is C.F. Maier Composites Inc. at 500 East Crystal Street. This 57,000 square foot facility has been operating since 1990 and specializes in highly difficult fiber reinforced composites and OEM component application. C.F. Maier offers product design, development, prototype and full production of reinforced composite parts for high stress or high impact uses. The company has a paved parking lot. The rest of the lot is covered in natural vegetation. There is a short (200 ft.) well maintained gravel road that leads up to the loading dock that gets used on average one a day. Site R has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers restricted maintained gravel and natural vegetation to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site S in Figure 130 is located to the north of the Lamar Power PM_{10} monitor on the northeast corner of Washington St and 4th St. Site S is at 201 E Washington St. The site used to be "Big R Warehouse" but is currently owned by Prowers County and is rented out to the Colorado State Patrol for office space. The lot is covered in gravel for dust suppression, drainage, and erosion control. Within the lot, vehicle speeds are restricted to 5 mph. Access to the lot is restricted by a chain link fence. The lot is watered on an as needed basis. Site S, as shown in Figure 130, has reasonable dust control measures in place with regard to AQCC Regulation 1 requirements (Section III.D.1(a)). The APCD considers restricted vehicle speeds in combination with maintained gravel and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site T in Figure 130 is Lamar Feed and Grain – White Stone Farms located at 110 Anderson St., Lamar, CO. This animal feed mill was purchased by Wells Fargo Bank in October 2009 and combined with 207 Anderson St., which Wells Fargo Bank foreclosed on in 7/2008. Wells Fargo reported that the mill had not operated for several years and would not be operated under the ownership of Wells Fargo Bank. In September 2011, the property was purchased by Lamar Feed and Grain, LLC and recommenced operations. The facility consists of a grain receiving pit, a grain shipping truck loadout station, grain storage, a grain cleaning scalper, and grain handling and milling systems. In November 2000, APCD issued the initial permit for this source (00PR0431) and at the time of this event, Lamar Feed and Grain, LLC was operating under the Final Approval permit issued on 7/21/2006. The permit includes the following point and fugitive dust control measures:

- Total PM, PM_{10} and $PM_{2.5}$ annual emissions limitations.
- Visible emissions cannot exceed 20%.
- All equipment must be maintained and operated in a manner consistent with good air pollution control practices for minimizing emissions.
- The feed mill must be equipped with a mineral oil spray system for the control of PM emissions.

The APCD considers the enforceable conditions of the permit, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. The winds speeds during the 2013 events did exceed the blowing dust thresholds of 30 mph or greater and gusts of 40 mph or greater at which the APCD expects stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed.

Site U in Figure 130 is Dragon ESP, located at 700 East Crystal Street. This equipment manufacturing facility commenced operation in 1993 and was combined with the Ranco Trailers facility in 2011. The APCD issued a joint permit for these facilities (08PR0603) on 12/21/2011 which consist of paint booths and abrasive blasting units. The permit includes the following point and fugitive dust control measures:

- Permitted annual TSP, PM_{10} and $PM_{2.5}$ emission limits.
- High Volume Low Pressure paint spray guns or other APCD-approved surface coating method must be used to meet PM emission limits.
- Paint spray booths shall be equipped with exhaust filters or paint arresters to control PM emissions and shall be maintained per manufacturer's recommendations.

- Blasting operations shall be done in a complete enclosure with baghouse filters to control PM emissions and blasting shall be done with doors closed. The baghouse shall be maintained per manufacturer's recommendation.
- Visible emissions shall not exceed 20% during normal operations.
- Source must follow the APCD approved O&M plan.

The facility was last inspected on 11/9/2011 and was found to be in compliance with all the permitted conditions. The APCD considers the enforceable conditions of the permit, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Site V in Figure 130 is restricted access property that lies south of State Highway 196 and north of the Arkansas River, East of Highway 287. The land is naturally vegetated and undisturbed as shown in Figure 132. Figure 132 demonstrates that this site has minimally (if any) disturbed soil as of this writing. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 132: Site V (Google Image 2012)

Site W in Figure 130 are rotating crop fields located south and west of U.S. Highway 287/U.S. Highway 50. As shown in Figure 133 and Figure 134, the crops in these fields are rotated from year to year, allowing fields to lay fallow between plantings.

Figure 133: Site W – Rotating crop fields, 6/2005. (Google Earth 2005)

Figure 134: Site W – Rotating crop fields, 8/2011. (Google Earth 2011)

Site X in Figure 135 is the Robins Redi-Mix Concrete Batch Plant located at 7355 State Highway 196, approximately 4.5 miles north of the Lamar Municipal PM_{10} site. This batch plant opened in the spring of 2010 and consists of a dry truck mix plant that utilizes a cement and a dry ash silo each of which are operated with pneumatic conveyors and bag houses for the control of emissions. According to Robins Redi-Mix, the bag houses control 98% of the emissions. In April 2010, APCD issued a permit exempt letter for this source (10PR1310.XP). The permit includes the following point and fugitive dust control measures:

- Uncontrolled total PM cannot exceed 10tpy and uncontrolled PM_{10} cannot exceed 5tpy.
- Visible emissions cannot exceed 20%.

In addition to these permitted requirements, the source reported in their application that they moisten materials throughout their processes and prior to transferring on an as needed basis and have placed gravel on the road to minimize emissions. The APCD considers the enforceable conditions of the permit, including identified Best Available Control Technology (BACT) for limestone and ash handling, paving, wash-down systems, and enclosures, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site. The winds speeds during the 2013 events did exceed the blowing dust thresholds of 30 mph or greater and gusts of 40 mph or greater at which the APCD expects stable surfaces (i.e., controlled anthropogenic and undisturbed natural surfaces) to be overwhelmed.

Figure 135: Site X - "Robins Redi-Mix Concrete Batch Plant", 7355 State Highway 196 Lamar (Google Earth 2012)

5.4 Potential Areas of Local Soil Disturbance South of Lamar

Figure 136: South of Lamar Municipal Building PM_{10} monitor. (Google Image 2014)

Figure 137: South of Lamar Municipal PM_{10} Monitor (~1mile) (Google Image 2014)

Site AA in Figure 137 is south of the Lamar PM_{10} monitor at 1105 Parkview Ave. The site is Parkview Elementary School and includes a gravel playground as shown in Figure 138. This site consists of a well maintained gravel yard that is surrounded by a fence to restrict access. Trees have also been planted around the parameter of the school yard, further reducing the potential for dust (Figure 138).The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years and is in an economic recession to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Figure 138: Site AA - Parkview Elementary School (Google Image 2012)

Site BB in Figure 137 is a large parking area for several businesses along South Main Street on both sides of Lee Ave. Most of the area is paved as shown in Figure 139. There is a small area of land in the middle of the parking area that is unpaved but this area is covered in weeds (see arrow in Figure 139).

Figure 139: Site BB - Parking area (Google Image 2012)

Site CC in Figure 137 is an undeveloped area behind several businesses east of Main Street and south of Forrest Street. The land is cordoned off from traffic through a barricade as shown in Figure 140 which restricts access to the area and the land behind the barricade is vegetated with weeds and grasses.

Figure 140: Site CC - Undeveloped area (Google Image 2012)

Site DD in Figure 137 is south of the Lamar PM_{10} monitor. It is located at approximately 106 Savage Ave. This parking lot has been paved over and is not a source of PM_{10}.

Figure 141: South of Lamar Municipal PM_{10} Monitor (~2mile) (Google Image 2014)

Site GG in Figure 141 is Country Acres RV Park located at 29151 US Highway 287. The park has well maintained gravel and Country Acres personnel reported that they have also purchased and put down recycled blacktop to help with dust suppression. The APCD considers maintained gravel and limited access to be the appropriate available and practical method for a small site of this size in this area of Colorado that has been designated a drought area for years and is in an economic recession to be technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site HH in Figure 141 is Lamar Community College's Equine Complex located south of the main campus on US Highway 287. The facility is well maintained and fenced to restrict access.

Site II in Figure 141 is the Lamar Ball Complex at approximately 100 Savage Street, which has limited access through fencing. These fields are used by the Lamar Community College but owned and maintained by the city of Lamar. City personnel reported that they have brought rotamilling and pea gravel in to help with dust control. Rotamilling is ground up asphalt that has been spread across parts of the parking areas and much of the open areas around the fields consist of pea gravel. The city will also drag the parking areas and apply water as needed for dust. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site. The fields are turf and regularly watered as shown in Figure 142. This complex is well maintained by the City and implements reasonable dust control measures on a regular basis.

Figure 142: Site II - Lamar Ball Complex (Google Image 2012)

Site JJ in Figure 141 is the Prowers County Fairgrounds located at 2206 Saddle Club Drive. The land is maintained by the county and is grated annually and watered frequently during most of the year. County personnel reported that the facility is frequently used from April to September and watered as needed during these times. The APCD considers pavement, maintained gravel, natural vegetation, and restricted access to be the appropriate available and practical methods that are technologically feasible and economically reasonable in order to minimize fugitive particulate emissions for this site.

Site KK in Figure 141 is restricted access property located just south of the Fort Bent Canal and east of Memorial Drive. The land is naturally vegetated and undisturbed, as shown in Figure 143.

Figure 143: Site KK (Google Image 2012)

Site LL in Figure 144 is the Prowers County Walker Pit North located approximately 6 miles south east of the Lamar PM_{10} monitor, south of County Road CC and County Road 10. This site is a sand and gravel production facility for which APCD issued a permit exemption letter for on 7/6/2010 (09PR0038F.XP). The permit exemption letter includes the following point and fugitive dust control measures:

- Comply with the developed dust control plan.
- Comply with production rate limit.

This facility was inspected by the Colorado Division of Reclamation, Mining and Safety Minerals Program on 3/29/14 and was found to be in compliance. The inspector commented that previous disturbed areas will be reclaimed to rangeland and that “native grasses, forbs and cottonwood trees have volunteered throughout the site”. Photos from of the site (Figure 145) indicate that the area is fenced and marked with a “No Trespassing” sign to restrict access and much of the land has been reclaimed by natural vegetation. The APCD considers the enforceable conditions of the permit, to be technologically feasible and economically reasonable for a facility of this size in order to minimize fugitive particulate emissions for this site.

Figure 144: Site LL – (approximately 6 miles from Lamar Municipal PM_{10} Monitor) - Prowers County – Walker Pit North (Google Image 2014)

Figure 145: Site LL - Walker Pit (Images from Colorado Division of Reclamation, Mining and Safety Minerals Program Inspection Report on 3/29/14)

The APCD conducted thorough assessments to determine if the potential soil disturbances shown in Figure 120 through Figure 145 were present during the 2013 exceedances in Lamar. During the course of these assessments, the APCD discovered that these sites were either reasonably controlled or considered to be natural sources during the 2013, high wind events. Therefore, these sites were not significant contributors to fugitive dust in the Lamar area during the 2013, high wind events.

Colorado State University CO-OP Extension Office

While the following initiatives are not meant to be enforceable, the CSU Co-Op Extension Office has many efforts underway that further reduce blowing dust and its impacts. These include:

- Crop residue efforts that encourage no- or low-till practices. These have been deemed appropriate and useful in reducing blowing dust.
- Ongoing outreach efforts to educate area agricultural producers on soil management programs. These include one-on-one visitations and annual meetings with various corn and wheat programs to discuss crop management.
- Drought workshops to protect topsoil throughout the county.

USDA: Natural Resources Conservation Service (NRCS)

1. *Conservation Reserve Program*

Prowers County is a predominately agricultural area that is made up of 1,048,576 acres of land area – 1,021,915 acres (or 97.5%) of which is land in farms.[2] For comparison, Baca County to the south is 91.9% land in farms, Bent County to the west is 75.0% land in farms, and Kiowa County to the north is 98.4% land in farms. It should be noted that cropland percentage in Bent County is lower than other Southeast Colorado counties at 11%. Figure 146 illustrates the counties of Southeast Colorado. Of the farm land acreage in Prowers County, cropland accounts for approximately half of the total (480,487 acres) and is approximately 46% of the total land in the county. Water, and often the lack of it, coupled with the frequent high winds experienced during late fall and early spring commonly destroy crops, encourage pests, and damage soil surfaces lending them susceptible to wind erosion, especially in recent drought years. Prowers County was classified as being in severe drought in November 2010 and remained so until July 2012 when the county was reclassified as being in an exceptional drought. Prowers County returned to being in a severe drought in October 2014 and remains in this classification. The majority of Prowers County cropland acreage is farmed using dryland practices (versus irrigated) and consists of soils classified as highly-erodible-land (HEL) by the Department of Agriculture.

[2] 2012 Census of Agriculture. Volume 1, Chapter 2: County Level Data. U.S. Dept. Of Agriculture, National Agricultural Statistics Service.

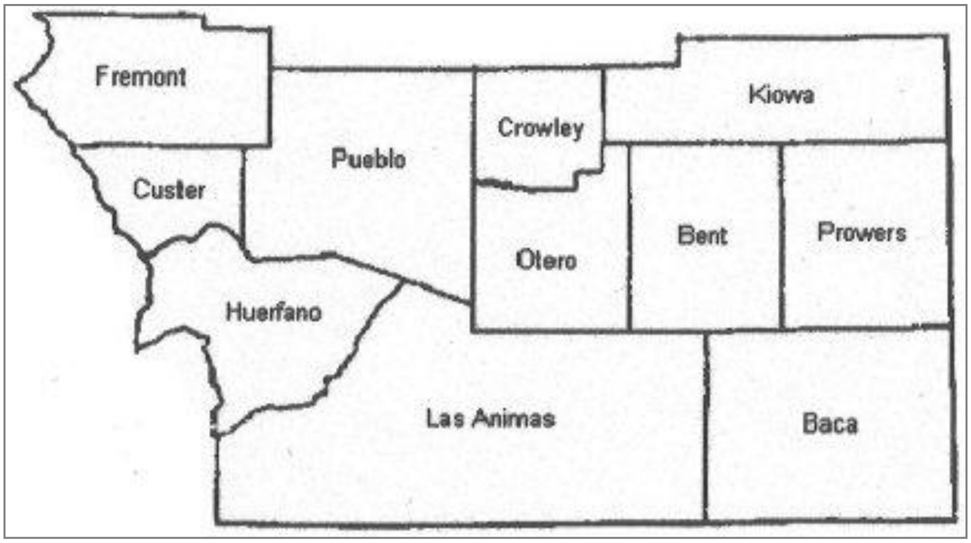

Figure 146: Southeast Colorado Counties

Recognizing the problems associated with erodible land and other environmental-sensitive cropland, the U.S. Department of Agriculture (USDA) included conservation provisions in the Farm Bill. This legislation created the Conservation Reserve Program (CRP) to address these concerns through conservation practices aimed at reducing soil erosion and improving water quality and wildlife habitat.

The CRP encourages farmers to enter into contracts with USDA to place erodible cropland and other environmentally-sensitive land into long-term conservation practices for 10-15 years. In exchange, landowners receive annual rental payments for the land and cost-share assistance for establishing those practices.

The CRP has been highly successful in Prowers County by placing approximately 155,611 acres of Prowers County cropland, or 32% of total cropland, under contract. Most of this land has been planted with a perennial grass cover to protect the soil and retain its moisture.

While the following initiatives are not meant to be enforceable, many efforts are underway that further reduce blowing dust and its impacts. These include:

- The CRP has moved to include all available area lands into area contracts. These contracts are good through 2007. Success of the CRP initiatives is measured through ongoing monitoring of the contracts to ensure ample grass coverage to minimize blowing dust.
- CRP sends out information several times per year through radio and the area newspaper to further reach farmers interested in topsoil protection.
- In response to the significant Colorado drought (2011-2013) the NRCS and FSA are working with multiple parties in extensive annual planning efforts to limit blowing dust and its impacts. These planning efforts change year to year depending on the severity of the drought.

2. *Limestone-Graveyard Creeks Watershed Project*

A watershed improvement project is currently underway in the Limestone-Graveyard Creeks Watershed. This project covers approximately 60,000 acres of land north of the Arkansas River between Hasty (Bent County) and Lamar. An estimated 44,500 acres of the watershed area are classified as priority land due to the highly erodible nature of the soil. Over 2,000 acres of agricultural cropland northwest of Lamar are included in this watershed project. As of 2013, NRCS informed the APCD that this project is approximately 99% complete.

Working with the NRCS, each farmer will create their own conservation plan with costs for improvements split equally between farmers and the federal government. The 15-year project will help reduce soil erosion and improve water quality and efficiency through conservation tillage practices and/or other conservation efforts. In short, the Limestone-Graveyard Creeks Watershed Project will help to reduce soil erosion and lower the impacts of blowing soils during future high wind events.

More recently (since the 1998 NEAP submittal), the Watershed project has been evaluated and is seen as an ongoing successful program as most eligible acres are signed up.

3. *New Initiatives*

While the following initiatives are not meant to be enforceable, the Natural Resources Conservation Service has many efforts underway that further reduce blowing dust and its impacts. These include:

- A comprehensive rangeland management program;
- Tree planting program;
- Drip irrigation purchase program, and;
- A multi-party drought response planning effort coordinated through the State of Colorado Governor's office.
- In 2013, NRCS also tried a proactive approach to drought management by offering producers incentives to mitigate erosion hazard areas before they became an erosion problem.

These are but a few of the efforts at the local, county, and regional level underway to reduce emissions of PM_{10} and limit impacts.

6.0 Summary and Conclusions

APCD is requesting concurrence on exclusion of the PM_{10} values from the Lamar Municipal Building site (08-099-0002) on February 8, 2013 (159 µg/m^3), April 9, 2013 (1220 µg/m^3), May 1, 2013 (207 µg/m^3), May 24, 2013 (406 µg/m^3) , May 25, 2013 (168 µg/m^3), May 28, 2013 (201 µg/m^3) and December 24, 2013 (168 µg/m^3).

Elevated 24-hour PM_{10} concentrations were recorded at the Lamar Municipal PM_{10} Monitor (08-099-0002) in Lamar, Colorado on February 8, 2013, April 9, 2013, May 1, 2013, May 24, 2013, May 25, 2013, May 28, 2013 and December 24, 2013 and the APCD is requesting concurrence on the exclusion of these exceedance PM_{10} values. All of the noted twenty-four-hour PM_{10} concentrations were above the 90th percentile concentrations for their locations (see Section 3). These events exceeded the 99th percentile values for these monitors. The statistical and meteorological data clearly shows that but for the high wind blowing dust events, Lamar would not have exceeded the 24-hour NAAQS on February 8, 2013, April 9, 2013, May 1, 2013, May 24, 2013, May 25, 2013, May 28, 2013 and December 24, 2013. Since at least 2005, there has not been an exceedance that was not associated with high winds carrying PM_{10} dust from distant sources in these areas. This is evidence that the events were associated with a measured concentration in excess of normal historical fluctuations including background.

The PM_{10} exceedances in Lamar would not have occurred if not for the following: (a) dry soil conditions over source regions with 30-day precipitation totals below the threshold identified as a precondition for blowing dust; and (b) meteorological conditions that caused strong surface winds over the area of concern.

Surface weather observations provide strong evidence that dust storms took place on February 8, 2013, April 9, 2013, May 1, 2013, May 24, 2013, May 25, 2013, May 28, 2013 and December 24, 2013. The meteorological conditions during these events in 2013 caused regional surface winds over 30 mph with gusts exceeding 40 mph. These speeds are above the thresholds for blowing dust identified in EPA draft guidance and in detailed analyses completed by the State of Colorado (see Blowing Dust Climatologies available at http://www.colorado.gov/airquality/tech_doc_repository.aspx#misc2). These PM_{10} exceedances were due to exceptional events associated with regional windstorm-caused emissions from erodible soil sources over a large source outside of the monitored areas. These sources are not reasonably controllable during significant windstorms under abnormally dry or moderate drought conditions.

Both wind speeds and soil moisture in surrounding areas were conducive to the generation of significant blowing dust. Multiple sources of data for the events in question and analyses of past dust storms in this area prove that these were natural events and, more specifically, significant natural dust storms originating outside the monitored areas. "But for" the dust storms on February 8, 2013, April 9, 2013, May 1, 2013, May 24, 2013, May 25, 2013, May 28, 2013 and December 24, 2013, these PM_{10} exceedances would not have occurred.

7.0 References

7.1 February 8, 2013 References

United States Environmental Protection Agency, June 2012. *Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule.*

7.2 April 9, 2013 References

United States Environmental Protection Agency, June 2012. *Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule.*

7.3 May 1, 2013 References

United States Environmental Protection Agency, June 2012. *Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule.*

7.4 May 24, 2013 References

Arizona Department of Environmental Quality, Maricopa County Air Quality Department and Maricopa Association of Governments, March 8, 2012. *State of Arizona Exceptional Event Documentation for the Events of July 2nd through July 8th 2011, for the Phoenix PM_{10} Nonattainment Area.*

United States Environmental Protection Agency, June 2012. *Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule.*

7.5 May 25, 2013 References

Arizona Department of Environmental Quality, Maricopa County Air Quality Department and Maricopa Association of Governments, March 8, 2012. *State of Arizona Exceptional Event Documentation for the Events of July 2nd through July 8th 2011, for the Phoenix PM_{10} Nonattainment Area.*

United States Environmental Protection Agency, June 2012. *Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule.*

7.6 May 28, 2013 References

Arizona Department of Environmental Quality, Maricopa County Air Quality Department and Maricopa Association of Governments, March 8, 2012. *State of Arizona Exceptional Event Documentation for the Events of July 2nd through July 8th 2011, for the Phoenix PM_{10} Nonattainment Area.*

United States Environmental Protection Agency, June 2012. *Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule*.

7.7 December 24, 2013 References

United States Environmental Protection Agency, June 2012. *Draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule*.