Technical Support Document For the Alamosa Exceptional Events Occurring on April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013

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

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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 On May 2, 2011, in an attempt to clarify this rule, EPA released draft guidance documents on the implementation of the EER to State, tribal and local air agencies for review.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 on April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 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 were caused by a natural event.

EPA's June 2012 draft Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule states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, Colorado, Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx). 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 Alamosa on April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 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 Alamosa Adams State College (08-003-0001) and Alamosa Municipal Building (08-003-0003) monitors on April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 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 southwestern, south-central and southeastern Colorado advising citizens of the potential for high wind/dust on April 8, 2013, April 22, 2013, April 30, 2013 and May 31, 2013. The counties included in these advisories were: Mesa, Delta, Montrose, Gunnison, San Miguel, Ouray, Dolores, San Juan, Montezuma, La Plata, Hinsdale, Archuleta, Mineral, Saguache, Rio Grande, Fremont, Alamosa, Conejos, Costilla, Custer, Huerfano, Pueblo, Las Animas, Corwley, Otero, Kiowa, Bent, Prowers, and Baca. The advisories that were issued on April 8, 2013, April 22, 2013, April 30, 2013 and May 31, 2013 can be viewed at: http://www.colorado.gov/airquality/report.aspx and are described further in Section 2.

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 April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013, sample values greater than 150 $\mu g/m^3$ were taken in Alamosa, Colorado during the high wind events that occurred on those days. These high values were taken at the monitors located in Alamosa at either Adams State College (SLAMS) or the Municipal Building (SLAMS) or both. Both of these monitors are 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 29, 2016 and closed comments on April 30, 2016. 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).

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.

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 April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013, blowing dust events and PM_{10} exceedances – Conceptual Model and Wind Statistics

Several powerful storm systems caused exceedances of the twenty-four hour PM_{10} standard in Alamosa, Colorado on April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013. Exceedances were recorded in Alamosa at the Alamosa Municipal Building monitor and/or the Alamosa Adams State College (ASC) monitor. The 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 and the Grand Junction Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx). 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 April 8, 2013 Meteorological Analysis

On April 8, 2013, a powerful spring storm system caused an exceedance of the 24-hour PM_{10} standard in Alamosa, Colorado at the Municipal Building (08-003-0003) monitor with a concentration of 162 $\mu g/m^3$. This elevated reading and the location of the monitor are plotted on a map of the Greater Alamosa area in Figure 1. The exceedance in Alamosa 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 southern Colorado and northern New Mexico, producing significant blowing dust.

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

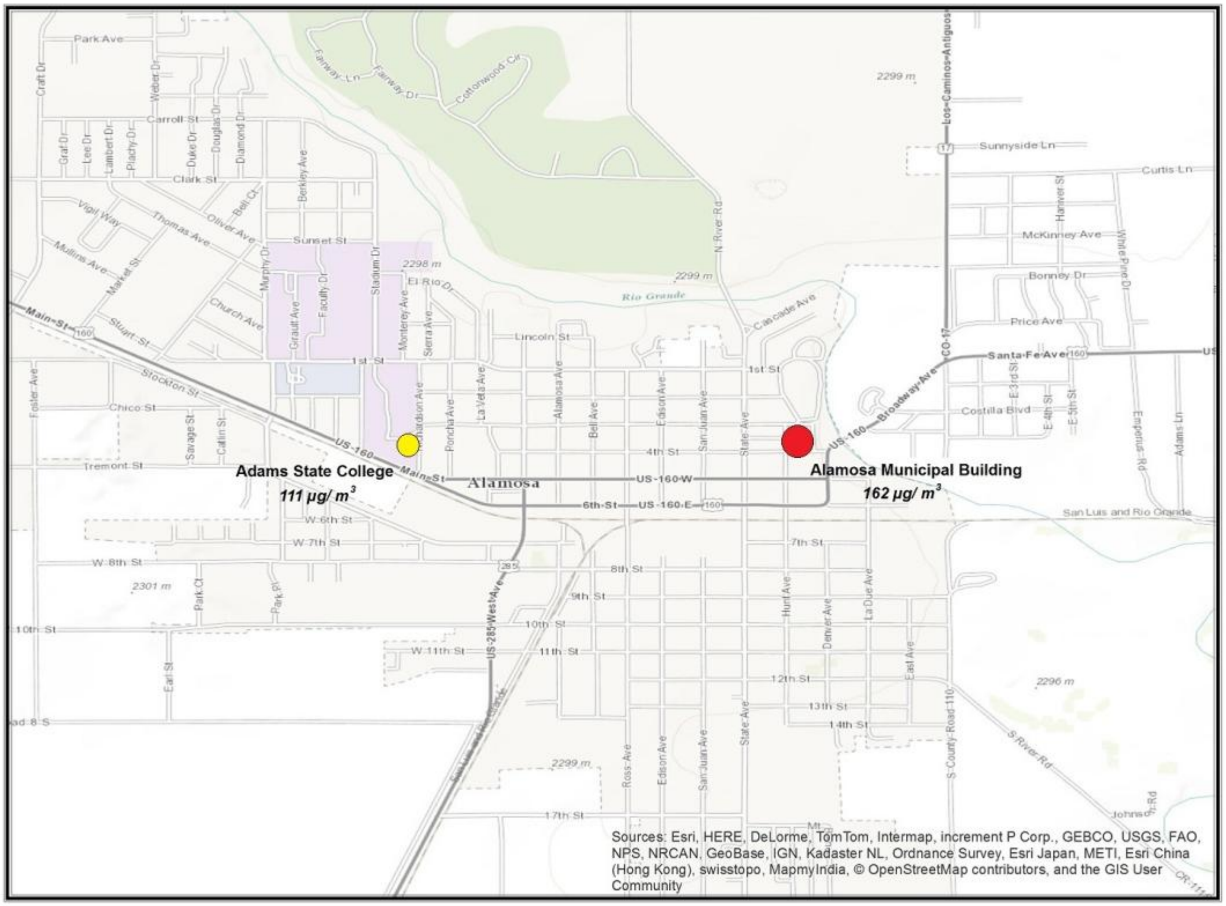


Figure 1: 24-hour PM_{10} concentrations for April 8, 2013.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

The upper-level trough associated with this storm system is shown on the 700 mb and 500 mb height analysis maps at 5:00 AM MST, April 8, 2013 in Figure 2 and Figure 3, respectively. The 700 mb level is located roughly 3 kilometers (km) 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 in the hours preceding the blowing dust event of April 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 Technical Support Document for the April 3, 2011 Alamosa and Lamar Exceptional Event at http://www.colorado.gov/airquality/tech_doc_repository.aspx).

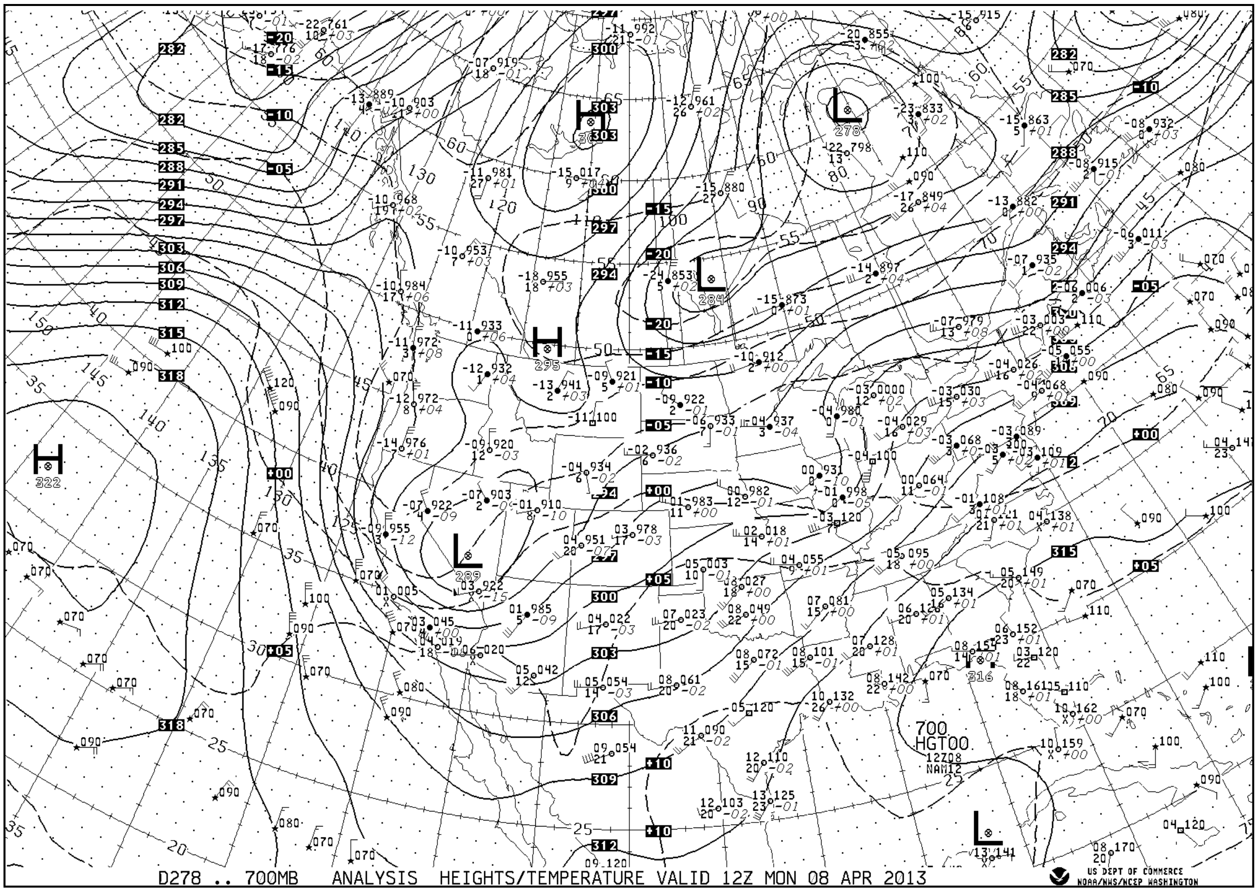


Figure 2: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z April 8, 2013, or 5:00 AM MST April 8, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

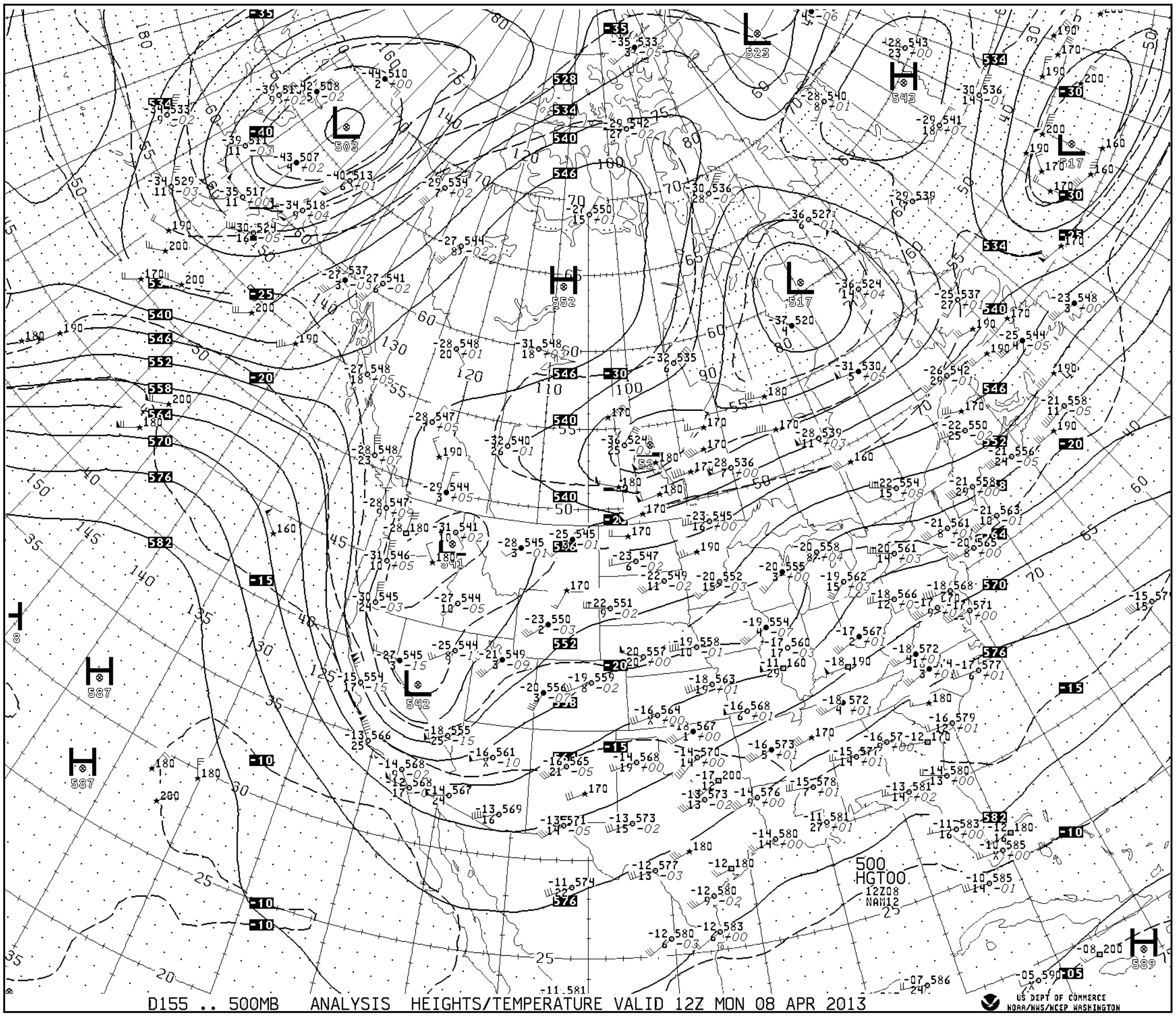


Figure 3: 500 mb (about 6 kilometers above mean sea level) analysis for 12Z April 8, 2013, or 5:00 AM MST April 8, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

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

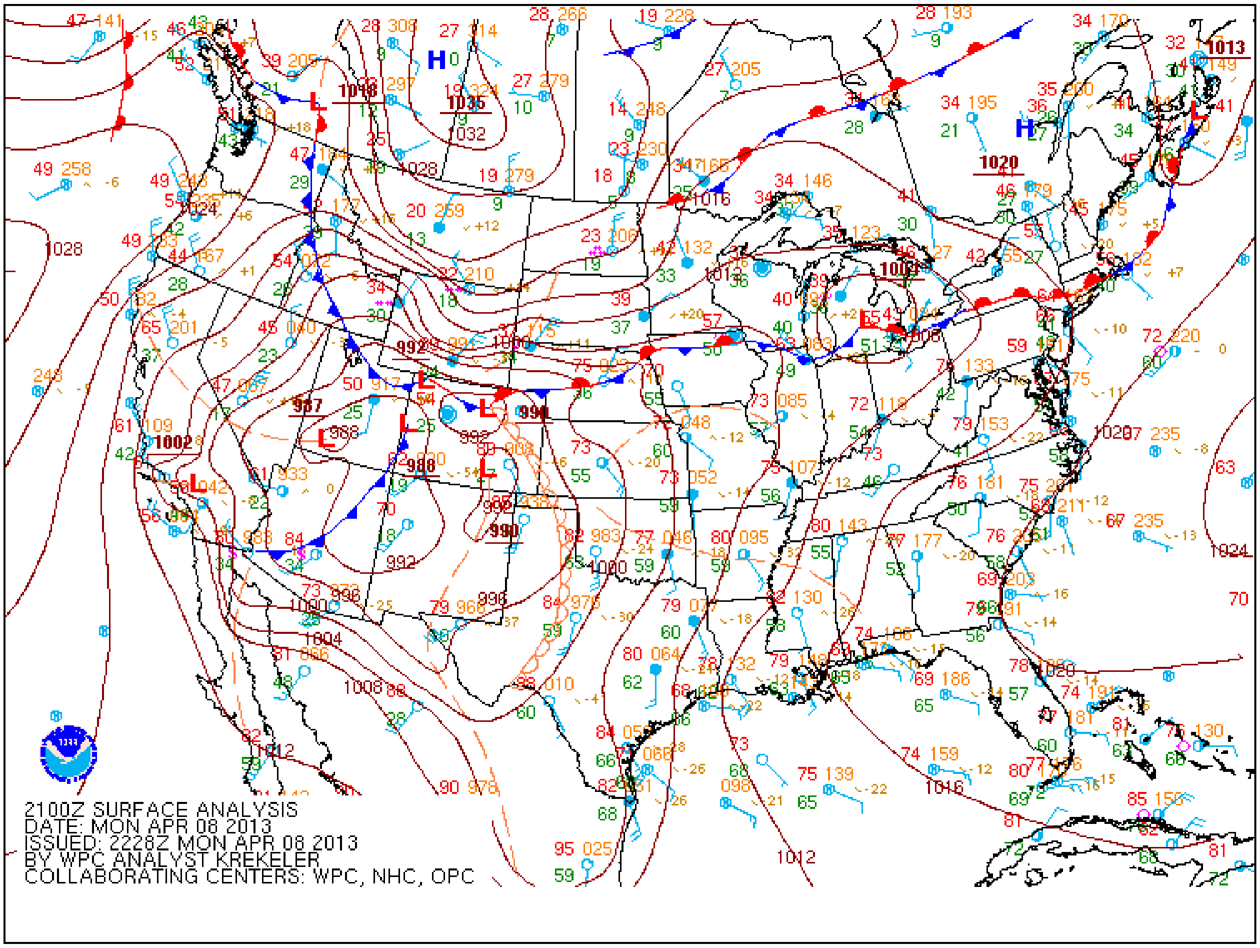


Figure 4: Surface analysis for 21Z April 8, 2013, or 2:00 PM MST April 8, 2013. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

In order to fully evaluate the synoptic meteorological scenario of April 8, 2013, a regional surface weather map is provided showing individual station observations during the height of the event in question. Figure 5 presents weather observations for the Desert Southwest, including southern Colorado, at 5:00 PM MST on April 8. On the map in Figure 5 the station observation for Alamosa (circled in red) shows two full flags and one half flag indicating sustained winds of 25 knots (29 mph). Additionally, many observation sites in New Mexico (upwind of Alamosa) include 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.erh.noaa.gov/er/box/glossary.htm). The abundance of haze observations in New Mexico suggests that a regional dust storm was ongoing during the afternoon of April 8.

Hourly surface observations, in table form, from Alamosa and Albuquerque provide additional evidence that there was a period of high winds, reduced visibility and blowing dust within the region. Table 1 lists observations for the PM_{10} exceedance location of Alamosa while Albuquerque observations can be found in Table 2. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology and the

Grand Junction Blowing Dust Climatology at
http://www.colorado.gov/airquality/tech_doc_repository.aspx) are highlighted in yellow.

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 near or above the threshold speeds for blowing dust on April 8, 2013.

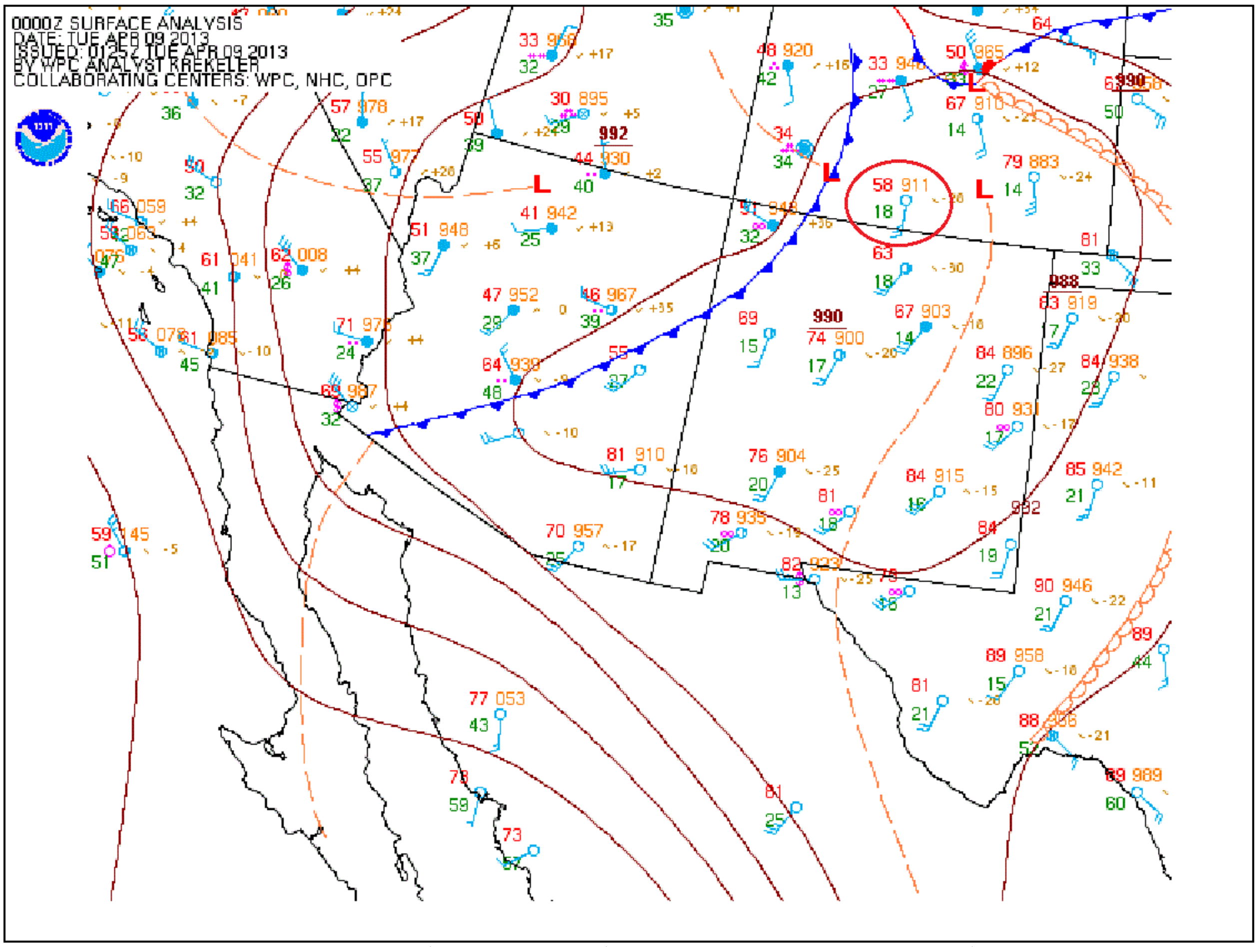


Figure 5: Four Corners regional surface analysis for 5:00 PM MST, April 8, 2013. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

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

Time MST April 8, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:52	32	47	7		100		10
1:52	32	47	5		170		10
2:52	29	51	4		180		10
3:52	26	52	6		170		10
4:52	34	43	9		200		10
5:52	34	47	6		190		10
6:52	39	46	8		160		10
7:52	48	37	15		180		10
8:52	50	32	16		240		10
9:52	53	28	18		230		10
10:52	58	23	21	33	210		10
11:52	59	20	23	29	200		10
12:52	58	22	14	25	180		10
13:52	58	20	15	21	180		10
14:52	57	21	23	33	200		10
15:52	59	20	23	31	190		10
16:52	58	21	30	39	180		8
17:52	57	20	23	32	190		10
18:52	51	24	7		220		10
19:52	50	29	13	22	230		10
20:52	50	27	17		210		10
21:52	48	32	16		180		7
22:52	45	51	16		180		10
23:52	44	49	10		190		10

Table 2: Weather observations for Albuquerque, New Mexico, on April 8, 2013.
(Source: http://mesowest.utah.edu/)

Time MST April 8, 2013	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
0:52	61	17	14		250		10
1:05	61	18	12		240		10
1:52	59	20	9		260		10
2:52	58	25	9		290		10
3:52	57	27	10		260		10
4:52	49	31	7		120		10
5:52	49	33	7		130		10
6:52	53	31	0				10
7:52	58	27	4		220		10
8:52	62	22	6		160		10
9:52	65	21	14	27	190		10
10:52	69	17	17	33	220		10
11:52	72	15	30	38	170		10
12:52	73	15	29	43	180		10
13:52	75	15	29	39	180		10
14:52	77	11	38	51	190	blowing dust	6
15:52	76	9	33	41	220		10
16:52	74	11	22	41	200		9
17:52	72	10	31	40	190		10
18:52	70	11	17	25	200		10
19:52	69	11	18	30	210		10
20:52	66	13	14		200		10
21:52	65	16	14	23	220		10
22:27	55	35	16	24	350		8
22:52	55	35	14		350		9
23:52	54	37	14		330		10

Unfortunately extensive cloud cover hindered any type of satellite detection of blowing dust in the San Luis Valley on April 8, 2013. However, web cam imagery from San Luis Valley Regional Airport in Alamosa does appear to have captured blowing dust during the late afternoon and evening hours. Figure 6 reveals suspected areas of blowing dust near the surface which were likely being enhanced by dry thunderstorms that were moving through the San Luis Valley at the time. The Arizona Department of Environmental Quality produced a comprehensive Exceptional Event report thoroughly describing how outflow winds from thunderstorms can produce a significant amount of blowing dust (see the reference for the State of Arizona Exceptional Event Documentation). That report received EPA concurrence on September 6, 2012 (Source: http://www.azdeq.gov/environ/air/plan/download/epacon090612.pdf)

The National Oceanic and Atmospheric Administration (NOAA) Satellite Services Division is in agreement with the conclusion that a regional blowing dust event was occurring on April 8, 2013. The Smoke Text Product from NOAA at 7:30 PM MST stated:

> "A significant blowing dust event was visible in satellite imagery this evening. A large broad area of blowing sand/dust covered much of the southwest US. Sand/dust originated from multiple sources in northern Mexico, Arizona, New Mexico and west Texas." (Source: http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2013/2013D090212.html)

Colorado was not specifically named in the above text product, however it can be assumed that the cloud cover mentioned above was also a hindrance to the Satellite Services Division in identifying dust in the San Luis Valley. Regardless, the Colorado Department of Public Health and Environment (CDPHE) and National Weather Service (NWS) office in Pueblo both anticipated high winds and/or blowing dust on April 8, 2013. The CDPHE issued a Blowing Dust Advisory for most of southern Colorado, including the San Luis Valley. Text from this advisory included:

> "Strong gusty winds will create areas of blowing dust on Monday. Blowing dust will likely increase during the mid-afternoon hours before gradually decreasing during the mid to late evening hours." (Source: http://www.colorado.gov/airquality/forecast_archive.aspx?seeddate=04%2f08%2f2013)

The Pueblo NWS Aviation Forecast at 2:35 PM MST stated:

> "KALS (Alamosa METAR station) …gusty south-southwest winds are anticipated with wind gusts to 35 knots at times. Showers/thunderstorms capable of generating locally strong downburst winds in excess of 35 knots will also be possible…especially from late this afternoon into early this evening." (Source: http://mesonet.agron.iastate.edu/wx/afos/)

Webcam imagery combined with reports and advisories from government agencies on April 8, 2013 indicate that a dust storm was taking place in the San Luis Valley of south-central Colorado.

Figure 6: San Luis Valley Regional Airport webcam images during the late afternoon and evening hours (exact times unknown) of April 8, 2013.
(Source:
http://www.wunderground.com/webcams/NEalamosa/1/video.html?month=04&year=2013&filename=2013048.mp4)

In order to definitively attribute at least a portion of the dust deposition in Alamosa to long-range transport and establish that the April 8, 2013 storm was a regional event, a NOAA HYSPLIT backward trajectory analysis (Draxler and Rolph, 2012) was conducted (Figure 7). The analysis includes 7-hour duration back trajectories from Alamosa for the time period of 2:00 PM MST to 6:00 PM MST. This encompasses the time period of the highest winds and reduced visibility observations recorded in Alamosa on April 8, 2013 (see the following link for more information on HYSPLIT from the NOAA Air Resources Laboratory: http://www.arl.noaa.gov/HYSPLIT_info.php). The trajectory analysis clearly shows the transport of air from northern New Mexico, including directly from the Albuquerque area where high surface winds and blowing dust are already known to have been occurring on April 8 (Table 2).

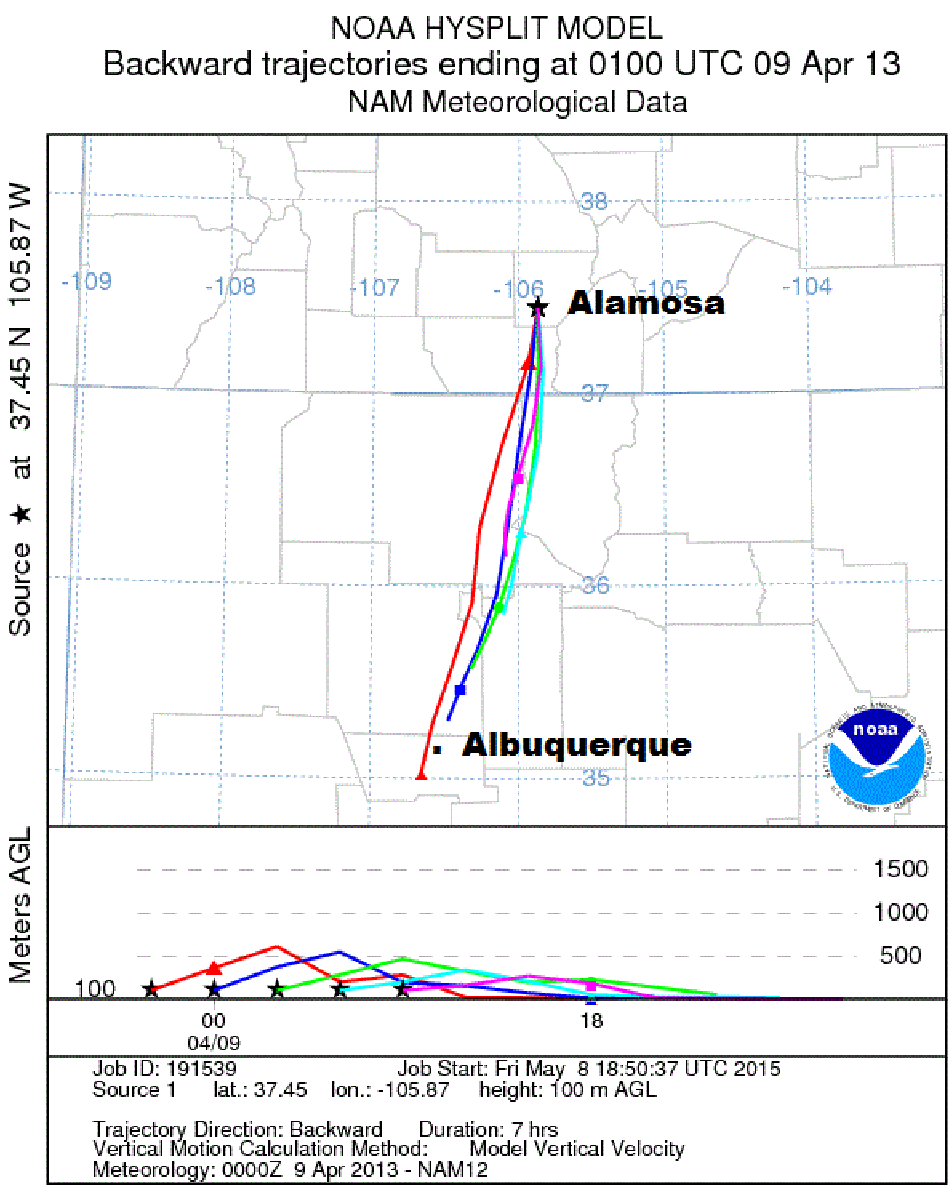
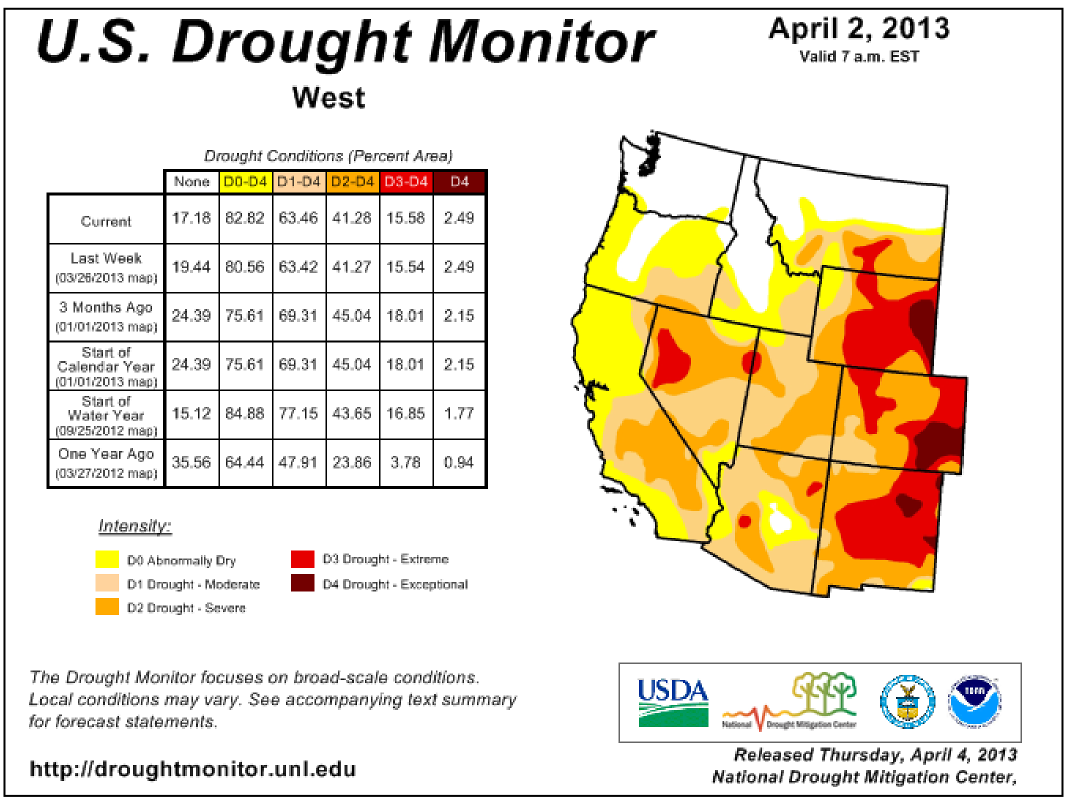


Figure 7: NOAA HYSPLIT NAM12 7-hour back-trajectories for Alamosa, CO for 2:00 PM MST (21Z) April 8, 2013, to 6:00 PM MST (1Z April 9) April 8, 2013. (Source: http://ready.arl.noaa.gov/HYSPLIT.php)

The synoptic weather conditions described above impacted a region that was in the midst of a moderate to severe drought (Figure 8). 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 9 shows the total precipitation in inches from March 9, 2013 to April 7, 2013 for southern Colorado and northern New Mexico. 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 are more likely to occur in Colorado when combined with high winds (see the Lamar Blowing Dust Climatology and the Grand Junction Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx). The HYSPLIT back-trajectory analysis in Figure 7 has already established the area between Alamosa and Albuquerque as a likely source region for the blowing dust in Alamosa. Figure 9 clearly shows that the vast majority of that area received less than 0.5 inches of precipitation during the 30-day period leading up to the April 8 dust event in Alamosa, providing additional evidence of a regional blowing dust event.

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in southern Colorado and particularly northern 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.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	17.18	82.82	63.46	41.28	15.58	2.49
Last Week (03/26/2013 map)	19.44	80.56	63.42	41.27	15.54	2.49
3 Months Ago (01/01/2013 map)	24.39	75.61	69.31	45.04	18.01	2.15
Start of Calendar Year (01/01/2013 map)	24.39	75.61	69.31	45.04	18.01	2.15
Start of Water Year (09/25/2012 map)	15.12	84.88	77.15	43.65	16.85	1.77
One Year Ago (03/27/2012 map)	35.56	64.44	47.91	23.86	3.78	0.94

Figure 8: Drought conditions for the Western U.S. at 5:00 AM MST April 2, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

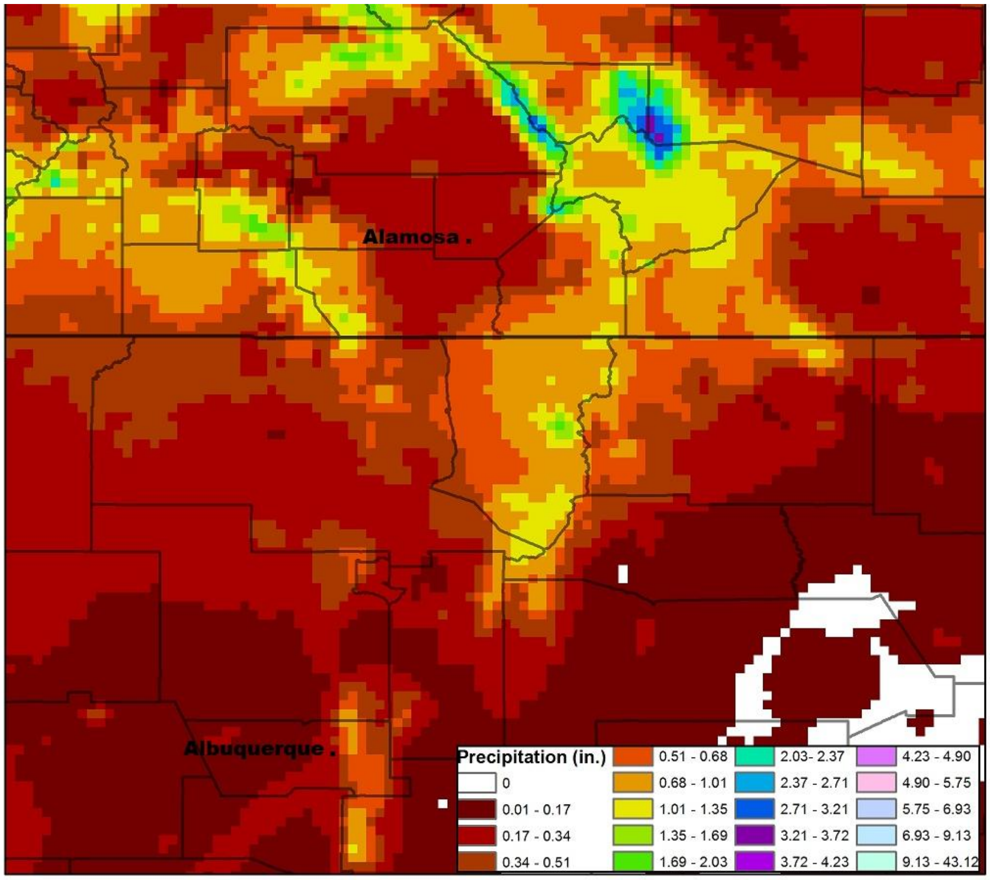


Figure 9: Total precipitation in inches for southern Colorado and northern New Mexico, March 9, 2013 – April 7, 2013.
(Source: http://prism.nacse.org/recent/)

2.2 April 23, 20103 Meteorological Analysis

On April 23, 2013, a powerful spring storm system caused an exceedance of the 24-hour PM_{10} standard in Alamosa, Colorado, at the Adams State College (08-003-0001) monitor with a concentration of 184 µg/m^3. The nearby Alamosa Municipal Building (08-003-0003) monitor, while not reporting an exceedance, also registered a highly elevated 24-hour concentration of 141 µg/m^3. These readings and the location of the monitors in the Greater Alamosa area are plotted on the map in Figure 10. The exceedance in Alamosa 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 the dry soils of the northern San Luis Valley, producing significant blowing dust.

High PM10 Natural Event in Colorado (April 23, 2013)

Figure 10: 24-hour PM_{10} concentrations for April 23, 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 23, 2013 in Figure 11 and Figure 12, respectively. The 700 mb level is located roughly 3 kilometers (km) 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 in the hours preceding the blowing dust event of April 23 and that it was moving over the western United States. This is a typical upper-air pattern for blowing dust events in Colorado (see the Technical Support Document for the April 3, 2011 Alamosa and Lamar Exceptional Event at http://www.colorado.gov/airquality/tech_doc_repository.aspx).

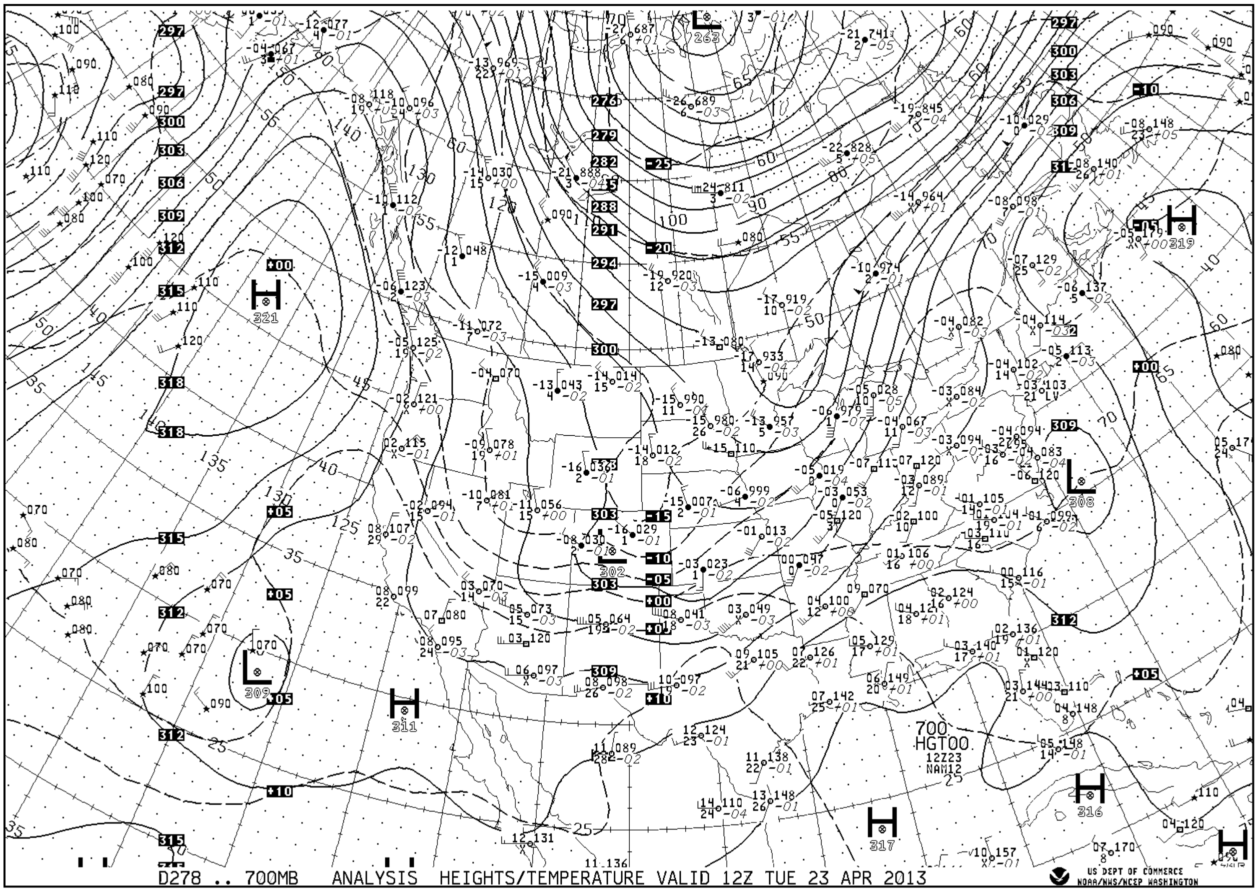


Figure 11: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z April 23, 2013, or 5:00 AM MST April 23, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

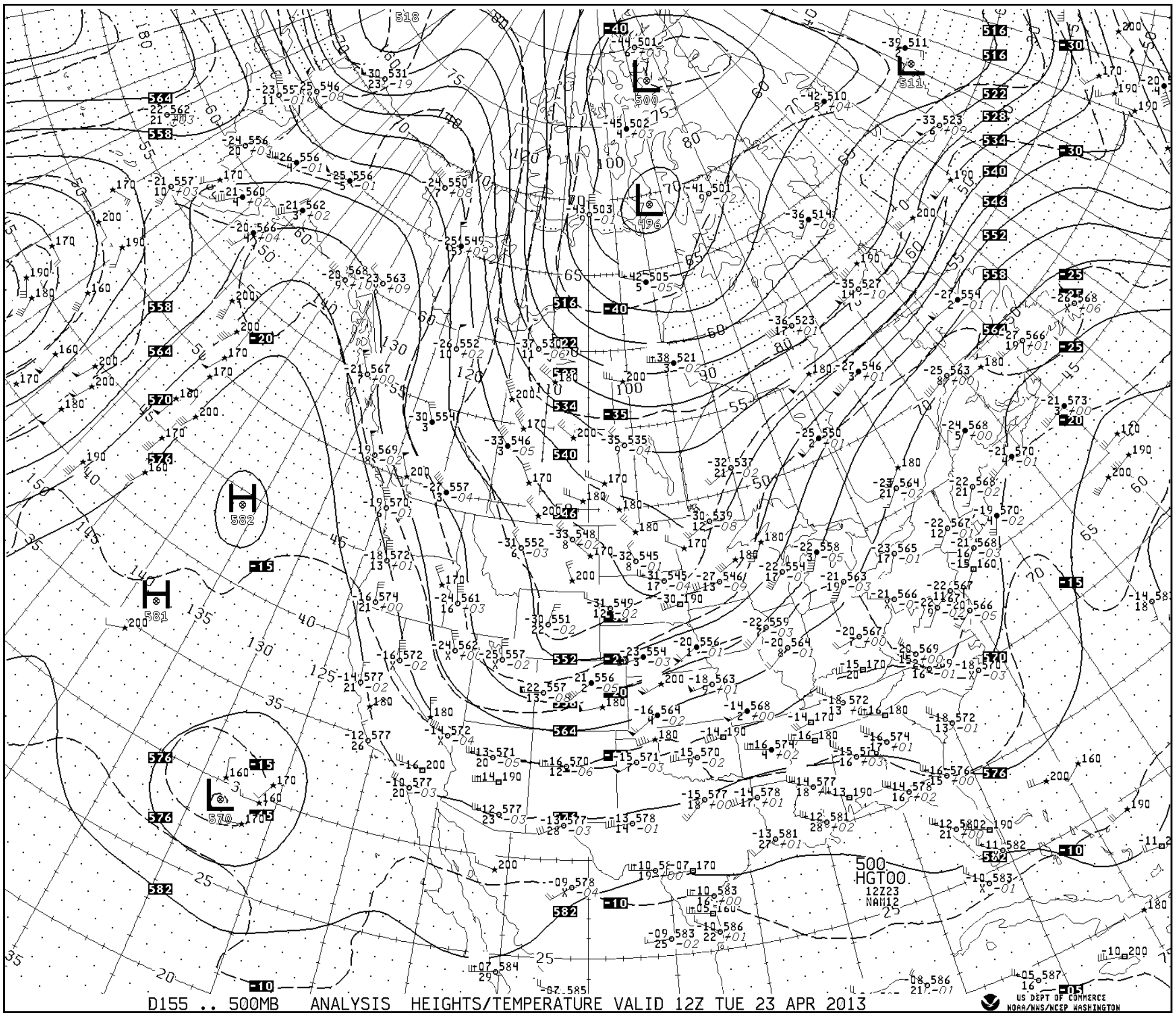


Figure 12: 500 mb (about 6 kilometers above mean sea level) analysis for 12Z April 23, 2013, or 5:00 AM MST April 23, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The surface weather associated with the storm system of April 23, 2013, is presented in Figure 13. Significant surface features impacting southern Colorado at 5:00 AM MST (12Z) included a cold front that had moved southward from Colorado into New Mexico several hours earlier that morning. This front was associated with a strong area of surface low pressure that was located along the Colorado/New Mexico state line. Simultaneously, a strong high pressure system stretched from the Washington and Oregon coastlines eastward into the northern High Plains. The interaction between the low and high pressure areas produced a very tight pressure gradient in south-central parts of Colorado. This tight pressure gradient contributed to the high winds which produced blowing dust in the San Luis Valley of south-central Colorado.

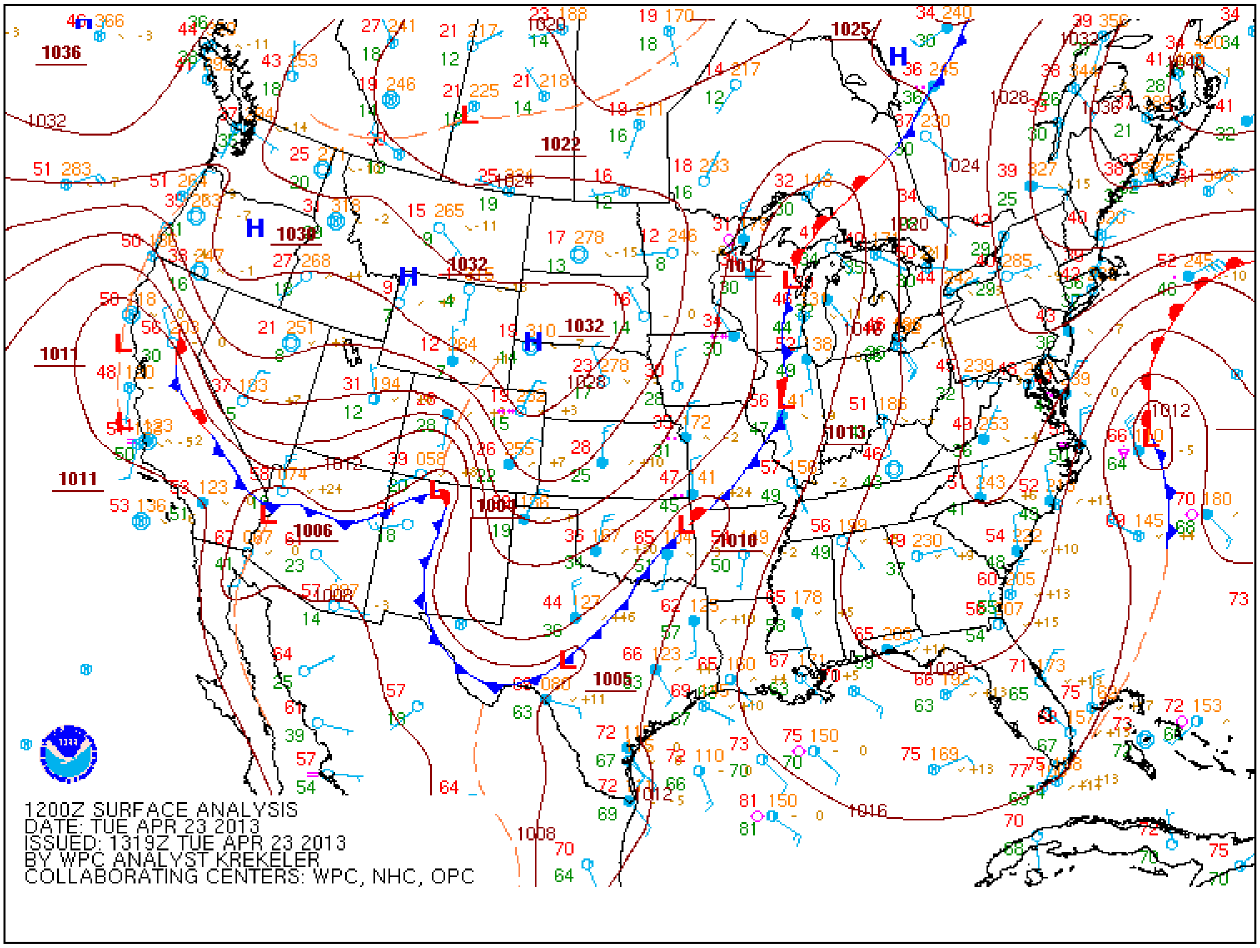


Figure 13: Surface analysis for 18Z May 26, 2012, or 11:00 AM MST May 26, 2012. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

In order to fully evaluate the synoptic meteorological scenario of April 23, 2013, a regional surface weather map is provided showing individual station observations during the height of the event in question. Figure 14 presents weather observations for southern Colorado and northern New Mexico at 5:00 PM MST on April 23. On the map in Figure 14 the station observation for Alamosa (circled in red) shows two full flags indicating sustained winds of 20 knots (23 mph). Additionally, the observation includes 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.erh.noaa.gov/er/box/glossary.htm). As discussed earlier, notice the strong pressure gradient building over the Alamosa area between the high pressure cell over eastern Colorado and the low pressure system in central New Mexico. This strong gradient is represented by the tight "bunching" of isobars which are readily visible over south-central Colorado. Wind speed is directly proportional to the pressure gradient. Hence, 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).

Hourly surface observations, in table form, from Alamosa provide additional evidence that there was an extended period of high winds and haze within the region. Table 3 lists observations for the PM_{10} exceedance location of Alamosa. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology and the Grand Junction Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx) are highlighted in yellow. Despite the fact that the sustained wind speeds and gusts never reached the customary intensities of 30 mph and 40 mph, respectively, the long duration of wind speeds being in close vicinity to those thresholds combined with extremely dry soil conditions were likely sufficient to produce enough blowing dust to cause a PM_{10} exceedance in Alamosa.

Surface weather maps and hourly observations indicate that a dust storm occurred under northerly flow in the wake of a cold front. This data provides clear evidence of an extended period of high winds which produced blowing dust on April 23, 2013.

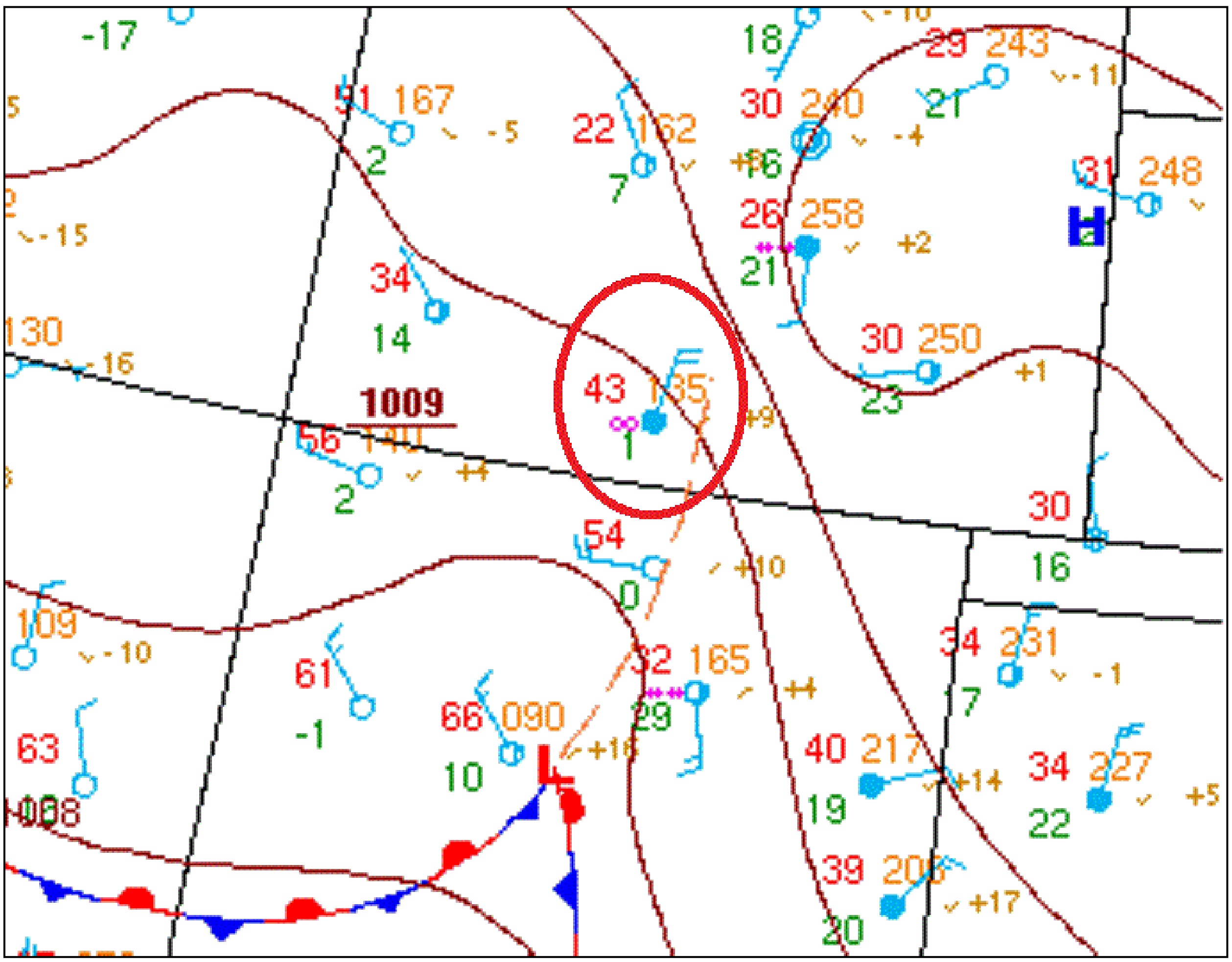


Figure 14: Regional surface analysis of southern Colorado and northern New Mexico at 5:00 PM MST, April 23, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

Table 3: Weather observations for Alamosa, Colorado, on April 23, 2013.
(Source: http://mesowest.utah.edu/)

Time MST April 23, 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	31	53	9		350		10
1:52	25	66	6		190		10
2:52	23	63	6		280		10
3:52	20	71	6		240		10
4:52	20	67					10
5:52	21	68	5		280		10
6:52	27	58	6		220		10
7:52	33	49	4		210		10
8:52	37	46	7		140		10
9:52	43	38	0				10
10:52	43	36	5				10
11:52	44	49	20	25	30		10
12:02	45	49	16	25	40		10
12:52	46	40	16	24	30		10
13:52	48	37	18	28	360		10
14:52	44	36	24	33	20		10
15:52	40	33	18	31	10		10
16:40	43	16	20	32	30	haze	2
16:49	43	17	23	31	10	haze	1.5
16:52	43	17	23	31	10	haze	1.75
17:01	43	17	24	32	10	haze	2
17:52	44	14	21	31	360	haze	1.25
18:09	43	15	24	33	340	haze	3
18:38	39	17	24	36	350	haze	5
18:52	38	18	24	33	350	haze	6
19:52	35	15	22	30	350		10
20:52	32	23	13	23	360		10
21:52	31	34	13		10		10
22:52	28	42	6		10		10
23:52	22	43	4		320		10

Satellite-generated data products from April 23, 2013 also indicate that dust caused the PM_{10} exceedance in Alamosa. Figure 15 displays the AIRS (Atmospheric Infrared Sounder) Dust Score zoomed on the San Luis Valley of south-central Colorado at 1:00 PM MST. The AIRS Dust Score is derived from the MODIS Aqua satellite image (see the following link for more information on Dust Score and other AIRS variables: http://disc.sci.gsfc.nasa.gov/nrt/data-holdings/airs-nrt-products). The tan pixels represent dust scores greater than 360, which is indicative of dust particles.

It should be noted that at the time of this AIRS image a vigorous 700 mb trough was approaching Alamosa from the north. This is clearly indicated by the well-defined band of clouds oriented in a northeast to southwest direction to the north of Alamosa. This line of clouds aligns well with the position of the 700 mb trough shown in the NARR (North American Regional Reanalysis) shown in Figure 16. It is feasible that embedded within this bright band of cloud cover was a cluster of dry showers or thunderstorms which could have further enhanced blowing dust in the San Luis Valley. The Arizona Department of Environmental Quality produced a comprehensive Exceptional Event report thoroughly describing how outflow winds from thunderstorms can produce a significant amount of dust (see the reference for the State of Arizona Exceptional Event Documentation). That report received EPA concurrence on September 6, 2012 (Source: http://www.azdeq.gov/environ/air/plan/download/epacon090612.pdf)

Radar imagery from the late afternoon of April 23, 2013 appears to have captured several areas of light rain and/or blowing dust. Figure 17 displays the Pueblo National Weather Service (NWS) composite reflectivity image at 4:34 PM MST. Note that the band of low-reflectivity echoes are in almost exact alignment to the bright band of clouds and to the 700 mb trough shown in Figure 15 and Figure 16, respectively. The Pueblo radar image is in “clear air” mode which allows a slower radar scan. This makes it very effective in detecting scatterers, which would include blowing dust (see the following link for more information on “clear air” mode: http://weather.noaa.gov/radar/radinfo/radinfo.html#clear).

Also notice that these radar echoes are in the Alamosa area at approximately the same time that haze and reduced visibility were being reported by local surface observations. Six minutes after the radar image of Figure 17, Alamosa reported haze and a reduced visibility of two statute miles at 4:40 PM MST (Table 3). Since haze, but no rain, was reported in the Alamosa observations during the afternoon of April 23, 2013, is it reasonable to assume that the low-reflectivity echoes of Figure 17 predominantly consist of dust particles.

Webcam imagery from the evening of April 23, 2013 would seem to support this conclusion. The webcam image of Figure 18 shows significant amounts of airborne dust with the horizon almost completely obscured. This image was taken from the San Luis Valley Regional Airport in Alamosa with the view to the northeast.

Satellite, radar and webcam imagery combine to reveal that a dust storm was taking place in the San Luis Valley of south-central Colorado on April 23, 2013, which was neither controllable nor preventable.

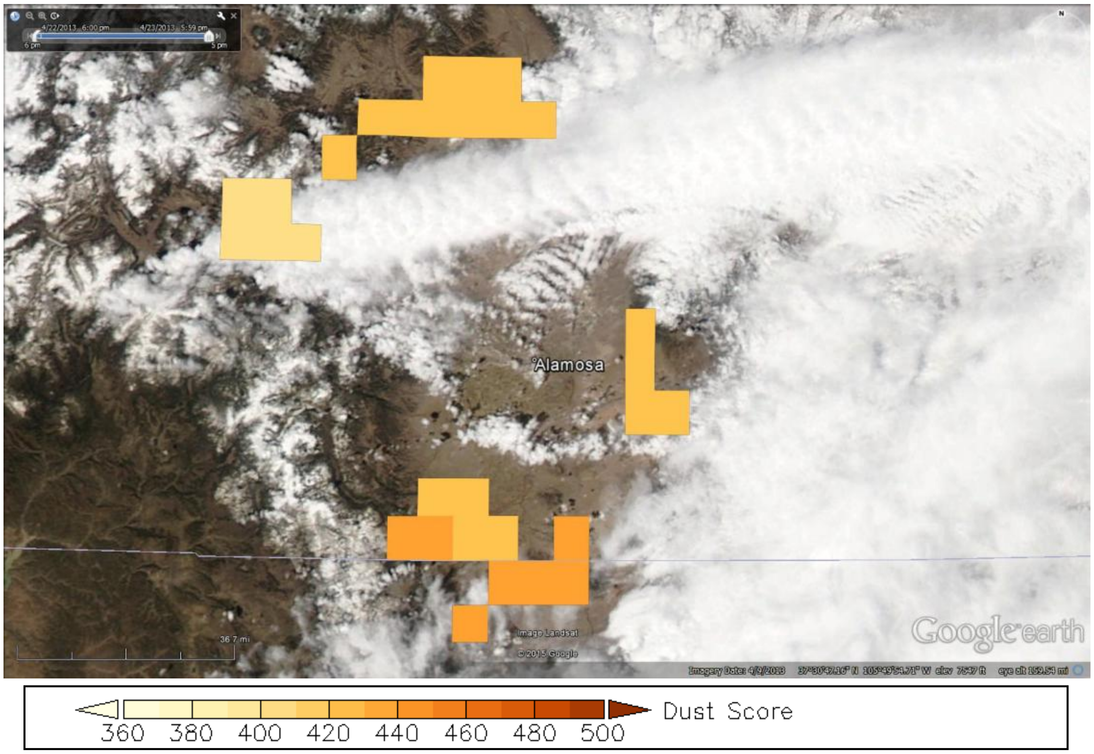


Figure 15: AIRS Dust Score from the MODIS Aqua satellite image at 1:00 PM MST (20Z) April 23, 2013.
(Source: http://www.earthdata.nasa.gov/labs/worldview)

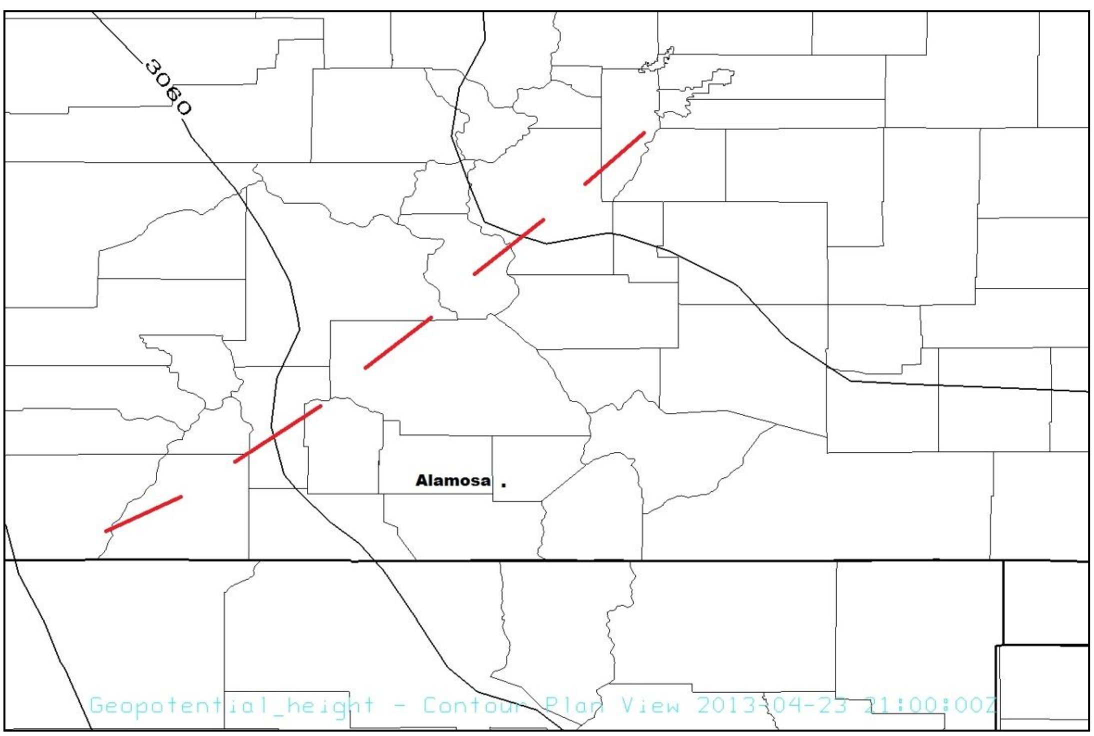


Figure 16: NARR 700 mb analysis for 2:00 PM MST (21Z) April 23, 2013.
(Source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets)

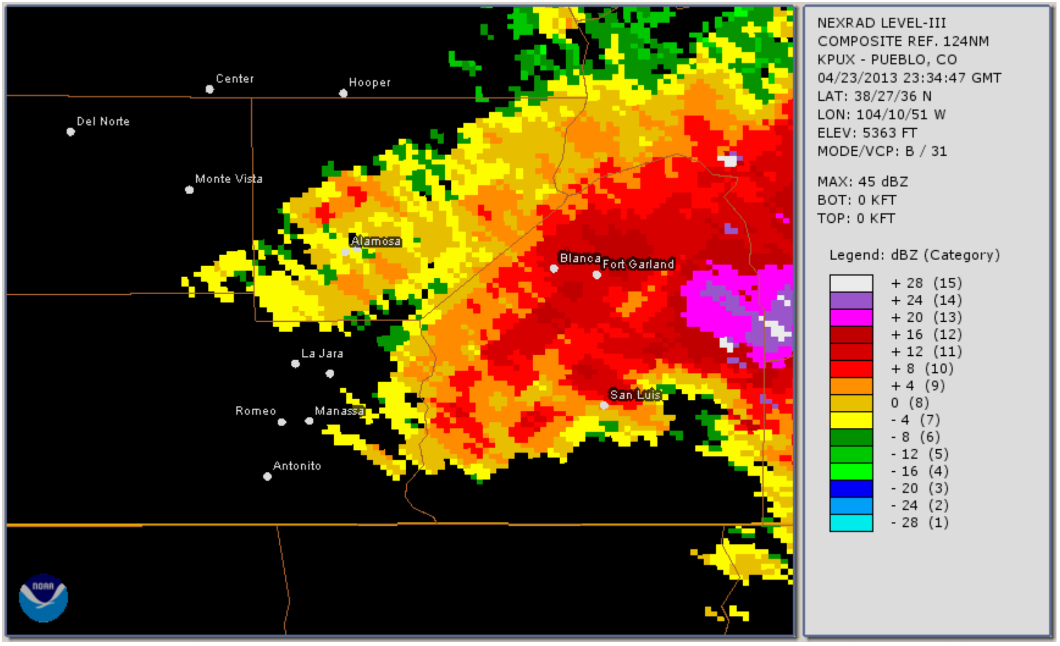


Figure 17: NEXRAD Short-Range Composite Reflectivity image from the Pueblo, CO radar at 4:34 PM MST (2334Z), April 23, 2013.
(Source: http://www.ncdc.noaa.gov/nexradinv/)

Figure 18: San Luis Valley Regional Airport webcam image taken during the evening hours (exact time unknown) of April 23, 2013.
(Source:
http://www.wunderground.com/webcams/NEalamosa/1/show.html?year=2013&month=04&time=evening&MR=1)

The synoptic weather conditions described above impacted a region that was in the midst of a severe drought (Figure 19). 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 20 shows the total precipitation in inches from March 24, 2013 through April 22, 2013 for southern Colorado and northern New Mexico. 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 are more likely to occur in Colorado when combined with high winds (see the Lamar Blowing Dust Climatology and the April 3, 2009 Pagosa Springs Exceptional Event at http://www.colorado.gov/airquality/tech_doc_repository.aspx). Figure 20 clearly shows that the vast majority of the San Luis Valley, including those areas upwind (north) of Alamosa received less than 0.5 inches of precipitation during the 30-day period leading up to the April 23, 2013 dust event. The area directly surrounding Alamosa was especially dry with less than 0.17 inches of precipitation over the previous 30 days.

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in the San Luis Valley of south-central Colorado were dry enough to produce blowing dust when combined with high winds. This information, combined with other evidence provided in this report, proves that this dust storm was a natural event that was not reasonably controllable or preventable.

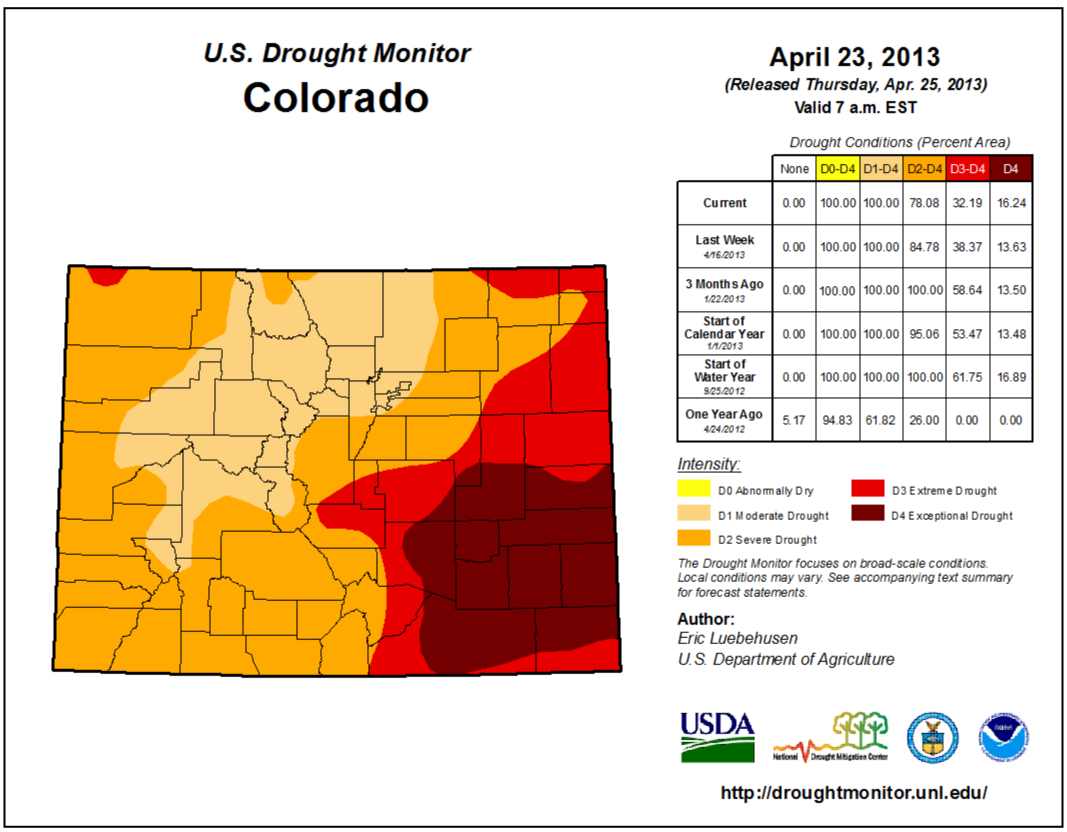


Figure 19: Drought conditions for Colorado at 5:00 AM MST April 23, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

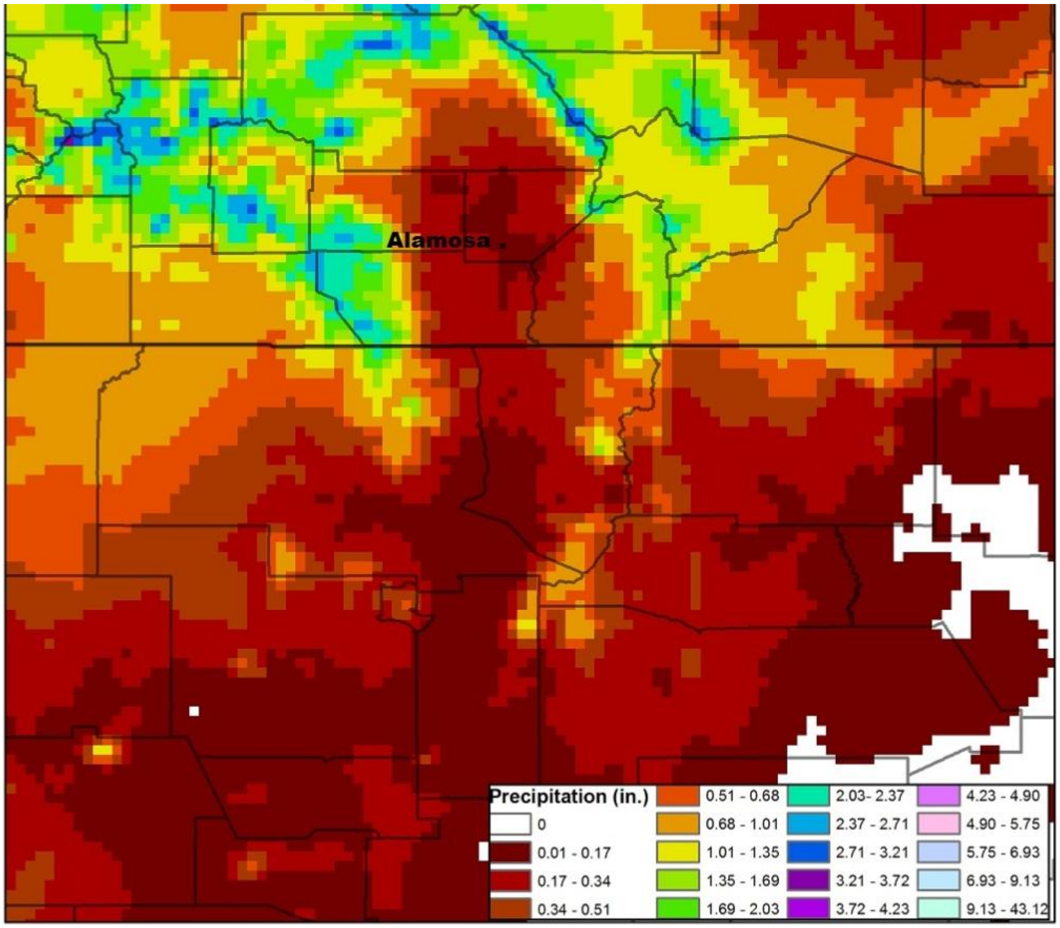


Figure 20: Total precipitation in inches for southern Colorado and northern New Mexico, March 24, 2013 – April 22, 2013.
(Source: http://prism.nacse.org/recent/)

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 Alamosa, Colorado at the Municipal Building (08-003-0003) monitor with a concentration of 246 $\mu g/m^3$ and at the Adams State College (08-003-0001) monitor with a concentration of 229 $\mu g/m^3$. These readings and the location of the monitors are plotted on the map of the Greater Alamosa area in Figure 21. The exceedances in Alamosa were the result of intense surface winds produced by a strong pressure gradient in the vicinity of a stationary 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 the dry soils of the northern San Luis Valley, producing significant blowing dust.

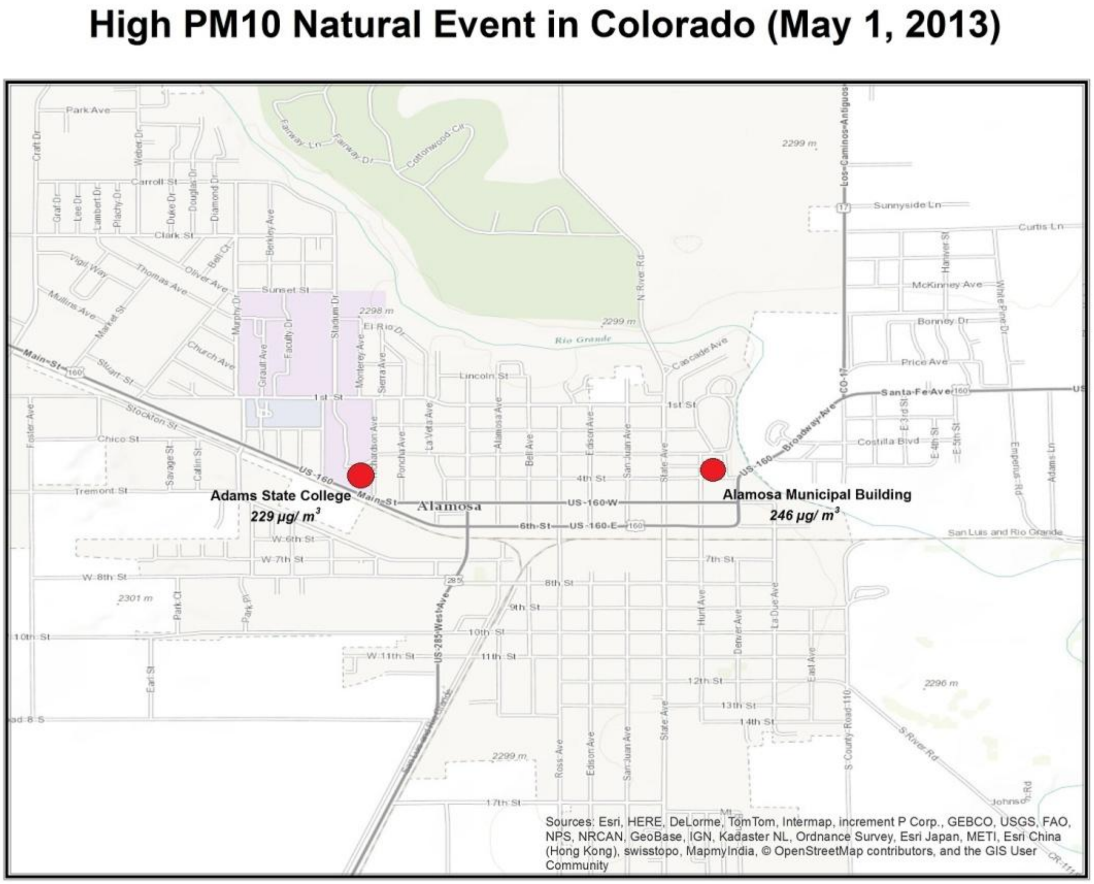


Figure 21: 24-hour PM_{10} concentrations for May 1, 2013.
(Source: http://webapps.datafed.net/datafed.aspx?dataset=AQS_D&parameter=pm10)

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 22 and Figure 23, respectively. The 700 mb level is located roughly 3 kilometers (km) 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 in the hours preceding the blowing dust event of May 1 and that it was moving over the western United States. This is a typical upper-air pattern for blowing dust events in Colorado (see the Technical Support Document for the April 3, 2011 Alamosa and Lamar Exceptional Event at http://www.colorado.gov/airquality/tech_doc_repository.aspx).

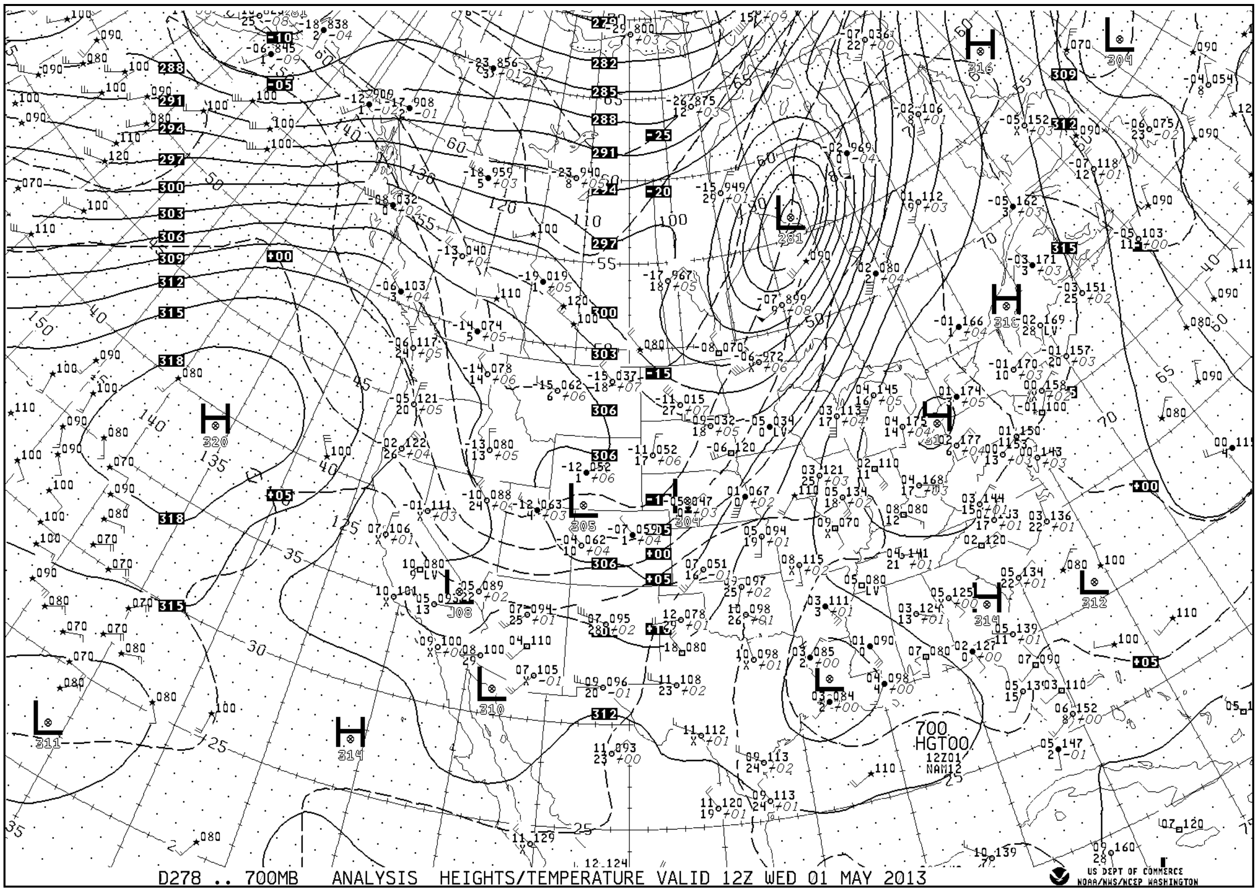


Figure 22: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z May 1, 2013, or 5:00 AM MST May 1, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

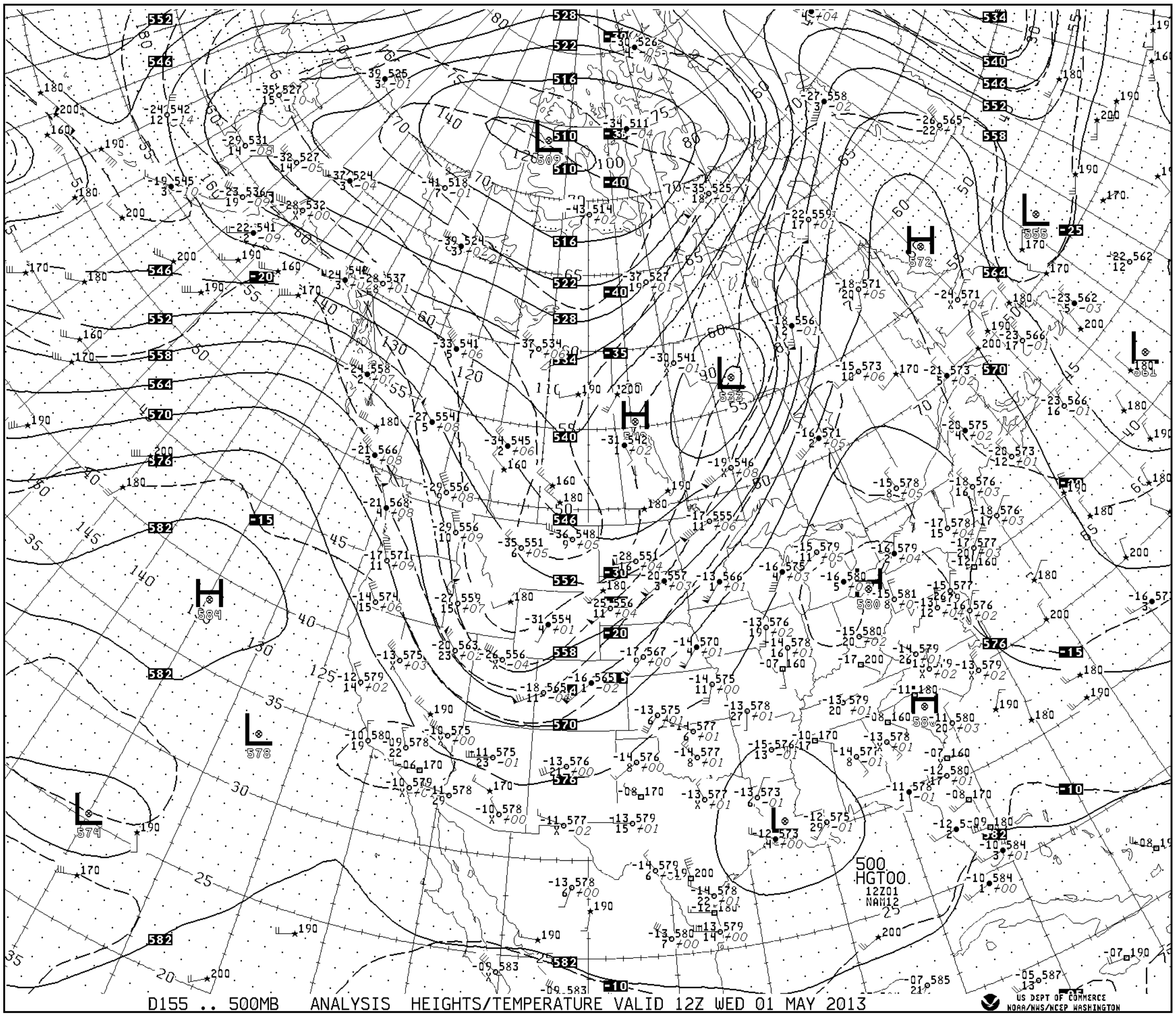


Figure 23: 500 mb (about 6 kilometers above mean sea level) analysis for 12Z May 1, 2013, or 5:00 AM MST May 1, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The surface weather associated with the storm system of May 1, 2013, is presented in Figure 24. Significant surface features impacting southern Colorado at 5:00 AM MST (12Z) included a stationary front that was draped across the central Rockies. This front separated two strongly contrasting air masses. A vigorous low pressure center was located in northwest New Mexico while simultaneously a strong high pressure system was building into eastern Colorado. The interaction between the low and high pressure areas produced a very tight pressure gradient in south-central parts of Colorado. This tight pressure gradient contributed to the high winds which produced blowing dust in the San Luis Valley of south-central Colorado.

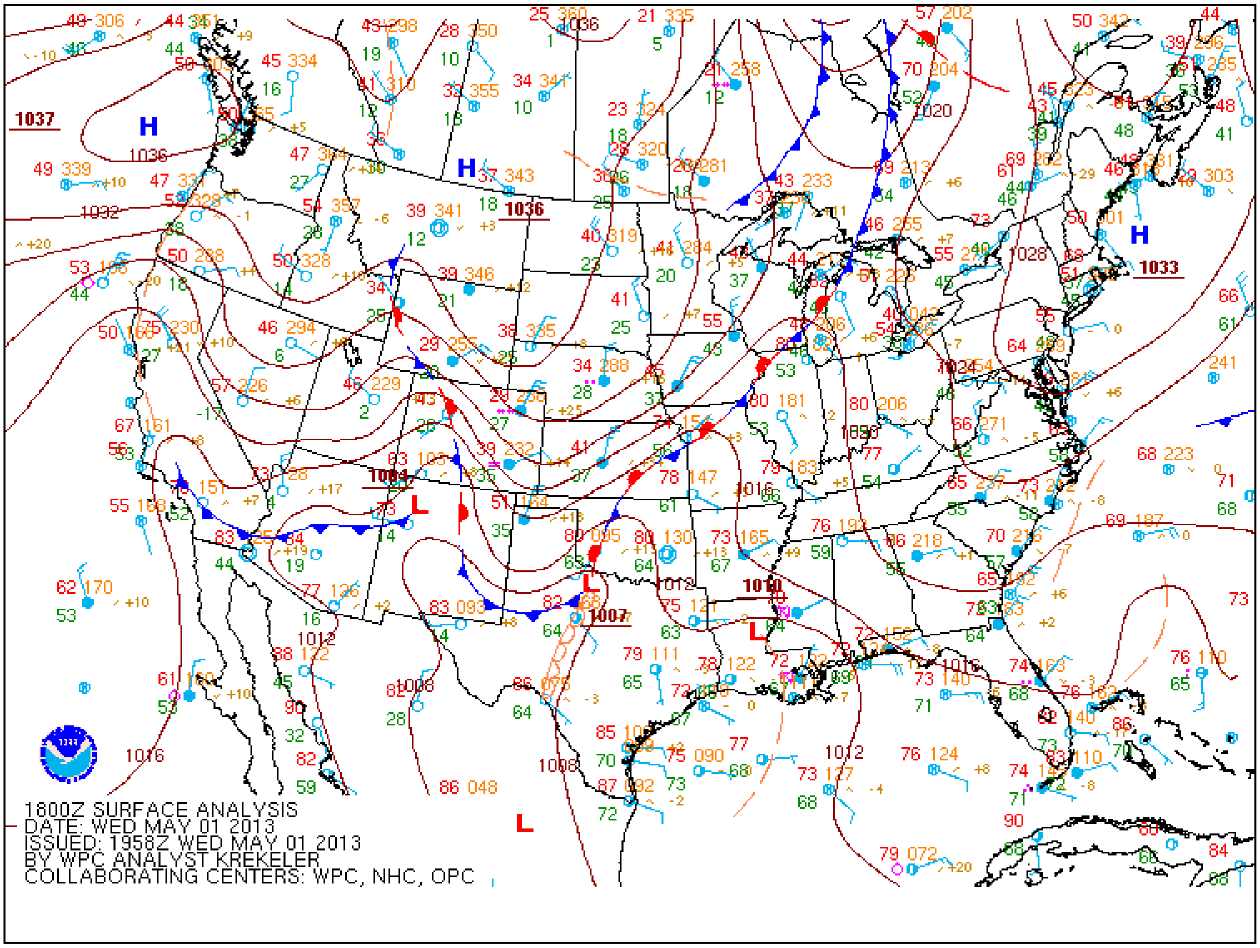


Figure 24: Surface analysis for 18Z May 1, 2013, or 11:00 AM MST May 1, 2013. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

In order to fully evaluate the synoptic meteorological scenario of May 1, 2013, a regional surface weather map is provided showing individual station observations as the winds approached their peak velocity. Figure 25 presents weather observations for southern Colorado and northern New Mexico at 5:00 PM MST on May 1. On the map in Figure 25 the station observation for Alamosa (circled in red) shows three full flags indicating sustained winds of 30 knots (35 mph). As discussed earlier, notice the strong pressure gradient building over the Alamosa area between the high pressure cell over eastern Colorado and the low pressure system in western New Mexico. This strong gradient is represented by the tight "bunching" of isobars which are readily visible over south-central Colorado. Wind speed is directly proportional to the pressure gradient. Hence, 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).

Hourly surface observations, in table form, from Alamosa and Great Sand Dunes National Park provide additional evidence that there was an extended period of high winds within the San Luis Valley on May 1, 2013. A reference map showing the location of these two stations within the San Luis Valley is provided in Figure 26. Table 4 lists observations for the PM_{10} exceedance location of Alamosa while Great Sand Dunes observations are shown in Table 5. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology and the Grand Junction Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx) are highlighted in yellow. Collectively, Alamosa and Sand Dunes experienced many hours of sustained wind speeds and gusts at or above the thresholds for blowing dust.

Referring back to Table 4, notice that Alamosa reported haze from 5:11 to 6:52 PM MST on May 1, 2013. 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.erh.noaa.gov/er/box/glossary.htm). Interestingly the haze observations in Alamosa did not ensue until the winds shifted to a more northerly direction. This suggests that the source of the blowing dust was in the northern part of the San Luis Valley. It should also be noted that observed weather and visibility observations are unavailable for the Great Sand Dunes National Park since it is a remote automatic weather station.

Surface weather maps and hourly observations indicate that a dust storm occurred under northerly flow in the vicinity of a stationary front. This data provides clear evidence of an extended period of high winds which produced blowing dust on May 1, 2013 in the San Luis Valley of south-central Colorado.

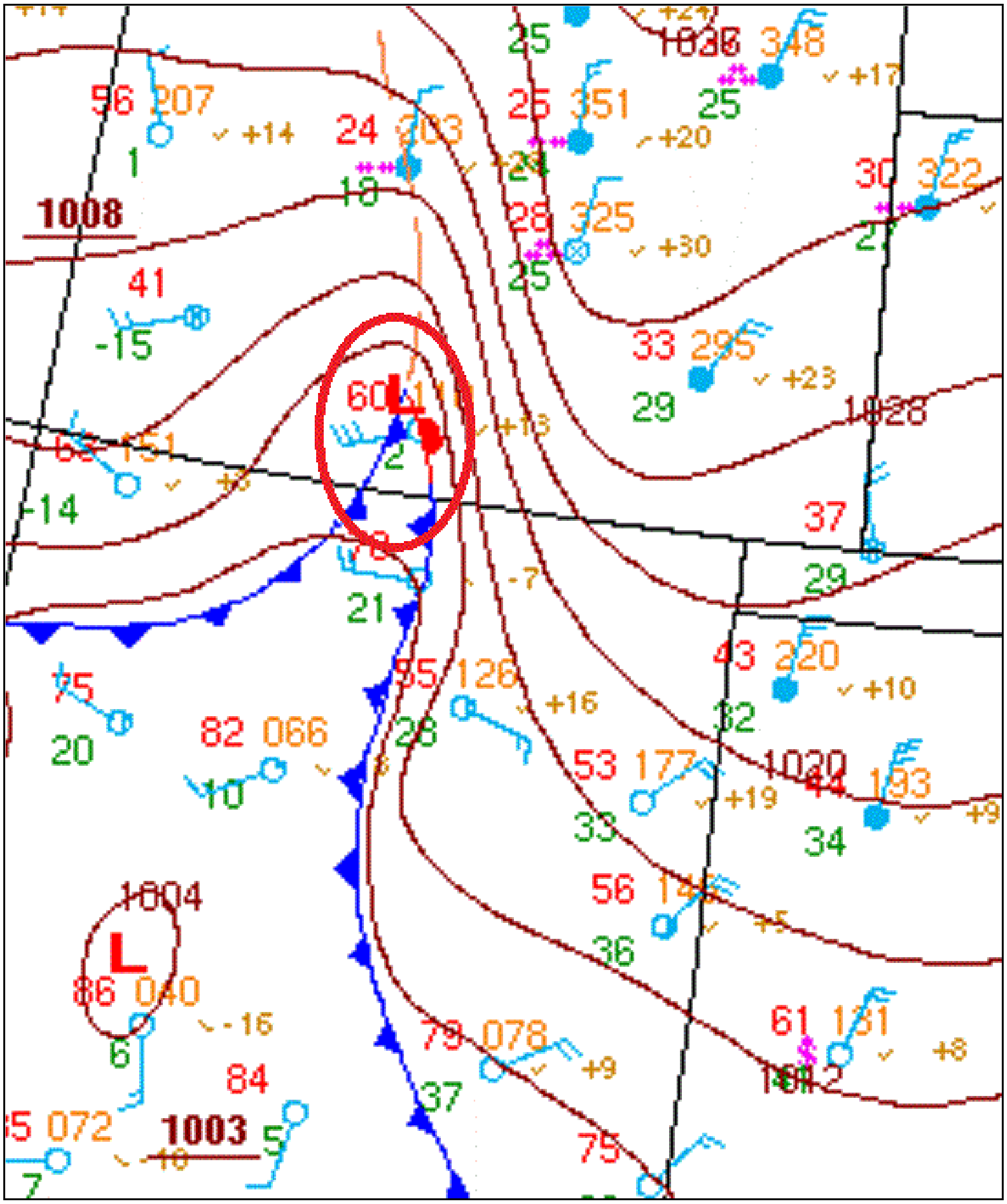


Figure 25: Regional surface analysis of southern Colorado and northern New Mexico at 5:00 PM MST, May 1, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

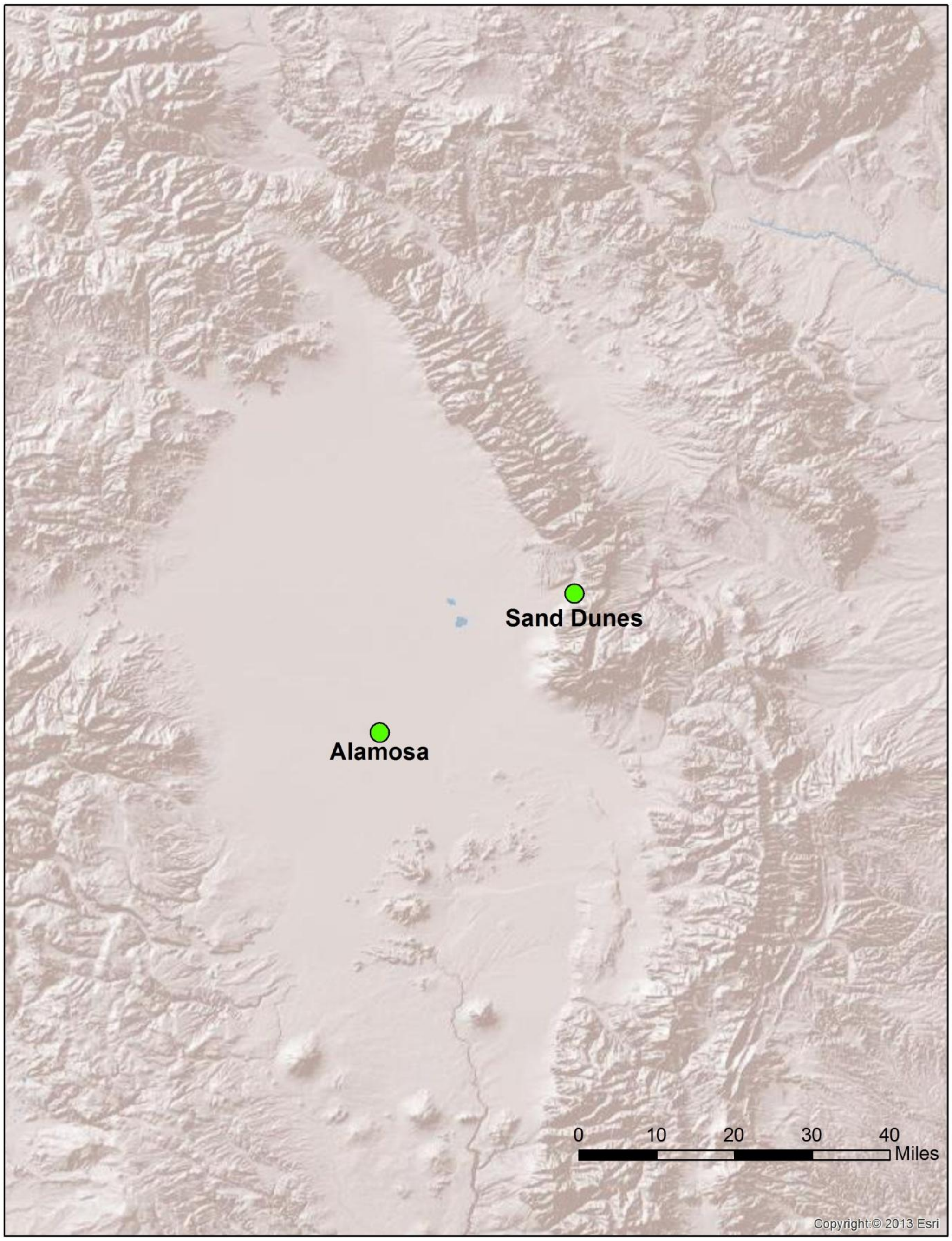


Figure 26: San Luis Valley weather observation stations for May 1, 2013.

Table 4: Weather observations for Alamosa, Colorado, 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	51	21	6		210		10
1:52	49	22	10		190		10
2:52	47	25	13		200		10
3:52	45	27	12		200		10
4:52	42	30	7		200		10
5:52	42	30	8		200		10
6:52	51	24	5		30		10
7:52	56	23	10		50		10
8:52	59	21	4				10
9:52	64	16	22	31	260		10
10:52	66	17	30	37	260		10
11:52	66	18	21	36	210		10
12:52	66	17	25	35	240		10
13:52	65	16	24	37	240		10
14:52	64	15	27	44	240		9
15:52	63	12	30	44	250		10
16:52	60	9	33	44	250		10
17:11	48	32	27	40	30	haze	4
17:22	46	34	23	30	40	haze	5
17:52	43	36	15	27	100	haze	5
18:52	34	45	17	25	90	haze	4
19:52	29	56	8		90		8
20:52	27	58	8		100		7
21:52	25	60	13		110		10
22:52	23	63	0				10
23:52	23	63	0				10

Table 5: Weather observations for Great Sand Dunes National Park, Colorado, 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
0:44	55	16	8	21	18		
1:44	54	16	8	20	12		
2:44	54	17	5	19	10		
3:44	52	17	3	20	12		
4:44	50	19	7	16	15		
5:44	42	45	10	18	26		
6:44	39	59	10	23	310		
7:44	35	64	15	27	288		
8:44	41	56	12	35	279		
9:44	46	45	12	26	287		
10:44	33	71	20	34	284		
11:44	38	62	21	45	279		
12:44	36	67	19	42	282		
13:44	36	62	19	45	18		
14:44	34	68	22	41	286		
15:44	31	70	27	49	284		
16:44	28	77	26	56	287		
17:44	27	69	22	50	293		
18:44	25	69	21	48	288		
19:44	24	68	21	44	292		
20:44	24	64	21	43	296		
21:44	25	57	21	41	294		
22:44	24	58	19	44	289		
23:44	23	57	18	37	289		

Satellite-generated data products from May 1, 2013 also indicate that dust caused the PM_{10} exceedance in Alamosa. Figure 27 displays the AIRS (Atmospheric Infrared Sounder) Dust Score zoomed on the San Luis Valley of south-central Colorado at 1:50 PM MST. The AIRS Dust Score is derived from the MODIS Aqua satellite image (see the following link for more information on Dust Score and other AIRS variables: http://disc.sci.gsfc.nasa.gov/nrt/data-holdings/airs-nrt-products). The tan pixels represent dust scores greater than 360, which is indicative of dust particles.

The National Oceanic and Atmospheric Administration (NOAA) Satellite Services Division was in agreement with the conclusion that blowing dust was occurring, not only in Colorado, but across large parts of the southwest United States on May 1, 2013. The Smoke Text Product from NOAA at 7:45 PM MST stated:

> “A strong cold front dropping southward through northwest Texas today and another frontal boundary across Arizona/New Mexico were causing strong surface winds that had kicked up quite a bit of blowing dust/sand by this evening……thicker dust was seen over southwest/west Texas, much of New Mexico, southwest Colorado, southern Utah, Arizona and southern Nevada…mostly moving southward.” (Source: http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2013/2013E020326.html)

Webcam imagery from the evening of May 1, 2013 would also seem to support this conclusion. The webcam image of Figure 28 shows significant amounts of airborne dust with the horizon almost completely obscured. This image was taken from the San Luis Valley Regional Airport in Alamosa with the view to the northeast.

Satellite, radar and webcam imagery combine to reveal that a dust storm was taking place in the San Luis Valley of south-central Colorado on May 1, 2013, which was neither controllable nor preventable.

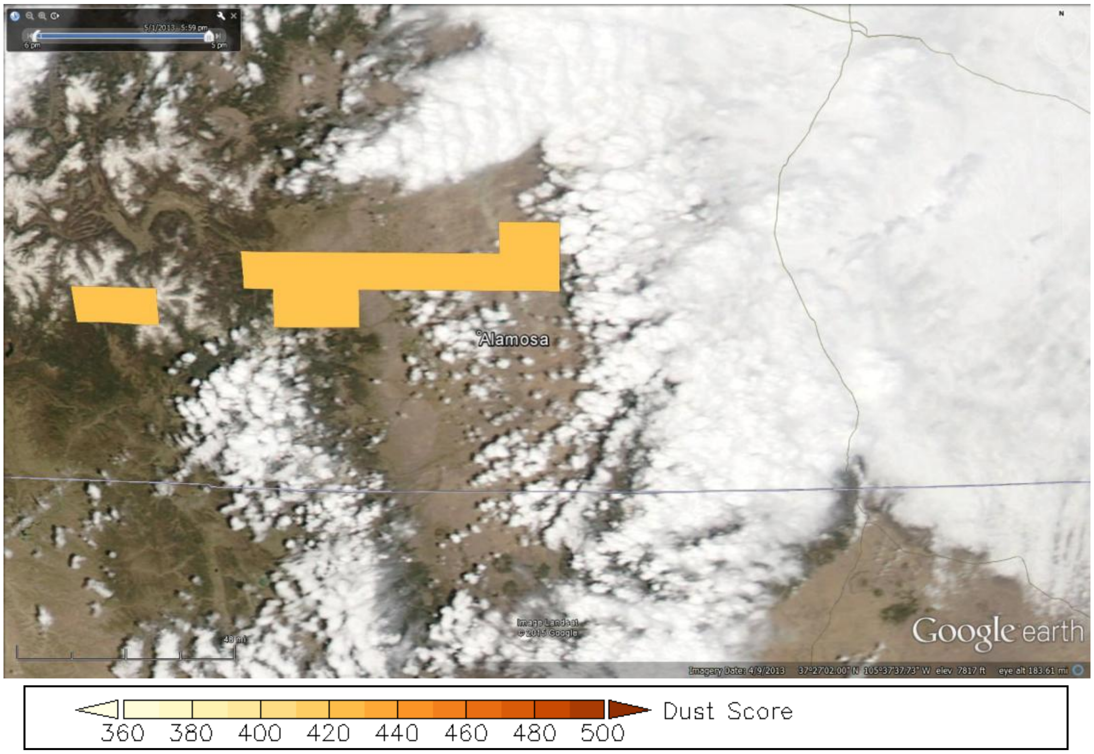
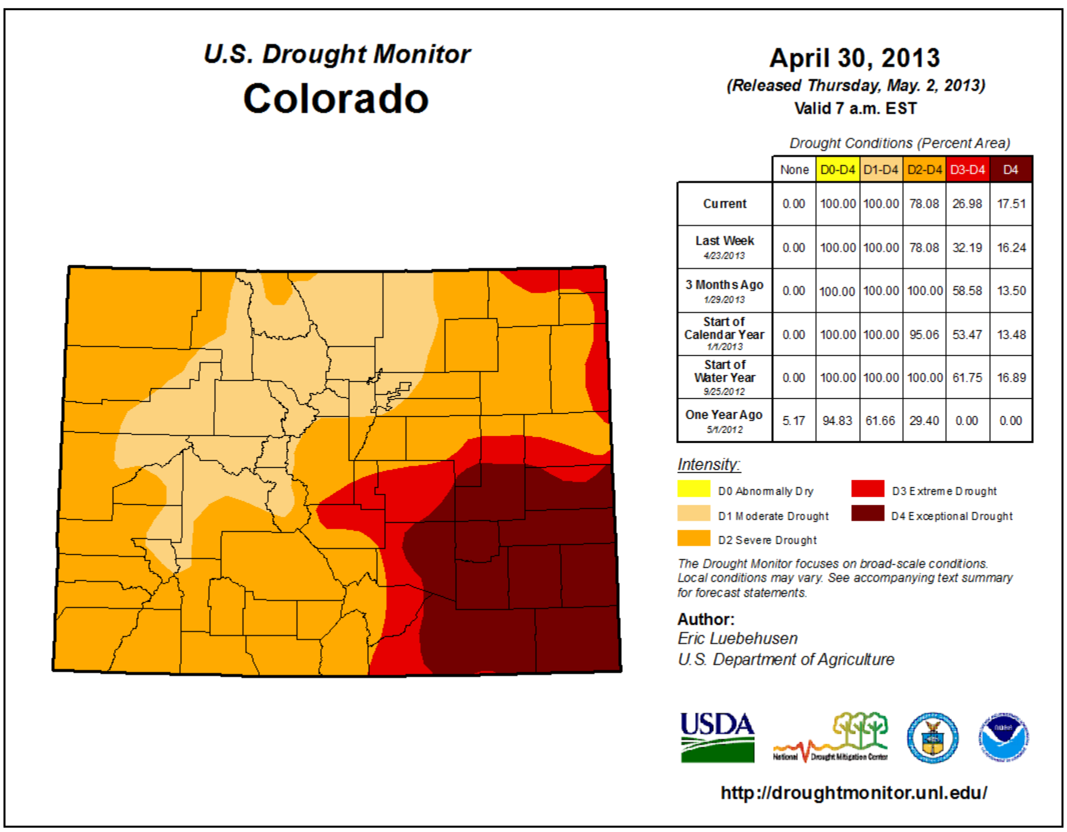


Figure 27: AIRS Dust Score from the MODIS Aqua satellite image at 1:50 PM MST (2050Z) May 1, 2013.
(Source: http://www.earthdata.nasa.gov/labs/worldview)

Figure 28: San Luis Valley Regional Airport webcam image taken during the evening hours (exact time unknown) of May 1, 2013.
(Source:
http://www.wunderground.com/webcams/NEalamosa/1/show.html?year=2013&month=05&time=evening&MR=1)

The synoptic weather conditions described above impacted a region that was in the midst of a severe drought (Figure 29). 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 30 shows the total precipitation in inches from April 1, 2013 through April 30, 2013 for 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 are more likely to occur in Colorado when combined with high winds (see the Lamar Blowing Dust Climatology and the Grand Junction Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx). Figure 30 clearly shows that the vast majority of the San Luis Valley, including the source region of the dust in the upwind (north) direction of Alamosa received less than 0.5 inches of precipitation during the 30-day period leading up to the May 1 dust event. The area immediately surrounding Alamosa was especially dry with less than 0.1 inches of precipitation over the previous 30 days.

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in the San Luis Valley of south-central Colorado were dry enough to produce blowing dust when combined with high winds. This information, combined with other evidence provided in this report, proves that this dust storm was a natural event that was not reasonably controllable or preventable.



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	78.08	26.98	17.51
Last Week 4/23/2013	0.00	100.00	100.00	78.08	32.19	16.24
3 Months Ago 1/29/2013	0.00	100.00	100.00	100.00	58.58	13.50
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 5/1/2012	5.17	94.83	61.66	29.40	0.00	0.00

Figure 29: Drought conditions for Colorado at 5:00 AM MST April 30, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

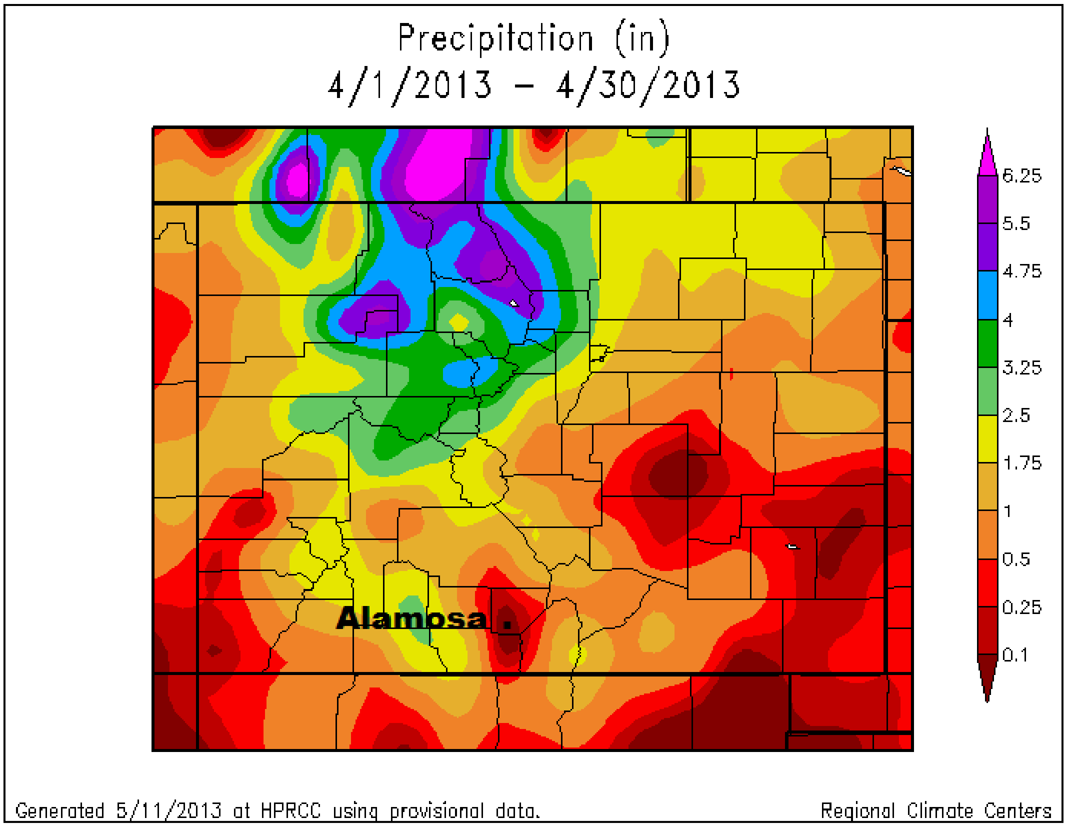


Figure 30: Total precipitation in inches for Colorado, April 1, 2013 – April 30, 2013. (Source: http://www.hprcc.unl.edu/maps/current/)

2.4 May 31, 2013 Meteorological Analysis

On May 31, 2013, a powerful spring storm system caused an exceedance of the 24-hour PM_{10} standard in Alamosa, Colorado at the Municipal Building (08-003-0003) monitor with a concentration of 204 µg/m^3 and at the Adams State College (08-003-0001) monitor with a concentration of 193 µg/m^3. These readings and the location of the monitors are plotted on the map of the Greater Alamosa area in Figure 31. The exceedances in Alamosa were the result of intense surface winds produced by a strong pressure gradient between two vastly contrasting air masses. 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 the dry soils of the northern San Luis Valley, producing significant blowing dust.

High PM10 Natural Event in Colorado (May 31, 2013)

Figure 31: 24-hour PM_{10} concentrations for May 31, 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 31, 2013 in Figure 32 and Figure 33, respectively. The 700 mb level is located roughly 3 kilometers (km) 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 in the hours preceding the blowing dust event of May 31 and that it was moving over the western United States. This is a typical upper-air pattern for blowing dust events in Colorado (see the Technical Support Document for the April 3, 2011 Alamosa and Lamar Exceptional Event at http://www.colorado.gov/airquality/tech_doc_repository.aspx).

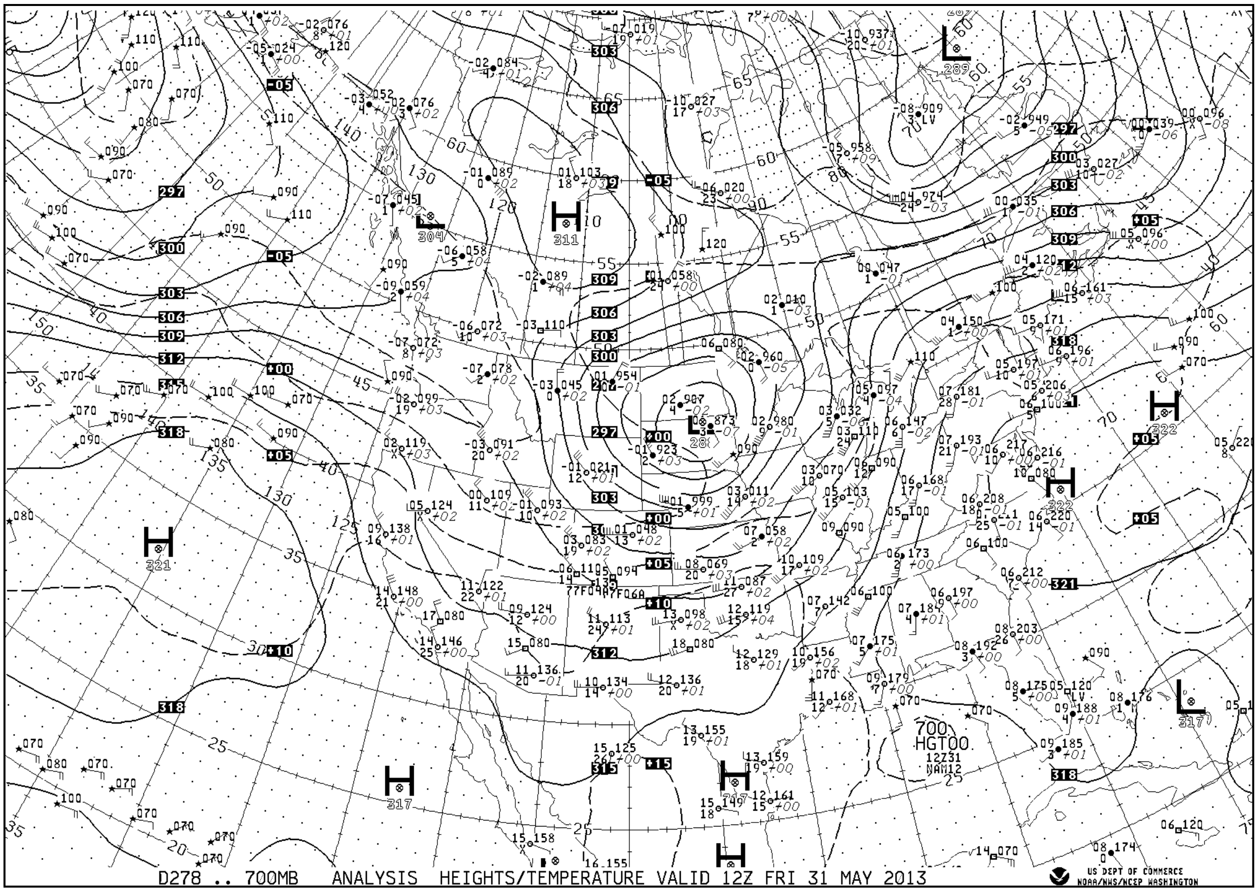


Figure 32: 700 mb (about 3 kilometers above mean sea level) analysis for 12Z May 31, 2013, or 5:00 AM MST May 31, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

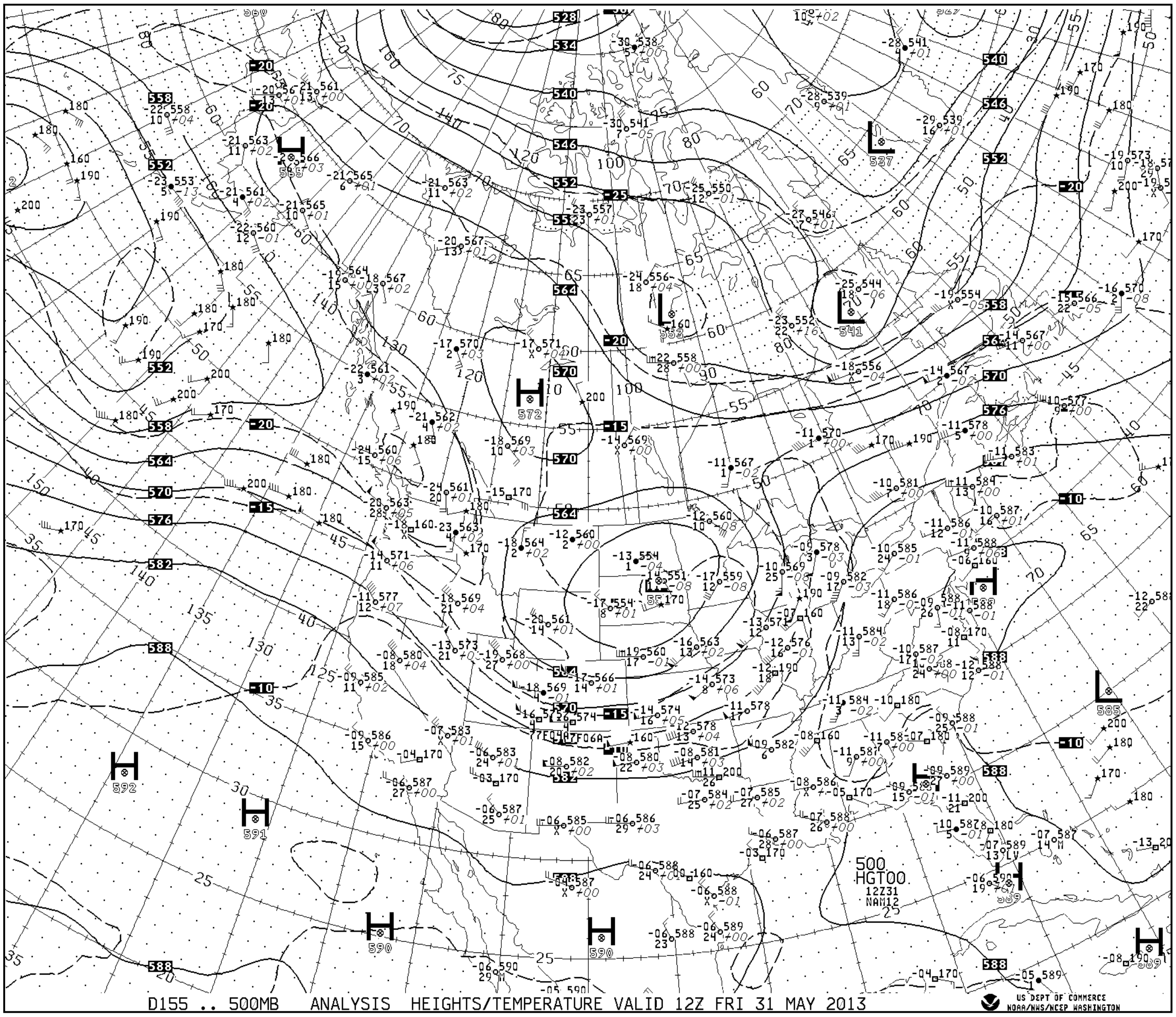


Figure 33: 500 mb (about 6 kilometers above mean sea level) analysis for 12Z May 31, 2013, or 5:00 AM MST May 31, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

The surface weather associated with the storm system of May 31, 2013, is presented in Figure 34. Significant surface features impacting southern Colorado at 2:00 PM MST (21Z) included an intensifying low pressure system in southeast Colorado and a building ridge of high pressure in western parts of Colorado. The interaction between the low and high pressure areas produced a strengthening pressure gradient in south-central parts of Colorado. This strong gradient is represented by the tight "bunching" of isobars which are readily visible over south-central Colorado. Wind speed is directly proportional to the pressure gradient. Hence, 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 tight pressure gradient contributed to the high winds which produced blowing dust in the San Luis Valley of south-central Colorado during the afternoon and evening of May 31, 2013.

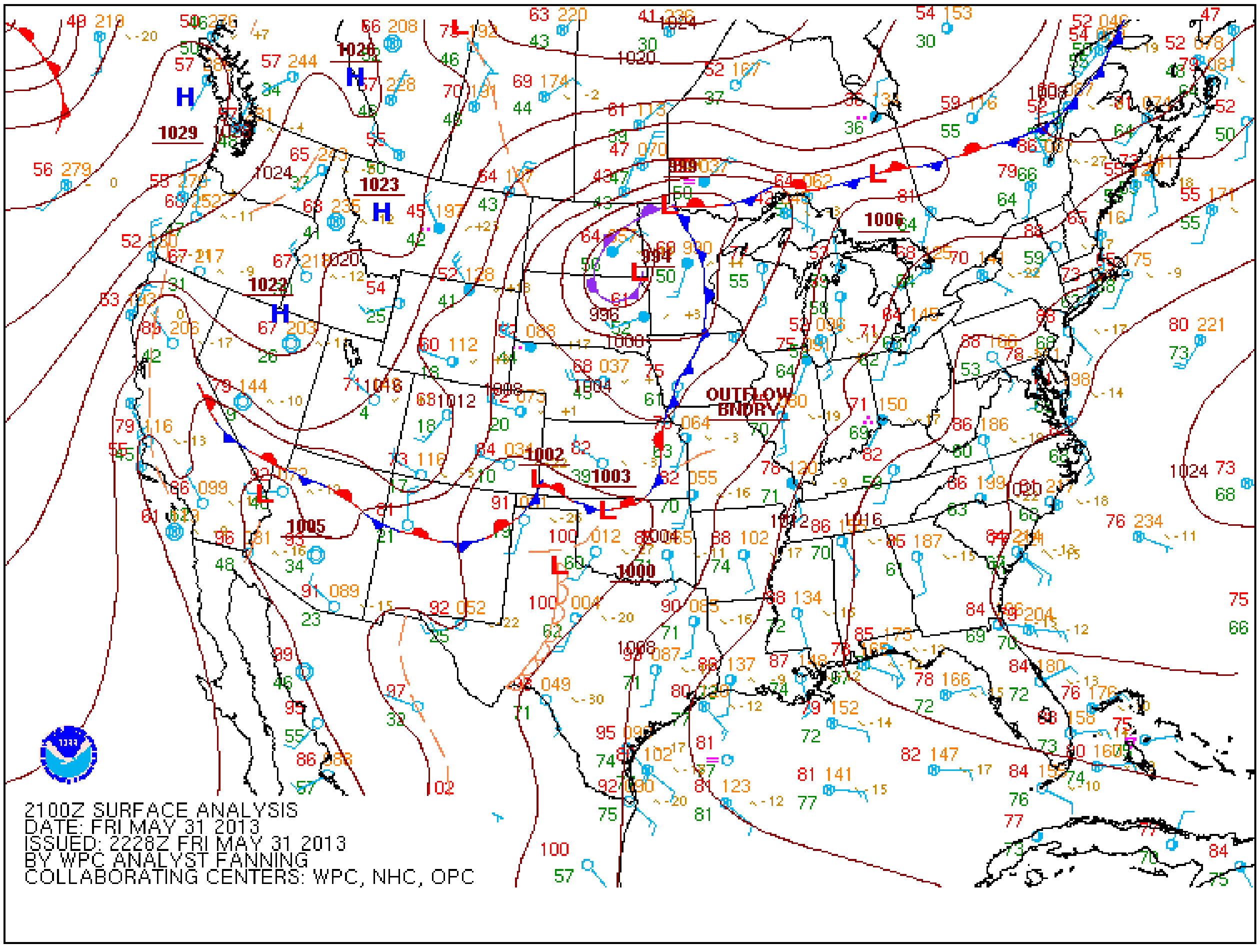


Figure 34: Surface analysis for 21Z May 31, 2013, or 2:00 PM MST May 31, 2013. (Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

In order to fully evaluate the synoptic meteorological scenario of May 31, 2013, a regional surface weather map is provided showing individual station observations during the height of the event in question. Figure 35 presents weather observations for southern Colorado and northern New Mexico at 4:43 PM MST on May 31. On the map in Figure 35 the station observation for Alamosa (circled in red) shows two full flags and one half flag indicating sustained winds of 25 knots (29 mph) with gusts to 35 knots (40 mph). Additionally, the observation includes visibility reduced to 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.erh.noaa.gov/er/box/glossary.htm).

Hourly surface observations, in table form, from Alamosa provide supporting evidence that there was an extended period of high winds and haze within the region. Table 6 lists observations for the PM_{10} exceedance location of Alamosa. Observations that are climatologically consistent with blowing dust conditions (see the Lamar Blowing Dust Climatology and the Grand Junction Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx) are highlighted in yellow. It is clearly evident that Alamosa 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 indicate that a dust storm occurred under northerly flow in the San Luis Valley of south-central Colorado. This data provides clear evidence of an extended period of high winds which produced blowing dust on May 31, 2013.

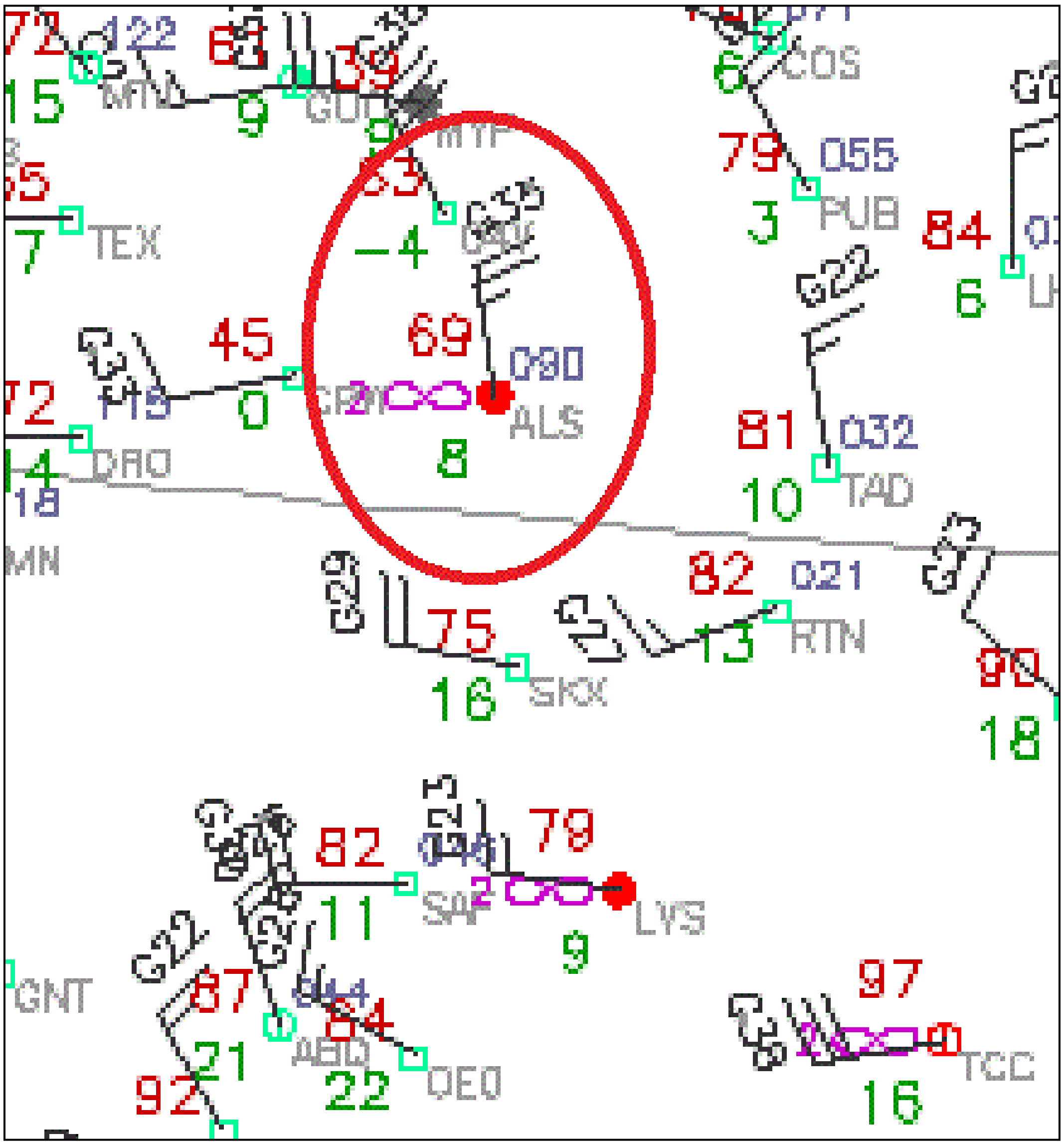


Figure 35: Regional surface analysis of southern Colorado and northern New Mexico at 4:43 PM MST, May 31, 2013.
(Source: http://nomads.ncdc.noaa.gov/ncep/NCEP)

Table 6: Weather observations for Alamosa, Colorado, on May 31, 2013.
(Source: http://mesowest.utah.edu/)

Time MST May 31, 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	45	35	7		20		10
1:52	45	35	9		30		10
2:52	37	50	6		250		10
3:52	33	58	5		280		10
4:52	31	63	4		270		10
5:52	40	48	4		240		10
6:52	49	34	0				10
7:52	56	25	14	18	360		10
8:52	59	23	13	20	10		10
9:52	61	21	6		350		10
10:52	65	18	7		210		10
11:52	68	17	13	17	200		10
12:52	72	10	6				10
13:52	74	6	21	30	320		10
14:52	73	9	24	40	350	haze	5
15:18	72	9	25	36	360	haze	1.75
15:52	69	9	28	40	350	haze	2
16:41	68	9	28	38	350	haze	4
16:52	66	9	29	38	350	haze	5
17:52	64	11	25	40	350		7
18:20	63	12	32	45	350	haze	3
18:52	60	12	25	39	350	haze	5
19:16	59	13	25	36	340	haze	6
19:26	57	14	27	36	340		9
19:52	56	14	27	36	360		10
20:52	54	15	16	25	360		10
21:52	53	16	10		360		10
22:52	47	21	7		330		10
23:52	39	28	0				10

Infrared satellite imagery from May 31, 2013 indicates that dust caused the PM_{10} exceedance in Alamosa. Figure 36(a) displays the 2:00 PM MST infrared satellite image zoomed on the San Luis Valley of south-central Colorado. This image shows little of note with generally clear conditions around the Alamosa area. This corresponds well with the 1:52 PM MST Alamosa surface observation (Table 6) with no haze reported and visibility considered good at 10 statute miles. One hour later at 3:00 PM MST, the satellite image had changed quite dramatically. Notice the low-intensity radiation "plume" that has appeared to the north and east of the Alamosa area. By referring back to Table 6, we can see that at 2:52 PM MST (8 minutes before the satellite image of Figure 36(b)), the observation of haze appears and visibility had dropped dramatically to 5 statute miles. This strongly suggests that the "plume" seen in Figure 6(b) is indeed airborne dust. The plume becomes even more expansive at 4:00 PM MST in Figure 6(c) with blowing dust reaching the New Mexico state line. At this point, nearly the entire northern and eastern half of the San Luis Valley was shrouded in dust. This aligns with the Alamosa surface observation of 3:52 PM MST (Table 6) with haze reported and visibility highly obscured at 2 statute miles.

Webcam imagery from the San Luis Valley firmly supports the conclusion that a dust storm took place during the afternoon of May 31, 2013. The 3:32 PM MST webcam image of Figure 37 shows significant amounts of airborne dust with the horizon almost completely obscured. This image was taken from the San Luis Valley Regional Airport in Alamosa with the view to the northeast.

The National Oceanic and Atmospheric Administration (NOAA) Satellite Services Division is in full agreement with the conclusion that blowing dust was occurring in the San Luis Valley on May 31, 2013. The Smoke Text Product from NOAA at 7:30 PM MST stated:

> "An area of blowing sand/dust was visible originating from south central Colorado, near the Great Sand Dunes National Park. Blowing sand/dust moved south/southeast into northern New Mexico beginning at 2045Z, and continued through sunset." (Source: http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2013/2013F010341.html)

Additionally, the Colorado Department of Public Health and Environment issued a Blowing Dust Advisory at 1:30 PM MST in anticipation of the blowing dust event of May 31, 2013. Text from this advisory included:

> "Strong gusty winds will produce areas of blowing dust Friday afternoon and evening…Expect dust to be most widespread in the San Luis Valley and along the I-25 corridor from Pueblo southward to the New Mexico state line. (Source: http://www.colorado.gov/airquality/forecast_archive.aspx?seeddate=05%2f31%2f2013)

Satellite and webcam imagery combined with reports from government agencies clearly reveal that a dust storm was anticipated and did take place in the San Luis Valley of south-central Colorado on May 31, 2013, which was neither controllable nor preventable.

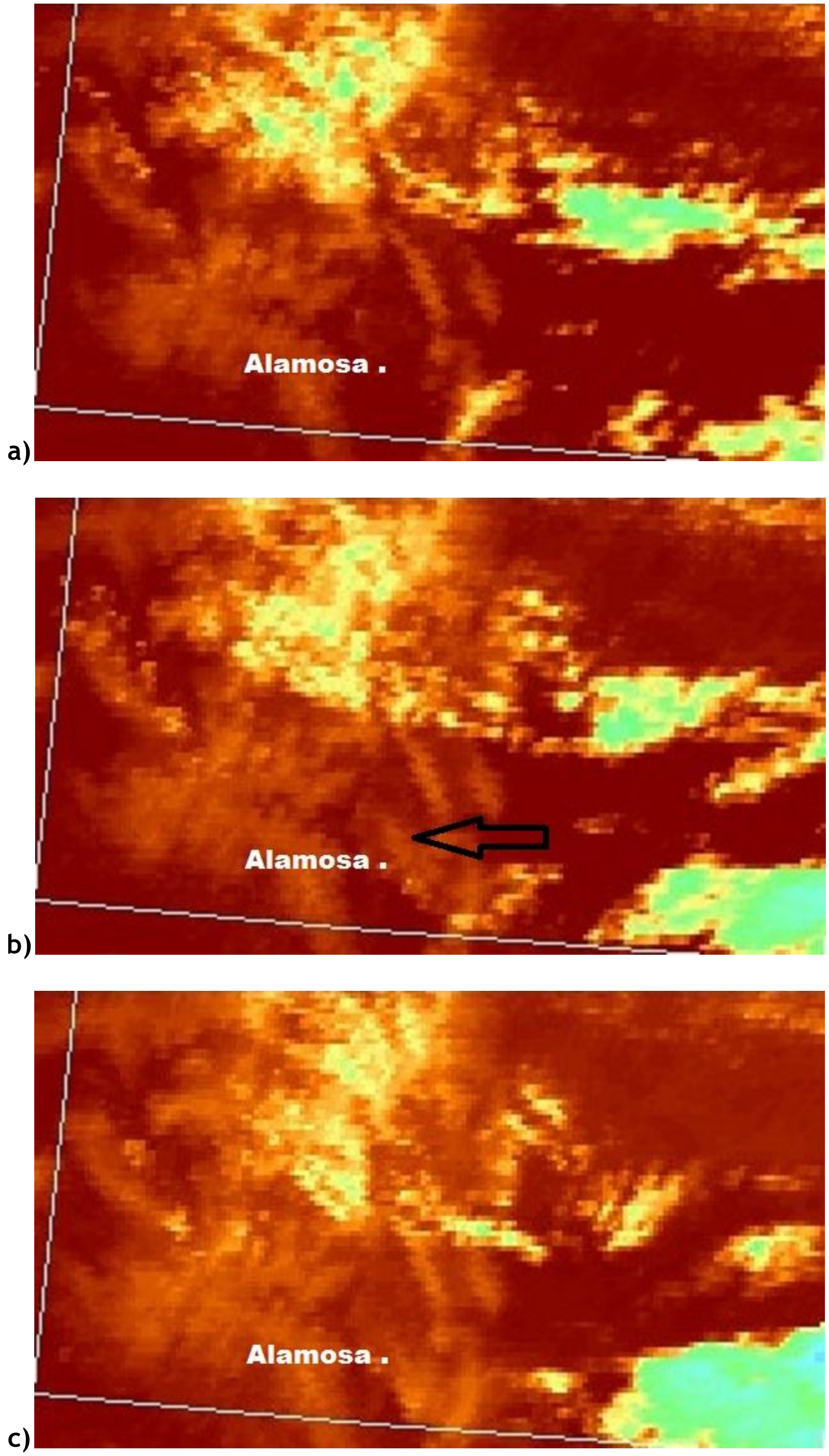


Figure 36: GOES infrared satellite image at a) 2:00 PM MST, b) 3:00 PM MST, and c) 4:00 PM MST, May 31, 2013.
(Source: http://www2.mmm.ucar.edu/imagearchive/)

Figure 37: San Luis Valley Regional Airport webcam image at 3:32 PM MST May 31, 2013. (Source: http://www.airportview.net/wx/usa/co/kals/depotav/camera1/viewer.php)

The synoptic weather conditions described above impacted a region that was in the midst of a severe 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 May 1, 2013 through May 30, 2013 for southern Colorado and northern New Mexico. 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 are more likely to occur in Colorado when combined with high winds (see the Lamar Blowing Dust Climatology and the Grand Junction Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx). Figure 39 clearly shows that the vast majority of the San Luis Valley, including those areas upwind (north) of Alamosa received less than 0.51 inches of precipitation during the 30-day period leading up to the May 31, 2013 dust event.

The U.S. Drought Monitor and 30-day precipitation totals indicate that soils in the San Luis Valley of south-central Colorado were dry enough to produce blowing dust when combined with high winds. This information, combined with other evidence provided in this report, proves that this dust storm was a natural event that was not reasonably controllable or preventable.

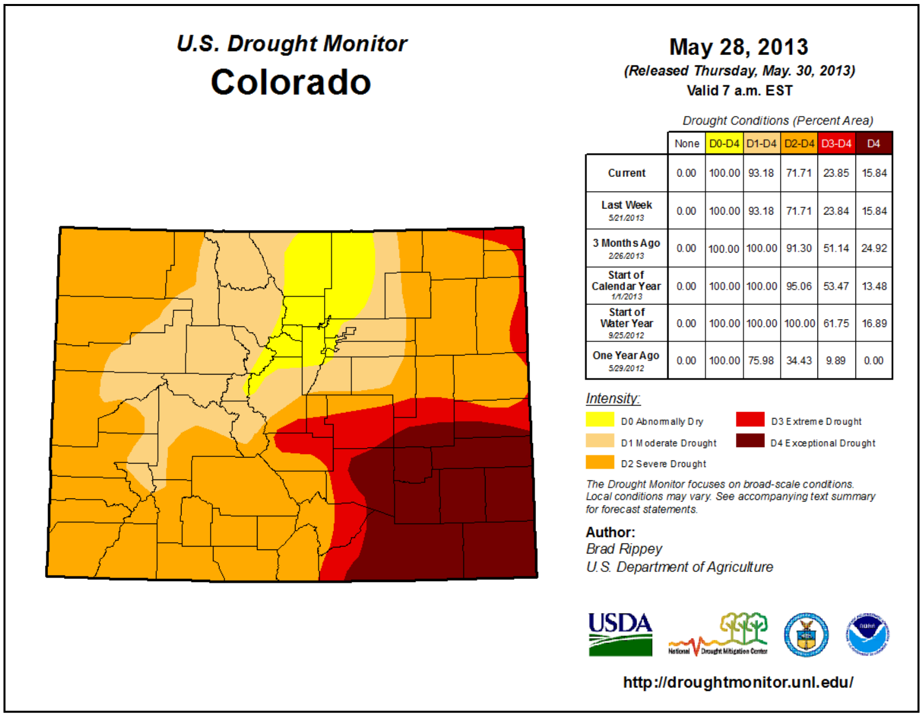


Figure 38: Drought conditions for Colorado at 5:00 AM MST May 28, 2013. (Source: http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx)

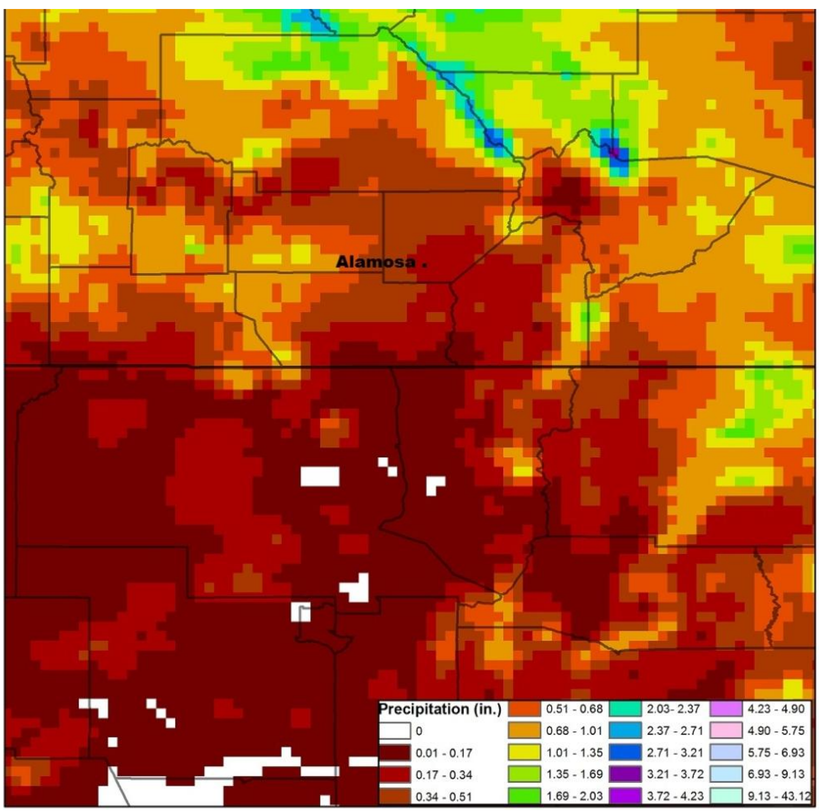


Figure 39: Total precipitation in inches for southern Colorado and northern New Mexico, May 1, 2013 – May 30, 2013.
(Source: http://prism.nacse.org/recent/)

3.0 Evidence - Ambient Air Monitoring Data and Statistics

Multiple intense fronts moved across southern Colorado in 2013. Several of these transported blowing dust into Alamosa from source regions outside of the monitoring area. Ambient Air Monitoring Data and Statistics for the events occurring on April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013 are discussed in this section.

3.1 April 8, 2013 Monitoring Data and Statistics

On April 8, 2013, a strong upper atmospheric trough combined with an intensifying surface low pressure system and strong cold front 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 southern Colorado and northern New Mexico, producing significant blowing dust. During this interval a PM_{10} sample value greater than 150 µg/m^3 was recorded at Alamosa Municipal (Alamosa Muni, 162 µg/m^3). Additionally, exceptionally high samples (greater than the 90th percentile for the site) was recorded at the PM_{10} monitors in Alamosa Adams State College (Alamosa ASC, 111 µg/m^3), Pagosa Springs (147 µg/m^3), and Lamar (137 µg/m^3).

3.1.1 Historical Fluctuations of PM_{10} Concentrations in Alamosa

This evaluation of PM_{10} monitoring data for sites affected by the April 8, 2013, event was made using valid samples from the PM_{10} sampler at Alamosa Muni from 2008 through the end of 2013. APCD has been monitoring PM_{10} concentrations at this site since 1985. Data in this analysis for sites affected by the event are from January 2008 through the end of 2013. The overall data summary for the affected sites is presented in Table 7, with all data values presented in µg/m^3.

Table 7: April 8, 2013, Event Data Summary

	Alamosa Muni
04/08/2013	**162**
Mean	28.9
Median	23
Mode	18
St. Dev	27.42
Var.	751.82
Minimum	1
Maximum	635
Percentile	99.4%
Count	1851

Alamosa Municipal – 080030003

The PM_{10} sample on April 8, 2013 at Alamosa Muni of 162 µg/m^3 is the 12th largest sample in the entire data set and exceeds 99% of all samples from 2008 through 2013. The eleven samples greater than the event sample are all associated with high wind events. There are 1,851 samples in this dataset. The sample of April 8, 2013 clearly exceeds the typical samples for this site.

Figure 40 and Figure 41 graphically characterize the Alamosa Muni PM_{10} data. The first, Figure 40, is a simple time series; every sample in this dataset (2008 – 2013) 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 1,851 samples in this data set, less than 1% are greater than 100 µg/m^3.

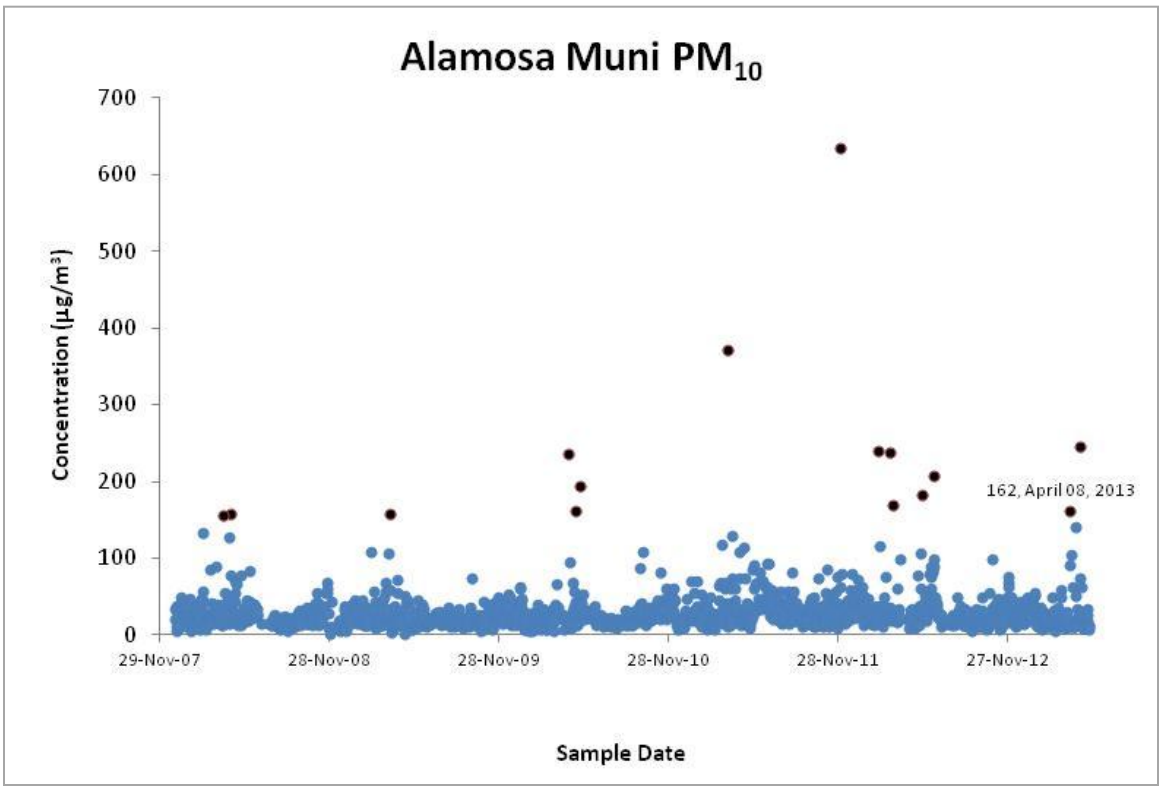


Figure 40: Alamosa Muni PM_{10} Time Series, 2008-2013

The monthly box-whisker plot in Figure 41 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 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.

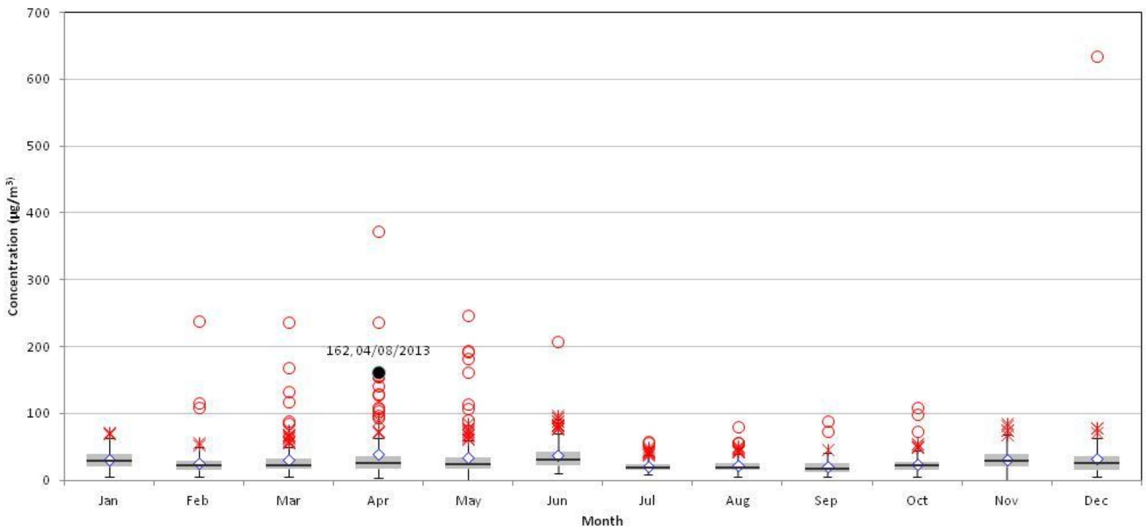


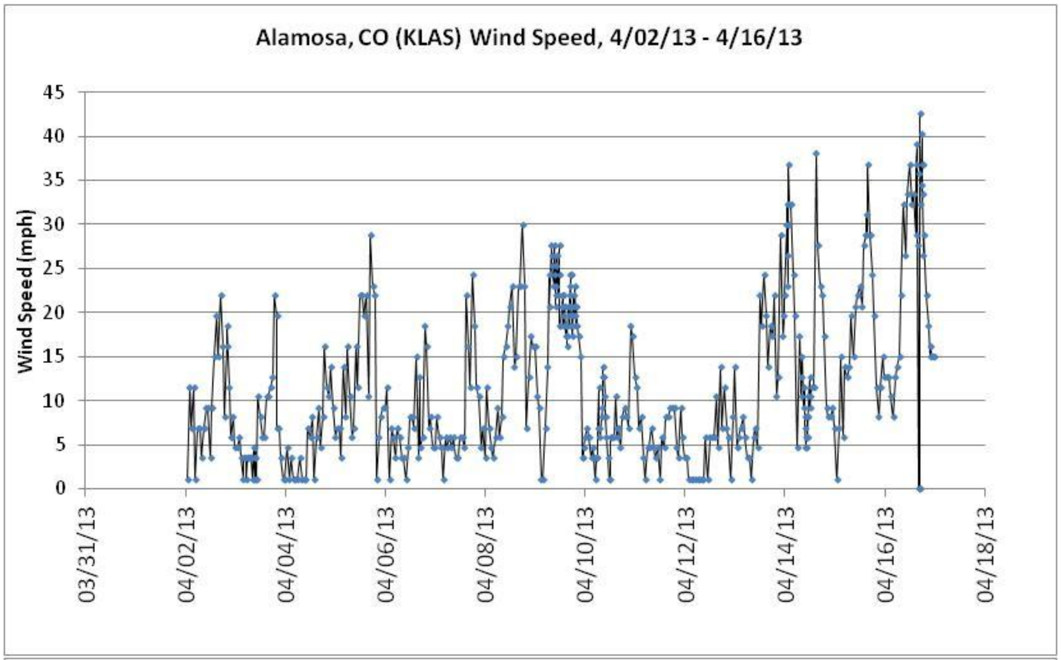
Figure 41: Alamosa Muni PM_{10} Box-whisper Plot, 2008-2013

The box-whisper plots graphically represent the overall distribution of each data set including the mean (◇), the inner quartile range (IQR, defined to be the distance between the 75th% and 25th%), the median (represented by the horizontal black line) and two types of outliers identifed in these plots: outliers greater than 75th% +1.5*IQR (✳)and outliers greater than 75th% + 3*IQR (○). At Alamosa ASC every sample greater than 150 µg/m^3 are associated with a known high-wind event similar to that of April 8, 2013.

Note the degree to which the data in the months of winter and spring, including April, is skewed. The April mean (39.4 µg/m^3) is greater than the April 75th percentile value. This 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 as the typical data is similar to every other month of the year. The sample of April 8, 2013 clearly exceeds the typical data at this site.

3.1.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased late in the evening of April 8, 2013, and stayed elevated through April 9, 2013, gusting to speeds in excess of 40 mph. The charts in Figure 42 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.



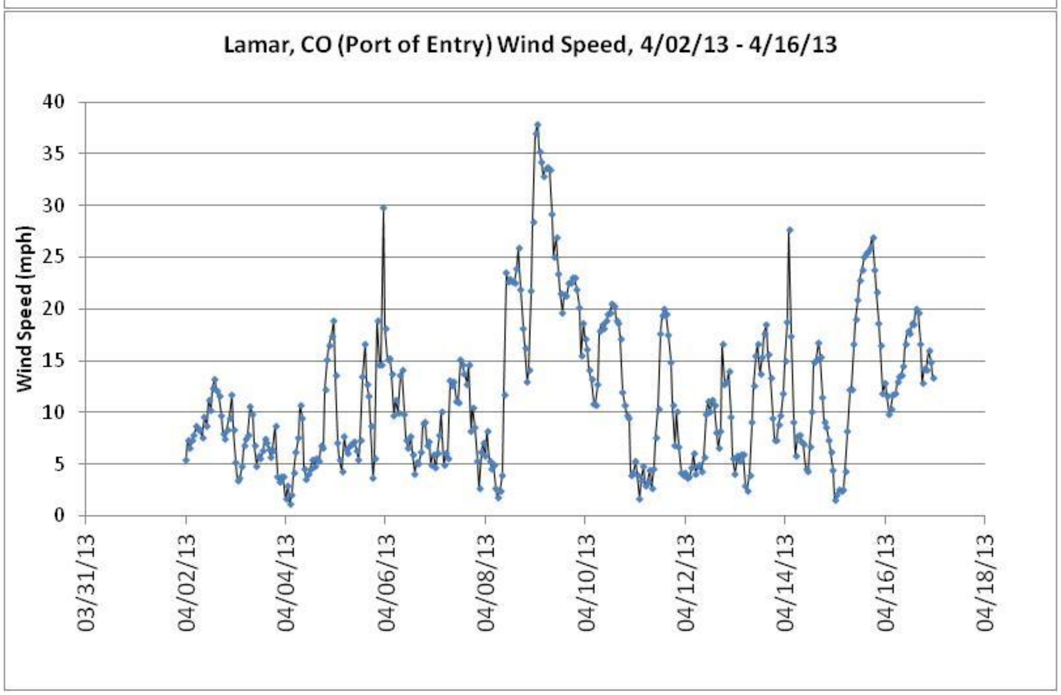


Figure 42: Wind Speed (mph), Alamosa and Lamar, CO, 4/02/2013 – 4/16/2013

Figure 43 plots PM_{10} concentrations from the affected sites for the period for seven days prior to and following the sample(s) of April 8, 2013.

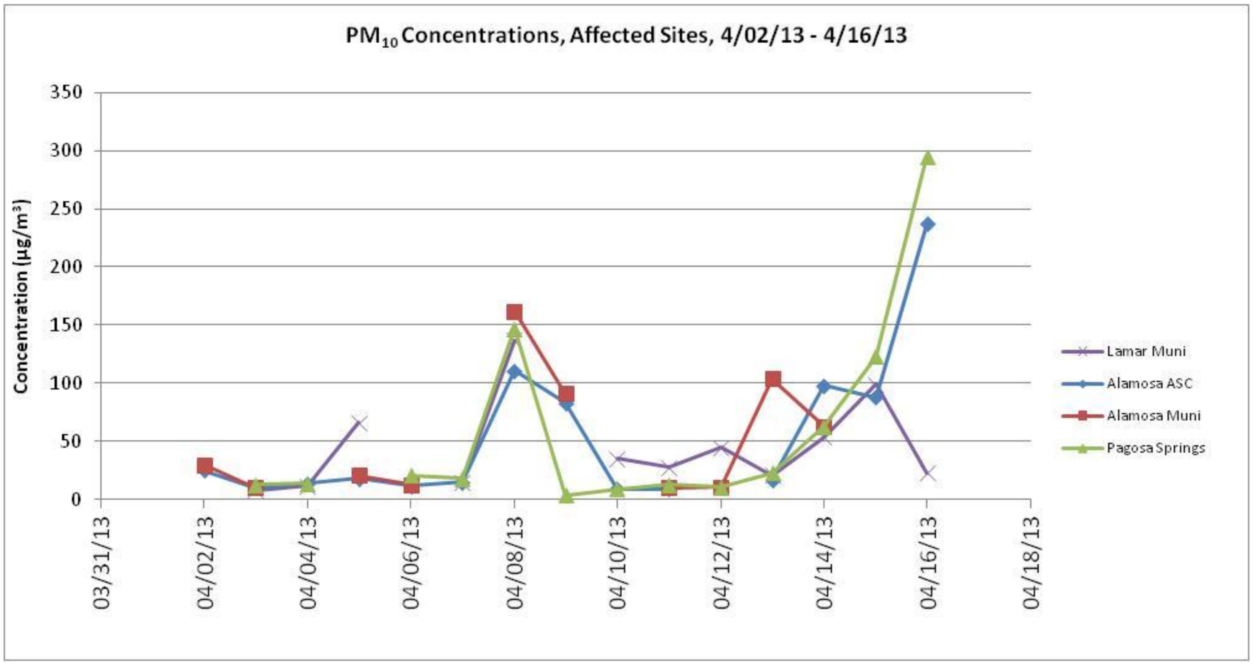


Figure 43: PM_{10} Concentrations, Affected Sites, 4/02/2013 – 04/16/2013

Figure 43 mimics the plots for wind speed, suggesting an association between the regional high winds and PM_{10} concentrations at the affected sites. As shown above, sites in Lamar and Pagosa Springs also experienced high values on April 8, 2013. These high sample values will be discussed seperately in Lamar and Pagosa Springs specific Exceptional Event Technical Support Documents but were included here to demonstrate the regional nature of this event. 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 Alamosa on April 8, 2013.

3.1.3 Percentiles

The monthly percentile plot for Alamosa Muni in Figure 44 demonstrates 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 Alamosa Muni and the monthly median is 0.56. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

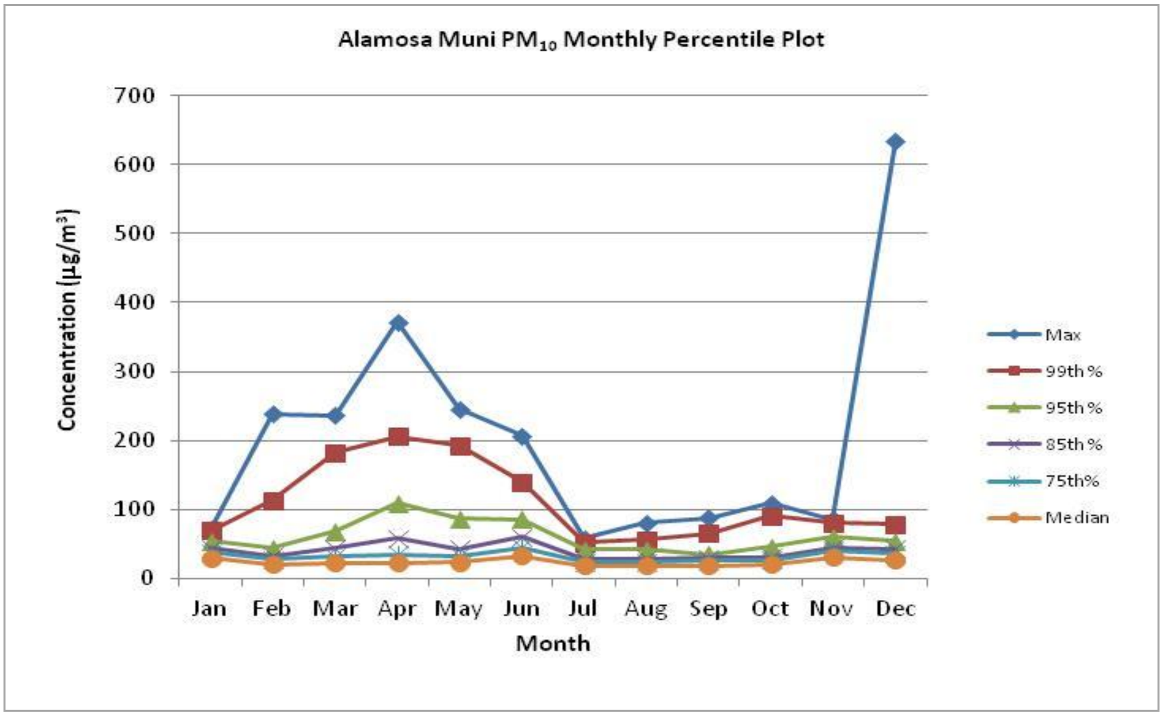


Figure 44: Monthly PM_{10} Percentile Plots, 2008-2013

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 (Alamosa Muni) 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 values of these data sets can be explained by the variation in monthly medians; for this site, the correlation between the median and monthly 75^{th} percentile values is $r^2 = 0.97$. A reasonable estimate of the contribution to the event from local sources for this data set may be the monthly 85^{th} percentile values, $r^2 = 0.79$. If these percentile values are taken as an estimate of event PM_{10} due to local variation, then the portion of the sample concentration remaining from these monthly percentile values would be the sample contribution due to the event.

Table 8 identifies various percentile values that are representative of the maximum contribution due to local sources for each site from all April data. In Table 8 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 8, 2013 sample at the sites listed in the table due to the high wind event.

Table 8: Estimated Maximum Event PM_{10} Contribution, 4/8/2013

Site	Event Day Concentration (µg/m³)	April Median (µg/m³)	April Average (µg/m³)	April 75th % (µg/m³)	April 85th % (µg/m³)	Est. Conc. Above Typical (µg/m³)
Alamosa Muni	**162**	26	39.4	36	60	**102 – 122**

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

3.2 April 23, 2013 Monitoring Data and Statistics

On April 23, 2013, intense surface winds following in the wake of a cold front moved across southern Colorado. These surface features were associated with a strong upper-level trough that was moving across the western United States. The strong northerly surface winds moving over dry soils transported dust into Alamosa. During this event a sample in excess of 150 µg/m³ were recorded at Alamosa Adams State College (Alamosa ASC, 184 µg/m³). An additional high sample was recorded at Alamosa Municipal (Alamosa Muni, 141 µg/m³).

3.2.1 Historical Fluctuations of PM_{10} Concentrations in Alamosa

This evaluation of PM_{10} monitoring data for sites affected by the April 23, 2013, event was made using valid samples from PM_{10} samplers in Alamosa from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Alamosa since 1985. The overall data summary for the affected sites is presented in Table 9, with all data values presented in µg/m³.

Table 9: April 23, 2013, Event Data Summary

	Alamosa ASC	*Alamosa Muni*
04/23/2013	**184**	**141**
Mean	23.9	28.8
Median	19	23
Mode	20	18
St. Dev	26.7	28.0
Var	710.2	782.4
Minimum	1	1
Maximum	440	635
Percentile	99.6%	99.9%
Count	1897	1795

Alamosa ASC – 080030001

The PM_{10} sample on April 23, 2013, at Alamosa ASC of 184 µg/m^3 is the 14th largest sample in the entire data set and exceeds 99% of all samples from 2009 through August 2014. The 13 samples greater than the event sample are all associated with high wind events. There are 1,897 samples in this dataset. The sample of April 23, 2013, clearly exceeds the typical samples for this site.

Figure 45 and Figure 46 graphically characterize the Alamosa ASC PM_{10} data. The first, Figure 45, 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 1,897 samples in this data set less than 1% is greater than 100 µg/m^3.

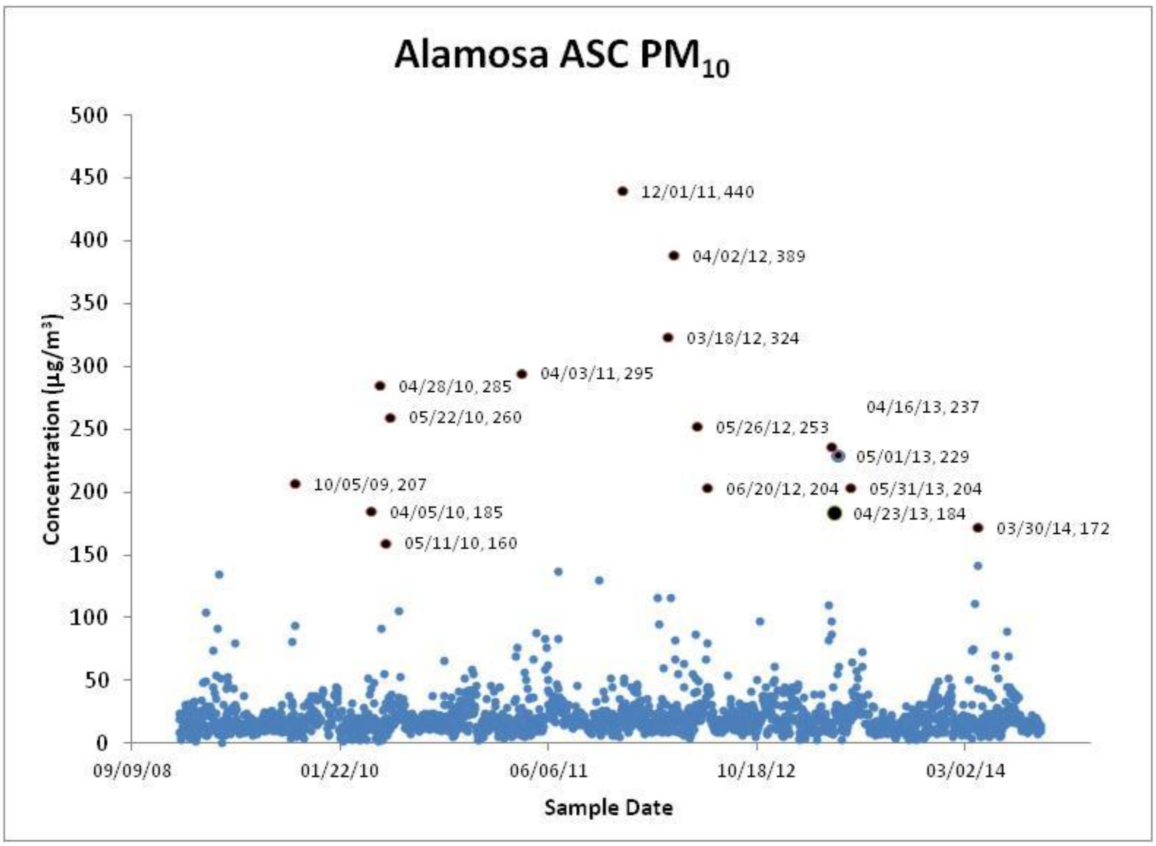


Figure 45: Alamosa Adams State College PM_{10} Time Series, 2009-2014

The monthly box-whisker plot in Figure 46 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 23, 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.

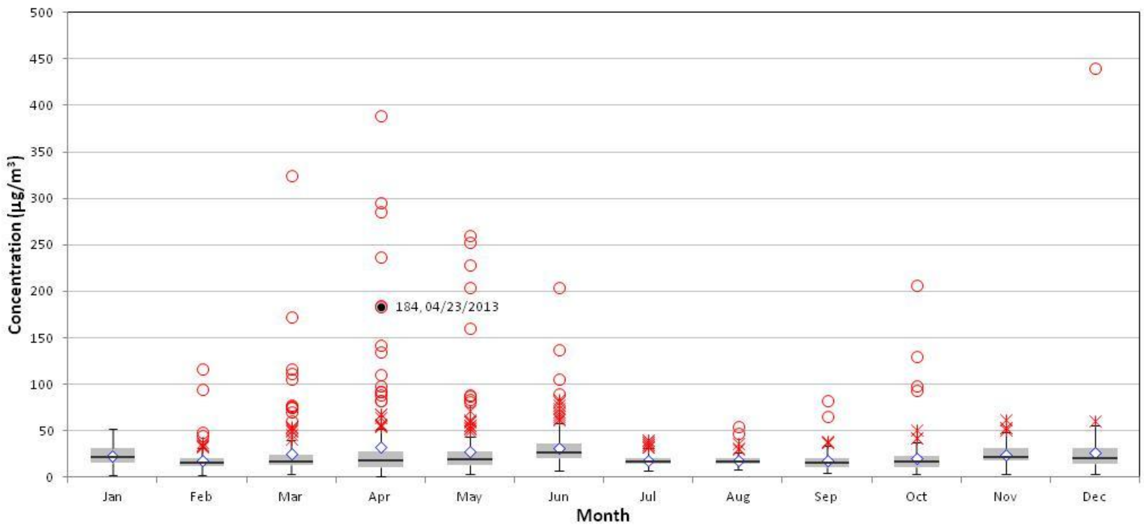


Figure 46: Alamosa Adams State College PM_{10} Box-whisper Plot, 2009-2014

The box-whisper plots graphically represent the overall distribution of each data set including the mean ( ), the inner quartile range (IQR, defined to be the distance between the 75^{th}% and 25^{th}%), the median (represented by the horizontal black line) and two types of outliers identifed in these plots: outliers greater than 75th% +1.5*IQR ( )and outliers greater than 75th% + 3*IQR ( ). At Alamosa ASC every sample greater than 150µg/m^3 are associated with a known high-wind event similar to that of April 23, 2013.

Note the degree to which the data in the months of winter and spring, including April, is skewed. The April mean (32.7 µg/m^3) is greater than the April 75^{th} percentile value (27.5 µg/m^3). This 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 as the typical data is similar to every other month of the year. The sample of April 23, 2013 clearly exceeds the typical data at this site.

3.2.2 Wind Speed Correlations

Wind speeds in southeast Colorado increased early afternoon of April 23, 2013 and stayed elevated through the late evening, with sustained hourly averages in excess of 20 mph and gusting to speeds in excess of 30 mph. Figure 47 displays wind speed (mph) as a function of date from a meteorological site within the affected area for a number of days before and after the event.

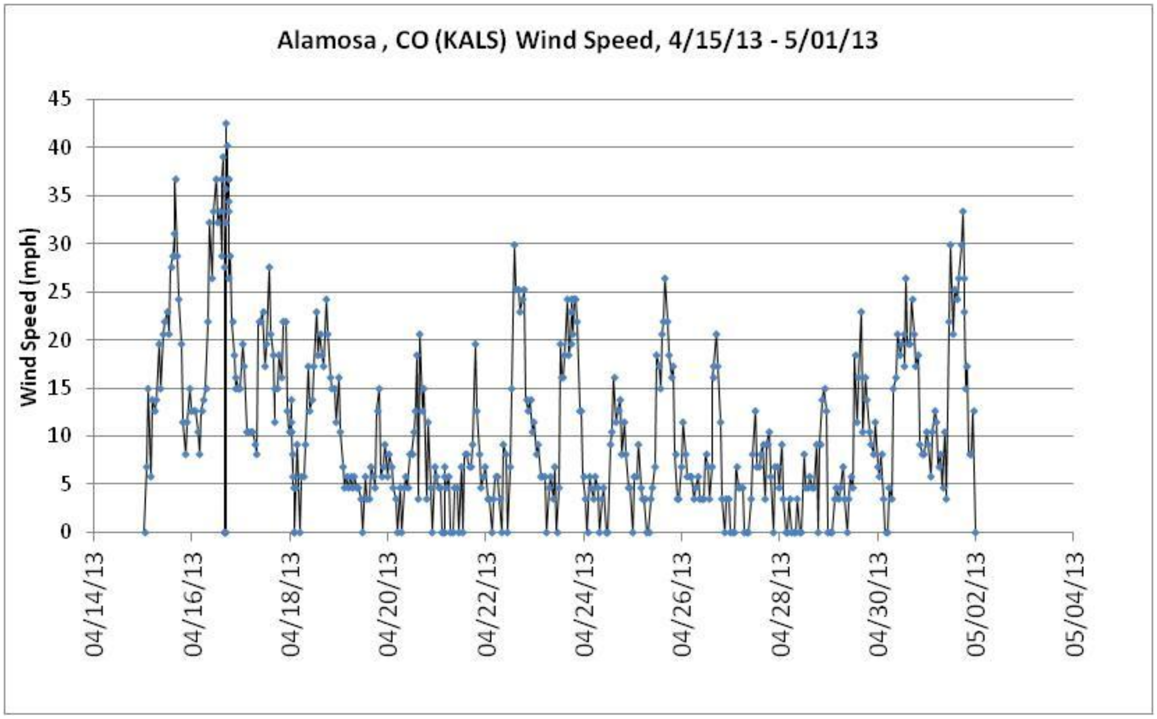


Figure 47:Wind Speed (mph), Alamosa, CO, CO, 4/15/2013 – 5/01/2013

Figure 48 plots PM_{10} concentrations from the affected sites for the period of seven days prior to and following the sample(s) of April 23, 2013.

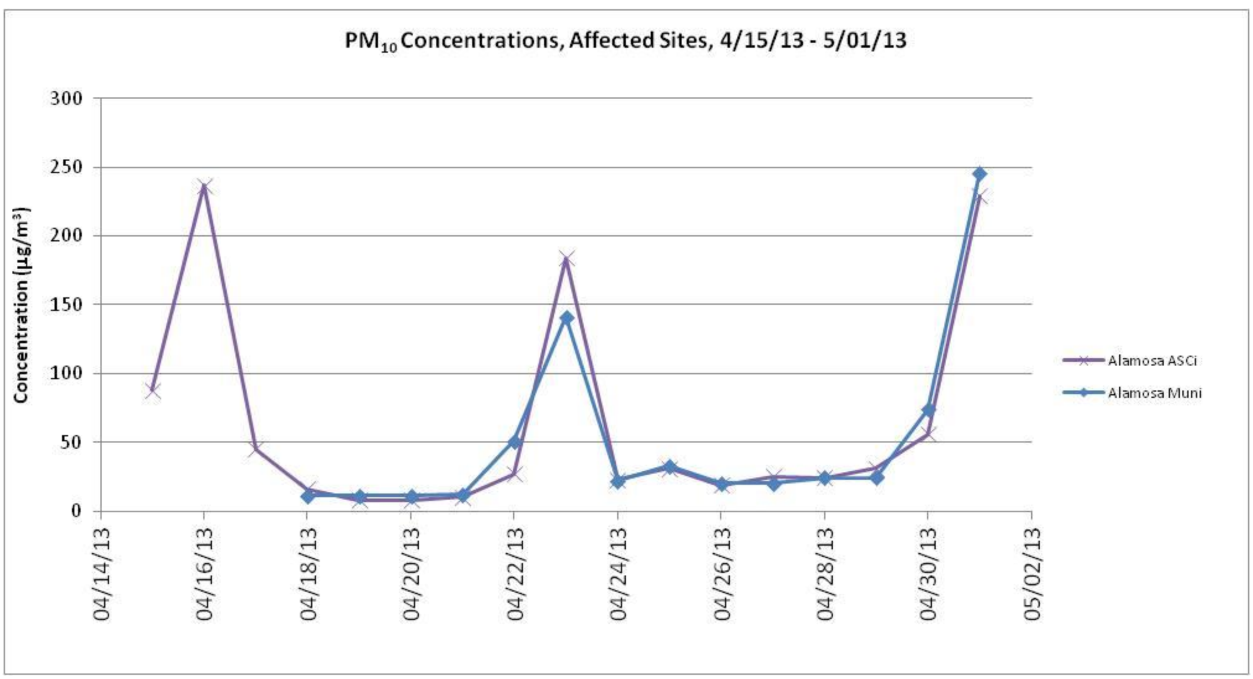


Figure 48:PM_{10} Concentrations, Alamosa, CO, 4/15/2013 – 05/01/2013

Figure 48 mimics the plots for wind speed, suggesting an association between the high surface 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. Given the spatial dislocation of the sites the relationship between the two data sets would suggest that the high winds had an effect on PM_{10} samples in Alamosa on April 23, 2013.

3.2.3 Percentiles

Monthly percentile plots for Alamosa sites in Figure 49 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 Alamosa Muni and the monthly median is 0.57. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

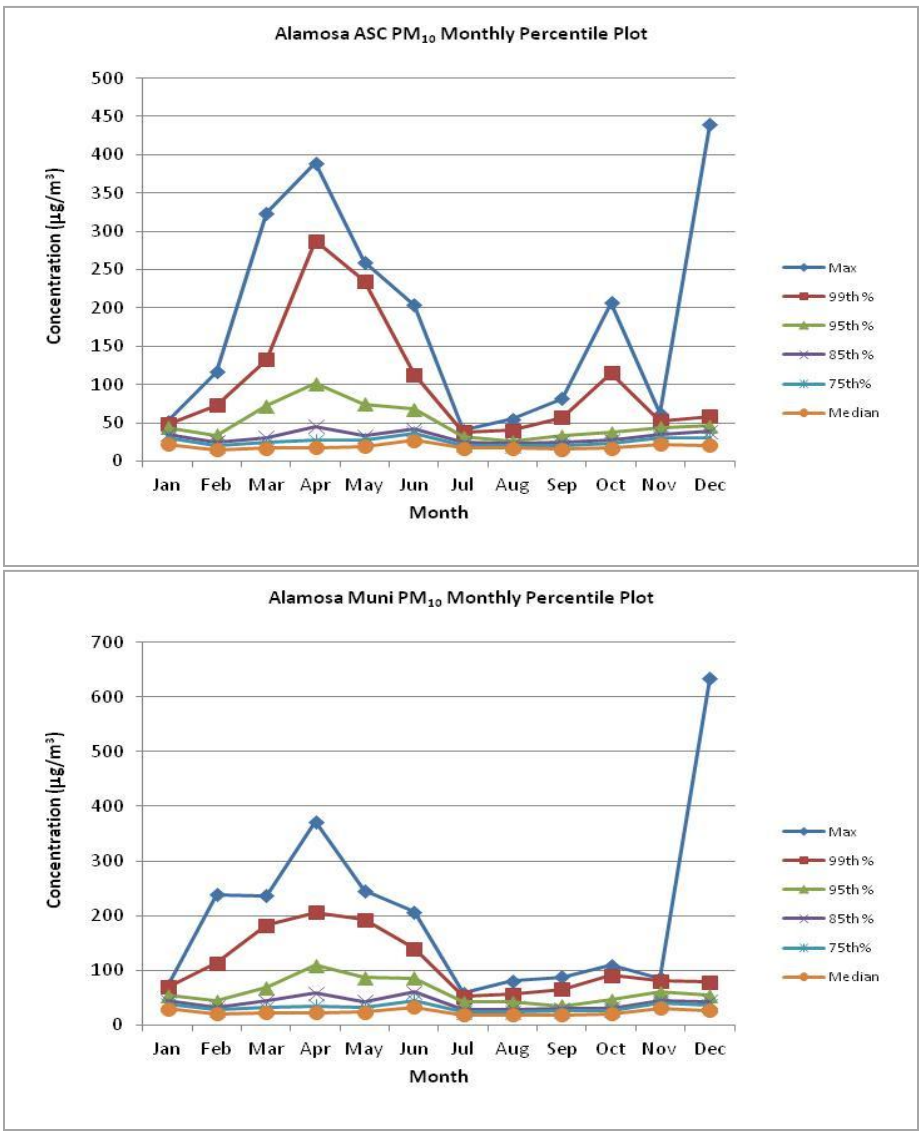


Figure 49: Monthly PM_{10} Percentile Plots, 2009-2014

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 (Alamosa ASC) 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 these three data sets can be explained by the variation in monthly medians; the correlation between the Alamosa ASC monthly median and monthly 75th percentile values is $r^2 = 0.94$. A reasonable estimate of the contribution to the event from local sources for these data sets may be the monthly 85th percentile values; the correlation between the median and the monthly 85th percentile values is $r^2 = 0.66$. If these percentile values are taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from these monthly percentile values would be the sample contribution due to the event.

Table 10 identifies various percentile values that are representative of the maximum contribution due to local sources for each site from all April data for the sample date. In Table 10 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 April 23, 2013 sample at Alamosa ASC due to the high wind event.

Table 10: Estimated Maximum Event PM_{10} Contribution, 4/23/2013

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)
Alamosa ASC	**184**	17.5	32.7	27.5	45.8	**138 - 156**

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 east to northeasterly post-frontal winds transported blowing dust into Alamosa. These winds transported dust into Alamosa from the eastern side of the San Luis Valley. Additional dust likely arrived in Alamosa from the eastern plains via Medano and Mosca Passes. The strong winds generated from the cold front's passing affected PM_{10} samples at multiple sites in Alamosa, CO. During this event samples in excess of 150 $\mu g/m^3$ were recorded at Alamosa Adams State College (Alamosa ASC, 229 $\mu g/m^3$) and Alamosa Municipal (Alamosa Muni, 246 $\mu g/m^3$).

3.3.1 Historical Fluctuations of PM_{10} Concentrations in Alamosa

This evaluation of PM_{10} monitoring data for sites affected by the May 1, 2013, event was made using valid samples from PM_{10} samplers in Alamosa from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Alamosa since 1985. The overall data summary for the affected sites is presented in Table 11, with all data values presented in $\mu g/m^3$.

Table 11: May 1, 2013, Event Data Summary

	Alamosa ASC	*Alamosa Muni*
05/01/2013	**229**	**246**
Mean	23.9	28.8
Median	19	23
Mode	20	18
St. Dev	26.7	28.0
Var	710.2	782.4
Minimum	1	1
Maximum	440	635
Percentile	99.6%	99.9%
Count	1897	1795

Alamosa ASC – 080030001

The PM_{10} sample on May 1, 2013 at Alamosa ASC of 229 $\mu g/m^3$ is the ninth largest sample in the entire data set and exceeds 99% of all samples from 2009 through August 2014. The eight samples greater than the event sample are all associated with high wind events. There are 1,897 samples in this dataset. The sample of May 1, 2013 clearly exceeds the typical samples for this site.

Figure 50 and Figure 51 graphically characterize the Alamosa ASC PM_{10} data. The first, Figure 50, is a simple time series; every sample in this dataset (2009 – 2014) greater than 150 $\mu g/m^3$ 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 $\mu g/m^3$. Of the 1,897 samples in this data set less than 1% is greater than 100 $\mu g/m^3$.

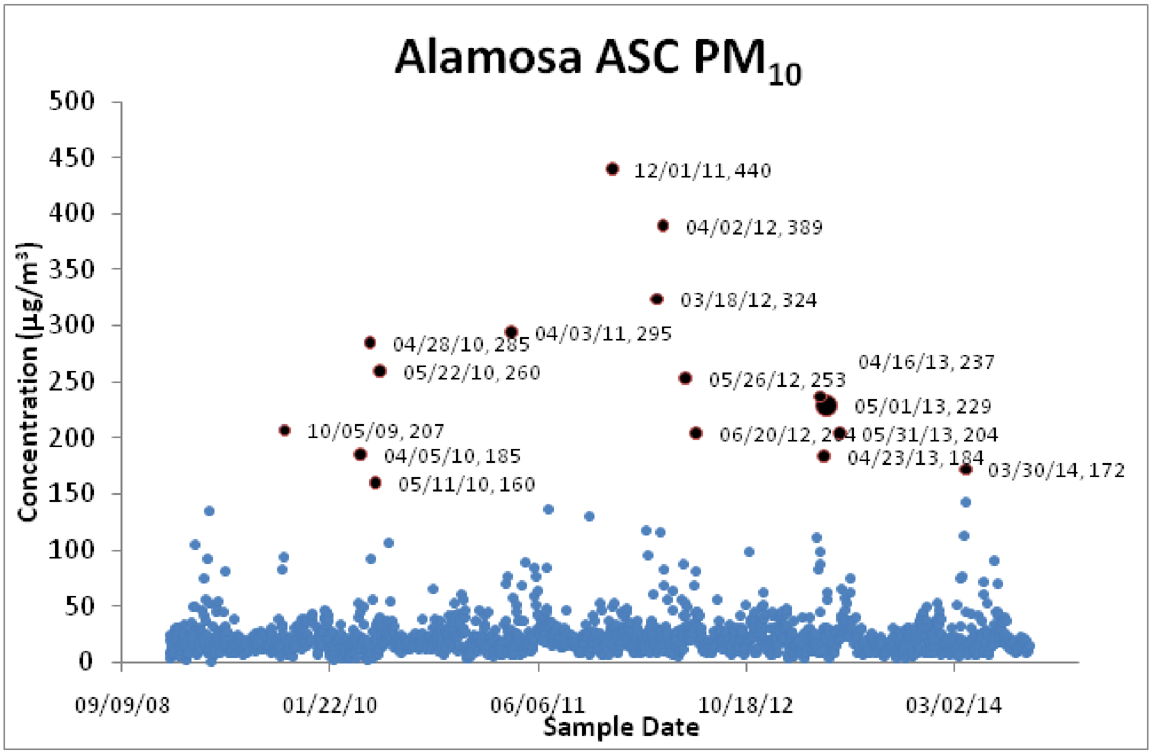


Figure 50: Alamosa Adams State College PM_{10} Time Series, 2009-2014

The monthly box-whisker plot in Figure 51 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.

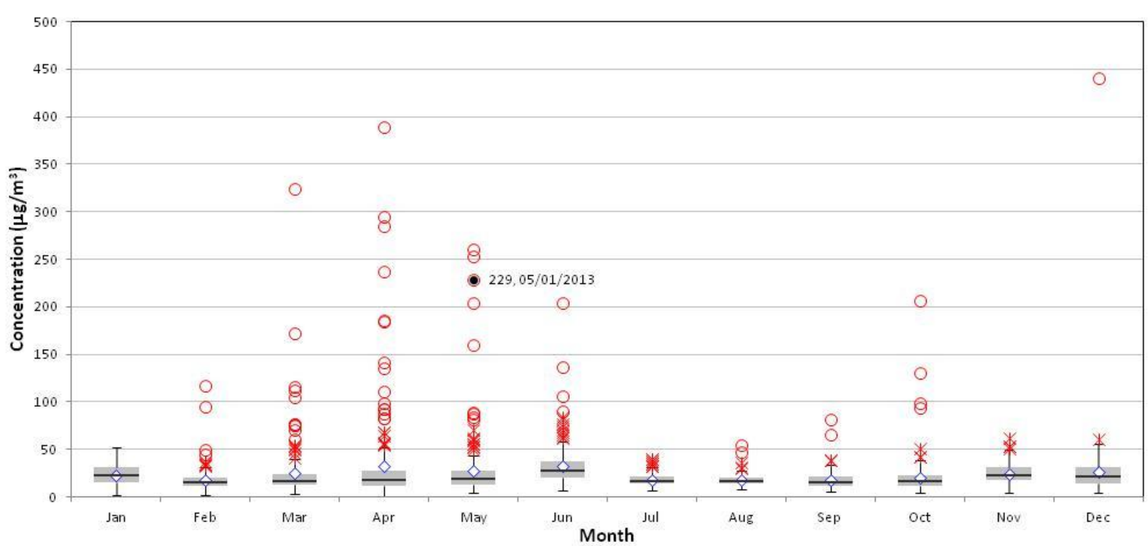


Figure 51: Alamosa Adams State College PM_{10} Box-whisper Plot, 2009-2014

The box-whisper plots graphically represent the overall distribution of each data set including the mean ( ), the inner quartile range (IQR, defined to be the distance between the 75th% and 25th%), the median (represented by the horizontal black line) and two types of outliers identifed in these plots: outliers greater than 75th% +1.5*IQR ( )and outliers greater than 75th% + 3*IQR ( ). At Alamosa ASC every sample greater than 150µg/m^3 are associated with a known high-wind event similar to that of May 1, 2013.

Note the degree to which the data in the months of winter and spring, including May, is skewed. The May mean (28 µg/m^3) is greater than the May 75th percentile value (27.75 µg/m^3). This 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 as the typical data is similar to every other month of the year. The sample of May 1, 2013 clearly exceeds the typical data at this site.

Alamosa Municipal - 080030003

The PM_{10} sample on May01, 2013 at Alamosa Muni of 246 µg/m^3 exceeds the 99th percentile value for all evaluation criteria and is the third largest sample of all samples from 2009 through August, 2014. Both samples greater than the event sample are both associated with high wind events. There are 1,795 samples in this dataset. The sample of May 1, 2013 clearly exceeds the typical samples for this site.

Figure 52 and Figure 53 graphically characterize the Alamosa Muni PM_{10} data. The first, Figure 52, is a simple time series; every sample in excess of 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 1,795 samples in this data set less than 1% are greater than 80 µg/m^3.

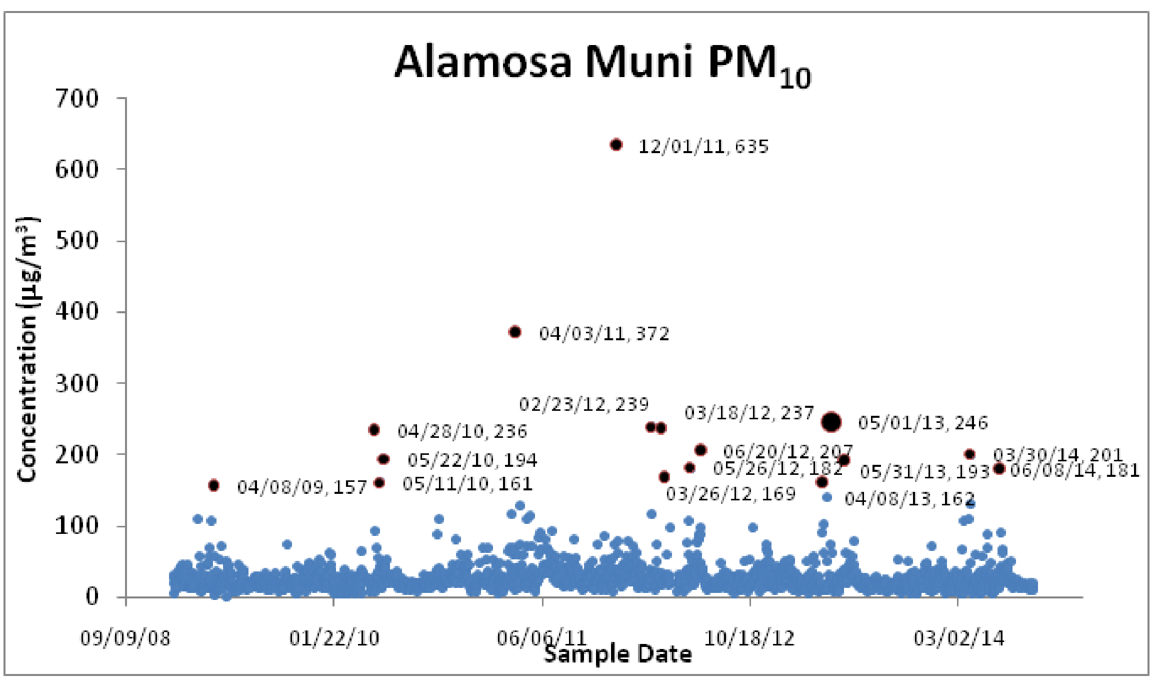


Figure 52: Alamosa Municipal PM_{10} Time Series, 2009-2014

The monthly box-whisker plot in Figure 53 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.

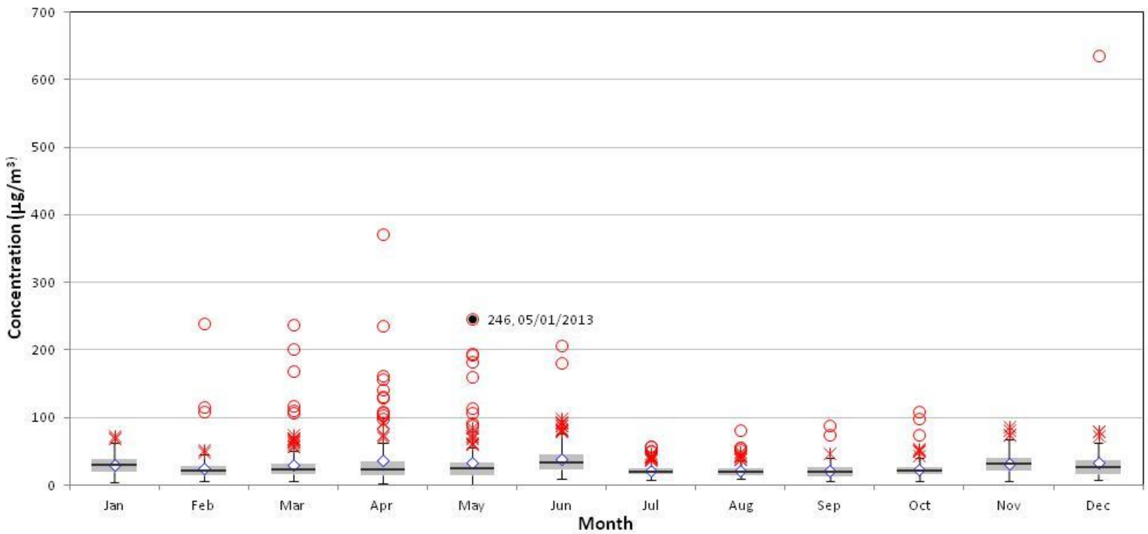


Figure 53: Alamosa Municipal PM_{10} Box-whisper Plot, 2009-2014

Note the degree to which the data from the months of winter/spring, including May, is skewed. The May mean (32 µg/m^3) is only slightly less than the 75th percentile value (33 µg/m^3). This 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 as the typical data is similar to every other month of the year. 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. Figure 54 displays wind speed (mph) as a function of date from a meteorological site within the affected areas for a number of days before and after the event.

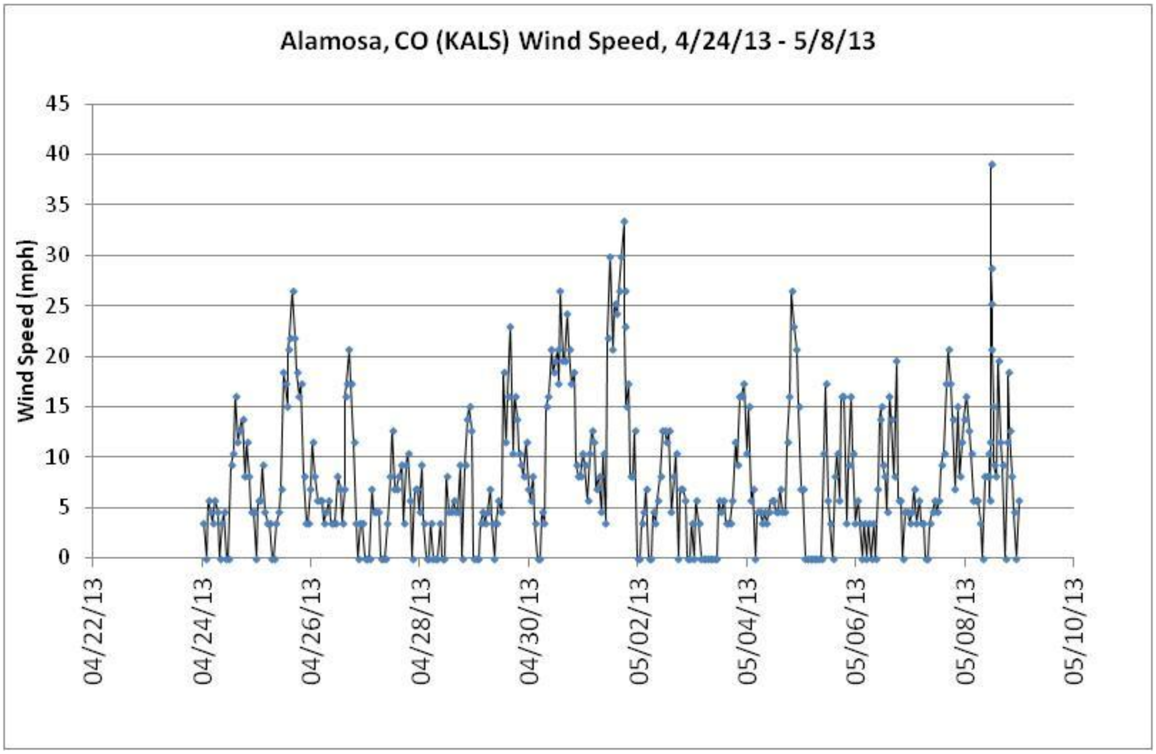


Figure 54: Wind Speed (mph), Alamosa, CO, 4/24/2013 – 5/08/2013

Figure 55 plots PM_{10} concentrations from the affected sites for the period for seven days prior to and following the sample(s) of May 1, 2013. It should be noted that a monitor in Lamar, CO also reported exceedances on May 1, 2013 and is included in Figure 55 for comparison purposes only. This additional exceedance in Lamar has be discussed in the 2013 Lamar Exceptional Event Technical Support Document.

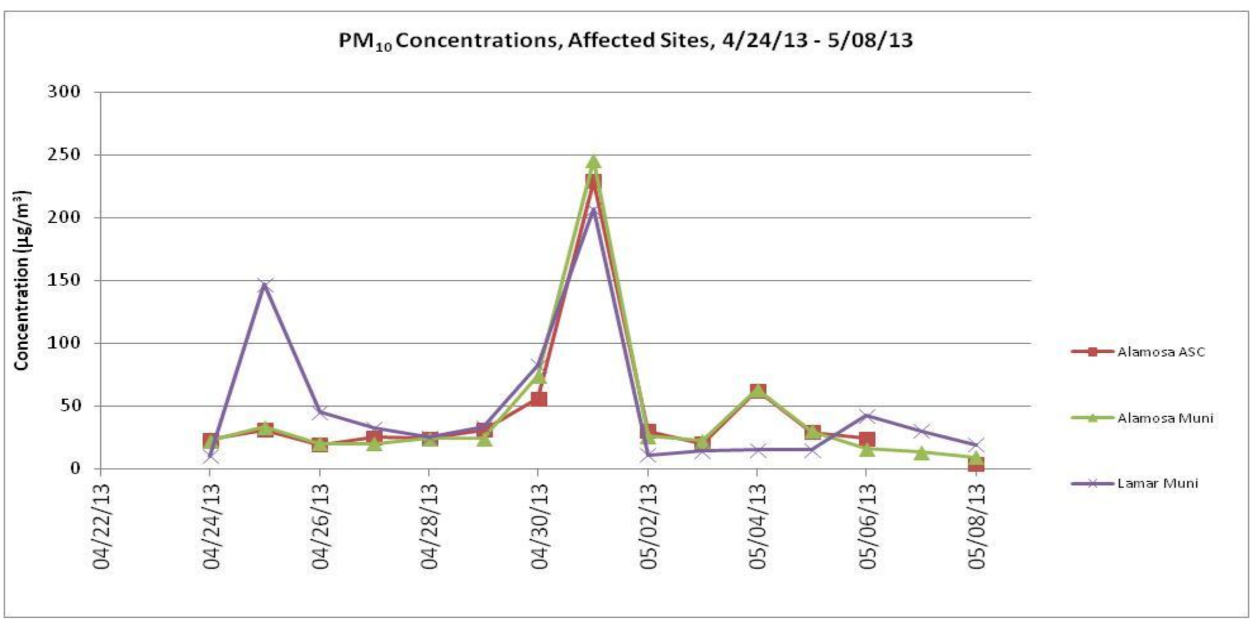


Figure 55: PM_{10} Concentrations, Alamosa, CO, 4/24/2013 – 05/08/2013

Figure 55 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. 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 Alamosa on May 1, 2013.

3.3.3 Percentiles

Monthly percentile plots for Alamosa sites shown in Figure 56 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 Alamosa Muni and the monthly median is 0.57. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

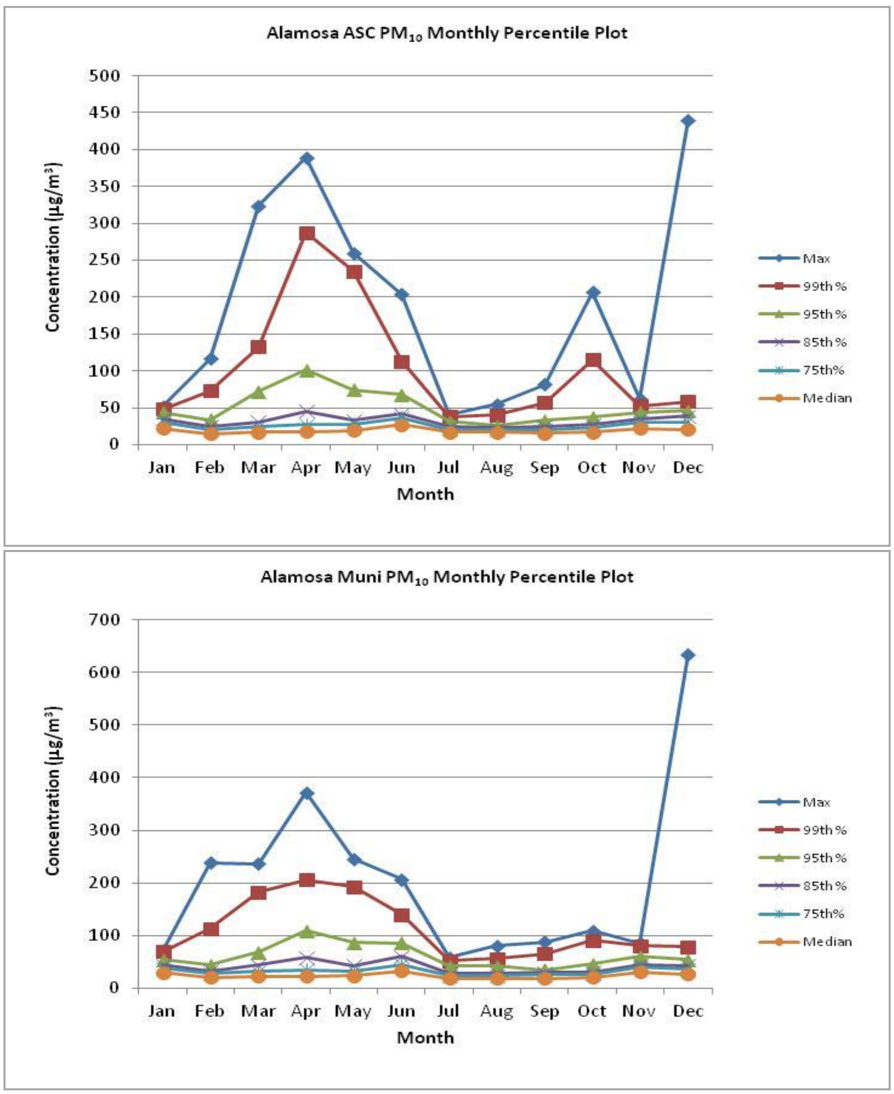


Figure 56: Monthly PM_{10} Percentile Plots, 2009-2014

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 sets of concern (Alamosa ASC and Alamosa Muni) 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 these two data sets can be explained by the variation in monthly medians; for these two sites, the correlation between the median and monthly 75th percentile values vary from an $r^2 = 0.97$ (Alamosa Muni) to an $r^2 = 0.9$ (Alamosa ASC). A reasonable estimate of the contribution to the event from local sources for these data sets may be the monthly 85th percentile values; for these two sites the correlation between the median and the monthly 85th percentile values is $r^2 = 0.66$ for both Alamosa ASC and Alamosa Muni. If these percentile values are taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from these monthly percentile values would be the sample contribution due to the event.

Table 12 identifies various percentile values that are representative of the maximum contribution due to local sources for each site from all May data for the sample date. In Table 12 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 event May 1, 2013 sample at the sites listed in the table due to the high wind event.

Table 12: Estimated Maximum Event PM_{10} Contribution, 5/1/2013

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)
Alamosa ASC	**229**	19	28.1	27.8	33.1	**195 - 201**
Alamosa Muni	**246**	24	32.6	33	43.7	**202 - 213**

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

3.4 May 31, 2013 Monitoring Data and Statistics

On May 31, 2013, an intense cold front moved across southern Colorado beginning on May 30, 2013. In Alamosa, post-frontal winds were also strong but were from an east to northeasterly direction. These winds transported dust into Alamosa from the eastern side of the San Luis Valley. Additional dust likely arrived in Alamosa from the eastern plains via Medano and Mosca Passes. The strong winds generated from the cold front's passing affected PM_{10} samples at multiple sites in Alamosa, CO. During this event samples in excess of 150 µg/m^3 were recorded at Alamosa Adams State College (Alamosa ASC, 204 µg/m^3) and Alamosa Municipal (Alamosa Muni, 193 µg/m^3).

3.4.1 Historical Fluctuations of PM_{10} Concentrations in Alamosa

This evaluation of PM_{10} monitoring data for sites affected by the May 31, 2013, event was made using valid samples from PM_{10} samplers in Alamosa from 2009 through August of 2014; APCD has been monitoring PM_{10} concentrations in Alamosa since 1985. The overall data summary for the affected sites is presented in Table 13, with all data values presented in µg/m^3

Table 13: May 31, 2013, Event Data Summary

	Alamosa ASC	*Alamosa Muni*
05/01/2013	**204**	**193**
Mean	23.9	28.8
Median	19	23
Mode	20	18
St. Dev	26.7	28.0
Var.	710.2	782.4
Minimum	1	1
Maximum	440	635
Percentile	99.6%	99.9%
Count	1897	1795

Alamosa ASC – 080030001

The PM_{10} sample on May 31, 2013, at Alamosa ASC of 204 µg/m^3 is the 12th largest sample in the entire data set and exceeds 99% of all samples from 2009 through August 2014. The 11 samples greater than the event sample are all associated with high wind events. There are 1,897 samples in this dataset. The sample of May 31, 2013, clearly exceeds the typical samples for this site.

Figure 57 and Figure 58 graphically characterize the Alamosa ASC PM_{10} data. The first, Figure 57, 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 1,897 samples in this data set less than 1% is greater than 100 µg/m^3.

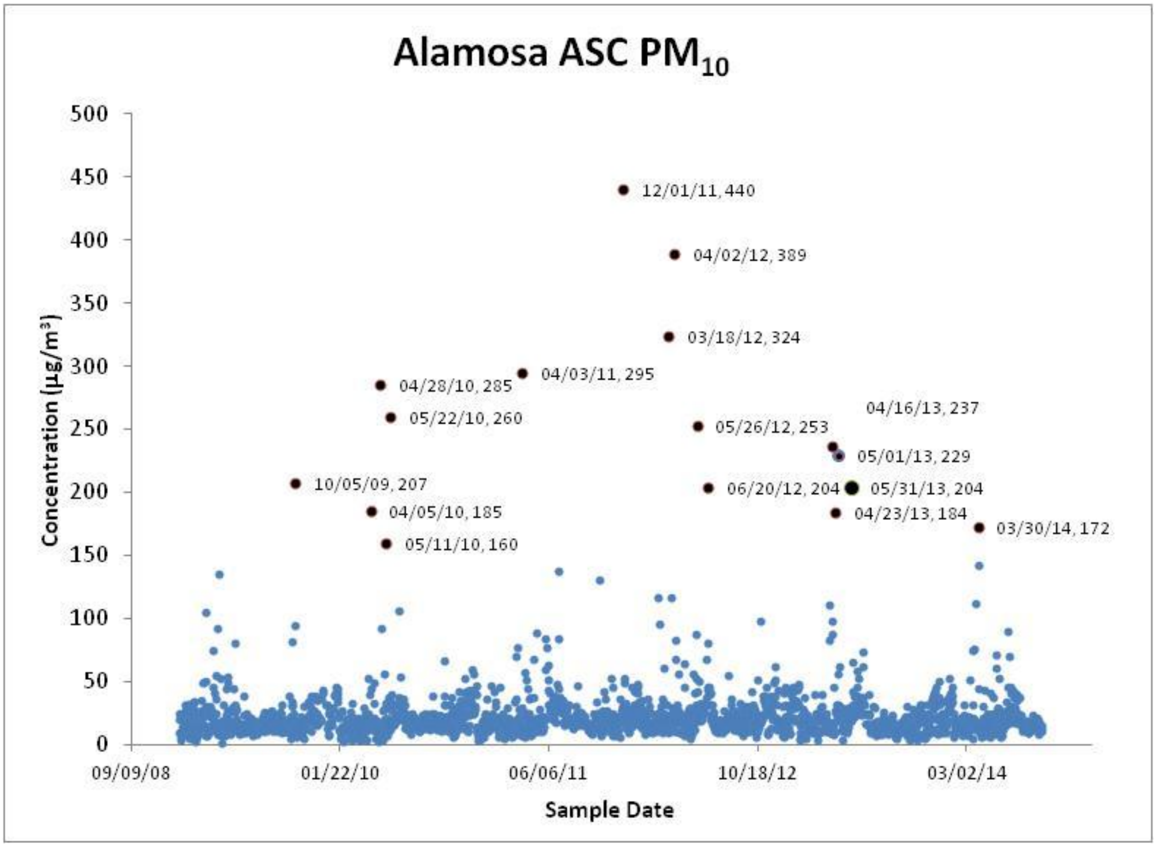


Figure 57: Alamosa Adams State College PM_{10} Time Series, 2009-2014

The monthly box-whisker plot in Figure 58 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 31, 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.

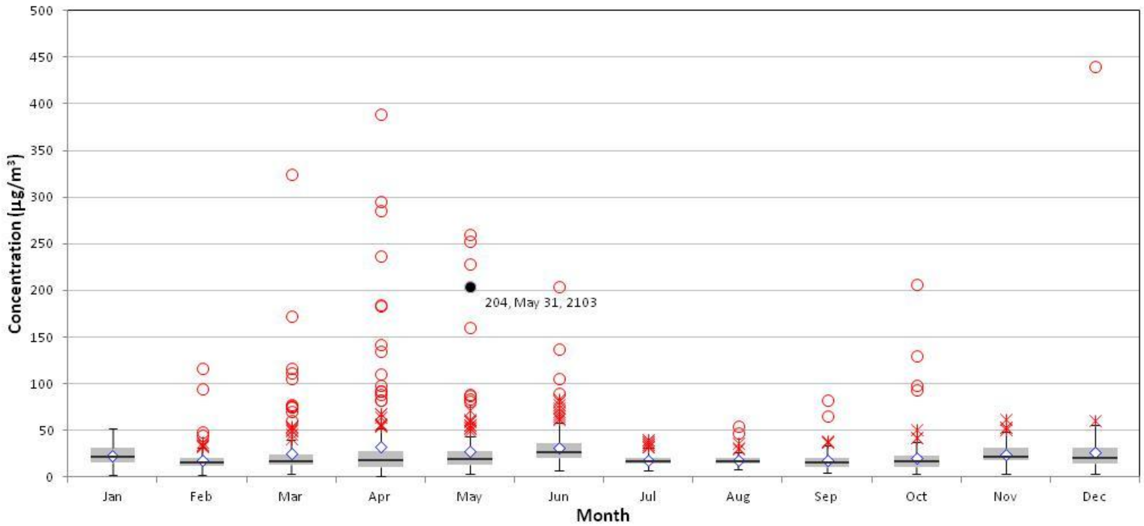


Figure 58: Alamosa ASC PM_{10} Box-whisper Plot, 2009-2014

The box-whisper plots graphically represent the overall distribution of each data set including the mean ( ), the inner quartile range (IQR, defined to be the distance between the 75th% and 25th%), the median (represented by the horizontal black line) and two types of outliers identifed in these plots: outliers greater than 75th% +1.5*IQR ( )and outliers greater than 75th% + 3*IQR ( ). At Alamosa ASC every sample greater than 150 µg/m^3 are associated with a known high-wind event similar to that of May 31, 2013.

Note the degree to which the data in the months of winter and spring, including May, is skewed. The May mean (28 µg/m^3) is greater than the May 75th percentile value (27.75 µg/m^3). This 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 as the typical data is similar to every other month of the year. The sample of May 31, 2013 clearly exceeds the typical data at this site.

Alamosa Municipal – 080030003

The PM_{10} sample on May 31, 2013 at Alamosa Muni of 193 µg/m^3 exceeds the 99th percentile value for all evaluation criteria and is the 10th largest sample of all samples from 2009 through August, 2014. The nine samples greater than the event sample are both associated with high wind events. There are 1,795 samples in this dataset. The sample of May 31, 2013, clearly exceeds the typical samples for this site.

Figure 59 and Figure 60 graphically characterize the Alamosa Muni PM_{10} data. The first, Figure 59, is a simple time series; every sample in excess of 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 1,795 samples in this data set less than 1% are greater than 80 µg/m^3.

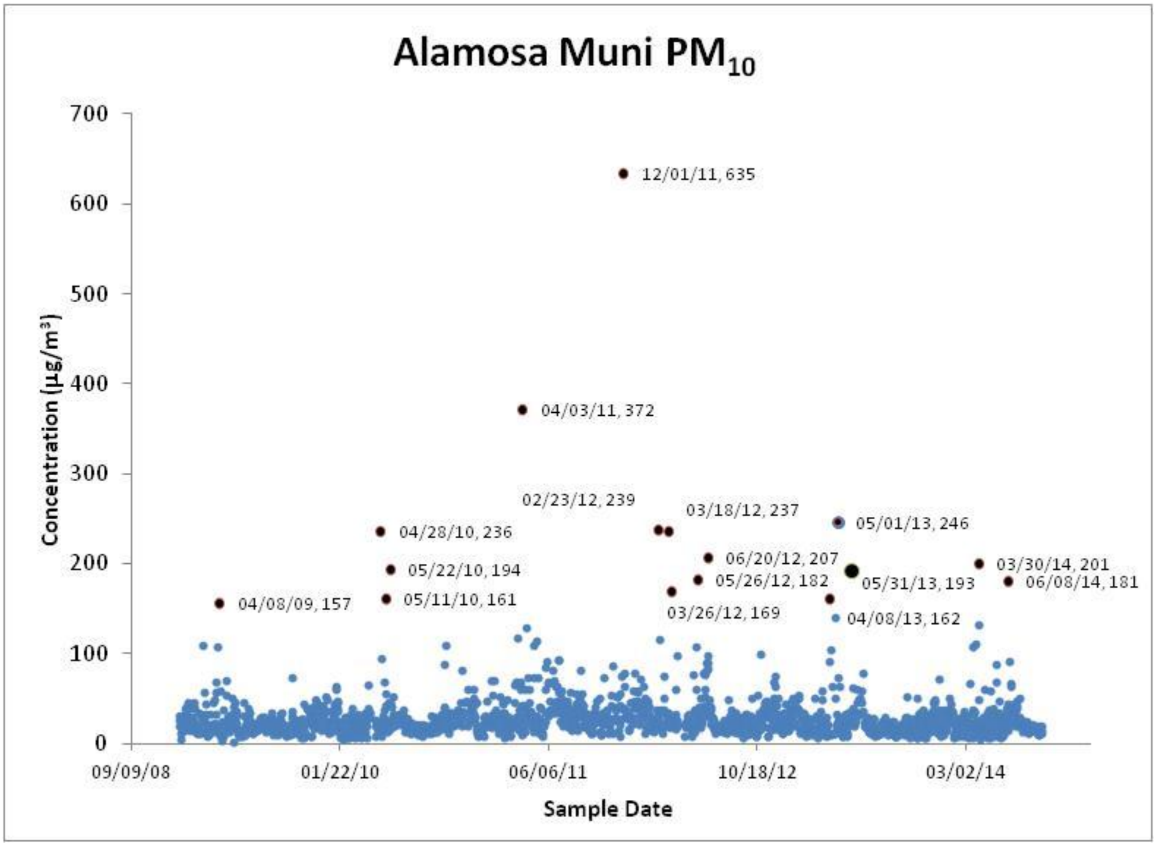


Figure 59: Alamosa Municipal PM_{10} Time Series, 2009-2014

The monthly box-whisker plot in Figure 60 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 31. 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.

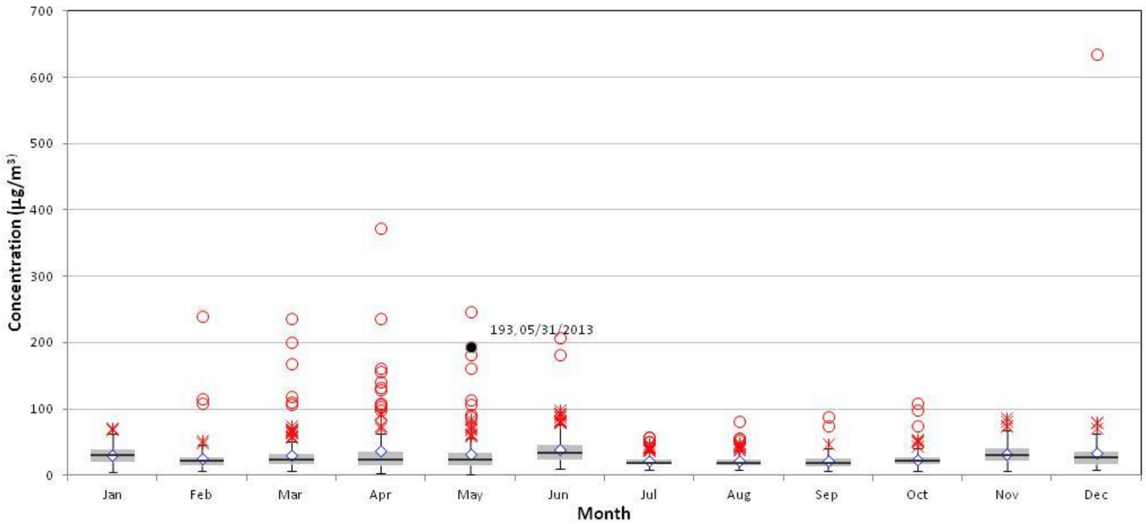


Figure 60: Alamosa Municipal PM_{10} Box-whisper Plot, 2009-2104

Note the degree to which the data from the months of winter/spring, including May, is skewed. The May mean (32 µg/m^3) is only slightly less than the 75th percentile value (33 µg/m^3). This 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 as the typical data is similar to every other month of the year. The sample of May 31, 2013 clearly exceeds the typical data at this site.

3.4.2 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 31, 2013, gusting to speeds in excess of 40 mph. Figure 61 displays wind speed (mph) as a function of date from a meteorological site within the affected areas for a number of days before and after the event.

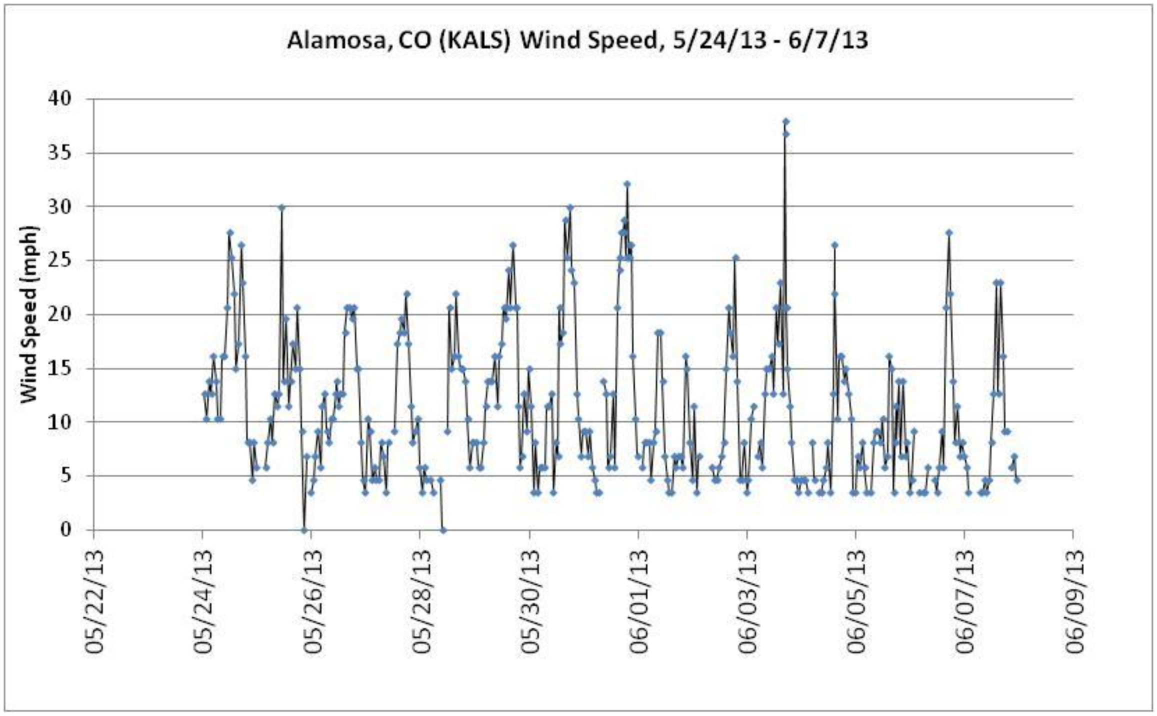


Figure 61: Wind Speed (mph), Alamosa, CO, 5/24/2013 – 6/07/2013

Figure 62 plots PM_{10} concentrations from the affected sites for a period prior to and following the sample(s) of May 31, 2013.

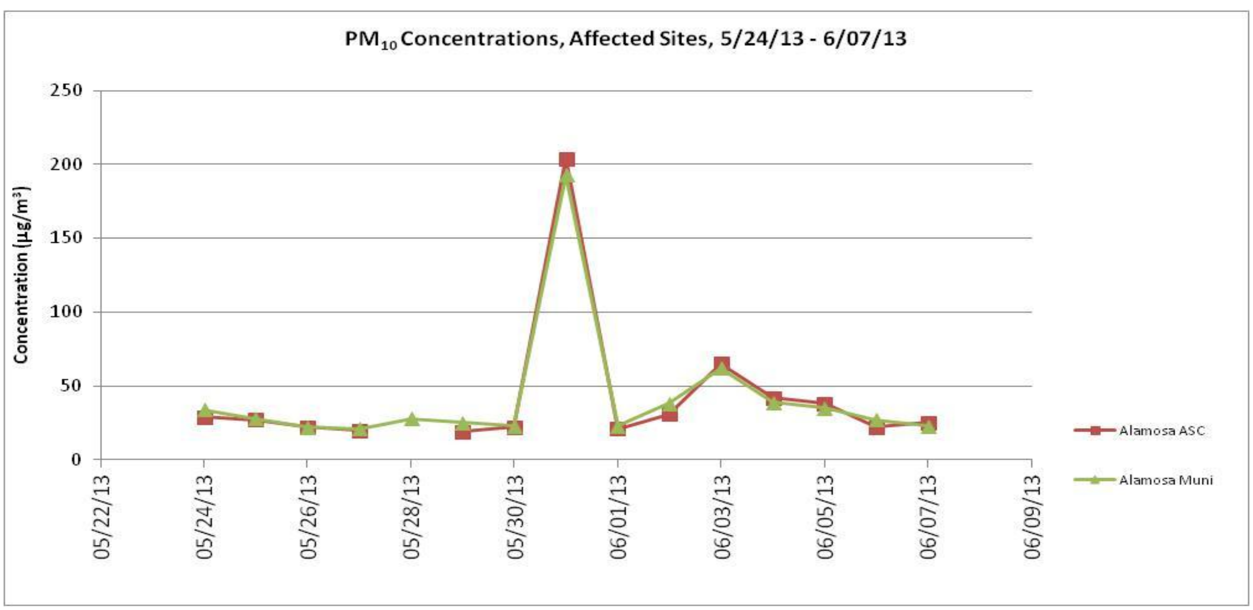


Figure 62: PM_{10} Concentrations, Alamosa, CO, 5/24/2013 – 06/07/2013

Figure 62 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. 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 Alamosa on May 31, 2013.

3.4.3 Percentiles

Monthly percentile plots for Alamosa sites in Figure 63 demonstrate a high degree of association between monthly median values and relatively high monthly percentile values, e.g. the Pearson's r^2 value between the monthly 90th percentile value at Alamosa Muni and the monthly median is 0.57. As the percentile value decreases (i.e. 85%, 75%, etc) the correlation between those values and the monthly median values increases sharply.

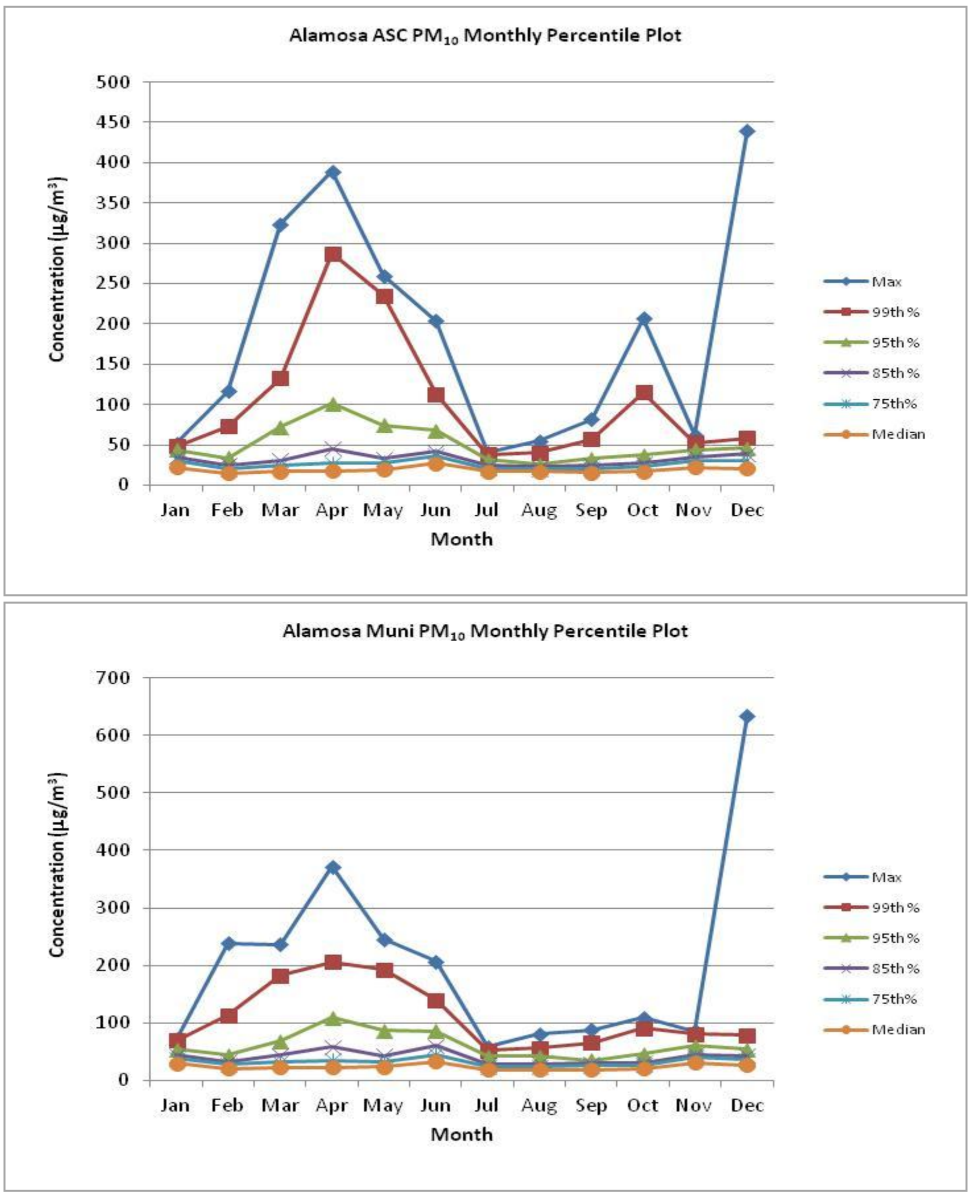


Figure 63: Monthly PM_{10} Percentile Plots, 2009-2014

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 sets of concern (Alamosa ASC and Alamosa Muni) 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 can be explained by the variation in monthly medians; for Alamosa ASC the correlation between the median and monthly 75th percentile values is $r^2 = 0.94$. A reasonable estimate of the contribution to the event from local sources for these data sets may be the monthly 85th percentile values; for Alamosa ASC the correlation between the median and the monthly 85th percentile values is $r^2 = 0.66$. If these percentile values are taken as an estimate of event PM_{10} due to local variation then the portion of the sample concentration remaining from these monthly percentile values would be the sample contribution from the event.

Table 14 identifies various percentile values that are representative of the maximum contribution due to local sources for each site from all May data for both sample dates. In Table 14 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 31, 2013 sample at the sites listed in the table due to the high wind event.

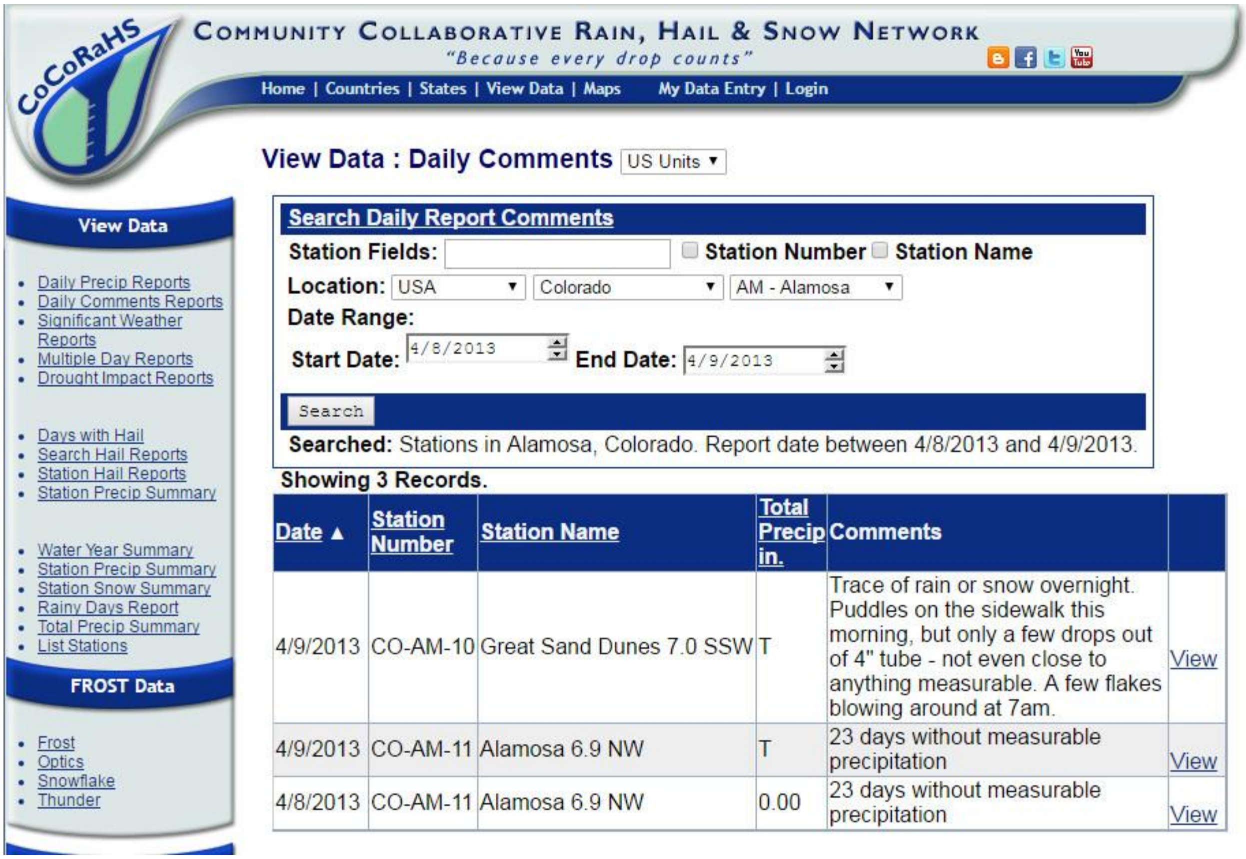
Table 14: Estimated Maximum Event PM_{10} Contribution, 5/31/2013

Site	Event Day Concentration ($\mu g/m^3$)	May Median ($\mu g/m^3$)	May Average ($\mu g/m^3$)	May 75th % ($\mu g/m^3$)	May 85th % ($\mu g/m^3$)	Est. Conc. Above Typical ($\mu g/m^3$)
Alamosa ASC	**204**	19	28.1	27.8	33.1	**171 - 176**
Alamosa Muni	**193**	24	32.6	33	43.7	**149 - 160**

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

Community Collaborative Rain, Hail, & Snow Network reports (www.cocorahs.org):



Community Collaborative Rain, Hail & Snow Network

"Because every drop counts"

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View Data

- Daily Precip Reports
- Daily Comments Reports
- Significant Weather Reports
- Multiple Day Reports
- Drought Impact Reports

- Days with Hail
- Search Hail Reports
- Station Hail Reports
- Station Precip Summary

- Water Year Summary
- Station Precip Summary
- Station Snow Summary
- Rainy Days Report
- Total Precip Summary
- List Stations

FROST Data

- Frost
- Optics
- Snowflake
- Thunder

View Data : Daily Comments US Units

Search Daily Report Comments

Station Fields: Station Number Station Name

Location: USA Colorado AM - Alamosa

Date Range:

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

Search

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

Showing 3 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
4/9/2013	CO-AM-10	Great Sand Dunes 7.0 SSW	T	Trace of rain or snow overnight. Puddles on the sidewalk this morning, but only a few drops out of 4" tube - not even close to anything measurable. A few flakes blowing around at 7am.	View
4/9/2013	CO-AM-11	Alamosa 6.9 NW	T	23 days without measurable precipitation	View
4/8/2013	CO-AM-11	Alamosa 6.9 NW	0.00	23 days without measurable precipitation	View

Community Collaborative Rain, Hail & Snow Network

"Because every drop counts"

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- Station Precip Summary
- Station Snow Summary
- Rainy Days Report
- Total Precip Summary
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Search Daily Report Comments

Station Fields: Station Number Station Name

Location: USA Colorado AM - Alamosa

Date Range:

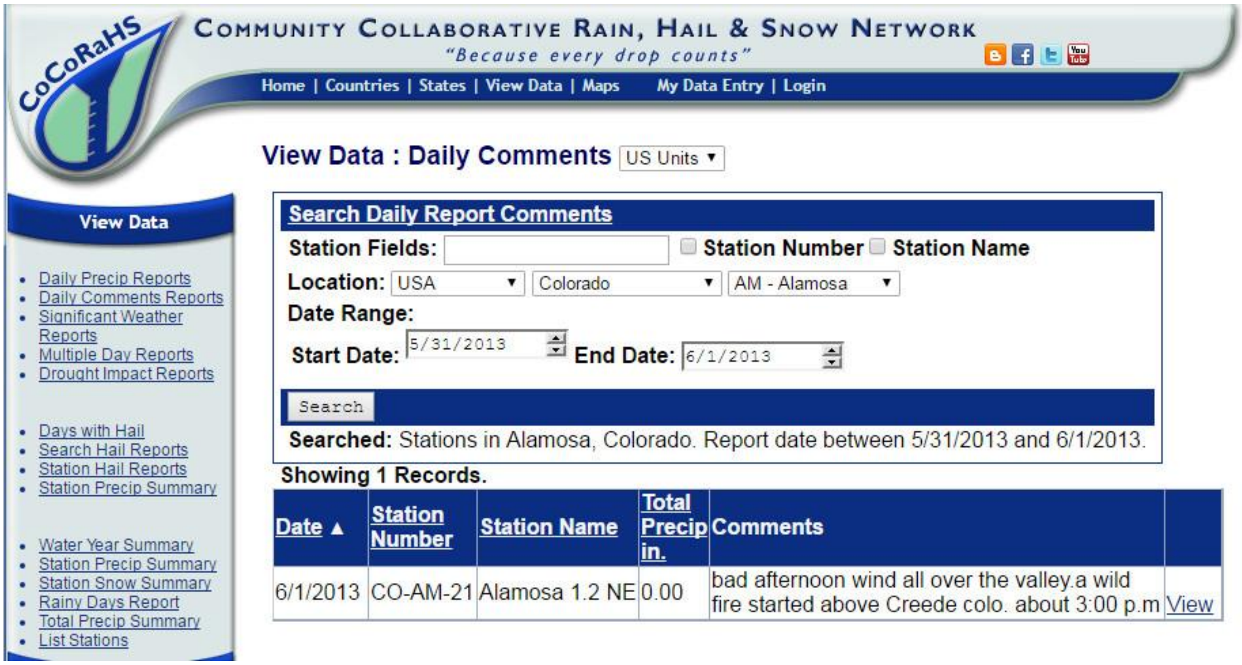
Start Date: 5/1/2013 End Date: 5/2/2013

Search

Searched: Stations in Alamosa, Colorado. Report date between 5/1/2013 and 5/2/2013.

Showing 1 Records.

Date ▲	Station Number	Station Name	Total Precip in.	Comments	
5/2/2013	CO-AM-10	Great Sand Dunes 7.0 SSW	0.00	WINDY Yesterday. COLD this morning. 5°F.	View



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Drought Impact Reports
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Search Hail Reports
Station Hail Reports
Station Precip Summary
Water Year Summary
Station Precip Summary
Station Snow Summary
Rainy Days Report
Total Precip Summary
List Stations
Search Daily Report Comments
Station Fields:
Station Number
Station Name
Location: USA Colorado AM - Alamosa
Date Range:
Start Date: 5/31/2013 End Date: 6/1/2013
Search
Searched: Stations in Alamosa, Colorado. Report date between 5/31/2013 and 6/1/2013.
Showing 1 Records.
Date ▲
Station Number
Station Name
Total Precip in.
Comments
6/1/2013
CO-AM-21
Alamosa 1.2 NE
0.00
bad afternoon wind all over the valley.a wild fire started above Creede colo. about 3:00 p.m
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 as gusts from the regional dust storms 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 area. 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 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 April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013, events. This information shall confirm that no unusual anthropogenic actions occurred in the local areas of Alamosa on these dates.

Regulatory Measures - State
The APCDs regulations on PM_{10} emissions are summarized in Table 15.

Table 15: 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 and Environment Regulation 6- Standards of Performance for New Stationary Sources	Implements federal standards of performance for 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.

5.1 Alamosa Regulatory Measures and Other Programs

Natural Events Action Plan (NEAP)

The Final NEAP for High Wind Events in Alamosa, Colorado was completed in May 2003. The NEAP addresses public education programs, public notification and health advisory programs, and determines and implements Best Available Control Measures (BACM) for anthropogenic sources in the Alamosa area. The APCD followed up with the City and County of Alamosa in January 2007 and in the spring of 2013 on whether the NEAP mitigation measures and commitments were satisfied, the results of which are detailed below. The City of Alamosa, Alamosa 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 Final Natural Events Action Plan for High Wind Events, Alamosa, Colorado at http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=AlamosaNaturalEventsActionPlan2003.pdf for more detail if needed.

Regulatory Measures - City and County

The APCD, the City of Alamosa, and Alamosa County are responsible for implementing regulatory measures to control emissions from agricultural sources, stationary sources, fugitive dust sources, and open burning within Alamosa. Alamosa's ordinances of PM_{10} emissions are summarized in Table 16.

Table 16: Rules and Ordinances Regulating Particulate Matter Emissions in Alamosa

Rule/Ordinance	Description
City of Alamosa Code of Ordinances Article VII of Section 21-140 (5)	Addresses dust control for home occupations.
City of Alamosa Code of Ordinances Article V Sec. 17-87(3))	Requires all new roads and alleys to be paved.
City of Alamosa Code of Ordinances (Article VI Sec. 21-119(g)(3)).	New large commercial/retail establishments must install underground automatic irrigation systems for all landscaped areas.
Alamosa County Land Use and Development Code (1.4.2)	Agriculture an important part of the economy and adds intrinsic value to life in Alamosa County. Agriculture, as a business, brings dust and other inconveniences. To maintain this way of life, Alamosa County intends to protect agricultural operators from unnecessary, intrusive litigation. Therefore, no inconvenience shall be considered a nuisance so long as it occurs as a part of non-negligent and legal agricultural practice, as stated in C.R.S. 35-3.5-101, 102 and 103.
Alamosa County Land Use and Development Code (3.5.2(A)(8))	For Feed lot, animal waste treatment, or animal waste collection facilities fugitive dust shall be confined on the property.
Alamosa County Land Use and Development Code (3.5.6(D)(2))	For a proposed oil and gas well installation, any interior transportation network shall be paved, or the company shall undertake appropriate dust abatement measures.
Alamosa County Land Use and Development Code (3.5.7(G))	All roads, driveways, parking lots and loading and unloading areas within 500 feet of any lot line shall be graded and paved with an approved concrete or asphalt/concrete surface as to limit adjoining lots and public roads the nuisance caused by wind-borne dust.
Alamosa County Land Use and Development Code (4.2.3(C)(2))	Where off-street facilities are provided for parking or any other vehicular use area, they shall be surfaced with asphalt bituminous, concrete or other dustless material approved by the administrator and shall be maintained in a smooth, well-graded condition.

City of Alamosa's Control Measures

The City of Alamosa has been active in addressing potential PM_{10} sources within the Alamosa area through various efforts. Some of these efforts, plus other potential future measures, include the adoption of local ordinances to reduce PM_{10}. Copies of current ordinances and any related commitments are included in the Final NEAP (See http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=AlamosaNaturalEventsActionPlan2003.pdf). According to the City's Public Works Director, in 2013, the

City is planning on adding additional dust control best management practices to the International Building Codes that are adopted by the city in the next update. The best management practices will include requiring a Dust Control Plan for any site that is issued a clearing permit over 2 acres. In 2013 the City was also working on revising part of their landscaping ordinances to require mulch in areas that are not vegetated or covered by rock to help mitigate fugitive particulate emissions. These efforts have been stalled in the past due to employee turnover at City Manager's Office.

Street Sweeping

The City of Alamosa sweeps on an every 4-week schedule or as needed, as determined by local officials on a case by case situation (e.g., following each snowstorm and/or where sand was applied). Sweeping occurs on every single City street with an emphasis on the downtown corridor where public exposure is expected to be greatest. As of spring 2013, street sweeping in the downtown corridor takes place twice per week according to the City's Public Works Director.

According to the City's Public Works Director in 2013, the city owns an Elgin Pelican (mobile mechanical sweeper) and a Tymko 600 (brush-assisted head) street sweeper. In June 2013, the City also acquired a new Elgin Broom Badger street sweeper and the Tymko 600 was sent in for a re-build. The new Elgin Broom Badger street sweeper can be used in the winter months when the Tymko cannot due to freezing of the water delivery system.

Unpaved Roads within the City

The City of Alamosa (as of 2008) requires all new roads and alleys to be paved according to the Municipal Code (Article V Sec. 17-87(3)) and some existing unpaved roads are being treated with dust suppressants until all underground utilities are installed. No new development is allowed until paving is complete unless a performance bond is in place.

According to the City's Public Works Director, in 2013, less than 3% of City roads were unpaved; most of these unpaved roads are legacy annexations. One of these unpaved roads was scheduled for paving in 2013. The remaining unpaved roads are all low traffic (less than 100 ADT) and the City continues to seek funding sources for paving these streets.

Sod/Vegetative Cover Projects in the City of Alamosa

In 2008, the City of Alamosa placed vegetative cover in all city parks and has installed irrigation systems to maintain the cover. In 2013, the City began emphasizing more low-water use landscaping with shrubs, mulch, etc. including both organic and rock. All turf areas do have irrigation systems which utilize drip systems for specimen plantings.

<u>Alamosa County's Control Measures</u>

Alamosa County has also been active in addressing blowing dust as detailed below.

Unpaved Roads

Alamosa County continues to address unpaved roads and lanes that are anticipated to contribute to PM_{10} emissions in the community. In 2002, Alamosa County was nearing the end of its five-year road paving plan and was developing their next plan with the intention of paving on a yearly basis, based on traffic, community needs/priorities, and funding availability.

In 2002, Alamosa County addressed approximately ten (10) miles of unpaved roads. This included the stabilization of approximately five section roads, the seal coating of two roads, and the overlay (repaving) of four (4) additional roads.

In 2003, approximately 14 miles of roads were paved. This includes the Seven Mile Road (three miles long), Road 109 (one mile long), and 10^{th} Street (also one mile long). These roads are in close proximity to the City of Alamosa, are upwind (prevailing) from the city, and have heavy traffic. Paving is anticipated to greatly reduce blowing dust and impacts in the vicinity.

No paving projects took place between 2004 and 2010 due to lack of funding. Between 2010 and 2013, the County was able to get funding but only for maintenance paving on previously paved roads that needed repair. Now that the county is caught up on maintenance paving, it is focusing on paving the remaining unpaved roads. The County's goal is to pave about 2.5 miles of unpaved road per year depending on funding availability.

In 2013, Alamosa County had funding to pave approximately 2.5 miles of County Road 106 North (located north of Alamosa off of Highway 17) which is currently unpaved. After this paving project the County will only have 2.5 miles of unpaved road remaining on the 106 North which is anticipated to be paved in the summer of 2014.

In the summer time the County regularly hauls water and wets down the unpaved roads (mostly gravel, clay and sand) to reduce the fugitive particulate emissions. The County wets the unpaved roads on an as needed basis based on weather conditions and traffic volume in the summer and wets down some of the more sandy roads in the winter when temperatures drop below a threshold in the area. Once the water soaks in and freezes, good dust suppression is seen. Road construction areas are also being dampened with water for dust control. These practices reduce PM_{10} emissions in and near Alamosa. This control measure is balanced with the availability of water in the area.

Alamosa County used to assess the need to use $MgC1_2$ treatment on roads in front of residences that request such service. This practice stopped in 2004 when funding was lost. Assessments included the sensitivity to dust of residents, the materials of the road base for safety reasons, and possible environmental concerns of the neighborhood. Most requests for treatment were granted. Other areas for treatment, such as commercial construction zones or gravel pits, were investigated on a case by case basis. The County hopes to be able to start offering this service again when funding is restored.

Dust Control Plans

Alamosa County requires dust control plans for selected construction/developments. The dust control plans are typically done through a negotiated agreement by the Alamosa Land Use Department and is supported by zoning codes.

The County may update the Comprehensive Plan to include a dust control plan. The Land Use Administrator is researching the potential for a dust control ordinance. This effort is anticipated to reduce PM_{10} emissions in Alamosa, especially as it relates to impacts on the community and high recorded PM_{10} values. At the time of this submittal, this effort is still underway.

Wind Erosion of Open Areas
To reduce PM_{10} emissions from open areas outside of the City limits, low tilling and other soil conservation practices continue to be utilized in the community. The Mosca-Hooper Conservation District and Natural Resources Conservation Service is working on education efforts to promote cover crops and no-till agriculture. In addition, the community is strategically using the Colorado State Forest Service's program to purchase and plant shelter trees to reduce wind erosion in open areas. Nursery seedlings from the program have been sold in Alamosa County since 1956. The number of seedlings sold has varied over the last few years as illustrated in Table 17.

Table 17: Number of Seedlings Sold in Alamosa per Year.

Year:	2008	2009	2010	2011	2012	2013
Seedlings Sold:	7,432	5,963	2,805	4,197	3,327	4,231

These trees have a demonstrated advantage for the community and for air quality. Once the trees reach maturity, it is anticipated that the equivalent of 112 miles of double-rowed trees will be in place. The survival rate of the tree seedlings varies but according to the District Coordinator for the Seedling Tree Program, potted seedlings have about a 60% to 80% survival rate and the bare root seedlings have about a 40% to 60% survival rate. The Seedling Program recommends Siberian elm and Rocky Mountain juniper trees for low maintenance, drought resistance windbreaks in the valley, but offers over 40 varieties to suit specific site conditions. The Colorado State Forest Service and the Mosca-Hooper Conservation District promote the windbreak program through workshops and consulting landowners.

In addition, there is ongoing planting of trees (approximately 50) on newly developed Alamosa County property south/southwest of Alamosa (prevailing winds from southwest) and the Airport south of Alamosa for added air quality improvement. Also, The Bureau of Reclamation has an ongoing project to plant windbreaks along their Closed-Basin Canal.

Windblown Dust from Disturbed Soils
Alamosa has a semi-arid climate with approximately 7.25 inches of precipitation annually. The San Luis Valley, as noted within 25 miles of the San Luis Valley Regional Airport in Alamosa, is primarily comprised of forests (43%) and scrublands (42%). Consequently, soils in all areas are typically a mixture of silt and sand with limited vegetation due to low precipitation. In winter and spring, windstorms are common, especially in drier years. It is due to these high velocity windstorms that Alamosa experiences most of the PM_{10} problems for the area. The City zoning map in Figure 65 which was provided by the City of Alamosa, depicts various areas of possible soil disturbance. These were evaluated by APCD staff in conjunction with local input from the City and County staff for the Alamosa Adams State and Municipal PM_{10} monitors over the past years. The area zoned agricultural remains mostly natural grassland and "Chico" shrubs. Figure 64 through Figure 97 illustrate other potential areas of local soil disturbance that have been evaluated by the APCD for the Alamosa Adams State PM_{10} monitor and the Alamosa Municipal Building PM_{10} monitor.

5.2 Potential areas of local soil disturbance south and southwest of Alamosa (ASC Monitor)

Figure 64: Relative positions of Adam's State College PM_{10} Monitor and potential disturbed soil. (Google Image 2015)

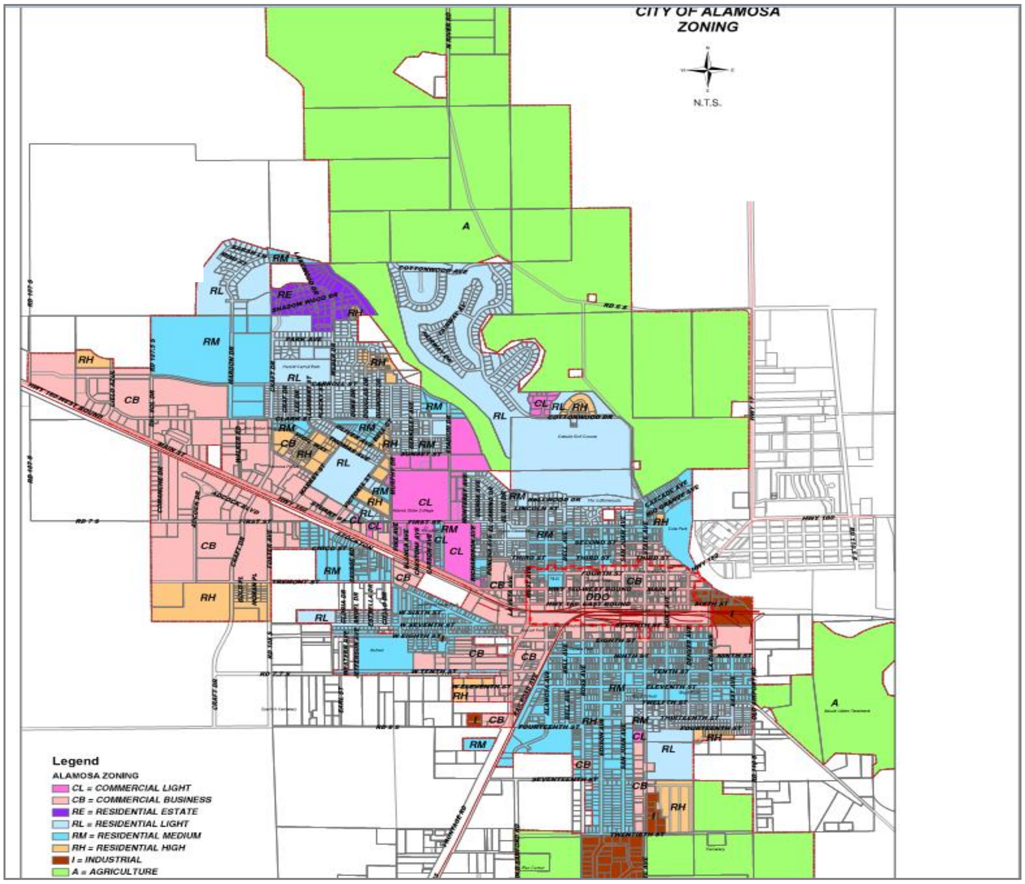

Figure 65: 2011 City of Alamosa Zoning Map (Provided by the Public Works Department)

Site A in Figure 64 (approximately 30 acres) is north of 10th St, south of 8th St, east of Park Ct, and west of West Ave. It is zoned mostly as a "Commercial Business" as shown in Figure 65. There is a small portion in the top right corner that is zoned as a "Parcel" and is outside of the city's limits. Site B in Figure 64 (approximately 22 acres) is south of Highway 160 and north east of Tremont St. It is zoned as a "Parcel" outside of the city's limits as shown in Figure 65. Site C (approximately 23 acres) in Figure 64 is east of Earl St, south of 10th St, and north of Rd 8 S. It is zoned as "Commercial business", "Residential High" and some "Industrial" as shown in Figure 65. Sites A, B, and C are naturally vegetated and potentially irrigated as shown in Figure 66, Figure 67 and Figure 69 which also demonstrate that these sites are minimally (if at all) disturbed soil areas. Photos of Sites A, B and C are shown in Figure 66 through Figure 69.

Figure 66: Site B (CDPHE August 2013)


Figure 67: Site A facing north (CDPHE August 2013)


Figure 68: West end of site A is a gravel elementary school overflow parking lot (CDPHE August 2013)


Figure 69: Site C with natural vegetation (CDPHE August 2013)

The APCD conducted thorough assessments to determine if the potential soil disturbances shown in Figure 64 were present during the 2013 exceedances. 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 Alamosa area during the 2013, high wind events.

5.3 Potential areas of local soil disturbance south and southwest of Alamosa (Muni Monitor)

Figure 70 illustrates potential areas of local soil disturbance that have been evaluated by the APCD for the Alamosa Municipal Building (08-003-0003) PM_{10} monitor. The climate for this monitor is identical to the Alamosa Adams State PM_{10} monitor, described above.

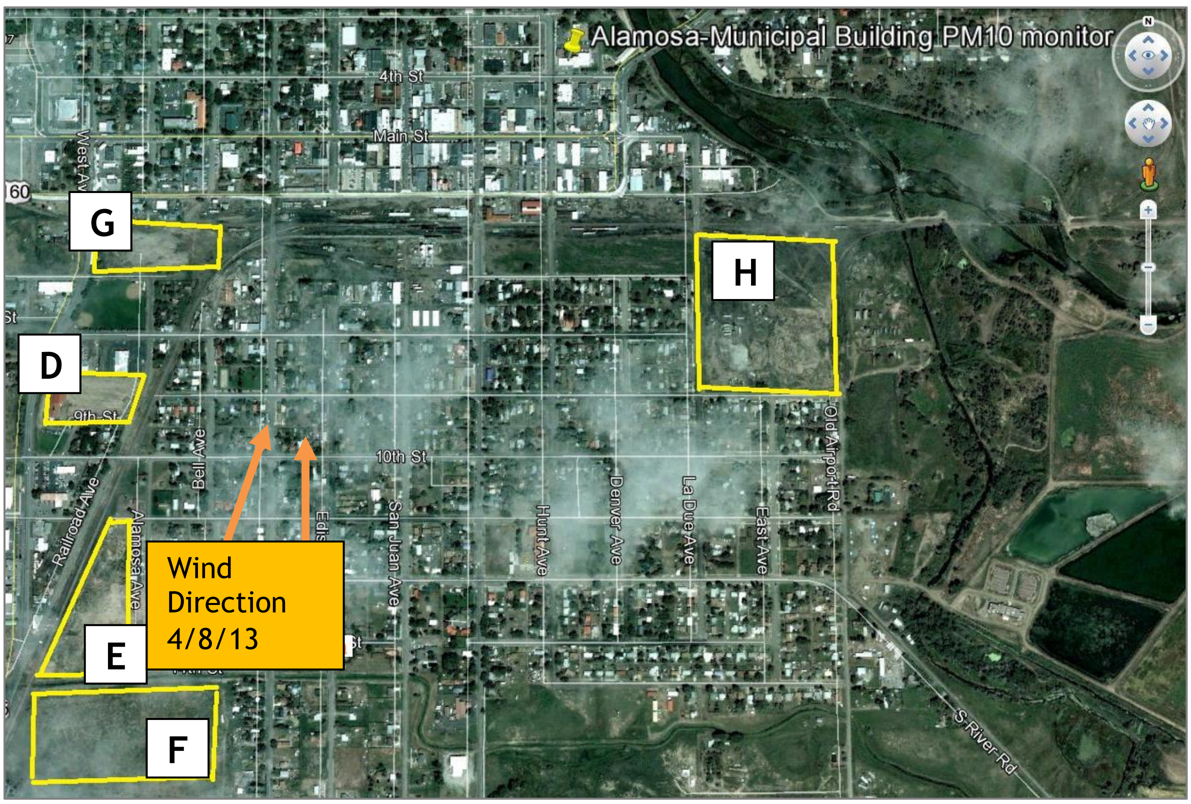

Figure 70: Relative positions of Municipal Building PM_{10} Monitor and potential disturbed soil. (Google Earth 2007)

Site D in Figure 70 (approximately 3 acres) is east of West Ave, north of 10th St, south of 8th St, and west of Railroad Ave. It is zoned by the city as "Commercial Business" as shown in Figure 65. Site D is "Friends" Park that is maintained by the City of Alamosa (Figure 71). Friends Park has a well maintained gravel parking lot, a cement basketball court, an irrigated field, and a small hard packed clay BMX bike dirt track. The park is well maintained by the City and implements reasonable dust control measures on a regular basis.

Figure 71: Site D – Friends Park as of August 2013 (CDPHE August 2013)

Site E in Figure 70 (approximately 9 acres) is north of 14th St, west of Alamosa Ave, east of Railroad Ave, and south of 10th St. It is zoned by the city as “Residential Medium” as shown in Figure 65. Site E is a vacant lot behind a small apartment building. The land is natural and undisturbed. There is no irrigation but natural vegetation grows as shown in Figure 72. The soil has a crust on the surface. When asked, residents of the adjacent apartment complex did not complain about blowing dust coming from Site E.

Figure 72: Site E as of August 2013 (CDPHE August 2013)

Site F in Figure 70(approximately 26 acres) is south of 14th St, north of 17th St, west of Ross Ave, and east of the Frontage Road. It is zoned by the city as “Residential Medium” as shown in Figure 65. Site F, as shown in Figure 73, is vacant land that is naturally vegetated and undisturbed.

Figure 73: Site F as of August 2013 (CDPHE August 2013)

Site G in Figure 70 (approximately 5 acres) is south of 6th St, west of Ross Ave, east of West Ave, and north of 7th St. It is zoned by the city as "Commercial Business" as shown in Figure 65. The vacant land is undisturbed gravel, dirt, and is naturally vegetated as shown in Figure 74. The railroad runs through this narrow strip of land rendering it unlikely to be developed in the future.

Figure 74: Site G as of August 2013 (CDPHE August 2013)

Site H in Figure 70 (approximately 22 acres) is east of La Due Ave, south of 6th St, north of 9th St, and west of Old Airport Rd. It is zoned by the city as "Commercial Business" and "Industrial" as shown in Figure 65. Site H is private property with restricted access located just south of the rail yard. The land is naturally vegetated and undisturbed as shown in Figure 75.

Figure 75: Site H as of August 2013 (CDPHE August 2013

5.4 Potential areas of local soil disturbance north, northeast and east of Alamosa (both monitors)

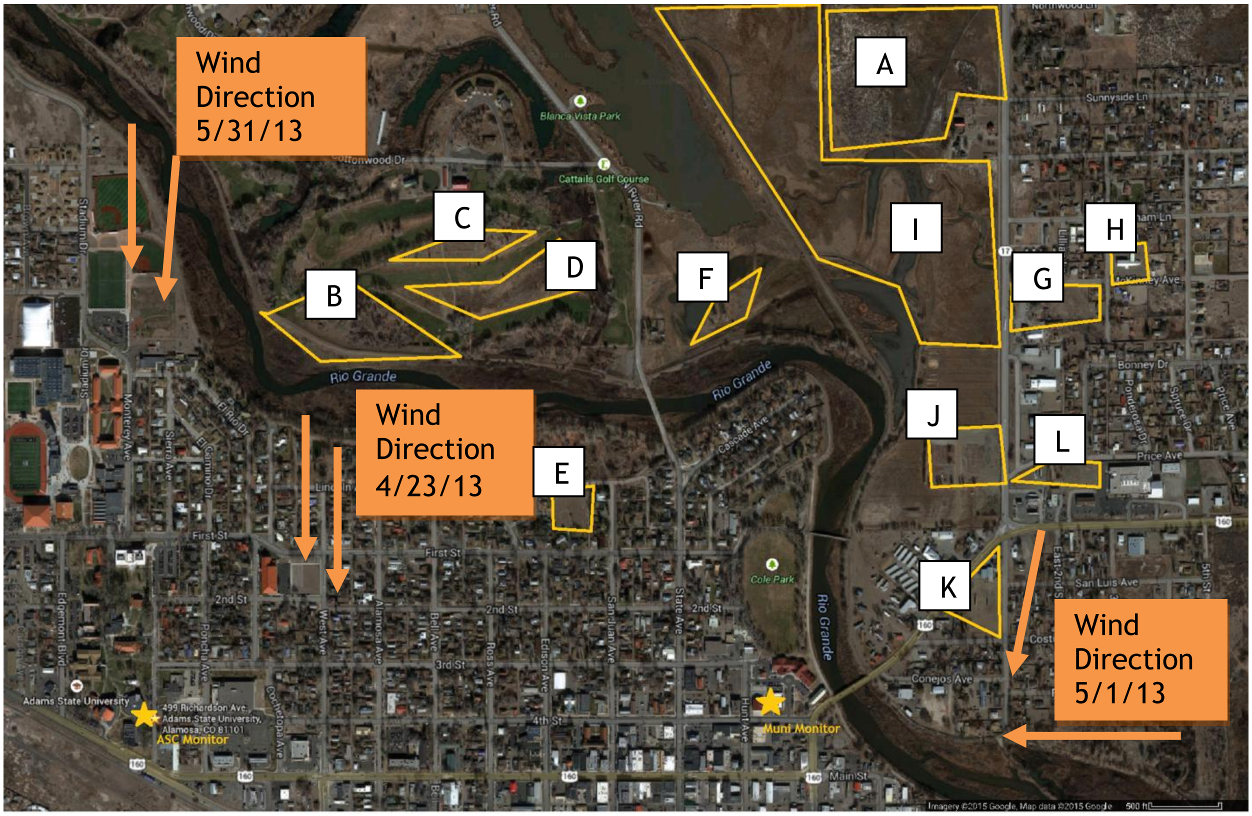

Figure 76: Relative positions of Adam's State College PM_{10} Monitor and Alamosa Municipal Building PM_{10} Monitor, wind direction and potential disturbed soil. (Google Earth 2013)

Site A in Figure 76 is naturally vegetated and undisturbed property that is fenced to restrict access as shown in Figure 77.

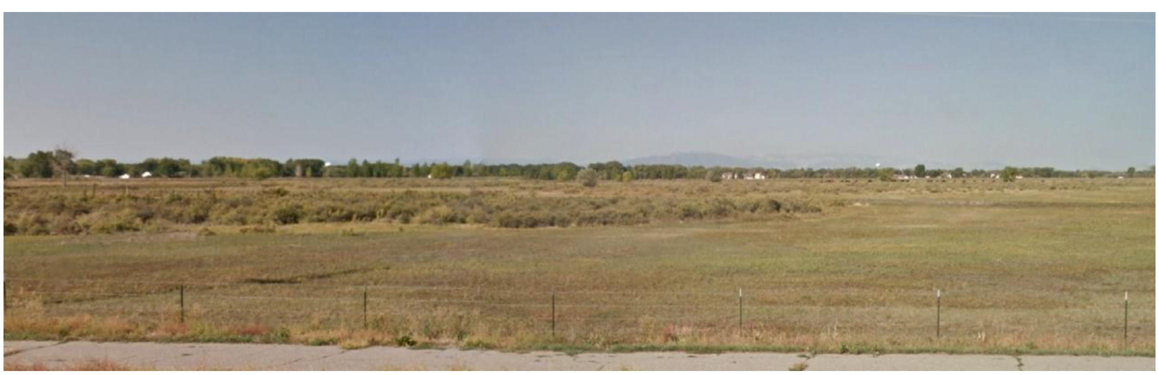

Figure 77: Site A (Google Image 2012)

Site B, C, and D in Figure 76 are located on a golf course. These areas of the golf course are natural, undisturbed, and unmaintained. These areas receive some of the irrigation sprinkling from the golf course but are not irrigated themselves. The golf carts use the designated paths and park on the greenways; they do not disturb these natural areas.

Figure 78: Representative of Site B, C and D as of August 2013 (also showing golf cart path) (CDPHE 2013)

Site E in Figure 76 is a private vacant lot in a residential area. The area is covered in gravel and weeds as shown in Figure 79. The land is used to store farm equipment in-between harvest seasons.

Figure 79: Site E as of August 2013 (CDPHE 2013)

Site F in Figure 76 is a public green space and gravel walking path maintained by the City of Alamosa. Motor vehicles are not permitted on the path. Adjacent to the path is private property that is fenced in with barbed wire. All the private land is irrigated and maintained by the owner. Figure 80 shows site F as of August 2013.

Figure 80: Site F as of August 2013 (CDPHE 2013)

Site G in Figure 76 is a vacant lot in a residential neighborhood. The vacant lot was for sale as of August 2013. The soil is hard packed with a crust. The lot is covered in natural vegetation and is undisturbed as shown in Figure 81.

Figure 81: Site G as of August 2013 (CDPHE 2013)

Site H in Figure 76 is a church parking lot. The lot is well maintained gravel that is watered on an as needed basis as shown in Figure 82. The lot is only used for church events.

Figure 82: Site H as of August 2013 (CDPHE 2013)

Site I in Figure 76 is naturally vegetated and undisturbed property that is fenced to restrict access as shown in Figure 83.

Figure 83: Site I (Google Image 2012)

Site J in Figure 76 is private property with restricted access through an electric gate as shown in Figure 84. The land is covered in gravel and weeds as shown in Figure 84.

Figure 84: Site J (Google Image 2012)

Site K in Figure 76 is a gravel parking lot for a semi-truck service station as shown in Figure 85. The gravel is graded and watered on an as needed basis.

Figure 85: Site K as of August 2013 (CDPHE 2013)

Site L in Figure 76 is a well maintained gravel parking lot for the Day's Inn hotel as shown in Figure 86. The parking lot is graded and watered on an as needed basis to mitigate blowing dust.


Figure 86: Site L as of August 2013 (CDPHE 2013)

There were several other areas that were identified by APCD staff for further investigation and are shown in Figure 87. Similar to the sites described earlier these sites were also 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 Alamosa area during the 2013 high wind events.

Figure 87: East of Municipal Building PM_{10} Monitor (~1mile distance) and potential disturbed soil. (Google Image 2014)

Site L in Figure 87 (approximately 20 acres) is a vacant lot that was for sale as of August 2013. The undisturbed land is fenced in with barbed wire. The land is in a heavily wooded area and has dense natural vegetation as shown in Figure 88.


Figure 88: Site L as of August 2013 (CDPHE 2013)

Site M in Figure 87 is all private undisturbed land (multiple owners) that is fenced in with barbed wire. The land has dense natural vegetation as shown in Figure 89.


Figure 89: Site M as of August 2013 (CDPHE 2013)

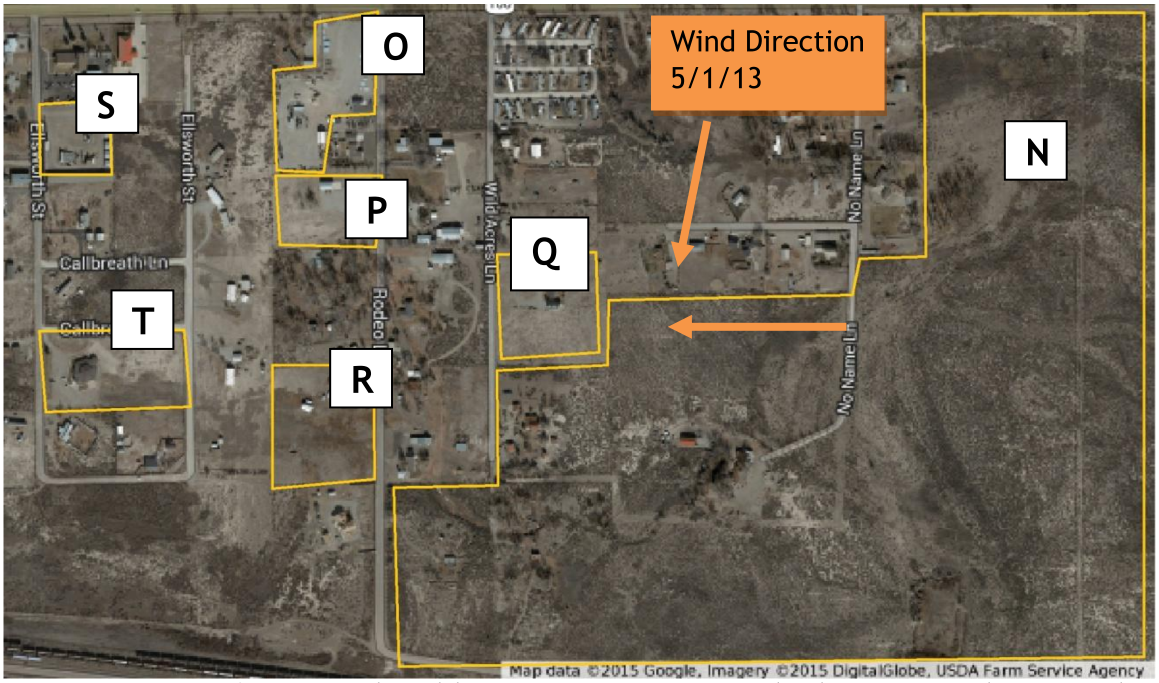

Figure 90: East of Municipal Building PM_{10} Monitor (~2mile distance) and potential disturbed soil. (Google Image 2014)

Site N in Figure 90 is restricted access property located just south of Highway 160. The land is naturally vegetated and largely undisturbed as shown in Figure 91. Figure 91 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 91: Site N (Google Image 2012)

Site O in Figure 90 is a restricted access property located on the corner of Rodeo Lane and Hwy 160. As show in Figure 92, the property is gated and fenced and the gravel storage yard is well maintained. Access into and out of the property is paved, minimizing carry out of particles from the gravel yard to the road. 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 92: Site O (Google Image 2012)

Site P in Figure 90 is a restricted access property located on Rodeo Lane. As shown in Figure 93, the property is gated and “No Trespassing” signs are posted (red arrow). Three sides of the property are fenced and large boulders are placed along Rodeo land to prevent entrance. The areas of the property that are not regularly used as a driveway are covered in weeds and the driveway is composed of well maintained gravel. 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 93: Site P (Google Image 2012)

Site Q in Figure 90 is a restricted access residential property located on Wild Acres Lane. As shown in Figure 94, the property is gated and fenced and the gravel yard is well maintained by grating. 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 94: Site Q (Google Image 2012)

Site R in Figure 90 Figure 90 is a restricted access property located on Rodeo Lane. As shown in Figure 95, the property is fenced and covered in weeds and native vegetation. 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 95: Site R (Google Image 2012)

Site S in Figure 90 is a restricted access property located on Ellsworth St. As shown in Figure 96, the property is surrounded by a security fence topped with barbed wire. The speed limit while onsite is posted at 5 mph and the gravel lot is well maintained. 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.

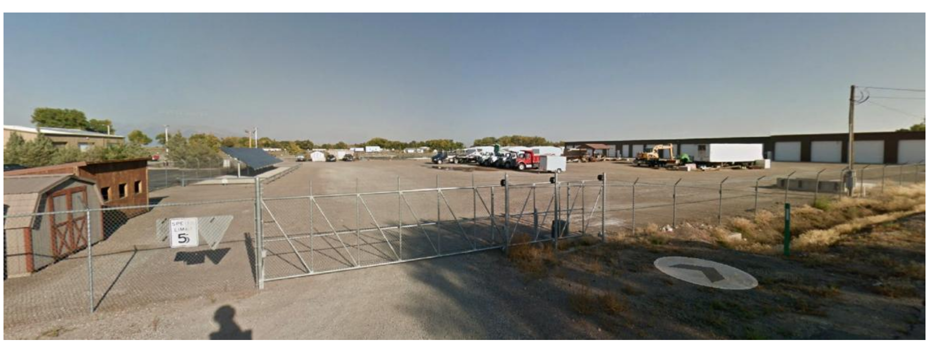

Figure 96: Site S (Google Image 2012)

Site T in Figure 90 is the Calvary Bible Chapel property located on Ellsworth St. As shown in Figure 97, the property is landscaped with sod around the parking areas which consist of well maintained gravel. 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 97: Site T (Google Image 2012)

The APCD conducted thorough assessments to determine if the potential soil disturbances shown in Figure 64 through Figure 97 were present during the 2013 exceedances in Alamosa. During the course of these assessments, the APCD discovered that these sites were either reasonably controlled or considered to be natural sources during the April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013, high wind events. Therefore, these sites were not significant contributors to fugitive dust in the Alamosa area during these high wind events.

Sod and Vegetative Projects in the County
The development and construction of a local park, Eastside Park, is complete in Alamosa County. It has been completed with turf grass, shrubs, and landscape rock. No exposed soil remains.

Numerous other projects to reduce blowing dust and its impacts have happened or are happening at the County Airport. For example:

- Through additional grounds maintenance of the 40-acre Alamosa County airport south of the city, “Xeriscape” has been installed for aesthetics and dust control.
- Decorative rock and xeriscape have been implemented in the landscaping of the Alamosa County property (2007-2012). These measures have directly abated blowing dust at the Airport.
- The widening of the airport’s safety areas (250 feet on either side of the runway) is complete and seeding of natural grasses was incorporated in the project. Trees and grass were incorporated in the approaches to the airport and have provided additional wind-break advantages to South Alamosa.

In other areas where watering is a problem, xeriscape (the use of native drought resistant vegetation and/or rock cover) is being encouraged for County owned property and for all other property owners.

Colorado State University Co-Op Extension Office
In response to extremely dry conditions, the need to maintain area topsoil, and reduce impacts, the Colorado State University Co-Op Extension Office of Alamosa County provides the following outreach efforts and recommendations:

- Modification of grazing practices to improve protective crop cover;
- Increasing crop residues left in the fields to reduce blowing dust;
- Planting of fall crops to maintain fields;
- Application of manure to protect top soils from blowing away;
- Staggering of the harvest to minimize blowing dust;
- Outreach programs on soil conservation efforts;
- Development of outreach/education materials (e.g., news articles, newsletters, fact sheets, etc.); and
- Attendance at Statewide workshop to educate other Co-Op offices to various practices to reduce blowing top soil and minimize impacts.

These control strategies are not meant to be enforceable. They are meant only to demonstrate the regional nature of cooperation in addressing blowing dust and its impacts on the community.

Natural Resources Conservation Service (NRCS)
Alamosa County is a predominately agricultural area where limited water, coupled with the frequent high winds experienced during late fall and early spring, can destroy crops, encourage pests, and damage soil surfaces lending them susceptible to wind erosion. Thus, activities that improve the topsoil and prevent its lifting during high wind events are encouraged. Some notable NRCS and agricultural examples include:

- Local Conservation Districts and farmers hold monthly meetings as an informal Soil Health Group, discussing ways to improve soil health. Cover crops, compost applications, and reduced tillage are the targeted practices. Public tours are held twice a year;
- NRCS continues to work with area farmers in the development of conservation compliance plans to also protect topsoil;
- NRCS encourages planting perennial grasses or the leaving weeds undisturbed or mowed on the corners of center pivots (instead of tilling that might lead to open, barren lands) to reduce soil blowing;
- NRCS “cost shares” on soil health practices and perennial grass seeding conservation practices with local farmers to prevent soil erosion; and
- The NRCS is working with Colorado State University, local Water Conservation District, and Farm Service Agency to encourage retirement of marginal cropland in the Conservation Enhanced Reserve Program (CREP) and seeding those acreages back to native grass, forbs and shrubs.

Other successful agricultural practices encouraged in the area include: timing of tillage, crop rotation, amount of crop residue left on the land, and proper water usage. These control strategies are not meant to be enforceable. They are meant only to demonstrate the regional nature of cooperation in addressing blowing dust and its impacts on the community.

Please refer to the Final NEAP for Alamosa at
http://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=AlamosaNaturalEventsActionPlan2003.pdf for more detail if needed.

6.0 Summary and Conclusions

APCD is requesting concurrence on exclusion of the PM_{10} values from Alamosa-Adams State College (08-003-0001) and Alamosa Municipal Building (08-003-0003) on April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013.

Elevated 24-hour PM_{10} concentrations were recorded at the Adams State College and Alamosa Municipal Building monitors on April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013. All of the noted twenty-four-hour PM_{10} concentrations were above the 90^{th} percentile concentrations for their locations (see Section 3) and exceeded the 99^{th} percentile value of any evaluation criteria. The statistical and meteorological data clearly shows that but for these high wind blowing dust events, Alamosa would not have exceeded the 24-hour NAAQS on April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 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 measured concentrations in excess of normal historical fluctuations including background.

The PM_{10} exceedances in Alamosa 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 April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013. The meteorological conditions during these events 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 the Lamar, Colorado, Blowing Dust Climatology at http://www.colorado.gov/airquality/tech_doc_repository.aspx). These PM_{10} exceedances were due to exceptional events associated with regional windstorm-caused emissions from erodible soil sources over a large source area 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 April 8, 2013, April 23, 2013, May 1, 2013 and May 31, 2013, these exceedances would not have occurred.

As demonstrated in this report, the PM_{10} exceedances in Alamosa on April 8, 2013, May 1, 2013 and May 31, 2013, would not have occurred “but for” the large regional dust storms that occurred on these dates.

7.0 References

7.1 April 8, 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.*

7.2 April 23, 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.*

7.3 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 31, 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.*