Technical Support Document
For the April 8, 2009
Alamosa Exceptional Event

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

May 29, 2012

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1.0 Introduction

1.1 PM_{10} Standards

In July 1987, the U.S. Environmental Protection Agency (EPA) promulgated National Ambient Air Quality Standards for Particulates with an aerodynamic diameter of 10 microns or less (PM_{10}). This is a size range that can affect the upper airways and can be inhaled into the alveolar regions of the lungs. The standard has one form, a 24-hour standard of 150 $\mu g/m^3$. The annual arithmetic mean standard of 50 $\mu g/m^3$ was revoked on October 17, 2006. The 24-hour standard is attained when the expected number of exceedances for each calendar year, averaged over three years, is less than or equal to one. The estimated number of exceedances is computed quarterly using available data and adjusting for missing sample days. A data recovery of 75 percent is needed for each calendar quarter to be considered a valid quarter of data. This standard was modified in by EPA in July 1997, but was subsequently nullified back to this form in May 1999.

1.2 Event Overview

On Wednesday April 8, 2009, Alamosa, Colorado, recorded an exceedance of the twenty-four-hour PM_{10} standard with a concentration of 157 ug/m3 at the Alamosa Municipal Building monitor. 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 in Alamosa and other areas of Colorado and the exceedance of the National Ambient Air Quality Standard (NAAQS) for PM_{10} at Alamosa were caused by a natural event, specifically a dust storm. It will be shown that this exceedance and the high PM_{10} readings are the consequence of a dust storm in the Four Corners area. This event meets the criteria outlined by the final "Treatment of Data Influenced by Exceptional Events" Rule (72 FR 13560). This report and the analysis and data contained within it show that this exceptional event passed the four required tests (a) through (d) under 40 CFR 50.14 (3)(iv). These tests are:

(a) The event satisfies the criteria set forth in 40 CFR 50.1(j) which requires that an exceptional event "affects air quality, is not reasonably controllable or preventable..." and that such events are "...natural event[s]".
(b) There is a clear causal relationship between the measurement under consideration and the event that is claimed to have affected the air quality in the area.
(c) The event is associated with a measured concentration in excess of normal historical fluctuations, including background; and
(d) There would have been no exceedance or violation but for the event.

Elevated 24-hour PM_{10} concentrations were recorded across Colorado on April 8, 2009. All of the noted April 8, 2009 twenty-four-hour PM_{10} concentrations were above the 90^{th} percentile concentrations for their locations. *The Alamosa concentration is nearly equal to the 99^{th} percentile, and a conservative estimate of the dust storm contribution to the total concentration is 116 – 123* $\mu g/m^3$*. This is evidence that the event was associated with a measured concentration in excess of normal historical fluctuations including background. But for the dust storm to be described in detail in this report, there would have been no exceedance on this day in Alamosa.*

This exceedance was the consequence of strong gusty winds ahead of a deep low pressure with a trailing cold front, in combination with dry conditions, which caused significant blowing dust across parts of Arizona, New Mexico, and Colorado. These winds were partly the result of a developing low pressure centered over southwestern Idaho with a cold front trailing to the south as well as a second low pressure system over east central Colorado. Strong winds aloft which mixed down to the surface in the deeply-mixed surface boundary layer also contributed to this exceedance. Surface weather analyses show an area of low pressure affecting the Four Corners region. The pressure gradient around the low contributed to strong gusty surface winds across much of Arizona, northwest New Mexico, and southwest Colorado. *Upper winds in the area bounded by Flagstaff, Arizona, Grand Junction, Colorado, and Albuquerque, New Mexico were 46 – 63 mph on April 8, 2009. Gusts of 23 to 49 mph were recorded across almost all of western Colorado, northern New Mexico, and northeast Arizona on March 8. These speeds are above the thresholds for blowing dust identified in EPA draft guidance and in detailed analyses completed by the State of Colorado.*

EPA‘s May 2, 2011 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 “Empirical evidence shows that a sustained wind speed of 25 mph is typically the minimum wind speed needed to entrain particles from many stable surfaces ...” 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 references for the *Natural Events Action Plan for High Wind Events – Lamar, Colorado* and the *Technical Support Document for the January 19, 2009 Lamar Exceptional Event* and Attachment A - Grand Junction, Colorado, Blowing Dust Climatology at the end of this document). For this blowing dust event, it has been assumed that sustained winds of 25 mph and higher or wind gusts of 40 mph and higher can cause blowing dust in northeast Arizona, northwest New Mexico, and southwest Colorado.

Climatological data for March and April shows that most of the Four Corners area had received less than normal precipitation for the period of interest. Soils in many areas of the Four Corners region had below normal moisture, and northeast Arizona was abnormally dry. Winslow in northeastern Arizona received only 0.05 inches of precipitation during the 30 days prior to April 8. This total is well below the approximate threshold for blowing dust conditions at Hopi identified in the analysis contained in Attachment A. Both wind speeds and soil moisture in the Four Corners area and northeastern Arizona were conducive to the generation of significant blowing dust.

Friction velocities calculated for the region also help to explain why blowing dust originated in the Four Corners region. Even undisturbed desert soils normally resistant to wind erosion will be susceptible to blowing dust when friction velocities are greater than about 1.0 to 2.0 meters per second. High values were present within the Little Colorado River Valley and Painted Desert region of northeast Arizona where satellite imagery shows the eruption of large plumes of blowing dust. Note that blowing dust will typically only occur where these values are high and the soils are dry and not protected by vegetation, forest cover, boulders, rocks, etc. This is why blowing dust occurred in the desert and more arid areas of northeast Arizona, southwest and south-central Colorado, and northwest New Mexico on April 8, 2009. Friction velocities were high enough for dust from undisturbed soils in many areas of south-central and southwestern Colorado, including the western sections of the arid San Luis Valley upwind of Alamosa. *The high friction velocities and the data on soil moisture conditions presented elsewhere in this report prove that this dust storm was a natural event that was not reasonably controllable or preventable.*

Satellite imagery shows large plumes of southwest to northeast trending blowing dust in the Painted Desert and Little Colorado River Valley region of northeastern Arizona and in northwest New Mexico on April 8, 2009. Backward trajectories, wind streamline analyses, and surface and upper-level wind patterns show that this dust would have been transported into Colorado on April 8, 2009. Northeastern Arizona and the Four Corners area is an area shown in Attachment A to be a significant source region for blowing dust transported into Colorado. *Multiple sources of data and analyses of past dust storms in this area prove that this was a natural event and, more specifically, a significant natural dust storm originating in northeastern Arizona and northwestern New Mexico and spreading into southwestern and south-central Colorado. But for the dust storm on April 8, 2009, this exceedance would not have occurred.*

The Center for Snow and Avalanche Studies (http://www.snowstudies.org/index.html) has been studying the effects of desert dust deposition on snowpack albedo and snowmelt in the San Juan Mountains of Colorado. The center's log of events lists April 8, 2009, as one of twelve Dust-on-Snow events for the 2008/2009 water year. Web cam photos from Alamosa and the Shamrock site in southwestern Colorado support the conclusion that widespread blowing dust was present on April 8, 2009. NOAA's Satellite Service Division also describes blowing dust stretching from Arizona into southwest Colorado on. *Multiple reports substantiate the conclusion that this was a natural event. But for the dust storm on April 8, 2009, this exceedance would not have occurred.*

2.0 Meteorological Analysis of the April 8, 2009 Blowing Dust Event

On Wednesday April 8, 2009, Alamosa, Colorado, recorded an exceedance of the twenty-four-hour PM_{10} standard with a concentration of 157 ug/m3 at the Alamosa Municipal Building monitor. Elevated readings were recorded at the Alamosa Adams State College monitor with a twenty-four-hour PM_{10} concentration of 135 ug/m3, the Breckenridge monitor with a twenty-four-hour PM_{10} concentration of 101 ug/m3, and the Mount Crested Butte monitor with a twenty-four-hour PM_{10} concentration of 56 ug/m3 as seen in Figure 1. *The twenty-four-hour PM_{10} concentrations at the Alamosa Municipal Building, Alamosa Adams State College, and Breckenridge, are above the 90th percentile concentrations for their locations. The Mount Crested Butte twenty-four-hour PM_{10} concentration is above normal fluctuations. This is evidence that the event is associated with a measured concentration in excess of normal historical fluctuations including background.*

This exceedance and the elevated readings were the consequence of strong gusty winds ahead of a deep low pressure with a trailing cold front, in combination with dry conditions which caused significant blowing dust across parts of Arizona, New Mexico, and Colorado. The prefrontal winds were partly the result of a 1000-millibar surface low pressure centered over southwestern Idaho with a cold front trailing to the south as shown in the 12Z April 8, 2009 (5 AM MST April 8, 2009) surface analysis in Figure 2. This low pressure moved to the northeast into Montana, and a second 995-millibar low pressure formed over east central Colorado as shown in Figure 3 the 0Z April 9, 2009 (5 PM MST April 8, 2009) surface analysis.

These surface features were associated with a strong upper level low moving into the Great Basin which is shown in Figure 4, the 500-millibar analysis for 12Z April 8, 2009 (5 AM MST April 8). There was a localized wind maximum of 60 to 80 knots over Arizona. Once the morning inversion broke, the momentum associated with these winds would have mixed down to the surface and enhance the prefrontal winds associated with the strong low pressure systems and cold fronts in Figures 2 and 3. Figure 5 is the 500-millibar analysis for 0Z April 9, 2009 (5 PM MST April 8) which shows that the upper level low had became an open wave and lifted to the east northeast. The upper level winds in the area bounded by Flagstaff, Arizona, Grand Junction, Colorado, and Albuquerque, New Mexico, were 40 to 55 knots.

Figures 6 through 8 show the afternoon soundings at Flagstaff, Arizona, Grand Junction, Colorado, and Albuquerque, New Mexico. Flagstaff had mixing to about 7,000 feet above ground level (AGL), while Grand Junction and Albuquerque had mixing of 15,000 to 18,000 ft AGL. Winds in this mixed layer ranged from 30 to 50 knots. These winds and the associated momentum were mixed down to surface enhancing the surface winds caused by the pressure gradient associated with the cold fronts and low pressure systems in Figures 2 and 3. Figure 9 is the UCAR surface map for the Denver area at 23:10Z April 8, 2009 (4:10 PM MST April 8). It shows almost all of western Colorado, northern New Mexico, and northeast Arizona with winds gusting between 23 and 49 mph. There is reduced visibility at several stations with Farmington reporting 6 miles and haze, Cortez has reduced visibility of 9 miles, and Alamosa has reduced visibility of 7 miles.

EPA's May 2, 2011, 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" indicates that a 25 mph minimum threshold wind speed is necessary to entrain particles from stable surfaces. In Eastern Colorado it has been shown that wind gusts of 40 mph or greater also cause blowing dust (see reference for the *Natural Events Action Plan for High Wind Events – Lamar, Colorado* and the *Technical Support Document for the January 19, 2009, Lamar Exceptional Event* and Attachment A - Grand Junction, Colorado, Blowing Dust Climatology at the end of this document). It is assumed that sustained winds of 25 mph and wind gusts to 40 mph can cause blowing dust in Colorado, New Mexico, and Arizona. It will be shown that these wind conditions were met at many of the weather stations in the affected states on April 8, 2009.

In a 1997 paper "Factors controlling threshold friction velocity in semiarid and arid areas of the United States" (Marticorena et al., 1997), the authors have characterized the erodibility of both disturbed and undisturbed desert soil types. The threshold friction velocity, which is described in detail in this paper, is a measure for conditions necessary for blowing dust and is higher for undisturbed soils and lower for disturbed soils.

Friction velocities have been calculated for 18Z April 8 (11AM MST April 8) and 0Z April 9 (5 PM MST April 8) using the NARR NAM12 model (data source: http://nomads.ncdc.noaa.gov/data.php?name=access#hires_weather_datasets). These friction velocities are shown in Figures 10 and 11, respectively. According to Marticorena and coauthors (1997), even undisturbed desert soils normally resistant to wind erosion will be susceptible to blowing dust when threshold friction velocities are greater than about 1.0 to 2.0 meters per second. These figures show that a wide area of Arizona, New Mexico, and southwest Colorado had friction velocities above 1.0 meters per second. High values were present within the Little Colorado River Valley and Painted Desert region of northeast Arizona where satellite imagery shows the eruption of large plumes of blowing dust. Note that blowing dust will typically only occur where these values are high and the soils are dry and not protected by vegetation, forest cover, boulders, rocks, etc. This is why blowing dust occurred in the desert and more arid areas of northeast Arizona, southwest and south-central Colorado, and northwest New Mexico on April 8, 2009. Friction velocities were high enough for dust from undisturbed soils in many areas of south-central and southwestern Colorado, including the western sections of the arid San Luis Valley upwind of Alamosa. *The friction velocities shown in Figures 10 and 11 and the data on soil moisture conditions presented elsewhere in this report prove that this dust storm was a natural event that was not reasonably controllable or preventable.*

Figure 12 is a portion of the 18:45Z April 8, 2009, (*11:45 AM MST April 8)* MODIS AERONET Sevilleta Subset - Terra 250m True Color satellite imagery. Streaks of blowing dust across portions of northeast Arizona and northwest New Mexico are outlined in black. A forest fire is visible on the Mogollon Rim in Arizona. The smoke from this fire is outlined in grey. Figure 13 is a portion of the 18:00Z April 7, 2009 (*11:00 AM MST April 7)* MODIS AERONET Sevilleta Subset - Terra 250m True Color satellite imagery on a clear day with light winds. This imagery is presented to show the contrast between a day with blowing dust, April 8, and a day with no blowing dust, April 7. The Smoke Text Product from NOAA's Satellite and Information Service (Descriptive Text Narrative for Smoke/Dust Observed in Satellite Imagery through 0102 Z April 9, 2009, 6:02 PM MST April 8) (http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2009/2009D090102.html) presented in Figure 14 describes blowing dust in northeast Arizona and northwest New Mexico stretching across Colorado and into northeast Colorado. The time of the text narrative was seven hours after the observation time for the satellite imagery in Figure 12.

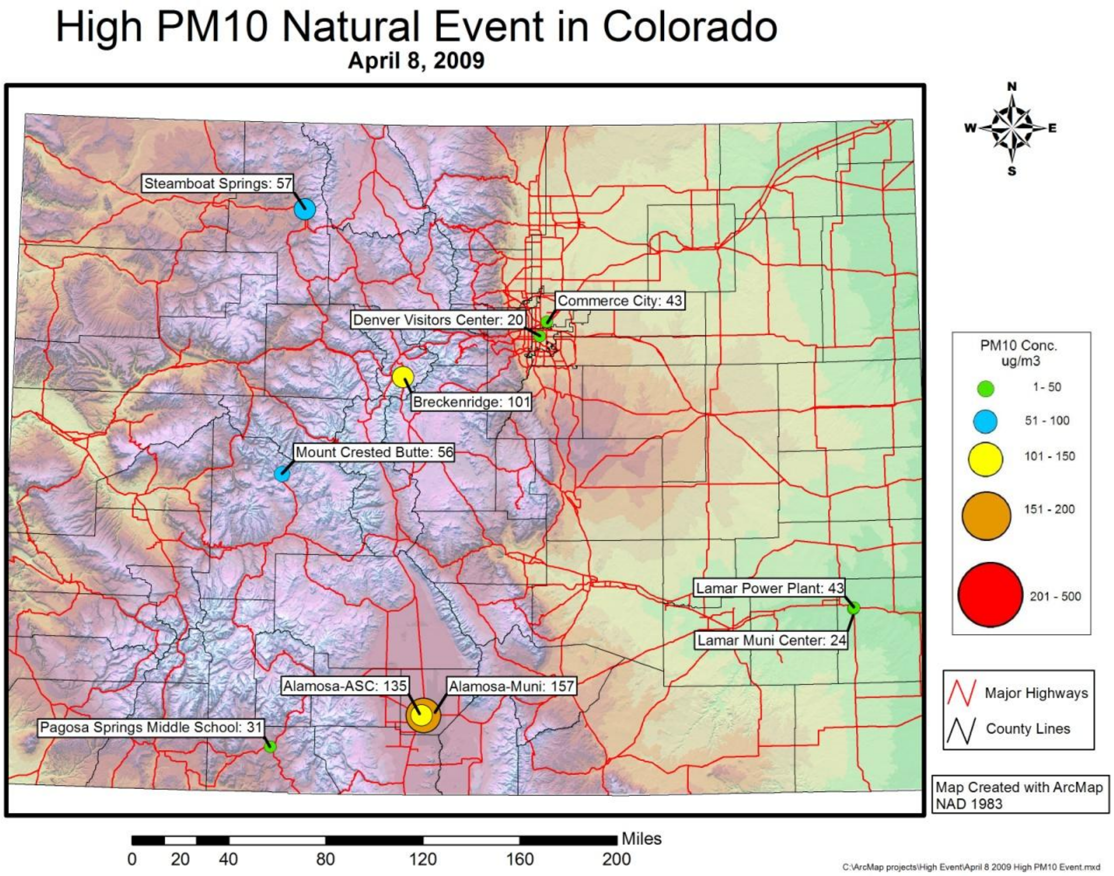

Figure 1. 24-hour PM10 readings for April 8, 2009.

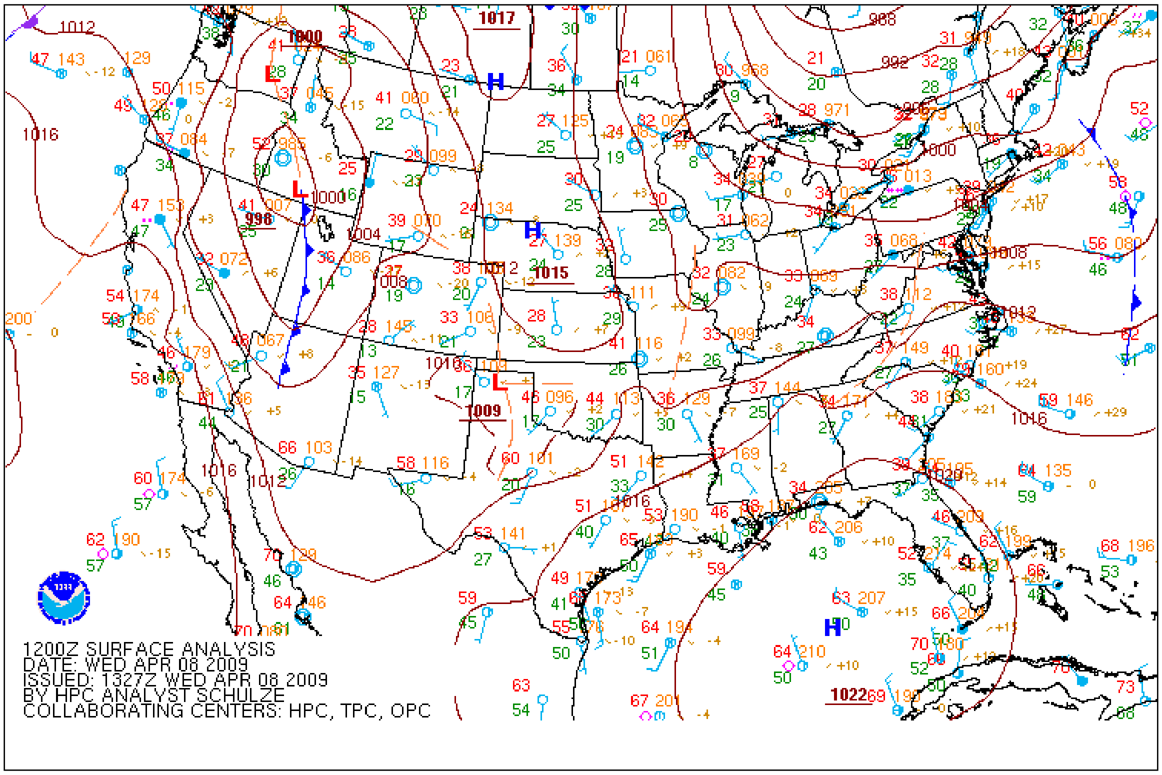

Figure 2. Surface analysis for 12Z April 8, 2009 (6 AM MST April 8) (from NCDC, SRRS Analysis and Forecast Charts http://nomads.ncdc.noaa.gov/ncep/NCEP).

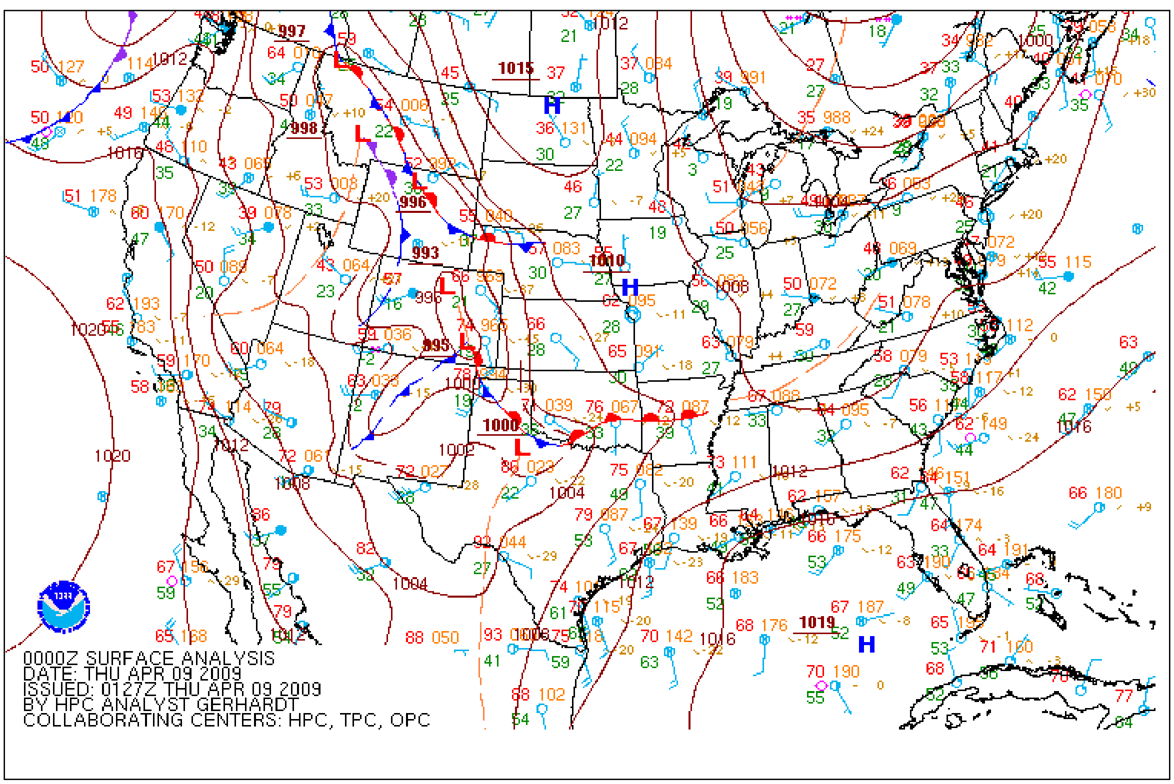

Figure 3. Surface analysis for 00Z April 9, 2009 (5 PM MST April 9, 2009) (from NCDC, SRRS Analysis and Forecast Charts http://nomads.ncdc.noaa.gov/ncep/NCEP).

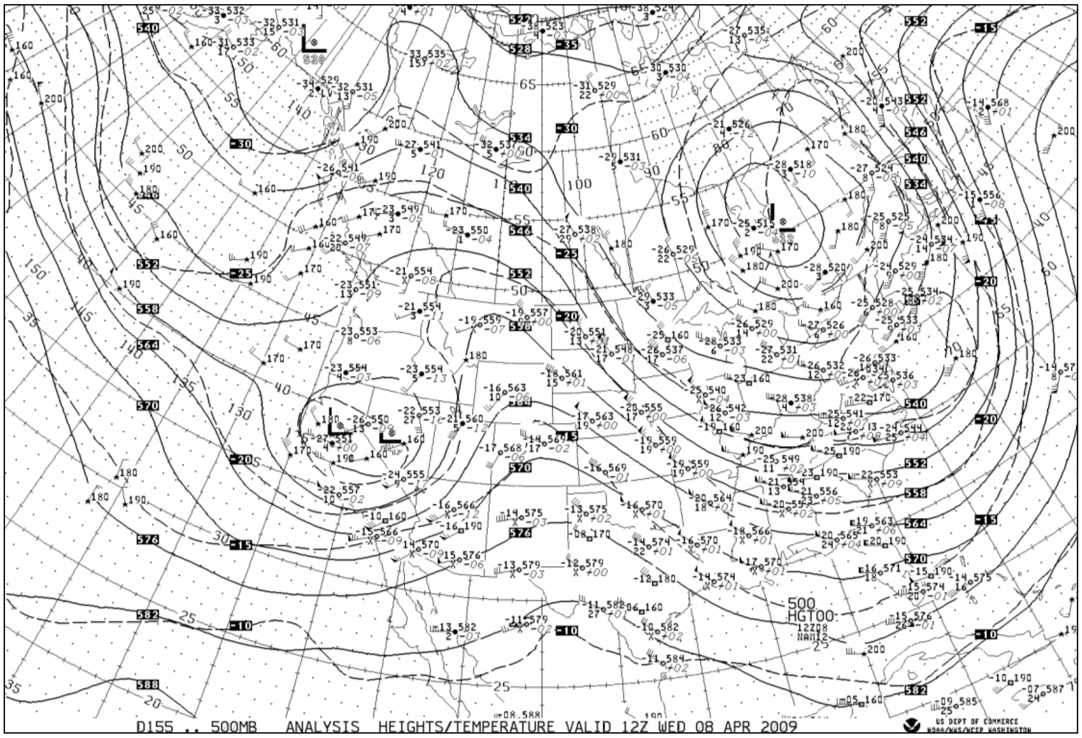

Figure 4. 500 mb analysis for 12Z April 8, 2009 (5 AM MST April 3, 2009) (from NCDC, SRRS Analysis and Forecast Charts http://archive.atmos.colostate.edu/).

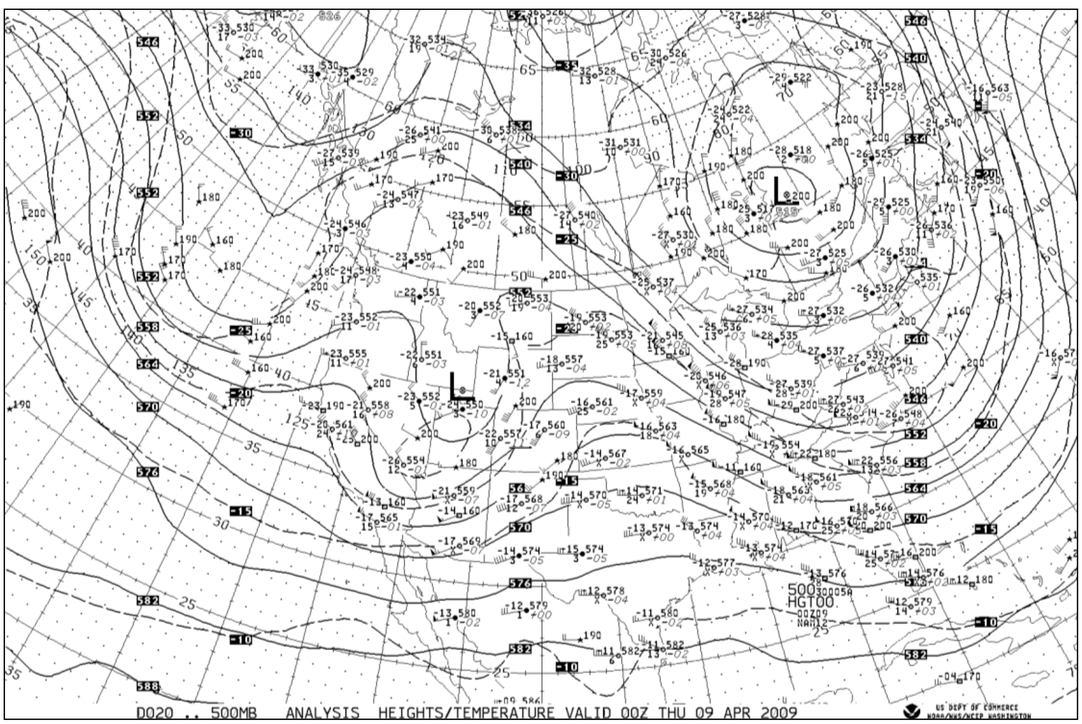

Figure 5. 500 mb analysis for 00Z April 9, 2009 (5 PM MST April 8, 2009) (from NCDC, SRRS Analysis and Forecast Charts http://archive.atmos.colostate.edu/).

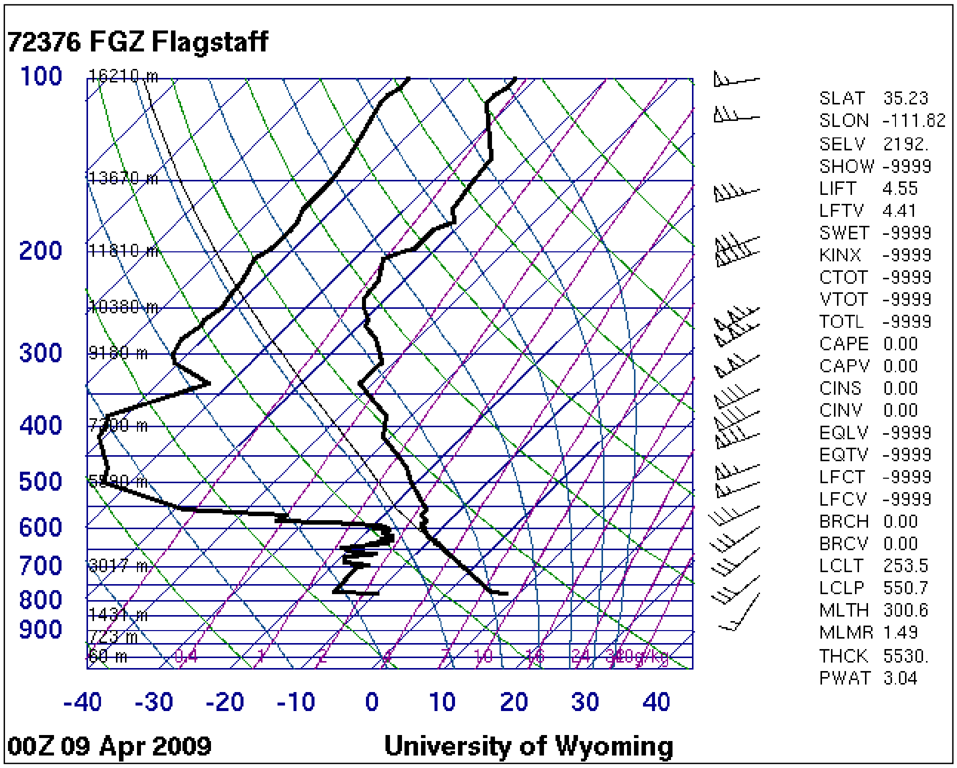

Figure 6. Flagstaff, Arizona sounding analysis for 00Z April 9, 2009 (5PM MST April 8 2009) (http://weather.uwyo.edu/upperair/sounding.html).

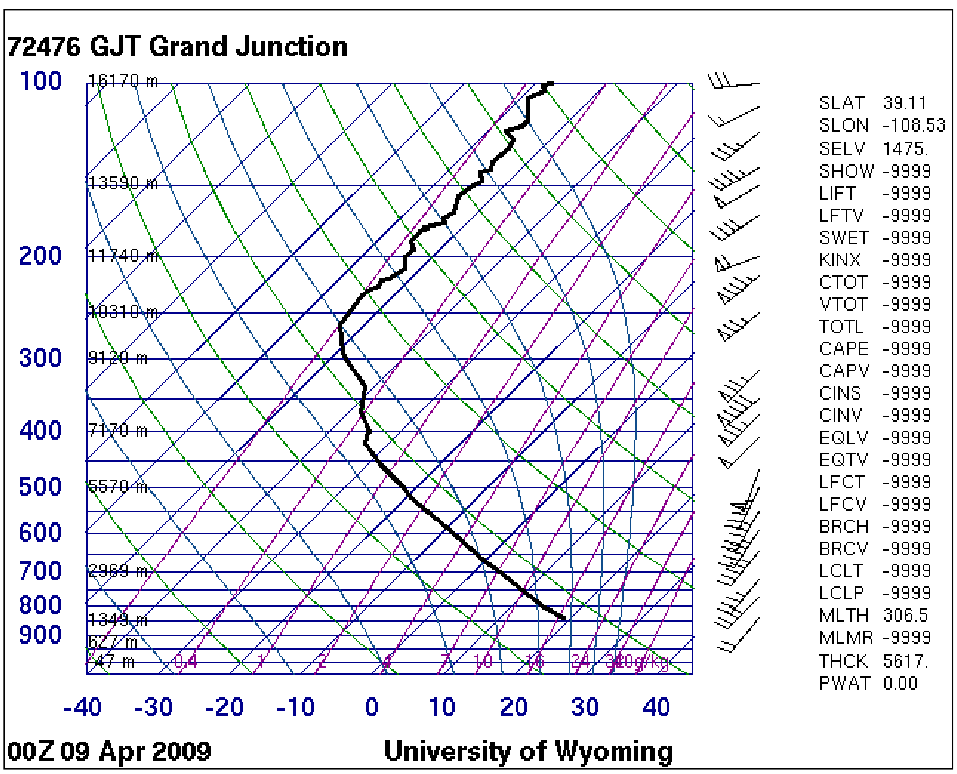

Figure 7. Grand Junction, Colorado sounding analysis for 00Z April 9, 2009 (5 PM MST April 8 2009) (http://weather.uwyo.edu/upperair/sounding.html).

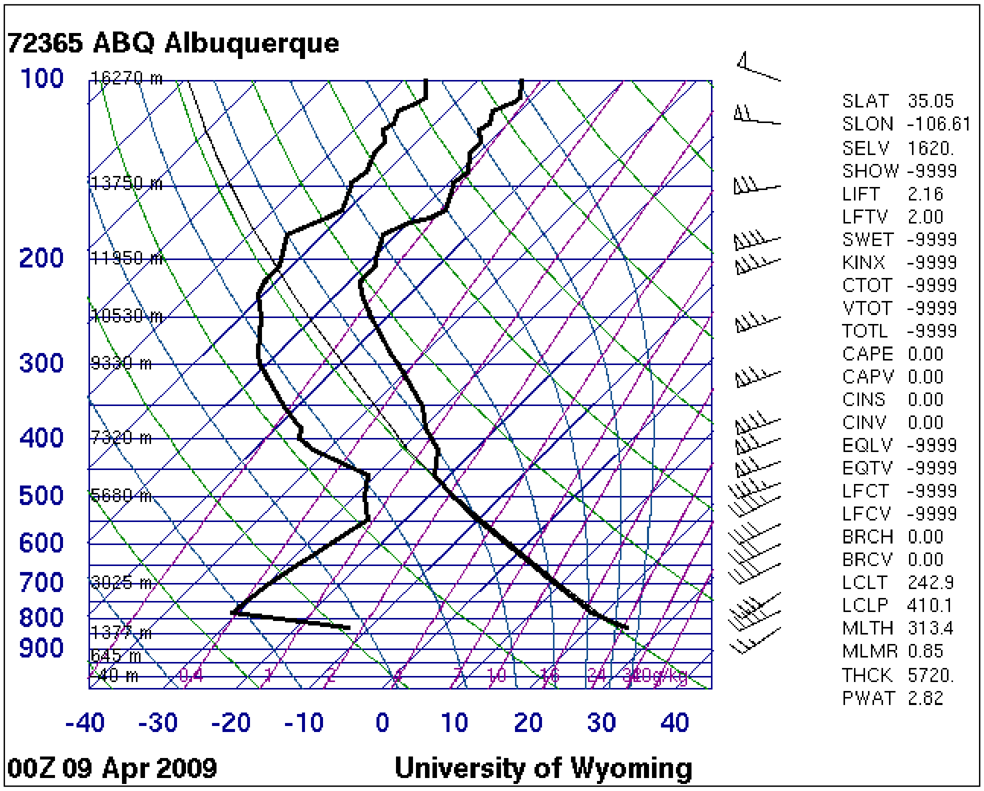

Figure 8. Albuquerque, New Mexico sounding analysis for 00Z April 9, 2009 (5 PM MST April 8 2009) (http://weather.uwyo.edu/upperair/sounding.html).

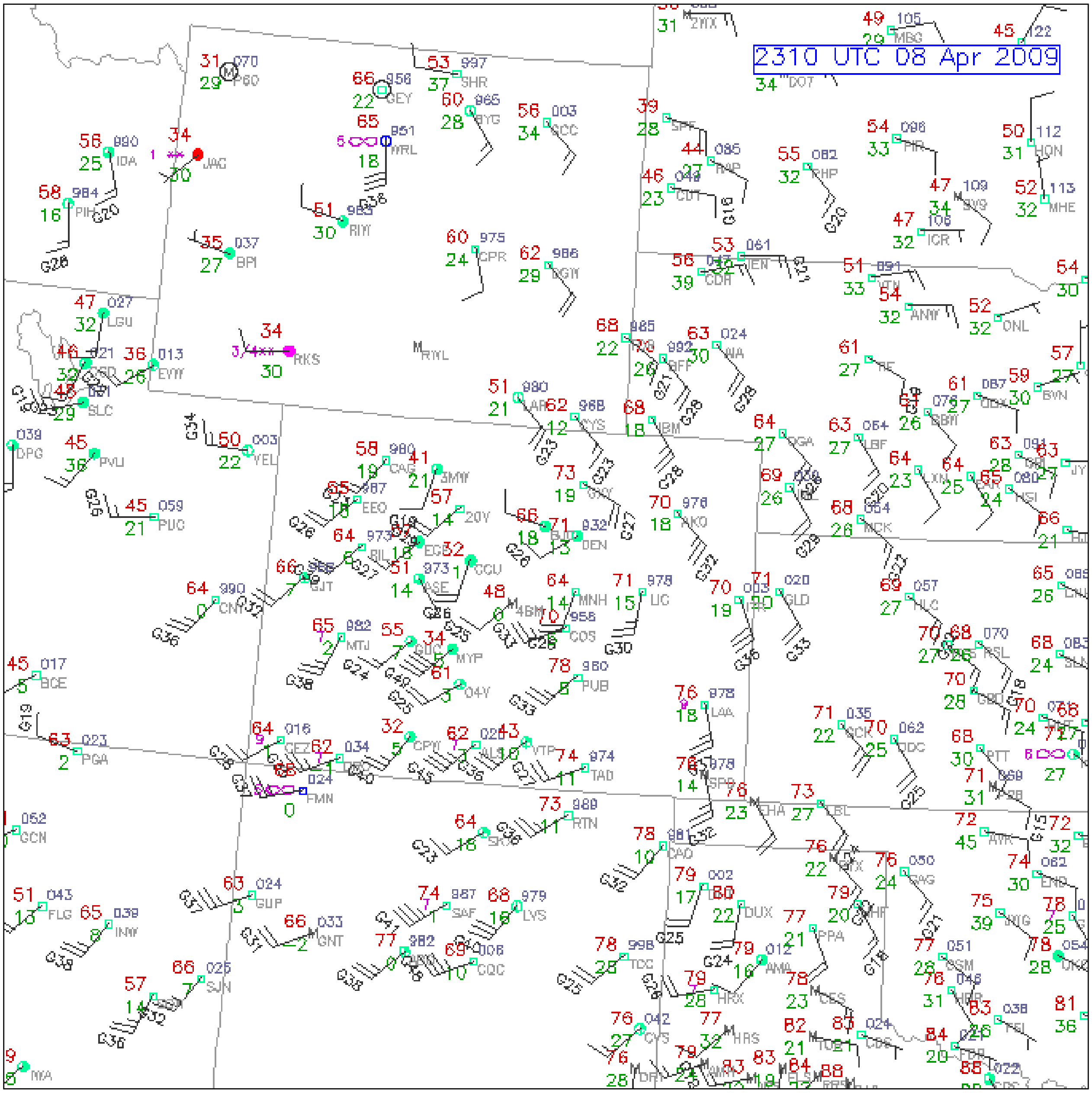

Figure 9. Surface analysis for 2310Z April 8, 2009 (4:10 PM MST April 8, 2009) (from NCAR RAP Real-Time Weather Data http://www.rap.ucar.edu/weather).

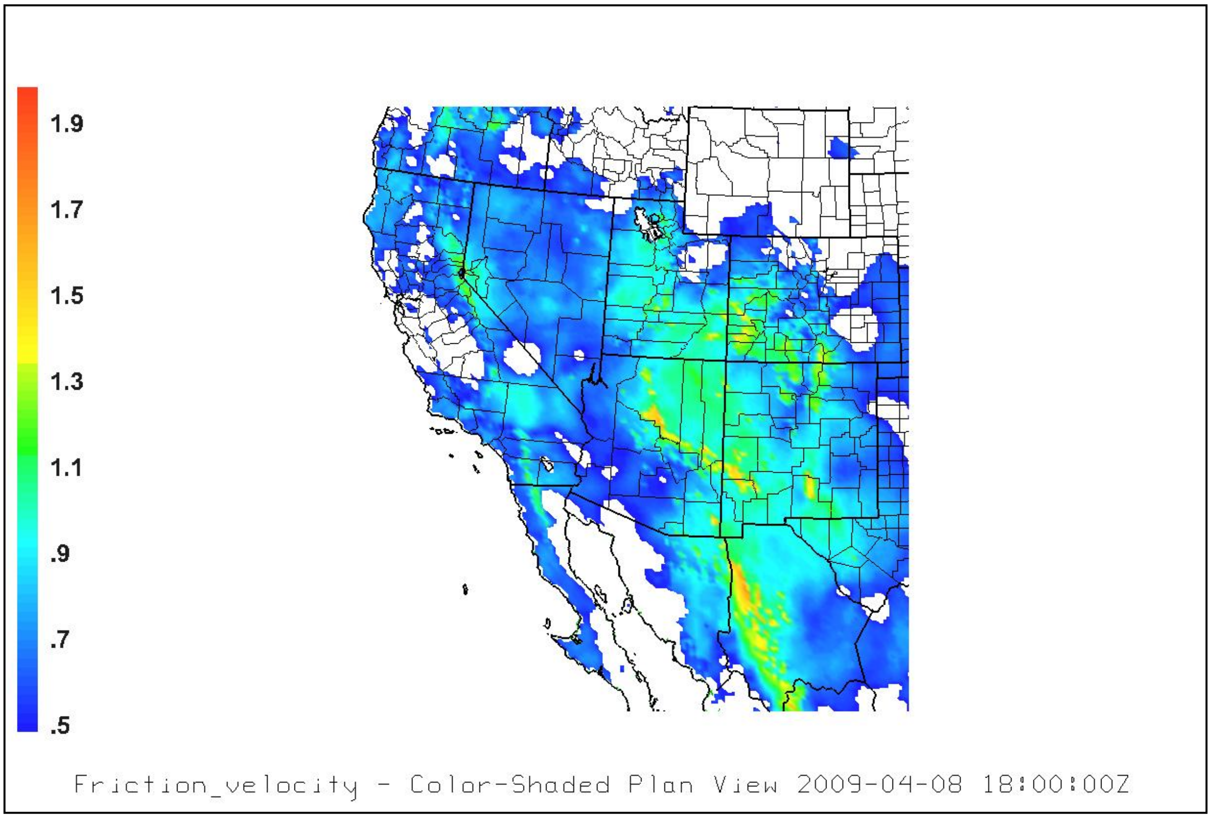

Figure 10. Friction velocities in meters/second from the NOAA NCEP North American Model with 12 kilometer grid spacing at 18Z April 8, 2009 (11 AM MST April 8).

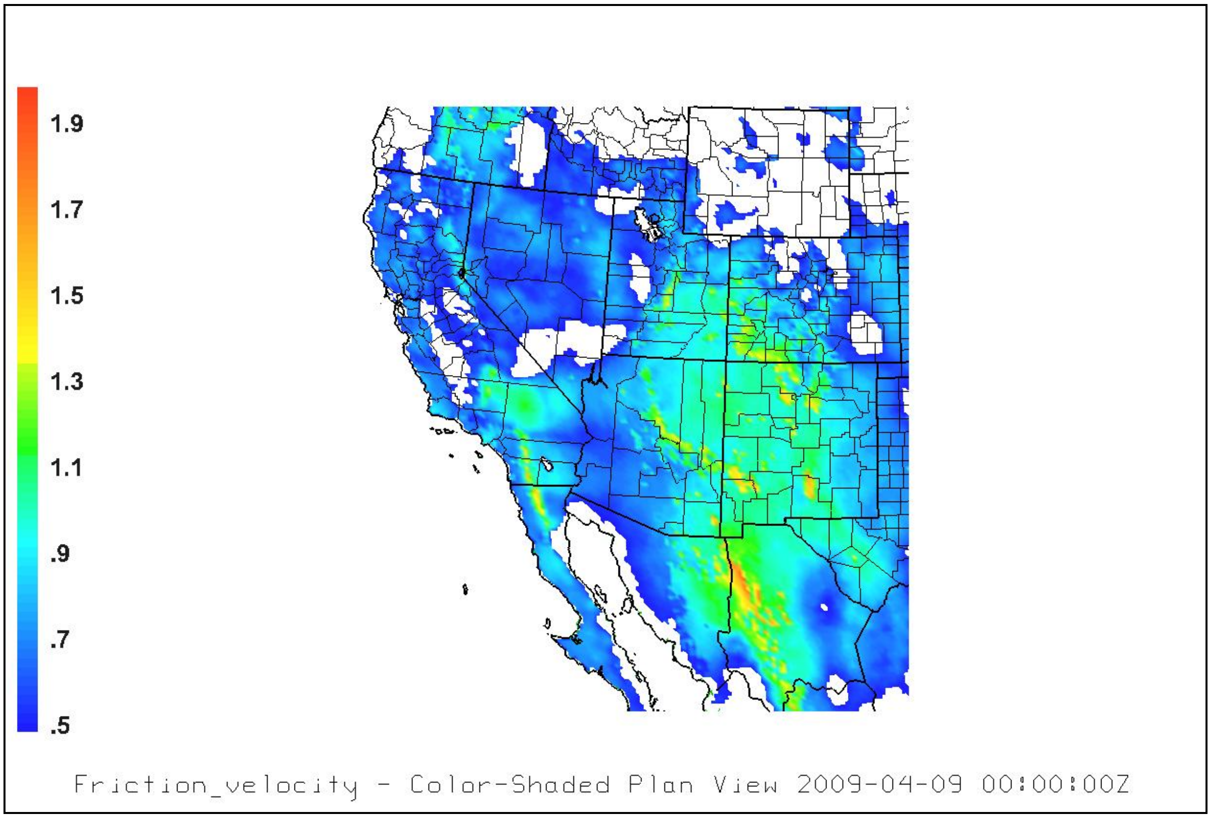

Figure 11. Friction velocities in meters/second from the NOAA NCEP North American Model with 12 kilometer grid spacing at 0Z April 9, 2009 (5 PM MST April 8).

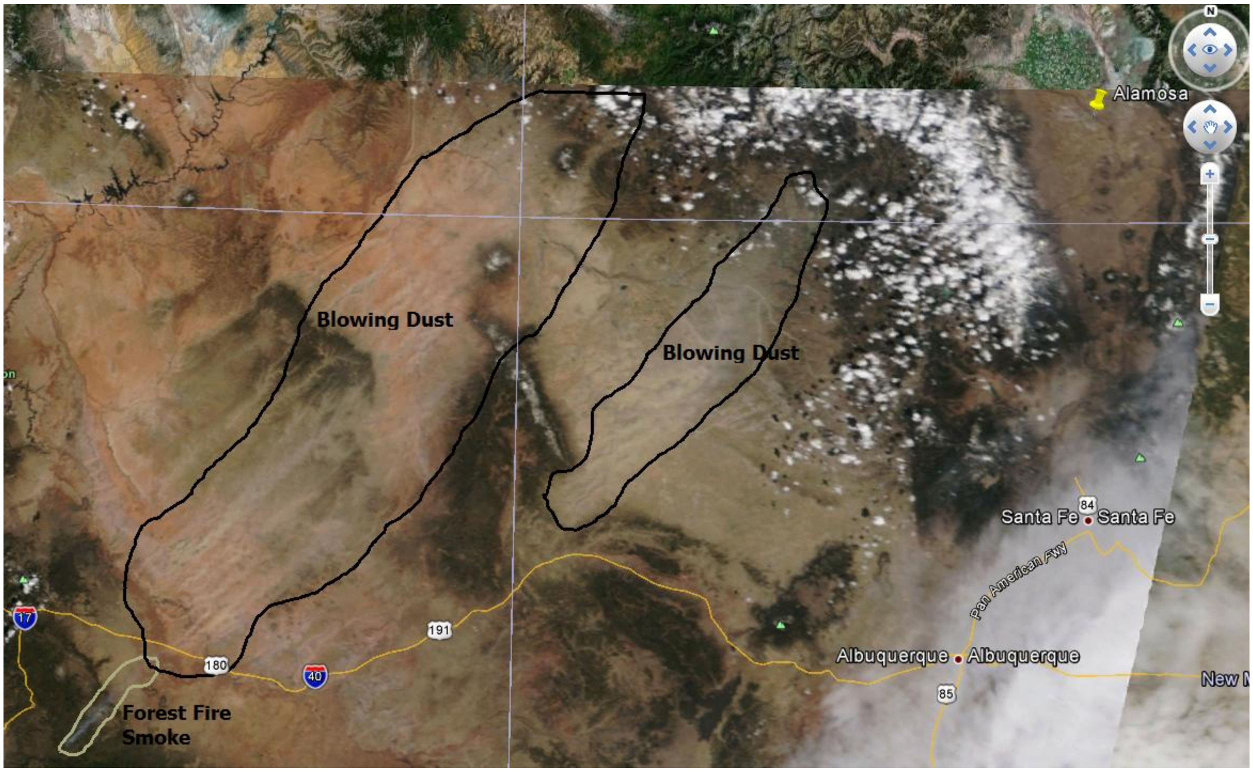

Figure 12. 18:45 Z April 8, 2009 (11:45 AM MST April 8, 2009) MODIS AERONET Sevilleta Subset - Terra 250m True Color satellite imagery. Areas outlined in black show blowing dust and the area outlined in grey shows smoke from a forest fire. (http://lance-modis.eosdis.nasa.gov/imagery/subsets/?subset=AERONET_Sevilleta.2009098.terra.250m).

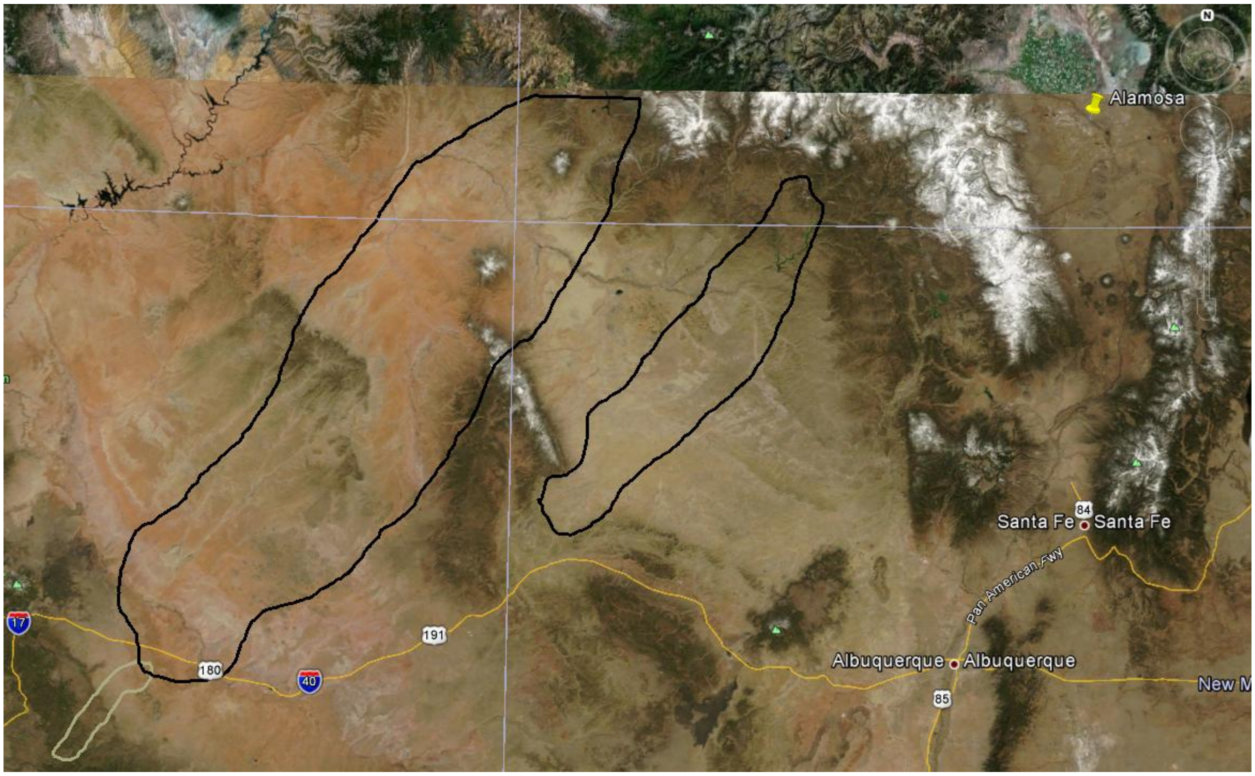

Figure 13. 18:00 Z April 7, 2009 (11:00 AM MST April 7, 2009) MODIS AERONET_Sevilleta Subset - Terra 250m True Color satellite imagery on a clear day with light winds. Areas outlined in black will have blowing dust and the area outlined in grey will have smoke from a forest fire on April 8, 2009. (source http://lance-modis.eosdis.nasa.gov/imagery/subsets/?project=aeronet&subset=Sevilleta.2009097.terra.250m).

WEDNESDAY APRIL 8, 2009

DESCRIPTIVE TEXT NARRATIVE FOR SMOKE/DUST OBSERVED IN SATELLITE IMAGERY THROUGH

```
Carolinas:
Residual light smoke from yesterday's ag fires could be seen at sunset
over the eastern Tennessee Valley and western Carolinas.

Southwest:
Dust was observed stretching from northeast Arizona across extreme
northwest New Mexico to northeastern Colorado.

See the links below for information about smoke plumes from ag fires
burning today.

THE FORMAT OF THIS TEXT PRODUCT IS BEING MODIFIED. IT WILL NO LONGER
DESCRIBE THE VARIOUS PLUMES THAT ARE ASSOCIATED WITH ACTIVE FIRES.
THESE
PLUMES ARE DEPICTED IN VARIOUS GRAPHIC FORMATS ON OUR WEB SITE:

JPEG:   http://www.ssd.noaa.gov/PS/FIRE/hms.html
GIS:    http://www.firedetect.noaa.gov/viewer.htm
KML:    http://www.ssd.noaa.gov/PS/FIRE/kml.html

THIS TEXT PRODUCT WILL CONTINUE TO DESCRIBE SIGNIFICANT AREAS OF SMOKE
WHICH HAVE BECOME DETACHED FROM AND DRIFTED SOME DISTANCE AWAY FROM THE
SOURCE FIRE, TYPICALLY OVER THE COURSE OF ONE OR MORE DAYS. IT WILL
ALSO
STILL INCLUDE DESCRIPTIONS OF BLOWING DUST.

ANY QUESTIONS OR COMMENTS REGARDING THESE CHANGES OR THE SMOKE TEXT
PRODUCT IN GENERAL SHOULD BE SENT TO SSDFireTeam@noaa.gov
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Figure 14. Smoke Text Product from the Satellite Services Division - Descriptive Text Narrative for Smoke/Dust Observed in Satellite Imagery through 0102 Z April 9, 2009 (6:02 PM MST April 8) (http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2009/2009D090102.html).

The Surface Streamline maps in Attachment B show that air over northeast Arizona was transported into portions of Colorado from 17Z April 8, 2009 (10 AM MST April 8) until 06 Z April 9, 2009 (11 PM MST April 8). This is a typical transport route for blowing dust moving into Colorado as shown in Attachment A. Figure 15 presents the 23:09Z April 8, 2009 (4:09 PM MST April 8) web cam picture looking east from the San Luis Regional Airport in Alamosa, Colorado. Blowing dust is visible in this image. In Figure 16 the 9:45 AM MST February 21, 2012, web cam picture clearly shows the mountains that were obscured by blowing dust on April 8 in Figure 15. These mountains are about 20 miles away. Figure 17 is the April 8, 2009, 3 PM image from the U.S. Forest Service Weminuche Wilderness Area Shamrock site east of Durango, Colorado. The view in this image is towards the southwest. Figure 18 is the baseline vista image for this site. The reduced visibility in Figure 17 is due to dust transported in to the area. There was likely very little if any local dust contribution since the local vegetation limits bare soil exposure and would have limited the surface friction velocities to levels below blowing dust thresholds. The Weminuche Wilderness Area Shamrock site is about 90 miles west of Alamosa.

Figure 19 is the Dust-on-Snow Deposition Events Log (http://www.snowstudies.org/index.html) provided by Chris Landry Executive Director of the Center for Snow and Avalanche Studies in Silverton, Colorado. It shows that dust was deposited on the snowpack at the Senator Beck Basin Study Area on Red Mountain Pass on April 8, 2009. Red Mountain Pass is in the San Juan Mountains west of Alamosa.

Figure 20 presents the 24-hour back trajectories from the NOAA HYSPLIT model using high-resolution NAM12 meteorological input data (http://ready.arl.noaa.gov/HYSPLIT.php) for Alamosa, Colorado, for each hour from 1 AM MST to Midnight MST on April 8, 2009. The back trajectories show that the air over Alamosa came from portions of Arizona and New Mexico on April 8 (Arizona is identified in the analysis in Attachment A as a common source area for blowing dust that enters Colorado and affects Grand Junction). Figure 21 is the output from the NOAA HYSPLIT back trajectories in Figure 20 overlaid on the 18:45 Z April 8, 2009 (11:45 AM MST April 8) MODIS AERONET Sevilleta Subset - Terra 250m True Color satellite imagery in Figure 12. It shows that some of the air that flowed over Alamosa on April 8, 2009 either originated from or flowed through areas of blowing dust before flowing over Alamosa. Note that the satellite imagery presented in Figure 12 shows blowing dust at the beginning of the event. It is believed that the area of blowing dust became larger later in the day.

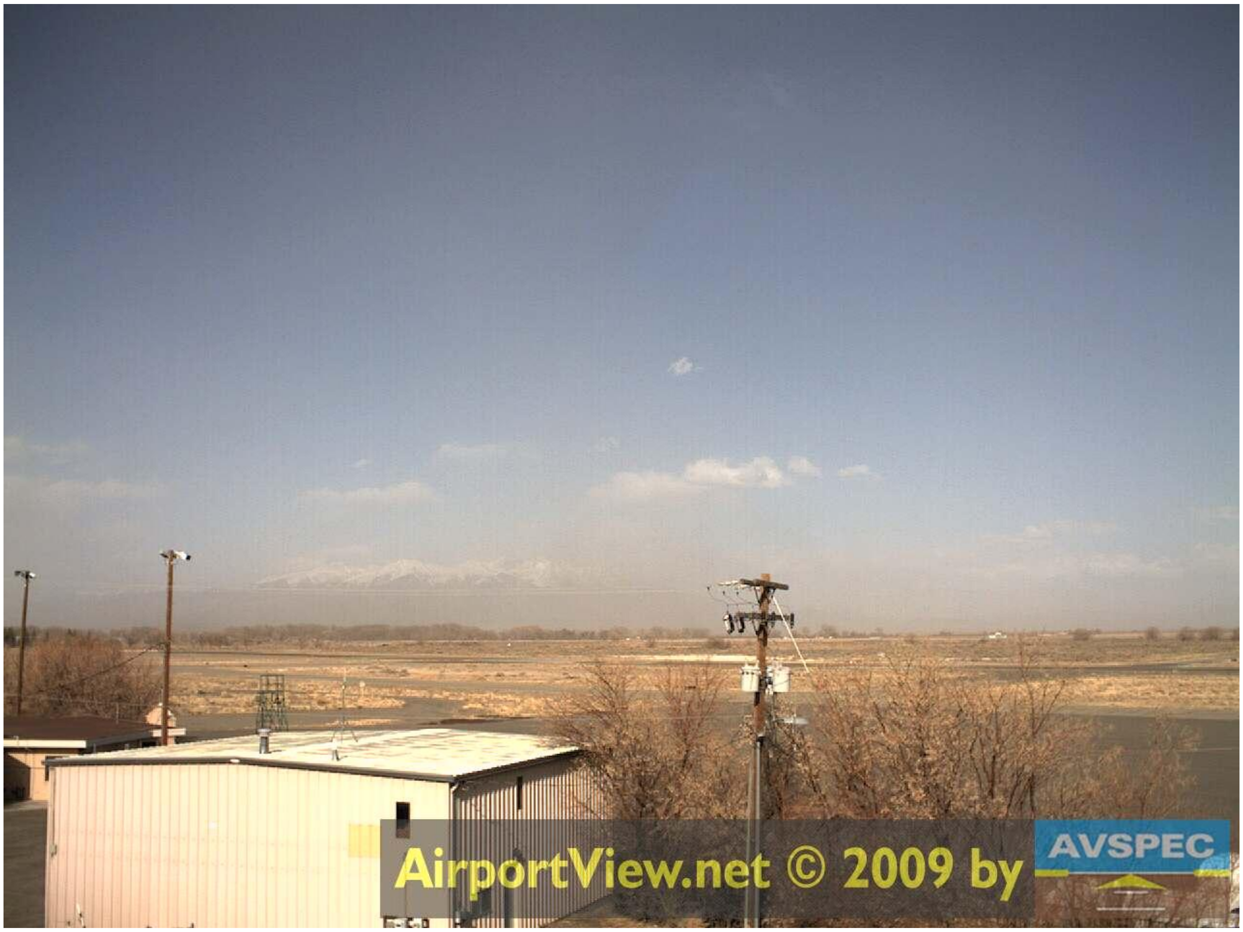


Figure 15. 23:09 Z April 8, 2009 (4:09 PM MST April 8, 2009) Web camera picture looking east from the San Luis Regional Airport, in Alamosa, Colorado (http://www.airportview.net/wx/usa/co/kals/depotav/camera4/index.php).

Figure 16. 16:45 Z February 21, 2012 (9:45 AM MST February 21, 2012) Web camera picture looking east from the San Luis Regional Airport, in Alamosa, Colorado (http://www.airportview.net/wx/usa/co/kals/depotav/camera4/index.php).

Figure 17. U.S. Forest Service, April 8, 2009, 3 PM Weminuche Wilderness Area image looking southwest from the Shamrock site east of Durango, Colorado.
(http://www.fsvisimages.com/search.aspx?site=SHAM1).

Figure 18. U.S. Forest Service, Weminuche Wilderness Area Baseline Image looking southwest from the Shamrock site east of Durango, Colorado.
(http://www.fsvisimages.com/search.aspx?site=SHAM1).

Colorado Dust-on-Snow (CODOS)
Dust-on-Snow Deposition Events Log

Thanks to our original National Science Foundation research grants for collaborative research (grants ATM-0432327 to Painter at National Snow and Ice Data Center and ATM-0431955 to Landry at Center for Snow and Avalanche Studies), and to the subsequent support of the emergent Colorado Dust-on-Snow program by Colorado water districts, this program has accumulated several seasons of dust-on-snow observations at our Senator Beck Basin Study Area (SBBSA) at Red Mountain Pass, summarized in the table below. It is reasonable to assume that our skill at detecting dust-on-snow events has improved and that we may have failed to observe very small events during the early years of this work. Therefore the table represents an absence of events in grey for the first two years of observation but thereafter indicates an absence of observed events as "0" (zero).

Dust-on-Snow Events Documented per Month, by Winter
Senator Beck Basin Study Area at Red Mountain Pass – San Juan Mountains

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	**Total**
2002/2003					2		1			**3**
2003/2004							2	1		**3**
2004/2005	0	0	0	0	0	1	2	1	0	**4**
2005/2006	0	0	1	0	1	1	3	2	0	**8**
2006/2007	0	0	1	0	1	1	3	1	1	**8**
2007/2008	0	0	0	0	0	3	3	1	0	**7**
2008/2009	1	0	1	0	1	4	5	0	0	**12**

Dates of the events, by winter/spring season, were as follows (WY = Water Year):

2002/2003 (WY2003): Feb 3, Feb 22, Apr 2-3

2003/2004 (WY 2004): Apr 17, Apr 28, May 11

2004/2005 (WY 2005): Mar 23, Apr 4, Apr 8, May 9

2005/2006 (WY 2006): Dec 23, Feb 15, Mar 26, Apr 5, Apr 15, Apr 17, May 22, May 27

2006/2007 (WY 2007): Dec 17, Feb 27, Mar 27, Apr 15, Apr 18, Apr 24, May 4, Jun 6

2007/2008 (WY 2008): Mar 16, Mar 26-27, Mar 30-31, Apr 15, Apr 21, Apr 30, May 12

2008/2009 (WY 2009): Oct 11, Dec 13, Feb 27, Mar 6, Mar 9, Mar 22, Mar 29, Apr 3, Apr 8, Apr 15, Apr 24, Apr 25

Figure 19. Dust-on-Snow Deposition Events Log at the Senator Beck Basin Study Area on Red Mountain Pass, Colorado. (source: Chris Landry. Chris Landry . Blowing Dust in Colorado. 7/9/2009).

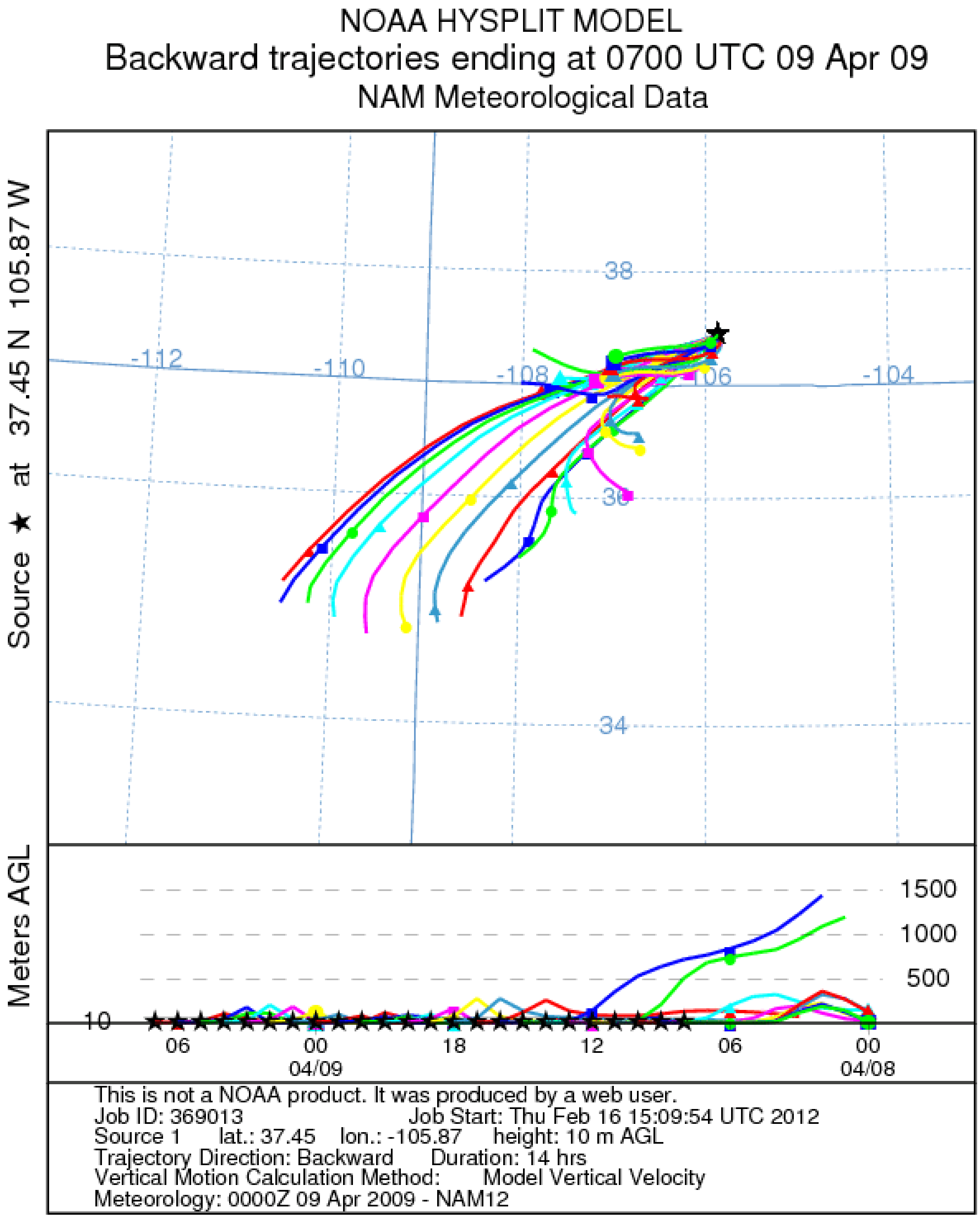


Figure 20. NOAA HYSPLIT 14-hour back trajectories for Alamosa, Colorado, from 10 AM, MST April 8, 2009 to midnight or from when the winds became strong enough to cause blowing dust in northeast Arizona to the end of the day. (source: NOAA Air Resources Laboratory at: http://ready.arl.noaa.gov/HYSPLIT.php).

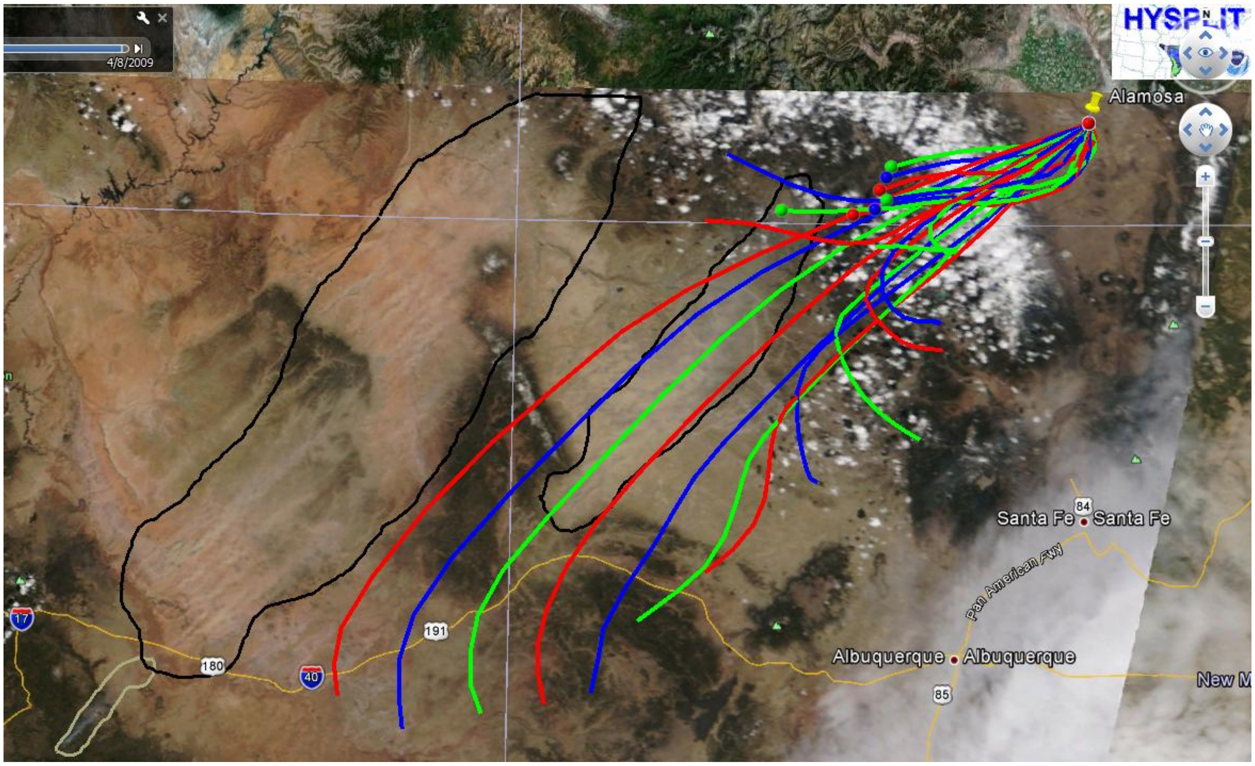


Figure 21. Output from NOAA HYSPLIT back trajectories in Figure 15 overlaid on 18:45 Z April 8, 2009 (11:45 AM MST April 8, 2009) MODIS AERONET_Sevilleta Subset - Terra 250m True Color satellite imagery in Figure 10.

Tables 1 through 3 list the Meso West Observations for Winslow, Hopi, and Window Rock, Arizona. These locations are either in or near the area in Figure 12 that has blowing dust. The three locations had 6 to 10 hours of winds of 25 mph or wind gusts of 40 mph or greater. Tables 4 and 5 list the Meso West observations for Gallup and Farmington, New Mexico. These locations are in or along the path the air took from Arizona into Colorado as shown in the surface streamlines in Appendix B and the back trajectories in Figures 20 and 21. They had 6 to 10 hours of winds of 25 mph or wind gusts of 40 mph or greater. Farmington also had 7 hours of reduced visibility due to dust. Tables 6 and 7 list the Meso West observations for Cortez and Alamosa, Colorado. Cortez had two hours of winds of 25 mph or wind gusts of 40 mph or greater and 3 hours of reduced visibility. Two of the hours of reduced visibility occurred when the wind was well below the blowing dust thresholds of 25 mph and wind gusts of 40 mph. Alamosa had 6 hours of winds of 25 mph or wind gusts of 40 mph or greater and 7 hours of reduced visibility due to dust. Three of the hours with reduced visibility due to dust occurred three to six hours after the wind had subsided below blowing dust thresholds. These hours with reduced visibility and winds below blowing dust thresholds are due to dust transported into the area from sources outside of the local area.

The High Wind Warnings and Advisories from the Flagstaff, Arizona, and Grand Junction, Colorado, National Weather Service Forecast Offices in Appendix C show that the National Weather Service expected widespread strong winds and areas of blowing dust across much of western Colorado and northeast Arizona.

Table 1. Wind and weather observations for Winslow, Arizona, reported by the University of Utah MesoWest site for April 8, 2009 (http://www.met.utah.edu/mesowest/). Speeds at or above the blowing dust thresholds, weather, and visibility (caused by or reduced by dust) have been highlighted in yellow.

Time in MST (April 8, 2009)	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:56	46	26	14	18	300	clear	10
22:56	45	31	8		250	clear	10
21:56	47	35	18		240	mostly cloudy	10
20:56	49	37	13		250	partly cloudy	10
19:56	51	28	14		210	clear	10
18:56	54	22	25	30	210	clear	10
16:56	63	15	30	39	220	clear	10
15:56	65	10	31	44	220	clear	10
14:56	67	8	37	52	220	clear	10
13:56	67	8	37	58	210	clear	9
12:56	68	8	44	55	220	clear	7
11:56	67	8	43	58	220	haze	6
10:56	67	8	29	43	210	clear	10
9:56	65	10	26	51	200	clear	10
8:56	63	10	24	39	210	clear	10
7:56	62	12	17		200	clear	10
6:56	51	24	5		160	clear	10
5:56	46	31	8		160	clear	10
4:56	48	31	13		200	clear	10
3:56	52	29	8		180	clear	10
2:56	52	28	16	24	180	clear	10
1:56	42	29	5		210	clear	10
0:56	45	25	6		110	clear	10

Table 2. Wind and weather observations for Hopi, Arizona, reported by the University of Utah MesoWest site for April 8, 2009 (http://www.met.utah.edu/mesowest/). Speeds at or above the blowing dust thresholds, weather, and visibility (caused by or reduced by dust) have been highlighted in yellow.

Time in MST (April 8, 2009)	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:13	44	23	15	24	274		
22:13	45	19	15	21	273		
21:13	47	21	12	19	283		
20:13	48	22	14	22	272		
19:13	51	20	17	31	277		
18:13	55	15	22	32	272		
17:13	59	13	23	38	266		
16:13	61	14	25	38	241		
15:13	63	11	23	36	243		
14:13	64	11	24	43	235		
13:13	64	10	27	42	239		
12:13	63	9	29	41	226		
11:13	63	10	30	44	232		
10:13	62	13	30	45	232		
9:13	59	16	28	39	219		
8:13	56	24	24	32	206		
7:13	49	33	4	11	235		
6:13	40	43	5	12	6		
5:13	43	36	5	9	262		
4:13	43	29	3	10	252		
3:13	48	24	8	17	248		
2:13	44	32	6	9	234		
1:13	50	25	6	13	246		
0:13	49	25	8	11	251		

Table 3. Wind and weather observations for Window Rock, Arizona, reported by the University of Utah MesoWest site for April 8, 2009 (http://www.met.utah.edu/mesowest/). Speeds at or above the blowing dust thresholds, weather, and visibility (caused by or reduced by dust) have been highlighted in yellow.

Time in MST (April 8, 2009)	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:53	40	53	21	37	240	overcast	10
22:53	41	38	15		240	clear	10
21:53	44	28	16	23	240	clear	10
20:53	46	23	20	28	240	clear	10
19:53	49	17	18	39	250	clear	10
18:53	53	13	25	41	240	clear	10
17:53	56	10	29	46	220	clear	10
16:53	59	9	36	52	240	clear	10
15:53	62	10	32	48	250	clear	10
14:53	63	9	29	48	230	clear	10
13:53	64	9	29	44	220	clear	10
12:53	62	9	31	48	220	clear	10
11:53	61	10	23	47	210	clear	10
10:53	58	16	22	43	210	clear	10
9:53	56	23	22	44	220	clear	10
8:53	52	31	15	26	210	clear	10
7:53	46	38	3		170	clear	10
6:53	37	46	6		80	clear	10
5:53	40	41	5		170	clear	10
4:53	40	37	5		130	clear	10
3:53	35	43	0			clear	10
2:53	43	30	6		150	clear	10
1:53	50	22	3	17	200	clear	10
0:53	50	22	7			clear	10

Table 4. Wind and weather observations for Gallup, New Mexico, reported by the University of Utah MesoWest site for April 8, 2009 (http://www.met.utah.edu/mesowest/). Speeds at or above the blowing dust thresholds, weather, and visibility (caused by or reduced by dust) have been highlighted in yellow.

Time in MST (April 8, 2009)	**Temperature Degrees F**	**Relative Humidity in %**	**Wind Speed in mph**	**Wind Gust in mph**	**Wind Direction in Degrees**	**Weather**	**Visibility in miles**
23:53	42	36	15	25	240	partly cloudy	10
22:53	43	30	14		240	mostly clear	10
21:53	46	23	15		240	partly cloudy	10
20:53	48	17	17	25	240	clear	10
19:53	51	13	21	32	250	clear	10
18:53	56	10	25	37	250	clear	10
17:53	59	9	32	47	230	clear	10
16:53	63	9	30	43	250	clear	10
15:53	64	9	36	52	230	clear	10
14:53	66	8	35	51	230	clear	10
13:53	65	9	35	53	230	clear	10
12:53	65	9	31	48	230	clear	10
11:53	63	13	33	44	230	clear	10
10:53	61	17	26	38	210	clear	10
9:53	58	22	22	40	210	clear	10
8:53	55	31	23	29	220	clear	10
7:53	40	41	0			clear	10
6:53	32	47	0			clear	10
5:53	30	46	3		70	clear	10
4:53	30	48	0			clear	10
3:53	31	43	5		100	clear	10
2:53	35	40	0			clear	10
1:53	36	38	3		80	clear	10
0:53	40	31	0			clear	10

Table 5. Wind and weather observations for Farmington, New Mexico, reported by the University of Utah MesoWest site for April 8, 2009 (http://www.met.utah.edu/mesowest/). Speeds at or above the blowing dust thresholds, weather, and visibility (caused by or reduced by dust) have been highlighted in yellow.

Time in MST (April 8, 2009)	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:53	50	17	15		280	mostly cloudy	10
22:53	52	15	14		270	overcast	10
21:53	53	17	15		260	overcast	10
20:53	55	13	16	24	250	mostly clear	10
19:53	58	9	21	32	250	clear	8
18:53	61	8	23	35	230	haze	4
18:04	64	6	25	40	260	haze	5
17:53	64	6	31	38	250	haze	4
16:53	68	6	29	43	260	haze	5
15:53	70	6	26	47	240	clear	9
14:53	72	6	28	41	230	clear	9
13:53	72	7	29	44	220	clear	10
12:53	72	8	21	39	210	clear	10
11:53	69	11	15	30	220	clear	10
10:53	66	16	17		200	clear	10
10:40	64	16	14	21	200	clear	10
9:53	56	24	8		110	clear	10
8:53	47	30	12		90	clear	10
7:53	39	39	12		110	clear	10
6:53	33	47	7		70	clear	10
5:53	35	43	8		80	clear	10
4:53	35	45	6		60	clear	10
3:53	36	44	8		70	clear	10
2:53	37	38	3		80	clear	10
1:53	38	39	6		80	clear	10
0:53	42	31	9		70	clear	10

Table 6. Wind and weather observations for Cortez, Colorado, reported by the University of Utah MesoWest site for April 8, 2009 (http://www.met.utah.edu/mesowest/). Speeds at or above the blowing dust thresholds, weather, and visibility (caused by or reduced by dust) have been highlighted in yellow.

Time in MST (April 8, 2009)	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:53	37	32	3			overcast	10
22:53	43	19	5		310	mostly cloudy	10
21:53	44	19	3			mostly clear	10
20:53	50	16	10		270	mostly cloudy	10
19:53	53	15	20	23	250	clear	10
18:53	57	12	20	28	250	clear	10
17:53	59	11	22	31	260	clear	10
16:53	64	8	18	32	240	clear	9
15:53	64	6	24	39	230	haze	4
14:53	67	8	33	43	210	clear	8
13:53	67	10	22	35	220	clear	10
12:53	67	11	28	41	200	clear	10
11:53	65	15	17	26	190	clear	10
10:53	63	17	17	26	190	clear	10
9:53	60	21	14		150	clear	10
8:53	56	23	14	28	180	clear	10
7:53	36	56	0			clear	10
6:53	31	61	0			clear	10
5:53	28	69	0			clear	10
4:53	31	61	3		90	clear	10
3:53	29	66	8		110	clear	10
2:53	30	63	7		90	clear	10
1:53	30	63	7		60	clear	10
0:53	29	63	6		50	clear	10

Table 7. Wind and weather observations for Alamosa, Colorado, reported by the University of Utah MesoWest site for April 8, 2009 (http://www.met.utah.edu/mesowest/). Speeds at or above the blowing dust thresholds, weather, and visibility (caused by or reduced by dust) have been highlighted in yellow.

Time in MST (April 8, 2009)	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:52	41	20	13		300	clear	8
22:52	42	19	13		260	clear	7
21:52	47	14	20	26	260	mostly clear	7
20:52	49	15	17		250	clear	10
19:52	53	13	24	36	250	clear	10
18:52	55	12	24	33	240	clear	10
17:52	60	8	32	44	240	clear	9
16:52	62	9	41	52	230	clear	7
15:52	63	11	26	45	240	clear	10
14:52	64	15	31	45	250	clear	10
13:52	64	13	33	46	240	clear	8
12:52	63	13	17	36	240	clear	10
11:52	61	14	24	33	240	clear	10
10:52	58	19	21	41	240	clear	8
10:18	57	23	21	32	220	clear	10
9:52	51	29	0			clear	10
8:52	41	36	0			clear	10
7:52	30	58	3		110	clear	10
6:52	18	80	5		30	clear	10
5:52	17	80	7		170	clear	10
4:52	19	77	0			clear	10
3:52	25	60	3		310	clear	10
2:52	25	60	0			clear	10
1:52	25	60	5		150	clear	10
0:52	31	43	5		30	clear	10

Figures 22 and 23 show the output for blowing dust from the NAAPS (Navy Aerosol Analysis and Prediction System) Global Aerosol Model for April 8, 2009 (http://www.nrlmry.navy.mil/aerosol/). The bottom panels in Figures 22 and 23 show where dust is blowing. They show a large area of blowing dust over northern Arizona with the dust cloud moving over portions of Colorado by 11 PM MST on April 8, 2009. The NAAPS model output is based on soil moisture content, soil erodibility factors, and modeled meteorological factors conducive to blowing dust (for a description of NAAPS see: http://www.nrlmry.navy.mil/aerosol_web/Docs/globaer_model.html).

Although the NAAPS forecast products can over predict dust PM_{10}, they do provide an independent calculation of the potential for blowing dust and the spatial extent of blowing dust for this event. The highest NAAPS concentrations of dust PM_{10} are in northeastern Arizona. All of the products discussed here point to a widespread, regional-scale dust storm that originated in portions of Arizona and grew to cover parts of Colorado.

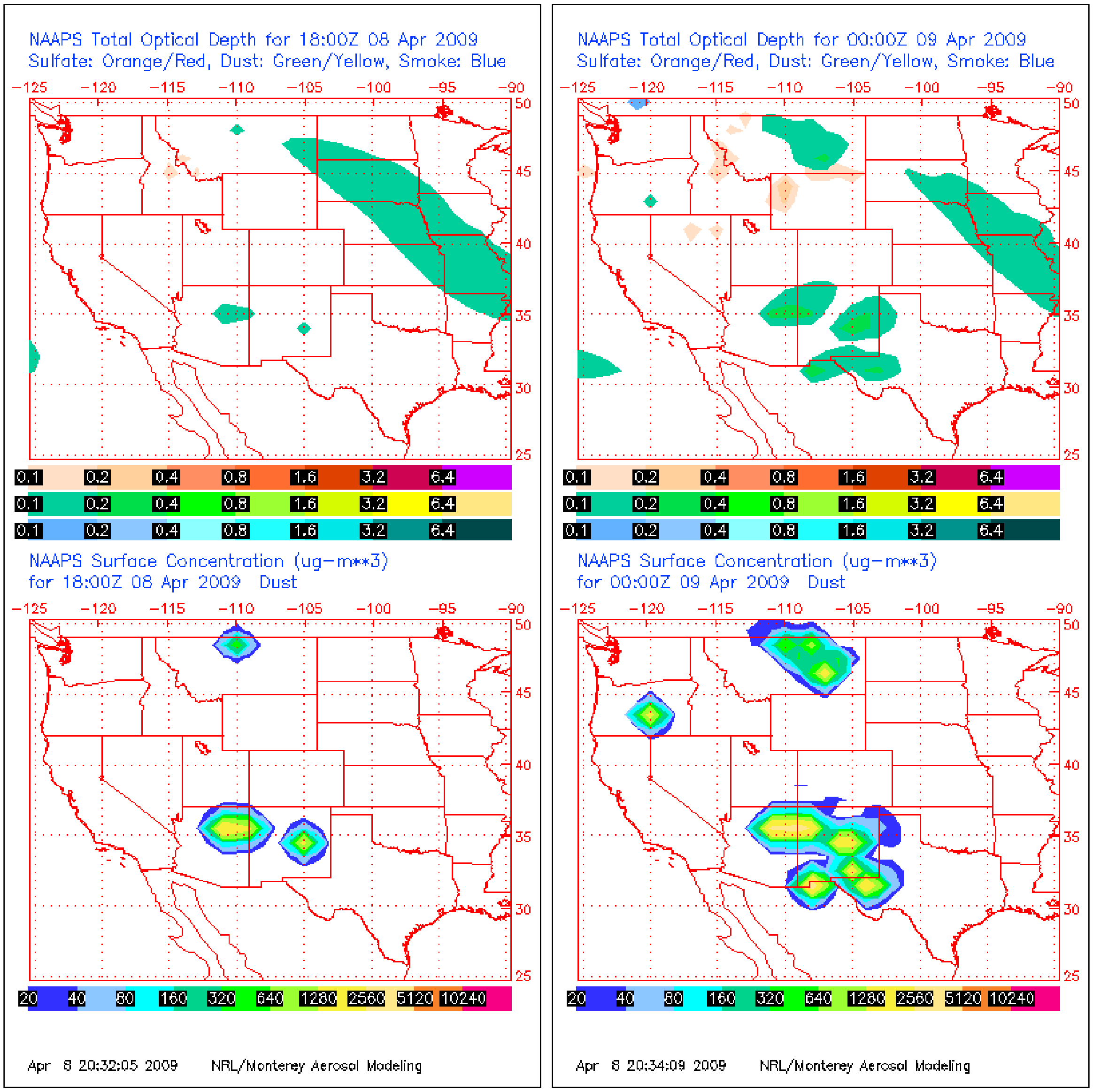


Figure 22. NAAPS forecasted surface dust concentrations and optical depth for11 AM and 5 PM MST April 8, 2009 (source http://www.nrlmry.navy.mil/flambe-bin/aerosol/display_directory_aer2?DIR=/web/aerosol/public_html/globaer/ops_01/wus/).

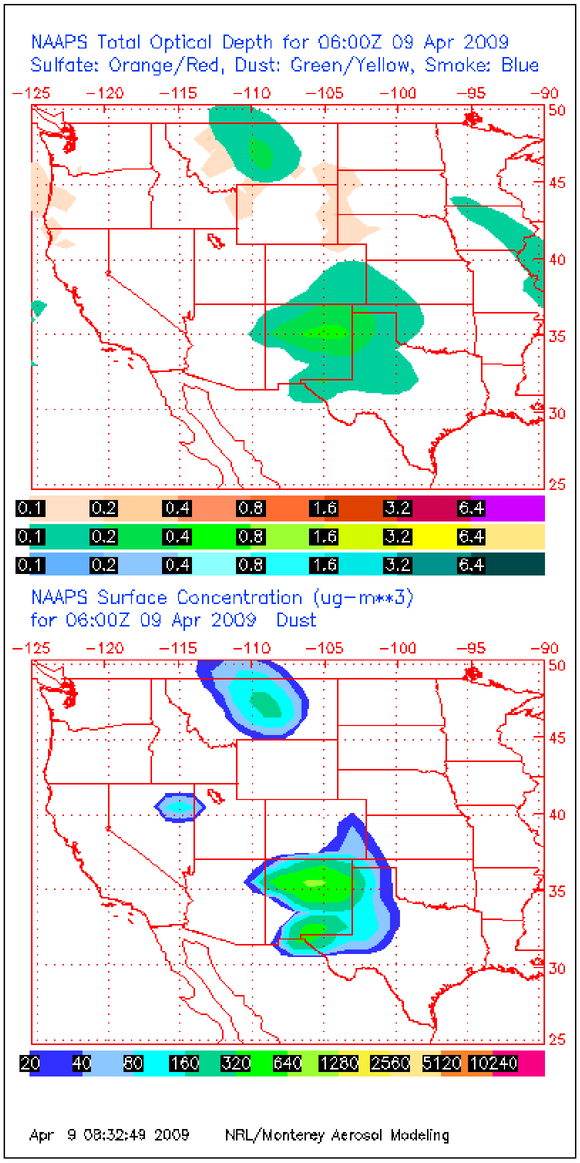


Figure 23. NAAPS forecasted surface dust concentrations and optical depth for11 PM MST April 8, 2009 (source http://www.nrlmry.navy.mil/flambe-bin/aerosol/display_directory_aer2?DIR=/web/aerosol/public_html/globaer/ops_01/wus/).

In order for blowing dust to occur, soils need to be dry. Figure 24 presents the monthly precipitation for the southwest U.S. for the March 2009. It shows that northeast Arizona, extreme southwest Colorado, and much of northwest New Mexico received less than one half of an inch of precipitation and that the rest of the area of concern received between a half inch and an inch. This is 50 percent or less of normal precipitation for most of the area as shown in Figure 25, the percent of normal precipitation for March 2009. Winslow, Arizona, is near the southern end of the blowing dust feature in Figure 12. Winslow had 0.05 inches of precipitation in the 30 days before April 8 as shown in the Record of River and Climatological Observations for March and April 2009 in Figures 26 and 27, respectively. Figure 28 is the Calculated Soil Moisture Anomaly map for April 7, 2009. It shows that the whole area had below normal soil moisture. Figure 29 is The Drought Monitor map of drought conditions across the western U.S. that shows normal (in a very dry region) to abnormally dry conditions prevailed in the dust source regions of Arizona and New Mexico while the portions of Colorado that experienced elevated PM 10 levels had normal conditions during the week ending on April 7, 2009.

Figures 30 and 31 are the daily precipitation records for Alamosa for the months of March and April 2009, respectively. They show that Alamosa had six inches of snow on March 26 and 27 and 0.56 inches of water in the 14 days prior to the dust dtorm. The snow did not completely melt until March 30, 2009. This moisture probably would have stabilized the soil in the Alamosa area and limited the amount of local soil that could become blowing dust on April 8, 2009. In a phone conversation with Kevin Reeves of the United States Department of Agriculture Farm Services in Alamosa, he stated that he believed that there was little if any pre-planting tilling of the soil on or before April 8, 2009. He thought this because of the soil moisture and because planting began around May , 20091 in the San Luis Valley.

This exceedance was the consequence of strong southwesterly winds in combination with dry conditions which caused significant blowing dust across much of northeast Arizona, northwest New Mexico, and southwest Colorado. *Surface winds of 20 to 44 mph with gusts of 25 to 58 mph were recorded across the Four Corners region on April 8. These speeds are above the thresholds for blowing dust identified in EPA draft guidance and in detailed analyses completed by the State of Colorado.*

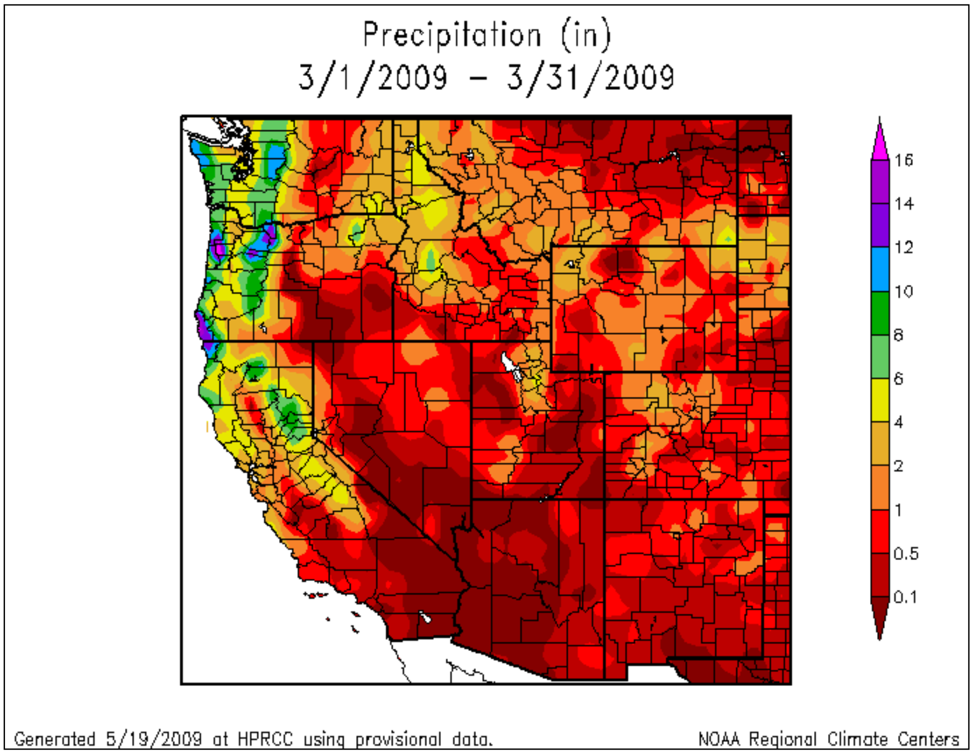


Figure 24. Precipitation 3/1/2009 – 3/31/2009 (from http://www.hprcc.unl.edu/maps/current/index.php?action=update_product&product=TDept).

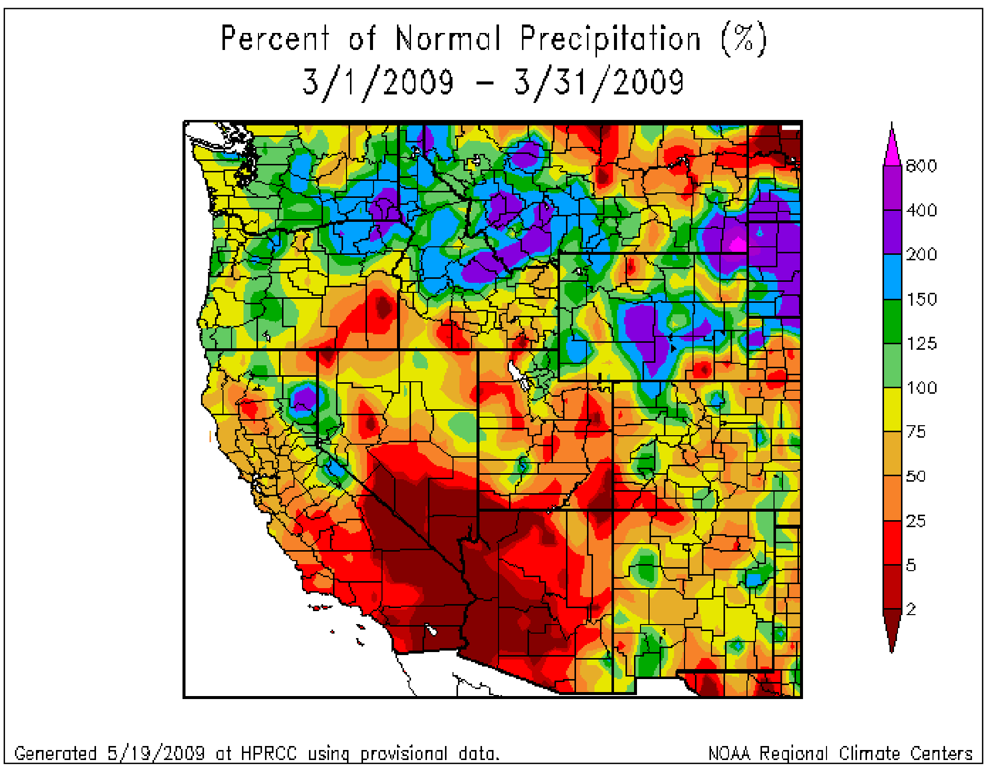
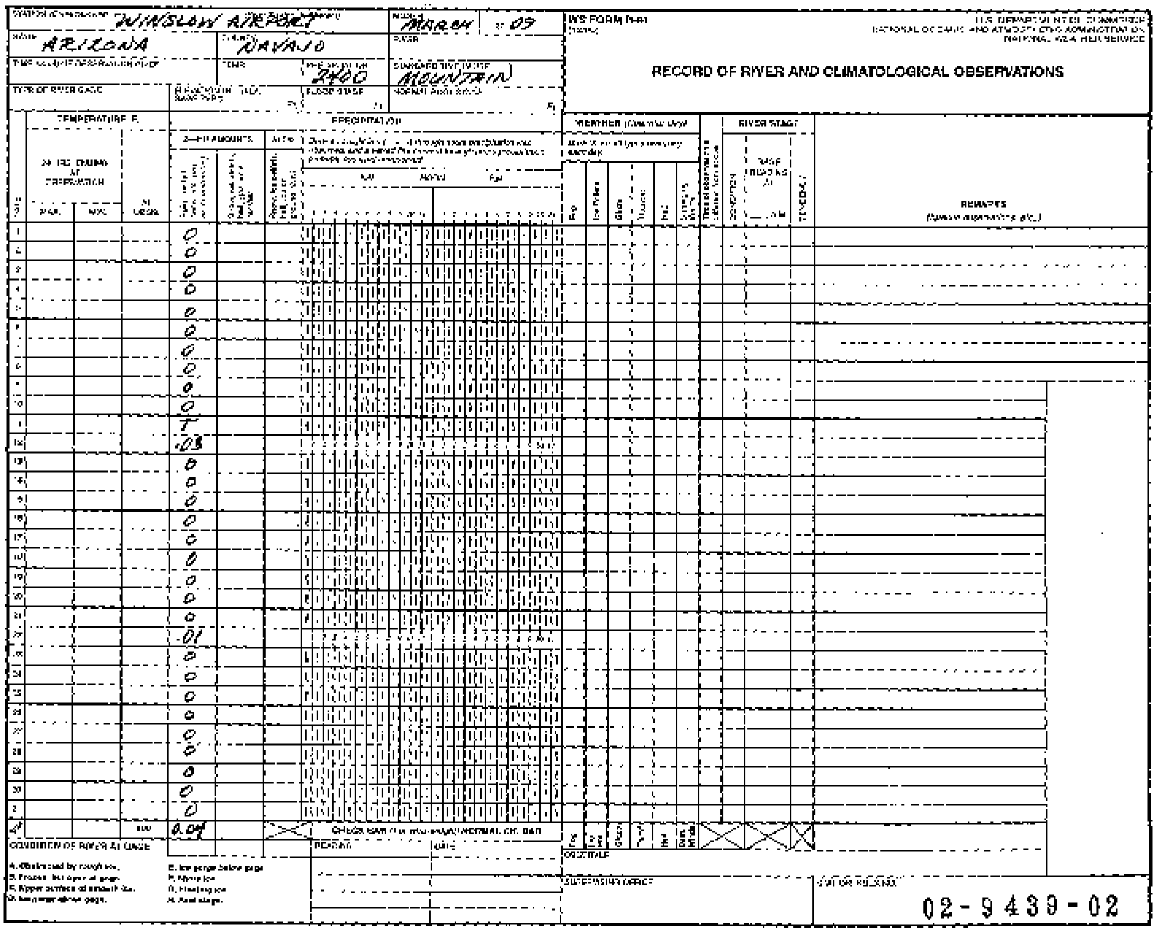
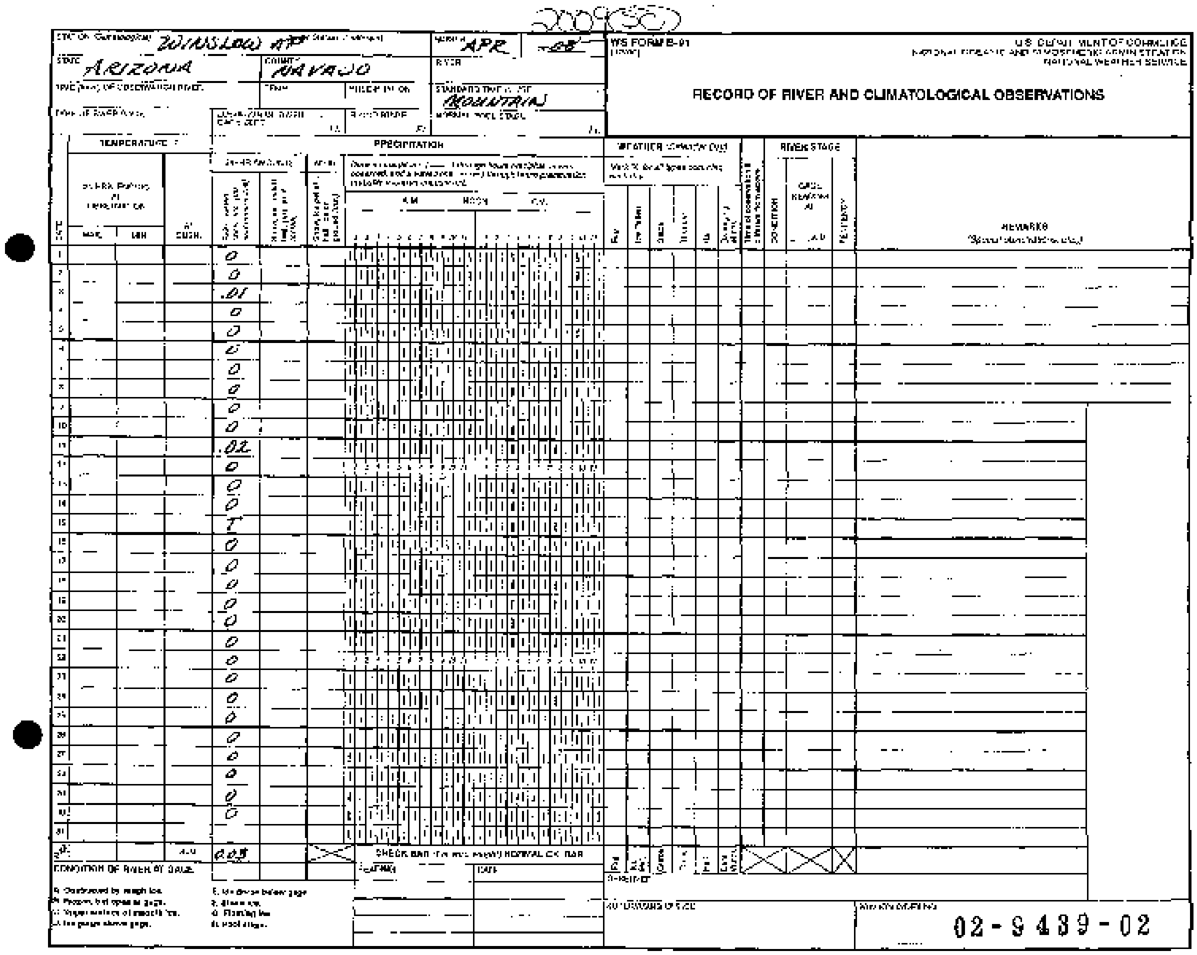


Figure 25. Percent of Normal Precipitation 3/1/2009 – 3/31/2009 (from http://www.hprcc.unl.edu/maps/current/index.php?action=update_product&product=TDept).



WINSLOW AIRPORT
ARIZONA
NAVAJO
MARCH 09
2400
MOUNTAIN
WS FORM B-91
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS
02-9439-02

Figure 26. Winslow, Arizona March 2009 Record of River and Climatological Observations (http://cdo.ncdc.noaa.gov/dly/DLY).



2009(50)

STATION: WINSLOW AP
STATE: ARIZONA
COUNTY: NAVAJO
MONTH: APR
STANDARD TIME IN USE: MOUNTAIN

WS FORM B-91

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE

RECORD OF RIVER AND CLIMATOLOGICAL OBSERVATIONS

TEMPERATURE — PRECIPITATION — WEATHER — RIVER STAGE — REMARKS

DATE	PRECIPITATION 24-HR AMOUNTS
1	0
2	0
3	.01
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	.02
12	0
13	0
14	0
15	T
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	
SUM	0.03

CONDITION OF RIVER AT GAGE

CHECK BAR (for wire weight) NORMAL CK. BAR

02-9439-02

Figure 27. Winslow, Arizona April 2009 Record of River and Climatological Observations (http://cdo.ncdc.noaa.gov/dly/DLY).

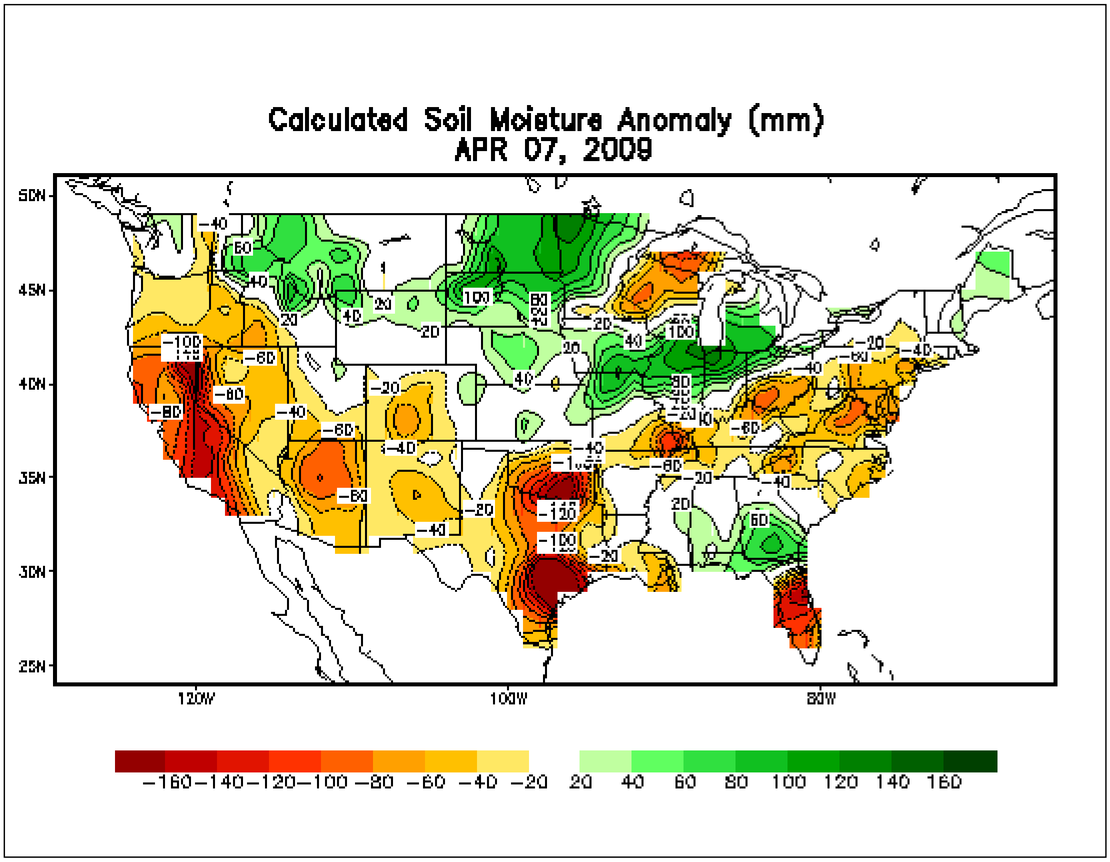
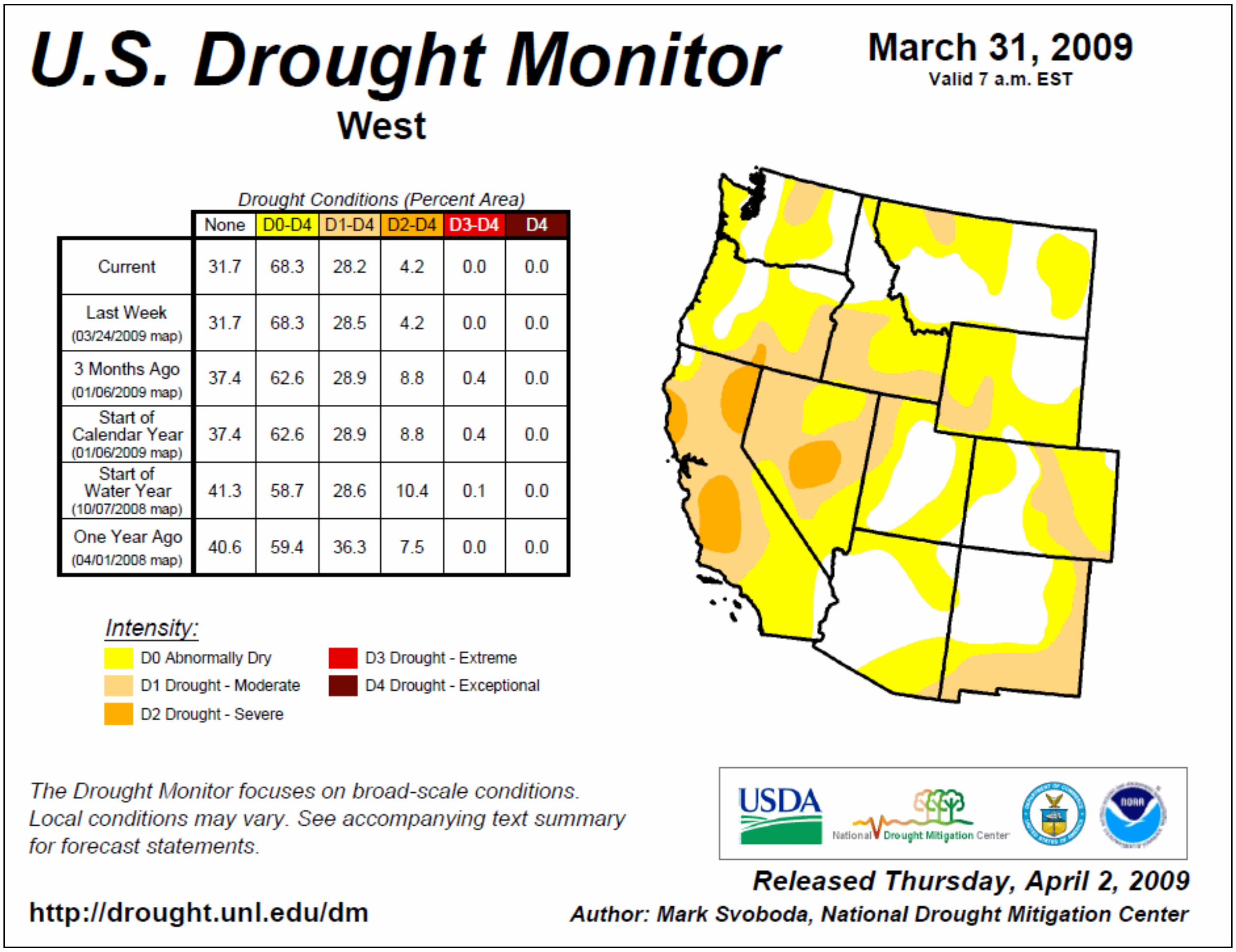


Figure 28. Calculated Soill Moisture Anormaly for April 7, 2009 (http://www.cpc.ncep.noaa.gov/cgi-bin/US_Soil-Moisture-Monthly.sh).



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	31.7	68.3	28.2	4.2	0.0	0.0
Last Week (03/24/2009 map)	31.7	68.3	28.5	4.2	0.0	0.0
3 Months Ago (01/06/2009 map)	37.4	62.6	28.9	8.8	0.4	0.0
Start of Calendar Year (01/06/2009 map)	37.4	62.6	28.9	8.8	0.4	0.0
Start of Water Year (10/07/2008 map)	41.3	58.7	28.6	10.4	0.1	0.0
One Year Ago (04/01/2008 map)	40.6	59.4	36.3	7.5	0.0	0.0

Figure 29. Drought status for the western U.S. on March 31, 2009 (source: the USDA, NOAA, and the National Drought Mitigation Center at: http://drought.unl.edu/dm/archive.html).

Station: ALAMOSA SAN LUIS AP
State: CO **County**: ALAMOSA **Standard Time**: MOUNTAIN

Observation Time Temperature: **Precipitation**: 2400
(LST) **Evaporation**: **Soil**:

Preliminary	Year	Month	Day	Temperature (°F) 24 hrs. ending at observation time Max.	Min.	at Observation	Precipitation (see **) 24 Hour Amounts ending at observation time Rain, melted snow, etc. (Inches & hundredths)	Flag	Snow, ice pellets, (Inches & tenths)	Flag	At Observation Time Snow, ice pellets, hail, ice on ground (Inches)
	2009	03	1	58	5		0		0		0
	2009	03	2	66	11		0		0		0
	2009	03	3	62	20		0		0		0
	2009	03	4	62	29		0		0		0
	2009	03	5	54	31		0		0		0
	2009	03	6	51	35		0.02		T		0
	2009	03	7	42	11		0.02		0.4		T
	2009	03	8	54	6		0		0		0
	2009	03	9	52	29		0		0		0
	2009	03	10	45	18		0		0		0
	2009	03	11	56	3		0		0		0
	2009	03	12	51	13		0		0		0
	2009	03	13	44	15		T		T		0
	2009	03	14	48	7		0		0		0
	2009	03	15	54	10		0		0		0
	2009	03	16	60	13		0		0		0
	2009	03	17	63	16		0		0		0
	2009	03	18	63	16		0		0		0
	2009	03	19	65	20		0		0		0
	2009	03	20	67	30		0		0		0
	2009	03	21	67	22		0		0		0
	2009	03	22	63	36		0		0		0
	2009	03	23	50	24		T		T		0
	2009	03	24	50	19		0		0		0
	2009	03	25	48	12		0		0		0
	2009	03	26	45	13		0.31		3.7		0
	2009	03	27	33	10		0.15		2.5		6
	2009	03	28	45	3		0		0		5
	2009	03	29	56	16		0		0		2
	2009	03	30	39	16		0.03		0.5		0
	2009	03	31	45	9		0		0		0
			Summary	53.5	16.7		0.53		7.1		

Figure 30. Alamosa, Colorado daily precipitation amounts for March 2009 Record of Climatological Observations (source http://cdo.ncdc.noaa.gov/dly/DLY).

Station: ALAMOSA SAN LUIS AP

State: CO **County**: ALAMOSA **Standard Time**: MOUNTAIN

Observation Time (LST) **Temperature**: **Evaporation**: **Precipitation**: 2400 **Soil**:

Preliminary	Year	Month	Day	Temperature (°F) 24 hrs. ending at observation time		at Observation	Precipitation (see **) 24 Hour Amounts ending at observation time				At Observation Time
				Max.	Min.		Rain, melted snow, etc. (Inches & hundredths)	Flag	Snow, ice pellets, (Inches & tenths)	Flag	Snow, ice pellets, hail, ice on ground (Inches)
	2009	04	1	43	23		0.05		0.9		0
	2009	04	2	52	9		0		0		T
	2009	04	3	56	27		0		0		0
	2009	04	4	43	21		0.02		0.2		0
	2009	04	5	44	7		0		0		T
	2009	04	6	55	10		0		0		0
	2009	04	7	62	11		0		0		0
	2009	04	8	65	16		0		0		0
	2009	04	9	53	23		0		0		0
	2009	04	10	63	15		0		0		0
	2009	04	11	44	28		0.22		0.4		0
	2009	04	12	41	30		0.65		7.1		1
	2009	04	13	56	22		0		0		5
	2009	04	14	60	27		0		0		0
	2009	04	15	56	30		T		0		0
	2009	04	16	50	28		0		0		0
	2009	04	17	40	27		0.18		1.6		1
	2009	04	18	51	19		T		T		T
	2009	04	19	59	25		0		0		0
	2009	04	20	67	24		0		0		0
	2009	04	21	70	27		0		0		0
	2009	04	22	69	28		T		0		0
	2009	04	23	70	26		T		0		0
	2009	04	24	69	32		0		0		0
	2009	04	25	67	39		T		0		0
	2009	04	26	59	28		0		0		0
	2009	04	27	64	26		0		0		0
	2009	04	28	70	35		0		0		0
	2009	04	29	72	37		0		0		0
	2009	04	30	74	24		0		0		0
			Summary	58.1	24.1		1.12		10.2		

Figure 31. Alamosa, Colorado daily precipitation amounts for April 2009 Record of Climatological Observations (source http://cdo.ncdc.noaa.gov/dly/DLY).

3.0 Ambient Monitoring Data and Statistics

A PM_{10} concentration that exceeded the level of the twenty-four-hour NAAQS was monitored in Alamosa, Colorado on Wednesday April 8, 2009. An exceedance of 157 $\mu g/m^3$ and a correspondingly elevated PM_{10} concentration of 135 $\mu g/m^3$ were recorded at the Alamosa Municipal Building (Alamosa Muni) and the Alamosa Adams State College (Alamosa ASC) monitoring sites, respectively. This exceedance and elevated concentration were caused by a nature; a large regional dust storm that was not preventable or reasonably controllable. The spatial extent of this dust storm was extensive. It originated in the deserts of northeastern Arizona and northern New Mexico and according to the National Weather Service "Dust was observed stretching from northeast Arizona across extreme northwest New Mexico to northeastern Colorado" (see Figure 14). Back trajectories and satellite photos also confirm the origin of this dust storm (see Figures 20 and 21). This weather system adversely affected the air quality in much of western Colorado and specifically the air quality in Alamosa. It also had a significant negative impact on PM_{10} concentrations at a few other monitoring stations in Colorado, including Breckenridge (101 $\mu g/m^3$), and Mount Crested Butte (56 $\mu g/m^3$).

Unfortunately, April 8, 2009 was not a scheduled once every third-day sampling day; thus, the high PM_{10} was only captured by the daily monitoring sites, which make up less than one third of the Colorado PM_{10} air monitoring network. For a map of the Colorado PM_{10} monitoring sites and all valid PM_{10} concentrations on April 8, 2009 see Figure. A more robust network of PM_{10} monitors on a daily frequency would have shown more exceedances or elevated concentrations from this natural blowing dust event. Section 2 provides the meteorological evidence for the spatial extent of this regional blowing dust event including the dust on snow data from the Colorado Dust-on-Snow (CODOS) network. The CODOS network clearly show that the spatial extent of this dust storm was quite large, covering thousands of square miles (see http://www.snowstudies.org/CODOS/Compiled%20WY%202010%20CODOS%20Updates.pdf). The concentration of 157 $\mu g/m^3$ at Alamosa Muni was the only site greater than the NAAQS of 150 $\mu g/m^3$ monitored on that day. PM_{10} levels before and after the April 8, 2009 episode were low as can be seen in Table 8 and Figure 32 below.

The APCD reviewed PM_{10} monitoring data in Alamosa and the surrounding areas in the path of the dust storm (see Section 3.1). The PM_{10} concentrations in Alamosa on April 8, 2009 were compared to the concentrations on the day before and two days after the regional dust storm. Table 8 and the Alamosa PM_{10} time series graphs in Figures 32, 33, and 34 clearly shows that the regional blowing dust storm adversely affected the air quality in Alamosa on April 8, 2009 and there were residual effects on April 9, 2009. The day before (April 7) and the day two days after (April 10) the event were quite low with concentrations that are typical for spring in Alamosa (see Table 8 and section 3.1, the Historical Fluctuations of PM_{10} Concentrations in Alamosa). April 9, 2009 was still slightly elevated for PM_{10} due to residual effects of the dust storm as it started in the afternoon and continued after midnight. Table 7 shows wind speeds dropping after 18:00 MDT, but still elevated at 13 - 24 mph sustained until midnight. These winds would likely cause concentrations to be elevated on April 9, 2009 and would allow the dust storm to continue to deposit its load.

Three other PM_{10} monitoring sites in Colorado had elevated PM_{10} concentrations that were above their typical seasonal and historical concentrations on April 8, 2009. These were Breckenridge, Mount Crested Butte, and Steamboat Springs. The percentiles of the associated PM_{10} concentrations are all above the 95^{th} percentile for seven years of daily sampling data and are shown in Table 9 of section 3.1 below. Even though these elevated concentrations were well below the NAAQS, concentrations this high are still quite rare for these clean mountain towns. The concentrations were 101 $\mu g/m^3$ in Breckenridge, 56 $\mu g/m^3$ in Mount Crested Butte, and 57

$\mu g/m^3$ in Steamboat Springs. These were the 99.7, 96.3, and 95.7 percentile concentration values, respectively, for all days from 2003 – 2009. In other words, even though the concentrations in these three towns were well below the NAAQS they were still sufficiently elevated to be near the highest concentrations in seven years of daily monitoring. All other Colorado sites recorded concentrations between 20 - 43 $\mu g/m^3$ on April 8, 2009. These sites with low PM_{10} concentration are located on the east side of the Front Range Mountains in the Denver area and Lamar with one exception, Pagosa Springs, which only recorded a 31 $\mu g/m^3$. Denver typically has low concentrations during these southwestern regional dust storm events.

Table 8. Elevated PM10 Concentrations in Colorado on Days Before, During, and After the April 8, 2009 Regional Dust Storm ($\mu g/m^3$).

Date	Alamosa Muni	Alamosa ASC	Breckenridge	Mount Crested Butte	Steamboat Springs
4/07/2009	20	17	45	19	36
4/08/2009	**157**	**135**	**101**	56	57
4/09/2009	58	52	28	18	14
4/10/2009	14	14	29	1	21

There were several weather stations across the path of the dust storm that recorded high winds and observations of haze. Haze is recorded when there is precipitation obscuring the view or when there is an absence of precipitation for that hour then, it is due to dust in the air (see Section 2). Some of these weather stations are located outside of Colorado or in areas that do not have daily PM_{10} monitoring sites. These meteorological stations can act as surrogates and help demonstrate the extent of the blowing dust in towns where there are no daily PM_{10} monitoring sites. See Section 2 for the full meteorological details and extent of the regional dust storm.

The time series graph in Figure 32 shows the seasonal PM_{10} concentrations at the Alamosa site during the months of March and April, 2009. There were seven regional blowing dust events in the State of Colorado during March and April 2009. According to CODOS logs, this was the worst two-month period since CODOS has been recording dust on snow events in the Rocky Mountains since 2003. APCD records also show more regional wind-blown dust days in March and April than any two month period in the history of PM_{10} monitoring using federal reference monitors in Colorado, which goes back to 1986. The graph shows that four of those seven events impacted Alamosa, including March 5, March 23, April 3, and April 8. Although, the graph show several elevated concentrations at both sites in Alamosa, only one concentration was above the NAAQS. The other blowing dust events in March and April 2009 showed similar results, low PM_{10} concentrations before and after the blowing dust days. These spikes in concentrations are not the norm for the spring period in Alamosa. A more robust statistical analysis is shown in section 3.1 below that demonstrates just how atypical these high PM_{10} events are. Figure 38 shows a pictorial in graph form that shows that high PM_{10} concentrations in Alamosa are uncommon.

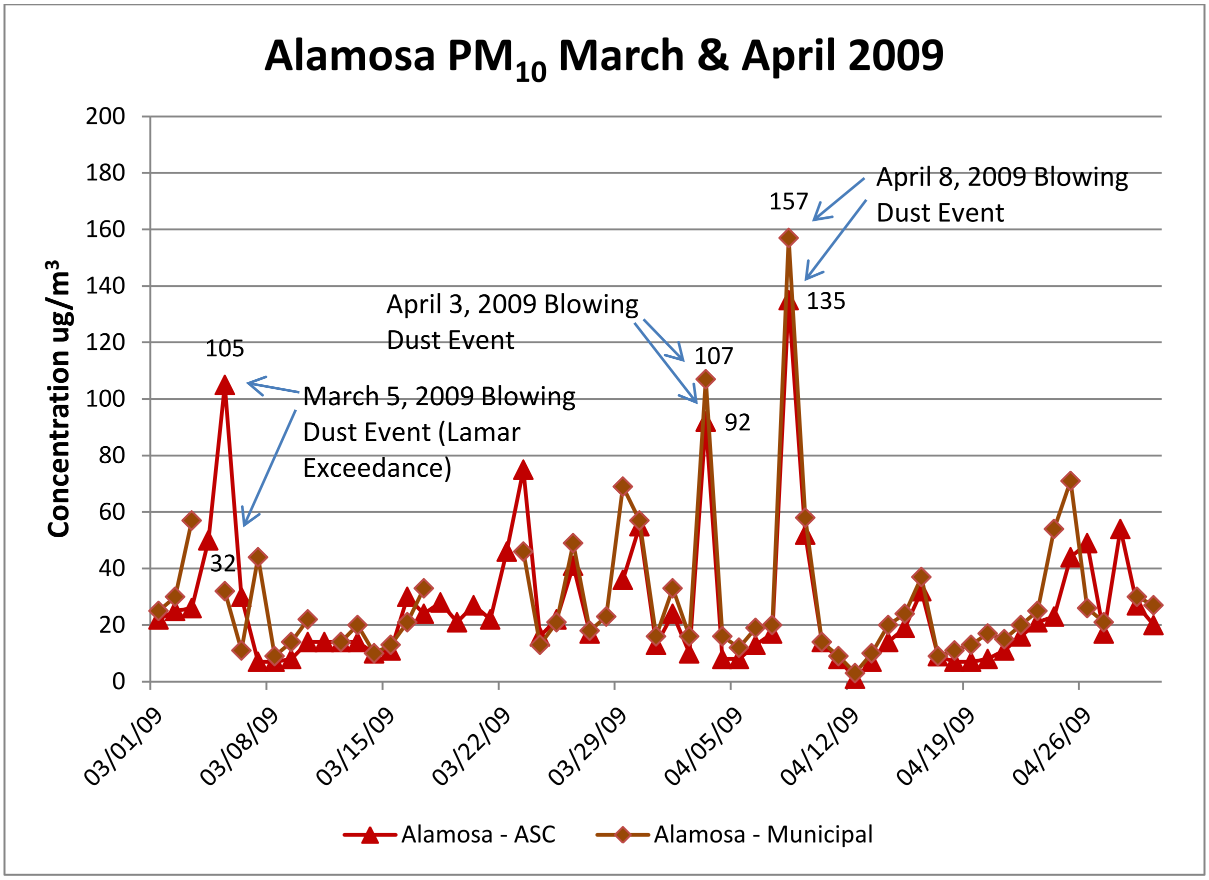


Figure 32 – Alamosa PM_{10} Time Series for March and April, 2009

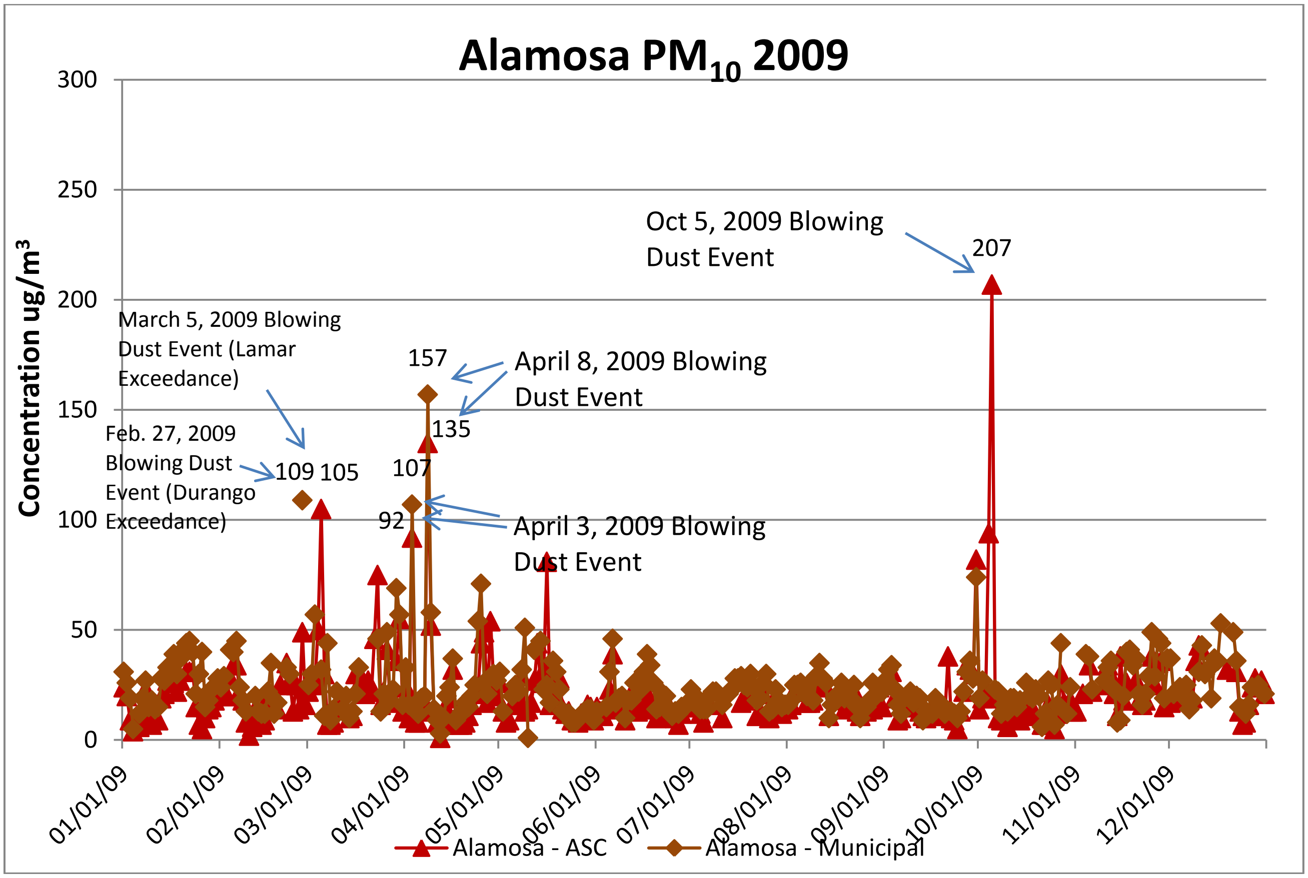


Figure 33 – Alamosa PM_{10} Time Series for 2009

Alamosa is located at 7,550 ft. (2301 m) in the broad flat San Luis Valley between the mountains. This topographic setting is conducive towards temperature inversions and stable air which can cause high PM_{10} concentrations especially in winter with snow on the ground. However, the local emissions in Alamosa are not sufficient to produce high PM_{10} concentrations. Especially since, the anthropogenic sources are relatively well controlled in Alamosa due to a Memorandum of Understanding (MOU) to control PM_{10} emissions. See section 5.0 Local Dust Controls for a comprehensive list of PM_{10} control measures employed in Alamosa through the PM_{10} MOU. Historically, the only times that PM_{10} concentrations have been high in Alamosa is during large regional blowing dust storms.

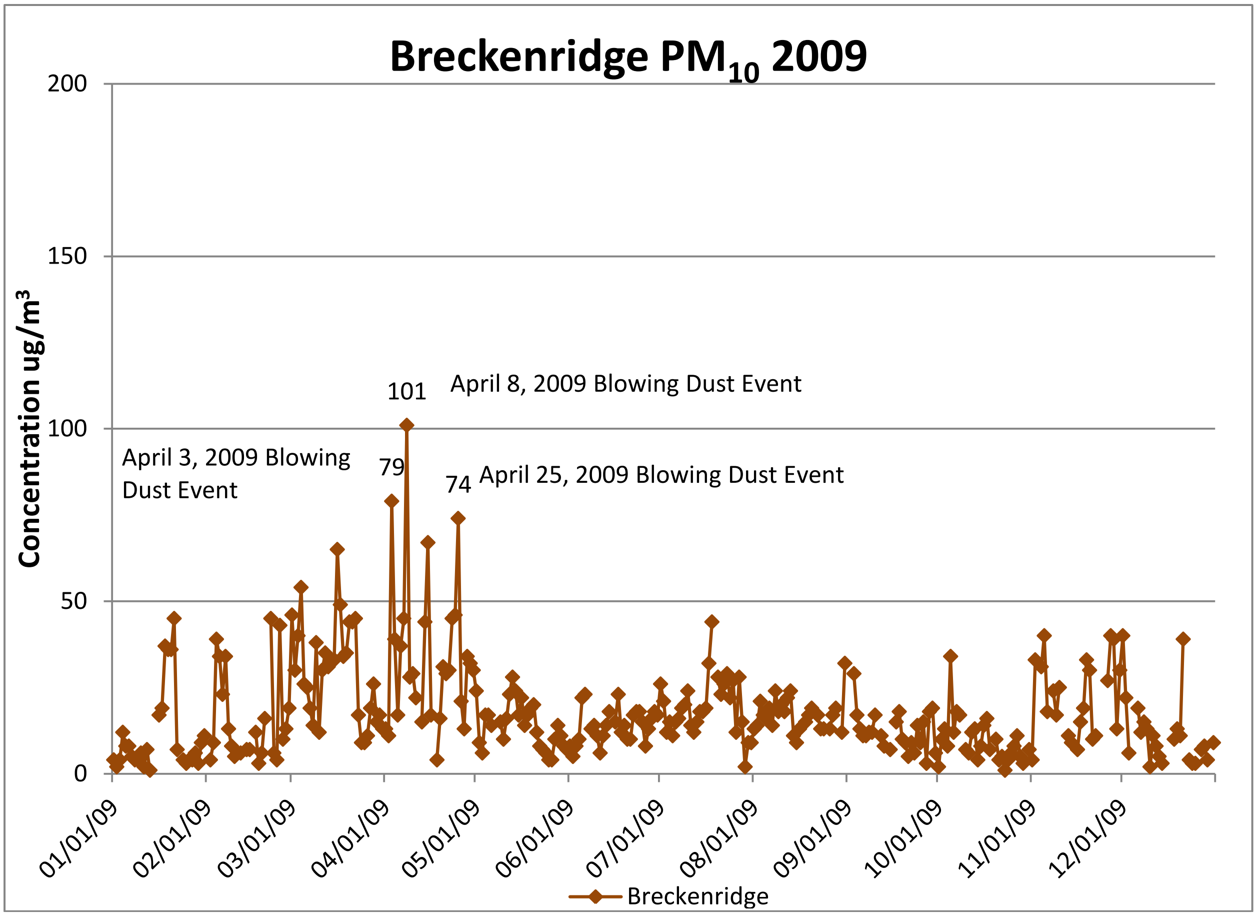


Figure 34. Breckenridge PM_{10} Time Series for 2009

The 2009 PM_{10} data for Breckenridge does appear to show a seasonal bias. The concentrations are higher in the spring period. This is confirmed in the 2004 - 2009 time series graph below, which shows significant seasonality unlike other sites in the south, southwest, and southeast Colorado. Breckenridge is an international resort ski town. The elevated PM_{10} emissions are probably due to paved street emissions in the winter and spring when the roads dry out. Also, there is a lack of PM_{10} control measures for street emissions in Breckenridge since there is no SIP or MOU in place. However, Breckenridge has banned residential wood burning for all but a few grandfathered woodstoves. The PM_{10} concentrations are not high enough to warrant a SIP or MOU. There has only been one exceedance recorded of the NAAQS in Breckenridge from 2004 – 2009, at a concentration of 170 μg/m^3 on May 19, 2005. The PM_{10} concentration of 101 μg/m^3 on April 8, 2009 is the highest concentration in 2009 and the fifth highest in the 2004 – 2009 dataset. The second, third and fourth highest concentrations are only 110 μg/m^3, 105 μg/m^3, and 104 μg/m^3, respectively. This April 8 concentration of 101 μg/m^3 was significantly impacted by the regional dust storm and is physical evidence for the spatial extent of this regional event.

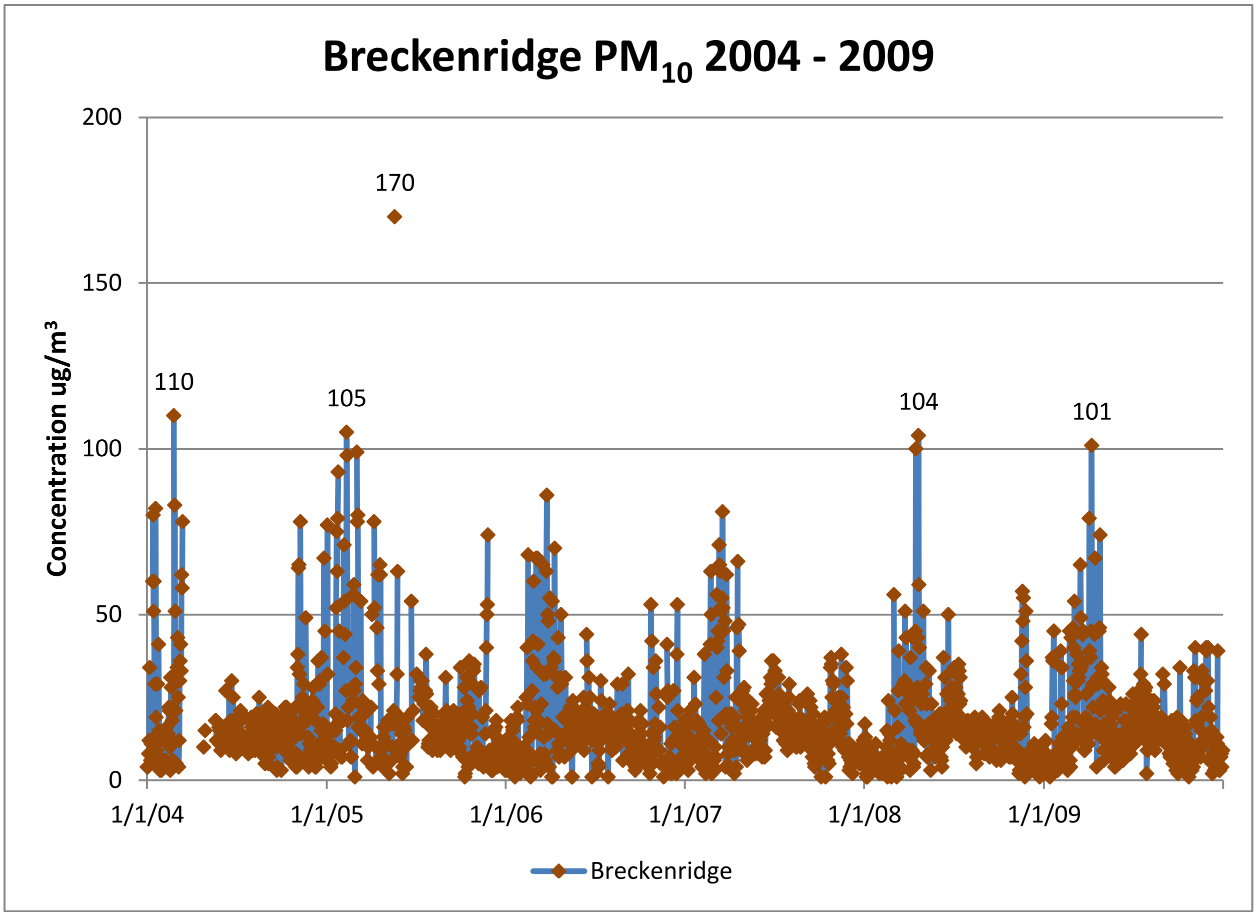


Figure 35. Breckenridge PM_{10} Time Series for 2004 - 2009

Steamboat Springs is different from most of the impacted sites as it is located farther away from the source area and in a relatively unique area of Colorado. Steamboat has the only state operated PM_{10} monitoring station located in the northwestern area of the state and in the northern mountain region. Steamboat Springs is located 220 miles (355 km) north of Alamosa with very complex terrain (13,000 – 14,000 foot peaks) and several mountain ranges between the two towns. Steamboat Springs is a ski area town and the PM_{10} monitor is located at an elevation of 6,739 feet (2,054 m). Being that far north Steamboat is not usually impacted by the dust storms generated in the Four Corners region as they usually travel from the southwest to the northeast and east. Steamboat Springs is in a regime of its own.

Steamboat is also impacted by daily temperature inversions and stagnant air due to its mountain-valley topography and the town is located in a valley bottom setting on the western side of the Gore Range Mountains. The Gore Range blocks the typical westerly flow of air. Steamboat Springs has a PM_{10} SIP Maintenance Plan that has required controls of geologic dust from the roads, such as using clean sand, sweeping highway 40, the main thoroughfare, immediately after sanding events. The Steamboat Springs SIP also has local restrictions on woodburning devices. (Reference: Steamboat Springs PM_{10} Redesignation Request and Maintenance Plan – Adopted by the Colorado Air Quality Control Commission November 15, 2001.) These control measures have kept the PM_{10} concentrations well below the 24-hour NAAQS of 150 $\mu g/m^3$. The remote forested northern location in the Rocky Mountains with a large surface roughness coefficient, which decreases PM_{10} concentrations as well as the SIP control measures used in Steamboat Springs explains why the PM_{10} concentration in Steamboat were only moderately elevated on April 8, 2009.

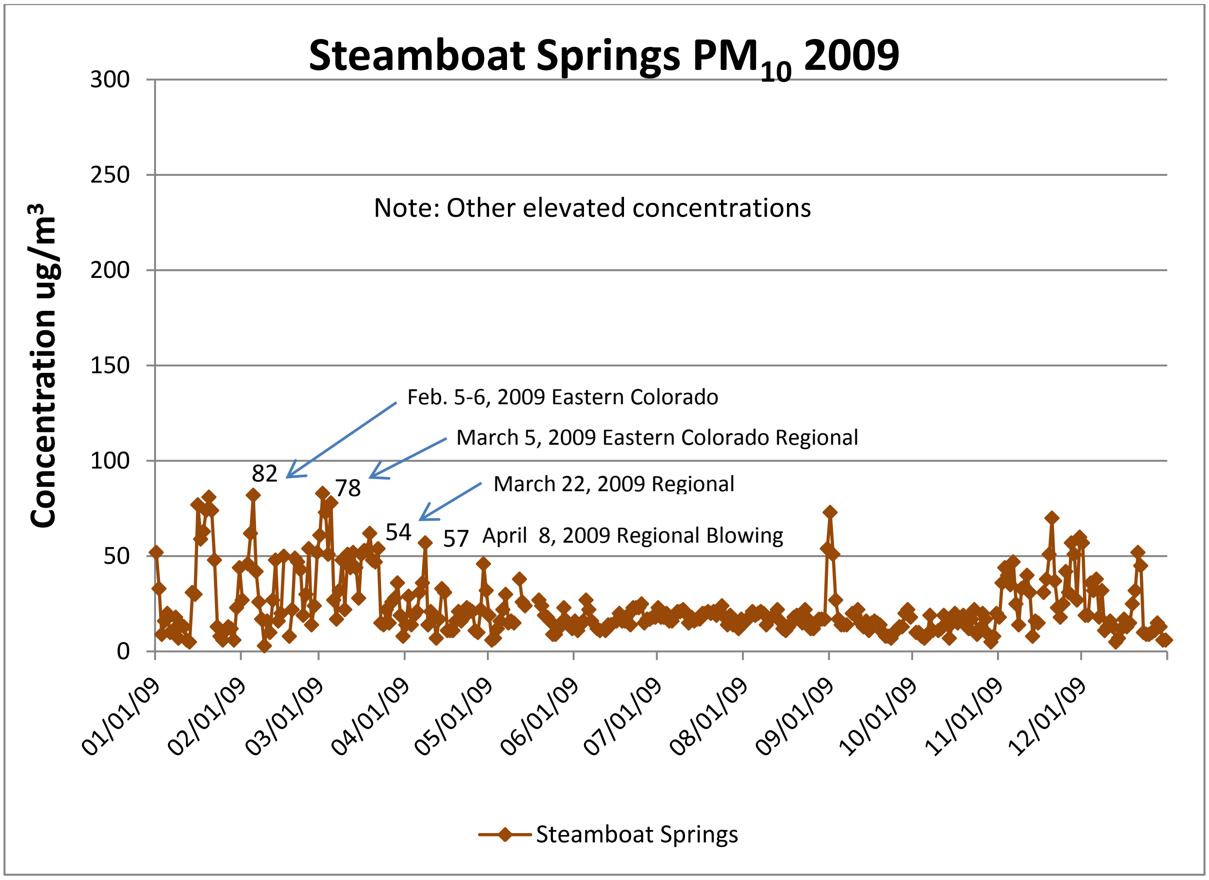


Figure 36. Steamboat Springs PM_{10} Time Series 2009

The monitoring data above shows the spatial extent and magnitude of impact of the regional blowing dust storm that impacted Alamosa and other Colorado towns. Section 3.1 below will discuss the historical fluctuations of PM_{10} in Alamosa and provide statistical analyses to demonstrate the magnitude and the seasonality of the April 8, 2009 dust storm. It will also provide a "but for" test using typical concentrations versus the exceptional event due to the regional dust storm to estimate the impact that was due to the regional dust storm.

3.1 Historical Fluctuations of PM_{10} Concentrations in Alamosa

This historical fluctuation evaluation of PM_{10} monitoring data for sites affected by the 08 April, 2009 event was made using valid samples from PM_{10} samplers in Alamosa from 2003 through 2009. APCD has monitored PM_{10} in Alamosa at the Adams State College (080030001) site since 1985. A second site was added in 2002, Alamosa Municipal (080030003); data collection began there in June 2002. Therefore, the data in this analysis is from both sites beginning January 2003 through the end of 2009. The overall data summary and a time series plot for data from 2003 to 2009 are presented here, with all data values being presented in $\mu g/m^3$:

Table 9 –Alamosa PM_{10} Monitoring Data Summary

	Alamosa ASC	Alamosa Muni
Mean	21.6	25.8
Median	18	22
Mode	16	15
sd	19.8	20.4
Variance	391.1	416.1
Minimum	1	1
Maximum	473	494
Count	2232	2266
4/8/2009	135	157

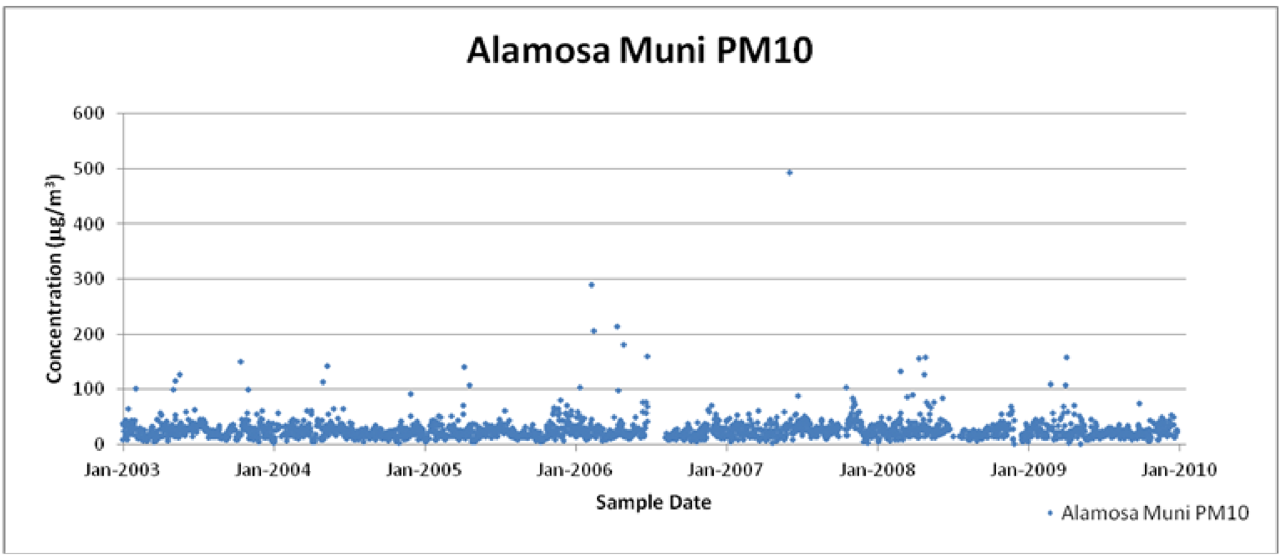


Figure 37 – Alamosa PM_{10} Seven Year Time Series

The spatial scope of this event, addressed elsewhere in this document, was fairly broad and had an impact on PM_{10} concentrations at multiple sites. However, the 157 µg/m^3 at Alamosa Municipal was the only sample greater than 150 µg/m^3; therefore the Alamosa sites will be the only data sets discussed in detail. A snapshot of data from those sites affected by the event is presented here, along with the approximate percentile value that data point represents for each site for their unique historical data sets, for the month of the event (every sample in any April), and for the year. All data sets were restricted to the interval 2003 – 2009.

Table 10 –Percentile Values for High PM10 Concentrations in Alamosa and Other Significant Colorado Sites (2003 – 3009 Data)

Evaluation	Alamosa ASC	Alamosa Municipal	Mt. Crested Butte	Breckenridge	Steamboat Springs
April 8, 2009	135 µg/m^3	157 µg/m^3	56 µg/m^3	101 µg/m^3	57 µg/m^3
Overall	99.7%	99.7%	96.3%	99.8%	95.1%
All April	98.4%	98.5%	95.0%	99.3%	97.6%
2009	99.7%	99.9%	99.1%	99.9%	94.8%

Each of the Alamosa data sets were summarized by month and year. These summaries (see charts, below) present no obvious 'season'; PM_{10} levels at any particular site in Colorado do not necessarily fluctuate by season. Of greater importance affecting day-to-day, typical PM_{10} concentrations are local sources, e.g. road sanding and sweeping, local burning from agriculture and residential heating, vehicle contributions via road dust, unpaved lots or roads, etc. While the historic monthly median values for both sites in Alamosa are higher during the winter and spring months than the rest of the year there is little month-to-month variation. This time frame (winter and early spring) is that which is most likely to experience the meteorological and dry conditions exhibited during this event and discussed in section 2 of this document. The lack of variability between monthly medians for either site suggests that typical data exhibiting regular variation due to local sources are those in the inner-quartile range (i.e. between the 75th and 25th percentile). If a conservative approach is taken then a typical value should be no higher than the historic monthly 75th percentile value. The summary data for the month of April (all samples in any April from 2003 - 2009) and for 2009 is presented in Table 11:

Table 11 – Month and Year PM_{10} Monitoring Data Summary

Site	Alamosa ASC		Alamosa Municipal	
	April	2009	April	2009
Mean	25.4	20.9	31.0	24.5
Median	19.5	17	23	21
Mode	11	14	23	19
sd	24.08	18.12	30.92	15.26
Variance	579.72	328.48	955.95	232.80
Min	1	1	3	1
Max	145	207	213	157
Count	192	323	196	314

Alamosa Municipal – AQS ID: 080030003

The PM_{10} sample on April 8, 2009 at Alamosa Municipal of 157 µg/m^3 is nearly equal to the 99th percentile value (158 µg/m^3) for all April data, is the maximum value for all 2009 data, and is greater than the 99th percentile value (100 µg/m^3) for the entire dataset. Overall, this sample is the seventh highest sample in the entire data set and the largest sample in 2009. The six samples greater than the event sample are 494 µg/m^3 (06/06/2007), 289 µg/m^3 (02/10/2006), 213 µg/m^3 (04/14/2006), 206 µg/m^3 (02/15/2006), 181 µg/m^3 (04/28/2006), and 160 µg/m^3 (06/26/2006); all six samples are associated with high wind events. There are 2266 samples in this dataset. The sample of April 8, 2009 clearly exceeds the typical samples for this.

The following plots graphically characterize the Alamosa Municipal PM_{10} data. Figure 38 is the overall frequency histogram. The histogram displays a well-formed density function, almost 90% of the samples values are less than 40 µg/m^3 and just under 99% of the samples are less than 100 µg/m^3.

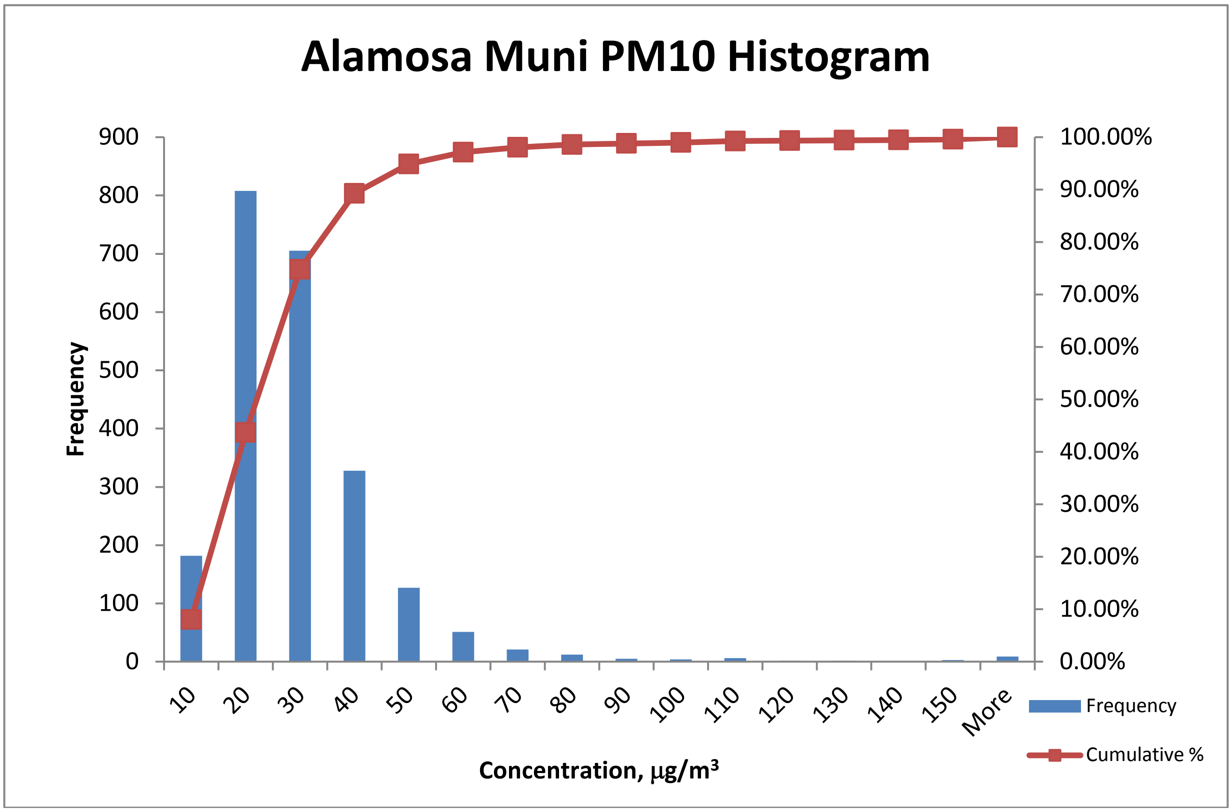


Figure 38. PM_{10} Histogram for Alamosa Municipal Building Site

The monthly box-whisker plot in Figure 39 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, 2009. Although these high values affect the variability and central tendency of the dataset they aren't representative of what is typical at the site.

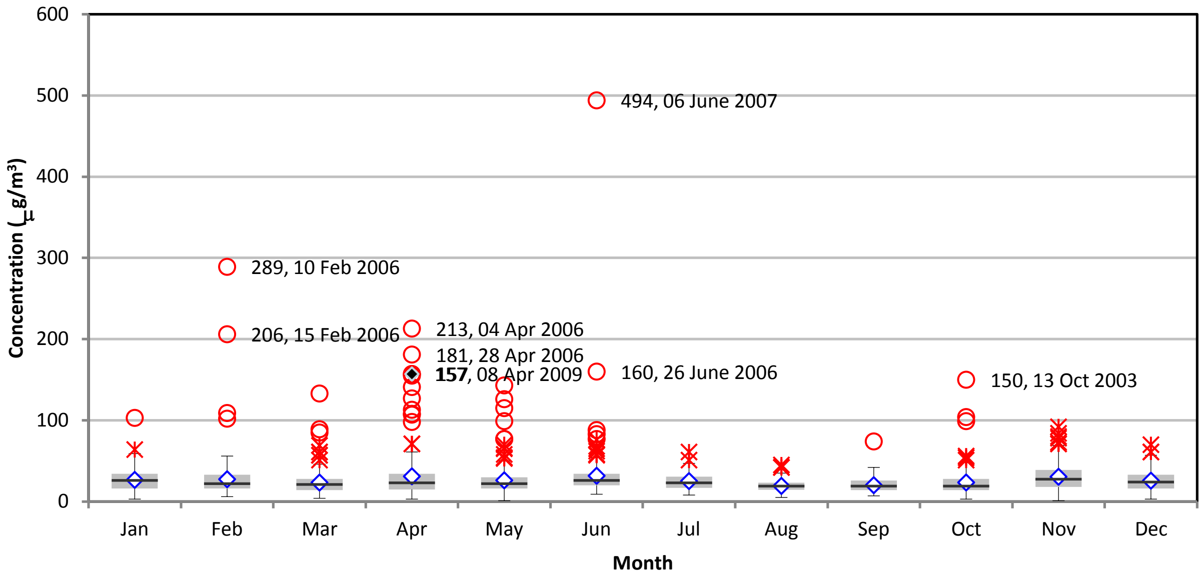


Figure 39. Monthly Alamosa Municipal PM10 Box and Whisker Plot

The box and whisker plots graphically represent the overall distribution of each data set including the median ( ), the inner quartile range (IQR, defined to be the distance between the 75^{th}% and 25^{th}%), the mean (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 ( ). The outliers that satisfy the last criteria are labeled with sample value and sample date for those samples greater than 150 µg/m^3. Each of these outliers is associated with a known high-wind event similar to that of April 8, 2009.

The annual box and whisker plot in Figure 40 demonstrates no clear trend. All the inner-quartile ranges are less than 18 µg/m^3, the greatest spread occurring in 2007. This year was also the year with the highest sample standard deviation, demonstrating how one extreme data point (494 µg/m^3, 06 June 2007) can alter the entire distribution.

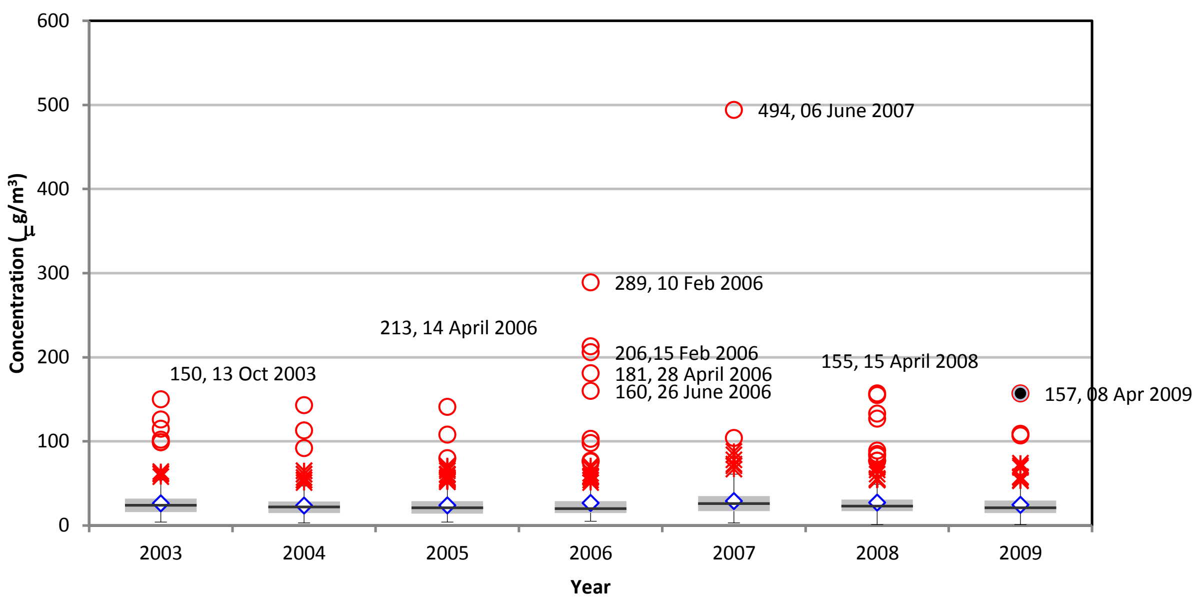


Figure 40. Annual Alamosa Municipal PM_{10} Box and Whisker Plot

The presence of the extreme value also distorts the graph, losing definition. The same plot graphed to 100 µg/m^3 showing almost 99% of all the data from Alamosa Municipal is presented in Figure 41.

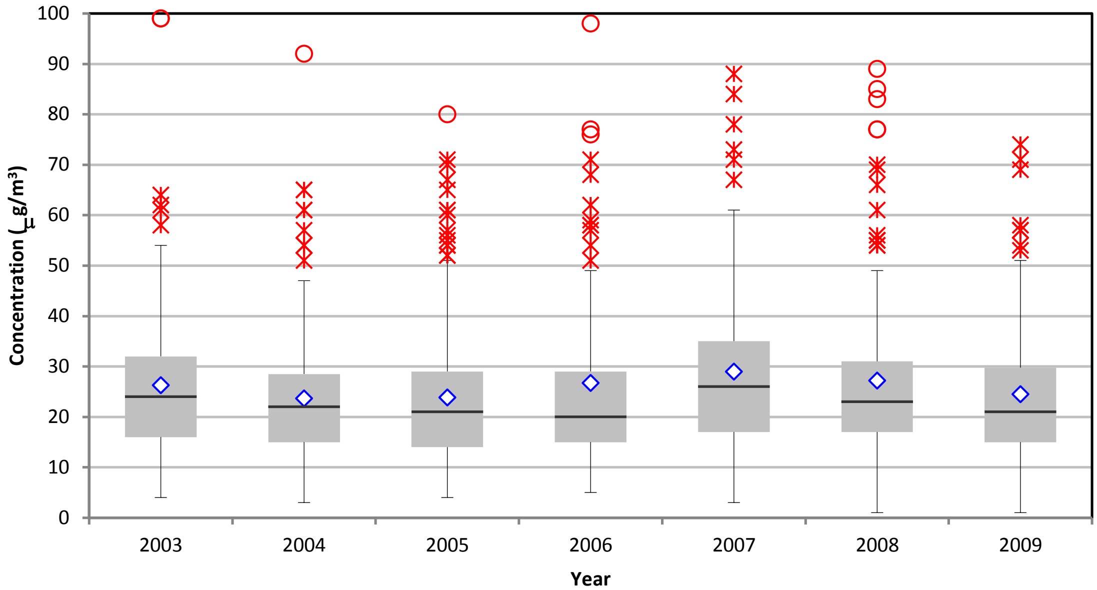


Figure 41. Annual Alamosa Muni PM_{10} Box and Whisker Plot, Reduced Scale

Alamosa ASC – AQS ID: 080030001

The PM_{10} sample on 08-April, 2009, at Alamosa ASC of 135 µg/m^3 is nearly equal to the 99th percentile value (147 µg/m^3) for all April data, is the second highest value of all 2009 data, and is greater than the 99th percentile value (91 µg/m^3) for the entire dataset. Overall, this sample is the eighth highest sample in the entire data set. The seven samples greater than the event sample are 473 µg/m^3 (06/06/2007), 424 µg/m^3 (02/10/2006), 207 µg/m^3 (10/05/2009), 158 µg/m^3 (02/15/2006), 145 µg/m^3 (04/28/2006), 142 µg/m^3 (4/20/2005), and 141 µg/m^3 (4/08/2005); all seven samples are associated with high wind events. There are 2232 samples in this dataset. The sample of April 8, 2009, although it is lower than the sample at Alamosa Municipal, clearly exceeds the typical samples for this site and sits well beyond the typical data distribution.

The following plots graphically characterize the Alamosa ASC PM_{10} data. The first plot is the overall frequency histogram. The histogram displays a well-formed density function, slightly more than 93% of the samples values are less than 40 µg/m^3 and just over 99% of the samples are less than 100 µg/m^3.

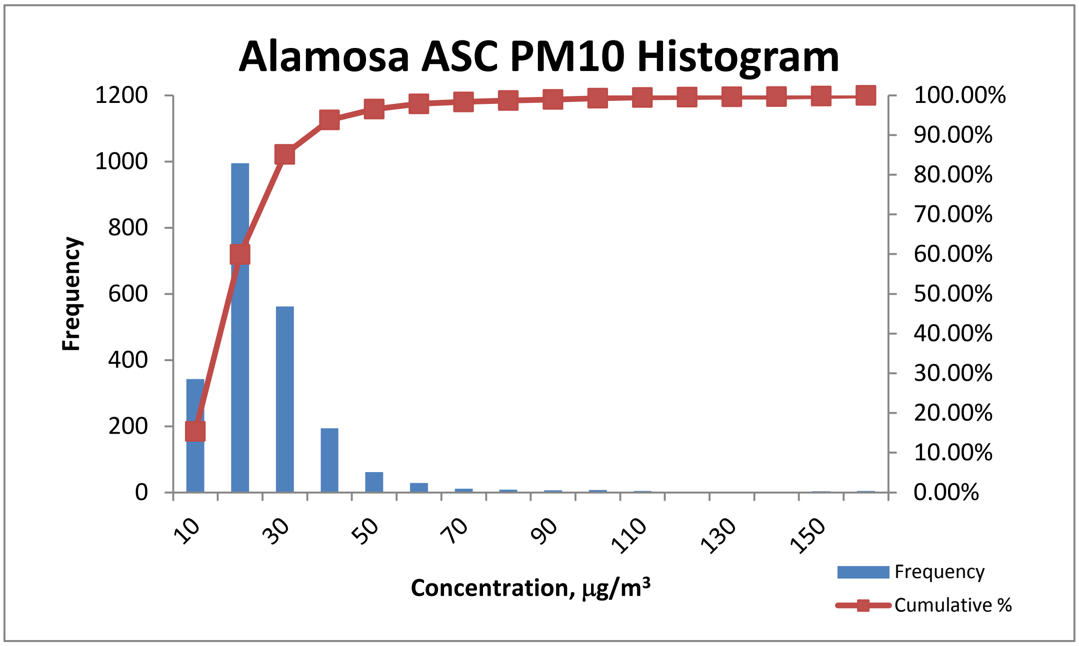


Figure 42. PM_{10} Histogram for Alamosa Adams State College Site

The monthly box-whisker plot in Figure 43 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, 2009. Although these high values affect the variability and central tendency of the dataset they aren't representative of what is typical at the site.

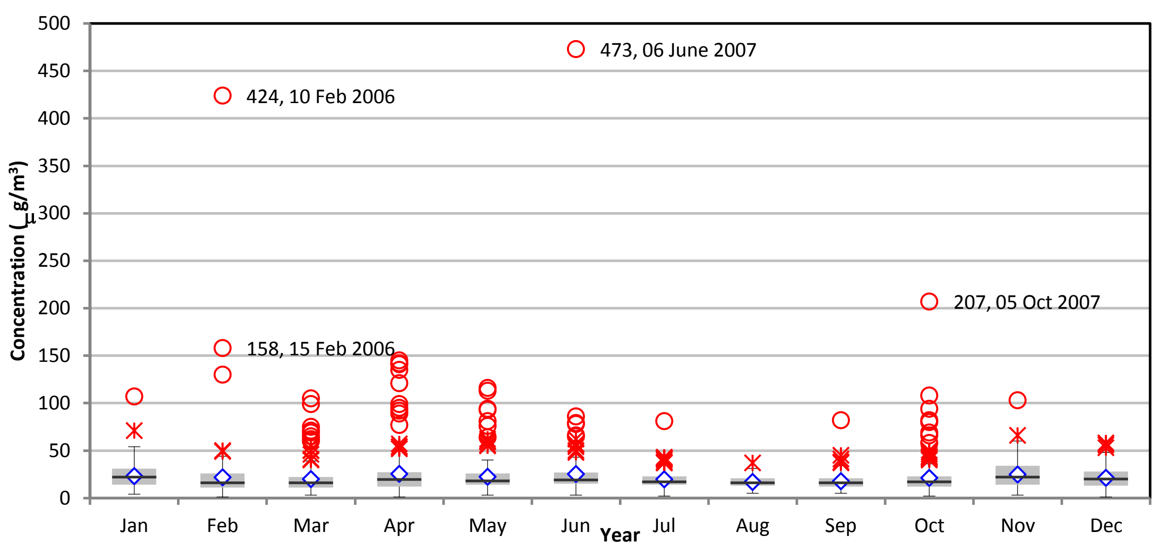


Figure 43. Monthly Alamosa ASC PM_{10} Box and Whisker Plot

As with the previous box and whisker plots outliers greater than 150 µg/m^3 are identified by concentration and date. Each of these outliers is associated with a known high-wind event similar to that of April8, 2009. As with the previous annual box and whisker plot, the Alamosa ASC plot in Figure 44 demonstrates no clear trend.

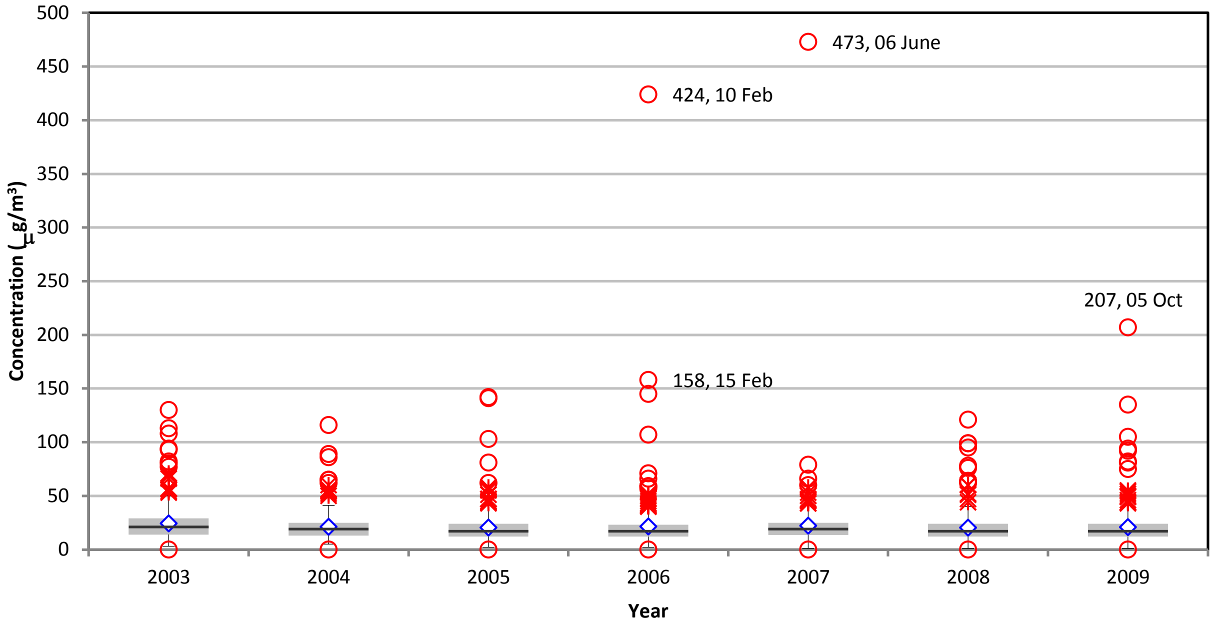


Figure 44. Annual Alamosa ASC PM_{10} Box and Whisker Plot

The presence of the extreme value also distorts the graph, losing definition. The same plot graphed to 100 µg/m^3 ,including almost 99% of all the data from Alamosa ASC, is presented in Figure 45.

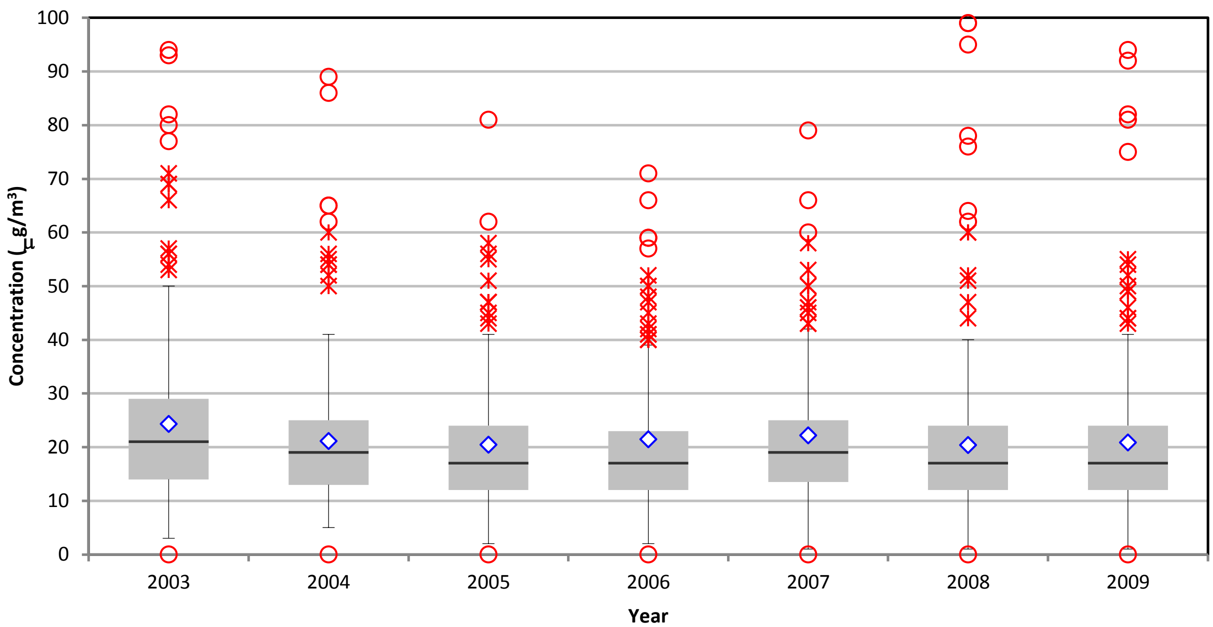


Figure 45. Annual Alamosa ASC PM_{10} Box and Whisker Plot, Reduced Scale

Speciation Results

Both Alamosa filters from the April 8, 2009 event were sent to Chester LabNet for speciation analysis. Chester LabNet used X-ray Flourescence or XRF to determine the elemental metals, ion chromatography to determine the ion concentrations for nitrates (NO3), sulfates (SO4) and other ions not shown here and thermal/optical carbon analyzer to determined elemental carbon (EC) and organic carbon (OC). A summary of the main species is presented here, expressed as percentages of the total mass concentration:

Table 12. PM_{10} Speciated Filter Results

Site	Est. Soil	EC	OC	NO3	SO4	Unknown
Alamosa ASC	32.7%	2.2%	4.4%	0.3%	4.9%	55.4%
Alamosa Muni	32.9%	2.2%	4.4%	0.3%	4.9%	55.3%

PM_{10} is sampled on a quartz fiber filter and the filter matrix is silicon dioxide (SiO2). The amount of silicon in the sample cannot be determined due to this interference. Thus, the APCD used Aluminum as a surrogate and factored it by 2.2 The contribution from 'Soil' was estimated using the IMPROVE equation for SOIL and substituting a value for Si equal to 2.2*Al. This surrogate was generated using PM2.5 CSN or Chemical Speciation Network data from our Powell $PM_{2.5}$ speciation site. The method will result in an estimate for SOIL that is low and should be used with this in mind. The results between the two sites are remarkably consistent, suggesting that the samples from the two disparate sites were subjected to remarkably similar conditions.

No Exceedance "But For" the Event

An estimation of PM_{10} due to the event is presented here. Based on the entirety of data in the Historical Summary (including multiple high wind events), a conservative estimate of the 'typical' values in April for Alamosa Municipal would have been between 34 and 41 $\mu g/m^3$ corresponding to the historical 75^{th} and 84^{th} Percentile values, respectively. And, since the anthropogenic sources are relatively well controlled in Alamosa due to the MOU in place to control PM_{10} emissions, the local contribution of PM_{10} in Alamosa is minimized. (See section 5.0 Local Dust Controls.) Using these conservative values as a range to estimate typical local contributions would indicate that the event provided an additional contribution of 116 – 123 $\mu g/m^3$. Clearly, there would have been no exceedance "but for" the additional contribution provided by the event.

Table 13. PM_{10} "But For" Test using Typical Concentrations

Site	Event Day Concentration ($\mu g/m^3$)	April Median ($\mu g/m^3$)	April Average ($\mu g/m^3$)	April 75^{th} % ($\mu g/m^3$)	April 84^{th} % ($\mu g/m^3$)	Est. Conc. Above Typical ($\mu g/m^3$)
Alamosa Municipal	157	23	31.0	34	41	116 - 123
Alamosa ASC	135	19.5	25.4	27	33	102 - 107

3.2 Monitoring Data and Conclusions

Since the local anthropogenic sources are fairly well controlled in Alamosa and since the sustained surface wind speeds were well above 25 mph in the region of the dust storm, it follows that the dust was transported into Alamosa on April 8, 2009. This high wind blowing dust event affected the air quality in Pagosa Springs and several other locations, including but not limited to Breckenridge, Mount Crested Butte, and Steamboat Springs in the state of Colorado on April 8, 2009. The size, extent, and origination of the blowing dust storm made the event not preventable and it could not be reasonably controlled. Statistical data in section 3.1 above clearly shows that but for this high wind blowing dust event Alamosa would not have exceeded the 24-hour NAAQS on April 8, 2009.

4.0 News and Credible Evidence

From Chappy Trails Blogspot (http://chappytrails.blogspot.com/2009/04/alamosa-co-day-3.html):

WEDNESDAY, APRIL 8, 2009

Alamosa, CO-Day 3

We started out the day by going to our favorite breakfast place, Campus Cafe. It is a small place off Main Street, frequented by students of Adams State College here in Alamosa. The managers are great supporters of Adams State and especially the athletes and many of the wait staff are ASC students.

(snip)

Then it was to Walmart (the only game in town unfortunately) for staples and then to City Market for groceries (Marcia-City Market is a Kroger store and it is my favorite also). We bought huge T-Bone steaks for $4.99 a pound. After buying three of them in a family pack that is about all I can get in my freezer.

The wind is really kicking butt today - shades of The Ranch windstorms. I just checked the weather online and it says the winds are 41 MPH with gusts of 52 MPH. We be rockin and rolling! Jim had to go to Walmart to buy a rivet gun and rivets cause the wind blew down the satellite dish and broke off the arm thingy. Howie's rivets held for a long time though.

I finally got my hands on a book I've been longing to read *Knit Two* by Kate Jacobs. She wrote A *Friday Night Knitting Club* a few years ago and I have waited for the sequel with anticipation.

While at Walmart I bought some yarn to try out making socks on the Magic Loop, which is a circular knitting needle with a 40 inch cable. You can knit two socks at the same time. The yarn I bought is called Simply Soft and, get this, it is made from **recycled plastic bottles**! It's that wonderful? My friends Linda B. and Linda S. would be proud of my recycling commitment!

Sticking close to home last night and eating some of those tamales we bought Monday. Travel safe and remember, you are loved.

From the Living in Sanctuary blog (http://menlagardensanctuary.wordpress.com/2009/04/):

DODGING THE SPRING WINDS

April 8, 2009, 11:49 pm

Filed under: Uncategorized

Another windy spring day in Alamosa Canyon. The weather extremes here demand a sort of strategy with working on the land. The winds return with fury this time of year which makes working outside challenging at times. Most recently I've developed the hit and run technique where I'll go out, knock out some hard labor and come back it once my eyes start crossing and I'm blowing dust out my ears. A bit of an exaggeration yet not far from it at times. All in all it's nothing compared to what I remember of Southern Spain just around Tarifa at the Strait of Gibraltar. The wind surf capital of Spain from what I recall. No surfing out here in NM, though the pleasantries of the desert still delight: coyotes, cacti, turkey vultures and wild sunflowers, here the sun is king and the full moon shines upon an all so lunar Chihuahuan landscape.

5.0 Local Dust Control

The Final Natural Events Action Plan (NEAP) for High Wind Events in Alamosa, Colorado was finalized 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 Division followed up with the City and County of Alamosa in January 2007 on whether the NEAP mitigation measures and commitments were satisfied, the results of which are detailed below.

The City of Alamosa, Alamosa County, the Division, and participating federal agencies have been working diligently to identify contributing sources and to develop appropriate BACM as required by the Natural Events Policy.

City of Alamosa

The City of Alamosa has been active in addressing potential PM10 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 PM10. Copies of current ordinances and any related commitments are included in the NEAP in Appendix A.

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. In fact, street sweeping in the downtown corridor currently takes place twice per week.

In addition, the City recently agreed to lease/own a new TYMCO 600 (brush-assisted head) sweeper. Efforts are underway to get this effective piece of equipment into place immediately. This new sweeper will complement a mobile mechanical sweeper already in use.

Unpaved Roads within the City

The City of Alamosa(as of 2008) requires all new roads to be paved and some existing unpaved roads are being treated with dust suppressants until all underground utilities are installed which may occur on most unpaved roads in the coming year.

Sod/Vegetative Cover Projects in the City of Alamosa

The development and construction of a local park, Eastside Park, is underway in Alamosa. It is anticipated that sodding at the park will take place this year. This commitment is anticipated to reduce blowing dust from this previously undeveloped site. As of 2008, the City of Alamosa has placed vegetative cover in all city parks and has installed irrigation systems to maintain the cover.

Alamosa County

Alamosa County has also been active in addressing blowing dust and is preparing county ordinance as such.

Unpaved Roads

Alamosa County is presently addressing unpaved roads and lanes that are anticipated to contribute to PM10 emissions in the community. As of 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 and community needs/priorities.

In 2002, Alamosa County addressed approximately ten (10) miles of unpaved roads. This includes 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 10th 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.

In addition, once it gets cold enough in the area, the County will wet down some of the more sandy roads. Once the water soaks in and freezes, it is anticipated that good dust suppression will be seen. These commitments are anticipated to reduce PM10 emissions in and near Alamosa. This control measure will be balanced with the availability of water in the area.

Finally, Alamosa County assesses the need to use $MgC1_2$ treatment on roads in front of residences that request such service. Assessments include 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 are granted. Road construction areas are being dampened with water for dust control. Other areas for treatment, such as commercial construction zones or gravel pits, are investigated on a case by case basis.

Dust Control Plans
Alamosa County is considering changes in local ordinances governing dust control plans at construction sites. This will be addressed through the revision of Alamosa County's Comprehensive Plan and supporting zoning codes. Alamosa County is currently reviewing language from other successful dust control programs for inclusion in their local ordinances.

The County is in the public meeting process of updating the Comprehensive Plan, which includes a dust control plan proposal. The Land Use Administrator has been asked to research and create 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 PM10 values. The Division commits to providing copies of this language to EPA upon finalization and availability.

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 will continue to be utilized in the community. In addition, the community is using in strategic areas the State of Colorado Agricultural Office's program to purchase and plant shelter trees to reduce wind erosion in open areas. 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. 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.

These commitments are anticipated to further reduce the PM_{10} emissions in Alamosa.

Sod and Vegetative Projects in the County
Numerous 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, grass is being grown for aesthetics and dust control.

- Sodding and the placement of decorative rock and ground cover will be implemented in the landscaping of the Alamosa County property, as well. These measures will directly abate blowing dust at the Airport.

- Also, the widening of the airport's safety areas (250 feet on either side of the runway) is now 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.

These efforts are anticipated to further reduce PM_{10} emissions in Alamosa.

Open Burning Issues at the County
The Colorado air pollution control laws and regulations prohibit 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. No open burning is allowed when local wind speeds exceed 5 miles per hour.

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
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:

- Cover crops and perennial crops (e.g., alfalfa) are recommended to protect soils;
- NRCS works with area farmers in the development of conservation compliance plans to also protect topsoil;

- NRCS encourages the use of perennial crops or the leaving in place of weeds on the corners of area acreage (instead of tilling that might lead to open, barren lands) to reduce the lifting of topsoil;
- NRCS "cost shares" on conservation practices with local farmers to prevent soil erosion, and;
- The NRCS works with Colorado State University to identify other strategies that minimize blowing dust.

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 in Appendix C for more detail if needed.

6.0 Laboratory and Field Data

C007 CDPHE
LabNet ID: 11-U713
Q7062825
Report #: 11-556

INTER-MOUNTAIN LABS
555 Absaraka
Sheridan, WY 82801
(307) 674-7506
www.imlairscience.com

Particulate Sampler Field Envelope

Network: Alamosa - ASC

Sampler ID: PM_{10}-3-1080

Filter Number: 7062825

Sample Date: 4/8/09

Time Off: 40422

Time On: 38990

Run Time: 1432

Tech.: Aldridge

P_{STG}

ΔP on	ΔP off
2.9	2.8

Comments:

INTER-MOUNTAIN LABS

IML Air Science
555 Absaraka
Sheridan, WY 82801
(307) 674-7506

C007 CDPHE
LabNet ID: 11-U721
07062383
Report #: 11-556

Particulate Sampler Field Envelope

ALAMOSA - MUNICIPAL BUILDING

Network ____________

Sampler ID TMIC # 2 5027

Filter Number 7062383

Sample Date 4/8/09

Time Off 24913

Time On 23467

Run Time 1446

Tech. JEFF RILLING

PSTG

ΔP on	ΔP off
3.2	3.2

Comments:

HIGH WINDS

7.0 Summary and Conclusions

Elevated 24-hour PM_{10} concentrations were recorded across Colorado on April 8, 2009. All of the noted April 8, 2009 twenty-four-hour PM_{10} concentrations were above the 90^{th} percentile concentrations for their locations. *The Alamosa concentration is nearly equal to the 99^{th} percentile, and a conservative estimate of the dust storm contribution to the total concentration is 116 – 123* µg/m^3. *This is evidence that the event was associated with a measured concentration in excess of normal historical fluctuations including background. But for the dust storm to be described in detail in this report, there would have been no exceedance on this day in Alamosa.*

This exceedance was the consequence of strong gusty winds ahead of a deep low pressure with a trailing cold front, in combination with dry conditions, which caused significant blowing dust across parts of Arizona, New Mexico, and Colorado. These winds were partly the result of a developing low pressure centered over southwestern Idaho with a cold front trailing to the south as well as a second low pressure system over east central Colorado. Strong winds aloft which mixed down to the surface in the deeply-mixed surface boundary layer also contributed to this exceedance. Surface weather analyses show an area of low pressure affecting the Four Corners region. The pressure gradient around the low contributed to strong gusty surface winds across much of Arizona, northwest New Mexico, and southwest Colorado. *Upper winds in the area bounded by Flagstaff, Arizona, Grand Junction, Colorado, and Albuquerque, New Mexico were 46 – 63 mph on April , 20098. Gusts of 23 to 49 mph were recorded across almost all of western Colorado, northern New Mexico, and northeast Arizona on April 8, 2009. These speeds are above the thresholds for blowing dust identified in EPA draft guidance and in detailed analyses completed by the State of Colorado.*

Climatological data for March and April shows that most of the Four Corners area had received less than normal precipitation for the period of interest. Soils in many areas of the Four Corners region had below normal moisture, and northeast Arizona was abnormally dry. Winslow in northeastern Arizona received only 0.05 inches of precipitation during the 30 days prior to April 8. This total is well below the approximate threshold for blowing dust conditions at Hopi identified in the analysis contained in Attachment A. Both wind speeds and soil moisture in the Four Corners area and northeastern Arizona were conducive to the generation of significant blowing dust.

Friction velocities calculated for the region also help to explain why blowing dust originated in the Four Corners region. Even undisturbed desert soils normally resistant to wind erosion will be susceptible to blowing dust when friction velocities are greater than about 1.0 to 2.0 meters per second. High values were present within the Little Colorado River Valley and Painted Desert region of northeast Arizona where satellite imagery shows the eruption of large plumes of blowing dust. Note that blowing dust will typically only occur where these values are high and the soils are dry and not protected by vegetation, forest cover, boulders, rocks, etc. This is why blowing dust occurred in the desert and more arid areas of northeast Arizona, southwest and south-central Colorado, and northwest New Mexico on April 8, 2009. Friction velocities were high enough for dust from undisturbed soils in many areas of south-central and southwestern Colorado, including the western sections of the arid San Luis Valley upwind of Alamosa. *The high friction velocities and the data on soil moisture conditions presented elsewhere in this report prove that this dust storm was a natural event that was not reasonably controllable or preventable.*

Satellite imagery shows large plumes of southwest to northeast trending blowing dust in the Painted Desert and Little Colorado River Valley region of northeastern Arizona and in northwest New Mexico on April 8, 2009. Backward trajectories, wind streamline analyses, and surface and upper-level wind patterns show that this dust would have been transported into Colorado on April

8, 2009. Northeastern Arizona and the Four Corners area is an area shown in Attachment A to be a significant source region for blowing dust transported into Colorado. *Multiple sources of data and analyses of past dust storms in this area prove that this was a natural event and, more specifically, a significant natural dust storm originating in northeastern Arizona and northwestern New Mexico and spreading into southwestern and south-central Colorado. But for the dust storm on April 8, 2009, this exceedance would not have occurred.*

The Center for Snow and Avalanche Studies (http://www.snowstudies.org/index.html) has been studying the effects of desert dust deposition on snowpack albedo and snowmelt in the San Juan Mountains of Colorado. The center‘s log of events lists April 8, 2009, as one of twelve Dust-on-Snow events for the 2008/2009 water year. Web cam photos from Alamosa and the Shamrock site in southwestern Colorado support the conclusion that widespread blowing dust was present on April 8, 2009. NOAA‘s Satellite Service Division also describes blowing dust stretching from Arizona into southwest Colorado on. *Multiple reports substantiate the conclusion that this was a natural event. But for the dust storm on April 8, 2009, this exceedance would not have occurred.*

8.0 Reference

Colorado Department of Public Health and Environment, City of Lamar, Prowers County Commissioners, *Natural Events Action Plan for High Wind Events – Lamar, Colorado*, April 1998.

Draxler, R.R. and Rolph, G.D., 2012. HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website (http://ready.arl.noaa.gov/HYSPLIT.php). NOAA Air Resources Laboratory, Silver Spring, MD.

Marticorena, B., G. Bergametti, D. Gillette, and J. Belnap, 1997, Factors controlling threshold friction velocity in semiarid and arid areas of the United States, *Journal of Geophysical Research 102 D19*, 23,277-23, 287.

Technical Services Program, Air Pollution Control Division, Colorado Department of Public Health and Environment, November 22, 2011,*Technical Support Document for the January 19, 2009 Lamar Exceptional Event.*

United States Environmental Protection Agency, May 2, 2011, 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.

Attachment A
Grand Junction, Colorado, Blowing Dust Climatology

January 24, 2012

Technical Services Program
Air Pollution Control Division
Colorado Department of Public Health & Environment

A case can be made for the significant transport of regional blowing dust into Grand Junction from source regions in Utah and Arizona. While there are sources for wind-blown dust within the Grand Valley and Grand Junction itself, there is evidence from the analysis of soil features, wind and precipitation climatology, and statistical analyses of Grand Junction exceedances of the PM10 standard that regional sources often play a significant role during these blowing dust events. This document provides a weight of evidence analysis for dust transport into Colorado.

Grand Junction, Colorado, is located in a part of the country that is largely arid to semi-arid. Figure A-1 through A-3 show the annual average precipitation for Colorado, Arizona, and Utah, respectively. Grand Junction is in the Grand Valley of Western Colorado where the annual precipitation is typically less than 10 inches. Northeastern Arizona, which is frequently upwind of Grand Junction during blowing dust events, receives between 5 and 15 inches of precipitation each year. The Colorado River Basin in eastern and southeastern Utah, which is also frequently upwind of Grand Junction during blowing dust events, also receives 5 to 10 inches per year.

Figure A-4 shows the 1971-2000 monthly normal precipitation amounts for Grand Junction, Colorado. The annual average for this time period is 8.99 inches. The wettest months are March through May and August through October. The driest months are January, February, June, July, November, and December. These months receive an average of 0.57 inches per month. The annual monthly average precipitation is 0.75 inches.

Arid to semi-arid soils make much of the region susceptible to blowing dust. The map in Figure A-5 shows that portion of the Colorado Plateau (circled in red) where modern wind erosion features are common and clearly visible in Google Earth images. These features include longitudinal dunes and other sand or soil erosion structures with a predominant southwest to northeast orientation. This orientation is the result of the predominant southwesterly flow that occurs during high wind and blowing dust events in the region. Figures A-6 through A-12 present aerial views of ubiquitous erosion features in northeastern Arizona and southeastern Utah. The Painted Desert of northeastern Arizona is frequently the source for much of the blowing dust in the Four Corners region. Figure A-13 provides a particularly good satellite image of a blowing dust event originating in the Painted Desert and extending northeastward across the junction of the Four Corners (source: NASA Tera satellite, http://earthobservatory.nasa.gov/IOTD/view.php?id=37791). Strong southwesterly winds caused this blowing dust event.

The text that accompanies this image on NASA's Earth Observatory 10th Anniversary page follows below:

> "A dust storm struck northeastern Arizona on April 3, 2009. With winds over 145 kilometers (90 miles) per hour reported near Meteor Crater, east of Flagstaff, the storm reduced visibility and forced the temporary closure of part of Interstate 40, according to *The Arizona Republic.*
>
> The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite captured this image on April 3, 2009. Clear skies allow a view of multiple source points of this dust storm. The source points occur along an arc that runs from northwest to southeast.
>
> This dust storm occurred in the area known as Arizona's Painted Desert, and the dust plumes show why. Whereas many dust plumes are uniform in color, these plumes resemble a band of multicolored ribbons, ranging from pale beige to red-brown, reflecting the varied soils from which the plumes arise. The landscapes of the Painted Desert are comprised mostly of Chinle Formation rocks—remains of sediments laid down during the time of the first dinosaurs, over 200 million years ago."

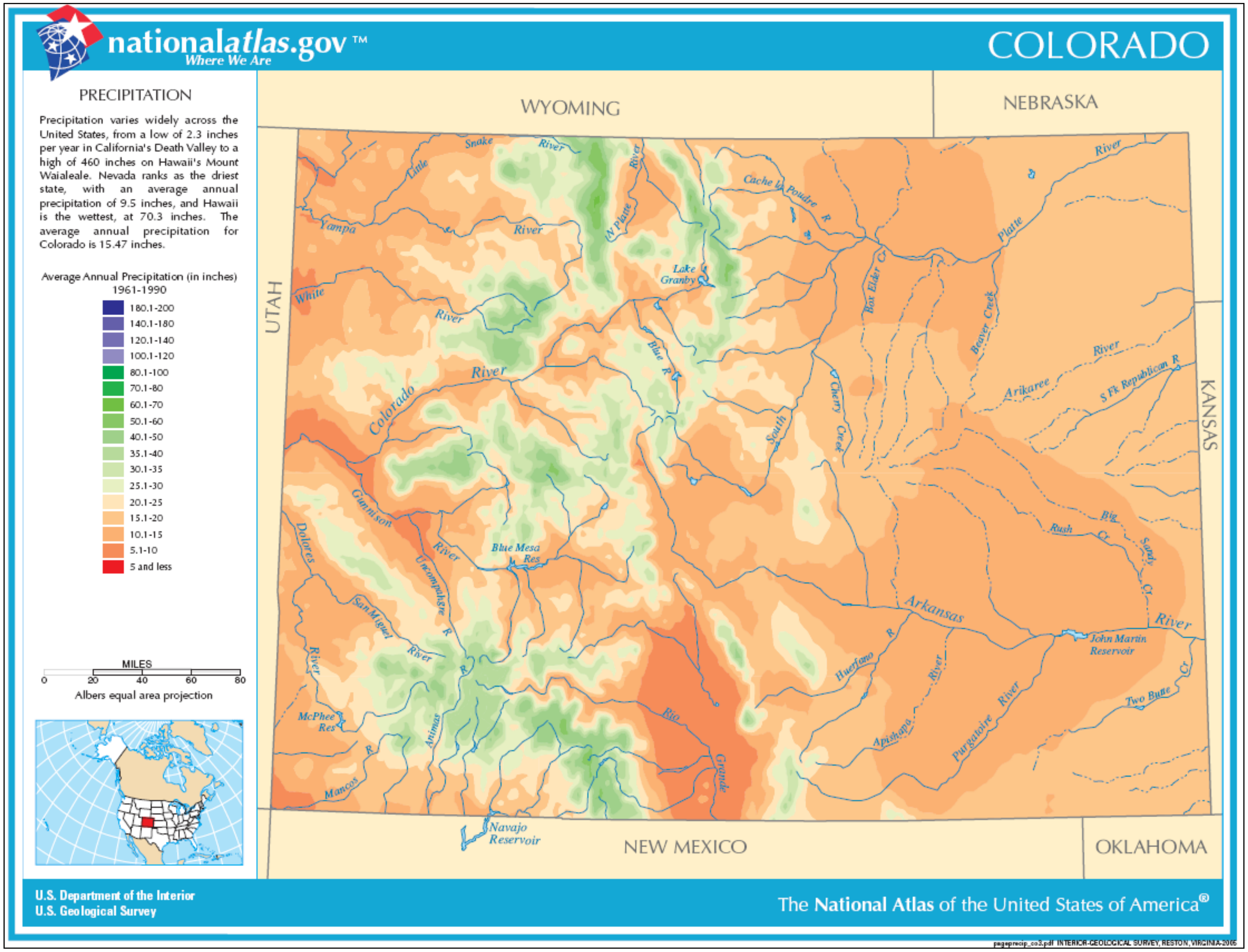


Figure A-1. Average annual precipitation in Colorado based on 1961-1990 normals.

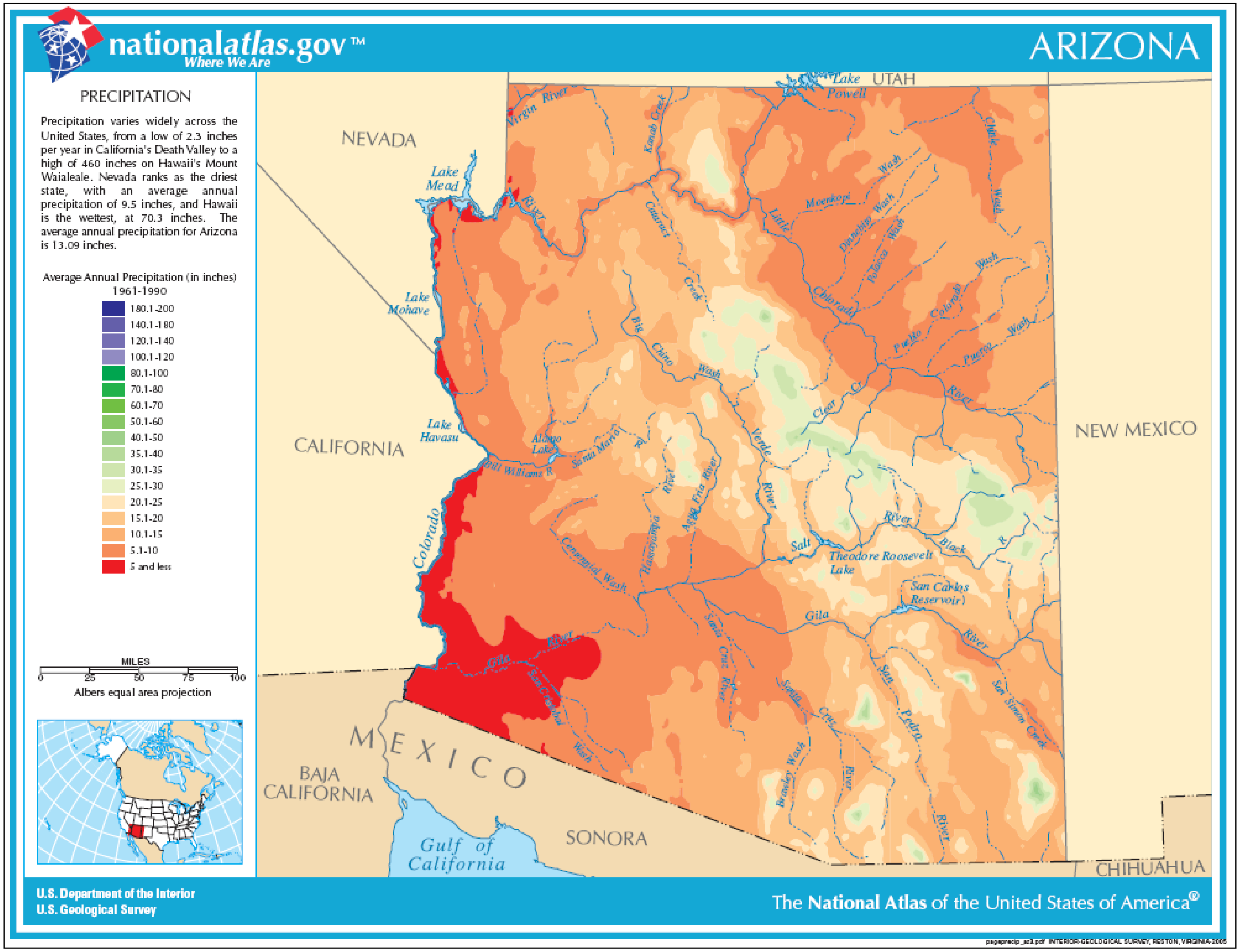


Figure A-2. Average annual precipitation in Arizona based on 1961-1990 normals.

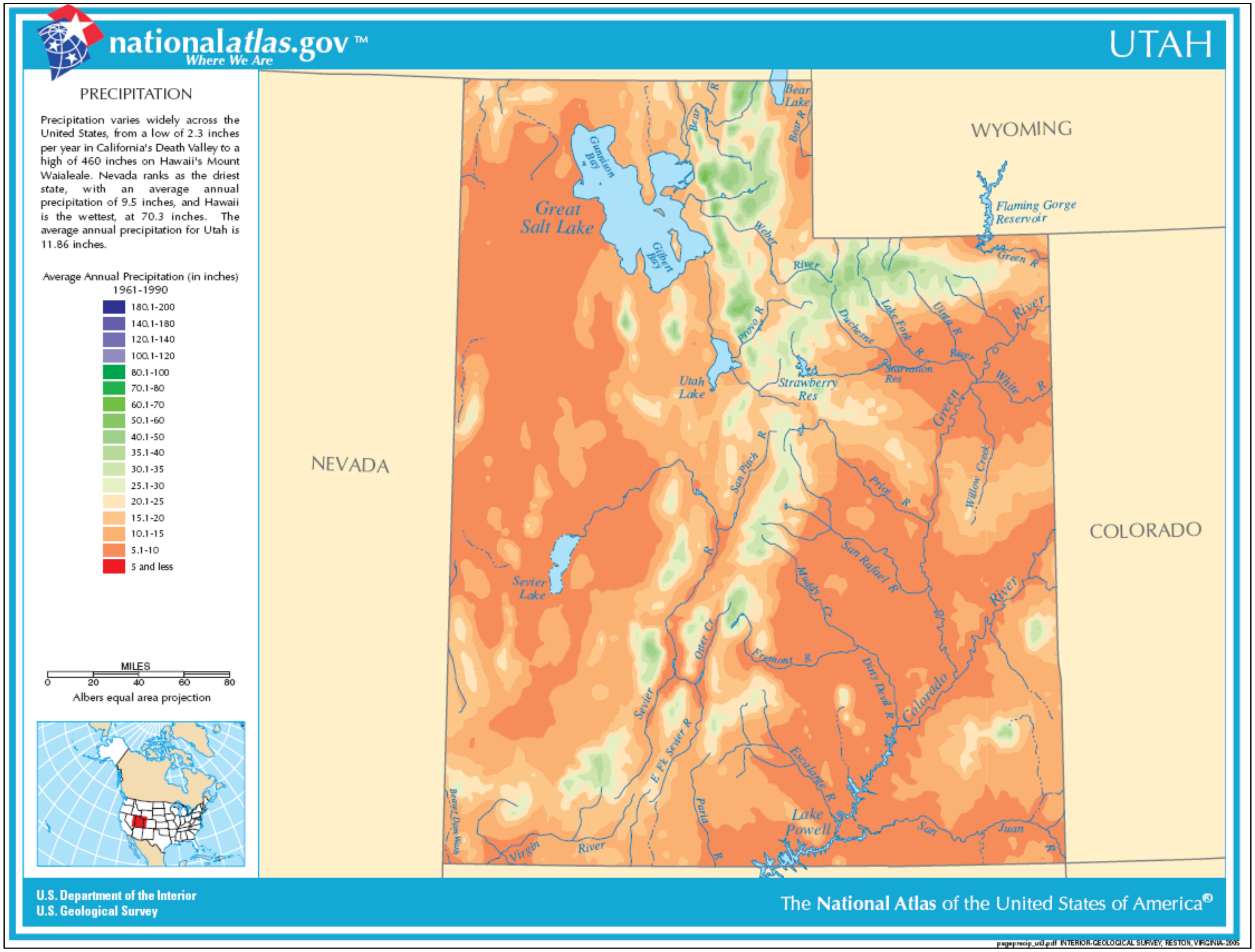


Figure A-3. Average annual precipitation in Utah based on 1961-1990 normals.

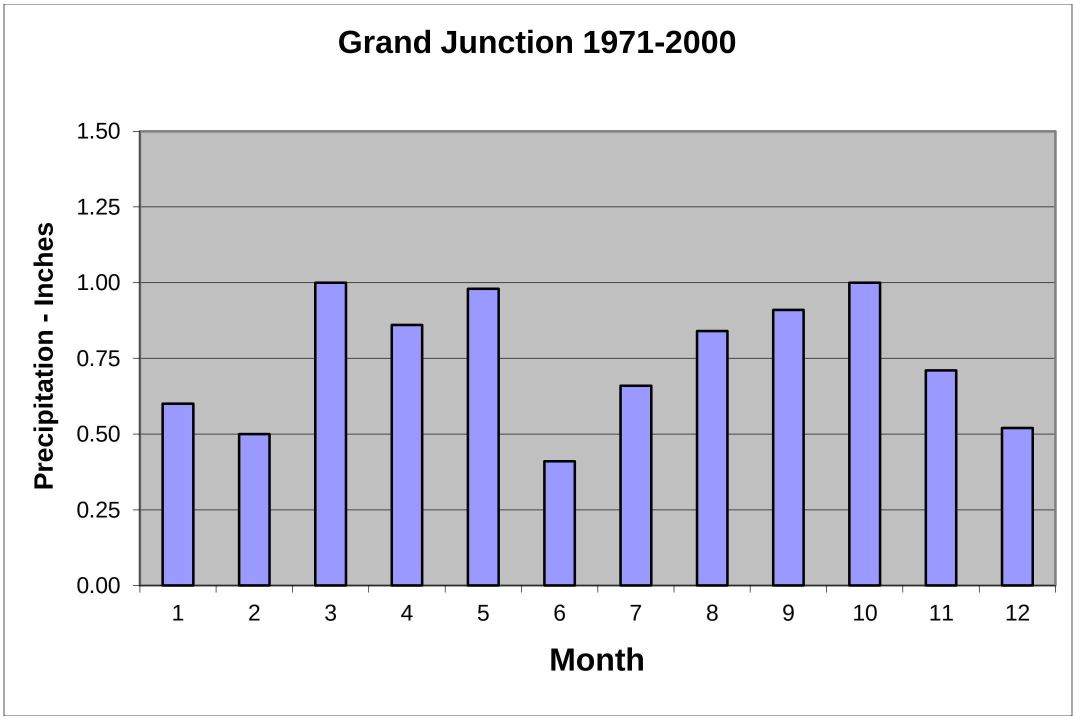


Figure A-4. 1971-2000 monthly normal precipitation in Grand Junction Colorado.

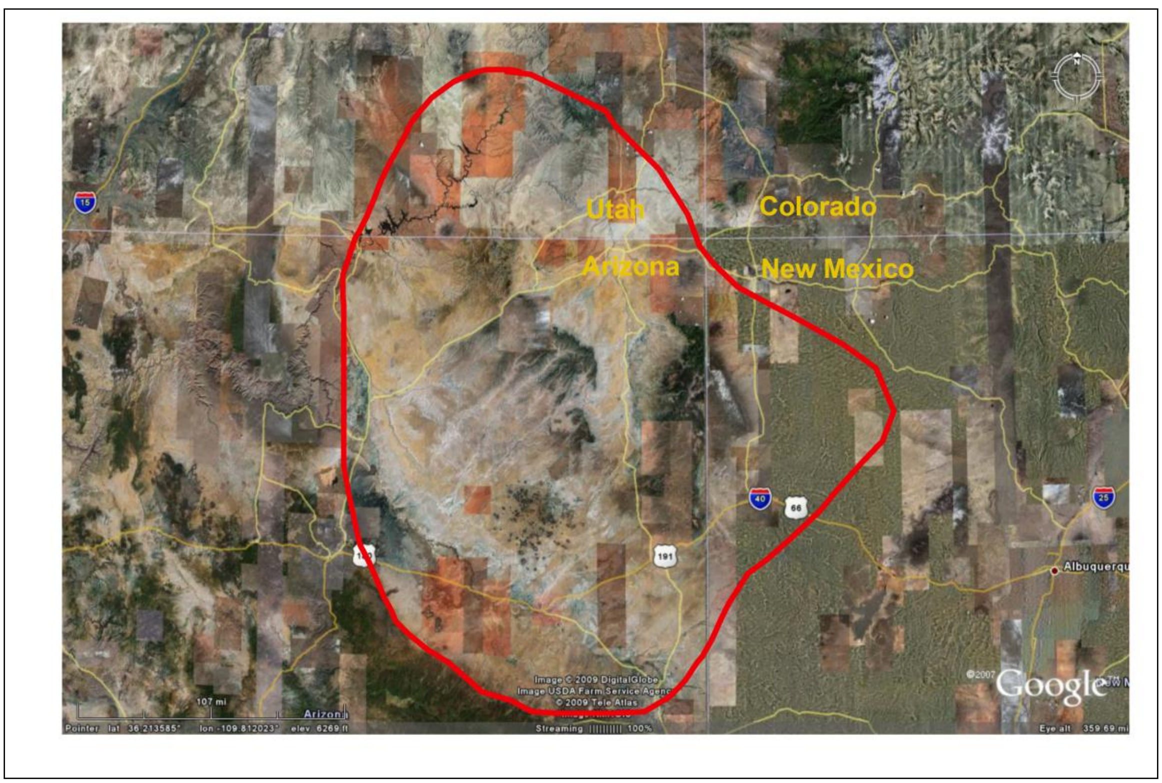


Figure A-5. The portion of the Colorado Plateau in Utah, Arizona, and New Mexico that exhibits widespread surface soil and sand erosion features in Google Earth imagery. Much of the highlighted area within Arizona is within the Painted Desert.

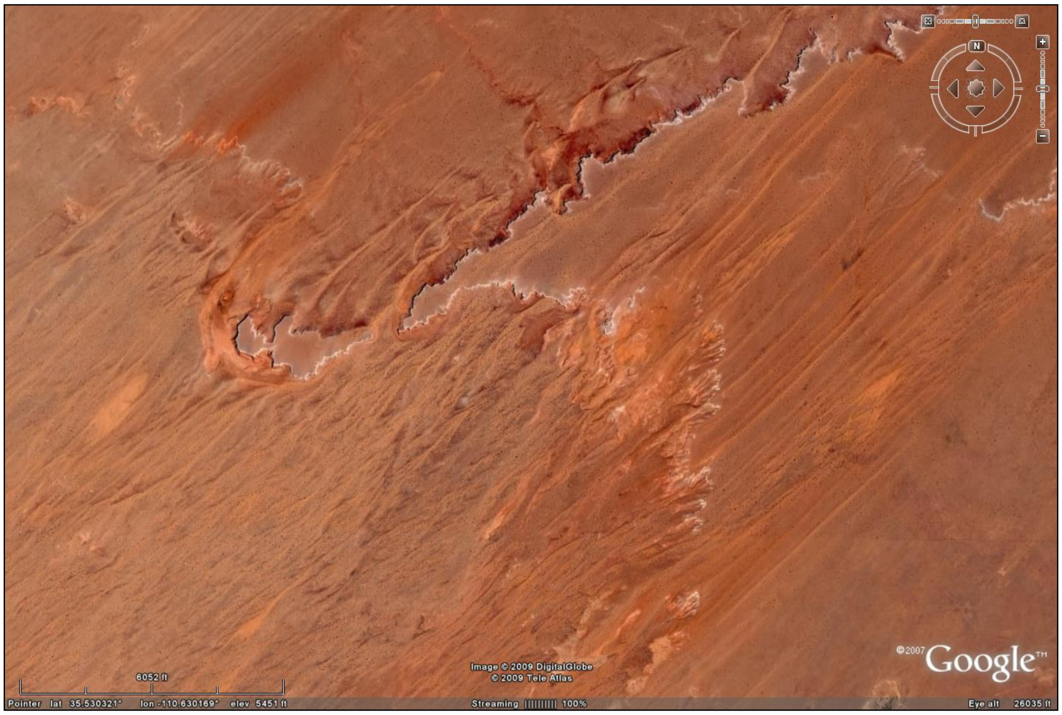


Figure A-6. Southwest to northeast soil and sand erosion structures in southeastern Utah.

Figure A-7. Southwest to northeast soil and sand erosion structures in northeastern Arizona (Painted Desert).

Figure A-8. Southwest to northeast soil and sand erosion structures in southeastern Utah.

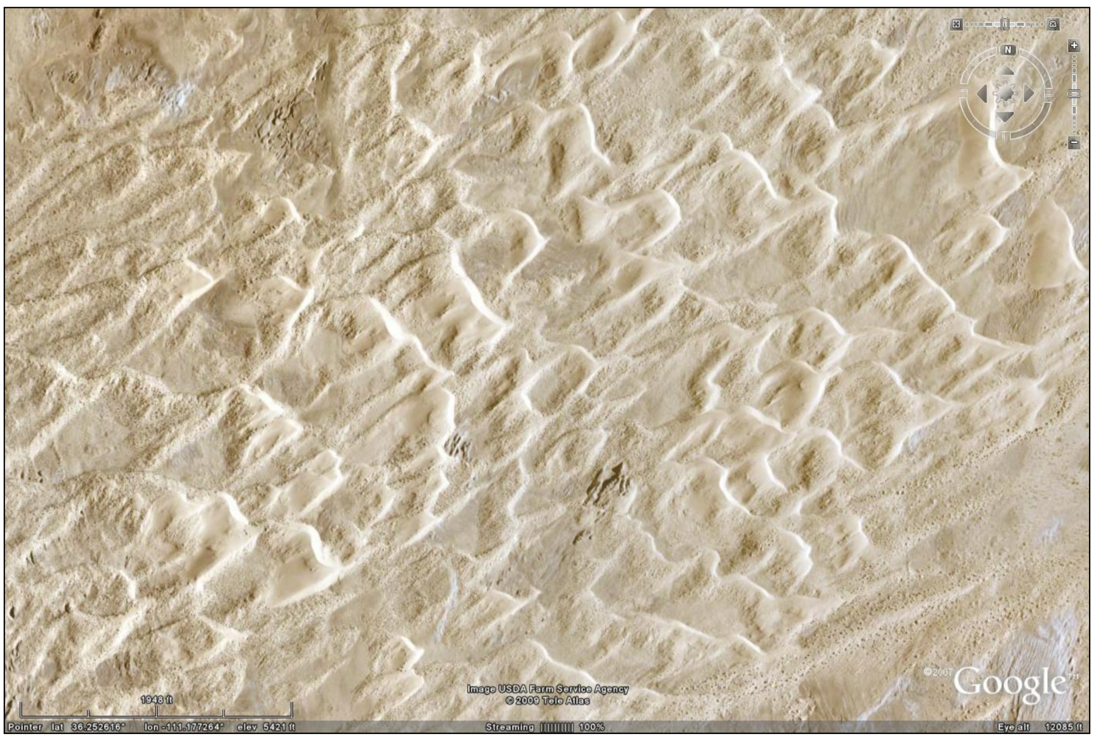


Figure A-9. Southwest to northeast soil and sand erosion structures in northeastern Arizona (Painted Desert). The slip faces of dunes (lighter bands) face in the direction of wind flow – toward the northeast.

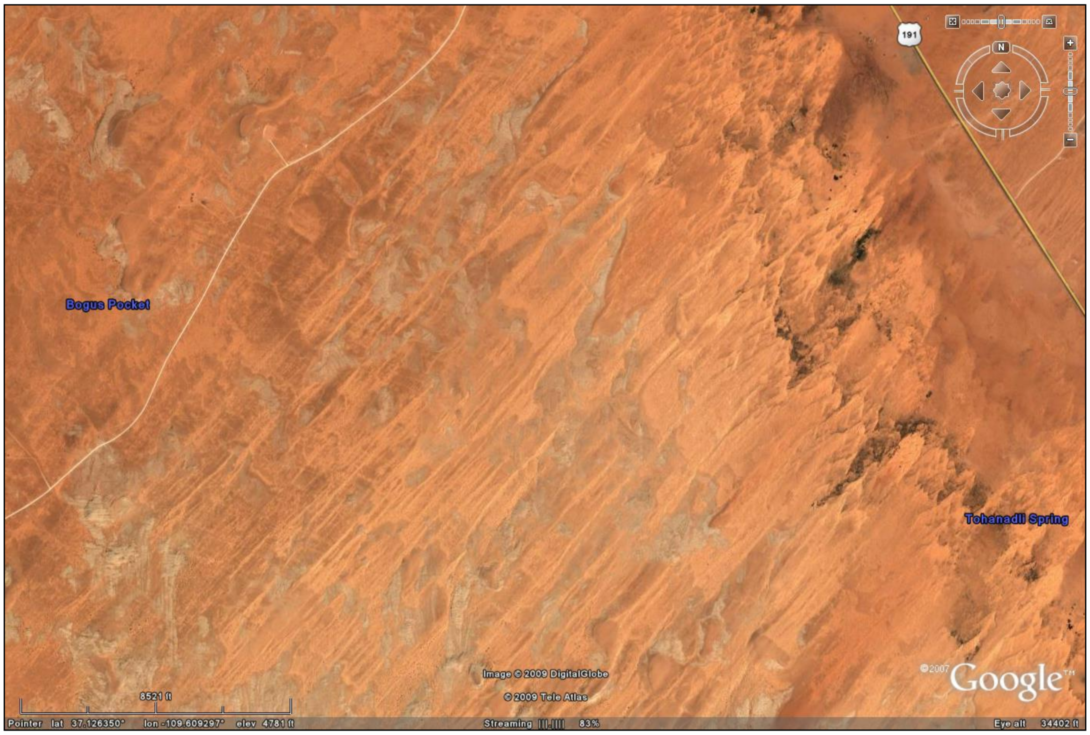


Figure A-10. Southwest to northeast soil and sand erosion structures in southeastern Utah.

Figure A-11. Southwest to northeast soil and sand erosion structures in northeastern Arizona (Painted Desert).

Figure A-12. Southwest to northeast soil and sand erosion structures in northeastern Arizona (Painted Desert).

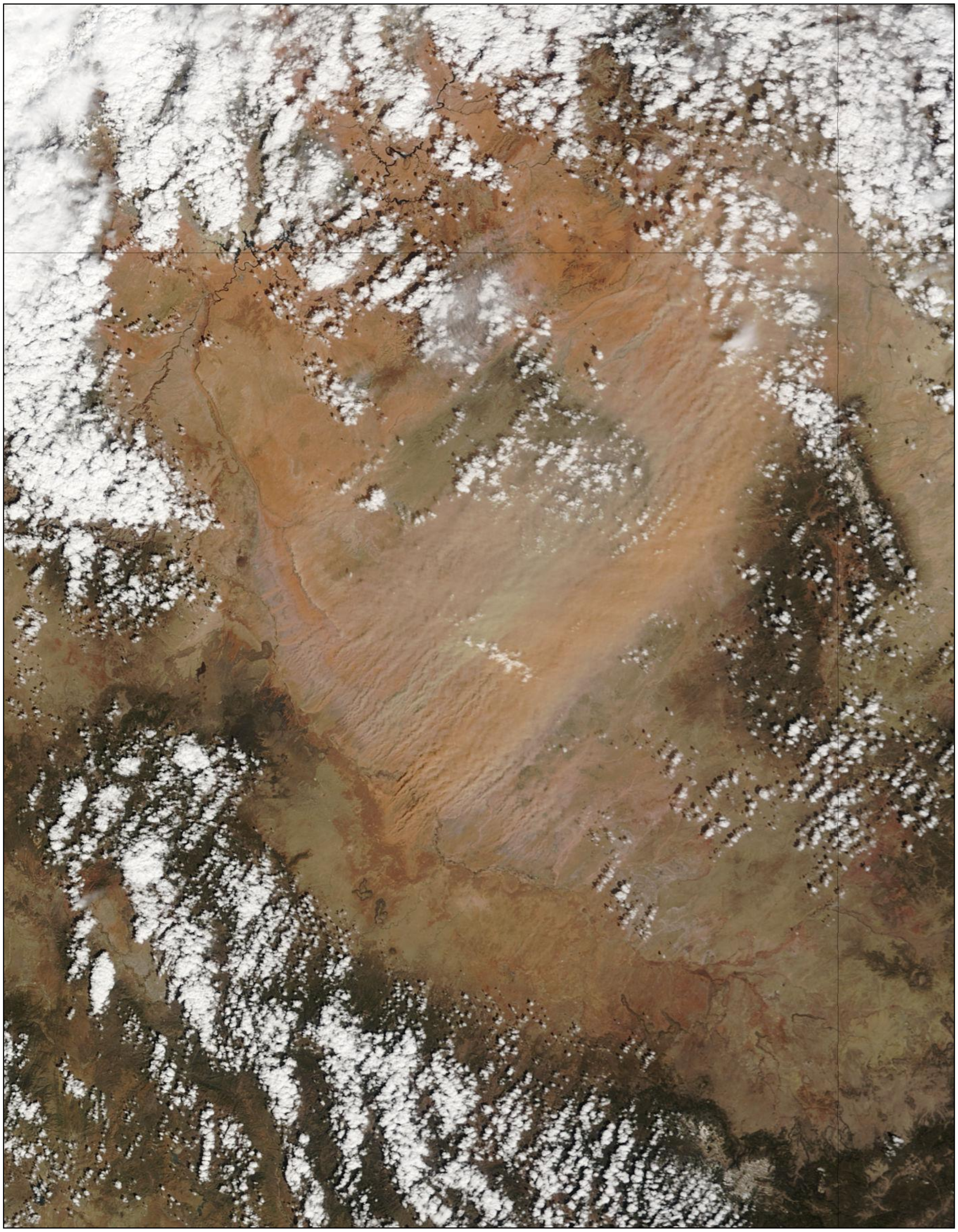


Figure A-13. NASA Tera satellite image of a dust storm on April 3, 2009, in southwesterly flow over the Painted Desert of northeastern Arizona (http://earthobservatory.nasa.gov/IOTD/view.php?id=37791).

Figure A-14 displays the surface weather map for this event (00Z April 4, 2009, or 5 PM MST April 3, 2009). A strong low pressure system in southern Colorado, strong southwesterly winds in the Four Corners area, and the blowing dust symbol (infinity sign) at Farmington (New Mexico) and Cortez (Colorado) are evident in this map. Blowing dust in this region is frequently associated with southwesterly flow.

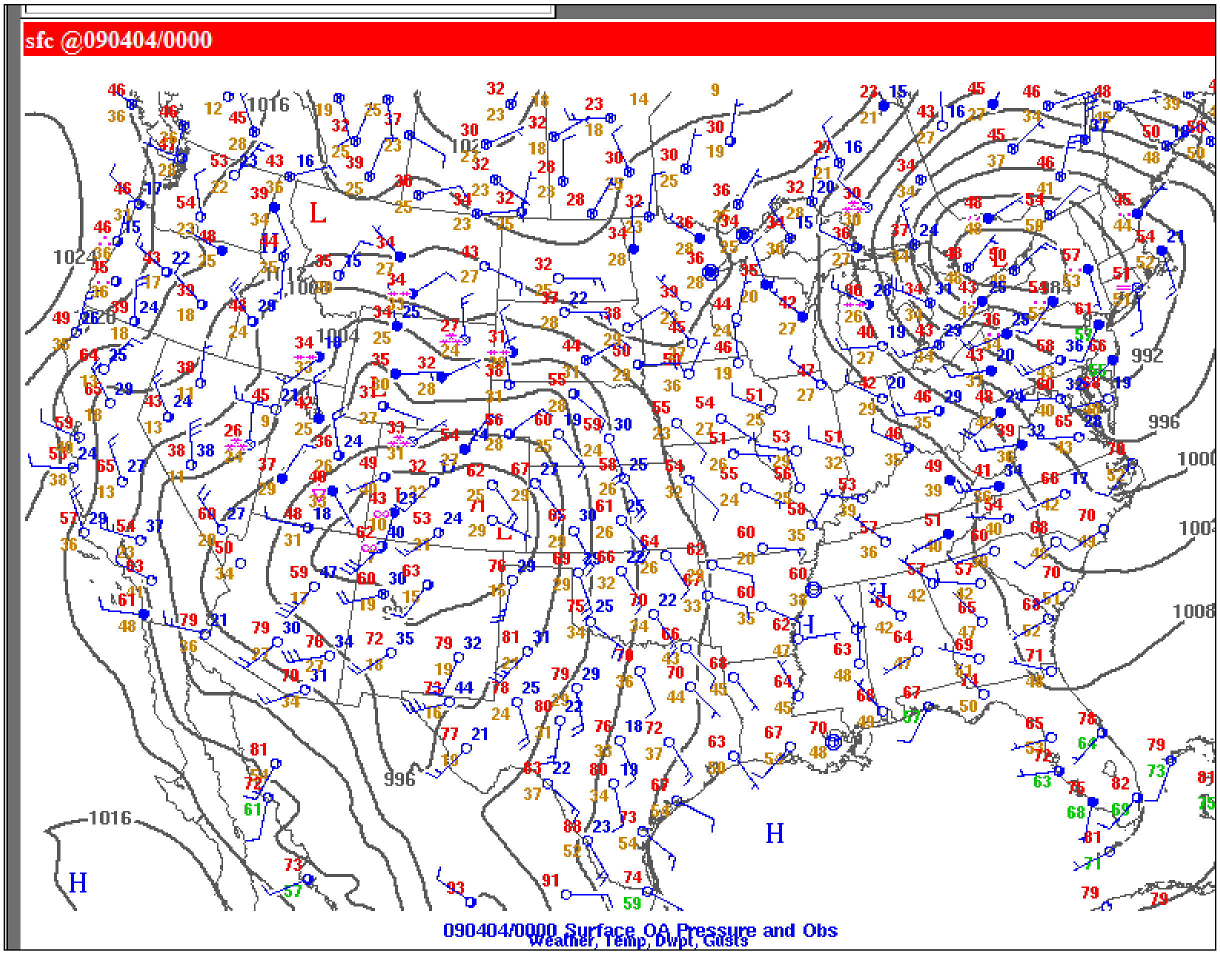


Figure A-14. Surface weather map for 00Z April 4, 2009, (5 PM MST April 3, 2009), showing a strong low pressure system in southern Colorado, strong southwesterly winds in the Four Corners area and the blowing dust symbol (infinity sign) at Farmington (New Mexico) and Cortez (Colorado).

A USGS map of the Colorado Plateau in Figure A-15 shows the prevalence of eolian or wind-blown sand deposits in southeastern Utah and northeastern Arizona. An analysis of the annual frequency of dust storms (Orgill and Sehmel, 1976) in the western half of the U.S. suggests that portions of eastern and western Utah and northeastern Arizona are source regions for blowing dust (see Figure A-16). Soil and sand structures point to the prevalence of southwesterly flow during blowing dust events, and precipitation climatology highlights the potential for blowing dust across much of the region. In addition, an analysis of back trajectories associated with high PM10 concentration events in Grand Junction discussed in the next section of this document supports the conclusion that soils in Arizona and

Utah are likely significant contributors to PM10 measured during many dust storms affecting Grand Junction.

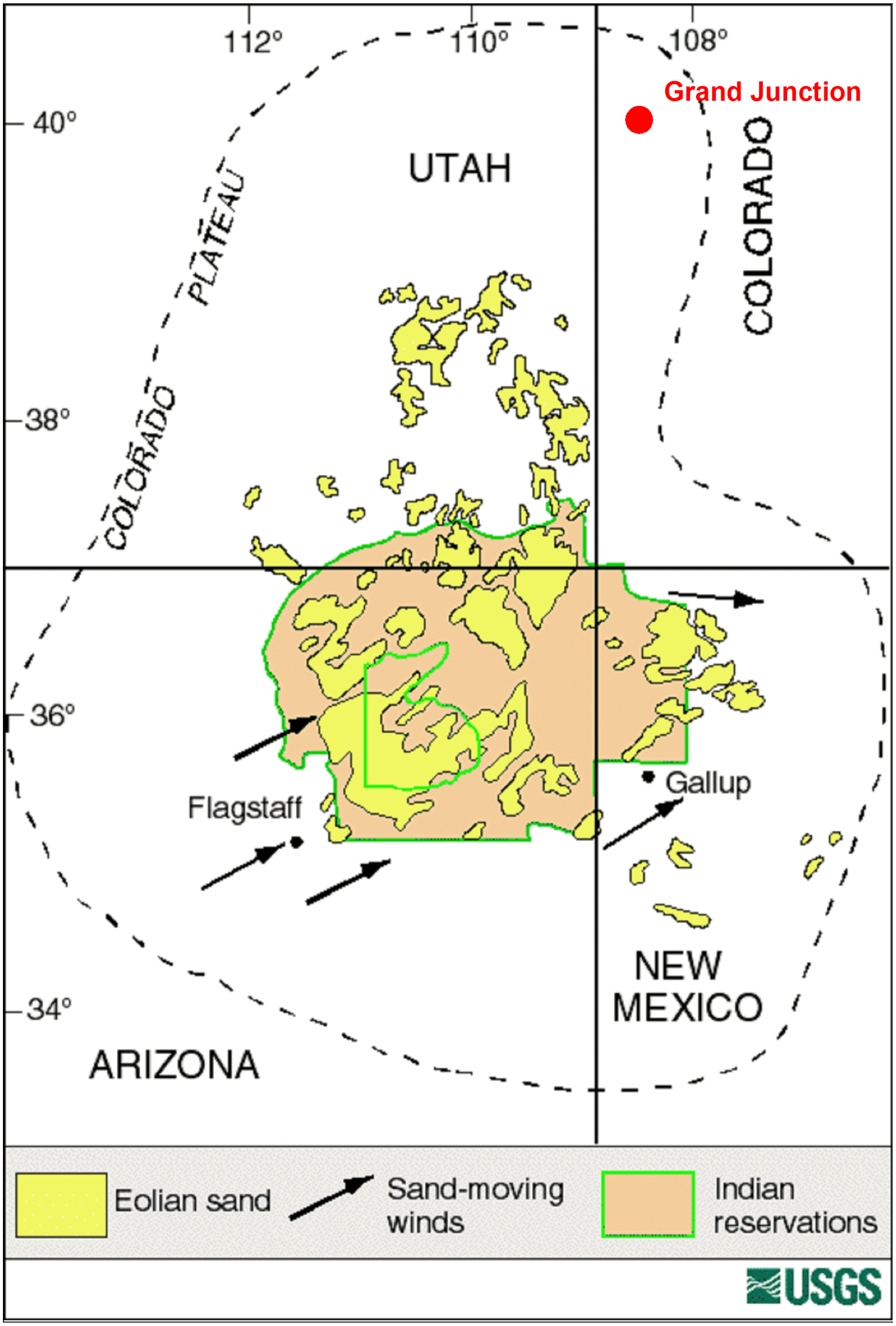


Figure A-15. USGS map of eolian sand features on the Colorado Plateau (http://geochange.er.usgs.gov/sw/impacts/geology/sand/).

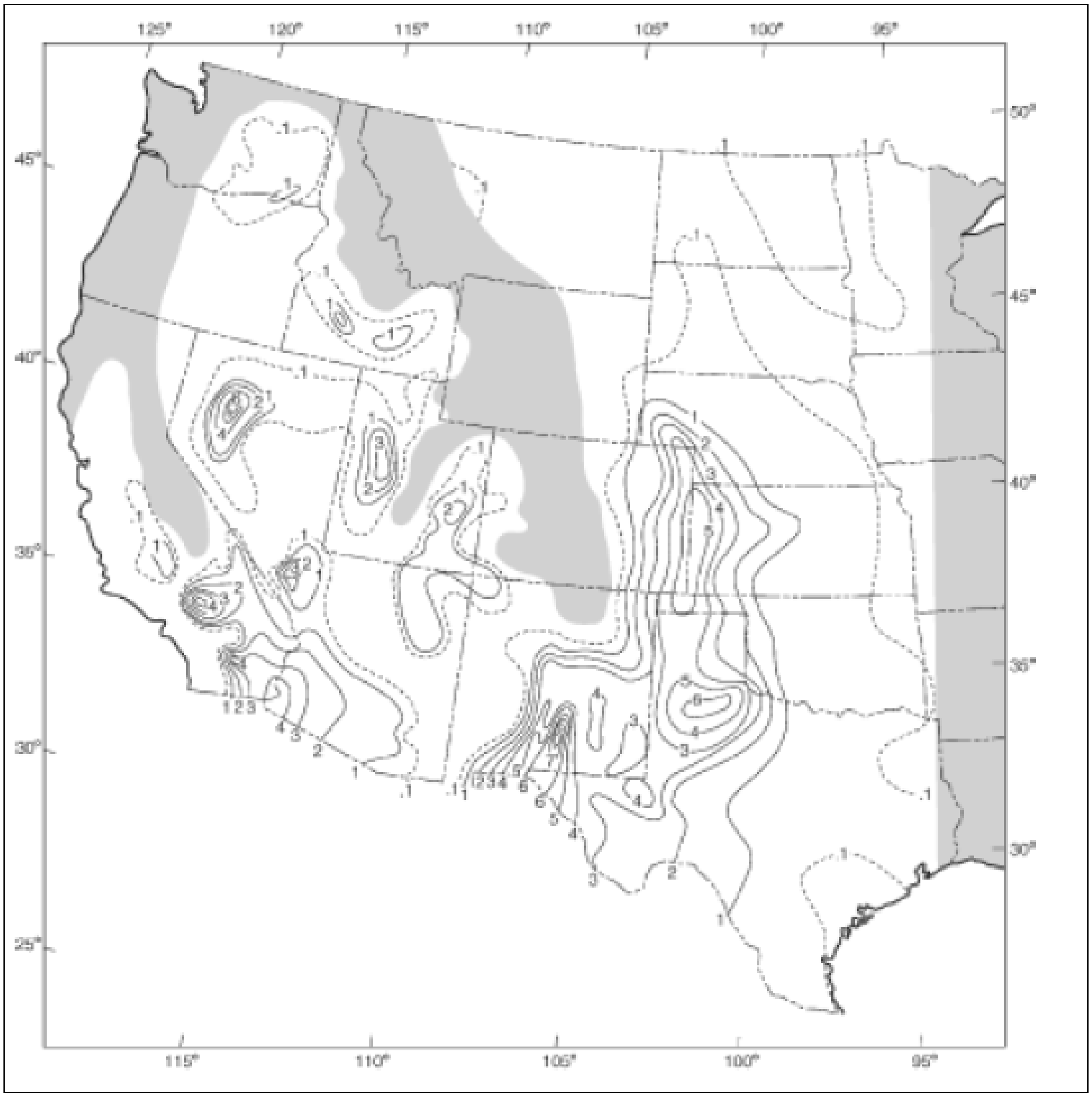


Figure A-16. Number of dust storms per year from: Orgill, M.M., Sehmel, G.A., 1976. Frequency and diurnal variation of dust storms in the contiguous USA. **Atmospheric Environment 10**, 813−825.

NOAA HYSPLIT 36-hour back trajectories were calculated for Grand Junction for the eight 24-hour periods from 2004 through early 2009 with the Powell monitor PM10 concentrations in excess of 75 ug/m3, strong regional winds, and dry soils. Trajectories were modeled every 4 hours for each day. Data presented later in this document provides evidence that the moderate to high PM10 levels on these days were from blowing dust. The 6 back trajectories for each day were calculated for an arrival height of 500 meters using EDAS40 data and model vertical velocities (see: http://www.arl.noaa.gov/HYSPLIT.php). The eight days used in the analysis and the Powell monitor concentrations measured on these days are presented in Table A-1.

The back trajectories for these high-concentration days are shown in Figure A-17. Transport was generally from the west through southwest. A high density of trajectory points is found in northeast Arizona and southeast Utah. Most of these trajectories in Figure A-17 are also consistent with transport from or across suspected or known blowing dust source regions highlighted in Figures A-5, A-13, A-15, and A-16.

Table A-1. Grand Junction Powell monitor days with concentrations in excess of 75 ug/m3 and blowing dust conditions (from 2004 through early 2009).

Year	Month	Day	Powell 24-hour PM10 concentration in ug/m3
2005	4	19	197.8
2008	4	15	116.1
2008	4	21	103.6
2004	9	3	102
2006	3	3	98.3
2008	5	21	86.7
2008	4	30	83.5
2006	6	7	77.9

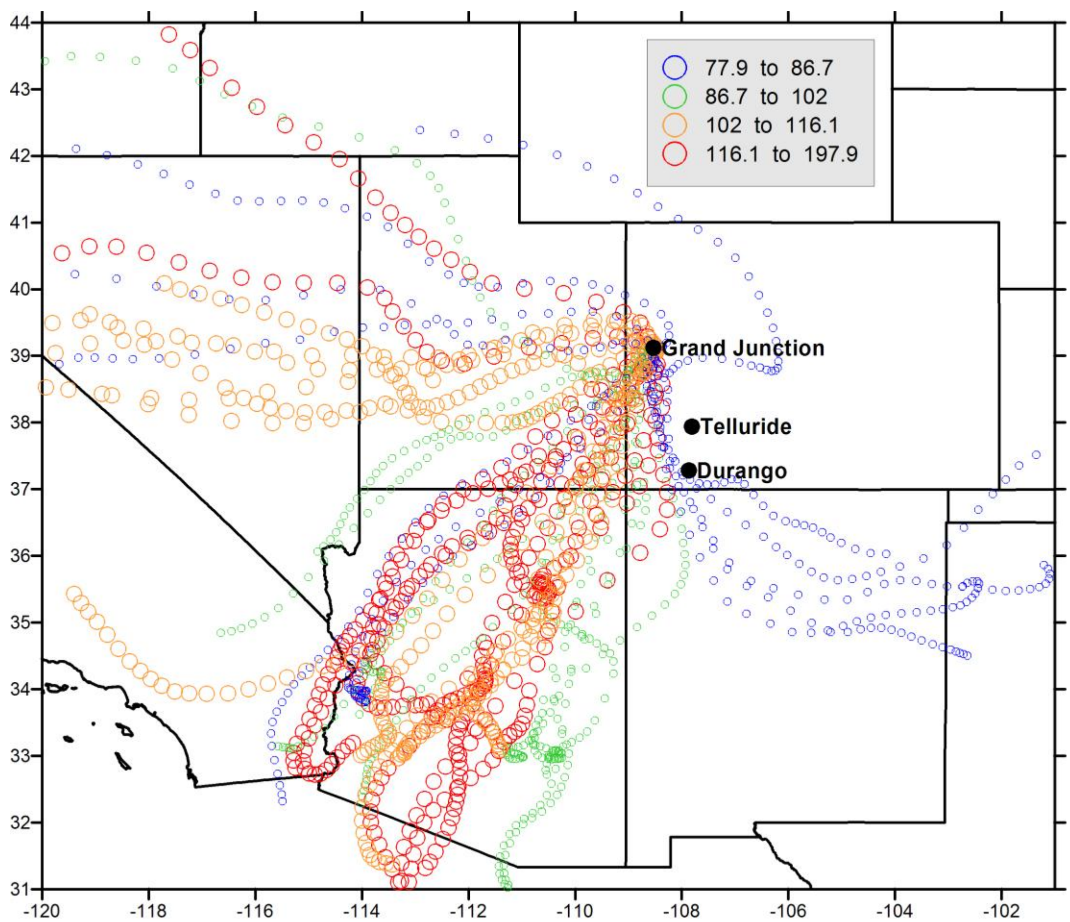


Figure A-17. NOAA HYSPLIT 36-hour back trajectories for Grand Junction for those eight 24-hour periods from 2004 through early 2009 with the Powell monitor PM10 concentrations in excess of 75 ug/m3, strong regional winds, and dry soils. Trajectory points are sized and color-coded to reflect 24-hour PM10 concentrations in ug/m3. Trajectories were calculated every 4 hours for each day.

The trajectories in Figure A-17 point to the possibility that, at times, dust from Utah and Arizona can have a major impact on Grand Junction and less of an impact elsewhere in western Colorado. This non-homogeneity is possible given the fact that dust storms are frequently organized into discreet plumes from discreet areas that maintain their integrity for long distances. An example of this can be seen in Figure A-18 that shows plumes of dust in New Mexico during a windstorm on May 20, 2008.

Figure A-19 shows the NOAA HYSPLIT back trajectories for the highest concentration day during the 2004 through early 2009 period: April 19, 2005. Twenty-four hour back trajectories for each hour during the period with high winds (using EDAS40 data and 500-meter arrival heights) show that the back trajectories for Grand Junction were more likely to have crossed the Painted Desert and southeastern Utah than those for Telluride and Durango, which measured lower PM10 concentrations on this day.

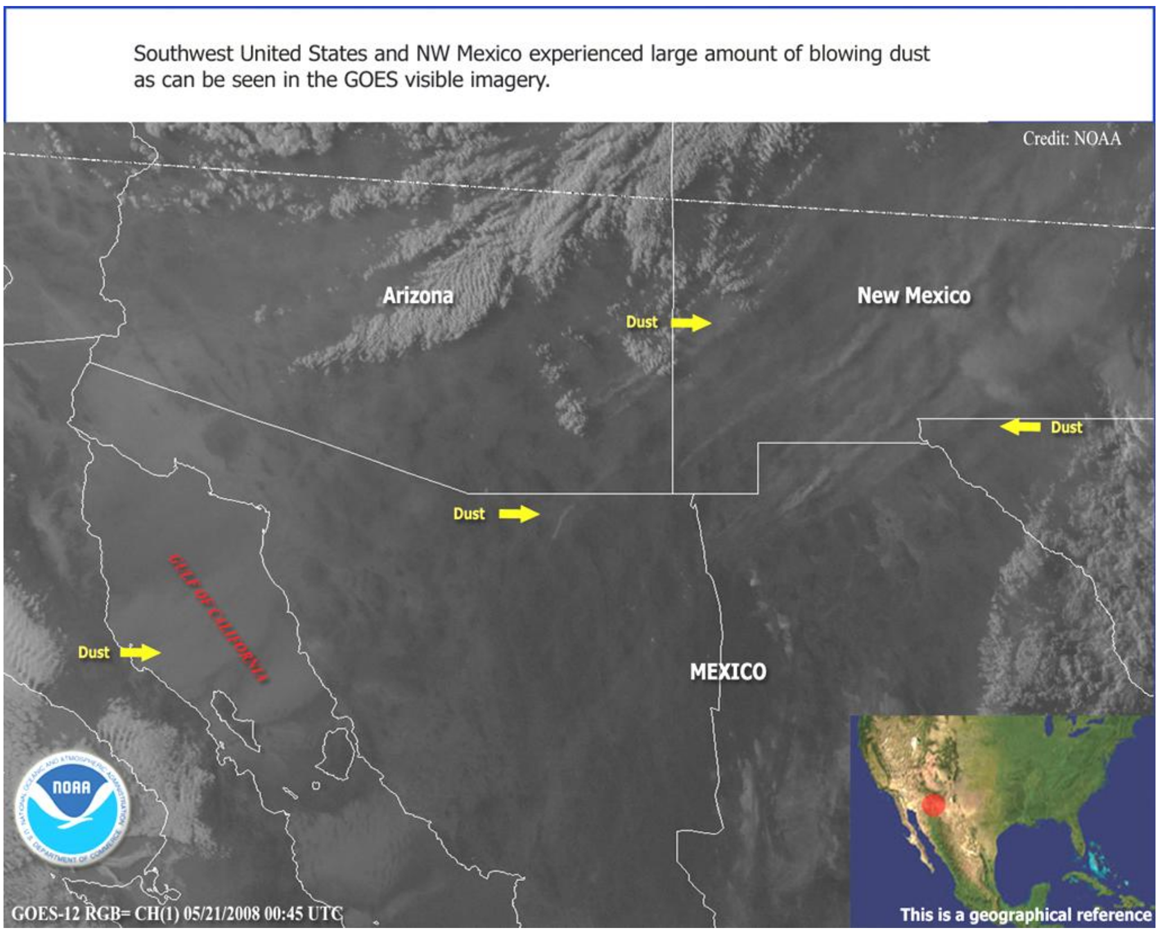


Figure A-18. Discreet plumes of blowing dust in New Mexico, Mexico, and Arizona visible in GOES satellite imagery for May 20, 2008 (http://www.osei.noaa.gov/Events/Dust/US_Southwest/2008/DSTusmx142_G12.jpg).

K-means cluster analysis has been applied to Grand Junction Powell PM10 concentrations, Grand Junction and Painted Desert 30-day total precipitation for each PM10 monitoring day, and Grand Junction and Painted Desert daily maximum wind gust speeds for each monitoring day. K-means cluster analysis is a statistical method for identifying clusters or groupings of values for many variables. For environmental variables, these clusters often represent distinct processes, conditions, or events. In this case, cluster analysis differentiates PM10 concentrations associated with strong winds, low soil moistures, and blowing dust by providing mean values for these 5 variables for 5 distinct categories of PM10 events. The period of record considered was from January 2004 through March 2009. The Hopi weather station located in the central portion of the Painted Desert was used to represent Painted Desert conditions in northeastern Arizona, and the Grand Junction National Weather Service station was used to represent Grand Junction conditions. The 30-day total precipitation values appear to be a better metric for blowing dust conditions than shorter-term totals.

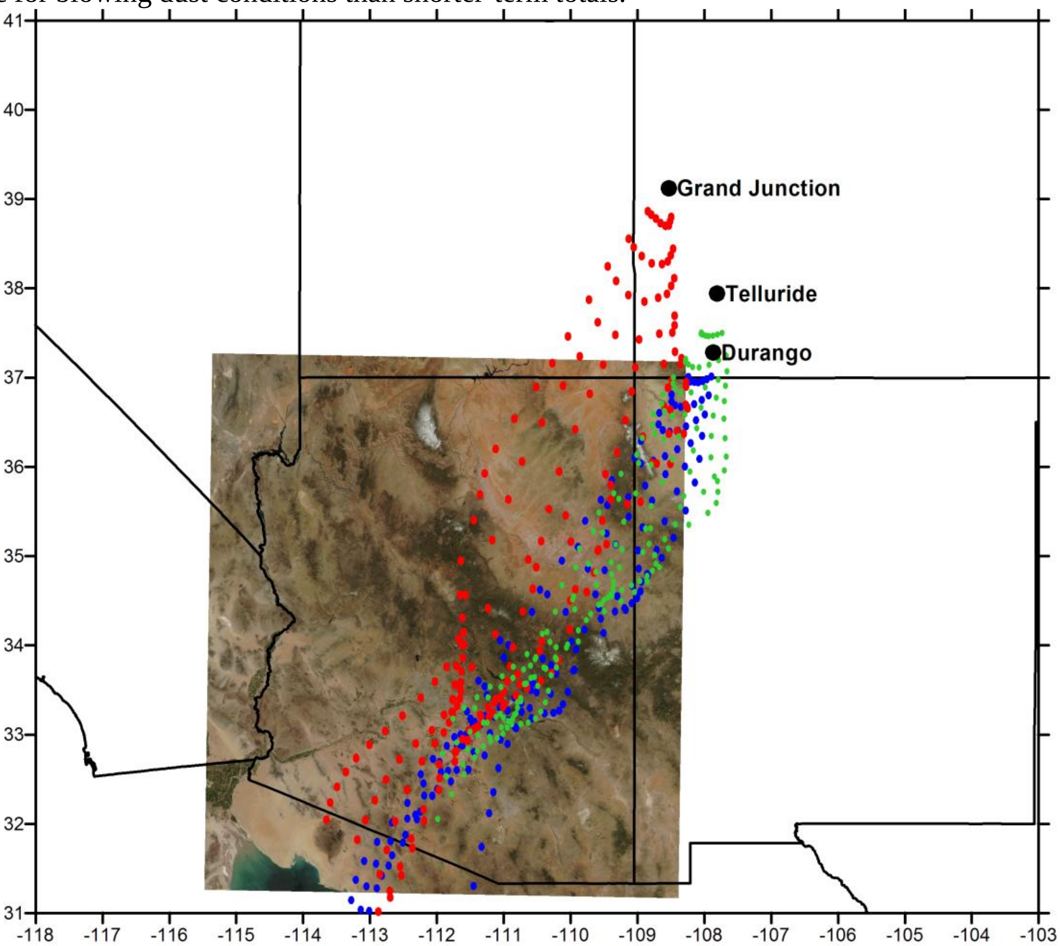


Figure A-19. 24-hour NOAA HYSPLIT back trajectories for every hour from 1500 MST to 2200 MST for Grand Junction (red), Telluride (green), and Durango (blue) for the dust storm of April 19, 2005.

The results of the cluster analysis are presented in Table A-2 below. Cluster 1 represents high soil moisture conditions, moderate gust speeds, and low PM10 concentrations. Cluster 2 represents very low soil moisture, moderate PM10, and low gust speeds. Cluster 3 represents low soil moisture, moderate gusts, and low PM10. Cluster 4 represents moderate soil moisture, low gusts, and low PM10. Finally, Cluster 5 represents high PM10, high gusts, and low soil moisture. Cluster numbers, Grand Junction Powell PM10 concentrations, and Grand Junction daily maximum gust speeds are plotted in Figure A-20.

The data in Figure A-20 clearly show that the highest PM10 concentrations tend to occur in Cluster 5 with gusts above 40 mph. The only exceedance in this period occurred on a day with a peak gust of 43 mph. Cluster 2 is likely to be indicative of wintertime inversion conditions with lighter winds and moderately elevated PM10. Figure A-21 shows the concentrations and cluster values associated with Hopi station daily maximum gust speeds. The overall pattern is similar. The highest concentration day is associated with a peak gust of 47 mph at Hopi. All of the days/events presented in Figure A-17, A-19, and Table A-1 were classified as Cluster 5.

Table A-2. K-means cluster analysis means for Grand Junction PM10 and meteorological variables.

Cluster Variables	Cluster 1 Means	Cluster 2 Means	Cluster 3 Means	Cluster 4 Means	Cluster 5 Means
Powell 24-hour PM10 in ug/m3	24.5	37.3	24.3	21.8	74.9
Hopi Wind Gust in mph	20.8	18.0	32.5	20.7	40.5
Grand Junction Wind Gust in mph	20.4	16.5	31.8	19.6	43.1
Grand Junction 30-day Precipitation	1.7	0.4	0.5	0.8	0.6
Hopi 30-day Precipitation	1.8	0.2	0.5	0.7	0.3
Count	85	120	170	147	24

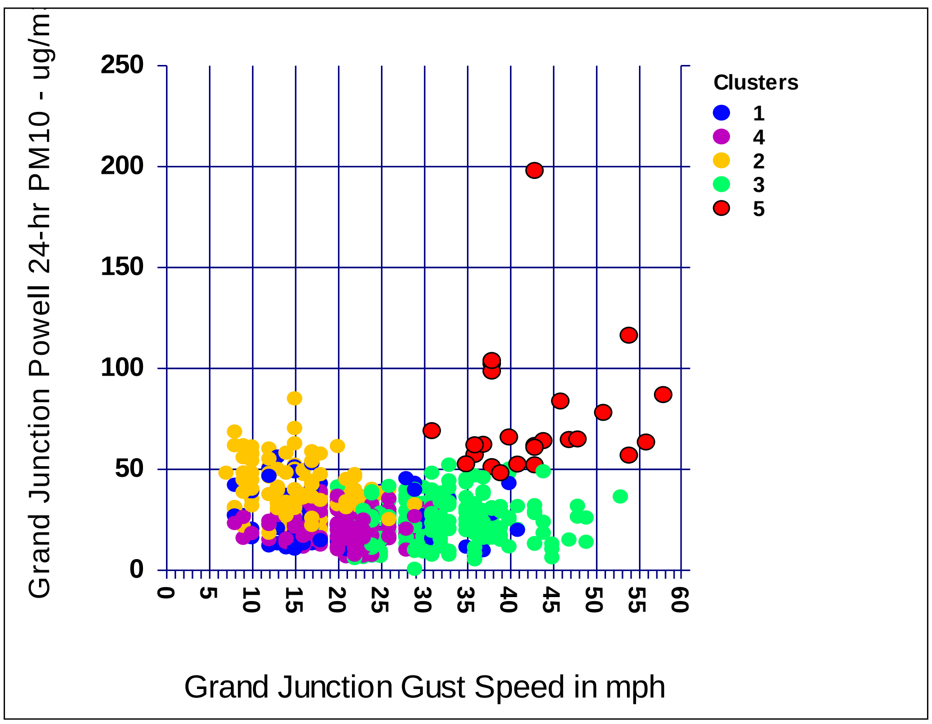


Figure A-20. Grand Junction Powell 24-hour PM10 concentrations versus Grand Junction gust speed by cluster.

Figures A-22 and A-23 show Powell PM10 concentrations versus Grand Junction and Hopi 30-day precipitation totals, respectively, by cluster. The blowing dust group, Cluster 5, is generally associated with 30-day precipitation totals of less than 1.00 inches at Grand Junction and less than 0.50 inches at Hopi. While this is not proof that the measured dust in Grand Junction is from Arizona, it adds to the weight of evidence that the Painted Desert makes a significant contribution to PM10 concentrations in Grand Junction during many blowing dust events. Of interest in this regard are the two high concentrations (greater than 100 ug/m3) that occurred when Grand Junction 30-day precipitation totals were greater than an inch (see Figure A-22). One of these occurred when transport was from the southwest. On this day (April 21, 2008) the NOAA Satellite Smoke Text Archive reported the following (see http://www.ssd.noaa.gov/PS/FIRE/smoke.html):

"Blowing dust is seen over most of Utah (and part of western Nevada) and the dust is moving toward the northeast, reaching into northwestern Colorado and southern Wyoming."

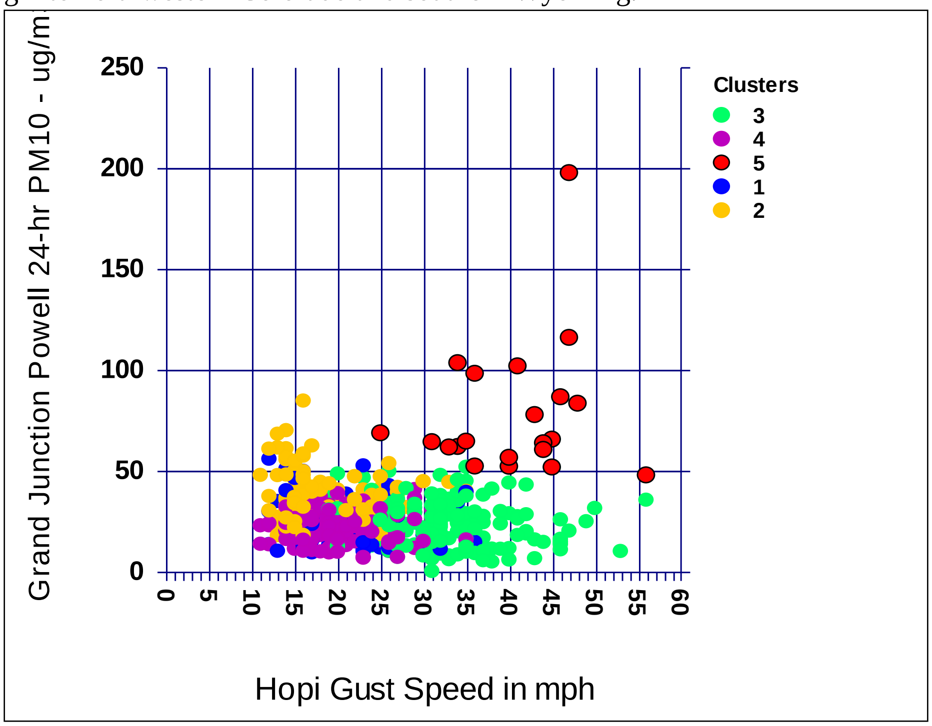


Figure A-21. Grand Junction Powell 24-hour PM10 concentrations versus Hopi gust speed by cluster.

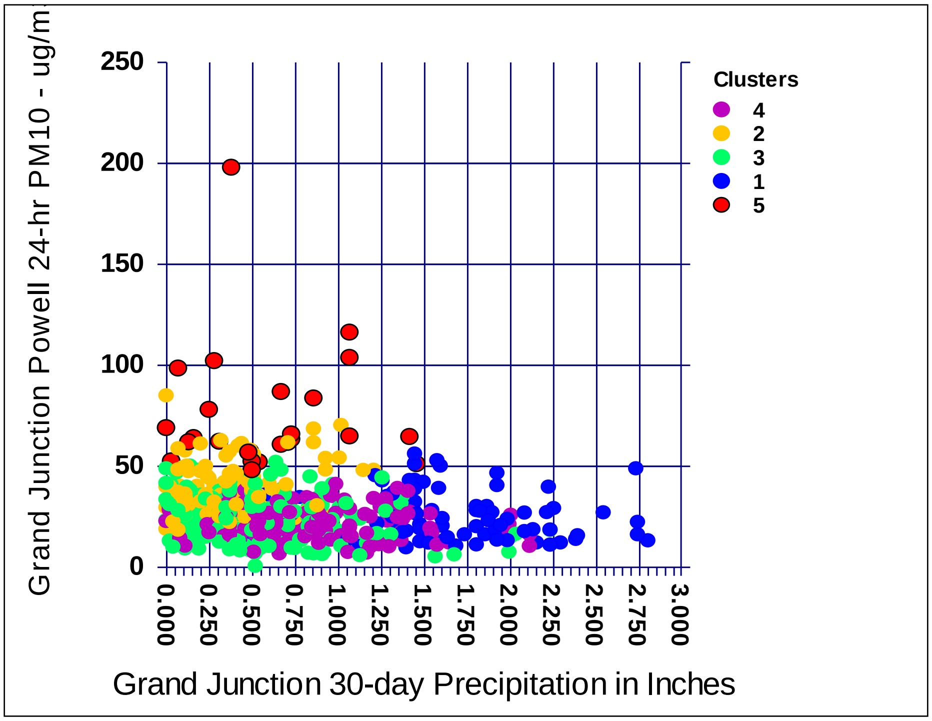


Figure A-22. Grand Junction Powell 24-hour PM10 concentrations versus Grand Junction 30-day total precipitation by cluster.

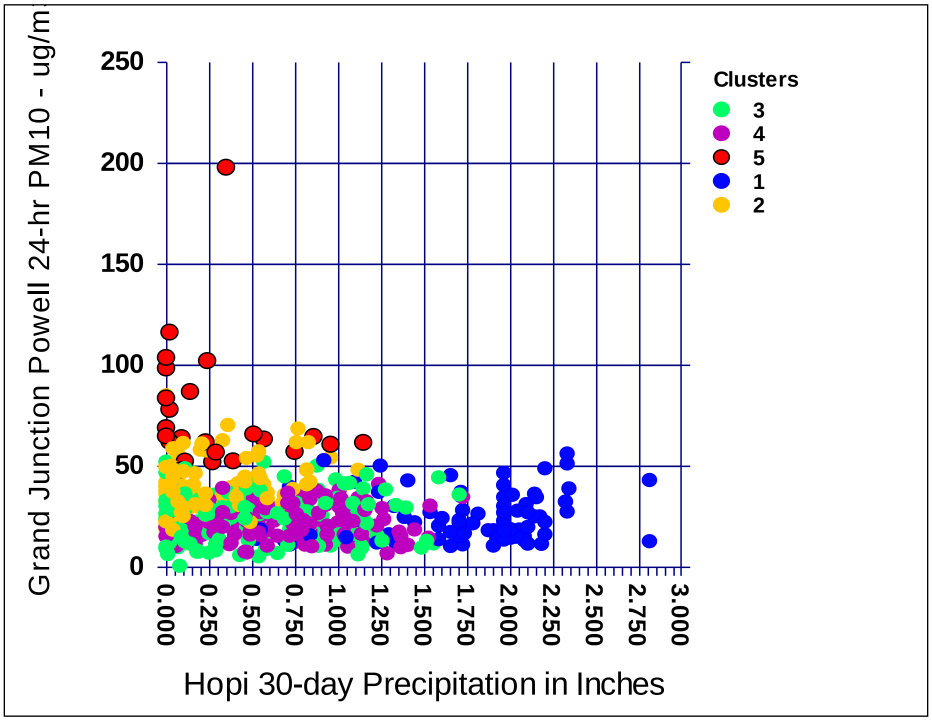


Figure A-23. Grand Junction Powell 24-hour PM10 concentrations versus Hopi 30-day total precipitation by cluster.

The other occurred on April 15, 2008, when the flow was from Arizona and southeast Utah. The transport conditions, the discrepancy between high recent precipitation in Grand Junction and low recent precipitation at Hopi for these two days, and, in one case, analyst discussion of what was visible in satellite images suggest that much of the dust might have originated from outside of the Grand Junction environment.

Figure A-24 shows Grand Junction Powell 24-hour PM10 concentrations versus peak gust wind directions at the Little Delores RAWS weather station about 25 miles west-southwest of Grand Junction. Grand Junction is situated on the floor of the Grand Valley, a major northwest to southeast trending basin than can force or channel synoptic scale flows. As a result, surface wind directions in Grand Junction may not be useful indicators of the direction of longer-range transport. Little Delores is on the Umcompahgre Plateau, and winds here are more likely to reflect the larger-scale transport directions for the region. This graph indicates that high PM10 at Grand Junction (Cluster 5) is associated with winds from the south-southeast to west-southwest at Little Delores. These directions point to dust sources in southeast Utah and northeastern Arizona. This is further evidence that dust from these areas may make a significant contribution to PM10 measured in Grand Junction during blowing dust events.

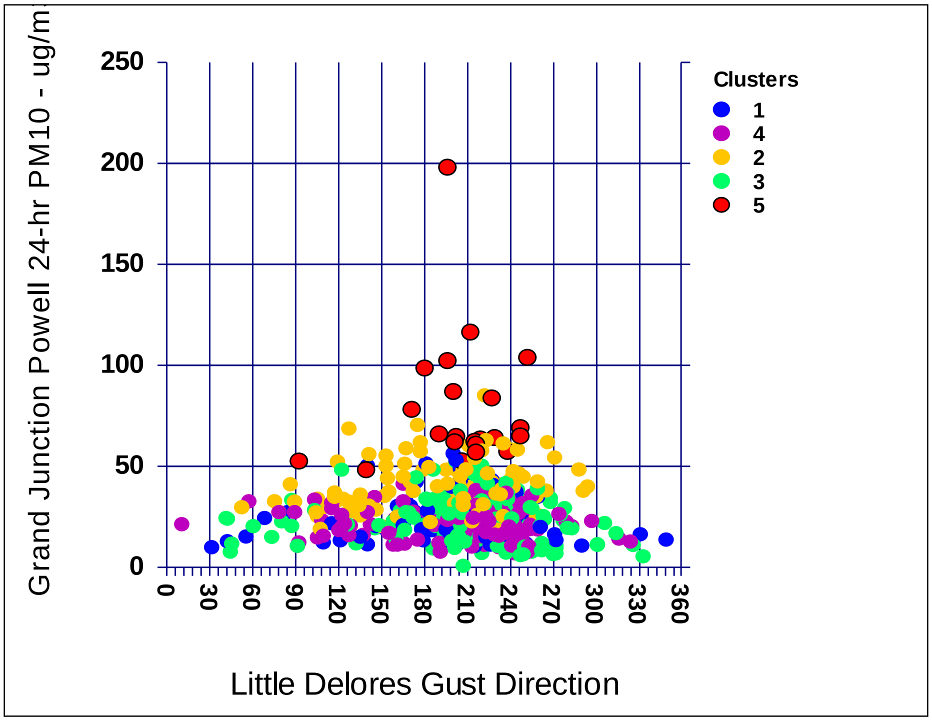


Figure A-24. Grand Junction Powell 24-hour PM10 concentrations versus peak gust wind directions at the Little Delores RAWS weather station, by cluster.

Figure A-25 presents monthly percentiles for Grand Junction gust speeds. Wind gusts generally considered to be high enough for significant blowing dusts (40 mph or higher) are within the upper 5 to 15 percent during each month of the year. Consequently, these events can be viewed as exceptional rather than normal. Gusts in this category can occur any month of the year, but are most likely in March, April, May and October. Figure A-4 shows that in Grand Junction these are typically among the wettest months of the year. It is in drier years, therefore, that blowing dust may be most prevalent during the spring and fall months. January, February, and June are typically very dry, and might be expected to have a significant proportion of blowing dust events.

Figures A-26 and A-27 show histograms for Grand Junction and Hopi wind gusts, respectively. The 95th percentile gust speed for Grand Junction is 43 mph. For Hopi it is 41 mph. For both sites, it is clear that gusts in the range that is associated with blowing dust are the exception rather than the rule. Cluster analysis also shows that the blowing dust events represent only 4% of the PM10 sample days (from Table A-2, Cluster 5 had 24 cases out of a total of 546). The weight of evidence presented in this document clearly suggests that source regions in Arizona and Utah can have a significant impact on PM10 concentrations in Grand Junction during blowing dust events and that these events occur when dry soils are affected by winds of exceptional strength. Control of these sources, which are outside of Colorado, may not be reasonably achievable or possible.

The precipitation climatology for the Four Corners area indicates that the area can be susceptible to blowing dust when winds are high. Landform imagery shows that northeastern Arizona and southeastern Utah in particular have experienced a long-term pattern of wind erosion and blowing dust when winds have been southwesterly and blowing into western and southern Colorado. Back trajectories, case studies, satellite imagery, and statistical analyses have also shown that northeastern Arizona and southeastern Utah are a significant source for blowing dust transported into Colorado. Elevated PM10 in Grand Junction during windstorms is generally associated with wind gusts of 40 mph or higher at Grand Junction and Hopi in northeastern Arizona and southwesterly flow in Grand Junction. Elevated PM10 in Grand Junction is generally

associated with 30-day precipitation totals of less than 1.00 inches at Grand Junction and less than 0.50 inches at Hopi.
Reference:

Orgill, M.M., Sehmel, G.A., 1976. Frequency and diurnal variation of dust storms in the contiguous USA. **Atmospheric Environment 10**, 813−825

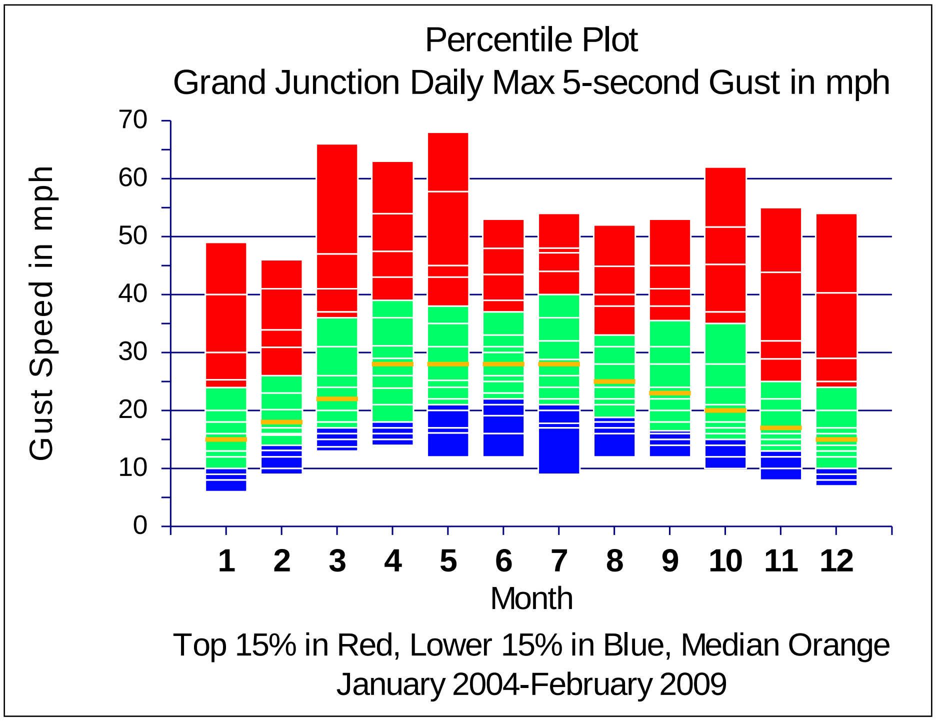


Figure A-25. Percentile plot of Grand Junction daily maximum 5-second gust speed in miles per hour showing that gusts of 40 mph or greater always occur within the top 15 percentile speeds for each month of the year.

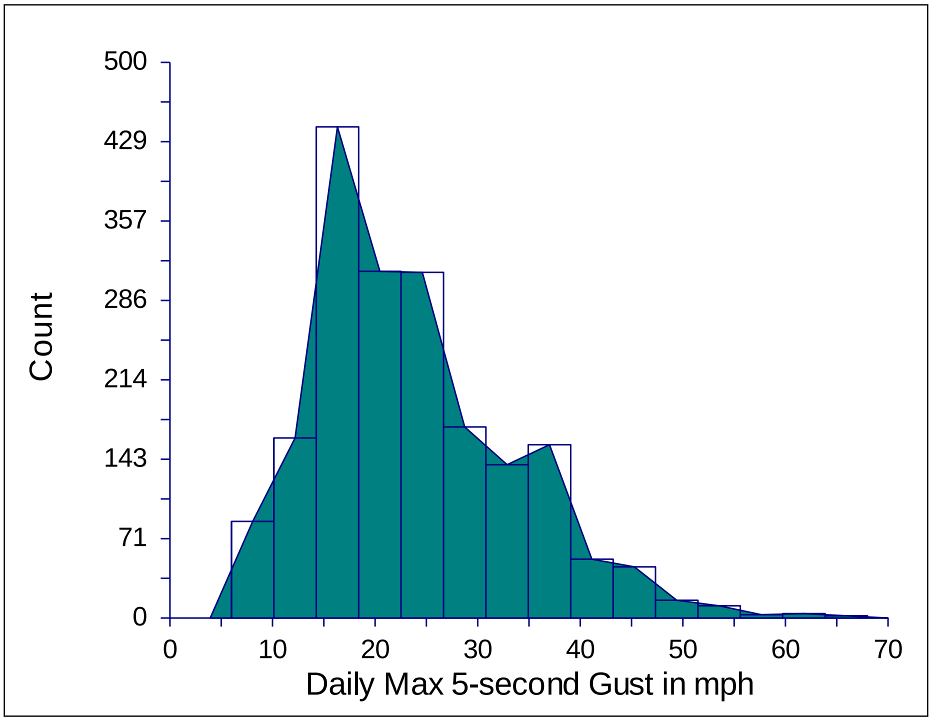


Figure A-26. Histogram of daily maximum 5-second wind gusts at Grand Junction based on January 2004 – February 2009.

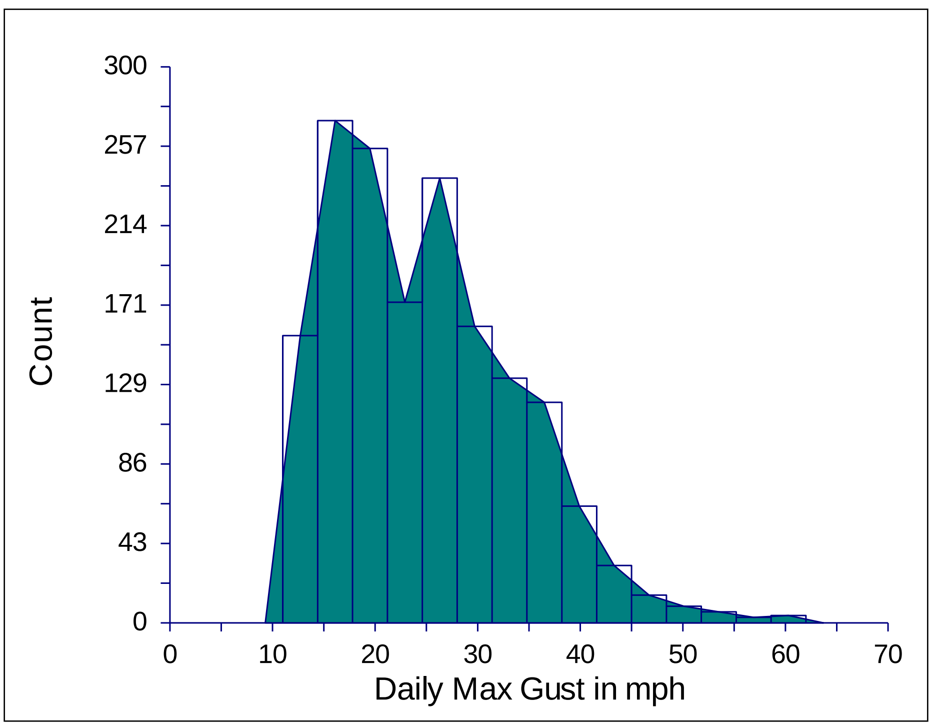


Figure A-27. Histogram of daily maximum 5-second wind gusts at Hopi based on January 2004 – February 2009.

Attachment B
Weather Warnings and Advisories
for
April 8, 2009

NWS SRRS PRODUCTS FOR:
2009040800 to 2009040900

WWUS75 KGJT 080639
NPWGJT
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE GRAND JUNCTION CO
1239 AM MDT WED APR 8 2009
...AN AFTERNOON COLD FRONT BRINGS STRONG GUSTY WINDS...
.THE NEXT IN A SERIES OF PACIFIC LOW PRESSURE SYSTEMS WILL BRING
GUSTY WINDS TO THE REGION TODAY. THE ASSOCIATED COLD FRONT WILL
PASS OVER EASTERN UTAH THIS AFTERNOON AND MUCH OF WESTERN COLORADO
BEFORE SUNSET. HIGH-BASED THUNDERSTORMS ARE POSSIBLE ALONG THE
FRONT. THESE STORMS WILL PRODUCE LIGHT SHOWERS AND VERY STRONG
LOCALIZED WIND GUSTS.
COZ001-002-006-007-011-020>023-UTZ022-024-027-029-081445-
/O.NEW.KGJT.WI.Y.0005.090408T2100Z-090409T0300Z/
LOWER YAMPA RIVER BASIN-CENTRAL YAMPA RIVER BASIN-GRAND VALLEY-
DEBEQUE TO SILT CORRIDOR-
CENTRAL GUNNISON AND UNCOMPAHGRE RIVER BASIN-
PARADOX VALLEY/LOWER DOLORES RIVER-
FOUR CORNERS/UPPER DOLORES RIVER-ANIMAS RIVER BASIN-
SAN JUAN RIVER BASIN-SOUTHEAST UTAH-EASTERN UINTA BASIN-
ARCHES/GRAND FLAT-CANYONLANDS/NATURAL BRIDGES-
INCLUDING THE CITIES OF...RANGELY...DINOSAUR...CRAIG...HAYDEN...
MEEKER...GRAND JUNCTION...FRUITA...PALISADE...RIFLE...SILT...
PARACHUTE...MESA...CEDAREDGE...DELTA...HOTCHKISS...MONTROSE...
GATEWAY...NUCLA...CORTEZ...DOVE CREEK...MANCOS...DURANGO...
BAYFIELD...IGNACIO...PAGOSA SPRINGS AND VICINITY...BLANDING...
BLUFF...MEXICAN HAT...VERNAL...JENSEN...BALLARD...FORT DUCHESNE...
RANDLETT...MOAB...CASTLE VALLEY...THOMPSON SPRINGS
1239 AM MDT WED APR 8 2009
...WIND ADVISORY IN EFFECT FROM 3 PM THIS AFTERNOON TO 9 PM MDT
THIS EVENING...
THE NATIONAL WEATHER SERVICE IN GRAND JUNCTION HAS ISSUED A WIND
ADVISORY...WHICH IS IN EFFECT FROM 3 PM THIS AFTERNOON TO 9 PM
MDT THIS EVENING.
SOUTH TO SOUTHWEST GUSTY WINDS WILL INCREASE THROUGH THE
AFTERNOON. WIDESPREAD GUSTS TO 45 MPH ARE LIKELY THIS AFTERNOON.
LOCALIZED GUSTS TO 60 MPH OR MORE ARE POSSIBLE NEAR THUNDERSTORMS
AND SHOWERS ALONG THE FRONT. BLOWING DUST MAY RESTRICT VISIBILITY
AT TIMES THIS AFTERNOON. THE GUSTY WINDS ARE EXPECTED TO
DIMINISH... BUT NOT END...AROUND SUNSET.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT GUSTY WINDS OF 45 MPH OR MORE ARE
EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...ESPECIALLY
FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.
&&
$$

WWUS75 KGJT 081226
NPWGJT
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE GRAND JUNCTION CO
626 AM MDT WED APR 8 2009
...AN AFTERNOON COLD FRONT WILL BRING STRONG GUSTY WINDS...
.THE NEXT IN A SERIES OF PACIFIC LOW PRESSURE SYSTEMS WILL BRING
GUSTY WINDS TO THE REGION TODAY. THE ASSOCIATED COLD FRONT WILL
PASS OVER EASTERN UTAH THIS AFTERNOON AND MUCH OF WESTERN
COLORADO BEFORE SUNSET. HIGH-BASED THUNDERSTORMS ARE POSSIBLE
ALONG THE FRONT. THESE STORMS WILL PRODUCE LIGHT SHOWERS AND VERY
STRONG LOCALIZED WIND GUSTS.
COZ001-002-006-007-011-020>023-UTZ022-024-027-029-082030-
/O.CON.KGJT.WI.Y.0005.090408T2100Z-090409T0300Z/
LOWER YAMPA RIVER BASIN-CENTRAL YAMPA RIVER BASIN-GRAND VALLEY-
DEBEQUE TO SILT CORRIDOR-
CENTRAL GUNNISON AND UNCOMPAHGRE RIVER BASIN-
PARADOX VALLEY/LOWER DOLORES RIVER-
FOUR CORNERS/UPPER DOLORES RIVER-ANIMAS RIVER BASIN-
SAN JUAN RIVER BASIN-SOUTHEAST UTAH-EASTERN UINTA BASIN-
ARCHES/GRAND FLAT-CANYONLANDS/NATURAL BRIDGES-
INCLUDING THE CITIES OF...RANGELY...DINOSAUR...CRAIG...HAYDEN...
MEEKER...GRAND JUNCTION...FRUITA...PALISADE...RIFLE...SILT...
PARACHUTE...MESA...CEDAREDGE...DELTA...HOTCHKISS...MONTROSE...
GATEWAY...NUCLA...CORTEZ...DOVE CREEK...MANCOS...DURANGO...
BAYFIELD...IGNACIO...PAGOSA SPRINGS AND VICINITY...BLANDING...
BLUFF...MEXICAN HAT...VERNAL...JENSEN...BALLARD...FORT DUCHESNE...
RANDLETT...MOAB...CASTLE VALLEY...THOMPSON SPRINGS
626 AM MDT WED APR 8 2009
...WIND ADVISORY REMAINS IN EFFECT FROM 3 PM THIS AFTERNOON TO
9 PM MDT THIS EVENING...
A WIND ADVISORY REMAINS IN EFFECT FROM 3 PM THIS AFTERNOON TO
9 PM MDT THIS EVENING.
SOUTH TO SOUTHWEST GUSTY WINDS WILL INCREASE THROUGH THE
AFTERNOON. WIDESPREAD GUSTS TO 45 MPH ARE LIKELY THIS AFTERNOON.
LOCALIZED GUSTS TO 60 MPH OR MORE ARE POSSIBLE NEAR THUNDERSTORMS
AND SHOWERS ALONG THE COLD FRONT. BLOWING DUST MAY RESTRICT
VISIBILITY AT TIMES THIS AFTERNOON. THE GUSTY WINDS ARE EXPECTED
TO DIMINISH...BUT NOT END...AROUND SUNSET.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT GUSTY WINDS OF 45 MPH OR MORE ARE
EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...
ESPECIALLY FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.
&&
$$

WWUS75 KGJT 081703
NPWGJT
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE GRAND JUNCTION CO
1103 AM MDT WED APR 8 2009
...AN AFTERNOON COLD FRONT WILL BRING STRONG GUSTY WINDS...
.THE NEXT IN A SERIES OF PACIFIC LOW PRESSURE SYSTEMS WILL BRING

GUSTY WINDS TO THE REGION TODAY. THE ASSOCIATED COLD FRONT WILL
PASS OVER EASTERN UTAH THIS AFTERNOON AND MUCH OF WESTERN
COLORADO BEFORE SUNSET. HIGH-BASED THUNDERSTORMS ARE POSSIBLE
ALONG THE FRONT. THESE STORMS WILL PRODUCE LIGHT SHOWERS AND VERY
STRONG LOCALIZED WIND GUSTS.
COZ001-002-006-007-011-020>023-UTZ022-024-027-029-090300-
/O.EXT.KGJT.WI.Y.0005.090408T1900Z-090409T0300Z/
LOWER YAMPA RIVER BASIN-CENTRAL YAMPA RIVER BASIN-GRAND VALLEY-
DEBEQUE TO SILT CORRIDOR-
CENTRAL GUNNISON AND UNCOMPAHGRE RIVER BASIN-
PARADOX VALLEY/LOWER DOLORES RIVER-
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ARCHES/GRAND FLAT-CANYONLANDS/NATURAL BRIDGES-
INCLUDING THE CITIES OF...RANGELY...DINOSAUR...CRAIG...HAYDEN...
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PARACHUTE...MESA...CEDAREDGE...DELTA...HOTCHKISS...MONTROSE...
GATEWAY...NUCLA...CORTEZ...DOVE CREEK...MANCOS...DURANGO...
BAYFIELD...IGNACIO...PAGOSA SPRINGS AND VICINITY...BLANDING...
BLUFF...MEXICAN HAT...VERNAL...JENSEN...BALLARD...FORT DUCHESNE...
RANDLETT...MOAB...CASTLE VALLEY...THOMPSON SPRINGS
1103 AM MDT WED APR 8 2009
...WIND ADVISORY NOW IN EFFECT UNTIL 9 PM MDT THIS EVENING...
THE WIND ADVISORY IS NOW IN EFFECT FROM 1 PM UNTIL 9 PM MDT THIS
EVENING.
SOUTH TO SOUTHWEST GUSTY WINDS WILL INCREASE THROUGH THE AFTERNOON.
THE STRONG GUSTY WINDS SHOULD FIRST BE NOTICED IN SOUTHEAST UTAH
AND SOUTHWEST COLORADO EARLY THIS AFTERNOON...SPREADING INTO THE
EASTERN UINTA BASIN AND NORTHWEST COLORADO BY MID-AFTERNOON.
WIDESPREAD GUSTS TO 45 MPH ARE LIKELY. LOCALIZED GUSTS TO 60 MPH OR
MORE ARE POSSIBLE NEAR ANY SHOWER OR THUNDERSTORM THAT MIGHT DEVELOP.
BLOWING DUST MAY RESTRICT VISIBILITY AT TIMES THIS AFTERNOON AND
EVENING. THE GUSTY WINDS ARE EXPECTED TO DIMINISH...BUT NOT
END...AROUND SUNSET.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT GUSTY WINDS OF 45 MPH OR MORE ARE
EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...
ESPECIALLY FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.
&&
$$
JAD

WWUS75 KGJT 082123
NPWGJT
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE GRAND JUNCTION CO
323 PM MDT WED APR 8 2009
...AN AFTERNOON COLD FRONT WILL BRING STRONG GUSTY WINDS...
.THE NEXT IN A SERIES OF PACIFIC LOW PRESSURE SYSTEMS WILL BRING
GUSTY WINDS TO THE REGION TODAY. THE ASSOCIATED COLD FRONT WILL
PASS OVER EASTERN UTAH THIS AFTERNOON AND MUCH OF WESTERN
COLORADO BEFORE SUNSET. HIGH-BASED THUNDERSTORMS ARE POSSIBLE
ALONG THE FRONT. THESE STORMS WILL PRODUCE LIGHT SHOWERS AND VERY
STRONG LOCALIZED WIND GUSTS.
COZ001-002-006-007-011-020>023-UTZ022-024-027-029-090300-

/O.CON.KGJT.WI.Y.0005.000000T0000Z-090409T0300Z/
LOWER YAMPA RIVER BASIN-CENTRAL YAMPA RIVER BASIN-GRAND VALLEY-
DEBEQUE TO SILT CORRIDOR-
CENTRAL GUNNISON AND UNCOMPAHGRE RIVER BASIN-
PARADOX VALLEY/LOWER DOLORES RIVER-
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SAN JUAN RIVER BASIN-SOUTHEAST UTAH-EASTERN UINTA BASIN-
ARCHES/GRAND FLAT-CANYONLANDS/NATURAL BRIDGES-
INCLUDING THE CITIES OF...RANGELY...DINOSAUR...CRAIG...HAYDEN...
MEEKER...GRAND JUNCTION...FRUITA...PALISADE...RIFLE...SILT...
PARACHUTE...MESA...CEDAREDGE...DELTA...HOTCHKISS...MONTROSE...
GATEWAY...NUCLA...CORTEZ...DOVE CREEK...MANCOS...DURANGO...
BAYFIELD...IGNACIO...PAGOSA SPRINGS AND VICINITY...BLANDING...
BLUFF...MEXICAN HAT...VERNAL...JENSEN...BALLARD...FORT DUCHESNE...
RANDLETT...MOAB...CASTLE VALLEY...THOMPSON SPRINGS
323 PM MDT WED APR 8 2009
...WIND ADVISORY REMAINS IN EFFECT UNTIL 9 PM MDT THIS EVENING...
A WIND ADVISORY REMAINS IN EFFECT UNTIL 9 PM MDT THIS EVENING.
STRONG AND GUSTY SOUTH TO SOUTHWEST WINDS WILL PERSIST THROUGH
EARLY EVENING. WIDESPREAD GUSTS TO 45 MPH ARE LIKELY. LOCALIZED
GUSTS TO 60 MPH OR MORE ARE POSSIBLE...ESPECIALLY NEAR ANY SHOWER OR
THUNDERSTORM THAT MIGHT DEVELOP. BLOWING DUST MAY RESTRICT
VISIBILITY AT TIMES THIS AFTERNOON AND EVENING. THE GUSTY WINDS
ARE EXPECTED TO DIMINISH... BUT NOT END...AROUND SUNSET.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT GUSTY WINDS OF 45 MPH OR MORE ARE
EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...
ESPECIALLY FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.
&&
$$
JAD

WWUS75 KGJT 082318
NPWGJT
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE GRAND JUNCTION CO
518 PM MDT WED APR 8 2009
...STRONG GUSTY WINDS WILL CONTINUE AHEAD OF AN APPROACHING COLD
FRONT...
.THE NEXT IN A SERIES OF PACIFIC LOW PRESSURE SYSTEMS WILL
CONTINUE TO BRING GUSTY WINDS TO THE REGION LATE THIS AFTERNOON
AND EARLY THIS EVENING. THE ASSOCIATED COLD FRONT WILL CONTINUE
THROUGH EASTERN UTAH LATE THIS AFTERNOON AND WILL PASS THROUGH MUCH
OF WESTERN COLORADO BEFORE SUNSET. HIGH-BASED THUNDERSTORMS ARE
POSSIBLE ALONG THE FRONT. THESE STORMS WILL PRODUCE LIGHT SHOWERS
AND VERY STRONG LOCALIZED WIND GUSTS.
COZ008-090300-
/O.EXA.KGJT.WI.Y.0005.000000T0000Z-090409T0300Z/
CENTRAL COLORADO RIVER BASIN-
INCLUDING THE CITIES OF...GLENWOOD SPRINGS...EAGLE...CARBONDALE
518 PM MDT WED APR 8 2009
...WIND ADVISORY IN EFFECT UNTIL 9 PM MDT THIS EVENING...
THE NATIONAL WEATHER SERVICE IN GRAND JUNCTION HAS ISSUED A WIND
ADVISORY...WHICH IS IN EFFECT UNTIL 9 PM MDT THIS EVENING.
STRONG AND GUSTY SOUTH TO SOUTHWEST WINDS WILL PERSIST THROUGH

EARLY EVENING. WIDESPREAD GUSTS TO 45 MPH ARE LIKELY. LOCALIZED
GUSTS TO 60 MPH OR MORE ARE POSSIBLE...ESPECIALLY NEAR ANY SHOWER
OR THUNDERSTORM THAT MIGHT DEVELOP. BLOWING DUST MAY RESTRICT
VISIBILITY AT TIMES THIS AFTERNOON AND EVENING. THE GUSTY WINDS
ARE EXPECTED TO DIMINISH...BUT NOT END...AROUND SUNSET.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT GUSTY WINDS OF 45 MPH OR MORE ARE
EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...
ESPECIALLY FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.
&&
$$
COZ003-009-012-017>019-UTZ025-028-090300-
/O.EXA.KGJT.WI.Y.0005.000000T0000Z-090409T0300Z/
ROAN AND TAVAPUTS PLATEAUS-GRAND AND BATTLEMENT MESAS-
WEST ELK AND SAWATCH MOUNTAINS-
UNCOMPAHGRE PLATEAU AND DALLAS DIVIDE-
NORTHWEST SAN JUAN MOUNTAINS-SOUTHWEST SAN JUAN MOUNTAINS-
TAVAPUTS PLATEAU-LA SAL AND ABAJO MOUNTAINS-
INCLUDING THE CITIES OF...RIO BLANCO...SKYWAY...CRESTED BUTTE...
TAYLOR PARK...MARBLE...RIDGWAY...GLADE PARK...OURAY...TELLURIDE...
LAKE CITY...SILVERTON...RICO...HESPERUS...MONTICELLO AND VICINITY
518 PM MDT WED APR 8 2009
...WIND ADVISORY IN EFFECT UNTIL 9 PM MDT THIS EVENING...
THE NATIONAL WEATHER SERVICE IN GRAND JUNCTION HAS ISSUED A WIND
ADVISORY...WHICH IS IN EFFECT UNTIL 9 PM MDT THIS EVENING.
STRONG AND GUSTY SOUTH TO SOUTHWEST WINDS WILL PERSIST THROUGH
EARLY EVENING. WIDESPREAD GUSTS TO 65 MPH ARE LIKELY. LOCALIZED
GUSTS TO 70 MPH OR MORE ARE POSSIBLE...ESPECIALLY NEAR ANY SHOWER
OR THUNDERSTORM THAT MIGHT DEVELOP. BLOWING DUST MAY RESTRICT
VISIBILITY AT TIMES THIS AFTERNOON AND EVENING. THE GUSTY WINDS
ARE EXPECTED TO DIMINISH... BUT NOT END...AROUND SUNSET.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT GUSTY WINDS OF 58 MPH OR MORE ARE
EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...
ESPECIALLY FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.
&&
$$
COZ001-002-006-007-011-020>023-UTZ022-024-027-029-090300-
/O.CON.KGJT.WI.Y.0005.000000T0000Z-090409T0300Z/
LOWER YAMPA RIVER BASIN-CENTRAL YAMPA RIVER BASIN-GRAND VALLEY-
DEBEQUE TO SILT CORRIDOR-
CENTRAL GUNNISON AND UNCOMPAHGRE RIVER BASIN-
PARADOX VALLEY/LOWER DOLORES RIVER-
FOUR CORNERS/UPPER DOLORES RIVER-ANIMAS RIVER BASIN-
SAN JUAN RIVER BASIN-SOUTHEAST UTAH-EASTERN UINTA BASIN-
ARCHES/GRAND FLAT-CANYONLANDS/NATURAL BRIDGES-
INCLUDING THE CITIES OF...RANGELY...DINOSAUR...CRAIG...HAYDEN...
MEEKER...GRAND JUNCTION...FRUITA...PALISADE...RIFLE...SILT...
PARACHUTE...MESA...CEDAREDGE...DELTA...HOTCHKISS...MONTROSE...
GATEWAY...NUCLA...CORTEZ...DOVE CREEK...MANCOS...DURANGO...
BAYFIELD...IGNACIO...PAGOSA SPRINGS AND VICINITY...BLANDING...
BLUFF...MEXICAN HAT...VERNAL...JENSEN...BALLARD...FORT DUCHESNE...
RANDLETT...MOAB...CASTLE VALLEY...THOMPSON SPRINGS
518 PM MDT WED APR 8 2009
...WIND ADVISORY REMAINS IN EFFECT UNTIL 9 PM MDT THIS EVENING...

A WIND ADVISORY REMAINS IN EFFECT UNTIL 9 PM MDT THIS EVENING.
STRONG AND GUSTY SOUTH TO SOUTHWEST WINDS WILL PERSIST THROUGH
EARLY EVENING. WIDESPREAD GUSTS TO 45 MPH ARE LIKELY. LOCALIZED
GUSTS TO 60 MPH OR MORE ARE POSSIBLE...ESPECIALLY NEAR ANY SHOWER
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WWUS75 KGJT 082318
NPWGJT
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE GRAND JUNCTION CO
518 PM MDT WED APR 8 2009
...STRONG GUSTY WINDS WILL CONTINUE AHEAD OF AN APPROACHING COLD
FRONT...
.THE NEXT IN A SERIES OF PACIFIC LOW PRESSURE SYSTEMS WILL
CONTINUE TO BRING GUSTY WINDS TO THE REGION LATE THIS AFTERNOON
AND EARLY THIS EVENING. THE ASSOCIATED COLD FRONT WILL CONTINUE
THROUGH EASTERN UTAH LATE THIS AFTERNOON AND WILL PASS THROUGH MUCH
OF WESTERN COLORADO BEFORE SUNSET. HIGH-BASED THUNDERSTORMS ARE
POSSIBLE ALONG THE FRONT. THESE STORMS WILL PRODUCE LIGHT SHOWERS
AND VERY STRONG LOCALIZED WIND GUSTS.
COZ008-090300-
/O.EXA.KGJT.WI.Y.0005.000000T0000Z-090409T0300Z/
CENTRAL COLORADO RIVER BASIN-
INCLUDING THE CITIES OF...GLENWOOD SPRINGS...EAGLE...CARBONDALE
518 PM MDT WED APR 8 2009
...WIND ADVISORY IN EFFECT UNTIL 9 PM MDT THIS EVENING...
THE NATIONAL WEATHER SERVICE IN GRAND JUNCTION HAS ISSUED A WIND
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STRONG AND GUSTY SOUTH TO SOUTHWEST WINDS WILL PERSIST THROUGH
EARLY EVENING. WIDESPREAD GUSTS TO 45 MPH ARE LIKELY. LOCALIZED
GUSTS TO 60 MPH OR MORE ARE POSSIBLE...ESPECIALLY NEAR ANY SHOWER
OR THUNDERSTORM THAT MIGHT DEVELOP. BLOWING DUST MAY RESTRICT
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PRECAUTIONARY/PREPAREDNESS ACTIONS...
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COZ003-009-012-017>019-UTZ025-028-090300-
/O.EXA.KGJT.WI.Y.0005.000000T0000Z-090409T0300Z/
ROAN AND TAVAPUTS PLATEAUS-GRAND AND BATTLEMENT MESAS-
WEST ELK AND SAWATCH MOUNTAINS-
UNCOMPAHGRE PLATEAU AND DALLAS DIVIDE-
NORTHWEST SAN JUAN MOUNTAINS-SOUTHWEST SAN JUAN MOUNTAINS-
TAVAPUTS PLATEAU-LA SAL AND ABAJO MOUNTAINS-

INCLUDING THE CITIES OF...RIO BLANCO...SKYWAY...CRESTED BUTTE...
TAYLOR PARK...MARBLE...RIDGWAY...GLADE PARK...OURAY...TELLURIDE...
LAKE CITY...SILVERTON...RICO...HESPERUS...MONTICELLO AND VICINITY
518 PM MDT WED APR 8 2009
...WIND ADVISORY IN EFFECT UNTIL 9 PM MDT THIS EVENING...
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ARE EXPECTED TO DIMINISH... BUT NOT END...AROUND SUNSET.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT GUSTY WINDS OF 58 MPH OR MORE ARE
EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...
ESPECIALLY FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.
&&
$$
COZ001-002-006-007-011-020>023-UTZ022-024-027-029-090300-
/O.CON.KGJT.WI.Y.0005.000000T0000Z-090409T0300Z/
LOWER YAMPA RIVER BASIN-CENTRAL YAMPA RIVER BASIN-GRAND VALLEY-
DEBEQUE TO SILT CORRIDOR-
CENTRAL GUNNISON AND UNCOMPAHGRE RIVER BASIN-
PARADOX VALLEY/LOWER DOLORES RIVER-
FOUR CORNERS/UPPER DOLORES RIVER-ANIMAS RIVER BASIN-
SAN JUAN RIVER BASIN-SOUTHEAST UTAH-EASTERN UINTA BASIN-
ARCHES/GRAND FLAT-CANYONLANDS/NATURAL BRIDGES-
INCLUDING THE CITIES OF...RANGELY...DINOSAUR...CRAIG...HAYDEN...
MEEKER...GRAND JUNCTION...FRUITA...PALISADE...RIFLE...SILT...
PARACHUTE...MESA...CEDAREDGE...DELTA...HOTCHKISS...MONTROSE...
GATEWAY...NUCLA...CORTEZ...DOVE CREEK...MANCOS...DURANGO...
BAYFIELD...IGNACIO...PAGOSA SPRINGS AND VICINITY...BLANDING...
BLUFF...MEXICAN HAT...VERNAL...JENSEN...BALLARD...FORT DUCHESNE...
RANDLETT...MOAB...CASTLE VALLEY...THOMPSON SPRINGS
518 PM MDT WED APR 8 2009
...WIND ADVISORY REMAINS IN EFFECT UNTIL 9 PM MDT THIS EVENING...
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STRONG AND GUSTY SOUTH TO SOUTHWEST WINDS WILL PERSIST THROUGH
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PRECAUTIONARY/PREPAREDNESS ACTIONS...
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EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...
ESPECIALLY FOR HIGH PROFILE VEHICLES. USE EXTRA CAUTION.
&&
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NWS SRRS PRODUCTS FOR:
2009040801 to 2009040900

WWUS75 KFGZ 080605
NPWFGZ
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE FLAGSTAFF AZ
1105 PM MST TUE APR 7 2009
AZZ004>007-009-015-016-081415-
/O.CON.KFGZ.WI.Y.0010.090408T1300Z-090409T0300Z/
KAIBAB PLATEAU-MARBLE AND GLEN CANYONS-GRAND CANYON COUNTRY-
COCONINO PLATEAU-NORTHEAST PLATEAUS AND MESAS HWY 264 NORTHWARD-
WESTERN MOGOLLON RIM-EASTERN MOGOLLON RIM-
INCLUDING THE CITIES OF...JACOB LAKE...FREDONIA...PAGE...
LEES FERRY...GRAND CANYON VILLAGE...SUPAI...NORTH RIM...VALLE...
KEAMS CANYON...KAIBITO...FLAGSTAFF...WILLIAMS...MUNDS PARK...
HEBER...HAPPY JACK...FOREST LAKES
1105 PM MST TUE APR 7 2009
...WIND ADVISORY REMAINS IN EFFECT FROM 6 AM TO 8 PM MST
WEDNESDAY...
A WIND ADVISORY REMAINS IN EFFECT FROM 6 AM TO 8 PM MST
WEDNESDAY.
A LOW PRESSURE SYSTEM AND COLD FRONT WILL MOVE ACROSS THE AREA ON
WEDNESDAY BRINGING STRONG WINDS TO THE REGION. WINDS WILL BEGIN
TO INCREASE DURING THE EARLY MORNING HOURS BECOMING SOUTHWEST
20 TO 30 MPH WITH GUSTS FROM 40 TO 50 MPH BY LATE MORNING AND
CONTINUING THROUGH THE AFTERNOON AND EARLY EVENING.
AFTER THE COLD FRONT MOVES THROUGH THE AREA...WINDS WILL BECOME
WESTERLY AND SLOWLY DIMINISH BECOMING 10 TO 20 MPH OVERNIGHT.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT SUSTAINED WINDS OF 30 TO 39 MPH...OR
GUSTS FROM 40 TO 57 MPH...ARE EXPECTED. WINDS THIS STRONG CAN
MAKE DRIVING DIFFICULT...ESPECIALLY FOR HIGH PROFILE VEHICLES.
CONSIDER SECURING LOOSE BELONGINGS ON YOUR PROPERTY. ADDITIONAL
WEATHER INFORMATION IS ON THE WEB AT WEATHER.GOV/FLAGSTAFF.
&&
$$
AZZ010>014-017-039-040-081415-
/O.CON.KFGZ.WI.Y.0010.090408T1500Z-090409T0500Z/
CHINLE VALLEY-CHUSKA MOUNTAINS AND DEFIANCE PLATEAU-
LITTLE COLORADO RIVER VALLEY IN COCONINO COUNTY-
LITTLE COLORADO RIVER VALLEY IN NAVAJO COUNTY-
LITTLE COLORADO RIVER VALLEY IN APACHE COUNTY-WHITE MOUNTAINS-
BLACK MESA AREA-NORTHEAST PLATEAUS AND MESAS SOUTH OF HWY 264-
INCLUDING THE CITIES OF...CANYON DE CHELLY...CHINLE...KAYENTA...
WINDOW ROCK...GANADO...WUPATKI N.M....TUBA CITY...WINSLOW...
HOLBROOK...SNOWFLAKE...ST. JOHNS...SPRINGERVILLE...SHOW LOW...
GREER...PINETOP...NAVAJO N.M....DILKON...KYKOTSMOVI
1105 PM MST TUE APR 7 2009
...WIND ADVISORY REMAINS IN EFFECT FROM 8 AM TO 10 PM MST
WEDNESDAY...
A WIND ADVISORY REMAINS IN EFFECT FROM 8 AM TO 10 PM MST
WEDNESDAY.
A LOW PRESSURE SYSTEM AND COLD FRONT WILL MOVE ACROSS THE AREA ON
WEDNESDAY BRINGING STRONG WINDS TO THE REGION. WINDS WILL BEGIN
TO INCREASE DURING THE MORNING BECOMING SOUTHWEST 25 TO 35 MPH
WITH GUSTS TO 55 MPH BY EARLY AFTERNOON AND CONTINUING INTO THE

EVENING. THE STRONG WINDS WILL RESULT IN AREAS OF BLOWING DUST AND MAY SIGNIFICANTLY REDUCE VISIBILITIES.
AFTER THE COLD FRONT MOVES THROUGH THE AREA...WINDS WILL BECOME WESTERLY AND SLOWLY DIMINISH BECOMING 10 TO 20 MPH OVERNIGHT.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT SUSTAINED WINDS OF 30 TO 39 MPH...OR GUSTS FROM 40 TO 57 MPH...ARE EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...ESPECIALLY FOR HIGH PROFILE VEHICLES. CONSIDER SECURING LOOSE BELONGINGS ON YOUR PROPERTY. ADDITIONAL WEATHER INFORMATION IS ON THE WEB AT WEATHER.GOV/FLAGSTAFF.
&&
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WWUS75 KFGZ 081315
NPWFGZ
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE FLAGSTAFF AZ
615 AM MST WED APR 8 2009
AZZ004>007-009-015-016-082115-
/O.CON.KFGZ.WI.Y.0010.000000T0000Z-090409T0300Z/
KAIBAB PLATEAU-MARBLE AND GLEN CANYONS-GRAND CANYON COUNTRY-
COCONINO PLATEAU-NORTHEAST PLATEAUS AND MESAS HWY 264 NORTHWARD-
WESTERN MOGOLLON RIM-EASTERN MOGOLLON RIM-
INCLUDING THE CITIES OF...JACOB LAKE...FREDONIA...PAGE...
LEES FERRY...GRAND CANYON VILLAGE...SUPAI...NORTH RIM...VALLE...
KEAMS CANYON...KAIBITO...FLAGSTAFF...WILLIAMS...MUNDS PARK...
HEBER...HAPPY JACK...FOREST LAKES
615 AM MST WED APR 8 2009
...WIND ADVISORY REMAINS IN EFFECT UNTIL 8 PM MST THIS EVENING...
A WIND ADVISORY REMAINS IN EFFECT UNTIL 8 PM MST THIS EVENING.
A COLD FRONT WILL APPROACH NORTHERN ARIZONA TODAY...BRINGING STRONG WINDS TO THE REGION. WINDS WILL INCREASE DURING THE MORNING HOURS BECOMING SOUTHWEST 20 TO 30 MPH WITH GUSTS FROM 40 TO 50 MPH BY LATE MORNING AND CONTINUING THROUGH THE AFTERNOON AND EARLY EVENING.
AFTER THE COLD FRONT MOVES THROUGH THE AREA THIS EVENING...WINDS WILL BECOME WESTERLY AND SLOWLY DIMINISH BECOMING 10 TO 20 MPH OVERNIGHT.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT SUSTAINED WINDS OF 30 TO 39 MPH...OR GUSTS FROM 40 TO 57 MPH...ARE EXPECTED. WINDS THIS STRONG CAN MAKE DRIVING DIFFICULT...ESPECIALLY FOR HIGH PROFILE VEHICLES. CONSIDER SECURING LOOSE BELONGINGS ON YOUR PROPERTY. ADDITIONAL WEATHER INFORMATION IS ON THE WEB AT WEATHER.GOV/FLAGSTAFF.
&&
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AZZ010>014-017-039-040-082115-
/O.CON.KFGZ.WI.Y.0010.090408T1500Z-090409T0500Z/
CHINLE VALLEY-CHUSKA MOUNTAINS AND DEFIANCE PLATEAU-
LITTLE COLORADO RIVER VALLEY IN COCONINO COUNTY-
LITTLE COLORADO RIVER VALLEY IN NAVAJO COUNTY-
LITTLE COLORADO RIVER VALLEY IN APACHE COUNTY-WHITE MOUNTAINS-
BLACK MESA AREA-NORTHEAST PLATEAUS AND MESAS SOUTH OF HWY 264-
INCLUDING THE CITIES OF...CANYON DE CHELLY...CHINLE...KAYENTA...
WINDOW ROCK...GANADO...WUPATKI N.M....TUBA CITY...WINSLOW...

HOLBROOK...SNOWFLAKE...ST. JOHNS...SPRINGERVILLE...SHOW LOW...
GREER...PINETOP...NAVAJO N.M....DILKON...KYKOTSMOVI
615 AM MST WED APR 8 2009
...WIND ADVISORY REMAINS IN EFFECT UNTIL 10 PM MST THIS EVENING...
A WIND ADVISORY REMAINS IN EFFECT UNTIL 10 PM MST THIS EVENING.
A COLD FRONT WILL APPROACH NORTHERN ARIZONA TODAY...BRINGING
STRONG WINDS TO THE REGION. WINDS WILL BEGIN TO INCREASE DURING
THE MORNING BECOMING SOUTHWEST 25 TO 35 MPH WITH GUSTS UP TO 55
MPH BY EARLY AFTERNOON AND CONTINUING INTO THE EVENING. THE STRONG
WINDS WILL RESULT IN AREAS OF BLOWING DUST...ESPECIALLY IN THE
LITTLE COLORADO RIVER VALLEY...AND MAY SIGNIFICANTLY REDUCE
VISIBILITIES.
AFTER THE COLD FRONT MOVES THROUGH THE AREA THIS EVENING...WINDS
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OVERNIGHT.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT SUSTAINED WINDS OF 30 TO 39 MPH...OR
GUSTS FROM 40 TO 57 MPH...ARE EXPECTED. WINDS THIS STRONG CAN
MAKE DRIVING DIFFICULT...ESPECIALLY FOR HIGH PROFILE VEHICLES.
CONSIDER SECURING LOOSE BELONGINGS ON YOUR PROPERTY. ADDITIONAL
WEATHER INFORMATION IS ON THE WEB AT WEATHER.GOV/FLAGSTAFF.
&&
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WWUS75 KFGZ 081916
NPWFGZ
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE FLAGSTAFF AZ
1216 PM MST WED APR 8 2009
AZZ004>007-009-015-016-090300-
/O.CON.KFGZ.WI.Y.0010.000000T0000Z-090409T0300Z/
KAIBAB PLATEAU-MARBLE AND GLEN CANYONS-GRAND CANYON COUNTRY-
COCONINO PLATEAU-NORTHEAST PLATEAUS AND MESAS HWY 264 NORTHWARD-
WESTERN MOGOLLON RIM-EASTERN MOGOLLON RIM-
INCLUDING THE CITIES OF...JACOB LAKE...FREDONIA...PAGE...
LEES FERRY...GRAND CANYON VILLAGE...SUPAI...NORTH RIM...VALLE...
KEAMS CANYON...KAIBITO...FLAGSTAFF...WILLIAMS...MUNDS PARK...
HEBER...HAPPY JACK...FOREST LAKES
1216 PM MST WED APR 8 2009
...WIND ADVISORY REMAINS IN EFFECT UNTIL 8 PM MST THIS EVENING...
A WIND ADVISORY REMAINS IN EFFECT UNTIL 8 PM MST THIS EVENING.
A COLD FRONT WILL CONTINUE TO APPROACH NORTHERN ARIZONA TODAY.
SOUTHWEST WINDS OF 20 TO 30 MPH WITH GUSTS FROM 40 TO 50 MPH CAN
BE EXPECTED INTO EARLY THIS EVENING.
AFTER THE COLD FRONT MOVES THROUGH THE AREA THIS EVENING...WINDS
WILL BECOME WESTERLY AND SLOWLY DIMINISH BECOMING 10 TO 20 MPH
OVERNIGHT.
SOME PEAK WIND GUSTS REPORTED AS OF NOON MST TODAY INCLUDE...
FLAGSTAFF AIRPORT .... 44 MPH.
DONEY PARK .... 42 MPH.
GRAND CANYON .... 37 MPH.
PAGE .... 33 MPH.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT SUSTAINED WINDS OF 30 TO 39 MPH...OR
GUSTS FROM 40 TO 57 MPH...ARE EXPECTED. WINDS THIS STRONG CAN

MAKE DRIVING DIFFICULT...ESPECIALLY FOR HIGH PROFILE VEHICLES.
CONSIDER SECURING LOOSE BELONGINGS ON YOUR PROPERTY. ADDITIONAL
WEATHER INFORMATION IS ON THE WEB AT WEATHER.GOV/FLAGSTAFF.
&&
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AZZ010>014-017-039-040-090330-
/O.CON.KFGZ.WI.Y.0010.000000T0000Z-090409T0500Z/
CHINLE VALLEY-CHUSKA MOUNTAINS AND DEFIANCE PLATEAU-
LITTLE COLORADO RIVER VALLEY IN COCONINO COUNTY-
LITTLE COLORADO RIVER VALLEY IN NAVAJO COUNTY-
LITTLE COLORADO RIVER VALLEY IN APACHE COUNTY-WHITE MOUNTAINS-
BLACK MESA AREA-NORTHEAST PLATEAUS AND MESAS SOUTH OF HWY 264-
INCLUDING THE CITIES OF...CANYON DE CHELLY...CHINLE...KAYENTA...
WINDOW ROCK...GANADO...WUPATKI N.M....TUBA CITY...WINSLOW...
HOLBROOK...SNOWFLAKE...ST. JOHNS...SPRINGERVILLE...SHOW LOW...
GREER...PINETOP...NAVAJO N.M....DILKON...KYKOTSMOVI
1216 PM MST WED APR 8 2009
...WIND ADVISORY REMAINS IN EFFECT UNTIL 10 PM MST THIS EVENING...
A WIND ADVISORY REMAINS IN EFFECT UNTIL 10 PM MST THIS EVENING.
A COLD FRONT WILL CONTINUE TO APPROACH NORTHERN ARIZONA TODAY.
SOUTHWEST WINDS OF 25 TO 35 MPH WITH GUSTS UP TO 55 MPH CAN BE
EXPECTED THROUGH THIS EVENING. THE STRONG WINDS WILL RESULT IN
AREAS OF BLOWING DUST...ESPECIALLY IN THE LITTLE COLORADO RIVER
VALLEY...AND MAY SIGNIFICANTLY REDUCE VISIBILITIES.
AFTER THE COLD FRONT MOVES THROUGH THE AREA THIS EVENING...WINDS
WILL BECOME WESTERLY AND SLOWLY DIMINISH BECOMING 10 TO 20 MPH
OVERNIGHT.
SOME PEAK WIND GUSTS REPORTED AS OF NOON MST TODAY INCLUDE...
WINSLOW .... 58 MPH.
ST. JOHNS .... 48 MPH.
WINDOW ROCK .... 48 MPH.
SHOW LOW .... 55 MPH.
WUPATKI NATIONAL MONUMENT ... 45 MPH.
ALPINE .... 47 MPH.
GREER .... 49 MPH.
TUBA CITY................... 43 MPH.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT SUSTAINED WINDS OF 30 TO 39 MPH...OR
GUSTS FROM 40 TO 57 MPH...ARE EXPECTED. WINDS THIS STRONG CAN
MAKE DRIVING DIFFICULT...ESPECIALLY FOR HIGH PROFILE VEHICLES.
CONSIDER SECURING LOOSE BELONGINGS ON YOUR PROPERTY. ADDITIONAL
WEATHER INFORMATION IS ON THE WEB AT WEATHER.GOV/FLAGSTAFF.
&&
$$
Source: National Climatic Data Center, HDSS Access System
http://has.ncdc.noaa.gov/pls/plhas/HAS.StationYearSelect?datasetname=9957ANX&subqueryby=STATION&applname=SRRSBTNSEL&outdest=APPS&dtypesort=dtypeord&stationsort=state

Attachment C

Final Natural Events Action Plan
For
High Wind Events
Alamosa, Colorado

FINAL NATURAL EVENTS ACTION PLAN

FOR

HIGH WIND EVENTS

ALAMOSA, COLORADO

Colorado Department
of Public Health
and Environment

CITY OF ALAMOSA,
ALAMOSA COUNTY,
and
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I. EXECUTIVE SUMMARY

On March 31 and April 9, 1999 and again on April 18 and December 17, 2000, the monitor located in Alamosa, Colorado recorded exceedances of the 24-hour National Ambient Air Quality Standard (NAAQS) for PM10 (particulate matter having a nominal aerodynamic diameter equal to or less than 10 microns).[1] Each of these exceedances was associated with high winds and blowing dust in the Alamosa area.

Recognizing that certain uncontrollable natural events, such as high winds, wildfires, and volcanic/seismic activity can have on the NAAQS, the Environmental Protection Agency (EPA) issued a Natural Events Policy (NEP) on May 30, 1996. The NEP sets forth procedures through the development of a Natural Events Action Plan (NEAP) for protecting public health in areas where the PM10 standard may be violated due to these uncontrollable natural events. The guiding principles of the policy are:

1. Federal, State, and local air quality agencies must protect public health;

2. The public must be informed whenever air quality is unhealthy;

3. All valid ambient air quality data should be submitted to the EPA Aerometric Information Retrieval System (AIRS) and made available for public access;

4. Reasonable measures safeguarding public health must be taken regardless of the source of PM10 emissions; and,

5. Emission controls should be applied to sources that contribute to exceedances of the PM10 NAAQS when those controls will result in fewer violations of the standards.

In response to Alamosa's four exceedances of the PM10 NAAQS in 1999 and 2000, the Colorado Department of Public Health and Environment's Air Pollution Control Division (Division), in conjunction with the City of Alamosa, Alamosa County, and other agencies developed a NEAP for the Alamosa area. The referenced NEAP was developed based on Natural Events Policy that calls for states to "develop a NEAP for any area where natural events cause or have caused a PM10 NAAQS to be violated within eighteen (18) months of the date of the violation." April 18, 2000 was the triggering event for the development of the NEAP. The referenced NEAP was developed and submitted to EPA in October 2001. A revised version of the NEAP (including U.S. EPA recommendations) was submitted February 2002. A copy of the letter of concurrence for these submittals is available in the Appendix.

The Natural Events Policy also indicates that in attainment areas (such as Alamosa), best available control measures (BACM) must be implemented within three (3) years after the triggering event. With that, this *Final Natural Events Action Plan for Alamosa, Colorado* includes BACM not identified in the February 2002 submittal and includes additional efforts in the community to limit blowing dust and its impacts on public health.

The *Final Natural Events Action Plan* also addresses PM10 exceedances experienced in the area that have occurred since the December 17, 2000 event.

The plan provides analysis and documentation of the exceedances as attributable to uncontrollable natural events due to unusually high winds. In addition, the NEAP is designed to protect public health, educate the public about high wind events; mitigate health impacts on the community during future events; and, identify and implement Best Available Control Measures (BACM) for anthropogenic sources of windblown dust.

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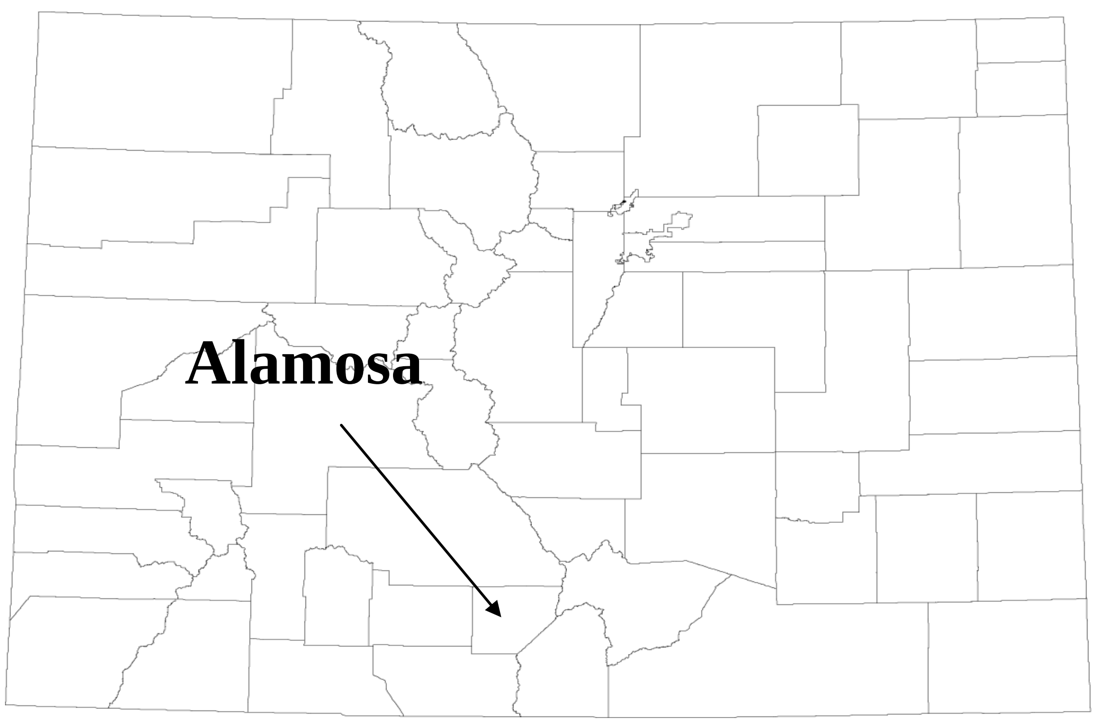
II. INTRODUCTION

The City of Alamosa is located in Alamosa County in south central Colorado. Situated in the San Luis Valley, Alamosa serves as one of the largest cities and the agricultural center for south central Colorado. The area surrounding Alamosa consists of gently rolling to nearly level uplands where the dominant slopes are less than 3 percent.[ii] The climate is generally mild and semiarid. Annual precipitation is about 7.5 inches. Summers are considered short and cool, with winters long and cold. 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 PM10 problems for the area.

Area Map



On March 31 and April 9, 1999 and again on April 18 and December 17, 2000 the PM10 monitor located on the roof of Alamosa's Adams State College recorded exceedances of the primary 24-hour NAAQS for PM10. The PM10 concentrations of 263 $\mu g/m^3$, 190 $\mu g/m^3$, 238 $\mu g/m^3$, and 217 $\mu g/m^3$ respectively, were recorded on these days - as were unusually high wind speeds and little or no precipitation. The circumstances surrounding the Alamosa exceedances has provided adequate reason for the Division to believe the high wind events and blowing dust have caused exceedances of the NAAQS that otherwise would not have occurred.

As required by the NEP, each of the exceedances was flagged by the Division's Technical Services Program in the AIRS system. The flags appear after the recorded values in AIRS with the descriptor code "A" for high winds. According to EPA guidance the type and amount of documentation provided for each event should be sufficient to demonstrate that the natural event occurred, and that it impacted a particular monitoring site in such a way as to cause the PM10 concentrations measured.[iii] This documentation has been previously submitted to EPA.

Recognizing the need to protect public health in areas where PM10 exceeds the NAAQS due to natural events such as the unusually high winds, a Natural Events Action Plan has been developed for the Alamosa area based on the NEP guidance. This plan outlines specific procedures to be taken in response to future high wind events. In short, the purpose of the plan is to:

1. Educate the public about the problem;
2. Mitigate health impacts on exposed populations during future events; and
3. Identify and implement Best Available Control Measures (BACM) for anthropogenic sources of windblown dust.

A. Background

High winds are common to the southern region of Colorado. Under some conditions, these winds are strong enough to lift particulate matter into the air and cause elevated levels of PM10 above the Federal and State standards. Due to observed problems in Alamosa, particulate monitoring of total suspended particulate pollution was instituted at the Adams State College monitoring site in 1970. In 1989, monitoring for PM10 began.

More recently, an additional monitoring site has been established in the Alamosa area. Specifically, a second PM10 monitor was established at the Alamosa Municipal Building to ensure adequate coverage of local air quality monitoring and to ensure protection of public health. This monitor, like the first PM10 monitor at Adams State College, operates on an everyday sampling protocol.

Alamosa's monitoring history shows that the annual PM10 standard of 50 $\mu g/m^3$ (averaged over an annual period) has never been exceeded. The 24-hour PM10 standard of 150 $\mu g/m^3$ has been exceeded on a number of occasions. However, all exceedances have been due to natural events. The associated weather conditions on each of the exceedance days conform to a repeated pattern of regional high winds and blowing dust. In each case an intense, fast-moving, surface low-pressure system tracked through Colorado. Typically these systems had surface lows that were not collocated with a closed upper low or nearly-closed upper level trough. This distinction is important because the collocated or vertically "coupled" systems usually bring significant up slope snow or rain to the region. The intensity of the lows associated with the PM10 exceedances is evident in the average central pressure of 990 mb (corrected to sea level). This value is typical of a deep, well-organized system. Such well-organized systems usually generate high winds in the vicinity of the low center.[iv]

The NEP applies only to emissions caused by natural events that have occurred since January 1, 1994.[v] Only those high wind events experienced since that time are addressed by this NEAP. This submittal includes those exceedances occurring since the previous NEAP submittal as well. See table on page 6 for more details of all area exceedances.

B. The Natural Events Policy

1. Background

On May 30, 1996, EPA issued the Natural Events Policy in a memorandum from Mary D. Nichols, Assistant Administrator for Air and Radiation. In this memorandum EPA announced its new policy for protecting public health when the PM10 NAAQS are violated due to natural events. Under this policy three categories of natural events are identified as affecting the PM10 NAAQS: (1) volcanic and seismic activity; (2) wildland fires; and, (3) high wind events. Only high wind events will be addressed in this NEAP.

Based on EPA's natural events policy high winds are defined as uncontrollable natural events under the following conditions: (1) the dust originated from non-anthropogenic sources; or, (2) the dust originated from anthropogenic sources controlled with best available control measures (BACM). Furthermore, the conditions that create high wind events vary from area to area with soil type, precipitation, and the speed of wind gusts.[vi]

2. Content

In order for exceedances of the NAAQS to be considered as due to a natural event, a Natural Events Action Plan must be developed to address future events. The following is a summary of the specific EPA guidance regarding development of a NEAP.[vii]

1. Analysis and documentation of the event should show a clear causal relationship between the measured exceedance and the natural event. The type and amount of documentation provided should be sufficient to demonstrate that the natural event occurred, and that it impacted a particular monitoring site in such a way as to cause the PM10 concentrations measured.

2. Establish education programs. Such programs may be designed to educate the public about the short-term and long-term harmful effects that high concentrations of PM10 could have on their health and inform them that: (a) certain types of natural events affect the air quality of the area periodically, (b) a natural event is imminent, and (c) specific actions are being taken to minimize the health impacts of events.

3. Minimize public exposure to high concentrations of PM10 through a public notification and health advisory program. Programs to minimize public exposure should (a) identify the people most at risk, (b) notify the at-risk population that a natural event is imminent or currently taking place, (c) suggest actions to be taken by the public to minimize their exposure to high concentrations of PM10, and (d)

suggest precautions to take if exposure cannot be avoided.

4. Abate or minimize appropriate contributing controllable sources of PM10. Programs to minimize PM10 emissions for high winds may include: the application of BACM to any sources of soil that have been disturbed by anthropogenic activities. The BACM application criteria require analysis of the technological and economic feasibility of individual control measures on a case-by-case basis. The NEAP should include analyses of BACM for contributing sources. If BACM are not defined for the anthropogenic sources in question, step 5 listed below is required.

5. Identify, study, and implement practical mitigating measures as necessary. The NEAP may include commitments to conduct pilot tests of new emission reduction techniques. For example, it may be desirable to test the feasibility and effectiveness of new strategies for minimizing sources of windblown dust through pilot programs. The plan must include a timely schedule for conducting such studies and implementing measures that are technologically and economically feasible.

6. Periodically reevaluate: (a) the conditions causing violations of a PM10 NAAQS in the area, (b) the status of implementation of the NEAP, and (c) the adequacy of the actions being implemented. The State should reevaluate the NEAP for an area every 5 years at a minimum and make appropriate changes to the plan.

7. The NEAP should be developed by the State in conjunction with the stakeholders affected by the plan.

8. The NEAP should be made available for public review and comment and may, but is not required, to be adopted as a revision to the State Implementation Plan (SIP) if current SIP rules are not revised.

9. The NEAP should be submitted to the EPA for review and comment.

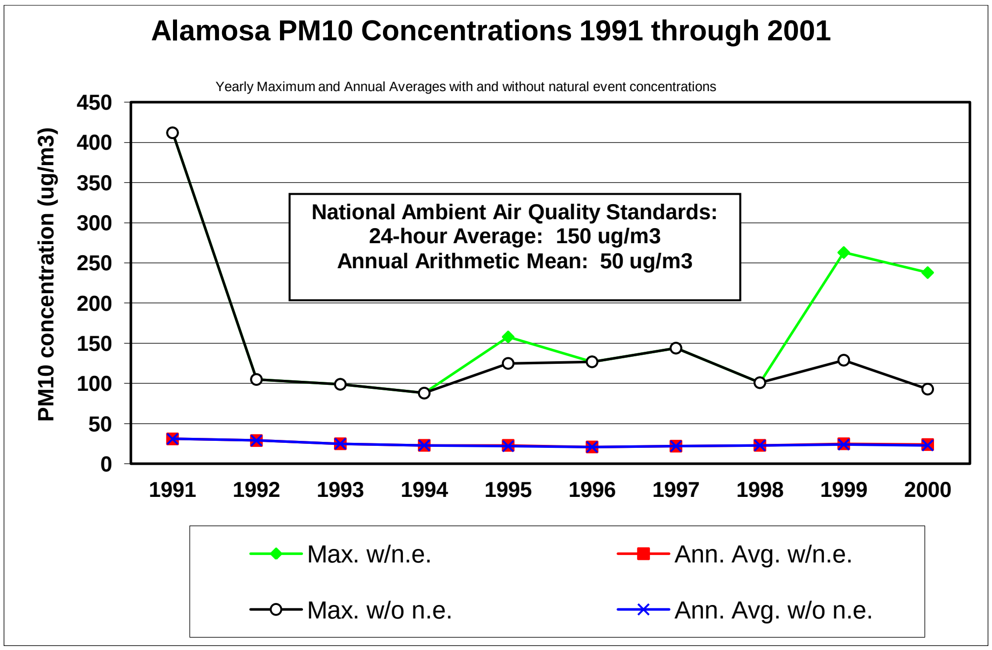
The following text describes the Alamosa NEAP and its conformance with the above-described EPA guidance on natural events.

III. NATURAL EVENTS ACTION PLAN

A. Element 1: <u>Documentation & Analysis</u>

On March 31 and April 9, 1999 and again on April 18 and December 17, 2000, the air quality monitor located in Alamosa, Colorado recorded exceedances of the 24-hour National Ambient Air Quality Standard (NAAQS) for PM10 (Figure 1). Each of these exceedances was associated with unusually high winds in the Alamosa area (Table 1).

Figure 1. Recent Alamosa PM10 Concentrations



n.e.- Natural Event

On October 29, 1999 and again on March 30, 2000 the Division submitted documentation to EPA Region VIII in support of Alamosa's most recent exceedances of the PM10 NAAQS due to natural events. The documentation contained monitoring data, meteorological data, PM10 filter analysis and receptor model results, maps of the area, news accounts of the events and other miscellaneous supporting material. On July 3, 2001, EPA concurred that the aforementioned natural events were, in fact, high wind events (Table 1). The EPA letter of concurrence can be found in the Appendix of this NEAP.

More recently (since the February 2002 submittal), several additional exceedances of the PM10 NAAQS have been experienced in the community. These exceedances were recorded at the Adams State site only; none have been seen at the recently sited PM10 monitor at the Municipal Complex. Details are included in the table below and documentation for these events is on file with EPA.

Table 1. Recent 24 Hour PM-10 Values in Alamosa Colorado

EVENT Date	**PM-10 Concentration**	***Details***
3/31/99	263 ug/m^3	Natural Event- EPA concurrence on July 3, 2001
4/9/99	190 ug/m^3	Natural Event- EPA concurrence on July 3, 2001
4/18/00	238 ug/m^3	Natural Event- EPA concurrence on July 3, 2001
12/17/00	217 ug/m^3	Natural Event- EPA concurrence on July 3, 2001
2/8/02	215 ug/m^3	Natural Event Under EPA consideration
2/25/02	182 ug/m^3	Natural Event Under EPA consideration
3/23/02	164 ug/m^3	Natural Event Under EPA consideration
5/21/02	160 ug/m^3	*Natural Event Under EPA consideration*

Taken together, the supporting documentation establishes a clear, casual relationship between the measured exceedances and the natural events as required by the NEP. On the days of Alamosa's PM10 exceedances, unusually high winds and/or wind gusts were experienced over a prolonged period of time. For example, meteorological data in and around the area (Trinidad, Colorado) demonstrate that on April 18, 2000, maximum wind speeds were over 41 miles per hour and gust speeds were as high as nearly 59 miles per hour. Meterological data for the December 18, 2000 event indicate that gusts were as high as 49 miles per hour in the Alamosa area. Both events were coupled with dry periods of weather.

According to the Natural Events Policy, "the conditions that create high wind events vary from area to area with soil type, precipitation and the speed of wind gusts." Thus, states are to determine the conditions that define high winds in an area. Making a precise determination, however, is a complex task that requires detailed information on soil moisture, daily wind speeds, temperature, and a number of other variables that are not readily available at this time. Until such research and/or guidance is available, the Division will use the definition of high winds included in the *Guideline on the Identification and Use of Air Quality Data Affected by Exceptional Events* for the Alamosa area. According to this guidance, high winds are defined as: "An hourly wind speed of greater than or equal to 30 mph or gusts equal to or greater than 40 mph, with no precipitation or only a trace of precipitation." In all these high wind events, hourly wind speeds and/or wind gust data coupled with low precipitation levels meet this high wind definition.

The analysis and documentation of the natural high wind events fulfill Element 1 as described on page 3 of this NEAP.

B. Element 2: Public Education Programs

The purpose of this program is to inform and educate the public about the problem. The Division has worked with the City of Alamosa, Alamosa County Commissioners, and interested stakeholders to educate the public about the problems associated with elevated levels of PM10 in the Alamosa area. Several meetings have taken place with the City and County governments to discuss these issues and to develop a plan to address future high wind events in Alamosa. Elements of the public education program include: informing the public when air quality in the area is unhealthy; explaining what the public can expect when high wind events occur; what steps will be taken to control dust emissions during future high wind events; and, how to minimize the public's exposure to high concentrations of PM10 during high wind conditions. The public notification and education programs will include but are not limited to:

- An informational and health-related brochure has been and will continue to be distributed by the local governments, the Alamosa County Health Nurses, and Alamosa County conservation and agricultural extension agencies to sensitive populations (elderly and local school districts) as well as the general public. Distribution of the *Blowing Dust Health Advisory Brochure* began in March 2000. A copy of this brochure is available in the Appendix. More recent (since the February 2002 submittal of the NEAP) activities include: 1) the revision of the area brochure to highlight additional activities in the community and make the document more reader friendly; 2) a review of the effectiveness of the brochure distribution in the community. The brochure is now available at additional sites in the community (e.g., County Land Use office), and; 3) the development of a Spanish version of the brochure.

- Beginning in February 2002, blowing dust watches and health advisories are being issued by the Alamosa County Public Health Nursing office during the high wind season (see Appendix for details). More recent (since the February 2002 submittal of the NEAP) activities include: 1) expanding the public education effort to include staff from the County Land Use office; 2) meetings with city, county, and local public health nurse to devise improved ways to educate/reach the community regarding blowing dust and its impacts.

- Media press releases for both the print and local radio will be issued in the community as needed. More recent (since the February 2002 submittal of the NEAP) activities include: 1) newspaper articles highlighting the significant impacts of the drought on blowing dust in the Alamosa area (e.g., "Biblical Level Help Needed for Drought," *The Denver Post*, April 22, 2002. This referenced article also highlighted some of the mitigation strategies underway to limit impacts), and; 2) identifying possible Public Service Announcement outlets for additional outreach into the community and the ongoing development of an area press release on the NEAP development and control strategies.

- Meetings have been held to review the requirements of and local involvement in the NEAP. Other meetings will be convened as deemed necessary by State and/or local agencies.

- Advertising at local meetings (e.g. Sunshine Festival - Summer 2003) of ongoing efforts to reduce blowing dust and its impacts. This is new effort not part of the February 2002 submittal.

- Development of a logo/brand to better familiarize area residents to the NEAP and components of that plan including the blowing dust advisory. An example of that logo can be found on the revised *Blowing Dust Health Advisory Brochure,* located in the Appendix. This is new effort not part of the February 2002 submittal.

- Ongoing development of educational materials to be made available through the County's tax announcement (2004). These educational materials will be distributed in the mail alongside tax announcements and are expected to go to all area residents (approximately 13,000 notices). Materials are likely to be in both English and Spanish. This is new effort not part of the February 2002 submittal.

- The Division in conjunction with the area County Public Health Nurse is revising the blowing dust education/notification procedure to highlight public health issues associated with blowing dust.

- Finally, County building inspectors will also educate citizens (home owners and contractors) about blowing dust issues and strategies to minimize such. This will be done in all construction zones in the county and documented as an item on the inspector's checklist of building issues covered during the permitting process. This is new effort not part of the February 2002 submittal.

This section fulfills the requirement of Element 2 as described on page 4.

C. Element 3: <u>Public Notification Program and Health Advisory Program</u>

The Blowing Dust Health Advisory program will notify the public that a high wind/blowing dust event is imminent or currently taking place, and will include an advisory suggesting what actions can be taken to minimize PM10 emissions and exposure to high concentrations of particulate matter.

Advisories are issued by the Alamosa area Public Health Nursing office, with forecasting assistance provided by the National Weather Service (Pueblo) and the Colorado Air Pollution Control Division. Since 2002, five (5) advisories have been issued locally. The forecasting methodology, the public education brochure, and a copy of the text of blowing dust forecasts and health advisories are provided in the Appendix.

Alamosa County will be investigating, during 2003, the possibility of modifying the 911 data base for reverse notification of sensitive populations during high wind events. This is new activity not included in the February 2002 submittal.

Finally, high winds are currently being documented to determine if the Division and the local agencies can better address these issues. For example, the Alamosa County Public Health Nursing office maintains records of all blowing wind events and the associated notifications. Included in this analysis is a rudimentary review of the high wind data to identify patterns of events and possible solutions to minimize public exposure. Given the drought conditions affecting the Alamosa area over the past several years, no consistent pattern (outside of extremely dry conditions and lack of rainfall) has been noted. Nonetheless, the Division is committed to continually investigating this issue and improving the advisory as possible. Ongoing review of those records will continue to investigate patterns of the exceedances and the notifications. This is a new activity that was not part of the February 2002 submittal and demonstrates additional efforts by the Division and the local agencies to minimize blowing dust and protect public health.

This section fulfills the requirement of Element 3 as described on page 4.

D. Element 4: Determination and Implementation of BACM

1. BACM Determination

According to the NEP, Best Available Control Measures (BACM) must be implemented for anthropogenic sources contributing to NAAQS exceedances in attainment and unclassifiable areas, like Alamosa. BACM must be in place for those contributing sources within *three years* after the first NAAQS violation attributed to high wind event(s) for sources in the Alamosa area. BACM must be in place no later than April 18, 2003. BACM for PM10 are defined (in 59 F.R. 42010, August 16, 1994) as techniques that achieve the maximum degree of emissions reduction from a source as determined on a case-by-case basis considering technological and economic feasibility.

On September 2, 1999 the Division attended several meetings in Alamosa with officials representing the City of Alamosa and Alamosa County Commissioners. Discussed were the monitoring data, meteorological data, potential contributing sources to the high wind events, the development of a NEAP, and possible control measures. In addition, meetings in December 2001 and February 2002 and numerous correspondences at other times have covered the same. The meetings, coupled with the analyses of the supporting documentation, identified two distinct sets of circumstances that lead to Alamosa's high wind/blowing dust exceedances of the PM10 NAAQS:

1. High concentrations of PM10 caused by a mixture of anthropogenic and non-anthropogenic sources coming largely from outside the area under high wind conditions; and,

2. Prolonged climatic conditions of low precipitation over an extended period of time that act to dry area soils, making them more susceptible to airborne activity under high wind conditions.

Discussions with the community stakeholders also covered local agricultural practices. Alamosa County is a predominately agricultural area where a lack of 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.

Other potential contributing sources may include construction sites, wind erosion of open areas, paved and unpaved roads, residential wood burning, and/or open burning. See below for more details on each of these potentially contributing sources and their consideration for BACM.

2. BACM Options Considered

Based on the contributing source analysis and/or in review with community stakeholders, the following BACM options were considered as possible PM10 control measures for the community:

a) Street Sweeping Activities- community street sweeping programs have demonstrated effectiveness in other communities. Such activities were considered as a local control measure. Expanding the current street sweeping program was also reviewed.

b) Construction/Demolition Activity – local ordinances to control emissions from construction and demolition sites have been implemented in other parts of the state with good success.

c) Wind Erosion of Open Areas – several practices were reviewed regarding the wind erosion of open areas, including both local and regional efforts.

d) Control of Stationary Source Emissions- as identified elsewhere in this NEAP, a review of stationary sources and their relative contribution to overall PM concentrations was completed.
It was determined that six PM-10 sources exist in the area, appearing to contribute a small amount of particulate matter to the overall inventory.

e) Road Stabilization- In a effort to better understand the effects of road stabilization, several options were reviewed including the use of chemical stabilizers and water as a stabilizing measure.

Also, periodic assessments to determine if traffic levels on unpaved roads surpass Colorado Regulation No. 1 limits were considered. If daily traffic counts exceed 200 trips per day on unpaved roads, state regulations apply that reduce PM-10 emissions from those roads. Specifically, periodic assessments of traffic levels on unpaved roads within the city limits and within one mile of the city limits were considered. State regulation calls for a road traffic count and dust control plan for roads that exceed the 200 trips threshold.

In addition, Alamosa currently suggests that drivers maintain their vehicles at a slow speed on unpaved roads and other dirt surfaces to reduce dust emissions.

f) Woodburning Curtailment Programs- the possibility of instituting a citywide curtailment program was reviewed and considered. This consideration includes discouraging wood burning on high wind days.

g) Open Burning- The usefulness of imposing and maintaining an open burning curtailment program during high wind events was reviewed. Current state air pollution control laws and regulations provide some guidance on the effort.

h) Avoidance of Dust Producing Equipment- The effectiveness of avoiding the use of dust producing equipment has also been considered. Currently Alamosa discourages the use of dust-producing equipment (e.g., leaf blowers) in an effort to reduce PM10 emissions and does so through public education and outreach efforts.

(i) Reducing or Postponing Tilling and Plowing or Other Agricultural Practices that Contribute to PM10 Emissions- It is well recognized that dust-producing activities such as tilling, plowing, and other agricultural practices increase the amount of PM10 released. As such, these control measures were discussed as part of the effort to reduce PM10 impacts on Alamosa. Review of existing and potentially future control practices were considered at the local, regional, state, and federal (e.g., Natural Resources Conservation Service) level.

j) Wind Break- Various trees are found throughout Alamosa. However, the placement of one row of barrier trees (e.g., Russian Olives) would block potential contributing sources. The Russian Olive is a quick growing large shrub/small tree will do well given the windy climate of Alamosa. According to section 3.5.2.1 of EPA guidance entitled Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures, dated September 1992, one-row of trees is considered an effective windbreak.

k) Vegetative Cover/Sod- Efforts elsewhere in the State have demonstrated the usefulness of using a vegetative cover at sites where dust is known to blow. Efforts to use this control measure were reviewed for applicability and effectiveness.

Alamosa PM10 Stationary Source Emissions

To ensure that PM10 emissions from local stationary sources are not a significant contributing factor to area exceedances, an emission inventory was prepared and reviewed. Identified stationary sources are as follows: Public Service Company (natural gas/fuel oil plant), Rakhra Mushroom Farm Corporation (coal-fired boilers and one natural gas fired boiler), Rocky Mountain Soils (fugitive dust emissions), Rogers Family Mortuary (crematorium), San Luis Valley Regional Medical Center (biomedical waste incinerator), and Southwest Ready Mix (concrete batch plant). While no emission inventory of natural sources was prepared as part of this NEAP, appreciation for the significant sand dunes at Great Sand Dunes National Monument highlights that these few and limited stationary sources have very little effect on the total PM10 emission inventory for the Alamosa area. The following table demonstrates their limited impacts on the total emission estimation.

Alamosa PM10 Emission Inventory (circa 2003)

Source	Emissions in lbs/day
Public Service Company of Colorado	44.4
Southwest Ready Mix	4.4
San Luis Valley Regional Medical Center	0.1
Rakhra Mushroom Farm Corp.	11.1
Rocky Mountain Soils, Inc.	11.5
Rogers Family Mortuary	0.5
TOTAL EMISSIONS	***72.1***

Limited Stationary Source Impacts

The largest of these stationary sources, Public Service Company of Alamosa (PSC), is 44.4 pounds per day of particulate matter (as reported to the Colorado APCD). At PSC, the site consists of two turbines that can run on natural gas, #1 fuel oil, #2 fuel oil, or a combination thereof. PSC must stay in compliance with Colorado Air Quality Regulation No. 1 particulate standard. PSC must also meet the state 20% opacity standard.

Other Alamosa area stationary sources have considerably smaller particulate matter emissions than PSC and their own existing control measures in place. For example:

Southwest Ready-Mix has a concrete batch plant in the City of Alamosa. Southwest Ready-Mix has several outside storage piles for their raw materials (sand & aggregate). There exists a sprinkler system at the facility to keep these piles watered. Cement and fly ash are stored in silos, each controlled with a baghouse to capture particulate when the silos are being loaded. When all of the raw materials are loaded into the concrete trucks, 25% of the total water is loaded first, followed by rock, sand, cement, and then the remaining water. This helps to minimize the particulate emissions from the truck during loading. The baghouses are part of the Southwest Ready-Mix permit, and as such are required. This source is also subject to the 20% opacity standard. Finally, Southwest Ready-Mix may be upgrading their baghouses.

San Luis Valley Regional Medical Center has a permit for a biomedical waste incinerator, which is natural gas fired. The incinerator is subject to New Source Performance Standards which limit opacity to 10% and also has a particulate standard. Ash removal from the incinerator must be done in an enclosed area to limit particulate emissions. Ash must be completely enclosed during transport as well.

3. BACM Options Discounted

Several BACM options were discounted from further consideration based on meteorological analysis, on-site inspections, and discussions with local government officials and sources.

Woodburning curtailment was discounted because high wind events are actually beneficial to good atmospheric clearing of particulate matter. In addition, woodburning curtailment was not recognized as an effective control measure on high wind days. Lastly, many of the community citizens rely on woodburning as their sole source of home heating- reducing or eliminating wood burning is thus not an option.

BACM of stationary sources at great distances from the City were discounted as their impacts would be negligible, if seen at all.

Finally, for this revised NEAP (since the February 2002 submittal), the community remains committed to meet BACM in all instances, as feasible. For example, meetings with local officials indicate that the ongoing regional drought may significantly impact the amount of water available as a control measure (e.g., watering of roads to reduce PM10). With that, water restrictions (and related economic impacts of the drought) will likely dictate the utility of this control measure.

4. <u>BACM IMPLEMENTED</u>

Refer to the stakeholder agreements for details of selected BACM.

IV. STAKEHOLDER AGREEMENTS

The City of Alamosa, Alamosa County, the Division, and participating federal agencies have been working diligently to identify contributing sources and to develop appropriate BACM as required by the Natural Events Policy. A copy of relevant agreements and supplemental information are included in the Appendix**.** This section fulfills the requirements of Element 4 as described on page 4.

City of Alamosa
The City of Alamosa has been active in addressing potential PM10 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 PM10. Copies of current ordinances and any related commitments are included in the Appendix.

Street Sweeping
Currently, the City of Alamosa sweeps on an every 6-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. In fact, street sweeping in the downtown corridor currently takes place three times per week.

In addition, the City recently agreed to lease/own a new TYMCO 600 (brush-assisted head) sweeper. Efforts are underway to get this effective piece of equipment into place immediately. This new sweeper will complement a mobile mechanical sweeper already in use.

Unpaved Roads within the City

While very few unpaved roads exist in the City of Alamosa, the city did recently annex new land. This annexation includes roadways not currently paved. The City of Alamosa is discussing the paving of these annexed roads. At a minimum, the City of Alamosa commits to continually provide in-kind engineering services for the development of the annexed lands.

Sod/Vegetative Cover Projects in the City of Alamosa

The development and construction of a local park, Eastside Park, is underway in Alamosa. It is anticipated that sodding at the park will take place this year. This commitment is anticipated to reduce blowing dust from this previously undeveloped site.

ALAMOSA COUNTY

Alamosa County has also been active in addressing blowing dust and is preparing county ordinance as such. Examples can be found below and available supporting documents in the Appendix.

UNPAVED ROADS

Alamosa County is presently addressing unpaved roads and lanes that are anticipated to contribute to PM10 emissions in the community. As of 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 and community needs/priorities.

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

For 2003, approximately 14 miles of roads are scheduled for paving. 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.

In addition, once it gets cold enough in the area, the County will wet down some of the more sandy roads. Once the water soaks in and freezes, it is anticipated that good dust suppression will be seen. These commitments are anticipated to reduce PM10 emissions in and near Alamosa. This control measure will be balanced with the availability of water in the area.

Finally, Alamosa County assesses the need to use $MgC1_2$ treatment on roads in front of residences that request such service. Assessments include 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 are granted. Road construction areas are being dampened with water for dust control. Other areas for treatment, such as commercial construction zones or gravel pits, are investigated on a case by case basis.

Dust Control Plans
Alamosa County is considering changes in local ordinances governing dust control plans at construction sites. This will be addressed through the revision of Alamosa County's Comprehensive Plan and supporting zoning codes. Alamosa County is currently reviewing language from other successful dust control programs for inclusion in their local ordinances. The process is due for completion in December 2003 or early 2004 and will specifically include dust control language. This effort is anticipated to reduce PM10 emissions in Alamosa, especially as it relates to impacts on the community and high recorded PM10 values. The Division commits to providing copies of this language to EPA upon finalization and availability.

Wind Erosion of Open Areas
To reduce PM10 emissions from open areas outside of the City limits, low tilling and other soil conservation practices will continue to be utilized in the community. In addition, the community is using in strategic areas the State of Colorado Agricultural Office's program to purchase and plant shelter trees to reduce wind erosion in open areas. 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.

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.

These commitments are anticipated to further reduce the PM-10 emissions in Alamosa.

SOD AND VEGETATIVE PROJECTS IN THE COUNTY

Numerous 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, grass is being grown for aesthetics and dust control.

- Sodding and the placement of decorative rock and ground cover will be implemented in the landscaping of the Alamosa County property, as well. These measures will directly abate blowing dust at the Airport.

- Also, the widening of the airport's safety areas (250 feet on either side of the runway) is now 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.

These efforts are anticipated to further reduce PM10 emissions in Alamosa.

Open Burning Issues at the County

The Colorado air pollution control laws and regulations prohibit 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. No open burning is allowed when local wind speeds exceed 5 miles per hour.

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

As stated elsewhere in this NEAP, 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:

- Cover crops and perennial crops (e.g., alfalfa) are recommended to protect soils;
- NRCS works with area farmers in the development of conservation compliance plans to also protect topsoil;

- NRCS encourages the use of perennial crops or the leaving in place of weeds on the corners of area acreage (instead of tilling that might lead to open, barren lands) to reduce the lifting of topsoil;
- NRCS "cost shares" on conservation practices with local farmers to prevent soil erosion, and;
- The NRCS works with Colorado State University to identify other strategies that minimize blowing dust.

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.

Natural Events Policy guidance indicates that control options must be implemented within three years of the exceedance in question. For Alamosa, BACM must be in place no later than April 18, 2003. This submittal is meant to meet that three year commitment.

This section fulfills the requirement of Element 4.

V. PUBLIC REVIEW AND PERIODIC EVALUATION

This section describes the public process used to develop this NEAP and the commitment made to periodically evaluate the plan.

STAKEHOLDER INVOLVEMENT

The EPA's NEAP development guidance states that the NEAP should be developed by the State in conjunction with the stakeholders affected by the Plan. The Colorado APCD worked with stakeholders mentioned throughout this document. Numerous meetings and telephone conversations occurred with stakeholders, and the final agreement here reflects control measures offered as part of the NEAP.

PUBLIC REVIEW

The Division made this documentation available for and presented the NEAP and its strategies to the public to ensure public review and comment. Examples of these efforts in Alamosa, beginning with the earliest community involvement, include:

- Briefing of the San Luis Valley County Commissioners, "Air Quality Briefing," San Luis Valley County Commissioners' Association Meeting, September 1999.
- "Control Alamosa's Dust? Lots of Luck." Newspaper article appearing in *Pueblo Chieftan* indicating the area is developing a plan (NEAP) to address blowing dust – November 1, 2001.
- Briefing of the Alamosa City Council, "Alamosa Air Quality and the Development of a Local Natural Events Action Plan," a meeting to reintroduce

the NEAP to City Council staff, February 6, 2002.
- Placement of *Natural Events Action Plan for Alamosa, Colorado* at the area library (Southern Peaks Public Library) for public review, February 2002.
- "Odd Issues Keep Alamosa Busy." Newspaper article appearing in *Valley Courier* indicating NEAP being developed and available for public review at the Southern Peaks Public Library, February 2002.
- Briefing of the Alamosa City Council, "Alamosa Natural Events Action Plan," a meeting to incorporate comments from the City Council, local stakeholders, and the public, February 20, 2002.
- Briefing of the Colorado Air Quality Control Commission, "Natural Events Action Plan for Alamosa, Colorado," May 2002.
- Briefing of the Colorado Air Quality Control Commission, "Alamosa Natural Events Action Plan – Final Activities," January 2003.
- Public Notice, "Natural Events Action Plan for Alamosa, Colorado" Available for Public Review and Comment at the Public Library, April 2003.
- "Media Advisory" notifying public of upcoming Alamosa City Council meeting to discuss the NEAP, monthly city council meeting agenda published in the area newspaper, May 2003.
- "Media Advisory" notifying public of City Council meeting to discuss the NEAP, Channel Ten Cable Access Channel Public Service Announcement, May 2003.
- Briefing of the Alamosa City Council, "Final Alamosa Natural Events Action Plan," May 2003.

Periodic Evaluation
EPA's Natural Events Policy guidance requires the state to periodically reevaluate: 1) the conditions causing violations of the PM10 NAAQS in the area, 2) the status of implementation of the NEAP, and 3) the adequacy of the actions being implemented. The State will reevaluate the NEAP for Alamosa at a minimum of every 5 years and make appropriate changes to the plan accordingly.

Evaluation of the effectiveness of the NEAP included several key strategies to ensure protection of public health and a robust plan. Strategies included: review of Natural Events Policy in specific relation to the Alamosa community, review of the effectiveness/appropriateness of ongoing control strategies, consideration of new/additional control options, review of meteorological and climatological conditions leading to blowing dust, review of local and regional PM10 monitoring data, discussions with other States (e.g., South Dakota, Washington) and Federal (US EPA) personnel regarding NEAP updates and protocols, review of the established emission inventory and identification of any new emission sources, review of the blowing dust advisory protocol and notification records, public/stakeholder meetings and community outreach/education efforts, etc.

The Division commits to continually review the effectiveness of the Alamosa Natural Events Action Plan and improve the effort, where feasible.

The Division commits to evaluate the NEAP at a minimum of every five years.

Submittal to EPA

The NEAP was submitted in its initial form to EPA in October 2001. Following EPA comment and input from stakeholders, appropriate changes were made to the NEAP. The Alamosa City Council heard and approved the NEAP in February 2002. Since that period, meetings with local agencies and stakeholders have led to finalization of stakeholder agreements (found elsewhere in the NEAP). The *Final Natural Events Action Plan for Alamosa, Colorado* and its Best Available Control Measures, where feasible, are presented here as required under the Natural Events Policy[1].

This section fulfills the requirements of Elements 6, 7, 8, and 9 as described on page 4 and 5.

1. Natural Events Policy (NEP). EPA, May 30, 1996.

ii. Soil Survey: Alamosa County Colorado. USDA, Soil Conservation Service. April 1966, p. 140.

iii. NEP. p. 8.

iv. Colorado State PM10 Natural Events Report: Technical Support Document. Colorado Department of Public Health and Environment, Air Pollution Control Division, Technical Services Program. October 6, 1996. p. 14.

v. NEP. p. 9.

vi. NEP. p. 5.

vii. NEP. p. 5.