Technical Support Document For the February 27, 2009 Durango Exceptional Event

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

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Table of Contents

Figures

Tables

Attachments

1.0 Introduction

PM_{10} Standards

In July 1987, EPA promulgated National Ambient Air Quality Standards for Particulates with an aerodynamic diameter of 10 microns or less (PM_{10}). This is a size that can be inhaled into the alveolar regions of the lungs. The standard originally had two forms, a 24-hour standard of 150 $\mu g/m^3$ (micrograms per cubic meter) and an annual arithmetic mean standard of 50 $\mu g/m^3$. 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. The annual arithmetic mean standard was revoked in 2006.

Event Overview

On Friday February 27, 2009, Durango Colorado recorded an exceedance of the twenty-four-hour PM_{10} standard with a concentration of 198 $\mu g/m^3$ at the River City Hall monitor. Elevated readings were also recorded at the Alamosa Municipal monitor with a twenty-four-hour PM_{10} concentration of 109 $\mu g/m^3$, the Alamosa Adams State College monitor with a twenty-four PM_{10} concentration of 49 $\mu g/m^3$ and the Telluride monitor with a twenty-four-hour PM_{10} concentration of 72 $\mu g/m^3$. The Colorado Department of Public Health and Environment, 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 Durango and other areas of southwestern Colorado and the exceedances of the National Ambient Air Quality Standard (NAAQS) for PM_{10} at Durango on 2/27/2009 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 dust that was transported into the Durango, Alamosa, and Telluride areas as an upper level low pressure system and associated surface low pressure and cold front moved southeast across the western U.S. 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.

The Drought Monitor map of the western U.S. for March 3, 2009 shows that all of Nevada was in some classification of dry conditions and that better than half the state was classified under moderate drought or severe drought conditions. The Calculated Soil Moisture Ranking Percentile for February 2009 shows that the majority of Nevada and western Utah had soil moisture conditions in the lower 30 percentile or worse for the month of February. Western Colorado was in the normal 30 to 70 percentile range. There was 0.05 inch of moisture or less across northern Nevada from February 18 - 27, 2009. These soil moisture conditions suggest that blowing dust was possible in Nevada and parts of Utah and unlikely in western Colorado.

Surface weather maps for northern Nevada during the hours of strongest vertical mixing of the atmosphere on February 26, 2009 show wind speeds across the region of 20 to 35 mph and wind gusts of 20 to 60 mph. Such winds were sufficiently high to cause blowing dust in Nevada and parts of Utah. Satellite imagery confirms large plumes of blowing dust in Nevada on February 27, 2009. NOAA HYSPLIT back trajectories for February 26 and 27 show that transport of airborne dust from the dust source regions to southwest Colorado was likely.

The blowing dust from dry lakes and desert areas visible in the 250m resolution MODIS satellite image, the NOAA Smoke Text Product description of dust from western Nevada to Salt Lake City and the NWS observations of winds above blowing dust thresholds and restricted visibilities from locations along I-80 in Nevada and Utah demonstrate that this is a natural event that cannot be reasonably controlled or prevented.

The Center for Snow and Avalanche Studies has been studying the effects of desert dust from outside of Colorado on deposition, snowpack albedo, and snowmelt at the Senator Beck Basin Study Area in the San Juan Mountains of southwestern Colorado. February 27, 2009, is the third event out of twelve recorded in the 2008/2009 water year by the Center for Snow and Avalanche Studies. The record of dust deposition on mountain snowpack in The San Juans on February 27, 2009, is consistent with the arrival of dust from Nevada identified in this analysis, and supports the conclusion that the elevated PM_{10} concentration in Durango was not caused by local sources in Durango or its immediate surroundings. Snow cover data for the Durango area also suggests that local area sources may have had too much snow cover and or soil moisture to support local emissions of dust.

Filter analysis data presented in this report shows that the PM_{10} measured in Durango on February 27, 2009, was largely geologic material or dust. High nitrate concentrations evident in the PM_{10} filter speciation report are consistent with high nitrate previously measured in a published characterization of windblown dust from a playa or dry lake bed in western Nevada.

All of the elevated twenty-four-hour PM_{10} concentrations at Alamosa, Telluride, and Durango are above the 90^{th} percentile concentrations for their locations. This is evidence that the event is associated with a measured concentration in excess of normal historical fluctuations including background.

The PM_{10} exceedance in Durango and the elevated PM_{10} values in Telluride and Alamosa on February 27, 2009, would not have occurred if not for the following: (a) dry soil conditions over northern Nevada and western Utah; (b) a tight surface pressure gradient and strong upper level winds mixing to the surface that lead to strong gusty surface winds over northern and western Nevada and portions of Utah on February26, 2009; and (c) the deep mixing of the blowing dust from western and northern Nevada that allowed for the transport of the dust to southwestern Colorado. The PM_{10} exceedance in Durango was due to an exceptional event associated with regional windstorm-caused emissions from erodible soil sources over a large area of western and northern Nevada, and these sources are not reasonably controllable during a significant windstorm under abnormally dry or moderate drought conditions.

2.0 Meteorological Analysis of the February 27, 2009, Blowing Dust Event

On Friday February 27, 2009, Durango Colorado recorded an exceedance of the twenty-four-hour PM_{10} standard with a concentration of 198 $\mu g/m^3$ at the River City Hall monitor. Elevated readings were recorded at the Alamosa Municipal monitor with a twenty-four-hour PM_{10} concentration of 109 $\mu g/m^3$, the Alamosa Adams State College monitor with a twenty-four PM_{10} concentration of 49 $\mu g/m^3$ and the Telluride Colorado monitor with a twenty-four-hour PM_{10} concentration of 72 $\mu g/m^3$ as seen in Figure 1. *All of these twenty-four-hour PM_{10} concentrations are above the 90th percentile concentrations for their locations. This is evidence that the event is associated with a measured concentration in excess of normal historical fluctuations including background.*

Both the Telluride and Durango areas had significant snow cover on February 27, 2009, and there were no reports of blowing dust in Durango, Telluride, and Alamosa. It will be shown that this exceedance and the high PM_{10} readings are the consequence of dust that was transported into the Durango, Alamosa, and Telluride areas as an upper level low pressure system and associated surface low pressure and cold front moved southeast across the western U.S. On February 27, 2009, there were some strong winds across eastern Utah and western Colorado but no reports of blowing dust. The weather system that caused the strong winds on February 27, 2009, also caused strong winds and areas of blowing dust across parts of Nevada on February 26, 2009. It is believed that the blowing dust on February 26, 2009, became well mixed in the boundary layer and was transported east and then southeast into southwest Colorado on February 27, 2009. Enough of the dust was deposited in southwest Colorado to cause the elevated PM_{10} readings in Telluride and Alamosa and the exceedance in Durango on February 27, 2009.

The strong winds on February 26, 2009 were partly the result of a strong pressure gradient associated with a surface low pressure in eastern Washington and a cold front trailing back to the southwestern Oregon coast as presented in the surface analysis for 12Z February 26, (5 AM MST February 26) in Figure 2. These surface features were associated with a strong upper level low pressure moving into the Pacific Northwest on February 26, 2009. Figure 3 shows the 500 millibar analysis for 12Z February 26, 2009 (5 AM February 26, MST). There was a closed low over Washington with a wind speed maximum of 95 knots at this level over Medford Oregon and winds of 50 to 70 knots across the western U.S. The 12Z February 26, 2009, (5 AM MST February 26) sounding at Reno, Nevada, in Figure 4 has wind speeds of 45 to 75 knots from just above the surface inversion to near 500 millibars. Once the morning inversion had dissipated, the momentum associated with the winds in this layer mixed down to the surface intensifying the winds induced by the surface pressure gradient associated with the surface low pressure and its cold front.

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* 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 Nevada. It will be shown that these wind conditions were met in most of northern Nevada on February 26, 2009, but on February 27, 2009, they were only briefly met in Price, Utah, and in Durango, Colorado.

The National Weather Service (NWS) Reno Forecast Office began issuing various wind advisories for the Nevada Zones of its forecast area on February 25, 2009, for February 26, 2009. These advisories called for sustained wind winds of 20 to 30 mph and gusts to 65 mph with areas of blowing dust. The NWS Reno Forecast Office Forecast Discussions for February 26 also discusses the strong winds across the forecast area. The advisories, forecast discussions, and a map of the Reno NWS Forecast Zones can be

found in Appendix A. Figures 5 through 7 show surface maps for northern Nevada during the hours of strongest vertical mixing of the atmosphere on February 26, 2009. They show wind speeds across the region of 20 to 35 mph and wind gusts of 20 to 60 mph. Tables 1 - 4 are the National Weather Service observations for Lovelock, Nevada; Winnemucca, Nevada; Elko, Nevada; and Salt Lake City, Utah. These sites are located along Interstate 80 across northern Nevada to Salt Lake City. The tables show a period of 2 to 5 hours at each location where the sustained winds and or wind gusts meet the blowing dust thresholds or the visibility was restricted by dust. These conditions started in the western-most locations in the late morning and ended in the evening in Salt Lake City. In Salt Lake City the winds did not meet the blowing dust threshold but the dust was transported into the area. The timing of visibility restrictions and lack of strong winds in Salt Lake City are consistent with the dust being transported from west to east as the weather system causing the blowing dust moved east on February 26, 2009.

These winds were able to cause blowing dust due to the dryness in northern Nevada and western Utah. Figure 8 is the Drought Monitor map of the western U.S. for March 3, 2009. It shows that all of Nevada was in some classification of dry conditions and that better than half the state was classified with moderate drought or severe drought conditions. Figure 9 is the Calculated Soil Moisture Ranking Percentile for February 2009. It shows that the majority of Nevada and western Utah had soil moisture conditions in the lower 30 percentile or worse for the month of February. It also shows western Colorado in the normal 30 to 70 percentile range. Table 5 shows that there was 0.05 inch of moisture or less across northern Nevada from February 18 - 27, 2009. These soil moisture conditions suggest that blowing dust was possible in Nevada and parts of Utah and unlikely in western Colorado.

Figure 10 is the USA1 sector (Washington, Oregon, Idaho, northern California, and Nevada, and parts of Utah and Montana) MODIS Today: USA Composite – February 26, 2009, (057) Aqua satellite picture, at a 2000m resolution (http://ge.ssec.wisc.edu/modis-today/). Figure 11 is the portion of the USA1 sector around Pyramid Lake in northwest Nevada at the 250m resolution. It shows extensive blowing dust developing across northwest Nevada. Table 6 is the Smoke Text Product Satellite Services Division, Descriptive Text Narrative for Smoke/Dust Observed in Satellite Imagery through 0100Z February 27, 2009, (6 PM February 26, MST) (http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2009B270256.html). It describes dust extending from western Churchill County in west central Nevada almost to Salt Lake City by late afternoon. The Nevada zones of the Reno NWS Forecast Office include the area in the MODIS satellite picture in Figure 11 with the blowing dust. Figure 12 is the Salt Lake City sounding for 00Z February 27, 2009, (5 PM MST February 26). It shows that the well mixed layer or boundary layer went from the surface to over 500 millibars (about 18,000 ft MSL).

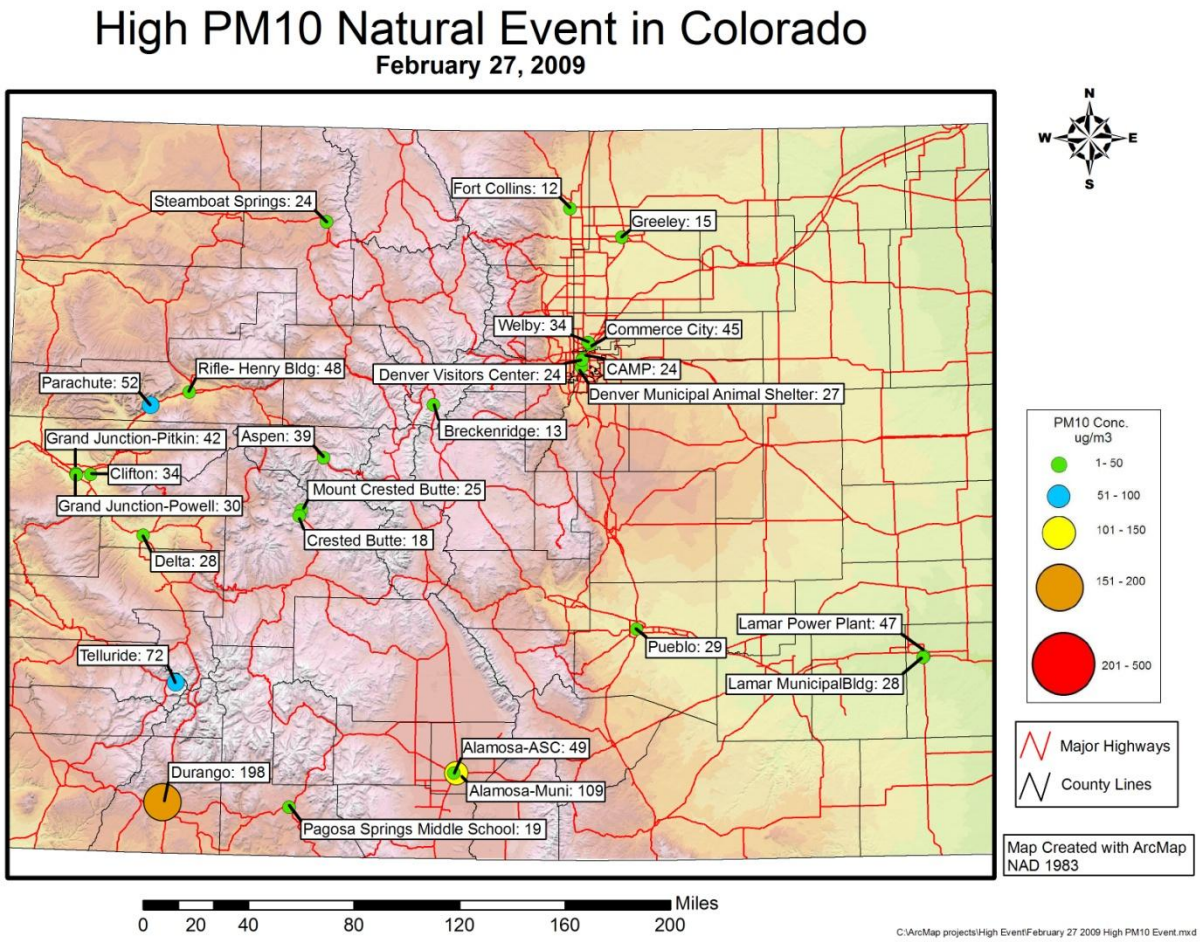

Figure 1. 24-hour PM_{10} Readings for February 27, 2009.

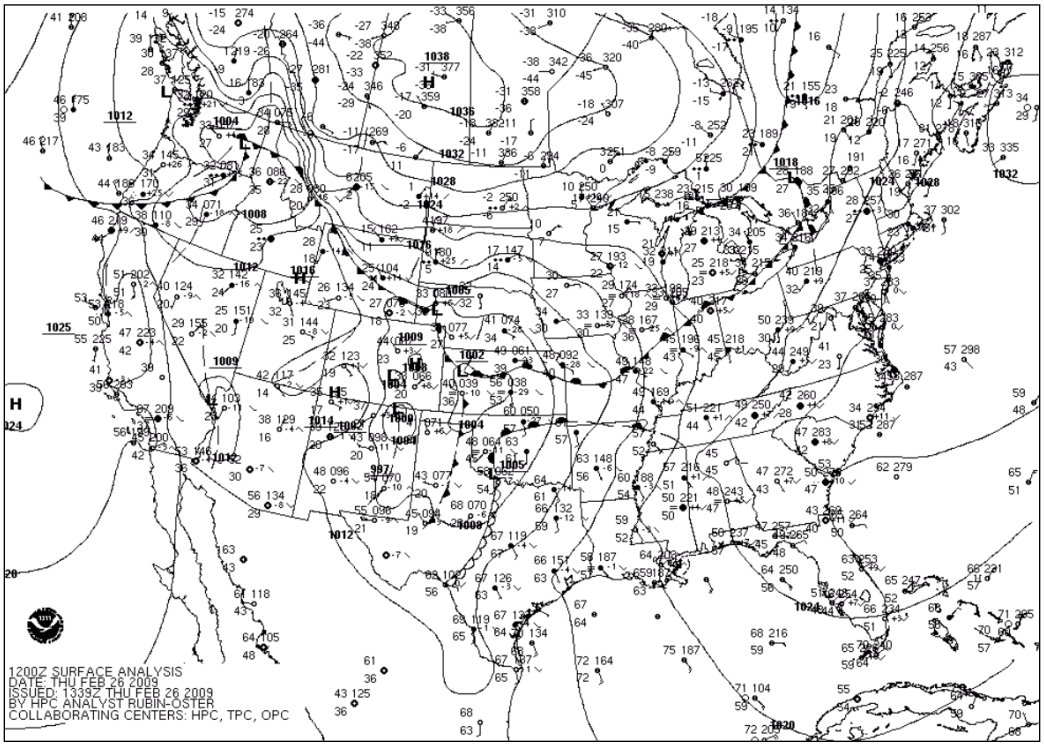

Figure 2. Surface analysis for 12Z February 26, 2009, or 5 AM MST February 26, 2009 (from National Weather Service fax maps http://archive.atmos.colostate.edu/).

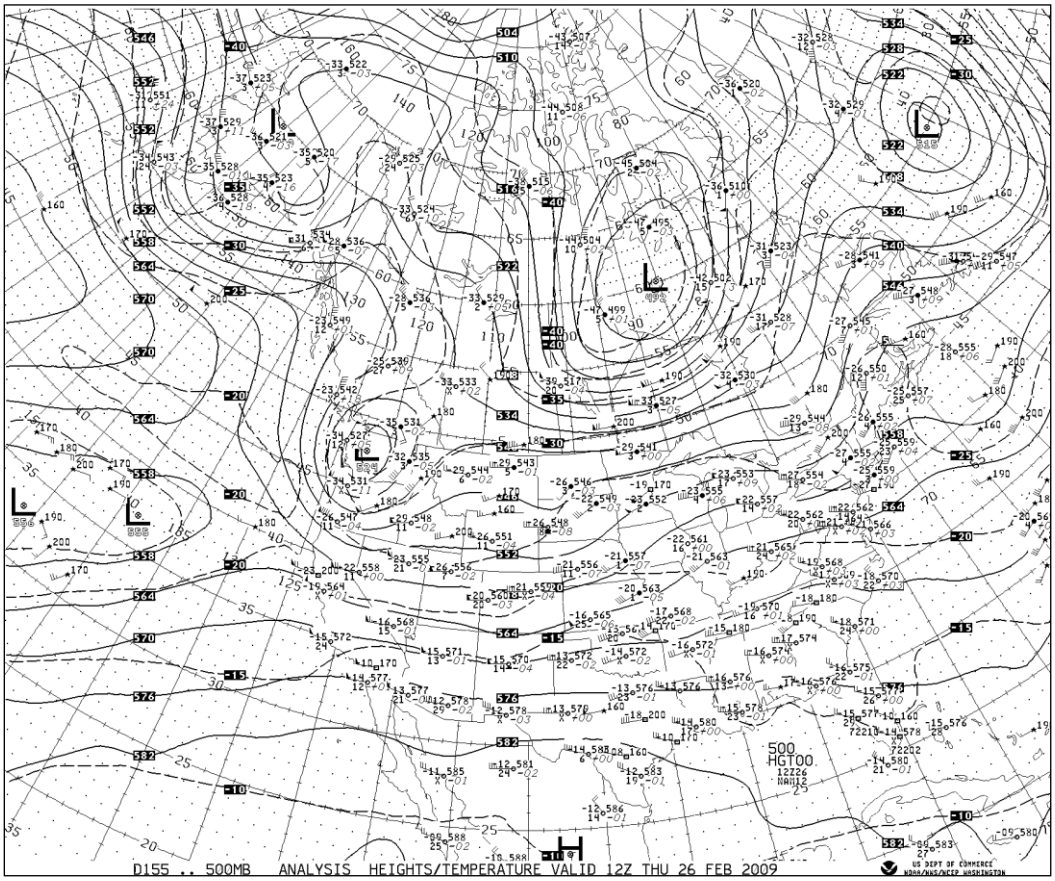

Figure 3. 500 mb analysis for 12Z February 26, 2009, or 5 AM MST February 26, 2009 (from National Weather Service fax maps http://archive.atmos.colostate.edu/).

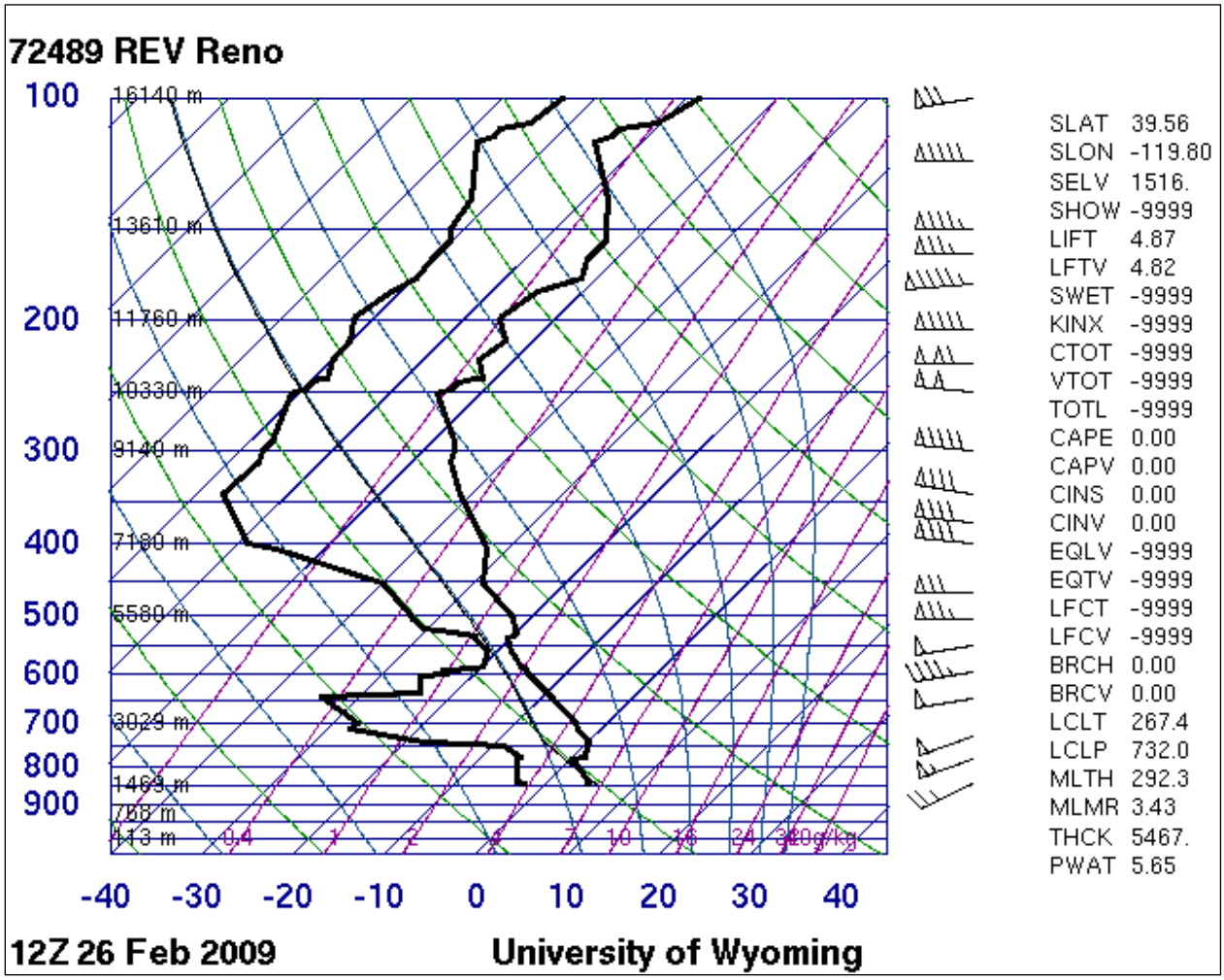

Figure 4. Reno, Nevada, sounding analysis for 12Z February 26, 2009 or 5 AM MST February 26, 2009 (http://weather.uwyo.edu/upperair/sounding.html).

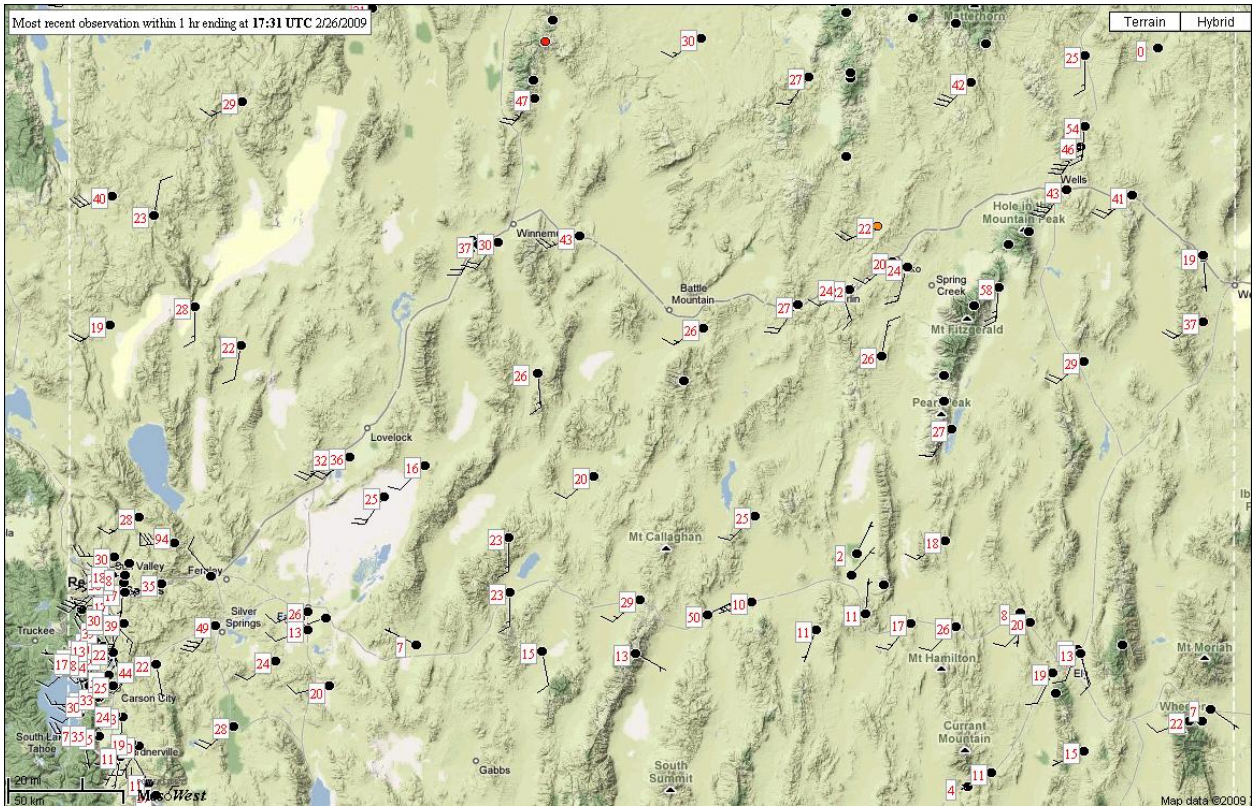

Figure 5. Wind directions and gust speeds in dust source regions of Nevada 17:31 UTC or 10:31 AM MST on February 26, 2009 (http://www.met.utah.edu/mesowest/).

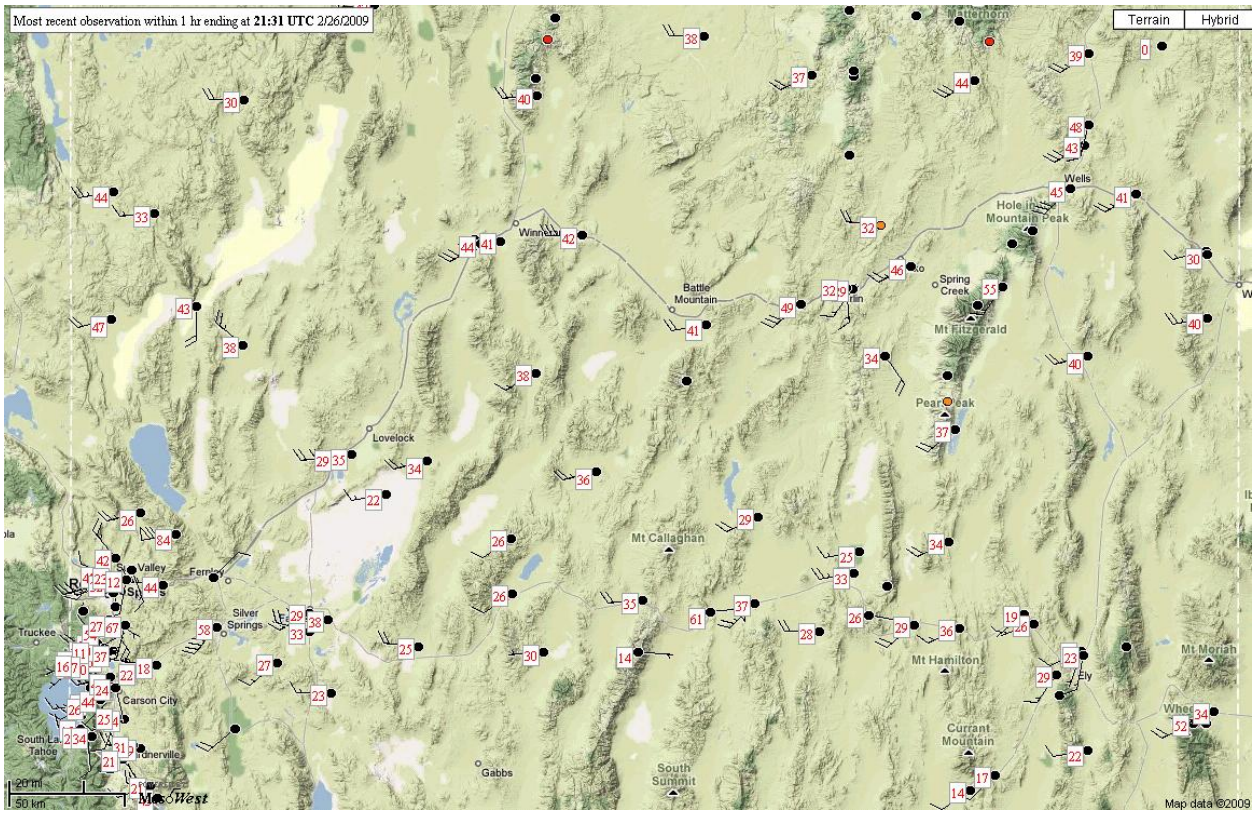

Figure 6. Wind directions and gust speeds in dust source regions of Nevada 21:31 UTC or 2:31 PM MST on February 26, 2009 (http://www.met.utah.edu/mesowest/).

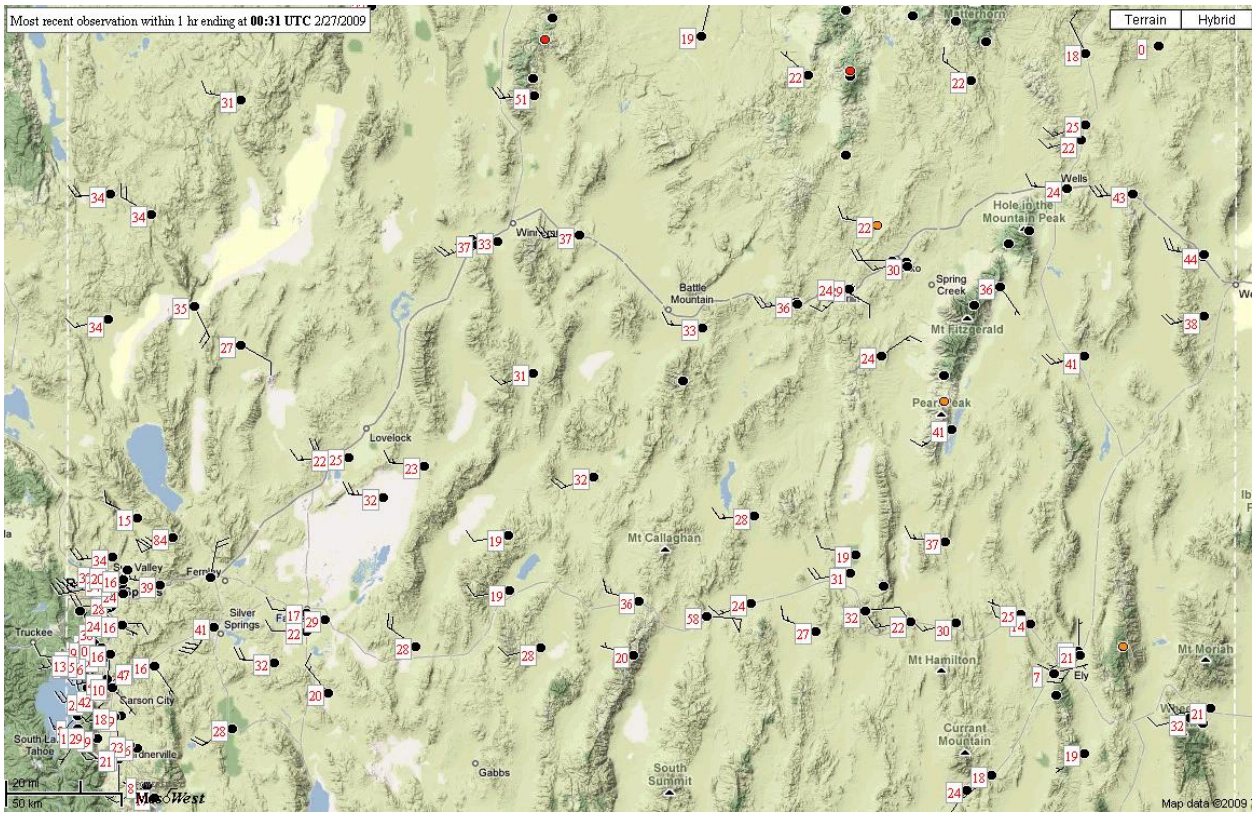

Figure 7. Wind directions and gust speeds in dust source regions of Nevada 00:31 UTC or 5:31 PM MST on February 26, 2009 (http://www.met.utah.edu/mesowest/).

Table 1. Wind and weather observations for Lovelock, Nevada reported by the University of Utah MesoWest site for February 26, 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 PST February 26	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	48	6		280	no value	10
22:53	41	46	6		220	no value	10
21:53	43	45	12		330	no value	10
20:53	41	46	8		260	no value	10
19:53	45	40	7		280	no value	10
18:53	48	34	5		340	no value	10
17:53	50	32	7		290	no value	10
16:53	55	23	21		270	no value	10
15:53	59	20	20	25	280	no value	10
14:53	60	18	15	27	290	no value	10
13:53	59	20	22	29	290	no value	10
12:50	61	19	27	35	260	haze	4
12:49	61	18	24	35	270	haze	3
12:35	61	20	22	32	270	haze	1.75
12:19	61	20	24	37	250	haze	4
11:53	60	22	18	31	260	no value	10
11:22	59	23	20	31	250	haze	5
10:53	58	25	21	31	250	no value	10
9:53	55	27	23	30	250	haze	3
9:37	54	30	16	31	240	no value	8
9:22	55	28	28	36	230	haze	2.5
8:53	53	36	12		200	no value	10
7:53	45	47	5		30	no value	10
6:53	43	49	10		200	no value	10
5:53	36	59	8		60	no value	10
4:53	36	59	0			no value	10
3:53	37	59	4		280	no value	10
2:53	39	52	7		220	no value	10
1:53	39	55	0			no value	10
0:53	38	57	0			no value	10

Table 2. Wind and weather observations for Winnemucca, Nevada reported by the University of Utah MesoWest site for February 26, 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 PST February 26	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:56	31	69	12		330	overcast	10
22:56	32	66	12		330	overcast	10
21:56	31	69	8		290	mostly cloudy	10
20:56	33	66	6		360	mostly clear	10
19:56	35	64	12		340	overcast	10
18:56	39	55	14		340	overcast	10
18:40	39	52	14		340	overcast	10
17:56	46	37	12	18	300	overcast	10
16:56	48	32	20	27	250	overcast	10
15:56	50	29	24	33	250	overcast	10
14:56	52	26	22	39	250	mostly cloudy	9
13:56	52	28	24	37	270	mostly clear	8
12:56	54	25	32	41	250	haze	6
11:56	52	28	24	35	260	mostly cloudy	10
10:56	49	34	27	41	230	overcast	10
9:56	49	37	22	32	230	haze	6
8:56	48	42	18	30	220	overcast	10
7:56	43	53	13		230	overcast	10
6:56	41	57	7		250	overcast	10
5:56	42	57	7			overcast	10
4:56	42	59	10		160	lt rain	10
3:56	41	61	13		190	overcast	10
2:56	40	65	7		190	overcast	10
1:56	40	59	9		160	overcast	10
0:56	41	51	7		180	overcast	10

Table 3. Wind and weather observations for Elko, Nevada reported by the University of Utah MesoWest site for February 26, 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 PST February 26	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:56	30	63	10		350	overcast	10
22:56	31	66	0			overcast	10
21:56	34	64	10		350	overcast	9
20:56	35	61	4			overcast	10
19:56	35	61	6		310	mostly clear	10
18:56	38	57	9	17	310	clear	10
17:56	41	48	14		270	partly cloudy	10
16:56	45	38	20	31	270	partly cloudy	10
15:56	47	37	18		270	partly cloudy	10
14:56	51	30	24	33	260	mostly clear	7
13:56	48	35	24	36	250	haze	5
11:56	50	33	27	44	250	partly cloudy	10
10:56	49	36	32	43	240	partly cloudy	10
9:56	45	47	21	30	230	overcast	10
8:56	42	49	14	20	230	overcast	10
7:56	39	57	6		240	overcast	10
6:56	37	59	5		180	overcast	10
5:56	35	64	4			overcast	10
4:56	33	69	6		260	overcast	10
3:56	32	72	5		210	overcast	10
2:56	31	75	5		100	overcast	10
1:56	30	78	0			mostly cloudy	10
0:56	30	75	4		350	mostly clear	10

Table 4. Wind and weather observations for Salt lake City, Utah reported by the University of Utah MesoWest site for February 26, 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 February 26	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:55	30	86	18		360	overcast	10
22:55	36	64	18		340	overcast	10
21:55	36	64	17		320	mostly cloudy	10
20:55	37	65	16	23	320	mostly cloudy	10
19:55	39	70	16		300	overcast	10
18:55	43	61	15		360	overcast	10
17:55	52	35	9		290	mostly cloudy	9
16:55	54	30	15		290	mostly clear	10
15:50	57	21	20	29	250	mostly clear	8
14:55	55	24	6		260	mostly cloudy	10
13:55	55	28	15	22	240	partly cloudy	10
12:55	55	24	14	24	260	partly cloudy	10
11:55	54	32	14	24	170	mostly clear	10
10:53	50	46	14		160	partly cloudy	10
9:53	45	60	13		150	partly cloudy	10
8:55	41	65	8		130	mostly clear	10
7:55	37	70	9		140	clear	10
6:53	34	82	8		140	mostly cloudy	10
5:53	35	85	7		150	mostly cloudy	10
4:55	36	87	7		150	overcast	10
3:55	36	87	7		150	mostly cloudy	9
2:55	34	86	7		150	partly cloudy	9
1:55	36	87	6		170	mostly cloudy	8
0:55	37	87	4		150	partly cloudy	10

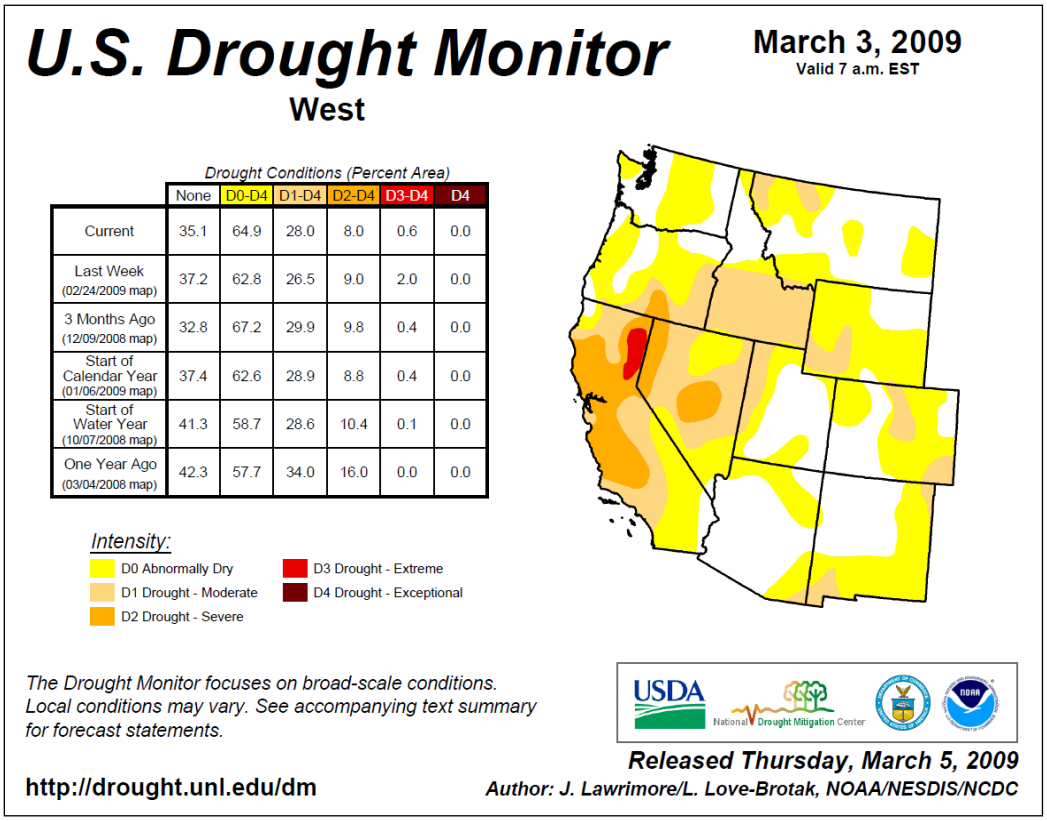

Figure 8. Drought status for the Western U.S. on March 3, 2009 (source: the USDA, NOAA, and the National Drought Mitigation Center at: http://drought.unl.edu/dm/archive.html).

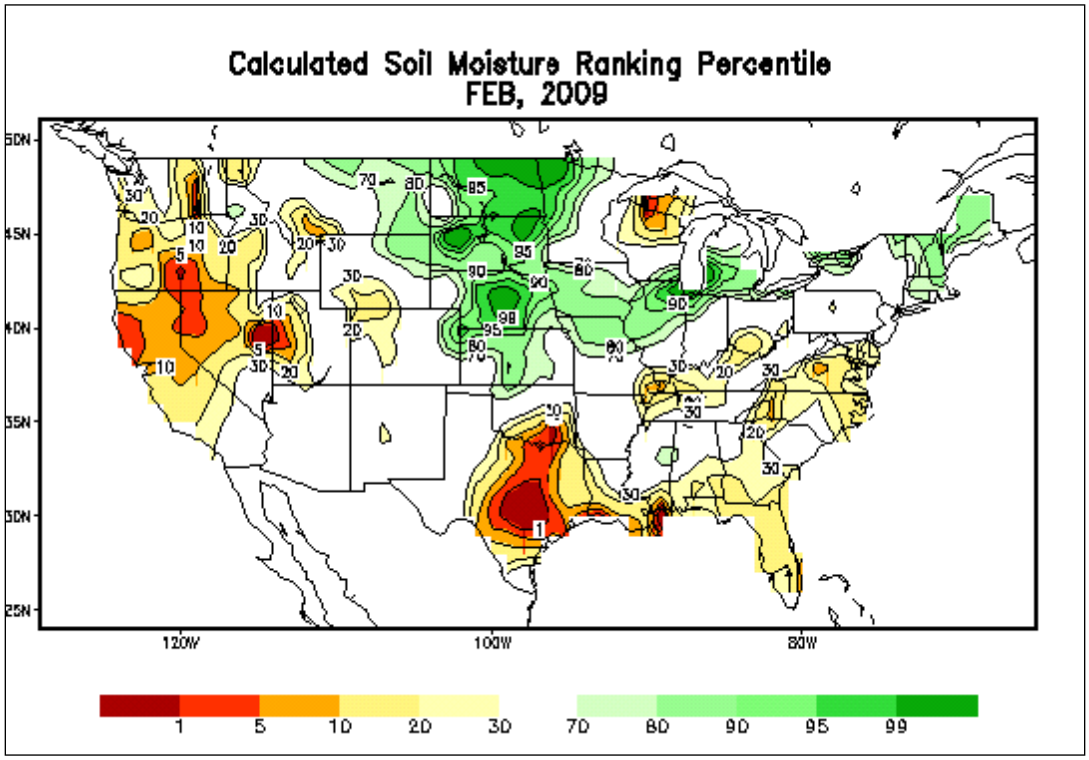

Figure 9. Calculated Soil Moisture Ranking Percentile for February, 2009 (source: the National Weather Service Climate Prediction Center: http://www.cpc.ncep.noaa.gov/soilmst/index_jh.html).

Table 5. Precipitation totals reported by the University of Utah MesoWest site (http://www.met.utah.edu/mesowest/). Monthly total and departure from normal from National Climatic Data Center site Annual Climatological Summary (http://cdo.ncdc.noaa.gov/ancsum/ACS).

Valid 1/28/2009 23:00 through 2/27/2009 Precipitation total in the previous:								
Station Location	**Network Info**	**2 days**	**5 days**	**7 days**	**10 days**	**30 days**	**February Precipitation**	**Departure from normal**
Elko Regional Airport	NWS/FAA 5144 ft	0.01	0.01	0.01	0.01	0.51	0.59	-0.29
Ely Airport	NWS/FAA 6257 ft	0	0	0	0	0.61	0.54	-0.21
Eureka	NWS/FAA 5945 ft	0	0	0	0	0.68	0.68	#
Fallon, Naval Air Station	NWS/FAA 3934 ft	0	0.01	0.01	0.01	0.26	0.26	-0.22
Lovelock, Derby Field	NWS/FAA 3904 ft	0	0	0.01	0.03	0.18	0.10	-0.38
Reno Tahoe International	NWS/FAA 4413 ft	0	0.03	0.03	0.05	0.27	0.21	-0.85
Winnemucca Municipal Airport	NWS/FAA 4301 ft	0	0.02	0.02	0.02	0.25	0.26	-0.36

Note: # only two years of data, no normal value.

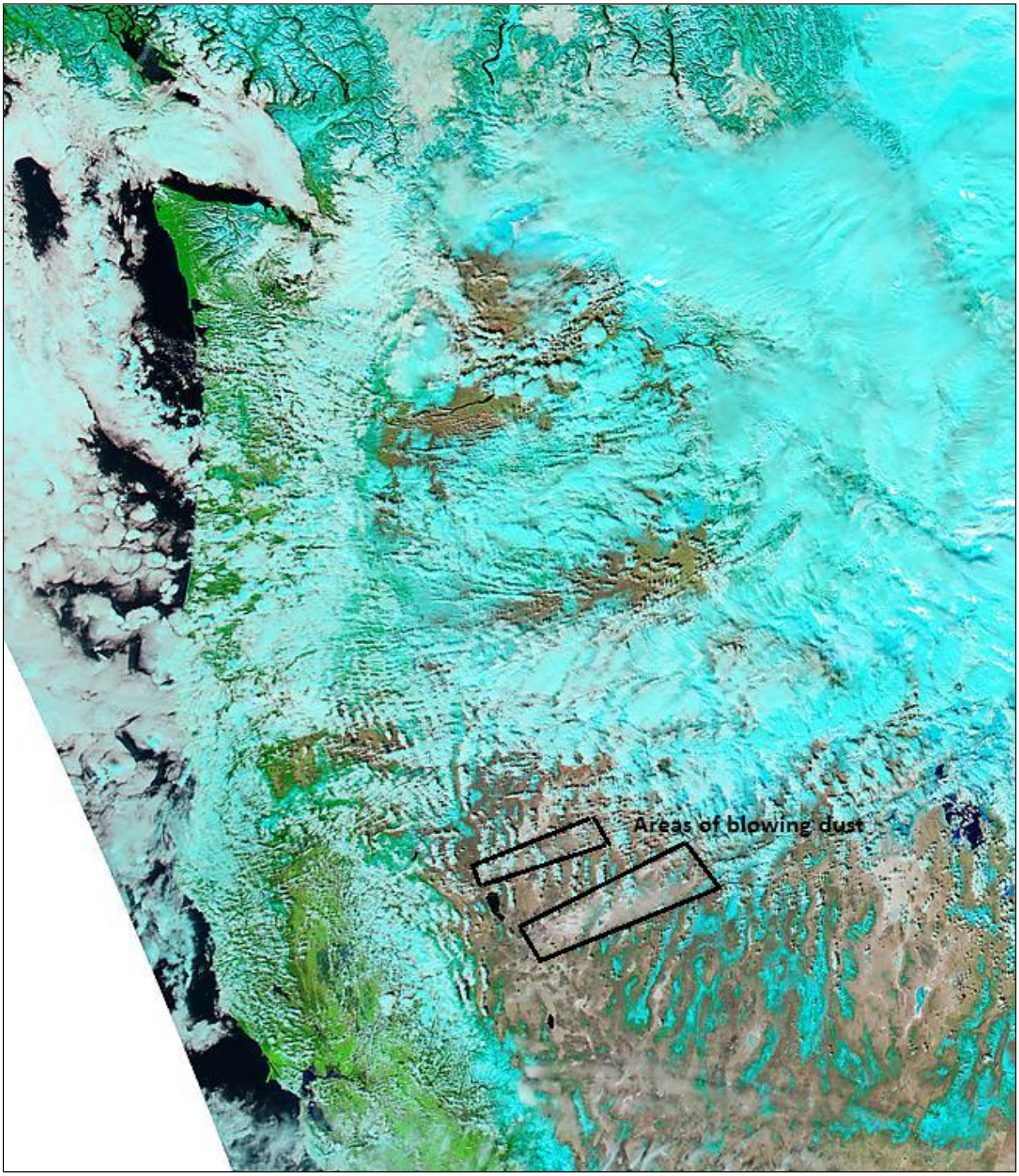

Figure 10. MODIS Aqua satellite, false color, sector USA1, 2000 m resolution for February 27, 2009 (http://ge.ssec.wisc.edu/modis-today/index.php).

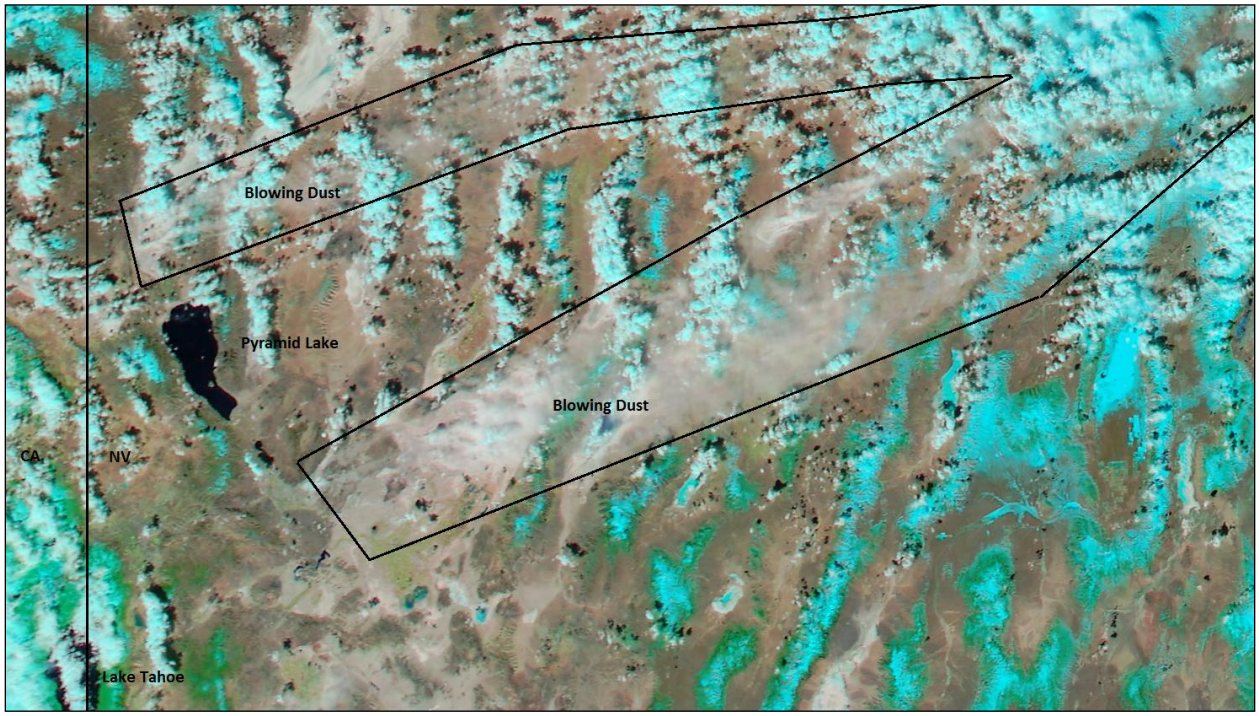

Figure 11. MODIS Aqua satellite, false color, a portion of sector USA1, 250 m resolution for February 27, 2009 (http://ge.ssec.wisc.edu/modis-today/index.php).

Table 6. Descriptive Text Narrative for Smoke/Dust Observed in Satellite Imagery through 0100Z February 27, 2009, reported by the Satellite Services Division of the National Environmental Satellite, Data, and Information Service site (http://www.ssd.noaa.gov/PS/FIRE/smoke.html).

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* THURSDAY, FEBRUARY 26, 2009 *

DESCRIPTIVE TEXT NARRATIVE FOR SMOKE/DUST OBSERVED IN SATELLITE IMAGERY
THROUGH 0100Z FEBRUARY 27, 2009

Once again, a significant amount of cloudiness across portions of
the south central and southeastern U.S. interfered with fire and smoke
detection in satellite imagery. The most numerous visible smoke producing
fires were analyzed across the state of Florida. For more graphical
information concerning these and other fires, please refer to the links
below. Elsewhere, a bit of blowing dust was visible moving eastward across
southwestern Texas, mainly in the area just south of Midland. Farther to
the west, a thicker swath of blowing dust extended from western Churchill
County in west central Nevada eastward to near Salt Lake City, Utah.  JS


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
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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

The blowing dust from dry lakes and desert areas visible in the 250m resolution MODIS satellite image, the Smoke Text Product description of dust from western Nevada to Salt Lake City, and the NWS observations of winds above blowing dust thresholds and restricted visibilities from locations along Interstate 80 in Nevada and Utah demonstrate that this is a natural event that cannot be reasonably controlled or prevented.

The dust in Nevada and Utah was picked up by the prefrontal winds associated with the surface front that swept through Nevada and Utah and mixed throughout the deep surface boundary layer that is apparent in Figure 12 (from the surface to about 500 mb). This dust was transported east as the weather system moved east on February 26, 2009. After sunset a surface based inversion developed and much of the dust was trapped in the remains of the boundary layer above the nighttime inversion. This inversion can be seen in the Grand Junction 12Z February 27, 2009 (5 AM MST February 27) sounding in Figure 13. The dust was transported east-southeast as the cold front and upper level low traveled to the east-southeast during the night of February 26 and the morning of February 27. During the day on February 27, 2009, the inversion dissipated allowing the dust to mix down to the ground. Figure 14 is the 00Z February 28, 2009 (5 PM MST February 27) Grand Junction, Colorado, sounding. It shows that the boundary layer extended to near 750 millibars (about 8,500 feet MSL) and that the winds in the boundary layer were 10 to 15 knots. These light winds would allow more of the transported dust to settle out than if the winds in the boundary layer continued to be strong as they were on February 26, 2009.

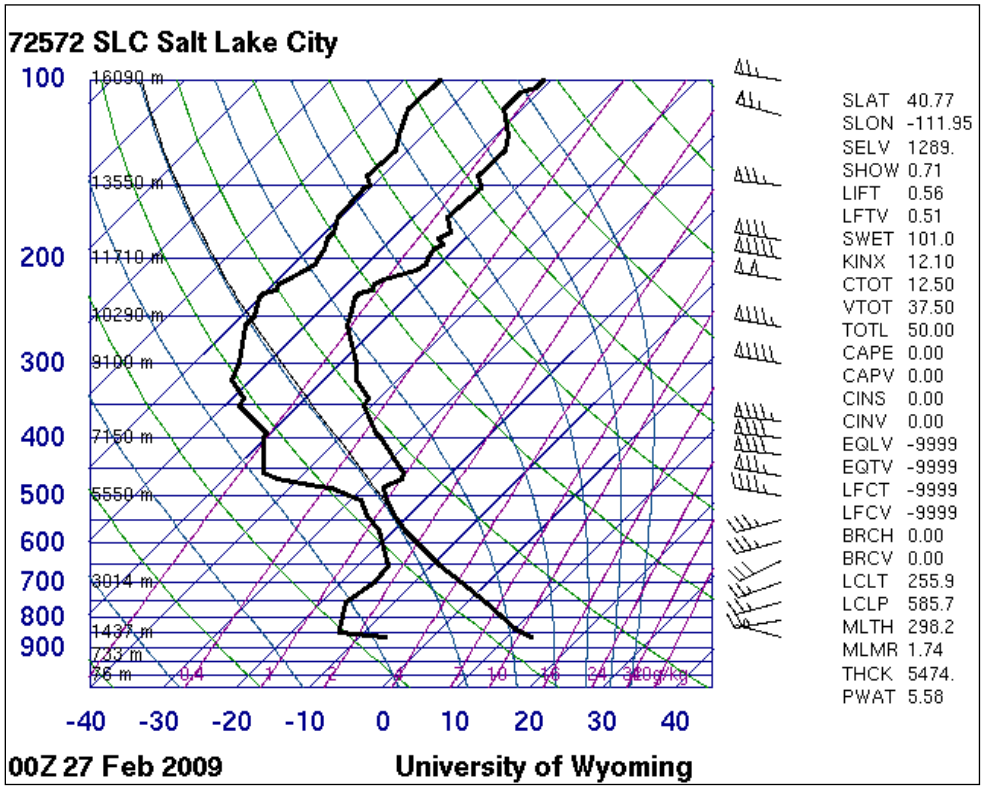


Figure 12. Salt Lake City, Utah, sounding analysis for 00Z February 27, 2009, or 5 PM MST February 26, 2009 (http://weather.uwyo.edu/upperair/sounding.html).

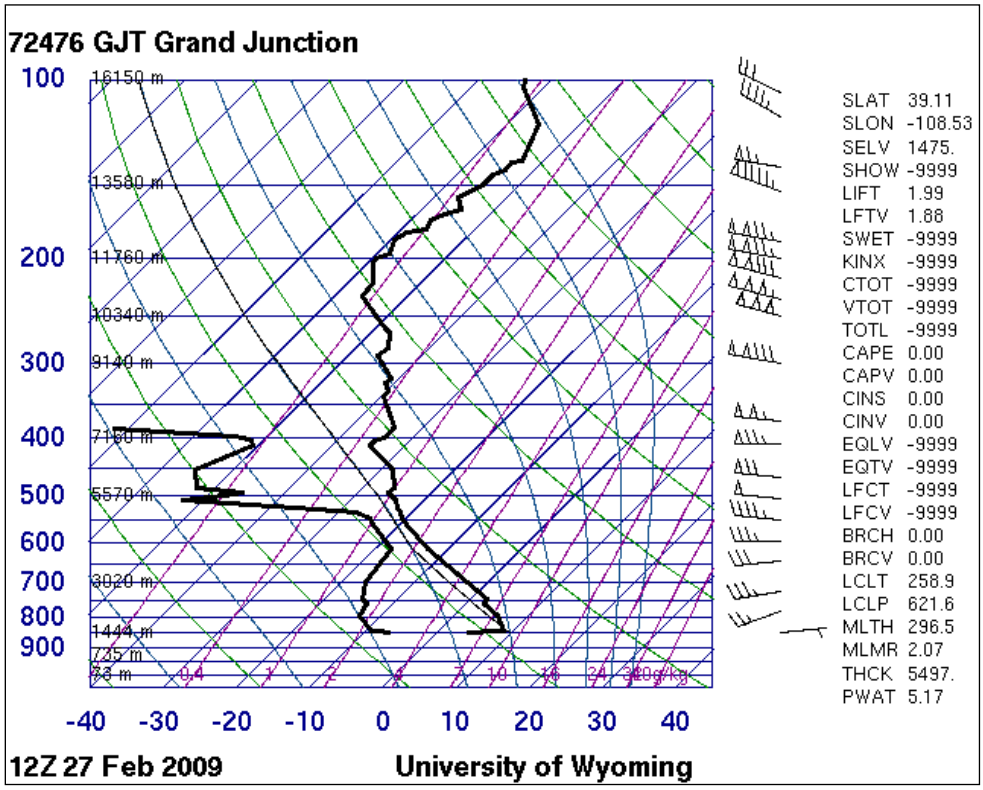


Figure 13. Grand Junction, Colorado sounding analysis for 12Z February 27, 2009, or 5 AM MST February 27, 2009 (http://weather.uwyo.edu/upperair/sounding.html).

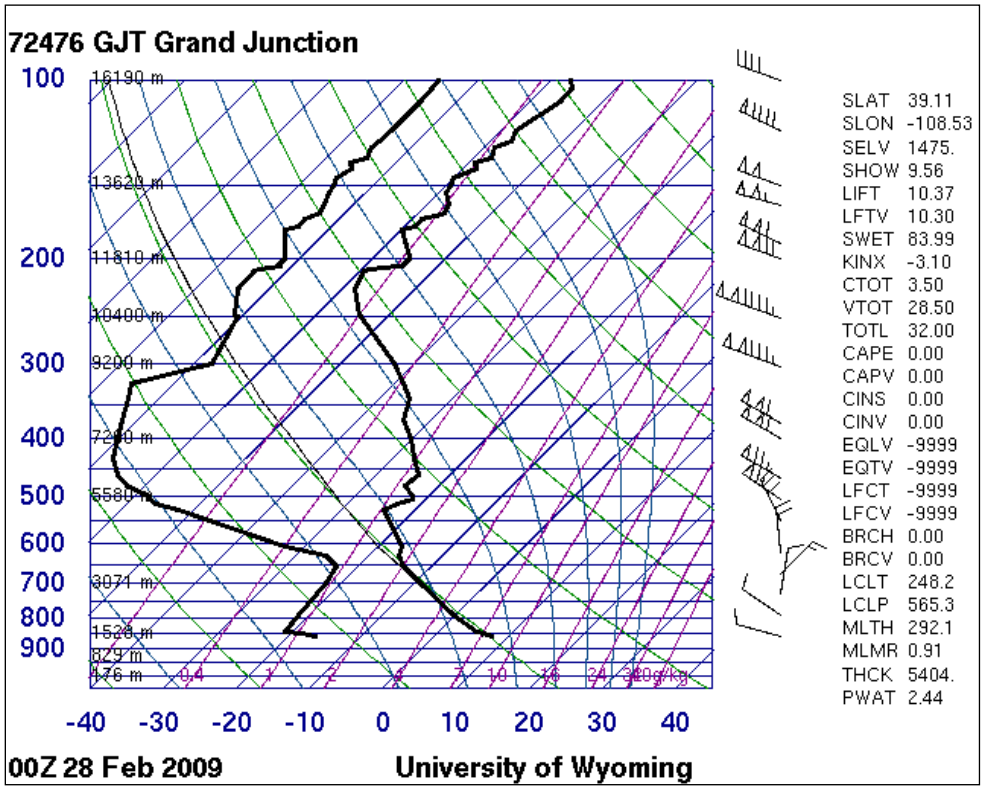


Figure 14. Grand Junction, Colorado sounding analysis for 00Z February 28, 2009, or 5 PM MST February 27, 2009 (http://weather.uwyo.edu/upperair/sounding.html).

Figure 15 is the 500 millibar analysis for 12Z February 27, 2009 (5 AM MST February 27). It shows that the upper low had moved to north central Wyoming and the height of the 500 millibar level in the center of the low had risen from 5240 m to 5390 m since 12Z February 26, 2009, (5 AM MST February 26). This weakening of the upper level low is evident in the weaker surface pressure gradient associated with the cold front shown in Figure 16 (the surface analysis for 12Z February 27, 2009 (5 AM MST February 27, 2009)) and in the surface winds on February 27, 2009 shown in Tables 7 – 11. Surface winds at Price and Moab, Utah, and Telluride, Durango and Alamosa, Colorado, were lower on February 27, 2009 than the winds across Nevada the day before (see Tables 1 – 4). The sites in Table 7 - 11 are the NWS observation sites along the path of the cold front on February 27, 2009. Price had two hours where the wind gusts reached the blowing dust threshold, and Durango had three hours where the wind speeds or the wind gusts reached blowing dust thresholds. No other NWS locations along the path or in southwest Colorado had sustained winds or wind gusts that meet blowing dust thresholds. Alamosa is the only location that reported any restrictions to visibility due to dust. The wind speed and wind gust values at Alamosa never reached the blowing dust thresholds of 25 mph and or wind gusts of 40 mph on February 27, 2009. This is an indication that dust was transported into the Alamosa area.

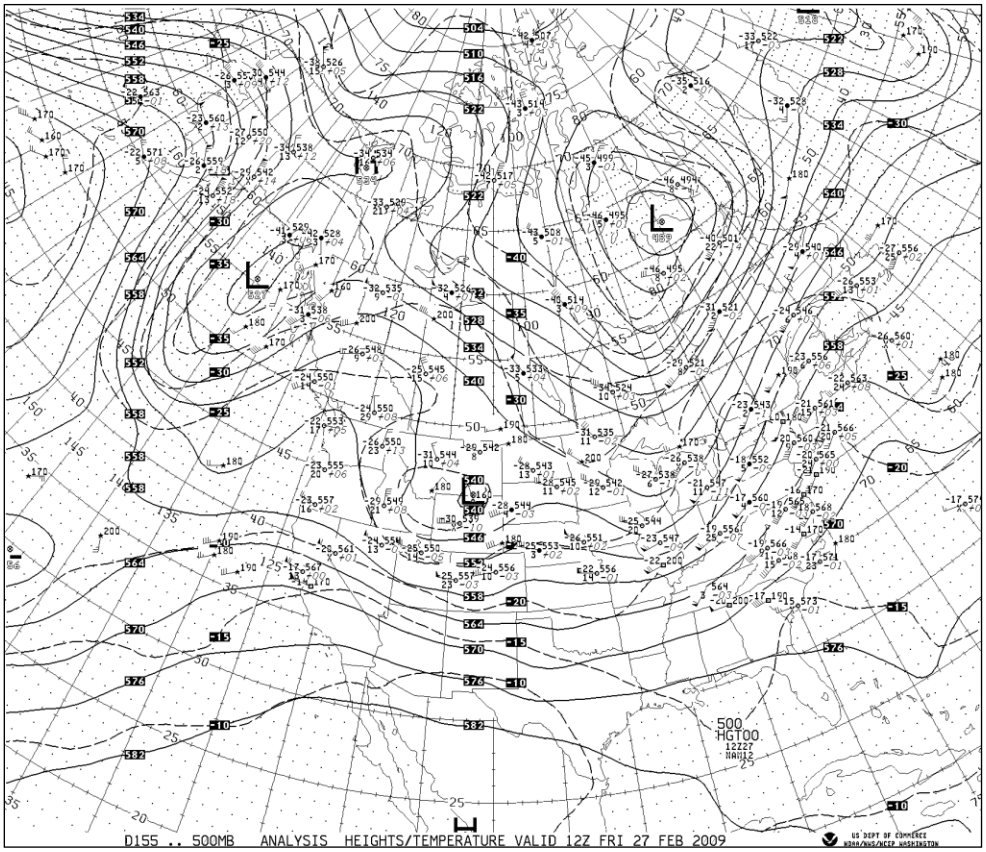


Figure 15. 500 mb analysis for 12Z February 27, 2009, or 5 AM MST February 27, 2009 (from National Weather Service fax maps http://archive.atmos.colostate.edu/).

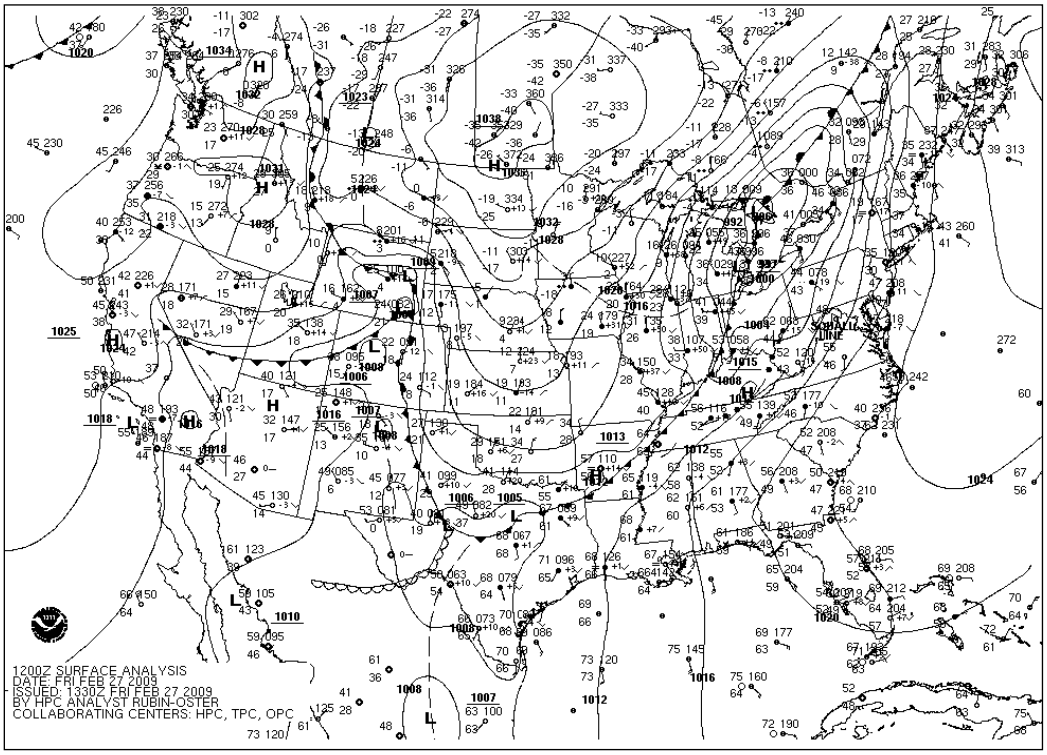


Figure 16. Surface analysis for 12Z February 27, 2009, or 5 AM MST February 27, 2009 (from National Weather Service fax maps http://archive.atmos.colostate.edu/).

Table 7. Wind and weather observations for Price, Utah reported by the University of Utah MesoWest site for February 27, 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 February 27	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:55	25	46	5		350	clear	10
22:53	27	38	0			clear	10
21:55	28	39	4		310	clear	10
20:55	27	42	5		20	clear	10
19:53	30	36	8		320	clear	10
18:53	31	33	9		330	clear	10
17:55	34	32	13		310	clear	10
16:55	37	25	16		320	clear	10
15:55	39	26	12	20	310	clear	10
14:55	37	25	22	29	320	clear	10
13:55	37	25	14	35	320	clear	10
12:53	36	25	14	27	340	clear	10
11:55	36	29	23	43	310	clear	10
10:55	34	34	18	46	290	clear	10
9:55	34	34	23	38	300	clear	10
8:55	34	40	12	21	310	clear	10
7:55	34	47	14	22	300	clear	10
6:55	32	47	15	30	310	clear	10
5:55	34	47	13	22	300	clear	10
4:55	36	47	9	20	290	clear	10
3:55	36	51	15	21	330	clear	10
2:55	37	48	10	17	320	mostly clear	10
1:55	39	44	7		310	mostly cloudy	10
0:55	37	44	8		300	partly cloudy	10

Table 8. Wind and weather observations for Moab, Utah reported by the University of Utah MesoWest site for February 27, 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 February 27	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:53	30	32	4		230	clear	10
22:53	32	30	0			clear	10
21:53	33	26	0			clear	10
20:53	31	28	5		240	clear	10
19:53	40	17	4		100	clear	10
18:53	40	18	6		330	clear	10
17:53	44	16	5		20	clear	10
16:53	48	12	4		60	clear	10
15:53	46	12	9		310	clear	10
14:53	48	13	16	25	310	clear	10
13:53	48	17	18	27	320	clear	10
12:53	48	19	17	25	310	clear	10
11:53	47	24	21		330	overcast	10
10:53	48	25	21	31	290	clear	10
9:53	47	29	23	30	280	clear	10
8:53	44	35	20		300	clear	10
7:53	40	43	13		320	clear	10
6:53	40	43	14		300	clear	10
5:53	40	41	14		280	clear	10
4:53	41	36	9		300	clear	10
3:53	41	36	7		230	clear	10
2:53	43	35	10		230	clear	10
1:53	44	35	12		230	clear	10
0:53	44	35	13		220	clear	10

Table 9. Wind and weather observations for Telluride, Colorado reported by the University of Utah MesoWest site for February 27, 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 February 27	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:50	19	62	0			clear	10
22:50	21	58	4		130	clear	10
21:50	23	53	4		130	clear	10
20:50	23	53	0			clear	10
19:50	25	54	0			clear	10
18:50	27	46	0			clear	10
17:50	28	46	5		40	partly cloudy	10
16:50	30	40	9		340	partly cloudy	10
15:50	30	43	12	20	270	mostly cloudy	10
14:50	32	40	7	18	300	mostly cloudy	10
13:50	32	40	21	29	270	mostly cloudy	10
12:50	32	47	23	32	260	mostly cloudy	10
11:50	34	44	14	31	280	partly cloudy	10
10:50	34	44	14	27	260	partly cloudy	10
9:50	32	43	12	18	300	clear	10
8:50	32	40	14	18	300	mostly cloudy	10

Table 10. Wind and weather observations for Durango, Colorado reported by the University of Utah MesoWest site for February 27, 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 February 27	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:53	29	53	5		340	clear	10
22:53	31	45	9		360	clear	10
21:53	33	41	0			clear	10
20:53	35	40	9		310	clear	10
19:53	36	38	4		190	clear	10
18:53	38	34	13		290	clear	10
17:53	41	29	14	22	270	clear	10
16:53	45	25	25	31	270	clear	10
15:53	47	25	23	30	300	clear	10
14:53	47	29	29	40	300	mostly clear	10
13:53	47	30	25	36	270	clear	10
12:53	47	33	24	38	260	clear	10
11:53	46	37	21	31	250	mostly clear	10
10:53	44	38	22	27	250	clear	10
9:53	37	52	0			clear	10
8:53	30	66	9		80	clear	10
7:53	26	71	4		80	clear	10
6:53	24	71	4		10	clear	10
5:53	24	74	6		40	clear	10
4:53	24	74	0			clear	10
3:53	24	77	0			clear	10
2:53	25	74	4		40	clear	10
1:53	27	68	0			clear	10
0:53	27	66	0			clear	10

Table 11. Wind and weather observations for Alamosa, Colorado reported by the University of Utah MesoWest site for February 27, 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 February 27	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:52	22	52	9		10	clear	10
22:52	25	50	13		10	clear	10
21:52	26	50	15		10	clear	10
20:52	30	41	13	21	340	clear	10
19:52	31	41	20	27	340	clear	10
19:13	32	40	16	25	360	haze	6
19:00	32	43	13	22	360	haze	4
18:52	32	43	9	24	10	haze	5
17:52	35	36	23	36	350	clear	9
16:52	40	37	23	32	360	clear	8
16:13	46	29	21	28	350	mostly clear	10
15:52	49	18	18	25	260	clear	10
14:52	50	17	21	35	260	clear	10
13:52	50	17	23	32	260	clear	10
12:52	51	14	24	39	250	mostly clear	10
11:52	49	14	18	35	300	clear	10
10:52	48	15	22	31	290	clear	10
9:52	45	23	14	23	230	clear	10
8:52	41	28	15		240	clear	10
7:52	35	38	13		250	clear	10
6:52	22	52	6		250	clear	10
5:52	26	44	12		250	clear	10
4:52	31	36	12		250	clear	10
3:52	16	70	6		160	clear	10
2:52	17	70	7		200	clear	10
1:52	17	70	4		120	clear	10
0:52	18	65	5		90	clear	10

Figure 17 presents the NOAA HYSPLIT (Draxler and Rolph, 2012, and Rolph, 2012) 24-hour back trajectories for Durango Colorado for each hour from 1 AM MST to Midnight MST on February 27, 2009, the period of the exceedance of the PM_{10} standard in Durango. This shows that the source of the air in Durango on February 27, 2009, originated in the area of the dust cloud mentioned in Table 6 and shown in the MODIS satellite images in Figures 10 and 11. Using the HYSPLIT model in matrix mode, back trajectories for single hour back trajectories were computed for 12Z February 27, 2009, (5 AM MST February 27), 16Z February 27, 2009, (9 AM MST February 27), 20Z February 27, 2009, (1 PM MST February 27, MST), 00Z February 28, 2009, (5 PM MST February 27), 04Z February 28, 2009, (9 PM MST February 27) and 07Z February 28, 2009, (12 AM MST February 28) and presented in Figures 18 – 23, respectively. The matrix area is shown in Figure 24. The matrix box includes the cities of Telluride, Durango and Alamosa.

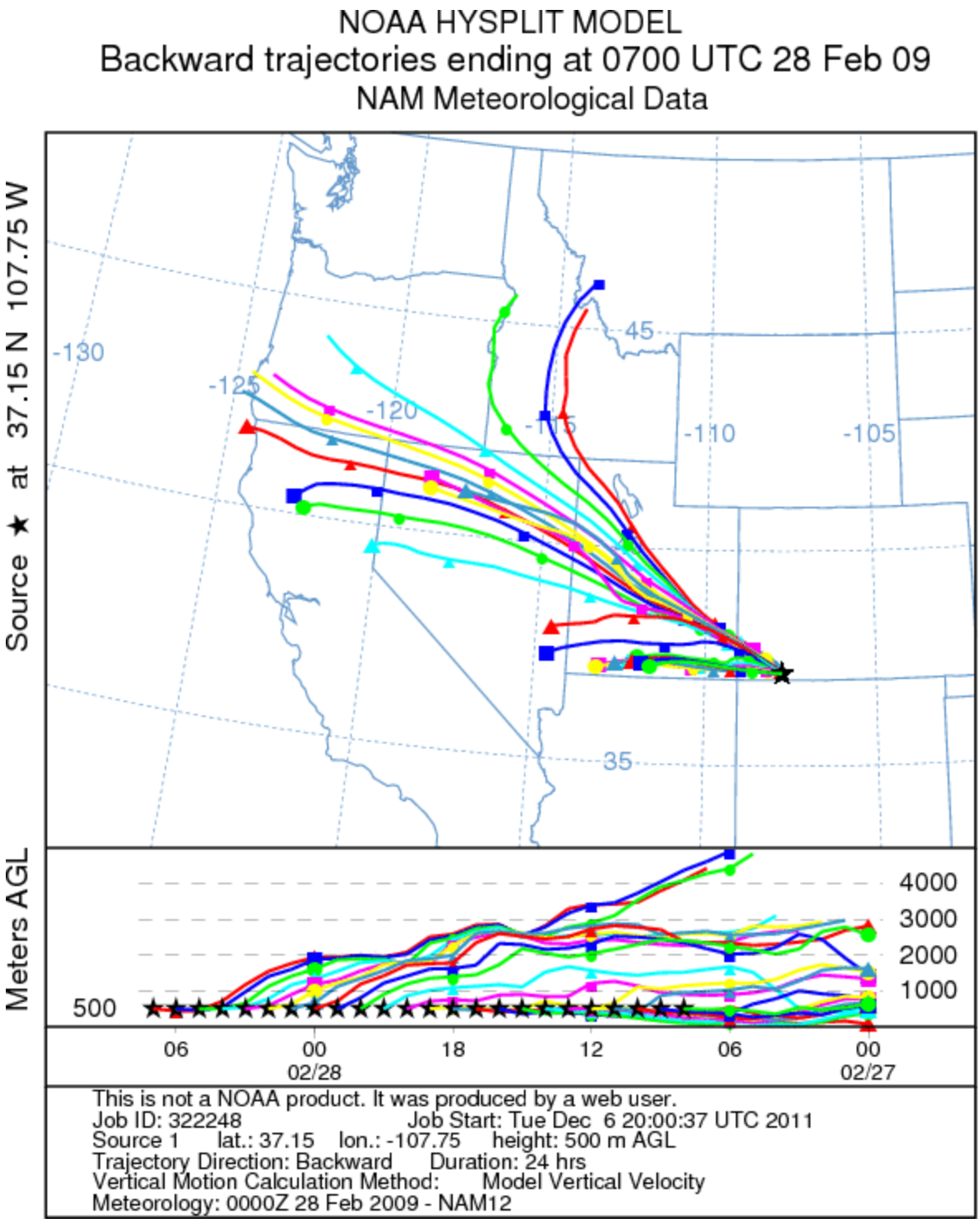


Figure 17. NOAA HYSPLIT 24-hour back trajectories for Durango Colorado for each hour from 1 AM MST to Midnight MST on February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

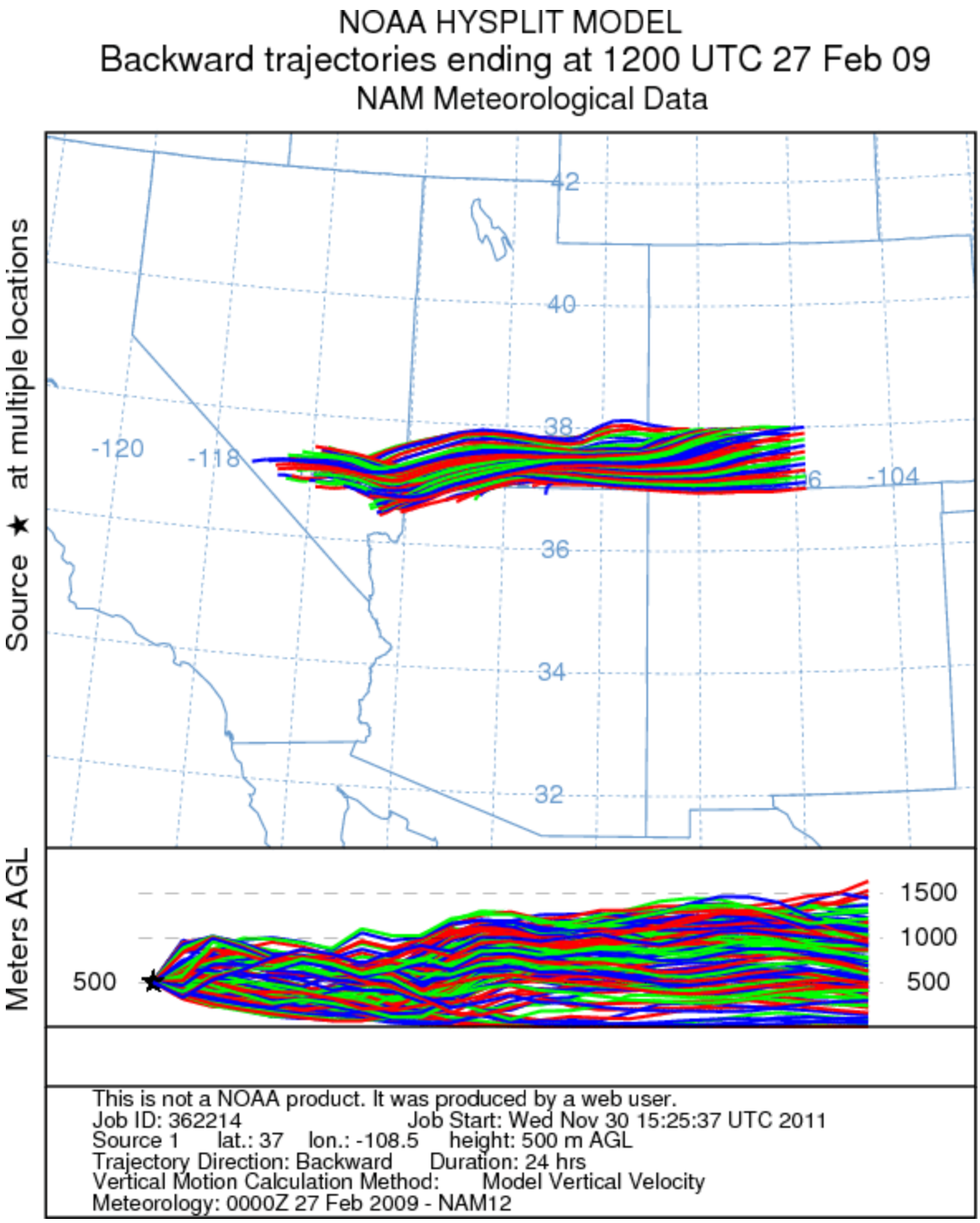


Figure 18. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 5 AM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

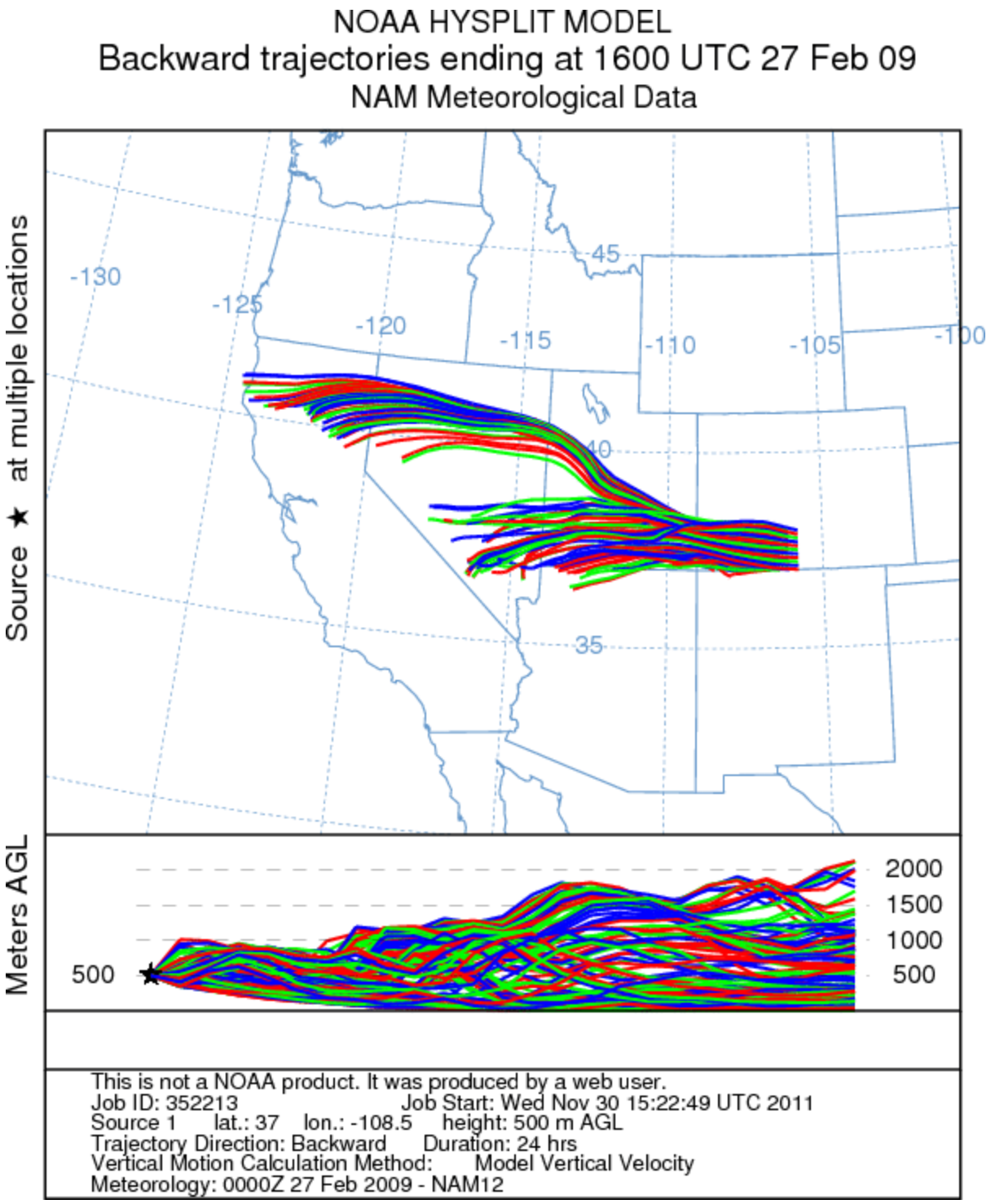


Figure 19. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 9 AM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

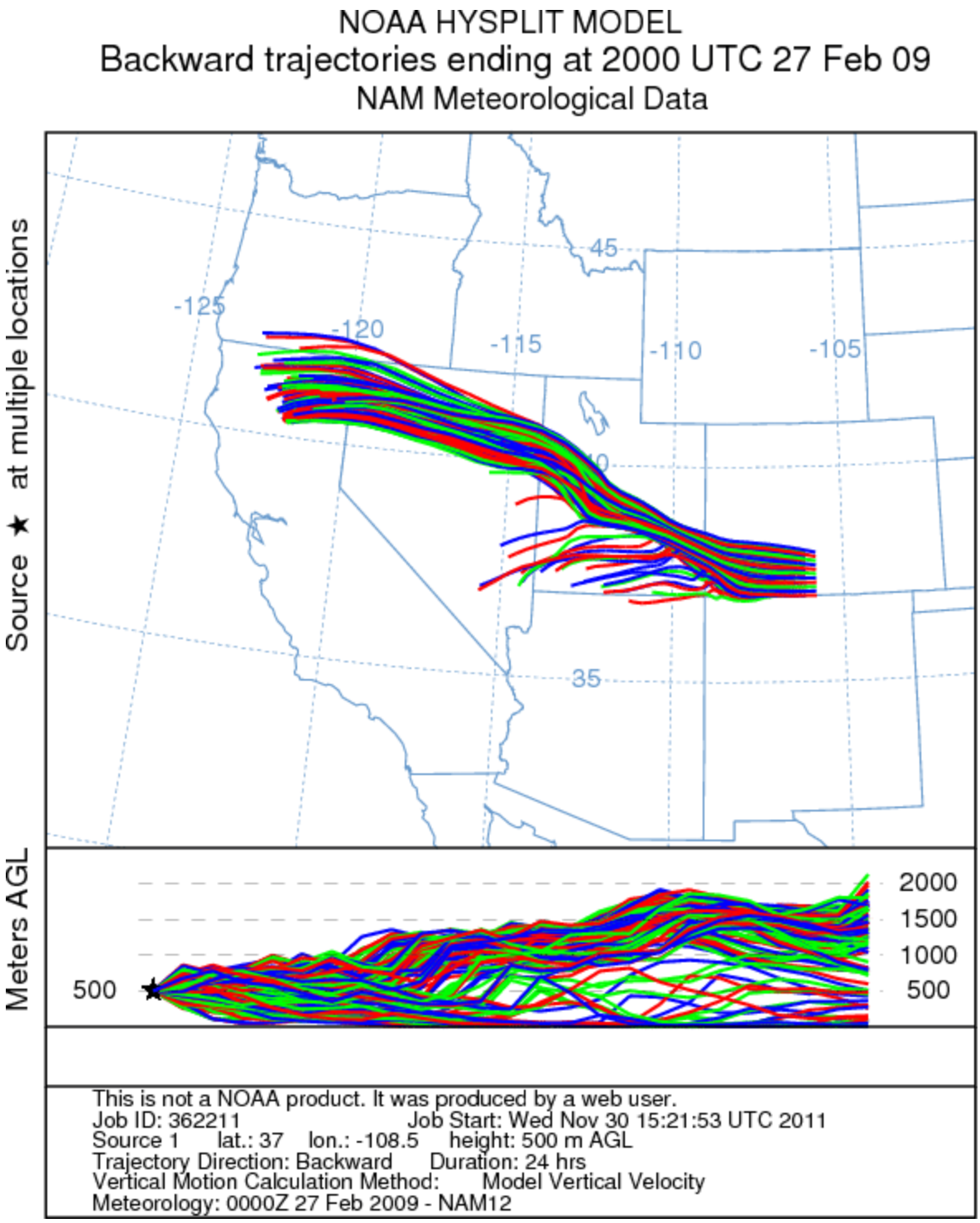


Figure 20. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 1 PM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

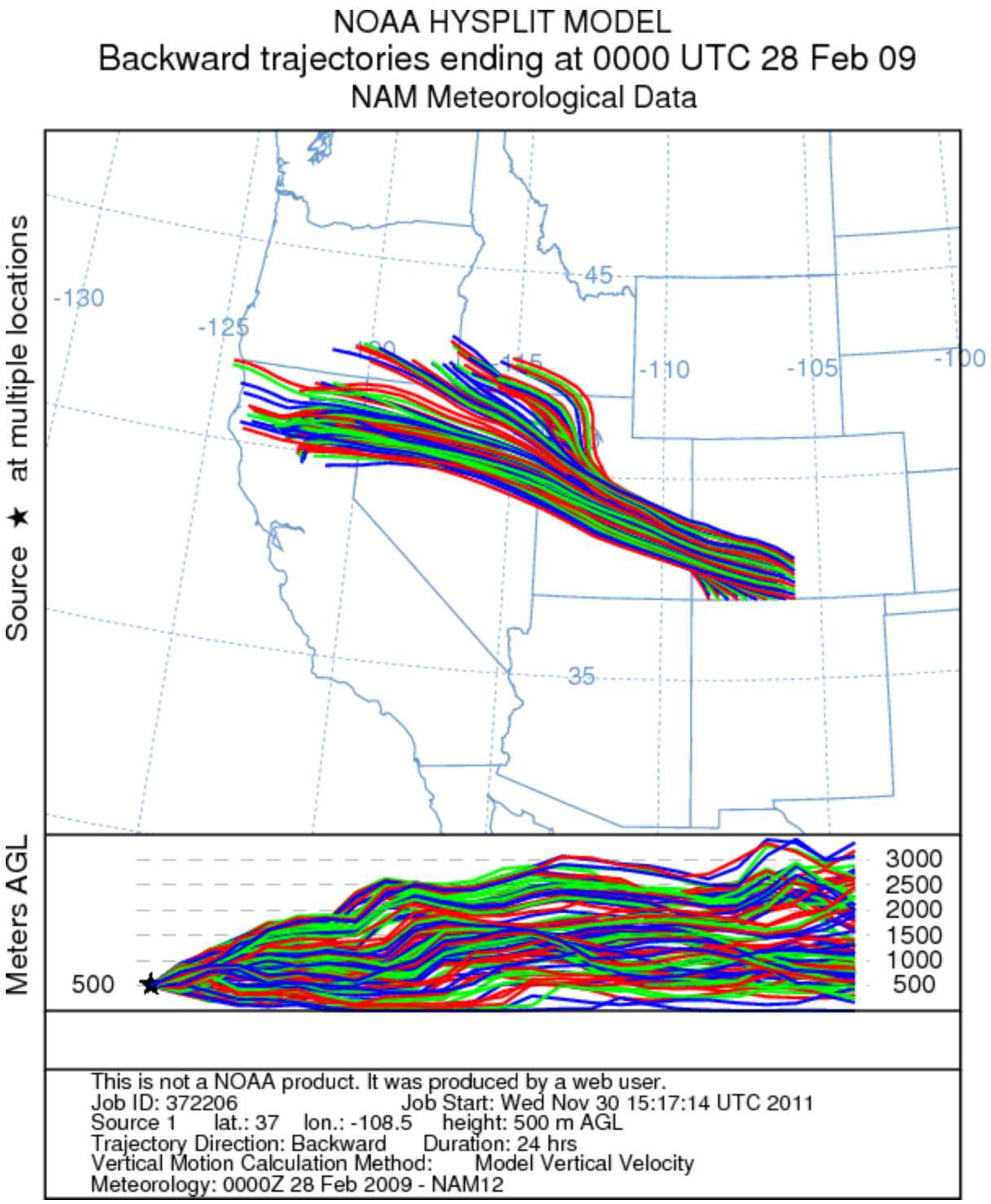


Figure 21. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 5 PM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

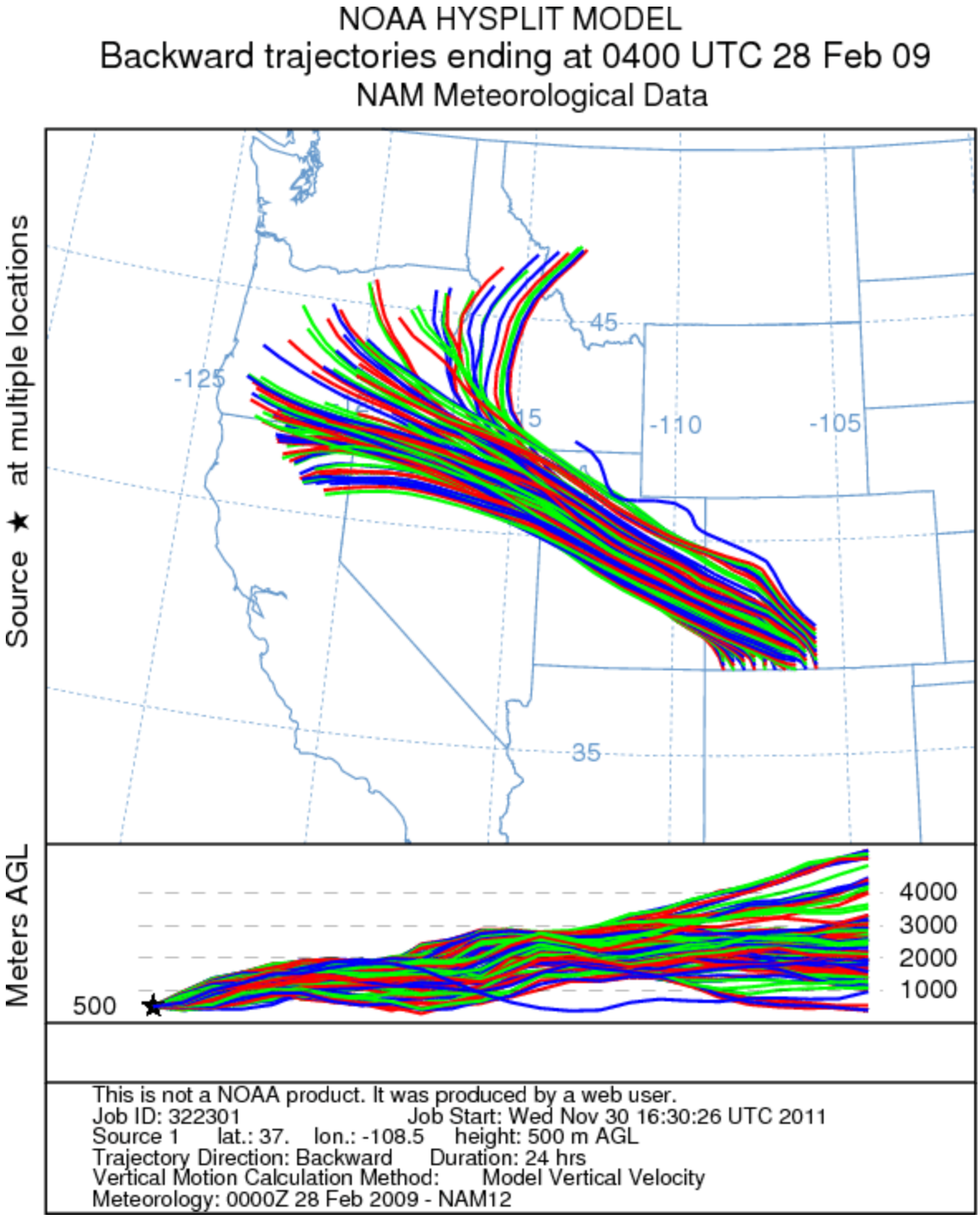


Figure 22. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 9 PM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

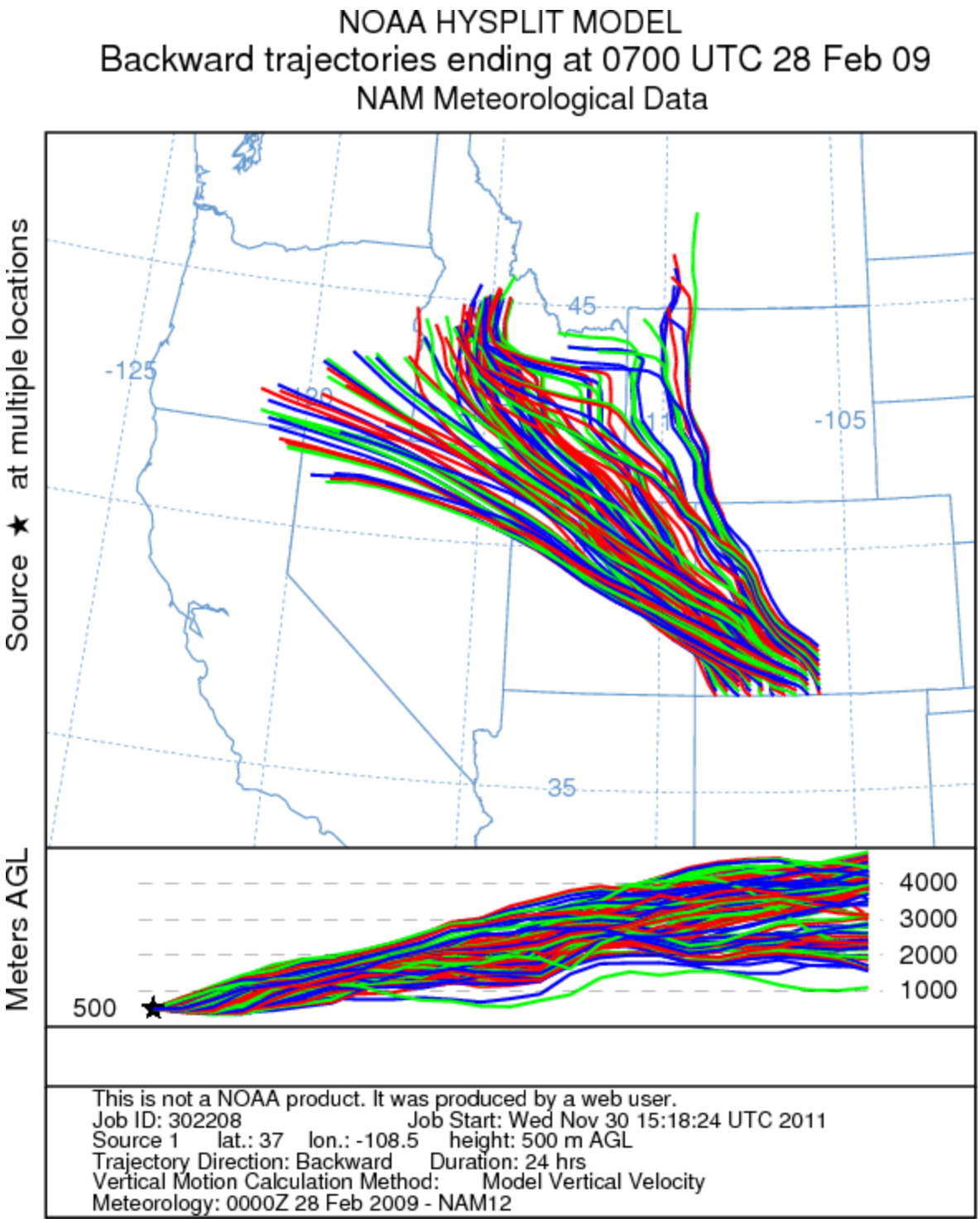


Figure 23. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 12 AM MST February 28, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

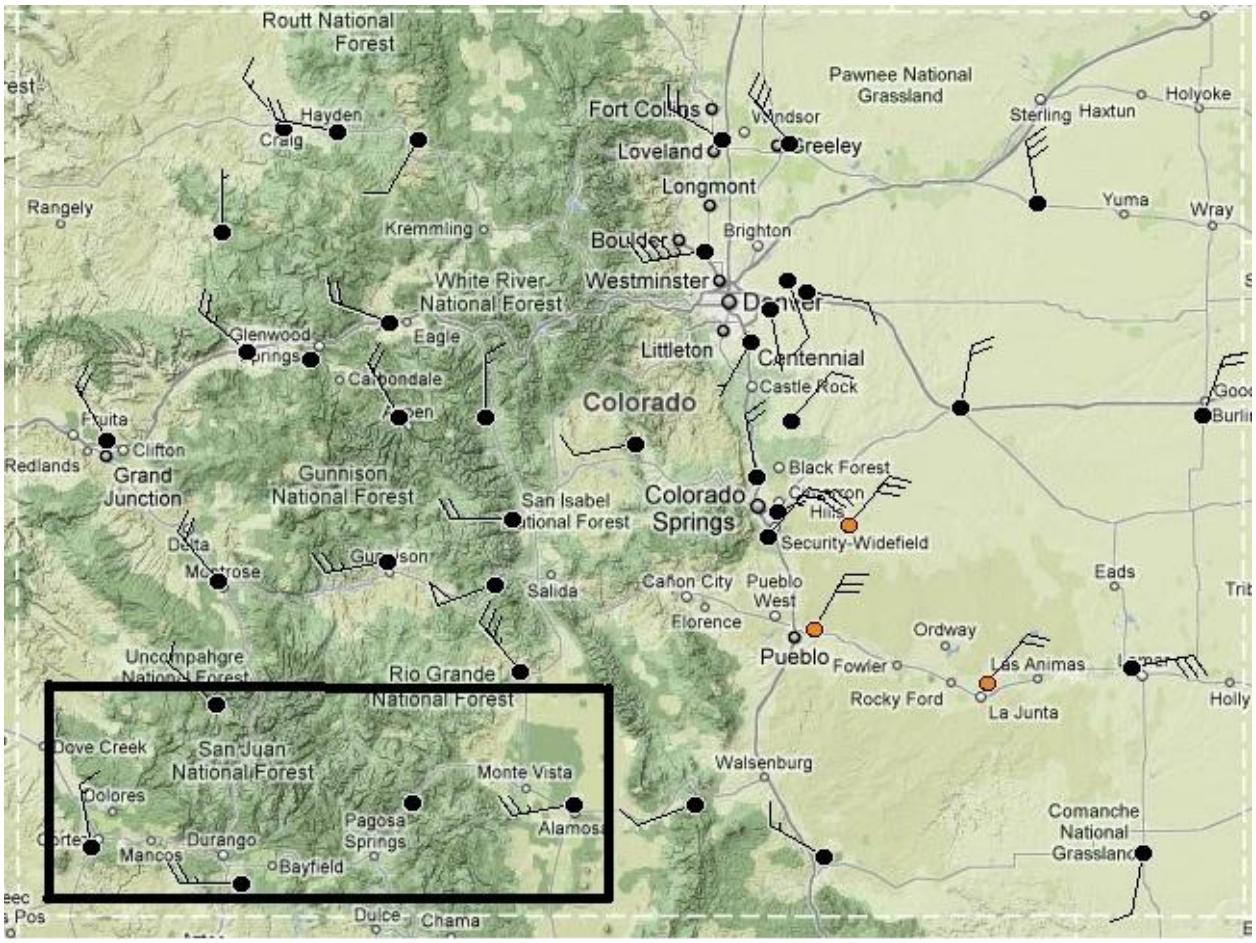


Figure 24. Location for NOAA HYSPLIT 24-hour back trajectories matrix box for Southwest Colorado.

The back trajectories show that air moving over Durango or the matrix box on February 27, 2009, originated in areas that the dust cloud would have been in the day before. They also show that for much of that time the air at 500 m over the matrix box and Durango started at heights well above 500 m. This would be air in the deep, well-mixed boundary layer which contained the dust being transported east southeast from Nevada. The air arriving at 500 m over Durango would have been mixed down to the surface once the morning inversion had dissipated. Table 12 lists the hourly PM_{10} values for Telluride. High hourly PM_{10} values match the arrival times for the back trajectories in Figures 17 - 23 that came from the dust source region shown in Figures 10 and 11, the MODIS satellite images. The morning inversion in the Telluride area probably dissipated by 7 or 8 AM due to a combination of the sun coming up and mechanical turbulence from the 10 to 20 mph winds flowing over the complex terrain in the Telluride area. This inversion break up allowed the dust in the previous days mixed layer to mix down to the surface.

Table 12. Hourly PM_{10} concentrations in Telluride, Colorado on February 27, 2009.

Date	Hour	µg/m^3
2/27/2009	0:00	62
	1:00	31
	2:00	44
	3:00	29
	4:00	28
	5:00	17
	6:00	40
	7:00	70
	8:00	131
	9:00	249
	10:00	128
	11:00	119
	12:00	103
	13:00	134
	14:00	181
	15:00	86
	16:00	116
	17:00	113
	18:00	76
	19:00	19
	20:00	37
	21:00	52
	22:00	38
	23:00	46

The Center for Snow and Avalanche Studies has been studying the effects of desert dust from outside of Colorado on deposition, snowpack albedo, and snowmelt at the Senator Beck Basin Study Area in the San Juan Mountains of southwestern Colorado. Table 13 is their log of events that deposited dust on the snowpack of the San Juan Mountains (http://www.snowstudies.org/codos1.html). February 27, 2009, is the third event out of twelve recorded in the 2008/2009 water year by the Center for Snow and Avalanche Studies. Durango and Telluride are in the San Juan Mountains of Colorado and Alamosa is in the San Luis Valley on the east side of the San Juan Mountains.

The record of dust deposition on mountain snowpack in The San Juans on February 27, 2009, is consistent with the arrival of dust from Nevada identified in this analysis, and supports the conclusion that the elevated PM_{10} concentration in Durango was not caused by local sources in Durango or its immediate surroundings.

Table 13. Dust-on-Snow Deposition Events Log reported by Chris Landry, Executive Director, Center for Snow and Avalanche Studies (www.snowstudies.org).

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*	*TBD*	*TBD*	*TBD*

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

Snow cover data for the Durango area also suggests that local area sources may have had too much snow cover and or soil moisture to support local emissions of dust. Figure 25 shows the snow depth from SNOTEL and NWS COOP sites in and around Telluride, Durango, and the Senator Beck Basin Study Area. It shows that the TIEC2 SNOTEL site that is a quarter mile to the east of the Telluride PM_{10} monitor had 7 inches of snow cover on February 27, 2009. The Senator Beck Basin Study Area is about 1.25 miles from the Red Mountain Pass Snotel site which had 66 inches of snow cover on February 27. The Durango River City Hall PM_{10} monitor is about 1.6 miles from the Durango NWS COOP site which had a half inch of snow cover. The Ft. Lewis College NWS COOP site which is to the southwest of the Durango River City Hall PM_{10} monitor had 8 inches of snow cover. This site is an indicator of the snow cover downwind of the Durango River City Hall PM_{10} monitor during the period of prefrontal winds at Durango on February 27. These prefrontal winds are the winds that transported the dust from outside the Durango area into Durango. The February 2009 Record of River and Climatological Observations for the Durango NWS COOP site in Figure 26 shows that Durango had snow cover for all the days of February

leading up to February 27, 2009. This would imply that the local soil was moist and incapable of producing blowing dust.

Filter analysis data presented elsewhere in this report shows that the PM_{10} measured in Durango on February 27, 2009, was largely geologic material or dust. The snow cover in and around Telluride and Durango on February 27, 2009, and previous days of the month indicates that PM_{10} values above background levels had to be transported into the area.

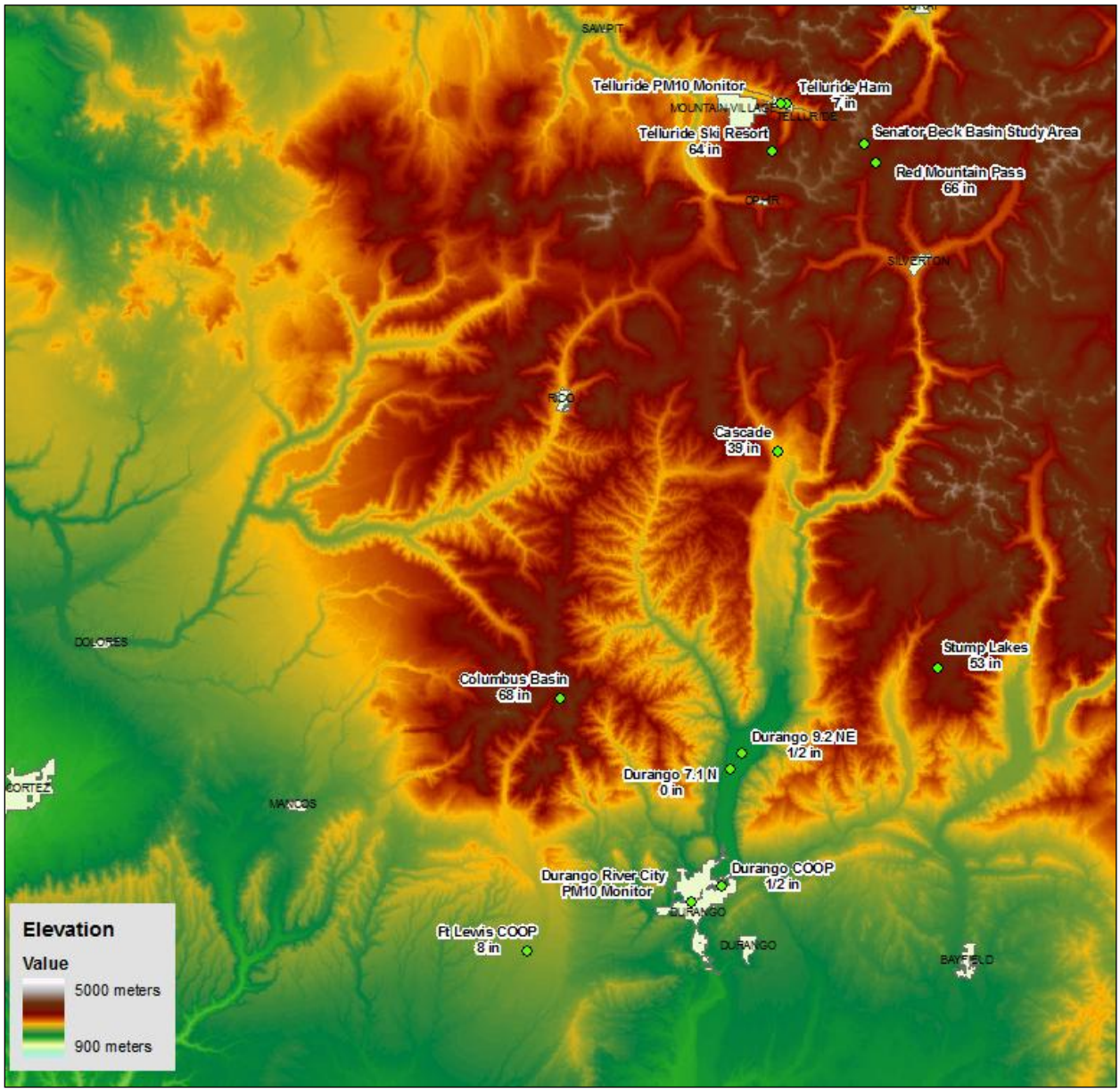


Figure 25. SNOTEL, NWS COOP, and CDPHE PM_{10} monitor sites (http://www.nohrsc.noaa.gov/ and http://cdo.ncdc.noaa.gov/dly/DLY)

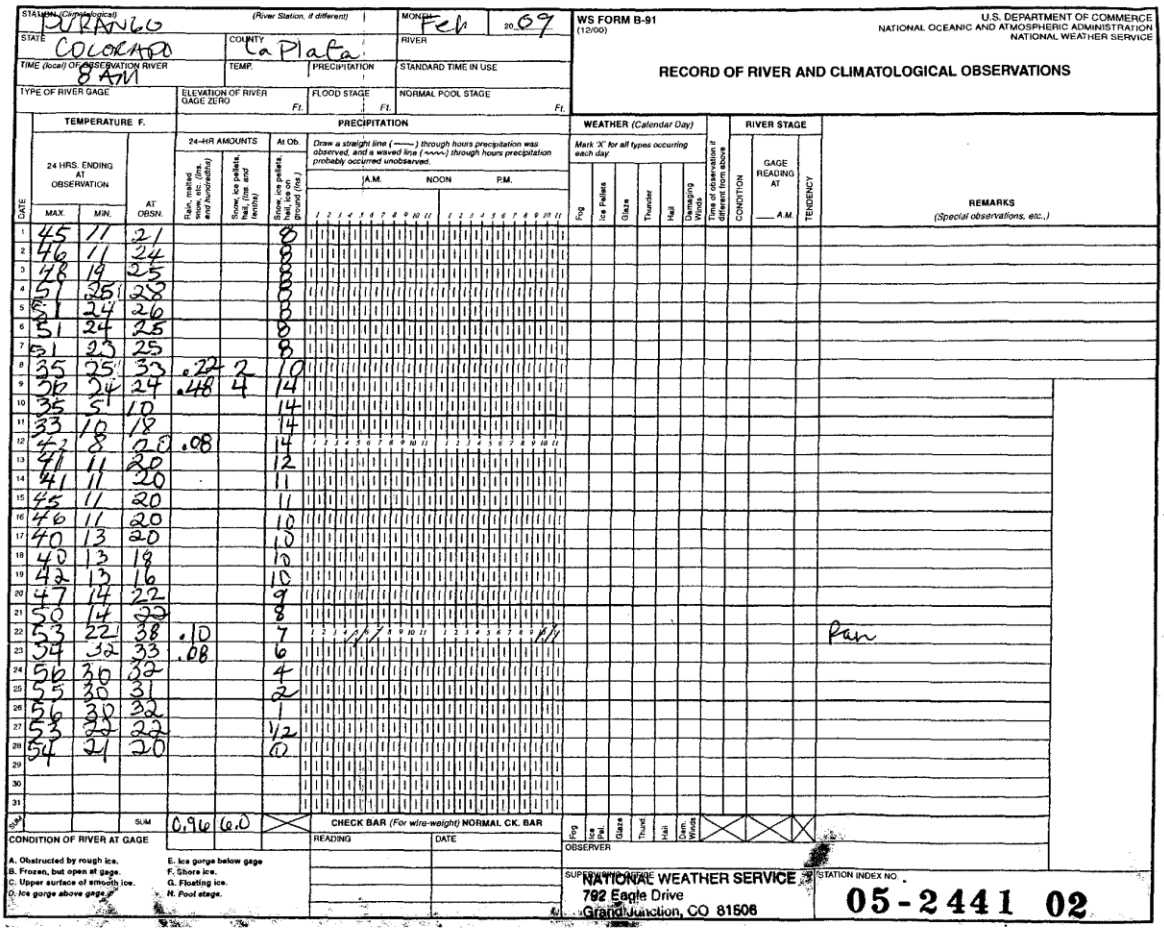


Figure 26. National Weather Service Climatological Observations for Durango, Colorado February 2009 (http://cdo.ncdc.noaa.gov/dly/DLY).

Figure 27 presents the forecasted dust PM_{10} concentrations from the Navy's NAAPS (Navy Aerosol Analysis and Prediction System) aerosol forecast model (http://www.nrlmry.navy.mil/aerosol/) for February 27, 2009. It shows a well-developed dust cloud by 12Z February 27, 2009, (5 AM MST February 27) and the daytime movement of dust from west to southeast is also consistent with the HYSPLIT output and surface observations during the event. It also shows that the dust was settling out of the atmosphere on February 27, 2009. The NAAPS model output is based on actual 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). Consequently, NAAPS forecast products provide an independent calculation of the potential for blowing dust and the spatial extent of blowing dust for this event. Many of the products discussed here point to a widespread, regional-scale dust storm that originated in areas extending far beyond southwest Colorado.

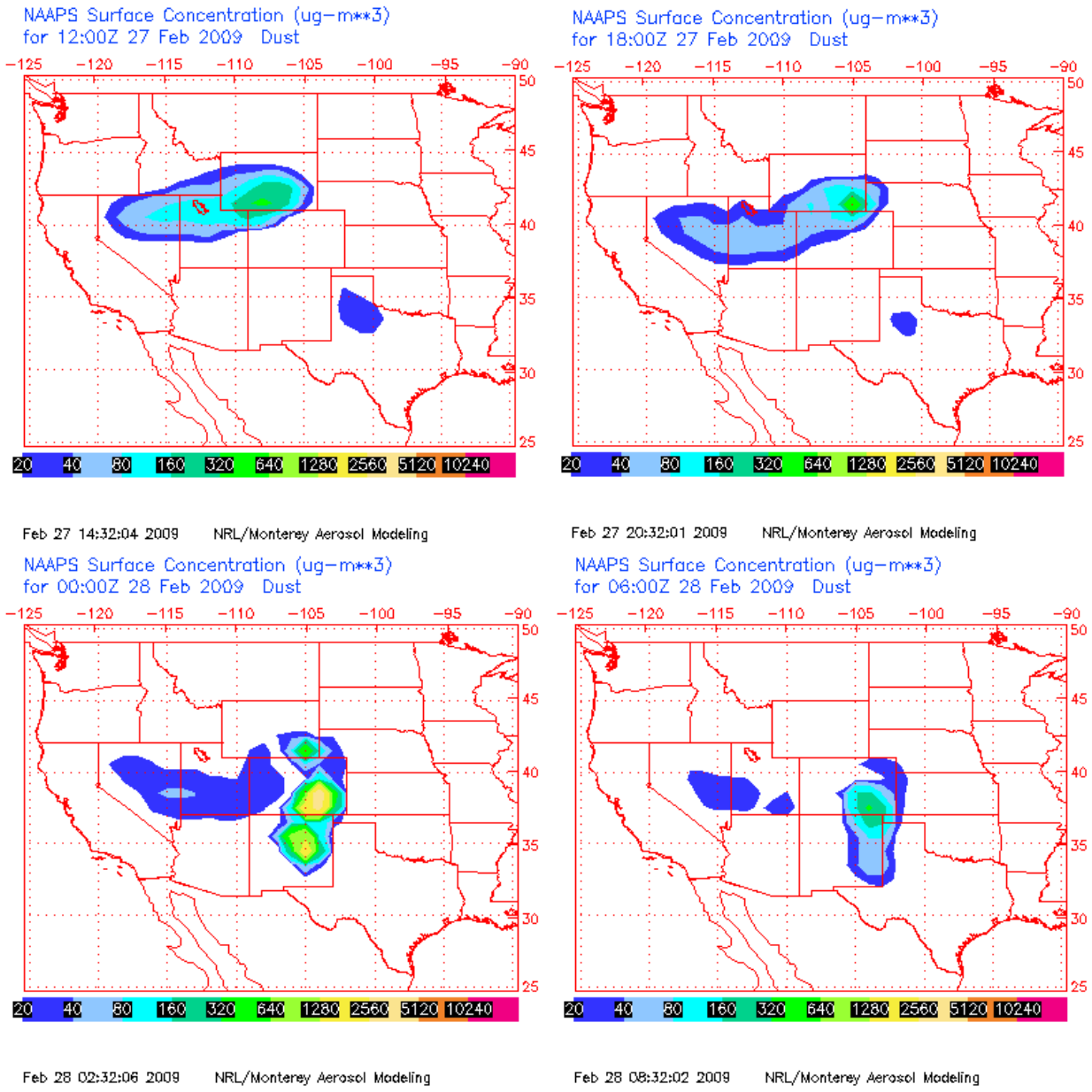


Figure 27. Forecast surface dust from NAAPS (Navy Aerosol Analysis and Prediction System) Global Aerosol Model for February 27, 2009, from the archives of the U.S. Navy NAAPS global aerosol forecast model (http://www.nrlmry.navy.mil/aerosol/).

3.0 Ambient Monitoring Data and Statistics

PM_{10} concentrations that exceeded the level of the NAAQS were monitored in Durango, Colorado on Saturday February 27, 2009. The recorded exceedance of the 24-hour PM_{10} standard was a concentration of 198 $\mu g/m^3$ at the Durango River City Hall monitoring site. Monitored PM_{10} levels before and after the February 27 episode were low as can be seen in Table 14 and Figure 28. The Durango River City Hall monitor was operating on a once every three day frequency in 2009. Thus the concentrations for the day before and day after the event are not available.

The APCD reviewed PM_{10} monitoring data in Durango and the surrounding area for the February 27, 2009, exceptional event. The PM_{10} concentrations in Durango on February 27, 2009, were compared to the concentrations three days before and the three days after the regional dust storm since the Durango site was on a once every third day sampling frequency. The days before and after the event were very low with typical concentrations for winter in Durango (see Figure 33 and the "Historical Fluctuations of PM_{10} Concentrations in Durango, Telluride, and Alamosa" section), with the exception of on March 2, 2009. Other PM_{10} monitoring sites in southwest Colorado had elevated PM_{10} concentrations above their typical historical concentrations on February 27, 2009, as explained in the "Historical Fluctuations of PM_{10} Concentrations in Durango, Telluride, and Alamosa" section, but did not exceed the 24-hour NAAQS. Three other sites with moderately elevated PM_{10} concentrations were Lamar Power Plant, Parachute, and Rifle with 47 $\mu g/m^3$, 48 $\mu g/m^3$, and 52 $\mu g/m^3$ respectively. All other Colorado sites recorded concentrations between 12 $\mu g/m^3$ and 34 $\mu g/m^3$ on February 27, 2009.

Table 14. PM_{10} Concentrations Before and After the February 27, 2009 Regional Dust Storm.

Date	**Durango River City Hall**	**Telluride**	**Alamosa ASC**	**Alamosa Municipal**
02/24/2009	19 $\mu g/m^3$	9 $\mu g/m^3$	13 $\mu g/m^3$	AF*
02/25/2009	NA	NA	25 $\mu g/m^3$	AF*
02/26/2009	NA	NA	14 $\mu g/m^3$	AF*
02/27/2009	**198 $\mu g/m^3$**	**72 $\mu g/m^3$**	**49 $\mu g/m^3$**	**109 $\mu g/m^3$**
02/28/2009	NA	NA	16 $\mu g/m^3$	AG**
03/01/2009	NA	NA	22 $\mu g/m^3$	25 $\mu g/m^3$
03/02/2009	32 $\mu g/m^3$	102 $\mu g/m^3$	25 $\mu g/m^3$	30 $\mu g/m^3$

*AF is the null code for "Scheduled but not collected"

**AG is the null code for "Sample time out of limits"

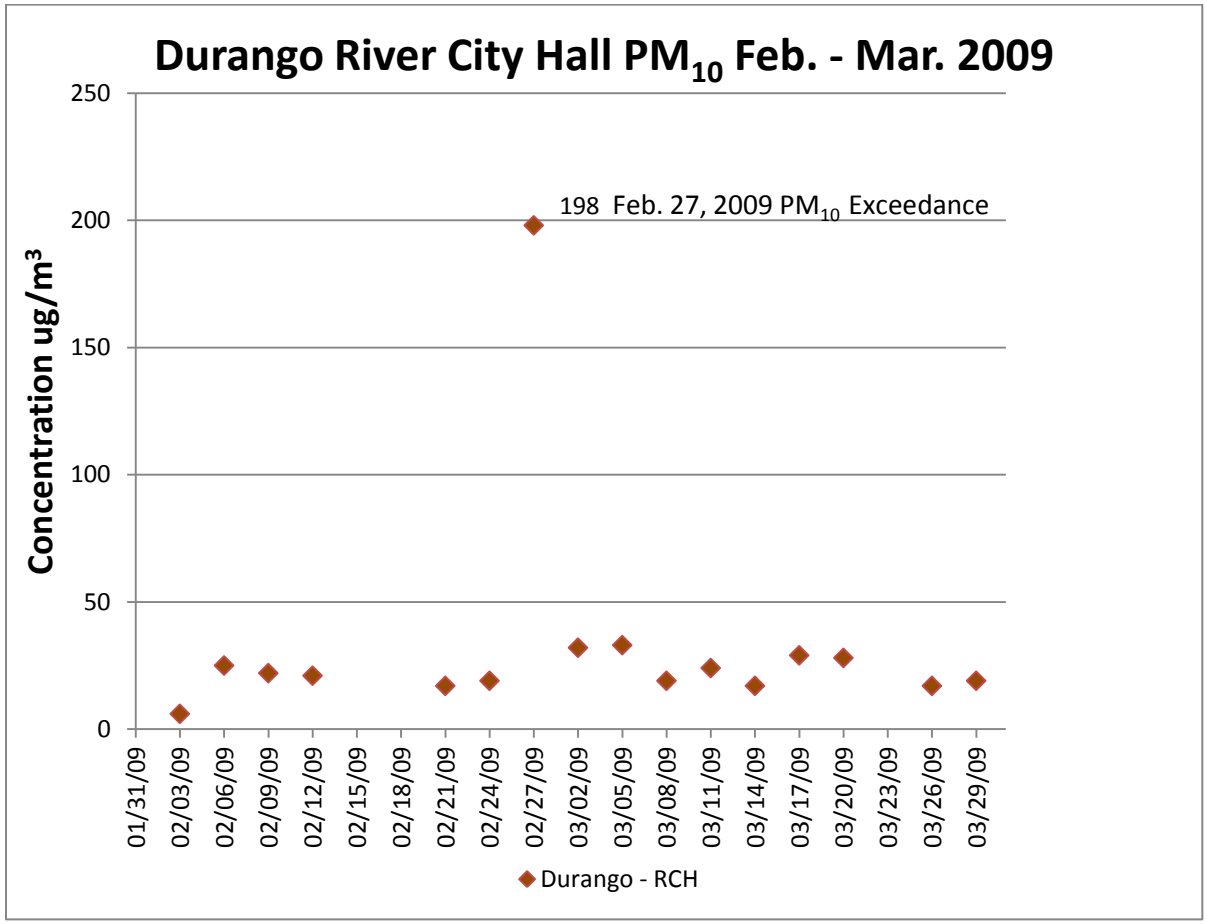


Figure 28. Durango River City Hall PM_{10} February – March 2009.

Other than on February 27, 2009, the highest PM_{10} concentration in the months of February and March 2009 in Durango was 33 µg/m^3. February 27, 2009, at 198 µg/m^3 was clearly an extreme event in Durango. The PM_{10} data in Durango before and after the high wind/blowing dust event and the data for the month of February and March clearly demonstrate that this particular blowing dust event occurred only on February 27 and it caused PM_{10} concentrations that were much higher than normal for the winter two month period of interest. In other words, the concentration of 198 µg/m^3 at Durango was much higher than surrounding days. A full statistical analysis of the monitoring data and a "but for" test is presented in the "Historical Fluctuations of PM_{10} Concentrations" section.

The time series charts in Figures 29 to 31show additional evidence that the regional dust storm brought elevated PM_{10} concentrations to other areas in southern Colorado on February 27, 2009.

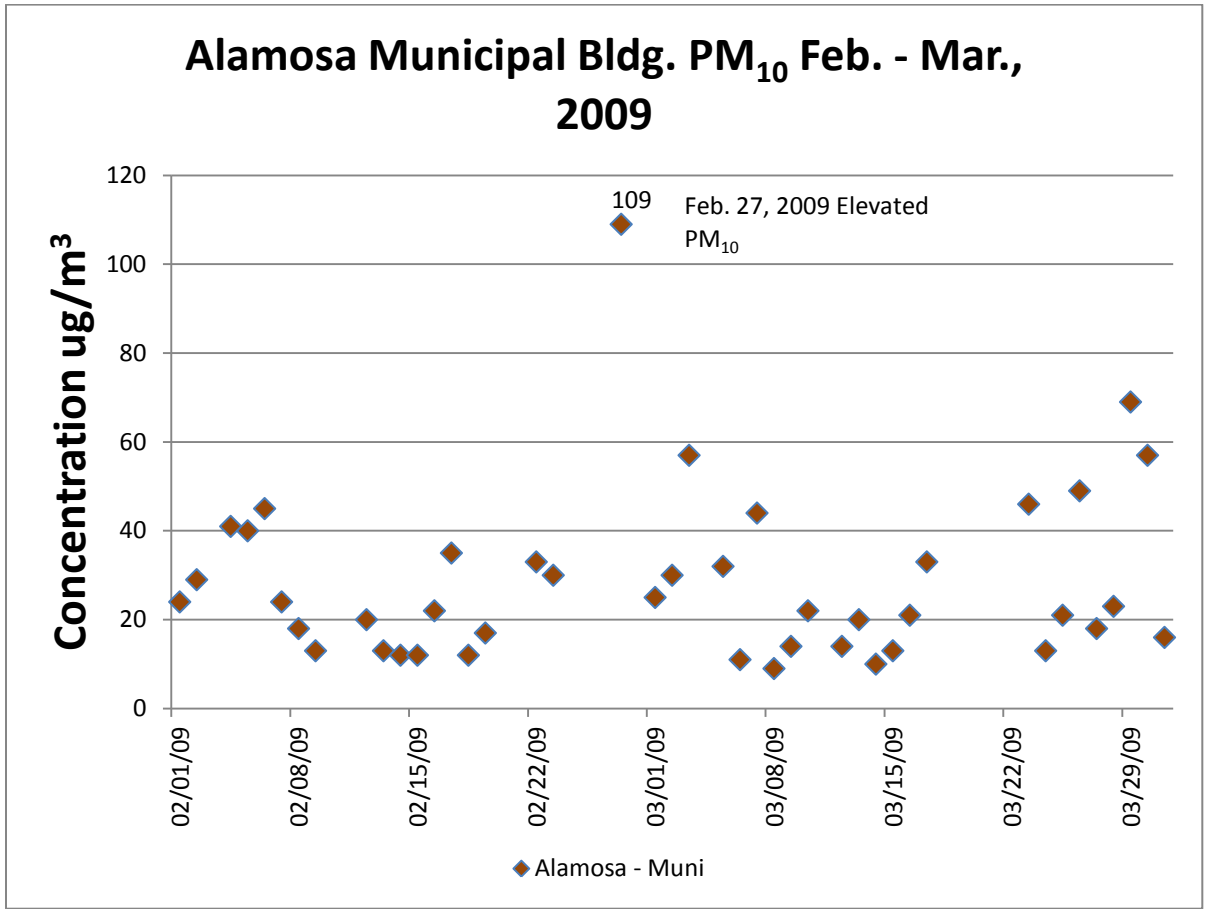


Figure 29. Alamosa Municipal Building PM_{10} February – March 2009.

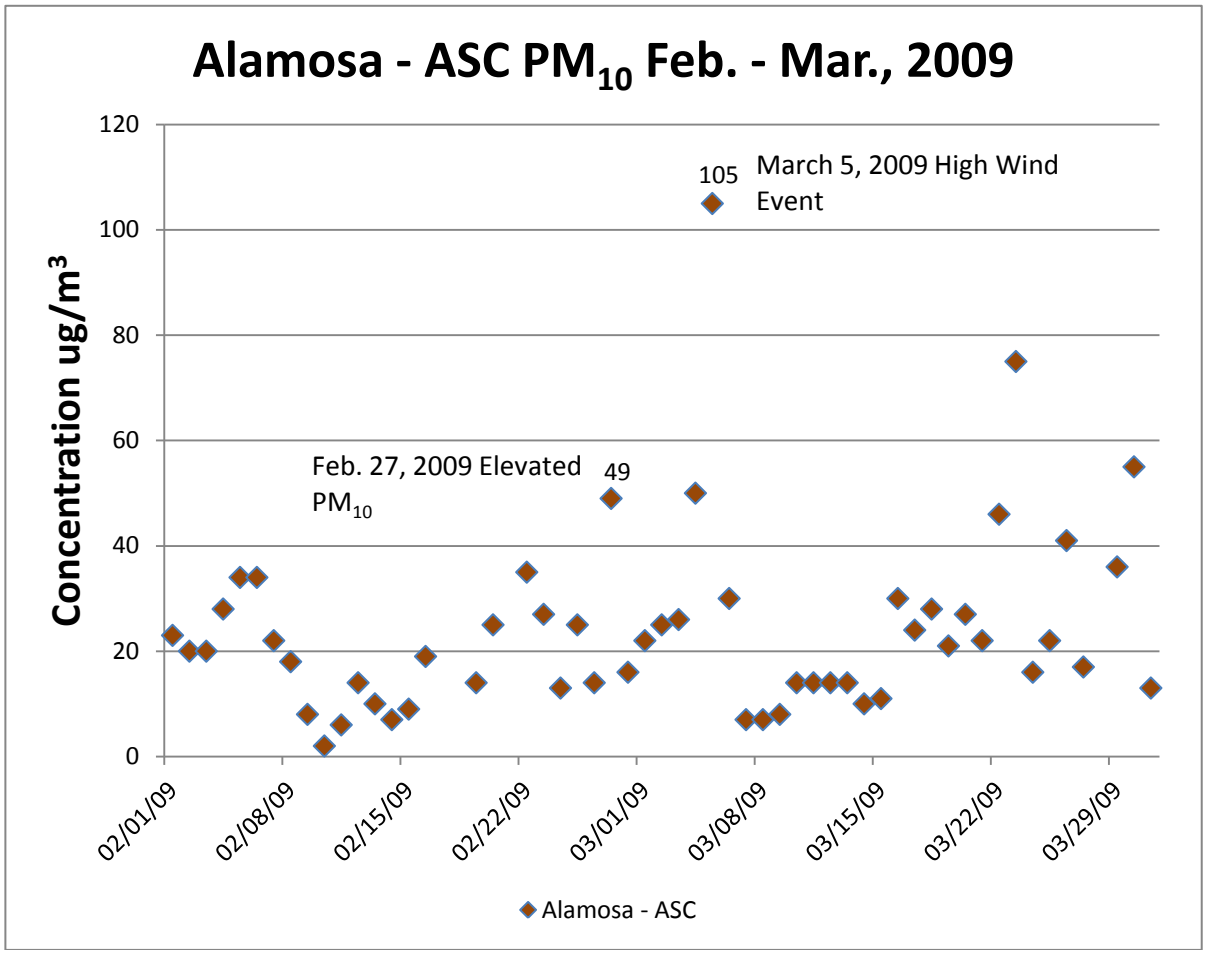


Figure 30. Alamosa – Adams State College PM_{10} February – March 2009.

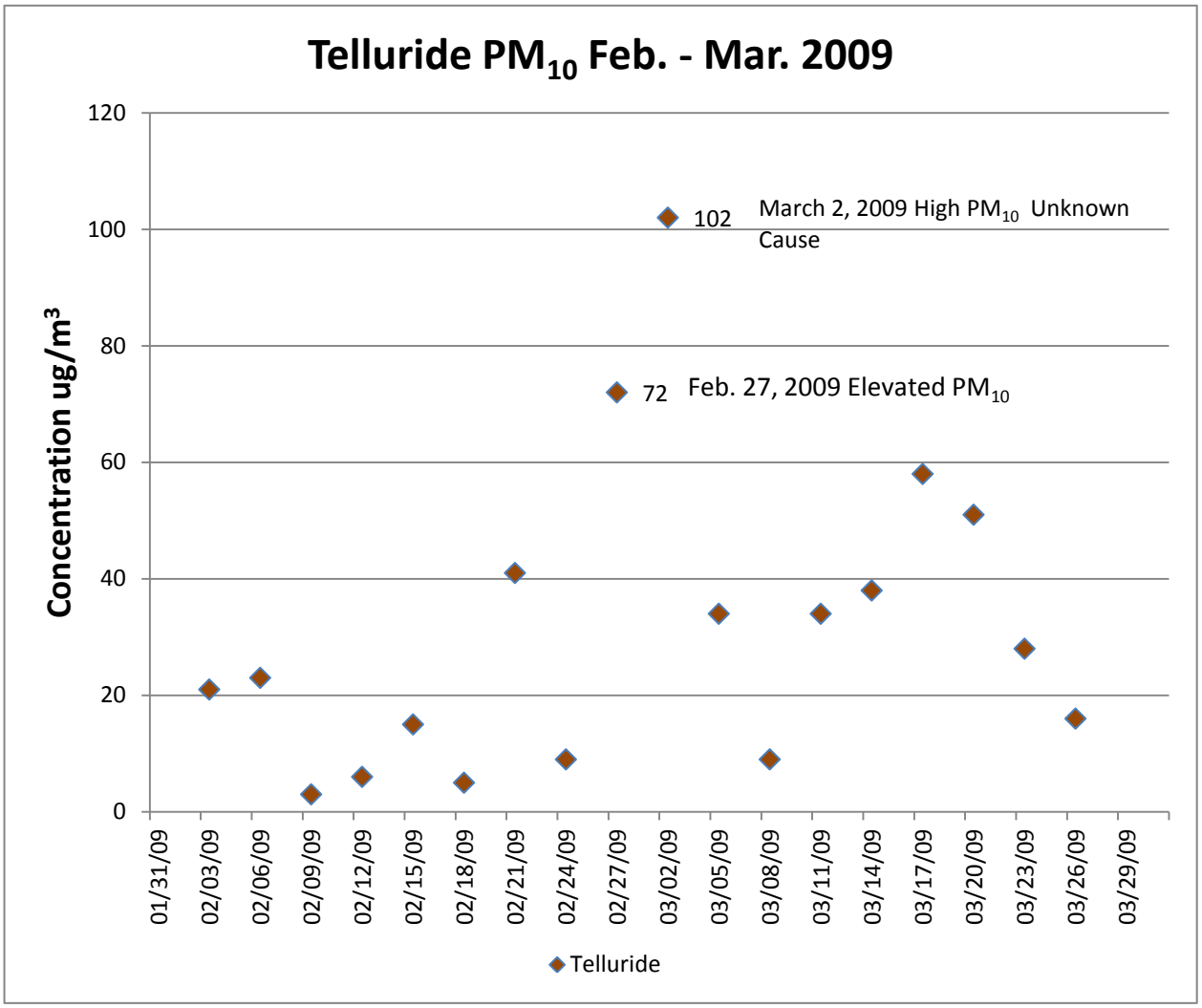


Figure 31. Telluride PM_{10} February – March 2009.

The spatial extent of this regional dust storm is difficult to ascertain from a monitoring perspective, but if one looks at just the monitors with high PM_{10} concentrations the area is considerable. As a crow flies it is about 111 miles (179 km) from Durango to Alamosa with Wolf Creek Pass (elevation 10,857 ft. or 3,310 m) between the two towns, and about 46 miles (74 km) between Durango and Telluride with Lizard Head Pass (elevation 10,222 ft. or 3,116 m) between the two. There are several 13,000 and 14,000 foot peaks between the three towns that make very complex terrain, high surface roughness, and a difficult path for dust plumes, which also makes the plumes much more heterogeneous. There were no other PM_{10} exceedances recorded in Colorado due to these heterogeneous dust plumes and the peculiar nature of this particular dust storm (see section 2), and because the PM_{10} network is very sparse in this area of Colorado. A more complete network of PM_{10} monitors would most likely show more exceedances from this blowing dust event. The elevated concentrations of 72 $\mu g/m^3$ in Telluride and 109 $\mu g/m^3$ at Alamosa Municipal Building on February 27, 2009, provide additional evidence that the regional dust storm brought dust to other areas in southern Colorado and that the spatial coverage of the dust storm was quite large.

Historical Fluctuations of PM_{10} Concentrations in Durango, Telluride, and Alamosa

This historical fluctuation evaluation of PM_{10} monitoring data for sites affected by the February 27, 2009, event was made using valid samples from PM_{10} samplers at Durango (080670004), Telluride

(081130004), Alamosa ASC (080030001), and Alamosa Municipal (080030003). All four sites collected samples that were greater than what would be typical; however, only the sample collected at Durango was in excess of 150 $\mu g/m^3$. Only data from approved FRM samplers were used in the analysis. Additionally, only years with complete data (>75% valid data capture per calendar quarter) were used to avoid bias, further restricting the data sets yet leaving a robust data set to completely characterize every site. Although the February 27, 2009, samples from Telluride, Alamosa Adams State College and Alamosa Municipal are not flagged as requesting exclusion, their inclusion in this evaluation supports the hypothesis of a regional high wind event affecting air quality above typical levels and aids in delineating the geographical extent of the event. The overall data summary is presented in Table 15. All concentration data values are presented in $\mu g/m^3$.

Table 15. PM_{10} Monitoring Data Summary.

Summary - entire dataset

	Durango	Telluride	Alamosa ASC	Alamosa Municipal
Count	790	3779	6347	2266
Minimum	3	1	1	1
1 Q	14	15	14	16
Median	18	23	20	22
3 Q	24	34.5	28	31
Maximum	203	24	473	494
Mean	20.4	27.5	23.7	25.8
SD	13.26	18.40	18.86	20.40
Date Range	2003 - 2009	1991 - 2009	1990 - 2009	2003 - 2009
2/27/2009	198	72	49	109

Additionally, each data set was summarized by month. These summaries (see charts) 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 re-entrained road dust, unpaved lots or roads, etc. Table 16 shows the historical monthly median PM_{10} concentrations at each site. While the historic monthly median values for these four sites are higher during the winter and spring months than the rest of the year there is little month-to-month variation for any site.

Table 16. Historical Monthly Median PM_{10}.

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Durango	20	18	19	19	19.5	20	20	16	15	16.5	21	20
Telluride	15.5	20	36.5	25	22	27	25	22	22	22	24	19
Alamosa ASC	25	21	17	20	20	22	18	16	17	20	23	25
Alamosa Muni	26	22	21	23	22	26	23	19	19	19	27.5	24

Since an examination of the data showed no obvious timeframe when PM_{10} concentrations are highest, a meaningful timeframe was selected that best represent the date of the exceptional event. The timeframe of winter and early spring is that which is most likely to experience the meteorological and dry conditions exhibited during the February 27, 2009, event and is discussed elsewhere in this document. The lack of variability between monthly medians suggests that typical data exhibiting regular variation are those in the inner-quartile range (i.e. between the 75^{th} and 25^{th} percentile). If a conservative approach is taken then a typical value should be no higher than the historic monthly 75^{th} percentile value. The exception of these four sites to the general trend is Telluride. Data from this site indicate notable correlations between

the extreme percentile/maximum values and the median. The summary data for the month of February for all sites is presented in Table 17. All concentration data values are presented in $\mu g/m^3$.

Table 17. February PM_{10} Monitoring Data Summary

Summary – all February Samples

	Durango	**Telluride**	**Alamosa ASC**	**Alamosa Municipal**
Count	57	307	506	181
Minimum	6	1	1	6
1 Q	14	12	14	16
Median	18	20	21	22
3 Q	24	38	29	33
Maximum	198	107	424	289
Mean	22.0	28.4	25.3	27.4
SD	24.91	22.41	26.01	27.48

Durango River City Hall (Durango) – 080670004

The PM_{10} sample on February 27, 2009, at Durango of 198 $\mu g/m^3$ exceeds the 99^{th} percentile value (111 $\mu g/m^3$) for all February data, exceeds the 99^{th} percentile value (180 $\mu g/m^3$) for all 2009 data, and exceeds the 99^{th} percentile value (56 $\mu g/m^3$) for the entire Durango dataset. There are 790 samples in this dataset. Overall, this sample is the second highest sample in the entire data set, the second highest sample in 2009, the highest sample in any February, and exceeds the 99^{th} percentile sample value for this site for all samples. The one sample in the entire data set greater than this value is 203 $\mu g/m^3$ and it is associated with a high wind event on April 25, 2009. The sample of February 27, 2009, clearly exceeds the typical samples at this site and it is an exceptional value.

Figures 32 and 33 graphically characterize the Durango PM_{10} data. The first figure is the overall frequency histogram. The histogram displays a well-formed density function; almost 80% of the 790 sample values are less than 25 $\mu g/m^3$ and over 90% of the samples are less than 30 $\mu g/m^3$.

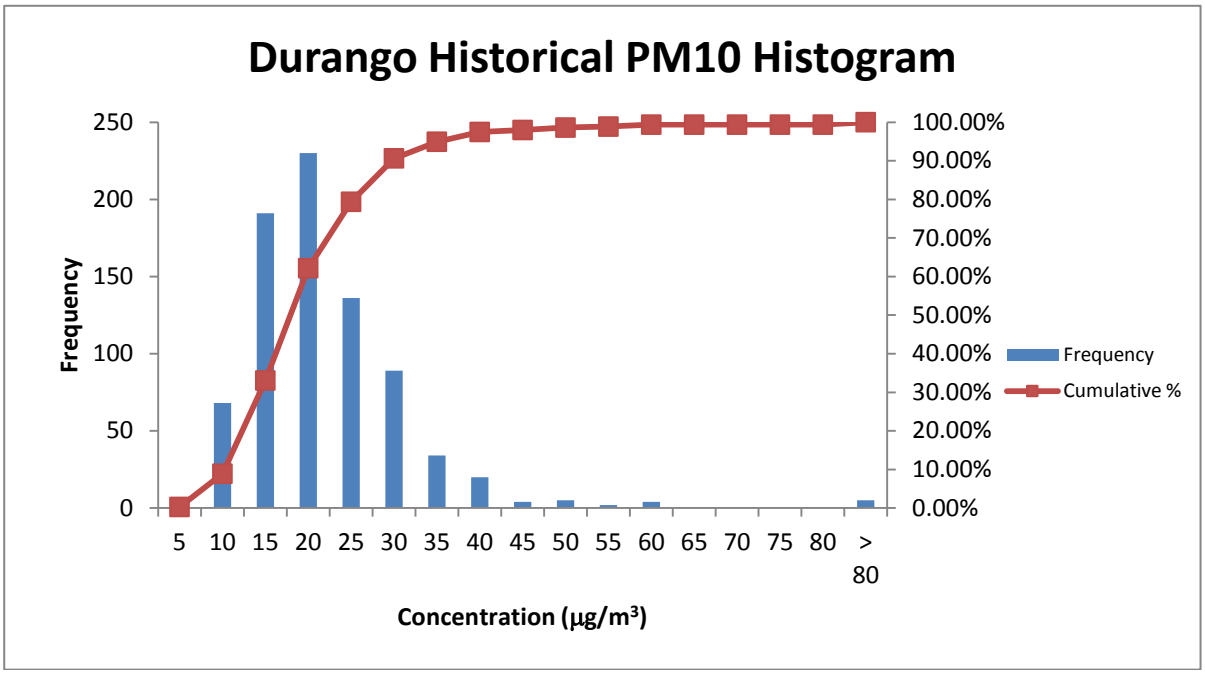
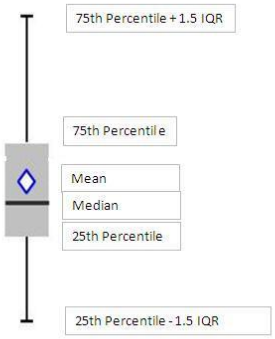


Figure 32. Durango Historical PM_{10} Histogram

The monthly box-whisker plot in Figure 33 highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) of the data through the winter and early spring months that is accompanied by typically greater monthly maxima. Recall, this time period experiences a greater number of days with meteorological conditions similar to those experienced on February 27, 2009. Although these high values affect the variability and central tendency of the datset, they aren't representative of what is typical at the site. The month of April is the only month with a mean greater than the median – due to the overwhelming weight of the outliers causing an increase in the mean. The three high values in April (out of 63 total samples) account for an increase in the mean of approximately 8 µg/m^3. Only one month (April) experienced a value greater than on the event day. All the box plot features in this evaluation can be identifed with the following legend:



Where:
1Q is the 25th percentile;
3Q is the 75th percentile value; and
IQR is the interquartile range or the range of the middle 50% of a distribution (75th percentile vlaue – 25th percentile value).

Additionally there are two types of outliers identifed in these plots: outliers greater than 3Q +1.5*IQR and outliers greater than 3Q + 3*IQR. The outliers that satisfy the last criteria are labeled with sample value and sample date. Each of these outliers is associated with a known high-wind event similar to that of February 27, 2009.

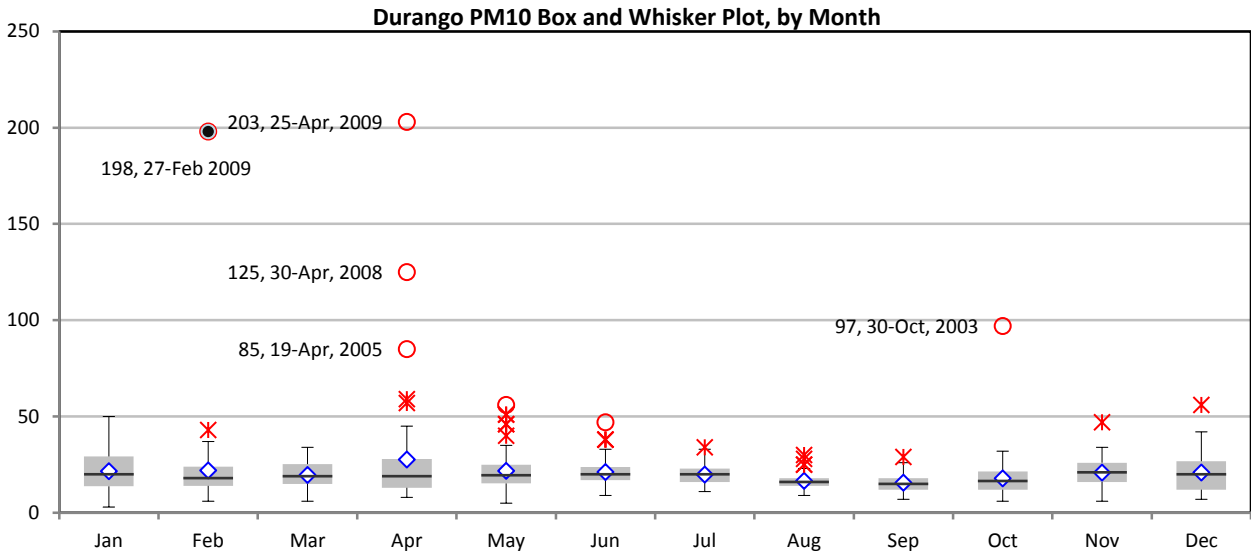


Figure 33. Durango PM_{10} Box and Whisker Plot by Month.

Figure 34 shows a time series graph for multiple years of PM_{10} data that was created for Durango to show how PM_{10} varies seasonally and from year to year. EPA Guidance states that a 3 – 5 year times-series graph for the exceptional event should be provided to show the seasonal distribution of PM_{10} concentrations. APCD selected a little more than five (5) full years of data, which includes the five years preceding the event and the first calendar quarter of 2009 (Jan. – March) in which the event occurred. Data after the event are not shown as the documentation of exceptional events has not yet occurred.

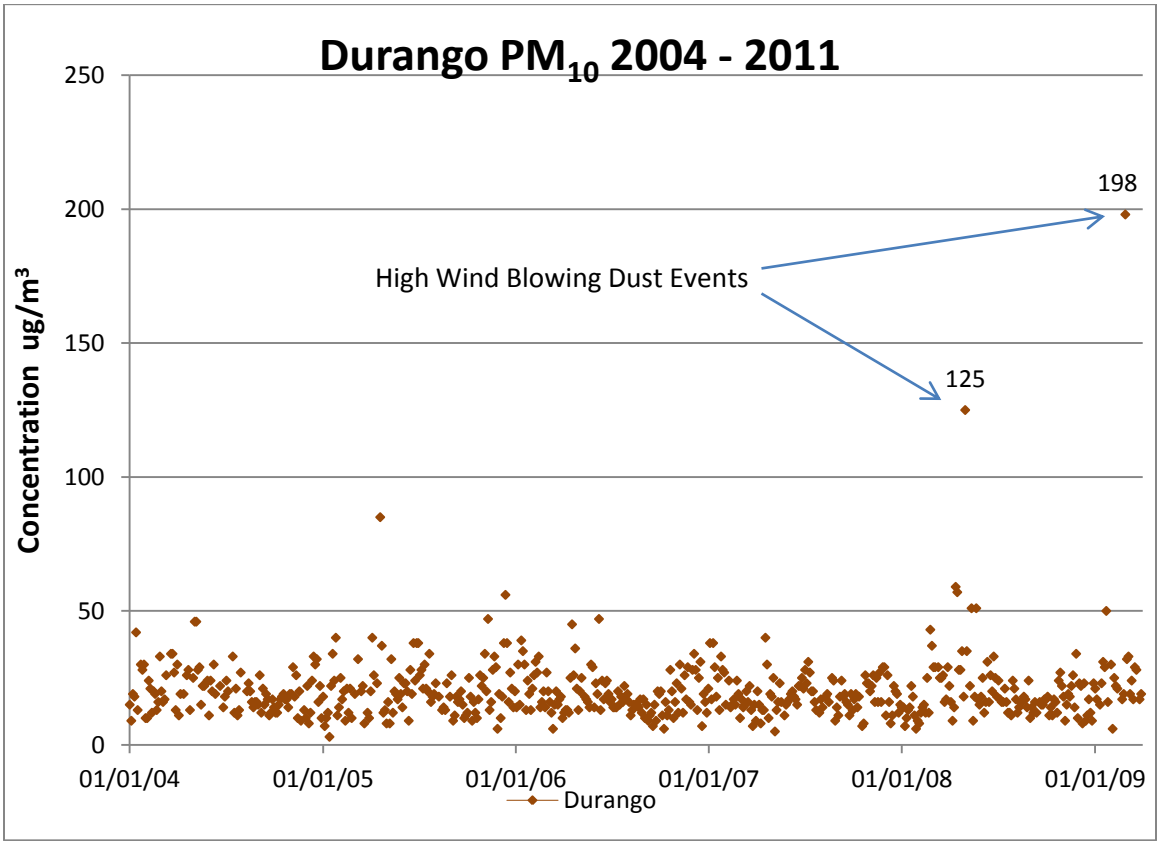


Figure 34: Five Year Time-Series Graph of PM_{10} in Durango

The time-series graph above shows that PM_{10} is rarely elevated. Nearly all the PM_{10} concentrations are below 50 ug/m^3 and there are just two excursions above 100 ug/m^3. There were no PM_{10} exceedances in Durango during the five year period preceding the 2/27/2009 exceptional event analyzed in this document. One relatively high day over 100 ug/m^3 occurred on 4/30/2008 (125 ug/m^3). This high PM_{10} event was not analyzed by the Division since it is well below the 24-hour PM_{10} NAAQS. However, archived weather data show that a low pressure system moved through the Four Corner area and Durango on April 30, 2008 (see: http://www.hpc.ncep.noaa.gov/dailywxmap/index_20080430.html). And, this date is recorded in the Colorado Dust-on-Snow Deposition Events Log (see Table 13 in section 2.0 above) showing that April 30 was a large regional blowing dust event that impacted snow covered regions in high mountain passes and other remote areas where there are little or no local anthropogenic sources of PM_{10}.

Telluride – 080990002

The PM_{10} sample on February 27, 2009 at Telluride of 72 µg/m^3 exceeds the 90th percentile value (64 µg/m^3) for all February data, exceeds the 95th percentile value (40 µg/m^3) for all 2009 data, and exceeds the 96th percentile value for the entire Telluride dataset. Overall, this sample is the 20th highest sample in any February (of 307 samples), the third highest sample in 2009 (of 114 samples), and exceeds the 96th percentile sample value for this site for all samples. There are 3779 samples in this dataset. The sample of February 27, 2009 clearly exceeds the typical samples at this site.

Figures 35 to 37 graphically characterize the Telluride PM_{10} data. Figure 35 is the overall frequency histogram. As with the Durango histogram the Telluride histogram is positively skewed as the density function exhibits a long right tail but features an atypical gradual decrease in the frequency as concentration increases. Slightly more than 50% of the samples are less than 25 µg/m^3 and it is not until a concentration of 50 µg/m^3 that we see 90% of the samples. This would seem to indicate that Telluride has historically experienced higher PM_{10} concentrations from local sources.

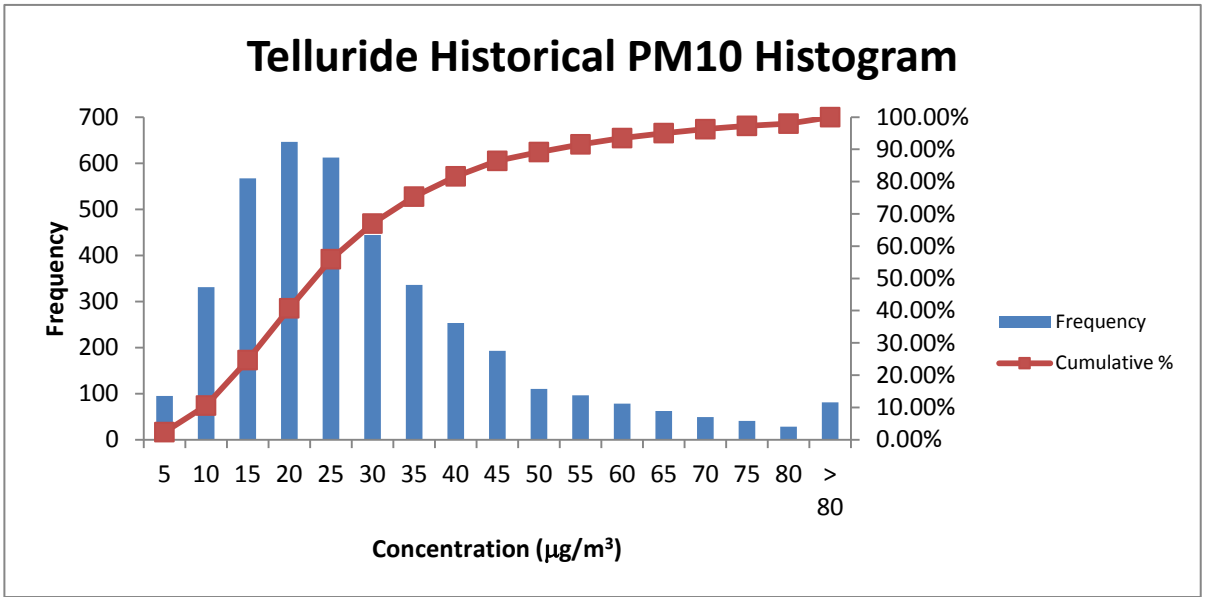


Figure 35. Telluride Historical PM_{10} Histogram.

Figure 36, the monthly percentile plot, highlights the consistency of the majority of data from month to month and features the generally higher medians in the winter and early spring. What differs in this plot from others in this evaluation is that there seems to be an association (see Table 18) among percentiles

(and monthly maxima) with monthly median values. This suggests that a larger than normal measure of every sample is from local sources, regardless of the magnitude of the sample.

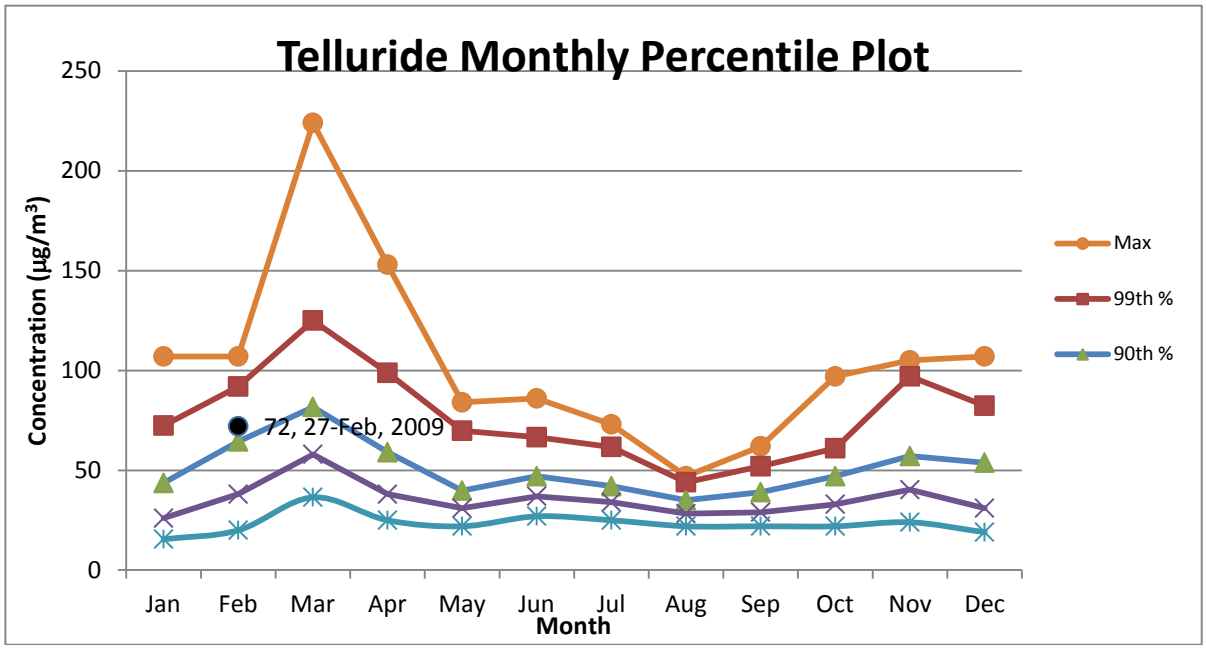


Figure 36. Telluride Monthly Percentile Plot.

Table 18 displays the correlation coefficients across the monthly percentile pairs for Telluride. This table has been included to demonstrate the degree of association between percentiles. The high measure of association is unique among PM_{10} sites in Colorado. The nature of the association suggests that typically a large portion of PM_{10} sampled in Telluride is due to local activities, regardless of magnitude.

Table 18. Correlation Coefficients Across Monthly Percentile Pairs for Telluride

	99th %	***95th %***	***90th %***	***85th %***	***84th%***	***80th %***	***75th%***	***70th %***
99th %	n/a							
95th %	0.96	n/a						
90th %	0.95	0.99	n/a					
85th %	0.91	0.97	0.99	n/a				
84th%	0.89	0.95	0.97	0.99	n/a			
80th %	0.87	0.93	0.95	0.98	0.99	n/a		
75th%	0.83	0.87	0.89	0.92	0.94	0.97	n/a	
70th %	0.77	0.80	0.83	0.86	0.89	0.94	0.99	n/a
Median	0.53	0.57	0.60	0.65	0.70	0.77	0.88	0.94

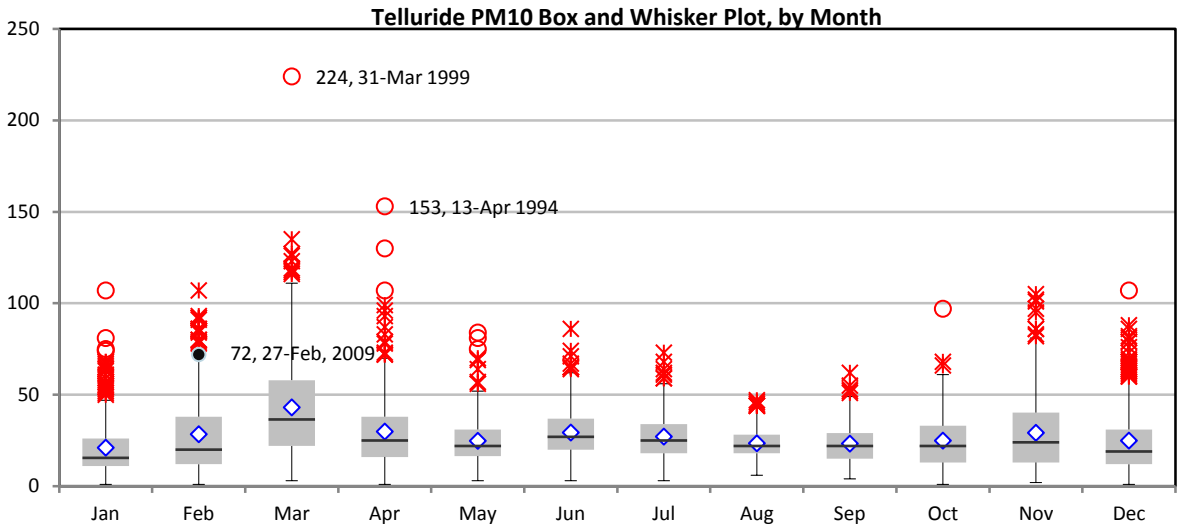


Figure 37. Telluride PM_{10} Box and Whisker Plot by Month.

Figure 37 demonstrates that although the sample value of February 27, 2009, was not as extreme as the sample at Durango, it is greater than what is typically found in the month of February (or any other month).

Alamosa Adams State College – 080030001

The PM_{10} sample on February 27, 2009, at Alamosa Adams State College of 49 µg/m^3 is the 90th percentile value for all February data, exceeds the 95th percentile value (44 µg/m^3) for all 2009 data, and exceeds the 94th percentile value for the entire dataset. There are 6347 samples in this dataset. While the value isn't notable for being extremely high, the sample of February 27, 2009, exceeds the typical samples at this site.

Figures 38 – 40 graphically characterize the Alamosa Adams State College PM_{10} data.

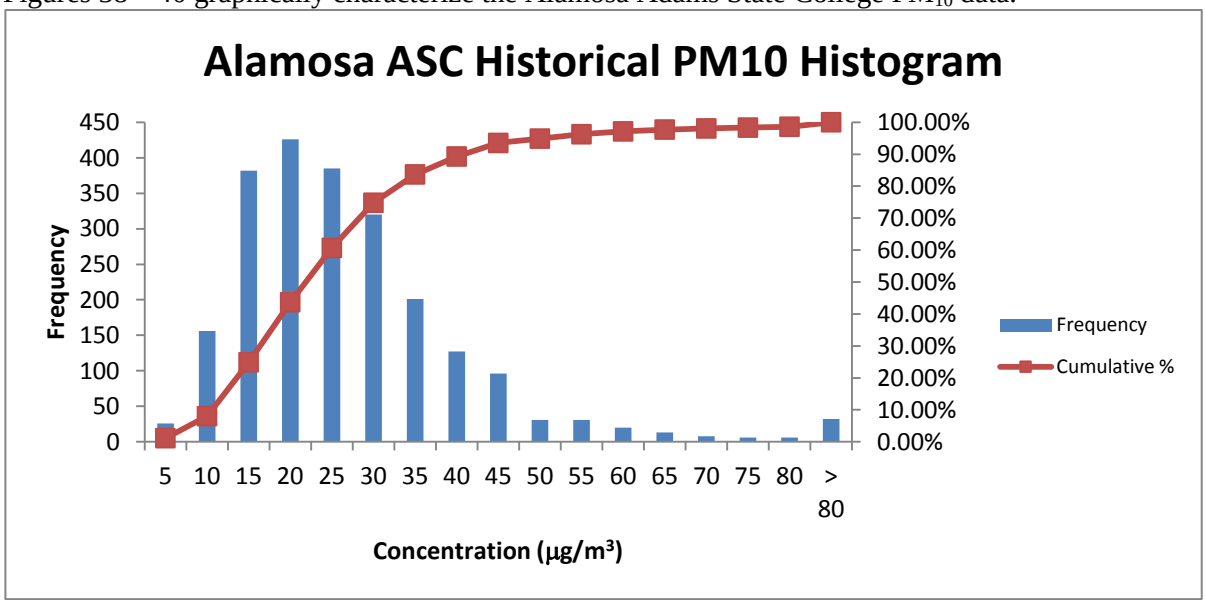


Figure 38. Alamosa Adams State College Historical PM_{10} Histogram.

As with the other histograms in this analysis, the Alamosa Adams State College histogram in Figure 38 is positively skewed as the density function exhibits a long right tail with a sharp decrease in frequency as concentration increases. Slightly more than 50% of the samples are less than 21 µg/m^3 and it is not until we exceed 40 µg/m^3 do we see 90% of the samples.

The monthly percentile plot in Figure 39 highlights the consistency of the majority of data from month to month and features the generally higher medians in the winter and early spring.

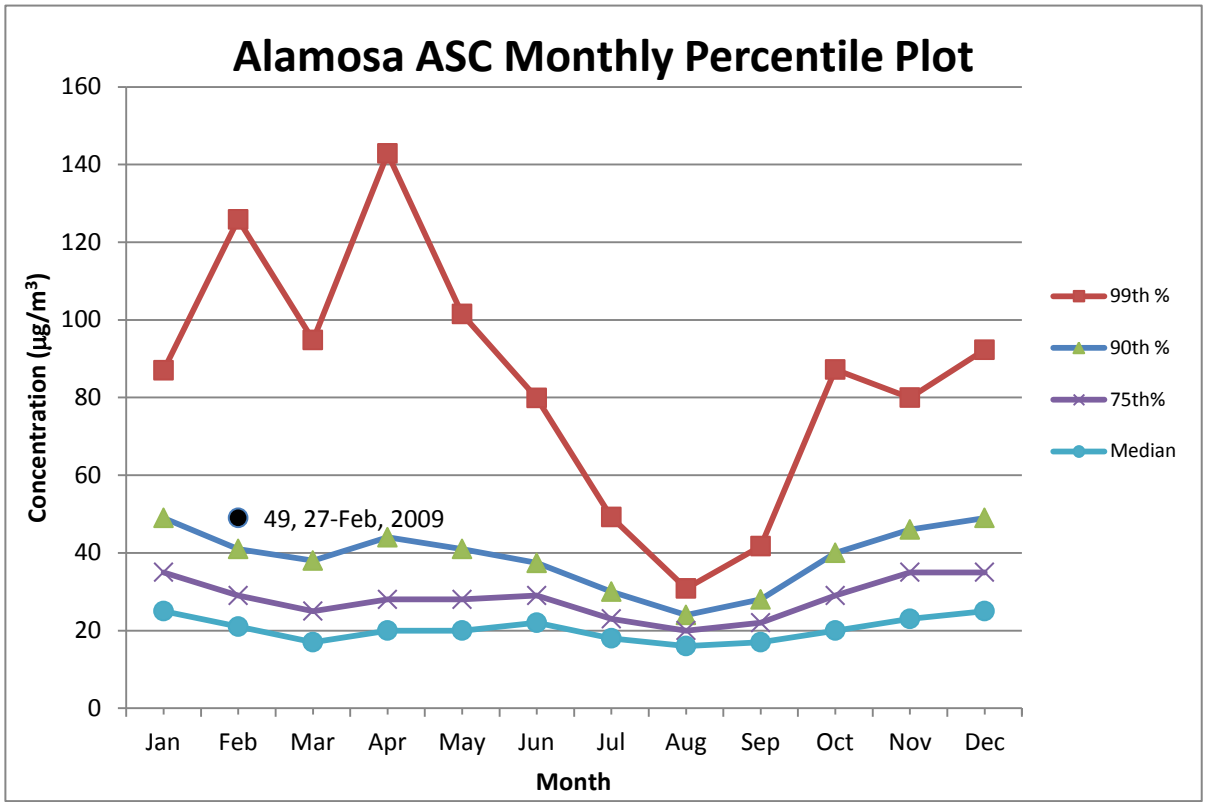


Figure 39. Alamosa Adams State College Monthly Percentile Plot.

The plot in Figure 39 is typical of other monthly percentile plots in Colorado in that there is little or no demonstration of association between monthly median values and higher percentiles. Although the sample value on the day of the event is not of the same magnitude as that for the other sites, it does exceed the 90th percentile value for February.

The monthly box-whisker plot in Figure 40 highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. This time period experiences a greater number of days with meteorological conditions similar to those experienced on February 27, 2009. Although these high values affect the variability and central tendency of the datset they are not representative of what is typical at the site. Every outlier identified by concentration and sample date is associated with a high-wind event. Several of these events were excluded as exceptional events by APCD, and EPA concurred in the past between 1991 and 2002. The 2006 and 2007 events were also due to high winds; however, the EPA did not concur on the two 2006 events (424 µg/m^3 on 10 Feb, 2006, and 158 µg/m^3 15 Feb, 2006) and the APCD did not flag the 2007 event (473 µg/m^3 on 6 June 2007) for unknown reasons. The APCD instead focused on local dust controls and instituted a Memorandum of Understanding and a Natural Event Action Policy with Alamosa City and County.

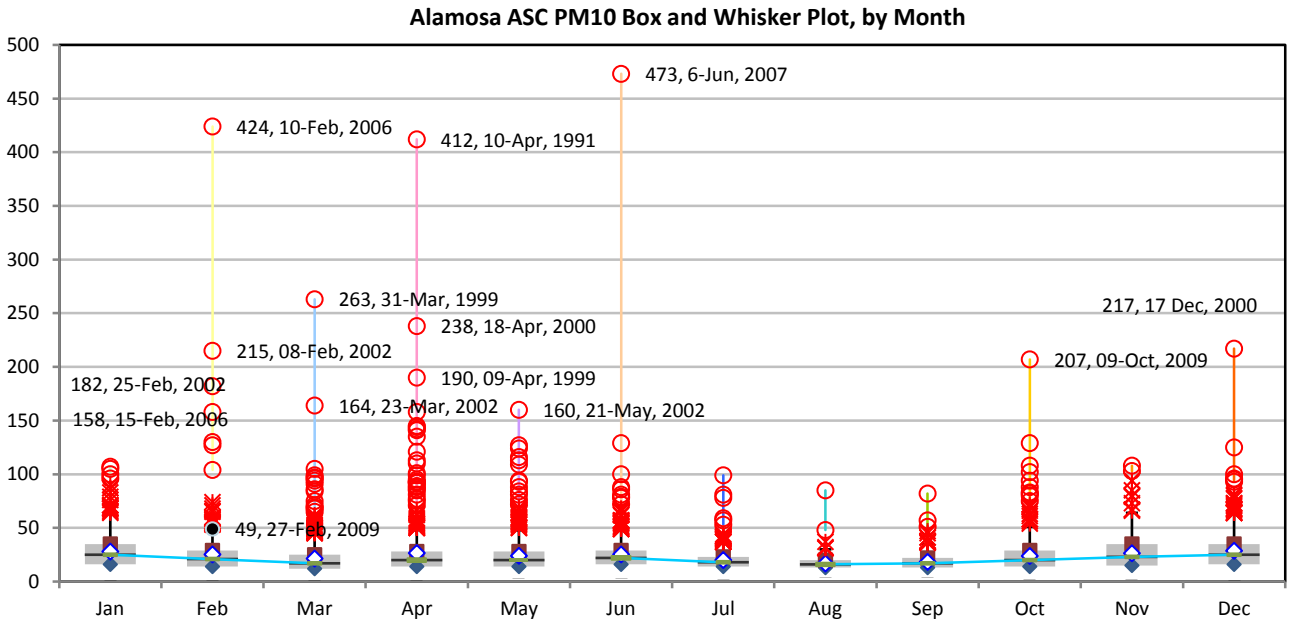


Figure 40. Alamosa Adams State College PM_{10} Box and Whisker Plot by Month.

Alamosa Municipal – 080030003

The PM_{10} sample on February 27, 2009, at Alamosa Municipal of 109 µg/m^3 is the 99th percentile value for all February data, exceeds the 99th percentile value for all 2009 data, and exceeds the 99th percentile value for the entire dataset, there are 2266 samples in this dataset. The sample of February 27, 2009, clearly exceeds the typical samples at this site.

Figures 41 to 43 graphically characterize the Alamosa Municipal PM_{10} data.

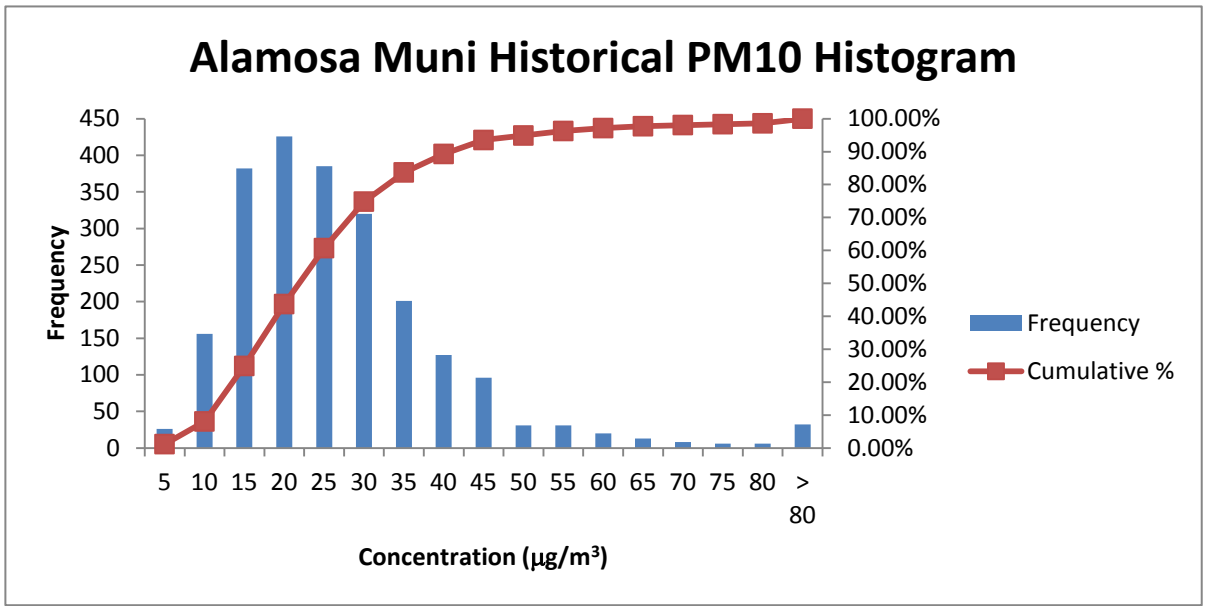


Figure 41. Alamosa Municipal PM_{10} Histogram.

As with the other histograms in this analysis, the Alamosa Municipal histogram in Figure 41 is positively skewed as the density function exhibits a long right tail with a sharp decrease in frequency as concentration increases. Slightly more than 50% of the samples are less than 22 µg/m^3 and it is not until we exceed 41 µg/m^3 that we see 90% of the samples.

The monthly percentile plot in Figure 42 highlights the consistency of the majority of data from month to month and features the generally higher medians in the winter and early spring.

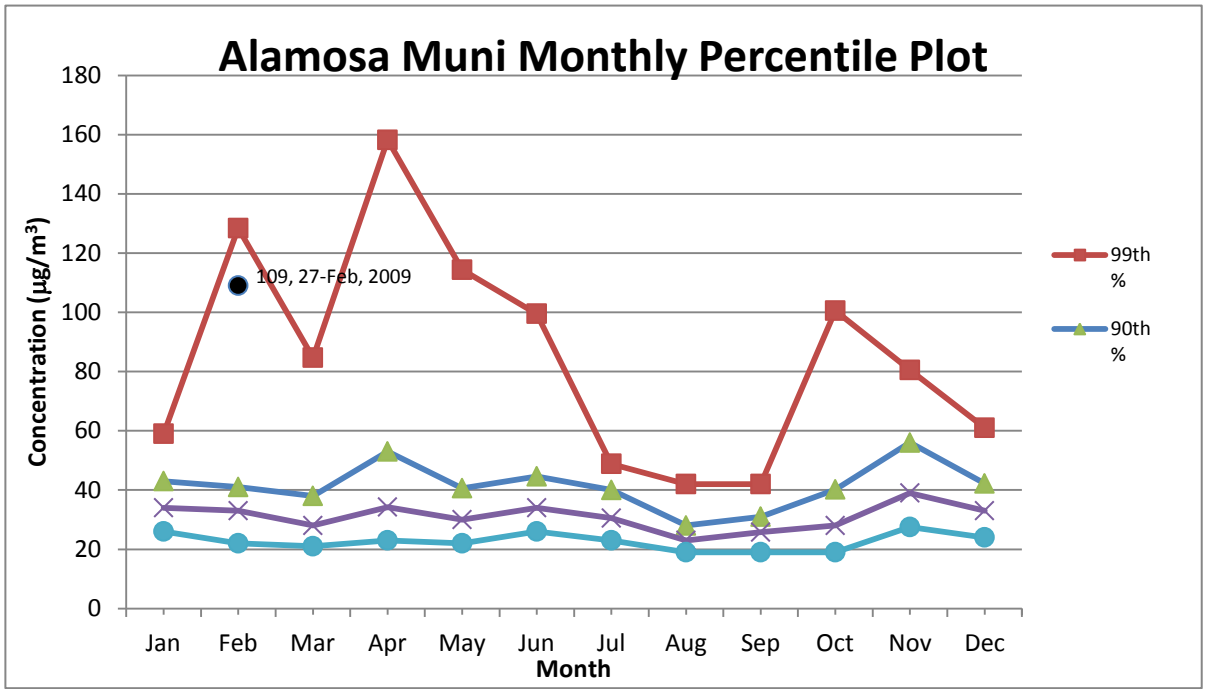


Figure 42. Alamosa Municipal Monthly Percentile Plot.

The plot in Figure 42 is typical of other monthly percentile plots in Colorado in that there is little or no demonstration of association between monthly median values and higher percentiles. The sample value on the day of the event clearly exceeds the typical values for this 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) of the data through the winter and early spring months that's accompanied by typically greater monthly maxima. This time period experiences a greater number of days with meteorological conditions similar to those experienced on February 27, 2009. Although these high values affect the variability and central tendency of the datset they are not representative of what is typical at the site. Every outlier identified by concentration and sample date is associated with a high-wind event.

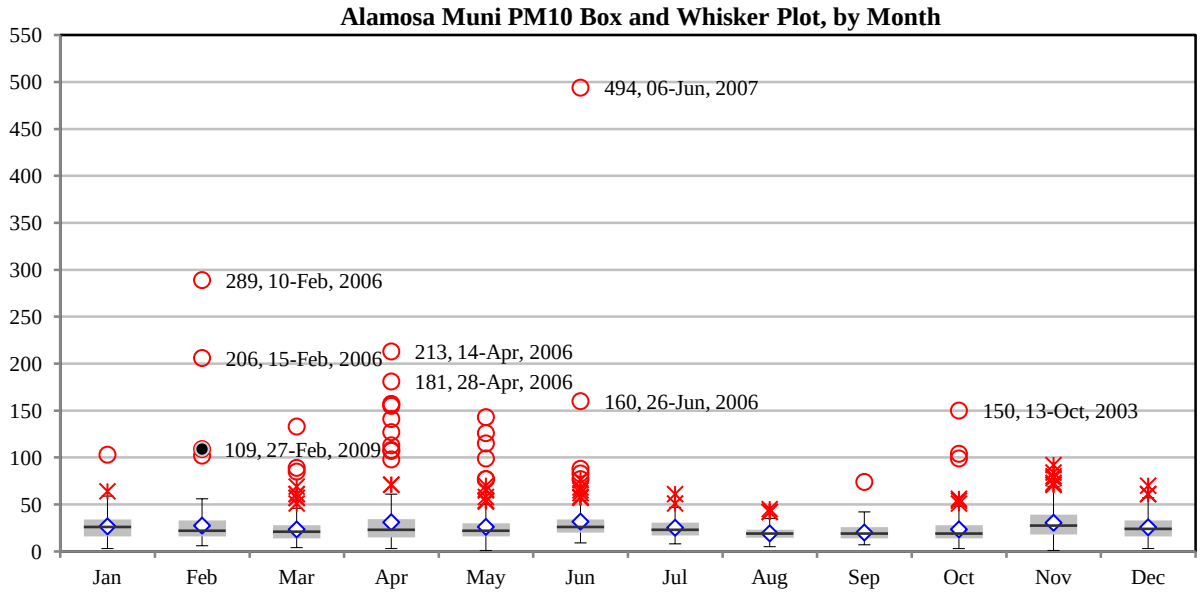


Figure 43. Alamosa Municipal PM_{10} Box and Whisker Plot by Month.

Filter Chemical Speciation

The Feb 27, 2009, sample from Durango was sent to ChesterLabNet of Tigard, Oregon, for chemical speciation. Chester performed three different analyses on the quartz filter, reporting 47 different elements and compounds. A summary of the notable results is presented below (all concentrations are in units of ug/m$^{3)}$.

Select chemical speciation results for Durango - February 27, 2009.

	Soil (estimated)	NO3	SO4	OC
Durango	49.1	6.4	2.8	30.2

The contribution from soil is estimated from the IMPROVE equation for geologic material: SOIL = 2.20*Al + 2.49*Si + 1.63*Ca + 2.42*Fe + 1.94*Ti, using a typical value of 2.5 for the ratio Si/Al (silicon isn't reported from quartz filter media). The large geologic component is typical of similar samples from high-wind events (note that the uncertainty in the geologic component estimate with this method can be large and the actual amount could be larger). The nitrate content of the sample is much higher than typical. APCD has analyzed 47 PM10 filters from high wind events occurring 2009 – 2011; the range of nitrate reported in those samples was 0.5 - 1.2 ug/m^3. Similarly, the OC component is higher than from samples taken during high wind events in 2009 – 2011. The range of OC reported in those samples was 5 - 23 ug/m^3.

In an article by Blank et al. (1999), researchers showed that "Pulses of nitrate-rich dust, synchronous with spring emergence" were measured in blowing dust from dry lake beds or playas in Nevada. The high nitrate in the Durango filter sample is consistent with transport of dust from dry lake beds in Nevada.

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 February for Durango would have been between 24 and 28 µg/m^3 corresponding to the 75th and 84th percentile values. Using these conservative values as 'typical' would indicate that the regional wind-blown dust event provided an additional 170 – 174 µg/m^3 contribution to the February 27, 2009, event. Thus, "but for" the regional blowing dust event there would not have been an exceedance of the PM_{10} NAAQS in Durango and the elevated PM_{10} concentrations in Alamosa would not have occurred.

Site	**Event Day Concentration (µg/m^3)**	**2009 Median (µg/m^3)**	**2009 Average (µg/m^3)**	**2009 75th % (µg/m^3)**	**2009 84th % (µg/m^3)**	**Est. Conc. Above Typical (µg/m^3)**
Durango	198	19	23.2	24	28	170 - 174
Telluride	72	13	18.6	22	28.9	43.1 - 50
Alamosa ASC	49	17	20.8	24	28	21 - 25
Alamosa Muni	109	21	24.5	30	34.9	74.1 - 79

4.0 News Accounts and Credible Evidence

Durango Telegraph

- Home
- » Archives
- » 2009
- » April-30-2009
- » Dust on the horizon

CoverStory

Dust on the horizon

Dust storms threaten the Southwest

The aftermath of a recent dust storm coats a local vehicle. If the dust seems more severe than before, you're not imagining it. According to Silverton's Center for Snow and Avalanche Studies, there have been 13 storms so far this winter, the most since the center began tracking them seven years ago. /Phoyo by Stephen Eginoire

by **Will Sands**

Another winter is literally biting the dust in Southwest Colorado. Regional forecasters, scientists and residents are marking a spring plagued by a record number of dust storms. Although the skies are currently clear, dust storms have done their part to accelerate run-off and denude the region's snowpack.

Chris Landry, of the Center for Snow and Avalanche Studies, has been getting his fingers dusty since 2002. At that time, he set up shop in Silverton with a vision for a research station that could assist scientists. To that end, he got permission from the U.S. Forest Service to establish what amounts to an outdoor laboratory. Throughout the winter, he takes measurements at two sites in the San Juans relatively unaffected by localized sources.

One of his first major clients and collaborators was Tom Painter, now of the University of Utah, who wanted to test the proposition that dust blown in by storms affects the rate of runoff. Thanks in part to Landry's observations, Painter is concluding that the dust has a significant impact, noting that the dirt in the snow absorbs heat and melts the snow. Pure snow reflects the sun's rays and withstands warmth to a much greater extent.

The impact of dust has been especially significant this winter. As of press time, 13 separate dust storms had ripped through the San Juan Mountains, marking a high point since Landry and company started their observations seven years ago.

“It is important to note that dust storms have been affecting the region for a very long time,” Landry said. “But in terms of our short and limited record, this winter and spring have had the largest number of events.”

Hesitant to point fingers, Landry noted that the workings of Mother Nature are one explanation for the phenomenon. The winter of 2008-09 was an especially windy one, and intense storm cells picked up dust over the Utah and Arizona deserts and then deposited it in the Colorado Rockies.

“The obvious explanation is that there have been more strong and windy systems tracking through the Colorado Plateau and into the Rockies this year than in past years,” Landry explained.

One man with several additional explanations is Jason Neff, a biogeochemist with the University of Colorado-Boulder. Neff’s quest for dust has brought him to the San Juans in recent years, where he has studied core sediments from several high-altitude lakes. The samples have enabled Neff to look thousands of years back in time. After analyzing the results, the team has arrived at a conclusion – dust storms are directly tied to human activity. Over Neff’s 5,000 year timeline, the first spike in dust was in the late 1800s, during the first significant settlement of the Southwest.

“Prior to settlement, there was not a lot of grazing, roads or soil disturbance,” Neff said. “The soil surfaces were stable, covered with biologic crusts and armored against erosion.”

Another spike has hit in recent years, and the size and frequency of dust storms appear to be on the rise again.

“In the late 1800s, dust loading skyrocketed and was about five times as high as our background data,” Neff said. “Today, dust is about three or four times the background, and livestock, off-road vehicles, human development, dirt roads and weather are all factors.”

Though causes may be up for debate, the effects are not. Heavy dust loading in the San Juans contributed to last week’s spike in run-off on the Animas River. After just a few warm days, flows shot up to nearly 2,000 cfs before subsiding with the cooling temperatures. The region’s snowpack – the water supply for coming summer months – dwindled dramatically during the same period, falling from 98 percent of average on April 18 to 73 percent of average early this week.

To make matters worse, the Center for Snow and Avalanche Studies has observed similar dust loading all over the Colorado Rockies, which will mean a widespread affect on the timing of run-off and the volume of water supplies in coming weeks and months. Recognizing the stakes, eight major water agencies in Colorado have entered into contracts with the Center to predict when the meltdown will begin.

“We’re involved and helping fund the study because when you get dust events it does affect the timing of run-off,” said Bruce Whitehead, executive director of the Southwest Water Conservation District in Durango. “The dust definitely impacts the long-term flow and can be serious detriment to senior water rights holders.”

Chris Landry analyzes a block in Senator Beck Basin near Silverton earlier this winter. Landry and the Center for Snow and Avalanche Studies have been studying the effects of dust on snowpack at sites all over the state for the last seven years./Photo by Stephen Eginoire

On the Animas River, early run-off promises to have negative impacts on agriculture, according to Whitehead. In addition, the wind and dust increase the rate of sublimation, where moisture simply evaporates into thin air, leaving the basin thirsty after all but the biggest winters. These factors will also become more complicated as the region grows.

“As the basin’s water becomes more appropriated, there’s more demand on the supply,” Whitehead said. “Though the Animas is not considered overappropriated at the moment, this may change in the future, and the administration of the river will have to change with it.”

Whether fields, crops or livestock go thirsty later this summer remains an unknown. But for the time being, water and river users should expect another big bump in Animas River flows in coming days and weeks.

“We just saw the first significant surge in snowmelt of the season,” Landry said. “That was curtailed a bit by a very thin layer of fresh snow over the weekend. But that clean new snow isn’t going to last more than a day or two, and when warm temperatures hit, the melt is sure to start again.”

Neff added that dust storms are certain to be popping up on the local radar for many years to come. “I suspect people haven’t really considered dust as a threat before this,” he said. “But it’s a pretty big deal and an impact on air quality and water supply. I’m sure this year has changed a lot of minds.”

In closing, Whitehead spoke for the entire basin and said, “The (storms) are no good for the snowpack, the air quality or our quality of life. I just hope we’re done with dust storms for the year.”

Colorado Alpine Dust Deposition and Associated Continental Winds[1]

Morgan Phillips[2]
Colorado Climate Center and Bureau of Land Management

Abstract. The winter and early spring of 2008-2009 brought an unusually high number of alpine dust deposition events to the Rocky Mountains of Colorado. The greatest dust accumulations were observed in the San Juan Mountains of southwestern Colorado. Significant dust accumulation was even observed along the Continental Divide in northern Colorado. The primary source for this dust has previously been identified as the Colorado Plateau. Analysis using the HYSPLIT(Hybrid Single Particle Lagrangian Integrated Trajectory) atmospheric trajectory model along with satellite imagery showed that dust from the 2009 events also originated from the Colorado Plateau, especially from areas in and around northeastern Arizona that were experiencing drought conditions this spring.

This study utilized data from the USFS/BLM RAWS (Remote Automated Weather Station) network over the southwestern U.S. to identify periods of high winds corresponding to documented Colorado dust events. Wind speeds for the study region were evaluated for the period January through April for the past 20 years in an attempt to quantify and compare both mean wind speed and maximum wind gusts on a seasonal basis. A linear regression analysis showed a significant correlation between the Southern Oscillation Index (SOI) and the frequency of these types of high wind periods, particularly during winter months. The correlation between periods of high winds and the SOI extends through the 20 years of wind data available for these weather stations.

1. Introduction

During the late winter and early spring mid-latitude cyclones and their associated fronts moving through the southwestern United States often generate intense regional dust storms which then deposit large amounts of airborne sediment in alpine mountain areas (McBride, 2007). Aeolian sediment deposition on alpine snow packs in the western United States is becoming a subject of greater concern as a larger percentage of the population continues to depend on mountain snow as a source of municipal water supplies. The accumulation of dust on mountain snow packs has the potential to alter the snowmelt regime and thus the rate and timing of snowmelt discharge (Painter et al. 2007).

In addition to water management, these types of events have an immediate impact on regional air quality. The primary goal of this study was to investigate potential origins of dust found in the San Juan snow pack by using a combination of data analysis and atmospheric models, while at the same time attempting to quantify the frequency of high wind periods capable of generating dust storms. Previous studies have shown inter-annual variations of wind gust magnitude are related to the El Niño/Southern Oscillation cycle (Enloe, O'Brian and Smith, 2003). By looking at multiple years of wind data this study was designed to determine if atmospheric conditions were more favorable for synoptic scale dust storm formation during 2009 than in other years.

[1] A joint research project through the Bureau of Land Management and the Colorado Climate Center

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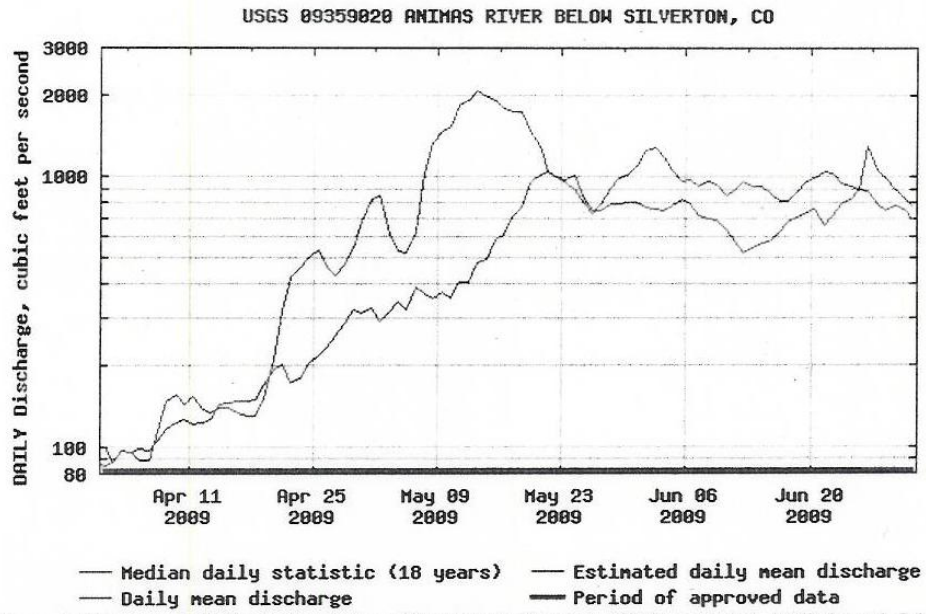

Figure 1. Discharge (cfs) for the Las Animas River below Silverton, CO from April 1, 2009 through July 1, 2009 compared to the 18 year historic average.

Isotopic analysis has shown that the dust accumulated on the San Juan snow pack during deposition events in 2004/2005 and 2005/2006 seasons originated from the basement rocks and their sedimentary derivatives in the area to the southwest of Colorado known as the Colorado Plateau (Painter et al. 2007). While it is likely that dust from many regions of the globe is transported to, and subsequently deposited in the San Juan Mountains (Jaffe, Snow and Cooper, 2003), dominant westerly flow over the region suggests that major dust sources in the upwind area would be the most likely to contribute to the majority of the aeolian sediment load.

2. Methodology

Individual RAWS Analysis

The project began with a simple visual analysis of wind data from individual RAWS locations in the western US. Stations with periods of sustained high winds (> 4 hours) best corresponding to multiple known dust deposition events (Table 1) over several years were then mapped using Geographic Information Systems (GIS) software. The resulting map indicates where conditions were most favorable for the generation of dust storms on a synoptic (non-convective) scale immediately surrounding a recorded deposition event in the San Juan Mountains.

Once several time series graphs had been identified as corresponding to dust deposition events it was possible to determine an average 'threshold' wind velocity above which dust storms were generated. This was done for both mean wind speed and maximum wind gusts, where the mean daily velocity threshold was found to be 15 mph and the threshold for maximum daily wind gusts was 44 mph. These threshold values were then used as an

indicator of high wind criteria for the frequency analysis. In addition to analyzing the spatial distribution of stations that corresponded well with dust events, the directional characteristics of the wind were analyzed when the velocity exceeded the threshold value to determine the dominant wind direction during potential dust generating episodes.

Table 1. Dust Deposition Events for Senator Beck Basin Study Area in the San Juan Mountains from winter of 2002/2003 through winter of 2008/2009 (Courtesy Center for Snow and Avalanche Studies)

Year	*2002/2003	*2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009
Event Dates	3-Feb	17-Apr	23-Mar	23-Dec	17-Dec	16-Mar	11-Oct
	22-Feb	28-Apr	4-Apr	15-Feb	27-Feb	26-Mar	13-Dec
	22-Apr	11-May	8-Apr	26-Mar	27-Mar	30-Mar	27-Feb
			9-May	5-Apr	15-Apr	15-Apr	6-Mar
				15-Apr	18-Apr	21-Apr	9-Mar
*Record Incomplete				17-Apr	24-Apr	30-Apr	22-Mar
				22-May	4-May	12-May	29-Mar
				27-May	6-Jun		3-Apr
							8-Apr
							15-Apr
							24-Apr
							25-Apr

HYSPLIT Trajectory Modeling

An atmospheric trajectory model from the National Air Resource Laboratory known as HYSPLIT was used to further analyze the movement of air parcels during known dust events. Both back trajectory (for air parcels originating over the deposition area) and forward trajectory (for air parcels originating over the suspected dust source) analyses were carried out for multiple events. HYSPLIT models were initialized by using weather stations near the suspected source area to determine the approximate time of peak wind velocity, and used EDAS (Eta Data Assimilation System) 40 km resolution data sets from the Air Resource Laboratory. A matrix of 15 origin points centered roughly over the San Juan Mountain range was used for the back trajectory analysis, while the forward trajectory analysis used a matrix of source points centered over the suspected source area in northeastern Arizona. The resolution on both matrices was set at 0.3 degrees.

Frequency Analysis

Wind data for the project was acquired from the RAWS network which collects hourly readings of wind speed, direction and maximum gust speed from a 20 ft. mast. Prior to beginning the analysis of high wind periods, RAWS locations with at least 20 years of high quality wind data were first identified throughout the states of Nevada, Utah, Arizona and western New Mexico. Out of the several hundred RAWS sites currently operating, 42 were identified as meeting the required criteria. From this initial data set the frequency analysis was carried out by counting the number of times the daily mean wind speed and maximum daily wind gusts exceeded the threshold values for each year of record. A 20 year average was created from these data. The values for individual years were then compared against the 20 year average to identify the departure from average.

3. Results and Discussion

Individual RAWS Analysis

The results from the visual analysis showed that the majority of RAWS locations with high wind periods best corresponding to known San Juan dust events were located in and around northeastern Arizona. The relationship between periods of sustained high winds and recorded dust events becomes weaker as one chooses stations further and further away from the northeast Arizona area (Fig. 1). This pattern suggests that conditions favorable to entraining and transporting aeolian sediment are present mostly in northeastern Arizona during a corresponding dust event in the San Juan Mountains, and therefore the source of this dust is most likely in the target area of northeastern Arizona. In addition to the data analysis, visual satellite imagery from Geostationary Operational Environmental Satellite (GOES) and Moderate Resolution Imaging Spectroradiometer (MODIS) instruments also show rising dust plumes prior to the dust events from the same areas in Arizona where the corresponding weather stations are located.

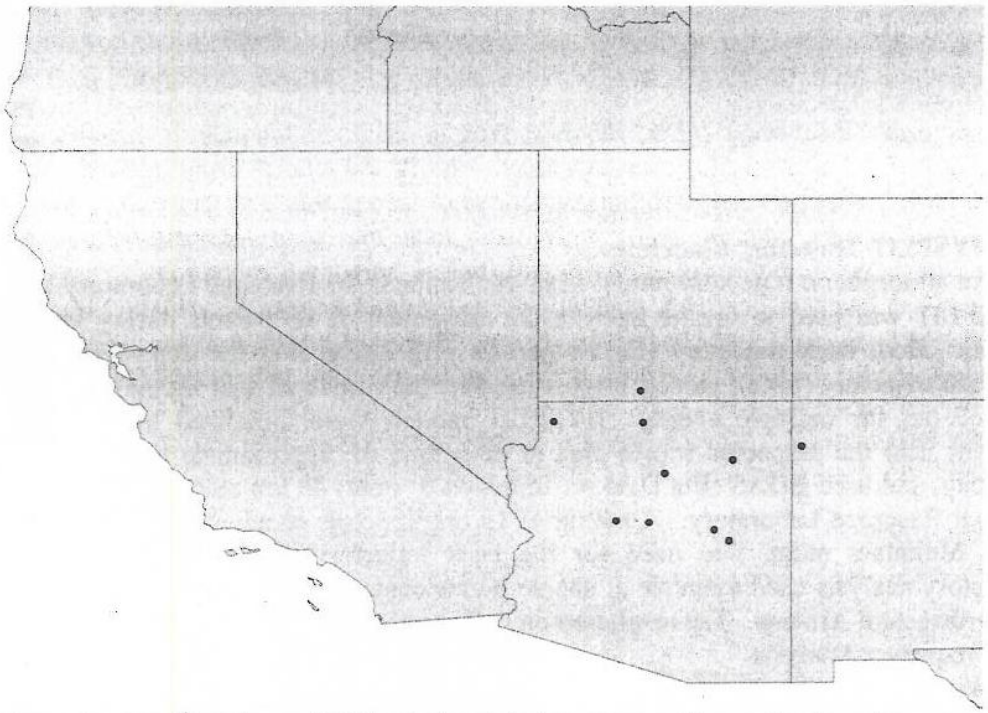

Figure 2. RAWS locations with high wind periods best corresponding to San Juan dust events from 2004 through 2009

Furthermore, directional analysis of high velocity wind periods at these stations indicates the strongest winds are from a southwesterly direction. The directional component of the surface winds appear to be a major indicator as to whether or not a high wind period corresponds to a San Juan dust event. This became evident during the investigation of anomalous high wind periods that did not correspond to dust events in the San Juan Mountains. A good example can be found in the wind analysis of the Hopi, Arizona RAWS location during March 29 through April 3 of 2009 (Fig. 2). Here, a high wind period on April 1 that does not correspond to a dust event in southwest Colorado

occurs in-between high wind periods matching dates of known San Juan dust events. The two high wind periods on March 29 and April 3 (Fig. 3 and Fig. 4) all have the strongest surface winds from the southwesterly direction, while the April 1 high wind event has the strongest winds coming from a north/northwesterly direction (Fig. 5). This evidence suggests that while the April 1 event likely entrained a significant amount of surface dust, the suspended dust was carried south of Colorado by the prevailing northerly winds associated with that particular storm system.

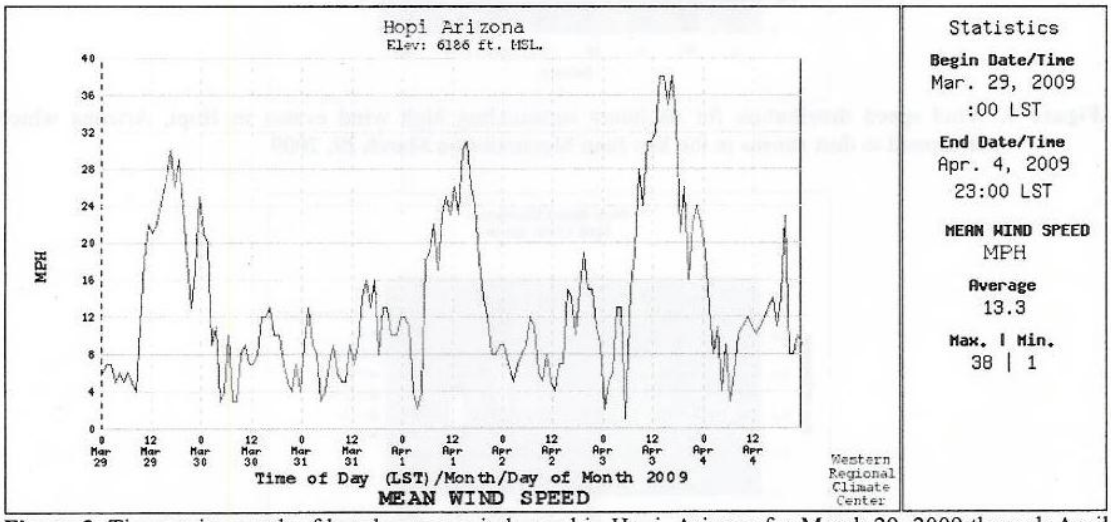

Figure 3. Time series graph of hourly mean wind speed in Hopi, Arizona for March 29, 2009 through April 4, 2009

HYSPLIT Trajectory Modeling

Assuming that entrained dust would travel at roughly the same speed as the boundary layer winds, the approximate time of travel from the suspected source to the San Juan Mountains was determined to be around 8 hours. Using this timing scenario HYSPILT models mostly show air parcels over the San Juan Mountains originated from northeast Arizona. Similarly, the forward trajectories were initialized during peak wind velocities on days with known San Juan dust events and run for 8 hours resulting in destinations over the southwestern Colorado Mountains. Since it is unrealistic to assume all events would have the same timing scheme, ensemble runs were made for several events using different initialization times. The resulting plots from the ensemble members showed only minor shifts in the trajectories.

The resolution for the matrix of source points was decided upon because of both the resolution of the meteorological data and the relatively large scale of the study area. At 0.3 degrees, the matrix is large enough to cover the area of interest while still retaining some level of spatial detail. The use of the model was not meant to isolate specific points of emission, but was intended to show that air parcels over the San Juan Mountains originated from the general area of the suspected dust source in northeast Arizona during known dust events.

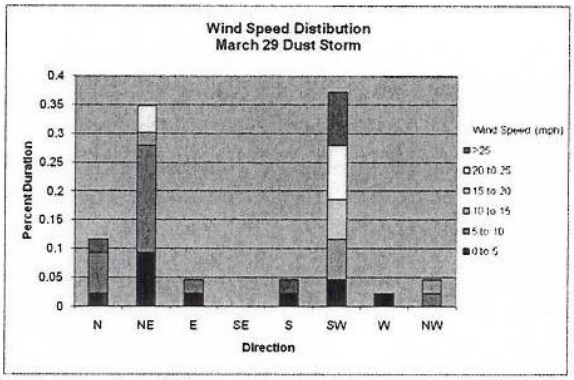

Figure 4. Wind speed distribution for 48 hours surrounding high wind events in Hopi, Arizona which correspond to dust storms in the San Juan Mountains on March 29, 2009

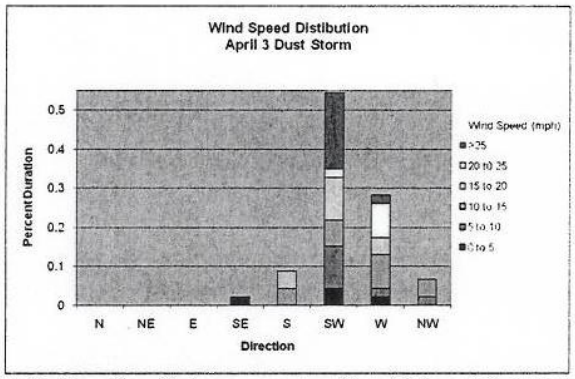

Figure 5. Wind speed distribution for 48 hours surrounding high wind events in Hopi, Arizona which correspond to dust storms in the San Juan Mountains on April 3, 2009

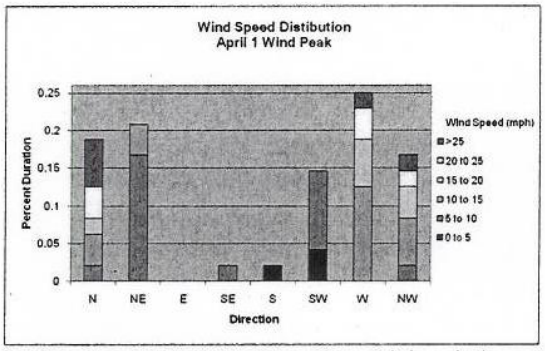

Figure 6. Wind speed distribution for 48 hours surrounding high wind event in Hopi, Arizona not corresponding to a dust storm in the San Juan Mountains on April 1, 2009

Frequency Analysis

The frequency analysis was designed to quantitatively measure the amount of high wind events in the southwestern US over a wide spatial range. By combining data from the entire population of 42 stations, a change in the frequency of high wind days could be measured on a synoptic scale to reveal trends common to all of the stations. Daily summaries were used instead of hourly values because the investigation was interested in the frequency of discrete, multi-hour periods of high winds rather than short duration

signals that are not likely to generate large scale dust events. By focusing on daily data and eliminating short duration, high velocity signals the measured signals should be more representative of dust storm generating events.

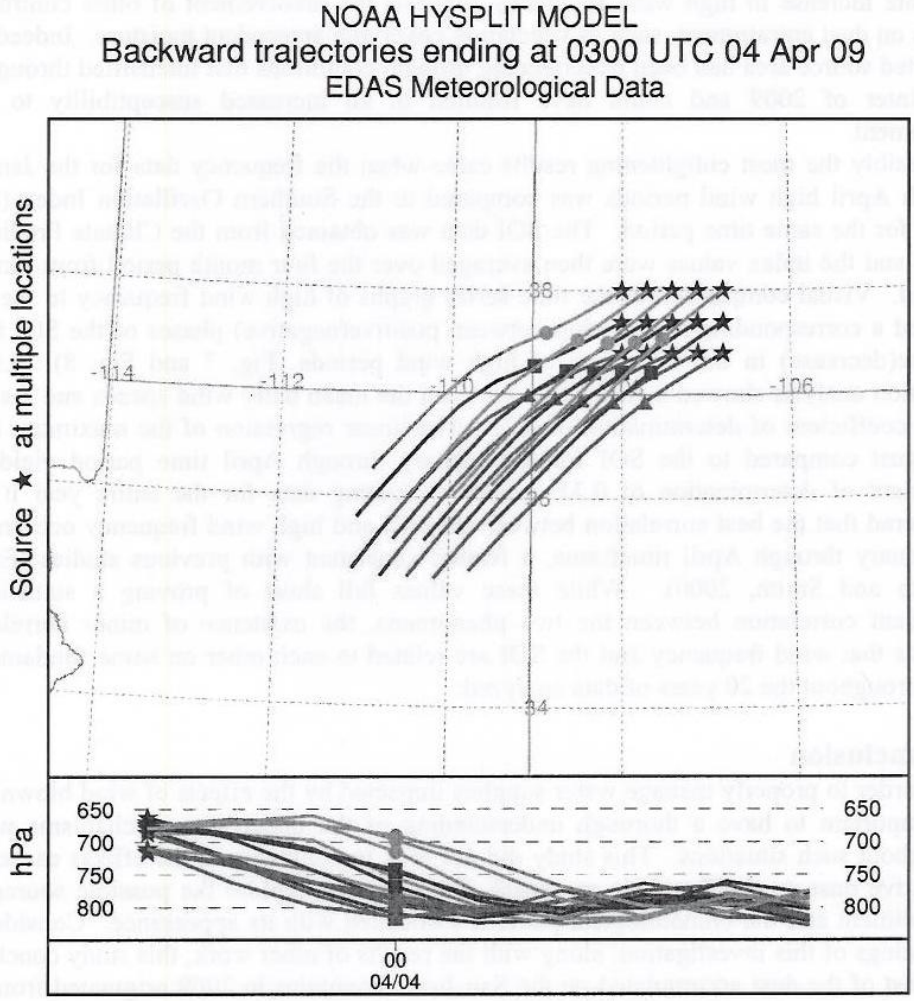

Figure 7. (Above) Back trajectory HYSPLIT model from 19:00 UTC April 3, 2009 to 03:00 UTC April 4, 2009 with air parcel sources indicated with stars. (Below) air parcel pressure (hPa) time series graph with the beginning time of 03:00 UTC April 4, 2009 on the left moving backward in time to 19:00 UTC April 3, 2009 on the right

Preliminary analysis consisted only of the data from January through April, as this is the ideal time for the formation of large scale dust storms in the southwestern US (McBride, 2007). Using the high wind criteria defined from the individual station analysis, the average number of days the mean daily wind speed exceeded 15 mph during January through April was found to be 4.4 days with a standard deviation of 1.1 over the 20 year period, and the average number of days maximum daily wind gusts exceeding 44 mph for

the same months was 6.6 days with a standard deviation of 1.6 over the 20 year period. While the winter of 2009 ranked above the 20 year average in terms of the number of days with high winds, it was not the largest increase seen in the period of record. The discrepancy between the unusually high numbers of dust storms in 2009 with only a moderate increase in high wind frequency suggests the involvement of other controlling factors on dust entrainment, such as vegetation cover and antecedent moisture. Indeed, the suspected source area had been experiencing drought conditions that intensified throughout the winter of 2009 and could have resulted in an increased susceptibility to dust entrainment.

Possibly the most enlightening results came when the frequency data for the January through April high wind periods was compared to the Southern Oscillation Index (SOI) values for the same time period. The SOI data was obtained from the Climate Prediction Center and the index values were then averaged over the four month period from January to April. Visual comparison of the time series graphs of high wind frequency to the SOI revealed a corresponding relationship between positive(negative) phases of the SOI to an increase(decrease) in the frequency of high wind periods (Fig. 7 and Fig. 8). Linear regression analysis showed a correlation between the mean daily wind speeds and the SOI with a coefficient of determination of 0.21. The linear regression of the maximum daily wind gust compared to the SOI for the January through April time period yielded a coefficient of determination of 0.31. After evaluating data for the entire year it was discovered that the best correlation between the SOI and high wind frequency occurred in the January through April timeframe, a feature consistent with previous studies (Enloe, O'Brian and Smith, 2000). While these values fall short of proving a statistically significant correlation between the two phenomena, the existence of minor correlation suggests that wind frequency and the SOI are related to each other on some fundamental level throughout the 20 years of data analyzed.

4. Conclusion

In order to properly manage water supplies impacted by the effects of wind blown dust it is important to have a thorough understanding of the underlying mechanisms which bring about such situations. This study did not seek to comment on the effects caused by non-native dust on the San Juan snowpack, but rather to explore the possible sources of this sediment and the climatological patterns associated with its appearance. Considering the findings of this investigation, along with the results of other work, this study concludes that most of the dust accumulated on the San Juan Mountains in 2009 originated from the arid basin areas of the Colorado Plateau. The identification of the Colorado Plateau as the primary dust source does not imply that airborne sediment does not come from other sources, but only that the majority of San Juan dust originated from there.

As far as the correlation between increased frequency of high wind periods in the southwestern United States and the ENSO, more research is necessary before any concrete conclusions can be made. It is clear that some underlying relationship does exist between the ENSO and continental winds; however, the exact magnitude and timing of this effect is as of yet unknown. Aside from the frequency of high winds, it has been shown that ENSO forcing is also related to other key factors responsible for the generation of dust storms including vegetation (Li and Kafatos, 2000) and antecedent moisture conditions. Given

the positive results yielded from this study, the connection between the ENSO and alpine dust deposition in the San Juan Mountains certainly warrants further investigation.

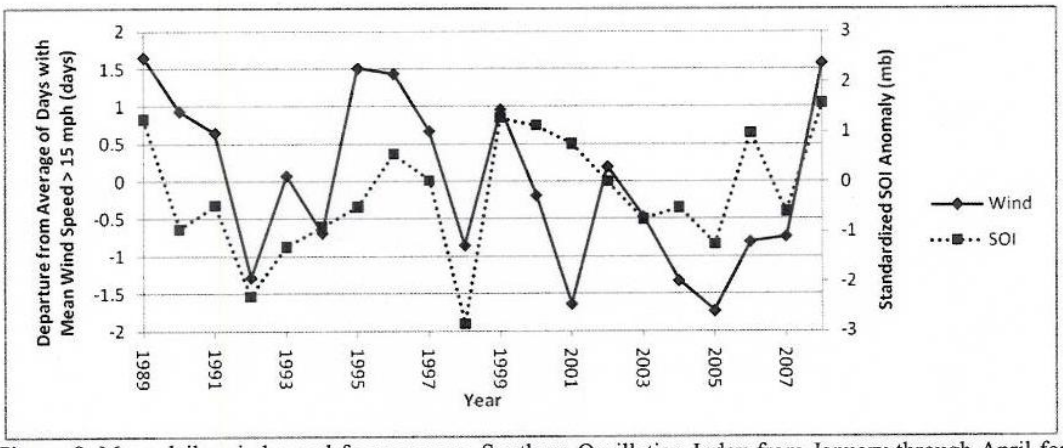

Figure 8. Mean daily wind speed frequency vs. Southern Oscillation Index from January through April for 42 RAWS in AZ, NV, UT and western NM

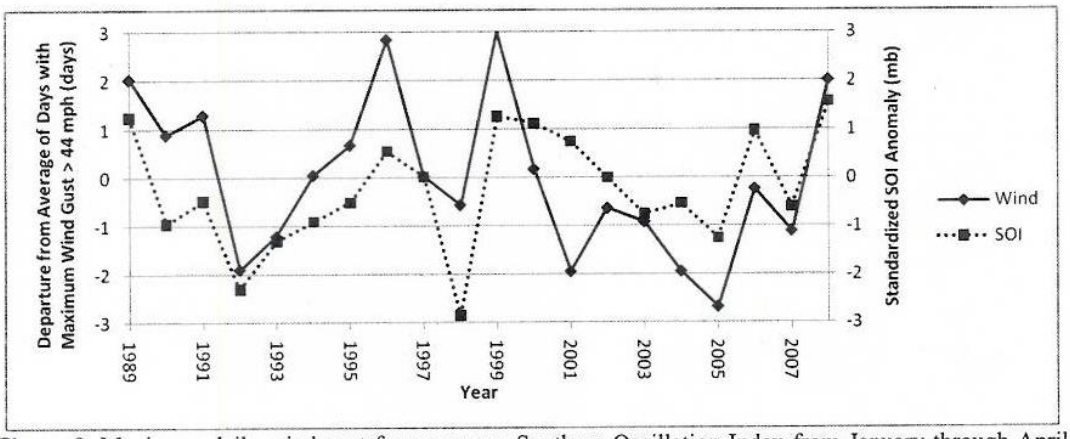

Figure 9. Maximum daily wind gust frequency vs. Southern Oscillation Index from January through April for 42 RAWS in AZ, NV, UT and western NM

5. References

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5.0 Local Dust Control

Local Dust Control Measures in the Durango Area:

The City of Durango, La Plata County, and the Southern Ute Indian Tribe have implemented dust control regulatory measures for numerous sources. Both the City and the County have a number of proactive programs that reduce dust from significant PM_{10} source categories in La Plata County. The following detail local dust control ordinances for the Durango area:

Street Sweeping and Sanding Controls

The City of Durango performs street sweeping five days per week in the downtown area on a rotating basis and once every two months in residential areas. The City is responsible for street sweeping State Highways 550 and 160 that run through the City. The City estimates sweeping an average of 6,320 miles per year, running sweeper operations 1,172 hours, and removing 3,013 cubic yards of debris. The town of Bayfield in La Plata County performs street sweeping on town streets periodically.

The City of Durango employs a Snow and Ice Division that uses street maintenance crews to remove snow and ice for 30% of their time. This Division de-ices major streets prior to snow with magnesium chloride ($MgCl_2$). Streets are plowed and sanded according to priority (i.e. hazardous intersections, snow routes, downtown, and bus routes) after snowstorms. The City spends on average 4,433 hours per year sanding and salting streets.

Dust Suppressant Program

La Plata County currently employs a dust suppressant program. The major focus of the program is to reduce dust from gravel roads. La Plata County has approximately 196 miles of paved roads and about 490 miles of gravel roads. Approximately 220 centerline miles of gravel road are treated with about 950,000 million gallons of $MgCl_2$ annually. The County typically begins application of $MgCl_2$ in late April or early May, and continues as needed through September. In May and June, roads not slated to receive new gravel are the first to be treated with $MgCl_2$. During July through September, other roads are treated, including roads being resurfaced, and those roads needing a second application.

Landfills

La Plata County closed the Durango Landfill in 1990, and has been working with the Colorado Department of Public Health and Environment to ensure post-closure care and maintenance standards are met. These include, but are not limited to, minor grading to correct any erosion, maintenance of the surface drainage, and ground cover enhancement.

The remaining landfill in La Plata County, Bondad Landfill, is located approximately 15 miles south of Durango within the exterior boundaries of the Southern Ute Indian Reservation, and has been in operation since 1997. The landfill is privately owned and operated by WCA Waste Corporation. The landfill has a fugitive dust emission control plan in its Part 71 permit currently enforced by the Environmental Protection Agency (EPA) (Region 8).

On March 2, 2012, the Southern Ute Indian Tribe received full approval from EPA to administer its Part 70 Operating Permit Program within the exterior boundaries of the Reservation. The Tribe is currently conducting the process of its Transition Plan to inform the Landfill (and other Title V sources) about the jurisdictional change. The Southern Ute Indian Tribe will transition Part 71

permits to the Tribe-issued Part 70 permits for all Reservation Title V sources. This transition process will take place over a three-year period.

Durango Train Smoke Mitigation Task Force

The Durango and Silverton Narrow Gauge Railroad operates historic coal-fired steam locomotives from its yard located on the south-side of Durango. Because of the potential for thermal stress damage (cracking) to the antique boilers (greater than100 years in age) from repeated cycling between cold and hot, they must idle throughout the night in order to be ready for use the next day, creating emissions from various pollutants. In 2001, the train operator installed scrubbers at the train yard roundhouse to control emissions from some of the locomotives while idling overnight. However, space limitations at the roundhouse prevented the operator from controlling all of the locomotives.

The railroad employs several emission-reducing alternatives, including burning wood pellets, building a new ash pit in Silverton to reduce idle time in Durango in 2005, using diesel for all switching and track maintenance, and specialized training for engine firemen on how to place coal and wood pellets. In 2007, the train operator pledged to spend $1 million over 5 years to reduce emissions by 10% each year. Currently, the Task Force is seeking funding to construct an expanded scrubber system, estimated at $1.2 million dollars.

Vegetative Cover/Parks

The Durango Parks Department removes sand, dirt, and organic debris from roads, walks, lots, and hard surfaces weekly. There are several multi-use trails either in completion or construction phases, which have multiple benefits, including reducing motor vehicle use and reducing fugitive dust from lengthy unpaved trails. The largest of these projects are the Animas River Trail (ART) and the Safe, Multi-Modal, Aesthetic, Regional Transportation trail aligning along Highway 160 (SMART 160). All multi-use unpaved trails are surfaced with gravel or rock screenings.

Federal Motor Vehicle Emission Control Program

The federal motor vehicle emission control program has reduced PM_{10} emissions through a continuing process of requiring diesel engine manufacturers to produce new vehicles that meet tighter and tighter emission standards. As older, higher emitting diesel vehicles are replaced with newer vehicles; the PM_{10} emissions in the Durango area will be reduced.

Municipal Codes

The municipal codes for the City of Durango contain a number of significant ordinances that result in PM_{10} emission reductions:

- All developed vehicular traffic areas, driveways, on-site parking areas, and off-site parking districts are required to be properly graded for drainage and surfaced with concrete, asphaltic concrete, or any other dust-free surface materials, and maintained in good condition, free of weeds, dust, trash, and debris (Ord. No. 10-1-6 (a) “Vehicular Circulation Areas”; Ord. No. 10-1-28 (a) “Driveways”; Ord. No. 10-2-1 (m)(6) “On-site Parking”; Ord. No. 4-3-12 (d)(1))
- Dust from developments is required to be effectively minimized to not be injurious to the neighborhood or detrimental to the general public (Ord. No. 10-1-8 “Pollution”)
- Recycling facilities are permitted and encouraged for redemption and recycling of reusable materials in order to reduce litter. These facilities are not allowed to produce dust that is detectable on neighboring properties (Ord. No. 10-1-17 (f)(14)”Recycling Facilities”)

- Self-storage facilities are prohibited for any use that produces dust or fumes (Ord. No. 10-1-31 (l) (6) "Self-storage Facilities")
- The surfaces of all bicycle parking spaces do not have to be paved, but shall be finished to reduce mud and dust (Ord. No. 10-2-4 "Bicycle Parking Spaces")
- All recreational campgrounds that have parking spaces and interior roads are required to be paved or treated to reduce dust (Ord. No. 10-5-14 (a)(6) "Campgrounds")
- Construction sites are required to evaluate and control dust pollutants for runoff potential (Ord. No. 10-10-16 (c)(11) (e))
- Construction sites are required to have an erosion control plan for gravel, sand, dirt, or topsoil removal (Ord. No. 10-10-16 (y)(1)(d))
- All work in the public right-of-way shall control dust and debris and promptly remove dirt and material deposited on roadways (Ord. No. 2000-10, § 1, 5-2-00)
- All planned residential districts must comply with dust ordinances and not be objectionable due to dust emissions (Ord. No. 6-2-1 (a)(4))

The La Plata County Land Use Code (LPLUC)[1] contains a number of significant ordinances that result in PM_{10} emission reductions:

- Proposed developments must conduct a compatibility assessment, including a neighborhood meeting, if there is a potential to produce dust or significant dust influence. Possible solution for dust may include changing emitter specifications to mitigate problem. Dust emissions cannot have significant adverse impacts on neighbors. (LPLUC Sec. 82-191-193)
- Proposed multiple unit developments are required to contain and/or mitigate dust among other external nuisances (LPLUC Sec. 82-167 (b)(3))
- Roads and access driveways for all new facilities shall be constructed in a manner that suppresses dust through construction, drilling, and operational activities. Facilities that reduce or destroys existing vegetation may consult with the Soil Conservation Service (renamed the Natural Resources Conservation Service in 1994) and develop a revegetation plan, specifying particular species as well as appropriate planting schedules and methods (LPLUC Sec. 90-124 (c)(8))
- Cattle guards are required to be kept clean of all sand, silt, dirt, and other solid debris (LPLUC Sec. 74-174 (a))

Oil and Gas Exploration and Development Standards for Federal Lands

- La Plata County and the Southern Ute Indian Reservation contain oil and gas exploration and development sites. The Bureau of Land Management (BLM) and the Forest Service (FS) have surface operating standards and guidelines for oil and gas exploration and development (see: (http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/oil_and_gas.Par.18714.File.dat/OILgas.pdf). These standards control dust from a number of contributing sources, including:
- Road maintenance is required for all roads that will be constructed or used in conjunction with drilling. These maintenance plan activities include blading, surface replacement, dust abatement, spot repairs, slide removal, ditch cleaning, culvert cleaning, litter cleanup, noxious weed control, and snow removal. Key maintenance considerations include regular inspections; reduction of ruts and holes; maintenance of crowns and outslope to keep water off the road; replacement of surfacing materials; clearing of sediment blocking ditches and culverts; maintenance of interim reclamation; and noxious weed control (page 30).
- Regarding BLM resource and FS local roads (page 25):

[1] The LPLUC applies to all county lands, which includes the exterior boundaries of the Southern Ute Indian Reservation, except trust lands, in order to decrease nuisances from approved land uses.

    - The design speed limit on roads, specific to oil and gas roads, is 10 to 30 miles per hour. For the FS, this should generally be less than 15 miles per hour.
    - The road gradient should not exceed 8 percent except for pitch grades (300 feet or less in length) in order to minimize environmental effects.
    - Drainage control must be ensured over the entire road through the use of drainage dips, insloping, natural rolling topography, ditch turnouts, ditches, or culverts.
- Regarding BLM local and FS collector roads (page 26):
    - The design speed limit is generally 15 to 50 miles per hour. For the FS, it is 15 to 25 miles per hour.
    - Maximum grades should not exceed 8 percent. Pitch grades for lengths not to exceed 300 feet may be allowed to exceed 8 percent in some cases.
- Regarding BLM collector and FS arterial roads:
    - Design speed is 30 miles per hour or greater unless otherwise directed.
    - Maximum grades should not exceed 8 percent. Pitch grades for lengths not to exceed 300 feet may be allowed to exceed 8 percent in some cases.

6.0 Summary and Conclusions

The PM_{10} exceedance in Durango and the elevated PM_{10} values in Telluride and Alamosa on February 27, 2009 would not have occurred if not for the following: (a) dry soil conditions over northern Nevada and western Utah; (b) a tight surface pressure gradient and strong upper level winds mixing to the surface that lead to strong gusty surface winds over northern and western Nevada and portions of Utah on February26, 2009; and (c) the deep mixing of the blowing dust from western and northern Nevada that allowed for the transport of the dust to southwestern Colorado.

The PM_{10} exceedance in Durango was due to an exceptional event associated with regional windstorm-caused emissions from erodible soil sources over a large area of western and northern Nevada, and these sources are not reasonably controllable during a significant windstorm under abnormally dry or moderate drought conditions.

7.0 References

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Attachment A

NWS Reno, Nevada Forecast Office
Wind Advisories, Forecast Discussions and Forecast Zones map for February 26, 2009

NWS Reno, Nevada Forecast Office Wind Advisories for February 26, 2009

FXUS65 KREV 251207
AFDREV
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RENO NV
407 AM PST WED FEB 25 2009
.SHORT TERM...
THERE ARE TWO ITEMS OF AT LEAST MILD INTEREST THIS MORNING. A JET STREAK MOVING INTO CENTRAL CALIFORNIA IS PRODUCING SOME LIFT FROM THE BAY AREA INTO THE WEST SLOPES OF THE SIERRA AS EVIDENCED BY INCREASING CLOUDS/COOLING CLOUD TOPS IN THE INFRARED SATELLITE. MEANWHILE...A FAST MOVING DISTURBANCE IS NEARING THE NORTHERN CALIFORNIA COAST AND ENHANCING SHOWERS THERE. THE SOUTHERN CLOUDINESS WITH THE JET STREAK DOES NOT LOOK TO MAKE IT MUCH OVER THE SIERRA CREST THIS MORNING AS IT IS RATHER SHALLOW (CLOUDS SHARPLY ENDING AT THE SIERRA CREST IN THE INFRARED)...BUT AS THE DISTURBANCE OVER NORTHERN CALIFORNIA MOVES INLAND TODAY IT WILL GIVE SOME LIFT AND DEEPENING OF MOISTURE FOR SHOWERS...ESPECIALLY FROM TAHOE NORTH.
THE LEFT EXIT REGION OF ANOTHER JET STREAK WILL NOSE INTO THE SIERRA SOUTH OF LAKE TAHOE TONIGHT AS A NORTHERN BRANCH SYSTEM OVER THE PACIFIC NORTHWEST RUNS INTO FAST ZONAL FLOW OVER CALIFORNIA AND NEVADA. STRONG UPSLOPE FLOW INTO THE SIERRA ALONG WITH THE JET STREAK WILL BRING PRECIP TO THE SIERRA...MOSTLY FROM LAKE TAHOE NORTH. I AM NOT EXPECTED TOO MUCH SNOW FOR THE SIERRA AS THE SYSTEM IS FAST MOVING WITH NOT A LOT OF COLD AIR ALOFT TO ENHANCE INSTABILITY AND CARRY OVER SHOWERS FROM THE WEST SLOPES.
FOR THE LOWER ELEVATIONS EAST OF THE SIERRA...THE JET STREAK IS EXPECTED TO INITIATE A GOOD FRONTOGENESIS BAND OVER NORTHERN NEVADA BY EARLY THURSDAY MORNING. THE 00Z NAM SHOWED THIS FIRING UP PRECIP OUT INTO PERSHING COUNTY WHILE THE 00Z GFS WAS LESS ENTHUSIASTIC. HOWEVER...THE 06Z GFS HAS DEVELOPED LIGHT PRECIP OVER NORTHERN NEVADA AND ADDED CONFIDENCE IN AT LEAST SOME VERY LIGHT PRECIP INTO THE BASIN FROM CIRCA RENO AND LOVELOCK NORTH EARLY THURSDAY MORNING. IN THE BASIN SOUTH OF INTERSTATE 80 AND ESPECIALLY SOUTH OF HIGHWAY 50...STRONG LEE OF THE SIERRA SHADOWING LOOKS LIKELY WITH ALL THE FRONTOGENESIS AND JET SUPPORT FURTHER NORTH.
THE OTHER STORY WITH THE INCOMING SYSTEM WEDNESDAY NIGHT AND THURSDAY WILL BE WIND. THE REGION NEVER REALLY GETS A COLD FRONT THURSDAY (EXCEPT PERHAPS FOR THE FAR NORTHERN CWA). IN ADDITION...A DECENT SURFACE GRADIENT WITH STRONG 700 MB FLOW LOOKS TO BE IN PLACE BY THURSDAY AFTERNOON. THIS IS EXPECTED TO REALLY KICK UP WINDS. EVEN AREAS THAT RECEIVE LIGHT PRECIP THURSDAY MORNING SHOULD HAVE NO PROBLEM GETTING WINDY AS MOISTURE SHALLOWS WITH CONTINUING ALONG AND WEST OF THE CREST SHOWERS ENHANCING THE LOW LEVEL GRADIENT FURTHER. FOR NOW I HAVE HINTED AT WIND ADVISORY CRITERIA FOR MANY OF THE ZONES (GUST 45-57 MPH)...BUT A DECISION ONE WAY OR THE OTHER WILL HAVE TO BE MADE WITH THE NEXT FORECAST PACKAGE.
THURSDAY NIGHT AND FRIDAY THINGS CALM DOWN AS A SHORT WAVE RIDGE MOVES OVERHEAD WITH NEXT SYSTEM RELOADING IN THE EASTERN PACIFIC.
SNYDER
.LONG TERM...SATURDAY THROUGH TUESDAY...
ACTIVE PATTERN TO CONTINUE DURING PERIOD WITH A COOLING TREND AND LOWERING SNOW LEVELS BY EARLY NEXT WEEK. THERE ARE TIMING ISSUES WITH THE INITIAL SHORTWAVE AND STRONG PACIFIC JET OVER THE WEEKEND AS THE GFS CONTINUES TO BE FASTEST IN BRINGING THIS FEATURE INTO THE

WEST COAST LATE SATURDAY INTO SATURDAY NIGHT. THE ECMWF ACTUALLY SUGGESTS SOME RETROGRESSION OF MEAN TROUGH AND DOES NOT BRING JET ENERGY INTO THE REGION UNTIL SUNDAY. SUBSEQUENT TO THIS...THE GFS DRIVES TROUGH INLAND NEXT WEEK WHEREAS THE ECMWF ACTUALLY SHOWS SOME RETROGRESSION OF LARGE SCALE TROUGH. THE LATTER HAS SUPPORT FROM TELECONNECTIONS. SO FORECAST WILL CONTINUE TO SHOW A HYBRID SOLUTION GOING INTO NEXT WEEK WHICH BRINGS SHORTWAVE ACROSS AREA LATE SATURDAY NIGHT INTO SUNDAY FOLLOWED BY COLDER WITH SOME CHANCE OF PRECIPITATION MONDAY INTO TUESDAY. IF THE ECMWF TURNS OUT TO BE CORRECT...THEN INITIAL SHORTWAVE MAY JUST LOWER TEMPERATURES AND SNOW LEVELS BRIEFLY AS MILD SOUTHWEST FLOW WOULD LIKELY PUSH THEM UP AGAIN INTO EARLY NEXT WEEK. POPS WERE BUMPED UP EVERYWHERE SUNDAY TO TRY AND PINPOINT A PERIOD OF MORE PRONOUNCED PRECIPITATION. OTHERWISE ONLY MINOR CHANGES WERE MADE TO FORECAST THIS MORNING. HOHMANN
&&
.AVIATION...
GUSTY WINDS AND CLOUDS HAVE MITIGATED FOG PROBLEM THIS MORNING AT KTRK. SO VFR TODAY WITH NO ISSUES. FAST MOVING SYSTEM WILL BRING INCREASING SNOW SHOWERS TONIGHT WITH CIGS/VSBYS DROPPING TO MVFR AT KTVL/KTRK WITH PERIODIC CONDITIONS BELOW AIRPORT MINIMUMS 06Z-12Z. ONLY LIGHT SHOWERS AT KRNO/KLOL OVERNIGHT WITH VFR CONDITIONS CONTINUING. RIDGE WINDS WILL INCREASE TO OVER 75KT LATE TONIGHT WITH WINDY CONDITIONS THURSDAY. HOHMANN
&&
.REV WATCHES/WARNINGS/ADVISORIES...
NV...NONE.
CA...NONE.
&&
$$
HTTP://WEATHER.GOV/RENO

FXUS65 KREV 251939
AFDREV
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RENO NV
1139 AM PST WED FEB 25 2009
.UPDATE...
GUSTY WINDS ON LAKE TAHOE PROMPTED THE ISSUANCE OF A LAKE WIND ADVISORY UNTIL 6 PM. UPDATED WIND GUSTS FOR MOST OTHER ZONES TO INCREASE THEM TO BETTER REFLECT CURRENT CONDITIONS AND TRENDS. NO OTHER CHANGES MADE TO FORECAST FOR TODAY...HOWEVER WILL BE LOOKING CLOSELY AT THE TONIGHT AND THURSDAY PERIOD FOR MUCH OF THE CWA. LATEST DATA COMING IN THIS MORNING SUGGESTS ADVISORY LEVEL WINDS POSSIBLE OVERNIGHT THROUGH THURSDAY ACROSS OUR CA ZONES AND INTO EXTREME WESTERN NV. WILL CONTINUE TO MONITOR THIS AND ISSUE ANY NECESSARY PRODUCTS WITH THE AFTERNOON PACKAGE. RC
&&
.PREVIOUS DISCUSSION... /ISSUED 407 AM PST WED FEB 25 2009/
SHORT TERM...
THERE ARE TWO ITEMS OF AT LEAST MILD INTEREST THIS MORNING. A JET STREAK MOVING INTO CENTRAL CALIFORNIA IS PRODUCING SOME LIFT FROM THE BAY AREA INTO THE WEST SLOPES OF THE SIERRA AS EVIDENCED BY INCREASING CLOUDS/COOLING CLOUD TOPS IN THE INFRARED SATELLITE. MEANWHILE...A FAST MOVING DISTURBANCE IS NEARING THE NORTHERN CALIFORNIA COAST AND ENHANCING SHOWERS THERE. THE SOUTHERN CLOUDINESS WITH THE JET STREAK DOES NOT LOOK TO MAKE IT MUCH OVER THE SIERRA CREST THIS MORNING AS IT IS RATHER SHALLOW (CLOUDS SHARPLY ENDING AT THE SIERRA CREST IN THE INFRARED)...BUT AS THE

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SNYDER
LONG TERM...SATURDAY THROUGH TUESDAY...
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HOHMANN
AVIATION...
GUSTY WINDS AND CLOUDS HAVE MITIGATED FOG PROBLEM THIS MORNING AT KTRK. SO VFR TODAY WITH NO ISSUES. FAST MOVING SYSTEM WILL BRING

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&&
.REV WATCHES/WARNINGS/ADVISORIES...
NV...LAKE WIND ADVISORY UNTIL 6 PM PST THIS AFTERNOON FOR NVZ002.
CA...LAKE WIND ADVISORY UNTIL 6 PM PST THIS AFTERNOON FOR CAZ072.
&&
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HTTP://WEATHER.GOV/RENO

FXUS65 KREV 260024
AFDREV
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RENO NV
424 PM PST WED FEB 25 2009
.SHORT TERM...
A VIGOROUS SHORT WAVE MOVED ACROSS THE AREA TODAY AND HELPED KICK UP SURFACE WINDS OVER MUCH OF THE CWA. MOISTURE IS LIMITED WITH THIS FEATURE AND PRECIPITATION HAS BEEN PRIMARILY LIMITED TO THE WEST SIERRA SLOPES. A FEW RAIN OR SNOW SHOWERS HAVE SPILLED OVER INTO MONO COUNTY THROUGH THE DAY...AND LIGHT SNOW HAS BEEN REPORTED AT BLUE CANYON. SNOW ACCUMULATIONS WILL BE LIMITED DUE TO THE SHALLOW NATURE OF THE MOIST LAYER AND THE STRONG SOUTHWEST OR WEST FLOW THAT WILL CREATE SOME SHADOWING EAST OF THE CREST. ON THE FLIP SIDE...WHEN SHADOWING OCCURS AND PRECIPITATION BANKS UP AGAINST THE WEST SLOPES...STRONG WINDS OFTEN DEVELOP IN THE EASTERN SIERRA AND WESTERN NV. IT LOOKS AS IF THAT WILL BE THE CASE FOR THIS EVENT. THE LATEST NAM MODEL SHOWS STRONG 30 AGL WINDS EXCEEDING 60 MPH IN THE TAHOE AREA AND EXTREME WESTERN NV BY 4AM TONIGHT...THEN CONTINUING AND EXPANDING SOUTH INTO MONO COUNTY AND NORTH INTO LASSEN AND NORTHERN WASHOE COUNTIES BY MID DAY THURSDAY. IN ADDITION...FORECAST SOUNDINGS SHOW A WEAK CRITICAL LAYER NEAR RIDGE LEVELS THAT MAY CONTRIBUTE TO STRONG GUSTY SURFACE WINDS EAST OF THE SIERRA CREST. AT THIS TIME WE DECIDED TO GO WITH WIND ADVISORIES FOR MUCH OF THE CWA UNTIL 4 PM THURSDAY. LATER SHIFTS WILL MONITOR AND UPGRADE TO WIND WARNINGS IF NECESSARY. THE EASTWARD EXTENT OF THE STRONGEST WIND SHOULD KEEP PERSHING AND CHURCHILL COUNTIES...AND MOST OF MINERAL COUNTY...A LITTLE LESS WINDY. A LAKE WIND ADVISORY WAS ISSUED FOR PYRAMID LAKE THROUGH 4PM THURSDAY AS GUSTS TO 35 OR 40 MPH ARE LIKELY THERE.
A SHORT WAVE RIDGE BUILDS IN RAPIDLY THURSDAY NIGHT AND FRIDAY WITH DECREASING WINDS AND AN END TO ANY PRECIPITATION. TEMPERATURES WILL WARM UP WITH UPPER 50S AND LOWER 60S EXPECTED IN WESTERN NV VALLEYS ON SATURDAY. SOUTHWEST FLOW WILL INCREASE ON SATURDAY AHEAD OF THE NEXT PACIFIC SYSTEM LATE IN THE WEEKEND. RC
.LONG TERM...SATURDAY NIGHT THROUGH WEDNESDAY...
ACTIVE PATTERN TO CONTINUE THRU THE MIDDLE OF NEXT WEEK. FIRST ROUND OF PRECIP ASSOCIATED WITH TROF AND MOISTURE TAP OFF THE WEST COAST BECOMING MORE LIKELY TO AFFECT THE REGION LATE SAT NIGHT THRU SUNDAY AS THE MAIN GUIDANCE SOURCES HAVE NARROWED THEIR TIMING DIFFERENCES. UNCERTAINTY IN DETAILS STILL EXIST...BUT CURRENT BEST ESTIMATE OF SNOW LEVEL EVOLUTION FOR THIS SYSTEM IS STARTING OUT NEAR 7000 FEET SAT EVENING AND REMAINING ABOVE LAKE LEVEL OVERNIGHT...THEN LOWER TO 5500-6000 FT ON SUNDAY FROM RENO-TAHOE NORTHWARD...AND TO THESE LEVELS BY SUNDAY EVENING OVER THE SOUTH ZONES. MODEL QPF ESTIMATING

1-2 INCHES NEAR THE SIERRA CREST AND IN NERN CA WITH THIS SYSTEM.
FOR LOWER ELEVATIONS OF WRN NV...SHORTER PERIODS OF LIGHT TO
MODERATE RAIN ARE POSSIBLE INITIALLY SUN MORNING AND AGAIN EARLY SUN
EVENING BEFORE PRECIP TAPERS TO SHOWERS.
BY MONDAY...MEDIUM RANGE GUIDANCE IS STILL INDICATING A SLIGHT
RETROGRADE OF THE LONG WAVE PATTERN WITH THE TROF A BIT FARTHER
OFFSHORE. HOWEVER...MOISTURE IS NOT EXPECTED TO MAKE A CLEAN EXIT
OUT OF THE REGION. AS A RESULT...SOME ISOLD-SCT SHOWERS COULD
PERSIST MONDAY-MON NIGHT MAINLY OVER THE CA ZONES.
FROM TUES-WED...BOTH THE ECMWF AND GFS HAVE COME IN MORE FAVORABLE
FOR A QUICK END TO ANY RETROGRADE PATTERN AND ADVANCE THE MAIN UPPER
LOW CLOSER TO THE WEST COAST. WHILE EARLIER RUNS OF THE ECMWF WERE
SLOWER IN ADVANCING THE MOISTURE INTO THE SIERRA...THE LATEST RUN OF
THE ECMWF IS EVEN FASTER THAN THE GFS WITH THE LEADING EDGE OF
PRECIP REACHING THE CREST BY TUES AFTERNOON. OVERALL ENSEMBLE DATA
HAS TRENDED TOWARD COOLING TEMPS AND LOWERING SNOW LEVELS...WITH
IMPROVING PRECIP CHANCES FROM LATE TUES THRU WED. THE FORECAST WILL
FOLLOW THIS TREND...WHICH KEEPS THE POSSIBILITY FOR A DECENT SIZED
SNOW EVENT IN THE SIERRA BY THE MIDDLE OF NEXT WEEK. MJD
&&
.AVIATION...
GUSTY WINDS WILL BE MAIN CONCERN THRU THURSDAY ESPECIALLY AT KRNO
WHERE FREQUENT GUSTS OF 30-40 KT ARE EXPECTED. SOME LLWS COULD BE
ENCOUNTERED AT TIMES DURING LULLS OR ROTOR ACTIVITY AT THE AIRPORT
WHILE STRONGER GUSTS CONTINUE ABOVE THE VALLEY FLOOR. A PERIOD OF
MORE INTENSE GUSTS OF 45 KT OR MORE POSSIBLE AT KRNO MAINLY BTWN
08Z-16Z.
FOR KTVL-KTRK...GUSTS MAINLY BTWN 25-35 KT EXCEPT FOR OCNL
STRONGER GUSTS AFT 08Z AS SNOW BANKS UP ALONG THE SIERRA. CIGS/VSBY
MAY WORSEN TO MVFR/IFR AT TIMES DUE TO -SHSN MAINLY BTWN
10Z-16Z...BUT SHALLOW MOISTURE WILL LIKELY KEEP ANY RESTRICTIONS
LIMITED TO SHORT DURATION AT BOTH SITES. MJD
&&
.REV WATCHES/WARNINGS/ADVISORIES...
NV...WIND ADVISORY FROM 2 AM TO 4 PM PST THURSDAY FOR NVZ002-005.
     LAKE WIND ADVISORY UNTIL 2 AM PST THURSDAY FOR NVZ002.
     WIND ADVISORY UNTIL 4 PM PST THURSDAY FOR NVZ003.
     LAKE WIND ADVISORY UNTIL 4 PM PST THURSDAY FOR NVZ004.
CA...WIND ADVISORY FROM 2 AM TO 4 PM PST THURSDAY FOR CAZ070>073.
     LAKE WIND ADVISORY UNTIL 2 AM PST THURSDAY FOR CAZ072.
&&
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HTTP://WEATHER.GOV/RENO

FXUS65 KREV 260426
AFDREV
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RENO NV
826 PM PST WED FEB 25 2009
.UPDATE...
PRIMARY CONCERN OVERNIGHT WILL BE RESUMPTION OF STRONG WINDS IN
THE LEE OF THE SIERRA BY EARLY MORNING...CONTINUING INTO THE LATE
AFTERNOON THURSDAY. WINDS HAVE SHOWN A STEADY DECREASE THE LAST
FEW HOURS...AS PER FORECAST. LATEST MODEL GUIDANCE SUPPORTS THIS
REDUCTION IN WIND SPEEDS...THEN BOTH GFS AND NAM SHOW AN INCREASE
BY 26/12 UTC IN 30 MB AGL WINDS...WITH NAM STRONGER THAN GFS.
FORECAST SOUNDINGS DO NOT INDICATE A WELL DEFINED CRITICAL LAYER
NEAR OR JUST ABOVE RIDGE TOP THAT WOULD INDICATE A STABLE LAYER
ALOFT. NAM DOES DEVELOP A CRITICAL LAYER EAST OF THE SIERRA...BUT

IT APPEARS TO BE TOO LOW. GFS DEVELOPS A BROAD ISOTHERMAL LAYER BY LATE MORNING/EARLY AFTERNOON EAST OF THE SIERRA WITH ITS BASE NEAR THE RIDGE TOPS. BUT WINDS ALOFT BEGIN TO DECREASE IN THE AFTERNOON. CURRENT ADVISORY WORDING INDICATES A DECREASE TONIGHT FOLLOWED BY INCREASING WINDS THURSDAY MORNING INTO THE AFTERNOON. THIS SEEMS REASONABLE AT THIS TIME AND INTEND NO CHANGE TO CURRENT ADVISORY. ISOLATED GUSTS TO **65 MPH** WELL WITHIN REASON THURSDAY IN MORE WIND PRONE AREAS IN THE IMMEDIATE LEE OF THE SIERRA. FOR THE TAHOE BASIN...BUOYS AT THE LAKE STILL SHOW SUSTAINED WINDS IN THE 20 TO 25 MPH RANGE. PCPN IS TRYING TO MAKE ITS WAY INTO THE BASIN BUT FOR NOW IS FALLING MAINLY ALONG AND WEST OF THE CREST. RAINFALL RATES HAVE NOT BEEN OVERLY IMPRESSIVE THIS EVENING AND WEB CAMS SHOW MAINLY WET CONDITIONS. OAK SOUNDING THIS EVENING SHOWED THE BULK OF THE MSTR CONFINED TO THAT PORTION OF THE ATMOSPHERE BELOW 725 MB. THIS RATHER SHALLOW MSTR WOULD EXPLAIN THE LACK OF PCPN REACHING OVER THE CREST...WITH UPSLOPE FAVORED AREAS WEST OF THE CREST RECEIVING THE BULK OF THE PCPN. SO QPF FOR TONIGHT LOOKS GOOD WITH A DRASTIC DROP OFF EAST OF THE CREST. WITH JET STREAK BECOMING ORIENTED MORE FAVORABLY BY EARLY MORNING INTO THE TAHOE BASIN THINK THE IDEA OF GOING WITH MORE WIDESPREAD WIND ADVISORY OVER LAKE ADVISORY MAKES GOOD SENSE. LACK OF PCPN EAST OF THE CREST SHOULD RESULT IN A PERIOD OF PCPN LOADING AS WELL CAUSING INCREASED WINDS IN THE LEE OF THE SIERRA AND IN A FEW LOWER ELEVATION AREAS WITHIN THE SIERRA. WILL UPDATE FOR A FEW MINOR TWEAKS...BUT OTHERWISE GOING FORECAST LOOKS GOOD. MLF

&&

.PREVIOUS DISCUSSION... /ISSUED 424 PM PST WED FEB 25 2009/

SHORT TERM...

A VIGOROUS SHORT WAVE MOVED ACROSS THE AREA TODAY AND HELPED KICK UP SURFACE WINDS OVER MUCH OF THE CWA. MOISTURE IS LIMITED WITH THIS FEATURE AND PRECIPITATION HAS BEEN PRIMARILY LIMITED TO THE WEST SIERRA SLOPES. A FEW RAIN OR SNOW SHOWERS HAVE SPILLED OVER INTO MONO COUNTY THROUGH THE DAY...AND LIGHT SNOW HAS BEEN REPORTED AT BLUE CANYON. SNOW ACCUMULATIONS WILL BE LIMITED DUE TO THE SHALLOW NATURE OF THE MOIST LAYER AND THE STRONG SOUTHWEST OR WEST FLOW THAT WILL CREATE SOME SHADOWING EAST OF THE CREST. ON THE FLIP SIDE...WHEN SHADOWING OCCURS AND PRECIPITATION BANKS UP AGAINST THE WEST SLOPES...STRONG WINDS OFTEN DEVELOP IN THE EASTERN SIERRA AND WESTERN NV. IT LOOKS AS IF THAT WILL BE THE CASE FOR THIS EVENT. THE LATEST NAM MODEL SHOWS STRONG 30 AGL WINDS EXCEEDING 60 MPH IN THE TAHOE AREA AND EXTREME WESTERN NV BY 4AM TONIGHT...THEN CONTINUING AND EXPANDING SOUTH INTO MONO COUNTY AND NORTH INTO LASSEN AND NORTHERN WASHOE COUNTIES BY MID DAY THURSDAY. IN ADDITION...FORECAST SOUNDINGS SHOW A WEAK CRITICAL LAYER NEAR RIDGE LEVELS THAT MAY CONTRIBUTE TO STRONG GUSTY SURFACE WINDS EAST OF THE SIERRA CREST. AT THIS TIME WE DECIDED TO GO WITH WIND ADVISORIES FOR MUCH OF THE CWA UNTIL 4 PM THURSDAY. LATER SHIFTS WILL MONITOR AND UPGRADE TO WIND WARNINGS IF NECESSARY. THE EASTWARD EXTENT OF THE STRONGEST WIND SHOULD KEEP PERSHING AND CHURCHILL COUNTIES...AND MOST OF MINERAL COUNTY...A LITTLE LESS WINDY. A LAKE WIND ADVISORY WAS ISSUED FOR PYRAMID LAKE THROUGH 4PM THURSDAY AS GUSTS TO 35 OR 40 MPH ARE LIKELY THERE.

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LONG TERM...SATURDAY NIGHT THROUGH WEDNESDAY...

ACTIVE PATTERN TO CONTINUE THRU THE MIDDLE OF NEXT WEEK. FIRST ROUND
OF PRECIP ASSOCIATED WITH TROF AND MOISTURE TAP OFF THE WEST COAST
BECOMING MORE LIKELY TO AFFECT THE REGION LATE SAT NIGHT THRU SUNDAY
AS THE MAIN GUIDANCE SOURCES HAVE NARROWED THEIR TIMING DIFFERENCES.
UNCERTAINTY IN DETAILS STILL EXIST...BUT CURRENT BEST ESTIMATE OF
SNOW LEVEL EVOLUTION FOR THIS SYSTEM IS STARTING OUT NEAR 7000 FEET
SAT EVENING AND REMAINING ABOVE LAKE LEVEL OVERNIGHT...THEN LOWER TO
5500-6000 FT ON SUNDAY FROM RENO-TAHOE NORTHWARD...AND TO THESE
LEVELS BY SUNDAY EVENING OVER THE SOUTH ZONES. MODEL QPF ESTIMATING
1-2 INCHES NEAR THE SIERRA CREST AND IN NERN CA WITH THIS SYSTEM.
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MORE INTENSE GUSTS OF 45 KT OR MORE POSSIBLE AT KRNO MAINLY BTWN
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FOR KTVL-KTRK...GUSTS MAINLY BTWN 25-35 KT EXCEPT FOR OCNL
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NV...WIND ADVISORY FROM 2 AM TO 4 PM PST THURSDAY FOR NVZ002-005.
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HTTP://WEATHER.GOV/RENO

FXUS65 KREV 261238
AFDREV
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RENO NV
430 AM PST THU FEB 26 2009
.SHORT TERM...
LATEST SATELLITE IMAGERY SHOWS AN UPPER LOW JUST OFF THE WASHINGTON

COAST MOVING SE TOWARD KPDX. A JET MAX IN THE BASE OF THE TROUGH IS PULLING THIS FEATURE TO THE SE. THE 00Z MEDIUM RANGE MODELS INITIALIZED WELL WITH THE PLACEMENT OF THE UPPER LOW. THE NAM...GFS ...UKMET AND ECMWF ALL BRING THE UPPER LOW TO NRN IDAHO BY 00Z FRIDAY.
A FLAT RIDGE IS CURRENTLY OVER MEXICO AND EXTENDS N INTO THE SWRN CONUS. THE HEIGHT AND SFC PRESSURE GRADIENT BETWEEN THIS RIDGE AND THE UPPER LOW TO THE NORTH IS CAUSING STRONG WINDS ACROSS THE NRN SIERRA AND NWRN NEVADA ATTM. SUSTAINED WINDS OF 15 TO 20 MPH ARE BEING REPORTED ACROSS THE ERN SIERRA AND WRN NEVADA THIS MORNING WITH WIND GUSTS TO 30 MPH AND LOCALLY HIGHER GUSTS. WIND SPEEDS SHOULD INCREASE AS THE MORNING PROGRESSES AS THE PRESSURE GRADIENT STRENGTHENS. THE NAM AND THE GFS SHOW 90AGL WINDS INCREASING TO AROUND 50 KTS BETWEEN 12Z AND 18Z OVER FAR NERN CALIFORNIA AND NWRN NEVADA. THE LOCAL WRF MODEL ALSO SHOWS THESE STRONG WINDS DURING THE DAY TODAY.
WIND ADVISORIES HAVE BEEN ISSUED FOR MUCH OF THE KREV CWFA FOR TODAY. STRONG WINDS WILL CAUSE SIGNIFICANT WAVES ON LAKE TAHOE WITH THE HIGHEST WAVES ALONG THE NORTH AND EAST SHORES. WINDS WILL NOT BE AS STRONG OVER WCNTRL NEVADA BUT CONDITIONS WILL STILL BE ROUGH ON PYRAMID LAKE.
SNOW IS STARTING TO SPILL INTO THE TAHOE BASIN ATTM. DO NOT EXPECT HEAVY SNOW ACCUMULATION ABOVE 6000 FEET TODAY SINCE THE UPPER LOW SHOULD MOVE THROUGH SRN OREGON RATHER QUICKLY. A WEAK RIDGE IS THEN PROGGED TO BUILD NORTH ALONG THE WEST COAST ON FRIDAY WHICH WILL BRING DRY AND MILD CONDITIONS TO THE REGION. O'HARA
.LONG TERM...SATURDAY NIGHT THROUGH THURSDAY...
ACTIVE PATTERN TO CONTINUE THRU NEXT WEEK. FIRST ROUND OF PRECIPITATION IS ASSOCIATED WITH AN UPPER LOW OFF OF THE PACNW COAST THAT PULLS IN A GOOD SUBTROPICAL MOISTURE TAP...MOVING INTO THE AREA SATURDAY NIGHT AND CONTINUING THROUGH SUNDAY NIGHT AND EARLY MONDAY. DYNAMICS WITH THIS SYSTEM LOOK TO BE VERY GOOD WITH A STRONG NE/SW ORIENTED JET THAT PUSHES DIRECTLY INTO THE SIERRA AROUND THE TAHOE BASIN THROUGH THE PERIOD. THIS WOULD ALSO MAKE SPILLOVER PRECIPITATION TO THE LEE OF THE SIERRA FAVORABLE FOR THIS PERIOD AS WELL. SNOW LEVELS START OUT AROUND 7000 FEET SATURDAY AND LOWER TO LAKE LEVEL SUNDAY AND TO MOST VALLEY FLOORS ALONG AND NORTH OF HIGHWAY 50 SUNDAY NIGHT. QPF INDICATES 1 TO 2 INCHES OF WATER EQUIVALENT ALONG THE CREST WHICH WOULD PUT HIGHER ELEVATION SNOW AMOUNTS IN THE 1-3 FOOT RANGE WITH THE HEAVIEST SNOW FALLING SUNDAY NIGHT. LAKE LEVEL COULD SEE UP TO A FOOT IN SOME AREAS IF THE DYNAMICS COME IN AS CURRENTLY INDICATED.
PRECIPITATION TAPERS TO SCATTERED SHOWERS FOR MONDAY AND MONDAY NIGHT BEFORE A SERIES OF SYSTEMS AFFECT THE AREA MIDWEEK. MEDIUM RANGE MODELS DIFFER ON THE DETAILS DURING THIS PERIOD. IN GENERAL...A TROUGH OR SERIES OF UPPER LOWS SETS UP NEAR THE WEST COAST AROUND TUESDAY AND GRADUALLY PROGRESSES INLAND BY THE END OF THE WEEK. THIS WOULD RESULT IN A PROGRESSIVELY COOLER AND MOIST PATTERN AS WAVES OF ENERGY ROTATE ACROSS THE AREA...ALONG WITH THE POTENTIAL FOR A DECENT PERIOD OF SIERRA SNOW AND SCATTERED LEE SIDE PRECIPITATION. JAH
&&
.AVIATION...
KRNO...STRONG SURFACE GRADIENT TODAY AS A COLD FRONT IN EASTERN OREGON AT 12Z SWEEPS SOUTHEAST ACROSS NORTHEAST CA AND BRUSHES NORTHERN NV. WIND DIRECTION WILL VARY BETWEEN SWLY AND NWLY UNTIL ABOUT 17Z WHEN THE DIRECTION STABILIZES TO WNW. THERE WILL ALSO BE SOME LULLS IN SFC WIND SPEED WITH THE POTENTIAL FOR SOME LLWS THROUGH ABOUT 15Z. WIND SPEEDS WILL INCREASE THROUGH THE MORNING

HOURS WITH GUSTS TO 45KT 15Z-19Z. STRONG GUSTS UP TO 35KTS WILL
CONTINUE THROUGH 02Z BEFORE WINDS DIMINISH.
KTVL-KTRK...GUSTS MAINLY BTWN 25-35 KT EXCEPT FOR OCNL STRONGER
GUSTS 18Z-00Z. SNOW WILL REDUCE VSBYS BLO 2SM WITH LCL CIGS BLO010
THROUGH 15Z. BY 18Z EXPECT GENLY VFR CONDITIONS WITH SCATTERED SNOW
SHOWERS DIMINISHING THROUGH THE AFTERNOON. JAH
&&
.REV WATCHES/WARNINGS/ADVISORIES...
NV...WIND ADVISORY UNTIL 4 PM PST THIS AFTERNOON FOR NVZ002-003-005.
     LAKE WIND ADVISORY UNTIL 4 PM PST THIS AFTERNOON FOR NVZ004.
CA...WIND ADVISORY UNTIL 4 PM PST THIS AFTERNOON FOR CAZ070>073.
&&
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HTTP://WEATHER.GOV/RENO

FXUS65 KREV 270015
AFDREV
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RENO NV
415 PM PST THU FEB 26 2009
.SHORT TERM...
A STRONG SHORT WAVE MOVED ACROSS SOUTHERN IDAHO TODAY WITH THE
MAIN EFFECT OVER NORTHEAST CA AND NORTHWEST NV BEING THE WIND.
WIND ADVISORIES WERE IN EFFECT FOR MOST OF THE DAY ACROSS THE
ENTIRE CWA WITH THE EXCEPTION OF MINERAL COUNTY WHERE GUSTS WERE
LIMITED TO THE 35-40 MPH RANGE. STRONG WIND GUSTS CONTINUE ALONG
THE SIERRA FRONT LATE THIS AFTERNOON INCLUDING THE RENO-SPARKS-
CARSON CITY AREAS. GUSTS TO 45-55 MPH CONTINUED IN WASHOE VALLEY
AND LOCATIONS AROUND CARSON CITY...AS WELL AS AT THE NWS OFFICE IN
NORTH RENO. THE WIND ADVISORY FOR THIS AREA HAS BEEN EXTENDED
UNTIL 7 PM...ALONG WITH THE LAKE WIND ADVISORY FOR PYRAMID LAKE
WHERE GUSTS UP TO 35 MPH WILL CREATE ROUGH LAKE CONDITIONS INTO
THE EVENING. A FEW SNOW SHOWERS ARE POSSIBLE IN THE SIERRA THIS
EVENING BUT NO ACCUMULATIONS ARE EXPECTED.
A SHORT WAVE RIDGE BUILDS QUICKLY OVER THE AREA FRIDAY AS AN UPPER
TROUGH DROPS SOUTH ALONG 140W LONGITUDE. A RATHER DEEP LOW SETS UP
AROUND 35N 140W BY SATURDAY. THIS ALLOWS THE WESTERN CONUS RIDGE
TO AMPLIFY OVER THE GREAT BASIN WITH WARMING TEMPERATURES PEAKING
IN THE LOWER 60S OVER WESTERN NV VALLEYS AND UPPER 40S TO LOWER
50S SIERRA VALLEYS ON SATURDAY.
THE SOUTHWEST FLOW AHEAD OF THE PACIFIC LOW TAPS INTO SUBTROPICAL
MOISTURE WITH PRECIPITABLE WATER VALUES OF .75 TO 1.0 INCHES
SPREADING ACROSS CENTRAL AND NORTHERN CA SATURDAY THROUGH SUNDAY.
THE MOIST AIR OVER THE AREA SHOULD HELP TO PRODUCE SOME DECENT
RAIN AND SNOW TOTALS AS THE UPPER LOW EJECTS A COUPLE SHORT WAVES
INTO NORTHERN CA SUNDAY INTO MONDAY. SNOW LEVELS WILL START OUT
QUITE HIGH BUT SHOULD LOWER TO LAKE (TAHOE) LEVEL LATE SUNDAY AND
CONTINUE TO FALL EARLY NEXT WEEK. THERE IS POTENTIAL FOR UP TO 2
FEET OF SNOW ABOVE 7000 FEET IN THE SIERRA BY MONDAY MORNING WHILE
LOWER ELEVATIONS IN THE SIERRA COULD SEE UP TO 6 INCHES OF SNOW. A
HEADLINE WAS PLACED ON OUR WEB PAGE AT WEATHER.GOV/RENO
SHOWING A GRAPHICAL SUMMARY OF EXPECTED WEATHER FOR THE WEEKEND
INTO EARLY NEXT WEEK. RC
.LONG TERM...MONDAY THROUGH THURSDAY...
ACTIVE PATTERN WITH GRADUAL COOLING TREND LIKELY THRU NEXT WEEK.
MEDIUM RANGE GUIDANCE HAS BACKED AWAY FROM THE RETROGRADE
PATTERN...NOW FAVORING A SLOW EASTWARD PROGRESSION IN THE LONG WAVE
PATTERN WHICH BRINGS THE MEAN TROF AXIS CLOSER TO THE WEST COAST.
MULTIPLE SHORTWAVES MOVING ONSHORE AROUND THE BASE OF THE MEAN TROF

WILL TAP INTO PACIFIC MOISTURE AND SPREAD POTENTIALLY SIGNIFICANT
SNOW ACROSS THE SIERRA FOR SEVERAL DAYS. IN LOWER ELEVATIONS...
LONGER BREAKS IN PRECIP ARE EXPECTED IN BETWEEN SHORTWAVE PASSAGES
BUT SEVERAL PERIODS OF RAIN AND SNOW ARE POSSIBLE FROM LATE MONDAY
THRU TUESDAY...THEN MORE LIKELY TO BE SNOW FOR WED-THURS IN MOST
AREAS EXCEPT THE LOWEST VALLEYS OF W-CNTRL NV.
THE MAIN CHALLENGES IN THE EXTENDED FORECAST INVOLVE SNOW LEVELS AND
WHEN THE HEAVIER PRECIP WILL OCCUR DUE TO TIMING DIFFERENCE BETWEEN
THE GUIDANCE SOURCES. CONFIDENCE IS SOMEWHAT HIGHER FOR STEADY
PRECIP FROM TAHOE NORTHWARD ACROSS NERN CA STARTING MON NIGHT...THEN
WORKING ITS WAY SOUTH ALONG THE SIERRA CREST TUESDAY THRU TUES NIGHT
SO POPS HAVE BEEN INCREASED TO LIKELY FOR THESE ZONES. WITH LESS
SUPPORT FOR RETROGRADE PATTERN EARLY NEXT WEEK WHICH WOULD HAVE
BROUGHT IN WARMER AIR MASS...THE FORECASTS WILL TREND TOWARD LOWER
SNOW LEVELS AND MAX TEMPS SEVERAL DEGREES BELOW THE GFS MOS GUIDANCE
FOR MON-TUES. CHANCE POPS WILL BE MAINTAINED IN MOST AREAS FOR
WED-THURS.
IF ALL OF THESE COOL AND WET SYSTEMS IMPACT THE SIERRA NEXT WEEK AS
INDICATED BY THE 12Z GUIDANCE ...SNOWPACK TOTALS COULD RECOVER TO
NEAR SEASONAL AVERAGES BY NEXT WEEKEND. MJD
&&
.AVIATION...
VFR CONDS THRU FRIDAY. AT KRNO...SOME LLWS COULD BE ENCOUNTERED AT
TIMES THRU 03Z DURING LULLS OR ROTOR ACTIVITY AT THE AIRPORT WHILE
STRONGER GUSTS UP TO 40 KT CONTINUE ABOVE THE VALLEY FLOOR. WINDS
ARE EXPECTED TO DIMINISH AFT 03Z. MJD
&&
.REV WATCHES/WARNINGS/ADVISORIES...
NV...WIND ADVISORY UNTIL 7 PM PST THIS EVENING FOR NVZ003.
     LAKE WIND ADVISORY UNTIL 7 PM PST THIS EVENING FOR NVZ004.
CA...NONE.
&&
$$
HTTP://WEATHER.GOV/RENO

NWS Reno, Nevada Forecast Office Forecast Discussions for February 26, 2009

FXUS65 KREV 270238
AFDREV
AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RENO NV
638 PM PST THU FEB 26 2009
.UPDATE...
WIND GUSTS IN THE LEE OF THE SIERRA DECREASING THIS EVENING AS
UPPER SHORT WAVE CONTINUES TO PULL AWAY TO THE EAST NORTHEAST AND
JET STREAK EXITS THE RGN. OBSERVED SOUNDING THIS EVENING FROM KREV
SHOWED LESS WINDS ALOFT THAN 26/12 UTC SOUNDING AND FORECAST
SOUNDINGS FROM MOST RECENT MODEL RUNS CONTINUE THIS TREND THROUGH
THE EVENING. SO WILL ALLOW WIND ADVISORIES TO EXPIRE AND WILL
UPDATE THE FORECAST TO INDICATE DECREASING WIND GUSTS OVERNIGHT.
HAVE ALSO OPTED TO LOWER POPS A BIT AND CONFINED ISOLATED SHOWERS
TO MAINLY THE NRN PORTION OF THE TAHOE BASIN NORTH INTO ZONE 71.
FEW RETURNS NOTED AND WITH SHORT WAVE TROF MOVING AWAY AND SHORT
WAVE RIDGE TRYING TO DEVELOP TO THE WEST THINK SUBSIDENCE WILL
BEGIN TO SPREAD INTO THE SIERRA LATE TONIGHT AND COMBINE WITH
DECREASING MSTR TO LIMIT AND SHOWER POTENTIAL. MLF
&&
.PREVIOUS DISCUSSION... /ISSUED 415 PM PST THU FEB 26 2009/

SHORT TERM...
A STRONG SHORT WAVE MOVED ACROSS SOUTHERN IDAHO TODAY WITH THE MAIN EFFECT OVER NORTHEAST CA AND NORTHWEST NV BEING THE WIND. WIND ADVISORIES WERE IN EFFECT FOR MOST OF THE DAY ACROSS THE ENTIRE CWA WITH THE EXCEPTION OF MINERAL COUNTY WHERE GUSTS WERE LIMITED TO THE 35-40 MPH RANGE. STRONG WIND GUSTS CONTINUE ALONG THE SIERRA FRONT LATE THIS AFTERNOON INCLUDING THE RENO-SPARKS-CARSON CITY AREAS. GUSTS TO 45-55 MPH CONTINUED IN WASHOE VALLEY AND LOCATIONS AROUND CARSON CITY...AS WELL AS AT THE NWS OFFICE IN NORTH RENO. THE WIND ADVISORY FOR THIS AREA HAS BEEN EXTENDED UNTIL 7 PM...ALONG WITH THE LAKE WIND ADVISORY FOR PYRAMID LAKE WHERE GUSTS UP TO 35 MPH WILL CREATE ROUGH LAKE CONDITIONS INTO THE EVENING. A FEW SNOW SHOWERS ARE POSSIBLE IN THE SIERRA THIS EVENING BUT NO ACCUMULATIONS ARE EXPECTED.
A SHORT WAVE RIDGE BUILDS QUICKLY OVER THE AREA FRIDAY AS AN UPPER TROUGH DROPS SOUTH ALONG 140W LONGITUDE. A RATHER DEEP LOW SETS UP AROUND 35N 140W BY SATURDAY. THIS ALLOWS THE WESTERN CONUS RIDGE TO AMPLIFY OVER THE GREAT BASIN WITH WARMING TEMPERATURES PEAKING IN THE LOWER 60S OVER WESTERN NV VALLEYS AND UPPER 40S TO LOWER 50S SIERRA VALLEYS ON SATURDAY.
THE SOUTHWEST FLOW AHEAD OF THE PACIFIC LOW TAPS INTO SUBTROPICAL MOISTURE WITH PRECIPITABLE WATER VALUES OF .75 TO 1.0 INCHES SPREADING ACROSS CENTRAL AND NORTHERN CA SATURDAY THROUGH SUNDAY. THE MOIST AIR OVER THE AREA SHOULD HELP TO PRODUCE SOME DECENT RAIN AND SNOW TOTALS AS THE UPPER LOW EJECTS A COUPLE SHORT WAVES INTO NORTHERN CA SUNDAY INTO MONDAY. SNOW LEVELS WILL START OUT QUITE HIGH BUT SHOULD LOWER TO LAKE (TAHOE) LEVEL LATE SUNDAY AND CONTINUE TO FALL EARLY NEXT WEEK. THERE IS POTENTIAL FOR UP TO 2 FEET OF SNOW ABOVE 7000 FEET IN THE SIERRA BY MONDAY MORNING WHILE LOWER ELEVATIONS IN THE SIERRA COULD SEE UP TO 6 INCHES OF SNOW. A HEADLINE WAS PLACED ON OUR WEB PAGE AT WEATHER.GOV/RENO SHOWING A GRAPHICAL SUMMARY OF EXPECTED WEATHER FOR THE WEEKEND INTO EARLY NEXT WEEK. RC
LONG TERM...MONDAY THROUGH THURSDAY...
ACTIVE PATTERN WITH GRADUAL COOLING TREND LIKELY THRU NEXT WEEK. MEDIUM RANGE GUIDANCE HAS BACKED AWAY FROM THE RETROGRADE PATTERN...NOW FAVORING A SLOW EASTWARD PROGRESSION IN THE LONG WAVE PATTERN WHICH BRINGS THE MEAN TROF AXIS CLOSER TO THE WEST COAST. MULTIPLE SHORTWAVES MOVING ONSHORE AROUND THE BASE OF THE MEAN TROF WILL TAP INTO PACIFIC MOISTURE AND SPREAD POTENTIALLY SIGNIFICANT SNOW ACROSS THE SIERRA FOR SEVERAL DAYS. IN LOWER ELEVATIONS... LONGER BREAKS IN PRECIP ARE EXPECTED IN BETWEEN SHORTWAVE PASSAGES BUT SEVERAL PERIODS OF RAIN AND SNOW ARE POSSIBLE FROM LATE MONDAY THRU TUESDAY...THEN MORE LIKELY TO BE SNOW FOR WED-THURS IN MOST AREAS EXCEPT THE LOWEST VALLEYS OF W-CNTRL NV.
THE MAIN CHALLENGES IN THE EXTENDED FORECAST INVOLVE SNOW LEVELS AND WHEN THE HEAVIER PRECIP WILL OCCUR DUE TO TIMING DIFFERENCE BETWEEN THE GUIDANCE SOURCES. CONFIDENCE IS SOMEWHAT HIGHER FOR STEADY PRECIP FROM TAHOE NORTHWARD ACROSS NERN CA STARTING MON NIGHT...THEN WORKING ITS WAY SOUTH ALONG THE SIERRA CREST TUESDAY THRU TUES NIGHT SO POPS HAVE BEEN INCREASED TO LIKELY FOR THESE ZONES. WITH LESS SUPPORT FOR RETROGRADE PATTERN EARLY NEXT WEEK WHICH WOULD HAVE BROUGHT IN WARMER AIR MASS...THE FORECASTS WILL TREND TOWARD LOWER SNOW LEVELS AND MAX TEMPS SEVERAL DEGREES BELOW THE GFS MOS GUIDANCE FOR MON-TUES. CHANCE POPS WILL BE MAINTAINED IN MOST AREAS FOR WED-THURS.
IF ALL OF THESE COOL AND WET SYSTEMS IMPACT THE SIERRA NEXT WEEK AS INDICATED BY THE 12Z GUIDANCE ...SNOWPACK TOTALS COULD RECOVER TO NEAR SEASONAL AVERAGES BY NEXT WEEKEND. MJD

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AVIATION...
VFR CONDS THRU FRIDAY. AT KRNO...SOME LLWS COULD BE ENCOUNTERED AT
TIMES THRU 03Z DURING LULLS OR ROTOR ACTIVITY AT THE AIRPORT WHILE
STRONGER GUSTS UP TO 40 KT CONTINUE ABOVE THE VALLEY FLOOR. WINDS
ARE EXPECTED TO DIMINISH AFT 03Z. MJD
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.REV WATCHES/WARNINGS/ADVISORIES...
NV...LAKE WIND ADVISORY UNTIL 7 PM PST THIS EVENING FOR NVZ004.
     WIND ADVISORY UNTIL 7 PM PST THIS EVENING FOR NVZ003.
CA...&&
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HTTP://WEATHER.GOV/RENO
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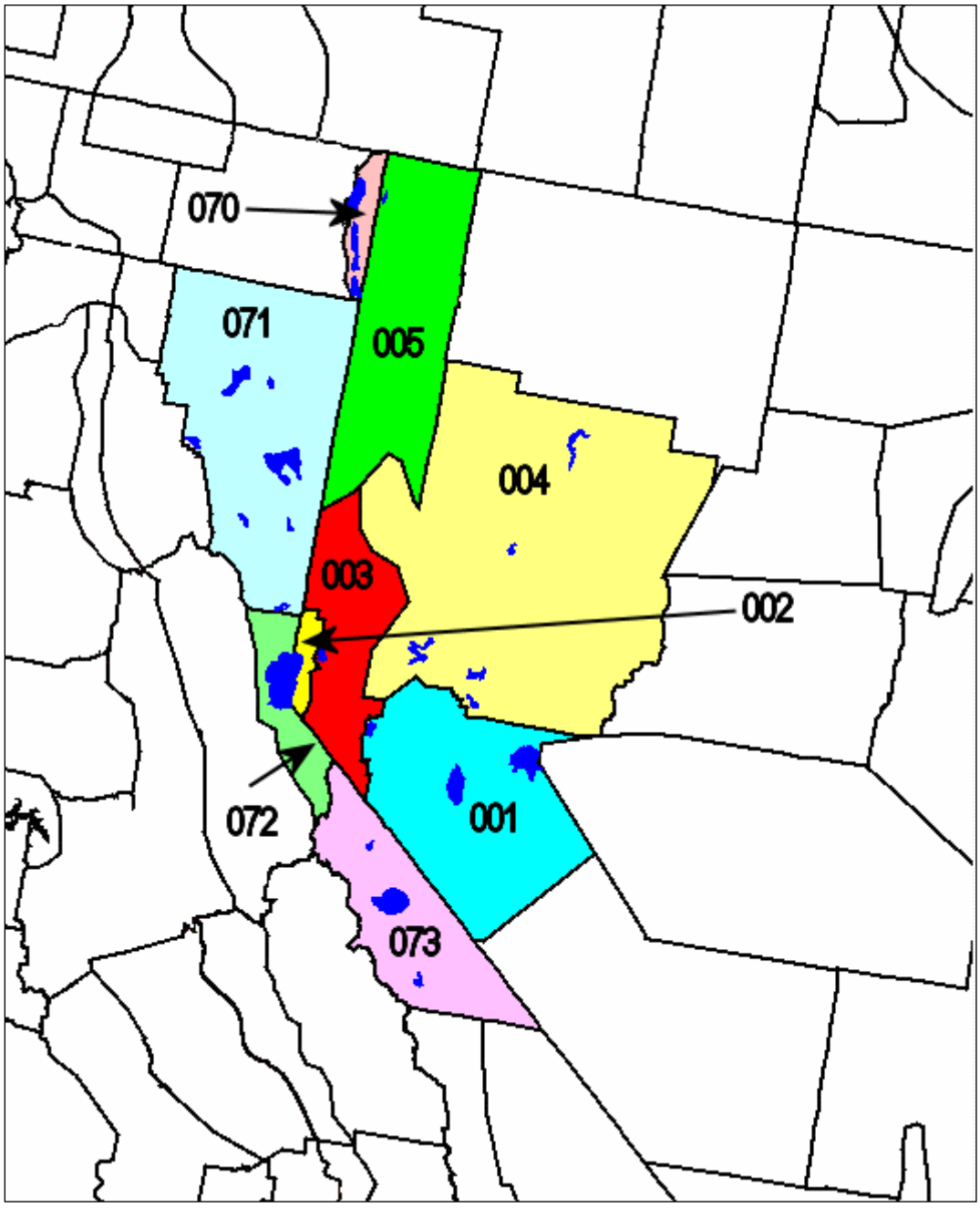

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