

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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# 1.0 Introduction

## PM<sub>10</sub> Standards

In July 1987, EPA promulgated National Ambient Air Quality Standards for Particulates with an aerodynamic diameter of 10 microns or less (PM<sub>10</sub>). 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 µg/m<sup>3</sup> (micrograms per cubic meter) and an annual arithmetic mean standard of 50 µg/m<sup>3</sup>. 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 The annual arithmetic mean standard was revoked in 2006.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<sub>10</sub> standard with a concentration of 198 µg/m<sup>3</sup> at the River City Hall monitor. Elevated readings were also recorded at the Alamosa Municipal monitor with a twenty-four-hour PM<sub>10</sub> concentration of 109 µg/m<sup>3</sup>, the Alamosa Adams State College monitor with a twenty-four PM<sub>10</sub> concentration of 49 µg/m<sup>3</sup> and the Telluride monitor with a twenty-four-hour PM<sub>10</sub> concentration of 72 µg/m<sup>3</sup>. 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<sub>10</sub> concentrations in Durango and other areas of southwestern Colorado and the exceedances of the National Ambient Air Quality Standard (NAAQS) for PM<sub>10</sub> 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<sub>10</sub> 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<sup>th</sup> 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 February 26, 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<sub>10</sub> standard with a concentration of 198 µg/m<sup>3</sup> at the River City Hall monitor. Elevated readings were recorded at the Alamosa Municipal monitor with a twenty-four-hour PM<sub>10</sub> concentration of 109 µg/m<sup>3</sup>, the Alamosa Adams State College monitor with a twenty-four PM<sub>10</sub> concentration of 49 µg/m<sup>3</sup> and the Telluride Colorado monitor with a twenty-four-hour PM<sub>10</sub> concentration of 72 µg/m<sup>3</sup> as seen in Figure 1. *All of these twenty-four-hour PM<sub>10</sub> concentrations are above the 90<sup>th</sup> 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<sub>10</sub> 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<sub>10</sub> 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).

# High PM10 Natural Event in Colorado

February 27, 2009

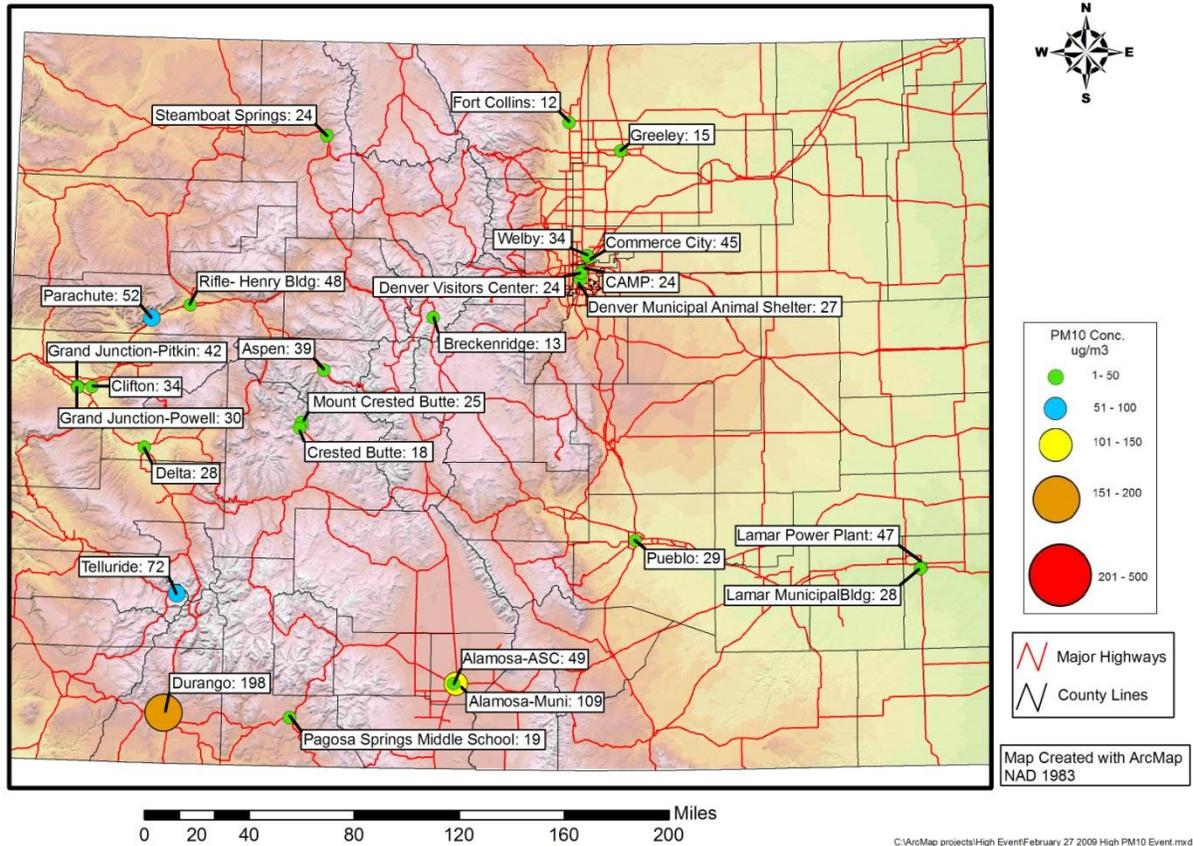


Figure 1. 24-hour PM<sub>10</sub> Readings for February 27, 2009.

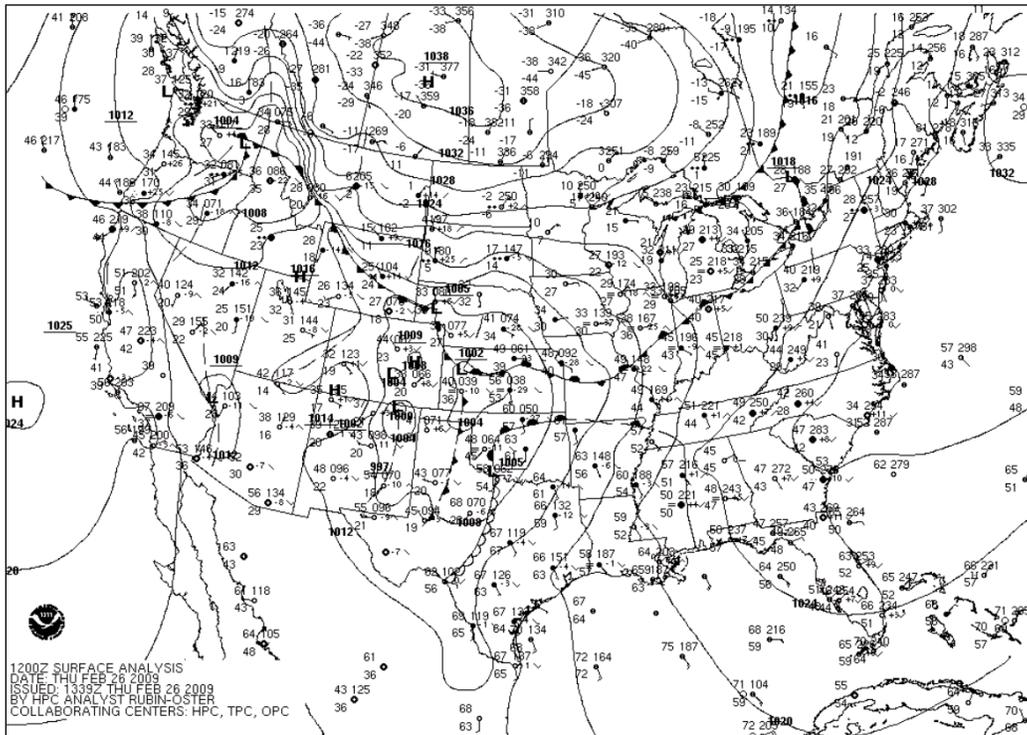


Figure 2. Surface analysis for 12Z February 26, 2009, or 5 AM MST February 26, 2009 (from National Weather Service fax maps <http://archive.atmos.colostate.edu/>).

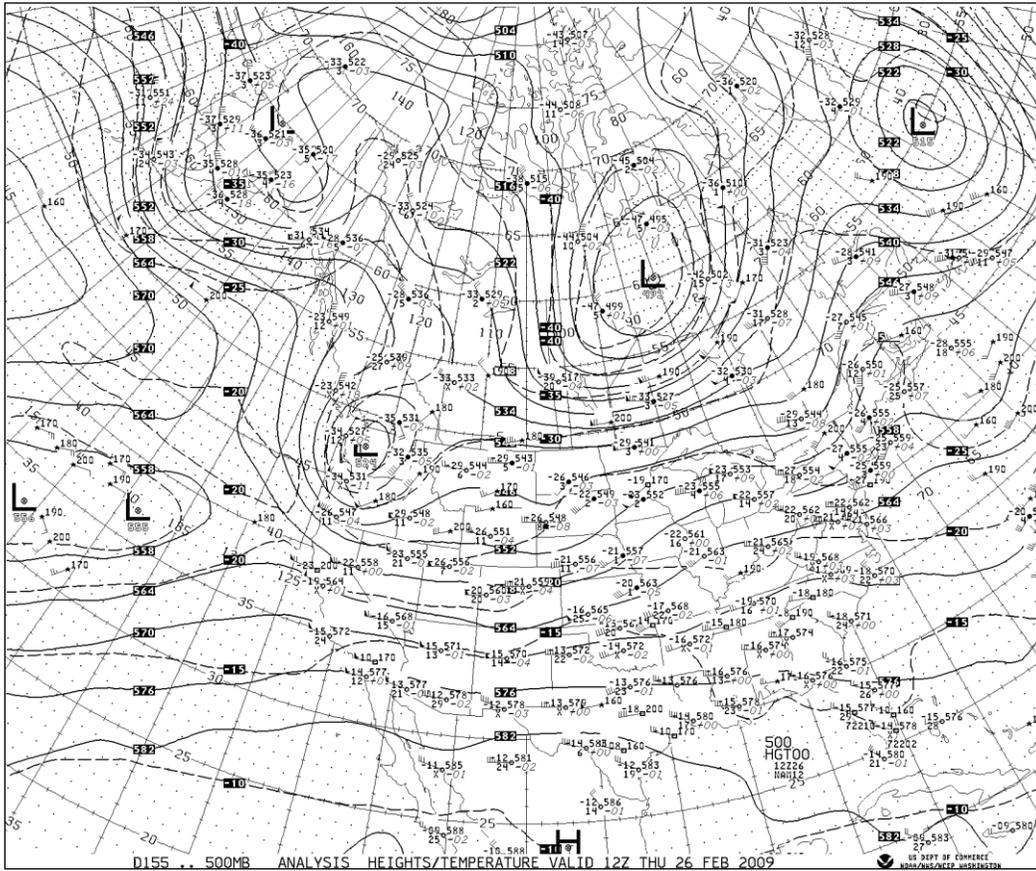


Figure 3. 500 mb analysis for 12Z February 26, 2009, or 5 AM MST February 26, 2009 (from National Weather Service fax maps <http://archive.atmos.colostate.edu/>).

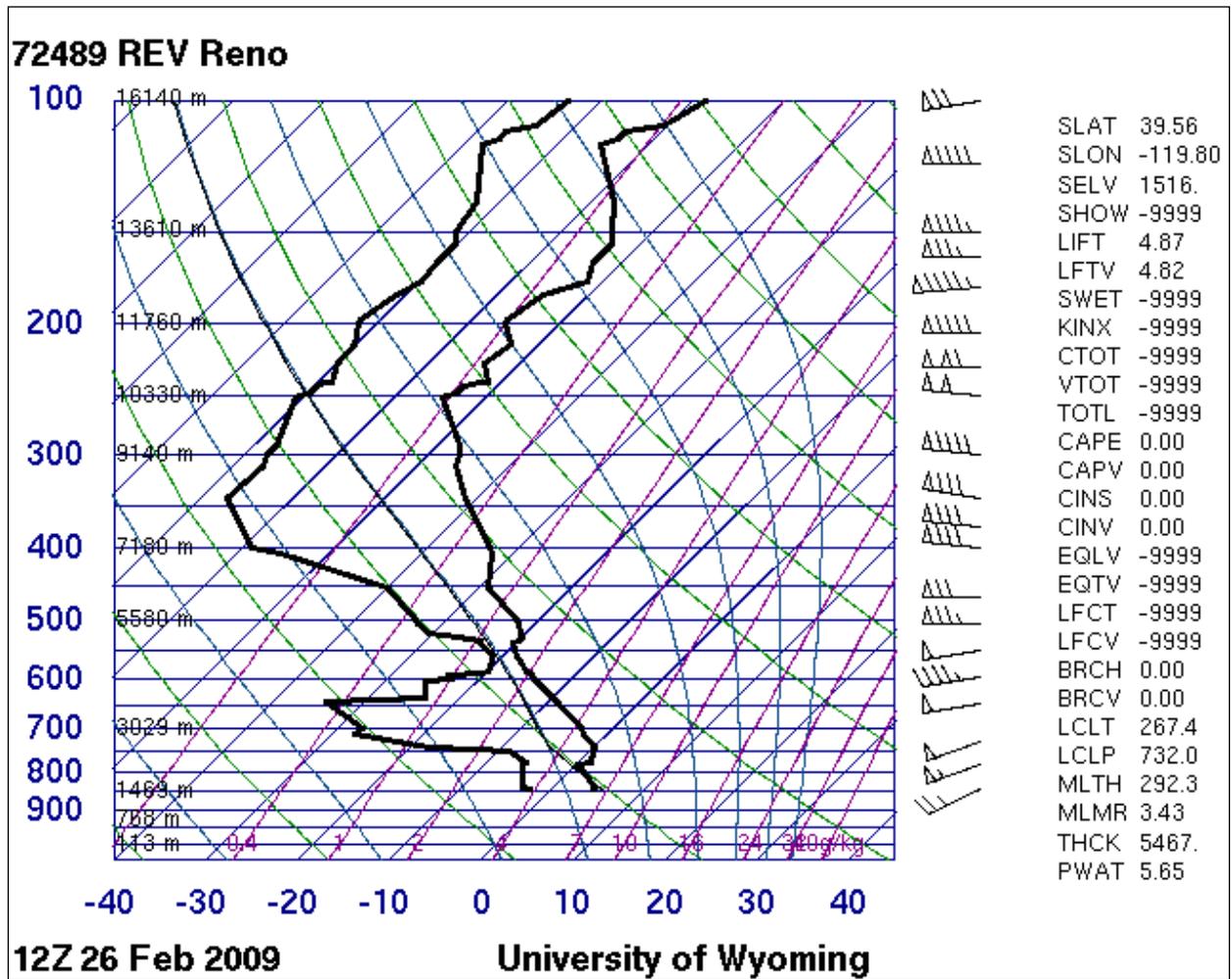


Figure 4. Reno, Nevada, sounding analysis for 12Z February 26, 2009 or 5 AM MST February 26, 2009 (<http://weather.uwyo.edu/upperair/sounding.html>).

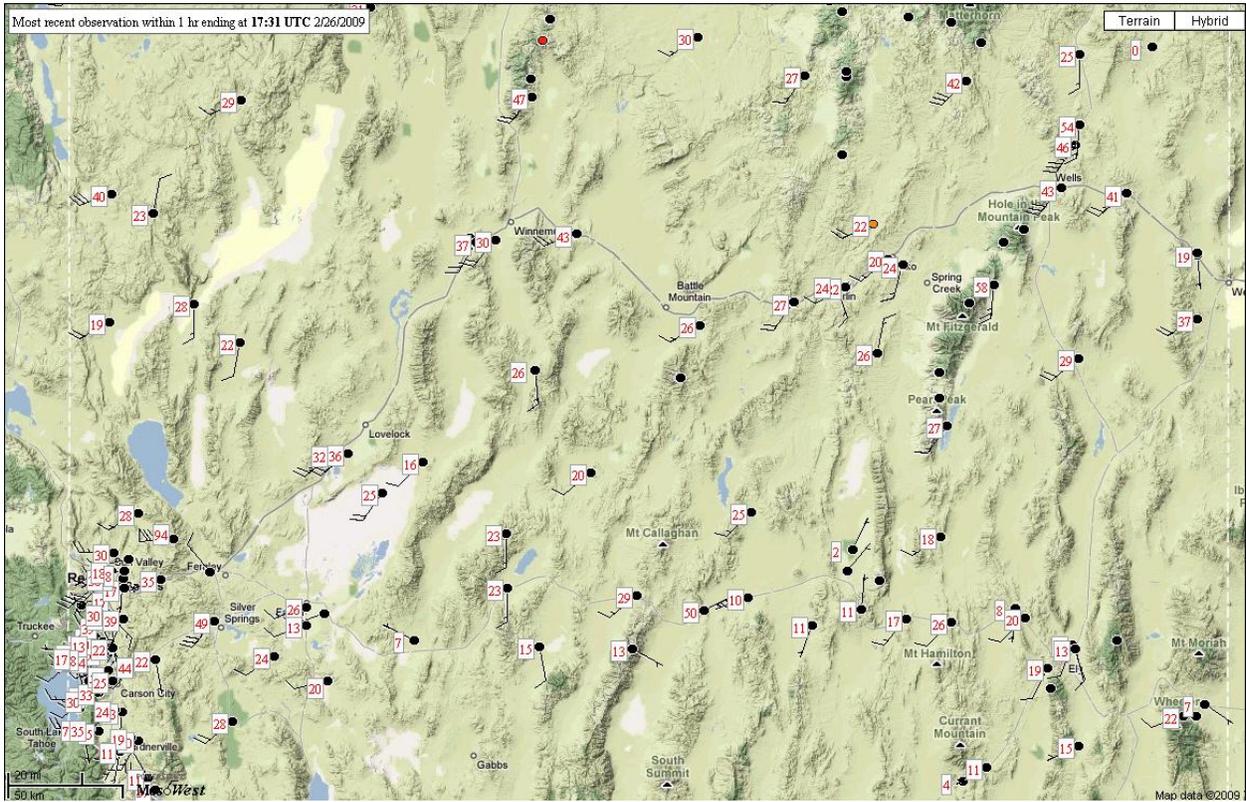


Figure 5. Wind directions and gust speeds in dust source regions of Nevada 17:31 UTC or 10:31 AM MST on February 26, 2009 (<http://www.met.utah.edu/mesowest/>).

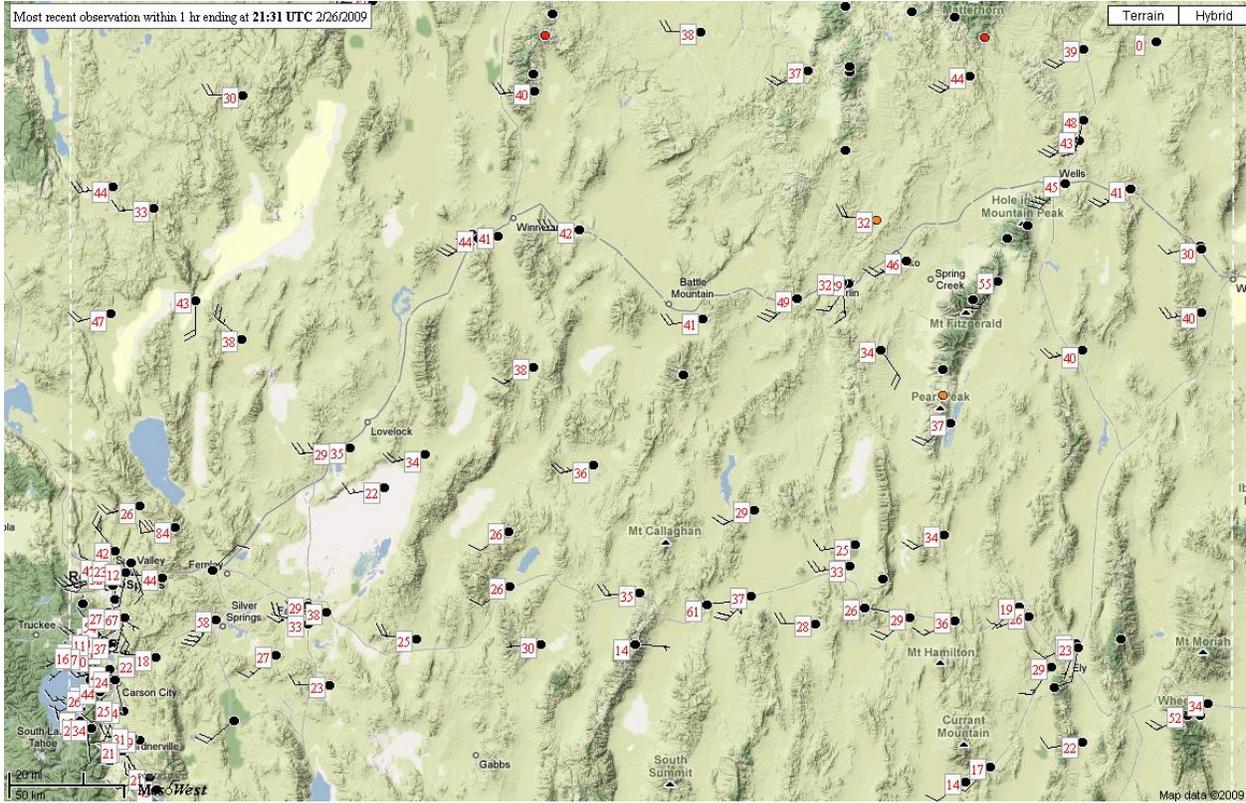


Figure 6. Wind directions and gust speeds in dust source regions of Nevada 21:31 UTC or 2:31 PM MST on February 26, 2009 (<http://www.met.utah.edu/mesowest/>).

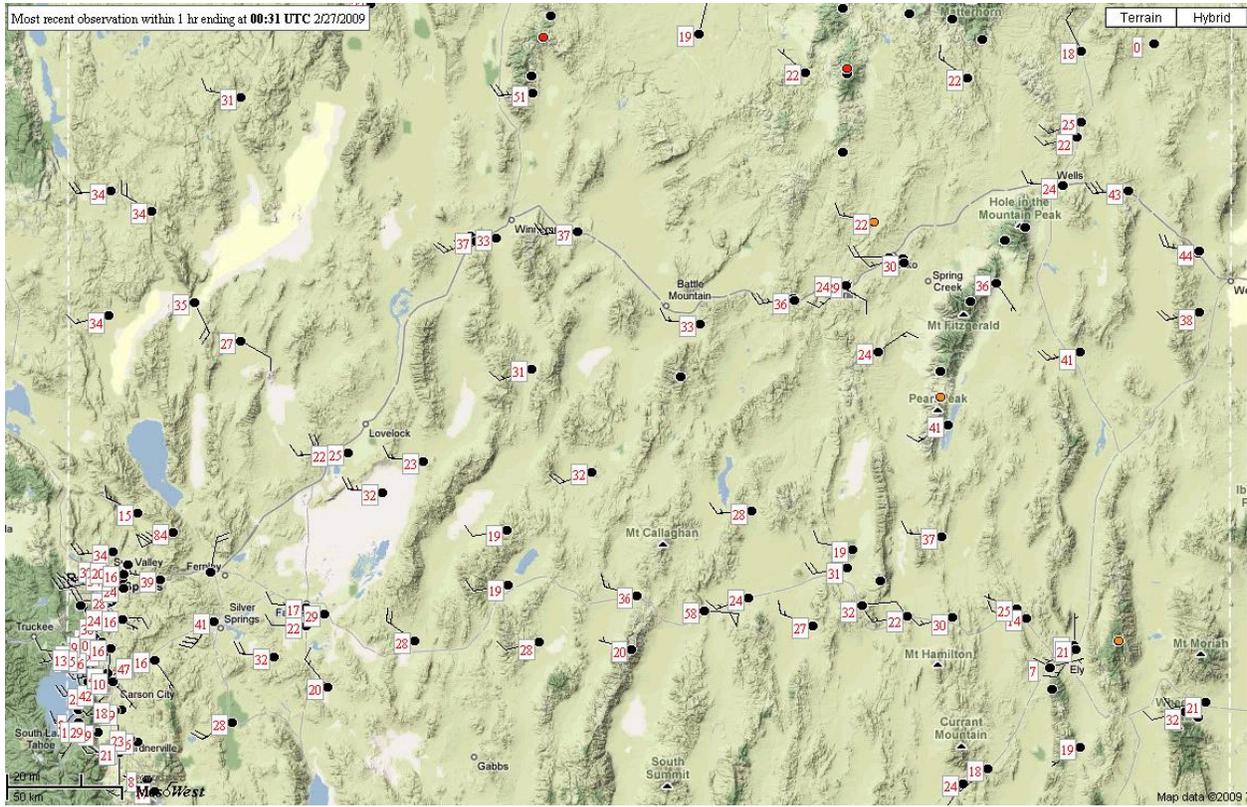


Figure 7. Wind directions and gust speeds in dust source regions of Nevada 00:31 UTC or 5:31 PM MST on February 26, 2009 (<http://www.met.utah.edu/mesowest/>).

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.

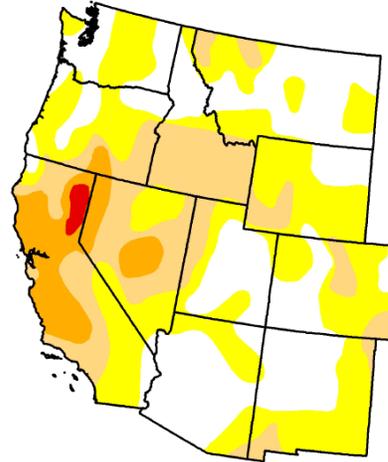
Time in MST February 26	Temperature Degrees F	Relative Humidity in %	Wind Speed in mph	Wind Gust in mph	Wind Direction in Degrees	Weather	Visibility in miles
23:55	30	86	18		360	overcast	10
22:55	36	64	18		340	overcast	10
21:55	36	64	17		320	mostly cloudy	10
20:55	37	65	16	23	320	mostly cloudy	10
19:55	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

# U.S. Drought Monitor

## West

March 3, 2009  
Valid 7 a.m. EST

	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.1	64.9	28.0	8.0	0.6	0.0
Last Week (02/24/2009 map)	37.2	62.8	26.5	9.0	2.0	0.0
3 Months Ago (12/09/2008 map)	32.8	67.2	29.9	9.8	0.4	0.0
Start of Calendar Year (01/06/2009 map)	37.4	62.6	28.9	8.8	0.4	0.0
Start of Water Year (10/07/2008 map)	41.3	58.7	28.6	10.4	0.1	0.0
One Year Ago (03/04/2008 map)	42.3	57.7	34.0	16.0	0.0	0.0



**Intensity:**

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions.  
Local conditions may vary. See accompanying text summary  
for forecast statements.



Released Thursday, March 5, 2009

Author: J. Lawrimore/L. Love-Brotak, NOAA/NESDIS/NCDC

<http://drought.unl.edu/dm>

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>).

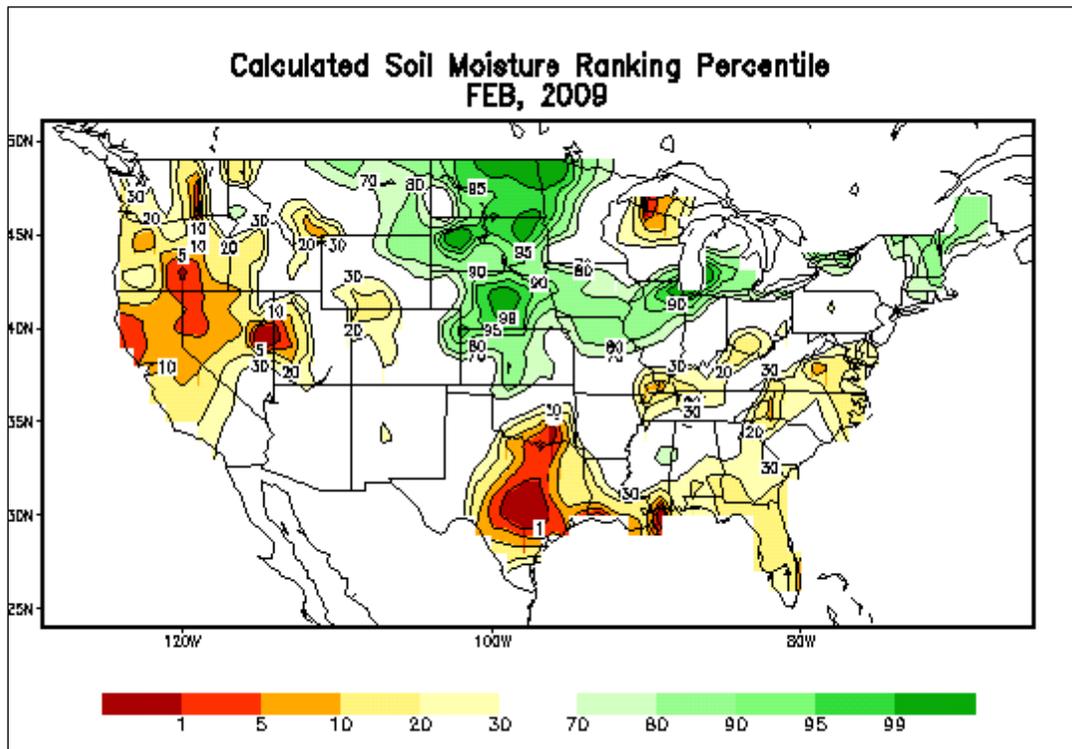


Figure 9. Calculated Soil Moisture Ranking Percentile for February, 2009 (source: the National Weather Service Climate Prediction Center: [http://www.cpc.ncep.noaa.gov/soilmst/index\\_jh.html](http://www.cpc.ncep.noaa.gov/soilmst/index_jh.html) ).

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.

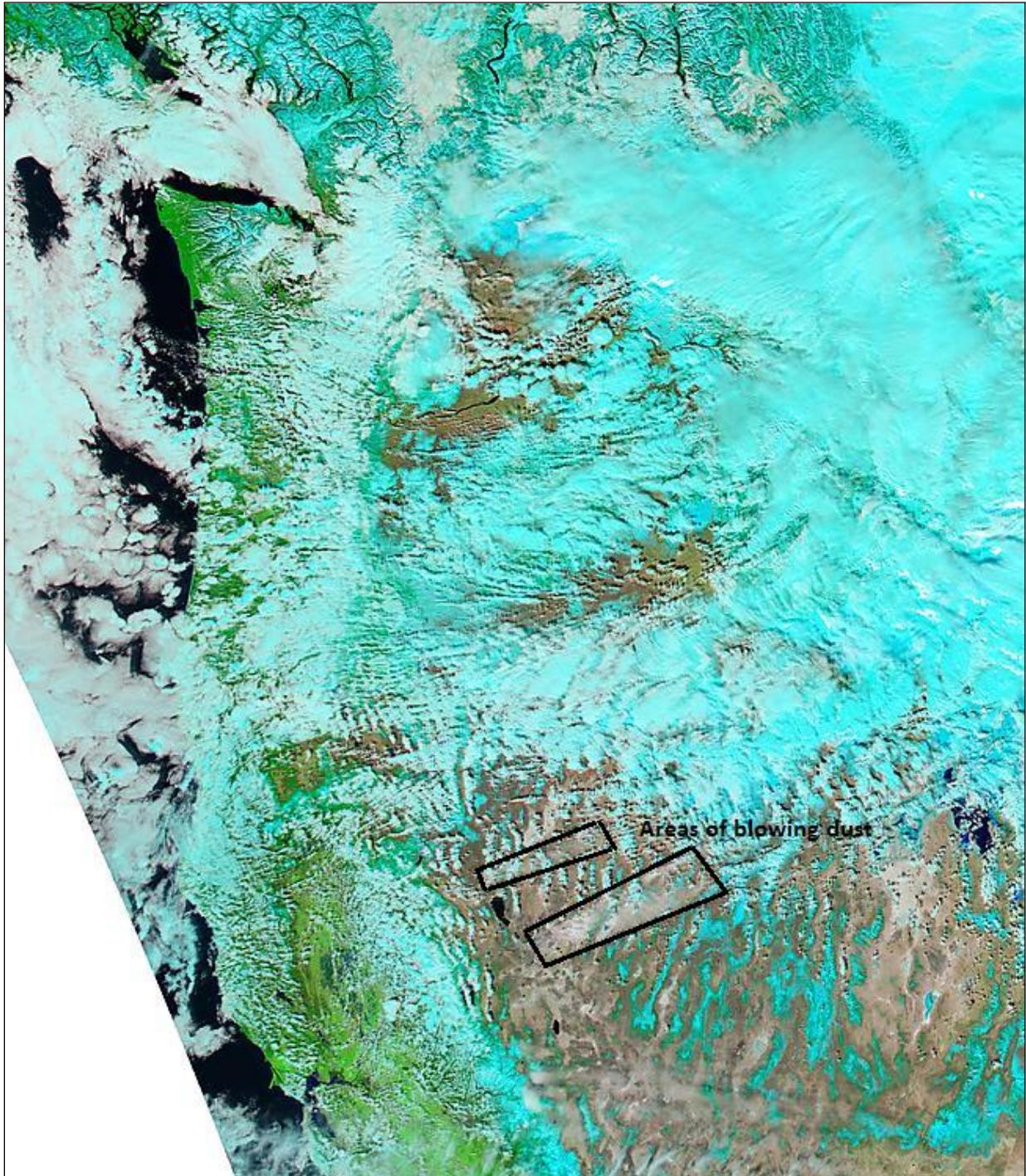


Figure 10. MODIS Aqua satellite, false color, sector USA1, 2000 m resolution for February 27, 2009 (<http://ge.ssec.wisc.edu/modis-today/index.php>).

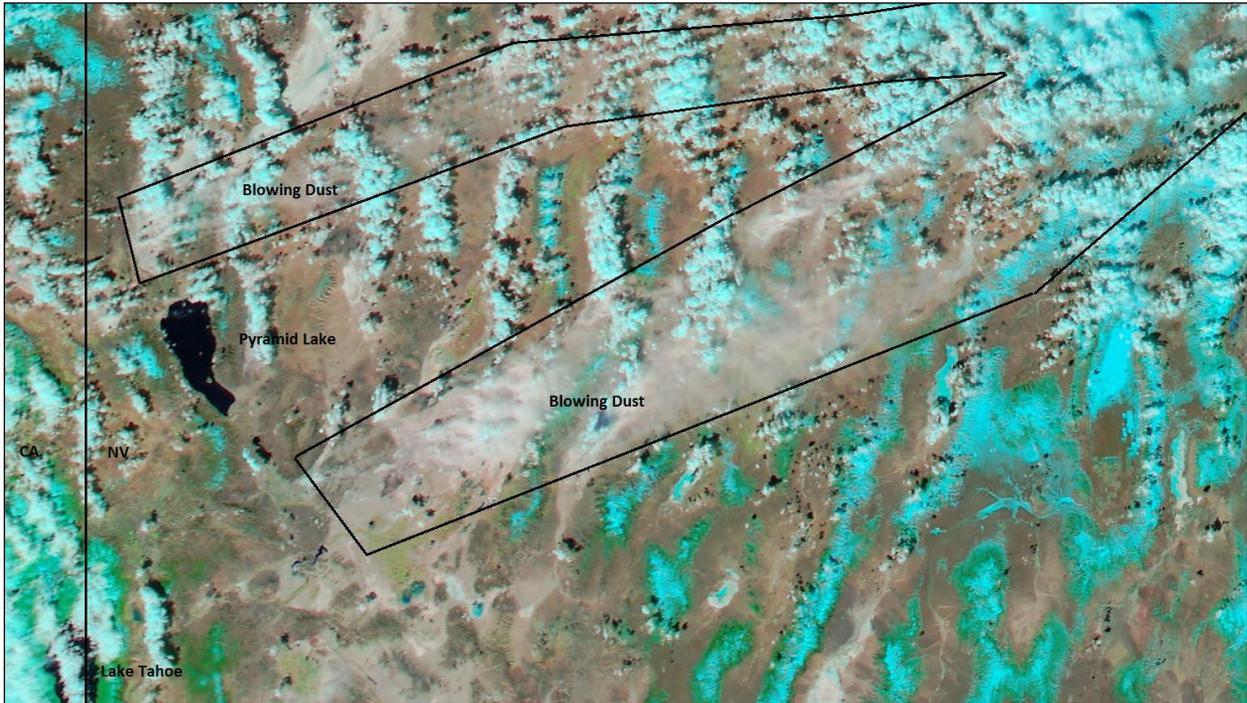


Figure 11. MODIS Aqua satellite, false color, a portion of sector USA1, 250 m resolution for February 27, 2009 (<http://ge.ssec.wisc.edu/modis-today/index.php>).

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>).

\* 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

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](mailto: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.

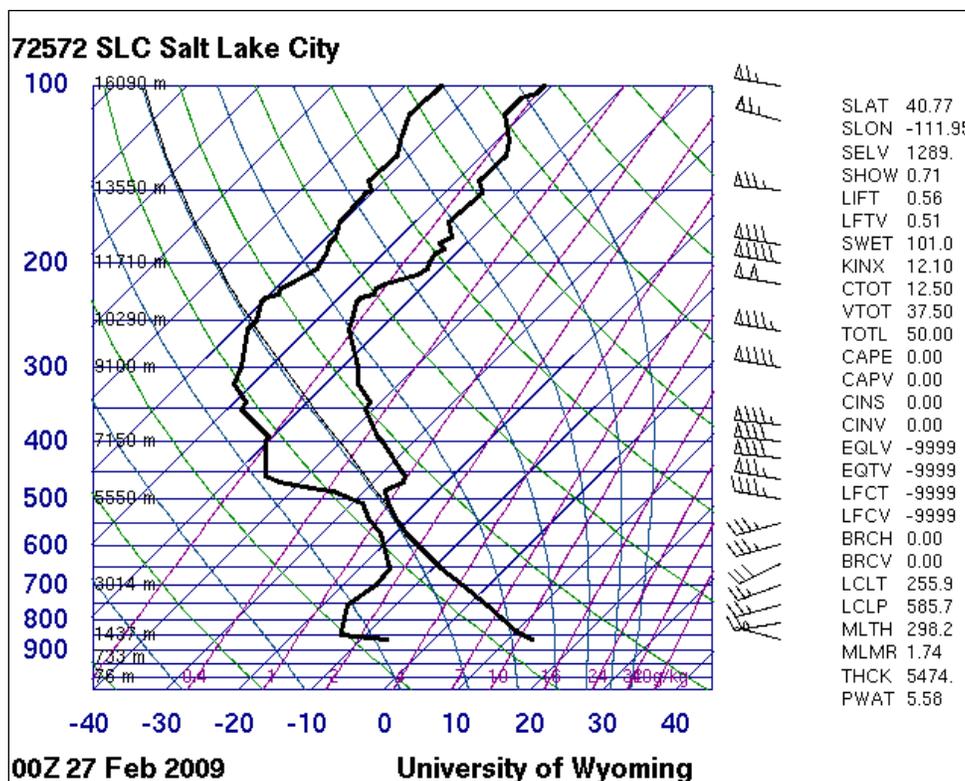


Figure 12. Salt Lake City, Utah, sounding analysis for 00Z February 27, 2009, or 5 PM MST February 26, 2009 (<http://weather.uwyo.edu/upperair/sounding.html>).

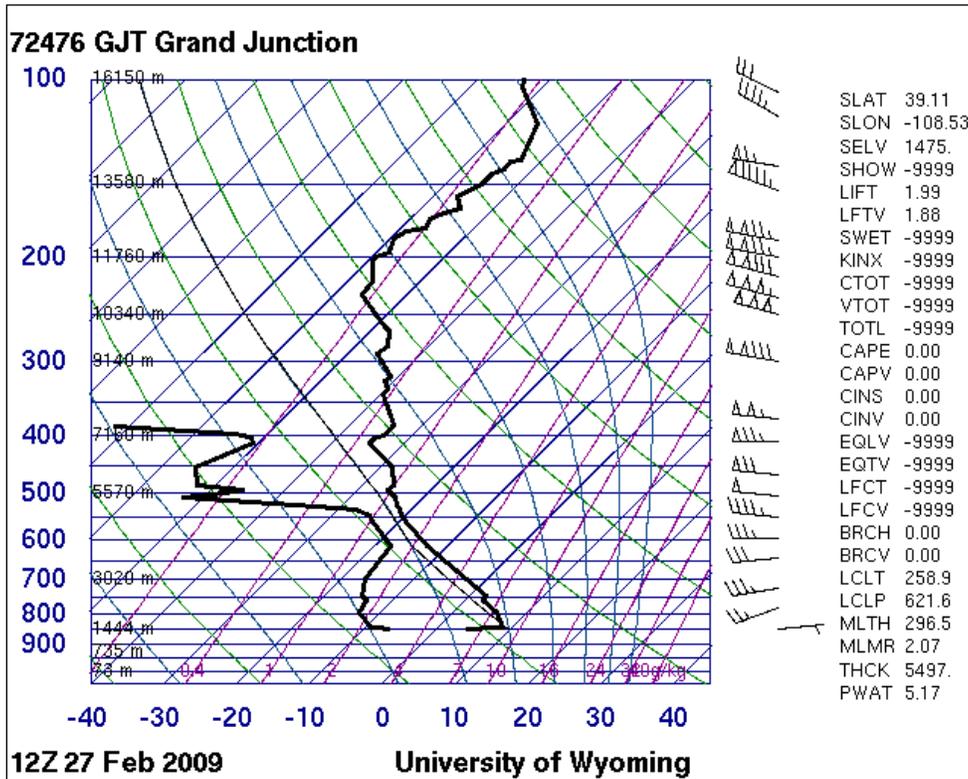


Figure 13. Grand Junction, Colorado sounding analysis for 12Z February 27, 2009, or 5 AM MST February 27, 2009 (<http://weather.uwyo.edu/upperair/sounding.html>).

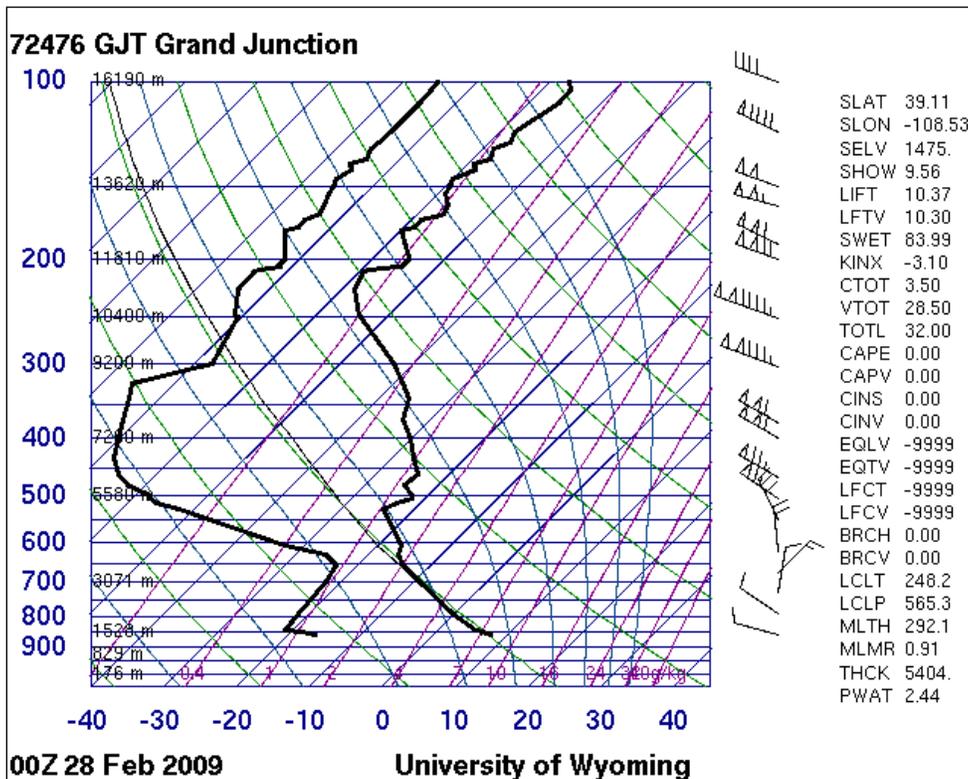


Figure 14. Grand Junction, Colorado sounding analysis for 00Z February 28, 2009, or 5 PM MST February 27, 2009 (<http://weather.uwyo.edu/upperair/sounding.html>).

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.

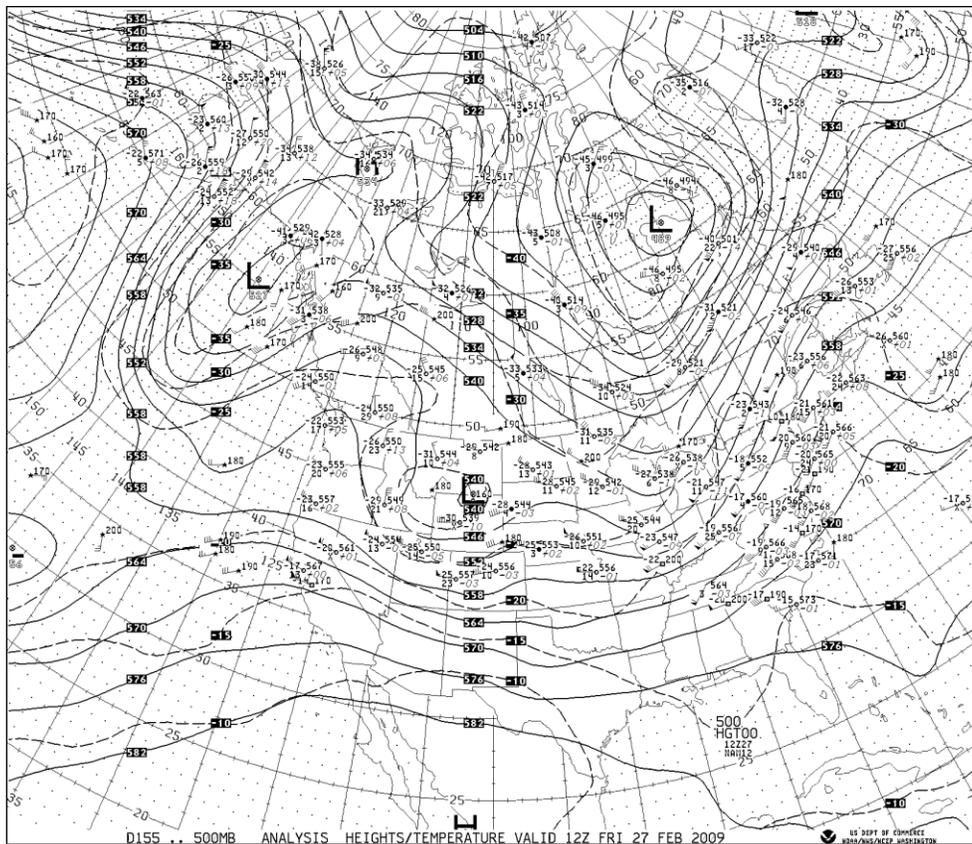


Figure 15. 500 mb analysis for 12Z February 27, 2009, or 5 AM MST February 27, 2009 (from National Weather Service fax maps <http://archive.atmos.colostate.edu/>).

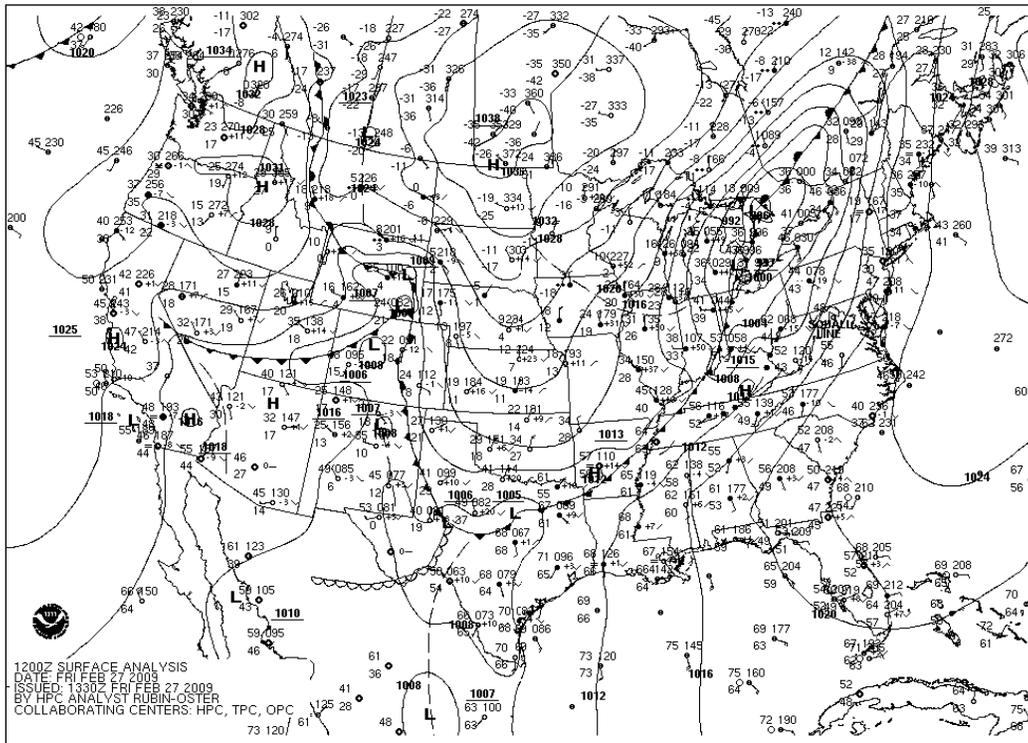


Figure 16. Surface analysis for 12Z February 27, 2009, or 5 AM MST February 27, 2009 (from National Weather Service fax maps <http://archive.atmos.colostate.edu/>).

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<sub>10</sub> 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.

NOAA HYSPLIT MODEL  
 Backward trajectories ending at 0700 UTC 28 Feb 09  
 NAM Meteorological Data

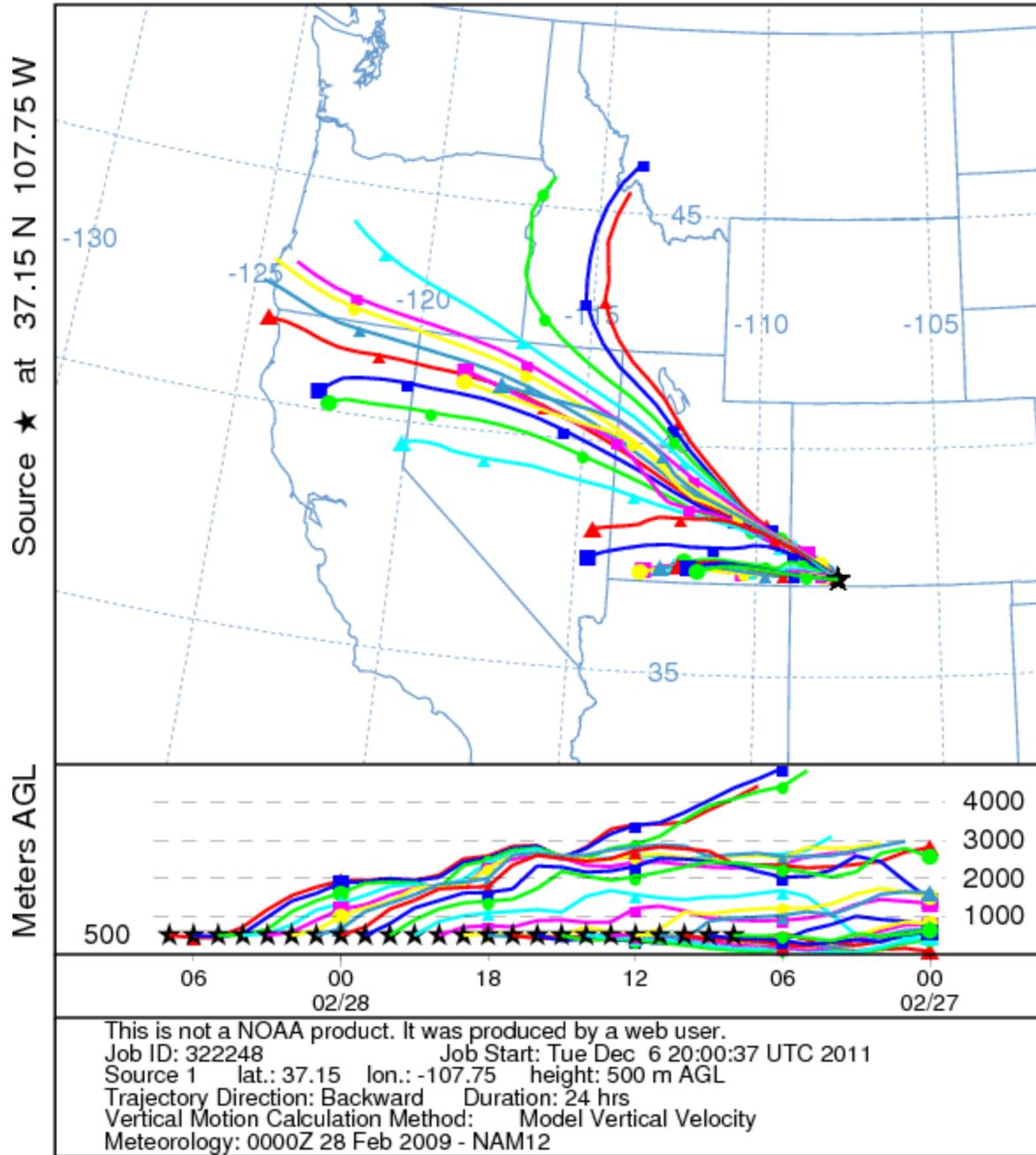


Figure 17. NOAA HYSPLIT 24-hour back trajectories for Durango Colorado for each hour from 1 AM MST to Midnight MST on February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

NOAA HYSPLIT MODEL  
Backward trajectories ending at 1200 UTC 27 Feb 09  
NAM Meteorological Data

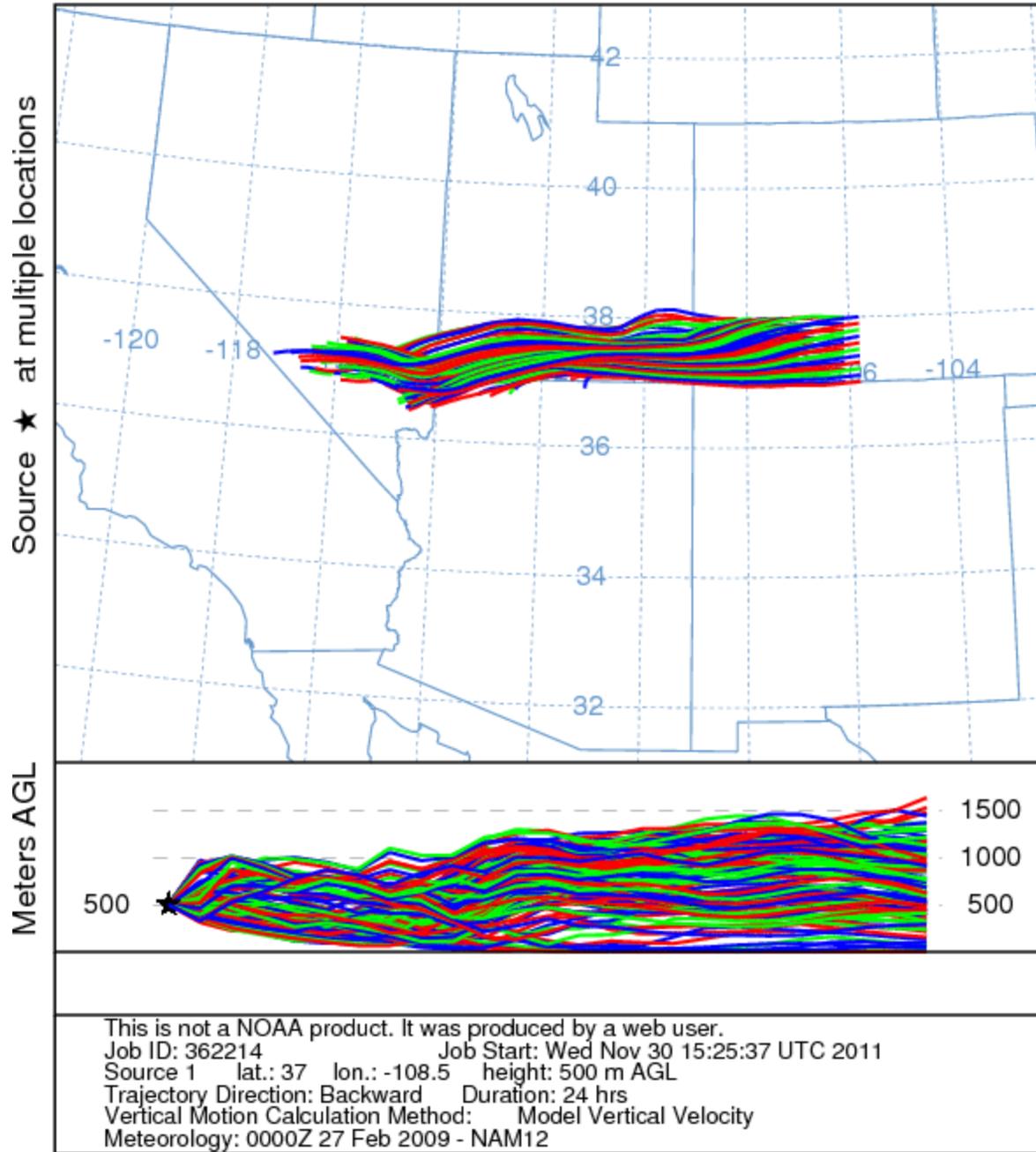


Figure 18. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 5 AM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

NOAA HYSPLIT MODEL  
 Backward trajectories ending at 1600 UTC 27 Feb 09  
 NAM Meteorological Data

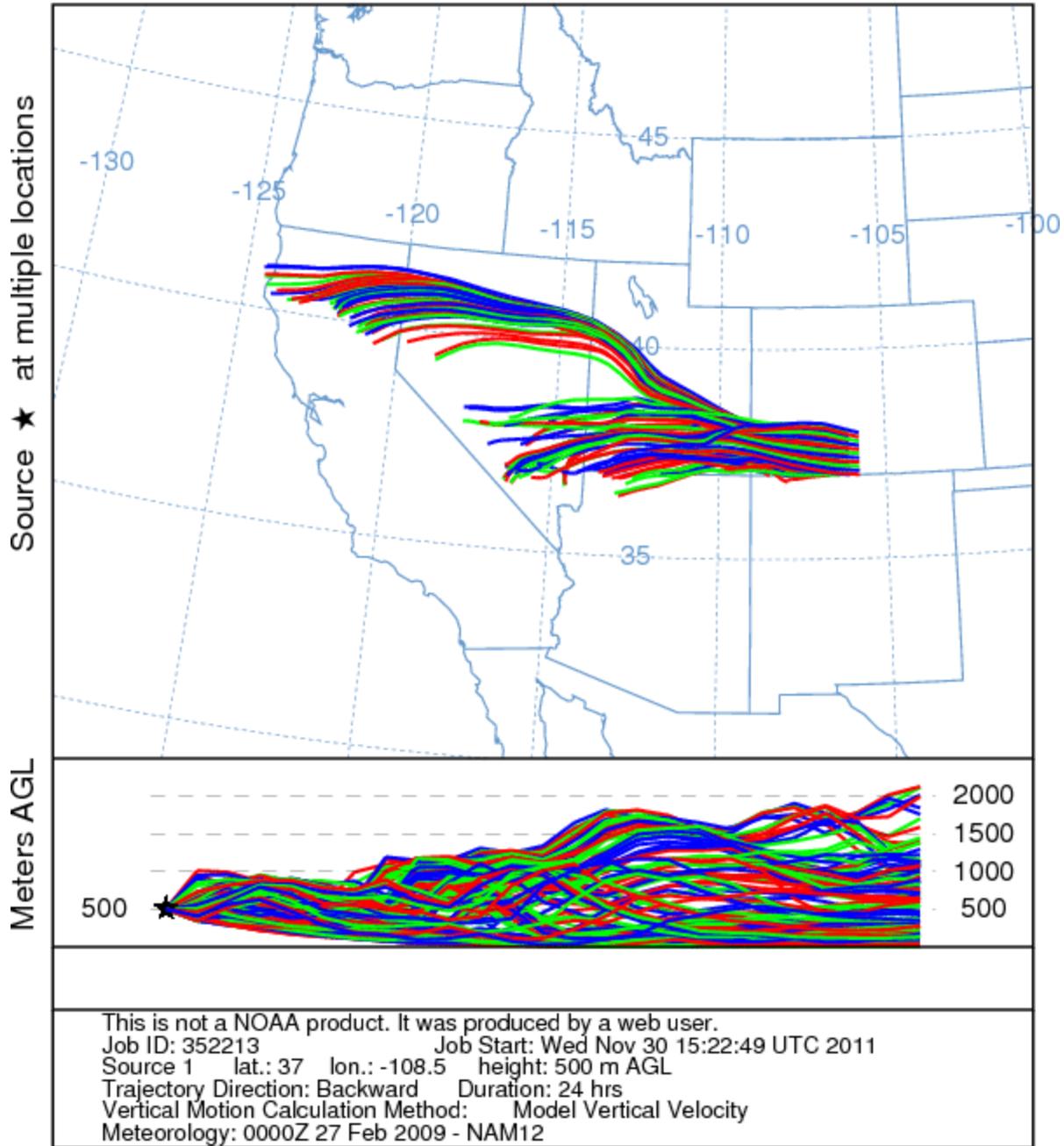


Figure 19. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 9 AM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

NOAA HYSPLIT MODEL  
 Backward trajectories ending at 2000 UTC 27 Feb 09  
 NAM Meteorological Data

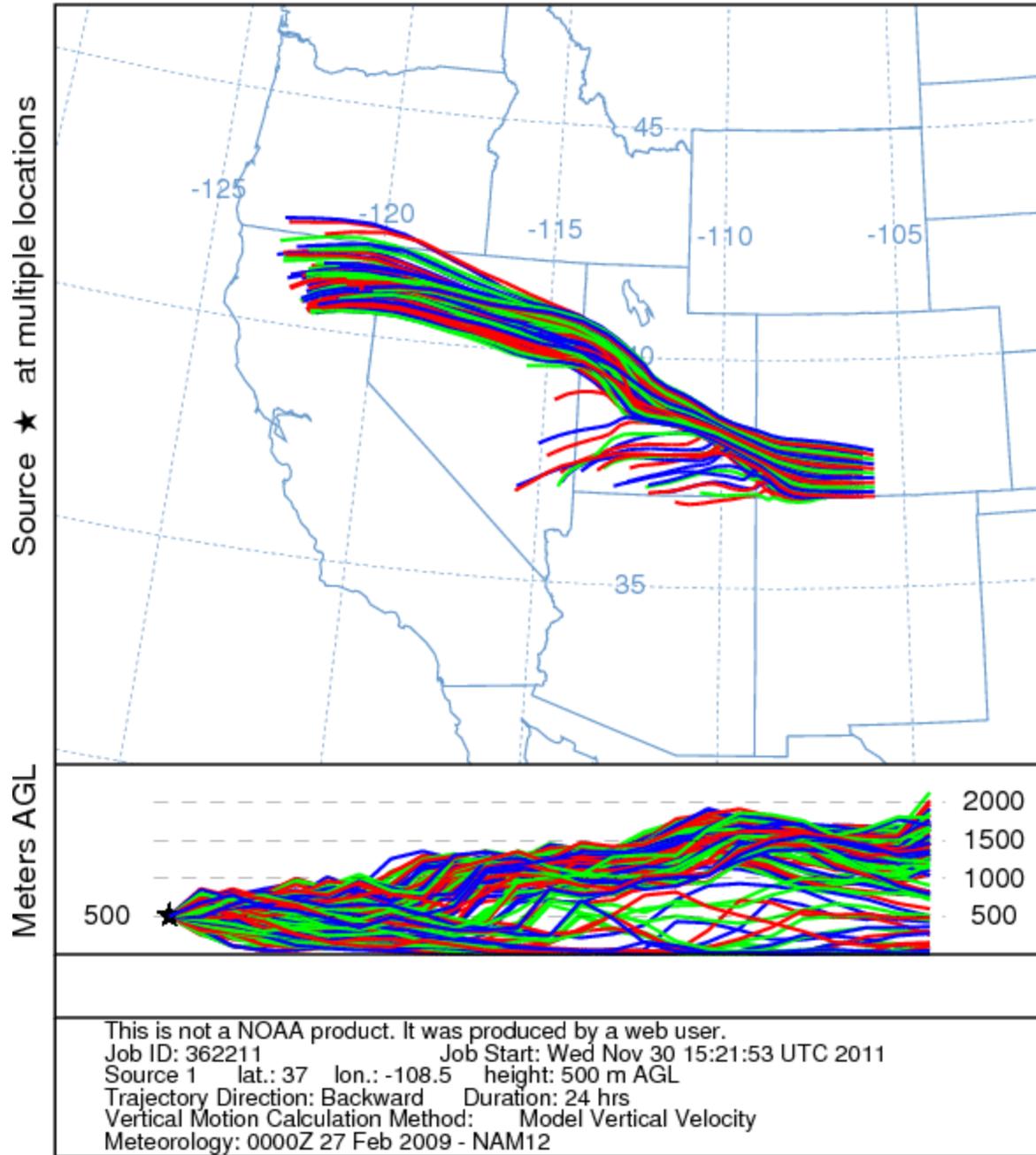


Figure 20. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 1 PM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

NOAA HYSPLIT MODEL  
 Backward trajectories ending at 0000 UTC 28 Feb 09  
 NAM Meteorological Data

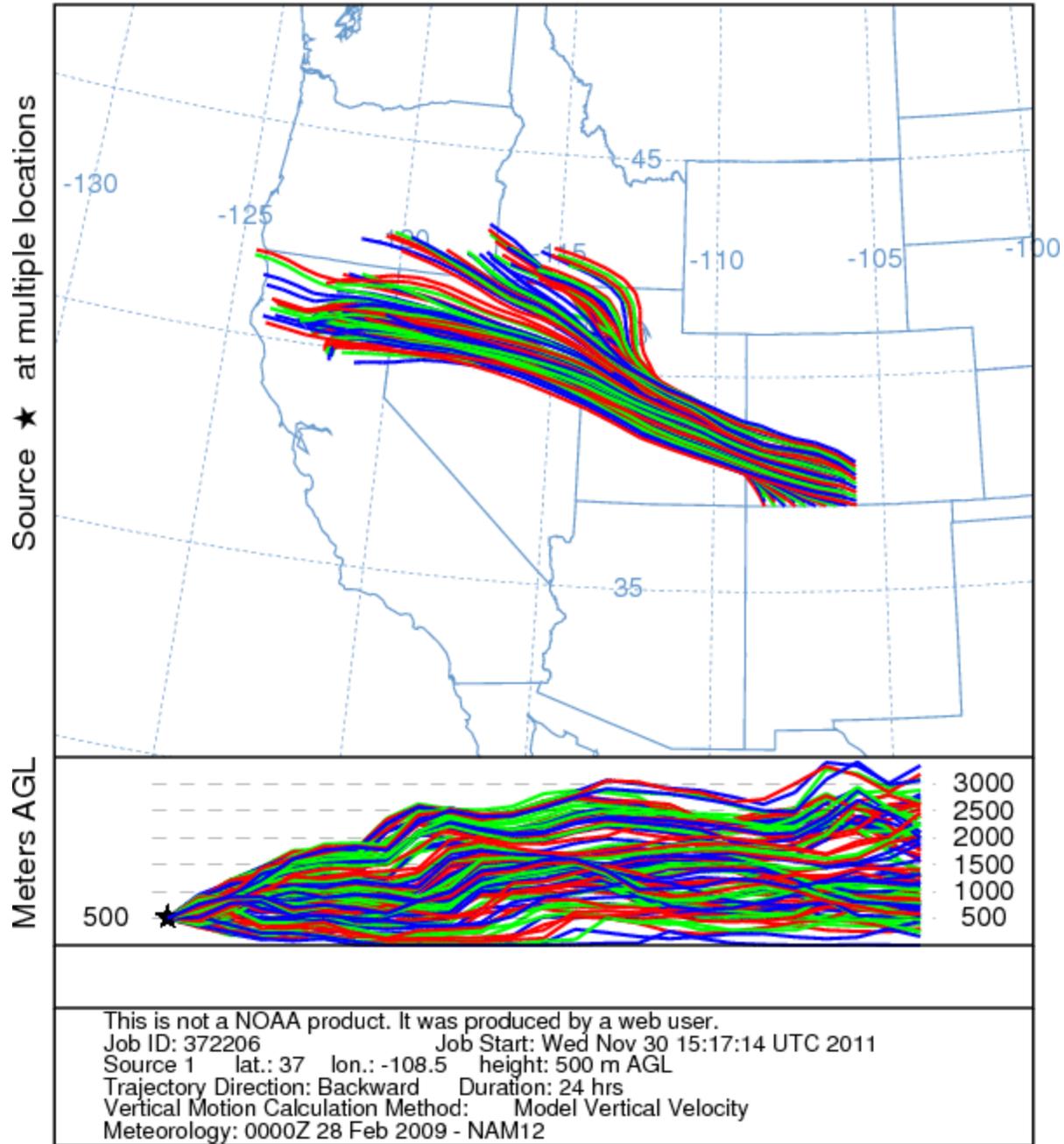


Figure 21. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 5 PM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

NOAA HYSPLIT MODEL  
 Backward trajectories ending at 0400 UTC 28 Feb 09  
 NAM Meteorological Data

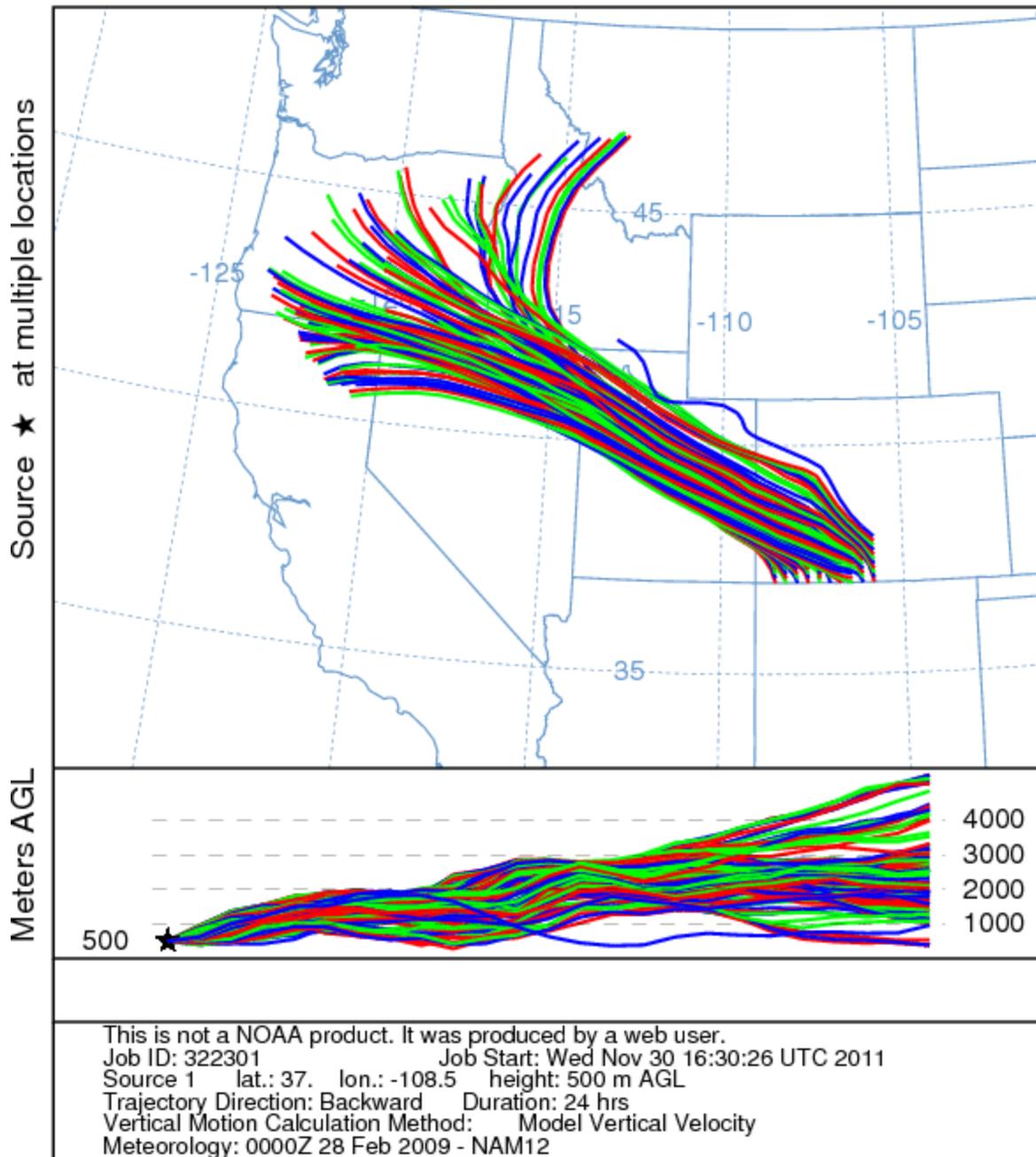


Figure 22. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 9 PM MST February 27, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

NOAA HYSPLIT MODEL  
Backward trajectories ending at 0700 UTC 28 Feb 09  
NAM Meteorological Data

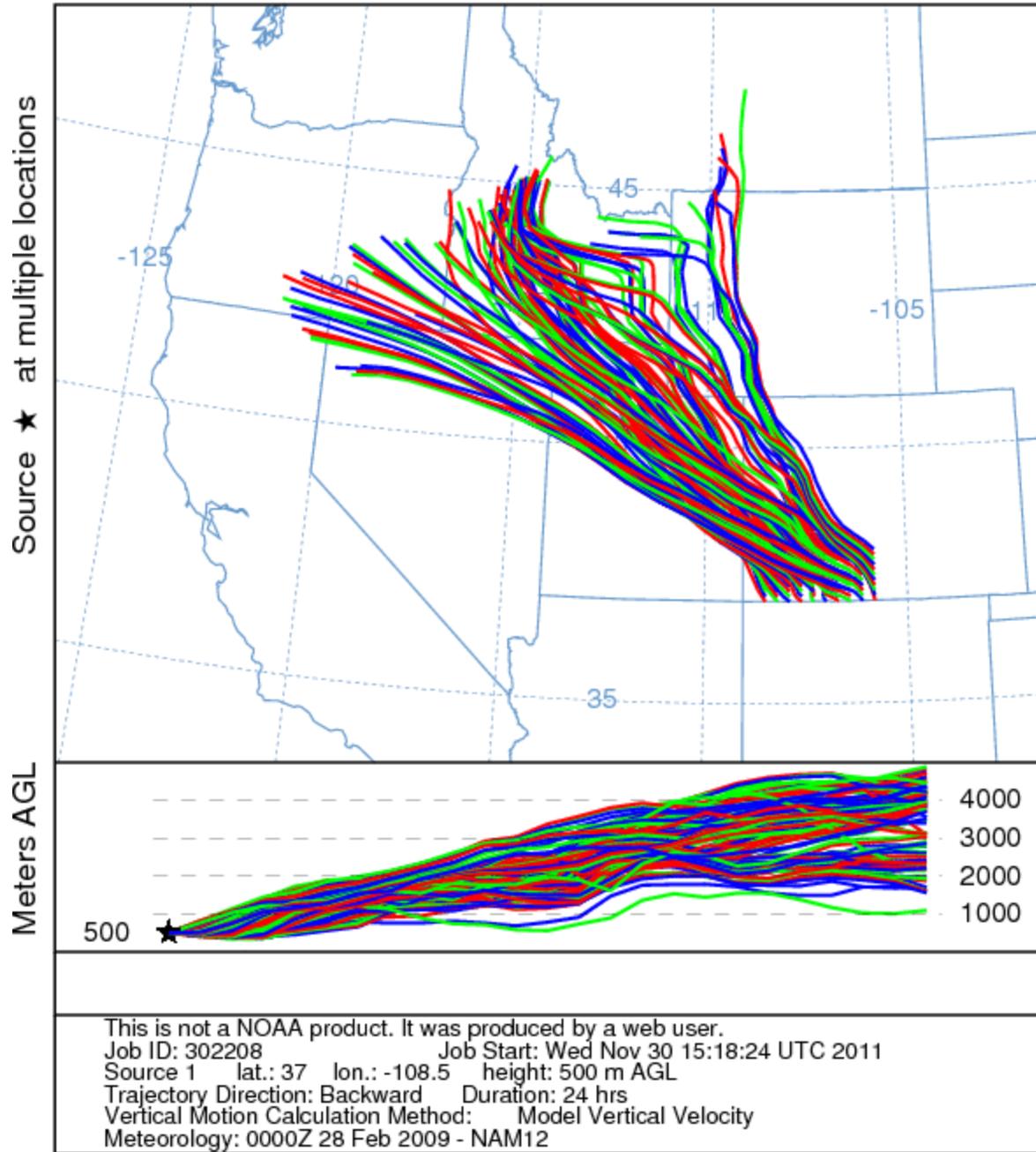


Figure 23. NOAA HYSPLIT Matrix 24-hour back trajectories for Southwest Colorado for 12 AM MST February 28, 2009. The HYSPLIT model run was based on data from the high-resolution 12-kilometer grid spacing NAM numerical weather model.

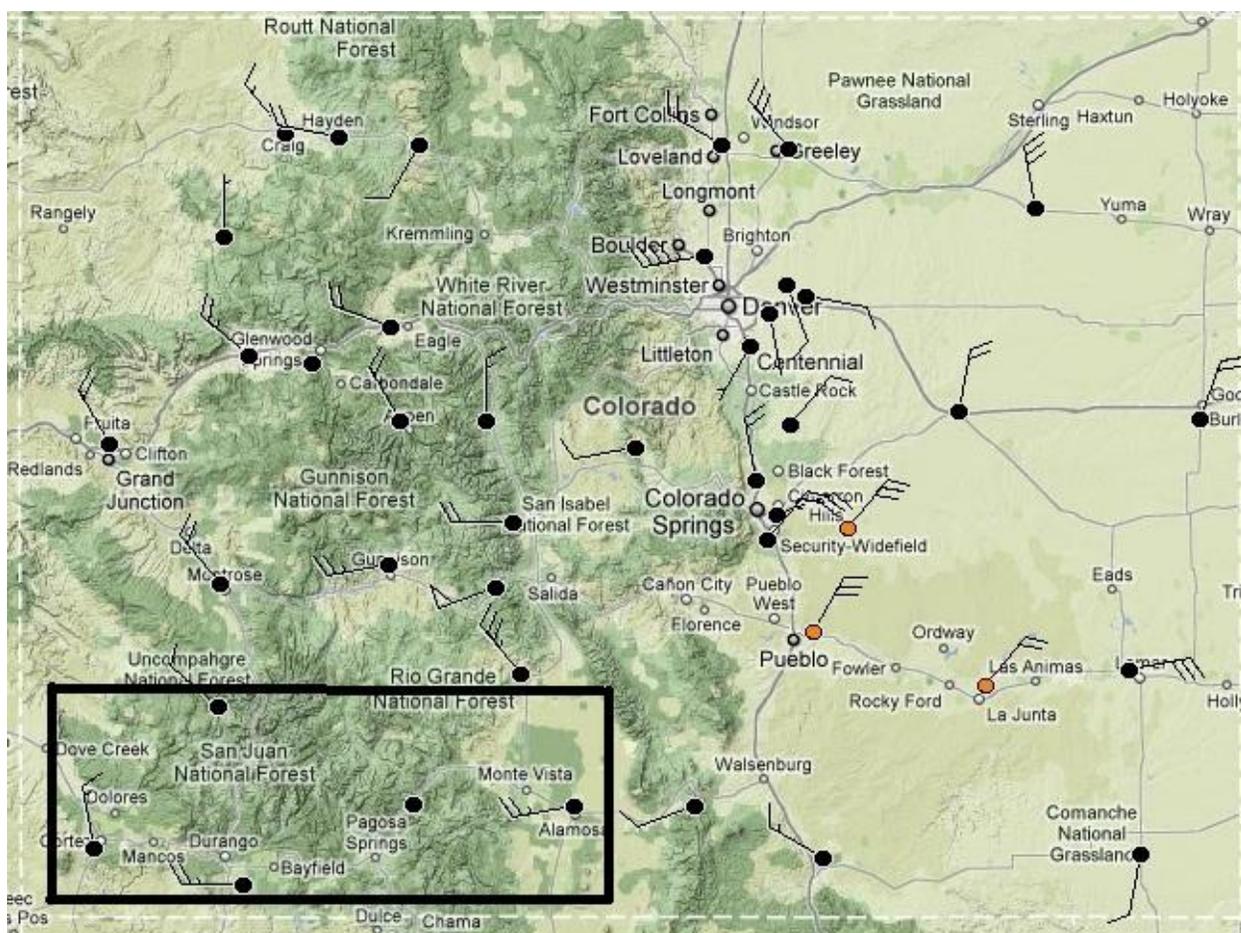


Figure 24. Location for NOAA HYSPLIT 24-hour back trajectories matrix box for Southwest Colorado.

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<sub>10</sub> concentrations in Telluride, Colorado on February 27, 2009.

Date	Hour	µg/m <sup>3</sup>
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<sub>10</sub> 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](http://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<sub>10</sub> 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<sub>10</sub> 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<sub>10</sub> monitor had 8 inches of snow cover. This site is an indicator of the snow cover downwind of the Durango River City Hall PM<sub>10</sub> 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.*

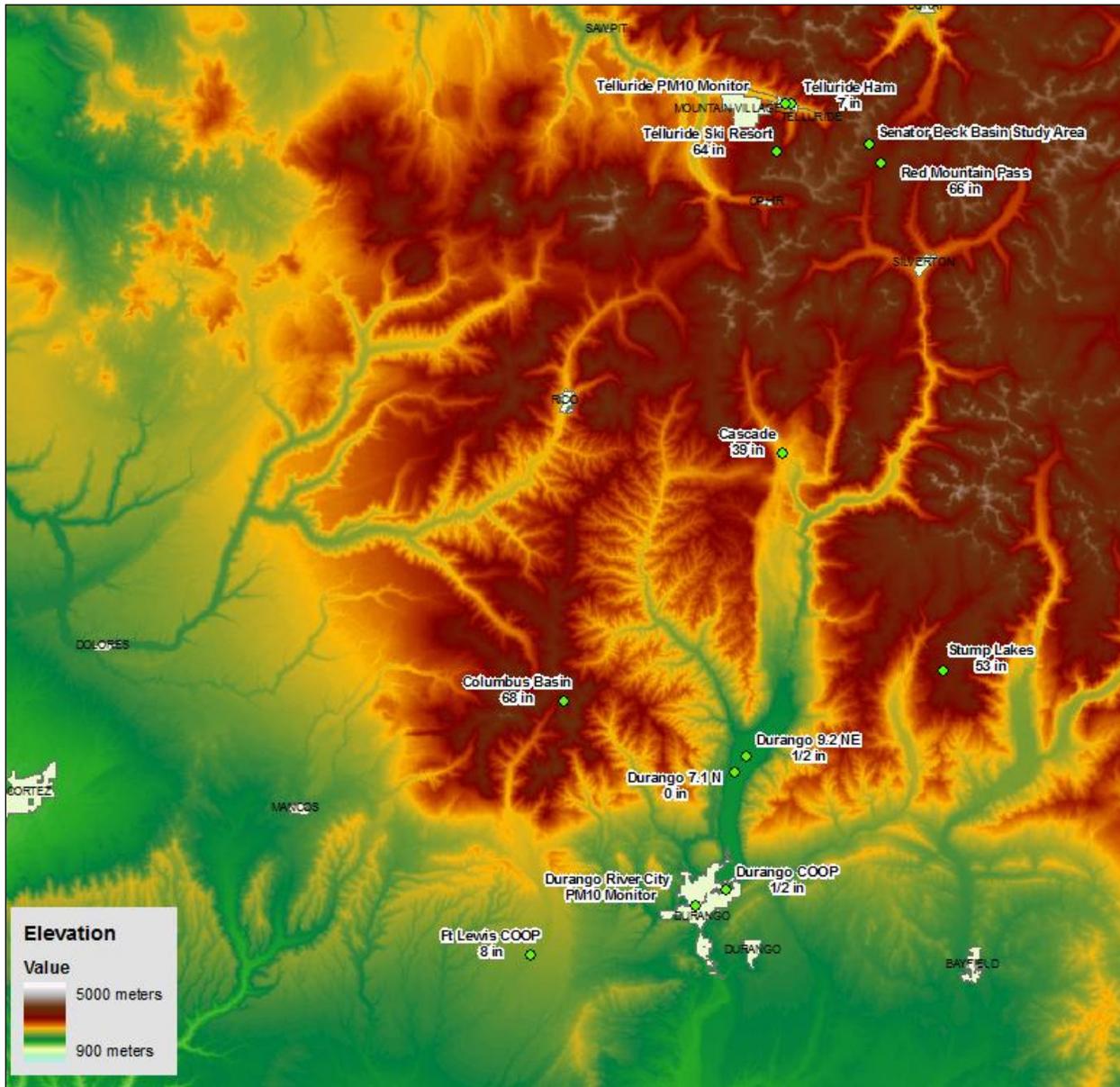


Figure 25. SNOTEL, NWS COOP, and CDPHE  $PM_{10}$  monitor sites (<http://www.nohrsc.noaa.gov/> and <http://cdo.ncdc.noaa.gov/dly/DLY> )



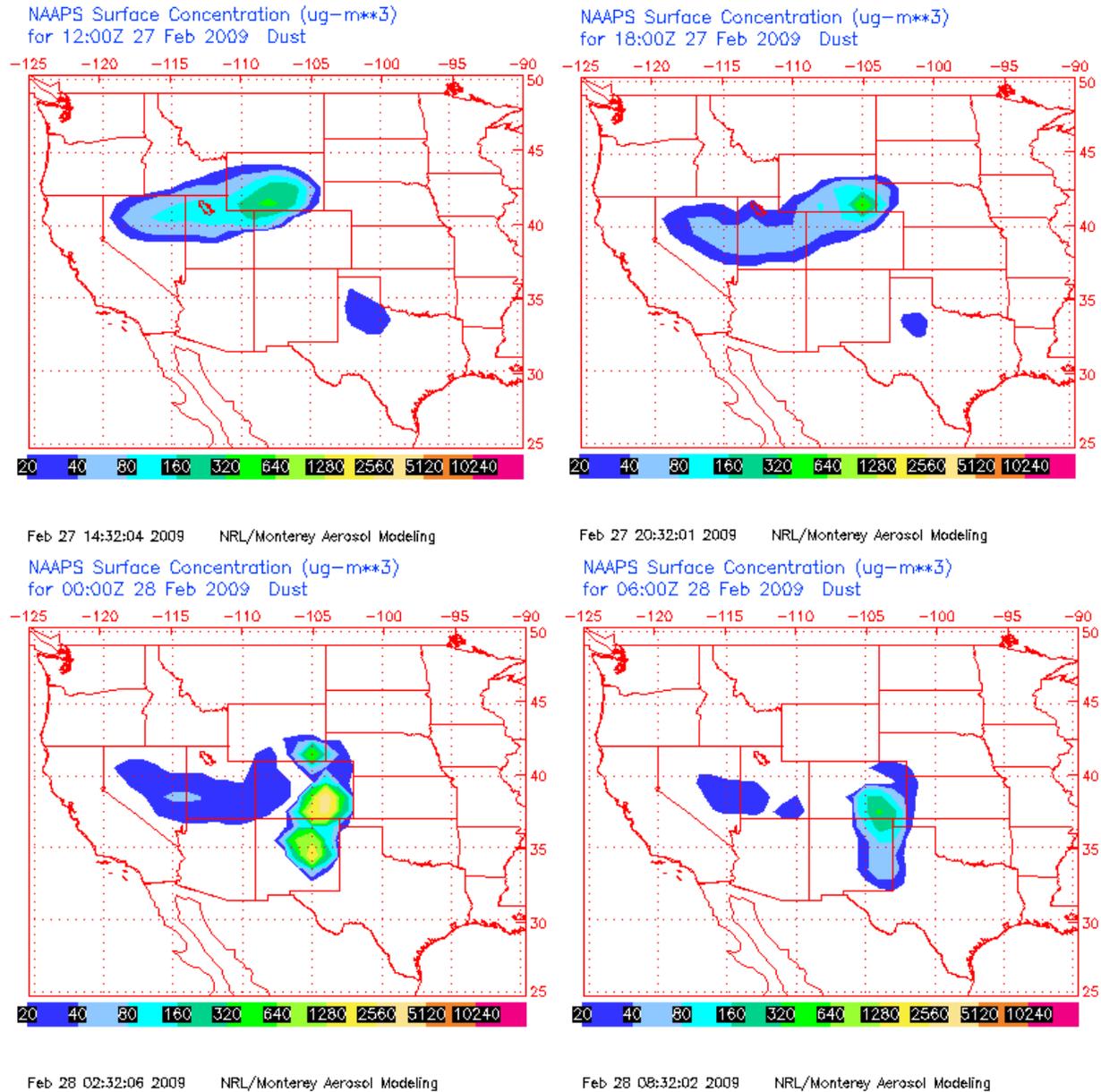


Figure 27. Forecast surface dust from NAAPS (Navy Aerosol Analysis and Prediction System) Global Aerosol Model for February 27, 2009 from the archives of the U.S. Navy NAAPS global aerosol forecast model (<http://www.nrlmry.navy.mil/aerosol/>).

### 3.0 Ambient Monitoring Data and Statistics

PM<sub>10</sub> 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<sub>10</sub> standard was a concentration of 198 µg/m<sup>3</sup> at the Durango River City Hall monitoring site. Monitored PM<sub>10</sub> 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<sub>10</sub> monitoring data in Durango and the surrounding area for the February 27, 2009 exceptional event. The PM<sub>10</sub> 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<sub>10</sub> Concentrations in Lamar” section), with the exception of Telluride and Steamboat Springs on March 2, 2009. Other PM<sub>10</sub> monitoring sites in southwest Colorado had elevated PM<sub>10</sub> concentrations above their typical historical concentrations on February 27, 2009 as explained in the “Historical Fluctuations of PM<sub>10</sub> Concentrations in Durango, Telluride, and Alamosa” section, but did not exceed the 24-hour NAAQS. Three other sites with moderately elevated PM<sub>10</sub> concentrations were Lamar Power Plant, Parachute, and Rifle with 47 µg/m<sup>3</sup>, 48 µg/m<sup>3</sup>, and 52 µg/m<sup>3</sup> respectively. All other Colorado sites recorded concentrations between 12 µg/m<sup>3</sup> and 34 µg/m<sup>3</sup> on February 27, 2009.

Table 14. PM<sub>10</sub> 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 µg/m <sup>3</sup>	9 µg/m <sup>3</sup>	13 µg/m <sup>3</sup>	AF*
02/25/2009	NA	NA	25 µg/m <sup>3</sup>	AF*
02/26/2009	NA	NA	14 µg/m <sup>3</sup>	AF*
02/27/2009	<b>198 µg/m<sup>3</sup></b>	<b>72 µg/m<sup>3</sup></b>	<b>49 µg/m<sup>3</sup></b>	<b>109 µg/m<sup>3</sup></b>
02/28/2009	NA	NA	16 µg/m <sup>3</sup>	AG**
03/01/2009	NA	NA	22 µg/m <sup>3</sup>	25 µg/m <sup>3</sup>
03/02/2009	32 µg/m <sup>3</sup>	102 µg/m <sup>3</sup>	25 µg/m <sup>3</sup>	30 µg/m <sup>3</sup>

\*AF is the null code for “Scheduled but not collected”

\*\*AG is the null code for “Sample time out of limits”

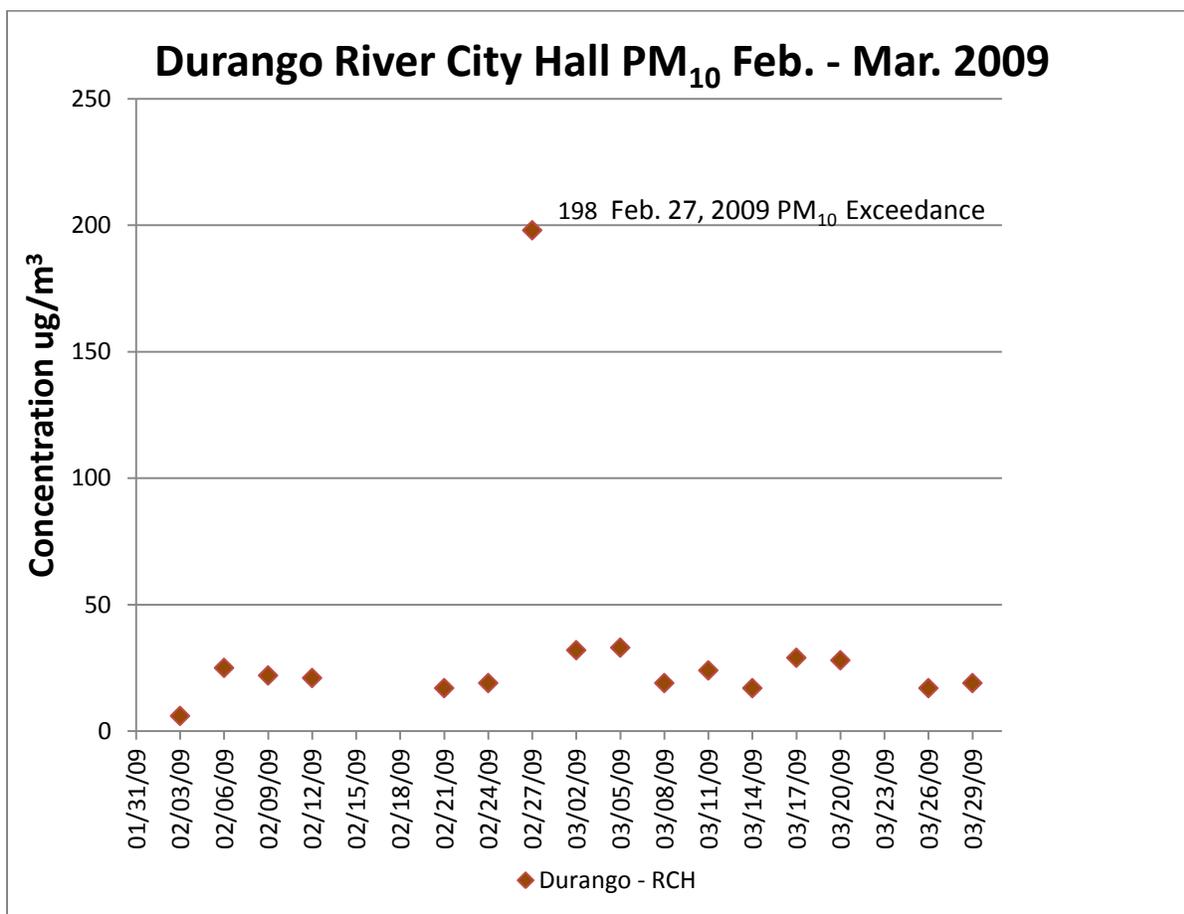


Figure 28. Durango River City Hall PM<sub>10</sub> February – March 2009.

Other than on February 27, 2009, the highest PM<sub>10</sub> concentration in the months of February and March 2009 in Durango was 33 µg/m<sup>3</sup>. February 27, 2009 at 198 µg/m<sup>3</sup> was clearly an extreme event in Durango. The PM<sub>10</sub> 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<sub>10</sub> concentrations that were much higher than normal for the winter two month period of interest. In other words, the concentration of 198 µg/m<sup>3</sup> 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<sub>10</sub> Concentrations” section.

The time series charts in Figures 29 – 31 show additional evidence that that the regional dust storm brought elevated PM<sub>10</sub> concentrations to other areas in southern Colorado on February 27, 2009.

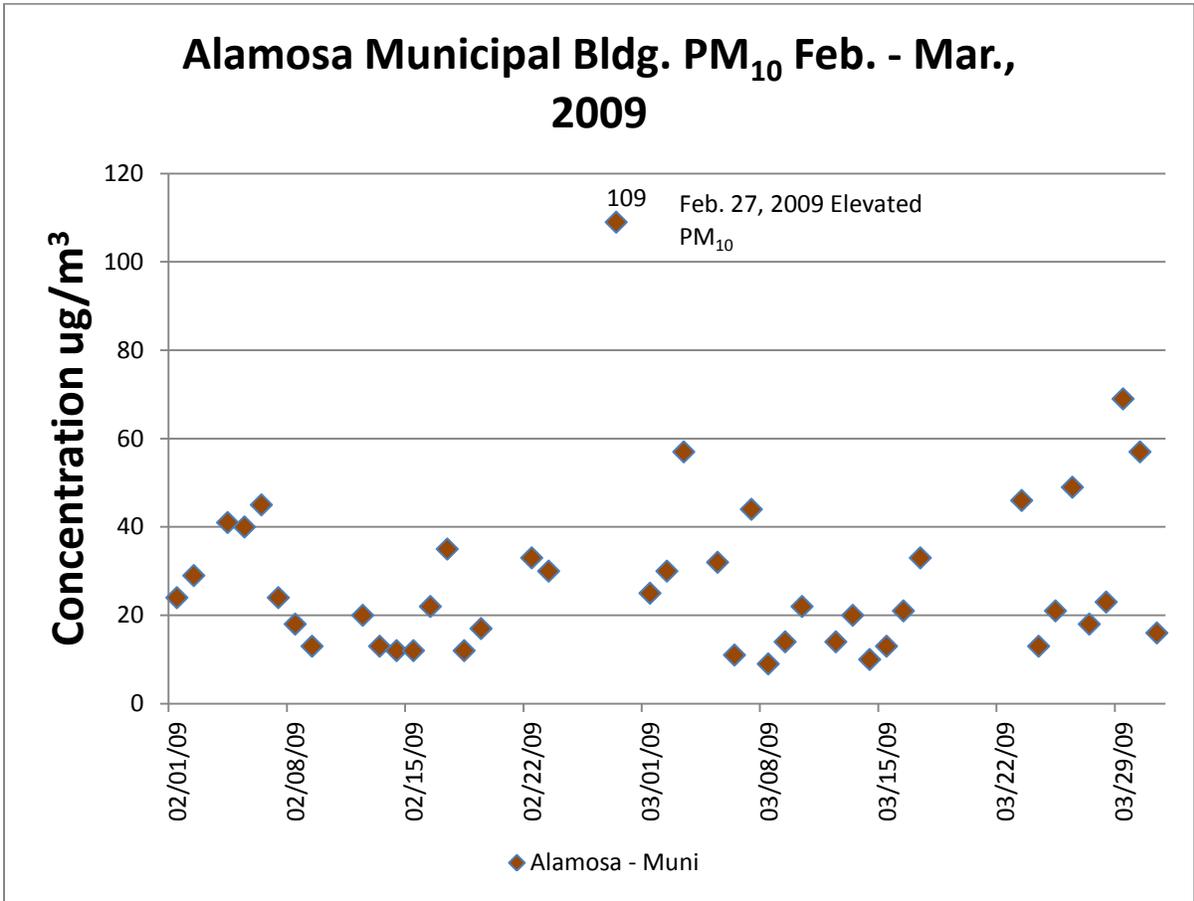


Figure 29. Alamosa Municipal Building PM<sub>10</sub> February – March 2009.

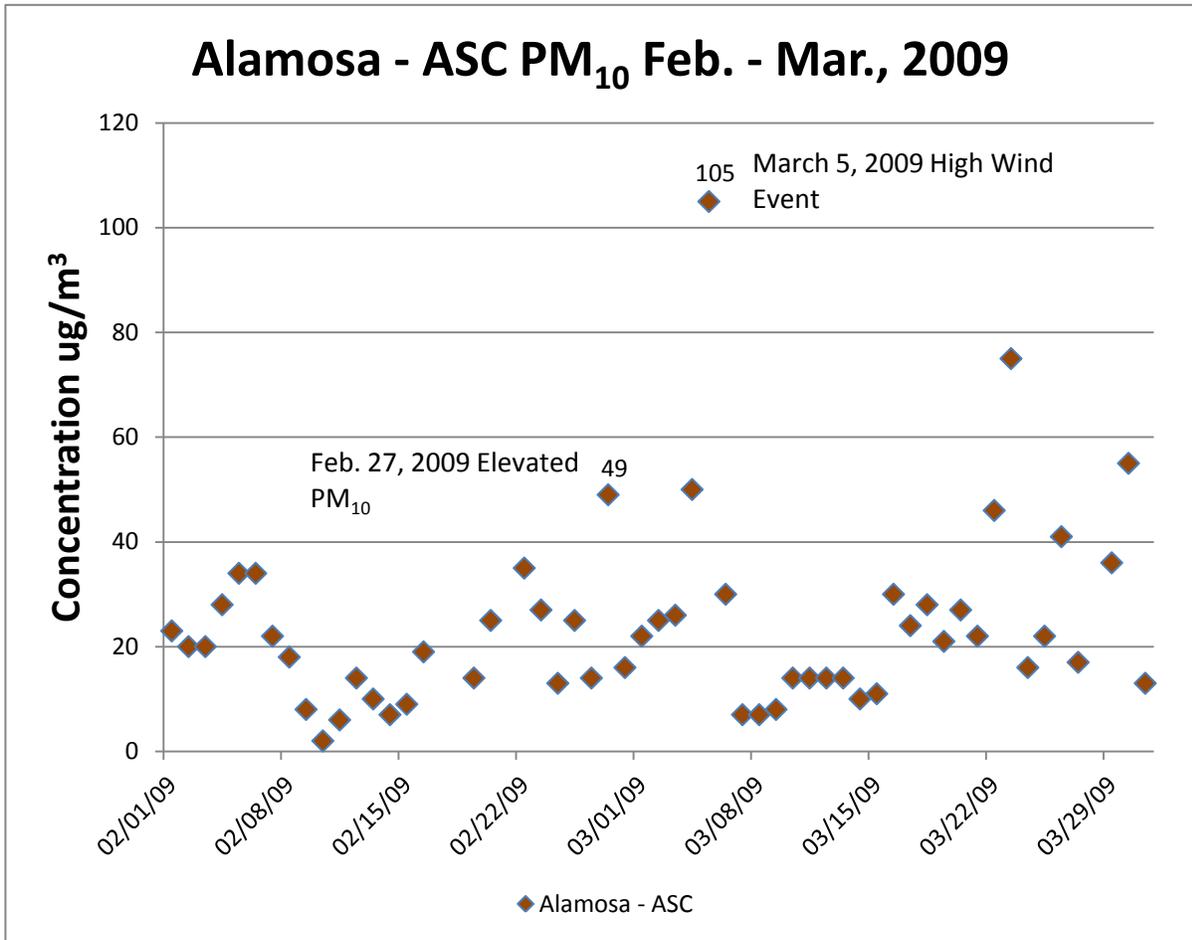


Figure 30. Alamosa – Adams State College PM<sub>10</sub> February – March 2009.

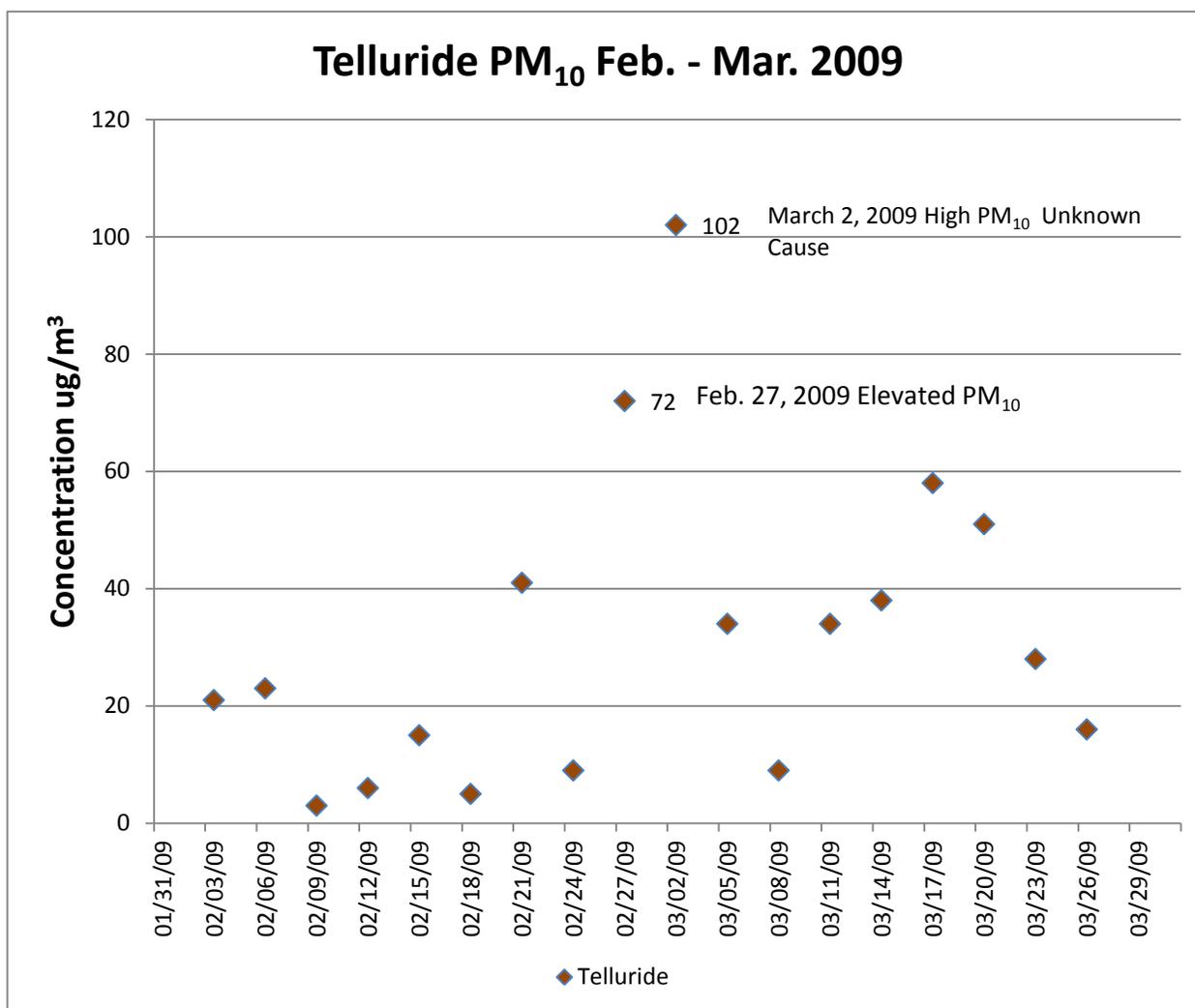


Figure 31. Telluride PM<sub>10</sub> February – March 2009.

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<sub>10</sub> 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<sub>10</sub> 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<sub>10</sub> network is very sparse in this area of Colorado. A more complete network of PM<sub>10</sub> monitors would most likely show more exceedances from this blowing dust event. The elevated concentrations of 72 µg/m<sup>3</sup> in Telluride and 109 µg/m<sup>3</sup> 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<sub>10</sub> Concentrations in Durango, Telluride, and Alamosa

This historical fluctuation evaluation of PM<sub>10</sub> monitoring data for sites affected by the February 27, 2009 event was made using valid samples from PM<sub>10</sub> samplers at Durango (080670004), Telluride

(081130004), Alamosa ASC (080030001), and Alamosa Muni (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  $\mu\text{g}/\text{m}^3$ . 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  $\mu\text{g}/\text{m}^3$ .

Table 15. PM<sub>10</sub> Monitoring Data Summary.

**Summary - entire dataset**

	<b>Durango</b>	<b>Telluride</b>	<b>Alamosa ASC</b>	<b>Alamosa Municipal</b>
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<sub>10</sub> levels at any particular site in Colorado do not necessarily fluctuate by season. Of greater importance affecting day-to-day, typical PM<sub>10</sub> 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<sub>10</sub> 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<sub>10</sub>.

<b>Site</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
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<sub>10</sub> 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<sup>th</sup> and 25<sup>th</sup> percentile). If a conservative approach is taken then a typical value should be no higher than the historic monthly 75<sup>th</sup> 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  $\mu\text{g}/\text{m}^3$ .

Table 17. February  $\text{PM}_{10}$  Monitoring Data Summary  
**Summary – all February Samples**

	<b>Durango</b>	<b>Telluride</b>	<b>Alamosa ASC</b>	<b>Alamosa Municipal</b>
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  $\text{PM}_{10}$  sample on February 27, 2009 at Durango of  $198 \mu\text{g}/\text{m}^3$  exceeds the 99<sup>th</sup> percentile value ( $111 \mu\text{g}/\text{m}^3$ ) for all February data, exceeds the 99<sup>th</sup> percentile value ( $180 \mu\text{g}/\text{m}^3$ ) for all 2009 data, and exceeds the 99<sup>th</sup> percentile value ( $56 \mu\text{g}/\text{m}^3$ ) 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<sup>th</sup> percentile sample value for this site for all samples. The one sample in the entire data set greater than this value is  $203 \mu\text{g}/\text{m}^3$  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 23 and 33 graphically characterize the Durango  $\text{PM}_{10}$  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  $25 \mu\text{g}/\text{m}^3$  and over 90% of the samples are less than  $30 \mu\text{g}/\text{m}^3$ .

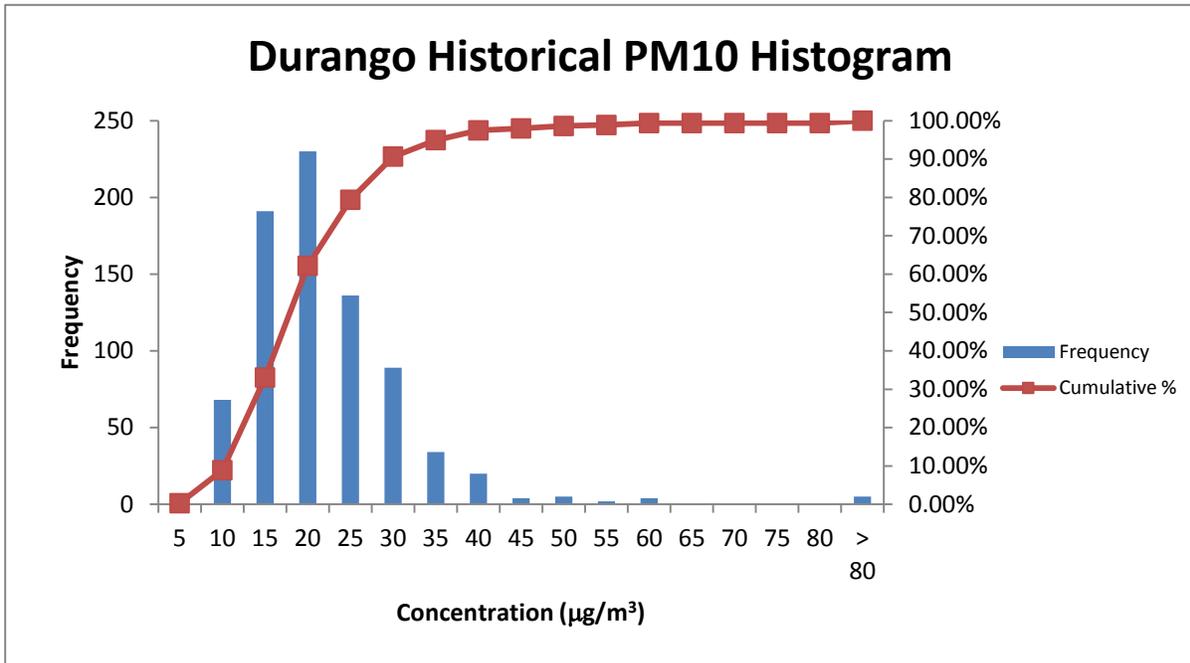
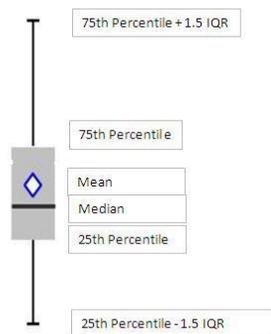


Figure 32. Durango Historical PM<sub>10</sub> Histogram

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 dataset, 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<sup>3</sup>. Only one month (April) experienced a value greater than on the event day. All the box plot features in this evaluation can be identified with the following legend:



Where:

1Q is the 25<sup>th</sup> percentile;

3Q is the 75<sup>th</sup> percentile value; and

IQR is the interquartile range or the range of the middle 50% of a distribution (75<sup>th</sup> percentile value – 25<sup>th</sup> percentile value).

Additionally there are two types of outliers identified in these plots: outliers greater than  $3Q + 1.5 \cdot IQR$  and outliers greater than  $3Q + 3 \cdot IQR$ . 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.

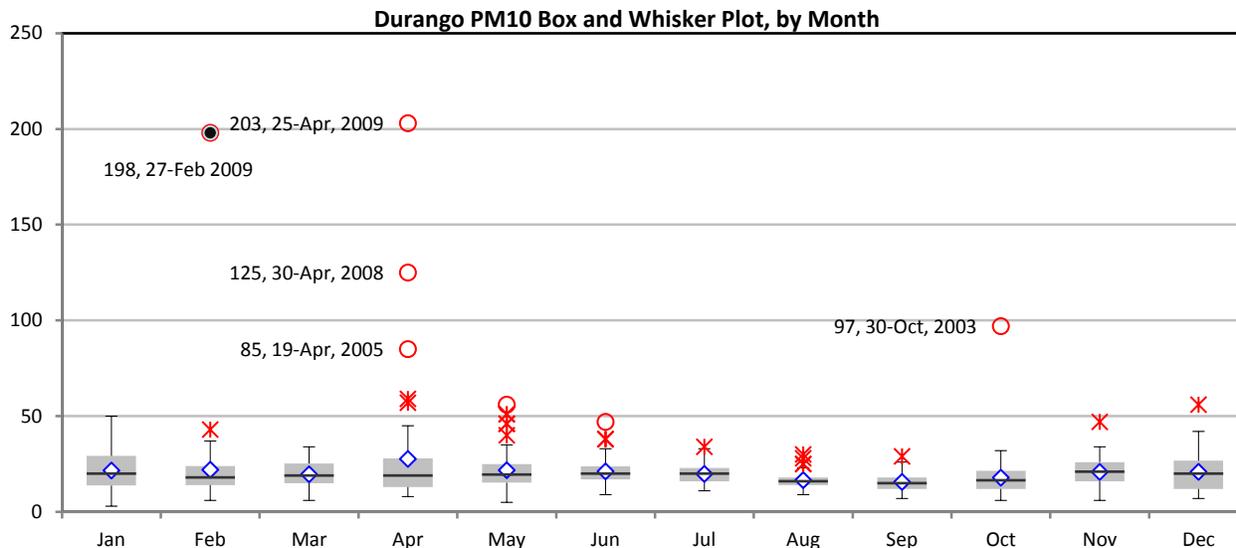


Figure 33. Durango PM<sub>10</sub> Box and Whisker Plot by Month.

### Telluride – 080990002

The PM<sub>10</sub> sample on February 27, 2009 at Telluride of 72 µg/m<sup>3</sup> exceeds the 90<sup>th</sup> percentile value (64 µg/m<sup>3</sup>) for all February data, exceeds the 95<sup>th</sup> percentile value (40 µg/m<sup>3</sup>) for all 2009 data, and exceeds the 96<sup>th</sup> percentile value for the entire Telluride dataset. Overall, this sample is the 20<sup>th</sup> highest sample in any February (of 307 samples), the third highest sample in 2009 (of 114 samples), and exceeds the 96<sup>th</sup> 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 34 – 36 graphically characterize the Telluride PM<sub>10</sub> data. Figure 34 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<sup>3</sup> and it is not until a concentration of 50 µg/m<sup>3</sup> that we see 90% of the samples. This would seem to indicate that Telluride has historically experienced higher PM<sub>10</sub> concentrations from local sources.

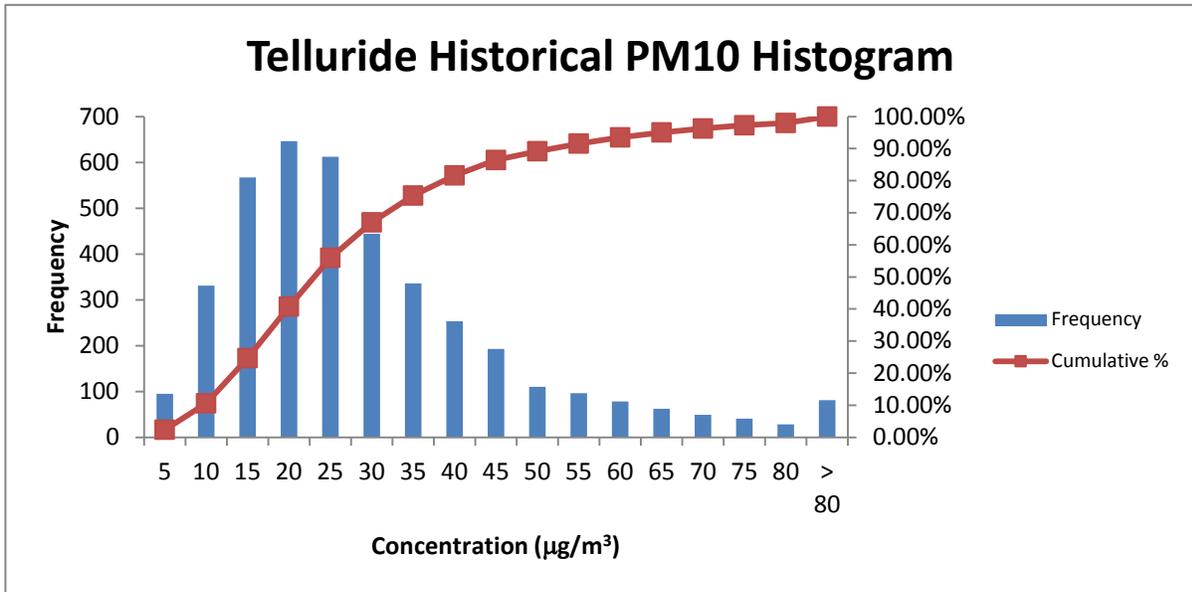


Figure 34. Telluride Historical PM<sub>10</sub> Histogram.

Figure 35. 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.

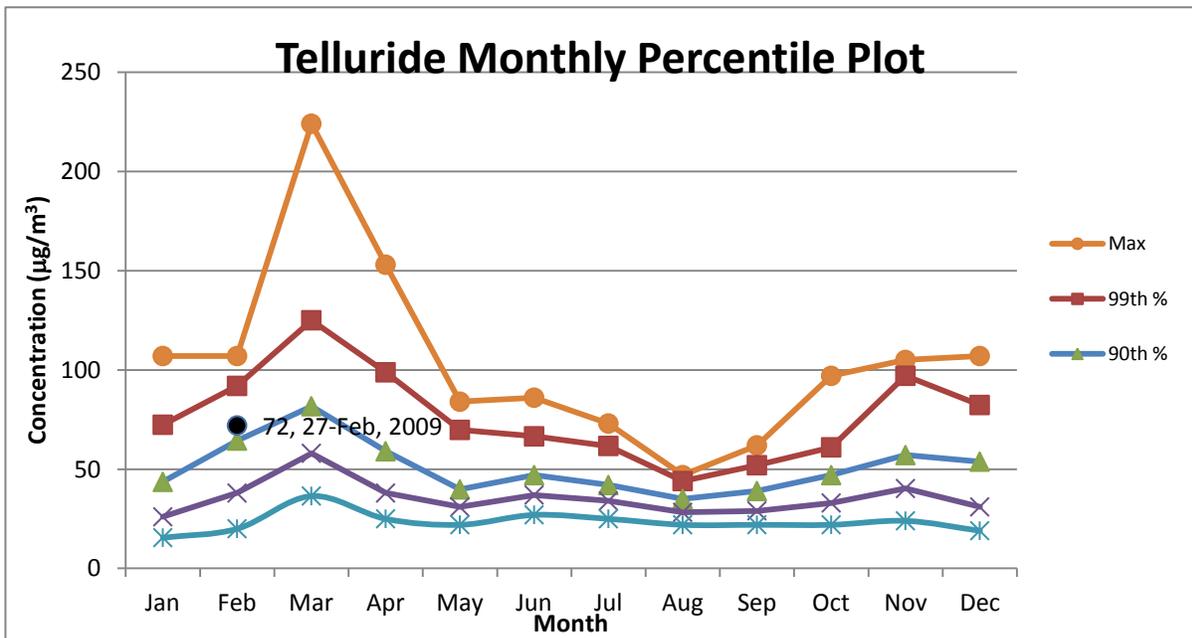


Figure 35. Telluride Monthly Percentile Plot.

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<sub>10</sub> sites in Colorado. The nature of the association suggests that typically a large portion of PM<sub>10</sub> 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

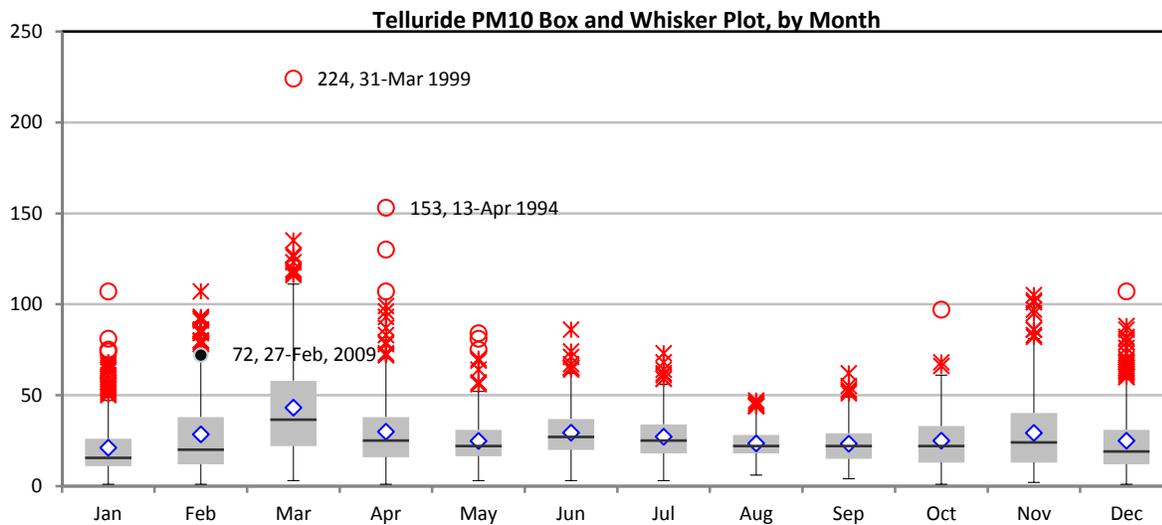


Figure 36. Telluride PM<sub>10</sub> Box and Whisker Plot by Month.

Figure 36 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<sub>10</sub> sample on February 27, 2009 at Alamosa Adams State College of 49 µg/m<sup>3</sup> is the 90<sup>th</sup> percentile value for all February data, exceeds the 95<sup>th</sup> percentile value (44 µg/m<sup>3</sup>) for all 2009 data, and exceeds the 94<sup>th</sup> 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 37 – 39 graphically characterize the Alamosa Adams State College PM<sub>10</sub> data.

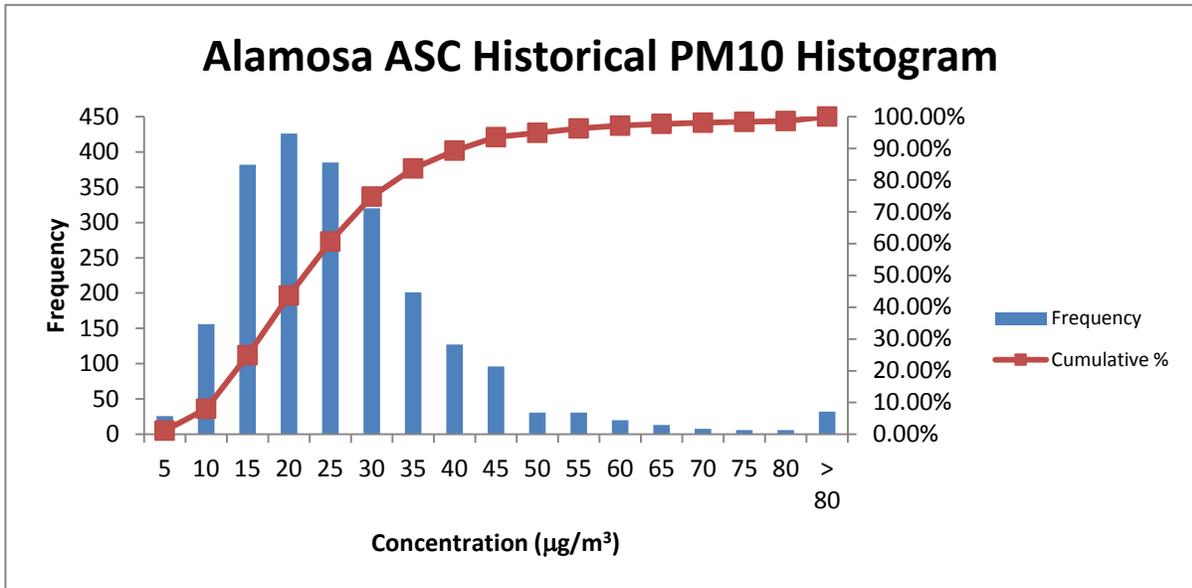


Figure 37. Alamosa Adams State College Historical PM<sub>10</sub> Histogram.

As with the other histograms in this analysis, the Alamosa Adams State College histogram in Figure 37 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<sup>3</sup> and it is not until we exceed 40 µg/m<sup>3</sup> do we see 90% of the samples.

The monthly percentile plot in Figure 38 highlights the consistency of the majority of data from month to month and features the generally higher medians in the winter and early spring.

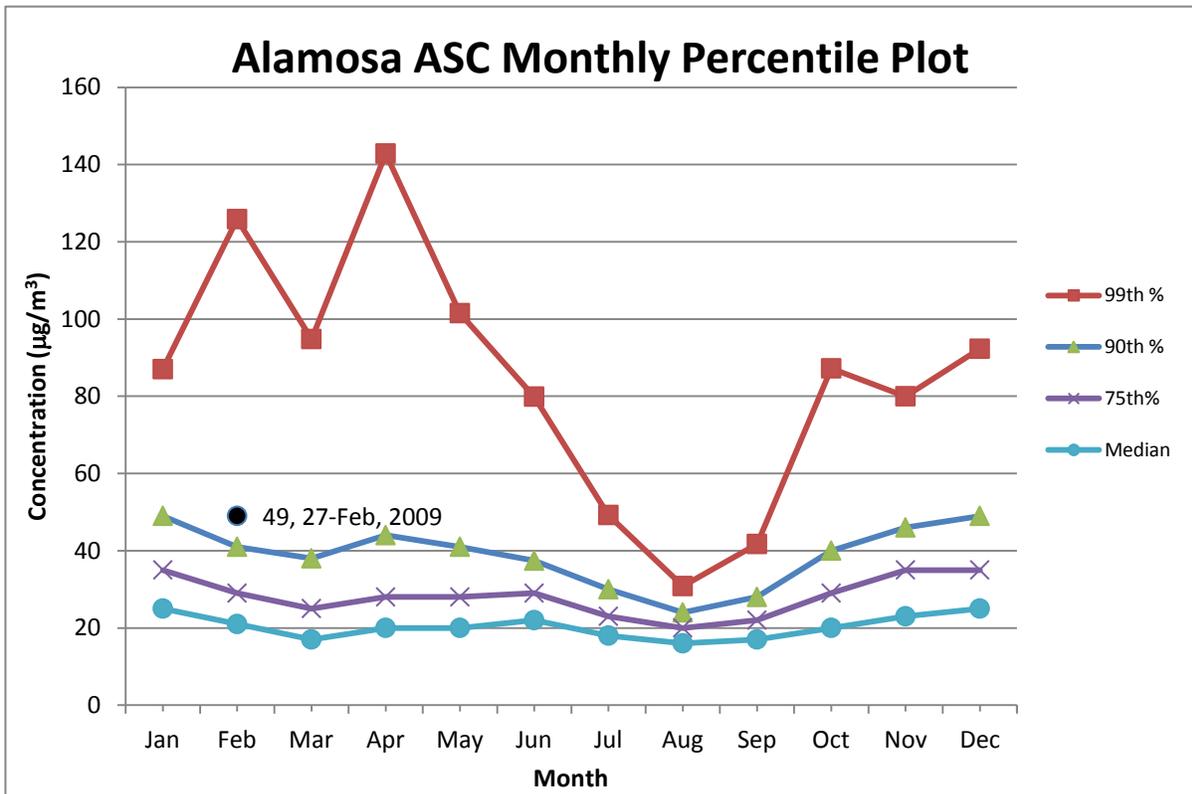


Figure 38. Alamosa Adams State College Monthly Percentile Plot.

The plot in Figure 38 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 90<sup>th</sup> percentile value for February.

The monthly box-whisker plot in Figure 39 highlights the consistency of the majority of data from month to month. Note the greater variability (wider inner-quartile range) 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 dataset 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  $\mu\text{g}/\text{m}^3$  on 10 Feb, 2006 and 158  $\mu\text{g}/\text{m}^3$  15 Feb, 2006) and the APCD did not flag the 2007 event (473  $\mu\text{g}/\text{m}^3$  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.

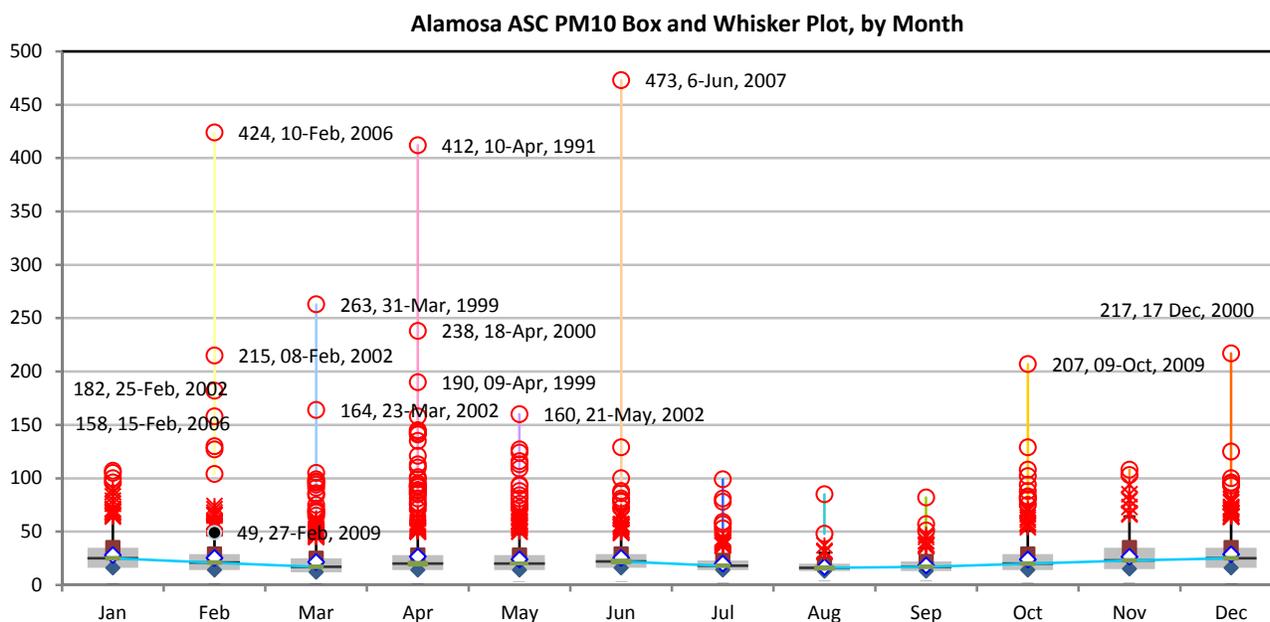


Figure 39. Alamosa Adams State College PM<sub>10</sub> Box and Whisker Plot by Month.

### Alamosa Municipal – 080030003

The PM<sub>10</sub> sample on February 27, 2009 at Alamosa Municipal of 109  $\mu\text{g}/\text{m}^3$  is the 99<sup>th</sup> percentile value for all February data, exceeds the 99<sup>th</sup> percentile value for all 2009 data, and exceeds the 99<sup>th</sup> 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 40 – 42 graphically characterize the Alamosa Municipal PM<sub>10</sub> data.

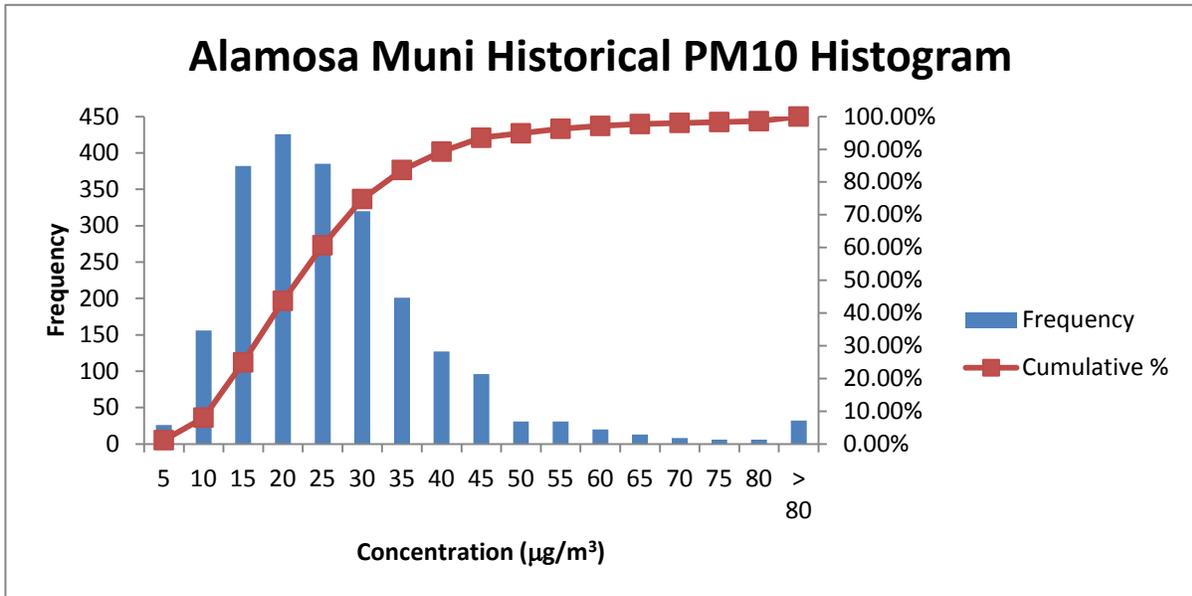


Figure 40. Alamosa Municipal PM<sub>10</sub> Histogram.

As with the other histograms in this analysis, the Alamosa Municipal histogram in Figure 40 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<sup>3</sup> and it is not until we exceed 41 µg/m<sup>3</sup> that we see 90% of the samples.

The monthly percentile plot in Figure 41 highlights the consistency of the majority of data from month to month and features the generally higher medians in the winter and early spring.

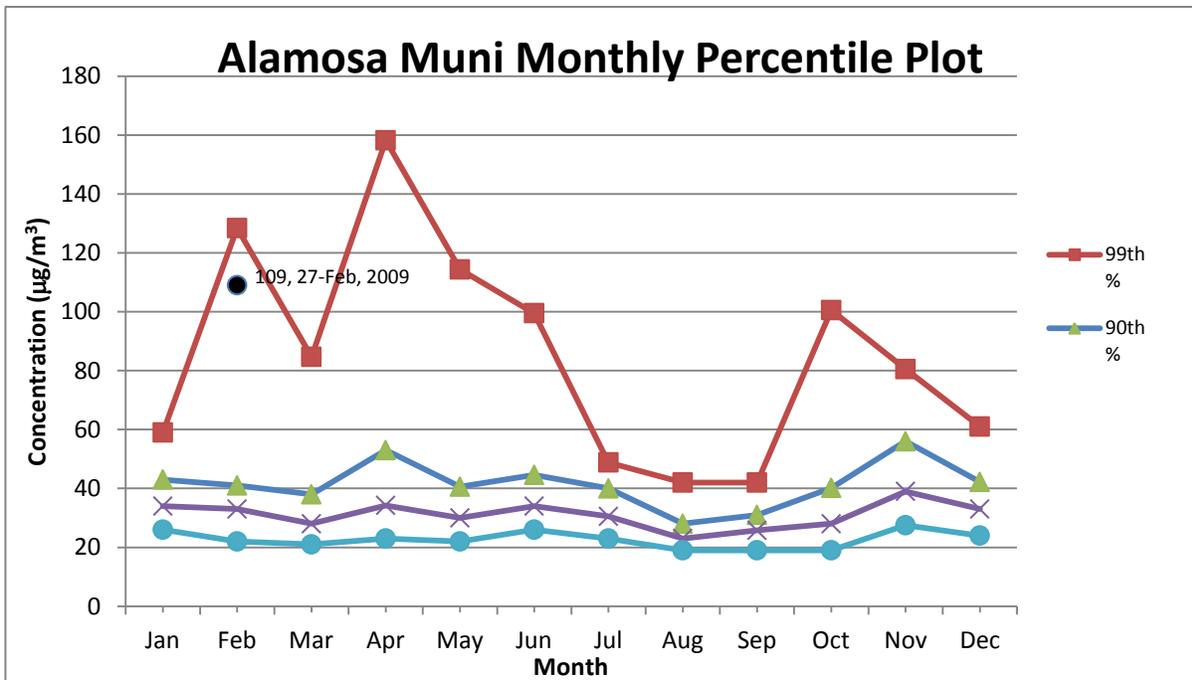


Figure 41. Alamosa Municipal Monthly Percentile Plot.

The plot in Figure 41 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 42 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 dataset 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.

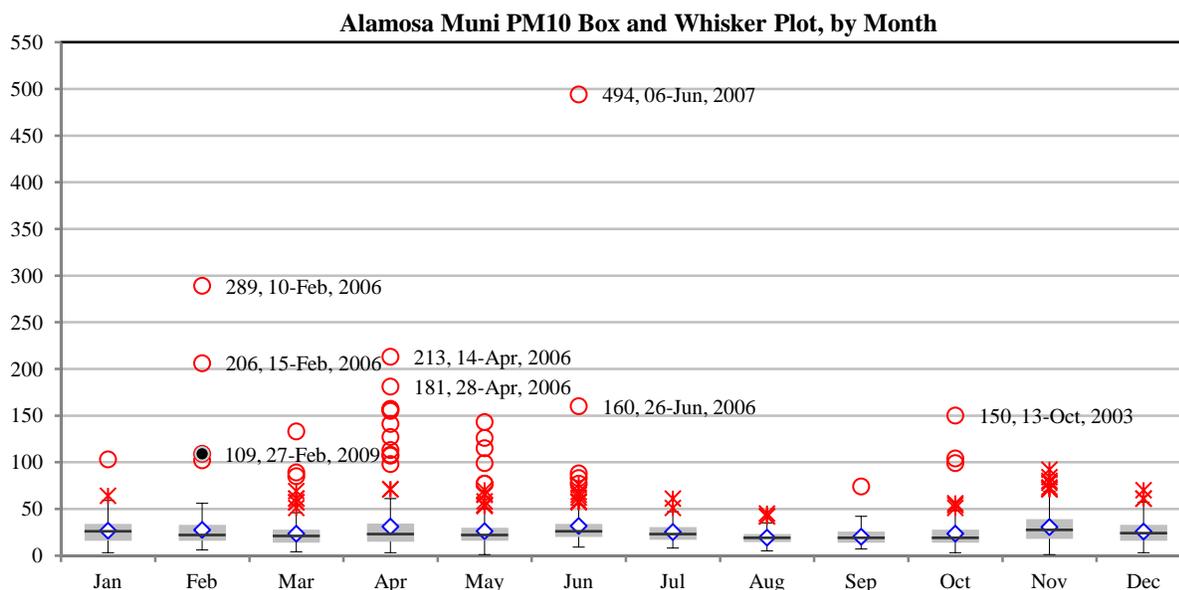


Figure 42. Alamosa Municipal PM<sub>10</sub> Box and Whisker Plot by Month.

### No Exceedance But For the Event

An estimation of PM<sub>10</sub> 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<sup>3</sup> corresponding to the 75<sup>th</sup> and 84<sup>th</sup> percentile values. Using these conservative values as ‘typical’ would indicate that the regional wind-blown dust event provided an additional 170 – 174 µg/m<sup>3</sup> 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<sub>10</sub> NAAQS in Durango and the elevated PM<sub>10</sub> concentrations in Alamosa would not have occurred.

Site	Event Day Concentration (µg/m <sup>3</sup> )	2009 Median (µg/m <sup>3</sup> )	2009 Average (µg/m <sup>3</sup> )	2009 75 <sup>th</sup> % (µg/m <sup>3</sup> )	2009 84 <sup>th</sup> % (µg/m <sup>3</sup> )	Est. Conc. Above Typical (µg/m <sup>3</sup> )
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

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### 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. /Photo by Stephen Eginore

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."

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."



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 Eginore

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.

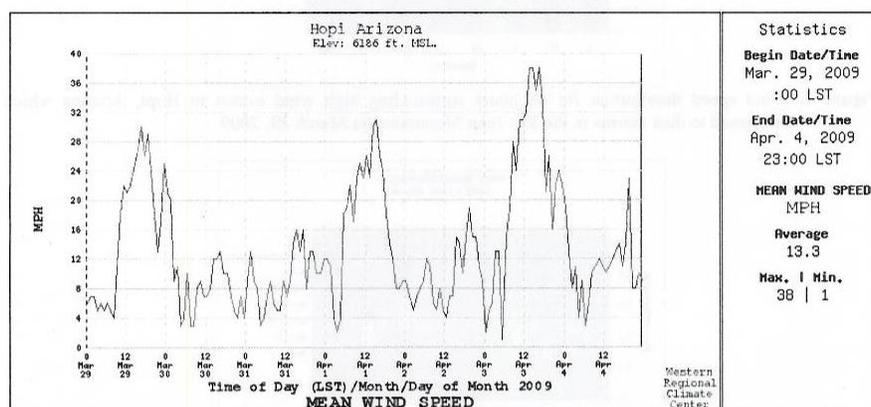


Figure 3. Time series graph of hourly mean wind speed in Hopi, Arizona for March 29, 2009 through April 4, 2009

#### 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 HYSPLIT 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.

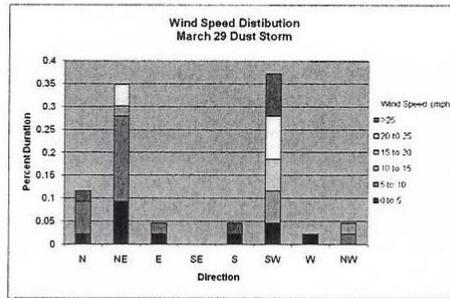


Figure 4. Wind speed distribution for 48 hours surrounding high wind events in Hopi, Arizona which correspond to dust storms in the San Juan Mountains on March 29, 2009

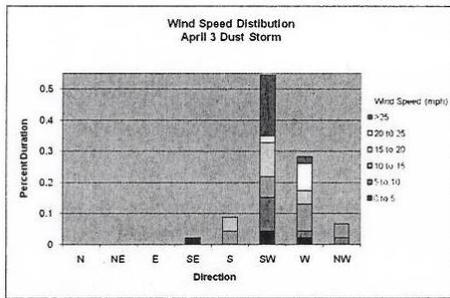


Figure 5. Wind speed distribution for 48 hours surrounding high wind events in Hopi, Arizona which correspond to dust storms in the San Juan Mountains on April 3, 2009

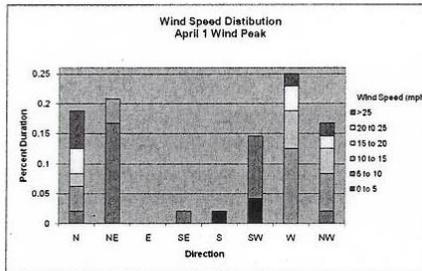
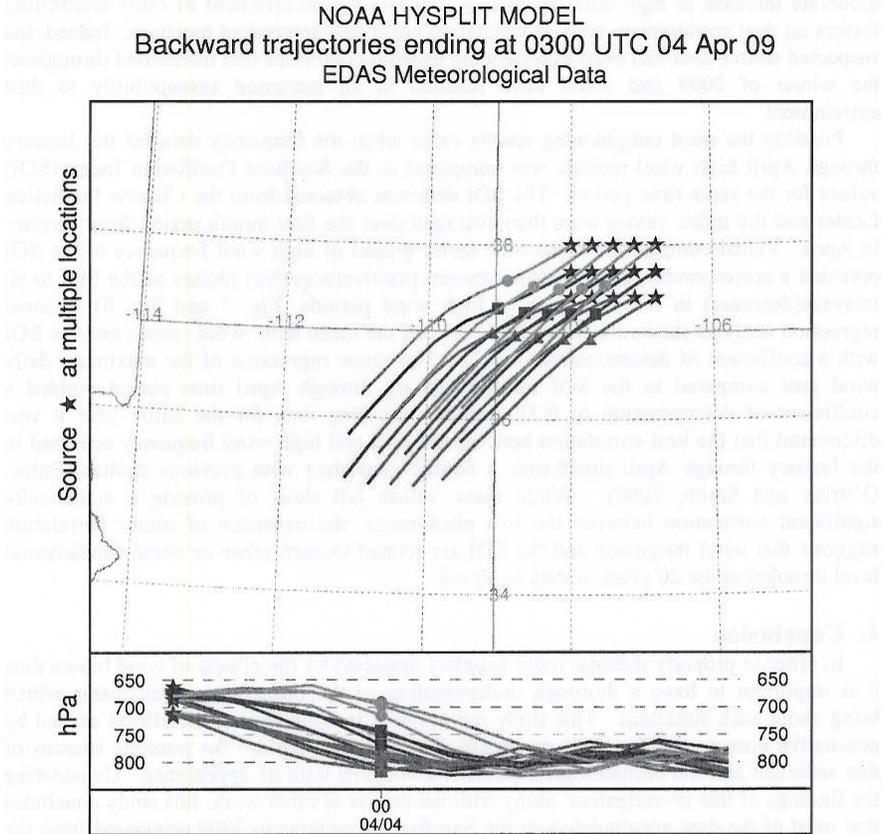


Figure 6. Wind speed distribution for 48 hours surrounding high wind event in Hopi, Arizona not corresponding to a dust storm in the San Juan Mountains on April 1, 2009

#### 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.

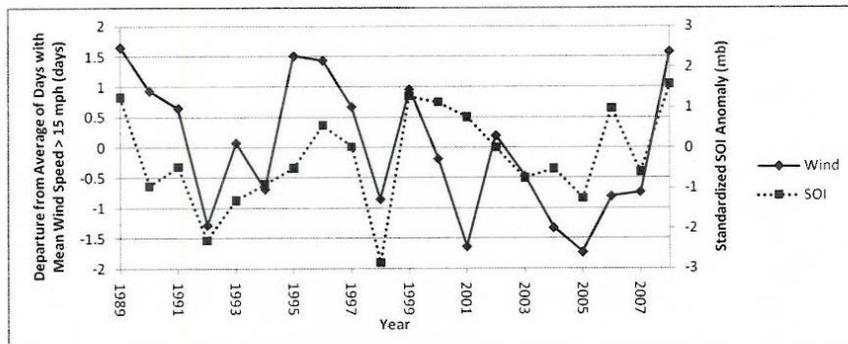


Figure 8. Mean daily wind speed frequency vs. Southern Oscillation Index from January through April for 42 RAWS in AZ, NV, UT and western NM

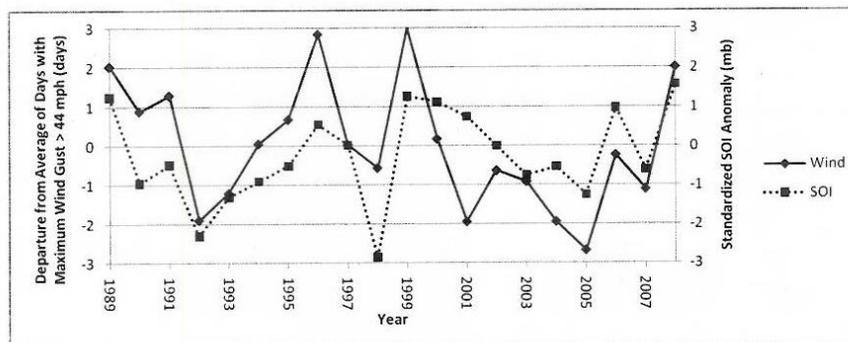


Figure 9. Maximum daily wind gust frequency vs. Southern Oscillation Index from January through April for 42 RAWS in AZ, NV, UT and western NM

### 5. References

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Painter, T. H., A. P. Barrett, C. C. Landry, J. C. Neff, M. P. Cassidy, C. R. Lawrence, K. E. McBride, and G. L. Farmer, (2007), Impact of disturbed desert soils on duration of mountain snow cover, *Geophys. Res. Lett.*, 34, L12502, doi:10.1029/2007GL030284.

## 5.0 Local Dust Control

### **Local Dust Control Measures in La Plata County and the City of Durango**

The City of Durango and La Plata County 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<sub>10</sub> 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). 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 annually. The County typically begins application of MgCl 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. 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 landfill is privately owned and operated by WCA Waste Corporation.

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 has a fugitive dust emission control plan enforced by the Southern Ute Indian Tribe.

#### *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 than 100 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<sub>10</sub> 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<sub>10</sub> 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<sub>10</sub> emission reductions:

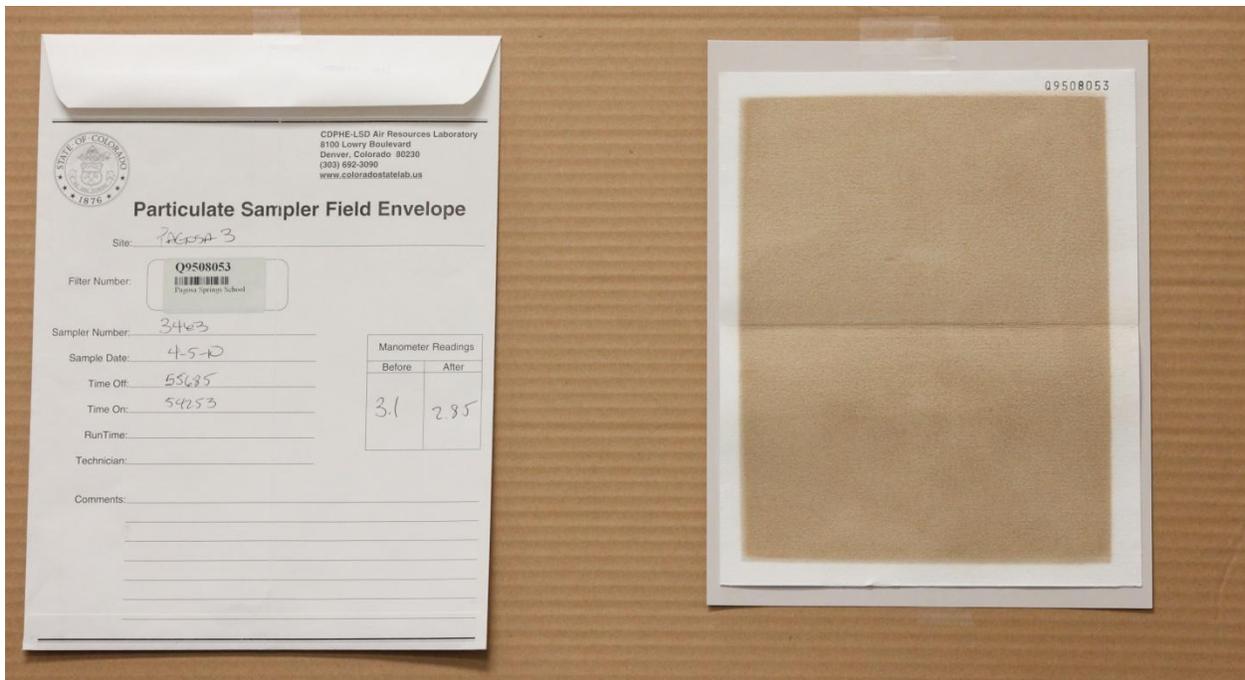
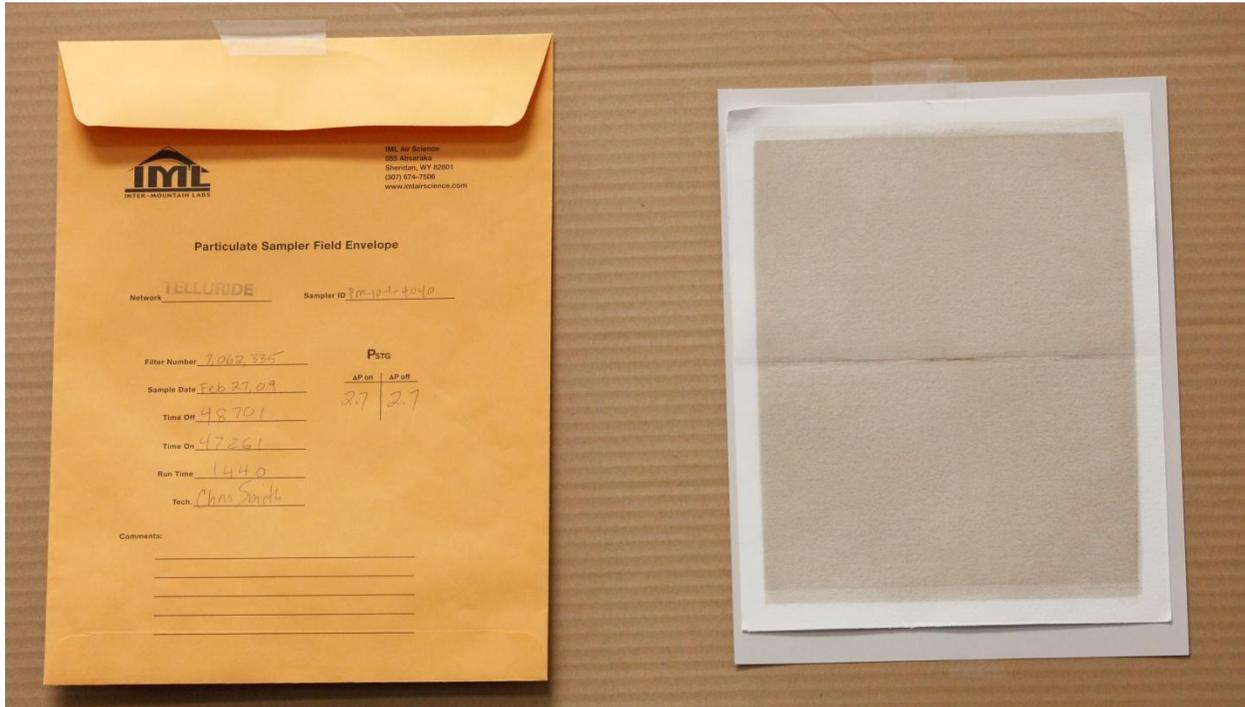
- All developed vehicular traffic areas, driveways, on-site parking areas, and off-site parking districts are required to be properly graded for drainage and surfaced with concrete, asphaltic concrete, or any other dust-free surface materials, and maintained in good condition, free of weeds, dust, trash, 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))

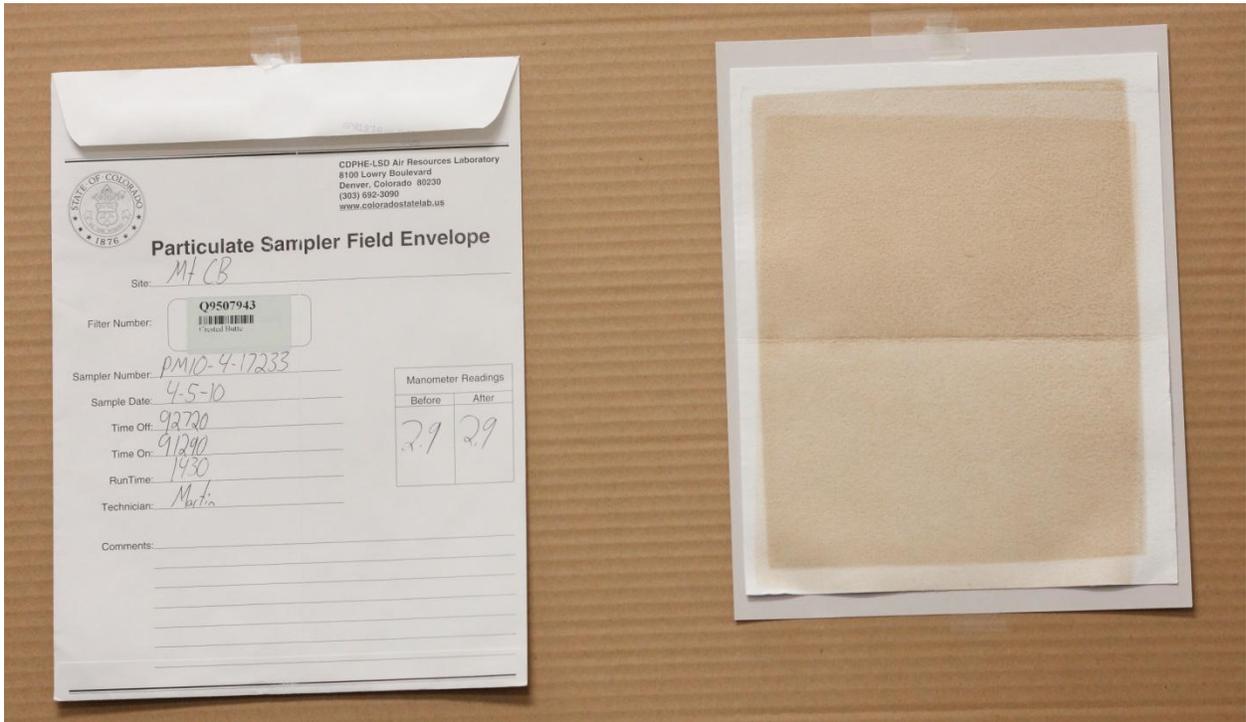
- All work in the public right-of-way shall control dust and debris and promptly remove dirt and material deposited on roadways (Ord. No. 2000-10, § 1, 5-2-00)
- All planned residential districts must comply with dust ordinances and not be objectionable due to dust emissions (Ord. No. 6-2-1 (a)(4))

The La Plata County Land Use Code (LPLUC) (excluding the Southern Ute Indian Reservation) contains a number of significant ordinances that result in PM<sub>10</sub> 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))

## 6.0 Laboratory and Field Data





STATE OF COLORADO  
1876

CDPHE-LSD Air Resources Laboratory  
8100 Lowry Boulevard  
Denver, Colorado 80230  
(303) 692-3090  
www.coloradostatelab.us

### Particulate Sampler Field Envelope

Site: MFCB

Filter Number: Q9507943  
Product Photo

Sampler Number: PM10-4-17233

Sample Date: 4-5-10

Time Off: 9:27:00

Time On: 9:29:00

Run Time: 1:30

Technician: Martin

Comments:

Manometer Readings	
Before	After
<u>2.9</u>	<u>2.9</u>



STATE OF COLORADO  
1876

CDPHE-LSD Air Resources Laboratory  
8100 Lowry Boulevard  
Denver, Colorado 80230  
(303) 692-3090  
www.coloradostatelab.us

### Particulate Sampler Field Envelope

Site: DELTA

Filter Number: Q8064292  
Delta County Health

Sampler Number: PM-10-1-19142

Sample Date: APR 5 2010

Time Off: 8:72:00

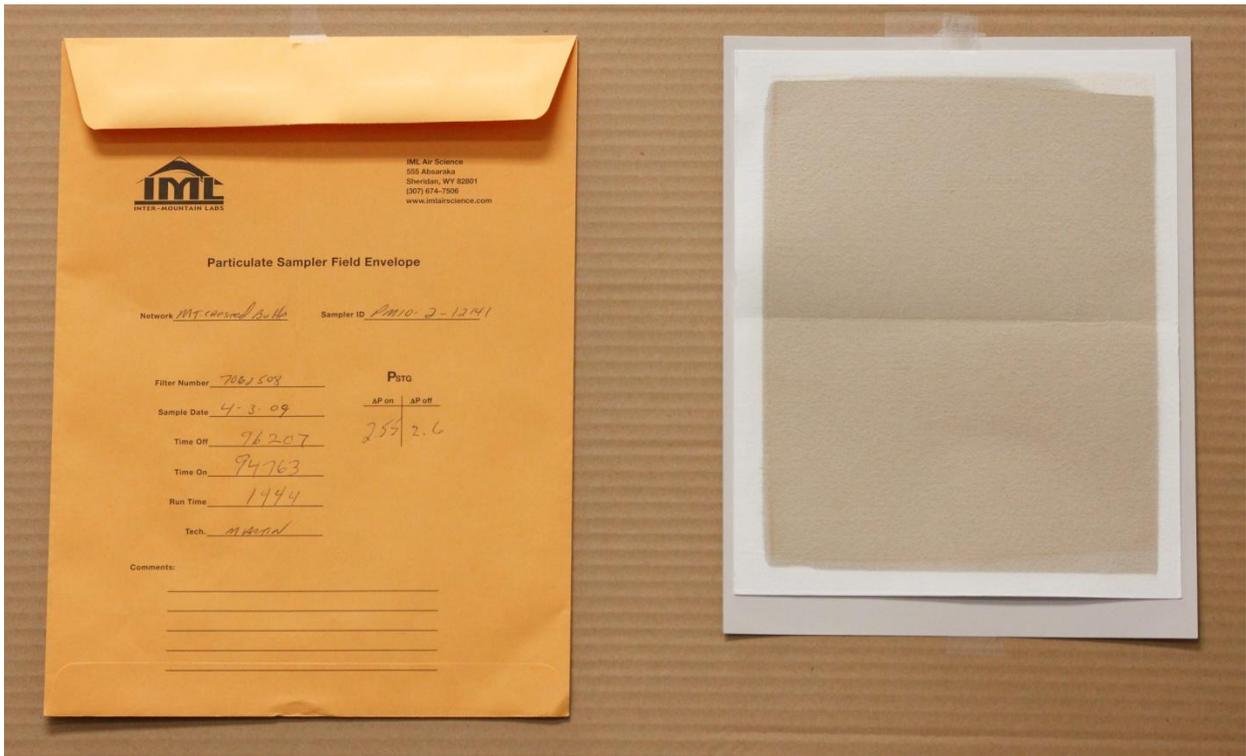
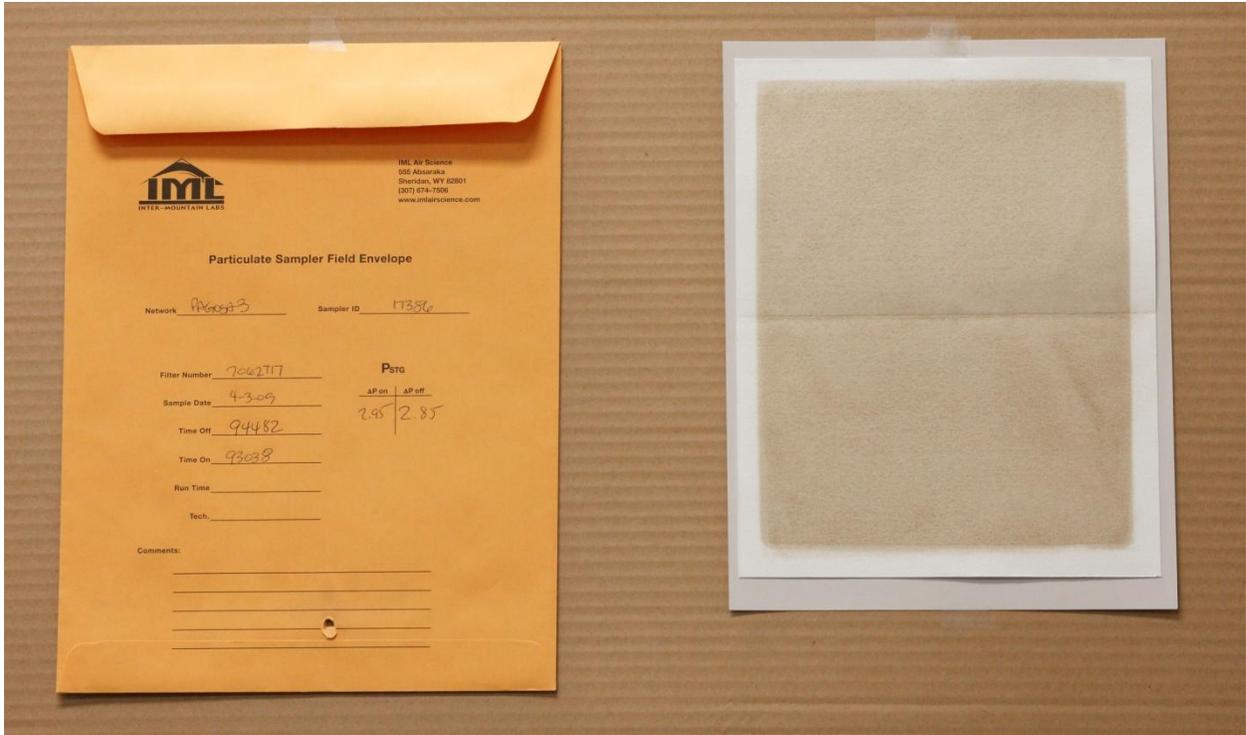
Time On: 8:58:28

Run Time: 14:32

Technician: Larry Hudnell

Comments: Dust storm 4-5-10

Manometer Readings	
Before	After
<u>3.20</u>	<u>3.60</u>



CO  
4/19

22



IML Air Science  
555 Alvarado  
Sheridan, WY 82801  
(307) 674-7506  
www.interairscience.com

**Particulate Sampler Field Envelope**

Network Alamosa - ASC Sampler ID 7062-364

Filter Number 7062, 364

Sample Date 4/19/08

Time Off 18:40

Time On 17:30

Run Time 1:10

Tech M. Kelly

Comments:

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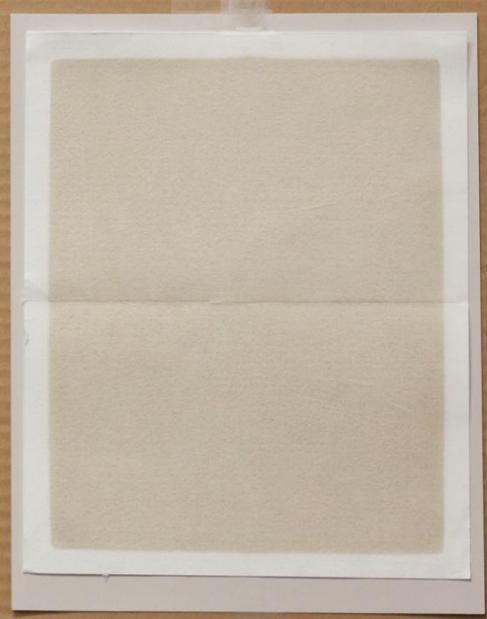
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## 7.0 Summary and Conclusions

*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 February 26, 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.

## 8.0 References

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

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

Rolph, G.D., 2012. Real-time Environmental Applications and Display sYstem (READY) Website (<http://ready.arl.noaa.gov>). NOAA Air Resources Laboratory, Silver Spring, MD.

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

United States Environmental Protection Agency, May 2, 2011, draft *Guidance on the Preparation of Demonstrations in Support of Requests to Exclude Ambient Air Quality Data Affected by High Winds under the Exceptional Events Rule*.

## Attachment A

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

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.REV WATCHES/WARNINGS/ADVISORIES...

NV...NONE.

CA...NONE.

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[HTTP://WEATHER.GOV/RENO](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

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.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

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...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](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

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.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.

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

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.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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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 WCNTL 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

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.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

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.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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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](http://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...WIND ADVISORY UNTIL 7 PM PST THIS EVENING FOR NVZ003.

LAKE WIND ADVISORY UNTIL 7 PM PST THIS EVENING FOR NVZ004.

CA...NONE.

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[HTTP://WEATHER.GOV/RENO](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

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.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.

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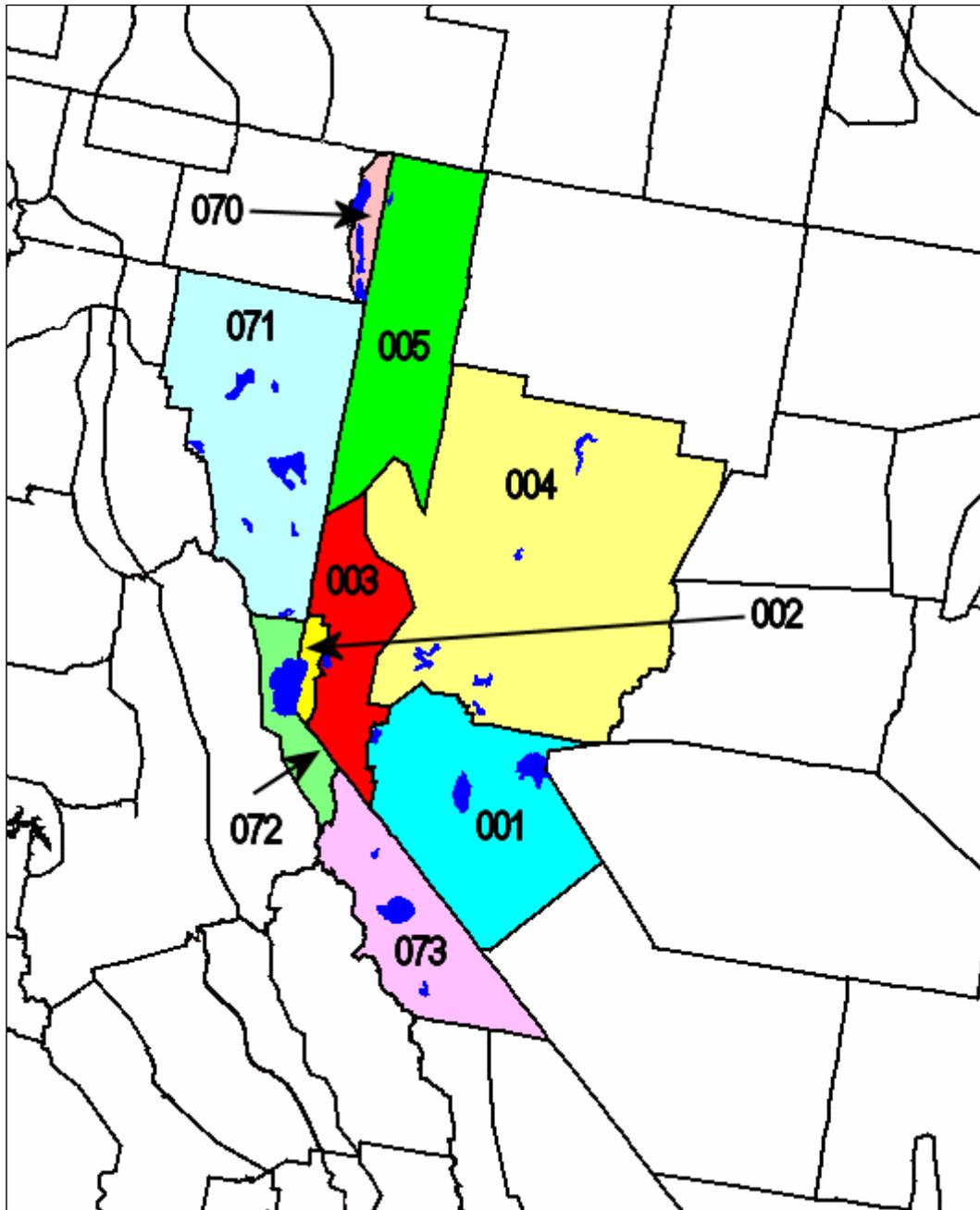
NV...LAKE WIND ADVISORY UNTIL 7 PM PST THIS EVENING FOR NVZ004.

WIND ADVISORY UNTIL 7 PM PST THIS EVENING FOR NVZ003.

CA...&&

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NWS Reno, Nevada Forecast Office Forecast Zones