18 HIGH WIND EXCEPTIONAL EVENT: May 9, 2011

18.1 Summary of Event

The passing of a Pacific cold front caused high winds and blowing dust in Doña Ana and Luna Counties resulting in exceedances of the PM_{10} and $PM_{2.5}$ 24-hour NAAQS and the $PM_{2.5}$ annual NAAQS at the Anthony, Chaparral, Deming Airport, and SPCY monitoring sites on this date. The FEM TEOM continuous monitors at these sites recorded 24-hour average concentrations of 269, 233, 263, and 337 µg/m^3, respectively. The FRM Wedding monitors at these sites recorded a 24-hour average concentration of 140 and 134 µg/m^3 at Anthony and SPCY sites. The FRM $PM_{2.5}$ Partisol monitor at SPCY recorded a 24-hour average of 39.5 µg/m^3. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were measured at Deming (263 µg/m^3), Desert View (130 µg/m^3), and Holman (135 µg/m^3) sites (Figure 18-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event. Elevated concentrations were also recorded by the $PM_{2.5}$ non-FEM/FRM TEOMs (Figure 18-2).

As the event unfolded, the wind blew from the west-southwest throughout the border region. These high velocity winds passed over large areas of desert within Texas, New Mexico and Mexico. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

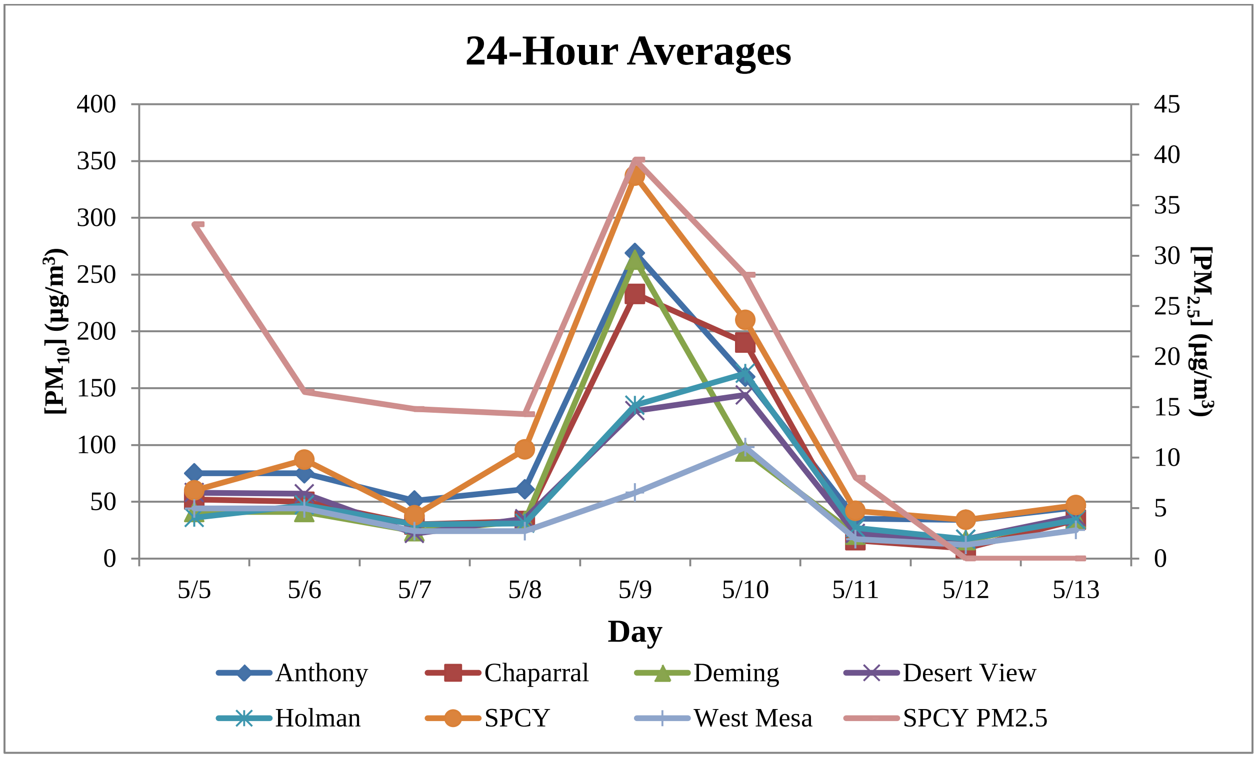

Figure 18-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after May 9, 2011.

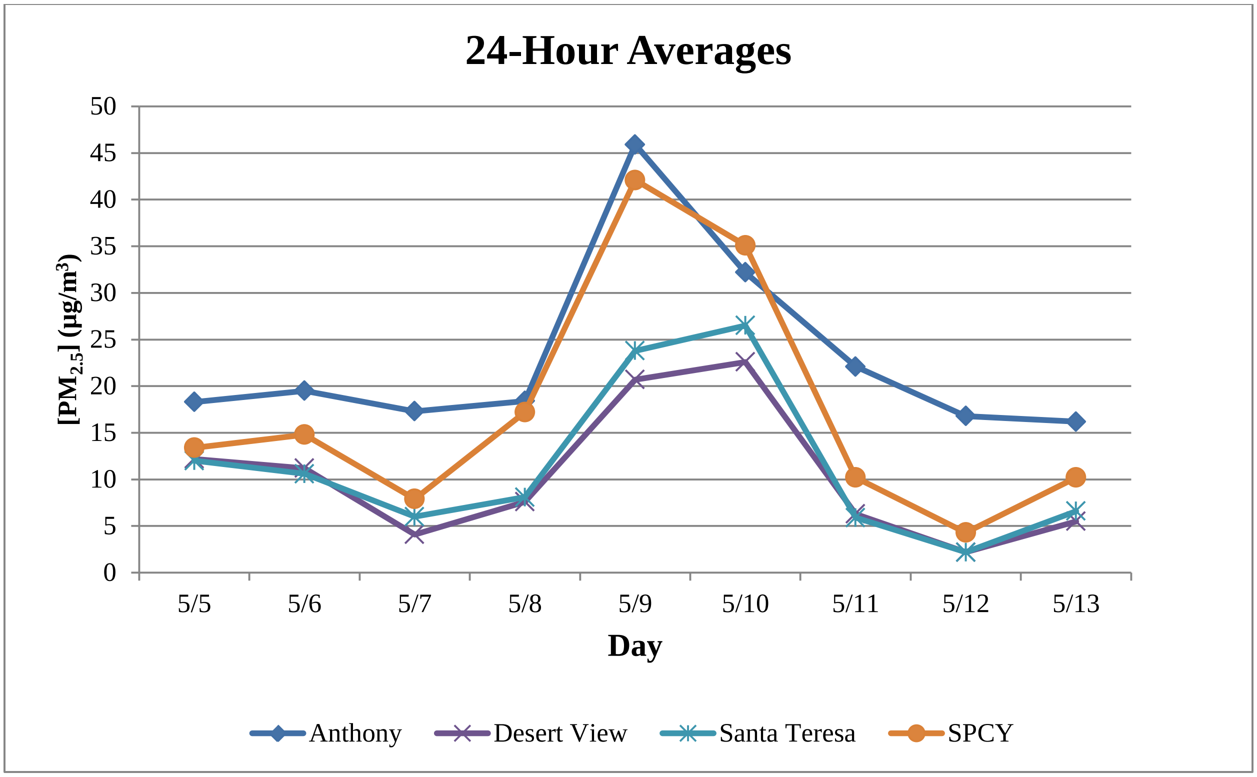

Figure 18-2. $PM_{2.5}$ 24-hour averages before and after May 9, 2011. Non-FEM TEOM Data.

18.2 Is Not Reasonably Controllable or Preventable

18.2.1 Suspected Source Areas and Categories Contributing to the Event

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in Texas, New Mexico, and Mexico. City of Las Cruces, City of Deming and Doña Ana and Luna Counties Ordinances require BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and the playas of northern Mexico (see Section 18.2.4 below).

18.2.2 Sustained and Instantaneous Wind Speeds

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On May 9, 2011, sustained wind speeds exceeded EPA's default threshold at five of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at six of the seven monitoring sites (Figures 18-3 and 18-4). Winds exceeded these thresholds at one or more monitoring sites beginning at the 1000 hour and ending at the 1800 hour.

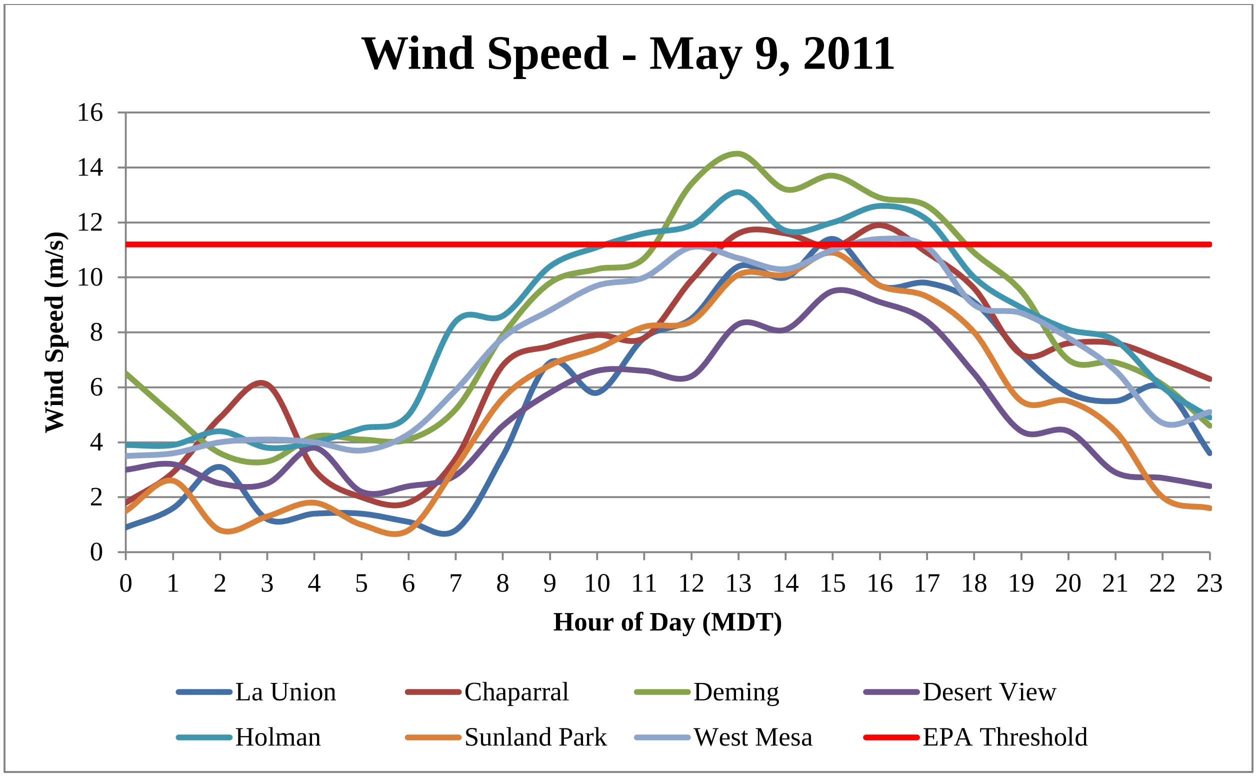

Figure 18-3. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

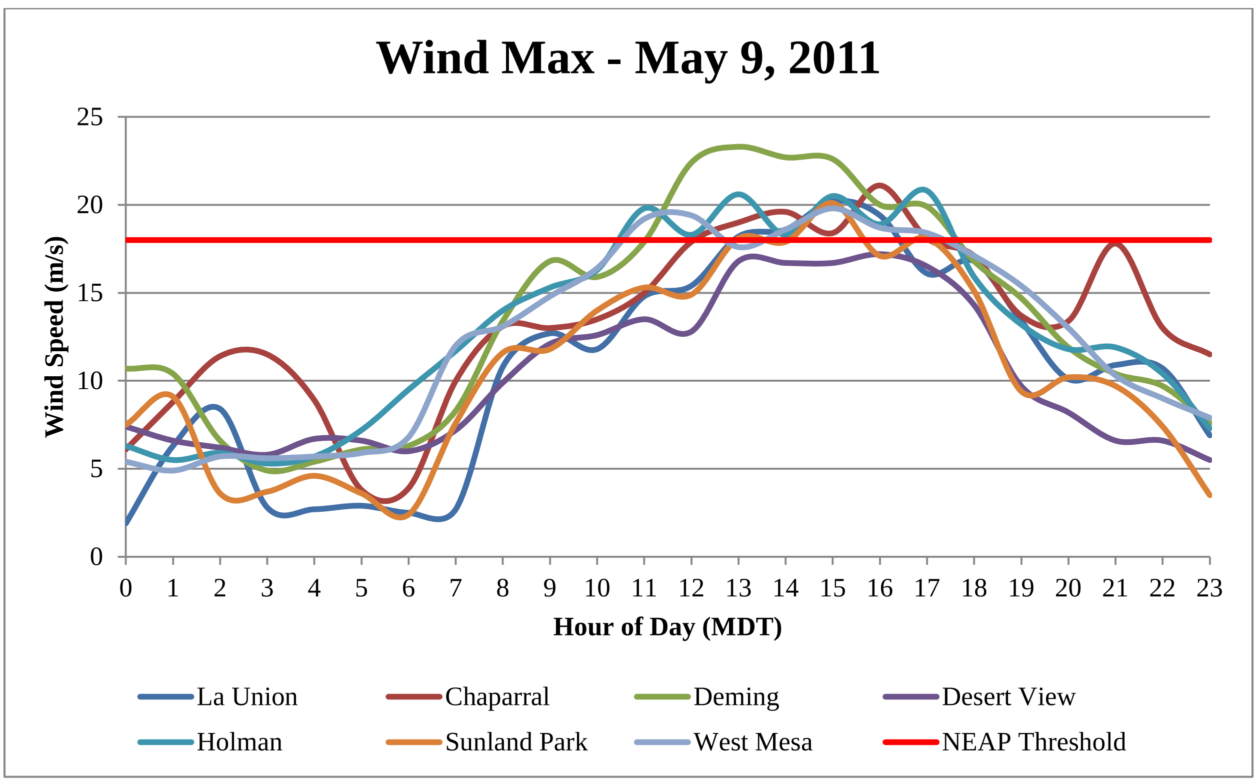

Figure 18-4. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

18.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the PM_{10} FEM TEOM monitors recorded 211 exceedances and the PM_{10} FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). The SPCY $PM_{2.5}$ FRM Partisol recorded 23 exceedances of the 24-Hour NAAQS from 2006-2010 (Figure A-2). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

18.2.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana and Luna Counties. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert and playas in New Mexico, Texas and northern Mexico. The southern sites in Doña Ana County and Deming Airport recorded the highest 24-hour averages in the monitoring network. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled from Texas and Mexico to the monitors in Doña Ana and Luna Counties. The model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figure 18-5). Costs prohibit controlling dust from the natural desert terrain and falls outside NMED's jurisdiction when it originates in Texas, Arizona and Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

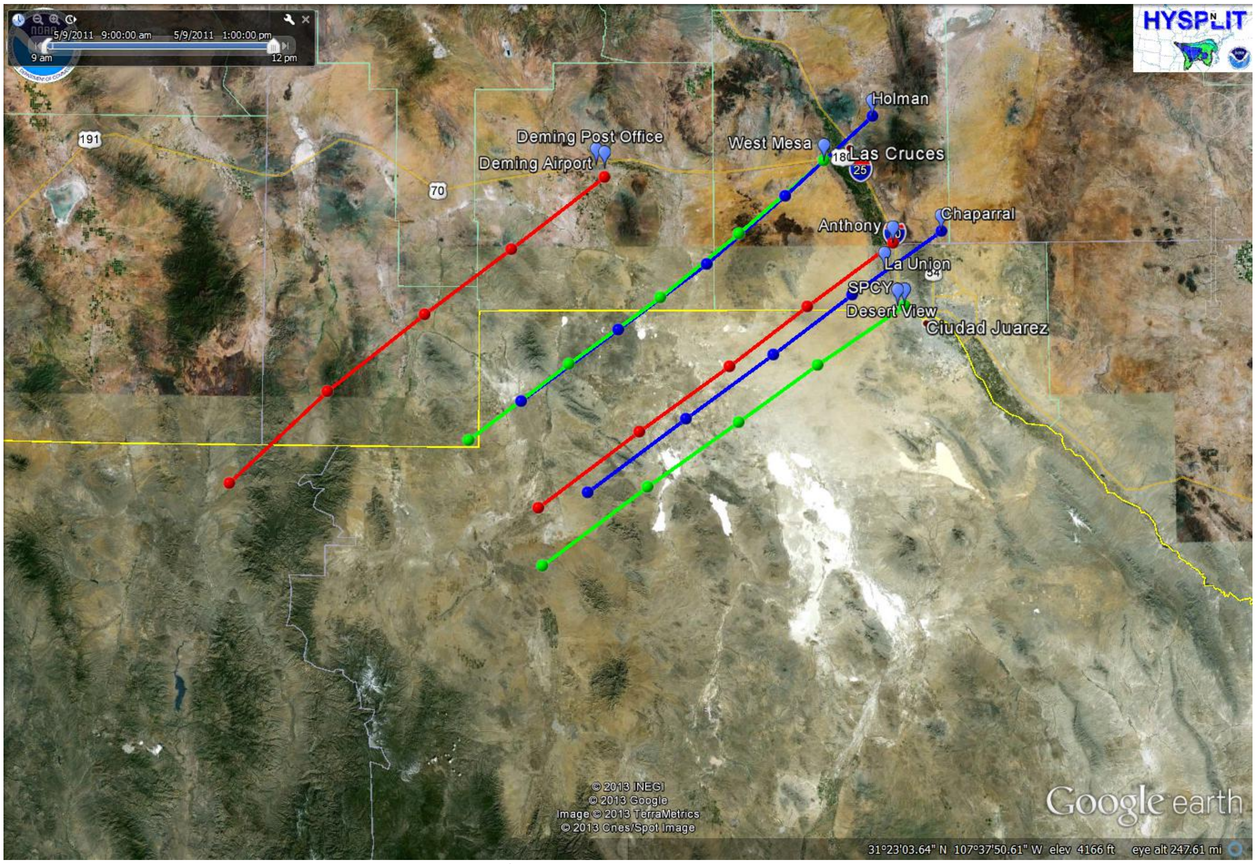

Figure 18-5. HYSPLIT back-trajectory model analysis for May 9, 2011.

18.3 Historical Fluctuations Analysis

18.3.1 Annual and Seasonal 24-hour Average Fluctuations

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded values for this day (269, 233, 263, 337, 39.5 µg/m^3) are above the maximum values recorded when no high wind exceedances are included and is above the 95^{th} percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for May 9, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95^{th} percentile for PM_{10}, $PM_{2.5}$, wind speed and wind gusts (Figures 18-6a-e through 18-8a-d). The top whiskers of the box and whisker plots represent the 95^{th} percentile of data. The hourly PM_{10} values during the high wind blowing dust storm far exceed the historical 95^{th} percentile of data.

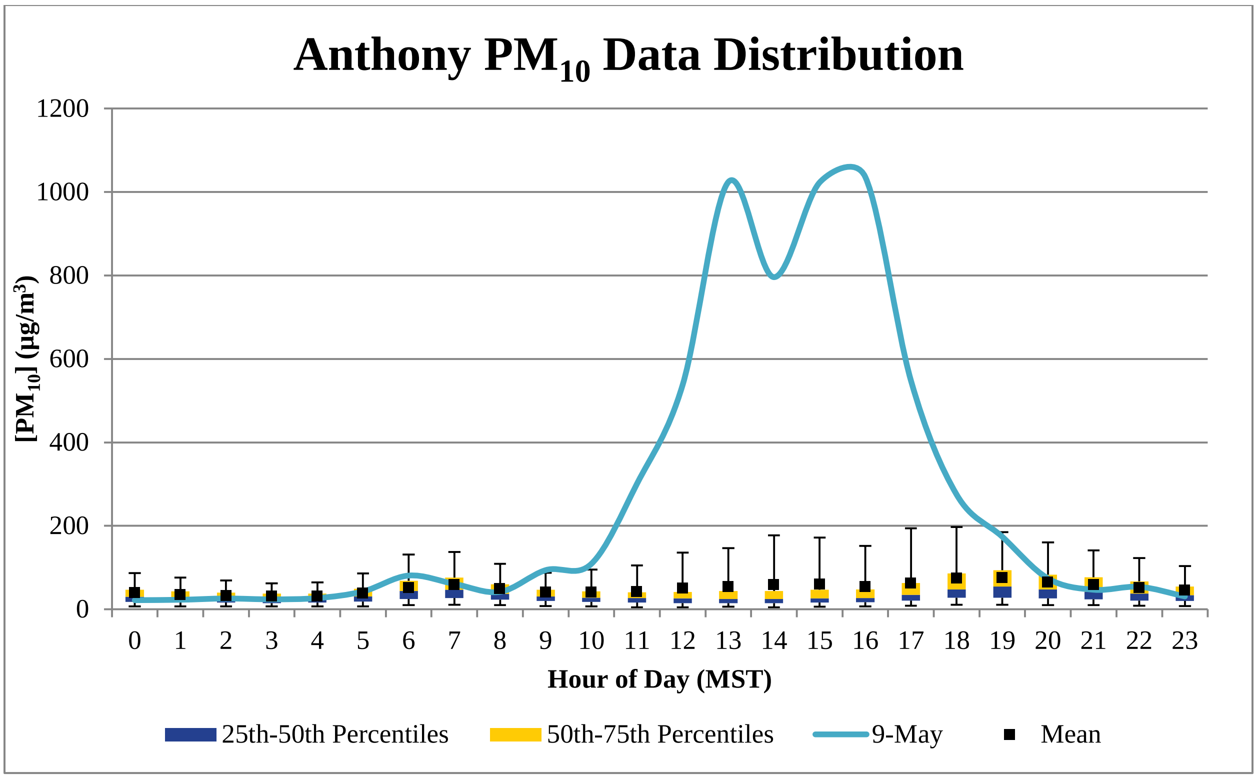

Figure 18-6a. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

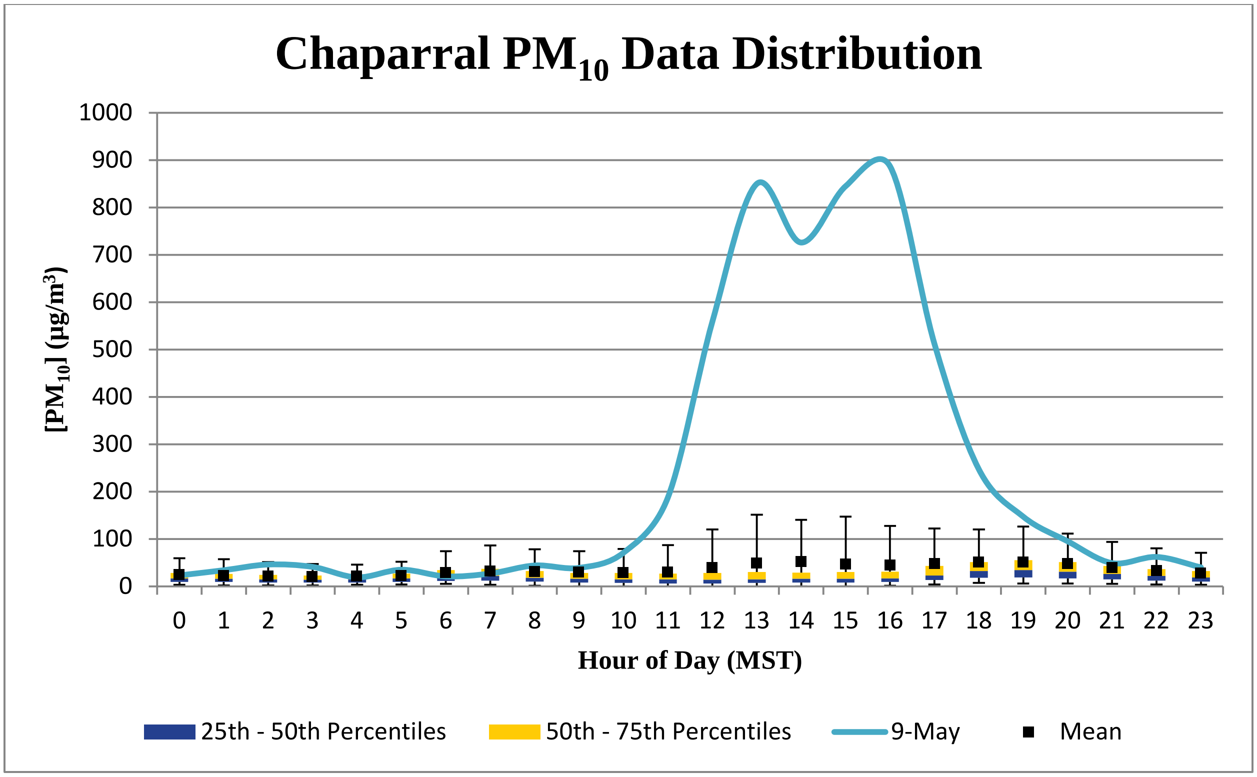

Figure 18-6b. PM_{10} **hourly data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.**

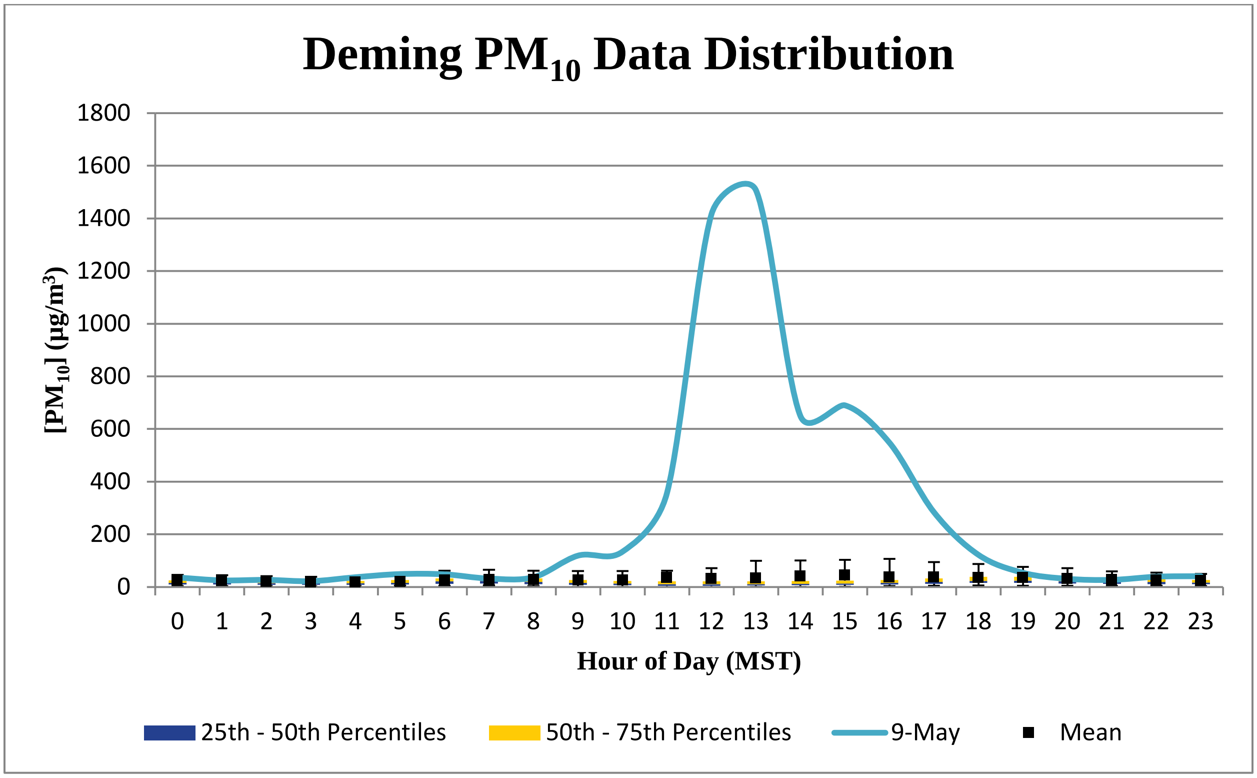

Figure 18-6c. PM_{10} **hourly data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.**

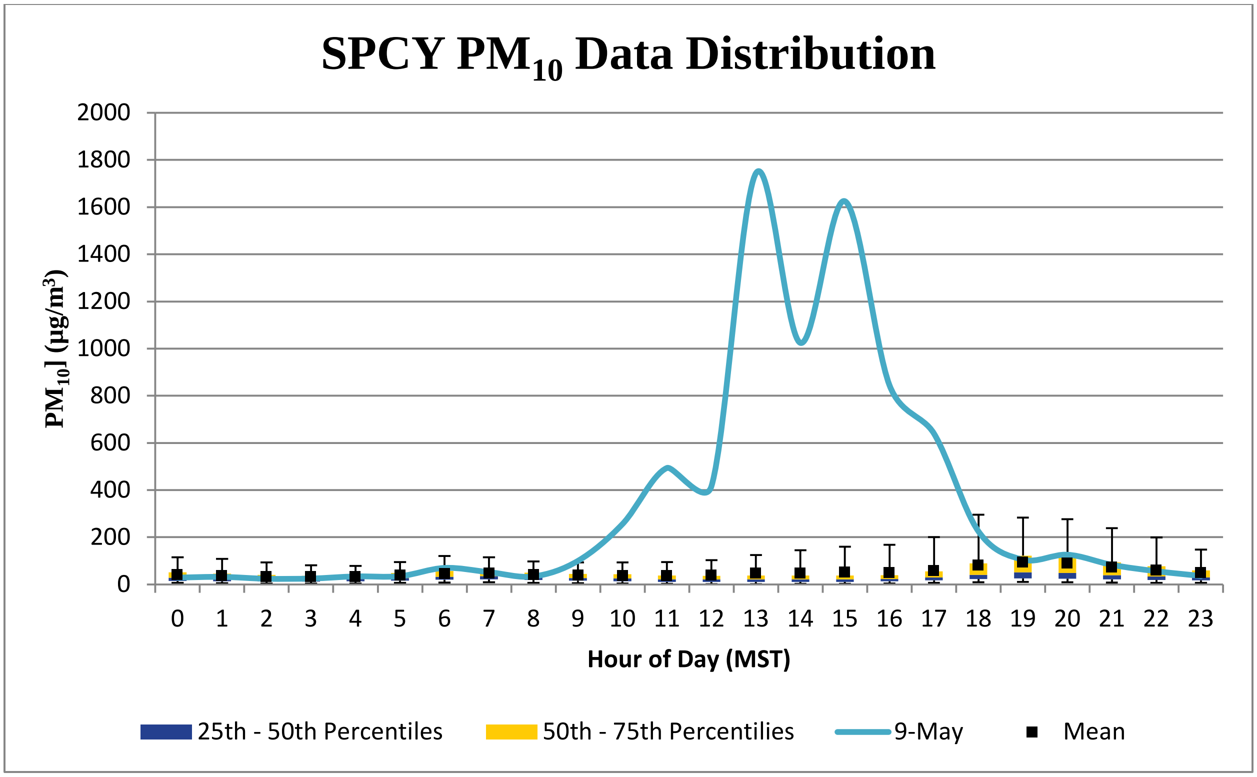

Figure 18-6d. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

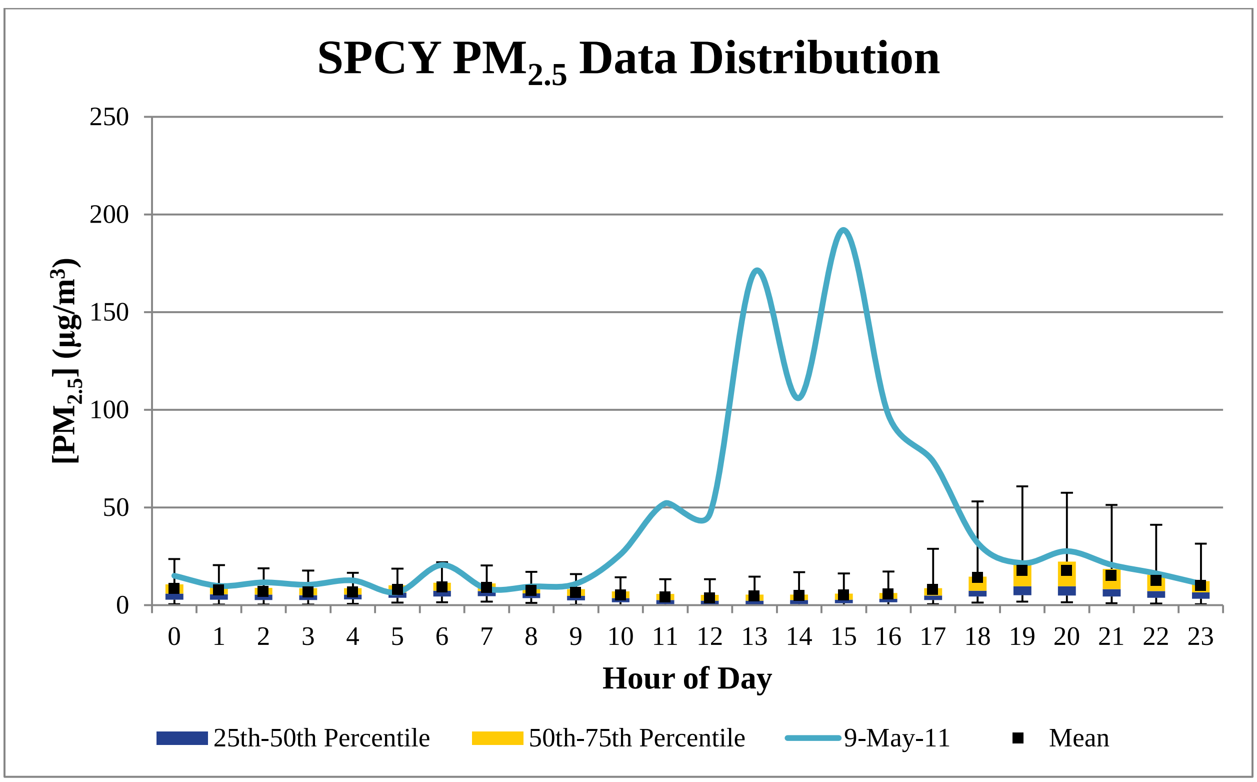

Figure 18-6e. $PM_{2.5}$ hourly data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

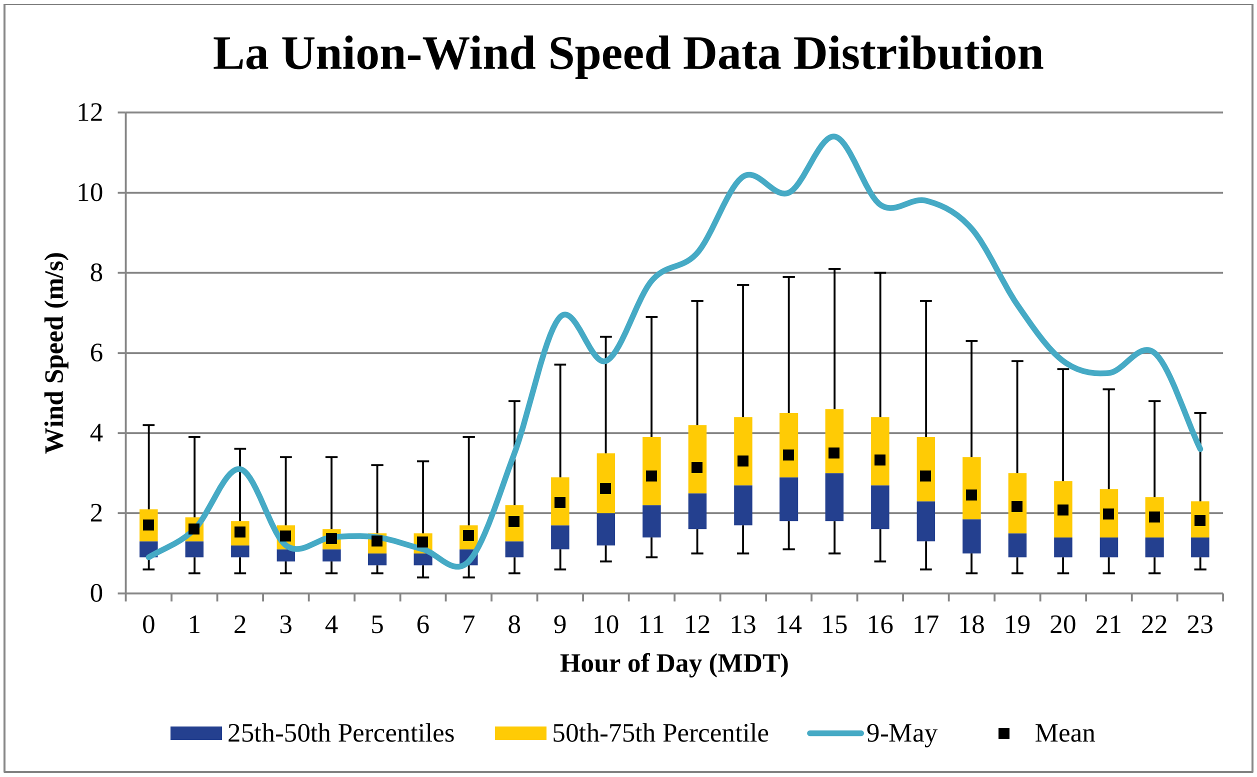

Figure 18-7a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

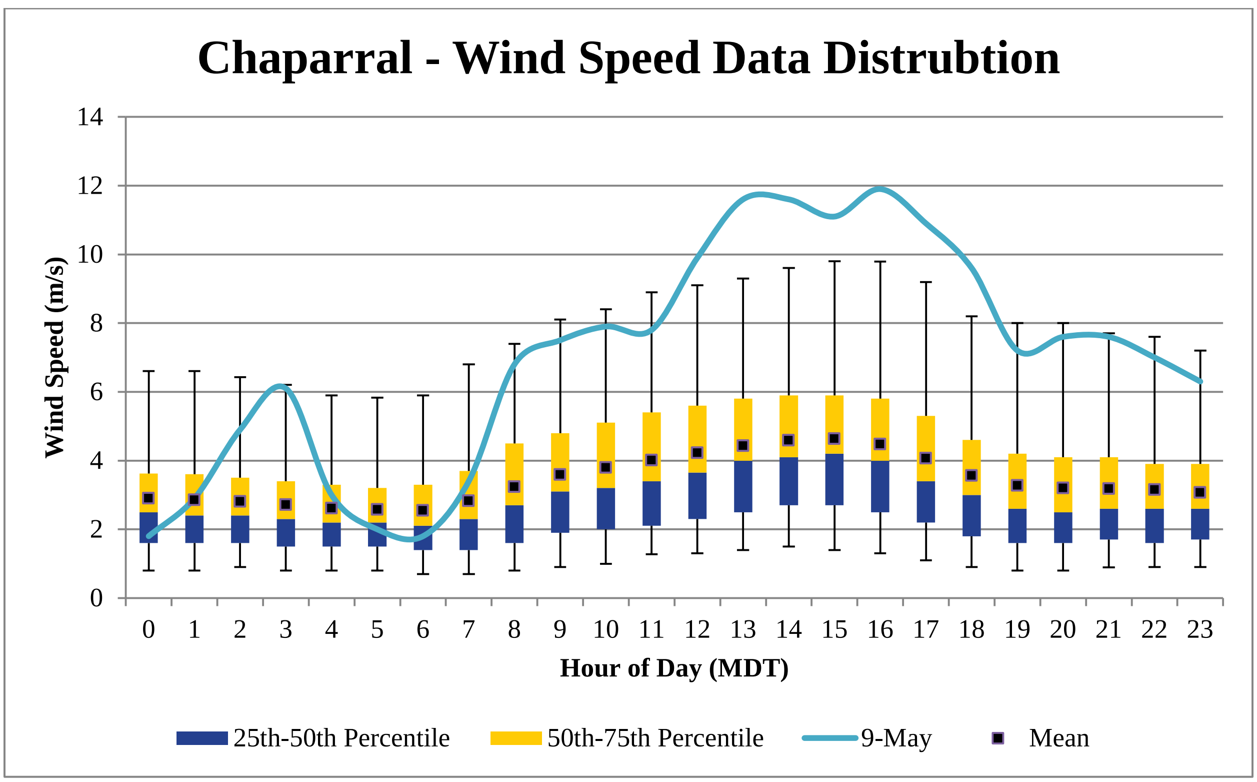

Figure 18-7b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

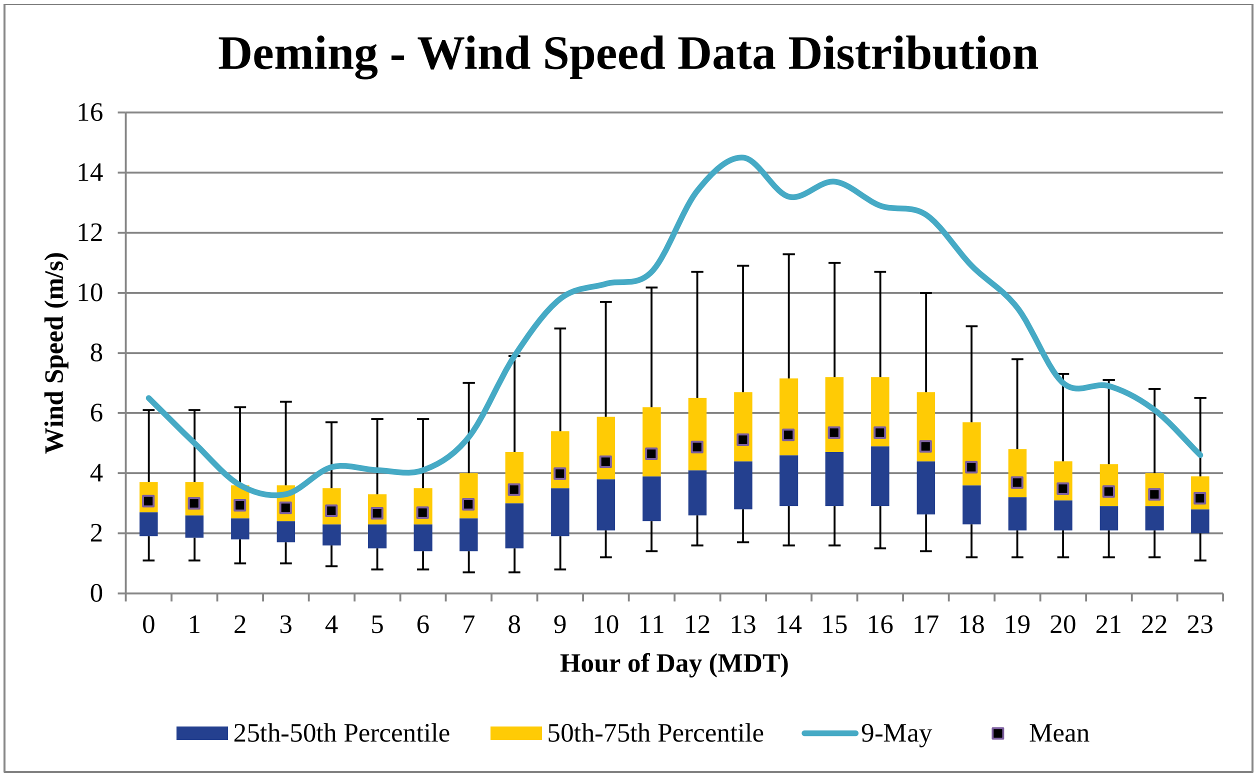

Figure 18-7c. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

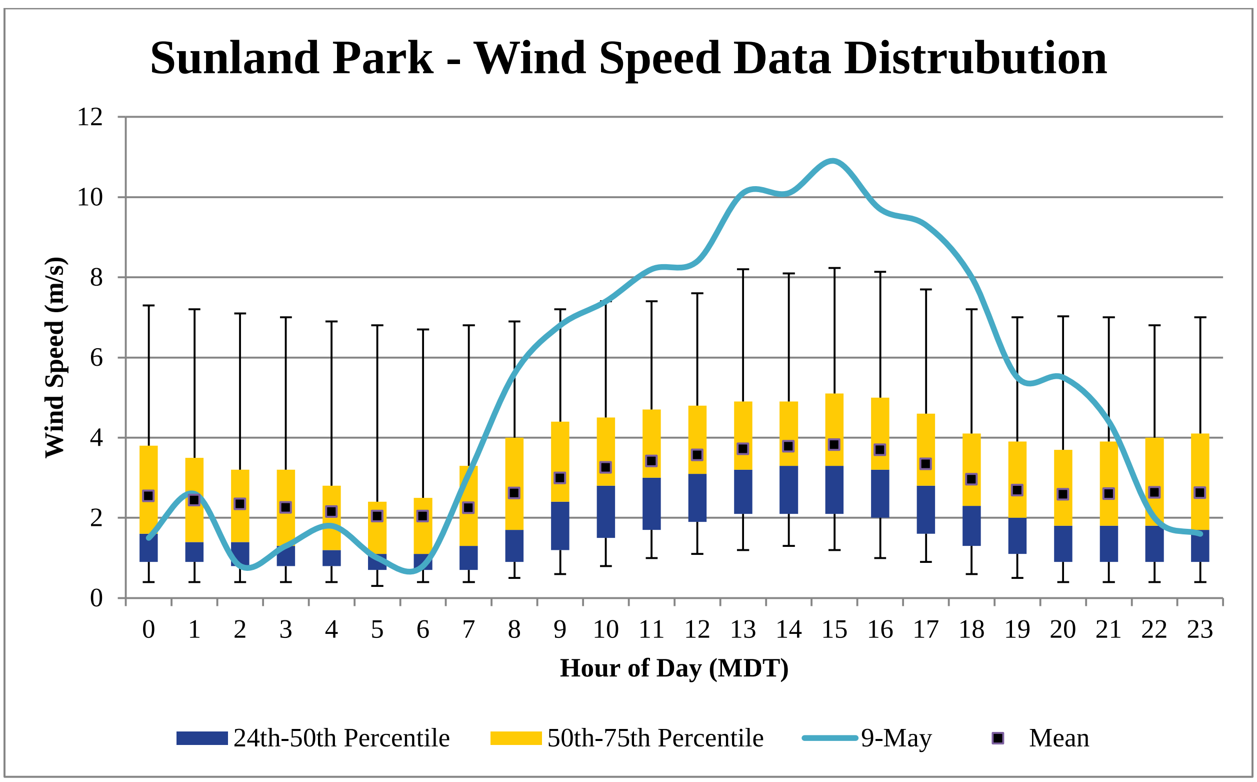

Figure 18-7d. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

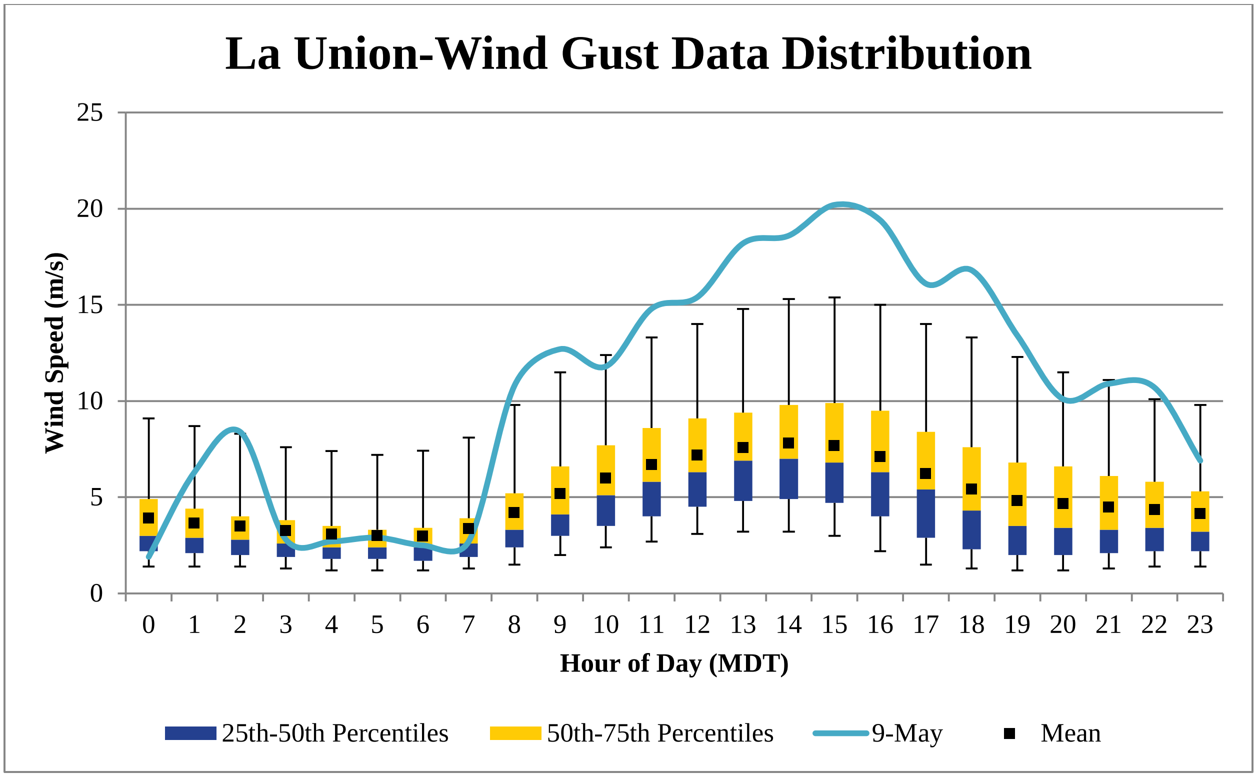

Figure 18-8a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

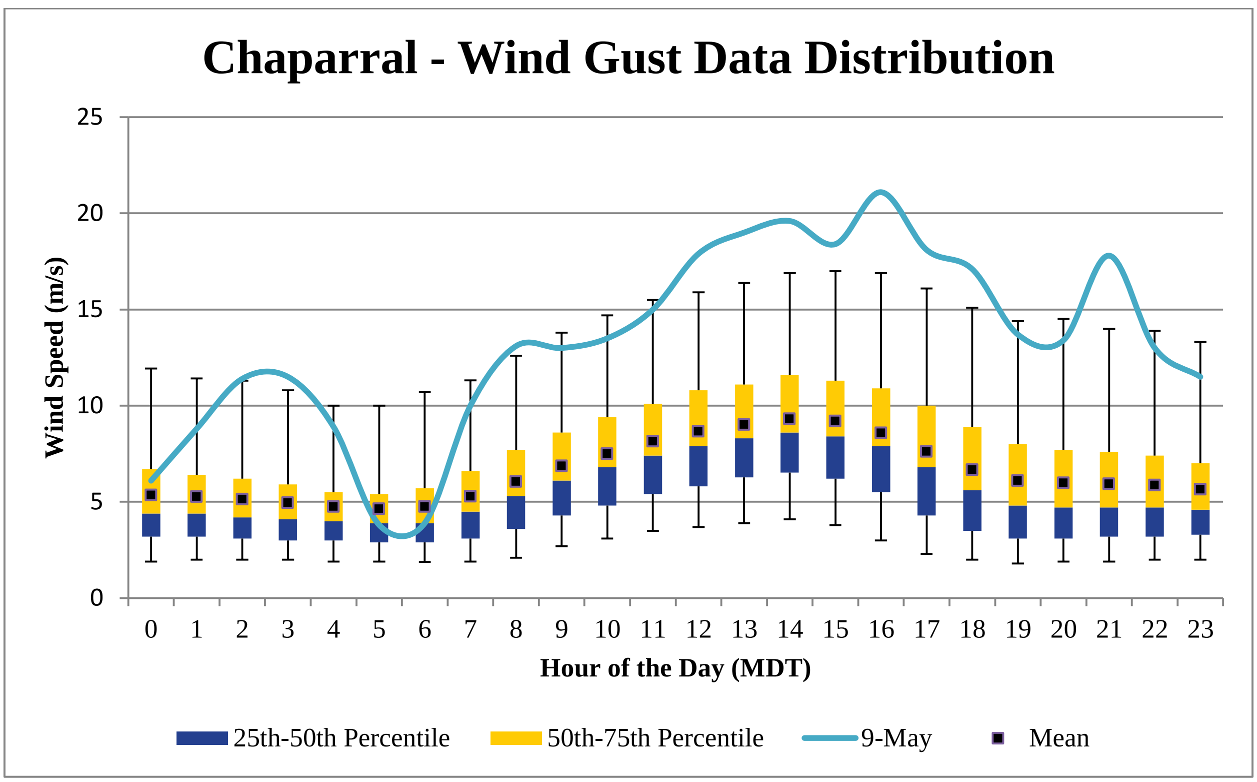

Figure 18-8b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

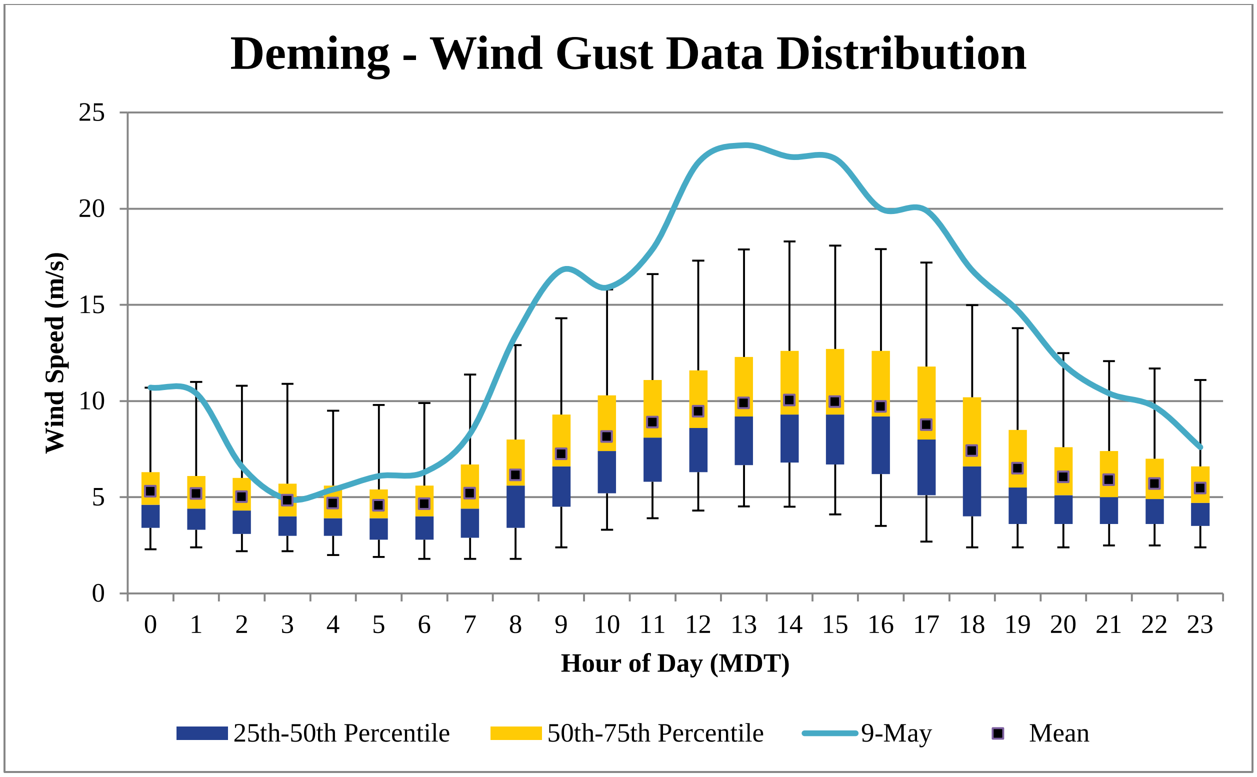

Figure 18-8c. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

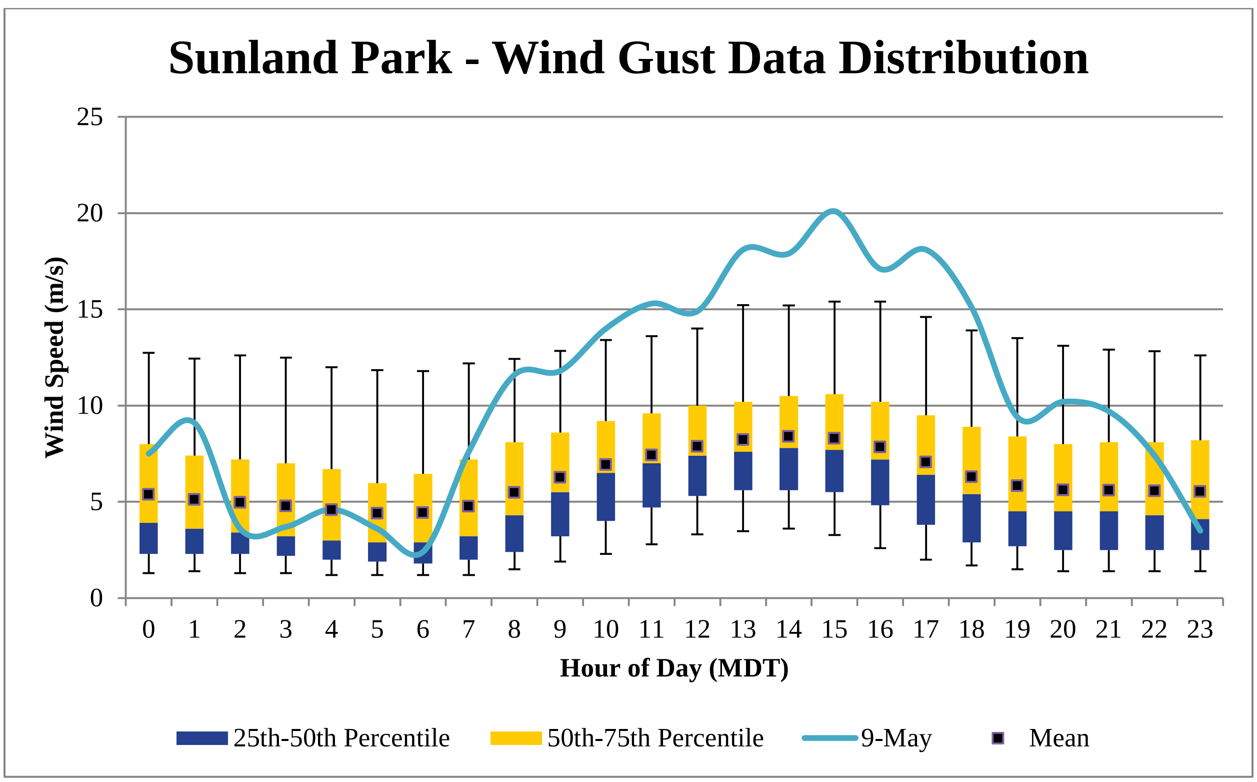

Figure 18-8d. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 9, 2011.

18.4 Clear Causal Relationship

A Pacific cold front passed through New Mexico on May 9, 2011, with a surface low pressure center along the Colorado-New Mexico border. A pressure gradient formed behind the front in southeastern Arizona, southwestern New Mexico and northern Mexico. As the Pacific cold front moved through New Mexico, the pressure gradient tightened and winds became even stronger at the surface (Figure 18-9). Surface winds flow perpendicular to the isobars from high to low pressure. The wind direction in the upper atmosphere aligned with the surface wind direction (Figure 18-10). Diurnal heating of the surface allowed winds aloft to mix downward, increasing the surface wind velocities and provided the turbulence required for vertical mixing and horizontal transport.

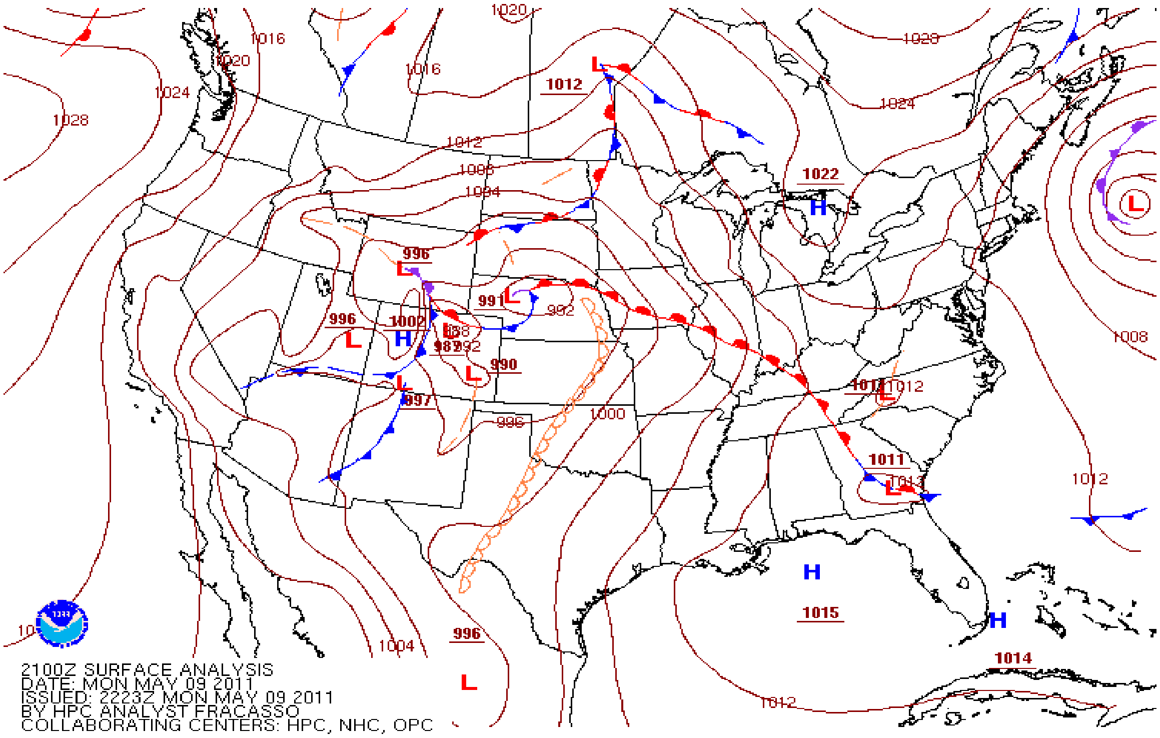

Figure 18-9. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for May 9, 2011 at the 1500 hour.

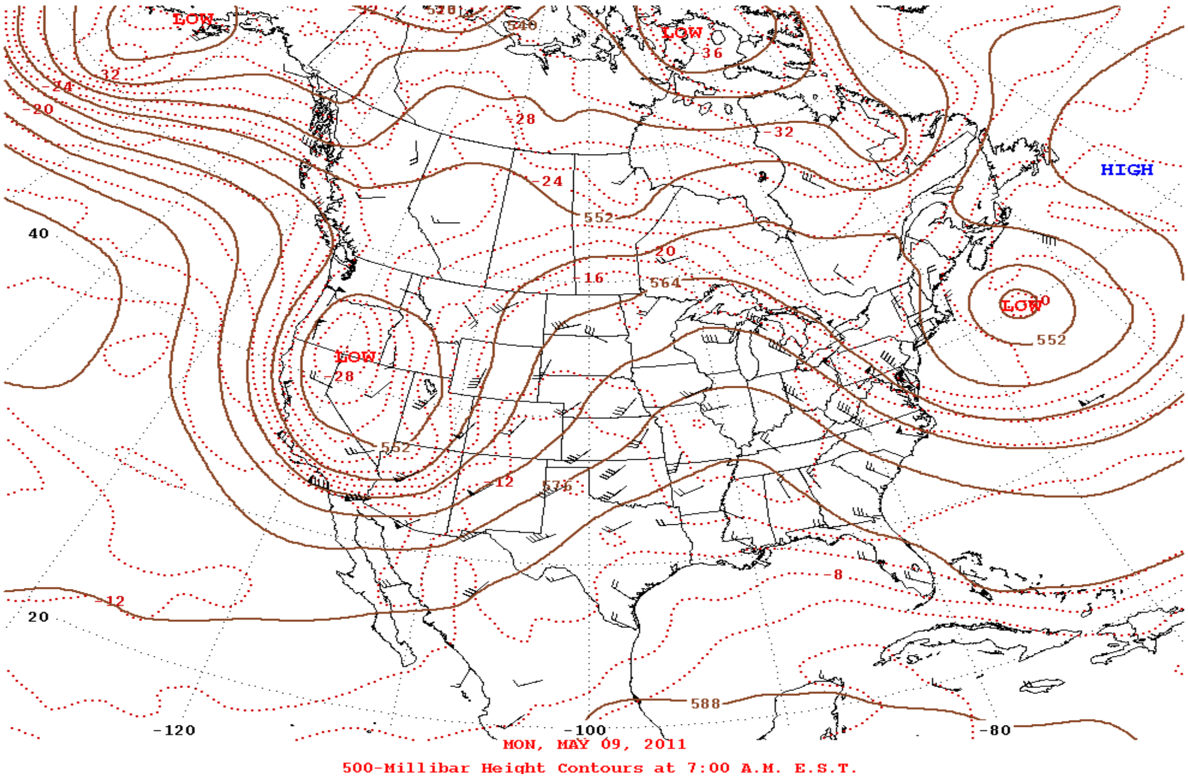

Figure 18-10. Upper air weather map showing geopotential heights (brown lines) at the 500 hour on May 9, 2011.

The weather pattern described above generated strong winds from the southwest beginning at the 1000 hour and lasting through the 1800 hour. Beginning at the 1000 hour, wind speeds exceeded 11.2 m/s or the historical 95th percentile of data at Holman site as shown in Figure 18-3. Peak wind speeds ranged from 9 m/s at Desert View to 14 m/s at Deming site (Figure 18-3). Peak wind gusts ranged from 17 m/s at Desert View to 23m/s at Deming site (Figure 18-4). Blowing dust caused elevated levels of PM_{10} during the same period as high winds as demonstrated by the time series plot in Figure 18-11a-e. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (1000-1800 hours). During these hours, hourly PM_{10} and $PM_{2.5}$ concentrations spiked at all monitoring sites in the network (Figure 18-12a-b). Hourly data from the SPCY PM_{10} and $PM_{2.5}$ TEOM Monitors show good correlation of the timing of spikes in concentrations (Figure 18-13).

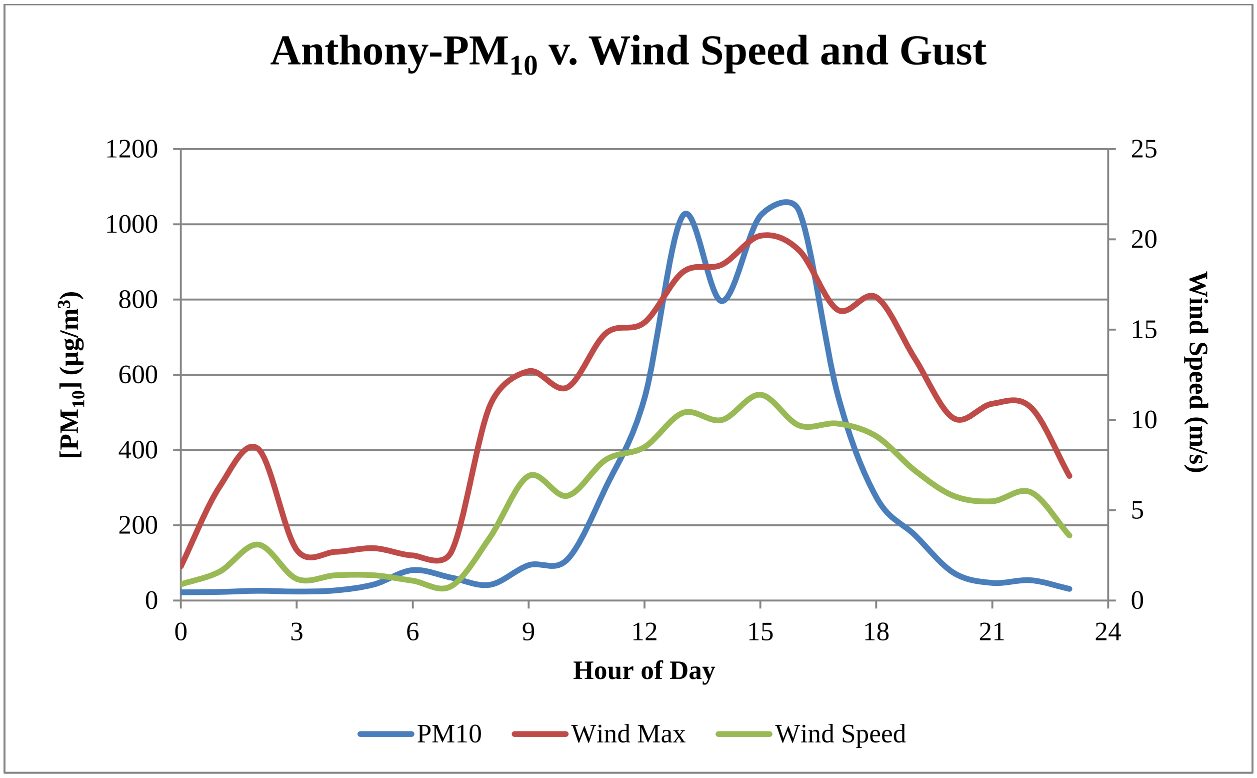

Figure 18-11a. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

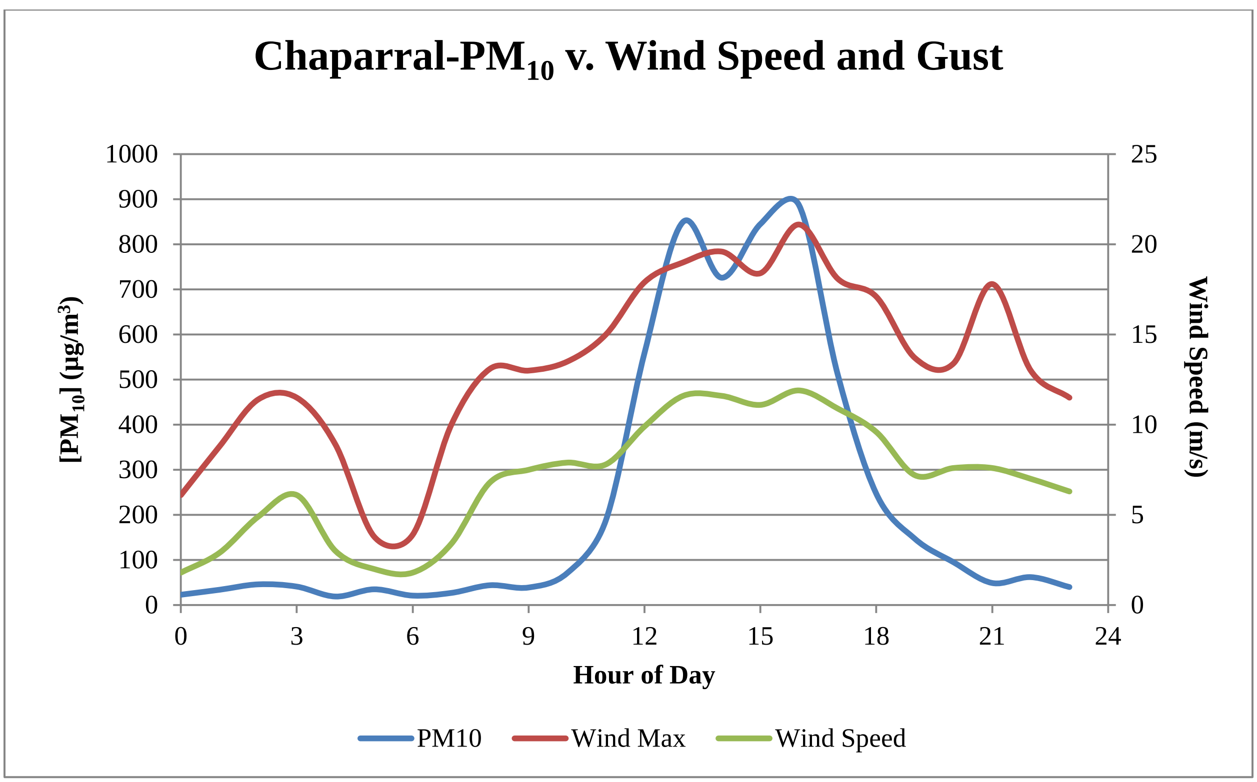

Figure 18-11b. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

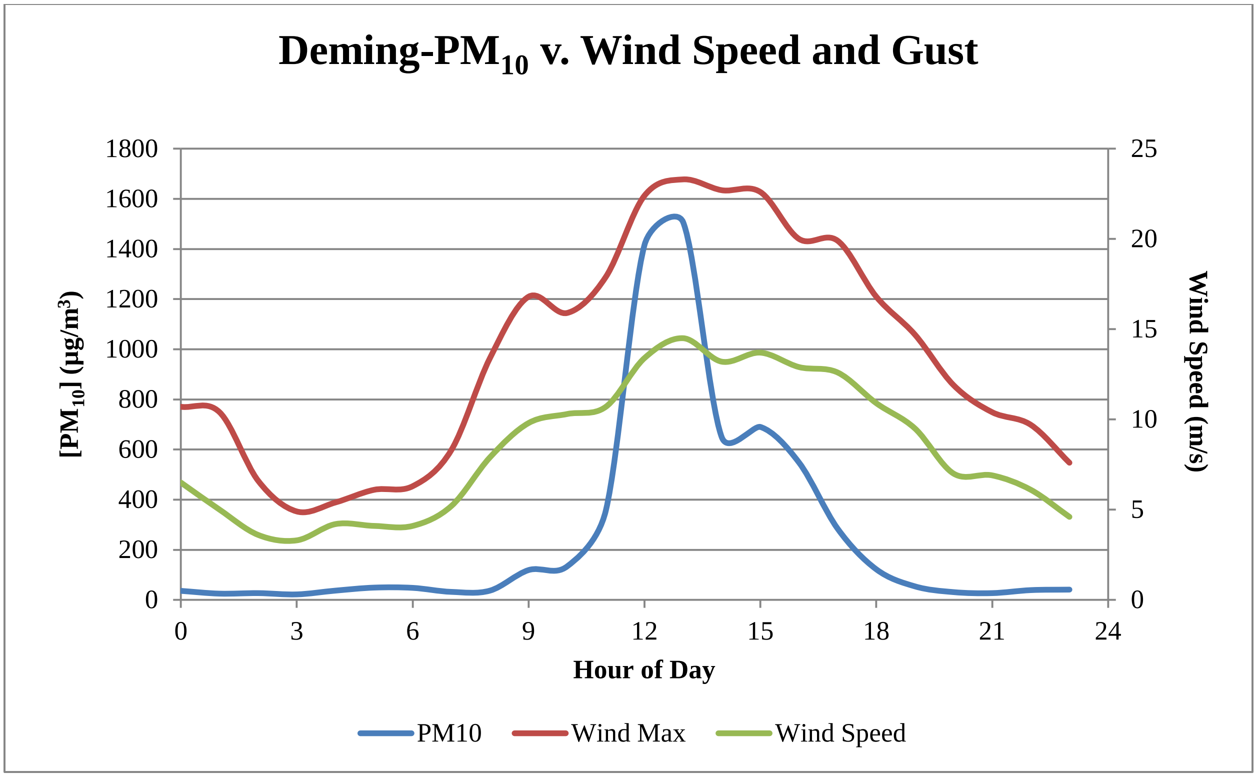

Figure 18-11c. **Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.**

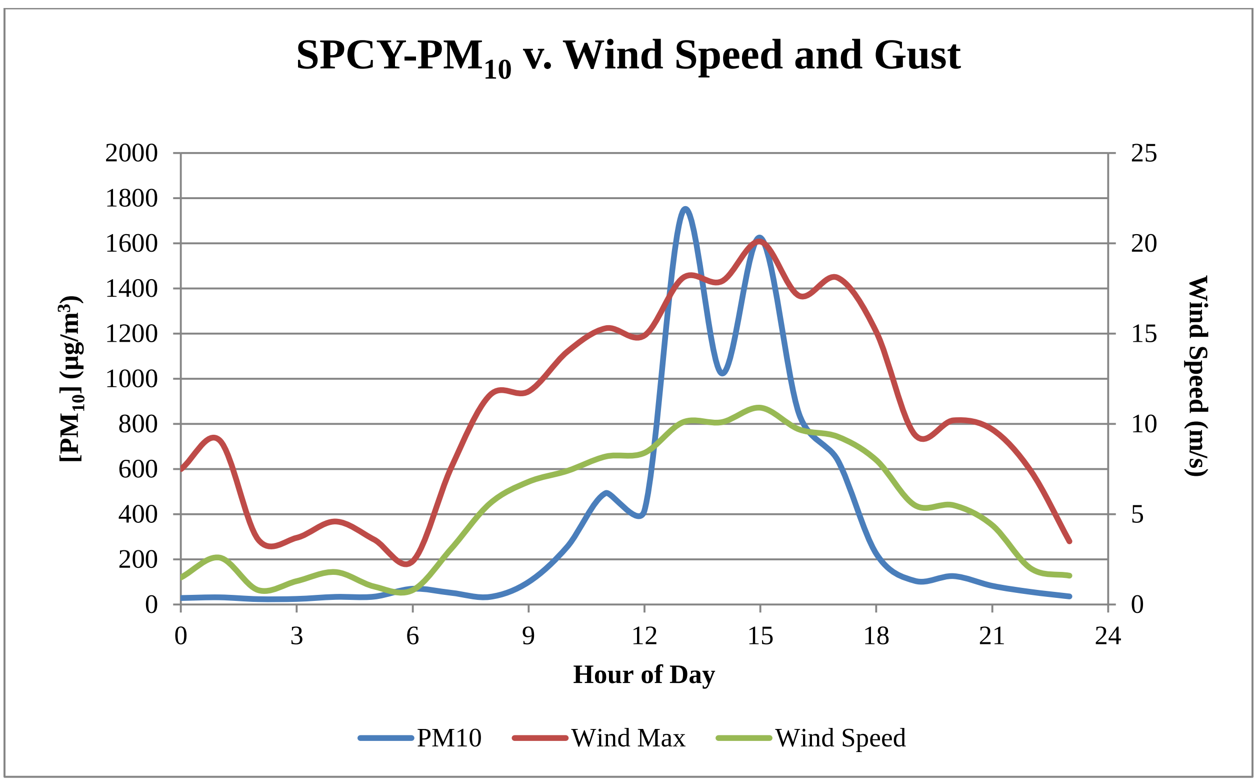

Figure 18-11d. **Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.**

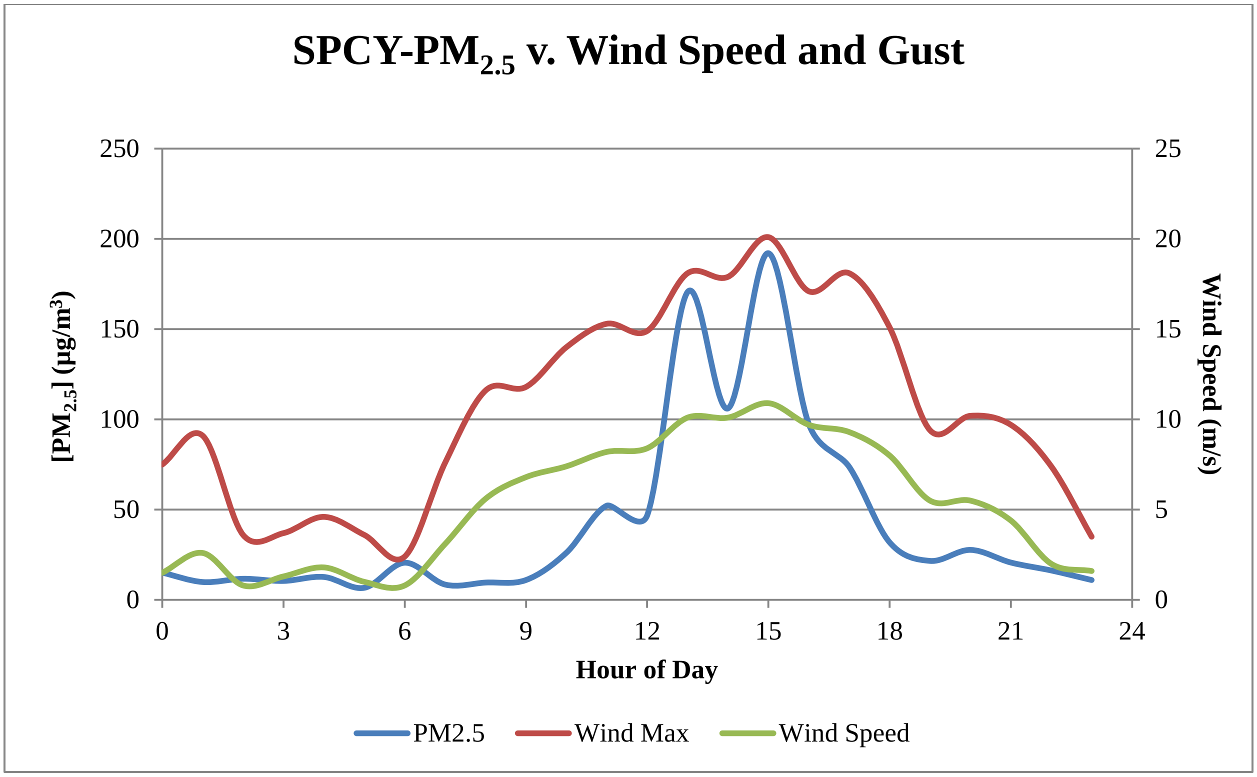

Figure 18-11e. Time series plot of hourly observations showing increased $PM_{2.5}$ concentrations as wind speeds and gusts increase. Non-FEM hourly $PM_{2.5}$ data.

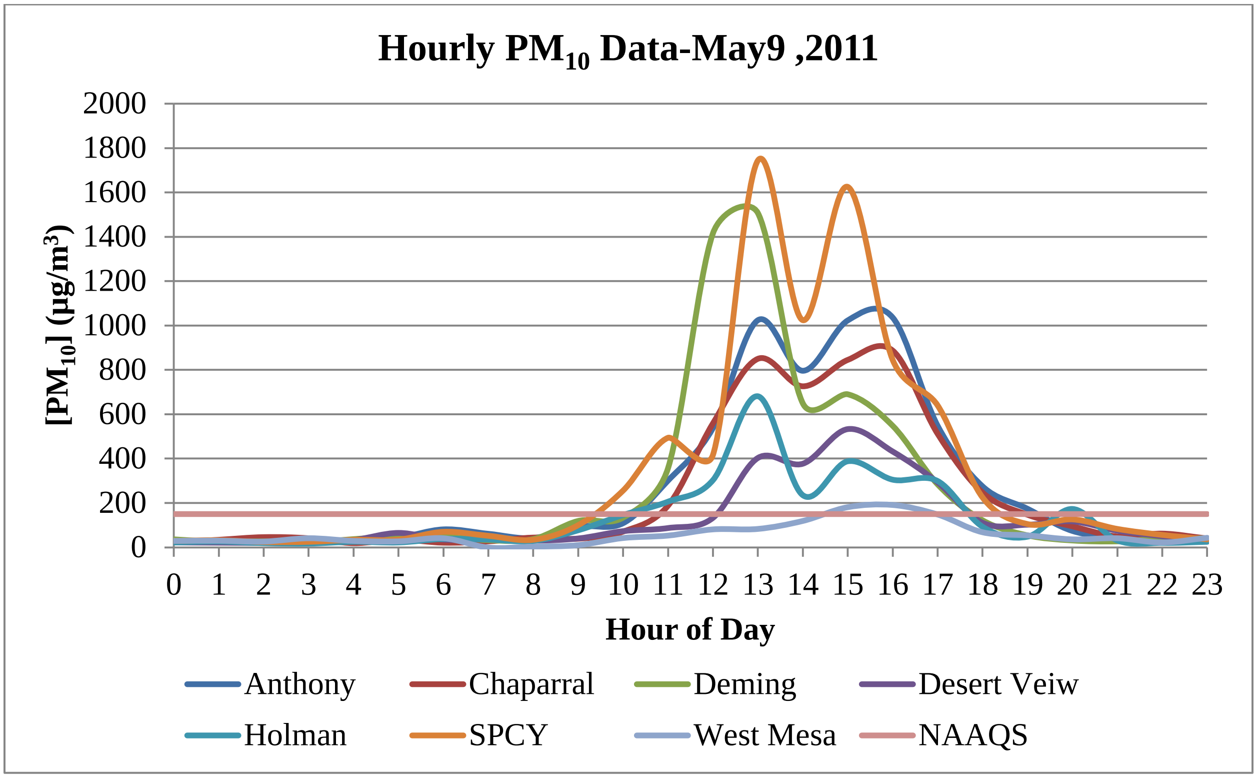

Figure 18-12a. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

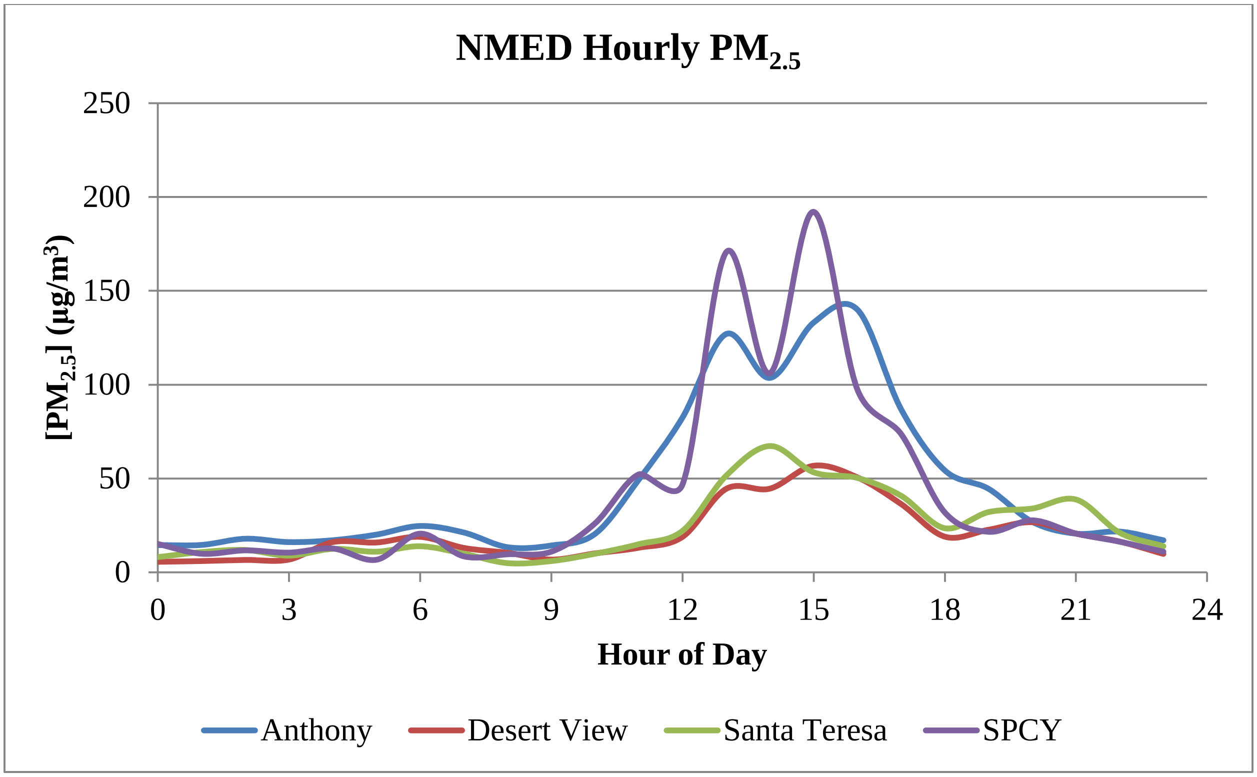

Figure 18-12b. Hourly $PM_{2.5}$ concentrations for Doña Ana and Luna Counties monitors. Non-FEM hourly $PM_{2.5}$ data.

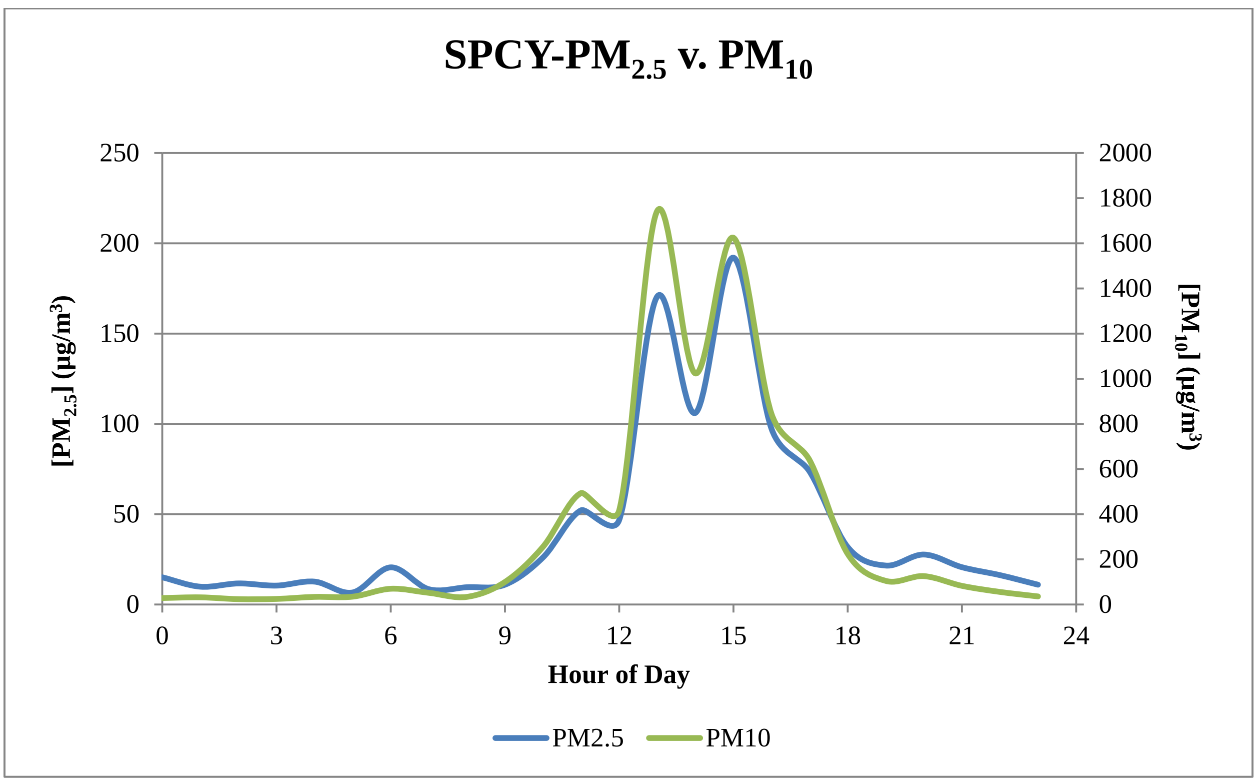

Figure 18-13. Hourly PM_{10} and $PM_{2.5}$ concentrations for the SPCY monitoring site on May 9, 2011.

Contemporary reports and modeling results support these claims. The NM Border AQ Blog posted a dust alert for this day, and reported:

> Dust alert for today. Forecast is for a little earth, wind and fire. The NWS forecasts (Figure 18-14) are telling us to expect west southwest winds in the afternoon between 31 and 34 mph with gusts as high as 48 mph (DuBois, 2011).

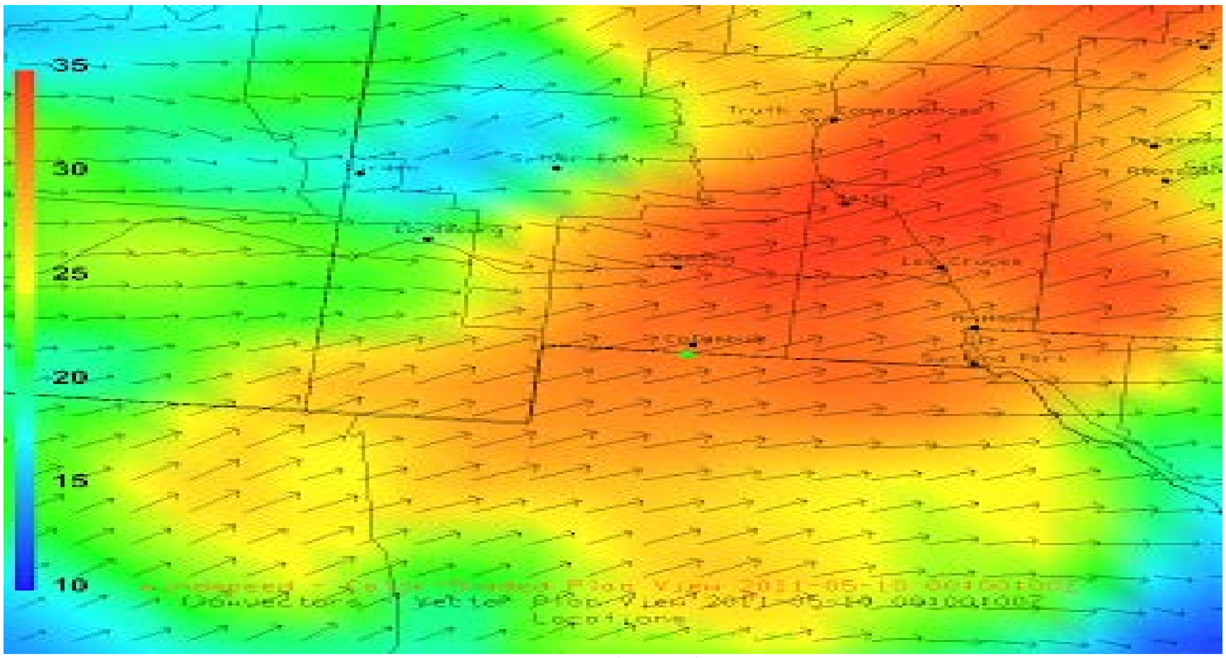

Figure 18-14. May 9, 2011 NOAA Rapid Update Cycle model wind forecast for the 1800 hour.

The NWS issued a wind advisory for most of the borderland on this date stating in part:

> ...STRONG WINDS AND BLOWING DUST RETURN TO SOUTHERN NEW MEXICO AND WEST TEXAS TODAY...
>
> SUSTAINED WIND SPEEDS WILL BE AROUND 30 MPH BY MID AFTERNOON WITH GUSTS TO 50 MPH ACROSS MANY LOCATIONS. GUSTS MAY EXCEED 60 MPH OVER MOUNTAIN PASSES AND ALONG EASTERN SLOPES. THE WINDS WILL RAISE AREAS OF BLOWING DUST...AND VISIBILITIES ACROSS DESERT AREAS MAY LOWER TO ONE MILE AT TIMES (NWS, 2011).

18.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on May 9, 2011.

18.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by high wind and blowing dust.

18.7 No Exceedance but for the Event

The Anthony monitor detected blowing dust around the 1100 hour with hourly concentrations heavily impacted until the 1800. The eight hourly PM_{10} values from 1100-1800 hours alone, exceed the 24-hour average standard at Anthony (301 + 538 + 1024 + 796 + 1023 + 1036 + 548 + 275) µg/m^3 = 5541 µg/m^3; (5541 µg/m^3)/24 = 230 µg/m^3]. By replacing these eight hourly values with the 95th percentile of hourly data at the Anthony site, the resulting 24-hour average (92 µg/m^3) does not exceed the NAAQS (Table 18-1). The values in red represent the 95th percentile of all hourly data collected at Anthony, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	22	22
1	23	23
2	26	26
3	24	24
4	27	27
5	43	43
6	81	81
7	61	61
8	42	42
9	94	94
10	109	109
11	301	**106**
12	538	**136**
13	1024	**146**
14	796	**177**
15	1023	**172**
16	1036	**152**
17	548	**194**
18	275	**197**
19	174	174
20	74	74
21	47	47
22	54	54
23	31	31
24-Hour Average	269	**92**

Table 18-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Anthony.

The Chaparral monitor detected blowing dust around the 1100 hour with hourly concentrations heavily impacted until the 1800 hour. The eight hourly PM_{10} values from 1100-1800 hours alone, exceed the 24-hour average standard at Chaparral [(188 + 559 + 850 + 726 + 845 + 887 + 512 + 247) µg/m^3 = 5541 µg/m^3; (5541 µg/m^3)/24 = 230 µg/m^3]. By replacing these eight hourly values with the 95th percentile of hourly data at the Chaparral site, the resulting 24-hour average (75 µg/m^3) does not exceed the NAAQS (Table 18-2). The values in red represent the 95th percentile of all hourly data collected at Chaparral, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	23	23
1	34	34
2	46	46
3	41	41
4	19	19
5	35	35
6	21	21
7	27	27
8	44	44
9	39	39
10	71	71
11	188	**87**
12	559	**120**
13	850	**151**
14	726	**141**
15	845	**147**
16	887	**127**
17	512	**122**
18	247	**120**
19	147	147
20	95	95
21	49	49
22	62	62
23	40	40
24-Hour Average	233	**75**

Table 18-2. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Chaparral.

The Deming Airport monitor detected blowing dust around the 1000 hour with hourly concentrations heavily impacted until the 1700 hour. The eight hourly PM_{10} values from 1000-1700 hours alone, exceed the 24-hour average standard at Deming Airport [134 + 357 + 1416 + 1507 + 649 + 690 + 548 + 284) µg/m^3 = 5585 µg/m^3; (5585 µg/m^3)/24 = 232 µg/m^3]. By replacing these eight hourly values with the 95th percentile of hourly data at the Deming Airport site, the resulting 24-hour average (60 µg/m^3) does not exceed the NAAQS (Table 18-3). The values in red represent the 95th percentile of all hourly data collected at Deming Airport, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	36	36
1	25	25
2	27	27
3	22	22
4	37	37
5	49	49
6	48	48
7	32	32
8	37	37
9	119	119
10	134	**60**
11	357	**62**
12	1416	**72**
13	1507	**99**
14	649	**101**
15	690	**103**
16	548	**107**
17	284	**95**
18	122	122
19	54	54
20	31	31
21	27	27
22	39	39
23	41	41
24-Hour Average	263	60

Table 18-3. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Deming.

The Sunland Park monitor detected blowing dust around the 1000 hour with hourly concentrations heavily impacted until the 1700. The seven hourly PM_{10} values from 1100-1700 hours alone, exceed the 24-hour average standard at Sunland Park [(256 + 494 + 417 + 1744 + 1024 + 1625 + 845 + 640) µg/m^3 = 7045 µg/m^3; (7045 µg/m^3)/24 = 293 µg/m^3]. By replacing these seven hourly values with the 95th percentile of hourly data at the Sunland Park site, the resulting 24-hour average (89 µg/m^3) does not exceed the NAAQS (Table 18-4). The values in red represent the 95th percentile of all hourly data collected at Sunland Park, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	29	29
1	32	32
2	24	24
3	25	25
4	34	34
5	35	35
6	70	70
7	52	52
8	34	34
9	100	100
10	256	**93**
11	494	**95**
12	417	**104**
13	1744	**125**
14	1024	**145**
15	1625	**160**
16	845	**168**
17	640	**201**
18	225	225
19	105	105
20	126	126
21	83	83
22	56	56
23	36	36
24-Hour Average	337	**89**

Table 18-4. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Sunland Park.

19 HIGH WIND EXCEPTIONAL EVENT: May 10, 2011

19.1 Summary of Event

The passing of a Pacific cold front caused high winds and blowing dust in Doña Ana and Luna Counties resulting in exceedances of the PM_{10} and $PM_{2.5}$ 24-hour NAAQS and the $PM_{2.5}$ annual NAAQS at the Anthony, Chaparral, Deming Airport, Holman, and Sunland Park monitoring sites on this date. The FEM TEOM continuous monitors at these sites recorded 24-hour average concentrations of 160, 190, 163, and 210 µg/m^3, respectively. The FRM Partisol at SPCY recorded a 24-hour average of 28.1 µg/m^3. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were measured at Deming Airport (94 µg/m^3), Desert View (144 µg/m^3), and West Mesa (98 µg/m^3) (Figure 19-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event. Elevated concentrations were also recorded by the $PM_{2.5}$ non-FEM/FRM TEOMs (Figure 19-2).

As the event unfolded, the wind blew from the Southwest throughout the border region. These high velocity winds passed over large areas of desert within Texas, New Mexico and Mexico. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

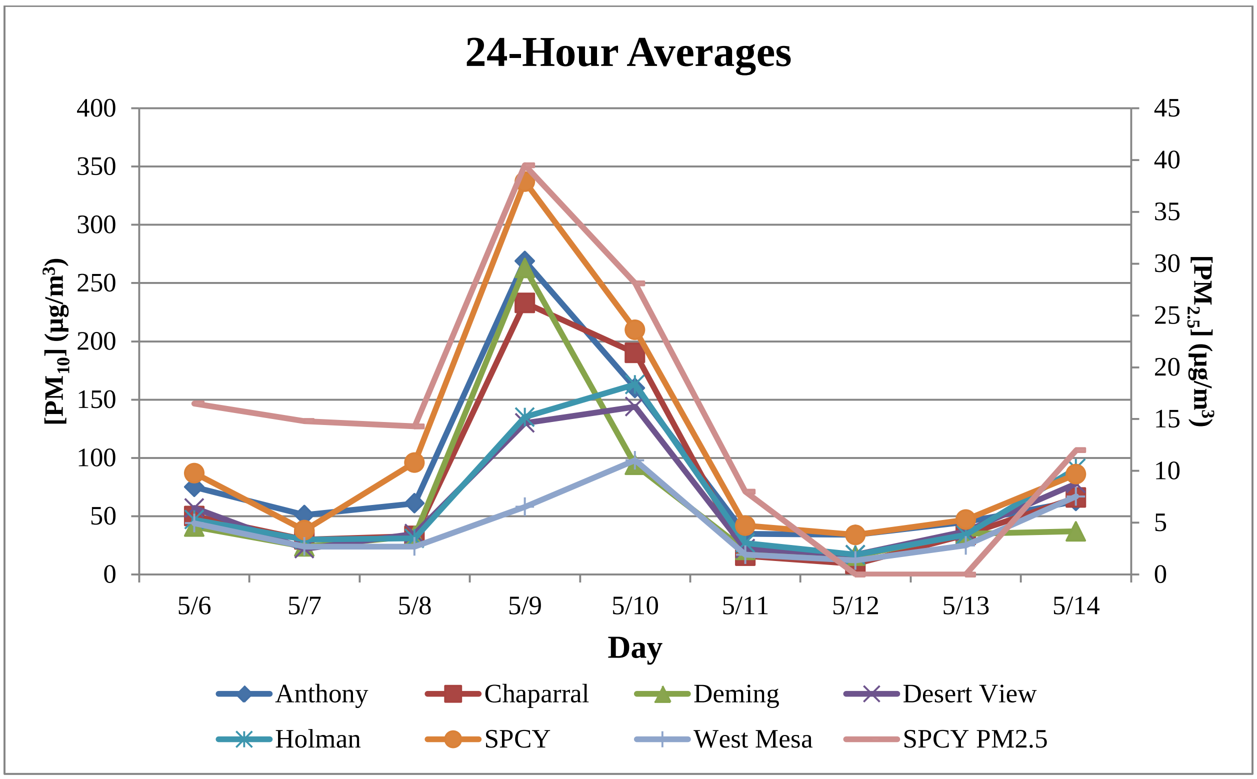

Figure 19-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after May 10, 2011.

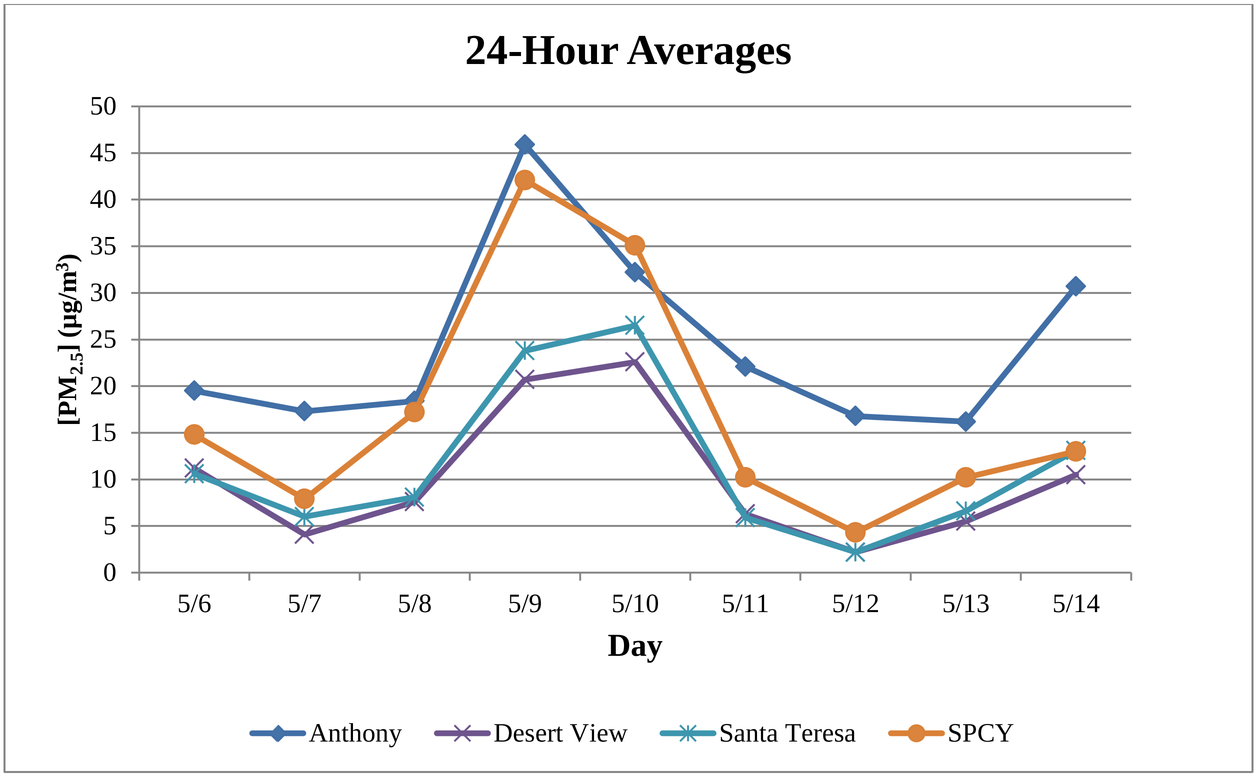

Figure 19-2. $PM_{2.5}$ 24-hour averages before and after May 10, 2011. Non FRM/FEM TEOM data.

19.2 Is Not Reasonably Controllable or Preventable

19.2.1 Suspected Source Areas and Categories Contributing to the Event

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in Texas, New Mexico, and Mexico. City of Las Cruces, City of Deming and Doña Ana and Luna Counties Ordinances require BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and the playas of northern Mexico (see Section 19.2.4 below).

19.2.2 Sustained and Instantaneous Wind Speeds

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On May 10, 2011, sustained wind speeds exceeded EPA's default threshold at four of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at six of the seven monitoring sites (Figures 19-3 and 19-4). Winds exceeded these thresholds at one or more monitoring sites beginning at the 1000 hour and ending at the 2200 hour.

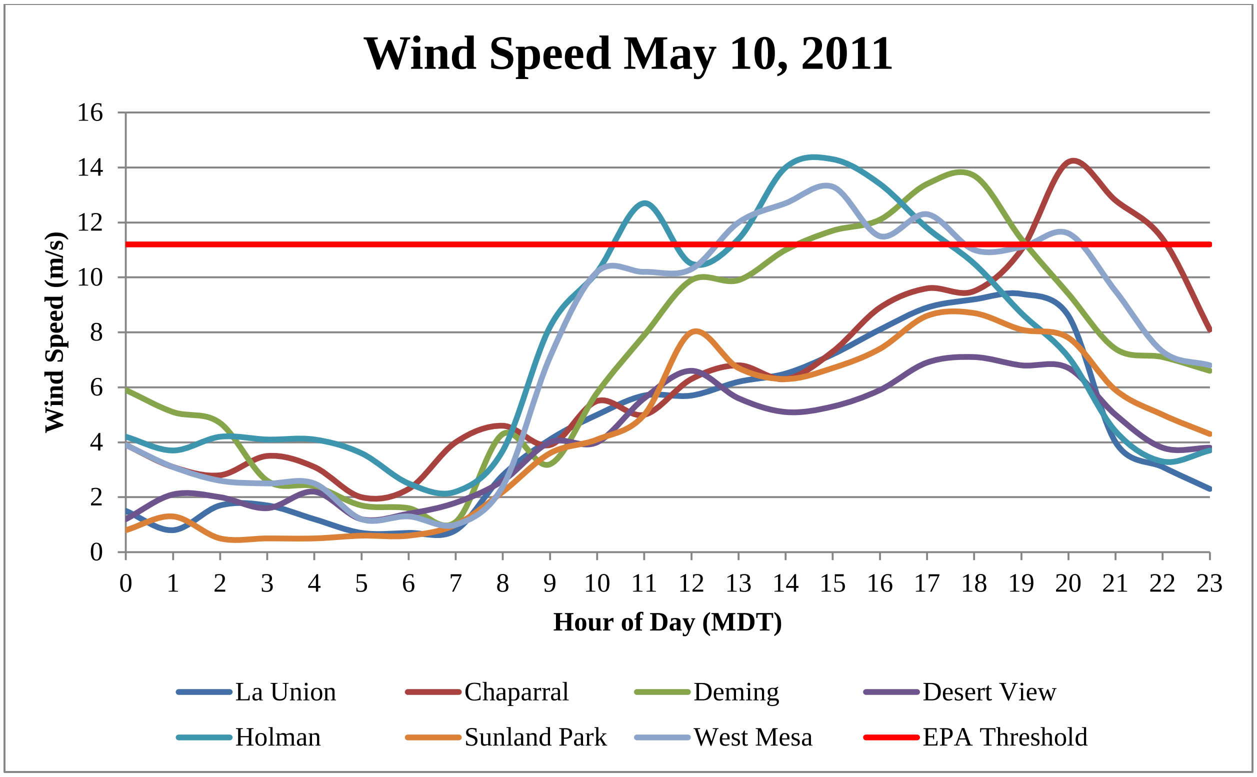

Figure 19-3. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

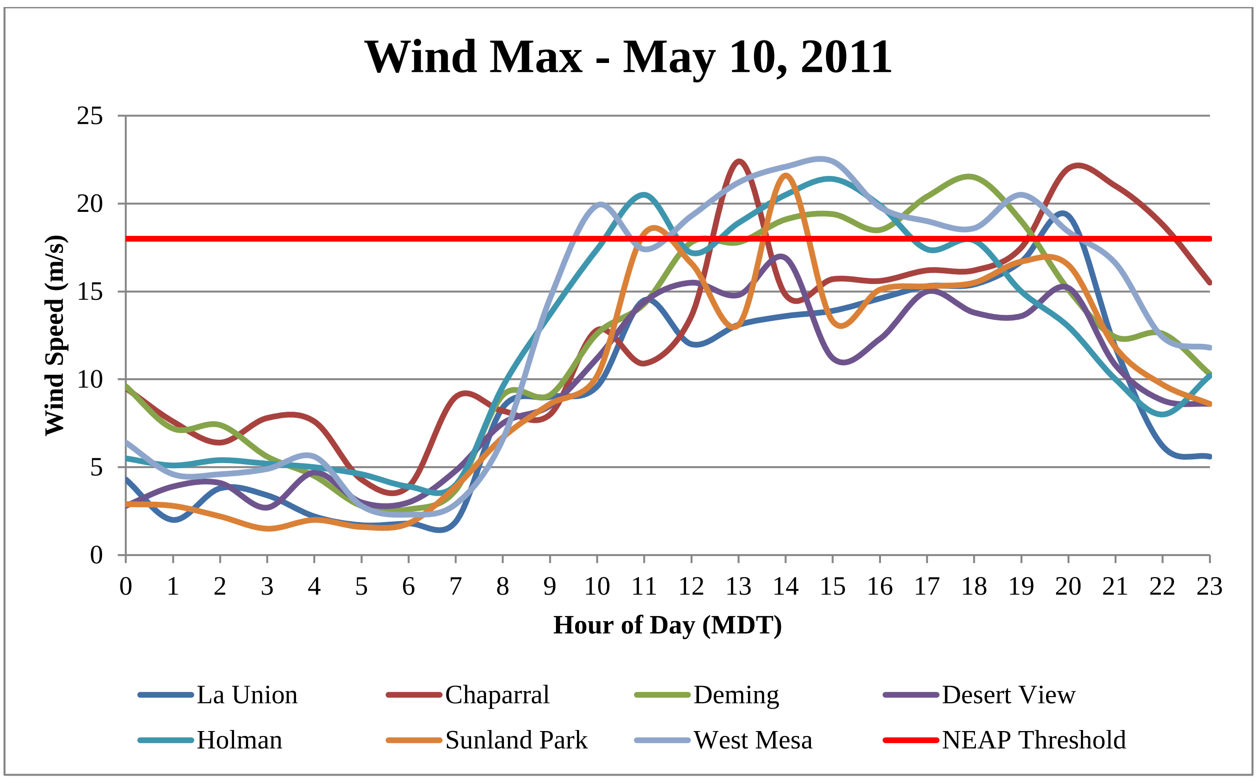

Figure 19-4. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

19.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the PM_{10} FEM TEOM monitors recorded 211 exceedances and the PM_{10} FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). The SPCY $PM_{2.5}$ FRM Partisol recorded 23 exceedances of the 24-Hour NAAQS from 2006-2010 (Figure A-2). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

19.2.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana and Luna Counties. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely sources contributing to the event are the natural desert and playas in New Mexico, Texas, and northern Mexico. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled from Mexico through New Mexico and Texas and onto the monitors in Doña Ana and Luna Counties. The model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figure 19-5). Costs prohibit controlling dust from the natural desert terrain and falls outside NMED's jurisdiction when it originates in Texas and Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

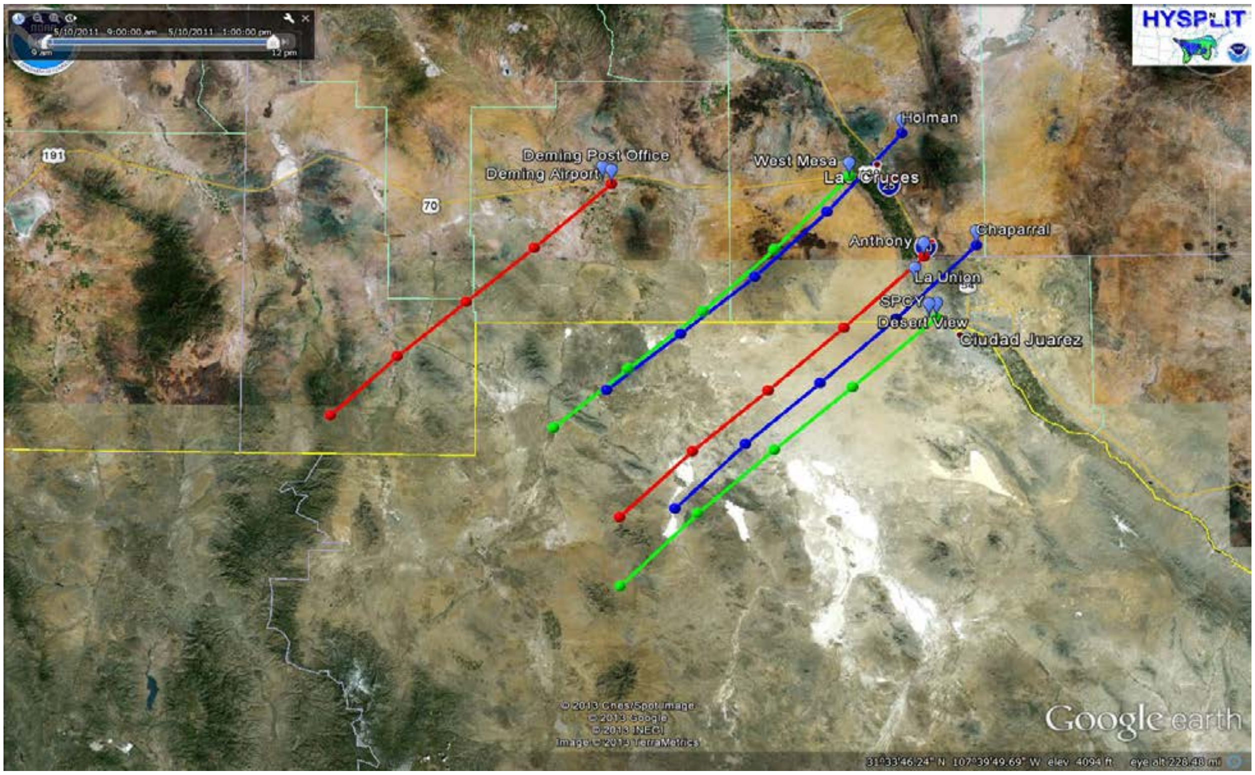

Figure 19-5. HYSPLIT back-trajectory model analysis for May 10, 2011.

19.3 Historical Fluctuations Analysis

19.3.1 <u>Annual and Seasonal 24-hour Average Fluctuations</u>

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM

TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded values for this day (160, 190, 163, 210, and 28.1 µg/m^3) are above the maximum values recorded when no high wind exceedances are included and is above the 95th percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for May 10, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95th percentile for PM_{10}, $PM_{2.5}$, wind speed and wind gusts (Figures 19-6a-e through 19-8a-d). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} values during the high wind blowing dust storm far exceed the historical 95th percentile of data.

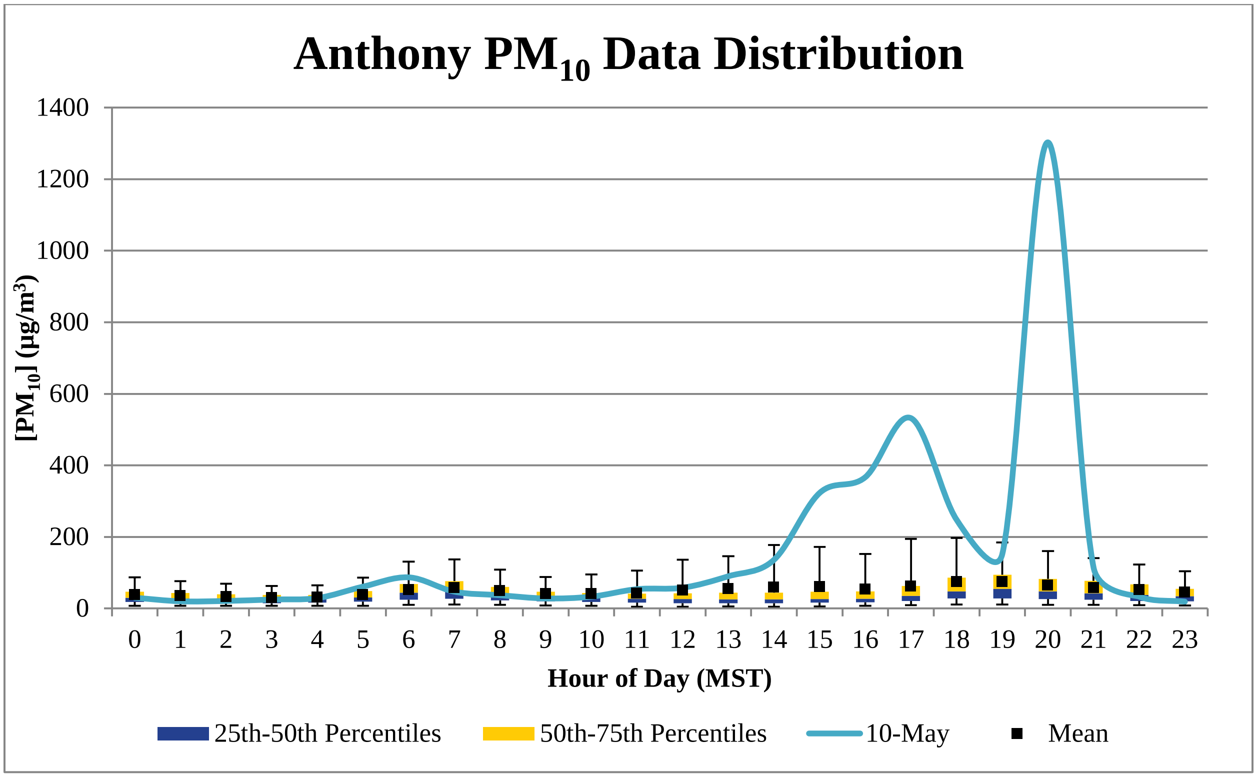

Figure 19-6a. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

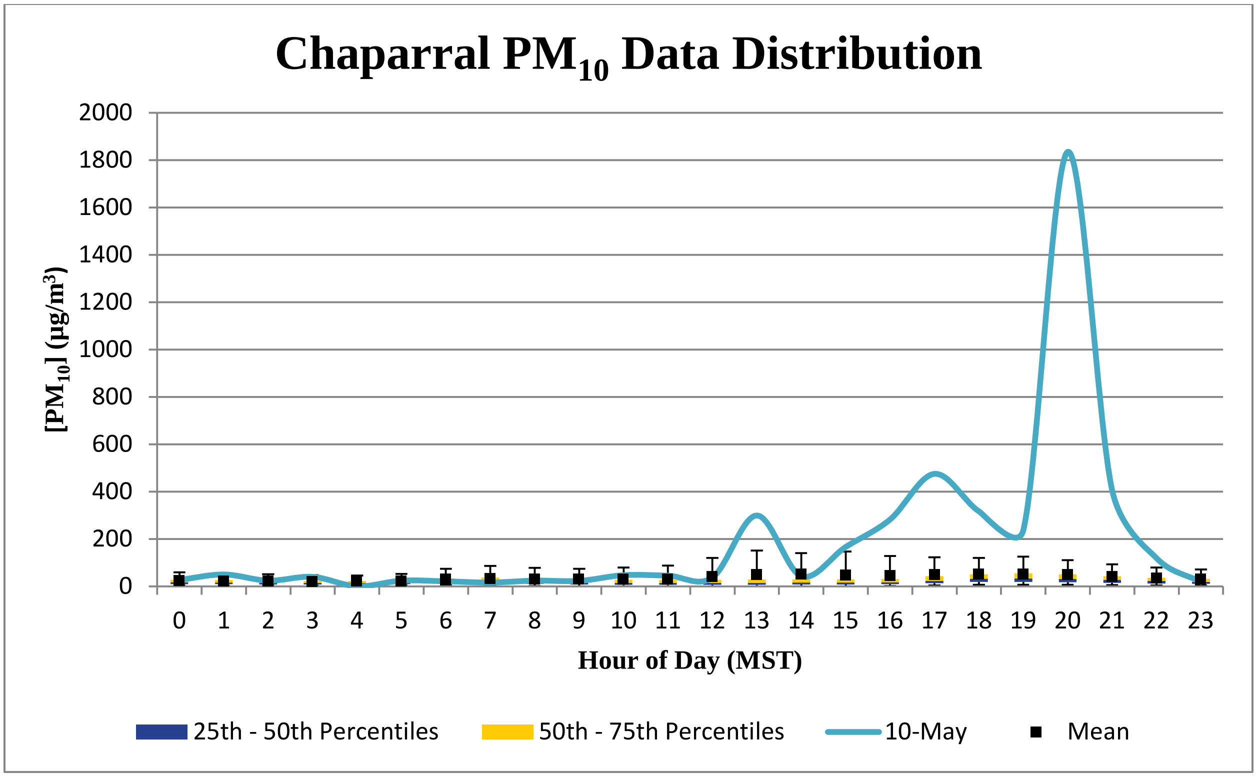

Figure 19-6b. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

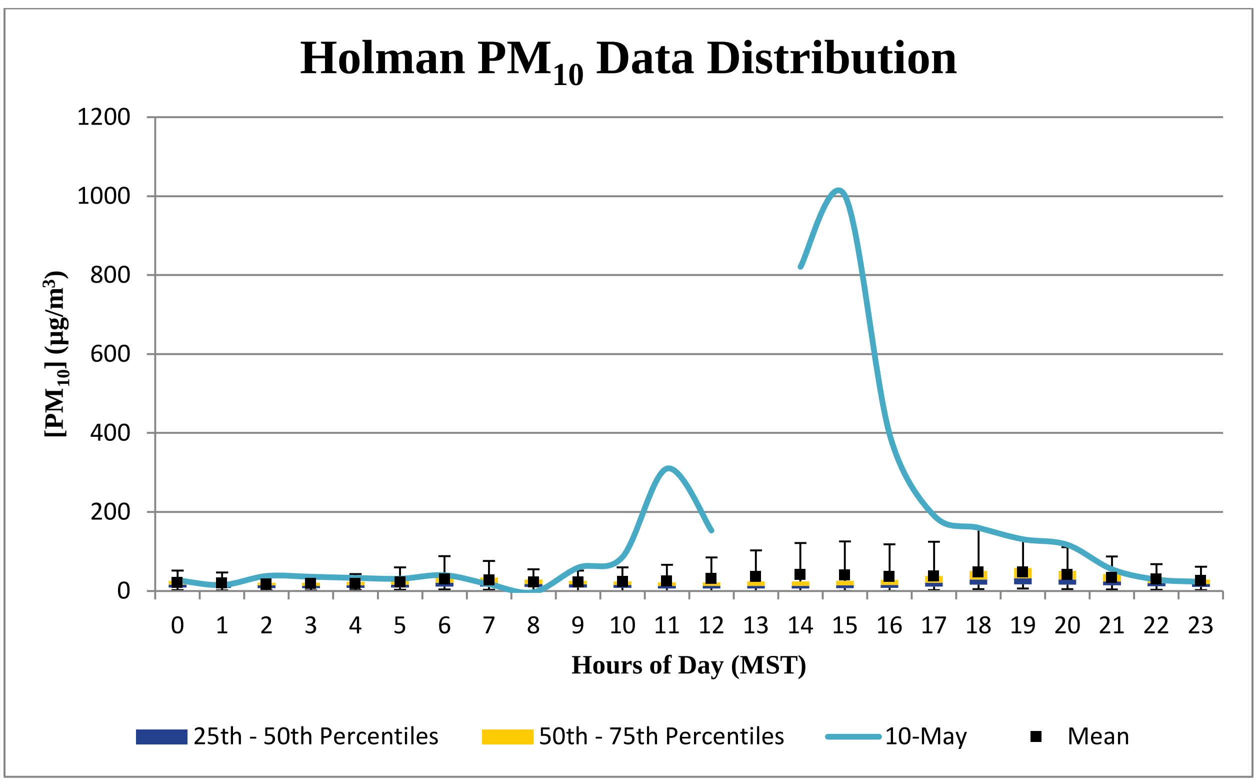

Figure 19-6c. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

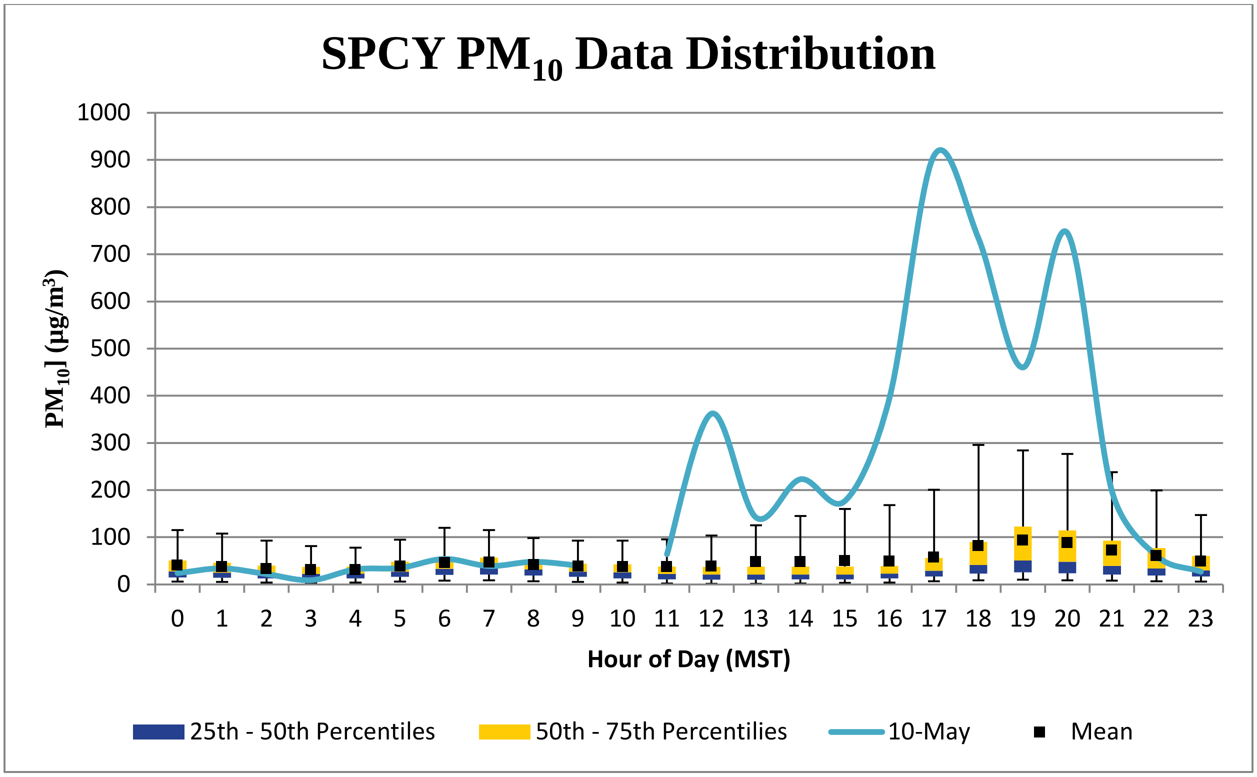

Figure 19-6d. PM_{10} **hourly data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.**

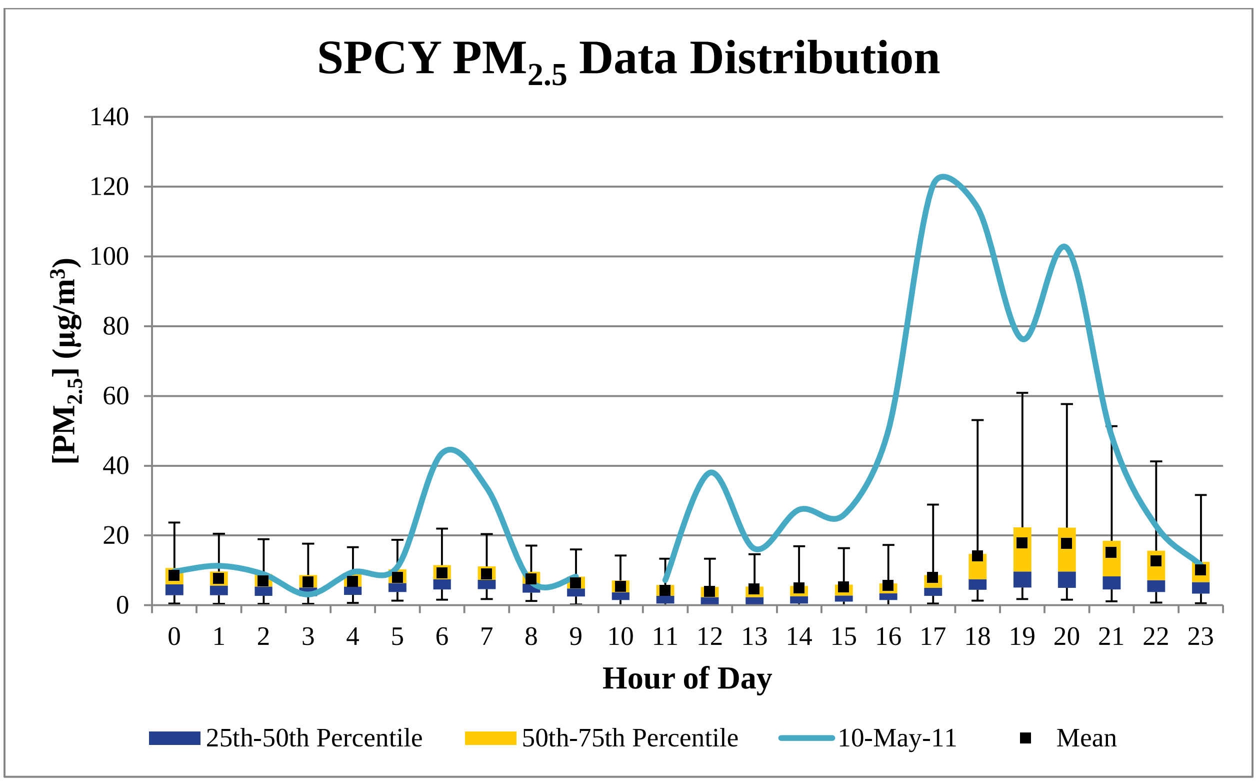

Figure 19-6e. $PM_{2.5}$ **hourly data distribution from 2006-2010 overlaid by hourly values for May 10, 2011**

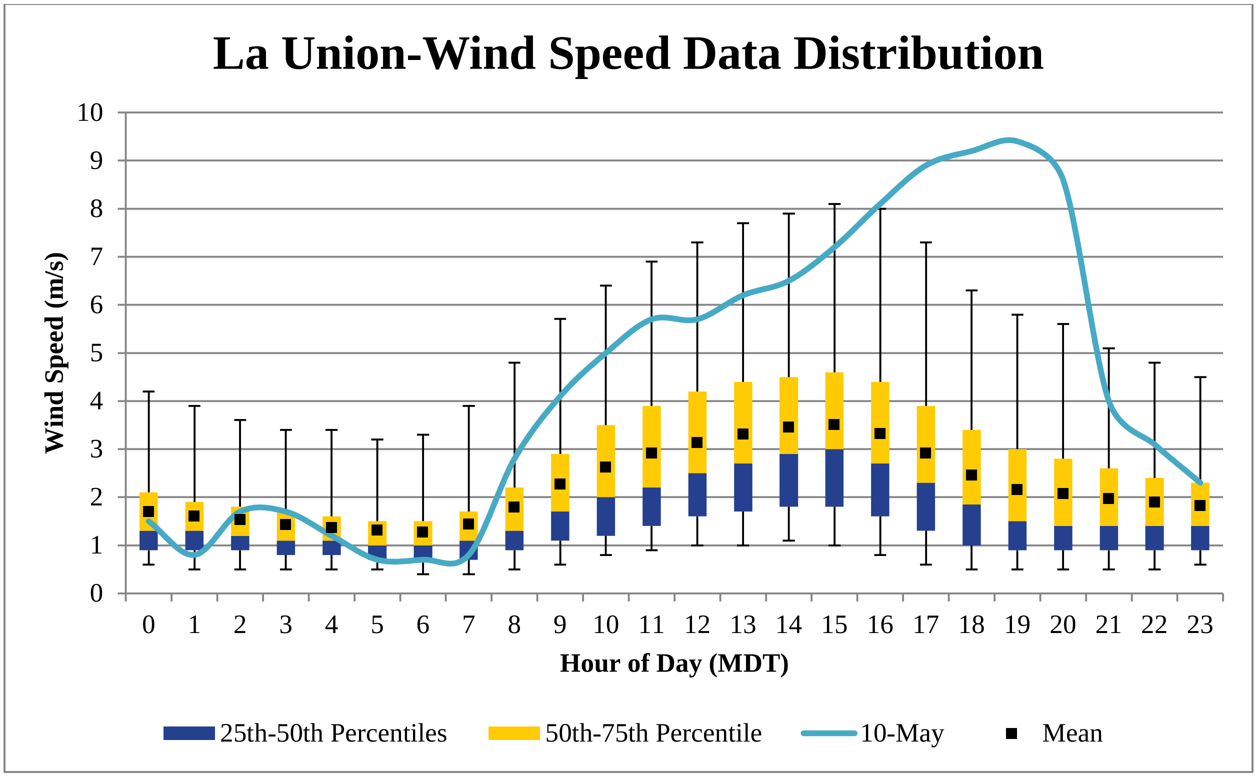

Figure 19-7a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

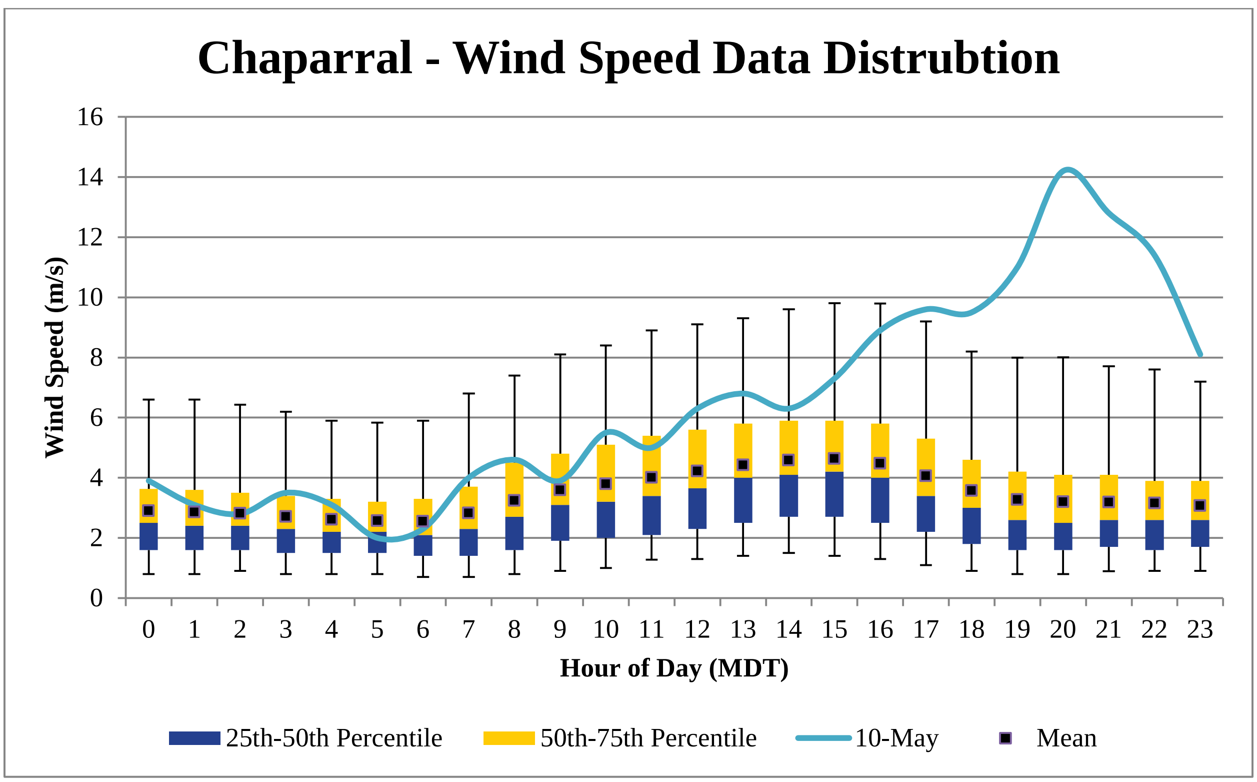

Figure 19-7b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

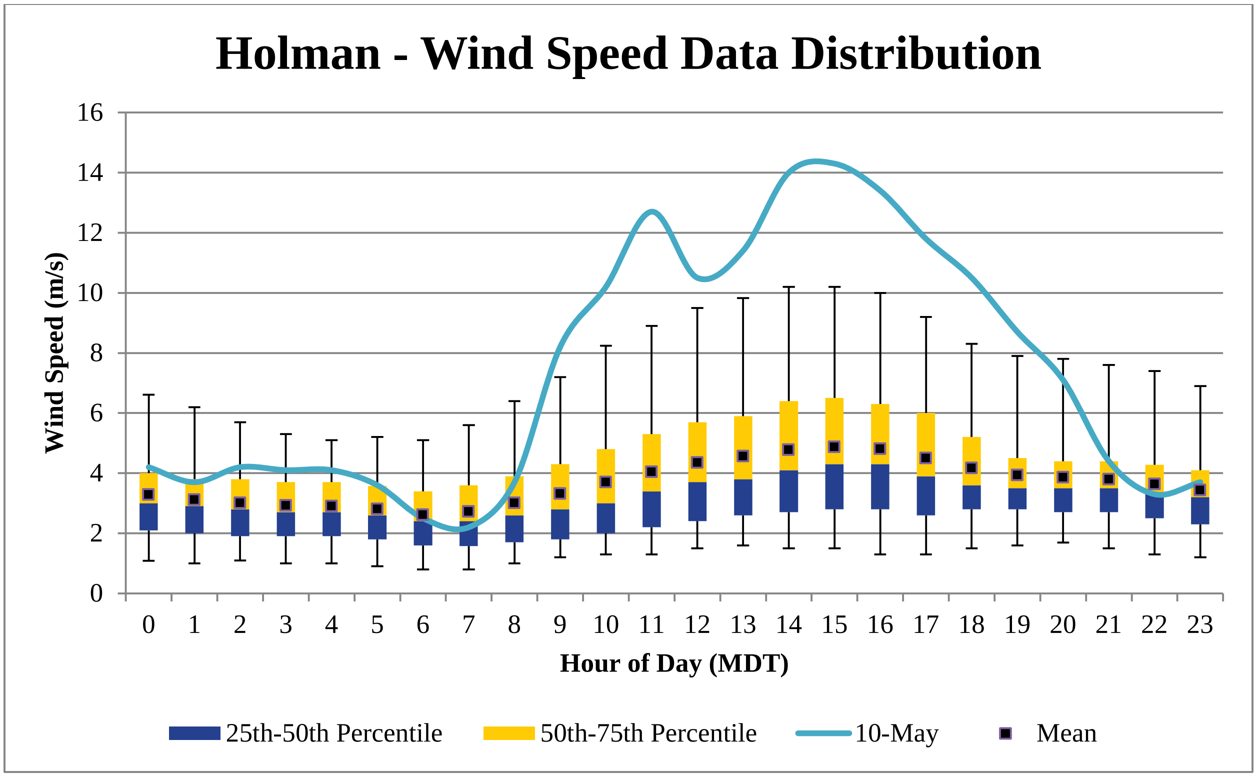

Figure 19-7c. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

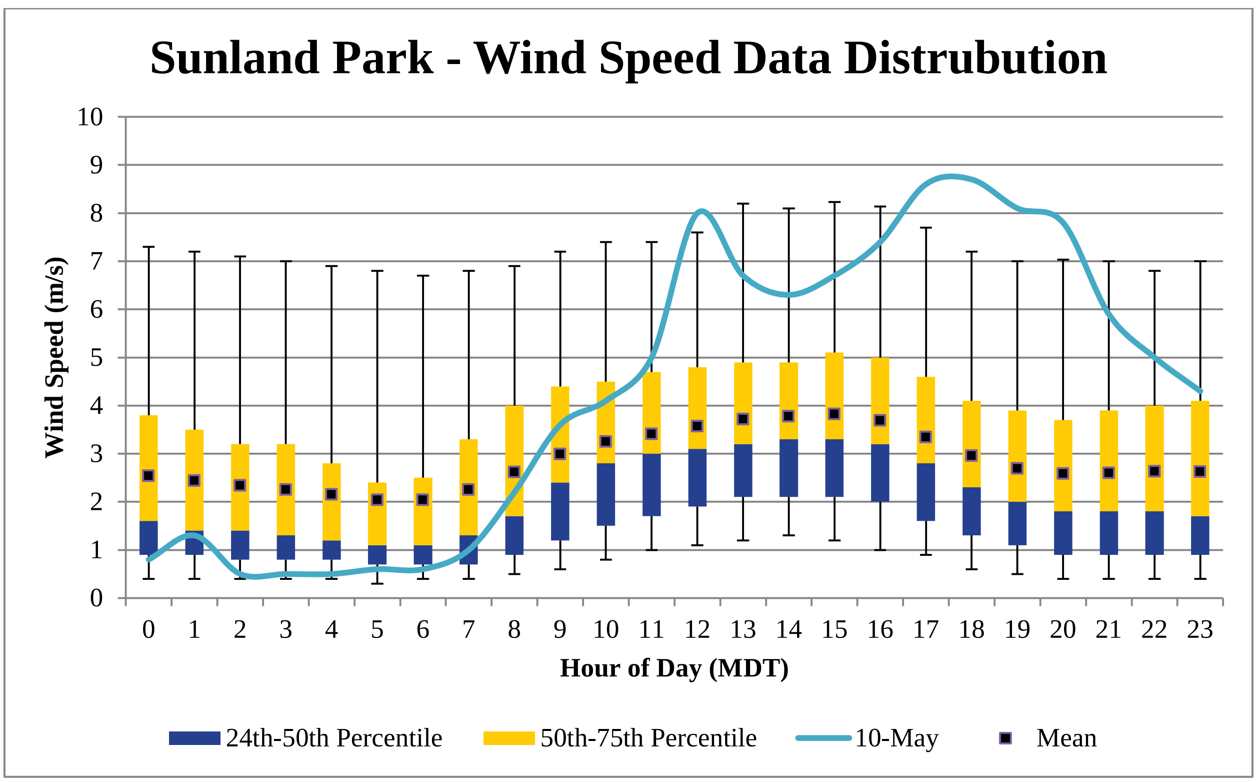

Figure 19-7d. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

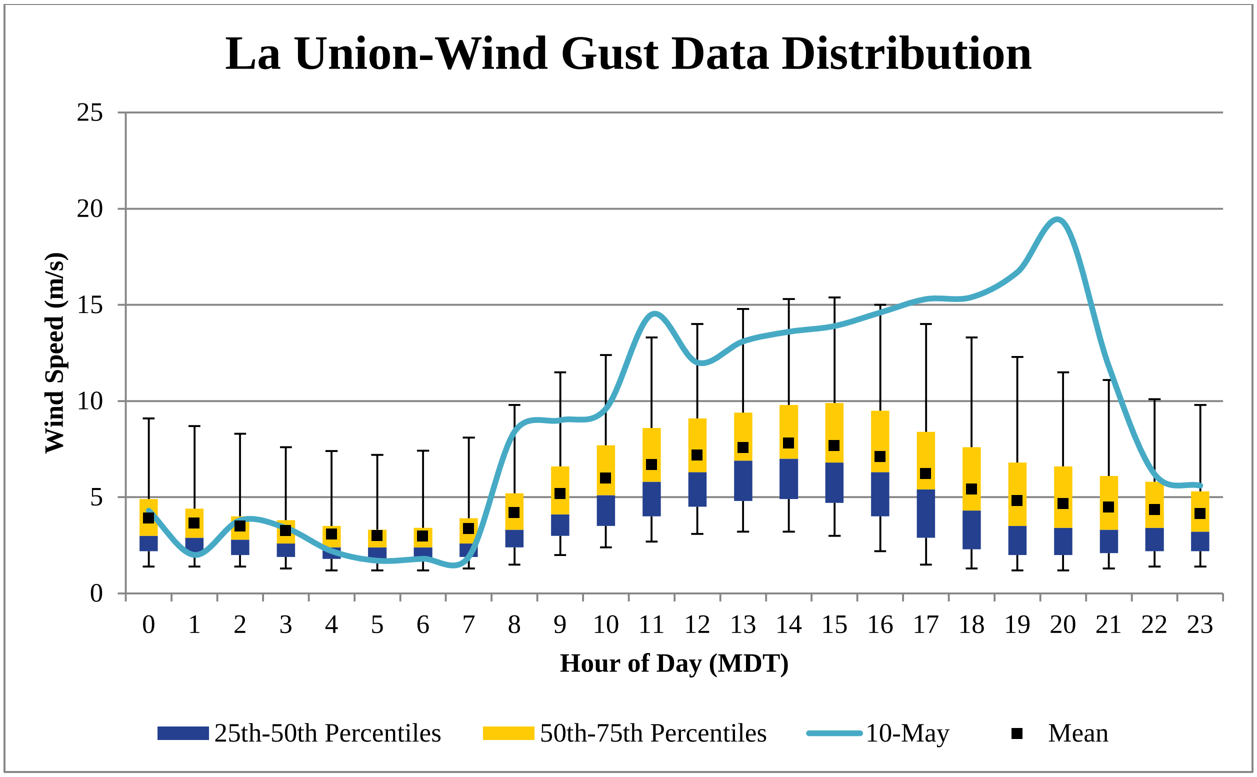

Figure 19-8a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

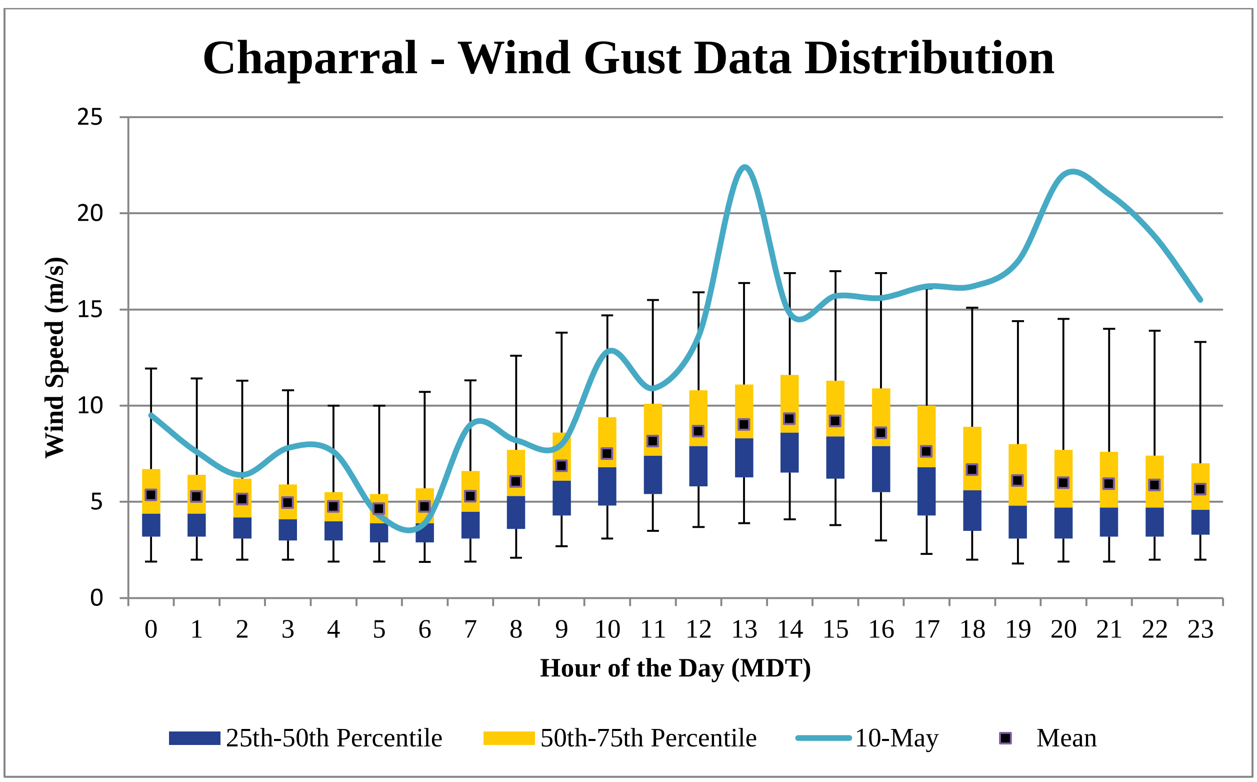

Figure 19-8b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

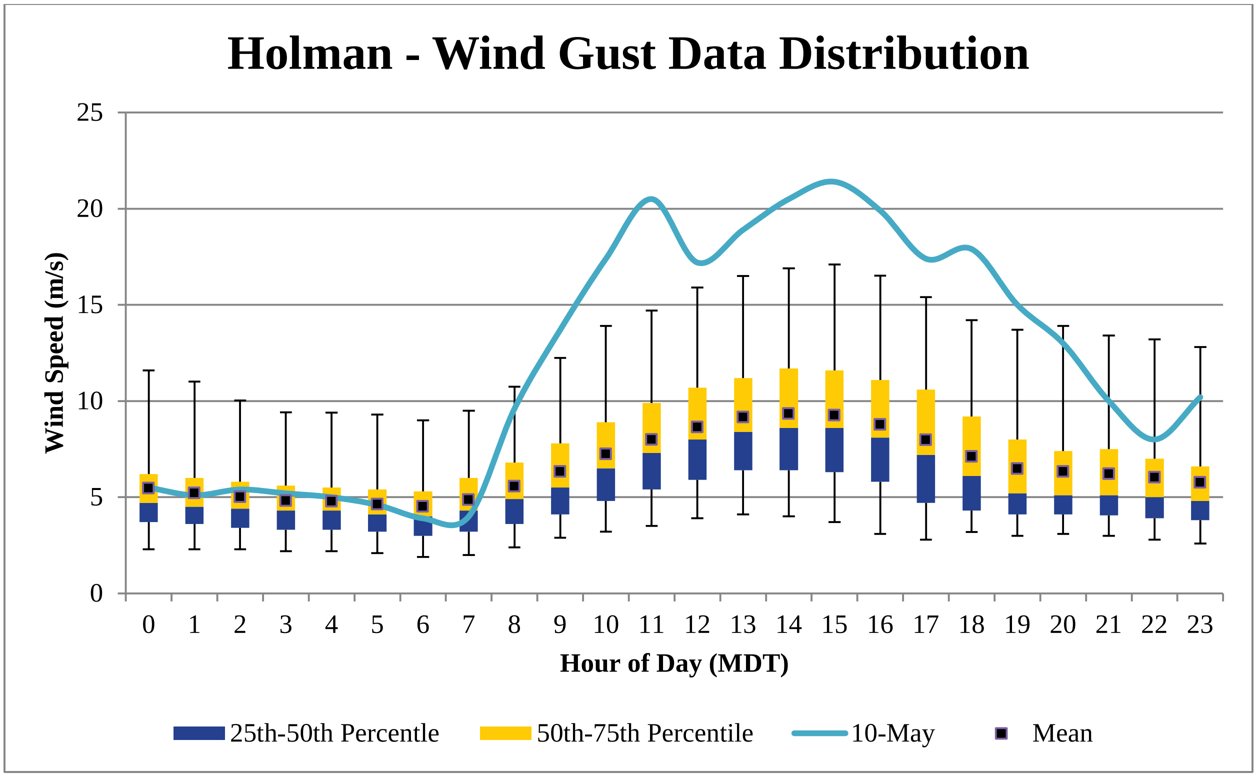

Figure 19-8c. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

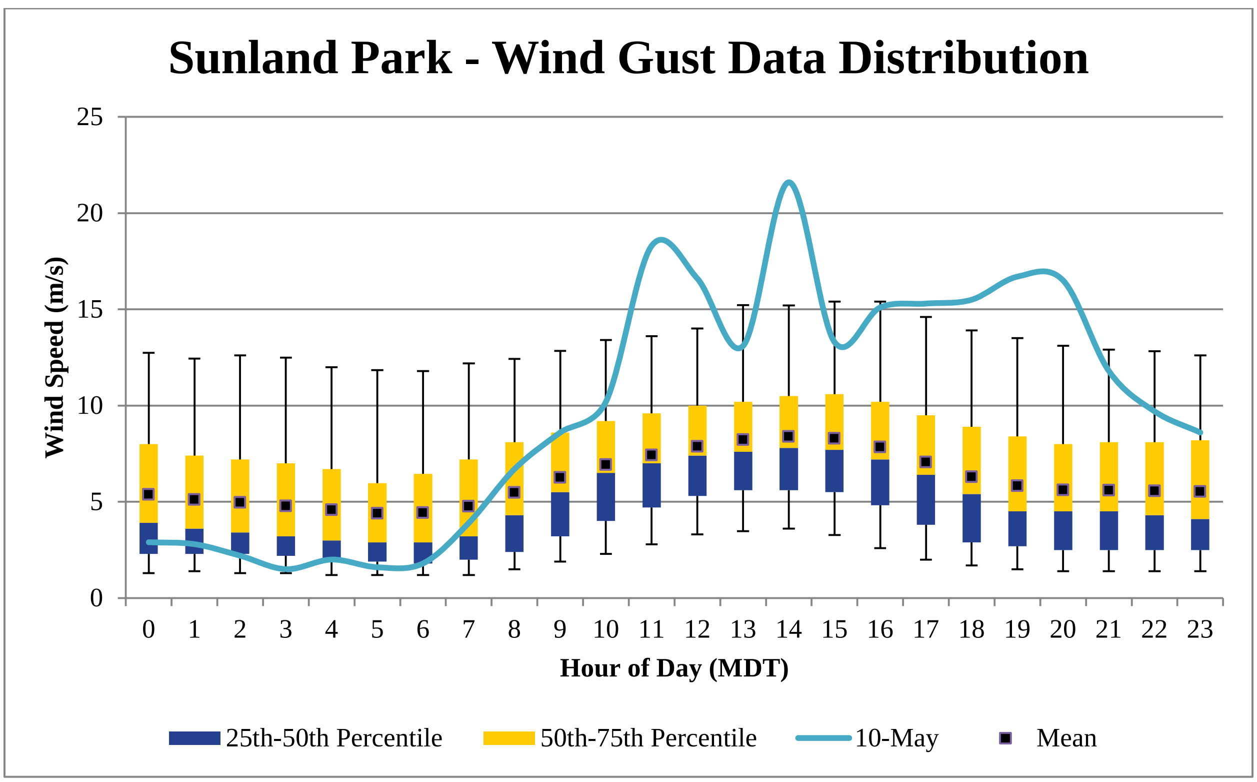

Figure 19-8d. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 10, 2011.

19.4 Clear Causal Relationship

A Pacific cold front passed through New Mexico on May 10, 2011, with a surface low pressure center in southeastern Colorado that created a pressure gradient over southeastern Arizona, southwestern New Mexico and northern Mexico. As the Pacific cold front moved through New Mexico, the pressure gradient tightened and winds became even stronger at the surface (Figure 19-9). Surface winds flow perpendicular to the isobars from high to low pressure. Low pressure aloft deepened the surface low tightening the pressure gradient and increasing surface winds. As the upper trough moved through New Mexico, the wind direction in the upper atmosphere aligned with the surface wind direction (Figure 19-10). Diurnal heating of the surface allowed winds aloft to mix downward, increasing the surface wind velocities and provided the turbulence required for vertical mixing and horizontal transport.

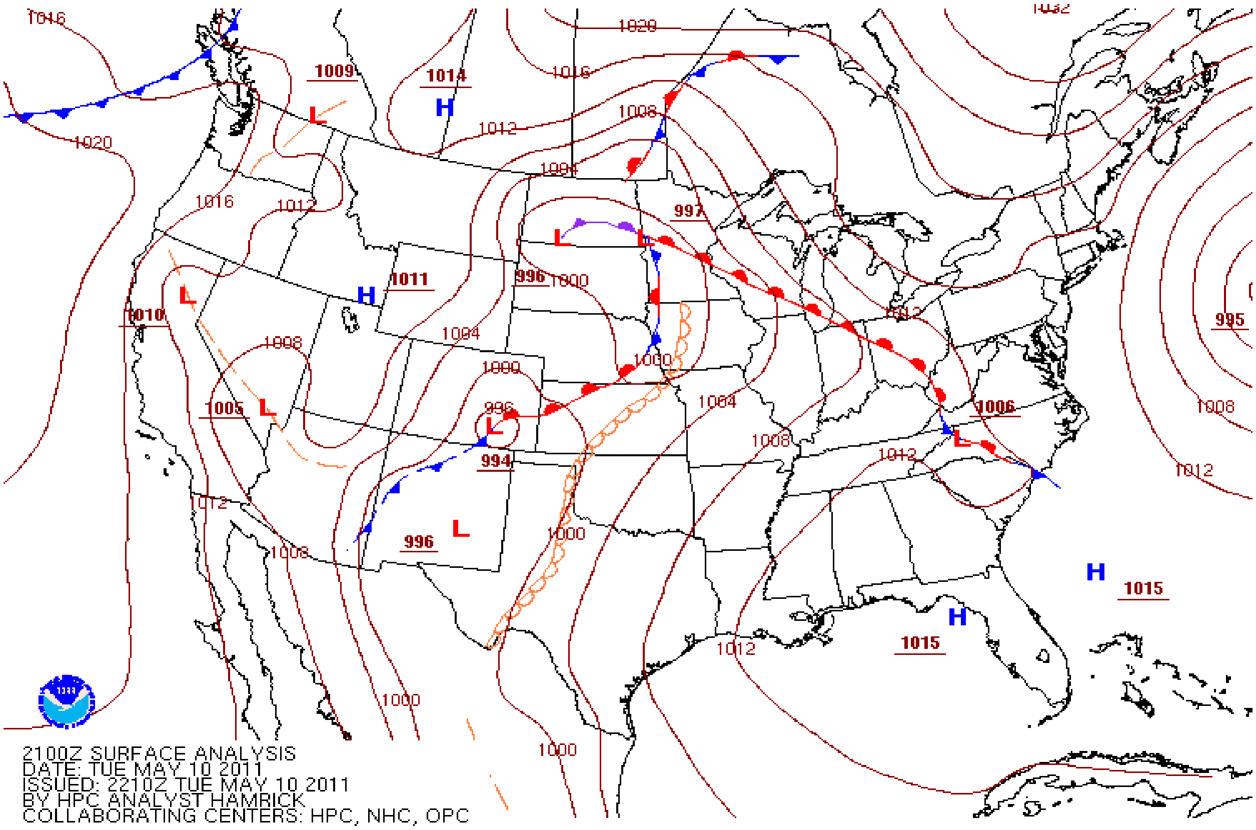

Figure 19-9. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for May 10, 2011 at the 1500 hour.

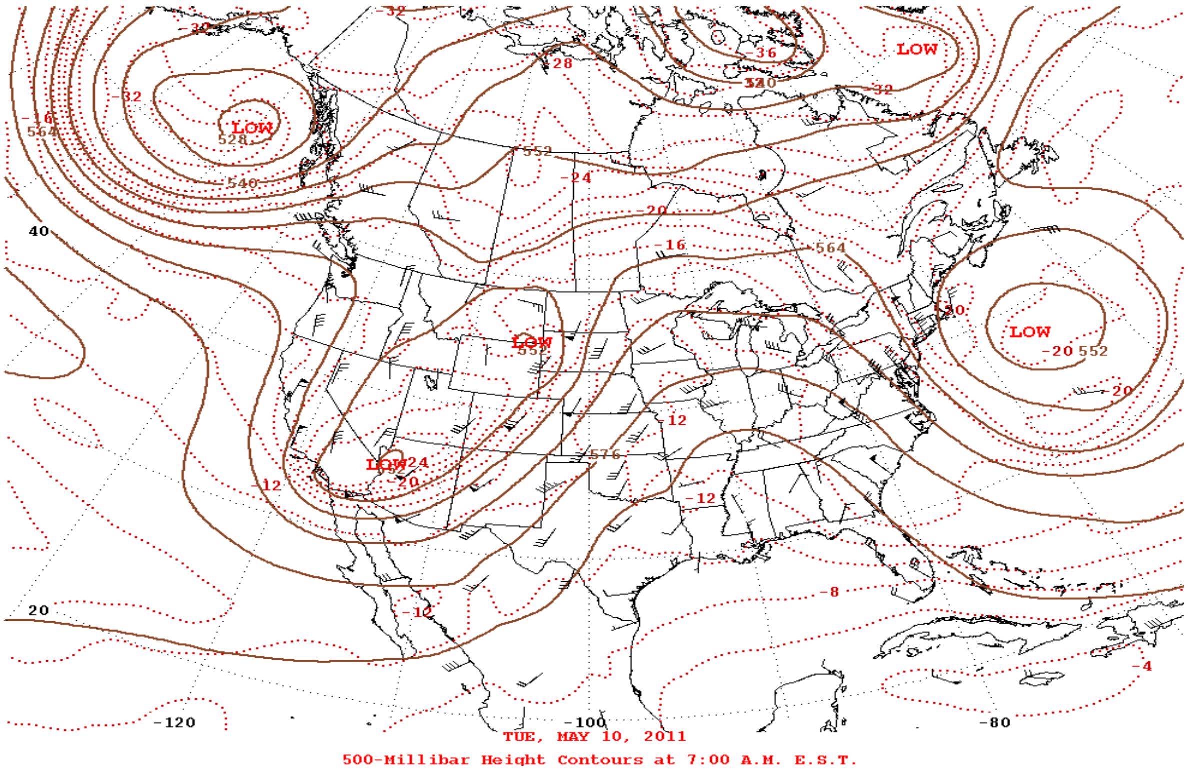

Figure 19-10. Upper air weather map showing geopotential heights (brown lines) at the 500 hour on May 10, 2011.

The weather pattern described above generated strong winds from the southwest beginning at the 1000 hour and lasting through the 2200 hour. Beginning at the 1100 hour, wind speeds exceeded 11.2 m/s at the Holman site as shown in Figure 19-2. Peak wind speeds ranged from 14.3 m/s at Holman monitoring site to 7.1 m/s at Desert View (Figure 19-2). Peak wind gusts ranged from 22.4 m/s at the Chaparral and West Mesa site to 16.9 m/s at the Desert View site (Figure 19-3). Blowing dust caused elevated levels of PM_{10} during the same period as high winds as demonstrated by the time series plot in Figure 19-11a-e. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (1000-2100 hours). During these hours, hourly PM_{10} and $PM_{2.5}$ concentrations spiked at all monitoring sites in the network (Figure 19-12a-b). Hourly data from the SPCY PM_{10} and $PM_{2.5}$ TEOM Monitors show good correlation of the timing of spikes in concentrations (Figure 19-13).

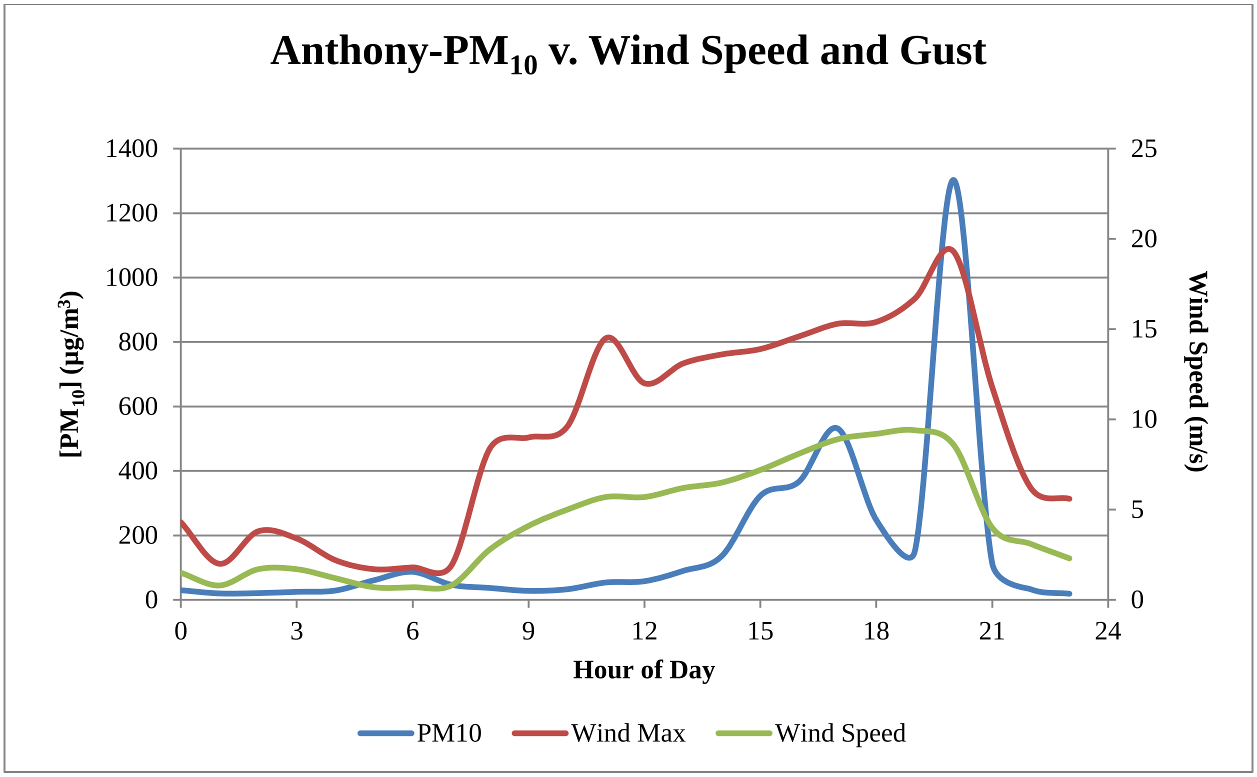

Figure 19-11a. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

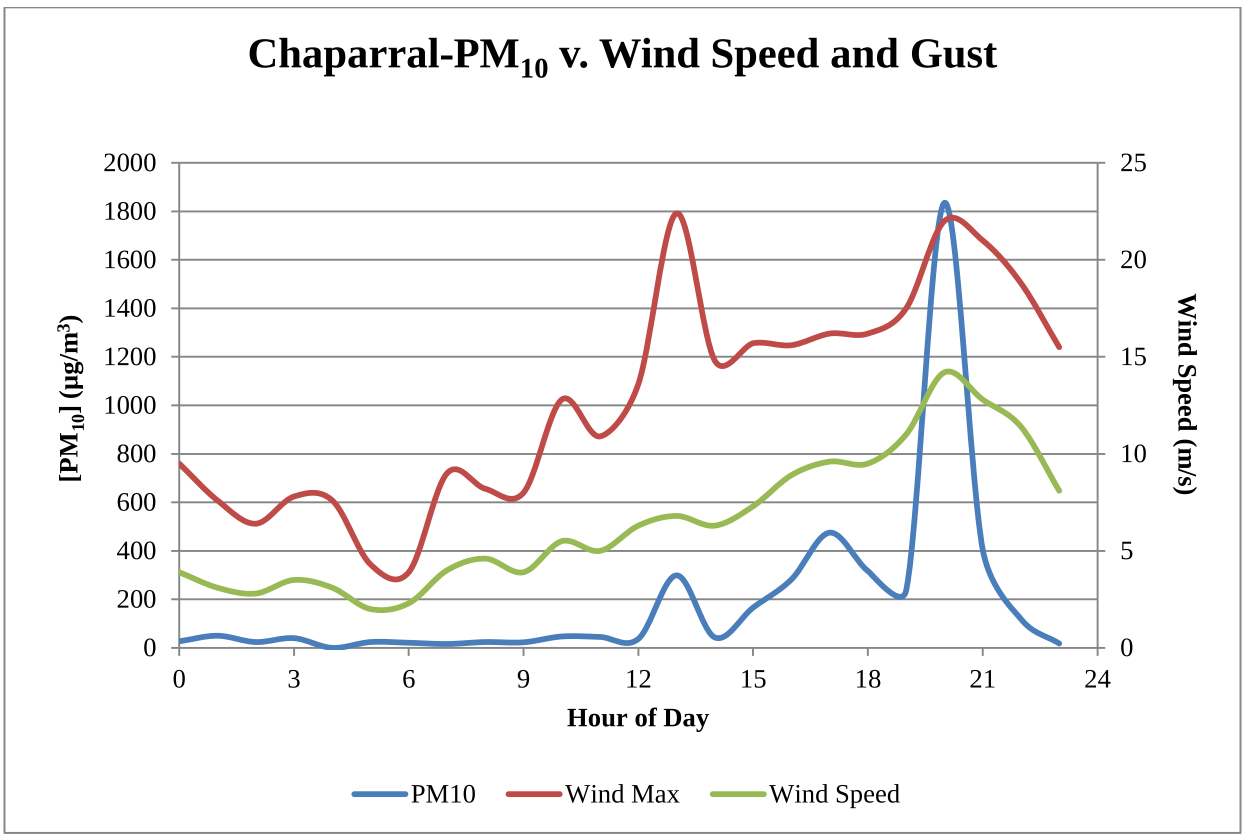

Figure 19-11b. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

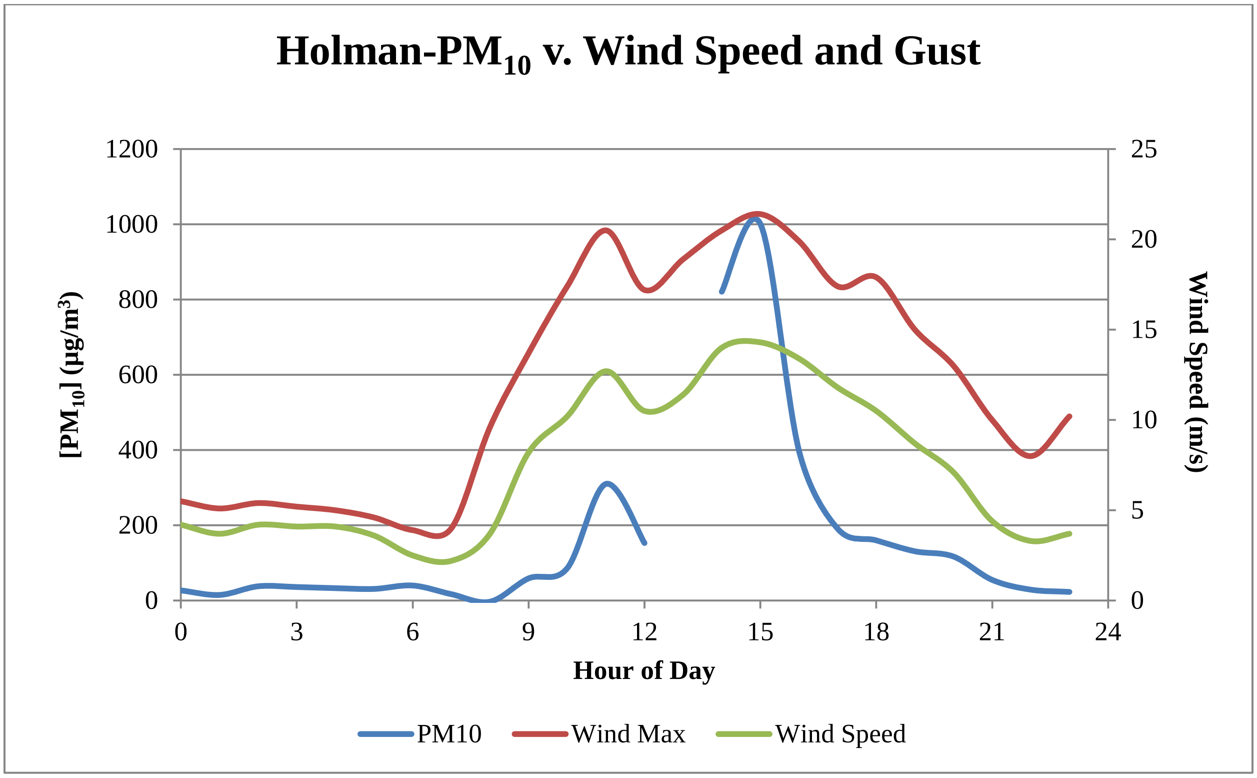

Figure 19-11c. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

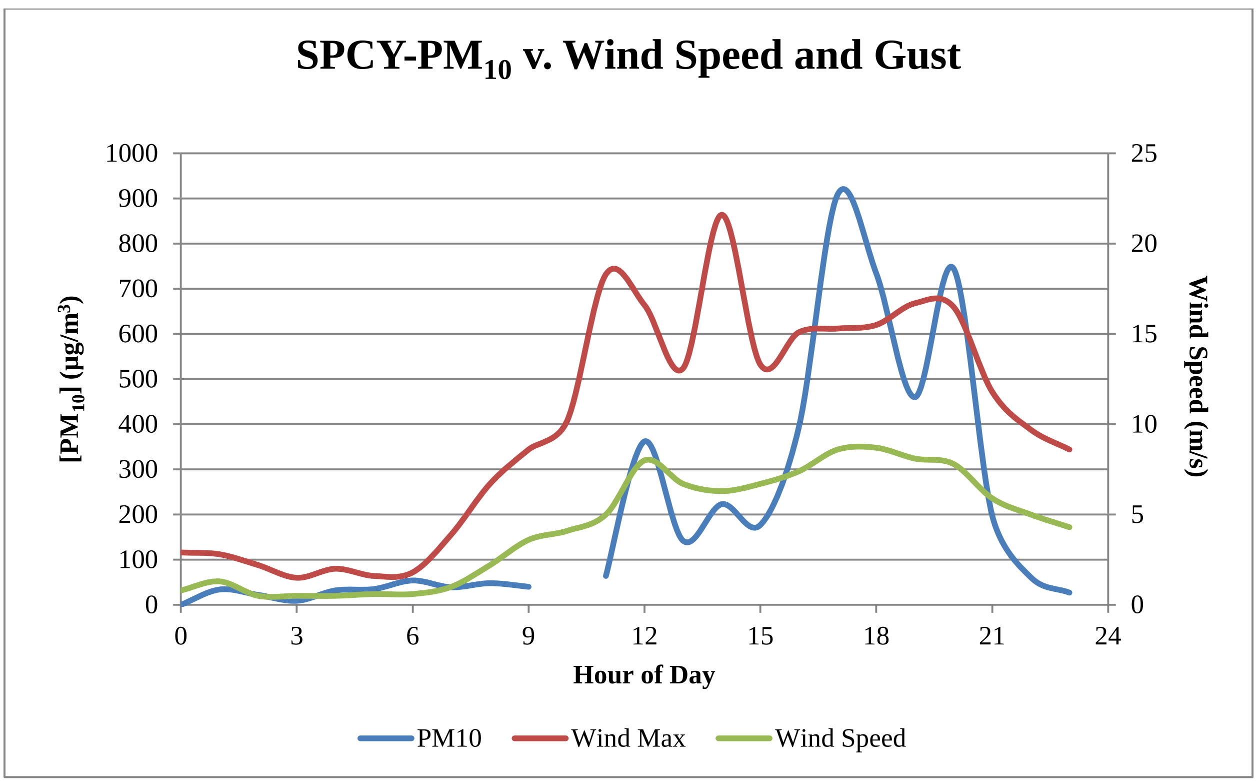

Figure 19-11d. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

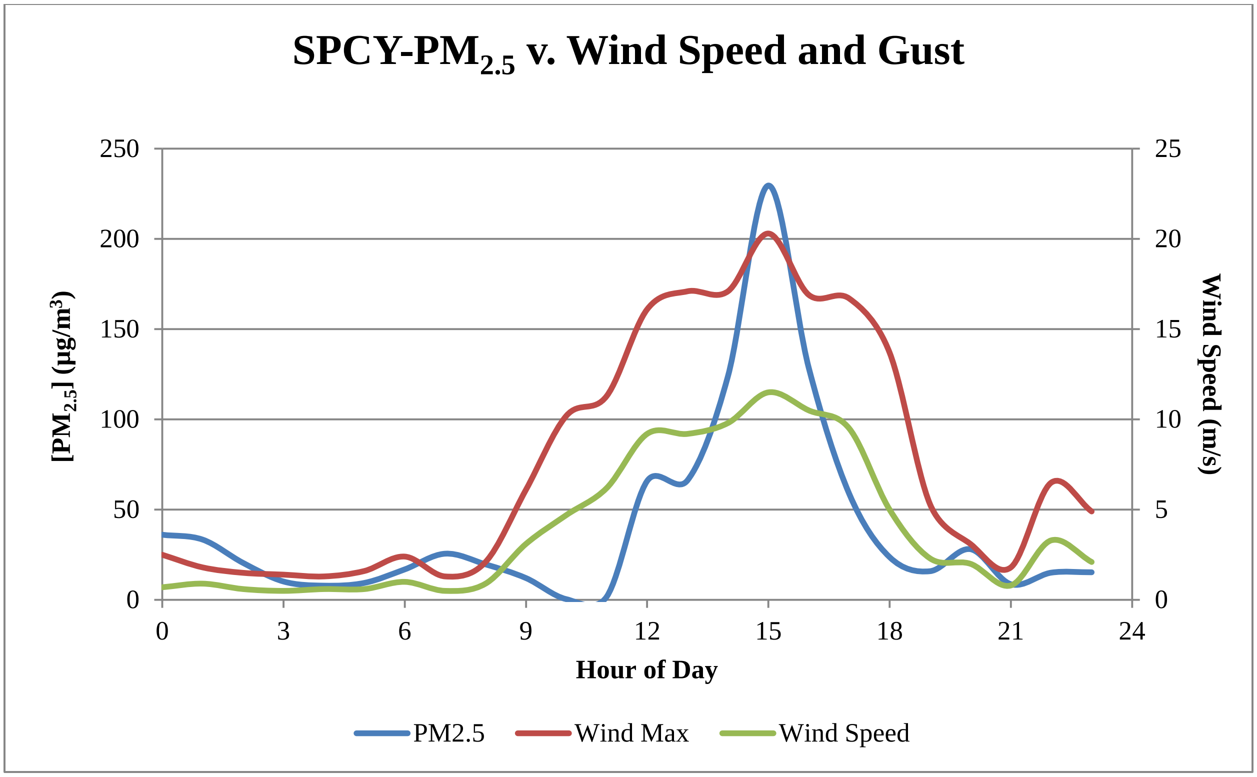

Figure 19-11e. Time series plot of hourly observations showing increased $PM_{2.5}$ concentrations as wind speeds and gusts increase. Non-FEM hourly $PM_{2.5}$ data.

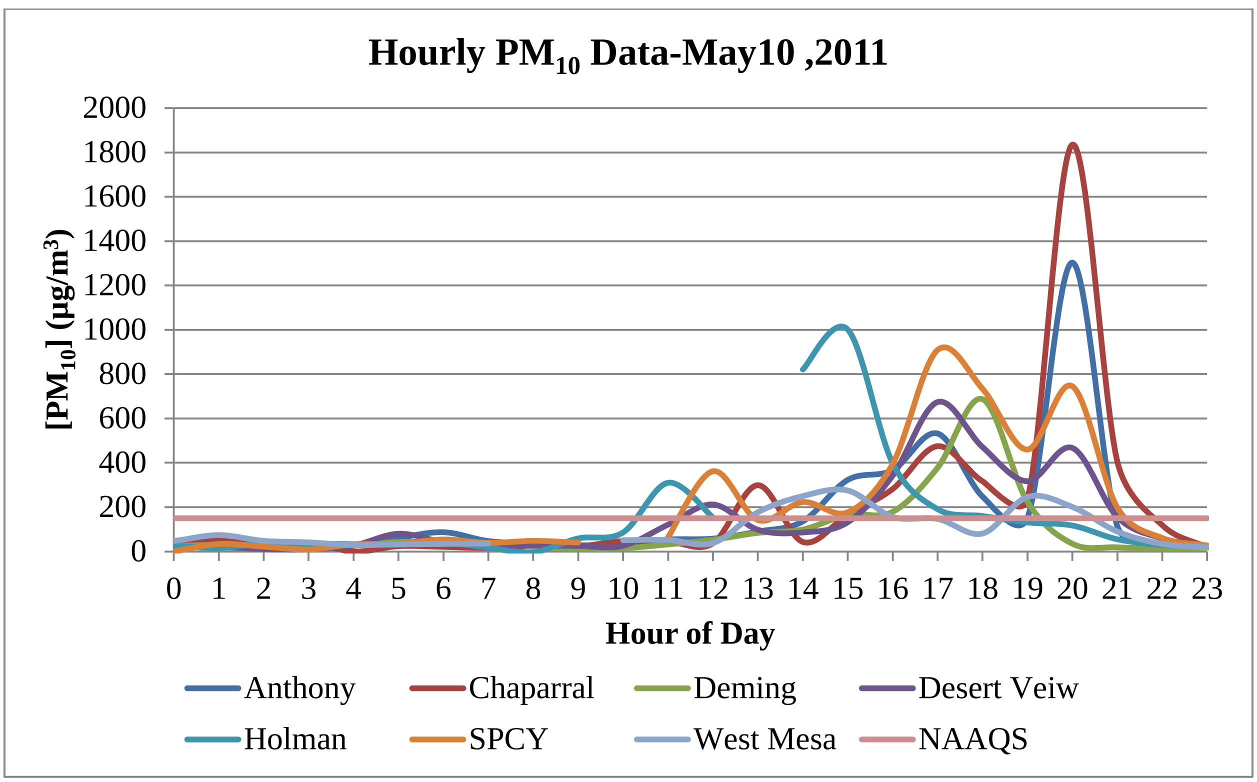

Figure 19-12a. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

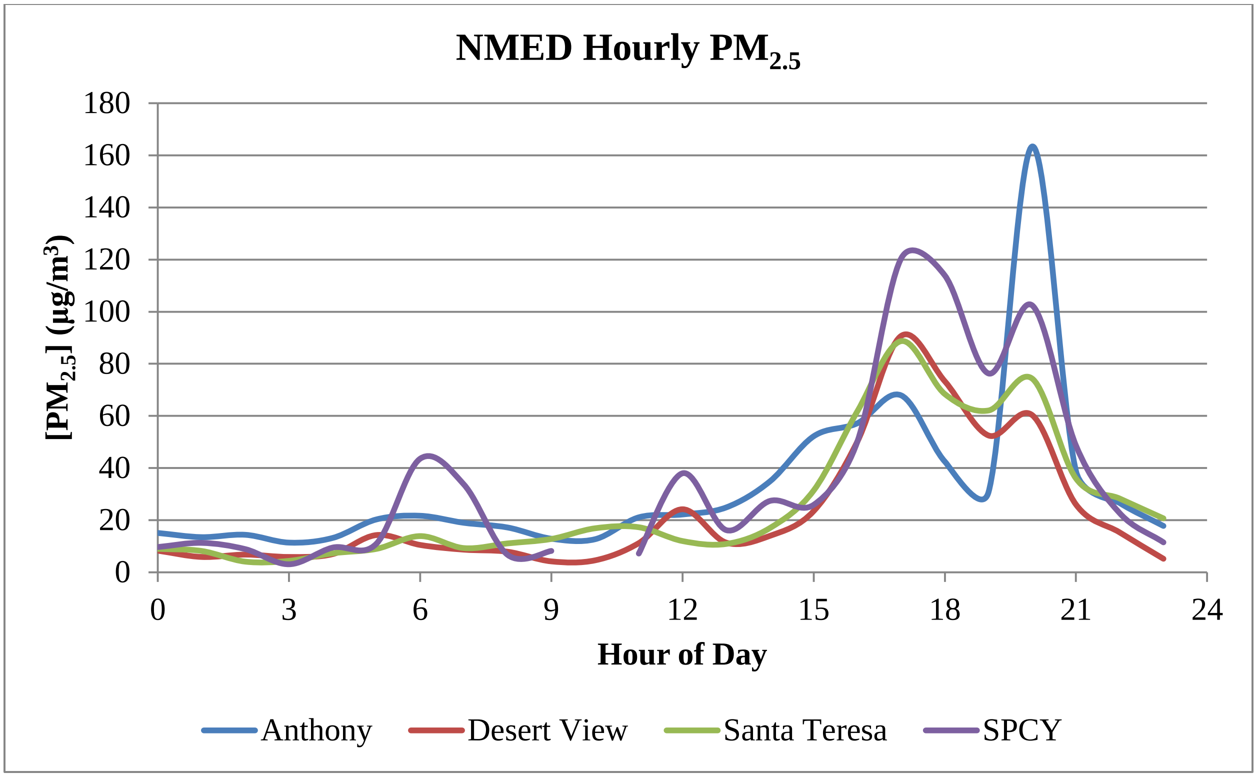

Figure 19-12b. Hourly $PM_{2.5}$ concentrations for Doña Ana County monitors. Non-FEM hourly $PM_{2.5}$ data.

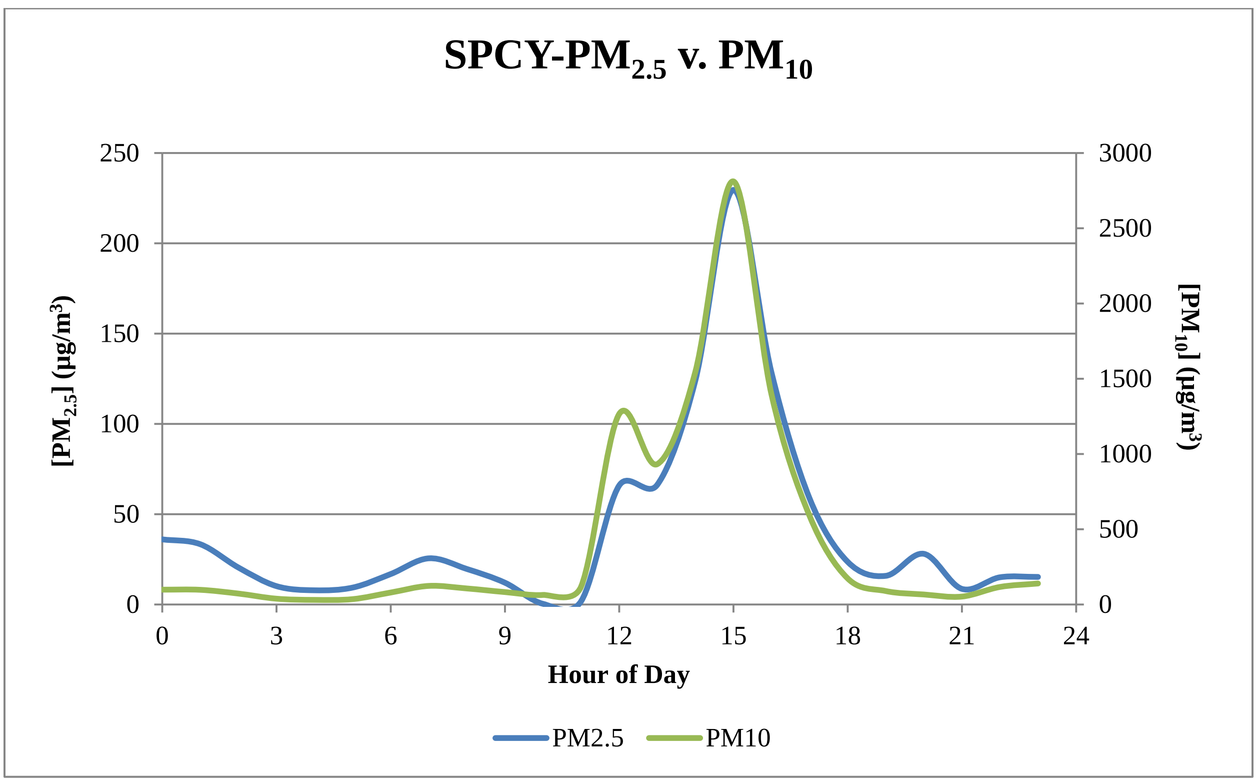

Figure 19-13. Hourly PM_{10} and $PM_{2.5}$ concentrations for the SPCY monitoring site on May 10, 2011.

Contemporary reports and modeling results support these claims. The NM Border AQ Blog reported (DuBois, 2011): "Another wind blown dust day. The NWS forecast is calling for afternoon winds in the 30 and 33 mph range with gusts up to 47 mph (Figure 19-14)."

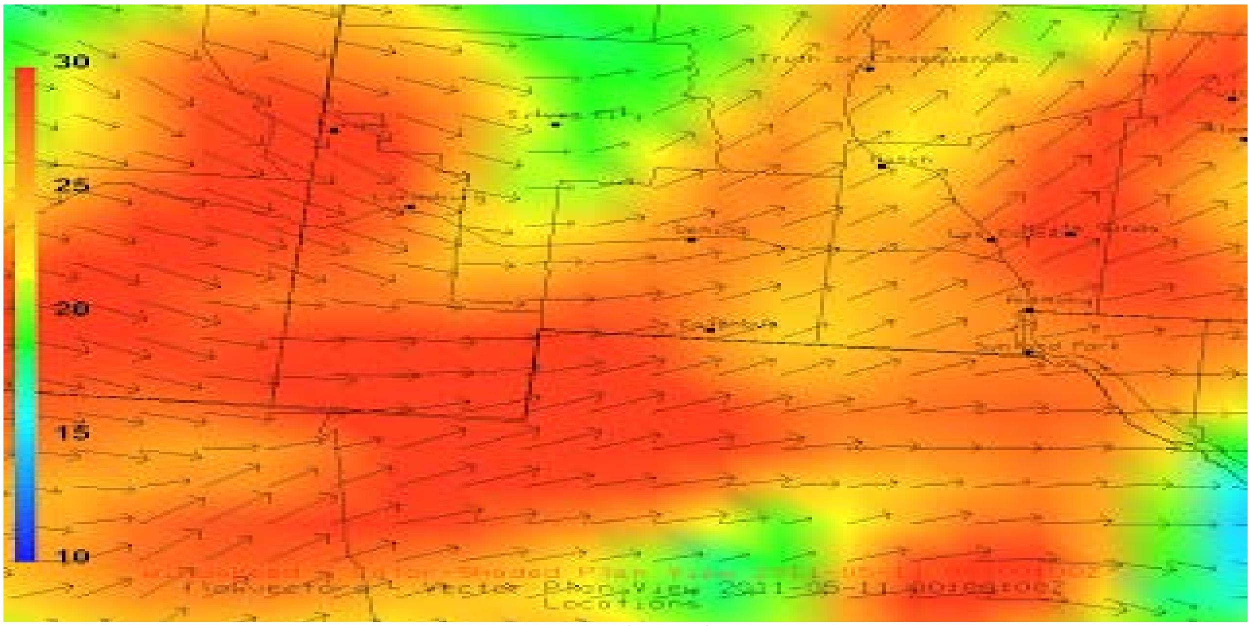

Figure 19-14. May 10, 2011 NOAA Rapid Update Cycle model wind forecast for the 1800 hour.

EPA's AQI forecast predicted air quality to be unhealthy for sensitive groups in southern Doña Ana and Otero counties and west Texas due to $PM_{2.5}$ for this date (Figure 19-15).

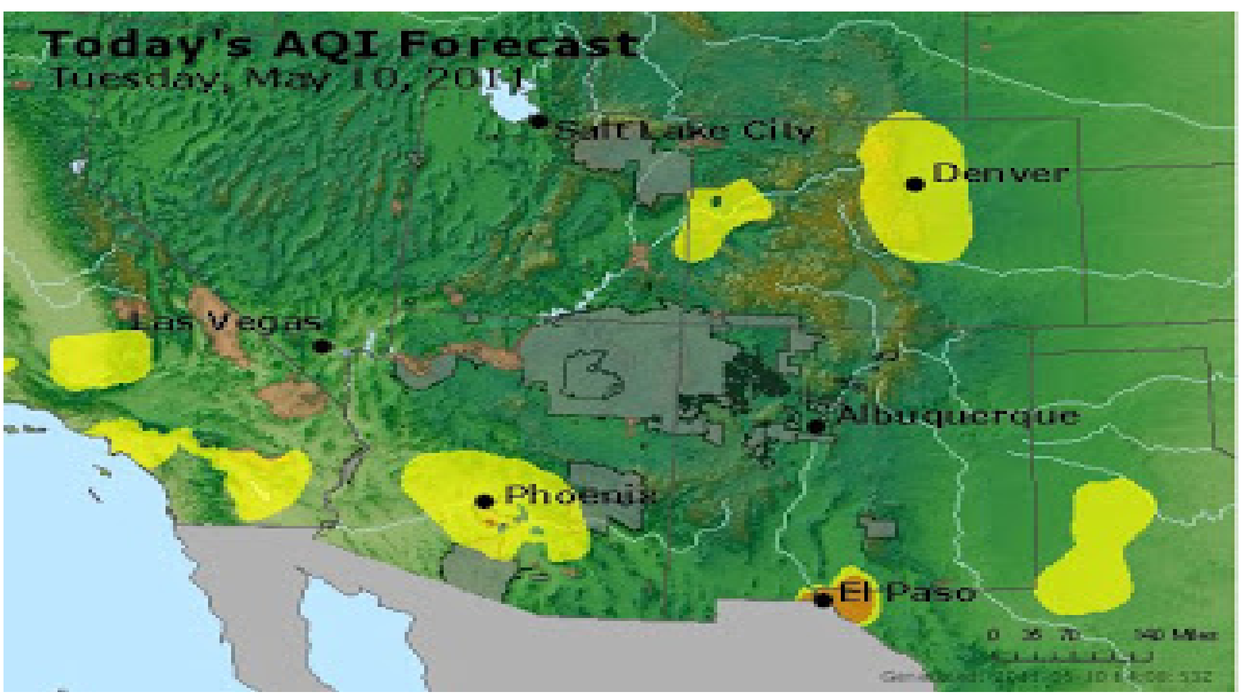

Figure 19-15. May 10, 2011 EPA AQI forecasts showing the expected impacts of blowing dust.

The GOES satellite detected blowing dust throughout southern New Mexico and west Texas as captured by the image below (Figure 19-16).

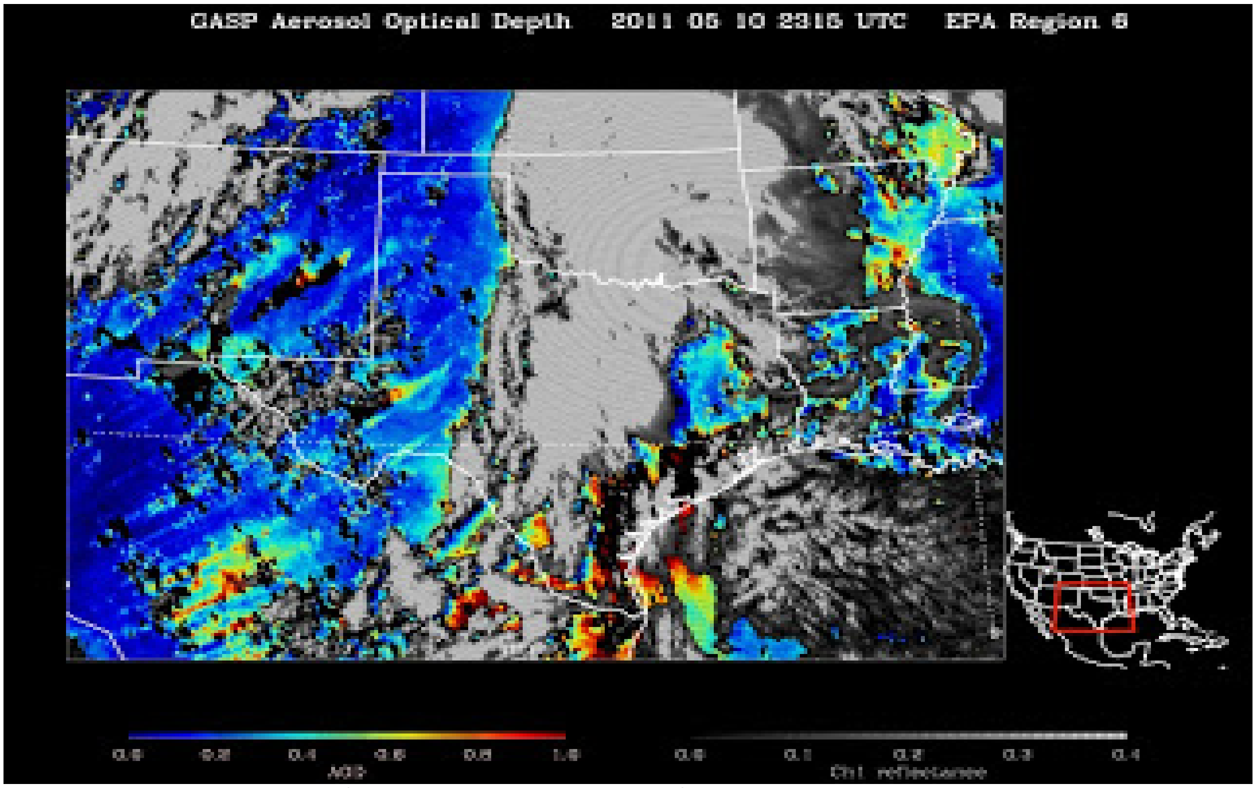

Figure 19-16. Aerosol Optical Depth from the GOES satellite. Courtesy of NOAA.

The NWS issued a high wind advisory for May 10, 2011 in the early morning and again in the afternoon with the following heading (NWS, 2011):

...STRONG WINDS AND BLOWING DUST ARE OCCURRING THIS AFTERNOON...

19.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on May 10, 2011.

19.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by high wind and blowing dust.

19.7 No Exceedance but for the Event

The Anthony monitor detected blowing dust around the 1500 hour with hourly concentrations heavily impacted until the 2000 hour. By replacing the five hourly values heavily impacted by blowing dust with the 95th percentile of hourly data at the Anthony site, the resulting 24-hour average (81 µg/m^3) does not exceed the NAAQS (Table 19-1). The values in red represent the 95th percentile of all hourly data collected at Anthony, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	30	30
1	20	20
2	21	21
3	25	25
4	29	29
5	61	61
6	87	87
7	47	47
8	37	37
9	28	28
10	33	33
11	54	54
12	58	58
13	90	90
14	136	136
15	323	**172**
16	367	**152**
17	532	**194**
18	248	**197**
19	152	152
20	1303	**160**
21	114	114
22	33	33
23	19	19
24-Hour Average	160	**81**

Table 19-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Anthony.

The Chaparral monitor detected blowing dust around the 1300 hour with hourly concentrations heavily impacted until the 2100 hour. The seven hourly PM_{10} values from 1300-2100 hours that were heavily impacted by dust alone, exceed the 24-hour average standard at Chaparral [(299 + 282 + 475 + 317 + 237 + 1835 + 406) $\mu g/m^3$ = 4060 $\mu g/m^3$; (4060 $\mu g/m^3$)/24 = 169 $\mu g/m^3$]. By replacing these seven hourly values with the 95th percentile of hourly data at the Chaparral site, the resulting 24-hour average (65 $\mu g/m^3$) does not exceed the NAAQS (Table 19-2). The values in red represent the 95th percentile of all hourly data collected at Chaparral, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	27	27
1	50	50
2	24	24
3	40	40
4	0	0
5	24	24
6	21	21
7	16	16
8	24	24
9	23	23
10	47	47
11	45	45
12	37	37
13	299	**151**
14	43	43
15	166	166
16	282	**127**
17	475	**122**
18	317	**120**
19	237	**126**
20	1835	**111**
21	406	**94**
22	119	119
23	18	18
24-Hour Average	190	**65**

Table 19-2. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Chaparral.

The Holman monitor detected blowing dust around the 1400 hour with hourly concentrations heavily impacted until the 1600 hour. By replacing these three hourly values with the 95th percentile of hourly data at the Holman site, the resulting 24-hour average (83 µg/m^3) does not exceed the NAAQS (Table 19-3). The values in red represent the 95th percentile of all hourly data collected at Holman, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	27	27
1	15	15
2	38	38
3	36	36
4	33	33
5	31	31
6	40	40
7	17	17
8	0	0
9	59	59
10	86	86
11	310	310
12	153	153
13		
14	821	**122**
15	1001	**125**
16	398	**118**
17	191	191
18	160	160
19	131	131
20	117	117
21	55	55
22	29	29
23	23	23
24-Hour Average	163	**83**

Table 19-3. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Holman.

The Sunland Park monitor detected blowing dust around the 1200 hour with hourly concentrations heavily impacted until the 2000. The nine hourly PM_{10} values from 1200-2000 hours alone, exceed the 24-hour average standard at Sunland Park [(362 + 142 + 223 + 177 + 395 + 909 + 734 + 460 + 745) µg/m^3 = 4147 µg/m^3; (4147 µg/m^3)/24 = 172 µg/m^3]. By replacing these nine hourly values with the 95th percentile of hourly data at the Sunland Park site, the resulting 24-hour average (106 µg/m^3) does not exceed the NAAQS (Table 19-4). The values in red represent the 95th percentile of all hourly data collected at Sunland Park, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	24	24
1	34	34
2	22	22
3	9	9
4	32	32
5	35	35
6	54	54
7	39	39
8	48	48
9	40	40
10		
11	64	64
12	362	**104**
13	142	**125**
14	223	**145**
15	177	**160**
16	395	**168**
17	909	**201**
18	734	**296**
19	460	**284**
20	745	**277**
21	198	198
22	61	61
23	27	27
24-Hour Average	210	**106**

Table 19-4. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Sunland Park.

20 HIGH WIND EXCEPTIONAL EVENT: May 18, 2011

20.1 Summary of Event

The passing of a Pacific cold front caused high winds and blowing dust in southern Doña Ana County resulting in exceedances of the PM_{10} and $PM_{2.5}$ 24-hour NAAQS and the $PM_{2.5}$ annual NAAQS at the Anthony, Chaparral, Desert View, and Sunland Park monitoring sites on this date. The FEM TEOM continuous monitors at these sites recorded 24-hour average concentrations of 233, 216,157, 299 µg/m^3, respectively. The $PM_{2.5}$ FRM Partisol at the SPCY site recorded a 24-hour average concentration of 29.7 µg/m^3. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were also measured at Deming Airport (134 µg/m^3) (Figure 20-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event. Elevated concentrations were also recorded by the $PM_{2.5}$ non-FEM/FRM TEOMs (Figure 20-2).

As the event unfolded, the wind blew from the southwest direction throughout the border region. These high velocity winds passed over large areas of desert within Arizona, Texas, New Mexico and Mexico. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

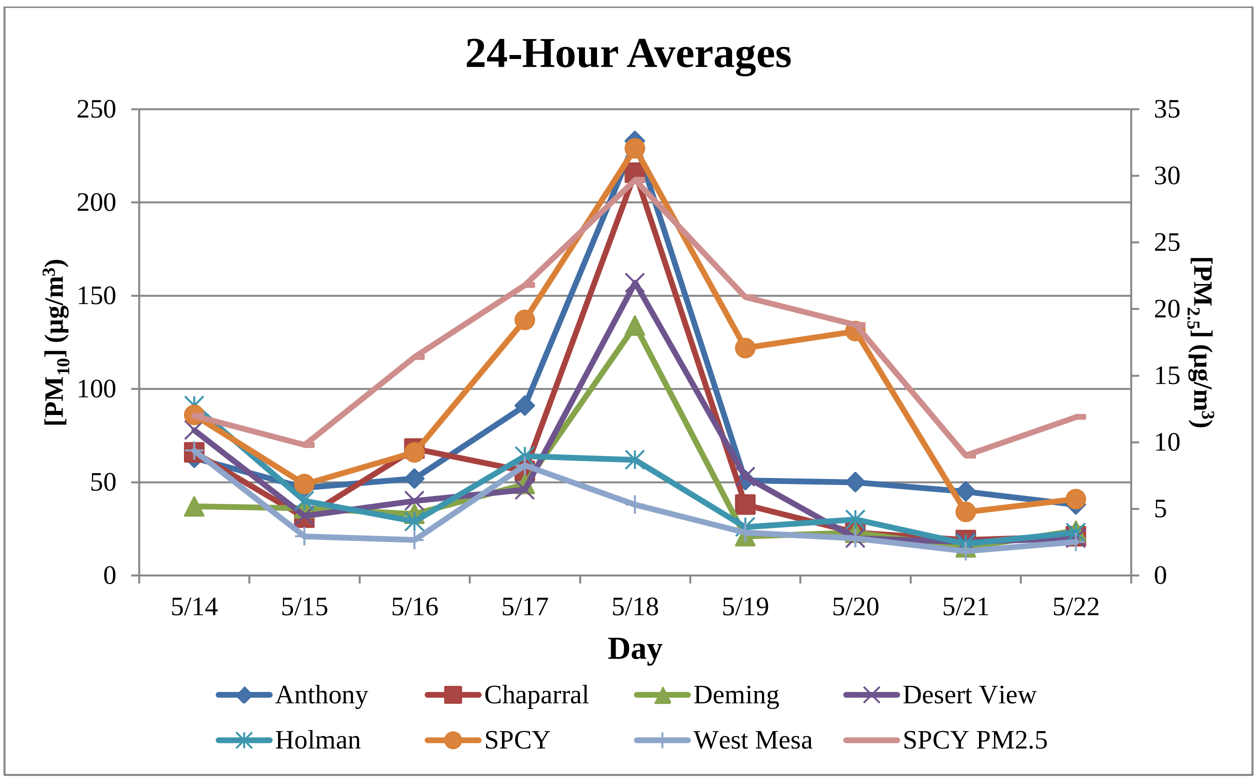

Figure 20-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after May 18, 2011.

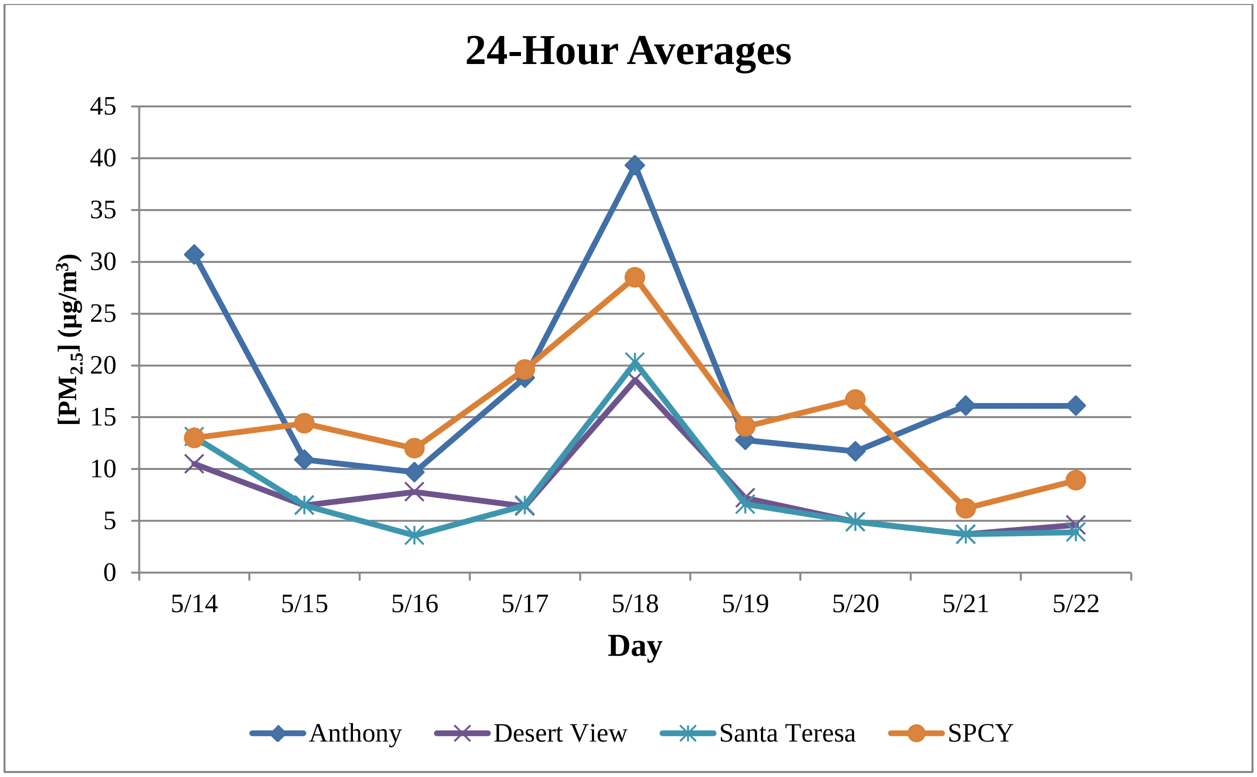

Figure 20-2. $PM_{2.5}$ 24-hour averages before and after May 18, 2011. Non FRM/FEM TEOM data.

20.2 Is Not Reasonably Controllable or Preventable

20.2.1 <u>Suspected Source Areas and Categories Contributing to the Event</u>

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in Arizona, Texas, New Mexico, and Mexico. City of Las Cruces, City of Deming and Doña Ana County Ordinances requires BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and the playas of northern Mexico (see Section 20.2.4 below).

20.2.2 <u>Sustained and Instantaneous Wind Speeds</u>

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On May 18, 2011, sustained wind speeds exceeded EPA's default threshold at three of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at six of the seven monitoring sites (Figures 20-3 and 20-4). Winds exceeded these thresholds at one or more monitoring sites beginning at the 1200 hour and ending at the 1900 hour.

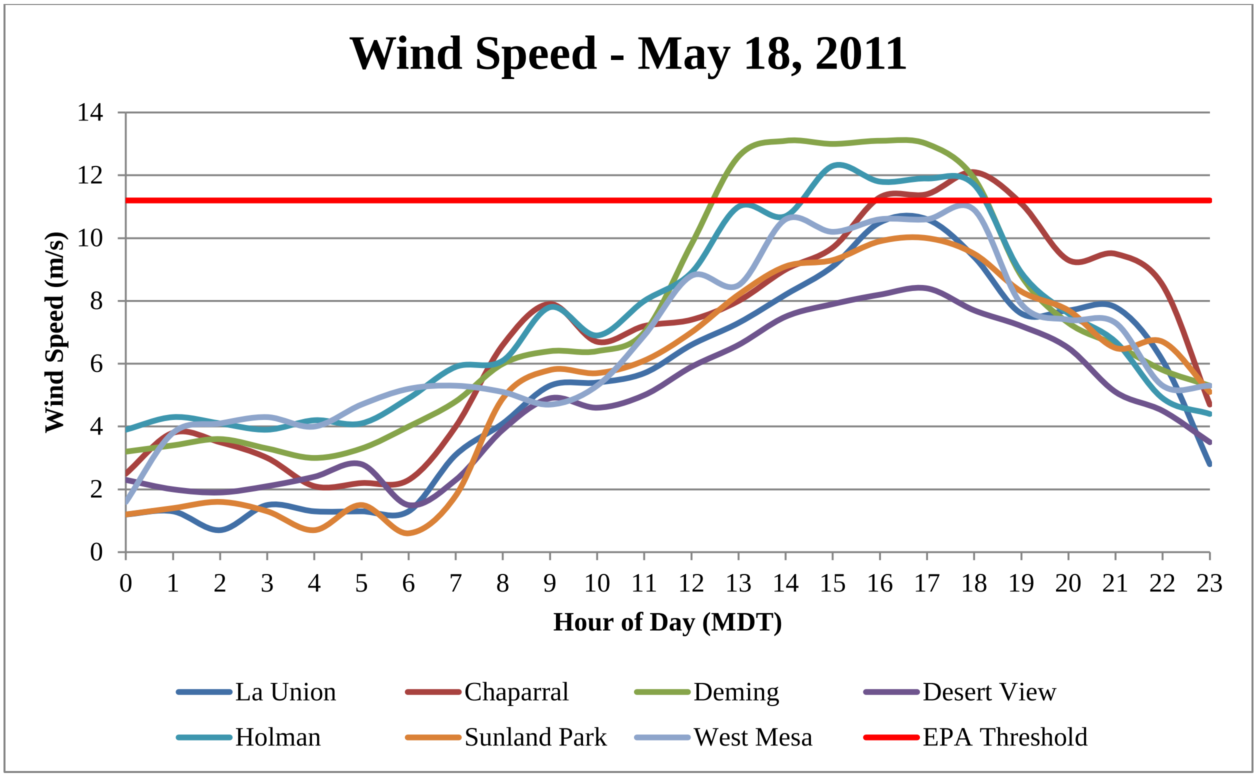

Figure 20-3. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

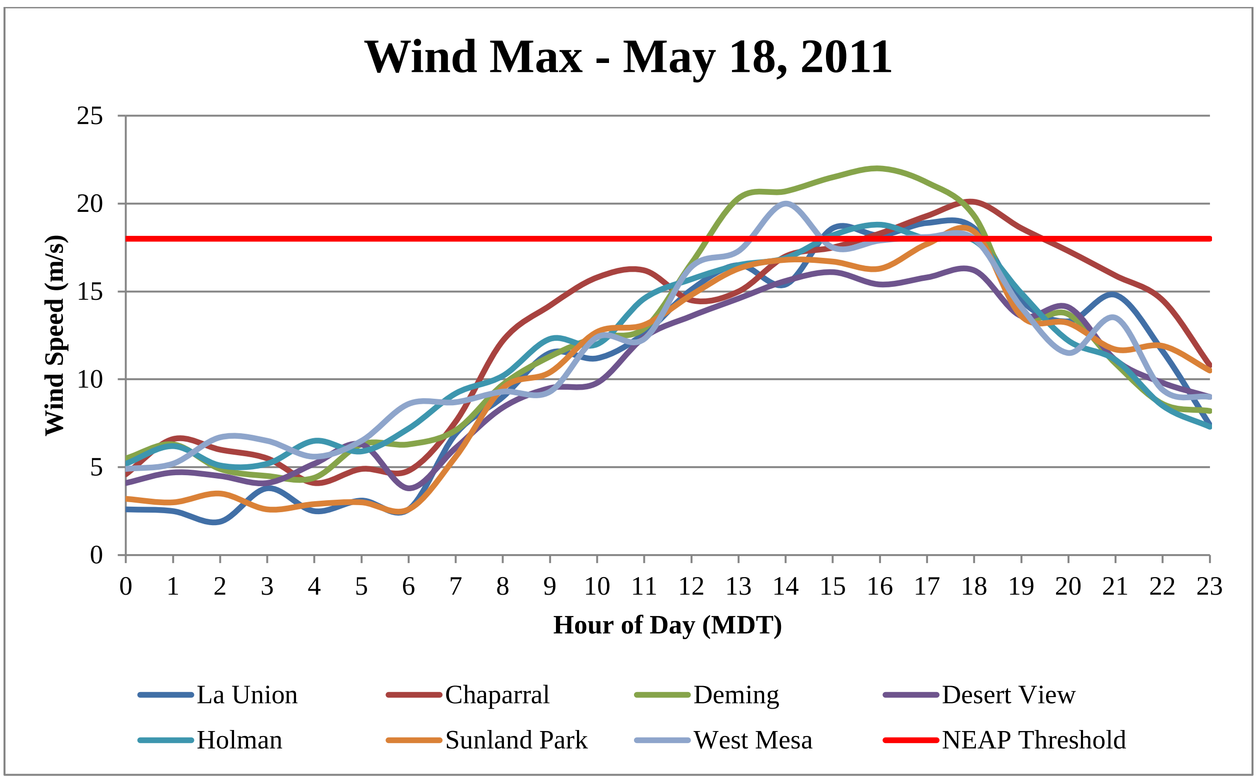

Figure 20-4. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

20.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the PM_{10} FEM TEOM monitors recorded 211 exceedances and the PM_{10} FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). The SPCY $PM_{2.5}$ FRM Partisol recorded 23 exceedances of the 24-Hour NAAQS from 2006-2010 (Figure A-2). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

20.2.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña County. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert and playas in New Mexico, Texas, Arizona and northern Mexico. The southern sites in Doña Ana County recorded the highest 24-hour averages in the monitoring network. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled from Texas, Arizona and Mexico to the monitors in southern Doña Ana County. The model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figure 20-5). Costs prohibit controlling dust from the natural desert terrain and falls outside NMED’s jurisdiction when it originates in Texas, Arizona and Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

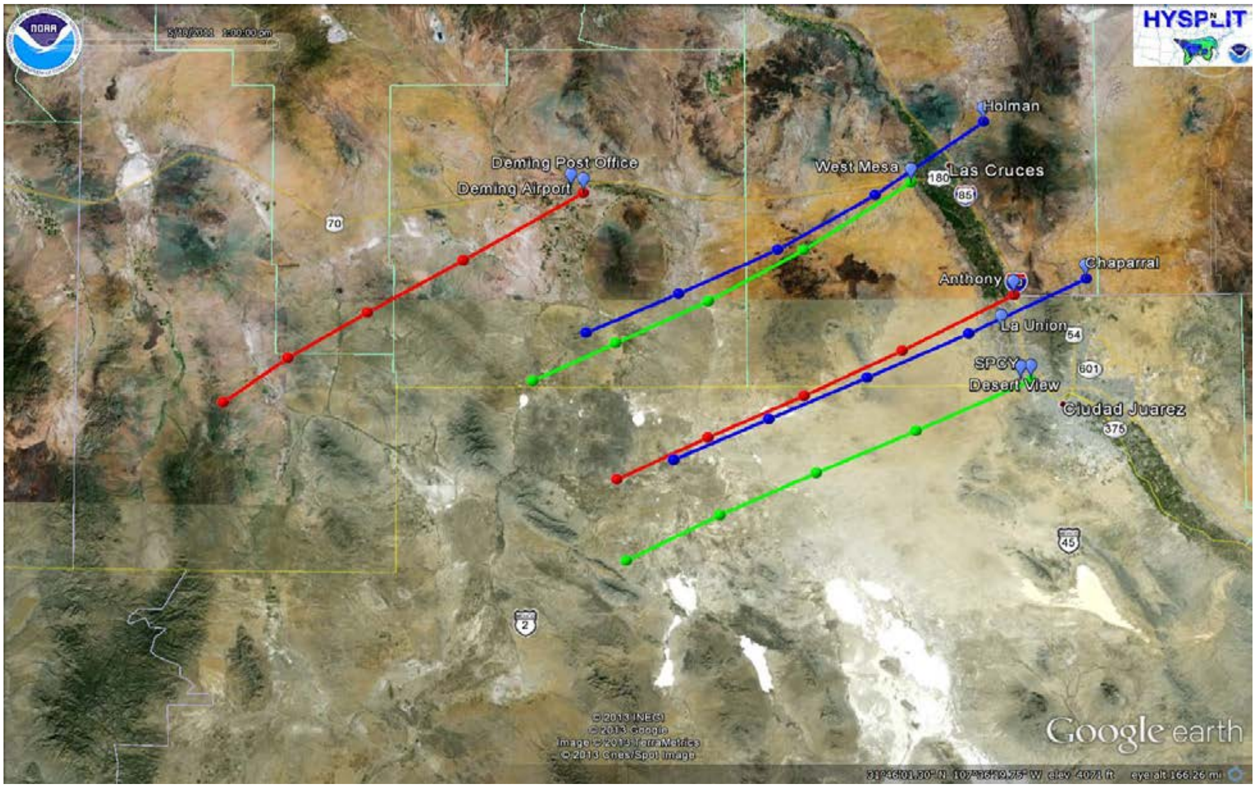

Figure 20-5. HYSPLIT back-trajectory model analysis for May 18, 2011.

20.3 Historical Fluctuations Analysis

20.3.1 <u>Annual and Seasonal 24-hour Average Fluctuations</u>

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded values for this day (233, 216, 157, 229 and 29.7 µg/m^3) are above the maximum values recorded when no high wind exceedances are included and is above the 95th percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for May 18, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95th percentile for PM_{10}, $PM_{2.5}$, wind speed and wind gusts (Figures 20-6a-e through 20-8a-d). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} values during the high wind blowing dust storm the historical 95th percentile of data.

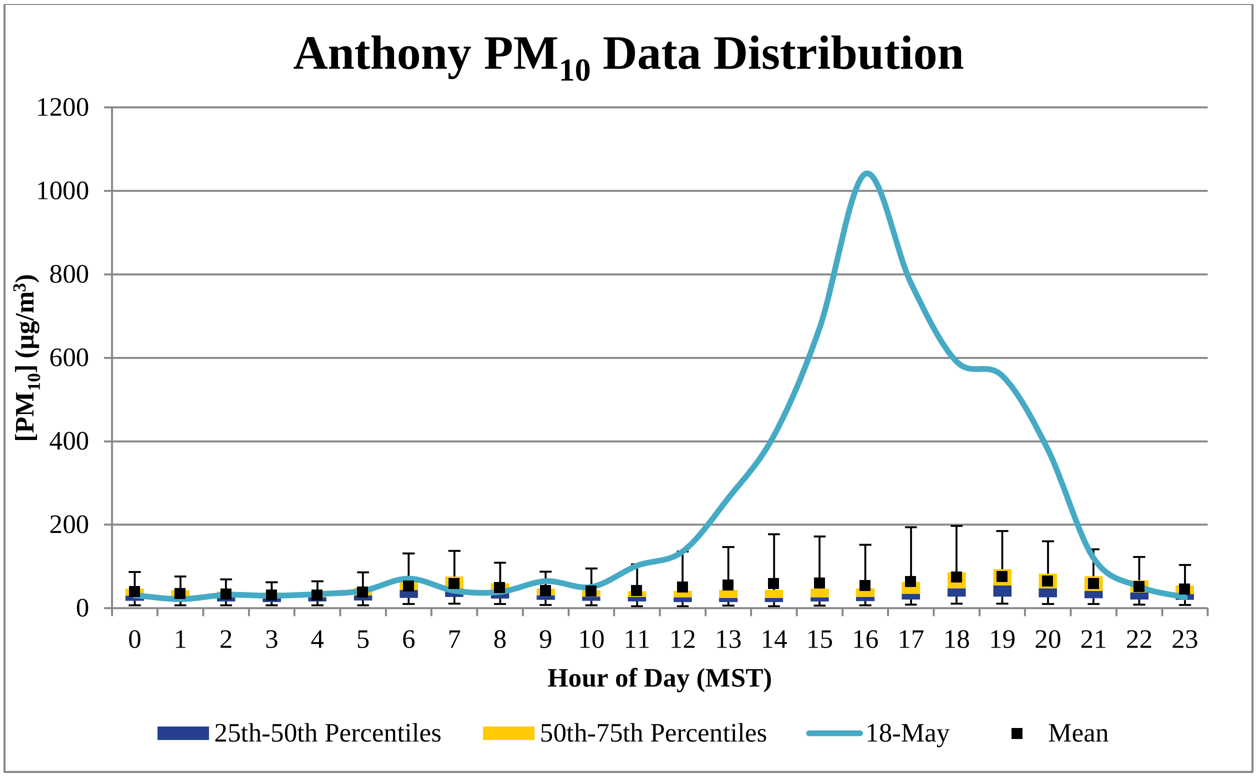

Figure 20-6a. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

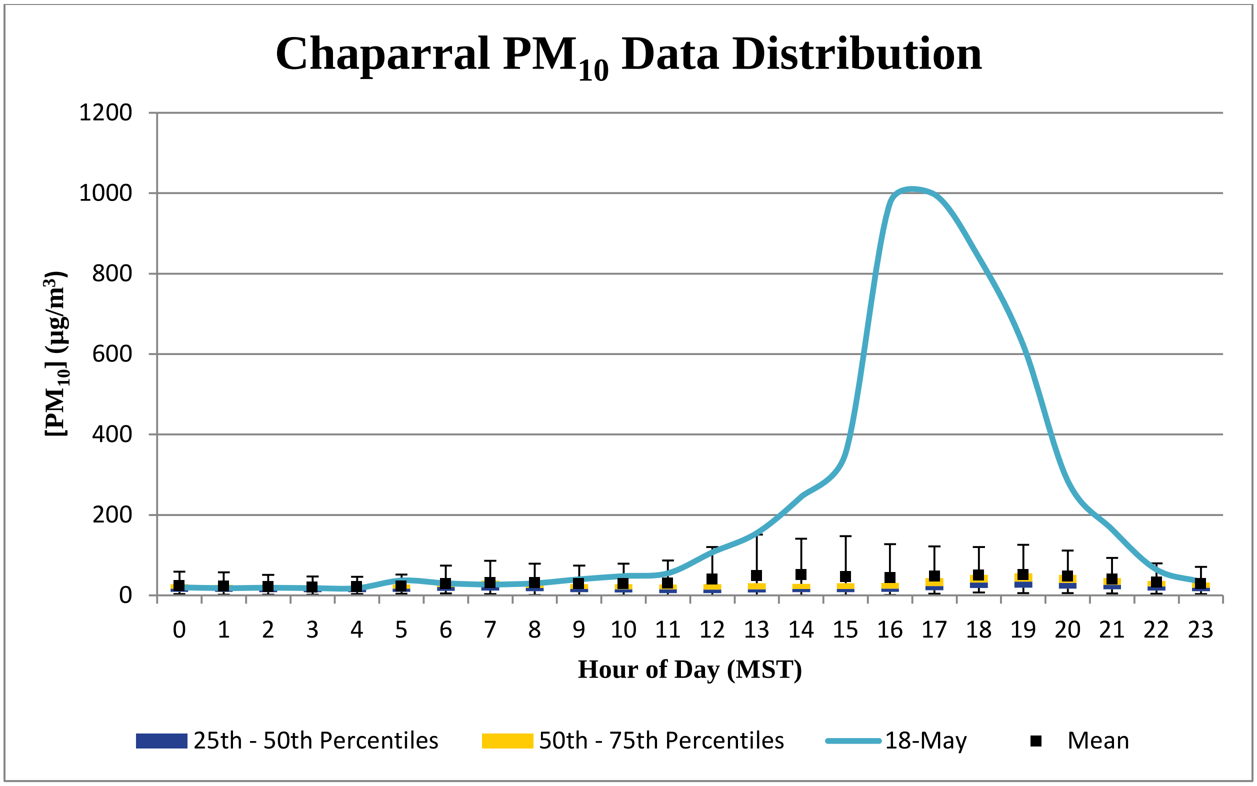

Figure 20-6b. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

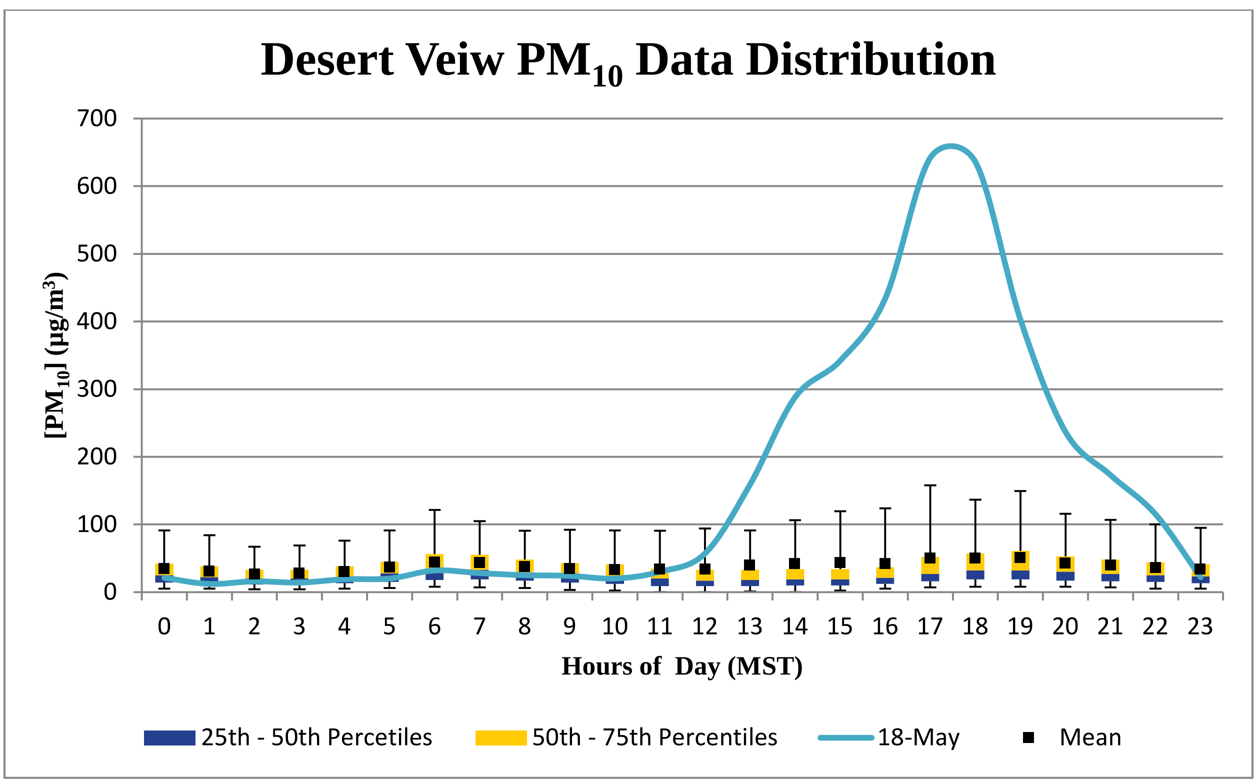

Figure 20-6c. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

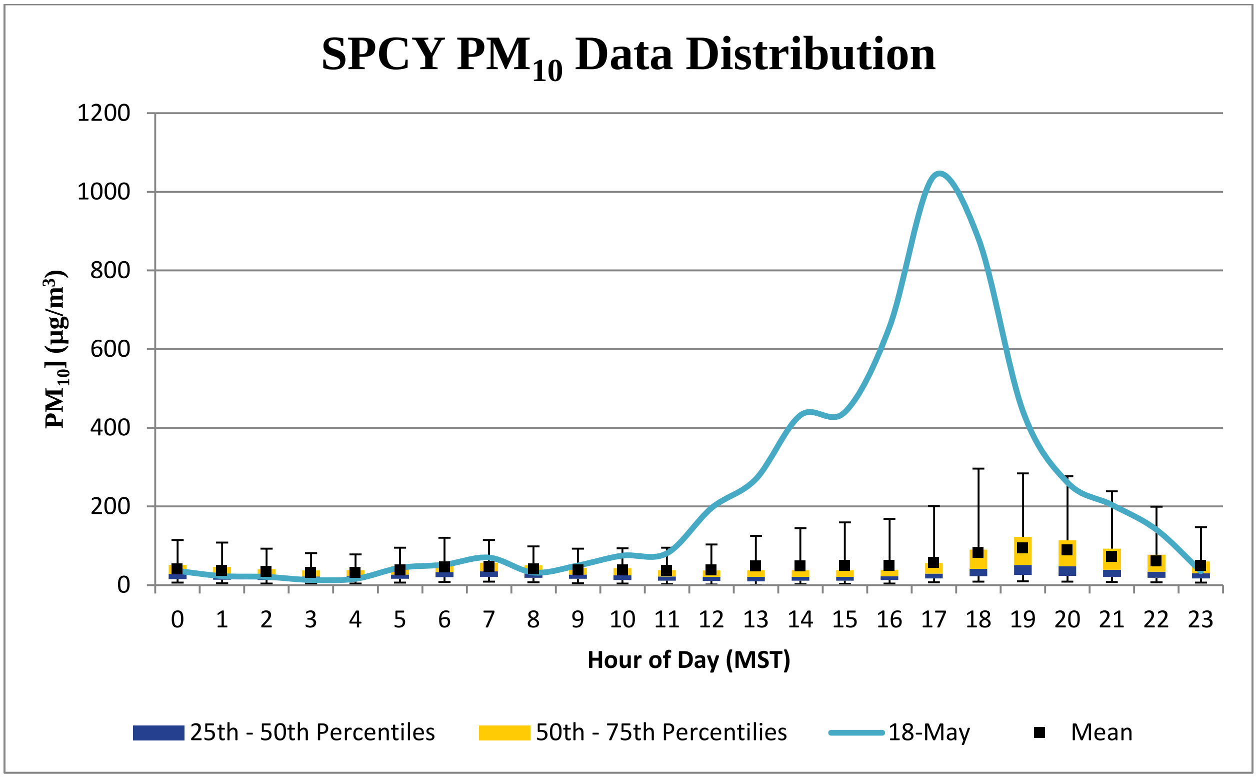

Figure 20-6d. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

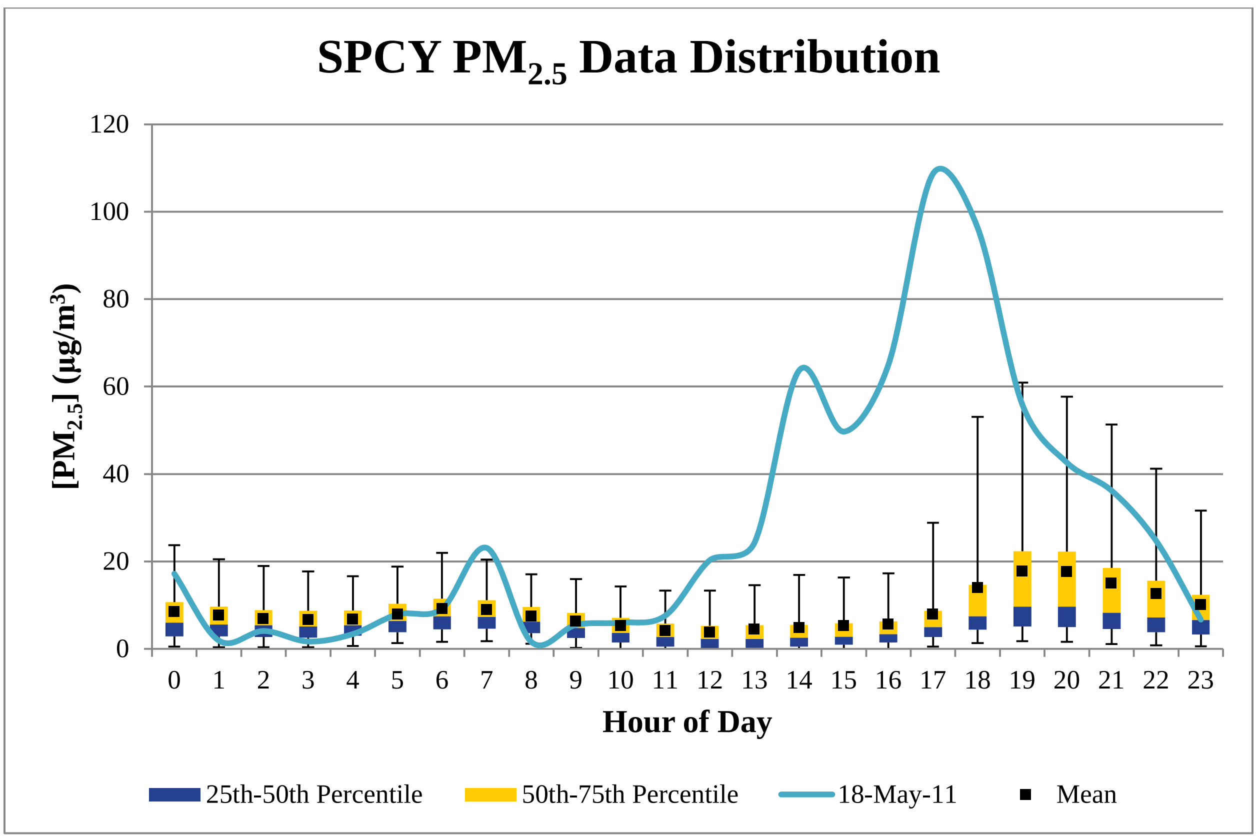

Figure 20-6e. $PM_{2.5}$ hourly data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

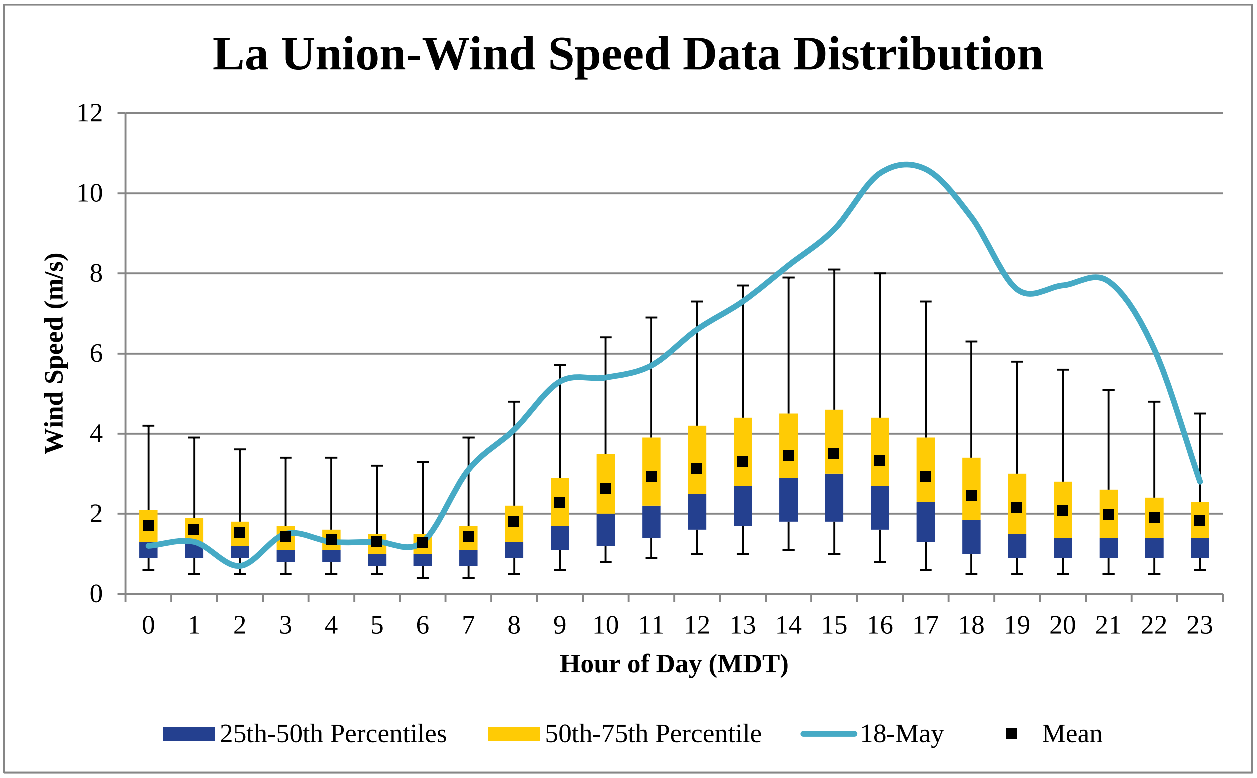

Figure 20-7a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

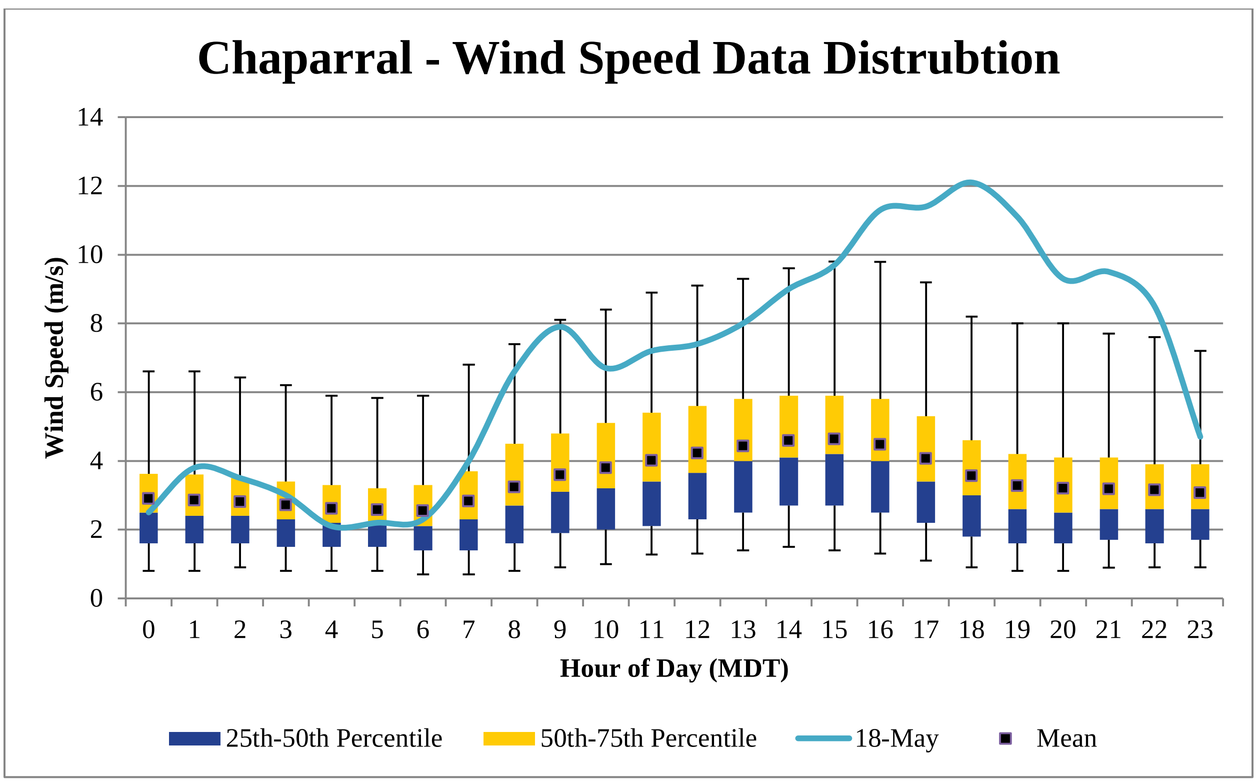

Figure 20-7b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

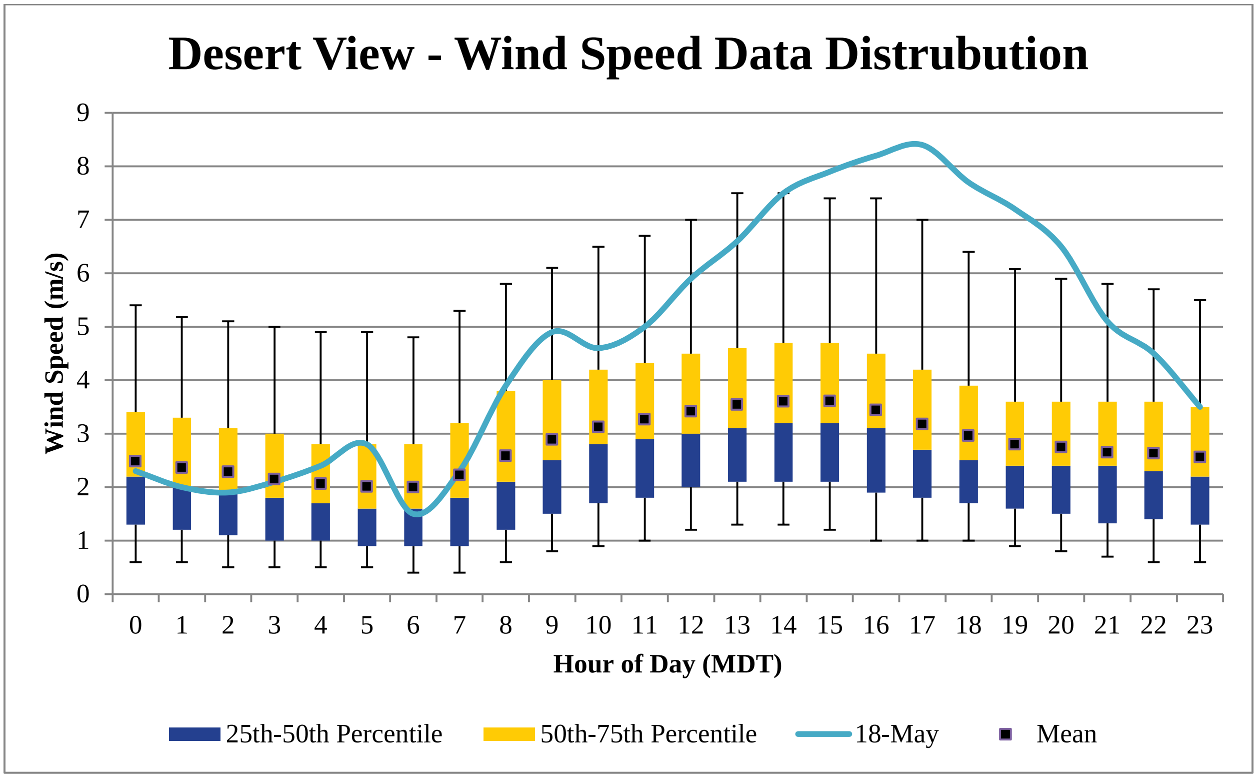

Figure 20-7c. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

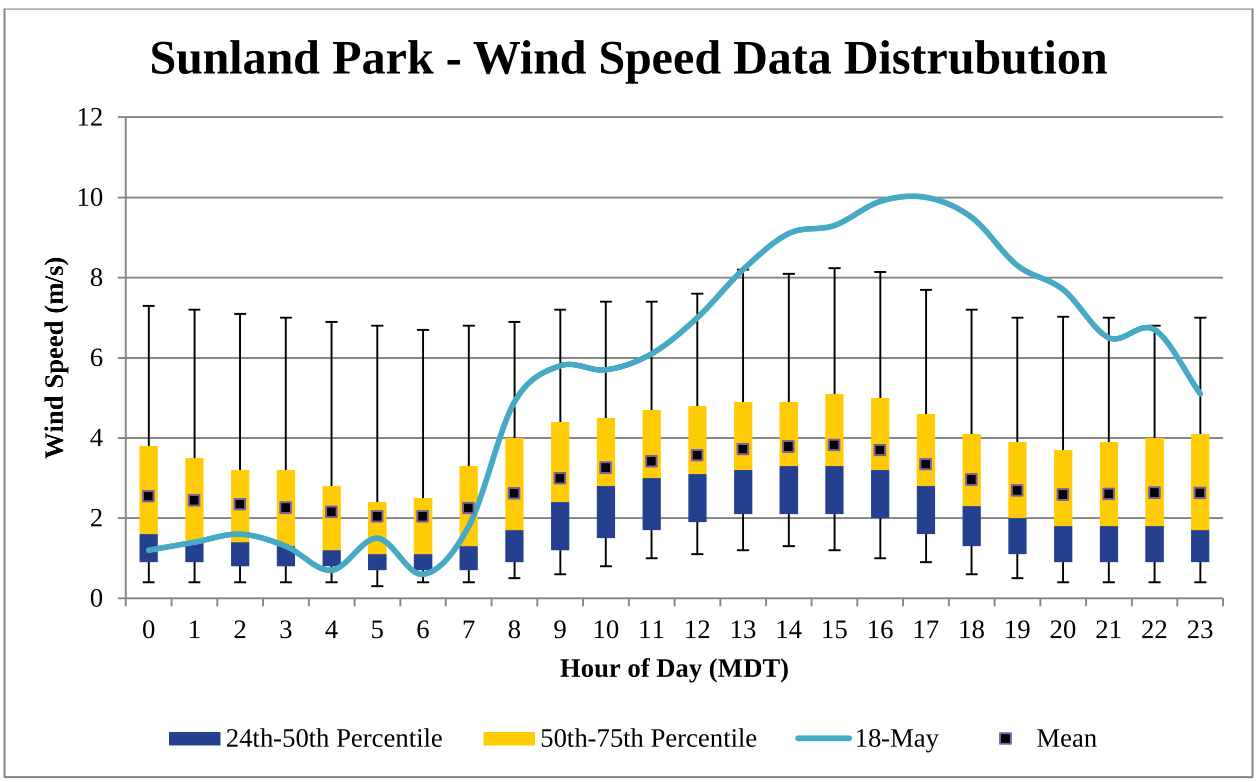

Figure 20-7d. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

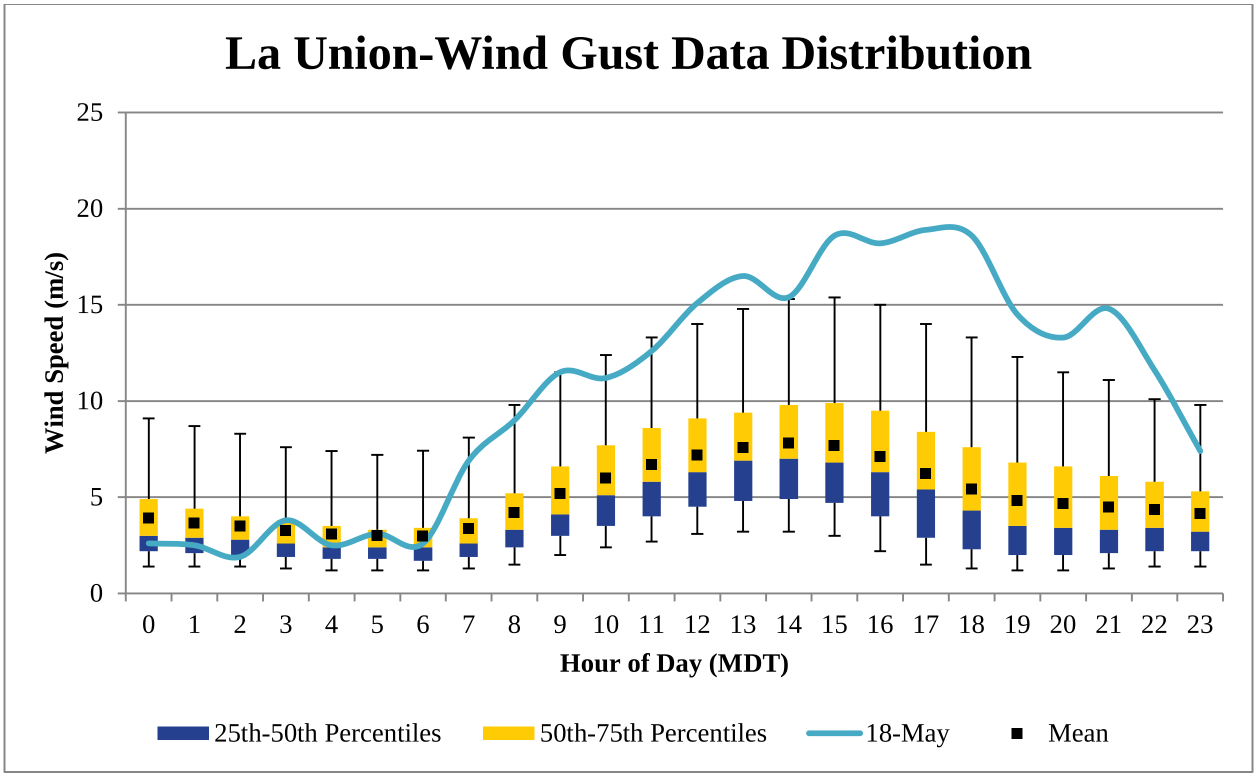

Figure 20-8a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

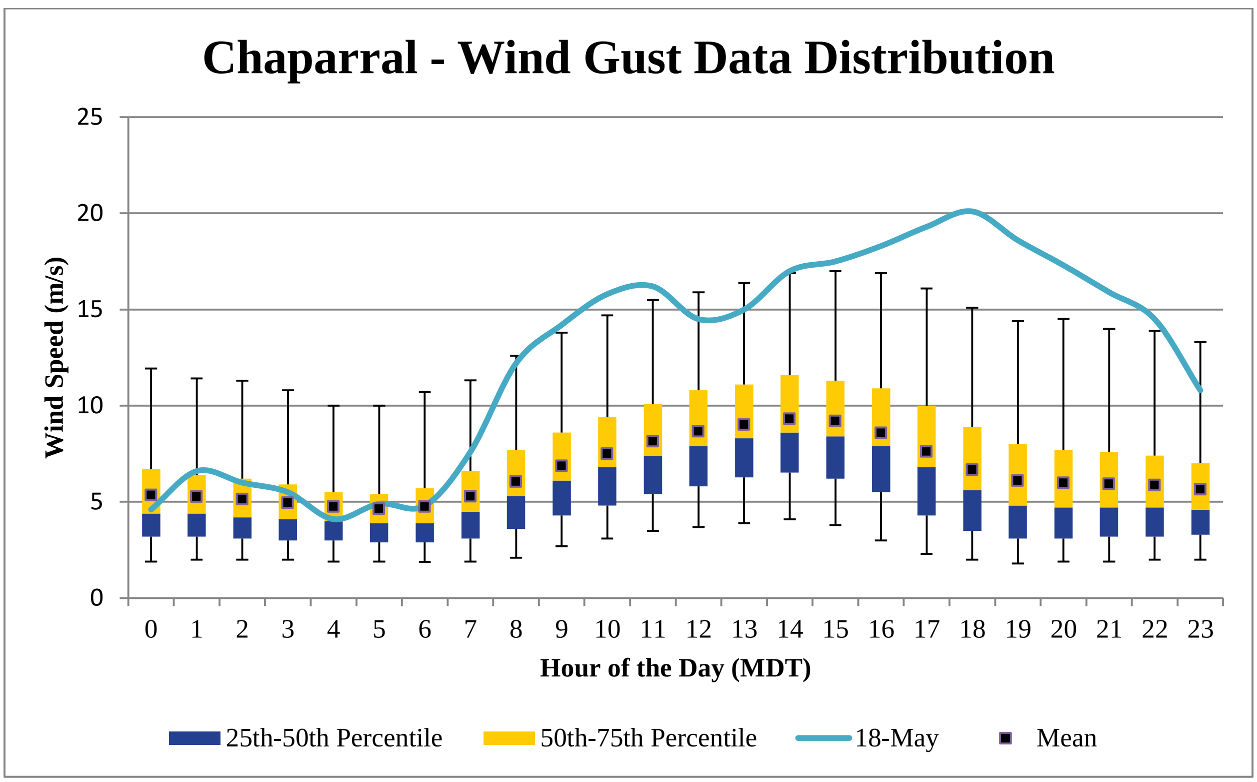

Figure 20-8b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

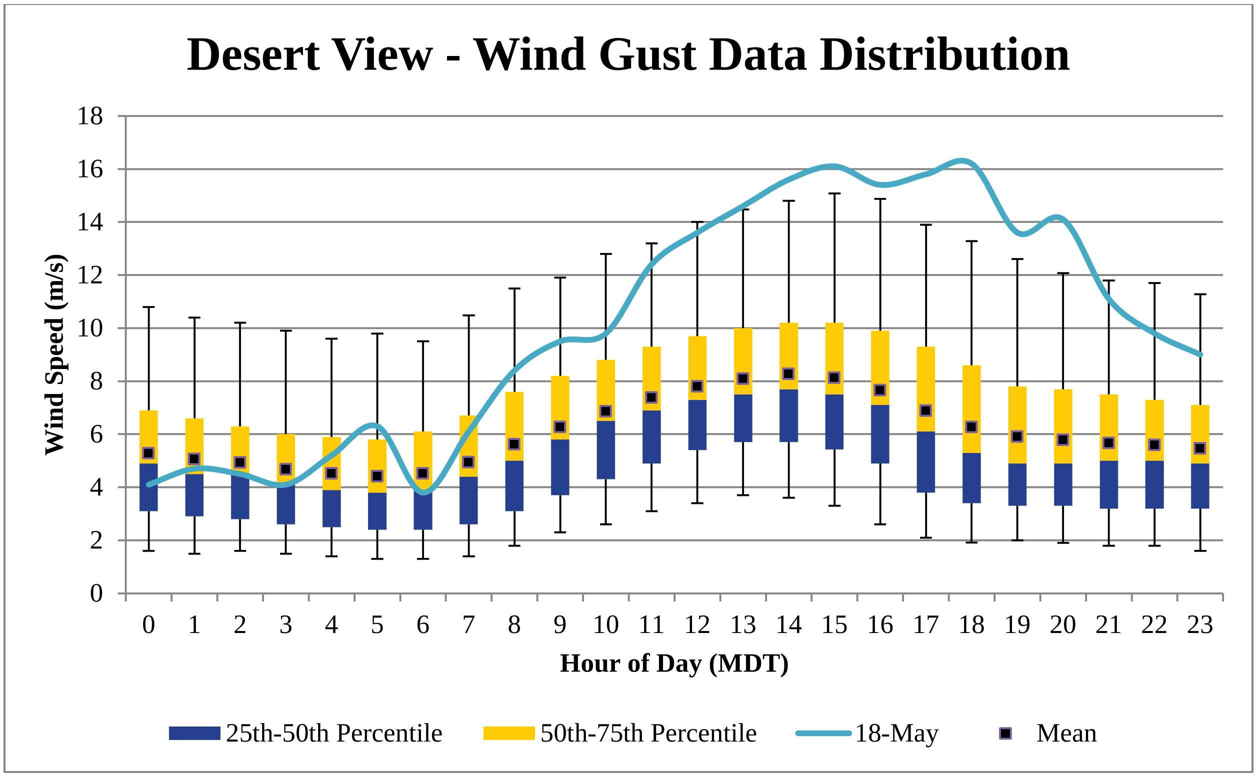

Figure 20-8c. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

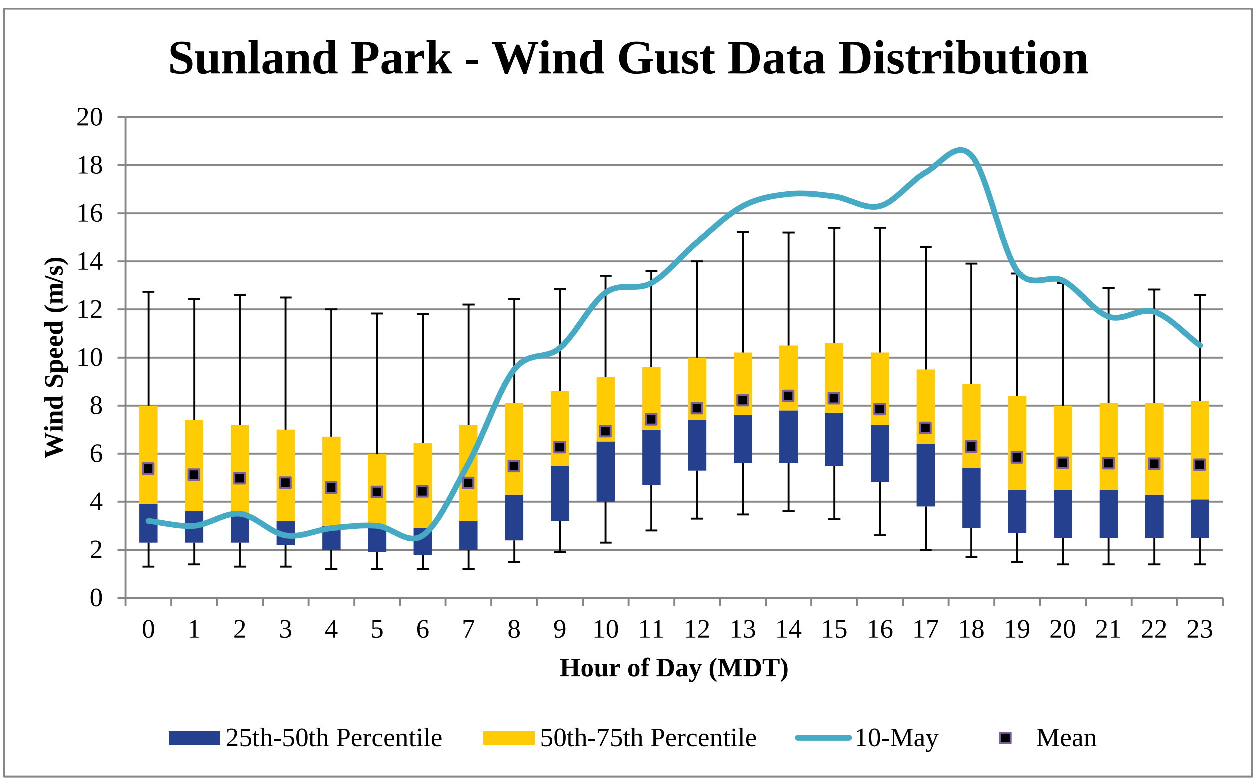

Figure 20-8d. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 18, 2011.

20.4 Clear Causal Relationship

A Pacific cold front and deep upper trough passed through New Mexico on May 18, 2011. These weather conditions combined to create a pressure gradient over southeastern Arizona, southwestern New Mexico and northern Mexico. As the systems moved through New Mexico, the pressure gradient tightened and winds became even stronger at the surface (Figure 20-9). Surface winds flow perpendicular to the isobars from high to low pressure. The wind direction in the upper atmosphere aligned with the surface wind direction (Figure 20-10). Diurnal heating of the surface allowed winds aloft to mix downward, increasing the surface wind velocities and provided the turbulence required for vertical mixing and horizontal transport.

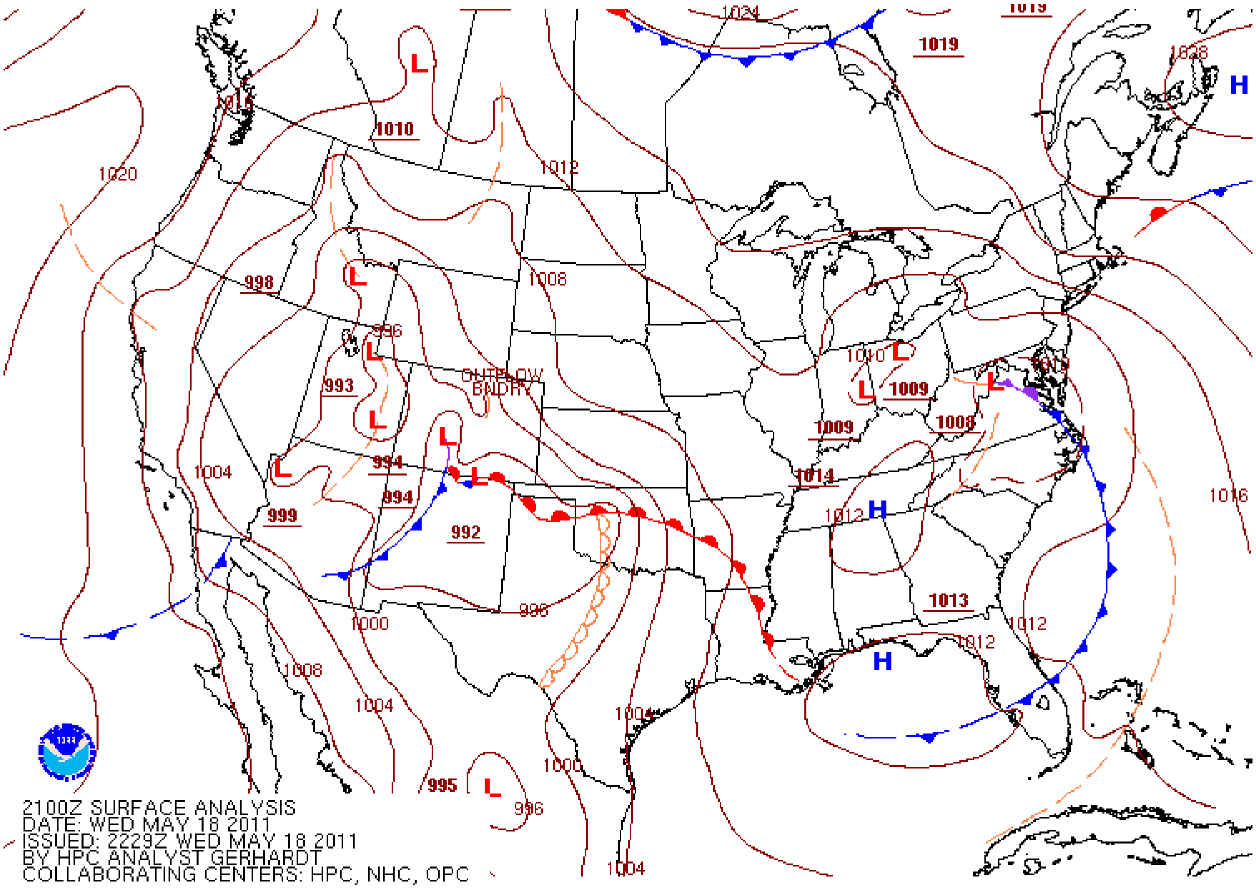

Figure 20-9. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for May 18, 2011 at the 1500 hour.

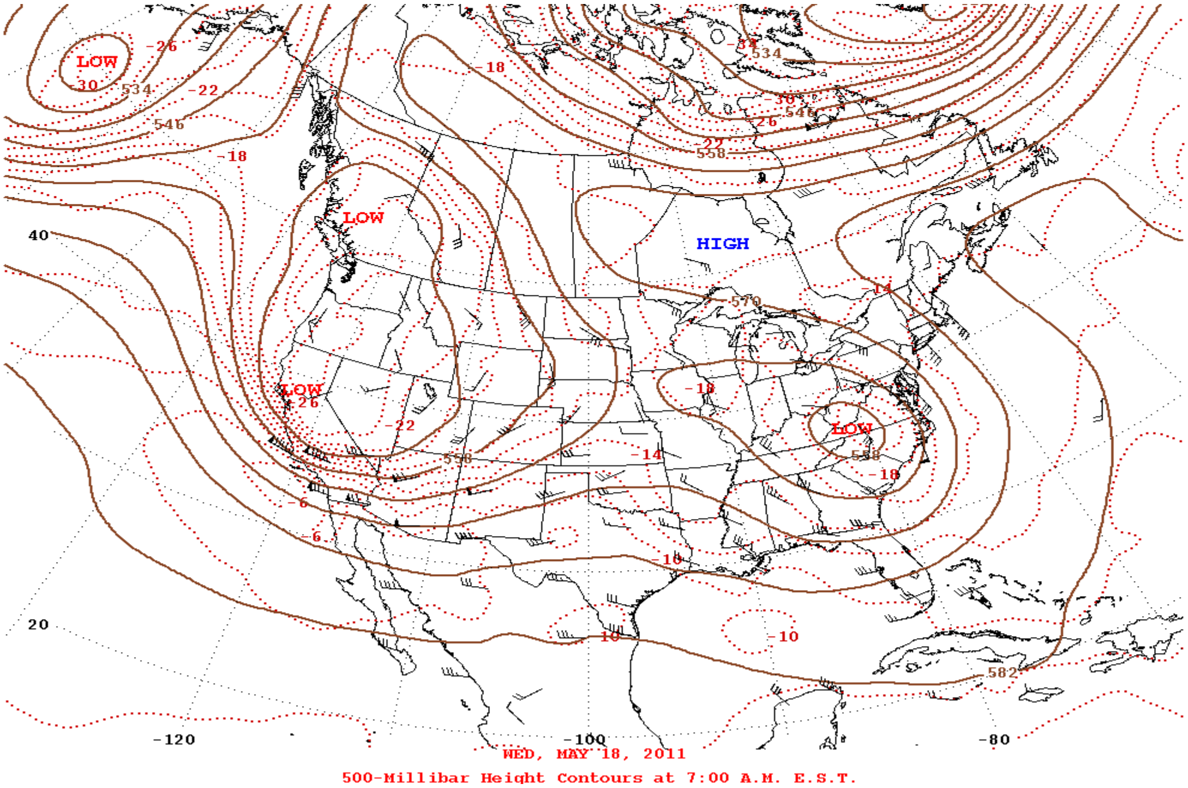

Figure 20-10. Upper air weather map showing geopotential heights (brown lines) at the 500 hour on May 18, 2011.

The weather pattern described above generated strong winds from the southwest direction beginning at the 1200 hour and lasting through the 1900 hour. Beginning at the 1200 hour, wind speeds exceeded 11.2 m/s at the Deming site as shown in Figure 20-2. Peak wind speeds ranged from 8.4 m/s at Desert View to 13.1 m/s at the Deming monitoring site (Figure 20-2). Peak wind gusts ranged from 16.2 m/s at Desert View to 22 m/s at the Deming site (Figure 20-3). Blowing dust caused elevated levels of PM_{10} during the same period as high winds as demonstrated by the time series plot in Figure 20-11a-e. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (1200-2100 hours). During these hours, hourly PM_{10} and $PM_{2.5}$ concentrations spiked at all monitoring sites in the network (Figure 20-12a-b). Hourly data from the SPCY PM_{10} and $PM_{2.5}$ TEOM Monitors show good correlation of the timing of spikes in concentrations (Figure 20-13).

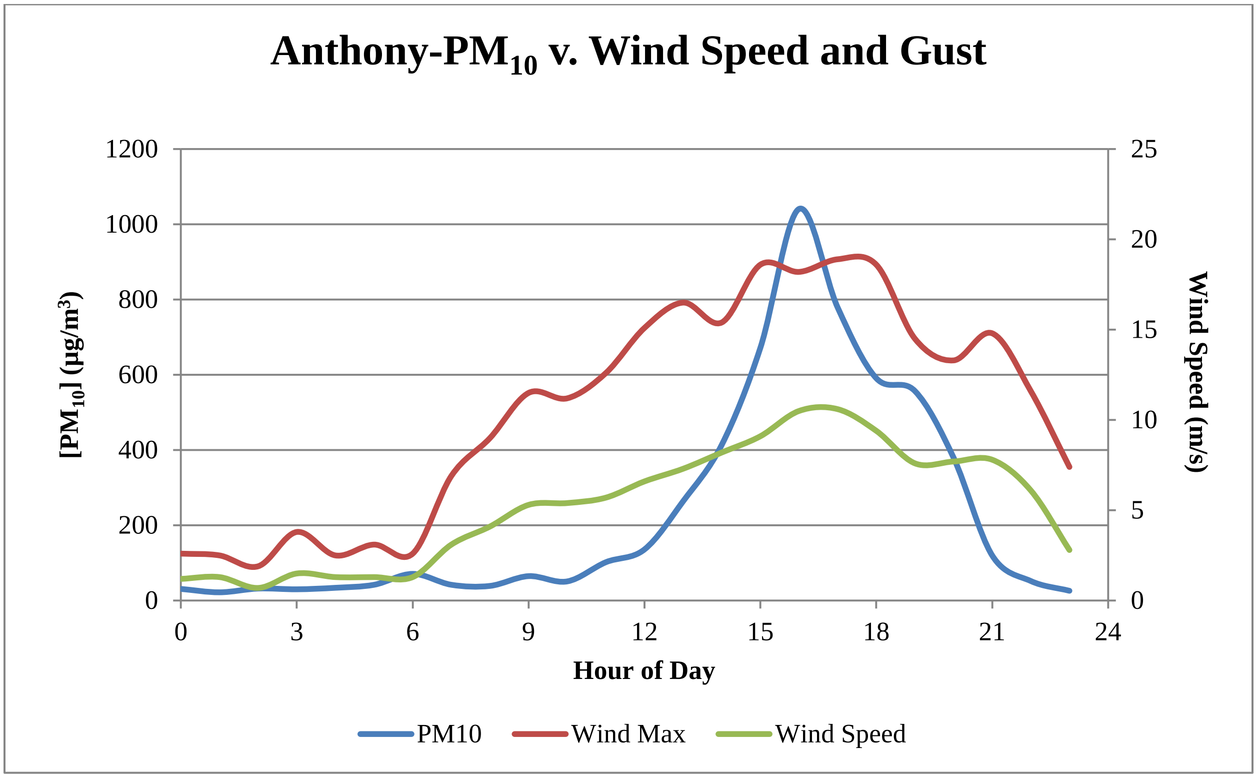

Figure 20-11a. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

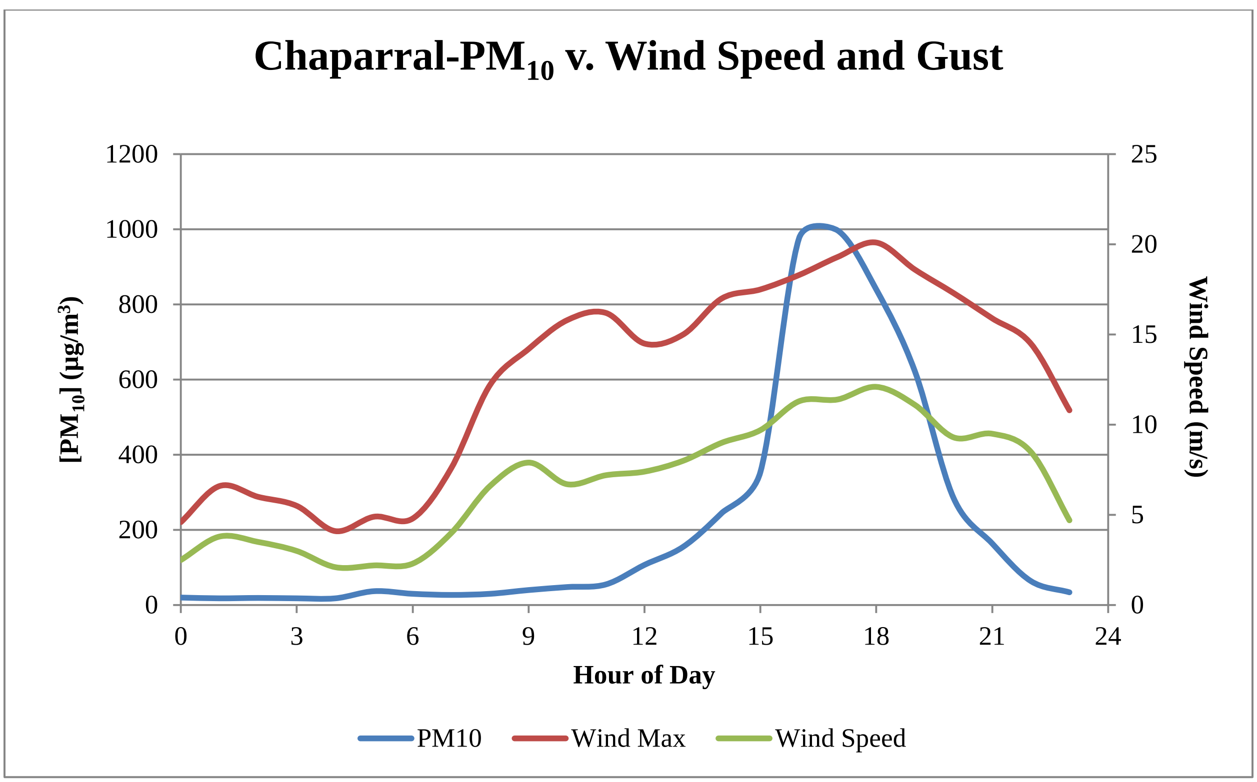

Figure 20-11b. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

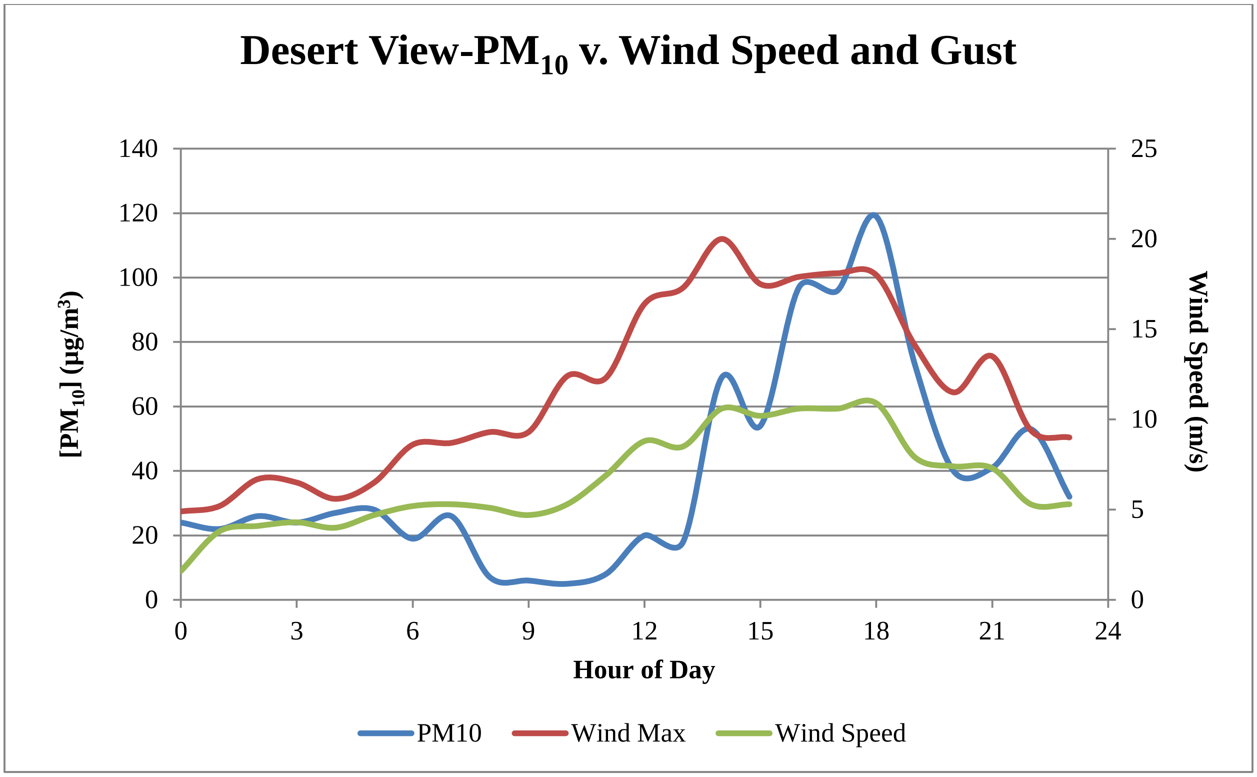

Figure 20-11c. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

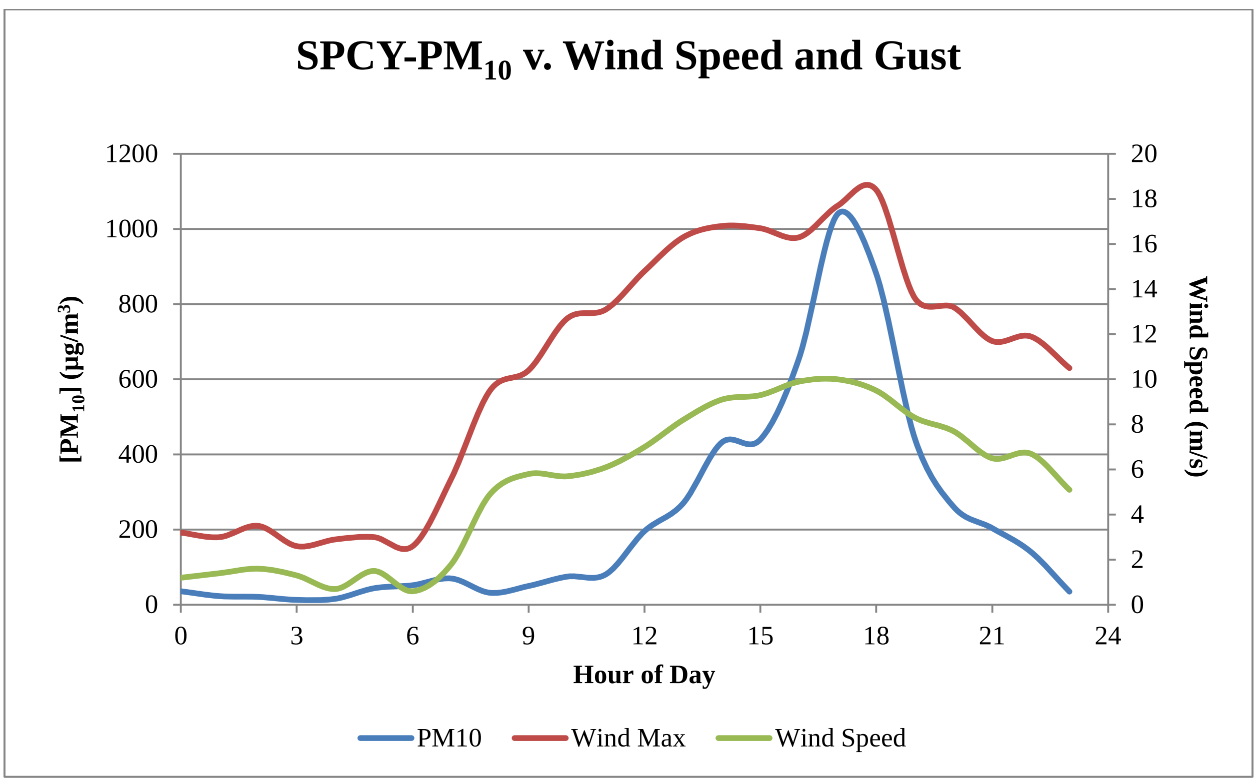

Figure 20-11d. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

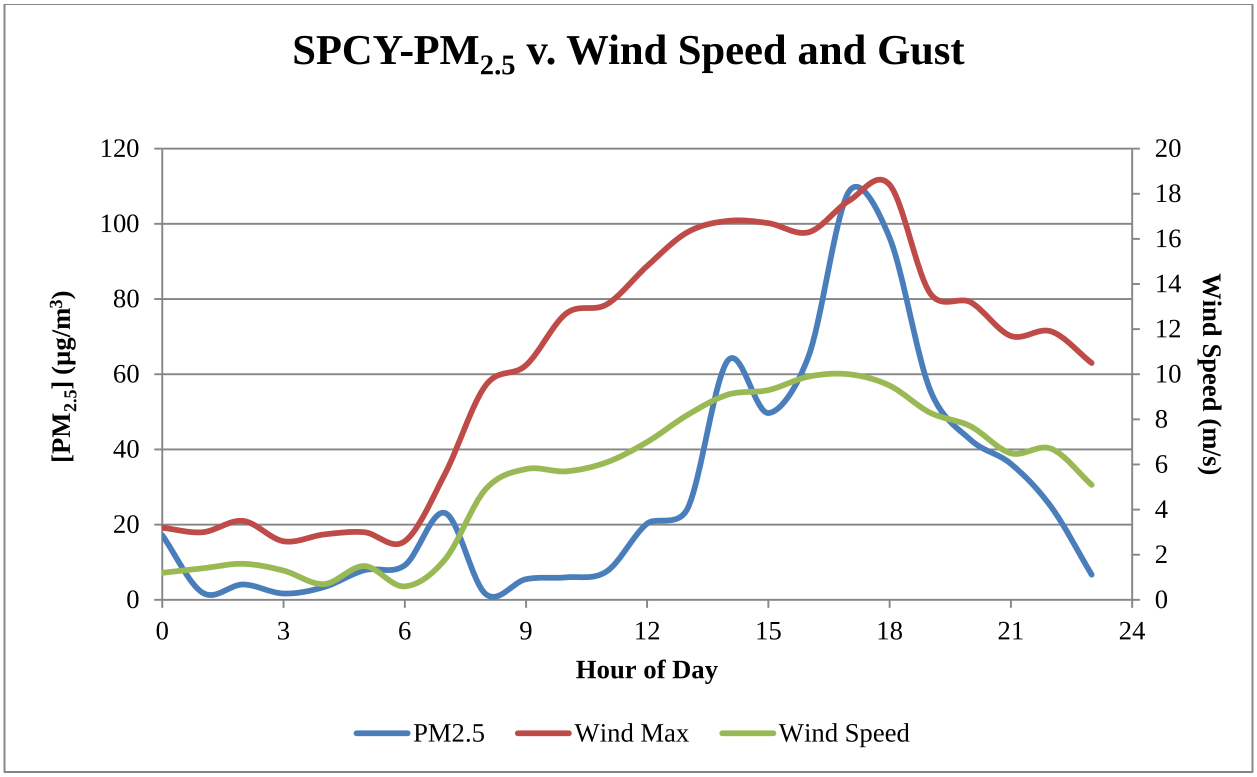

Figure 20-11e. Time series plot of hourly observations showing increased PM_{10} and $PM_{2.5}$ concentrations as wind speeds and gusts increase. Non-FEM hourly $PM_{2.5}$ data.

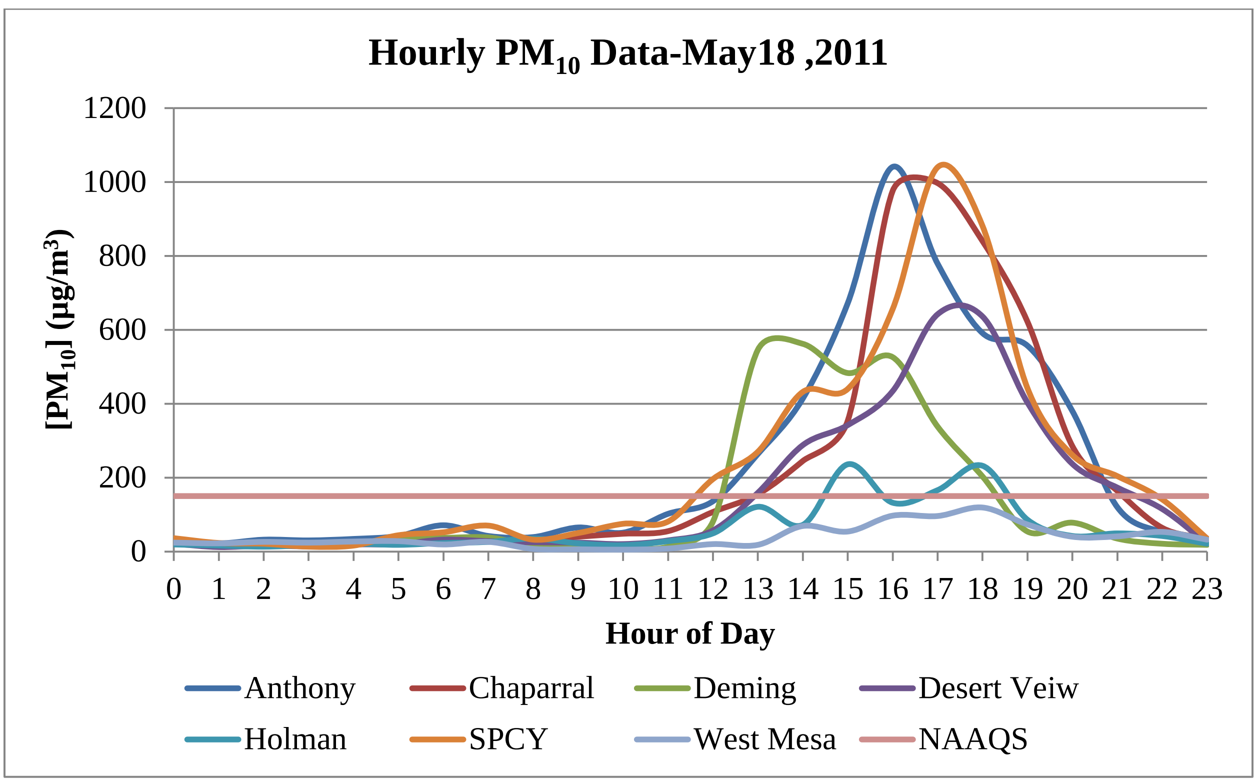

Figure 20-12a. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

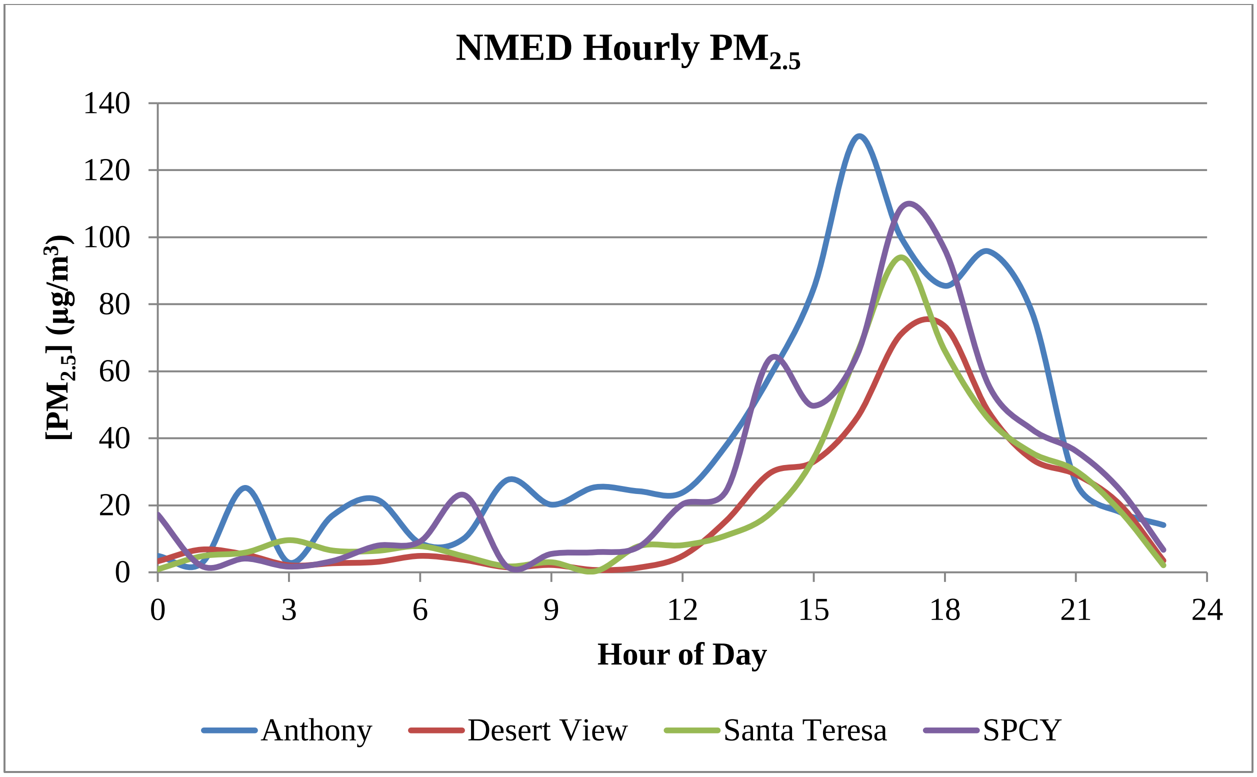

Figure 20-12b. Hourly $PM_{2.5}$ concentrations for Doña Ana County monitors. Non-FEM hourly $PM_{2.5}$ data.

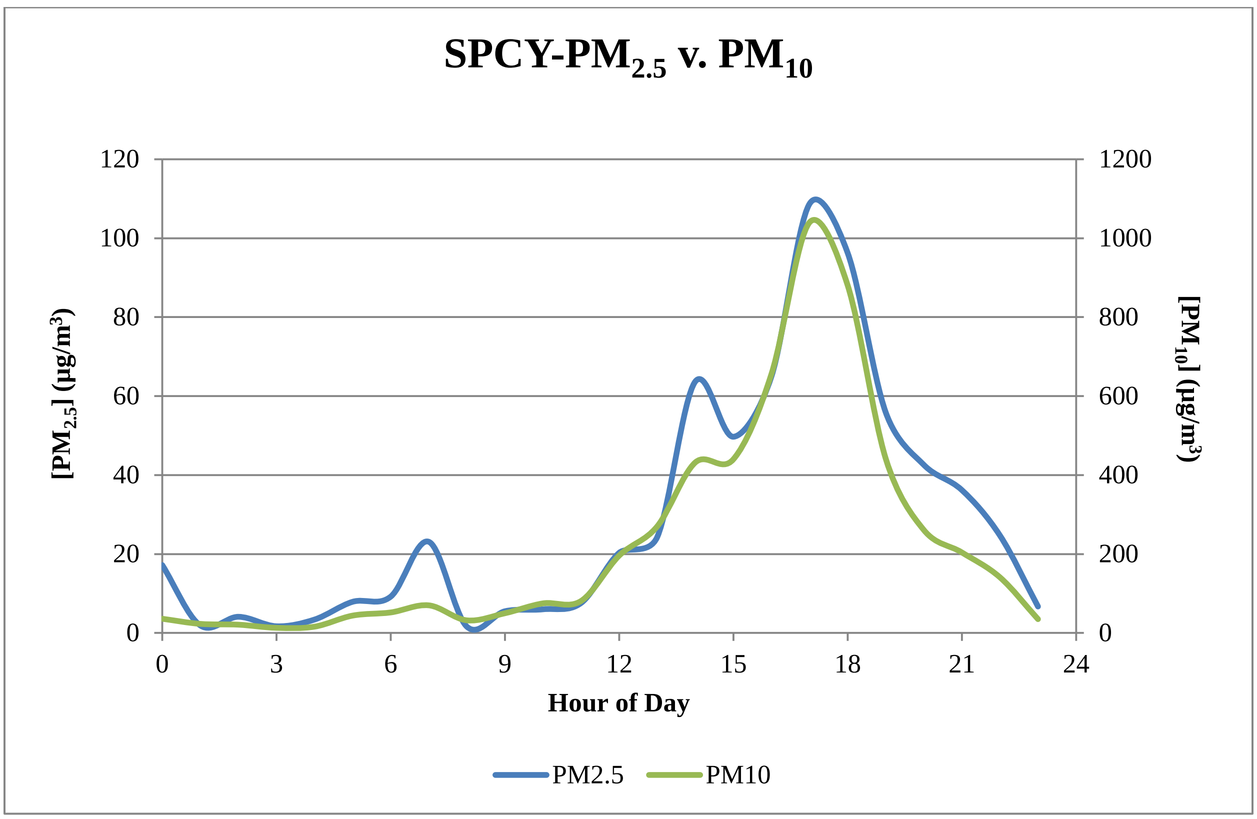

Figure 20-13. Hourly PM_{10} and $PM_{2.5}$ concentrations for the SPCY monitoring site on May 18, 2011.

Contemporary reports and modeling results support these claims. The NM Border AQ Blog reported (DuBois, 2011): "Dust alert for today. Blowing dust and low visibilities will be on the menu starting in the early afternoon and continuing through the evening. High winds look to be widespread across the region" (Figure 20-14).

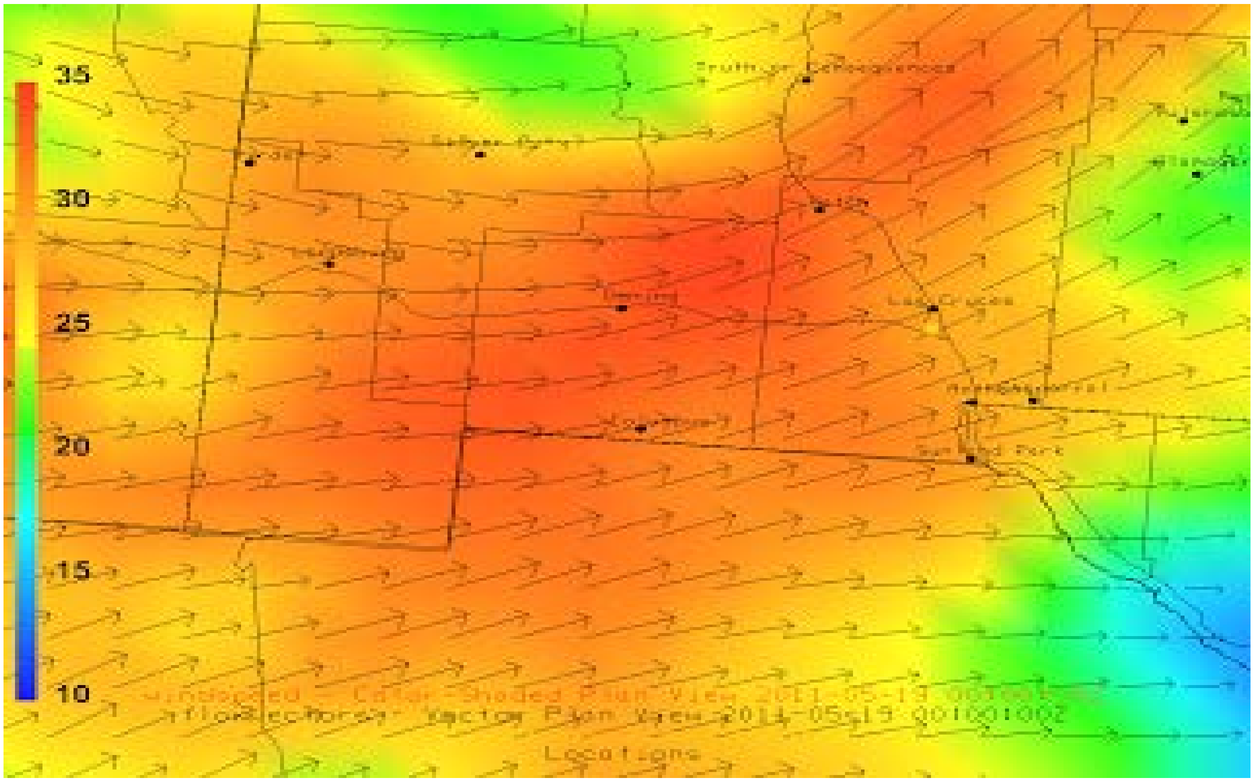

Figure 20-14. **May 18, 2011 NOAA Rapid Update Cycle model wind forecast for the 1800 hour.**

The Blog goes on to report (DuBois, 2011), "As of 3:30 pm highway 11 is closed south of Deming due to zero visibility from blowing dust. The dust plumes show up on the evening visible GOES imagery" (Figure 20-15).

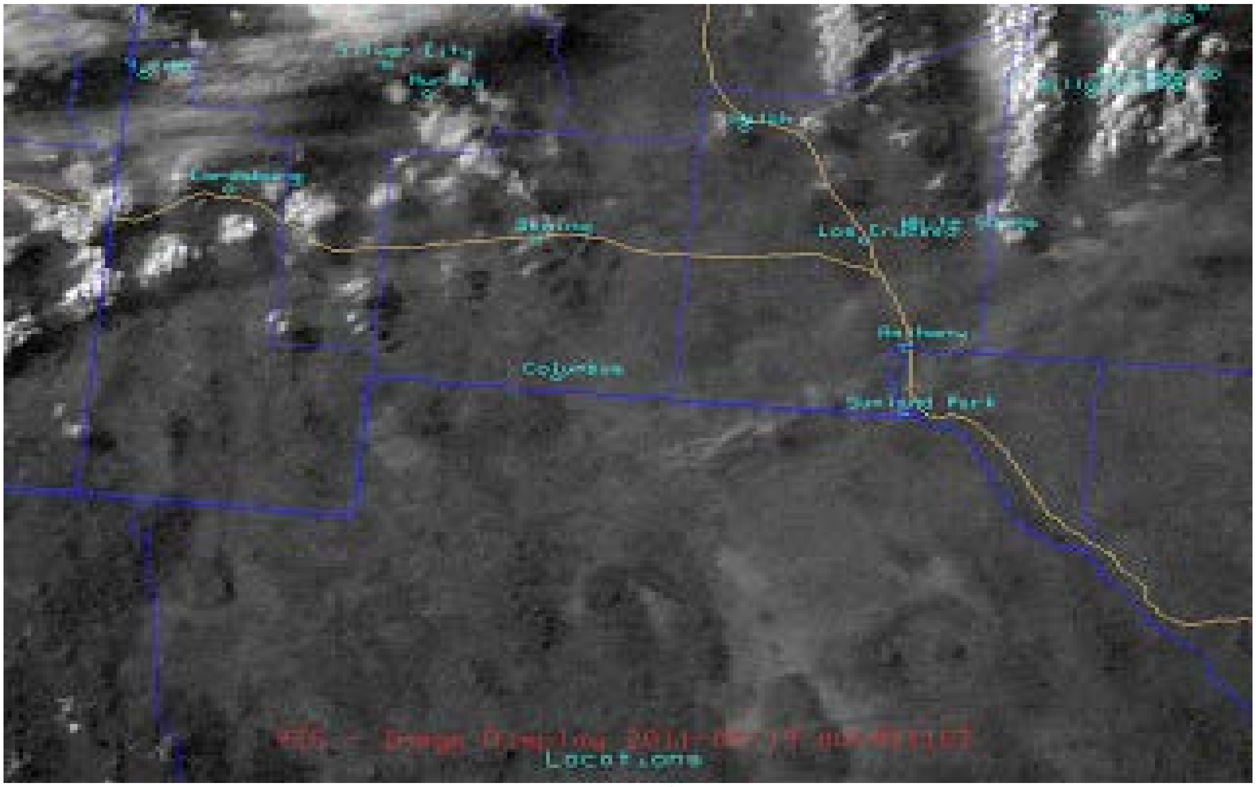

Figure 12-14 GOES image at the 1845 hour on May 18, 2011. Courtesy of NOAA.

The NWS issued a wind advisory for the border area for May 18, 2011 stating in part (NWS, 2011):

> ...WINDY CONDITIONS WITH BLOWING DUST ACROSS SOUTHERN NEW MEXICO AND WESTERN TEXAS WEDNESDAY AFTERNOON AND EARLY EVENING...
>
> WEST TO SOUTHWEST WINDS WILL HAVE SUSTAINED SPEEDS AROUND 30 MPH ON WEDNESDAY AFTERNOON WITH GUSTS TO 50 MPH POSSIBLE. THE WINDS WILL PRODUCE BLOWING DUST WITH VISIBILITIES REDUCED TO LESS THAN A MILE OVER A FEW AREAS.

20.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on May 18, 2011.

20.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by high wind and blowing dust.

20.7 No Exceedance but for the Event

The Anthony monitor detected blowing dust around the 1300 hour with hourly concentrations heavily impacted until the 2000. The eight hourly PM_{10} values from 1300-2000 hours alone, exceed the 24-hour average standard at Anthony [(264 + 414 + 672 + 1041 + 779 + 591 + 557 + 380) µg/m^3 = 4698 µg/m^3; (4698 µg/m^3)/24 = 195 µg/m^3]. By replacing these eight hourly values with the 95th percentile of hourly data at the Anthony site, the resulting 24-hour average (94 µg/m^3) does not exceed the NAAQS (Table 20-1). The values in red represent the 95th percentile of all hourly data collected at Anthony, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	31	31
1	22	22
2	32	32
3	30	30
4	34	34
5	42	42
6	71	71
7	42	42
8	39	39
9	65	65
10	51	51
11	102	102
12	136	136
13	264	**146**
14	414	**177**
15	672	**172**
16	1041	**152**
17	779	**194**
18	591	**197**
19	557	**185**
20	380	**160**
21	120	120
22	52	52
23	26	26
24-Hour Average	233	94

Table 20-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Anthony.

The Chaparral monitor detected blowing dust around the 1400 hour with hourly concentrations heavily impacted until the 2000 hour. The seven hourly PM_{10} values from 1400-2000 hours alone, exceed the 24-hour average standard at Chaparral [(245+354+976+997+840+622+285) $\mu g/m^3$ = 4319 $\mu g/m^3$; (4319 $\mu g/m^3$)/24 = 179 $\mu g/m^3$]. By replacing these seven hourly values with the 95th percentile of hourly data at the Chaparral site, the resulting 24-hour average (74 $\mu g/m^3$) does not exceed the NAAQS (Table 20-2). The values in red represent the 95th percentile of all hourly data collected at Chaparral, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	20	20
1	18	18
2	19	19
3	18	18
4	18	18
5	37	37
6	30	30
7	27	27
8	30	30
9	40	40
10	48	48
11	55	55
12	107	107
13	155	155
14	245	**141**
15	354	**147**
16	976	**127**
17	997	**122**
18	840	**120**
19	622	**126**
20	285	**111**
21	164	164
22	64	64
23	34	34
24-Hour Average	216	**74**

Table 20-2. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Chaparral.

The Desert View monitor detected blowing dust around the 1400 hour with hourly concentrations heavily impacted until the 2000 hour. By replacing these seven hourly values with the 95th percentile of hourly data at the Desert View site, the resulting 24-hour average (70 µg/m^3) does not exceed the NAAQS (Table 20-3). The values in red represent the 95th percentile of all hourly data collected at Desert View, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	21	21
1	12	12
2	16	16
3	14	14
4	19	19
5	20	20
6	32	32
7	28	28
8	25	25
9	24	24
10	20	20
11	30	30
12	57	57
13	159	159
14	288	**106**
15	342	**119**
16	434	**124**
17	642	**158**
18	636	**137**
19	403	**149**
20	237	**116**
21	173	173
22	115	115
23	22	22
24-Hour Average	157	**70**

Table 20-3. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Desert View.

The Sunland Park monitor detected blowing dust around the 1200 hour with hourly concentrations heavily impacted until the 1900. The eight hourly PM_{10} values from 1200-1900 hours alone, exceed the 24-hour average standard at Sunland Park [(196 + 270 + 432 + 440 + 656 + 1040 + 881 + 442) µg/m^3 = 4357 µg/m^3; (4357 µg/m^3)/24 = 181 µg/m^3]. By replacing these eight hourly values with the 95th percentile of hourly data at the Sunland Park site, the resulting 24-hour average (109 µg/m^3) does not exceed the NAAQS (Table 20-4). The values in red represent the 95th percentile of all hourly data collected at Sunland Park, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	36	36
1	23	23
2	21	21
3	13	13
4	16	16
5	44	44
6	52	52
7	70	70
8	32	32
9	50	50
10	75	75
11	81	81
12	196	**104**
13	270	**125**
14	432	**145**
15	440	**160**
16	656	**168**
17	1040	**201**
18	881	**296**
19	442	**284**
20	261	261
21	204	204
22	141	141
23	35	35
24-Hour Average	229	**109**

Table 20-4. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Sunland Park.

21 HIGH WIND EXCEPTIONAL EVENT: May 24, 2011

21.1 Summary of Event

The passing of a backdoor cold front caused high winds and blowing dust in Doña Ana and Luna Counties resulting in exceedances of the PM_{10} 24-hour NAAQS at the Holman and Sunland Park monitoring sites and the $PM_{2.5}$ annual NAAQS at the Sunland Park monitoring site on this date. The FEM TEOM continuous monitors at these sites recorded 24-hour average PM_{10} concentrations of 174 and 209 µg/m^3, respectively. The FRM Partisol monitor at Sunland Park recorded a 24-hour average $PM_{2.5}$ concentration of 32.9 µg/m^3. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were measured at the Anthony (149 µg/m^3) and Deming Airport (113 µg/m^3) monitoring sites (Figure 22-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event. The Anthony and SPCY $PM_{2.5}$ TEOM monitors also recorded elevated levels on this date (Figure 22-2).

As the event unfolded, the wind blew from the west throughout the border region. These high velocity winds passed over large areas of desert within New Mexico and Mexico. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

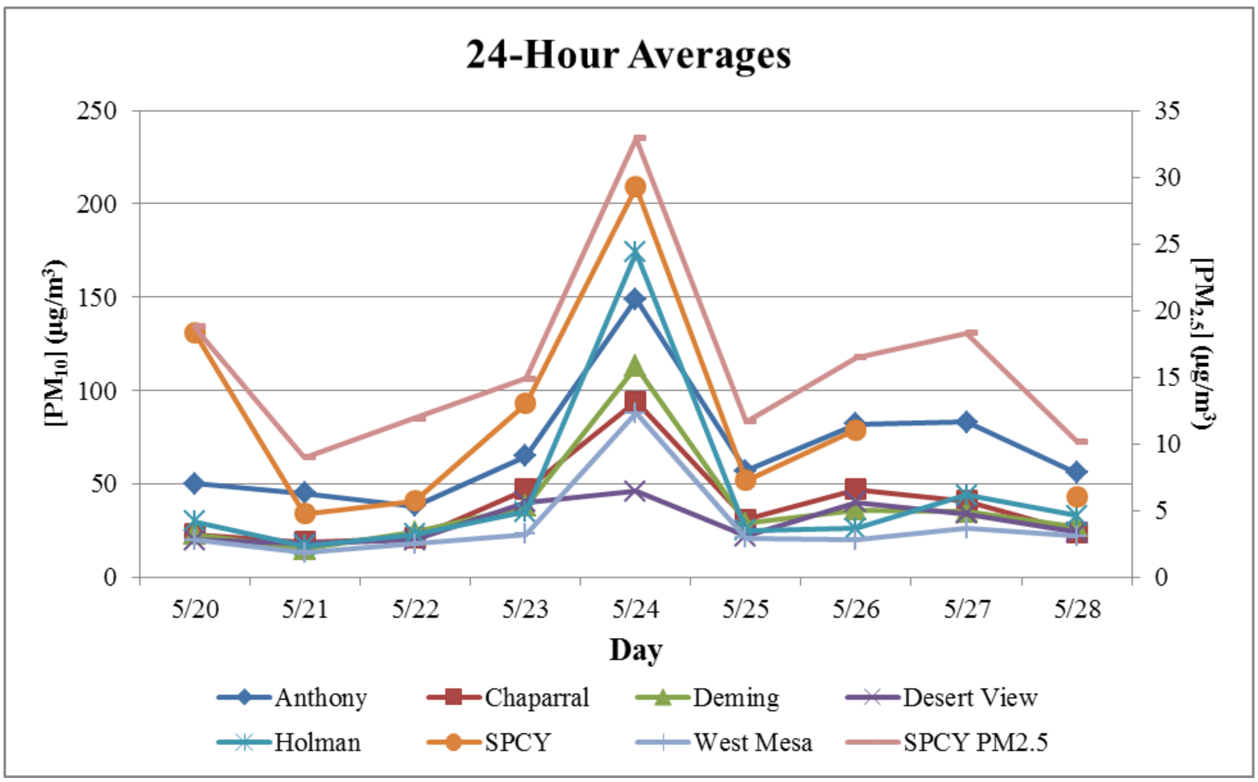

Figure 21-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after May 24, 2013.

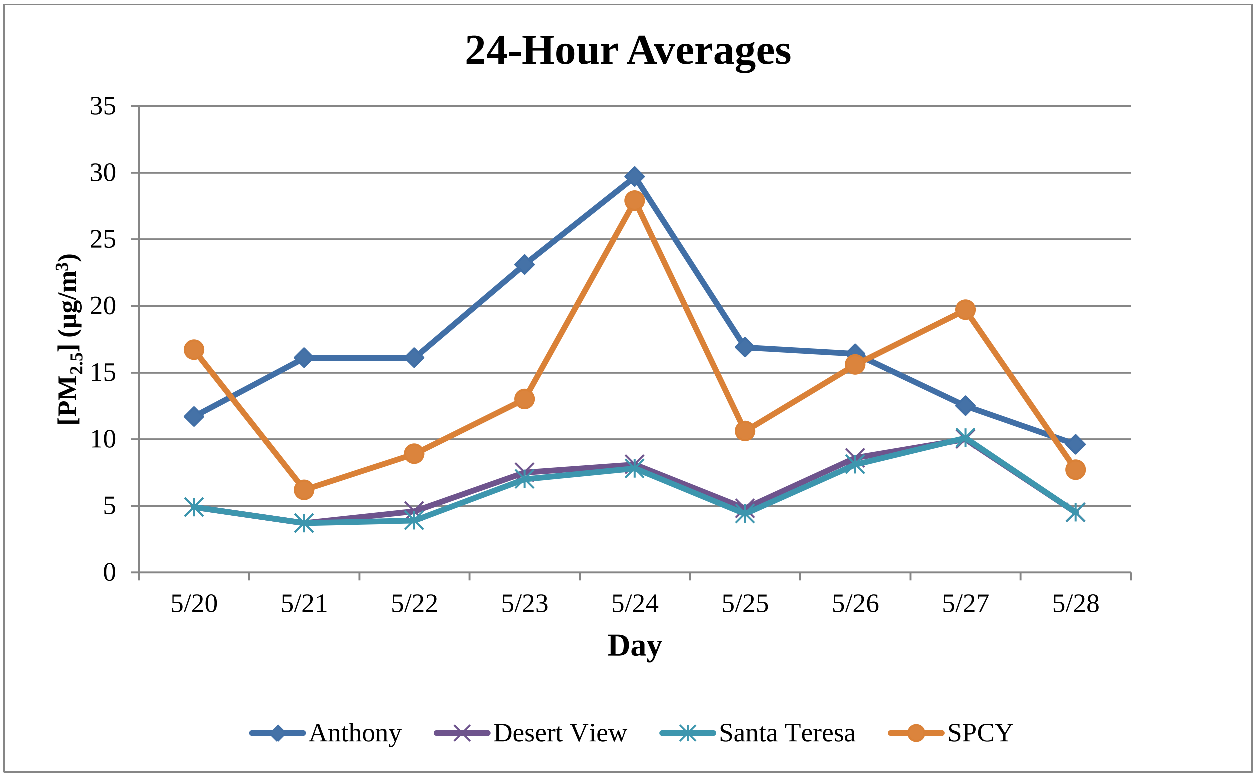

Figure 21-2. $PM_{2.5}$ 24-hour averages before and after May 18, 2011. Non FRM/FEM TEOM data

21.2 Is Not Reasonably Controllable or Preventable

21.3.1 <u>Suspected Source Areas and Categories Contributing to the Event</u>

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in Mexico and New Mexico. City of Las Cruces, City of Deming and Doña Ana and Luna County Ordinances require BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and the playas of northern Mexico (see Section 21.2.4 below).

21.3.2 <u>Sustained and Instantaneous Wind Speeds</u>

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On May 24, 2011, sustained wind speeds exceeded EPA's default threshold at four of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at five of the seven monitoring sites (Figures 21-3 and 21-4). Winds exceeded these thresholds at one or more monitoring sites beginning at the 9:00 hour and ending at the 18:00 hour.

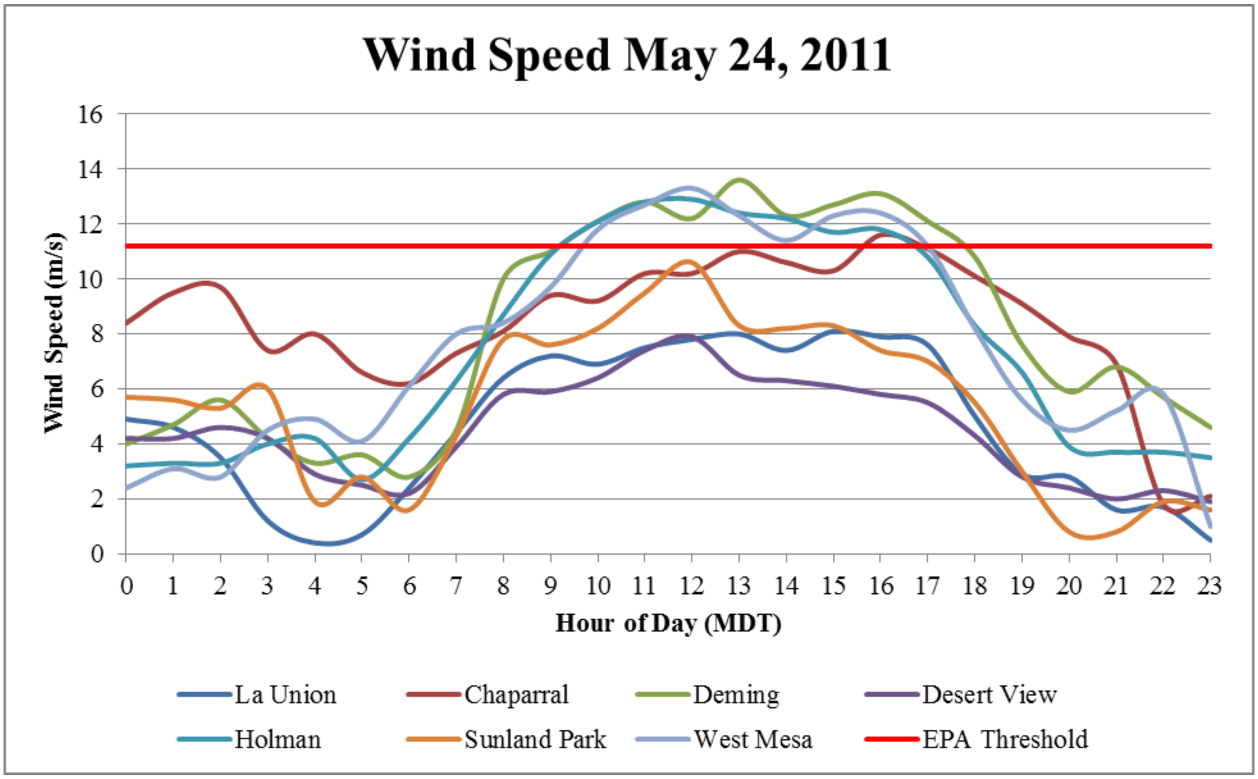

Figure 21-3. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

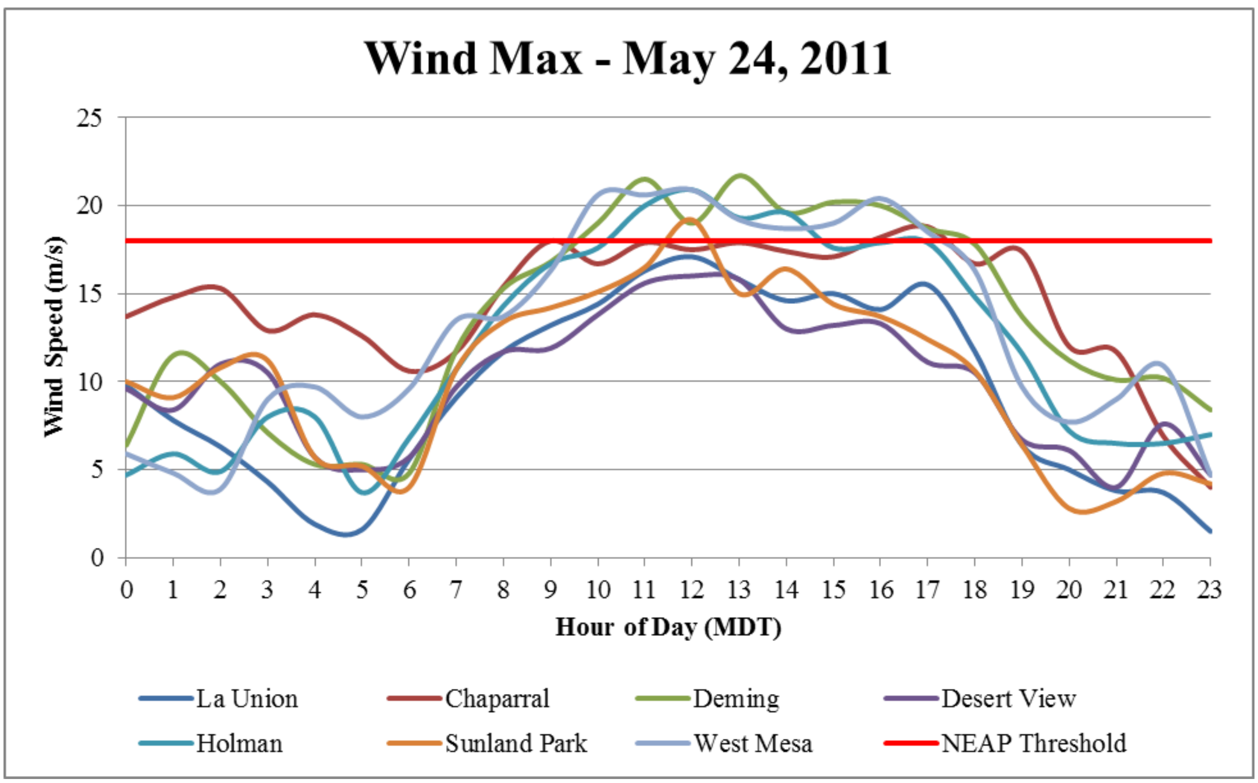

Figure 21-4. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

21.3.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the PM_{10} FEM TEOM monitors recorded 211 exceedances and the PM_{10} FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

21.3.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana and Luna Counties. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert and playas in New Mexico and northern Mexico. The sites in Doña Ana County recorded the highest 24-hour averages in the monitoring network. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled from Arizona and Mexico to the monitors in Doña Ana and Luna Counties. The model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figure 21-5). Costs prohibit controlling dust from the natural desert terrain and falls outside NMED's jurisdiction when it originates in Arizona or Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

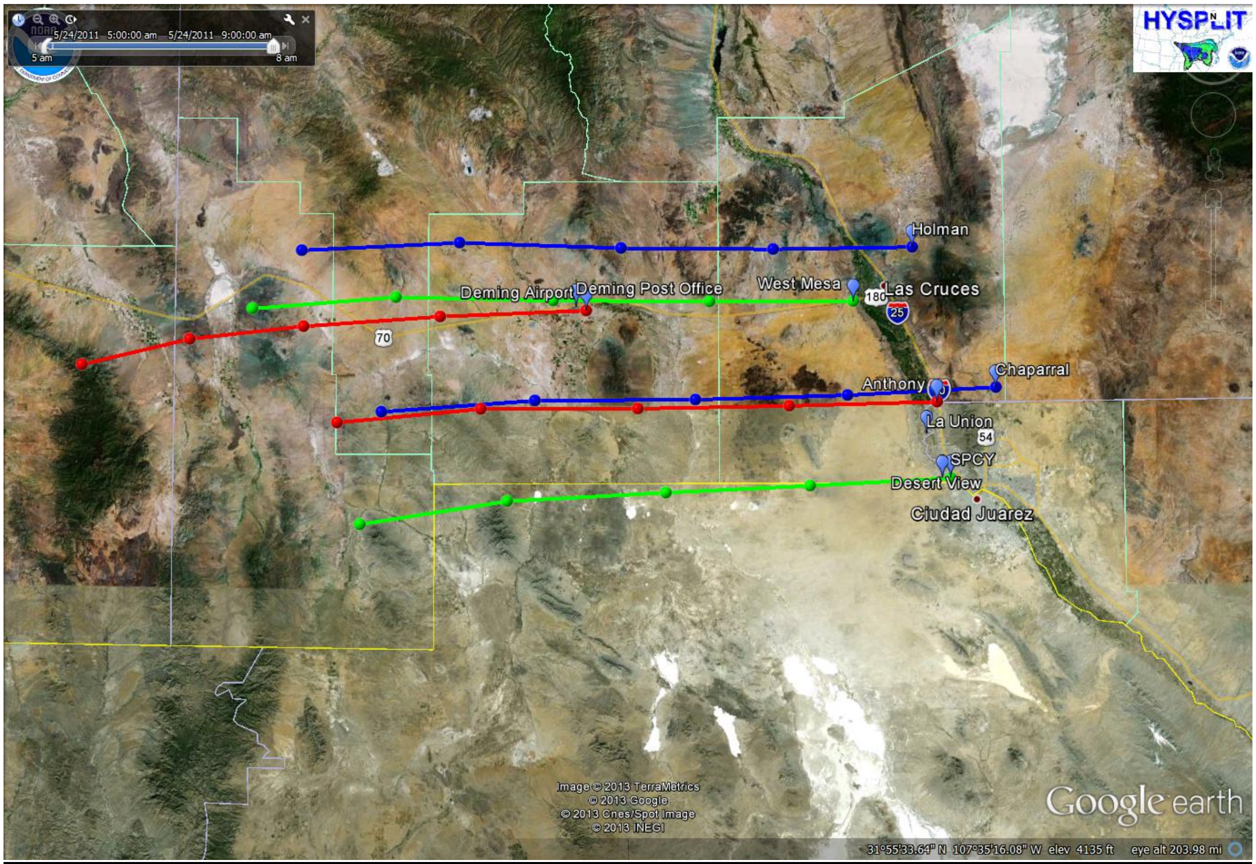

Figure 21-5. HYSPLIT back-trajectory model analysis for May 24, 2011.

21.3 Historical Fluctuations Analysis

21.3.5 Annual and Seasonal 24-hour Average Fluctuations

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded values for this day (174 and 209 µg/m^3) are above the maximum values recorded when no high wind exceedances are included and is above the 95th percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for May 24, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95th percentile for PM_{10} and $PM_{2.5}$, wind speed and wind gusts (Figures 21-6a-c through 21-8a-b). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} values during the high wind blowing dust storm far exceed the historical 95th percentile of data.

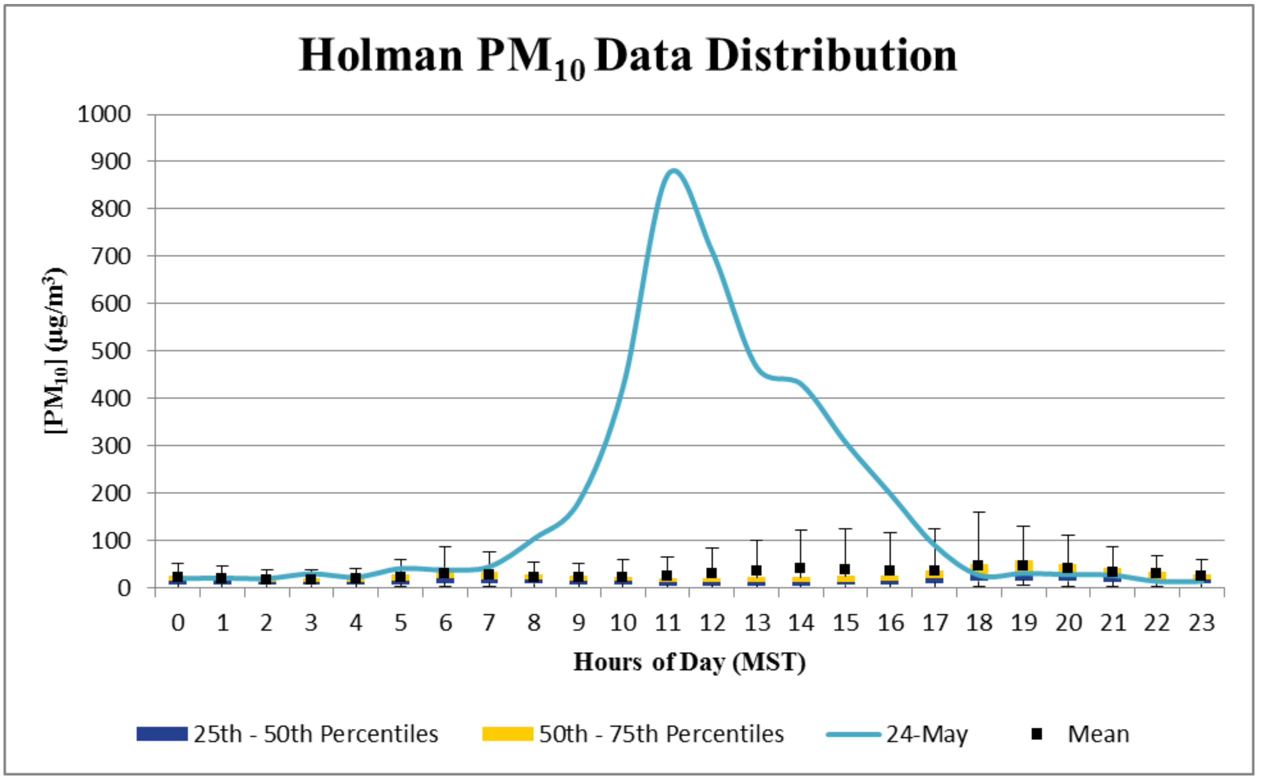

Figure 21-6a. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 24, 2011.

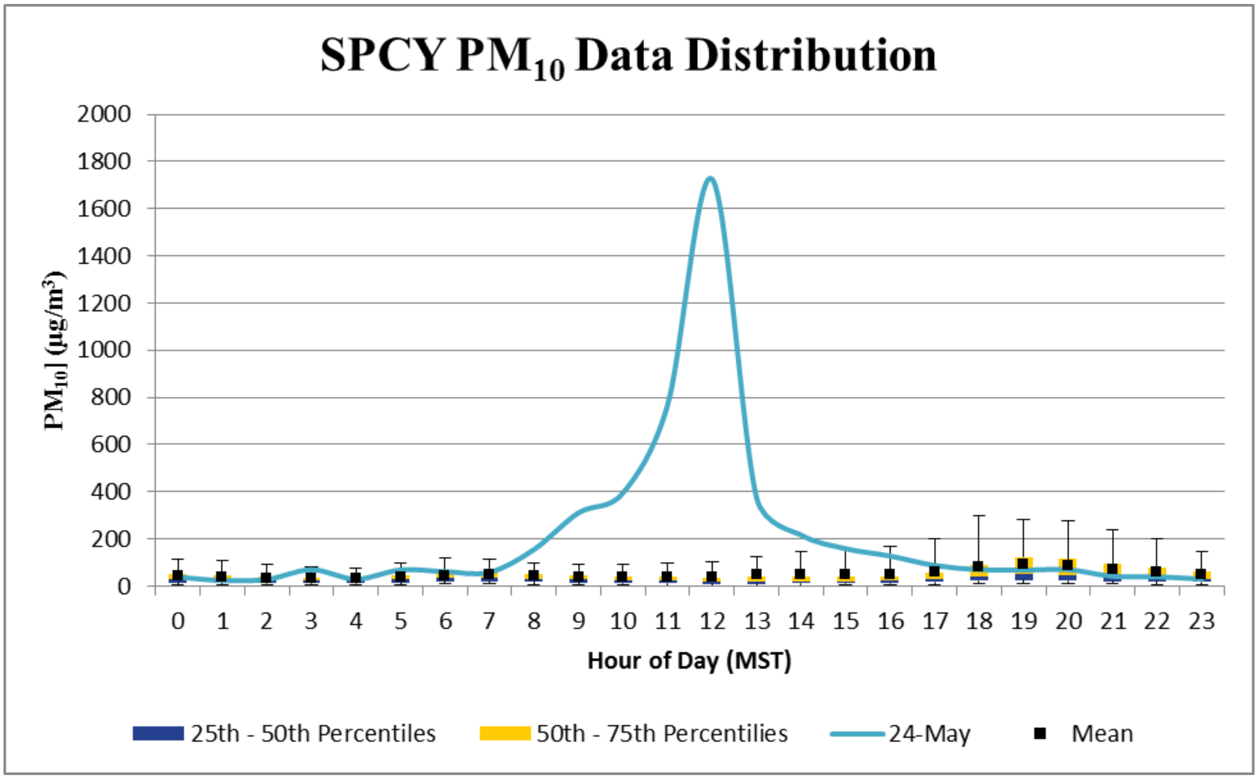

Figure 21-6b. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 24, 2011.

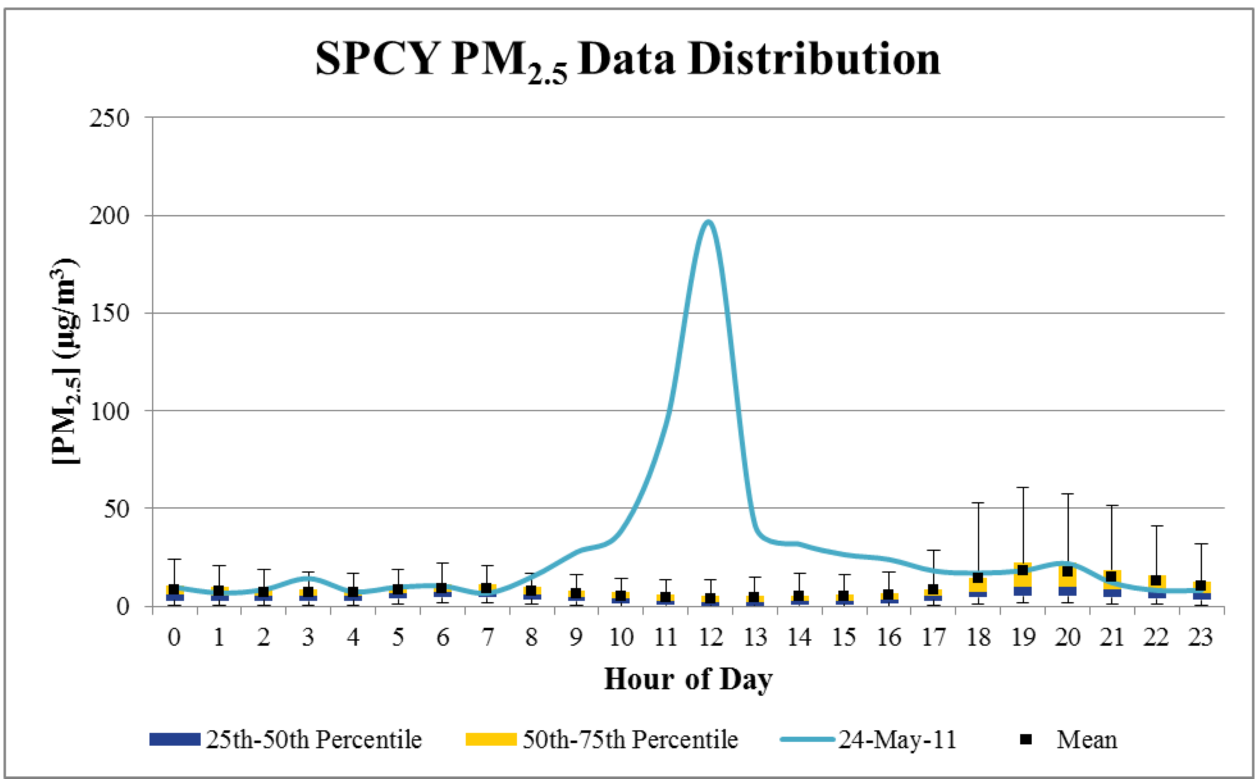

Figure 21-6c. $PM_{2.5}$ hourly data distribution from 2006-2010 overlaid by hourly values for May 24, 2011.

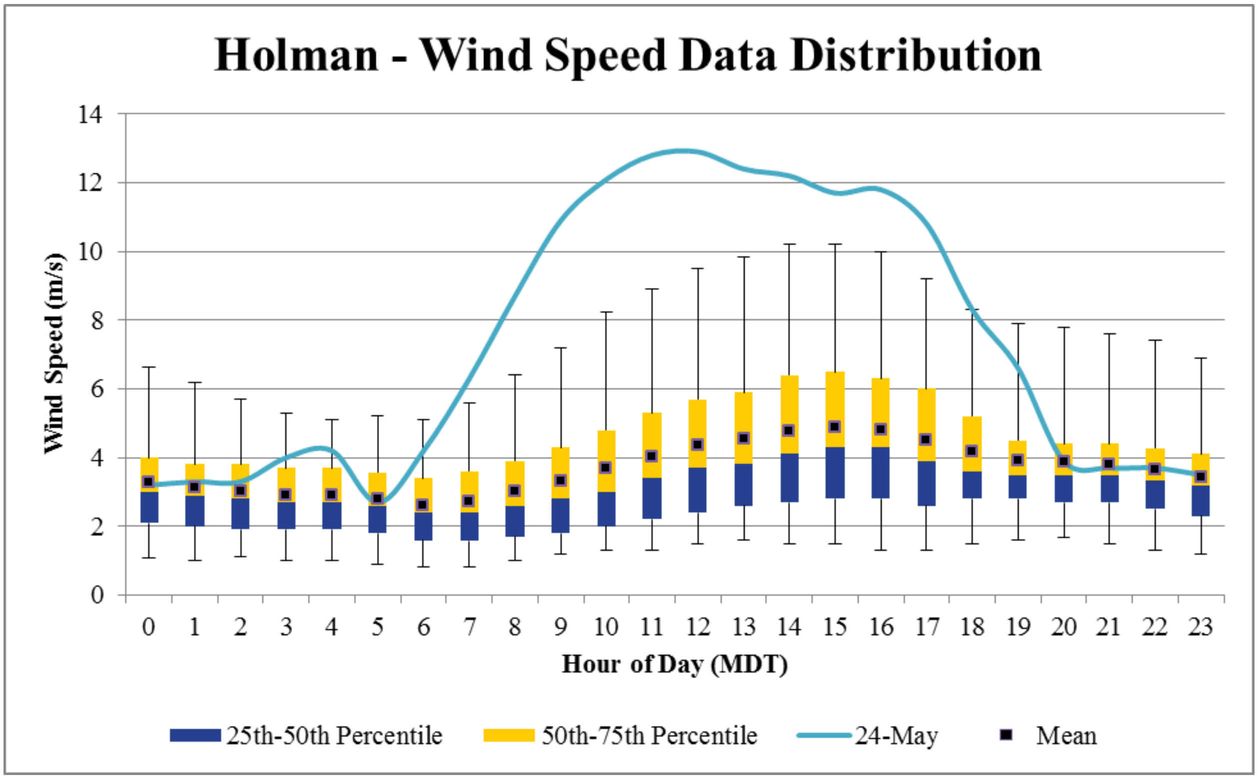

Figure 21-7a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 24, 2011.

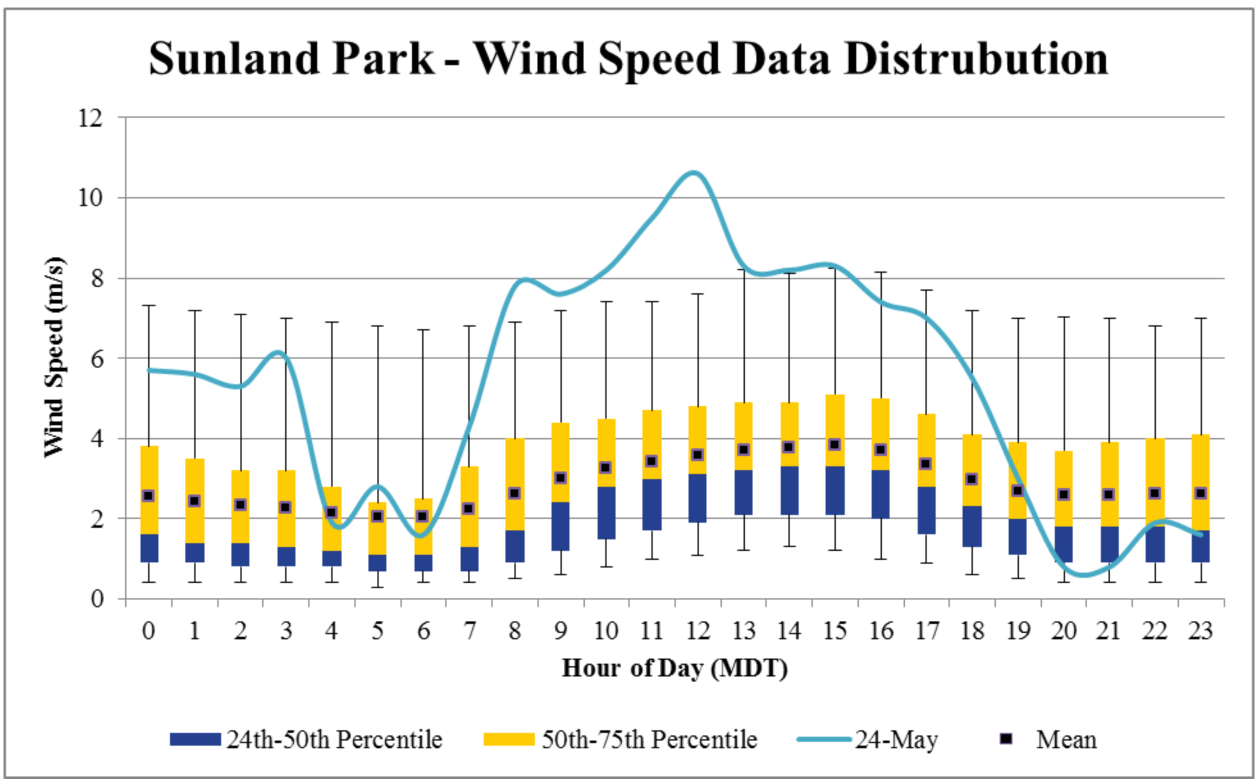

Figure 21-7b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 24, 2011.

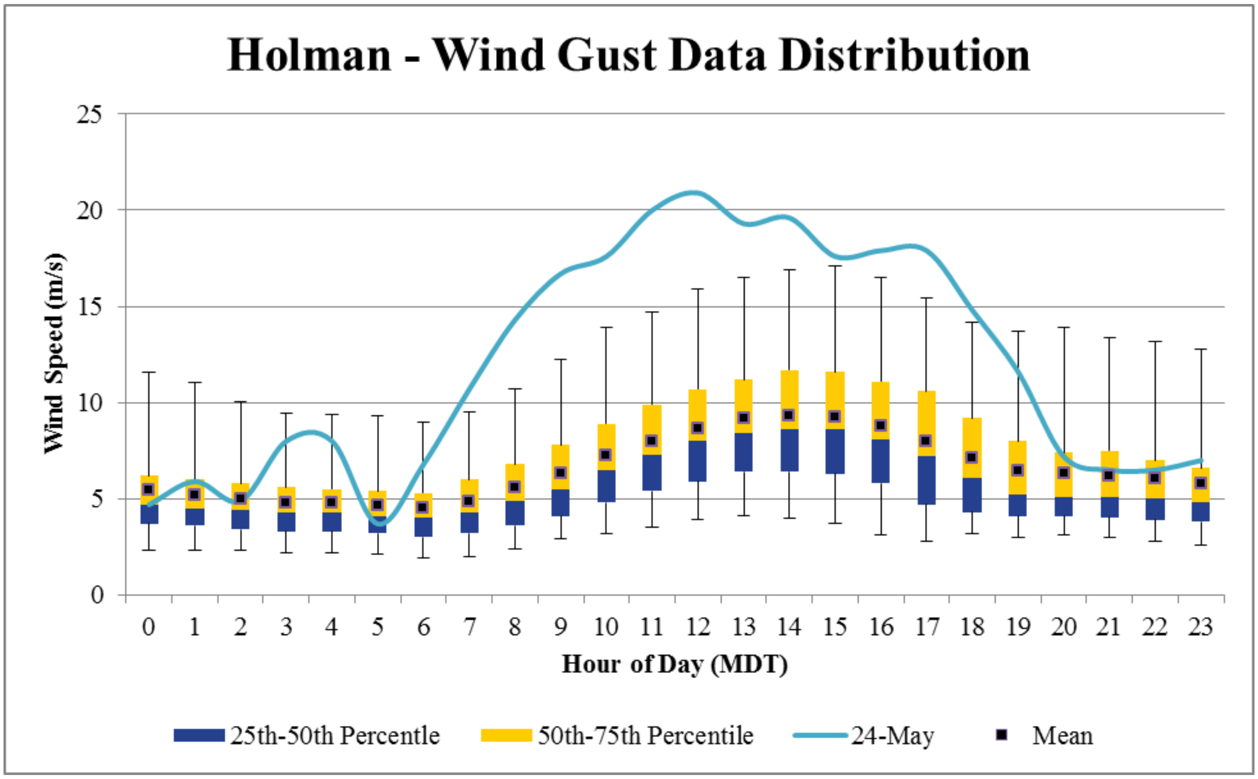

Figure 21-8a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 24, 2011.

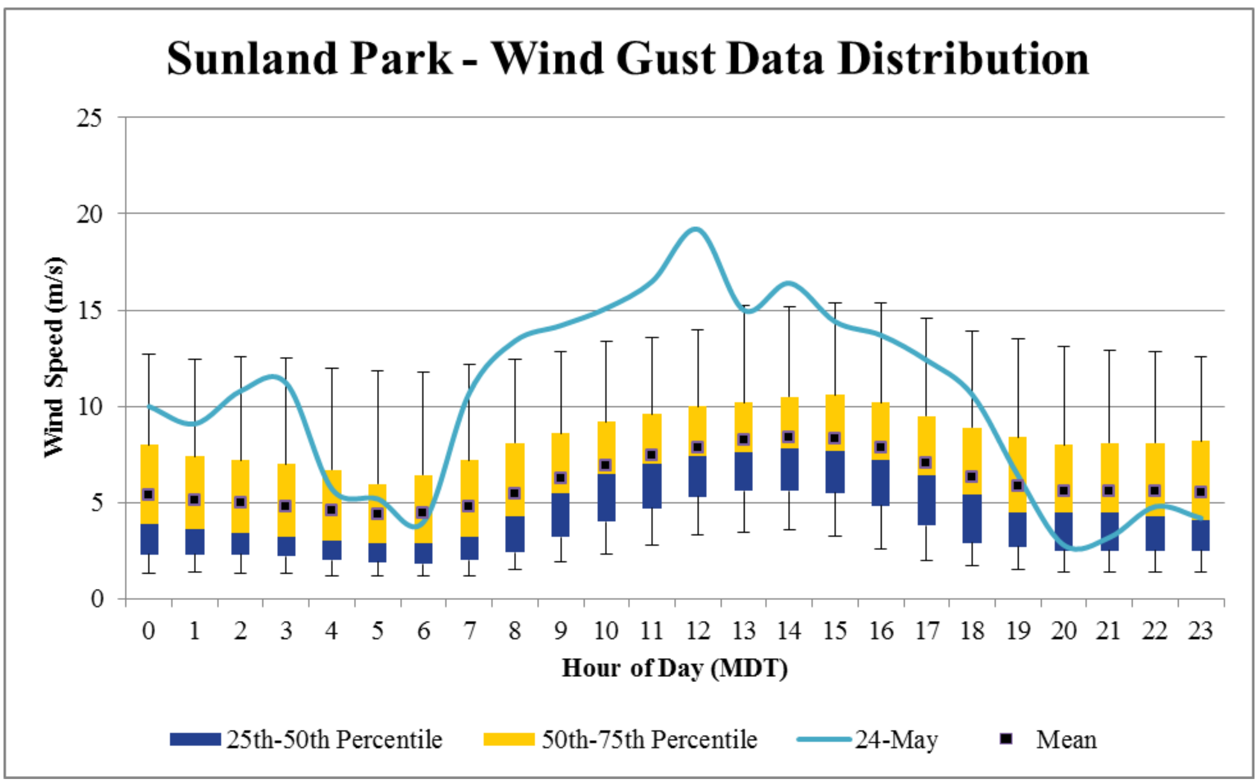

Figure 21-8b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 24, 2011.

21.4 Clear Causal Relationship

A backdoor cold front passed through New Mexico on May 24, 2011 with a surface low pressure in the panhandle of Oklahoma. An approaching upper level low deepened the surface low creating a tightened pressure gradient and winds became even stronger at the surface (Figures 21-9a-c). Surface winds flow perpendicular to the isobars from high to low pressure. As the upper low moved into New Mexico, the winds in the upper atmosphere aligned with the surface wind direction (Figure 21-10). Diurnal heating of the surface allowed winds aloft to mix downward, increasing the surface wind velocities and provided the turbulence required for vertical mixing and horizontal transport.

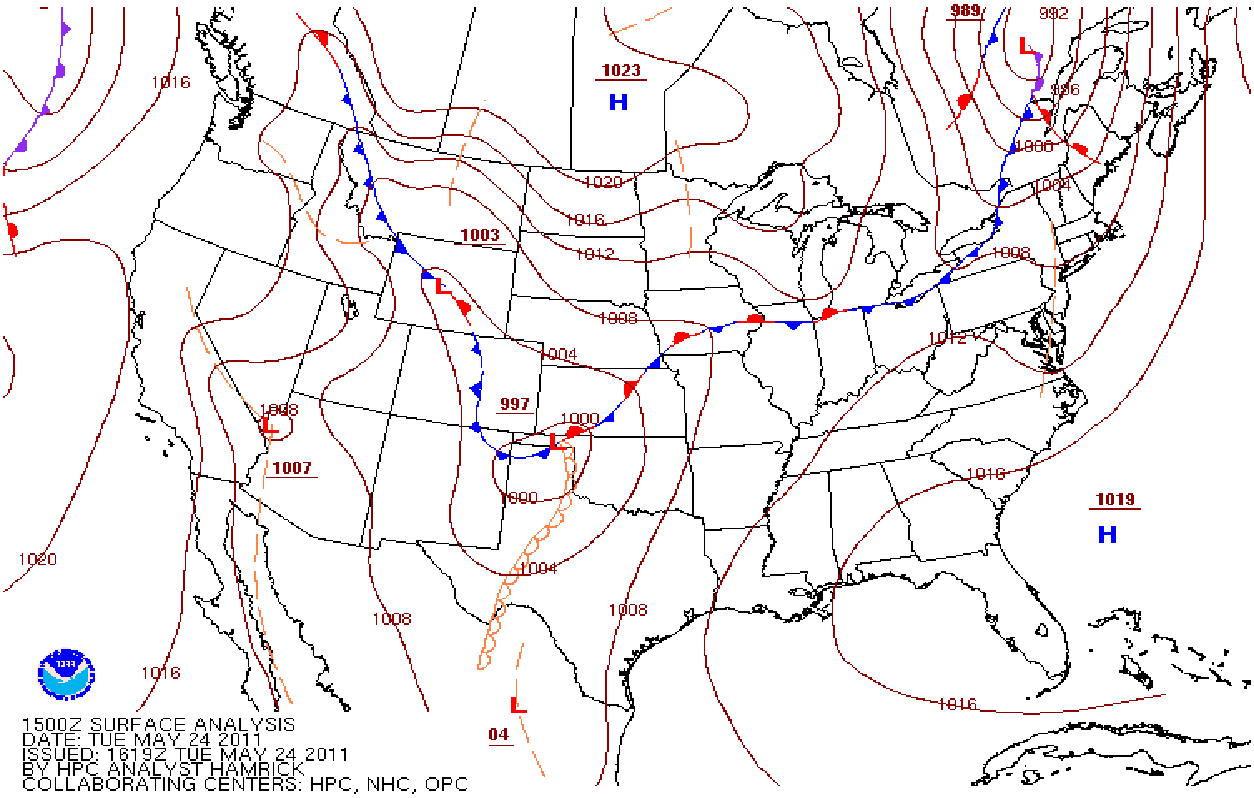

Figure 21-9a. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for May 24, 2011 at the 0900 hour MDT.

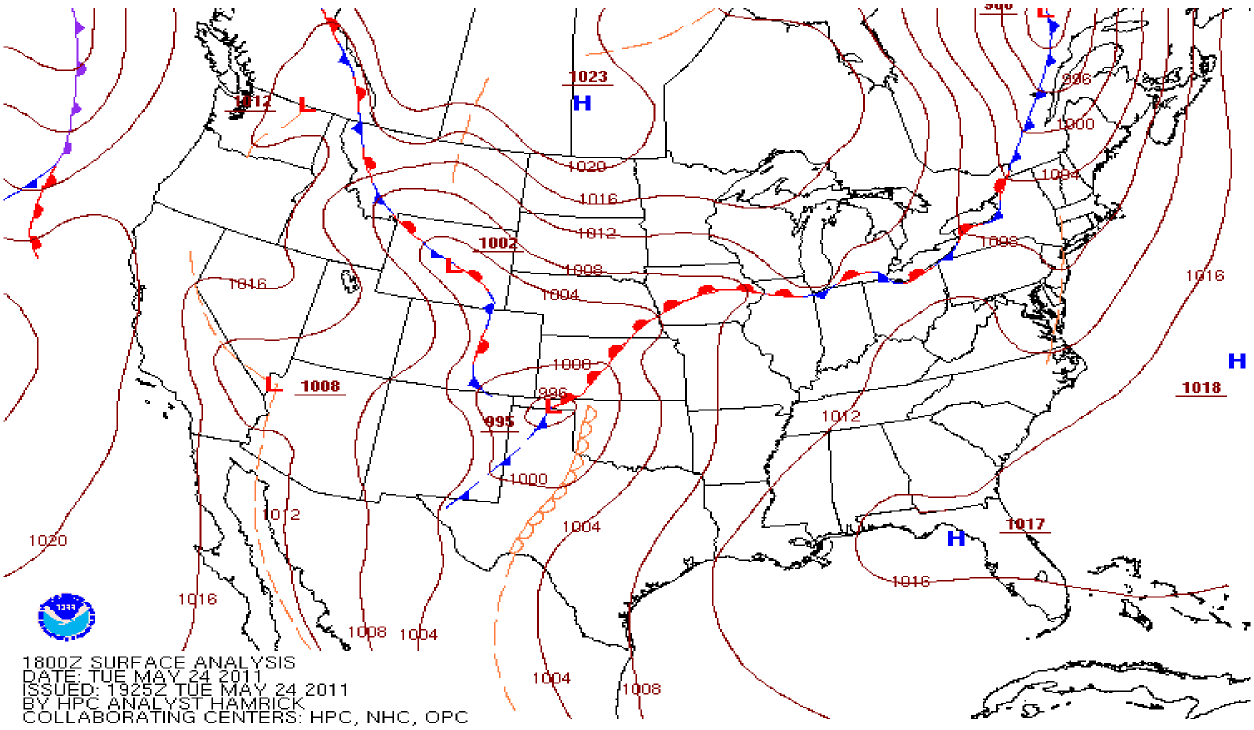

Figure 21-9b. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for May 24, 2011 at the 1200 hour MDT.

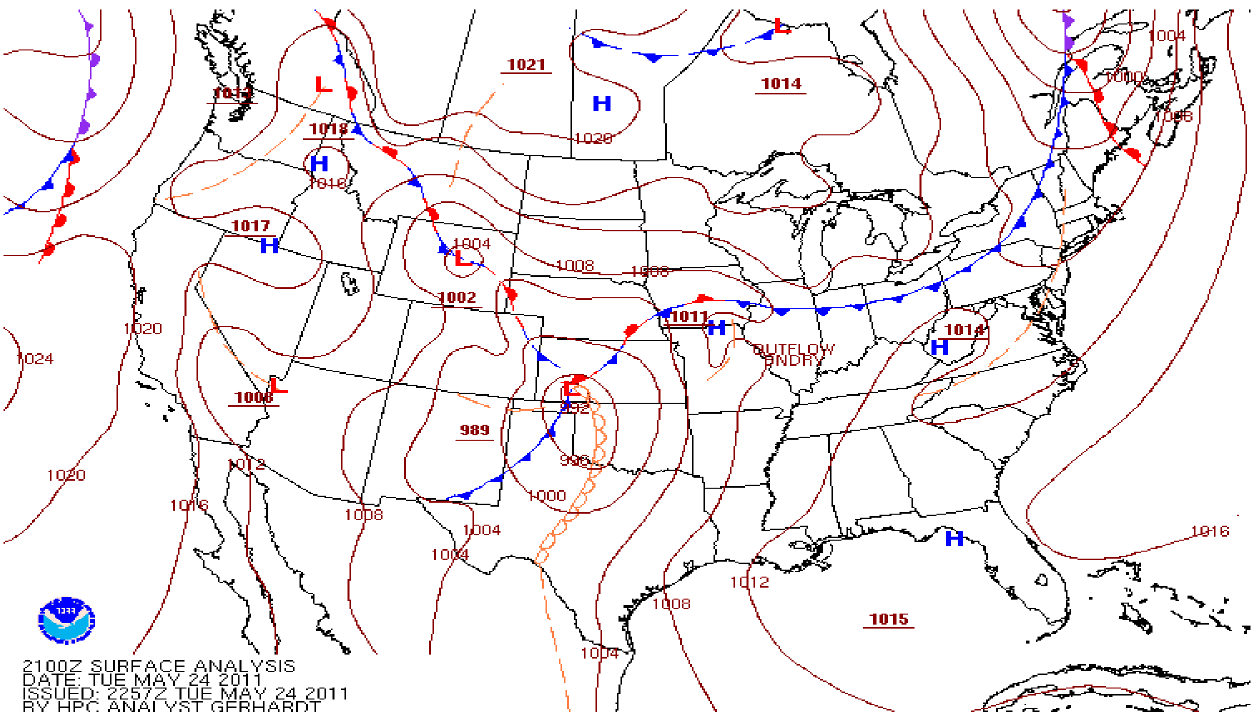

Figure 21-9c. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for May 24, 2011 at the 1500 hour MDT.

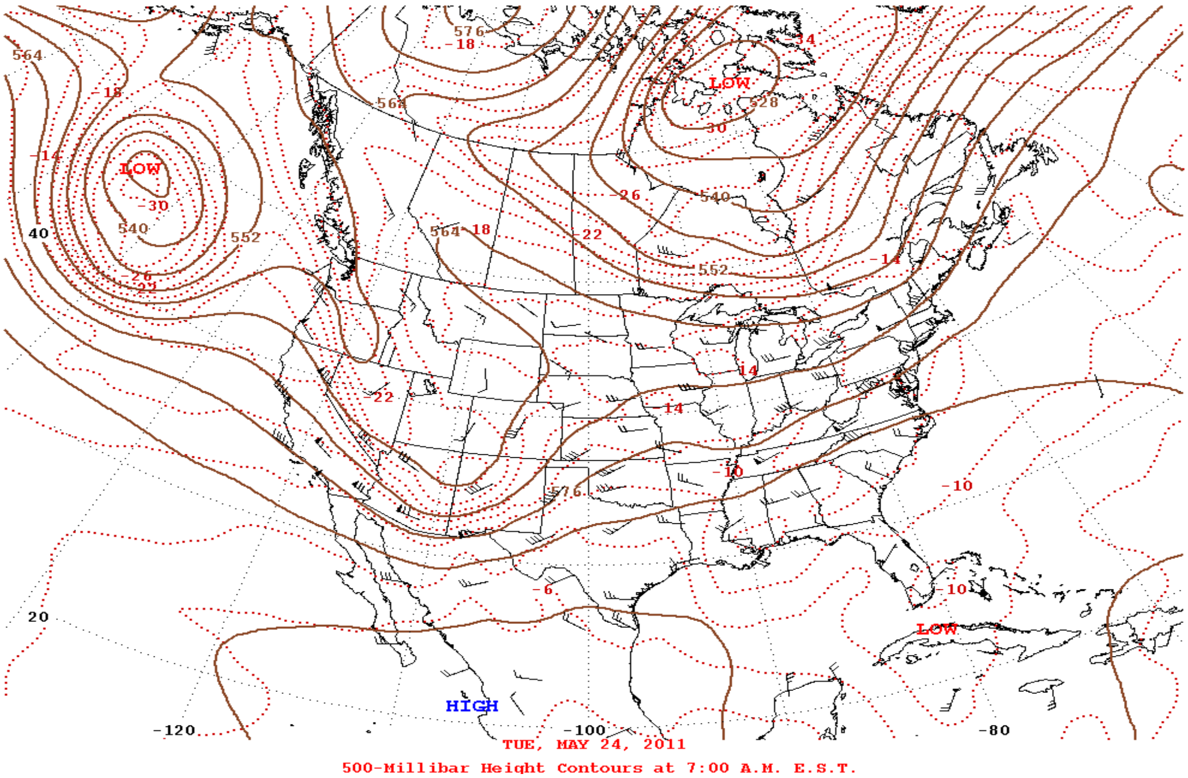

Figure 21-10. Upper air weather map showing geopotential heights (brown lines) at the 500 hour MDT on May 24, 2011.

The weather pattern described above generated strong west winds beginning at the 0800 hour and lasting through the 1900 hour. Beginning at the 1000 hour, wind speeds exceeded 11.2 m/s at the Deming and Holman monitoring sites. Peak wind speeds ranged from 7.9 m/s at Desert View monitoring site to 13.6 m/s at Deming monitoring site (Figure 21-3). Peak wind gusts ranged from 16 m/s at Desert View to 21.7 m/s at Deming (Figure 21-4). Blowing dust caused elevated levels of PM_{10} and $PM_{2.5}$ during the same period as high winds as demonstrated by the time series plot in Figures 21-11a-h. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (0600-2000 hours). During these hours, hourly PM_{10} and $PM_{2.5}$ concentrations spiked at all monitoring sites in the network (Figure 21-12a-b). Hourly data from the SPCY PM_{10} and $PM_{2.5}$ TEOM Monitors show good correlation of the timing of spikes in concentrations (Figure 21-13).

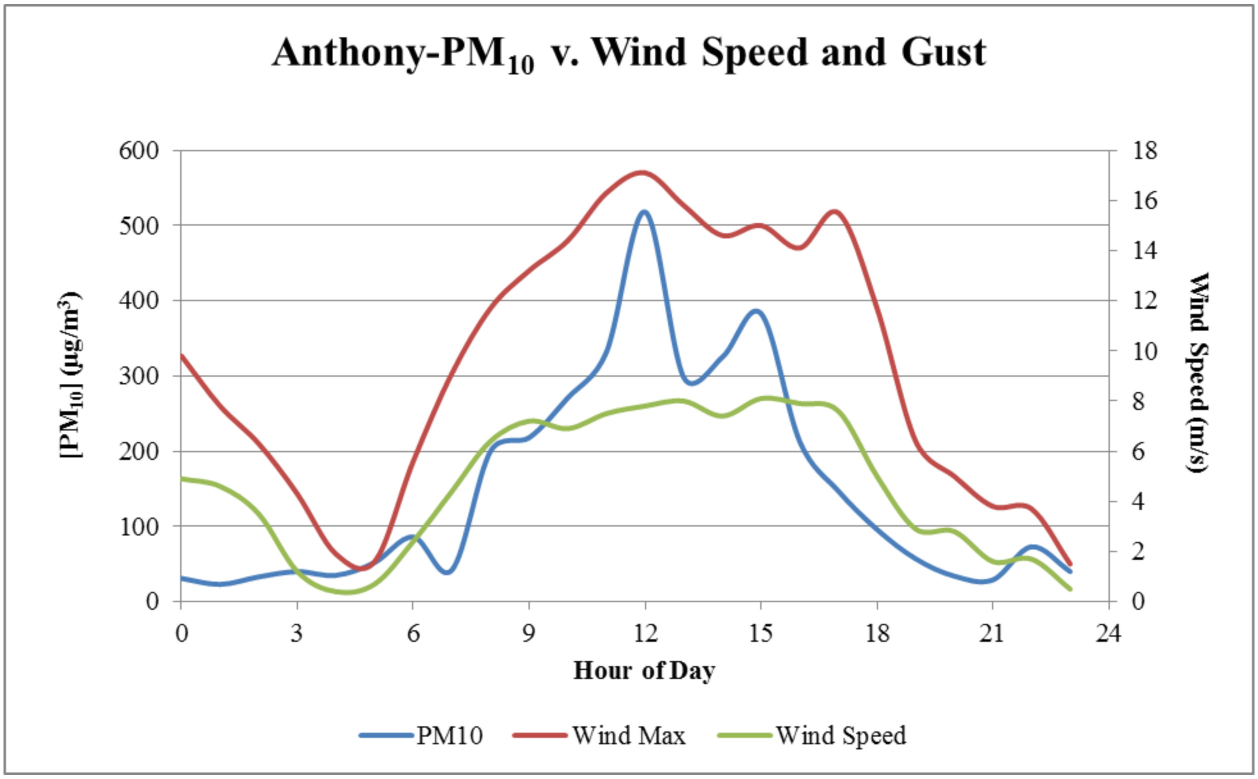

Figure 21-11a. Time series plot of hourly observations in Anthony showing increased PM_{10} concentrations as wind speeds and gusts increase.

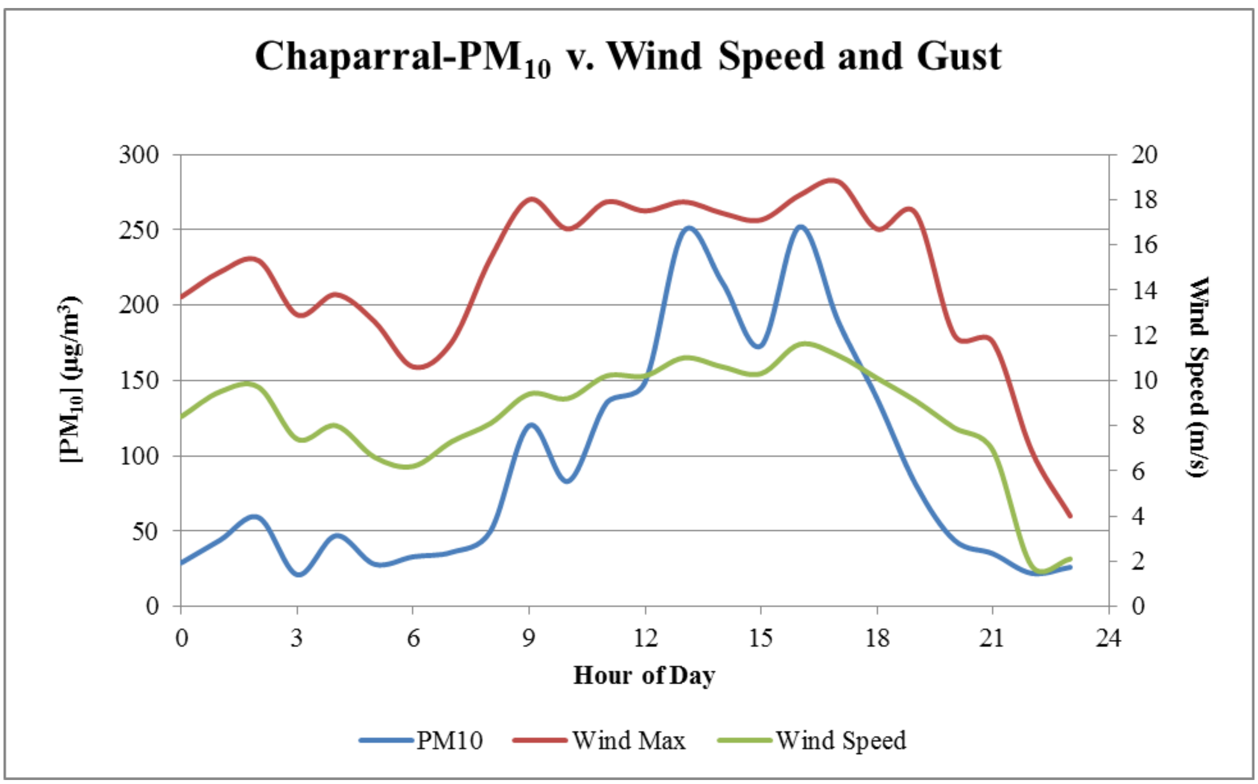

Figure 21-11b. Time series plot of hourly observations in Chaparral showing increased PM_{10} concentrations as wind speeds and gusts increase.

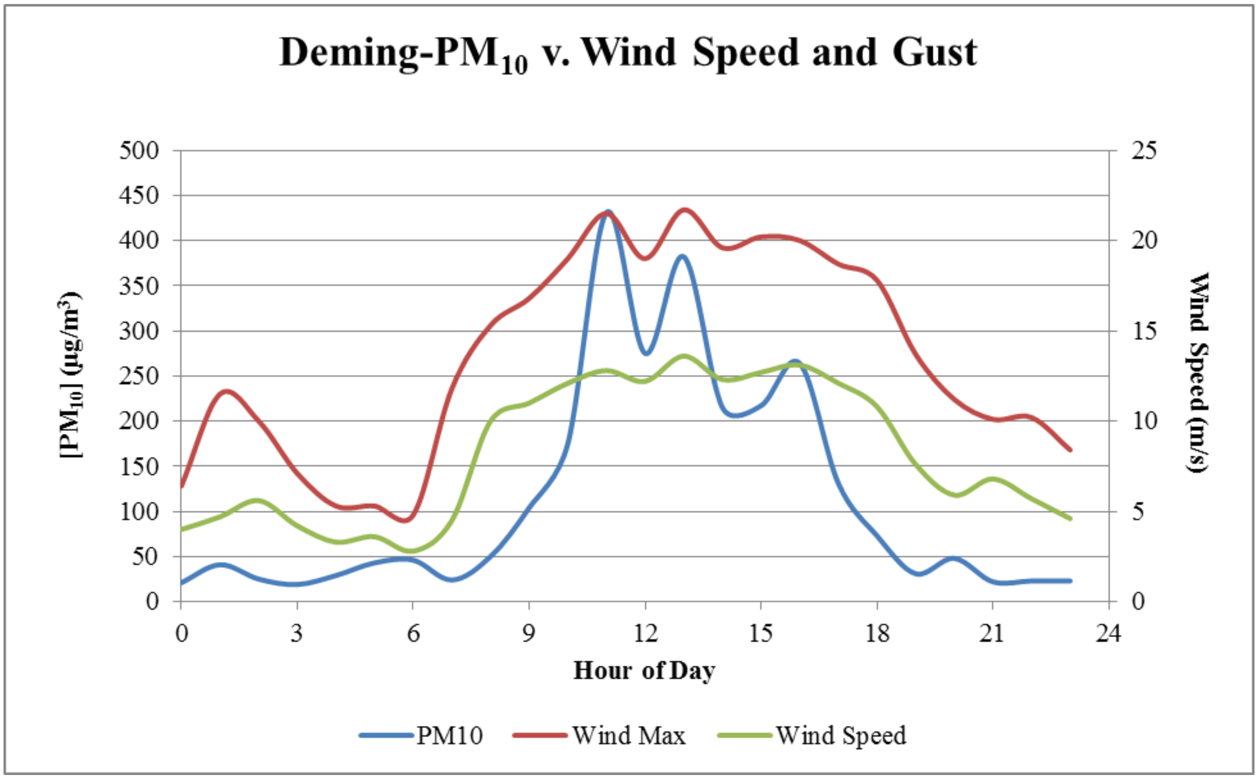

Figure 21-11c. Time series plot of hourly observations in Deming showing increased PM_{10} concentrations as wind speeds and gusts increase.

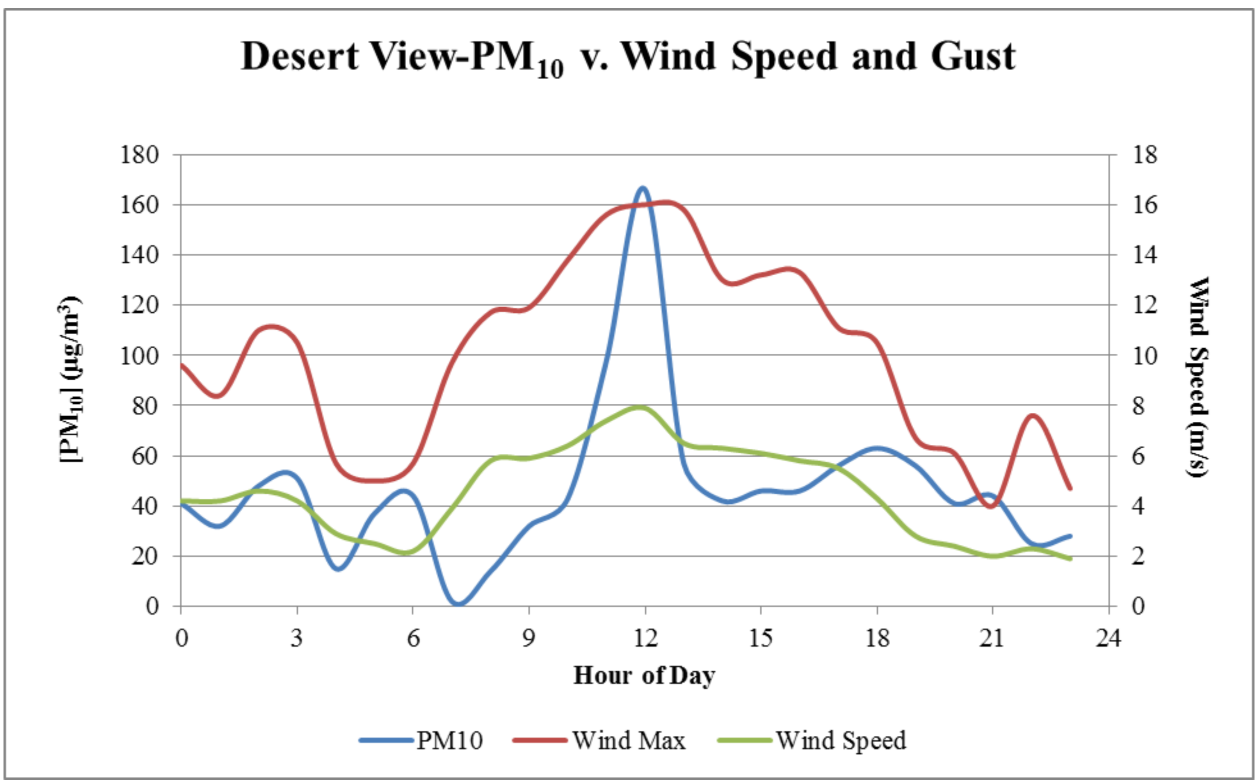

Figure 21-11d. Time series plot of hourly observations in Desert View showing increased PM_{10} concentrations as wind speeds and gusts increase.

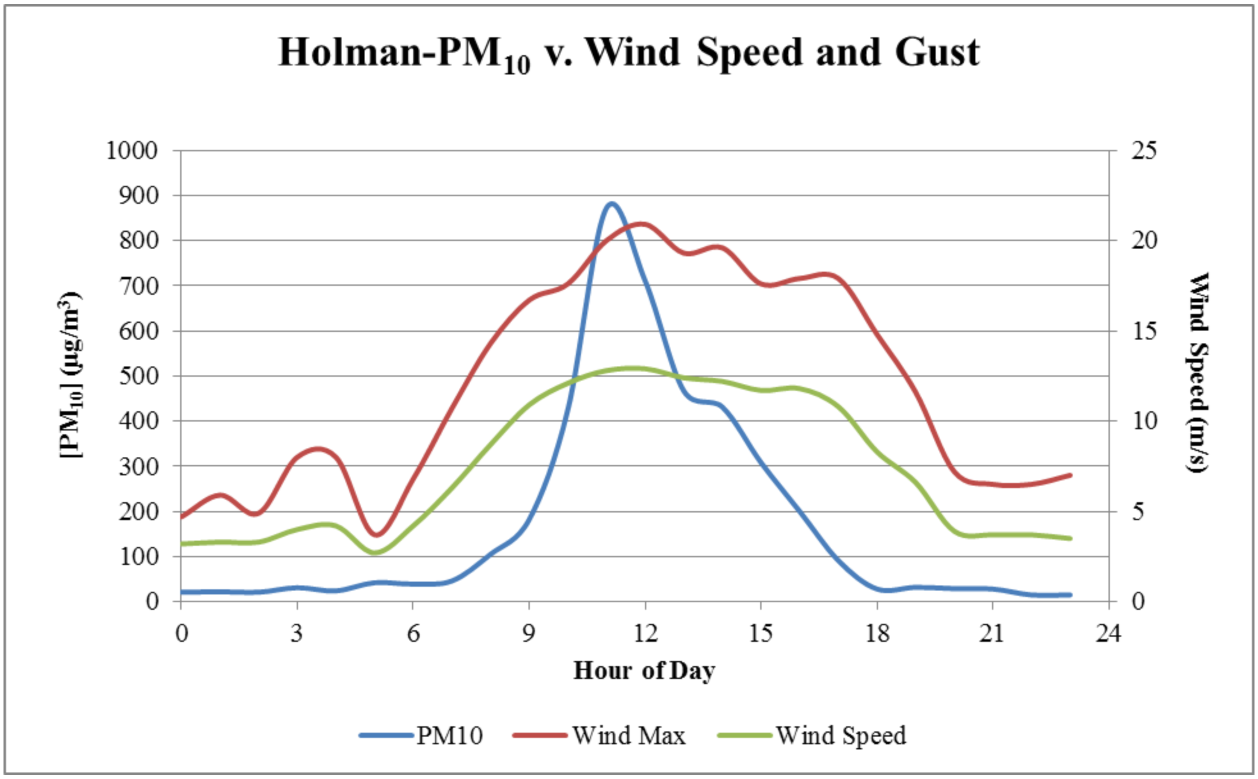

Figure 21-11e. Time series plot of hourly observations at Holman showing increased PM_{10} concentrations as wind speeds and gusts increase.

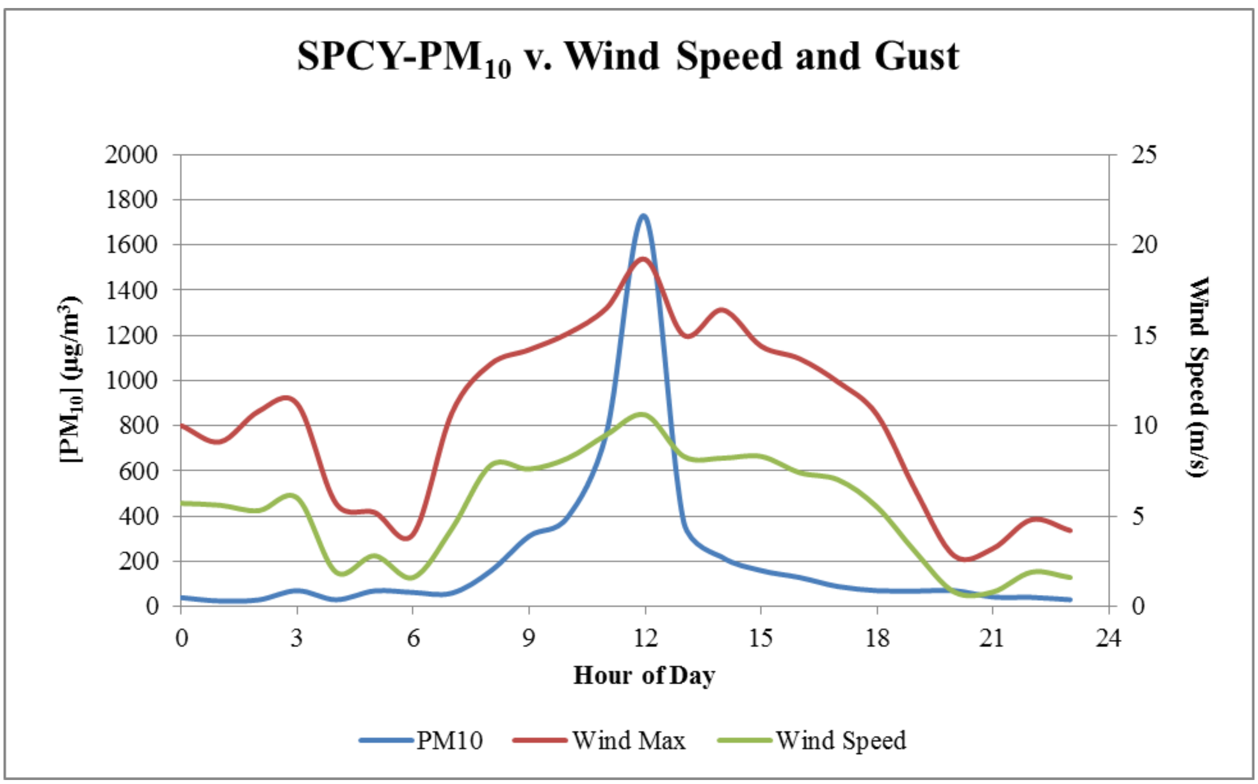

Figure 21-11f. Time series plot of hourly observations in Sunland Park showing increased PM_{10} concentrations as wind speeds and gusts increase.

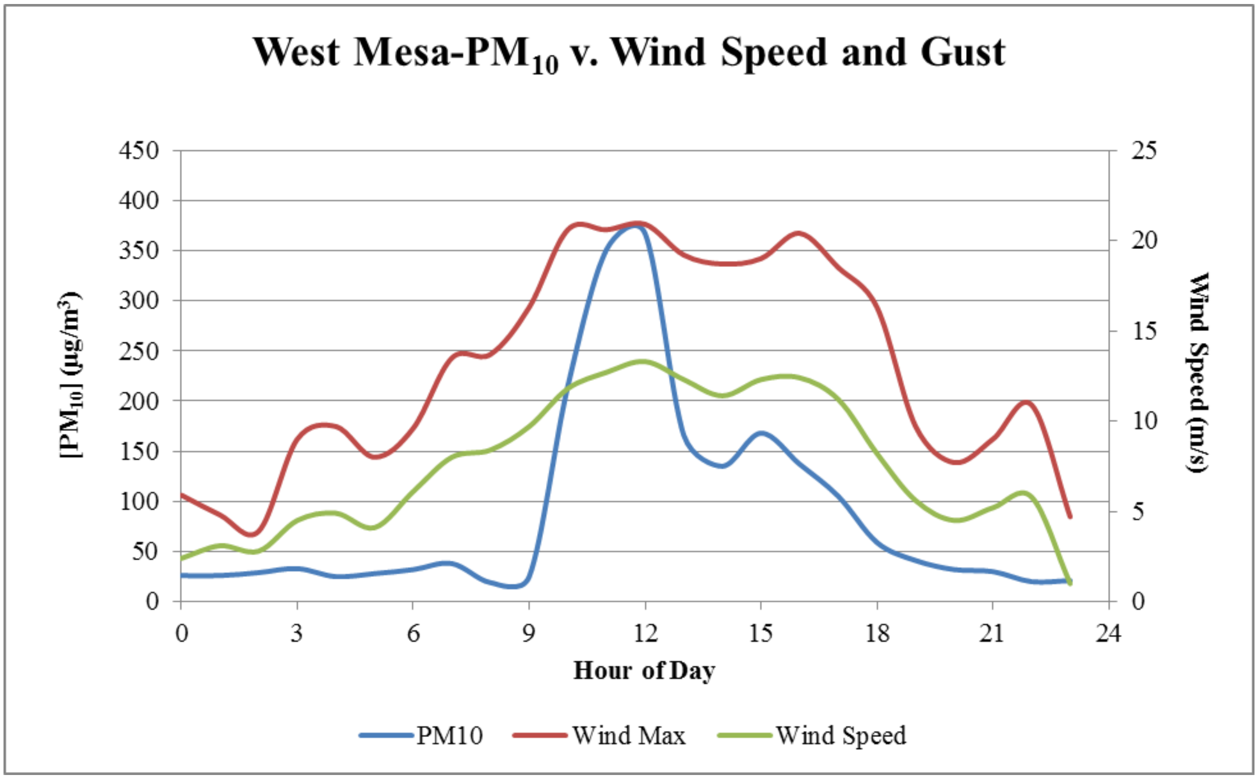

Figure 21-11g. Time series plot of hourly observations at West Mesa showing increased PM_{10} concentrations as wind speeds and gusts increase.

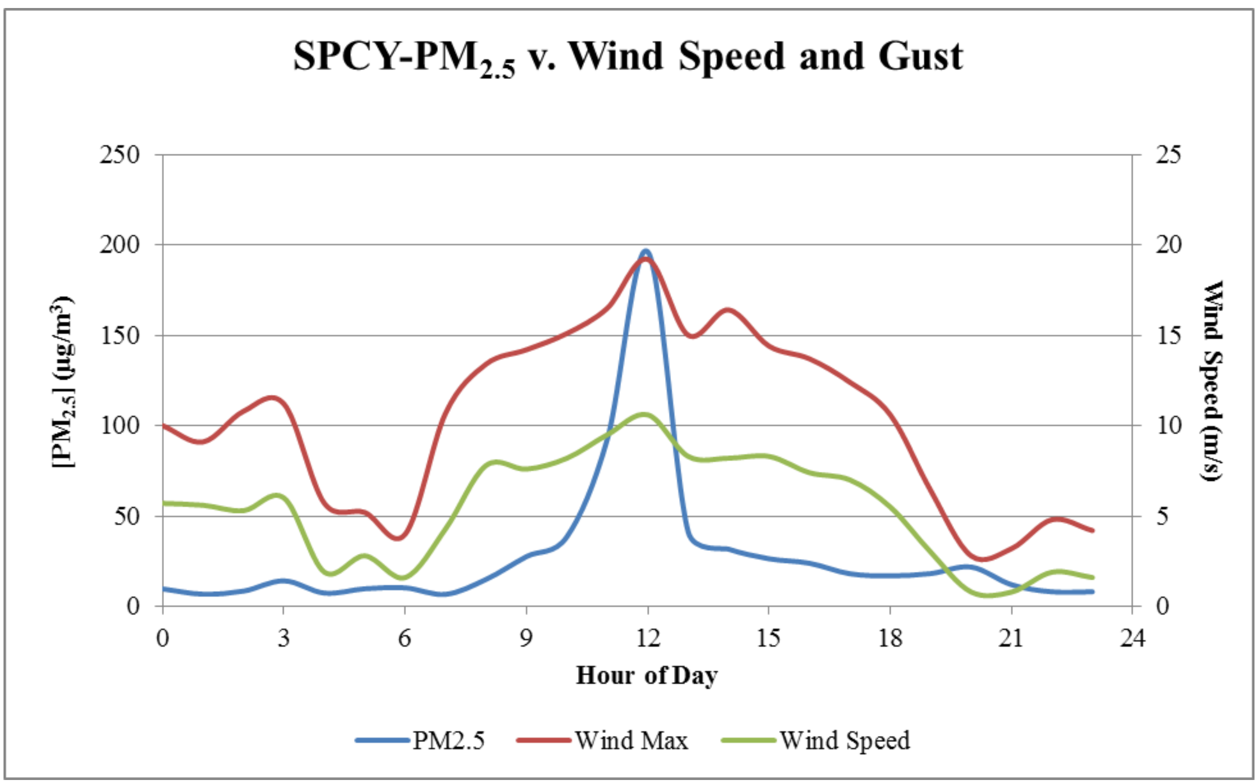

Figure 21-11h. Time series plot of hourly observations at West Mesa showing increased $PM_{2.5}$ concentrations as wind speeds and gusts increase.

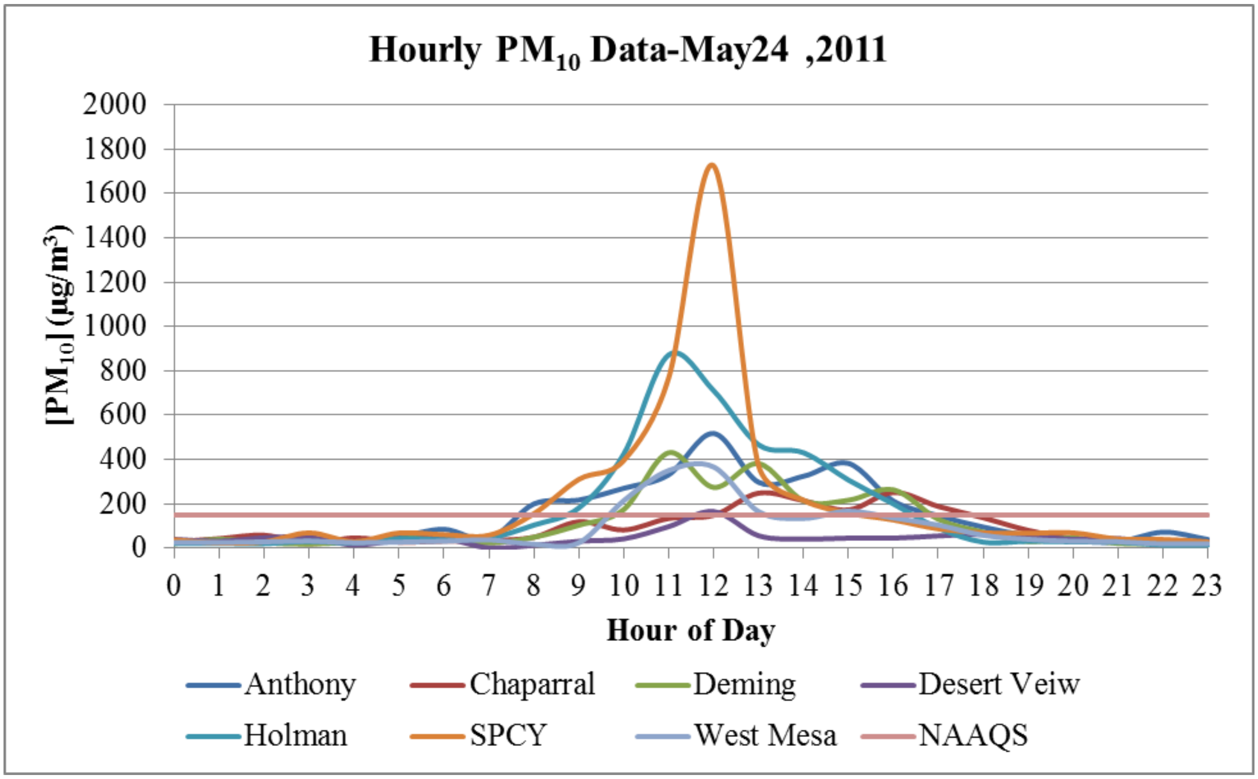

Figure 21-12a. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

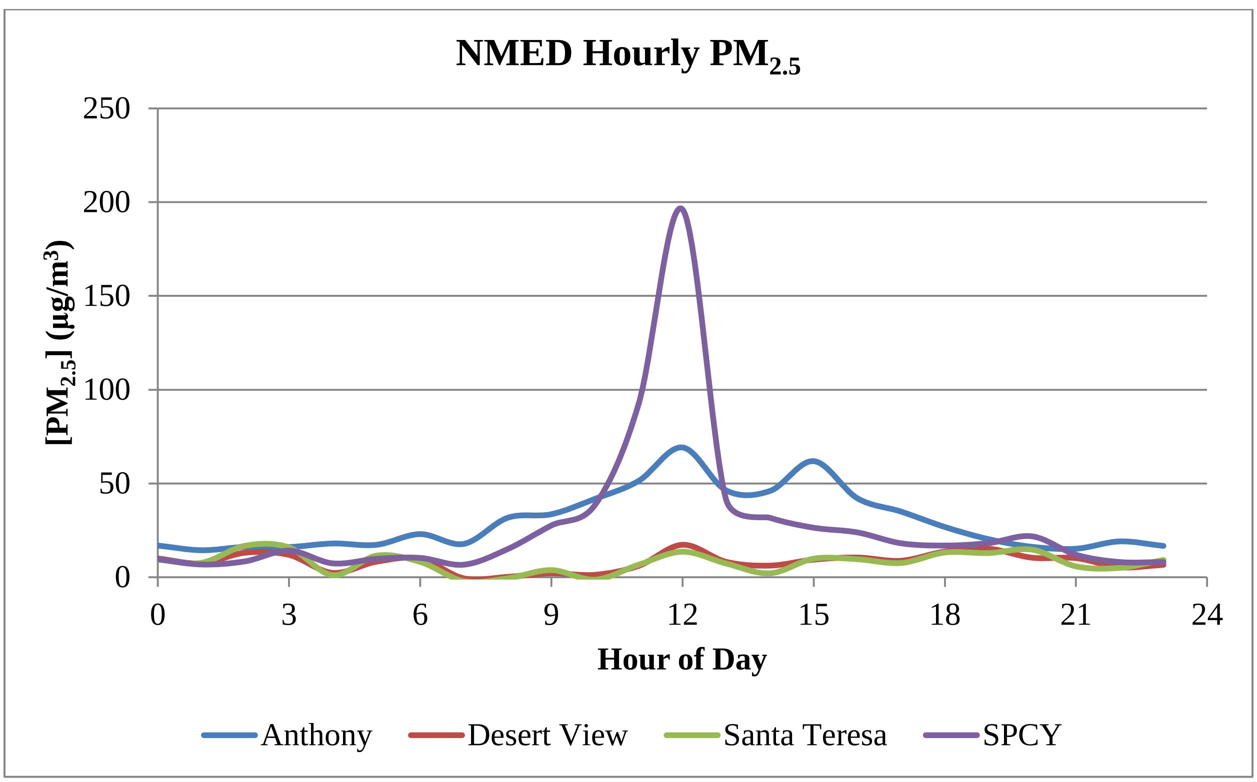

Figure 21-12b. Hourly $PM_{2.5}$ concentrations for Doña Ana County monitors.

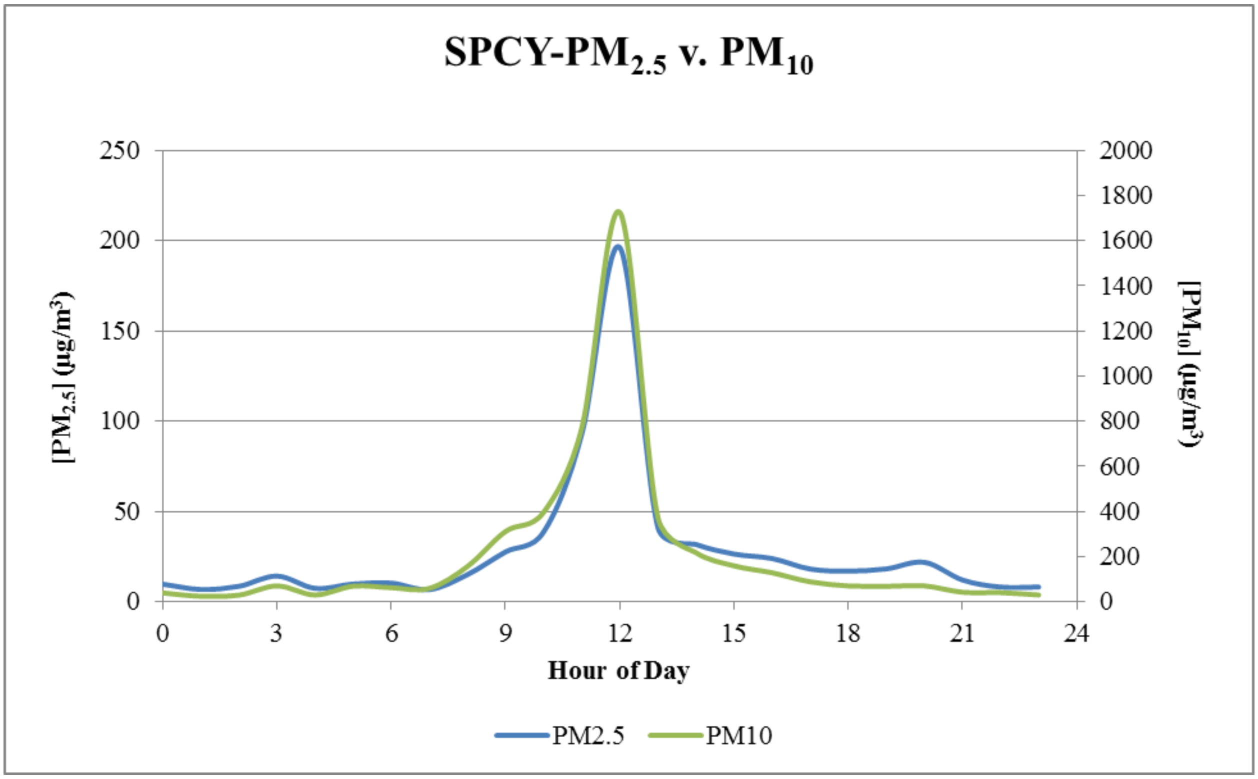

Figure 21-13. Correlation of Hourly PM_{10} and $PM_{2.5}$ concentrations for the SPCY monitoring site on May 24, 2011.

The MODIS instrument on NASA's Aqua satellite captured blowing dust coming off of White Sands National Monument (Figure 21-14).

The NM Border AQ Blog reported a dust alert for this day, announcing "Another windy day for our region" (DuBois, 2011).

The NWS issued a wind advisory on May 24, 2011 stating in part,

> ...VERY STRONG WINDS ACROSS THE REGION THIS AFTERNOON AND EVENING…
>
> AN UPPER LEVEL TROUGH CURRENTLY MOVING ACROSS THE ROCKIES WILL COMBINE WITH A STRONG PRESSURE GRADIENT TO CREATE WINDS SPEEDS OF 25 TO 35 MPH WITH GUSTS TO 50 MPH THROUGH THE EVENING. THE STRONG WINDS AND WARM TEMPERATURES WILL ALLOW FOR SOME PATCHY AREAS OF BLOWING DUST TO DEVELOP...MAINLY IN DUST PRONE REGIONS AROUND DEMING AND EL PASO (NWS, 2011).

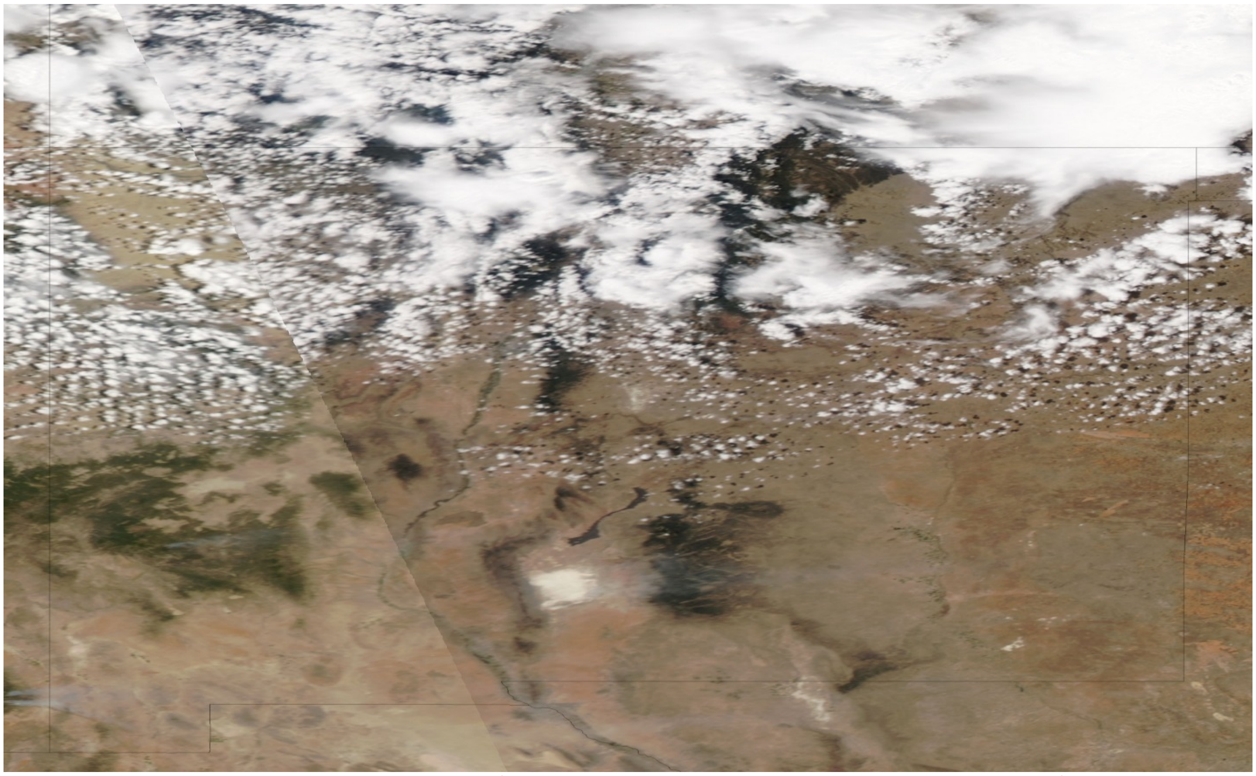

Figure 21-14. Satellite imagery showing blowing dust from White Sands and in southern El Paso. Image courtesy of NASA.

21.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on May 24, 2011.

21.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by high wind and blowing dust.

21.7 No Exceedance but for the Event

The Holman monitor detected blowing dust around the 0800 hour with hourly concentrations heavily impacted until the 1600 hour. The nine hourly PM_{10} values from 0800-1600 hours alone, exceed the 24-hour average standard at Holman [(105 + 182 + 425 + 872 + 711 + 467 + 431 + 308 + 200) µg/m^3 / 24 = 154 µg/m^3]. By replacing these nine hourly values with the 95th percentile of hourly data at the Holman site, the resulting 24-hour average (53 µg/m^3) does not exceed the NAAQS (Table 21-1). The values in red represent the 95th percentile of all hourly data collected at Holman, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	21	21
1	22	22
2	21	21
3	31	31
4	24	24
5	42	42
6	39	39
7	46	46
8	105	**55**
9	182	**52**
10	425	**60**
11	872	**66**
12	711	**85**
13	467	**102**
14	431	**122**
15	308	**125**
16	200	**118**
17	91	91
18	28	28
19	32	32
20	29	29
21	28	28
22	15	15
23	15	15
24-Hour Average	174	**53**

Table 21-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Holman.

The Sunland Park monitor detected blowing dust around the 0800 hour with hourly concentrations heavily impacted until the 1400 hour. The seven hourly PM_{10} values from 0800-1400 hours alone, exceed the 24-hour average standard at Sunland Park [(156 + 311 + 396 + 769 + 1725 + 373 + 217) µg/m^3 / 24 = 176 µg/m^3]. By replacing these seven hourly values with the 95th percentile of hourly data at the Sunland Park site, the resulting 24-hour average (76 µg/m^3) does not exceed the NAAQS (Table 21-2). The values in red represent the 95th percentile of all hourly data collected at Sunland Park, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	39	39
1	24	24
2	29	29
3	70	70
4	30	30
5	69	69
6	62	62
7	59	59
8	156	**98**
9	311	**93**
10	396	**93**
11	769	**95**
12	1725	**104**
13	373	**125**
14	217	**145**
15	159	159
16	128	128
17	88	88
18	70	70
19	68	68
20	70	70
21	42	42
22	40	40
23	30	30
24-Hour Average	209	**76**

Table 21-2. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Sunland Park.

22 HIGH WIND EXCEPTIONAL EVENT: May 29, 2011

22.1 Summary of Event

The passing of a Pacific cold front caused high winds and blowing dust in Luna and Doña Ana Counties resulting in an exceedance of the PM_{10} 24-hour NAAQS at the Anthony and Sunland Park monitoring sites on this date. The FEM TEOM continuous monitors at these sites recorded 24-hour average PM_{10} concentrations of 208 and 206 µg/m^3, respectively. The FRM Partisol monitor at Sunland Park recorded a 24-hour average $PM_{2.5}$ concentration of 36.2 µg/m^3. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were measured at Chaparral (101 µg/m^3), Deming Airport (103 µg/m^3), and Desert View (131 µg/m^3) monitoring sites (Figure 22-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event. Elevated concentrations were also recorded by the $PM_{2.5}$ non-FEM TEOMs (Figure 22-2). In addition, smoke from wildfires in Mexico and Arizona may have contributed to these exceedances.

As the event unfolded, the wind blew from the southwest throughout the border region. These high velocity winds passed over large areas of desert within New Mexico and Mexico. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

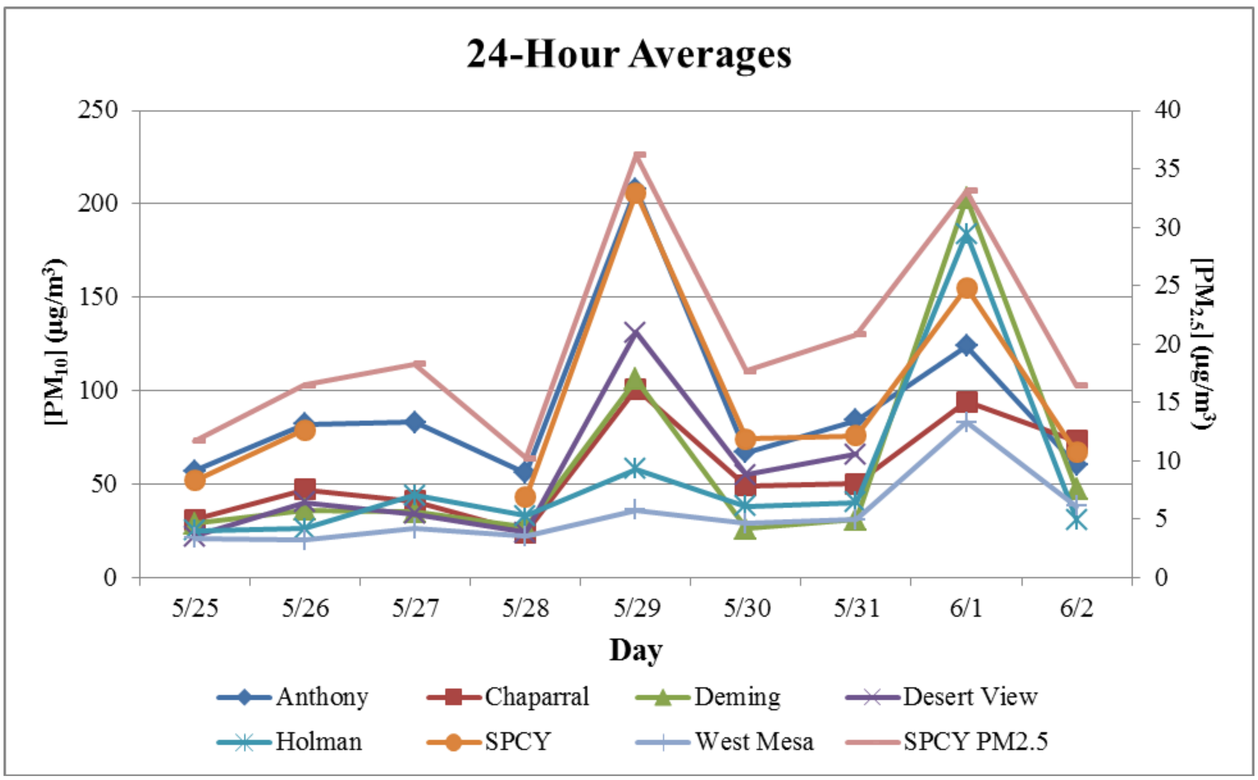

Figure 22-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after May 29, 2011.

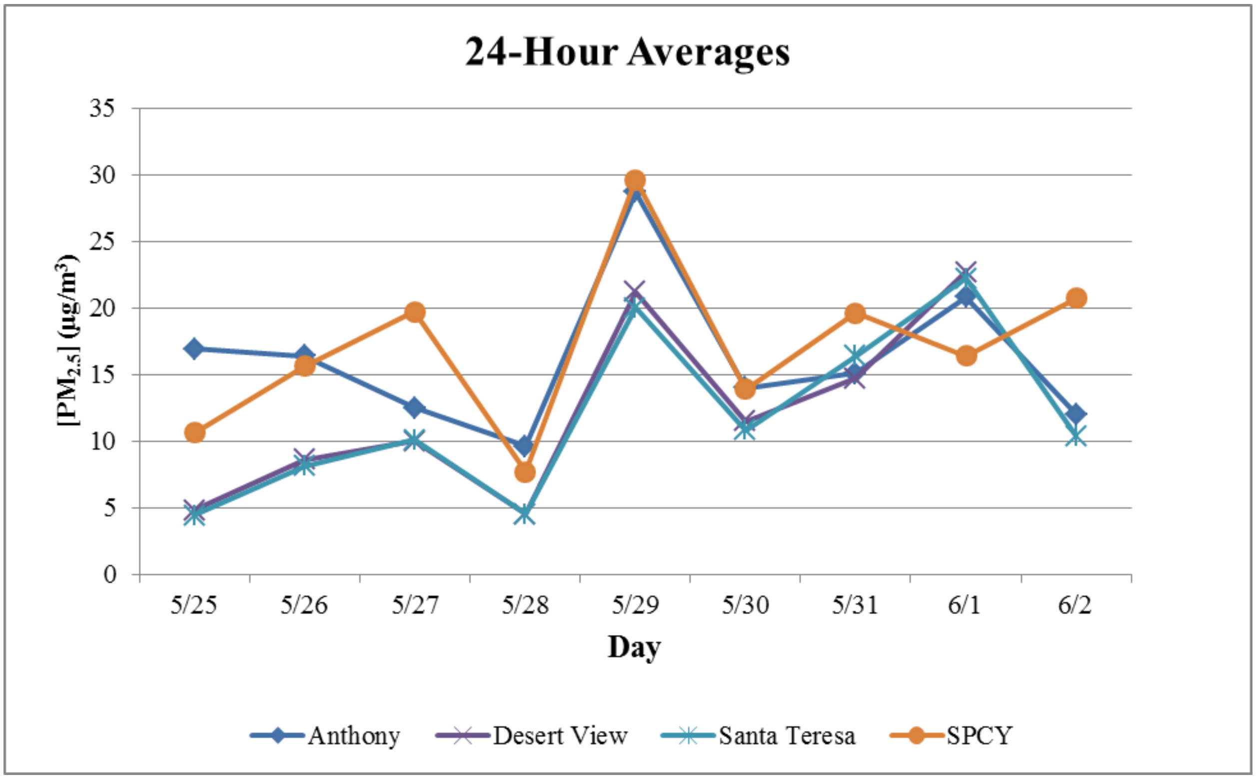

Figure 22-2. $PM_{2.5}$ 24-hour averages before and after May 29, 2011. Non-FEM TEOM Data.

22.2 Is Not Reasonably Controllable or Preventable

22.3.1 <u>Suspected Source Areas and Categories Contributing to the Event</u>

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in Mexico and New Mexico. City of Las Cruces, City of Deming and Doña Ana and Luna Counties Ordinances require BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and the playas of northern Mexico (see Section 22.2.4 below).

22.2.2 <u>Sustained and Instantaneous Wind Speeds</u>

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On May 29, 2011, sustained wind speeds exceeded EPA's default threshold at two of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at six of the seven monitoring sites (Figures 22-3 and 22-4). Winds exceeded these thresholds at one or more monitoring sites beginning at the 1100 hour and ending at the 1700 hour.

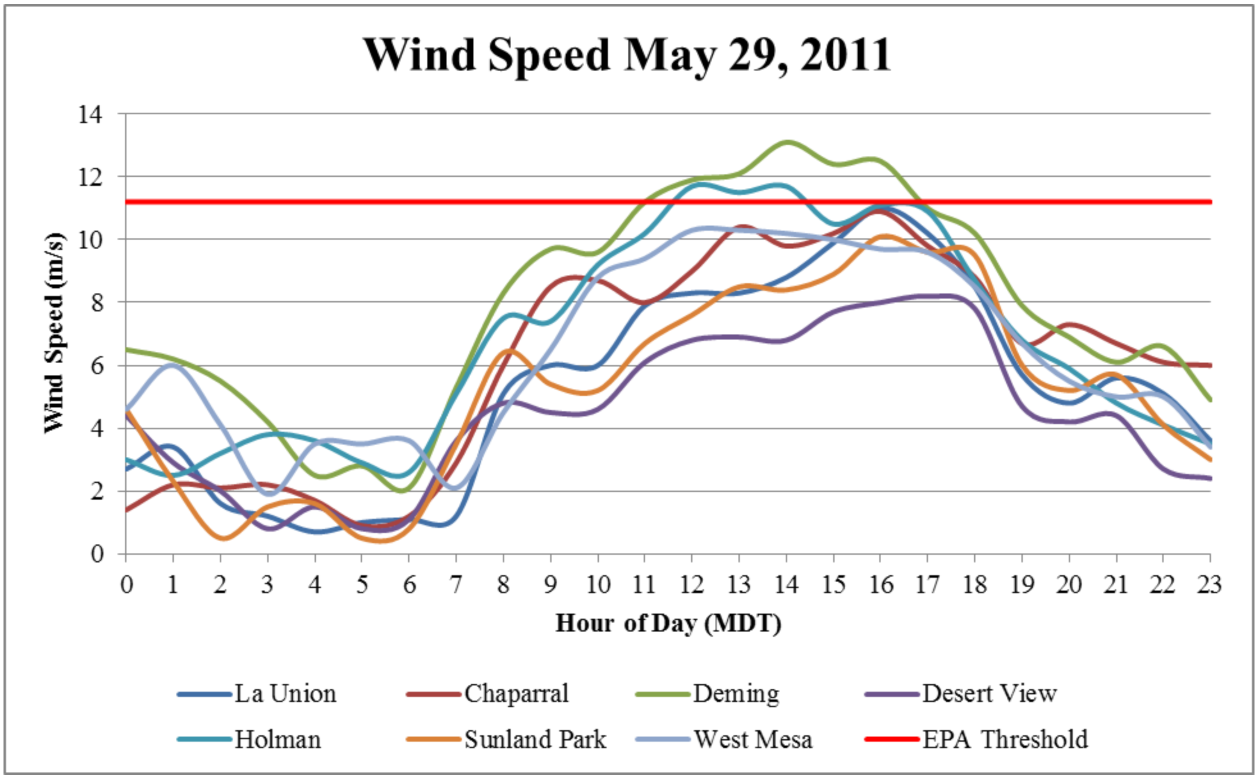

Figure 22-3. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

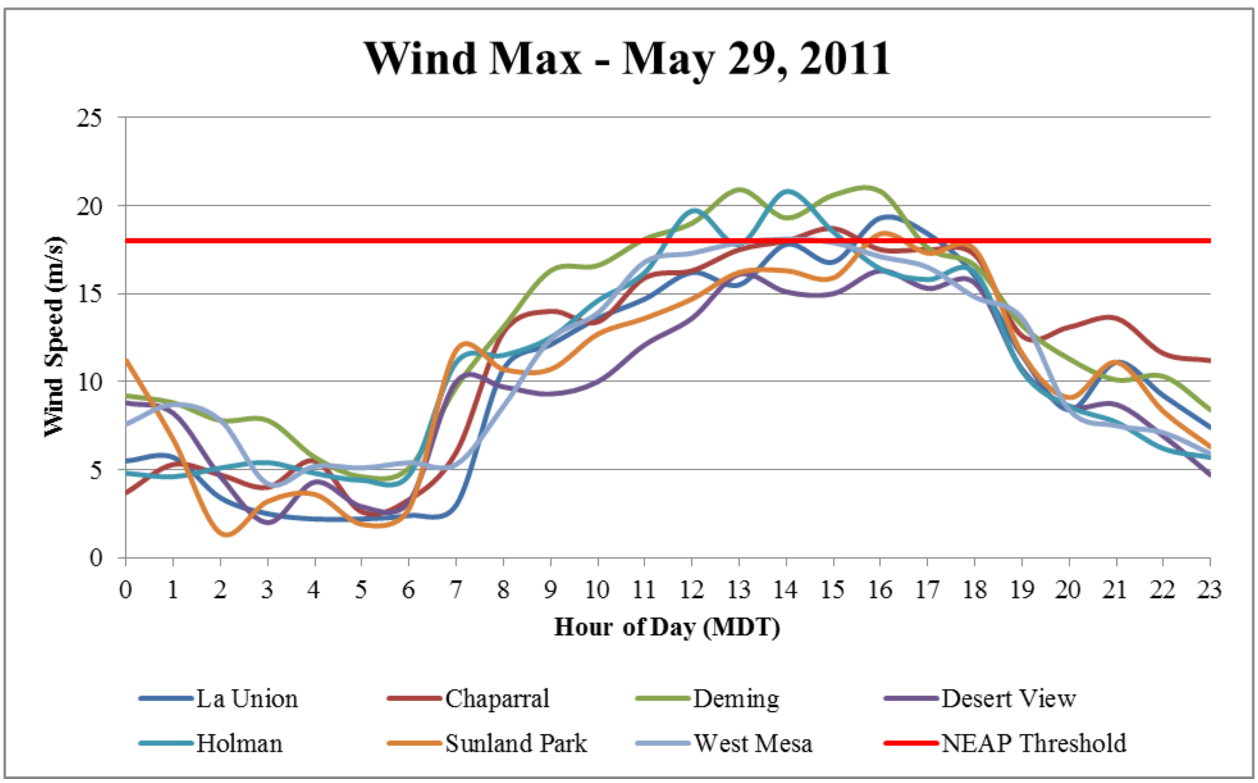

Figure 22-4. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

22.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the PM_{10} FEM TEOM monitors recorded 211 exceedances and the PM_{10} FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). The SPCY $PM_{2.5}$ FRM Partisol recorded 23 exceedances of the 24-Hour NAAQS from 2006-2010 (Figure A-2). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

22.2.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana and Luna Counties. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert and playas in New Mexico and northern Mexico. The southern sites in Doña Ana County recorded the highest 24-hour averages in the monitoring. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled from Mexico to the monitors in Doña Ana and Luna Counties. The model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figure 22-5). Costs prohibit controlling dust from the natural desert terrain and falls outside NMED's jurisdiction when it originates in Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

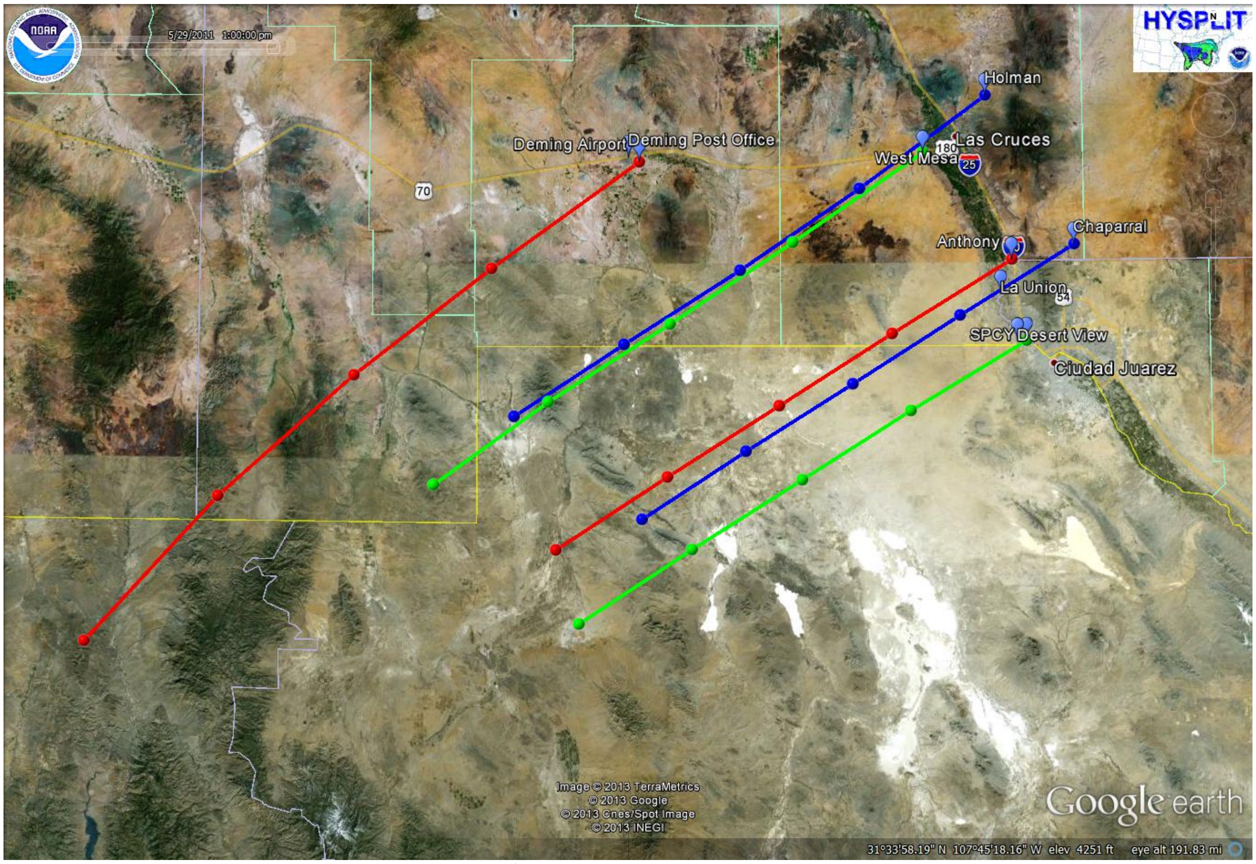

Figure 22-5. HYSPLIT back-trajectory model analysis for May 29, 2011.

22.3 Historical Fluctuations Analysis

22.3.1 Annual and Seasonal 24-hour Average Fluctuations

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded values for this day (208 and 206 µg/m^3) are above the maximum values recorded when no high wind exceedances are included and is above the 95th percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for May 29, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95th percentile for PM_{10}, $PM_{2.5}$, wind speed and wind gusts (Figures 22-6a-c through 22-8a-b). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} values during the high wind blowing dust storm far exceed the historical 95th percentile of data.

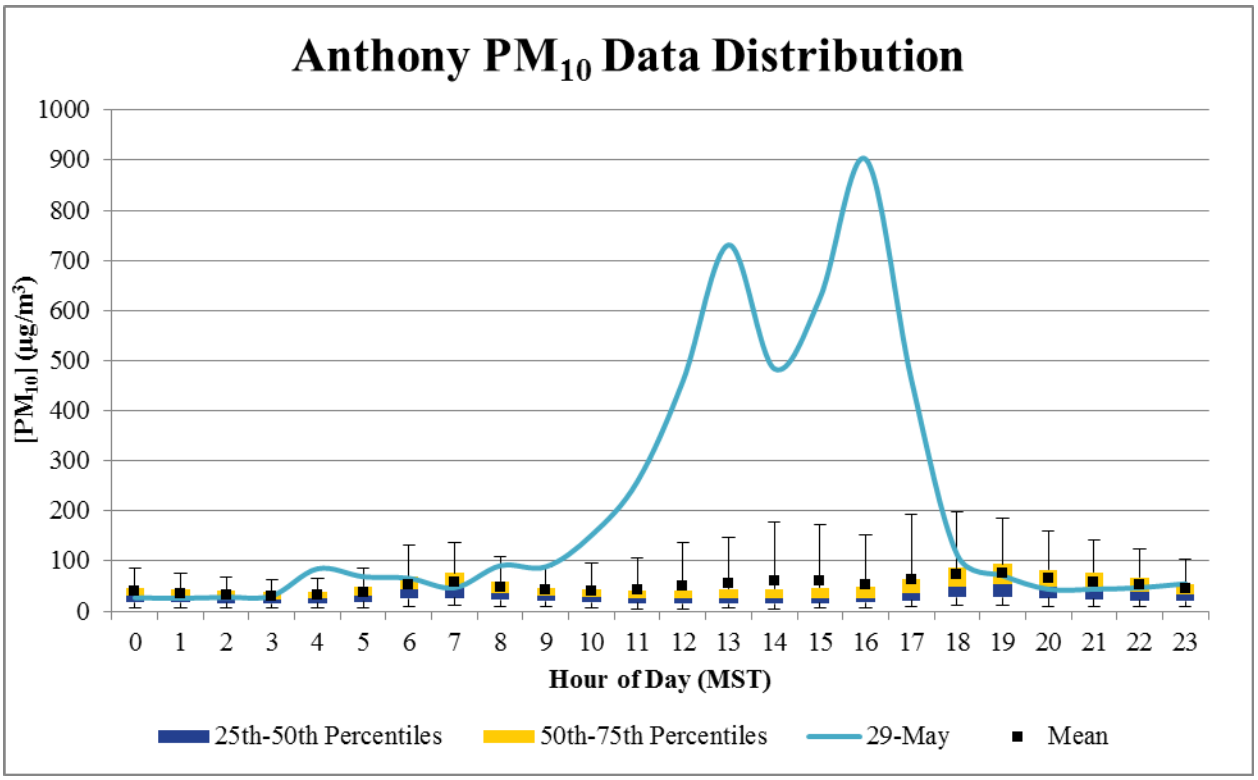

Figure 22-6a. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 29, 2011.

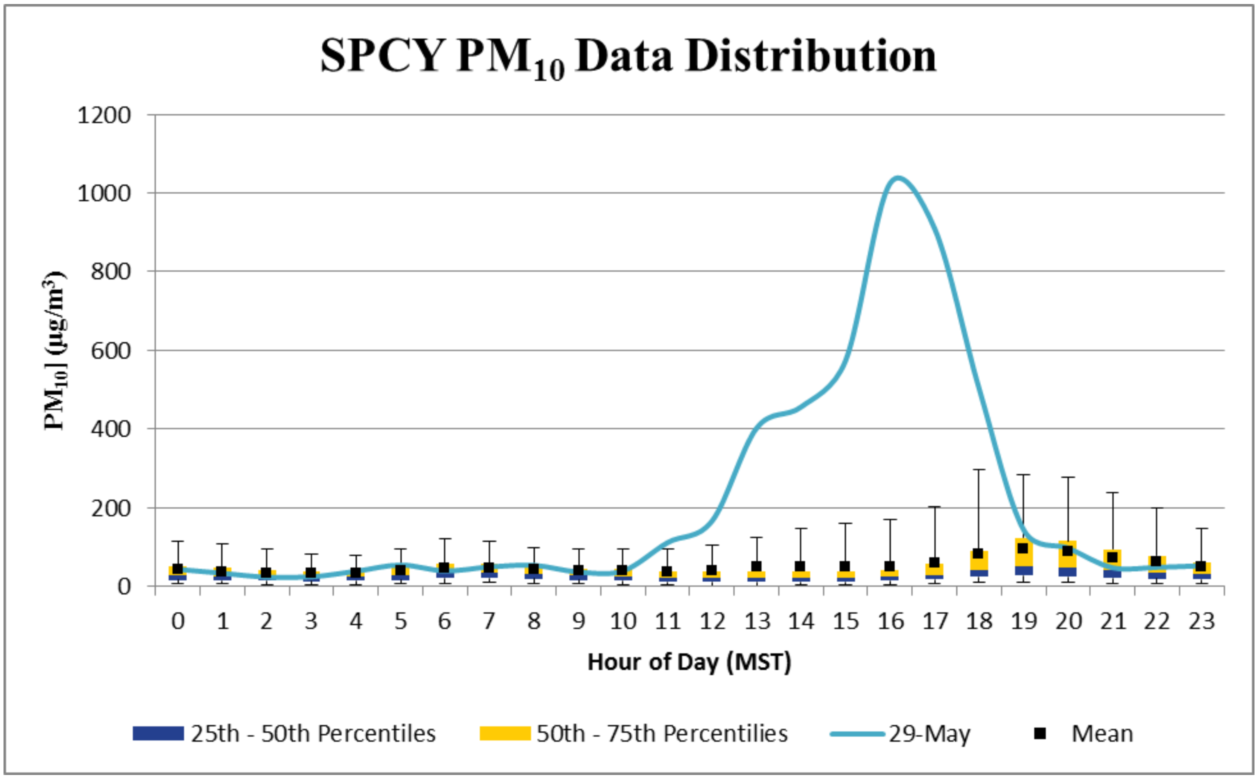

Figure 22-6b. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for May 29, 2011.

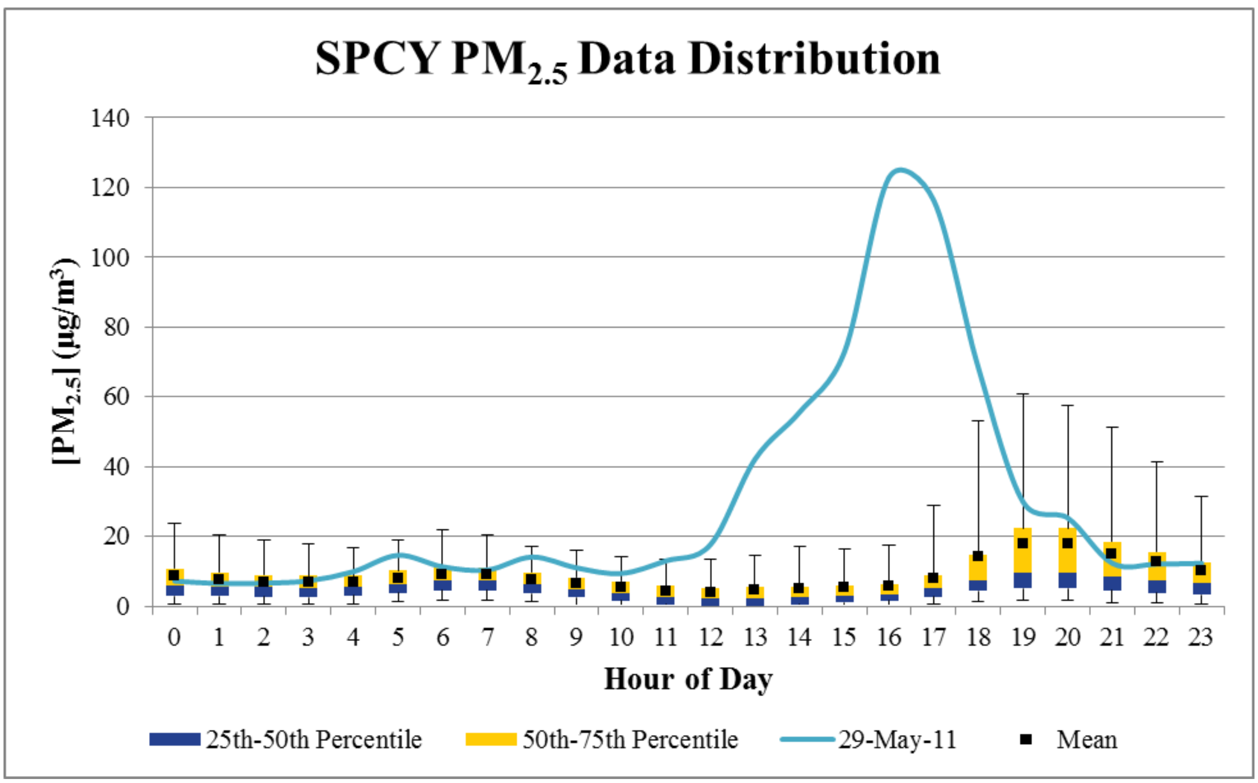

Figure 22-6c. $PM_{2.5}$ hourly data distribution from 2006-2010 overlaid by hourly values for May 29, 2011.

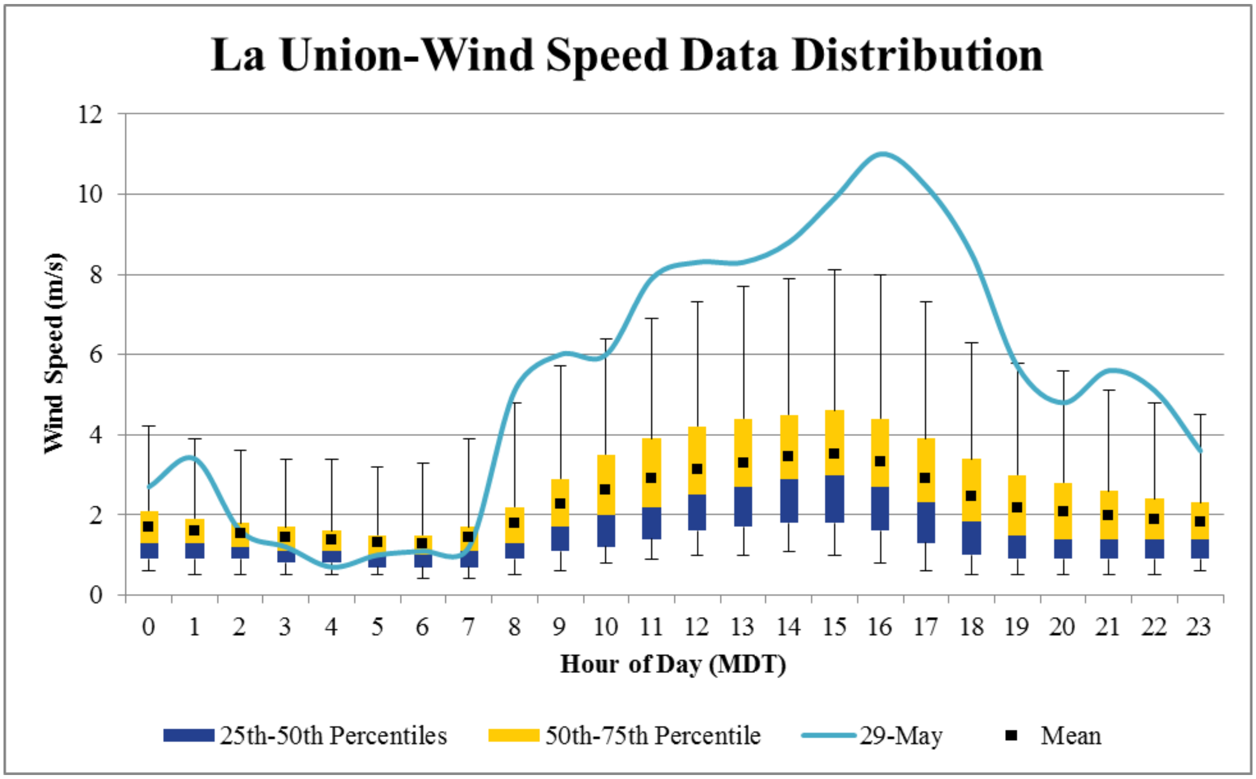

Figure 22-7a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 29, 2011.

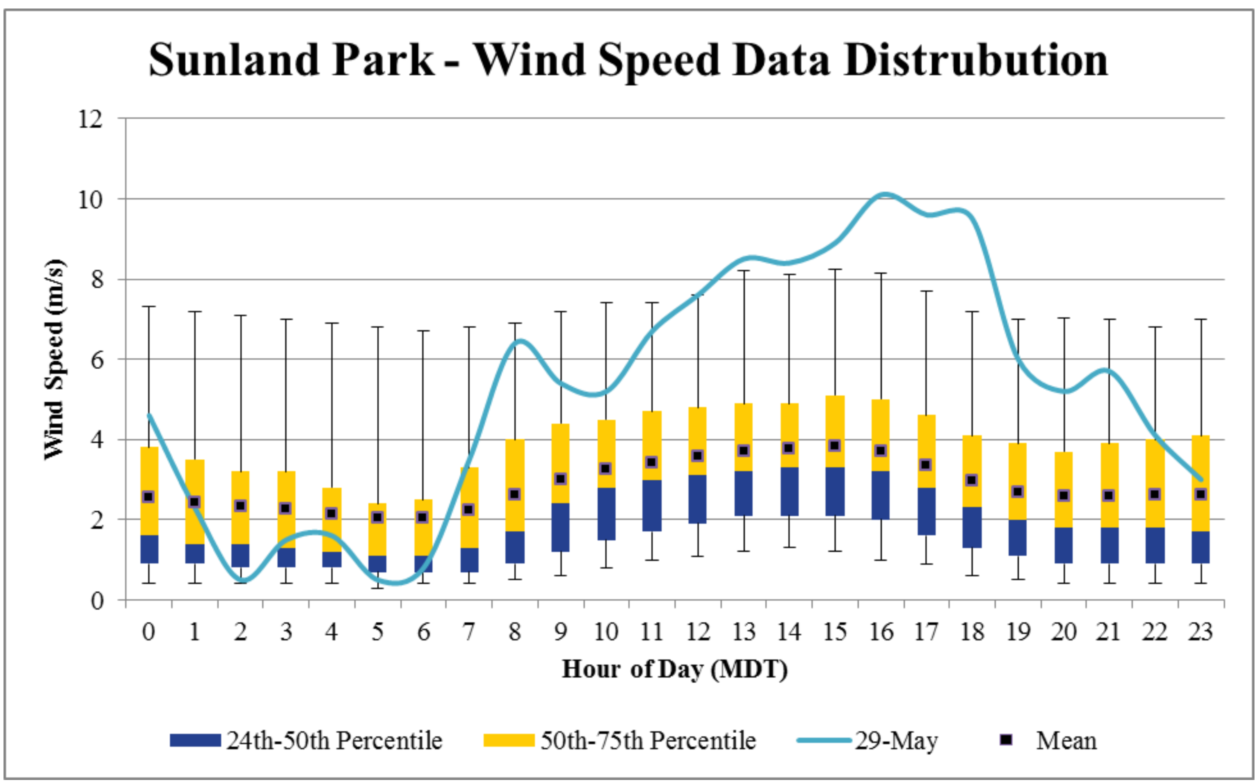

Figure 22-7b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for May 29, 2011.

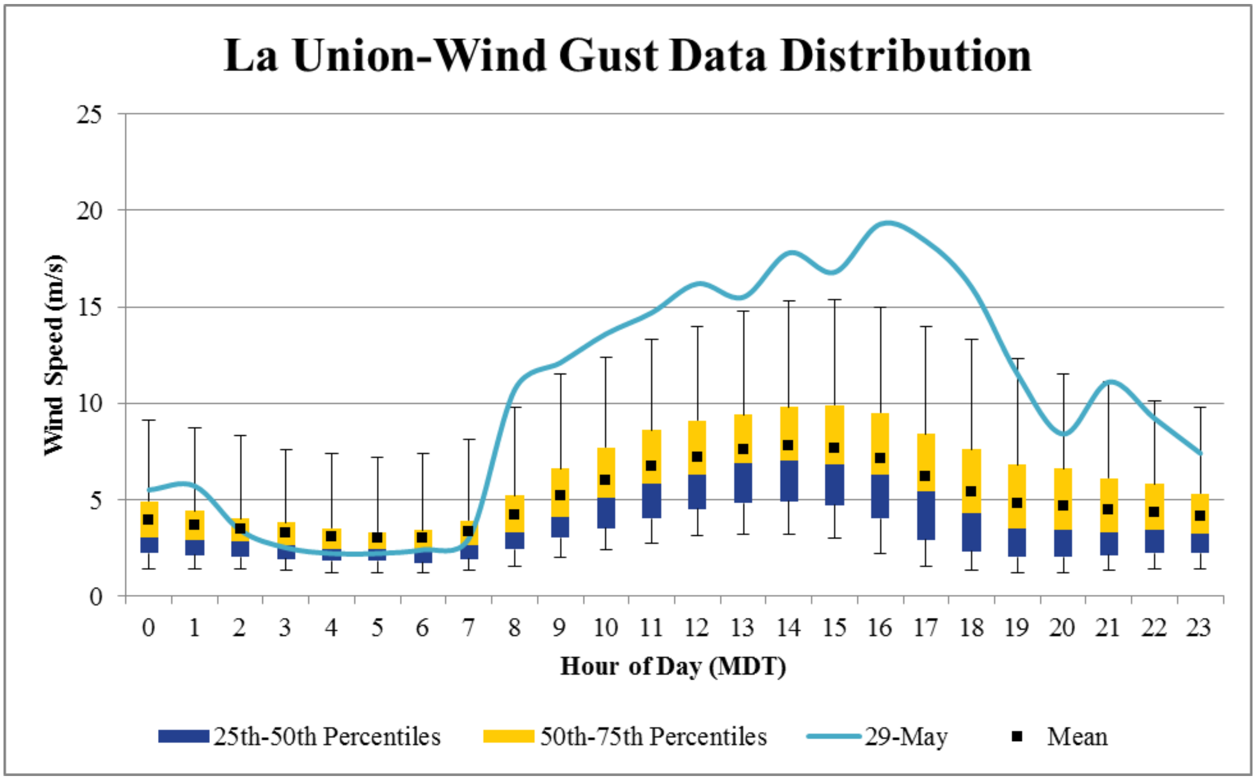

Figure 22-8a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 29, 2011.

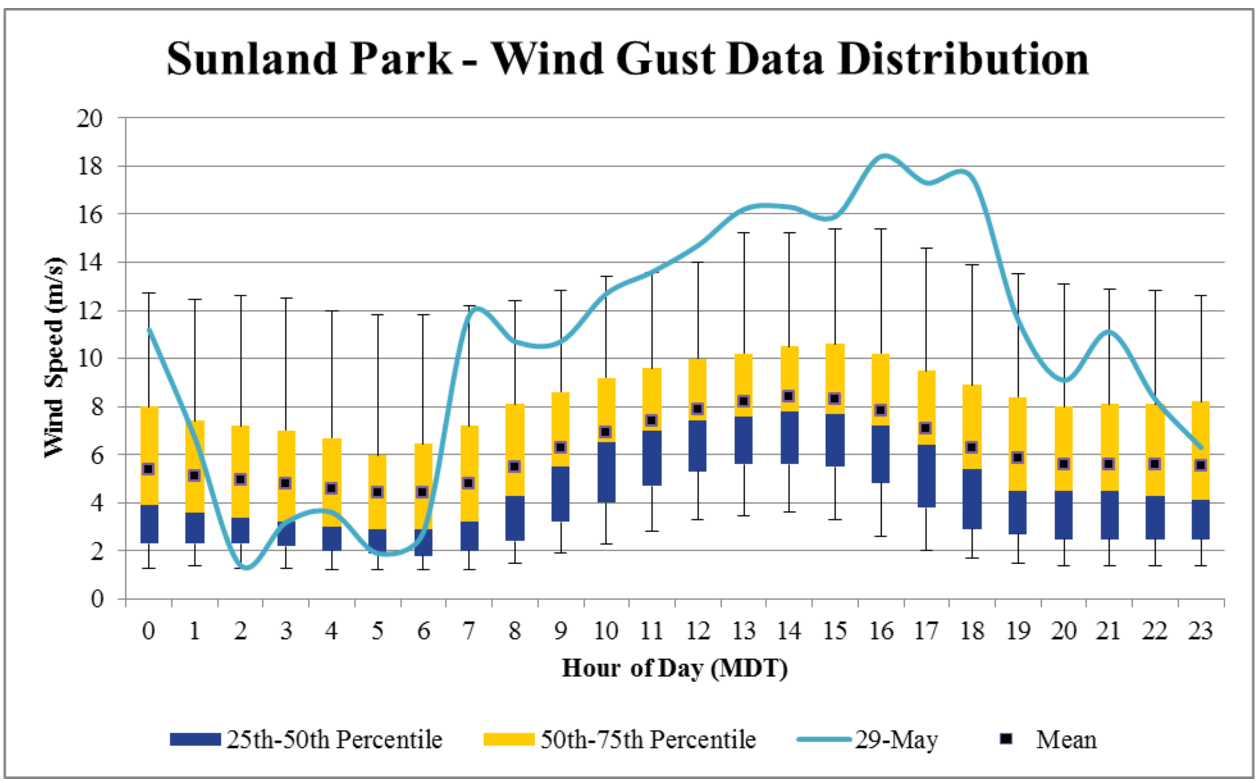

Figure 22-8b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for May 29, 2011.

22.4 Clear Causal Relationship

A Pacific cold and strong upper level low pressure system approached New Mexico on May 29, 2011. This created a strong pressure gradient with strong gusty winds in southern New Mexico (Figure 22-9). The upper and lower low pressure systems aligned well as the wind direction in the upper atmosphere matched with the surface wind direction (Figure 22-10). Diurnal heating of the surface allowed winds aloft to mix downward, increasing the surface wind velocities and provided the turbulence required for vertical mixing and horizontal transport.

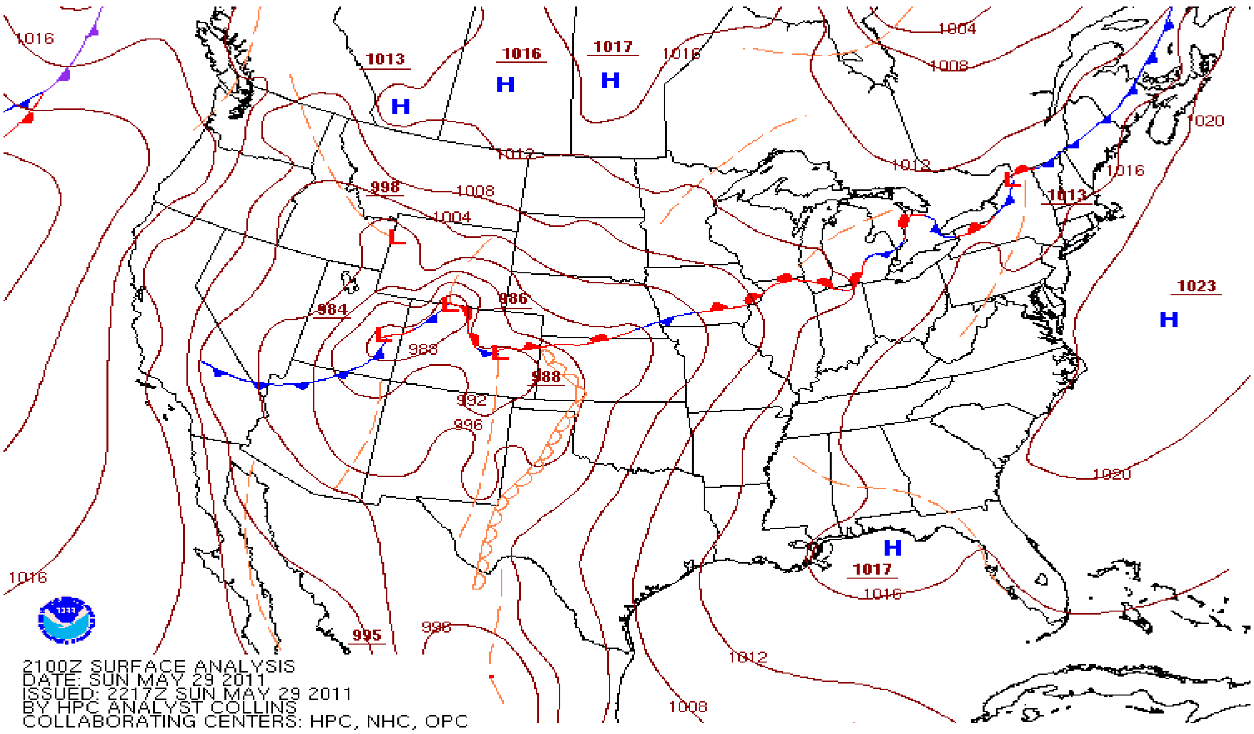

Figure 22-9. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for May 29, 2011 at the 1500 hour MDT.

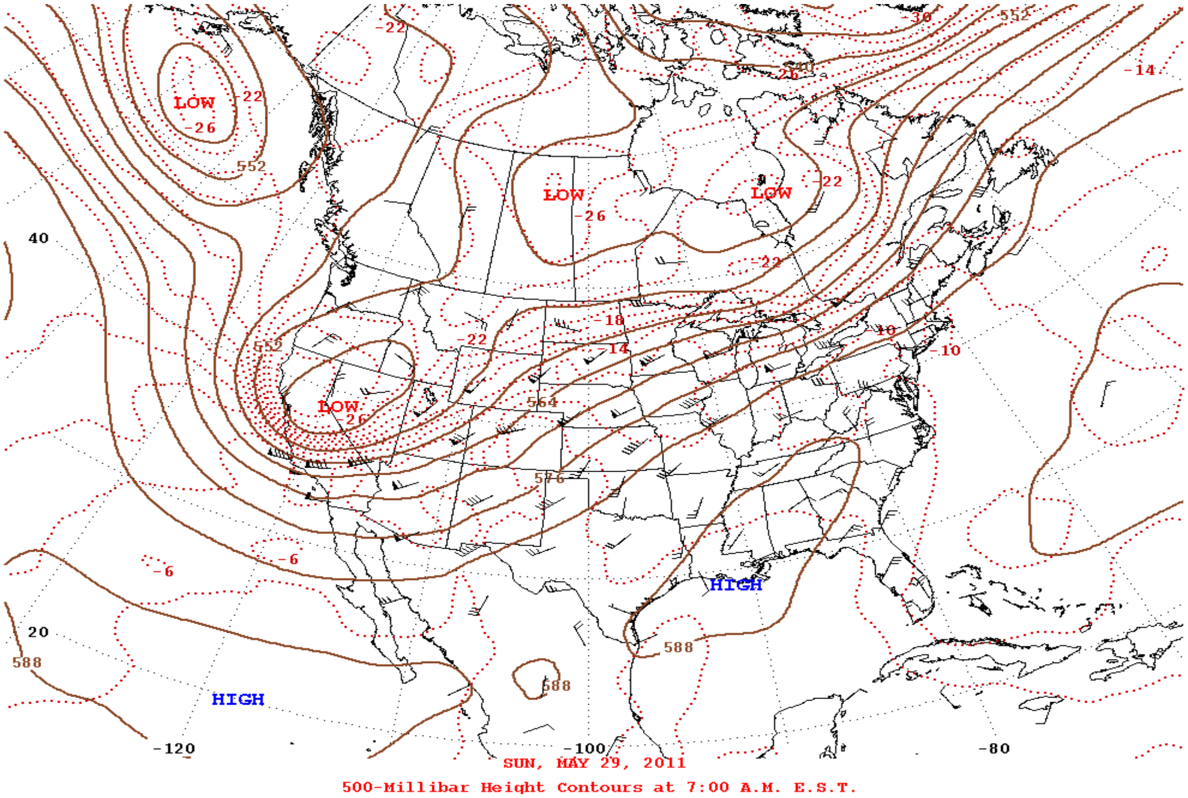

Figure 22-10. Upper air weather map showing geopotential heights (brown lines) at the 0500 hour MDT on May 29, 2011.

The weather pattern described above generated strong gusty winds from the southwest-south beginning at the 1100 hour and lasting through the 1800 hour. Beginning at the 1100 hour, wind speeds exceeded 11.2 m/s data at Deming as shown in Figure 22-3. Peak wind speeds ranged from 8.2 m/s at Desert View to 13.1 m/s at Deming (Figure 22-3). Peak wind gusts ranged 16.3 m/s at Desert View to 20.9 m/s at Deming (Figure 22-4). Blowing dust caused elevated levels of PM_{10} during the same period as high winds as demonstrated by the time series plot in Figure 22-11a-c. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (1000-1900 hours). During these hours, hourly PM_{10} and $PM_{2.5}$ concentrations spiked at all monitoring sites in the network (Figure 22-12a-b). Hourly data from the SPCY PM_{10} and $PM_{2.5}$ TEOM Monitors show good correlation of the timing of spikes in concentrations (Figure 22-13).

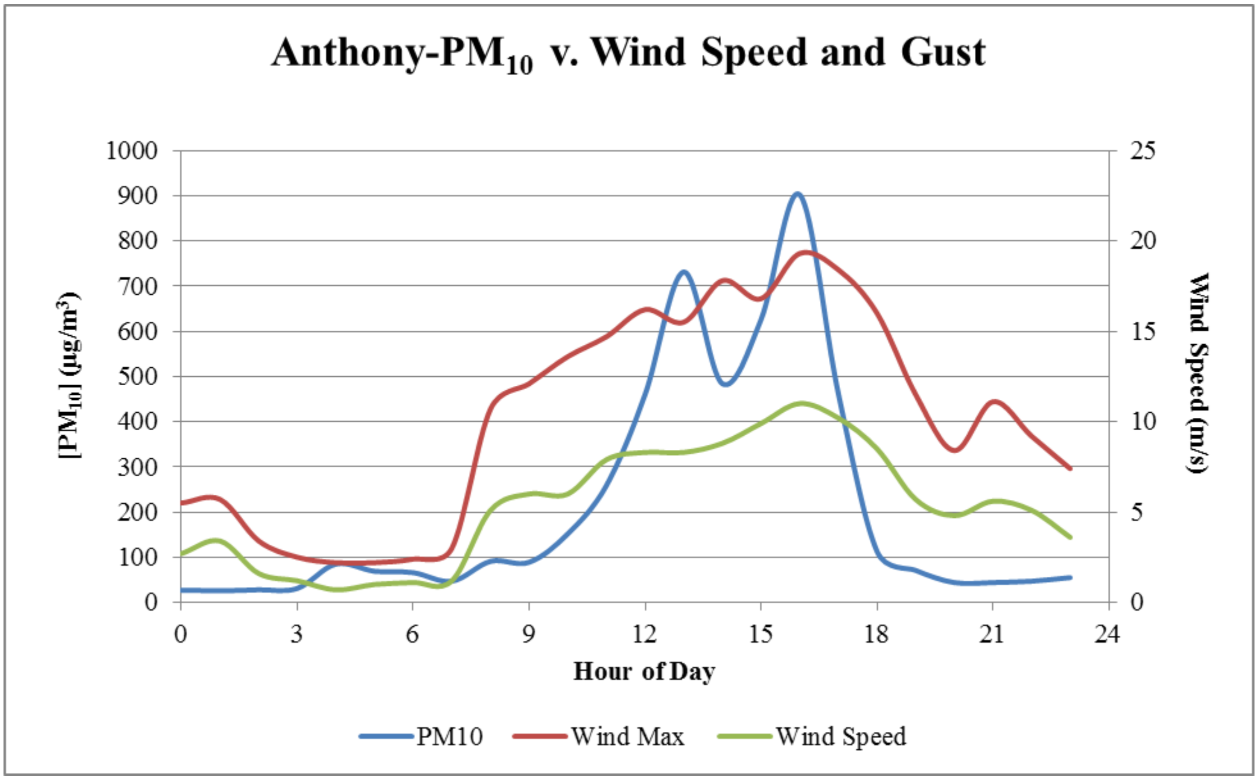

Figure 22-11a. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

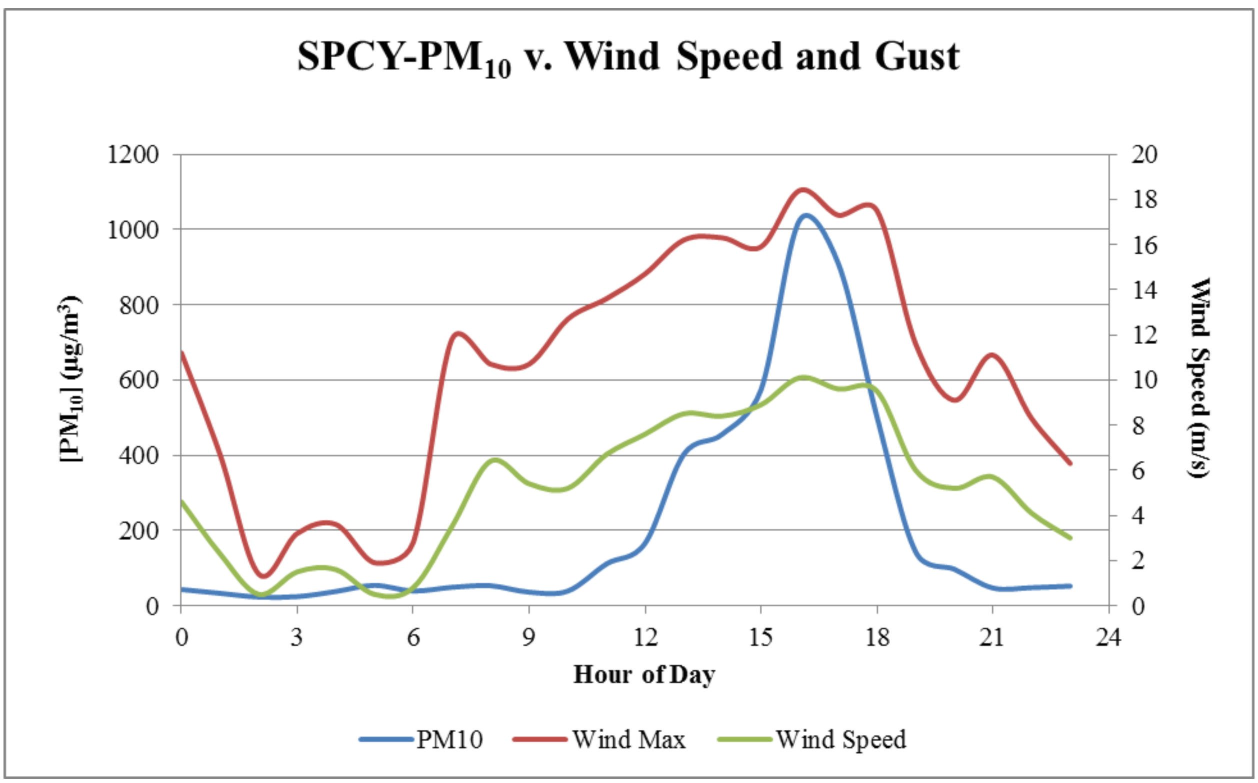

Figure 22-11b. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

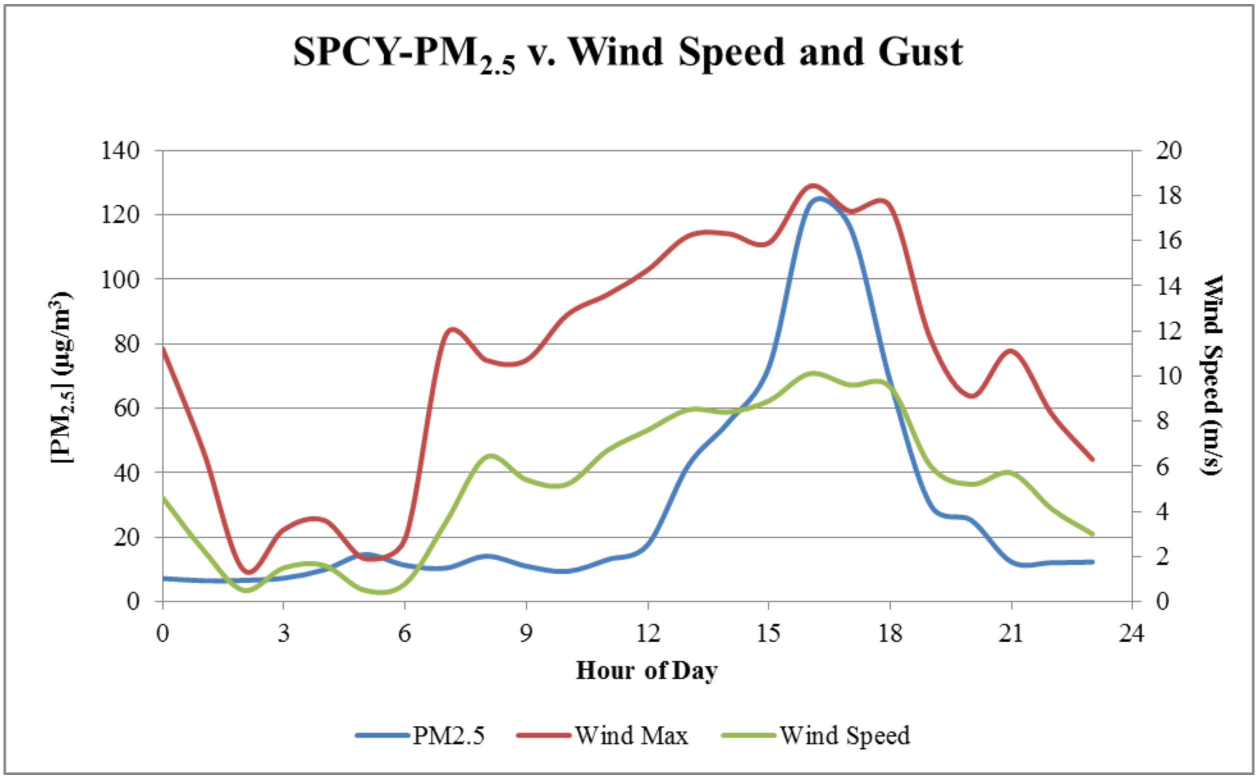

Figure 22-11c. Time series plot of hourly observations showing increased $PM_{2.5}$ concentrations as wind speeds and gusts increase. Non-FEM hourly $PM_{2.5}$ data.

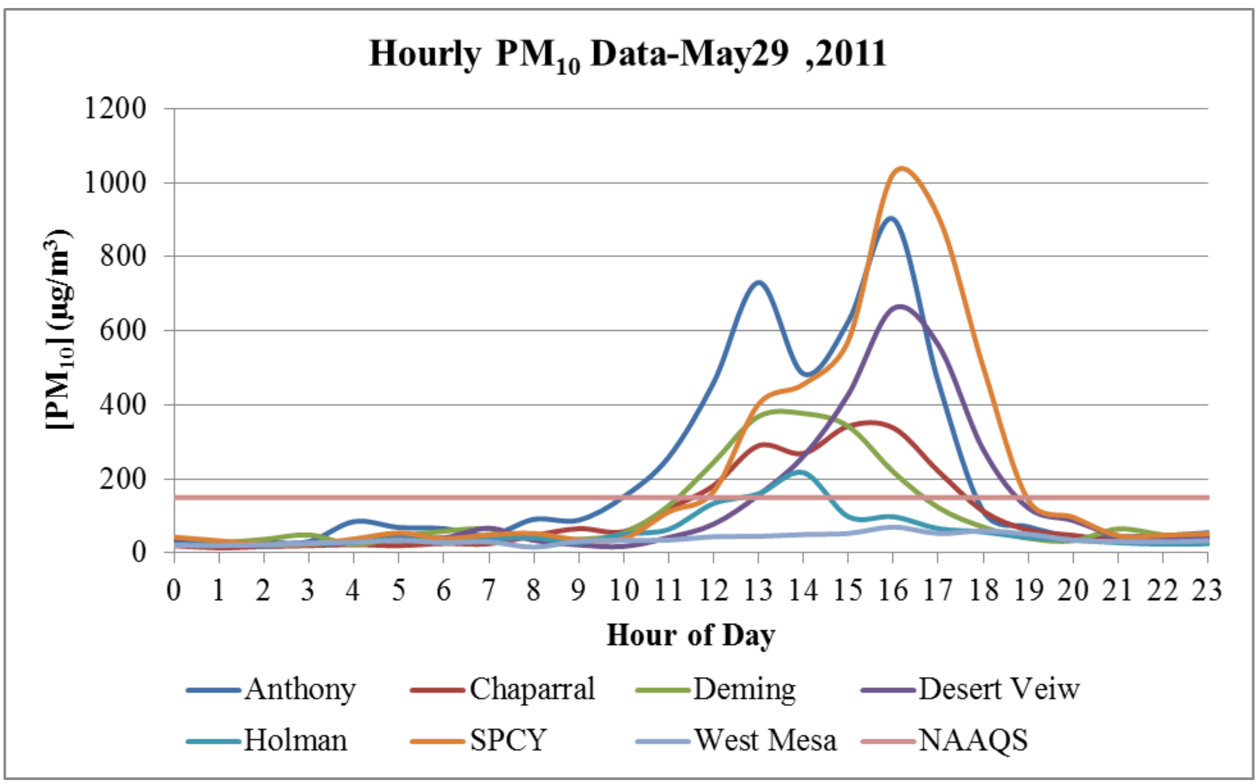

Figure 22-12a. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

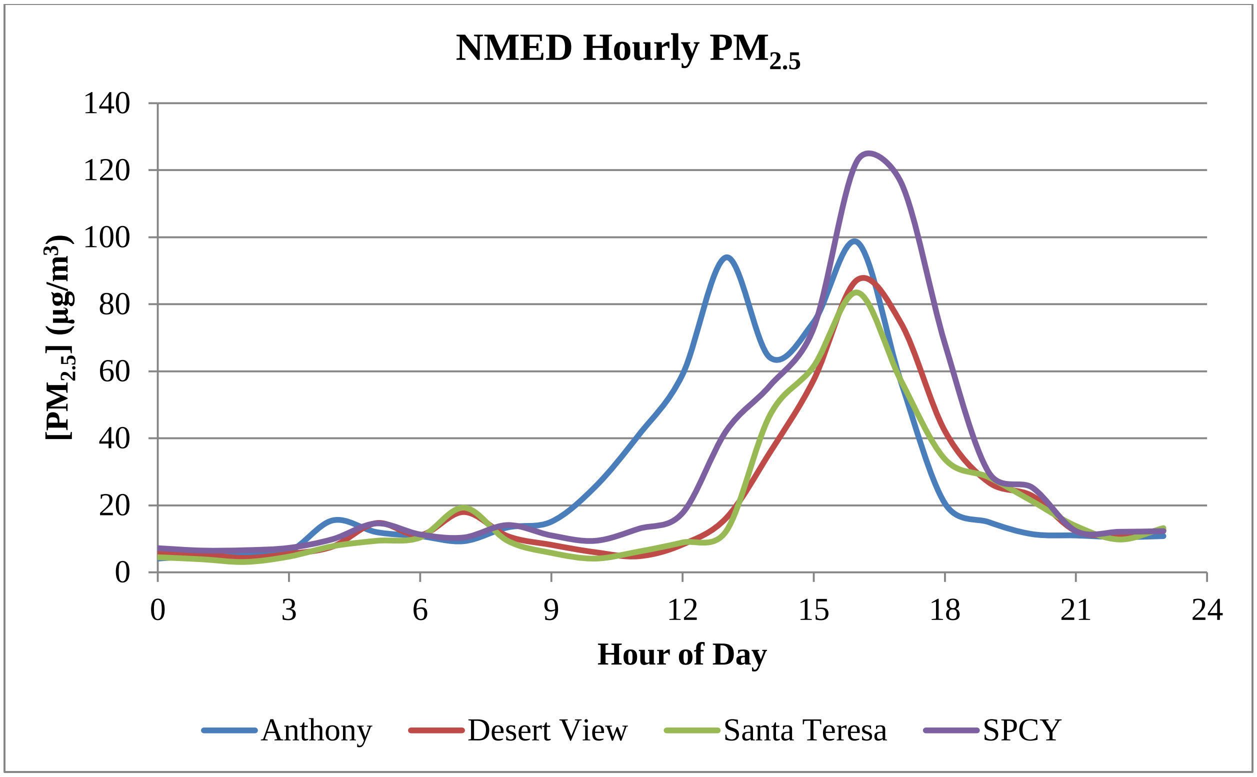

Figure 22-12b. Hourly $PM_{2.5}$ concentrations for Doña Ana County monitors. Non-FEM hourly $PM_{2.5}$ data.

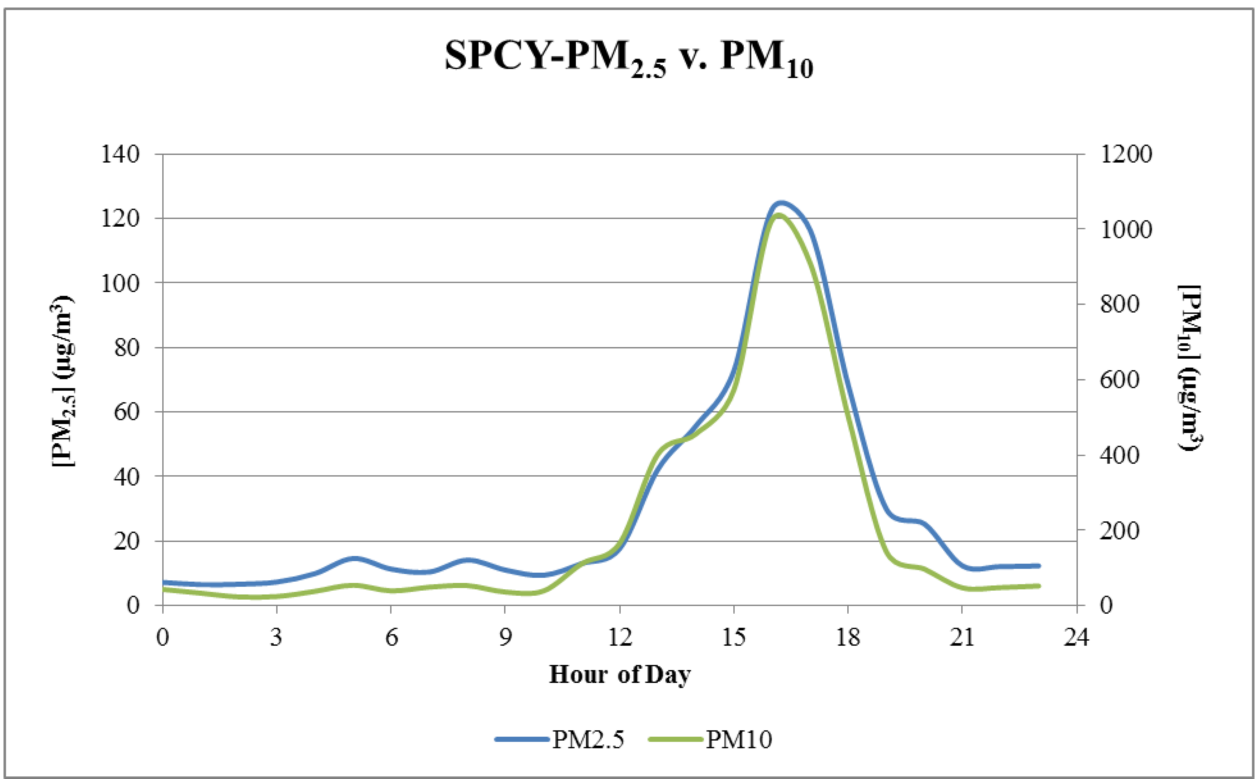

Figure 22-13. Hourly PM_{10} and $PM_{2.5}$ concentrations for the SPCY monitoring site on May 29, 2011.

Contemporary reports and modeling results support these claims. The NM Border AQ Blog posted a dust alert for this day, and reported:

> We saw high winds, windblown dust, and smoke plumes across the region today… Southern New Mexico was covered with both dust and smoke plumes. At the end of the day the smoke plumes from the Horseshoe 2 Fire and fires in Chihuahua were blowing across the region.
>
> Looking from space there was a lot of action today. First smoke plumes from the wildfires. Then there was the dust from the high winds. On top of that there was the smoke plume that was transported from Mexico into far southeast NM… [T]he dust sources included a few hot spots in Chihuahua and White Sands. Other active dust sources included a few locations in the northeastern Arizona and northwestern NM (DuBois, 2011).

Figure 22-14, from the National Oceanic and Aeronautical Administration (NOAA), shows smoke from fires in Mexico reaching the Sunland Park and Anthony areas on this day. Figure 22-15 based on satellite imagery and reported on http://www.wunderground.com/wundermap for May 29, 2011shows that earlier in the day (before the winds shifted) smoke from fires in Arizona also blew across southern New Mexico (later in the day, the satellite imagery on this website match that of Figure 22-14). In Figure 22-16, the 7:15 pm GOES satellite visible image from the National Center for Atmospheric Research (NCAR), shows both the smoke and blowing dust.

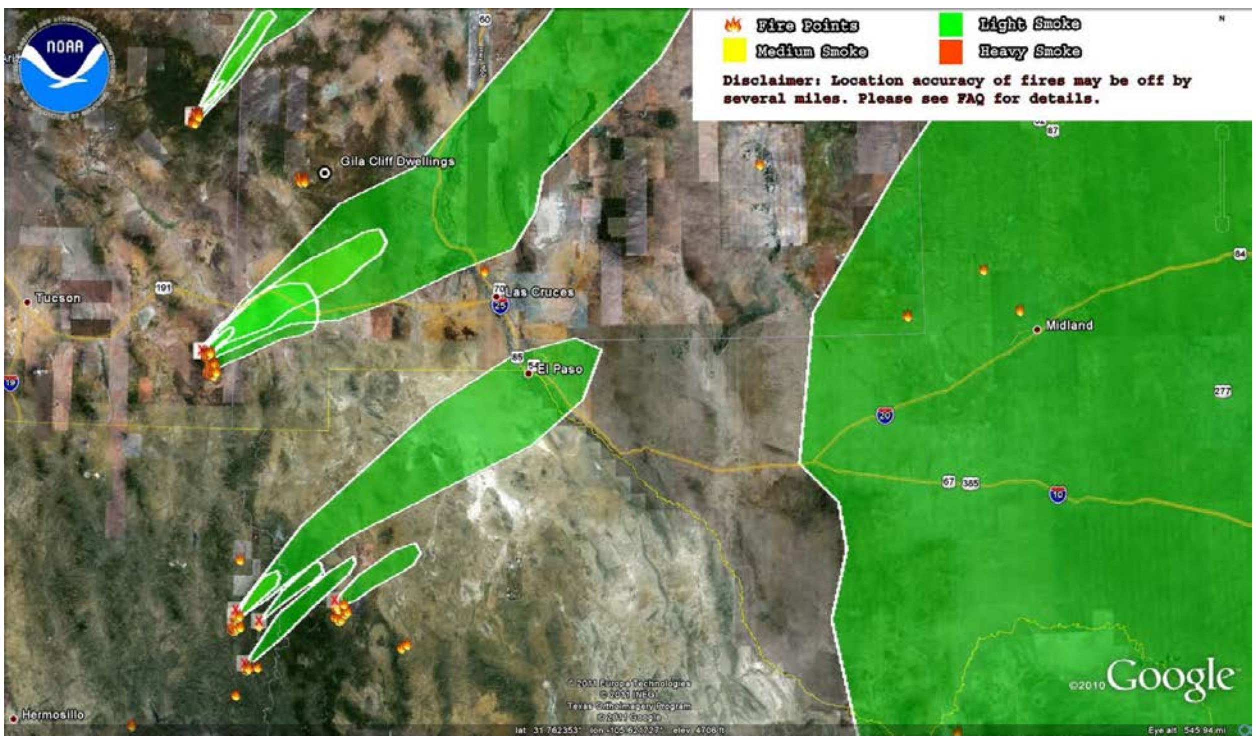

Figure 22-14. NOAA Smoke Forecast for May 29, 2011.

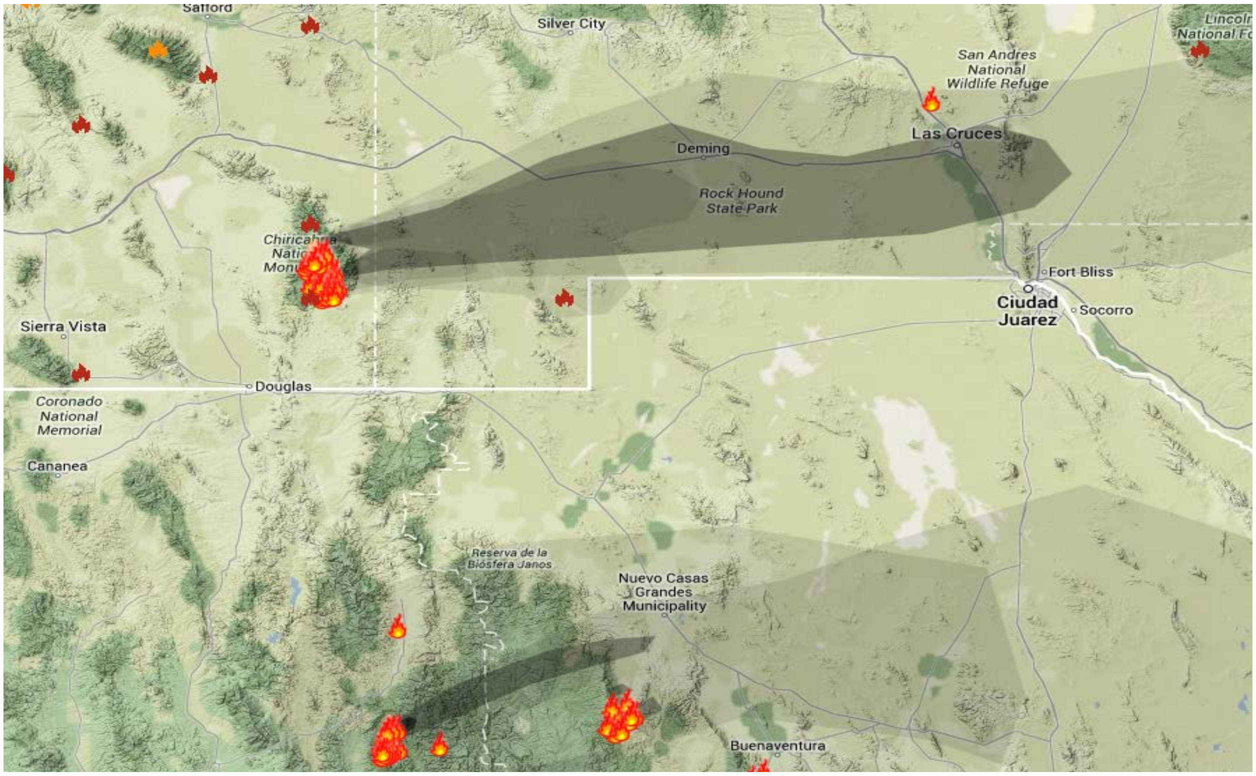

Figure 22-15. Smoke and active fires as sensed via satellite on the morning of May 29, 2011, courtesy of weather underground.

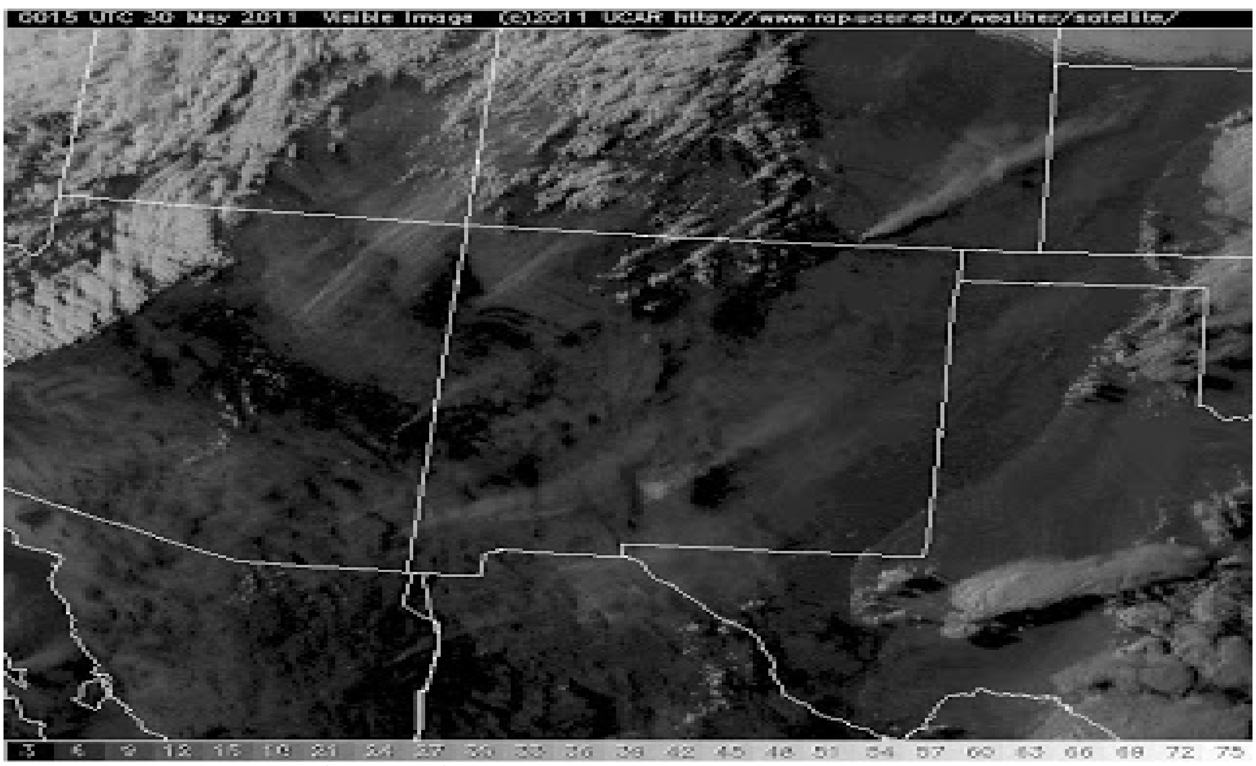
Figure 22-16. GOES visible image from NCAR for 7:15 pm on May 29, 2011.

The NWS issued a wind advisory for the area stating in part that they expected,

> ...STRONG WINDS ACROSS SOUTHERN NEW MEXICO THIS AFTERNOON AND EVENING...
>
> THIS WILL ALSO PRODUCE BLOWING DUST WITH VISIBILITIES DROPPING TO A MILE IN DUST PRONE AREAS WEST OF THE RIO GRANDE RIVER. WINDS WILL REMAIN STRONG ALONG EASTERN SLOPES OF AREA MOUNTAINS OVERNIGHT...BUT MOST SECTIONS WILL SEE A DECREASE IN WINDS NOT LONG AFTER SUNSET. FAR WEST TEXAS WILL ALSO BE WINDY...BUT WIND SPEEDS WILL NOT BE QUITE AS STRONG (NWS, 2011).

22.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on May 29, 2011.

22.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by high wind and blowing dust, with small contributions from wildfires in Arizona and Mexico.

22.7 No Exceedance but for the Event

The Anthony monitor detected blowing dust around the 0900 hour with hourly concentrations heavily impacted until the 1700 hour. The nine hourly PM_{10} values from 0900-1700 hours alone, exceed the 24-hour average standard at Anthony [(88 + 95 + 106 + 136 + 146 + 177 + 172 + 152 + 194) µg/m3 / 24 = 189 µg/m3]. By replacing these nine hourly values with the 95th percentile of hourly data at the Anthony site, the resulting 24-hour average (88 µg/m3) does not exceed the NAAQS (Table 22-1). The values in red represent the 95th percentile of all hourly data collected at Anthony, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	27	27
1	26	26
2	28	28
3	31	31
4	85	85
5	69	69
6	66	66
7	47	47
8	91	91
9	89	**88**
10	152	**95**
11	259	**106**
12	460	**136**
13	731	**146**
14	484	**177**
15	626	**172**
16	902	**152**
17	462	**194**
18	113	113
19	71	71
20	44	44
21	44	44
22	47	47
23	55	55
24-Hour Average	208	**88**

Table 22-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Anthony.

The Sunland Park monitor detected blowing dust around the 1100 hour with hourly concentrations heavily impacted until the 1800 hour. The eight hourly PM_{10} values from 1100-1800 hours alone, exceed the 24-hour average standard at Sunland Park [(111 + 166 + 402 + 456 + 574 + 1025 + 909 + 502) µg/m^3 / 24 = 188 µg/m^3]. By replacing these nine hourly values with the 95th percentile of hourly data at the Sunland Park site, the resulting 24-hour average (88 µg/m^3) does not exceed the NAAQS (Table 22-2). The values in red represent the 95th percentile of all hourly data collected at Sunland Park, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	43	43
1	33	33
2	23	23
3	24	24
4	38	38
5	54	54
6	39	39
7	49	49
8	53	53
9	36	36
10	39	39
11	111	**95**
12	166	**104**
13	402	**125**
14	456	**145**
15	574	**160**
16	1025	**168**
17	909	**201**
18	502	**296**
19	143	143
20	97	97
21	47	47
22	48	48
23	52	52
24-Hour Average	206	**88**

Table 22-2. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Sunland Park.

23 HIGH WIND AND SMOKE EXCEPTIONAL EVENT: June 1, 2011

23.1 Summary of Event

Early morning smoke impacts and afternoon thunderstorm activity caused high winds and blowing dust in Doña Ana and Luna Counties resulting in exceedances of the PM_{10} NAAQS and the $PM_{2.5}$ annual NAAQS at the Deming, Holman and Sunland Park monitoring sites on this date. The FEM TEOM continuous monitors at these sites recorded 24-hour average concentrations of 203, 184 and 155 µg/m^3, respectively. The FRM Partisol monitors at Sunland Park recorded a 24-hour average concentration of 33.1 µg/m^3. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were measured at the Anthony (124 µg/m^3), Chaparral (94 µg/m^3), and West Mesa (83 µg/m^3) monitoring sites (Figure 23-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event.

As the high wind event unfolded, the wind blew from the south (1500-1900 hours) throughout the border region. These high velocity winds passed over large areas of desert within Texas, New Mexico and Mexico. Severe thunderstorms with little to no rain moved across the region on that day (NWS, 2011b). The co-occurrence of high winds from thunderstorm outflow, elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

In addition to the high wind event, wildfires in Mexico and Arizona produced significant smoke prior to and during this day. The Deming Airport site saw significant smoke impacts in the early morning hours (200-400 hours) that drove the exceedance at this site. As discussed in Sections 2.8, 23.2.3, 23.4.2, smoke contributed to the exceptional events to a lesser extent at the rest of the monitors.

In Deming, a significant spike of particulate matter occurred between the 200 and 400 hours, peaking at the 300 hour (929 µg/m^3) when wind speeds were relatively low (2 m/s). Although Deming was influenced by the high winds in the afternoon, the exceedance for June 1 would not have occurred without the smoke impact. The two most likely contributors to these spikes are high winds from thunderstorm activity and smoke from wildfires.

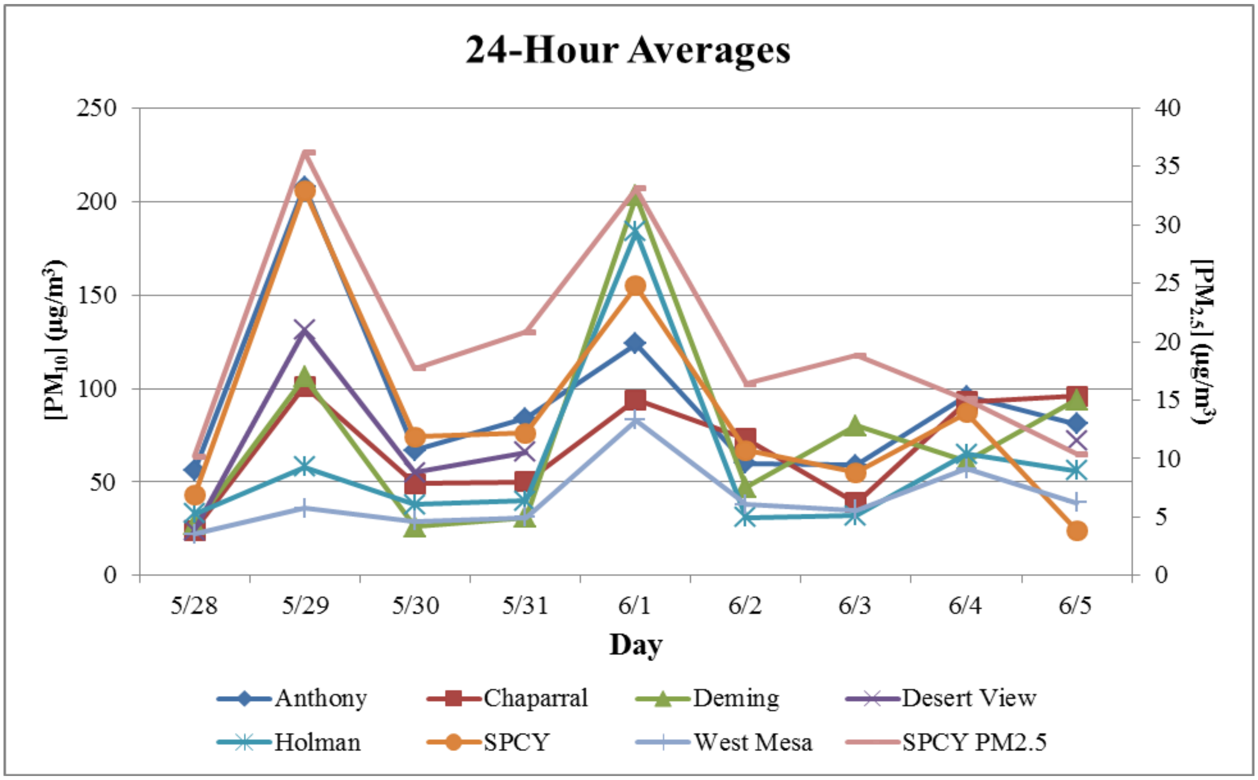

Figure 23-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after June 1, 2013.

23.2 Is Not Reasonably Controllable or Preventable

23.2.1 Suspected Source Areas and Categories Contributing to the Event

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in Texas, Mexico and New Mexico. City of Las Cruces, City of Deming and Doña Ana and Luna County Ordinances require BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and/or the playas of northern Mexico (see Section 23.2.4 below). The smoke that contributed to this exceedance was produced by wildfires in Arizona and Mexico (see Section 23.2.5 below).

23.2.2 Sustained and Instantaneous Wind Speeds

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On June 1, 2011, sustained wind speeds exceeded EPA's default threshold at one of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at four of the seven monitoring sites (Figures 23-2 and 23-3). Winds exceeded these thresholds at one or more monitoring sites beginning at the 1500 hour and ending at the 1900 hour.

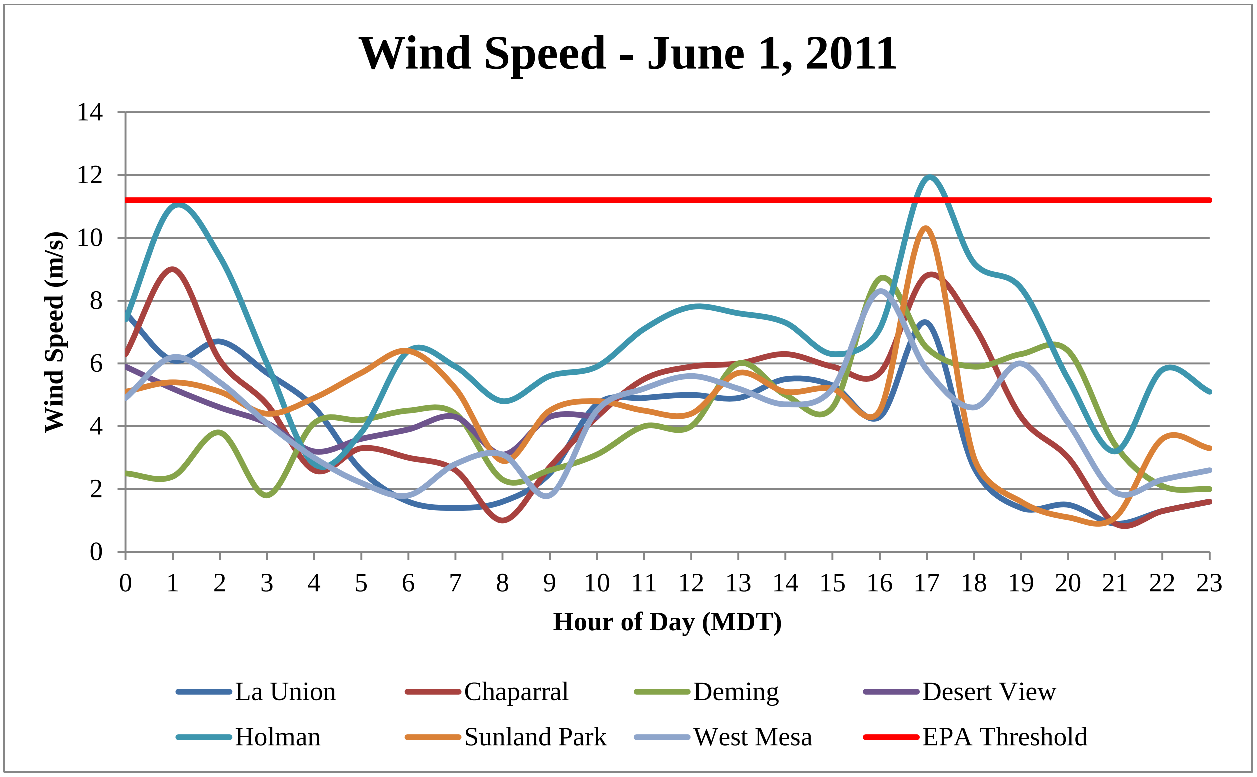

Figure 23-2. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

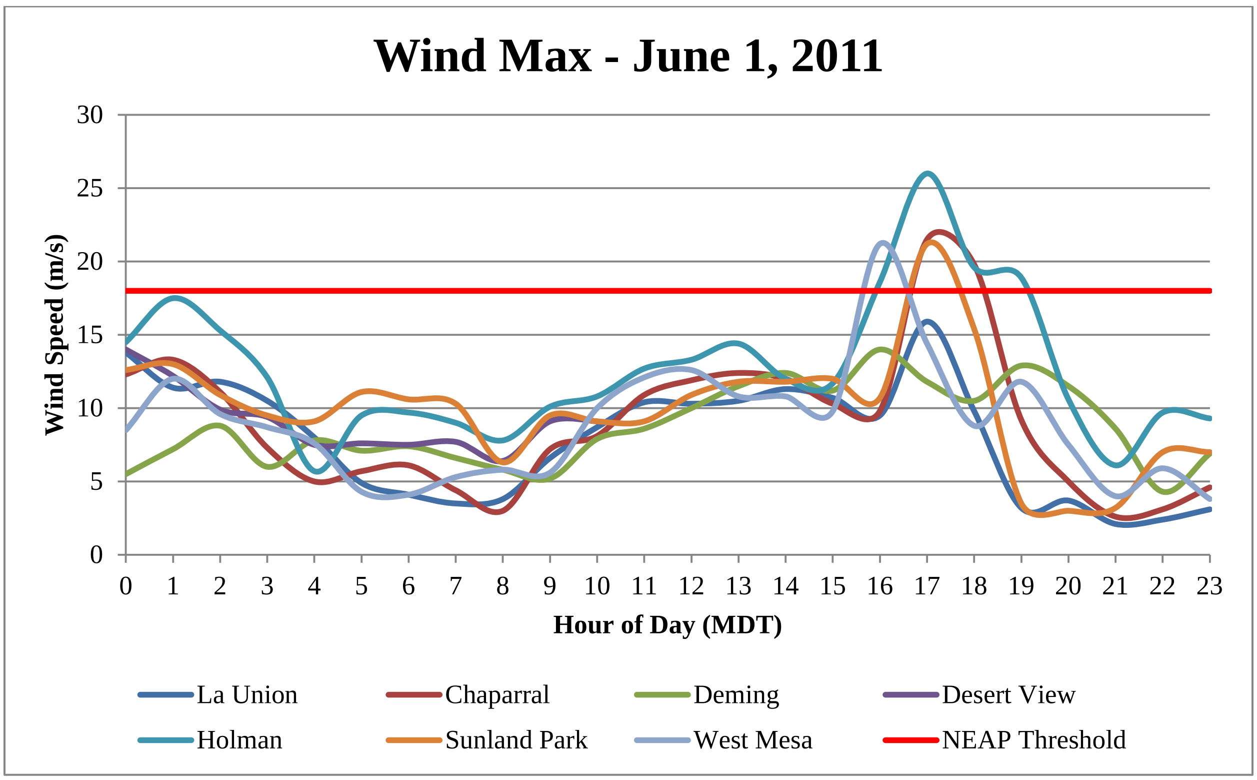

Figure 23-3. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

23.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the PM_{10} FEM TEOM monitors recorded 211 exceedances and the PM_{10} FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). The SPCY $PM_{2.5}$ FRM Partisol recorded 23 exceedances of the 24-Hour NAAQS from 2006-2010 (Figure A-2). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

The forests, rangelands and grasslands of New Mexico are fire-adapted ecosystems where long absence of fire has led to hazardous fuel and unhealthy forest conditions. Most fires occur during the spring and early summer when conditions are commonly dry and windy (see Section 2.7). The frequency and intensity of wildfires, including the frequency of catastrophic fires, has been exacerbated by ongoing drought conditions (see Section 2.8). Between May 31, 2011 and July 5, 2011, southern New Mexico advanced from a drought intensity of ‘extreme’ to ‘exceptional’. During that period, conditions of high fire risk persisted in general across most of the western half of the North American Continent; on June 1, 2011, catastrophic fires were raging in eastern Arizona, southern Colorado, North Dakota, western Mexico and western Canada. The ongoing effects of climate change are likely to aggravate these conditions. While the recurrence frequency for exceptional events resulting from smoke cannot be estimated, such events will continue to recur and most likely increase.

23.2.4 Controls Analysis for High Wind Event

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana and Luna Counties. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert and playas in New Mexico, Texas and northern Mexico. Morning and evening back-trajectory analyses using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model show that the air masses traveled from Texas and Mexico to the monitors in Doña Ana and Luna Counties. The model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figures 23-4). Costs prohibit controlling dust from the natural desert terrain and falls outside NMED’s jurisdiction when it originates in Texas or Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

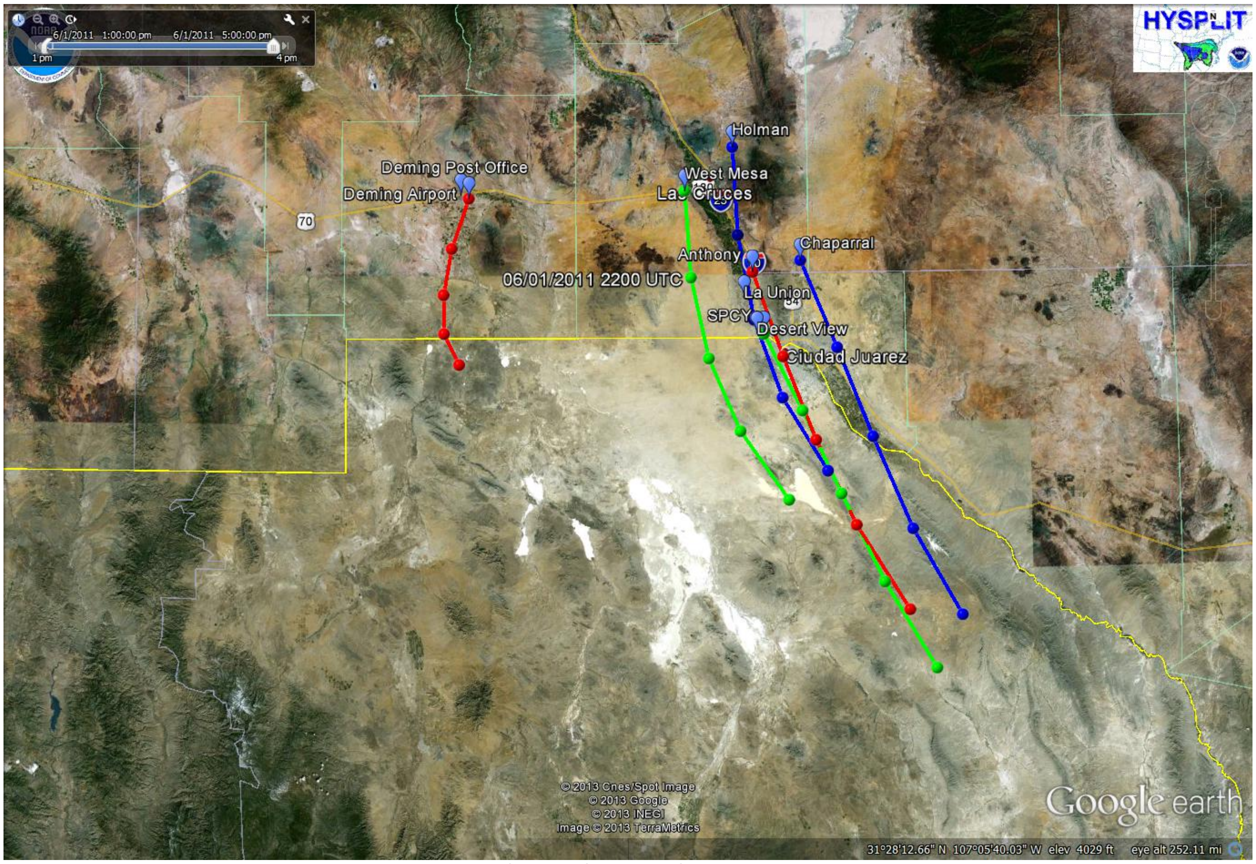

Figure 23-4. HYSPLIT back-trajectory model analysis for the afternoon of June 1, 2011.

23.2.5 <u>Controls Analysis for Smoke Event</u>

The fires that result in smoke-related exceptional events can begin in a variety of ways. Fires that result from natural causes such as lightening cannot be prevented, although they are often controlled after they begin; active fire suppression was underway for all of the fires that contributed to this event. Public education programs, transmission line regulations and fire restrictions when fire danger is high, have been established to reduce the number of fires that result from human error, such as downed power lines or untended camp fires. Federal agencies such as the Forest Service, National Parks Service and Bureau of Land Management conduct controlled burns to reduce the hazardous buildup of fuel and improve forest health. Smoke management during these controlled burns is required under 20.2.65 NMAC – *Smoke Management*. The fires that contributed to this exceptional event occurred in Arizona and Mexico, and fall outside NMED's jurisdiction. NMED concludes that the sources contributing to the event are not reasonably controllable.

23.3 Historical Fluctuations Analysis

23.3.1 <u>Annual and Seasonal 24-hour Average Fluctuations</u>

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded values for this day (203, 184 and 155 µg/m^3) are above the maximum values recorded when no high wind exceedances are included and are above the 95^{th} percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for June 1, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95^{th} percentile for PM_{10}, wind speed and wind gusts (Figures 23-5a-c through 23-7a-c). Hourly $PM_{2.5}$ data for the SPCY TEOM monitor is not available for this date. The top whiskers of the box and whisker plots represent the 95^{th} percentile of data. The hourly PM_{10} values during the high wind blowing dust storm far exceed the historical 95^{th} percentile of data.

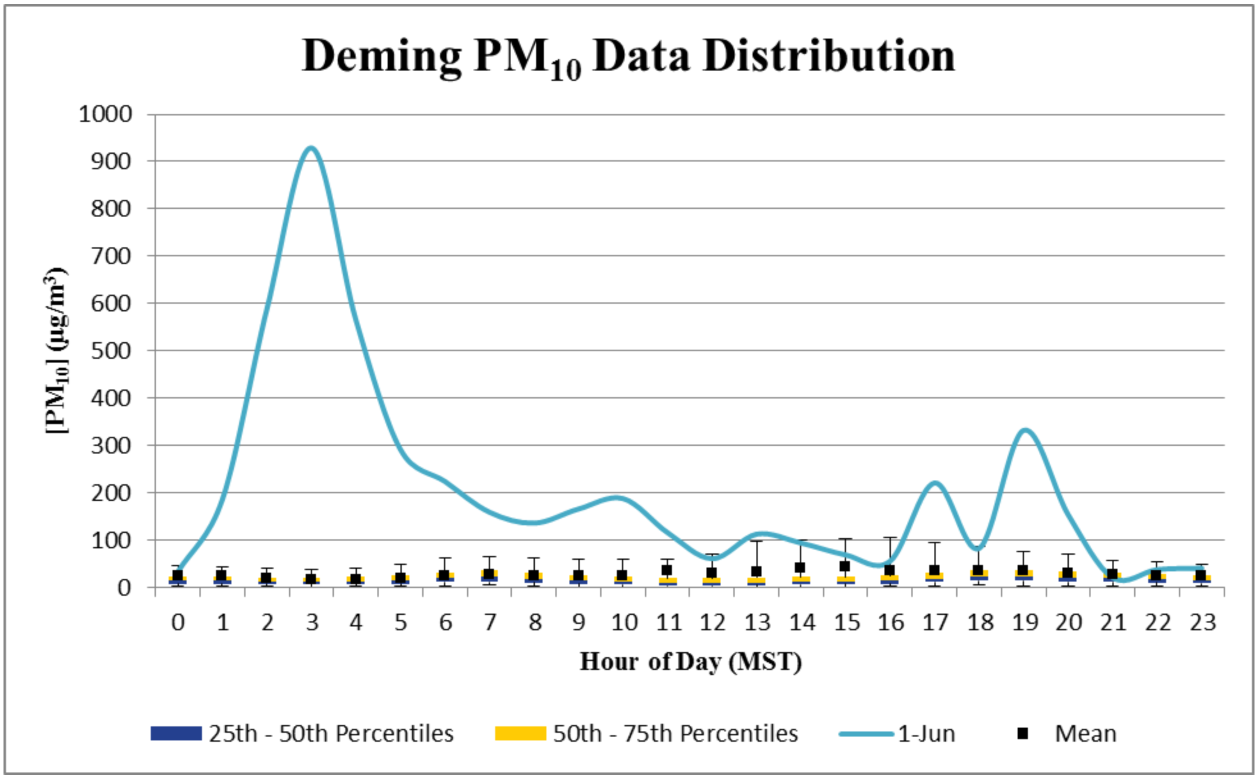

Figure 23-5a. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for June 1, 2011.

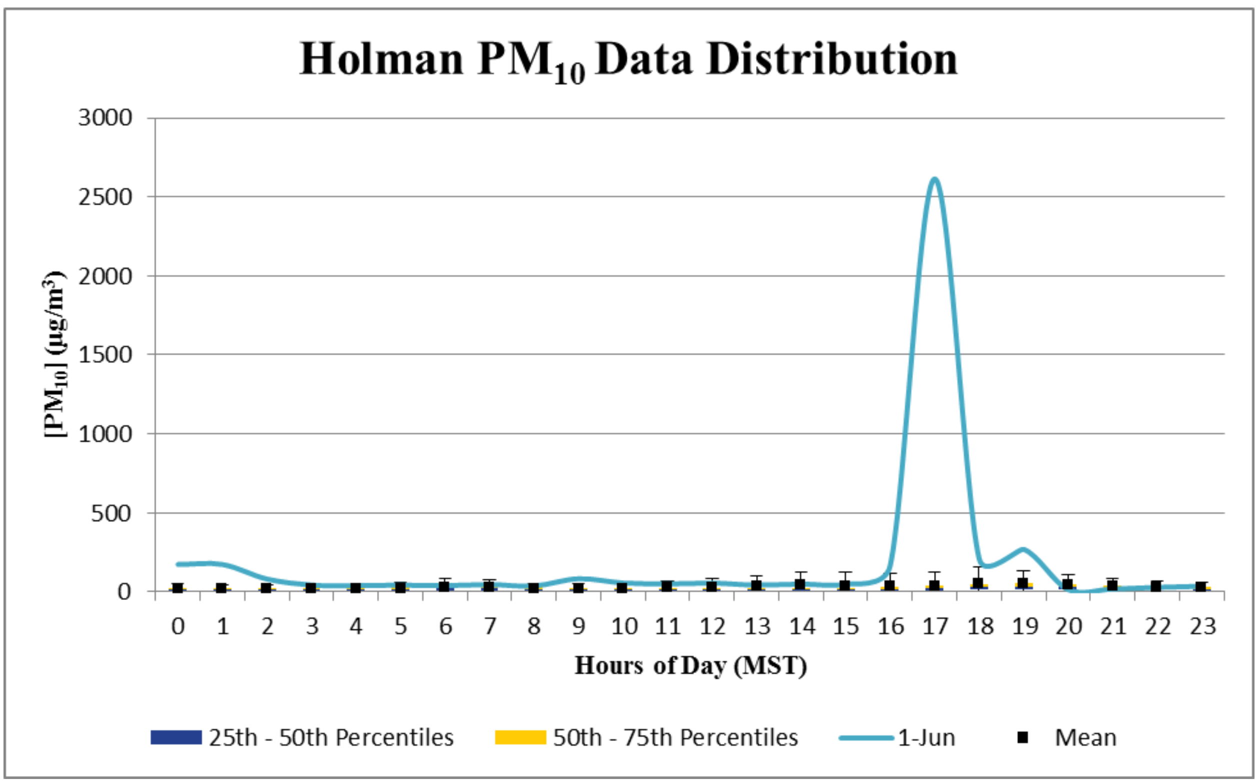

Figure 23-5b. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for June 1, 2011.

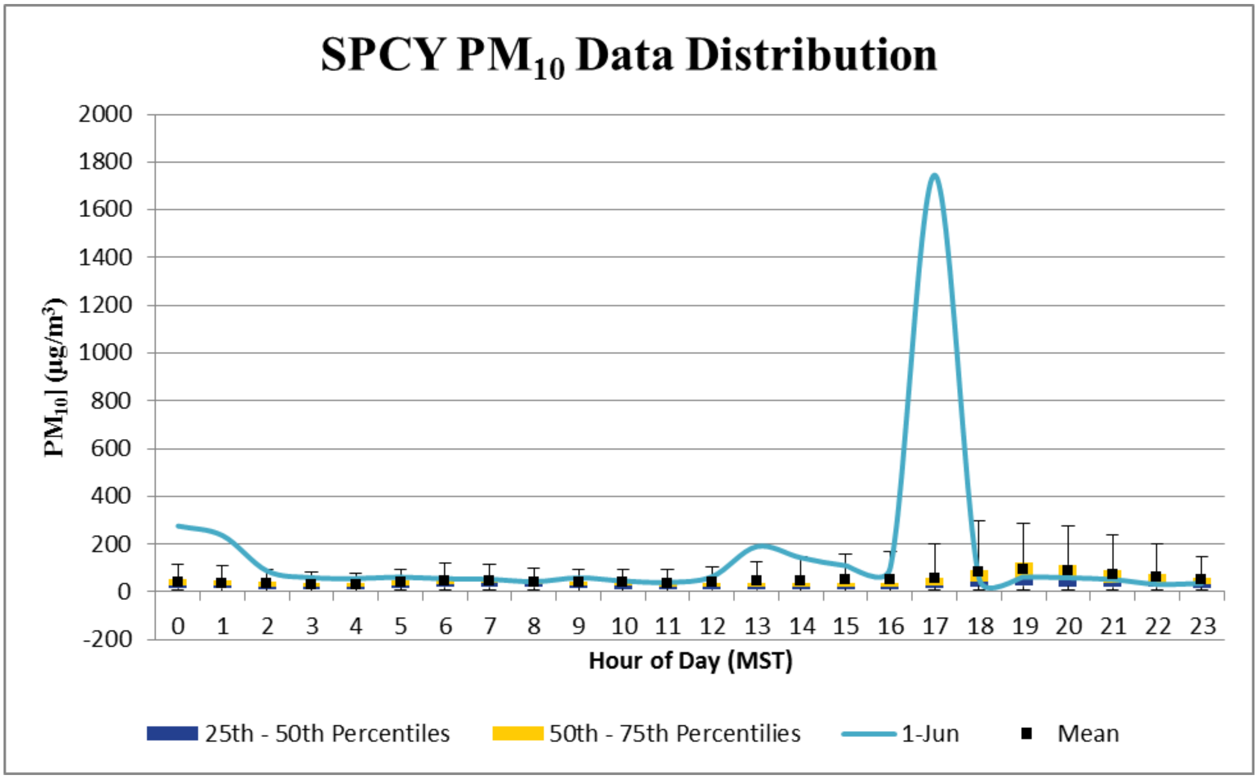

Figure 23-5c. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for June 1, 2011.

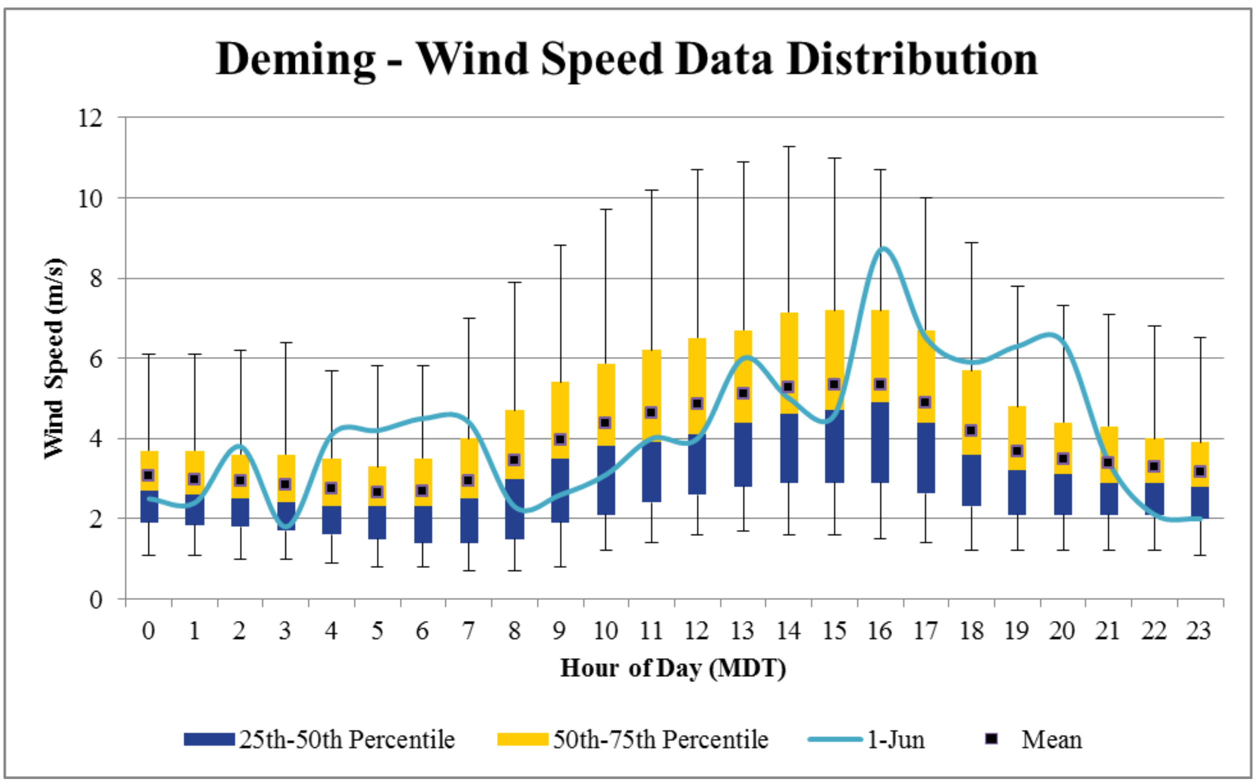

Figure 23-6a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 1, 2011.

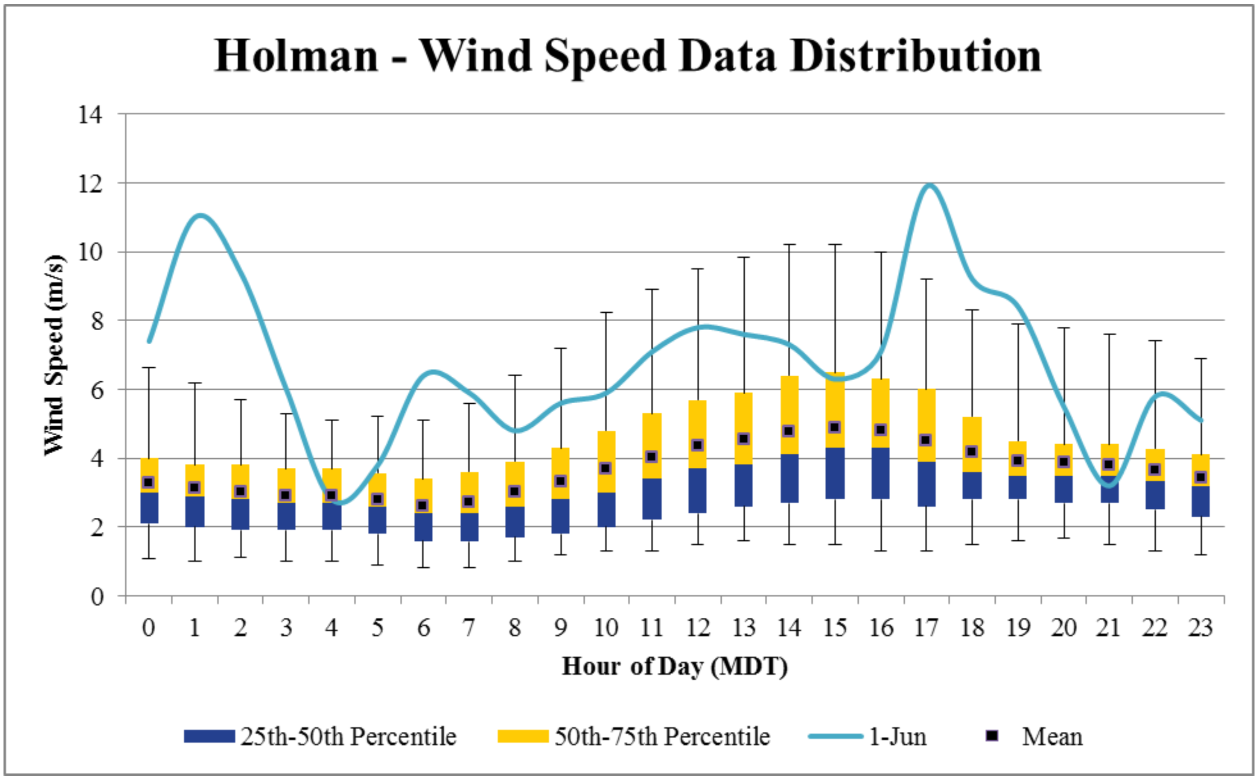

Figure 23-6b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 1, 2011.

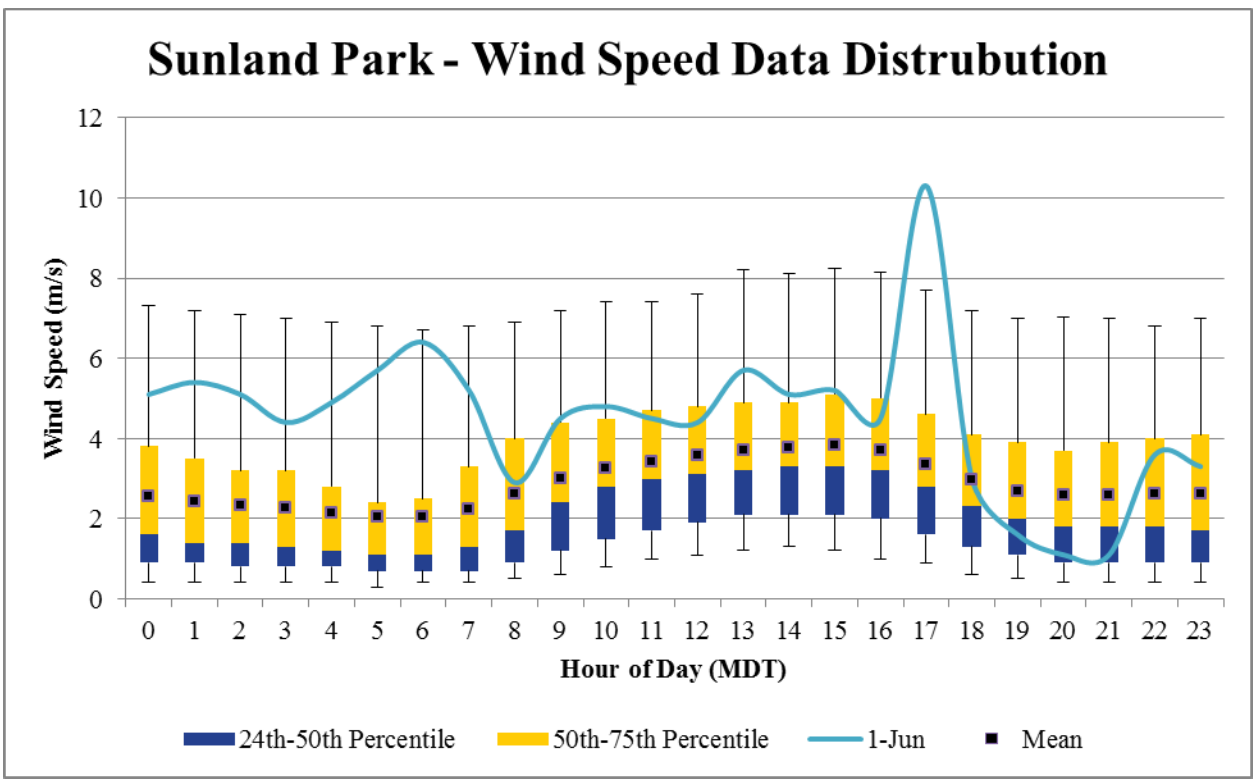

Figure 23-6c. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 1, 2011.

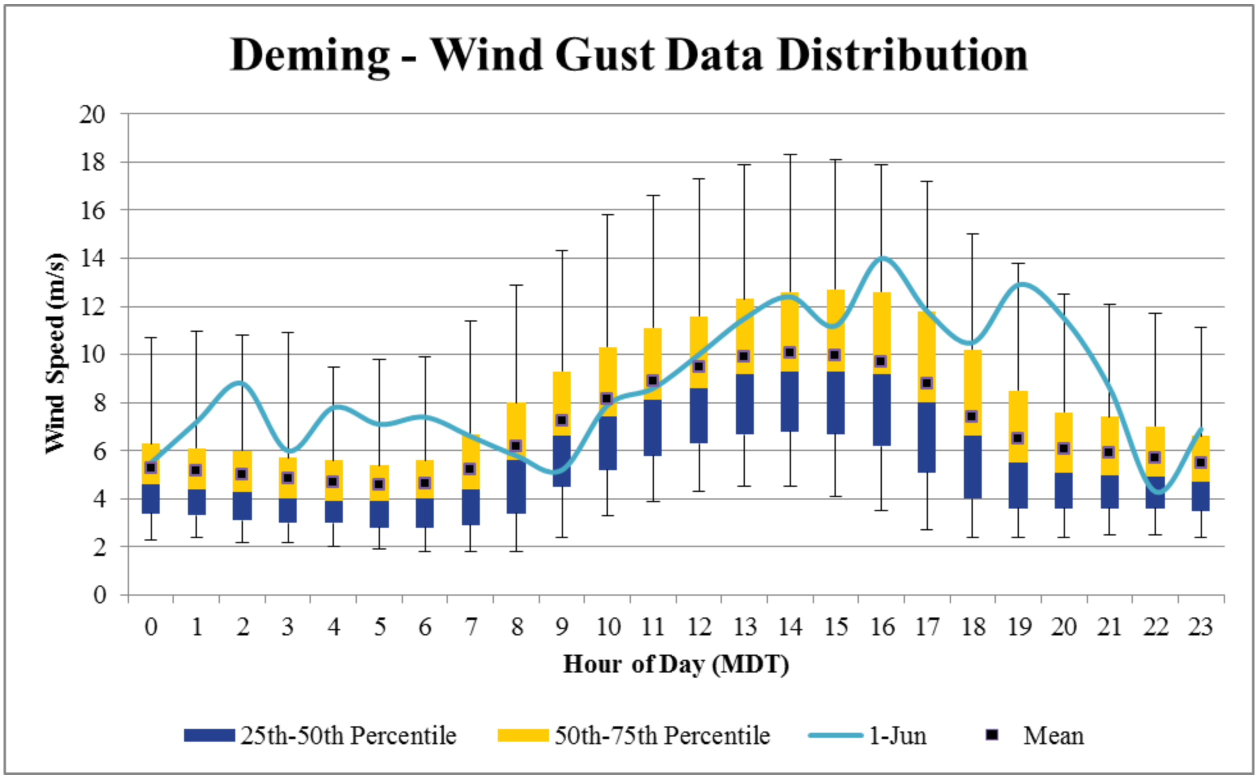

Figure 23-7a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for June 1, 2011.

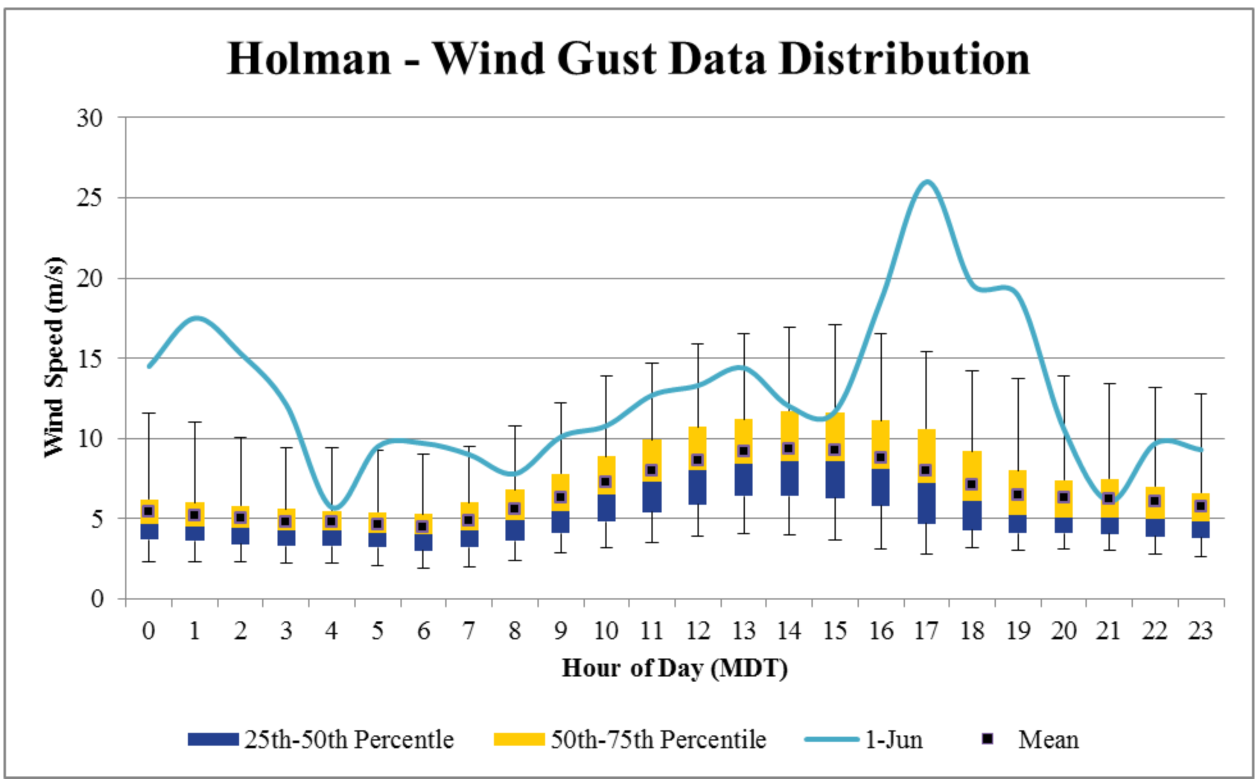

Figure 23-7b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for June 1, 2011.

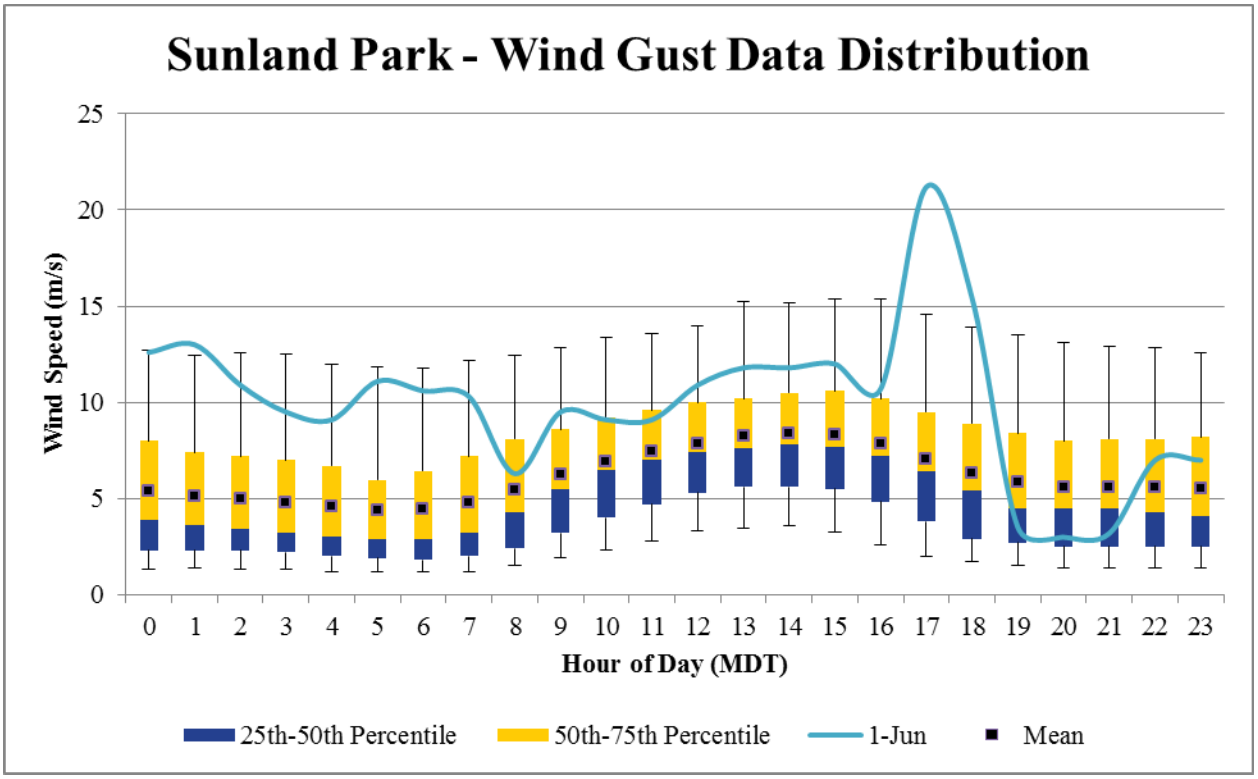

Figure 23-7c. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for June 1, 2011.

23.4 Clear Causal Relationship

23.4.1 <u>High Wind Event</u>

Thunderstorm outflows were active that evening, and there was a large thunderstorm complex over Chihuahua and southern Doña Ana County that night (Figure 23-8). Soils in the area were likely to be highly susceptible to blowing, since the region was in a severe drought. After one or more thunderstorm outflows had entrained particulate matter, winds calmed and the dust remained suspended until it was dispersed by convective mixing. As discussed in Section 23.4.2, another likely contributor to this exceedance was smoke from wildfires.

The Southwest Weather Bulletin, Fall-Winter 2011-2012 Edition, published by the National Weather Service El Paso-Santa Teresa office described June 1, 2011 as follows: "A trace of rain falls at El Paso Airport ending a record string of 118 consecutive days without precipitation. Severe thunderstorms also move across portions of the area producing wind gusts to 72 mph near Holloman Air Force Base, 66 mph at Northrup Landing Strip in Dona Ana County, and 61 mph over El Paso." The most likely cause of windblown dust is outflow caused by dry microbursts. The localized nature of the high PM_{10} concentrations and little precipitation supports this assertion. Convective weather cells in the upper atmosphere and low moisture levels below cause dry microbursts. As rain falls from the high-level clouds, dry air below evaporates it and converts the falling rain into wind energy. Upper air sounding data best detect dry microbursts (Novlan et al., 2007). The sounding for a dry microburst depicts an inverted V as seen in the skew-t plot from the National Weather Service in Santa Teresa, NM (Figure 23-9). The blue line shows relative humidity while the red line depicts the environmental adiabatic lapse rate.

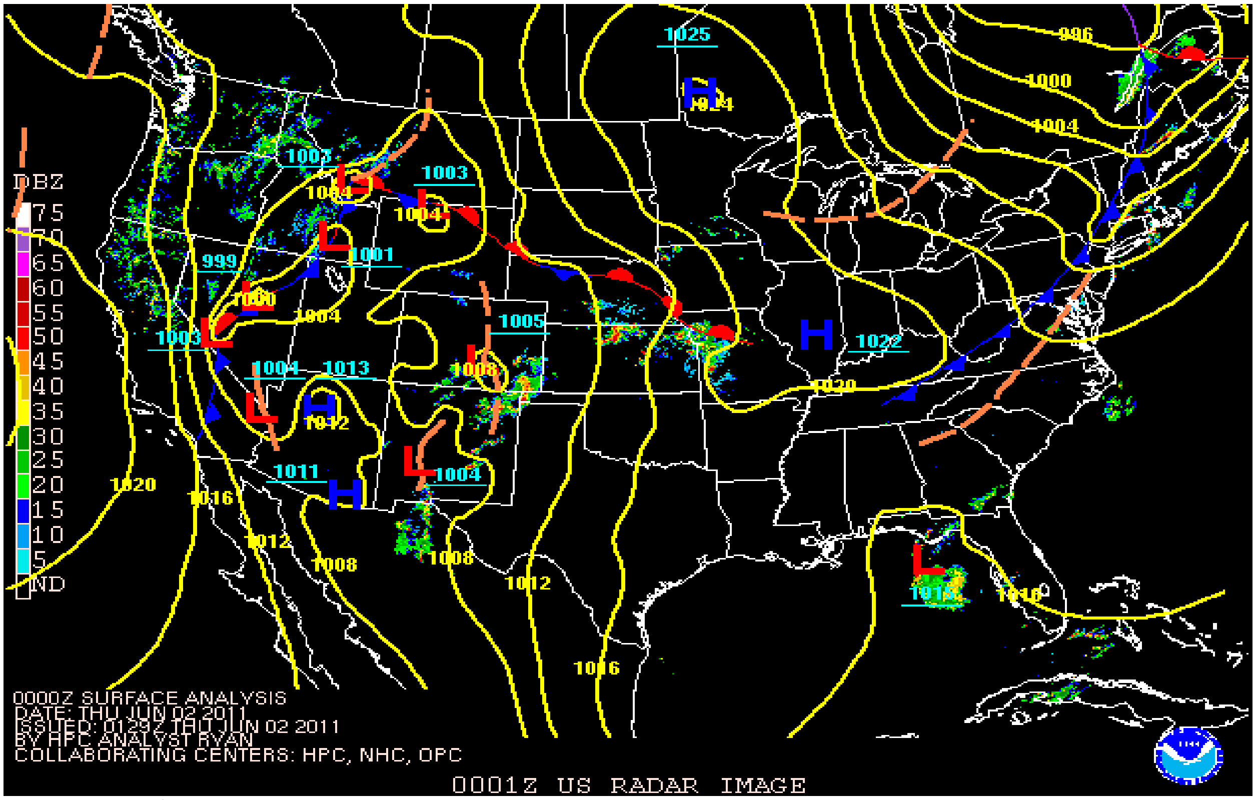

Figure 23-8. Surface weather map showing thunderstorm activity on June 1, 2011 at the 1800 hour.

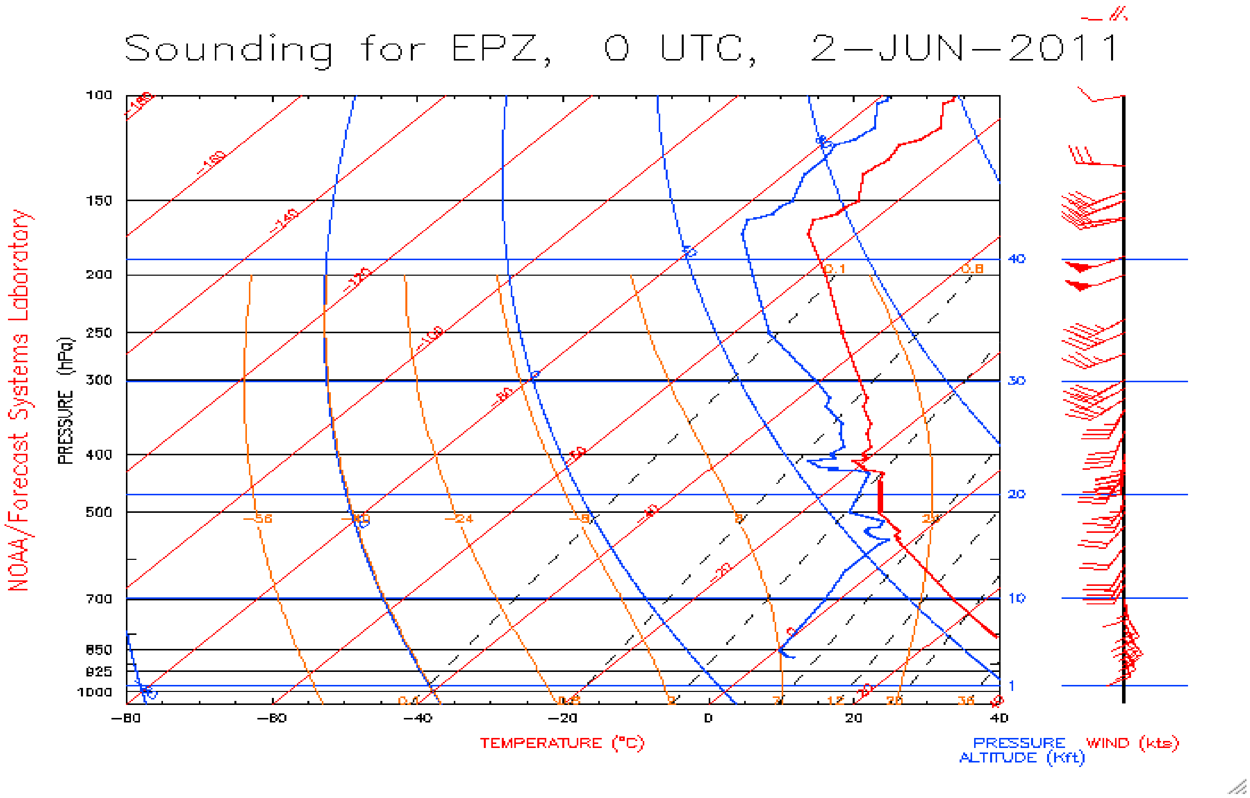

Figure 23-9. Skew-t plot for June 1, 2011 at the 1800 hour. Courtesy of NOAA/NWS.

The weather pattern described above generated strong winds from the southeast-south beginning in the 1500 hour and ending in the 1800 hour. In the 1700 hour, wind speeds exceeded 11.2 m/s at the Holman site as shown in Figure 23-2. Peak wind speeds ranged from 8.3 m/s at West Mesa to 11.9 m/s at Holman (Figure 23-2). Peak wind gusts ranged from 14 m/s at Deming to 26 m/s at Holman (Figure 23-3). Blowing dust caused elevated levels of PM_{10} during the same periods as high winds as demonstrated by the time series plot in Figure 23-10a-c. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (1500-2000 hours). During these hours, hourly PM_{10} concentrations spiked at all monitoring sites in the network (Figure 23-11). Hourly data from the SPCY $PM_{2.5}$ monitor was insufficient to indicate correlation of the timing of spikes in concentrations PM_{10}.

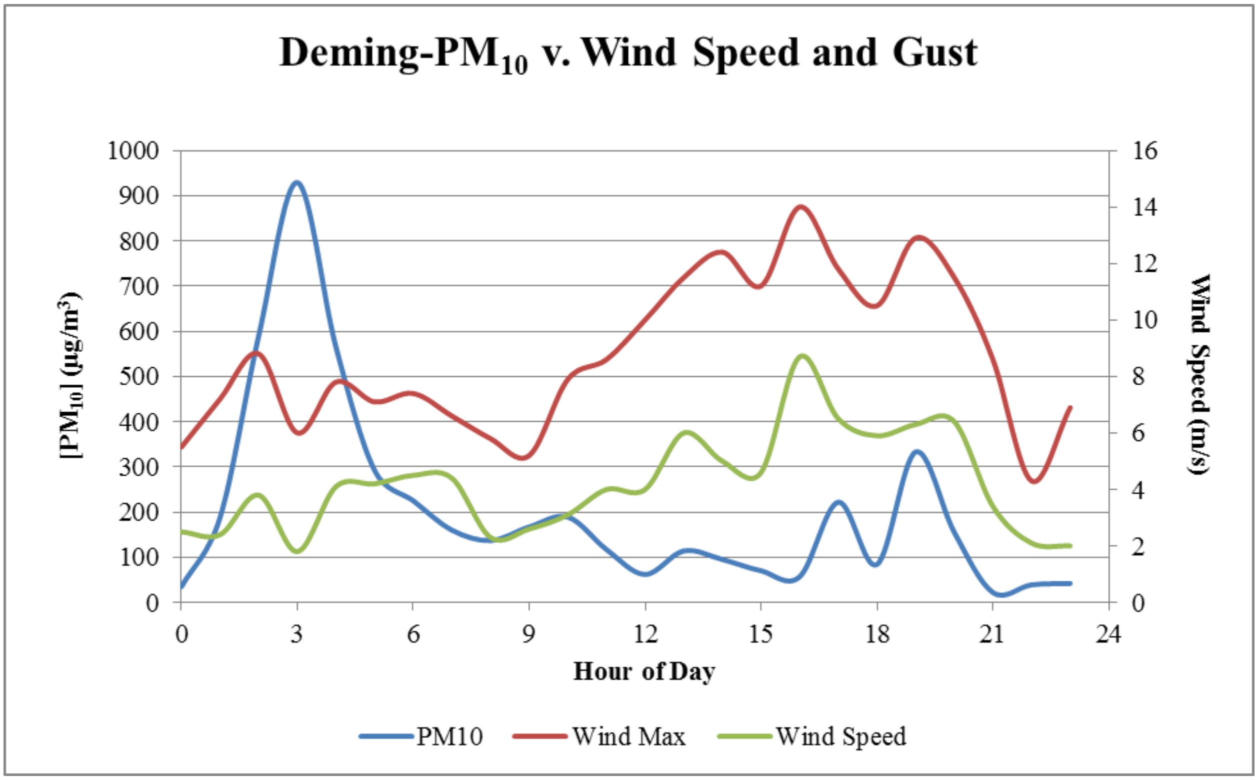

Figure 23-10a. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

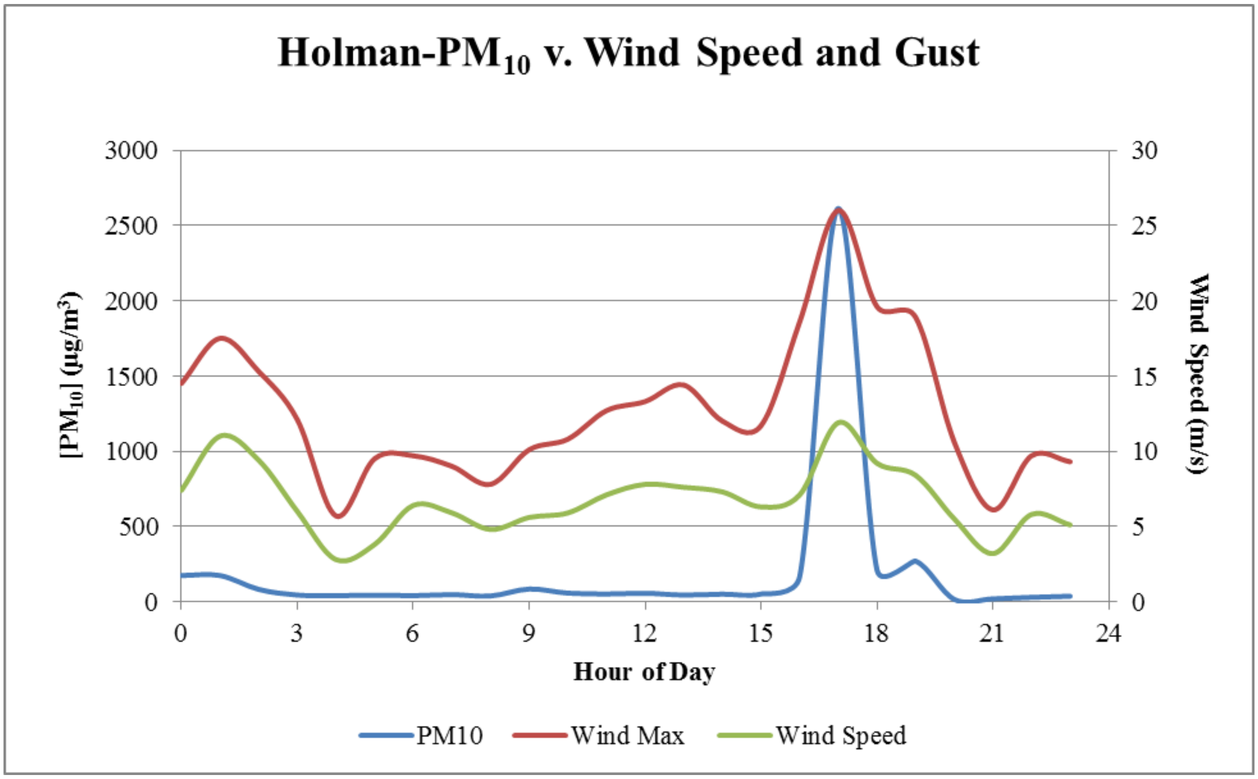

Figure 23-10b. Time series plot of hourly observations showing increased PM$_{10}$ concentrations as wind speeds and gusts increase.

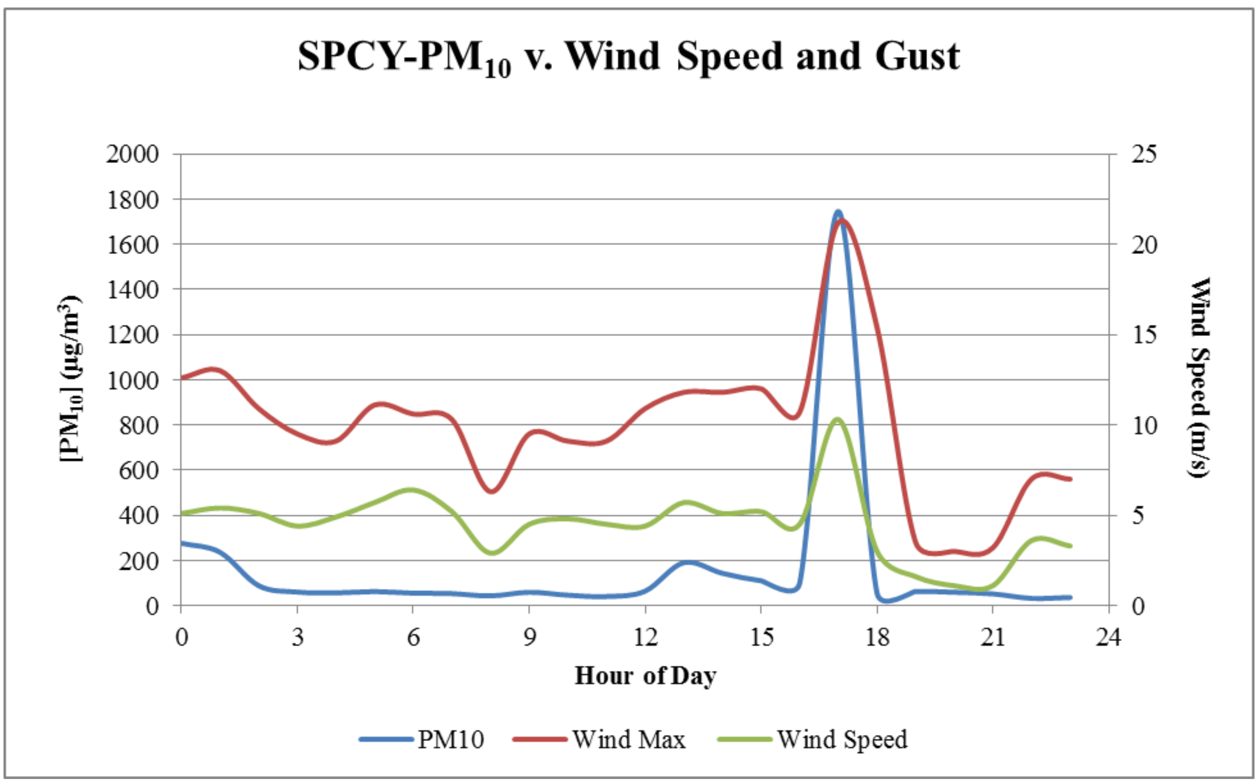

Figure 23-10c. Time series plot of hourly observations showing increased PM$_{10}$ concentrations as wind speeds and gusts increase.

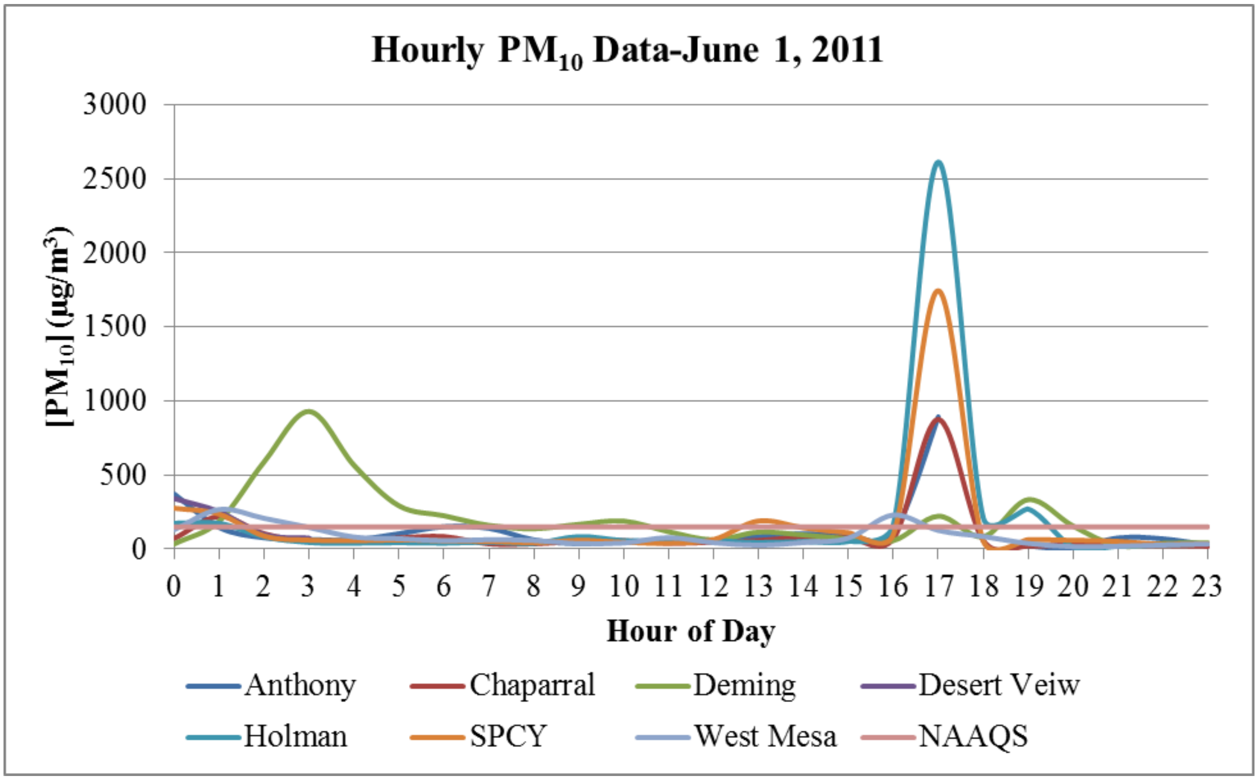

Figure 23-11. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

The NWS issued a severe thunderstorm warning for Luna and Doña Ana Counties in the afternoon stating in part,

> ...NATIONAL WEATHER SERVICE METEOROLOGISTS DETECTED A SEVERE THUNDERSTORM CAPABLE OF PRODUCING QUARTER SIZE HAIL...AND DAMAGING WINDS IN EXCESS OF 60 MPH. THIS STORM WAS LOCATED 20 MILES NORTHEAST OF COLUMBUS...MOVING NORTH AT 30 MPH.
>
> ALSO MOTORISTS ALONG INTERSTATE 10 WEST OF LAS CRUCES SHOULD BE ADVISED THAT THIS STORM WILL CROSS THE INTERSTATE AND COULD PRODUCE BLOWING DUST THAT WOULD REDUCE VISIBILITIES BRIEFLY TO NEAR ZERO.
>
> SEVERE THUNDERSTORMS MAY PRODUCE DAMAGING WINDS OF AT LEAST 58 MPH... (NWS, 2011)

23.4.2 <u>Smoke Event</u>

On June 1, 2011, catastrophic fires were raging in eastern Arizona, southern Colorado, North Dakota, western Mexico and western Canada. The Fall-Winter 2011-2012 edition of the Southwest Weather Bulletin, published by the National Weather Service El Paso-Santa Teresa office, reported that in June 2011 "Smoke from area wildfires also drift[ed] into much of the region resulting in periods of poor unhealthy air quality and reduced visibilities." The smoke also contributed to exceedances during the days bracketing this exceedance; Section 30 addresses $PM_{2.5}$ exceptional events from smoke on the days May 26, 27, 30 & 31, and June 2 & 3, and Section 25 for a $PM_{2.5}$ smoke exceptional event on June 4.

Although smoke was a likely contributor to all of the exceedances on June 1, its contribution is most relevant at the Deming monitor, where a significant spike of particulate matter occurred between 0200 and 0400, peaking (929 $\mu g/m^3$) at 0300 when wind speeds dropped to approximately 2 m/s (Figure 23-10a). Deming's 0300 hour spike in particulate matter is attributed to smoke from wildfires with the afternoon spike attributed to high winds resulting from thunderstorm activity. The greatest likelihood is that the Deming exceedance was the result of a combination of these events. However, the $PM_{2.5}/PM_{10}$ ratio which may have indicated the relative contributions of crustal material (dust) or smoke cannot be determined because $PM_{2.5}$ is not monitored at the Deming site.

On the day of this exceedance, the Horseshoe 2 fire in southeastern Arizona and fires in northern Mexico had the greatest influence on air quality in southern New Mexico. The NM Border Air Quality Blog reported on May 29 that "smoke plumes from the Horseshoe2 Fire and fires in Chihuahua, Mexico were already blowing across the region" (DuBois, 2011). Figure 23-12 is a HYSPLIT model of the forward trajectories of smoke from wildfires in Mexico, illustrating that the smoke blew directly towards Deming on June 1, 2011.

Figure 2-5 shows the major wildfires in southeastern Arizona and southwestern New Mexico during 2011. The large fires burning on June 1, 2011 include the Wallow fire and the Horseshoe 2 fire. An additional fire of interest is the Miller fire, which burned a total of 88,835 acres from April 28 to June 14, 2011 in the Gila National Forest north of Silver City.

The Silver City Sun-News reported on June 1 that "Silver City residents woke up to smoke and haze [this] morning that had some wondering if they were living in Los Angeles again. The Gila National Forest and the National Weather Service both said the hovering haze is the result of normal yearly weather patterns combined with several large-scale fires burning in the Gila Wilderness, the Apache-Sitgreaves National Forest and the Coronado National Forest, both in Arizona." Figure 23-13 is a NOAA HYSPLIT model analysis of estimated smoke impacts for the evening (2100 hour) on May 31, 2011. This model shows the smoke blowing towards Silver City, 60 miles northwest of Deming, with impacts that include Deming.

The length and paths of the trajectories represented by these figures indicate that smoke was present and strongly influencing air quality in the region, with dispersion likely occurring towards Deming from at least two directions. However, with regards to the particulate levels in Deming at 0300 hour on June 1, it is important to note that this spike coincided with cooling night air and a calming of the wind, indicating a possible inversion, which would allow drainage into and concentration of area smoke into Deming. Topography played an important part in the dispersion of smoke as two valleys channel drainage of smoke from these active fires towards Silver City and Deming.

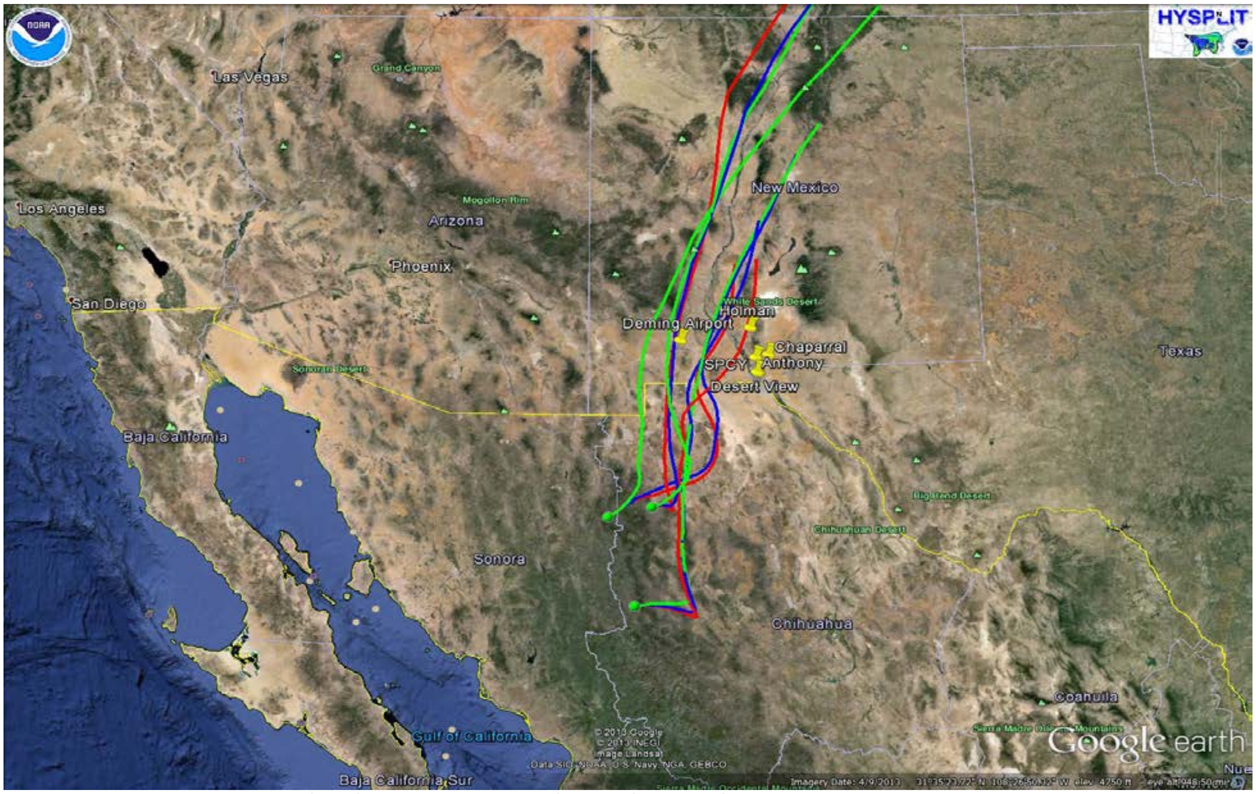

Figure 23-12. HYSPLIT model of the forward trajectories of smoke from wildfires in Mexico, June 1, 2011.

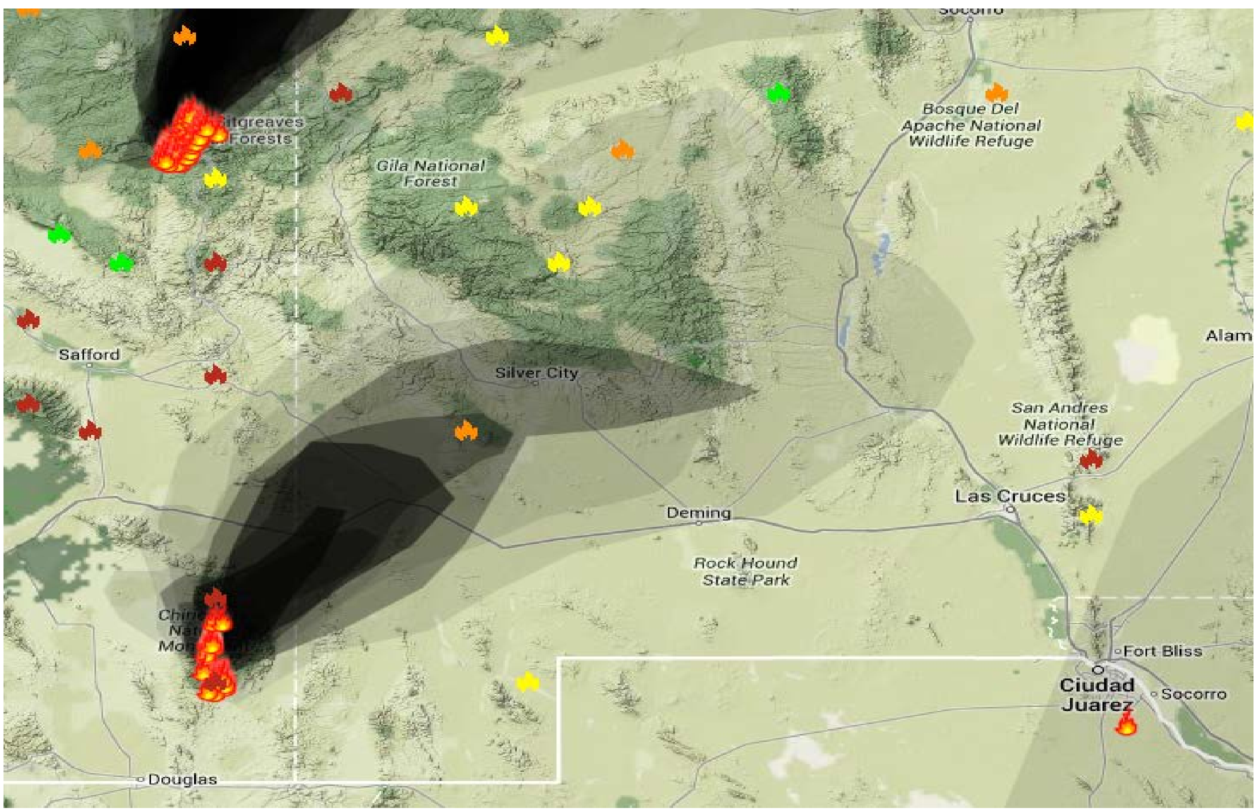

Figure 23-13. NOAA HYSPLIT model analysis of smoke impacts for the 2100 hour, May 31, 2011.

23.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on June 1, 2011.

23.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by high wind and blowing dust.

23.7 No Exceedance but for the Event

The Deming monitor detected smoke and blowing dust around the 0100 hour with hourly concentrations impacted throughout the day. Blowing dust from a regional high wind event occurred in the afternoon and evening. Fifteen of the 24 hours measured PM_{10} values above the 95^{th} percentile. The hourly PM_{10} values for these hours alone exceed the 24-hour average standard at Deming [191 µg/m^3]. By replacing the hourly values most heavily impacted by these events with the 95^{th} percentile of hourly data at the Deming site, the resulting 24-hour average (89 µg/m^3) does not exceed the NAAQS (Table 23-1). The values in red represent the 95^{th} percentile of all hourly data collected at Deming, including data affected by smoke and high wind blowing dust events in the table below. However, although the afternoon high wind event occurred at this monitor, it would not have in itself resulted in an exceedance. A significant spike of particulate matter between 0200 and 0400, peaking (929 µg/m^3) at 0300 when wind speeds dropped to approximately 2 m/s, would have resulted in an exceedance at Deming regardless of the high wind event in the afternoon. Replacing only the hours 0200 and 0300 with the 95^{th} percentile of hourly data would result in a 24-hour average of 144 µg/m^3. NMED concludes that without blowing dust and the smoke from wildfires in Mexico and Arizona (see Section 23.4.2), an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	35	35
1	188	188
2	590	**41**
3	929	**39**
4	565	**41**
5	292	**49**
6	225	**62**
7	160	160
8	137	137
9	167	167
10	189	189
11	117	117
12	62	62
13	114	114
14	95	95
15	70	70
16	57	57
17	222	**95**
18	84	84
19	333	**76**
20	155	155
21	22	22
22	39	39
23	42	42
24-Hour Average	203	**89**

Table 23-1. 95th percentile of data substituted for those hours when windblown dust and smoke was the most intense does not result in an exceedance at Deming.

The Holman monitor detected smoke in the early morning (0000-0200) and blowing dust with hourly concentrations heavily impacted in the afternoon hours (1600-1900). The average PM_{10} values for the nine heavily impacted hours alone exceed the 24-hour average standard at Holman [158 µg/m^3]. However, the single hourly measurement for the 1700 hour (2614 µg/m^3) at the Holman monitor accounted for 60% of all particulate collected at that monitor on that day. By replacing that single hourly value with the 95th percentile of hourly data at the Holman site, the resulting 24-hour average (81 µg/m^3) does not exceed the NAAQS (Table 23-2). The Hourly values in red in the table below represent the hours when the values were above the 95th percentile of all hourly data collected at Holman, including data affected by high wind blowing dust events; the single hourly data value substituted with the 95th percentile value is also shown in red. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	174	174
1	174	174
2	82	82
3	44	44
4	40	40
5	43	43
6	40	40
7	47	47
8	38	38
9	84	84
10	57	57
11	51	51
12	56	56
13	44	44
14	50	50
15	51	51
16	167	167
17	2614	**125**
18	210	210
19	270	270
20	15	15
21	19	19
22	29	29
23	36	36
24-Hour Average	185	**81**

Table 23-2. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Holman.

The Sunland Park monitor detected around the 0000 hour with hourly concentrations heavily impacted until the 0100 hour\and also blowing dust during the afternoon (1300-1700 hours). By replacing these four hourly values with the 95th percentile of hourly data at the Sunland Park site, the resulting 24-hour average (88 µg/m^3) does not exceed the NAAQS (Table 23-3). In fact, by only replacing the 1700 hour with the 95th percentile of hourly data at the Sunland Park site, the resulting 24-hour average (91 µg/m3) does not exceed the NAAQS. The values in red represent the 95th percentile of all hourly data collected at Sunland Park, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	276	**115**
1	236	**108**
2	88	88
3	60	60
4	56	56
5	62	62
6	55	55
7	53	53
8	43	43
9	59	59
10	46	46
11	40	40
12	64	64
13	190	**125**
14	143	143
15	110	110
16	100	100
17	1745	**201**
18	55	55
19	63	63
20	59	59
21	52	52
22	32	32
23	36	36
24-Hour Average	155	**76**

Table 23-3. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Sunland Park.

24 HIGH WIND & SMOKE EXCEPTIONAL EVENT: June 4, 2011

24.1 Summary of Event

A southeasterly breeze which turned southwesterly late in the day on June 4, 2011 caused smoke from northern Mexico fires to move into southern Doña Ana County with high winds and blowing dust in the evening resulting in an exceedance of the $PM_{2.5}$ annual NAAQS at the Sunland Park (SPCY) monitoring site on this date. The Partisol monitor at this site recorded a 24-hour average concentration of 15.1 µg/m^3. Thunderstorms caused localized and short-lived blowing dust on this evening. Although no other exceedances were recorded, elevated levels of PM_{10} were monitored in southern Doña Ana County at the Anthony (96 µg/m^3), Chaparral (93 µg/m^3) and SPCY monitoring sites (87 µg/m^3).

24.2 Is Not Reasonably Controllable or Preventable

24.2.1 Suspected Source Areas and Categories Contributing to the Event

Sources of smoke contributing to this exceedance include wildfires in northern Mexico, southeastern Arizona, and southwestern New Mexico, and the nearby cities of El Paso, Texas and Ciudad Juarez, Mexico. As described in the 2009 report, "Particulate Monitoring Analysis for the Paso del Norte Airshed in the United States – Mexico Border Region November 13, 2008-April 30, 2009," pollution crosses state and international boundaries on a regular basis, especially affecting Sunland Park because of the unique topography of the area (DuBois, 2009). The most likely sources of $PM_{2.5}$ are the wildfire smoke plumes, especially from northern Mexico. Minor sources of PM_{10} and $PM_{2.5}$ include the natural desert, residential properties, and dirt roads in Texas, Mexico, and New Mexico (See Section 24.2.4 below).

24.2.2 Sustained and Instantaneous Wind Speeds

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On June 4, 2011, sustained wind speeds exceeded EPA's default threshold at two of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at two of the seven monitoring sites (Figures 24-1 and 24-2). Winds exceeded these thresholds at one or more monitoring sites beginning at the 1800 hour and ending at the 1900 hour.

24.2.3 Recurrence Frequency

The SPCY $PM_{2.5}$ FRM Partisol recorded 23 exceedances of the 24-hour NAAQS from 2006-2010 (Figure A-2). See Appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

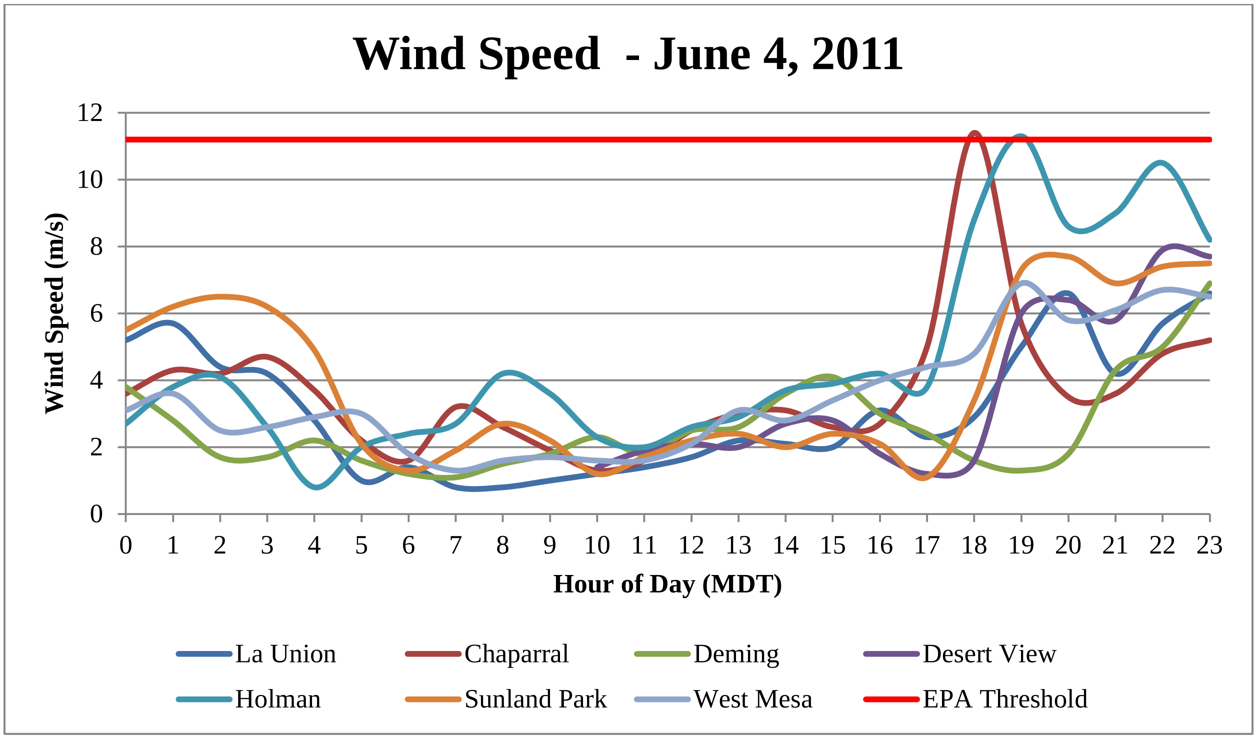

Figure 24-1. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties

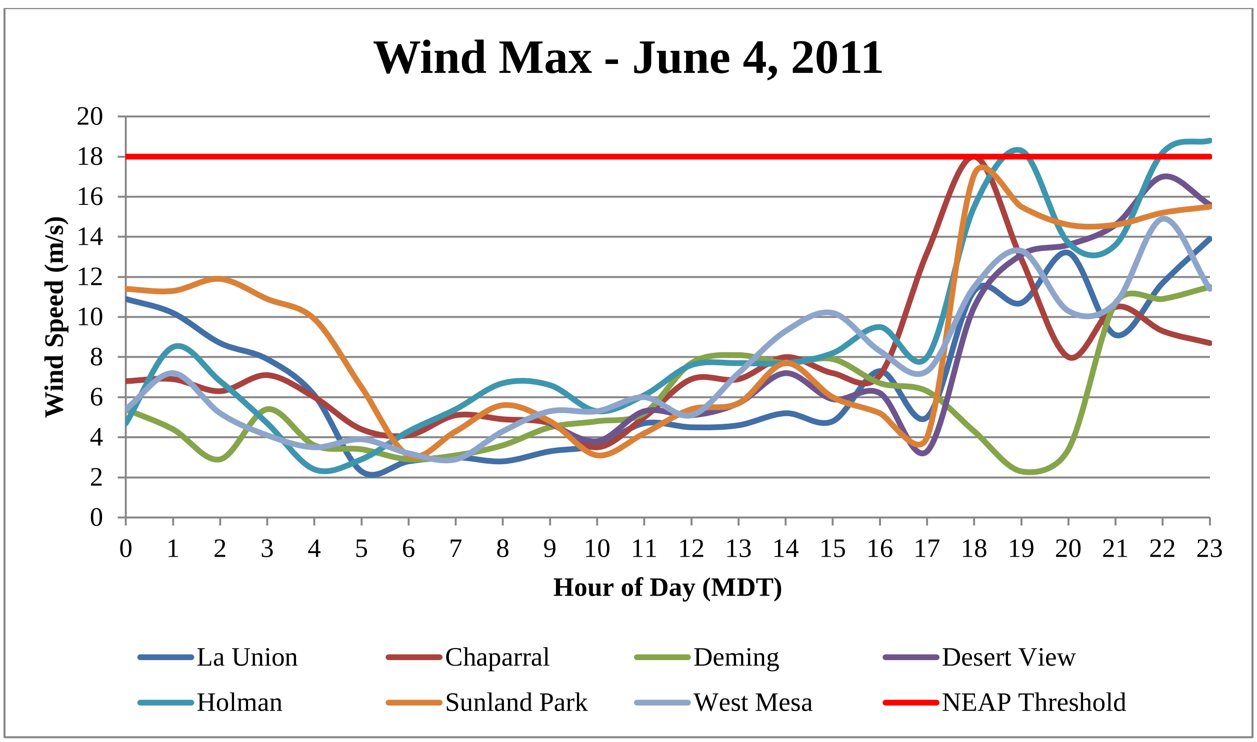

Figure 24-2. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties

24.2.4 Controls Analysis

As has been shown in the summary discussion above, smoke from wildfires in northern Mexico contributed to the event on this date. The most likely source of smoke impacts was fires and windblown dust from Mexico and New Mexico. NMED ran forward and back trajectory analyses using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model, showing that the air masses traveled from northern Mexico to the monitors in southern Doña Ana County. The forward trajectory model run shows that winds would have carried the smoke directly to the Sunland Park monitoring site. The forward trajectory model run starts 30 hours before peak afternoon concentrations and originates from the three Mexico fires, at 250 m (red), 500 m (blue) and 1000 m (green). The Sunland Park monitoring station is marked with a yellow pin and is located precisely where four trajectories pass at different times of the day (Figure 24-3). The back trajectory model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figure 24-4). Costs prohibit controlling dust from the natural desert terrain and falls outside NMED's jurisdiction when it originates in Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

Figure 24-3. HYSPLIT forward trajectory model for June 4, 2011.

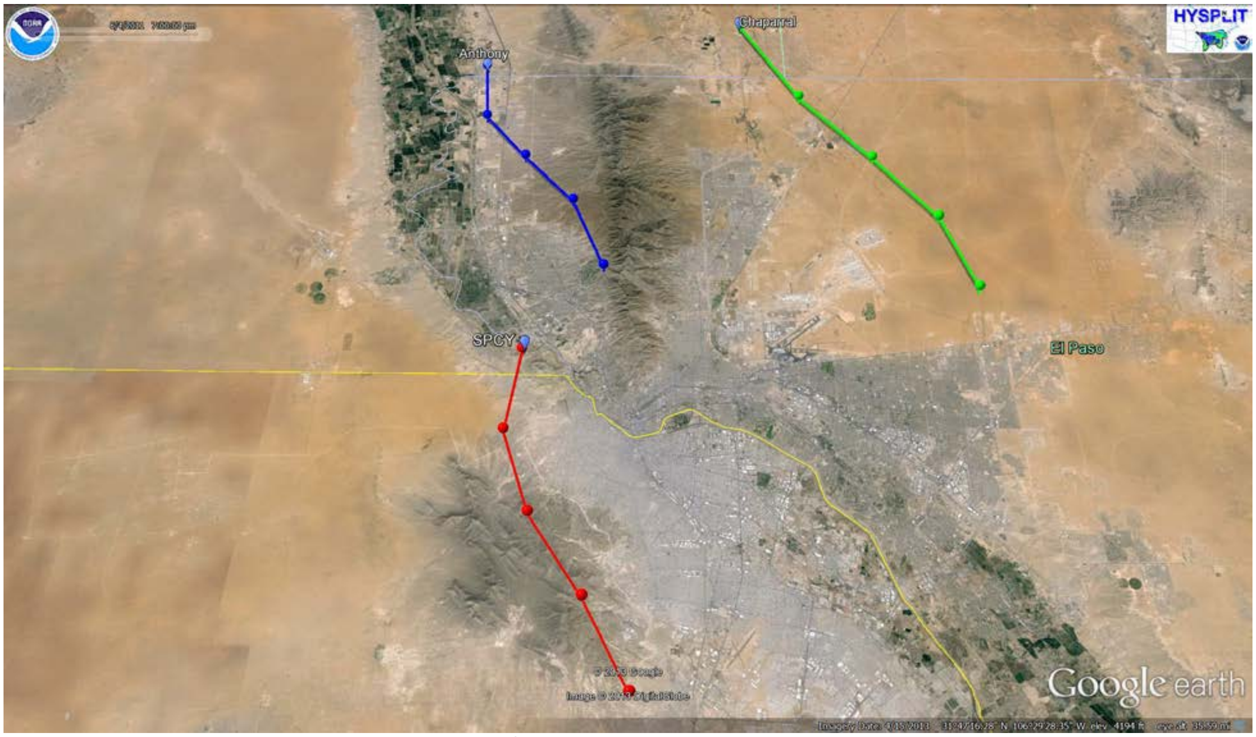

Figure 24-4. HYSPLIT back-trajectory model analysis for June 4, 2011.

24.3 Historical Fluctuations Analysis

24.3.1 Annual and Seasonal 24-hour Average Fluctuations

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010.

An hourly data distribution analysis was performed for $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). Overlaying the hourly data for June 4, 2011on the hourly data distribution plots shows that the values recorded during the smoke and high wind event exceed the 95th percentile for PM_{10}, $PM_{2.5}$, wind speed and wind gusts (Figures 26-5a-b through 26-7). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} and $PM_{2.5}$ values during the high wind blowing dust storm far exceed the historical 95th percentile of data.

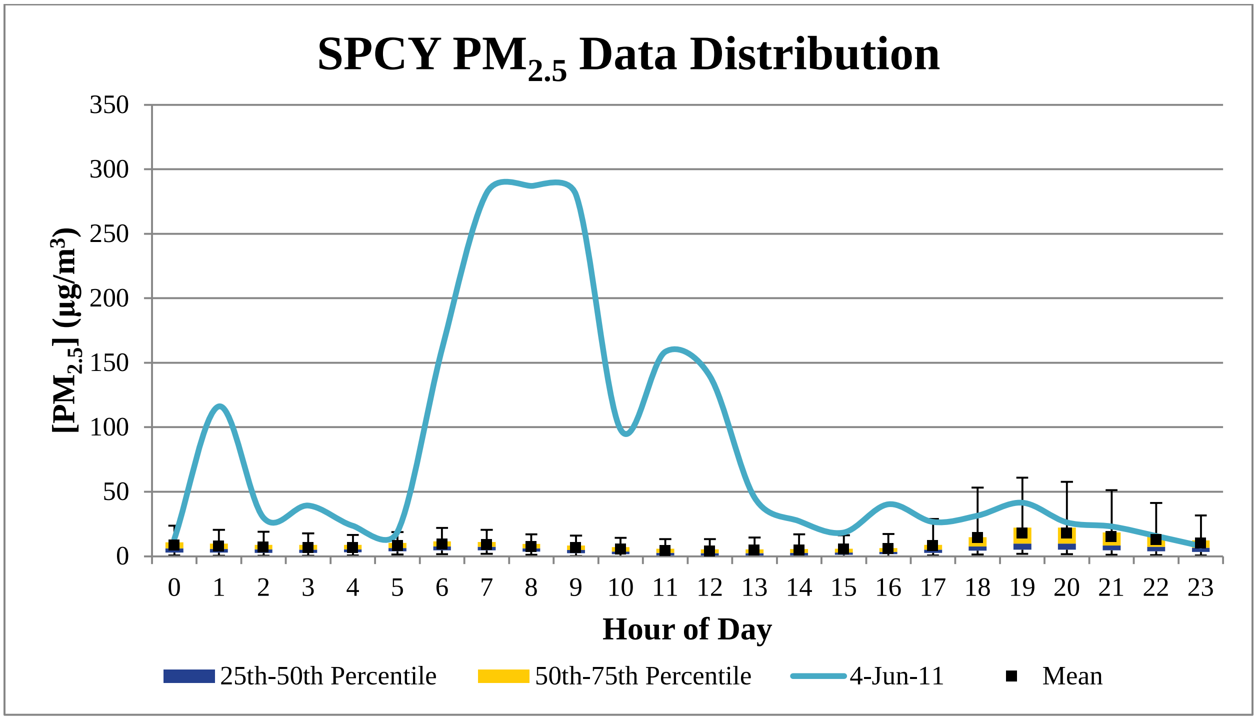

Figure 24-5a. $PM_{2.5}$ hourly data distribution from 2006-2010 overlaid by hourly values for June 4, 2011.

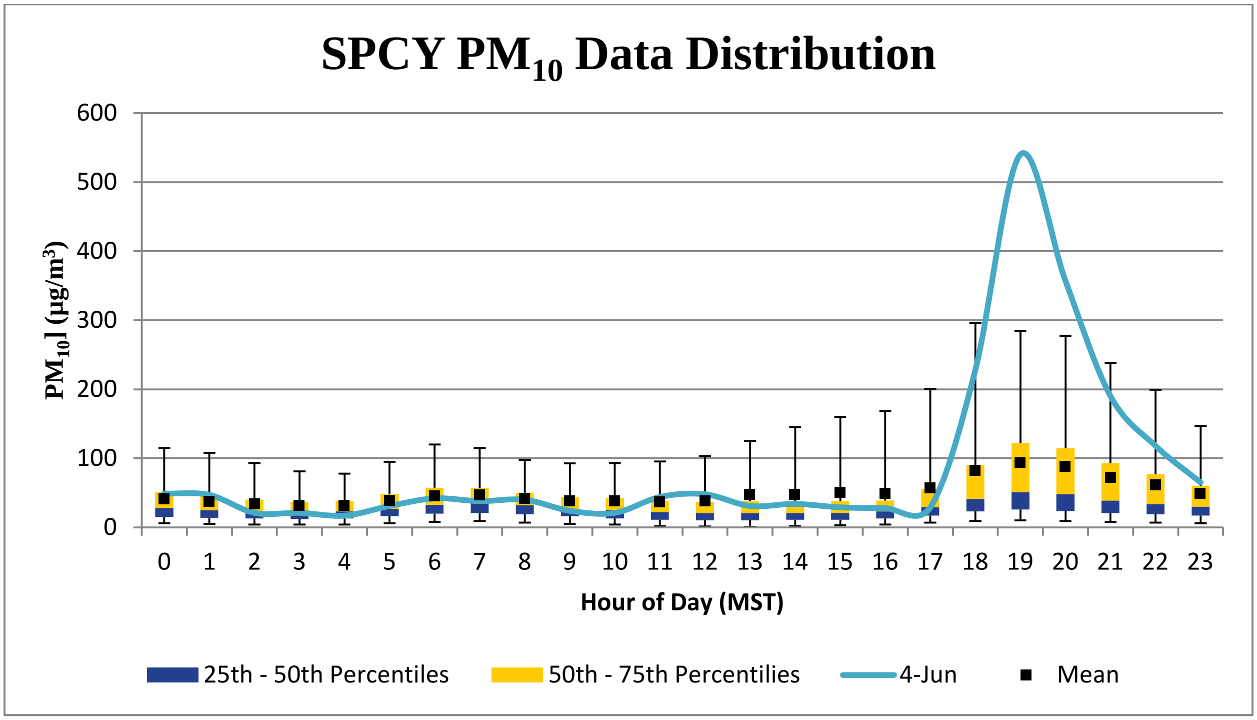

Figure 24-5b. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for June 4, 2011.

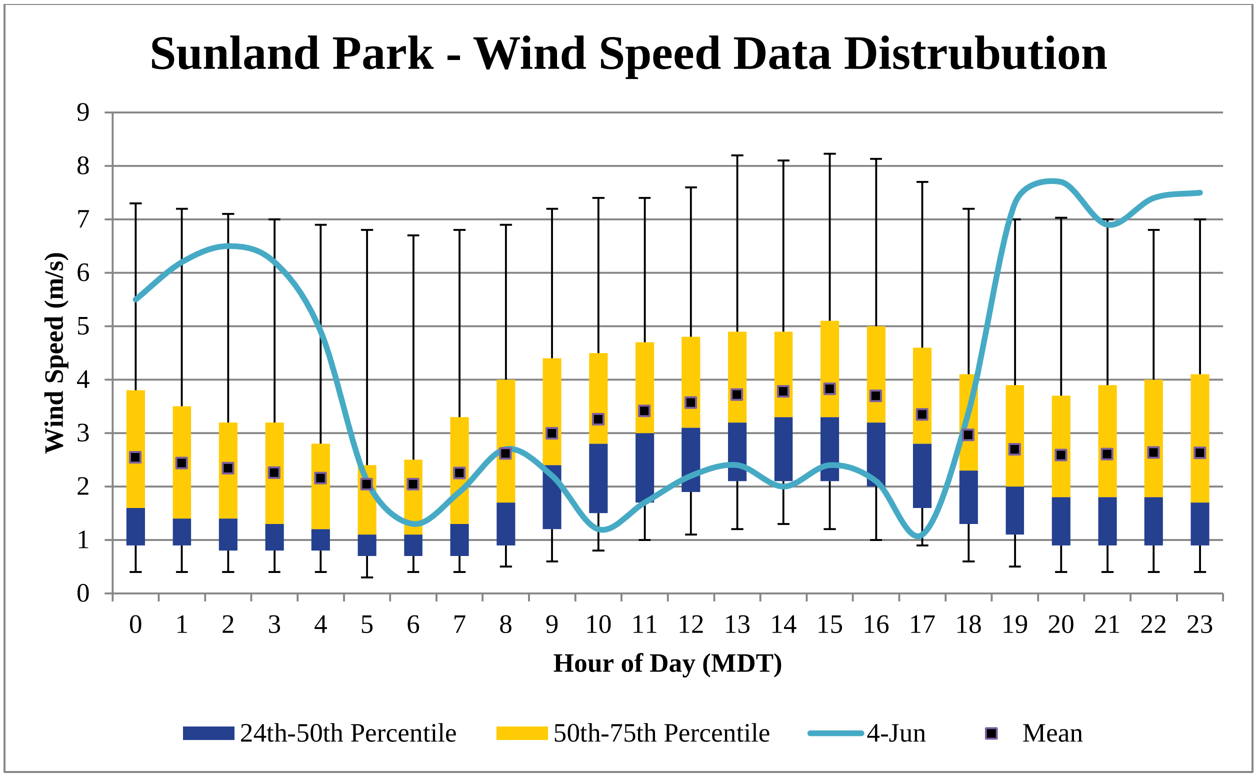

Figure 24-6. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 4, 2011.

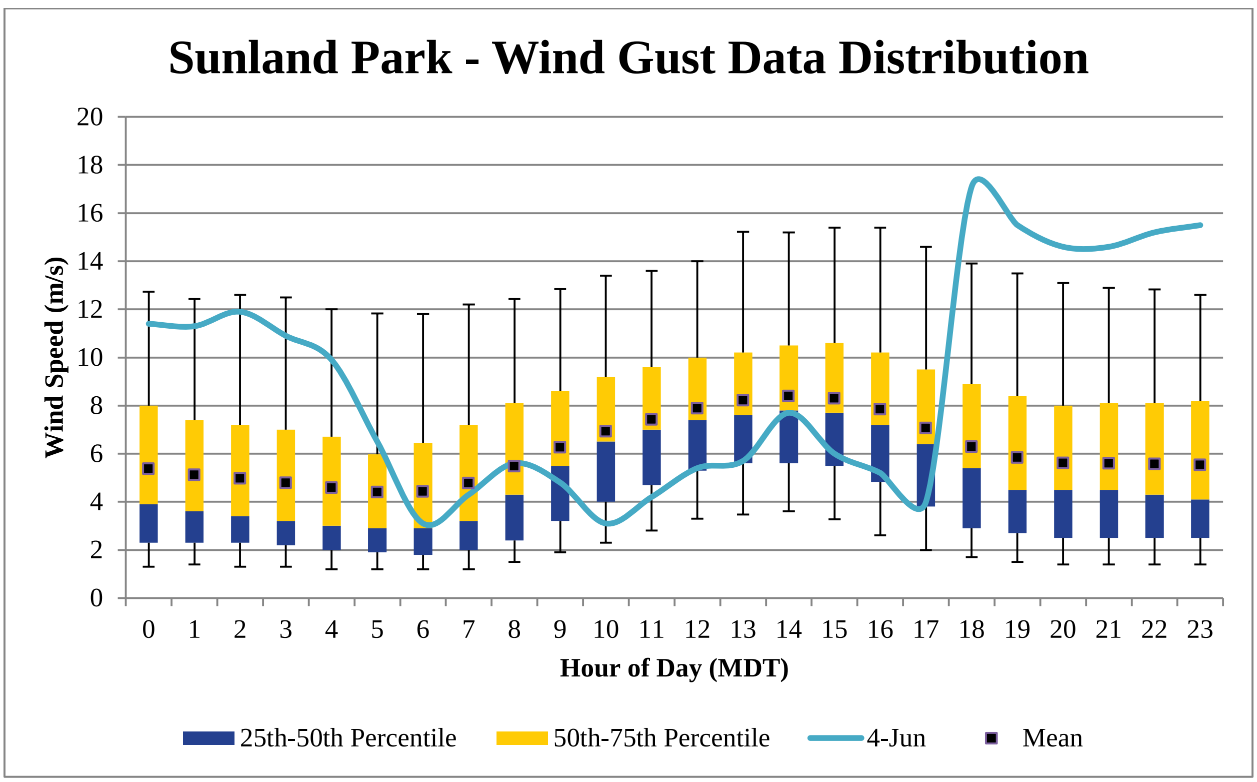

Figure 24-7. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 4, 2011.

24.4 Clear Causal Relationship

Smoke entered the Sunland Park area during the early morning hours on June 4, 2011 and was trapped in the valley due to low winds before being blown out of the area in the evening. Due to a lack of funds, the NMED has not been able to install monitors that would provide speciation data as further proof that the exceedance was caused by smoke.

On June 4, 2011, several fires were burning in northern Mexico with smoke impacts on the border region. These fires are mapped using WunderMap® and fire detects from NASA satellites (Figure 24-8). The three fires have the following associated data:

Fire ID	Latitude	Longitude
42244775	30.45	-109.13
42244887	30.39	-109.12
42244777	29.92	-108.80

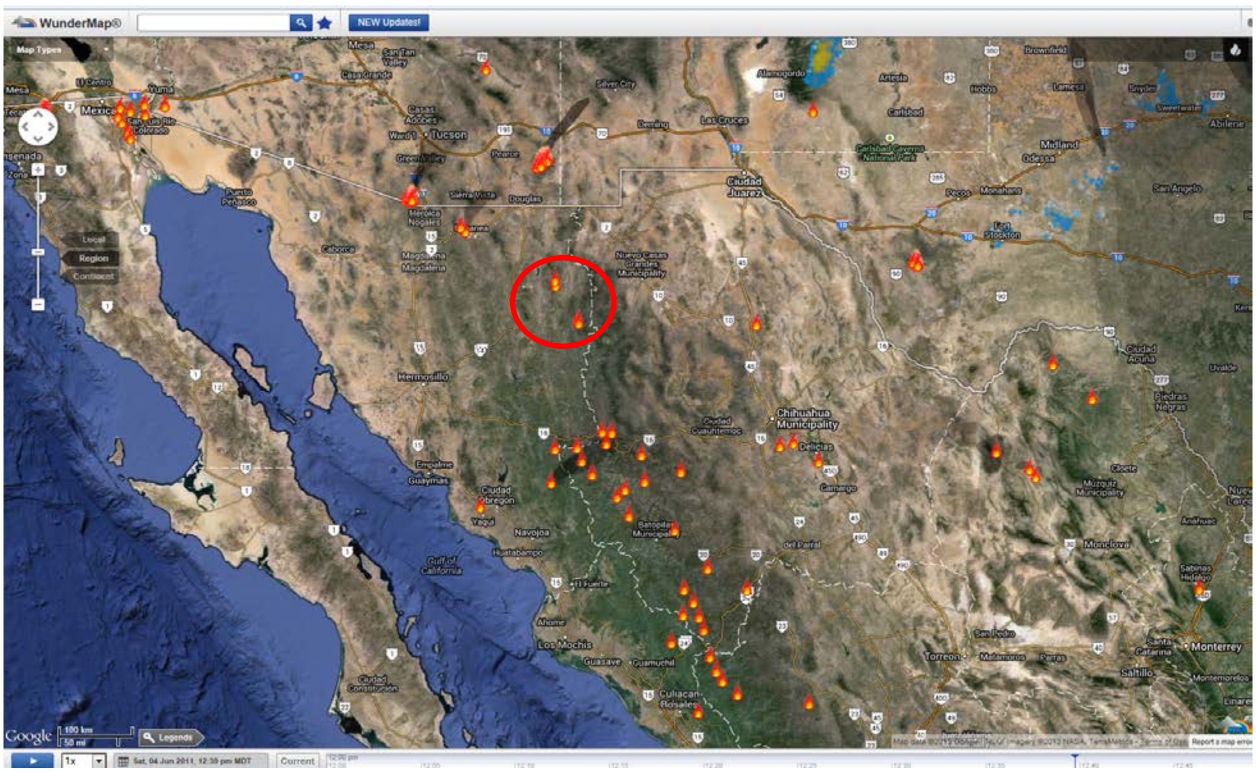

Figure 24-8. Satellite-detected fires in northern Mexico, southern California, Arizona and New Mexico on June 4, 2011.

A HYSPLIT smoke dispersion model, run by NOAA (Figure 24-9) shows widespread smoke emanating from northern Mexico and eastern Arizona covering New Mexico and parts of Colorado, Texas, Oklahoma, Kansas, Nebraska and Iowa on this date. Figure 24-10 is a higher resolution image of the same model, showing Sunland Park with smoke impacts ranging from 5.0 to 20.0 $\mu g/m^3$.

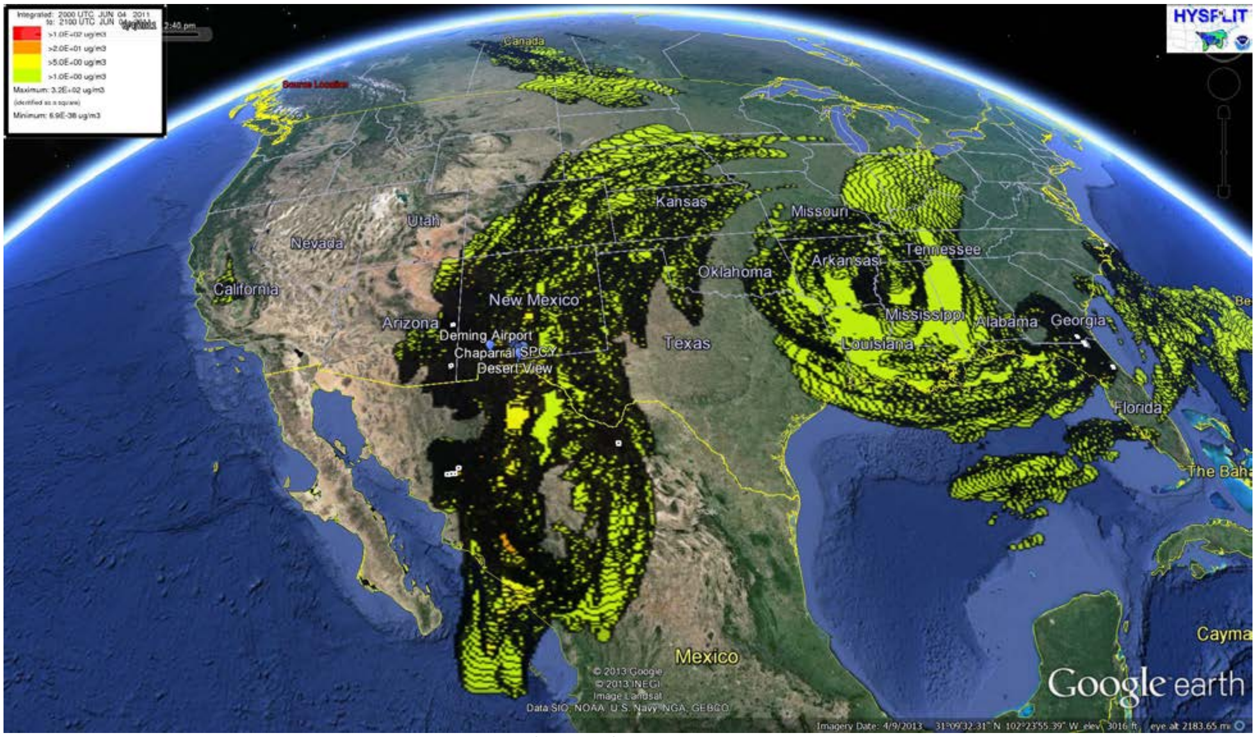

Figure 24-9. NOAA's HYSPLIT smoke dispersion model forecast for June 4, 2011.

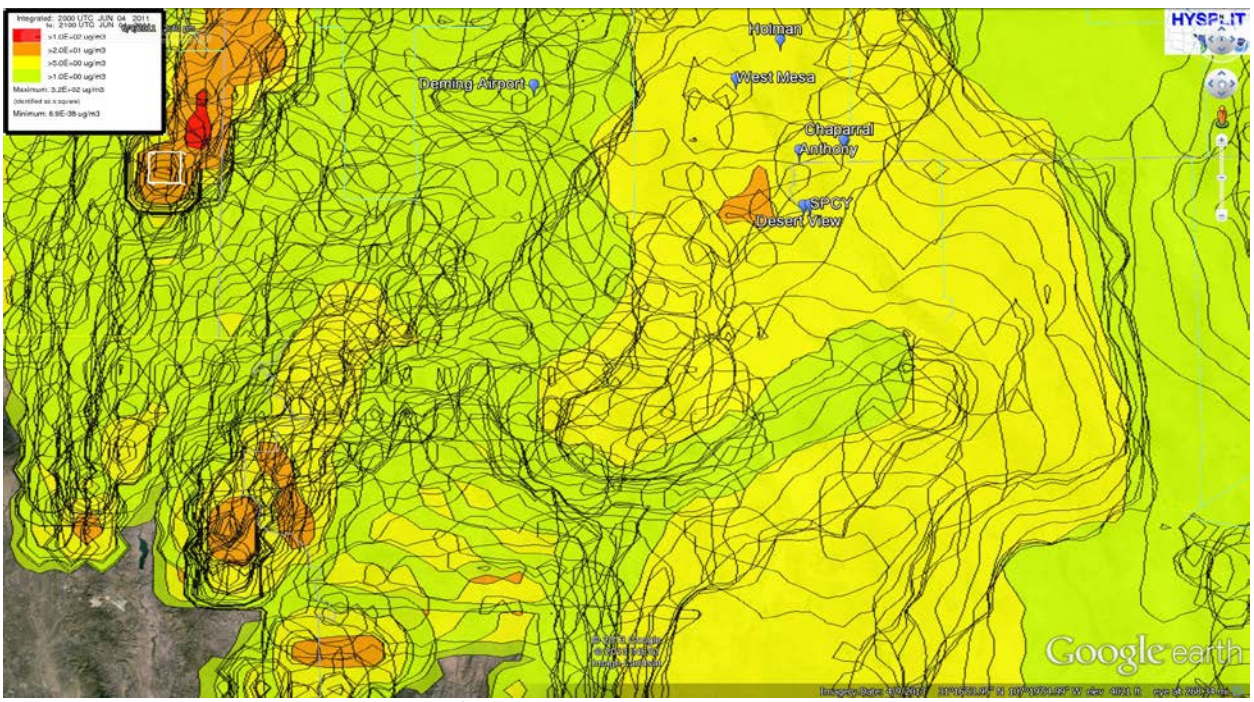

Figure 24-10. HYSPLIT smoke dispersion model for June 4, 2011 at the 1440 hour.

As 2011 was a very active wildfire season in the southwest and northern Mexico, smoke was widespread, as evidenced by the satellite images related to aerosol optical depth (AOD) shown in Figures 24-11 and 24-12. Figure 24-11 shows aerosol optical depth, with the deep blue wavelength used to correct for bright areas, such as desert. AOD is a unitless measure which relates reflectance and quantity of aerosols in the atmospheric column. A high AOD indicates a high concentration of aerosols in the atmosphere. Figure 24-12, "Mass Concentration," quantifies the aerosol concentration based on AOD.

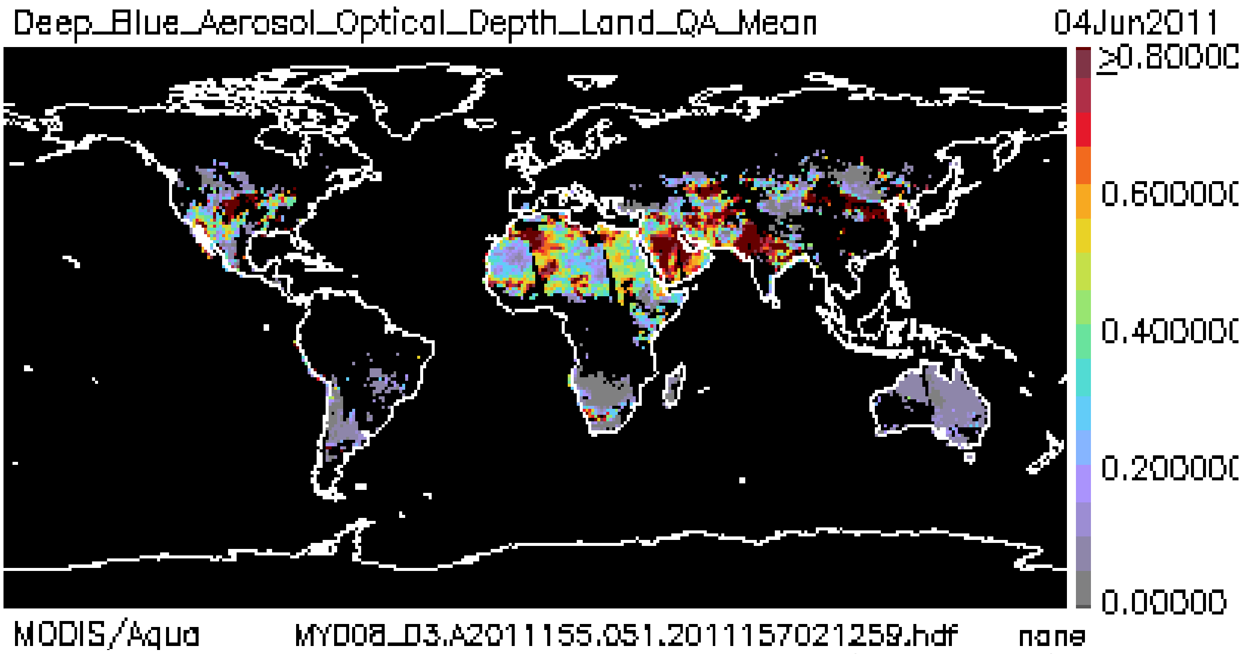

Figure 24-11. Deep blue AOD image showing widespread aerosols in the western US and all of Mexico. (Courtesy of NASA).

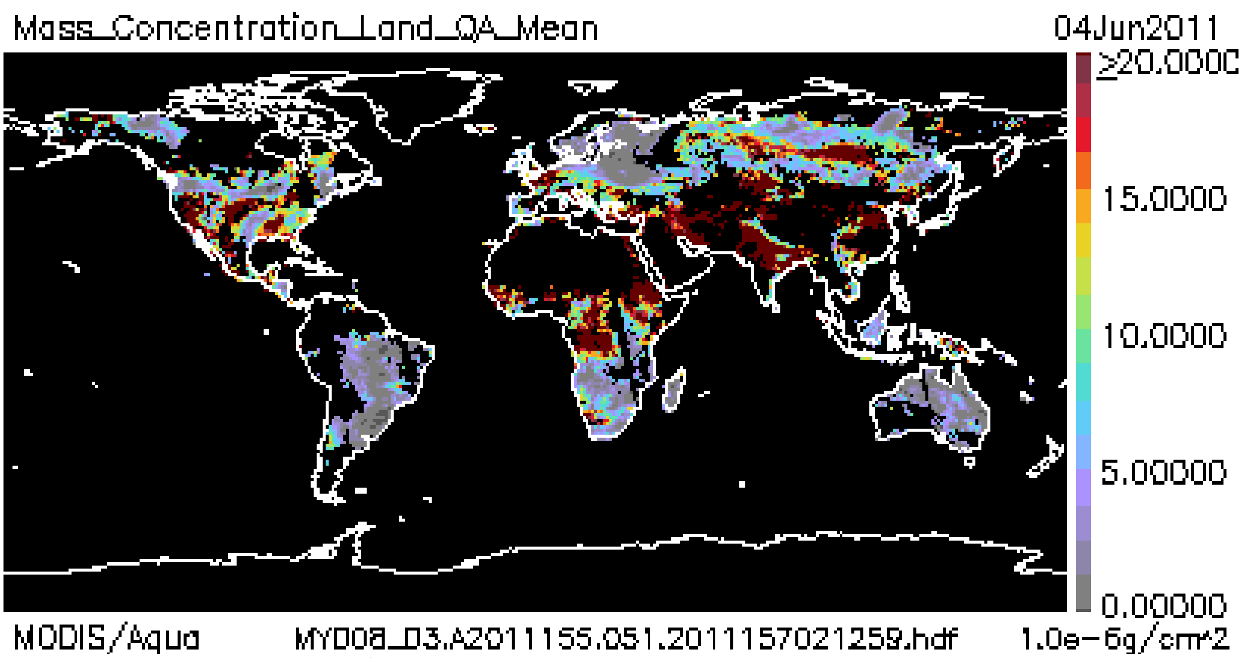

Figure 24-12. Image showing the mass of aerosol in the atmospheric column, measured in micrograms per cubic centimeter. (Courtesy of NASA). Note the high concentrations in the border area (New Mexico, Texas, Mexico) and beyond.

Further analysis using satellite AOD data breaks down the aerosols into types: sulfates, dust and smoke. Figure 24-13 represents a Naval Research Laboratory analysis of June 4, 2011 using MODIS AOD data which shows smoke covering a large portion of New Mexico, including the SPCY monitor at Sunland Park.

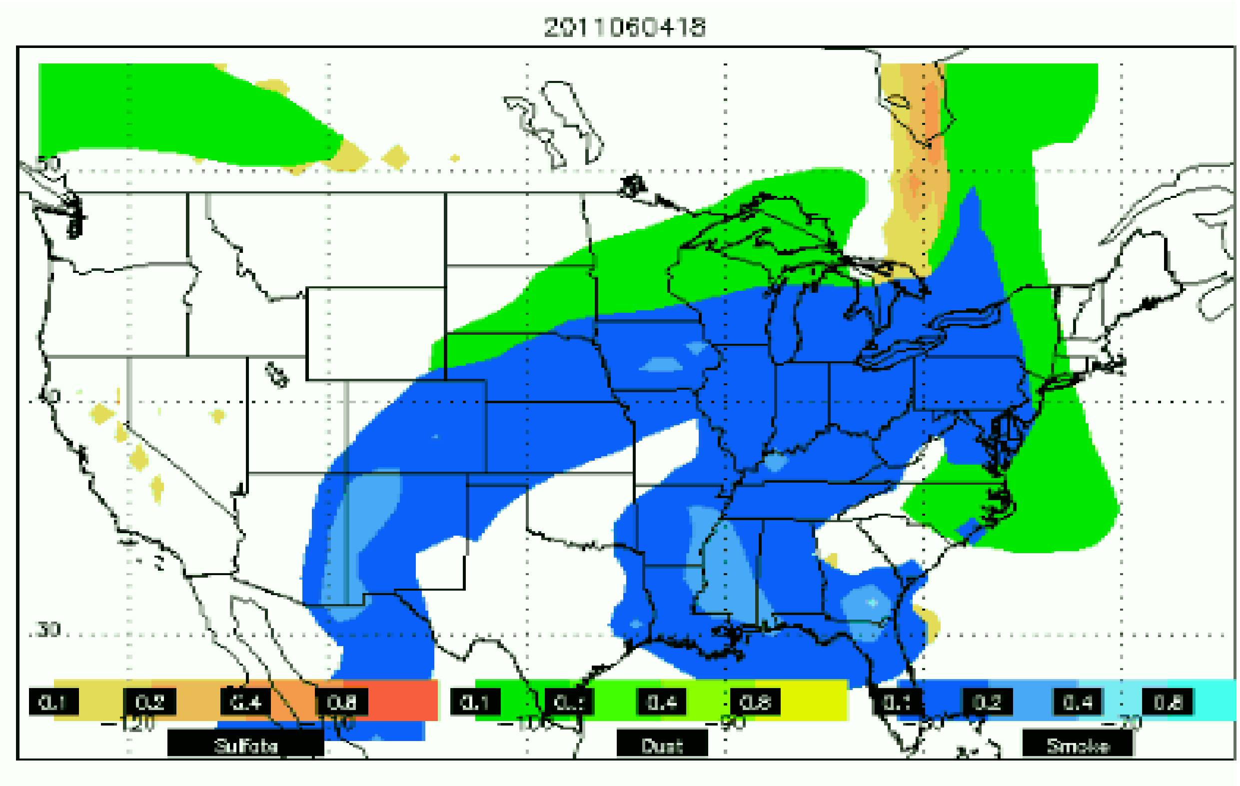

Figure 24-13. Aerosol type map, based on MODIS AQUA AOD data. Smoke is shown in blue. Like raw satellite data, this Level 3 data (analyzed) is unitless. The lighter the blue, the denser the smoke.

As Figure 24-13 shows, smoke emanating from Mexico, Arizona and New Mexico covered a large portion of the United States, including most of New Mexico. The New Mexico Department of Health issued a smoke advisory for the state on June 3, 2011 and a smoke advisory was issued for the city of El Paso on June 6, 2011. Elevated smoke on June 4, 2011 and previous dates caused readings at SPCY's Partisol monitor to be elevated, resulting in an exceedance of the annual $PM_{2.5}$ NAAQS on this date.

Relatively light winds may also have contributed to the lack of smoke dispersal on this date, as can be seen by Figure 24-14a. At times of both low average wind speed and low wind maximum, $PM_{2.5}$ levels rose significantly. This may be explained as winds carrying in smoke during the early morning hours, then dropping off, leaving the smoke trapped in the valley until wind speeds again increase in the evenings. As the wind speeds increased blowing dust was detected by the SPCY PM_{10} TEOM monitor (Figure 24-14b).

Radar detected thunderstorm activity south of Cd. Juárez and over Otero County around the 1800 hour moving in a easterly direction as they developed (Figures 24-15a-b). The inverted v shape of the upper air sounding from the 1800 hour suggests that dry microbursts were likely the cause of the outflow winds experienced in the region (Figure 24-16). The large increase in $PM_{2.5}$ relative to PM_{10} concentrations throughout the morning suggest that smoke impacted the SPCY monitor first while the high spike in PM_{10} compared to $PM_{2.5}$ in the evening suggests that blowing dust impacted the site in the evening (Figure 24-17).

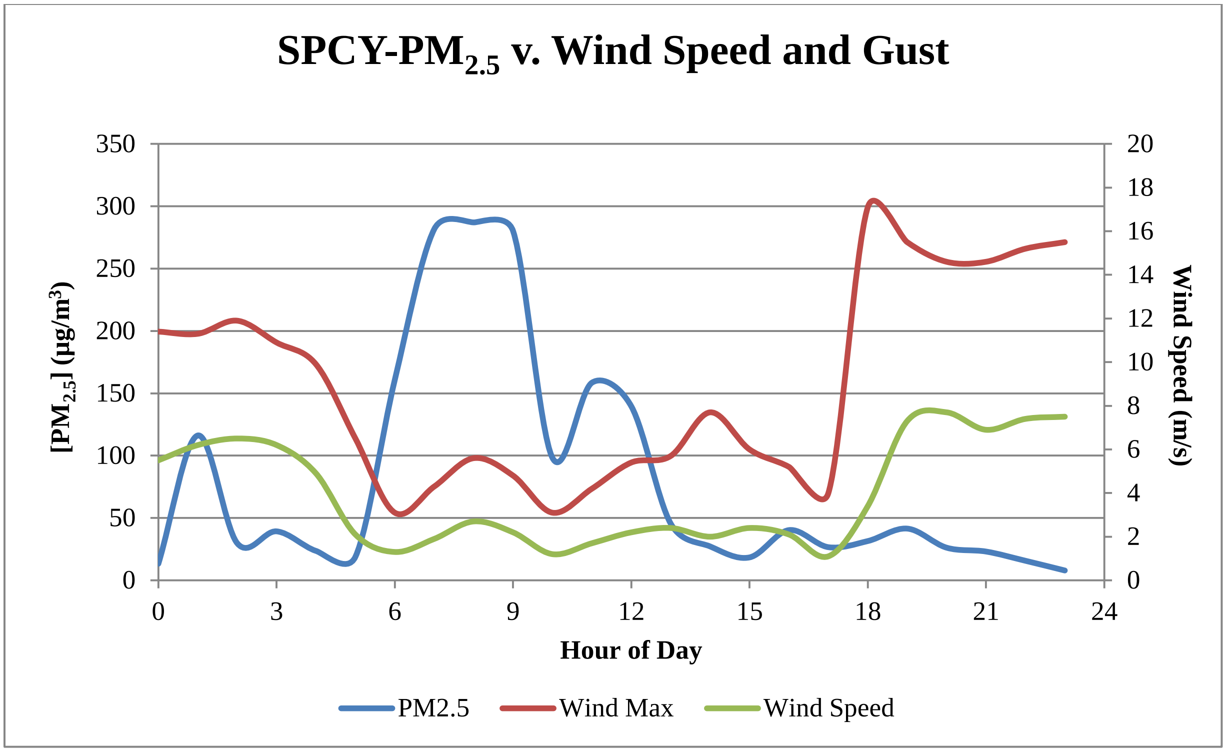

Figure 24-14a. **Hourly data from the Sunland Park monitor showing an inverse relationship between both wind speed and $PM_{2.5}$ concentrations and wind gusts and $PM_{2.5}$ concentrations.**

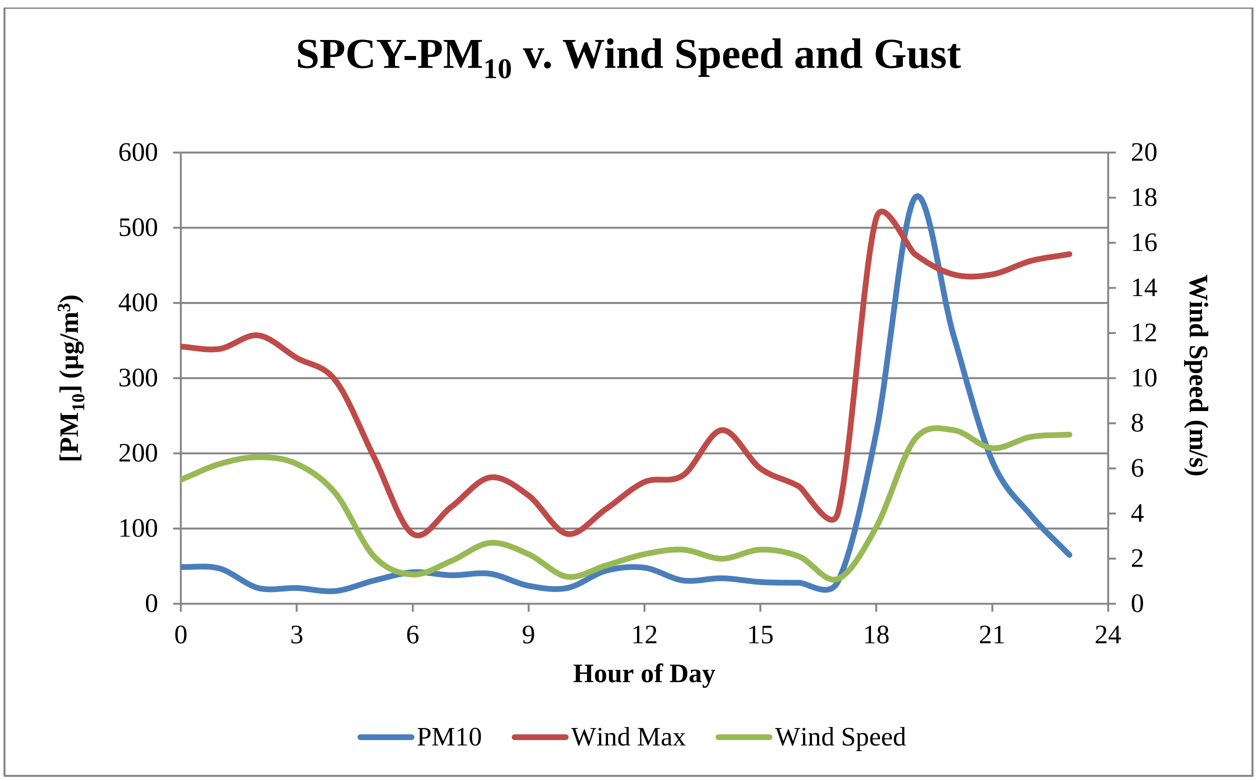

Figure 24-14b. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase

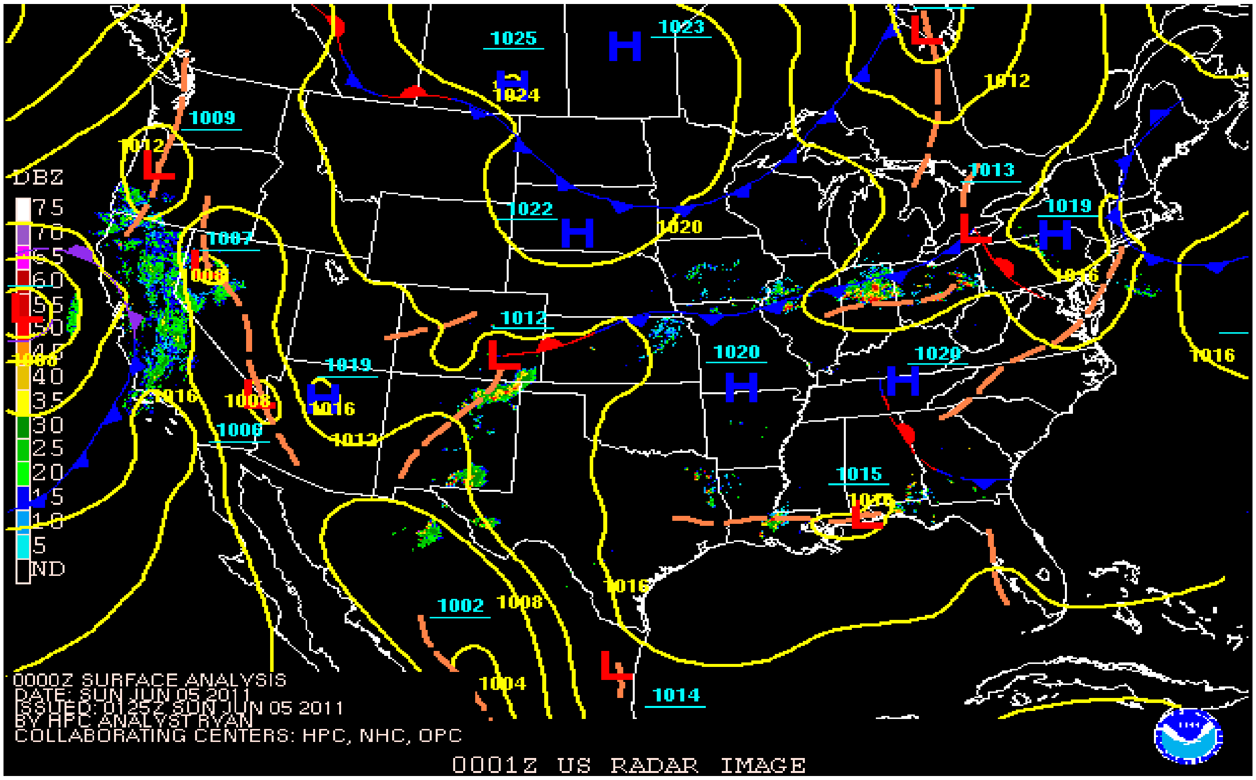

Figure 24-15a. Surface weather map showing thunderstorm activity at the 1800 hour.

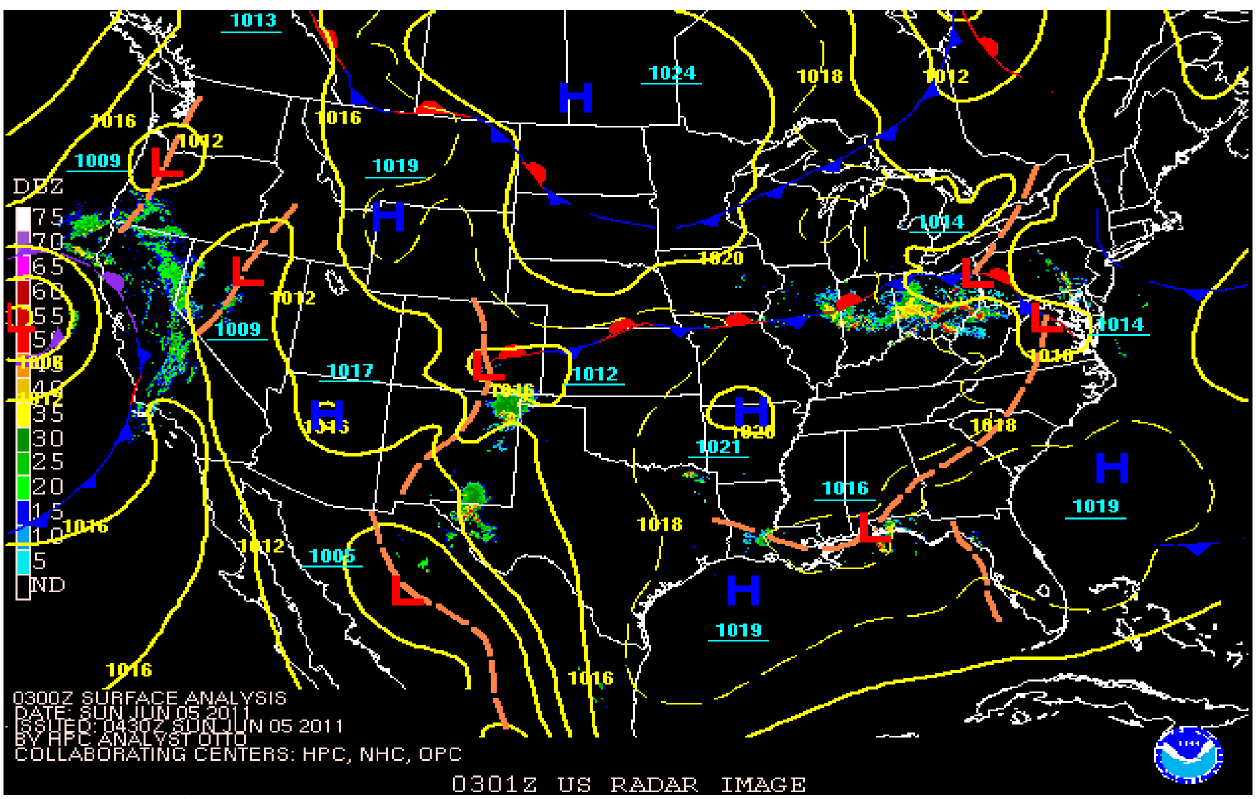

Figure 24-15b. Surface weather map showing thunderstorm activity at the 2100 hour.

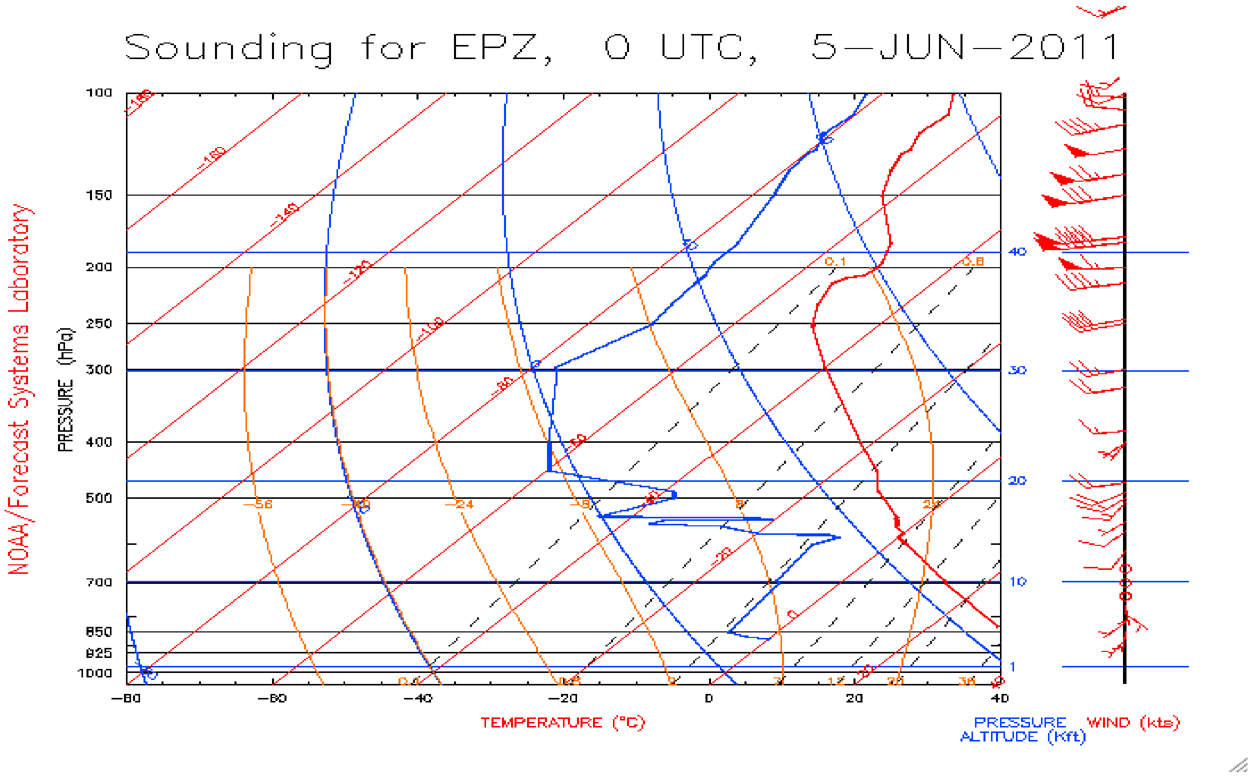

Figure 24-16. Skew-t plot showing high levels of moisture in the upper atmosphere and lower levels of moisture near the surface.

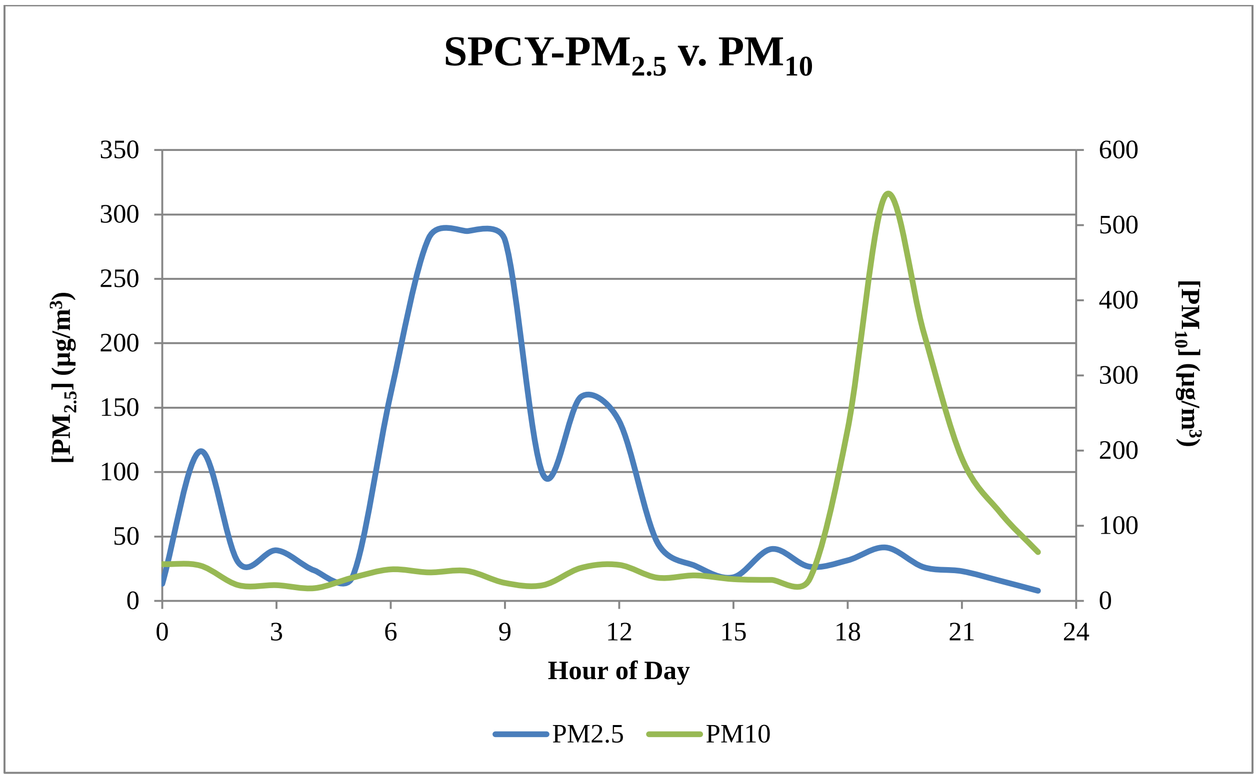

Figure 24-17. Hourly PM_{10} and $PM_{2.5}$ concentrations for the SPCY monitoring site on June 4, 2011

24.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on June 4, 2011.

24.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by wildfires and moderate winds carrying smoke toward the Sunland Park monitor.

24.7 No Exceedance but for the Event

As the previous sections of this chapter have shown, the exceedance on this date was caused by natural events of a very active wildfire season in Arizona, New Mexico and northern Mexico, which put significant amounts of smoke into the atmosphere when moderate winds caused smoke to be blown into the valley. The only other possible source for $PM_{2.5}$ would have been from high winds and blowing dust caused by outflow winds from thunderstorms. Therefore, the SPCY $PM_{2.5}$ Partisol monitor would have had not recorded this annual exceedance but for the smoke and blowing dust impacts.

25 HIGH WIND EXCEPTIONAL EVENT: June 19, 2011

25.1 Summary of Event

The passing of a Pacific cold front caused high winds and blowing dust in Doña Ana and Luna Counties resulting in exceedances of the PM_{10} and $PM_{2.5}$ 24-hour NAAQS at the Anthony, Deming Airport, Desert View, Holman, and SPCY monitoring sites and an exceedance of the $PM_{2.5}$ annual NAAQS at SPCY on this date. The presence of smoke from numerous wildfires in the region also contributed to the measured $PM_{2.5}$ during the high wind events as well as the early morning hours. The FEM TEOM continuous monitors at these sites recorded 24-hour average concentrations of 200, 184, 198, 211, and 267 µg/m^3, respectively. The FRM Partisol monitor at the Sunland Park site recorded a 24-hour average concentration of 54.3 µg/m^3. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were measured at the Chaparral (135 µg/m^3) and West Mesa (110 µg/m^3) monitoring sites (Figure 25-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event. Elevated concentrations were also recorded by the $PM_{2.5}$ non-FEM/FRM TEOMs (Figure 25-2).

As the event unfolded, the wind blew from the southwest throughout the border region. These high velocity winds passed over large areas of desert within New Mexico and Mexico. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

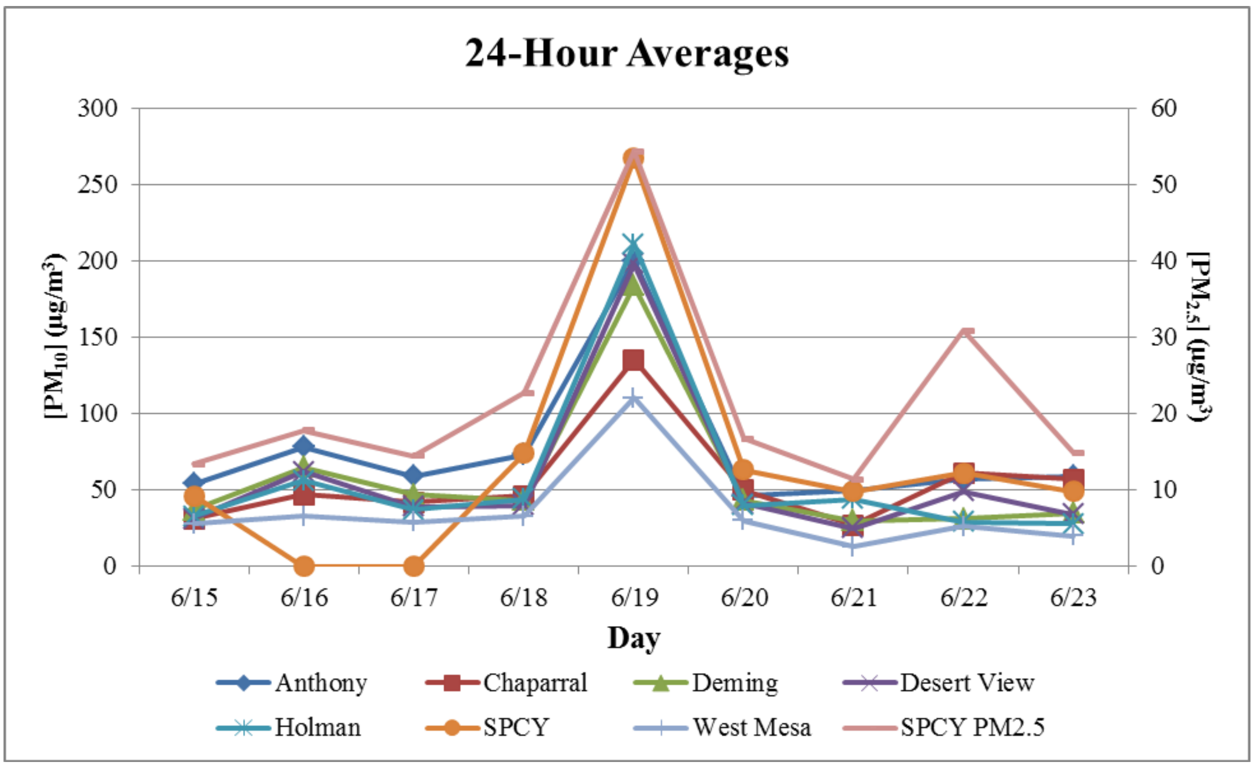

Figure 25-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after June 19, 2011.

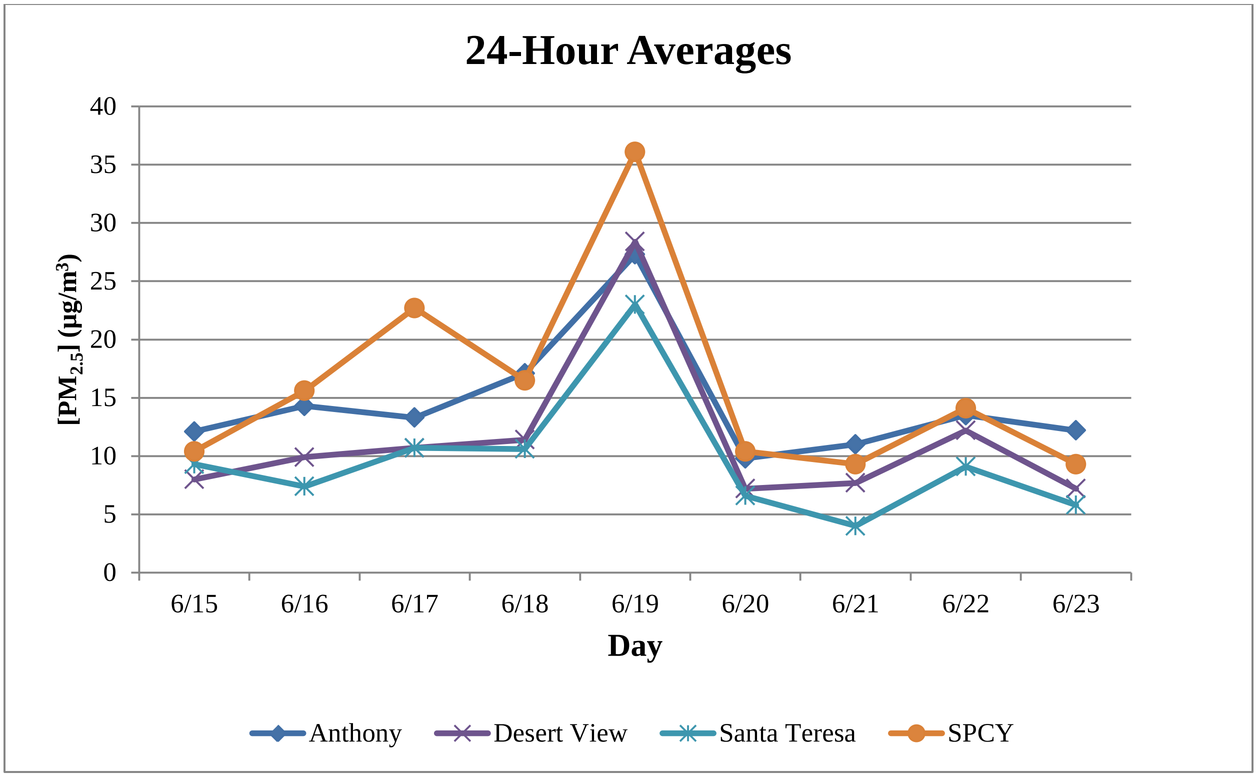

Figure 25-2. $PM_{2.5}$ 24-hour averages before and after June 19, 2011. Non-FEM TEOM Data.

25.2 Is Not Reasonably Controllable or Preventable

25.2.1 Suspected Source Areas and Categories Contributing to the Event

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in northern Mexico and New Mexico. The City of Las Cruces, the City of Deming and Doña Ana and Luna Counties Ordinances require BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and the playas of northern Mexico (see Section 25.2.4 below). Smoke from wildfires is also suspected of impacting concentrations on this date.

25.2.2 Sustained and Instantaneous Wind Speeds

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On June 19, 2011, sustained wind speeds exceeded EPA's default threshold at four of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at all seven of the seven monitoring sites (Figures 25-3 and 25-4). Winds exceeded these thresholds at one or more monitoring sites beginning approximately at the 1100 hour and ending approximately at the 1800 hour.

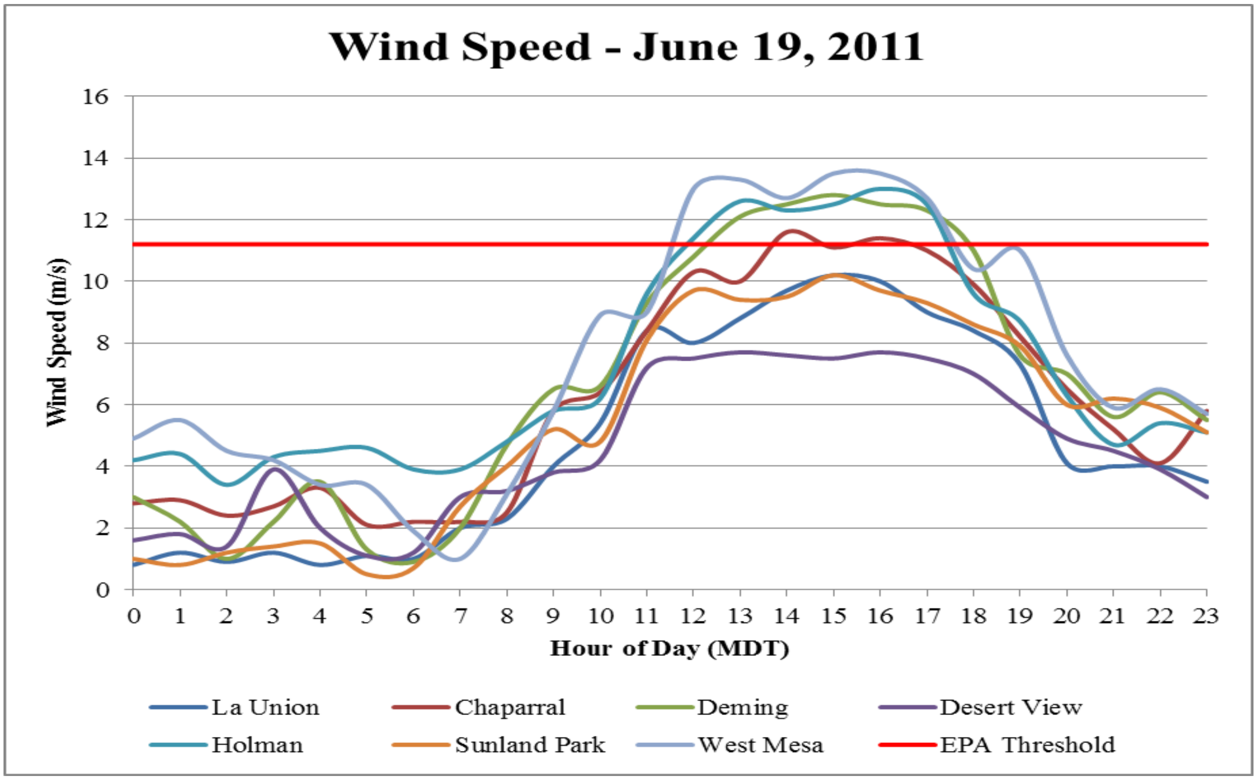

Figure 25-3. **Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.**

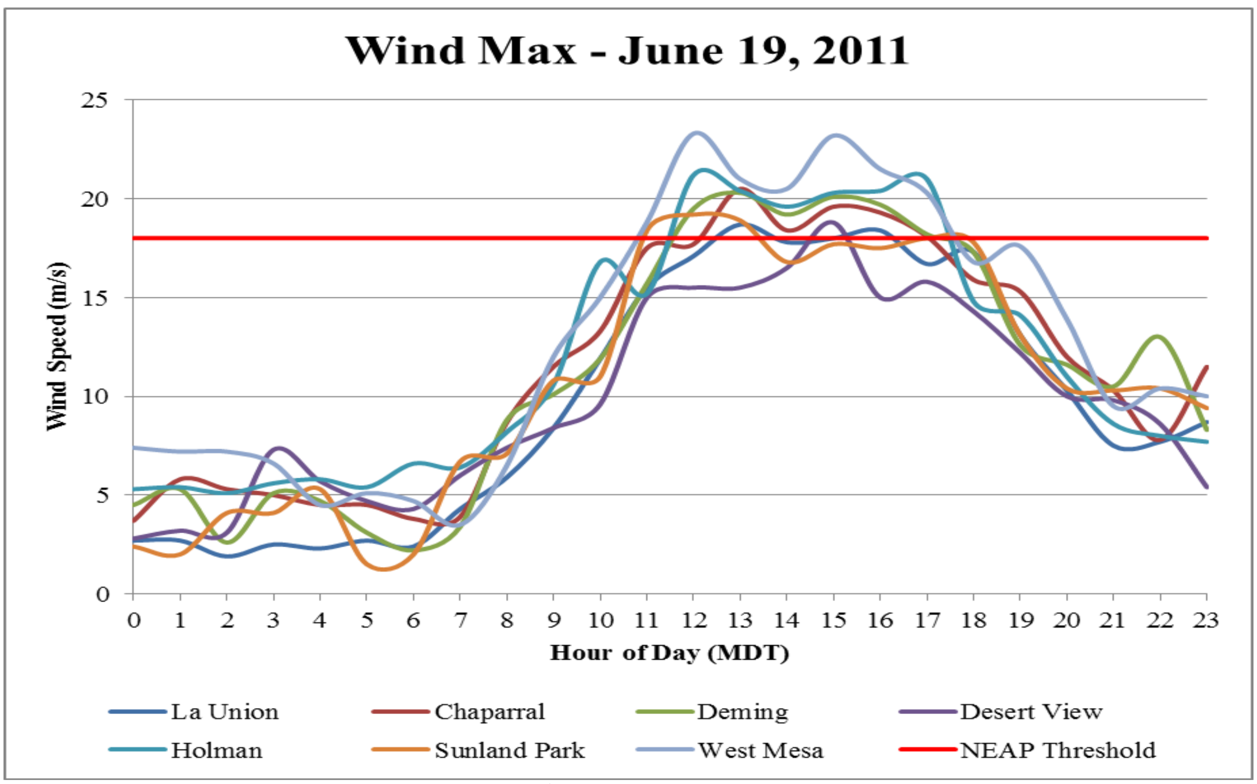

Figure 25-4. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

25.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the PM_{10} FEM TEOM monitors recorded 211 exceedances and the PM_{10} FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). The SPCY $PM_{2.5}$ FRM Partisol recorded 23 exceedances of the 24-Hour NAAQS from 2006-2010 (Figure A-2). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

25.2.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana and Luna Counties. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert and playas in New Mexico and northern Mexico. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled from northern Mexico to the monitors in Doña Ana and Luna Counties. The model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figure 25-5). Costs prohibit controlling dust from the natural desert terrain and falls outside NMED's jurisdiction when it originates in Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

Figure 25-5. HYSPLIT back-trajectory model analysis for June 19, 2011.

25.3 Historical Fluctuations Analysis

25.3.1 <u>Annual and Seasonal 24-hour Average Fluctuations</u>

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded values for this day (200, 184, 198, 211, and 267 µg/m^3) are above the maximum values recorded when no high wind exceedances are included and is above the 95th percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for June 19, 2011on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95th percentile for PM_{10}, $PM_{2.5}$, wind speed and wind gusts (Figures 25-6a-f through 25-8a-e). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} and $PM_{2.5}$ values during the high wind blowing dust storm far exceed the historical 95th percentile of data.

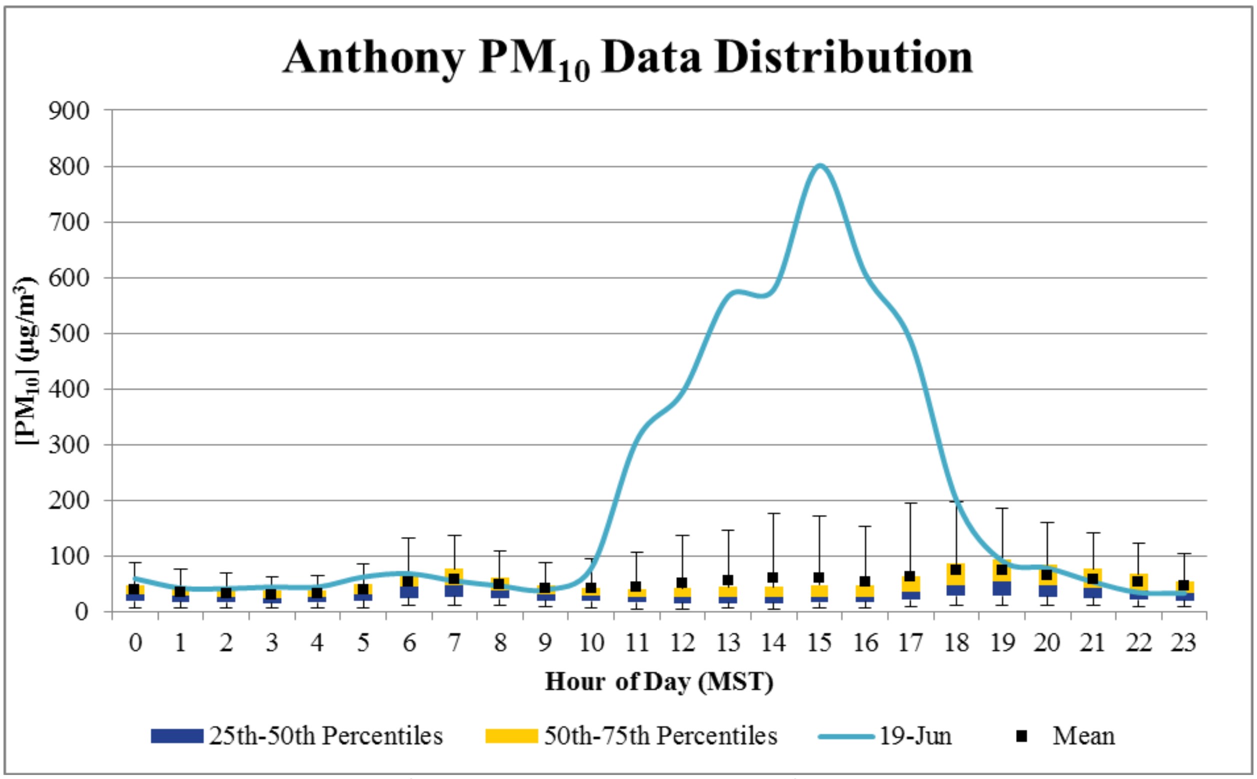

Figure 25-6a. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

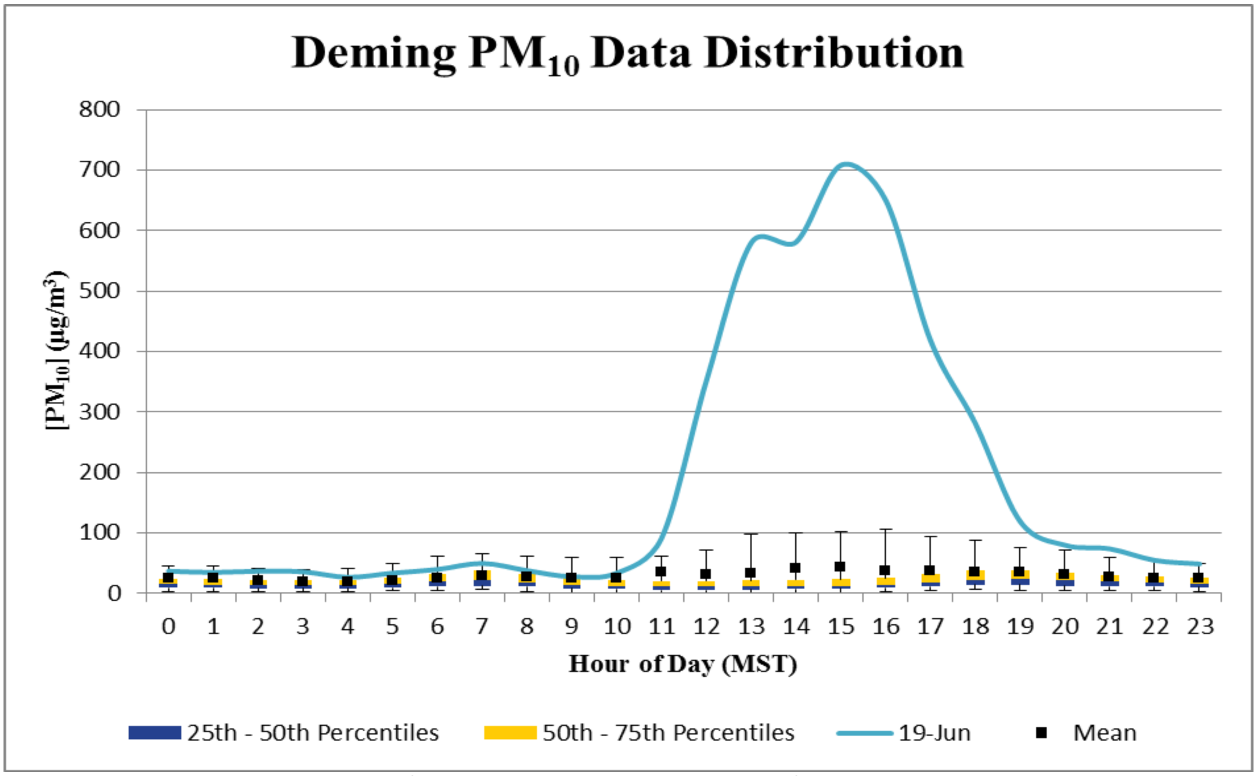

Figure 25-6b. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

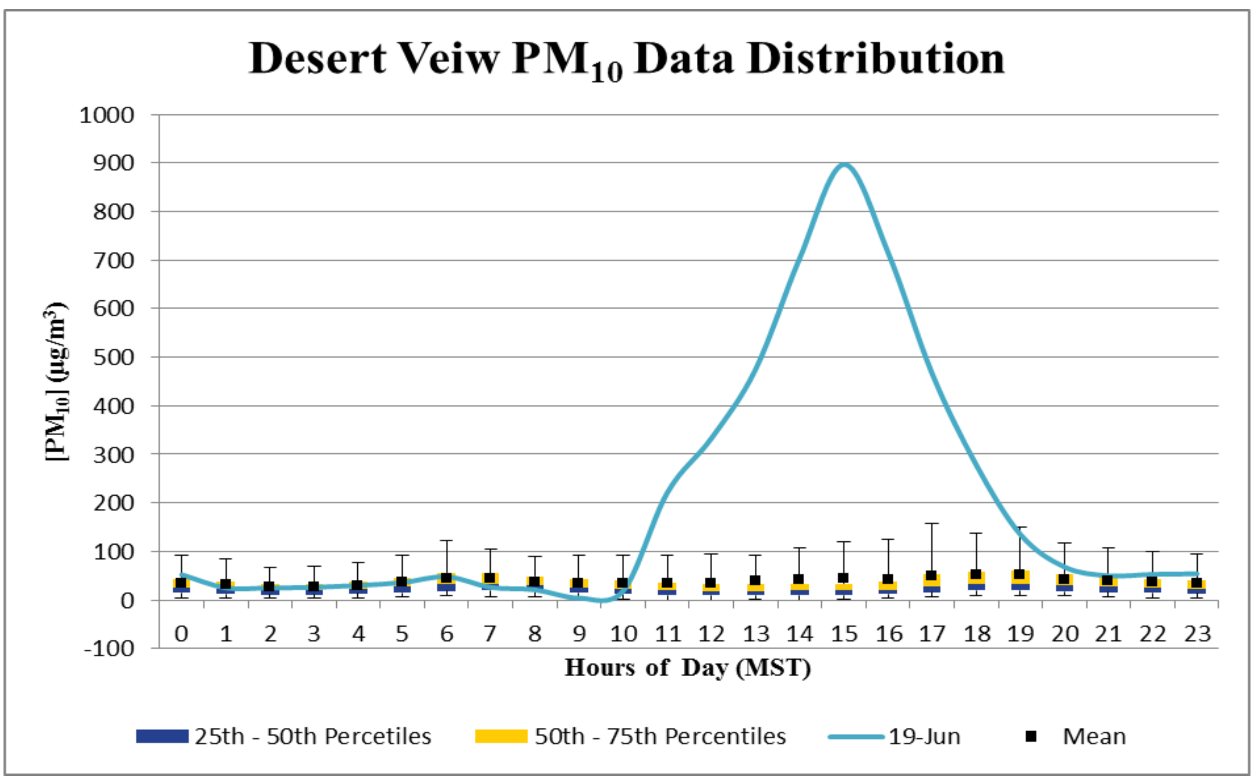

Figure 25-6c. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

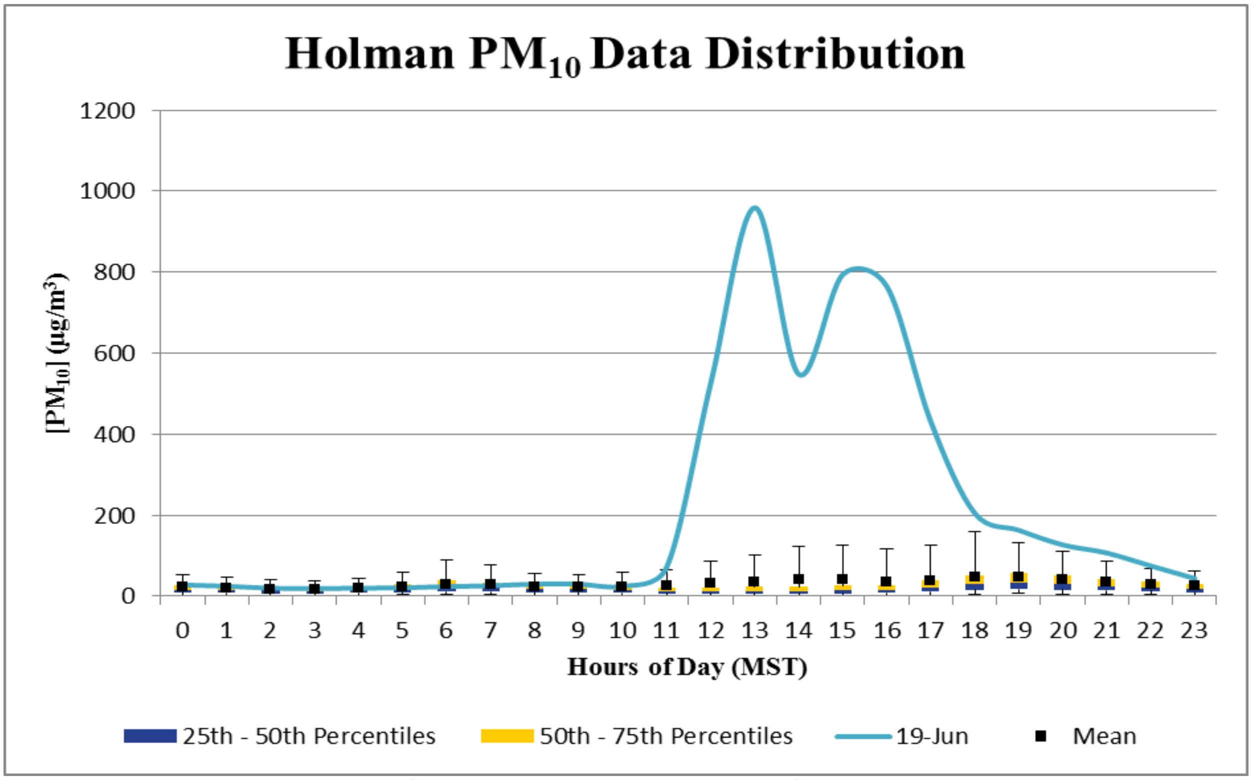

Figure 25-6d. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

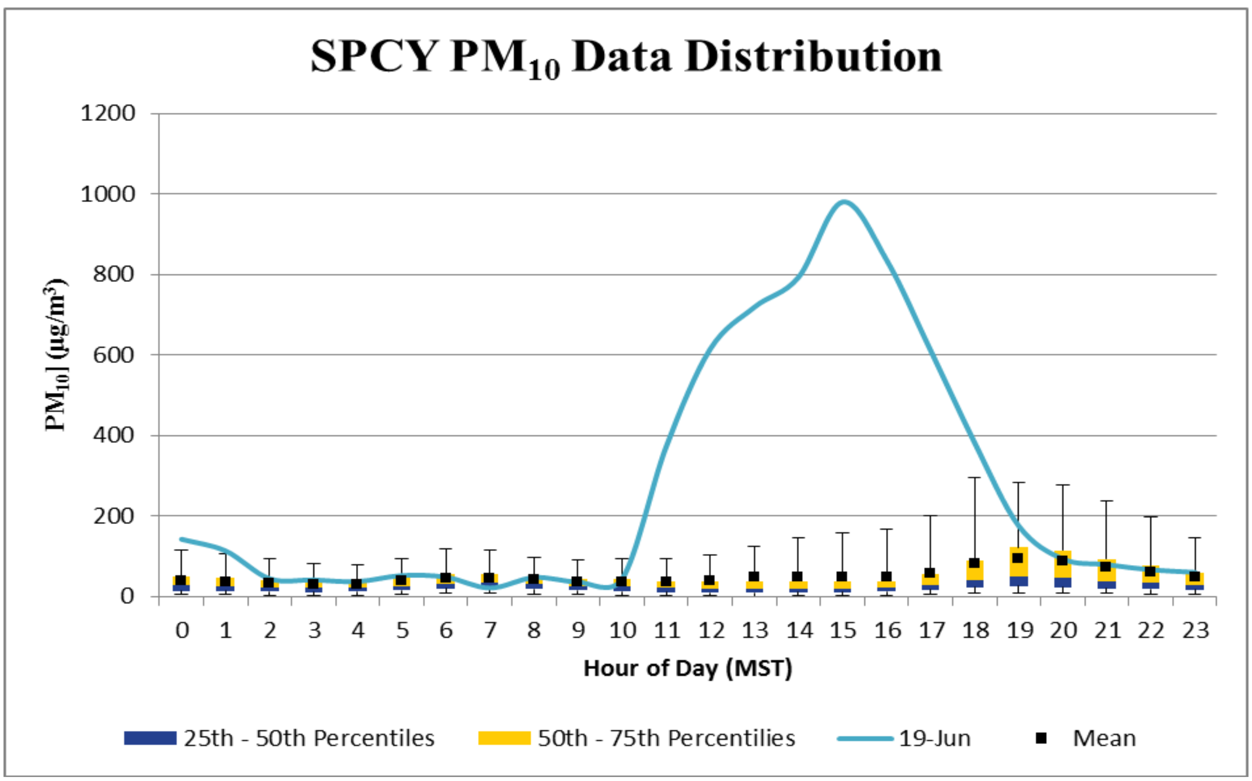

Figure 25-6e. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

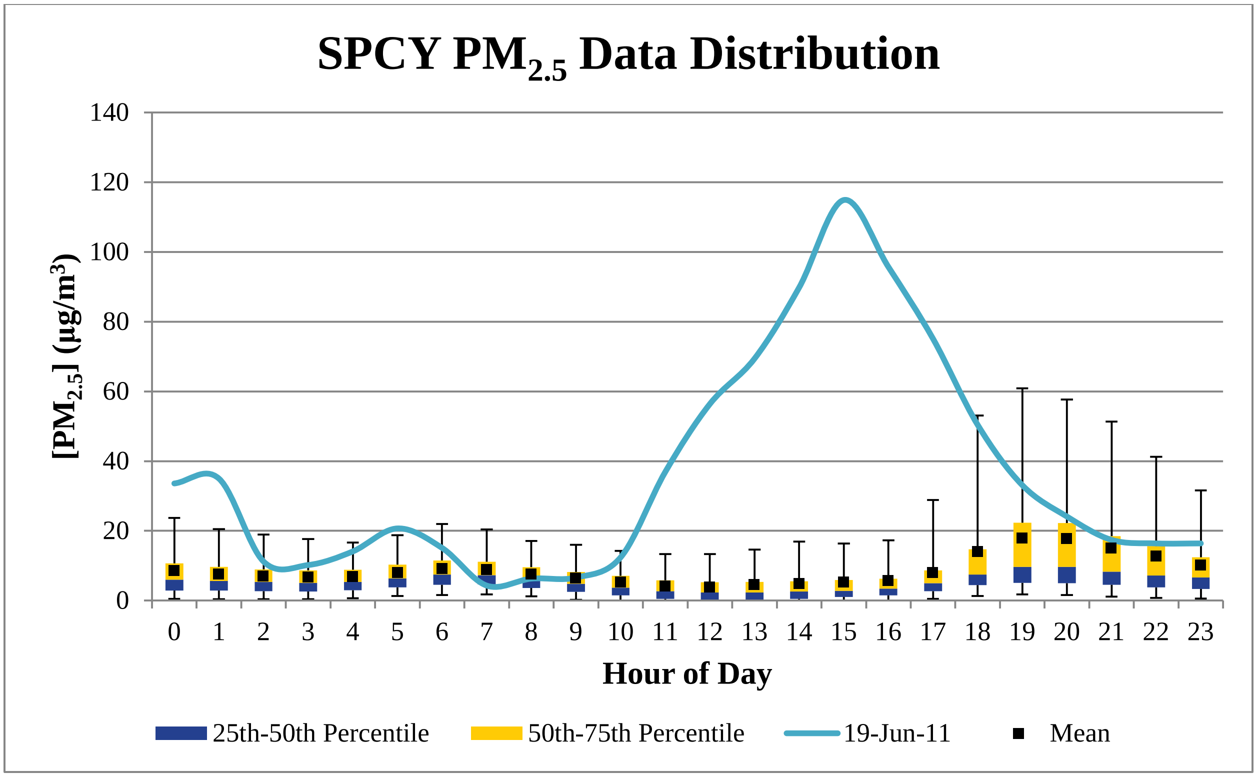

Figure 25-6f. $PM_{2.5}$ hourly data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

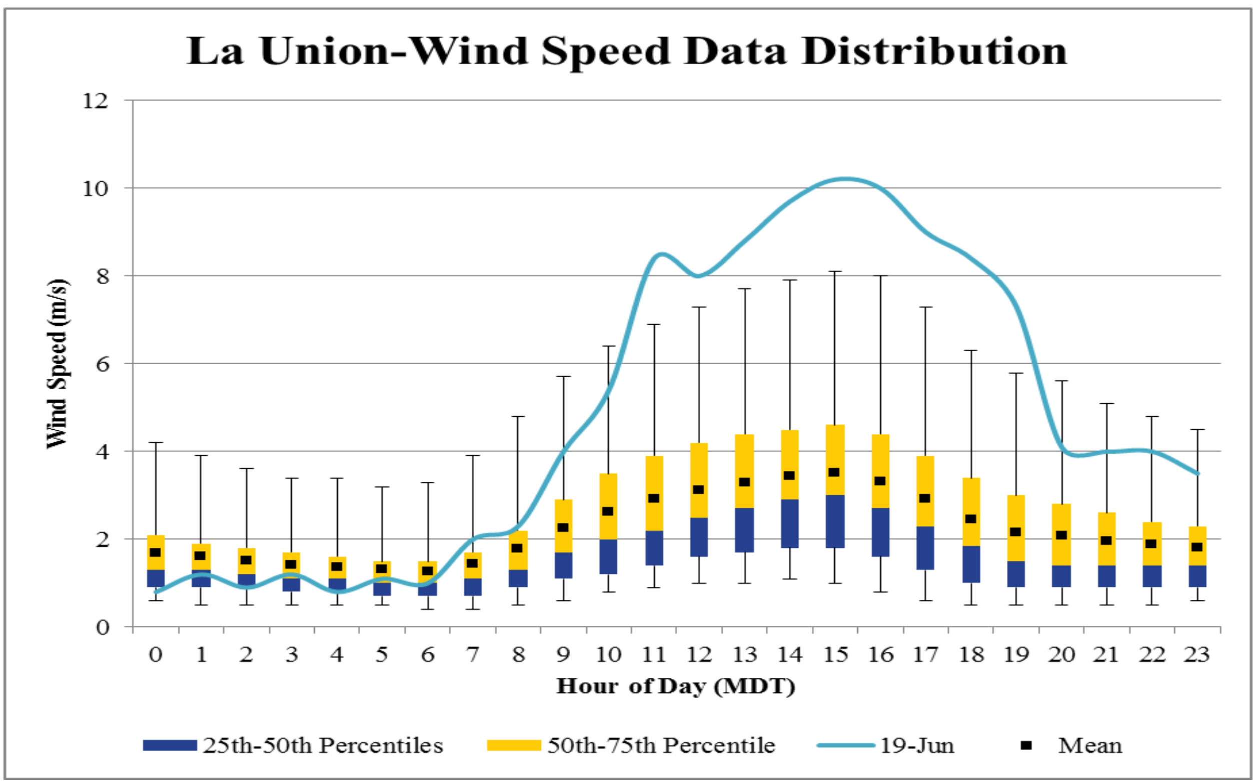

Figure 25-7a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

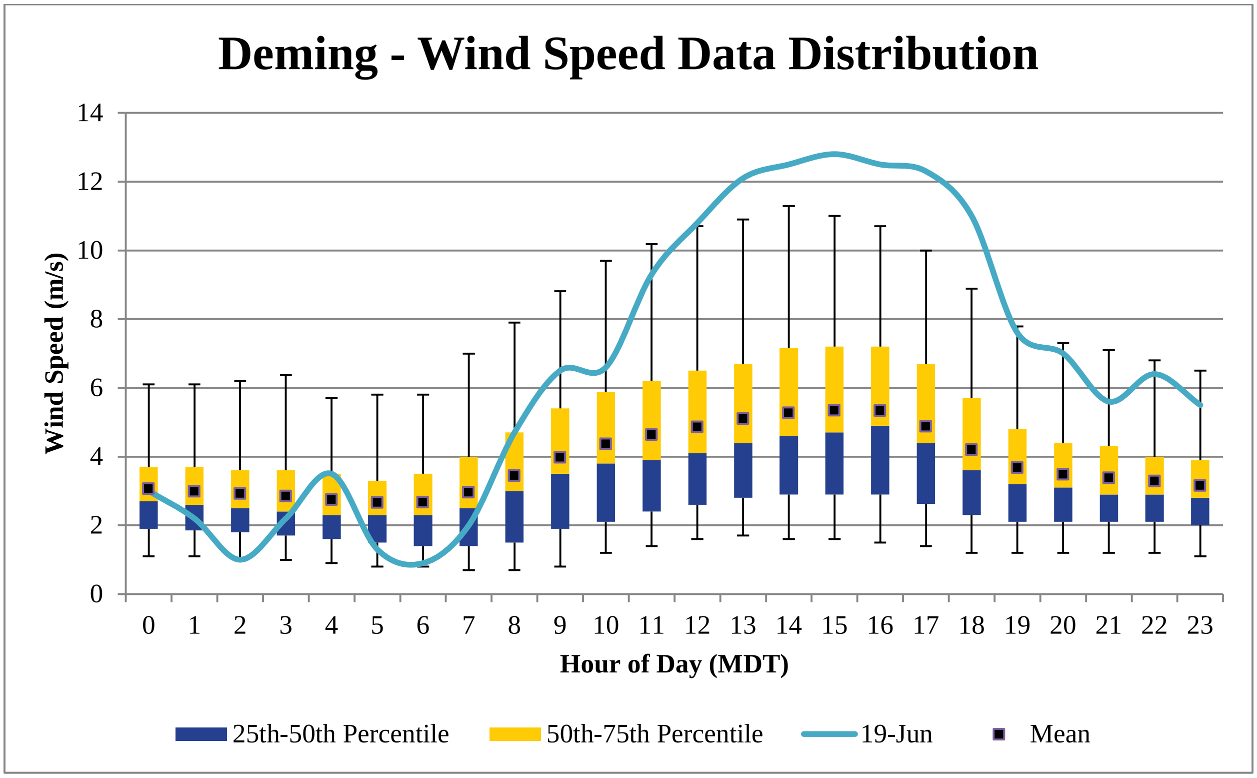

Figure 25-7b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

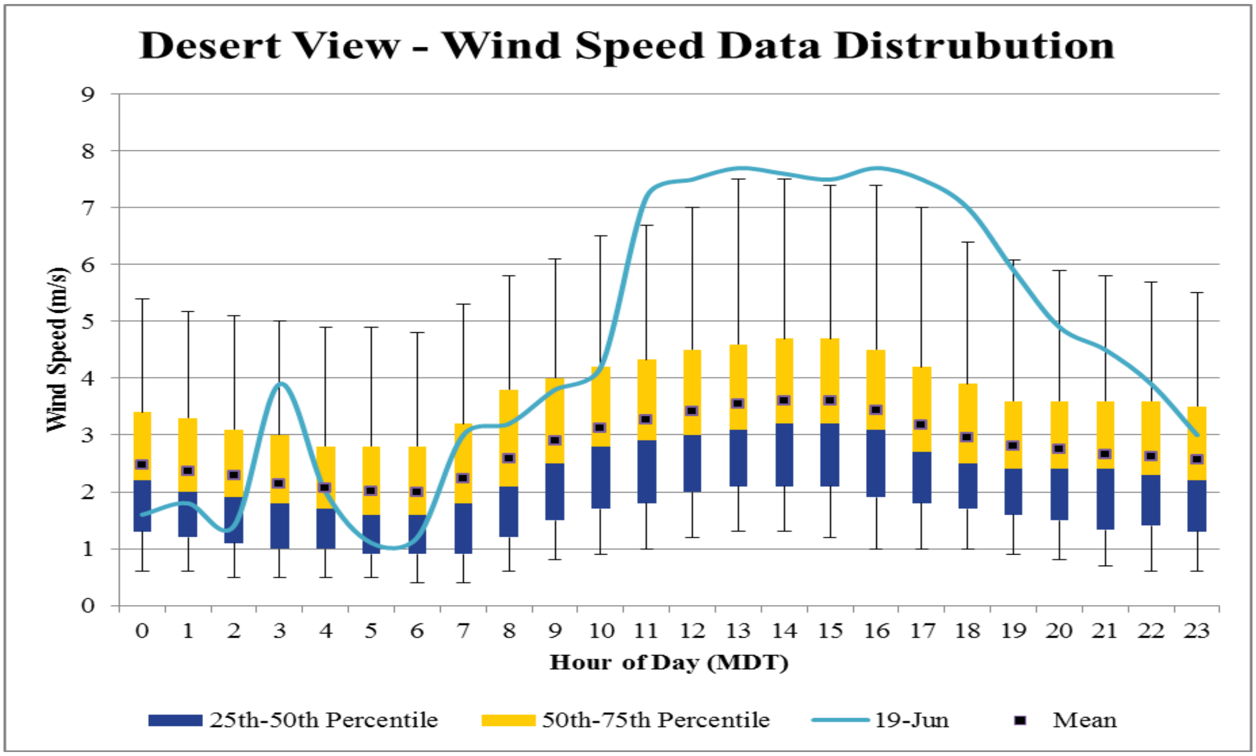

Figure 25-7c. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

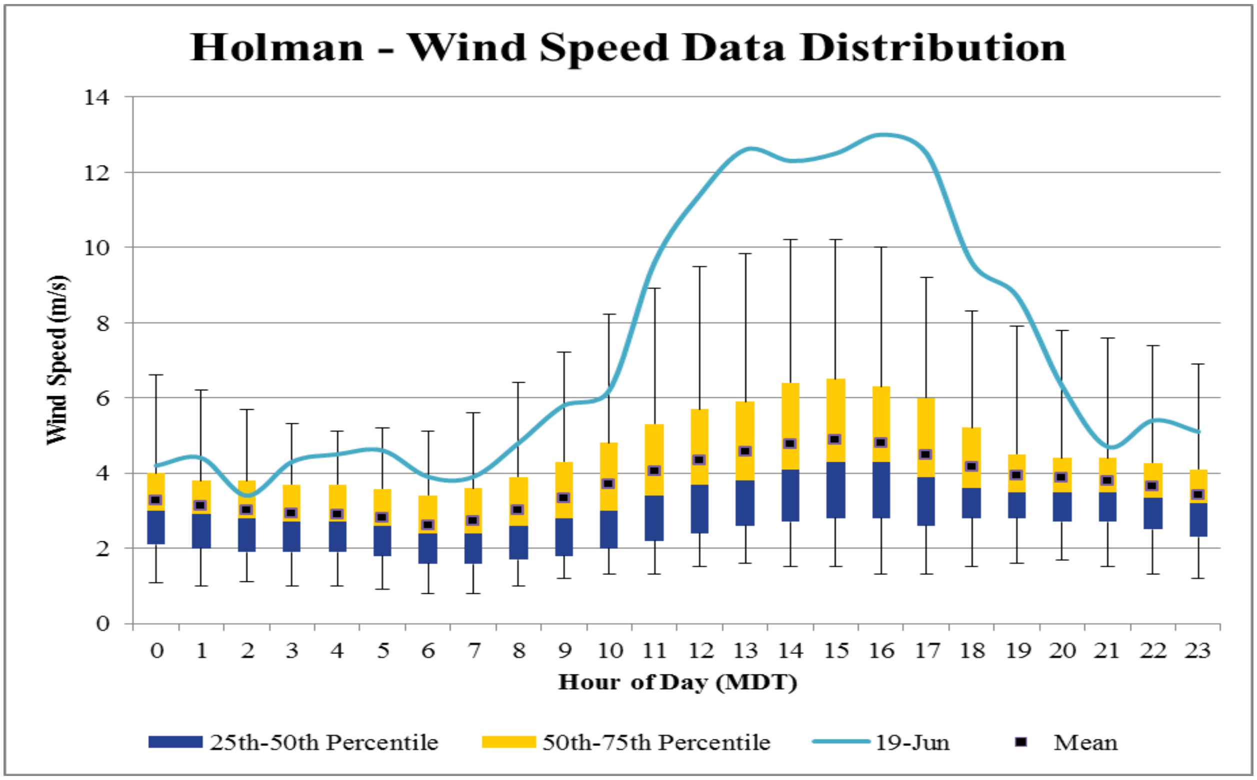

Figure 25-7d. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

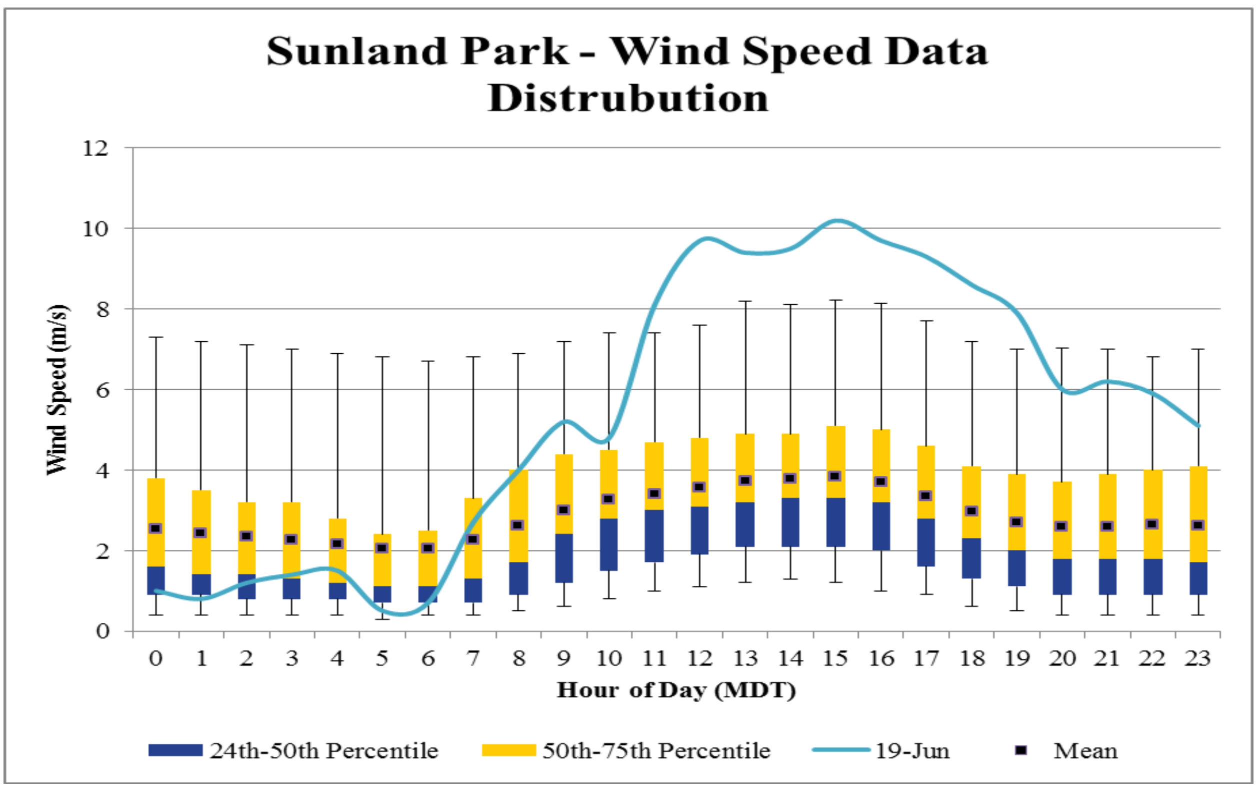

Figure 25-7e. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

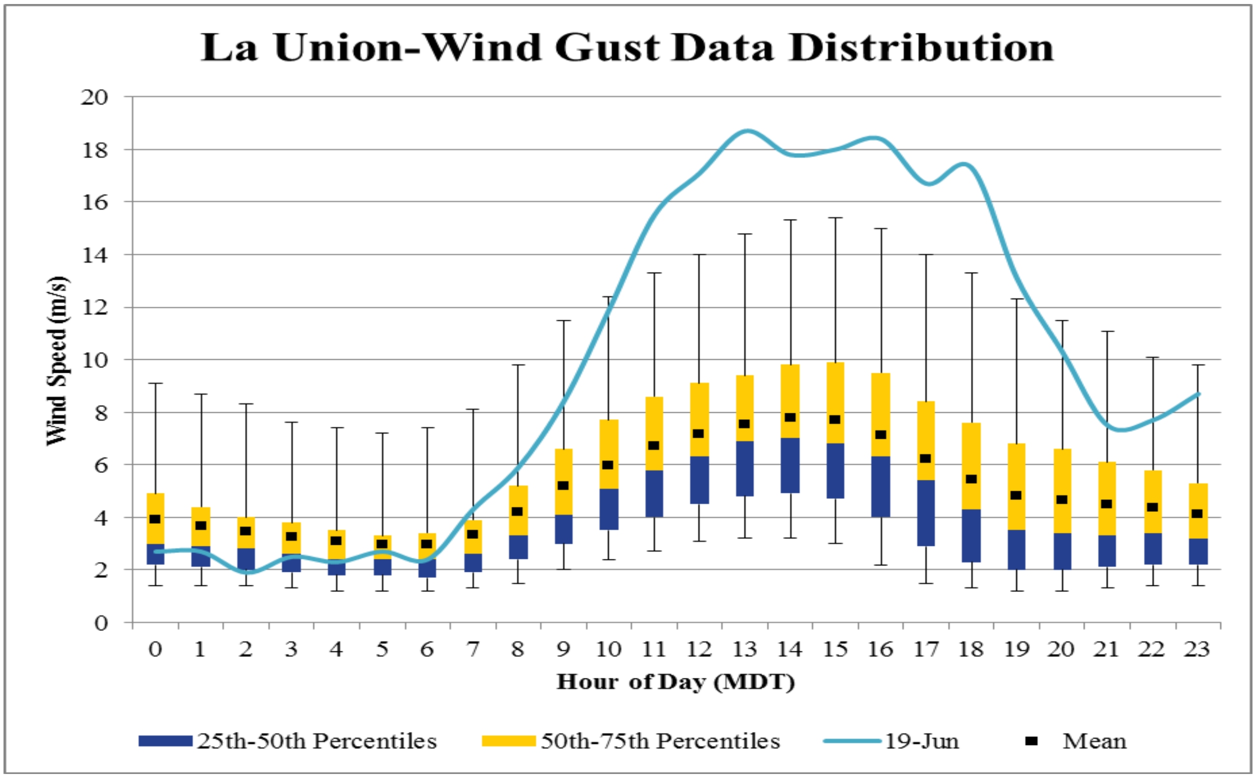

Figure 25-8a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

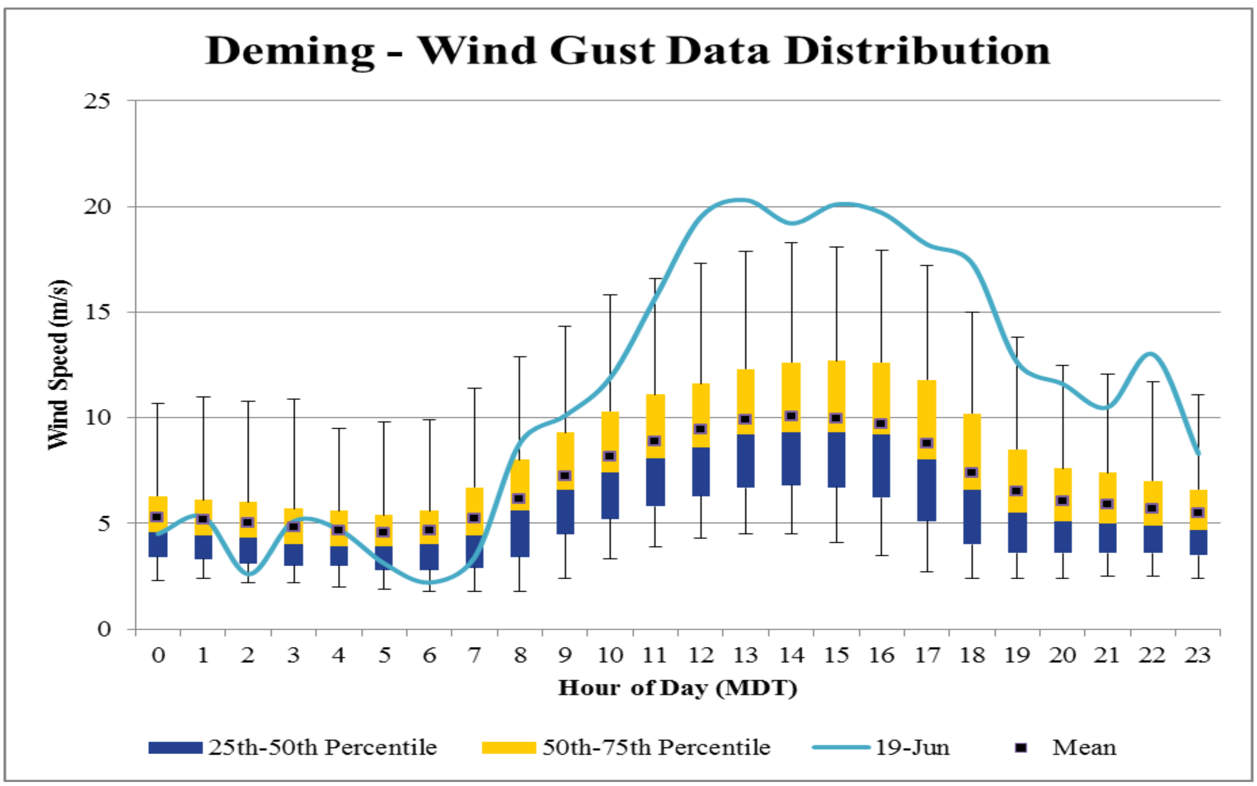

Figure 25-8b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

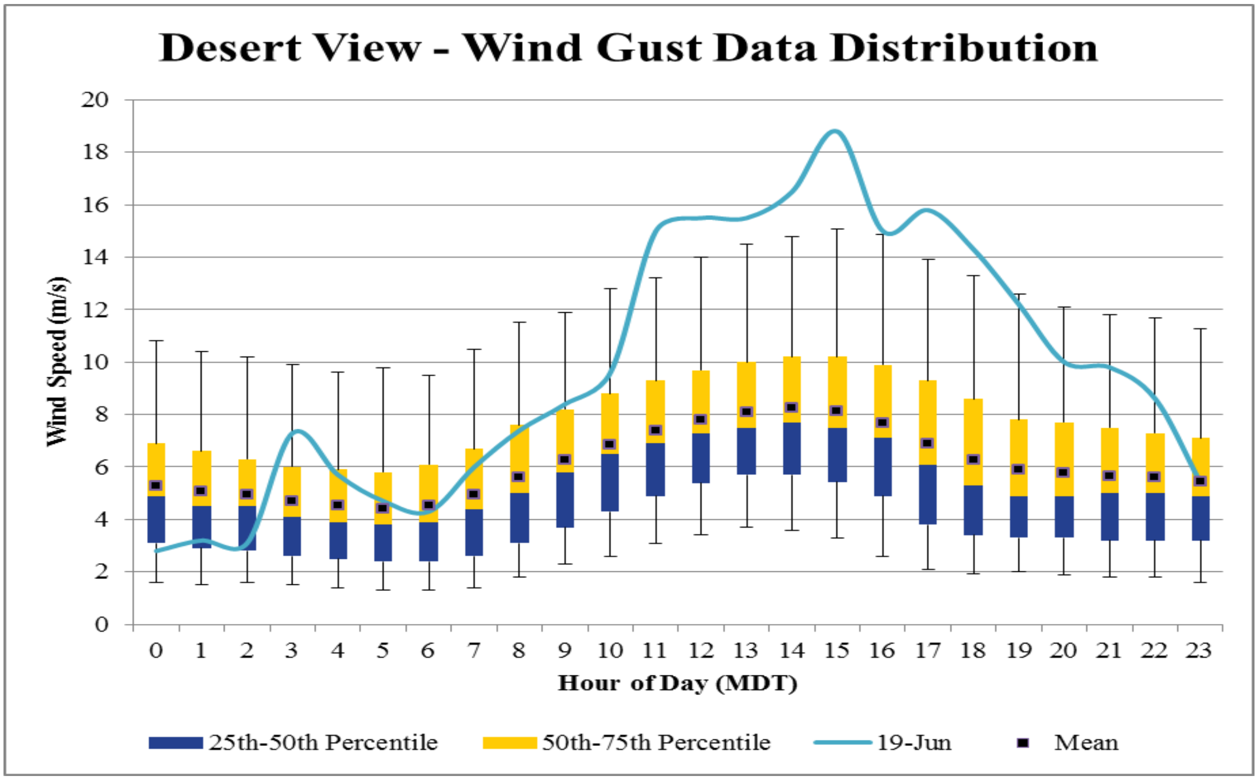

Figure 25-8c. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

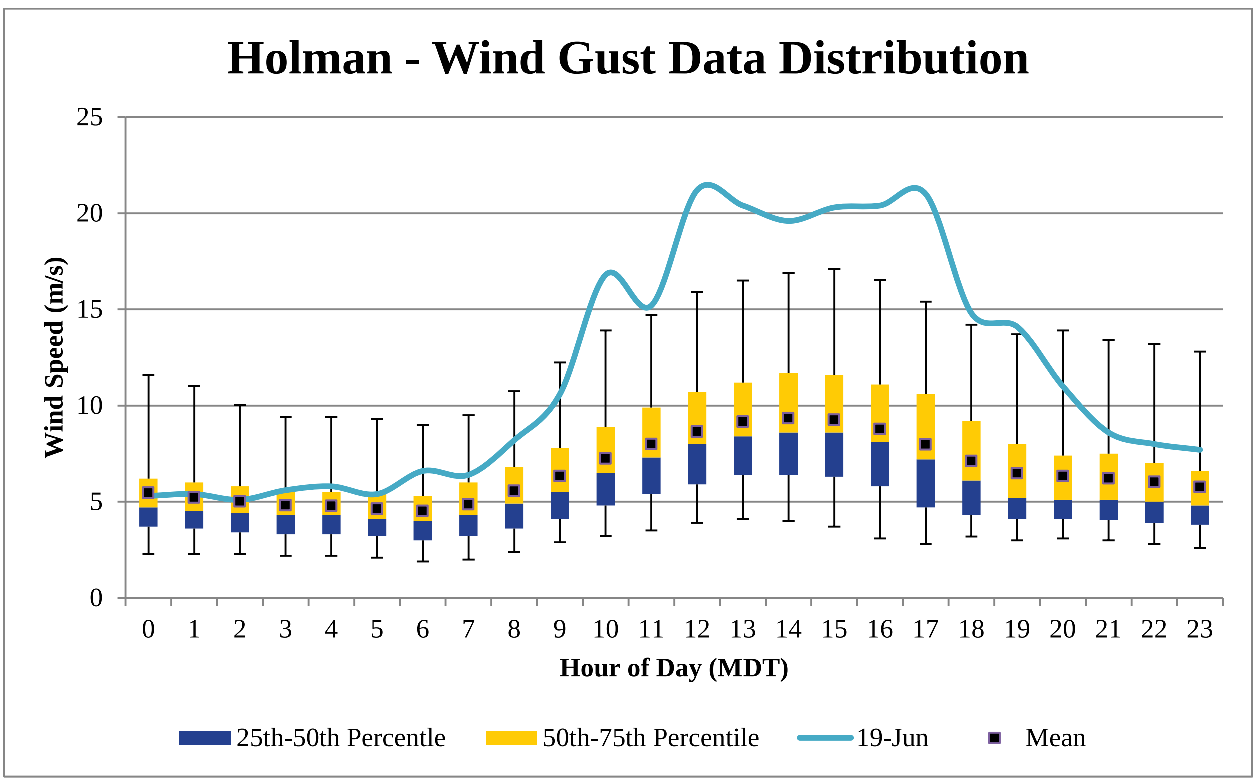

Figure 25-8d. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

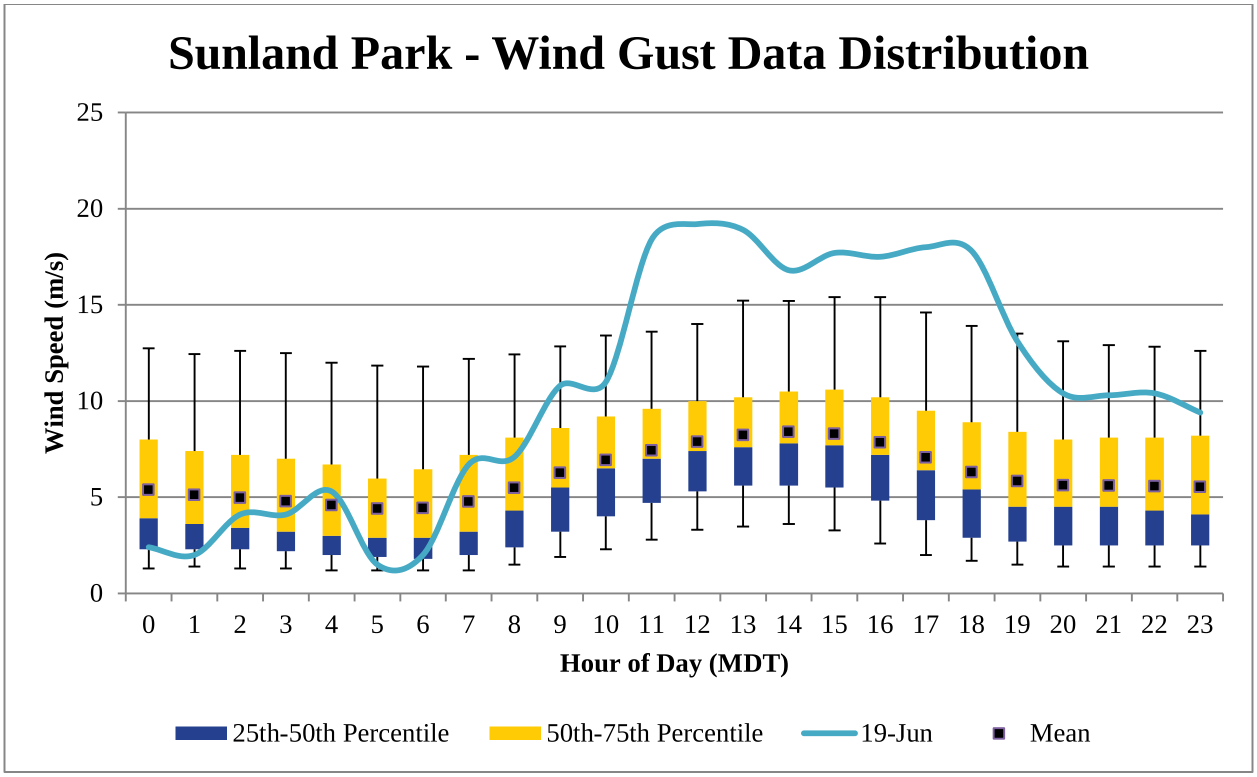

Figure 25-8e. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for June 19, 2011.

25.4 Clear Causal Relationship

A late season Pacific cold front hovered over northern Arizona on June 19, 2011 with areas of low pressure in the Four Corners Region and southeastern Colorado creating a pressure gradient over southeastern Arizona, southwestern New Mexico and northern Mexico. The surface weather map below (Figure 25-9a) shows a low pressure trough and higher pressures in northwestern New Mexico. As the day progressed the pressure gradient tightened and surface wind speeds increased (Figure 25-9b). The surface wind speeds were further enhanced as the wind direction in the upper atmosphere aligned with the surface wind direction while diurnal heating of the surface allowed winds aloft to mix downward and provided the turbulence required for vertical mixing and horizontal transport (Figure 25-10).

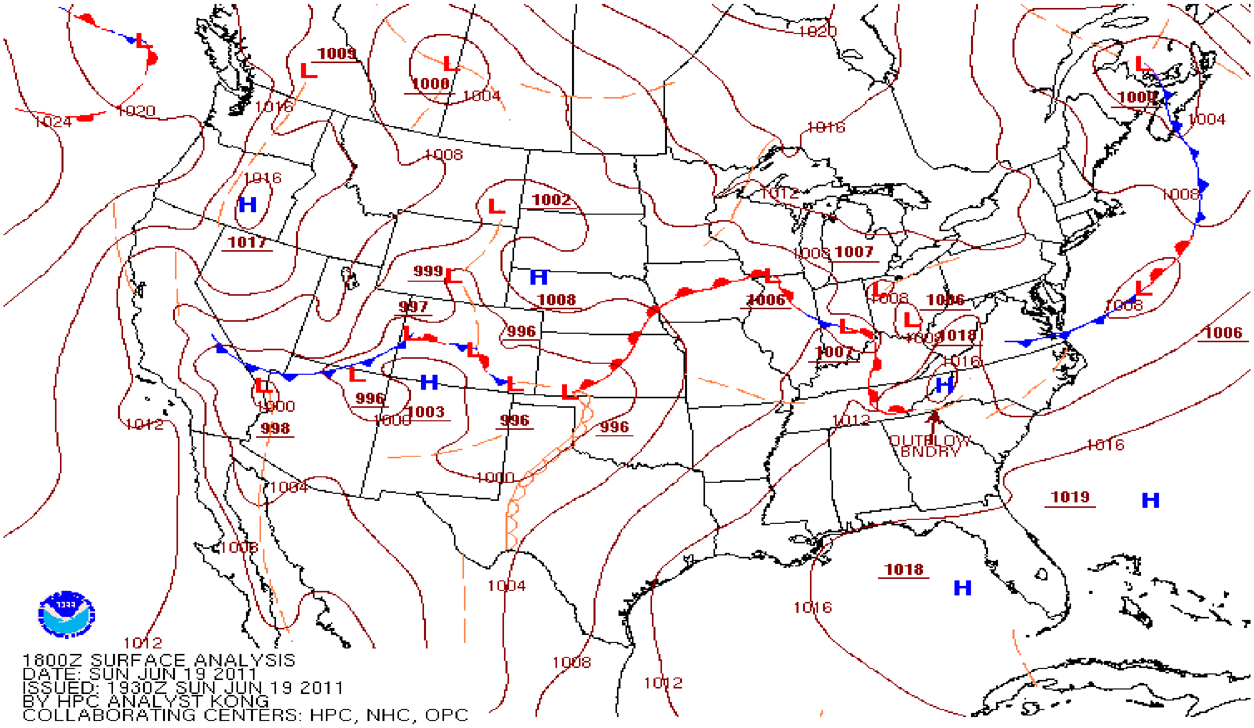

Figure 25-9a. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for June 19, 2011 at the 1200 hour.

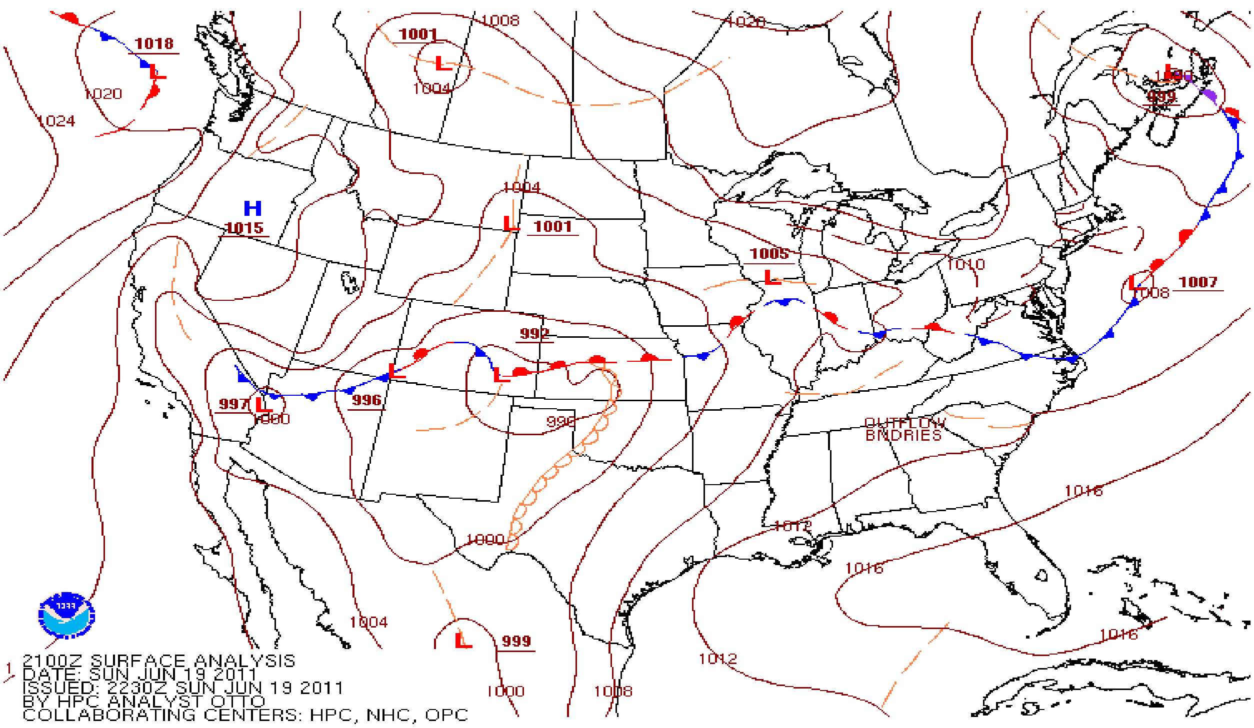

Figure 25-9b. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for June 19, 2011 at the 1500 hour.

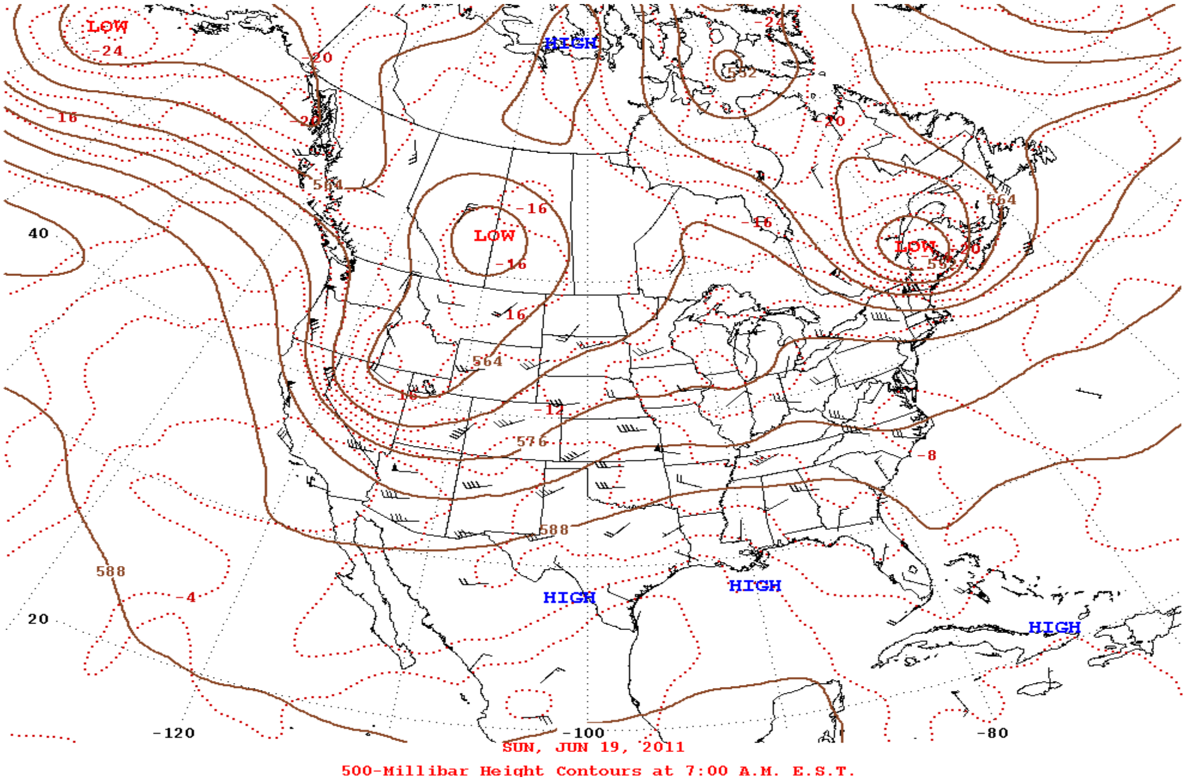

Figure 25-10. Upper air weather map showing geopotential heights (brown lines) at the 500 hour on June 19, 2011.

The weather pattern described above generated strong southwesterly winds beginning at the 1100 hour and lasting through the 1900 hour. Beginning at the 1100 hour, wind speeds exceeded the historical 95th percentile of data at La Union as shown in Figure 25-7a. Peak wind speeds ranged from 7.7 m/s at Desert View to 13.5 m/s at West Mesa (Figure 25-3). Peak wind gusts ranged from 18.7 m/s at La Union to 23.3 m/s at West Mesa (Figure 25-4). Blowing dust caused elevated levels of PM_{10} and $PM_{2.5}$ during the same period as high winds as demonstrated by the time series plots in Figures 25-11a-f. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (1100-1800 hours). During these hours, hourly PM_{10} and $PM_{2.5}$ concentrations spiked at all monitoring sites in the network (Figures 25-12a-b). Hourly data from the SPCY PM_{10} and $PM_{2.5}$ TEOM Monitors show good correlation of the timing of spikes in concentrations (Figure 25-13).

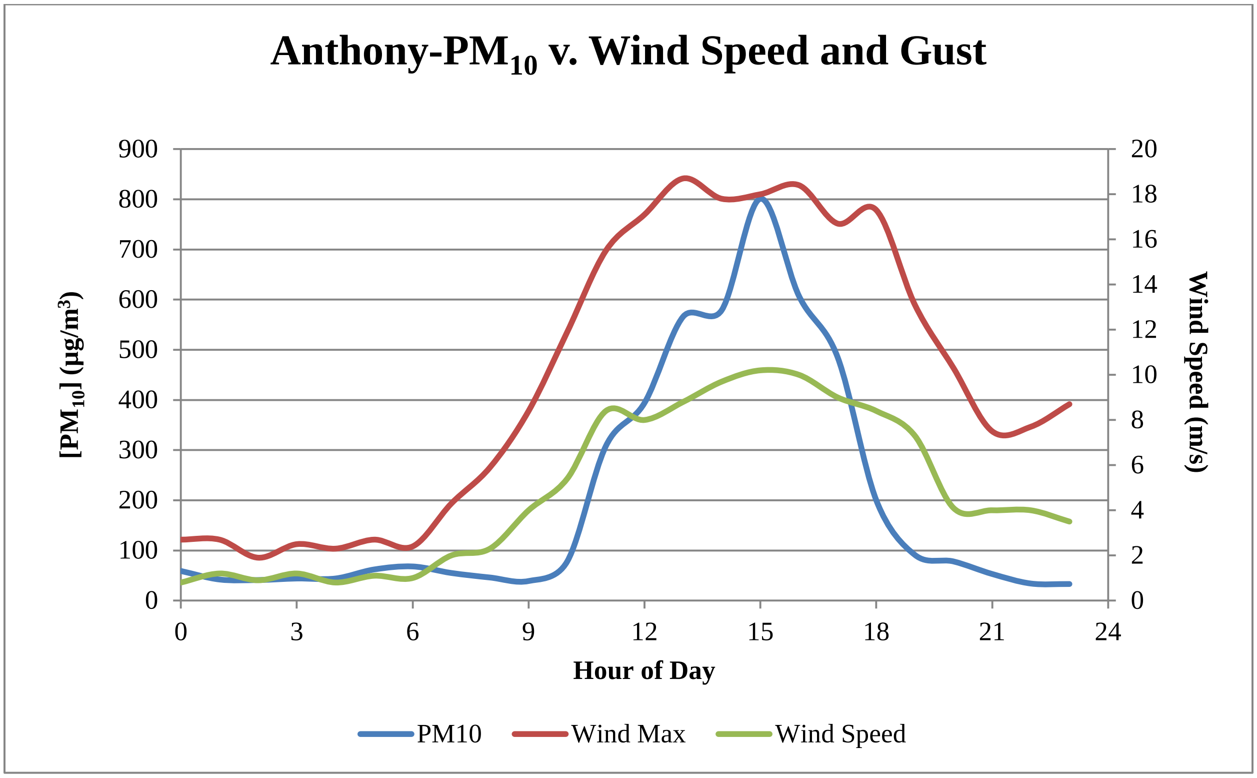

Figure 25-11a. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

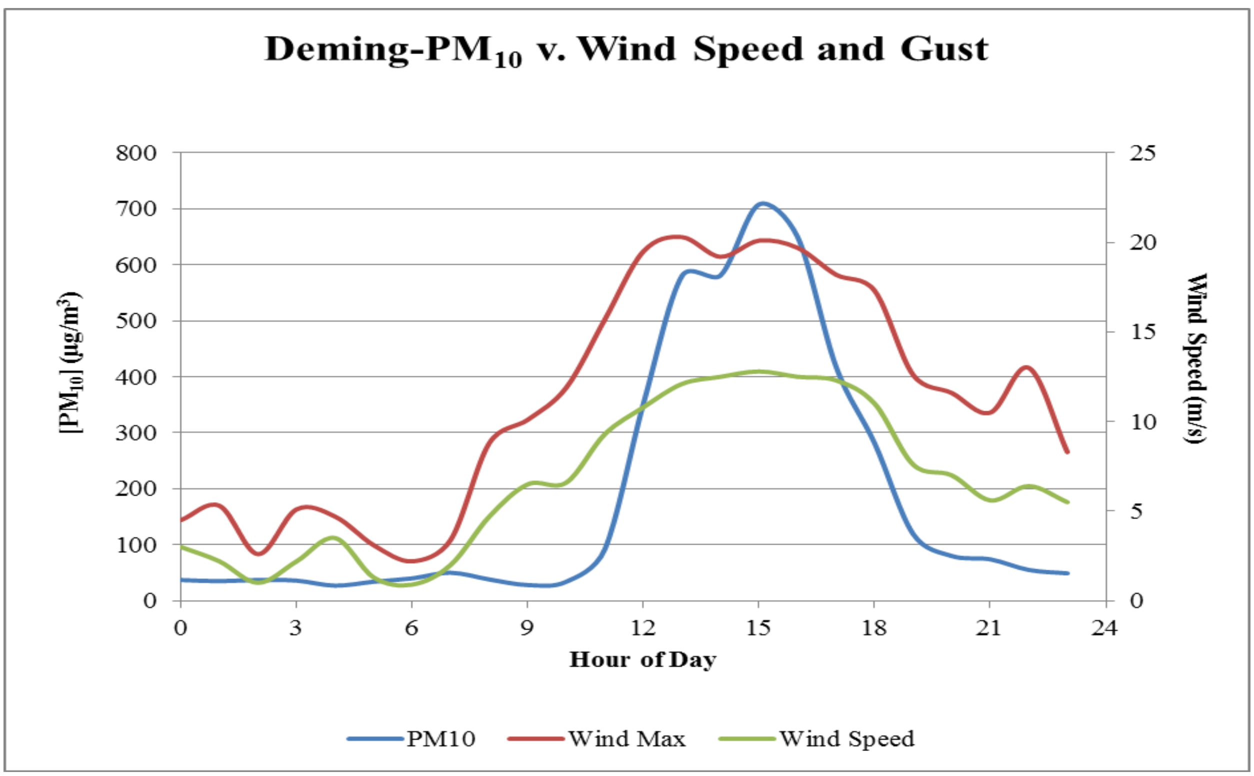

Figure 25-11b. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

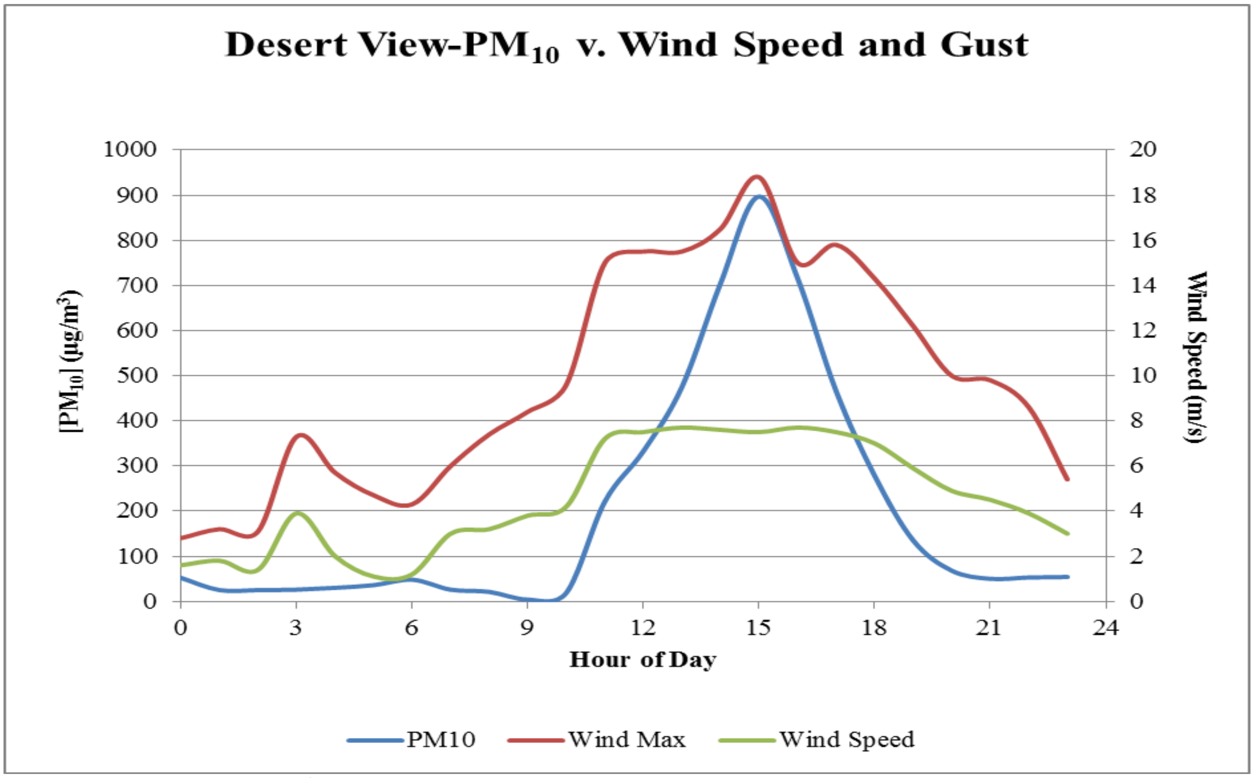

Figure 25-11c. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

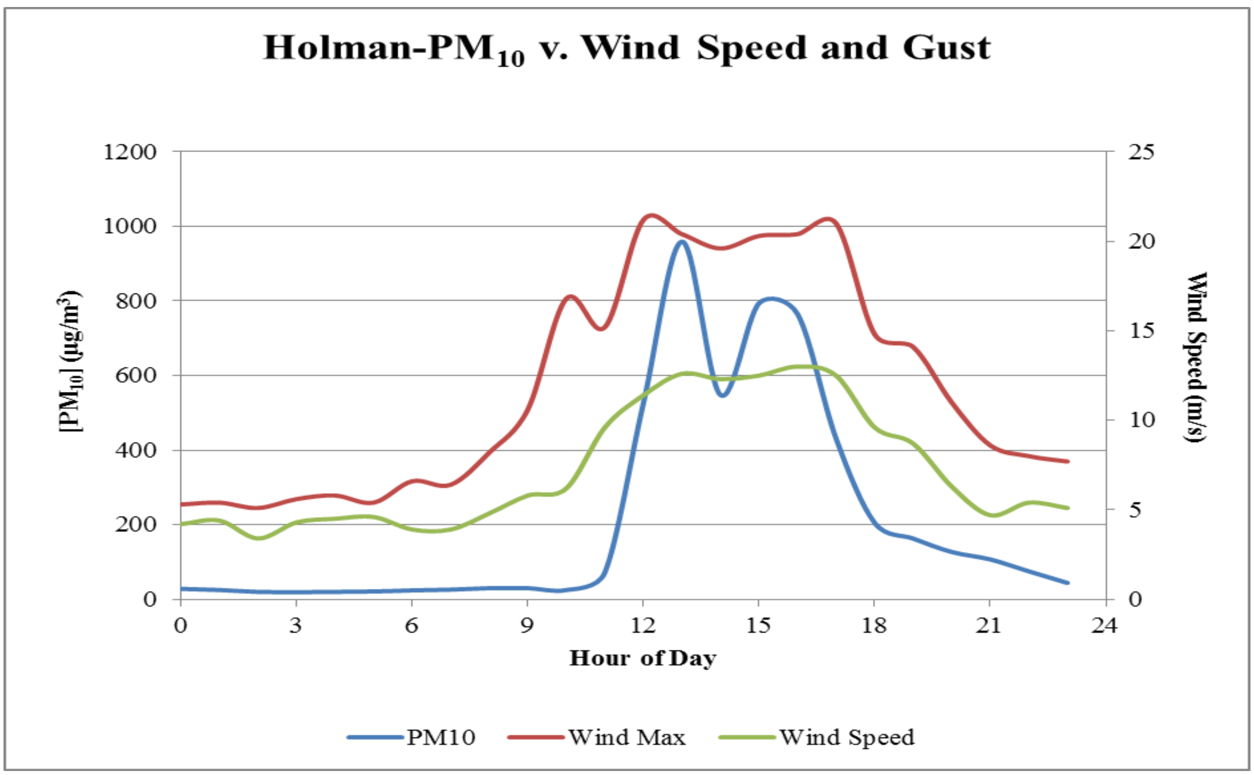

Figure 25-11d. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

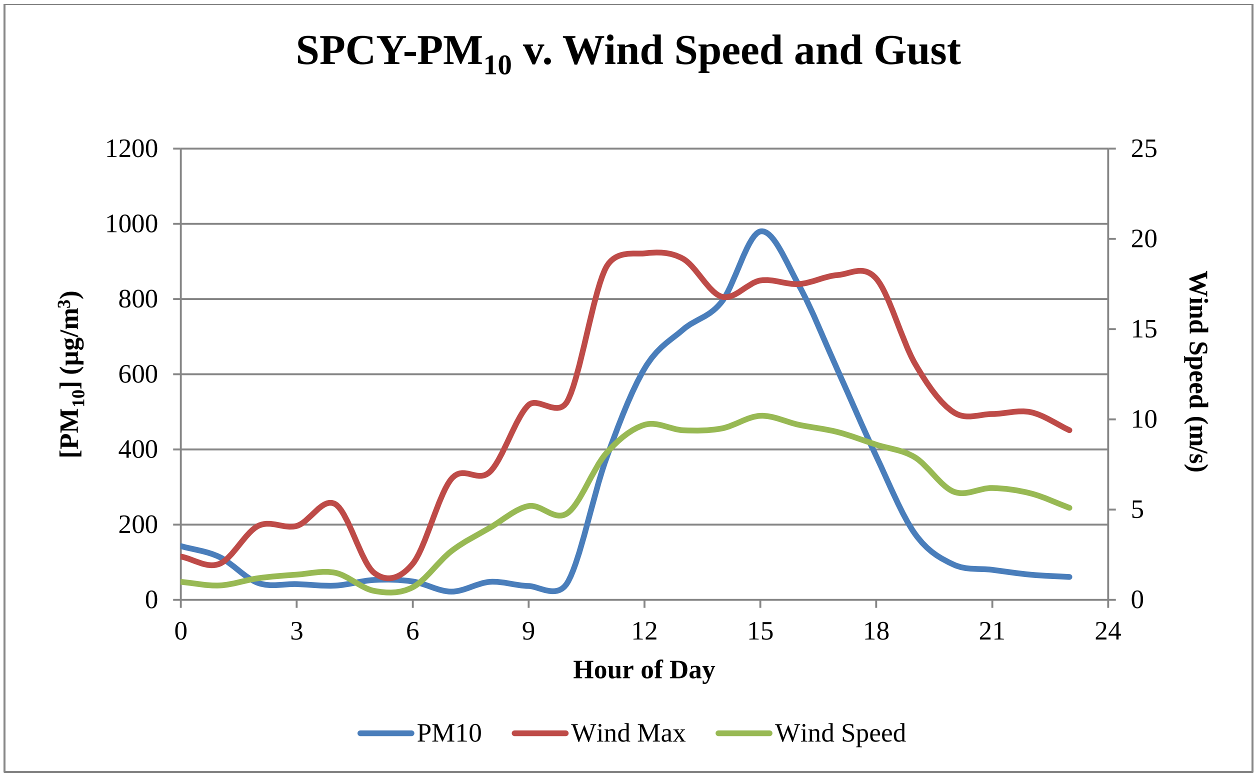

Figure 25-11e. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

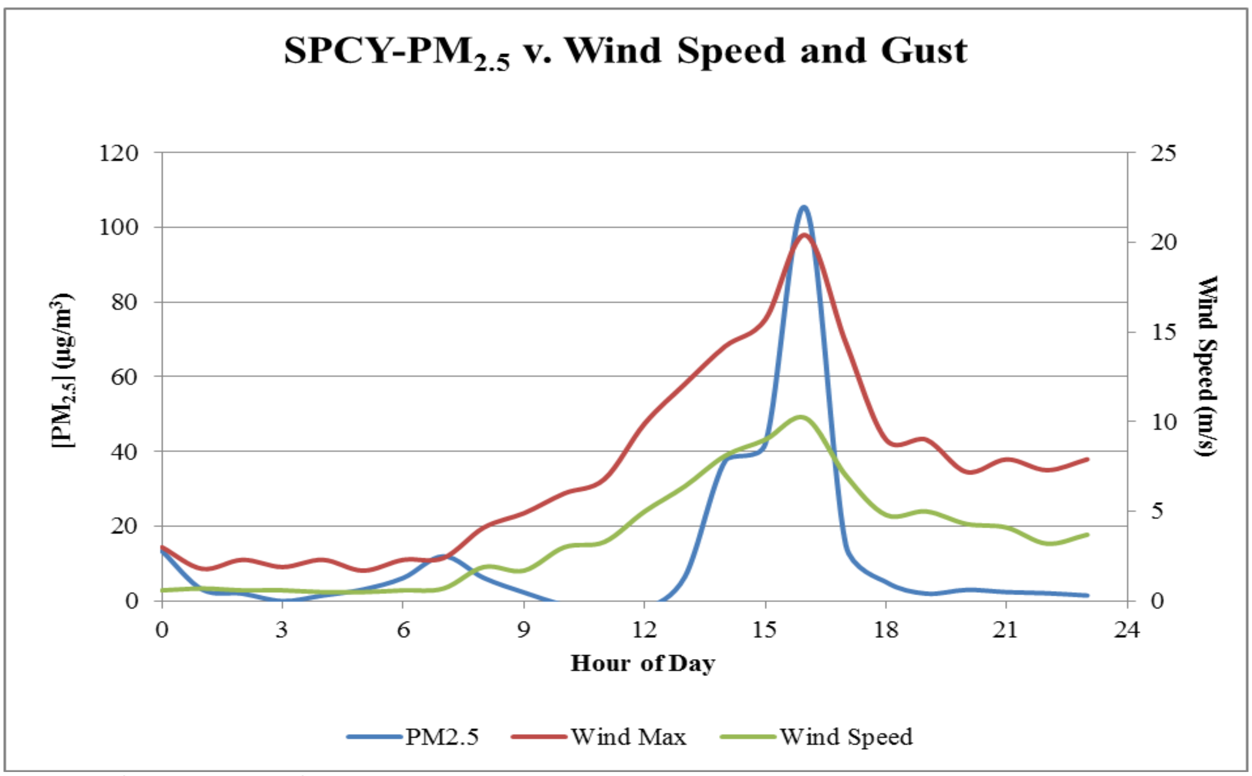

Figure 25-11f. Time series plot of hourly observations showing increased $PM_{2.5}$ concentrations as wind speeds and gusts increase.

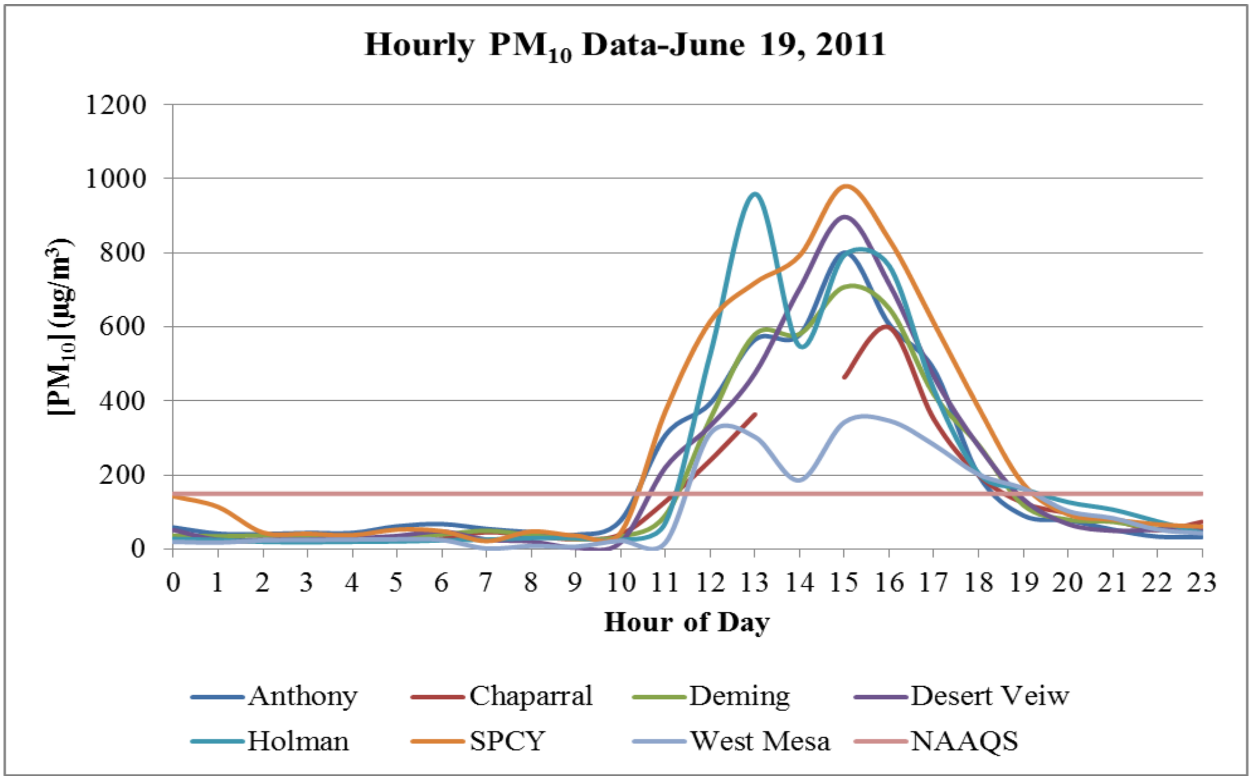

Figure 25-12a. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors. Non-FEM hourly $PM_{2.5}$ data.

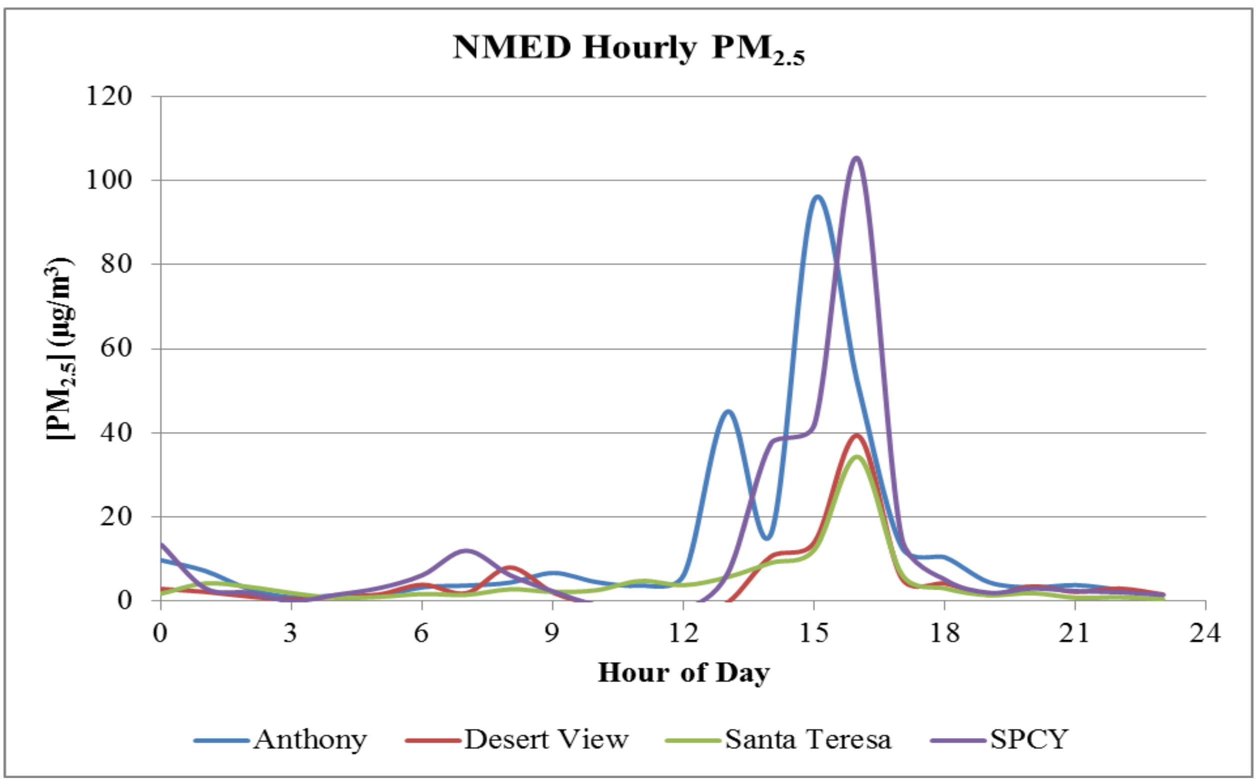

Figure 25-12b. Hourly $PM_{2.5}$ concentrations for Doña Ana and Luna Counties monitors. Non-FEM hourly $PM_{2.5}$ data.

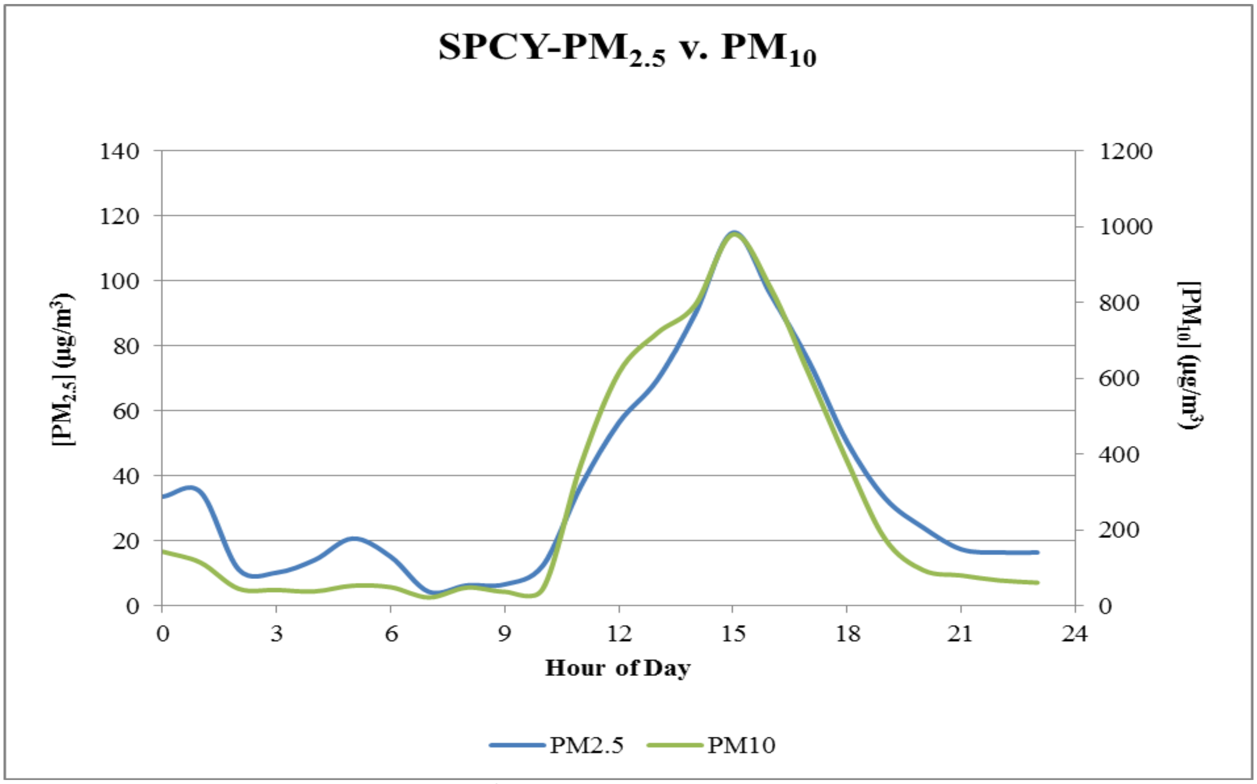

Figure 25-13. Hourly PM_{10} and $PM_{2.5}$ concentrations for the SPCY monitoring site on June 19, 2011.

The NM Border Air Quality Blog relayed the NWS's daily forecast of strong west-southwest winds between 28 and 33 mph, gusts up to 47 mph, and included a map of wind predictions for 6 pm MDT (Figure 25-14) and the NOAA Hazard Mapping System (HMS) smoke and fire product predicting smoke impacts at1130 hours indicating a smoke plume SE of Deming, smoke trajectories from the Monument fire, and the Hachita fire (Figure 25-15).

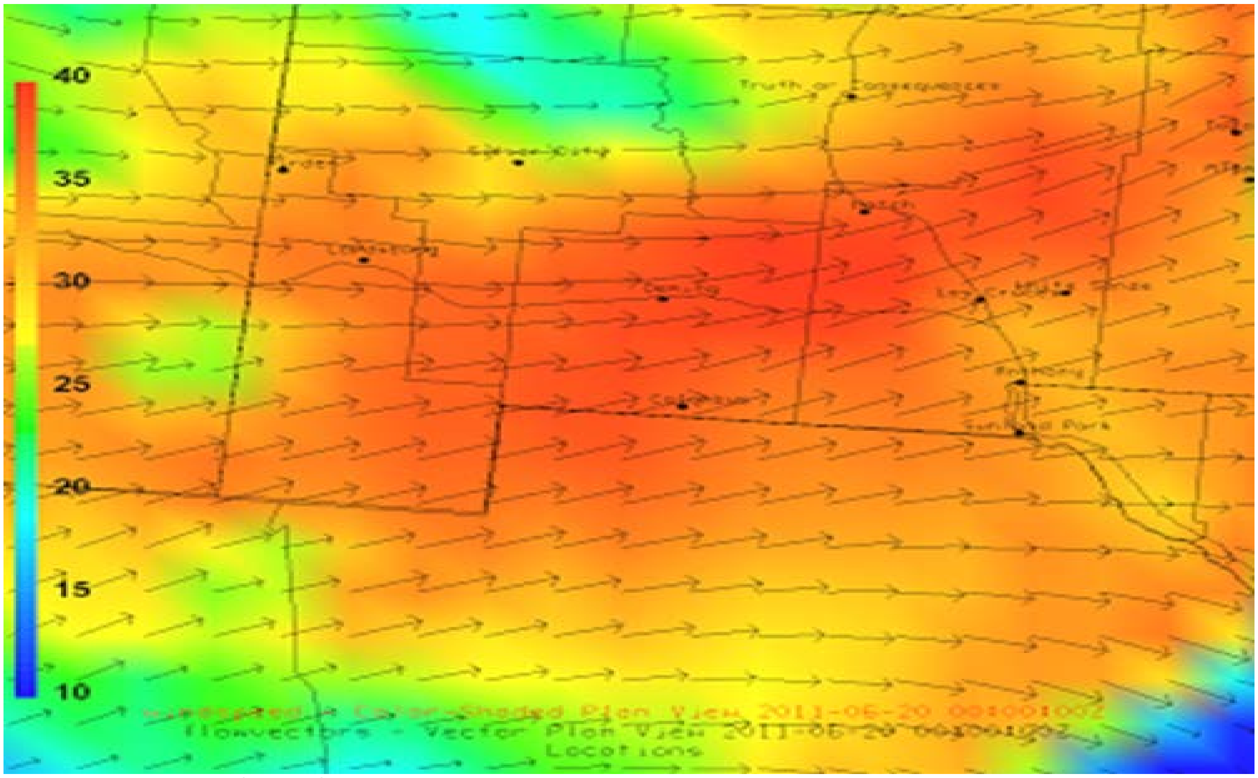

Figure 25-14. NWS wind forecast for June 19, 2011 (Courtesy D. Dubois and NWS).

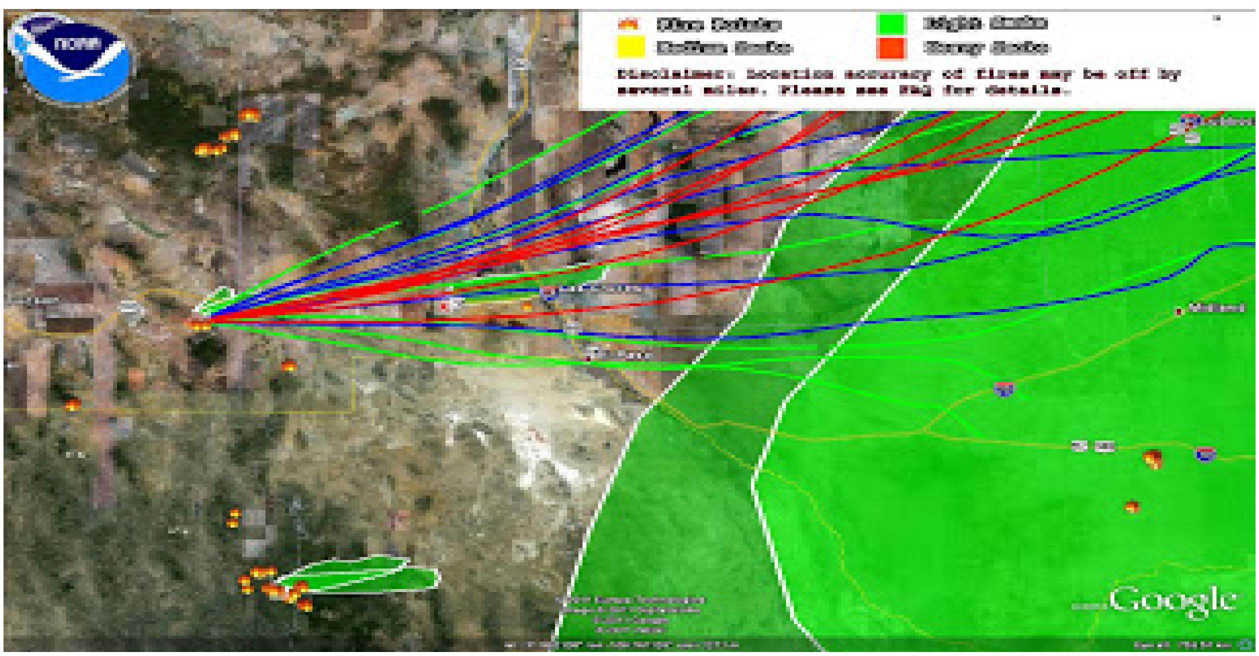

Figure 25-15. NOAA HMS product at 1130 hours for June 19, 2011 (Courtesy D. DuBois and NOAA).

This day's blog also included a photograph of haze dense with blowing dust (Figure 25-16), and a report of thick haze from both smoke and dust around 6 pm with the NOAA HMS smoke and fire products at 8:53 pm (Figure 25-17).

Figure 25-16. View looking southwest from the Highrange Neighborhood (Las Cruces) showing haze dense with smoke at 1700 hours (Courtesy of D. Dubois)

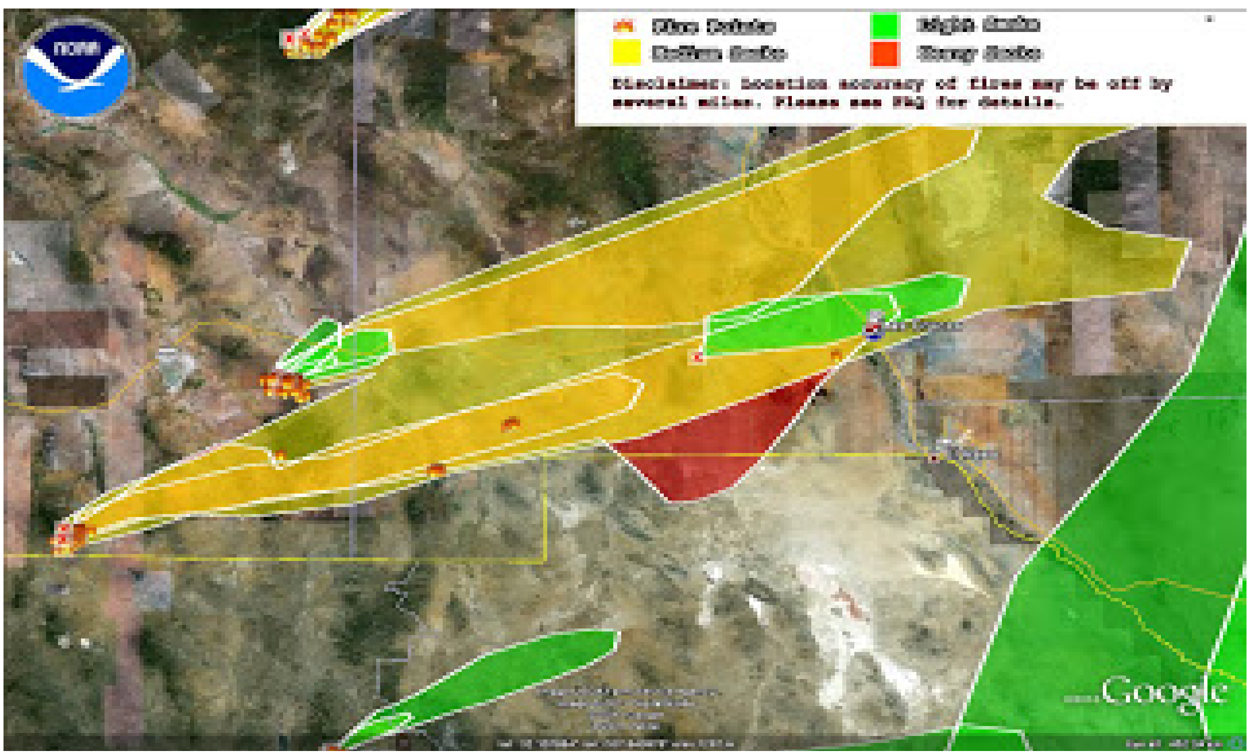

Figure 25-17. NOAA HMS smoke and fire product at 2053 hours showing thick smoke (red) over Luna County (Courtesy D. DuBois and NOAA).

The NWS issued a wind advisory for the region stating in part,

...PACIFIC STORM SYSTEM TO BRING WINDY CONDITIONS TO SOUTHERN NEW MEXICO AND FAR WEST TEXAS TODAY...

A LATE SEASON PACIFIC LOW PRESSURE SYSTEM WILL APPROACH THE SOUTHWEST U.S. THIS AFTERNOON. THIS WILL POSITION STRONG WINDS ALOFT OVER THE REGION AND CREATE A STRONG SURFACE PRESSURE GRADIENT. DEEP MIXING DUE TO DAYTIME HEATING WILL RESULT IN STRONG GUSTY WINDS IN SOUTHERN NEW MEXICO AND FAR WEST TEXAS. THESE STRONG WINDS WILL PRODUCE DANGEROUS WILDFIRE CONDITIONS AND RESULT IN WIDESPREAD BLOWING DUST ACROSS THE LOWLANDS. WINDS WILL REMAIN STRONG ALONG EASTERN SLOPES OF AREA MOUNTAINS OVERNIGHT...BUT MOST SECTIONS WILL SEE A DECREASE IN WINDS NOT LONG AFTER SUNSET. WINDS WILL NOT BE AS STRONG MONDAY AS THE SYSTEM SLOWLY PULLS AWAY FROM THE REGION (NWS, 2011).

25.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on June 19, 2011.

25.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by high wind and blowing dust.

25.7 No Exceedance but for the Event

The Anthony monitor detected blowing dust around the 1100 hour with hourly concentrations heavily impacted through the 1800 hour. The eight hourly PM_{10} values from 1100-1800 hours alone, exceed the 24-hour average standard at Anthony [(308 + 394 + 566 + 579 + 801 + 607 + 485 + 200) µg/m^3 = 3940 µg/m^3; (3940 µg/m^3)/24 = 164 µg/m^3]. By replacing these eight hourly values with the 95th percentile of hourly data at the Anthony site, the resulting 24-hour average (89 µg/m^3) does not exceed the NAAQS (Table 25-1). The values in red represent the 95th percentile of all hourly data collected at Anthony, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	59	59
1	42	42
2	41	41
3	44	44
4	44	44
5	62	62
6	68	68
7	55	55
8	46	46
9	39	39
10	78	78
11	308	**106**
12	394	**136**
13	566	**146**
14	579	**177**
15	801	**172**
16	607	**152**
17	485	**194**
18	200	**197**
19	91	91
20	78	78
21	53	53
22	34	34
23	33	33
24-Hour Average	200	**89**

Table 25-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Anthony.

The Deming Airport monitor detected blowing dust around the 1100 hour with hourly concentrations heavily impacted through the 2100 hour. The eleven hourly PM_{10} values from 1100-2100 hours alone, exceed the 24-hour average standard at Deming Airport [(92 + 352 + 580 + 581 + 708 + 650 + 418 + 281 + 119 + 80 + 74) µg/m^3 = 3935 µg/m^3; (3935 µg/m^3)/24 = 164 µg/m^3]. By replacing these eight hourly values with the 95th percentile of hourly data at the Deming Airport site, the resulting 24-hour average (65 µg/m^3) does not exceed the NAAQS (Table 25-2). The values in red represent the 95th percentile of all hourly data collected at Deming Airport, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	37	37
1	35	35
2	37	37
3	36	36
4	27	27
5	34	34
6	40	40
7	50	50
8	38	38
9	28	28
10	34	34
11	92	**62**
12	352	**72**
13	580	**99**
14	581	**101**
15	708	**103**
16	650	**107**
17	418	**95**
18	281	**87**
19	119	**76**
20	80	**71**
21	74	**59**
22	55	55
23	49	49
24-Hour Average	184	**65**

Table 25-2. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Deming Airport.

The Desert View monitor detected blowing dust around the 1100 hour with hourly concentrations heavily impacted through the 1800 hour. The eight hourly PM_{10} values from 1100-1800 hours alone, exceed the 24-hour average standard at Desert View [(221 + 333 + 475 + 704 + 897 + 716 + 466 + 278) µg/m^3 = 4090 µg/m^3; (4090 µg/m^3)/24 = 170 µg/m^3]. By replacing these eight hourly values with the 95th percentile of hourly data at the Desert View site, the resulting 24-hour average (66 µg/m^3) does not exceed the NAAQS (Table 25-3). The values in red represent the 95th percentile of all hourly data collected at Desert View, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	52	52
1	25	25
2	25	25
3	26	26
4	30	30
5	36	36
6	48	48
7	26	26
8	21	21
9	4	4
10	19	19
11	221	**91**
12	333	**94**
13	475	**91**
14	704	**106**
15	897	**119**
16	716	**124**
17	466	**158**
18	278	**137**
19	135	135
20	68	68
21	50	50
22	53	53
23	54	54
24-Hour Average	198	**66**

Table 25-3. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Desert View.

The Holman monitor detected blowing dust around the 1100 hour with hourly concentrations heavily impacted through the 2200 hour. The twelve hourly PM_{10} values from 1100-2200 hours alone, exceed the 24-hour average standard at Holman [(72 + 526 + 959 + 548 + 794 + 765 + 431 + 205 + 163 + 127 + 75) µg/m^3 = 4772 µg/m^3; (4772 µg/m^3)/24 = 199 µg/m^3]. By replacing these twelve hourly values with the 95th percentile of hourly data at the Holman site, the resulting 24-hour average (67 µg/m^3) does not exceed the NAAQS (Table 25-4). The values in red represent the 95th percentile of all hourly data collected at Holman, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	28	28
1	25	25
2	20	20
3	19	19
4	20	20
5	21	21
6	24	24
7	26	26
8	30	30
9	30	30
10	25	25
11	72	**66**
12	526	**85**
13	959	**102**
14	548	**122**
15	794	**125**
16	765	**118**
17	431	**125**
18	205	**160**
19	163	**132**
20	127	**111**
21	107	**87**
22	75	**68**
23	44	44
24-Hour Average	211	**67**

Table 25-4. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Holman.

The SPCY monitor detected blowing dust around the 1100 hour with hourly concentrations heavily impacted through the 1800 hour. The eight hourly PM_{10} values from 1100-1800 hours alone, exceed the 24-hour average standard at SPCY [(373 + 615 + 719 + 793 + 980 + 836 + 611 + 382) $\mu g/m^3$ = 5309 $\mu g/m^3$; (5309 $\mu g/m^3$)/24 = 221 $\mu g/m^3$]. By replacing these eight hourly values with the 95th percentile of hourly data at the SPCY site, the resulting 24-hour average (102 $\mu g/m^3$) does not exceed the NAAQS (Table 25-5). The values in red represent the 95th percentile of all hourly data collected at SPCY, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	143	143
1	114	114
2	45	45
3	42	42
4	38	38
5	53	53
6	49	49
7	22	22
8	48	48
9	37	37
10	45	45
11	373	**95**
12	615	**104**
13	719	**125**
14	793	**145**
15	980	**160**
16	836	**168**
17	611	**201**
18	382	**296**
19	176	176
20	94	94
21	80	80
22	67	67
23	61	61
24-Hour Average	195	**102**

Table 25-5. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at SPCY.

26 HIGH WIND EXCEPTIONAL EVENT: September 7, 2011

26.1 Summary of Event

A hurricane in the Gulf of Mexico brought moisture into the area creating thunderstorms that caused high winds and blowing dust in Doña Ana County resulting in exceedances of the PM_{10} 24-hour NAAQS and the $PM_{2.5}$ annual NAAQS at the Chaparral and SPCY monitoring sites on this date. The FEM TEOM continuous and Partisol monitors at the Chaparral and SPCY sites recorded a 24-hour average PM_{10} concentration of 165 µg/m^3 and an annual $PM_{2.5}$ concentration of 12.3 µg/m^3, respectively. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were measured at Anthony (119 µg/m^3), Holman (112 µg/m^3), and SPCY (91 µg/m^3) monitoring sites (Figure 26-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event.

As the event unfolded, the wind blew from the north-northeast direction throughout the border region. These high velocity winds passed over large areas of desert within New Mexico. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

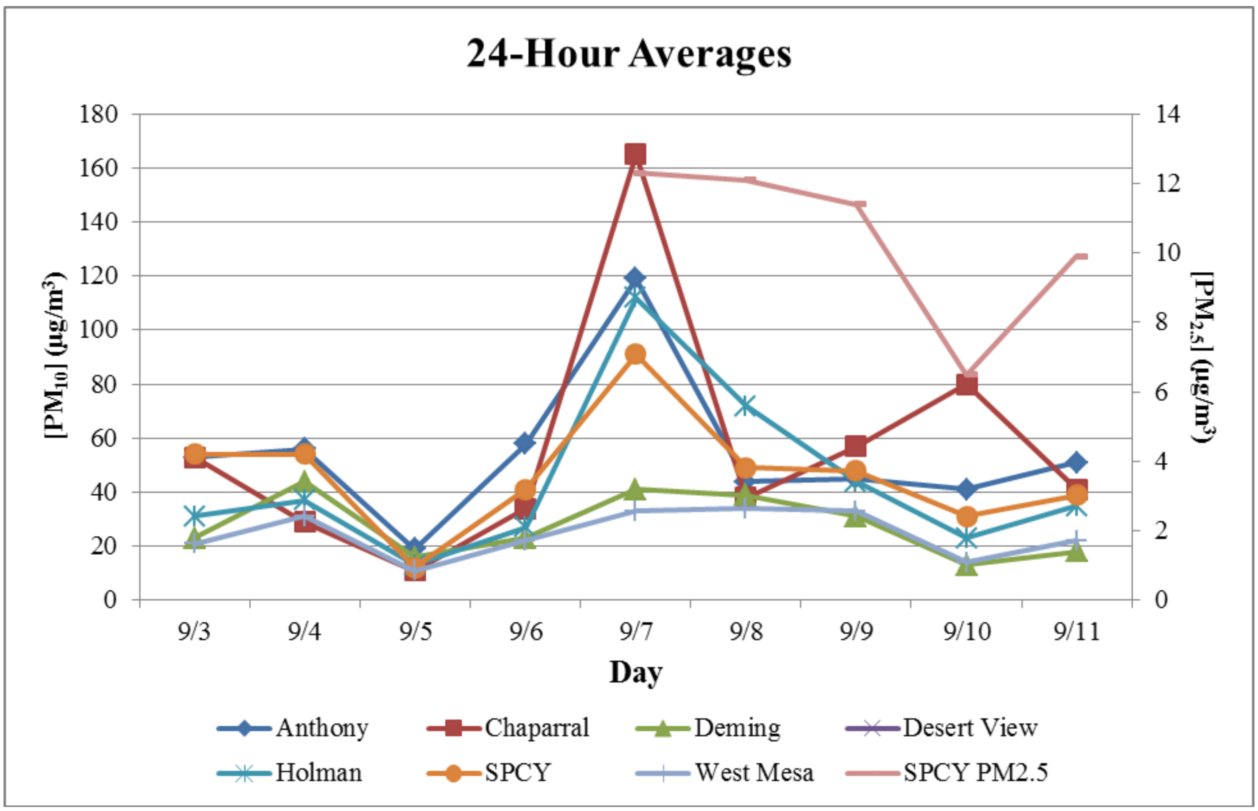

Figure 26-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after September 7, 2011.

26.2 Is Not Reasonably Controllable or Preventable

26.2.1 Suspected Source Areas and Categories Contributing to the Event

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in New Mexico. Doña Ana County Ordinance requires BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert, White Sands Missile Range, and White Sands National Monument in New Mexico (see Section 26.2.4 below).

26.2.2 Sustained and Instantaneous Wind Speeds

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On September 7, 2011, sustained wind speeds exceeded EPA's default threshold at two of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at two of the seven monitoring sites (Figures 26-2 and 26-3). Winds exceeded these thresholds at one or more monitoring sites beginning at the 2000 hour and ending at the 2300 hour.

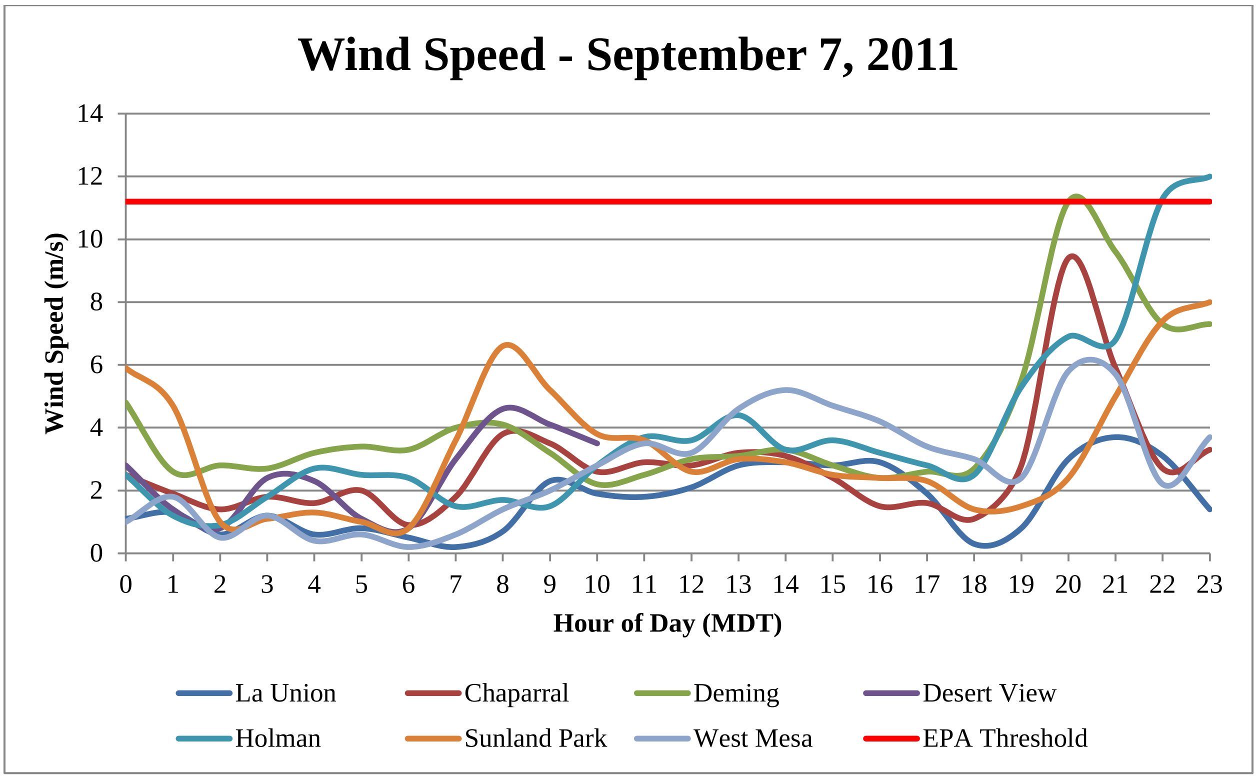

Figure 26-2. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

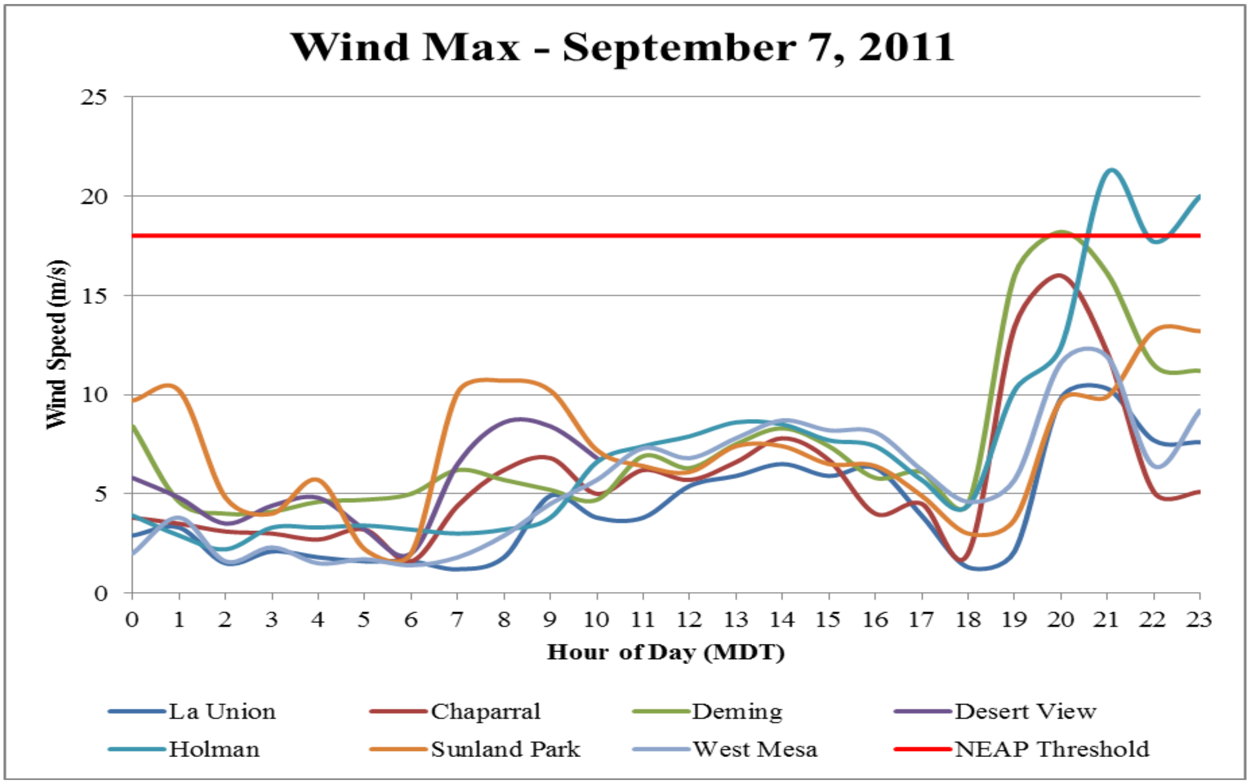

Figure 26-3. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

26.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the PM_{10} FEM TEOM monitors recorded 211 exceedances and the PM_{10} FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

26.2.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana County. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert in New Mexico. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled from Texas and Mexico (Figure 26-4) before switching to a north-northeast flow (1945 hour) and onto the monitors in Doña Ana County (Figure 26-5). The model starts four hours before the start of elevated PM_{10} concentrations measured during the event. Costs prohibit controlling dust from the natural desert terrain. NMED concludes that the sources contributing to the event are not reasonably controllable.

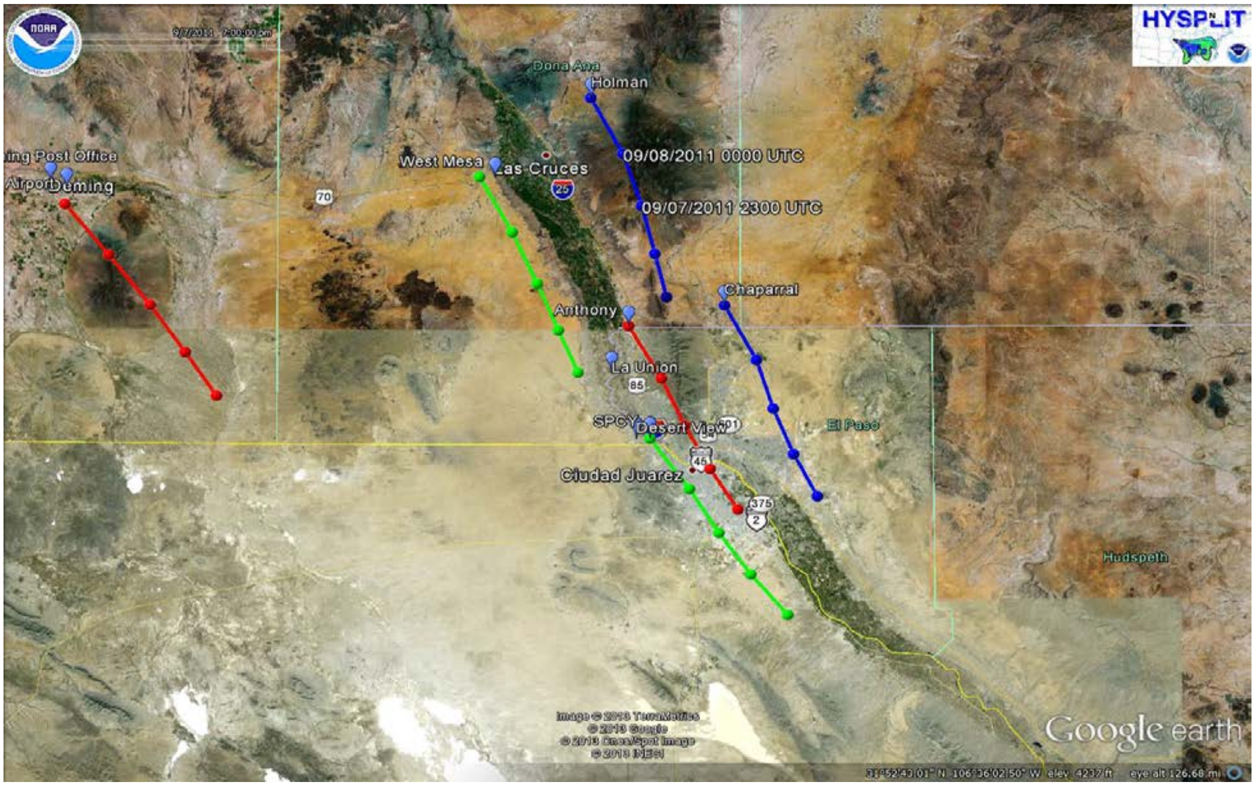

Figure 26-4. HYSPLIT back-trajectory model analysis for September 7, 2011.

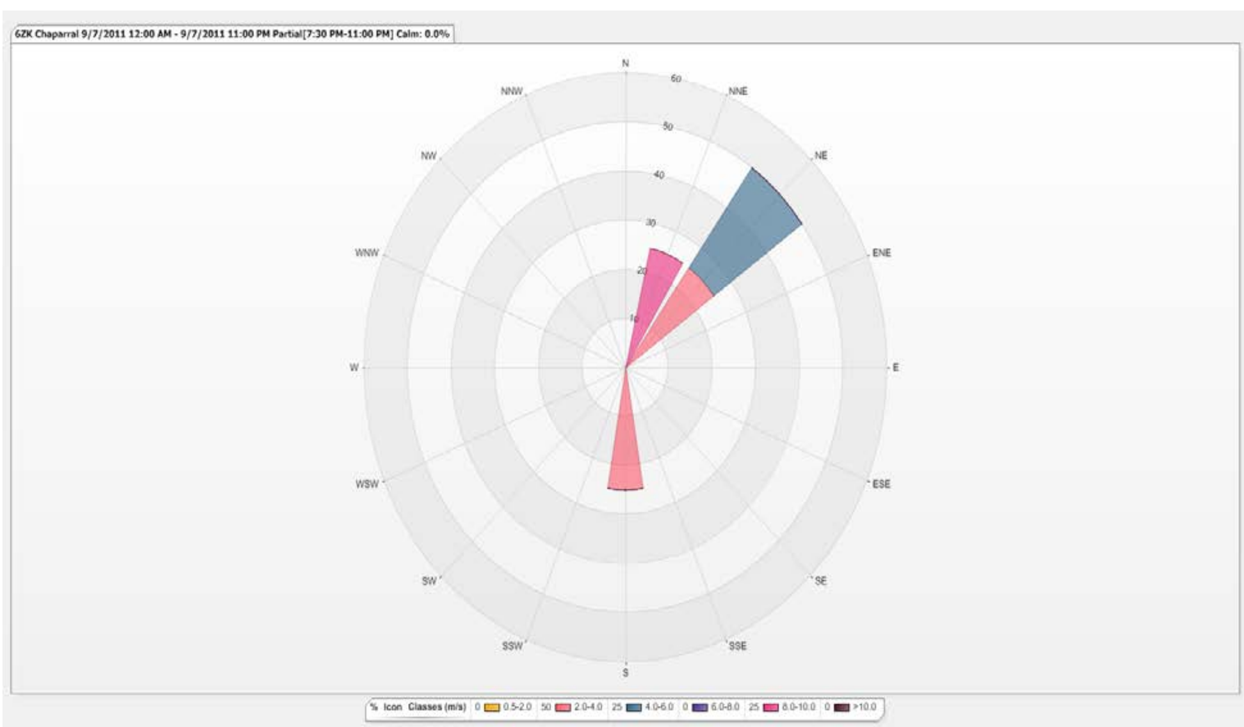

Figure 26-5. Wind Rose for Chaparral from the 1930 through 2300 hour.

26.3 Historical Fluctuations Analysis

26.3.1 Annual and Seasonal 24-hour Average Fluctuations

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded value for this day (165 µg/m^3) is above the maximum value recorded when no high wind exceedances are included and is above the 95th percentile

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for September 7, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95th percentile for PM_{10}, $PM_{2.5}$, wind speed and wind gusts (Figures 26-6a-b through 26-8a-b). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} values during the high wind blowing dust storm far exceed the historical 95th percentile of data.

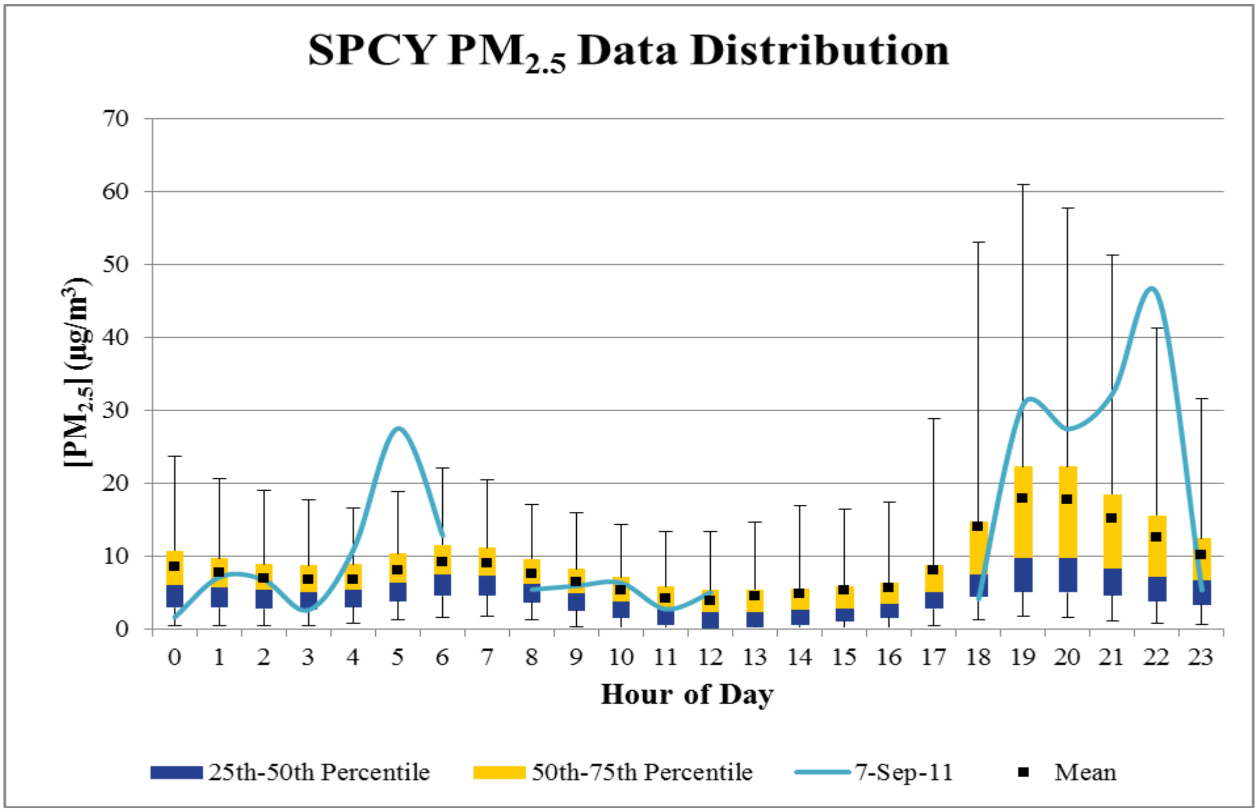

Figure 26-6a. $PM_{2.5}$ hourly data distribution from 2006-2010 overlaid by hourly values for September 7, 2011.

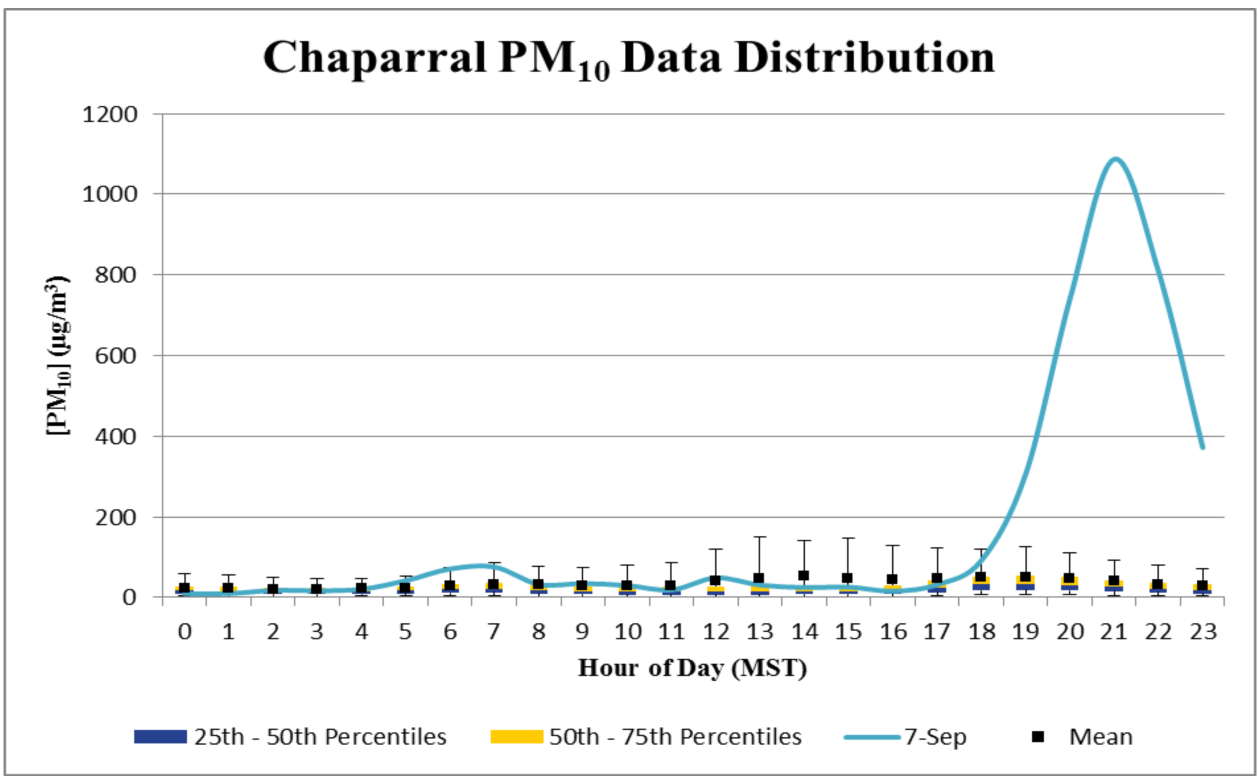

Figure 26-6b. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for September 7, 2011.

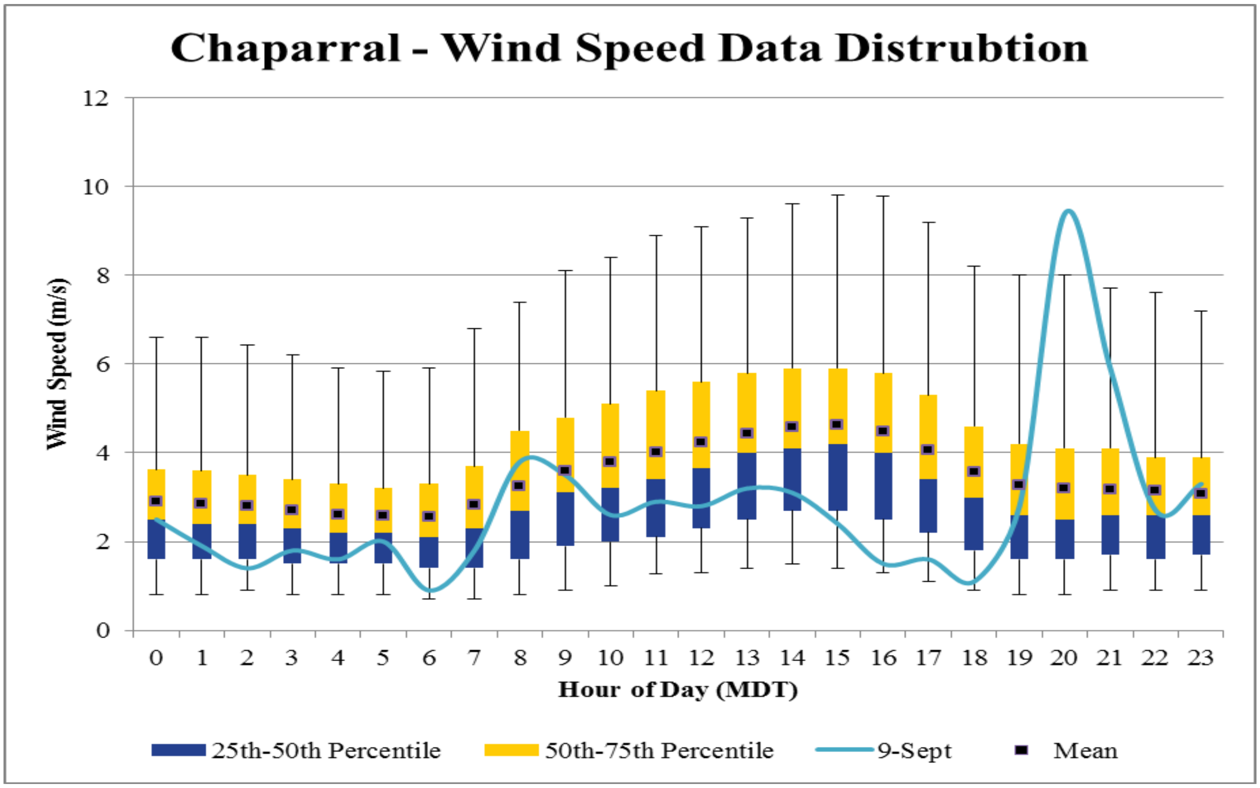

Figure 26-7a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for September 7, 2011.

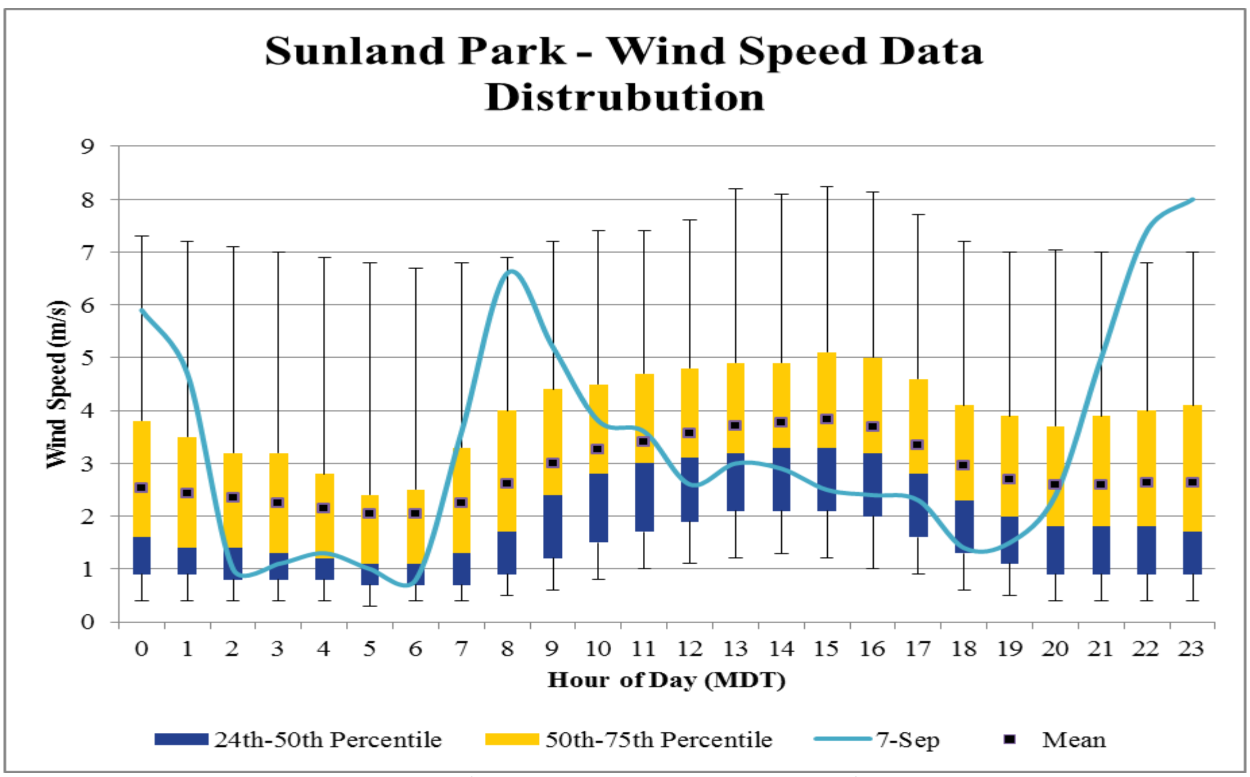

Figure 26-7b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for September 7, 2011.

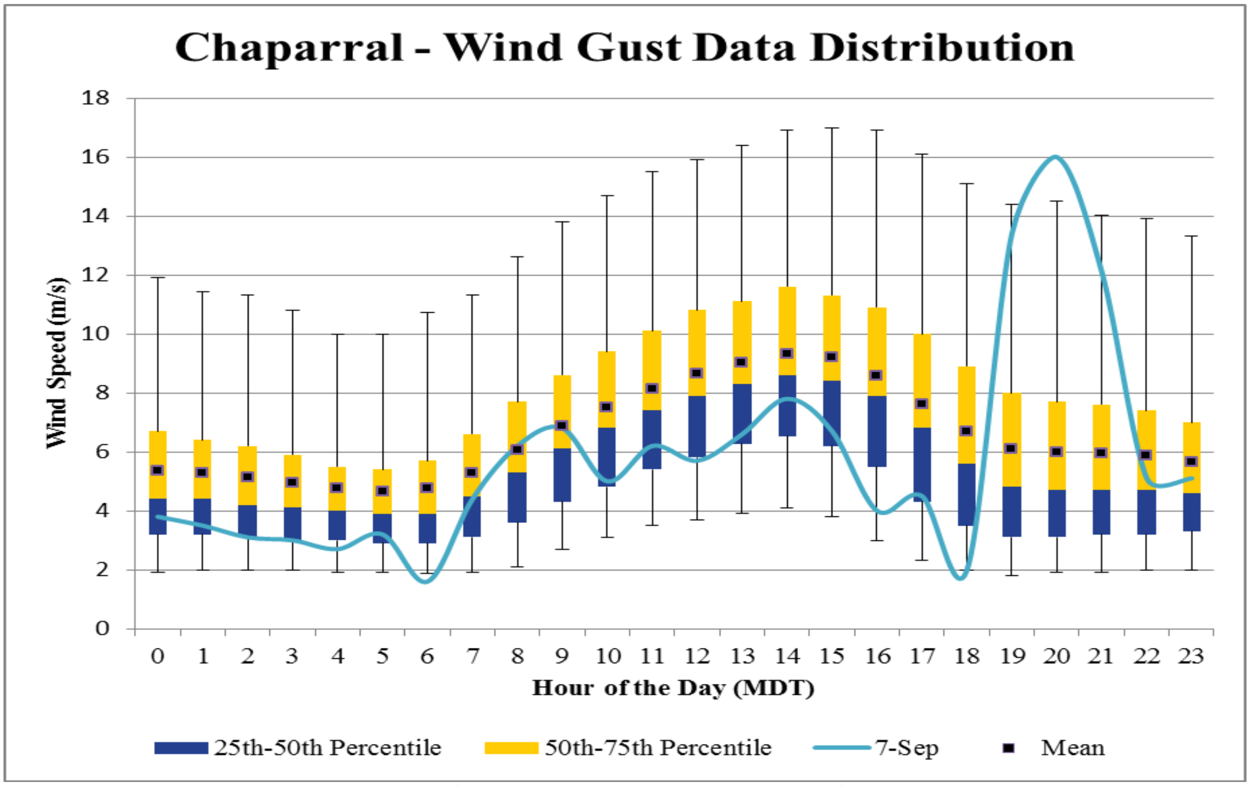

Figure 26-8a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for September 7, 2011.

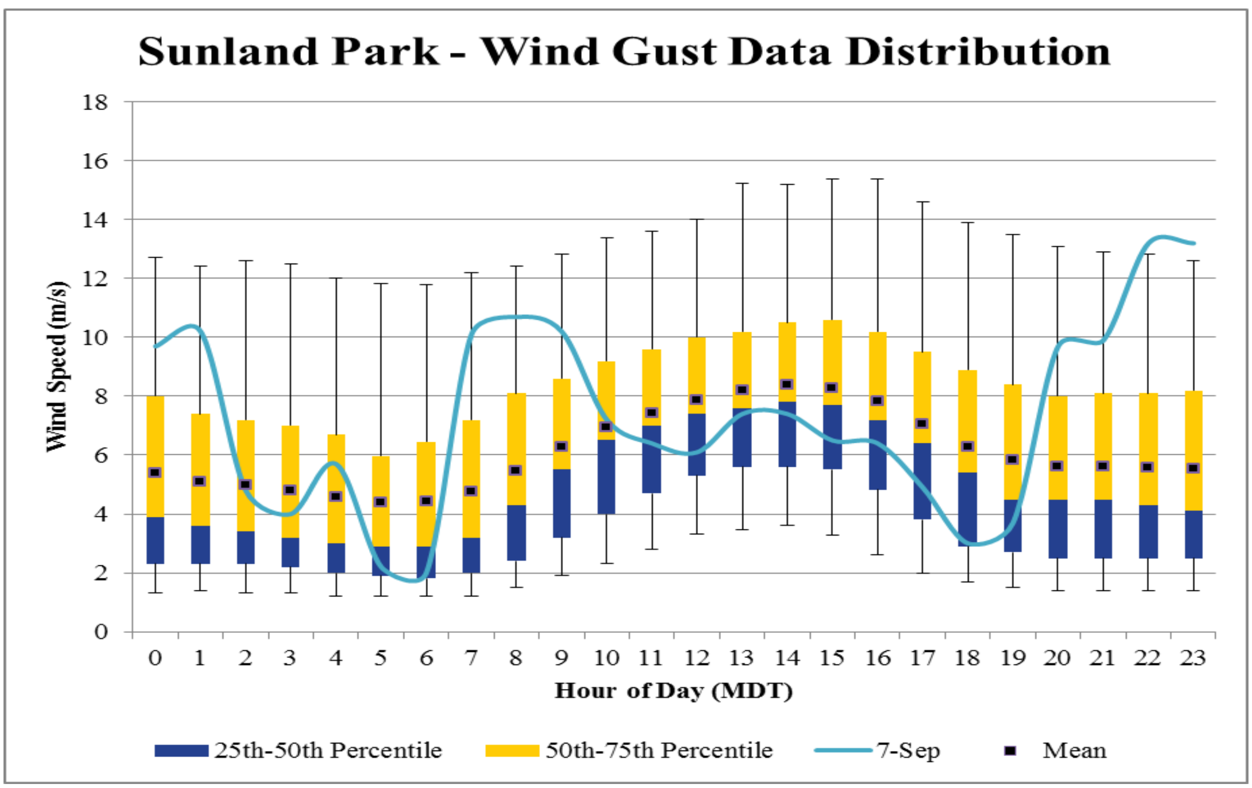

Figure 26-8b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for September 7, 2011.

26.4 Clear Causal Relationship

The major contributing factor to the high wind event that occurred on September 7, 2011 was the formation thunderstorms sparked by an infusion of moisture from a hurricane in the Gulf of Mexico, Hurricane Nate (Figure 26-9). High pressure aloft pulled in moisture from the Gulf of Mexico that allowed for thunderstorm development in the evening (Figure 26-10). Daytime heating allowed clouds and thunderstorms to form over central New Mexico with a smaller line of storms forming in Doña Ana and Luna Counties in the afternoon and evening (Figures 26-11).

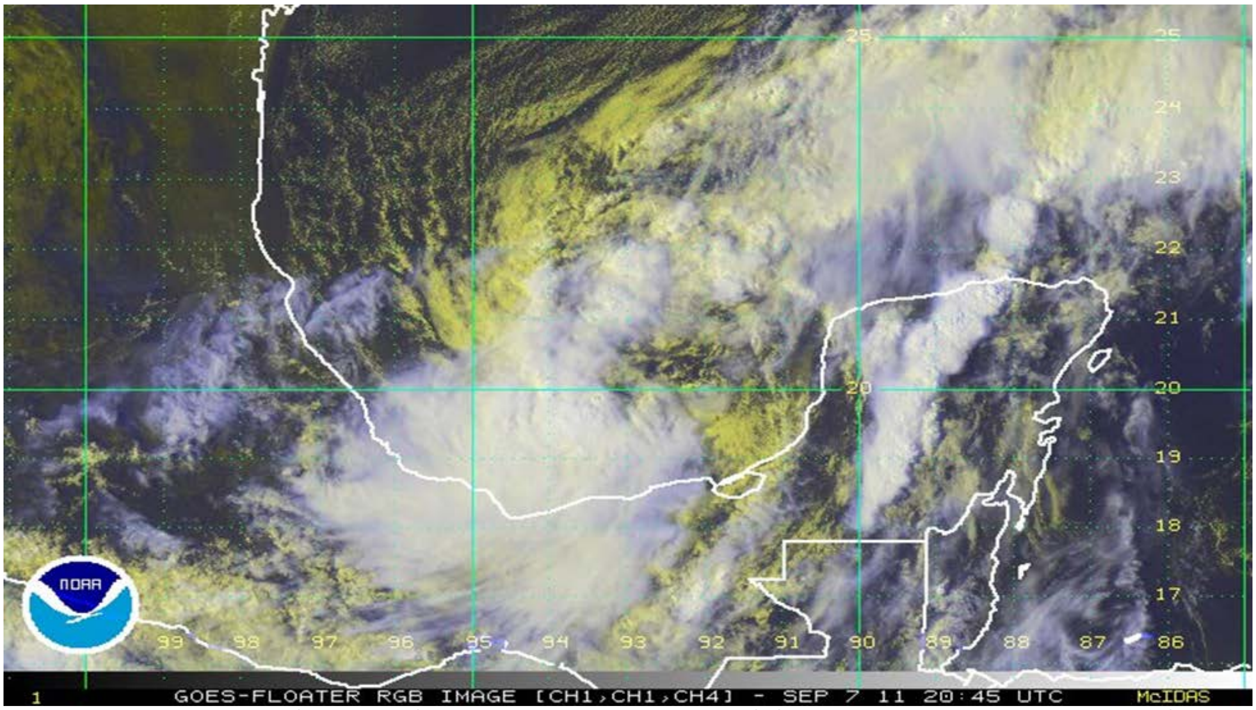

Figure 26-9. Satellite imagery of the center of Hurricane Nate in the southern Gulf of Mexico on September 7, 2011 (Courtesy of GOES).

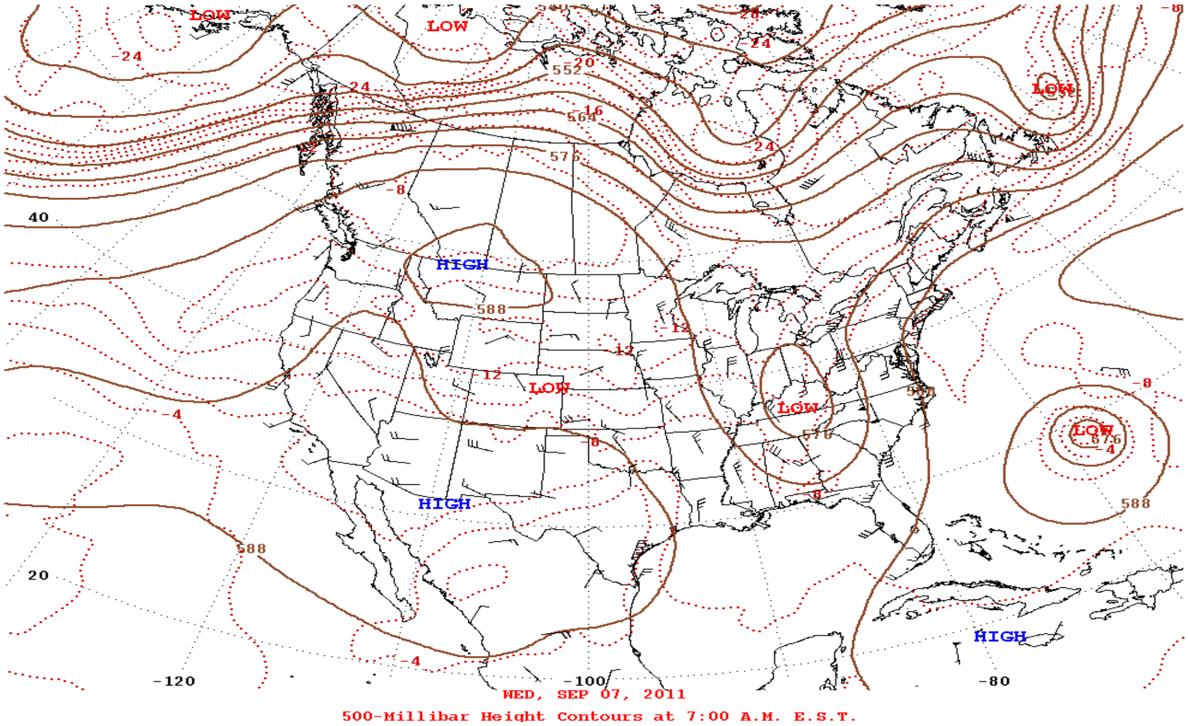

Figure 26-10. Upper air weather map for September 7, 2011 at the 500 hour.

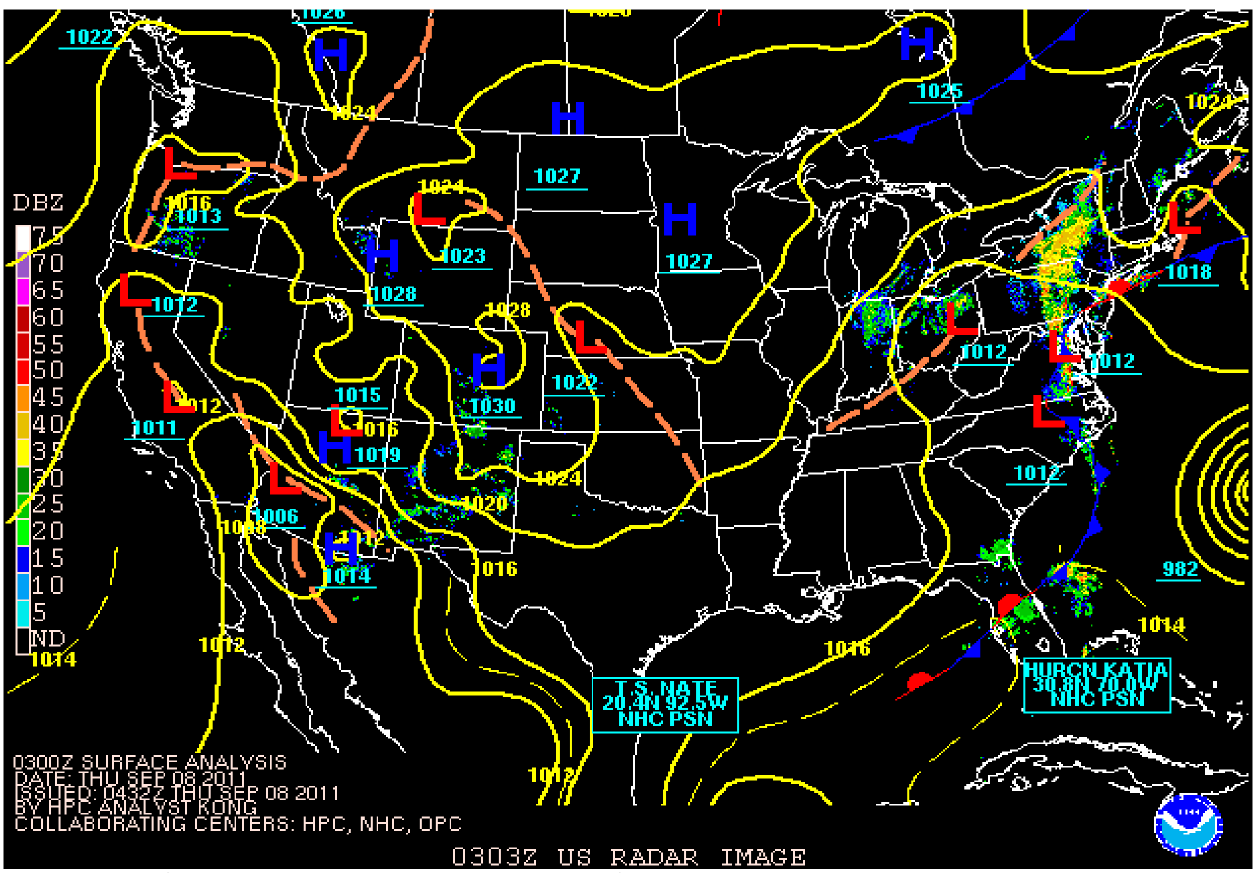

Figure 26-11. Surface weather map showing thunderstorm activity for September 7, 2011 at the 2000 hour.

Thunderstorms generated strong north-northeast winds beginning at the 2000 hour and lasting through the 2300 hour. Beginning at the 2000 hour, wind speeds exceeded 11.2 m/s at Holman and the historical 95th percentile of data at Chaparral as shown in Figures 26-2 and 26-7a. Peak wind speeds ranged from 3.7 m/s at La Union to 12 m/s at Holman (Figure 26-2). Peak wind gusts ranged from 10.3 m/s at La Union to 21.2 m/s at Holman (Figure 26-3). Blowing dust caused elevated levels of PM_{10} during the same period as high winds as demonstrated by the time series plot in Figures 26-12a-b. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (1900-2300 hours). During these hours, hourly PM_{10} and $PM_{2.5}$ concentrations spiked at most sites in the network (Figure 26-13a-b). Hourly data from the SPCY PM_{10} and $PM_{2.5}$ TEOM Monitors show good correlation of the timing of spikes in concentrations (Figure 26-14).

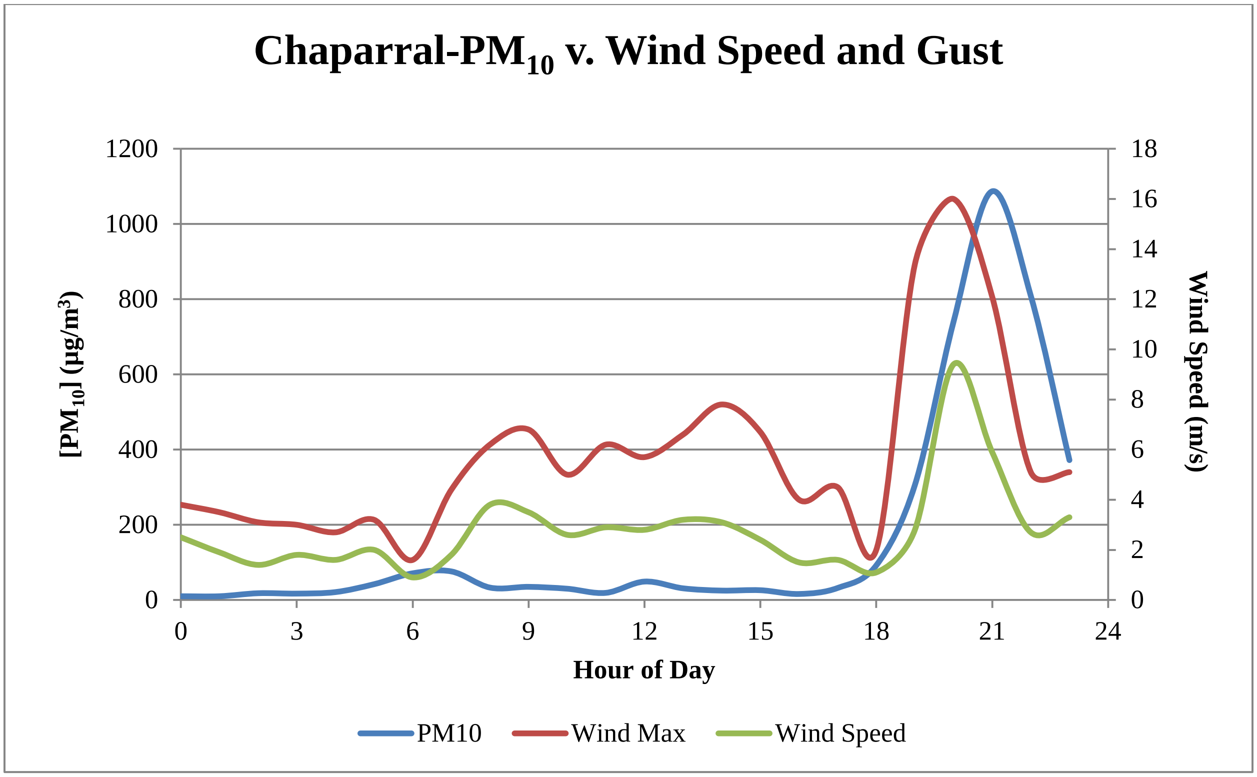

Figure 26-12a. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

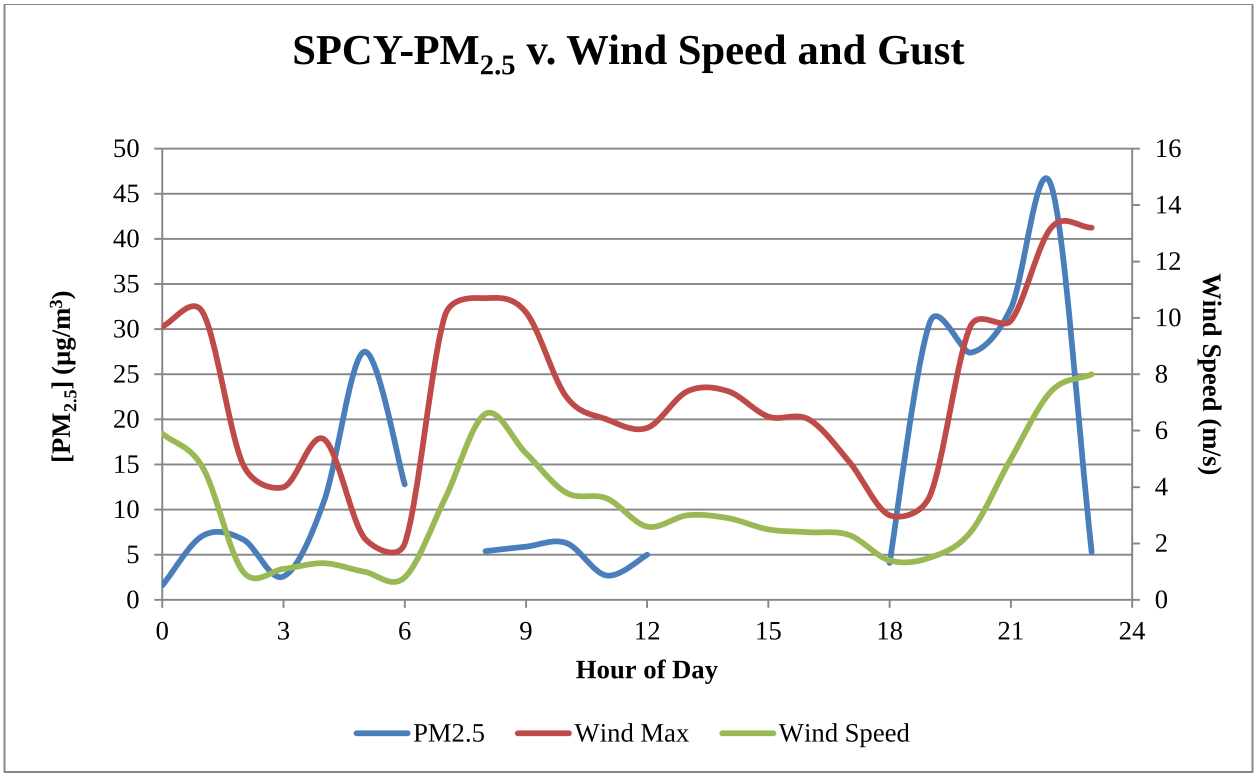

Figure 26-12b. Time series plot of hourly observations showing increased $PM_{2.5}$ concentrations as wind speeds and gusts increase.

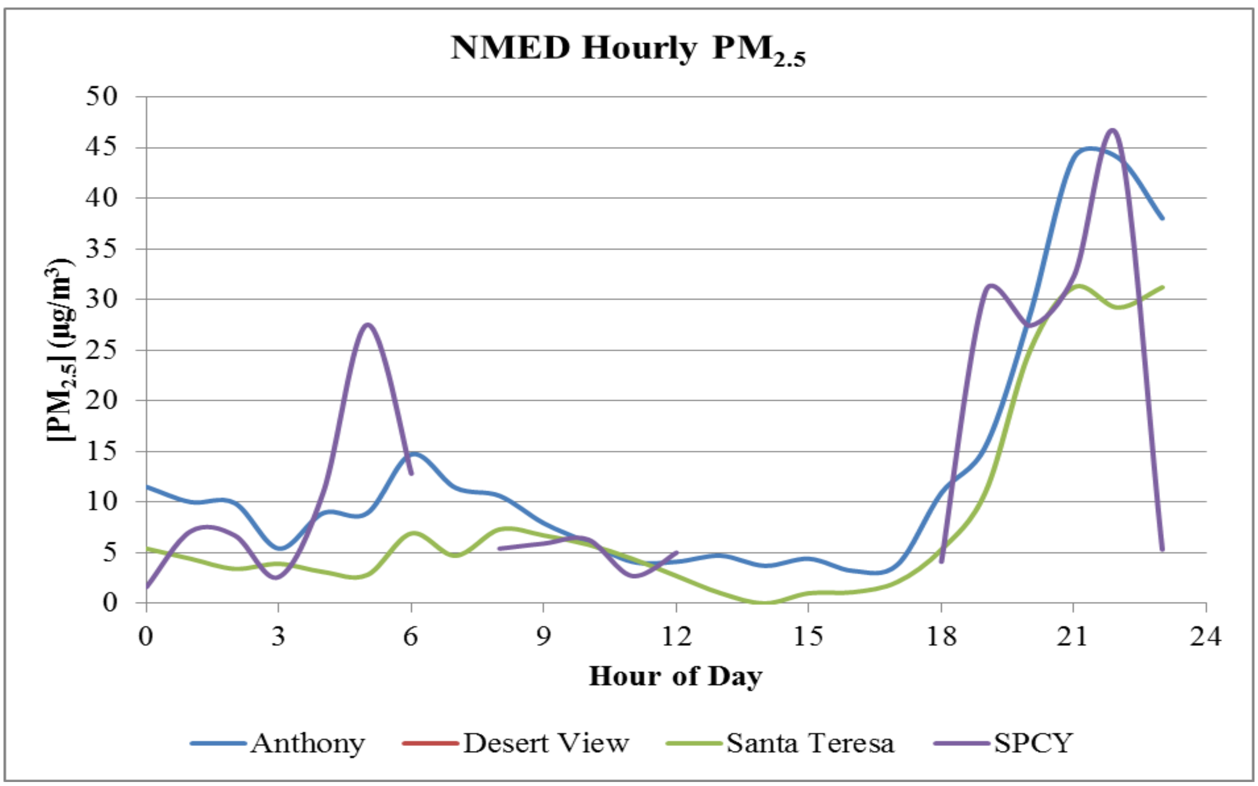

Figure 26-13a. Hourly $PM_{2.5}$ concentrations for Doña Ana and Luna Counties monitors. Non-FEM hourly $PM_{2.5}$ data.

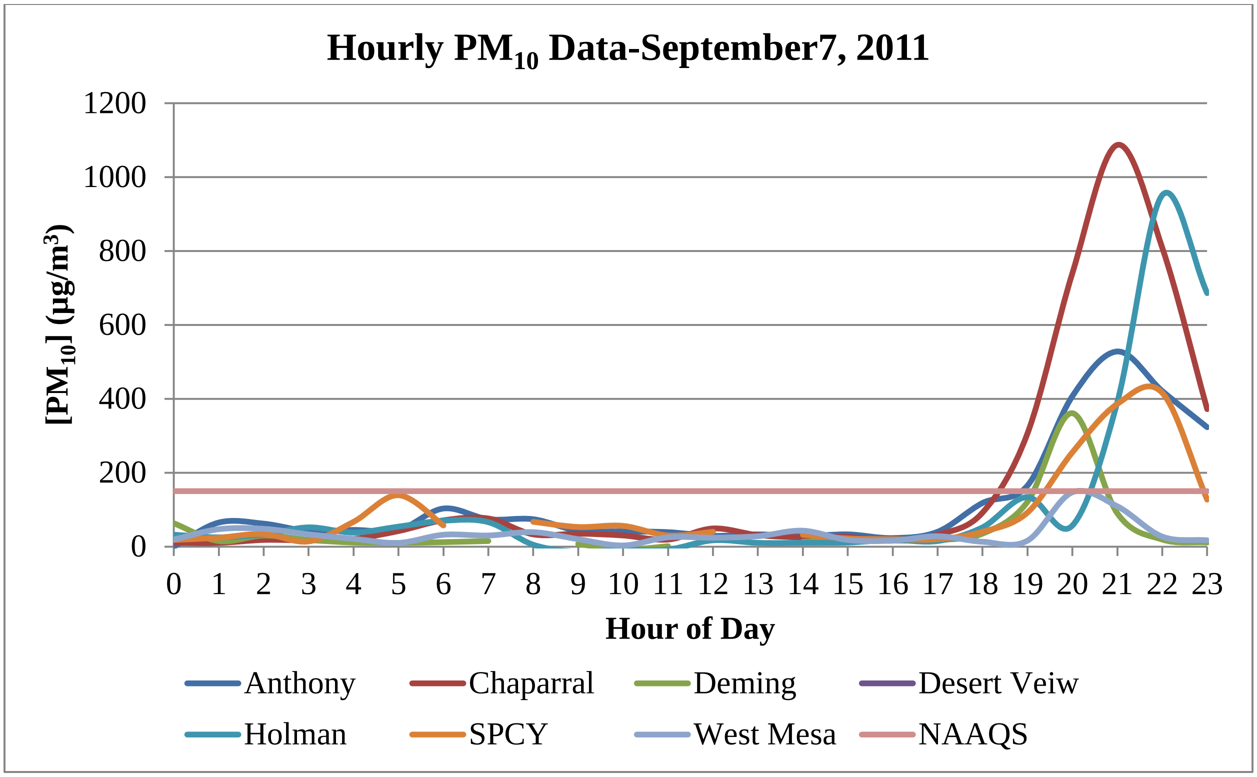

Figure 26-13b. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

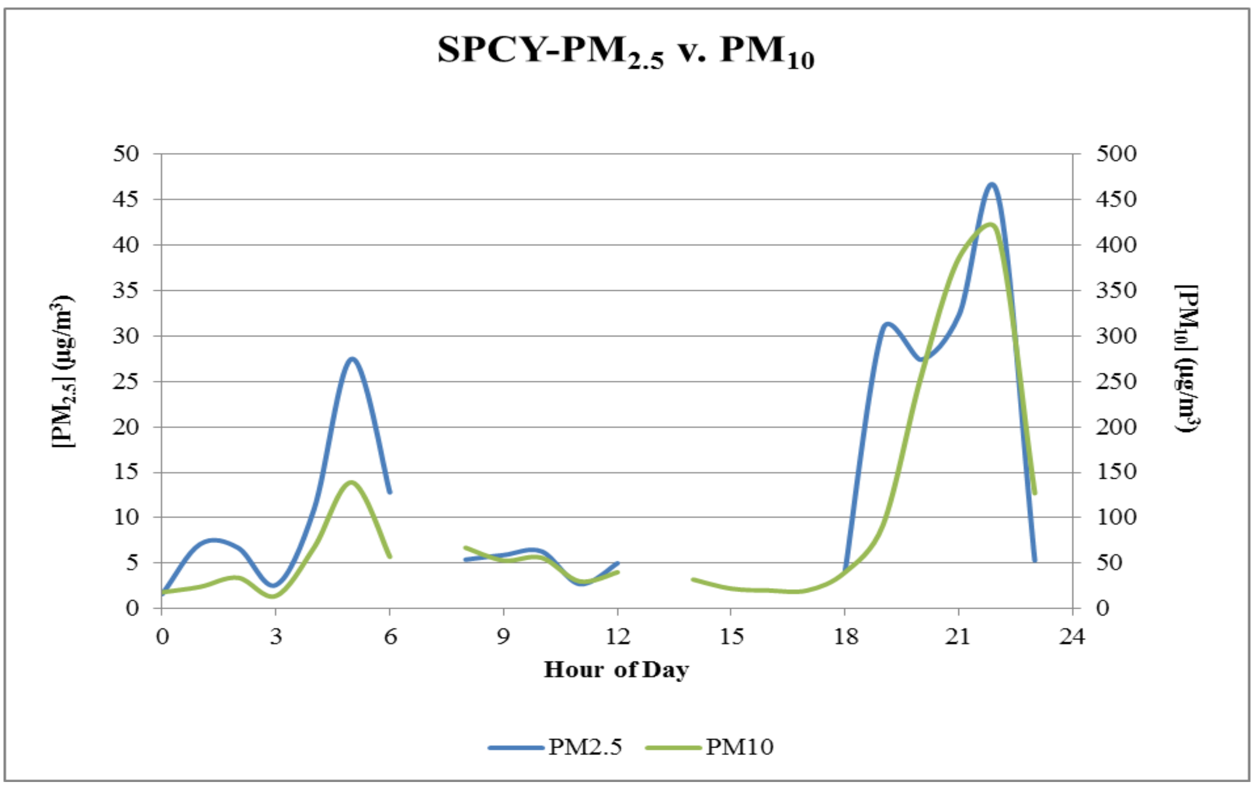

Figure 26-14. Hourly PM_{10} and $PM_{2.5}$ concentrations for the SPCY monitoring site on September 7, 2011.

The NWS noted the following weather conditions in the area in their daily climate summary,

> ...THE EL PASO CLIMATE SUMMARY FOR SEPTEMBER 7 2011...
>
> WEATHER CONDITIONS
> THE FOLLOWING WEATHER WAS RECORDED YESTERDAY.
> SANDSTORM
>
> ...THE DEMING CLIMATE SUMMARY FOR SEPTEMBER 7 2011...
>
> WEATHER CONDITIONS
> THE FOLLOWING WEATHER WAS RECORDED YESTERDAY.
> HAZE
>
> ...THE TRUTH OR CONSEQUENCES CLIMATE SUMMARY FOR SEPTEMBER 7 2011...
>
> WEATHER CONDITIONS
> THE FOLLOWING WEATHER WAS RECORDED YESTERDAY.
> LIGHT RAIN (NWS, 2011).

26.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on September 7, 2011.

26.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by high wind and blowing dust.

26.7 No Exceedance but for the Event

The Chaparral monitor detected blowing dust around the 1900 hour with hourly concentrations heavily impacted until the 2300 hour. By replacing these five hourly values with the 95th percentile of hourly data at the Chaparral site, the resulting 24-hour average (47 µg/m^3) does not exceed the NAAQS (Table 26-1). The values in red represent the 95th percentile of all hourly data collected at Chaparral, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	10	10
1	10	10
2	18	18
3	17	17
4	21	21
5	42	42
6	71	71
7	76	76
8	33	33
9	35	35
10	30	30
11	19	19
12	49	49
13	31	31
14	25	25
15	26	26
16	16	16
17	32	32
18	92	92
19	306	**126**
20	740	**111**
21	1087	**94**
22	809	**80**
23	372	**71**
24-Hour Average	165	**47**

Table 26-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Chaparral.

27 HIGH WIND EXCEPTIONAL EVENT: November 2, 2011

27.1 Summary of Event

The passing of a combined Pacific and backdoor cold front caused high winds and blowing dust in southern Doña Ana County resulting in an exceedance of the PM_{10} 24-hour NAAQS and the $PM_{2.5}$ annual NAAQS at the Chaparral and SPCY monitoring sites, respectively, on this date. The FEM TEOM continuous monitor at the Chaparral site recorded a 24-hour average concentration of 180 µg/m^3. In accordance with the EER and the $PM_{2.5}$ annual NAAQS, the AQB flagged this data on EPA's AQS database as a high wind natural event. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were measured at Anthony (154 µg/m^3), Desert View (140 µg/m^3), and SPCY (136 µg/m^3) monitoring sites (Figure 27-1a). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event. Elevated concentrations were also recorded by the $PM_{2.5}$ non-FEM/FRM TEOMs (Figure 27-1b).

As the event unfolded, the wind blew from the northwest throughout the border region then shifted north-northeast. These high velocity winds passed over large areas of desert within New Mexico, including the White Sands National Monument. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

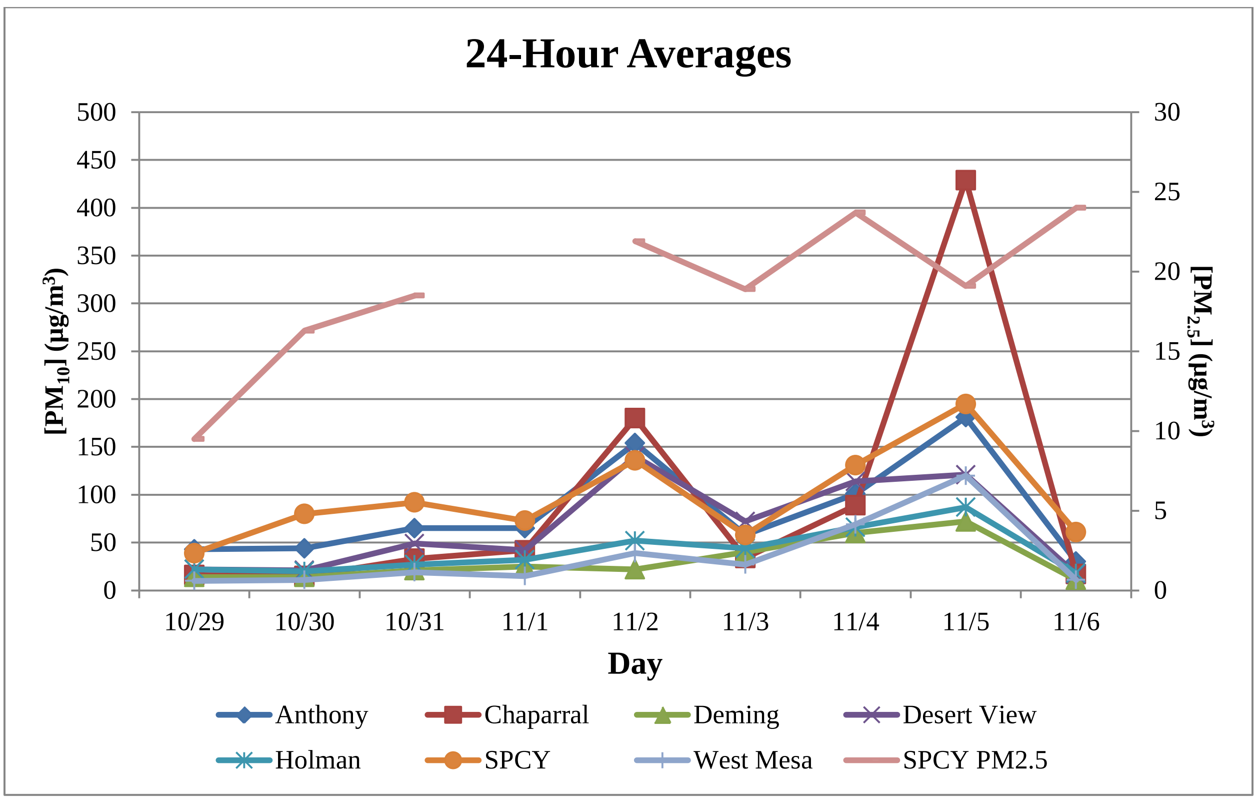

Figure 27-1a. PM_{10} and $PM_{2.5}$ 24-hour averages before and after November 2, 2011.

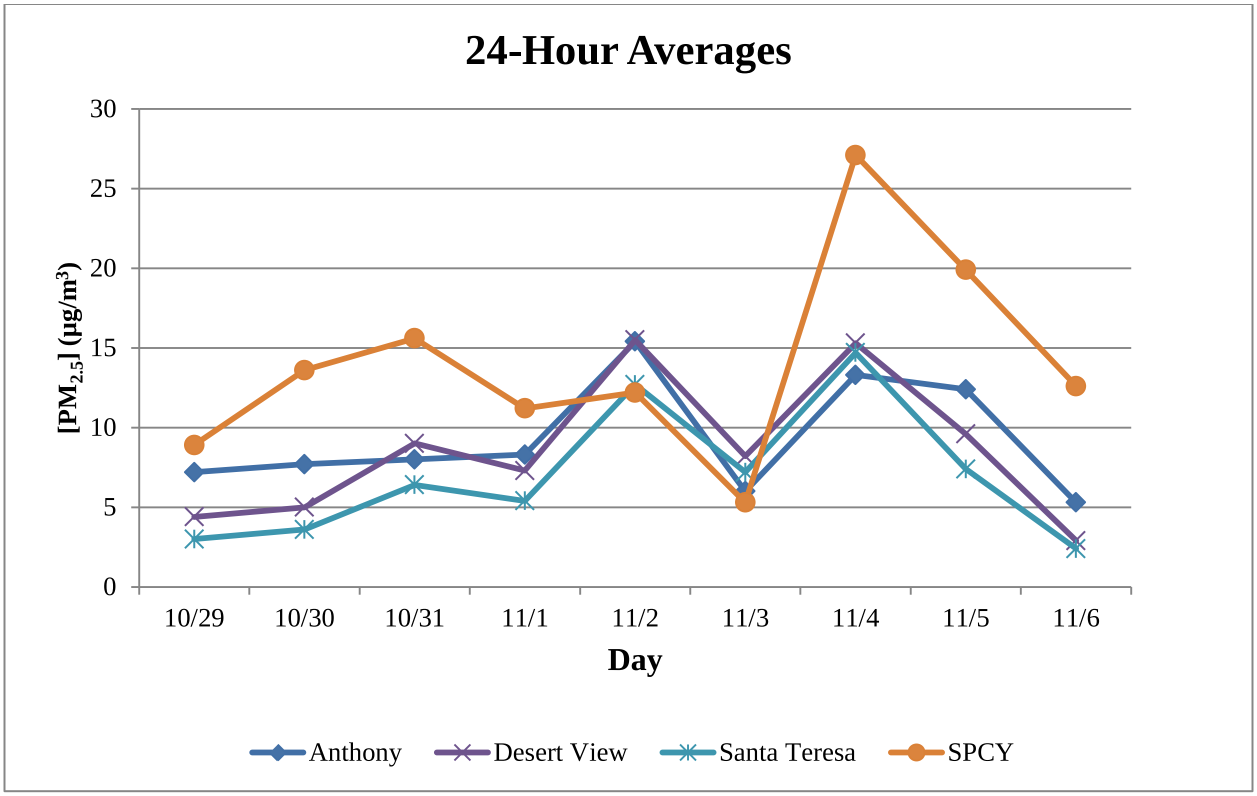

Figure 27-1b. $PM_{2.5}$ 24-hour averages before and after November 2, 2011.

27.2 Is Not Reasonably Controllable or Preventable

27.2.1 <u>Suspected Source Areas and Categories Contributing to the Event</u>

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in New Mexico. The City of Las Cruces, the City of Deming and Doña Ana and Luna County Ordinances require BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and White Sands National Monument (see Section 27.2.4 below).

27.2.2 <u>Sustained and Instantaneous Wind Speeds</u>

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On November 2, 2011, sustained wind speeds approached EPA's default threshold at two of the seven monitoring sites in southern New Mexico and wind gusts approached the NEAPs agreed upon threshold at two of the seven monitoring sites (Figures 27-2 and 27-3). However, NMED has found that a sustained hourly wind speed lasting two hours or more of 6 m/s with instantaneous wind gusts of 12 m/s or more can create blowing dust in the border region (Aaboe, Cook, Musick, et. al 1997-2007). As indicated in Figures 27-2 and 27-3, these conditions were met on November 2, 2011.

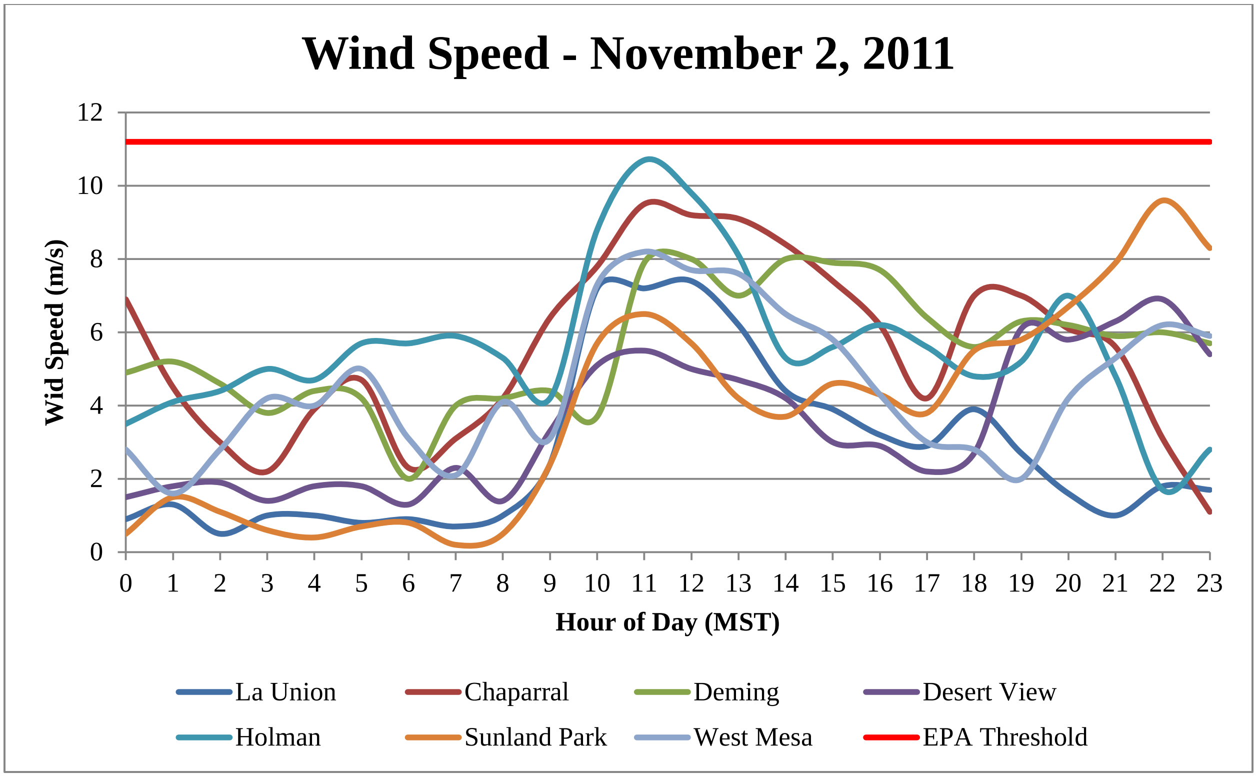

Figure 27-2. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

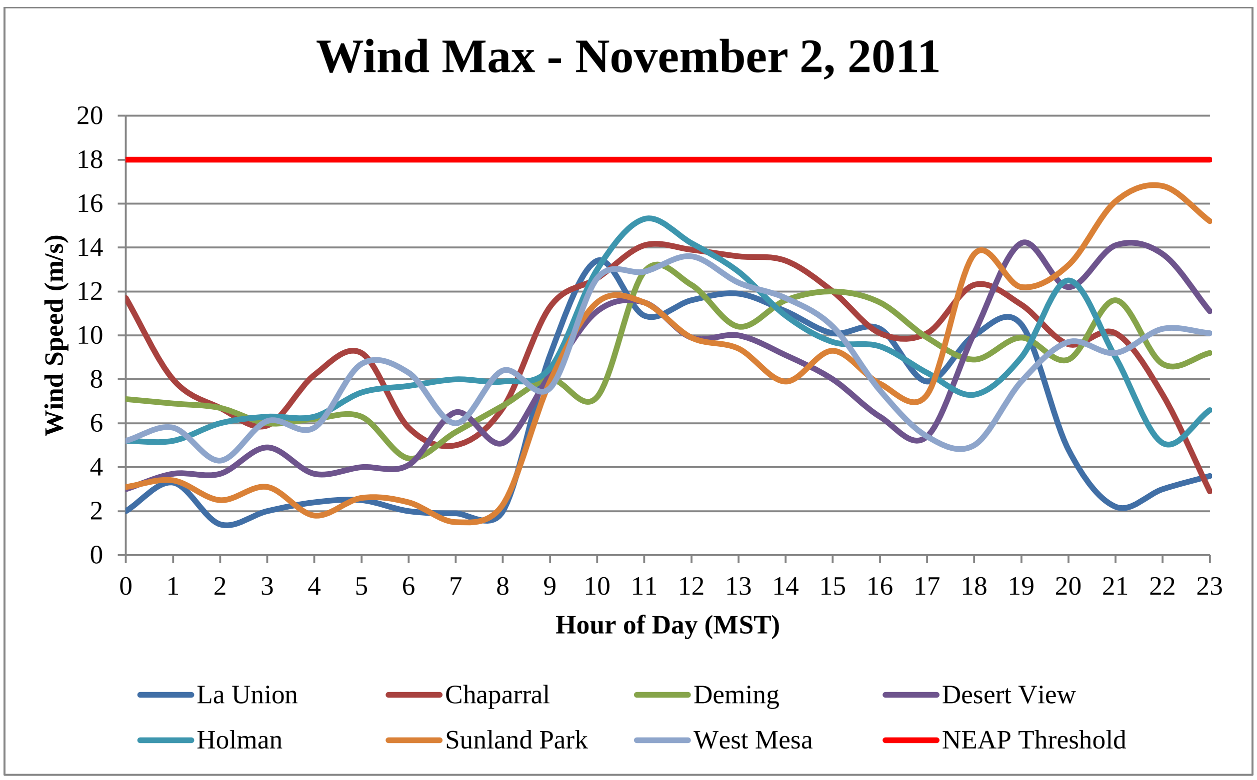

Figure 27-3. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

27.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the PM_{10} FEM TEOM monitors recorded 211 exceedances and the PM_{10} FRM Wedding monitors recorded 5 exceedances (Figure A-2). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

27.2.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana County. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert and playas in New Mexico. The southern sites in Doña Ana County recorded the highest 24-hour averages in the monitoring network. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled northwest then shifted and traveled from a northerly direction over White Sands National Monument to the monitors in southern Doña Ana County. The model starts eight hours before the start of elevated PM_{10} concentrations measured during the event (Figure 27-4). Costs prohibit controlling dust from the natural desert terrain, such as the White Sands National Monument. NMED concludes that the sources contributing to the event are not reasonably controllable.

Figure 27-4. HYSPLIT back-trajectory model analysis for the Chaparral Monitor at 1200 hours on November 2, 2011.

27.3 Historical Fluctuations Analysis

27.3.1 Annual and Seasonal 24-hour Average Fluctuations

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM

TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded value for this day (180 µg/m^3) is above the maximum value recorded when no high wind exceedances are included and is above the 95th percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for November 2, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95th percentile for PM_{10} and wind speed (Figures 27-5 to 27-7). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} values during the high wind blowing dust storm far exceed the historical 95th percentile of data.

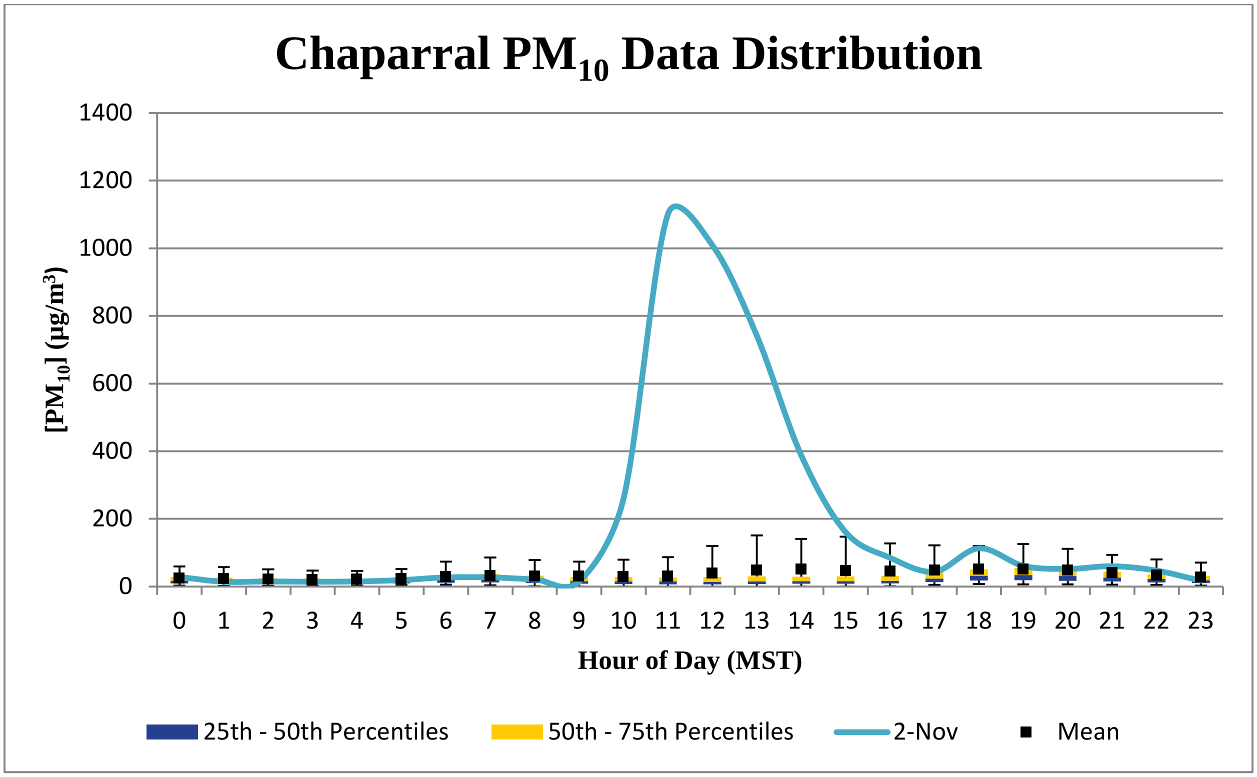

Figure 27-5. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for November 2, 2011.

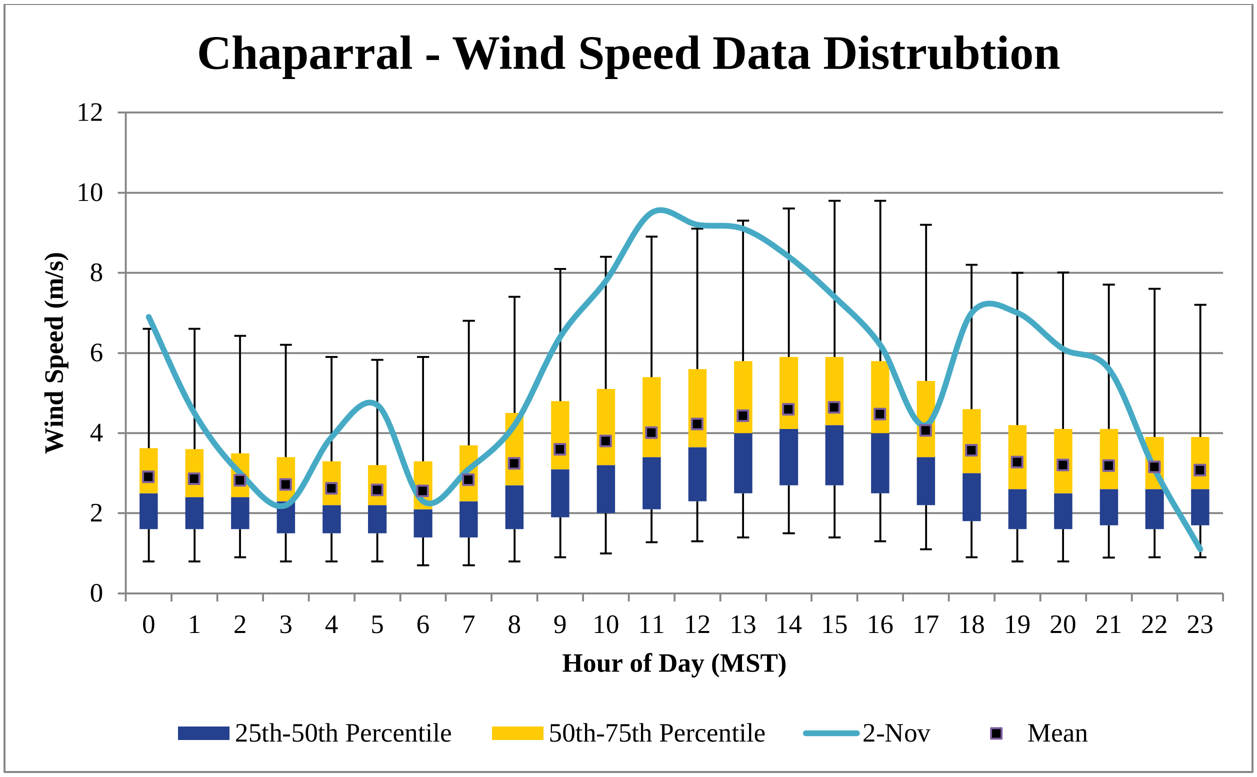

Figure 27-6. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for November 2, 2011.

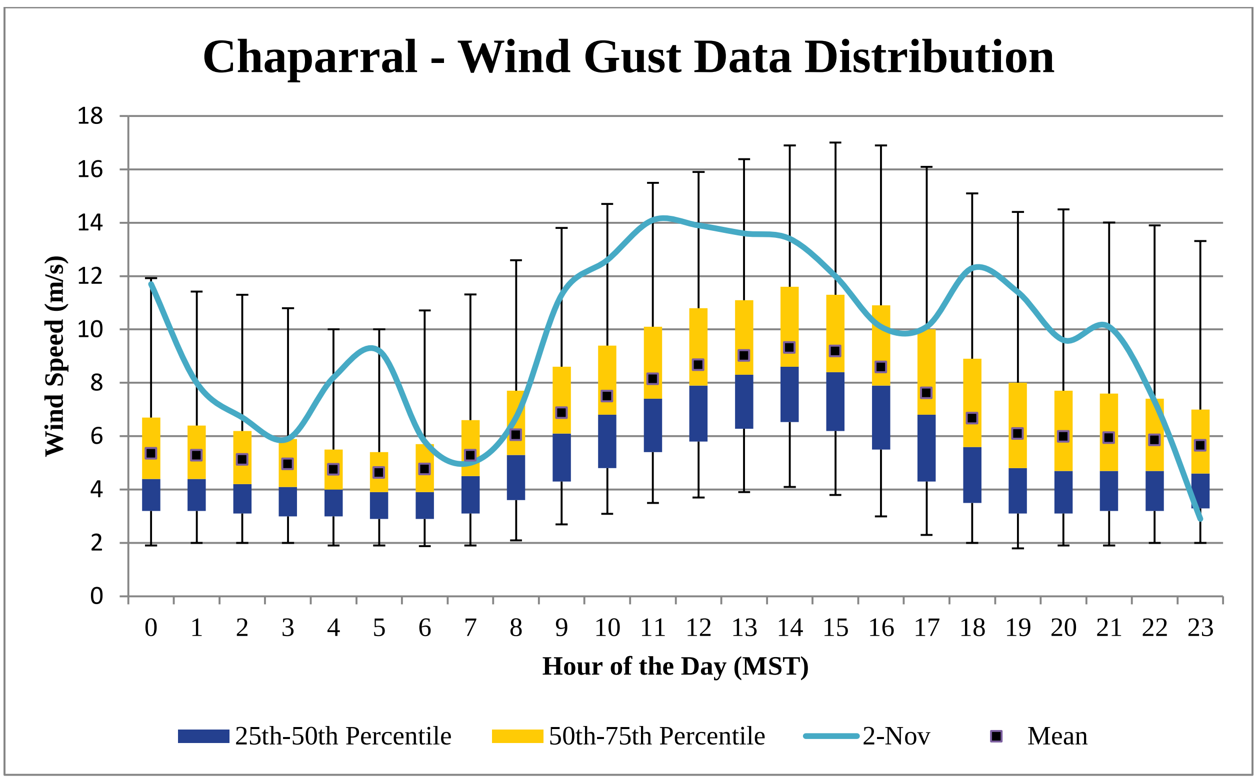

Figure 27-7. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for November 2, 2011.

27.4 Clear Causal Relationship

An approaching Pacific cold front gave way to a backdoor cold front that passed through New Mexico on November 2, 2011. At the 0300 hour, these cold fronts met with a low pressure center over central Colorado, creating a weak pressure gradient over southeastern Arizona, central and southern New Mexico, Texas, and northern Mexico (Figure 27-8a). As the backdoor cold front moved south through New Mexico, the pressure gradient shifted to northern New Mexico (Figure 27-8b). Surface winds flow perpendicular to the isobars from high to low pressure. The associated upper trough did not align with the surface winds and did not enhance wind speeds (Figure 27-9). Little to no downward mixing further suppressed wind speeds and widespread blowing dust.

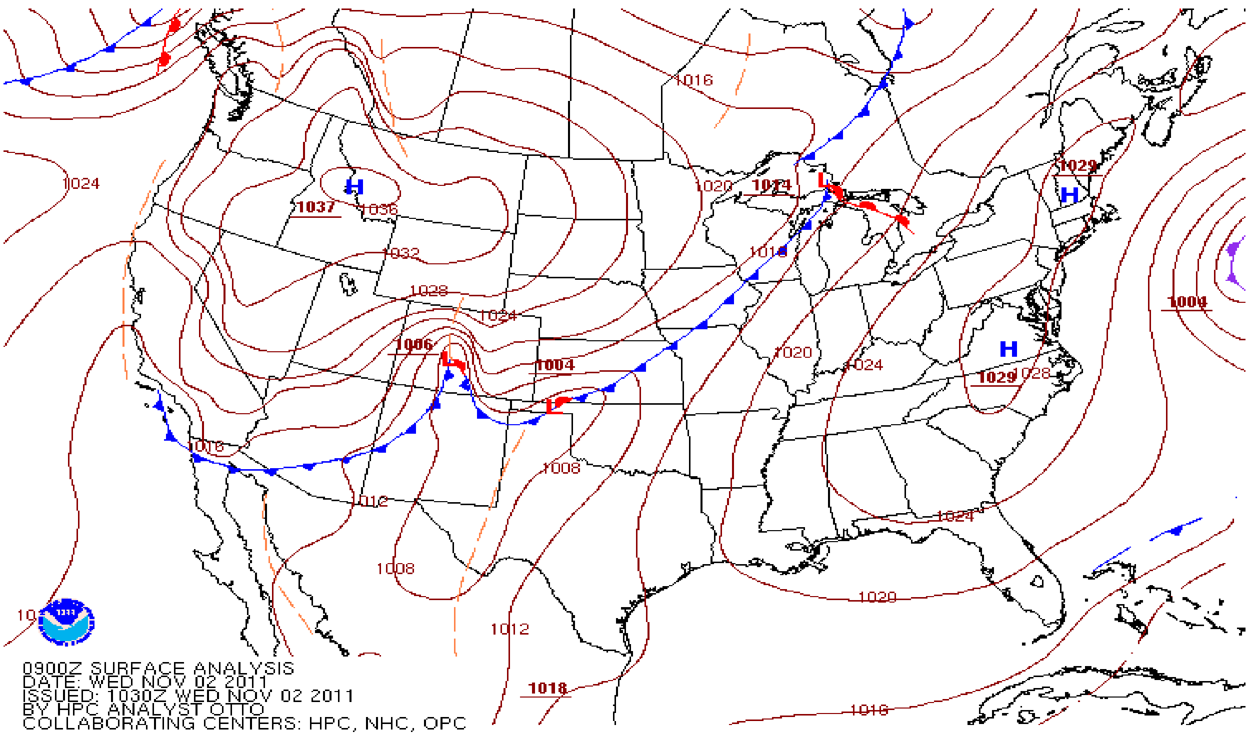

Figure 27-8a. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for November 2, 2011 at the 0300 hour MST.

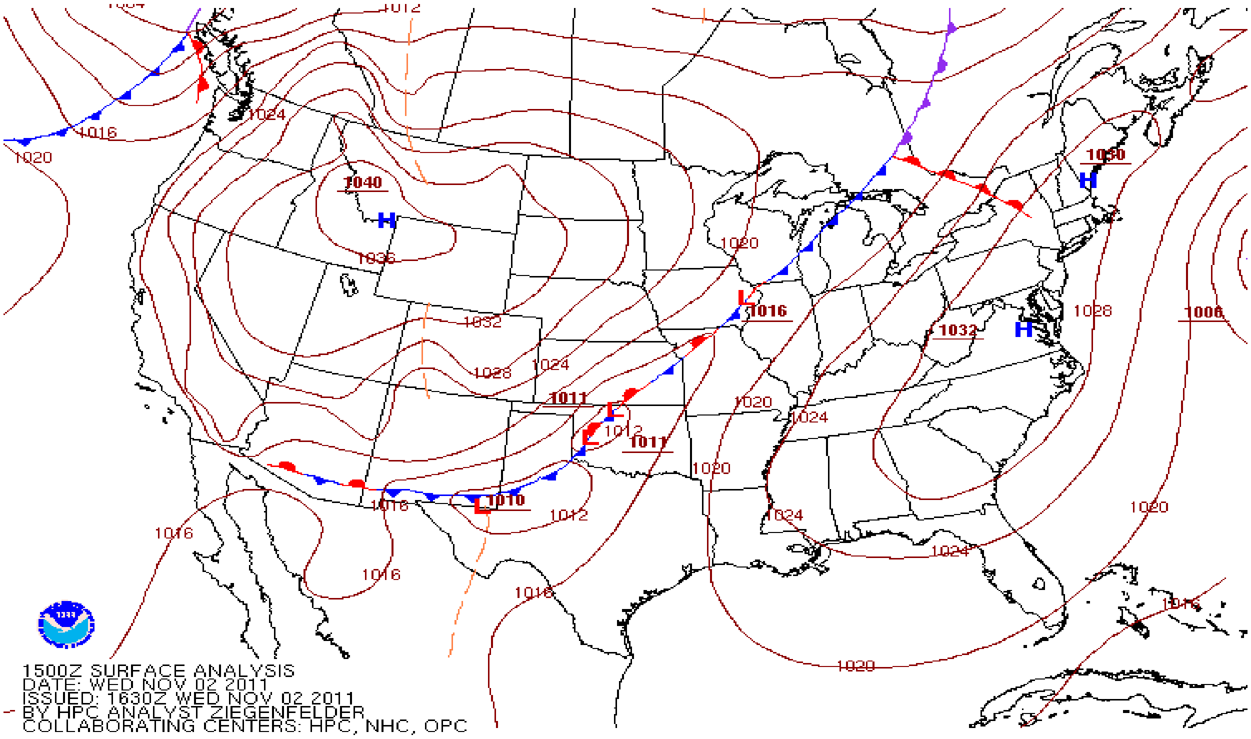

Figure 27-6b. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for November 2, 2011 at the 1100 hour.

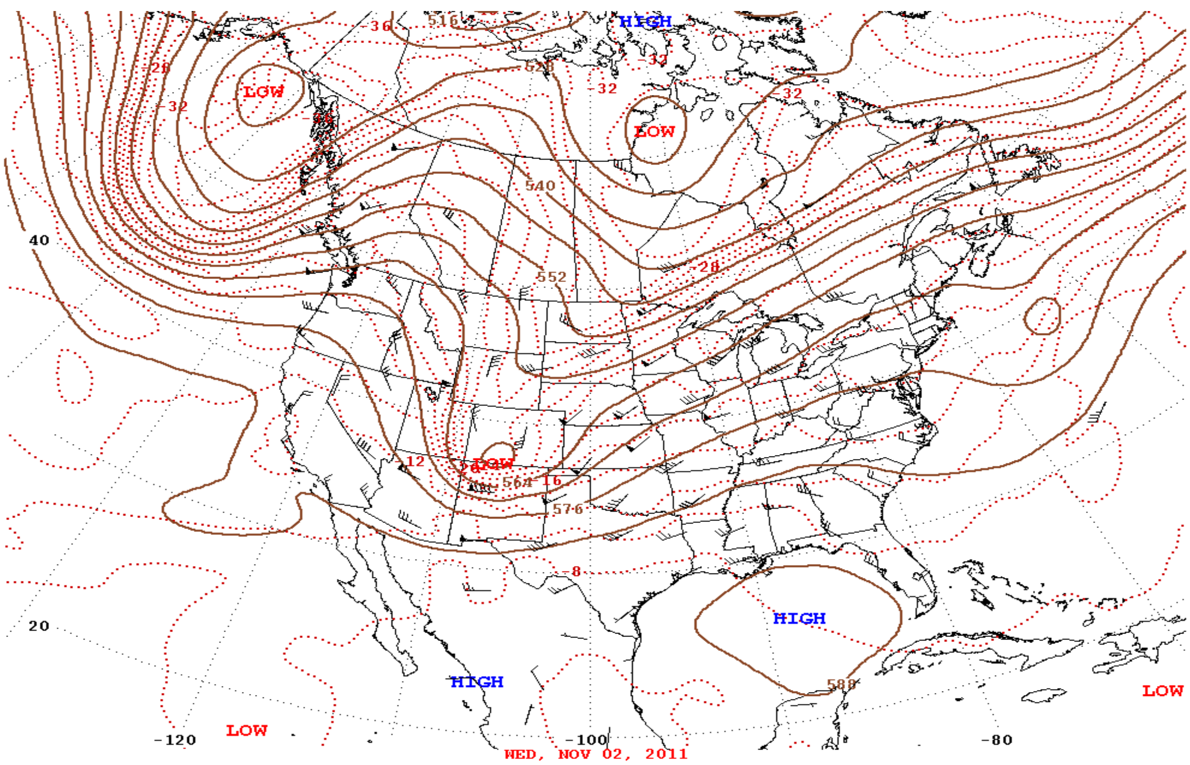

Figure 27-9. Upper air weather map showing geopotential heights (brown lines) at the 500 hour on November 2, 2011.

The weather pattern described above generated strong northwesterly and northerly winds beginning at approximately the 1030 hour and lasting through the 1200 hour. Beginning at the 1100 hour, wind speeds exceeded the historical 95th percentile of data at Chaparral as shown in Figure 27-6. Peak wind speeds ranged from 5.5 m/s at Desert View to 10.7 m/s at Holman (Figure 27-2). Peak wind gusts ranged from 11.5 m/s at Desert View and Sunland Park to 15.3 m/s at Holman (Figure 27-3). Blowing dust caused elevated levels of PM_{10} during the same period as high winds as demonstrated by the time series plot in Figure 27-10. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (1000-1500 hours). During these hours, hourly PM_{10} concentrations spiked at all monitoring sites in the network (Figure 27-11). Hourly data from the SPCY PM_{10} and $PM_{2.5}$ TEOM Monitors show good correlation of the timing of spikes in concentrations (Figure 27-12).

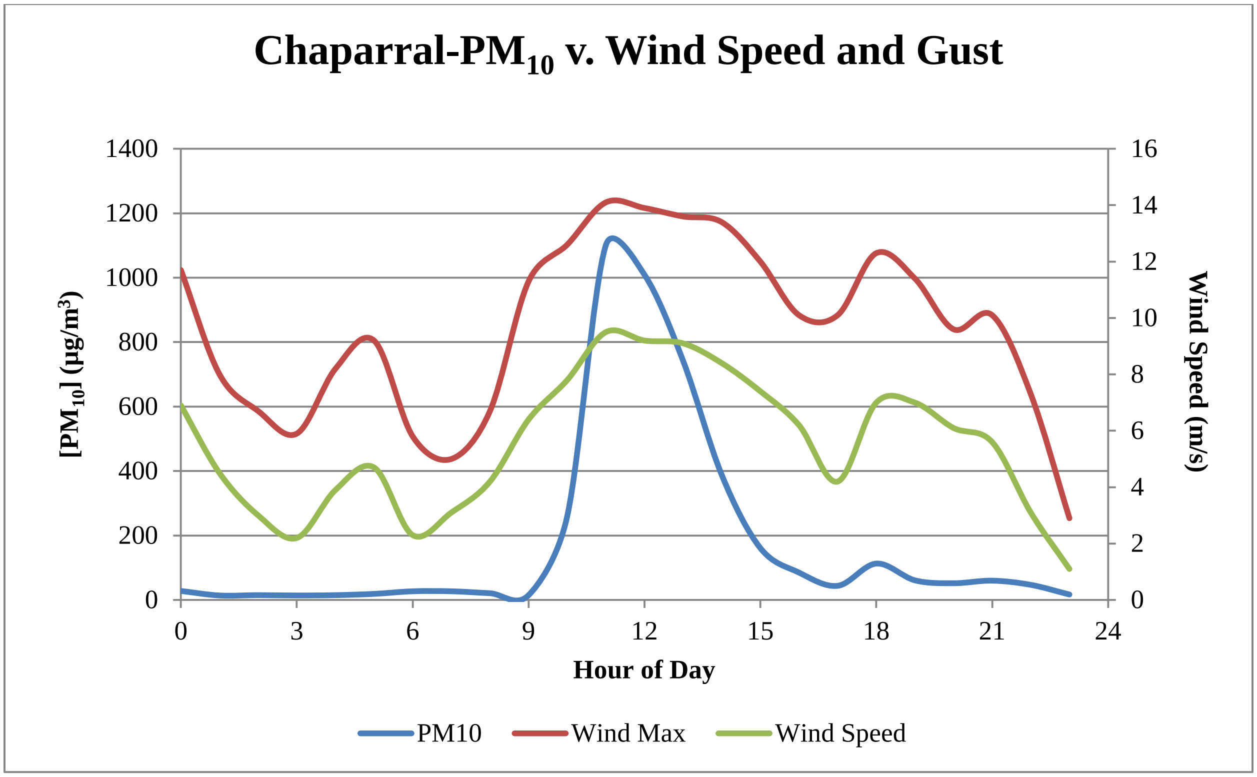

Figure 27-10. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

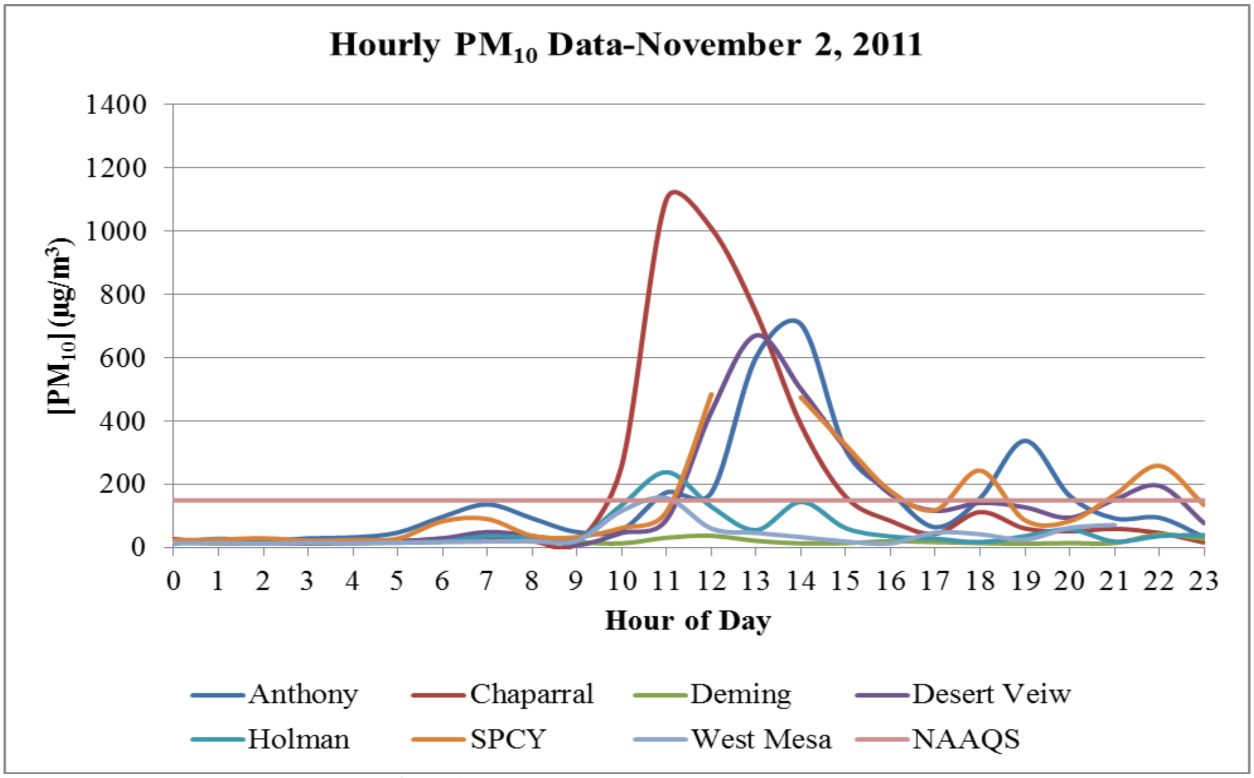

Figure 27-11. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

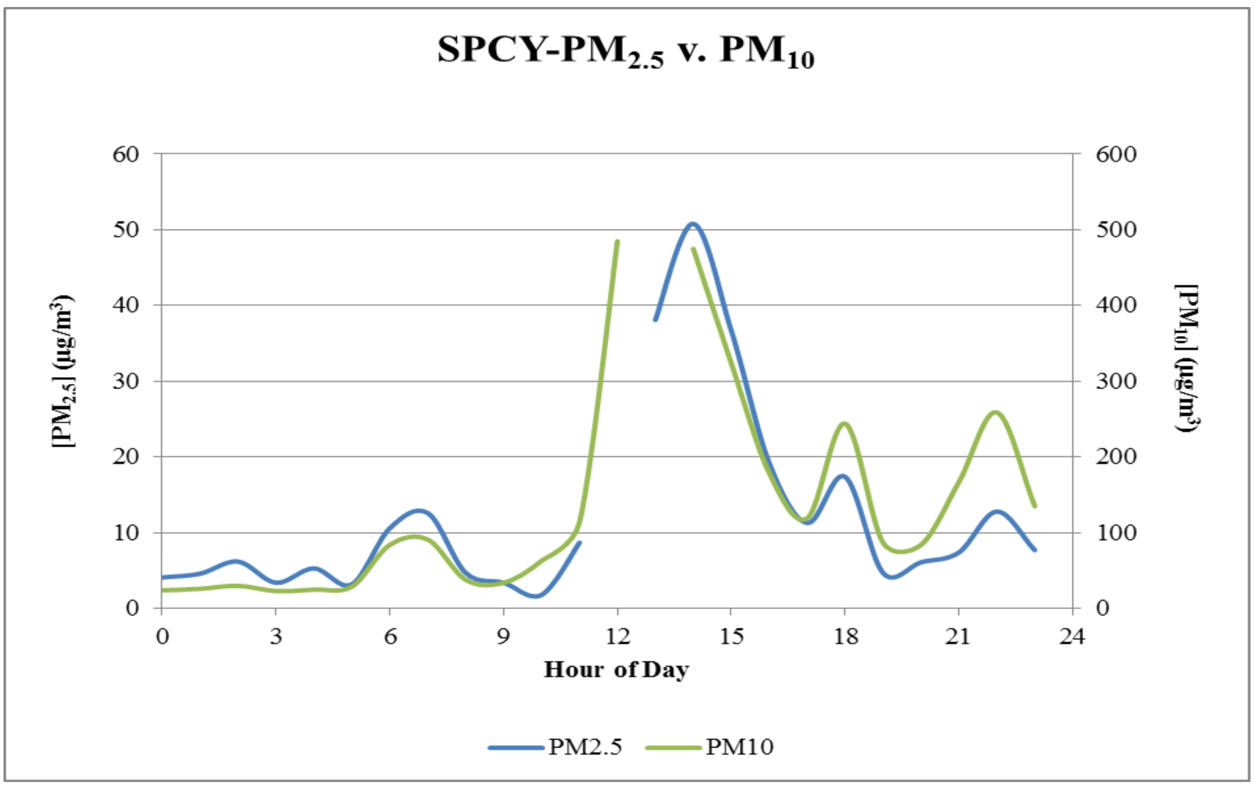

Figure 27-12. Hourly PM_{10} and $PM_{2.5}$ concentrations for the SPCY monitoring site on November 2, 2011.

The NM Border Air Quality Blog reported that on this date, "Winds lofted sand from the White Sands dune field" (DuBois, 2011), and included a link to a satellite photo (Figure 27-13) produced by the US National Weather Service – El Paso, TX.

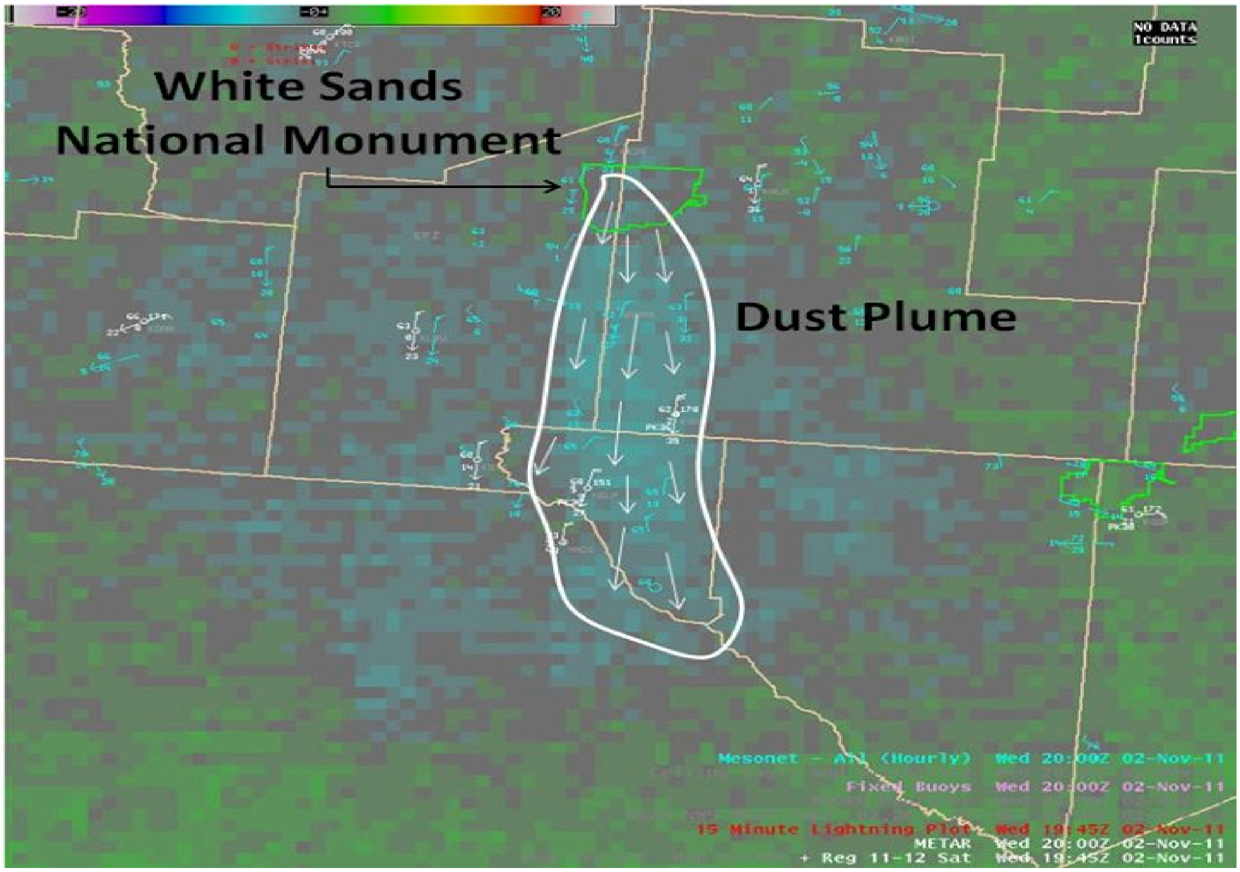

Figure 27-13. US NWS satellite image showing the location of the White Sands National Monument and dust plume (Courtesy US NWS El Paso, TX).

The NWS issued a special weather statement in the afternoon noting the blowing dust from in desert areas and White Sands National Monument,

> A COLD FRONT PUSHED SOUTH THROUGH THE REGION DURING THE DAY WEDNESDAY. IT BROUGHT COOLER TEMPERATURES AND GUSTY NORTH WINDS. BLOWING DUST WAS ALSO EXPERIENCED ACROSS THE LOWLAND DESERT AREAS...AND IN PARTICULAR SOUTH OF WHITE SANDS MONUMENT ALL THE WAY TO EL PASO (NWS, 2011).

27.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on November 2, 2011.

27.6 Natural Event

The Clear Causal Relationship and not Reasonably Controllable or Preventable analyses show that this was a natural event caused by high wind and blowing dust.

27.7 No Exceedance but for the Event

The Chaparral monitor detected blowing dust around the 1000 hour with hourly concentrations heavily impacted until the 1500 hour. By replacing these six hourly values with the 95th percentile of hourly data at the Chaparral site, the resulting 24-hour average (58 µg/m^3) does not exceed the NAAQS (Table 27-1). The values in red represent the 95th percentile of all hourly data collected at Anthony, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	28	28
1	14	14
2	15	15
3	14	14
4	15	15
5	19	19
6	27	27
7	27	27
8	21	21
9	15	15
10	260	**79**
11	1101	**87**
12	1009	**120**
13	742	**151**
14	388	**141**
15	161	**147**
16	85	85
17	44	44
18	113	113
19	61	61
20	52	52
21	60	60
22	47	47
23	17	17
24-Hour Average	180	**58**

Table 27-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Chaparral.

28 HIGH WIND EXCEPTIONAL EVENT: November 5, 2011

28.1 Summary of Event

The passing of a Pacific cold front caused high winds and blowing dust in southern Doña Ana County resulting in exceedances of the PM_{10} 24-hour NAAQS at the Anthony, Chaparral, and SPCY monitoring sites and the $PM_{2.5}$ annual NAAQS at SPCY on this date. The FEM TEOM continuous monitors at these sites recorded 24-hour average concentrations of 181, 429, and 195 $\mu g/m^3$, respectively. The $PM_{2.5}$ FRM Partisol at SPCY recorded a 24-hour average concentration 19.1 $\mu g/m^3$. The PM_{10} FRM Wedding monitors recorded 24-hour average concentrations of 94 and 91 $\mu g/m^3$ at the Anthony and SPCY sites. Although no other monitoring sites recorded an exceedance on this date, elevated PM_{10} concentrations were measured at the Desert View (121 $\mu g/m^3$) and West Mesa (120 $\mu g/m^3$) monitoring sites (Figure 28-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event.

As the event unfolded, the wind blew from the southwest throughout the border region. These high velocity winds passed over large areas of desert within New Mexico and Mexico. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

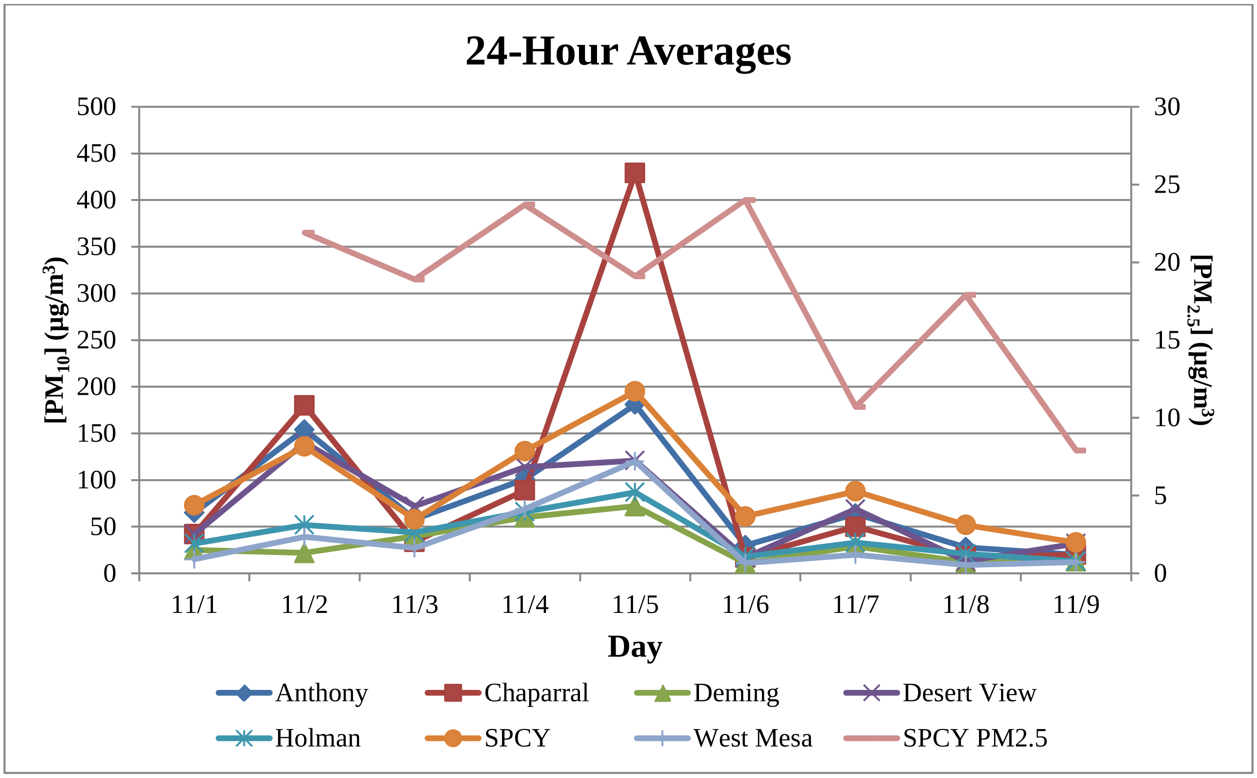

Figure 28-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after November 5, 2011.

28.2 Is Not Reasonably Controllable or Preventable

28.2.1 Suspected Source Areas and Categories Contributing to the Event

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in northern Mexico and southwestern New Mexico. The City of Las Cruces and Doña Ana County Ordinances require BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and the playas of northern Mexico (see Section 28.2.4 below).

28.2.2 Sustained and Instantaneous Wind Speeds

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On November 5, 2011, sustained wind speeds exceeded EPA's default threshold at four of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at six of the seven monitoring sites (Figures 28-2 and 28-3). Winds exceeded these thresholds at one or more monitoring sites beginning in the 0600 hour and ending at the 1600 hour.

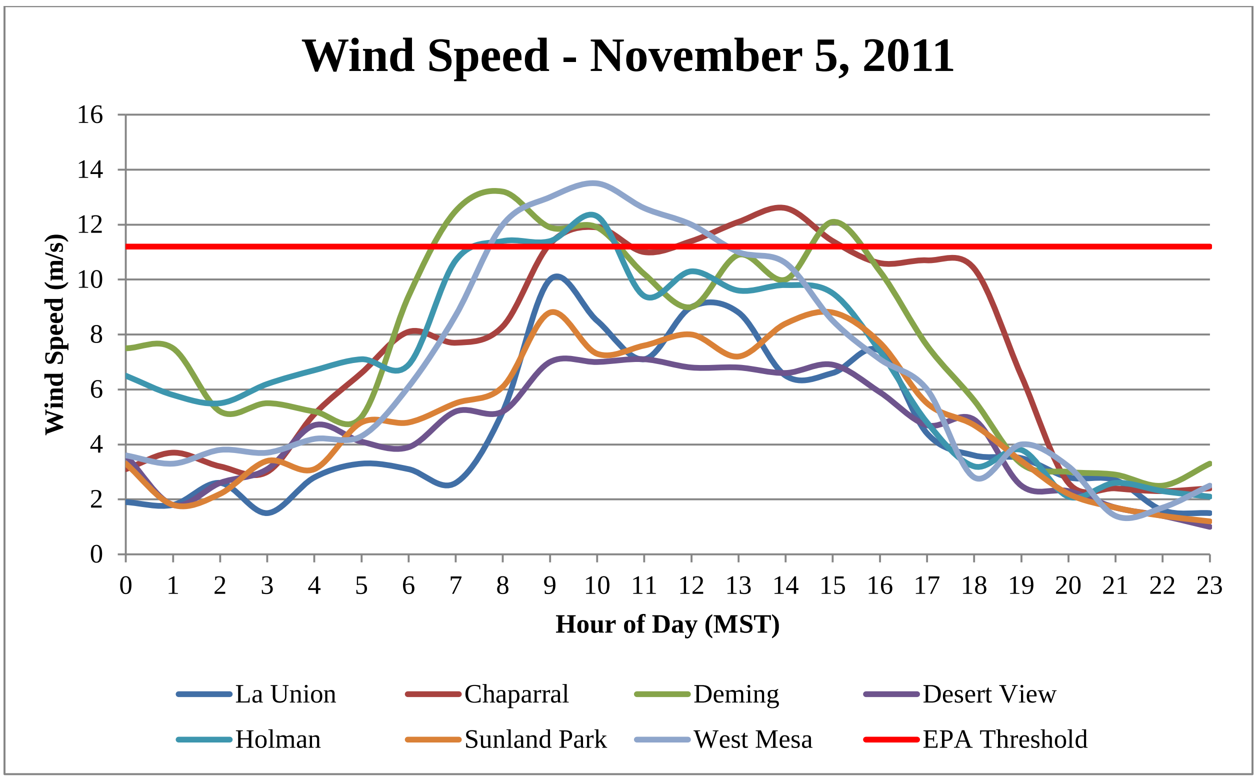

Figure 28-2. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

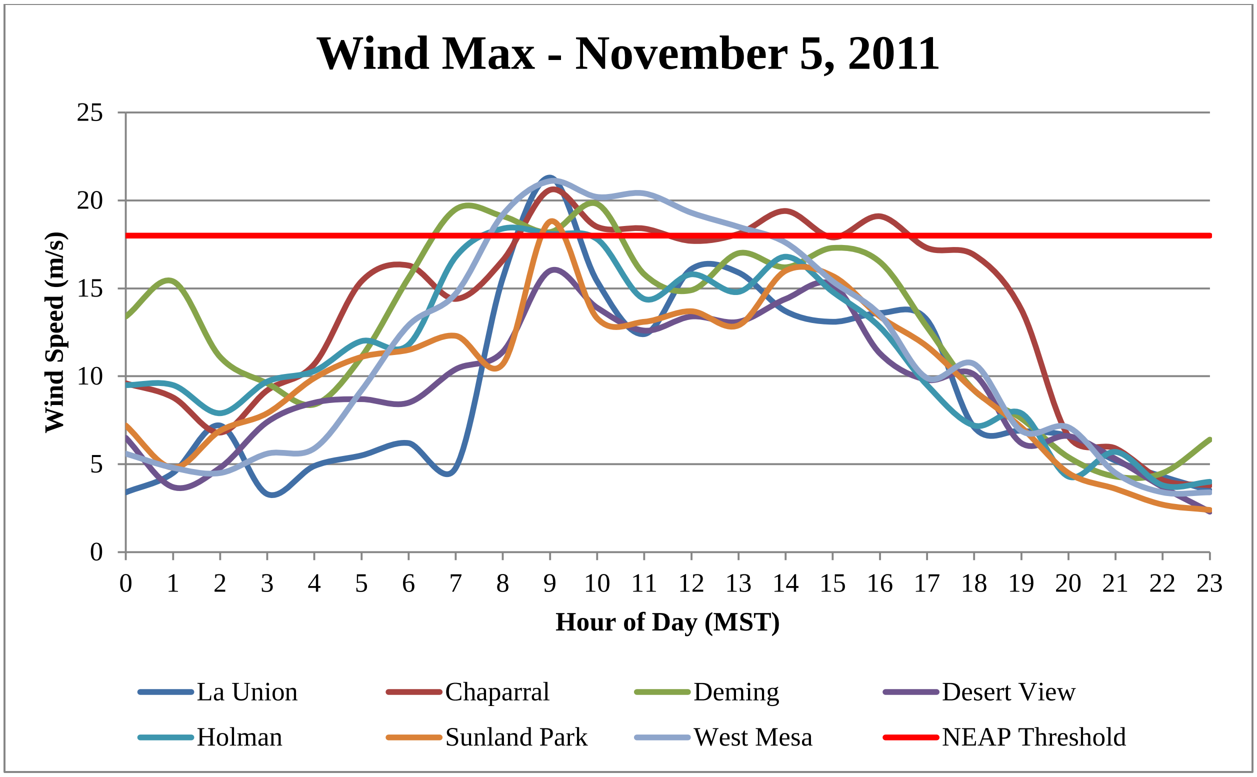

Figure 28-3. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

28.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the FEM TEOM monitors recorded 211 exceedances and the FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). See appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

28.2.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana County. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert and playas in New Mexico and northern Mexico. The southern sites in Doña Ana County recorded the highest 24-hour averages in the monitoring network. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled from Mexico to the monitors in southern Doña Ana County. The model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figure 28-4). Costs prohibit controlling dust from the natural desert terrain and falls outside

NMED's jurisdiction when it originates in Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

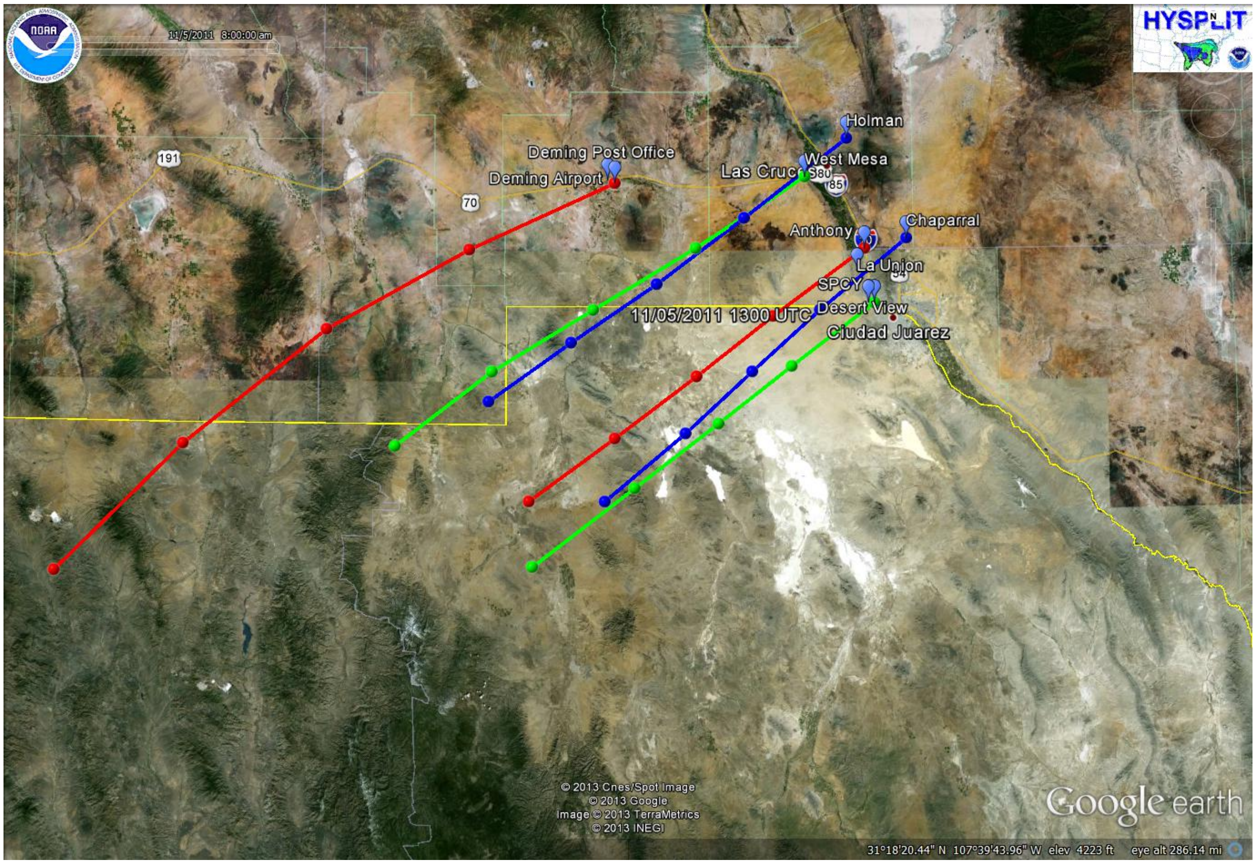

Figure 28-4. HYSPLIT back-trajectory model analysis for November 5, 2011.

28.3 Historical Fluctuations Analysis

28.3.1 Annual and Seasonal 24-hour Average Fluctuations

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 µg/m^3 in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded values for this day (181, 429, and 195 µg/m^3) are above the maximum values recorded when no high wind exceedances are included and are above the 95th percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for November 5, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95th percentile for PM_{10}, $PM_{2.5}$, wind speed and wind gusts (Figures 28-5a-c through 28-7a-c). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} values during the high wind blowing dust storm far exceed the historical 95th percentile of data.

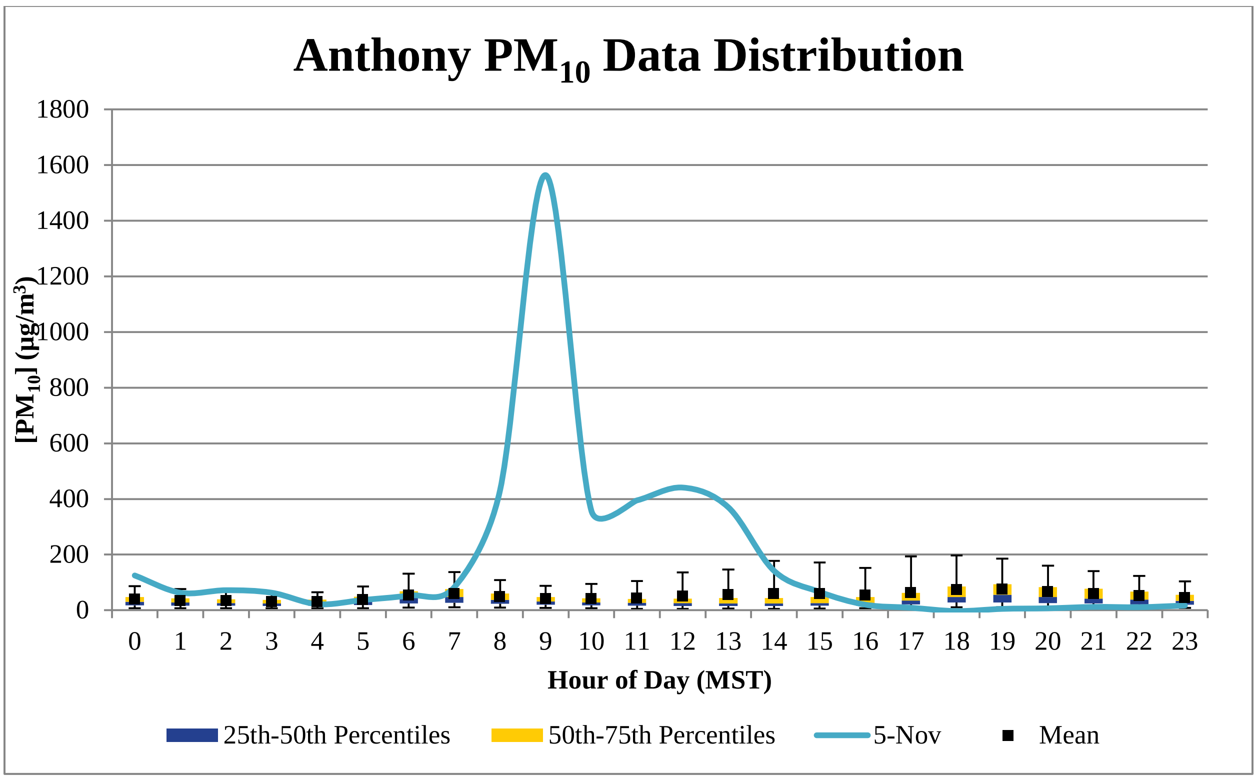

Figure 28-5a. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for November 5, 2011.

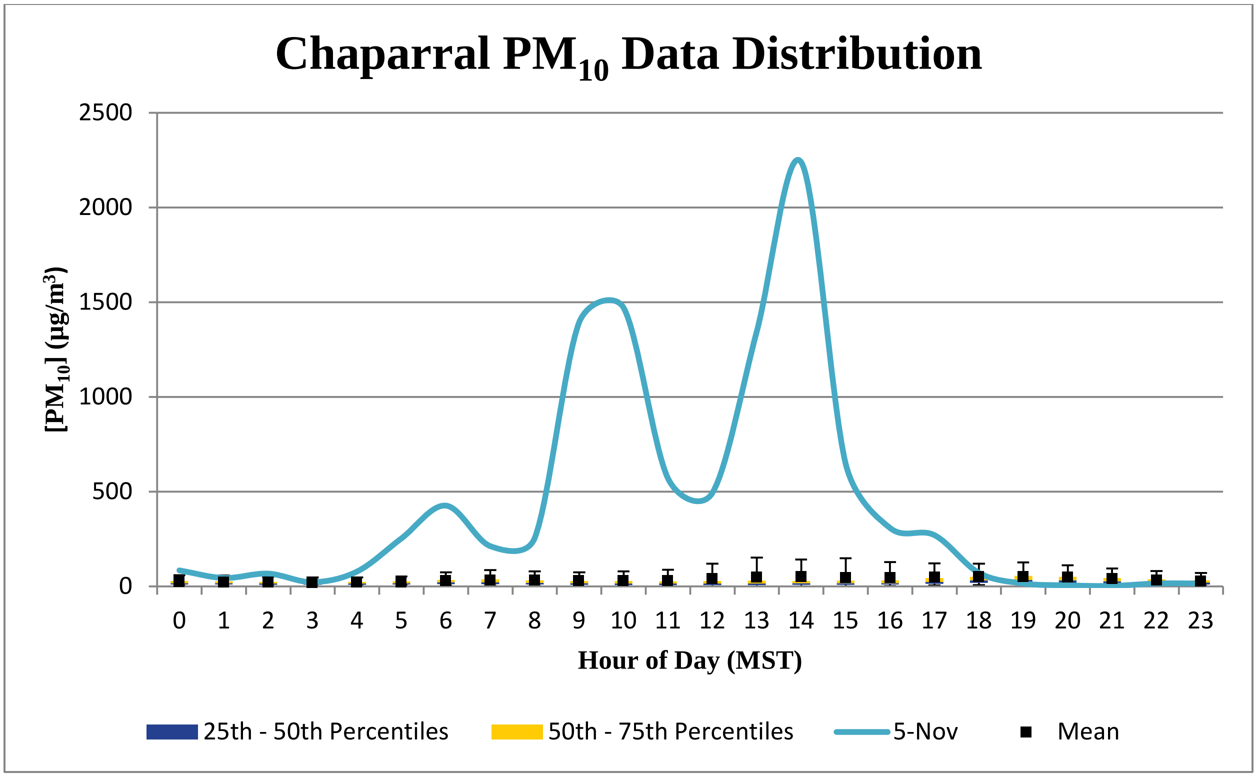

Figure 28-5b. PM_{10} **hourly data distribution from 2006-2010 overlaid by hourly values for November 5, 2011.**

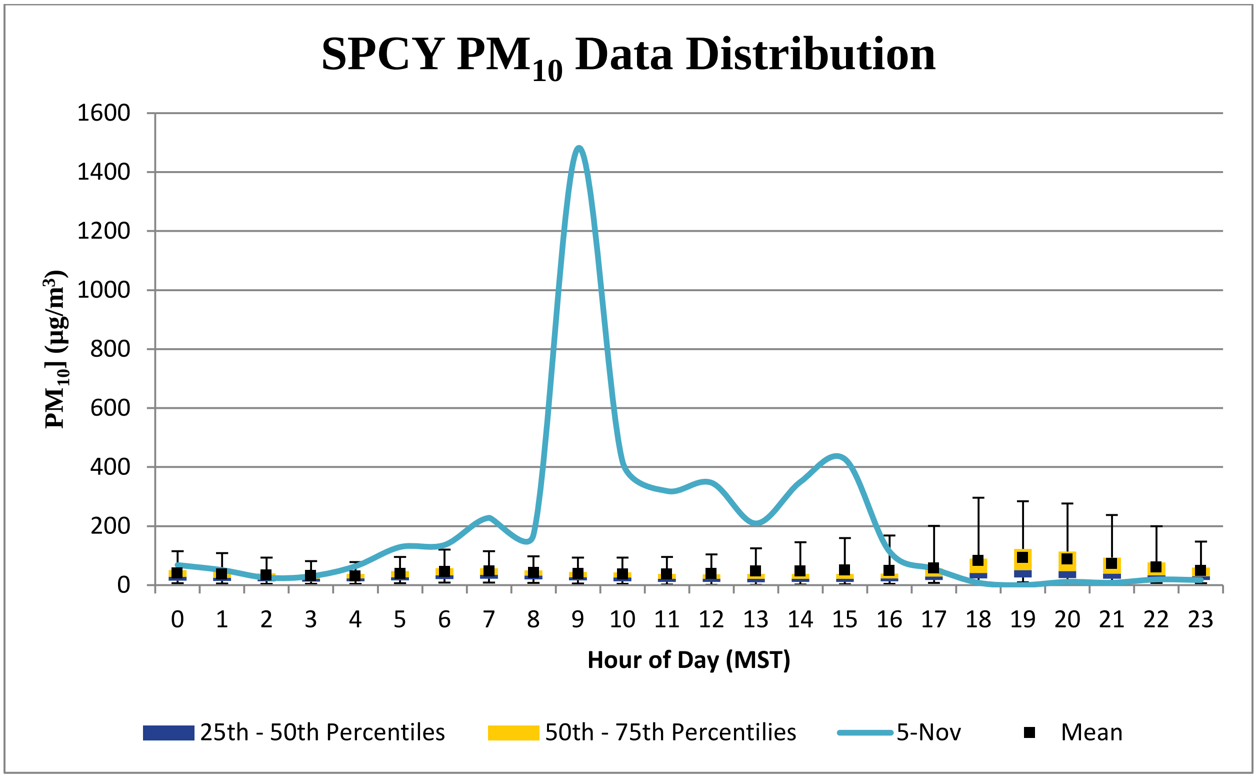

Figure 28-5c. PM_{10} **hourly data distribution from 2006-2010 overlaid by hourly values for November 5, 2011.**

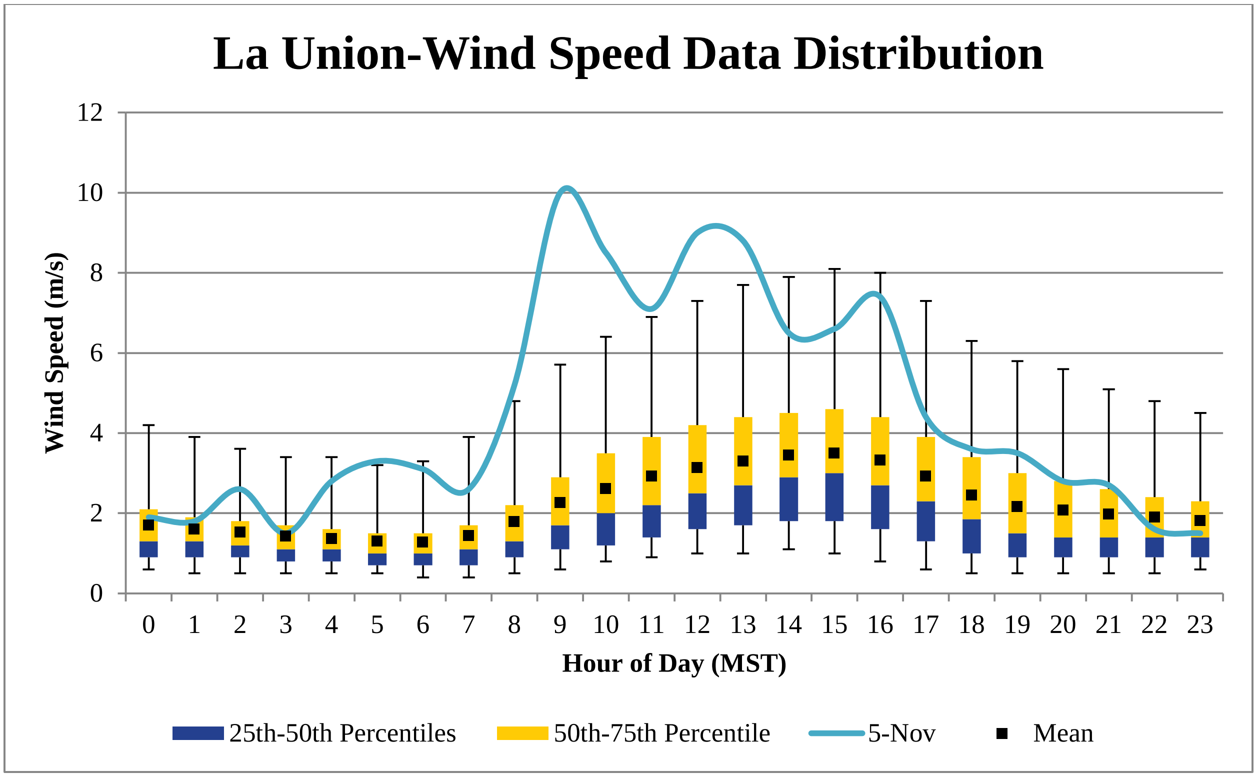

Figure 28-6a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for November 5, 2011.

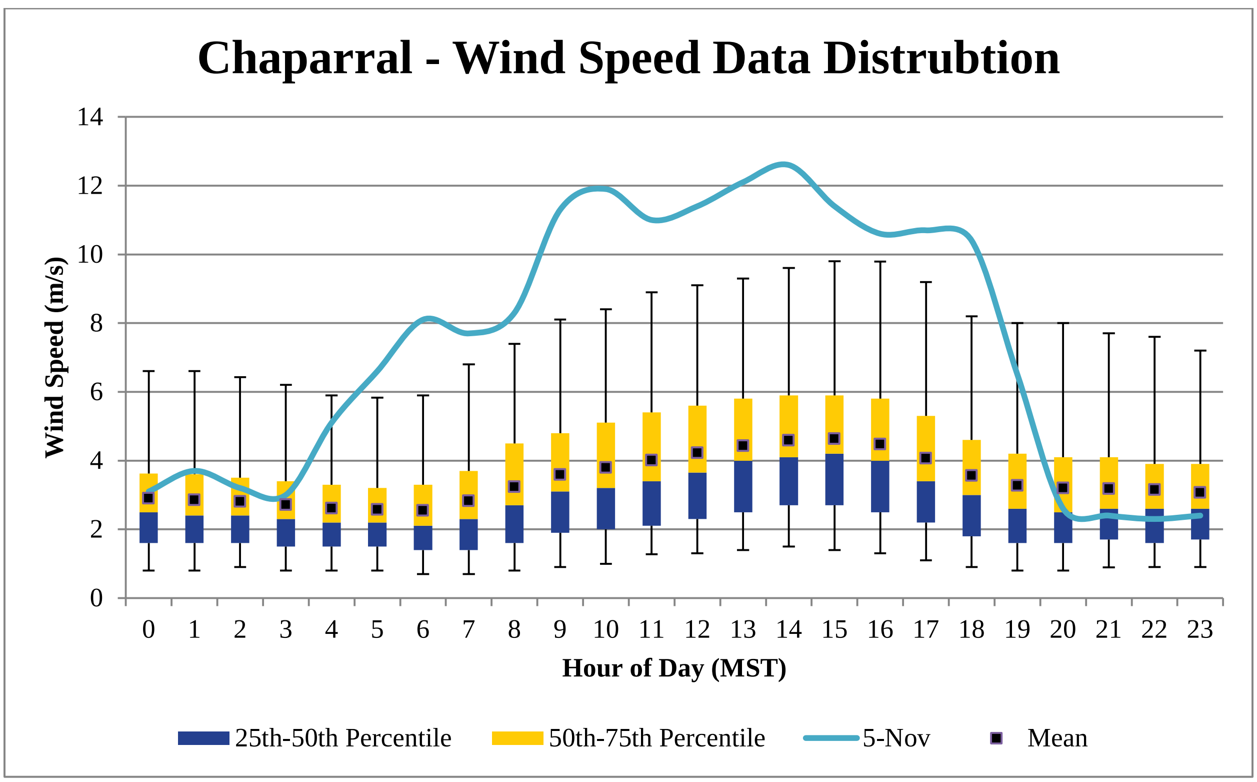

Figure 28-6b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for November 5, 2011.

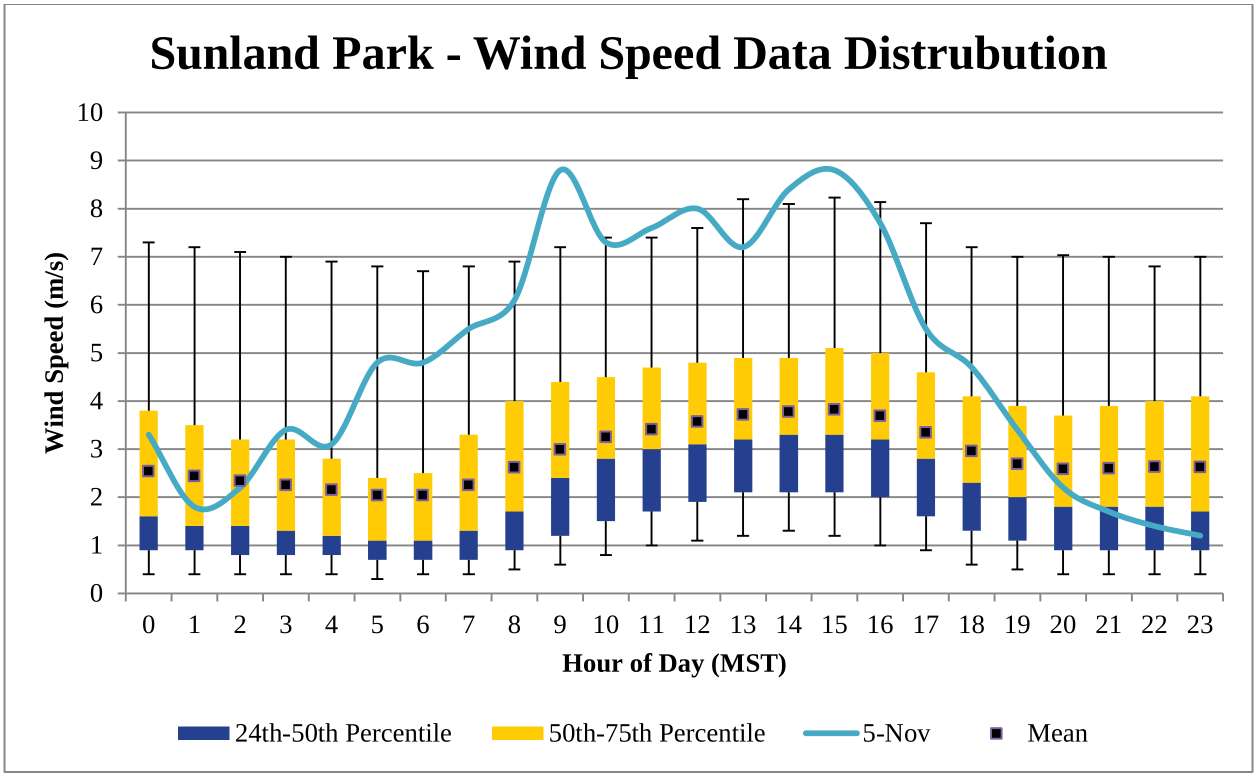

Figure 28-6c. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for November 5, 2011.

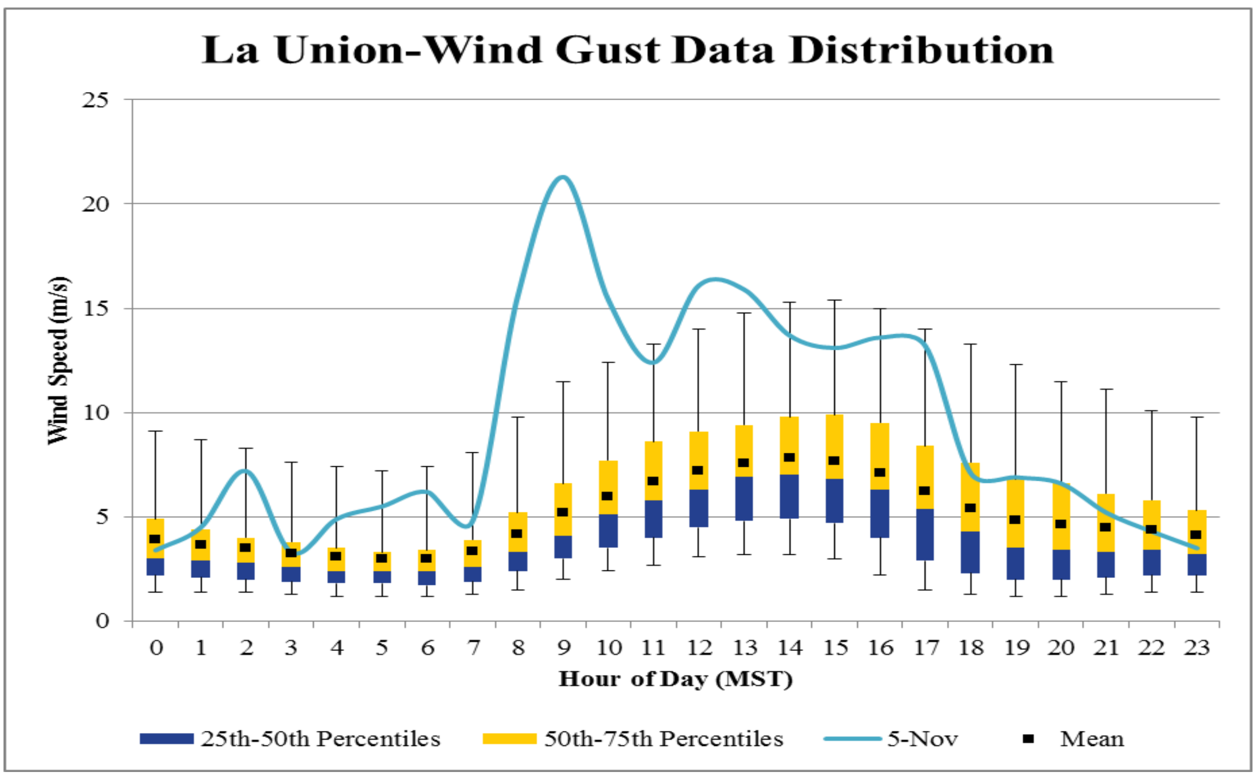

Figure 28-7a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for November 5, 2011.

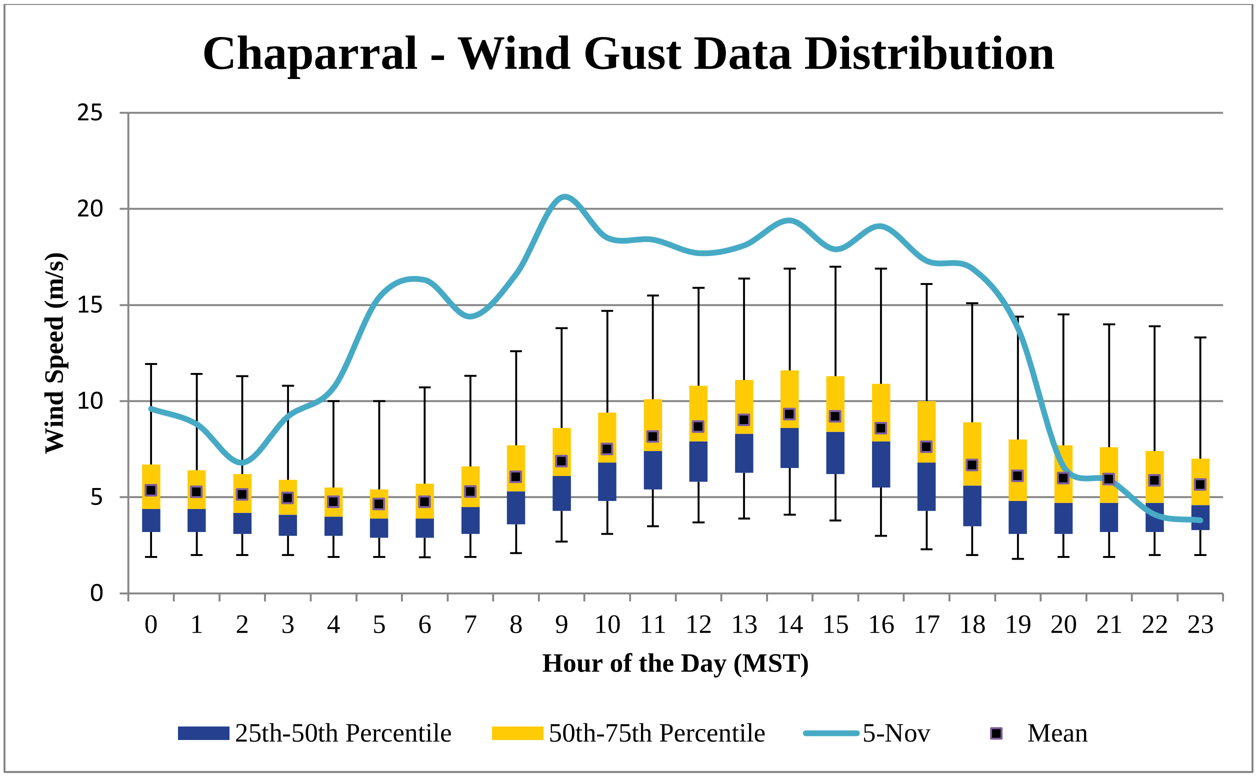

Figure 28-7b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for November 5, 2011.

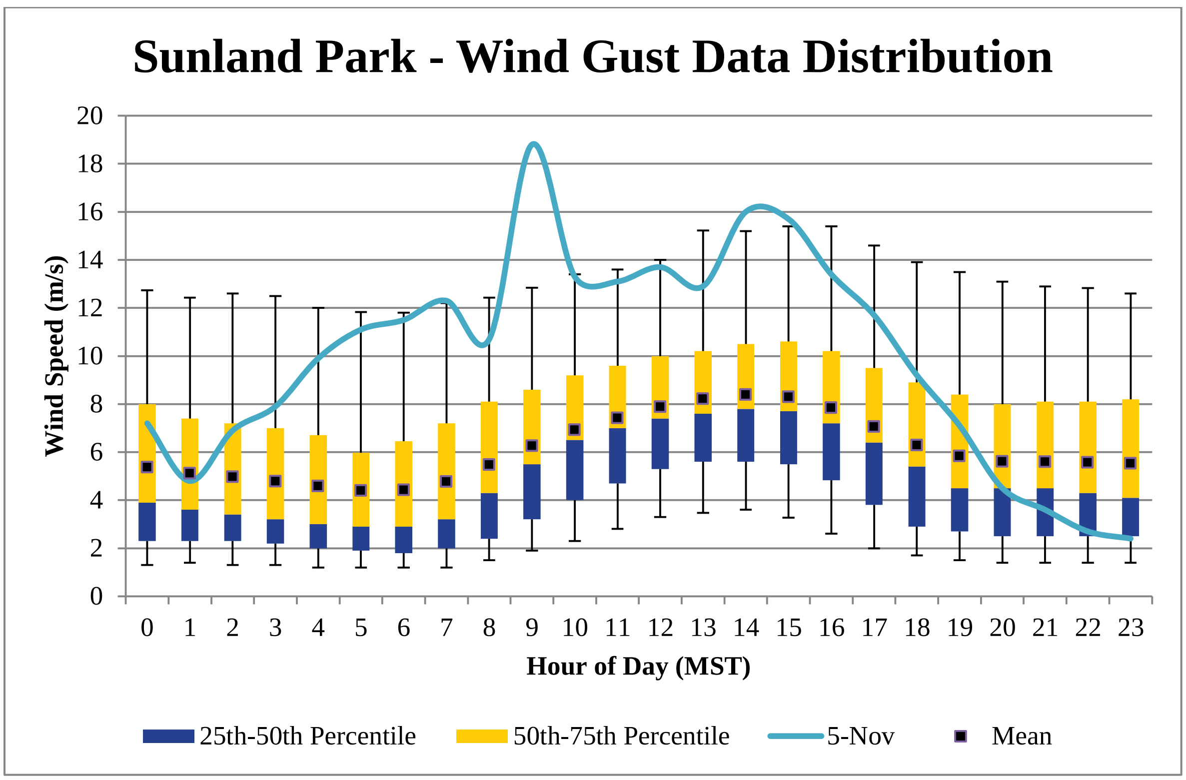

Figure 28-7c. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for November 5, 2011.

28.4 Clear Causal Relationship

A Pacific cold front passed through New Mexico on November 5, 2011. Prior to the cold fronts arrival, a surface low pressure center in southeast Utah and northeast Arizona created a strong pressure gradient over Arizona, New Mexico and northern Mexico (Figure 28-8a). As the Pacific cold front moved through New Mexico, the surface low travelled along the New Mexico-Colorado border tightening the pressure gradient with winds becoming even stronger at the surface (Figure 28-8b). Surface winds flow perpendicular to the isobars from high to low pressure. The upper level trough coincided with the surface low further deepening the low pressure center and increasing winds (Figure 28-9). Diurnal heating of the surface allowed winds aloft to mix downward, increasing the surface wind velocities and provided the turbulence required for vertical mixing and horizontal transport.

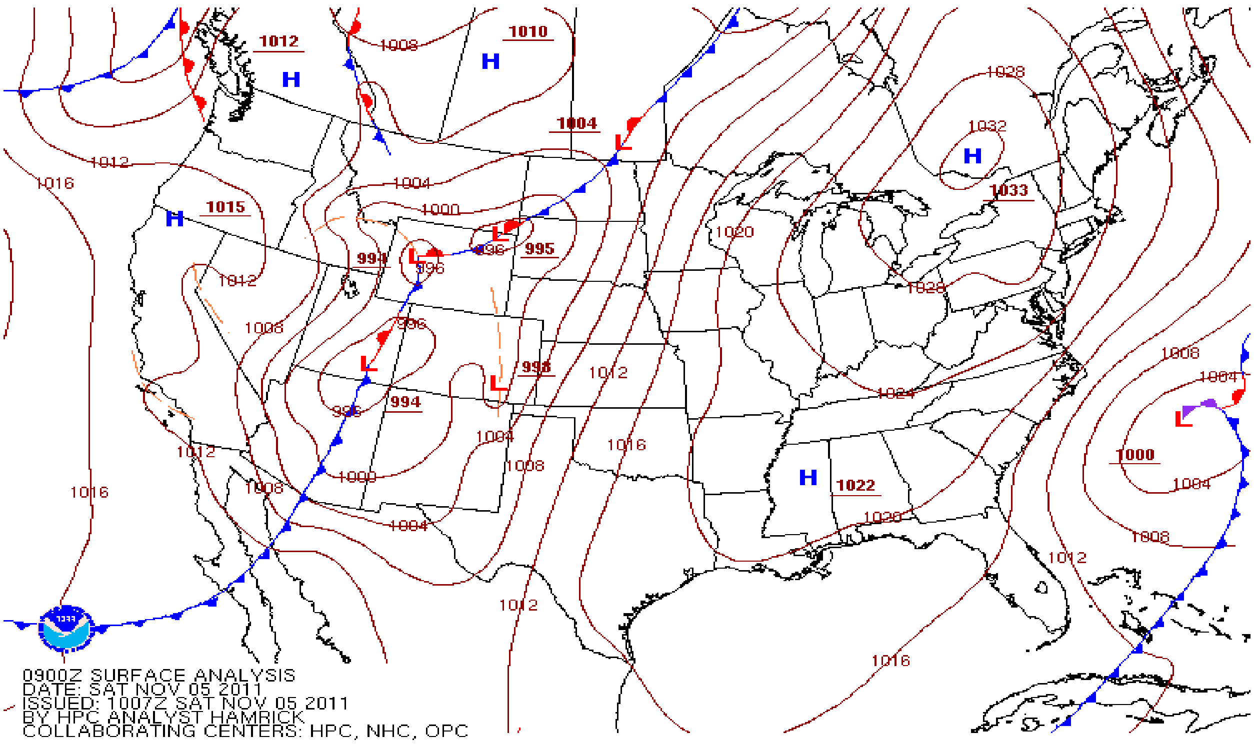

Figure 28-8a. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for November 5, 2011 at the 0300 hour.

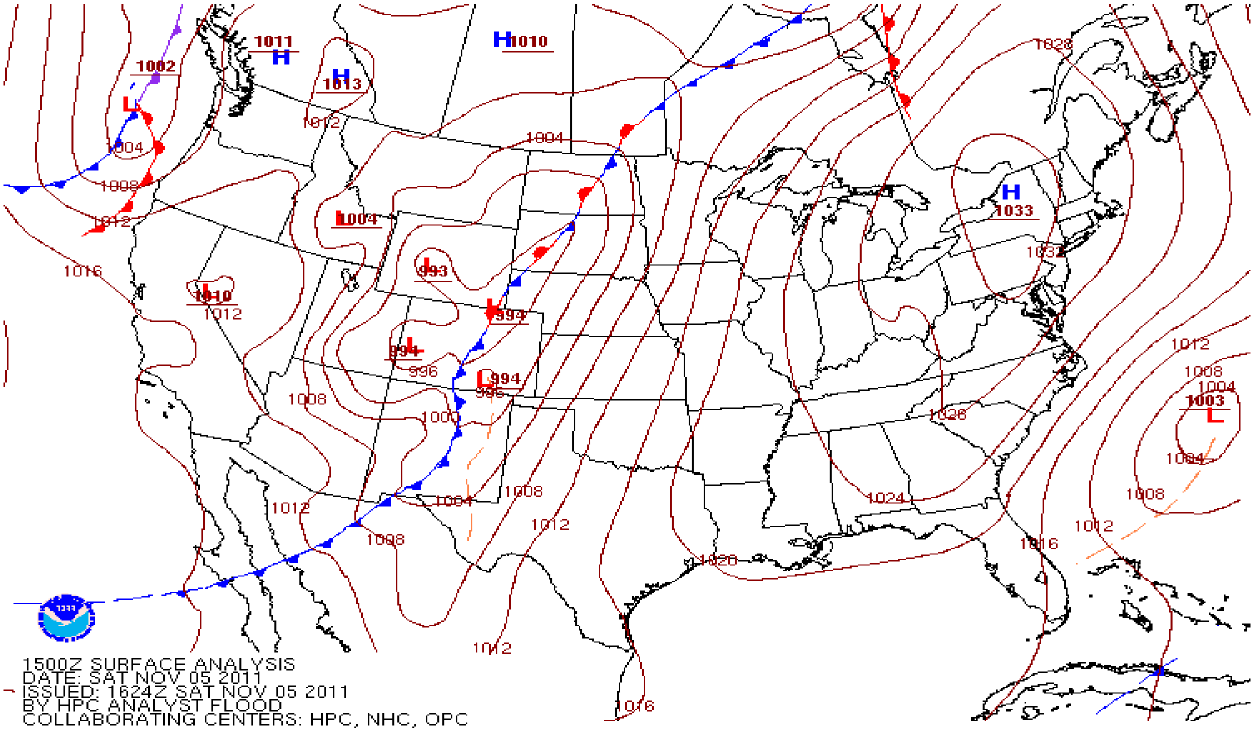

Figure 28-8b. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for November 5, 2011 at the 1100hour.

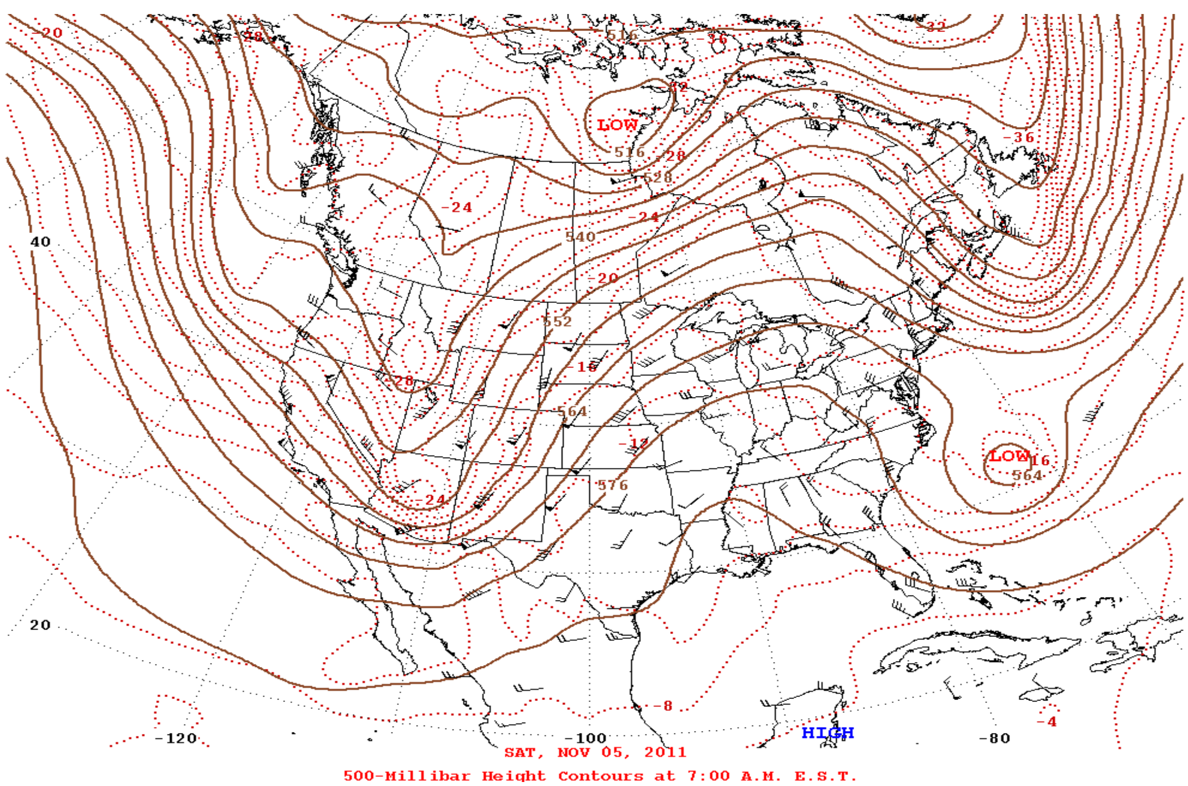

Figure 28-9. Upper air weather map showing geopotential heights (brown lines) at the 0500 hour on November 5, 2011.

The weather pattern described above generated strong southwesterly winds beginning at the 0500 hour and lasting through the 1800 hour. Beginning at the 0500 hour, wind speeds exceeded the historical 95th percentile of data at the Chaparral monitoring site as shown in Figure 28-6b. Peak wind speeds ranged from 12.6 m/s at Chaparral to 13.5 m/s at West Mesa (Figure 28-2). Peak wind gusts ranged from 19.2 m/s at West Mesa to 21.3 m/s at La Union (Figure 28-3). Blowing dust caused elevated levels of PM_{10} during the same period as high winds as demonstrated by the time series plots in Figures 28-10a-c. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (0500-1800 hours). During these hours, hourly PM_{10} concentrations spiked at all monitoring sites in the network (Figure 28-11).

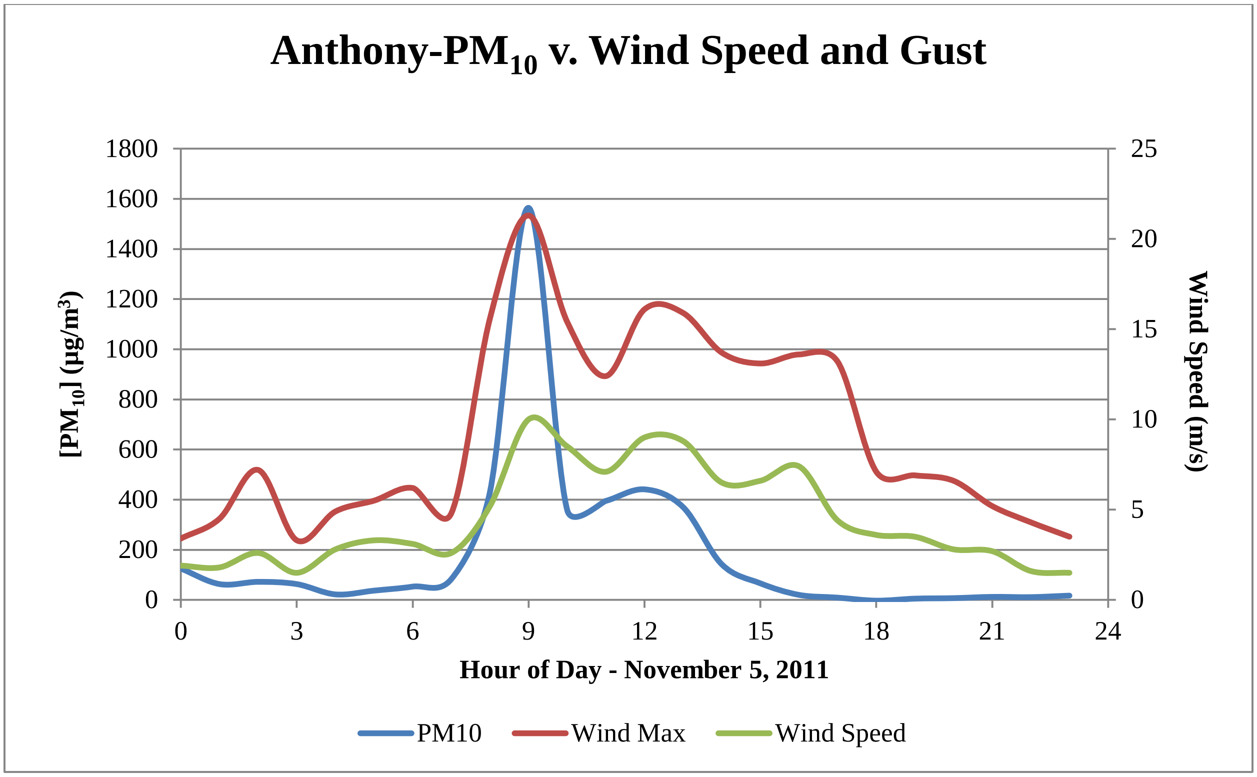

Figure 28-10a. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

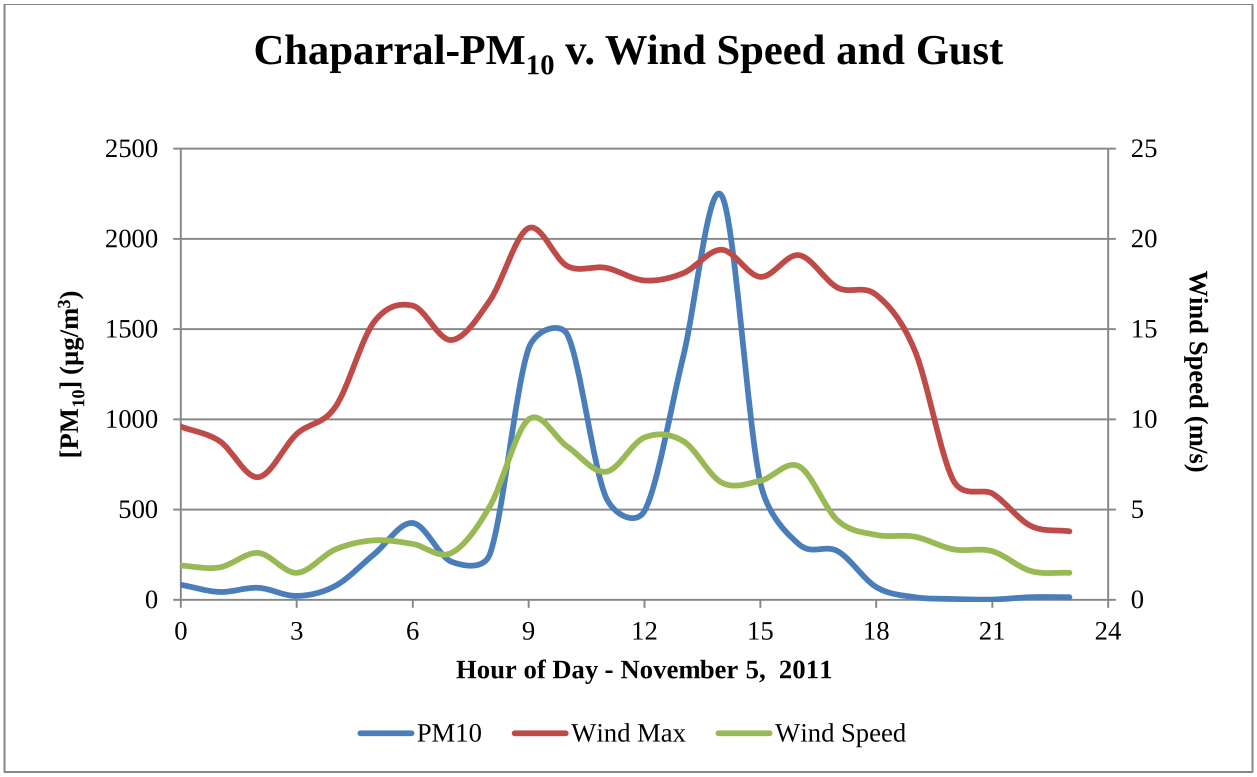

Figure 28-10b. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

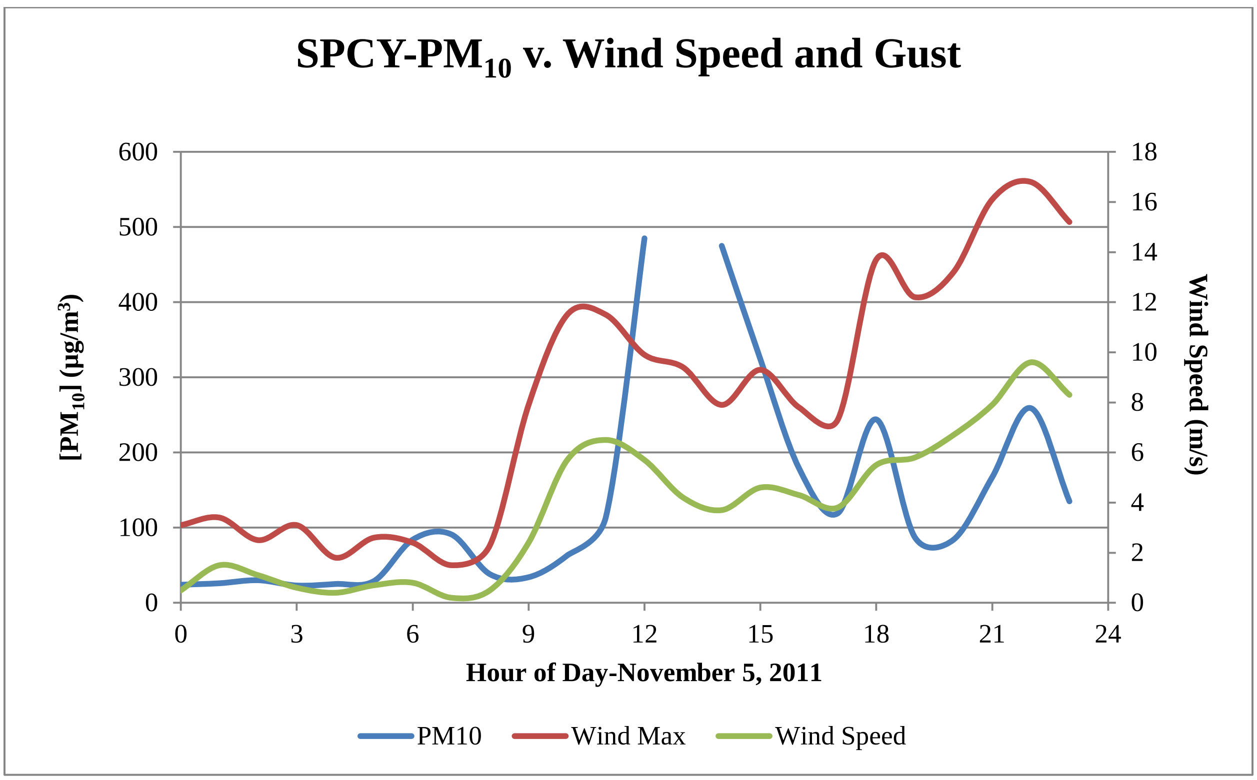

Figure 28-10c. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

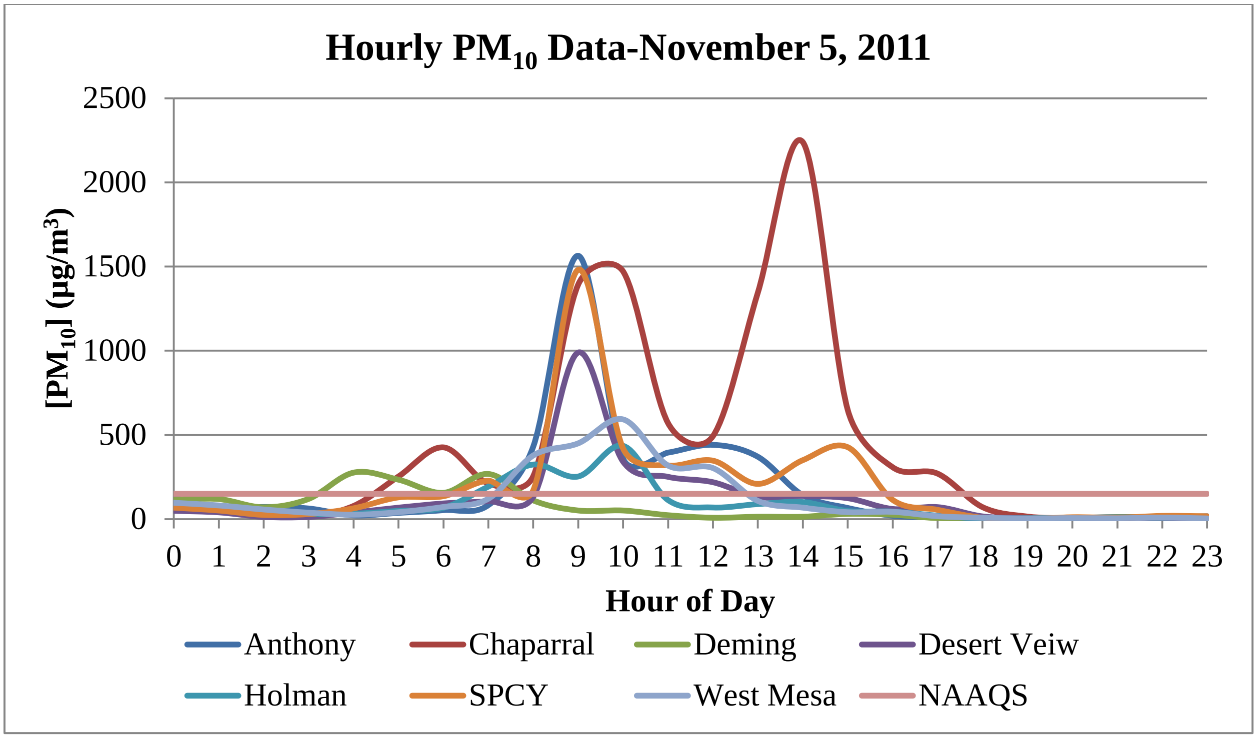

Figure 28-11. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

The National Weather Service El Paso/Santa Teresa office reported very windy conditions, with gusts near 70 miles per hour (mph) over northeast El Paso and around 50 – 60 mph elsewhere (NWS Southwest Weather Bulletin, 2011). The NWS issued a wind advisory in the early morning hours stating in part,

> SIGNIFICANT AREAS OF BLOWING DUST ARE EXPECTED ACROSS THE DESERT LOWLANDS WITH VISIBILITY DROPPING TO LESS THAN A MILE...ESPECIALLY ALONG AND SOUTH OF THE I-10 CORRIDOR. WINDS ARE EXPECTED TO DIMINISH SATURDAY AFTERNOON FROM WEST TO EAST (NWS, 2011).

The NM Border Air Quality Blog reported,

> The high winds started early today with peak winds at the Las Cruces airport at 9:55 am. The airport recorded a peak west wind at 35 mph with gusts to 43 mph. Deming had their peak wind at 8:53 am with a west wind of 30 mph with gusts to 44 mph. A clear cloud of dust could be seen from GOES throughout the day (DuBois, 2011).

Figure 28-12 shows the entrained dust and clouds that covered the Las Cruces area on this date.

Figure 28-12. View of dust in Las Cruces on November 11, 2011 at 0928 hours looking west from a location near Solano and Missouri Aves. (Courtesy of D. DuBois)

28.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on November 5, 2011.

28.6 Natural Event

The CCR and nRCP analyses show that this was a natural event caused by high wind and blowing dust.

28.7 No Exceedance but for the Event

The Anthony monitor detected blowing dust around the 0800 hour with hourly concentrations heavily impacted until the 1300 hour. The six hourly PM_{10} values from 0800-1300 hours alone, nearly exceed the 24-hour average standard at Anthony [(431 + 1564 + 358 + 395 + 441 + 370) $\mu g/m^3$ = 3756 $\mu g/m^3$; (3756 $\mu g/m^3$)/24 = 148 $\mu g/m^3$]. By replacing these six hourly values with the 95th percentile of hourly data at the Anthony site, the resulting 24-hour average (61 $\mu g/m^3$) does not exceed the NAAQS (Table 28-1). The values in red represent the 95th percentile of all hourly data collected at Anthony, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	125	87
1	63	63
2	72	69
3	63	63
4	22	22
5	37	37
6	53	53
7	83	83
8	431	**109**
9	1564	**88**
10	358	**95**
11	395	**106**
12	441	**136**
13	370	**146**
14	142	142
15	66	66
16	20	20
17	9	9
18	-3	-3
19	5	5
20	7	7
21	12	12
22	11	11
23	17	17
24-Hour Average	181	**61**

Table 28-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Anthony.

The Chaparral monitor detected blowing dust around the 0500 hour with hourly concentrations heavily impacted until the 1700 hour. The three hourly PM_{10} values from 1300-1500 hours alone, exceed the 24-hour average standard at Chaparral [(1346 + 2239 + 648) µg/m^3 = 4233 µg/m^3; (4233 µg/m^3)/24 = 176 µg/m^3]. By replacing these thirteen hourly values with the 95th percentile of hourly data at the Chaparral site, the resulting 24-hour average (73 µg/m^3) does not exceed the NAAQS (Table 28-2). The values in red represent the 95th percentile of all hourly data collected at Chaparral, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	84	84
1	44	44
2	67	67
3	22	22
4	78	78
5	253	**52**
6	426	**74**
7	212	**86**
8	255	**79**
9	1393	**74**
10	1471	**79**
11	570	**87**
12	493	**120**
13	1346	**151**
14	2239	**141**
15	648	**147**
16	308	**127**
17	270	**122**
18	71	71
19	15	15
20	5	5
21	2	2
22	15	15
23	15	15
24-Hour Average	429	**73**

Table 28-2. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Chaparral.

The Sunland Park monitor detected blowing dust around the 0500 hour with hourly concentrations heavily impacted until the 1500 hour. The eleven hourly PM_{10} values from 0400-1700 hours alone, exceed the 24-hour average standard at Sunland Park [(129 + 136 + 228 + 171 + 1481 + 419 + 319 + 347 + 209 + 350 + 427) µg/m^3 = 4216 µg/m^3; (4216 µg/m^3)/24 = 176 µg/m^3]. By replacing these fourteen hourly values with the 95th percentile of hourly data at the Sunland Park site, the resulting 24-hour average (71 µg/m^3) does not exceed the NAAQS (Table 28-3). The values in red represent the 95th percentile of all hourly data collected at Sunland Park, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	68	68
1	51	51
2	25	25
3	30	30
4	64	64
5	129	**95**
6	136	**120**
7	228	**115**
8	171	**98**
9	1481	**93**
10	419	**93**
11	319	**95**
12	347	**104**
13	209	**125**
14	350	**145**
15	427	**160**
16	114	114
17	55	55
18	8	8
19	0	0
20	11	11
21	8	8
22	19	19
23	17	17
24-Hour Average	261	**71**

Table 28-3. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Sunland Park.

29 HIGH WIND EXCEPTIONAL EVENT: December 1, 2011

29.1 Summary of Event

The passing of a backdoor cold front caused high winds and blowing dust in southern Doña Ana and Luna Counties resulting in exceedances of the PM_{10} and the $PM_{2.5}$ annual NAAQS at the Chaparral, Deming Airport, Desert View, Sunland Park, and West Mesa monitoring sites on this date. The FEM TEOM continuous monitors at this/these sites recorded 24-hour average concentrations of 171, 197, 326, 261, and 156 μg/m^3, respectively. The FRM Partisol monitor at the Sunland Park site recorded a 24-hour average concentration of 21.5 μg/m^3. There was no data available for the Anthony, Deming, and Holman monitoring sites on this date. No other monitoring sites recorded an exceedance on this date, attributed to the data gaps for the Anthony, Deming, and Holman sites (Figure 29-1). The averages in this figure were calculated using PM_{10} FEM TEOM and $PM_{2.5}$ FRM Partisol instrument data for the four days before and after the event.

As the event unfolded, the wind blew from the east to south-southeast throughout the border region. These high velocity winds passed over large areas of desert within Mexico, Texas and New Mexico. The co-occurrence of high winds and elevated levels of blowing dust, little to no point sources in the area, and the high hourly and daily PM_{10} and $PM_{2.5}$ concentrations support the assertion that this was an exceptional event, specifically a natural event caused by high wind and blowing dust.

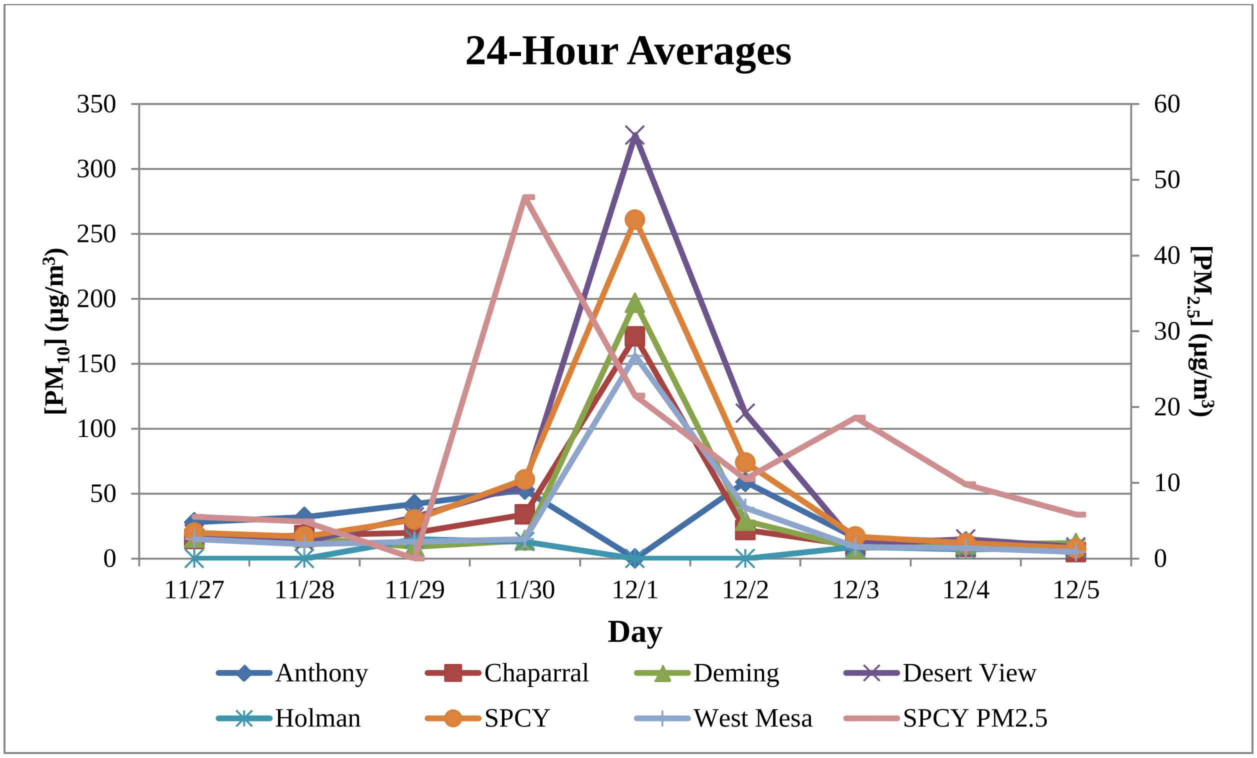

Figure 29-1. PM_{10} and $PM_{2.5}$ 24-hour averages before and after December 1, 2011.

29.2 Is Not Reasonably Controllable or Preventable

29.2.1 Suspected Source Areas and Categories Contributing to the Event

Sources of windblown dust contributing to this exceedance include the natural desert, residential properties, agricultural land and unpaved roads in Mexico, Texas and New Mexico. The City of Las Cruces, the City of Deming and Doña Ana and Luna County Ordinances require BACM for any dust producing activities. The largest and most likely sources of windblown dust are the natural desert and the playas of northern Mexico, Texas and New Mexico (see Section 29.2.4 below).

29.2.2 Sustained and Instantaneous Wind Speeds

EPA uses a default entrainment threshold of sustained wind speeds at 11.2 m/s (25 mph) for natural and well controlled anthropogenic sources contributing to natural events caused by high wind and blowing dust (EPA, 2013). Under the Doña Ana and Luna County NEAPs, EPA and NMED agreed that wind gusts exceeding 18 m/s would overwhelm any natural and well-controlled anthropogenic sources and cause windblown dust. On December 1, 2011, sustained wind speeds exceeded EPA's default threshold at three of the seven monitoring sites in southern New Mexico and wind gusts exceeded the NEAPs agreed upon threshold at five of the seven monitoring sites (Figures 29-2 and 29-3). Winds exceeded these thresholds at one or more monitoring sites beginning at the 1400 hour and lasting into the 2300 hour.

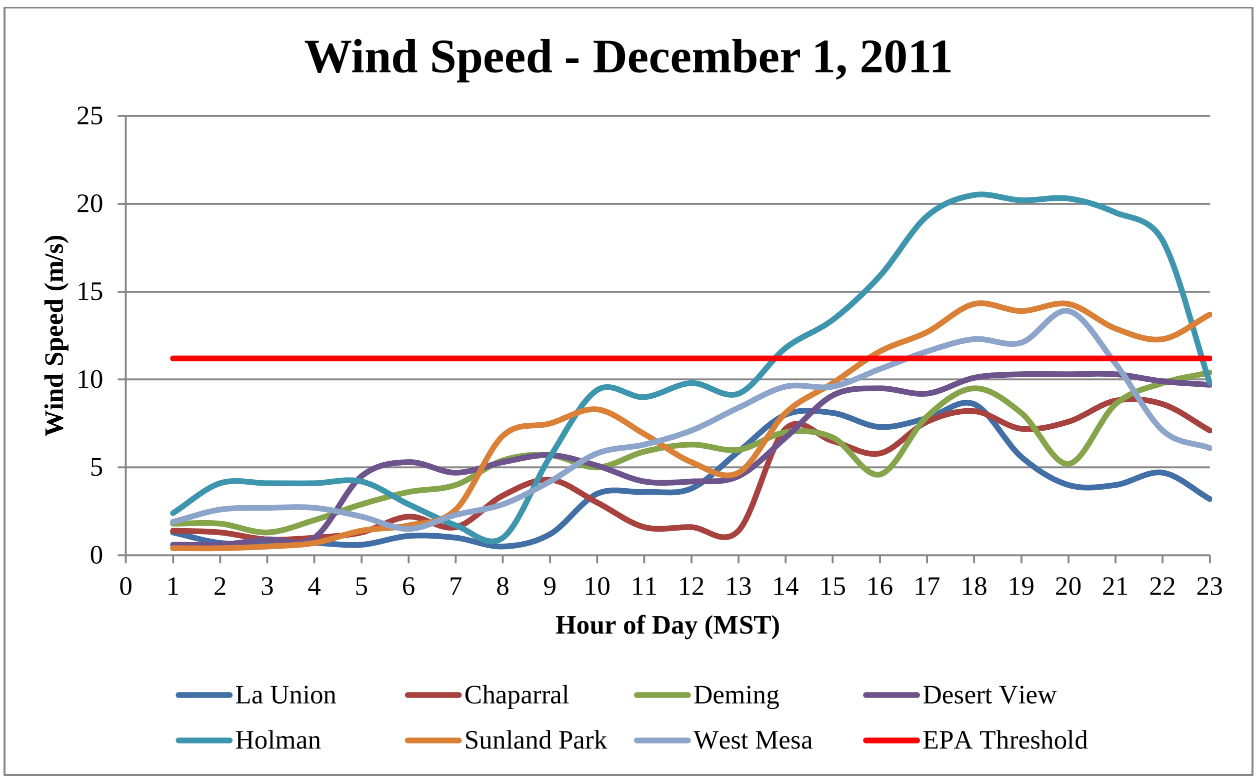

Figure 29-2. Sustained wind speeds at monitoring sites in Doña Ana and Luna Counties.

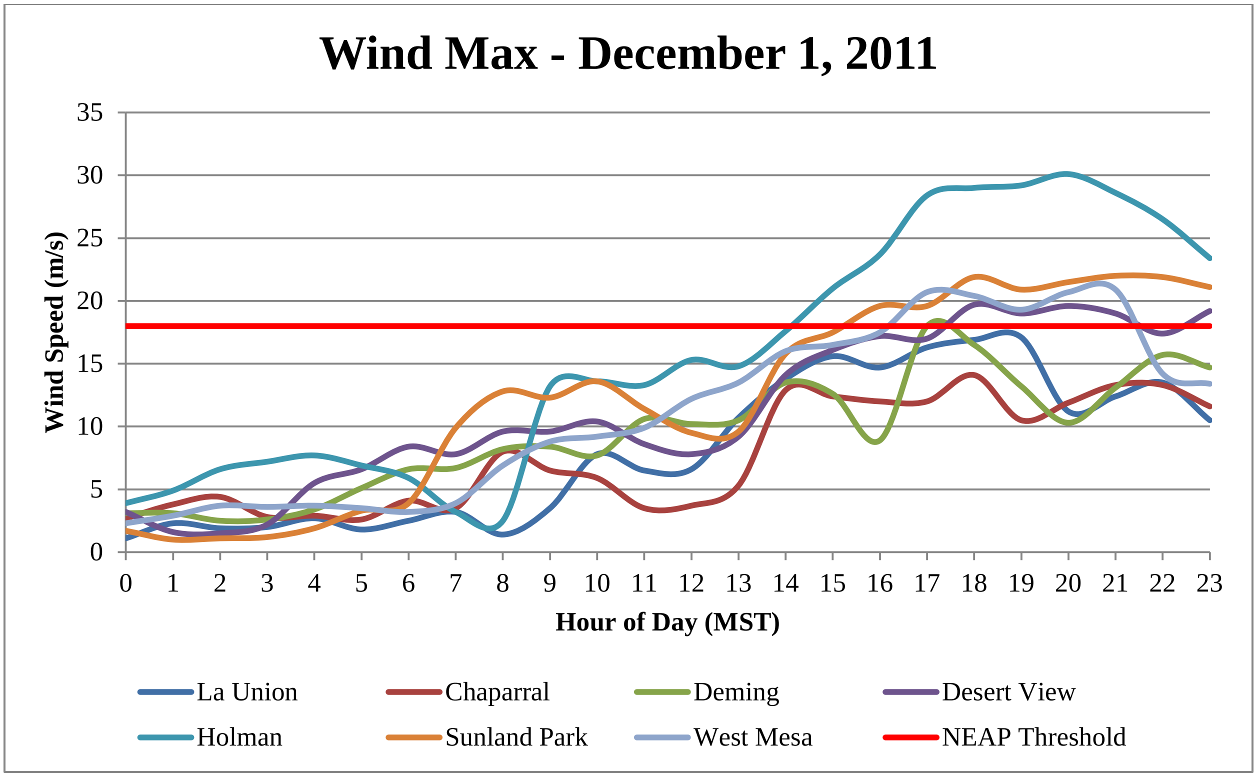

Figure 29-3. Maximum wind gusts at monitoring sites in Doña Ana and Luna Counties.

29.2.3 Recurrence Frequency

The monitoring sites in Doña Ana and Luna Counties can record exceedances of the PM_{10} NAAQS throughout the year. From 2006-2010 the FEM TEOM monitors recorded 211 exceedances and the FRM Wedding monitors recorded 5 exceedances (Figure A-1). The Deming Airport and Desert View monitoring sites (FEM TEOMs) were established in 2006 and 2007 respectively and do not show exceedances until the year following startup (Table 2-1). See Appendix A for a more in-depth discussion about recurrence frequency and the number of exceedances at each monitoring site.

29.2.4 Controls Analysis

The local ordinances and MOUs adopted under the NEAP direct the implementation of BACM for sources of dust in Doña Ana and Luna Counties. The ordinances regulate disturbed lands, construction and demolition, vacant parking lots and materials handling and transportation. Our investigation did not identify any unusual PM_{10} producing activities on this day, and anthropogenic emissions remained constant before, during and after the event. The most likely source contributing to the event is the natural desert in Texas, Mexico and New Mexico. The southern sites in Doña Ana County and Deming Airport recorded the highest 24-hour averages in the monitoring network. A back-trajectory analysis using the HYSPLIT (Draxler et al., 2013; Rolph, 2013) model shows that the air masses traveled from Texas and Mexico to the monitors in southern Doña Ana and Luna Counties. The model starts four hours before the start of elevated PM_{10} concentrations measured during the event (Figure 29-4). Costs prohibit controlling dust from the natural desert terrain and falls outside NMED's jurisdiction when it originates in Mexico. NMED concludes that the sources contributing to the event are not reasonably controllable.

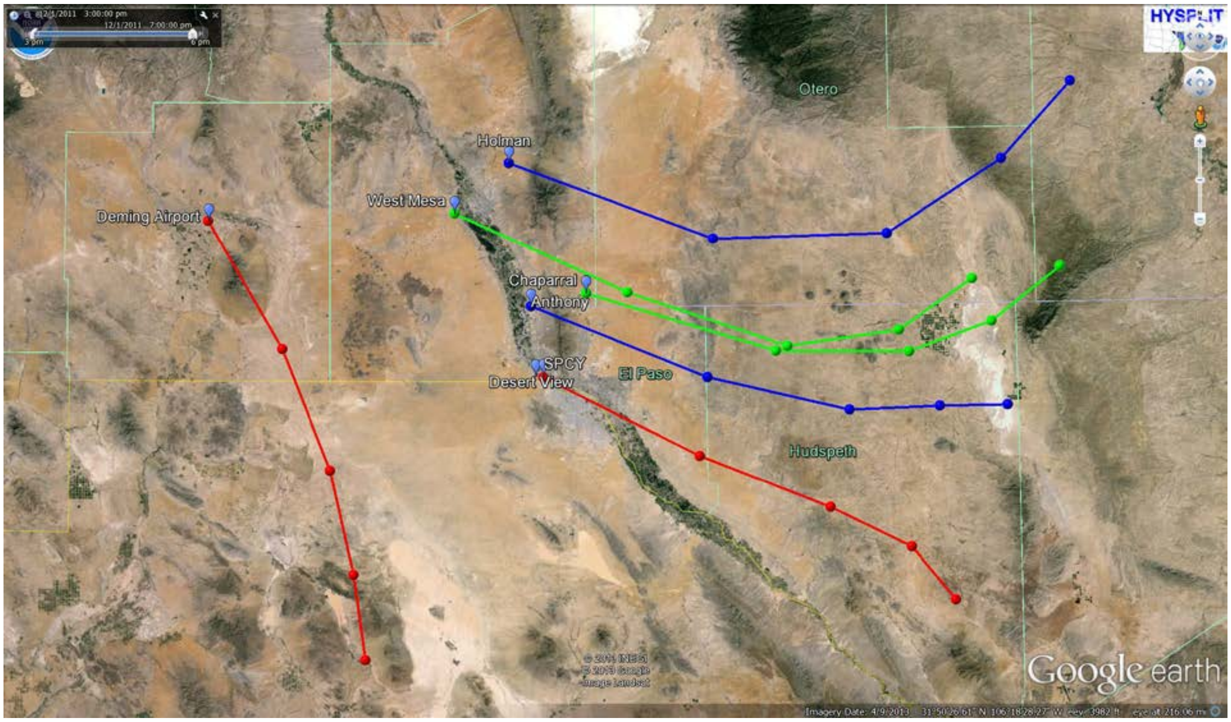

Figure 29-4. HYSPLIT back-trajectory model analysis for December 1, 2011.

29.3 Historical Fluctuations Analysis

29.3.1 <u>Annual and Seasonal 24-hour Average Fluctuations</u>

Since being established, the monitoring sites in Doña Ana and Luna Counties have recorded exceedances of the PM_{10} NAAQS. High winds cause these exceedances and they can occur at any time of year (Figure B-4 through B-11). Most exceedances occur from late winter through early summer (February-June) and are associated with the passage of Pacific cold fronts. High winds caused all recorded exceedances from 2006-2010 and NMED submitted natural events demonstrations to EPA under the NEAP or EER.

Since the 24-hour $PM_{2.5}$ NAAQS was lowered from 65 to 35 $\mu g/m^3$ in 2006, the SPCY Partisol monitor has routinely recorded exceedances of the standard. These exceedances occurred throughout the year during high and low wind conditions. In 2009, NMED investigated the cause of the low wind exceedances and found that emissions from Ciudad Juárez, Mexico contribute significantly to elevated concentrations. The high wind exceedances were caused by blowing dust on days when PM_{10} monitors also recorded exceedances.

Appendix B contains a more in-depth discussion about historical fluctuations and charts showing annual and seasonal trends at each monitoring site.

Table B-1 and B-2 show normal historical fluctuations with and without high wind natural events that caused exceedances from 2006-2010. The analysis excludes only those high wind events that resulted in an exceedance. Data for PM_{10} in this table includes FRM Wedding and FEM TEOM measurements and data for $PM_{2.5}$ comes from the FRM Partisol measurements from 2006-2010. The recorded values for this day (171, 197, 326, 261, and 156 µg/m^3) are above the maximum values recorded when no high wind exceedances are included and is above the 95th percentile of all 24-hour averages recorded.

An hourly data distribution analysis was performed for PM_{10} and $PM_{2.5}$ concentrations, wind speeds and wind gusts (Appendices C, D, and E). All data used for the PM_{10} distribution charts come from the FEM TEOM monitors and the non-FEM/FRM $PM_{2.5}$ TEOM monitor at SPCY. Overlaying the hourly data for December 1, 2011 on the hourly data distribution plots shows that the values recorded during the high wind event exceed the 95th percentile for PM_{10}, $PM_{2.5}$, wind speed and wind gusts (Figures 29-5a-e through 29-7a-e). The top whiskers of the box and whisker plots represent the 95th percentile of data. The hourly PM_{10} values during the high wind blowing dust storm far exceed the historical 95th percentile of data.

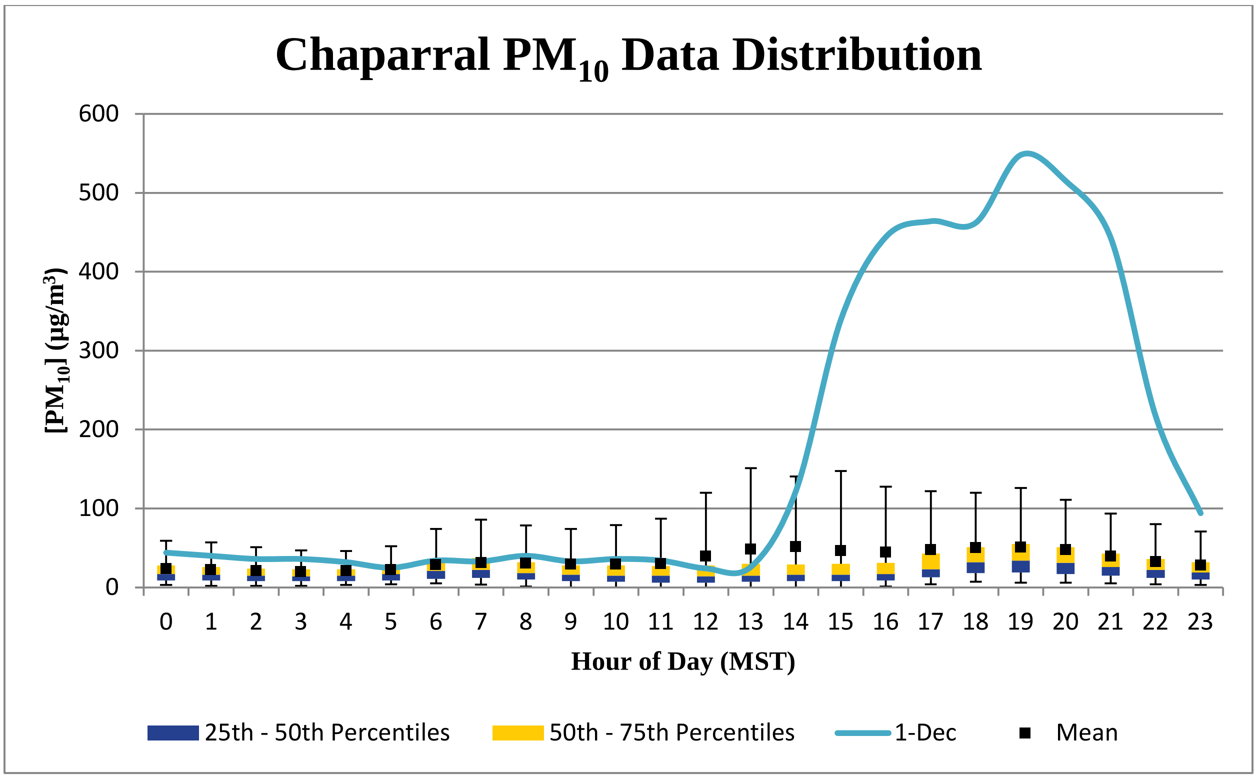

Figure 29-5a. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

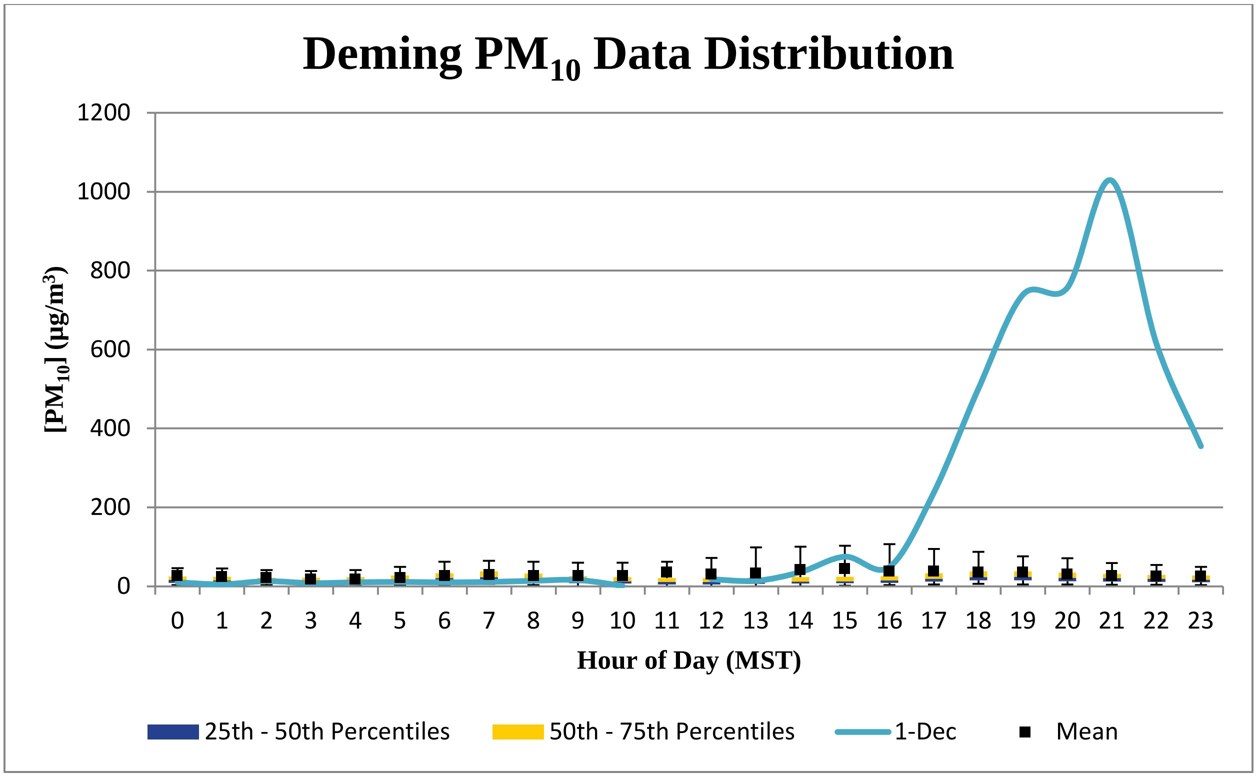

Figure 29-5b. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for December 1, 2011

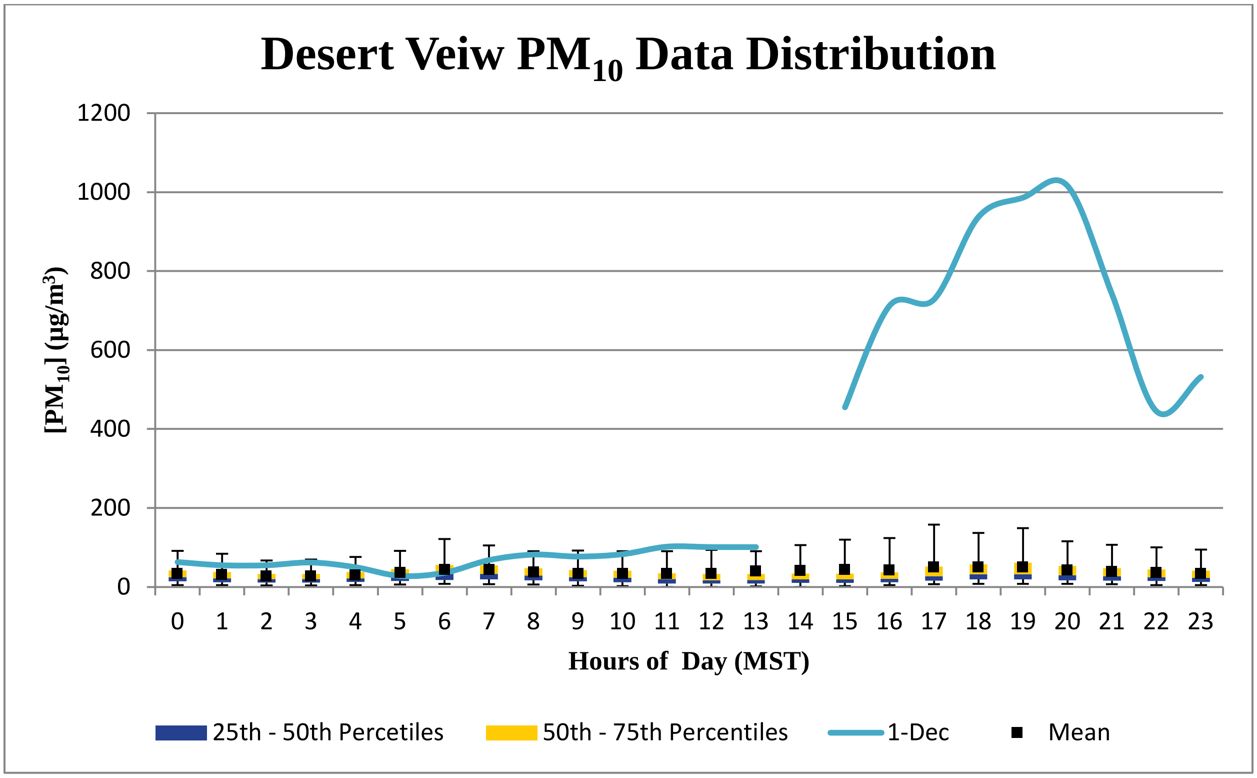

Figure 29-5c. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for December 1, 2011

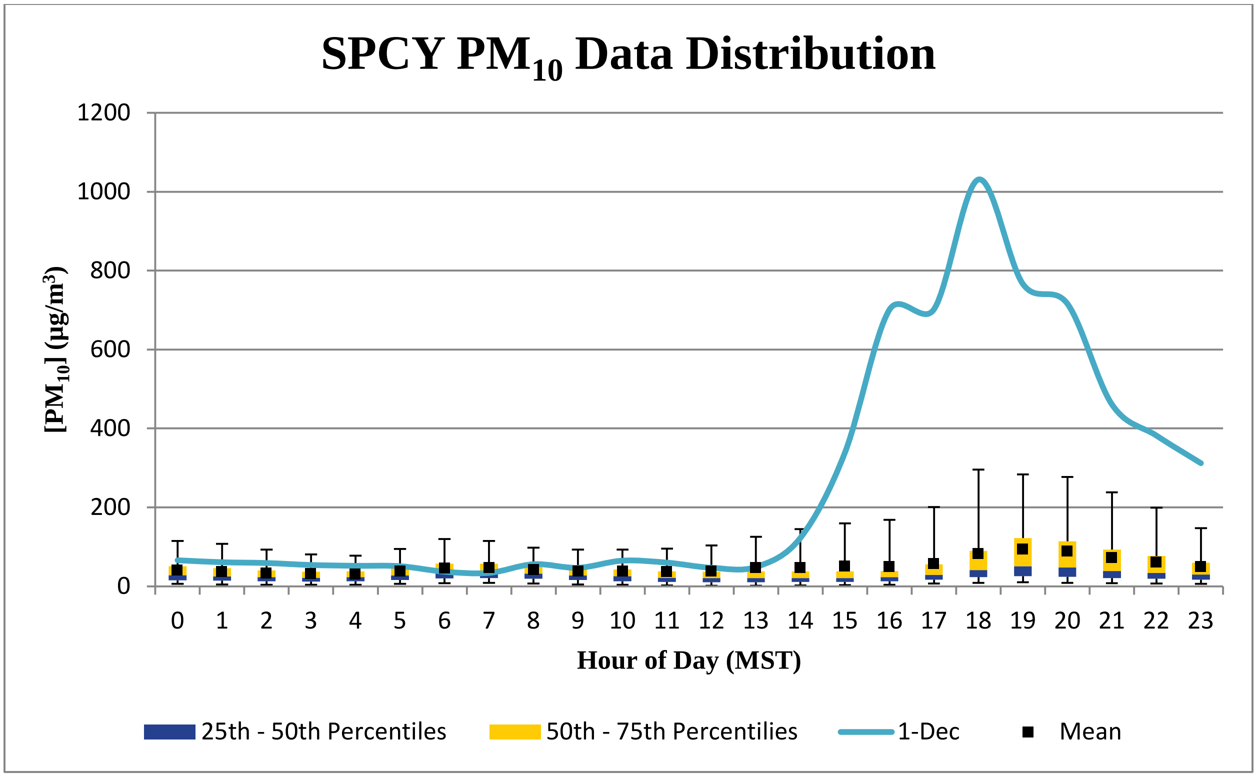

Figure 29-5d. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for December 1, 2011

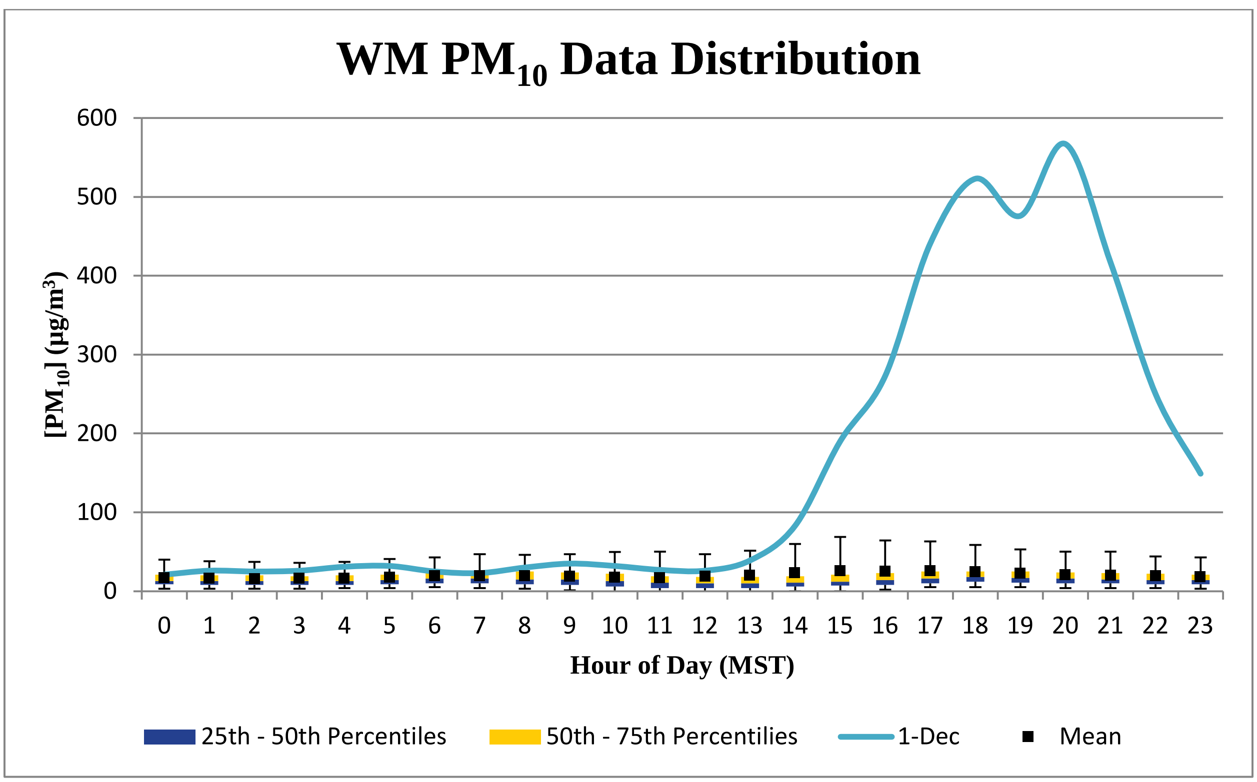

Figure 29-5e. PM_{10} hourly data distribution from 2006-2010 overlaid by hourly values for December 1, 2011

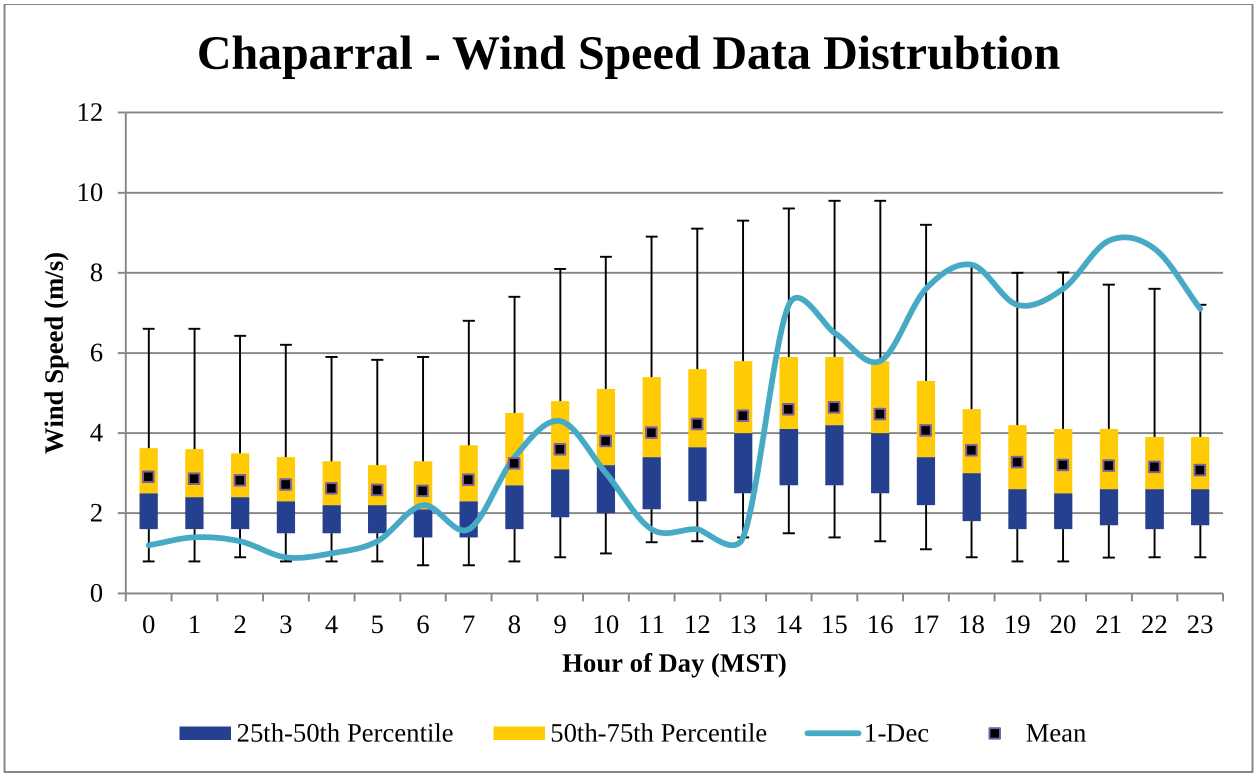

Figure 29-6a. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

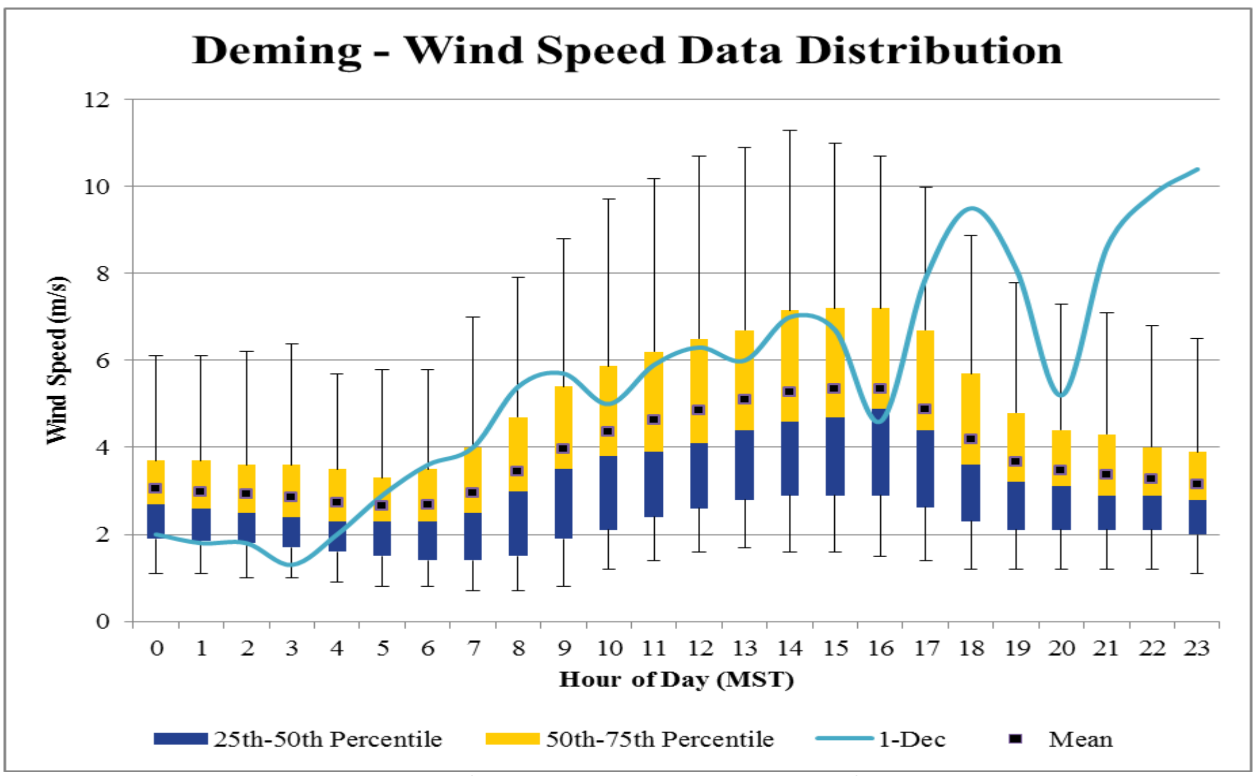

Figure 29-6b. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

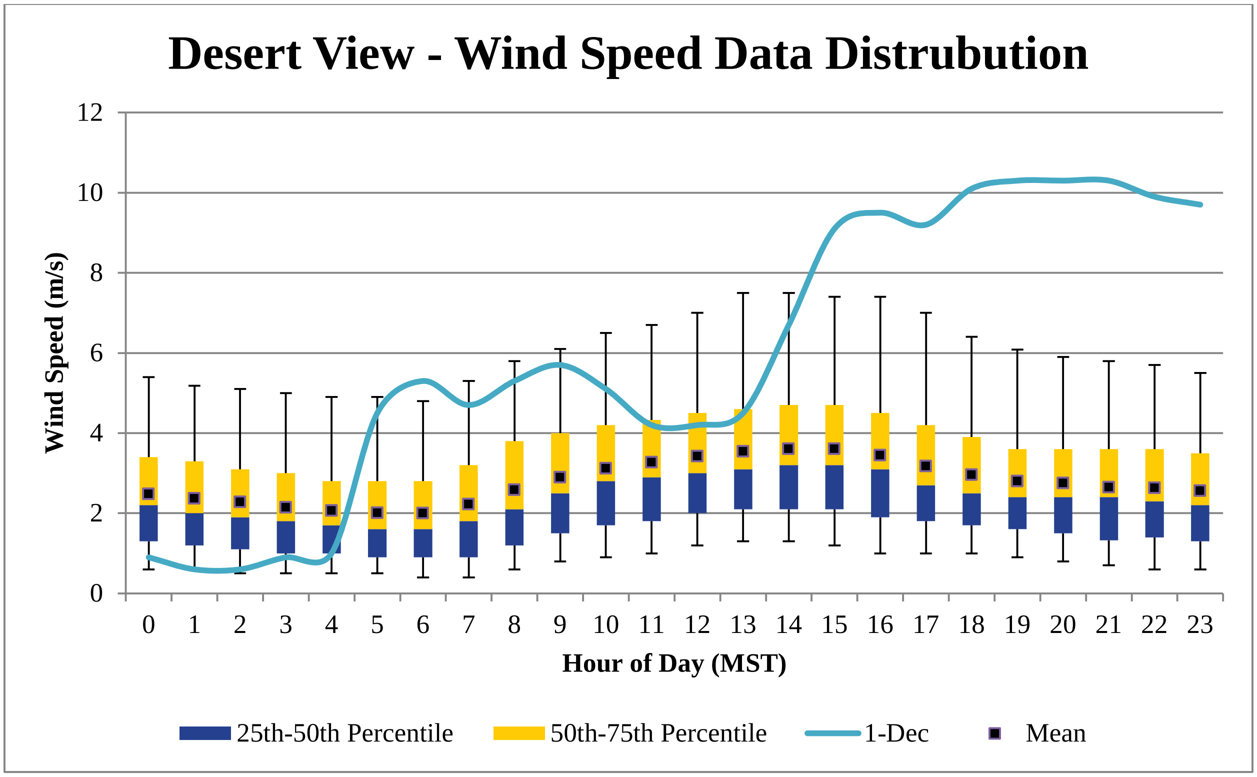

Figure 29-6c. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

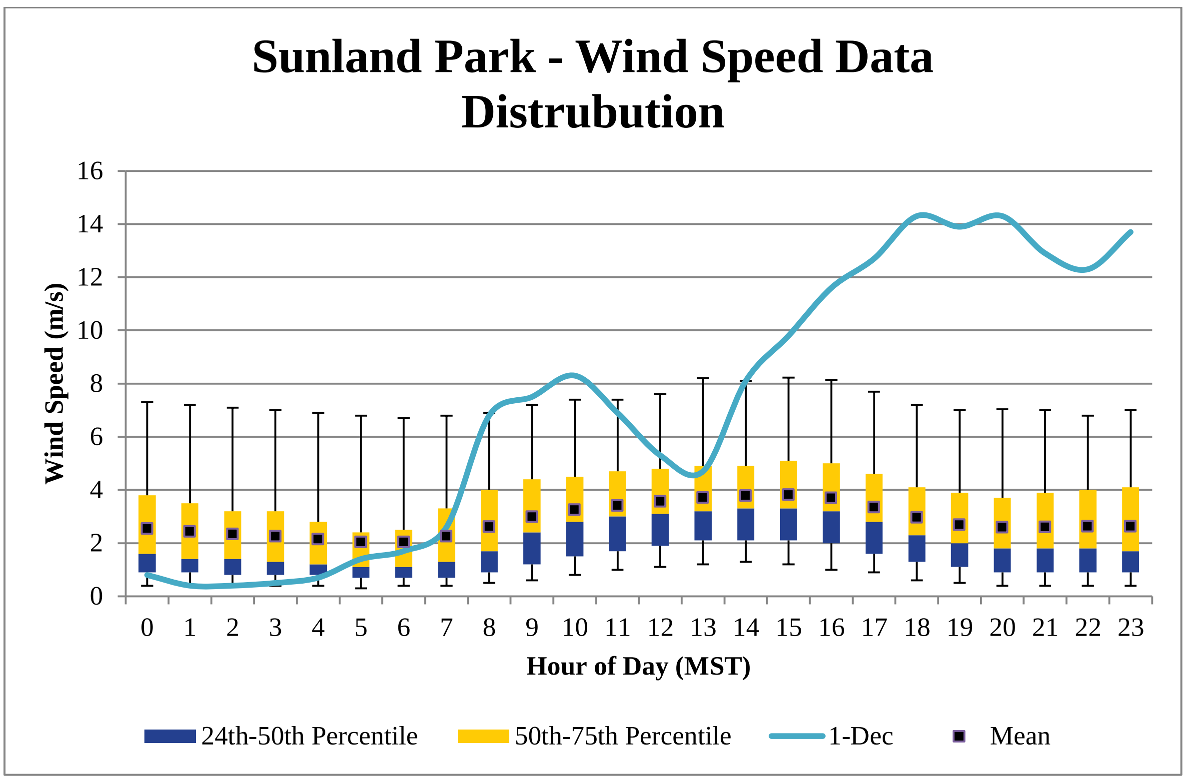

Figure 29-6d. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

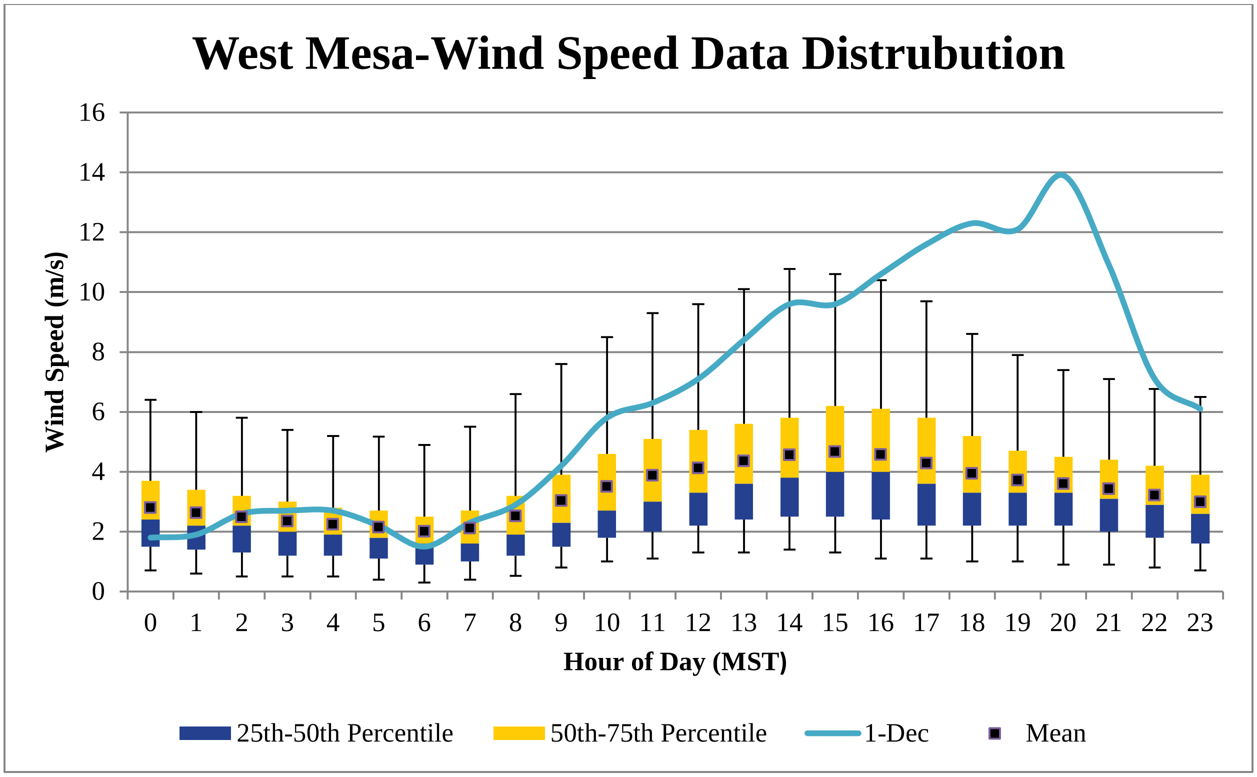

Figure 29-6e. Hourly wind speed data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

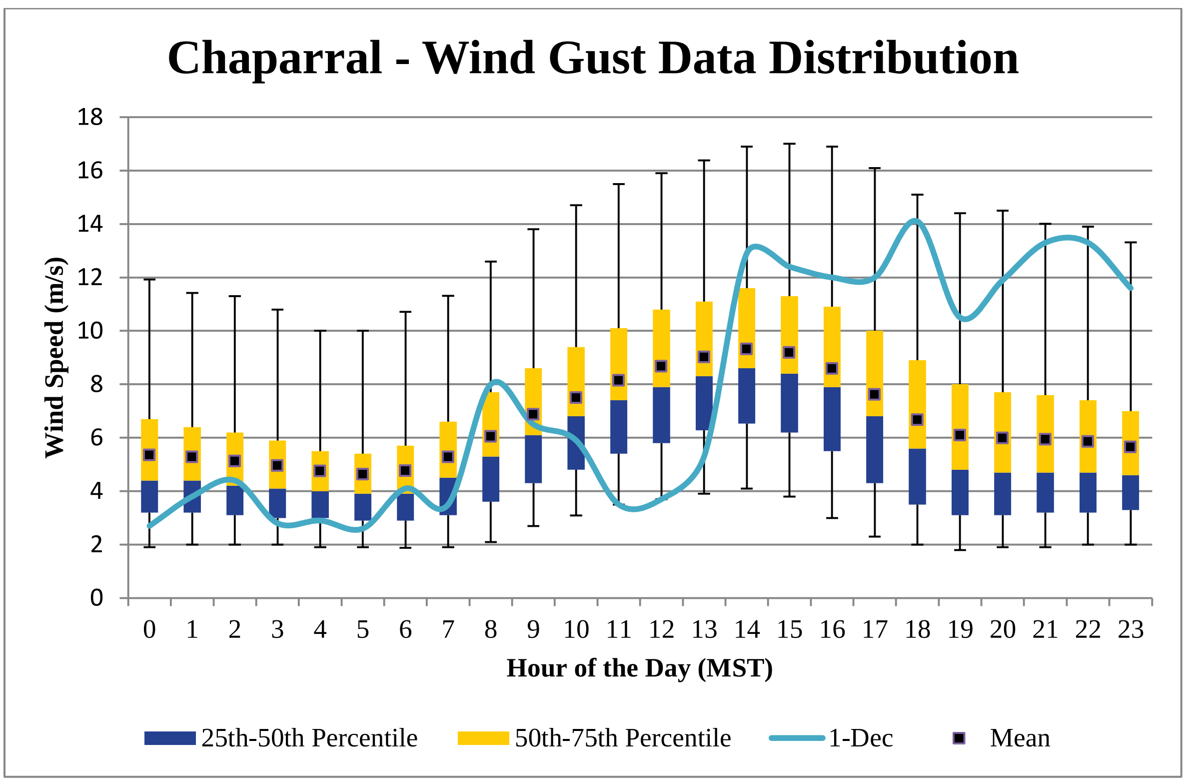

Figure 29-7a. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

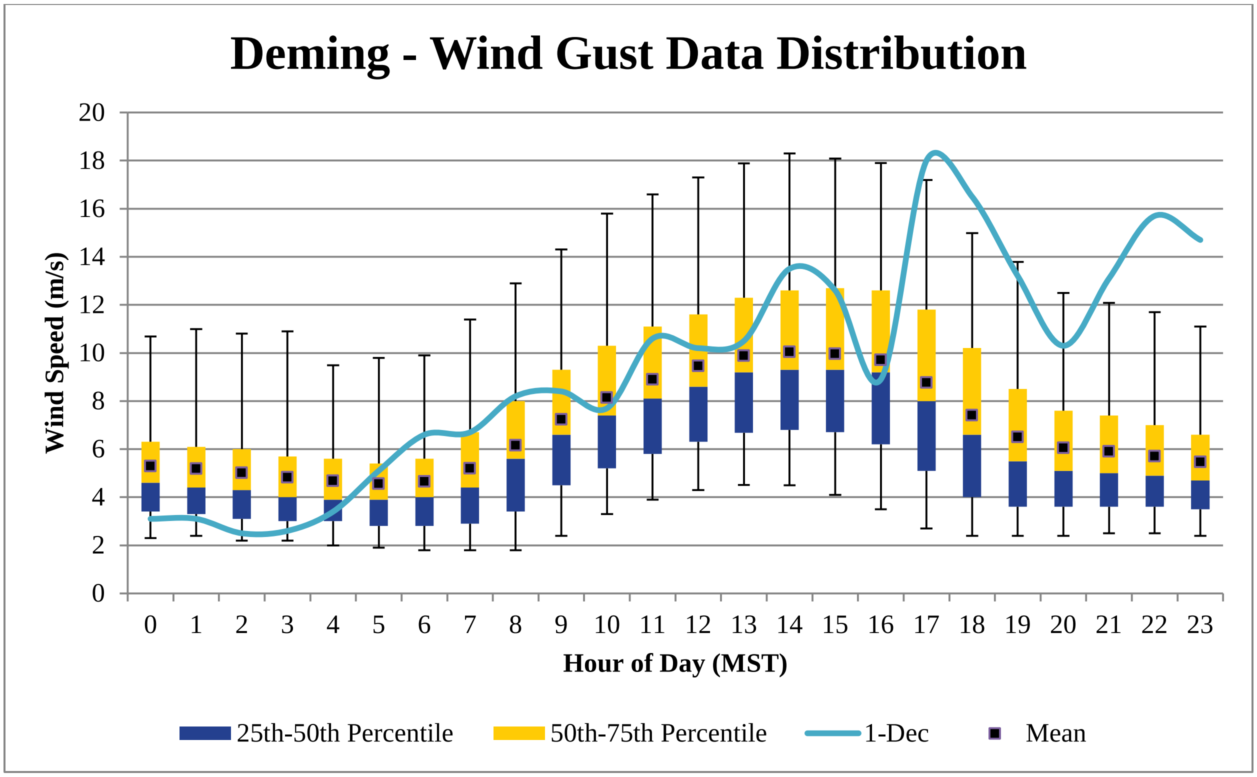

Figure 29-7b. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

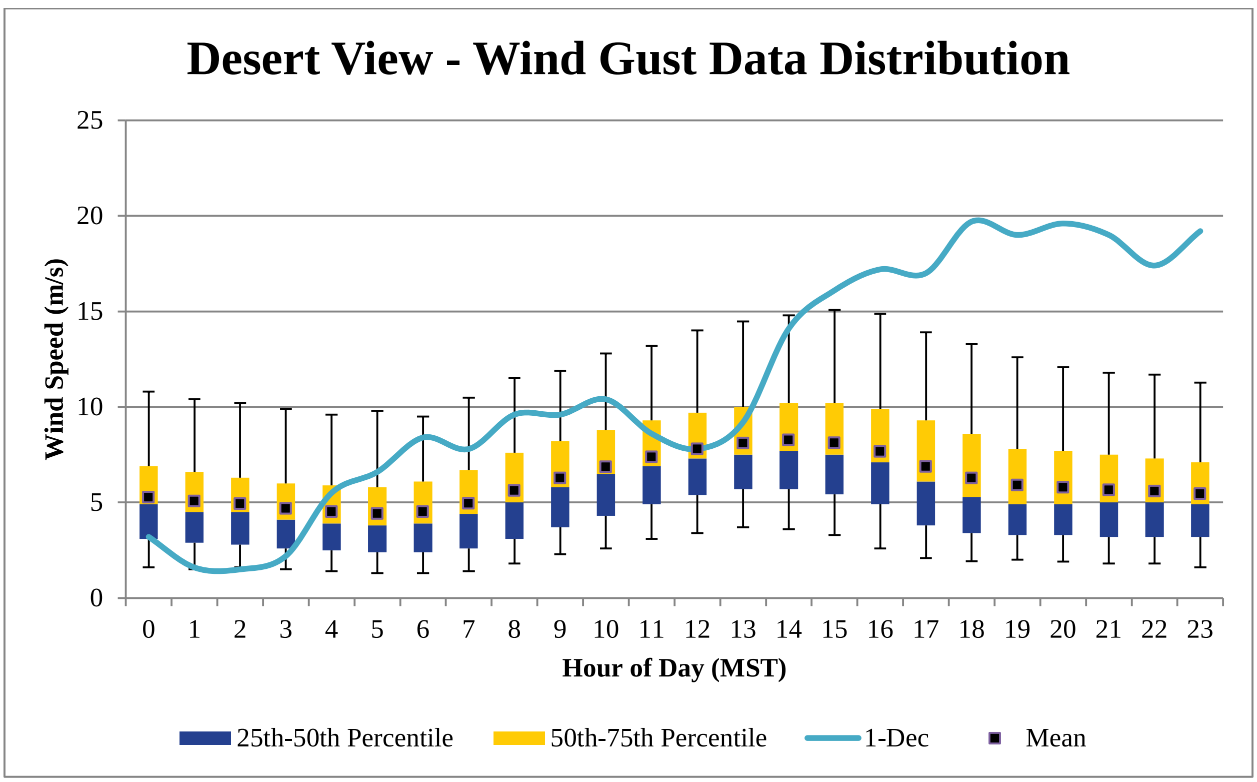

Figure 29-7c. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

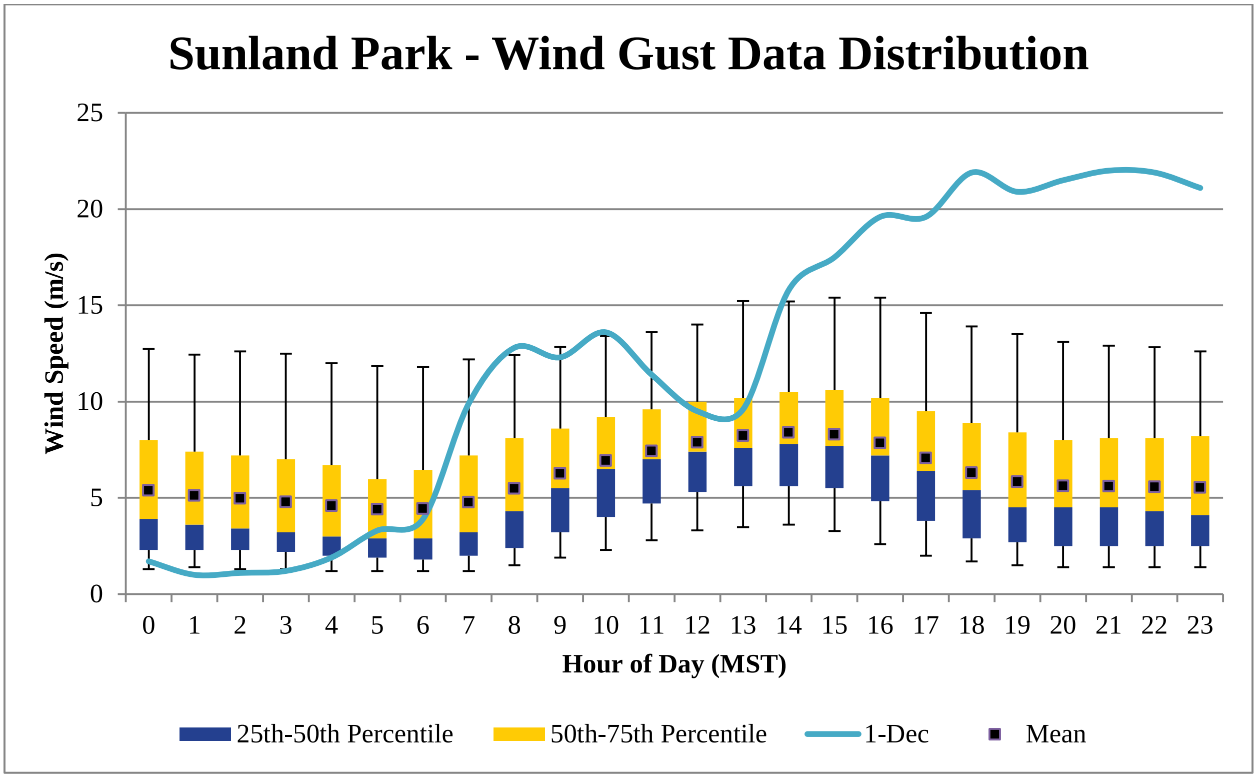

Figure 29-7d. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

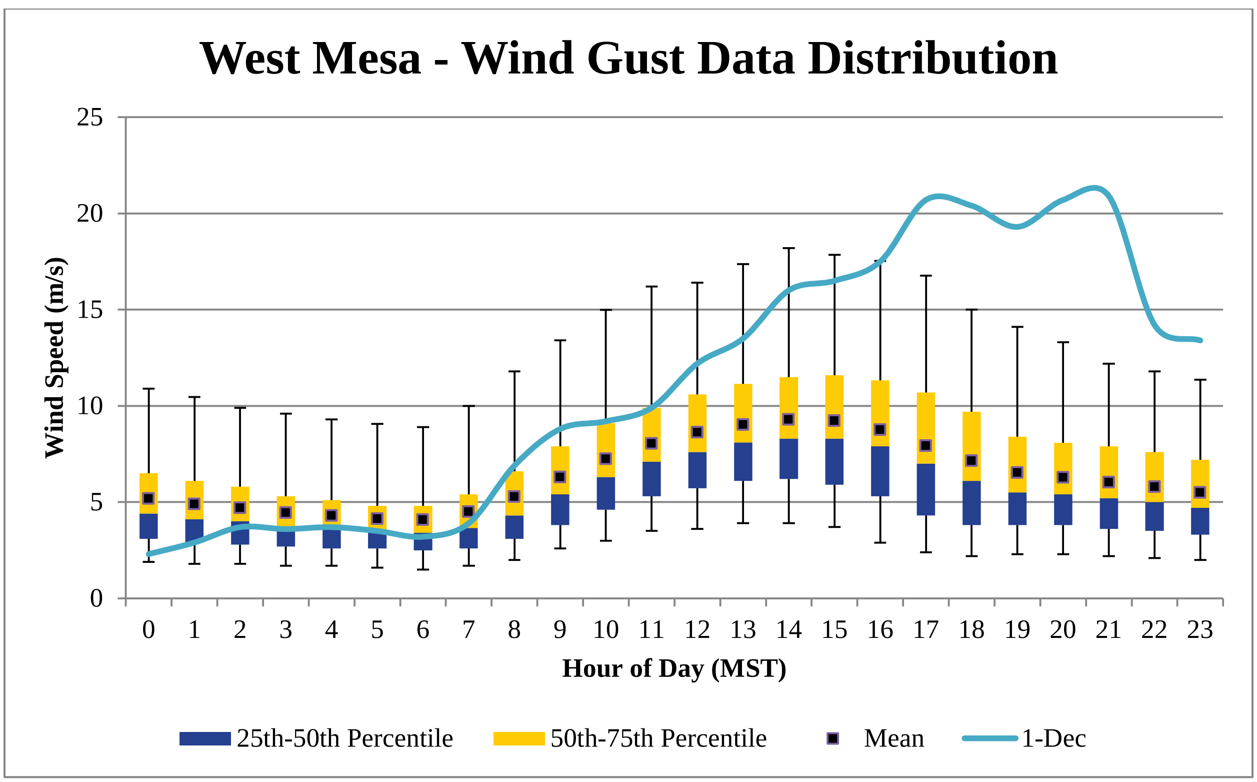

Figure 29-7e. Hourly wind gust data distribution from 2006-2010 overlaid by hourly values for December 1, 2011.

29.4 Clear Causal Relationship

A complex winter storm approached New Mexico on December 1, 2011. A pacific cold front moved toward New Mexico from the west as a backdoor cold front approached from the north (Figure 29-8a). An area of high pressure over Montana moved south to the Great Plains pushing the backdoor cold front south with the low pressure centers for both systems located in Arizona (Figure 29-8b). This created strong east to south blowing winds as the pressure gradient tightened over New Mexico, Texas and Mexico. Surface winds flow perpendicular to the isobars from high to low pressure.

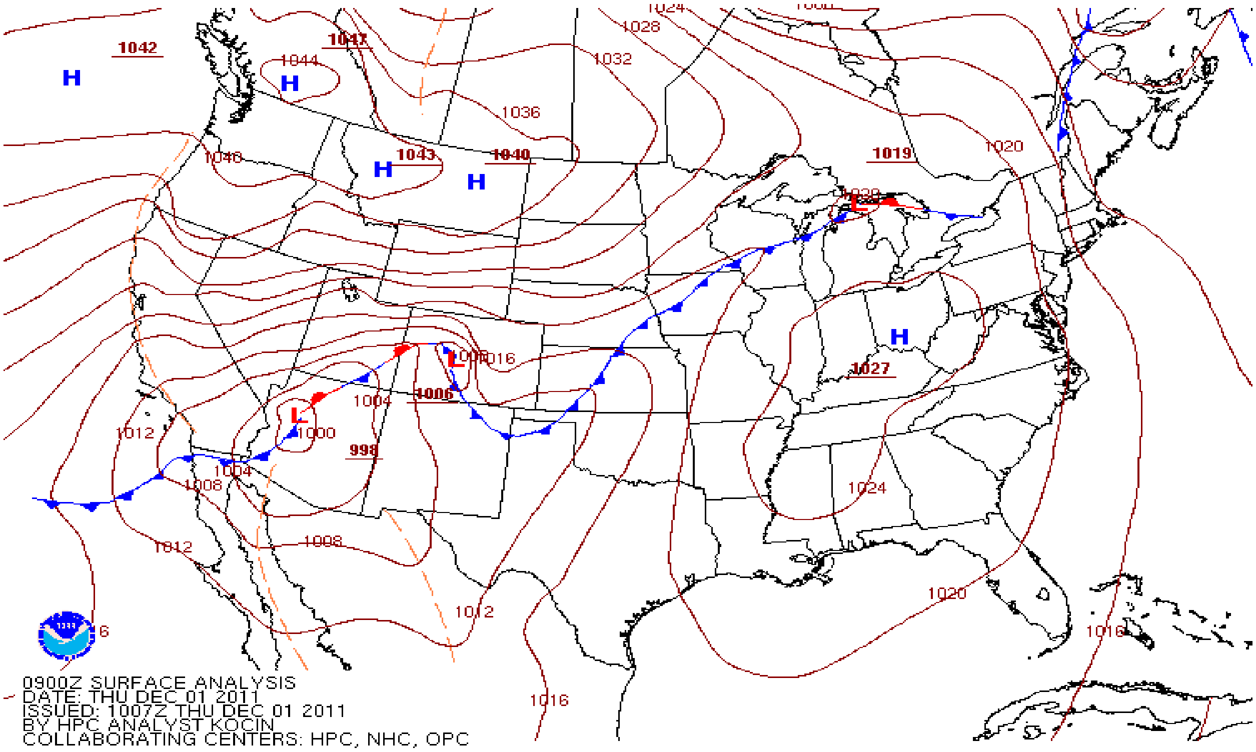

Figure 29-8a. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for December 1, 2011 at the 0300 hour.

The upper level system associated with the Pacific cold front helped to deepen the surface lows and tighten the pressure gradient but upper level winds did not align with the surface wind flow (Figure 29-9). Diurnal heating of the surface provided the turbulence required for vertical mixing and horizontal transport.

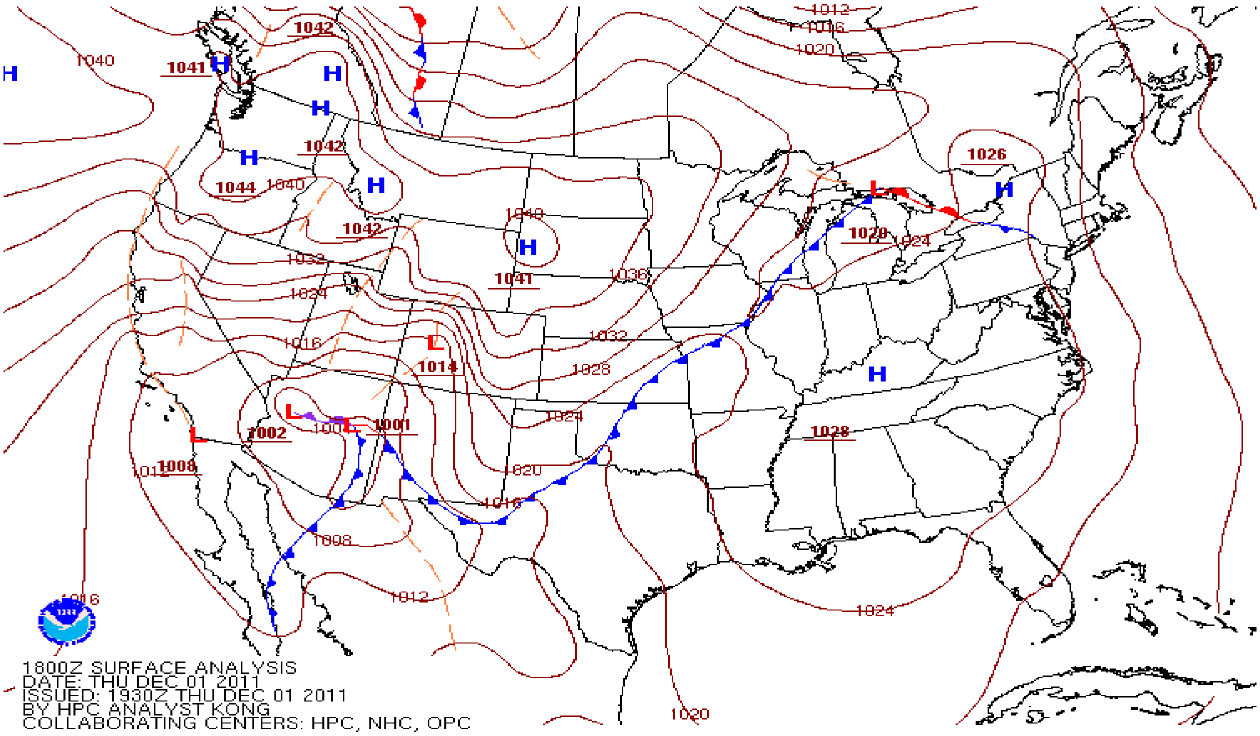

Figure 29-8b. Surface weather map showing frontal activity and isobars of constant pressure (red lines) for December 1, 2011 at the 1200 hour.

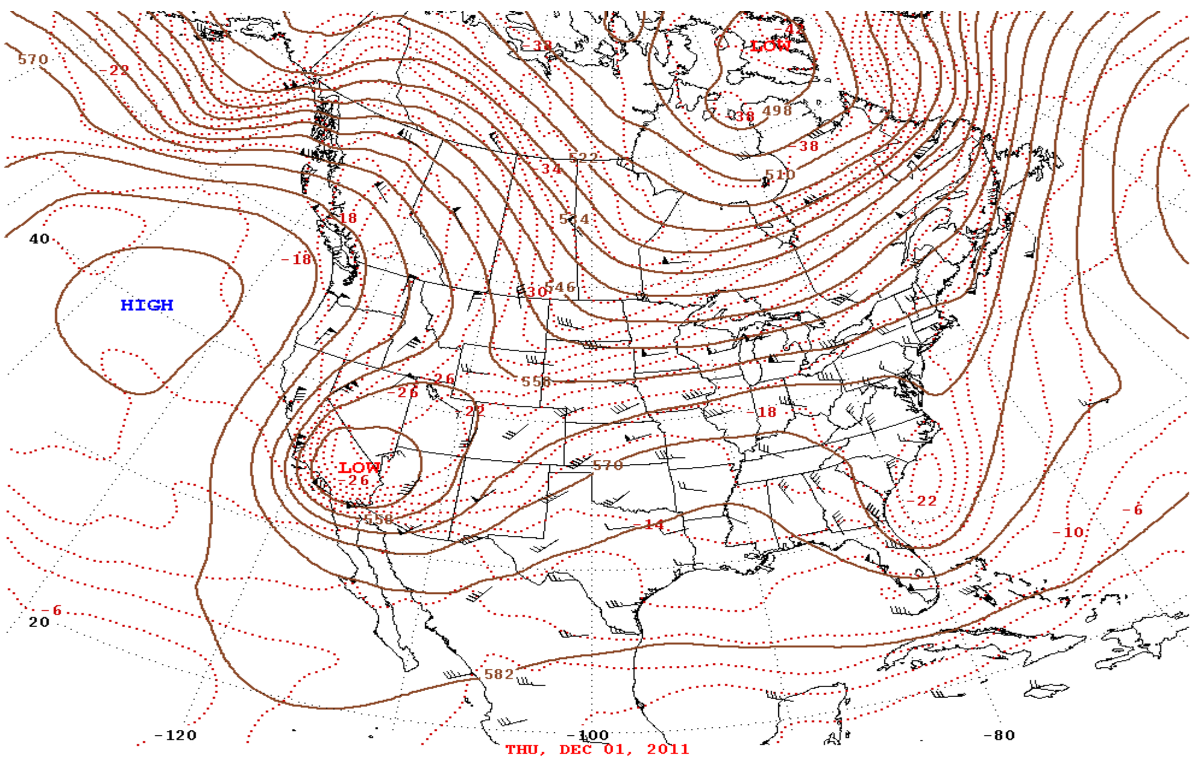

Figure 29-9. Upper air weather map showing geopotential heights (brown lines) at the 0500 MST hour on December 1, 2011.

The weather pattern described above generated strong southerly winds beginning at the 1400 hour and lasting through the 2300 hour. Beginning at the 1400 hour, wind speeds exceeded 11.2 m/s at Holman as shown in Figure 29-2. Peak wind speeds ranged from 8.6 m/s at Anthony (La Union) to 20.5 m/s at Holman (Figure 29-2). Peak wind gusts ranged from 14.1 m/s at Chaparral to 30.1 m/s at Holman (Figure 29-3). Blowing dust caused elevated levels of PM_{10} during the same period as high winds as demonstrated by the time series plots in Figures 29-10a-e. As wind speed and wind gusts exceed the 95th percentile of historical data so do hourly PM_{10} concentrations on this date (1400-2300 hours). During these hours, hourly PM_{10} concentrations spiked at all monitoring sites in the network (Figure 29-11).

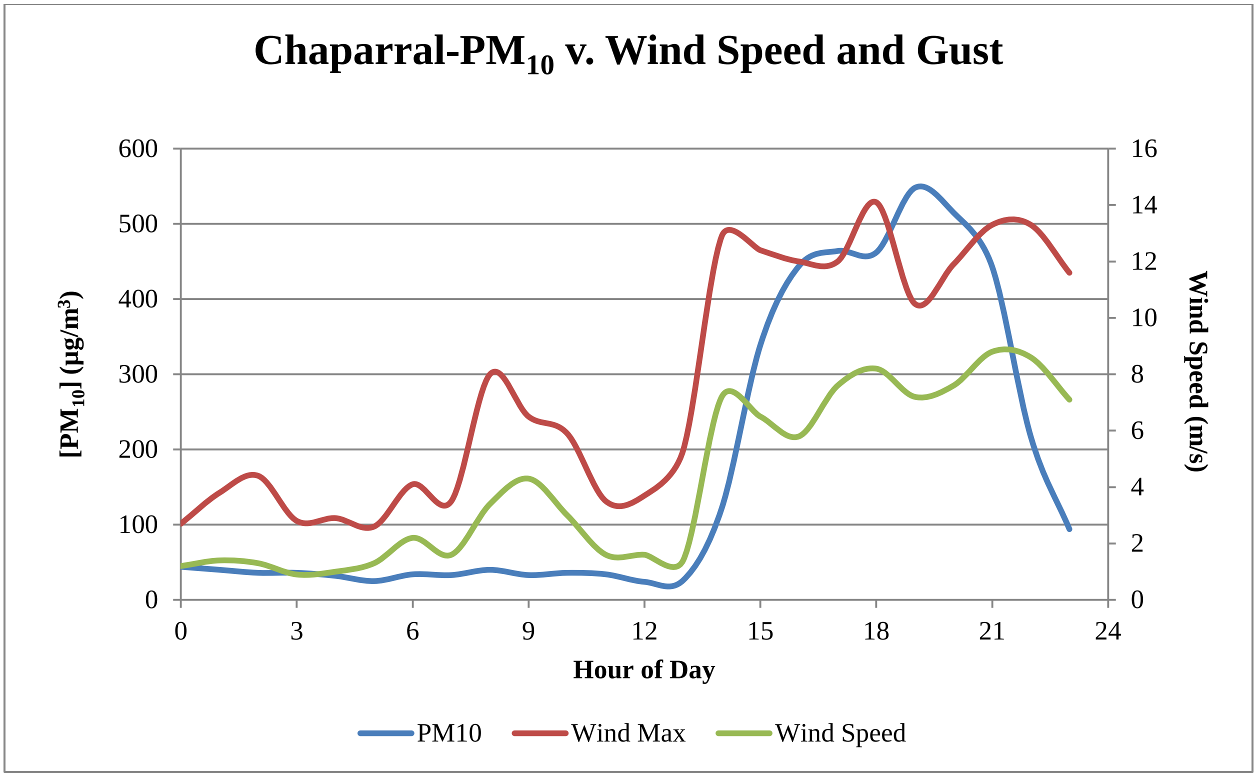

Figure 29-10a. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

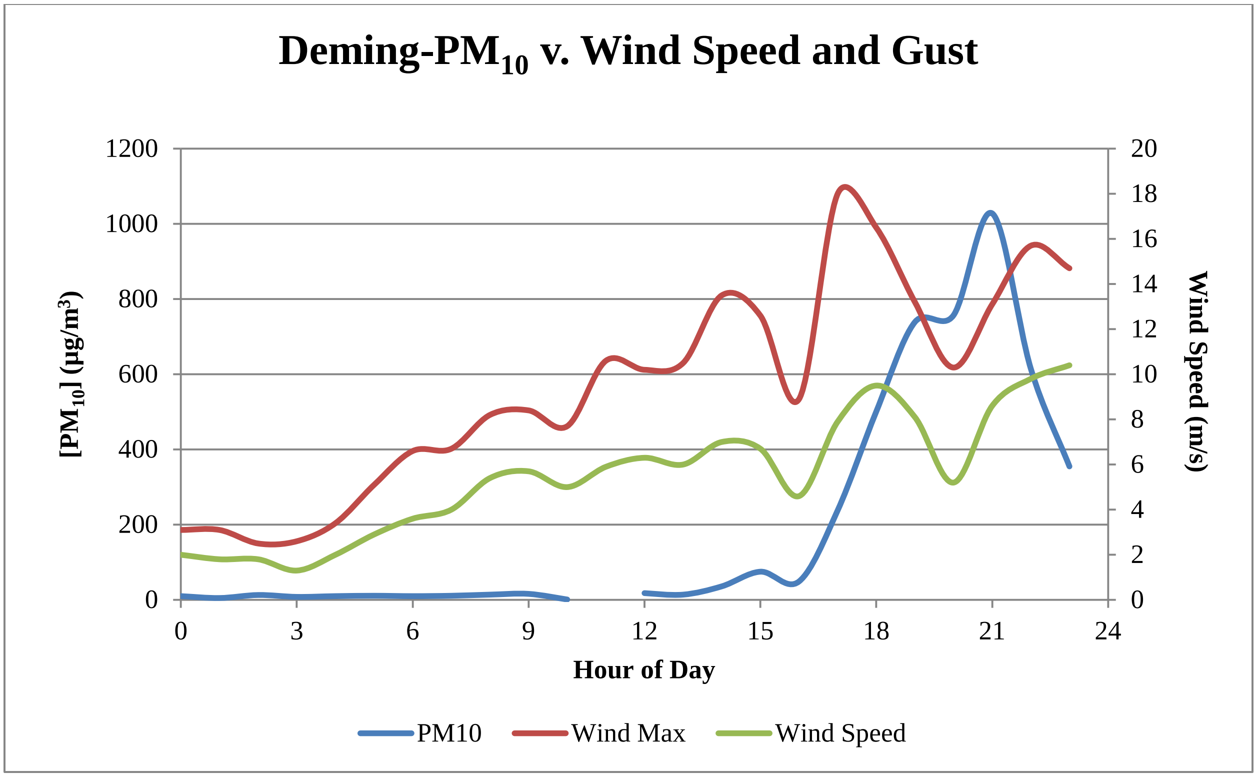

Figure 29-10b. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

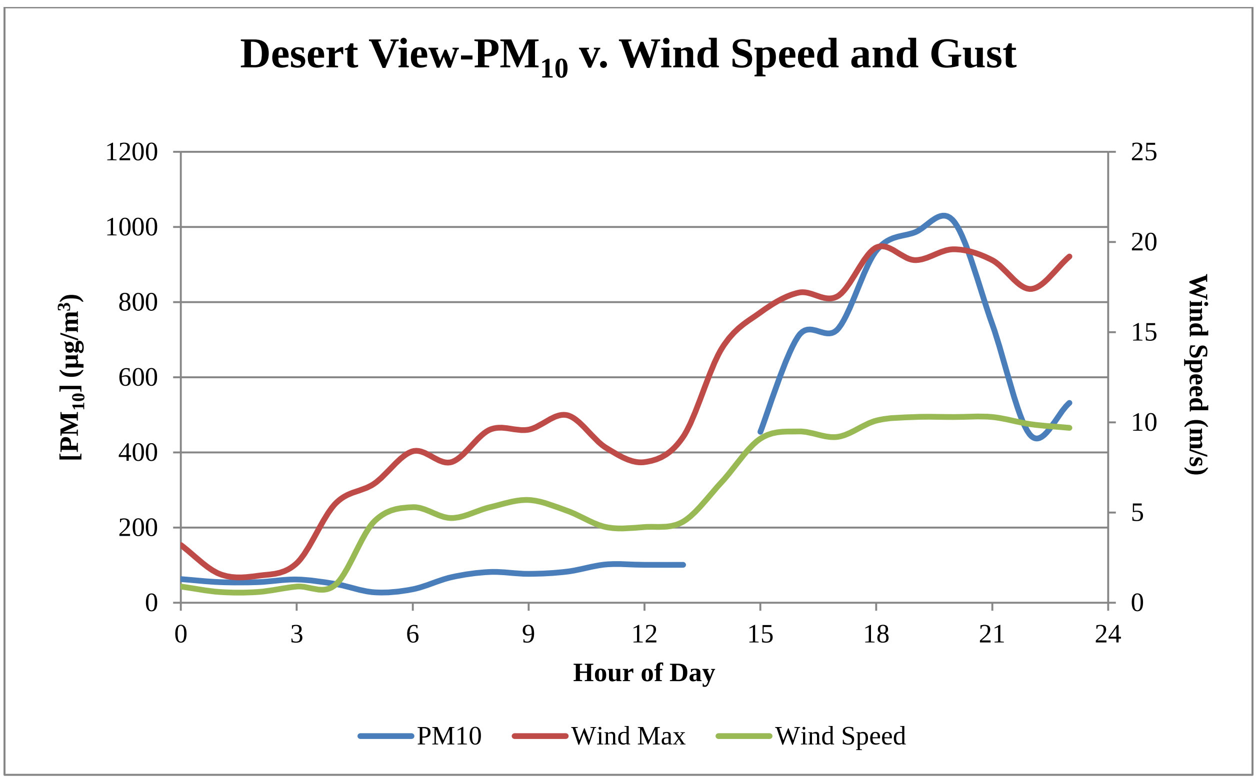

Figure 29-10c. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

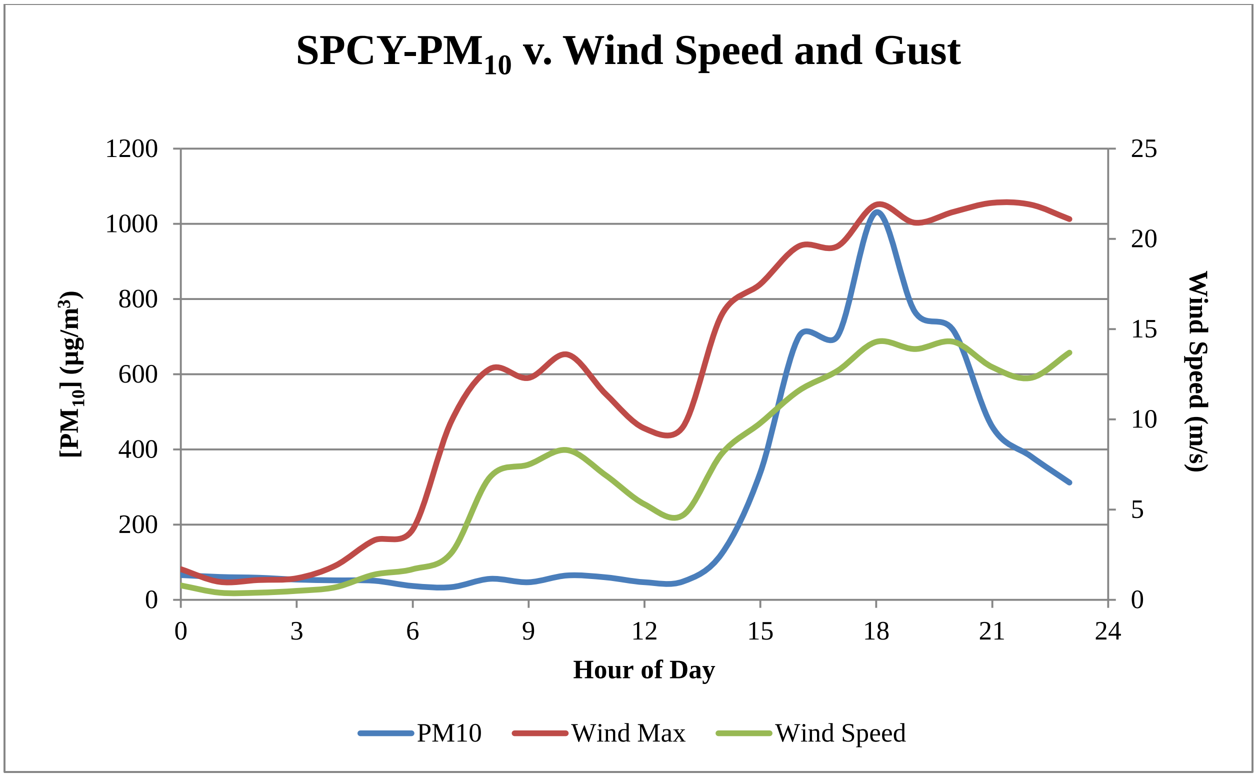

Figure 29-10d. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

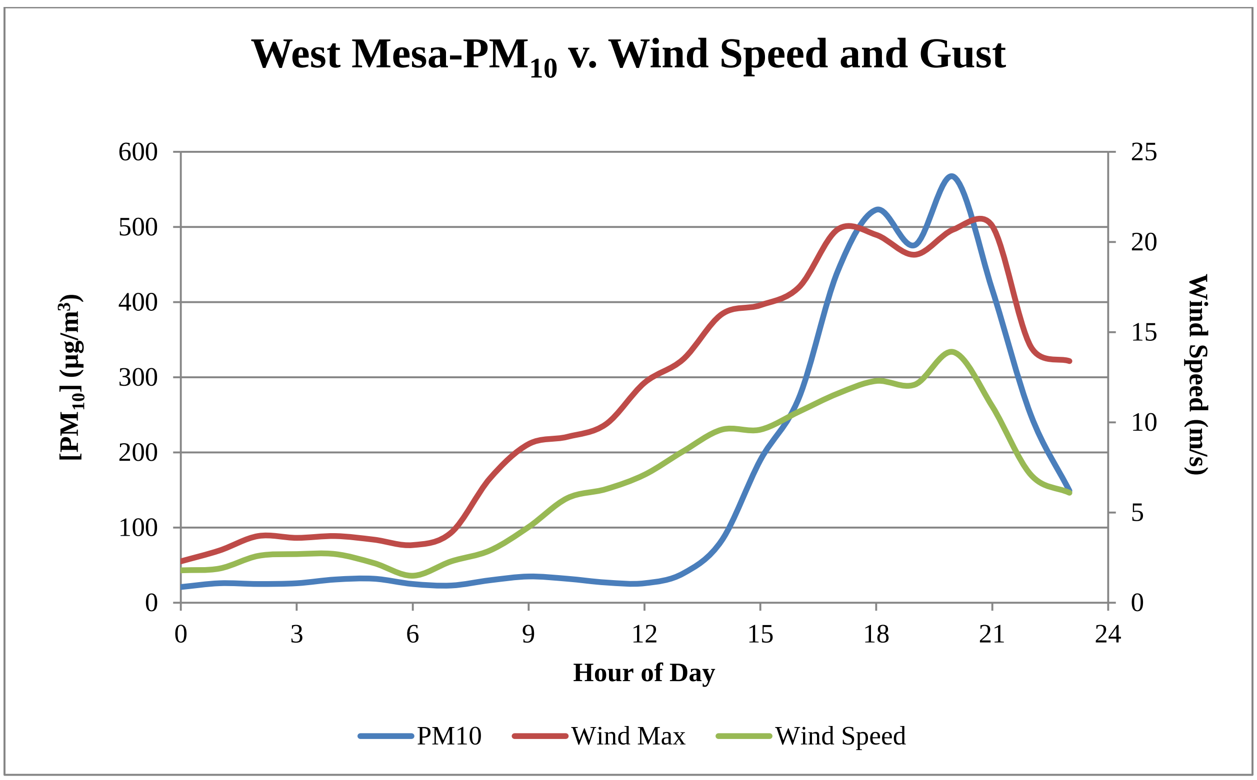

Figure 29-10e. Time series plot of hourly observations showing increased PM_{10} concentrations as wind speeds and gusts increase.

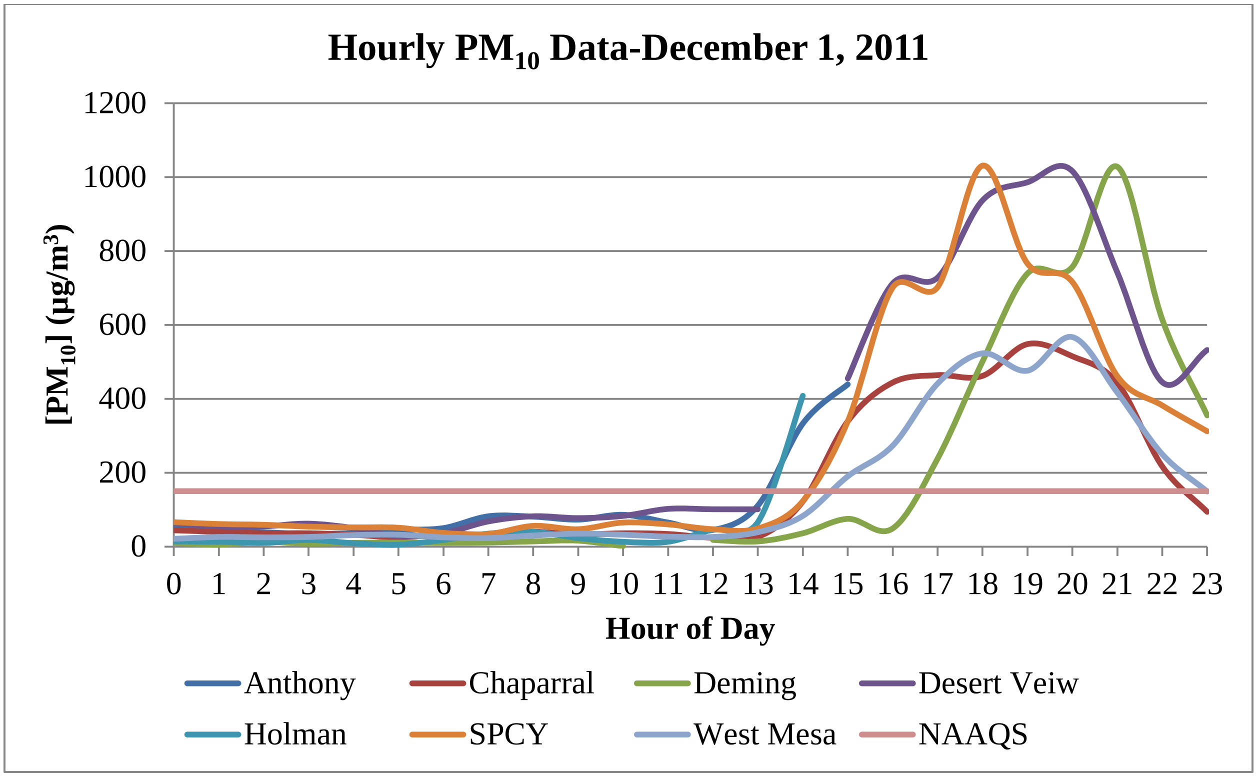

Figure 29-11. Hourly PM_{10} concentrations for Doña Ana and Luna Counties monitors.

The NWS El Paso/Santa Teresa office reported very windy regional conditions with gusts >75 mph over west El Paso, gusts near 80 mph at Dripping Springs, NM and gusts around 60 mph in the Las Cruces area (NWS Southwest Weather Bulletin, Spring Summer 2012 Edition). The CALIPSO Aerosol Subtype chart for this date also shows heavy dust in the region (Figure 29-12).

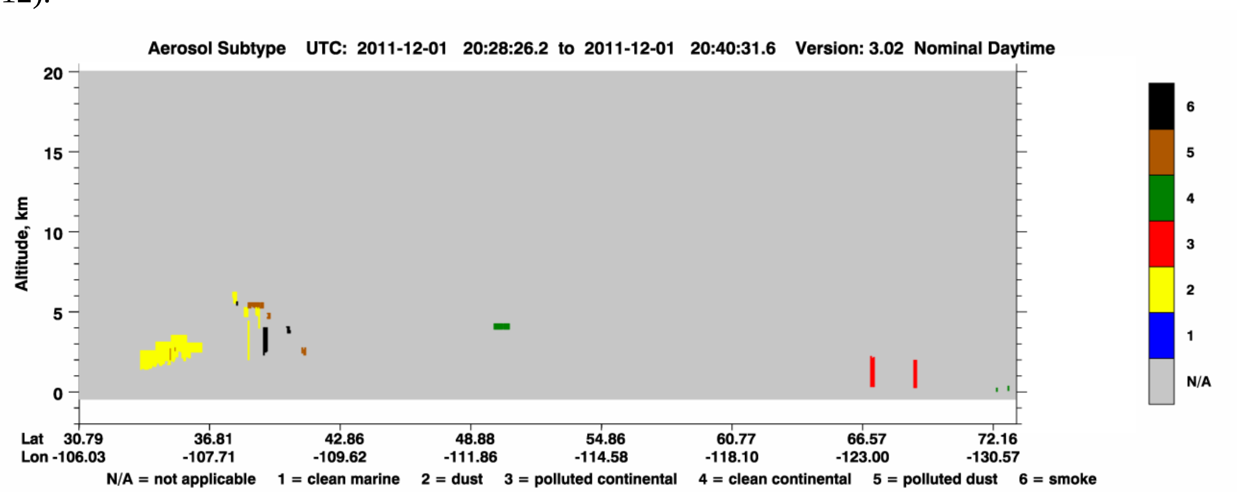

Figure 29-12. CALIPSO Aerosol Subtype chart for December 1, 2011 (Courtesy NASA).

29.5 Affects Air Quality

The historical fluctuations and clear causal relationship analyses prove that the event in question affected air quality on December 1, 2011.

29.6 Natural Event

The CCR and nRCP analyses show that this was a natural event caused by high wind and blowing dust.

29.7 No Exceedance but for the Event

The Chaparral monitor detected blowing dust around the 1500 hour with hourly concentrations heavily impacted through the 2200 hour. By replacing these nine hourly values with the 95th percentile of hourly data at the Chaparral site, the resulting 24-hour average (67 μg/m^3) does not exceed the NAAQS (Table 29-1). The values in red represent the 95th percentile of all hourly data collected at Chaparral, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	44	44
1	40	40
2	36	36
3	36	36
4	32	32
5	25	25
6	34	34
7	33	33
8	40	40
9	33	33
10	36	36
11	34	34
12	24	24
13	26	26
14	122	122
15	339	**147**
16	444	**127**
17	464	**122**
18	462	**120**
19	548	**126**
20	515	**111**
21	443	**94**
22	217	**80**
23	94	**71**
24-Hour Average	171	**67**

Table 29-1. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Chaparral.

The Deming monitor detected blowing dust around the 1700 hour with hourly concentrations heavily impacted through the 2300 hour. The seven hourly PM_{10} values from 1500-2300 hours alone, exceed the 24-hour average standard at Deming [(238+501+739+757+1028+615+355) $\mu g/m^3$ = 4233 $\mu g/m^3$; (4233 $\mu g/m^3$)/24 = 176 $\mu g/m^3$]. By replacing these nine hourly values with the 95th percentile of hourly data at the Deming site, the resulting 24-hour average (34 $\mu g/m^3$) does not exceed the NAAQS (Table 29-2). The values in red represent the 95th percentile of all hourly data collected at Deming, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	Recorded Hourly Data	Substituted Hourly Data
0	10	10
1	5	5
2	13	13
3	8	8
4	10	10
5	11	11
6	10	10
7	11	11
8	14	14
9	16	16
10	1	1
11		
12	18	18
13	14	14
14	36	36
15	75	75
16	49	49
17	238	**95**
18	501	**87**
19	739	**76**
20	757	**71**
21	1028	**59**
22	615	**54**
23	355	**49**
24-Hour Average	197	**34**

Table 29-2. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Deming.

The Desert View monitor detected blowing dust around the 1500 hour with hourly concentrations heavily impacted through the 2300 hour. The nine hourly PM_{10} values from 1500-2300 hours alone, exceed the 24-hour average standard at Desert View [(455 + 712 + 728 + 937 + 986 + 1016 + 742 + 445 + 532) µg/m^3 = 6553 µg/m^3; (6553 µg/m^3)/24 = 273 µg/m^3]. By replacing these nine hourly values with the 95th percentile of hourly data at the Desert View site, the resulting 24-hour average (90 µg/m^3) does not exceed the NAAQS (Table 29-3). The values in red represent the 95th percentile of all hourly data collected at Desert View, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	63	63
1	55	55
2	55	55
3	62	62
4	50	50
5	28	28
6	36	36
7	68	68
8	82	82
9	77	77
10	83	83
11	102	102
12	101	101
13	101	101
14		
15	455	**119**
16	712	**124**
17	728	**158**
18	937	**137**
19	986	**149**
20	1016	**116**
21	742	**107**
22	445	**100**
23	532	**95**
24-Hour Average	326	**90**

Table 29-3. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at Desert View.

The Sunland Park monitor detected blowing dust around the 1500 hour with hourly concentrations heavily impacted through the 2300 hour. The nine hourly PM_{10} values from 1500-2300 hours alone, exceed the 24-hour average standard at Sunland Park [(339 + 701 + 702 + 1031 + 766 + 716 + 461 + 382 + 312) µg/m^3 = 5410 µg/m^3; (5410 µg/m^3)/24 = 225 µg/m^3]. By replacing these nine hourly values with the 95th percentile of hourly data at the Sunland Park site, the resulting 24-hour average (118 µg/m^3) does not exceed the NAAQS (Table 29-4). The values in red represent the 95th percentile of all hourly data collected at Sunland Park, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	66	66
1	61	61
2	59	59
3	54	54
4	52	52
5	51	51
6	37	37
7	34	34
8	56	56
9	47	47
10	65	65
11	60	60
12	47	47
13	49	49
14	123	123
15	339	**160**
16	701	**168**
17	702	**201**
18	1031	**296**
19	766	**284**
20	716	**277**
21	461	**238**
22	382	**199**
23	312	**147**
24-Hour Average	261	**118**

Table 29-4. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at SPCY.

The West Mesa monitor detected blowing dust around the 1400 hour with hourly concentrations heavily impacted through the 2300 hour. By replacing these nine hourly values with the 95th percentile of hourly data at the West Mesa site, the resulting 24-hour average (40 µg/m^3) does not exceed the NAAQS (Table 29-5). The values in red represent the 95th percentile of all hourly data collected at West Mesa, including data affected by high wind blowing dust events in the table below. NMED concludes that without the high wind and blowing dust an exceedance would not have occurred.

Hour of Day (MST)	**Recorded Hourly Data**	**Substituted Hourly Data**
0	21	21
1	26	26
2	25	25
3	26	26
4	31	31
5	32	32
6	25	25
7	23	23
8	30	30
9	35	35
10	32	32
11	27	27
12	26	26
13	39	39
14	83	**60**
15	190	**69**
16	273	**65**
17	441	**63**
18	523	**59**
19	426	**53**
20	567	**50**
21	417	**50**
22	250	**44**
23	149	**43**
24-Hour Average	156	**40**

Table 29-5. 95th percentile of data substituted for those hours when windblown dust was the most intense does not result in an exceedance at West Mesa.