

El Paso 2010-2012 Particulate Matter Exceptional Events Demonstration

**For PM_{2.5} and PM₁₀ Exceptional Events
at El Paso Monitoring Sites**

11/1/2013

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Introduction

Exceptional events are unusual or naturally occurring events that affect air quality and are not reasonably controllable or preventable. An event may also be caused by human activity that is unlikely to recur at a particular location. Under Section 319 of the Federal Clean Air Act (FCAA), states are responsible for identifying air quality monitoring data affected by an exceptional event and requesting the United States Environmental Protection Agency (EPA) to exclude the data from consideration when determining whether an area is in attainment or nonattainment of a National Ambient Air Quality Standard (NAAQS). EPA has promulgated an exceptional event rule, 40 Code of Federal Regulations (CFR) Part 50.14, as well as guidance to implement the requirements of the FCAA regarding exceptional events. States are required to identify air quality monitoring data potentially affected by exceptional events by “flagging” the data submitted into the EPA air quality system (AQS) database. If EPA concurs with this demonstration, the flagged data will not be eligible for consideration when making NAAQS attainment or nonattainment determinations.

This document discusses the Texas Commission on Environmental Quality’s (TCEQ) proposed ten exceptional event day flags for particulate matter of 2.5 micrometers or less in aerodynamic diameter ($PM_{2.5}$) and three exceptional event day flags for particulate matter of 10 microns or less in aerodynamic diameter (PM_{10}) during the period from 2010 through 2012 for monitoring sites in the El Paso area as shown in Appendix A. These 13 proposed exceptional event flags occurred on ten event days, and are for daily average measurements from the Federal Reference Method (FRM) $PM_{2.5}$ monitors at the Chamizal and the University of Texas at El Paso (UTEP) sites, the Federal Equivalent Method (FEM) $PM_{2.5}$ monitor at the Chamizal site, and the FRM PM_{10} monitor at the Socorro site. Maps identifying the El Paso area $PM_{2.5}$ and PM_{10} sites, including the Chamizal, UTEP, and Socorro sites, are shown in Figures 1 and 2.

With this demonstration, the TCEQ is providing detailed evidence to support concurrence by the EPA for the $PM_{2.5}$ and PM_{10} exceptional event flags shown in Appendix A. This document will be posted on the main TCEQ web page beginning on November 1, 2013, for a 30-day public comment period. All comments received will be submitted to EPA for consideration.

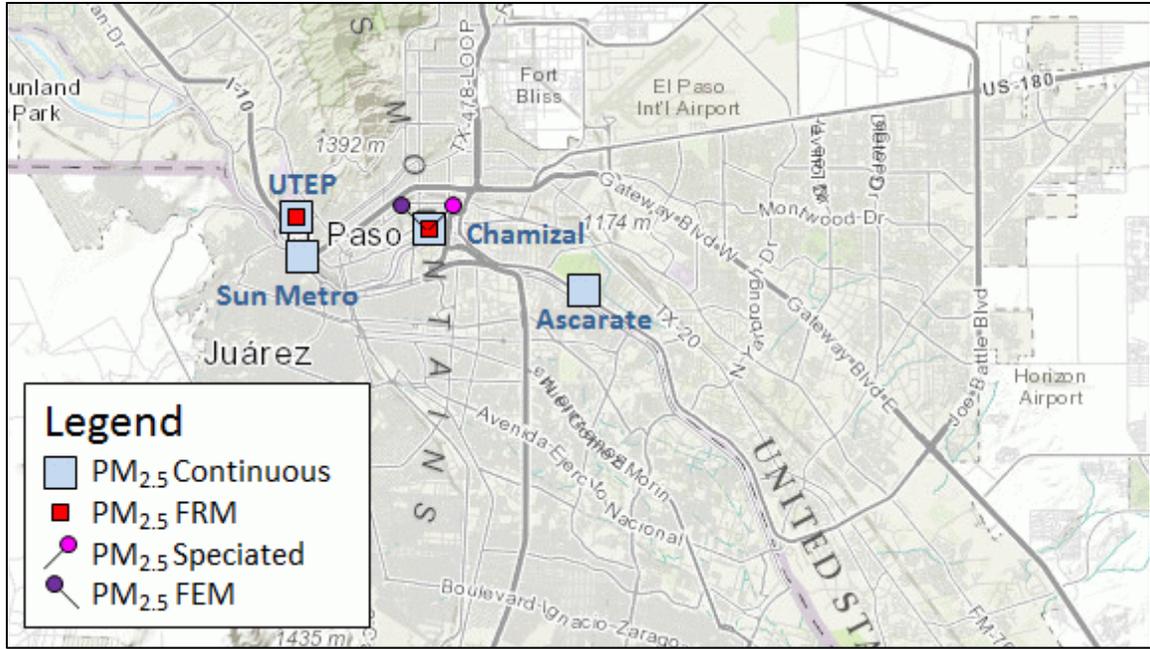


Figure 1. Map of El Paso area PM_{2.5} monitoring sites referenced in this document.

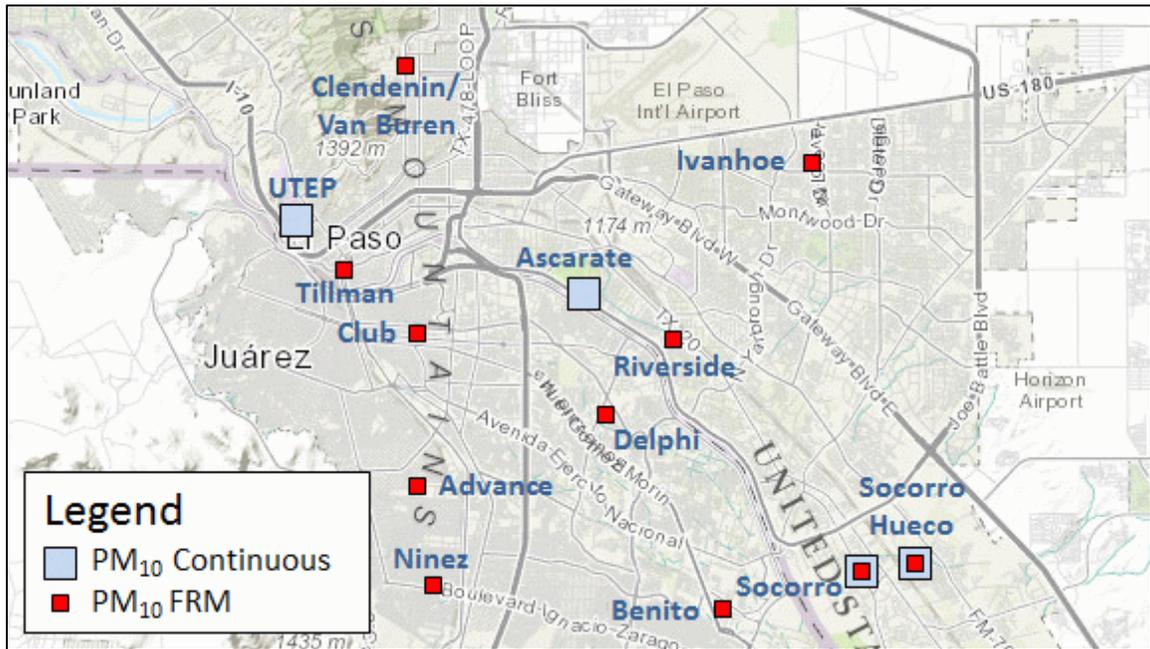


Figure 2. Map of El Paso area PM₁₀ monitoring sites referenced in this document.

Exceptional Event Definition and Criteria

An exceptional event is defined in 40 CFR Part 50.1(j) as “[1] an event that affects air quality, [2] is not reasonably controllable or preventable, [3] is an event caused by human activity that is unlikely to recur at a particular location or a natural event, and [4] is determined by the [EPA] Administrator in accordance with 40 CFR Part 50.14 to be an exceptional event”. Furthermore, 40 CFR Part 50.14(c)(3)(iv) states that the demonstration to justify data exclusion shall also provide evidence that “[5] there is a clear causal relationship between the measurement under consideration and the event that is claimed to have affected the air quality in the area; [6] the event is associated with a measured concentration in excess of normal historical fluctuations, including background; and [7] there would have been no exceedance or violation but for the event”. These seven requirements must all be satisfied for data to be excluded from regulatory decisions as an exceptional event. Requirements 1 through 3 and 5 through 7 will be addressed individually in this demonstration document.

Mitigation of exceptional events is also required by 40 CFR Part 51.930, which reads:

A State requesting to exclude air quality data due to exceptional events must take appropriate and reasonable actions to protect public health from exceedances or violations of the national ambient air quality standards. At a minimum, the State must:

- (1) provide for prompt public notification whenever air quality concentrations exceed or are expected to exceed an applicable ambient air quality standard;*
- (2) provide for public education concerning actions that individuals may take to reduce exposures to unhealthy levels of air quality during and following an exceptional event; and*
- (3) provide for the implementation of appropriate measures to protect public health from exceedances or violations of ambient air quality standards caused by exceptional events.*

These requirements will be addressed in the “Mitigation of Exceptional Events” section.

Summary of Approach

The TCEQ used several methods for developing a demonstration that indicates the high PM_{2.5} and PM₁₀ measurements in question qualify as exceptional events. PM_{2.5} measurements from two El Paso FRM monitors and PM₁₀ measurements from 12 El Paso FRM monitors were evaluated for a period of over 10 years to adequately establish historical trends in the data. In addition, the TCEQ evaluated PM_{2.5} speciation data from these monitors to identify dust contributions to observed PM_{2.5} concentrations. Satellite imagery from the National Oceanic and Atmospheric Administration (NOAA) (NOAA, 2013) was used to track blowing dust from primary source areas in Mexico and New Mexico. The TCEQ also analyzed moderate wind days to conservatively estimate the PM_{2.5} and PM₁₀ levels “but for” the transported dust on the high wind exceptional event days.

Summary of Findings

The information provided in this demonstration document supports the conclusion that the 13 high PM_{2.5} and PM₁₀ daily average measurements proposed as exceptional events (listed in Appendix A) qualify as exceptional events. The measured PM_{2.5} and PM₁₀ concentrations on these days were not reasonably preventable, were clearly due to internationally transported dust events associated with high winds, were in excess of normal historical fluctuations, and would not have occurred but for the high wind dust events. The TCEQ requests EPA’s concurrence on these exceptional events and to have these flagged days removed from consideration when making attainment or nonattainment determinations for the annual PM_{2.5} and PM₁₀ NAAQS.

Data and Analysis Methods

Data and Imagery Used

For the analyses presented in this document, the TCEQ utilized an extensive set of monitoring data, satellite imagery, and air trajectory information. The particulate data are presented in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) with $\text{PM}_{2.5}$ in local conditions (LC) of temperature and pressure measured at the monitor and PM_{10} in standard conditions (SC) adjusted to a standard temperature of 25 degrees centigrade and atmospheric pressure of 760 millimeters of mercury as required for reporting to EPA's AQS database. The satellite imagery includes Moderate Resolution Imaging Spectroradiometer (MODIS) sensor three-channel composite true color visible imagery from the Terra and Aqua polar orbiting satellites with 0.25 kilometer resolution and high time resolution Geostationary Operational Environmental Satellites (GOES) single channel visible imagery from the GOES-13 satellite with one kilometer resolution. As detailed in Table 1, the monitoring data include FRM non-continuous $\text{PM}_{2.5}$ and PM_{10} daily measurements, non-continuous $\text{PM}_{2.5}$ acceptable speciated daily measurements, and continuous $\text{PM}_{2.5}$ and PM_{10} acceptable hourly and daily measurements used for daily reporting of the EPA Air Quality Index (AQI), as well as hourly and daily wind measurements including National Weather Service (NWS) wind data.

All of the non-continuous and hourly continuous monitoring data used in this demonstration document are available in EPA's AQS database (EPA1, 2013) and meet EPA quality assurance requirements and guidelines. The satellite imagery used in this document are from NOAA (NOAA, 2013) and the imagery shown in the appendices were received and processed by the TCEQ and routinely displayed on the TCEQ web site for the most recent 24 hours (TCEQ, 2013). The air parcel trajectories were produced using the NOAA Applied Research Laboratory (ARL) Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model available on the [ARL HYSPLIT web page](http://ready.arl.noaa.gov/HYSPLIT.php) (<http://ready.arl.noaa.gov/HYSPLIT.php>) (NOAA ARL, 2013). Times are listed in Mountain Standard Time (MST) and, from some sources, in Coordinated Universal Time (UTC) which is seven hours later than MST.

Table 1. El Paso area PM_{2.5} and PM₁₀ monitors with data used for analyses.

Site Name	AQS Site Identifier	AQS Parameter Identifier	POC	Sampler Type
Tillman	481410002	81102	2	PM ₁₀ FRM non-continuous
Ivanhoe	481410029	81102	1	PM ₁₀ FRM non-continuous
UTEP	481410037	81102	4	PM ₁₀ continuous
UTEP	481410037	88101	1	PM _{2.5} FRM non-continuous
UTEP	481410037	88502	3	PM _{2.5} acceptable continuous
Riverside	481410038	81102	1	PM ₁₀ continuous
Chamizal	481410044	88101	1	PM _{2.5} FRM non-continuous
Chamizal	481410044	88101	6	PM _{2.5} FEM non-continuous
Chamizal	481410044	88502	5	PM _{2.5} acceptable non-continuous speciated
Chamizal	481410044	88502	3	PM _{2.5} acceptable continuous
Sun Metro	481410053	88502	3	PM _{2.5} acceptable continuous
Ascarate	481410055	81102	4	PM ₁₀ continuous
Ascarate	481410055	88502	3	PM _{2.5} acceptable continuous
Socorro	481410057	81102	1	PM ₁₀ FRM non-continuous
Socorro	481410057	81102	4	PM ₁₀ continuous
Clendenin	481410059	81102	1	PM ₁₀ FRM non-continuous
Van Buren	481410693	81102	1	PM ₁₀ FRM non-continuous
Advance*	800060004	81102	1	PM ₁₀ FRM non-continuous
Benito*	800060005	81102	1	PM ₁₀ FRM non-continuous
Club*	800060006	81102	1	PM ₁₀ FRM non-continuous
Delphi*	800060007	81102	1	PM ₁₀ FRM non-continuous
Delphi*	800060007	81102	2	PM ₁₀ FRM non-continuous
Ninez*	800060011	81102	1	PM ₁₀ FRM non-continuous

* site is in Ciudad Juarez, Mexico

Note: AQS stands for EPA's air quality system database.

POC stands for AQS parameter occurrence code to differentiate collocated monitors.

FRM stands for federal reference method.

FEM stands for federal equivalent method.

Analysis Methods

Several methods were used to analyze the data to determine if the proposed events qualify as exceptional events. These methods include time series plots to show trends and events, comparison to statistical percentiles to show relevance, examination of satellite imagery for evidence of dust plumes, and review of backward-in-time air trajectories for independent confirmation of transport path of the affected air. In addition, daily averages of hourly PM_{2.5} and PM₁₀ continuous data were compiled for comparison with non-continuous data and Interagency Monitoring of Protected Visual Environments (IMPROVE) calculated particulate matter components. PM_{2.5} speciation components (IMPROVE, 2013) (Eldred, 2003) were calculated from PM_{2.5} speciation data to confirm the dominance of the soil component in high wind blowing dust events.

The TCEQ also used El Paso area PM_{2.5} and PM₁₀ monitoring data on moderate wind speed days to conservatively estimate what the expected PM_{2.5} and PM₁₀ concentration would have been “but for” the high wind dust events. The surrogate moderate wind speed days were selected based on daily wind direction and lack of precipitation comparable to the event days.

El Paso Climate and Particulate Matter Trends and Sources

Climate

Much of far West Texas, including the El Paso area, is part of the Chihuahuan Desert, which extends into Arizona, New Mexico, and the Mexican state of Chihuahua. The limited rainfall in this area is highly variable from year to year, with an average of 8.53 inches of rain per year measured at the El Paso Airport over the period from 1997 to 2012, as shown in Figure 3.

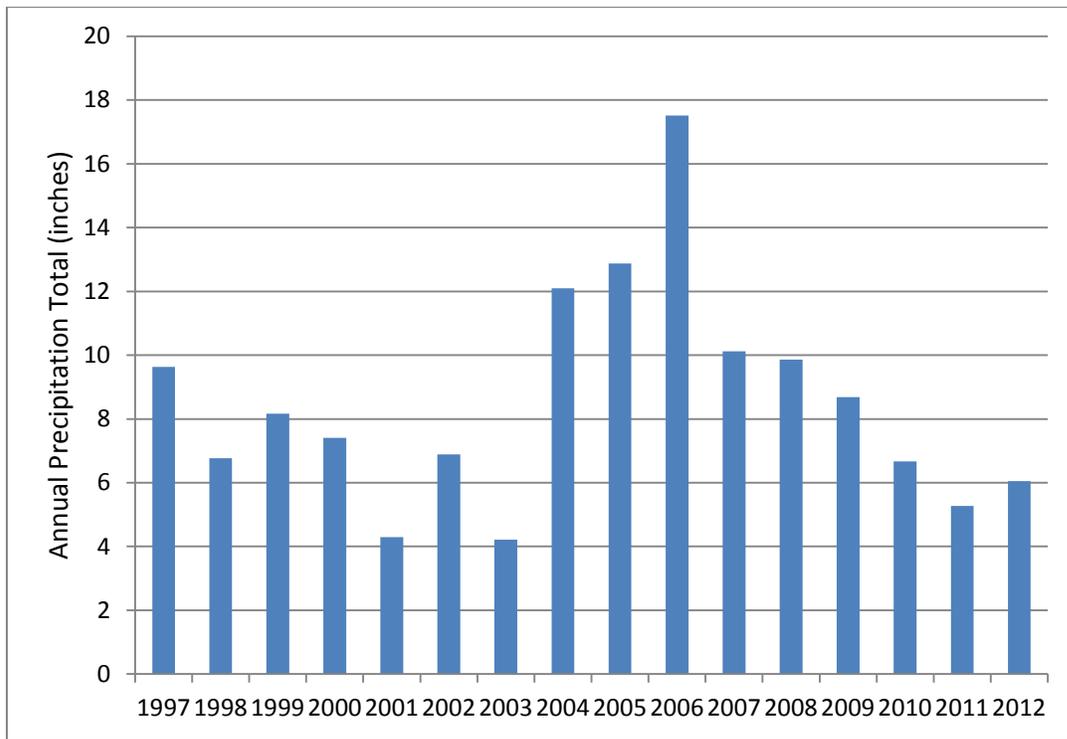


Figure 3. Graph of annual precipitation measured at El Paso International Airport from 1997 through 2012.

A large portion of this scarcely vegetated desert contains dried up lakebeds and playas made up of loose fine soils. These soils can easily be picked up into the air by moderate to high wind gusts of 30 mph or greater (TCEQ1, 2007). The overall frequency and intensity of the dust storms are highly dependent on weather conditions and the moisture content of the soils. Because similar meteorological trends are expected to continue, it is likely that similar dust storms will continue to occur in future years.

Particulate Matter Air Quality Trends

Overall, the annual $PM_{2.5}$ levels in the El Paso area have been relatively stable since 2000, while the 24-hour average $PM_{2.5}$ measurements have shown more variability from year to year. Since the 98th percentile of the 24-hour average represents the highest 2 percent of all 24-hour measurements, the presence or absence of dust events on sampling days can greatly influence trend variability. Figure 4 graphically depicts the trends in both the annual and 98th percentile of the 24-hour average using FRM data collected on a one in six day frequency from the Chamizal and UTEP sites. Please note that the UTEP and Chamizal FRM monitors were not operational from April 2003 through 2005 resulting in a gap in the presented data.

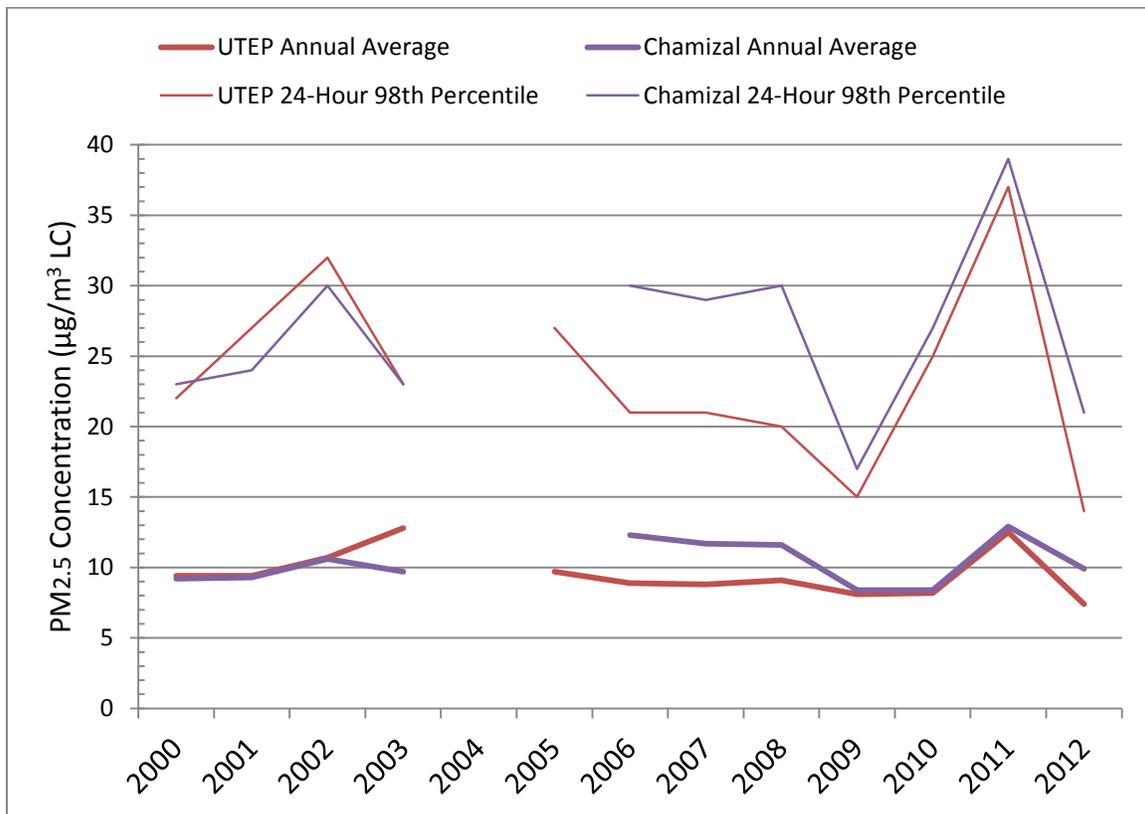


Figure 4. Trends of El Paso $PM_{2.5}$ annual averages and annual 98th percentile of 24-hour averages for long-term FRM monitoring sites including exceptional event days.

Trends in the PM_{10} annual maximum 24-hour averages for El Paso show an overall decline from 1997 to 2012, but are also influenced by dust events coinciding with sampling days. Figure 5 graphs the PM_{10} trends from FRM monitors with a long period of record in the El Paso area.

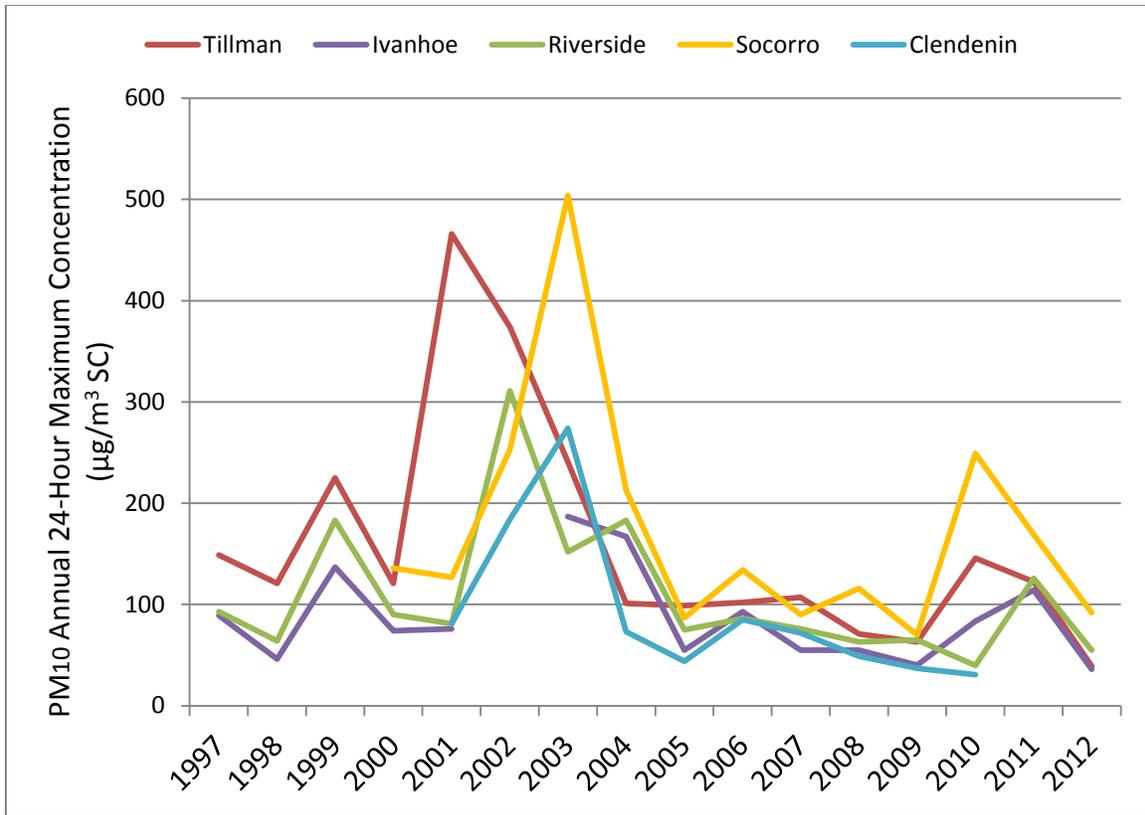


Figure 5. Trends of El Paso PM₁₀ annual maximum 24-hour averages for FRM monitoring sites including exceptional event days.

Historically, PM_{2.5} and PM₁₀ levels in the El Paso area have been heavily impacted by natural high wind events where large amounts of blowing dust are generated outside of the area and transported into the area. These dust events are most commonly caused by regional high winds associated with large low pressure systems. Less frequently, regional blowing dust from the White Sands area in New Mexico can be transported into the El Paso area and regional blowing dust generated in eastern New Mexico and the Texas Panhandle behind strong cold fronts can also be transported into the El Paso area. These large regional-scale dust storms occur mainly in the spring, but can occur from late October through the winter and spring into early June. On a local scale, high winds from nearby thunderstorms can generate dust that is transported into the El Paso area. These local-scale thunderstorm high wind dust events are most common in June and July. Long-range transport from other types of events also impact particulate matter in the El Paso area, including smoke from forest fires in the Rocky Mountains and haze and smoke accumulated from man-made emissions in the U.S. and Mexico (also known as continental haze). These smoke and haze transport events affect PM_{2.5}

levels more than PM₁₀ levels because of the inherent small particle sizes, but are relatively rare overall.

Blowing Dust and Wind

EPA guidance suggests using a peak sustained two-minute wind speed of 25 mph as a threshold for possible blowing dust influence. In El Paso peak sustained wind measurements are only available from the NWS weather station at the El Paso Airport, providing a limited data set for analysis of the potential for wind generated dust across the El Paso area. Peak wind gust measurements, however, are available from most air quality monitoring sites in El Paso and allow for a more representative analysis of dust generation potential across the area than from a single location.

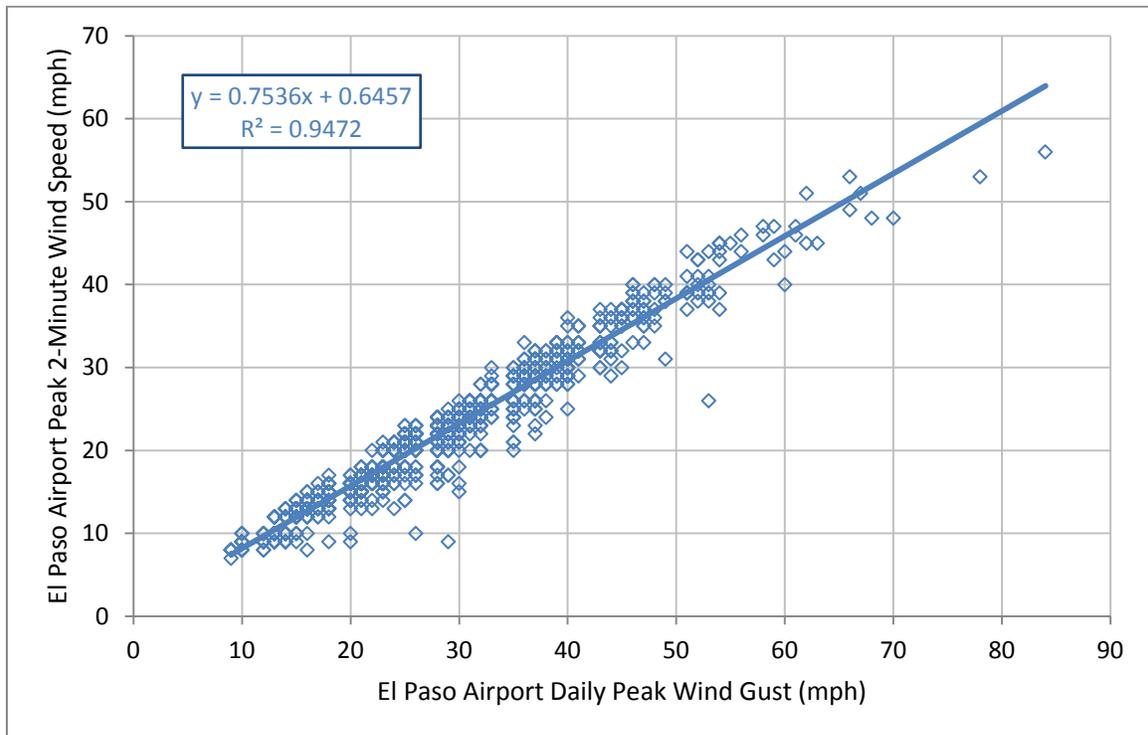


Figure 6. NWS El Paso Airport daily peak sustained two-minute wind speed versus daily peak wind gust for 2010 through 2012, showing a strong correlation.

An analysis of the peak sustained two-minute wind speed average and peak instantaneous wind gust data from the El Paso Airport shows a strong correlation between the two, as illustrated in Figure 6. Based on this correlation and to provide a more representative analysis of dust generation potential across the El Paso area, this demonstration relies on peak wind gusts measured at area monitors in place of peak sustained wind speed.

Without the influence of blowing dust, higher wind speeds normally result in particulate concentrations that are dominated by incoming background levels. At higher wind speeds, the impact of local sources becomes substantially diluted, with the dilution in proportion to the wind speed for a given vertical mixing height. Additionally, high winds cause mechanical mixing at night and weaken the formation of nocturnal inversions, thus providing stronger vertical mixing and lower pollutant concentrations.

An evaluation of El Paso $PM_{2.5}$ and PM_{10} measurements versus peak wind gust reveals an increase in particulate levels is observed when wind gusts approach 30 mph or more, indicating a strong influence from wind-blown dust. Figures 7 and 8 plot daily peak wind gusts against daily $PM_{2.5}$ averages from Chamizal and daily PM_{10} averages from Socorro, respectively. As can be seen in both of these figures, the highest measured $PM_{2.5}$ and PM_{10} concentrations are experienced when wind gusts exceed 30 mph. In addition, Figure 7 illustrates the impact of local sources on $PM_{2.5}$ concentrations as evidenced by the elevated measurements when peak wind gusts are between 10 and 20 mph.

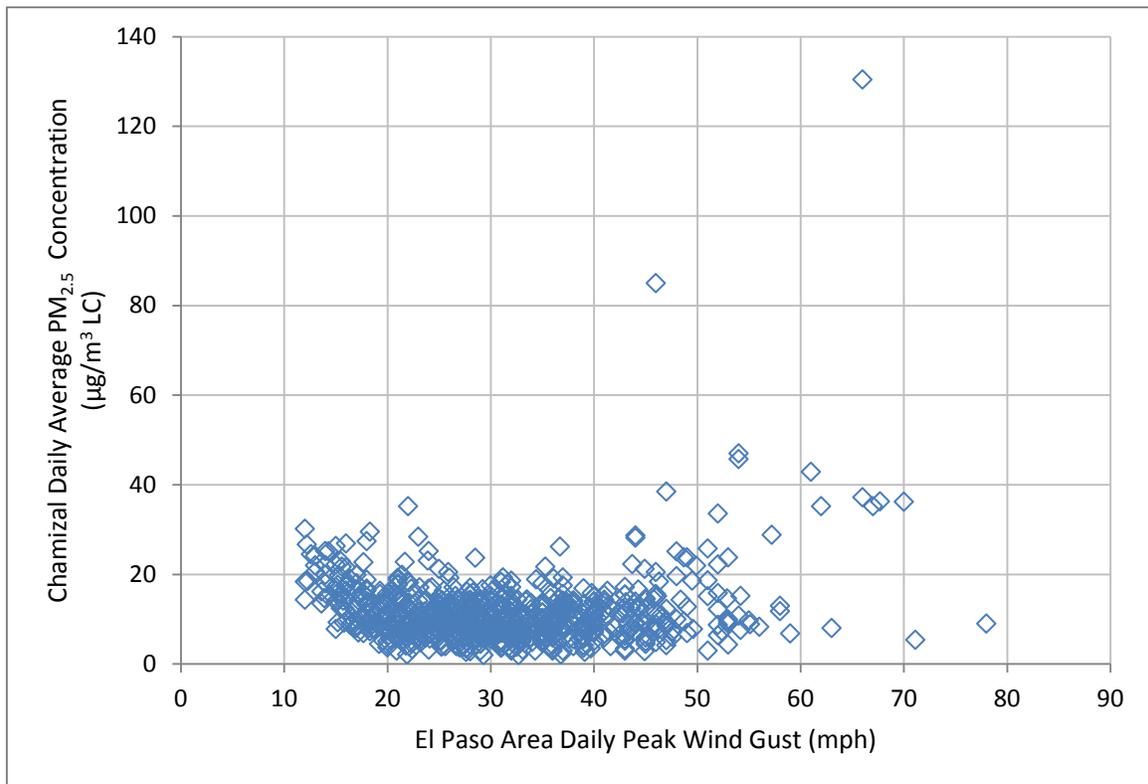


Figure 7. Chamizal daily $PM_{2.5}$ average for FRM-FEM measurements versus El Paso area daily peak wind gust for 2008 through 2012.

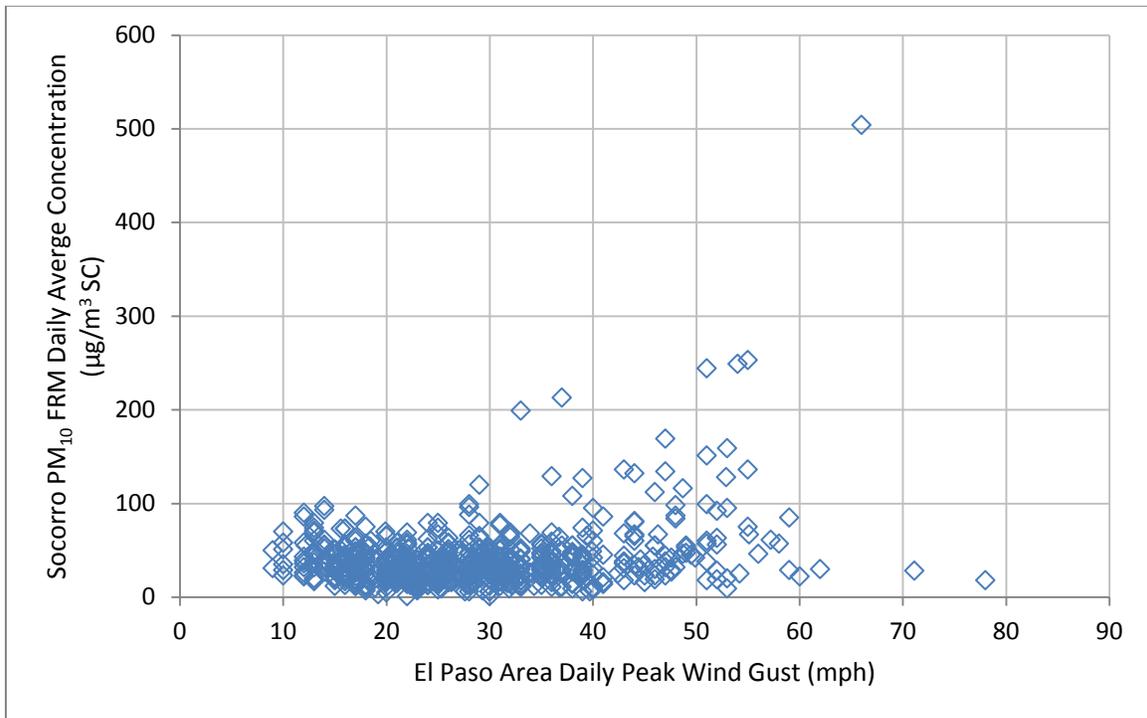


Figure 8. Socorro daily PM₁₀ average versus El Paso area daily peak wind gust for 2000 through 2012.

Local Source Contributions

El Paso and the Mexican city of Ciudad Juarez are located in a bowl-shaped valley where particulate matter gets trapped by strong temperature inversions and down-sloping winds from surrounding mountains during air stagnation events. Anthropogenic sources that contribute to the elevated particulate matter concentrations during these episodes often include local industrial facilities, automobiles, heating fires, and the combustion of refuse in Ciudad Juarez. Ciudad Juarez has minimal controls on the burning of wood, tires, scrap plastics, and construction debris. In addition, the automobiles in Ciudad Juarez are on average much older than those in El Paso and have greater emissions per vehicle. El Paso and nearby Sunland Park, New Mexico, have strict controls on pollution sources from various combustion types that are considered reasonably available control technology (RACT) or reasonably available control measures (RACM) (TCEQ1, 2007).

A study of blowing dust plume origins in the Chihuahua Desert area surrounding El Paso based on satellite imagery for 26 episodes from 2001 through 2009 indicated that the origin locations were primarily in northern Mexico and southwestern New Mexico (Baddock, Gill, Bullard,

Acosta, & Rivera, 2011). This study did not find any large blowing dust sources in the immediate El Paso area. The closest blowing dust sources identified were about 30 to 35 miles east-northeast of the El Paso area and these sources would not have been a factor on the proposed exceptional event days since they were not upwind of El Paso on the event days.

With the exception of dust, local source contributions to measured particulate levels in El Paso are highest with air stagnation conditions. The worst air stagnation conditions occur with light winds and clear skies on winter nights when strong temperature inversions develop and trap locally emitted air pollution in a thin layer near the ground (NOAA NWS, 2013). Since non-continuous measurements are based on the calendar day from midnight to midnight local standard time, the highest calendar day local source impacts occur with two stagnant nights in a row during the months of November through February when inversions are strongest because of colder and drier conditions. Since 2008, there have been no exceedances of the 24-hour $PM_{2.5}$ or PM_{10} standards from air stagnation conditions at the Chamizal, UTEP, and Socorro sites, although local source contributions on these days do impact the annual $PM_{2.5}$ averages.

The Chamizal speciation data show that the IMPROVE organic carbon component is highest with light winds, as would be expected with local contribution during air stagnation, whereas the IMPROVE soil component is highest with high winds. Figure 9 plots the Chamizal IMPROVE organic carbon component versus Chamizal daily peak wind gusts and, in general, indicates that the highest local carbon related emission impacts on $PM_{2.5}$ occur with lower wind speeds. Figure 10 shows the Chamizal IMPROVE soil component versus Chamizal peak wind gusts and demonstrates that the IMPROVE soil component is highest with high winds, as is the case for the $PM_{2.5}$ and PM_{10} concentrations previously shown in Figures 7 and 8. Unlike the $PM_{2.5}$ concentrations, the IMPROVE soil component does not increase significantly at lower wind speeds, indicating that local dust is not a major contributor to particulate concentrations without high winds.

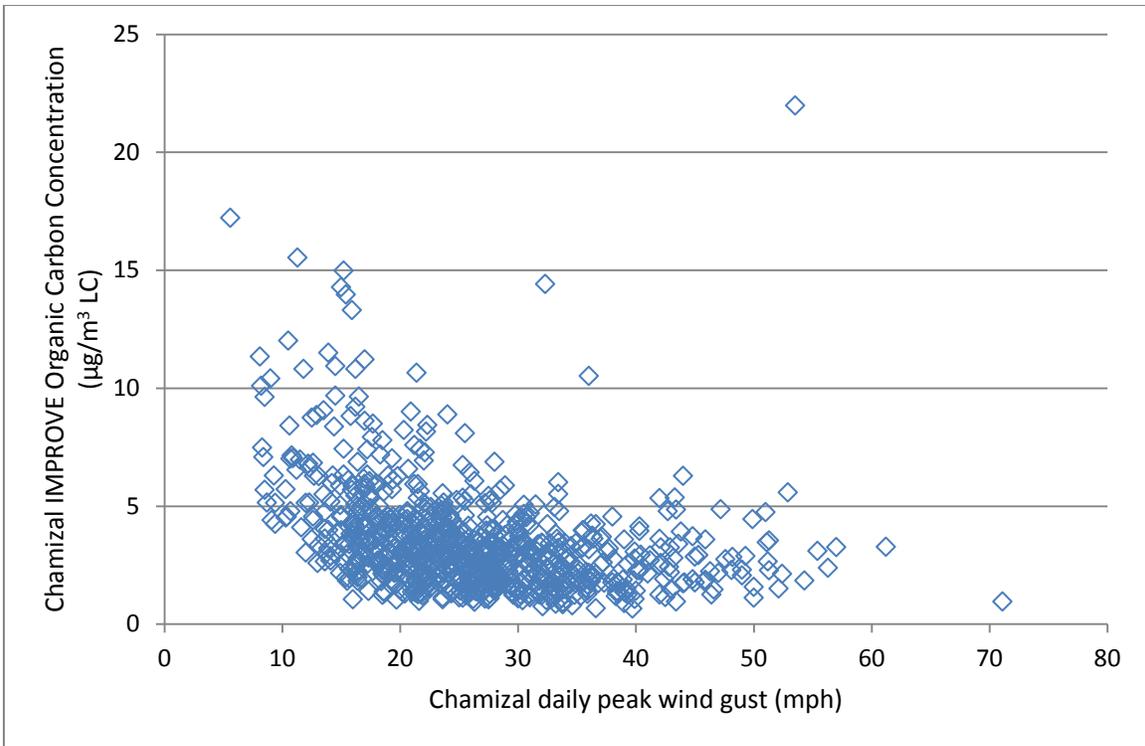


Figure 9. Chamizal $\text{PM}_{2.5}$ IMPROVE organic carbon concentration versus Chamizal daily peak wind gust for 2001 through 2012.

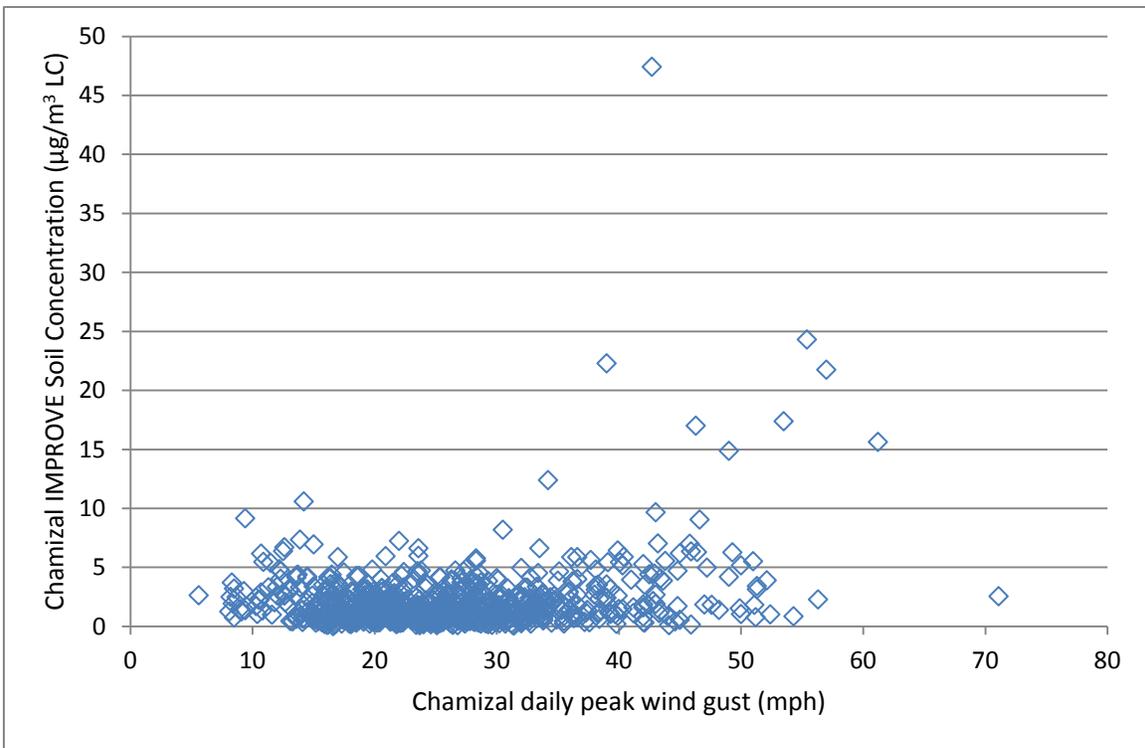


Figure 10. Chamizal $\text{PM}_{2.5}$ IMPROVE soil concentration versus Chamizal daily peak wind gust for 2001 through 2012.

The Chamizal, UTEP, and Socorro sites are located near the Rio Grande and thus receive substantial influence on particulate measurements from sources in Mexico whenever winds are from the south to southwest to west. Sources in Mexico cannot be controlled by U.S. regulations. El Paso urban emissions affect these sites when winds are from the east to north to northwest. During air stagnation events, winds are light and variable, allowing emissions from both the U.S. and Mexico to mix and thus affect all sites along the border. With stronger winds, the direction of the wind will more directly indicate the source of any air pollution present. Figure 11 shows wind rose plots for the Chamizal, UTEP, and Socorro sites from 2010 to 2012 to illustrate typical overall wind patterns seen in the El Paso area.

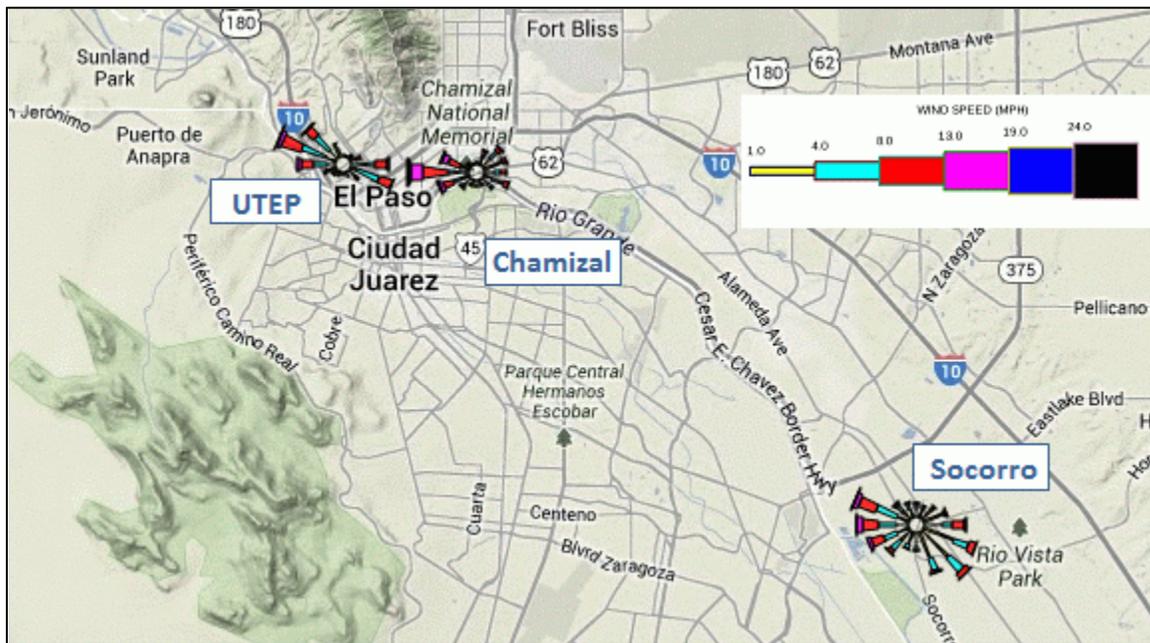


Figure 11. Wind rose plots for the UTEP, Chamizal, and Socorro sites for 2010 through 2012. The length of the wind rose bars indicate the frequency of hourly winds blowing from the direction of the bar toward the site. The width of the bars indicates the hourly wind speeds for the ranges shown in the key.

Attainment Status and Control Measures

The El Paso area has been classified as nonattainment for the 24-hour PM_{10} NAAQS since November 15, 1990, but has been classified as attainment for both the annual and 24-hour $PM_{2.5}$ NAAQS since $PM_{2.5}$ designations were first made on December 17, 2004. The State of Texas adopted State Implementation Plan (SIP) provisions in November 1991 that include regulations on PM_{10} sources in the El Paso area, and it was approved by the EPA effective February 17, 1994. The approved SIP incorporated all nonattainment requirements including

RACT and RACM. Additionally, a Memorandum of Understanding (MOU) between the City of El Paso and the Texas Air Control Board (TACB), a predecessor agency of the TCEQ, was incorporated to define the division of responsibility and commitments to carry out the provisions of the rules developed in the 1991 El Paso PM₁₀ SIP revision.

On January 25, 2012, the TCEQ adopted a SIP revision to incorporate a revised Memorandum of Agreement (MOA) between the TCEQ and the City of El Paso to reflect updates to the PM₁₀ control measures. The regulations included in these SIP revisions are summarized below (the symbol "§" stands for "Rule"):

- 30 TAC §111.111(c) prohibits the use of solid fuel heating devices during periods of atmospheric stagnation in the City of El Paso, including the Fort Bliss Military Reservation.
- 30 TAC §111.141 establishes that §111.143 (relating to Materials Handling), §111.145 (relating to Construction and Demolition), §111.147 (relating to Roads, Streets, and Alleys), and §111.149 (relating to Parking Lots), and associated dates of compliance, shall apply to the City of El Paso and portions of the Fort Bliss Military Reservation.
- 30 TAC §111.145 establishes measures to control dust emissions related to land clearing and construction, repair, alteration and demolition of structures, roads, streets, alleys, or parking areas of any size.
- 30 TAC §111.147 establishes measures to control dust emissions on public, industrial, commercial, or private roads, streets, or alleys including application of asphalt, water, or suitable oil or chemicals and mechanical street sweeping. Specific requirements are established for alleys and levee roads within the City of El Paso, including paving new alleys and disallowing use of unpaved existing alleys for residential garbage and recycling collection.

Other existing regulations applicable to particulate matter control in the El Paso area are summarized below:

- 30 TAC §111.143 establishes measures to control dust emissions related to the handling, transport, or storage of materials which can create airborne particulate matter including the application of water, chemicals, or coverings on materials stockpiles; use of hoods, fans, and filters to enclose, collect, and clean the

emissions of dusty materials; and the covering of all open-bodied trucks, trailers, and railroad cars transporting materials in the City of El Paso.

- 30 TAC §111.149 establishes measures to control dust emissions, including appropriate application of asphalt, water, or suitable oil or chemicals for temporary parking lots, parking lots having more than five spaces, and paved parking lots having more than one hundred spaces.
- City of El Paso Municipal Code Chapter 9.38, concerning wood burning, prohibits the operation of a solid fuel heating device within the city of El Paso during a no-burn period, unless an exemption has been obtained.
- City of El Paso Municipal Code Chapter 19.15.020, concerning subdivider responsibility, establishes standards for proposed roads serving new developments, including alleys.
- City of El Paso Municipal Code Chapter 19.15.160 establishes standards for the construction and improvement of alleys.
- City of El Paso Municipal Code Chapter 20.14 establishes standards for the provision of off-street parking, loading and storage, including standards for dust-free surfacing.

Event Summary Information

All ten of the event days are characterized by very strong winds associated with large low pressure systems that were generally centered to the north and north-northeast of the El Paso area. West to southwest winds at sustained speeds of 38 to 53 miles per hour (mph), along with peak gusts of 46 to 70 mph, carried high levels of particulate matter associated with blowing dust into the El Paso area. In the southwest to west to west-northwest directions coincident with the wind flow for the proposed exceptional events, the blowing dust sources are about 50 to 150 miles away from the El Paso area and in areas where wind measurements are not available. At these distances, with a typical dust storm hourly wind speed average of about 25 mph, the transport time to El Paso would be 2 to 6 hours. Depending upon the location and intensity of the low pressure systems, the duration of these dust events ranged from four to 13 hours per event. Evidence to support the impact of these dust events provided in this analysis includes webcam images, satellite imagery, backward-in-time air parcel trajectories, continuous particulate matter data, and wind gust data. An example event day analysis is provided here with detailed analyses for each specific event day provided in Appendices B through K.

Particulate and Wind Measurements

A listing of the flagged particulate matter measurements is provided in Table 2 along with peak wind statistics for each event day. All of the event days had peak sustained winds measured in excess of the suggested 25 mph threshold for blowing dust cited in EPA guidance (EPA, 2013). The wind directions associated with the peak sustained winds during the events were from the west to southwest, consistent with satellite imagery depicting these dust plumes and back trajectory models for the air parcels arriving at the time of the peak particulate matter hourly measurements.

Table 2. El Paso exceptional event flagged 24-hour measurements from 2010 through 2012 with El Paso area peak wind measurements.

Day	Chamizal FRM PM _{2.5} (µg/m ³ LC)	Chamizal FEM PM _{2.5} (µg/m ³ LC)	UTEP FRM PM _{2.5} (µg/m ³ LC)	Socorro FRM PM ₁₀ (µg/m ³ SC)	Peak Wind Gust (mph)	Peak Wind Speed (mph)	Peak Wind Direction (degrees)
11/28/2010				249	54	44	250
02/08/2011	42.9		36.8		61	46	260
03/07/2011		37.2			66	53	260
04/03/2011				159	53	44	250
04/09/2011	38.5		48.7	169	47	38	240
04/26/2011		36.2			70	48	280
05/10/2011		36.3			68	43	280
03/07/2012		85.0			46	38	260
03/18/2012		130.4			66	49	230
11/10/2012		45.7			54	43	260

Note: only flagged particulate matter concentrations are listed in this table. See Table 3 for all available particulate matter measurements. Wind measurements are from the NWS El Paso Airport weather station and also include wind gust measurements from El Paso area air quality monitoring stations reported to AQS. The peak wind speeds are sustained two-minute averages and the associated peak wind directions are in degrees clockwise from true north and indicate the direction from which the wind was blowing at the time of the peak sustained wind speed.

All available continuous and non-continuous El Paso daily average particulate measurements from each of the event days, along with available daily average PM₁₀ measurements from upwind sites in Ciudad Juarez, are provided in Table 3 below. These measurements demonstrate the widespread impact of these dust events on the El Paso region. Also, it is important to note that, when available, PM₁₀ measurements from monitors upwind in Ciudad Juarez were much higher than those measured within the City of El Paso itself, providing further evidence of the regional transport of dust.

Table 3. El Paso area particulate measurements on exceptional event days.

Site	Type	Method	11/28/2010	02/08/2011	03/07/2011	04/03/2011	04/09/2011	04/26/2011	05/10/2011	03/07/2012	03/18/2012	11/10/2012
UTEP	PM _{2.5}	FRM	37.9	36.8		25.2	48.7					
UTEP	PM _{2.5}	AC	28.7	23.9	29.0	20.9	28.5	28.2	27.5			20.4
Chamizal	PM _{2.5}	FRM	47.0	42.9		23.8	38.5					
Chamizal	PM _{2.5}	FEM		28.4	37.2	33.0	33.8	36.2	36.3	85.0	130.4	45.7
Chamizal	PM _{2.5}	AS	47.4		38.7	24.4	26.8			69.1		
Sun Metro	PM _{2.5}	AC	43.9	35.1	39.1	29.7	32.8	47.0	35.4	71.2	89.2	38.4
Ascarate	PM _{2.5}	AC		24.1	44.5	38.7	38.4	80.8	39.8	73.4	109.7	29.4
Tillman	PM ₁₀	FRM	146	114		83	123					
Ivanhoe	PM ₁₀	FRM	84	82		80	114					
UTEP	PM ₁₀	C	159	143	185	120	157	161	111		601	175
Riverside	PM ₁₀	FRM				80	126					
Ascarate	PM ₁₀	C	196	147	232	166	152	327	142	385	748	257
Socorro	PM ₁₀	FRM	249			159	169					
Socorro	PM ₁₀	C	251	162	288	167	171	253	131			
Van Buren	PM ₁₀	FRM	69			61	93					
Advance*	PM ₁₀	FRM	655			307	437					
Benito*	PM ₁₀	FRM	374			212	211					
Club*	PM ₁₀	FRM	123			81	90					
Delphi*	PM ₁₀	FRM	140			99	119					
Delphi*	PM ₁₀	FRQ				113	141					
Ninez*	PM ₁₀	FRM				362	356					

Note: empty table cells indicate a sample was not scheduled or the measurement was not valid and bold highlighting indicates the measurement is proposed as an exceptional event.

* indicates the site is in Juarez, Mexico.

PM_{2.5} measurements are in µg/m³ LC and PM₁₀ measurements are in µg/m³ SC.

FRM stands for federal reference method non-continuous.

FRQ stands for federal reference method non-continuous quality control.

FEM stands for federal equivalent method continuous.

AC stands for acceptable continuous

AS stands for acceptable speciated non-continuous.

C stands for continuous.

PM_{2.5} speciation data were available from the Chamizal site for five of the ten event days. A summary of the Chamizal speciation data on the event days is provided in Table 4, including averages for the period from 2010 through 2012 for comparison. The speciation data shows a

dominance of the IMPROVE soil component on the exceptional event days as would be expected with transported dust from high winds.

Table 4. Chamizal PM_{2.5} speciation summary for exceptional event days.

	2010-2012*	11/28/2010	02/08/2011	03/07/2011	04/03/2011	04/09/2011	04/26/2011	05/10/2011	03/07/2012	03/18/2012	11/10/2012
FRM	9.9	47.0	42.9		23.8	38.5					
FEM			28.4	37.2	33.0	33.8	36.2	36.3	85.0	130.4	45.7
AS	9.3	47.4		38.7	24.4	26.8			69.1		
IRC	8.6	43.9		29.3	18.4	21.6			54.3		
ISoil	2.1	17.4		24.3	14.9	17.0			47.4		
IAS	1.6	1.2		1.1	0.9	1.7			1.4		
IAN	0.5	2.3		0.5	0.4	0.5			0.7		
ILAC	0.8	1.1		0.2	0.2	0.2			0.1		
IOC	3.7	22.0		3.1	2.1	2.2			4.8		
IU	0.8	3.5		9.4	6.0	5.2			14.8		
Silc	0.4	3.3		5.1	3.2	4.0			11.4		
Alum	0.1	1.0		1.7	1.0	1.3			3.9		
Iron	0.1	0.9		1.1	0.7	0.8			2.3		
Calc	0.3	2.9		3.0	1.7	1.3			2.7		

Note: empty table cells indicate a sample was not scheduled or the measurement was not valid and all units are in µg/m³ LC.

Abbreviations:

- * Average for 2010 through 2012 including event days
- FRM federal reference method PM_{2.5} concentration
- FEM federal equivalent method PM_{2.5} concentration
- AS acceptable speciation PM_{2.5} concentration
- IRC IMPROVE reconstructed PM_{2.5} concentration calculated from speciation data
- ISoil IMPROVE soil concentration calculated from speciation data
- IAS IMPROVE ammonium sulfate concentration calculated from speciation data
- IAN IMPROVE ammonium nitrate concentration calculated from speciation data
- ILAC IMPROVE light absorbing carbon concentration calculated from speciation data
- IOC IMPROVE organic carbon concentration calculated from speciation data
- IU IMPROVE unidentified concentration (AS minus IRC)
- Silc silicon speciation concentration
- Alum aluminum speciation concentration
- Iron iron speciation concentration
- Calc calcium speciation concentration

Synoptic Weather Maps

Weather maps are helpful for displaying large-scale observation based weather features. On all ten event days, regional weather maps depict large and intense low pressure systems covering a large region surrounding the El Paso area. These systems produced strong westerly to southwesterly winds, which is consistent with the orientation of dust plumes in northern Mexico seen on satellite imagery. Figure 12 provides an example weather map from the November 28, 2010, event. Wind direction in the El Paso area is indicated by a large arrow. Weather maps for each event day are provided in the appendices.

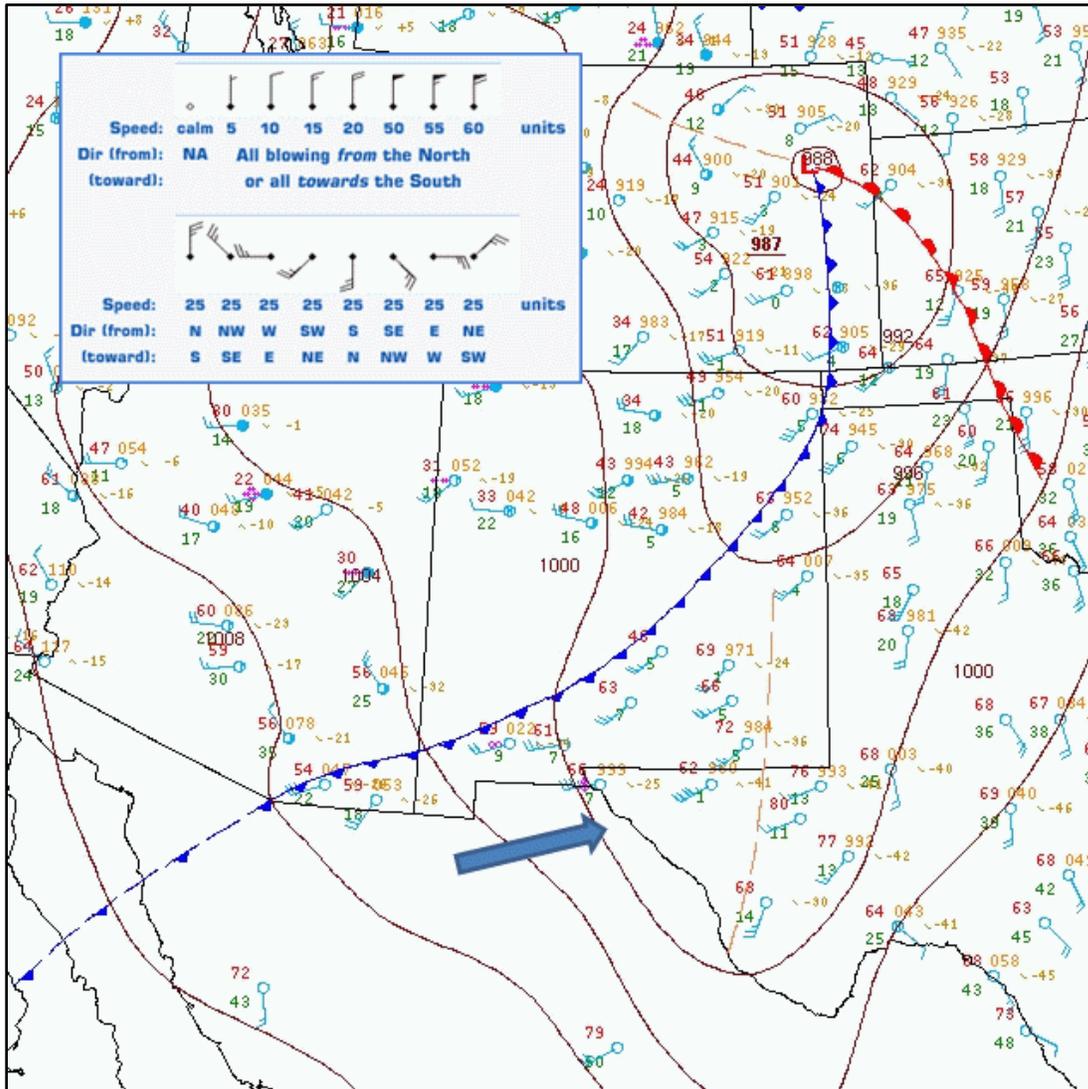


Figure 12. Example regional weather map for November 28, 2010, at 1400 MST showing a large intense low pressure system bringing wide-spread high winds over a large region around the El Paso area. A key to interpreting the wind flags is shown in the upper left of this weather map and a large arrow indicates the wind direction in the El Paso area.

Webcam Images

Webcam imagery illustrates the large-scale nature of these high wind blowing dust events. If dust was coming primarily from local sources, only local dust plumes would be visible on these images as visible plumes emanating from local sources. Instead, the webcam images show a broad, rapid decrease in visibility across the entire horizon with the onset of these events, consistent with the large-scale nature of regional dust plumes. A map of the El Paso Chelsea Street and Ranger Peak webcam locations is provided in Figure 13 with webcam images from the November 28, 2010, event day shown in Figures 14 and 15 below. In the webcam images, the top frame in each figure shows good visibility at 1200 MST and the bottom frame in each figure shows very poor visibility near the peak of the blowing dust at 1500 MST. These images dramatically show the impact of internationally transported regional blowing dust associated with these events.

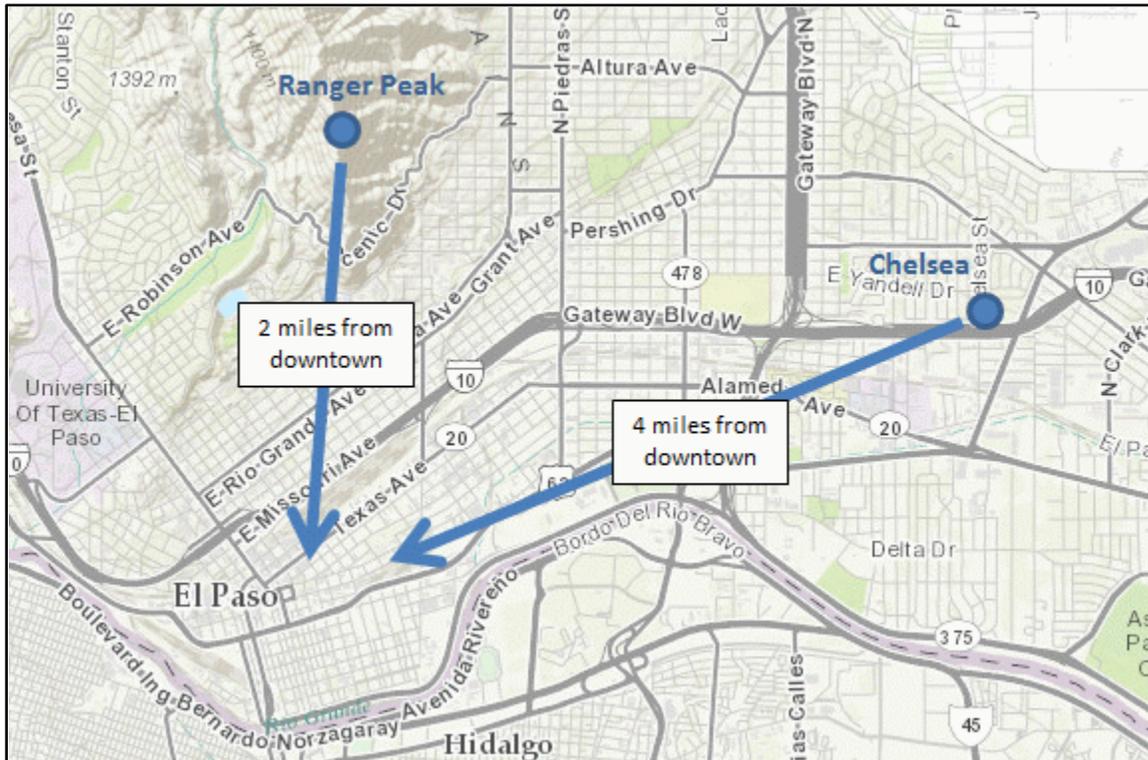


Figure 13. Webcam locations showing direction of view and distance from downtown El Paso.



Figure 14. Chelsea Street webcam images for November 28, 2010, looking west-southwest toward downtown El Paso about 4 miles away. The top frame at 1200 MST has good visibility and the bottom frame at 1500 MST shows intense blowing dust.



Figure 15. Ranger Peak webcam images for November 28, 2010, looking south-southwest toward downtown El Paso about 2 miles away. The top frame at 1200 MST has good visibility and the bottom frame at 1500 MST shows intense blowing dust.

Satellite Images

Satellite imagery from NOAA provides the strongest evidence that the dust on the ten exceptional events days was caused primarily by overwhelming transport from sources outside of Texas. The high resolution true color images show numerous smaller dust plumes emanating from exposed soil areas in the desert of northern Mexico and merging into larger plumes as the dust reaches the El Paso area. There is no evidence of dust plumes originating in the El Paso urban area as would be expected if local dust sources were dominant.

Example Aqua and GOES satellite images, shown in Figures 16 and 17, compare views with minimal dust to views with intense dust plumes from the November 28, 2010, event. Similar satellite images for all ten event days are provided in the appendices.

These satellite images clearly show large dust plumes emanating from northern Mexico into the El Paso area, causing the observed high particulate concentrations. On these satellite images clouds appear bright white and usually have distinct edges, whereas dust plumes are characterized by grayish to brownish streaks that do not appear on clear sky images where dust is not present.

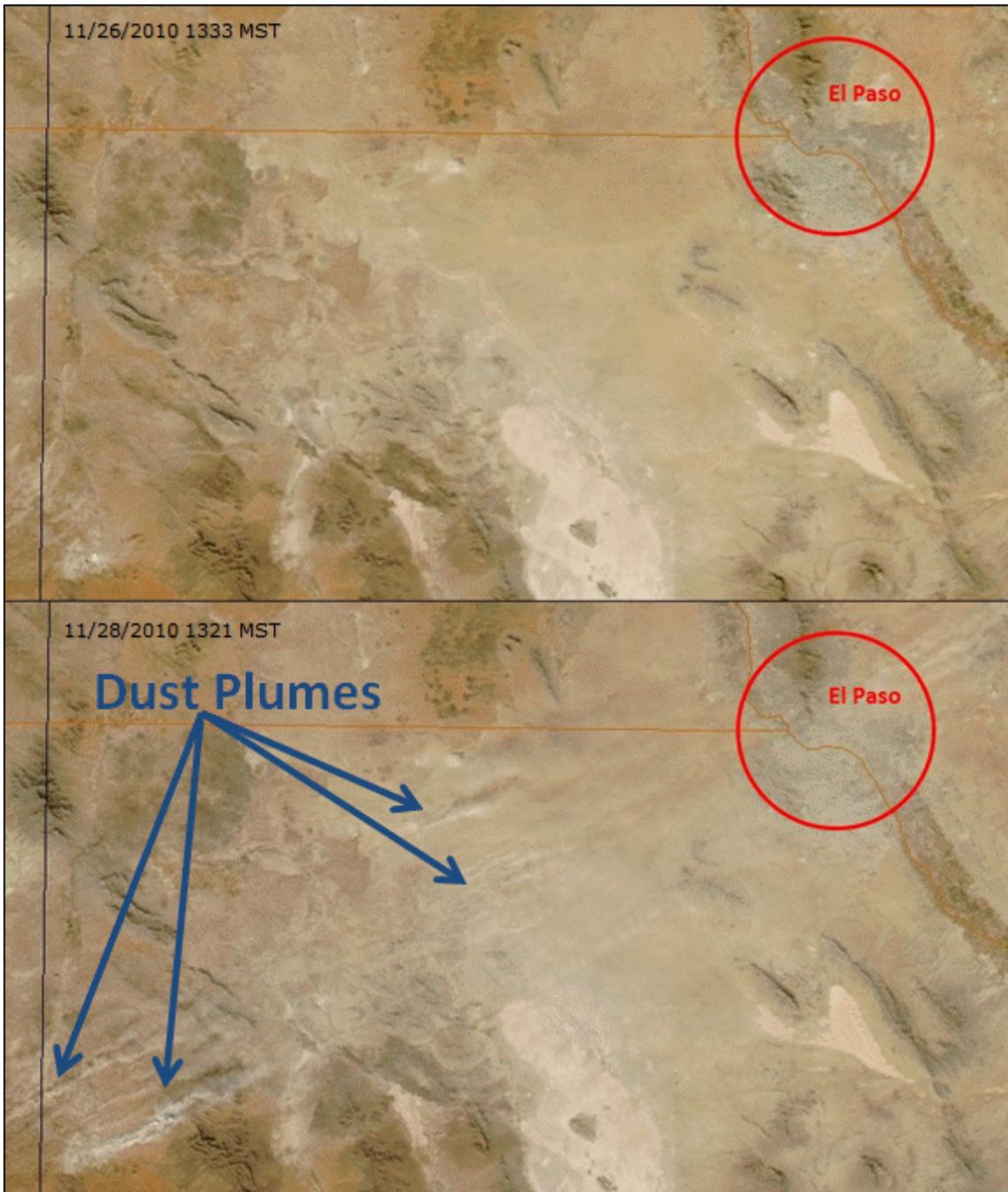


Figure 16. True color Aqua satellite image showing numerous large dust plumes in northern Mexico blowing northeast towards El Paso on November 28, 2010 (bottom) and dust-free image on November 26, 2010 (top).

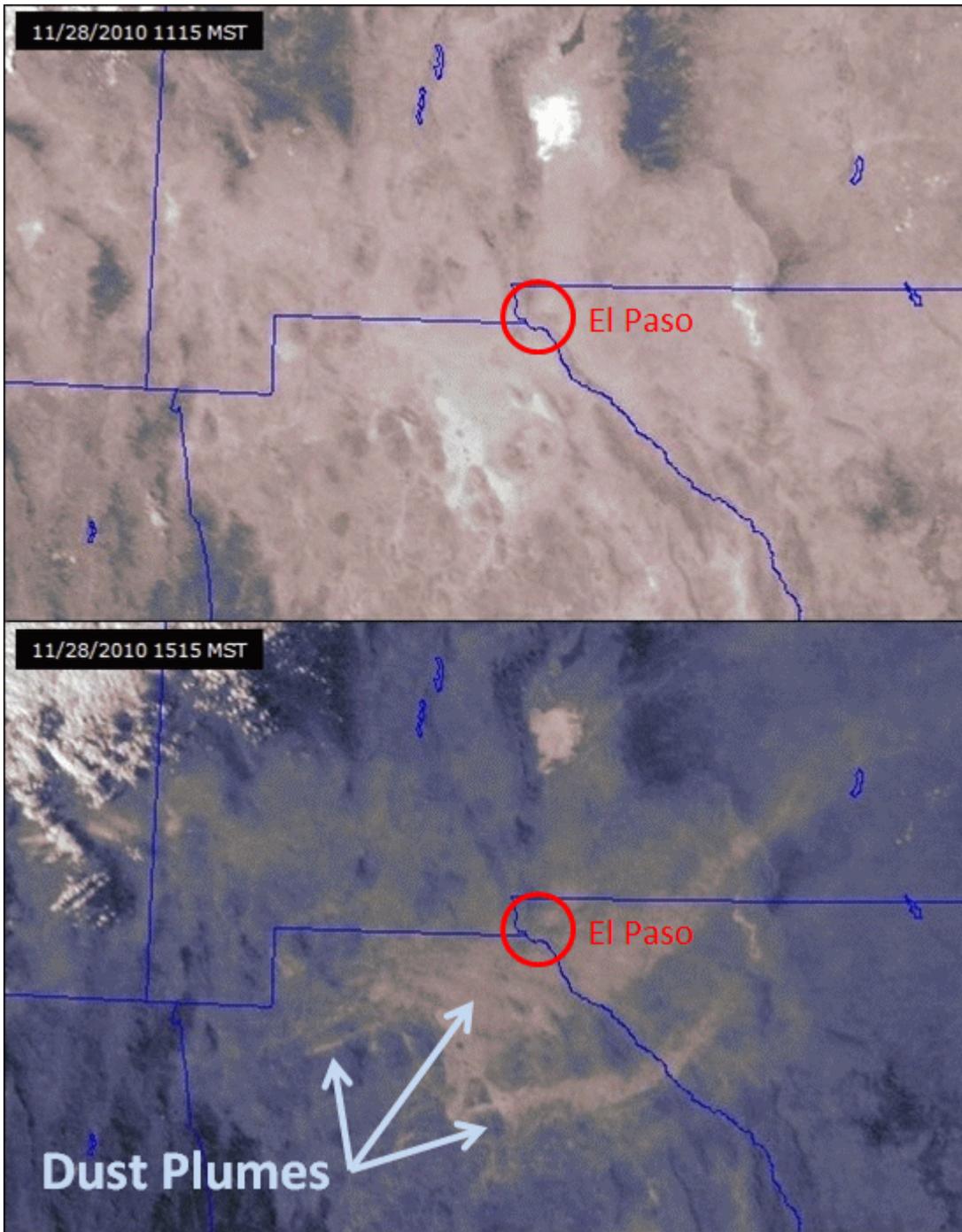


Figure 17. GOES false color satellite images of the El Paso area on November 28, 2010, at 1115 MST (top) with minimal blowing dust and at 1515 MST (bottom) with intense blowing dust plumes in northern Mexico blowing northeastward into the El Paso area.

Backward-In-Time Air Trajectories

Backward-in-time air parcel trajectories were derived using the NOAA HYSPLIT model for each proposed exceptional event occurrence. The trajectories track the air arriving at the time of the highest one-hour average concentration observed at the site on the event day and follow the air backward-in-time for 12 hours. In Figure 18 the air parcel associated with the November 28, 2010, event day is shown to have passed across northern Mexico during the time when satellite imagery indicated widespread blowing dust along the same path. Trajectories for each proposed exceptional event day are provided in the appendices.

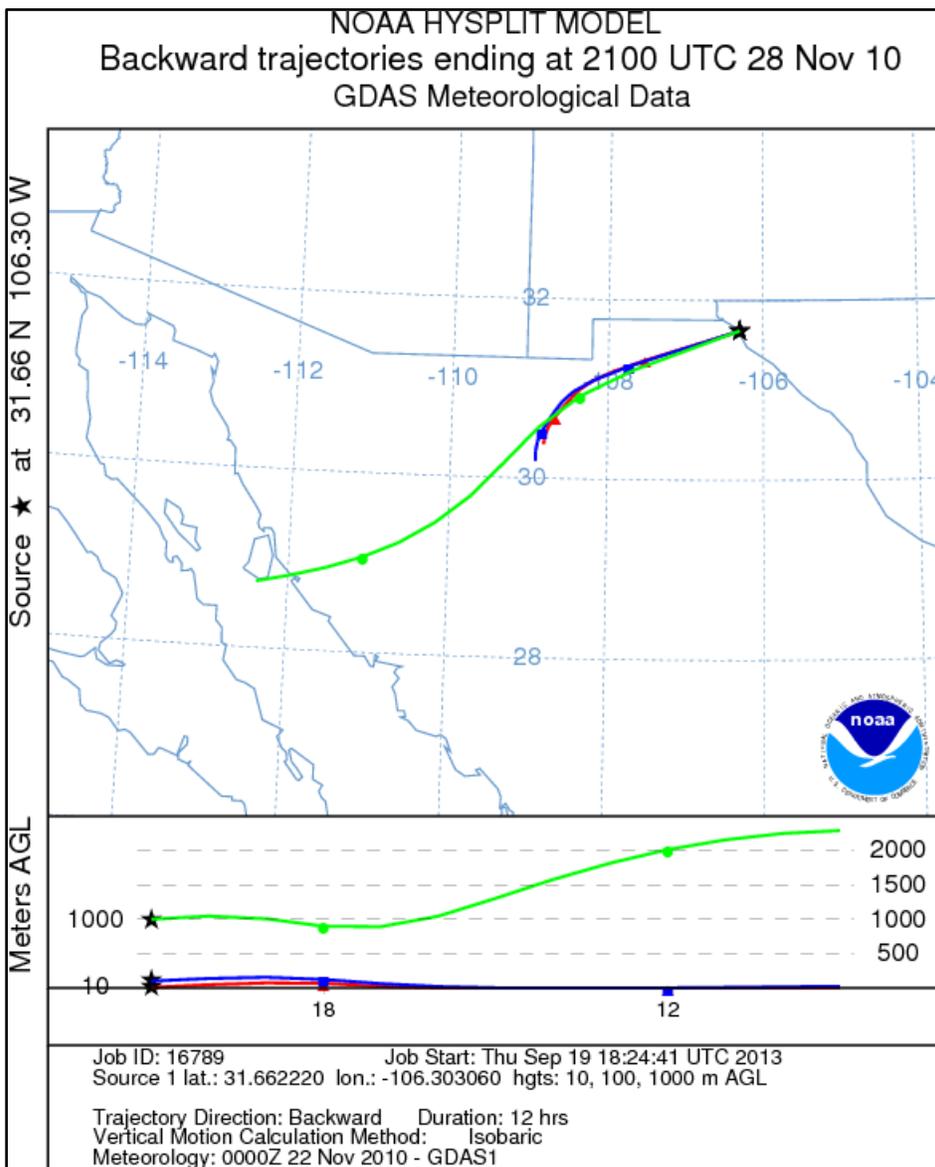


Figure 18. Backward-in-time air trajectory for November 28, 2010.

Maps of Daily Average Particulate Matter

Maps of the daily average PM_{2.5} and PM₁₀ concentrations show the spatial distribution of measurements on the event days, with the flagged measurements identified by site name. Example maps from November 28, 2010, are provided in Figure 19 for PM_{2.5} and in Figure 20 for PM₁₀. Note the highest measured PM₁₀ values occurred to the west of El Paso in Ciudad Juárez. Maps for each event day are included in the appendices.

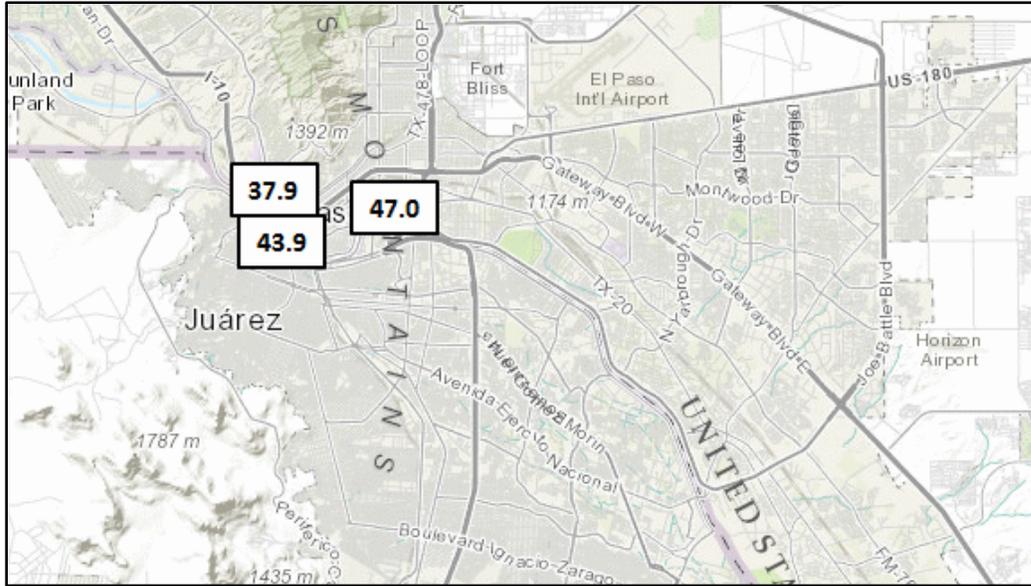


Figure 19. Map of daily average PM_{2.5} measurements (µg/m³ LC) on November 28, 2010.

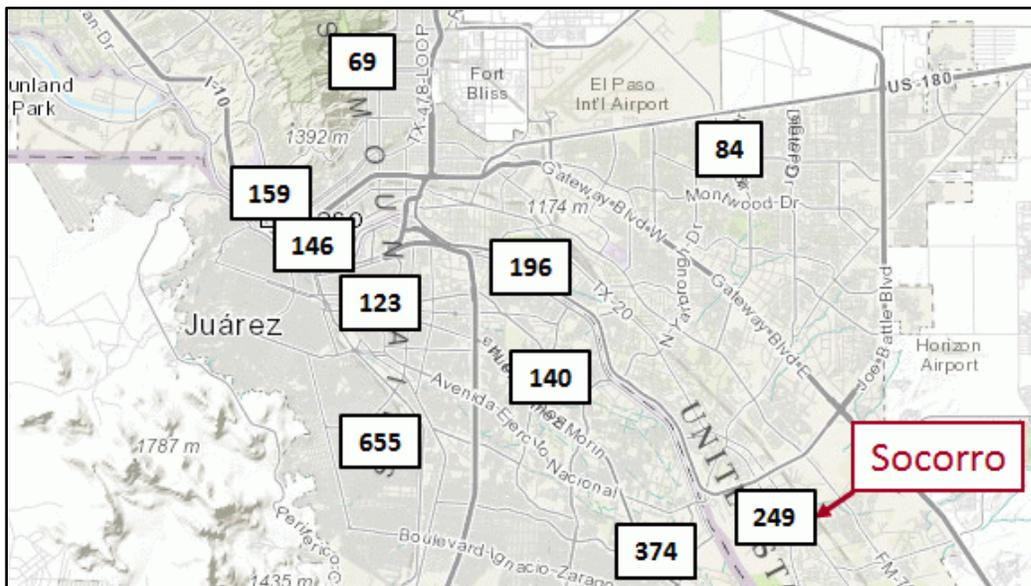


Figure 20. Map of daily average PM₁₀ measurements (µg/m³ SC) on November 28, 2010.

Continuous Data Time Series Graphs

Time series graphs plotting continuous particulate measurements against wind gust measurements illustrate the abrupt and intense nature of the dust events, with particulate concentrations rising rapidly as wind gusts reached 30 to 40 mph or more. Continuous PM₁₀ and PM_{2.5} five-minute data along with continuous five-minute peak wind gusts were plotted for each event day. For pertinence to the graphed particulate concentrations, the highest five-minute peak wind gust measurement from among the UTEP, Chamizal, Ascarate, and Socorro particulate matter monitoring sites was used in this analysis. As can be seen in Figures 21 and 22, peak wind gusts measurements on November 28, 2010, began steadily rising around 10:00 am MST and remained well above 30 mph for several hours. However, the corresponding rise in particulate matter measurements did not begin until just after 1200 MST, indicative of a dust source some distance from the monitors. At such high wind speeds, a dust source nearer the monitor locations would have resulted in the measurement of high levels of particulate matter within a few minutes after the high wind gusts occurred. A complete set of graphs for each event is presented in the appendices.

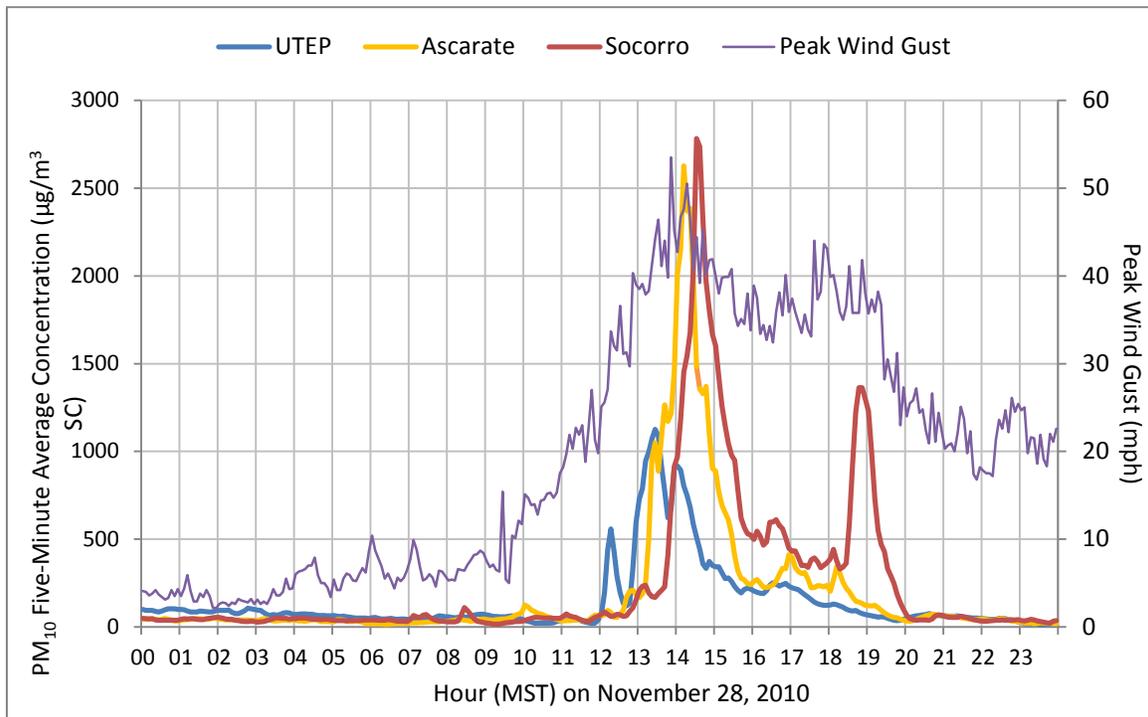


Figure 21. PM₁₀ and peak wind gust continuous measurements on November 28, 2010.

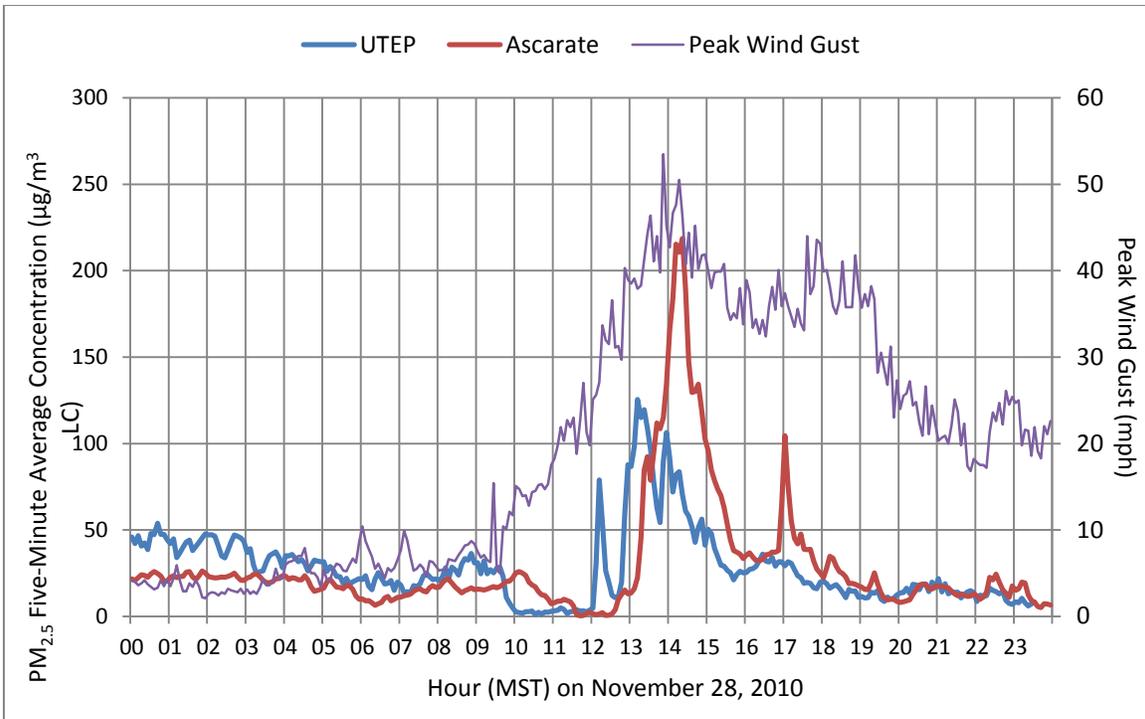


Figure 22. PM_{2.5} and peak wind gust continuous measurements on November 28, 2010.

Exceptional Events Demonstration

Affects Air Quality

The flagged measurements on all of the proposed exceptional event days exceeded the respective 24-hour NAAQS for PM_{2.5} or PM₁₀. In addition, PM_{2.5} FRM-FEM measurements at Chamizal and PM_{2.5} FRM measurements at UTEP were well above the 95th percentiles of 22.2 µg/m³ and 20.2 µg/m³, respectively, during the 2008 through 2012 period. Likewise, PM₁₀ FRM measurements at Socorro were well above the 95th percentile of 68 µg/m³ during the same five year period. Thus, these measurements were among the highest five percent of measurements and significantly affected air quality. The preamble to the Exceptional Event rule (72 *Federal Register* 13569) states:

For extremely high concentrations relative to historical values (e.g., concentrations greater than the 95th percentile), a lesser amount of documentation or evidence may be required to demonstrate that the event affected air quality.

Not Reasonably Controllable or Preventable

All ten of the proposed event days were characterized by overwhelming international and/or interstate transport of blowing dust and not indicative of local sources. Satellite imagery and back trajectories confirm the transport of large amounts of dust from uncontrollable sources outside of the United States and Texas associated with regional high winds as described throughout this demonstration document.

Natural Events

All of the proposed exceptional event flags for 2010 through 2012 are for high wind blowing dust events, which are natural events. High wind blowing dust events, typically associated with large low pressure systems, impact the El Paso area every year. Satellite and webcam imagery provide visual evidence of intense dust plumes from northern Mexico moving into the El Paso area during nine of these events and from southwestern New Mexico in one event as previously described. These dust source locations are consistent with a study of blowing dust origin locations in the Chihuahua Desert surrounding El Paso during the period 2001 through 2009 (Baddock, Gill, Bullard, Acosta, & Rivera, 2011).

On the event days when speciation monitoring data were available, the IMPROVE soil component also provides evidence that the elevated particulate concentrations were from natural sources. The Chamizal IMPROVE soil component shown previously in Table 4 ranged from 14.9 to 47.4 $\mu\text{g}/\text{m}^3$ on five event days compared to the 95th percentile of 5.4 $\mu\text{g}/\text{m}^3$ for all sample days during the period from 2001 through 2012 (including high wind dust events). Figure 10 previously showed that all of the IMPROVE soil concentrations over 11 $\mu\text{g}/\text{m}^3$ were associated with high wind events as would be expected with natural events caused by blowing dust associated with high winds.

Clear Causal Relationship

Numerous sources provide evidence that the elevated particulate concentrations on the ten event days were caused by blowing dust generated by high winds, including wind information, $\text{PM}_{2.5}$ speciation data, backward-in-time air parcel trajectories, satellite imagery, and webcam imagery. As previously presented in Figures 7 and 8, an analysis of the $\text{PM}_{2.5}$ measurements at Chamizal from 2008 through 2012 and PM_{10} measurement at Socorro from 2000 through 2012 showed that the highest concentrations occurred when peak wind gusts exceeded 30 to 40 mph. Likewise, the highest IMPROVE calculated $\text{PM}_{2.5}$ soil component values occurred with similar high peak wind gusts, as demonstrated in Figure 10. A comparison of the chemical speciation data from the Chamizal site, presented in Table 4, confirmed that for event days where speciation data were available the IMPROVE soil component was anywhere between 7 to 20 times higher than the average IMPROVE soil component for 2010 through 2012.

Satellite imagery, such as those previously presented in Figures 16 and 17, provide some of the most compelling evidence of the relationship between these high wind dust plumes and measured concentrations. The sequence of satellite images for each event day shows dust plumes originating in northern Mexico and southern New Mexico moving into and sweeping across the El Paso area. Backward-in-time air trajectories (NOAA ARL, 2013) corroborate the visual evidence from satellite images and confirm that the air arriving at the hour of the peak particulate concentration for each event came from northern Mexico and/or southern New Mexico. Figure 23 shows one trajectory from each event day for the time of the peak hourly particulate measurement at the monitoring site with the proposed exceptional event flag.

Additional wind data, back trajectories, visible satellite imagery, and webcam imagery providing further evidence of the causal relationship for each event day are presented in Appendices B through K.

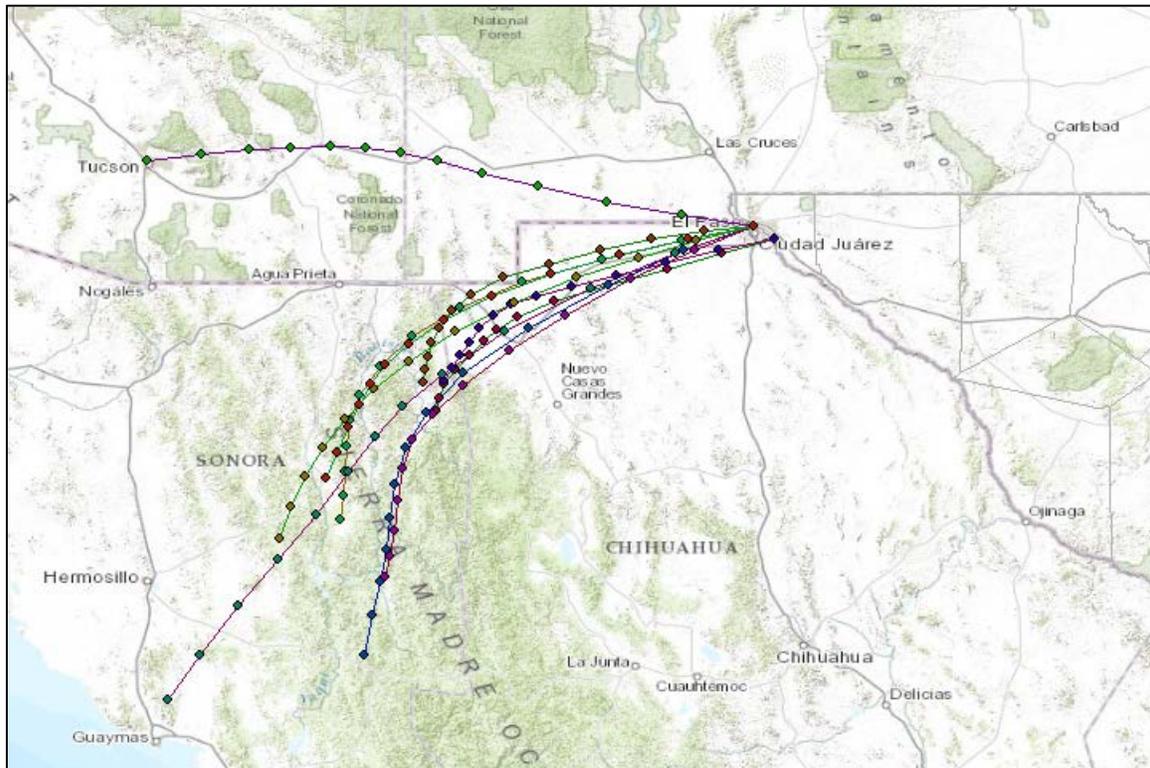


Figure 23. Plot of HYSPLIT model backward-in-time air parcel trajectories for the peak hourly particulate measurement on each exceptional event day (NOAA ARL, 2013).

Event In Excess of Normal Historical Fluctuations

As mentioned previously in this section, the flagged $PM_{2.5}$ and PM_{10} concentrations during the proposed exceptional event days were among the highest five percent of measurements at the Chamizal, UTEP, and Socorro sites and thus were well above normal historical fluctuations. Figures 24 and 25 plot the valid daily measurements of $PM_{2.5}$ at Chamizal and UTEP for the period from 2008 through 2012 along with the level of the 95th percentile. The proposed 2011 and 2012 exceptional event days are indicated in red. Likewise, Figure 26 shows the valid daily measurements of PM_{10} at Socorro for the period from 2005 through 2012 along with the level of the 95th percentile. The proposed 2010 and 2011 exceptional event days are also identified in red. All three figures demonstrate that flagged measurements on each event day were well outside of normal historical fluctuations in measured particulate concentrations for the El Paso area.

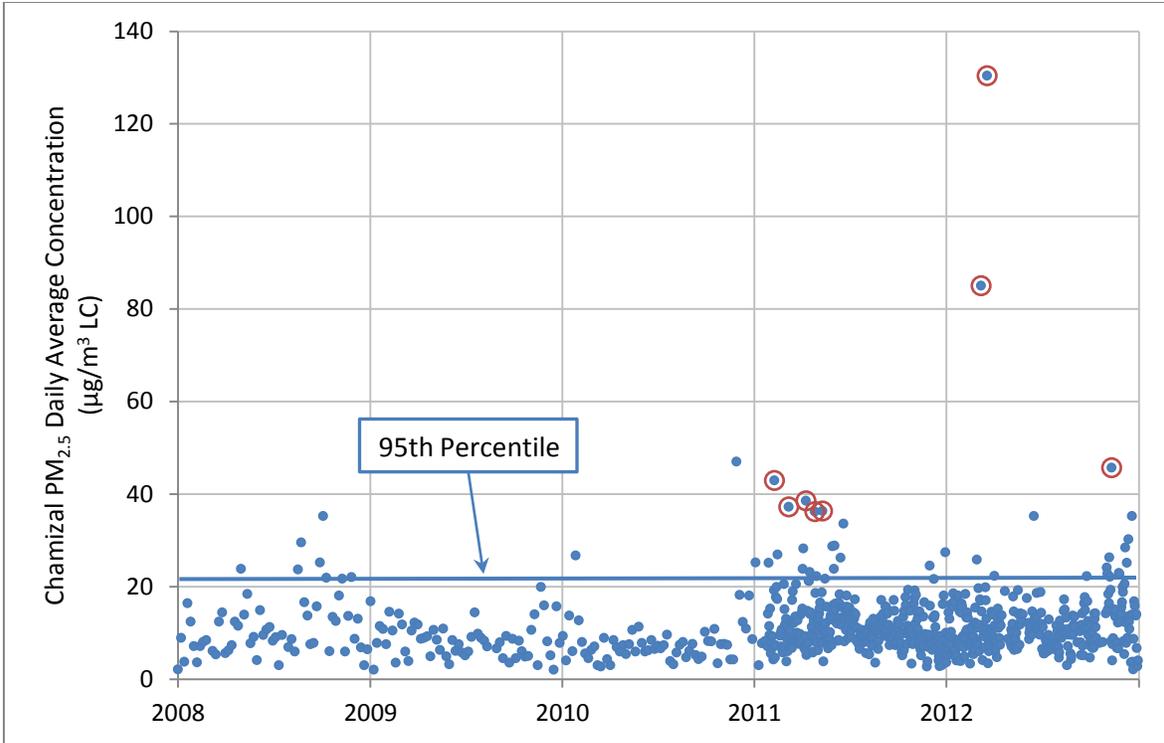


Figure 24. Chamizal FRM and FEM PM_{2.5} daily measurements from 2008 through 2012, with proposed exceptional event days circled in red.

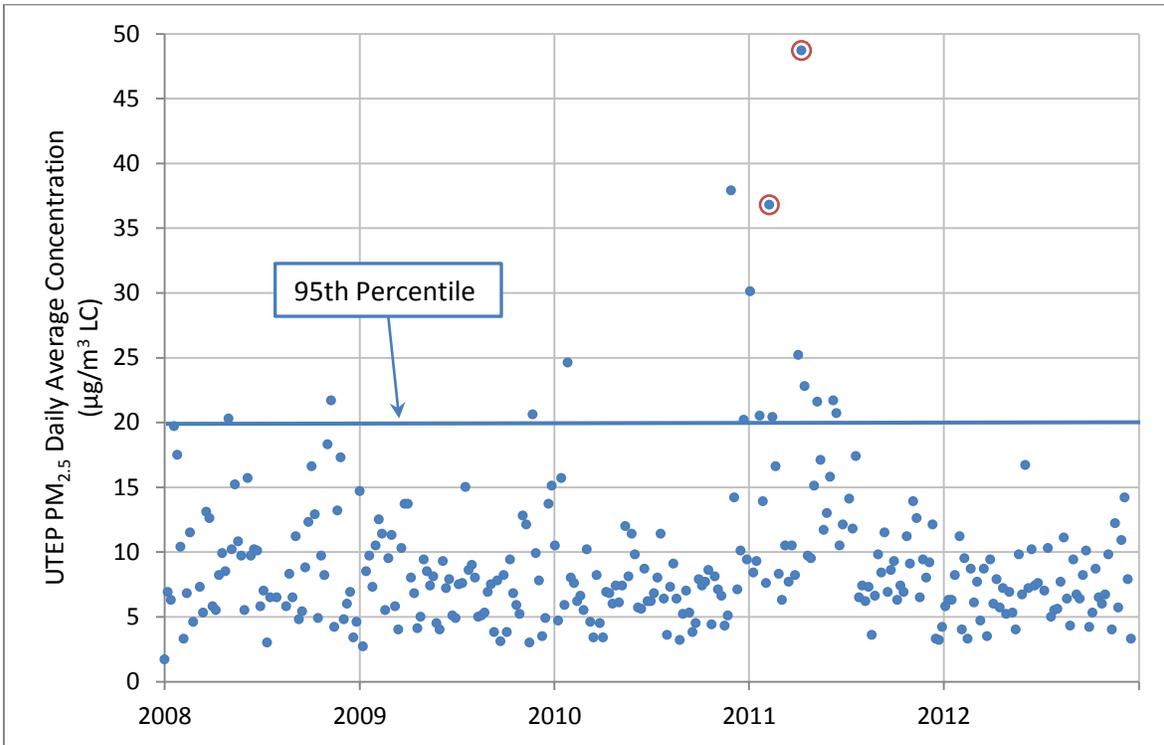


Figure 25. UTEP FRM PM_{2.5} daily measurements from 2008 through 2012, with proposed exceptional event days circled in red.

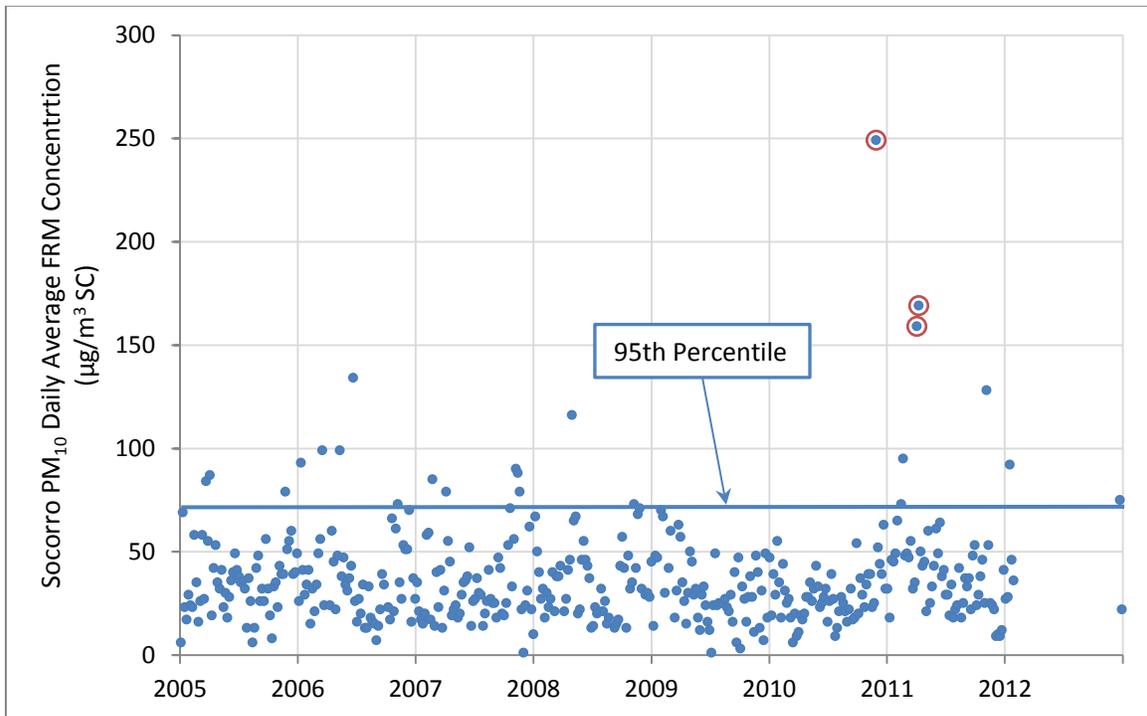


Figure 26. Socorro FRM PM₁₀ daily measurements from 2005 through 2012, with proposed exceptional event days circled in red.

No Exceedance But For the Event

Title 40 CFR Part 50.14(c)(3)(iv)(D) states the demonstration to justify the exceptional event designation shall provide evidence that “there would have been no exceedance or violation but for the event.” The TCEQ identified matching surrogate days to estimate the appropriate daily “but for” PM_{2.5} and PM₁₀ concentrations at each of the three sites with proposed exceptional event flags.

For comparison to the proposed exceptional event days at each site, the TCEQ identified surrogate days during the November through May time period with moderate wind speeds but otherwise similar meteorological conditions. Moderate wind days were chosen to avoid those days where particulate measurements could possibly be affected by blowing dust from higher winds or significant local source contributions due to air stagnation with lower winds. In order to determine the surrogate days, the TCEQ compiled 2010 through 2012 daily measurements of peak wind gust (Gust), peak one-hour average wind speed (Peak1), daily average wind speed (WSA), daily resultant wind speed (WSR), daily resultant wind direction (WDR), and daily wind direction variability ratio (WDV) from each event, and the three-day precipitation total for the day and two previous days (Prc3) from

the El Paso Airport NWS weather station. The WDV was calculated by dividing WSR by WSA, with the resulting ratio indicating steady wind directions when close to one and variable wind directions as the resulting ratio decreased to zero. These parameters were chosen to best eliminate factors associated with blowing dust and air stagnation and to ensure similar meteorological conditions between event days and surrogate days.

At Chamizal, days were sorted to remove those with peak wind gusts above 24 mph to eliminate days potentially influenced by blowing dust. To eliminate days potentially influenced by air stagnation situations that could result in local source contributions at higher levels than would be expected on high wind days, days with daily average wind speeds below 8.0 mph were also removed. To match the west to southwest wind flow on the event days, the daily resultant wind direction was constrained to be between 240 and 285 degrees clockwise from true north and only days with a WDV of 0.5 or higher were included to ensure limited wind variability. Finally, days that had measured precipitation within the last three days were removed because recent precipitation could reduce possible local dust contributions that need to be included in the "but for" case since no recent rain was observed on the proposed exceptional event days. There were a total of 16 days that met the above criteria at the Chamizal site. Of those, 10 days had valid PM_{2.5} FRM or FEM measurements that could be used to evaluate the "but for" concentration.

Tables 5 and 6 list the key local meteorological parameters for the Chamizal proposed exceptional event days and surrogate days, respectively. As illustrated by this analysis, on all ten surrogate days with winds consistently from the west to southwest at moderate wind speeds, the Chamizal 24-hour PM_{2.5} measurements were well below 12.0 µg/m³, thus providing strong evidence that the 24-hour and annual PM_{2.5} NAAQS would not have been exceeded but for the high wind dust event.

Table 5. Chamizal FRM-FEM PM_{2.5}, wind, and El Paso Airport precipitation measurements on proposed PM_{2.5} exceptional event days.

Day	PM _{2.5}	Gust	Peak1	WSA	WSR	WDR	WDV	Prc3
02/08/2011	42.9	46.7	26.1	11.1	5.7	280	0.52	0.00
03/07/2011	37.2	55.4	31.6	15.5	14.7	256	0.95	0.00
04/09/2011	38.5	46.3	26.7	16.1	13.7	254	0.85	0.00
04/26/2011	36.2	55.4	27.9	19.7	18.9	283	0.96	0.00
05/10/2011	36.3	47.4	25.1	15.2	12.9	265	0.85	0.00
03/07/2012	85.0	42.7	25.7	15.7	11.8	245	0.75	0.00
03/18/2012	130.4	63.7	31.9	17.7	14.3	244	0.81	0.00
11/10/2012	45.7	54.0	30.0	14.6	12.2	273	0.84	0.00
Average	56.5	51.5	28.1	15.7	13.0	263	0.82	0.00

PM_{2.5} is in µg/m³ LC.

Gust is the peak wind gust in mph.

Peak1 is the peak 1-hour wind speed average in mph.

WSA is the daily wind speed average in mph.

WSR is the daily wind speed resultant (vector magnitude) in mph.

WDR is the daily wind direction resultant in degrees from north.

WDV is the wind direction variability ratio (WSR divided by WSA).

Prc3 is the precipitation total over the most recent three days.

Table 6. Chamizal FRM-FEM PM_{2.5}, wind, and El Paso Airport precipitation measurements on the ten surrogate days.

Day	PM _{2.5}	Gust	Peak1	WSA	WSR	WDR	WDV	Prc3
03/12/2011	7.0	22.9	13.5	9.8	9.3	267	0.94	0.00
03/13/2011	6.7	21.6	14.2	8.1	7.0	276	0.86	0.00
10/21/2011	9.7	23.7	11.7	8.0	7.2	268	0.90	0.00
01/18/2012	6.2	23.5	14.3	9.4	8.4	258	0.90	0.00
02/03/2012	6.8	21.0	12.6	8.6	5.2	277	0.60	0.00
02/29/2012	11.1	23.2	12.1	8.9	8.1	261	0.91	0.00
03/14/2012	6.8	23.4	11.8	8.6	8.1	263	0.94	0.00
06/07/2012	10.0	20.3	13.0	8.1	7.2	267	0.89	0.00
07/31/2012	5.9	23.7	12.2	8.0	6.5	261	0.81	0.00
11/09/2012	8.1	22.0	11.2	8.1	6.8	264	0.83	0.00
Average	7.8	22.5	12.7	8.6	7.4	266	0.86	0.00

PM_{2.5} is in µg/m³ LC.

Gust is the peak wind gust in mph.

Peak1 is the peak 1-hour wind speed average in mph.

WSA is the daily wind speed average in mph.

WSR is the daily wind speed resultant (vector magnitude) in mph.

WDR is the daily wind direction resultant in degrees from north.

WDV is the wind direction variability ratio (WSR divided by WSA).

Prc3 is the precipitation total over the most recent three days.

To determine applicable surrogate days at UTEP, meteorological data were sorted to remove days that had peak wind gust above 24 mph and daily average wind speed below 5.0 mph. Because of the lower sampling frequency of the one in six day FRM sampler, less data were available for this site versus the Chamizal site; therefore, selection of the more conservative 5 mph lower limit allowed consideration of more surrogate days. The daily resultant wind direction was constrained to be between 240 and 295 degrees clockwise from true north to match the range of wind direction on the event days. Again, only those days with WDV of 0.5 or higher were included and days with measured precipitation within the last three days were removed. There were a total of 45 days that met these criteria and six of those days had valid PM_{2.5} FRM measurements that could be used to evaluate the “but for” concentration.

Tables 7 and 8 list the key local meteorological parameters for the UTEP proposed exceptional event days and surrogate days, respectively. This analysis demonstrates that under similar wind flow patterns and precipitation amounts, the 24-hour PM_{2.5} measurements at UTEP were below 12.0 µg/m³, thus providing strong evidence that the 24-hour and annual PM_{2.5} NAAQS would not have been exceeded but for the high wind dust event. Furthermore, despite including some surrogate days with lower wind speeds that might have had more local contribution (and therefore higher expected particulate matter concentrations), all surrogate days had concentrations below the PM_{2.5} NAAQS and demonstrate that particulate matter concentrations on event days likely would have similarly remained below the NAAQS but for the dust events.

Table 7. UTEP FRM PM_{2.5}, wind, and El Paso Airport precipitation measurements on proposed PM_{2.5} exceptional event days.

Day	PM _{2.5}	Gust	Peak1	WSA	WSR	WDR	WDV	Prc3
02/08/11	36.8	38.8	20.1	8.7	3.6	291	0.41	0.00
04/09/11	48.7	40.6	19.5	11.2	8.9	266	0.79	0.00
Average	42.8	39.7	19.8	10.0	6.2	279	0.60	0.00

PM_{2.5} is in µg/m³ LC.

Gust is the peak wind gust in mph.

Peak1 is the peak 1-hour wind speed average in mph.

WSA is the daily wind speed average in mph.

WSR is the daily wind speed resultant (vector magnitude) in mph.

WDR is the daily wind direction resultant in degrees from north.

WDV is the wind direction variability ratio (WSR divided by WSA).

Prc3 is the precipitation total over the most recent three days.

Table 8. UTEP FRM PM_{2.5}, wind, and El Paso Airport precipitation measurements on the six surrogate days.

Day	PM _{2.5}	Gust	Peak1	WSA	WSR	WDR	WDV	Prc3
05/20/10	8.1	20.0	8.9	5.3	3.6	284	0.68	0.00
11/16/10	4.3	23.9	12.1	7.4	6.5	287	0.88	0.00
01/31/12	11.2	22.6	11.2	5.4	3.4	294	0.63	0.00
03/16/12	8.7	20.5	9.3	5.3	4.0	295	0.75	0.00
04/03/12	6.0	23.1	9.4	6.0	4.9	291	0.81	0.00
05/03/12	6.9	22.4	10.1	7.4	6.0	278	0.82	0.00
Average	7.5	22.1	10.2	6.1	4.7	288	0.76	0.00

PM_{2.5} is in µg/m³ LC.

Gust is the peak wind gust in mph.

Peak1 is the peak 1-hour wind speed average in mph.

WSA is the daily wind speed average in mph.

WSR is the daily wind speed resultant (vector magnitude) in mph.

WDR is the daily wind direction resultant in degrees from north.

WDV is the wind direction variability ratio (WSR divided by WSA).

Prc3 is the precipitation total over the most recent three days.

Surrogate moderate wind days for Socorro were determined by sorting meteorological data to remove days that had peak wind gust above 32 mph and daily average wind speed below 5.0 mph. Less stringent wind criteria were used for Socorro because of the low sample size from one in six day sampling and because wind effects on PM₁₀ may be different than on PM_{2.5}. The daily resultant wind direction was constrained to be between 240 and 285 degrees clockwise from true north to match the range of wind direction on the event days. Only days with a steady wind direction variability ratio of 0.5 or higher were included and days that had measured precipitation within the last three days were removed. There were a total of 52 days that met these criteria, with 12 of those days having valid PM₁₀ FRM measurements that could be used to evaluate the “but for” concentration.

The key local meteorological parameters for the Socorro proposed exceptional event days and surrogate days, respectively, are listed in Tables 9 and 10. On all 12 of the surrogate days, the Socorro 24-hour PM₁₀ FRM measurements were well below 150 µg/m³, providing strong evidence that without the high wind blowing dust events the 24-hour PM₁₀ NAAQS would not have been exceeded.

Table 9. Socorro FRM PM₁₀, wind, and El Paso Airport precipitation measurements on proposed PM₁₀ exceptional event days.

Day	PM ₁₀	Gust	Peak1	WSA	WSR	WDR	WDV	Prc3
11/28/10	249	41.8	21.0	9.4	7.2	261	0.76	0.00
04/03/11	159	41.5	21.0	13.8	12.9	260	0.94	0.00
04/09/11	169	38.5	18.3	11.3	8.2	242	0.73	0.00
Average	192	40.6	20.1	11.5	9.4	254	0.81	0.00

PM₁₀ is in µg/m³ SC.

Gust is the peak wind gust in mph.

Peak1 is the peak 1-hour wind speed average in mph.

WSA is the daily wind speed average in mph.

WSR is the daily wind speed resultant (vector magnitude) in mph.

WDR is the daily wind direction resultant in degrees from north.

WDV is the wind direction variability ratio (WSR divided by WSA).

Prc3 is the precipitation total over the most recent three days.

Table 10. Socorro FRM PM₁₀, wind, and El Paso Airport precipitation measurements on the 12 surrogate days.

Day	PM ₁₀	Gust	Peak1	WSA	WSR	WDR	WDV	Prc3
03/16/11	55	24.8	11.1	5.2	3.3	240	0.64	0.00
12/10/10	44	30.8	12.3	6.7	3.4	271	0.51	0.00
04/21/11	43	26.5	13.1	6.7	5.0	268	0.74	0.00
05/27/11	43	29.8	13.2	7.4	6.0	279	0.81	0.00
03/28/11	35	28.9	12.0	6.2	4.7	273	0.75	0.00
05/21/11	33	21.6	9.4	5.3	3.7	252	0.70	0.00
03/22/11	32	27.0	13.2	9.1	8.2	285	0.90	0.00
02/19/10	31	21.9	11.4	5.3	3.9	241	0.73	0.00
11/22/10	25	29.9	13.4	6.4	4.2	273	0.65	0.00
11/16/10	23	22.0	11.7	5.0	3.1	256	0.63	0.00
01/09/11	18	30.3	15.8	7.1	5.6	282	0.80	0.00
02/07/10	18	27.0	14.4	7.3	4.4	263	0.60	0.00
Average	33	26.7	12.6	6.5	4.6	265	0.70	0.00

PM₁₀ is in µg/m³ SC.

Gust is the peak wind gust in mph.

Peak1 is the peak 1-hour wind speed average in mph.

WSA is the daily wind speed average in mph.

WSR is the daily wind speed resultant (vector magnitude) in mph.

WDR is the daily wind direction resultant in degrees from north.

WDV is the wind direction variability ratio (WSR divided by WSA).

Prc3 is the precipitation total over the most recent three days.

Mitigation of Exceptional Events

Title 40 CFR Part 51.930 requires that “a State requesting to exclude air quality data due to exceptional events must take appropriate and reasonable actions to protect public health from exceedances or violations of the national ambient air quality standards.” Three specific requirements are described in this regulation and are addressed individually below. Examples of each of the web pages identified below can be found in Appendix E.

Prompt Public Notification

The first requirement is to “provide for prompt public notification whenever air quality concentrations exceed or are expected to exceed an applicable ambient air quality standard.” The TCEQ provides ozone, PM_{2.5}, and PM₁₀ AQI forecasts for the current day and the next three days for 14 areas in Texas including El Paso. These forecasts are available to the public on the [Today's Texas Air Quality Forecast](#) web page of the TCEQ Web site

(http://www.tceq.texas.gov/airquality/monops/forecast_today.html) (TCEQ2, 2013) and on the [EPA AIRNOW Web site](#) (<http://airnow.gov/>) (EPA3, 2013). The Today's Texas Air Quality web page forecast discussions for each event day are quoted below:

Sunday 11/28/2010

Moderate to strong winds and low background levels should help to keep air quality in the "Good" range statewide. Winds may be strong enough to cause light amounts of blowing dust in parts of far West Texas and the Panhandle, but not likely enough to raise the PM₁₀ daily AQI beyond the "Good" range.

Tuesday 02/08/2011

Moderate to strong winds and low background levels should help to keep air quality in the "Good" range statewide. Strong winds behind a cold front should cause blowing dust for an hour or two after frontal passage in the Panhandle this afternoon and evening, but the intensity and duration are not likely to be enough to raise PM₁₀ daily AQI levels beyond the "Good" range.

Monday 03/07/2011

Winds should be strong enough to cause intense blowing dust in parts of northern Mexico, southern New Mexico, and far West Texas today. The blowing dust could raise PM₁₀ to "Unhealthy for Sensitive Groups" in the El Paso area with highest concentrations this afternoon and evening. Elsewhere in the state, moderate

winds and lower background levels should help to keep air quality in the "Good" range.

Sunday 04/03/2011

Very strong winds should cause intense blowing dust across parts of northern Mexico, southern New Mexico, far West Texas, and the Panhandle and the blowing dust could raise PM₁₀ levels to "Unhealthy" or possibly higher in the El Paso area and to "Unhealthy for Sensitive Groups" or possibly higher in the Lubbock area in the afternoon and early evening. Smoke from agricultural burning in Mexico and Central America with "Moderate" fine particulate levels should cover most of South Texas in the morning and should spread rapidly northward into Central and North Central Texas by the afternoon and evening. Elsewhere in the state, moderate winds and lower background levels should help to keep air quality in the "Good" range.

Saturday 04/09/2011

Very strong winds should generate intense blowing dust in much of northern Mexico, southern New Mexico, far West Texas, and the Panhandle that could raise PM₁₀ levels to "Unhealthy for Sensitive Groups" or possibly higher in the El Paso area and to "Moderate" in the Lubbock, Midland-Odessa, and Amarillo areas, with highest concentrations in the afternoon and early evening. Smoke from agricultural burning in Mexico and Central America with "Moderate" fine particulate levels should continue over the middle of the state, mainly south and east of a line from Sanderson to Childress and along and west of a line from Galveston to Paris, and including South, Central, and North Central Texas. Elsewhere in East Texas, moderate winds and lower background levels should help to keep air quality in the "Good" range.

Tuesday 04/26/2011

Smoke from agricultural burning in Mexico and Central America with "Moderate" fine particulate levels should continue over most of the eastern third of the state, mainly along and east of a line from Laredo to San Antonio to Waco to Texarkana. Winds should be strong enough to generate blowing dust in far West Texas and the Panhandle and could raise PM₁₀ to "Moderate" or possibly higher levels in the El Paso, Amarillo, Lubbock, and Midland-Odessa areas and well downwind to the east with highest concentrations in the afternoon and early evening. The strong winds and dry conditions should exacerbate any wildfires

in West Texas resulting in heavy smoke well downwind of any fires. Elsewhere in the state, moderate winds and lower background levels should help to keep air quality in the "Good" range.

Tuesday 05/10/2011

Winds may be strong enough to cause intense blowing dust in parts of far West Texas and the Panhandle, which could raise PM₁₀ to "Unhealthy for Sensitive Groups" in the El Paso area and to "Moderate" levels in the Amarillo, Lubbock, and Midland-Odessa areas, with highest concentrations this afternoon and evening. Strong winds and dry conditions will likely exacerbate any wildfires in West Texas, which could produce locally intense smoke near and well downwind of any fires. Smoke from agricultural burning in Mexico and Central America with "Moderate" fine particulate levels should continue over most of the eastern two-thirds of the state, mainly along and east of a line from Sanderson to Childress.

Wednesday 03/07/2012

Blowing dust generated by strong west-southwesterly winds in far West Texas and the Panhandle may be heavy enough for the daily PM₁₀ AQI to reach "Unhealthy for Sensitive Groups" in the El Paso area and "Moderate" in the Lubbock area, with highest concentrations this afternoon and into the early evening. Elsewhere in the state, moderate to strong winds and low incoming background levels should help to keep air quality in the "Good" range.

Sunday 03/18/2012

Strong west-southwesterly winds will result in blowing dust that could raise PM₁₀ to "Moderate" or possibly higher levels, with highest concentrations in the afternoon and evening. Winds may be strong enough to generate light amounts of blowing dust in parts of the Panhandle, including the Lubbock area, but probably not enough to raise PM₁₀ beyond the "Good" range. Smoke from agricultural burning in Mexico and Central America may return to South Texas, resulting in slightly increase fine particulate levels, though smoke production appears too light at this time to raise the daily AQI beyond the "Good" range. Elsewhere in the state, moderate to strong winds, increased cloud cover, and low incoming background levels should help to keep air quality in the "Good" range.

Saturday 11/10/2012

Very strong winds should cause blowing dust in much of far West Texas and the Panhandle. The blowing dust could possibly raise the daily PM₁₀ AQI to "Unhealthy for Sensitive Groups" in the El Paso area and to "Moderate" in dust prone areas of the Panhandle with highest concentrations in the afternoon and early evening. Elsewhere in the state, moderate to strong winds and decreasing background levels should help to keep air quality in the "Good" range.

The TCEQ also provides near real-time hourly PM_{2.5} measurements from monitors across the state, including El Paso, that are available to the public on the [Current PM-2.5 Levels - Soot, Dust, and Smoke in Your Metro Area Web page](http://www.tceq.state.tx.us/cgi-bin/compliance/monops/texas_pm25.pl) of the TCEQ Web site (http://www.tceq.state.tx.us/cgi-bin/compliance/monops/texas_pm25.pl) (TCEQ3, 2013). Finally, the TCEQ publishes an AQI Report on the [Air Quality Index Web page](http://www.tceq.state.tx.us/cgi-bin/compliance/monops/aqi_rpt.pl) of the TCEQ Web site (http://www.tceq.state.tx.us/cgi-bin/compliance/monops/aqi_rpt.pl) (TCEQ4, 2013) that displays the latest and historical daily AQI measurements. These measures allow the public to assess forecast, current, and past PM_{2.5} air quality levels.

Public Education

The second requirement is to "provide for public education concerning actions that individuals may take to reduce exposures to unhealthy levels of air quality during and following an exceptional event." Links to TCEQ and EPA Web pages describing recommended actions for individuals to reduce exposure to PM_{2.5} whenever it is high (EPA2, 2013) are included on TCEQ web displays of forecast and measured AQI levels, including [TCEQ's Air Pollution from Particulate Matter web page](http://www.tceq.texas.gov/airquality/sip/criteria-pollutants/sip-pm) (<http://www.tceq.texas.gov/airquality/sip/criteria-pollutants/sip-pm>) and [EPA's AQI - A Guide to Air Quality and Your Health web page](http://www.airnow.gov/index.cfm?action=aqibasics.aqi) (<http://www.airnow.gov/index.cfm?action=aqibasics.aqi>). EPA also provides similar links on the AIRNOW Web pages where TCEQ forecasts and current data are displayed.

The TCEQ also pursues outreach and educational opportunities in the El Paso area through work with the Paso Del Norte Joint Advisory Committee and through public informational meetings. The Joint Advisory Committee holds monthly meetings that are open to the public and these meetings are attended by TCEQ staff.

Implement Measures to Protect Public Health

The third requirement is to “provide for the implementation of appropriate measures to protect public health from exceedances or violations of ambient air quality standards caused by exceptional events.” Since 1991, the TCEQ and the City of El Paso have implemented dust control measures in the El Paso area as part of the PM₁₀ SIP revisions for El Paso as previously described in more detail under “Attainment Status and Control Measures” in the “El Paso PM_{2.5} and PM₁₀ Trends and Sources” section.

Conclusion

The information provided in this document demonstrates that the 13 proposed exceptional event flags for PM_{2.5} and PM₁₀ data at three El Paso area sites during the period of 2010 through 2012 meet all of the requirements for exceptional events. Measured PM_{2.5} and PM₁₀ concentrations on these days were well above the 95th percentile of historical measurements and thus affected air quality in excess of normal historical fluctuations. The elevated levels of PM_{2.5} and PM₁₀ transported into the El Paso area on these days were heavily impacted by blowing dust caused by regional high winds, were not reasonably preventable, and were due to natural events. As indicated by satellite imagery, back trajectories, and measurement statistics, high wind blowing dust clearly caused exceedances of the annual and 24-hour PM_{2.5} NAAQS and/or the 24-hour PM₁₀ NAAQS on the proposed days. Estimates of PM_{2.5} and PM₁₀ concentrations without the blowing dust provide strong evidence that measurements on the proposed exceptional event days would not have exceeded the levels of the PM_{2.5} or PM₁₀ NAAQS without the high wind blowing dust events. The TCEQ therefore requests EPA's concurrence on these 13 exceptional event flags and to have the associated measurements removed from consideration when making attainment or nonattainment determinations for the annual PM_{2.5} NAAQS, the 24-hour PM_{2.5} NAAQS, and the 24-hour PM₁₀ NAAQS.

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Appendix A: Proposed El Paso PM_{2.5} and PM₁₀ Exceptional Event Flags for 2010 through 2012

Table A-1. Proposed 2011-2012 El Paso PM_{2.5} Exceptional Event Flags.

Date	Site ID	Site Name	POC	PM _{2.5}	Flag	Description
02/08/2011	481410037	UTEP	1	36.8	RJ	High winds – regional blowing dust
02/08/2011	481410044	Chamizal	1	42.9	RJ	High winds – regional blowing dust
03/07/2011	481410044	Chamizal	6	37.2	RJ	High winds – regional blowing dust
04/09/2011	481410037	UTEP	1	48.7	RJ	High winds – regional blowing dust
04/09/2011	481410044	Chamizal	1	38.5	RJ	High winds – regional blowing dust
04/26/2011	481410044	Chamizal	6	36.2	RJ	High winds – regional blowing dust
05/10/2011	481410044	Chamizal	6	36.3	RJ	High winds – regional blowing dust
03/07/2012	481410044	Chamizal	6	85.0	RJ	High winds – regional blowing dust
03/18/2012	481410044	Chamizal	6	130.4	RJ	High winds – regional blowing dust
11/10/2012	481410044	Chamizal	6	45.7	RJ	High winds – regional blowing dust

Abbreviations:

Site ID - EPA site identification number

POC - EPA Parameter Occurrence Code

PM_{2.5} - daily average concentration in micrograms per cubic meter local conditions (µg/m³ LC)

Table A-2. Proposed 2010-2011 El Paso PM₁₀ Exceptional Event Flags.

Date	Site ID	Site Name	POC	PM ₁₀	Flag	Description
11/28/2010	481410057	Socorro	1	249	RJ	High winds – regional blowing dust
04/03/2011	481410057	Socorro	1	159	RJ	High winds – regional blowing dust
04/09/2011	481410057	Socorro	1	169	RJ	High winds – regional blowing dust

Abbreviations:

Site ID - EPA site identification number

POC - EPA Parameter Occurrence Code

PM₁₀ - daily average concentration in micrograms per cubic meter standard conditions (µg/m³ SC)

Appendix B: Event Analysis for November 28, 2010

Event Summary

A large low pressure system centered in northeastern Colorado brought strong west to southwest winds across a large region from Colorado through New Mexico and Arizona and into northern Mexico and West Texas on November 28, 2010. Figure B-1 shows a NOAA weather map for November 28, 2010, at 1400 MST depicting the low pressure system.

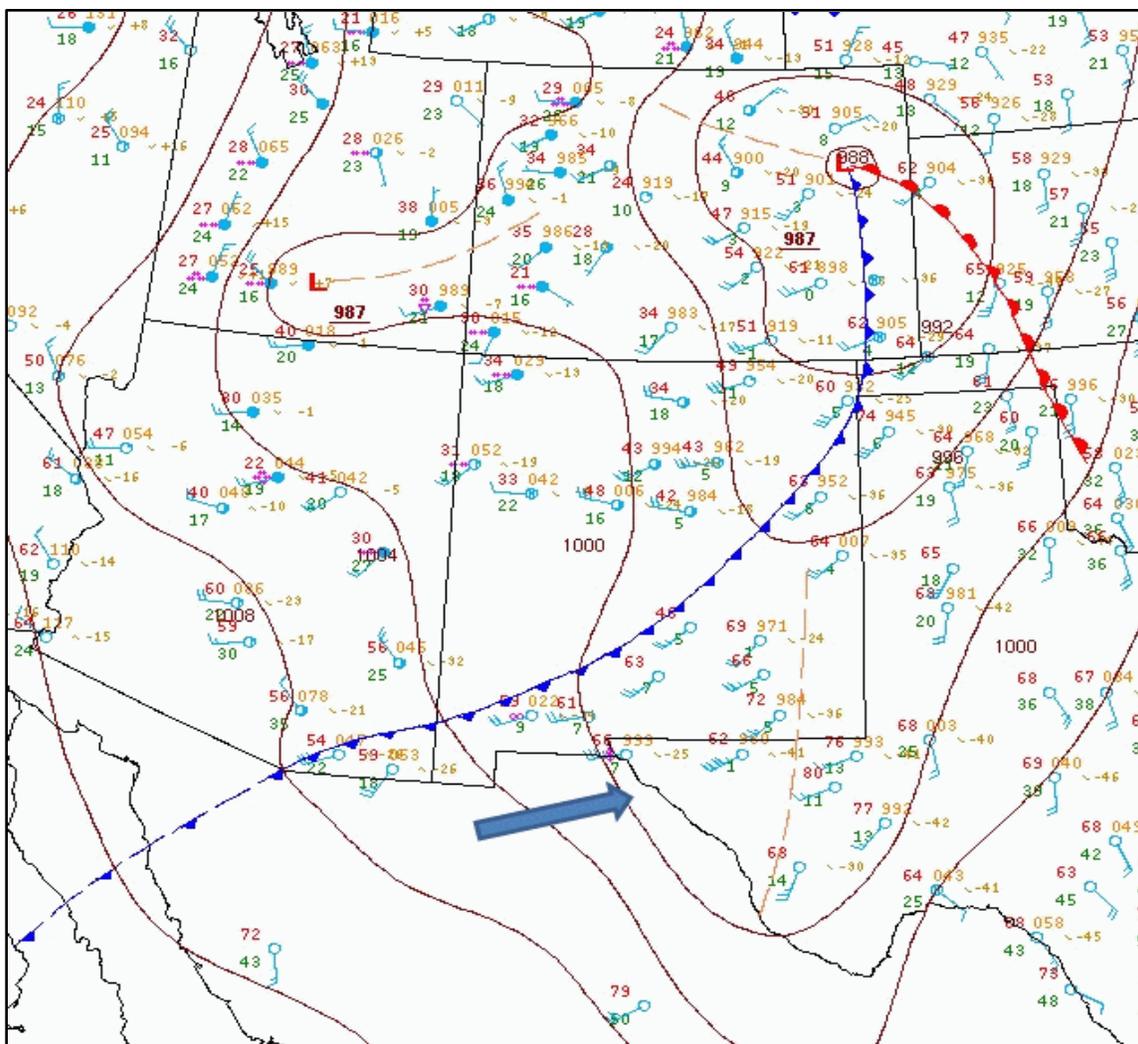


Figure B-1. Regional weather map for 1400 MST on November 28, 2010.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots. The measured wind speed at each station is the sum of the values shown with the individual barbs. The overall wind direction for the El Paso area is indicated by a large arrow.

High winds associated with this low pressure system generated a large area of blowing dust in northern Mexico that began impacting the El Paso area in the late morning and continued through the afternoon with high particulate matter concentrations measured across the area from 1200 to 2000 MST, peaking from 1400 to 1500 MST. Area peak wind gusts reached 54 mph and peak sustained winds were up to 44 mph at the El Paso Airport.

An exceptional event flag is proposed for the Socorro FRM PM₁₀ measurement of 249 µg/m³ on this day. The collocated continuous PM₁₀ monitor measured a daily average of 251 µg/m³ and a peak one-hour average of 1,846 µg/m³ for the hour beginning 1400 MST. The hourly average PM₁₀ concentrations were above the 24-hour NAAQS of 150 µg/m³ for seven hours beginning at 1300 MST, and the average wind direction during this period was from 260 degrees (slightly south of west) at an average speed of 18.7 mph. The peak measured wind gust at Socorro was 41.8 mph and the highest five-minute average wind speed was 26.0 mph.

Webcam Images

Two El Paso webcams, located at Chelsea Street and Ranger Peak, provide visual images of the dust impacting the El Paso area on November 28, 2010. A map of the webcam locations is presented in Figure 13 of the “Event Summary Information” section.

Figure B-2 below displays two images from the Chelsea Street webcam at 1200 MST, when dust levels were low, and at 1500 MST when intense blowing dust near the peak of the event was impacting the El Paso region. Downtown El Paso, about 4 miles to the west-southwest, and the Juarez Mountains, about 9 miles to the west-southwest, are clearly visible from the Chelsea Street webcam in the 1200 MST frame, but are totally obscured by intense blowing dust in the 1500 MST frame.

Similarly, Figure B-3 shows the Ranger Peak webcam view at 1200 MST compared to the 1500 MST view. Again, downtown El Paso, approximately 2 miles to the south-southwest, and the Juarez Mountains, approximately 8 miles to the south-southwest, are clearly visible in the 1200 MST frame, but are totally obscured in the 1500 MST frame.



Figure B-2. El Paso Chelsea Street webcam images for 1200 MST (top) and 1500 MST (bottom) on November 28, 2010.



Figure B-3. El Paso Ranger Peak webcam images for 1200 MST (top) and 1500 MST (bottom) on November 28, 2010.

Satellite Imagery

Satellite imagery visibly illustrates the intense dust plumes generated by high winds in northern Mexico and blowing east-northeastward into the El Paso area. Figure B-4 shows two true color composite MODIS visible wavelength images of the El Paso area from the polar orbiting Aqua satellite provided by the University of Texas (UT) Center for Space Research (CSR). The top image is from a clear day with no dust on November 26, 2010, at 1340 MST. The bottom image is the same view on November 28, 2010, at 1326 MST at the beginning of the most intense portion of the dust event when numerous large dust plumes were blowing east-northeastward from northern Mexico into the El Paso area. In Figure B-4, El Paso is circled in red in the upper right side of each image and the Texas and Mexico boundaries are marked by gold colored lines.

In addition, Figures B-5 through B-10 provide a sequence of six GOES visible satellite images for November 28, 2010, at one hour intervals from mid-day at 1115 MST through 1615 MST near sunset. The GOES images are not as high in resolution as the MODIS images, but numerous dust plumes can be seen in the sequence developing in northern Mexico and merging into a large dust cloud sweeping from west to east across the El Paso area. The west to east timing of the visible dust cloud impacting El Paso matches the timing and west to east sequence of sharp rises in $PM_{2.5}$ and PM_{10} levels seen in the time series graphs presented in Figures B-14 and B-15.

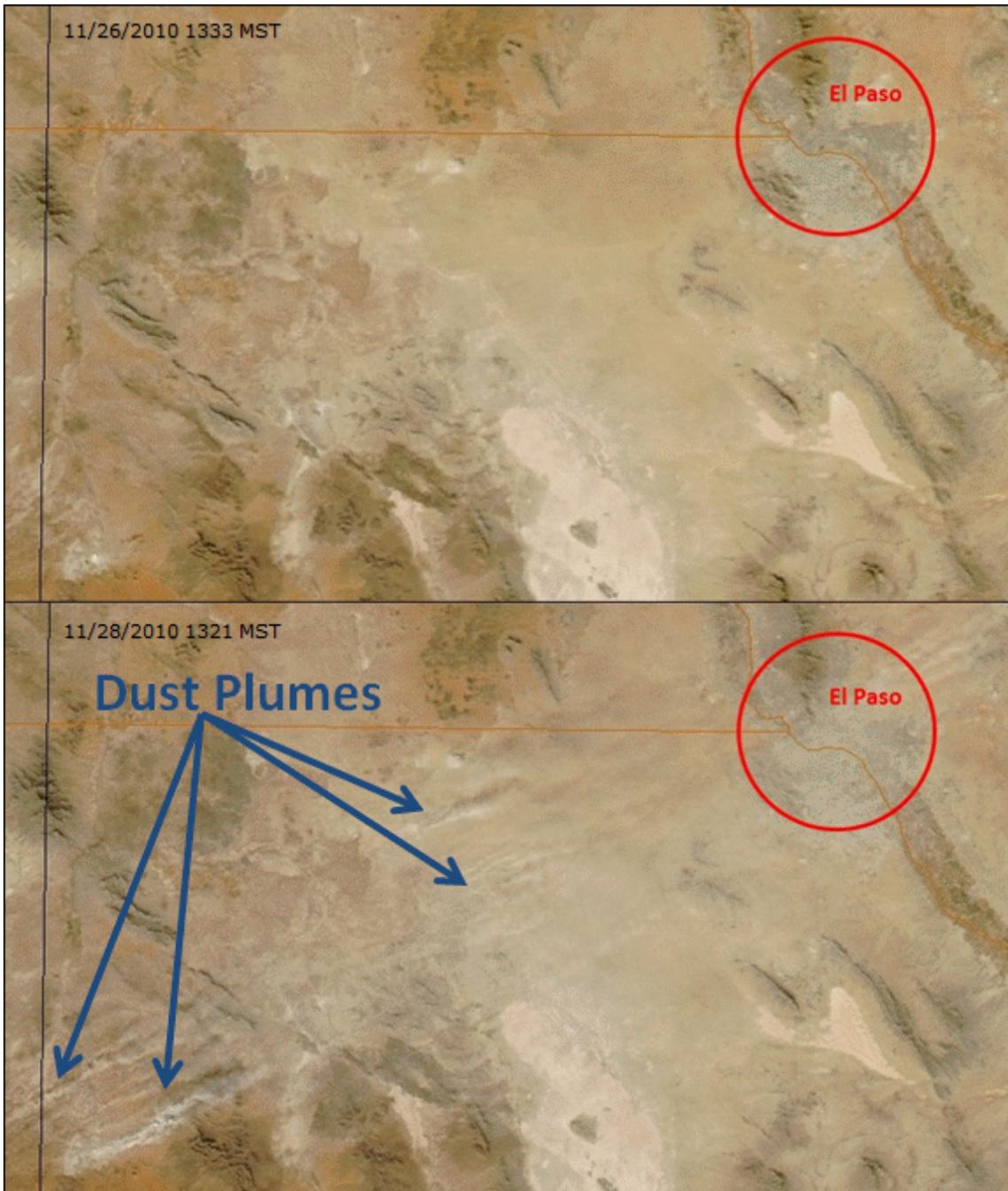


Figure B-4. True color Aqua satellite images showing numerous large dust plumes in northern Mexico blowing towards El Paso at 1326 MST on November 28, 2010, in the bottom frame compared to a dust-free view at 1340 MST on November 26, 2010, in the top frame.

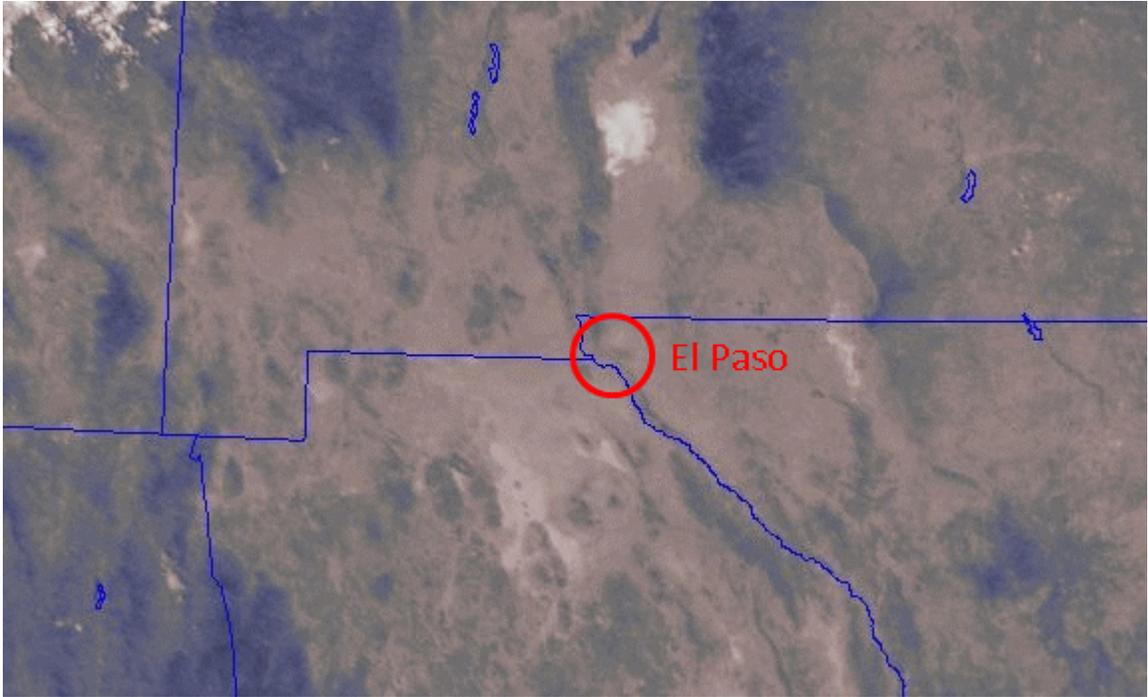


Figure B-5. GOES image for 1115 MST on November 28, 2010.

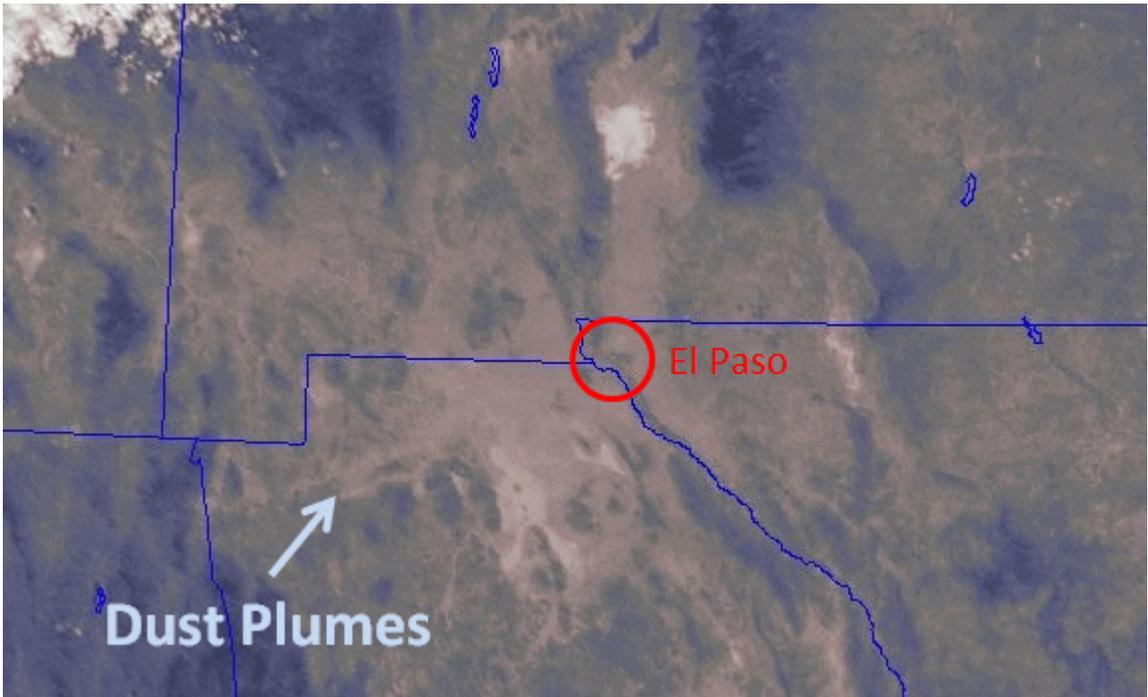


Figure B-6. GOES image for 1215 MST on November 28, 2010.

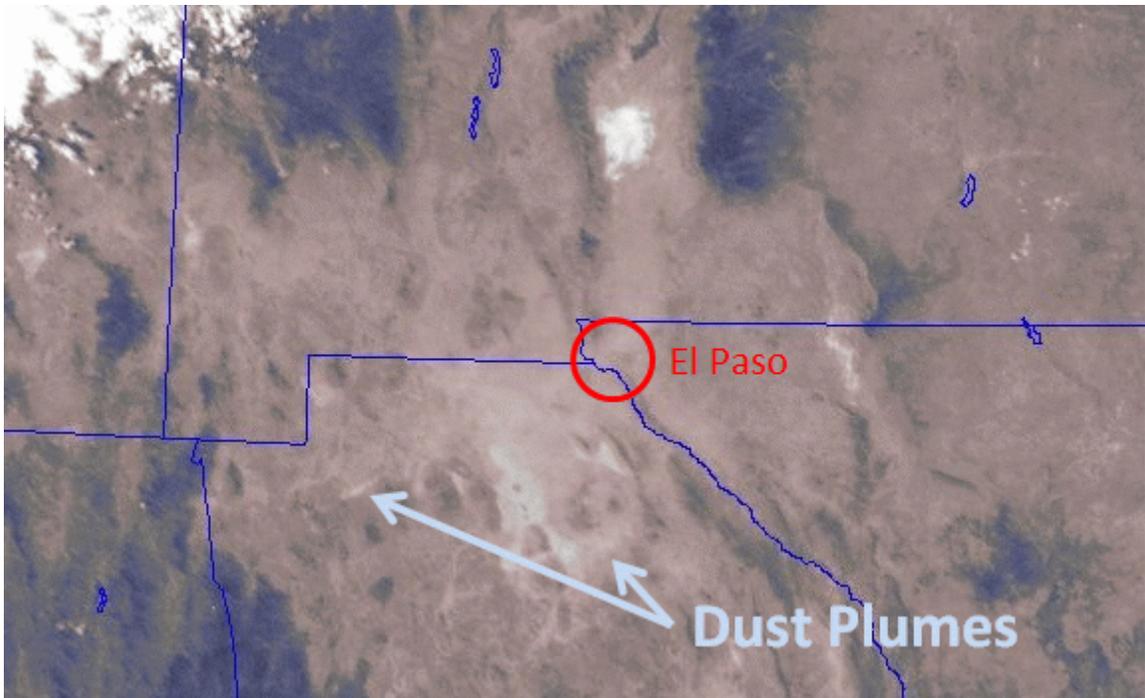


Figure B-7. GOES image for 1315 MST on November 28, 2010.

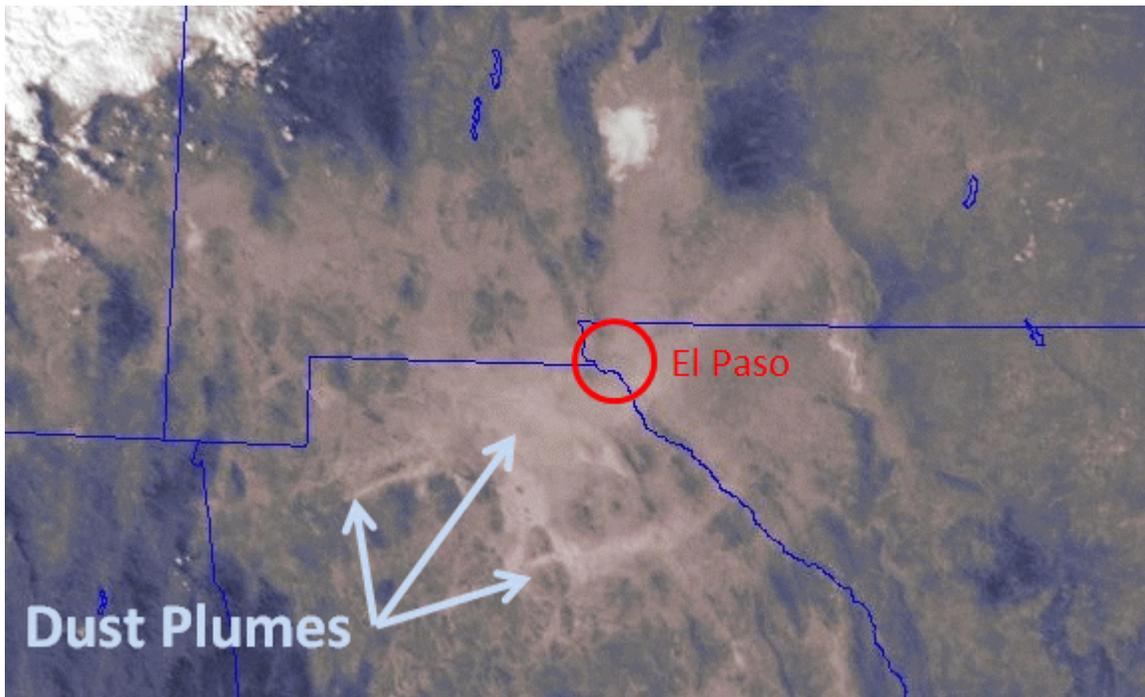


Figure B-8. GOES image for 1415 MST on November 28, 2010.

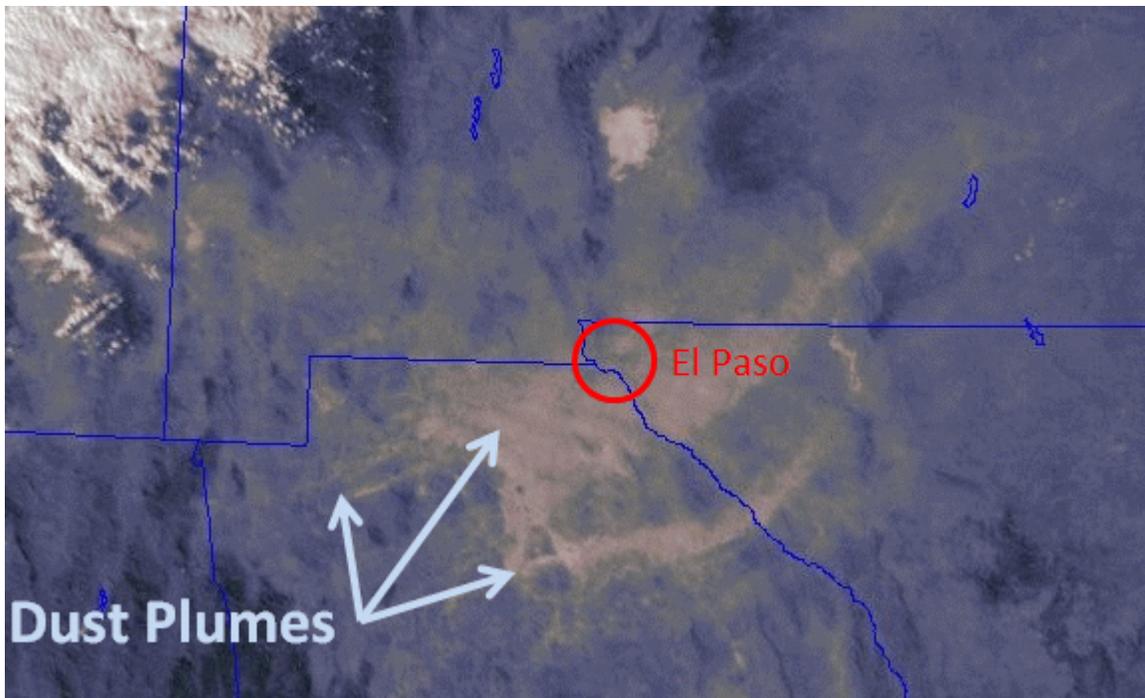


Figure B-9. GOES image for 1515 MST on November 28, 2010.

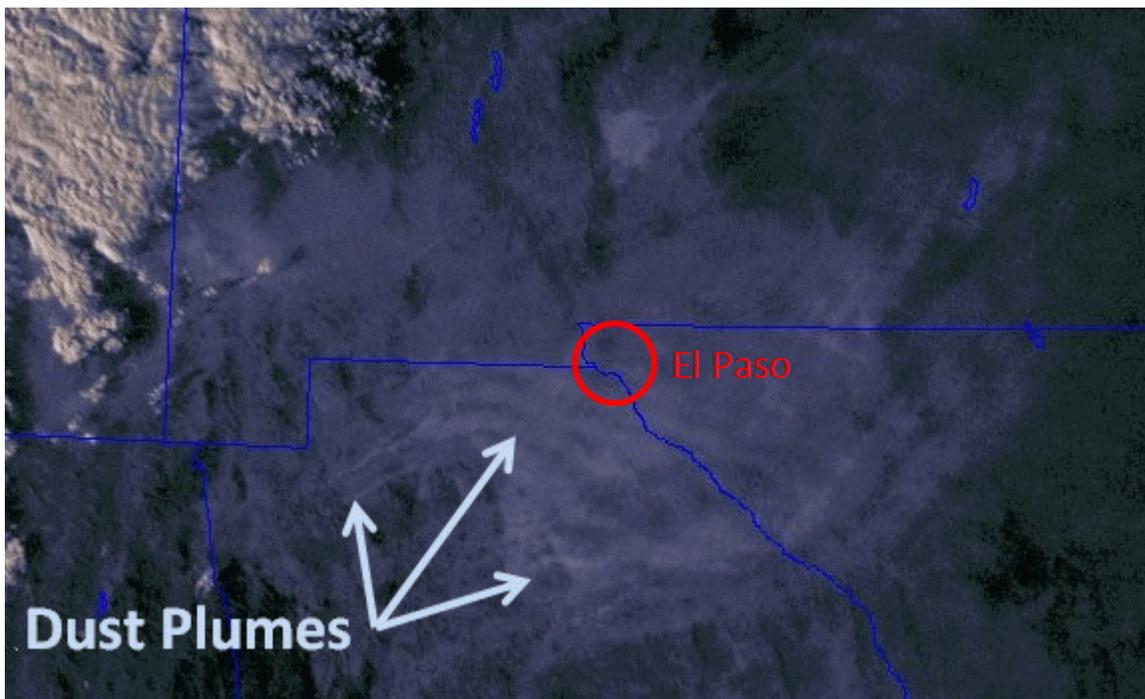


Figure B-10. GOES image for 1615 MST on November 28, 2010.

Back Trajectories

Figure B-11 provides HYSPLIT back trajectories that show the approximate path of air arriving at the Socorro site at 1400 MST (2100 UTC) on November 28, 2010. Trajectory paths are plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours. These trajectories indicate that the air arriving at the Socorro site at the time of the highest PM₁₀ levels on November 28, 2010, originated from northern Mexico, as visually demonstrated in the satellite imagery.

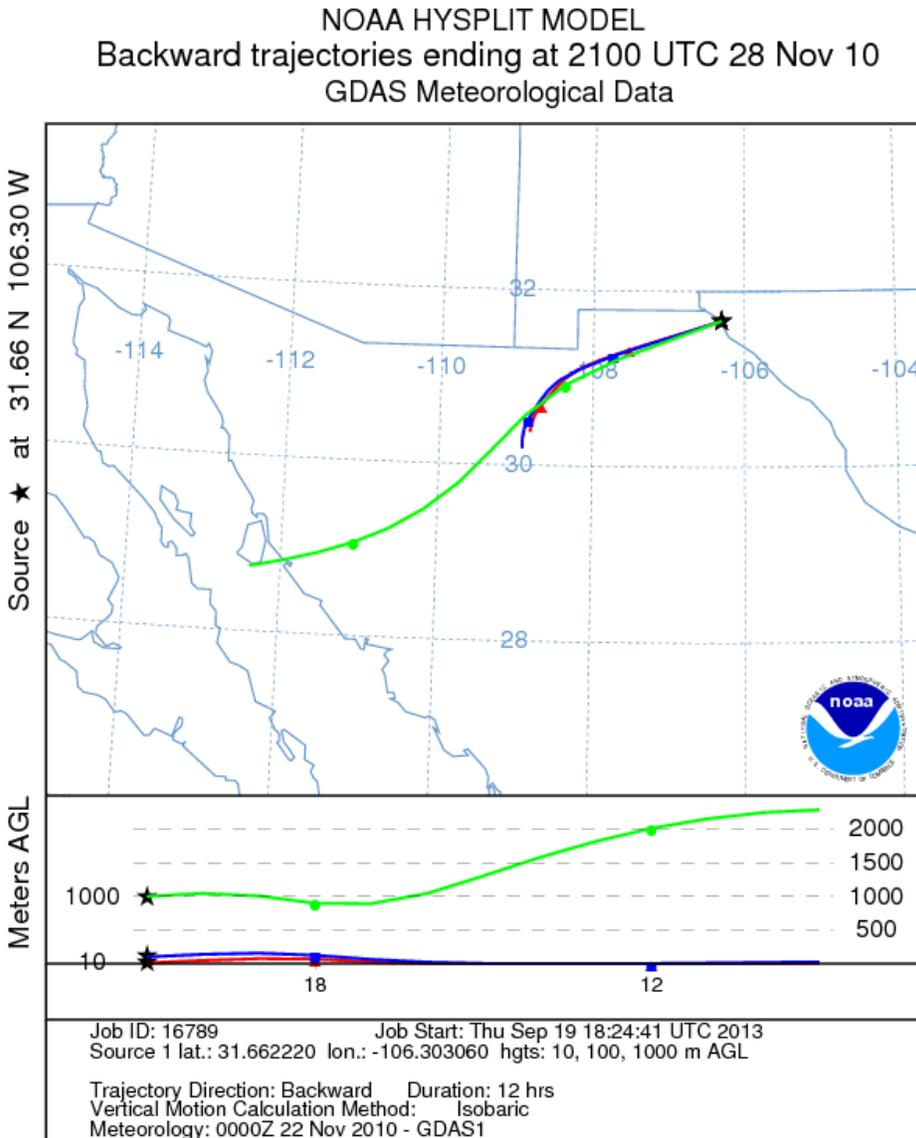


Figure B-11. Backward-in-time air trajectory for November 28, 2010, for air arriving at Socorro at 1400 MST (2100 UTC).

Map Plots of Daily Particulate Matter Data

The following maps display daily average PM_{10} and $PM_{2.5}$ measurements from the November 28, 2010, event for El Paso area monitors. Figure B-12 shows the daily average $PM_{2.5}$ measurements and Figure B-13 shows the daily average PM_{10} measurements, including the Socorro measurement proposed as an exceptional event. The highest PM_{10} measurements were at sites in Mexico upwind of Socorro, indicating transport of very high incoming background levels from the west to southwest.

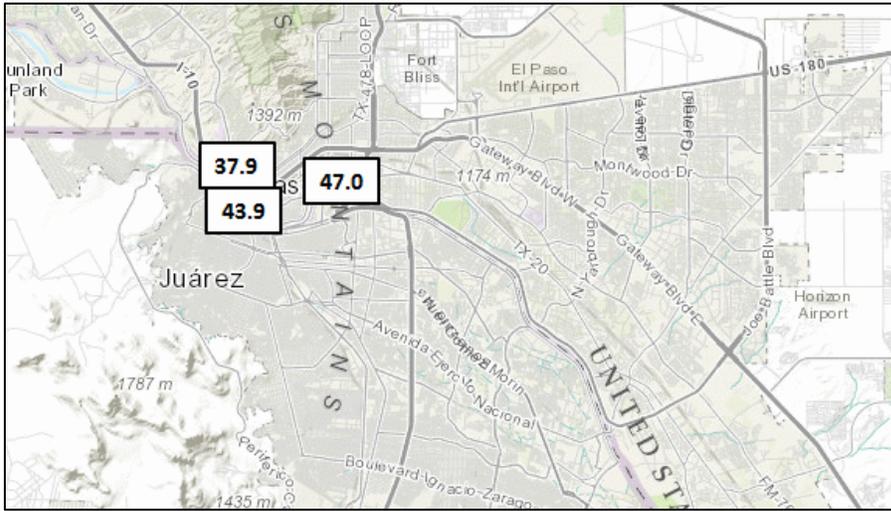


Figure B-12. Map of El Paso area daily average $PM_{2.5}$ measurements ($\mu\text{g}/\text{m}^3$ LC) on November 28, 2010.

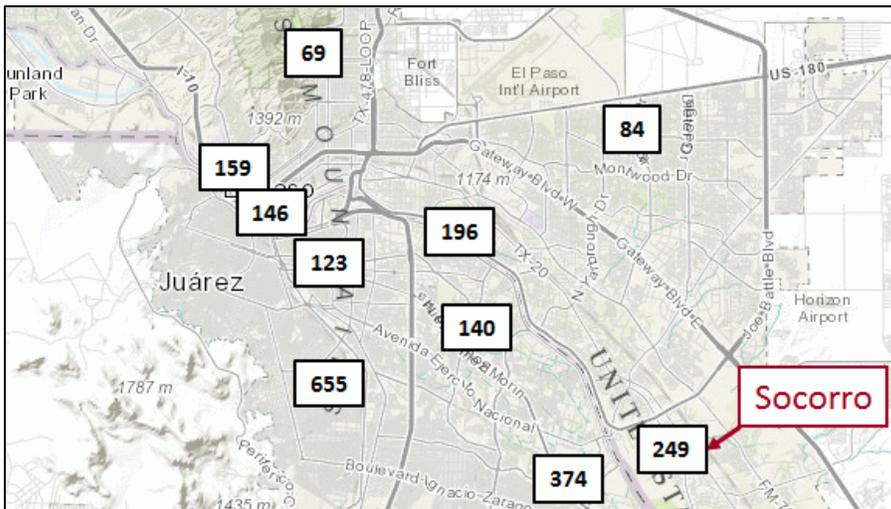


Figure B-13. Map of El Paso area daily average PM_{10} measurements ($\mu\text{g}/\text{m}^3$ SC) on November 28, 2010.

Continuous Particulate Matter and Wind Graphs

Graphs of five-minute continuous $PM_{2.5}$, PM_{10} , and wind gust data for the November 28, 2010, event are provided in Figures B-14 and B-15. Continuous five-minute $PM_{2.5}$ measurements plotted against peak wind gust data in Figure B-14 indicate that dust arrived first at UTEP and then later at Ascarate farther to the east. It also shows that the $PM_{2.5}$ concentrations rose much more sharply than the peak wind gust and then dropped quickly despite continuing high wind gusts. This pattern is consistent with an intense dust cloud advecting into the area and passing through as indicated by satellite imagery.

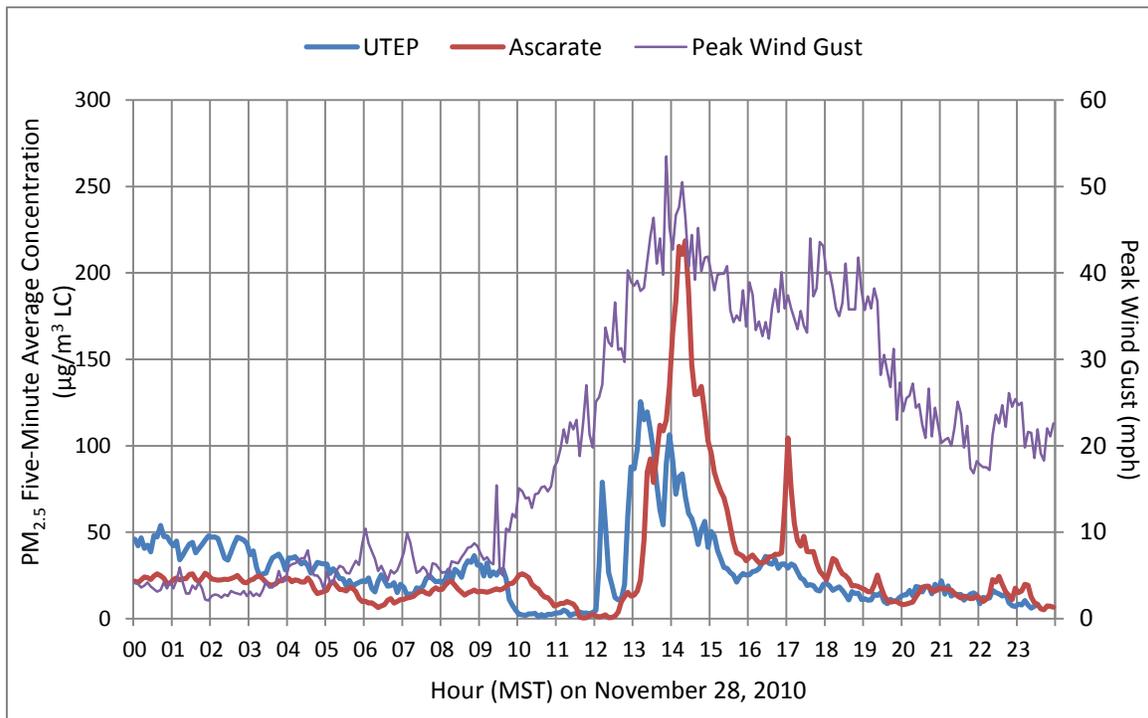


Figure B-14. El Paso five-minute average $PM_{2.5}$ concentrations from continuous monitors on November 28, 2010.

Figure B-15 plots continuous five-minute PM_{10} data from three sites in the El Paso area and shows sharp rises in PM_{10} beginning first at the westernmost UTEP site, then arriving at the intermediate Ascarate site, and last arriving at the easternmost Socorro site in agreement with satellite imagery showing dust plumes from Mexico first moving into the west side of the El Paso area and then sweeping eastward across the area. The figure also shows the peak wind gust, which indicates that peak wind gusts exceeded 40 mph more than an hour before the arrival of the highest dust concentrations. This lag time indicates a dust source many miles distant from the monitoring site. At such high wind speeds, a dust source nearer the monitor location would have

resulted in high measurements of particulate matter within a few minutes after the high wind gusts occurred.

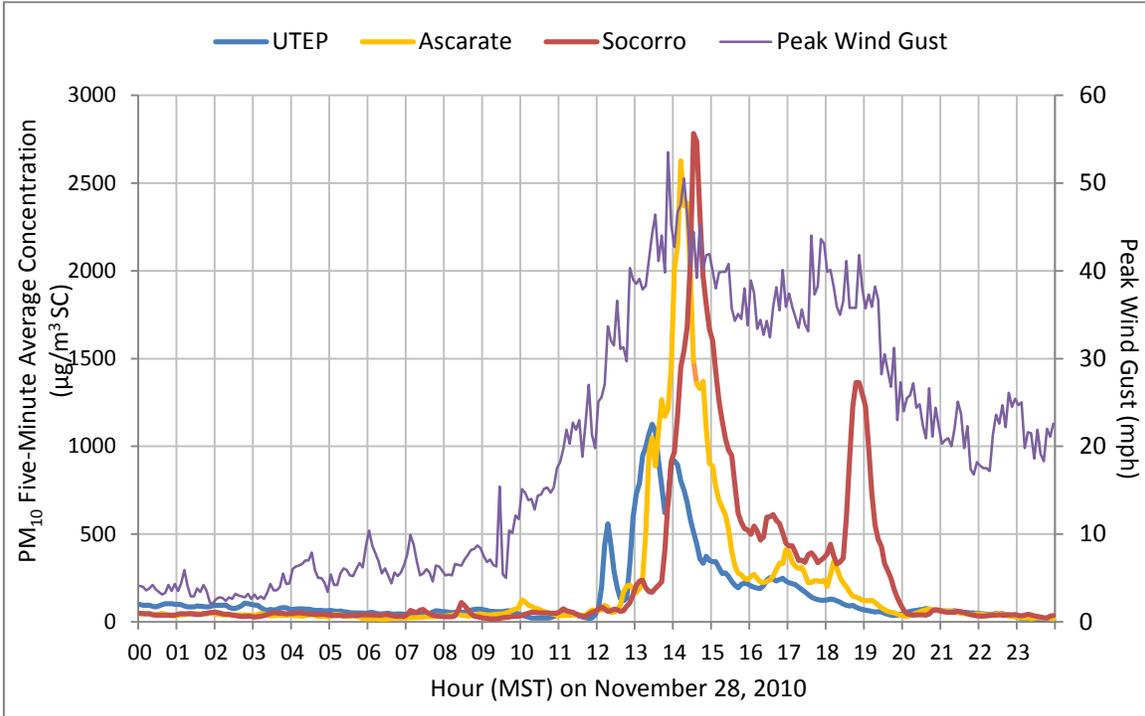


Figure B-15. El Paso five-minute average PM₁₀ from continuous monitors on November 28, 2010.

Appendix C: Event Analysis for February 8, 2011

Event Summary

A large low pressure system centered in southern New Mexico brought strong west to southwest winds across a large region from southern New Mexico and Arizona and into northern Mexico and far West Texas on February 8, 2011. Figure C-1 shows a weather map for February 8, 2011, at 1400 MST provided by NOAA depicting the low pressure system.

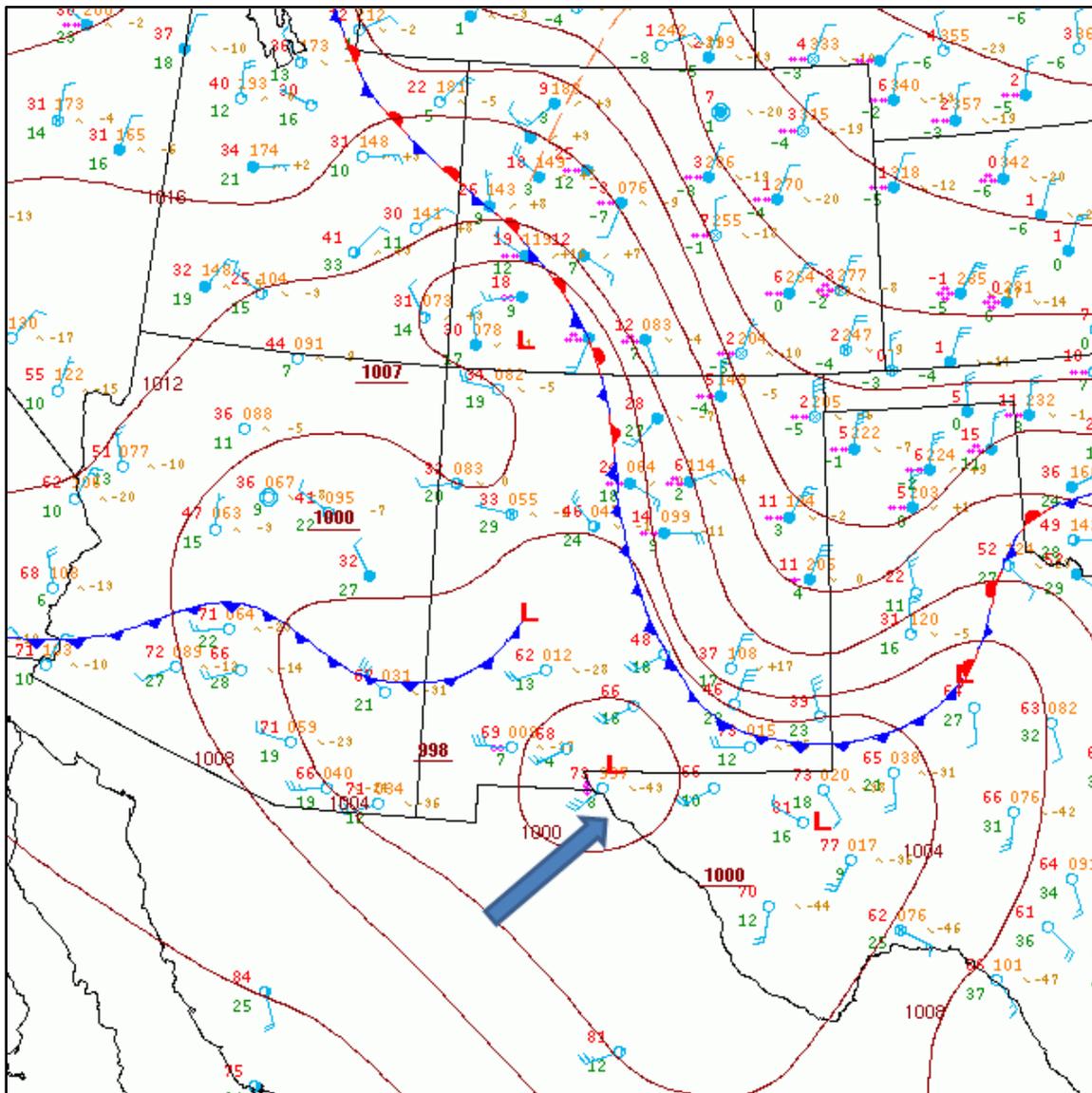


Figure C-1. Regional weather map for 1400 MST on February 8, 2011.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots and the wind speed is the sum of the values shown with the individual barbs. Wind direction in the El Paso area is indicated by a large arrow.

High winds associated with this large low pressure system generated a large area of blowing dust in northern Mexico that began impacting the El Paso area in the late morning and continued through the afternoon with high particulate matter concentrations measured across the area from 1200 to 1900 MST. Area peak wind gusts reached 61 mph and peak sustained winds were up to 46 mph at the El Paso Airport.

An exceptional event flag is proposed for the Chamizal FRM PM_{2.5} measurement of 42.9 µg/m³ on this day. The collocated continuous FEM PM_{2.5} monitor measured a daily average of 28.4 µg/m³ and a peak one-hour average of 82 µg/m³ for the hour beginning at 1500 MST. The hourly average PM_{2.5} concentration was above the 24-hour NAAQS of 35 µg/m³ for five hours beginning at 1200 MST and the average wind direction during this period was from 260 degrees (slightly south of west) at an average speed of 24.1 mph. The peak measured wind gust at Chamizal was 46.7 mph and the highest five-minute average wind speed was 29.5 mph.

An exceptional event flag is also proposed for the UTEP FRM PM_{2.5} measurement of 36.8 µg/m³ on this day. The collocated continuous acceptable PM_{2.5} monitor measured a daily average of 23.9 µg/m³ and a peak one-hour average of 77.2 µg/m³ for the hour beginning at 1500 MST. The hourly average PM_{2.5} concentration was above the 24-hour NAAQS of 35 µg/m³ for four hours beginning at 1300 MST and the average wind direction during this period was from 266 degrees (slightly south of west) at an average speed of 16.5 mph. The peak measured wind gust at UTEP was 38.8 mph and the highest five-minute average wind speed was 21.9 mph.

Webcam Images

The El Paso Ranger Peak webcam provided visual images of the dust impacting the El Paso area on February 8, 2011. The Chelsea Street webcam was not operating that day. A map of the webcam locations was previously presented in Figure 13.

Figure C-2 shows the Ranger Peak webcam view at 1100 MST when dust levels were low compared to the 1500 MST view with intense blowing dust near the peak of the event. From the Ranger Peak webcam, downtown El Paso is about 2 miles to the south-southwest and the Juarez Mountains about 8 miles south to southwest. Both are clearly visible in the 1100 MST frame, but are totally obscured by intense blowing dust in the 1500 MST frame.



Figure C-2. El Paso Ranger Peak webcam images for 1100 MST (top) and 1500 MST (bottom) on February 8, 2011.

Satellite Imagery

Satellite imagery visibly shows the intense dust plumes generated by high winds in northern Mexico blowing east-northeastward into the El Paso area. Figure C-3 shows two true color composite MODIS visible wavelength images of the El Paso area on February 8, 2011, provided by the University of Wisconsin (UW) Space Science and Engineering Center (SSEC). The top image is from the Terra satellite at 1100 MST and shows a few large dust plumes beginning to form in northern Mexico. The bottom image shows the same view from the Aqua satellite at 1240 MST, the beginning of the most intense portion of the dust event. Numerous large dust plumes generated by high winds in northern Mexico can be seen merging together as the dust blows east-northeastward into the west side of the El Paso area. In Figure C-3 El Paso is circled in red in the upper right side of each image and the Texas and Mexico boundaries are marked by gray lines.

In addition, Figures C-4 through C-9 provide a sequence of six GOES visible satellite images for February 8, 2011, at one hour intervals from mid-day at 1115 MST through 1615 MST near sunset. The GOES images are not as high in resolution as the MODIS images, but numerous dust plumes can be seen developing in northern Mexico and merging into a large dust cloud sweeping from west to east across the El Paso area in the sequence of images. The west to east timing of the visible dust cloud impacting El Paso matches the timing and west to east sequence of sharp rises in $PM_{2.5}$ and PM_{10} levels seen in the time series graphs presented in Figures C-14 and C-15 later in this appendix.

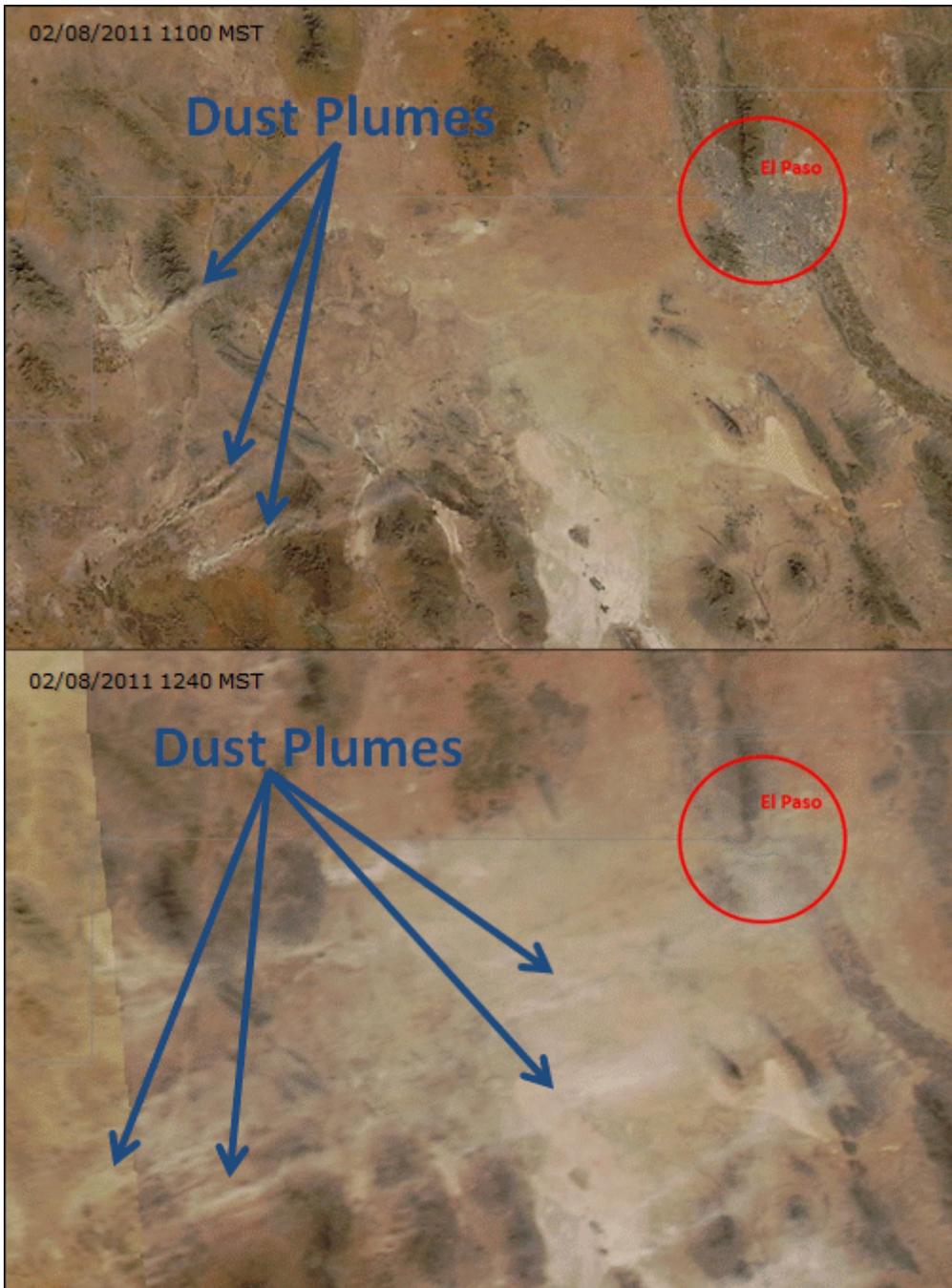


Figure C-3. True color Terra satellite image at 1100 MST in top frame showing an early start to large dust plumes in northern Mexico blowing towards El Paso on February 8, 2011, and in the bottom frame a later true color image from the Aqua satellite at 1240 MST showing widespread blowing dust in northern Mexico blowing towards El Paso.

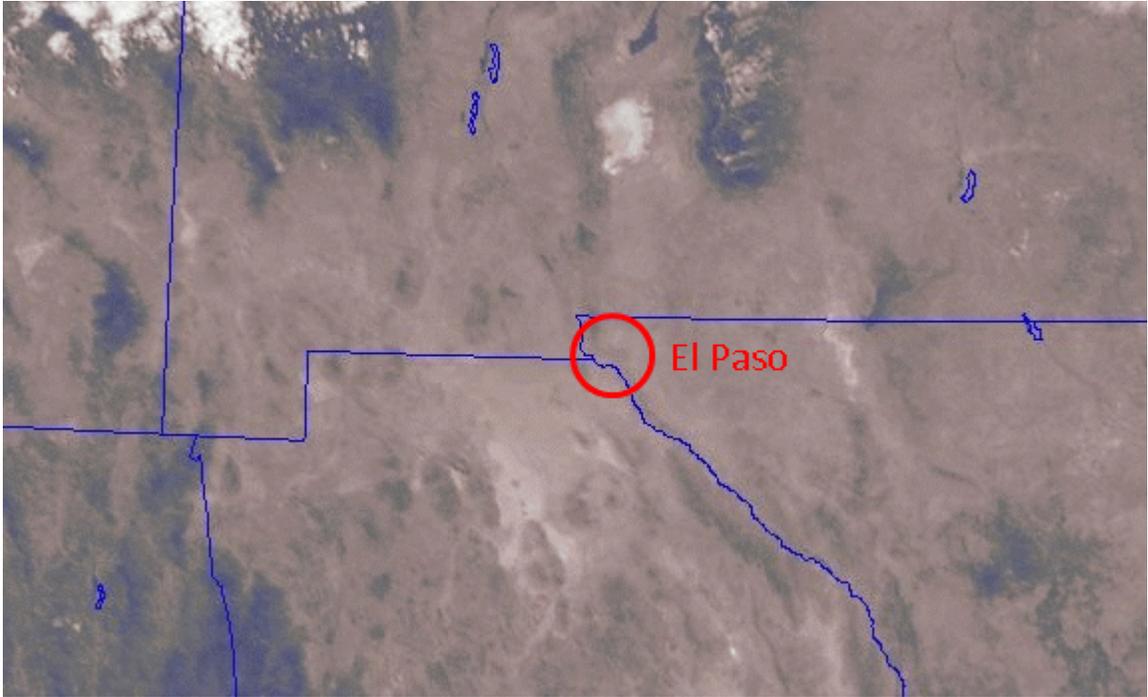


Figure C-4. GOES image for 1115 MST on February 8, 2011.

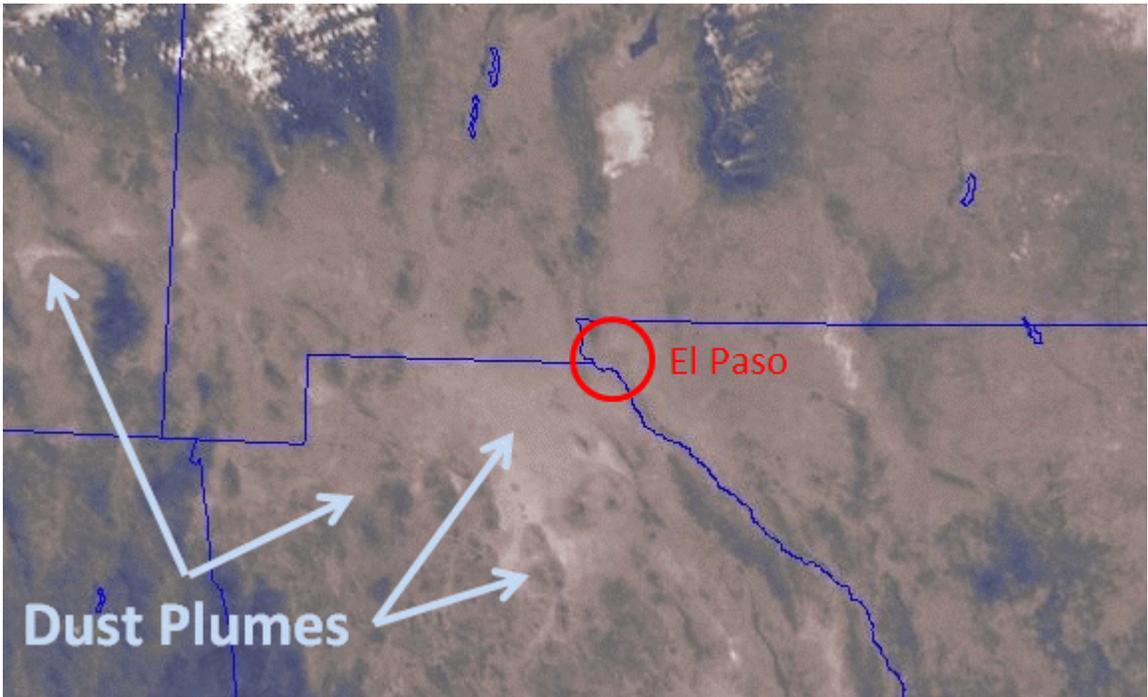


Figure C-5. GOES image for 1215 MST on February 8, 2011.

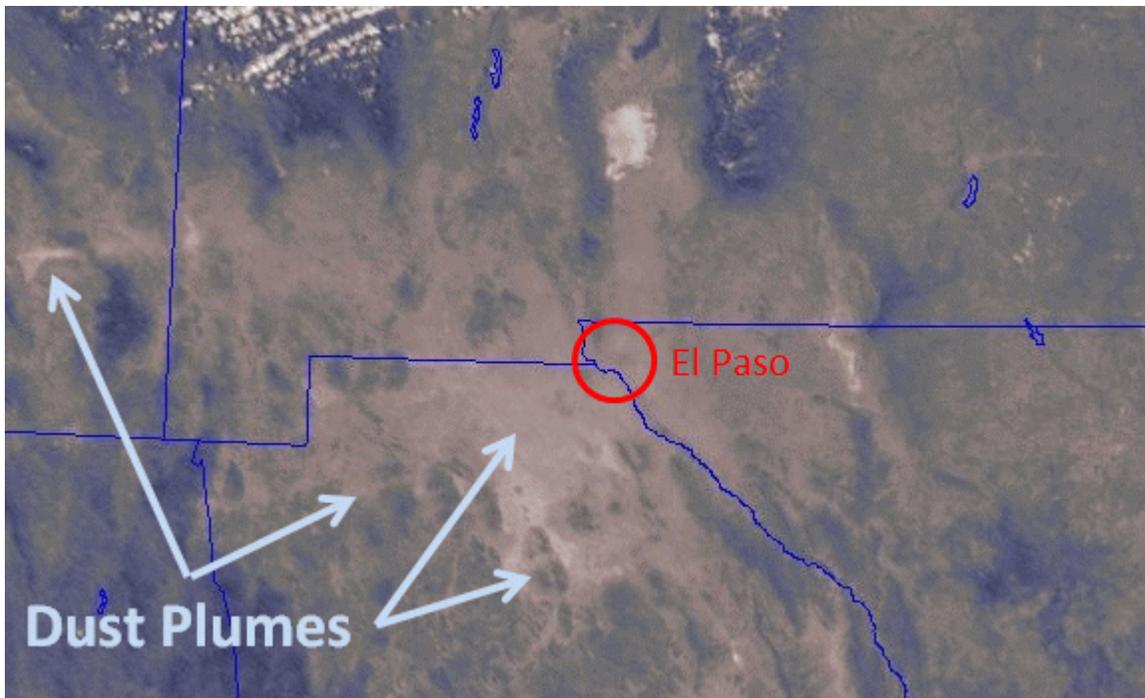


Figure C-6. GOES image for 1315 MST on February 8, 2011.

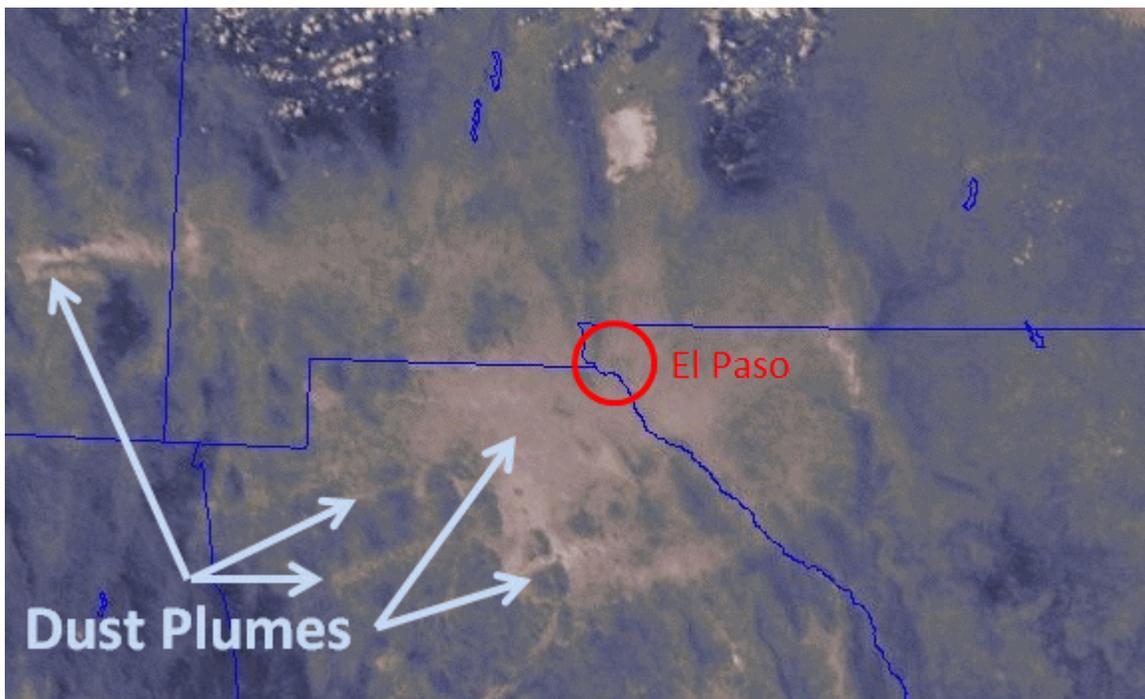


Figure C-7. GOES image for 1415 MST on February 8, 2011.

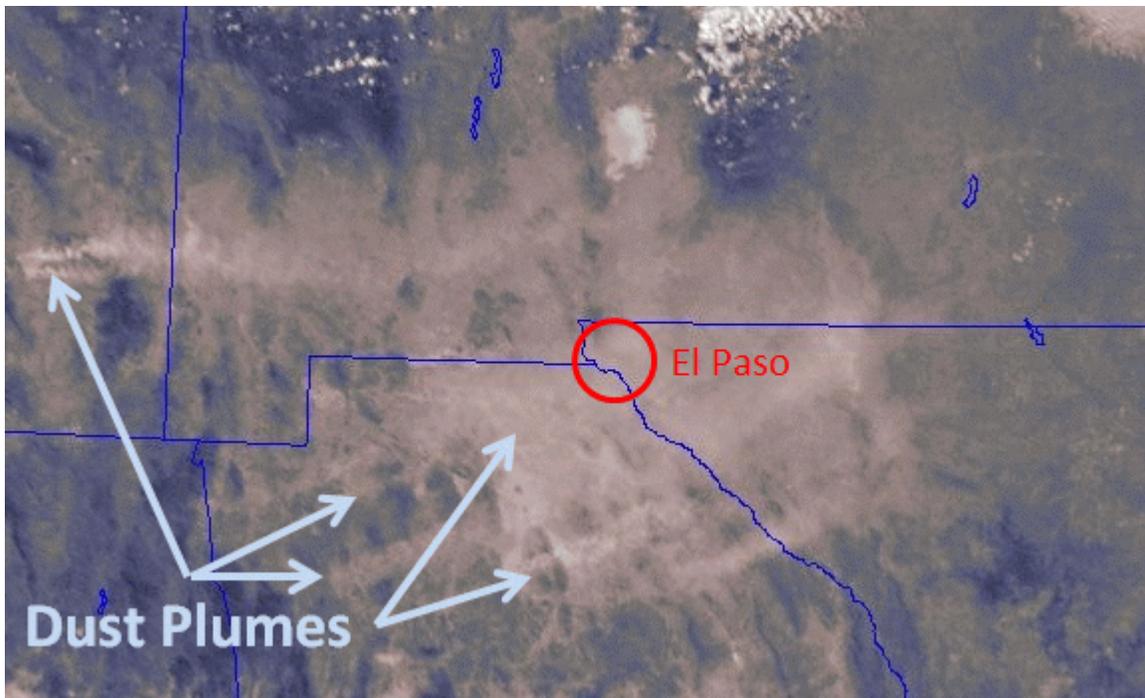


Figure C-8. GOES image for 1515 MST on February 8, 2011.

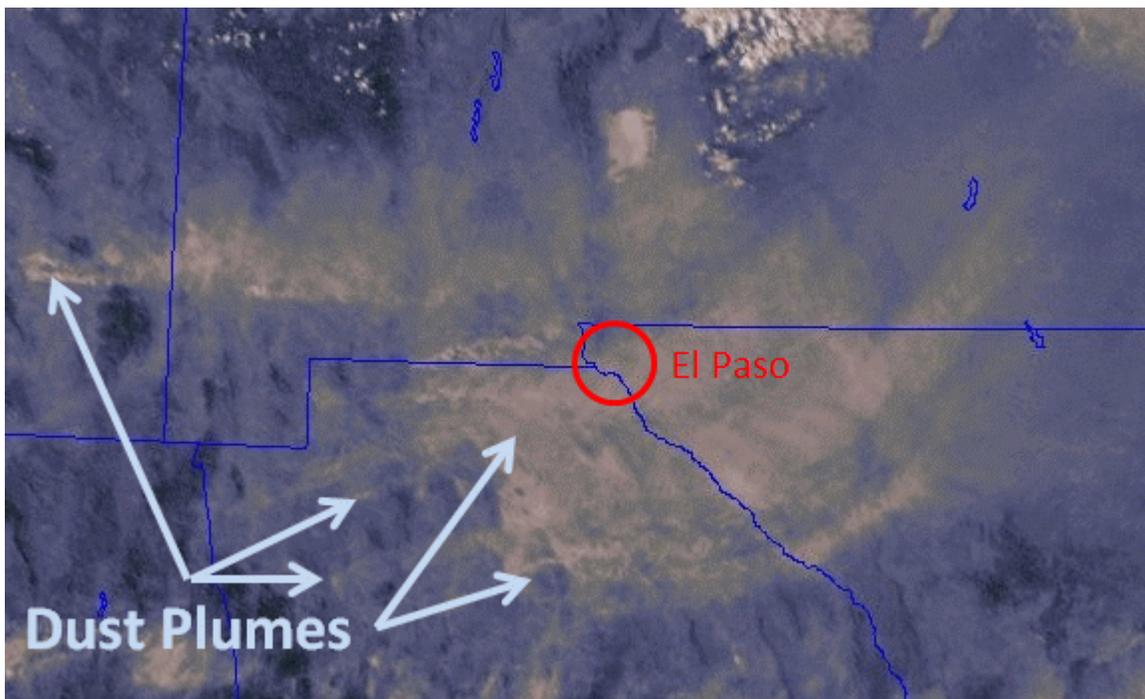


Figure C-9. GOES image for 1615 MST on February 8, 2011.

Back Trajectories

Figures C-10 and C-11 provide HYSPLIT back trajectories that show the approximate path of air arriving at the Chamizal and UTEP sites at 1500 MST (2200 UTC) on February 8, 2011. Trajectory paths are plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours. These trajectories indicate that the air arriving at Chamizal and UTEP at the time of the highest PM_{2.5} levels on February 8, 2011, came from northern Mexico as presented in the satellite imagery.

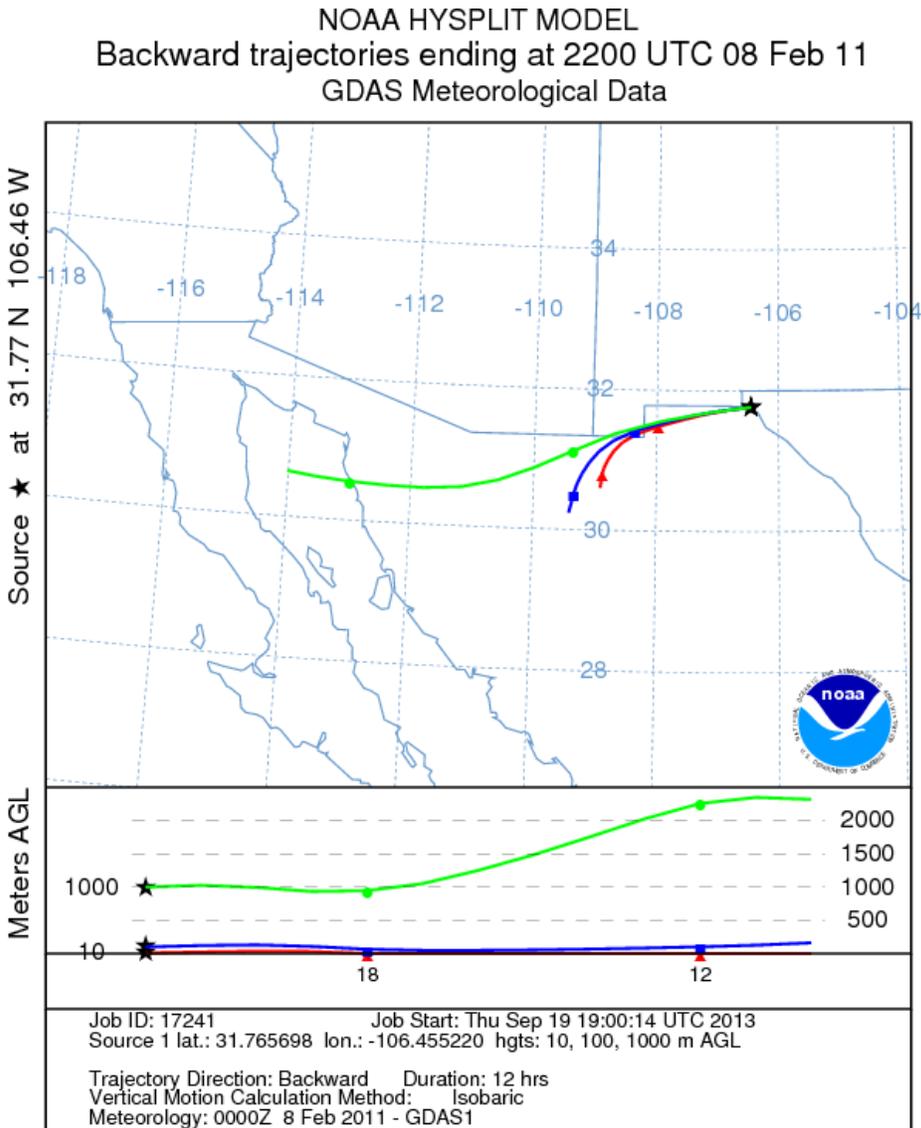


Figure C-10. Backward-in-time air trajectory for February 8, 2011, for air arriving at Chamizal at 1500 MST (2200 UTC).

NOAA HYSPLIT MODEL
 Backward trajectories ending at 2200 UTC 08 Feb 11
 GDAS Meteorological Data

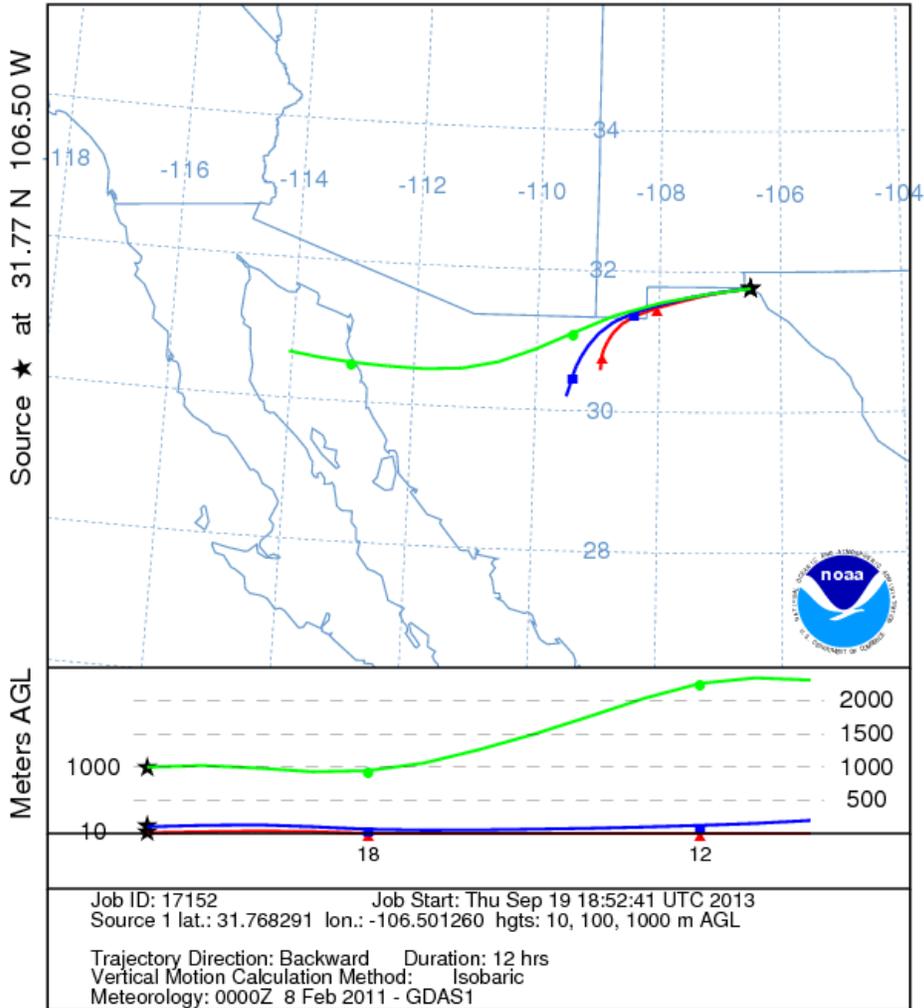


Figure C-11. Backward-in-time air trajectory for February 8, 2011, for air arriving at UTEP at 1500 MST (2200 UTC).

Map Plots of Daily Particulate Matter Data

This section provides maps of daily average PM_{10} and $PM_{2.5}$ measurements from the February 8, 2011, event. Figure C-12 shows the daily average $PM_{2.5}$ measurements, including the Chamizal and UTEP measurements proposed as exceptional events, and Figure C-13 shows the daily average PM_{10} measurements. Both maps show high particulate matter concentrations along the border with Mexico consistent with transport from the west to southwest.

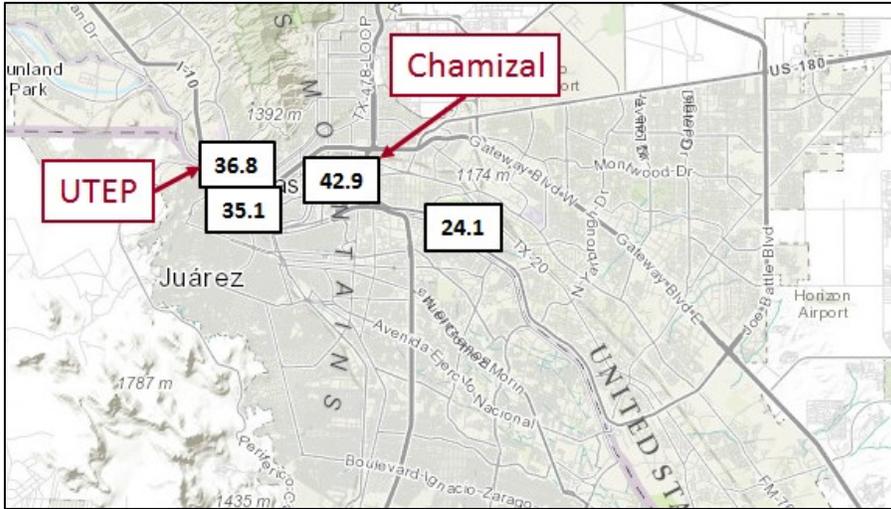


Figure C-12. Map of El Paso area daily average $PM_{2.5}$ measurements ($\mu\text{g}/\text{m}^3$ LC) on February 8, 2011.

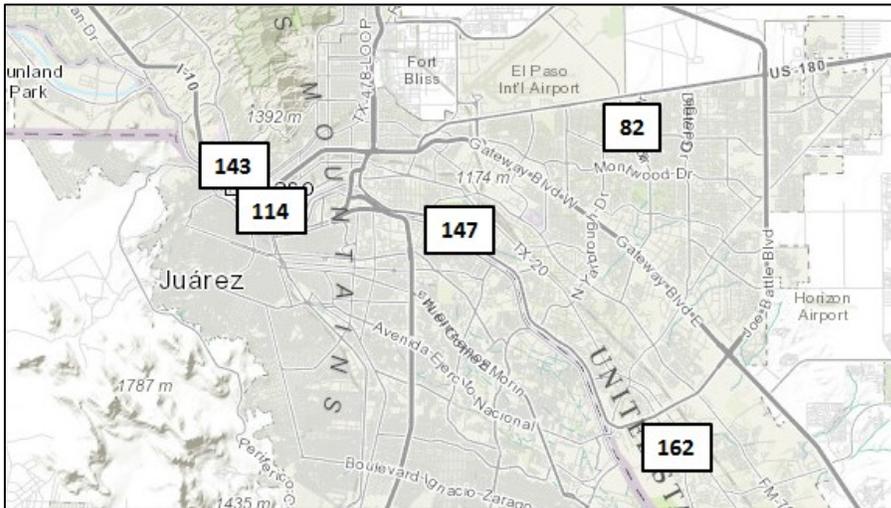


Figure C-13. Map of El Paso area daily average PM_{10} measurements ($\mu\text{g}/\text{m}^3$ SC) on February 8, 2011.

Continuous Particulate Matter and Wind Graphs

Graphs of five-minute continuous $PM_{2.5}$, PM_{10} , and wind gust data for the February 8, 2011, event illustrate the spatial relationship of measured concentrations, as well as the temporal relationship with elevated wind speeds. Figure C-14 shows a plot of continuous five-minute $PM_{2.5}$ data that indicates dust arriving first at UTEP at about 1220 MST and then about 20 minutes later at Ascarate, farther to the east. The Chamizal continuous $PM_{2.5}$ data is only available in one-hour average time resolution and does not resolve the timing of the dust arrival as well. Plotting peak wind gusts against $PM_{2.5}$ measurements shows an increase in peak wind gusts about an hour prior to the rise in $PM_{2.5}$ levels. This delay is consistent with the arrival of a large transported dust plume generated by higher winds well upwind of the area, as supported by satellite imagery.

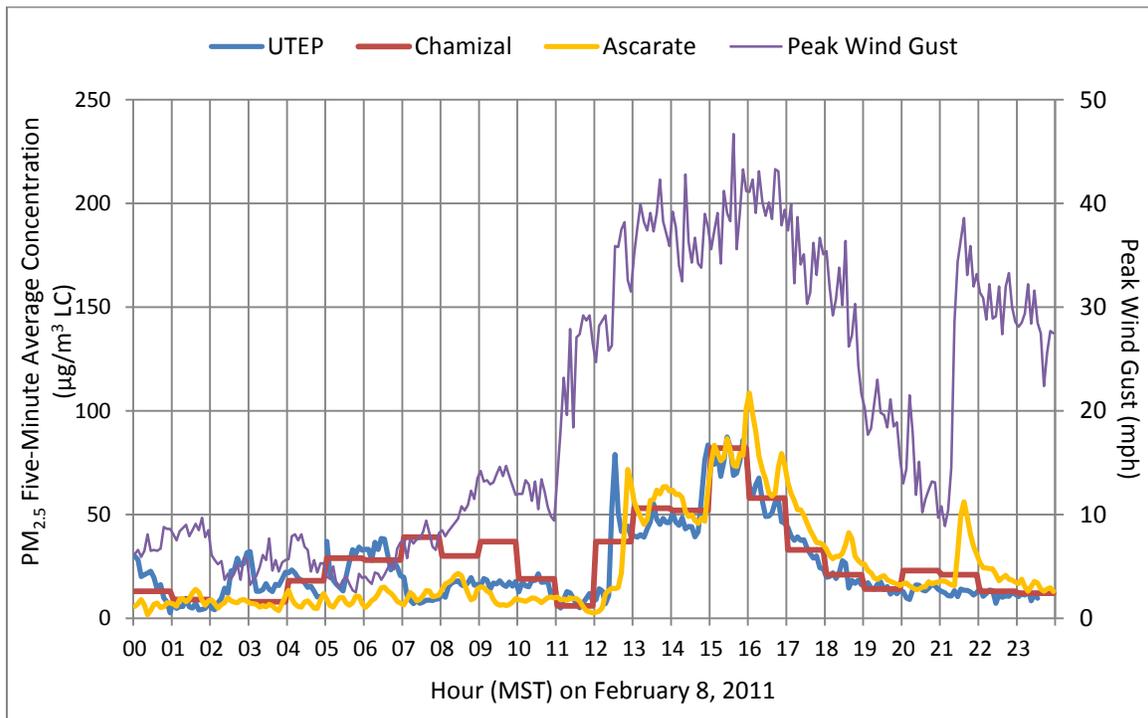


Figure C-14. El Paso five-minute average $PM_{2.5}$ concentrations from continuous monitors on February 8, 2011.

Figure C-15 plots continuous five-minute PM_{10} data from three sites in the El Paso area illustrating sharp rises in PM_{10} beginning first at the westernmost UTEP site, then later at Ascarate, and finally farther to the east at Socorro. This pattern supports the visual evidence provided in the satellite imagery showing intense dust plumes from Mexico first moving into the west side of the El Paso area and then sweeping eastward across the area.

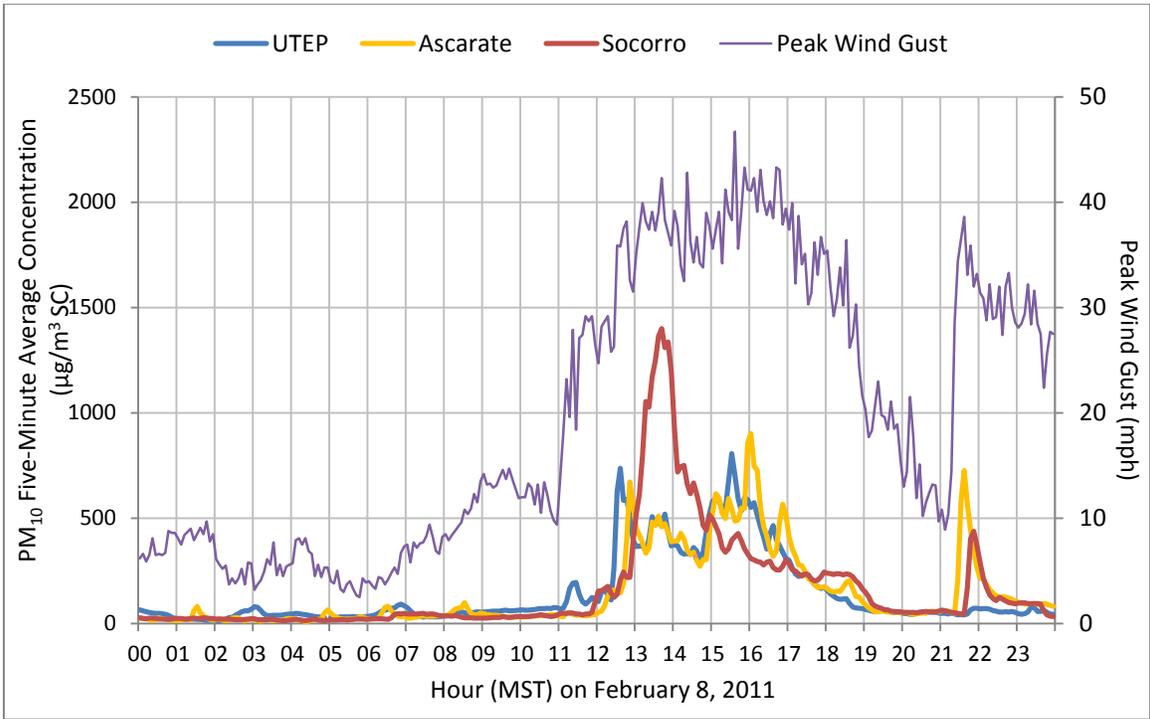


Figure C-15. El Paso five-minute average PM₁₀ concentrations from continuous monitors on February 8, 2011.

Appendix D: Event Analysis for March 7, 2011

Event Summary

A large low pressure system centered in southern New Mexico brought strong west to southwest winds across a large region from southern New Mexico and Arizona and into northern Mexico and far West Texas on March 7, 2011. Figure D-1 shows a weather map for March 7, 2011, at 1400 MST provided by NOAA depicting the low pressure system.

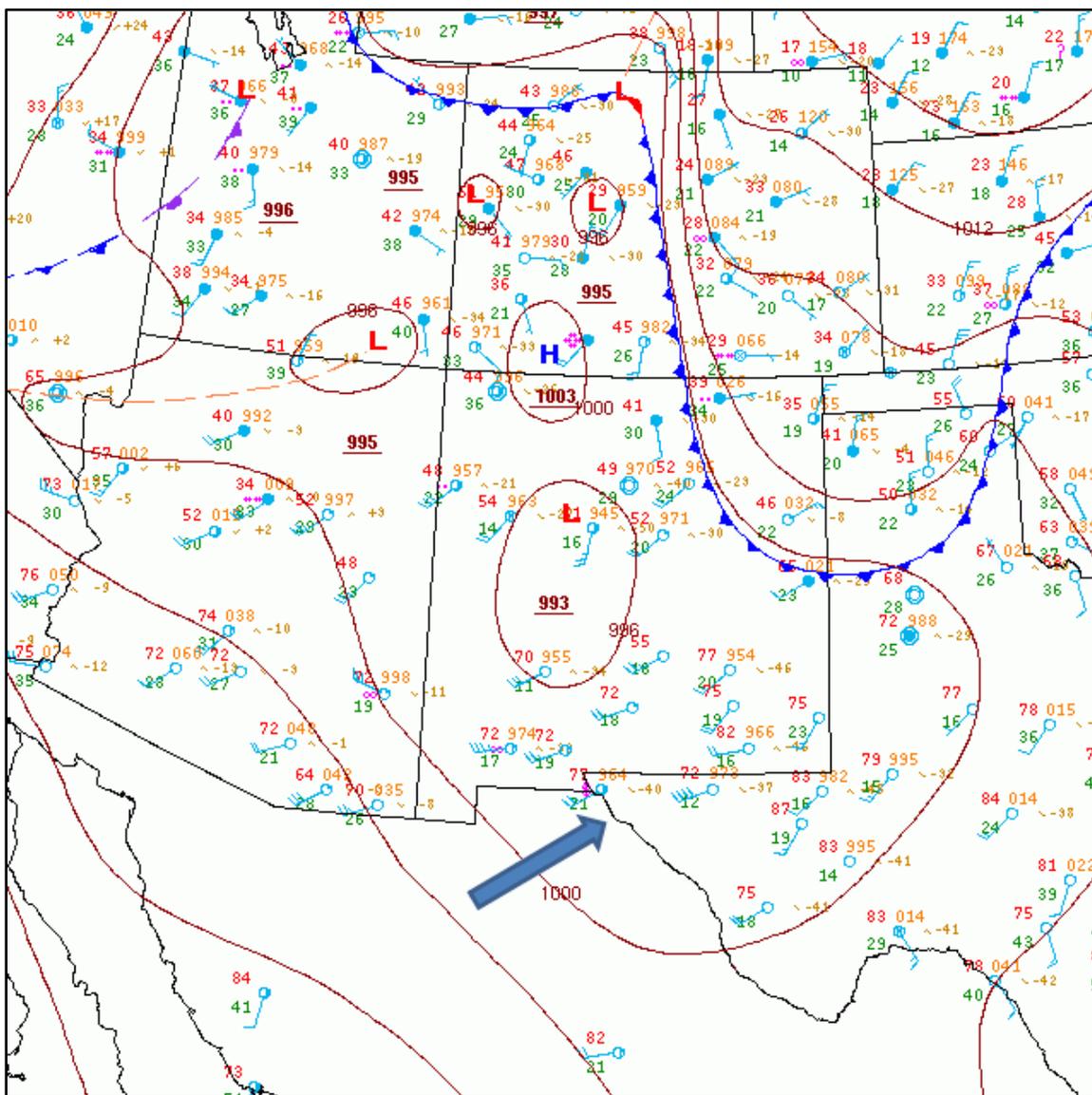


Figure D-1. Regional weather map for 1400 MST on March 7, 2011.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots and the wind speed is the sum of the values shown with the individual barbs. Wind direction in the El Paso area is indicated by a large arrow.

High winds associated with the large low pressure system generated a large area of blowing dust in northern Mexico that began impacting the El Paso area in the early afternoon with highest particulate matter concentrations measured from 1300 to 1800 MST. Area peak wind gusts reached 66 mph and peak sustained winds were up to 53 mph at the El Paso Airport. Only continuous particulate matter measurements were available on this day since it was not a routine sample day for any of the non-continuous monitors.

An exceptional event flag is proposed for the Chamizal continuous FEM PM_{2.5} daily average measurement of 37.2 µg/m³ on this day. The FEM PM_{2.5} monitor measured a peak one-hour average of 161 µg/m³ for the hour beginning at 1500 MST. The hourly average PM_{2.5} concentration was above the 24-hour NAAQS of 35 µg/m³ for five hours beginning at 1200 MST and the average wind direction during this period was from 253 degrees (west-southwest) at an average speed of 29.0 mph. The peak measured wind gust at Chamizal was 55.4 mph and the highest five-minute average wind speed was 37.0 mph.

Webcam Images

The two El Paso webcams provided visual images of the dust impacting the El Paso area on March 7, 2011. A map of the webcam locations was previously presented in Figure 13.

Figure D-2 shows the Chelsea Street webcam view at 1000 MST when dust levels were low compared to the 1400 MST view with intense blowing dust near the peak of the event. From the Chelsea Street webcam, downtown El Paso at about 4 miles to the west-southwest and the Juarez Mountains about 9 miles west to southwest are clearly visible in the 1000 MST frame, but are totally obscured by intense blowing dust in the 1400 MST frame.

Similarly, Figure D-3 shows the Ranger Peak webcam view at 1000 MST when dust levels were low compared to the 1400 MST view with intense blowing dust near the peak of the event. From the Ranger Peak webcam, downtown El Paso at about 2 miles to the south-southwest and the Juarez Mountains about 8 miles south to southwest are clearly visible in the 1000 MST frame, but are totally obscured by intense blowing dust in the 1400 MST frame.



Figure D-2. El Paso Chelsea Street webcam images for 1000 MST (top) and 1400 MST (bottom) on March 7, 2011.



Figure D-3. El Paso Ranger Peak webcam images for 1000 MST (top) and 1400 MST (bottom) on March 7, 2011.

Satellite Imagery

Satellite imagery shows intense dust plumes generated by high winds in northern Mexico blowing east-northeastward into the El Paso area. Figure D-4 shows two true color composite MODIS visible wavelength images of the El Paso area on March 7, 2011, provided by the UW SSEC. The top image is from the Terra satellite at 1040 MST and shows a few small dust plumes developing in northern Mexico. The bottom image shows the same view from the Aqua satellite at 1356 MST. Although heavy cloud cover over most of the area limits visibility, dust plumes can be seen in areas between the clouds. In Figure D-4 El Paso is circled in red in the upper right side of each image and the Texas and Mexico boundaries are marked by gray lines.

A sequence of four GOES visible satellite images for March 7, 2011, are presented in Figures D-5 through D-8 at one hour intervals from mid-day at 1315 MST through 1615 MST near sunset. The GOES images are not as high in resolution as the MODIS images and cloud cover is obscuring much of the view, but dust plumes can be seen developing in northern Mexico in areas not covered by clouds.

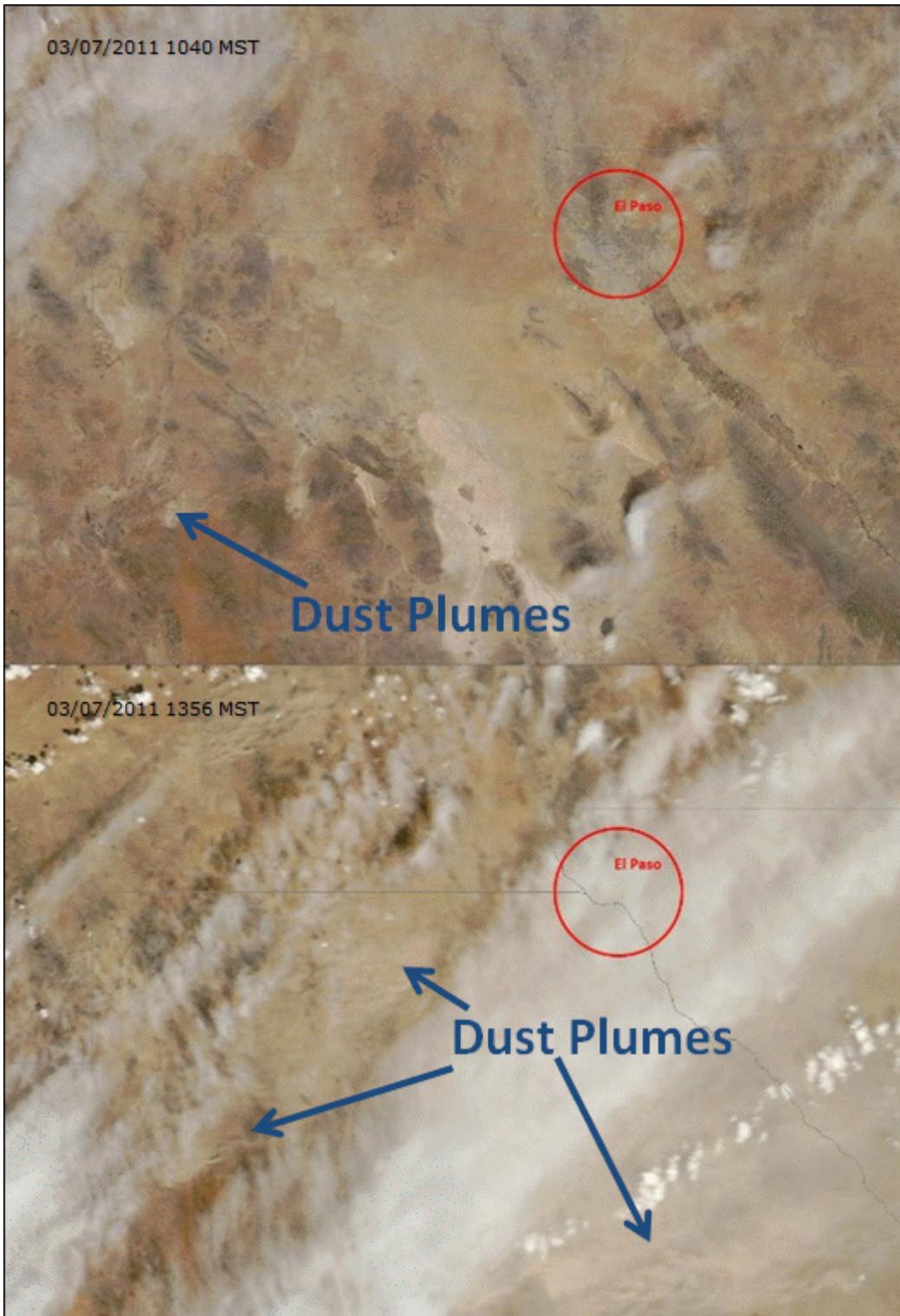


Figure D-4. True color Terra satellite image at 1040 MST in top frame showing small dust plumes starting early in northern Mexico blowing towards El Paso on March 7, 2011, and in the bottom frame a later true color image from the Aqua satellite at 1356 MST showing large areas of blowing dust between clouds in northern Mexico blowing towards El Paso.

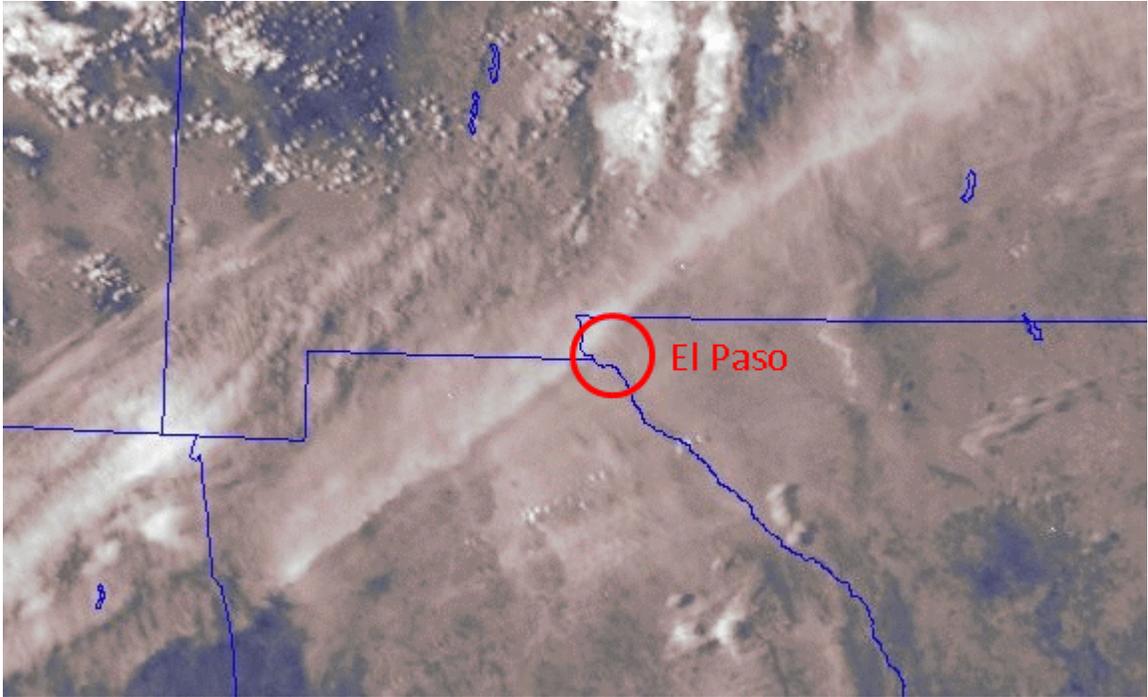


Figure D-5. GOES image for 1315 MST on March 7, 2011.

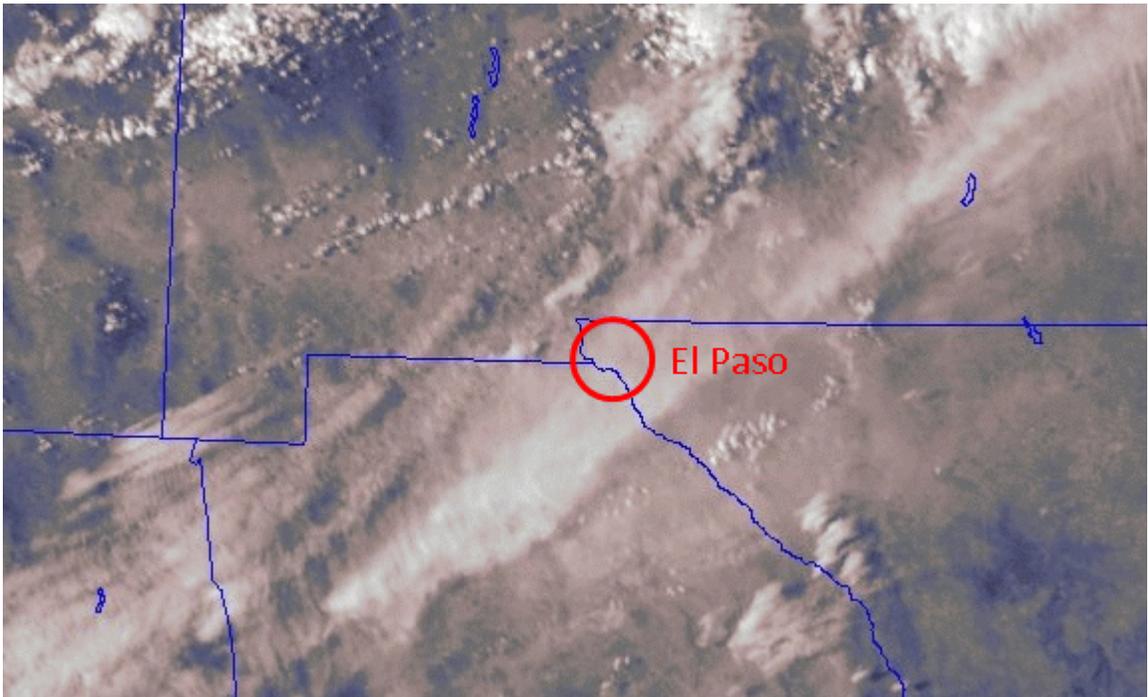


Figure D-6. GOES image for 1415 MST on March 7, 2011.

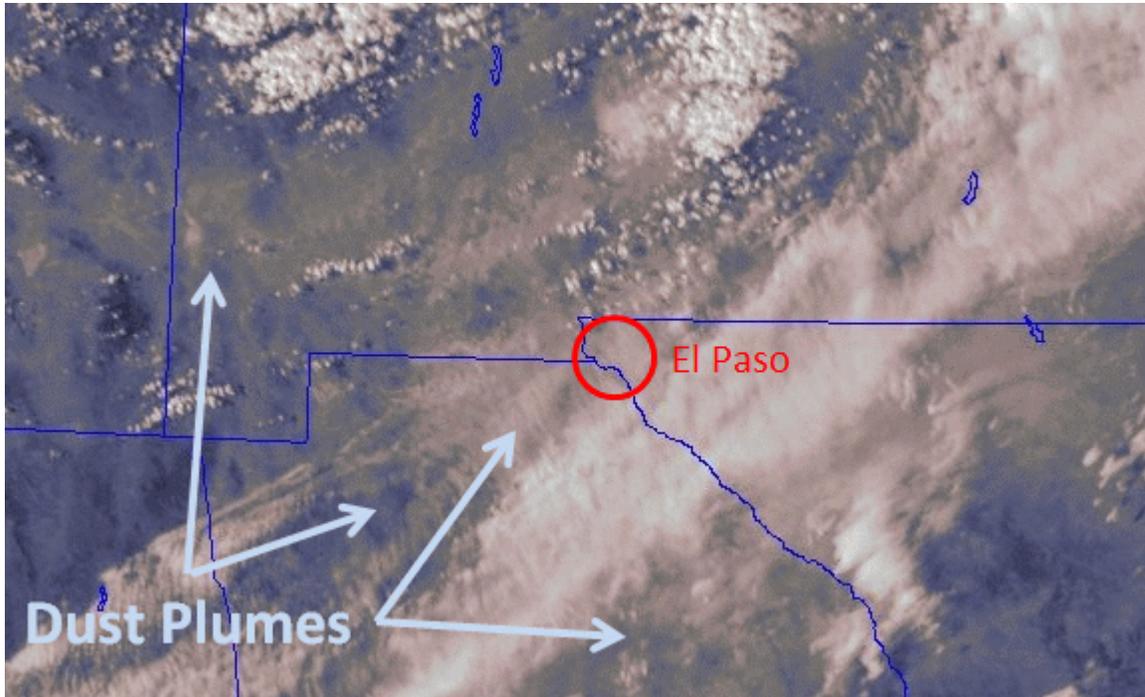


Figure D-7. GOES image for 1515 MST on March 7, 2011.

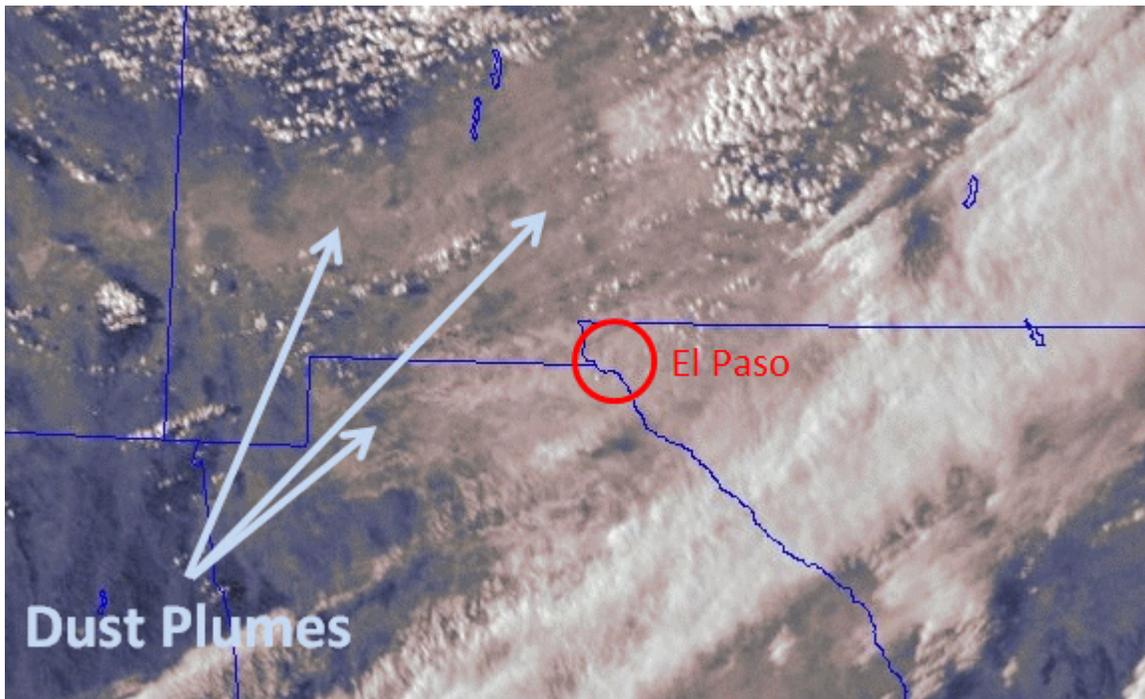


Figure D-8. GOES image for 1615 MST on March 7, 2011.

Back Trajectories

Figure D-9 provides HYSPLIT back trajectories that show the approximate path of air arriving at the Chamizal site at 1600 MST (2300 UTC) on March 7, 2011. Trajectory paths are plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours. These trajectories indicate that the air arriving at the Chamizal site at the time of the highest PM_{2.5} levels on March 7, 2011, originated from northern Mexico, as depicted in the satellite imagery.

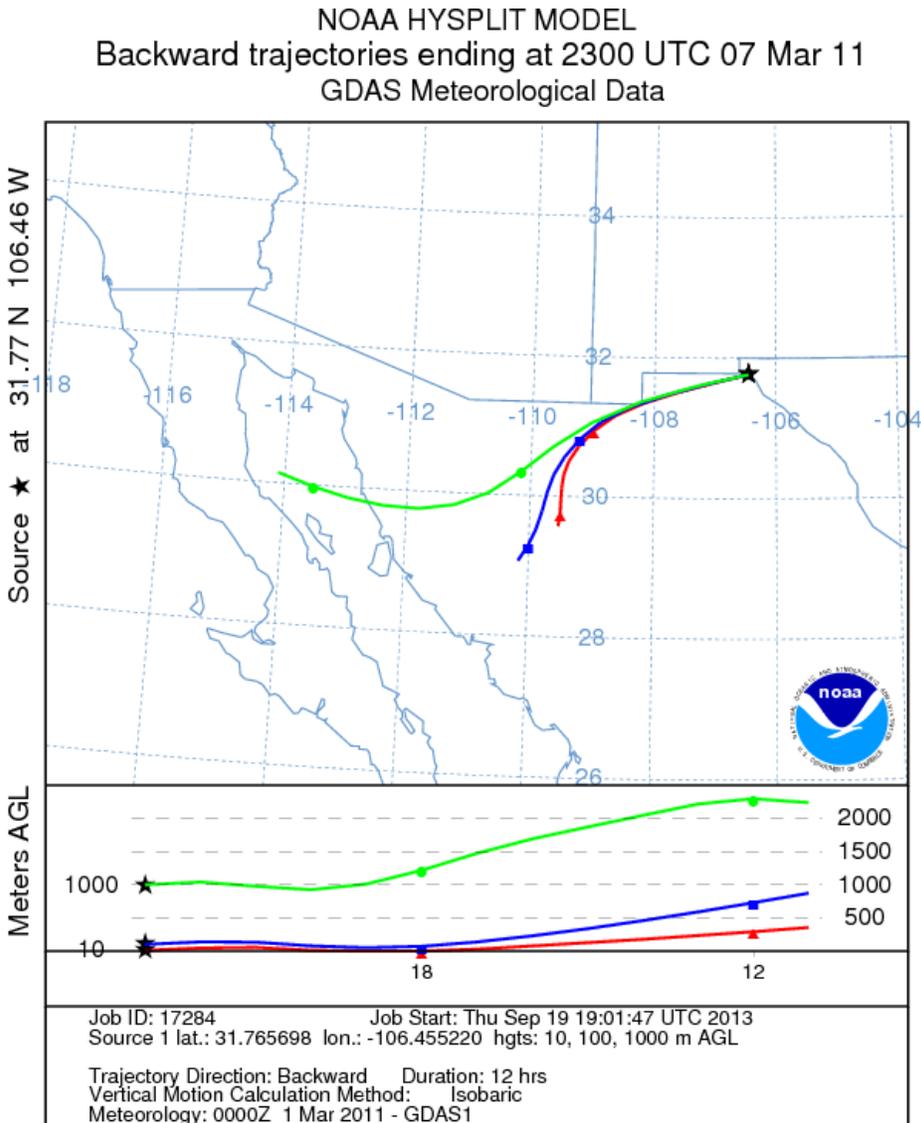


Figure D-9. Backward-in-time air trajectory for March 7, 2011 for air arriving at Chamizal at 1600 MST (2300 UTC).

Map Plots of Daily Particulate Matter Data

Maps of daily average PM₁₀ and PM_{2.5} measurements from the March 7, 2011, event illustrate the widespread impact of the event in the El Paso area. Figure D-10 shows the daily average PM_{2.5} measurements, including the Chamizal measurement proposed as an exceptional event, and Figure D-11 shows the daily average PM₁₀ measurements. Both maps show widespread high particulate matter concentrations along the border consistent with transport from northern Mexico.

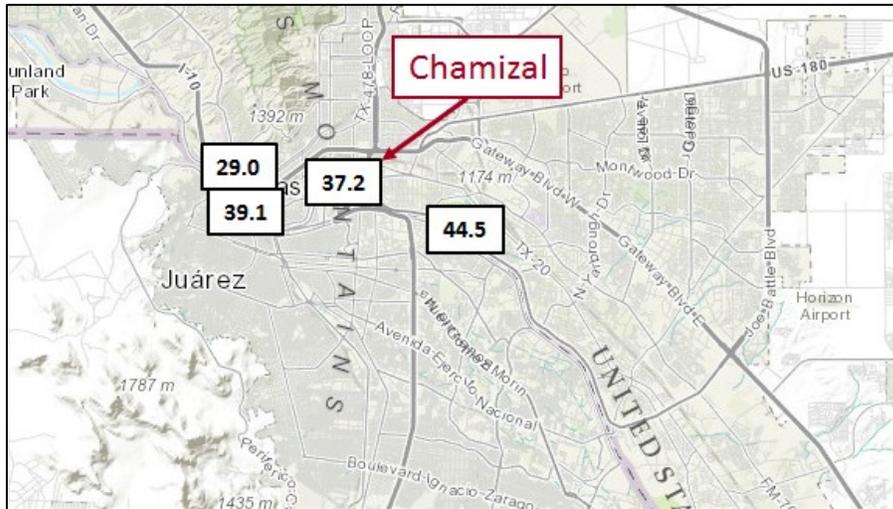


Figure D-10. Map of El Paso area daily average PM_{2.5} measurements (µg/m³ LC) on March 7, 2011.

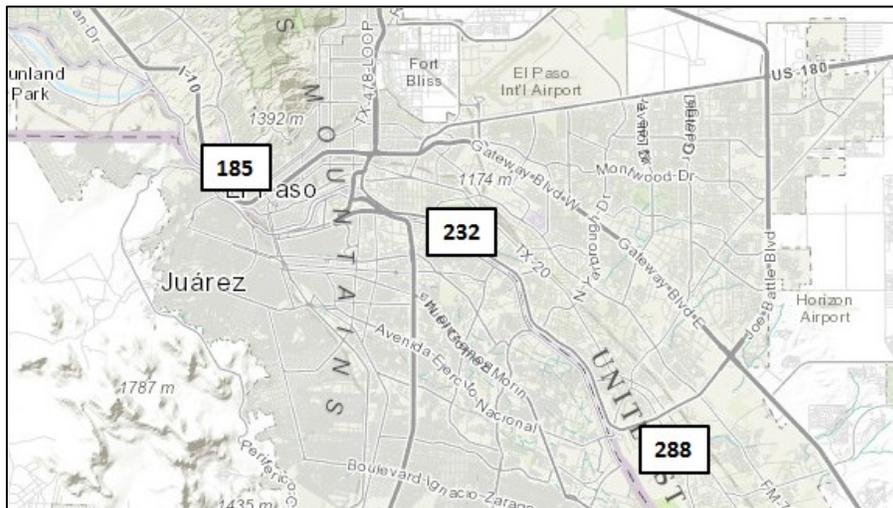


Figure D-11. Map of El Paso area daily average PM₁₀ measurements (µg/m³ SC) on March 7, 2011.

Continuous Particulate Matter and Wind Graphs

Graphs plotting five-minute continuous $PM_{2.5}$ and PM_{10} measurements against wind gust data for the March 7, 2011, event are provided in Figures D-12 and D-13. A plot of continuous five-minute $PM_{2.5}$ data in Figure D-12 illustrate the sharp rise at all three sites around 1300 MST with particulate matter levels remaining very high for the next five hours. This increase in particulate following a steady increase in peak wind gusts is consistent with the arrival and persistence of a large transported dust cloud.

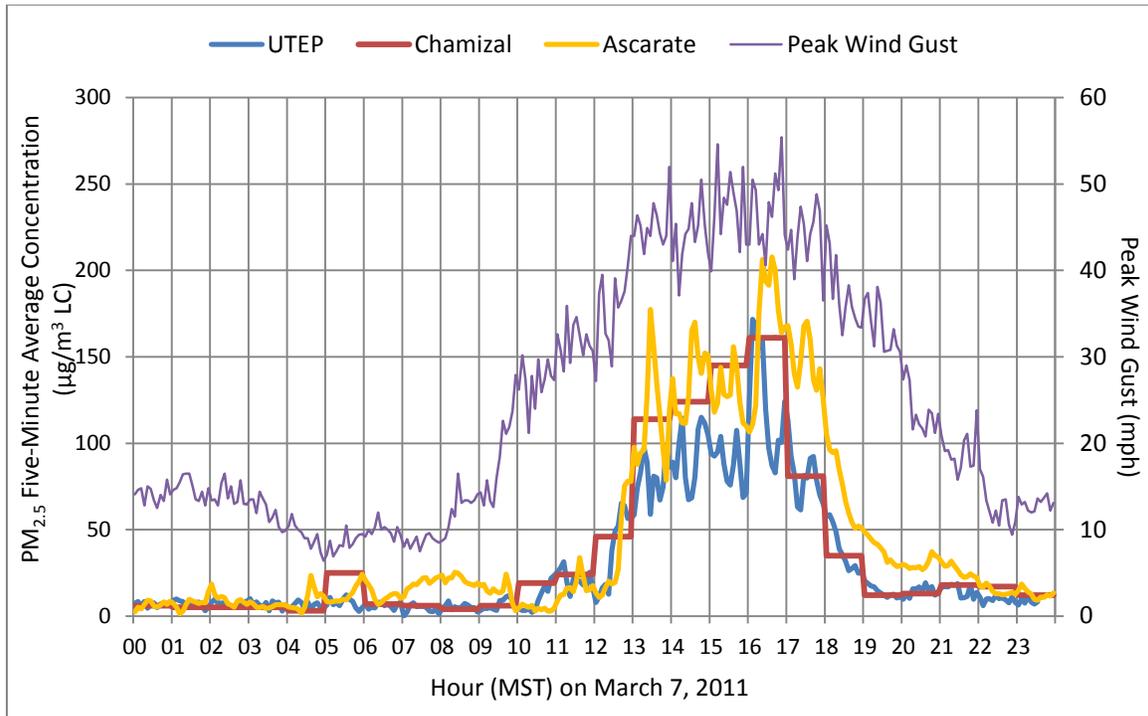


Figure D-12. El Paso five-minute average $PM_{2.5}$ concentrations from continuous monitors on March 7, 2011.

Figure D-13 plots continuous five-minute PM_{10} data from three sites in the El Paso area along with peak wind gusts. Again, the graphed data illustrate a sharp rise in PM_{10} at all three sites around 1300 MST, a couple of hours after peak wind gusts began to approach 30 mph. As peak wind gusts increased above 40 mph and persisted over the next five hours, particulate matter levels remained very high, consistent with the arrival of a large transported dust cloud.

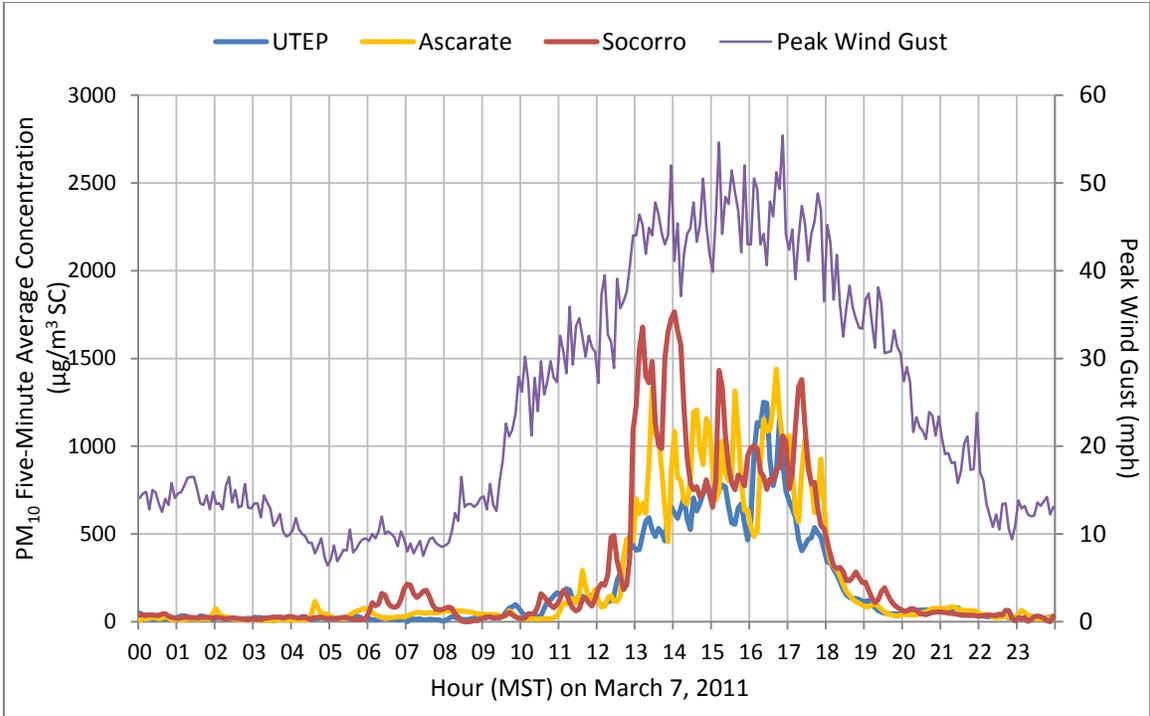


Figure D-13. El Paso five-minute average PM₁₀ concentrations from continuous monitors on March 7, 2011.

Appendix E: Event Analysis for April 3, 2011

Event Summary

A large low pressure system centered in southeastern Colorado brought strong west to southwest winds across a large region from New Mexico and Arizona into northern Mexico and West Texas on April 3, 2011. Figure E-1 shows a weather map for April 3, 2011, at 1400 MST provided by NOAA depicting the large low pressure system.

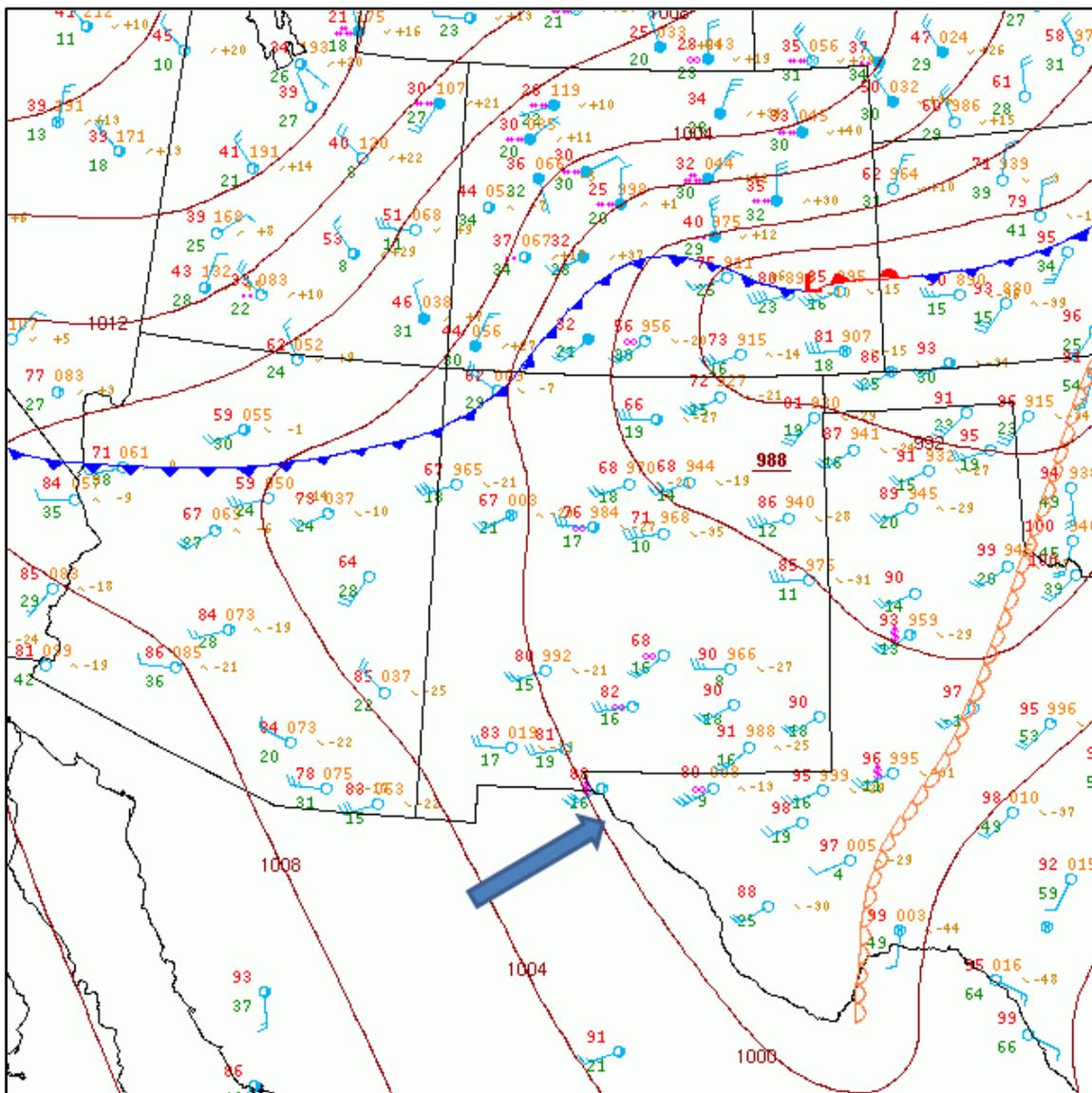


Figure E-1. Regional weather map for 1400 MST on April 3, 2011.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots and the wind speed is the sum of the values shown with the individual barbs. Wind direction in the El Paso area is indicated by a large arrow.

High winds associated with the large low pressure system generated a large area of blowing dust in northern Mexico that began impacting the El Paso area in the late morning and continued through the afternoon. High particulate matter concentrations were measured across the area from 1000 to 1900 MST, peaking from 1300 to 1400 MST. Area peak wind gusts reached 53 mph and peak sustained winds were up to 44 mph at the El Paso Airport.

An exceptional event flag is proposed for the Socorro FRM PM₁₀ measurement of 159 µg/m³ on this day. The collocated continuous PM₁₀ monitor measured a daily average of 167 µg/m³ and a peak one-hour average of 693 µg/m³ for the hour beginning 1300 MST. The hourly average PM₁₀ concentration was above the 24-hour NAAQS of 150 µg/m³ for nine hours beginning at 1000 MST and the average wind direction during this period was from 254 degrees (west-southwest) at an average speed of 17.2 mph. The peak measured wind gust at Socorro was 41.5 mph and the highest five-minute average wind speed was 24.1 mph.

Webcam Images

The El Paso Chelsea Street and Ranger Peak webcams provided visual images of the dust impacting the El Paso area on April 3, 2011. A map of the webcam locations was previously presented in Figure 13.

Figures E-2 and E-3 show the Chelsea Street and Ranger Peak webcam views at 0800 MST when dust levels were low compared to the 1400 MST view with intense blowing dust near the peak of the event. From both webcams, downtown El Paso and the Juarez Mountains are clearly visible in the 0800 MST frame, but are only dimly visible because of the intense blowing dust in the 1400 MST frame.



Figure E-2. El Paso Chelsea Street webcam images for 0800 MST (top) and 1400 MST (bottom) on April 3, 2011.



Figure E-3. El Paso Ranger Peak webcam images for 0800 MST (top) and 1400 MST (bottom) on April 3, 2011.

Satellite Imagery

Satellite imagery of the area in northern Mexico where the intense dust plumes were expected to have been generated were significantly obscured by heavy cloud cover on this day. Figure E-4 shows two true color composite MODIS visible wavelength images of the El Paso area on April 3, 2011, provided by the UW SSEC. The top image is from the Terra satellite at 1020 MST showing patchy clouds over northern Mexico with no visual evidence of dust. The bottom image shows the same view from the Aqua satellite at 1345 MST, however identification of dust plumes is difficult due to the presence of heavy cloud cover over most of the area. In Figure E-4 El Paso is circled in red in the upper right side of each image and the Texas and Mexico boundaries are marked by gray lines.

Figures E-5 through E-8 present a sequence of four GOES visible satellite images at one hour intervals from mid-day at 1315 MST through 1615 MST near sunset. The GOES images are not as high in resolution as the MODIS images but show the same heavy cloud cover obscuring the area where dust plumes are expected in northern Mexico.

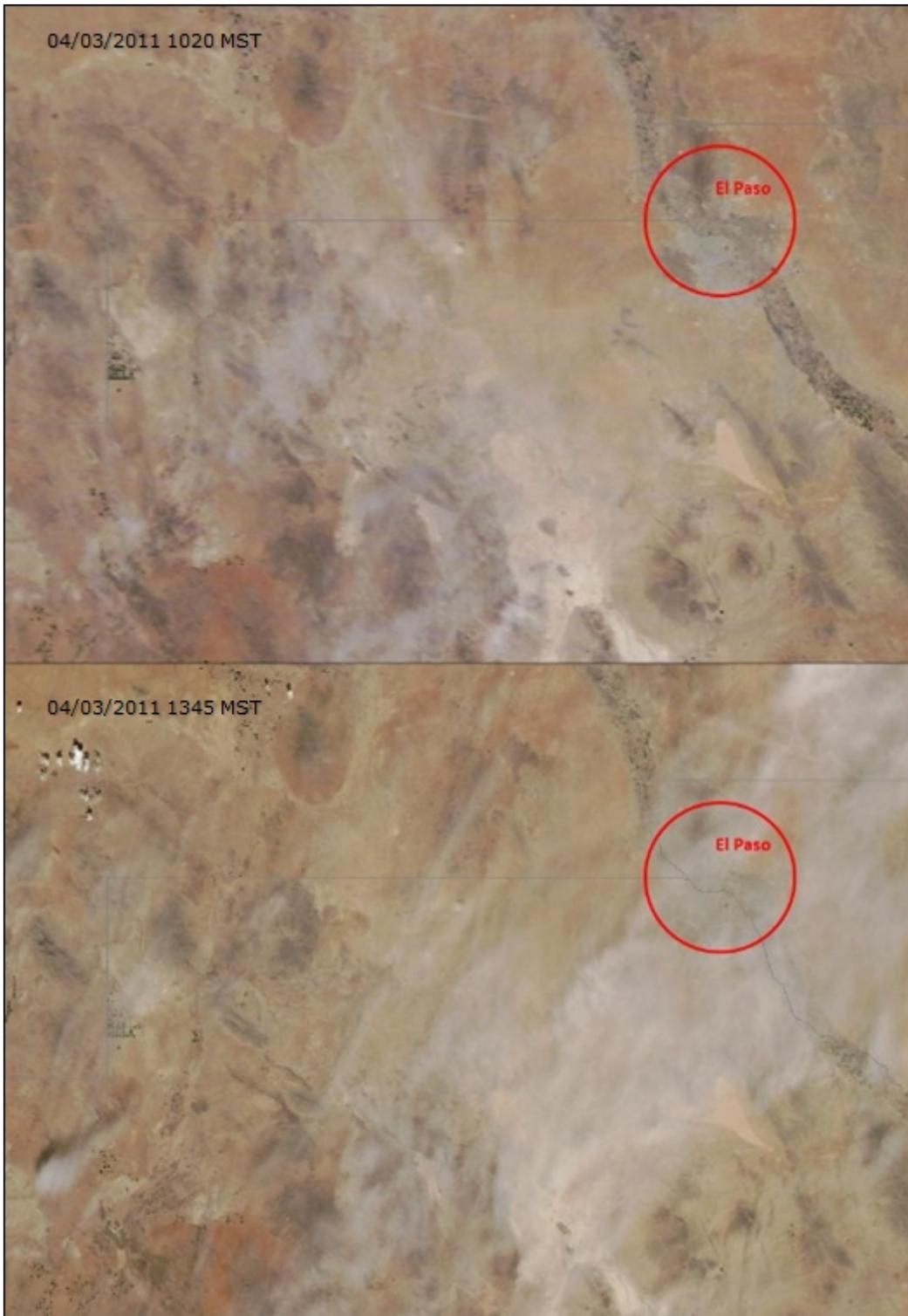


Figure E-4. True color Terra satellite image at 1020 MST in top frame showing patchy clouds but no evidence of early blowing dust on April 3, 2011, and in the bottom frame a later true color image from the Aqua satellite at 1345 MST showing widespread cloud cover obscuring the view over the expected blowing dust area in northern Mexico.



Figure E-5. GOES image for 1315 MST on April 3, 2011.



Figure E-6. GOES image for 1415 MST on April 3, 2011.

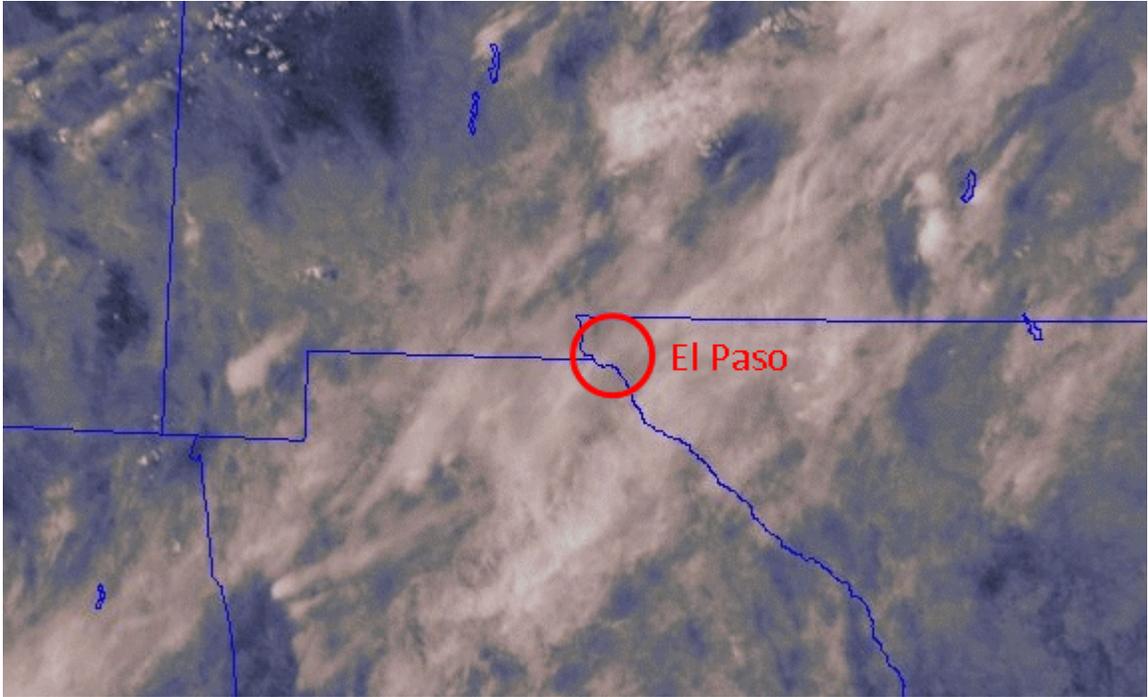


Figure E-7. GOES image for 1515 MST on April 3, 2011.

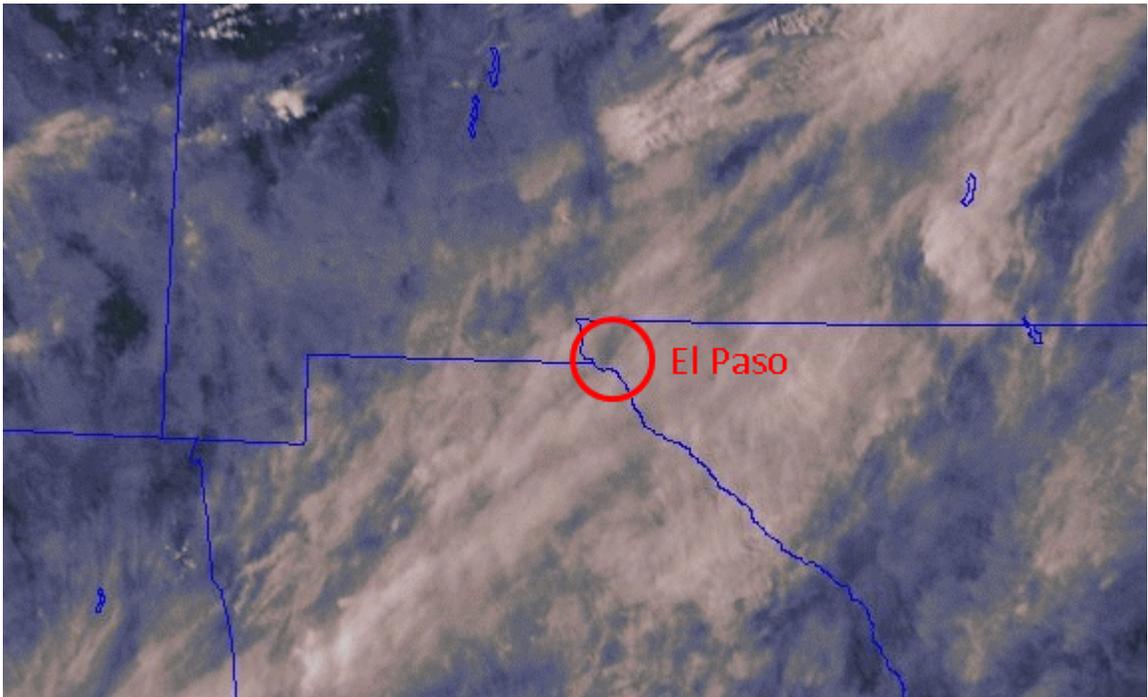


Figure E-8. GOES image for 1615 MST on April 3, 2011.

Back Trajectories

Figure E-9 provides HYSPLIT back trajectory paths plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours showing the approximate path for air arriving at the Socorro site at 1300 MST (2000 UTC) on April 3, 2011. These trajectories provide evidence that the air arriving at the Socorro site at the time of the highest PM₁₀ levels on April 3, 2011, originated from northern Mexico.

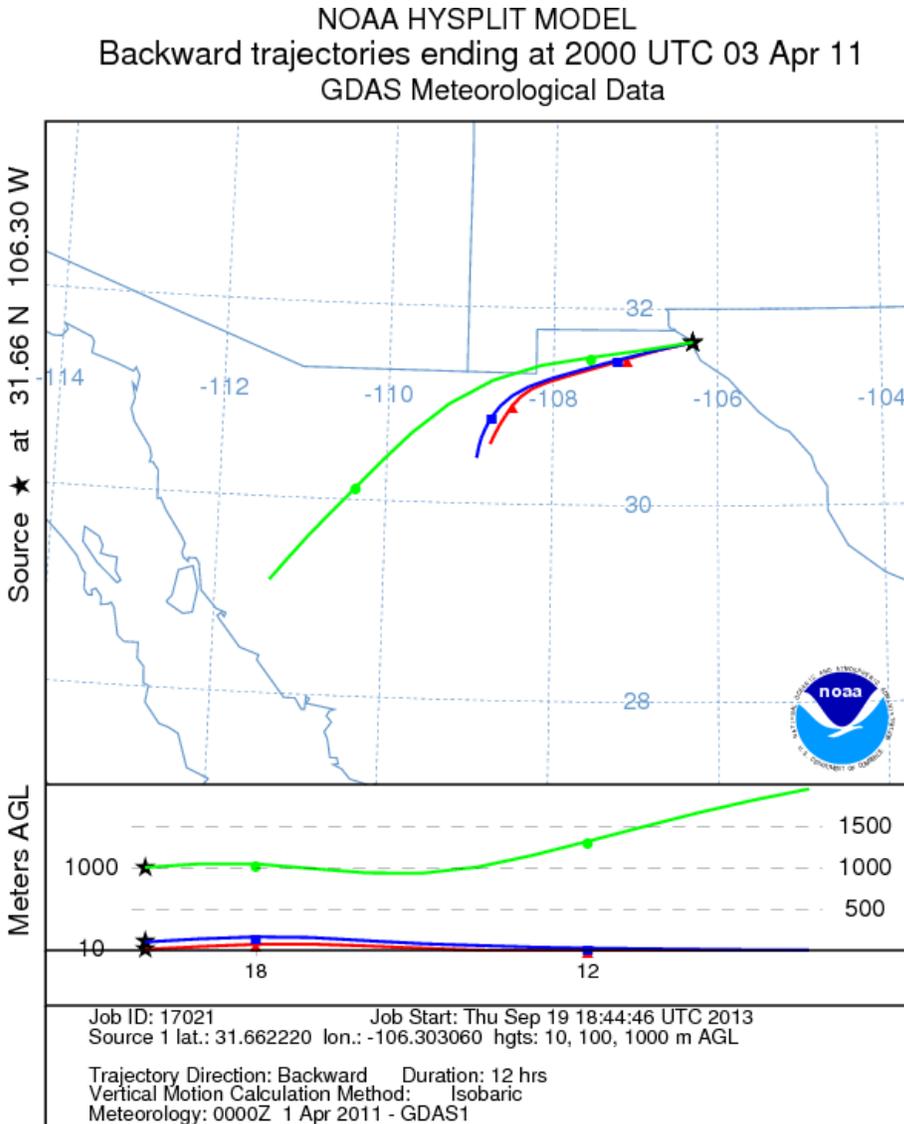


Figure E-9. Backward-in-time air trajectory for April 3, 2011, for air arriving at Socorro at 1300 MST (2000 UTC).

Map Plots of Daily Particulate Matter Data

The following maps display daily average PM₁₀ and PM_{2.5} measurements from the April 3, 2011, event. Figure E-10 shows the daily average PM_{2.5} measurements, while Figure E-11 shows the daily average PM₁₀ measurements, including the Socorro measurement proposed as an exceptional event. The highest PM₁₀ measurements were at sites in Mexico upwind of Socorro, indicating transport of very high incoming background levels from the west and southwest.

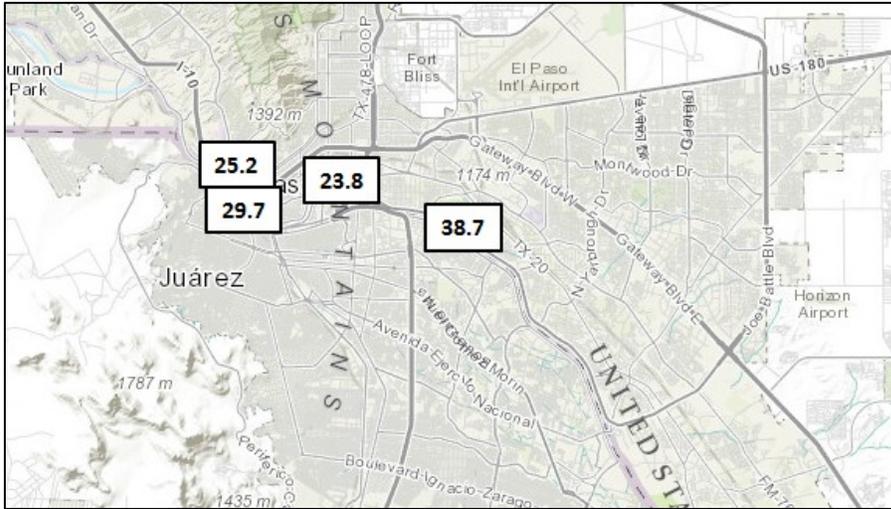


Figure E-10. Map of El Paso area daily average PM_{2.5} measurements ($\mu\text{g}/\text{m}^3$ LC) on April 3, 2011.

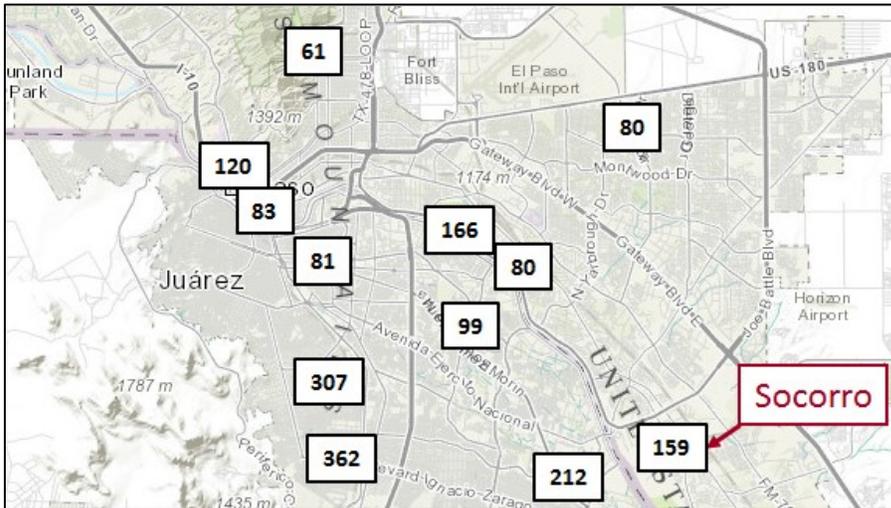


Figure E-11. Map of El Paso area daily average PM₁₀ measurements ($\mu\text{g}/\text{m}^3$ SC) on April 3, 2011.

Continuous Particulate Matter and Wind Graphs

Graphs of five-minute continuous $PM_{2.5}$, PM_{10} , and wind gust data for the April 3, 2011, event are provided in Figures E-12 and E-13. A plot of continuous five-minute $PM_{2.5}$ data show a gradual rise at all three sites tracking with the steady increase in peak wind gusts. The highest measured concentration at Chamizal was for the hour beginning 1500 MST when peak wind gusts reached almost 50 mph.

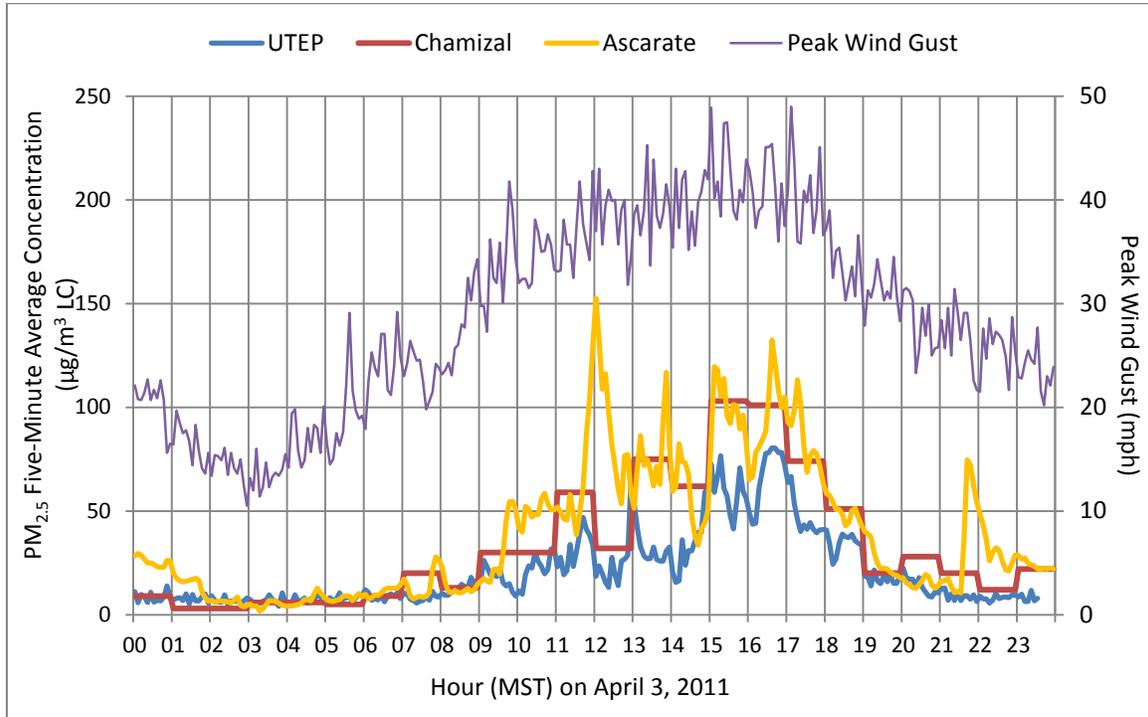


Figure E-12. El Paso five-minute average $PM_{2.5}$ concentrations from continuous monitors on April 3, 2011.

Figure E-13 plots continuous five-minute PM_{10} data from three sites in the El Paso area against peak wind gusts. The plotted data show a gradual rise in PM_{10} in the morning with a sharp rise and peak at Socorro around 1300 MST, roughly an hour after peak wind gusts had begun to exceed 40 mph. The timing of this sharp rise is consistent with the arrival of a transported dust plume.

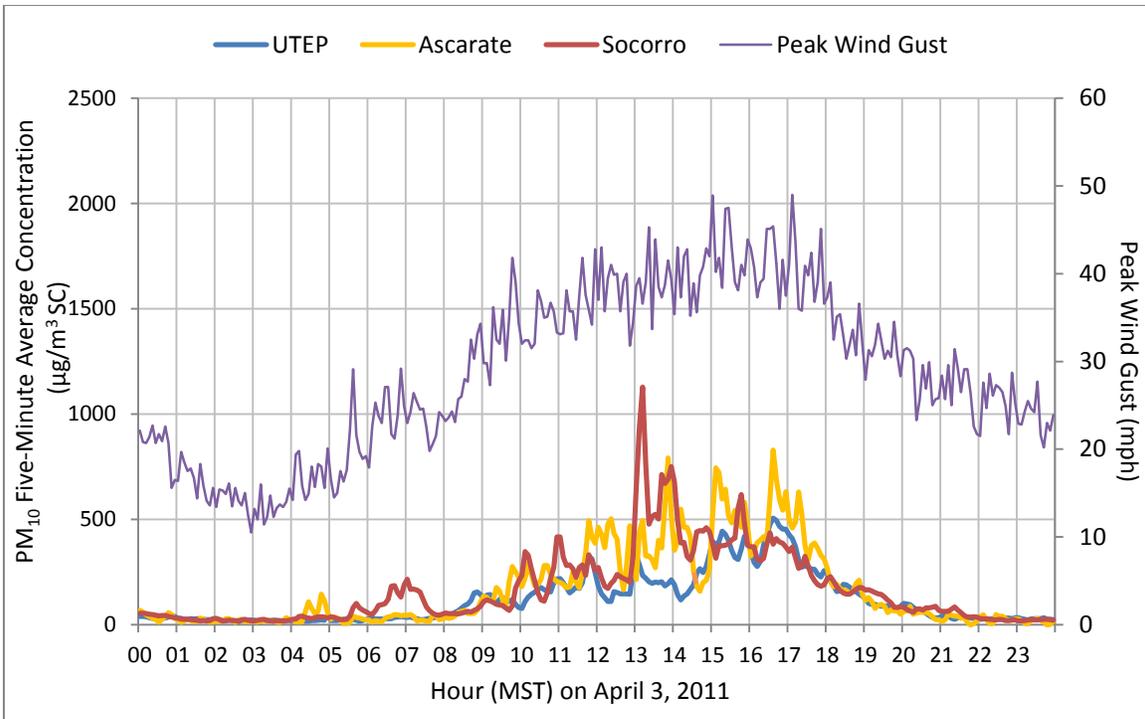


Figure E-13. El Paso five-minute average PM₁₀ concentrations from continuous monitors on April 3, 2011.

Appendix F: Event Analysis for April 9, 2011

Event Summary

A large low pressure system centered in Colorado brought strong southwest winds across a large region from Colorado through New Mexico into northern Mexico and West Texas on April 9, 2011. Figure F-1 shows a weather map for April 9, 2011, at 1400 MST provided by NOAA depicting the large low pressure system.

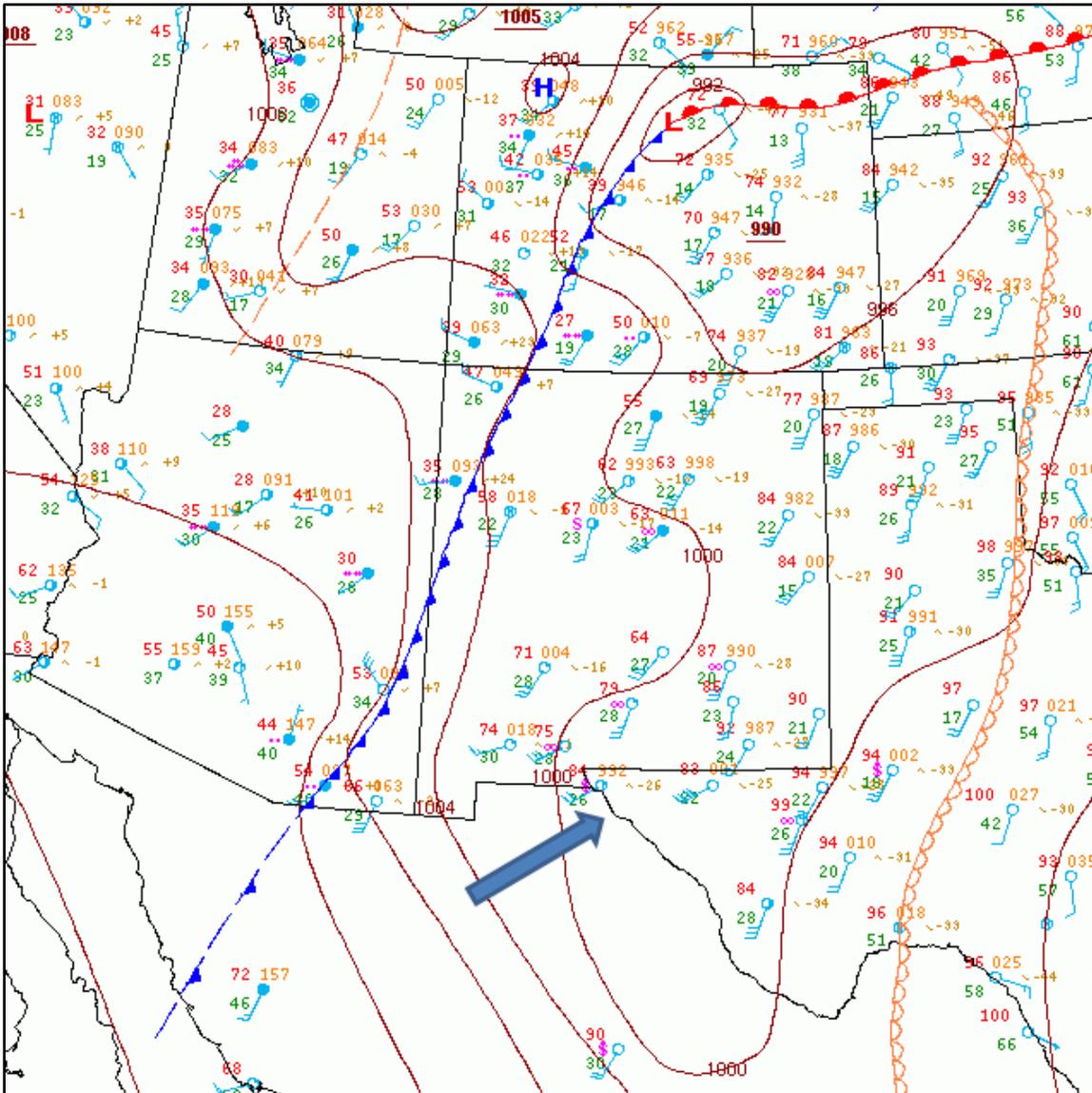


Figure F-1. Regional weather map for 1400 MST on April 9, 2011.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots and the wind speed is the sum of the values shown with the individual barbs. Wind direction in the El Paso area is indicated by a large arrow.

High winds associated with the low pressure system generated a large area of blowing dust in northern Mexico that began impacting the El Paso area in the late morning and reached peak intensity in the afternoon with a pronounced, very intense peak at all sites for the hour beginning 1700 MST. Area peak wind gusts reached 47 mph and peak sustained winds were up to 38 mph at the El Paso Airport.

An exceptional event flag is proposed for the Chamizal FRM PM_{2.5} measurement of 38.5 µg/m³ on this day. The collocated continuous FEM PM_{2.5} monitor measured a daily average of 33.8 µg/m³ and a peak one-hour average of 112 µg/m³ for the hour beginning at 1700 MST. The hourly average PM_{2.5} concentration was above the 24-hour NAAQS of 35 µg/m³ for seven hours beginning at 1400 MST and the average wind direction during this period was from 265 degrees (slightly south of west) at an average speed of 22.6 mph. The peak measured wind gust at Chamizal was 46.3 mph and the highest five-minute average wind speed was 31.6 mph.

An exceptional event flag is also proposed for the UTEP FRM PM_{2.5} measurement of 48.7 µg/m³ on this day. The collocated continuous acceptable PM_{2.5} monitor measured a daily average of 28.5 µg/m³ and a peak one-hour average of 92.3 µg/m³ for the hour beginning at 1700 MST. The hourly average PM_{2.5} concentration was above the 24-hour NAAQS of 35 µg/m³ for six hours beginning at 1400 MST and the average wind direction during this period was from 267 degrees (slightly south of west) at an average speed of 15.0 mph. The peak measured wind gust at UTEP was 40.6 mph and the highest five-minute average wind speed was 22.5 mph.

An exceptional event flag is also proposed for the Socorro FRM PM₁₀ measurement of 169 µg/m³ on this day. The collocated continuous PM₁₀ monitor measured a daily average of 171 µg/m³ and a peak one-hour average of 444 µg/m³ for the hour beginning 1500 MST. The hourly average PM₁₀ concentration was above the 24-hour NAAQS of 150 µg/m³ for ten hours beginning at 1100 MST and the average wind direction during this period was from 251 degrees (west-southwest) at an average speed of 15.8 mph. The peak measured wind gust at

Socorro was 38.5 mph and the highest five-minute average wind speed was 22.6 mph.

Webcam Images

The El Paso Chelsea Street and Ranger Peak webcams provided visual images of the dust impacting the El Paso area on April 9, 2011. A map of the webcam locations was previously presented in Figure 13.

Figure F-2 shows the Chelsea Street webcam view at 0900 MST when dust levels were low compared to the 1600 MST view with intense blowing dust near the peak of the event. From the Chelsea Street webcam, downtown El Paso and the Juarez Mountains are clearly visible in the 0900 MST frame, but are totally obscured from the intense blowing dust in the 1600 MST frame.

Similarly, Figure F-3 compares the Ranger Peak webcam view before and during the dust event. In the images, downtown El Paso and the Juarez Mountains are clearly visible in the 0900 MST frame, but are partially obscured by intense blowing dust in the 1430 MST frame. No webcam images were available from the Ranger Peak webcam after 1430 MST on this day.



Figure F-2. El Paso Chelsea Street webcam images for 0900 MST (top) and 1600 MST (bottom) on April 9, 2011.



Figure F-3. El Paso Ranger Peak webcam images for 0900 MST (top) and 1430 MST (bottom) on April 9, 2011.

Satellite Imagery

Satellite imagery visibly shows intense dust plumes originating in northern Mexico and blowing east-northeastward into the El Paso area on this event day. Figure F-4 shows two true color composite MODIS visible wavelength images of the El Paso area on April 9, 2011, provided by the UW SSEC. The top image, from the Terra satellite at 1120 MST, shows numerous large dust plumes developing early in northern Mexico. The bottom image is the same view from the Aqua satellite at 1305 MST showing the same large dust plumes beginning to spread into the El Paso area. In Figure F-4 El Paso is circled in red in the upper right side of each image and the Texas and Mexico boundaries are marked by gray lines.

A sequence of six GOES visible satellite images from mid-day at 1215 MST through 1745 MST near sunset are presented in Figures F-5 through F-10. In these images, the clouds are bright white with sharp edges casting shadows and dust appears light brown with less distinct edges. The GOES images are not as high in resolution as the MODIS images but show numerous large blowing dust plumes developing early in northern Mexico, spreading northeastward in the afternoon, and merging into a large dust cloud enveloping much of northern Mexico, southern New Mexico, and far West Texas, including the El Paso area by sunset.

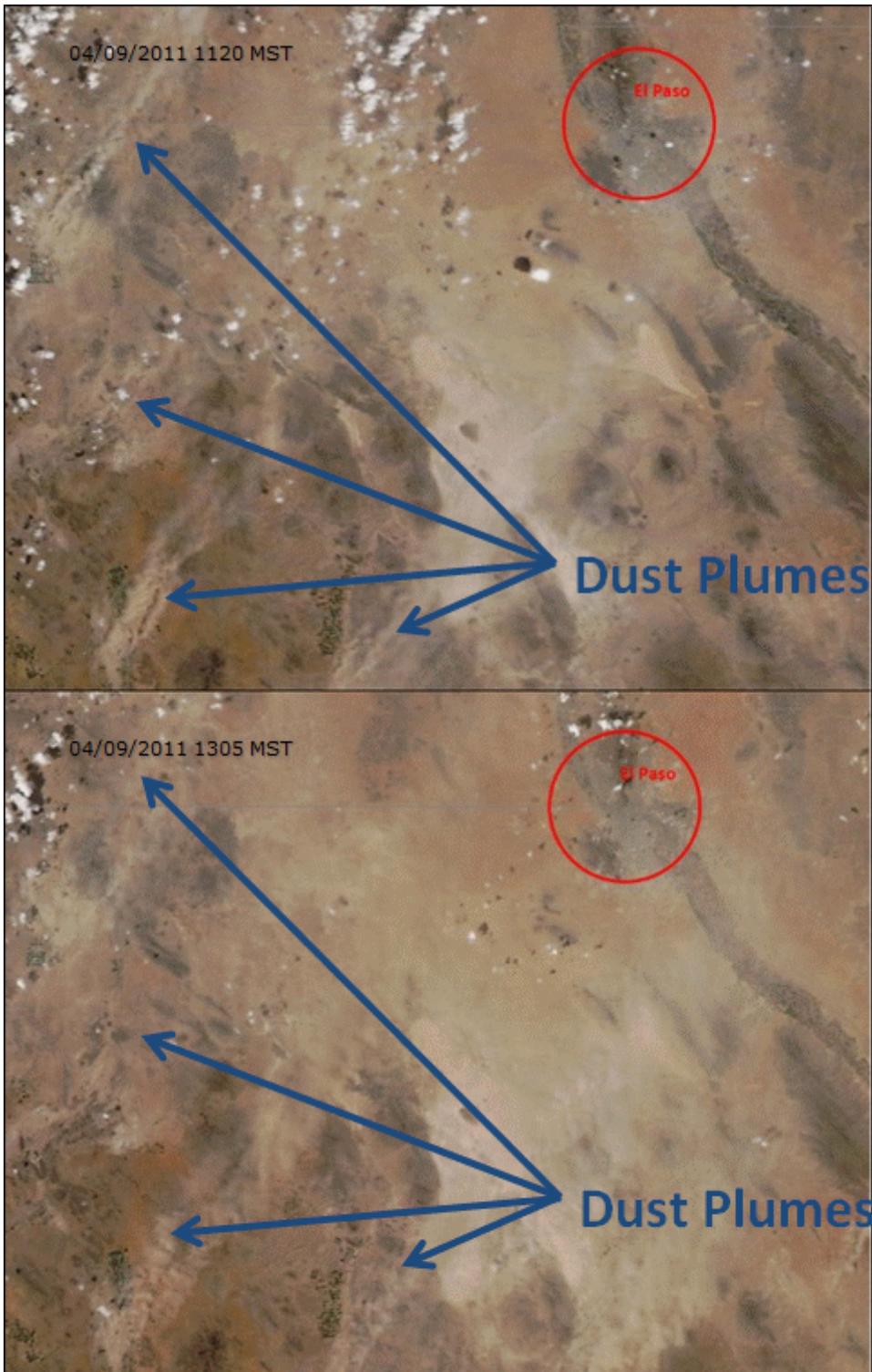


Figure F-4. True color Terra satellite image at 1120 MST in top frame showing numerous large blowing dust plumes in northern Mexico early on April 9, 2011, and in the bottom frame a later true color image from the Aqua satellite at 1305 MST showing the dust plumes reaching the El Paso area.

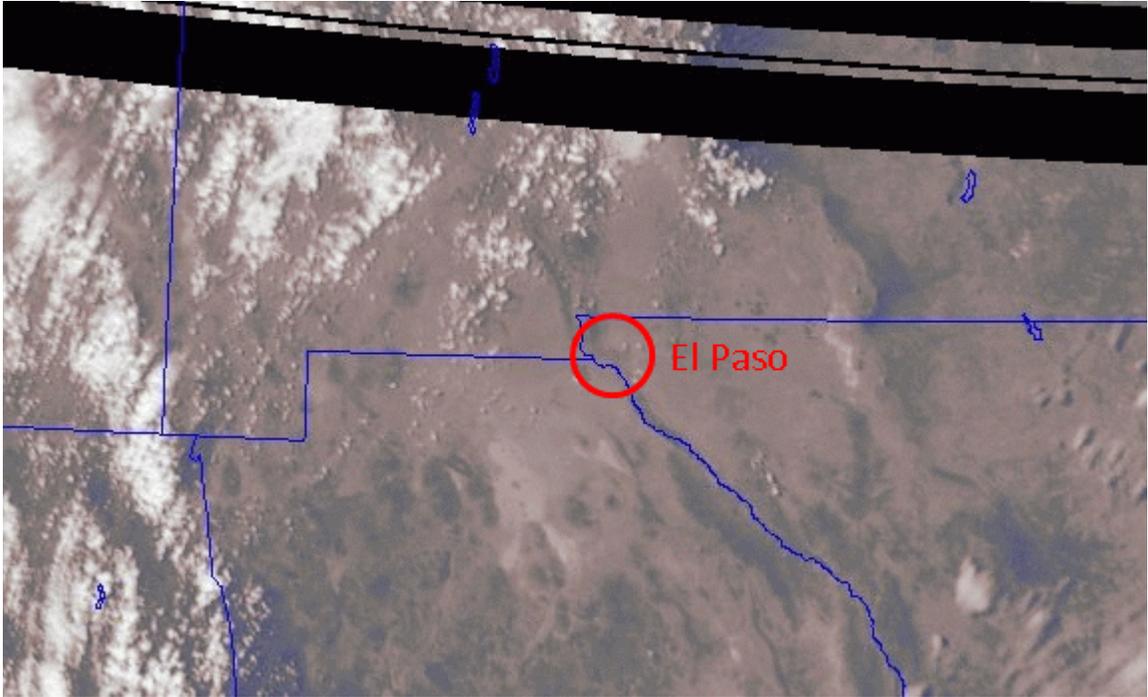


Figure F-5. GOES image for 1215 MST on April 9, 2011.

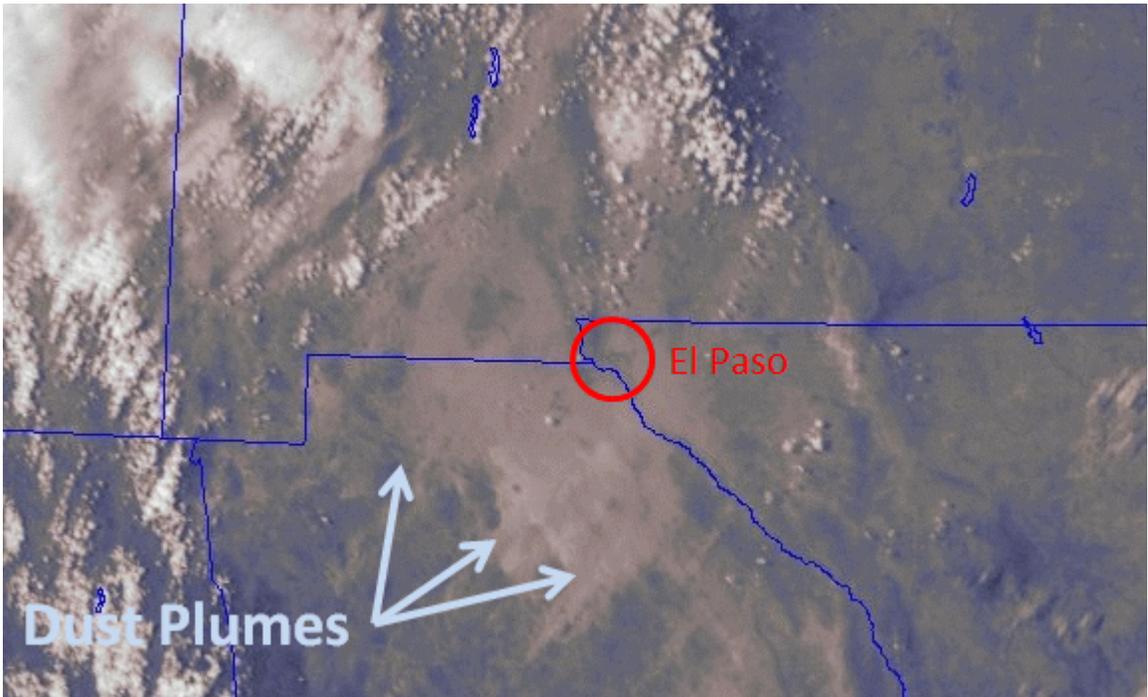


Figure F-6. GOES image for 1315 MST on April 9, 2011.

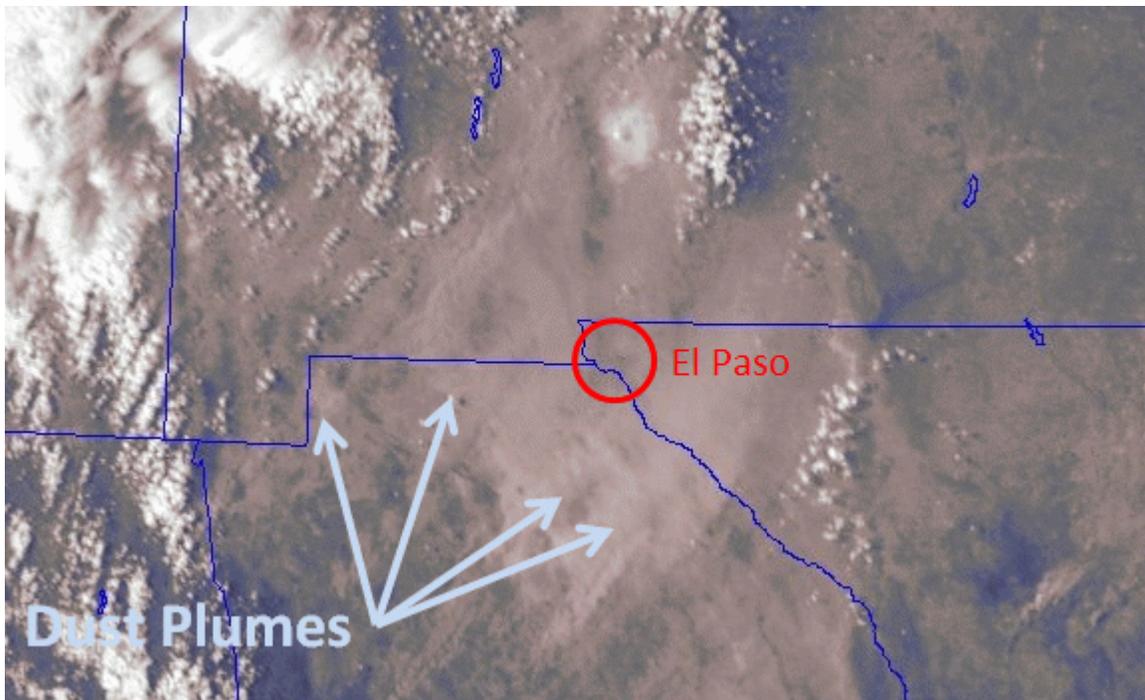


Figure F-7. GOES image for 1415 MST on April 9, 2011.

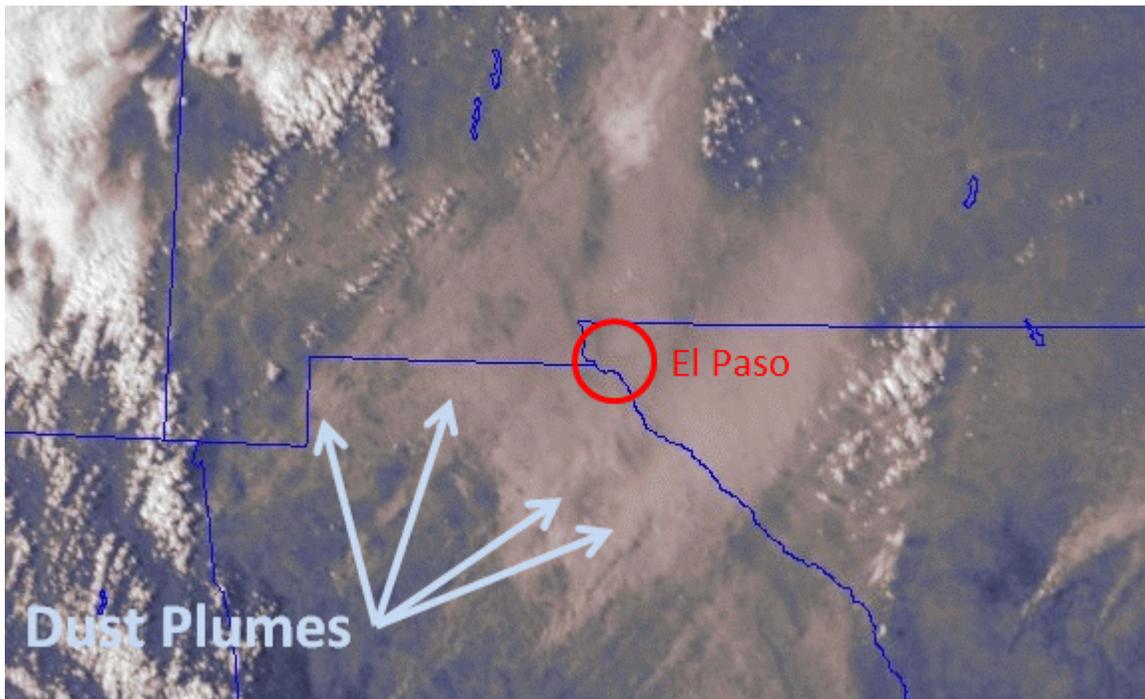


Figure F-8. GOES image for 1515 MST on April 9, 2011.

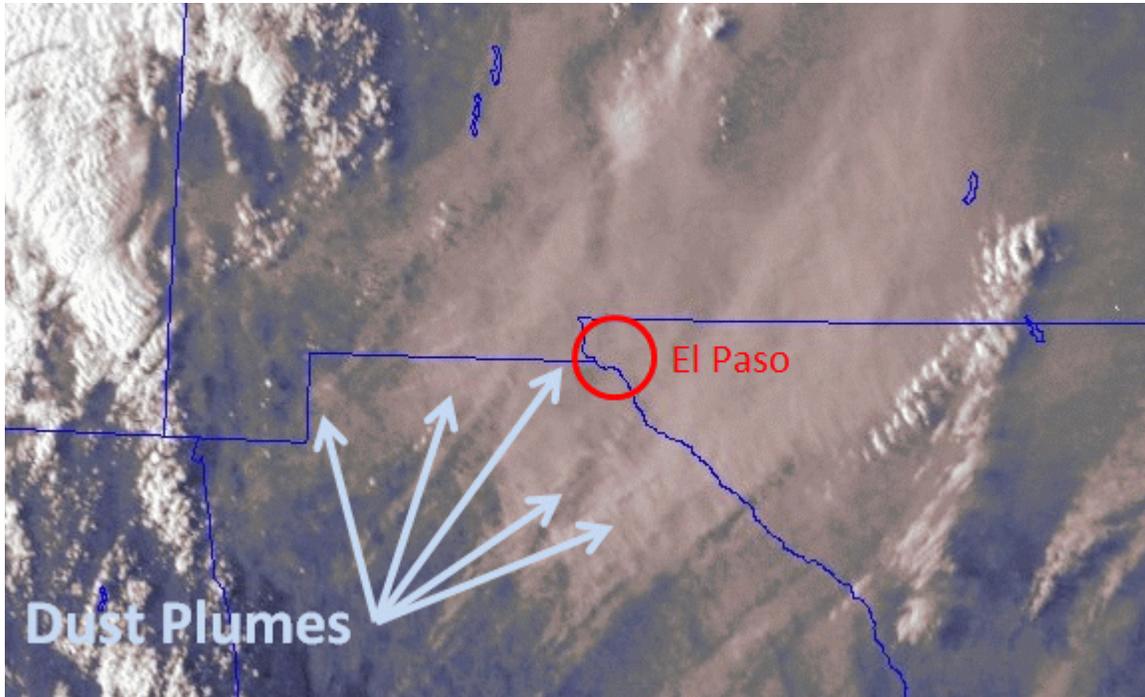


Figure F-9. GOES image for 1645 MST on April 9, 2011.

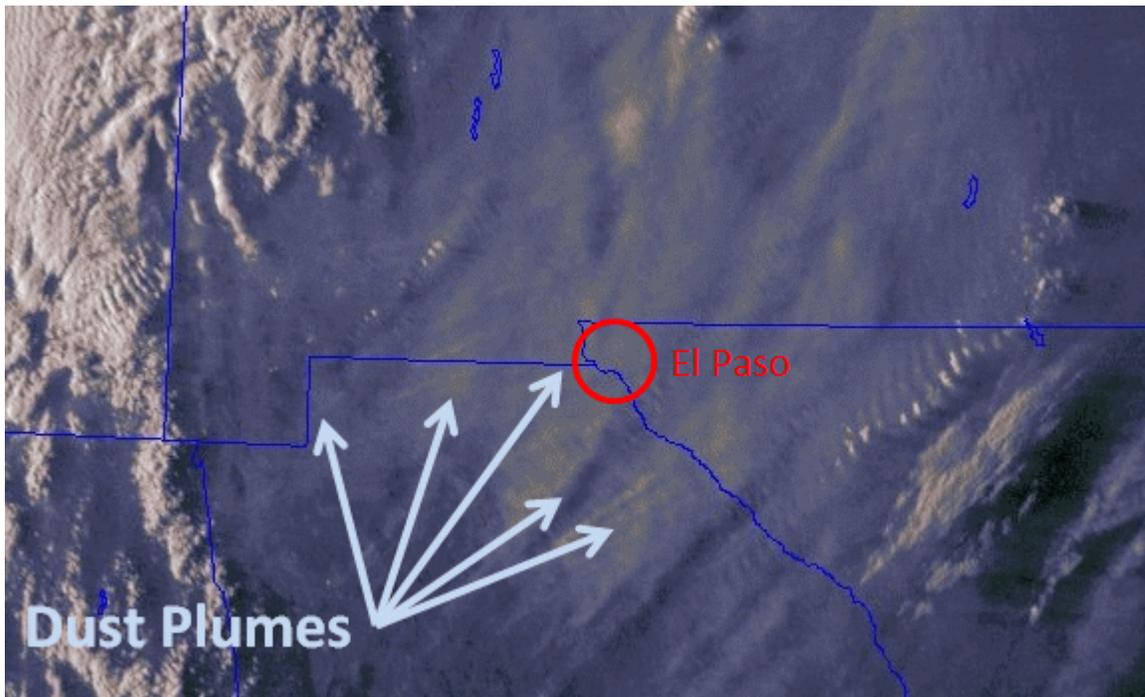


Figure F-10. GOES image for 1745 MST on April 9, 2011.

Back Trajectories

Figures F-11 and F-12 provide HYSPLIT back trajectories predicting the approximate path of air arriving at the Chamizal and UTEP sites at 1700 MST (2400 UTC) on April 9, 2011. Similarly, Figure F-13 displays the modeled back trajectory for the path of air arriving at the Socorro site at 1500 MST (2200 UTC) on April 9, 2011. Trajectory paths are plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours. These trajectories indicate that the air arriving at these sites at the time of the highest PM_{2.5} levels on April 9, 2011, originated in northern Mexico as indicated by satellite imagery.

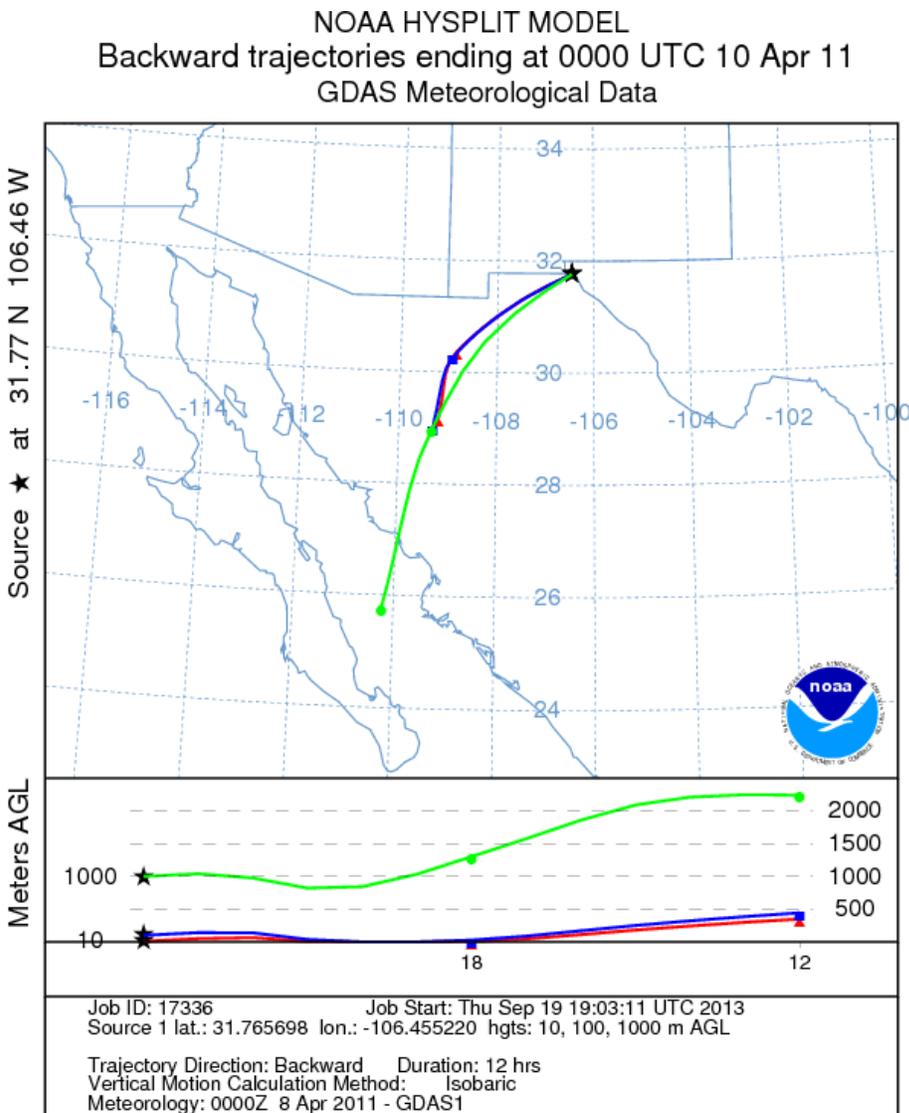


Figure F-11. Backward-in-time air trajectory for April 9, 2011, for air arriving at Chamizal at 1700 MST (0000 UTC on April 10, 2011).

NOAA HYSPLIT MODEL
 Backward trajectories ending at 0000 UTC 10 Apr 11
 GDAS Meteorological Data

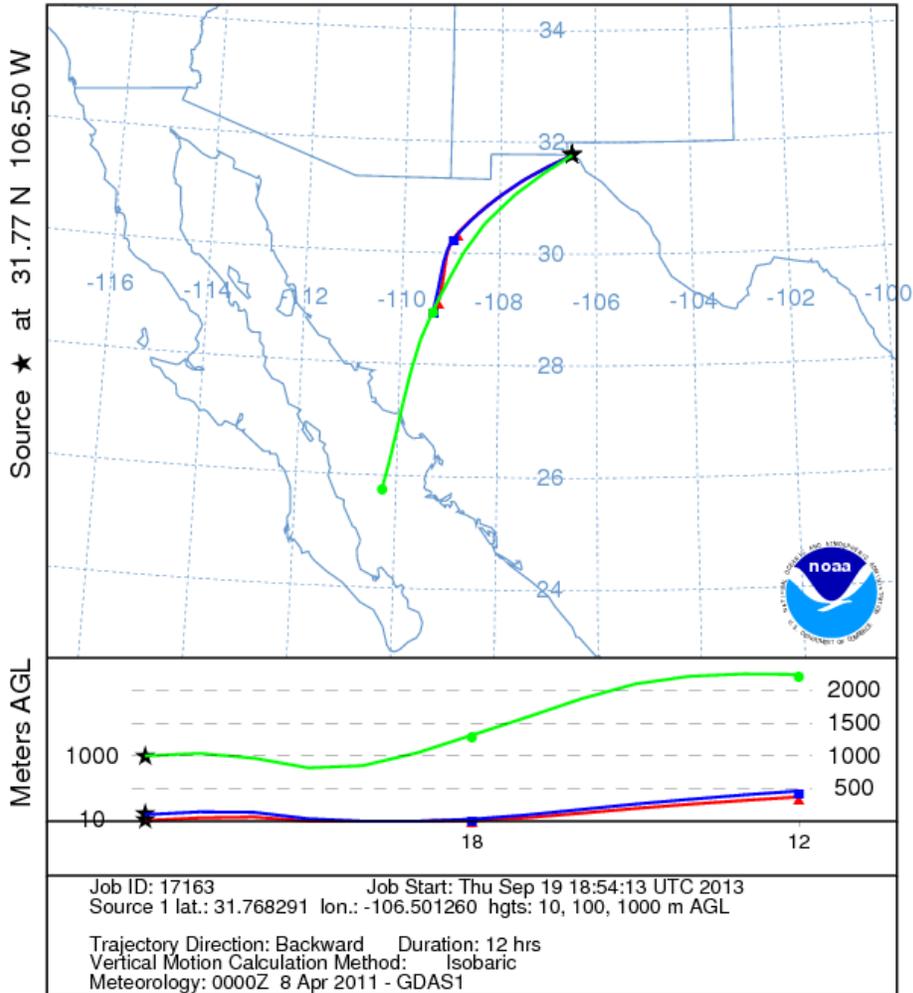


Figure F-12. Backward-in-time air trajectory for April 9, 2011, for air arriving at UTEP at 1700 MST (0000 UTC on April 10, 2011).

NOAA HYSPLIT MODEL
 Backward trajectories ending at 2200 UTC 09 Apr 11
 GDAS Meteorological Data

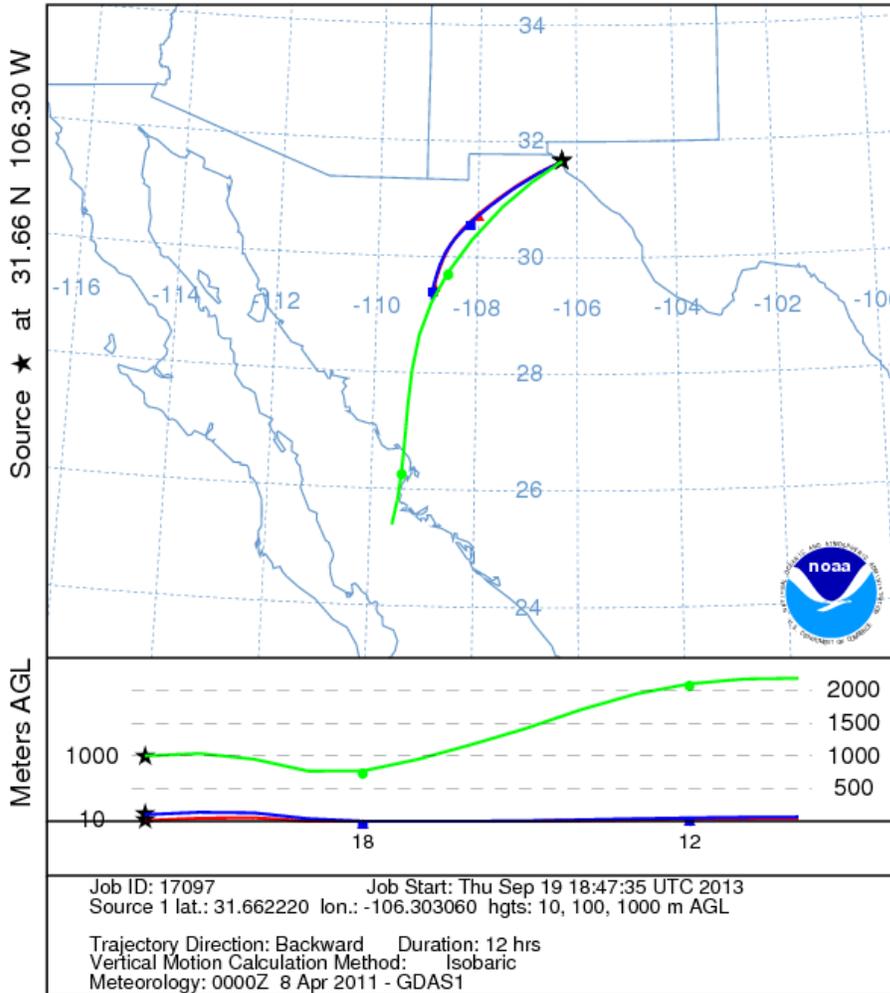


Figure F-13. Backward-in-time air trajectory for April 9, 2011, for air arriving at Socorro at 1500 MST (2200 UTC).

Map Plots of Daily Particulate Matter Data

The following maps show daily average PM₁₀ and PM_{2.5} measurements from the April 9, 2011, event. Figure F-14 displays the daily average PM_{2.5} measurements, including the Chamizal and UTEP measurements proposed as an exceptional events. Figure F-15 shows the daily average PM₁₀ measurements, including the Socorro measurement proposed as an exceptional event. The highest PM₁₀ measurements recorded on this day were at upwind sites in Mexico indicating transport of very high incoming background levels from west to east.

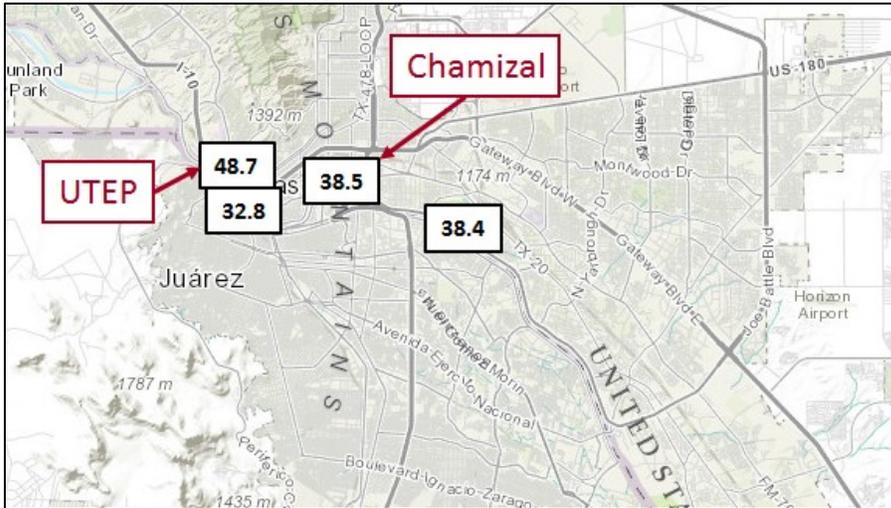


Figure F-14. Map of El Paso area daily average PM_{2.5} measurements (µg/m³ LC) on April 9, 2011.

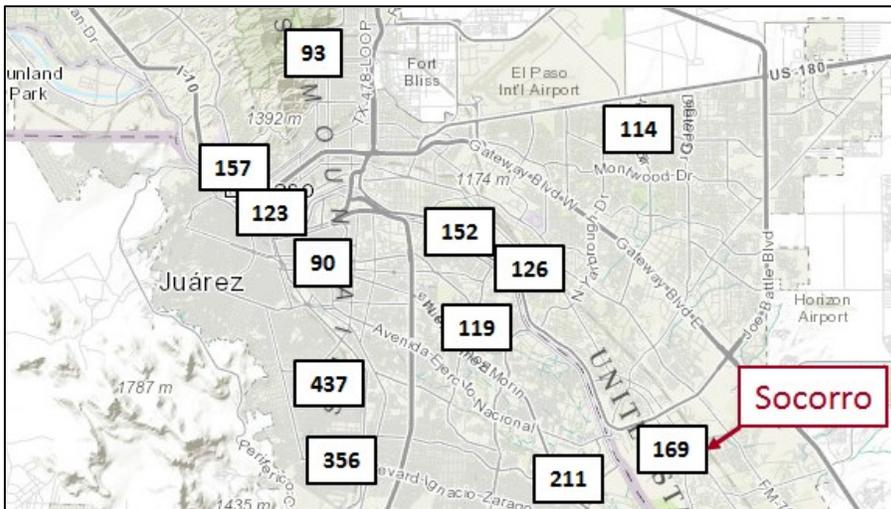


Figure F-15. Map of El Paso area daily average PM₁₀ measurements (µg/m³ SC) on April 9, 2011.

Continuous Particulate Matter and Wind Graphs

Figures F-16 and F-17 plot five-minute continuous $PM_{2.5}$, PM_{10} , and wind gust data for the April 9, 2011, event. A plot of continuous five-minute $PM_{2.5}$ data in Figure F-16 indicates a sharp rise in measured concentrations beginning at about 1300 MST with very high concentrations for about five hours beginning at 1400 MST. This sharp increase occurs several hours after a sustained increase in peak wind gusts consistent with the passage of a large dust cloud transported from many miles away.

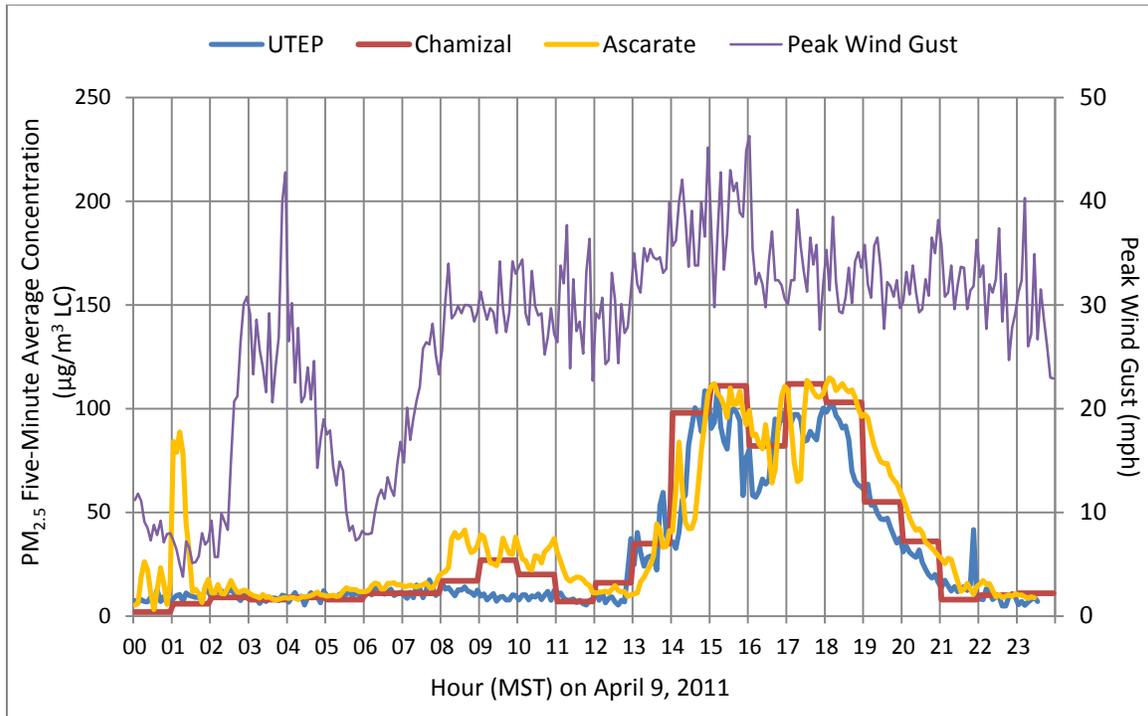


Figure F-16. El Paso five-minute average $PM_{2.5}$ concentrations from continuous monitors on April 9, 2011.

Figure F-17 plots continuous five-minute PM_{10} data against peak wind gusts from three sites in the El Paso area. The graphed measurements show a sharp peak around 1100 MST at Socorro indicative of the passage of a narrow but intense dust plume followed by a larger transported dust cloud affecting all three sites in the afternoon. As with the $PM_{2.5}$, the timing of the increase in measured concentrations compared with increases in the peak wind gusts is consistent with the passage of a large transported dust cloud.

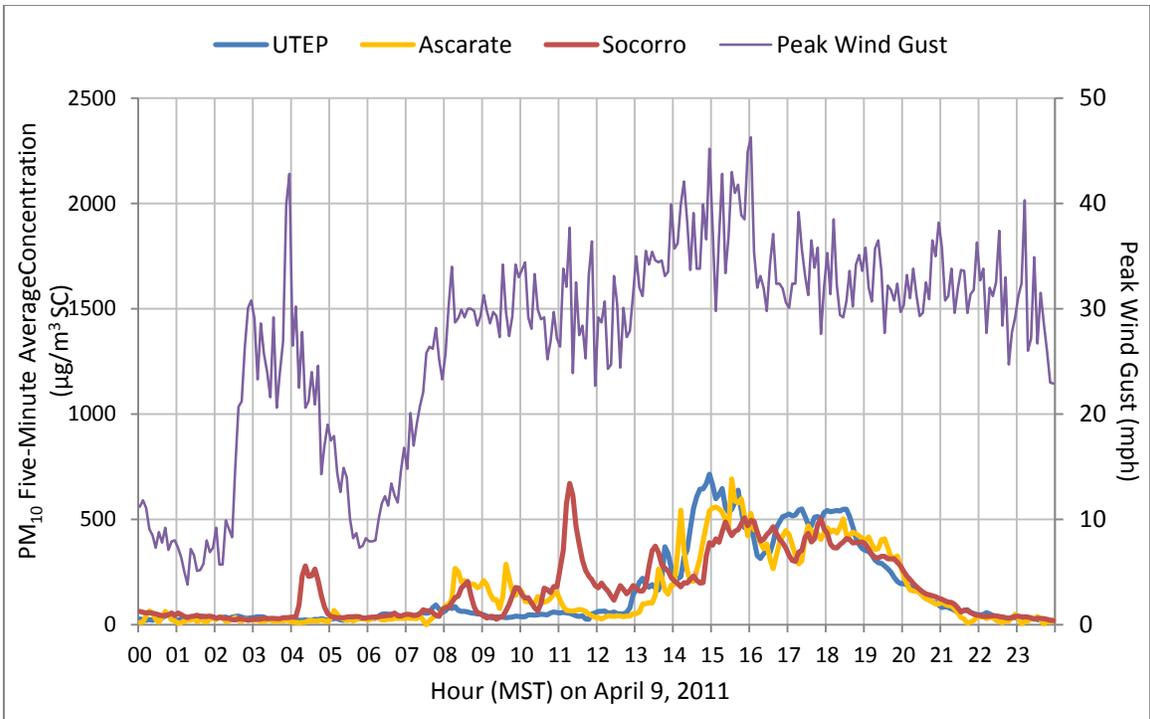


Figure F-17. El Paso five-minute average PM₁₀ concentrations from continuous monitors on April 9, 2011.

Appendix G: Event Analysis for April 26, 2011

Event Summary

A large low pressure system centered in the northern Texas Panhandle brought strong west to northwest winds across a large region from southern New Mexico and Arizona and into northern Mexico and far West Texas on April 26, 2011. Figure G-1 shows a weather map for April 26, 2011, at 1400 MST provided by NOAA depicting the large low pressure system.

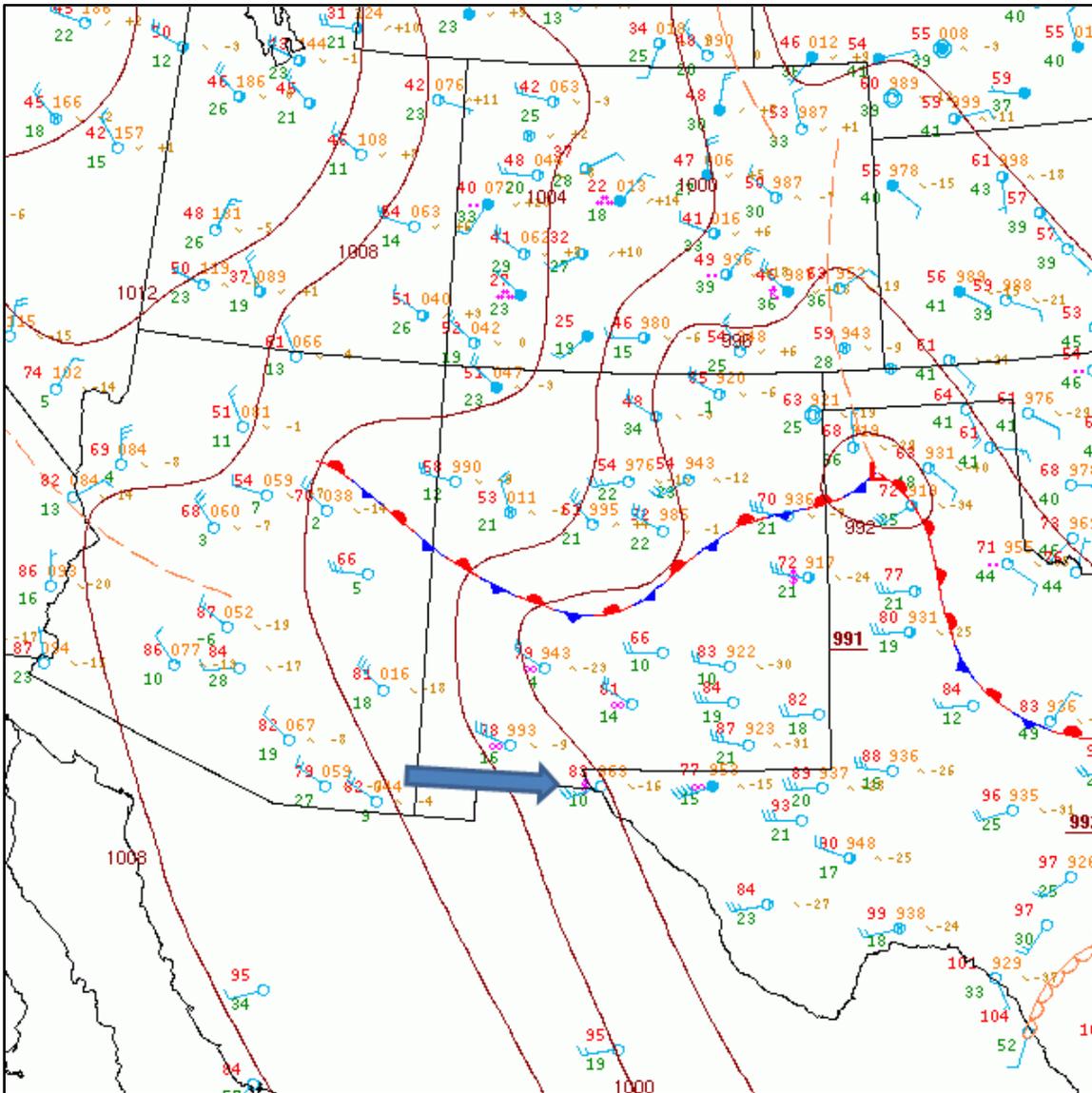


Figure G-1. Regional weather map for 1400 MST on April 26, 2011.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots and the wind speed is the sum of the values shown with the individual barbs. Wind direction in the El Paso area is indicated by a large arrow.

High winds associated with the large low pressure system generated an area of blowing dust in southern New Mexico and northern Mexico that reached the El Paso area between 1200 and 1300 MST when particulate matter concentrations began to increase sharply and remained very high until 2100 MST. Area peak wind gusts reached 70 mph and peak sustained winds were up to 48 mph at the El Paso Airport. Only continuous particulate matter measurements were available on this day since it was not a routine sample day for any of the non-continuous monitors.

An exceptional event flag is proposed for the Chamizal continuous FEM PM_{2.5} daily average measurement of 36.2 µg/m³ on this day. The FEM PM_{2.5} monitor measured a peak one-hour average of 119 µg/m³ for the hour beginning at 1600 MST. The hourly average PM_{2.5} concentration was above the 24-hour NAAQS of 35 µg/m³ for most of the eight hours beginning at 1300 MST and the average wind direction during this period was from 286 degrees (west-northwest) at an average speed of 24.5 mph. The peak measured wind gust at Chamizal was 55.4 mph and the highest five-minute average wind speed was 34.0 mph.

Web Cam Images

The El Paso Chelsea Street and Ranger Peak webcams provided visual images of the dust impacting the El Paso area on April 26, 2011. A map of the webcam locations was previously presented in Figure 13.

Figures G-2 and G-3 show the Chelsea Street and Ranger Peak webcam views at 1000 MST when dust levels were low compared to the 1730 MST view with intense blowing dust near the peak of the event. From the webcams, downtown El Paso and the Juarez Mountains are clearly visible in the 1000 MST frame, but are totally obscured by intense blowing dust in the 1730 MST frame.



Figure G-2. El Paso Chelsea Street webcam images for 1000 MST (top) and 1730 MST (bottom) on April 26, 2011.



Figure G-3. El Paso Ranger Peak webcam images for 1000 MST (top) and 1730 MST (bottom) on April 26, 2011.

Satellite Imagery

Satellite imagery shows intense dust plumes generated by high winds originating in southern New Mexico blowing east-southeastward into the El Paso area. Figure G-4 shows two true color composite MODIS visible wavelength images of the El Paso area on April 26, 2011, provided by the UW SSEC. The top image is from the Terra satellite at 1030 MST before any dust became visible. The bottom image shows the same view from the Aqua satellite at 1345 MST with large dust plumes oriented west-northwest to east-southeast. In Figure G-4 El Paso is circled in red in the upper right side of each image.

Figures G-5 through G-10 provide a sequence of six GOES visible satellite images for April 26, 2011, from mid-day at 1215 MST through 1715 MST near sunset. The GOES images are not as high in resolution as the MODIS images, but large dust plumes can be seen developing in southern New Mexico and being transported into the El Paso area.

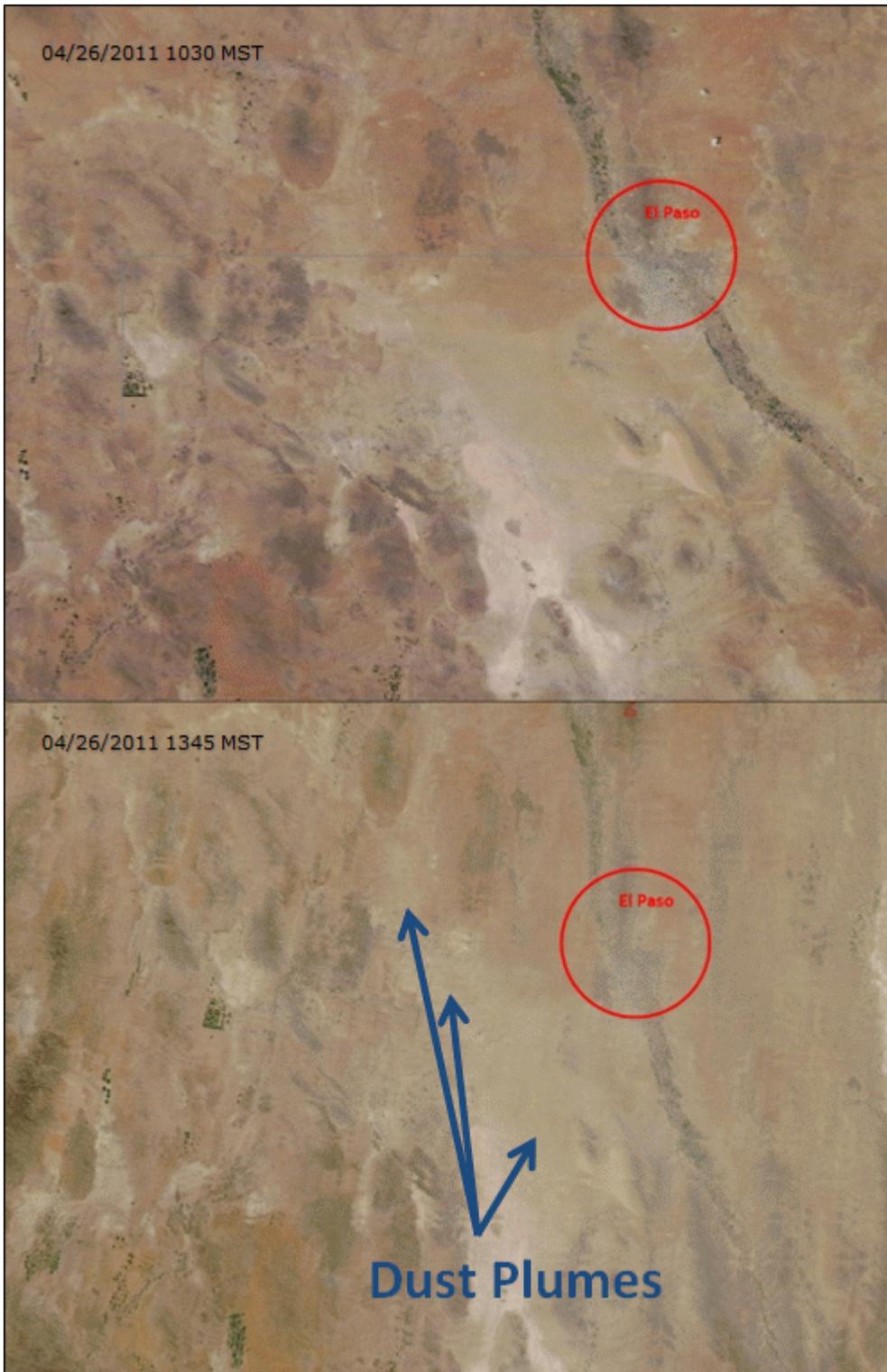


Figure G-4. True color Terra satellite image at 1030 MST in top frame showing before any blowing dust can be seen on April 26, 2011, and in the bottom frame a later true color image from the Aqua satellite at 1345 MST showing large areas of blowing dust oriented west-northwest to east-southeast blowing towards El Paso.

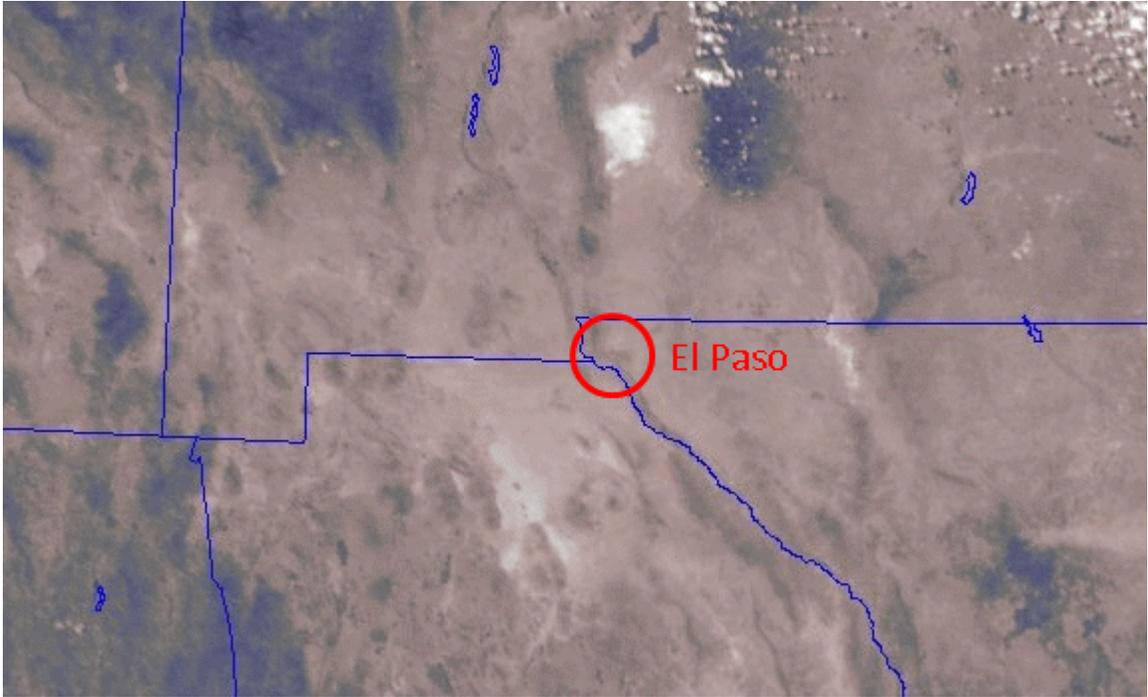


Figure G-5. GOES image for 1215 MST on April 26, 2011.

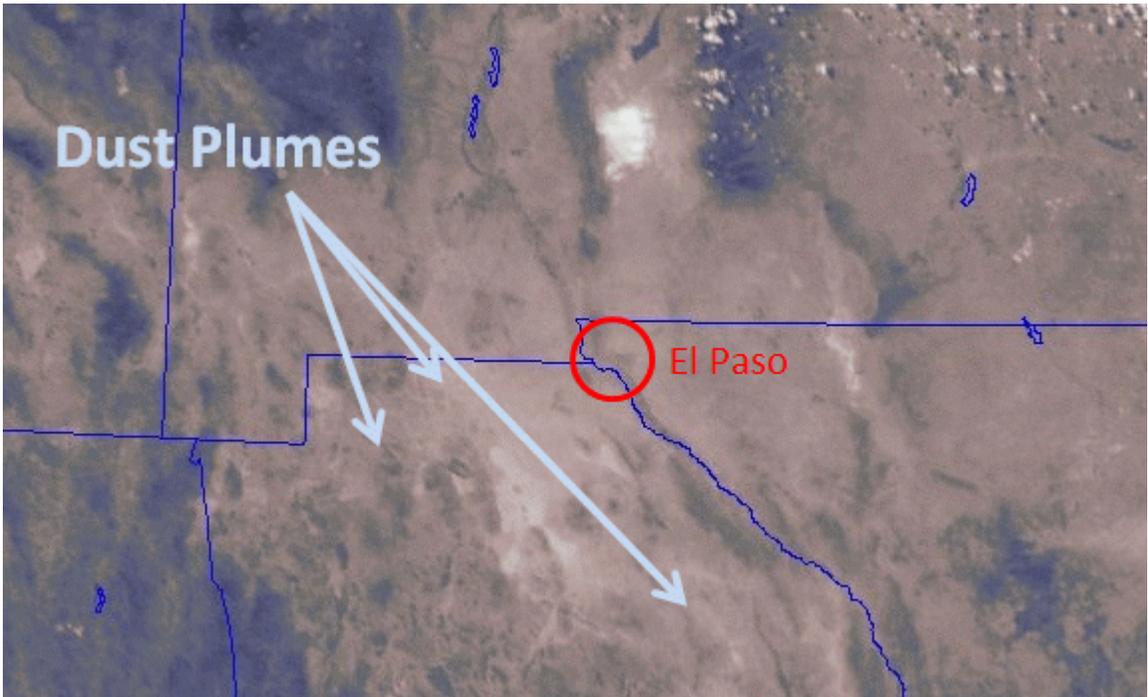


Figure G-6. GOES image for 1315 MST on April 26, 2011.

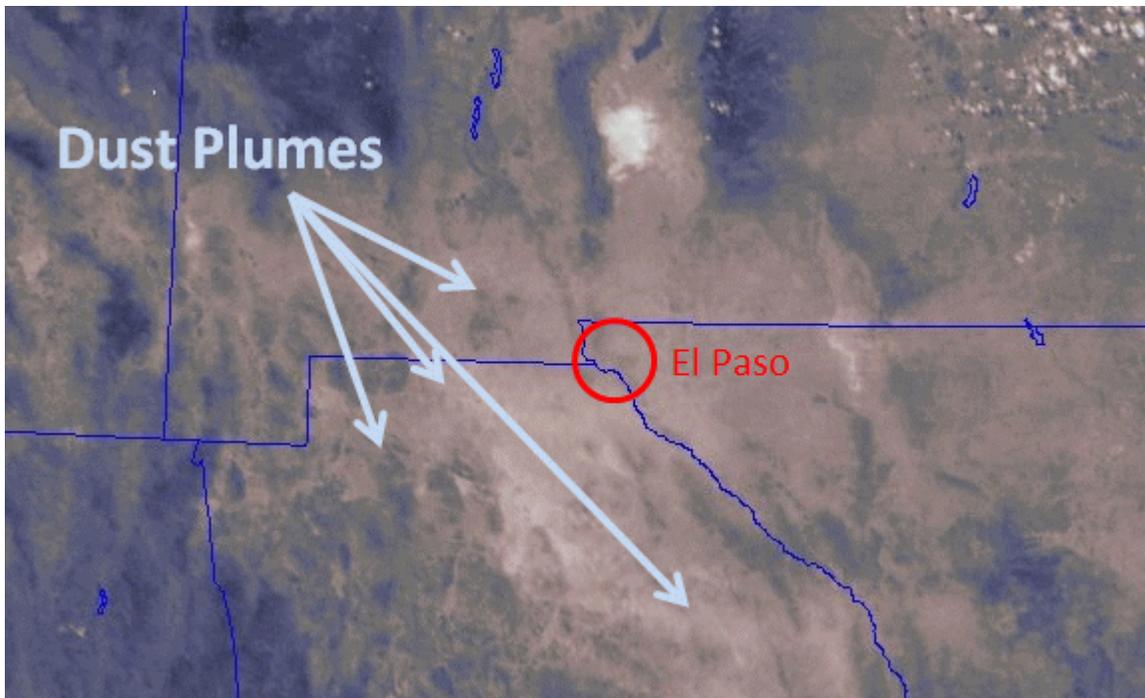


Figure G-7. GOES image for 1415 MST on April 26, 2011.

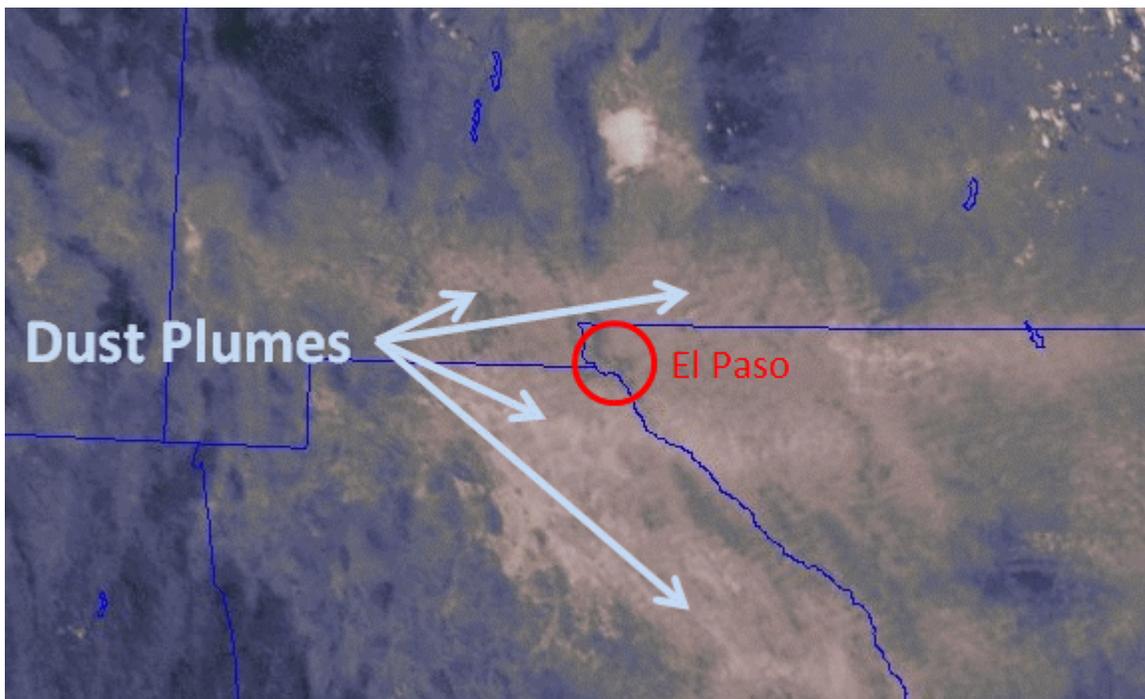


Figure G-8. GOES image for 1530 MST on April 26, 2011.



Figure G-9. GOES image for 1615 MST on April 26, 2011.

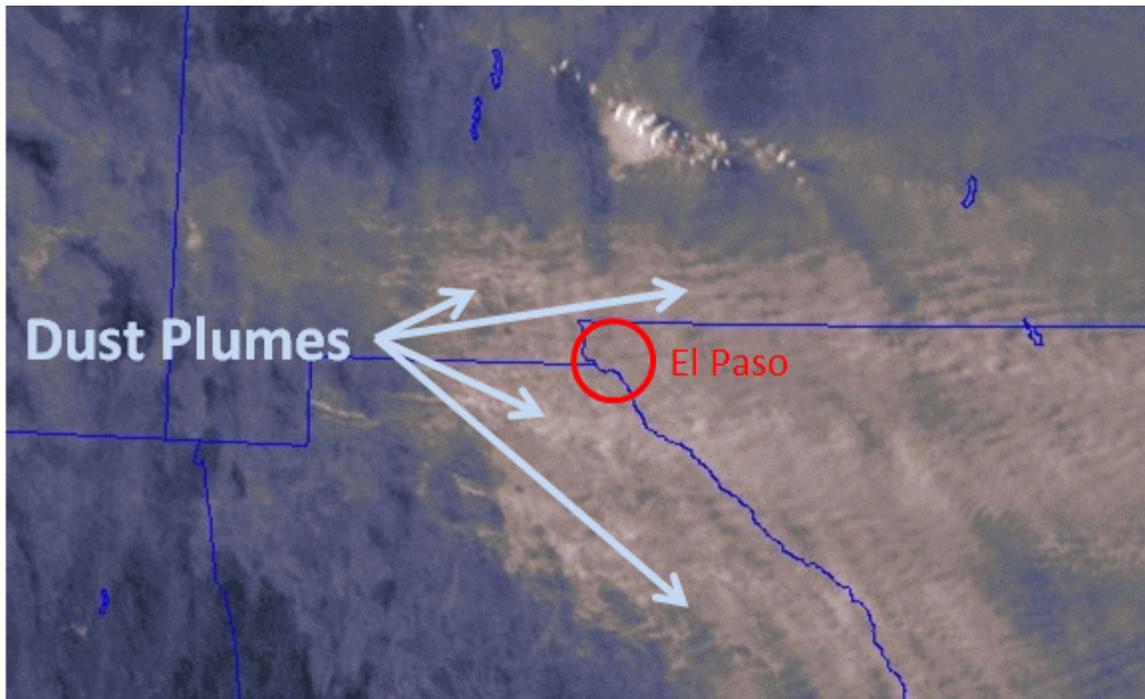


Figure G-10. GOES image for 1715 MST on April 26, 2011.

Back Trajectories

Figure G-11 provides HYSPLIT back trajectories that predict the approximate path of air arriving at the Chamizal site at 1600 MST (2300 UTC) on April 26, 2011. Trajectory paths are plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours. These trajectories indicate that the air arriving at the Chamizal site at the time of the highest $PM_{2.5}$ levels on April 26, 2011, came from southern New Mexico as indicated by satellite imagery.

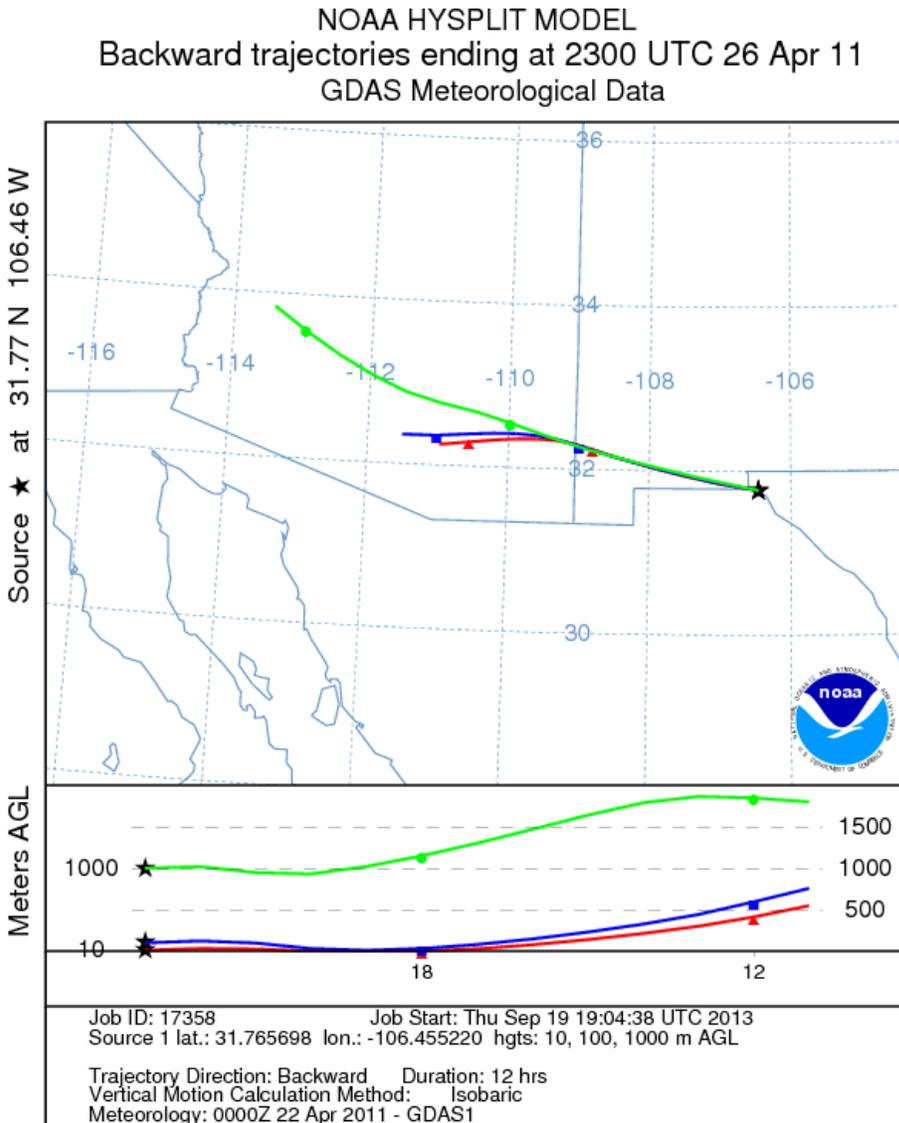


Figure G-11. Backward-in-time air trajectory for April 26, 2011, for air arriving at Chamizal at 1600 MST (2300 UTC).

Map Plots of Daily Particulate Matter Data

Maps of daily average PM₁₀ and PM_{2.5} measurements from April 26, 2011, demonstrate the widespread impact of the dust event in the El Paso area. Figure G-12 shows the daily average PM_{2.5} measurements, including the Chamizal measurement proposed as an exceptional event, while Figure G-13 shows the daily average PM₁₀ measurements.

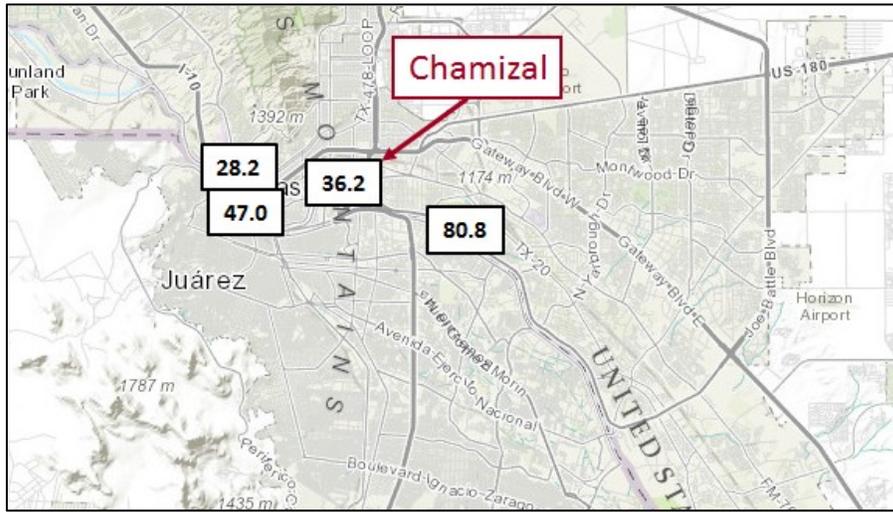


Figure G-12. Map of El Paso area daily average PM_{2.5} measurements (µg/m³ LC) on April 26, 2011.

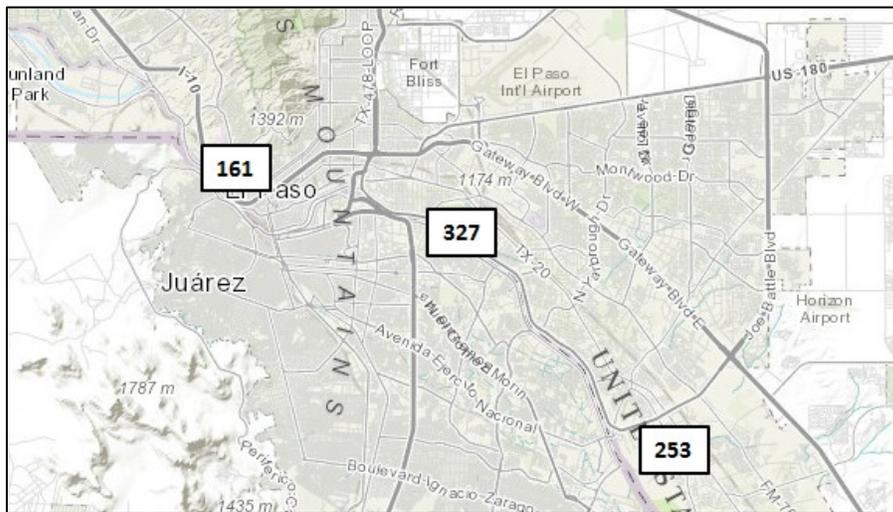


Figure G-13. Map of El Paso area daily average PM₁₀ measurements (µg/m³ SC) on April 26, 2011.

Continuous Particulate Matter and Wind Graphs

Graphs of five-minute continuous $PM_{2.5}$, PM_{10} , and wind gust data for the April 26, 2011, event demonstrate the temporal relationship between particulate increases and wind speed. Figure G-14 plots continuous five-minute $PM_{2.5}$ data against peak wind gusts showing the most intense blowing dust arriving at the sites around 1300 MST, several hours after peak wind gusts had risen above 30 mph. As peak wind gusts eclipsed 40 mph, several sharp increases in measured particulate matter occurred between 1300 and 1800 MST, indicative of the passing of multiple intense dust plumes. The Chamizal continuous $PM_{2.5}$ data is only available in one-hour average time resolution and does not resolve the time of the dust arrival as well.

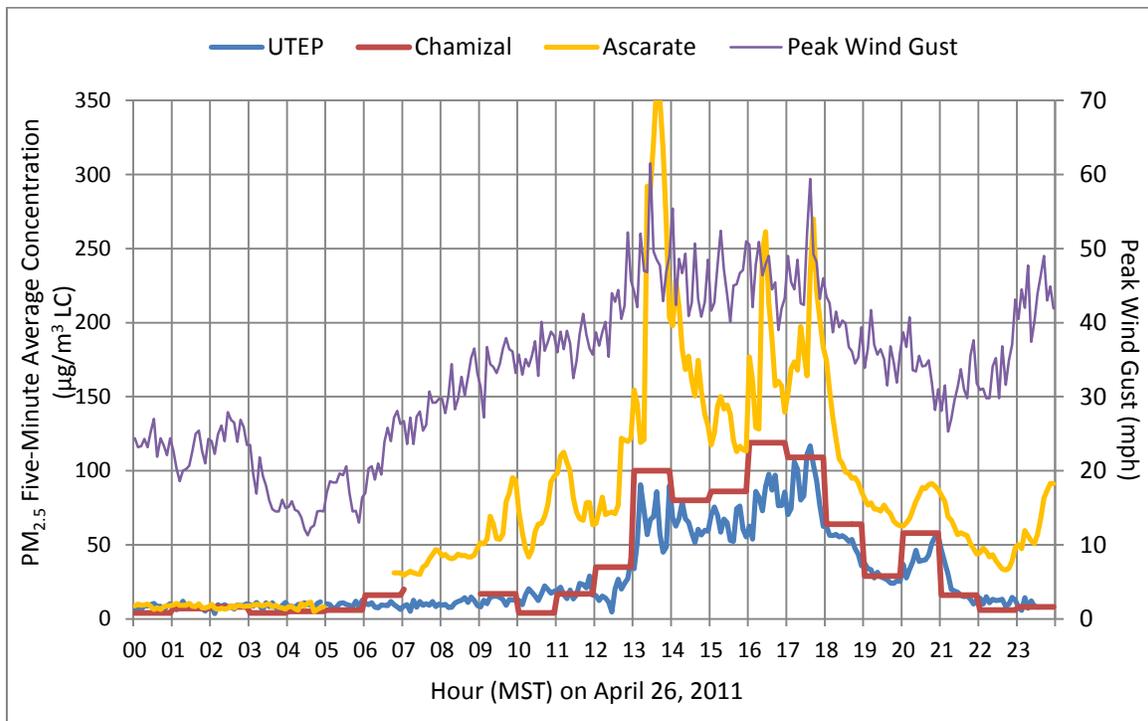


Figure G-14. El Paso five-minute average $PM_{2.5}$ concentrations from continuous monitors on April 26, 2011.

Figure G-15 plots continuous five-minute PM_{10} data from three sites in the El Paso area. As was seen with the $PM_{2.5}$ measurements, PM_{10} values began to gradually rise around 0900 MST, followed by a sharp rise around 1300 MST with several peaks through 1800 MST as intense dust plumes passed.

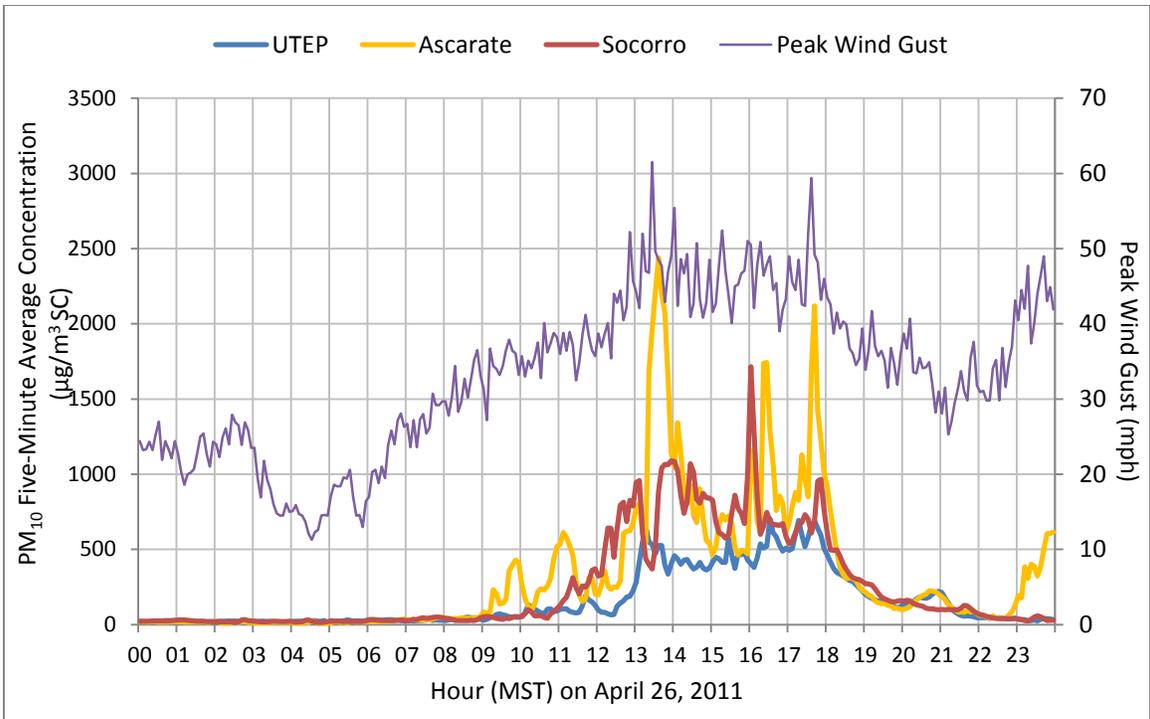


Figure G-15. El Paso five-minute average PM₁₀ concentrations from continuous monitors on April 26, 2011.

Appendix H: Event Analysis for May 10, 2011

Event Summary

A large low pressure system centered in southeastern Colorado brought strong southwest winds across a large region from New Mexico into northern Mexico and far West Texas on May 10, 2011. Figure H-1 shows a weather map for May 10, 2011, at 1400 MST provided by NOAA depicting the large low pressure system.

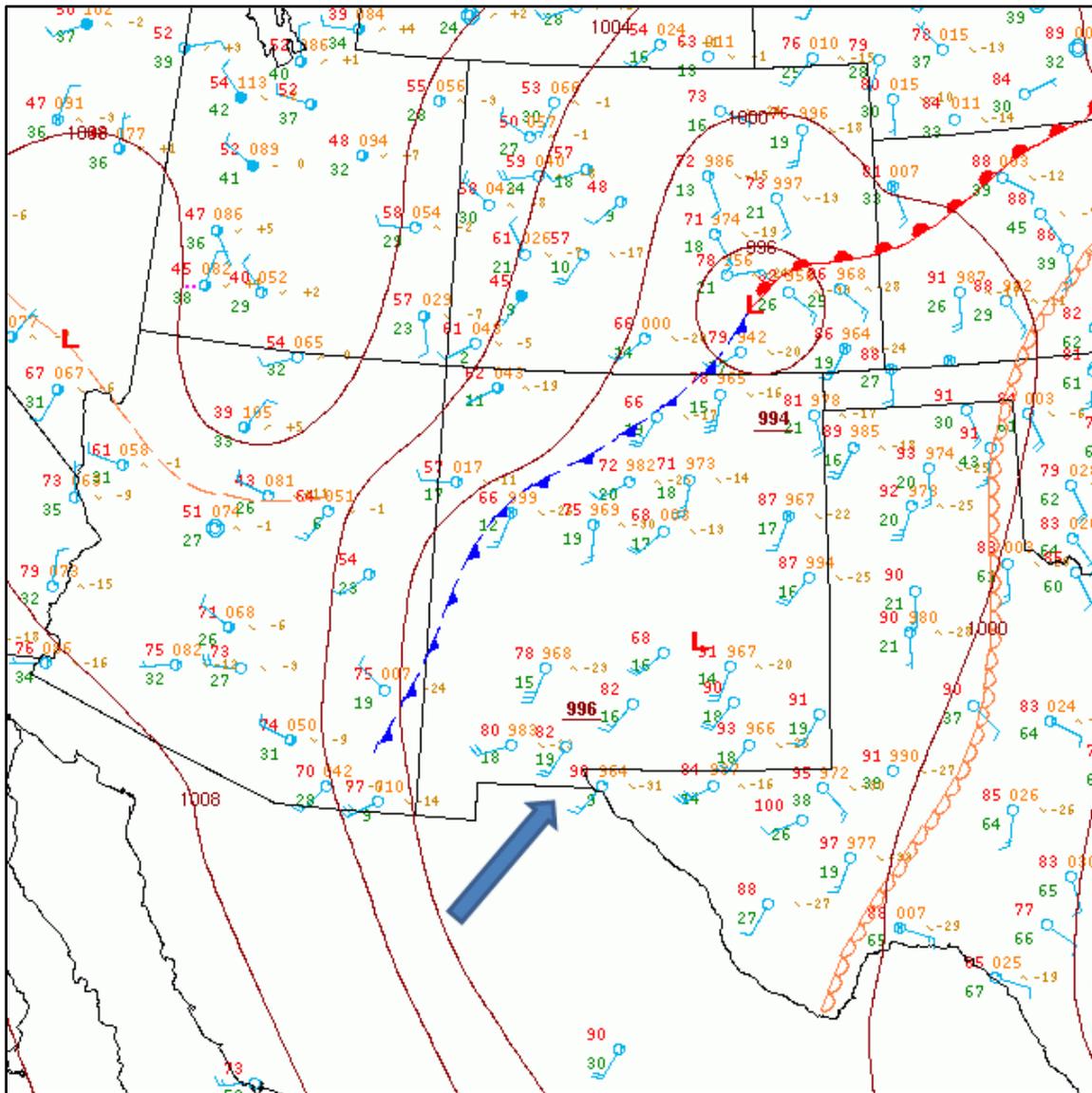


Figure H-1. Regional weather map for 1400 MST on May 10, 2011.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots and the wind speed is the sum of the values shown with the individual barbs. Wind direction in the El Paso area is indicated by a large arrow.

High winds associated with the large low pressure system generated an area of blowing dust late in the afternoon in northern Mexico that reached the El Paso area about 1700 MST when particulate matter concentrations increased sharply by 1800 MST. Particulate concentrations remained very high through 2100 MST, then dropped sharply by 2200 MST as the dust plume passed. Area peak wind gusts reached 68 mph and peak sustained winds were up to 43 mph at the El Paso Airport. Only continuous particulate matter measurements were available on this day since it was not a routine sample day for any of the non-continuous monitors.

An exceptional event flag is proposed for the Chamizal continuous FEM $PM_{2.5}$ daily average measurement of $36.3 \mu\text{g}/\text{m}^3$ on this day. The FEM $PM_{2.5}$ monitor measured a peak one-hour average of $148 \mu\text{g}/\text{m}^3$ for the hour beginning at 1800 MST. The hourly average $PM_{2.5}$ concentration was above the 24-hour NAAQS of $35 \mu\text{g}/\text{m}^3$ for most of the ten hours beginning at 1200 MST and the average wind direction during this period was from 255 degrees (west-southwest) at an average speed of 21.3 mph. The peak measured wind gust at Chamizal was 47.4 mph and the highest five-minute average wind speed was 28.6 mph.

Webcam Images

The El Paso Chelsea Street and Ranger Peak webcams provided visual images of the dust impacting the El Paso area on May 10, 2011. A map of the webcam locations was previously presented in Figure 13.

Figures H-2 and H-3 show the Chelsea Street and Ranger Peak webcam views at 0900 MST when dust levels were low compared to the 1900 MST view with intense blowing dust near the peak of the event. From the webcams, downtown El Paso and the Juarez Mountains are clearly visible in the 0900 MST frame, but are totally obscured by intense blowing dust in the 1900 MST frame.

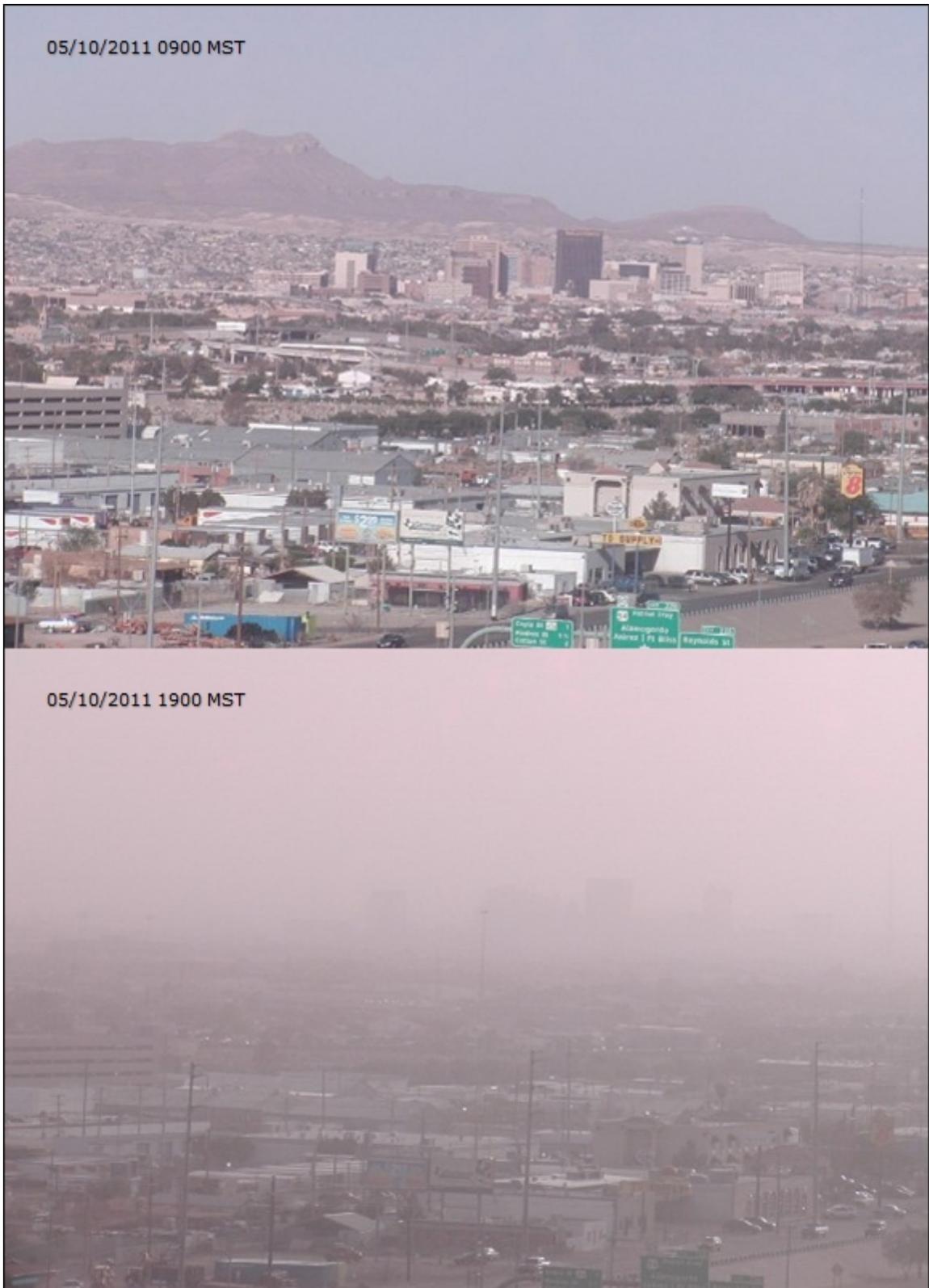


Figure H-2. El Paso Chelsea Street webcam images for 0900 MST (top) and 1900 MST (bottom) on May 10, 2011.



Figure H-3. El Paso Ranger Peak webcam images for 0900 MST (top) and 1900 MST (bottom) on May 10, 2011.

Satellite Imagery

Satellite imagery visibly illustrates dust plumes generated by high winds in northern Mexico and blowing east-northeastward into the El Paso area. Figure H-4 shows two true color composite MODIS visible wavelength images of the El Paso area on May 10, 2011, provided by the UW SSEC. The top image is from the Terra satellite at 1040 MST and the bottom image is from the Aqua satellite at 1400 MST; both images were taken before the dust event began. In Figure H-4 El Paso is circled in red in the upper right side of each image and the Texas and Mexico boundaries are marked by gray lines. The four GOES visible satellite images for May 10, 2011, provided at one hour intervals from 1345 MST through 1645 MST, are shown in Figures H-5 through H-8. The images show a sequence of growing dust plumes that merge together into a large dust cloud that moves into the western side of the El Paso area near sunset.

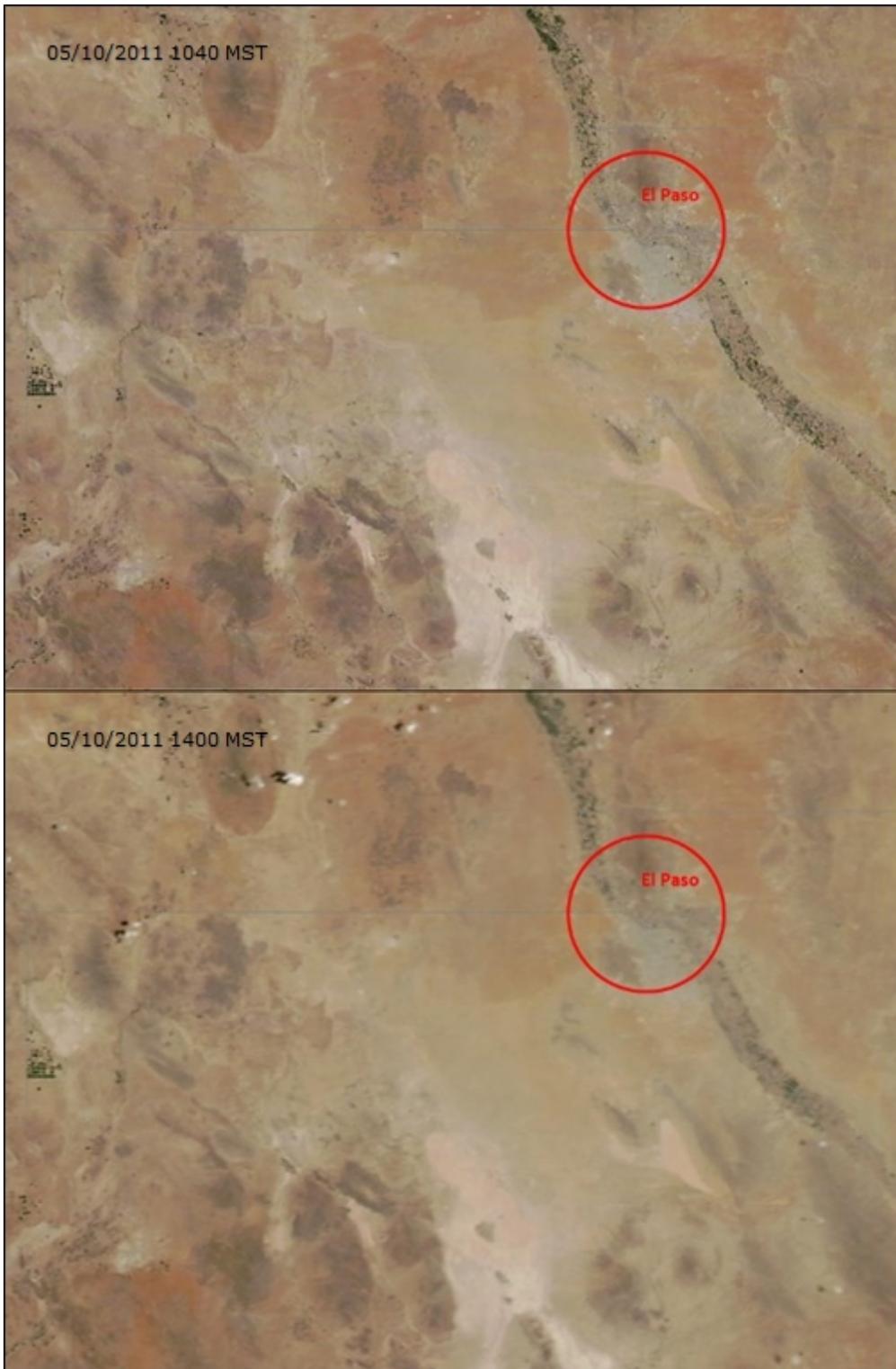


Figure H-4. True color Terra satellite image at 1040 MST in top frame showing no evidence of early blowing dust in northern Mexico on May 10, 2011, and in the bottom frame a later true color image from the Aqua satellite at 1400 MST still showing no evidence of blowing dust plumes early in the afternoon.

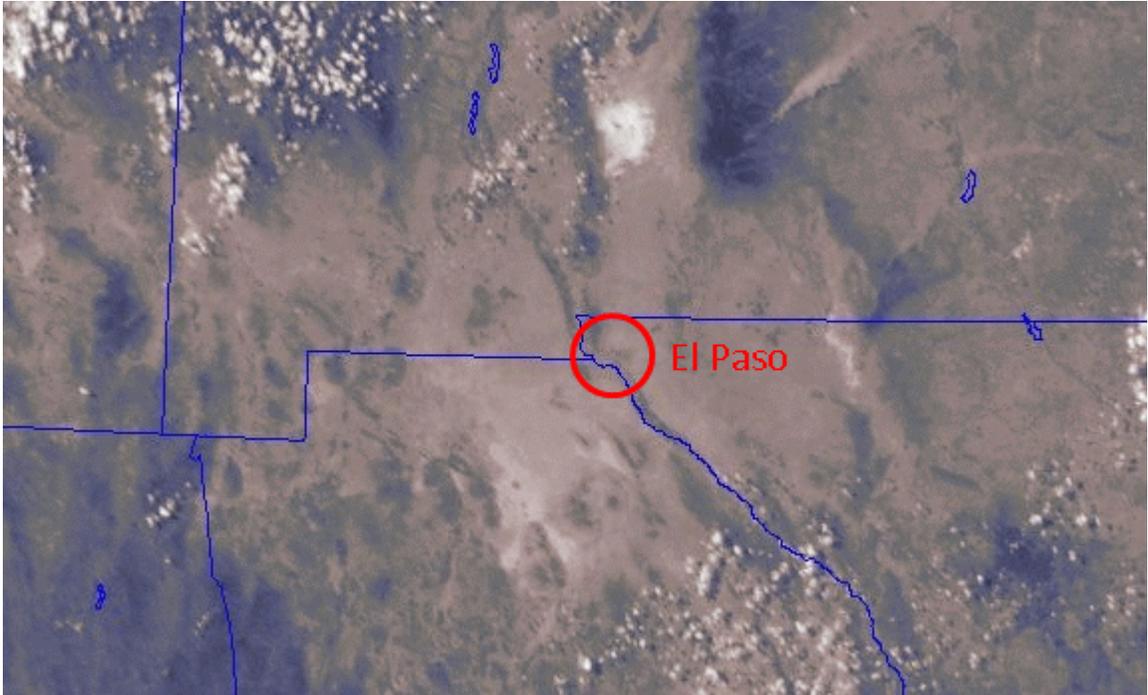


Figure H-5. GOES image for 1345 MST on May 10, 2011.

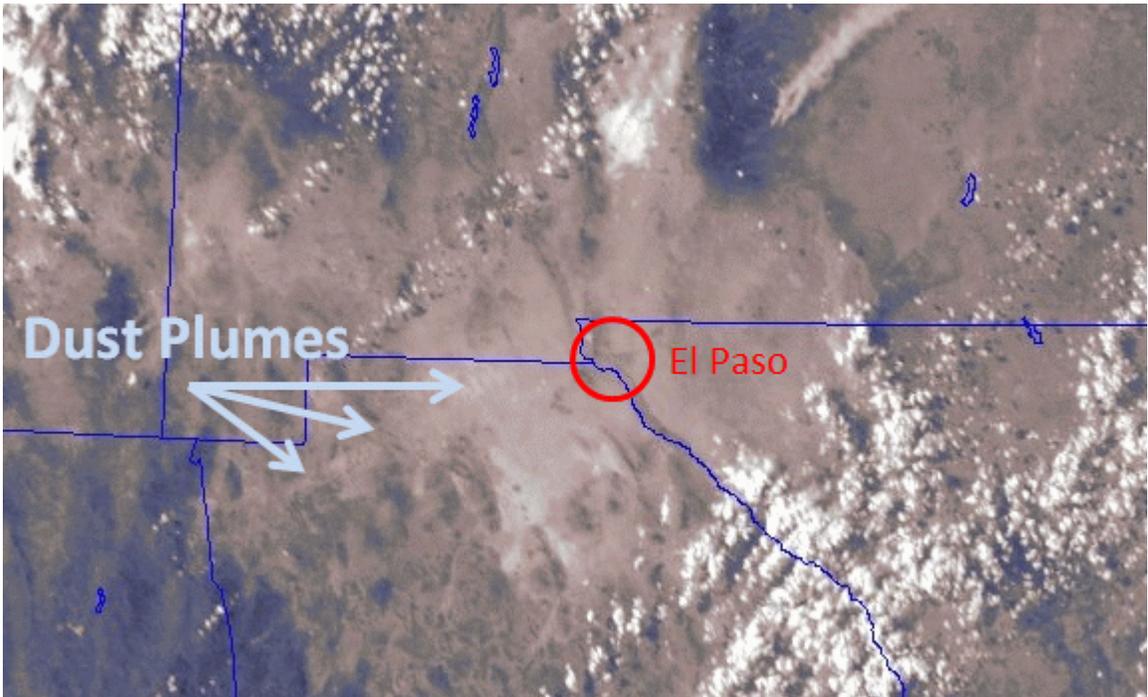


Figure H-6. GOES image for 1445 MST on May 10, 2011.

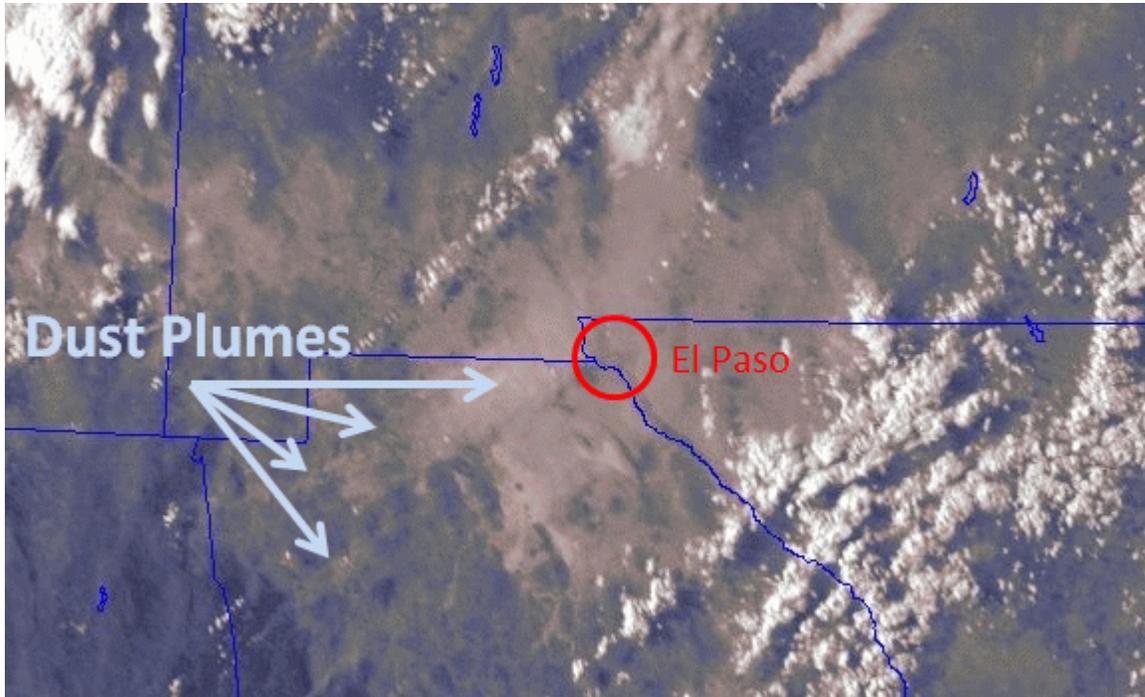


Figure H-7. GOES image for 1545 MST on May 10, 2011.

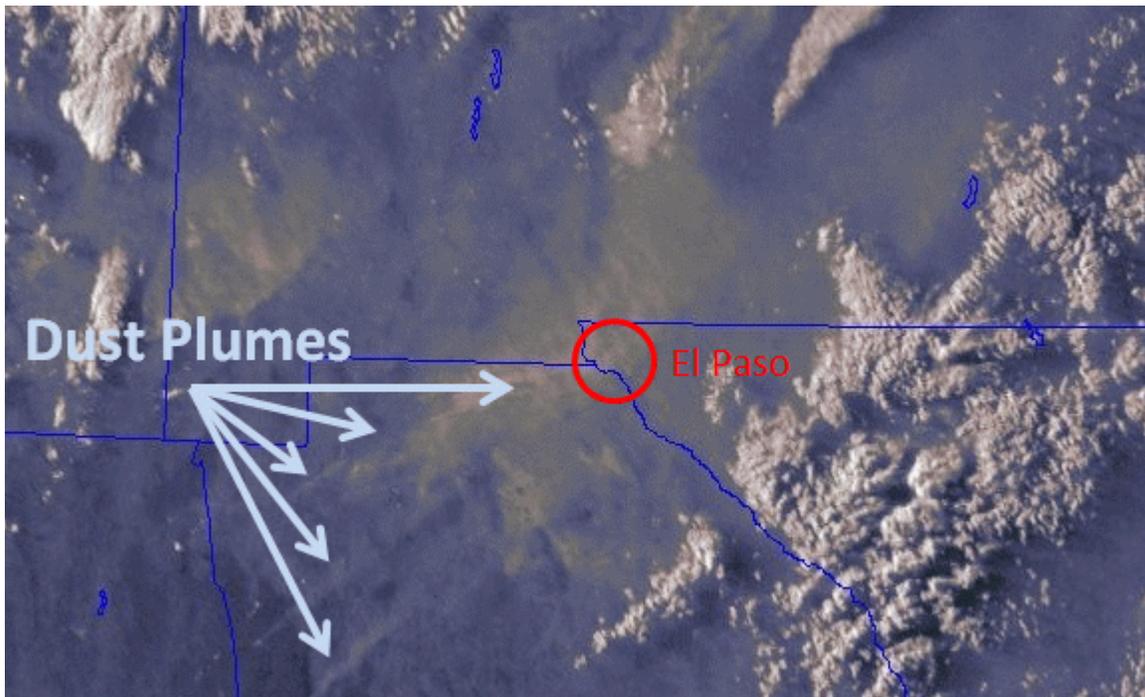


Figure H-8. GOES image for 1645 MST on May 10, 2011.

Back Trajectories

Figure H-9 provides HYSPLIT back trajectories that show the approximate path of air arriving at the Chamizal site at 1800 MST (0100 UTC) on May 10, 2011. Trajectories are plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours. These trajectories indicate the path of the air arriving at the Chamizal site at the time of the highest PM_{2.5} levels on May 10, 2011, came from northern Mexico, as indicated by satellite imagery.

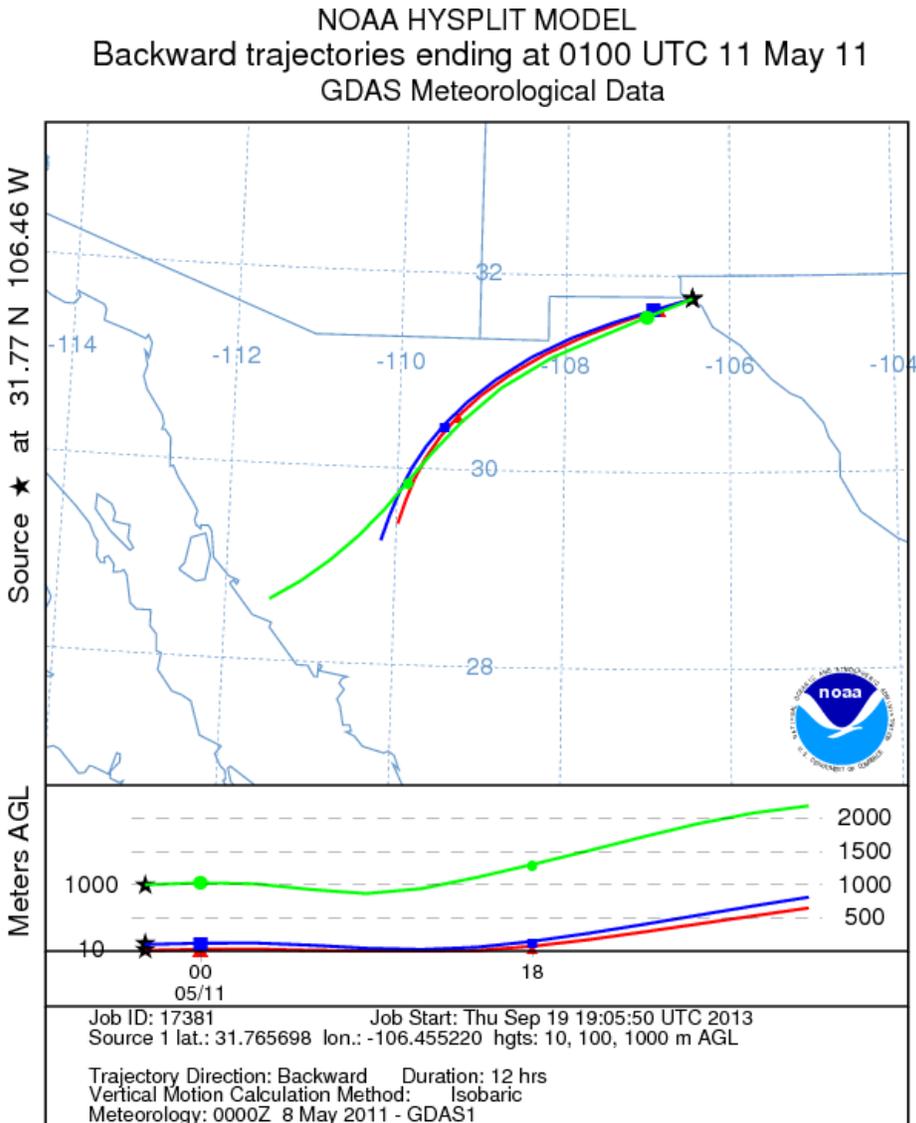


Figure H-9. Backward-in-time air trajectory for May 10, 2011, for air arriving at Chamizal at 1800 MST (0100 UTC on May 11, 2011).

Map Plots of Daily Particulate Matter Data

Maps of daily average PM₁₀ and PM_{2.5} measurements from the May 10, 2011, event are provided in Figures H-10 and H-11. Both maps show widespread high particulate matter concentrations across the El Paso area consistent with a transported dust event.

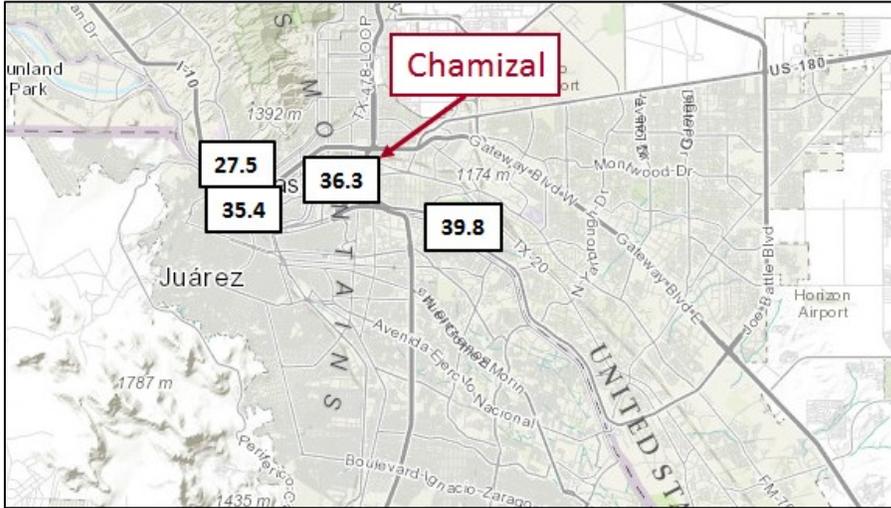


Figure H-10. Map of El Paso area daily average PM_{2.5} measurements ($\mu\text{g}/\text{m}^3$ LC) on May 10, 2011.

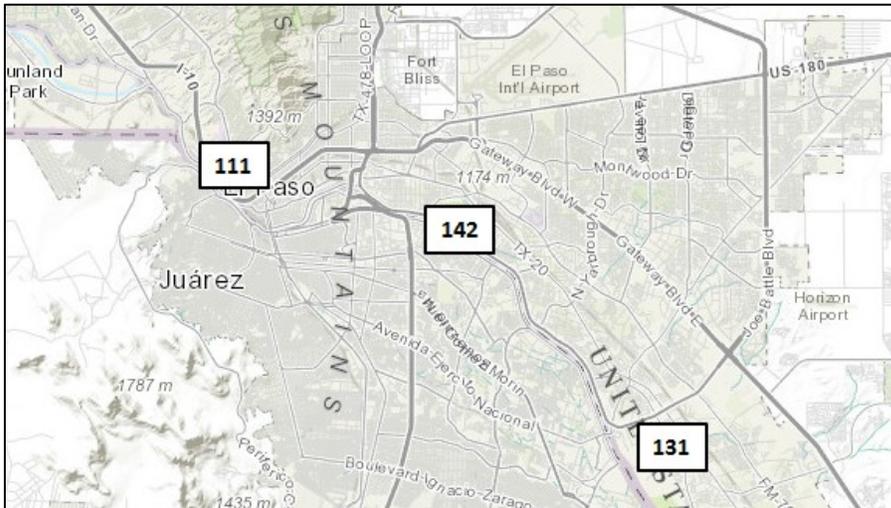


Figure H-11. Map of El Paso area daily average PM₁₀ measurements ($\mu\text{g}/\text{m}^3$ SC) on May 10, 2011.

Continuous Particulate Matter and Wind Graphs

Five-minute continuous $PM_{2.5}$, PM_{10} , and wind gust data were plotted for the May 10, 2011, event. Figure H-12 shows a plot of continuous five-minute $PM_{2.5}$ data that indicates rising concentrations in the early afternoon with a sharp rise at all sites around 1700 MST followed by very high concentrations for about four hours. Once again, the changes in concentration do not immediately correspond with the increase in peak wind gust and are more consistent with large transported dust plumes affecting the entire area.

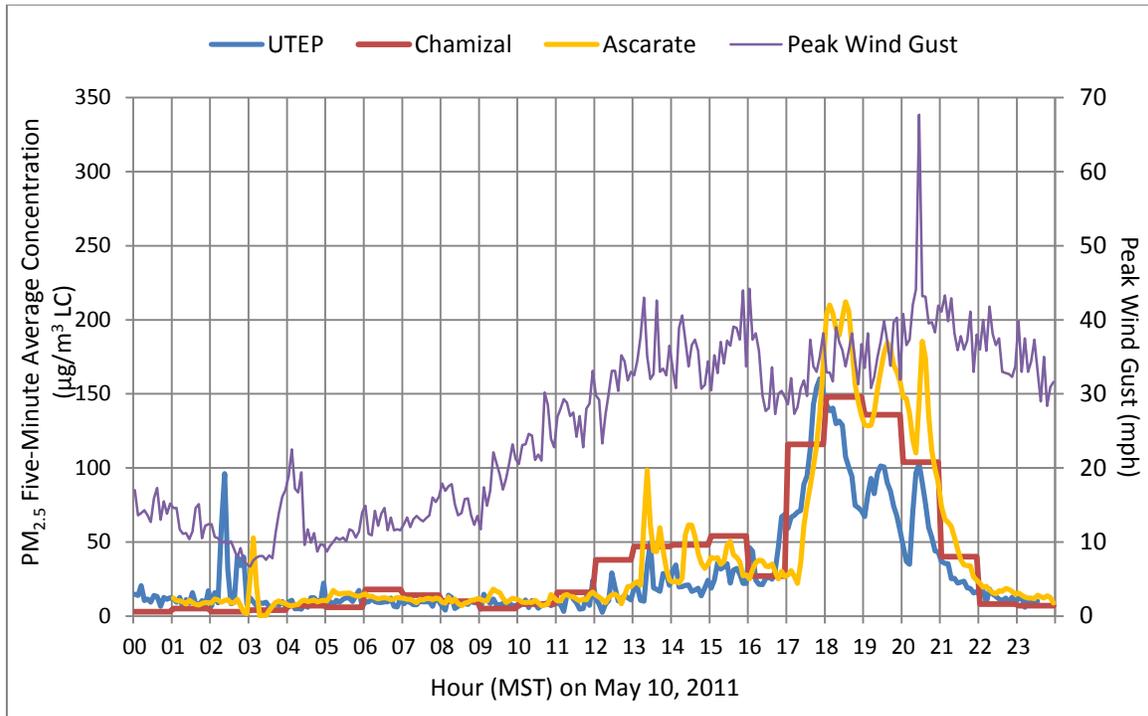


Figure H-12. El Paso five-minute average $PM_{2.5}$ concentrations from continuous monitors on May 10, 2011.

Figure H-13 plots continuous five-minute PM_{10} data from three sites in the El Paso area against peak wind gusts. These data show rises in PM_{10} beginning first at the westernmost UTEP site at about 1700 MST, then arriving at Ascarate about 1730 MST, and Socorro farther to the east at about 1800 MST, consistent with dust plumes from Mexico sweeping eastward across the El Paso area.

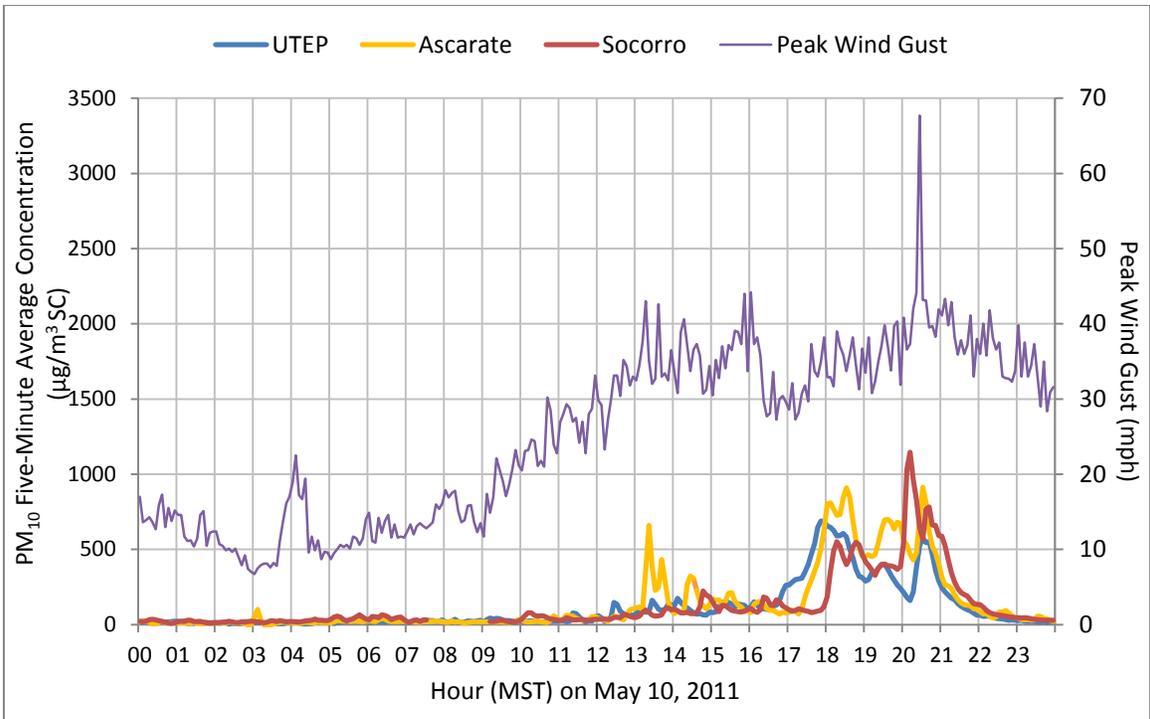


Figure H-13. El Paso five-minute average PM₁₀ concentrations from continuous monitors on May 10, 2011.

Appendix I: Event Analysis for March 7, 2012

Event Summary

A large low pressure system centered in Colorado brought strong southwest winds across a large region from New Mexico into northern Mexico and far West Texas on March 7, 2012. Figure I-1 shows a weather map for March 7, 2012, at 1400 MST provided by NOAA depicting the large low pressure system.

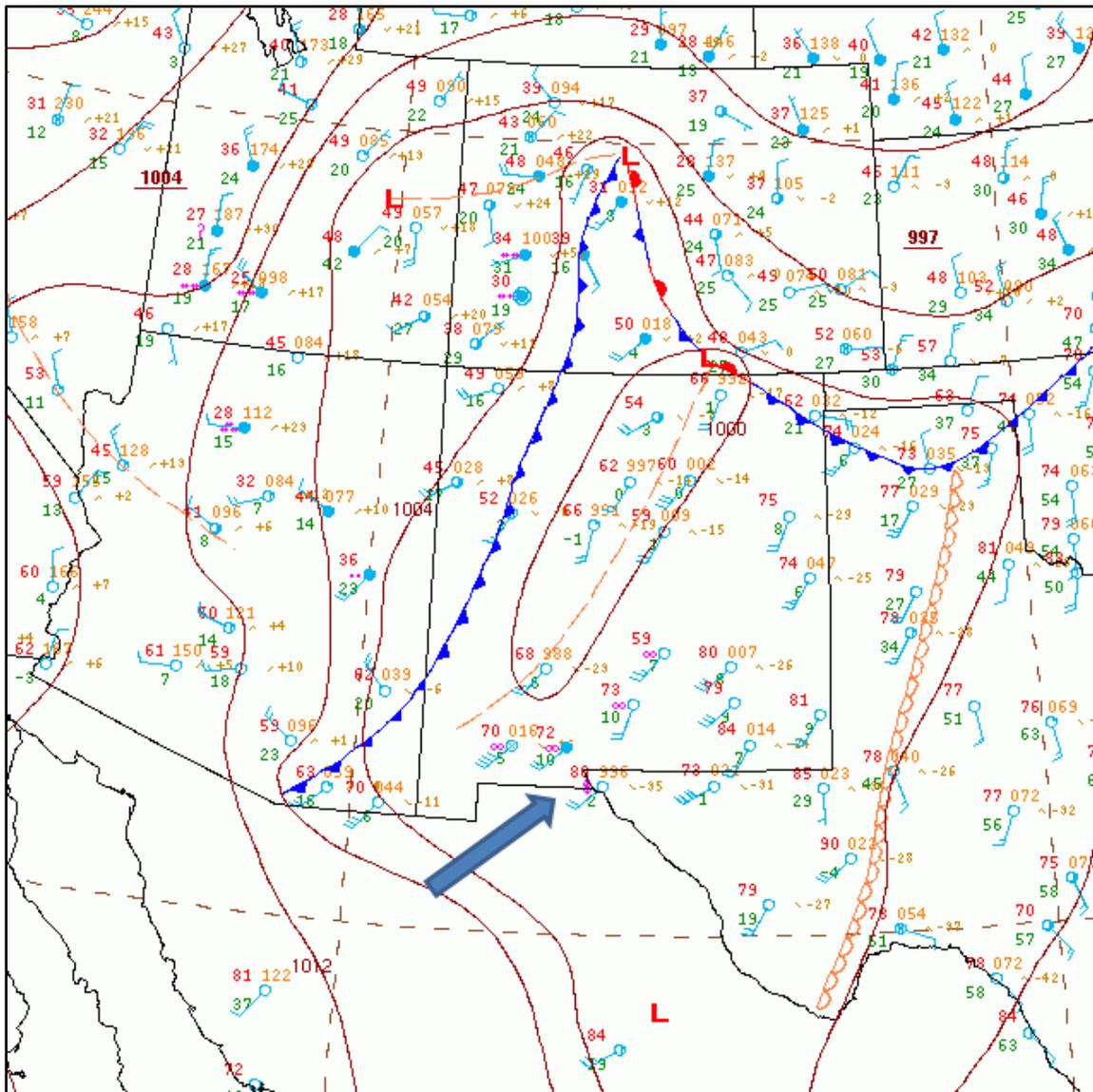


Figure I-1. Regional weather map for 1400 MST on March 7, 2012.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots and the wind speed is the sum of the values shown with the individual barbs. Wind direction in the El Paso area is indicated by a large arrow.

High winds associated with the low pressure system generated a large area of blowing dust in northern Mexico that began impacting the El Paso area in the late morning and reached peak intensity in the afternoon with highest concentrations from 1500 to 2100 MST. Peak wind gusts reached 46 mph and peak sustained winds were up to 38 mph in the El Paso area, but the intensity of blowing dust on satellite imagery suggests that wind gusts were much higher in the dust source areas of northern Mexico. With the exception of the non-continuous acceptable PM_{2.5} speciation monitor at Chamizal, only continuous particulate matter measurements were available on this day since it was not a routine sample day for any of the other non-continuous monitors.

An exceptional event flag is proposed for the Chamizal continuous FEM PM_{2.5} daily average measurement of 85.0 µg/m³ on this day. The collocated non-continuous acceptable PM_{2.5} speciation monitor measured a daily average of 69.1 µg/m³. The FEM PM_{2.5} monitor measured a peak one-hour average of 399 µg/m³ for the hour beginning at 1600 MST. The hourly average PM_{2.5} concentration was above the 24-hour NAAQS of 35 µg/m³ for the eight hours beginning at 1200 MST and the average wind direction during this period was from 251 degrees (west-southwest) at an average speed of 21.8 mph. The peak measured wind gust at Chamizal was 42.7 mph and the highest five-minute average wind speed was 33.0 mph.

Web Cam Images

The El Paso Chelsea Street and Ranger Peak webcams provided visual images of the dust impacting the El Paso area on March 7, 2012. A map of the webcam locations was previously presented in Figure 13.

Figures I-2 and I-3 show the Chelsea Street and Ranger Peak webcam views at 0830 MST when dust levels were low compared to the 1630 MST view with intense blowing dust near the peak of the event. From the webcams, downtown El Paso and the Juarez Mountains are clearly visible in the 0830 MST frame, but are totally obscured by intense blowing dust in the 1630 MST frame.



Figure I-2. El Paso Chelsea Street webcam images for 0830 MST (top) and 1630 MST (bottom) on March 7, 2012.



Figure I-3. El Paso Ranger Peak webcam images for 0830 MST (top) and 1630 MST (bottom) on March 7, 2012.

Satellite Imagery

Satellite imagery provides compelling evidence of the intense dust plumes generated by high winds in northern Mexico and blowing east-northeastward into the El Paso area on this day. Figure I-4 shows two true color composite MODIS visible wavelength images of the El Paso area on March 7, 2012, provided by the UW SSEC. The top image, from the Terra satellite at 1100 MST, shows a few large dust plumes already developing in northern Mexico. The bottom image shows the same view from the Aqua satellite, whose trajectory on this day required two passes to capture the El Paso area of interest. The first pass displayed on the right side of the image occurred at 1235 MST and showed partly cloudy skies with some dust appearing in the El Paso area, while the second pass almost two hours later at 1415 MST shows intense dust plumes over northern Mexico advecting into the El Paso area. In Figure I-4 El Paso is circled in red in the upper right side of each image.

The sequence of six GOES visible satellite images for March 7, 2012, at one hour intervals from 1115 MST through 1615 MST provided in Figures I-5 through I-10 also depict dust plumes developing in northern Mexico early before advecting into the El Paso area.

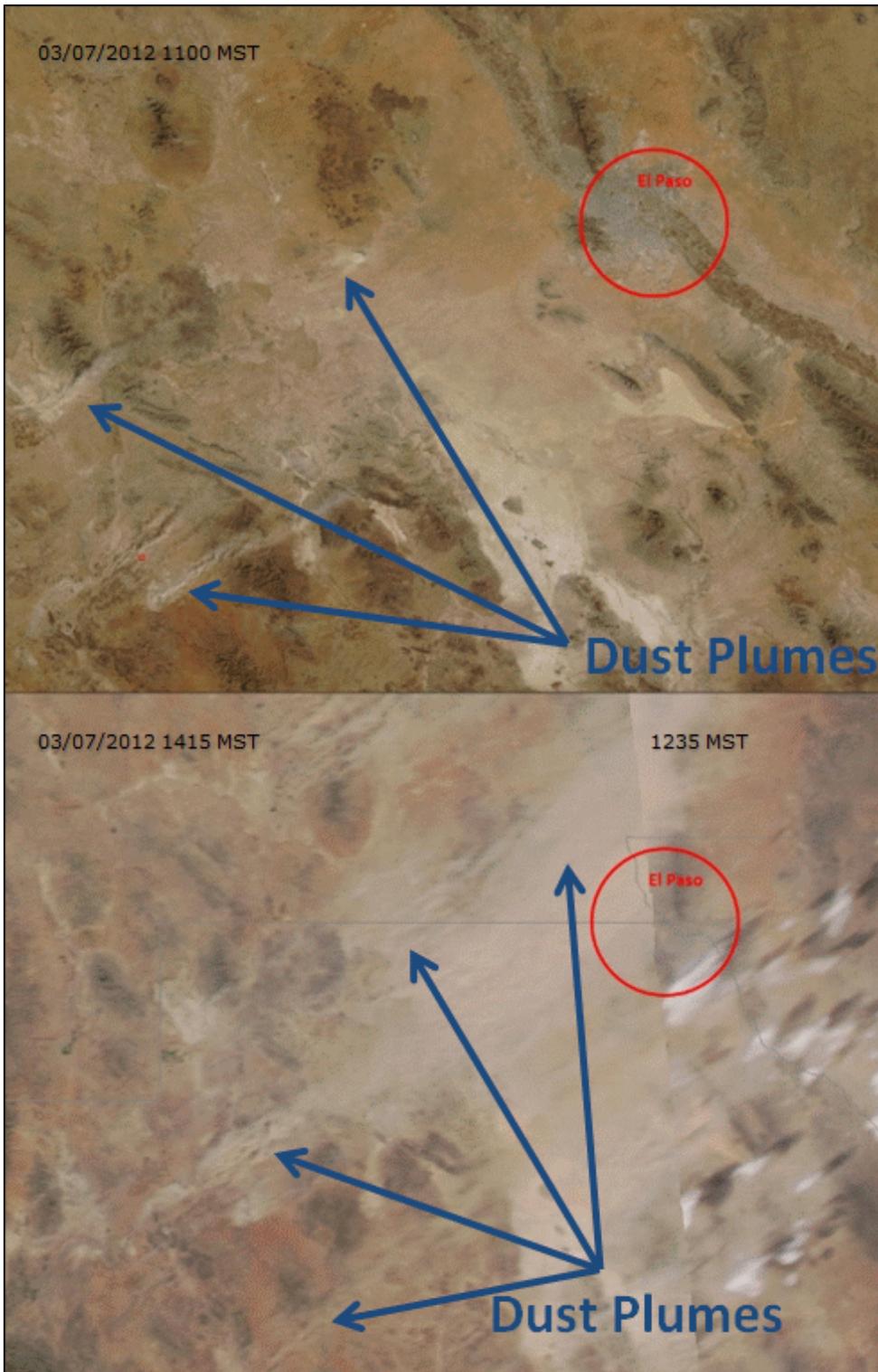


Figure I-4. True color Terra satellite image at 1100 MST in top frame showing small dust plumes starting early in northern Mexico blowing towards El Paso on March 7, 2012, and in the bottom frame a later true color image composite from the two Aqua satellite passes at 1235 MST and 1415 MST showing large areas of blowing dust advecting towards El Paso.

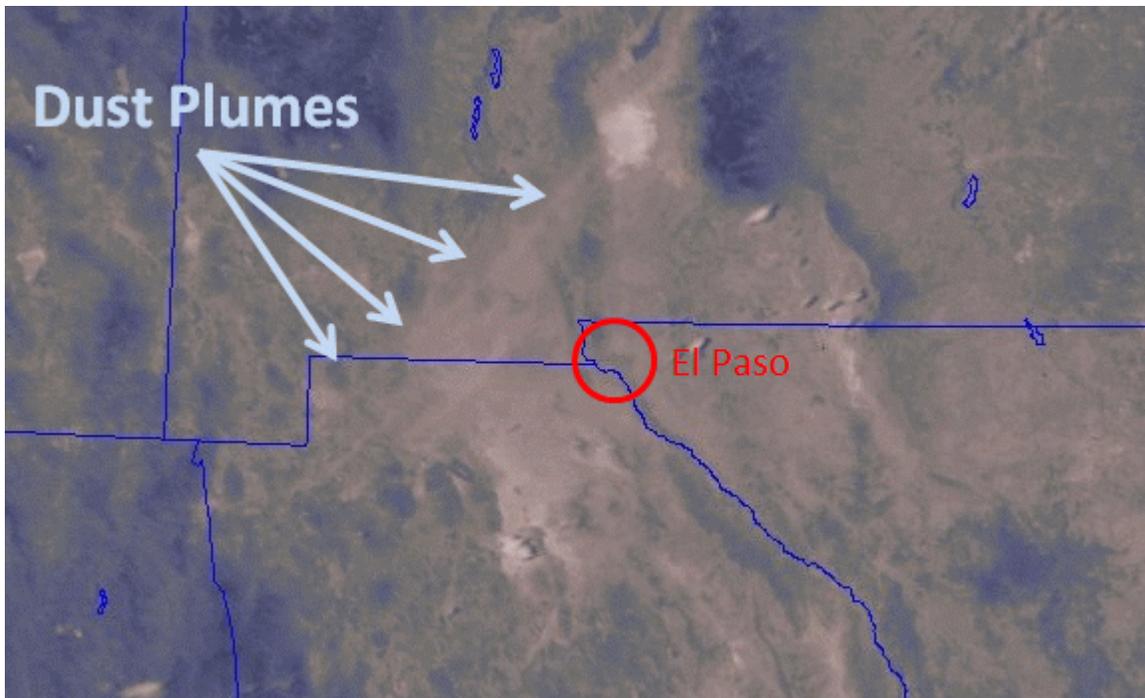


Figure I-5. GOES image for 1115 MST on March 7, 2012.

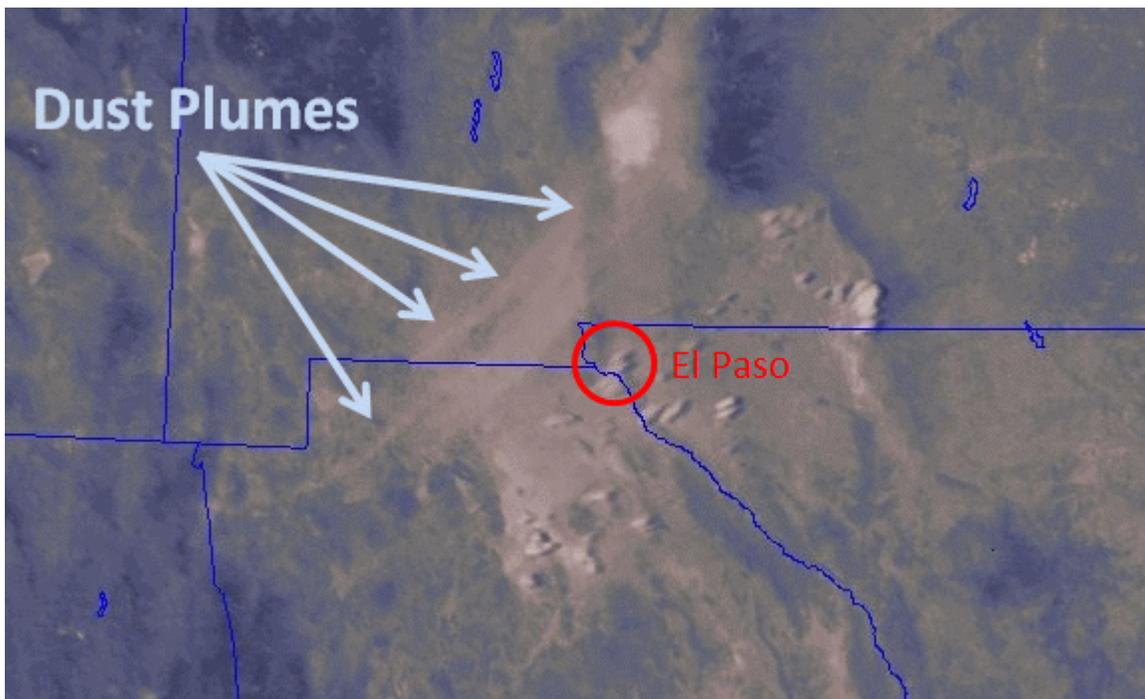


Figure I-6. GOES image for 1215 MST on March 7, 2012.

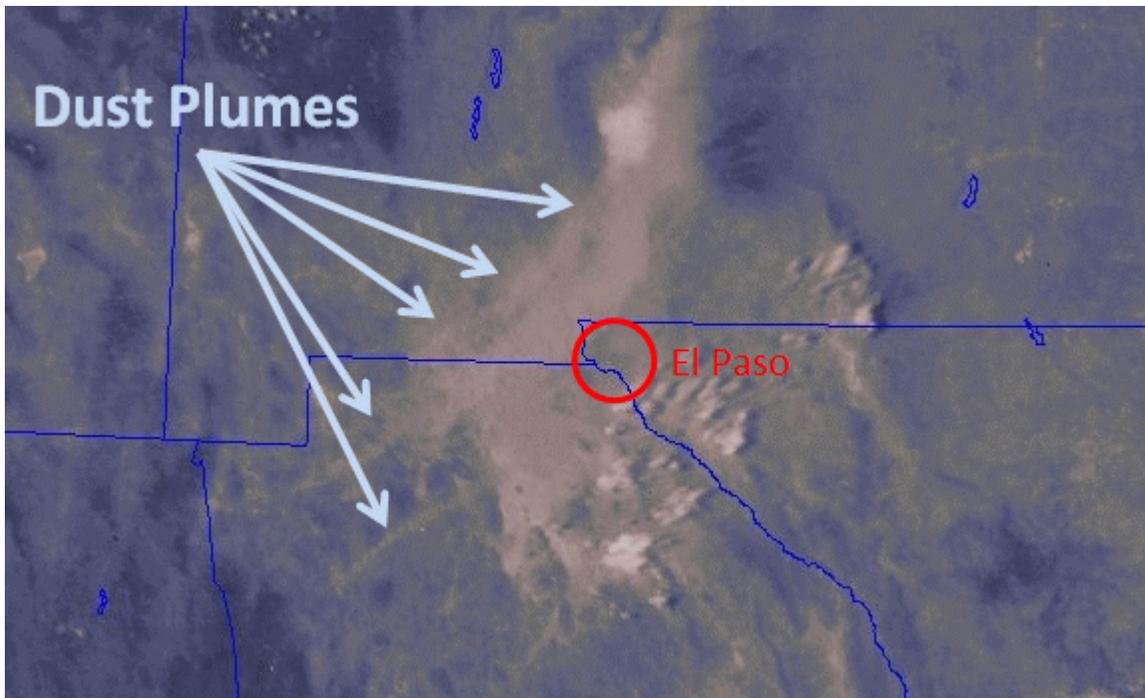


Figure I-7. GOES image for 1315 MST on March 7, 2012.

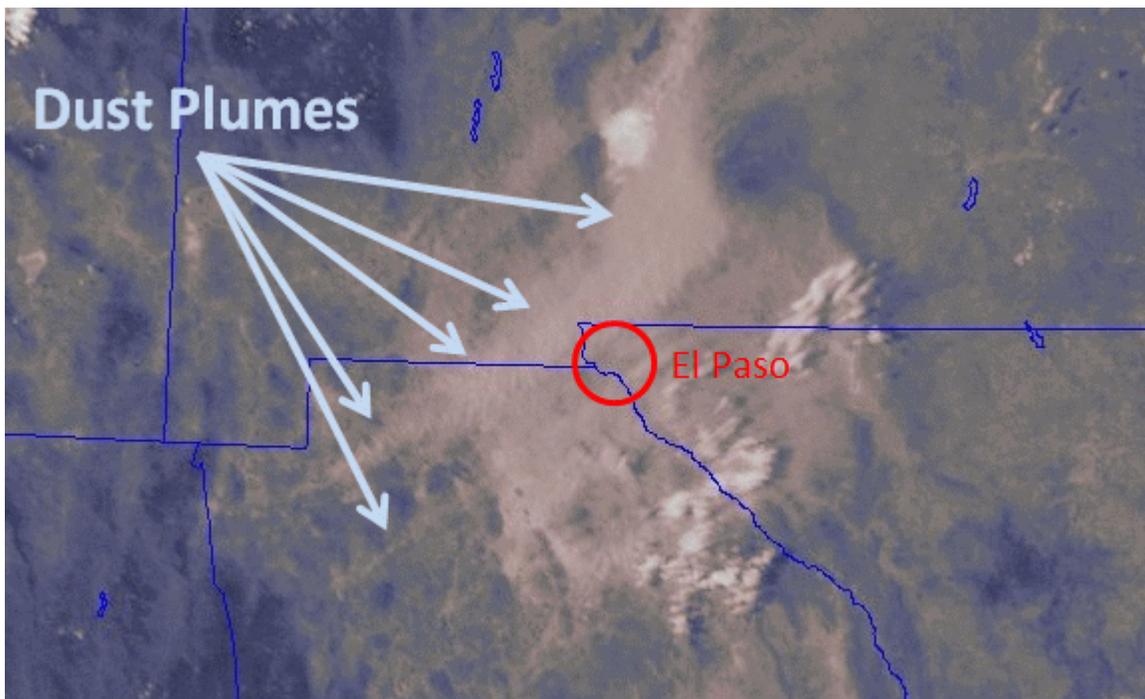


Figure I-8. GOES image for 1415 MST on March 7, 2012.

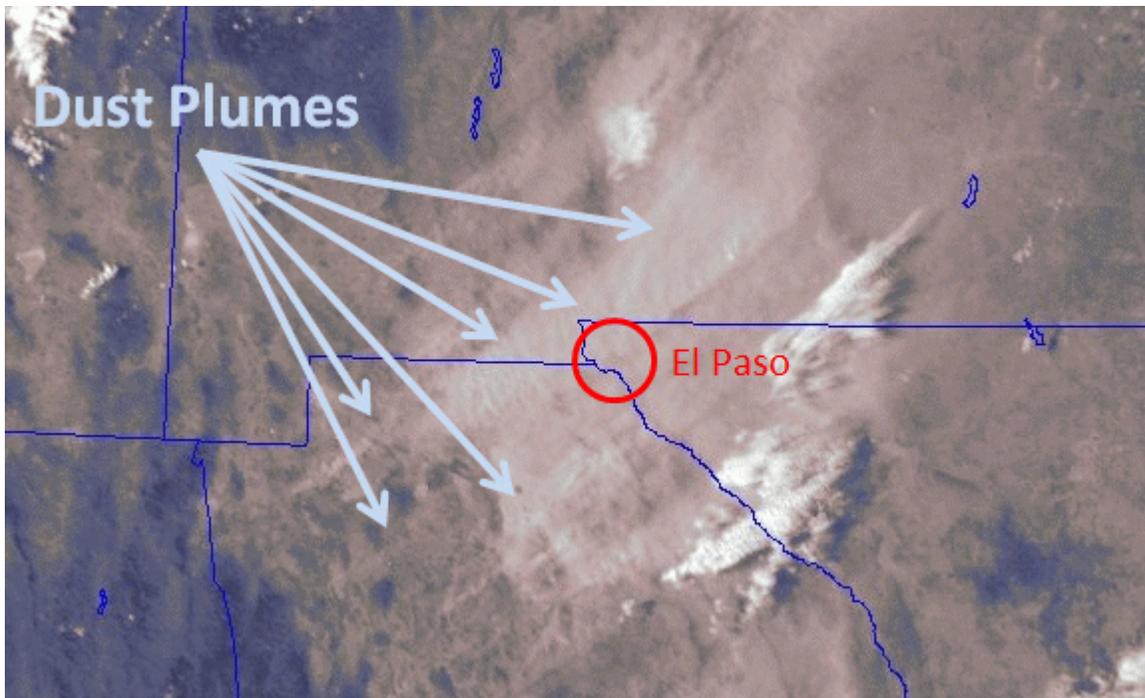


Figure I-9. GOES image for 1515 MST on March 7, 2012.

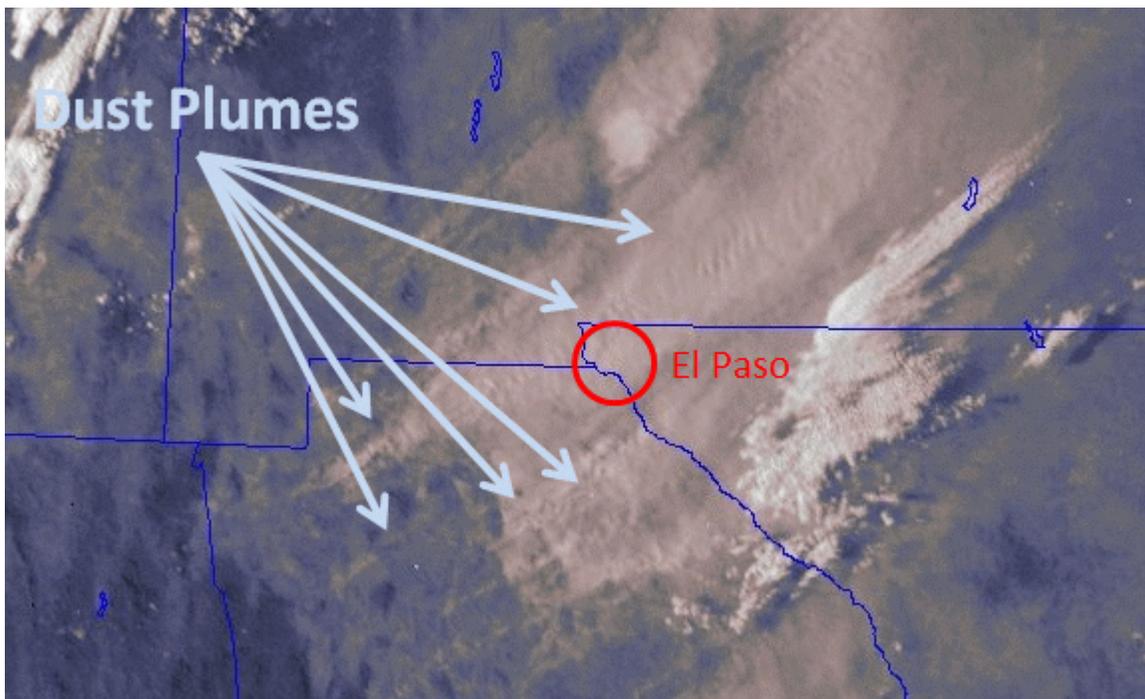


Figure I-10. GOES image for 1615 MST on March 7, 2012.

Back Trajectories

Figure I-11 provides HYSPLIT back trajectories predicting the approximate path of air arriving at the Chamizal site at 1600 MST (or 2300 UTC) on March 7, 2012. Trajectory paths are plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours. These trajectories indicate that the predicted pathway of the air arriving at the Chamizal site at the time of the highest PM_{2.5} levels on March 7, 2012, came from northern Mexico, as evidenced by satellite imagery.

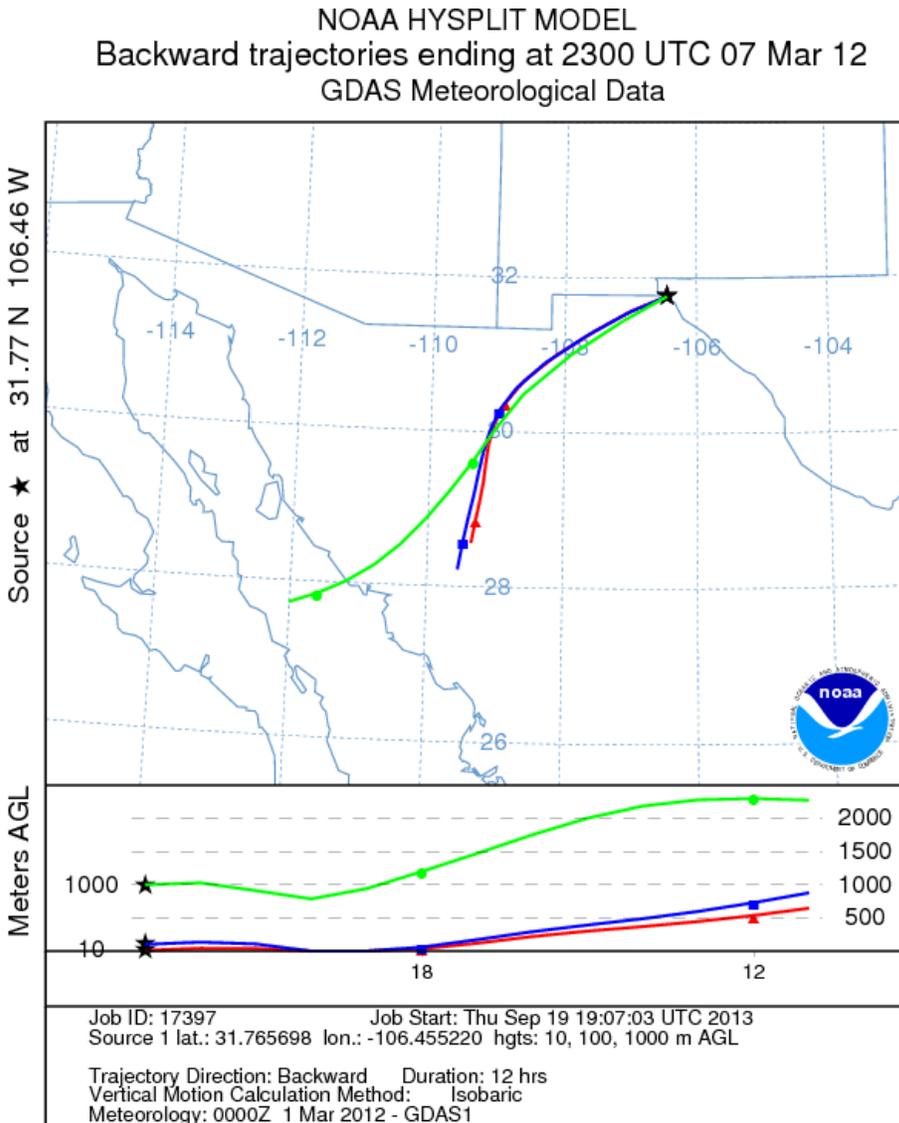


Figure I-11. Backward-in-time air trajectory for March 7, 2012, for air arriving at Chamizal at 1600 MST (2300 UTC).

Map Plots of Daily Particulate Matter Data

Figures I-12 and I-13 provide maps of daily average PM_{10} and $PM_{2.5}$ measurements from the March 7, 2012, event. Both maps show very high particulate matter concentrations along the border consistent with transport from northern Mexico.

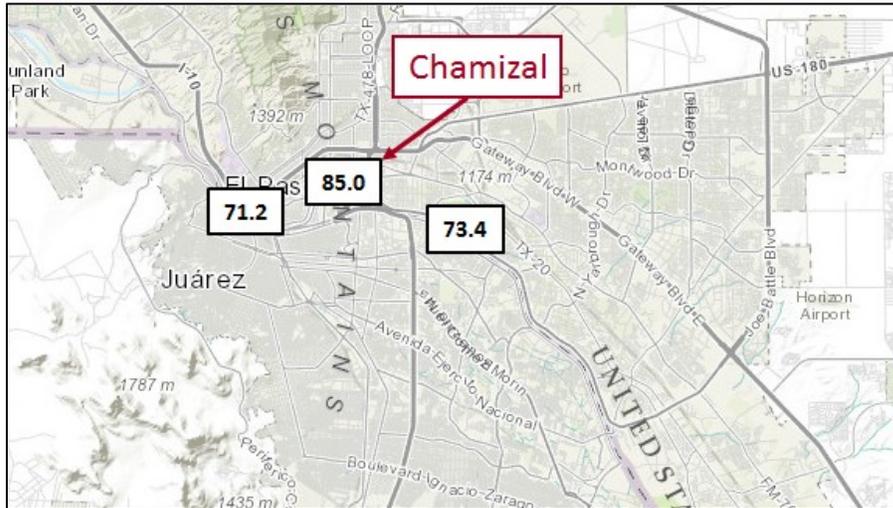


Figure I-12. Map of El Paso area daily average $PM_{2.5}$ measurements ($\mu\text{g}/\text{m}^3$ LC) on March 7, 2012.

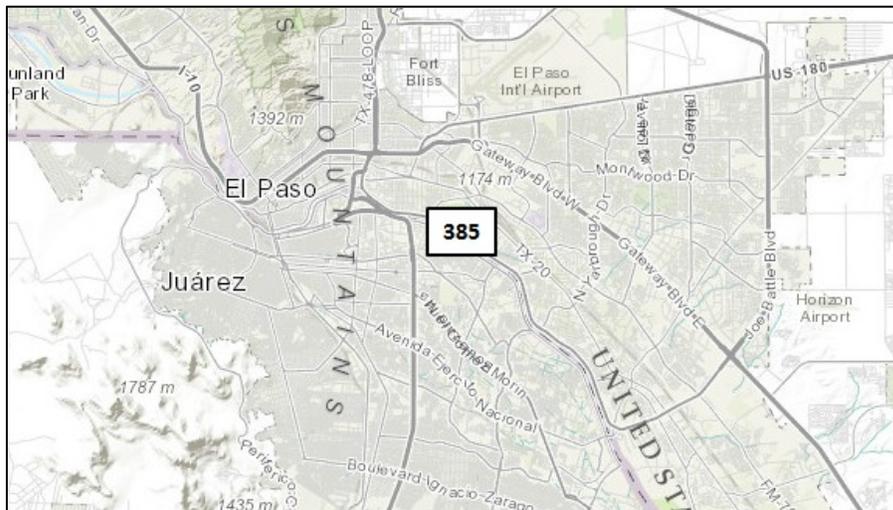


Figure I-13. Map of El Paso area daily average PM_{10} measurements ($\mu\text{g}/\text{m}^3$ SC) on March 7, 2012.

Continuous Particulate Matter and Wind Graphs

Figures I-14 and I-15 provide graphs of five-minute continuous PM_{2.5}, PM₁₀, and wind gust data for the March 7, 2012, event. A plot of the continuous five-minute PM_{2.5} data in Figure I-14 indicates a gradual rise in concentration in the early afternoon with a sharp increase about 1500 MST and very high concentrations continuing for about six hours. Once again, the changes in concentration do not directly correspond to the increases in peak wind gust and are more consistent with the transport of large dust plumes into the area. Data from the UTEP continuous PM_{2.5} monitor are missing from 0900 to 1700 MST because the data were invalidated due to the temperature in the instrument cabinet exceeding the manufacturer specified upper limit for optimal instrument operation.

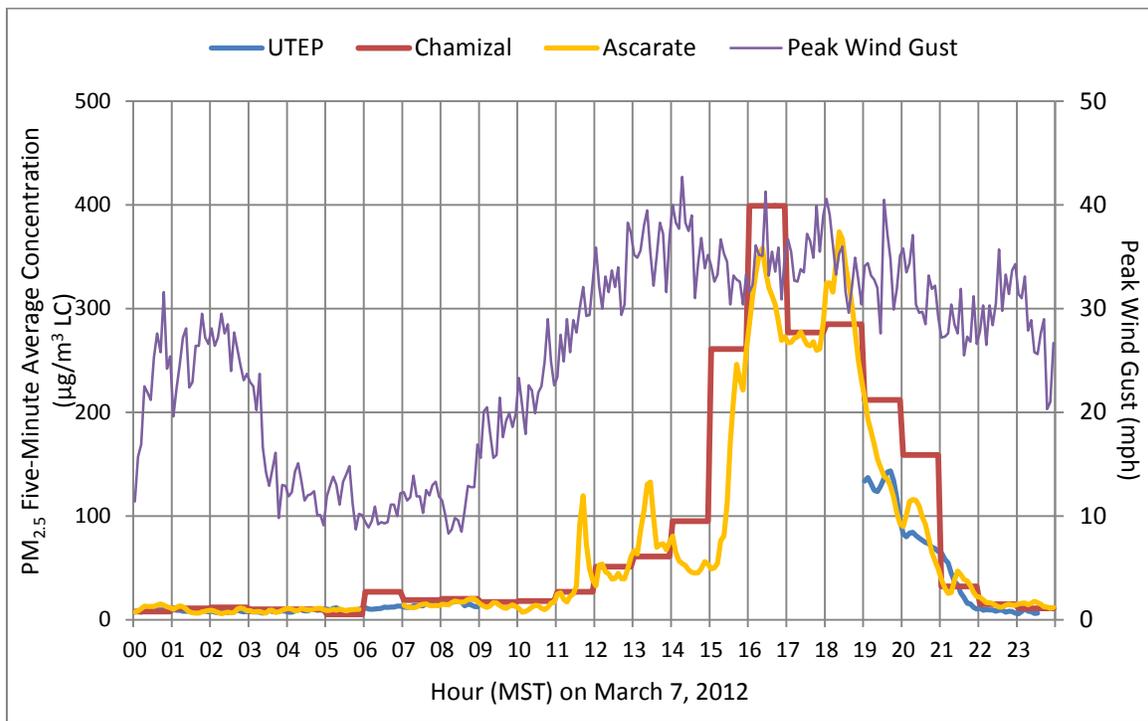


Figure I-14. El Paso five-minute average PM_{2.5} concentrations from continuous monitors on March 7, 2012.

Figure I-15 plots available continuous five-minute PM₁₀ data from two sites in the El Paso area and shows a sharp rise in PM₁₀ just before noon with several peaks throughout the afternoon and into the evening when the most intense period of blowing dust occurred. The timing of high concentrations indicated by the PM₁₀ data is in agreement with the arrival of dust plumes apparent in the satellite imagery. Data from the UTEP continuous PM₁₀ monitor are missing from 0800 to 1800 MST because the data were invalidated due to the

temperature in the instrument cabinet exceeding the manufacturer specified upper limit for optimal instrument operation.

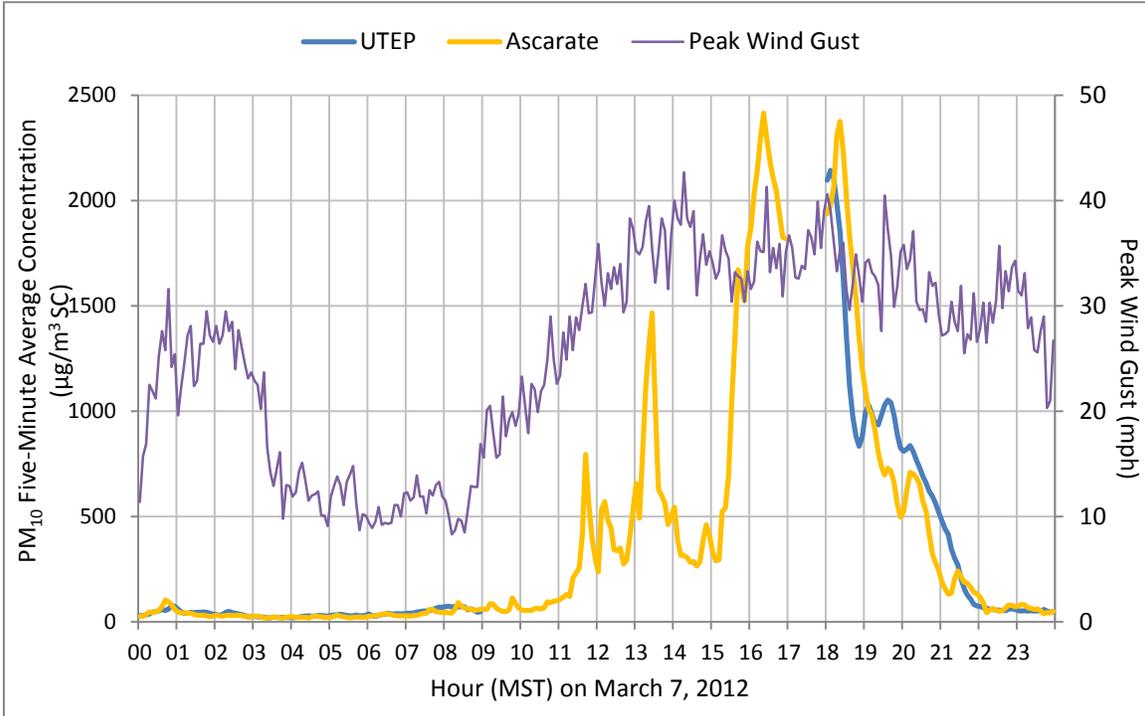


Figure I-15. El Paso five-minute average PM₁₀ concentrations from continuous monitors on March 7, 2012.

Appendix J: Event Analysis for March 18, 2012

Event Summary

A large low pressure system centered in southeastern Colorado brought strong southwest winds across a large region from New Mexico into northern Mexico and far West Texas on March 18, 2012. Figure J-1 shows a weather map for March 18, 2012, at 1400 MST provided by NOAA depicting the large low pressure system.

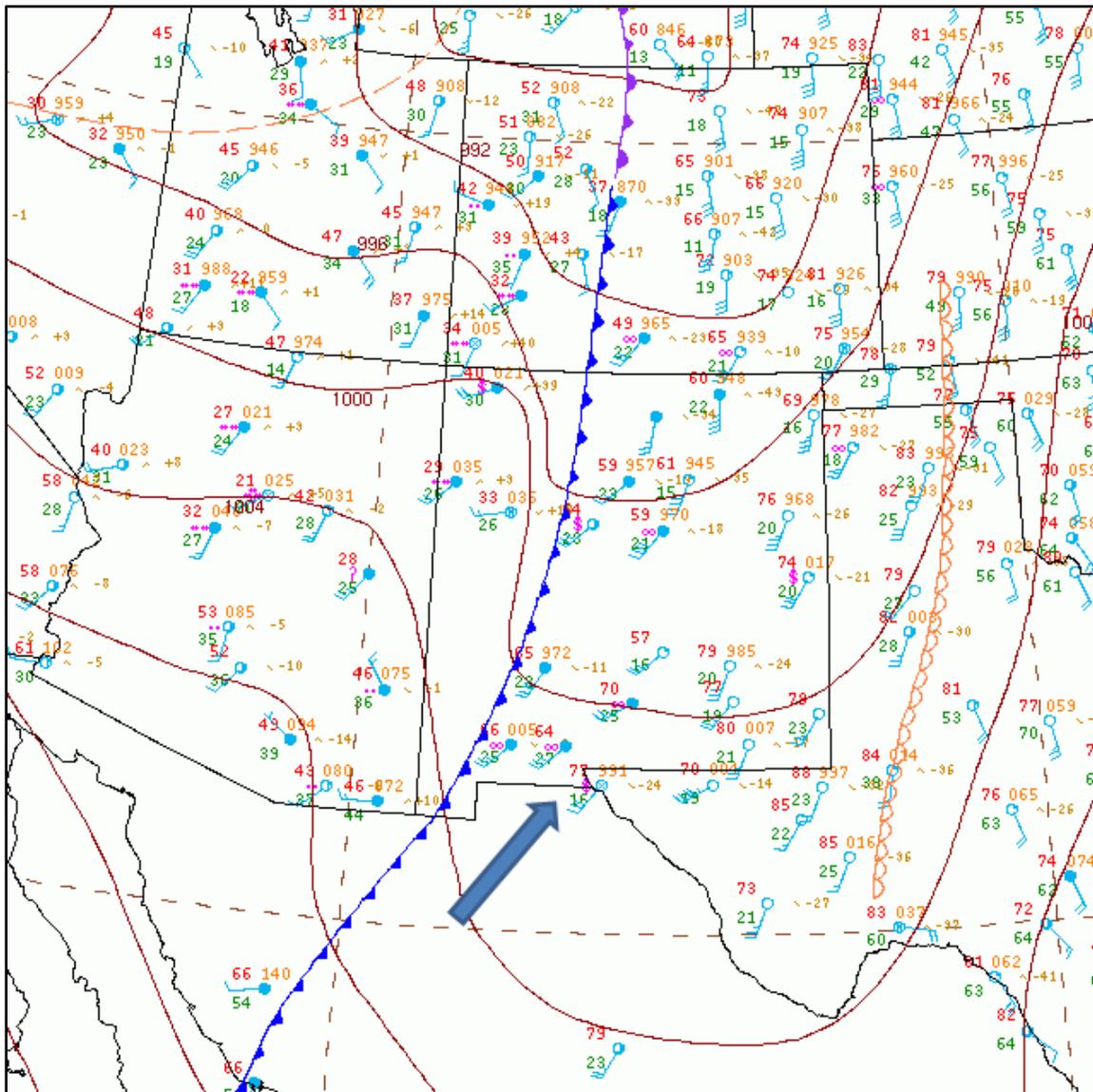


Figure J-1. Regional weather map for 1400 MST on March 18, 2012.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots and the wind speed is the sum of the values shown with the individual barbs. Wind direction in the El Paso area is indicated by a large arrow.

High winds associated with this low pressure system generated a large area of blowing dust in northern Mexico that began impacting the El Paso area in the late morning and reached peak intensity in the afternoon with a pronounced, very intense peak at all sites for the hour beginning 1700 MST. Area peak wind gusts reached 66 mph and peak sustained winds were up to 49 mph at the El Paso Airport. Only continuous particulate matter measurements were available on this day since it was not a routine sample day for any of the non-continuous monitors.

An exceptional event flag is proposed for the Chamizal continuous FEM PM_{2.5} daily average measurement of 130.4 µg/m³ on this day. The FEM PM_{2.5} monitor measured a peak one-hour average of 716 µg/m³ for the hour beginning at 1700 MST. The hourly average PM_{2.5} concentration was above the 24-hour NAAQS of 35 µg/m³ for the 13 hours beginning at 1100 MST through the end of the day and the average wind direction during this period was from 255 degrees (west-southwest) at an average speed of 25.9 mph. The peak measured wind gust at Chamizal was 63.7 mph and the highest five-minute average wind speed was 39.1 mph.

Webcam Images

The El Paso Chelsea Street and Ranger Peak webcams provided visual images of the dust impacting the El Paso area on March 18, 2012. A map of the webcam locations was previously presented in Figure 13.

Figures J-2 and J-3 show the webcam views at 0800 MST when dust levels were low compared to the 1700 MST view with intense blowing dust near the peak of the event. Downtown El Paso to the west-southwest and the Juarez Mountains to the west to southwest are clearly visible in the 0800 MST frame, but are totally obscured by intense blowing dust in the 1700 MST frame.



Figure J-2. El Paso Chelsea Street webcam images for 0800 MST (top) and 1700 MST (bottom) on March 18, 2012.

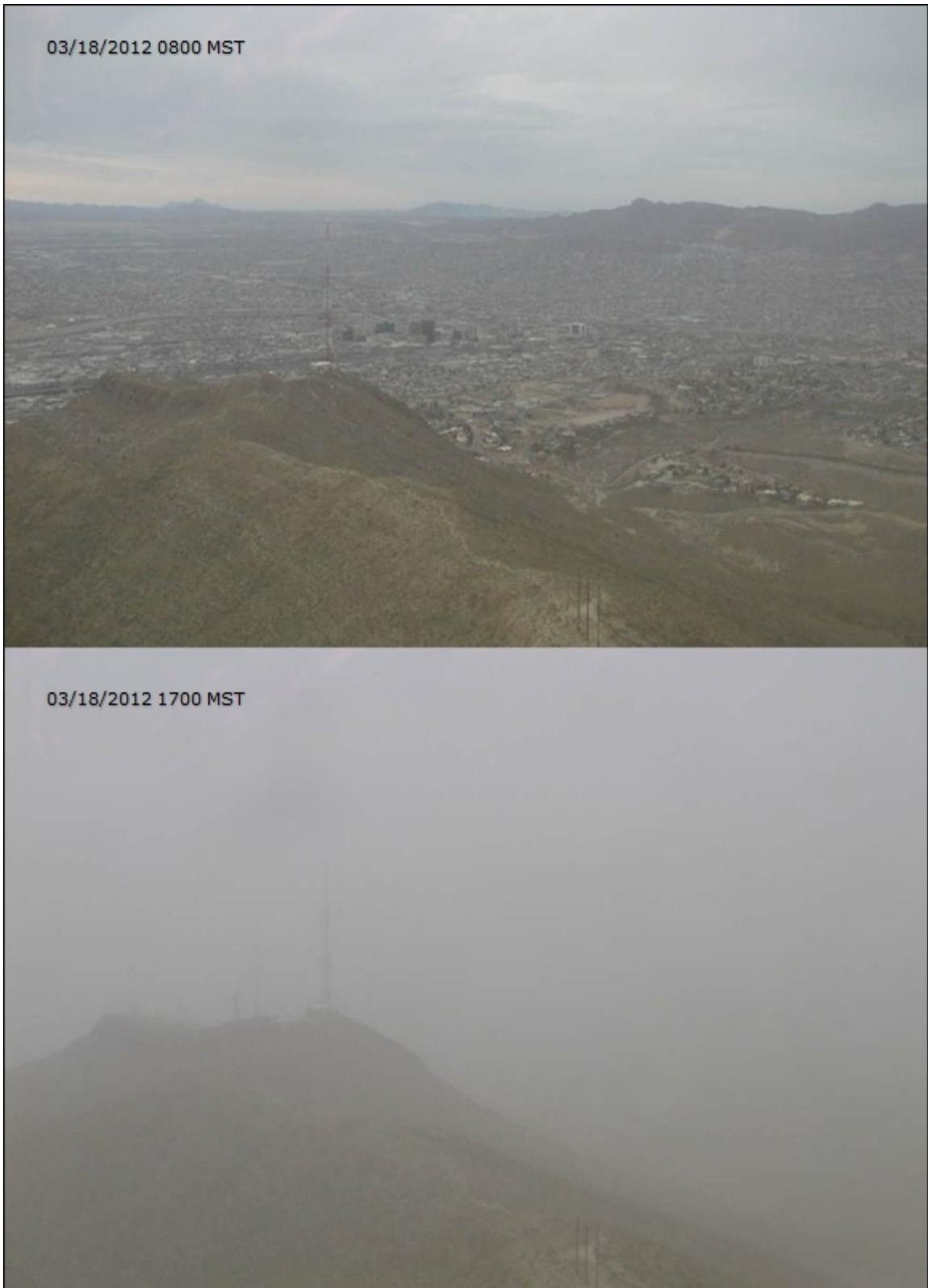


Figure J-3. El Paso Ranger Peak webcam images for 0800 MST (top) and 1700 MST (bottom) on March 18, 2012.

Satellite Imagery

Satellite imagery available for this day is somewhat obscured by heavy cloud cover making it difficult to identify the intense dust plumes generated in northern Mexico. Figure J-4 shows two true color composite MODIS visible wavelength images of the El Paso area on March 18, 2012, provided by the UW SSEC. The top image, from the Terra satellite at 1030 MST, shows hints of blowing dust developing in northern Mexico. The bottom image shows the same view from the Aqua satellite at 1350 MST, however heavy cloud cover over most of the area limits visibility of blowing dust to areas between the clouds. In Figure J-4 El Paso is circled in red in the upper right side of each image and the Texas and Mexico boundaries are marked by gray lines.

A sequence of four GOES visible satellite images for March 18, 2012, from 1315 MST through 1615 MST is presented in Figures J-5 through J-8. The GOES images are not as high in resolution as the MODIS images and show heavy cloud cover moving into the El Paso area in the afternoon that obscures the blowing dust. Even though cloud cover obscures the blowing dust, the wind flow pattern, as indicated by regional wind measurements and back trajectories, is identical to other intense blowing dust events where dust plumes are visible on satellite imagery.

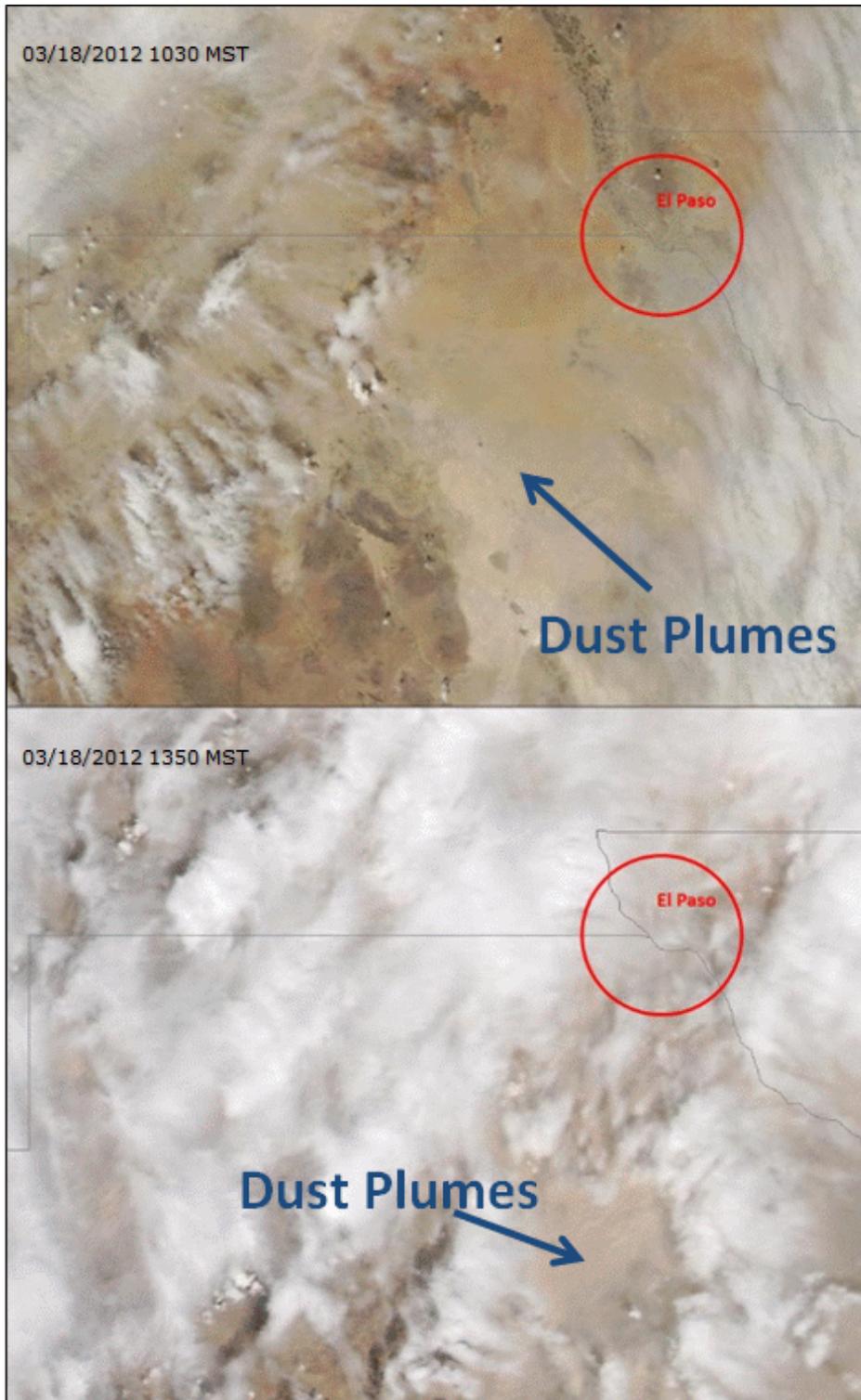


Figure J-4. True color Terra satellite image at 1030 MST in top frame showing hints of early blowing dust in northern Mexico on March 18, 2012, and in the bottom frame a later true color image from the Aqua satellite at 1350 MST shows heavy cloud cover but visible blowing dust between the clouds.

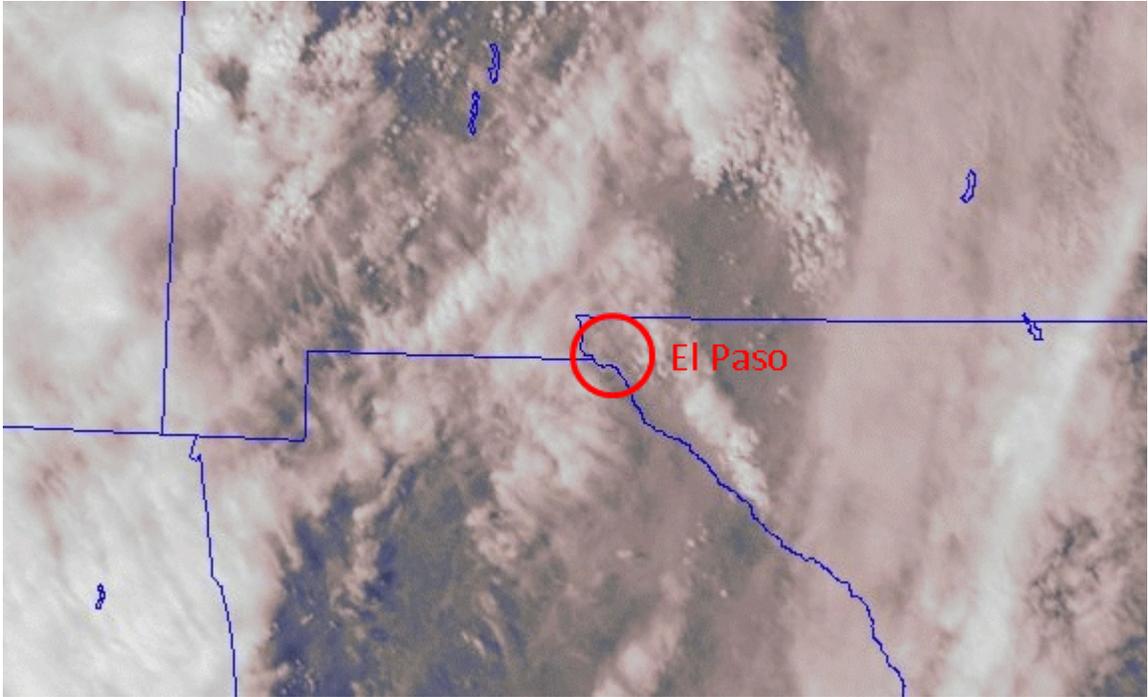


Figure J-5. GOES image for 1315 MST on March 18, 2012.

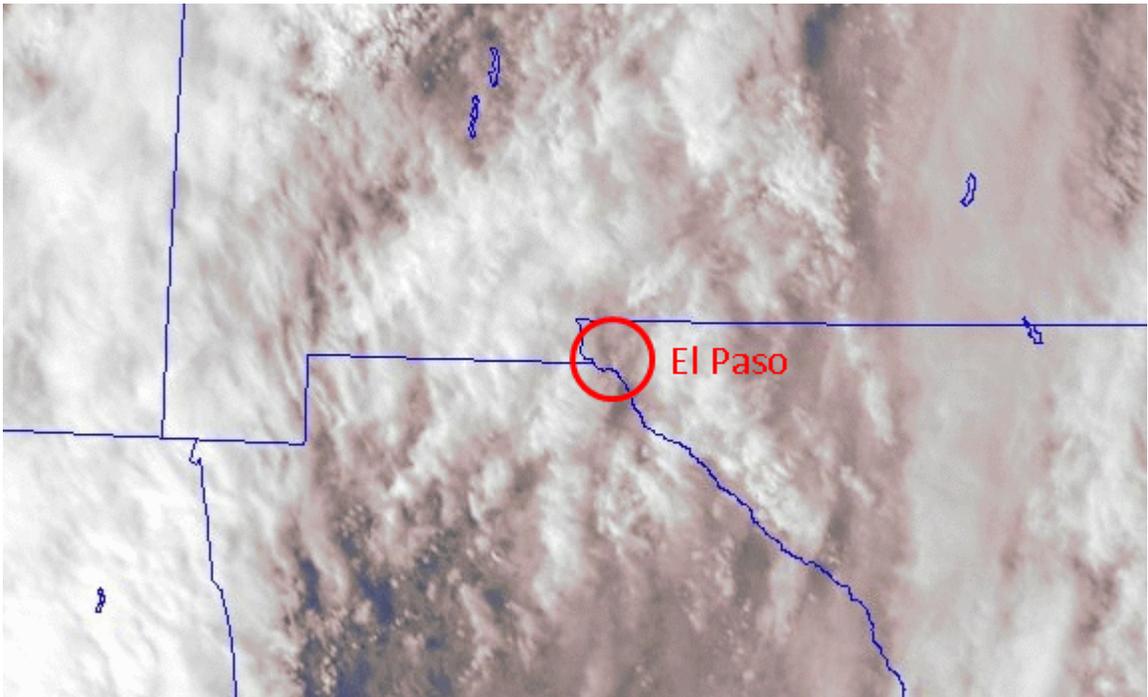


Figure J-6. GOES image for 1415 MST on March 18, 2012.



Figure J-7. GOES image for 1515 MST on March 18, 2012.

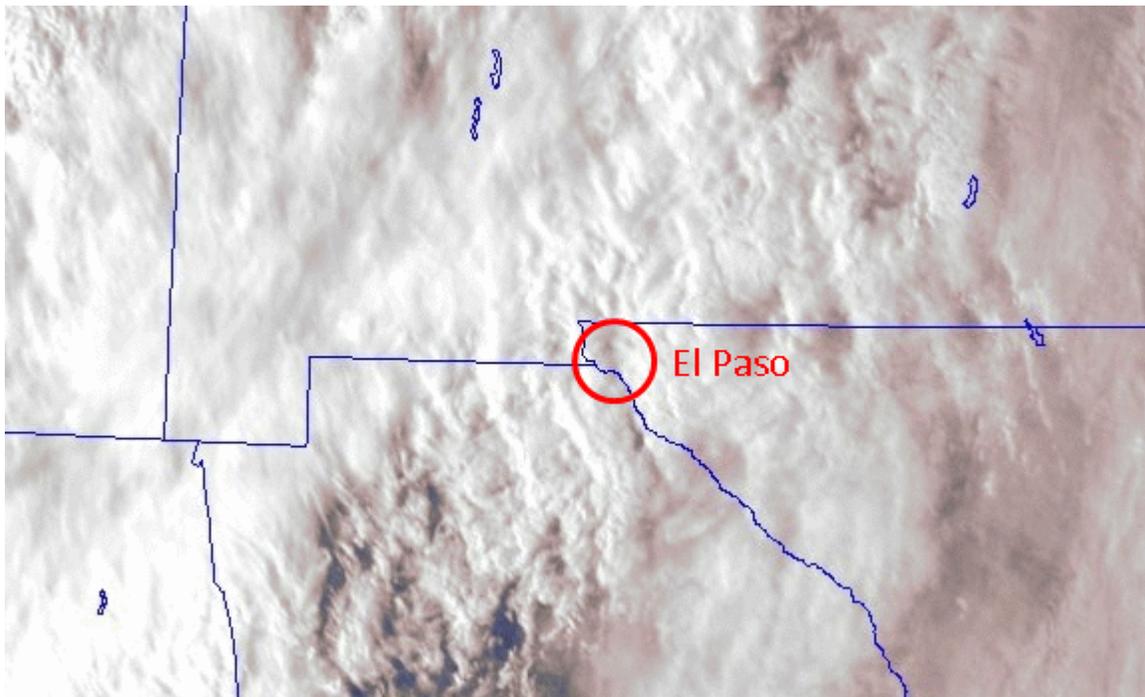


Figure J-8. GOES image for 1615 MST on March 18, 2012.

Back Trajectories

Figure J-9 provides HYSPLIT back trajectories that predict the approximate path of air arriving at the Chamizal site at 1700 MST (or 0000 UTC) on March 18, 2012. Trajectories are plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours. These trajectories indicate that the predicted pathway of the air arriving at the Chamizal site at the time of the highest PM_{2.5} levels on March 18, 2012, came from northern Mexico.

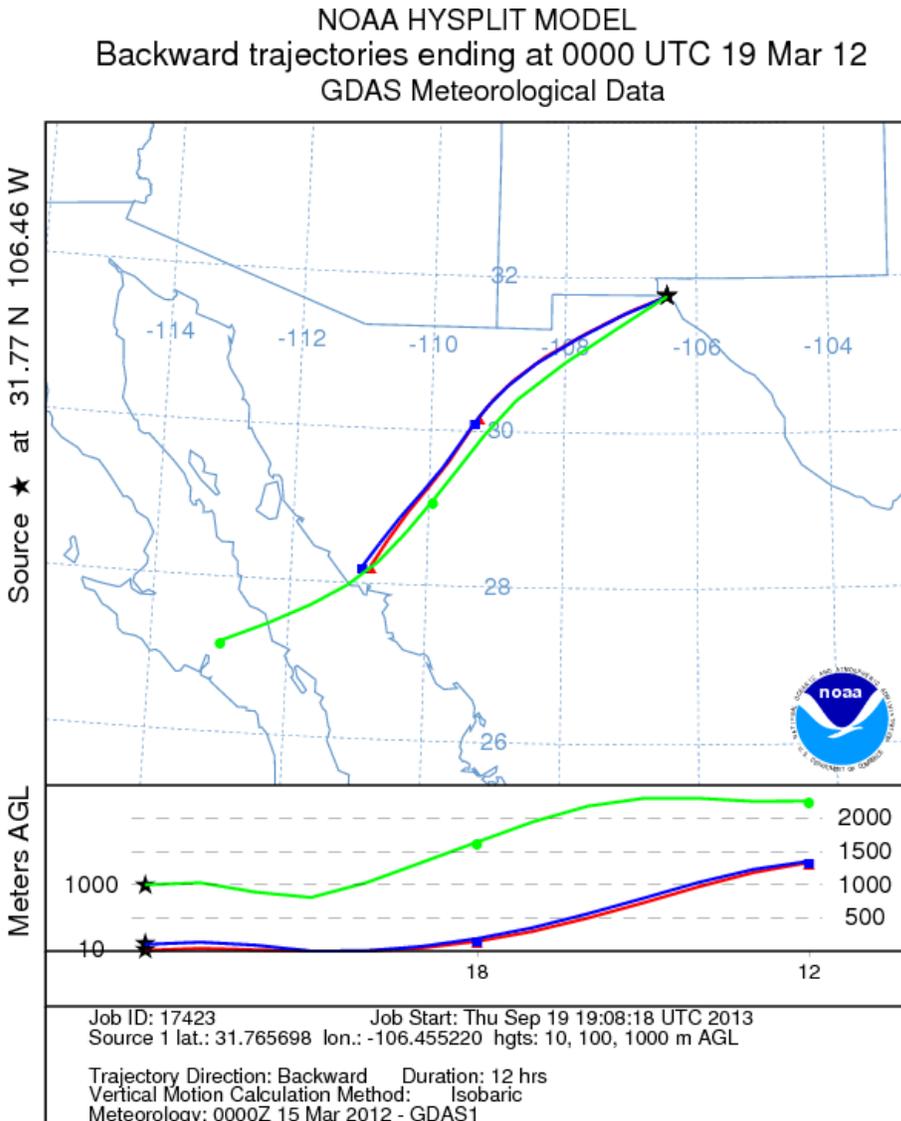


Figure J-9. Backward-in-time air trajectory for March 18, 2012, for air arriving at Chamizal at 1700 MST (0000 UTC on March 19, 2012).

Map Plots of Daily Particulate Matter Data

Maps of daily average PM_{10} and $PM_{2.5}$ measurements from the March 18, 2012, event provided in Figures J-10 and J-11 show extremely high particulate concentrations across the El Paso area. PM_{10} measurements at both UTEP and Ascarate reached "Hazardous" on the AQI scale for this day.

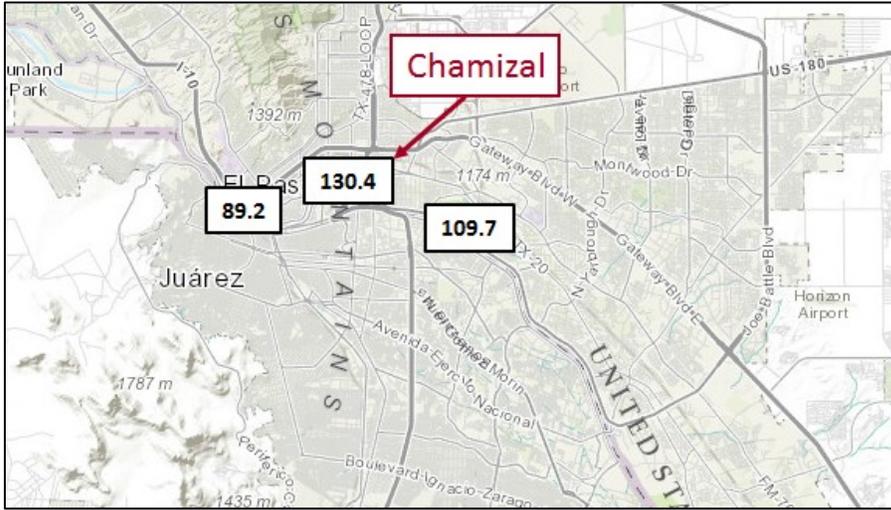


Figure J-10. Map of El Paso area daily average $PM_{2.5}$ measurements ($\mu\text{g}/\text{m}^3$ LC) on March 18, 2012.

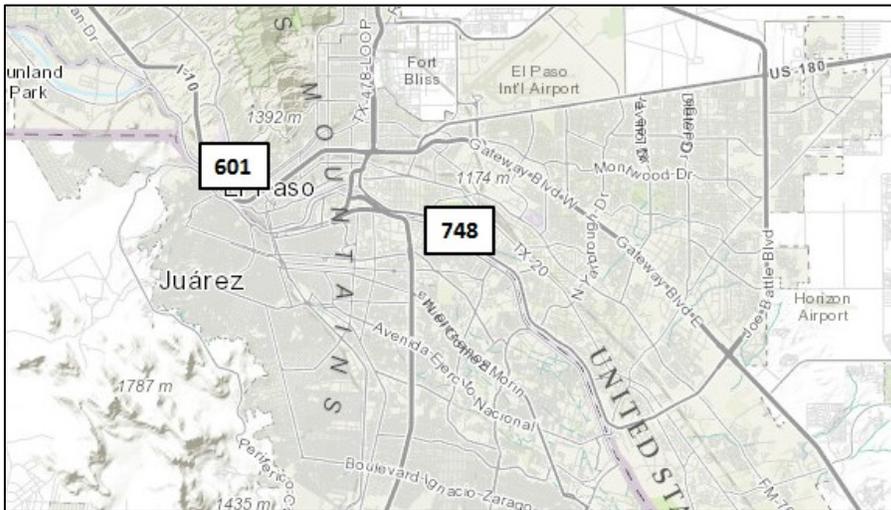


Figure J-11. Map of El Paso area daily average PM_{10} measurements ($\mu\text{g}/\text{m}^3$ SC) on March 18, 2012.

Continuous Particulate Matter and Wind Graphs

Figures J-12 and J-13 present graphs of five-minute continuous PM_{2.5}, PM₁₀, and wind gust data for the March 18, 2012 event. A plot of continuous five-minute PM_{2.5} data in Figure J-12 indicates intense dust arriving first at Chamizal around 1300 MST and then later at Ascarate farther to the east around 1500 MST, consistent with dust advecting from west to east as in many of the previous events. Particulate measurements at all three sites spike sharply to very high levels at 1700 MST and then fall rapidly by 1900 MST, indicating the passing of an intense dust plume. Data from the UTEP continuous PM_{2.5} monitor are missing from 0900 to 1600 MST because the data were invalidated due to the temperature in the instrument cabinet exceeding the manufacturer specified upper limit for optimal instrument operation.

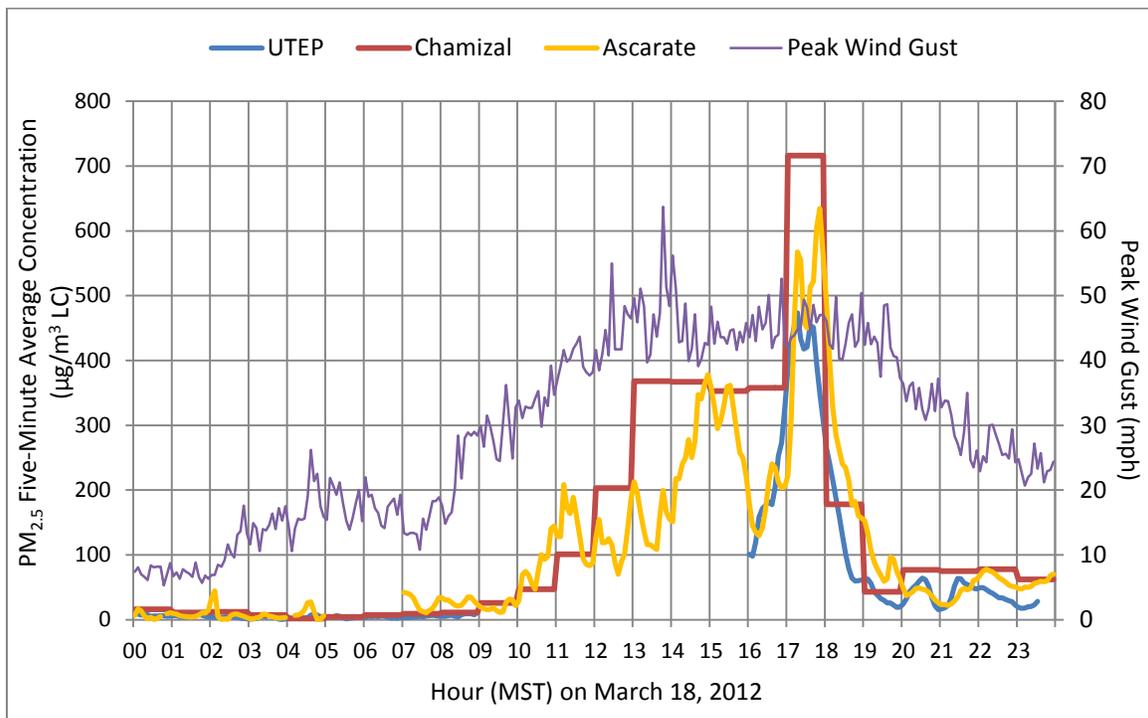


Figure J-12. El Paso five-minute average PM_{2.5} concentrations from continuous monitors on March 18, 2012.

Figure J-13 plots continuous five-minute PM₁₀ data from two sites in the El Paso area and shows a gradual rise in particulate from around 1000 MST to 1400 MST with a very high spike in concentrations at both sites at 1700 MST. The five-minute PM₁₀ concentrations at UTEP pegged at the instrument full-scale of 5,000 $\mu\text{g}/\text{m}^3$ for almost an hour at that time. Data from the UTEP continuous PM₁₀ monitor are missing from 1000 to 1600 MST because the data were invalidated due to the

temperature in the instrument cabinet exceeding the manufacturer specified upper limit for optimal instrument operation.

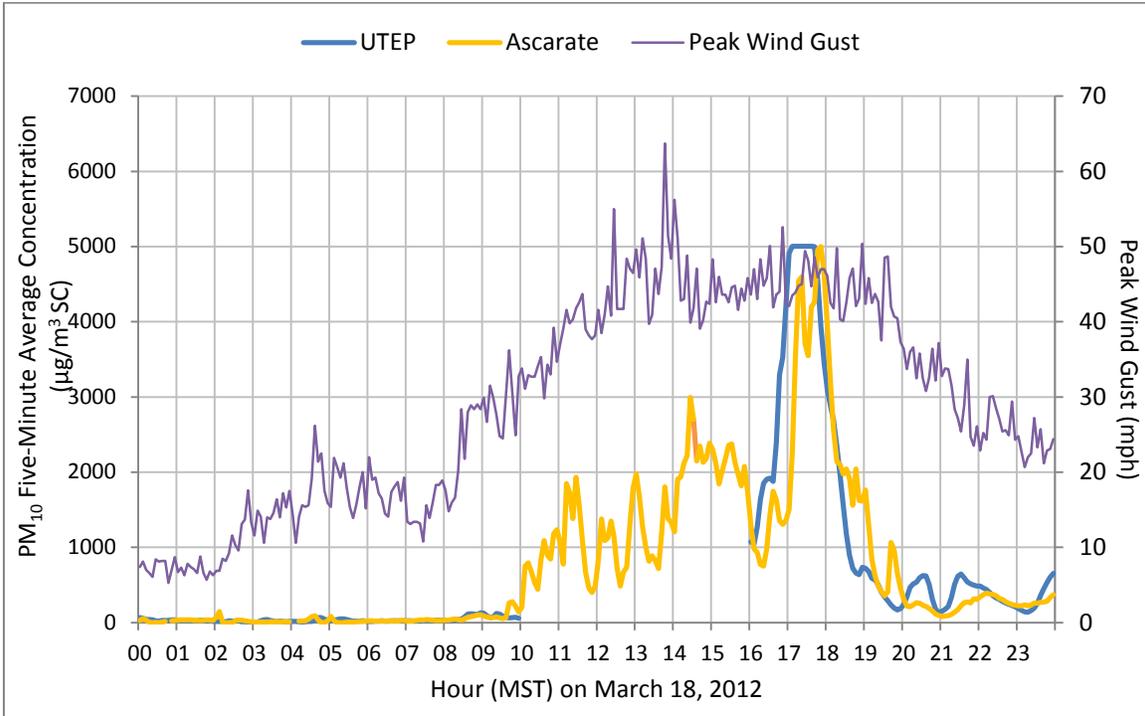


Figure J-13. El Paso five-minute average PM₁₀ concentrations from continuous monitors on March 18, 2012.

Appendix K: Event Analysis for November 10, 2012

Event Summary

A large low pressure system centered in eastern Colorado brought strong west to southwest winds across a large region from southern New Mexico and Arizona and into northern Mexico and far West Texas on November 10, 2012. Figure K-1 shows a weather map for November 10, 2012, at 1400 MST provided by NOAA depicting the large low pressure system.

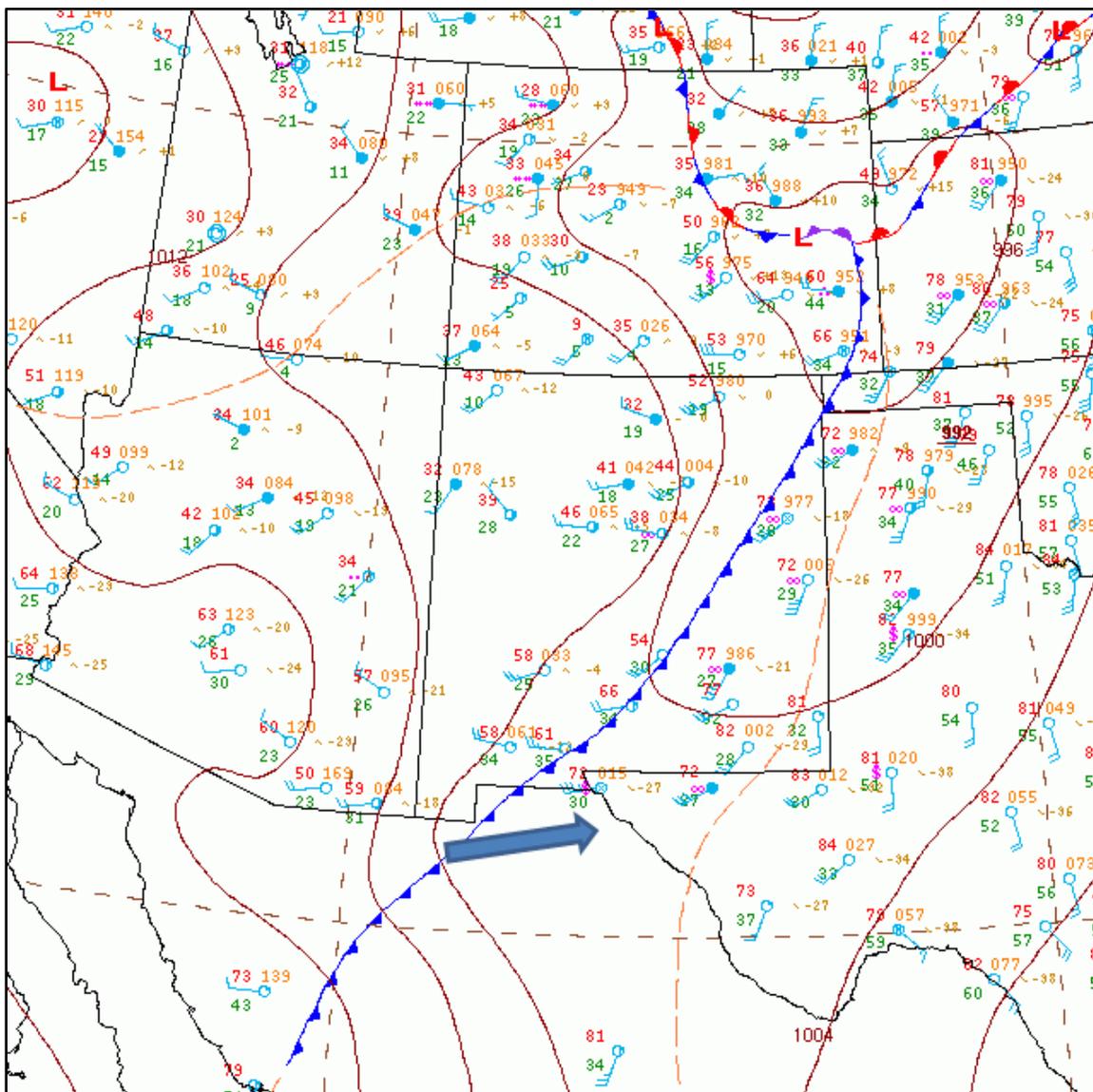


Figure K-1. Regional weather map for 1400 MST on November 10, 2012.

On the weather map, winds are shown in blue with wind blowing along the line toward each weather station indicated by a circle. Barbs at the end of each wind vector indicate the wind speed with a full barb for 10 nautical miles per hour (knots) and a half barb for 5 knots and the wind speed is the sum of the values shown with the individual barbs. Wind direction in the El Paso area is indicated by a large arrow.

High winds associated with this low pressure system generated an area of blowing dust in northern Mexico that began impacting the El Paso area in the late morning with high particulate matter concentrations from 1100 MST to 1700 MST and very high concentrations from 1200 to 1500 MST. Peak wind gusts reached 54 mph and peak sustained winds were up to 43 mph. Only continuous particulate matter measurements were available on this day since it was not a routine sample day for any of the non-continuous monitors.

An exceptional event flag is proposed for the Chamizal continuous FEM PM_{2.5} daily average measurement of 45.7 µg/m³ on this day. The FEM PM_{2.5} monitor measured a peak one-hour average of 377 µg/m³ for the hour beginning at 1300 MST. The hourly average PM_{2.5} concentration was above the 24-hour NAAQS of 35 µg/m³ for the five hours beginning at 1100 MST and the average wind direction during this period was from 267 degrees (slightly south of west) at an average speed of 24.8 mph. The wind direction gradually shifted from west-southwest at the beginning of the high particulate matter period to west-northwest by the end of the period. The peak measured wind gust at Chamizal was 54.0 mph and the highest five-minute average wind speed was 36.4 mph.

Webcam Images

The El Paso Ranger Peak webcam provided visual images of the dust impacting the El Paso area on November 10, 2012. The Chelsea Street webcam was not operating that day. A map of the webcam locations was previously presented in Figure 13.

Figure K-2 shows the Ranger Peak webcam view at 0930 MST when dust levels were low compared to the 1300 MST view with intense blowing dust near the peak of the event. From the Ranger Peak webcam, downtown El Paso is about 2 miles to the south-southwest and the Juarez Mountains about 8 miles south to southwest and are clearly visible in the 0930 MST frame, but are totally obscured by intense blowing dust in the 1300 MST frame.



Figure K-2. El Paso Ranger Peak webcam images for 0930 MST (top) and 1300 MST (bottom) on November 10, 2012.

Satellite Imagery

Satellite imagery for this day provides strong evidence of the intense dust plumes generated in northern Mexico blowing east-northeastward into the El Paso area. Figure K-3 shows two true color composite MODIS visible wavelength images of the El Paso area on November 10, 2012, provided by the UW SSEC. The top image is from the Terra satellite, whose trajectory on this day required two passes to capture the El Paso area of interest. The first pass displayed on the far right side of the image occurred at 1005 MST and shows hints of blowing dust south of the El Paso area. The second pass, almost two hours later at 1145 MST, shows intense dust plumes over northern Mexico already impacting the El Paso area. The bottom image shows the same view from the Aqua satellite at 1320 MST with intense blowing dust visible in northern Mexico and far West Texas. In Figure K-3 El Paso is circled in red in the upper right side of each image and the Texas and Mexico boundaries are marked by gray lines.

Figures K-4 through K-9 provide a sequence of six GOES visible satellite images for November 10, 2012, from mid-day at 1115 MST through 1615 MST. The GOES images are not as high in resolution as the MODIS images, but dust plumes can be seen developing in northern Mexico early before advecting into the El Paso area.

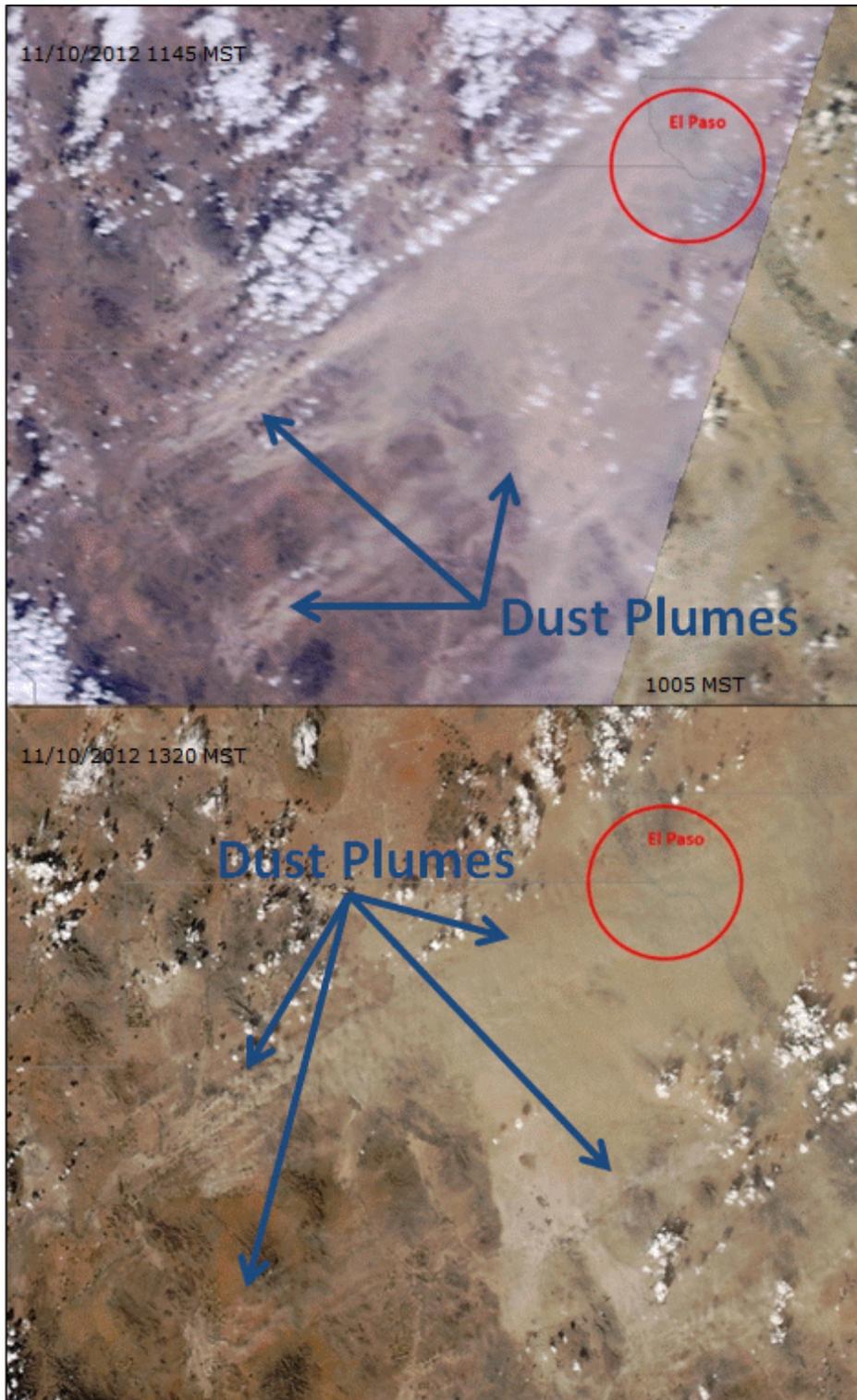


Figure K-3. True color Terra satellite composite image from two passes at 1005 MST and 1145 MST in top frame showing blowing dust starting early in northern Mexico on November 10, 2012, and in the bottom frame a later true color image from the Aqua satellite at 1320 MST shows visible blowing dust heavily impacting the El Paso area.

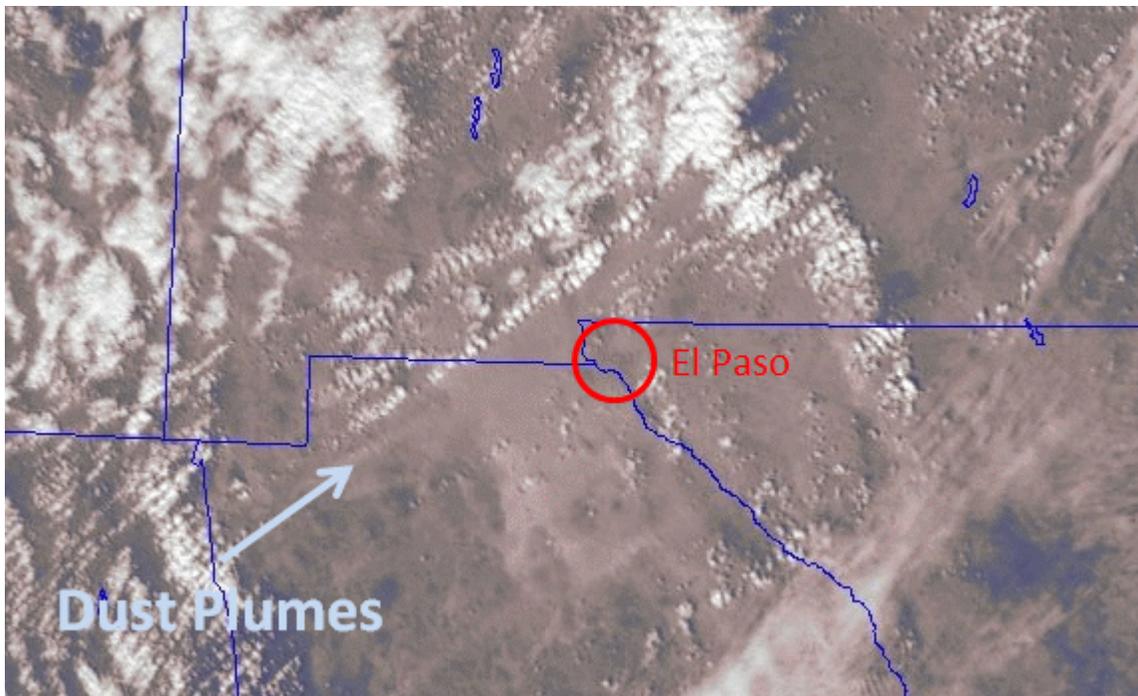


Figure K-4. GOES image for 1115 MST on November 10, 2012.

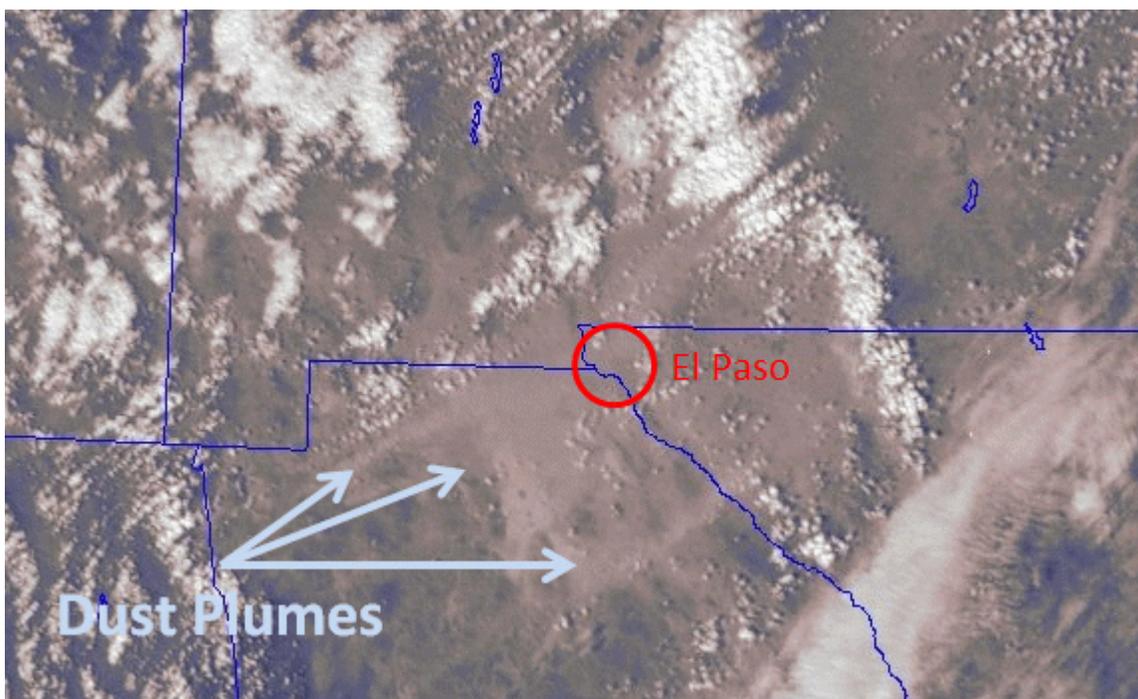


Figure K-5. GOES image for 1215 MST on November 10, 2012.

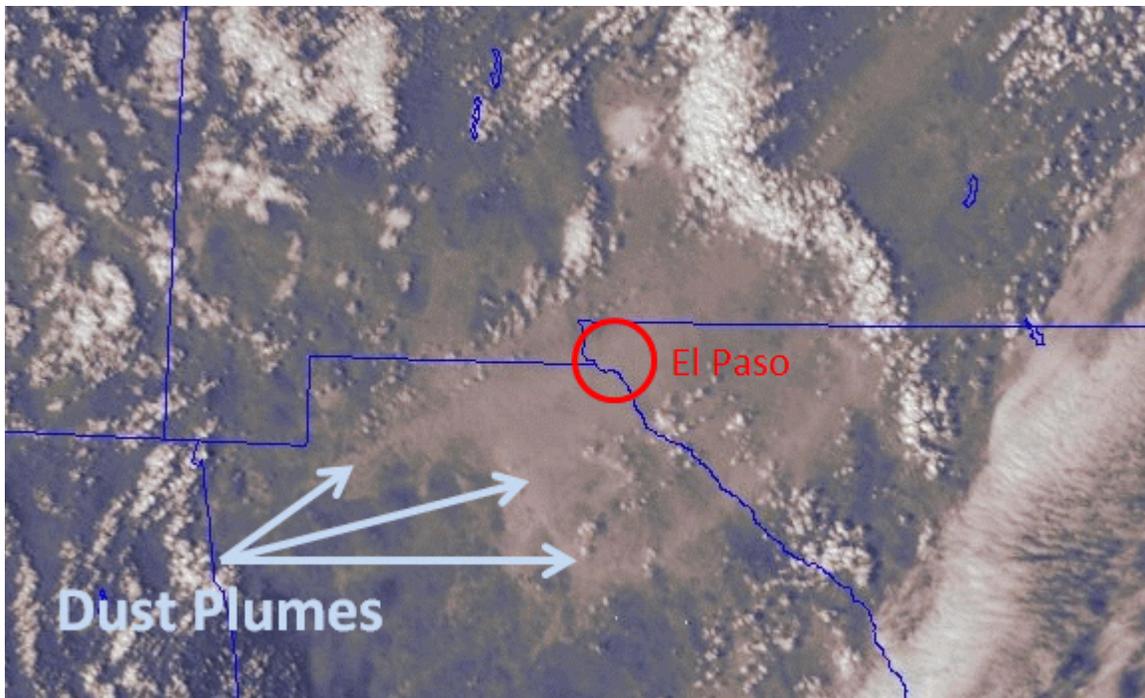


Figure K-6. GOES image for 1315 MST on November 10, 2012.

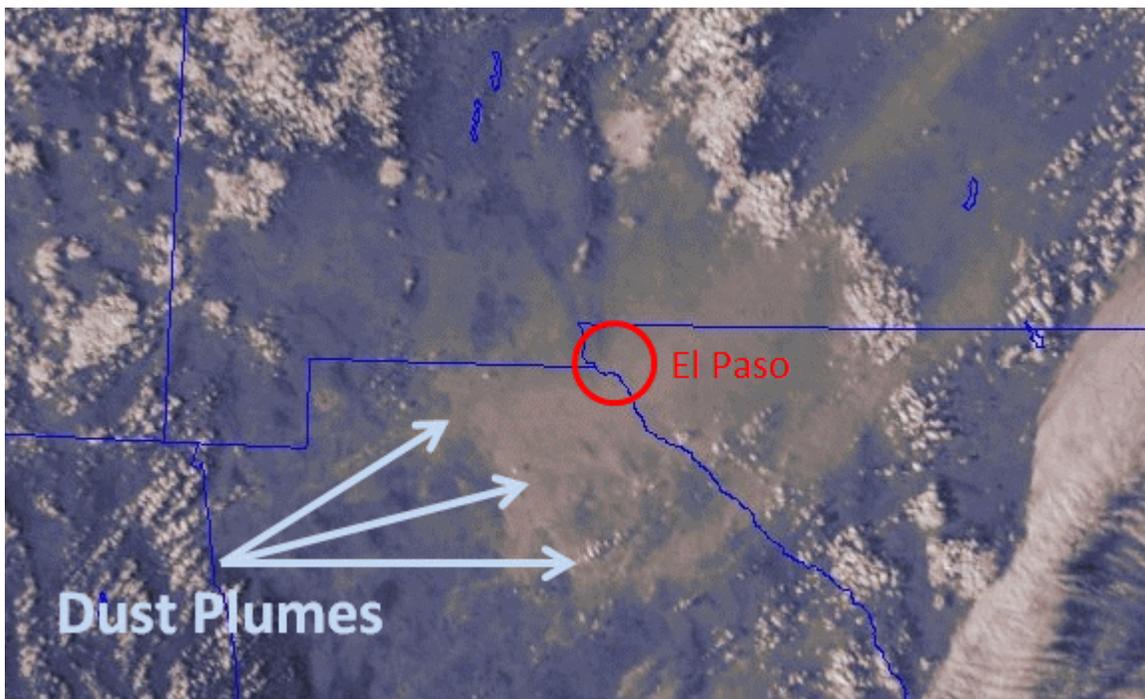


Figure K-7. GOES image for 1415 MST on November 10, 2012.

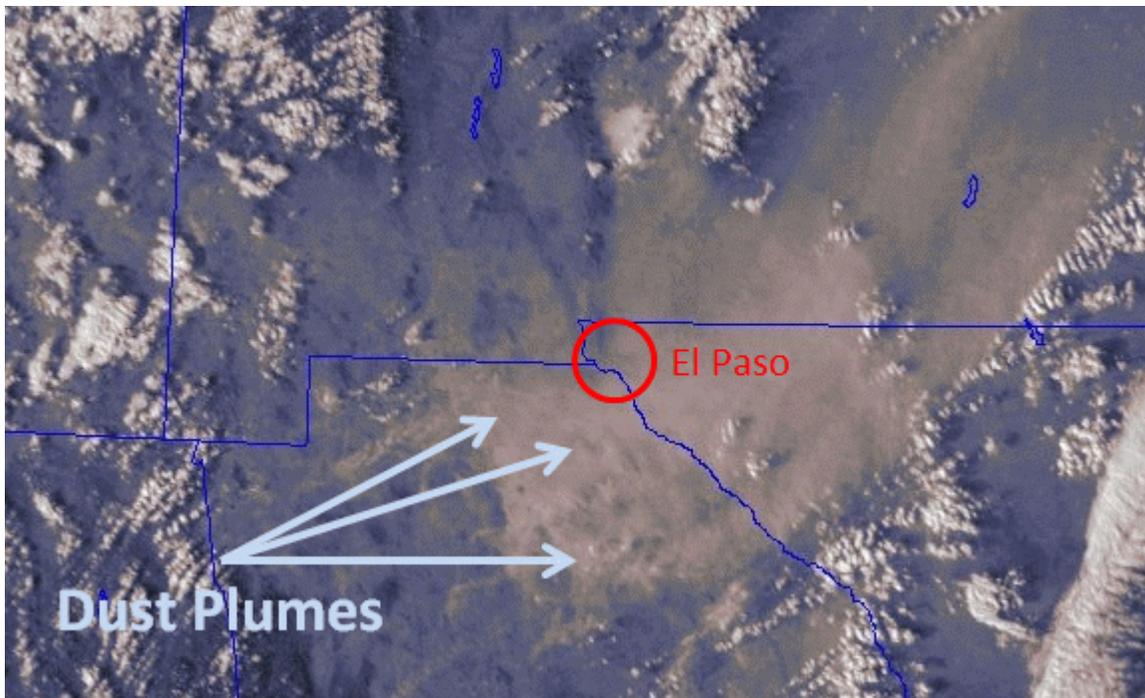


Figure K-8. GOES image for 1515 MST on November 10, 2012.

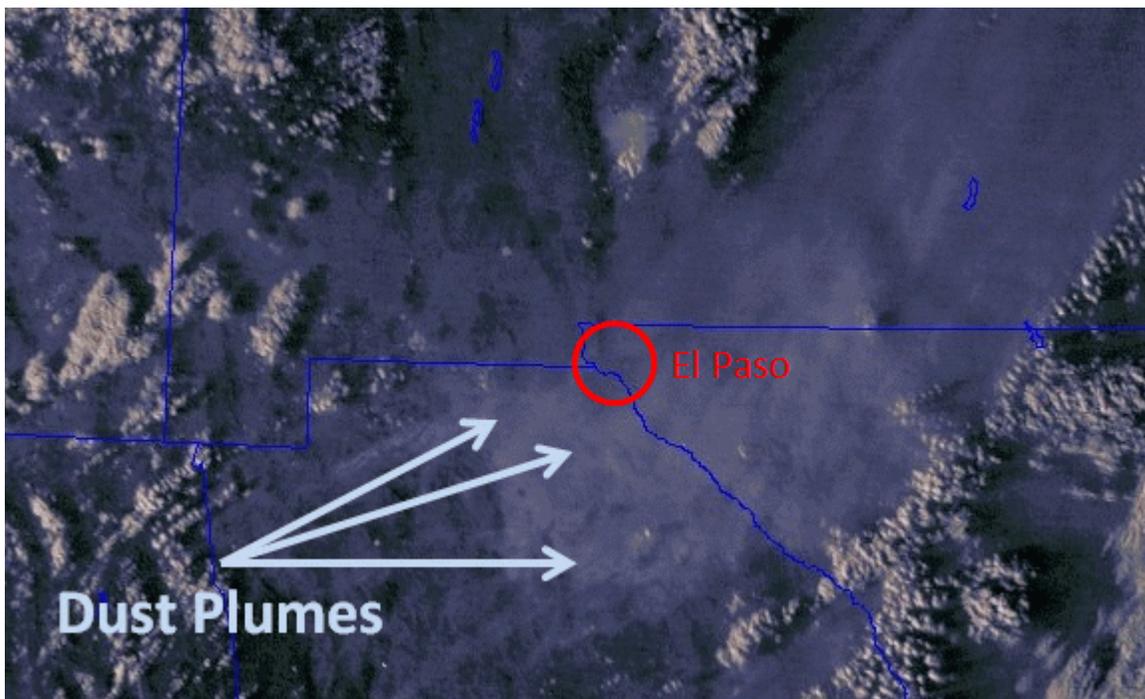


Figure K-9. GOES image for 1615 MST on November 10, 2012.

Back Trajectories

Figure K-10 provides HYSPLIT back trajectories predicting the approximate path of air arriving at the Chamizal site at 1300 MST (2000 UTC) on November 10, 2012. Trajectory paths are plotted for air arriving at 10 meters, 100 meters, and 1,000 meters above ground level going backward in time 12 hours. These trajectories indicate that the air arriving at the Chamizal site at the time of the highest PM_{2.5} levels on November 10, 2012, came from northern Mexico, as seen in satellite imagery.

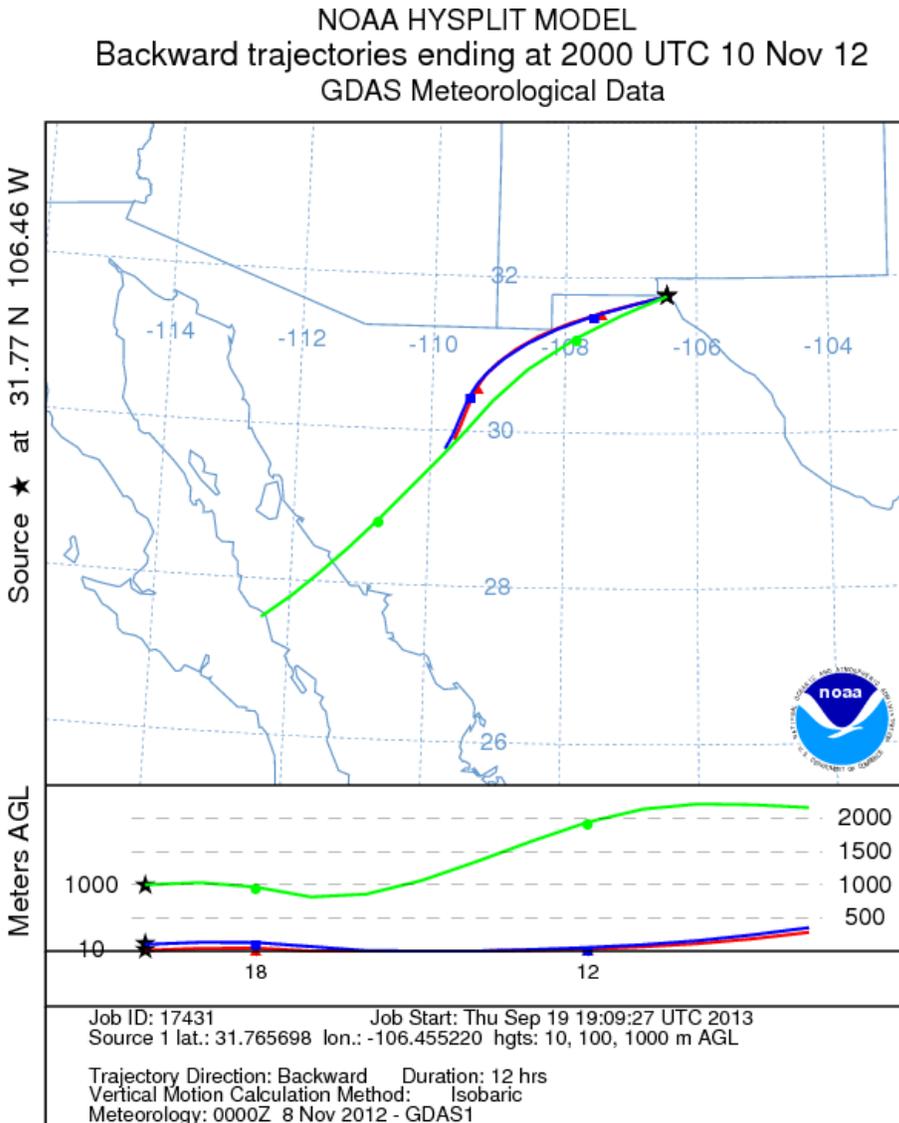


Figure K-10. Backward-in-time air trajectory for November 10, 2012, for air arriving at Chamizal at 1300 MST (0000 UTC).

Map Plots of Daily Particulate Matter Data

Figures K-11 and K-12 display maps of daily average PM₁₀ and PM_{2.5} measurements from the November 10, 2012, event. Both maps show high particulate matter concentrations along the border consistent with transport into the El Paso area from northern Mexico.

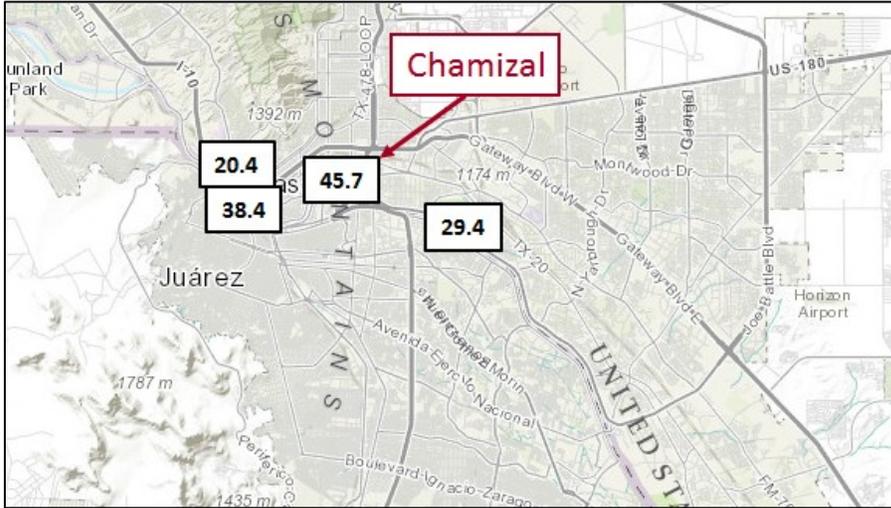


Figure K-11. Map of El Paso area daily average PM_{2.5} measurements ($\mu\text{g}/\text{m}^3$ LC) on November 10, 2012.

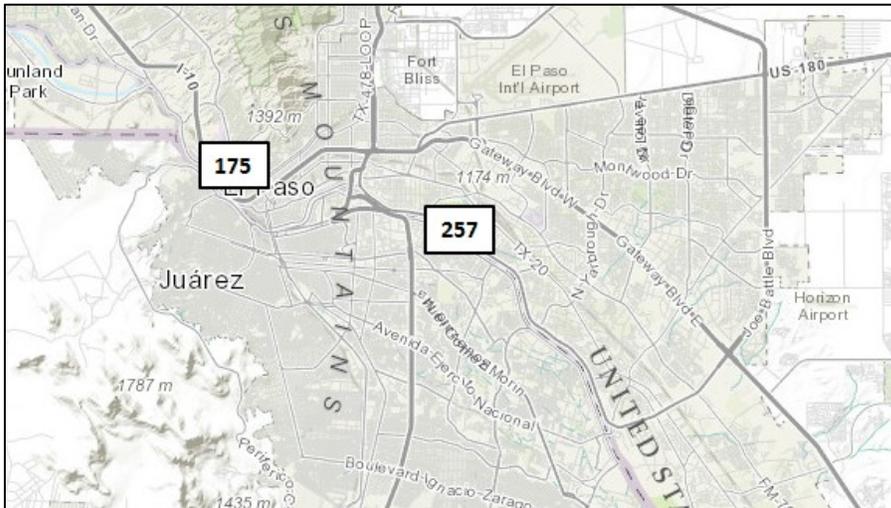


Figure K-12. Map of El Paso area daily average PM₁₀ measurements ($\mu\text{g}/\text{m}^3$ SC) on November 10, 2012.

Continuous Particulate Matter and Wind Graphs

Graphs of five-minute continuous $PM_{2.5}$, PM_{10} , and wind gust data for November 10, 2012, illustrate the timing and intensity of the dust event. Figure K-13 shows a plot of continuous five-minute $PM_{2.5}$ data that indicates intense dust arriving first at Chamizal around 1100 MST and then later at Ascarate farther to the east around 1200 MST. The temporal and spatial relationship of these measurements is consistent with dust advecting from west to east as in many of the previous events. All three sites spike sharply to very high levels at 1300 MST and then fall rapidly by 1600 MST despite continuing high wind gusts. Likewise, the plot of continuous five-minute PM_{10} data in Figure K-14 indicates a sharp rise in measured concentrations starting around 1100 MST and peaking between 1300 and 1500 MST before rapidly falling off. This pattern is consistent with the passage of a large transported dust cloud as is supported by satellite imagery.

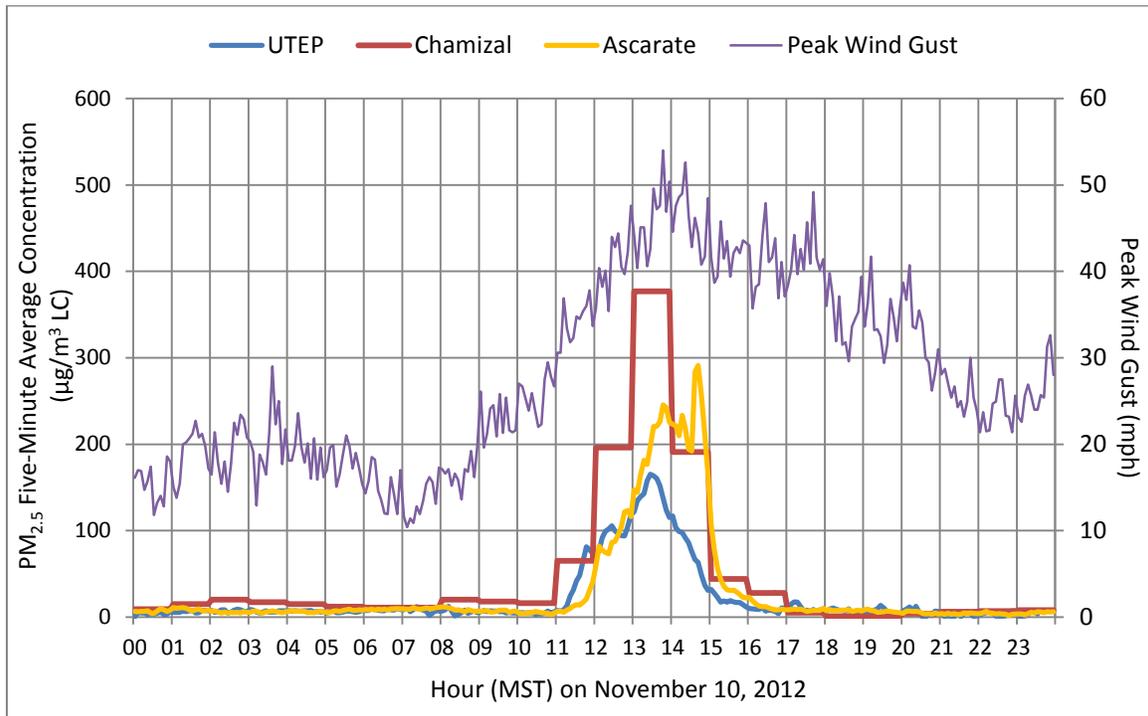


Figure K-13. El Paso five-minute average $PM_{2.5}$ concentrations from continuous monitors on November 10, 2012.

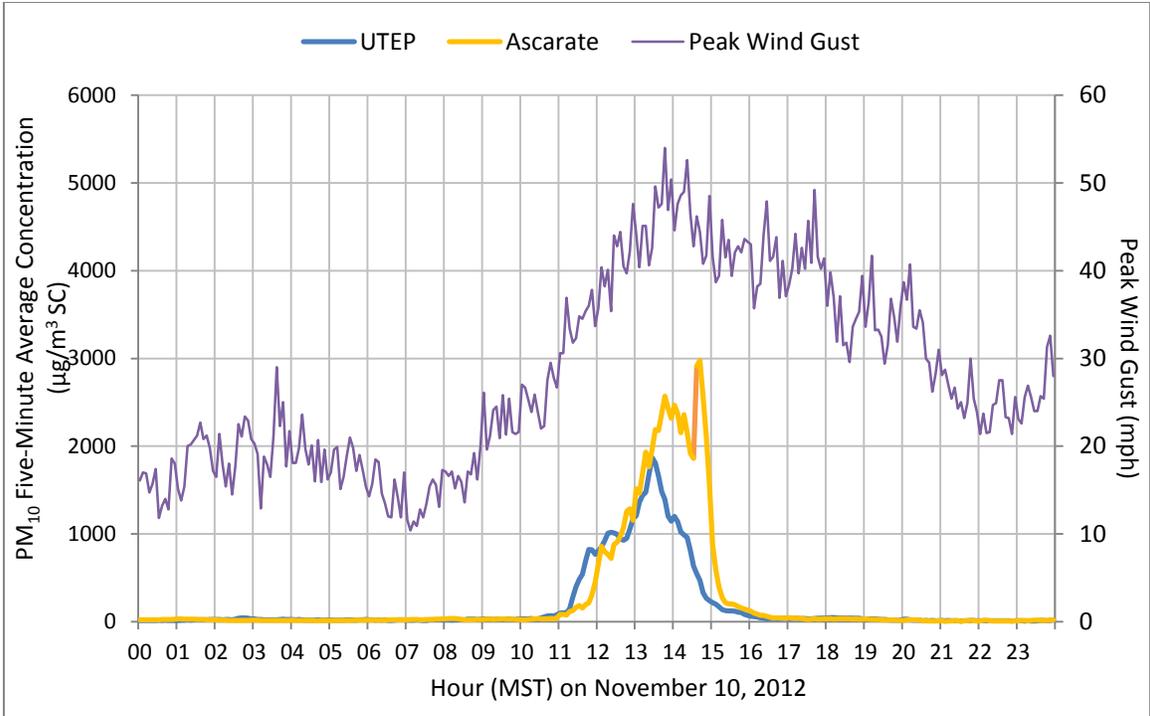


Figure K-14. El Paso five-minute average PM₁₀ concentrations from continuous monitors on November 10, 2012.

Appendix L: Web Page Examples

Figures L-1 through L-6 show examples of web pages cited by links in the Mitigation of Exceptional Events section.

Today's Texas Air Quality Forecast

The latest forecast for air quality conditions in Texas' metropolitan areas.

August 23, 2013

Related Current Data

- [Air Quality Index \(AQI\) Report](#)
- [Map of Current PM2.5 Levels](#)
- [Map of Current Ozone Levels](#)
- [Current Satellite Images](#)
- [Real-Time Winds Aloft](#)

Related Information

- [Ozone: The Facts](#)
- [Texas Air Monitoring Data](#)
- [EPA AIRNow Air Quality Forecasts](#) [Exit...](#)
- [NOAA/EPA Ozone Model Forecasts](#) [Exit...](#)
- [NRL Aerosol Model Forecasts](#) [Exit...](#)

**Air Quality Index (AQI)
Forecast**

Air Quality Index Scale

Good	Moderate	Unhealthy Sensitive	Unhealthy	Very Unhealthy	Hazardous
------	----------	---------------------	-----------	----------------	-----------

Forecast Region (Click name for AIRNOW version)	Fri 08/23/13	Sat 08/24/13	Sun 08/25/13	Mon 08/26/13
Austin	Good	Good	Good	Good
Beaumont-Port Arthur	Good	Good	Good	Good
Brownsville-McAllen	Good	Good	Good	Good
Corpus Christi	Good	Good	Good	Good
Dallas-Fort Worth	Ozone	Ozone	Ozone	Ozone
El Paso	Good	Good	Good	Good
Houston	Ozone	Good	Good	Good
Laredo	Good	Good	Good	Good
Lubbock	Good	Good	Good	Good
Midland-Odessa	Good	Good	Good	Good
San Antonio	Good	Good	Good	Good
Tyler-Longview	Ozone	Good	Good	Good
Victoria	Good	Good	Good	Good
Waco-Killeen	Good	Good	Good	Good

Discussion

Friday 8/23/13

Winds may be light enough and incoming background levels high enough for ozone to reach "Moderate" levels on the southwest and west side of the Houston area, on the northwest side of the Dallas-Fort Worth area, and in the Tyler-Longview area with highest concentrations this afternoon and into the early evening. Elsewhere in the state, moderate winds and lower incoming background levels should help to keep air quality in the "Good" range.

Saturday 8/24/13

Winds may be light enough and incoming background levels high enough for ozone to reach "Moderate" levels on the northwest side of the Dallas-Fort Worth area with highest concentrations in the afternoon and early evening. Elsewhere in the state, moderate winds and lower incoming background levels should help to keep air quality in the "Good" range.

Sunday 8/25/13 Outlook

Winds may be light enough and incoming background levels high enough for ozone to reach "Moderate" levels on the northwest side of the Dallas-Fort Worth area with highest concentrations in the afternoon and early evening. Elsewhere in the state, moderate winds and lower incoming background levels should help to keep air quality in the "Good" range.

Monday 8/26/13 Outlook

Winds may be light enough and incoming background levels high enough for ozone to reach "Moderate" levels on the northwest side of the Dallas-Fort Worth area with highest concentrations in the afternoon and early evening. Elsewhere in the state, moderate winds and lower incoming background levels should help to keep air quality in the "Good" range.

Tuesday 8/27/13 Extended Outlook

Winds may be light enough and incoming background levels high enough for ozone to reach "Moderate" levels on the north and northwest side of the Dallas-Fort Worth area with highest concentrations in the afternoon and early evening. Elsewhere in the state, moderate winds and lower incoming background levels should help to keep air quality in the "Good" range.

Figure L-1. Sample of the TCEQ Today's Texas Air Quality Forecast.

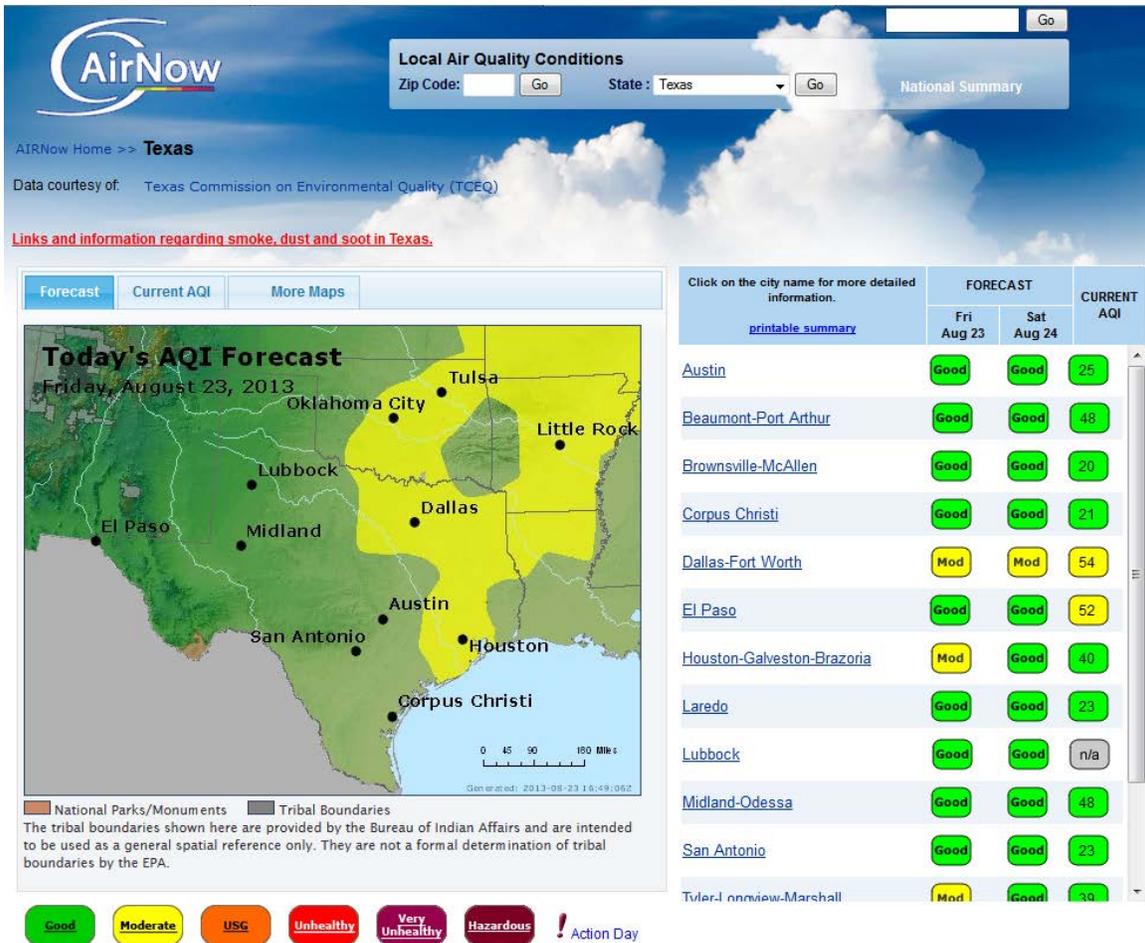


Figure L-2. Sample of the EPA AIRNOW web page.

Air Quality Index



How clean is the air in your metropolitan area? The U. S. Environmental Protection Agency (EPA) has provided a scale called the Air Quality Index (AQI) for rating air quality. This scale is based on the National Ambient Air Quality Standards (NAAQS) and is described in the Code of Federal Regulations, Part 58, Appendix G. This report is based on the AQI standards.

Interpreting the AQI

Reporting for August 23, 2013 as of 12:12 pm CDT																
Metropolitan Area or Non-Metropolitan County	Air Quality	Critical Pollutant	Air Quality Index Rating													
			Ozone			Carbon Monoxide	Sulfur Dioxide	Nitrogen Dioxide		PM-10 (Std Cond)	PM-2.5 (Lcl Acpt)					
			1-Hour	8-Hour	8-Hour	1-Hour	1-Hour		24-Hour †	24-Hour †						
			AQI	ppb	AQI	ppb	AQI	ppm	AQI	ppb	AQI	ppb	AQI	µg/m ³ (25° C)	AQI	µg/m ³ LC
Amarillo -- Region 1																
Amarillo	Good	PM-2.5												36	8.6	
Lubbock -- Region 2																
Lubbock †	††														§	
Abilene -- Region 3																
Wichita Falls	Good	PM-2.5												35	8.4	
Dallas-Fort Worth -- Region 4																
Dallas †	Moderate	PM-2.5	*	56	27	32	2	0.2	5	3	14	15		53	13.3	
Fort Worth-Arlington	Good	PM-2.5	*	51	28	33	2	0.2			25	27		36	8.7	
Navarro County †	Good	PM-2.5	*	39	19	23			6	4			§	30	7.1	
Tyler-Longview-Marshall -- Region 5																
Longview-Marshall	Good	PM-2.5	*	52	19	23			1	1	11	12		34	8.3	
Tyler	Good	Ozone	*	39	21	25					4	4				
El Paso-Juarez -- Region 6																
Brewster County	Good	Ozone	*	36	25	30								25	5.9	
El Paso	Good	PM-2.5	*	43	27	32	5	0.4	1	1	22	23	20	21.2	31	7.4
Juarez †	Good	Ozone	*	28	17	20	3	0.3								
Odessa-Midland -- Region 7																
Odessa-Midland	Good	PM-2.5												38	9.2	
Waco -- Region 9																
Killeen-Temple	Good	Ozone	*	35	14	16										
Waco	Good	PM-2.5	*	38	21	25	1	0.1	2	1	5	6		28	6.6	
Beaumont-Port Arthur -- Region 10																
Beaumont-Port Arthur	Good	PM-2.5	*	46	17	20	2	0.1	3	2	16	17		46	11.1	
Austin -- Region 11																
Austin-San Marcos †	Good	PM-2.5	*	43	17	20	1	0.1	2	1	12	13		19	4.5	
Fayette County	Good	Ozone	*	32	14	16								14	3.4	
Houston-Galveston-Brazoria -- Region 12																
Brazoria	Good	Ozone	*	40	14	16					13	14				
Galveston-Texas City	Good	Ozone	*	36	23	27			1	1	14	15		17	4.0	
Houston †	Good	PM-2.5	*	48	14	16	4	0.3	6	4	22	24		33	8.0	

Figure L-4. Sample of a portion of the TCEQ Air Quality Index Report.

Air Pollution from Particulate Matter

General information on particulate matter (PM), and TCEQ planning that addresses the PM National Ambient Air Quality Standards (NAAQS).

- [Particulate Matter \(PM\): The Facts](#)
- [Latest air quality planning that addresses the PM NAAQS](#) **NEW**
- [Related Web pages and publications](#)
- [Get more information on the Texas SIP and contact the TCEQ](#)

Particulate Matter (PM): The Facts

What is PM?

Particulate matter (PM) is a mix of small particles and liquid droplets. These particles can be made up of acids, organic chemicals, metal, dust, or soil. Particulates are different in several ways including size.

PM₁₀ is sometimes referred to as coarse particles. They consist of particles that are less than 10 micrometers in diameter but greater than 2.5 micrometers in diameter.

PM_{2.5} are fine particles and are the smallest particles that are regulated. They consist of particles that are 2.5 micrometers and smaller in diameter. By comparison, the average diameter of human hair is 70 micrometers.

The Federal Clean Air Act requires the United States Environmental Protection Agency (EPA) to set air quality standards, including those for PM, to protect both public health and the public welfare (e.g., visibility, crops, and vegetation).

What are the health effects of PM?

Particle size is directly related to its potential for causing health problems. Small particles less than 2.5 micrometers in diameter can be inhaled deeper into the lungs. Scientific studies have linked exposure to high concentrations of some types of PM with a variety of problems, including:

- irregular heartbeat;
- aggravated asthma;
- decreased lung function;
- increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing;
- nonfatal heart attacks; and
- premature death in people with heart or lung disease.

These associations are much less certain at concentrations below the current standard set by the EPA for PM in ambient air.

How does PM affect the environment?

PM can contribute to haze, which reduces visibility. When PM is present in the air, it can absorb sunlight, and it can reflect sunlight. This reduces clarity in the air and can cause haze. Humid air can also combine with PM to further reduce visibility. PM from the air can deposit on water and soil harming ecosystems, soil, and crops. PM can stain and damage stone and other materials, including culturally important objects such as statues and monuments.

Where can I see daily PM levels in my area?

The TCEQ has multiple monitors that directly measure PM concentrations throughout the state. The TCEQ also offers air quality forecasts that include PM. The public can sign up for these to be delivered via e-mail using the Agency's GovDelivery system.

The EPA provides a web site that monitors and forecasts the quality of the air using a scale called the Air Quality Index (AQI). The AQI is based on the National Ambient Air Quality Standards (NAAQS) for the six criteria pollutants. The AQI is on a scale of 0 to 500, with 100 corresponding to the NAAQS set by the EPA. A higher AQI value means a larger level of air pollution and a greater potential health concern. These forecasts can be found on the EPA's Air Now Web page (<http://airnow.gov/>). [Exit...](#)

You can also sign up to receive e-mail alerts about PM through the EPA's EnviroFlash web site (<http://www.enviroflash.info/>). [Exit...](#)

Figure L-5. Sample of a portion of the TCEQ particulate matter web page.

AirNow Local Air Quality Conditions

Zip Code: Go State: Alabama Go National Summary

Air Quality Index (AQI) - A Guide to Air Quality and Your Health

AQI
AIR QUALITY INDEX

The AQI is an index for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a concern for you. The AQI focuses on health effects you may experience within a few hours or days after breathing polluted air. EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established national air quality standards to protect public health. Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country.

How Does the AQI Work?

Think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality.

An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy-at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Understanding the AQI

The purpose of the AQI is to help you understand what local air quality means to your health. To make it easier to understand, the AQI is divided into six categories:

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
<i>When the AQI is in this range:</i>	<i>...air quality conditions are:</i>	<i>...as symbolized by this color:</i>
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Each category corresponds to a different level of health concern. The six levels of health concern and what they mean are:

- "Good" AQI is 0 - 50. Air quality is considered satisfactory, and air pollution poses little or no risk.
- "Moderate" AQI is 51 - 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.

Publications

- Air Quality Index - A Guide to Air Quality and Your Health (PDF, 12pp., 629KB, about PDF)
- Air Quality Guide for Ozone
- Air Quality Guide for Particle Pollution
- Other AIRNow Publications
- Other AIRNow Publications - En Español
- AQI Calculator: AQI to Concentration
- AQI Calculator: Concentration to AQI
- Order any of our AIRNow publications from EPA's NSCEP

Figure L-6. Sample of a portion of the EPA Air Quality Index guide.